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EUROPEAN COMMISSION

Non-Nuclear Energy Research in Europe – A comparative study

Country Reports A – I

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Directorate-General for Research
2005 Sustainable Energy Systems EUR 21614/2

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Country study Austria

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1 Summary of country study indicating main points for synergy

Descriptions of the Austrian RTD policy often refer the Austrian paradox: good economic performance accompanied by relatively low R&D-spending. Economic structure (relatively weak position in R&D-intensive sectors) and low propensity of industry to invest in R&D seem to be the two major reasons for Austria legging behind in its R&D investments.

Against this background Austria has increased its activities to catch up with the first league of European RTD performers. This is reflected both by the steady increase of public spending on R&D in the last decade and by the implementation of new funding instruments aimed at building up critical mass in specific thematic areas. Most outstanding in this respect was the launch of the competence centres programmes[1] that specifically address science-industry linkages.

NNE RTD policy as one specific RTD policy field has not remained unaffected by the overall developments. The following chapter outlines some basic features of the Austrian NNE RTD policy and highlights the most important policy innovations with respect to funding instruments and organisational changes.

2 National RTDI system

NNE RTD policy as one specific RTD policy field has not remained unaffected by the overall developments. The following chapter outlines some basic features of the Austrian NNE RTD policy and highlights the most important policy innovations with respect to funding instruments and organisational changes.

2.1 Policy formulation and organisational setting

On the federal level the ministry for transport, innovation and technology (BMVIT) is responsible for NNE RTD. At the same time the agenda for energy policy lies with the ministry for economic affairs and labour (BMWA). The third relevant player on the federal policy level is the ministry of agriculture, forestry, environment and water management (BMLFUW).

Being the core actor in formulating and implementing NNE RTD policy BMVIT fulfils delivers several functions:

- Strategy setting: In its white book on energy research and technology (published June 2002) BMVIT set out the major lines for orientation for future activities in enhancing Austria's energy research performance.
- Programme design: In the last years technology programmes as a new way of channelling public research funds have become an important funding instrument in NNE RTD. With the programme on Technologies for Sustainable Development on the one hand and Kplus on the other, BMVIT has been the pioneer in setting

[1] Three different competence centre programmes are in place: K*plus* (BMVIT, managed by TIG), Kind (BMWA, managed by FFF), Knet (BMWA, managed by FFF).

up focused programmes for energy research. This resembles a radical innovation in the Austrian funding system as bottom-up project funding was the predominant funding instrument before the start of the new programme in the year 2001.

- Internationalisation: BMVIT has been playing an important role in enhancing the integration of the Austrian energy research community in the European area. In this context the membership in IEA has proved to be an important and helpful entry gate. Austria's accession to the EU was obviously the next most important step in fostering internationalisation of the Austrian research community. BMVIT has been one of the central interfaces between national and international research. To highlight here is not just the formal mandate and representation in international bodies but also the activities to mobilise the Austrian community. Looking back the increased opportunities for international cooperation triggered the reflection on 'Austria's perspective' and sharpened the sense for the need of a more distinct national profile.

Compared to other research policy fields the organisational setting of the Austrian NNE RTD policy appears fairly concentrated with BMVIT being the core actor integrating important tasks on the national and international level. Nevertheless interviewees reported some tendency of excessive programming in the last years. This does not refer to funding volumes available but to the number of programmes addressing a relative small community at the same time. This has to be seen in the context of the overall governance in the RTD policy system in Austria. Competition between ministries for additional research funding ("Sonderforschungsmittel") distributed by the council of research and technology has played a role here. Given the recent activities towards further concentrating research funding on the national level it is hoped that this lack of co-ordination of themes, timing and procedures for technology programmes gets solved in the future.

2.1.1 Priority setting

On first instance priorities in NNE RTD reflect the size of the country and its endowment with energy sources. At this level it is not surprising that Austria has set clear priorities on conservation and renewable energy. On a lower level of aggregation priority setting is considered as core task of research policy. As for the overall research landscape Austria has showed a relative low degree of thematic specialisation. This has increasingly come under question and was linked to a deficit of appropriate mechanisms for priority setting or – on a more cultural line of argumentation – as a reluctance to take discriminating decisions. Only in the last years – not least triggered by the upcoming concept of ERA – the pressure to concentrate national funding sources increased. This applies also to NNE RTD.

An other framework condition affecting the priority setting process was given by the regulative regime of the energy market before latest deregulation phase. The big players in energy production and distribution were excluded from public research funding as they were expected to finance their R&D investments by themselves. An incentive to do so was given by the fact that R&D spending were taken into account in the price fixing negotiations. Under this precondition public spending on NNE RTD was historically driven by energy users on the one hand and specialised suppliers of energy technology on the other hand.

A showcase of how priorities in NNE RTD are set in practice is the preparation of the BMVIT programme on Technologies for Sustainable Development. The thematic specification of the programme was developed with strong involvement of the research community itself. BMVIT provided the communication platform and played most of all the role of a moderator and mediator between different research interests. The advantage of this high degree of participation of research performers was seen in the close link to existing competences and the strong commitment of the research community. On the negative side the danger selectivity and bias towards well established networks with increased entry barriers for newcomers was mentioned. This risk of establishing a closed shop was reduced by the involvement of independent external experts on programme development and by contracting out the programme management. Furthermore the use of tendering procedures in project selection ensures transparency and openness of the programme implementation. As for the result the thematic priorities of the programme were set in terms of technology demand or application. Two main areas were identified: “Building of Tomorrow” and “Factory of Tomorrow”.

A second approach for priority setting can be observed in the competence centres programme K*plus*. As the name suggests one of the main objectives of K*plus* is to establish internationally visible and competitive centres of technological competence in specific areas. Interestingly policy completely abstained from thematic priority setting on first hand. Priorities are set endogen only by the selection process which is highly competitive and mostly based on scientific quality. This is a clear commitment to build on existing national strengths rather than opening up new high potential themes.

2.1.2 Role of Regions

In terms of funding sources NNE RTD is clearly a federal issue. According to the latest statistics on energy research (BMVIT, Faninger 2003) only 5 % (see Exhibit 2-1) come from regional states budgets (“Bundesländer”). Nevertheless regions have been playing an important role in mobilising research performers and most of all in creating platforms for cooperation. Interesting examples in this respect are Styria and Upper Austria. Both states have implemented technology clusters as a new instrument for enhancing co-operation in sectors with strong regional specialisation. Energy clusters (Energiecluster Oberösterreich) or in a more broader version clusters on environmental technology (Eco&Co Steiermark) were not so much established on basis of regional strength but with a strong commitment to technologies for sustainable development.

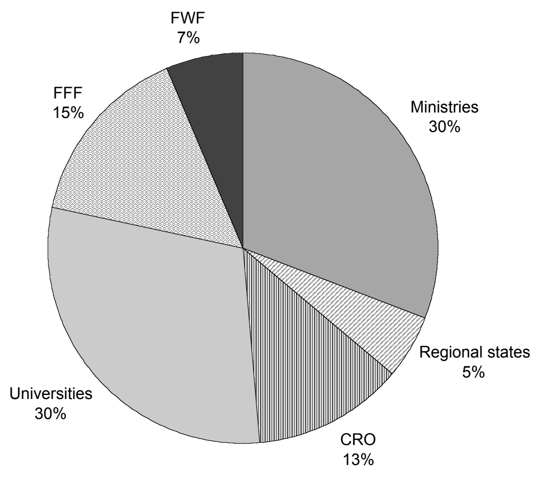
Even though these Clusters have been focusing on business co-operation and marketing platforms research and development has been playing an increasing role. So far these initiatives are perceived as helpful platforms for bringing in new firms and deepening regional linkages between science and enterprise sector. Thus the role of Clusters was important for implementing national programmes as they prepared the ground for co-operative R&D activities. At least in Upper Austria the Cluster initiative was accompanied by a regional programme on energy technology. In the case of Styria regional funding of energy related research is coordinated and channelled through an regional network of research funding institution, public administration and expert organisations (NOEST).

2.2 Public funding of NNE RTD

The following subchapter is based on the latest survey on energy research expenditures commissioned by BMVIT and conducted by Prof. Faninger, university of Klagenfurt.

Exhibit 2-1 illustrates the distribution of various funding sources across different funding entities. As can be seen 95% of public funding of NNE RTD is provided at the federal level. Compared to the respective figures in 1999 a substantial shift between FFF (Austrian Industrial Research Promotion Fund) and Ministries can be observed. The share of FFF decreased from 38% (1999) to 15% (2002). At the same time Ministries increased their share from 13% (1999) to 30% (2002). To some extend this shift resembles also a shift from bottom-up project funding (FFF) towards programme funding.
The share of Universities own spending on NNE RTD (30%) remained unchanged. Universities are the most important beneficiaries of public NNE RTD funding. If we add 7% from FWF (Science Fund) that mostly funds research projects from universities and take also into account that at least some of the ministries funding goes to the universities the share of universities should lay around 40%. To mention here is that the major fraction of the available funding for universities comes from 'General University Funds' and can not be decided upon within the NNE RTD policy setting.

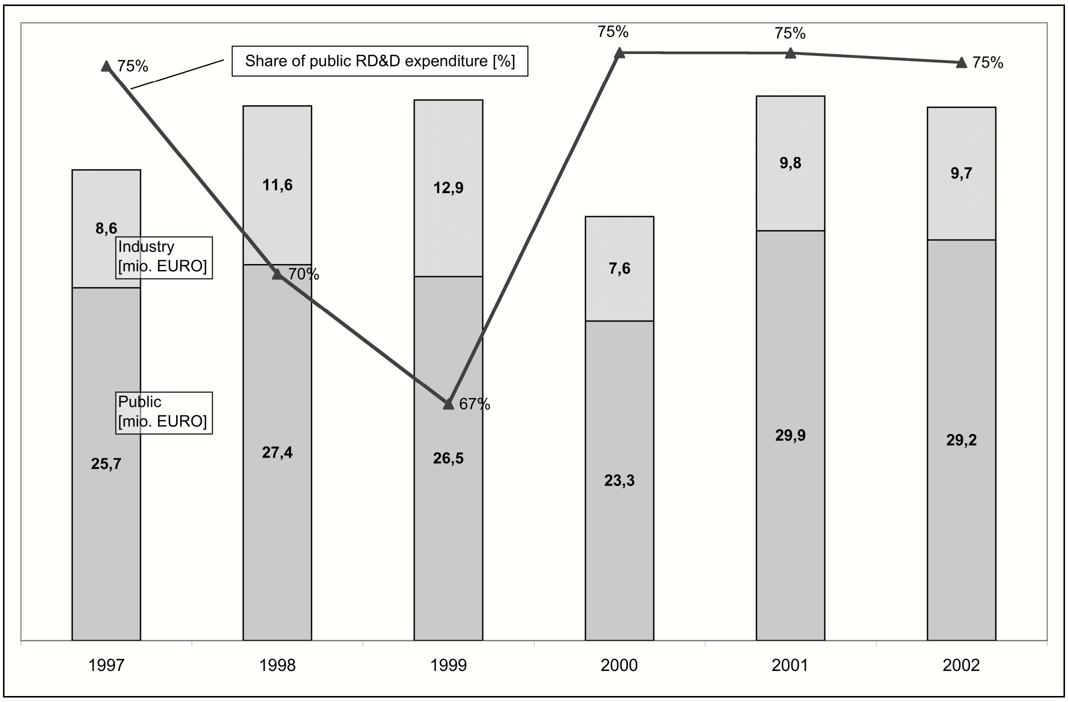
Exhibit 2-1: Public funding of energy research, main sources and research actors



Source: BMVIT, Faninger

According to the presented figures (see Exhibit 2-2) energy research relies to a big extent to public funding. Since the year 2000 the share of public funding on total expenditures is at a stable level of 75%. This figure has to be taken with caution. Our interviewees warned in this context from over interpreting IEA statistics for which the presented figures represent the latest Austrian contribution. Apparently a narrow definition of RTD is likely to miss out on substantial relevant RTD activities in the private sector[2]. However the used statistics are produced on a regular basis applying the same mythology. Thus longer time series can be observed. Looking at the development of overall funding volumes Exhibit 2-2 indicates a stagnation of total spending on energy research.

Exhibit 2-2: Expenditure on energy research, public/private, 1997 - 2002

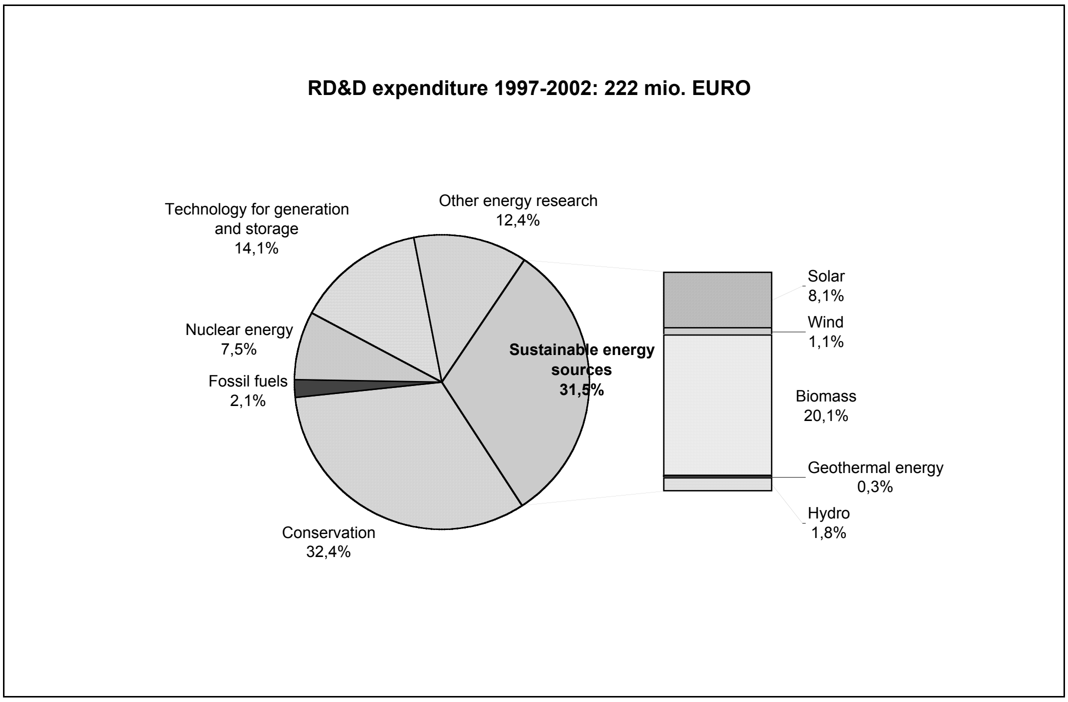


Source: BMVIT, Faninger

As for the distribution of funding volumes across thematic areas (see Exhibit 2-3 and Exhibit 2-4) conservation and sustainable energy resource are clearly the two dominating themes in Austria. Research in the field of renewable energy is very much concentrated on Biomass and Solar.

[2] Taking the total project volume of energy related research projects from firms supported by FFF as a reference point one gets to a spending volume of the private sector between 12 to 15 mio. EURO a year.

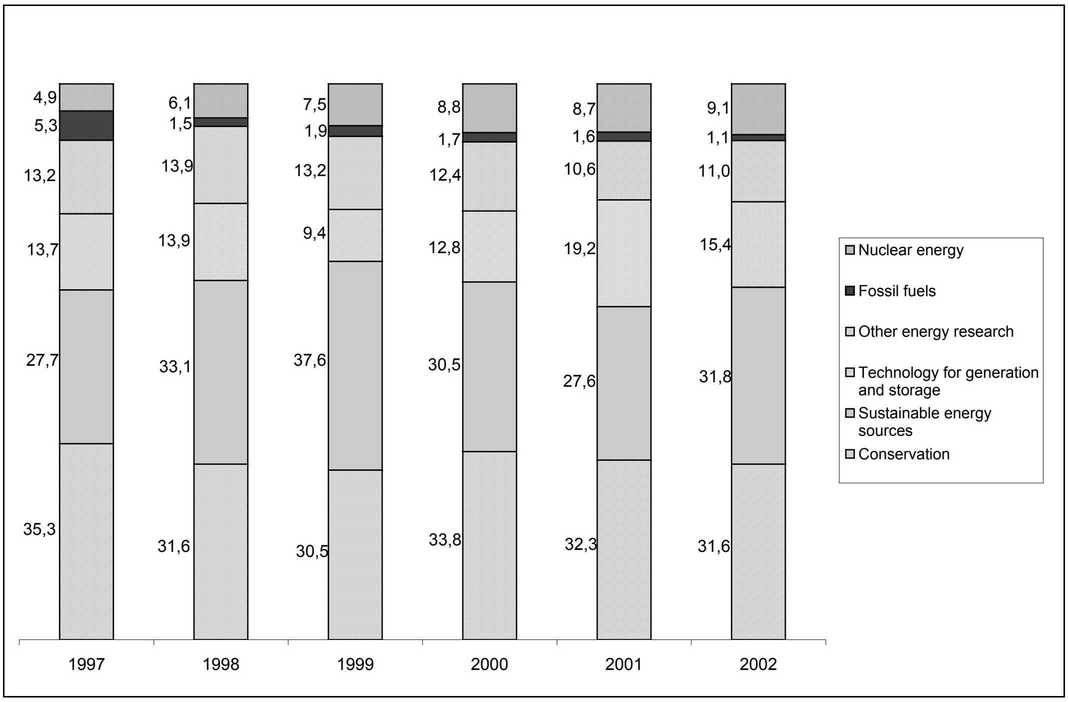
Exhibit 2-3: Expenditure on energy research across thematic areas, cumulated 1997 - 2002



Source: BMVIT, Faninger

Over time the shares of single thematic areas have been changing somewhat with renewable energy laying in the bandwidth between 37.6 % (1999) and 27.6% (2001). The steadily increasing share of nuclear energy goes back to Austria's participation in international RTC activities in nuclear fusion.

Exhibit 2-4: Distribution of RD&D-expenditure across thematic areas, in %



Source: BMVIT, Faninger

3 Internationalisation of NNE RTD from an Austrian perspective

International co-operation in energy research ranks high on the agenda of the Austrian NNE RTD policy. Before we explore internationalisation activities in more detail some basic characteristics of Austria's energy research community affecting propensity and capability for international co-operation should be kept in mind:

- **High degree of organisation.** Austria's energy research community is relatively small and highly organised. The later is the result of a range of new policy measures aiming at local clustering, establishment of national RTD networks (Kind, Knet, Kplus) and the strong involvement of research performance in the design process of the BMVIT programme on technologies for sustainable development.
- **Strong organisational linkages between national research and EU FP programmes.** This points to the central positioning of BMVIT as the main funding entity of national research on one hand and its involvement in the programme committee work on EU level. The international perspective is furthermore strengthened by the fact that BMVIT hosts National contact points (NCP) for the supporting participants in FP 6.
- **Profiling of national specialisation patterns.** Austria's RTD policy increasingly became aware of over fragmentation of national research. This holds also for NNE RTD. As reaction a range of measures have been taken to better focus national research funding and further developing national strengths. As result the research community eventually was able to build up strong research groups in specific niches (e.g. Biomass, Solar).
- **Strong commitment to international co-operation.** Following the discussion on participation in EU-FP one might get the impression that international co-operation has become a goal by itself rather than a mean to achieve specific impacts not feasible on a national basis. At least implicitly national programmes derive some of their rational from increasing the capability of the national research community to participate in international programmes. On first sight the underlying goal is maximising funding inflows from EU RTD budgets. This is legitimate. However to some extent it distracts from the discussion on complementarities and synergies between national and international research agendas.

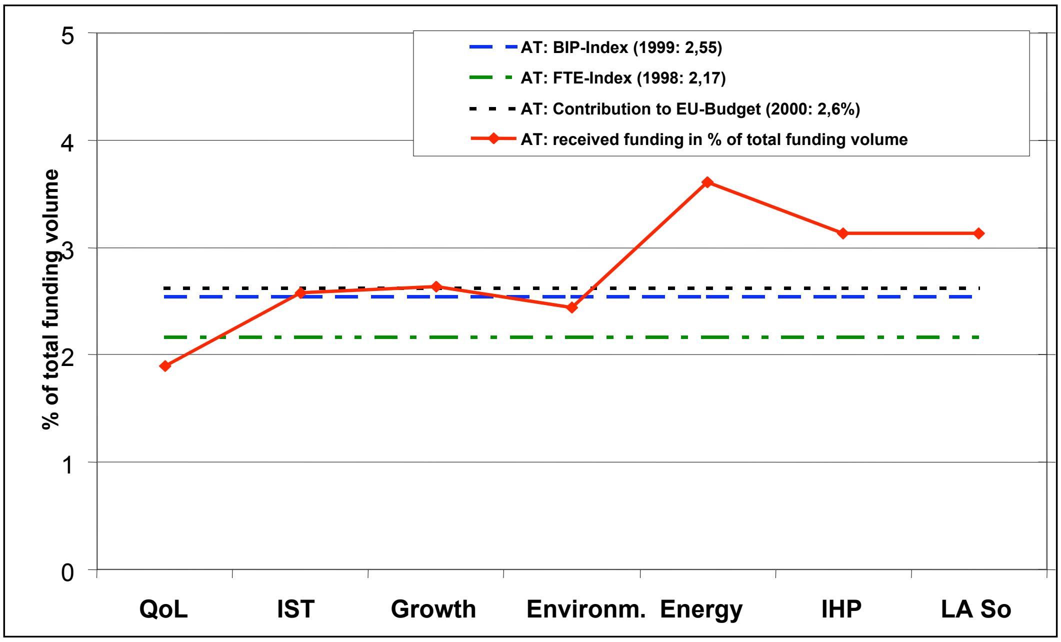
Overall participation in EU-FP's dominates the discussion on internationalisation of RTD-activities. Historically the membership in IEA has played an important role as entry gate and platform for first international RTD co-operations. Bilateral co-operation has played a minor role, even though quite some linkages have been established with accession countries. Most of these linkages go back to regional initiatives (e.g. in Upper Austria). Funding was also provided by BMLFUW ("Ostförderung"). The RTD intensity of these bilateral activities seems to be limited though.
A last interesting example of internationalisation which should be mentioned here is the established linkage between TNO and Joanneum Research, both contract research organisations with competence in energy research. TNO bought a minority stake of Joanneum Research in 2002. The underlying financial transaction has partly been devoted to building up co-operation platforms on the operational level. At this stage

impacts of this new linkages remain unclear. However this examples opens up a scenario for new ways of how the concept of ERA might be put into practice: The establishment of a European research market with multinational research performers.

3.1 Participation in EU FP programmes

The following subchapter reports the Austrian performance in EU FP 5. Overall the energy research community has been fairly successful. If we take the share of received funding in the respective area as indicator, Autria's share (3.7%) in Energy is well above its contribution to the EU-Budget (2.6%). From this perspective Austria's energy research community was the most successful group in Austria.

Exhibit 3-1: Austrian participation in EU-FP 5, overall share of received funding



Source: BMVIT, proviso

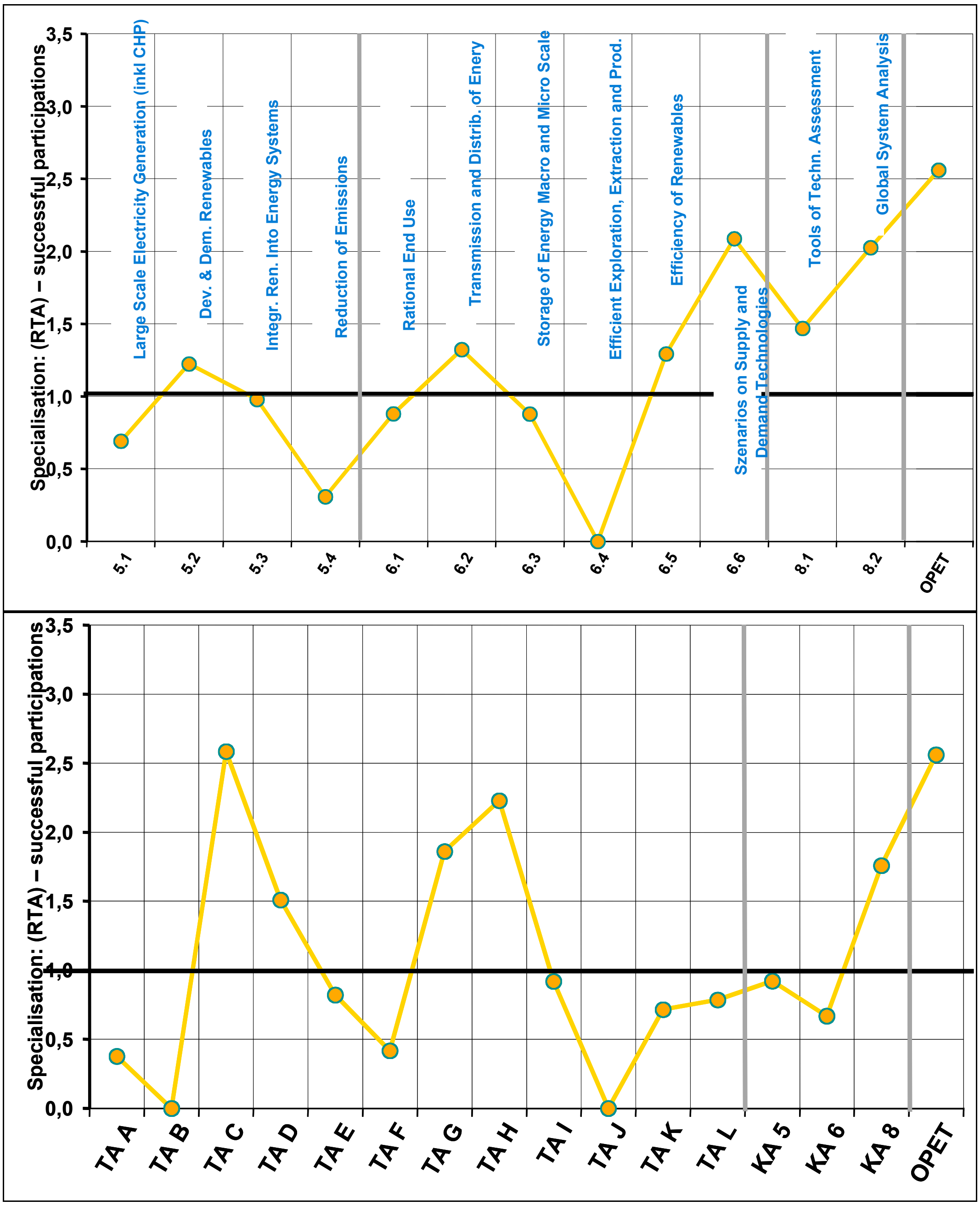
The overall performance goes back to relatively high numbers of participations and above average success rates of submitted proposals with Austrian participation. Furthermore more successful projects were co-ordinated by Austrians than in other research areas. Interestingly average consortia size with Austrian participation lays significantly above the overall EU-average.

As for the type of organisations participating in FP 5 research organisations are underrepresented whereas more consultants and big firms participated with better success rates in relative terms.

An important role enabling this good performance played the strong specialisation in a limited number of thematic areas within the whole energy area. Exhibit 3-2 illustrates the pattern of specialisation.

The specialisation pattern seems to be a fairly good fingerprint of Austria's national RTD competences. Beside the clear strength in Bio Energy Austria has shown clear positive specialisation in a range of more technology diffusion oriented themes (e.g. Sustainable Communities, OPET).

Exhibit 3-2: Thematic specialisation of Austria in RP 5, thematic priorities



Source: BMVIT, proviso

TA A	*Application Driven Fuel Cell*	*TA G*	*Fuel Cells & H2*
TA B	*Bio Electricity*	*TA H*	*Bio Energy*
TA C	*Sustainable Communities*	*TA I*	*Integration*
TA D	*Clean Urban Transport*	*TA J*	*Cleaner Fuels for Transport*
TA E	*ECO Buildings*	*TA K*	*Storage*
TA F	*Gas Power Generation*	*TA L*	*PV*

4 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

The presented outline of latest developments in Austria's NNE RTD system confirms that the pursued strategy of strengthening national research capabilities in specific niches has been quite successful. A number of research teams play in the European league and is confident to do so also in the new setting of FP 6. On the face of it collaboration in an European context seems to be every days business rather than a challenge where national positions have be reconsidered. At a similar line of argumentation complementarity seems not really to be an issue in the Austrian discussion about ERA. The predominating perception is that the national research agenda should translate into the European agenda as good as possible. In practice the Austria's position towards ERA comes down to feed in themes of national strengths in the European programming process. This general picture of Austria's perception of what ERA should be, might be due to country size and its recent experience of successful internationalisation.

Nevertheless behind this general picture some issues were brought up by our interviewees with respect to collaboration, synergies and complementarity with regard to the NNE RTD ERA:

- National NNE RTD is focused on energy users (households, energy intensive production processes) and specialised technology suppliers. The big players in energy production and distribution seem to have fairly weak linkages to the national research community. One reason being the exclusion from public RTD funding before the liberalisation of energy markets. EU FP's have proved to be an important 'substitute' for national funding. This is underlined by the fact that themes most relevant to the big energy production and distribution seem best tackled on a European scale.
- European research funding that is strongly devoted to scientific excellence is seen in an ambivalent manner: On one hand there is a number of Austrian research teams well positioned to participate in 'excellent' networks. On the other hand, the danger of increased entry barriers in areas where Austria does not have such strong RTD competence was mentioned. The message here is, that mechanisms are needed to allow concentration on excellence in niches and at the same time, mechanisms that maintain minimum levels of absorptive capacity in other fields.
- The concept of ERA might prove hard to implement as long as priority setting on the European level relies mostly on the involvement of national states. A collection of national interests is seen as an inappropriate basis for developing European themes.

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6 Annex

Table 1: Energy research, expenditure in EURO, public/industry

Group			1997 Public	1997 Industry	1998 Public	1998 Industry	1999 Public	1999 Industry	2000 Public	2000 Industry	2001 Public	2001 Industry	2002 Public	2002 Industry
I		Conservation	8518	3576	6841	5460	7630	4385	7153	3304	9148	3674	7919	4360
1	1	Industry	1587	15	577	10	1631	25	3214	35	2986	41	2395	1817
1	2	Residential and commercial	3187	1526	3109	2180	3243	2180	2101	1453	4641	1817	4058	727
1	3	Transport	2792	1744	2919	2907	1734	1817	1190	1453	676	1453	812	1453
1	4	Other	952	291	236	363	1022	363	648	363	845	363	654	363
II		Fossil fuels	1696	109	590	0	648	109	445	73	633	0	411	0
2	0	Total oil and gas	244	0	244	0	139	0	34	0	287	0	132	0
2	1	Enhanced Oil and Gas	168	0	0	0	42	0	0	0	62	0	92	0
2	2	Refining, transport, storage	7	0	0	0	0	0	5	0	91	0	22	0
2	3	Oil shale and tar sands	0	0	0	0	0	0	0	0	0	0	0	0
2	4	Others	69	0	244	0	97	0	29	0	134	0	18	0
3	0	Total coal	1452	109	346	0	509	109	411	73	346	0	279	0
3	1	Production prepar.. and transport	15	0	0	0	87	0	0	0	31	0	0	0
3	2	Combustion	595	0	284	0	393	0	394	0	289	0	105	0
3	3	Conversion	835	109	40	0	5	109	3	73	0	0	0	0
3	4	Others	7	0	22	0	24	0	14	0	26	0	174	0
III		Sustainable energy sources	7441	2042	9824	3053	9265	5522	6499	2943	7927	3016	9681	2689
4	0	Total solar	2073	145	3553	291	1843	290	2413	981	2068	908	2900	581
4	1	Heating and cooling	1224	145	1607	218	667	145	1444	872	1064	654	1422	218
4	2	Photo electric	825	0	1815	73	1082	145	649	109	771	254	1386	363
4	3	Thermal electric	24	0	131	0	94	0	320	0	233	0	92	0
5	0	Wind	462	0	567	0	337	0	409	0	185	0	391	0

Group			1997 Public	1997 Industry	1998 Public	1998 Industry	1999 Public	1999 Industry	2000 Public	2000 Industry	2001 Public	2001 Industry	2002 Public	2002 Industry
6	0	Ocean	0	0	0	0	0	0	0	0	0	0	0	0
7	0	Biomass	4127	1853	4547	2544	6736	5087	3526	1817	4981	1817	5864	1817
8	0	Geothermal energy	42	44	400	0	1	0	25	0	71	0	126	0
9	0	Hydro	737	0	757	218	348	145	126	145	622	291	400	291
9	1	Large (capacity > 10 MW)	611	0	445	0	122	0	126	145	90	0	103	0
9	2	Small (less < 10 MW)	126	0	312	218	226	145	0	0	532	291	297	291
IV		Nuclear energy	1671	0	2378	0	2952	0	2705	0	3356	82	3467	82
10	0	Total nuclear fission	561	0	0	0	382	0	0	0	250	0	169	0
10	1	Light water reactor	0	0	0	0	0	0	0	0	0	0	0	0
10	2	Other converter reactors	0	0	0	0	0	0	0	0	0	0	0	0
10	3	Fuel cycle	0	0	0	0	0	0	0	0	0	0	169	0
10	4	Nuclear supporting technology	561	0	0	0	382	0	0	0	250	0	0	0
10	5	Nuclear breader	0	0	0	0	0	0	0	0	0	0	0	0
11	0	Nuclear fusion	1110	0	2378	0	2570	0	2705	0	3106	82	3298	82
V		Technology for generation and storage	3678	1018	4168	1235	3030	654	3220	726	4605	3016	3789	2180
12	1	Electric power conversion	2091	618	1064	0	994	0	1426	581	980	145	1491	727
12	2	Electricity transm. and distribution	948	109	2061	1090	1303	363	1260	0	1063	327	1490	363
12	3	Energy storage	639	291	1043	145	733	291	534	145	2562	2544	808	1090
VI		Other energy research	2717	1817	3585	1817	3001	2180	3263	581	4202	0	3915	363
13	1	Energy system analysis	645	0	1306	0	942	0	1544	581	1271	0	1336	0
13	2	Other	2072	1817	2279	1817	2059	2180	1719	0	2931	0	2579	363

Source: BMVIT, Faninger

Country study Belgium

Contents:

1 Summary

Belgium is a federal country and has, besides the federal government, three regional governments for the regions of Flanders, the Walloon region and Brussels-Capital. The regions are leading in many policy issues, including energy and innovation policy, and on have their own responsibility for the promotion of (NNE) RTD.

The Flanders and the Walloon region RTD system and priority setting process differ in many ways. A real specific NNE RTD policy does not exists, in both Flanders and the Walloon region it forms part of the general RTD strategy.
The Flanders RTD system has a generic character for industrial and university support and a more specific system for institute support. There are no specific data on the amount of NNE RTD funding in the generic programmes but this is estimated by Technopolis at €5-10 mln/yr. The amount of institute NNE RTD support is estimated at €15-20 mln.
The Walloon region RTD system has some specific NNE programmes, but is also mainly bottom-up, aiming at creating new processes, products and companies. The amount of government NNE RTD support is estimated at €10 mln/yr.
Total Belgian NNE RTD government support is therefore €30-40 mln/yr.

Important players from Belgium from an NNE ERA point of view are VITO (general energy technology) and especially IMEC (in the field of solar cells) that already participate in and coordinate FP6 projects.
Capabilities in coordinating European projects are also found in (many) Belgian universities (though not in the NNE field (yet)).

The industrial infrastructure in Belgium in the NNE field in general is not very strong. Belgium has only one major industrial energy company (Electrabel).
In the area of solar cells there is however a cluster of companies around IMEC which is strong.

Governments of both Flanders and the Walloon region have recently raised their ambitions in the area of NNE and are starting activities in the areas of hydrogen and fuel cells.

To summarize, the NNE RTD policies in Flanders and the Walloon region are not very explicit, and the funds available are limited in compared to some other nations. Capabilities do however exist to participate in the European Research area. In general the universities, institutes and governments of Flanders and the Walloon region as well as a number of Belgian companies have shown capabilities of participating and leading European projects. More specifically in the field of NNE RTD, IMEC and VITO are already participating (and leading) in FP6 projects.

Belgium shall not be able to participate in an NNE ERA over the whole range of the scientific field. However on topics like solar cells they already have a leading role while on new topics like fuel cells and hydrogen they have an ambition that mat be developed further.

2 From the Belgium NNE RTD system towards a NNE ERA: possible starting points

In this chapter the NNE RTD systems in Flanders and The Walloon region are described from an ERA point of view. In the following chapters (3-6) the NNE RTD systems, budgets, and priorities in Flanders and The Walloon region are described in more detail.

2.1 Policy

Today Belgium is a Federal Authority. Institutional reforms implemented over the past three decades led to progressive transfer of several responsibilities, so far in the hands of the central state, to the regions (Flanders, Brussels and The Walloon region).

This did not, to a large extent effect **energy** policy. The objectives of Belgium's overall energy policy have not changed since the early 1970s. Currently, the main energy policy goals of the federal government are rational use of energy, progressive phasing-out of nuclear energy and the accelerated liberalisation of the energy market.

In the field of **RTD** policy "prime" responsibility is assigned to the regions. The Federal Authority, however, exceptionally still withholds certain "exclusive" responsibilities. Some of these are subject to co-operation agreements signed with the federated authorities concerned. The regions are responsible for the general support of research carried out in higher education institutions and provide the general support of industrial and technological research and innovation. The Federal Authority, besides supporting research required for the fulfilment of its own assignments, also finances the federal scientific institutions (e.g. the nuclear research centre), space research conducted in an international context, data transfer networks between scientific institutions as well as several other activities requiring uniform implementation at national or international level. As a consequence, the regions have a high degree of autonomy with respect to RTD policy. At the same time, however, structures of dialogue and co-operation mechanisms between the various federal and regional authorities has been set up, both at ministerial level (the Inter-ministerial Conference for Science Policy, IMCSP) and at administrative level (the International Co-operation Commission, CIS, the Federal Co-operation Commission, CFS and their specialised groups)."

There is no explicit policy in Belgium (at federal or regional level) on **non nuclear energy RTD**. However within the general (and in Flanders generic) RTD policies NNE RTD does have it's place, and there are various groups and organisations that perform NNE RTD.

2.2 Thematic complementarities / synergies

Specific budgets in Belgium for NNE RTD are fairly small compared to the more NNE RTD oriented countries, and do mainly exist in the Walloon region. In Flanders NNE RTD is supported from in generic innovation programmes (no data are available on the amount). There is also NNE research financed in institutes (IMEC and VITO).

2.3 Institutional complementarities / synergies

In Belgium are no energy specific research institutes, however there are two research institutes in Flanders with significant energy related RTD activities: VITO (a.o. energy technology and rational use of energy) and IMEC (solar cells).
There are different NNE RTD activities set up within the seven universities in Flanders as well.
In the Walloon region there does not exist a specific NNE RTD centre. Research is performed in university research units. There are e.g. research units from the Walloon region in IEA implementing agreements, such as ECERC (COMBUSTION), ECBS and SHAC.

2.4 Type of research

Long term strategic NNE RTD actions in Belgium are mainly embedded within the research centres VITO and IMEC, some research in the universities of both Flanders and the Walloon region, and in the participation of the Walloon region and Flanders in the HY-CO ERA-NET.
In the period 1993-1997, Flanders operated a long-term programme for the Promotion of Energy Technology (VLIET). Today the financing mechanisms are no longer specifically aiming at certain technologies or application areas, but are generic, and open for all scientific or technological disciplines. There is no monitoring of the amount NNE-related research in the programmes. However some, mainly shorter term research will be present in these programmes.
Most NNE research in The Walloon region is considered to be short and medium term oriented. The "industrial basic research" made in university units lasts from two to four years, and produces results that have to be kept by companies which will continue applied research during two years in order to develop a marketable product, process or service.

SMEs and in Flanders the institutes benefit most of the public funds for NNE RTD. In Flanders 50 % of the RTD funds flow to SMEs and in The Walloon region even up to 70 %.

2.5 Possibilities for an NNE ERA

To assess the opportunities to integrate Belgium NNE RTD efforts into the EU NNE RTD policy it is essential to take in account the high autonomy of the federated entities. Structures of dialogue and co-operation mechanisms between the various federal and regional authorities have been set up, both at ministerial and administrative level.

Both Flanders and The Walloon region participate in IEA agreements and have an active policy to stimulate RTD in general. There are not many specific NNE RTD programmes.

The Flemish and Walloon Region both have a big involvement in NNE-ERA nets. Flanders and The Walloon region participate in the ERA–NET Hy-Co (HYDROGEN - CO-ORDINATION) with an involvement to annual Hydrogen and fuel cell programmes. Both regions are represented in the mirror group of the European

Hydrogen and Fuel Cell Technology Platform. Flanders will participate in the PV-ERA-NET

The Walloon region co-ordinates ERA-STAR REGIONS, the ERA-NET about aerospace. The Region has also developed 12 "pôles d'excellence that are co-ordinators or partners of several research projects in the FP6, or EUREKA (not specific on NNE RTD). While these activities are not in the specific NNE RTD area they show the capacity of the Walloon Region to fit into research at the European level.

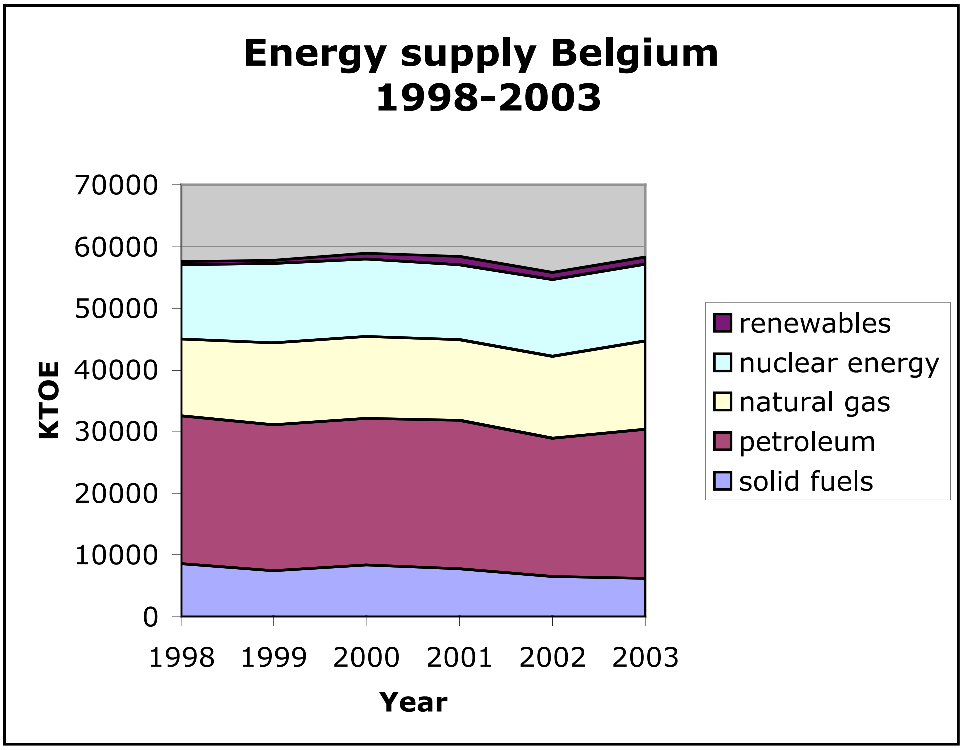
In general terms, the involvement of Belgian actors in the EU Framework Programmes is relative low and international collaboration seems to be rather limited, with exception for the two research institutes (VITO and IMEC) and some specific research groups at the universities. With the start of FP6 (first call of TREN and Energy) and its structure of NoE's and IP's that oriented on strong research partnerships with top institutes in Europe, we notice only participation of VITO, IMEC and the Catholic University of Louvain in the medium-to long term oriented Integrated Projects. Policy actions are planned to reinforce the Belgian participation (especially towards FP7), both in Flanders as well as in The Walloon region.

3 Overview of Belgium energy characteristics

3.1 Energy supply

Belgium has no oil or natural gas resources, the last coalmines were closed in 1993, and the use of renewable energy sources is, although rapidly growing, still limited with a share of 2 % in total energy supply in 2003. The energy supply is for 75 % based on imported fossil fuels. The remaining energy comes from nuclear power. The energy supply per fuel in Belgium is shown in Exhibit 3-1

Exhibit 3-1 Energy supply Belgium 1973-2010



Source: EIA In-Depth review Belgium, 2004

The consumption of primary energy registers a remarkable increase with 4,4% in 2003 and contrasts clearly with the downward tendency recorded in 2002. In spite of the heat wave of August 2003, the average climate was less mild than this of the exceptional year 2002. The climatic rigour observed in 2003 is similar to the one of the year 2001 and due to this induces a level of primary energy consumption that is very close to the one observed in 2001.
With regard to the differences in consumption between 2002 and 2003 the following can be said:

- The consumption of coal went down with 5% because of a reduction in demand of the coking plants and the residential sector. The industrial sector and the steel industry in particular made a considerable progress in 2003.
- Sales of natural gas (+7,3%) especially developed in the industrial sector and in the sector of the production electricity. Sales to the residential sector and equivalents also progressed in 2003, especially taking into account the increase of the number of degree-days.
- The consumption of petroleum (+8,1%) increased fairly significant
- Nuclear energy remained stable (+0,0%) with an average use rate of 88,4%
- The contribution of renewables increased mainly because wind energy went up (+36,8% in net production, in comparison with 2002)

3.2 Electricity production

With regard to the net production of electricity, an increasing appeal has been made to power plants working on gaseous, liquid and solid fuels.

In comparison with the years before the appeal to nuclear energy practically remains unchanged (around 59%) . In 2003 wind energy increases, displaying a growth of 36,8%.
In 2000 the federal government has set a higher target for renewables, at 3% in 2004 and 5% in 2010. The regional governments have established even more ambitious targets (see section 3.4).

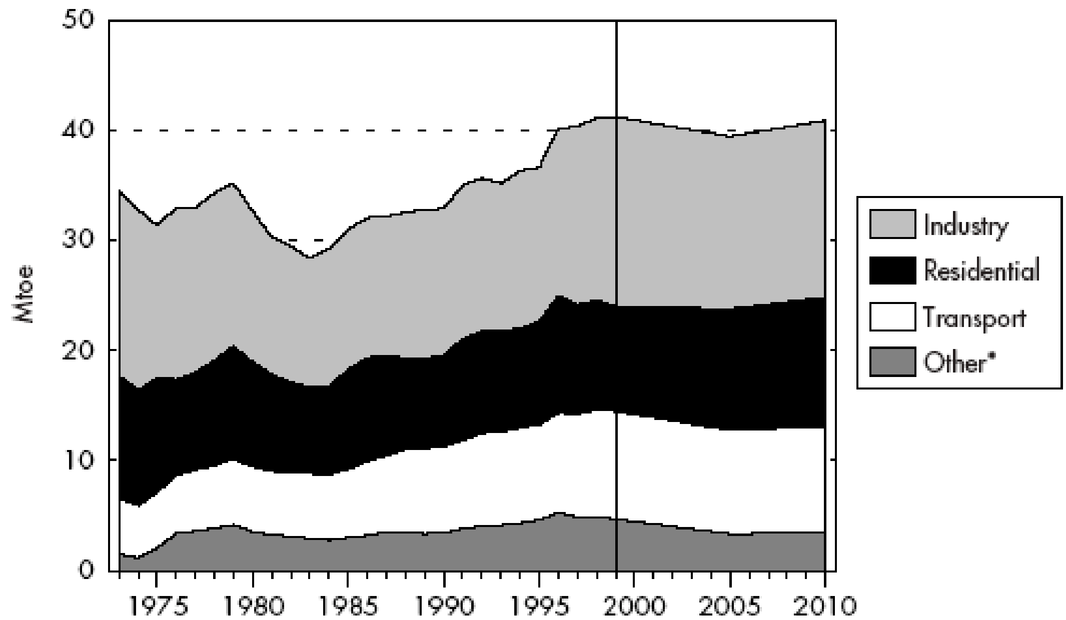
Biomass used to be the most important renewable source in Belgium with a 90% share of total renewable energy production, followed by hydropower. Now wind energy is increasing rapidly.

3.3 Energy demand

While total final energy consumption decreased from the 1970s to the early 1980s, it has grown since then, except for the early 1990s when there was a recession. In 2002 there was a decrease in energy use (influenced by the high outside temperature), while in 2003 the energy use was again on the level of 2001.

In 1999, the industrial sector had the biggest share (41.6%) of total final energy consumption. The share of the different sector in total energy demand is shown in Exhibit 3-2.

Exhibit 3-2 Energy demand in Belgium per economic sector for the period



1973-2010

** Includes commercial, public service and agricultural sectors.*
Source: IEA

3.4 Energy policy

Each regional government in Belgium has its own responsibilities for designing and implementing energy policies, while the federal government is responsible for those issues that need to be dealt with at national level, like nuclear energy, large distribution networks, and tax on energy. In general the regional governments put more emphasis on renewable energy and energy efficiency.

The objectives of Belgium's overall energy policy have not changed since the early 1970s. They include security of supply based on diversification of geographical sources and fuels, energy efficiency, transparent and competitive energy prices, and environmental protection. Currently, the main energy policy goals of the federal government are rational use of energy, progressive phasing-out of nuclear energy and the accelerated liberalisation of the energy market.

In the context of the EU Burden-Sharing Agreement, Belgium is committed to reduce its greenhouse gas emissions by 7.5% for the 2008-2012 period, compared to 1990 levels. The Federal State and the three Regions agreed on the necessity to clarify their respective responsibilities as regards the compliance with international commitments. Therefore, an internal burden sharing was negotiated between the Federal State and the three Regions, under the aegis of the National Climate Commission (the executive body of the Cooperation Agreement, see above).
This internal burden sharing agreement defines the targets of the three Regions as follows:

Wallonia:	emissions 1990 - 7,5 %	=	50.23 Mton CO_2-eq
Flanders:	emissions 1990 - 5,2 %	=	83.37 Mton CO_2-eq
Brussels-Capital:	emissions 1990 + 3,5 %	=	4.13 Mton CO_2-eq

The sum of these regional targets exceeds the national target. The federal authority will compensate this difference (2.46 Mton / year) by the acquisition of emission allowances on the international market. Up to the end of 2007, the federal government will only make use of joint implementation (JI) and clean development mechanisms (CDM) projects. Afterwards, the internal emission trading (IET) could be used as well, only if the gap can not be totally filled by the credits obtained from JI and CDM projects, given the limited budget available for those credits.

Like other EU countries Belgium has also accepted the Kyoto protocol, which reduces the emission of CO2. To achieve the goals established in the Kyoto protocol energy policy in Flanders is aimed at:

- Rational use of energy (REG) by reducing the use of energy in the households sector and establishing energy efficiency gains in the industry and service sector
- Higher share of renewable energy in global energy production; 3% in 2004 and 5% in 2010
- Social acceptable prices for energy

Since the 2001 in-depth review, the main developments in Belgian energy policy have been the taking of major steps towards the establishment and implementation of the National Climate Plan, the advances in market liberalisation and a progressive phasing-out of nuclear energy.

4 Energy Research, Technology & Development

In this chapter the Belgium NNE RTD system is described. The Belgium (NNE) RTD system consist of an independent system in Flanders and an independent system in The Walloon region. The description of the two systems is based on interviews with government representatives in Flanders[3] and The Walloon region[4].

4.1 Introduction in Belgium RTD system

An overall Belgium RTD system does not exist but there are separate Flemish and Walloon RTD systems with limited coordination between the two. The federal government is responsible for scientific research in the fields of space research and nuclear energy research. Furthermore it promotes knowledge exchange between (inter)national research institutes. The three regions in Belgium (Flanders, The Walloon region, Brussels-Capital) are competent for research related to the economy, energy policy (excluding nuclear), public works, the environment, and transport. This covers support for basic technological and industrial research, the development of prototypes, new products and production processes, the distribution and transfer of technologies and technological innovation. The public support involves companies as well as universities and research centres.

The RTD system lacks major Belgium companies and consequently their R&D efforts. Some foreign multinationals have located their production activities in Belgium, especially industrial half fabricates and car manufacturing, but R&D activities of these companies are usually located abroad. Public RTD support is therefore more focussed on Belgium small- and medium seized enterprises (SME) then in other EU countries.

4.2 NNE RTD system

The same remarks that are valid for the general Belgium RTD system are valid for the specific NNE RTD system. The regions therefore are the leading government level. As will be described in the next paragraphs.

At the federal level the Minister for Economy, Energy, Foreign Trade and Science Policy has the responsibility for the field of energy policy and research.

The Belgium regions are independent of the federal government in their RTD policy on NNE RTD. Therefore the different NNE RTD systems in Flanders and The Walloon region are described separately.

4.3 Organisation of the NNE RTD in Flanders

The Flemish NNE RTD system is shown in Exhibit 4-1. In Flanders the Department of Economy, Employment, Internal Affairs and Agriculture is in charge of energy matters and the Department of Environment and Infrastructure deals with environmental matters. The Department of Education and the Department of Science,

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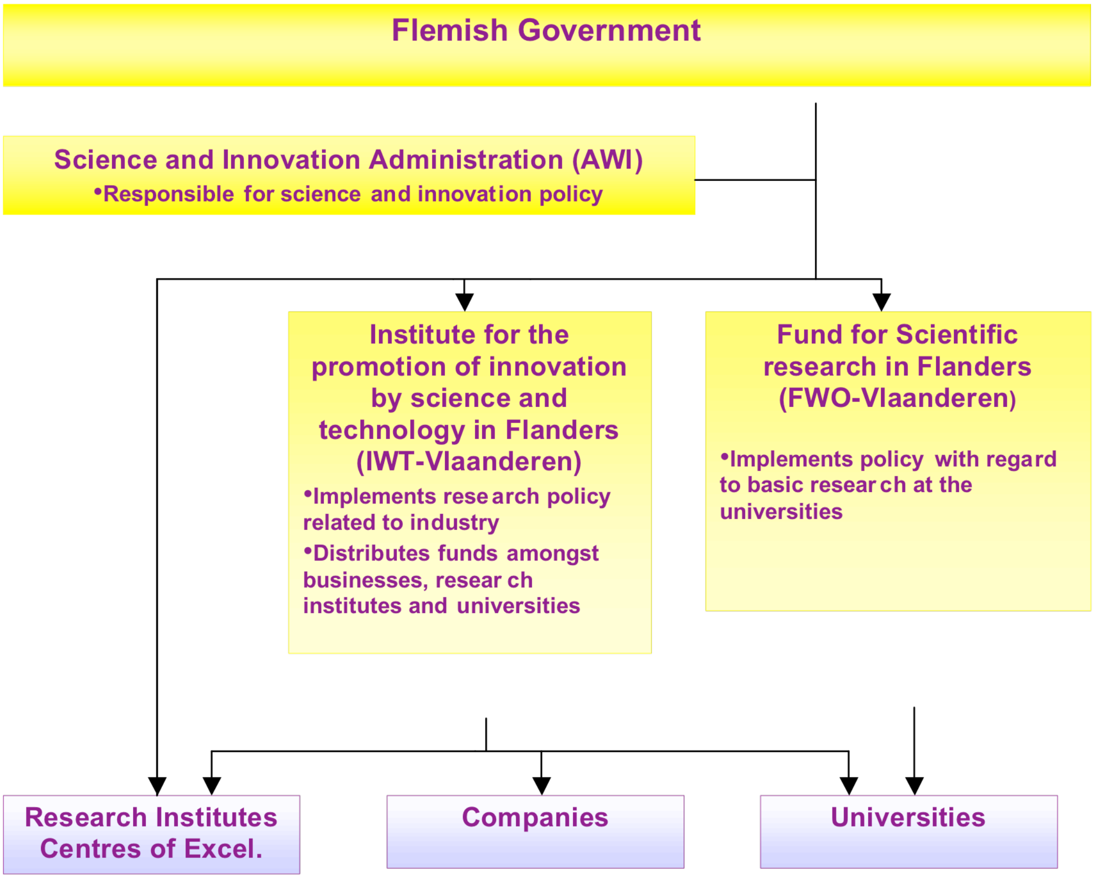
[3] Veerle Lories. Ministry of the Flanders Government: Administration of Science and Innovation (AWI). Brussels

[4] Alain Stephenne. Direction Generale des Technologies, de la Recherche et de l' Energie (DGTRE). Namur

Innovation and Media are responsible for the science and innovation policy, which is executed by the Administration of Science and Technology (AWI). Two intermediary organizations are responsible for the allocation and distribution of RTD funds:

- IWT-Flanders: Institute for the promotion of innovation by science and technology in Flanders. IWT implements policy related to industry and distributes the funds amongst businesses and research institutes.
- FWO Flanders: Fund for scientific research in Flanders. FWO implements policy with regard to basic research at the universities.

Exhibit 4-1 Flemish NNE RTD system



With regard to energy related RTD the research institutes of VITO and IMEC are of interest. Besides the NNE-research at the research institutes different NNE RTD activities are set up within the seven universities in Flanders.

In the government policy statement (2004-2009) of the new Flemish Government specific attention is given towards the stimulation of research and investments in renewable energy. As a consequence new policy initiatives in that field can be expected in the near future.

4.3.1 NNE Research institutes in Flanders

4.3.1.1 VITO

VITO is the Flemish Institute for technological research and is a specialised research centre with a semi-private status that operates under the auspices of the Flemish government. The energy division consists of several research centres that focus on:

- Rational use of energy
- Transport and the environment
- Product and process assessments
- Energy technology

More recently VITO started a specific strategic research activity dedicated to hydrogen and fuel cell technology. Within this particular context a thematic innovation network entitled "Flemish Co-operation Network Fuel Cells" has been launched, in which a number of companies and research institutes join forces in order to stimulate information dissemination and innovation in the field of hydrogen and fuel cell technology. The network is currently working on defining research projects with a common strategy and vision.

The turnover of VITO is € 51,4 million (2003), partly paid by the Flemish government, through a yearly budgetary allocation. It is estimated that one-third of the turnover is related to NNE RTD [5]. Every five years an agreement is signed between the Flemish government and VITO, which secures the basic funding of VITO, but also obliges VITO to conduct strategic research and contract research. The most important elements in the last agreement (period 2001-2005) are: strategic research with industrial relevance, more focus on fewer research themes, and internationalisation of research.

4.3.1.2 IMEC

IMEC, the Interuniversity Micro Electronics Centre, founded in 1984, is Europe's leading independent research centre in the field of microelectronics, nanotechnology, enabling design methods and technologies for ICT systems. In 2003 IMEC's revenues amounted 145 million Euros. IMEC generates 76% of its total budget, the remaining 24% being funded by the Flemish community, through an agreement with the Flemish government that also secures a basic funding. Similar to the VITO, an agreement is signed for a period of 5 years. Development of solar cells is one of its strategic programs with the aim to provide low-cost, highly efficient solar cell technologies as to make photovoltaic energy generation an economically viable renewable energy source ($Solar^+$ program). The $Solar^+$ program is covering technologies based on crystalline Si, active organic layers and high-efficiency mechanical stacks incorporating III-V and Ge sub cells. Specific technological topics that are investigated at IMEC:

- Solar cells based on crystalline Si
- High-efficiency photovoltaic stacks
- Organic solar cells

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5 Ministry of Flanders; Science and Innovation Administration. 2003. The Science, Technology and Innovation Information Guide. p 67-68. Brussels.

IMEC has being partner and/or coordinator of many PV-related projects in the former and current EC framework programs and has a large portfolio of ESA-projects. Its R&D-efforts are supporting the local industry that is active over the whole value chain from the materials production to the production of solar cells and modules and their integration into custom-tailored PV-systems.
The budget of IMEC related to PV-related research can be estimated up to €4,5 million per year.

4.3.2 Energy RTD programmes

In Flanders, the RTD budget for energy was € 14 million in 1999[6]. This represented 62% of total R&D expenditures in the field of non-nuclear energy in Belgium, by then.
The budgets for innovation stimulation in Flanders are divided by IWT.

From 1993-1996 IWT managed the Flemish programme for the Promotion of Energy Technology (VLIET). This programme had a total budget of € 20 million for the period 1993-1996. Around 10 % of the budget was devoted to projects supporting the Flemish energy policy and 25 % was devoted to projects in the fields of renewables. In 1997 VLIET-bis was started with a budget of € 7 million.

From 1999, IWT changed its funding policy from a thematic oriented system towards a bottom-up organised system (see also 6.1). From that time NNE RTD in Flanders is channelled through the innovation stimulation programmes co-ordinated by the IWT. As already mentioned, these new instruments (strategic basic research, RTD-projects for industrial basic research activities and projects for industrial development) can be considered as "bottom-up" initiatives. They are open for all scientific or technological disciplines.

A specific stimulus towards rational energy or renewable energy research is given by the introduction of the "Sustainable Development" programme (SDR). This programme requires that a certain percentage of all funding in the different Flemish programmes must be devoted to Sustainable Development (in 2004: 18%). If this target is not met Sustainable Development projects that have been submitted will be positively discriminated. Extra financial incentives (+10%) are available for those projects that can prove significant added value in terms of sustainable technological development (eco-efficiency improvement). In 2004-2005 IWT will analyze the outcomes of this SDR-approach. One of the outcomes of this project will be an overview of the NNE activities in this programme.

On top of the bottom-up financing programs, the Flemish Government launched in 2004 the so-called Environmental Innovation Platform. This platform brings together companies, research institutions and public services active in the field of environmental and energy technologies. The platform will encourage research in strategic environmental and energy areas through clustering formation and scaling up. Additional financial support will be allocated to set up a Flemish centre of excellence in the field of Environmental and Energy technologies. This centre of excellence will

[6] International Energy Agency. 2000. Energy policies of IEA countries: Belgium 2001 review. ISBN: 92-64-18734-0

be a virtual cluster of knowledge and expertise in the research institutes, universities and high-schools in Flanders and will focus on:

- valorisation-development of existing knowledge and expertise towards market applications
- new "knowledge-development" in a limited amount of topics by clustering the existing research capacity.

For its start-up phase (2004), 7 m€ has been allocated to this centre of excellence.

Beside the R&D programmes run by IWT, the Department of Economy, Employment, Internal Affairs and Agriculture, which is in charge of the Flemish energy policy, created a fund for demonstration projects for energy technologies. This fund wants to stimulate new innovative production procedures and/or technologies focusing on a rational use of energy in the industry and service sector. These demonstration projects must comply with the priority themes defined on a yearly base by the government. Current priorities are:

- rational use of energy in the industry and service sector, with emphasis on process integrated, source-directed technologies
- renewable energy sources with emphasis on biomass

Because the lack of data from generic programmes only a rough estimation of funds involved can be made. Technopolis estimates that the total amount of government NNE RTD in Flanders is between €20-30 mln.

4.4 Organisation of the NNE RTD in The Walloon region

In the Walloon Region, the Minister for Scientific Research and New Technologies is in charge of RTD in general, meanwhile since 1999, the Minister for Energy is responsible for the stimulation and promotion of NNE RTD. The D.G.T.R.E. (Direction Générale des Technologies, de la Recherche et de l'Énergie) is the Administration in charge of applying the ministries 'policy.

A strategic approach in the definition and orientation of research and innovation politics was developed since mid '90.
Since 2003, a new "programme wallon d'actions innovatrices" is in course, with a European FEDER sustain.
The strategy aims at the following objectives :

- encourage partnerships and technological synergies, also beyond the borders of the Walloon Region ;
- reinforce the innovation potential of the Walloon Region ;
- organise a net of supply of competencies adapted to the needs of the enterprises.

The Region provides :

- grants and refundable loans for companies. The Region encourages co-operation with universities ;
- follow-up of the EUREKA tool in business ;
- management of resources provided to companies under structural funds and international programmes such as EUCLIDE.

The Region is eager to develop innovation in SMEs. It has therefore drawn up several policy schemes grants such as:

- RIT (Responsable à l'Innovation Technologique) grants for subsidising the salaries of persons at SMEs investigating the prospects of and areas related to innovation. It includes a technical support (ST) scheme which pays for a feasibility study ;
- technical and economic assistance (ETE) tackles strategic marketing ;
- sectoral studies (ES) are used to analyse a specific sector with a view to targeting technological clusters that could be exploited by SMEs ;

RIT Europe examines the possibility of developing technological co-operation with one or several SMEs located in one or more EC member states, other than Belgium.

Moreover, the Walloon Region supports "inventors" by enabling them to develop and finalise new products on their own without requiring any corporate assistance. This grant covers the costs of protecting industrial property rights, of producing a prototype and carrying out tests by a certified body.

The Region indirectly supports SMEs by funding thirty research centres, which perform research programmes in important areas for innovation. The Walloon Region also financially supports the activities of 50 "guides", i.e. scientific experts attached to these centres supporting and advising businesses, especially SMEs, in matters relating to innovation.

The DGTRE identifies priority areas for research, allocates research funding from governmental budgets, sets up and takes operational responsibility for RTD programmes, conducts evaluations of submitted proposals and follow-up of selected projects. It also has a role in disseminating scientific content to the public.

The budget for public RTD support in the Walloon Region is generally not allocated according to sector or field, and the projects that are selected may concern a variety of interests, not just energy.

4.4.1 Research institutes in the Walloon Region

The Walloon Region has many research centres with different statutes, activities and financing sources. With the grant of the European structural funds (FEDER and FSE), the Walloon Region has developed 12 "pôles d'excellence" .Some research centres or "pôles d'excellence" are co-ordinators or partners of several research projects in the FP6, or EUREKA. There is no specific NNE RTD centre.

The ISSEP (Institut Scientifique de Service Public), former INIEX (Institut National des Industries Extractives) receives an annual sustain of € 8,5 million (outside of the programme budgets). Previously implied in research programme of valorisation of coal products, coal gasification and conversion of coal products, it orientates its activities towards environmental research.

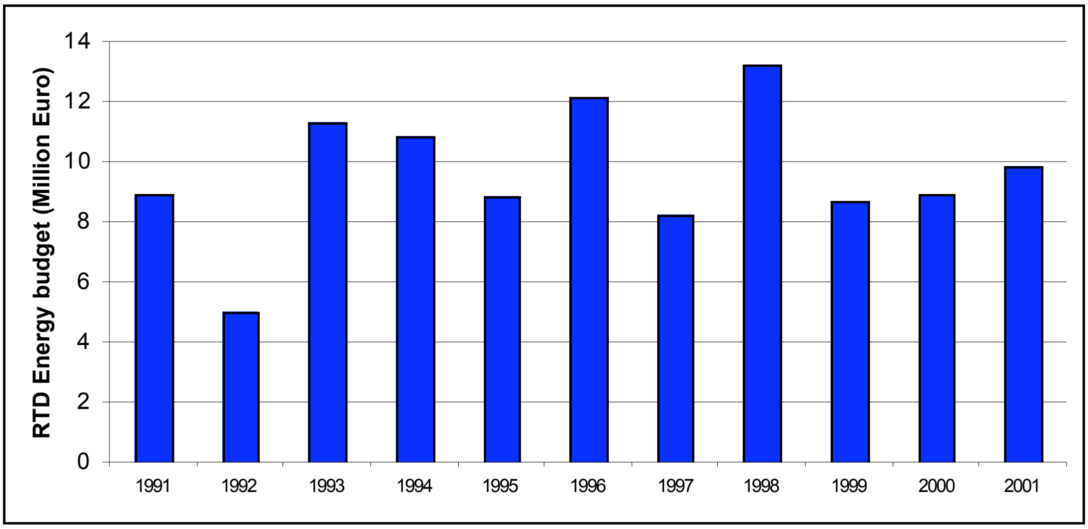
4.4.2 Energy RTD programmes

The budget of D.G.T.R.E. is € 234,2 millions in 2003. Since 1999, there is a specific budget allocated for energy RTD. The budget of DGTRE for energy was €19,7 million in 2001[7]. Besides the funding of RTD, this also includes dissemination of science and technology, energy efficiency subsides, promotion of energy efficiency, data collecting, studies, etc.

Based on the IEA-classification, the RTD budget of DGTRE for NNE is almost € 10 million a year. It encompasses grants for research projects, but not the general sustain to research centres or universities.

Exhibit 4-2 shows the amount of public funded NNE RTD for the period 1991-2001.

Exhibit 4-2 Walloon public RTD budget for NNE (1991-2001)



Source: DGTRE 2001

Since 1990, the Walloon Region (via Belgium) participates in implementing agreements of the IEA, granting research teams for an amount of € 1,4 mln/yr.

The public grant to enterprises is about € 5 million a year.

The Walloon Region regularly launches calls of proposals on specific thematic priorities of research, named "Programmes Mobilisateurs", the results of which are likely to be of interest to existing companies or might lead to the creation of new enterprises. Programmes in the area of NNE RTD were:

- Cogénération : l'Énergie totale (combined heat and power generation) : 2 calls, on the priority thematic of micro Cogeneration and Biomass Cogeneration. The budget for the period 2000-2001 was € 5,1 million.
- PIMENT (Projets Innovants relatifs à la Maîtrise de l'Énergie utilisant de Nouvelles Techniques) : 2 calls, on the general subject of energy efficiency and reduction of CO_2 emissions. The budget for the period 2002-2003 was € 8,4 millions.
- PILES À COMBUSTIBLE (fuel cells) : materials and components of PEM fuel cells. Deadline: 1st of October 2004. Budget : € 1,2 million.

7 Direction Generale des Technologies, de la Recherche et de l' Energie. 2001. Rapport'd activites 2001.

4.5 Energy RTD in Brussels-Capital

Brussels-Capital does not have a specific R&D budget for energy and therefore informally collaborates with the other regions. In Brussels-Capital, the Brussels Institute for the Management of the Environment (IBGE/BIM) is responsible for all energy-related issues in the region.

4.6 Industrial energy RTD

There are several companies in Belgium that perform research in the NNE area. Below some examples (not an exhaustive list):

Laborelec is a Belgium laboratory for scientific and technical research in the electricity sector and is owned by Electrabel and SPE. The turnover in 1999 was €32 million, exceeding the regional governments combined R&D budgets. The research areas include energy audits, combustion, electromagnetic compatibility, power quality, condition monitoring and predictive maintenance for combined-cycle power plants and CHP installations and biomass for electricity generation.
Photovoltech is a spin-off company of IMEC using the proprietary process for multicrystalline Si solar cells, developed in the IMEC-pilotline, of which Electrabel and Total Fina Elf are the main shareholders. The company has at present a production capacity for solar cells of about 10 MW, but a further substantial expansion is to be expected in near future. This production capacity is partially used for the production of classical two-side contacted solar cells, but also allows for the production of back-contacted solar cells. The latter product represents a strong improvement on the level of aesthetics and is therefore perfectly suited for integration in the building environment. BIPV (building-integrated PV) is the strongest growing market segment with a growth rate near to 70%/year.
Soltech is another spin-off company of IMEC, which is active in the design, and production of custom-tailored PV-systems and modules.
UMICORE is a large non-ferro material producer. Within the context of PV, the company is known for its dominant position on the market of epi-ready Ge-substrates, which are mainly used for space solar cells. The company supplies more than 90% of the Ge-substrates needed worldwide for this activity. In order to preserve this position, UMICORE is collaborating with IMEC towards the development of very thin Ge-substrates and on alternative Si-based substrates suitable for high-quality growth of active III-V layers. In order to check and improve the epi-readiness of the Ge-substrates UMICORE is also involved in MOCVD-growth. This MOCVD-capacity is co-developed with and supported by IMEC.
The **UCB Surface Specialities** is part of the UCB Group is an international pharmaceutical and speciality chemical company. This company is specifically interested in the incorporation of its sealant layers in organic solar cells to improve stability and in the development of active compounds for organic solar cells
3E is a consulting company with specific interest for the Solar Roadmap development and the implications on electricity grid architecture
Electrabel is the main Belgian Electricity company. Apart from their involvement in several start-ups as mentioned above they follow up PV-introduction on measures to stabilise voltage and frequency of the grid and have other NNE RTD activities.

Other companies Wanson (industrial boilers), Solvay (PEM membranes for fuel cells), Dow Corning (PV cells), etc.

5 Research priorities in Energy RTD

As described in 4.2 the Regions are in charge of their own industrial and applied research policy.

5.1 Flanders

As mentioned before there are no thematic priorities in the Flemish RTD support programmes. Because the institutional financing plays a large role in the Flemish RTD system the priorities of the relevant research institutes are the main RTD priorities for Flanders, i.e. solar cells (IMEC) and energy technology and innovative decentralised energy systems (VITO, Hydrogen and fuel cell technology, micro turbines, combined heat and power generation and sustainable energy sources are important components of this research field).

Due to the horizontal organisation of the RTD financing programs in Flanders no recent exact figures on the overall NNE-RTD related funds can be given.

5.2 Walloon region

Following the IEA classification, the major research areas are oriented to renewable energy (45%) and energy conservation (35%), followed by power and storage technologies (15%).
The research priorities are :

- *Combustion of fossil fuels* through the IEA implementing agreement "Combustion" ;
- *Building*, climate-sensitive architecture and passive solar energy technology in buildings, mainly through the IEA implementing agreements SHAC (Solar Heating and Cooling) and ECBCS (Energy Conservation in Buildings and Community Systems).
- *Production of energy from Biomass and waste*, mainly Gasification of Biomass, combined heat and power ;
- *Catalysts*, for several uses : catalytic combustion of Biomass, catalytic purification of combustion gases, hydrogen production from natural gas and alcohol, low temperature combustion of natural gas ;
- *Hydrogen and fuel cells* ;
- recently, *Solar thermal and photovoltaics.*

6 Priority setting process

In this chapter the priority setting process in Flanders and the Walloon region is described. The characterisation of the priority setting process is based on the interviews with government representatives.

6.1 Flanders

As mentioned in section 4.3 there are no specific thematic priorities for NNE RTD in Flanders. The priority setting process is bottom-up organised. There are no thematic restrictions and researchers are relative free in the selection of research projects. Anyone has a good chance in obtaining funds for research. The most important criteria scientific are quality and utility perspectives of the research. Although no thematic programs in NNE RTD are set up, research in this field is encouraged through the extra funding mechanism for projects that focus on sustainable development.

In order to improve the organisation, co-ordination and priority setting of research in the field of environmental and energy-technology the Flemish Government established in 2004 the Environmental Technology Platform. This concept aims at improving synergy between innovation, environmental and energy policy in Flanders. But also a tuning to federal and European policy actions, as far as relevant, is of concern of this platform. The platform will encourage and realise a better and more co-ordinated use of the previously mentioned financial instruments in the field of energy and environmental technologies. On top of that, this platform will create a new (virtual) centre of excellence for environmental and energy technologies. Research priorities of this centre will be defined by the steering committee of the Environmental Technology Platform.

6.2 Walloon region

Only since 1999, there are specific actions in the energy RTD field, except for the participation in IEA implementing agreements, where the Walloon Region is present since 1990.

The Co-generation programme (2000-2001) was established in co-operation and discussion with involved actors of the Walloon RTD system. The different thematic topics were narrow defined. 31 proposals were submitted, 13 were granted for a support of 4,5 M€. There were relatively few proposals submitted, but it was in line with the narrow subject and the possibilities of the Walloon Community.

For the programming of PIMENT (2002-2003), another approach was chosen. The programme was very wide oriented with little thematic focus (energy efficiency and reduction of CO2 emissions, plus an emphasise on buildings in 2003). 57 proposals were submitted, of which 17 proposals were granted for a global amount of 8,2 M€. More proposals were submitted, in accordance with the more wide topics.

In 2004, a Fuel Cell programme was launched, which lead to the grant of a research project on PEM membranes for 1,2 M€.

The funding criteria are the following :

- general quality of the proposal
- scientific quality
- technological quality
- valorisation (positive impact on the development of new products, processes and services by Walloon companies)

In the future, the Walloon Region will take a more co-ordinated and multi-annual approach.

DGTRE tries to co-ordinate their programmes with the EU priorities in order to help Walloon research units and companies participate in the European RTD.

Several measures are taken in favour of SME's in all fields of research. Public funding of SME's granted research projects amounts to 70 % of the total cost of the project. The other measures are described on point *4.4. Organisation of the NNE RTD in the Walloon Region*.

Collaboration between universities and companies is encouraged by the demand that results of the research projects are presented in such a way that they are applicable for the development of new products, processes and services by Walloon companies.

Country study Bulgaria

Contents:

1 Summary of country study indicating main points for synergy

Although Bulgaria overall economic situation has not allowed its accession in European Union as a member State, Bulgarian non nuclear energy research and technical development (NNE RTD) seems to be increasingly embedded in the European Research Area (ERA). Bulgarian RTD excellence is in some fields recognised within Europe, for example in electrochemical power sources and solar energy : two research units have been recognised as European Centre of Excellence. The government policy is notably oriented toward the support of these RTD fields, with a special funding and evaluation role increasingly devoted to the National Council for Scientific Research.

Bulgarian NNE RTD collaborations are mainly embedded within NATO and UNESCO frameworks, and within European bilateral co-operations instead of European Framework Programmes (FPs).

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Existing opportunities for ERA

During the last 10 years Bulgarian research units have had very active international collaboration, within European Union mainly, but also within the programme Science for Peace of NATO and UNESCO programmes. The collaborations intervened with other universities and with foreign private companies. International collaboration with companies is a necessity because Bulgarian firms are young and are still not investing in research : the Bulgarian market for research exists barely not.

In their RTD international and European collaborations, Bulgarian researchers encounter mainly language and funding problems – public RTD expenditures are low in Bulgaria, even if the government tries to support internationally recognised Bulgarian RTD units and researchers.

Bulgarian researchers are more oriented toward bilateral co-operation, through direct contracts with another research institution : "bilateral structures of common research between selected countries are important", because "not everything has to be done by the European Union" assessed the Director of CLEPS, the Bulgarian Academy of Science Central Laboratory of Electrochemical Power Sources. For example this laboratory had between 100 and 120 collaborations during the last 10 years, mainly with Germany, the USA, Japan. Its European collaborations are only with western countries (Germany, the UK, Greece, Spain, France…), and this last characteristic seems to be common to many Bulgarian European collaborations.

International collaboration is presented as one of the main priorities of research organisations, some institutes having recently set up a commission for European integration, CLEPS for example. The importance of first steps toward co-operation through RTD projects is highlighted, for example common papers, professors exchanges, visits, meetings.

2.2 Concrete possible policy actions

Improving mobility with associate countries has been one of the main preoccupation of our interlocutors, and the only policy actions suggestion has been the extend of Marie Curie fellowships to associate members.

3 Short background information

Bulgaria is a South-eastern Europe country, with a total land area of 110 550 square kilometres, and circa 8 millions inhabitants. Bulgaria has had significant problems in transitioning from a centrally-planned economic system to a market-based economy, has encountered a continued recession in the industrial sector and has engaged a radical restructuring of its economy.

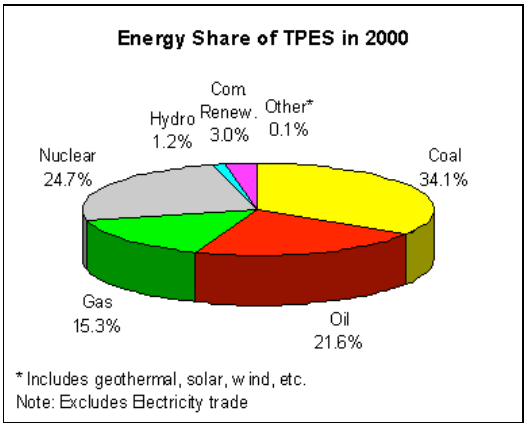
Bulgaria will remain, with Romania and Turkey, an associate country of European Union in 2004. Its entry in EU is planned in 2007, but it was invited to join the North Atlantic Treaty Organisation (NATO) in 2001.

3.1 The overall energy situation of Bulgaria

3.1.1 Distribution of energy sources

The major energy sources in Bulgaria are coal (34,1% in 2001), nuclear energy (24,7%), oil (21,6%) and gas (15,3%). This energy mix is highly emitting greenhouse gas.

Exhibit 3-1 Energy share of TPES in 2000



Source : IEA

Bulgaria's electricity is generated from coal (50%), nuclear power (40%) and hydropower (10%).

3.1.2 Imports/exports[8]

"Bulgaria depends largely on imports to meet its energy needs. The country has virtually no oil reserves and extremely low amounts of natural gas deposits. Bulgaria balances its dependence on international sources of energy with its strategic location, which allows Bulgaria to serve as an integral transporter of energy from Russia to South-eastern Europe and Turkey. Nevertheless, coal is one resource in relative abundance in Bulgaria. Additionally, Bulgaria generates a surplus of electricity that is exported south-westward to Turkey, Macedonia, Kosovo, former Yugoslavia and Greece. (…)

More important than Bulgaria's lack of oil and gas resources is its position as a non-Bosporus channel for delivering Russian oil and natural gas. Bulgaria plans to maximise its geographic location through the development of new pipeline routes. Given concerns over the heavy traffic, economic viability and safety of the Bosporus straits as a transportation channel, Bulgaria could solidify itself as an important location for the transportation of oil and natural gas from Russia to South-eastern Europe and Turkey.

Bulgaria's most plentiful resource is low quality, brown lignite coal. However, domestic consumption still exceeds production, requiring large amounts of coal imports from the international market, particularly from the Ukraine. The Bulgarian Energy Strategy calls for US$437 million investment in the coal sector to increase production through refurbishing facilities and incorporating newer technologies."

3.1.3 Market concentration

"The Bulgarian government initiated an energy sector liberalisation plan in the late 1990s. Much of the government's effort is outlined in the Bulgarian Energy Strategy 2002, which calls for seven state-owned energy firms to be privatised by June 2003. Currently, there are greater than 100 state-owned energy companies operating in Bulgaria and the strategy finds that roughly 75% of them should be sold. A central rationale for the liberalisation efforts underway in Bulgaria is to harmonise with European Union (EU) energy sector reforms in preparation for Bulgarian accession. Lawmakers modelled recent energy legislation around EU mandates, including: unbundling monopolies, improving efficiency, attracting investment, and promoting privatisation. For example, Bulgaria created an autonomous State Energy Regulatory Commission, which has the authority to issue licenses and set price levels for electricity, natural gas and district heating.

(…)

Liberalisation of the power sector began in 1998. Legislation unbundled generation, transmission, and distribution of electricity from the national electricity firm, the National Electric Company (NEK). In the process NEK lost purview over seven generation units, seven distribution entities and the sole nuclear power plant (Kozloduy). Bulgaria may lose its position as the electricity hub of the Balkan/South-eastern Europe region in the near future, as 40% of generating capacity will be retired by 2010."

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[8] The following developments come from CEEBIC, the American Central Eastern Europe Business Information Centre _ www.mac.doc.gov/ceebic/

3.2 The national RTDI system

3.2.1 Public/private spending on RTD

Bulgarian total R&D expenditures are among the lowest in ERA countries : 0,6% of GDP for the period 1996-2000 according to UNDP[9]. Private R&D expenditures are very low, representing less than 5% of total R&D spending.
In 1996, R&D expenditures represented 20% of their level in 1989. According to the Joint Research Centre, "the spending for research and development on enterprise level was divorced from the demands of the market and followed a trend of rapid decline (over 10 times for the 1989-1998 period)."

3.2.2 Main public research

The RTD system is composed of

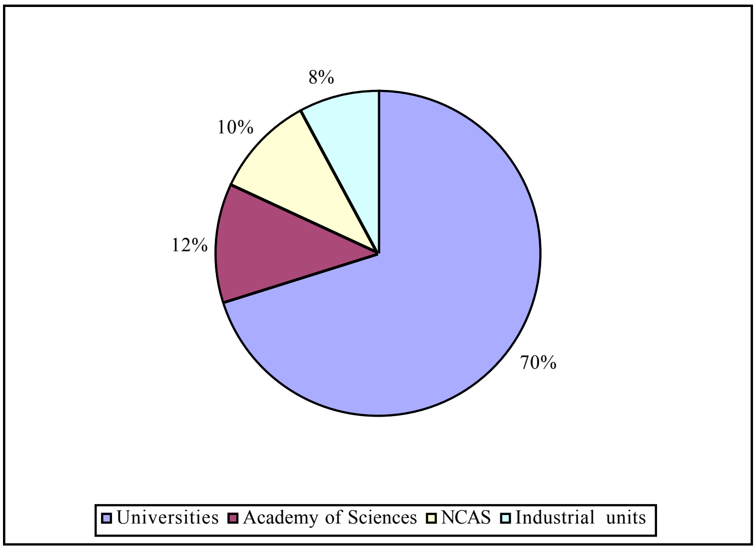
- universities
- the Bulgarian Academy of Sciences (BAS) and the National Centre of Agrarian Sciences (NCAS)
- professional research institutes

The major part of public funding is given to the Academy of Sciences. The Academy is well-embedded in international collaboration, having many centres of excellence in mathematics, physics, biology and technology.
Some universities (Sofia, Varna…) are also important research poles.

Research organisations have introduced the notion of economic profitability in their research activities. A larger share of their resources is now coming from contracts with industry.

[9] United Nations Development Programme

Exhibit 3-2 Distribution of researchers among research organisations

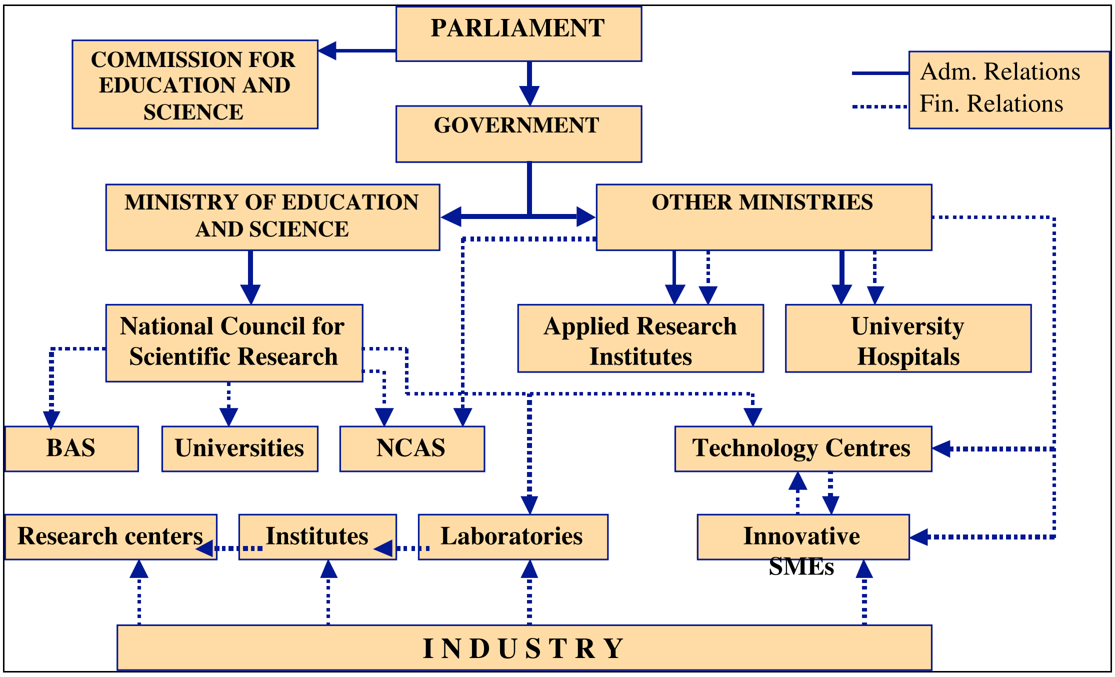


Source : National Research Council

3.2.3 Funding institutions

The Exhibit 3-3 presents an overview of the Bulgarian R&D system.

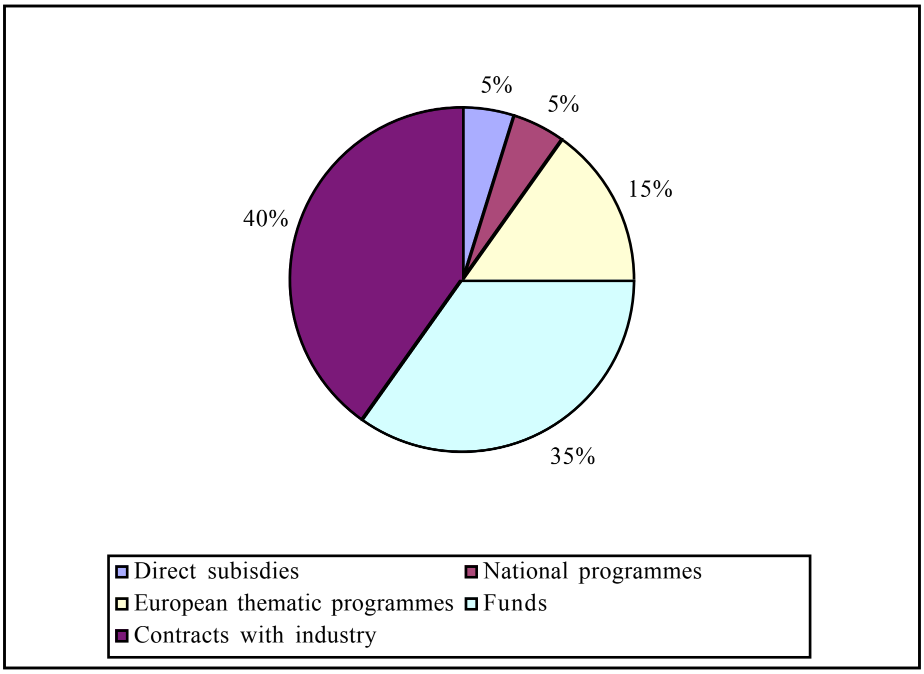
Exhibit 3-3 Bulgarian R&D organisation



Source : National Research Council

The Ministry of Education and Science funds 85% of research. Other ministries (Economy ; Agriculture and Forest) have other special research programmes.
The Ministry of Education and Science is the supervision authority of all the research organisations.

Exhibit 3-4 Financial streams for R&D



Source : National Research Council

The government is progressively replacing the direct funding of research activities by instruments more market-oriented, for example fiscal exonerations or new legislation. Since 1990 the Ministry of Education and Science has been developing

- the National Science Fund (see researchers and economic actors
-), promoting research in fields where the Bulgarian excellence is internationally recognised
- the Structural and Technological Policy Fund, reinforcing interactions between researchers and economic actors

Exhibit 3-5 The National Science Council[10]

The National Science Council is a supportive and consultative body of Ministry of Education and Science. The NSC finances and supports implementation of scientific research, evaluates and results thereby obtained, organises and promotes international collaboration. It was established in 1990. Even during its infancy the NSC (then it was NSF- National Science Fund) gained recognition as the one and only Bulgarian national institution financing research. This period saw the restructuring of scientific research, and the transition from institutional financing to direct project-based financing. The competitive principle projects became the dominant fund-allocation principle for financing research instead of the organisational financing principle formerly employed. Independent reviewing by outstanding scientists using sound professional criteria was introduced. For the period of its existence NSC considerably extended its international contacts, participation in international projects.

[10] www.minedu.government.bg/nsfb/Default-En.html

4 Brief description of NNE RTD research actors

There is **no governmental programme toward NNE RTD** in Bulgaria, and as we have previously seen, the Ministry of Education and Research policy is mainly oriented toward innovation in companies and toward already existing RTD competencies in public research institutions, especially internationally recognised competencies.

The main actor of NNE RTD[11] is the **Bulgarian Academy of Science**, especially two of its Institutes:

- the Central Laboratory of Electrochemical Power Sources (CLEPS) : it was founded 30 years ago and carries out fundamental and applied research, technology and development projects, in the field of electrochemical power sources: classical and valve-regulated lead-acid batteries; metal-air systems; solid-state elements; Lithium-primary cells and secondary batteries. CLEPS also conducts research in some new areas such as biosensors, information storage technologies nanotechnologies, fuel cells, PV Concentration. CLEPS' Portable and Emergency Energy Sources (POEMES) is a European Centre of Excellence
- the Central Laboratory of Solar Energy & New Energy Sources (SENES) : it was founded in 1975 and is approved as a leader in photovoltaic researches in Bulgaria. The unit is involved mainly in applied studies and projects in co-operation with national and West-European partners. Research topics are focused on :
  - photovoltaic materials preparation, photovoltaic device
  - design and simulations, solar thermal system design,
  - photometric and solar-metric measurements.

Other Institutes in the Academy are active in NNE RTD like

- the Institute of Geology at the Bulgarian Academy of Science, in geothermal energy
- the Institute of Hydrology and Meteorology, in wind energy
- the Institute of Water Problems, in hydro-energy

Universities are also performing NNE research, in support to their teaching activities :

- in solar energy (photoelectric and photo-thermal conversion are the principal technologies for utilisation of solar energy)
  - Technical University – Sofia: monitoring of photovoltaic systems, concentrators ; thermal systems – design, monitoring.
  - Technical University – Gabrovo: monitoring of photovoltaic systems.
  - Technical University – Varna: monitoring of photovoltaic systems.
  - Southwestern University – Blagoevgrad: photovoltaic systems – application and monitoring.
  - Institute of Apply Physics at the Bulgarian Academy of Sciences, Plovdiv – photocells.
  - Institute of Non-ferrous Metallurgy – Ltd., Plovdiv – fabrication of silicon .
  - National Institute of Hydrology and Meteorology at the Bulgarian Academy of Science – measuring of solar radiation, simulation.
- in biomass

[11] We have not been able to collect information on coal, petroleum and hydro power RTD (except regarding CLEPS)

- Agricultural University – Plovdiv: energy potential evaluation.
- University of Forestry – Sofia: energy potential evaluation for different kinds of biomass.
- Technical University – Varna.
- Technical University – Sofia: bio-diesel fuels.
- Research Institute of Agriculture Mechanisation and Electrification – Sofia: plant waste combustion.

- in geothermal energy
  - Technical University – Sofia: design and evaluation of thermal pumps, heat-exchangers and thermal installations.
- in wind energy
  - Sofia Energy Agency: investigation on wind energy potential.
- in hydro-energy
  - Technical University – Sofia.
  - "Energoproject" Institute.

5 Current NNE RTD priorities relevant for ERA in NNE RTD

Photovoltaic and solar energy are involving many Bulgarian research organisations. As the CLEPS (Central Laboratory of Electrochemical Power Sources) is one of the leaders in Electrochemical Power Sources RTD, this thematic could also be considered as relevant for ERA.

6 Description of Priority setting process

RTD priorities are mainly an internal process within research units. For example at CLEPS priorities are defined by department leaders and approved by the scientific council of the Institute.
European Framework Programmes are said to be very influent on the research projects, according to the Director of CLEPS (Central Laboratory of Electrochemical Power Sources). He is pushing his researchers to have international collaborations because the funding amounts are bigger than the national ones.

The National Council/Fund for Scientific Research evaluates scientifically the proposals. From our point of view, this is the main governmental interlocutor regarding RTD matters. In an ERA perspective, this institution could be considered, in the future, as the focal point for eventual priority settings.

Annexe A Acronyms

BAS	Bulgarian Academy of Sciences
CLEPS	Central Laboratory of Electrochemical Power Sources
ERA	European Research Area
EU	European Union
FP	Framework programme
GDP	Gross domestic product
NATO	North Atlantic Treaty Organisation
NNE	Non nuclear energy
NSC	National Science Council (i.e. NSF, National Science Fund, or National Council for Scientific Research)
POEMES	Portable and Emergency Energy Sources
RTD	Research and technical development
SENES	Central Laboratory of Solar Energy & New Energy Sources
SME	Small and medium enterprise
TPES	Total primary energy supply

Country study Cyprus

Contents:

1 Summary of country study indicating main points for synergy

Cyprus is highly dependant on energy imports, which are mainly oil products: in 1999 the cost of imported energy represented more than 70% of the country's earnings from domestic exports. 4.5% of its energy comes from renewable energy sources. The Government is aware of the necessity to develop non nuclear energies in general. It has formulated and is implementing a comprehensive energy policy, which contains clear objectives of development of renewable sources of energy, with concrete application measures.

So far **it has not considered Research and Technological Development as a priority**. In the island, the amount spent in RTD is about 0.25% of the Gross Domestic Product, half of it being financed directly by the government, 17% by the business community, and the rest being financed by the University of Cyprus and foreign sources of funding.

Nevertheless, during the last few years RTD activities in Cyprus have been significantly expanding, mainly as a result of the establishment of the University of Cyprus. Moreover, the participation of Cyprus in the Fifth Framework Programme for Research, Technological Development and Demonstration Activities of the European Union, is considered of utmost importance, as it plays a catalytic role to the expansion of research activities and enables Cypriot scientists to create networks of co-operation and interact with their European colleagues. Additionally, the increase of research activities undertaken by a number of research organisations, in the public as well as in the private sector, as well as the establishment of the Research Promotion Foundation - an institute responsible for the co-ordination and support of research activities - has also been important steps towards the promotion of RTD in Cyprus.

Given the recent participation of Cyprus to European programs, and the youth of its only University, Cyprus organisations are not much engaged in European co operations. The main country with which co operations take place is Greece, because its characteristics are similar to Cyprus' ones. The Ministry of Commerce and Industry, which is the competent authority for energies issues set up the following priority themes of research in terms of non nuclear energies.

- Solar energy
- Hydro energy
- Wind energy. This last theme is exploratory research only.

2 Main points for collaboration

2.1 Necessary conditions for making ERA happen

2.1.1 Good practices

European equipments facilitate Cyprus research, since the country cannot afford to buy expensive equipment.

2.1.2 Barriers to collaborations

Efforts to develop RTD activities are constrained by the small size of the Cyprus economy. Its enterprises are small size companies often family run. This does not favour the development of industrial research, because lots of small size companies cannot afford to spend large amounts of funds in RTD.

Moreover, in a small country like Cyprus, where family firms compete among themselves on the local market, there is no tradition of collaboration and trust, either between companies or with the local R&D infrastructure.

Additionally, the University of Cyprus which was created in 1992 is very young, and has a lack of experience in terms of collaborations.

2.2 Existing opportunities for ERA

2.2.1 Thematic complementarities / synergies

The Cyprus government is willing to explore the potential of renewable energy sources of Cyprus. It deals mainly with solar energy, biomass and wind energy. As a consequence any collaboration at an international level that would support these aims would be favoured.

The national Contact Point for the 6th FP on Sustainable development, global change and ecosystems explained that there were "many" RTD European collaborations in the field of Non Nuclear Energies, but he could give no synthetic overview information on that field. Examples of current approved projects given by the National Contact Point for the FP6 were often demonstration projects, and the few projects on applied research were on biomass, and combined heat themes.

As there are no car manufacturers in Cyprus, no RTD is undertaken between the fields of transport and energy. Nevertheless, there are some work undertaken in RTD in energy in the environment theme; Biomass is an example of such activity.

2.2.2 Institutional complementarities / synergies

Networks are promoted through the COST Programme, which has developed into one of the largest frameworks for research co-operation in Europe. The Government has constructed the necessary organizational structures and mechanisms for the promotion of the participation of Cypriot scientists in the Programme.

There is a wish from the part of the government to set up institutional Research in Cyprus, and it seems that this could be supported by an increase in funding from the European Community according to the OPET contact.

2.2.3 Type of research

The type of the projects depends widely on opportunities. In general, Cyprus organisations work on small size projects.

The increase in the business sector contribution to R&D spending is partly the result of the participation of Cyprus in the 5th EU Framework Programme for RTD and the increased amounts granted to businesses within the framework of the programmes to finance research projects managed by the Research Promotion Foundation.

2.2.4 Opportunities for international co operations

Most collaborations are performed with Greece, and there has been some common projects in the past gathering German and Israeli firms. Actually, neighbouring countries such as Greece work in similar fields in the area of energy , and it is very helpful to work with them, because it creates synergies according to Ioannis Chrysis from the Applied Energy Centre.

Cyprus is promoting the participation of research institutes to European programs, especially in the frame of Mediterranean revised policy (LIFE, AVICENNE, MED-CAMPUS, etc.), from the INCO program, and from some other projects.

As for the mobility of researchers, the national Contact Point for the 6th FP on Sustainable development, global change and ecosystems explained that there is a net export of researchers who find better living conditions and work opportunities abroad. The Research Promotion Foundation is in progress to implement an Internet portal that would facilitate and advise on research mobility and research work opportunities in Cyprus.

2.3 Concrete possible policy actions

An expert suggested to provide simplified applying information for European projects to companies, in order to increase the participation of companies to European projects. Actually, he found out that there are less companies financing and performing research than public institutions.

It seems that Cyprus research entities feel they are far from the European decision centres, and they are badly informed on what happens at the European level. Therefore, the national Contact Point for the 6th FP on Sustainable development, global change and ecosystems suggested that in order to foster the creation of the European Research Area (ERA), and to improve the co operations in NNE RTD, some further meetings should be implemented by the European Commission. It could also be undertaken under the COST Program, under the European Science Foundation, or under a pan European entity. This would develop networks further, and ease communication with remote countries.

3 Short background information

3.1 The overall energy situation of Cyprus

3.1.1 Distribution of energy sources

The final energy consumption per capita in 1998 was 1.56 millions of Tones Oil Equivalent (TOE)[12]. Cyprus does not have any indigenous fossil-fuel resources. It is almost totally dependent on imported energy products, mainly crude oil and refined products. Solar energy is the only indigenous source of energy in Cyprus. The contribution of solar energy to the energy balance of the country is about 4.5%.

Solar energy is utilized extensively by households and hotels for the production of hot water. Indeed, Cyprus is a leading country in installed solar collectors per capita (0.86 m2 of solar collector per capita[13]).
Solar energy is also used in non-thermal applications. Photovoltaic cells are in systematic use by the Cyprus Telecommunication Authority and the Cyprus Broadcasting Corporation to power telecommunication receivers and transmitters in remote areas. It is also important to note that the Electricity Authority of Cyprus is now committed to purchasing electricity produced from renewable energy sources at relatively high prices in order to boost the development of these sources.

The government has given no subsidies and the growth of solar energy industry is led by market forces. This growth has been continuous, due to the profitability of solar energy in the island.

3.1.2 Imports

The isolated energy system of the island[14] is almost totally dependent on imported energy. In 1999 the cost of imported energy represented more than 70% of the country's earnings from domestic exports. In 1999 1.2 million toes of crude oil, 50% of Primary Energy Supply (PES), and 1.2 million toes of refined products, 50% of PES, were imported of which 35% were converted to electricity. The only other form of conventional energy used in Cyprus is coal for cement production. Coal accounted for 6% of PES in Cyprus in the same year. Between 1990 and 1999 gross inland energy requirements increased at an average annual rate of 4% in line with GDP growth for the period.

3.1.3 Energy policy

A comprehensive energy policy

In an effort to alleviate the energy dependency problem to the largest possible extent, the Government of Cyprus has formulated and is implementing a comprehensive energy policy. Its main objective is the reduction of the country's dependence on imported energy through rational use of energy, and the greatest possible exploitation

[12] http://www.islandsonline.org/island2010/PDF/cyprus.pdf
[13] Sun in Action, Altener, February 1996
[14] http://www.islandsonline.org/opet/chania/folders/40_Chrysis.pdf

of renewable energy sources. In this framework a number of measures to promote the use of renewable energy sources in Cyprus have been taken.

Main objectives

The main objectives of the country's energy policy can be summarised as follows:

- Security of supply
- Meeting demand
- Energy conservation
- Development of renewable energy sources
- Mitigation of energy consumption impacts on the environment
- Harmonisation of the energy sector with the Acquis-Communautaire

Measures

The energy policy of the country will be supported by an Action Plan which should be ready in 2004. On top of that, a number of measures have been taken, some of which are:

- the establishment of the Applied Energy Centre
- the establishment of the Institute of Energy in 2000
- the operation of grant Schemes
- the national grid utility agreed to purchase electricity generated from renewable energy sources

3.1.4 Market concentration

The Electricity Authority of Cyprus (EAC) is an independent, non-profit making semi-government corporation aimed at exercising and performing functions relating to the generation, transmission and distribution of electric energy in Cyprus.
As a consequence, there is a State monopoly of energy supply in Cyprus.

3.2 The national RTDI system

3.2.1 RTD funding

According to the European Commission, Cyprus suffers from a very low level of R&D expenditure[15] (in 1999 it was 0.25 % of the GDP). By sector, the government accounted for 49 % of this expenditure, the business sector for 20 % (14 % in 1998), higher education institutions for 24 % and private non-profit institutions for 7 %. As regards the sources of funding for R&D activities, 51 % was financed from the government budget, 17 % from the business community (14 % in 1998) and the rest from the University of Cyprus and sources from abroad.

It is worth noticing[16] that the lion's share of Cypriot R&D funds have gone to research in agriculture, leaving manufacturing industry with a very low level of research funding. Indeed, it is a well established fact that manufacturing suffers from relatively low levels of technological development, with little support from public

[15] European Commission http://europa.eu.int/comm/enterprise/enterprise_policy/enlargement/cc-best_directory/research/cyprus.htm

[16] Cyprus 2002: EU accession, economic reform and innovation policy Dr. Bernard Musyckhttp://www.eanpc.org/eanpc/pdfs/epi_2002201.pdf

research institutions and an over-reliance on imported technology in a "packaged" form (purchase of machinery, licensing, etc.). According to Dr. Bernard Musyck, "in this tourism-and-service-based economy, the "innovation framework" was not a real concern"[4].

3.2.2 Definition of research agenda

The planning Bureau defines and co ordinates all government interventions in favour of research, as well as international co operations in that field. This governmental agency defines the strategy, the objectives, and the policy measures that will be needed to implement the strategy. It also provides direct financing to research organisations, and prepares a proposal for a development plan. Additionally, the Planning Bureau participates to committees related to RTD with the European Commission, and for bilateral agreements. In order to implement the scientific and technical policy, the planning Bureau works with the Research Promotion Foundation.

The Research Promotion Foundation is a non profit independent institution created in 1996 and financed by the government. It is used as an interface with the scientific community. The Research Promotion Foundation manages all activities related to program financing and administration of European Programs such as the FP 6th.

The aim of both entities is to co ordinate and support scientific and technical research, and is made though financial aids given to RTD projects and though the creation of databases which are of interest for the scientific community.

4 Brief description of NNE RTD organisation

4.1 Main actors (national and regional level)

Applied Energy Centre; the Centre was established in 1986 to serve as the focal point for all renewable efforts in the country. It oversees the implementation of the national renewable energy program, the main aim of which is to bring viable renewable energy technologies to a level of wide scale acceptance. Its main roles are to promote and disseminate renewable energies. According to an OPET contact in Cyprus, working at the Applied Energy Centre, there is currently no research on Non Nuclear Energies in this organisation, although there has been some in the past.

Institute of Energy; the Institute was established in 2000. Its main aim is the development and promotion of renewable energy sources and the dissemination of financially viable energy technologies in Cyprus. It closely collaborates with the Applied Energy Centre.

Agricultural Research Institute (ARI); it was founded in 1962 as a co-operative venture of the Government of Cyprus, the United Nations Special Fund and the FAO. In 1967, it became the responsibility of the Government and is entrusted with applied agricultural research responsibilities. According to the OPET contact from the applied

Energy Centre, this entity is performing research in terms of greenhouses gases and biomass.

University of Cyprus; it started operations in academic year 1992-93 with four Schools (Humanities and Social Sciences; Pure and Applied Sciences; Economics and Administration; Letters) and eleven Departments. The promotion of scientific research is one of the major objectives of the University, which it pursues through a large number of research projects, mainly in the fields of information technology, environment, biotechnology, energy, archaeology, mathematics and statistics, physics and chemistry, Greek studies, Turkish studies, economics and education.

Frederick Institute of Technology depends on the Ministry of Commerce and Industry, and has some activities of RTD transfer. It does not performs research.

4.2 Expected future evolution

According to the OPET contact from the applied Energy Centre, Cyprus is very dependant on imports of energy, and the government would therefore approve a further development of Non Nuclear Energies such as solar, biomass, and wind energies. The involvement of the government is further explained in the above mentioned Action Plan.

5 Current NNE RTD priorities relevant for ERA in NNE RTD

According to the National Contact Point for the 6th FP on Sustainable development, global change and ecosystems, most priorities in Non Nuclear RTD in Cyprus come from the Ministry of Commerce and Industry, because it is the competent authority for energies issues.
Current priorities in that field are to develop:

- renewable energy sources
- production of energy
- hydrogen technologies
- application of renewable energy sources in the industry
- application of renewable energy sources in the agriculture sector
- energy saving systems

The current priority themes of research are

- solar energy
- hydro energy
- wind energy. This last theme is exploratory research only.

The National Contact Point for the FP6 on Sustainable development, global change and ecosystems was unable to give the corresponding funds dedicated to each priority, and which part of it would be dedicated to RTD. As a consequence, it is not possible to assess the importance of these priorities.

6 Description of Priority setting process

6.1 Priority setting process

Scientific and technological research in Cyprus, is promoted through the annual Programme of the Research Promotion Foundation for financing of research projects. Within the framework of the first three calls, the programme supported a number of topics defined in advance, which attracted a total of 259 proposals. Taking into consideration the evaluation of the proposals, 50 of them are currently financed. The available amount for financing proposals in 2000 was 1,2 millions Euros (0,5 and 0,8 million Euros in 1998 and 1999 respectively). The Foundation, which is an independent organisation supported by the Government, is also responsible for the management of the European research Programmes.

A permanent committee of advisers composed of representing persons from each ministry, gathers to set up the priorities of the Research Promotion Foundation. According to the National Contact Point for the 6th FP on Sustainable development, global change and ecosystems there would be no public opinion push to increase renewable energies.

6.2 Incentives

Two grant schemes are currently in operation, the first one provides financial incentives in the form of governmental grants for the materialisation of investments in the field of energy conservation and the substitution of conventional fuels with renewable energy sources. The grant is set at 30% of total investment cost, with the maximum amount of grant not exceeding 52000 Euro. Beneficiaries are existing enterprises, which operate in the sectors of manufacturing industry, hotels and agriculture. The second Scheme provides financial incentives for the installation of plants for the treatment of animal manure, including anaerobic digesters.

6.3 Research evaluation

According to the OPET contact, the Cyprus Research Institute and the University of Cyprus both elaborate yearly a report on what research was undertaken in their organisation.

According to Dr. Bernard Musyck in Cyprus 2002: EU accession, economic reform and innovation policy[17], incentives which were made available, such as financial grants for new technology, environmental protection or export of high tech products, were never really evaluated.

This situation of low support activities is about to change, because a call for tender for external evaluator are to evaluate all processes of the Research Promotion Foundation and research programs. The government has also decided to ask for external advisers to evaluate all the RTD administration system.

[17] http://www.eanpc.org/eanpc/pdfs/epi_2002201.pdf

7 Sources

7.1 Contacts

Ioannis Chrysis, Applied Energy Centre

Dr. Kadis, National Contact Points for the 6th FP Sustainable development, global change and ecosystems, Research Promotion Foundation

7.2 Internet Web sites

http://europa.eu.int/comm/enterprise/enterprise_policy/enlargement/cc-best_directory/research/cyprus.htm European Commission

http://www.research.org.cy/index.php?s=2 Research Promotion Foundation

http://www.eubuero.de/arbeitsbereiche/beitritt/isa/ncps/ncpcy National Contact Points for the 6th Framework Programme in Cyprus

7.3 Pdf documents

Dr. Musyckhttp, Bernard: Cyprus 2002: EU accession, economic reform and innovation policy, Nicosia, 2002, Pdf.
http://www.eanpc.org/eanpc/pdfs/epi_2002201.pdf

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Country study Czech Republic

Contents:

1 Summary of country study indicating main points for synergy

The Czech Republic is a relatively small country with 10, 3 million inhabitants, and makes part of the accession countries entering the European Union in 2004. Its energy production is mainly based on brown coal and two nuclear power plants. Renewable energy is marginal today, but shall increase according to the Czech Energy policy and according to accession agreements with the European Union.

Even if some competent research institutes can be identified in the Czech Republic, and the success rate of applicants to FP5 in energy research corresponds to the European mean, it is rather limited in absolute terms, and covers most often applied research.

The integration to the European Union and the European Research Area is perceived by our Czech interlocutors as an important chance, impacting both on the research system and on research in NNE, through the intensification of international exchange and priorities given by the framework programmes.

International research collaboration and mobility of Czech partners is not limited to European projects, but also happens on the basis of intra-institutional cooperation agreements with universities abroad, notably in Austria, Germany or France. As it holds for other accession countries, Czech contacts with the Visegrad countries are very rare, some contacts exist with the Slovak Republic, with which it was a single country (Czechoslovakia) until 1993.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

“We expect them to help us to find a better way” – This statement of one of our interview partners concerning ERA and the role research policy has in the Czech Republic seems representative for a very positive attitude, at least of the people we could meet, towards their accession to the EU and their integration into ERA. Another interview-partners stated that “there will be new options to increase research, as we will be part of ERA. This will lead to the establishment of some research centres, connected to other countries”. Due to the announced increase of the public budget for research, “the research ministry will have money to support research in every university”.

Due to missing data, no robust overview exists about international collaboration. According to the head of an energy research department in a Czech university and former member of the European Programme Committee, his institute collaborates mostly with Czech partners as it is mainly based on Czech funds. On a bilateral level, there exists a mobility agreement with the Technical University of Vienna in Austria, that can support some small activities, outside FP6. An other partner is the Technical University Dresden in Germany. Students mobility is also important and financed through Socrates. Mobility does not only go in one direction: students from France, Austria, Germany or Turkey are also coming to the Czech university.

Collaboration is not limited to mobility, there is also some collaboration in research outside the framework programmes. As our interview partner states, "it is not so easy to penetrate FP6. We only have two projects FP6 in energy in our university". Bilateral collaboration is based on long term contacts, as for instance with French universities. They concern common publications, the organisation of conferences, participation in programme committees and so on, mostly in the field of applied research and often with industry participation.

As it holds for other accession countries, Czech contacts with the Visegrad countries are very rare, some contacts exist with the Slovak Republic, with which it was a single country (Czechoslovakia) until 1993.

ERA is perceived as very efficient, notably concerning the possibility of dissemination of results through workshops.
The weakness of the framework programmes from a Czech point of view is related to the missing support of the participation of research organisation from accession countries. One of our interview partners stated: "The main proposers are well known. They have no reason to ask for new partners. Formerly, the participation of an accession country was a plus point". Another interlocutor said that "if you don't have pre-existing contacts, you have very little chance to become a partner, only with extremely good results. Or you have already participated in a project…".

The size of the FP6 projects is perceived as too big to be involved as project coordinator. Even in FP5, there was no Czech project coordinator, but, according to the Czech National Contact Point, "we tried to push people to coordinate. But this does not make sense any more, the projects are too big. Projects have a bigger budget than the budget of a Czech research department."

The interview partners mentioned that it would be interesting

- to know good practice in the organisation of energy research in other countries, to invite some policy makers
- to understand the flows and the evaluation of IPRs through practical presentations with industry.

Concerning energy research it has to be beard in mind that it is more applied than other topics.

3 Short background information

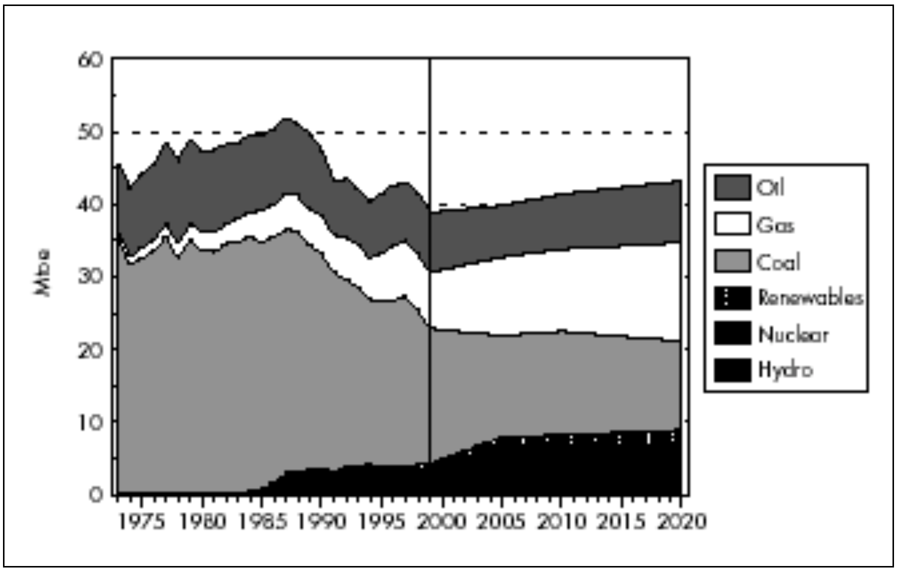
3.1 The overall energy situation of the Czech Republic

3.1.1 Energy supply and energy production

The Czech domestic energy production is dominated by coal production (85% in 1999), followed by nuclear energy. Other fossil fuels (gas and oil) are imported (see

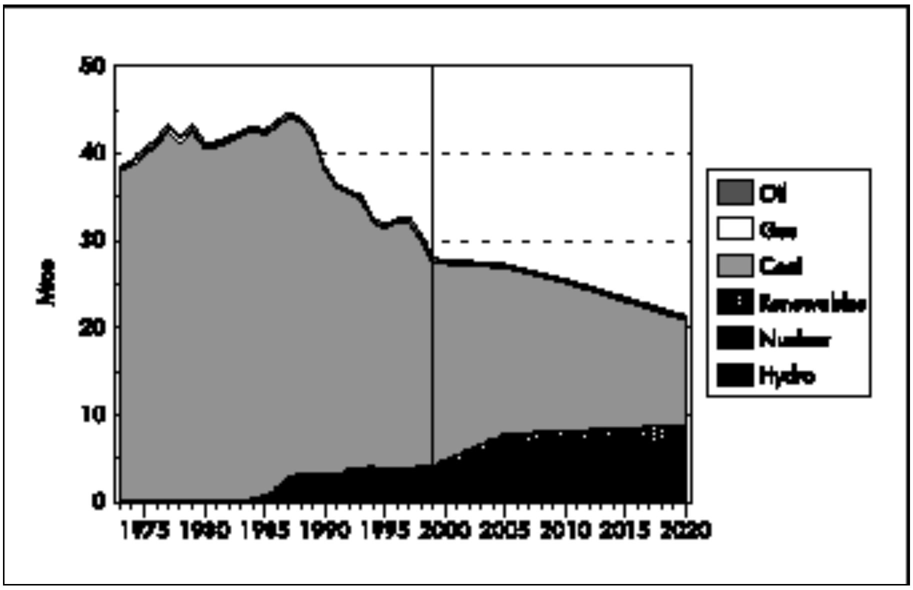
Exhibit 3-1 and Exhibit 3-2). In 1999, domestic energy production covered 51% of TPES. According to the IEA report[18], security of energy supply is an important objective of Czech energy policy. Hydrocarbon imports have been diversified since 1996. The cost of energy imports represented 5% of GDP in 1998, a figure expected to remain stable over the next decade.

Exhibit 3-1 Primary Energy Supply, 1973 to 2020



Source: IEA Country Report 2001

Exhibit 3-2 Energy Production by Fuel, 1973 to 2020



Source: IEA Country Report 2001

The growing share of natural gas in direct applications and district heating has reduced the importance of brown coal, which still dominates in power generation. The part of renewables in energy production is marginal but growing.

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18 IEA: Energy Policies of IEA Countries, Czech Republic 2001 Report

Energy transformation and consumption under the centrally-planned system exerted considerable stress on the environment. Thanks to dedicated policies and investment, performance has improved in terms of greenhouse gas emissions and pollutants which, however, remain much higher than the average in OECD Europe[19].

3.1.2 Energy policy

The energy situation inherited from half a century of central planning was characterised by isolation from the international market, high energy intensity, heavy dependence on solid fuels and dependence on hydrocarbon imports from COMECON countries at politically-controlled prices. The Czech Republic has gradually reformed its energy markets and opened them to international trade and competition without experiencing supply disruptions. The government's energy policy was embodied in the 1994 Energy Act, which was largely consistent with basic policy objectives of the European Union. It aims at diversification of energy supply through the development of nuclear energy and new hydrocarbon imports.
In January 2000, a new "Energy Policy" paper was approved by the government. It contained new objectives up to 2020, including the acquisition of reliable, safe and environmentally-acceptable energy supplies to support economic competitiveness. Based on this paper, a new Energy Act came into effect in January 2001.

The following basic objectives are respected in Czech energy policy:

- Assurance of economically favourable use of domestic primary energy sources
- Specification of public service obligations, or those in the general economic interest
- Achievement of accordance between economic and social development and protection of the environment of the Czech Republic, its regions and localities
- Gradual assurance of common objectives with the EU, including implementation of legislation applicable for the energy sector.
- Expansion of freedom for final customers to decide about the type or sources of energy supplies and services
- Creation of transparent and relatively stable material and legislative conditions for effective management of business processes by energy and energy service suppliers.

In the context of accession to the EU, the compliance with EU legislation is one of the driving forces in Czech energy policy. The list of objectives cited above shows that research and technological development don't rank within the major policy objectives.

On a more operational level, the Ministry of Industry and Trade has also developed a "National Programme for the Energy Effective Management and the Utilisation of Renewable and Secondary Sources of Energy" for a four years period, starting in 2000. Here as well, the "preferential domains of the implementation"[20] of the

[19] See IEA: Energy Policies of IEA Countries, Czech Republic 2001 Report

[20] - Integration of the energy efficiency objectives […] into other energy politics and programmes
- Enforcement of a support for the existing energy savings projects, measures and activities to ensure their repetition and dissemination
- Support for the utilisation of renewable and secondary sources of energy.
See MIT, National Programme.

programme don't concern research or development objectives, but only dissemination, even if some R&D projects have been supported, at least until 2002.

3.2 The national RTDI system

3.2.1 Recent developments in strategic policy formulation[21]

In the first half of 1997 the Government adopted new Principles for Research and Development. The Principles established both the system and the amount of State support of research and development, legal regulations and all other documents in this field pertaining to the forthcoming accession of the Czech Republic to the European Union. One of the aims which the Government stipulated by these principles was to increase - regularly and according to economic possibilities - the direct financial support of research and development so that the support at the moment of the accession of the Czech Republic into the European Union represents at least 0.7 % of the gross domestic product. Another important step in fulfilling the new principles was the formulation of the "Rules of Assessment of Research Intentions and Results of Organisations for the Purpose of Provision of Institutional Support to Research and Development".

At the beginning of the year 2000 the Government adopted the "National Research and Development Policy of the Czech Republic." This proposal was prepared by the Ministry of Education, Youth and Sport and the Council in the co-operation with other bodies and institutions.

The same resolution by which the Government approved the "National Research and Development Policy of the Czech Republic" also authorised the creation of two independent new acts - one on research and development and the other on public research institutions. The Government also decided upon the elaboration of the proposal of the National Oriented Research Programme.

A new act on research and development, Act No. 130/2002 Coll., on State-Funded Support of Research and Development and on the Amendment of Certain Related Acts, was prepared by the Council in co-operation with the Ministry of Education, Youth and Sport and a large number of other relevant bodies and institutions with respect to the incoming accession of the Czech Republic to the European Union. The act governs the system of research and development support from public funds, public tenders in research and development, procedures of research intentions assessment, the provision of information on research and development, and stipulates the rights, obligations and assignments of bodies, authorities and institutions involved in research and development. The act became effective on July 1, 2002.

3.2.2 R&D expenditure

The Gross Expenditure for R&D (GERD) amounts to some 1,35% of GDP[22], out of which a "smaller half" comes from the State budget, which in 2002 contributed by 0,59% GDP to GERD. The R&D system has undergone substantial changes since

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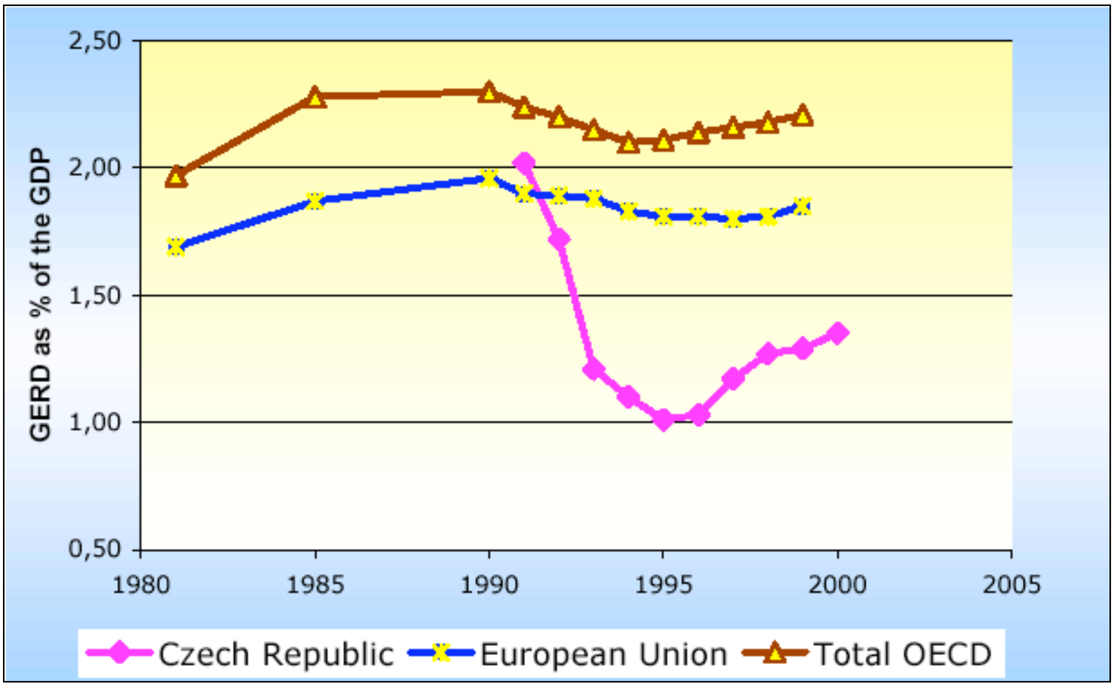
[21] This paragraph is based on Office of the Government of the Czech Republic: research and Development Council, Prague 2003.

[22] See : http://www.czechrtd.info, based on OECD

1989, for instance a functioning system of grants and public tenders was set up: The necessary reform of State financing of R&D was mainly focused on changing its structure: financing realised via newly established grant agencies and tenders became more and more important.
In the second half of THE nineties, the time dynamics of the Gross Domestic Expenditure on R&D expenditures was positive (see Exhibit 3-3).

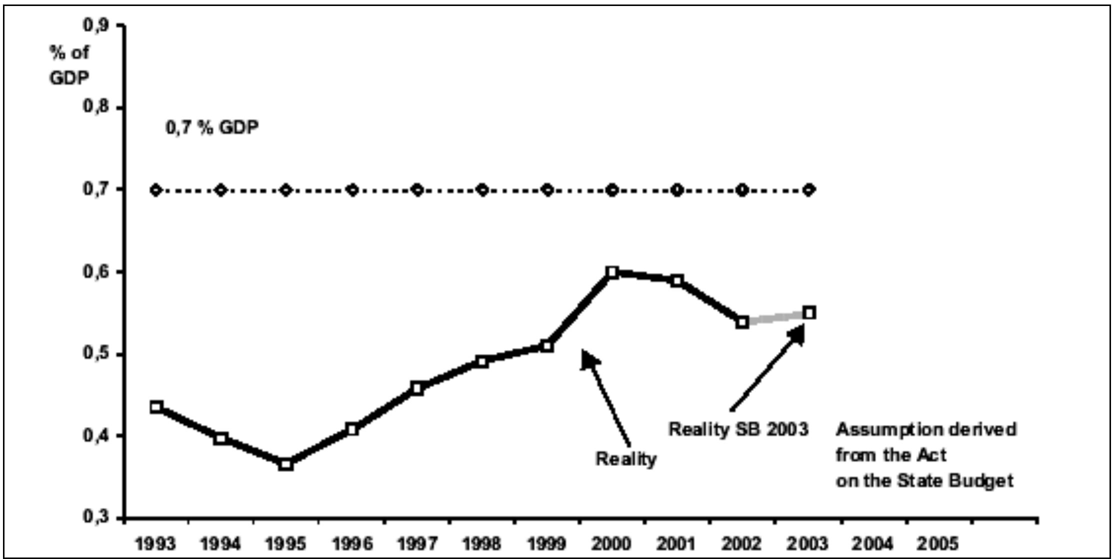
Exhibit 3-3 Comparison of the levels and time trends of the Gross Expenditure on R&D (GERD) in the Czech Republic, EU-15 (average) and OECD countries (average).



Source: http://www.czechrtd.info, based on OECD Science, Technology and Industry Scoreboard 2001, Towards a knowledge-based economy.

The development of the amount of total State-funded research and development support since 1993 is illustrated by Exhibit 3-4:

Exhibit 3-4 Research and development support from the State Budget, 1993-2003



Source: Office of the Government of the Czech Republic : Research and Development Council, Prague, 2003

According to the Research and Development council,

> "It is obvious from this figure that the amount of research and development support from state funds expressed by the standard indicator (i.e., share of the GDP) had been increasing only until 2000 when it reached the peak value during the existence of the Czech Republic, 0.6 % of GDP. A slight decrease in 2001 and a substantial decrease in 2002 was due to the fact that the Government and individual governmental departments began to give preference to short-term measures with instant outcomes over longer-term ones, research and development being among the latter. The obligations of the Government both to the EU and to Czech society expressed by the governmental resolutions thus were not fulfilled."

In the Czech Republic a slight increase of total **R&D expenditures in private sector**[23] is apparent in the period 1995-1999. Even though the number is twice as large as in Poland and Hungary, however it is half-size in comparison with the EU countries average. The situation has not substantially improved in recent years. As a result, the Czech Republic lags behind the EU and other developed countries with regard to expenditures on private R&D. This adverse trend is confirmed by the results of regular surveys conducted by the Confederation of Industry and Transport of the Czech Republic which confirm that large and medium-sized enterprises in the Czech Republic spend 1 to 2% of their annual revenues on research and development. In the EU countries, private firms invest 4 to 10 % of their annual revenues in research and development depending on the respective sector. Moreover, private enterprises in the Czech Republic prefer short-term programmes and tasks expected to bring immediate return of capital. More basic and long-term research is not established and financed. This fact is caused by a number of reasons including practically non-existent indirect support extended to private research and development.

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[23] This paragraph is based on Ministry of Education, Youth and Sport of the Czech Republic: Analysis of previous trends and existing state of research and development in the Czech Republic and a comparison with the situation abroad. Prague, May 2002

In the Czech Republic the previous decrease in the **absolute number of persons involved in R&D**[24] (the total number of employees in R&D dropped from 106 000 in 1990 to less than 40 000 in 1994) has been arrested. Without the FTE adjustment (so called labour force referred to in the sources) the number of persons involved in R&D per 10 000 employees would be 44 in 1995 and 45 in 1996.

3.2.3 Institutional setting of the R&D system

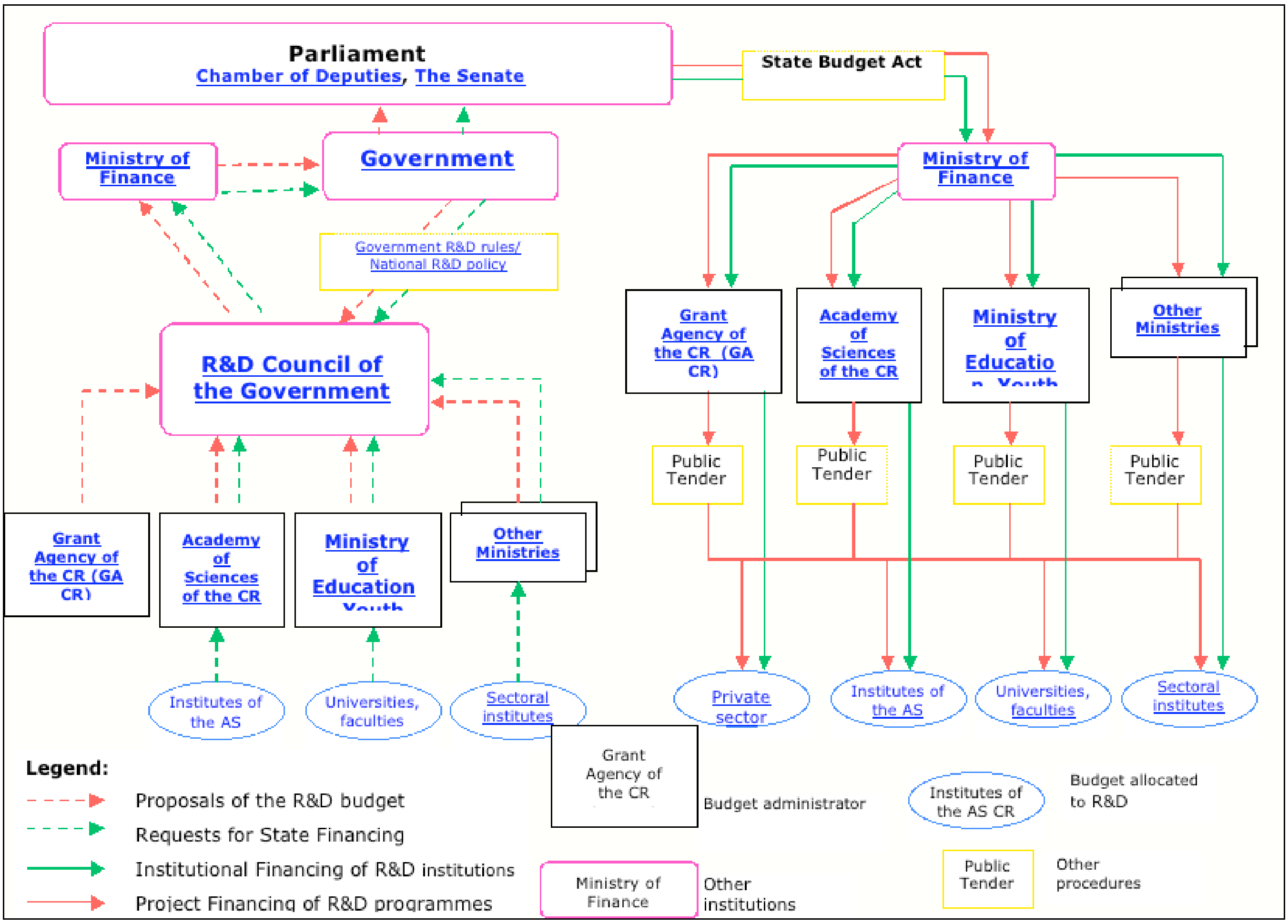
Public research is executed in the Czech Republic by

- 20 public universities
- More than 50 institutes of the Academy of Science
- more than 50 other research institutes.

As it is shown in Exhibit 3-5, funding passes either by the State budget act or by the R&D Council of the Government, and is then either accorded as institutional funding to the Academy of Science and to universities, or through public tender, managed by the Grant Agency of the CR to research institutes (university, Academy of Science, other public institutes or private sector research).

[24] See : http://www.czechrtd.info

Exhibit 3-5 Scheme of the state support of R&D



Source: : http://www.czechrtd.info

4 Brief description of NNE RTD organisation

Through the interviews and written material, we couldn't distinguish a clear "NNE-RTD organisation" in the Czech Republic: Research in this field is mainly undertaken in university institutes, some research in the field of biomass is also done in other agricultural institutes, the Academy of Science seems less involved in NNE RTD. In general, energy research is very oriented towards applied research, the Director of the Energy Policy Department in the Czech Ministry of Industry even states that he doesn't know any field of energy that will be supported by extensive research, only nuclear energy having some regular research base.

In terms of funding, programme specific funding either comes from the Czech Energy Agency (CEA)[25], who is executing the National programme for energy management, or from the environmental fund. However, both of them are oriented towards applications and not so much towards research.

Within the State programme for energy management, a part is support for the development and use of state-of-the art technology and materials for increasing

25 http://www.ceacr.cz/?page=titulni_en

energy efficiency. In 2002, subsidies amounting to CZK 1,365 million supported 5 projects in this area having a total cost of CZK 16,133 million. New products and technologies are later applied in conservation projects. However, as it is shown in Exhibit 4-1, this budget is less important than the previous one; a report on the 2003 funding indicates no more R1D projects but only demonstration projects in the field of NNE.

Exhibit 4-1 Selected and supported R&D project of the National Programme, 2001, 2002.

	2001	2002
Number of applications	9	
Number of selected projects	6	5
Total costs (CZK)	19 733 000	16 133 000
Provided subsidy (CZK)	4 552 000	1 365 000

Source: Czech Energy Agency

5 Current NNE RTD priorities relevant for ERA in NNE RTD

The transformation of the Czech research system during the last 1,5 decades had a considerable impact on research priorities in this country: According to the Director of the Energy Policy Department in the Czech Ministry of Industry,

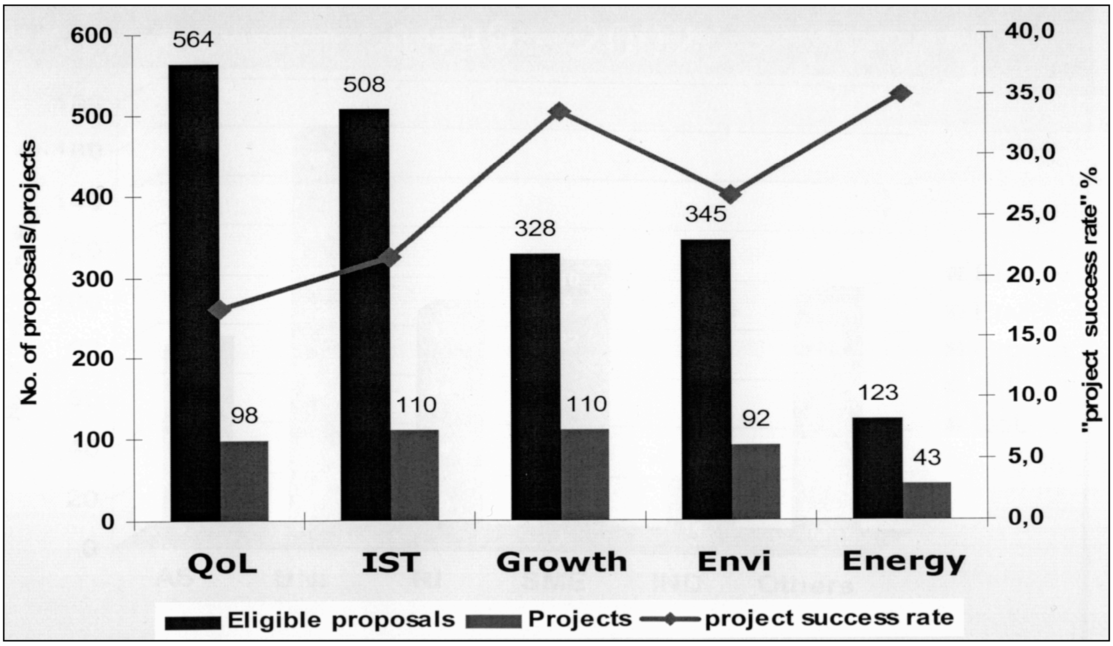
> "Research was very extensive in the past, but we had a shortage of financial means for implementation. I worked for more than 20 years in the research sector, on carbonisation. We had a lot of solutions, but they have never been implemented. After the change, everybody was focussed on implementation by markets, which means short-term income. If you speak about research, you speak about future, not of immediate profit. Our new energy policy would like to stress this point, and attract money for new technologies and methods helping to increase energy efficiency, savings, and environmentally oriented technologies."

Interviews undertaken in the Czech Republic clearly showed that European integration is an important driving force for priority setting in research policy. For instance, the recently started research programme has a similar structure as FP6.

Even if the country is member of the IEA, the IEA R&D database does not provide data on the Czech Republic, so no quantitative analysis of research priorities can be provided.

In terms of participation to FP5, Exhibit 5-1 shows that the success-rate of Czech participation was highest in the Energy programme, but on a lower absolute level than in the other programmes.

Exhibit 5-1 Participation of the Czech Republic in the thematic programmes of the F5 1999-2002



Source: Cejkova, Technology Centre AS CR.

In the domain of NNE, interview partners mentioned a potential for biomass and some potential for wind, and of course a potential for clear coal energy conversion.

An assessment of Czech Republics RTD needs and capacities (see Annexe A) identifies several fields with a high need, differentiating between high and low capacity to respond to this need:

The following fields (technologies / processes / issues) are indicated as "high need and high capacity":

- Combustion
- Small scale combustion plants (< 100kW)
- Policies, barriers
- Environmental issues
- Greenhouse gas and Kyoto related issues

Far more issues are indicated with "high need" and "low capacity":

- Co-combustion
- Fixed bed gasification
- Medium to large scale combustion systems (> 100 kW, < 5 MW)
- Small scale CHP plants (>100 kWel, < 20 MWel)
- Solid fuel upgrading from forestry and wood industry residues
- Solid fuel upgrading from municipal solid waste
- Solid fuel upgrading from agricultural residues
- Solid fuel upgrading from agricultural dedicated crops
- Combustion engines for gaseous fuels
- Combustion engines for liquid fuels

- Fuel cells for gaseous fuels
- Fuel cells for liquid fuels
- Biomass potential and trade
- Socio-economic issues

6 Description of Priority setting process

Recent policy papers on research policy have been presented under the heading 3.2.1. The last version of the National Research Programme (NRP II) was approved by the Czech Government on 28 April 2003. The first projects under this Programme are to be launched in January 2004. It is for the first time based on a national foresight exercise, conceived and organised by the Technology Centre AS CR in co-operation with the Engineering Academy of the CR, both entrusted with the preparation of the proposal of the National Research Programme.

According to our interview partner from the Technology Centre, this new Programme will introduce substantial changes, as it resembles the competencies of different domains under the prime responsibility of the Ministry of Education, whereas the different technical ministries have been in charge for their domain specific research before. In terms of content, "research should reflect the need of the Czech society".

The foresight exercise seems to have worked well, basically as it could count on a good selection of experts, but the results remain rather general then operational. A web-page provides information on the exercise[26], however, detailed information on the research programme are only available in Czech.

Besides the national research programme and the definitions of priorities, the integration in the European Research Area has also considerable weight in the expectation on the development of the Czech research system: National Research programmes do not refer to energy research, but the grant agency supports the participation in EU programmes, so there is an obligation to fund energy research corresponding to the part in the Framework Programme.

Programme evaluation is not yet very developed: the grant agency is in charge of research statistics, but according to one of our interview partners from the Technology Centre of the Academy of Science, these statistics are manly done on the basis of expenditure, without an evaluation on a sector basis.

7 Documentation

Act of 25th October 2000 on energy management

CEA: Analysis of the Government Programme for the Support for Energy Conservation and the Utilisation of Renewable Sources of Energy for the year 2001 – Part 1

[26] http://www.foresight.cz

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Cejkova, Jana: Information on the Czech research system. Presentation, Technology Centre AS CR.

Office of the Government of the Czech Republic : Research and Development Council, Prague, 2003

Ministry of Education, Youth and Sport of the Czech Republic: Analysis of previous trends and existing state of research and development in the Czech Republic and a comparison with the situation abroad. Prague, May 2002

Annexe A Assessment of Czech Republics RTD needs and capacities

	Need		*Capacity*	
Need and capacitiy indication	*High*	*Low*	*High*	*Low*
Technologies/processes/issues			x	
Combustion	x		x	
Co-combustion	x			x
Fixed bed gasifcation	x			x
Fluid bed gasification		x		x
Flash pyrolysis liquid production		x		x
Flash pyrolysis liquid application		x	x	
Small scale combustion plants (< 100kW)	x		x	
Medium to large scale combustion systems (> 100 kW, < 5 MW)	x			x
Small scale CHP plants (>100 kWel, < 20 MWel)	x			x
Medium to large scale CHP systems (> 100 kW, < 20 MWel)		x		x
Solid fuel upgrading from forestry and wood industry residues	x			x
Solid fuel upgrading from municipal solid waste	x			x
Solid fuel upgrading from agricultural residues	x			x
Solid fuel upgrading from agricultural didcated crops	x			x
Ethanol production from starch biomass		x		x
Ethanol production from lignocellulosic biomass		x		x
Feed stock for biodiesel		x		x
Biodiesel producttion		x		x
Liquid fuels from synthesis gas		x		x
Liquid fuels through hydrothermal upgrading		x		x
Hydrogen from biogas ans synthesis gas		x		x
Anaerobic dicgestion of agricultural residues		x	x	
Anaerobic dicgestion of food industry residues		x	x	
Combustion engines for gaseous fuels	x			x
Combustion engines for liquid fuels	x			x
Fuel cells for gaseous fuels	x			x
Fuel cells for liquid fuels	x			x
Biomass potential and trade	x			x
Socio-economic issues	x			x
Policies, barriers	x		x	
Environmental issues	x		x	
Greenhouse gas and Kyoto related issues	x		x	

Annexe B Goals to fulfil the EU electricity target , GWh

	Generation in 2001	Generation in 2010
Wind	0.6	930
Small hydro	826	1 120
High hydro	1 165	1 165
Biomass	5.9	2 200
Geothermal	0	15
Photovoltaic	0	15
TOTAL	1 998	5 445

Source : Cisek, Enviros

Annexe C State budget expenditures on R&D 2001 – 2002, in thousands of CZK

	State budget 2001			State budget 2002		
	Institutional expenditure	Targeted expenditure	Expenditures in total	Institutional expenditure	Targeted expenditure	Expenditures in total
Office of the Government	6 019	2 250	8 269	9 046	2 250	11 296
Czech Security Information Service	0	5 100	5 100	0	5 100	5 100
Ministry of Foreign Affairs	7 000	11 000	18 000	8 050	9 950	18 000
Ministry of Defence	107 400	390 805	498 205	107 400	283 212	390 612
National Security Authority	10 000	10 005	20 005	7 000	12 000	19 000
Ministry of Labour and Social Affairs	36 050	15 800	51 850	38 200	18 140	56 340
Ministry of Interior	9 634	9 466	19 100	11 550	7 550	19 100
Ministry of Environment	201 707	210 849	412 556	201 707	210 849	412 556
Grant Agency of the CR	21 235	1 051 500	1 072 735	23 237	1 051 241	1 074 478
Ministry of Industry and Trade	0	1 200 000	1 200 000	0	1 100 000	1 100 000
Ministry of Transport and Communication	24 550	69 534	94 084	25 400	68 584	93 984
Ministry of Agriculture	244 056	231 235	475 291	266 000	249 000	515 000
Ministry of Education, Youth and Sport	3 408 159	1 325 423	4 733 582	3 408 159	1 322 326	4 730 485
Ministry of Culture	31 104	85 002	116 106	44 523	50 583	95 106
Ministry of Health	253 229	459 329	712 558	253 229	459 329	712 558
Ministry of Justice	12 073	0	12 073	15 973	0	15 973
Cz Office for Surveying, Mapping, Cadastre	16 555	4 250	20 805	18 730	3 550	22 280
Czech Mining Authority	0	23 000	23 000	0	23 000	23 000
Academy of Sciences of the CR	2 465 845	581 687	3 047 532	2 682 012	458 515	3 140 527
State Office for Nuclear Safety	16 500	20 640	37 140	23 750	18 390	42 140
Total	**6 871 116**	**5 706 875**	**12 577 991**	**7 143 966**	**5 353 569**	**12 497 535**

Source: Cejkova, Technology Centre AS CR.

Conversion: 1000 CZK = 31,14 Euro at the 01.01.2002

Country study Denmark

Contents:

1 Summary of country study indicating main points for synergy

Danish energy policy has for decades been characterised by the objectives of security of supply and environmental energy system. In addition there has been a strong wish to develop domestic industry based on energy technologies. Denmark has used taxation and rather strong measures to reach these objectives. They can harvest from a sector with domestic production of oil and gas, infrastructure for district heating and natural gas, relatively low energy intensity, a remarkable development in wind industry as well as a high share of wind power in the national supply.

Through liberalisation processes some of the measures are harmonised, but the main objectives remain the same. R&D is a strong component of energy policy, and even attracts political interest and debate. In 2003 a political agreement lead to increased funding for energy R&D.

The R&D system has a strong sector perspective, although basic research is financed by the Ministry of Science. All funds for applied energy research are handled by the Energy Agency (EA). In addition power sector organise this sector's R&D activities based on approval by EA. The Research Agency (RA) is from now on going to approve the scientific content of EA's R&D allocations. This way a fragmented energy R&D system is increasingly co-ordinated.

EA is in the process of developing a number of research strategies (PV, fuel cell, wind etc.). These processes are organised by EA, but involve both industry and research community. EA also has an Advisory Committee for Energy Research. The strategies imply some priority, but still announcement of R&D grants are quite open for proposals.

Participation in EU energy R&D is considered positive, but is not an important criterion in the evaluation of proposals. Also there are very few initiatives or measures to stimulate participation in EU programmes. RA can give support to the development of proposals with Danish co-ordinators.

The priorities in FP6 are viewed as quite well in line with Danish priorities in energy research. The general positions on EU research are developed by Ministry of Science, whereas EA is following the energy-related programmes. A general critique of EU activities is the bureaucracy and time consuming processes, as well as the priority of large projects making it hard for SMEs to play a part.

The following issues are considered relevant for the further development of European NNE R&D in Denmark.

From the EU side

- Increased attention to how social sciences can play a role in the policy making and public debate related to energy market liberalisation, energy and environment issues and innovation based on energy developments could be an interesting use

for the benefit of the whole EU and draw on important experiences from all the Scandinavian countries
- The EU NNE R&D needs a more prominent alternative to the dominant large integrated projects to attract SME participation
- Increased flexibility

From the Danish side
- Development of a strategy on how to reach the general objective of increased Danish participation in EU research.
- Consider whether Danish legal systems allow a more flexible system of instruments, like letting Danish funds go to foreign projects.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

Denmark has had a high project acceptance rate in previous FPs. In general, objectives between EU NNE research and Danish energy R&D are shared to a high extent. Both give high priority to renewable energy, efficient use of energy and the industrial potential of new energy technologies. Also the challenges brought forward by the liberalisation of energy markets are very much at hand for both. In Denmark a R&D programme in social sciences were established early in the 90-ies.

The main Danish interests in the preparatory process of FP6 has been to keep up the interest and financing of wind energy developments, and to underline the barriers felt by SMEs facing the larger Integrated Projects of FP6.

At national level, participation in EU projects is generally seen as a positive aspect of a proposal and of a research group. But supplementary national grants are not automatically given to such projects. To some extent grants are given in the preparatory stages of EU proposals, under the condition that the Danish part is having a coordinating or leading role in the project.

The policy towards EU R&D programmes in general are developed and taken care of in the Ministry of Research. Representation in programme committees on the energy side is, however, taken care of by EA.

International co-operation in energy R&D mainly means EU programmes. Two other organisations play an important role, namely:
- IEA where Denmark takes an active role in the various Implementing Agreements
- Nordic Council, where The Nordic Energy Research Programme is a significant initiative to develop joint competence in relevant technologies. The programme is now developing into a Nordic and Baltic Region programme.

3 Short background information on overall energy situation

The Danish primary energy production was 334 TWh (2002), of which 8.6 % came from renewables and the rest from fossil fuels (oil and gas). Both wind energy and oil production is increasing. The total energy consumption was 229 TWh and has been relatively stable over the last 20 years. In 1997 Denmark reached "self-sufficiency" for the first time in modern times.

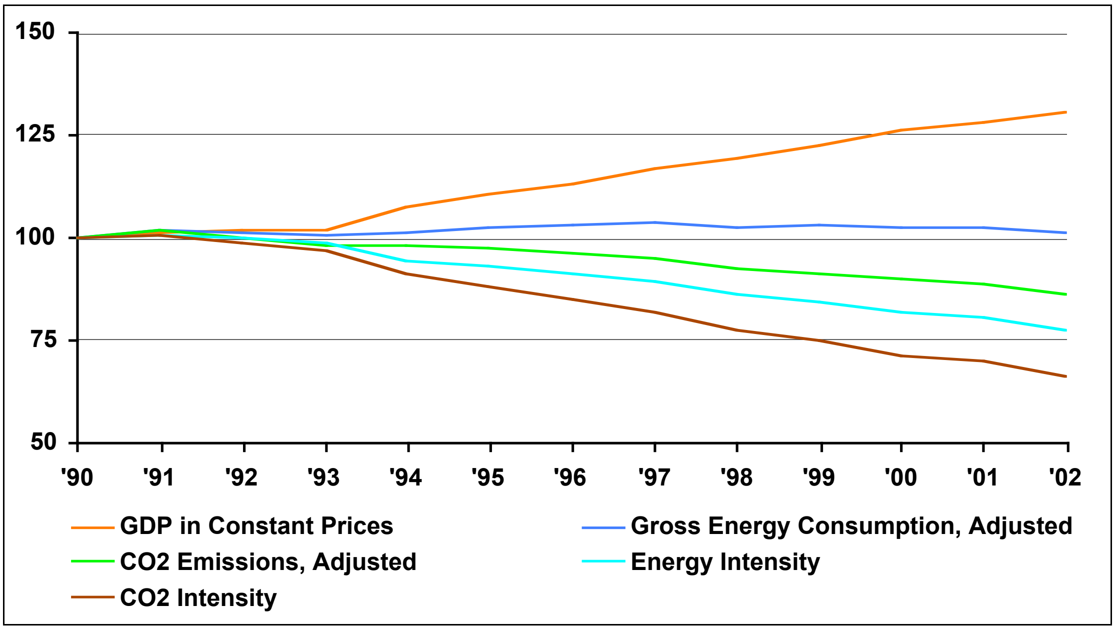
Energy consumption is dominated by coal in the production of electricity. Both natural gas and wind energy (14 % in 2002) takes a growing share. In district heating the role of coal and oil has been reduced by increased use of natural gas and renewables, mostly bio energy.

The household and transport sectors are the largest energy consuming sectors followed by industry, each of them around 20 % of total consumption.

Through an active policy, the Danish Government has reached the goal of self-sufficiency. This has been possible by:

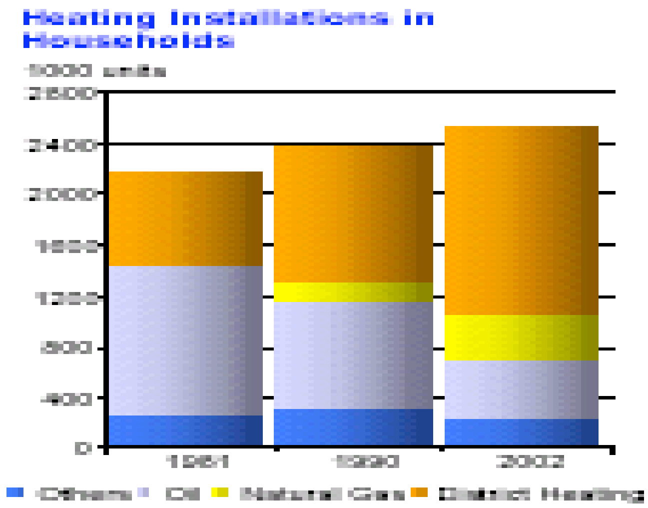
- Increased offshore petroleum production
- Development of infrastructure for natural gas and district heating, mostly in separated areas
- The development of wind energy and bio energy as domestic energy sources.
- Strong focus on reduction of energy intensity in households and industry.
- Significant taxation.

Figure 1 GDP, CO2 and energy consumption.



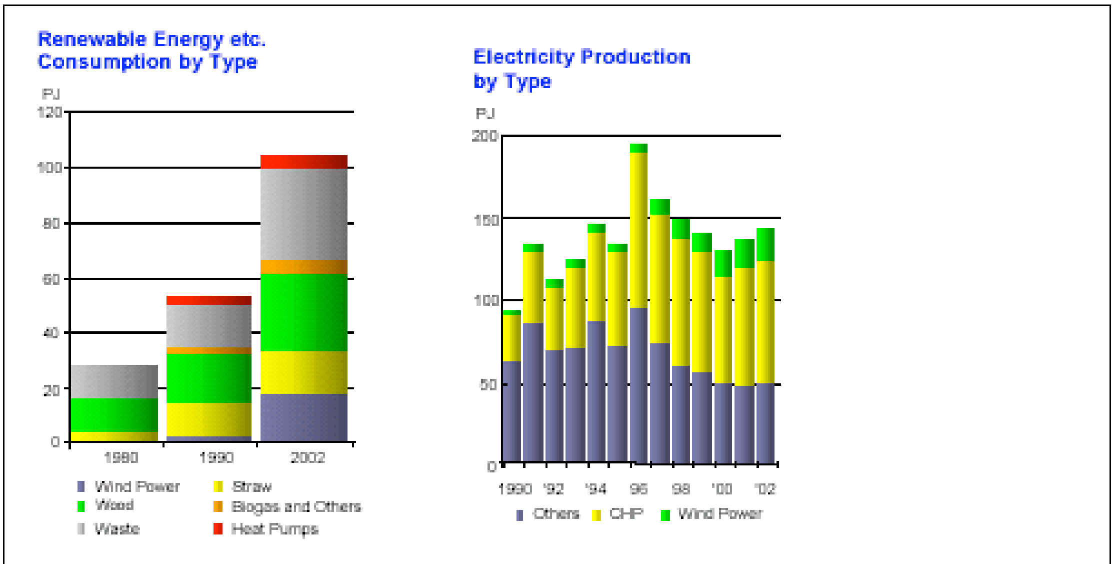
Source: Danish Energy Authority, http://www.ens.dk/graphics/Publikationer/Statistik_UK/uk2002_forl/Graphs_2002.ppt

Figure 2 Heating in installations in households



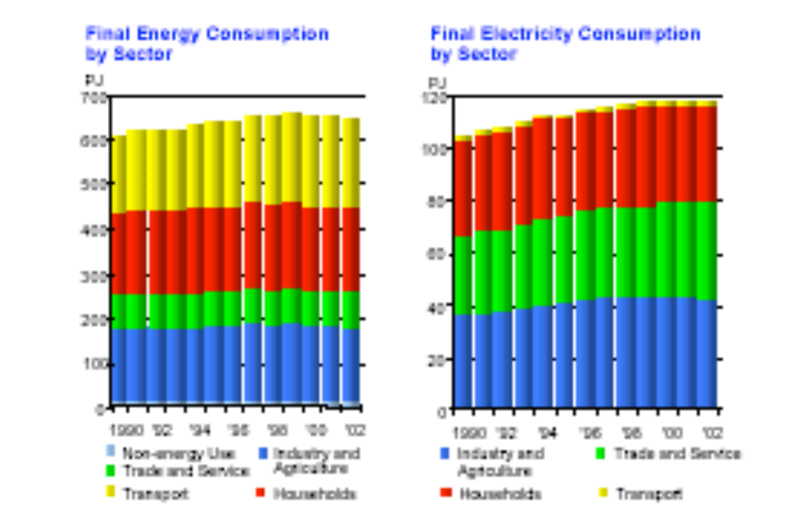
Source for all graphs: Energy Statistics 2002, Danish Energy Authority, http://www.ens.dk/graphics/Publikationer/Statistik_UK/uk2002_forl/Graphs_2002.ppt

Figure 3 Renewable energy and electricity production by type



Source for all graphs: Energy Statistics 2002, Danish Energy Authority, http://www.ens.dk/graphics/Publikationer/Statistik_UK/uk2002_forl/Graphs_2002.ppt

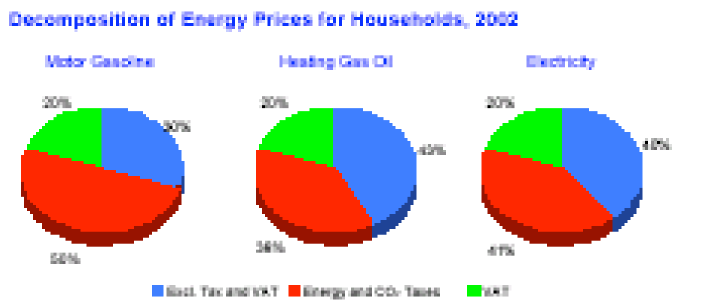
Figure 4 Final energy and electricity consumptions by sector



Source for all graphs: Energy Statistics 2002, Danish Energy Authority, http://www.ens.dk/graphics/Publikationer/Statistik_UK/uk2002_forl/Graphs_2002.ppt

Figure 5 Energy prices for households 2002

Energy Prices for Households, 2002	DKK	Euro
Gasoline Regular (DKK per litre)	8.20	1.11
Heating Gas Oil (DKK per litre)	5.81	0.78
Natural Gas (DKK per Nm^3)	6.18	0.83
Electricity (DKK per kWh)	1.79	0.24



Source: Energy Statistics 2002, Danish Energy Authority, http://www.ens.dk/graphics/Publikationer/Statistik_UK/uk2002_forl/Graphs_2002.ppt

The supply of electricity, heating and gas is covered by a number of political agreements. The political agreements are outlined on the underlying pages, divided into electricity, heating and natural gas. There are some overlaps between the areas, so some agreements can be found under more than one area. A number of the agreements are implemented in legislation.

Since the first oil crisis in 1973, energy policy has occupied a relatively significant position in the political debate in Denmark. The Danish Energy Authority was established in 1976, primarily as a reaction to the problem of security of supply, but gradually the focus also was brought to bear on domestic energy production (North Sea oil and gas, renewable energy etc.), on energy supply and distribution (the natural gas grid, CHP etc.), and on energy savings (insulation, labeling schemes etc.). In addition, international sustainability targets – not least reduction of CO2 emissions – and economic considerations have had a significant role to play in recent years, during which the Danish Energy Authority has administered, for example, subsidies for energy savings and green energy taxes together with a liberalization of the electricity and gas markets.

The long term policy objectives still comprise energy security and environmental sustainability. This leads to more detailed objectives concerning effective use of energy, increased renewable energy production, further development of domestic petroleum resources and further liberalisation of energy markets.

The focus on industrial development is strong throughout the energy sector. Particular interest is devoted to the wind energy industry, as well as petroleum production. In 2001 wind industry exported worth of 20 bill. DKK; 5 % of Denmark's export, and the industry employed 16 000 persons. But there are strong industries also in areas of natural gas, other renewables and environmental technologies in general.

4 National RTDI system

The Ministry of Research is responsible for R&D policy and general funding of research. The Danish Research Agency is their acting part in all matters related to basic and long term research: basic funding for universities, a few R&D institutes like Risø National Laboratory and a few programmes. The Danish Research Agency is an independent institution and serves as the secretariats for The Board of Danish Research Councils (Forum) and the six Danish Research Councils (SHF, SJVF, SNF, SSF, SSVF, STVF) and different programme committees.

4.1 The Board of Danish Research Councils

The Board of The Danish Research Councils consists of 13 members, appointed by the Minister for Science, Technology and Innovation. The Chairman and six other members are appointed in their personal capacity while the six Danish research councils each appoint one member. The Board of The Danish Research Councils handles tasks of common interest and importance to the interdisciplinary and strategic activities of the Danish research councils. The tasks include support for Danish research and scientific advice on research issues.

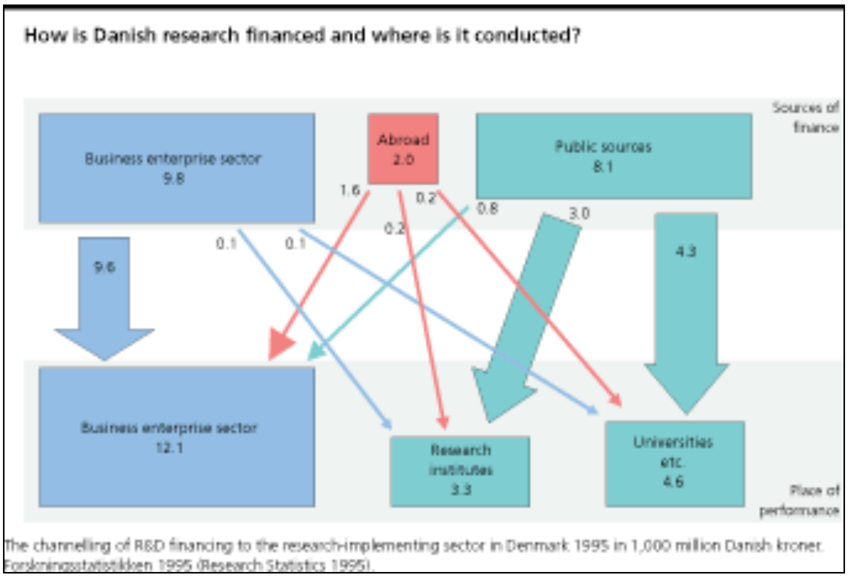
4.2 The Six Research Councils

Each research council consists of 15 members, appointed by the Danish Minister for Science, Technology and Innovation in their personal capacity. The six research councils provide financial support to research activities and research training. Also they provide advice especially to the Parliament, The Ministry of Science, Technology and Innovation, other ministries, The Danish Research Council, public and private institutions. The advice is given either in reply to requests or by making statements on their own initiative.

The organizations and functions of the research councils are determined by the Danish legislation, most recently by the Act on research, advice etc. (1997).. This act determines the total structure of the Danish advisory functions within the research area.

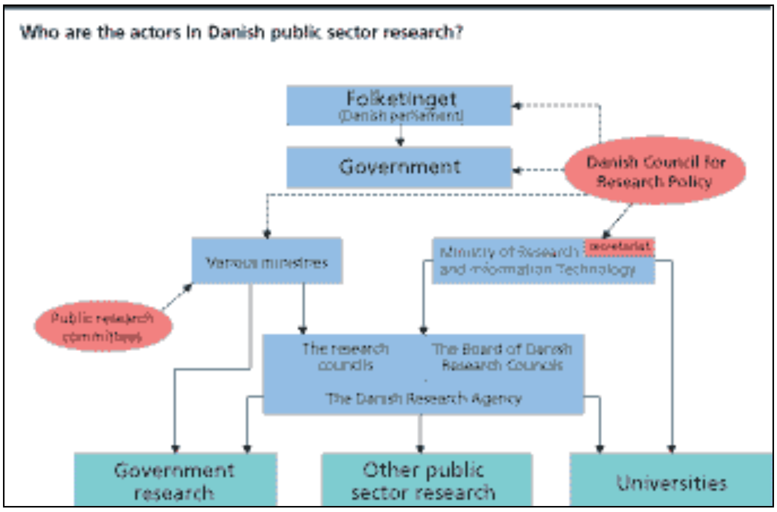
Applied research is a sector responsibility, mostly handled in the sector agency under the respective ministries.

Exhibit 4-1 How is Danish research financed and where is it conducted?



Source: Ministry of Science, Technology and Innovation
http://www.videnskabsministeriet.dk/cgi-bin/doc-show.cgi?doc_id=36806&leftmenu=NOEGLETAL

Exhibit 4-2 Actors in Danish public research?

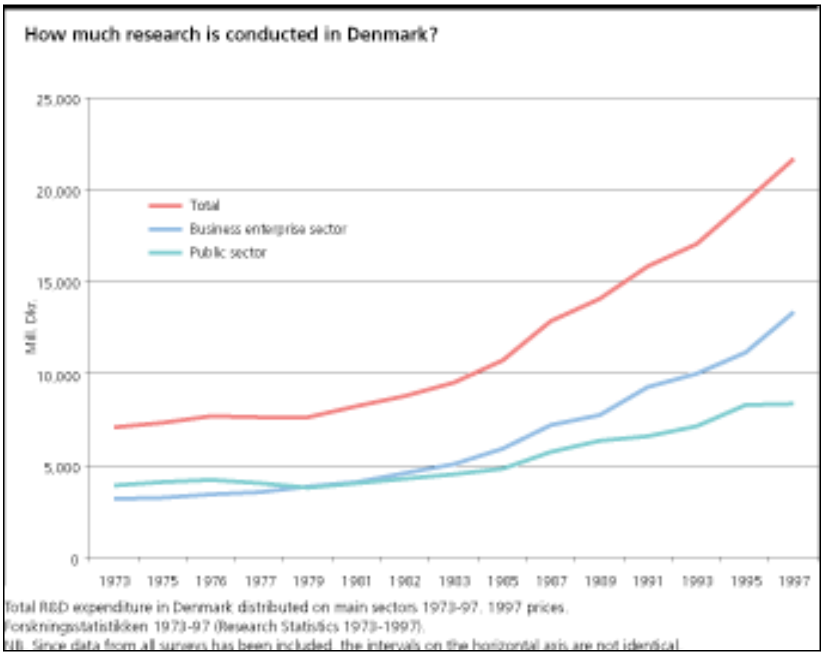


Source: Ministry of Science, Technology and Innovation,
http://www.videnskabsministeriet.dk/cgi-bin/doc-show.cgi?doc_id=36806&leftmenu=NOEGLETAL

The policy toward EU FPs and other aspects are handled by the Ministry of Research, in co-operation with the respective sector agencies.

Denmark has had a steady increase in R&D spending as a percentage of GNP. I 2001 it had reached 2.2 %, as compared with Norway (1.7), Sweden (4.1), Finland (3.2) and EU (1.8). The total volume was 31.8 bill. DKK, of which the public spendings were 31 %. Of Governmental funds for R&D, the Research Councils' share of the funds was 7.8 %.

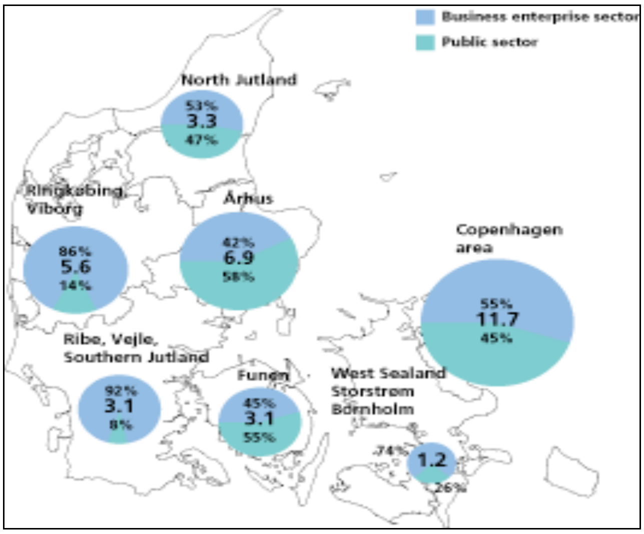
Exhibit 4-3 How much research is conducted in Denmark



Source: Ministry of Science, Technology and Innovation
http://www.videnskabsministeriet.dk/cgi-bin/doc-show.cgi?doc_id=36806&leftmenu=NOEGLETAL

Danish research has a high performance in terms of number of articles in international scientific journals (142 per 100 000 capita in 1999), but is only slightly over the EU average in number of domestic patent applications (30 per 100 000 capita in 1999).

Exhibit 4-4 Geographical distributions of research activities



Source: Ministry of Science, Technology and Innovation,
http://www.videnskabsministeriet.dk/cgi-bin/doc-show.cgi?doc_id=36806&leftmenu=NOEGLETAL

The Danish Minister of research in 2003 proposed a "Knowledge Strategy", taking into consideration the challenges of the future society. In this strategy the conclusion is that

Denmark has the potential to do well in the global knowledge economy although the statistics also indicate that there is room for improvement in certain areas:

- *Danish research is in growth.* The total public and private expenditure on research and development has been on the rise for the last ten years and has reached, as of 2001, a level of more than 2.4 per cent of Denmark's GDP. Although this is above the EU average, it is lower than other leading research nations.
- *The research and development effort in Danish business and industry is rising - but from a moderate level.* Over a ten-year period, Danish business and industry has steadily increased its expenditure on research and development. However, Denmark continues to lag behind other leading countries in this field when considering the business and industry community's R&D expenditure compared to GDP. Danish business and industry invests the equivalent of approximately 1.7 per cent of the GDP in research and development while business and industry in so-called leading knowledge economies invest between 2 and 3 per cent. Furthermore, Danish companies primarily focus on development work that has an immediate commercial objective and to a lesser extent on basic and applied research.
- *A few large - many small and medium-sized knowledge institutions.* The activities in the Danish knowledge system are spread among a relatively large number of knowledge institutions. According to international standards, most of the Danish knowledge institutions are small.
- *The level of education in Denmark has greatly improved in the last 20 years.* In Denmark, 27 per cent of the adult population has a higher education compared to an OECD average of 23 per cent. On the other hand, only 18 per cent of a generation of young adults in Denmark begins a university education, which is slightly below the OECD average.
- *The majority of Danish business and industry is not particularly high-tech.* High-technology companies in Denmark make up a modest share of Danish business and industry's total turnover and employment.
- *The number of entrepreneurs within the knowledge services and high-technology industries in Denmark is rising.* From 1995 to 2000, the number of newly established companies in Denmark increased from approximately 14,000 to just under 19,000 a year.
- *There is a moderate level of interaction between companies and knowledge institutions in Denmark.* Four out of ten Danish companies with more than ten employees have conducted product or process innovation between the years 1998 and 2000. A few more than every tenth of these companies has directly involved a Danish university or other public research institution in their innovation efforts.
- *IT usage is widespread in Denmark.* Denmark is the EU country where the Internet is most widespread.

Challenges facing the Danish knowledge system

- To improve the overall level of education and recruit highly qualified knowledge workers for both private companies and knowledge institutions.

- To prepare Danish companies and knowledge institutions for a global knowledge market with increasing competition for investments and knowledge work.
- To create better conditions for growth for knowledge-based production
- To increase investments in knowledge.
- To convert Danish IT usage into increased efficiency, productivity and competitive strength.

The strategy points at a number of initiatives to further develop the intellectual capacity, the innovation capacity and the interaction between numerous actors in this system.

5 Brief description of NNE RTD organisation

5.1 Main actors

In public energy research there are three main actors at the strategic level:

- The research councils, represented by the Danish Research Agency under Ministry of Research fund individual projects and broad energy-oriented programmes with a basic and long term perspective.
- The Danish Energy Authority is an Authority under the Ministry of Economic and Business Affairs. It has a wide responsibility for energy policy and instruments, including the organisation and co-ordination of energy R&D.
- The system operators ELTRA and ELKRAFTSYSTEM grant subsidies to research and development projects concerning environmentally-friendly production of power and heat. ELFOR (distribution companies) has a similar programme for R&D on systems for electricity consumption. These PSO programmes are proposed and financed by industry, but need Government approval.

The PSO programmes were established recently. However the Energy Authority (EA) maintains a central coordinating role for all of the three actors. EA has an advisory committee on energy research, giving advice on strategic level. In addition strategy processes are currently under way for a number of themes and technology areas. This is a process involving both industry and the R&D community.

At the R&D level, both universities, institutes and companies are active and eligible for R&D funding. Important institutions are Risø National Laboratories with history in nuclear energy research, Technical University of Denmark, Danish Centre of Gas Technology, Danish Geological Survey and a number of universities.

5.2 Expected future evolution

Denmark has ambitious goals for its R&D policy. There are no indications of major changes to the system. But increased co-ordination is expected between the actors. Reference can be made to EA's role towards the PSO programmes, and the newly approved demand that Ministry of Research/Research Agency shall approve the research content of proposals with the sector agencies.

6 Current NNE RTD priorities relevant for ERA in NNE RTD

Energy R&D funding grew during the late 90-ies to a level of 350 mill. DKK in 2001. For the year 2002 the corresponding figure were approximately 150 mill. DKK, tending to grow in 2003 (200 est.) and the near future. These figures include EA and RA funding as well as the PSO programmes and correspond rather well with IEA statistics.

Following the reduced funds, the support for petroleum R&D has been reduced to near zero.

Important priorities in NNE R&D are:
- Renewable energy in general, and in particular: Wind energy to maintain and develop Danish competence and manufacturing industry.
- In general support R&D with an innovation potential in Danish industry. Examples being solar PV, fuel cells, hydrogen technologies.

7 Description of Priority setting process

Energy policy and even energy research attracts considerable political interest. In a broad political agreement in the Parliament from 2003, increased funding for energy research was one important result. Priorities within energy research happens to be a political issues, but the current agreement lead to increased attention to long term research and demonstration activities as well as increased funding.

The increase in funding came at a point when funding for energy research had been radically reduced (2002), due to a wish to reduce Government spending and leaving more of research to market actors.

The Government, through its ministries gives very little guidance on the priorities within energy research. The EA gives priority to R&D leading to innovation and industrial development, and increasingly so since EA in 2001 became subordinate to The Ministry of Economic Affairs (previously Ministry of Environment). Industry is involved in the priority setting in three ways:

- Industrial parties take part in strategy development on energy R&D, cfr. Processes on solar PV, fuel cells, wind energy etc. They are also represented in the Advisory Committee for Energy Research and are in general widely involved in consultations with EA.
- The two PSO programmes are managed by the power transmission companies.
- Industry is involved in R&D proposals.

The Advisory Committee for Energy Research does only play an advisory role. In 2002 the Committee gave its recommendations on future use of public funds for energy research, some of which are:
- Both industrial, environmental and energy sector needs underline the need for continued support to energy research.

- Potential for improved coordination between institutions and programmes.
- There is a need for a common vision and strategy.
- Activities should be divided into short term (mainly industrial actors), medium term (joint activities and networks between institutions and industry) and long term (universities and institutes).
- A national strategy should take account of the EU FP6 priorities and support actors who can play a role at the European scene.

Under the Ministry of Research/RA, the quality of research is the dominating criteria, and industry is not directly involved, except as proposers and occasionally by individual experts.

Both EA and RA have quite open calls for proposals. Some guidance is given by underlining themes and issues of particular relevance, but no issues are omitted. The main priority process thus takes place when proposals are evaluated. EA involves different experts within it's own organisation, as well as external consultants, whereas RA decisions are based on scientific expertise in the research councils and peer reviews.

8 Information sources

Energy Agency: http://www.ens.dk/
Research Agency: http://www.forsk.dk/

Country study Estonia

Contents:

1 Summary of country study indicating main points for synergy

Estonia has been, and still is, in a process of thorough change through most sectors since the fall of the Soviet Union. Both the energy and research sectors are radically changed over a few years, and the accession process with the EU is both fuelling and giving orientation.
One can distinguish two main characteristics of the last decade in the development of Estonia's science:

- transition from being a part of a large country's (USSR) science to the science of a small country
- hope for a full-scale entry to the new united space of European science

It could be considered that to a certain extent the Estonian science is already in Europe by taking part in many common programmes and projects financed by the European Union or by some Western European country. The EU, NATO and Western countries provide financial support for the participation of Estonian scientists in international conferences etc. Entry to the united space of European science implies an idiomatic return to the model of Estonia's science being part of a big science.

Energy research is not mentioned in the main overall R&D strategy. This may be reflecting priorities and the country's resource situation, but it may also be an effect of the need to put aside issues which can wait. With a massive load of issues to handle it is understandable that the public administration can not develop long term strategies in all areas. However, an energy R&D strategy is being prepared and is expected to be ready in a year.

As an accession country, Estonia has already had access to the EU R&D programmes for some time. This has opened a broad range of new co-operative possibilities. With a rather weak national energy research base, invitations to participate in European programmes and a national fee for participation which is related to GDP, the actors in this field have an obvious interest in becoming an active partner in the EU R&D projects.

There are no formal obstacles to an increased R&D co-operation. Indeed, partly prompted by the European Commission's initiative to establish a common European Research Area and by several international R&D programmes, Estonia has started to revise the priorities of its national R&D and innovation policy and to strengthen its resource base through international cooperation. Since the fall of the Soviet Union, the whole R&D system has changed from what was an integral part of the USSR scientific system, to an open system with financing principles of the western world. *The Organisation of Research and Development Act* is the main law regulating the organisation of research and development in Estonia. This document entered into force in May 1997 and was amended in 2002.

In spite of this open situation, there are a number of more practical obstacles to the development of science in general and in particular international co-operation:

- Lack of national financial resources for R&D
- Lack of scientific personnel and a challenging age structure for active scientists
- Innovation capacity and competence in the industry and the public in general
- Weak national strategy for R&D as a measure for development

This situation leaves priorities to a large extent to the actors and the sum of their efforts. Both sector ministries, R&D institutions, industry and a number of scientists take an active role. Not the least important for the total activity are the possibilities generated through foreign finance sources, both bilateral and multilateral.

The Ministry of Economic Affairs and Communication is responsible for energy policy and for funding of applied research and innovation. The Ministry is showing increased willingness to take responsibility for energy research, and is currently preparing an energy R&D strategy. As the development of the strategy is on an early stage, the outcome is still unknown. However, the Ministry has proposed oil shale, renewable energy sources, fuel cells and hydrogen technology as possible priority areas in the future.

Other R&D matters are "left with" the Ministry of Education and Science and the Estonian Science Foundation. Energy R&D is not an area with particular attention, although energy projects have received funding. Over the last years, research has been conducted in the areas of:

- Renewable energy resources and their application
- Energy efficiency in power plants and industry
- Environmental-friendly use of oil shale
- New and improved energy sources

Other priorities have been: energy storage devices, reliability of energy supply, environmental friendly transport and harmonisation with EU energy politics. With a possible exception of oil shale, the priorities and the challenges of the energy sector of Estonia, is well within the current priorities of FP6. EU activities in the fields of renewables, rational use of energy and social research related to market mechanisms, regulation etc. will probably attract interest from Estonian groups. The same is definitely the case for EU mechanisms to transfer technologies and R&D results to SMEs and other users. Innovation has high priority in Estonia, and the state owned organisation Estonia Enterprise has been established to facilitate research and innovation.

The move towards larger integrated project in the FPs makes it almost impossible for Estonian parties to take a leading role in projects. On the other hand, this has made it easier for Estonian parties to come inside a project as a "follower" who does not have to take a leading role in the development of projects.

Estonia will probably also in the future seek finances and cooperation through a number of international channels, but co-operation through ERA will be dominating. To facilitate further co-operation in the field of non nuclear energy research, and the utilisation of R&D results, the following measures could be beneficial:
On the Estonian side:

- Strategic process involving both Government, industry and research institutions to identify strongholds in energy research and areas where R&D is needed. Further; possible steps to develop national clusters of international competitive companies and R&D groups.
- Financial mechanisms to ensure that good projects can meet the requirement of national (own) financing.

On the EU side:
- Flexibility in the requirements of financial contributions from project partners from Estonia for a period would facilitate the participation.
- General measures dedicated to stimulate Estonian parties' (probably most accession countries) participation.
- All EU countries face a number of challenges following the liberalisation processes in the energy sector, but the East European countries most. Increased attention to (mostly social) science as a measure to develop policies, innovation etc. would be beneficial to all and facilitate the integration processes.
- A mechanism for transfer of experiences, and possibly the development of new – in the integration of policy making of energy and R&D sectors. Even if this is an East European issue, most countries find it difficult to have the right balance between the two.
- Facilitate countries with R&D issues in common, but issues which do not reach the community level, to develop co-operative mechanisms. Example: Peat, district heating.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

Many sources speak of a lack of national priority process related to NNE RTD. This leading priorities to be set mainly by researchers in the extent they are able to find financial resources to cover their expenses. This leads to scientific quality being an important parameter in the priority setting, as well as finance institution's (often foreign) priorities.

As a national policy on energy research does not yet exist, the synergy and complementarity towards EU NNE RTD should be judged by the characteristics of the national research system in this area and the general challenges of the energy sector of Estonia.

In terms of energy resources and energy policies to exploit these, Estonia's position fits quite well with the current priorities of EU RTD: The development of renewables, increased efficiency throughout the energy system and issues related to deregulation are important on both sides. In these areas there is in general a thematic synergy in common R&D. Potential synergy is also present, but not so obvious based on today's priorities in EU FPs, when it comes to the further exploitation of Estonia's oil shale resources. As oil shale research fits in with the objectives of the research fund for coal and steel, it is agreed between Estonia and the EU that oil shale is included in this research fund, thus creating the room for new mechanisms for international co-operation.

Estonia has given high priority to the establishment of an innovation policy. In this area it is anticipated that a number of East European countries face the same challenge of education, change of general attitudes concerning competition etc., financing mechanisms etc. Although the general objective of letting R&D generate business development is shared throughout Europe, it could be that the accession countries, for a period, need special mechanisms in this area.

Estonia has a strong drive to international co-operation, and this is oriented to western countries. Surprisingly little is left of contacts and cooperative activity with Russian parties. The western orientation has also included co-operation with the US. It is anticipated that this will go further, but that EU activities will be the most extensive and not leave much capacity to develop other relations.

With a weak base of national energy research and limited capacity in terms of both personnel and funding, there is a strong need of defining some priority areas. This should be done on the basis of:

- Fields with strong scientific competence
- Industry's priorities and potential co-operation
- Government's long term policy objectives
- Areas with the need for domestic competence; either because the problem is a Estonia-specific one or because it is considered vital to have national competence.

Probably other accession countries face the same situation. If the Commission could facilitate this process through co-operation or parallel processes in a number of countries, this could be beneficial to all.

The financial requirements to parties of RTD contracts are an important obstacle, because of the present lack of funds in Estonia. The priority of integration in the EU with an agreed national fee for participation in FPs has presently the effect that national R&D funding is even more scarce. This problem of finance needs special attention both at national and EU level.

The liberalisation process of the energy sector is challenging to all European countries, but no doubt mostly to the East-European ones. A program to let social sciences develop the policy making processes of all countries could be an interesting initiative, both to facilitate the liberalisation, but also the integration between countries. In Scandinavia, there are interesting examples of social science R&D programmes with the objective of improved policy making and public debate in the energy sector.

Potential interesting initiatives for increased synergy and complementarity:
On the Estonian side:

- Strategic process involving both Government, industry and research institutions to identify strongholds in energy research and areas where R&D is needed. Further; possible steps to develop national clusters of international competitive companies and R&D groups.

- Financial mechanisms to ensure that good projects can meet the requirement of national (own) financing.

On the EU side:
- Flexibility in the requirements of financial contributions from project partners from Estonia for a period would facilitate the participation.
- General measures dedicated to stimulate Estonian parties' (probably most accession countries) participation.
- All EU countries face a number of challenges following the liberalisation processes in the energy sector, but the East European countries most. Increased attention to (mostly social) science as a measure to develop policies, innovation etc. would be beneficial to all and facilitate the integration processes
- A mechanism for transfer of experiences, and possibly the development of new – in the integration of policy making of energy and R&D sectors. Even if this is an East European issue, most countries find it difficult to have the right balance between the two.
- Facilitate countries with R&D issues in common, but issues which do not reach the community level, to develop co-operative mechanisms. Example: Peat, district heating.

In their attempts to participate in European R&D programmes, Estonia as well as the other Central and Eastern European countries has faced a number of problems. A survey carried out within the framework of the Ideal-ist project brings out the following points as the main obstacles:
- many potential participants in R&D projects fail to see the logic behind competitive programmes aimed at solving specific socio-economic problems; on the other hand, it is extremely difficult to plan a successful project if one has a limited understanding of the rules;
- due to the weakness of the liaison network, finding suitable strategic partners for successful launching of projects is often a major problem;
- having little experience and only limited knowledge of the world market, it is extremely complicated to plan application schemes and business strategies for projects whose scale is much broader than one is accustomed to.

3 Short background information

3.1 Overall energy situation

3.1.1 Exploration and reserves

Estonia is unique among nations in its heavy use of oil shale. Oil shale (Kukersite) has been a major source of energy in Estonia for many decades, and is Estonia's primary mineral resource. Estonia accounts for about 70% of the world's oil shale production.

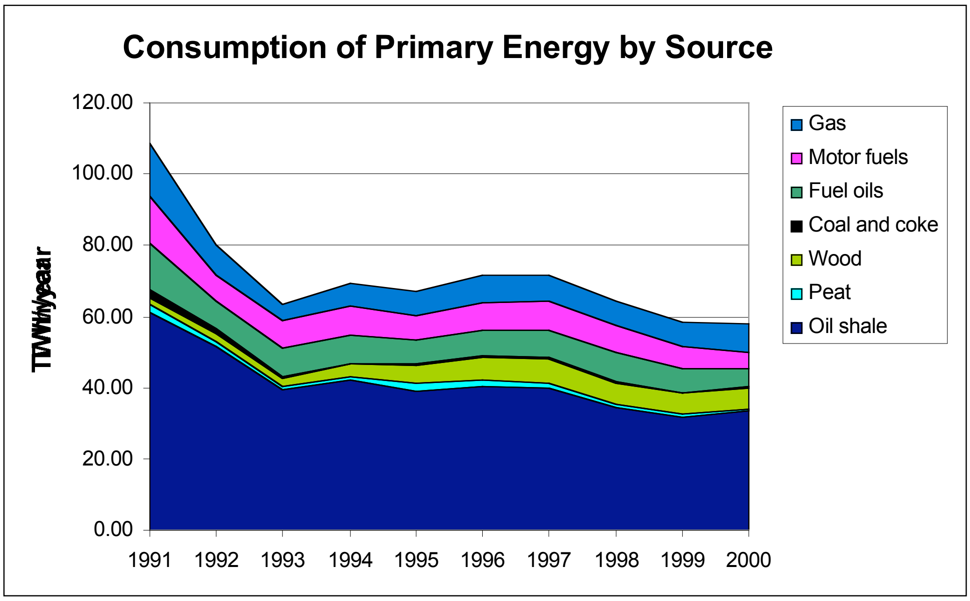
There is also some use of peat and wood waste as fuel at small heating plants. Estonia has a reserve of 929 million metric tons of peat.

Small hydroelectric power plants serve some villages.

Supply and Consumption

Exhibit 3-1 shows consumption of primary energy from 1991 – 2000. It reflects the overall pattern of economic outlook, emphasizing the sharp fall in economy at the beginning of the period and a stabilization period (1994-1996). Since 1996 it is possible to detect a moderate, but constant decrease of consumption of primary energy, although the economy itself has been growing.

Exhibit 3-1 Consumption of primary energy by source [TWh/year], Estonia 1991 – 2000

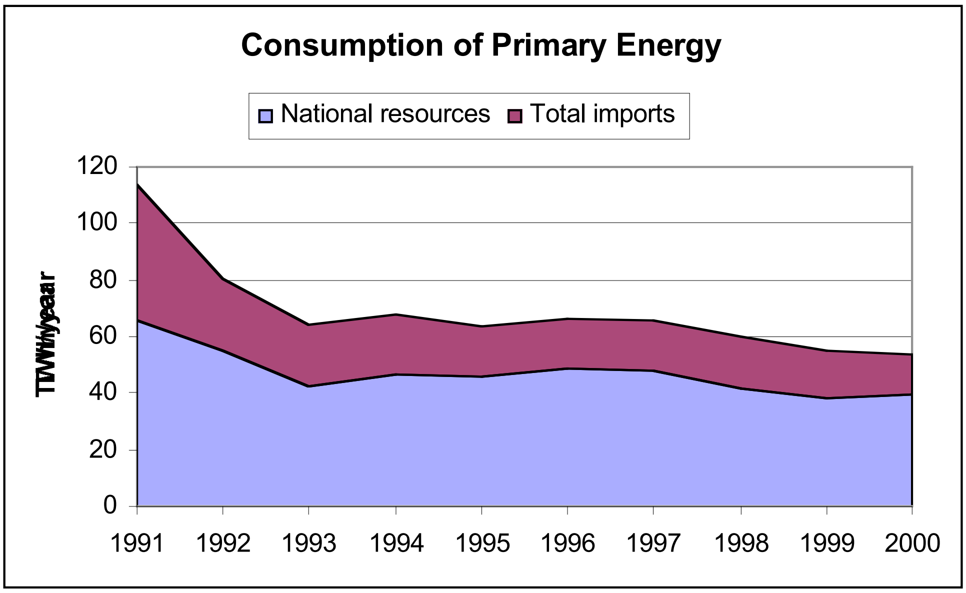


1.

Source: "Estonian Energy 1991-2000", Ministry of Economic Affairs and Communication, 2001

Estonia produces no significant amounts of coal, oil, or natural gas. Natural gas and petroleum products are imported. Estonia does not currently have any physical connections with the electricity and natural gas networks of the EU member states, but the country will soon be connected to Finland through a new cable.

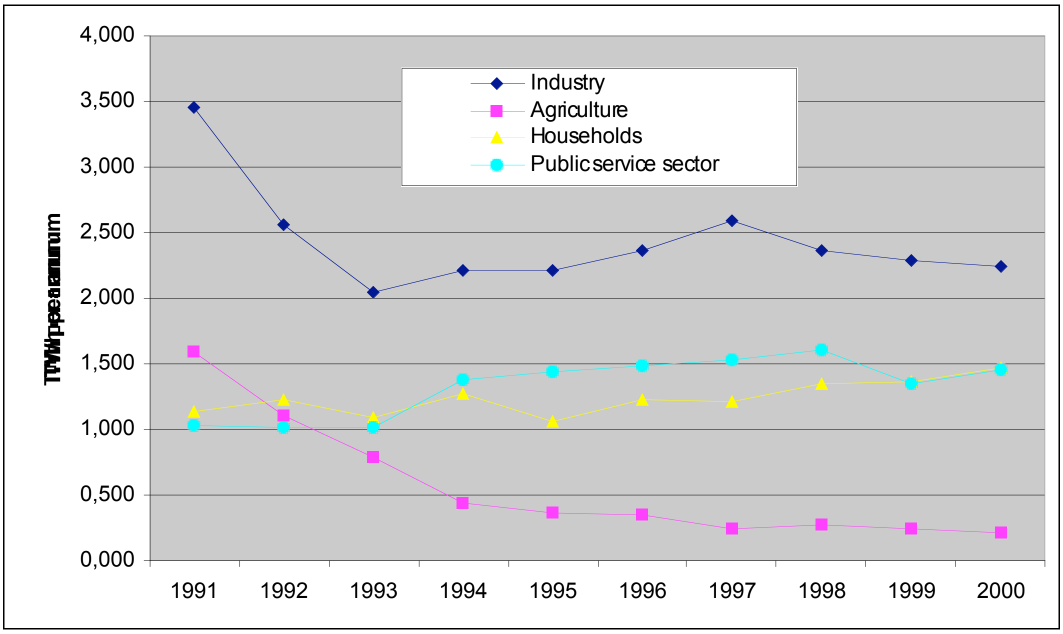
Exhibit 3-2 Consumption of primary energy, national resources and imports [TWh/year]



Source: "Estonian Energy 1991-2000", Ministry of Economic Affairs and Communication, 2001

Estonian production of electricity is predominantly from its oil-shale-fired power plants. Estonia has an electric power plant capacity of 2,722 MWe. Production and consumption of electricity has fallen significantly since 1991. The main reasons are overall fall in industrial output and a sharp contraction of the export market, resulting from economic restructuring. Exhibit 3-3 shows end consumption of electricity by sectors.

Exhibit 3-3 End consumption of electricity in economic sectors, TWh/year

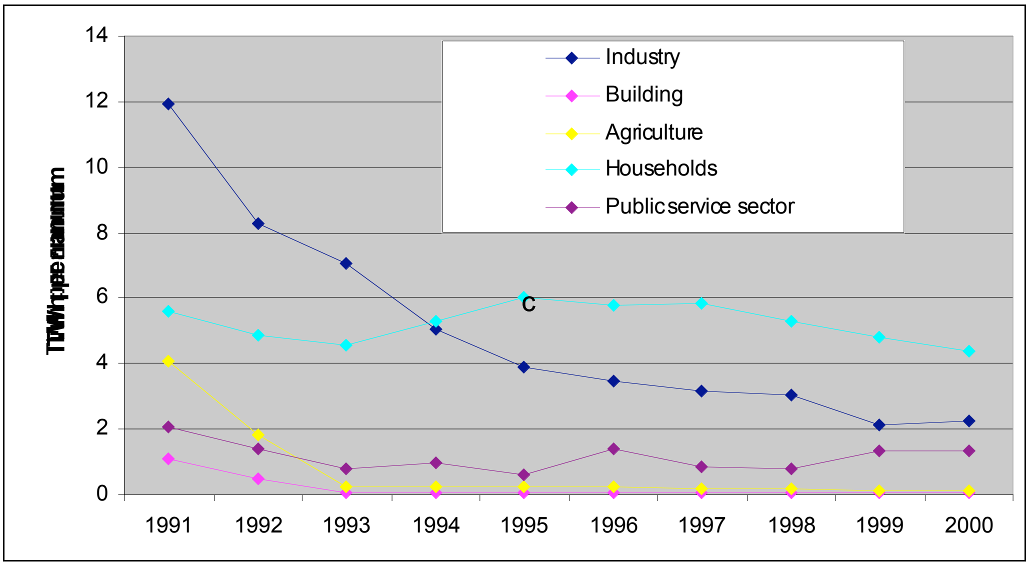


Source: Report "Estonian Energy 1991-2000", Ministry of Economic Affairs and Communication, 2001

In ten years, the production of thermal heat has fallen by half, stabilising at around 10 TWh. Heat production generally means district heating, which represents around 94% of end-consumption of heat. Although the use of different types of fuels in producing heat directly depends on world fuel prices, the popularity of so-called clean fuels has been increasing. Foreign assistance has played a major role in completing the transition to the use of local fuels. The importance of oil shale and natural gas has remained largely unchanged. At the same time the volume of fuel oil has been falling, while biofuel and peat have been increasing strongly. At present around 25 percent of the heat is produced as combined production of heat and electricity.

Total consumption of heat fell from 24.7 TWh in 1991 to 8.1 TWh in 2000, or about three times.

Exhibit 3-4 End consumption of heat in different economic branches, TWh/year



Source: "Estonian Energy 1991-2000", Ministry of Economic Affairs and Communication, 2001

3.1.2 Energy policy

2. On 12 June 1995 the European Communities, their Member States and the Republic of Estonia signed the association agreement (so-called Europe Agreement) which was ratified on 1 August 1995. Under this agreement, Estonia assumed political and legislative obligation to harmonize its legislation with the EU law and its principles. Until now energy has been one of the five accession negotiation chapters in which Estonia has applied for a transition period. In this chapter the biggest problem was providing a 90-day reserve for liquid fuel. In its position Estonia has requested that full compliance with EU requirements be delayed until 2010. Full compliance with the internal market directive on electricity is not possible until Estonia is linked over transmission lines with the EU. A similar situation is in the natural gas market in Estonia. Other chapters that have a profound impact on the development of energy sector are taxation of fuels and energy which is harmonized under the financial chapter.

3. The EU has been pressuring Estonia to reduce shale oil use due to environmental concerns. Estonia requested that the EU consider oil shale the same way it does coal, and the request was granted in July 2002. This enabled Estonia to close out the energy chapter in its accession negotiations with the EU.

The Estonian Government is giving high priority to its energy sector in its ongoing economic reform program. Government policy and objectives toward its energy sector can be summarized in two ways: to provide a reliable source of energy for the country, and to provide such energy at the lowest possible cost. The chosen means for accomplishing these include improving the efficiency in use of energy, improving the overall reliability of electricity generation and distribution, attracting investment capital where such capital can help finance needed infrastructure improvements, and allowing competition and diversity into areas where state-owned monopolies exist.

The Long-term National Development Plan for the Estonian Fuel and Energy Sector sets the main goals for Estonian energy strategy to 2005, and with principal development trends to 2018. This document provided two important reference figures: to increase the importance of renewable energy sources by two-thirds until 2010 in comparison with 1996, and, secondly, to reduce the importance of oil shale as fossil fuel in primary energy supply in average by 20 percent (as a reference, from 62 percent to 47-50 percent).

Other energy related strategies include the *Energy Conservation Target Programme* (aim: ensuring energy quality) and the *Action Plan for the Restructuring of Estonian Oil Shale Energy* (aim: self supply of primary energy).

Estonian National Environmental Strategy has set an aim to reduce negative environmental impact of energy sector, to orientate the energy policy on the technological development and use of renewable resources, to reduce the generation of the greenhouse gases and to internalise the external costs of the energy production and consumption into the price of energy.

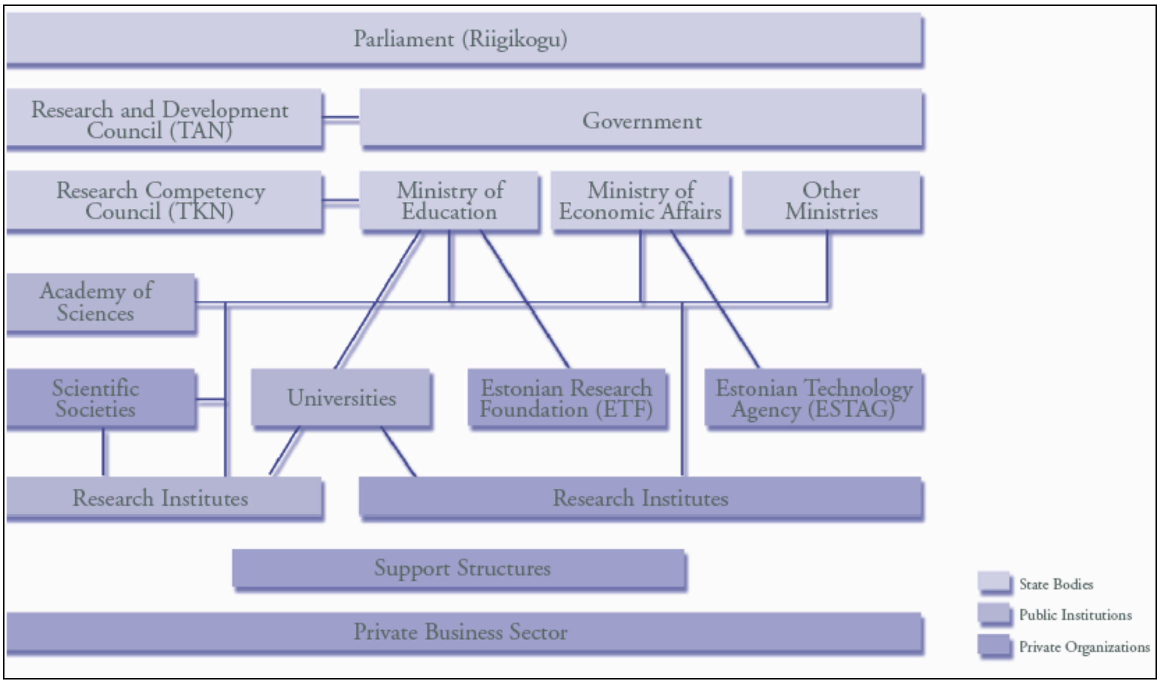
The Estonian Riigikogu ratified the membership in the Energy Charter Treaty in 1998. The Energy Charter Treaty is a multilateral international agreement focussing on the energy sector. It includes several agreements and protocols and one of the most important is the protocol on energy efficiency and on related environmental issues that lays down obligations for energy efficiency and for environmental aspects. Provisions brought in the protocol are mandatory for member states.

3.2 National RTDI system

3.2.1 The national organization of research and development

The Organisation of Research and Development Act is the main law regulating the organisation of research and development in Estonia. This document entered into force in May 1997 and was amended in 2002. As seen in Exhibit 3-5, the **Riigikogu** and the **Government** represent the highest level in the innovation system, with legislative and executive powers respectively. At this level, state budget for RTDI activities is decided as separate budget lines for the different ministries and streams of funding.

Exhibit 3-5 Organization of Estonian research & development and innovation



Source: "Knowledge-based Estonia. Estonian Research and Development Strategy 2002 – 2006", Research and Development Council, 2002.

The Research and Development Council (TAN) is a strategy advisory body for the Government in the entire field of RD&I. According to the Organisation of Research and Development Act, the Research and Development Council has 12 members and its composition is confirmed by the Government for a period of up to three years.

Two ministries are primarily involved in financing (and formulating and implementing of research policies) RDTI; the Ministry of Education and the Ministry of Economic Affairs and Communication. With their responsibilities as specified by the law, the division of the RTDI funding in two distinctive parts is apparent:

The Ministry of Education is responsible for the organisation of research and education policy and for the financing of R&D at research and development institutions.

The Ministry of Economic Affairs and Communication has a central role in organizing technological development and innovation on state level, being responsible for the planning, coordination, execution and surveillance of the policies for technology and innovation. The Energy Department within the Ministry of Economic Affairs and Communications
is responsible for energy policy issues, including energy efficiency.

The executive agencies of the two main ministries are **the Estonian Research Foundation (ETF)** and **the Estonian Technology Agency (ESTAG).** The main task of the Estonian Research Foundation (ETF), which functions under the jurisdiction of the Ministry of Education, is to support research projects by means of the allocation of grants. The task of the Estonian Technology Agency (ESTAG) is to support technological development projects within enterprises and market-oriented research projects in research and development institutions.

Institutions advising the Ministry of Education in research and educational issues include the **Estonian Academy of Sciences** and the **Research Competency Council (TKN).**

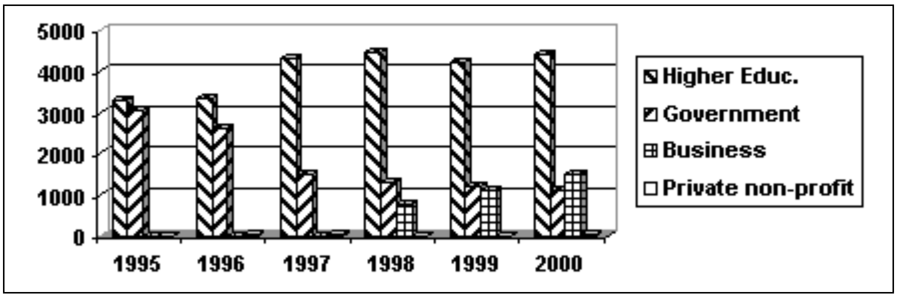
The Ministry of Education is assisted in carrying out its research and development functions by the **Archimedes Foundation** which organizes evaluations of Estonian higher education and research and acts as the national contact point for the EU's 6th Framework Programme.

Enterprise Estonia was founded by the Ministry of Economic Affairs in the year 2000 with the aim of promoting the competitiveness of the Estonian entrepreneurial environment and businesses. Future grants to energy R&D is likely to be allocated by this organisation.

Historically, energy research has been concentrated at Tallinn Technical University (Faculty of Power Engineering) and Academy of Sciences (Energy Research Institute). In 2002, the Energy Research Institute became a part of TTU. Furthermore, some energy research is being conducted by the Estonian Agriculture Institute (Dept. of Agricultural energetics), the University of Tartu and a few smaller institutions.

As a consequence of the Soviet research policy the majority of research institutions were separated from the higher education system. This isolation did not augur well for the development of strong links between research and higher education. One of the major tasks of the research policy over the past years has been to eliminate this isolationism and for this reason the Ministry of Education and Science is now realizing the integration and incorporation of individual state research institutes and their staff into universities with the primary aim of modernizing and strengthening the research capacity of these universities. Changes of structural reform of Estonian science institutions can be see the figure below.

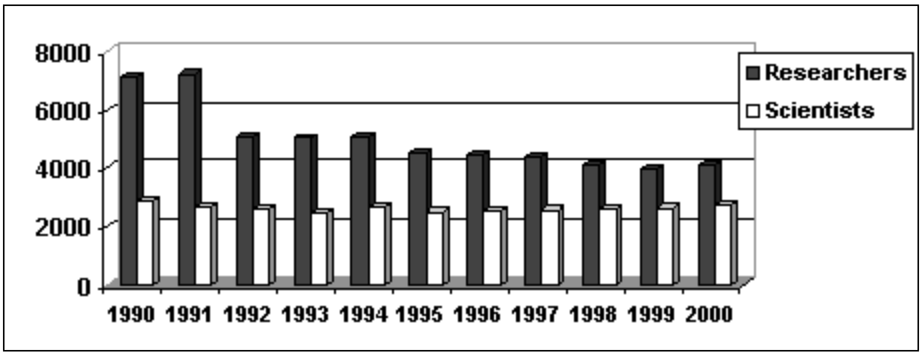
Exhibit 3-6 Researchers by sector 1995 – 2000



Source: Estonian Union of Scientists, http://www.iiss.ee/etl/world/index.html

The number of scientific personnel was dramatically reduced during the first years of independence, but stabilized in the mid-90s.

Exhibit 3-7 R&D Staff, 1990 – 2000



Source: Estonian Union of Scientists, http://www.iiss.ee/etl/world/index.html

3.2.2 R&D Policy

The overall Estonian R&D strategy (Knowledge based Estonia – Estonian R&D strategy 2002-2006) was prepared by a working group with participation from the Ministry of Education, Ministry of Economic Affairs and the Estonian Academy of Sciences and approved by Parliament in 2001. Key areas specified are information society technologies, biomedicine, and materials and nanotechnologies.

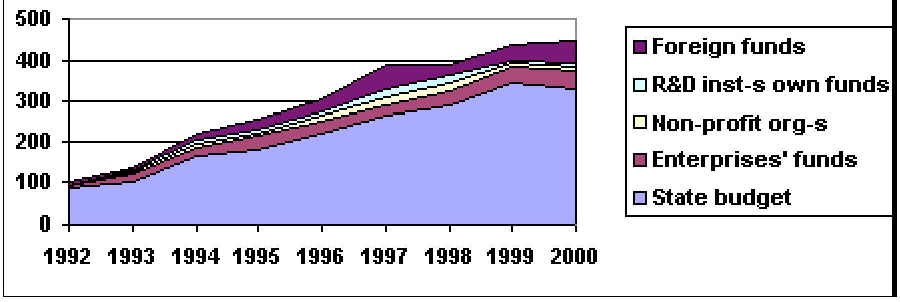
A new energy research strategy is being prepared by Ministry of Economy and Communication. For now, the energy strategy from 1998 is still valid.

3.2.3 R&D Expenditure

According to the Organisation of Research and Development Act, research and development in Estonia is financed '…from the state budget, a city or rural municipality budget, endowments, income from the economic activities of research and development institutions, and other sources.'

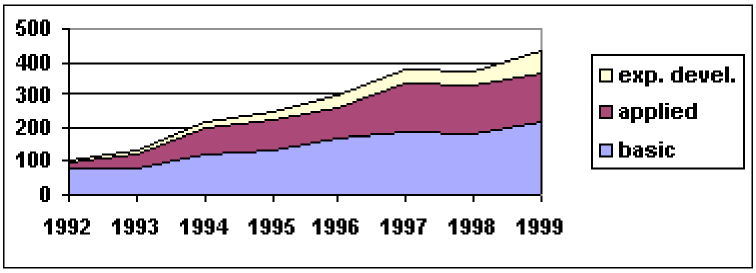
The level of RDTI funding in Estonia has been stable at about 0.6% of GDP for the last years, but as the GDP has been increasing, so has the amount of R&D funding. Total expenditure on Estonian R&D in 2001 comprised 0.75% of GDP. As seen in figure 3.8, the State Budget is the dominating source of finance for Estonian research.

Exhibit 3-8 Total R&D financing in Estonia [mill. EEK].



Source: Estonian Union of Scientists, http://www.iiss.ee/etl/world/index.html

Exhibit 3-9 Expenditures by kind of R&D activity, 1992 - 1999 [mill. EEK]



Source: Estonian Union of Scientists, http://www.iiss.ee/etl/world/index.html

There are no direct financing for energy R&D. The only programme on the energy field that has (relatively small) state financing is the Energy Conservation Programme. The research activities are all grant-based. The last years, energy research has been financed through the "general national science grants", which is the responsibility of the Ministry of Education and Science. In 2003, the financing by the Ministry of Education and Science amounted to EEK 184 million (about 11,5 mill Euro). The share of energy related projects was 3,5% (6,5 million EEK, or about 400.000 Euro). The Estonian Science Foundation supported energy related basic research with about EEK 1,8 mill (about 110.000 Euro). This was financed through the state budget and by the European Science Foundation. The Ministry of Economics and Communication financed some studies in addition to financing the Estonian Enterprise (EAS), who grants applied research and product development.

Tallinn Technical University is performing energy R&D projects each year for ca 17 million EEK (about 1 mill Euro), mainly for Estonian Energy and other companies, ministries, counties, etc. They are responsible for most of the energy research in Estonia, and we therefore estimate the total volume for energy research in 2003 to 1 mill. Euro.

3.2.4 Expected future evolution

It is intended that by 2006, total expenditure on RD&I will be 1.5% of GDP. The strategic principles for financing research and development will include a significant increase in the state financing and more active participation of private and foreign capital.

Exhibit 3-10 Expected state budget financing of R&D according to the overall Estonian R&D strategy [mill. EEK]

	1998	1999	2000	2001	2002	2003	2004	2005	2006
State budget allocations for research & development, million EEK	312.5	363.8	370.6	430.9	497.5	614.0	714.0	884.0	1014.0
of which, Ministry of Education	278.0	331.0	329.0	357.3	413.3	430.0	460.0	550.0	600.0
of which, Ministry of Economic Affairs	30.0	28.0	37.0	61.4	70.0	170.0	240.0	320.0	400.0
of which, other ministries [6]	4.5	4.8	4.6	12.2	14.2	14.0	14.0	14.0	14.0

Source: "Knowledge-based Estonia. Estonian Research and Development Strategy 2002 – 2006", Research and Development Council, 2002.

As the energy R&D strategy is not ready, it is not possible estimate the future spending on energy research yet. However, energy is not one of the main priorities in the overall RTDI strategy, and can not be expected to receive a large portion of the funding.

Through the study "Assessment of the Estonian Research Development Technology and Innovation Funding System" by Nedera and Georghiou at the Victoria University of Manchester, four problems-reasons of the RDTI funding system in Estonia have been identified:

1. Insufficient funding for RDTI expressed in: under-funding of research organisations; pressures in the system originating in this under-funding; aging research (innovation) community; obsolete research equipment and crumbling infrastructure; etc.;
2. Lack of base-line funding for research institutions making the funding process unpredictable, reducing the level of flexibility in the system, preventing the development of research strategy at institutional level and increasing the administrative overhead of research institutions;
3. Fragmentation of the RDTI (funding) system as expressed in the mismatch between research capacity and research users, the duality of the system and the ensuing fragmentation of research funding;
4. Problems broadly associated with the image and visions of research;

4 Current NNE RTD priorities relevant for ERA in NNE RTD

The energy policy states that Estonia intends to increase the use of renewable energy sources by two-thirds until 2010 in comparison with 1996 and to reduce the importance of oil shale as fossil fuel. As oil shale research fits in with the objectives of the research fund for coal and steel, it is agreed between Estonia and the EU that oil shale is included in this research fund.

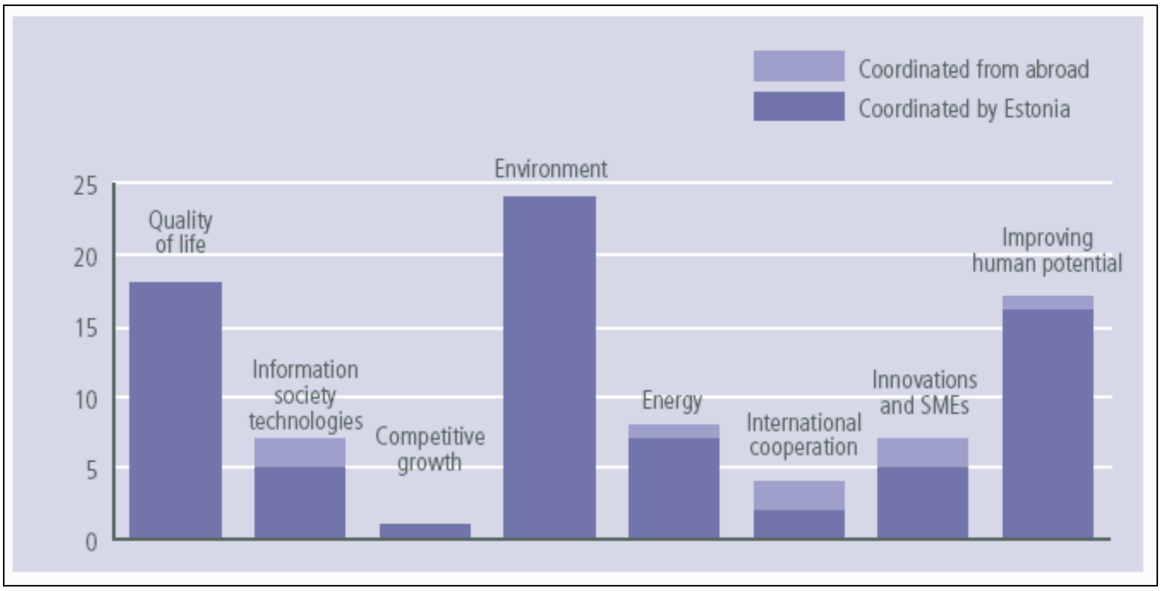
An R&D energy strategy is being prepared by the Ministry of Economics and Communication. After talking to experts from the Ministry and the main energy research organisations, the following topics seem to be of great interest to Estonia:

- oil shale as a primary national energy source
- renewable energy (wind and bioenergy have been mentioned)
- fuel cells and hydrogen energy technology
- energy saving technologies
- energy storage devices
- reliability of energy supply
- environmental friendly transport

The main reasons for choosing these fields seem to be harmonisation with EU energy politics and use of the country's own natural resources of oil shale.

Estonia is eager to participate in the EU 6th FP. For the better representation of Estonian research within the European Union and in order to intensify the exchange of information, the Government has dispatched an attaché for education and research to Brussels. The participation in the 5th FP, is shown in the figure below.

Exhibit 4-1 Estonia's participation in EU 5th Framework programme (Number of projects)



Source: "Research and Development in Estonia 2000 – 2001" Research and Development Council, 2002

5 Description of priority setting process

While actually all ministries should take responsibility for organising R&D activities (including financing) within their respective governance domains in reality the two ministries that are primarily involved in financing RDTI (and respectively formulating and implementing policies for RDTI) are the Ministry of Education and

Research and the Ministry of Economic Affairs and Communications. Correspondingly, these two ministries have some additional responsibilities.

The long-term (project based) funding is decided by Ministry of Education on the recommendation of the Science Competence Council (SCC). The Ministry of Economic Affairs and Communications is responsible for applied research. Short-term grants are allocated by the Estonian Science Foundation. In lower levels the R&D strategies are set by energy companies and universities according to market needs and trends. The Estonian Energy company also has influence in energy R&D.

When deciding on research funding the members of the SCC consider the following three areas: 1) the quality of the research proposal (proposed research); 2) critical mass of applying unit (2 full-time researchers or more); and 3) there is an attempt to ensure continuity of funding so some security in the system is guaranteed. In practice, however, there are no guarantees that the funding will be continued after the 5 or so years for which allocation has been made.

6 Sources

1.1 Organisations:

Ministry of Economic Affairs and Communications: http://www.mkm.ee/eng/
Research and Development Council: www.tan.ee
Estonian Ministry of Education and research: http://www.hm.ee/
Archimedes Foundation: http://www.archimedes.ee
Estonian Energy Research Institute: www.eeri.ee
Tallin Technical University: www.ttu.ee

1.2 Other sources of information:

ERIS, Research and Science in Estonia http://www.eris.ee/
Estonian Science Statistics and Policy Resources:
http://www.iiss.ee/etl/world/index.html
Baltic 21 Energy Sector: http://www.ee/baltic21/report/reports/energy.htm
Ideal-IST http://www.ideal-ist.net/
EU enlargement: http://www.europa.eu.int/comm/enlargement/estonia/
Estonia’s EU agreement: http://www.vm.ee/eng/euro/kat_318/2811.htmlo/kat_318

Country study Finland

Contents:

1 Summary of country study indicating main points for synergy

Finland is a net energy importer. It has no significant domestic reserves of any fossil fuels except peat, and its electricity generation is not sufficient, without supplemental imports, to meet demand. The total consumption in 2002 was 1 403 PJ.

Finland relies largely on nuclear and fossil-fuelled thermal-electric power plants for its electricity supply. Many of the fossil-fuelled power plants use peat, especially the smaller facilities which cogenerate combined heat and power (CHP).

Nuclear power has been part of Finland's energy mix since the late 1970s, and it now accounts for slightly more than 25% of its total electricity supply. In June 2002, Finland's parliament approved the decision to construct a fifth nuclear reactor.

There are presently about 200 hydroelectric power plants in Finland. However, most of these are small. Finland has more than 60 relatively small wind power plants, with a total installed capacity of more than 40 MWe.

Forest-based fuels are an important energy source in Finland. In 2001, about one million cubic meters of forest fuels was consumed in Finland's power plants, the equivalent of nearly 2 TWh of usable energy. Finland has a national goal of increasing that usage to 5 million cubic meters by the year 2010.

Tekes, The National Technology Agency, is the main financing organisation for applied and industrial R&D in Finland. Funding is granted from the state budget. Tekes is the most important Finnish agency with regard to NNE RTD with an annual budget for NNE of about 60 mill.€. Tekes is a financing body; they do not perform research themselves.

The main focus is applied research, but basic research at Universities and Research Institutions can also be funded. Tekes offers companies grants, capital loans and industrial loans.

VTT Technical Research Centre of Finland, is the largest national RTD institute in the energy sector, and covers 30-50% of the Finnish energy RTD.

The importance of internationalisation has been clearly stated in the Finnish innovation policy. Yet the full consequences and challenges posed by internationalisation to organisations like Tekes and other research organisations are still unforeseen. There is an ongoing change of policy also in Tekes as international collaboration is given a higher focus. It is stated that about one third of the funded RTD-projects should have a substantial international involvement. It has however been expressed during the interviews that international focus seems to be more a rhetoric phrase rather than concrete policy.

Tekes evaluates and takes the funding decisions for all the RTD-proposals by internal persons, there are normally no use of external experts. Once a year the project portfolio is evaluated and the administration discuss if there should be a change of priorities.

A couple of expressed ideas for future ERA:

- EU funds should be much more focused to be able to carry through large programs on specific topics which are not possible on a national level.
- European added value should be more important in the project evaluation process.

The EU Commission has to be more pro-active to involve national programs, this is crucial to get to the ERA.

Long term R&D activities might be a good area for ERA but the activities needs to be more focused. In the short term activities, it is important to have a close cooperation among the national managers of RTD programs and by this contact develop projects for collaboration. The organisation of the IEA Implementing Agreements might be a good example of this type of organisations.

The personal view of the author is that there are questions among Finnish RTD actors both to the value of the current EU RTD programmes as well as the value of further integration of European research in ERA.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

The importance of internationalisation has been clearly stated in the Finnish innovation policy. Yet the full consequences and challenges posed by internationalisation to organisations like Tekes and other research organisations are still unforeseen.

A few years back, problems in the domestic energy system had the highest attention in the RTD-programs, but more and more focus is given to international markets and export possibilities for Finnish companies. There is an ongoing change of policy also in Tekes as international collaboration is given a higher focus. It is stated that about one third of the funded RTD-projects should have international involvement. Included in the final reports to Tekes, all projects have to report on the level of international collaboration.

As a general statement, it has however been expressed during the interviews that international focus seems to be more a rhetoric phrase rather than concrete policy. According to present policy, all the RTD programs should include some international elements, but the experience and types of projects funded indicates that the overall focus is still on domestic energy systems with limited international collaboration. The international visions of Tekes do not seem to have enough influence on the project funding decision process.

New project proposals are evaluated by Tekes according to a set of evaluation criteria. Effective networking is described as one essential criterion. It is also stated that projects that include the promotion of international cooperation are welcomed.

However, the author gets the impression that in practice, networking is important mainly on a national level and international collaboration has less focus. This is explained by language problems as well as limited incentives from Tekes to support international collaboration. Tekes should be much more pro-active in this field.

The Finnish energy sector is described as very special compared to the situation in most other European countries. The energy infrastructure is large, and Finland has a high electricity intensity. (Annual consumption is 85 TWh). As a result many energy players find it more convenient to have bilateral RTD collaboration with countries of common interests instead of attending EU Programs. Also bilateral projects are considered more effective than the EU-projects, due to much less paperwork.

As an example, Finland might be seen at as very national oriented in the bioenergy sector. This can be explained because the EU 6.FP does not include production technologies. The largest sector within the Finnish biomass sector is the pulp and paper industry, and their main interest which is production technologies are not included as a topic in the 6.FP.

Tekes runs several technology programs. It is an ongoing discussion on how these programs should collaborate with EU- or other countries programs. There will probably always be a potential conflict between international collaboration and national interests. It was expressed that this can not be handled on a general level but has to be discussed case by case. In certain sectors Tekes has to be very careful, this for example is essential for some areas in the biomass sector.

The EU NNE program have typically 200 M€ annual budget. As Finland has 2.5% of the European GNP, the expected feedback from EU funds is very limited compared to the national funds, typically 60 M€ annually. From this it is to make the conclusion that EU is not important in terms of funding in Finland

It is also a general opinion that Tekes has a much more simple bureaucracy than the EU Commission, and the industry will first come to Tekes to get the projects financed.
It seems to be a common understanding that the EU Programs are sources of funds, but are not considered important in the process of developing the national RTD strategy. There is little national interest to spend lot of resources to the development of EU programs. It is a feeling that these programs are far away from the national focuses. Other international collaboration activities, for example bilateral collaboration, are considered as more important.

To which extent the Finnish programmes should open up and take active part in the ERA is a topic for much discussions for the time being. There are different opinions in Finland about the value of increased international cooperation. To collaborate on a project basis is no problem, but to open up whole programs is more questionable.

The general impression is that Tekes in globally wants to increase the collaboration with Japan and the US, and the EU collaboration is considered to be at an appropriate level.
However, Finnish Universities and Research Institutions take part in several EU-funded projects, and VTT Processes is the leader of a NOE in the bioenergy sector.

During 2003, international networking in company projects was on the level of 25-45% and in the public research projects (universities and research institutes) networking index was 50-60%. These figures represent the share of project funding in projects having some kind of international co-operation compared to the total funding in the energy, environmental and construction area.

A general opinion is that the long term public R&D is a matter for ERA, while more short term projects with heavy industry involvement is much more difficult.

Comments also stressed that the present targets on renewables and especially the incredible high focus on hydrogen was commented to be far from reality. This is bad for the credibility of the Commission and will influence on the reliability of other Commission targets like the ERA: "…to move from 15 + 1 RTD policies to one integrated RTD policy."

Tekes provides funds for companies for the preparation phase of EU proposals. However the paying principle is no cure no pay. The proposals have to be accepted by the Commission before Tekes pays the money. Integrated projects (IP) are important step towards ERA, but these projects are big and the chance to carry through a successful project proposal is limited. Finnish actors do not take the risk to start up such work without a better commitment from Tekes.

Regarding research mobility, Finnish students and researchers tend to prefer to go to the US before any European country. (Except for the Nordic countries where there is a good exchange of researchers due to cultural similarities and special Nordic incentives). In some countries (like Norway) there are more personal economic incentives for the travel to the US due to reduced income taxes.

A couple of expressed ideas for future ERA:

- EU funds should be much more focused to be able to carry through large programs on specific topics which are to big on a national level.
- European added value should be more important in the project evaluation process.

The EU Commission has to be more pro-active to involve national programs, this is crucial to get to the ERA.

Long term R&D activities might be a good area for ERA. But the program should be more focused, so that the EU funds could be concentrated to areas where national funds are too small to develop new technologies. Fusion is an example on such an area, and other areas could be Hydrogen and PV.

In the short term activities, it is important to have a close cooperation among the national managers of RTD programs and by this contact develop projects for collaboration. The organisation of the IEA work might be a good example of this type of organisations. A relatively large number of programmes or Implementing Agreements are established, and these programmes are run by an Executive Committee with one representative from the participating countries. The ExCo members are national representatives, mostly persons from the relevant Ministry or

Government funding agencies who responsible for the national program in the actual sector.

The personal view of the author is that there are questions among Finnish RTD actors both to the value of the current EU RTD programmes as well as the value of further integration of European research in ERA.

3 Short background information

3.1 Overall energy situation

3.1.1 Energy policy

The electric industry in Finland is regulated by the Electricity Market Authority (EMA). EMA monitors the reasonableness of prices and the equal treatment of customers and competitors. The Office of Free Competition monitors the wholesale market for energy.

In June 1995, Finland's Electricity Market Act removed the licensing requirements for constructing power plants and selling electricity directly to ultimate customers. The Act started out applying to large users over 500 megawatts (MWe), but has included smaller users since 1997. The law also made it easier to import and export electricity and has mandated transmission access and unbundled functional activities.

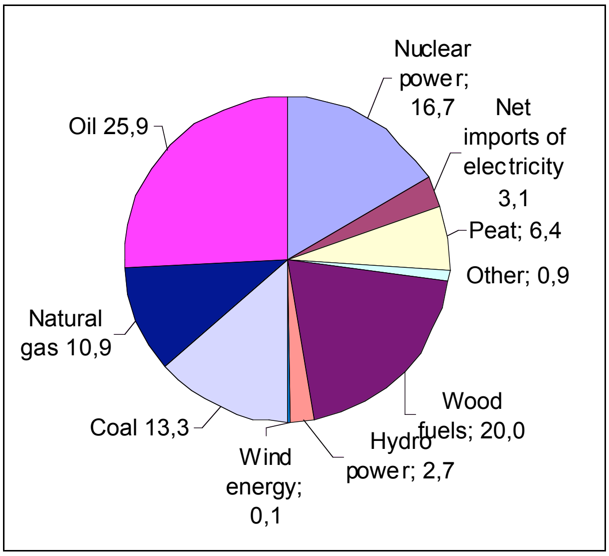
In May 1997, Finland adopted an energy strategy that includes promoting a competitive energy market and diversifying energy supplies. The strategy also emphasized energy efficiency, use of renewables, and reduction of carbon dioxide emissions. In 1990, Finland became the first country in the world to institute a carbon tax; the tax on district heating is based on the carbon content of the fuel. Finland also has a tax on electricity usage.

3.1.2 Exploration and reserves

Finland is a net energy importer. It has no significant domestic reserves of any fossil fuels except peat, and its electricity generation is not sufficient, without supplemental imports, to meet demand. A diagram of Finland's sources of primary energy sources in 2002 is shown in the figure on the left. The total consumption in 2002 was 1 403 PJ.

Peat bogs cover about one-third of Finland's total area, but Finland derives only a relatively small proportion of its energy from peat. Peat presently constitutes about 6-7% of Finland's total primary energy supply, including about 18-20% of the energy input for the smaller combined heat and power (CHP) facilities at municipal and industrial sites.

Exhibit 3-1 Sources of primary energy, 2002



Source: Tekes

3.1.3 Supply and Consumption

Finland relies largely on nuclear and fossil-fuelled thermal-electric power plants for its electricity supply. Many of the fossil-fuelled power plants use peat, especially the smaller facilities that cogenerate combined heat and power (CHP). Electricity is also imported from neighbouring countries (mostly from Sweden and Russia), accounting for about 10% of the electricity consumed in Finland.

All of Finland's oil is imported, with oil imports being handled by Finland's energy company, Fortum Oy, which was created in 1998 as the merger of the electricity generating company Imatran Voima Oy (IVO) and the oil company Neste Oy.

All of Finland's gas is imported from Russia. The gas import company is Gasum Oy, which also is responsible for natural gas transmission within Finland. Natural gas presently accounts for about 11% of Finland's total energy needs. About three-quarters of the gas is used for combined heat and power (CHP) generation in industrial and municipal power plants.

Finland's coal is imported from Poland, Russia, and the United States, and is used for electricity generation and steelmaking process.

Nuclear power has been part of Finland's energy mix since the late 1970s, and it now accounts for slightly more than 25% of its total electricity supply. Finland has two nuclear power plants, the 1,020 MWe Loviisa facility originally built by IVO and now owned by Fortum Oy and the 1,680 MWe Olkiluoto facility owned by Teollisuuden Voyma Oy (TVO). In June 2002, Finland's parliament approved the decision to construct a fifth nuclear reactor, the first time a new nuclear power plant in western Europe had been approved in more than a decade.

There are presently about 200 hydroelectric power plants in Finland. However, most of these are small -- only eight have generating capacities of at least 100 MWe with none more than 200 MWe.

Finland presently has more than 60 relatively small wind power plants, with a total installed capacity of more than 40 MWe. Most of these are less than 2 MWe, and all are located near the seacoast or in northern mountain areas.

Forest-based fuels are an important energy source in Finland. In 2001, about one million cubic meters of forest fuels was consumed in Finland's power plants, the equivalent of nearly 2 TWh of usable energy. Finland has a national goal of increasing that usage to 5 million cubic meters by the year 2010.

3.2 National RTDI system

3.2.1 Main actors

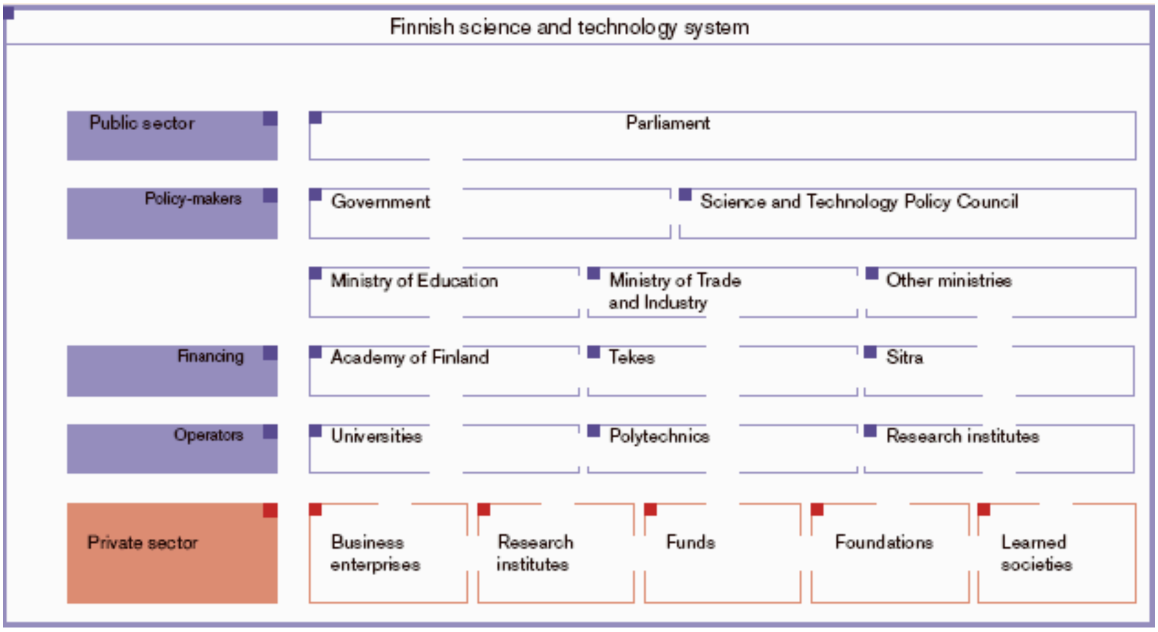
Science policy is the responsibility of the **Ministry of Education**; the most important financing organisation for fundamental academic research is the **Academy of Finland**.

Tekes, The National Technology Agency, is the main financing organisation for applied and industrial R&D in Finland. Funding is granted from the state budget.

The Ministry of Trade and Industry oversees Finland's technology policy.

The Science and Technology Policy Council of Finland, chaired by the Prime Minister, advises the government and its ministries in questions relating to science and technology. The Council is responsible for the strategic development and coordination of Finnish science and technology policy as well as of the national innovation system as a whole.

Exhibit 3-2 Organisation of the Finish science and technology system



Source: www.research.fi/innojarj_en.html

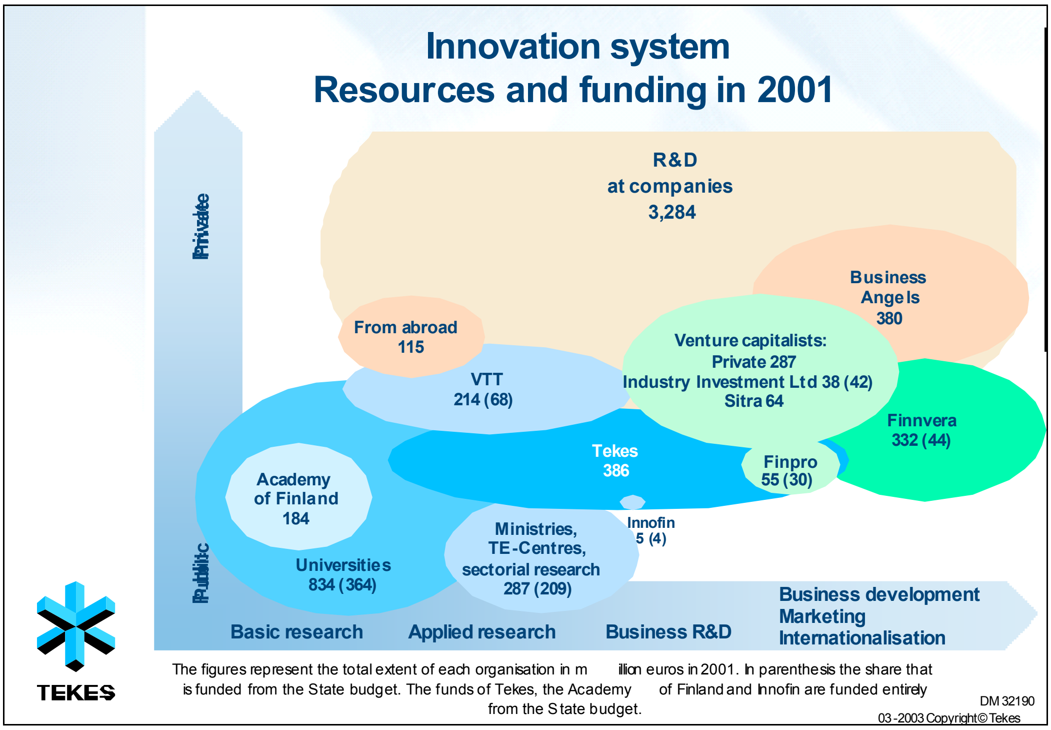
3.2.2 R&D Policy and Expenditure

Finland is increasingly investing in research and technological development and R&D investment now totals 4.9 billion euros, 3.5 per cent of the Gross Domestic Product (GDP) in 2002. The private sector share accounted for 3.4 billion euros.
On an operational level Tekes independently promotes and coordinates R&D projects and programmes, in addition to maintaining cooperation within international networks.

The primary objective of Tekes is to improve the competitiveness of Finnish industry and the service sector by technological means. Activities are aimed at diversifying production structures, increasing productivity and exports and creating a foundation for employment and social well-being. Tekes finances applied and industrial R&D in Finland to an extent of nearly 400 M€ annually.

The technology programmes are an essential part of the Finnish innovation system. About 50% of Tekes financing is directed through the present 34 programmes. Technology programmes are used to promote development in specific sectors of technology and industry, and to pass on results of the research work to businesses.

Exhibit 3-3 Innovation system – Resources and funding 2001

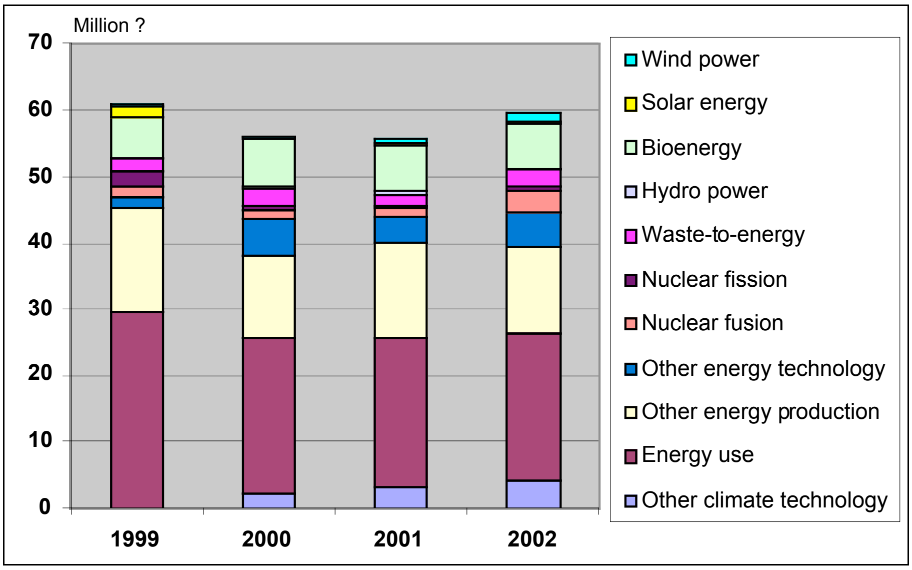


Source: Tekes

The figure above shows the Finnish innovation system. The numbers represent the total extent of each organisation in million euros in 2001. In parenthesis the share that is funded from the State budget. The funds of Tekes, the Academy of Finland and Innofin are funded entirely from the State budget.

Tekes is the most important Finnish agency with regard to NNE RTD. The annual budget for NNE is about 60 mill.€, which could be compared to less than 1 mill.€ for NNE from the Academy of Finland.

Exhibit 3-4 Tekes' annual budget for NNE-RTD



Source: Tekes

TEKES is a financing body; they do not perform research themselves.
The main focus is applied research, but also basic research at Universities and Research Institutions can be funded. The outcome of the basic research activities should always be public available, and Tekes can in principle cover up to 100% of the eligible costs. Projects should however always be of importance to the industry, and most of these projects have 10-20% of finance from the industry. The industrial co-financing is assumed to be a good sign of industrial relevance of these kinds of projects.

An example of a fundamental research area could be university projects dealing with basic combustion processes.
Tekes offers companies grants, capital loans and industrial loans. Funding is given within the following parameters:

- Industrial R&D grants run from 15 to 50 percent of the eligible costs.
- Capital R&D loans run from 35 to 60 percent of the eligible costs.
- Industrial R&D loans run from 45 to 70 percent of the eligible costs.

Differing funding measures can be combined in a single project. One project may, for example, receive a grant of 15 percent of the eligible costs, and in addition, a loan of 45 percent.
About 60% of Tekes budget is allocated to programs, the other part is allocated to so-called free projects.

3.2.3 Main actors

VTT Technical Research Centre of Finland is the largest national RTD institute in the energy sector, and covers 30-50% of the Finnish energy RTD. VTT is a contract research organisation and provides a wide range of technology and applied research services for its clients, private companies, institutions and the public sector. Turnover is about 220 million euros.

VTT has 30% of the turnover as basic funds from the Ministry of Trade and Industry. Other big contributors are Tekes and the Finnish industry. Through the participation of VTT in EU-projects, the Commission covers about 10% of the turnover.

VTT Processes is a technology partner for energy and forest clusters and has 550 employees. The institute offer demonstration services with their large-scale facilities. An important part of the operation is the development of new growth areas. The research fields are:

- Nuclear energy
- Energy production
- Emission Control
- Pulp and Paper Industry
- Materials and Chemicals

Other key R&D players in Finland:

- Helsinki University of Technology
- Lappeenranta University of Technology
- Tampere University of Technology
- Åbo University
- Oulu University
- Vasa University

Key industry players in this sector are:

- Foster Wheeler (boilers, gasifiers, steam turbines)
- Wãrtsilä (engines)
- PVO (utility)
- Vapo (peat production)
- Vacon (energy efficient technologies)
- ABB (energy efficient technologies and generator for wind)
- KWH-pipe OY (district heating pipes and solar collectors)
- NAPS (PV systems)
- Autocompo OY (manufacturer of copper products, heat exchangers and solar absorbers)
- LPM (heat exchangers)
- Win-Wind OY (wind turbines)
- Rantarokki OY (special iron for wind turbines and solar collectors)
- Metso (gear systems for wind turbines)
- Wind Arc OY (offshore wind)

Key associations:

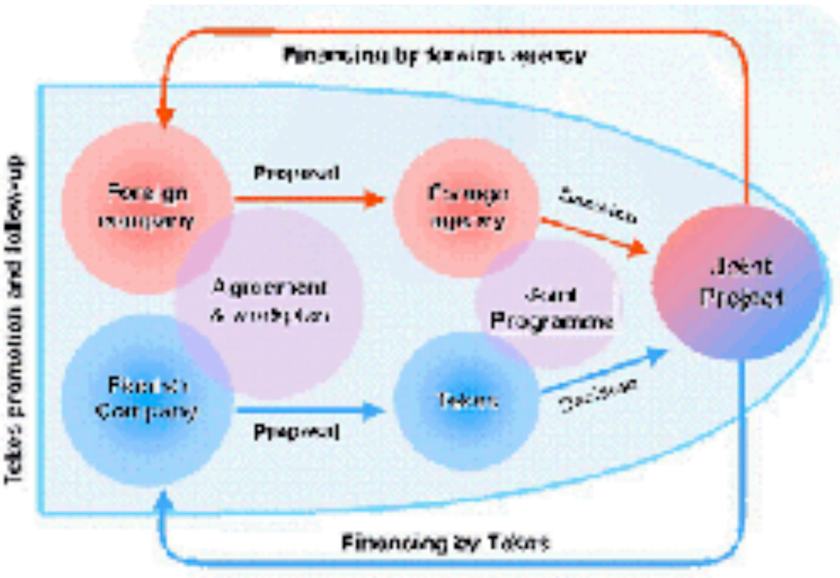
- Finergy (**Finnish Energy Industries Federation)** is an organisation of the companies carrying out power and heat generation, procurement, transmission, sales, and building of power transmission grid.
- Sky (**The Finnish District Heat Association** (FDHA) is an to promote district heating and Combined Heat and Power (CHP) generation.

- Finnish Forest Industry Association
- Finnish Wind Energy Association
- Finnish Solar Industries Group
- Finnish Heat Pump Association

4 Current NNE RTD priorities relevant for ERA in NNE RTD

The importance of internationalisation has been clearly stated in the Finnish innovation policy. Yet the full consequences and challenges posed by internationalisation to organisations like Tekes and other research organisations are still unforeseen.
Tekes actively encourages open cooperation on program level and is eager to be involved in the preparation of **joint technology programs** in cooperation with other funding authorities in different countries. Such programs should focus on international cooperation and how this can provide **added value to the participants**. Funding authorities agree on the general principles of funding and the interpretation of the results (IPR).

Exhibit 4-1 Decision making and financing of collaborative projects



Source: www.tekes.fi

Typically, international cooperation is accomplished in the field of basic research, however enterprises are also encouraged to collaborate with their foreign counterparts in greater depth as joint technology programs can provide an ideal framework for collaboration. Foundations for cooperation are in the main, made at project level.

Foreign research institutes, universities and enterprises benefit from direct access to **top-level research and development projects** within the Tekes technology programmes. The program management organizes opportunities for building **partnerships** between foreign companies and program participants. Relevant costs of participation are primarily covered by the foreign entity itself or by national funding from its own country of origin.

Research institutes and enterprises from outside of Finland can also participate in the Tekes technology programmes using a variety of means.

Research Institutes and Universities
Research institutes and universities can become jointly involved or alternatively pair up with partners in industry. Public funding covers the costs of the research institutes and universities and each participant receives funding from its country of origin. There are three different forms of cooperation.

1. Exchange of research information

- Networking and meeting partners
- Arranging seminars in Finland or abroad
- Exchange of research plans and results

2. Joint research projects

- Projects with a common objective and shared tasks - Each party will be funded primarily by their own sources
  - Rights for the results are agreed among the participants
- Subcontracting for research projects - Project participant purchases services from a foreign research unit to complete its own project
  - A Finnish research unit offers a service to a foreign institute for a common objective of the project

3. Mobility of researchers within a collaboration project

- A foreign researcher is employed by the project - The project participants will utilize results as agreed
  - IPR: according to own agreement
- A Finnish researcher works at a foreign research unit for executing specific parts of the project Tekes may support extra costs resulting from international cooperation

Industry
R&D cooperation for industry can be pre-competitive or it can lead to the creation of joint business based upon the results of the project. The benefits include a shorter time to the market with controlled risks as a result of close cooperation. Public funding covers R&D costs of the enterprises. Each enterprise receives funding from its own country of origin. Foreign enterprises can participate in Tekes technology programmes in four different ways.

1. Joint project

- Common objective, shared resources and tasks
- Each party covers their own costs as agreed
- Utilisation of the results agreed among the participants

2. Subcontracting

- Project participants may purchase services from a foreign entity to complement the project, provided no such domestic source is available

3. Technology transfer

- Project participants may purchase licensed or existing technology from a foreign entity to complement R&D project work

4. Collaboration for marketing and distributing the project results

- Project participants may collaborate with foreign enterprises in order to bring the products to the market

5 Description of Priority setting process

Technology programs are used by Tekes to promote development in specific sectors of technology or industry, and to pass on results of the research work to business in an efficient way. Programs have proved to be an effective form of cooperation and networking for companies and the research sector. During 2003, a total of 34 national technology programs are under way. In 2002, Tekes provided 204 million euros to financing technology programs.

To plan a new program is a long process, normally 1-2 years. The planning process includes market studies, as well as identification of actors and players in the sector. This includes studies on an international level. These studies are crucial for starting up new programs. External groups, industry, agency, R&D institutions, are involved in the preliminary discussions. The final content, priorities and financing is decided by internal persons in Tekes. The decision of launching a program is made by the board of Tekes.

Implementation of Programs

Each technology programme has a steering group, a co-ordinator and a responsible person at Tekes. The duration of the programs ranges from three to five years; their volumes range from 10 million to 120 million euros. Tekes usually finances about half of the costs of programs. The second half comes from participating companies.

Evaluation of Programs

The impact analysis unit in Tekes uses external experts to carry out the evaluation of technology programmes in order to compile varied and independent effectiveness data. The evaluation provides information and understanding on the dynamics of research and development practice and the factors contributing to its success or failure.

Tekes technology programmes are always evaluated at the end of the programme and often also halfway through. The aim of the evaluation is to provide feedback on how the programme aims have been realized, to find out how relevant the programme is and to produce information to support the strategic development of programme activities and the activities of Tekes in general.

The programs and their results are described in the evaluation and final reports which ar mostly public available.

Project evaluation

Tekes evaluates and takes the funding decisions for all the RTD-proposals by internal persons, there are normally no use of external experts.

The following factors are evaluated:

- The company's competitiveness and growth
- The competitive advantages of the proposed technology
- The company's financial and other resources
- The positive impact of Tekes financing on the project

In addition, Tekes welcomes projects that involve:
- Networking with other companies
- Joint execution between SMEs, large companies and universities
- Subcontracting services provided by Finnish SMEs
- Participation in national technology programmes
- Contracting of services from Finnish research institutes and universities
- The promotion of international cooperation

Once a year the project portfolio is evaluated and the administration discuss if there should be a change of priorities.

There is a discussion going on in Finland on how the government funds could be involved in public procurement projects. The motivation for a more active role in this will be to help the industry into the initial phase of a commercial market.

6 Sources / contacts

6.1 Meetings and interviews with the following persons:

- Mikko Kara, Executive Director, VTT Processes
- Robin Gustafsson, Senior Technolgy Advisor, TEKES Impact Analysis
- Peter Lund, Professor, Helsinki University of Technology, Dept. of Physics
- Jukka Lepälahti, Tekes

1.3 Visited web-sites:

- Energy overview Finland: http://www.fossil.energy.gov/international/finover.html
- Research Finland: www.research.fi
- Ministry of education: http://www.minedu.fi/minedu/research/index.html
- Tekes: www.tekes.fi
- VTT: www.vtt.fi
- Energia – meeting point www.energia.fi

1.4 Written material:

- Climate change – Impacts of technology policy and programmes; Tekes 2003
- Growing Power – Advanced solutions for bioenergy technology from Finland; Tekes 2002
- Energy visions 2030 for Finland; VTT Energy, 2003

Country study France

Contents:

1 Summary of country study indicating main points for synergy

In analysing France with regard to NNE RTD it is important to acknowledge first of all that a major feature of the French energy system is constituted by the predominance of nuclear energy. 70 to 80% of final electricity consumption have over the past decades been produced by nuclear power. Renewable energy was the post-war pillar of French energy policy, but this concerned large scale hydropower mainly, with a national policy of major dams since the 1950s, the potential for hydropower being today fully exploited. Solar and wind energy have always played a very minor role in the national energy mix. Because of nuclear energy however, representing low CO2 emissions, energy efficiency in transport is relatively important in order to respond to Kyoto targets.

In the area of non-nuclear energy 4 major actors are active in France – the national energy Agency (ADEME) which implements several incentive RTD programmes related to different aspects of NNE (both oriented towards rational use of energy and to new and renewable energy sources). These programmes range from quite "upstream" (in the field of fuel cells for instance), to "downstream," user oriented programmes (RUE, domotics, etc). The second major actor is the national petroleum research institute IFP which is a research performer. As the name indicates it is involved with exploration, extraction, processing and use of petroleum derivatives. Thirdly, the CNRS, the French (public) fundamental research institute is leading a major programme related to non-nuclear energy research. Finally, 25% of EDF (Electricité de France, an electricity company) R&D budget is mainly dedicated to fossil-fired power plants, hydroelectricity and renewable energies.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Necessary conditions for making ERA happen

Before entering into country specific issues it is important to mention some of the more generic observations made by the persons interviewed in France. These concern FP6, the balance between excellence and egalitarianism in RTD and public-private collaborations. After having this discussed these this chapter will consider country specific issues and suggestions.

2.1.1 Energy and Research strategies, and decentralisation of project management

A quite interesting feature of the French interviews is that most people encountered were very much in favour of creating multi-lateral networks, not so much of researchers per se, but of programme managers, who far less have the occasion to encounter each other.

A representative of ADEME, the French Energy and Environment Agency, suggested a more strategic and pro-active approach to be taken by the European Commission to organise and prioritise its RTD support. By identifying the actors in a given field (or from a certain product, service or method) at a European level, gaps and imperfections in the "network" from research to the market can be identified and actions defined. The European Commission should take a role of facilitator and concentrate on strategy, programme definition, etc., and the national agencies responsible for energy research should be much more networked and co-ordinated and, implement and manage this strategy, directly integrated in projects.

This latest point is also stressed by the representative of the IFP (French Oil Research Institute), who regrets the lack of strategic planning known to be present in the 1970's in hydrocarbons. "Europe" should elaborate "long term strategies, with well-defined choices." Finally, representatives from the French Ministry of Industry that were interviewed for the present study suggested that benefits may also come from increased co-ordination and co-operation between the Framework Programme implemented by DG RESEARCH and the policy-orientated programmes managed by DG TREN. The expectation is that this would enhance relevance of RTD work through macro-economical reflections on energy issues and policies.

Finally, the director of the CNRS Energy Programme also suggested that contacts should be established between European programme managers, to discuss of the necessities of each country beyond European programmes. This could led to a better matching of NNE RTD activities: for example, Germany could decide to launch a research programme on clean coal exploitation and should be able to identify French researchers do have the competencies for that activity and could join in with the German programme easily. Today this is much left to the researchers' own initiative.

In other words, a far more pro-active approach to European co-ordination at all levels seems to be favoured.

2.1.2 Excellence vs. egalitarian development

In the interviews a striking opposition could be found between those interviewees who though that there should not be the (implicit) obligation to associate smaller or in R&D terms less developed countries to European research projects: only scientific excellence and competence should count. The opposite view was also expressed however and consisted in saying that associating such countries has helped countries in the "second circle" of academic research to boost their competence, which in the longer term would be beneficial to the Union as a whole. This is an important subject again today with the advent of the new accession countries in the EU: the danger of creating poles or networks of (previously proven) excellence may exclude countries with potential but who currently would not have the means to impose themselves. A balance should therefore be sought between the two criteria "excellence" and a sort of "egalitarianism."

2.1.3 Public/private collaborations

Several issues concerning the relationships between public and private collaborations have been highlighted during the interviews in France. On the one hand, it was sometimes felt that industry prefers a national support for its RTD: this is more simple, less hazardous, management is less heavy. Moreover in European collaborations the results are almost always public, and the return on investment at the national level is problematic.

A different point of view was that the collaboration between public research and industry is fruitful, even if culturally the building of a relationship takes time. According to a research director of a private company interviewed, the key issue is to what extent and at which point in the development the different actors involved are willing to share information. Agreements between partners on (sharing of) IPR are seen as increasingly crucial.

2.1.4 Mobility

Mobility is problematic and does not seem to be well developed among French researchers. One of the specificities of the French situation is that most of the public researchers are civil servants and this makes it difficult both to send out or receive researchers. Mobility therefore mainly comes through doctorates and post-doc positions.

Hiring foreign researchers in companies may be hampered because of administrative barriers. In the public research sector on the contrary, foreign researchers, also non-EU, can be easily employed

The Strategy Direction of CNRS (National Centre of Scientific Research, the main public research body) has decided to favour the introduction of foreign teams in the CNRS Energy Programme. For example, a French research team in Nancy is used to work with a German team. German researchers are then invited to assist in the internal meetings of the French team. The German team does not obtain CNRS funding but it gives them extra “points” when they are evaluated. The director of the Energy Programmes suggests that such initiatives could be further worked out and improved with a view on ERA.

2.1.5 Importance of personal relations

Finally, although it may sound as a cliché, all persons interviewed emphasise the key role played by personal relations among the scientific community. Events which put people into contact etc., are a good way to create (international) networks which then should be further consolidate by real opportunities for working together – but then this is what the Framework Programme has been trying to do, often with success, over the past decades.

2.2 Existing opportunities for ERA

France has in the past been quite active in NNE RTD at the European level. As just one example, one can cite the AFME (ADEME’s predecessor) who was very much involved in the development of the European label on energetic consumption of electric household goods. Other examples are geothermal energy, photovoltaic energy and fuel cells.

2.2.1 Importance of involvement in the Framework programme

The integration in the European Framework Programme is seen as an important objective for French research in NNE RTD. Being visible at the European level is seen as a matter of survival, because participating to a European project leads to new contacts (relations with other research organisations) and to visibility. It is generally thought however that European priorities should be in line with French priorities. Advice, if not influence, on these priorities is seen as important.

2.2.2 European relationships

Relations with neighbour Germany are one of the strongest and most common RTD relations: examples of bilateral research initiatives can be found in transport, where the national programmes Mobilität in Germany and PREDIT in France have launched common calls for proposals, and where in geothermal research a joint RTD project exists (Hot Dry Rock at Soultz in the east of France; this is co-funded though by the EU; it also associates Switzerland). For many interviewees encountered Germany is frequently, in the environmental field, a reference, since generally seen as advanced in environment related technologies.

Besides Germany, the main European partners of France actors in NNE RTD are Spain, Italy, Greece, the Netherlands (TNO being the main reference here), Denmark and the United Kingdom. On specific topics collaboration with other countries exist, such as with Sweden on biomass (ADEME) or Iceland on the hydrogen economy (CEA). These relationships appear to be established, most of the time, through European FP projects. Following these collaborations, it is quite usual that bilateral agreements between two European public research bodies are signed. For example, the CEA with the German LBST on the development of technico-economical modelling related to NNE.

Collaborations mainly result from two factors: geography and technological/research affinities. The Soultz European project is a good illustration of both.[27] It is a deep geothermal project, based on "hot dry rock technology," involving 3 European countries (France, Germany and Switzerland). These countries are the only European ones to have potential deposits.

2.2.3 International collaborations

France participates in the IEA. Bilateral RTD collaborations are mostly thematically inspired. Most French actors active in the field of NNE RTD (ADEME, CEA, National Oil Institute-IFP, EDF, Ministry in charge of Research…) collaborate with partners in the United States (mainly focused on hydrogen and fuel cells). Other bilateral collaborations exist with eastern European countries (Romania is cited because the two languages have common roots, many Romanians speak French, and the relationships between the 2 countries are historical), Mediterranean area (Maghreb countries – with which because of colonial history close relationships exist – and Middle-East), Asia (China, Japan, Korea, India, Thailand, Vietnam…), Brazil. All such collaborations relate to specific thematic interests: ADEME has a focus on sustainable development and renewable energy ; IFP on petroleum and petroleum by product strategic developments (collaborations with Middle-East or Latin America for example); the French atomic energy agency CEA is aiming to mobilise its traditional nuclear sector network for non nuclear energy activities ; the research network of EDF R&D comprises the University of Tsinghua or the Thermal Power Research

[27] www.soultz.net

Institute (TPRI) in China. Many of these collaborations are only emerging (for example between ADEME and Japan).

2.2.4 Language and research methods are two main barriers for collaboration

Two major barriers were identified through the interviews: language and research work methods.

Language is often if not always cited as a main barrier for research cooperation. English is the scientific language, but is not always spoken fluently by French researchers in the area. Mobility, of course, is a way to partially solve that problem; the situation is improving.

"Research culture" also matters. Work methods and work organisation are crucial: one of the interviewees – director of an energy programme at a major public research organisation – stressed that Spanish teams are organised much like US teams, i.e. one professor with 2 or 3 researchers. In the United Kingdom or Germany the size and organisational structure of research laboratories is more like in France hence facilitating communication and collaboration.

2.3 Concrete possible policy actions

2.3.1 Financial and funding implications, and suggestions

For several partners interviewed – but the issue seems more important for more applied research – it takes a lot of effort (including financial) to build up or to participate to an European project, but the financial return is very low. The preparation is heavy, the management with sometime 20 partners can be 'monstrous', and proposals are not always successful. The expenditures for building international partnerships are quite substantial and the aspect of cost-effectiveness should be taken into account.

2.3.2 European research as platform for national research

For ADEME, the European level is sometime very quibbling, so the Agency uses this level to redefine the activities eventually conduct at other levels: the European level can trigger topics that are translated into national terms and nationally treated. A good example is formed by fuel cells. These, after having been virtually "banned" from the French NNE research landscape started off again with a JOULE project in the beginning of the 1990s, and are now subject of a national "network" (PACO – see below for more detail). Retrospectively, the Framework programme has served as stepping stone to get the item back on the *national* research agenda. This movement was however not inspired by the quibbling-ness of the European level alone, but also by other considerations such as credibility of the research theme in France, and the European research programme providing a platform on which new ideas could be tested, before introducing them back onto the national research scene. Especially in France, where, as said, NNE research has never been top priority, European programmes have been very important in this respect in the past.

2.3.3 A shift from energy to environment related research

In the eyes of our French interviewees, energy and environmental research are seen as very close, mainly due to the Kyoto Protocol and to the thoughts on greenhouse effect.[28] Some of our interviewees wished that the European Commission make precise political choices concerning renewables and new energies in this regard. However another, more critical point of view was expressed, i.e. that environmental concerns should not alter long term energy needs and energy RTD competencies. The European Framework Programme's recent orientation towards environmental issues has undermined, among research teams, the interest for longer term RTD relating to energy supply. This unbalance could in the longer term alter scientific expertise in energy matters, as a matter of training, of technical competencies.

Socio-economic RTD has been mentioned in association with both energy and environmental RTD. RTD on "social acceptance" to be performed in early stages of technological trajectories, was underlined as a necessity by many French interviewees.

3 Short background information

3.1 The overall energy situation of France

French energy policy has been characterised over the past decades by 3 principal objectives:

- Security and energy supply
- Economic efficiency (low energy prices)
- Sustainable and environmentally benign energy supply (cf. Kyoto Protocol : France is required to stabilise its CO2 equivalent emissions – 6 gases – by 2008-2012)

Also, energy policy refers to the principle of public service or general interest: cf. the Electricity Act ("*Loi de la modernisation et du développement du service public de l'électricité*," 10 February 2000). The electricity cost to the consumer is the same all over the French territory (principle of "peréquation"). It is especially the latter principle that in the past allowed the development of alternative energy production, i.e. in geographical niche markets (overseas territories, remote sites such as mountain areas) where nuclear energy would be too expensive.

3.1.1 Distribution of energy sources

The French energy system has 3 main characteristics

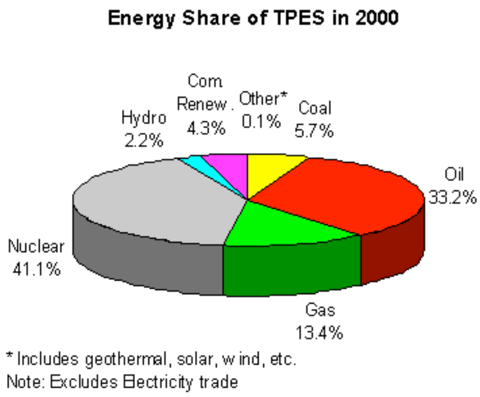
- A high share of nuclear energy in the energy mix. This has consequences on R&D: during the past 30 years there have been many investments in that sector, especially to standardise nuclear reactors.
- little national fossil fuel resources: gas, oil, and especially few coal (the last French coal mine will be closed in 2004). The share of coal in the energy mix is

[28] For example the Ministries of Environment (MEDD) and Research seem very concerned by biological and biomimetic RTD: how to produce energy resources from vegetal energy caption.

very low ; concerning the share of oil, France is in the European average, and for the share of gas France is slightly under the European average

- the production of renewable energy can be considered as a strong point, as in from 1950s a national policy of great dams was established; France has developed technologies in hydraulics, related later to nuclear energy. Today, the potential for hydraulic energy is fully exploited. Also, the production of energy linked to the wood sector is increasingly important. Solar and wind energies only have a minor share in the energy supply.

Exhibit 3-1 French energy share of TPES in 2000



Source : IEA

As a consequence of the high share of nuclear in the energy production and supply, France is one of the lowest producers of greenhouse gas in Europe. The sectors mainly emitting increasingly greenhouse gas are transports and housing. The energetic consumption of industry has been stabilised after many years of effort.[29]

3.1.2 Imports/exports

Following the 1973 oil crisis; one of the main objectives of French energy (RTD) policy was to become as independent as possible from energy imports. From that moment on France has launched a nuclear programme with the objective of national independence.

3.1.3 Market concentration

EDF (Electricity of France) and GDF (Gas of France) are nationalised firms (but their privatisation is on the way). They are, for the moment, in situation of monopoly, although this is shortly bound to change in regards to the market opening process (July 2004 : 70% of the market opens by enlargement to all non-residential customers, totally 250 TWh).

The oil sector is private. TotalFina and Elf merged in 2000, after Elf was privatised.

[29] Bernard Spinner, *Pourquoi un programme Energie au CNRS ?,* Le journal du CNRS n° 389, 2003.

3.2 The national RTDI system

3.2.1 Public/private spending on RTD

The Research and Development Domestic Expenditure (DIRD-"*Dépense Intérieure de Recherche et Développement*") assesses the research effort accomplished on the national territory ; and the Research and Development National Expenditure (DNRD-"*Dépense Nationale de Recherche et Développement*") assesses the research outlay of French actors whatever the place of accomplishment.

Exhibit 3-2 Structure of DIRD and DNRD 2000-2002 (M€)

	2000	2001	2002 (estimated)
DNRD	32 081	33 570	34 195
Financing by administrations	14 404	14 673	15 276
Financing by firms	17 677	18 897	18 919
Share of administrations in DNRD	44,9%	43,7%	44,7%
DIRD	31 517	32 887	33 396
Accomplished by administrations	11 717	12 105	12 614
Accomplished by firms	19 800	20 782	20 782
Share of firms in DIRD	62,8%	63,2%	62,2%
Share of DIRD in GDP	2,22%	2,23%	2,20%
Share of DIRDA[30] in GDP	0,83%	0,82%	0,83%
Share of DIRDE[31] in GDP	1,39%	1,41%	1,37%

Source : MJENR – DEP B3 – 08/2003

Exhibit 3-3 Contributions to DNRDA in 2000

	M€	Structure
BCRD[32]	7 228	50,7%
Contribution of French State to FP	419	2,9%
Ministry of Defence	2 589	18,2%
Ministry of Education for universities	2 763	19,4%
Other ministries	250	1,7%
Regions	142	1,0%
Non-profit making institutions (except subventions)	239	1,7%
Proper resources (contracts…)	626	4,4%
DNRDA	14 256	100,0%

Source : MJENR

Some cross-combinations are existing ; for example, for the universities, a credit line "university research" exists in the BCRD, in addition to the contribution of the Ministry of Youth, National Education and Research for the financing of university research.

30 DIRD of Administrations
31 DIRD of firms (*Entreprises*)
32 Civil Budget for Research and Development

Exhibit 3-4 Distribution of research jobs in public administrations and firms

	1999	2000
Administrations	140 167	145 464
Firms	171 564	177 688
TOTAL	311 731	323 143

Projet de loi de Finances 2003

3.2.2 Public research institutions

In France, the following types of organisations perform research

- Public research organisations:
  - EPST (Scientific and Technological Public Institution – Etablissement public à caractère scientifique et technologique)
  - EPIC (Economically and commercially oriented Public Institution – Etablissement public à caractère économique et commercial)
  - Specific research organisations, with a private status but publicly funded: IFP for example (the National Petroleum Institute)
- Higher education institutions, divided in universities and "Grandes écoles"
  - Research in higher education is done by universities and by 'grandes écoles'. Their R&D expenditure is of 3 928 M€ (including salaries, logistic…), with 61 318 employed in R&D in 2000[33].
- Ministries are also leading research (EPA : Public Administrative Institution – Etablissement public à caractère administratif)

Exhibit 3-5 Distribution of research jobs in high education institutions and public administrations

	1999	2000
EPIC	21 112	21 253
EPST	44 217	45 891
EPA	8 339	10 296
Universities and "Grandes écoles"	59 689	61 318

Projet de loi de Finances 2003

3.2.3 Funding system

BCRD: Civil Budget of Research and Development

The BCRD is the government co-ordination mechanism for the individual ministries' research budgets. It describes the budget

- to public research institutions[34]: they define their own programmes strategies and objectives
- per ministry, to fund RTD actions

The BCRD is co-ordinated by the Ministry of Research, who co-ordinates the proposals made by individual research organisations and the different ministries that contribute to the research budget.

[33] Projet de loi de Finances 2003.

[34] Due to visibility matters, the RTD budget of universities is not fully included in the BCRD.

3.2.3.1 Pluri-annual contracts between State and public research institutions

- Assessed every 4 years between the State and each individual university, the pluri-annual contracts describe the strategy of each establishment in terms of research, education, human resources and international policy. The public funding is allocated according to the university's priorities. The research projects are evaluated either by the University Scientific Mission (MSU) of the Ministry of National Education and Research, or by the corresponding EPST in case of research partnerships. This scientific evaluation determines whether project will be financed.[35]
- EPST's and EPIC's objectives and actions contracts are defining, every 6 years, the establishment's objectives (in terms of themes and partnerships), its scientific priorities, its management (human resources, evaluation, information systems, valorisation), and the engagements of State and establishment. Financial and human resource budgeting is however done yearly within the framework of the annual Finance Law.

3.2.3.2 FNS and FRT

- The National Science Fund (FNS-Fonds National de la Science) was created in 2000, and shall impulse research in priority fields, and promote concerted actions between publics laboratories.
- The Technological Research Fund (FRT-Fonds de la Recherche Technologique) aims at developing basic research effort of enterprises and theirs partnerships with public laboratories. The FRT has recently been reoriented towards SMEs.

Both funds are granted with around 200 M€ annually (though budget cuts may change this at present). It should be noted however that both funds do not constitute two single programmes but each is simply a general pot out of which individual types of actions can be funded. Hence most of the FNS funding is going into different "incentive concerted actions" (see below) and around 70% of the FRT's budgets is dedicated to the 16 different Research and technological innovation networks (RRIT-Réseaux de recherche et d'innovation technologique)

3.2.3.3 Incentive Concerted Actions (ACI-Actions concertées incitatives)

ACIs, implemented by the Ministry of Research, are seen as a complement to public research organisations' actions and support public research teams. ACIs have 3 main objectives:

- support structuring actions in specific disciplinary field
- encourage experts communities to work together in interdisciplinary operations
- promote young researchers bearing projects

ACIs are funded mainly through the FNS (see infra) and managed by a director, assisted by a scientific council. Several actions are led in co-ordination with the Research and Technological innovation networks (RRIT-Réseaux de recherche et d'innovation technologique), financed through the FRT, or with research and innovation support systems of Europe and of other ministries. The most recent ACIs are led together with EPST and/or EPIC.

ACIs are based on calls for proposals.

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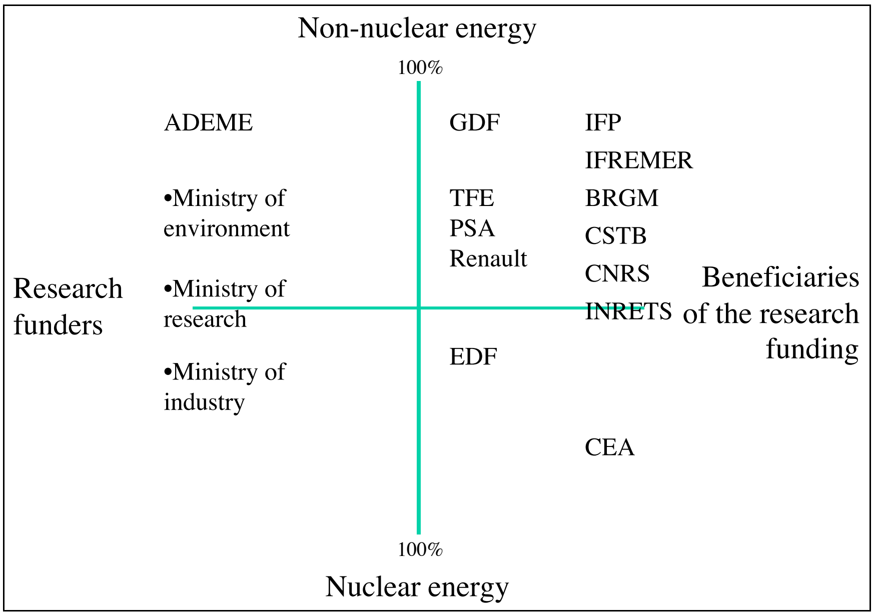
[35] The contractualisation policy is currently being evaluated.

4 Brief description of NNE RTD organisation

4.1 Main actors

The following figure presents the main actors of the French NNE RTD system. Universities are not represented, because no data is available on their RTD in NNE.

Exhibit 4-1 Main French NNE RTD actors



Legend

Research funders	Public research organisations	Private organisations
ADEME : National Energy and Environment Management Agency	IFP : National Oil Institute IFREMER : French Research Institute for Exploitation of the Sea BRGM : Geological and Mining Research Office CSTB : Scientific and technical Building Centre CNRS : National Centre of Scientific Research INRETS : National Institute of Research on Transports	GDF : Gas of France EDF : Electricity of France TFE : TotalFinaElf PSA : Peugeot S.A.

4.1.1 Ministries

4.1.1.1 Ministry of Youth, National Education and Research

Ministry in charge of research, Direction of Technology - Department energy, transports, environment and natural resources

Position: the Ministry's role is to facilitate RTD not to determine R&D priorities very precisely. Nevertheless sets of themes are put forward, with a general orientation on energy management and consumption, i.e.

- hydrogen path, including fuel cells
- CO2 management (also in complement with hydrogen if produced from hydrocarbons)
- new and renewable energies : photovoltaic, geothermics ,wind (off-shore), biomass (agricultural biofuels), thermic energy
- energy control (through hydrogen path, energy savings, storage, distribution)

4.1.1.2 Ministry of Economy, Finance and Industry

Ministry of industry: the General Direction of energy and raw materials

The strategic orientation of the MINEFI evolved from, 5 years ago, energy independence, to, today, a focus on greenhouse gases and the diversification of the energy mix (i.e. not to depend on a single energy path, like the nuclear one).

DGEMP funds the following programmes (see below for explanation)

- CEA's NTE Programme (see below)
- RTPG (even if the ANVAR manages the network), however the DGEMP does not select the projects funded by the RTPG : the Ministry of Research is in charge of this selection, in accordance with the DGEMP policy

4.1.1.3 Ministry of Environment and Sustainable Development

This Ministry does not directly fund RTD on non-nuclear energy, but promotes its general objectives to the actors of the NNE RTD:

- effort is to be directed towards energies that are not producing greenhouse gas, and that can replace nuclear energy
- promotion of energy saving
- promotion of every tool allowing to reduce greenhouse emissions in a global assessment (CO2 capitalisation in agriculture…), along the whole energy cycle
- promotion of integrated research, in consortia

This is mostly done in collaboration with ADEME. The Ministry of environment is taking part to the negotiations of the State/ADEME Contract.

The Ministry is in particular interested in hydrogen: mainly hydrogen production, carbon storage.

4.1.1.4 Ministry of Equipment and Transports

The ministry of equipment and transport is one of the government departments for the PREDIT programme relating to land transport. The energy aspects within this programme are however mainly funded by the ADEME.

4.1.2 ADEME, the French energy and environment management agency

ADEME is the public agency devoted to the support to energy and environment RTD activities of public and private actors. The agency tries to foster innovation within what it calls socio-technical networks,[36] by bringing together the different parties

[36] For an outline see for instance SENSER report, European Commission, March 1998.

involved with technical innovations in the energy field (research institutes, firms, users, regulation, local authorities, etc.). The Agency tries to improve and strengthen the relationships between the different parties by identifying strengths and weaknesses in such networks and putting concrete actions against identified weaknesses.

ADEME is funded by different ministries ("ministères de tutelle").

Exhibit 4-2 ADEME's resources per origin in M€

Year	Total	Ministry of Research	Ministry of Environment	Ministry of Industry	External resources
2001	296	21	225	38	12
	100%	7%	76%	13%	4%
2002	342	10	248	31	53
	100%	3%	72,5%	9%	15,5%

ADEME - Annual reports 2001 and 2002

Exhibit 4-3 ADEME's R&D budgets per origin in M€

Year	Total	BCRD	Ministry of Environment	Ministry of Industry	Others
2000	51,4	17,4	25,9	4,5	3,6
	100%	34%	51%	8%	7%
2001	53,4	16,8	27,8	5,1	3,7
	100%	32%	52%	10%	6%

ADEME - R&D Activity report 2000-2001

Concerning NNE, ADEME is focusing on
- Rational Use of Energy (RUE)
- New and renewable energies (ENR)

ADEME is organised in 3 programmes :
- energy and greenhouse effect
- pollution and nuisances
- wastes

Exhibit 4-4 ADEME's R&D budget per programme in M€

	2000	2001	2002
Energy and greenhouse	27,3	30,1	31,3
Pollution and nuisances	16,3	15,5	17,8
Wastes	7,8	7,8	8,0
TOTAL	51,4	53,4	57,1

ADEME - R&D Activity report 2000-2001 and Activity Report 2002

In these three programmes the energy concern can be both specific (the Energy and Greenhouse effect Programme) and transversal (there are many interfaces with the two other programmes).

The following exhibit presents an overview of the Energy and Greenhouse effect Programme, every specific action area being linked to key actions.

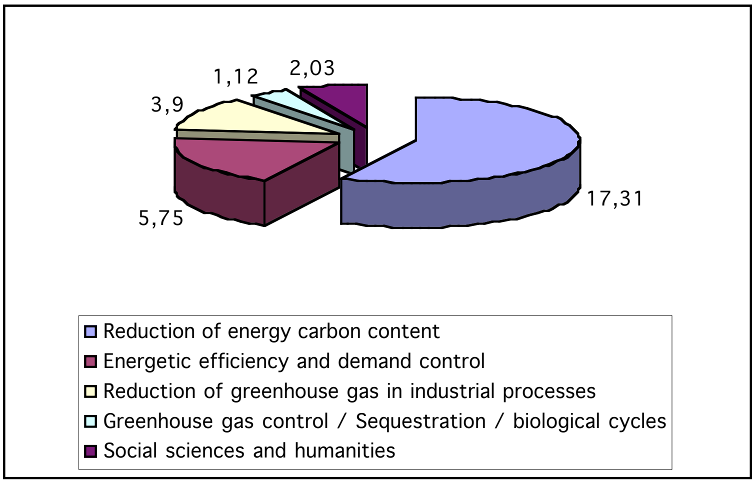
Exhibit 4-5 Energy and Greenhouse effect Programme : overview[37]

Key actions	M€	Specific areas
Reduction of energy carbon content	17,31	• Renewables • Hydrogen paths • Energy storage (electricity and heat)
Energetic efficiency and demand control	5,75	• Transport sector • Industry sector • Building – Tertiary sector
Reduction of greenhouse gas in industrial processes	3,9	• Advanced combustion • Chemical specification and capture • Others greenhouse gas
CO2 sequestration	1,12	• Transport • Storage : technical feasibility, environmental control, acceptability
Impact and control of greenhouse gas emissions from agricultural practices and organic wastes		• Biogas valorisation • Agricultural emissions control (carbon cycle and nitrogen) • Biosequestration and biomaterials
Social sciences and humanities	2,03	• Sociology • Economy • Law and institutions

ADEME - R&D Activity report 2000-2001

The budgets of every key action are illustrated in the following figure.

Exhibit 4-6 Energy and greenhouse Programme : budget per key action in M€, 2001



ADEME - R&D Activity report 2000-2001

[37] See the R&D Activity report for more precise information on the programme (detailed research topics per strategic axis).

4.1.3 Public research and technology organisations

4.1.3.1 CNRS

The CNRS is Europe's biggest public research organisation, counting around 25 000 staff of which around 11 000 are scientists and engineers. CNRS still has some own laboratories, however most of researchers are working in joint laboratories with, mainly, universities (UMR's, Unité Mixte de Recherche). Therefore in an international perspective CNRS is often compared to a research *council* rather than being a research organisation "having its own walls."

In 2000 CNRS has developed an interdisciplinary programme on Energy, involving 7 out if its 8 Scientific Departments.[38] After the oil crisis of 1973 and 1979, the CNRS established programmes on new energy sources. But, with the decrease of the oil prices, funding for such programmes also decreased. From 1988 to 1997 (Kyoto Protocol), the preoccupation with greenhouse gas emission led to new thoughts on renewables.[39] The CNRS decided then to set up a structured action on energy, with the objective of the Kyoto Protocol: to reduce greenhouse gas emission to the level of 1990 in 2010.

The priorities of this Programme are

- to better control energy demand and production in housing and transports
- to remove the technological locks of mid- and long-term

The Programme emphasises socio-economic research and Hydrogen related research.

Priorities were inspired by main 2 concerns :

- Energy independence: according to national scenario exercises, France is expected to undergo an energy crisis in 15 years, amongst other things related to the age of the nuclear park (most of nuclear reactors having been built in quite short period of time); energy independence must be maintained or searched for, especially for transports and housing
- Reduction of greenhouse gas emissions, through renewables, fuel cells, carbon sequestration and energy efficiency

In terms of time horizon, the research programme aims the:

- mid-term : 15-20 years, where the industry support is expected
- long-term : 20-50 years, where radical technological change may be needed for which today no solutions exist

The programme concentrates on the following themes :

- renewables (photovoltaic, biomass, geothermal, thermal solar) for heat production, for fuel in transports and for electricity production
- new energy vectors : electricity, hydrogen, heat (production, storage, transport)
- improvement of classic energetic process for energy efficiency or emission treatment matters

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38 CNRS, Rapport d'activité 2002.

39 See Claude Birraux, Jean-Yves Le Déaut, *Rapport sur l'état actuel et les perspectives techniques des énergies renouvelables*, OPECST, 2001.

- socio-economic research on energy

These themes have been defined after the constitution of working groups (CNRS, other research organisations, and frequently industrial actors), charged to draw up the national and international state of the art, in order to identify unexplored thematic and adapt the choices to France[40].

In 2002, the Programme financing[41] was of 1,524 M€, only from CNRS (this data is to be related to the CNRS total budget : of 2 154 M€ in 2002)[42]. In 2003, this financing tripled due to the participation of Ministry of Research (through an ACI), ADEME and the Ministry of Defence's DGA (General Armament Direction)[43] :

- CNRS for 2M€
- Ministry of Research for 1M€
- DGA for 1,4M€

Being incentive funding only, an estimate of the consolidated budget of the Programme (i.e. including salaries, overheads, etc.), can be obtained by multiplication by a factor 10. Hence in 2003, the Programme can be said to represent around 44M€ in terms of total cost.

Around 700 researchers from the CNRS are involved in the Programme (not everyone is in full time).

The Programme is supervised by a steering committee, composed of 12 personalities from CNRS and the Ministry of Research. Calls for proposals are launched every year, with the objectives of favouring partnerships with other public research organisations and with industrial companies, and of bringing closer interdisciplinary competencies.[44] The success rate in these calls lies around 1/3.

The following exhibit shows the general objectives of the Programme per priority. It is to be noted that some objectives may also concern nuclear RTD but this cannot easily be separated out.

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40 See www.imp.CNRS.fr/energie

41 It has not been possible to know the share devoted to NNE.

42 CNRS, Rapport d'activité 2002.

43 Bernard Spinner, *Pourquoi un programme Energie au CNRS ?,* Le journal du CNRS n° 389, 2003.

44 www.cnrs.fr/DEP/prg/Energie.html

Exhibit 4-7 Overview of CNRS Energy Programme

Axis	M€	Themes	General objectives
New energetic resources		Biomass	Biomass production ; gasification, enzymatic processes (fuels, biogas) ; cogeneration
		Solar energy	Photovoltaic : thin layers ; polymers ; 3rd generation (nanostructures) Thermic : housing ; thermochemicals ; thermic electricity
		Geothermics Hydrogen Fuel cells	Housing or industrial heat Production PEMFC-SOFC (electrolytes, electrodes, systems)
Control of energetic vectors		Electricity	New concepts : networks, composings, storage
		Heat	New concepts : recuperation, transformation, heat/refrigeration production, storage, long distance transport
		Hydrogen	Storage, transport, safety
Clean, economical and performing processes, and environment		Combustion	Motors, boilers Wastes, biomass – synthetic gas and cogeneration, safety
		Industrial process	Optimisation (safety, quality, energetic efficiency) in transformation industries : agro-food, iron and steel metallurgy ; industrial refrigeration
		Heat exchangers	Exchange optimisation, multi-scales systems, multiprocessing, combined processes
		Housing	Bioclimatic housing : new isolators, thermic inertia Couplings : new solar captors / surface geothermics / heat pump ; biomass ; photovoltaic
		Waste Greenhouse gas	Emissions treatment, effluents ; nuclear wastes Capture, treatment, destruction
Socio-economics		Demand determinants	Economic and social acceptability
		Models and data	Taking developing countries into consideration
		New institutional environment and regulation	Standards and legislation
		Innovation diffusion Security, economic and social safety	Industrial property

www.imp.CNRS.fr/energie

4.1.3.2 CEA

The Atomic Energy Commission (Commissariat à l'Energie Atomique) has, also since 2000, been leading an RTD programme on "New Energy Technologies" (NTE), therewith explicitly leaving the "nuclear-only" vision practiced so far.

Before this programme was launched, CEA's R&D activities included technology areas like solar energy, fuel cell, hydrogen… but without any attempt to overall structuring. With NTE this changed and 3 priorities were defined

- Energy carriers: hydrogen and fuel cells (production, storage, conversion)
- Photovoltaic as a full path, as a system; energy storage as a full system, in both cases reaching comparative cost-effectiveness being the main objective
- Energy efficiency and thermal/housing, mainly through hybridisation of energy sources (photovoltaic, biomass…). RTD activities here are in strong interaction with the GRETh (Research Group on Thermic Exchangers, set up in the 1980s by

ADEME's predecessor AFME), a consortium of industrial companies relating heat exchangers of all sorts

These priorities have been chosen after the evaluation of the current competencies of CEA laboratories. This evaluation showed that the CEA had many competencies related to 'new energy technologies' in-house, but this was not explicitly organised and therefore not integrated. For example, LETI, a major laboratory concentrating on micro- and nano-technologies has competencies in polymers that could be used in photovoltaic cells; but these two issues were not naturally connected within CEA. The Programme introduced a structuring of activities, and a rationalisation whilst explicit choices were made on the RTD to support as indicated above.

It is important to note that the RTD activities in the Programme do no longer have to be based on nuclear RTD; for example, RTD on biomass gasification for hydrogen production, one of the themes within the programme, is exempt of nuclear energy aspects.

The CEA is also teaming up with industrial companies in its RTD projects, both for national, European and international partnerships

In 2004, the NTE Programme is planned to involve 290 people, among which

- 174 on hydrogen and fuel cells
- 81 on photovoltaic and energy storage
- 35 on energy efficiency

The total budget of the Programme is of 32,8 M€ for 2004.

4.1.3.3 IFP and RTPG

The **French Petroleum Institute** (IFP- Institut français du pétrole) has a particular status: it is a private research institute, but under the "tutelle" (supervision) of the Ministry of Industry. The contract 2001-2007 with the State is the third one, but for the first time the budgetary donation (since 2003 of 200 M€) is listed in the BCRD (see above). Before 2003, IFP was financed directly by a tax on oil products (TIPP), but this practice was stopped through European directive. In 2001, IFP budget was of 278 M€.[45]

About one third of that budget comes from contracts or subsidiaries' dividends, and returns on participation in firms: in France, the legislation authorises a public body to have private status subsidiaries (for technology transfers, for example). Concerning IFP, many RTD projects are led with its subsidiaries (like Axens).

IFP's RTD covers the whole oil ad gas sector: from exploration to refining and to utilisation. It is an institute with a good reputation even though France has itself only limited oil and gas resources.

RTD projects are of two sorts :

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[45] Projet de loi de finances 2003.

- Basic ('upstream') research, the objective of which is to make sure that the institute's competencies are State-of-the-Art. This research is mainly done in collaboration with other public research institutes: CNRS, INRA (on biofuels), universities, IFREMER…, and internationally
- Industry-oriented research covering the lion's share, i.e. 80% of IFP's RTD

Programmes are either pluri-annual or annual, but are in any case revised every year. The Contract with the State is put in quite generic terms and therefore actually does not determine the effective priorities of the Institute. Most of the programmes are set up in dialogue with industry and its needs.

Exhibit 4-8 RTD in IFP: overview (2002)

Programme	M€	Strategic axis
Exploration/ Oilfields	60 (25%)	Exploration of new oil territories
		Evaluation of oil systems
		Improved oil recuperation
		Oilfield monitoring
		Environment
Sinking/ Production	34 (14%)	Production in complex tanks
		Ultra-deep sinking and production
		Treatment and transport of oil effluents
Refining/ Petrochemistry	82 (34%)	Industrial projects : refining, petrochemistry, gas and other energies (production of hydrogen or synthetic gas)
		Competencies acquisition projects : catalyse, analyse, thermodynamics and separations, development of processes and inorganic materials
		Worktools projects
		Prestations projects
Motors/Energy	41 (17%)	Combustion
		Optimisation of the motors/fuels system
		Electronic control
		Reduction of pollution and nuisances
		Industrial thermic
TOTAL	**217**	

IFP Annual Report 2002

The total budget in 2002 was of 241,1 M€, but this also covers training (the IFP runs the national "Petroleum and Engine School"), information and valorisation activities.

IFP participates to ADEME's AGRICE[46] group, concerning biomass and biofuel RTD

Concerning hydrogen, as from the 1960s IFP worked on the development of fuel cells for automobiles but, confronted to storage and electrochemical problems, this programme was stopped at the beginning of the 1980s. Since 4 years IFP has been working on hydrogen production related to CO2 capture and sequestration, for 2 main reasons:

[46] The scientific interest group AGRICE (initially an incentive programme), Agriculture for Chemicals and Energy, focuses on new uses and enhanced value for agricultural products and byproducts as energy, chemical and materials feedstocks. AGRICE is committed to coordinating, funding, monitoring and evaluating research and development programmes that further these goals. See www.ademe.fr/partenaires/agrice for more information.

- the establishment of the national hydrogen research network (PACO, see below)
- the change of vision within the international oil industry about the end of the fossil fuel era, as well as a concern about greenhouse gas emissions

The **Research network on oil and gas technologies** (RTPG-*Réseau de recherche sur les technologies pétrolières et gazières*) allocates funding to firms having RTD programmes on hydrocarbons exploitation/production and on oil refining.
In 2001, 114 projects have been selected, associating in total 67 industrial partners. IFP is leading 25% of them.

The RTPG is managed by ANVAR, the national agency for research valorisation.

Exhibit 4-9 Funding by RTPG per thematic, in M€, 2001

Thematic	Amount
Marine exploitation	15 650
Natural Gas[47]	2 134
Geology - geophysics	11 065
Wells (sinking)	4 090
Refining (utilisation)	1 709
TOTAL	34 678

Projet de loi de Finances 2003

This network has lead to the creation of a national platform in which oil and gas actors can meet and exchange, allowing the development of a powerful para-petroleum industry.

4.1.3.4 BRGM

The Geological and Mining Research Office (BRGM-Bureau de recherches géologiques et minières) is an EPIC under the supervision of the Ministries of Industry and Research. In the energy field, the Office has programmes in partnership with IFP on geothermal energy and CO2 sequestration.

The organisation is also the French lead partner of the deep geothermal energy programme of Soultz (Hot dry rock technology).

4.1.3.5 Universities

It has appeared impossible to determine the energy budget of universities. The Ministry of Research evaluates that circa 500 university researchers are working on energy-related issues ; in terms of wages (university researchers are paid by the State) this would represent around 50 M€ per annum.

4.1.3.6 Other

The following research institutes are marginally working on NNE issues:

- **IFREMER** (French Research Institute for Exploitation of the Sea), an EPST, is engaged mainly on research actions on marine wind energy, or, with IFP, on off-shore sinking.

[47] Mainly transportation.

- **INRETS**, an EPST, is engaged in PREDIT.
- **Technical Centers** such as CETIAT (aerolic and thermic industries) or CETIM (mecanical industry), but also the **CSTB** (Scientific and technical Building Centre), are playing a role on RTD in housing (R&D on energy demand : in construction…).
- **LCPC** (Laboratoire des Ponts et Chaussées)

4.1.4 Companies

We will here focus on EDF and GDF, even if many French firms (Air Liquide, TotalFinaElf…) are conducting NNE RTD projects.

4.1.4.1 EDF

The total research budget of EDF is of 381M€[48], including 95M€ for the protection of the environment. Nuclear energy represents 44% of the total RTD budget, and about 25% of the research concerns fossil-fired power plants, hydroelectricity, renewable energies and networks i.e. 95,25M€. Moreover, EDF launched in 2002 a 50M€ five years research program aiming at developping renewable energy sources.

The NNE R&D activities are governed by the Group strategies, supported by the R&D Division :

- Fossil-fuel power plants : RTD mainly concerns “clean coal”, and projects are focused on the “Best Available Techniques” (BAT), in particular in terms of protection of the environment : desulfurization, denitrification, reduction of particulates emissions, CO2 captation and storage, reduction of atmospheric pollution, re-utilization of ashes, etc …)
- Hydraulic energy RTD is important for EDF because the company operates a large number of French dams : the objectives are to lower the exploitation costs and to optimise water management (pollution, environment...)
- Biomass RTD : the research mainly aims at improving co-combustion in thermal power stations. R&D Division is also involved in an European project called RENEW
- Concerning solar energy, with the help of ADEME, EDF has launched, with CNRS, a research program on photovoltaic cells. The issues are the increase of cost-effectiveness and overcoming of technological barriers
- A large RTD program is also running on fuel cells (stationary and for vehicules). Studies on heat pumps, RES in the buildings and houses, … are also performed
- Wind farms are studied from the point of view of their technical performances, meteo forecasting, and inclusion on the grid
- New techniques related to marine current turbines are also investigated
- EDF is also very much involved in the deep geothermal project of Soultz-la-Forêt with other European partners
- Finally, with the help of ADEME, EDF performs RTD on energetic efficiency and electricity demand control

48 EDF Annual Report 2003.

4.1.4.2 GDF[49]

The Research and Development Division conducts R&D projects in all gas related areas for the GDF group ranging from gas production, transport and distribution to end use.

696 researchers are working in the Research Direction of GDF. The total budget of the Direction was in 2002 of 74,5M€[50].

Main research areas include:

- Upstream: Liquefied Natural Gas (LNG), gas networks (pipelines, corrosion , treatment and metering)
- The use of gas in industrial processes (glass making, metallurgy, and agribusiness especially)
- Everyday gas use: combustion and burners, heating, hot water and cooking
- Innovative techniques: air-conditioning, cogeneration , fuel cells , and Natural Gas Vehicles (NGVs)
- Miscellaneous areas: statistics, economics, sociology and the environment

Both EDF and GDF will in term be privatised. It is not clear which consequences this may have for RTD, although the trend that can be observed abroad indicates that generally RTD investments are decreased at privatisation.

5 Current NNE RTD priorities relevant for ERA in NNE RTD

5.1 Figures

Exhibit 5-1 Total government expenditures for energy R&D, per thousand units of GDP

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Budget on energy R&D including nuclear research	0,45	0,42	0,42	0,38	0,43	0,40	0,39	0,41	0,46
Budget on NNE R&D	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,04

Source: IEA annual report, 2000

49 http://innovation.gazdefrance.com/public/php/accueil.php?langue=en
50 GDF, Annual Report 2002.

Exhibit 5-2 Government R&D budgets per NNE technology area, in million US$ at 1999 prices and exchange rates

	1991	1992	1993	1994	1995	1996	1997	1998	1999
Conservation	19,2	18,6	12,1	8,1	7,9	7,1	4,6	6,5	12,3
Oil and gas	37,8	36,2	33,6	33,5	32,1	31,6	31,2	30,9	30,7
Coal	5,5	5,4	5,6	5,5	5,6	5,2	5,1	0,1	-
Renewables	8	7,8	5,7	5,3	5,2	5,0	3,0	4,1	13,3
Energy systems analysis and others	-	-	-	-	-	-	-	-	-

Source: IEA annual report, 2000

IEA does not take in account the R&D of EDF (Electricity of France) and GDF (Gas of France), considering those two institutions as private. The IEA data for France are gathered and processed by the Ministry of Industry – Department of Energy and Raw Materials. The Department is confronted to many counting problems, especially the fact that the R&D in university laboratories is not referenced.

5.2 Energy issues are strongly linked to environment

In the BCRD the line “Energy” represents 6,4% of total research budgets; however energy funding can furthermore be found under “Environment and sustainable”, “Materials” or “Transports” budget lines. It is therefore difficult to determine exactly from the BCRD how much is effectively allocated to energy RTD, and even more so in the case of NNE RTD (nuclear energy seems to count for a huge share of the former 6,4%).

In the “Projet de loi de finances 2003”, it is quite interesting to see that Energy and Environment themes are treated in the same chapter, and then even mostly through environmental concerns. The PACO network related to fuel cells (see below) only appears in the Materials chapter. The Ministry of Industry is probably the only ministry to consider energy also from the supply side of view, as energy *per se*.

5.3 Two national “research networks” relate to NNE RTD

RRITs are support tools to RTD; 16 RRITs are existing today in France, their goal is to improve collaboration between the public and private research, from SMEs to MNEs.

The networks are not incentive research programmes in the traditional sense of the word, but labelling procedures. Labelled projects are eventually co-funded by the Ministry in charge of Research, through the FRT, and also by other ministries and agencies.

Two Research and technological innovation networks (RRITs) in France are related to NNE: PACO and PREDIT.

- PACO (“**P**iles **A** **CO**mbustibles”) is the RRITs focusing on fuel cell research, created in June 1999. Its goal is to improve public/private research co-operation in fuel cells, from production to utilisation in transport or stationary applications (production of heat and electricity). The network is funded by the Ministries of Research, Industry, Transports, by ADEME and by ANVAR (the French Agency of research valorisation) : the public funding has been of 32M€ in 3 years (when the network was launched, only 7,62M€ of public funding were supposed to be

devoted to it for the same period of time). The network is facilitated by ADEME and CEA.
Its main themes are
- performances and behaviour of components
- core of cell (electrodes…)
- fuel alimentation of cell
- hydrogen production and storage
- systemic studies
- safety
- socio-economic evaluation of the different paths
- development perspectives of hydrogen path

• PREDIT (Research and Innovation Programme in Terrestrial Transports) associates the Ministries of Research, Transports, Industry and Sustainable Development, by ADEME and by ANVAR. The network has been allocated 305 M€ for the period 2002-2006[51]. Some research themes of PREDIT are concerning NNE RTD.

Finally it should be mentioned that a Committee on New Energy Technologies reflects on the way to improve support to promote New Energy Technologies, i.e. renewables (wind, thermal solar and photovoltaic, geothermics, sea energy, biomass and biofuels), hydrogen, fuel cells, heat exchangers… Also, inspired by the aforementioned CEA programme, a creation of a new network on New Energy Technologies is under discussion by the Ministry of Research.

6 Description of Priority setting process

6.1 Two main objectives: reducing greenhouse gas emissions and promote a new energetic mix

It has been 4 or 5 years by now that the problem area concerning 'energy' is as a matter of fact defined according to the greenhouse effect: this is obvious in the Ministries of Research and Environment, ADEME, CEA, but also IFP, EDF… Some interviewees however indicate that such a definition incorporates the risk of loss of energy technology related research competence per se.

This notwithstanding, one can thus say that most of current RTD priorities in France are influenced by the Kyoto Protocol and the necessary limitation of greenhouse gas emissions. In France, CO2 production has increased despite the implementation of the nuclear programme in the 1970's. According to our interlocutor in CEA, this increase can be explained by the use at 95% of fossil fuels in transports. Transport represents the 1/4 of France's oil importation.

For example in CEA, the responsible for the NTE Programme is very concerned by environmental issues. The NNE RTD actions of CEA are explicitly oriented towards the objective given by the Kyoto Protocol. Transport and housing are the 2 major

[51] Projet de loi de finances 2003.

contributors to greenhouse effect, so the actions of the NTE Programme are oriented towards it.

This objective can also be linked with the energy efficiency preoccupation.

The second main objective is to promote a new energetic mix, reducing the share of traditional energies: nuclear, coal and hydrocarbons.

6.2 The relationships between public research organisations, ADEME, and supervision ('tutelle') ministries, in priority setting processes

The main instrument of government is incentive actions. The Ministries are defining general orientations. The main tools of the Ministry of Research are the National Science Fund and the Technological Research Fund discussed above. However the FRT is mainly devoted to the funding of the networks (RRITs). There is no strong strategic planning in energy RTD, as it was present for nuclear energy in the 1970's.

However the governmental level can identify key actions to be sustained, initiatives taken by public research organisms, and can try to structure such actions. For example the CIRST (Interministerial comittee for scientific and technological research) issued in June 1999 research priorities, among them energy. The main priority in energy was the creation of a technological network on fuel cells (leading to the constitution of the PACO network).

In sum, in the French NNE RTD field the research community de facto defines the research priorities and there is little top down steering.

We have seen that the relationships between supervision ('tutelle') ministries and EPSTs and EPICs are defined in contracts (so-called "contrats d'objectifs"), discussed every 6 years. An assessment is done at mid term. Each individual organisation proposes the ministries an overall RTD Programme, elaborated mainly by its Direction and its Scientific Council according to the recommendations of the programme managers. The ministries allocate overall funding to the organisation. The Contracts are followed-up through "meeting points" in time. Nevertheless these contracts are purely formal since they apply at a very general level only and do not much go into detail. Therefore, decisions concerning effective RTD priorities are made within the organisations. A Contract represents only general RTD lines, that can be eventually re-defined halfway considering RTD results. For example, ADEME's Research Programme, inscribed in the Contract 2000-2006, has been re-oriented following a change in the Direction ; the new Programme is then integrated in the Contract, on the occasion of the mid-term assessment. Finally even though an overall sum is indicated, the contract with the research organisations do not signify a strong budgetary engagement since budgets remain defined annually.

6.3 Importance given to scientific evaluation of projects

6.3.1 Programme evaluation

Every RTD activity is scientifically evaluated at least every 3 years. EPSTs are performing their own evaluation of RTD projects (including those in partnership with universities, ADEME, CEA…). One call to tender is usually renewed during 2 or 3 years. Concerning ACI's, as projects are funded for 3 years, they are scientifically evaluated every 3 years and at mid term. An ACI can be continued if the ex-post evaluation is satisfactory, it can be translated in a new set of themes or, partly, in new ACIs. The evaluation of the RITTs (PACO, PREDIT…) has so far been left very much to the initiative of the individual secretariats: the previous PREDIT programme was evaluated at mid-term and by the end of the programme; PACO underwent only a technical evaluation to assess the relevance of the research it promotes.

Concerning more finalised organisations (IFP, ADEME), 'evaluation' is often de facto performed by assessing, eventually, industrial returns of projects. EDF R&D is currently developing a methodology to evaluate the value it creates in terms of Group earnings (estimation of net actual value). This is the same for the Ministry of Environment where a programme is most often judged successful if it has lead to research results, to what in French is called "valorisation."

More structured evaluation practices may appear in future with the new finance law that takes effect in 2006 and that is based on the definition of programmes with as much as possible quantified objectives and the evaluation of the effectiveness of these programmes.

6.3.2 Other RTD support activities

Foresight, ex-ante evaluation or impact assessment, are not very explicitly used in the priority setting process or more generally to guide political decision making. Relevance of decisions is mostly "evaluated" from the results of the project or priority: scientific and technological production, "success"… The decision is related, most of the time, to the current economic/scientific/technological climate. For example, the launch on RTD activities on biofuels 10 years ago was motivated by the high cost of oil barrel, by the fallow issue, by the perspective of the European Agricultural Policy… Currently, RTD activities on hydrogen and fuel cell are said to be in relation to the necessity of reducing greenhouse gas emissions.

The Ministry of Industry is using a guide of key technologies to be supported, published by ADIT (www.adit.fr), the Agency for the diffusion of technological information. This document used to be the reference for any support action from the Ministry (arrow credits to ADEME, CEA, RTPG… for example on fuel cells).

A current initiative has also to be mentioned: FutuRIS, a foresight exercise involving many actors of the French RTD field, on the national research and innovation system to improve in the future.

Concerning ADEME's RTD support activities, 3 observations can be made:

- It relies firmly on socio-economic networks : partners of a project are consulted every year on next year's orientations, from past year's assessment. This is also done at the end of a project : an evaluation is conducted, partners are gathered and future actions are redefined
- ADEME does not usually lead market studies, considering it can rely on its industrial and private partners. However, if a network is not well-structured,

ADEME can launch a study; it has been done for example on innovation in individual wood heating

- ADEME does not perform much technical project monitoring: as ADEME is not in charge of the research itself the Agency finds it difficult. It has nevertheless carried out evaluation of past programmes, and in 2000 a meta-evaluation of 10 years of NNE RTD (1985-1995) funded by the agency and its predecessor AFME was performed at the request of the ADEME.

In general, the energy agency ADEME does not dispose of of an all encompassing "forward-looking" activity that would allow to set overall priorities. However there do exist individual model studies, expert groups, market analysis, impact assessments, etc. to guide individual pieces of research or research programmes…

CEA on the contrary has recently performed a major foresight, for two reasons

- The supervision ministries have asked the CEA to set up a mid- and long-term plan (PMLT), to define the evolution of CEA's missions from 2003 to 2012. The PMLT is currently in negotiation between the supervision ministries and the CEA.
- The NNE RTD support activities in CEA are multifold and had to be tied together in some way
  - Marketing studies : what are the markets, at what cost the technologies will be interesting for industrials. CEA has got a special team for that activity
  - Involvement of firms that are doing active technology watch, to have a state of the art and the positioning of CEA on a certain market
  - An international relay system with units present in Washington, Korea, Japan, Canada, and to the European Commission
  - Every year a mid-term plan is organised (PMT, 4-5 years); thematic workshops are set up, gathering CEA researchers, allowing to select interest matters. Then a 2-days meeting is organised, where a general framework is given, in order to mobilise different competencies, allowing to better structure CEA's offer in this problem area. In 2003 the theme for example was thermal/housing. A document is published, diffused to every CEA laboratory, summing-up the discussions and the workshops and declining programmatic directives informing research units on what the Programme could develop in the year to come. Next, units propose projects and partnerships, sometimes unexpected ones. In 2003, 90 people came to such an annual meeting, some of which were not involved in the NTE Programme. The idea is also to increasingly motivate persons previously involved with nuclear research to propose NTE projects
  - CEA organises thematic roadmaps
  - In 2003 a scientific evaluation of the NTE Programme was set up and all participating laboratories will be evaluated every 3 years by external experts

6.4 Priority setting process: the importance of networks (formal and informal)

The interviews has show the importance of formal and informal relationships in the definition of NNE RTD priorities:

- The Ministry of Research has defined its priorities through the discussion between the Ministry Heads of Departments, the Ministry Directors, but also with its partners in public research and industrial research (Renault, Peugeot, EDF…)
- IFP has built a network on industrial partners, and the choice and management of projects are more and more shared between the actors of the network

- Programmes definition, projects evaluation, intermediary implementation and animation (manifestations, colloquies…) involve ADEME and every partner of a network. The research programme is discussed in the Scientific Council (CS) of ADEME, on the basis of technological areas and of future challenges for society (health, environment, culture…). The reflections on RTD orientations are made at Scientific Directions and CS levels, but as well, regularly, with partners.

The importance of Scientific Councils in research organisations and agencies, as well as "labelling networks" such as RRIT have to be noted. ADEME's CS members (although not representing their organisation) are from public research organisations (CNRS, INSA[52] …), industry (wind, air treatment…), CSTB, AFNOR (standardisation), OECD, INERIS[53]…). The composition of ADEME's CS has to respect an equilibrium between public and private sectors, and between the RTD themes. In other words, the priority setting process in NNE RTD depends very much on the multiple links of actors that as a matter of fact are very much entwined.

6.5 The Foresight exercise of ADEME, CEA and CNRS

ADEME, CEA and CNRS have recently set up a foresight exercise. This was performed in May 2002, as a 6 years foresight. The Foresight exercise is in a way the institutionalisation of former relations between the 3 organisationss. It was launched following a request of the Ministry of Research's Direction of Technology, asking ADEME, CEA and CNRS to build up a multidisciplinary programme in energy, in order to take a position in ERA. During the writing of the proposal, IFP joined the team.

The actors have determined what key points could be developed together. Thirteen key technologies were identified:

- photovoltaic
- thermic solar energy and thermodynamic
- biomass thermochemical conversion processes
- biomass / biofuels byhumid and enzymatic way
- hydrogen production
- hydrogen storage
- fuel cells (PEMFC, DMFC, SOFC)
- electricity management
- electric storage
- combustion processes
- energy efficiency
- greenhouse gas treatment
- socio-economic research

For each technology a presentation has been elaborated, presenting the context, the common points, and the concrete objectives (data, prototypes realisation, processes demonstration, cost reduction…).

52 National Institute of Applied Sciences
53 National Institute of Industrial Environment and Risk

The choices have been made after a market analysis, the analysis of the positioning of CEA and CNRS laboratories compared to European and international teams, and following technological innovation potential analysis.

The exercise should have led to the allocation of new means, but given the change in government followed by severe budget cuts in 2003, and probably continued in 2004, not much progress could be made on the issue. The positive effect of the exercise is however, in consultation with the Ministry of Research, the actors involved have developed a common view on NNE RTD.

Annexe A Acronyms

ACI	Incentive Concerted Actions
ADEME	Energy and Environment Management Agency
ANVAR	National agency for research valorisation
BCRD	Civil Budget for Research and Development
BRGM	Geological and Mining Research Office
CEA	Atomic Energy Commission
CIRED	International Research Centre on Environment and Development
CNRS	National Centre of Scientific Research
CSTB	Scientific and technical Building Centre
DGEMP	General Direction of energy and raw materials
EDF	Electricity of France
EPIC	Economically- and commercially-oriented Public Institution
EPST	Scientific and Technological Public Institution
ERA	European Research Area
FNS	National Science Fund
FP	Framework Programme
FRT	Technological Research Fund
GDF	Gas of France
IEA	International Energy Agency
IFP	National Oil Institute
IFREMER	French Research Institute for Exploitation of the Sea
INRETS	National Institute of Research on Transports
MEDD	Ministry of Environment and Sustainable Development
MEFI	Ministry of Economy, Finance and Industry
MJENR	Ministry of Youth, Education and Research
NNE	Non nuclear energy
NTE	New Energy Technologies
PACO	"Fuel Cell" network
PREDIT	Research and Innovation Programme in Surface Transports
RRIT	Research and Technological innovation networks
RTD	Research and Technical Development
RTPG	Research network on oil and gas technologies
SME	Small and medium enterprise

Annexe B Bibliography

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Country study Germany

Contents:

1 Summary of country study indicating main points for synergy

Germany undoubtedly plays a major role in European Research Area (ERA) in non-nuclear energy research and technical development (NNE RTD), not only because of its size but also because of the strength of its research institutions and the priority Germany has given to NNE RTD in recent years.
This priority is in effect oriented not only towards renewables, but very explicitly formulated in contrast to nuclear research, as Germany has taken the decision to phase out nuclear power supply.

Cumulated financial support for research projects in 2003 by the federal ministries in charge of NNE-RTD[54] amount to € 152 million: € 73 million for renewable energies, € 79 million for rational use of energy and around € 40 million basic funding for renewable energies in the research centres of the Helmholtz Gemeinschaft.[55]

A major tendency in recent research policy in Germany is related to the effort of bundling competencies, recognising on the one hand the need for efficiency in a context of tight research budgets, on the other hand the importance of complex research problems calling for intra- and trans-disciplinary approaches. The restructuring of the Helmholtz-Gemeinschaft and in particular of its energy research, as well as the creation of national and regional research associations and networks illustrate this effort.

Visibility of competencies is also regarded as a success factor of integration in relations increasingly marked by a combination of competition and cooperation that play a role within Germany as well as on the European and the global level. Due to its complexity, it may be excessive to resume points for synergy in one sentence, anyhow, after screening of diverse written documentation and a series of 11 interviews, the more or less explicit logic of subsidiarity in research collaboration most often show through, with activities close to industry located at the regional or national level, and long term, high scale projects ideally placed on the European level.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Necessary conditions for making ERA happen

A basic and most necessary condition for making ERA happen is that the need for international cooperation in research. Within the domain of NNE-RTD, Germany has with no doubt a dominant position, due to competencies and industrial involvement, which can be illustrated notably by the interest expressed by foreign interview partners in close cooperation with Germany.

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54 The competencies for energy research are split in 4 ministries, in charge of research, economic affairs, the environment and agriculture.

55 See Forschungsverbund Solar (2003), Expunktpapier, p.6.

Our German interview partners often underlined that firstly, researchers are very well integrated in international networks that work on the (traditional) basis of conferences and publications as well as cooperations within EU framework programmes, and that secondly, networking has transaction costs, in monetary terms but also in terms of opportunity costs, related to time losses for research activities as such. Perfectly recognising the evidence of the international character of research, they insist on the fact that local impact (mainly on industrial participation) is very much a matter of local activity.

According to Dr. Eisenbeiss, coordinator of energy research at the Helmholtz Association and member of the board of Research Centre Jülich, ERA (or at least the globalisation of research) already exists because it exists for industry, choosing research providers all over the world according to expected results, and not according to the country of origin.

The development of ERA is in this sense accompanied by increased competition and cooperation. In the field of non-nuclear energy research, where industrial involvement is recognised as an important element, competition is relevant both on the level of high excellence requested by internationally active companies, and on the level of SMEs, with a certain need of protection and geographical closeness in their cooperative pattern.

Barriers to international cooperation have mainly been identified on the following levels:

- Transaction costs: costs for travelling, time for exchanges, increased demand for networking on several levels (regional, national and international), which leads to a kind of overkill in coordination activities. Some interview partners generally doubt about the usefulness of "top-down-coordination" of research.
- Barriers of language: in big countries like Germany, people (especially in small research structures or companies) are used to work in German, communication in a foreign language is still perceived as a barrier. There is some tendency to introduce English teaching in (technical subjects) in university, which could perhaps partly provide a solution to this problem.
- Administrative barriers: administrative obligations in European projects are perceived as extremely burdensome, considerably reducing incentives to apply for a European project. According to a researcher in Baden-Würtemberg, a clear correlation between the administrative weight and the geographical level of administration (regional – national – European) can be observed, both concerning application formalities and reporting.
- Institutional differences between countries: especially for new instruments like ERA-Net, the different institutional setting of research systems makes it difficult to integrate in a project all the partners that would be interesting, due to problems of eligibility. For example, the programme manager in North Rhine-Westphalia referred to an idea for an ERA-Net launched with a Dutch partner, that should also integrate French participants. However, the institutional setting in France did not allow for eligibility for ERA-Net, the project has been abandoned in its initial version and shall now be pursued as a Coordination action.

- The way of functioning of European structures in Brussels is difficult to understand for people who have never been involved in European decision making, mainly met on the regional level. Moreover, and this has also been mentioned by national actors (even by the national contact point for EU-projects), information coming from Brussels is often contradictory from one source to the other, as well as over time. As an example, the financial guidelines in the framework of integrated actions has been mentioned, still available only in a draft version and apparently in contradiction to the possibilities of financial officers of the projects[56]. The varying size of integrated projects from one call to the other has also been mentioned as difficult to explain to national actors who firstly are deterred from application due to the envisaged size and have afterwards to be informed that in fact, projects may also be submitted with far less partners and a smaller budget…
- Intellectual property rights protection is generally perceived as a most evident barrier to collaboration, but not specific to the development of ERA, as these problems also emerge on the national level.
- The idea of opening up national programs to international partners is either not so new, if the opening results in cooperative projects where each country pays its participants, or it is politically extremely difficult to defend, if tax-payers money, directed to national programs and not to European ones, shall benefit participants from other countries. This observation also holds for regional funding in Germany. The willingness of national governments to give up national autonomy will depend on the thematic domain.

2.2 Existing opportunities for ERA

2.2.1 Regional versus national actors in ERA

A question particular to Germany concerns the implications of regions or “Länder” in the European research area: the biggest of these Länder are bigger than the small European member states, with more than 8 million inhabitants. Anyhow, it came out as rather rare and exceptional if a German Land has direct contacts to the national level of another country. Collaborative and informative contacts are mainly established with other provinces, as for instance with Austrian regions, even if Austria as a whole is smaller that the German partner.

In section 3.1.3 it will be discussed that regions are mainly supporting research activities with an (economic) impact on the region itself. Anyhow, even if they are interested in participating in European activities, they may have the impression to be the odd one out, when the size of the projects and the need for well established relationships discourage newcomers, don’t feeling necessarily as a partner with equal rights.

2.2.2 Thematic complementarities

According to our interview partner from the German National Contact Point, the thematic domains treated in Brussels and Germany do not considerably differ, which

[56] A financial plan shall be established for the first 18 months and then outlined in milestones, anyhow, such a plan can not be controlled according to the rules of financial officers, who does not know which kind of costs are really incurred.

can be explained by the fact that Germany itself has important financial means for research funding, and is therefore autonomous. As a big country, EU-funding is perceived as a complement, whereas it can be a substantial input for small countries. Anyhow, several interview partner mentioned the domain of coal plant technologies as missing in the EU-programs, as it is considered as one of the most promising technology for CO_2 reduction under the (given) condition of available energy resources in Europe today.

Complementarities between the national and the European level are mainly connected to research either with a need of big equipment (like in the framework of Euratom) or in a long time horizon, like nuclear fusion.

2.2.3 Trans-border cooperations

Interview partners referred to several trans-border cooperations, notably with other German speaking countries (Austria and Switzerland), but also around an environmental and regional objective (i.e. the Alpine region).

- The German-Austrian-Swiss energy cooperation (DÖSE) has been presented as a network of persons that know each other since a long time, meeting regularly to exchange information on research activities. It is now considering the submission of an ERA-Net project.
- ARGE Alp, a free association of alpine regions[57] created in 1992, aims to deal with the joint expectations of its members, within the field of its competencies, in particular in the cultural, social, economic and ecological fields, thanks to cross-border cooperation and, with a minimum of institutionalisation, to increase awareness of the general responsibility towards the natural alpine environment, to make contact between populations and citizens easier, to strengthen the positions of the countries, Regions, provinces and cantons and contribute to cooperation in Europe together with other institutions. According to M. Olk from the Bavarian Ministry of the Economy, ARGE Alp has tried to establish a common project in NNE and energy savings, but due to institutional differences this became to complicated and has been limited to mutual exchange of information.
- Alpen Adria is a working community created in 1978 with the task of joint informative expert treatment and co-ordination of issues in the interests of the members. One of the 15 working areas is generation and transmission of energy, where there was an attempt launched in the mid 1990s to sign an energy convention, which finally did not work out as Switzerland would not participate.

2.2.4 Bilateral cooperation

Bilateral cooperation of Germany is content driven and not driven by preferences to one partner country or an other. Nevertheless, agreements are often historically determined. M. Eisenbeiss mentions for instance the good relationship of the Research Centre Jülich with Krakau, providing a specific scholarship to young researchers.

Bilateral relations exist to the USA, which is perceived as most interesting, other non-European relations exist with China in the domain of environmental technologies.

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[57] Ticino, St Gallen, Grisons, Vorarlberg, Tirol, Salzburg, Baden-Württemberg, Bayern, Bolzano Süd-Tirol, Trento and Lombardie.

Within Europe, bilateral relations are very domain specific, oriented at the excellence of partner countries.

2.2.5 Other international cooperations

Germany is an active partner in the implementing agreements of the International Energy Agency (IEA) There exist about 40 agreements, and Germany is partner in about half of them.
The intensity of collaboration varies a lot between agreements, some are limited to an information platform with meetings twice a year, others have determined budgets and commitments.

2.2.6 The use of new cooperative instruments of the European Commission

- ERA-Net has been mentioned several times as a possible evolution of existing contacts or collaborations. However, at the same time the perception of ERA-Net is not very clear, an institutional incompatibilities seem to occur as possible problems.
- Networks of excellence are perceived as the right instrument for collaboration between universities, anyhow, the participation of industrial partners is regularly brought up. Due to competition between actors in applied research, NoEs don't seem a priori the best instrument in domains like material science and energy research[58]. They are also criticised for the high transaction costs the generate, without directly financing research.
- Integrated projects are well known for the high project management intensity, that can only be assured by very big and competent partners in exactly this domain. It has been mentioned that existing cooperative links may suffer if one partner is not allowed to participate in a specific IP. The reorientation of IPs to a more classical dimension is largely welcomed by most of our interview partners. However, the existence of very big projects is still welcomed by others, as soon as they are strong enough to apply for (participation in) several IPs.
  A critique concerns the importance of lobbying in the preparation of IPs, as this is a very complicated process where only those actors that have a permanent presence in Brussels are finally able to follow.

2.3 Concrete possible policy actions

Interview partners have generally not promoted any concrete policy actions that should be developed. According to one of them, special attention should be paid to the risk of east-western brain-drain: by now, European projects do not specially pay attention on the support and enhancement of research competence in central and eastern European countries, or in Russia. Scholarships that support both a stay in Western Europe and the return to the country of origin should be promoted.

[58] Interview with M. Neef, Projektträger Jülich.

3 Short background information

3.1 The overall energy situation of Germany

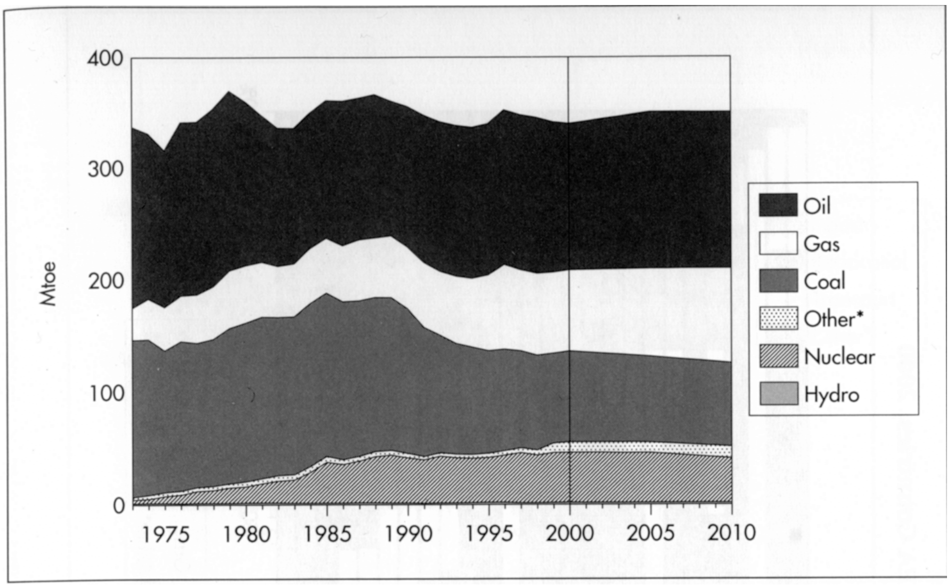
3.1.1 Energy supply and energy production: phasing out nuclear power[59]

Energy security is an important issue for Germany as the country has limited indigenous energy resources. Moreover, the decision to gradually phase out nuclear power by 2035, covering 30% of electricity generation and 13% of total primary energy supply in 2001, will increase Germany's reliance on imports of coal and natural gas, which represent 27% and 78% of demand for these fuels. Germany will also continue to depend heavily on imported oil, at about 40% of its total primary energy supply. To address these energy security issues, Germany is focusing on the development of domestic fuels and renewables, energy end-use efficiency , and on good relations with energy exporting countries (IEA 2002, p7).

Germany is the most populated European country, and has the largest European energy market. In 2000, total primary energy supply (TPES) was 339,6 Mtoe. TPES has decreased in the last decade due to reduction in energy consumption in the new Länder, a recent energy forecast[60] predicts a slight growth (3,2%) between 1999 and 2010.

A comparison of Total Primary Energy Supply (Exhibit 3-1) and Energy Production by Source (Exhibit 3-2) illustrates the important dependency on oil and gas imports.

Exhibit 3-1 Total Primary Energy Supply, 1973 to 2010

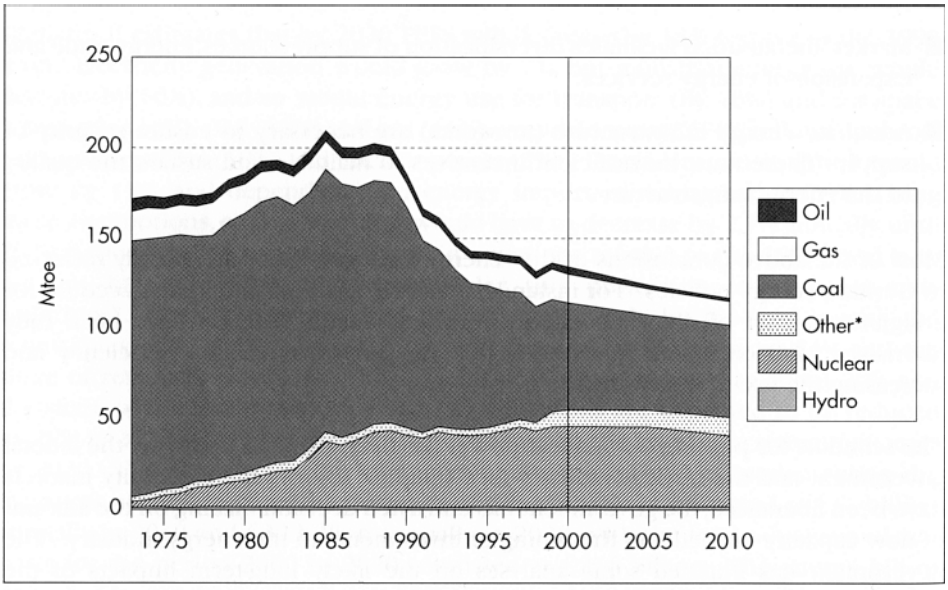


*… includes solar, wind, combustible renewables and waste, and ambient heat production.
Source: IEA 2002, Germany country review, based on energy balances of OECD Countries, IEA/OECD Paris 2001, and country submission.

[59] The following paragraphs are mainly based on IEA 2002, Country Report Germany.

[60] Energy forecast prepared by PROGNOS/EWI by order of the Federal Ministry of Economic and Technology, cited after IEA 2002.

Exhibit 3-2 Energy Production by Source, 1973 to 2010



*… includes solar, wind, combustible renewables and waste, and ambient heat production.
Source: IEA 2002, Germany country review, based on energy balances of OECD Countries, IEA/OECD Paris 2001, and country submission.

Germany also is the largest electricity market in Europe, legally fully opened to competition since 1998.

3.1.2 Renewable energies

In October 2000, the federal government introduced the *National Climate Protection Programme*[61], aiming to meet the national CO_2 reduction target, which is tighter than Germany's Kyoto target.

In 2000, the share of renewables (including hydro-power) in primary energy supply was 3,4% and in electricity generation 7,3%. The Renewable Energies Act of April 2000 aims to double the share of renewables in total energy supply by 2010 compared to 2000 levels. With 9 GW of installed capacity, Germany is world leader in the area of wind power. Renewables are supported by both direct subsidies and feed-in tariffs, introduced by the 2000 act.

However, the German government wishes to maintain a significant coal-based electricity generation capacity to avoid over-dependence on imported energies. The policy of hard coal, poorly competitive, is related to social, regional and employment policies, including considerable but declining subsidies.
Germany's gas market is second largest in Europe, after the United Kingdom, and fully liberalised, with about 750 companies operating in the German gas sector.

3.1.3 Main actors in energy policy[62]

The federal government and Land governments each have their roles in energy policy formulation and implementation, energy legislation adopted on the federal level is

[61] Including eco-tax, promotion of co-generation and renewables, fuel switching, energy efficiency improvements in buildings, and industrial voluntary agreements
[62] Main actors of the NNE-research system are referred to in section 4.2.

implemented on the Länder level, the 16 Länder can also conceive their own programmes to promote, e.g. renewables and energy conservation.[63]

The Federal Ministry of Economics and Labour (BMWA[64]) has the main responsibility for energy policy, the Federal Ministry of the Environment, Nature conservation and Nuclear Safety (BMU) is in charge of environmental policies, including climate change mitigation, as well as the safety of nuclear facilities and the disposal of radioactive waste.

The German Energy Agency (DENA) was established in 2000 to promote sustainable energy, mainly through energy efficiency and renewables. The DENA works in close co-operation with the energy agencies of the Länder or with other local contact points that are active in energy efficiency.

3.2 The national RTDI system

3.2.1 Research financing and research implementation

Gross domestic expenditure for research and development (GERD) accounted for € 50,1 billion in 2000, which corresponds to 2,45% of GDP, with a growing tendency since the mid-1990, mainly due to increases in industrial R&D expenditure. Exhibit 3-3 and Exhibit 3-4 provide an overview of research expenditure according to financing and implementing sectors in 1999, as well as the evolution of research expenditures according to financing sectors since 1981.

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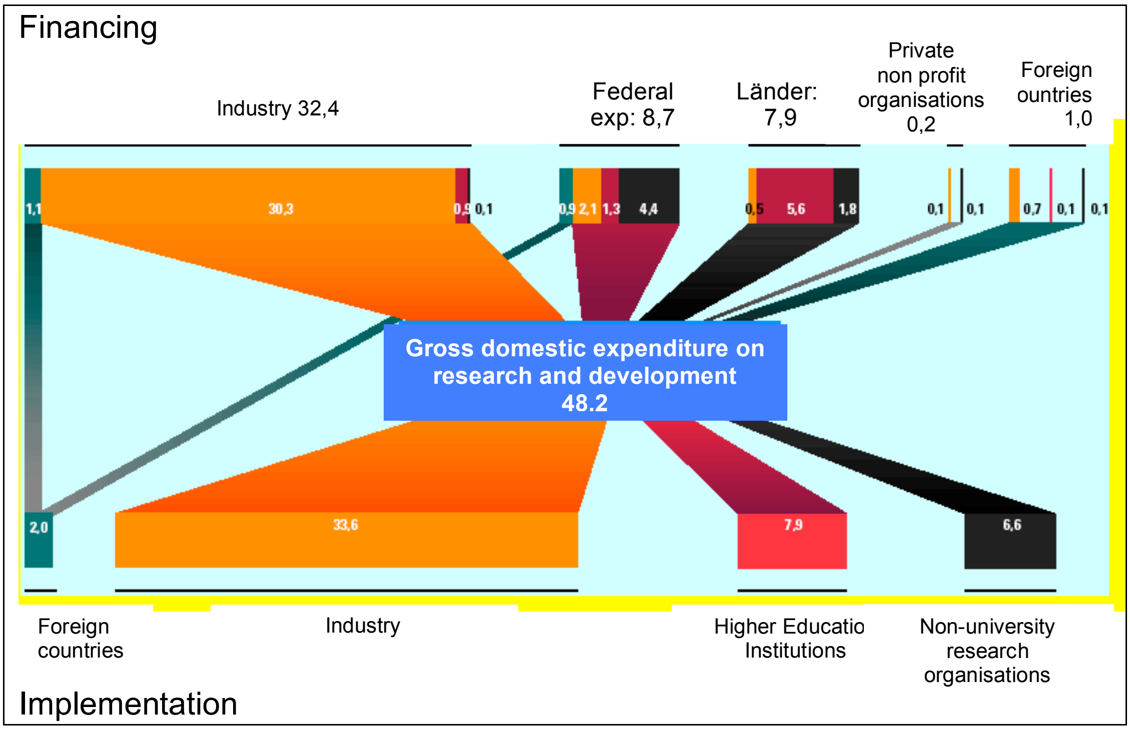
63 See IEA Country report Germany, 2002.

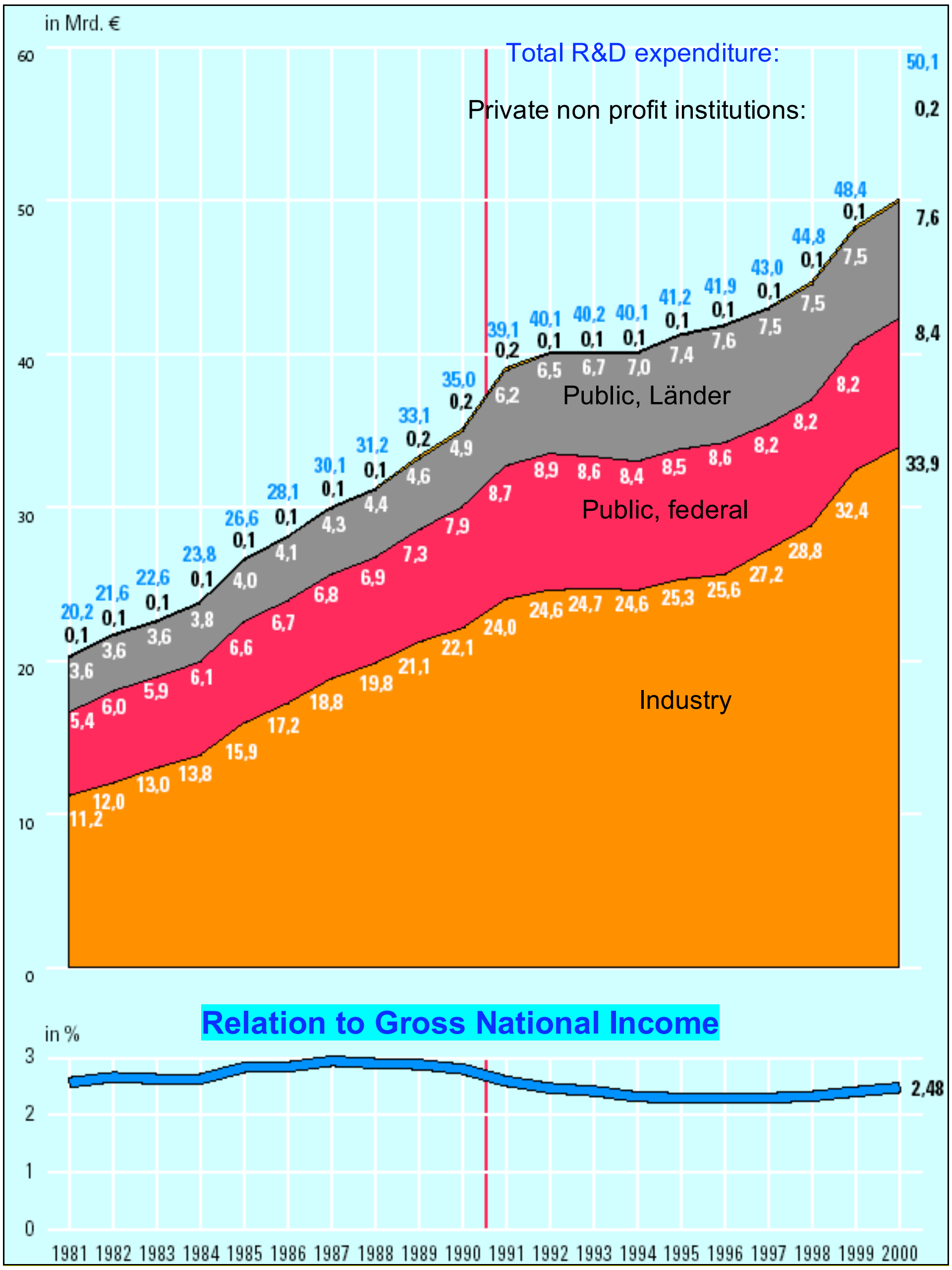
64 Formally Federal Ministry for Economics and Technology (BMWi)

Exhibit 3-3 Germany's R&D expenditure according to financing and implementing sectors, 1999, in billion €



Source: BMBF, Faktenbericht Forschung 2002

Exhibit 3-4 R&D expenditure in Germany, according to financing sectors[65]



Source: BMBF, Faktenbericht 2002, based on Stifterverband Wissenschaftsstatistik, Statistisches Bundesamt

65 Data collected at domestic financing sectors, partly estimated, up to 1990 former federal republic of Germany, from 1991 onwards Germany.
Data on Länder expenditure : federal institutions (from 1981 onwards and Länder (from 1985 onwards) only with their R&D contributions.
Industry : R&D expenditure financed by industry in the specific sector, and financing that other sectors have received from the specific sector, as well as industrial R&D financing to foreign countries.

3.2.2 Institutional setting

The institutional setting of the German research system is characterised by a differentiation along three dimensions: the federalist division of competencies between the federal level and the 16 Länder, the organisational division of policy development, funding implementation, finally the differentiation of research organisations according to the degree of application of research and according to domains.

- Within the federalist setting of the German research system, funding of R&D is organised both on the national and the federal level, with (basic) university funding mainly in the competence of Länder and more applied funding under shared competence of the federal government and the Länder. The federal Ministry of Education and Research (BMBF) is in charge of research policy, domain specific R&D funding is partly dispatched to the technical ministries. R&D competencies in the 16 Länder are found in Ministries for Culture and Research, and in Ministries for industrial affairs.
- Non-institutional funding of scientific research is financed by the independent German Research Foundation (Deutsche Forschungsgesmeinschaft – DFG), financed at more or less equal parts by the federal government and the Länder.
- The implementation of domain specific project funding, organised in research programmes and funded either by the federal ministries in charge or by the Länder, is most often delegated to so called “Projektträger”. These programme managers are selected after open call for tenders for several years, and paid at up to 5% of the overall programme budget.
- Research is realised in universities, in non-university research centres and by industry.
  - Universities are implicated in the entire range of research, from fundamental research to applied research in collaboration with industry. Actually, there exist 92 universities in Germany and 253 other higher education institutions.
  - The Max-Planck Society (MPG) with its 80 institutes, research units, laboratories and working groups promotes extra-university basic research in the domains of biology, medical research, chemical and physical research and humanist research
  - The Fraunhofer-Gesellschaft is the leading organisation for institutes of applied research in Europe, undertaking contract research on behalf of industry, the service sector and the government. Actually, 56 Fraunhofer Institutes exist all over Germany.
  - The Helmholtz Association is a community of 15 scientific-technical and biological-medical research centres. These centres have been commissioned with pursuing long-term research goals on behalf of the state and society. Helmholtz centres are financed at 90% by the federal budget and 10% by the Länder they are situated in.
  - Research institutes of the so called “blue list” are financed at equal parts by the federal budget and the Länder. Currently, 79 such institutes exist, all with some supra-regional service mission.
  - Moreover, there exist 50 institutes directly connected to the federal government for specific research and expertise, 167 research institutions of the Länder and communities, and seven academies of science.

4 Brief description of NNE RTD organisation

4.1 National funding of non-nuclear energy

4.1.1 National funding programmes

The basic national plan for energy R&D in Germany is set out in the **1996 “Fourth Programme on Energy Research and Energy Technologies”**, which runs until 2005, and provides up to 50% of additional project costs of R&D projects realised by industry or research centres and institutes, as well as cooperative projects. The programme is organised in the following domains:

- Efficiency increase and secondary energy
- Rational use of energy and energy saving
- Energy supply with reduced CO_2 emissions (photovoltaic, wind, biomass, renewables)

In 2003, the BMWA has launched a parallel programme called **COORETEC**, that shall provide the basis for the replacement of existing coal-plants from 2010 onwards, aiming at the reduction of CO_2 emissions and the efficient conversion of energy, and under recognition of the dependency on fossil fuels.

In the domain of renewable energies, a programme of the Federal Ministry of Consumer Protection, Food and agriculture (BMVEL) finances research, development, information diffusion and consulting, as well as public relations under the heading of **“renewable primary products”**, including their energetic use.

The Ministry for Education and Research (BMBF) has launched a **“Strategy fund**”,in the late 1990s, initially for financing the restructuring of the Helmholtz Gemeinschaft and the increasing cooperation between different national research institutions as well as their enlargement on the international level. Quickly, the networking initiative went beyond the Helmholtz Gemeinschaft, in 2000 a “fund for networking (Vernetzungsfonds)”, has been created as a part of the strategy fund, and has received € 29 million until 2002. A third layer of activity of the Strategy fund is the enhancement of the economic exploitation of research results.
Initially very broad, the Networking fund has now been limited to projects in the field of renewable energies, corresponding to the priority that the national government gives to this domain. In 2003, the budget of this “networking fund for renewable energy research” will go beyond 10 million Euro.
Financing is provided for:

- organisation, presentation, reporting, Internet presentation
- R&D projects
- System-analytical accompanying research

In the case of ReFuelNet (see below, paragraph 4.2.4), R&D projects receive the largest part, with about 70-80% of total funding.

4.1.2 Quantitative overview of federal research budgets

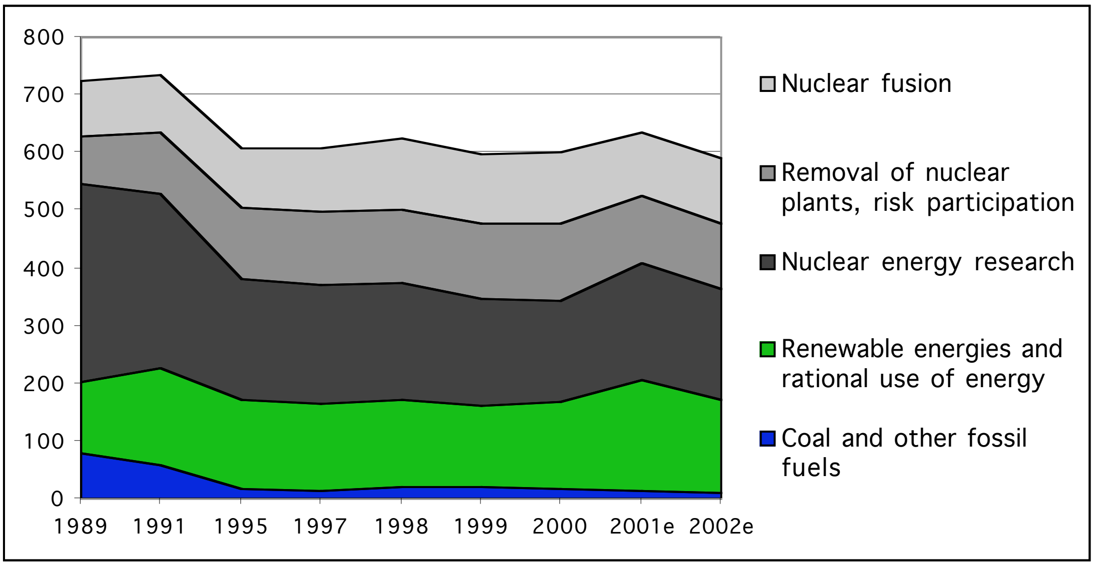
Federal spending on energy research decreased by 26% between 1993 and 2002, mainly due to the decrease in nuclear research, even if non-nuclear research also decreased by 12% in this period. As Exhibit 4-1and Exhibit 4-2 show, in 2001, federal spending in non-nuclear energy rose by 34% in one year, profiting from an extra budget, the "investing in the future" programme, that was financed by the revenues of the UMTS licences. In total, additional DM 100 million (more than € 50 million) have been devoted to energy research.
In total, according to data presented in the IEA country report on Germany (2002), non-nuclear energy research accounts for 55% of federal budget for energy R&D (Exhibit 4-1); numbers from the Federal Ministry of Education and Research (BMBF, Faktenbericht Forschung 2002) show an even lower weight of non-nuclear energy research (Exhibit 4-2), referring generally to higher overall budgets than the IEA.

Exhibit 4-1 Federal Government Energy R&D Budget (million Euros)

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001e*	*2002e*
Non-nuclear	170	130	105	135	114	122	106	123	165[1]	150[1]
Nuclear fission	78	66	66	52	37	36	20	23	16	8
Nuclear fusion	118	104	91	99	108	122	126	122	110	112
Total	366	300	262	285	259	280	252	269	292	271

e: estimate
[1]: Includes financing from the "Investing in the Future Programme".
Source: IEA 2002, based on Country submission.

Exhibit 4-2 Federal expenditure on energy research and technology, Million €



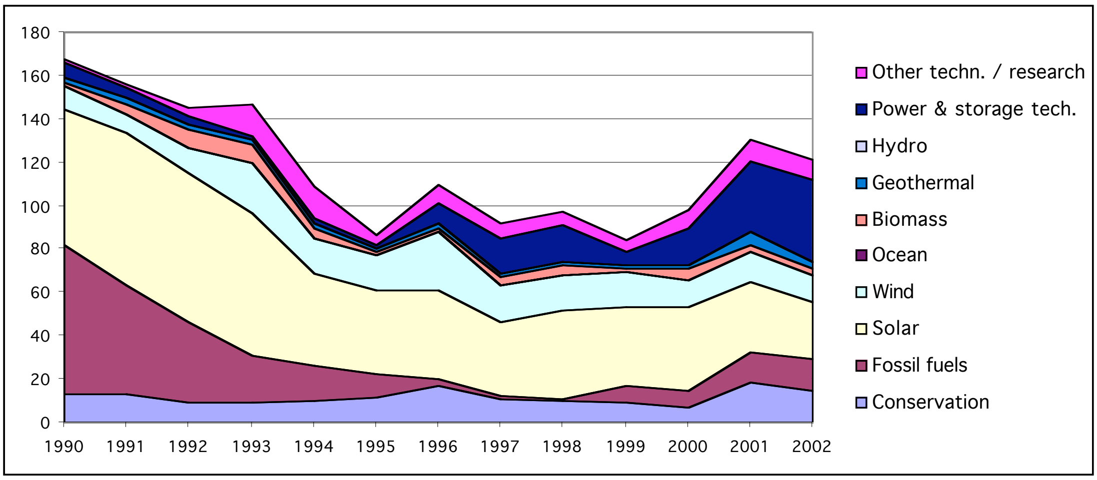
e: estimate
Source: BMBF, Faktenbericht Forschung 2002.

Even if an international comparison of data in energy research is very delicate if not impossible, the IEA database provides internal differentiation according to technologies in non-nuclear energy research, depicted in Exhibit 4-3 and rendered in the following table (Exhibit 4-4). The picture clearly shows that

- Solar energy research diminishes continuously, but still holds the second position, after having dominated research budgets in the 1990s.

- Power and storage technologies developed as the new priority under the 2001 peak of public research budgets.
- Fossil fuels, on the top of national research spending in 1990, quickly declined in the first half of the last decency, approaching their bottom line with € 1 million in 1997 and 1998, and benefit from some new interest since then, continuously growing up to € 15 million in 2002.
- Wind energy lost some weight but has relatively stable budgets.
- Conservation technologies, like power and storage technologies and fossil fuels, belong to the new priorities of the early years 2000.

Exhibit 4-3 National expenditure on non-nuclear research, 1990 – 2002, IEA data, Million €



Source: IEA R&D database

Exhibit 4-4 National expenditure on non-nuclear research, 1990 – 2002, IEA data, Million €, figures

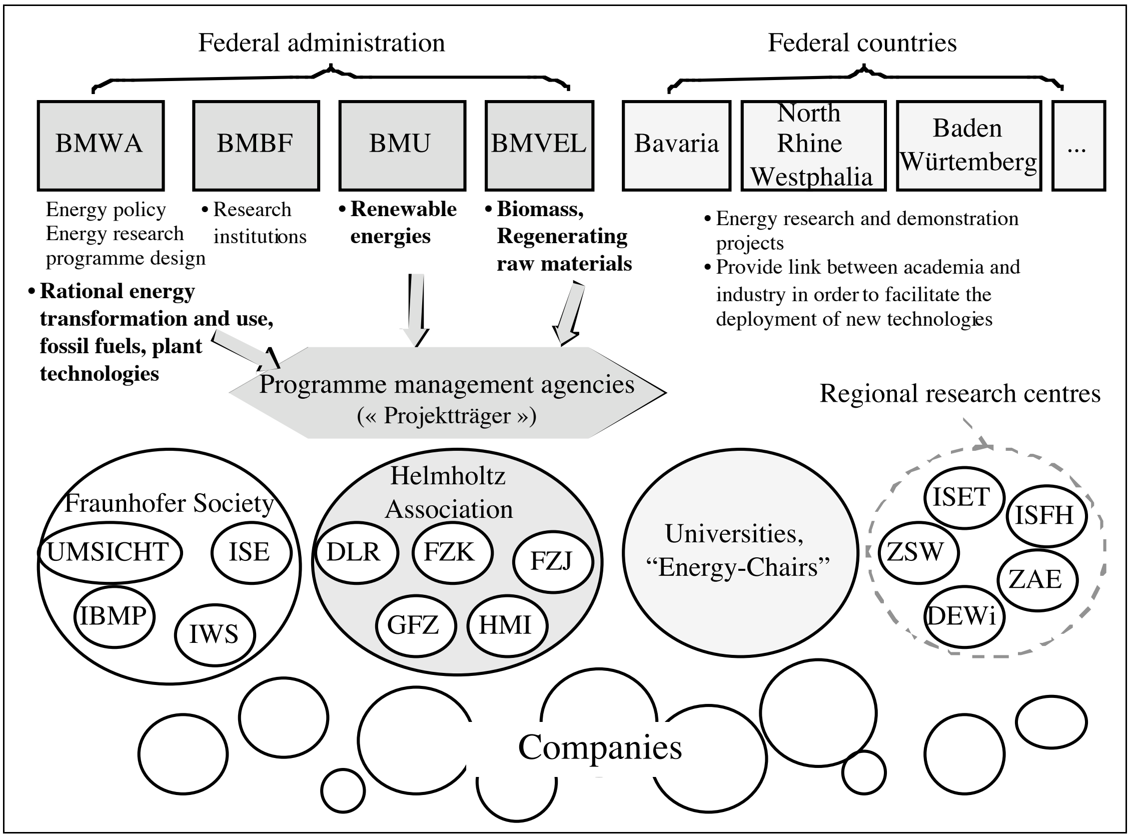
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Conservation	13	13	9	9	10	12	17	11	10	9	7	19	15
Fossile fuels	69	50	37	22	16	11	3	1	1	8	7	14	15
Solar	63	70	69	66	42	39	41	34	41	36	39	33	27
Wind	11	9	12	23	16	16	27	17	16	17	12	14	12
Ocean	0	0	0	0	0	0	0	0	0	0	0	0	0
Biomass	1	4	8	9	5	1	2	4	5	1	5	3	3
Geothermal	3	3	2	2	2	2	2	2	1	1	2	6	3
Hydro	0	0	0	0	0	0	0	0	0	0	0	0	0
Power & storage tech.	7	5	4	2	2	2	9	16	17	6	17	33	38
Other techn. / research	2	1	4	14	15	5	9	7	6	5	9	10	10

Source: IEA R&D database

4.2 Main actors (national and regional level)

An overview of main actors in non-nuclear energy research in Germany is provided in Exhibit 4-5: actors that are globally important in the German research system but without a particular link to NNE, and actors in energy policy without a focus on RTD are *not* mentioned, even if they may be involved in NNE-RTD activities at the margin. Moreover, the list of federal countries (Länder) is not complete but only picks out the three biggest Länder known for their engagement in energy research.

Exhibit 4-5 Main actors in non-nuclear energy research, Germany



Source: Technopolis

4.2.1 Public Funding bodies on the federal level

Germany is well known for its federal policy structure, with research as one of the domains where both the federal (national) and the regional (Länder) level are concerned.

On the federal level, during the last 5 years, several redistributions of responsibilities for research funding in the domain of energy research took place. Until 1998, energy research and development was under the responsibility of the Federal Ministry of Education and Research (BMBF). In 1998, most of the responsibility for energy R&D was transferred to the Federal Ministry of Economics and Technology (BMWi[66]), the responsibility for R&D in biomass was in within the Federal Ministry of Consumer Protection, Food and agriculture (BMVEL), whereas the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) was only in charge of radiation protection, the BMBF still held the responsibility for nuclear fusion R&D. In summer 2003, responsibilities moved once more, basically from the BMWA (former BMWi) to the BMU concerning renewable energy.

[66] Now Federal Ministry for Economics and Labour, BMWA

4.2.2 Länder initiatives in non-nuclear energy research

In the framework of the present study, we have visited 3 of the 16 German Länder, **Baden Würtemberg, North Rhine-Westphalia and Bavaria,** representing not only the most active Länder in NNE-RTD, but more generally the most important ones in terms of research expenditure. To this list, Lower Saxony could by added, well known for research in wind-energy.

All interview partners, whether they come from energy (research) departments in regional governments, from programme managers or from regional research institutes, underlined that the RDT-policy instruments on the regional level aim at the very regional level, supporting the creation and enhancement of competencies and, most importantly, technology transfer from research to industry. The international orientation is not specially promoted by the Länder we visited. This does of course not mean that research is not internationally oriented, on the contrary, as it is stressed by a representative of the Ministry in charge of Research in Baden Würtemberg, research financing in this Land aims at increasing links between different research entities (universities, non-university research centres, industry), on a very high level, and in a way that supports their excellence, allowing them to apply successfully for other financial means, that may be distributed according to criteria of scientific excellence. International orientation can therefore be seen as indirect, when it exists.

The thematic orientation is determined either by industry (North Rhine-Westphalia, with important electricity plants, is known as the "Energy-Land" in Germany, and as a consequence more interested in plant technologies than others; Baden-Würtemberg, with its well developed industrial region around Stuttgart has a special focus on fuel cells…).

Besides classical subsidies for research and transfer projects, an important instrument of Länder policy is the funding of regional research centres, mostly at a rate of about 20% of overall costs. Following centres can be noted:

- Zentrum für Sonnenenergie und Wasserstoff Forschung, Baden Würtemberg (ZSW)
- Bavarian Centre for applied Energy Research, Bavaria (ZAE)
- Institut für Solarenergieforschung GmbH, Lower Saxony (ISFH)
- German Institute for Wind Energy, Lower Saxony (DEWi)
- Institut für Solare Energieversorgungstechnik, Hessen (ISET)

4.2.3 Main research institutions involved in NNE-RTD

The **Helmholtz Association** is a community of 15 scientific-technical and biological-medical research centres, commissioned with pursuing long-term research goals on behalf of the state and society, they perform research in strategic programmes in six core fields: Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space. Six of these centres participate in energy research:

- German Aerospace Center (DLR, Deutsches Zentrum für Luft- und Raumfahrt)
- Forschungszentrum Karlsruhe (FZK)
- Forschungszentrum Jülich (FZJ)
- Geo-Forschungs Zentrum Potsdam (GFZ)
- Hahn-Meitner Institut (HMI)

- Max-Plack-Institut für Plasmaphysik (IPP)[67]

Mid October 2003, a new orientation for energy research has been announced by the governing board (Senate) of the Helmholtz Association, designed for the coming 5 years, with a considerable increase of annual budgets (1%). Particular growth (21% in 5 years) is foreseen for the programme renewable energies, where growth will mainly concentrate on thin film photo-voltaic and concentrated solar systems, and for efficient energy conversion, where a 15% growth is foreseen within the next 5 years. Two other programmes concern nuclear fusion and nuclear safety research. For 2004, financial support of 230 million € is projected for energy research.

Helmholtz Centres are financed by the federal government and the Länder at a 90:10 proportion.

Exhibit 4-6 Total costs (basic funding and third party funding), Million €

	2001	*2002*	*2003*
Renewable energy	38	40	33
Rational energy conversion	45	55	45
Nuclear fusion	153	163	135
Nuclear safety	44	41	44
Total	*280*	*229*	*252*

Source: Helmholtz Gemeinschaft 2003: Programme – Zahlen – Fakten.

Exhibit 4-7 Costs (basic funding), Million €

	2001	*2002*	*2003*
Renewable energy	30	28	23
Rational energy conversion	33	42	35
Nuclear fusion	107	118	105
Nuclear safety	39	35	31
Total	*209*	*223*	*194*

Source: Helmholtz Gemeinschaft 2003: Programme – Zahlen – Fakten

.

The new orientation is based on a radical reorganisation of the governance structure of the Helmholtz association, based on the programmatic-strategic evaluation of program proposals prepared jointly by the participating Helmholtz centres in the different domains by international and national high level experts. The integration of international experts can be regarded as recognition of the importance of the international orientation of the centres; the evaluators have been expected to comment the strategic orientation and scientific quality of the programs and centres, and give recommendations.

This evaluation is based on the criteria of scientific quality (mainly backward oriented), strategic significance (forward looking), including cooperation, and the appropriateness of expenditure.

In order to support the European activities the Helmholtz association has a representation in Brussels.

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67 Only nuclear fusion

The **Fraunhofer-Gesellschaft**[68] is the leading organisation for institutes of applied research in Europe, undertaking contract research on behalf of industry, the service sector and the government. At present, the organisation maintains 80 research establishments at 40 locations throughout Germany. A staff of some 13,000, the majority of whom are qualified scientists and engineers, generate the annual research volume of more than about one billion Euro. Of this amount, about one billion Euro is derived from contract research. Research contracts on behalf of industry and publicly financed research projects generate approximately two thirds of the Fraunhofer-Gesellschaft's contract revenue. One third is contributed by the Federal and Länder governments, as a means of enabling the institutes to work on solutions to problems that are expected to attain economic and social relevance in the next five to ten years.

Several institutes are involved in NNE-RTD, as for instance

- ISE: Institute for Solar Energy Systems
- IBP: Building Physics
- UMSICHT: Environmental, Safety and Energy Technology
- IWS: Material and Beam Technology

A global overview about NNE-RTD in **universities** could not be found. Several universities have so called “energy chairs” (Energie-Lehrstuhl); a linkage to non-university research centres and organisations is often assured through a double position of professors, both heading these centres and teaching in university.

4.2.4 Forschungsverbände

Several so called “Forschungsverbände” or research-networks aim to coordinate the activities of non-university research centres in specific fields. Exhibit 4-8 sketches some of these networks, the best known is probably the **Forschungsverbund Sonnenenergie** (solar energy network), with eight participating research centres[69]. Besides agreements on common research activities between the centres, the network is also oriented towards industry (especially concerning the identification of relevant research issues), policy makers and the general public.

In the domain of Solar energy research, another consortium exists in Nordhrine Westfalia (**Arbeitsgemeinschaft Solar**), conceived as a “virtual research institute” with 40 higher education institutions in Nordhrine Westfalia connected through the network and three non-university research centres as members, two of them being national (DLR and FZ-Jülich) and one regional (ISE). The network is financed in the framework of the “Land-Initiative energies of the future”, it is managed by the regional programme manager (Projektträger ETN, Energietechnische Nachhaltigkeit) situated in Jülich.

Finally**, local networks** exist **in fuel cell research** both in North Rhine-Westphalia and Baden Würtemberg[70].

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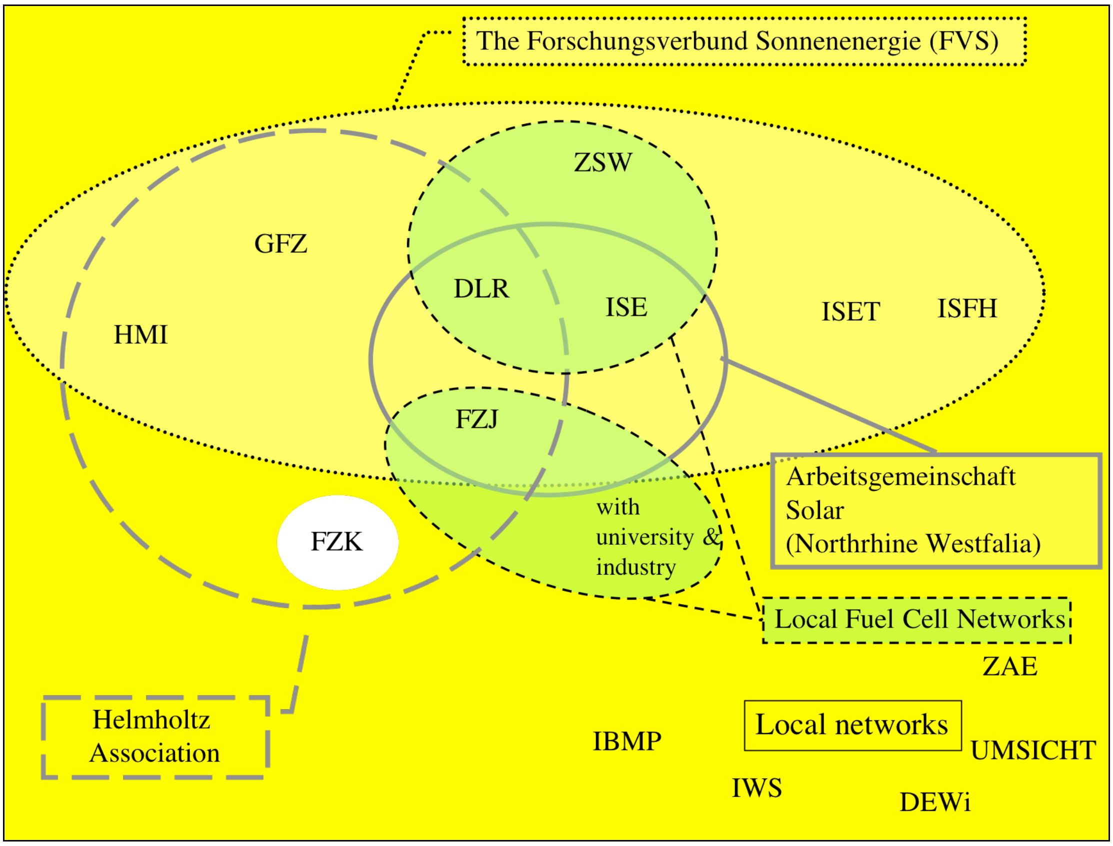
68 See http://www.fraunhofer.de/english/company/index.html
69 See Exhibit 4-5 and paragraph 4.2.3 for more details on the participating centres.
70 Fuel Cell Research Alliance Baden-Würtemberg - BZI

Exhibit 4-8 Networks of German non-nuclear energy research, without universities and industry



Source: Technopolis France, on the basis of a presentation by Dr. Eisenbeiss and Dr; Meulenberg, FZ Jülich, modifications: Technopolis.

Networks of Competence are promoted by the Ministry of Education and Research, with financial means provided through the Networking fund (Vernetzungsfonds) on the one hand, and through a common internet sight (www.kompetenznetze.de) on the other.

In this framework, besides the two regional networks in fuel cells mentioned above, two further networks in energy technologies exist:

EnergieRegion Nürnberg e.V. integrates research competence of university institutes and industrial research as well as a Fraunhofer Institute.

ReFuelNet has started in 2002 and brings together 4 universities and 8 research centres from all over Germany, three major industrial partners as network participants as well as four research alliances[71]. It is conceived as an open network, with “external partners” participating in particular projects without being members of the core-team.

4.3 Expected future evolution

During the end of the 90s and in the early years 2000, a reorientation of energy policy and as a consequence of energy research policy has taken place, marked by global environmental goal (Kyoto) and Germany specific targets, the changing political orientation of the government and a broad consultation process on the political (parliamental) and associative level. It resulted in the decision

[71] German Hydrogen Association, Forschungsallianz Brennstoffzellen, Forschungsverbund Sonnenenergie, VES (Verkehrswirtschaftliche Energiestrategie)

- to phase out nuclear power, with the implication on the limitation of nuclear research on nuclear fusion and nuclear safety, as well as a diminution of financial support in these two fields,
- and to increase non-nuclear energy research. Herein, renewable energies play a certain role, but due to the phasing out of nuclear power, clean coal plant technologies and energy savings have especially gained in importance.

A new national energy research programme is expected to be launched in 2004. Anyhow, as the actual programme, it will mainly give major orientations, and focus on a selection according to research quality, without budgets defined à priori for specific research domains, which corresponds to maintaining the bottom-up approach actually in place.

Another important change in the research landscape of the last years can be seen in several networking initiatives, many of these networks have been launched after the turn of the century. These networks often invest in an English presentation of their activities, allowing for a better visibility in the European Research Area.

Finally, the reorganisation of the Helmholtz Association according to research programmes is an important turn from basic funding centre by centre to increased competition between these centres, in parallel to increased cooperation, based on ex-post and ex-ante evaluation of research programmes. It would not be surprising if this experience will be extended to institutions outside Helmholtz.

Our interview partner underlined these changes, but did not announce any other major challenges for reorientation in the coming years.

5 Current NNE RTD priorities relevant for ERA in NNE RTD

NNE-RTD priorities relevant for ERA can be distinguished in institutional and organisational priorities on the one hand, and thematic priorities on the other.
On the institutional level, the trend for the creation of networks on the national level, aiming at structuring research and increasing visibility of excellence on the national but also on the international level have certainly some relevance for the German integration in ERA.
Inversely, programmes that only finance coordination costs and not research activities itself are often perceived as costly and not as helpful, as for reasons of reputation, it is felt like an obligation to participate even if this is very time-consuming.

On the thematic level, interviews mainly converge in the following points:
- European programs shall invest in big research ambitions and equipment intensive research like nuclear fusion.
- Industrial research near to demonstration projects better profits from national and regional funding mechanisms, due to administrative reasons, language barriers and transaction costs of international collaborations.
- On several levels and in different regions, a turn away from photovoltaics has been mentioned in the interviews.
- Plant technologies, especially coal plant technologies should be further developed in Europe.

6 Description of Priority setting process

The actual federal programme for energy research dates back to 1996, the present government has announced that a new programme shall be launched before the end of the legislation period, it will probably be discussed in the coming year.

On a global basis, the priority given to NNE research is based on an assessment of energy research in 1999 by the Wissenschaftsrat[72]. This kind of domain specific assessment is a unique task, since no other science policy body in Germany carries out such independent analyses examining the research fields themselves, the strengths and weaknesses of the relevant work at the scientific establishments, as well as structural aspects. The recommendations include the increase of national research funding for energy research by 30% in 3 years from 1997 onwards, and the bundling of research in universities and non-university research centres. Both of these recommendations have been considered, even if the threshold of 30% could not be achieved.

The priority setting process on the federal policy level is somehow marked by rather frequent mutations of responsibilities in energy research after the creation of a new government (see paragraph 4.2.1). According to interviews with M. Flath[73], former head of the strategy unit in BMWi and Sabine Semke[74], the transfer of responsibilities from BMBF to the BMWi was accompanied by a move of parts of BMBF personnel. The integration of two cultures (with the BMWi oriented towards liberalisation and bottom up support, whereas BMBF has more of an expert view, defending the financing of politically defined themes) took about a year, anyhow, in practice, from the point of view of the agency managing the R&D support programme (Projektträger Jülich), there was no break but rather continuity in the approach.

According to Knut Kübler, head of the strategic division in energy policy in the Ministry of Economics, the department heading the preparation of the new energy research programme expected to be launched in 2004, evaluation is an ongoing process and an important tool for decision making in this ministry. Anyhow, evaluations are confidential, no published evaluation reports on energy research are available. Programme evaluations are most often realised internally, sometimes with the support of external consultants and experts.

Another approach for information exchange between actors of research and of policy making is linked to mobility of the programme-management agency's staff: several persons of Projektträger Jülich are regularly working within the ministry for some months, one of them coming from the energy department.

On the regional level, policy setting is more oriented towards industry and applied research than on the national level. The priority setting process varies from one Land to the other, anyhow, evaluation procedures are used, as it was for instance the case in

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72 An advisory body to the Federal Government and the state (Länder) governments, whos function is to draw up recommendations on the development of higher education institutions, science and the research sector as regards content and structure, as well as on the construction of new universities.

73 In an interview with Technopolis France in September 2001

74 Projektträger Jülich, in an interview with Technopolis France in September 2001

North Rhine-Westphalia, where the photovoltaic programme has been evaluated after 10 years in order to prepare a new orientation, or in Bavaria, that evaluated the research funding in the domain of hydrogen energy. In Baden Würtemberg, strategic evaluation or foresight projects have not been referred to in the interviews, priority setting is partly supported through communication platforms, organised either by the one hand the research alliances and networks themselves, or by the Ministry, as for instance in the framework of a conference on the future of energy supply.

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Country study Greece

Contents:

1 Summary of country study indicating main points for synergy

Greek research organisations have been well-embedded in European Framework Programmes (FP) 4 and 5,and have developed strong non nuclear energy (NNE) research fields, for example in wind energy research and technical development (RTD). Public research institutions and universities are willing to collaborate at the European level as the national funding sources are scarce, either regarding Greek industry RTD funding or Greek State's funding :

- according to IEA, the total amount of government NNE-RTD expenditures was of 7,4M€ in 2002[75]
- private RTD expenditures correspond only to 25% of total RTD expenditures[76]

European priorities have thus a strong influence on the setting of NNE RTD themes by researchers.

European structural funds for regional development and European Framework Programmes stand for important RTD funding sources in Greece, and the Greece State energy RTD budget is essentially used for making national contributions to projects financed by those EU programmes. Some 57,8% of all energy RTD financing is national, and 42,2% comes from the EU.

The major objective of Greece RTD policy is the development of industry RTD through collaboration with public research institutes.

Renewable energy sources, especially wind and biomass, but also energy saving in transports, building and industry correspond to "national priorities" as a national programme has recently been launched by the government. Even if the total amount of this programme is quite limited, of circa 15M€ (50% from public funding, on which 75% from European funds), this interest in renewable energy sources might be explained by the energy policy objective of generating 20,1% of electricity by renewables in 2020 and by the necessities of local energy production in Greek islands.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Necessary conditions for making ERA happen

Greece was involved in European Framework Programmes 4 and 5 (see the CORDIS database[77]), but our interviewees encountered difficulties to participate to FP6. The **implication of European industry** and the **size of projects and networks** are the two main concerns that have been risen.

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75 IEA Greece report 2002 (estimate).
76 Regarding RTD as a whole, not only energy RTD
77 http://dbs.cordis.lu/fep/FP4_MS/ms_el_en.html

2.1.1 Optimising European industry participation in European projects

The necessary involvement of European industry in European projects has been highlighted by the majority of our interview partners, but this participation is sometime hard to ensure and can also lead to several difficulties. This problem is even more accurate since Greek industry RTD funding is more than scarce.
The 6th European Framework Programme is judged much more difficult to participate in, especially because "all the money is going to big industry" according to the RTD Director of CRES.

Our interlocutors have stressed that European industry, with very few exceptions, is not prepared to collaborate.
3 main problems have been encountered :

- Intellectual property rights problems, that burdens with debts public/private RTD collaborations ; this issue is related to frequent overlapping in partners activities, according to one of our interviewees
- Industry is very reluctant to share information, one interlocutor assessed
- By now, the inclusion of industrial partners is most of the time seen as an artefact in order to get funds from EU, according to Greek researchers

To ease European industry participation, one suggestion has been expressed. Regarding his long experience in teaching and research in the US, the RTD Director of a research institute referred to the US policy toward integration of public and private research in projects. In deed the internal laboratories of the US Department of Energy have specific solicitations to solve industry problems ; the project is led and defined by the companies, but to get funded a proposal has to be submitted to DoE. This interviewee assessed thus that EU should launch specific calls to satisfy industry needs and demand, even for short term research.

2.1.2 Networks, projects, should have a limited number of partners

In order to make networks more manageable, one interviewee suggested that multidisciplinary networks could be created at a local/regional level (for example the south-east of France…), and each geographical network could be connected at a pluri-regional level.
The RTD Director of CRES assessed that the perfect networking to him consists in 5 successive stages, according to his experience in the Academy of Wind Energy[78] :

- the gathering of several institutes in order to form a 'virtual research centre'
- the exchange of information
- the exchange of people (including in teaching and training)
- the building of a common infrastructure
- finally the sharing of budgets

2.1.3 European FPs shall better balance between demonstration projects and mid-long term RTD

Our interlocutors have stressed that FP6 focus on demonstration projects, and this tendency is considered as dangerous, as "it is no more research" according to a representative of CRES, the Centre for Renewable Energy Sources. According to

78 www.eawe.org

them, mid-long term research resulting from the anticipation of social, economic, research needs are also a necessity.

2.2 Existing opportunities for ERA

The Greek government considers international co-operation to be an important component of Greek R&D energy policy. Greece has been participating actively in EU programmes : THERMIE, ENERGIE, SAVE, ALTENER, JOULE… Indeed a large part of projects and funding come from EU, if not the majority, for Greek research organisations (including universities), not only through FPs, but also through Competitive programmes, i.e. European non-directive funding for regional development used by the Greek government. It is to be noted moreover that the Greek State energy RTD budget is essentially used for making national contributions to projects financed by those EU programmes (see chapter 4.1).

Most of European collaborations seem to occur in Framework Programmes (in contrary to bilateral or government-driven multilateral co-operations). They are driven by thematic complementarities needs. For example the National Technical University of Athens works with Spain, the UK, Italy, France because of the common interests in energy in islands. On biomass its collaborations are with Austria, Sweden, Denmark…
Wind is one of the major Greece thematic, and Greek researchers have developed collaborations with other European countries known to have a high level of competencies in that field : Denmark, Germany, the Netherlands, the UK. For example the Academy of Wind Energy is an important project for Greece in the European framework, self-funded by the different partners (research organisations of Greece, Germany, Denmark, and the Netherlands) in the FP6 perspective.
Greek researchers and research institutions do not encounter barriers to collaboration ; however, as their budget is highly relying on European funding, they are at present quite worried about eventual cuts due to a more difficult accession to FP6 calls. "I anticipate that in the near future many countries will be driven out European RTD", as FP6 seems to evolve to "a club restricted to big partners" the RTD Director of CRES assessed.

2.3 Apart from EU FP

Outside the European Union, partnerships with Mediterranean countries are favoured (Israel, Egypt, Tunisia, Cyprus…), because of geographical reasons i.e. common preoccupations, like energy and water for instance. Some Greek research organisations are working with Central and Eastern European countries (Poland, Slovenia, Balkan countries), mainly in the framework of NATO, UN or Science for Peace programmes, most of the time after a demand of researchers of such countries.

2.4 Concrete possible policy actions

Some suggestions on financing & funding have been made :

- EU should have more flexible guidelines, according to the characteristics of each organisation ; for example public research organisations have different overheads rates, SMEs may not have the same financial capacities to participate in EU projects than big industry…
- Seed money should be available for exploratory research

- Talented young researchers can usually not participate in integrated projects, in big networks, although most of the time innovation comes from them. Funds shall be given to these young people starting research, to build a laboratory for example, in their own countries. For example the US have a “carrier programme” for good young researchers, in order to make them independent early

From a legal point of view, it has been stressed that the efforts toward a European patent is a good thing.

Concerning the relations with other energy-related themes, our interviewees assessed that a closer link with environment should be enforced, especially through the definition of strong priorities and targets.

3 Short background information

The Greek population numbered 10,6 millions in 2000. The land area of Greece covers 132 000 km2 ; and Greece is geographically isolated (in 2003) from other EU countries.
Greece is among the smallest of the economies in the European Union (EU), but has enjoyed fairly strong growth over the past few years with relatively low inflation. In 2001 and 2002, for instance, Greece's real gross domestic product (GDP) grew by an estimated 4.1% and 4.0%, respectively.

3.1 The overall energy situation of Greece

3.1.1 The Greek energy policy highly relies on European structural funds

The EU Community Support Framework, which correspond to structural funds for regional development as an Objective 1 Programme[79], has provided financial resources to the Operational Programme for Energy (OPE) and the Operational Programme for Competitiveness (OPC). These programmes have subsidised a number of energy-related projects in Greece.
The total budget for the OPE programme was 1,1 billion € (1994-2001) ; the EU contributed 33,8%, the Public Power Corporation (PPC) 39,6%, private sources 21% and the State 5,6%.
OPC (2000-2006) applies not only to the energy sector but also to a variety of other economic activities (see chapter 3.2). Four sub-programmes have energy objectives (increase the use of renewables, etc.). Calls for energy projects proposals were first launched in 2001: of a total budget of 510M€, 170M€ came from EU Community Support Framework grants.

3.1.2 Distribution of energy sources

Greece has little national fossil fuel resources, except low-quality lignite. Lignite accounts for 82%of Greece’s indigenous energy production and 64% of its electricity supply.

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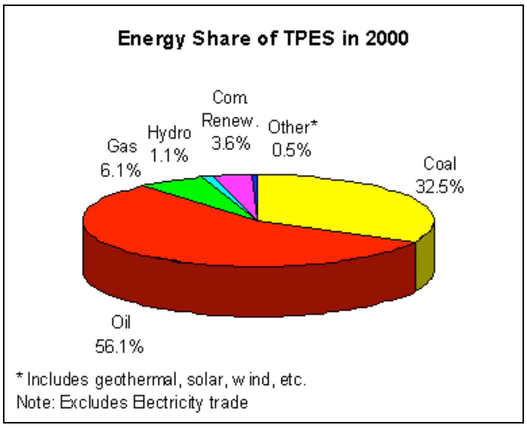
[79] http://europa.eu.int/comm/regional_policy/country/prordn/details.cfm?gv_PAY=GR&gv_reg=ALL&gv_PGM=2000GR161PO016&LAN=5

Oil represents 56,1% of Greece energy (see Exhibit 3-1).
Greece introduced natural gas into its energy mix in 1996. In 2000 natural gas accounted for 6,1% or primary energy supply, and gas consumption is growing fast.

Exhibit 3-1 Energy share of TPES in 2000



Source : IEA

The 1995 Climate Action Plan established a target for increasing the share of renewable energy (including large-scale hydro) in primary energy supply to 10% by 2000. The target was not achieved, and the actual renewables share was 5,2% in 2000. A new indicative target has been set to generate 20,1% of electricity by renewables in 2010.
The geographical situation of Greece, having many isolated islands, is, with the objective of reducing greenhouse gas, a reason for improving renewables, in a local energy production perspective.

3.1.3 Imports/exports

Greece depends heavily on imported energy, especially oil, even if its dependence on oil has decreased since the early 1970's (77,7% in 1973).

3.1.4 Market concentration

The energy markets in Greece are dominated by highly integrated state-owned enterprises :

- although the oil market have been largely liberalised, products may be imported only by refineries, oil marketing companies and a few large oil users
- the Greek State owns all lignite deposits, and the Public Power Corporation (PPC) had exclusive rights to mine lignite until the electricity market was liberalised and a bidding process was established to lease them ; currently however, there have not yet been any bidders
- the natural gas market is dominated by one incumbent supplier, however following the EU Gas Directive Greece plans to liberalise soon this market
- approximately 34% of the Greek electricity market was opened to competition in February 2001. The Greek electricity market remains still one of the most concentrated in the EU : for instance PPC holds the predominant share of the transmission system operator

3.2 The national RTDI system[80]

The main focus of the Greek national RDT strategy for the coming years are :

- to increase the share of corporate participation in R&D activities and create critical mass in the private sector, so that the national R&D system becomes self-funding
- and to build a working relationship between research establishments and industry

The 3rd Community Support Framework (CSF), particularly the Operational Programme "Competitiveness" (OP "COM"), is the main vehicle for promoting the national R&D strategy over the next six years, as was the case previously with Operational Programme for Research and Technology I-II (EPET I-II) and STRIDE.

3.2.1 Public/private spending on RTD

Gross Domestic Expenditure on R&D (GERD) has increased most notably in recent years. The progress achieved in the last ten years is also quite significant, with GERD rising from 0,38% of GDP in 1989 to 0,68% in 1999. However, this percentage is the lowest in the European Union where the corresponding EU average is 1,92%. This is mainly due to the limited contribution of the private sector, compared to the public sector contribution.

Exhibit 3-2 Total R&D Expenditure by sector of performance (1999)

Sector of performance	%
Government Research Organisations	21,70
Businesses	28,50
Higher Education Institutions	49,50
Private Non Profit Institutions	0,30

Source : GSRT

The imbalance between public RTD expenditure (70% of expenditure on R&D – national and EU) and private RTD expenditure (25%) explains the central aims of Greek policy on R&D in the coming five-year period (2001-2006) : adjusting these ratios and striking an overall balance in the system.

The small contribution made by businesses to the Greek R&D system is even lower in terms of RTD funding, as seen in the Exhibit 3-3.

80 See www.cordis.lu/greece/rd.htm for more information. The following developments have been extracted from the CORDIS web site.

Exhibit 3-3 Total R&D Expenditure by source of funds (1999)

Source of funds	%
Government	49,94
Industry	24,01
Abroad	25,76 (16,61: CSF/EU)
Other	0,28

Source: GSRT

3.2.2 Main public research organisations and their funding institutions

The majority of government research centres are monitored by the General Secretariat for Research and Technology of the Ministry of Development, while the rest come under other ministries. The GSRT supervises 16 research bodies and 15 technological bodies, including 6 industrial R&D institutions operating as business firms. Other government R&D bodies are the National Foundation for Agricultural Research (NAGREF), which comes under the Ministry of Agriculture, the Institute of Geology and Mineral Exploration (IGME), which comes under the Ministry of Development and the Research and Technology Centre for National Defence, which comes under the Ministry of National Defence.

Higher Education Institutions (universities, technological educational institutes and university research institutes) come under the Ministry of National Education and Religious Affairs and account for the greater part of research activity, given that most Greek researchers work within them.

The main entity engaged in drawing up and implementing R&D policies in Greece is the General Secretariat for Research and Technology (GSRT), which comes under the Ministry of Development. The GSRT co-ordinates research projects funded by structural funds from the European Union. As regards developing policies, the GSRT is backed by the National Council for Research and Technology and other joint bodies (chambers of commerce, Federation of Greek Industries, etc.).

The Ministry of Development is also responsible for issues relating to industry, energy, commerce and tourism. In this context, the ministry co-ordinates all research initiatives and particularly R&D projects funded by the 3rd Community Support Framework (3rd CSF 2000-2006), and supervises the research centres performing approximately 20% of the national R&D effort. The principal authority for the entire 3rd CSF negotiation is the Ministry of Economy and Finance.

Other ministries involved in R&D projects are the Ministries of Education, Agriculture and National Defence. The Ministry of Education and Religious Affairs is responsible for research organisations in the universities. Moreover, R&D issues in the agricultural sector and the defence sector are monitored by the Ministry of Agriculture and the Ministry of National Defence, respectively.

4 Brief description of NNE RTD organisation

4.1 General Secretariat for Research and Technology

GSRT's major objectives of energy-related RTD programmes are to encourage partnerships between research organisations and industry, and to promote innovation in renewables and energy efficiency. The following areas are emphasised[81] :

- improvement of the efficiency of the components used in renewable energy systems and reduction of costs. This includes activities on biomass use, photovoltaic cell and wind turbine efficiency, reducing the manufacturing costs of equipment
- improvement of power quality, optimisation of local load factors, increase of capacity utilisation, and integration of renewables with the electricity grids
- development of new technologies and applications for saving energy in buildings, transports and industry

To implement these policies, financial support is provided mainly by the general state budget, Competitive Programmes (see chapter 3.1), and EU research programmes. Some 57,8% of all energy RTD financing is national, and 42,2% comes from the EU. GSRT's energy RTD budget is essentially used for making national contributions to projects financed under the EU programmes, including the Operational Programmes, and as direct financial support to the centre for Renewable Energy Sources (CRES, see below) and the Centre for Solid Fuels Technologies and Applications (CSFTA).

GSRT has launched in 2003 a call for proposals **Renewable energy sources and Energy Saving**[82], in the framework of the Operational Programme on Competitiveness (RTD actions, Measure 4.5 "Research and Technological Development Consortia in Sectors of national Priority").
The total budget is of 16,7M€, including 8,8M€ of public expenditure. This is the fourth main budget on 8 "Measure 4.5" programmes. Public part of the funding is composed of the European Regional Development Fund (75%) and of National Funds (25%).
The objective is to "promote collaboration between research institutes, private bodies, and the creation of innovative products, processes and services" according to the GSRT. The recipients are companies in collaborations with research institutions : universities and research centres. Products or services will contribute to cost-reduction and improvement of the effectiveness of renewable energy sources, optimum integration of renewable energy sources in electricity production networks and the development of new technologies and energy-saving applications for buildings, industry and transport. The Programme supports industrial research and initial demonstration (pre-competitive research).

It is pointed out that for each co-financed project, public expenditure will be up to 50% of the total budget. The total budget for each project will range between 1M€ and 2,5M€. The maximum duration for research or demonstration projects is 36 months. By now 15 projects have been funded. Our interlocutor at CRES (Centre for Renewable Energy Sources) assessed that it is difficult to get into the programme

[81] Source : IEA Greece report, 2002.
[82] www.gsrt.gr/default.asp?V_ITEM_ID=1287

because of the need of being covered by private companies, given they have little RTD funding capacities.

Exhibit 4-1 Renewable energy sources and Energy Saving Programme : thematic areas

Renewable Energy Sources	Energy Saving
Wind	Energy Saving in transport and industry
Energy	Energy Saving in buildings
Photovoltaic Systems	
Active Solar Systems	
Biomass	
Geothermal energy	
Fuel Cells and Hydrogen Technologies	
Integration of Renewable Energy Sources into Energy Systems	

Source : GSRT

4.2 RTD performers

The main NNE RTD performer is the CRES, the Centre for Renewable Energy Sources, a research institute supervised by GSRT. Other research institutes and universities are also involved in NNE RDT.

Centre for Renewable Energy Sources

CRES is both a research centre and an energy centre : its activities includes dissemination, etc., but also advisory to public authority. One of its role is to create an energy industry, pushing also industrials to perform research. CRES :

- is the official Greek government consultant on matters of renewable energy sources, rational use of energy and energy saving (RES/RUE/ES) in national policy, strategy and planning
- carries out applied research and develops innovative technologies which are both technically/economically viable and environment-friendly
- organises, supervises and carries out demonstration and pilot projects, to promote the above technologies
- implements commercial RES/RUE/ES applications in relevant energy projects of the private sector, local authorities, professional associations, etc.
- provides technical services and advice, in the form of specialised know- how and information, to third parties
- disseminates technologies in its areas of expertise and provides reliable information and support to interested organisations and investors
- organises and/or participates in technical and scientific seminars, educational programmes, specialised training courses, meetings, etc.

170 people are working in CRES, but only 55 are researchers working on renewables. Wind is the major RTD activity in CRES, with more than 25 researchers. Then are coming biomass (10 people), photovoltaic (10 people), small geothermal (2 people : mid and low temperature, heat pumps).

Until the 5th Framework programme, CRES has received funds for its wind energy RTD ; as it is not a priority anymore in the 6th FP, CRES tries to counterbalance its losses in EU funding by transferring its developed goods and services to the market. "We are following the market because it is a matter of survival."

Exhibit 4-2 CRES Renewable energy sources RTD budget for 2000-2003

RTD	M€
Wind	4,9
Water	0,5
Biomass	1,9
Hydrogen	1,2
Geothermal	0,2
Photovoltaic	1,9
Solar thermal	0,7
Total	11,3

Source : CRES

CRES perform also RTD in energy saving, in the following sectors : industry, buildings, transportation, new technologies in energy saving and rational use of energy, environmental impacts of energy investments and energy saving measurements.

Other research institutes are involved in NNE RDT, like the Centre for Solid Fuels Technologies and Applications (CSFTA), the National Centre for Scientific Research (Demokritos), the Institute for Chemical Processes Engineering (CPERI), the Institute of Electronic Structure and Lasers (ISEL-FORTH) and the Institute of Chemical Engineering and High Temperature Chemical Processes (ICE-HT, which operates as an Independent Academic Institute in close co-operation with the University of Patras).

Universities

There are mainly 3 universities performing NNE RTD :

- National Technical University of Athens (NTUA) : several departments are performing NNE RTD, on clean coal, on renewables (including the Unit for Renewable Energy Sources RENES[83], mostly working on wind energy, biomass, hydro-wave energy, policy issues)
- University of Tessaloniki
- University of Patras

5 Current NNE RTD priorities relevant for ERA in NNE RTD

According to the IEA Greece report 2002, on estimated 8,8M€ of government energy RTD budget, 7,4M€ is devoted to NNE RDT. On the 8,8M€, 37% of the Greek State's energy RTD budget is allocated to power and storage technologies, 31% to renewables, 9% to energy conservation and 8% to fossil fuels technologies[84]. The IEA 1998 report states that "the pattern of Government spending in energy research and

[83] www.ntua.gr/renes/renesengl

[84] 16% to nuclear technologies.

development is difficult to characterise because it has varied substantially from year to year, both in categories of research and in total amounts. (…) The large yearly variations in research funding suggest that research priorities are not clearly established, and that they are set more by availability of funds than by systematic planning."

If this statement seems to be still actual, the launch of the Programme "Renewable energy sources and energy efficiency" indicates that these themes are the main concerns of the Greek State in the field of NNE RDT (see chapter 4.1). Nevertheless this programme is especially devoted to support the development of industry RTD activities and industry RTD expenditures.
Renewables are mostly wind and biomass energy. The energetic needs of the Greek islands, and the necessity of local energy production, are one of the reasons for the development of renewables. Some RTD on hydrogen (in CRES for example) from renewable energy sources are thus carried out.
Energy saving RTD is focusing on buildings, marginally on industry and barely not on transports.

6 Description of Priority setting process

6.1 The Greek "Priority" setting process

RTD priority setting is characterised by a high degree of laissez-faire for researchers, and by an opportunistic behaviour of those researchers concerning funding sources.

- There is no orientation given by ministries to research institutions and researchers. RTD subjects are defined in laboratories, not even at the research organisation level. Our interlocutors in different research organisations even assessed that the words "national priority" are inappropriate for Greece.
- Research works are mostly determined by the scarce sources of funds. EU priorities and national priorities are particularly important because they represent the huge majority of research funding. The RTD Director of CRES told us that "when a researcher has an idea, he tries first to know if a budget is available through call to tenders and then competes for it." Forecasting activities are only "to see where the money will be available" according to the same interviewee. The needs of eventual industrial partners have also an influence on internal research priorities of research organisations

New orientations in RTD activities (for example the introduction of hydrogen RTD) usually come from international watch and experience, or from considering existing Greek RTD / funding capacities (for example when CRES was founded its members choose to perform wind RTD "by accident" : "this was the only technology that could be developed in Greece, that we could afford by ourselves.")

6.2 Little support activities

Evaluation of projects intervenes mainly at their beginning, i.e. for a proposal to be funded. In universities the autonomy is highly recognised : "we can do what we want" assessed a university researcher. In CRES the result assessment of a project (products, publications…) is the only way to evaluate it ex post.

According to IEA, “projects funded under the new Operational Programme for Competitiveness are subject to more rigorous monitoring, often resulting in new employment, patents, reports, citations, prototypes etc.” However our interlocutor managing the programme on Renewable energy sources an energy saving only assumed that a halfway evaluation will be done.

In research units as well as in the GSRT, foresight exercises or impact assessments, etc., seem to be barely used.
However a recent initiative has been launched by the Greek government : the Greek Technology Foresight (TF) Programme. The programme aims at looking into the future of Greek society by identifying the implications of emerging science and technology. In particular, TF seeks to investigate how science, research and technology are expected to contribute in shaping the Greek “knowledge society”. The time horizons for this investigation are the years 2015 and 2021.

Annexe A Acronyms

CRES	Renewable Energy Sources
CSFTA	Centre for Solid Fuels Technologies and Applications
CSF	Community Support Framework
ERA	European Research Area
ES	Energy saving
FP	Framework programme
GDP	Gross domestic product
GSRT	General Secretariat for Research and Technology
IEA	International energy agency
IGME	Institute of Geology and Mineral Exploration
ICE-HT	Institute of Chemical Engineering and High Temperature Chemical Processes
NAGREF	National Foundation for Agricultural Research
NNE	Non nuclear energy
NTUA	National Technical University of Athens
OPC	Operational Programme for Competitiveness
OPE	Operational Programme for Energy
PPC	Public Power Corporation
RENES	Unit for Renewable Energy Sources
RES	Renewable energy sources
RUE	Rational use of energy
RTD	Research and technical development

Annexe B Bibliography

IEA Greece report 2002
IEA Greece report 1998

Country study Hungary

Contents:

1 Summary of country study indicating main points for synergy

The Republic of Hungary is located in Central Eastern Europe, and makes part of the countries accessing the EU in May 2004. It has a population of about 10,2 million, out of which 1,9 million live in the capital Budapest.

Almost all of Hungary's primary energy supply (TPES) is derived from fossil fuels, mainly gas (40%), coal an oil (16% and 28% respectively, in 2000). Nuclear energy accounts for about 15%, renewables have only a marginal role in energy production.

In comparison to other accession countries, the energy system in Hungary is marked by its high degree of privatisation (nearly 100%), the working of a regulator, and its situation as a net importer of energy, that raises the issue of security of supply.[85]

The research system has also undergone major changes, leading to an increased role of universities and a diminishing (but still important) role of the National Academy of Sciences. With a ratio of DERD/GDP[86] of less then 1%, research expenditures are very low in Hungary, and mostly (and increasingly) oriented towards applied research.

Public funding for energy research is mainly administered by the Ministry of Education, in yearly programmes that are based on the orientations of the national energy policy and on European priorities, in order to promote participation in the framework programmes.

European research collaboration of Hungarian partners primarily passes through the participation in framework programmes and concerns mostly universities and the Academy of Science. The low industrial integration in the European Research Area, besides internationalisation through privatisation and foreign direct investment, is perceived as a weakness, especially concerning SMEs, who miss both capacity, experience and consultancy structures.

National priorities in NNE-RTD cover European priorities in so far as they are oriented along national energy policy objectives, that are themselves bound to the results of the EU-accession negotiations, obliging Hungary to increase renewables and green electricity. However, interview partners stress the lack of a clear energy research strategy.

[85] In contrast to that, the Czech Republic as an other example, has not privatised the entire electricity sector, it has only recently installed a regulator, and has secured its energy supply trough the installation of a new nuclear plant.

[86] Domestic enxpenditure on research and development / gross domestic product.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA[87]

2.1 The institutional and sectoral participation in ERA

The settings of both the public research system and the energy industry system led to different ways of international integration of research in the two domains:

- Hungarian universities have good connections with universities abroad, mainly in Europe. They can participate in European high level research.
- According to our interview partner, "All energy companies are privatised from big western companies: they don't have any problems doing their research activities, as their research activity is anyhow in their home country." At least, it seems that research results in industry are rather attributed to headquarters (i.e. in terms of patenting and publication), even if Hungarian teams participate (substantially) in the development. As a result, the international integration of research activities is somehow already in place in this sector, due to the Hungarian privatisation policy.
- The situation is different with regard to SMEs who neither have the capacity nor sufficient experience in European cooperation. The tendering process of the framework programmes is too complicated for them, which is even more a problem as a well developed consultancy system for SMEs is missing in Hungary. The chambers have information, but they cannot provide direct support in the project preparation, as it is offered for instance in Austria by BIT[88].

2.2 Different forms of international cooperation

International cooperation in NNE-RTD mainly passes through the European Framework Programs. Bilateral cooperation rather concerns investment than research, as for instance the improvement of old heating systems, with the Netherlands.
In principle, collaborations (may) exist with all countries, traditionally, German partners are most important.
According to our interview partners, there is no research cooperation with Visegrad countries, but there exit special energy efficiency projects in this area.

Beyond research and development projects with European funding, an other programme has been mentioned in the field of geo-thermal heating systems: This is a domain, where Hungary shows relative strengths, as it has the biggest geo-thermal heated greenhouse system. In early 2003, the World Bank started an initiative, financed by the Central and European Geothermal fund, allowing to decrease the risk of innovative investment projects in this domain. During 6 months, a feasibility study is financed, in case of a positive result, the beneficiary is obliged to do the investment.

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87 Chapter two is entirely based on the interviews with M. Meszaros from the Ministry of Education and M. Poos from the Ministry of Industry, held in November 2003. It has therefor to be interpreted as appreciation of main points of synergy, and not so much as robust results of profound research in the field.

88 BIT - the Bureau for International Research and Technology Cooperation - is the Austrian centre offering services to participants in European and international programmes, actions and initiatives for cooperation in research, technological development and demonstration (RTD).

In the field of low temperature geothermal energy, collaborations also exist with Iceland.

2.3 Thematic priorities for Hungary and Hungarian international cooperation

The development of bio-fuels and green electricity is an official objective of the Hungarian State, negotiated with the European Union in the framework of the accession process. Green electricity should increase by 8 times from 0,5% today to 3,6% in 2010, taking into account the expected rise in consumption.

In the domain of bio-fuels, biomass and wind energy are on the top of Hungarian technologies, followed by waste incineration and (to a limited extent) geothermal energy, mainly low temperature. Concerning hydropower, the geographical situation in Hungary is particularly difficult, as it is a very flat country, so the Danube can not really be used for energy generation.
The domain of wind energy is all hold by private investment; the Ministry is not always informed. According to our interview partner, municipalities and environmental authorities participate in the support of wind energy.

Special needs for research, also in international collaboration, concern the closer linkage between energy and transport related questions, as transport is the fastest growing energy consumption sector, and there is no solution to this problem yet available .

Generally, any research aiming to close the technology gap related to the climate change challenge is needed, from production up to consumption, and always with an integrated view.
Moreover, questions of security of energy supply, including energy efficiency and renewables, are of primary importance for Hungary.

2.4 Strengths and weaknesses of Hungary in ERA and of ERA for Hungary

Hungarian success rates in the European Framework Programs is relatively satisfying, but participation is limited in two ways: firstly, it mainly concerns universities and institutes from the Academy of Science, and very rarely industrial partners, as they are either hold by foreign companies or too small to participate. Secondly, the actual size of the projects makes it very difficult for Hungarian partners to take the role of a project leader, as the lead came out to be very intensive in project-management where Hungarians lack experience. This led to a considerable fall in the number of Hungarian leaders from the second call of FP6 onwards.

The difficulty of finding other potential participants in European projects than university institutes also concerns communities, that could participate in the "Concerto" initiative: For the second call, only due to personal connections of M. Meszaros, in charge of information diffusion about the Community programs, a city could by found that had experience in energy research, in energy efficiency as part of a regional policy, and that has the capacity needed for a European project.

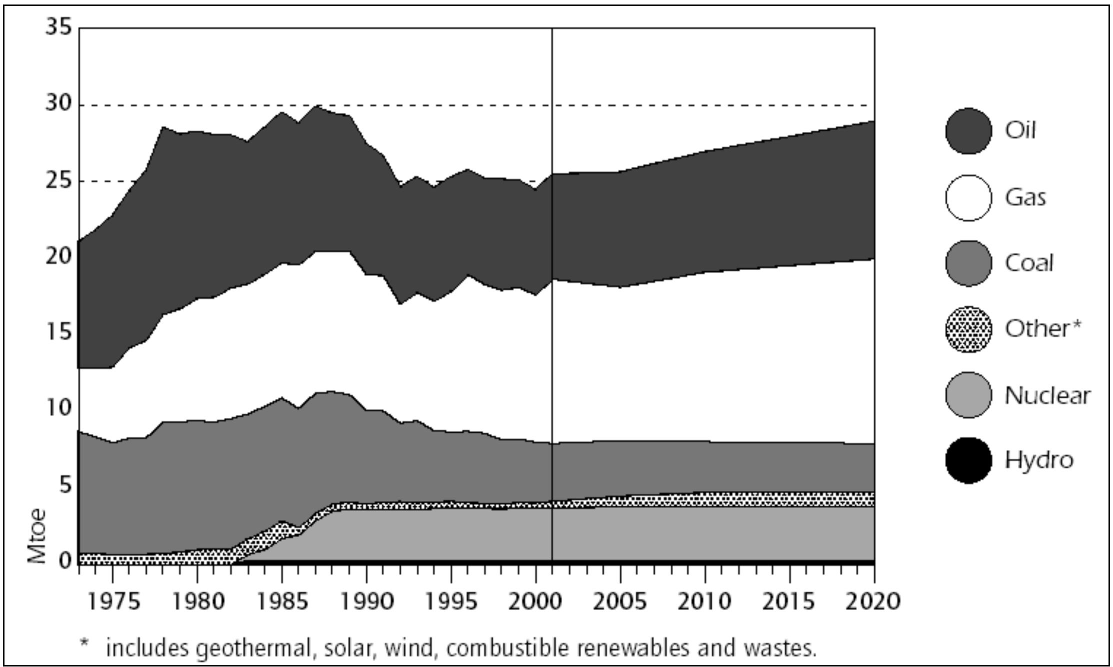
On the question of possible improvements, our Hungarian interlocutors rather reacted with self-criticism: The major difficulty of Hungarian energy research and, as a consequence, its integration in the European Research Area, stem from the missing strategy on the national level: No white paper on energy research policy exists, providing a framework of the promotion of Hungarian research and actors. Moreover, an improvement of educational programmes and of the regional institutional basis in Hungary are asked for. All that is partly in the responsibility of the national, partly of the regional level, but not of the European level.

3 Short background information

3.1 The overall energy situation of Hungary

Though energy supply in Hungary is fairly diversified, almost all of Hungary's TPES is derived from fossil fuels (Exhibit 3-1)[89]; In 2000, coal and oil represent large but gradually decreasing shares, equivalent to 16% and 28% respectively. Gas confirms its leading role with almost 40% of TPES in 2000. Nuclear remains important, accounting for 15% of the energy supply in 2000 and maintaining a large role in electricity supply. Combustible renewables and wastes (1,5% in 2000 against 1,2% in 1990) and hydro (stable at 0,1%) are negligible. Since 1990, almost all primary energies have decreased, the main change being a fall in coal use by more than 4% between 1990 and 2000.

Exhibit 3-1 Total Primary Energy Supply, 1973 to 2020

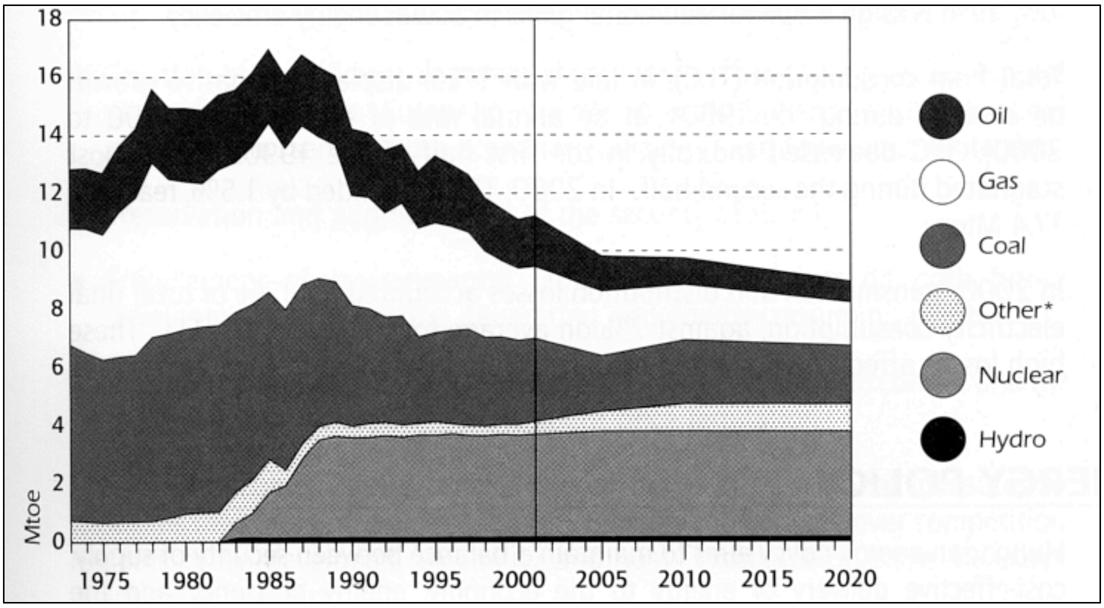


Source: IEA: Energy Policies of IEA Countries -- Hungary (2003) -- 2003 Review. Based on: Energy Balances of OECD Countries, IEA/OECD Paris, 2002; and country submission.

89 See IEA (2003), p. 22.

Hungary is a small producer of oil and net dry gas. In 2000, Hungary imported 16 Mtoe, out of which 5,8 Mtoe was crude oil, 7,3 Mtoe was natural gas and 1,2 Mtoe was coal. During this period, Hungary exported a total of 2,4 Mtoe energy, of which 1,7 Mtoe of petroleum products and 0,5 Mtoe of electricity. Hungary's external energy dependency grew from 47% in 1994 to 56% in 2000[90]

Exhibit 3-2 Energy Production by Source, 1997 - 2030

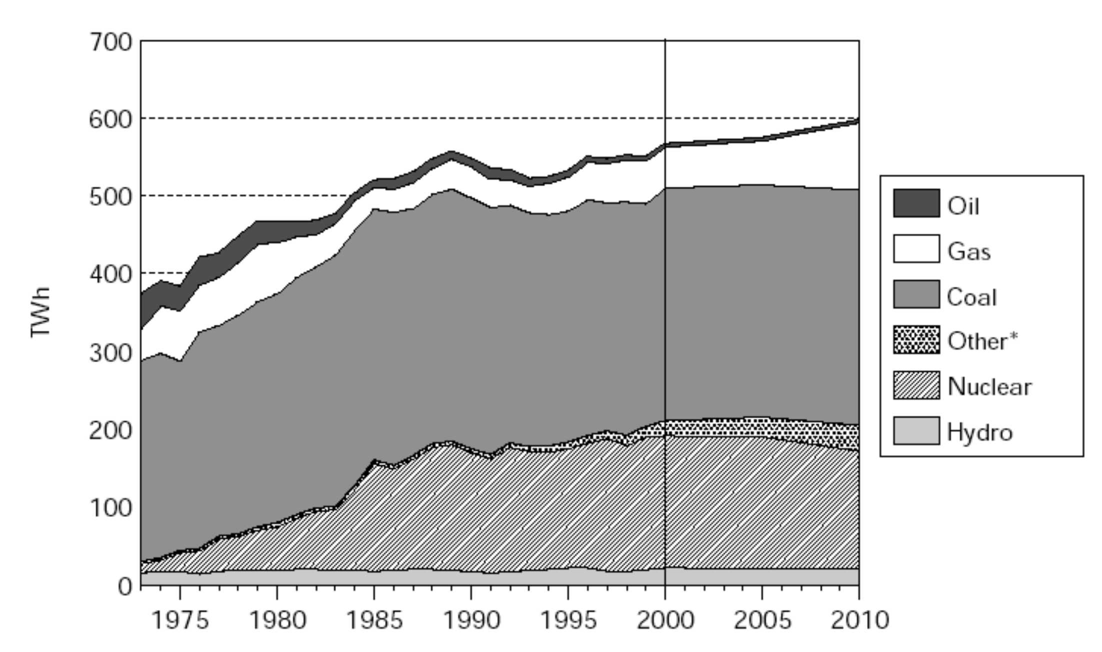


* includes geothermal, solar, wind, combustible renewables and wastes.

Source: IEA: Energy Policies of IEA Countries -- Hungary (2003) -- 2003 Review. Based on: Energy Balances of OECD Countries, IEA/OECD Paris, 2001, and country submission.

[90] Imports minus experots divided by TPES, see IEA (2003) p. 22.

Exhibit 3-3 Electricity Generation by Source, 1973 to 2010

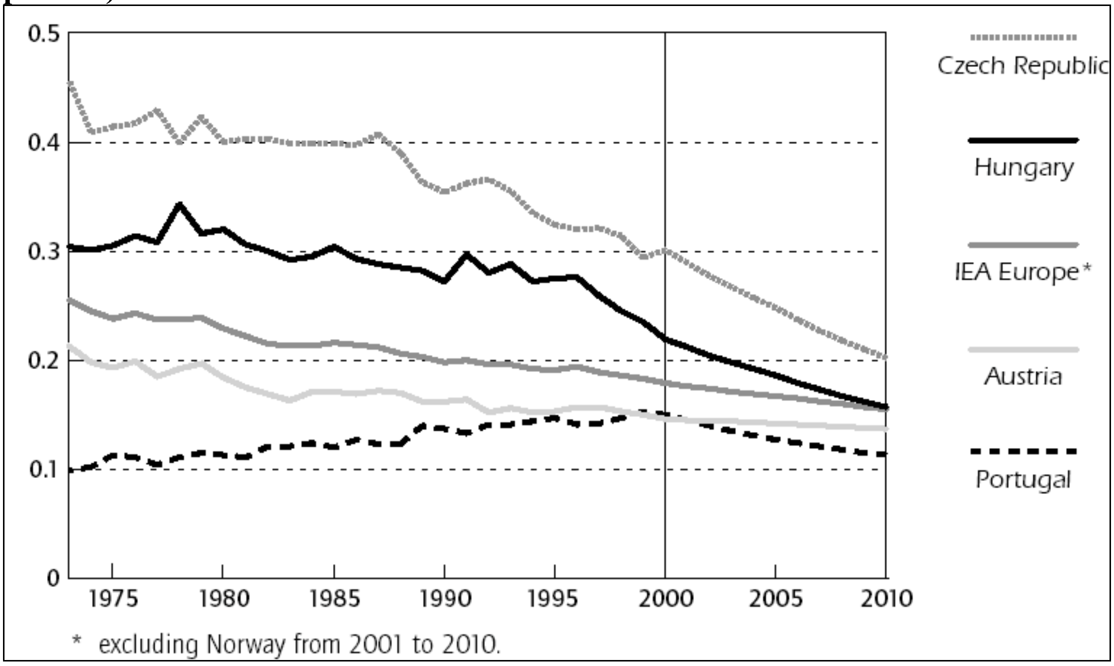


** includes solar, wind, combustible renewables and waste, and electricity from heat pumps.*
Source: IEA: Energy Policies of IEA Countries -- Hungary (2003) -- 2003 Review. Based on: Energy Balances of OECD Countries, IEA/OECD Paris, 2001, and country submission.

The energy intensity of the Hungarian economy improved between 1990 and 2000, from the tenth highest in OECD countries (lower than North America), at 0,27 toe per unit of GDP (in US$ 1995 PPP), to the thirteenth highest, at 0,22 toe per unit of GDP, roughly equivalent to the IEA average (**Exhibit 3-4**)[91]

[91] see IEA (2003), p. 22.

Exhibit 3-4 Energy Intensity in Hungary and in Other Selected IEA Countries, 1973 to 2010, (toe per thousand US$ at 1995 prices and purchasing power parities)



Source: IEA: Energy Policies of IEA Countries -- Hungary (2003) -- 2003 Review. Based on: Energy Balances of OECD Countries, IEA/OECD Paris, 2002; National Accounts of OECD Countries, OECD Paris, 2002; and country submissions.

Hungarian energy policy aims to maintain a balance between security of supply, cost-effective delivery of energy to the economy, energy efficiency and the environment[92]. The Hungarian energy sector is still in transition and is expanding its energy markets with the perspective of becoming an EU member State. Hungary has been a front runner in the future expansion of the EU, it has complied with the *acquis communautaire* including the section on energy.

The 2001 Electricity Acts brings the Hungarian electricity market into accordance with EU directives in terms of third party access to the electricity grid and removal of subsidies, and defines a market structure that includes electriciy generation companies, electricity distributors, power traders, and an electricity grid operator. Since January 1, 2003, the 200 largest industrial users, constituting about 35% of total consumption, are allowed to choose their electricity suppliers. Third party access to the grid has begun, and independent power suppliers are now allowed to "wheel" power through the grid. The transitional public utility market will still have an official price for electricity, with the Hungarian national electricity company, MVM[93], as the wholesaler; this will cover the 65% of the market not affected by the first stage of market liberalisation, and will gradually diminish as the competitive market expands; The public utility market should entirely disappear no later than 2010[94].

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92 See the IEA country report.

93 Magyar Müvek Részvénytarsasag, Hungarian Electricity Companies Ltd. MVM's generation is organised into eight different generating companies.

94 See Fossil Energy International : An Energy Overview of the Republic of Hungary. http://www.fe.doe.gov/international/hungover.html

3.2 The national RTDI system

Like other countries in transition, Hungary has seen its national effort in R&D drastically reduced during the 1990s: the relation DERD/GDP passed from 1,09% in 1991 to 0;75% in 1996 and started to recover than slightly, to 0,94% in 2001.

The national RTDI system has undergone profound changes since the transition to democracy in 1989, and even since the turn of the century, the institutional setting is moving.
Since January 2000, the direction for R&D (OM KFHA) of the Ministry of Education (OM) is in charge of the coordination of science, technology and innovation policy (STI), of piloting national R&D programmes and of promoting international scientific collaborations[95]. In 2001, the implementation of research programmes has been attributed to the newly created direction of resources in the same ministry.

The programmes are either financed by

- the National fund for technological development (KMUFA), covering about 20 million Euros in 2002, oriented toward technological innovation, the development of R&D infrastructure, distribution of research results and their economic application. It finances notably experimental projects in generic technologies like biotechnology, environmental technologies and information- and telecommunication technologies.[96]
- or belong to the national R&D programmes (NKFP) covering about forty million Euros in 2002[97]. They have been launched in 2001, funds are attributed after public calls for tender. They shall support big research activities, innovation and development initiatives, interdisciplinary collaborations and cross fertilisation between fundamental and applied research.

Some "technical" ministries also finance applied research in their domain (for instance the ministry for agriculture, rural development, environment and water management).

A third public fund is the National fund for scientific research (OTKA), launched in 1986, which is an independent source of financing since 1991, mostly for basic research and work of young researchers. 50% of its funding goes to universities, 30% to public research centres, the remaining 20% are used for different scientific initiatives.

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95 This description is taken from a report of OST, based on an investigation in March 2003. However, our interview partners announced in November 2003 that the coordination tasks shall be attributed to an agency external to the ministry in 2004.

96 See OST, after Ministry of education.

97 See OST 2003.

Exhibit 3-5 Volume of the three major Hungarian R&D programmes, allocated resources

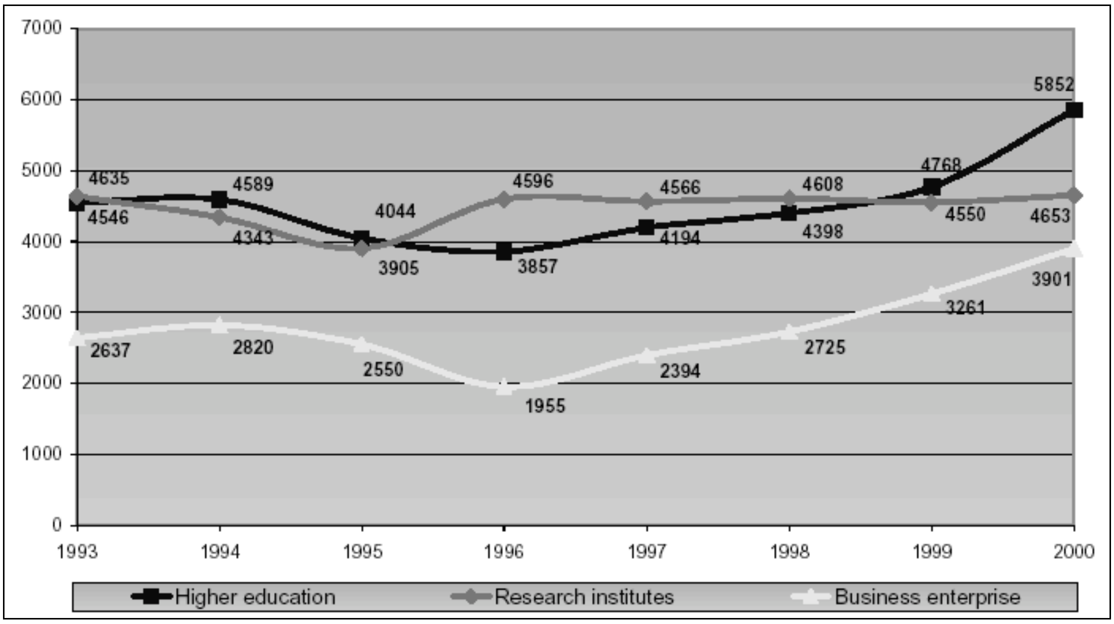
	1999 (HUF 1 billion)	2000 (HUF billion)	2001 (HUF billion)	2002 (HUF billion)
National Scientific Research Fund	2.5	3.1	4.2	5.4
National Technology Development Fund	5.1	6.3	8.75	10.94
National R&D Programmes	0	0	5.572	10

Source: OECD 2003

The transformation of the system has changed relative weights in the sector distribution of actors in R&D: the **national academy of science** has been reduced, even if it still holds an important position, and sees its funds increasing again since 1996. Its research institutes have been reorganised, in 2002, 38 institutes existed within the Academy of Science.

In parallel, **universities**, which are the only institutions that can deliver doctoral degrees, have increased their importance, not only in terms of number of students but also in terms of research personnel (see Exhibit 3-6).

Exhibit 3-6 R&D staff number by sector (FTE)



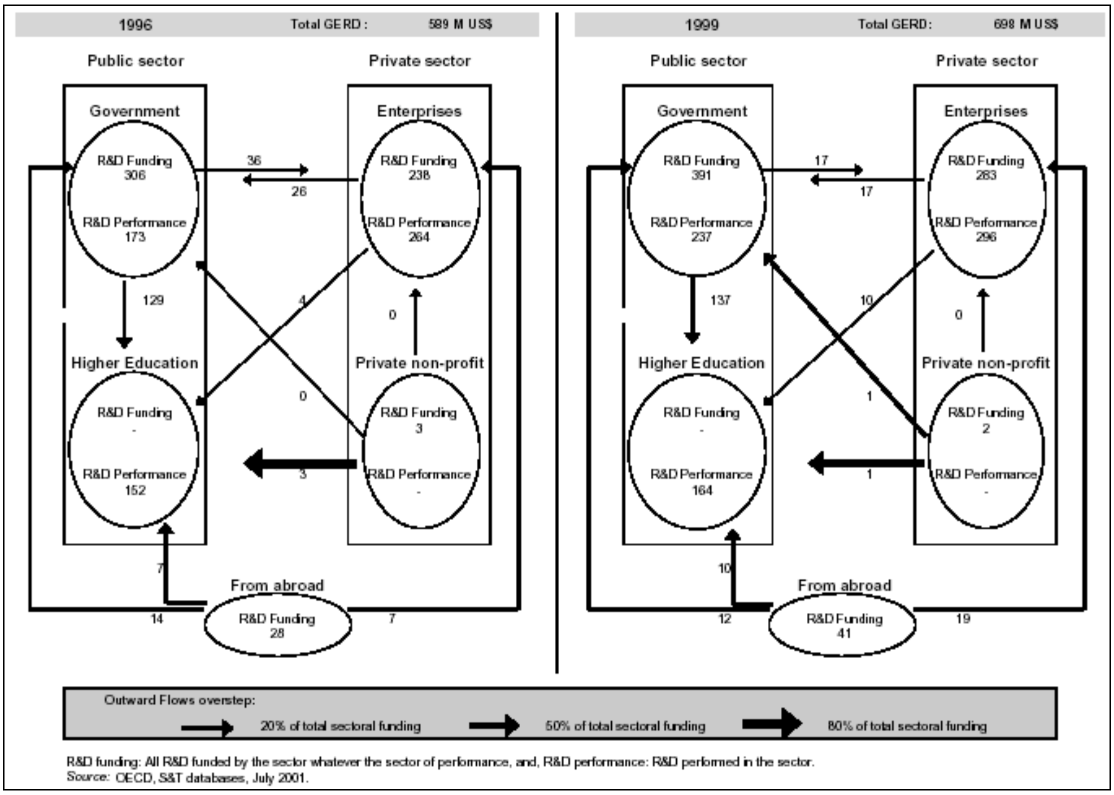
Source: OECD 2003

As Exhibit 3-7 shows[98], government and business are the main performers and funders of research; In 1999 higher education played a less important role than the other sectors. As it has been said above, that has changed since. Between 1996 and 1999 funding, both from government and business, has increased, but increases were higher with regard to government funding; This trend continues. During the same period funding from abroad has increased by roughly 40%, due to funding from the EU Framework Programme and multinational companies. The latter also relates to the fact that business support for higher education has increased by a factor of 2,5.

[98] See OECD 2003 for the following paragraphe.

Industrial financing of research lies far below the European average: In 2000, companies in the EU finance 65,5% of DERD in average, which corresponds to 1,26% of GDP, whereas respective numbers in Hungary are 37,8% and 0,3[99].

Exhibit 3-7 Structure of the R&D system: Funding and Performance (in millions 1995 US$)



Source: OECD 2003

During the last decency, new types of research organisations have emerged in Hungary, notably cooperative research centres (CRC), the Bay Zoltan foundation, and the community centres of excellence.

4 Brief description of NNE RTD organisation

4.1 Main actors (national and regional level)

There is no single institution co-ordinating energy R&D efforts in Hungary. According to our interview partner, the biggest part of funding in NNE goes to the following universities:

- Technical University of Budapest
- University Scendisdvan, active in agricultural activities, biomass, and renewables
- Debrecen University active in renewables
- Djös Uniersity.

99 See OST 2003.

- The Hungarian Energy Centre is an implementing agency of the Ministry of Industry. It is not involved in research. It is organised in two main parts: the energy efficiency program directorate (including European programmes) and the Energy information directorate, preparing all energy statistics (instead of the Hungarian Statistical Office).

4.2 Energy related R&D funding

Public funding for energy related R&D is very limited in Hungary, which is partly related to the very low R&D activity of industry in this sector.

Exhibit 4-1 Funded energy related R&D projects in National Programmes

Funded energy related R&D projects	million HUF
National R&D Programmes (NKFP), 2001	1 296
National R&D Programmes (NKFP), 2002	120
national technology Development Fund (KMFA)	197

Source: Meszaros, Presentation, 2002.

4.3 Participation in European programmes

Hungary is fully associated to the European Framework programmes. The financial and institutional framework of Hungarian participation has been clearly established.

Since 1999, the Hungarian contribution to FP5 has continuously increased. Hungary has had a 30% "success rate" in the FP5, "Thematic Programme 4: Energy, Environment and sustainable Development – Part B. Energy" (113 submitted projects with Hungarian applicants for 35 projects funded with 45 Hungarian participants)[100].

5 Current NNE RTD priorities relevant for ERA in NNE RTD

Hungary has integrated energy efficiency in the medium-term economic development plan (Szechenyi plan, 1999) with a significant effort to allocate resources for an integrated organisation (Energy Centre Hungary) and sectoral programmes, notably to retrofit housing.[101]

The National R&D Programmes established in the frame of the Szechenyi Plan with through the Government Resolution 1073/2000 foresee call for proposals in the following domains (energy related subjects are put forward as separated bullet points):[102]

- Improving the quality of life
- Information and communication technologies
- Environmental and material science
  - utilisation of new energy sources
  - energy-saving and energy efficient technologies
- Research on agribusiness and biotechnology
- Research on the national heritage and contemporary social challenges.

[100] See IEA 2003, p. 138.
[101] IEA: Energy, Efficiency in Economies in Transition (EITs): A Policy Priority. Sept. 2003.
[102] The follwing paragraphes are based on the presentation of M. Meszaros at the IEA in 2003.

Typical projects in the field of energy are integrated technology systems for RES utilisation, the financing of an innovation centre for photovoltaic technology, or surveying of solar and wind energy potential.

The National Technology Development Fund[103] also covers some energy related subjects in its call for proposals in 2002:

- Applied research
  - improving product quality (EE and ENV aspects)
- Biotechnology
- Information Technologies and applications
- Environmental research activities
  - combustion equipment with low emission
  - equipment using RES
- Human resources for research and innovation.

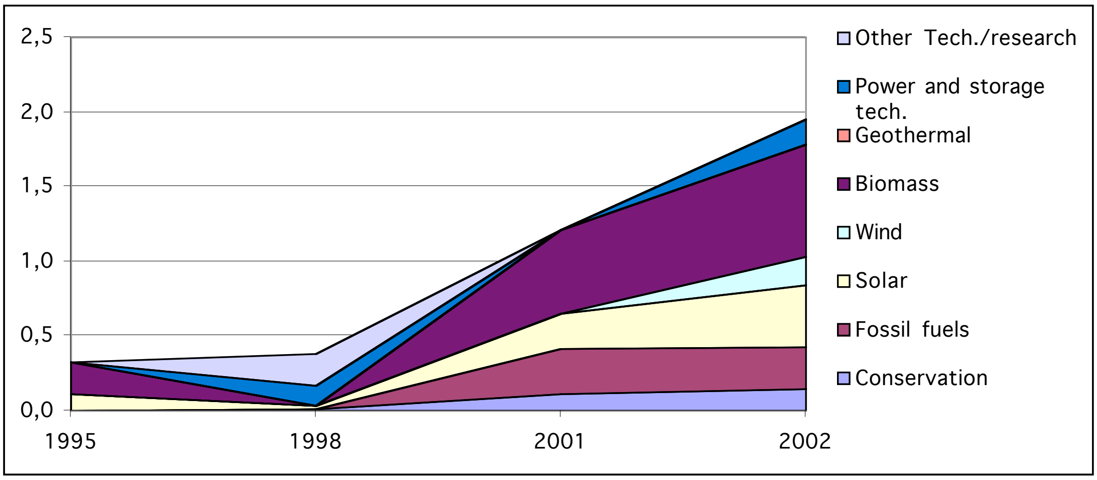
Six other areas do not cover energy at all, the last to programme lines concern "Joining the Eu R&D FP" and "Participation in the R&D thematic networks of the EU".

Altogether, according to M. Meszaros, energy only covers a very small part of the total research budget.

The only statistical basis concerning the thematic differentiation in non-nuclear energy research in Hungary that we have at our disposal is drawn from the IEA research database, and depicted in Exhibit 4-3. Data exist for the years 1995, 1998 (showing very little NNE RTD expenditure), 2001 and 2002. The figure shows that in these two recent years, biomass is dominating NNE-RTD in Hungary, followed by solar energy and fossil fuels. Wind only emerges in 2002.

[103] Government Decree 98/1996

Exhibit 5-1 National expenditure on non-nuclear research, 1995 – 2002, IEA data, Million €



Source: IEA R&D database

6 Description of Priority setting process

The Hungarian Ministry of Education is in charge of the coordination of public research programmes, including energy research. The role of the energy department is

- the preparation of the concept of the programme
- its implementation
- information dissemination about the programme
- and information dissemination about energy related issues in FP6 of the European Union.

Even if a programme for non-nuclear energy is globally defined, there are no predefined budgets for different sectors, and the only selection criterion is the quality of the project, not its thematic orientation. Therefore, the sectoral distribution differs a lot from one year to the other. `

According to our interview partner from the Ministry of Education, the main weakness is the missing general research strategy. The Ministry's stuff is very limited for strategy building: "We can prepare good programmes, but they are not always harmonised with each office". Within the broad national foresight exercise launched in 1997 energy related issues are covered in the chapter on the environment. According to our interview partner, the study is very theoretic and doesn't provide an orientation "what we shall do tomorrow", even if some emerging technologies are mentioned.

In the field of energy research, and once the overall R&D budget is defined, the Energy unit of the Ministry of Education first prepares a concept and discusses it with different actors individually, namely with representatives from the ministry of the economy (in charge of energy policy) and the ministry of the environment. Formally, all ministries are officially asked. The preparation of a programme takes about 2 months.

Priorities for the research programs come from the energy policy, and from the objectives concerning the EU integration process, and concern[104]

- the increase of renewables
- the improvement of energy efficiency on the side of the end-user
- the improvement of the emission balance.

The orientations of FP6 are taken into consideration, as the ministry wishes to encourage participation.

After publication of the research programmes, the incoming applications are evaluated by independent experts and then ranked, first within each domain. A higher committee discusses the overall ranking and prepares the final selection, the State Secretary decides for funding.

Once the projects have been funded, the programs undergo some internal ex-post evaluation, but no overall evaluation report exists. The internal evaluation is based on a project report prepared by the project leader.
About twice a year "information days" are organised by the Ministry where the project leaders are invited to present their project and results.

Due to limited State support, basic research is very limited, most funds go o applied research and demonstration.

A final remark on the priority setting process in Hungary concerns an observation that is not scientifically robust, but has been confirmed both by the way (potential) interview partners referred to each other[105] and by the interviewees themselves: In parallel to a formal exchange of information, the persons involved in energy research policy do know each other rather well, not only because the number of persons concerned is relatively limited, but also because these persons partly have passed former parts of their career in another institution, where present representatives from different institutions or ministries may have formally been colleagues sharing the same office… This leads to a network with a good information flow between the energy agency and the different ministries involved.

7 Documentation

Bergasse, Emmanuel (2003): What energy policy for South East Europe? Public Servic Review, European Union, Bruxelles/Luxembourg, Spring 2003.

Fossil Energy International : An Energy Overview of the Republic of Hungary. http://www.fe.doe.gov/international/hungover.html

Havas Attila, (2000) : Foresight in Reshaping the National Innovation System – Preliminary lessons of TEP, the Hungarian Technology Foresight Programme. Background Papers "Awareness of and deepened knowledge of foresight issues and results", Editor: S.Ertel, IPTS, Sevilla, April 2000.

[104] Interview with M. Meszaros, November 2003.

[105] The attempt to meet different persons, one from the ministry of agriculture, and another one from the Ministry of Education, all resulted in the same recommendation to contact M. Meszaros, who perfectly represents the consensus between them all.

http://jrc.es/projects/enlargement/FN/ThematicNetworkMeetings/Nicosia-00-03/Positionpapers/…
International Energy Agency (2003): Energy Policies of IEA Countries, Hungary 2003 Review. Paris.
Mesaros, Geza (2002) : Energy Technology an Research – Presentation for the IEA In Depth Review 2002, R&D Division of the Ministry of Education, Department for Advanced Technologies.
OECD (2003): Steering and funding of research institutions – Country report: Hungary. Paris, 2003.
OECD (2000): Regulatory reform in Hungary, regulatory reform in the electricity sector, Paris.
Schoen, Antoine (2003): Les Systèmes Nationaux de Recherche et d'Innovation du Monde et leurs Relatios avec la France: La Hongrie. Anlayse réalisée par l'OST en collaboration avec le MJENR et le MAE. Dossier réalisé par Antoine Schoen, Paris 2003.

Country study Iceland

Contents:

1 Summary of country study indicating main points for synergy

Iceland, an EU associate country, has the third highest rate of R&D expenditure in Europe : more than 3% of GDP. Energy RTD represents 2% of total Icelandic RTD expenditures, both public and private, i.e. 5,3 M€ in 2001. The country is only performing non-nuclear energy research and technical development (NNE RTD). This RTD is driven by two main considerations :

- the use and development of domestic energy sources
- the reduction of the share of fossil fuels in energy consumption

This has led to performing RTD on geothermal and hydrothermal energy, as applied research mainly, and to the growing interest for hydrogen research, especially for transports (the fishing fleet in the first CO_2 producer in Iceland).

As a consequence, Icelandic European co-operation are mainly devoted to these themes. However, within EU framework Programmes (FP), if Iceland's collaborations on hydrogen are developing, problems occur regarding geothermal and hydropower RTD, as these specific needs and preoccupations are far to be common to all European countries.

Recent organisational changes, both in the science, technology and innovation system and in the NNE RTD system, have led to a greater competitive environment for research funding, and to the designation of a energy RTD funding agency, the National Energy Authority. Consequently, it seems that priority setting process definition is currently ongoing.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Necessary conditions for making ERA happen

NNE RTD in Iceland is strongly oriented towards national energy resources, geothermal energy and hydropower, and as a consequence Icelandic RTD international co-operations are determined by this specific national framework (see chapter 2.2). These Iceland characteristics represents a problem for European collaboration, as only a few European countries have shared potential and interests in geothermal energy and hydropower. According to our Icelandic interview partners, the main necessary condition for making ERA happen would be the support of specific needs of each country, an emphasis on specific solutions. "The main obstacle for development in geothermal is non technical : it is political", as some countries (the United Kingdom, Sweden, which have no geothermal resources) strongly opposed a European support to geothermal energy. Our interviewees count on the entrance of Central and Eastern European Countries, among which some have a special interest on geothermal and hydropower, to counter-balance European opponents.
As well, two instruments are mentioned by our interview partners to solve this problem :

- ERA-NET. However, our interlocutor in Rannís, the Icelandic Centre for R&D, assessed that obstacles for the building of ERA are mainly located in Iceland, since the ministries are not aware of what ERA or ERA-NET mean
- networking : the constitution of a network of those who are involved in geothermal RTD in Europe

Some other various suggestions have been expressed by our Icelandic interlocutors in order to improve the building of an ERA in NNE, that are not tightly linked to the Iceland specific situation.

- ERA should more focus on long term research, as for short term and applied research (for example in geothermal) it is more easy to be funded by other entities, like companies etc. Long term research should be a preoccupation of the European union as it is a way of ensuring benefits for the future. This long term research can involve companies, in a close co-operation with public research institutions.
- One interview partner took example on the US Department of Energy to suggest a closer co-operation between DG Tren and DG Research, i.e. a strong common research policy and energy policy, ensuring a more optimal RTD funding. He suggested the creation of a single entity in charge of policy making. FPs would be organised in that framework.
- Mobility would be very valuable, i.e. performing research in another country, even for a few months. The European Commission could support this mobility through funding the difference in the cost of living, one interviewee suggested. This measure would add to existing means of developing individual contacts (colloquies…) that are seen as a necessity for making ERA happen.
- Applying procedures to FPs should be simplified.

2.2 Existing opportunities for ERA

2.2.1 European collaborations

Iceland collaborates mostly in geothermal RTD, with countries having potential and needs in this field. Among this type of countries, Iceland is mostly collaborating with European partners, especially from Central and Eastern Europe Countries : Poland, Slovakia, Hungary, Romania. This co-operation consists mainly of applied research, know-how providing and advises services. However Iceland faces there competition with bigger countries, like France for example.
France, Germany, Turkey, Greece, Portugal, having geothermal activity, are also partners for Icelandic RTD organisations on applied research.
Iceland is also part of the Nordic Energy Research organisation, and has in consequence taken part in some energy RTD programmes with Nordic countries in that framework.

Iceland has been participating in European Framework Programmes since 1994. But as geothermal has been more or less "expelled" from the 5th and 6th Framework Programmes, according to ÍSOR Director, the Icelandic involvement in EU projects has decreased. Moreover, Iceland does not participate in the Soultz project on hot dry rock technology between France, Germany and Switzerland, as the programme was already initiated when Iceland entered FPs.

However, in the 5th and especially 6th FPs, Iceland has been involved in hydrogen RTD, through many companies, universities and public research organisations (IceTech, for example). The creation of NewEnergy, a limited liability company devoted to hydrogen RTD, takes place in the European project on hydrogen. The collaboration on hydrogen is strong with Germany and is currently developing with Norway.

2.2.2 Extra-European collaborations

As previously, Iceland partners are countries with potential and interests in geothermal : African countries (Kenya, Burundi, Ethiopia…), Russia, Georgia, some Asian countries (China, Japan, Indonesia…) and Latin America countries (El Salvador, Nicaragua…).
Iceland has also some collaborations with the United States (Department of Energy), and with the World Bank and the UN (the Geothermal Training Programme, for developing countries students, managed by the National Energy Authority and with the majority of teaching and training being ensured by ÍSOR, a research organisation).

2.3 Concrete possible policy actions

2.3.1 Legal implications & suggestions

In Iceland, the utilisation of geothermal energy in housing has been facilitated by a law, encouraging all the houses to be equipped for geothermal heating. One of our interviewees suggested therefore that the European Commission could do that sort of incentive, in order to replace fossil fuels by environment-friendly energies.

2.3.2 Relations with other energy-related themes

Energy RTD in Iceland is strongly linked to environmental concerns ; this is indeed one of the main reason for the development of geothermal energy in housing, and hydrogen in transports for example.

3 Short background information

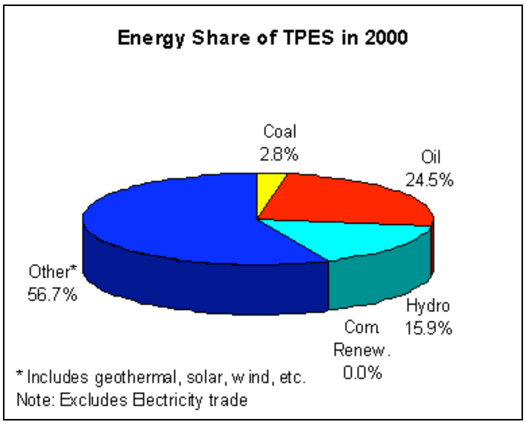
Iceland is Europe's westernmost country and is an EU associate country. Its land area is 100 250 sq km and the country is sparsely populated, with 280 798 inhabitants in 2003.
Iceland Gross Domestic Product was estimated 6,5 billion € in 2002. The economy depends heavily on the fishing industry, which provides 70% of export earnings and employs 12% of the work force. The two other Icelandic natural resources are abundant hydrothermal and geothermal power.

3.1 The overall energy situation of Iceland

3.1.1 Distribution of energy sources

Geothermal energy and hydropower are the main energy sources in Iceland, representing more than 70% of TPES (see Exhibit 3-1).

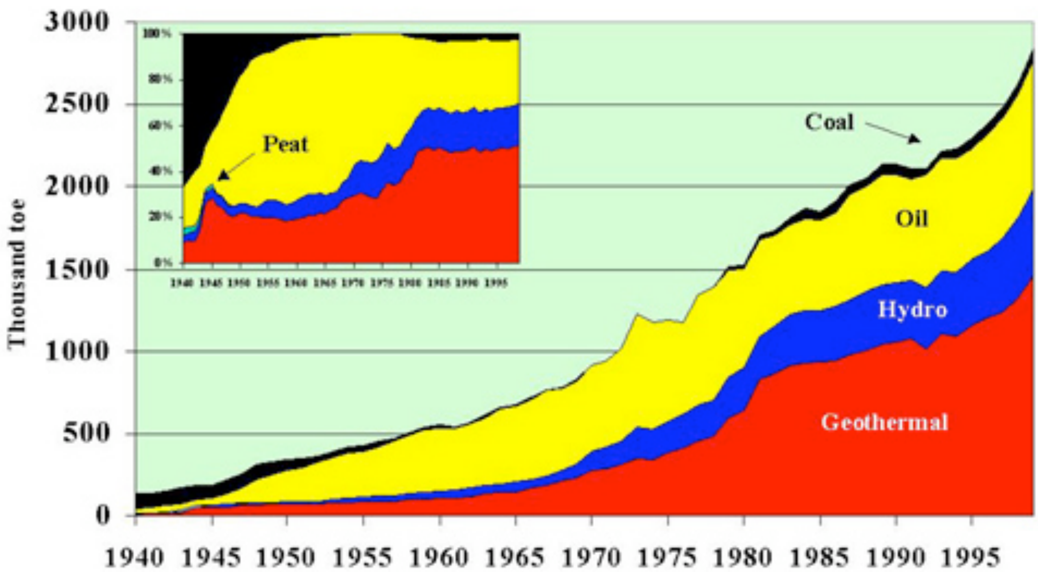
Exhibit 3-1 Energy share in total primary energy supply, 2000



Source : IEA

The share of oil (nearly 25% in 2000) has strongly decreased in the past decades, as it can be seen in Exhibit 3-2 : following the oil crisis of 1973-1974, efforts were made to use domestic sources of energy to replace oil, particularly for space heating.

Exhibit 3-2 Evolution of primary energy consumption, 1940-2000



Source : Ministry of Industry

Iceland has an abundant energy potential in the form of geothermal energy and hydropower. Energy consumption per capita in Iceland is the second highest in the world. About 85% of all housing in the country is heated with geothermal energy, the remainder being heated with electricity. Most of the country's electricity (93%) is generated using hydropower, the remainder being based on geothermal power. Only 10-15% of the technically feasible hydropower has been harnessed, and only a fraction of the geothermal potential available for electricity production.

- **Hydro Power** – Natural conditions in Iceland favour the harnessing of hydropower for the generation of electricity. The hydropower potential is theoretically estimated at about 64 TWh per year, of which 40 – 45 TWh per year may be technically and economically feasible. After taking into account environmental aspects the potential will probably be 25 -30 TWh per year. So far only 6,5 TWh per year have been harnessed.

- **Geothermal Resources** – An estimate has been made for the geothermal resources. The geothermal resource is not strictly renewable in the same sense as the hydro resource. An assessment of the total potential for electricity production from the high-temperature geothermal fields in the country gives a value of about 1500 TWh or 15 TWh per year over a 100 year period. The electricity production capacity from geothermal fields is now only 1.3 TWh per year.

This energy mix ensure a low level in greenhouse gas emissions. As the Minister of Industry and Commerce assessed in 2000[106] :

> "Emissions of greenhouse gases in Iceland differ from other OECD countries. Firstly, due to the large share of renewable energy resources and secondly due to the large share of emissions from the fishing fleet and transportation. (…) In 1990, the base year of the Kyoto protocol, Iceland's greenhouse gas emissions were some 40% lower than they would have been had our Government failed to act as it did during the oil crisis. (…) Almost 100 per cent of the electricity production, and over 95 per cent of the stationary energy use is supplied by renewable sources. On the other hand, Iceland has already reduced its greenhouse gas emissions almost as far as possible given the current state of technology. Bear in mind that the fishing industry accounts for almost 50% per cent of the national income. The potential for reducing emissions from this sector and transportation sector for the commitment period 2008 – 2012 is very limited."

3.1.2 Market concentration

The Icelandic government has been engaged since a decade in a general privatisation programme, having effects on the energy market. The major sector (with telecommunications) still subject to government ownership is electricity. In 2003 Iceland has adopted a new law about deregulation of electricity market, according to EU directives.

An OECD report[107] assesses :

> "Currently, the predominantly state-owned National Power Company (NPC) dominates generation, and distribution is performed by a number of local-government-controlled utilities. This structure does not distinguish between natural monopoly areas (such as transmission and system operation) and competitive elements (such as generation and distribution). Reform is also needed to comply with EU directives under the European Economic Area agreement. Proposals before Parliament would separate the natural monopoly and competitive areas and eventually privatise government-owned enterprises. However, some aspects could be improved.
>
> The inter-regional distortion resulting from the uniform tariff schedule (as distribution is less expensive in Reykjavik, for instance) should be removed to encourage efficient use. Moreover, the government guarantees NPC's debt, and its tax-exempt status further distorts the playing field relative to potential competing energy suppliers. Removal of these measures would make the social returns to power-generation projects more transparent and also provide a clearer market basis for the development of energy-intensive industries."

106 "Iceland's Renewable Power Sources", Address delivered by The Minister of Industry and Commerce at "Hyforum 2000" in München, Germany, September 12, 2000.

107 OECD, Economic Survey of Iceland, 2003, assessment and recommendations, April 2003.

3.1.3 Energy policy[108]

In early 2001 The Ministry of Industry and Commerce made public its overall policy objectives and corresponding measures for the coming four years. The 3rd objective of 4 was "Increasing the use of domestic energy sources".

> "Iceland possesses extensive sources of renewable energy that have been exploited only to a limited degree. However, they are more intensively utilised here than anywhere else in the world. Approximately 2/3 of primary power use in the country comes from renewable resources, and their share of electric power production is 99%.
> The production and export of aluminium, along with other energy-intensive industry, are actually exports of renewable Icelandic energy. Economic growth in recent years can be attributed largely to foreign investment in renewable energy sources, and experience has shown that industry based on these resources can play a role in halting migration from rural areas.
> The Minister of Industry and Commerce considers it essential to increase the utilisation of domestic renewable energy resources in order to encourage diversification in industry, create a basis for foreign investment, increase the number of well-paid jobs, and support business and population development in rural areas.
> There must be competition in the production and sale of electricity. At the same time, there must be continuing research and development on new sources of energy/means of transmitting energy, to replace dependence on fossil fuels. Environmental concerns must also be taken into account in exploiting domestic energy sources, and there must be attempts to reconcile interests in utilising and conserving natural resources."

Among the means[109] of achieving these aims (increasing use of domestic sources of energy and promoting competition in the energy sector) the Minister of Industry and Commerce has defined that

- "energy will be utilised as close as possible to its point of origin" (i.e. decentralisation of energy production)
- a plan for a comprehensive utilisation of hydropower and geothermal power will be concluded
- the energy sector legislation will be reviewed (in accordance with the European Directive) ; "there will be emphasis on encouraging competition in the production and sale of electric power as well as greater efficiency and security of energy supplies"

The Ministry puts also emphasis on research and development and announces the restructuring of the National Energy Authority (see chapter 4).

3.2 The national RTDI system

3.2.1 Public/private spending on RTD

R&D expenditure in Iceland in 2001 was about 250M€, amounting to about 3,06% of GDP, the third highest rate in Europe.
Commercial companies spend about 150M€ annually on R&D. This constitutes about 60% of Iceland's total expenditure on R&D (GERD). Around 46% of the total expenditure on R&D was financed by commercial companies. 34% was from public institutions and around 18% from abroad.

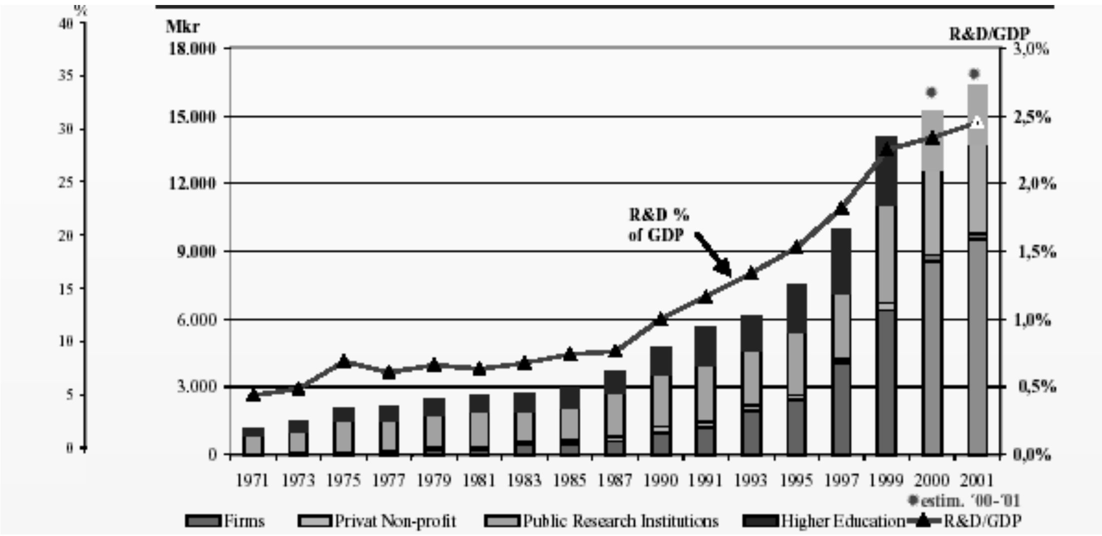
108 Source : Ministry of Industry, Ministry of Finance, in OECD : STI Outlook 2002 – Country response to policy questionnaire – Iceland.
109 See the OECD document for the complete list.

Exhibit 3-3 Total R&D expenditure by funding body and conducting organisation, 2001, in thousand €

	Business enterprise		Private non profit		Public institutions		Higher education		TOTAL Funding body	
Business enterprise	109 824	*73,1*	161	*2,8*	2 559	*5*	5 237	*10,9*	117 782	*46,2*
Private non profit	294	*0,2*	2 784	*48,3*	560	*1,1*	403	*0,8*	4 042	*1,6*
Public institutions	2 089	*1,4*	2 266	*39,3*	43 633	*85,2*	38 764	*80,9*	86 754	*34*
Abroad	38 019	*25,3*	557	*9,7*	4 484	*8,8*	3 536	*7,4*	46 598	*18,3*
TOTAL Conducting org.	150 228	*100*	5 769	*100*	51 238	*100*	47 942	*100*	255 178	*100*
%	*58,9*		*2,3*		*20,1*		*18,8*		*100*	

Source : Rannís

Exhibit 3-4 R&D expenditures (in 1999 year prices, Icelandic crowns) and share of GDP, 1971-2001



Source : Rannís

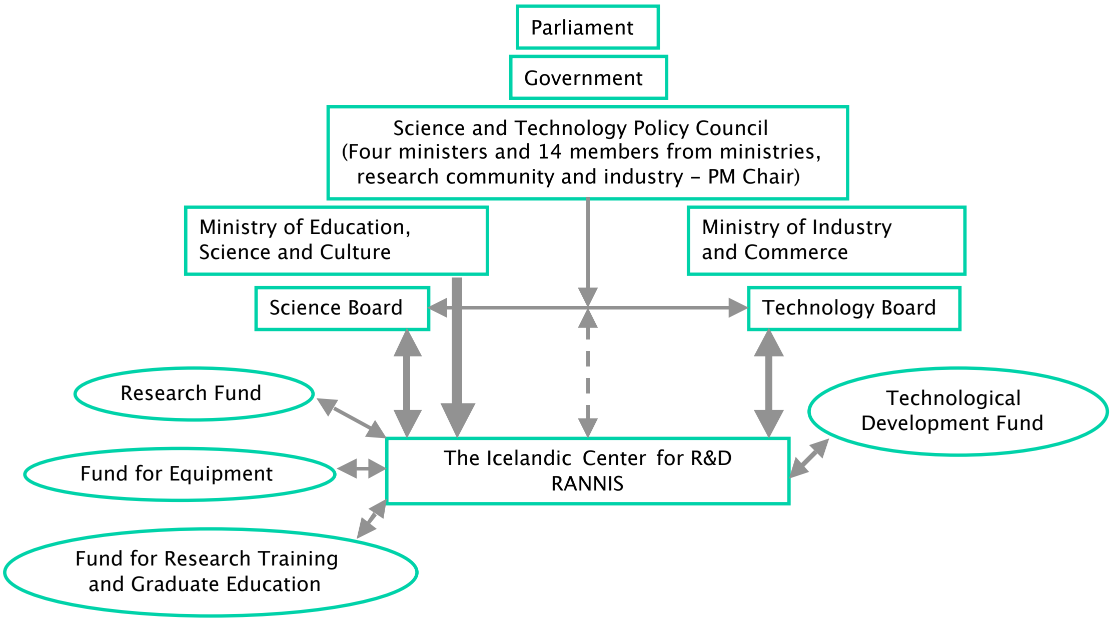
3.2.2 New Icelandic RTDI system

A new RTDI organisation has been set up in 2003. Three new Acts laid the groundwork for a new organisational structure for science and technology policy in Iceland :

- Law on the Science and Technology Policy Council - under the Office of the Prime Minister
- Law on Public Support to Scientific Research - under the Ministry of Education, Science and Culture
- Law on Public Support to Technology Development and Innovation in the Economy - under the Ministry of Industry and Commerce

The main features of the new laws are as follows (see Exhibit 3-5).

Exhibit 3-5 New structure of STI policy in Iceland



Source : Rannís

A new **Science and Technology Policy Council** headed by the Prime Minister has been established to replace the Icelandic Research Council. The Council provides permanent seats for three other ministers, the Minister of Education and Science, the Minister of Industry and Commerce and the Minister of Finance. Fourteen other members are appointed to the Council through nominations from higher education institutions (four members), labour market organisations (two representing employers and two representing employees) and other resort ministries (six members).
The mission of the STPC is to strengthen scientific research, scientific training and technology development in the country in support of Icelandic cultural development and increased economic competitiveness. The SPTC shall issue tri-annual guidelines (declarations) for public policies on science and technology. The policy declarations shall be prepared by the Science Board and the Technology Board respectively.

The Law on Support to Scientific Research establishes the Research Fund through fusion of the previous Science Fund and the Technology fund of the Icelandic Research Council. The Research Fund is governed by a board, whose chairman is also the chairman of the Science Board. Linked to the same board is also the Instrument Fund financed by 20% annual levies on the University Lottery net income.

Similarly **the Law on the Support to Technology Development and Innovation establishes a new Technology Development Fund** which is governed be a board chaired by the Chairman of the Technology Board. So far there is no decision on the size of this new fund. Thus the link between policy and implementation through funding is achieved. This law also provides for the establishment of an Innovation Center, which is to be linked to IceTechh.

The chief responsibility for assistance in preparing policy oriented papers is to be provided by the Ministry of Education and the Ministry of Industry for the two respective boards. Overall co-ordination is provided by a secretary to the Science and

Technology Policy Council to be placed within the Ministry of Education and Science.

The administrative services to the operational level of the whole structure is provided by the **Icelandic Centre for Research – Rannís** which is the secretariat of the previous Icelandic Research Council. Its mission is to give administrative and operational support to the boards and funding bodies, to manage the international connections, monitor the effects and impacts of policies and to provide intelligence and informed advice to the STPC and its boards and sub-committees. Thus Rannís will administer all the Funding bodies set up by the new legislation including the Research Fund The Technology Development fund, the Instrument Fund and Graduate Training Fund and other funding bodies for science that the government may want to assign to it. It will maintain the National Contact Point Co-ordination and support network to the EU Framework program, the Nordic NOS - organisations and other international bodies in science and technology. Thus Rannís will function as the operational arm of the new council structure.

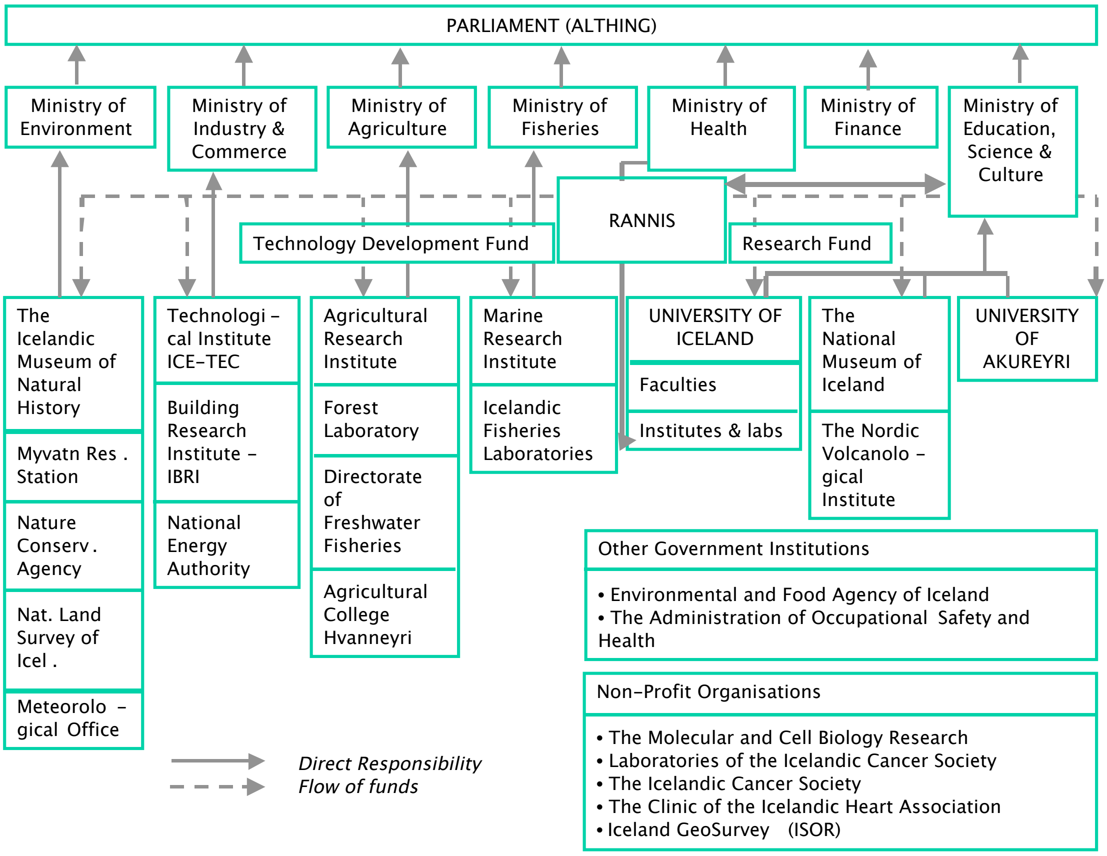
Rannís operates on an annual budget of about 1,5M€, of which about half comes from the direct budget and the rest from services fees and contracts. The grants funds operated by Rannís have the following annual budgets :

- Research fund : 4,63 M€
- Instrument fund : 1 M€
- Technology Development fund : to be decided (the first call will intervene in February 2004)
- Graduate Education Fund : 0,45M€
- Information Technology and Environmental Research Programme : 1M€

3.2.3 RTD institutions

The following figure (Exhibit 3-6) shows the complete organisation of scientific and technological research in Iceland.

Exhibit 3-6 Overall organisation of scientific research in Iceland



Source : Rannís and Technopolis

4 Brief description of NNE RTD organisation

4.1 Recent changes in Icelandic NNE RTD organisation

4.1.1 Restructuring of Orkustofnun, the National Energy Authority

Until April 2003, Orkustofnun had 2 main purposes :

- report for parliament for energy policy, build energy statistics etc.
- carry out most of RTD necessary for exploiting Icelandic energy resources

But in accordance with the European Union’s directive, the Icelandic parliament adapted in 2003 laws on the deregulation of the electricity market in Iceland. The supervision of the deregulated market was transferred to Orkustofnun, as well as increasing role in administrative and regulatory work regarding management of non-biological natural resources.
These new functions were incompatible with the activity of selling research to companies. This led to split Orkustofnun into 2 units, and to separate the RTD part to form a new institution, ÍSOR (see chapter 4.2.2)[110]. Orkustofnun remained an RTD

[110] This evolution had been anticipated and the research part of Orkustofnun was already functioning as an independent entity.

funding institution, redistributing the Ministry of Industry funds for energy RTD through RTD contracts with public or private RTD organisations.
Another reason for that restructuring is that the Ministry of Industry has been criticised for funding only one energy RTD organisation, Orkustofnun ; this restructuring means then a greater competition for RTD funding.

The new structure of Orkustofnun is the following :

- the energy division is responsible for all of the permissions, energy statistics, industry supervision etc.
- the resource division has the responsibility of elaborating strategic plans for the government concerning the support of energy projects and research projects. This division is performing socio-economic, environmental research, geological measurements etc. in order to evaluate potentials for geothermal or hydropower RTD ; then Orkustofnun is contracting the technical part of RTD to companies or research institutes.

To conclude, the role of the National Energy Authority as an advisory and public administrative body has been strengthened.

4.2 Main actors

4.2.1 NNE RTD funding

Rannís through the **Research Fund** is funding a few projects on rational use of energy.
The **Ministry of Industry** allocates funding on energy research through **Orkustofnun** but allocates also an ad hoc support for hydrogen. The definition of **Orkustofnun**'s role as a funding agency is currently in process (see chapter 6).

4.2.2 Public research organisations

ÍSOR, Iceland GeoSurvey[111], is a service and research institute providing specialist services to the Icelandic power industry, the Icelandic government and foreign companies, in particular in the field of geothermal sciences and utilisation. It was established on the 1st of July 2003, taking over all responsibilities of the former GeoScience Division of Orkustofnun.
ÍSOR is a 100% self-financed, non-profit governmental institution which operates on the free market like a private company. It gets no direct funding from the government but operates on project and contract basis. The annual turnover is close to 4,5 M€. The ÍSOR staff comprises about 50 people.

ÍSOR provides a wide variety of energy research, exploration and development services on contract in Iceland and abroad. The main services provided are listed in Exhibit 4-1.

[111] www.isor.is

Exhibit 4-1 Services provided by ÍSOR

	Services
Geothermal and hydropower resources	Exploration and research on geothermal resources Consulting services related to exploration, earth sciences, drilling and production Services related to geothermal system management, operation and exploitation Geothermal system modelling Technical and economic feasibility studies related to utilisation options Supervision and training of geothermal scientists Geodetic surveying Geological mapping Exploration and evaluation of groundwater resources
Environment	Environmental impact assessment of energy development and chemical pollution Geological and chemical investigations Basic data collection and appraisal of undeveloped energy resources Monitoring of environmental impact of energy production
Other research	Marine geosciences including oil and gas prospecting Processing and interpretation of seismic surveys Freshwater studies Geotechnical studies for tunnels and constructions

The **Icelandic Building Research Institute**[112], an independent institution responsible to the Ministry of Industry, performed some RTD related to energy savings, in its Building technology research. According to its web site, IBRI's annual turnover is approximately 3 millions ECU. IBRI is financed over the State budget (approximately 30%) and its own income from e.g. material testing, contract research and cofinancing of research projects, etc.

IceTech[113], within its department Materials and Environmental Technology, has begun to perform RTD on hydrogen, especially through two projects on hydrogen for city transport systems and on hydrogen storage. The aim is "to replace the use of fossil fuel in Iceland with domestic renewable energy sources".

University of Iceland, Reykjavik University and University of Akureyi are performing some basic energy research, on earthquakes or on local energy stakes for example, and are more and more funded through RTD contracts with companies.

4.2.3 Companies

Three companies are the main private actors in energy RTD :

- the National Power Company, Landsvirkjun[114]
- the Reykjavik Energy Company[115], operating a geothermal district-heating system, an electricity distribution network and a water distribution system
- Hitaveita Sudurnesja[116], owned by the State and some municipalities and districts

[112] www.rabygg.is/r/main/engsummary.asp
[113] www.iti.is
[114] www.lv.is
[115] www.or.is
[116] www.hs.is

5 Current NNE RTD priorities relevant for ERA in NNE RTD

According to Rannís, Icelandic energy RTD expenditures amounted 5,273 M€ (454 millions crowns) in 2001. This represents both private and public expenditures.
It has not been possible to gather data on the share of public and private expenditures in NNE RTD as well as an evolution of that shares. However it seems that public expenditures as decreasing (scientists interviewed have stressed that their amount was moreover already low), whereas private funding is now supporting basic university research.

Exhibit 5-1 Public and private Energy RTD expenditure, 2001

	Thousand €	%
Hydropower	3 395	64
Geothermal power	1 784	34
Other energy sources	92	2
Total	5 273	100

Source : RANNIS

Geothermal energy and hydropower RTD are the main NNE RTD performed in Iceland. This is mostly an applied research, in the fields of production and distribution.

They also all stress that hydrogen research is becoming more and more important in Iceland – even if this RTD is on a small scale compared to geothermal for example. Hydrogen is moreover seen by the Ministry of Industry as a way to fulfil the objective of phasing out the use of fossil fuels in Iceland (cf. chapter 3.1.1 especially). In December the government decided to define a policy line in hydrogen RTD (securing energy for transportation in the next years, etc?).
Iceland, within European projects, is seen as a testing platform, especially because of city sizes and social acceptance. Emphasis is put on transports (urban transports and fishing fleet), but some research is also done on hydrogen storage.
All our interviewees have given the example of the creation of the Icelandic New Energy company to stress the growing importance of hydrogen RTD in Iceland (see Exhibit 5-2).

Exhibit 5-2 Icelandic New Energy[117]

Icelandic New Energy is a limited liability company. Its mission is to "investigate the potential for eventually replacing the use of fossil fuels in Iceland with hydrogen and create the world's first hydrogen economy" according to the web site. The company is held among others by Shell, Daimler-Chrysler, Mercedes-Benz, University of Iceland and IceTech. Icelandic New Energy is run as a platform for demonstration and research concerning hydrogen as a fuel.

Finally, it seems that a new emphasis is put on bioenergy for transports (methane, biogas…) by Orkustofnun, the National Energy Authority.

[117] www.newenergy.is

6 Description of Priority setting process

Due to the reorganisation of the NNE RTD system in Iceland, i.e. the redefinition of the role of Orkustofnun, the National Energy Authority, priority setting processes in Iceland are yet not completely clear[118]. Some characteristics can however be stressed :

- RTD activities are strongly linked to Icelandic energy resources (geothermal energy and hydropower), and to the energy policy objective of reducing the share of fossil fuels in the energetic mix (hydrogen and biogas use in energy-consuming industries and transport)
- Orkustofnun bases its RTD funding policy on model studies on energy use (for example energy use in industry) and on society studies (social acceptance and social demand). Economical and environmental impacts of NNE RTD are taken into account : NNE RTD is for example considered in the perspective of economical growth and employment.
- Orkustofnun policy line will be drawn in a periodic strategic 5-year plan, commented and approved by the Ministry of Industry, and built after the hearing of all energy and energy RTD players. The Director of Orkustofnun assesses that this process will be more and more formalised ; he stresses indeed that as Iceland is a small country, decisions until now were often taken through an informal process.
- RTD units in universities or research centres are free to define their research topics. They can apply to the Research Fund (and soon to the Technological Development Fund) where their project is scientifically evaluated by an Evaluation Board, established for each yearly call

[118] The writing of a first Orkustofnun 5-year-plan is ongoing.

Annexe A Acronyms

ERA	European Research Area
FP	Framework programme
GDP	Gross domestic product
IceTech	Icelandic Technical Institute
ÍSOR	Iceland GeoSurvey
NNE	Non nuclear energy
Rannís	Icelandic Centre for Research and Development
RTD	Research and technical development
STI	Science, Technology and Innovation
TPES	Total primary energy supply

Annexe B Bibliography

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- OECD, Economic Survey of Iceland, 2003, assessment and recommendations, April 2003.
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- Ministry of Industry and Commerce, Energy in Iceland (http://brunnur.stjr.is).

Country study Ireland

Contents:

1 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

1.1 Conditions to be created in order to make ERA happen

1.1.1 Identification of good, existing, practice leading to special motivation for collaboration in an ERA-type manner

There is evidence that Irish researchers are already well connected in the two energy fields (wind and wave energy) which are likely to become the focus of future national priorities. The main institutions are already engaged in existing networks MARINE-NET, OCEAN-NET; and are actively pursuing participation in both Networks of Excellence (MI) and Integrated Partnership (UCC) bids for FP6. These follow on from earlier EU collaborative work:

There is also evidence of application of Irish expertise, which may not necessarily be energy-focussed to support multidisciplinary projects (e.g. NMRC contributes to transport projects). These active participants appear to enjoy a good level of integration with European projects, even operating as co-ordinators of some projects. As research continues to become more interdisciplinary in nature, such collaborations will enhance Irish participation in its areas of strength – rather than having to develop new capabilities.

Furthermore, though not directly related, Ireland takes up its presidency of the EU in January 2004. This may present opportunities for a focus on Euro-centred activity in Ireland – including the energy field, which will continue to be a political focus.

Market liberalisation (which is still in train) may create conditions for other providers to enter the Irish energy supply market. The danger is though that companies are reluctant to invest in R&D while they are unsure of their long-term market share. Measures have been taken to try and encourage their investment. There are already favourable tax benefits for companies investing in renewable energy. Investment in the market could bring with it a demand for Irish expertise in the relevant energy sector. In December 2003, the Irish government announced the introduction of R&D tax credits for companies, both Irish and multinational – a further encouragement to perform R&D in Ireland.

1.1.2 Barriers for collaboration

The main problem for Irish researchers is the lack of significant funding to support their work. Some have expressed the view that involvement in collaborative/FP6 projects and networks will be hampered by this lack of funding. Whilst recognising the renewed focus on energy (SEI's RDD programmes are one example) past efforts have been driven by political considerations (meeting Kyoto commitments etc).
The limited indigenous energy market for Ireland will continue to present a barrier to funding from national R&D – as long as Ireland is not producing the energy (or the

equipment needed to produce energy) there will be a lower priority placed on calls for support in Energy RTD – particularly research of a more basic nature.

Future prospects may be more favourable for efforts in the fields of wind and wave energy – if the claims made for the potential resource in these can be realised, they will provide a larger proportion of Irish energy needs (increasing indigenous energy provision) and reduce reliance on imported fuel.

The oversight of Energy RTD lies with Sustainable Energy Ireland – this has benefits as well as drawbacks. SEI operates what are effectively Irelands first targeted actions with relation to Energy RTD. The main disadvantage appears to be a need to strengthen institutional ties between SEI and research performers. SEI does not currently fund basic research nor does it fund very much in the way of R&D work, concentrating instead on Demonstration projects and initiatives to facilitate commercial and industrial entry into RTD activity. Academic research departments tend to have stronger links with their funding bodies (HEA, through PRTLI[119] etc) Consequently there may be a risk of a lack of connection between SEI and the work being carried out under other (non-SEI) initiatives.

1.2 Potential for ERA

1.2.1 Thematic complementarities/synergies

The main priorities for Ireland will be wind and wave energy. As stated above, Irish researchers are already well placed to contribute to these fields through their involvement in existing European projects.

While short term developments will be in onshore wind there is already a recognition of the need to develop offshore wind capability. Permission was granted in 2002 for a first offshore farm in the northwest of Ireland.

Recent consultation has suggested that rather than seeking to become world-leaders, Ireland should engage in appropriate activities such that it can keep pace with new developments in the field.

In common with (for example) Nordic countries Ireland is still attempting to reduce its reliance on peat as a source of fuel. Running concurrently with efforts in this area, the expansion of the electricity and gas

Whilst concentrating on wind/wave energy as national capabilities, there may be a tendency to want to pursue other (all?) renewable technologies (CHP is discussed as a new way forwards) – this can be common of countries looking for a ‘world-leading’ niche – but may not be realistic for a country with relatively low levels of investment in energy R&D.

Transport is not currently a priority for SEI, but is likely to be in the near future. As in most countries it makes a significant contribution to energy consumption in Ireland.

---

[119] PRTLI – the Programme for Research in Third Level Institutions, administered by the Higher Education Authority (HEA)

Given its large contribution toward TPER, buildings is a focus – and will need to remain so. Sustainable village projects present opportunities for collaboration with similar actions in other countries

1.2.2 Institutional complementarities/synergies

The new national energy agency, Sustainable Energy Ireland (SEI) is the first Irish energy authority to have its own RTD programme budget. Currently it has committed only a portion of its budget to specific programmes (see below) possibly similar experience to others?

Focus on renewable/sustainable as well as consumer awareness – We may be able to find other national agencies in a similar position – a wide remit, encompassing not only R&D, with a relatively small energy market, and much of this is reliant on imported fuel.

The Marine Institute is involved in Marine-NET type activity – and wants to pursue this activity under FP6. UCC is also anticipating involvement in Wave-NET/ Ocean-NET in FP6.

Other commercial players are small but numerous (in wind and wave) and are active at a regional/local level – and in line with national priorities (e.g. Sustainable Village project focussing on housing). With the anticipated focus on public-private partnerships in ERA, these companies may be well placed to take their experience and expertise overseas. For Ireland, the liberalisation of the electricity market and support for renewables will assist their entry into market This is true particularly for those involved in AER projects, where they have purchase agreements lasting for 15 years.

1.2.3 Type of research

Whilst the majority of work to date has been focussed on meeting targets (Kyoto) Most work is at development and demonstration phase – although increasing 'research' component to portfolio. Ireland aiming to develop core competence in wind and wave energy, would do well to relate to others

Private actors may be encouraged by the liberalisation of market and support from state (as demonstrated by AER programme) where market intervention may be required. The lack of a market for new energy technologies often presents a barrier to investment in their development, particularly when such technologies are in their early stages of development.

There has been considerable effort made to bring large energy customers 'onside', and demonstrated the cost efficiencies of energy savings (for example, through SEI's Large Industry Network). Consequently there should be potential for their engagement in supporting Irish R&D efforts.

The success of the AER programme as a means of achieving the target for 500Mw of renewable energy may act as an example to other countries. The Programme is currently under evaluation before entering a new round –the results of this assessment my be of interest from a programme management perspective as well as the energy technologies addressed. Whilst the programme has been effective as a means of implementing targets, there will also have been potential for new understanding of how to transfer technologies into the commercial market – perhaps this indicates why 'less mature' technologies have been less fruitful in achieving the goals of the programme. Is there any experience which might be useful in a European network, particularly where an activity is aimed more at the development and dissemination (i.e. applied) aspects of RTD?

Long-term research will be required to support development of RE infrastructure – once Ireland becomes more reliant on these, it will need the expertise to maintain and improve its equipment. Longer-term research is likely to be focussed on storage technologies and developments required to the supply grid in order to accommodate the provision of power from a more diverse range of sources. There have already been a number of studies outlining the likely future scenarios required[120][121]

1.2.4 Opportunities for international collaboration

If the potential for wind and wave can be realised, then Ireland has the potential to become a focus for innovation in these fields – researchers encouraged to work here to make real-time, field observations - and possibly develop an international centre of competence (e.g. within Marine Institute or UCC).

Existing engagement will probably be the first avenue of entry into FP6/ERA-type activity; although the relatively small Irish Energy R&D portfolio will need further expansion if it is to make a sufficient contribution to collaborative projects (i.e. a fair contribution, rather than a 'sleeping partner').

Given SEI's relatively small RDD budget it might be appropriate to look for other countries who are in a similar position – that is, not in a position to commit significant resources to mature technologies, but still keen to stimulate a market. For instance, micro-CHP has been investigated in many other countries (including the UK) and biomass as a fuel for these plants is currently being researched by Sweden (amongst others). Close collaboration with researchers from these countries may increase the efficiency/effectiveness of Irish investment.

Another positive experience from AER must be the evaluation of success of implementing technologies, and the resulting changes in focus for the programme. Whilst this may have some negative effects (e.g. the timing of programme rounds has been erratic) it has shown that energy technologies which are able to be implemented on a commercial scale can be given a market for their output.

Other technologies such as onsite CHP and short rotation forestry (for fuel) which have been taken further in other countries (e.g. Sweden) demonstrate how large industries can implement renewable and sustainable energy technologies.

[120] "Penetration of Wind Energy in Ireland: a Report prepared for the Irish Wind Energy Association", Econnect Consultants, 2000

[121] "Study into the impacts of increased levels of wind penetration on the Irish electricity system" CER/OFREG, 2002

Emerging economies (where heavy industries may be prevalent in the commercial sector) may wish to partner in the R&D of such technologies. For example, DCMNR Renewable Energy Division has already received a delegation from Slovakia. At a national level Ireland's Research Council for Science and Technology (IRCSET) has recently signed a significant research collaboration agreement with the French Centre National de la Recherche Scientifique (CNRS).

Ireland has signed up to three IEA Implementing Agreements, in

- Bioenergy – Ireland has responsibilities in three areas:
  - Socio-Economic Aspects of Bio-energy Systems
  - Greenhouse Gas Balances of Biomass & Bio-energy Systems
  - Liquid Bio-fuels
- Ocean Energy Systems
- Wind Energy

SEI is the representative body for Ireland in these Implementing Agreements. It is expected that participation in the Agreements will supplement/complement Irish investment in EU activities such as WAVE-NET as well as providing contact with researchers and policymakers in other countries.

Although the projects funded under FP6 represent areas of strong capability in Ireland, they do not necessarily reflect all the areas where SEI would be interested in pursuing internationally collaborative projects. SEI has stated that it would consider joining international collaborative projects involving:

- eco-buildings
- wind
- wave
- biomass
- any aspect of the electricity grid

1.3 Concrete possible policy actions

1.3.1 Financial & funding implications & suggestions

The budget for energy-related R&D is small compared to other countries. It remains to be seen whether it is sufficient to support meaningful Irish engagement in FP6 and ERA activity – much of the work to date has been possible largely through FP funding, rather than from Irish sources. The current economic climate in Ireland reduces the prospect of any significant increase in funding in the short-term; commitments under the Sustainable Energy Green Paper (and subsequent Act) have been 'frozen'.

1.3.2 Legal implications & suggestions (e.g. relating to status of national RTOs)

SEI is a relatively new body (albeit one with a lineage dating back to earlier organisations), it is also rather small – c.40 people; if it is to be the focal point for Irish energy R&D efforts it will need much more resource (people and money) to maintain an oversight of all national activity/ participation in networks; currently it appears to be only beginning to build a picture of what is going on nationally – this raises the issue of fragmentation of funding – there is money from other funders, e.g. HEA/ EI but this is small and targeted at their own brief (education/industrial development); while SEI's budget is arguably large in Irish terms, it is comparatively small in international terms – perhaps SEI's brief needs clarifying/ strengthening.

The dual efforts of SEI and DCMNR might be thought to present a duplication of renewable energy programmes, and in some respects there may be efficiencies to be gained by rationalising the two streams into one organisation? This could lead toi better strategic planning; e.g. SEI supports programmes in negotiated agreements, could these be linked more closely with Enterprise Ireland and their industry-focused support programmes? More importantly for FP6/ NNE-RTD, this could offer more consistent identification of opportunities for Irish participation in networks; SEI attends EU meetings, and would be well-placed to identify problems of relevance to Irish suppliers/researchers.

1.3.3 Relations with other energy-related themes (transport, environment…)

Transport, whilst mentioned as a future area of investigation, is not currently a priority for SEI. It is however recognised that the sector makes a significant demand on energy resources. There is some small amount of activity DETE funds work on hydrogen, and NMRC is involved in FP5 projects, where it is contributing its ICT expertise. This multidisciplinary approach is likely to be a feature of FP6 work, and whilst ERA-NETs may be focused along more 'single-discipline' lines, the projects which participants are involved will enable them to make more complex relationships. Needs to be in a position to exploit this – making connections to enable realisation of goals in wind and wave, for example.

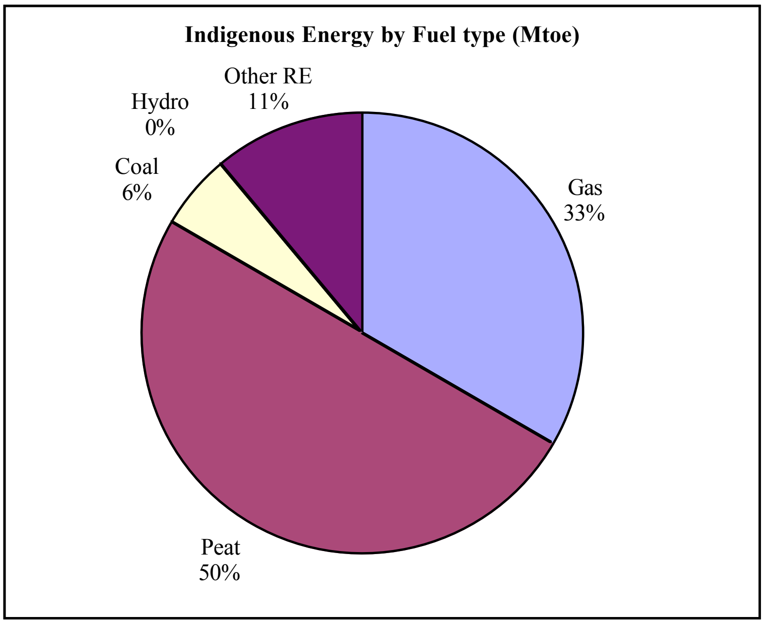
Environmental considerations are likely to be high on the agenda, with both wind and wave energy having potential considerable environmental impact. The current work done by Marine Institute amongst other has meant that Irish policy is well informed in this regard (e.g. the priorities for R&D in SEI's renewable energy programme highlight many environmental issues – see Annexe A).

2 Overall energy situation of country

2.1 Ireland's Energy Portfolio

Ireland has limited indigenous energy resources – in 2001, energy output from 'Irish' energy sources amounted to less than 2Mtoe, representing around 15% of total energy output– the breakdown by fuel type is shown in Exhibit 2-1 below. Peat still forms the largest contribution - despite production being significantly reduced in recent years.

Exhibit 2-1 Ireland indigenous fuel resources, proportion as Mtoe (2001)



2.2 Fuel imports

Ireland is heavily reliant on imported fuel, increasingly so in recent years as demand has increased alongside the rapid expansion in the Irish economy.

- Between 1995 and 2001, dependency on imported energy sources grew from 65% to 87%. This increase was due both to the closure of gas production facilities and a decrease in the use of peat.
- In 2001, oil and gas imports accounted for 74% of TPER– in 1990, they represented only 45%.

2.3 Future Prospects

Future developments may change the balance of import vs indigenous fuels: in 2004, a new gas field will come on-stream and there will be an increase in the use of renewables resulting from AER-funded projects.

Renewable energy has contributed around 2% of TPER, being drawn primarily from wind, biomass and hydro energy. In recent years, there has been a rapid growth in wind power, although this is still a small contribution at around 0.14% of TPER (2001 figures). This is likely to increase further on the basis of current commitments (e.g. through AER projects and continued commissioning of new onshore wind farms).

3 National RTDI system

3.1 Spending on RTD

In the middle of the 1990s, gross expenditure on research and development (GERD) represented 1.3% of GDP compared to an average for EU member states of 1.82%, as shown in Exhibit 3-1 below. The most recent data indicate that this gap has increased with Ireland falling further short of the EU average (1.21% compared to EU average of 1.88% in 2000). During the late 90s, Ireland's GDP grew at an annual average rate of 8.5%, compared to the EU average of 2.3%, and was expected to reach 117 billion Euro in 2001.

This period has also seen significant development in the institutional framework supporting R&D.

Exhibit 3-1 Overview of R&D Expenditure

Indicator	1994	1995	1996	1997	1998	1999	2000
Total R&D Personnel per 1000 labour force	6	6.6	6.6	7.0	7.2	7.3	
GERD as % GDP	1.31	1.34	1.32	1.29	1.26	1.21	
% GERD financed by Govt	20.9	21.4	24.2	24.3	23.1	21.8	
% GERD financed by Industry	68.9	68.7	66.8	67.3	65.4	64.1	
BERD as % GDP	0.91	0.96	0.93	0.91	0.91	0.88	
HERD as % GDP	.26	.26	.26	.27	.26	.26	
GOVERD as % GDP	.13	.11	.11	.10	.09	.07	.07

Source: OECD MSTI Database 2002

In the business sector, the ratio of R&D expenditure to GDP more than doubled from 0.5% in 1990 to 1.3% in 1997.

Although business expenditure on R&D in Ireland is comparatively low compared to the EU average, data[122] shows that BERD has grown at a rate of 20 per cent per annum in real terms during the 1990s. Business expenditure on research and development (BERD) amounted to 679 MEuro in 1997.

Industrial R&D expenditure is dominated by a few large foreign owned multinational firms. These firms spend approximately twice as much on R&D as the whole of the indigenous manufacturing base (according to Forfás data).

Irish-owned companies are more likely to perform R&D on a small-scale (less than IR£100,000 per annum), than are foreign firms. Smaller foreign owned companies tend not to have little commitment to R&D.

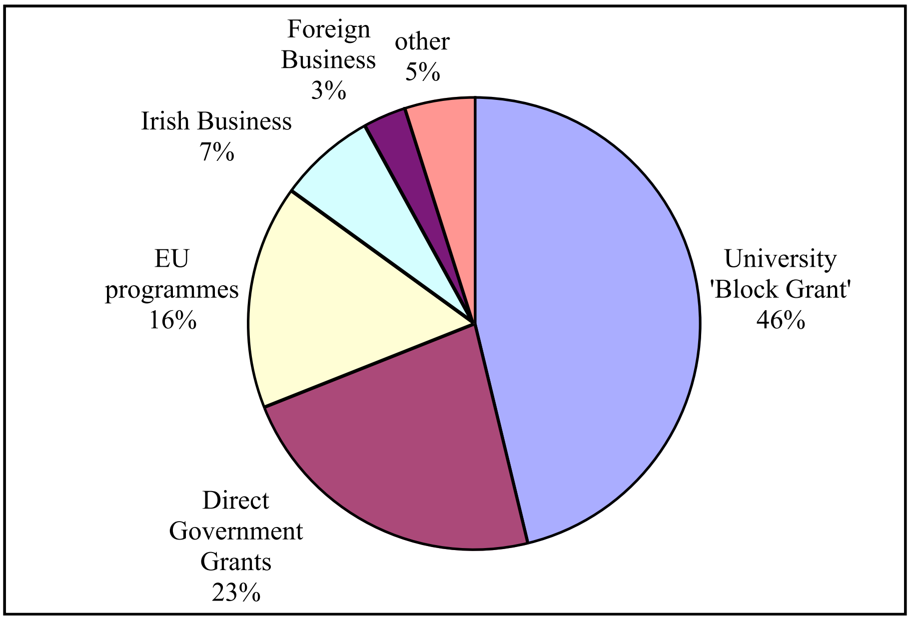
Most multinational activity in Ireland is focused on manufacturing. Much of innovation policy in Ireland is addressed at increasing investments in R&D by multinational firms.

3.2 Research performed in Higher Education

HE research is supported primarily from public funding (66% of total funding). Of this total, the breakdown of contributions from various sources is given in **Exhibit 3-2**

[122] Forfás Survey of Product and Process Innovation in Irish Industry 1993-1995

Exhibit 3-2 Breakdown of funding for HE Research (2000), by funding source



Source: Public Accounts (2001)

3.3 Main public research

R&D performed in higher education and government institutes accounts for less than 30% of GERD. Recent efforts (such as the creation of Science Foundation Ireland – see below) mean that there is significant growth in this area.

However there have been significant revisions to original funding commitments. The National Development Plan (NDP) committed significant increased funding for research in the natural resources, but much of this investment is behind schedule. For example, in 2003 the NDP Marine research budget was reduced from a scheduled amount of €4.4 million to €1.4 million, a reduction of €3 million (68% in one year).

The NDP set out five sub-measures for RTD funding, each of these is described below (Exhibit 3-3)

Exhibit 3-3 National Development Plan RTD sub-measures (2000-2006)

Sub-measure	Description
Basic Research Funding	Basic research funds totalling approximately 1.19 billion Euro have been earmarked for the period 2000-2006. These funds are channelled through two routes: • from the Department of Enterprise, Trade and Employment, via **OST** • from the Department of Education and Science, via the **Higher Education Authority (HEA)**
Collaborative & Strategic Applied Research	Public funding for collaborative and strategic R&D is administered primarily by **Enterprise Ireland**. Funding is allocated to the universities, institutes of technology and (in

	the case of the sectoral funding) public research institutes mainly on a competitive basis. The funds administered by Enterprise Ireland (totalling around 230 million for the period 2000-2006) are allocated through a number of programmes (see below).
Business Research and Development	Support for industrial R&D is handled by **Enterprise Ireland** and **IDA Ireland**, the agency with national responsibility for securing new investment from overseas in manufacturing and international services sectors and for encouraging existing foreign enterprises in Ireland to expand their businesses.
Research Infrastructure	Research infrastructure under the NDP is addressed primarily through the **Programme for Research in Third Level Institutions PRTLI** (see below)
Business Innovation Support	Enterprise Ireland offers a range of business and innovation supports to Irish-based companies, categorising these as • Business Planning & Information • Research, Development & Design • Production & Operations • Marketing & Business Development • Human Resource Development • Finance for Growth

3.4 Funding institutions

Key funding institutions are

- Higher Education Authority
- Enterprise Ireland
- the two Research Councils (IRCSET and IRCHSS)

Each of these operates a number of funding mechanisms, which are described in more detail in the relevant section.

3.4.1 Higher Education Authority (HEA)

HEA is the principal agency of the Department of Education and Science dealing with higher education. It regulates the higher education sector, channelling both the university block grants and the money to the research councils.

HEA administers the **Programme for Research in Third Level Institutions** (**PRTLI)**. Established in 1998 the objective of PRTLI is to enhance the research capabilities of third level institutions through the funding of institutional research strategies. Key objectives of the PRLTI are (a) to promote the development of high quality research capabilities in the third level sector, (b) enhance the quality and relevance of graduate output and (c) encourage inter-institutional collaboration, particularly in the Irish context. The programme requires the institutions to develop and implement their own research strategies based on a self-assessment of their existing and emerging research strengths. In developing these strategies, institutions have to prioritise their research, and applications for PRTLI funding should be consistent with the research strategy adopted.

Funding supports research in many disciplines including the bioscience, biomedicine, environment, marine, ICT, engineering, materials, social sciences and the humanities.

Although some PRTLI funds support basic research, the majority of PRTLI allocations are directed to new infrastructure.

3.4.2 Enterprise Ireland (EI)

Enterprise Ireland operates as an agency of Forfas. The greater part of its spending is in support of business development, but it has increased the proportion of its activity directed towards R&D funding. Around 51 MEuro (17%) of its 2001 funding was directed towards "Science and Technology Infrastructure".

Enterprise Ireland's Board comprises 12 people - nine of whom are company representatives (of which, two are foreign-owned companies). R&D subsidies are approved by a committee of 16 people, (comprising 12 civil servants, 2 academics and 2 industrialists).

To date, Enterprise Ireland has administered two of the principal funding routes for R&D activity: Science Foundation Ireland (SFI) and the Basic Research Grant Scheme.

3.4.2.1 Science Foundation Ireland (SFI)

SFI was set up in 2001 (under Forfás) to administer the Technology Foresight Fund. The findings of the Foresight exercise determined that the focus of funding should be in the two areas of Biotechnology and Information and Communication Technologies (ICT).

3.4.2.2 Basic Research Grants Scheme

The Basic Research Grant Scheme was introduced in the early 1980s to provide a source of *competitive* project funding for HEIs. The scheme has an annual open call for proposals and independent peer review. Since 1993 the programme has been operated by Enterprise Ireland. From 2004, it will be operated by IRCSET in conjunction with SFI.

3.4.3 Research Councils

Ireland has two Research Councils

- Irish Research Council for the Humanities and Social Sciences (IRCHSS)
- Irish Research Council for Science Engineering and Technology (IRCSET)

3.4.3.1 Irish Research Council for Science, Engineering and Technology (IRCSET)

IRCSET was set up in 2001, with a budget of over 95 MEuro for the period 2002 – 2006. Its main function was envisaged as support for research students in science and engineering. It also joined forces with the Basic Research Grants Programme in Enterprise Ireland to double the level of project funding for the programme in 2002.

(although this is seen as a one-off collaboration pending further clarification of the role in research of the two organisations).

IRCSET has a Council of 24 members - including 18 from academic and learned institutes, and 2 company representatives.

3.4.3.2 Irish Research Council for the Humanities and Social Sciences (IRCHSS)

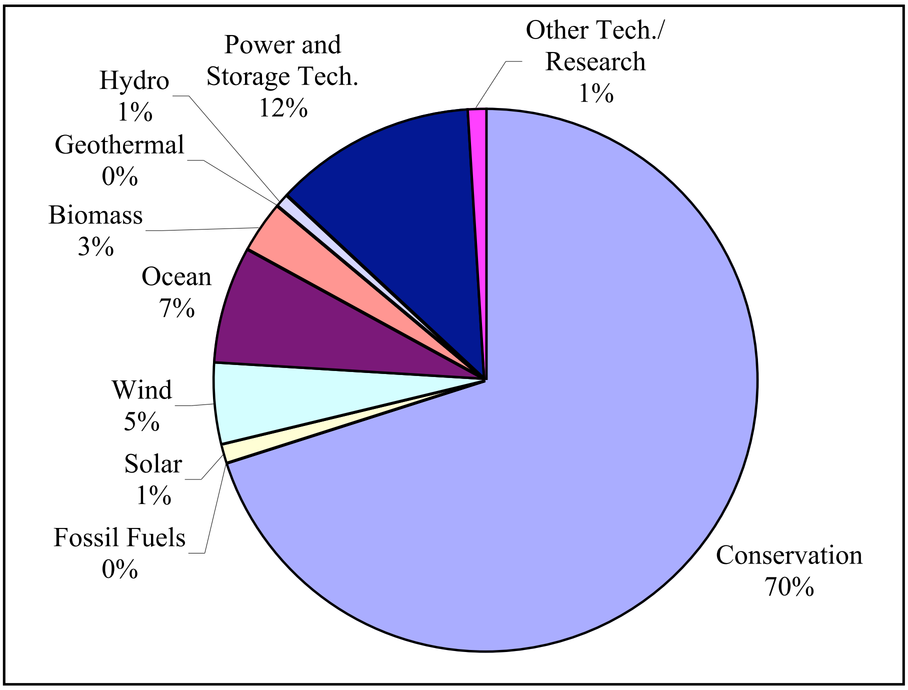
IRCHSS was established by the Minister for Education and Science in 2000. It comprises 9 academics, one senior university administrator and a representative of the administration of the Conference of Heads of Irish Universities. Research is funded through the Department of Education and Science. To date, 5.71 MEuro has been allocated to the IRCHSS and a further 47 MEuro will be allocated until 2006.

4 Brief description of NNE RTD organisation

Exhibit 4-1 below illustrates the most recent data on the balance of focus of RTD activity in the field of non-nuclear energy. According to IEA data, the total budget for NNE-RTD was equivalent to 3.46Million US$ (at 2002 prices and exchange rates). It can be seen that the vast majority of spending was directed towards 'conservation' activity. More than 80% of work in this sector was aimed at the "residential and commercial building" sector - with much of the remainder (14%) being spent on industry and only 2% focussing on the transport sector.

16% of total activity is directed toward renewable technologies (solar/ wind/ hydro/ ocean/ biomass). Ocean energy accounts for the largest single contribution (7%) of renewable energy technology R&D.

Exhibit 4-1 Focus on NNE-RTD in Ireland, distribution by technology (2002)



Source: IEA (2001)

5 Main actors

5.1 Sustainable Energy Ireland (SEI)

5.1.1 SEI - function and responsibilities

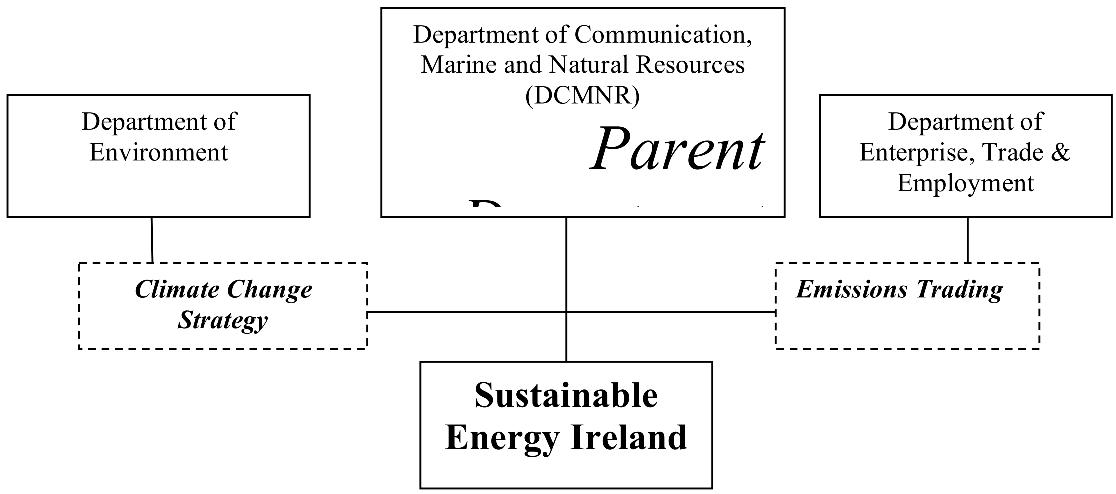
SEI is the Irish national agency for energy efficiency and renewable energy information, advice and support. It was inaugurated in the Sustainable Energy Act 2002, and replaced the former Irish Energy Centre – although SEI has a much wider remit.

SEI is an agency of the Department of Communication, Marine and Natural Resources (DCMNR) whereas the Energy Centre was responsible to the Department of Enterprise Trade and Employment (and Enterprise Ireland). The shift of responsibility from one Department to another is a further indication of the refocusing of Irish policy on renewables.

SEI's responsibilities include:
- Stimulating sustainable energy supply
- Stimulating sustainable use
- Helping to reduce greenhouse gas emissions
- Helping to stimulate competitive indigenous industry
- Contributing to rural development

Exhibit 5-1 below sets out the relationship between SEI and various Government Departments with whom it has relationships. SEI is foremost an agency of DCMNR, but it interacts with the Department of the Environment (which has overall responsibility for climate change) and the Department of Enterprise (which has overall responsibility for emissions trading).

Exhibit 5-1 SEI and its Relationship with DCMNR and other Government Departments



The multifaceted role of SEI is perhaps a recognition of the view that, in order to achieve the ambitious targets set in the Green Paper, all areas of society will need to be targeted to reconsider their energy use.

5.1.2 R&D at SEI

Typically SEI funding will be provided for applied research – 'basic research' is expected to be funded (at least from national funds) through grants from programmes such as PRTLI or Basic Research Grants Scheme (see above).

In its first five-year strategy, SEI has prioritised RDD programmes in housing, renewable energy technologies, CHP/DH, Industry and Commercial Sector Energy use, Negotiated Agreements. The aims and budget for each of these are described briefly in **Exhibit 5-2** below.

Exhibit 5-2 SEI RDD programmes

House of Tomorrow (*21Meuro)* Stimulating widespread uptake of superior sustainable energy planning, design, specification and construction practices in both the new home building and home improvement markets. (Primarily a consumer awareness programme)
Renewable Energy RDD Programme (*16.25 Meuro)* Various renewables including: Wind Energy/ Wave Energy/ Biomass/ Geothermal/ Solar/ Hydropower/ Fuel Cells. The Programme is not intended to support universities or other third-level institutions in undertaking fundamental research. Third-level institutions wishing to undertake fundamental research should contact the relevant body for such funding (such as the Irish Research Council for Engineering Science & Technology or the Programme for Research in Third Level Institutions, administered by the Higher Education Authority (HEA)). The indicative split of the €16.25M funding for RE related RD&D is as follows: • Wind and Biomass 6.3- 10 MEuro • Other RE Technologies 3.8 – 6.3 MEuro • Cross-Sector RD&D 1.3 – 3.8 MEuro The priorities for each of these areas are presented in detail in Appendix 2.
Combined Heat and Power (CHP) and District Heating (DH) (*5.08 Meuro)* Aims to stimulate deployment of CHP / DH technologies. Potential technologies supported: Micro CHP (< 20 kWe)/ CHP with absorption chilling/ CHP with district heating/ RE based CHP/ CHP incorporating fuel cell technology. ***Target: 250 MWe of installed CHP capacity by 2010***
Negotiated Agreements (*6.2 Meuro)* Aims to address mechanisms which can encourage industry to use sustainable energy – pursuant to National Climate Strategy.
Industry and Commercial Sector R&D *(13 MEuro)* Aims to support the development and adoption of energy efficient technologies (recently completed pilot phase)

SEI allows project teams to be funded under these programmes whilst also participating in other relevant international research networks - such as EU or IEA.

5.1.3 Other activity at SEI

5.1.3.1 Large Industry Energy Network (LIEN)

SEI also coordinates the Large Industry Energy Network (LIEN) - a network of 80 industries – accounting for around 35% of the energy demand in the industrial sector. The Network was established in 1994 to share information on energy technology, and in anticipation of new policy initiatives on energy efficiency and emissions, which are likely to impact on large industry. Through this network SEI was able to coordinate some of the work in the Negotiated Agreements research programme.

5.1.3.2 Public Consultation

SEI recently carried out a public consultation exercises into attitudes to Wind Energy: Attitudes Towards the Development of Wind Farms in Ireland[123]. The generally favourable views gathered in the consultation will undoubtedly have a facilitating effect (e.g. easing planning concerns etc) on future prospects for onshore wind developments.

5.1.4 FP6 at SEI

SEI also has responsibility for coordinating Irish submissions for FP6. In December 2002, it led a campaign to promote FP6 funding opportunities – currently this has resulted in two successful submissions. Research teams are not *obliged* however to use SEI as a channel for applications to FP6.

5.2 Department of Communications, Marine and Natural Resources (DCMNR)

DCMNR is the 'parent Department' of Sustainable Energy Ireland, and also has its own Divisions of Renewable and Sustainable Energy. These are responsible implementing Irish Government policy. Additionally the Division manages the Alternative Energy Requirement programme – a demonstration/commercial R&D programme designed to meet the targets of the Green Paper on Sustainable Energy

5.2.1 Alternative Energy Requirement (AER) programme

The AER Programme was launched in 1995, and was designed to support infrastructure/ 'plant' projects which would supply energy from renewable resources. The programme has been the primary mechanism by which the 2005 target for an additional 500Mwe from renewable sources will be achieved. Given the target of bringing actual energy generation on-stream, the programme has a predominantly 'demonstration' (and even market development?) focus –although there may be some elements to certain projects which can contribute to better understanding of the R&D requirements for these technologies the evaluation of success of implementing technologies, and the resulting changes in focus for the programme. The evaluation of the Programme, which is currently underway should help identify these opportunities.

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[123] The report can be downloaded at SEI' website on http://www.sei.ie/uploads/documents/upload/publications/Attitudes_towards_wind_.pdf

The rationale for support is that *"…electricity generation from renewable energy based technologies are not as yet competitive with conventional fossil fuel technology and …market support is required because these technologies operate from a higher cost base than conventional (fossil fuel) technologies."*[124]

The programme is focused primarily on energy providers – including SME companies – and encourages them to demonstrate potential for sustainable energy supply from renewables. Following the 100% liberalisation of the green electricity market (allowing 'renewable suppliers' access to the electricity supply grid) this has created an extra incentive for projects under the programme (i.e. once the facility is in place and producing energy, access to grid is provided for all participants). Prospective generators bid to build and operate newly installed electricity-generating plant based on renewable energy. Successful bids are given a Power Purchase Agreement (PPA) of up to 15 years duration, guaranteeing supply to the Electricity Supply Board (ESB) and the network.

To date, six AER competitions have been held. In each subsequent competition, the focus of technology has changed, but proposals have been funded on their potential to contribute to the '500Mwe target'. Supported technologies include wind energy, small-scale hydropower, combined heat and power (CHP) and biomass (landfill gas).

The sixth competition (AER VI) was launched in February 2003 and resulted in sufficient number of projects and potential supply to realize the 500Mw target. Exhibit 5-3 below describes the technologies focused upon in each Round of the Programme.

Exhibit 5-3 Successive AER Programmes and their Technology Focus

Technology Supported	**AER Programme** / **Date**	**1**	**II**	**III**	**IV**	**V**	**VI**
		Apr '96	*Feb '97*	*Apr '98*	*Aug '98*	*Feb' 02*	*July '03*
Biomass	**Landfill gas**	✓		✓		✓	
	Anaerobic digestion						✓
	CHP						✓
Combined Heat & Power (CHP)		✓			✓		
Small scale hydro		✓		✓		✓	
Waste to energy			✓				
Wave energy				✓			
Wind energy	**Large-scale**			✓		✓	✓
	Small-scale	✓		✓		✓	✓
	Off-Shore						✓

The table represents the technologies *under focus*, rather than those which *actually came on-stream* under the relevant programme. This is in order to give a sense of the

[124] AER Programme Information, DCMNR 2003

‘design and development’ issues which might have been under consideration at the time. Indeed, some technologies were not successful (e.g. waste-to-energy has not been implemented under AER).

5.2.2 Future of AER programme

Currently the programme is under review in order to inform the most appropriate mechanisms to support new targets (covering the period from 2005 to 2010).

5.3 Marine Institute (MI)

The Marine Institute (MI) has been involved in supporting a range of projects. Working with DCMNR and SEI, the Institute has taken a lead role in the promotion of research into wave energy technology.

MI has funded the building of national R&D capacity through support for the turbine test-beds at the Department of Mechanical and Aeronautical Engineering at the National University of Ireland, Limerick (NUIL), and wave tank testing facilities at the Hydraulic and Maritime Research Centre (HMRC) at University College Cork (UCC).

5.3.1 FP involvement at MI

The MI funds twice-yearly Energy "Marie Curie" Research Training Fellowships Conferences, first held in 1997. These conferences have effectively formed a "Cluster" of the Training Fellowship activities within the Energy programme, and at the same time providing a method of monitoring the progress of projects. Current Fellows are being funded under FP4 and FP5.

5.3.2 FP6 at MI

MI is participating in the formation of a MARINE ERA-NET linking European Marine RTD Programme Managers. While ocean energy is a small part of this agenda they are keen to develop the concept of an OCEAN ENERGY ERA-NET. There is already collaboration with other Member States including Portugal.

MI will host the EUROCEAN 2004 Conference (www.eurocean2004.com) in Galway in May 2004– where OCEAN ENERGY ERA-NET will be further promoted.

5.3.3 Other activity

In November 2002, Sustainable Energy Ireland and The Marine Institute carried out a consultation process aimed at building a consensus around a strategic approach to ocean energy development in Ireland.

Responses to the consultation included suggestions and recommendations from Irish and international experts in the field of wave energy. These responses have provided a input to the creation of a Development Scenario for Ocean Energy, which is currently being prepared by MI, in association with SEI.

This strategy will include the production of an Industry roadmap (which will highlight the potential economic benefit to Ireland of developing the sector) and a Protocol for

Ocean Energy device developers (identifying the essential R&D and technical requirements at each stage of the development of an Ocean Energy device).

6 Current NNE RTD priorities relevant for ERA in NNE RTD

Current priorities for energy R&D have resulted from a period of legislative and organisational change with regard to energy in Ireland. Two documents form the basis for the current position: the report of the **Energy Panel of Technology Foresight Ireland** and the **Sustainable Energy Green Paper 1999**.

6.1.1 Energy Technology Foresight Panel 1998

Ireland's first Technology Foresight exercise, conducted by the Irish Council for Science, Technology and Innovation (ICSTI)[125] identifies key technologies in eight sector areas for the national economic development. In each technology area, recommendations were made to address the associated "opportunities and challenges". Energy was one of the areas under consideration.

The report of the Energy Panel of the Foresight Exercise, of April, 1999 considered two key questions:

- How to maximise the benefits to Ireland of innovation in the energy sector?
- How to manage and meet Ireland's energy demand up to 2015?

The Panel suggested that the response to the first question should be to identify new technologies, research, development and demonstration needs and business opportunities, which result from innovation in the energy sector. The second question would entail examining the energy technology response to Ireland's commitments under the Kyoto Climate Change Protocol, while maintaining international competitiveness and security of supply.

The Panel argued that Ireland should "position itself in those energy technologies which offer the best commercial opportunities" – these were felt to be wave energy, hybrid energy systems, energy storage, environmentally-friendly transport, and intelligent consumer products.

The Panel recommended an initial three-year programme, covering the following areas:

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125 The Irish Council for Science, Technology & Innovation was established in 1997, in order to provide expert advice to Government on all aspects relating to the strategic direction of science, technology and innovation (STI) policy. Its role encompasses all aspects of STI policy including

- primary, second and third level education
- scientific research, technology and research and development in industry
- prioritisation of state spending in STI
- public awareness of STI issues

The Council has twenty-five members drawn from industry, academia and government departments/agencies.

- New and renewable energy technologies for the electricity, thermal and transport markets, including wave energy, hybrid energy systems, energy storage systems and alternative transport systems
- Development of intelligent consumer energy products, such as photosensitive lighting controls, motion and heat detectors, and the 'home of tomorrow'
- Energy efficient and renewable energy technologies in buildings, such as design for passive solar heating, lighting and cooling,
- Optimising the provision, distribution and utilisation of energy at all levels of energy consumption

Many of these themes are reflected in the later work undertaken (e.g. by SEI).

6.2 Sustainable Energy Green Paper

In 1999 the Irish Government published its Sustainable Energy Green Paper, which set out the future priorities for development of the energy market in Ireland, and the means by which the targets for sustainable and renewable energy production would be reached.

The recommendations of the Green Paper (as well as those of the Foresight Panel) fed into the National Development Plan(2000-2006) – discussed above, which set out the priorities for the work of Government (in all areas) for the period under consideration.

The Green Paper concluded that, as Ireland 'does not produce much of the capital equipment' needed by the energy industry and consumers, there was correspondingly narrower demand for relevant R&D than in larger countries. However it did suggest a short list of national priorities:

- An **inventory of energy R&D** in progress in the public, private and third level sectors to complement existing international databases
- More **collaborative R&D** between industry, the public sector, and third level colleges should be encouraged to best exploit the resources of all sectors
- The **built environment** requires R&D actions to answer problems specific to Ireland
- The **transport sector** needs particular support actions
- **CHP systems for small users** should be evaluated, and if prospects are good, developed
- Further **develop techniques for assessing the wind regime at on-shore sites** and consider the **development of site assessment techniques for off-shore wind**.
- Provide general training for professionals and craftsmen in design, specification, and workmanship for energy conservation technologies
- For the longer term, develop collaborative research in wave power

Following consultation, the Green Paper contributed to the publication of Ireland's National Climate Change Strategy in 2000. Later it would lead to the Sustainable Energy Act 2002, which set up the national energy authority, SEI.

6.2.1 National Climate Change Strategy 2000

The National Climate Change Strategy was published in 2000 and outlines the strategy for meeting Ireland's commitment to limit greenhouse gases to a 13% increase over 1990 levels by 2008-2012, further to the Kyoto Protocol.

The strategy discusses various R&D measures which can be undertaken in a number of sectors (including housing, agriculture, energy supply and transport). Although specific R&D targets are not set out, the document became the basis for future policy development and prioritisation

6.2.2 The Sustainable Energy Act 2002

The Sustainable Energy Act 2002 authorised the creation of a national energy authority (Sustainable Energy Ireland) with overall responsibility for implementation of Irish energy policy. The Act set out the priorities for focus of SEI's activity and determined the issues which would be the subject of RTD programmes, as well as indicative budgets for these.

6.3 Other activities which have informed priorities

6.3.1 Public Consultation on Wind Energy

The recent public consultation by SEI (see Section 5.1.3 below) has presented a positive future for wind technology in Ireland. While the AER programme has ensured at least a short-term market for the technology, increased participation in European networks (IEA and FP6) should encourage more development of expertise, and – more importantly – the transfer of knowledge from 'market-leading' countries. Since the inauguration of SEI, the AER programme has continued to be operated by the Renewable Energy Division of DCMNR. While there remains close liaison between the two - SEI is an agency 'under' DCMNR and representatives from both sit on all relevant 'energy committees and participate in meetings - the programme has not thus far been subsumed into SEI's R&D portfolio.

6.3.2 SEI Strategy Groups

SEI has also instigated the idea of strategy groups in developing policy. To date two have been prioritised – in CHP and in Biomass.
The Biomass Strategy Group's membership is drawn from SEI/DCMNR/Department of Environment/Department of Agriculture and industry representatives. The Group's target is to produce (within 12 months) a roadmap for the development of use of biomass. It is expected to report in early 2004.

The CHP Strategy Group will be convened in early 2004 and report at the end of the year.

Annexe A Priorities for SEI Renewable Energy RDD Programme

Energy Type	Research and Development Priorities	Development Priorities
Wind Energy	• Irish Wind Resource Analysis • Survey on Public Attitude to Wind Energy • Wind forecasting • Study of the impact of wind farms on Irish Landscape/Environment	Small scale (0.5 to 5MW) wind energy auto production plants • Privately owned/Industrial Wind Turbines for Auto production • Domestic/Small Commercial Wind Turbines (1 to 100 kW) for Auto production
Offshore	• Assessment of support mechanisms for offshore wind energy • Assessment of the breakdown of costs in constructing offshore wind farms in Irish waters • Assessments of the environmental impacts of offshore wind energy development • Resource prediction and energy storage.	
Biomass	• Support for feasibility studies for biomass projects • R&D support for biomass fuel supply and manufacturing of processing equipment and components • Assessment of specific resources (to complement/update existing EU Altener and other reports); e.g. agricultural/forestry residues & waste wood, feasible landfill gas resource by county etc. • Desk-top study of scale of plant (electricity/thermal) to suit Irish conditions • Development of fuel supply strategies • Information Campaign for biomass	• Wood/Agricultural **Biomass Combined Heat and Power Plants** • Medium Scale (> 20MWe). • Small to Medium (1 to 20) MW • **Biomass Heating Plants;** • Small Scale (1 to 10 MW) Industrial Biomass Heating Plants.. • Biomass Heating Systems (0.1 to 1 MW) for Large Buildings. • **Biogas AD Heat or Power Plants** • Small Scale (30 kW to 1 MW) Biogas AD Plants.
Solar	• Collection of data on direct and indirect solar radiation on an hourly basis in Ireland for simulation and feasibility calculations of solar systems • R&D on lower cost manufacturing processes	• Large scale (>100m2) Collective Solar Thermal Systems in Buildings • Medium to large scale (20 to 100m2) Combi Solar Thermal Systems (Combined Space Heating and Hot Water Production) in

	• Training and certification schemes for suppliers/installers of solar energy • Development of Guidelines or Codes of Practice (potentially leading to legislation) for installation and maintenance, design and specification, and for Green/Solar procurement for public buildings • R&D of advanced materials in order to improve efficiency of PV systems particularly suited to Irish conditions of diffuse sunlight; • Research on grid-connected PV electricity generation	large buildings
Solar - PV	•	• PV in domestic housing or commercial/industrial buildings • Stand-alone PV applications
	•	•
Ocean Energy	• Large Scale (0.1 to 1MW) Floating Wave Energy Prototype Devices • Study to identify best locations for wave and tidal energy devices around Ireland's coast • Modelling of wave energy device performance and survivability both theoretically and in wave tanks	Large Scale (0.1 to 1MW) Floating Wave Energy Prototype Devices
Small Hydro		• Small Scale (30 kW to 1 MW) Hydro Power Plants (either new, or refurbishment and repowering of existing plant)- high efficiency standardised, modular turbine design with full remote control, condition monitoring , high reliability and high availability.
Ambient Heat (Heat Pumps)	• R&D of innovative non-polluting working fluids (refrigerants) and adaptation of legislation to enforce their use in heat pumps as well as refrigeration equipments	• Large Scale Ambient Energy (ground or water source) Heat Pump Systems. large scale (> 100 kW) vapour compression systems • medium scale Ambient Energy Heat Pump Systems in Buildings. for (30 to 100 kW) vapour compression systems
Geothermal Energy	• Studies to identify the potential or likely best locations for geothermal energy, and for the deployment of geothermal energy technologies;	• Demonstration projects may be considered for large-scale geothermal heating projects

	• Developing a Geothermal Energy Strategy based on results of the above study • Small-Scale Field Verification (construction and testing of prototype systems)	
Hybrid or Cross-Sector RD&D Actions	• Development of strategic action and implementation plans for RE technologies near to commercial viability; • Recommendations on implementing Net Metering; • Research on benefits of a Green Certificate market; • Hydrogen Fuel-cells and other Energy Storage Technologies; • Recommendations on Green Procurement by Government Agencies/Bodies (including meeting Green Paper/EC targets on a departmental basis e.g. 13.2% green electricity, 12% of energy from RES).	
Community Schemes		Embedded generation • network potential to connect to facilitate forward planning and reinforcement • long term economic and technical implications/ costs and benefits of renewable energy embedded generators • preparation of updated codes, standards and guidelines on system design and operation, connection, protection, switching and metering of embedded generation/ appropriate tariffs and system charges • other specific issues raised by the RE and CHP industries such as, 'non-standard' voltages for connections, and requirements for 'T' connections to the distribution network, access to competitive standby and backup power capacity

Country study Israel

Contents:

1 Summary of country study indicating main points for synergy

As an "isolated island" with an energy endowment almost limited to solar energy, oil shales and natural gas, Israel policy decision makers are eager to cooperate with international partners to develop new and more efficient energy technologies as substitutes to expensive and unstable imported fossil resources. Israel has strong comparative advantage in innovative and challenging solar energy technologies, especially solar thermal. Since financing for these technologies are scarce, cooperation with foreign partners is a way to push these technologies further toward commercialization.

However, cooperation opportunities remain somewhat unclear in practice. This is principally due to three factors:

- The specific "outsider" position of Israel within ERA. It is clear that ERA is not structuring nor influencing Israeli RTD activities at the moment. ERA does not intervene in the Israeli RTD policy decision process. Even more, EU RTD activities as a whole are perceived less as an opportunity as the disappointment generated by FP6 grows among public and private Israeli stakeholders.
- Specific political problems of Israel since the beginning of the second intifada. The on-going conflicts draw the attention of politicians toward short to mid term concerns. In this context, NNE RTD appears to many politicians as a "luxury" Israel cannot afford. The very low priority of NNE RTD in Israeli politicians agenda in the current period of political turmoil and economic slowdown partly explains that cooperation opportunities are rather overlooked in that domain.
- The Office of Chief Scientist at the Ministry of National Infrastructures (formerly Ministry of Energy), who is in charge of public support to NNE RTD activities, can barely launch strong strategic initiatives in this area. Opportunities for this Ministry are all the weaker since its budget has gone through severe cuts as the Israeli economy is experiencing a slowdown (Energy RTD at the Ministry of National Infrastructures accounted for $2m in 2003 and was reduced by half in 2004).
- The overall RTD budget of the Ministry of Industry is an order of magnitude greater than that of the Ministry of National Infrastructures. However, the "principle of neutrality" that governs the allocation of grants from the Office of Chief Scientist at the Ministry of Industry and Trade does not allow any national technology/sector strategies. The bulk of the public RTD expenses are therefore going through open calls for applications, selected on an individual basis. This "neutral policy" does not favour RTD toward more efficient or environmentally-friendly energy technologies which need strong and voluntary initiatives.

In this difficult context, joint calls for applications within bilateral relationships remain the main vehicle for RTD cooperation between Israel and foreign partner countries. There is currently no RTD bilateral relationships dedicated to NNE RTD.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Existing opportunities for ERA

2.1.1 Thematic complementarities

As it is detailed in section 4, Israeli public support for NNE RTD is increasingly focused on solar energy, both photovoltaic and thermal. This area, which ranks high in the agenda of the EU (especially PV) and of ERA countries (Spain for instance for solar thermal with the Almeria center) includes many opportunities for potential cooperation within ERA.

First of all, Israel stakeholders have strong scientific and industrial capabilities in this area, exploring very challenging and innovative options (for instance highly concentrated solar thermal). The interviewees also emphasised that, given the country climatic conditions, Israel could be a very appropriate testing ground for solar energy technologies developed elsewhere (within the frame of a cooperation with Israel or not). Other examples of international cooperation have proved that demonstration and testing activities can be a very efficient way to start international partnerships out of which can emerge research/development cooperation.

It was clearly claimed during interviews that Israeli public decision makers involved in NNE RTD EC programs felt like that they did not have any hold on the EC priority setting process. They feel as “outsiders” as we were told. As a result, complementarities are most of the time weak. Solar thermal particularly was said to be overlooked within EC RTD programs.

2.1.2 Trans-border cooperation

Although Israel does not share borders with any ERA country, the specificity of the country position leads us to devote some scrutiny to this issue. Throughout its history, Israel has initiated several NNE related project cooperation with neighbouring countries, especially Jordan (for instance for operating a wind power park) and Egypt. These attempts were often hampered by regional political conflicts or, at least, reluctance at the political level from the partners. However, recent events tend to show that cooperative relationships with Egypt are increasing.

For ERA countries, relationships with Israel could in the future open larger cooperation opportunities in the middle-east region.

2.1.3 Bilateral cooperation

Given the international position of Israel, bilateral relationships are the main vehicle for cooperation with foreign partners.

Israel has set-up several bi-National R&D funds. The most important ones are BIRD (Bi-national Industrial R&D American Israeli Foundation) with the US, BRITECH (Britain-Israel Industrial R&D Foundation) with the UK and CIIRDF (Canada-Israel

Industrial R&D Foundation) with Canada. Although these funds have specific rules, they all finance up to 50% of eligible R&D costs of joint projects proposals between companies of both countries. The funds come from both countries, for instance £15.5m over five years in the case of BRITECH given equally by the UK and Israeli governments.

Beside R&D bilateral funds, Israel has R&D agreements with France, the Netherlands, Italy, Spain, Portugal, Austria, Finland, Belgium, Ireland, India, China, Hong Kong. Through these agreements, public authorities intend to provide guidelines and raise awareness of international cooperation between Israeli and foreign companies. Interestingly, joint call for proposals aimed at international cooperative projects have been launched through these bilateral agreements. This is for instance the case of two recent calls for applications:

- the SIBED (Sweden Israel Testbed Program for Telecom Applications) call for proposal with Sweden
- the Israel Call for Proposals For Joint R&D Projects in Information and Telecommunications Technologies with Sweden (the latter amounts to €10m of R&D)

There is also a bilateral cooperation program between Israel (Ministry of Science and Ministry of Industry and Trade) and Germany (BMBF) aimed at financing joint RTD projects (between academic partners since 1973 for academic partners and since 2000 for companies). Its annual budget originates from the interests on a €160m fund. The board of governors of the fund is composed of an equal number of Israeli and German partners. This framework has generated several sectoral joint call for applications:

- MST The German-Israeli call in Microsystems Technology
- BIO-DISC The German-Israeli call in Biotechnology
- DICOT The German-Israeli call in Interdisciplinary Optical & Laser Technology
- WING Cooperation projects in Materials Technology
- German-Israeli Chemical Nanotechnology Call For Papers

These R&D agreements are implemented and managed by MATIMOP (the Israeli Industry Center For R&D), a public non-profit organization initiated by two manufacturers associations in Israel. This centre aims at encouraging and assisting participation of Israeli companies (especially small ones) in international bi-lateral or multi-lateral cooperation programs for industrial R&D. The Office of the Chief Scientist (OCS) at the Israeli Ministry of Industry and Trade is in charge of the decisions regarding these agreements.

The only significant initiative that was reported to us in the NNE RTD area is a partnership between the University of Tel Aviv and Italian partners on environmental technology RTD. This partnership that entails 6 projects is fully financed by the Italian Ministry of Environment. One of the 6 projects aims at developing innovative solar energy technology (integrated spherical solar collectors). This partnerships started as a conference in 2002 ("Italian-Isreali Forum on Environmental technologies").

2.1.4 Regional versus national actors in ERA

The decision making regarding the allocation and management of NNE RTD resources is centralized at the national level.

2.2 Concrete possible policy actions

The strong dissatisfaction with FP6 new instruments, detailed below, leaves little room for addressing opportunities for strengthening ERA. It appears clearly that from now on EC initiatives are looked upon with caution. FP7 will be determinant for the future involvement of Israeli stakeholders in EC initiatives. On the other hand, this might encourage Israeli potential partners to favour direct bilateral frameworks for cooperating with European countries. Given the weak priority put on energy issues at the moment, it does not appear that NNE RTD will benefit from such initiatives in the near future. Therefore we believe that the initiative should come from foreign partners, based on the specific comparative advantage of Israel, especially on solar energy technologies.

According to interviewees, international cooperation is greatly needed in many projects after the feasibility stage, when costs become too heavy for the Israeli partners alone. It appears that Israeli partners are eager to conserve the hold on the project, which might partly explain their will to seek international cooperation only when key intellectual property has been secured.

2.2.1 Legal implications & suggestions

Within the frame of the 1985 law that governs the RTD policy of the Ministry of Industry and Trade, international cooperation was hampered by several restrictions applied to foreign companies.

The awarding of a grant from the OCS of the Ministry of Industry and Trade was granted to three conditions that may cause problems in the case of an international collaboration

- the R&D project must be executed by the applicant firm itself
- the product that result from the R&D project must be manufactured in Israel
- the know-how acquired in the course of the R&D may not be transferred to third parties

In 2002, the law was amended in order to include rules for transfer abroad of know-how developed with government financial incentives. The law balances the need for international operation with national economic interests. A company receiving a grant can now export its technological know how if it pays a certain fee and higher royalty returns. The new R&D law also allows for government investment in Israeli companies operating overseas.

2.2.2 The use of new cooperative instruments of the European Union

There was consensus among interviewees, apparently reflecting a broader consensus within the Israeli science and industry community, that the new FP6 instruments have significantly reduced the opportunity for Israeli stakeholders to participate in EC RTD programs. Israel is clearly facing a “transition problem” to that regard.

The dissatisfaction is all the greater since FP5 fitted very well Israeli partners and raised strong enthusiasm in the industry and in universities. The rate of success and number of participation were especially high in the IST Programme.

The critical size for participating within new FP6 instruments is believed to be too high for allowing participation of Israeli potential partners. The latter also suffer from a lack of relevant information, for instance regarding the identity of coordinators of Integrated Projects under FP6. It is therefore very difficult for Israeli partners to enter a project during the preparation phase. It was claimed that IPs are built upon existing European networks in which Israeli partners are poorly represented. As the result the participation of Israeli stakeholders in the projects selected in the two first calls of the FP6 – which put the emphasis on the new instruments – is low. Most of the projects with Israel partners are in fact follow-on of FP5 projects.

It is also significant that no Israeli partners is involved in the European PV Platform, despite the capabilities of Israel in that area.

It is also worthwhile noticing that, during our interviews, some NNE RTD decision makers clearly questioned the relevance of Israel's participation to the Joint Research Centre (JRC). The benefit for Israel does not appear obvious to these policy makers.

From a more general point of view, another trend is meaningful regarding the general attitude of some public decision makers toward Israel involvement in EC RTD programs: the Ministry of Finance use the funds awarded to Israeli stakeholders as a rationale for legitimating national RTD budget cuts, especially in the NNE RTD area. In order to secure its budget, the Ministry of National Infrastructures must sometimes advocate that both EC-funded and Nationally funded research are complementary, not substitutes.

3 Short background information

3.1 The overall energy situation of Israel

As regards its energy situation Israel cumulates two main challenges:

- its initial limited energy source endowment
- its conflictual relationships in the region

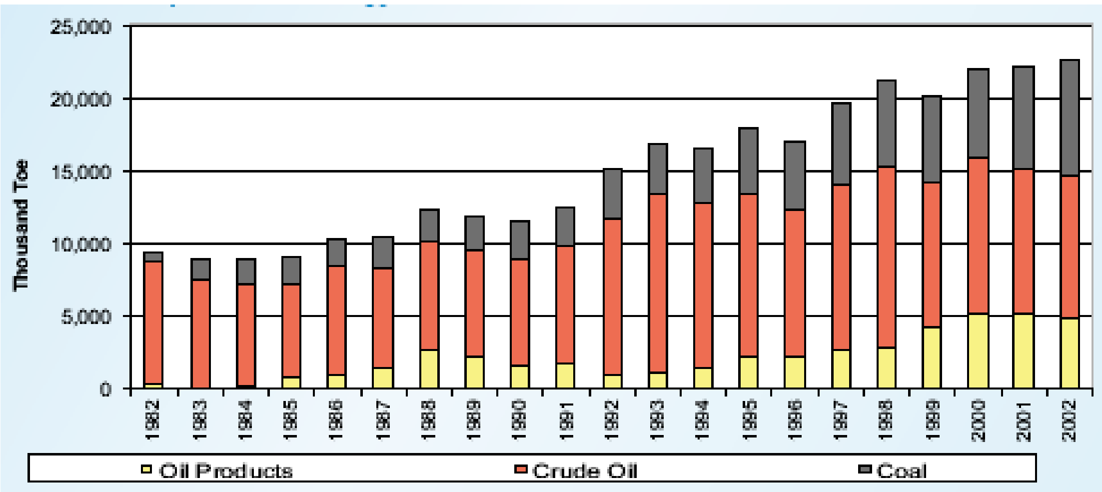
This particular situation makes Israel an "isolated island" with heavy reliance on imports and few opportunities to develop connection and partnerships at the regional level in order to manage and overcome this reliance.

3.1.1 Distribution of energy sources

3.1.1.1 Supply and imports

Until the recent discovery of offshore natural gas sources and, earlier, oil shales, Israel had no fossil fuel resources on its territory. It was therefore almost entirely dependent on import for meeting its energy needs. As a result, the distribution of energy sources and the structure of energy imports is almost equivalent.

Exhibit 3-1 Import of energy sources, 2002



Source: Ministry of National Infrastructures, 2003

Energy imports has increased over 6% a year since 1990 in order to meet the increasing demand for energy. This surge is due to the relatively high rate of population growth (2,6% a year, which is high compared to European standards) and the rise of the standard of living of the Israeli population.

3.1.1.2 Traditional energy sources

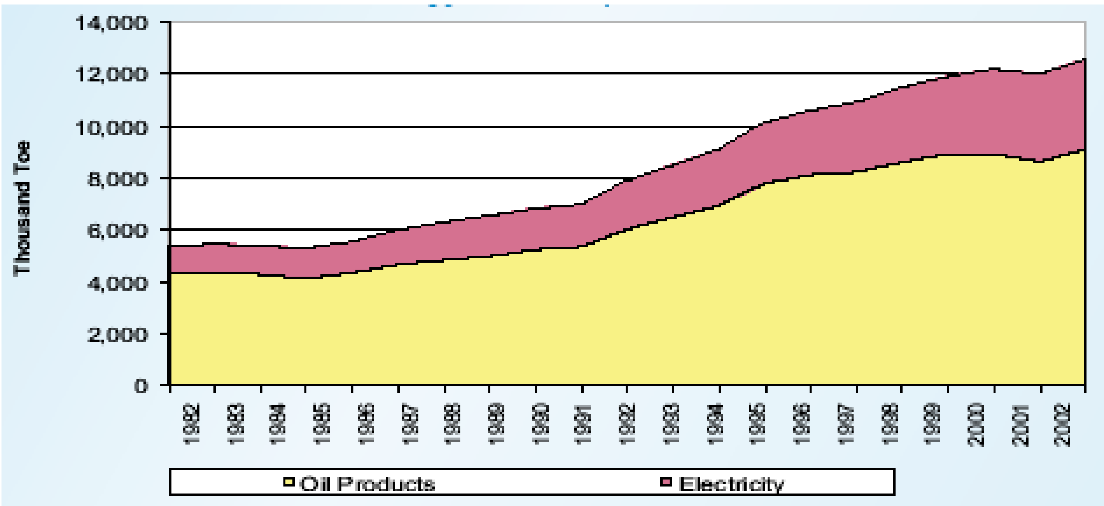
The two main end uses of energy supply are electricity and road transportation. Both are rapidly increasing and affect the trend in energy imports.

Electricity accounted for 17% of energy consumption in 1980, 24% in 1998 and now represents 27% of end use energy demand in 2002. As a result, the share of coal in energy import, which remains the main energy source for electricity generation (80% of the electricity generated in Israel), has rapidly grown since the 1990s. It reached 35% of the 22,5 million TOE[126] imported in 2002 (respectively 28% of 18 million in 1998).

Road transportation accounts for one third of the end-user energy consumption. The rise of the use of transportation as measured by the average number of kilometres travelled per annum – which has tripled since the mid-1980s – explains the increase in oil products (especially diesel fuel) consumption. Beside diesel for transportation, the rapid increase of naphtha consumption by industry is also noticeable.

Exhibit 3-2 Total final energy consumption, 2002

[126] TOE: Tons of Oil Equivalent



Source: Israel National Infrastructure, 2003

Regarding electricity, the challenge Israel has to overcome is not only the growing electricity demand per year but also the increase of peak demand (3480MW in 1991, 8750MW in 2002) which drives the capacity requirement for the country[127]. As we were told, this is a major concern for Israel because of the use of air conditioning appliances. It creates a major appeal for innovation in that domain. However, as the technology that would enable storage of large capacity of electricity are still lacking, the solutions are for the moment sought among voluntary and mandatory energy conservation programs (lower price against individual agreement to limit the household energy consumption during peak demand days).

Since 1997 the Government has made strong commitment toward natural gas in order to diversify its energy sources, especially for electricity generation. The discovery of offshore natural gas resources in the recent years has supported this strategy. The objective is to have natural gas reaching a share of 25% of total energy supply by 2025.

3.1.1.3 Renewable energy sources

Renewable energy, which includes hydro, wind and solar power, accounts for a minor share of energy supply, around 3% as of 2002 (2,7% in 1997 and 1998, 2,9% in 2001[128]). These 3% were almost entirely due to the solar water heaters that are placed on the roof of 80% of Israeli families. This portion represents 21% of the electricity used by the domestic sector and 5.2 % of national electricity consumption. Let us remind that solar water heating equipments are mandated by law as an element of the building codes.

[127] Summer morning peak demand.

[128] 1997 and 1998 data originates from the MNI 2000 report (MNI, 2000). Data for 2001 originates from IEA web site.

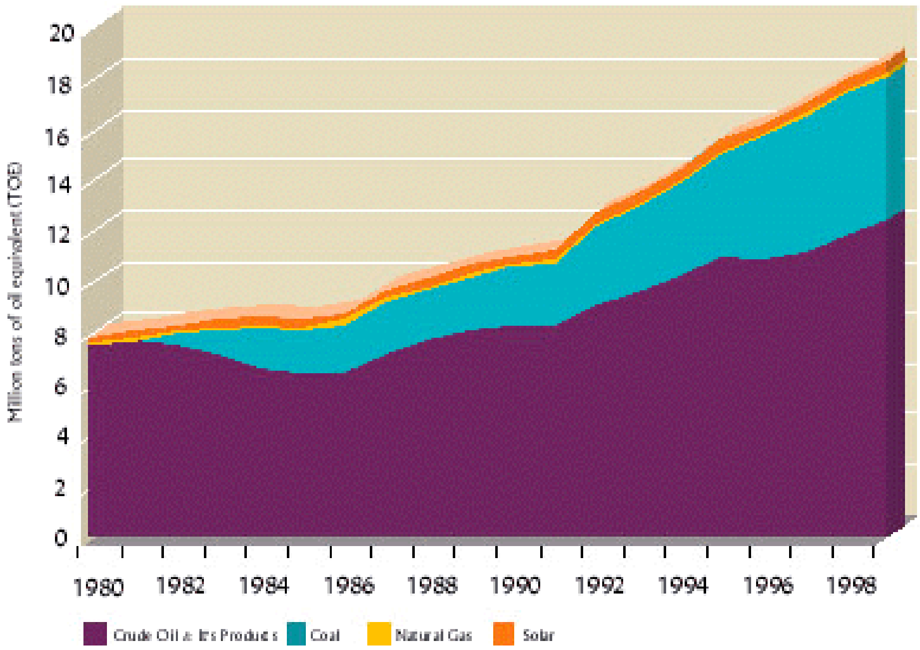
Exhibit 3-3 : Total Primary Energy Supply, 1997-1998

	1997		1998	
	TOE	**%**	**TOE**	**%**
Crude oil and petroleum products	11177	65.6	11875	65.9
Coal	5466	32.1	5748	31.9
Solar and other alternative energy sources	466	2.7	487	2.7
Natural gas	17	0.1	11	0.1
Export of electricity	-95	-0.6	-104	-0.6
Total primary energy source	17031	100	18016	100

Source : http://www.mni.gov.il

Although Israel has declared very early in its history that solar energy was of prime importance in order to diversify its energy sources and exploit indigenous energy sources, the share of solar energy in primary energy sources has remained low since the 1980s, contrary to the share of oil and coal.

Exhibit 3-4 : Evolution of primary energy supply, 1980-1998



Source : http://www.mni.gov.il

The recent Electricity Generation Master Development Plan provides guideline for an increase of the renewable energy installed capacity (100 MW of solar energy and 50 MW of wind energy with an option for an addition of 100 MW at the end of the decade). Moreover, targets have been set by the government for electricity production from renewable sources of 2% of total electricity consumption by 2007 and at least 5% by 2016. Despite this challenging goal, efforts to support effective take off of renewables remains very weak.

3.1.2 Market concentration

The energy sector remains largely nationalized and state-regulated.
The government-owned Israeli Electric Corporation operates the electricity sector as a monopoly (IEC supplied 99% of the nation electricity consumption).

3.2 The national RTDI system

3.2.1 Public private spending on RTD

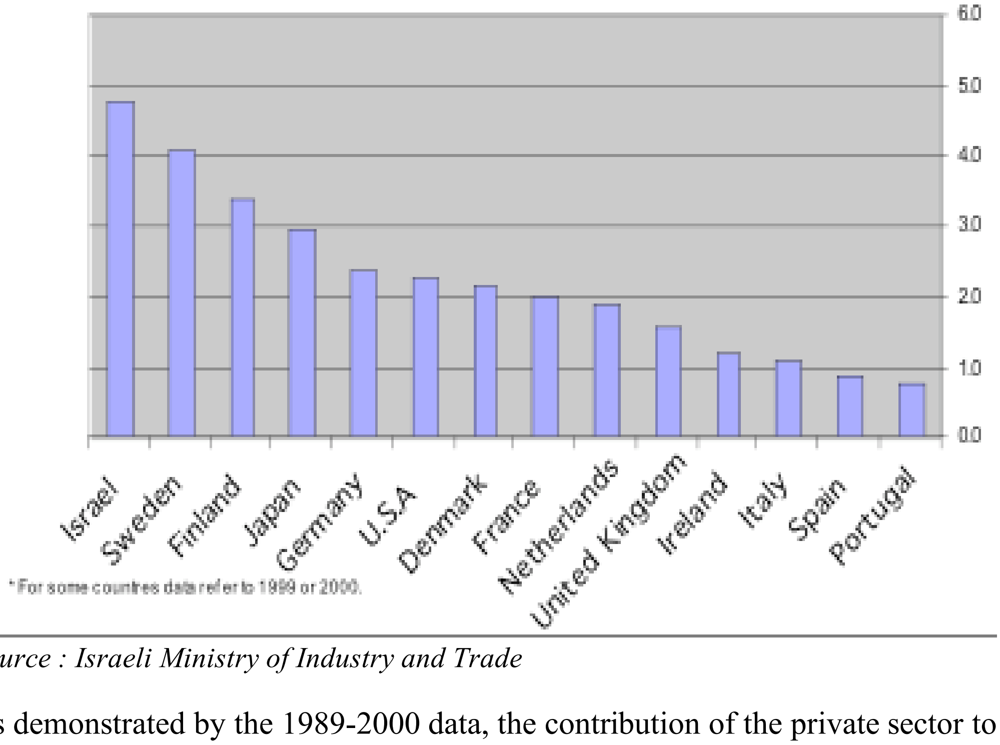
National expenditures on civilian R&D has dramatically increased in recent years, exceeding the increase in the GDP during the nineties. It reached 4.2% of the GDP in 2000, as opposed to 3.6% in 1999. According to the last edition of OECD R&D data, Israeli civilian R&D expenditures as a percentage of GDP reached 4.7% in 2001.

Exhibit 3-5 : Civilian R&D expenditures as a percentage of GDP, 1995-2001

	1995	1996	1997	1998	1999	2000	2001
R&D exp./GDP	2.6	2.7	2.8	2.9	3.2	3.6	4.2

This high level of RTD expenditures is greater than the level of most advanced nations, and far above the 3% "Barcelona objective" .

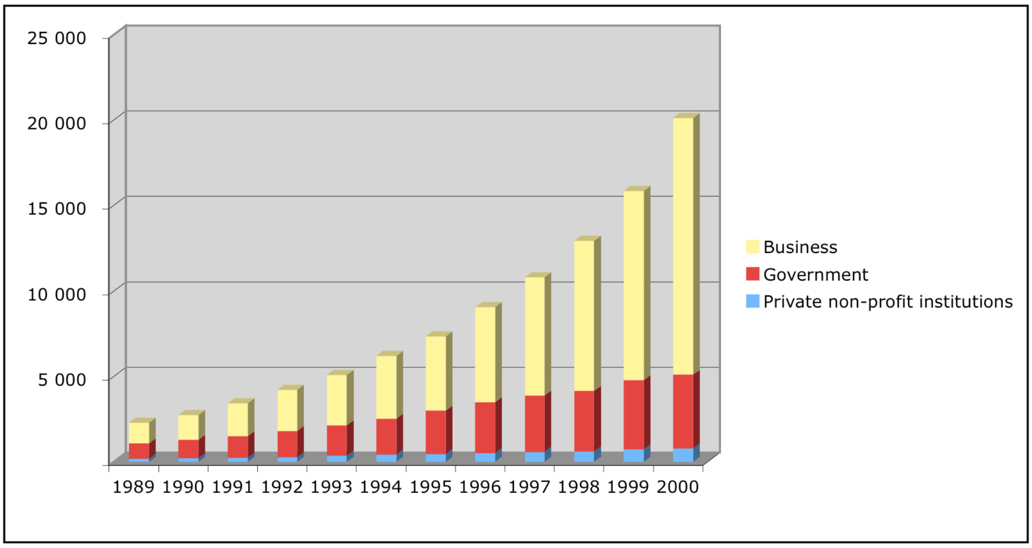
Exhibit 3-6 : Civilian R&D expenditures as a percentage of GDP in selected countries, 2001



Source : Israeli Ministry of Industry and Trade

As demonstrated by the 1989-2000 data, the contribution of the private sector to civilian R&D expenditures (74,7% not including non profit organizations) is also above the OECD average.

Exhibit 3-7 : Public and private R&D expenditures, 1989-2000 in NIS million



Source: Israeli Central Bureau of Statistics,, http://www.cbs.gov.il/
Note: government expenditures includes universities and the Weizmann Institute of science

The share of business R&D is rapidly growing, not only in comparison to government expenditures, but also comparatively to other business investments. This tends to reflect the rapid rise of the Israeli knowledge economy in the 1990s. However, although recent figures of the respective share of public and private R&D expenditures could not be obtained, it is likely that the share of business R&D has been decreasing since 2000 as a result of the regional political problems and the international crisis that hit high tech sectors, especially ICT, a sector in which Israel private sectors had been massively investing during the last decade.

Exhibit 3-8 : Private expenditures as a percentage of gross investment in capital formation

	1995	1996	1997	1998	1999	2000	2001
%	6.4	7.0	8.2	10.2	12.0	16.3	-

Source: Israeli Central Bureau of Statistics

3.2.2 Funding institutions

Since 1968, public support to science and technology activities in all concerned ministries are under the responsibility of their respective Office of the Chief Scientist (OCS). The Ministries of Agriculture, Communications, Defence, Infrastructure (formerly Ministry of Energy), Health as well as the Ministry of Industry and Trade, have their own intervention modes, objectives and domain of intervention to support science and/or technology activities. Support to all RTD activities, including industrial R&D were previously being taken care of by national R&D laboratories.

Exhibit 3-9 : Ministries RTD expenditures 1995-2000 (current prices NIS Million)

	1995	1996	1997	1998	1999	2000	2000 / 1995
Industry and Trade	890	985	1296	1313	1329	1648	+85.2%
Agriculture	219	213	253	254	280	289	+32%
Science, culture and sport	135	166	215	194	191	213	+57.8%
Energy/National Infrastructures	92	99	93	93	81	113	+22.8%
General University Funds	965	1142	1356	1495	1699	1839	+90.6%
Other ministries	139	181	146	156	194	226	+62.6%
Total	2440	2786	3359	3505	3774	4328	+77.4%

Source: Israeli Central Bureau of Statistics

Reflecting the priority to industrial R&D, the Ministry of Industry and Trade appears as the leading decision maker of the Israeli RTD policy since its creation. Its OCS budget accounts for 66% of the overall RTD expenditure of the Israel government in 2000. This budget has increased drastically from 1990 to 1999, from $110m to $428m. In 2000 alone, RTD expenditures rose by 24%. Of all ministries, the Ministry of Industry and Trade has experienced the highest growth of its RTD budget from 1995 to 2000 (rise of 85%). In 1999, RTD expenditures accounted for 48% of the ministry's overall expenditure.

Exhibit 3-10 : Share of ministries in total public RTD expenditures (not including General University Funds), 1995-2000 (in %)

	1995	1996	1997	1998	1999	2000
Ministry of Ind. and Trade	60.3	59.9	64.7	65.3	64.0	66.2
Ministry of Agriculture	14.8	13.0	12.6	12.6	13.5	11.6
Ministry of Science, culture and sport	9.2	10.1	10.7	9.7	9.2	8.6
Ministry of Energy/National Infrastructures	6.2	6.0	4.6	4.6	3.9	4.5
Other ministries	9.4	11.0	7.3	7.8	9.3	9.1
Total	100	100	100	100	100	100

Source : adapted from Israeli Central Bureau of Statistics

The Ministry of Industry and Trade RTD policy is governed by the "Law for the Encouragement of Industrial R&D" that was passed in 1985 and later revised. This law provides the Ministry with the basic principles of public support in the RTD area: the objective is to develop science-based, export-oriented industries, which will promote employment and improve the balance of payments.

The Ministry mainly intervenes through the allocation of conditional grants to companies, financing from 20 to 50% of their R&D costs[129]. These grants are subject to royalty payment from 3 to 5% of future product sale (up to the amount of the grant[130]). Over 1000 projects, representing about 500 companies, are financed using this scheme every year.

Exhibit 3-11 : Grants distributed by the Ministry of Industry and Trade in $million, 1989-1998

	Grants	Percent change from previous year
1989	125.2	4.3
1990	136	8.6
1991	178.6	30.8
1992	199	11.7
1993	231	16
1994	316	36.7
1995	346	9.4
1996	348	0.5
1997	330	−5.4
1998	254	−23

Source : Teubal, 1999

Acknowledging that the Israeli industrial research capacity was too fragmented among small companies that were not strong enough to compete internationally, the Ministry of Industry and Trade started in 1993 providing incentives for the formation of larger partnership involving several companies – even competing ones – and research laboratories for a three to five year duration. Through this new scheme, called the "Magnet" Program, up to 66% of the costs of the development of generic, pre-competitive technologies could be financed (without any refunding required). $60m per year are distributed through the Magnet program. Since then, the program has evolved and now encompasses three different sub-programs in addition to the original consortia :

- Users' Associations for the uptake of generic technologies and the creation of suitable infrastructure for these technologies.
- Magneton for the transfer of technology from the research laboratories to industrial companies. Contrary to Magnet consortia, a one to one connection between a laboratory and a company is eligible.
- NUFAR in order to assist researchers to bring their research closer from industry in the biotechnology area. The grants can represent 90% of the expenses without any royalty payment.

Through the Ministry of Industry and Trade OCS, Israel has allocated growing funds to the support of entrepreneurship during the 1990s. Beyond the worldwide high-tech bubble during this period, this comprehensive support to entrepreneurship also

[129] Larger percentage grants (up to 75%) are available for projects located in designated development areas.

[130] In 1999, the royalties repaid to the OCS totalled more than 139 million dollars. This indicates a very high success rate when compared to the $300m budget.

specifically aimed at exploiting the technological opportunities originating from the mass immigration of scientists and skilled workers from the former Soviet Union since the beginning of the 1990s. The share of persons employed in high tech sectors has dramatically increased as a result of both this inflow of scientifically trained immigrants and the intervention of public authorities. In 1997, this share was 6.7%, to be compared with 3.5% in the US and 3.1% in Japan and France.

It has set up special programs that are often taken as benchmarks internationally. This is especially the case of its Technological Incubators Programme that distributes about $30m a year to new companies. This programme is currently being privatized. The Ministry of Industry and Trade also operates since recently a seed fund. There is also a grant scheme designed to encourage and support individual entrepreneurs in their initial efforts to set up a business based on a new technology. Finally, the government owns a venture capital company, Yozma, to which it contributes up to 49% of the equity in selected projects.

The RTD budget of the Ministry of National infrastructures (formerly Ministry of Energy) grew 22,8% during the same period, which is the lowest growth rate of all Israeli ministries OCS budgets. In absolute terms, with NIS 213m in 2000, the Ministry of National infrastructures ranks last of all ministries' RTD budget. More recently, although we do not have data for the last period, interviewees confirmed that the Ministry experienced important cuts in its RTD budget. The number of projects supported by the Ministry was 60 in 2000, down to 40 in 2003. In 2004, we were told that no new call for proposal has been launched.

The funds are allocated by the Ministry of National Infrastructures through two main types of call for applications: one for small individual projects and one for larger multi-year programs involving several academic organizations.

4 Brief description of NNE RTD organisation

4.1 Main actors

NNE RTD is under the responsibility of the Ministry of National Infrastructures. The policy of the Ministry is set by its OCS and implemented by its Division of Research and Development. Its main activities consist in supporting financially energy technologies that use indigenous energy resources. As previously claimed, the latter are scarce, the main one being solar energy. In the 1990s, between 30 to 50% of the total budget of the Ministry of National Infrastructures (at that time the Ministry of Energy) were allocated to renewables ($2.96m in 1995), of which the bulk was directed toward solar energy.

Beside the research supported by the Ministry of National Infrastructures, there is no program dedicated to NNE RTD. However, incidentally, the Ministry of Industry and Trade is also intervening in this area through its support schemes to industrial R&D. As far as the OCS grant system is concerned, the resources allocated to NNE RTD are limited. The bulk of these funds are allocated to IT related sectors in which private sectors profit-led initiatives are much more important.

Regarding pre-competitive R&D, only a small amount of the resources allocated through the MAGNET programs are supporting consortia in the NNE RTD area. In 1999, 18 Magnet consortia were supported by the Ministry, of which only one was related to NNE RTD ("ConSolar").

Exhibit 4-1 : Active Magnet Consortia as of December 1999

1. Ground Stations for Satellite Communications
2. Digital Wireless Communications
3. Broad-Wide Band Communication (BISDN)
4. Multimedia On-Line Services
5. Diode Pumped Lasers
6. Multi Chip Module (MCM)
7. Magnesium Technologies
8. Hybrid Seeds and Blossom Control
9. Algae Cultivation Biotechnology
10. DNA Markers
11. Drug and Kits Design and Development ("Daa't")
12. MMIC/GaAs components
13. 0.25 micron/300 mm devices
14. Ultra Concentrated Solar Energy ("Consolar")
15. Network Management Systems
16. Digital Printing
17. Image Guided Therapy ("Izmel")
18. Computerized Industrial Processes

Source : Tratjenberg, 1998

5 The NNE RTD Priority setting process

5.1 Description of the Priority setting process

The rapid increase in the scientific and technology potential of the country during the 1990s was supported by an RTD policy that was both strong and highly specific. The specificity relates to the priority setting process, based on the "principle of neutrality" according to which the priority is to avoid setting any priority…
As it was claimed by Manuel Trajtenberg from NBER, "*the paramount principle of "neutrality" that has been a cornerstone of R&D Policy in Israel since the late 1960s precludes also picking projects according to fields or any other such consideration*". Another renowned economist, Morris Teubal, ranks first in his list of weakness of the Israeli RTD system "*the absence of government 'strategic decision making' and, more specifically, of an explicit process designed to identify the technology policy needs of the country*" (1998). Our interviews confirmed that these overall RTD system level statements are also valid for the NNE RTD area.

Precisely, following the submission of a grant application, companies proposals to the Ministry of Industry and Trade are reviewed by a Research Committee that leads the selection process. This committee is composed of nine members: the Chief scientist and three members from the Ministry of Industry and Trade, two from the Ministry of Finance and three public representatives. The committee relies upon outside professional referees and advisers to review the applications. their quality according to criteria relating to both technological and economic potentials

However, with the recent budget downsizing imposed by the Ministry of Finance, the question of the effectiveness of such a mode of intervention arose. As it is not anymore possible to finance all the projects that satisfy the selection criteria, it was proposed to set priorities and select the best projects within these areas. However, no deviations from the technological neutrality principle has been reported during our interviews or in the literature. According to M. Teubal, budget cuts has not led to 'sector/technology selectivity' but rather to differences in incentives between large and small firms and a tighter selection.

Although neutrality in incentives still prevails, it is to be noticed that biotechnology and IT sectors have been awarded specific support schemes. For instance, in 2000, the Israeli government launched a program to place biotechnology on the national agenda and a national strategy for the biotechnology sector was elaborated. Nanotechnologies also benefited from the so-called Israel National Nanotechnology Initiative. It has been proposed that a portion of the large funds that originates from the Jewish community, mainly in North America, could be directed toward RTD in prioritized activities such as the creation of a nanotechnology research centre[131]. IT-related RTD is also offered a special treatment given the Israeli capabilities in this sector. According to figures originating from the Israel Association of Electronics & Information Industries, the share of IT and electronics industry in the OCS budget has grown from 19.4 to 56.1% from 1995 to 2000. However, this might be more the *ex post* result of the growth of this sector than the reflect of a national strategy.

Although the principle of neutrality governs the allocation of resources to RTD, NNE RTD might benefit from a better position than other sectors given the existence of a Ministry of National Infrastructures whose in charge of NNE RTD. However as mentioned earlier, the Ministry can only direct few resources toward NNE RTD. As regard the structuring of the priority setting process, the Ministry consults since the end of 1990s an advising committee mainly composed of university researchers for strategic decisions such as the priority given through the Ministry's call for applications.

The Interdisciplinary Center for Technological Analysis and Forecasting (ICTAF) at Tel-Aviv University is providing information and analyses into the NNE RTD priority setting process. An example of such contribution to decision making in NNE RTD is the Delphi study foresight study for energy technologies that was recently conducted by ICTAF. A senior researcher at ICTAF, who is also the former Chief Scientist of the Ministry of National Infrastructures, participated in this foresight initiative.

[131] As of today the bulk of these donations goes towards social welfare for the Jewish community in Israel or in the US.

Exhibit 5-1 : Results of the Israeli Delphi foresight study for energy technologies

Topics that are rated most highly by degree of importance (value)	- Low cost, efficient photovoltaics - Widespread use of renewables - Water decomposition with sunlight (presumably for hydrogen production) - Aqueous biomass production and biotreatment of wastes - Carbon dioxide fixation from fossil fuel combustion - Electric vehicles, including both fuel cells and much improved batteries - High temperature superconductive materials - Improved building energy efficiency - More efficient vehicles using internal combustion engines
Topics that are rated most highly by degree of business advantages	- Renewable energy systems (presumably reflecting Israeli companies active in solar thermal, geothermal, and waste heat recovery) - Efficient photovoltaics - Water decomposition with sunlight - Biomass via aquaculture - Technology for reduced truck emissions - Efficient batteries

Source : Spiewak I, Einav A., Sharan Y., 2004.

5.2 Current NNE RTD priorities relevant for ERA in NNE RTD

5.2.1 The Energy Master Plan recommendations

The Ministry of National Infrastructures has commissioned independent energy experts to provide recommendations for an Israeli energy strategy, namely the Energy Master Plan. This plan has just been released.

The main recommendations are:

- The promotion of energy efficiency and conservation
- Greater focus upon renewable energy, especially solar energy
- The promotion of natural gas penetration
- Reforms of the energy sector (privatization of energy companies)

5.2.2 Overall priorities of Israeli public authorities

The low priority given to energy RTD as a whole is obvious from the figures of the allocation of public financing by objectives.

Exhibit 5-2 : Israel public financing by Objectives, 1999 (in %)

	1993	1994	1995	1996	1997	1998	1999	2000
Development of agriculture, forestry and fishing	10.4	9.3	9.8	8.4	8.2	8.0	8.1	7.3
Promotion of industrial development technology	36.7	36.4	36.5	35.4	38.6	37.5	35.2	38.1
Production and use of energy	1.5	1.4	2.1	2.3	1.6	1.3	0.9	1.4
Development of infrastructure	2.0	1.9	0.9	1.0	0.5	0.6	0.6	0.5
Control and care of the environment	0.0	0.0	0.2	0.4	0.1	0.1	0.1	0.2
Health	0.5	0.5	0.4	0.5	0.4	0.5	0.4	0.5
Social development and services	4.7	5.0	4.2	4.6	3.3	3.4	4.2	4.1
Exploration and exploitation of the earth and atmosphere	1.1	1.3	0.8	0.5	0.4	0.5	0.4	0.5
General advancement of knowledge	43.0	44.2	45.0	46.8	46.7	48.0	50.0	47.3
Civil space	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.1
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source : adapted from Israeli Central Bureau of Statistics

Compared to other countries, it appears clearly that energy is not a priority in Israel (0,9% of public financing as compared to 5,1 in France and 19,2 in Japan). Is also far below the OECD average (5,2%).

Exhibit 5-3 : Israel and selected OECD countries public financing by objectives, 1999 (in %)

	Adv of knowl.	Social dev and services	Health	Environ	Infras-tructure	Energy	Indus dev	Agric	Other	Total
Israel	**50.0**	**4.2**	**0.4**	**0.1**	**0.6**	**0.9**	**35.2**	**8.1**	**0.5**	**100**
OECD average	45.8	3.8	6.2	2.7	2.3	5.2	10.5	6.9	16.6	100
Germany	54.8	2.5	3.2	3.5	1.7	3.6	12.2	2.7	15.8	100
United Kingdom	29.7	2.2	14.5	2.3	1.7	0.6	0.9	4.3	43.8	100
France	37.5	1.2	5.5	2.2	0.6	5.1	5.7	3.8	38.4	100
Japan	49.5	0.9	3.7	0.7	3.1	19.2	7.1	3.5	12.3	100
United States	6.2	1.0	19.8	0.9	2.6	1.9	0.6	2.4	64.6	100
Canada	10.3	4.5	11.7	4.0	5.2	7.0	16.3	14.4	26.6	100

Source : OECD figures for all countries except Israel, Israeli Central Bureau of Statistics
Note: Defense RTD was not provided for Israel. For all other countries, we included defense RTD expenditures in the category "Other".

5.2.3 The NNE RTD priorities of the Ministry of National Infrastructures

Since the Ministry of Energy became the Ministry of National Infrastructures, its priorities go beyond NNE RTD and also include topics related to water, earth science and mining for instance. It is important to keep in mind that only 10% of the Ministry of National Infrastructures' RTD budget is traditionally dedicated to energy RTD. The bulk of the Ministry's RTD budget goes to geological research. Energy RTD at the Ministry of National Infrastructures accounted for NIS8.5m in 2003 and was reduced by half in 2004 to NIS4.33m. As a result, the share of NNE RTD in the total budget of the Ministry went down to 6,5% (cf. Exhibit 5-4).

Exhibit 5-4 : Allocation of the RTD budget of the Ministry of National Infrastructures, 2002-2004

	2002		2003		2004	
	in million NIS	%	in million NIS	%	in million NIS	%
NNE RTD	7.76	10.62	8.65	10.87	4.33	6.51
Other RTD*	65.30	89.38	70.90	89.13	62.20	93.49
Total	73.06	100	79.55	100	66.53	100

* *Geology, geophysics, sea and lakes*

As of 2003, the overall official priorities of the Ministry were the following (Ministry of National Infrastructures, 2003):

- R&D of technologies for the exploitation of indigenous alternative energy resources and for a more efficient utilization of conventional ones;
- R&D in the areas of water production and consumption;
- Maintaining a knowledge base in areas of activity in which the Ministry is involved, that will enable the absorption and utilization of modern technologies (either imported or locally developed).

Regarding NNE RTD topics, the activities supported by the Ministry are increasingly focused on solar energy as a result of its comparative advantage in this domain but also because of choices caused by severe cuts in its OCS budget. The solar/thermal technologies upon which the popular solar water heating equipments are based were developed during the 1950s. There are only few opportunities for improvements of these distributed technologies.

Strong emphasis is put on concentrated solar thermal and, to a lesser extent, to photovoltaics. The Ben Gurion Solar Energy Research Center (Ben Gurion University of the Neguev) has carried-out an 8-year solar radiation survey of the Neguev desert (including development of sun-tracking measuring instruments) and is also working on reducing cost of cells for concentrated photovoltaic power system. It is also used as a demonstration facility for various solar-thermal and photovoltaic technologies.

The activities of the Weizmann Institute of Science on highly-concentrated solar energy technologies have been supported by the Ministry of National Infrastructures for over a decade. Especially, the large projects of the solar tower complex has now reached a commercial phase and is therefore now supported by the Ministry of Industry and Trade (ConSolar consortium, see *infra*) in order to associate companies in the project. WIS research projects also include development of advanced technologies for high-temperature heat and electricity generation, gasification of biomass, storage and transport of energy and development of a solar-powered laser.

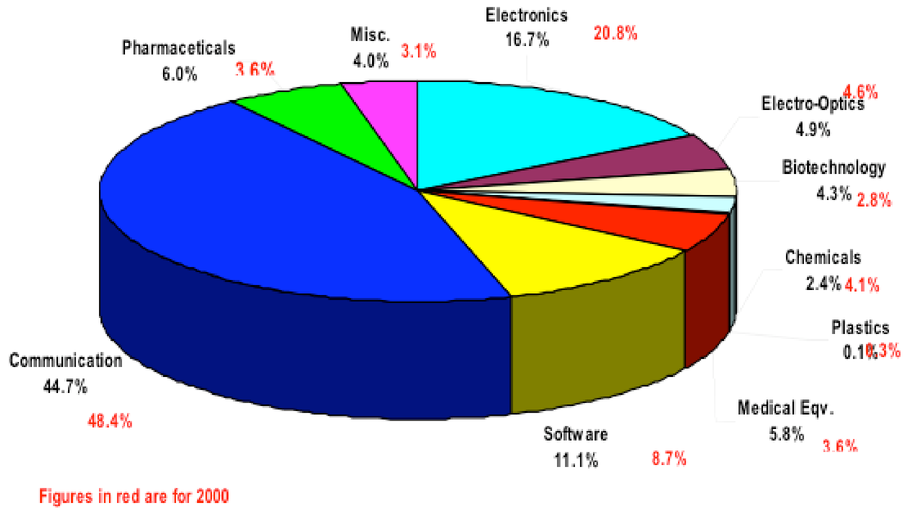
Oil Shales, the only fossil fuel energy resource of Israel with natural gas, have attracted in the past about half of the Ministry's OCS budget, through the financing of PAMA a company established by the government and large Israeli companies (IEC, Israel Chemicals and Oil Refineries). However, the Ministry has put an end to its support to these activities after the construction of a pilot plant because of the high fuel extraction costs.

Finally, the Ministry is also allocating some resources to the development of efficient technologies for buildings.

5.2.4 The NNE RTD priorities of the Ministry of Industry and Trade

As we said before, the Ministry of Industry and Trade does not prioritize areas as most of its financial contribution to RTD projects is allocated according to a strictly bottom-up grants system. Projects are judged one by one without any attempt to rank or establish priorities among the proposals. As a result, the distribution of funds among the various areas reflects the *ex post* structure of the industrial structure, not the *ex ante* priorities of public authorities.

Exhibit 5-5 : OCS grants by sector in 2000 and 2001



Source:: Israeli Ministry of Industry and Trade

Although MAGNET programs financing are also distributed based on initial proposals from science-industry partnerships, it is the closest Israeli technology policy can get from strategic support. "ConSolar Ltd." (Concentrated Sunlight Consortium) is one of the very few consortia related to NNE RTD. This consortium that gathered together four industry companies and three research companies. It aimed at developing and commercializing applicable concentrated solar energy technologies. It was established in July 1995 and ended its activities, at least within the Magnet Program, at the end of 2000. Four different projects originating from former Ministry of National Infrastructures-sponsored activities at the Weizmann Institute of Science were hosted and financed through this umbrella.

Exhibit 5-6 : Description of the projects within the ConSolar Ltd consortium

Project content	Partners
Beam- Down Reflective Tower concept, intended for utilizing multi-megawatt Central Solar Power Plants	ORMAT Industries, ROTEM Industries, WIS (+BOEING)
Small (<100 kWe), solar facilities intended primarily for off-grid applications, based on concentrator photovoltaic facilities	MLM Division of the Israel Aircraft Industry and Tel-Aviv University
Solar thermal energy driven facilities, involving "small" Solar Tower and Dish Concentrator options and a Solar Energy driven Gas Turbine Generator. Technology intended for off-grid applications using fuel for hybrid operations	EDIG Industry, ROTEM and WIS
Solar-pumped laser technological development for communication, energy transmission and for industrial photochemical applications	ROTEM Industries and Ben-Gurion University

Source: adapted from http://magnet.consortia.org.il
Note : WIS: Weizmann Institute of Science

During our interviews with NNE RDT public decision makers it was clearly claimed that, beyond the principle of neutrality, NNE RTD ranked poorly in the agenda of politicians in Israel. Despite the regional position of the country and the strategic importance of NNE technologies, strong initiatives and momentum are still lacking at the top level of political decision making. For most Israeli politicians, NNE RTD is considered as a luxury that the country cannot afford since NNE technologies are still loosely related to short to mid term tangible results in terms of competitiveness and growth. Long term environment and strategic issues are only loosely included in the political process, providing poor incentives for a focus on NNE RTD in the Ministries that have strong influence resource allocation, the Ministry of Finance and that of Industry and Trade.

The fact that a “Commissioner for the Coming Generation” was nominated at the Knesset might be a sign that long term issues, including environment and energy related issues, will be more weighted in the political process in the future. This person was said to put strong emphasis on NNE technologies, especially solar energy, which might benefit from favourable regulations and subsidies in the future.

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Country study Italy

Contents:

1 Summary of country study indicating main points for synergy

Italy is well-embedded in European research. It is however concentrating its European research and technical development (RTD) collaborations, especially as concerns NNE, with Spain, France and Greece, and, for some projects, Germany. The main difficulty is the lack of national funding allowing ENEA, the Italian main actor in public non nuclear energy (NNE) RTD, and other research organisations, to participate to EU projects, and allowing researchers to move to other European and European countries' research centres.

According to IEA, the International Energy Agency, the Italian government invested 190M€ in NNE RTD in 2002. It has to be noted that even if the nuclear programme was stopped in 1987, nuclear energy RTD still represents more than one third of the total energy RTD budget of the government.

Regarding NNE RTD, Italy is focusing on long-term research (especially in hydrogen and thermodynamic solar energy) and high-resources research projects. Interviewees expressed the view that future European projects and programmes shall better balance between mid-long term projects and short term RTD. Renewables in particular has been benefiting of substantial added funding since 2001. However the priority setting process remains at the "collegial discussion" level, and there no such thing as a fixed budgetary planning, which would ensure a continuity in RTD activities.

2 Main points for collaboration, synergy, complementarity with regard to the NNE RTD ERA

2.1 Necessary conditions for making ERA happen

Even if well-embedded in European RTD collaborations,[132] Italian participation is hampered by the relative weakness of and uncertainties in national funding. Research organisations can not rely on fixed annual or pluri-annual budgetary planning (see in particular section 6); moreover the Italian State general amount of funding for energy RTD has been decreasing in the past decades (see chapter 4).
A similar financial problem occurs in mobility issues. Mobility of researchers seems to be an Italian preoccupation, and researchers should be able to work where relevant RTD activities are carried out independent of the country. ENEA researchers are participating to EU research centres, for example the Joint Research Centre (part of which happens to be located in Italy), but they are less and less able to do so for financial reasons. Mobility of Italian researchers in other European Member States' institutes is also very weak for that reason.

Apart from this – quite crucial – financial issue, Italian researchers do not seem to encounter specific structural barriers to collaborate at the European level. Two issues

[132] According to the frequent quotation of Italy by foreign interview partners. See also the CORDIS web site for more precise information on Italian participation in European projects.

related to information were nevertheless highlighted on communication and on dissemination of data and project results by interviewees:

- It was felt that dissemination of research results deserves more attention; for example there could be an obligation to exchange RTD data or to make them available more widely
- Concerning information on results, communication actions should be organised, for example special events around some key results. Italy, at a national level, would lack activities concerning communication and co-ordination of research results; this could be organised, as it was suggested, through a national conference at the end of each Framework Programme.

There was also a concern for a more balanced European intervention between mid or long-term oriented research vs short-term RTD. According to the representative of ENEA we spoke to long-term issues would have been neglected by European projects in the last 10 years, and our interviewees assessed that research should be more oriented towards mid-term and long-term projects, that should mainly involve public research actors. At the same time, according to them, the transfer of results to society, to market, should be better improved, as European projects are presently not concerning technologies close to the commercial stage. This means also to boost the industry participation in short-term projects.

2.2 Existing opportunities for ERA

For **geographical reasons**, Italy is mostly working with Mediterranean countries: France, Spain and Greece, but also with North-African and Middle-East countries. The latter collaborations were especially developed because of EU funding opportunities (programmes focusing on Mediterranean area). Now that EU programmes are more oriented towards Central and Eastern Europe Countries, Italian collaborations are, in a way, following the funds.[133]

Other collaborations are due to the recognised **thematic competencies** of partner countries (for example Germany in photovoltaic, or Denmark in wind energy). This reason is also strongly linked to the identification of themes internationally perceived as important, like for example fuel cells, whose related European projects are involving many Italian teams.

From an **extra-European** point of view, Italy contributes to many partnerships in 20 IEA Implementing Agreements.

In the area of energy, Italy also has 3 bilateral agreements with the US relating, respectively, to

- Climate change technologies (Ministry of Environment)
- Clean energy technologies (Ministry of Industry)
- Carbon sequestration since June 2003 (Ministry of Industry): Italy takes part in the Carbon Sequestration Leadership Forum, an American initiative involving 13 countries and the European Union

[133] For ENEA, the National Agency for New Technology, Energy and Environment, this concerns however more expertise and support activities than RTD.

ENEA also collaborates with China to promote the national energy industry since the 1980's, but this seems to depend much on personal contacts.

2.3 Concrete possible policy actions

2.3.1 Relations with other energy-related themes

The interviewees were especially concerned with two related themes: environment (and climate change) and socio-economic research, and a third one.

Energy must be related to climate change RTD, according to ENEA: energy and environment matters are quite the same, because energy RTD shall reduce environmental impacts. There is a link with transport for the same reason. That is why a clear action of the European Commission towards Kyoto Protocol requirements, i.e. to focus on RTD activities reducing CO2 emissions, is needed.

The necessity of linking energy RTD to social cost and welfare research was also emphasised by different interviewees and hence the issue of externalities. In order to reduce the social cost of energy production, RTD shall aim at identifying and quantifying instruments to take these costs into account for the evaluation of the cost per KWh. In this regard, Italy is already involved at the European level in projects such as ExternE and NEEDS (New Energy Externalities Development for Sustainability).

A third issue that came to the fore was how new technologies can contribute to energy savings. Technologies that are not traditional energy technologies per se, such as biotechnologies, nanotechnologies and new materials, should be investigated in this regard.

2.3.2 Involving companies

It was also suggested that the Commission could take a more active role in encouraging risk-capital and venture-capital in order to involve companies in projects. Other suggestions would be tax credits in order to involve industry in short-term RTD projects. The latter of course would be a national not a European issue.

3 Short background information

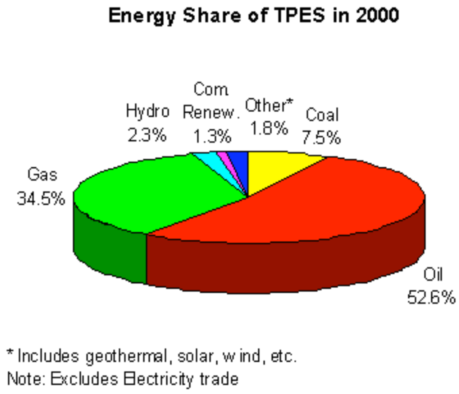
Italy is a founding Member State of the European Union.
The Italian population counted 57.3 million in 2001. Italy's geographical surface is 301 300 km2. Italy's gross domestic product (GDP) grew by an estimated 0,4% between 2001 and 2002.

3.1 The overall energy situation of Italy

3.1.1 Distribution of energy sources

Almost all of Italy's energy supply is derived from fossil fuels. Oil still represents the largest share, but is gradually decreasing. The share of gas has been increasing since 1990 (it represented then 25,6% of TPES). Combustible renewables and wastes, including geothermal, solar and wind are increasing (3,2% in 2000 against 2,5% in 1990[134]) though remaining small, and hydraulics share remains stable since 1990.

Exhibit 3-1 Energy share of total primary energy supply in 2000



Source : www.iea.org

3.1.2 Imports/exports

Italy is a minor producer of oil and gas. The Ministry of Productive Activities states[135] that the Italian energy system is strongly dependent on oil and gas imports (about 84%) and imports about 99% of its coal requirements ; this dependence is of 82% in the power generation sector. This represents a significant concern in terms of security of primary energy supply.

The diversification of energy sources is an important policy priority in Italy owing to this high dependence on oil and gas imports. It has to be noted however that Italy ruled out the nuclear option in a 1987 moratorium that is still valid today.
The government expects to achieve diversification through the promotion of renewable energy and an increased role of coal in power generation (use of clean coal technologies).

3.1.3 Market concentration

Large state-owned companies, including ENI (the oil and natural gas company) and ENEL (the Italian electricity company), have started to be privatised. The energy market has been opened in respect of EU directives. However, in practice, the gas market is still dominated by ENI and barriers exist for new entrants. The electricity market should be fully liberalised in 2007.

[134] IEA, Italy 2003 review.
[135] Ministry of Productive Activities, Report on national fossil fuels RD&D programmes, June 2003.

3.2 The national RTDI system

3.2.1 Public/private spending on RTD

In 2000, public and private gross expenditure were of €15 billion for overall R&D, representing 1,1% of Italian GDP. The government funded almost half of the total R&D expenditure.[136]

Exhibit 3-2 R&D expenditure per execution sector, in M€

	1980	1990	1995	1996	1997	1998	1999	2000
Public administration	613	3 660	4 627	4 901	5 606	6 156	6 291	6 544
Firms	883	5 120	5 762	6 217	6 389	6 657	6 746	7 380
Total	1 496	8 780	10 389	11 117	11 995	12 813	13 037	13 924

ISTAT

Exhibit 3-3 R&D expenditure in 2000 per funding origin

	Public administration	Firms	Foreign country	Total
%	50,8	43,0	6,2	100

OECD

3.2.2 Main public research

The private sector is executing near the half of the Italian RTD. Public research is mainly performed by universities.

Exhibit 3-4 R&D expenditure in 2000 per executive sector

	State	University	Firms	Total
%	19,2	31,5	49,5	100

OECD

Universities and public research organisations are funded by ministries and budgets are decided annually, by law. Some public research organisations have external resources, mainly the National Centre for Research, CNR, and ENEA, the National Agency for New Technology, Energy and Environment.

3.2.3 Funding institutions

The Ministries are directly funding research. The allocation of financing to research by the government and the parliament is following the strategic priorities defined in the annual DPEF (Economic and Financial Programmatic Document). General objectives and realisation modalities of financial interventions are established in that document, mainly by the Ministry in charge of research with the approval of the InterMinisterial Committee for Economic Planning (CIPE).

On the DPEF basis is the triennial PNR (National Research Programme) made up by the Ministry in charge of Research, with the approval of CIPE. It is the main tool for

[136] IEA Italy 2003 review.

identifying trends, strategic priorities and financial resources for scientific and technological research. The 2003-2006 PNR define 8 RTD macro areas to focus on

- Production system
- Information and communication
- Energy
- Environment
- Transports
- Agro-food
- Health
- Cultural goods

Also, PNR's guidelines identify 4 strategic lines

- Advancing of the knowledge frontier
- Supporting research for the development of key multisectorial enabling technologies
- Strengthening of industrial research and technological development activities
- Promoting SME's capacity in innovating products and processes

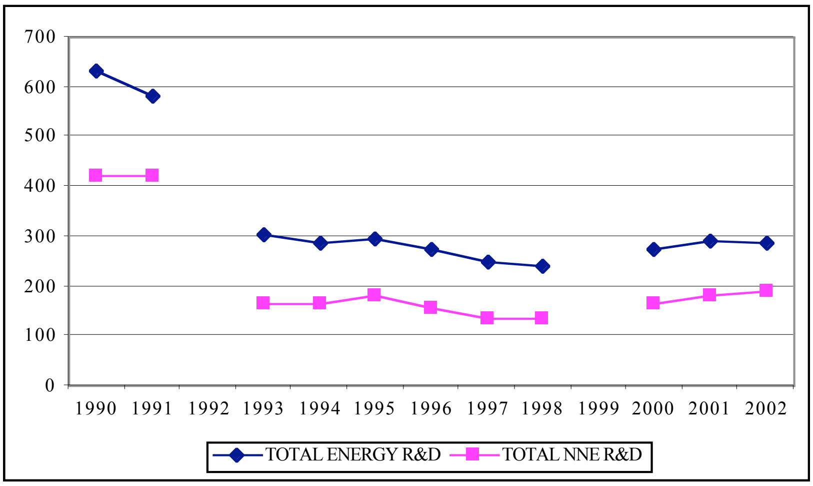
4 Brief description of NNE RTD organisation

According to the IEA Italian 2003 review, "energy R&D accounts for only a few percentage points of public R&D spending, and less than 5% of total R&D spending. Public funding for energy R&D was about 263M€ in 2000 and 283M€ in 2001. Public energy R&D investment has dropped significantly since the late 1980's from a peak at 1MM€ in 1985 (in 2001 €)."

NNE RTD represented 190M€ of government funding in 2002.

Exhibit 4-1 Total Government energy RTD and NNE RTD budgets, in M€, in 2002 prices[137]

[137] 1992 and 1999 : data not available.



Source : IEA

The main actors are the 3 funding Ministries (Research, Environment, Industry) and ENEA, the National Agency for New Technology, Energy and Environment, which is leading RTD activities in the energy field. Also, CESI, an ENEL subsidiary that is leading research on electricity systems, CNR (National Research Council), some universities, some regions and local research institutes play a role in NNE RTD.

4.1 Funding Ministries

4.1.1 Ministry of Education, University and Research (MIUR)

The MIUR prepares the annual PNR (National Research Plan), and this Plan is the basis for its funding policy. We have just seen that energy was one of the macro areas the PNR focused on; the support to 12 specific enabling technologies is the basis of the MIUR's action. Each of these technologies is matched with each macro area. Energy is thus put in relation to micro and nanotechnologies, structural and functional materials technologies, chemical technologies and electrochemistry, fluid dynamics and combustion technologies, electronics, robotics and advanced planning systems, as well as advanced informatics.

MIUR is mainly funding RTD activities through calls for proposal.[138]

4.1.2 Ministry of Productive Activities (MAP)

The General Direction of energy and mineral resources is in charge of energy policies. The Ministry funds few energy RTD; its only energy-related RTD fund is the Public Fund for Electricity System, which represents 85M€ per year, allocated through calls for proposal.

[138] Because of the focus on enabling technologies serving different thematic areas at a time, information on the total budget allocated to NNE RTD or to energy RTD was not available.

4.1.3 Ministry for Environment and Territories[139]

The Ministry is funding energy RTD related to environmental concerns.

4.2 ENEA

The National Agency for New Technology, Energy and Environment is responsible for research, development and dissemination of technology and for covering energy efficiency, renewables and environmental technologies. ENEA is a public institution supervised by the Ministry of Industry, the Ministry for the Environment and the Ministry of Education, University and Research. ENEA designs R&D programmes and implements projects. The agency works closely with both large and small enterprises to transfer and disseminate relevant technologies. It also provides scientific and technological consulting and support services to national and regional administrations for their planning and implementing of energy and environmental measures.

ENEA's 2001-2003 Three-year Plan[140] "sets out the tasks for the period 2001-2003, meeting the need to focus on well-defined targets in order to streamline all activities and optimise all available financial and human resources, as well as equipment and expertise."

The Plan envisages seven aims and 21 objectives that define ENEA's mission (Exhibit 4-2).

[139] It has not been possible to organise an interview with a representative of the Ministry, nor in face to face nor in telephone.

[140] www.enea.it

Exhibit 4-2 ENEA Three-year Plan 2001-2003: overview

Aims	Objectives
Energy for the future	• New fuels • Renewable and clean energies • Higher energy efficiency
Protection of the Planet	• Development of environmentally-friendly products and processes • Waste cycle, water treatment, CO^2 capture • Radioactive waste disposal and radiation protection
Protection of Mankind	• Health protection • Safe food, safe environment • Sustainable cities and safe transportation
Large-scale advanced techniques	• Plasma fusion and physics • Particle accelerators • High-performance modelling and computing
New technologies for competitiveness	• New materials • Innovative industrial technologies • Plants and animals, agro-biotechnologies and the food-processing industry
Global changes	• Climate and oceanographic models • The Mediterranean habitat • Technologies for analysing and responding to change
Services for the Country	• Adviser • Assistance to local public administrations and to small and medium-sized enterprises • Technology transfer to public services

According to IEA, "the objective is to facilitate the development of frontier energy technology enabling a possible future shift away from fossil fuels."

The 'agency activity' of ENEA (expertise, technical support to companies and public administrations on both central and local level) is substantial, although it has not been possible to obtain information on the budgets devoted to each Aim described in the table above.

The funding of ENEA by the Ministries is the following:

- The main funding source is the Ministry of Productive Activities (for 50%), but this is mostly concerning management costs (salaries, infrastructures…) and programme agreements on specific topics (for example renewables and energy saving) concerning however only agency's activities like expertise, technical support… The Ministry's overall funding is of circa 250 M€ according to our interlocutor at MAP
- The Ministry of Environment funds ENEA only for specific tasks, specially needed by the Ministry. The agency does not have the possibility to change these tasks

- The MIUR's funding comes from successful tenders from ENEA to the Ministry's calls

ENEA co-operates with the national industry for its RTD activities, especially with ENEL (mainly on high temperature component). New regulations authorises ENEA researchers to work in private companies, on companies' demand, for a limited period of time. Their salaries are still paid by the Agency.

4.3 Other public organisations

CNR is leading some NNE RTD, for example with one of its research institutes the Institute for advanced energy technologies "Nicola Giordano." The **Institute of Geophysics and Volcanology** has RTD activity on carbon sequestration. But most of the NNE RTD remains in ENEA.

Universities
The MIUR is mainly working with the universities through calls for proposal.

The Regions play some role in RTD, however the process of decentralisation is not yet completed. Their role in the energy policy is recognised though by the Italian Constitution (the establishment of the general principles lies with the Government, while the detailed definition of the provisions is care of the Regional Administrations). Concerning energy RTD things are not fixed yet: some regions have officially adopted the Energy-Environment Programs of the Regional Administrations (PEAR), in which the role of technological innovation is considered as fundamental.[141]

Regions can submit proposals to the ministries to get funding, with the local research institutions. Northern regions (Milan, Trieste, Trento…) are the most involved in RTD tenders.

4.4 Industrial sector

The Italian industrial sector has reduced its energy RTD investments in the past years. This evolution is mainly the consequence of the privatisation of ENEL and ENI (see chapter 3.1.3), who are the main private bodies in NNE RTD.

It is to be noted that, according to our interviewee at the Ministry of Research, the private sector is only investing, in the energy field, for circa 80% in oil and gas and for circa 20% in electricity.

ENI, the Italian Oil and Natural Gas Company
ENI conducts RTD activities mainly through EniTechnologie SpA, which is responsible for corporate R&D. In 2002, 1 390 employees were involved in RTD activities.

[141] To know more about the actual state in the definition of PEARs region by region, see ENEA, Energy and Environment Report 2002, vol.1 Analysis, p.359 (in Italian).

Exhibit 4-3 ENI's RTD expenses in M€

	2000	2001	2002
Amount	234	203	175

Source : ENI report 2002

Exhibit 4-4 ENI's major research areas in 2002

Axis	Research areas
Reduction of exploration and development costs	• Geosciences • High resolution prospecting techniques • Field simulation models • Field productivity enhancement methods • Advanced drilling system • Production in hostile environments
Performance and product differentiation	• Advanced process control • Innovative polymerisation catalysis
Feedstocks enhancement	• Long distance gaslines • Conversion of gas into liquid products • Conversion of heavy crudes into light products
Environmental protection	• Hydrogen • New formulas for fuels and lubricants • "Clean" catalytic processes • Air quality monitoring • Reclaiming of polluted soils

Source : ENI report 2002

According to the IEA Italian 2003 review, in 2001, "RTD relating to exploration and production, natural gas and refining and marketing activities as well as strategic research accounted for 52% of ENI's total R&D expenditures, while 34% was attributed to petrochemical activities. The remaining 13% was attributed to oilfield services and engineering activities."

ENEL, the Italian Electricity Company, has substantially reduced its RTD investments, letting its subsidiary CESI (see below) to conduct RTD activities on electricity. According to ENEL's 2002 annual report:

> "The objective of our research and development activity is to improve the efficiency and capacity, and innovate and expand the service offering, of our core energy businesses, as well as to educe their environmental impact. (…)
> During the past three years, we have conducted research and development activities mainly to improve the efficiency of our generation plants and our transmission and distribution networks, to minimise the environmental impact of electricity generation, and to develop innovative technologies so as to deliver new services through our network infrastructure. We conduct our research and development activities mainly through Enel Produzione, Enel.Hydro and Enel Green Power. We also conduct research and development activities through CESI SpA, which was one of our consolidated subsidiaries until 2002 (…)

Research and development programs involved about 1 000 of our employees in 2002. Our expenditures on research and development were approximately 100 M€ for 2002, 100M€ for 2001 and 124M€ for 2000."

CESI is a research company owned by ENEL. It spends more than 250 M€ for RTD on the electricity system. It is funded by a fee on electricity collected from the consumer. CESI is also the main beneficiary of the Ministry of Productive Activities' Fund for Electricity Systems.

RTD activities carried out by CESI include

- Relating to electricity :
  - electrical power conversion
  - electricity system evolution
  - interaction between the electricity system and the environment
- relating to renewables :
  - wind energy mapping
  - parabolic dish for solar concentration
  - photovoltaic cells

CESI has few international collaborations, mainly because an Intellectual Property Agreement with MAP does not allow it to share its RTD results.

5 Current NNE RTD priorities relevant for ERA in NNE RTD

Italy has chosen to focus its NNE RTD on mid-long-term activities, and especially on hydrogen and high temperature solar energy. The following figure shows indeed that renewables and power and storage technologies correspond to the larger shares of the budget NNE RTD government in 2002.

Exhibit 5-1 Government NNE RTD budget, 2002

	M€	%
Total conservation	**25,0**	**13**
Industry	10,0	5
Residential Commercial	15,0	8
Transportation	0,0	0
Other Conservation	0,0	0
Total fossil fuels	**0,0**	**0**
Total renewable energy	**52,0**	**27**
Total Solar	49,5	26
Solar Heating & Cooling	4,0	2
Solar Photo-Electric	10,0	5
Solar Thermal-Electric	35,5	19
Wind	0,5	0
Ocean	0,0	0
Biomass	2,0	1
Geothermal	0,0	0
Total Hydro	0,0	0
Large Hydro (>10 MW)	0,0	0
Small Hydro (<10 MW)	0,0	0
Total power & storage tech.	**78,2**	**41**
Electric Power Conversion	30,0	16
Electricity Transm. & Distr.	36,0	19
Energy Storage	12,2	6
Total other tech./research	**35,0**	**18**
Energy Systems Analysis	0,0	0
Other Tech. or Research	35,0	18
TOTAL NNE R&D	**190,2**	**100**

Source : IEA

Hydrogen

Italy has chosen hydrogen because of an international technology watch, using the EU "Hydrogen and fuel cells road map", but also because of a co-operation with the American Department of Energy (DoE).

Hydrogen RTD is related to solar energy RTD (see below), to nanotechnologies RTD and to activities in CO2 sequestration (research on production of hydrogen from fossil fuels).

The inter-ministerial decree of 17 December 2002 allocated 51M€ to research on hydrogen. The same decree allocated 39M€ to research on fuel cells; it has to be noted that this is more a short-time oriented research (for stationary and transport applications).

High temperature solar energy

This RTD is the main priority of ENEA, whose programme focus on 2 main potential applications:

- The generation and storage of medium temperature (550°) heat for the electric power generation

- The generation and storage of high temperature heat (superior to 850°) for the generation of hydrogen

ENEA has been given through the Finance Act 2001 a contribution of around 103 M€ over the 3 years period of the programme[142], to be provided on the basis of prescribed progress targets in research, experimentation, design and implementation of the project, and profitability of programme management.

ENEA has chosen to concentrate its RTD efforts on long-term-oriented high temperature solar energy for 3 main reasons

- The belief that short-term RTD will not change dramatically the Italian situation (high energy dependency, etc.), even in activities like energy efficiency for example
- The solar potential of Italy
- The fact that the level of funding in Italy is very low, even more in energy research, making choices necessary

6 Description of Priority setting process

There is no clear priority setting process regarding NNE RTD in Italy. In order to define policy orientations, the relevant persons (administration, research...) meet and exchange views.

The European priorities defined in Framework Programmes are included in the reflection on PNR priorities. The priorities of the PNR 2003-2006 refer to

- International major trends
- European Union identified priorities, i.e. FP6 thematic priorities

On this basis programmatic choices for Italy have been defined. The 2003-2006 PNR is explicitly updated to allow Italian research organisation to participate to FP.

Also, the ENEA Three-year Plan has been developed taking account of the following key reference points

- An analysis of ENEA's mission and tasks as defined in Italian Legislative Decree no. 36/99
- A definition of strategical R&D priorities in several fields
- The structure of competencies and actual capabilities as well as existing fields of excellence
- The role of ENEA in the research field
- Technical and scientific support to the Public Administration and enterprises
- The Guidelines set out by the 2001-2003 National Research Programme
- The Recommendations set out by the sixth EU Five-year Research Plan"[143]

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[142] IEA Italy 2003 review.
[143] www.enea.it

In practice, ENEA's overall policy is elaborated mainly by the presidency (3 Commissioners in usual times), in a consultation process with ENEA's Research Unit Directors.

Also, ENEA publishes every year an Energy and Environment Report, the analyses of which are used as a basis for much of the policy work done by the ministries. It has to be noted, in the same way, that ENEA acts as an advisory organisation for the ministries (research, environment, industry), including through the mobility of people between the ministries and the agency.

Many funds exist in Italy, managed by the different ministries (the Fund for universities to finance research projects of national interest, the Fund for investments in basic research, etc., of MIUR, or the Fund for technological innovation of MAP, for example). There are many problems concerning the co-ordination of government's funding, to avoid repetitions.

This means that there are no real policy cycles, as resources and programmes may change every year. There is quite no fixed budgetary planning, therefore it is hard for researchers and research institutions to engage themselves for more than a year.

As well, there is **no scientific ex-post evaluation** of projects; they are only evaluated by expert groups before being funded (project selection on the criterion of relevance). Milestones are regularly checked during the project's life. A "successful" project is a project leading to "good results." Recently the CIVR (Committee for research evaluation) has produced guidelines for evaluation but they are not yet applied.

Annexe A Acronyms

CESI	Research subsidiary of ENEL
CIPE	InterMinisterial Committee for Economic Planning
CNR	National Centre for Research
DPEF	Economic and Financial Programmatic Document
ENEA	National Agency for New Technology, Energy and Environment
ENEL	Italian Electricity company
ENI	Italian oil and natural gas company
ERA	European Research Area
FP	Framework programme
GDP	Gross domestic product
IEA	International Energy Agency
MAP	Ministry of Productive Activities
MIUR	Ministry of Education, University and Research
NNE	Non nuclear energy
PNR	National Research Programme
RTD	Research and technical development
SME	Small and medium enterprise
TPES	Total primary energy supply

Annexe B Bibliography

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