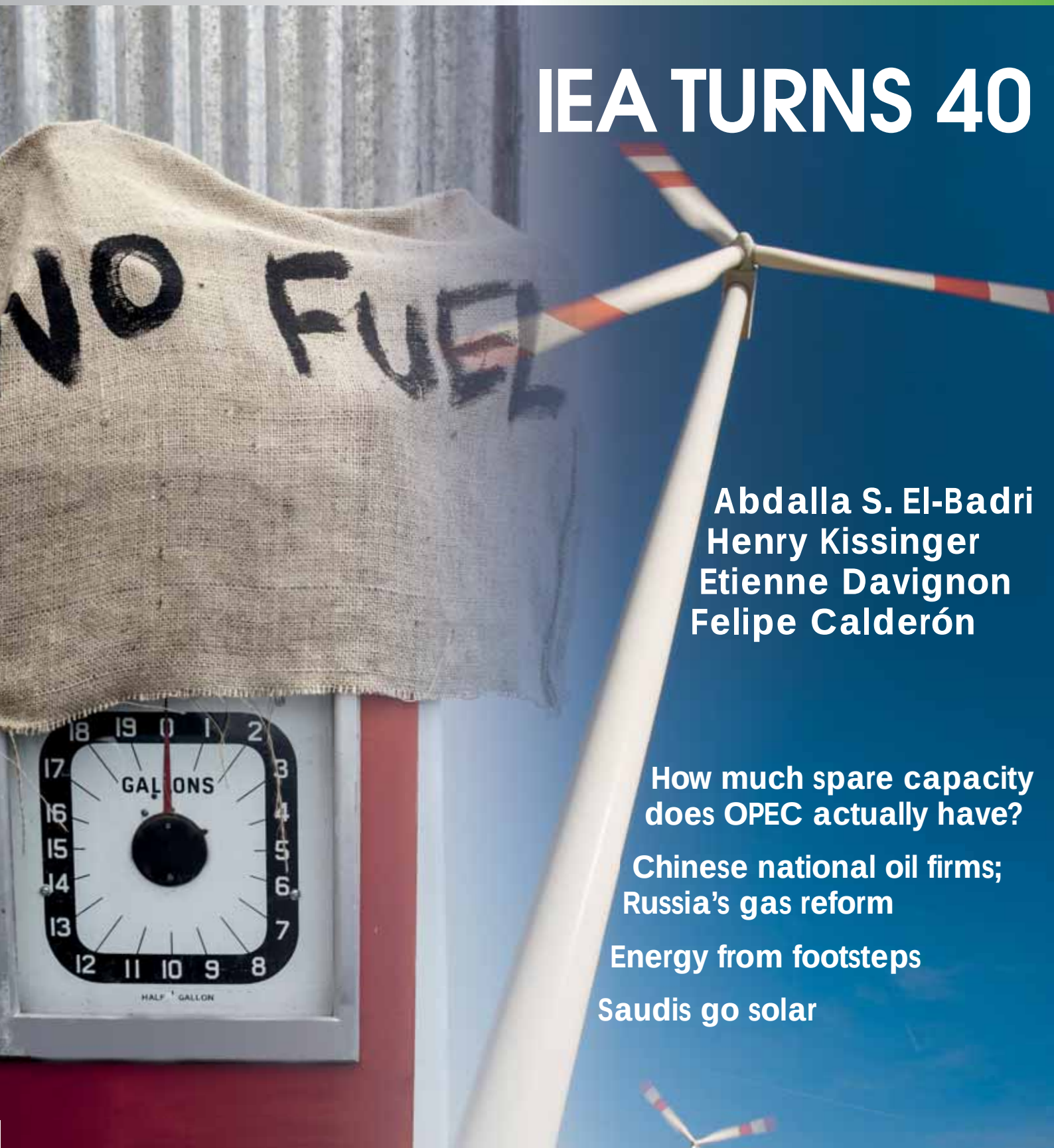
The Journal of the International Energy Agency

iea Energy

Issue 7 – **4th quarter 2014**



IEA TURNS 40

Abdalla S. El-Badri
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How much spare capacity does OPEC actually have?

Chinese national oil firms; Russia's gas reform

Energy from footsteps

Saudis go solar

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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The European Commission also participates in the work of the IEA.

International Energy Agency 1974•2014

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International Energy Agency
9 rue de la Fédération
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ENERGY SECURITY: BEST BIRTHDAY GIFT

By Maria van der Hoeven

Maria van der Hoeven is in her fourth year as Executive Director of the International Energy Agency, where she has worked to promote IEA effectiveness in global energy security. Before taking the helm of the IEA, she served as Minister of Economic Affairs for the Netherlands from February 2007 to October 2010, during which time she demonstrated leadership on energy policy at the national, regional and global levels.

At times, it is appropriate to celebrate, and that is what this issue of *IEA Energy* is doing. Not just because it's the Agency's 40th anniversary: it's because looking back, we have a lot to be proud of. The IEA was born in the time of energy crisis, the result of one of the worst oil supply disruptions in history. Back then, economies stumbled, cars idled outside of tapped-out service stations and some people despairingly feared a future of an energy-starved world.

Not the IEA. We co-ordinated creation of an emergency preparedness system that has proved invaluable in blunting the impact of subsequent supply disruptions, not only through oil releases but also by reassuring governments and markets that a fail-safe protection is in place. We have advised member and non-member countries on best practices to strengthen energy security while galvanising research for new policy and technology solutions, and we have fostered accuracy and transparency in the data necessary to monitor energy demand and supply to recognise threats and opportunities. Forty years ago, global oil demand was around 57 million barrels per day (mb/d); now it is just under 93 mb/d and is set to hit 99 mb/d by 2020. Yet despite no end to geopolitical tensions, the world is adequately supplied.

So far so very good. Our mission 40 years ago was to ensure and improve member countries' energy security – and it remains that today, only that goal now applies to more than just oil and includes the whole world. Our work is to ensure global and reliable access to affordable, ample and clean supplies of energy. And just like the details have evolved with the times, so have the ways the IEA goes about assuring energy security.

The challenge is ever more global

When the IEA was formed, member countries accounted for around three-quarters of global energy demand: now they account for less than half. And our flagship publication, the *World Energy Outlook*, whose newest edition is arriving during the 40th anniversary celebrations, foresees more than 90% of global net energy demand growth through 2035 coming from emerging economies. So naturally the IEA is working to expand and deepen its long co-operation with key partner countries, especially China and India, which are driving much of this demand.

We also encourage energy diversification. For instance, when the IEA was formed, member countries relied on oil for nearly 25% of power generation. Now it is about 3%, replaced largely by natural gas, nuclear and renewable energy. This is a transition other countries can learn from.

With diversification comes investment, which is essential for sustained energy security. But the majority of energy investment goes to offset declining production from existing oil and gas fields and to replace power plants and other assets that reach the end of their productive life. Our *Energy Technology Perspectives* scenario for limiting the increase in average global temperatures to 2 degrees Celsius calls for an extra USD 44 trillion in decarbonisation investment by 2050.

Closely related to diversification and investment are innovation and technology, whose advances have made it possible to reach previously unthinkably deep undersea deposits or use hydraulic fracturing to power the North American shale gas revolution. But innovation also makes possible progress in a relatively new component of energy security: sustainability. Forty years ago, energy use's environmental impacts were little acknowledged, and climate change was not yet a global concern. We are running out of time to address this critical threat, but we are also seeing a surge in low-carbon alternatives, as our latest *Medium-Term Renewable Energy Market Report* expects a 45% increase in global electricity generation from renewable sources by 2020, for almost 26% of the total.

Happy Birthday to the IEA, but the present is for the whole world

Who wants to see fuel shortages again? As we blow out the candles, I don't mind at all sharing this IEA birthday wish: at least 40 more years of secure, affordable and sustainable energy for member countries and everyone else on the planet.

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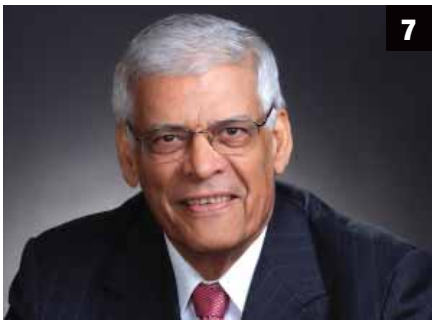

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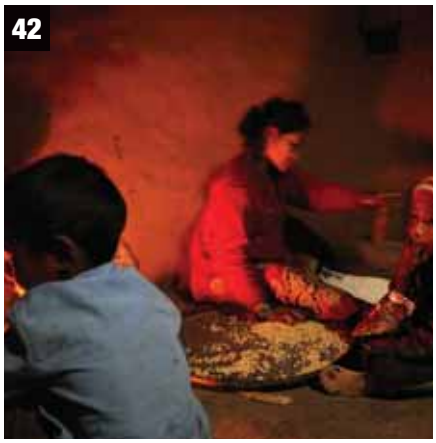

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International Energy Agency
Communication and Information Office
9 rue de la Fédération
75739 PARIS cedex 15 (France)

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www.iea.org

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Executive Editor
Rebecca Gaghen

Managing Editor
Robert Youngblood

Production and Layout
Angela Gosmann

Cover design
Bertrand Sadin

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Address advertising inquiries to
Laurent Djaoui of LD Media Development
via laurent.djaoui@noos.fr; 23 rue du Roule, 75001 Paris; or +33 1 82 83 38 70.

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Read *IEA Energy* in PDF format at www.iea.org/ieaenergy

WHAT DO YOU THINK?

What do you think will be the biggest changes to the energy sector in the next 40 years?

One respondent, selected at random, will win a free copy of the World Energy Outlook 2014.

Share your thoughts and submit your raffle entry by 30 January 2015 at: http://bit.ly/IEAenergySurvey

FROM OUR LAST ISSUE:

What are the greatest risks to a secure electricity supply: a) inadequate investment; b) government policy; c) variable renewables; or d) climate change?

Creating mass awareness of renewable energies, energy conservation and efficiency methods among the general public, industry and consumers would save the environment plus secure electricity for present and future generations.

Matam M. I Mora, India

LOCALISE ELECTRICITY PRODUCTION.

Chrissy K. I Devon, United Kingdom

National energy policy needs to rely more on recommendations/assessment by supranational and more technical institutions.

Benito V. I Madrid, Spain

INVOLVE AS MANY INDUSTRY EXPERTS (TECHNICAL AND FINANCIAL) AS POSSIBLE IN POLICY-MAKING.

Laura P. I Houston, United States

Need to try to reach a consensus on the way ahead for managing the challenge of climate change. This will be at the country level and at the international level (between countries).

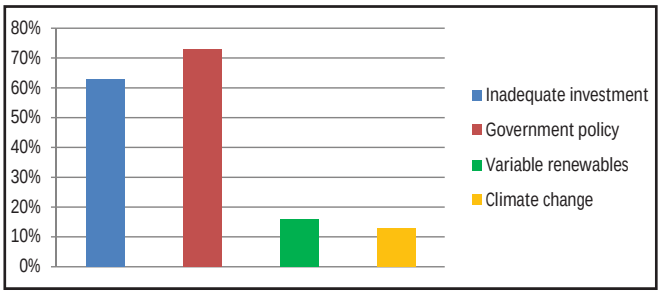
John S. I Canberra, Australia

DON'T PROMOTE THE UNREALISTIC HOPE OF RENEWABLE ENERGY.

Hsien Ta W. I Tapei, Chinese Tapei

Make a total commitment to move to 100% renewable sources and intelligently design a distributed and decentralised grid to support greater efficiency and redundancy throughout the entire system.

Maki I. I New York, United States



Respondents could chose more than one category, and 59% selected at least two. In addition, write-in options included: cyberwarfare vulnerability; energy uses and technology; demand growth management; and fuel costs.

DEREGULATION, REAL PRICE ON CARBON AND STABILITY IN POLICIES TO ALLOW LONG-TERM PERSPECTIVES FOR INVESTORS.

Xavier M. I Rueil-Malmaison, France

Electricity demand can reach unexpected "high points". Ideal conditions for wind energy (e.g.) to respond to those "high points" may not be enough.

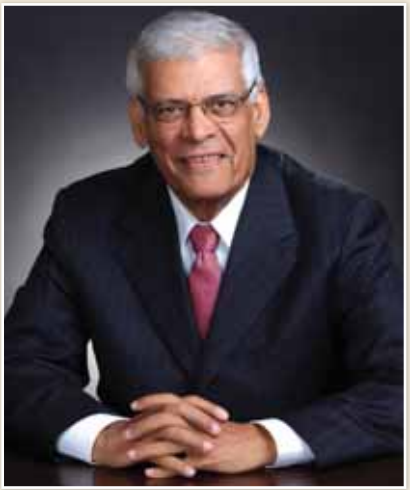
Gonçalo N. H. I Lisbon, Portugal

INTERNATIONAL CO-OPERATION IN FUNDING AND SHARING OF ENERGY RESOURCES IN A COST-EFFECTIVE MANNER.

Pradeep K. D. I Guragon, India

The winner of the previous raffle for a copy of The Power of Transformation: Wind, Sun and the Economics of Flexible Power Systems *is Ramakrishnan Kesavan of Hindustan Petroleum Corporation Limited Mumbai.*

DIALOGUE REPLACES OPEC-IEA MISTRUST



By Abdalla Salem El-Badri

His Excellency Abdalla Salem El-Badri has been Secretary-General of the Organization of the Petroleum Exporting Countries (OPEC) since 1 January 2007. He had held the position for six months in 1994, in addition to two periods as President of the OPEC Conference.

When the International Energy Agency was formed 40 years ago, there was no talk of dialogue with OPEC. In many respects, it was quite the opposite. There was a sense of mistrust and caution. This continued for a number of decades, with the two organisations having minimal contact.

Gradually, however, this has changed, and in the early years of the last decade there was a coming together and an understanding that in many respects our interests, particularly in regard to market stability, were, if not identical, at least similar.

Since then our dialogue and co-operation have advanced considerably. In 2003, we held the first joint IEA-OPEC workshop, followed by further workshops on a variety of topical energy issues. We have also been two of the partners involved in the development of the Joint Organisations Data Initiative that increases transparency in energy market data. And since 2010, following the Cancún Declaration at the 12th International Energy Forum (IEF) Ministerial meeting in Mexico, OPEC, the IEA and the IEF have collaborated on a number of workshops and symposia, such as those on energy outlooks and the interaction between physical and financial energy markets.

Personally I have also visited the headquarters of the IEA to discuss various issues with Executive Directors, with reciprocal visits made to the OPEC Secretariat in Vienna.

It all adds up to a healthy and positive dialogue. We see this as an important platform from which to collectively better understand trends, analysis and viewpoints and advance market transparency and predictability.

Moreover, the relationship is beneficial not only to our two organisations. It can help to address current and future energy market challenges, and it is an important element in the stability of global energy markets. This is not only in terms of maintaining market stability, but restoring it in times of crisis. IEA emergency oil stocks and OPEC spare capacity are key components in the market stability we all desire.

Today, the importance of dialogue between our two organisations has never been greater. We live in an increasingly energy-interdependent world; one where our co-operation matters to many.

We have come a long way, from the early confrontation to the co-operation we see today. I hope this continues to flourish further in the years ahead.

OPEC Secretary-General El-Badri and IEA Executive Director Maria van der Hoeven show their groups' closer ties.

All photos: © OPEC

International Energy Agency

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Capturing the Multiple Benefits of Energy Efficiency

The traditional focus on energy savings as the main goal of energy efficiency policy has, at times, led to an underestimation of the full value of energy efficiency in both national and global economies. The IEA recommends taking "a multiple benefits approach" to energy efficiency policy which identifies and quantifies a broader range of impacts of energy efficiency. This new approach repositions energy efficiency as a mainstream tool for economic and social development.

FOCUS

CHINA PEAK COAL? DON'T BET ON IT YET

By Carlos Fernández Alvarez

Carlos Fernández Alvarez joined the IEA in 2010 with more than 20 years of experience in the energy sector. He began as a consultant for electricity producers, focused on system modelling and nuclear plant safety assessments, before joining the Spanish government.

For decades, Chinese coal consumption has known only one direction: upwards. During the last 30 years, annual coal use in China decreased only twice, most recently in 1997. Given the orientation of Chinese policy to diversify the power system beyond coal and the big emphasis on air quality, the question is whether the trend will stop soon, resulting in a peak in coal demand during the IEA *Medium-Term Coal Market Report* (*MTCMR*) horizon, which for the 2014 edition runs through 2019.

Due out in December, the *MTCMR 2014* bases its outlook for Chinese coal demand on annual gross domestic product (GDP) growth averaging 7%. But GDP decouples from, or outpaces, electricity growth by 1.4 percentage points per year. At the same time, demand rises 2.3% per year in the non-power sector and gas use nearly doubles. The outlook also counts on 1 200 terawatt hours (TWh) of new non-coal power generation from gas, nuclear and renewables through 2019 – thus assuming 110 gigawatts (GW) of new hydro capacity, or roughly one Three Gorges Dam per year; 110 GW of new wind, about the currently installed capacity in Europe; and 80 GW of new solar photovoltaic (PV), more than Europe's present installed capacity.

What would it take to stall demand growth?

But can coal peak within the 2019 horizon? To cover all the bases, the *MTCMR 2014* looks at that possibility, and the answer is … yes, it is possible – but only if one of these happens:

- GDP growth slows to 3% from 2015 onwards, i.e. less than half of the assumed 7% per year. Since 1978, the lowest growth rate in China was 3.8% in 1990.
- Or GDP and electricity growth decouple by 4.5 percentage points per year. But from 1980 to 2010 the maximum five-year annual average for this rate was 1.4 points in Japan. In China the annual average over the last five years was 0.4 points.
- Or China produces 2 500 TWh of additional power generation from gas, nuclear or renewables. This extra output is equivalent to four times global wind generation or 18 times global solar PV generation in 2013. To generate 2 500 TWh with modern gas power plants, China would have to raise natural gas consumption by 250%. Alternatively, China would have to commission 300 nuclear reactors in addition to the about 30 already expected in the *MTCMR 2014* outlook.
- Or China cuts non-power coal demand at a 2.9% annual rate. This would be equivalent to reducing non-power coal demand in 2019 by 360 megatonnes (Mt) from 2013, and does not consider China's plans to expand its coal-to-gas conversion programme. Substituting 360 Mt of coal with natural gas would more than double current Chinese gas demand.

Of course, a combination of more moderate versions of these scenarios would also produce peak coal. For instance:

- Either non-power coal demand remains constant but China adds 1 900 TWh of additional power generation from gas, nuclear or renewables.
- Or GDP and electricity growth decouple by 3 percentage points per year with an additional 1 900 TWh of power generation from gas, nuclear or renewables.
- Or GDP grows 5% per year from 2015 combined with constant non-power coal demand, while GDP and electricity growth decouple by a 1.7% annual rate.
- Or 5% GDP growth from 2015 combines instead with an additional 1 500 TWh of power generation from gas, nuclear or renewables – plus GDP and electricity growth decouple by 2.5 percentage points per year.

Because this calculation is a static analysis, it does not consider the effect of variations on other factors – which makes the prerequisites for coal demand to peak in China even harder to achieve. If, for example, GDP growth were to decrease significantly, it is not clear whether the assumed primary energy diversification of power generation through renewables, nuclear or gas would still be achieved. Experience in Europe shows that in a crisis, subsidies to renewables are among the choices for cuts in spending.

History offers little likelihood of a collapse

This exercise shows that peaking coal demand in China within this decade necessitates either a significantly lower GDP growth or dramatic changes concerning power generation or energy intensity in the economy. While of course past performance is no guarantee of future results, neither development has been observed, not even closely, in recent history.

Coal-based cakes for home heating in China, where coal use has declined in only two of the last 30 years.

"SOCKET PARITY" FOR SOLAR PV

By Cédric Philibert

A former science journalist, Cédric Philibert arrived at the IEA in 2000, following a tenure at the United Nations Environment Programme. Before that, he served as an adviser to the French environment minister and to the CEO of the French Agency for the Environment and Energy Efficiency.

Socket parity is the holy grail for new energy technologies, and solar photovoltaics (PV) has attained that status in a growing number of markets.

What constitutes "socket parity"? As explained in the IEA publication *Medium-Term Renewable Energy Market Report 2014*, it is when a distributed generation technology's levellised cost of energy falls to or below the per-kilowatt-hour price of electricity obtained from the grid.

Socket parity is distinct from "grid parity", the more usual term, which is employed in a number of ways, sometimes to imply a technology's competitiveness via other options, other times to relate to retail prices. Socket parity refers only to the price of the energy from a technology compared with the price the utility charges, and once attained, it means customers can save money by generating electricity rather than purchasing it from their utility.

Exactly when the rapid reduction of component costs lets solar PV reach socket parity varies because of large differences in generation costs of PV, which depend on system prices, resource conditions and financing costs. Tariffs also differ by customer group: residential, commercial or industrial.

Socket parity suffices to make PV investment profitable in the absence of direct economic incentives only when the match between PV generation and power demand allows for self-use of all or most of the resulting electricity, as in the case of some commercial or industrial consumers. Remuneration of PV electricity injected into the grid most often is an important element of profitability, especially for households. It is achieved through arrangements such as feed-in tariffs or premiums, solar certificates or net-energy metering, i.e. the possibility for electricity injected into the grid to be "counted against" what is withdrawn from the grid at another time.

Small systems make it easier to achieve high shares of self-use: the smaller the system, the less likely PV generation is to exceed the customer's power demand at any specific time.

Storage and demand-side response are two options available to better match supply and demand for "prosumption", i.e. when a user both produces and consumes electricity. The options would simultaneously help increase both self-use and self-sufficiency. But current storage costs make reaching full self-sufficiency through PV prohibitively expensive in most cases.

With socket parity, debate over grid charges

As socket parity of PV electricity leads more and more consumers to install systems and consume fewer kilowatt hours from the grid, debate surges over whether it is fair and economically sound for them to avoid payment of grid costs.

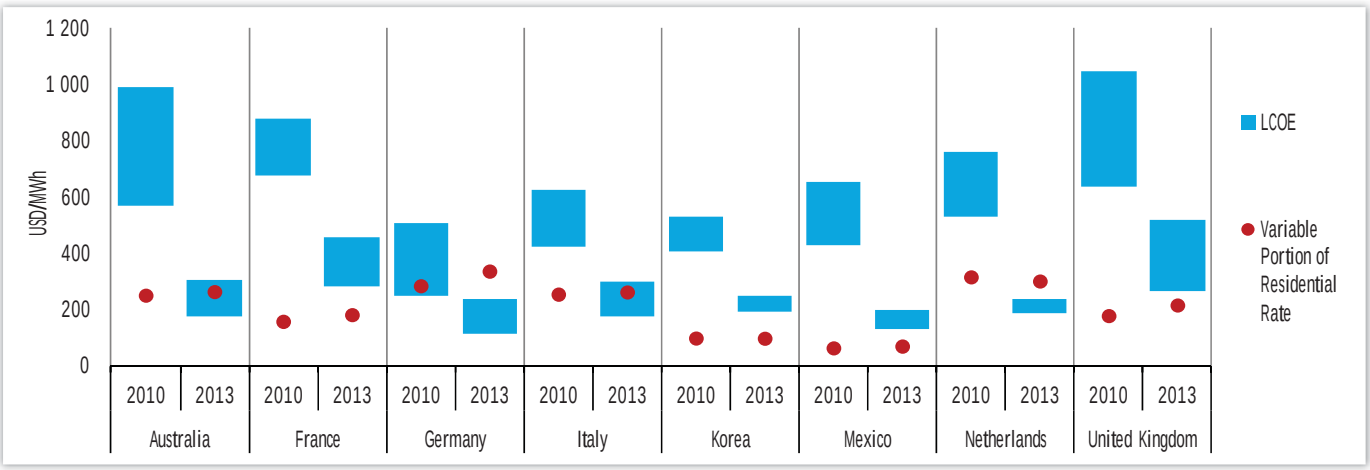
The cost of the transmission and distribution grid is determined by a number of factors, including population density, geographical properties and grid design, but ultimately reflects the need to accommodate times of peak utilisation: those hours of the year when a maximum amount of electricity is flowing through the lines. Fixed costs of grid infrastructure can make up roughly one-quarter to one-half of the total cost of electricity to end customers.

Most electricity prices include a fixed charge that applies to grid infrastructure, but it tends to be much smaller than the actual fixed cost.

AS SOCKET PARITY LEADS TO MORE CONSUMERS INSTALLING SYSTEMS, DEBATE SURGES OVER WHETHER IT IS FAIR AND ECONOMICALLY SOUND FOR THEM TO AVOID PAYMENT OF GRID COSTS.

This approach to pricing is based on two rationales. First, a too-low per-kilowatt-hour charge for electricity incentivises wasteful consumption. Second, consumers with high kilowatt-hour consumption overall are more likely to be consuming power also during periods of peak demand.

Simply put, by paying per kilowatt hour, heavy consumers are considered to be responsible for a larger part of the fixed cost. To the extent that this holds up in practice, allocating part of the fixed cost to the variable component of the electricity bill ensures a simple way to allocate costs to those who cause them.



A comparison of the variable component of electricity tariffs and the levellised cost of energy of solar PV, showing that socket parity has been reached in some countries.

With solar PV socket parity, self-use expands.

So, is it fair and economically sound if owners of PV systems can avoid the payment of grid costs?

IEA analysis finds that the answer depends on the degree to which the PV system helps reduce grid flows during periods of peak utilisation. If it assists significantly, it can be economically efficient and fair to allow offsetting payments for fixed infrastructure costs. However, where PV does not reduce the customer's reliance on the grid during times of peak demand, avoiding payments via self-consumption would be unfair. Consumers would still be responsible for the same amount of infrastructure costs, but pay much less to recover such costs.

Charges that include time-based pricing

While it might seem that fixed costs should simply be recovered by fixed charges, the reasons those costs are discounted remain valid: even when produced from a renewable source, waste is waste. A limited and progressive increase of fixed charges is conceivable, but it should be part of a balanced portfolio of measures, possibly including time-based pricing. Time-based pricing allows tariffs to better reflect the impact of electricity consumption patterns on grid and other system costs. It can take the form of time-of-use pricing, usually with four to eight distinct prices according to hours in the day, days in the week and seasons, or real-time pricing with smart metering.

Order the Medium-Term Renewable Energy Market Report 2014, *part of an IEA series on the primary energy sources:* http://bit.ly/MTREMR14

WHAT STATISTICS INDICATE AND HOW

By Roberta Quadrelli

Roberta Quadrelli heads the IEA Energy Data Centre's section on Balances, Prices, Emissions and Efficiency and has led its section on non-member countries. Previously science officer at the International Council for Science, she holds a Ph.D. in atmospheric sciences and a master's in physics.

As collecting any statistics has a cost, a general principle is to collect only what is necessary. But not only do policy makers, governments and citizens need statistics, as lack of proper data can lead to wrong decisions and actions, they also need it compiled in a meaningful way to drive effective and efficient energy use.

So statisticians do not just collect data, they also have to aggregate it into indicators. Energy-related indicators are usually composed of energy consumption being the numerator and activity data as the denominator. They can be very aggregate, giving a broad view (e.g. total energy consumption per unit of economic output) or they can be disaggregated, i.e. broken down into very specific observations to allow for more detailed analysis (e.g. average space heating consumption per floor area of single houses using natural gas for heating).

Available for almost every country, energy balances provide a good overview of consumption because of what they represent: an energy balance expresses in a common unit all data about energy products entering, exiting and being used in a country. Balances are useful to understand the structure and the evolution of energy consumption and, when coupled with macroeconomic variables, to produce aggregate indicators – such as total residential consumption per capita – which help in monitoring high-level trends. But such aggregated data give a broad overview, while policy, actions and measures may need more focused results.

A "pyramidal approach" to indicators

The new IEA manual *Energy Efficiency Indicators: Fundamentals on Statistics* explains to statisticians around the world how to complement energy balances with a variety of disaggregated data to build even more meaningful indicators. That helps reveal which sub-sectors or end uses drive energy consumption within a sector. An example of such an indicator for the industry sector is energy consumption per unit of steel produced.

The IEA proposes indicators based on a "pyramidal approach", from the most aggregated level at the top of the pyramid down to the most disaggregated one.

Beyond the sub-sectoral and end-use level, indicators can be computed at an even more disaggregated level: the unit energy consumption level. Within the residential sector, for example, space heating energy consumption per floor area is an energy efficiency indicator at the end-use level, while energy consumption per unit of appliance, such as televisions or dishwashers, is an indicator at the unit consumption level.

Space heating can be assessed by unit or by use.

Why the IEA emphasises indicators

Without data there are no indicators, and without indicators it becomes difficult, if not impossible, to assess a situation. Inadequate resources, expertise, know-how and practices are often put forward to explain the lack of data and indicators.

For that reason, the IEA makes statistics tools, like the new manual and its companion volume, *Energy Efficiency Indicators: Essentials for Policy Makers*, as well as training workshops part of its ever-growing function to share knowledge and best practice in the field of energy globally. Besides best practice, the outreach also imparts experience and establishes contacts and links among users and countries. As good policies so often start with good statistics, an important intermediate step is determining the best indicators based on country-specific priorities, and then sharing them.

Download Energy Efficiency Indicators: Fundamentals on Statistics: http://bit.ly/StatsEEManual

HOW TO FINANCE ENERGY EFFICIENCY

By Lorcan Lyons

Lorcan Lyons joined the Energy Efficiency Unit of the IEA in 2014, principally as an author of the Energy Efficiency Market Report. *He was previously a consultant on energy and environment policy with Bio Intelligence Service and before that worked at the IEA from 2004 to 2008.*

Interest in financing energy efficiency is increasing worldwide, as are investment opportunities, with a dramatic expansion in recent years in the number and variety of funding programmes as well as the diversity of investors, financiers and intermediaries.

Many OECD countries in particular are trying to encourage the private sector to scale up investment in energy efficiency. Governments are accelerating this process with access to finance but also regulation, incentives, de-risking measures and capacity building.

Banks lead in lending but at times need help

Commercial banks are the largest lenders, with the Citi group, for example, having directed a total of USD 1.4 billion to energy efficiency activities from 2007 to 2013.

Banks take two approaches to such lending: demand-driven and strategy-driven. The demand-driven approach involves re-packaged products, such as lending for commercial retrofits, mortgages extended to include energy-reduction improvements, or car loans for less fuel-thirsty cars. The strategy-driven approach assesses whether energy efficiency product types and target markets fit within a bank's existing strategy or portfolio mix. For instance, a strategy-driven investment might improve an existing industrial client's risk profile and profitability through better energy performance by replacing inefficient motors.

Commercial banks are also an important relay in channelling public finance towards energy efficiency. Many development banks and green investment banks, which specialise in lending for sustainable growth, distribute funds through local commercial banks, which in turn often provide complementary financing. The Asian Development Bank, for example, implemented energy efficiency loan projects in three Chinese provinces, providing USD 100 million to each respective government, with the funds re-lent through a financial intermediary. Public finance programmes are particularly important for consumer market segments that are underserved by private markets, such as small businesses or affordable housing.

Often the public sector must catalyse commercial lending when private financing faces challenges beyond such general barriers to improved energy efficiency as lengthy payback periods or situations where incentives and costs are misaligned between owner and lender.

To start with, projects are often diffuse and too small to attract lenders, raising development and implementation costs. In addition, the price – in expense, time or expertise – to arrange financing can be too daunting for businesses, especially smaller ones, as many lack the skills or bandwidth to meet project requirements or the cash to contract out the work. As the performance results for energy efficiency investment are generally not collected in a systematic manner, the paucity of transparent data and financial research can also block deals. Finally, some financial institutions fail to see energy cost savings as potential cash-flow sources for debt repayments. This is particularly an issue in industry, where investment in process change rather than new assets can achieve great savings.

Moreover, the public sector has a role as an implementer of projects, as when local agencies invest in efficient lighting for municipal buildings or in a government-owned enterprise's use of more efficient industrial processes.

More generally, scaled-up lending is constrained by the lack of suitable vehicles with attributes sought by institutional investors: the options available often lack investment-grade credit ratings or related financial research.

Besides the detrimental effects on all forms of energy efficiency that result from subsidies for fossil fuels, the investment milieu often features government policies and regulations that favour investment in fossil-fuel use and production, as well as absent or low carbon prices.

Signs of growth in deals and savings

Despite these challenges, the IEA publication *Energy Efficiency Market Report 2014* detects signs of acceleration in the rate of change in energy efficiency finance, indicating that growth should continue over the next several years. Supportive factors include a wider variety of tailored financial products, a gradual increase in the amount of energy and loan performance data, and increased attention to related policy issues such as climate change mitigation and energy security. Plus, as markets mature, the menu of financial products should expand and the access to data increase, further boosting activity.

Additional growth can come from improved co-ordination among the investor, policy and financial communities as well as better appreciation of the multiple economic and social benefits of energy efficiency, from greater employment to reduced public expenditure.

Banks are altering loans for building retrofits, like this one in Istanbul, to include costs to better energy efficiency.

Order the Energy Efficiency Market Report 2014, *part of an IEA series on the primary energy sources:* http://bit.ly/EEMR14

Building: photo by soragoldsmith on Flickr. https://creativecommons.org/licenses/by/2.0/

"EFFECTIVE" OPEC SPARE CAPACITY

REALITY-BASED DATA

The IEA tweaked the measure of OPEC's spare production to provide a more realistic snapshot of current and future upstream supply flexibility.

By Diane Munro

Diane Munro recently left the IEA after five years as a Senior Oil Market Analyst, adding to her 25-plus years of monitoring international oil market developments and geopolitical issues. She previously worked for companies including Wood Mackenzie, BP, Arthur Andersen and John S. Herold.

Political turmoil in OPEC countries has complicated the task of assessing the level of OPEC spare crude production capacity. So the IEA introduced the concept of "effective" spare capacity to capture the difference between nominal capacity and the fraction of that capacity actually available to markets.

Historically, calculation of OPEC spare production capacity was in part meant to capture the amount of crude output capacity that member countries chose to withhold from markets as a matter of policy, whether to support prices or to comply with production quotas. The idea was that in the event of a supply disruption or a spike in demand, the countries had the option of activating that production to balance markets. Whether or not to activate that production depended on a collective decision by OPEC or a sovereign decision by member countries.

Over the years, however, some OPEC member country governments, for various reasons, have lost control over part of their production capacity. One example is Nigeria, where sabotage forced the closure of onshore portions of the Niger Delta; another is Iran, where international sactions have curtailed access to markets and investment.

Given this new reality, the IEA in 2005 introduced effective spare capacity as an important measurement in its reports on oil markets.

A Saudi oilfield: the IEA bases OPEC "effective" spare capacity partly on actual supplies available to markets.

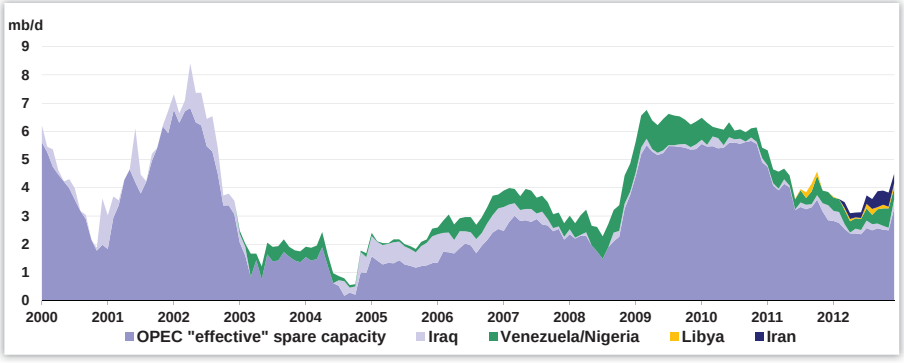
How the new measure is calculated

The IEA calculates effective spare capacity first by determining installed, i.e. implied, capacity: total capacity minus the IEA "call on OPEC" for production, issued each month in the *Oil Market Report*, and also minus stock changes. It then adjusts notional capacity for a rolling average of the observed difference between implied capacity and recent estimates of actual supplies available to markets. The resulting estimated effective spare capacity, as distinct from the nominal measure, offers a more realistic snapshot of current and future upstream supply flexibility.

In its *Medium-Term Oil Market Report 2014*, the IEA calculated OPEC implied spare crude oil production capacity at 4.56 million barrels per day (mb/d) in 2013, about 90% of it in Saudi Arabia, rising by 1.23 mb/d on paper through 2016 before plateauing at just above 6 mb/d to 2019. The average over the five years from 2013 to 2019 is estimated at 5.6 mb/d.

In practice, given high disruption risks, only a fraction of this nominal capacity is available to markets. The *Medium-Term Oil Market Report 2013* did not estimate effective spare capacity because supply interruptions resulting from Libya's civil war of 2011 were thought to have been a one-off event. But in view of continued disruption risks there as well as in other OPEC member countries, the IEA this year halved, to four, the number of preceding quarters it reviews to calculate the rolling average used as the adjustment factor to assess effective spare capacity. The change effectively increased estimated "ineffective" spare capacity to 1.5 mb/d, from 1 mb/d earlier.

Based on this method, the IEA estimates OPEC effective spare capacity at 3.52 mb/d this year, ramping up to a peak of 4.60 mb/d in 2017 from 3.06 mb/d in 2013, with the average over the years ending 2019 at 4.06 mb/d.



Saudi Arabia is the source of the lion's share of OPEC spare output capacity, which can offset turmoil elsewhere.

To learn more about IEA insights into oil production, plus the outlook for supply and demand through 2019, order the Medium-Term Oil Market Report 2014: *http://bit.ly/MTOMR14*

A PIPELINE ALTERNATIVE TO LNG

ASEAN GAS NETWORK

As Southeast Asia pursues local solutions to meet surging gas demand, a 15-year-old effort to network the region's pipelines gets a fresh look

By Anne-Sophie Corbeau

After five years as Senior Gas Analyst, Anne-Sophie Corbeau recently left the IEA, joining the King Abdullah Petroleum Studies and Research Center as a gas expert. She previously worked at Cambridge Energy Research Associates and in Peugeot's fuel cell and hydrogen department.

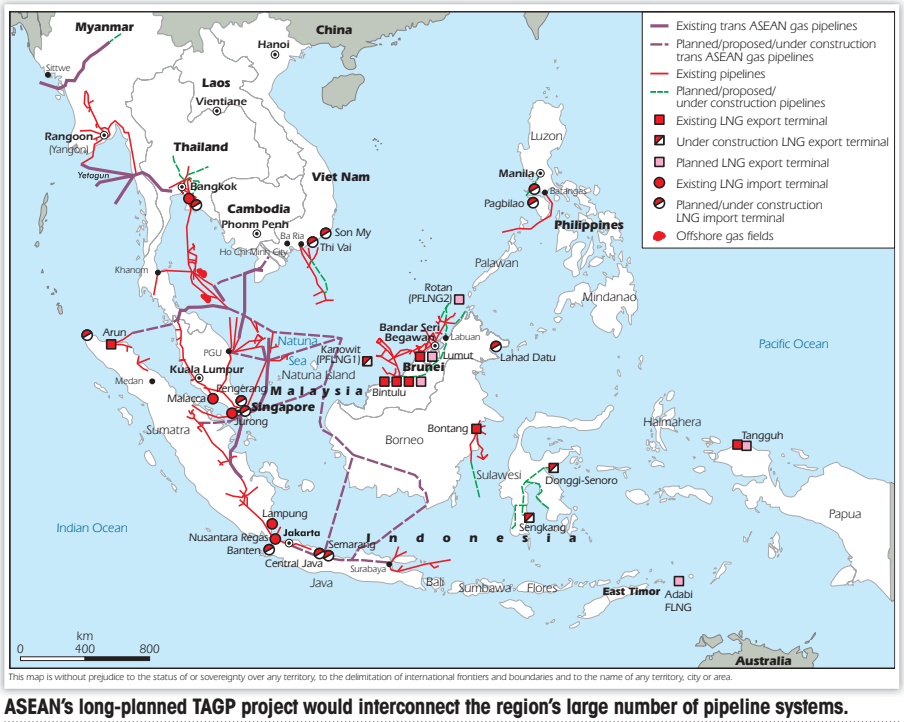
Unprecedented growth in global liquefied natural gas (LNG) supply is adding 150 billion cubic metres (bcm) of LNG capacity that is already under construction or set to start in the next four years. But prospects for further natural gas demand and, in particular, LNG growth in key regions, have never been so uncertain.

The pricing picture is in full swing, too, with an average gap in 2013 between US and Asian gas prices of USD 12 per million British thermal units. This gap is responsible not only for the flurry of planned LNG projects targeting mostly Asia, but also for renewed Asian attempts to develop innovative and cost-cutting approaches to gas delivery.

Since the 1990s, the economic development of nations in the Association of Southeast Asian Nations (ASEAN) has led to a thirst for energy. The IEA expects more than 80% growth in regional energy demand through 2035 compared with 2011, as the economy triples and population expands by almost one-quarter. Coal will supply much of the new energy, but gas will also play a role, with 100 bcm in new demand lifting consumption to 250 bcm.

Early on in planning for the demand surge, ASEAN expected to rely on pipeline supplies. New output for distribution was, and still is, expected from the East Natuna gas field in the sea between Indonesia, Malaysia and Singapore. So energy ministers announced the Trans-ASEAN Gas Pipeline (TAGP) system in 1999 to connect existing pipelines for a fully integrated network that would also deliver supply from East Natuna. The region has extensive pipelines that in many cases cross borders – but such links are only binational. Aimed at enhancing security of supply and greater economic co-operation within the region, the TAGP is to connect gas reserves in the Gulf of Thailand, Indonesia, Myanmar and the Philippines to the rest of the region.

But over the past four years, LNG developed quickly as countries in the region built terminals, while the TAGP project lost steam. However, these terminals suffer from the inefficiencies of the global LNG market and are sometimes too large for smaller domestic demand centres. A 400 megawatt gas-fired plant needs about 0.4 bcm per year to run 5 000 hours per year – about four LNG cargoes per year.



ASEAN's long-planned TAGP project would interconnect the region's large number of pipeline systems.

New relevance for a regional network

Within this context, a new IEA report, *The Asian Quest for LNG in a Globalising Market*, finds that the TAGP project could still be a valuable solution. The network could provide flexibility and diversity of supplies within the region, based on both LNG and the development of East Natuna with the TAGP as backbone. For example, the TAGP could facilitate swapping gas within the region for an optimal allocation, through time or cargo swaps of LNG or via additional LNG imports through terminals in neighbouring countries.

The TAGP, however, faces several significant challenges:

- overcoming technical issues such as different gas quality and obstacles to developing East Natuna
- reconciling differences in market structures and pricing among countries
- moving from the existing bilateral cross-border pipelines system to an integrated and harmonised system
- harmonising regulation such as third-party access rules and regulatory authorities.

All of these issues limit the access of buyers, sellers or both from non-neighbouring countries to the imagined single network. In other words, many fundamental issues limit third-party access and hence the move to an efficient integrated network.

Overcoming the challenges to linkage

The East Natuna field has been difficult to develop, despite its substantial 1 300 bcm of natural gas. Located in a basin in Indonesia's most northern territory in the South China Sea, it is far from the consuming areas. Another difficulty is the very high carbon dioxide (CO_2) content of the gas, which would compound technical issues in aligning gas quality across

An LNG site in Malaysia: the completion of a pan-ASEAN pipeline network could complement LNG trade.

the TAGP. In Singapore, for example, imported natural gas must comply with Gas Network Code specifications before it can be injected into the transmission system. The minimum methane level in Singapore is set at 80% of the volume, with CO_2 no higher than 5%. But in Thailand, natural gas from onshore fields in the north-eastern part on average contains 76% methane and 13% CO_2, while that from offshore fields in Myanmar contains 72.4% methane, 6.2% CO_2 and 16% nitrogen.

The quality issue also applies to LNG. TAGP-facilitated swaps of LNG between terminals or between LNG and pipeline gas offer an opportunity to harmonise qualities system-wide. Without becoming an obstacle to new LNG supplies, quality could be managed at the import terminals before the gas is injected into the TAGP.

National systems impede regionalisation

Perhaps the greatest challenge for the TAGP is the different market structures found among the ten ASEAN member countries. For example, besides national monopolies in several nations, Thailand and Indonesia have vertically integrated companies, while Singapore is on a firm course towards deregulation with the unbundling of transport and commercial activities. Most countries do not provide efficient and transparent third-party access, even if there is regulation supporting this principle. Fulfilling the TAGP aim of a single network would involve harmonisation of regulatory oversight.

Other limitations to development are national policies that favour domestic energy use before considering exports – policies that limit the most efficient allocation of gas within the region. The most common form of favouring domestic energy users is through subsidies, which many countries in the region use to protect gas consumers from higher international market prices, a trend likely to worsen as countries become increasingly reliant on imports.

Connecting these diverse markets through a single pipeline network would enable access to the various countries. But the distinctions among national market structures would limit that access, as the parties' interests and risks vary. The absence of third-party access to the transmission grid in some countries would hinder the creation of an integrated network in which gas would flow to where the highest prices are paid, which would create additional challenges for the countries with artificially low prices.

Network offers option to crowded market

Over the medium term, gas markets of non-OECD Asian countries will play a key role in attracting additional LNG supplies, according to the IEA *Medium-Term Gas Market Report 2014*. For Southeast Asia, LNG will always be necessary, as it brings flexibility and matches some countries' island geography.

But ASEAN countries will be turning to a crowded market, as demand expands elsewhere, too. By 2019, total Asian LNG imports will near 150 bcm, more than Japan's current world-leading deliveries. China will overtake Korea to rank as the second-largest overall gas importer behind Europe, relying on LNG as well as pipeline gas to maintain a diversified supply mix and feed its gas-hungry coastal region, which remains distant from pipeline or most domestic supplies. In India, LNG is the only likely source of imports over the medium term as pipeline projects remain a far-away dream.

As such, the requirements for ASEAN to develop import and transport infrastructure will be significant, and the competition for product high. As most Southeast Asian countries are interlinked bilaterally by pipeline, increasing these connections by reinvigorating the TAGP project can diversify delivery, buttressing the energy security crucial to the region's economy.

SINGAPORE'S OPPORTUNITY

Singapore is trying to establish Asia's first natural gas hub, which would depend heavily on LNG supplies. But as an ASEAN member, the country is also involved in the TAGP project. Developing both LNG and the pipeline network could prove synergistic rather than competitive: the TAGP could link Singapore with gas fields and LNG regasification terminals region-wide, enhancing supply security and diversity while increasing the hub's liquidity. Further, a hub that provides a reliable, single-price reference for all TAGP transactions could end different cross-border price regimes, a key obstacle to the project's success.

Over the longer term, Asia could have multiple trading hubs to capture differences among intraregional markets. Asia has no spot price, unlike Europe and North America, and the IEA is focused on the obstacles and opportunities for Asia-Pacific economies to establish natural gas trading hubs that allow gas prices to reflect local and regional demand and supply.

But most of ASEAN is far from fulfilling what the IEA sees as necessary to establish a regional hub: hands-off government approach, separate transport and commercial activities, sufficient network capacity and non-discriminatory access, wholesale price deregulation, a competitive number of market participants, and involvement of financial institutions. Without improvement in these areas, the TAGP cannot realise the synergies possible from a trading hub in Singapore or elsewhere.

Download Developing a Natural Gas Trading Hub in Asia: *http://bit.ly/AsianGasHub*

As of 6 November, download The Asian Quest for LNG in a Globalising Market: *http://bit.ly/Quest4LNG*

OIL THAT LIMITS SUPPLY DISRUPTIONS

EMERGENCY STOCKS

To prevent economic damage from a supply interruption, IEA member countries have stored oil for 40 years. Here's how the system works.

By Martin Young

Since June 2012, Martin Young has led the IEA Emergency Policy Division, working on energy security issues with member and partner countries. He previously was a UK government official and a longstanding UK delegate on the IEA Standing Committee on Emergency Questions.

Energy security has been the main objective since the IEA was founded against the backdrop of the oil crisis of 1973-74, and no mechanism captures that priority better than member countries' stockpiling of emergency stocks for collective release to counter a supply disruption.

Over the 40 years of IEA history, member countries have set aside billions of barrels of crude oil and oil products. As of the end of March 2014, the constantly refreshed stocks totalled 4.1 billion barrels, equivalent to about 44 days of total global demand. Three times in its history, the IEA has released those energy stocks in collective actions to ease supply constraints that threatened the global economy: in the build-up to the 1991 Gulf War; after hurricanes Katrina and Rita damaged oil production and oil refineries in the Gulf of Mexico in 2005; and in response to the prolonged disruption of oil supplies from Libya in 2011.

IEA rules and other reasons to store oil

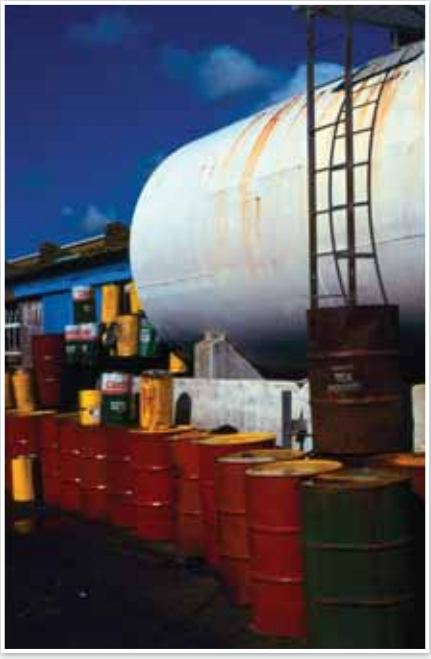
To be a member of the IEA, a country must commit to holding in reserve oil stocks equivalent to at least an average of 90 days' worth of its net oil imports, if any, from the previous year. Three members are net exporters – Canada, Denmark and Norway – and so do not have to hold stocks under the IEA rules, but do need to be able to support a collective action via other policies. The rest hold reserves, with almost all stocks exceeding 100 days, ranging as high as about 250 days' worth in the case of Korea.

Countries can hold their oil in several different ways: the requirement can be met with either crude or refined products held publicly or by industry. More than 80% of publicly held stock is in the form of crude oil, while a bit more than half of industry stocks is oil products. Countries also have the option to store oil abroad, which adds flexibility. All stocks, in whatever form, are counted in oil barrels.

The aggregate stock level has grown over the years, reflecting increases in both oil demand, which has lifted net imports, and the number of countries that have joined the IEA. But an equally important reason is political decisions by some member countries to bolster public stocks well above the minimum: in the mid-1980s, reserves barely totalled 3 billion barrels. That greater political will has come even as the global energy map changes, with most-developed countries accounting for a smaller global share of oil demand.

How stocks temper supply disruptions

From its start, the IEA has developed emergency response mechanisms to create a concrete and co-operative action plan in the event of a major oil supply disruption. Initially, they were designed to take effect should a disruption cut off 7% or more of normal oil supply, either for the IEA as a whole or any individual member country. As oil markets evolved, so did the IEA tools. Now the Agency uses a detailed impact assessment to determine how and when to resort to emergency measures.



Countries hold oil stocks in a variety of manners.

The market context of an oil supply disruption determines when emergency action is warranted. If the world market does not have sufficient spare capacity, a relatively small disruption can be quite severe. By contrast, a larger supply disruption would be manageable in the short term if sufficient spare production capacity or commercial oil stocks can offset the lost oil.

When IEA analysis identifies a significant supply disruption or the likelihood of one in the very near future, the Executive Director informs member countries through the Governing Board, which is made up of representatives of all 29 member countries, specifying whether or not activation of the emergency response measures is desirable.

If action is recommended, the Executive Director suggests how much oil-equivalent should be made available to the market. Each country's share in the action is based on its share of total IEA oil consumption.

It takes most member countries two to seven days to implement the necessary approvals for the release, after which actual physical delivery to markets can take as little as one day or as long as three weeks, depending on the emergency stocks structure.

An economic remedy, not a price-cutter

There have been multiple supply interruptions since oil became a dominant energy source in the 1950s. The first significant disruption was the Suez Canal Crisis in 1956-57, and of the subsequent significant disruptions, the largest accompanied the Iranian revolution of 1978-79, causing international economic havoc.

The primary purpose of an IEA collective action is to mitigate the economic damage associated with a disruption of oil supply. But by temporarily replacing disrupted supplies, the action seeks to help oil markets re-establish balance between supply and demand, and potentially at a lower price level than would otherwise have been the case.

Managing oil prices is not the purpose of an IEA collective action. High prices can have underlying causes that temporary emergency measures cannot address. Moreover, attempting to manage prices with emergency measures

risks masking important market signals, such as the need to invest in supply infrastructure or more fuel efficient technologies, which are essential to assuring supply security in the future.

A variety of responses to an emergency

Those signals buttress other IEA actions, as collective stockdraws are only the most visible of the many emergency response measures the IEA can rely on. The International Energy Programme Agreement of 1974, which established not just the IEA but also the emergency response mechanisms, outlines three other key response measures besides a stock release: restraint of demand; switching from oil to other fuels; and increasing domestic oil production.

Short-term reductions in oil use are an important part of any response to a supply disruption, as demand restraint measures free up oil in an under-supplied market. Demand-restraint measures are not restricted to one particular sector of consumption. For instance, in residential sectors that use oil for heating, publicity campaigns can cut consumption substantially by encouraging people to turn down thermostats a few degrees during the winter. Where the industry sector uses oil for power, member countries might consider a limit on operating times.

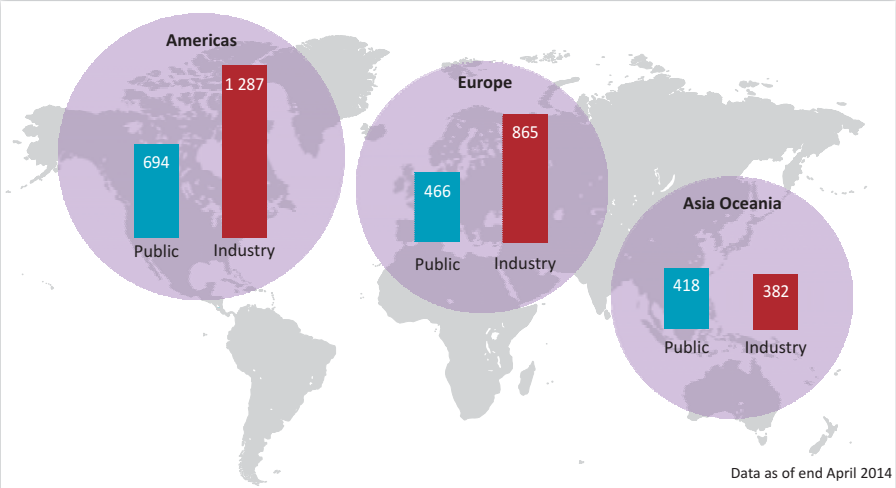
SHORT-TERM REDUCTIONS IN OIL USE ARE AN IMPORTANT PART OF ANY RESPONSE TO A SUPPLY DISRUPTION.

But most demand restraint policies focus on transportation because of the sector's high – and increasing – proportion of oil use. At one end of the spectrum, measures can be light-handed, such as encouraging people to use their automobiles less, to car-pool or to drive more efficiently. At the other extreme, governments can impose such heavy-handed measures as rationing or allocation of oil.

Similar to demand restraint, fuel switching seeks to reduce the use of oil during a supply disruption by encouraging consumption of alternative energy sources. This includes, for example, burning coal or natural gas rather than oil in electricity production. But lately, another example of fuel switching is oil replacing gas, an option available to IEA member countries given recent European supply concerns.

But the actual potential to use fuel switching in a crisis has declined significantly in member countries since the 1970s. In particular, the growth of natural gas and gas-only power stations leaves little scope for fuel switching in power generation. Oil-fired electricity generation in IEA member countries has declined significantly since 1973, when oil accounted for close to 25% of electricity generation, compared with about 3% in 2012.

By contrast, the emergency response measure of surge production is a rapid and short-term effort to increase indigenous oil production. The measure is limited to those member countries with significant levels of production, and the potential volume available in a crisis depends on the amount of spare or surge production capacity maintained in individual nations. In the current oil market climate, this option is much less viable: overall, IEA member countries have little or no spare capacity. In addition, the need to maintain good oilfield practices limits the extent to which extraction can be increased on a short-term basis.



IEA member countries' oil stocks totalled 4.1 billion barrels earlier this year, equal to 44 days of global demand.

An evolution in energy stocks

When the IEA was created, OECD member countries (not all of which belong to the IEA) represented nearly three-quarters of global oil demand. The oil crises of the 1970s triggered efforts to switch to other energy sources, such as the launch of large nuclear programmes in several countries. As a result, oil use in power generation dropped significantly. At the same time, a number of OECD member countries developed domestic oil production. These factors significantly reduced overall reliance on imports; by the mid-1980s, dependence reached its lowest level in percentage terms since the 1960s, when the OECD as a whole first became a net oil importer. After that, however, new demand for transportation fuel stimulated greater oil use in OECD member countries, outpacing increases in domestic supply and resuming the trend of increasing dependence on imported oil.

While its share in the world's energy supply mix has declined, oil will remain the most important fuel in the world's primary energy supply for the foreseeable future, particularly given the transportation sector's dependency on the fuel. In 1973, transportation accounted for less than 35% of OECD oil consumption, while in 2011, its share was nearly 60%. For that reason most of all, the IEA maintains its robust oil emergency response system.

Not just reserves bolster energy security

But fundamental changes in the global energy mix, especially apparent among IEA member countries, mean that energy security requires much more than just oil stocks.

Since the IEA was founded, natural gas has grown from 16% to top 21% of total global primary energy supply, accounting for more than 25% of member countries' total primary energy supply mix in 2012. So the IEA has included the fuel in its most recent reviews of member countries' emergency response systems.

Also, electricity security is a growing concern in many emerging markets as well as in OECD member countries. With electricity demand set to rise faster than any other final form of energy through 2035, the IEA has expanded its emergency response review analysis to cover electricity security, too.

Download Energy Supply Security: The Emergency Response of IEA Countries – 2014 Edition: *http://bit.ly/ESS-iea*

A HISTORY OF FLEXIBLE FOCUS

THE FIRST 40 YEARS

Much has changed in 40 years, but the IEA has never deviated from its mandate to ensure reliable, affordable and clean energy for all.

How much has changed in 40 years? Well, it was a different century in 1974, when polyester was the fabric of fashion, pocket calculators the newest rage, and both US President Richard Nixon and Ethiopian Emperor Haile Selassie left office. And while Saudi Arabian light crude averaged USD 9.60 per barrel, that nominally small figure conceals how energy security topped consumer governments' policy concerns.

Oil powered the global economy then, and the 24 OECD member countries at the time accounted for 72% of demand. The producer group, OPEC, provided 50% of the world's oil. When the Organisation for Arab Petroleum Exporting Countries implemented an embargo that year, cutting supplies to major consumer countries, 17 OECD member countries formed the IEA to respond to future disruptions and to serve as a counterweight to OPEC.

Forty years later, smartphones are all the rage, web-enabled materials are (maybe) the next big thing for clothes and the IEA works with OPEC, even issuing a monthly indicator, or "call", as to how much it should alter its crude and stocks to provide adequate global oil supply. And while the IEA has 29 member countries, they represent less than half of global energy consumption. Yet no other organisation covers the full energy mix and represents consumers' interests with the expertise and the experience of the IEA.

The founding conference for the IEA in 1974.

Formed in crisis, focused on security

When the IEA was founded, its main objectives were to secure access to reliable and ample oil supplies and to establish and maintain effective emergency response capabilities.

To achieve those goals, the IEA first set up its emergency response capability, which now holds oil stocks equivalent to about 44 days of global demand. Under the 1974 accord creating the Agency, member countries agreed to hold oil stocks equivalent to at least 90 days of each prior year's net imports and – in the event of a major supply disruption – to release stocks, restrain demand or increase supply, or some combination of these three.

It was 17 years before the first activation of the IEA emergency response system, in the run-up to the first Gulf War in 1991. Two releases have followed since: after hurricanes Katrina and Rita damaged Gulf of Mexico oil infrastructure in 2005, and as civil war halted Libyan production in 2011 amid growing global demand.

Beyond just oil security

While it was created in reaction to an oil crisis, the IEA has from its earliest days focused on a broad definition of energy security. So while the IEA core mission has not changed, its scope of activities has.

The expansion started quickly, with the creation of research networks in the Agency's first year, accelerated with the formation of the Coal Industry Advisory Board in 1979, and further transformed in 1993, when the Governing Board approved new Shared Goals that included a stronger emphasis on economic and environmental sustainability. This evolution continued in 2005 when leaders at the Group of Eight summit meeting asked the IEA to develop plans for a climate-friendly energy future while maintaining economic growth.

Climate change is a core concern because 70% of greenhouse gas emissions derive from energy production or use. Besides the overall impact on human life and economic activity that a warming planet presents, rising sea levels, severe weather and other effects of climate

1974
Washington Energy Conference; IEA is formed; Ulf Lantzke (Germany) becomes first Executive Director

IEA founding member countries: Austria, Belgium, Canada, Denmark, the Federal Republic of Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States of America; Norway has participated in the Agency under a special agreement since 1974

1975
Multilateral technology initiative (Implementing Agreements) started

1976
Long-Term Co-operation Programme provides for periodic review of member countries' energy policies

1977
New Zealand and Greece join

1979
Coal Industry Advisory Board is established; Australia joins

1981
Portugal joins

change also threaten recovery of fossil fuels as well as power generation from them and from nuclear and renewables.

The IEA works to counter climate change in many ways: scenarios in its flagship publications that warn of unsustainable policies, policy recommendations on how to decarbonise the energy system, even talks it hosts for regulators and executives on the climate-energy nexus.

IEA Executive Directors (from left) Nobuo Tanaka, Maria van der Hoeven, Robert Priddle and Claude Mandil.

Analysis and data remain at the core

To provide better understanding of the dynamics and trends in energy markets in the past, present and future, the IEA has developed a broad range of reports, papers and publications, including its monthly *Oil Market Report*, which includes the "call" on OPEC concerning production; the annual *World Energy Outlook* (*WEO*) and *Energy Technology Perspectives*; plus yearly market reports for oil, gas, coal, renewables and energy efficiency.

The IEA has also compiled and provided comprehensive and authoritative energy data and statistics to underpin its work. Among its many recommendations, since 2008 the IEA has proposed its 25 Energy Efficiency Recommendations, which, if implemented globally and without delay, could reduce worldwide carbon dioxide (CO_2) emissions by 17% per year by 2030 – equivalent to roughly 1.5 times current US annual CO_2 emissions. Since 2011, the IEA has provided an annual progress report to the Clean Energy Ministerial, tracking key technological developments and clean energy deployment among countries.

For almost four decades, the IEA energy technology collaboration network of Implementing Agreements has enabled a pooling of resources among governments, academia, industry and other organisations to focus on research, development, demonstration and deployment of energy-related technologies. The more than 40 Implementing Agreements, which include participants from both IEA member and non-member countries, cover topics ranging from concentrated solar power to carbon capture to nuclear fusion.

And since 2010, the Low-Carbon Energy Technology Platform brings together stakeholders from the private and public sectors to share experience and compare progress on technological and deployment progress.

A growing global presence

Much of the IEA work on climate change and other issues is co-ordinated with other international organisations, extending the Agency's reach and providing broader inputs. The IEA has agreements with global energy groups such as the International Renewable Energy Agency, as well as development agencies such as the Asian Development Bank and the European Bank of Reconstruction and Development that generate synergies for research, workshops and dissemination of policy recommendations.

The IEA also works with UN agencies, including the Sustainable Energy for All initiative, to the point where Executive Director Maria van der Hoeven sits on its Advisory Board. That's because the IEA is responsible for some of the most-cited research on energy poverty, a concern that has been a focus of the *WEO* since 2002. The *WEO* provides recommendations and spending plans to provide electricity to the 1.3 billion people without access to modern energy.

The IEA also works with the private sector, particularly through its Energy Business Council, made up of 35 of the top energy and energy-consuming companies. The chief executives of

1983
First issue of monthly *Oil Market Report*

1984
Helga Steeg (Germany) becomes Executive Director

1989
IEA mandate expanded to include environmental protection

1990
OECD non-member economies consume more than half of global energy

1991
IEA co-ordinates oil release related to the Gulf War (below); dialogue between major energy consumers and producers

1992
Finland and France join

1993
First annual *World Energy Outlook*

1994
IEA Memorandum of Understanding with Russia; Robert Priddle (United Kingdom) becomes Executive Director; IEA data extended to non-member countries

1996
Chinese agency signs Memorandum of Policy Understanding with the IEA

A 2011 meeting of the Energy Business Council, a platform for executives to discuss policy with IEA officials.

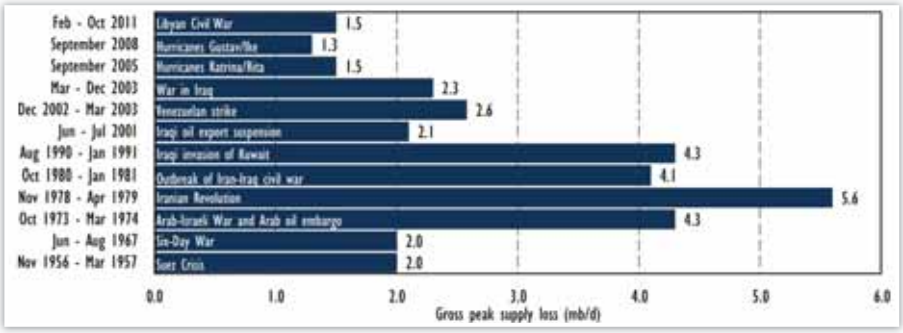
those companies now take part not just in IEA meetings but also sit side-by-side with energy ministers at the biennial Ministerial meetings.

29 members and broader engagement

The IEA has almost doubled its membership in four decades, most recently welcoming Estonia as its 29th member. To join the IEA, a country must already belong to the OECD. But as directed by its member countries, the IEA has since the 1980s developed close co-operative working relationships with major energy consuming, producing and transit countries. These extensive working relationships culminated most recently at the 2013 IEA Ministerial meeting, where six key partner countries – Brazil, China, India, Indonesia, Russia and South Africa – issued a Joint Declaration on Association that represents the first time that the IEA and partner countries have publicly expressed interest in exploring the mutual benefits of adding a multilateral dimension to already-strong bilateral co-operation.

The IEA works closely with other consumer countries, including members of the Association of Southeast Asian Nations, which in 2011 signed a Memorandum of Understanding formally recognising ongoing co-operation in energy-related activities. An example of these close ties was the IEA review that year of Thailand's preparations against an oil or gas supply disruption, the first such review of a non-member country. In 2012, the IEA carried out a similar review of India's emergency preparedness.

Perhaps the most remarkable outreach, but one that is now routine, is IEA relations with OPEC and such leading oil producers as Saudi Arabia. OPEC and the IEA held their first talks 20 years ago; they now meet regularly through the International Energy Forum and co-operate extensively on making energy data transparent and widely available.



The IEA has used its emergency response capability during three of the major oil supply disruptions since 1974.

A lot of change, but one constant

Over the past four decades, the IEA has worked to provide sound advice and appropriate recommendations for a reliable and sustainable energy future, instituting its "3Es" of sound energy policy: energy security, environmental protection and economic development.

Much has changed in 40 years, not least which countries use energy how, but the core mission of the IEA remains intact. Energy security has always been its *raison d'être*, even as its definition has expanded.

So after a pause to blow out candles, it's on to the next 40 years, with new projects and new associates but always the same priority: secure and sustainable energy.

1997
Hungary joins; first edition of *Key World Energy Statistics*

1998
Indian Ministry of Power and IEA sign Declaration of Co-operation

1999
IEA compiles member countries' policies and measures on climate change, energy efficiency and renewable energy, which become publicly available as the Policies and Measures Database

2001
Czech Republic joins; IEA co-founds Joint Oil Data Initiative (left)

2002
The Republic of Korea joins

2003
Russian Energy Minister takes part in Ministerial meeting; Claude Mandil (France) becomes Executive Director

2005
China, India and Mexico at Ministerial; after hurricanes, IEA co-ordinates oil release; G-8 asks IEA to pursue "clean, clever and competitive energy future"

A HISTORY MADE UP OF NUMBERS

DECADES OF DATA

Statistics are at the heart of the IEA mission, as security and policy require accurate and timely data concerning energy use and supply worldwide.

By Jean-Yves Garnier

Jean-Yves Garnier is retiring this year as Energy Data Centre chief. Before his nearly 20 years at the IEA, he held posts in Jakarta, Djibouti, Abidjan and Berkeley plus Paris, where he was in charge of National Energy Plans and energy efficiency policy as well as building energy information systems.

The IEA may be best known for its co-ordination of emergency stockpiles, but the most-used tool the Agency offers to member and non-member countries alike is its vast and authoritative trove of data, with regular updates of such critical factoids as oil and gas supply and demand figures, carbon dioxide emissions from energy combustion, and prices and taxes for energy products.

Each year, and even each month, a wave of data arrives from member countries and around the world, data that governments, policy makers, analysts and the IEA Secretariat depend on to spot threats and opportunities. The statistics inform everything from emergency preparedness to how much energy is used per sector and per end-use.

Statistics for a shifting energy map

In the past four decades, global population and economic output have surged and shifted, with huge effects on energy usage. Whereas OECD member countries used about two-thirds of global energy when the IEA was founded, the Agency determined in 2005 that their share that year was falling below one-half – and this year their consumption of oil also fell below one-half – thanks to other economies' demand growth but also member countries' more efficient as well as diversified use of energy. OECD member countries have cut the share of oil in their total primary energy supply (TPES) from 50% to 35% by minimising the use of oil for power generation and in the residential sector.

That is an example of the many statistics that the IEA Energy Data Centre has tracked since the Agency's founding. At first, the IEA focused mainly on OECD member countries, but as the heft of other countries in global energy grew greater, it turned its attention to the whole world.

Though the IEA is the leader in global energy data, it does not act alone. It works with OECD and non-OECD countries as well as international organisations, developing a consistent methodology for collecting energy data. IEA statistics now apply to more than 130 countries around the world and more than 95% of total energy supply and demand.

In its mission to provide more timely data and extended coverage, the IEA was instrumental in founding the Joint Oil Data Initiative in 2005 together with five other partner groups to provide monthly updates on oil supply and demand. That effort has now expanded to natural gas, always with IEA data as a principal component. The IEA was also a leader in the InterEnerStat initiative that led to a global agreement on definitions of energy flows and products.

Challenges to maintaining high standards

But expanding the range and variety of statistics for the world presents strains. The economic crisis has caused resource limitations in countries both wealthy and less so. As a result, data can arrive late and incomplete, preventing a timely and comprehensive picture of the world energy situation. Luckily, there are some happy exceptions to this trend, including the Chinese National Bureau of Statistics, which over the last ten years has multiplied by four the number of its statisticians working on energy.

The next goals for IEA statistics include further improving OECD member countries' data quality, coverage and timeliness while working with organisations and non-OECD countries to further increase global data coverage and transparency for the benefit of all. That's because, just like 40 years ago, the statistics the IEA collects and shares are crucial not just to measuring energy use and supply but advising on best policy for improving energy security, affordability and sustainability.

2006
First editions of *Energy Technology Perspectives* and *Medium-Term Oil Market Report*

2007
The Slovak Republic joins; Nobuo Tanaka (Japan) becomes Executive Director

2008
Poland joins; IEA proposes "25 Energy Efficiency Policy Recommendations"

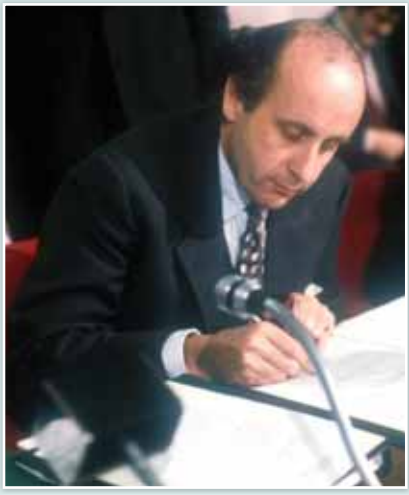
2009
Energy Business Council founded (right)

2011
Libyan disruption prompts oil release; Maria van der Hoeven (Netherlands) becomes Executive Director; key partner country ministers attend Ministerial

2012
First *Medium-Term Renewable Energy Market Report*

2013
Six key partner countries sign Joint Declaration of Association with IEA; first *Energy Efficiency Market Report*

2014
Estonia joins



By Etienne Davignon

Etienne Davignon, who had headed the Belgian Foreign Affairs Ministry's cabinet, was the IEA Governing Board Chair from the 1974 signing of the founding accord (above) to 1977. He then was Vice President of the European Economic Community's Commission and, next, Industry Commissioner. He later was Chair of the Société générale de Belgique and now, among other entities, is Chair of the Palais des Beaux-Arts and the Royal Institute for International Relations.

HOW IT ALL STARTED

Following the oil embargo decided by OPEC, and after considerable confusion and disagreements, the United States finally organised a ministerial conference in Washington in February 1974 grouping OECD member countries.

The meeting was characterised by a confrontation between Henry Kissinger and Michel Jobert, the French foreign minister, and disputes among the Europeans trying to define a unified position. It ended without a consensus, but mandated a working party to search for a collective answer to the crisis. I was asked to lead this effort, taking into account the attempts I had made to find a compromise in Washington.

So the personal representatives of the concerned ministers started to work. Quickly we agreed that three main objectives should be pursued:

- binding legal commitments
- permanent supply reserves
- a crisis mechanism which would trigger an oil-sharing system.

A working party during July and August, under the leadership of our Danish colleague G. Ribberholdt, would prepare the legal texts for the treaty. Ulf Lantzke, the German representative who would become the first Executive Director of the new institution, Tom Enders, Henry Kissinger's representative, and I tried to reach the indispensable political consensus.

I strongly believed that the credibility of a sharing mechanism required that the decision to employ it be taken by majority voting. So with great pain we worked out a system of weighted votes, which would require at least three states to stop the application of the sharing mechanisms in the case of an identified crisis.

As so often, solidarity was praised in principle, but contested in practice. Henry Kissinger was of the opinion that this would create major difficulties in Congress. So I was summoned to Washington but managed, thanks to the mandate I had received from my colleagues, to make our case!

The next steps towards the birth of the IEA

The rest was simpler, but not much more:

- how to take into account that among the signatories, there were also producing countries (Canada, Norway and the United States)
- how to persuade the neutral countries – Finland, Sweden and Switzerland – that their commitments would not affect their status
- how to fix the level of state-owned national reserves
- how to define in practice the level of crisis which would trigger the sharing mechanism
- how to co-operate with industry.

Eventually we managed to overcome these hurdles.

Resistance from within and without

The regular meetings of an unchanging group of officials influenced us in defining the governance for the new institution. We proposed that it would be part of the OECD set-up but with a separate council of ministers and with a permanent governing body composed of personal representatives of ministers, coming from the capitals. A dedicated secretariat would be put in place, and a specific budget for the institution.

This proposal was not supported by the Secretary-General of the OECD, but the governments considered that something new was required due to the existing tensions at the time and the uncertainties related to an unknown future.

These proposals were strongly criticised by the OPEC countries, who considered the creation of the IEA a provocation. But finally, two years later, Sheikh Yamani invited me to attend, as Chairman of the Governing Board, a session of an official OPEC meeting in Vienna.

So, as time has taught me, what starts with difficulties does not necessarily end badly.

Happy Birthday, IEA.

Etienne Davignon: OECD/IEA, 1974

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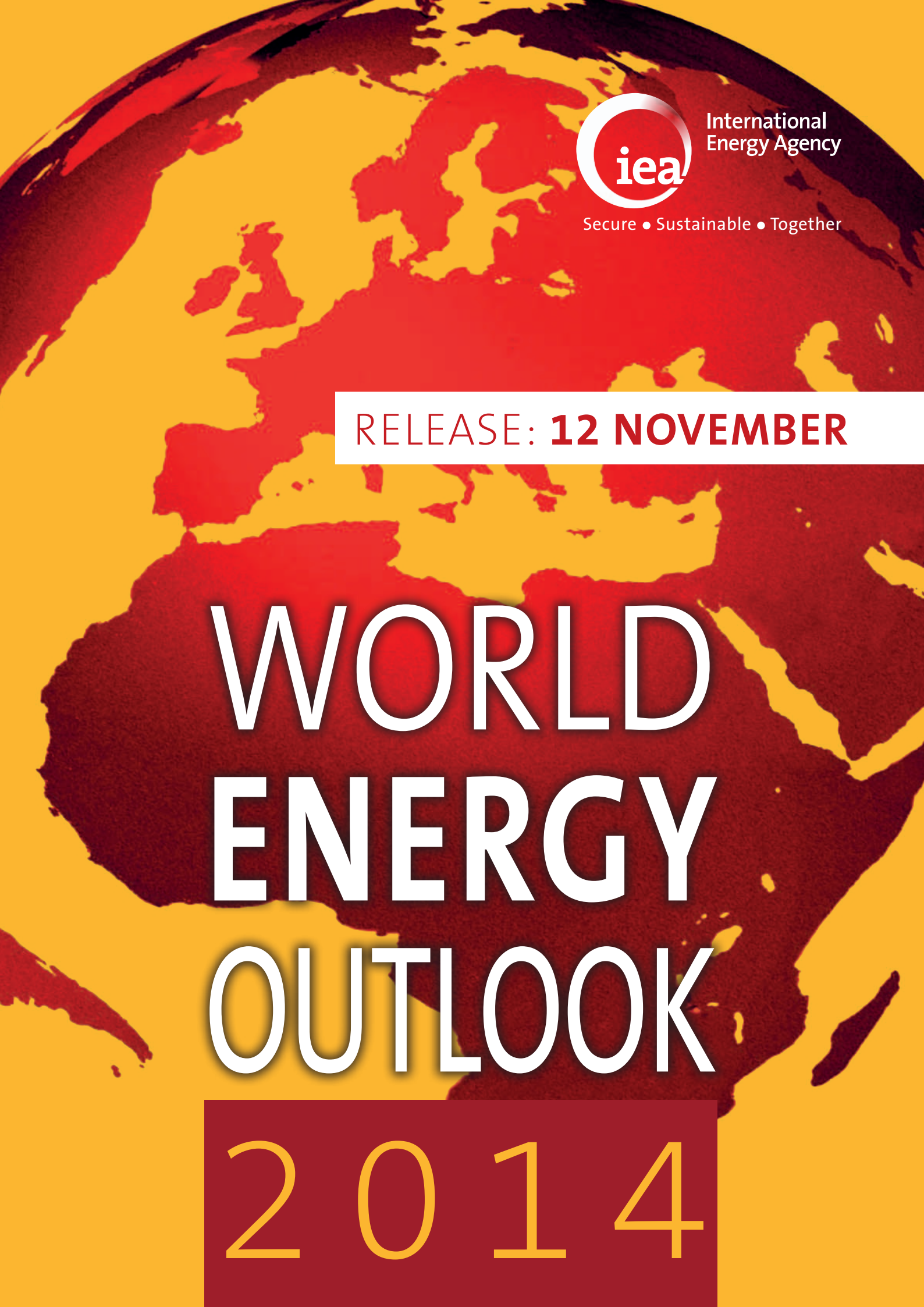
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A "FATHER OF THE IEA" LOOKS TO ITS FUTURE

By Henry Kissinger

Dr. Henry A. Kissinger was awarded the Nobel Peace Prize in 1973, the year he became US Secretary of State, a post he held until 1977. He was Assistant to the President for National Security Affairs from 1969 to 1975. From 1984 to 1990 he served on the President's Foreign Intelligence Advisory Board. Now Chairman of Kissinger Associates, Inc., he is a member of the Defense Policy Board and an Honorary Governor of the Foreign Policy Association.

Four decades ago, the developed economies faced an energy crisis that challenged the complacencies of an era in which oil supplies had been affordable and seemingly plentiful. Although a crisis had been looming, it was the October 1973 Arab-Israeli war and subsequent embargo that exposed the vulnerability of the energy system. The ensuing economic upheaval forced a search for a new approach.

For the industrialised nations, the problem involved a technical aspect as well as a diplomatic and psychological dimension. So long as the major oil-consuming states operated in isolation from one another, their policies would remain subject to concerted pressure. Public confidence, and diplomatic leverage, would suffer absent a demonstration that importers as well as exporters were capable of a co-operative approach.

I was not at that point considered a technical expert on the subject of energy. It is with pride but some wonder that I have borne the distinction of a "father of the IEA", since the Agency's achievements have rested on the work of a superb group of professional experts. My December 1973 speech to the Pilgrims of Great Britain was intended to signal that the United States would put its diplomatic and economic weight behind the search for a solution.

The call in that speech for "a massive effort to provide producers an incentive to increase their supply, to encourage consumers to use existing supplies more rationally and to develop alternative energy sources" was answered by a remarkable and determined group of affected nations. Less than a year later, the International Energy Agency was established within the framework of the Organisation of Economic Co-operation and Development.

The new agency carried a broad institutional mandate to foster improved energy security through co-operation on energy policy among major consuming nations, including the co-ordinated stockpiling of emergency energy supplies to cushion against real or threatened future supply disruptions. Original membership included 17 industrialised countries which, at that time, accounted for almost 60% of global oil demand. The major consumers had shown their determination to shape the new energy era as active participants.

40 years of strengthening energy security, now a global priority

Since then, the IEA has made invaluable contributions to global energy security. The Agency has utilised the strategic reserve programme three times in actual supply disruptions, and in other crises the knowledge of these stockpiles has contributed to mitigating tensions. The IEA has played a unique informational role as a source for reliable data and analysis, publishing an annual *World Energy Outlook* studied carefully in every governmental and financial centre across the world. It has encouraged the diversification of energy supplies, including in new areas such as renewables. And it has promoted energy efficiency and conservation efforts important both as strategic and environmental imperatives.

As the IEA looks to its next four decades, its membership is broader and the challenges it addresses are global in scope. Today, energy security and the stability of international energy markets are no longer the primary focus of a specific country or region; they are worldwide concerns. As I salute the achievements of the Agency, it is my hope that the spirit of creativity and solidarity displayed in the IEA's opening years can continue on this newly global basis and support an even broader common security and prosperity.

Henry Kissinger: © Jürgen Frank

FELIPE CALDERÓN

FELIPE CALDERÓN, PRESIDENT OF MEXICO FROM 2006 TO 2012, NOW CHAIRS THE GLOBAL COMMISSION ON THE ECONOMY AND CLIMATE, WHICH BRINGS TOGETHER FORMER GOVERNMENT LEADERS AND FINANCE MINISTERS WITH BUSINESS CHIEFS AND PROMINENT ECONOMISTS TO COMMUNICATE CLIMATE CHANGE'S ECONOMIC IMPACTS. LOOKING TO THE NEXT 40 YEARS OF ENERGY, IN THIS INTERVIEW HE CALLS FOR A GRAND TRANSITION.

What has changed the most in the energy sector since 1974?

The world has changed dramatically since the 1970s, and the energy sector is no exception. In fact, it has been one of the engines of change. International trade has multiplied 22 times from the 1970s to the beginning of this decade and the world economy has expanded 12 times in nominal terms. Maintaining this pace has posed a challenge to the energy sector which, to keep up with global energy demand, has based its production, resources and innovation capabilities on fossil fuels, particularly oil.

This energy model is reaching its limits. On the one hand, it is under tremendous pressure not only because of the rising demand but also due to the increase in energy costs as well as high price volatility and uncertainty in energy supply. On the other hand, the model creates greenhouse gas emissions that have accelerated global warming. Temperatures in the last four decades have been the highest in hundreds of years. The dire consequences of this situation are seen in climate change around the globe. The long-term implications remain to be seen, but there is no doubt that climate change will have very high costs in every social, economic and political aspect of human activity.

With regard to the rising demand, the technological response has given a higher viability to the fossil fuel model in the short and medium term. A clear example is the technological development in both hydraulic fracturing, or fracking, and horizontal perforation. This has given place to a technological revolution for the extraction of shale oil and shale gas. This change is so important that it is already creating a new perspective in terms of global energy, economy and even probably the geopolitical order. In the case of North America, the United States, Canada and Mexico have technically recoverable reserves of about 2 quadrillion cubic feet [57 trillion cubic metres] of shale gas. With such reserves, North America can strengthen its energy security: the United States alone will go from net importer to net exporter of hydrocarbons.

With regard to climate risk, current trends put us on a path of global warming that can reach up to 4 degrees Celsius, which poses a serious problem. If the technological transformation in fossil fuels has some benefit, it will be in terms of the increased ability to extract and use shale gas, which is cleaner than coal and oil. This might imply that natural gas can substitute in the mid-run for the fuel that creates most of the greenhouse gas emissions: coal. But this would not be enough. The world needs a full transition towards a low-carbon economy based on renewable fuels. The good news is that policies that have put restrictions and taxes on emissions, particularly in Europe, have encouraged new, unprecedented developments in renewable energies, which have made solar and wind energies as – or even more – competitive than fossil fuels in some countries. This is not the rule yet, but we are witnessing a hopeful evolution.

What will change most in the next 40 years?

Climate change is a reality. As long as global warming as a result of carbon emissions continues, in the following years we will witness extreme meteorological events in higher number and intensity.

The energy matrix that supports global economic growth must change. To meet this transition is a challenge that needs an effort from many fronts. On the supply side, new energy projects must be based on cleaner energies such as hydro, wind and solar. This implies strong commitments for financing and technological progress to keep abating energy generation, transmission and storage costs. On the demand side, it is key to create conditions to reduce per capita consumption and, at the same time, have energy at competitive prices.

The role of governments is to generate the right incentives for society and the private sector to promote the transition to a low-carbon economy. The goal must be a new model of sustainable development that leaves behind the false dilemma between economic growth and the fight against climate change. The most important policy tool will be a clear pricing system that includes negative externalities related to the use of fossil fuels, tax burdens linked to the use of coal and, of course, the full elimination of public subsidies to fossil fuels.

What is the top challenge to energy security?

The transition towards a sustainable economy entails several challenges. Perhaps the most important is to take the cost of generating, transmitting and delivering renewable energy to a turning point for it to be as cheap – or cheaper – than fossil energy. Market mechanisms are needed to encourage technological innovation. Global elimination of fossil fuel subsidies and the creation and regulation of carbon taxes are key, even in substitution of other taxes on labour or income, in a way that the effects on global economic growth are positive or neutral.

Some key costs must be cut, such as for energy storage. Also, there is clear need for substantial advances in carbon capture and storage technologies, which are still in a very early stage of development. This will require an increase in public research and development budgets, in a way that governments create market incentives for private investment in these and other technological developments in the energy model.

In 40 years, what will be said of our policies?

If in 40 years we were to look back to the policies and decisions made today, I think we would wonder: "Why did we not start before?" Among the decisions that the policy makers of the future would have liked us to start earlier and more boldly:

- A global commitment to the drastic reduction of greenhouse gases.
- Innovation-oriented policies to reduce the carbon footprint of every person on the planet.
- Elimination of subsidies to fossil fuels to channel resources to clean energies.
- Relevant increases in public budgets for research and development in areas such as production of clean energies, carbon capture and storage, and in general a reduction in the costs of renewables. Another area is the provision of clean energy to millions of people who still lack access to it.
- A new global policy that changes the current urban development model and starts developing compact and efficient cities. This is crucial, as in the next two decades, more than 1 billion people will join the global urban population.
- Sustainable use of forests and jungles, and the end of deforestation and desertification.
- Innovation in the agricultural sector to increase productivity while decreasing the impact on the environment.
- Further internalisation of environmental costs on energy projects.

In general, we are talking about public policies with a human approach; policies that will create paths towards a sustainable energy sector and at the same time create opportunities for economic development in every nation.

With its reform, former President Calderón sees a Mexico able to utilise all of its energy sources, including wind.

What role do you see for the IEA in this?

Both IEA member and non-member countries have their share of responsibility in the planet's energy future. It is very important to create a permanent dialogue among all nations whether they are member countries of the IEA or not and whether they are net energy consumers or producers.

The challenges ahead are significant and demand that all stakeholders add their efforts towards a common goal: sustainable development. Actions from the private sector, civil society, governments and international organisations must create incentives to promote investments and agreements to attain this common goal.

One of the key international institutions in this context will be the IEA, which has among its challenges to increase its membership, particularly among those countries that have a greater impact in the international energy map as big consumers or producers. I am talking of countries such as China, India, Russia, Saudi Arabia, Iran, the United Arab Emirates, Venezuela and Mexico.

The IEA will also have to look for a deeper collaboration with other organisations and the creation of spaces to share experiences and technological improvements. In this way, the IEA will mark the path of energy sustainability in the 21st century.

The IEA must contribute in order to balance the energy matrix: it is central that private firms, consumers, governments and producers understand that the current model based on fossil fuels has reached its limits. We need to accelerate the transition towards a new energy model, and we have to do it while promoting economic growth.

MEXICO'S ENERGY REFORM

How will Mexico's reforms increase domestic and global energy security?

As President of Mexico, I made attempts to reform the energy sector. I proposed to Congress a reform that allowed private firms to invest in every link of the value chain in order to bring fresh capital to the energy sector and increase competition to benefit the final consumer via more competitive prices.

When the results of the current energy reform become visible, Mexico will be able not only to increase its infrastructure to produce raw energy but also to boost its capacity to produce intermediate goods (petrochemicals). The reform will strengthen Mexico's energy security, allowing the state to complement its investments with private resources along every step of the value chain.

In general terms, Mexico will have a great opportunity to reaffirm its stance as an oil nation, with a high development of the hydrocarbons industry, conventional and non-conventional. It will also have new capabilities to balance its energy matrix, developing in a sustainable manner all of its natural renewable resources. Mexico is a latecomer to this step, and the fossil fuel model is almost exhausted. Despite this fact, Mexico has to design its own transition towards a low-carbon economy, making good use of available natural gas to make that transition smoothly, without compromising economic growth.

What can we learn from Mexico's reform?

One lesson has to do with the importance of the timing of reforms. Mexico needs public policies with a long-term vision that are implemented at the right moment. In my opinion, Mexican energy reform should have happened at least ten years ago, not now when the need to open the sector has a sense of urgency, as the nation's energy security would have otherwise been compromised.

Another lesson is that we have achieved the participation of all national actors: society, government, businesses and the political parties, in particular the opposition parties that have acted with responsibility to enrich a comprehensive reform, with far-reaching effects.

By Helga Steeg

Helga Steeg was the second IEA Executive Director, serving from 1984 to 1994, after a German civil service career that began with the Ministry of Economics in Bonn and included promotion to Director General for International Trade and Investments and service as Alternate Director of the World Bank's Governing Board. She then earned a University of Bochum law doctorate with the dissertation Energy Security under Changing Circumstances.

REMARKABLE CHANGE

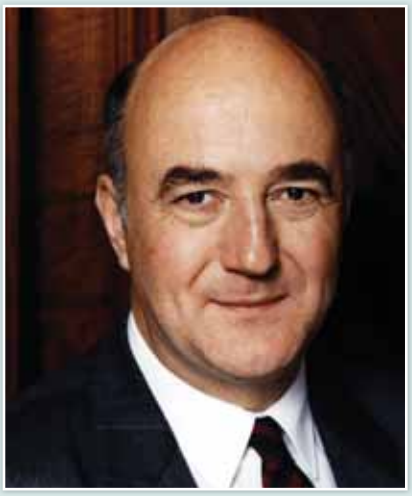
I want to start by mentioning that during my tenure the relationship with the OECD Secretary-General was excellent, and this has remained so ever since. Let me also say that it was an excellent experience working with the IEA staff from our different member countries – they were so devoted to the work in our organisation.

There were many different highlights during my time at the IEA:

- The accession of France to the IEA at the outbreak of the first Gulf War. The negotiations were completed very quickly and without any difficulties.
- The solidarity of our member countries during the Kuwait crisis and Gulf War, although there was some difference of opinions with regard to the emergency sharing system: whether to use it to bring down prices or to use it only when there was a real deficit. The agreement reached was to offer oil on the market during the night of the outbreak of war (1991) because of uncertainty of supply.
- The invitation by the King of Saudi Arabia to visit his country. This invitation came by normal air mail at the beginning of the 1990s. I followed up on it and thereby opened up the relations that my successors so effectively widened.

When I compare the founding documents of 1974 with the official Shared Goals member countries agreed to two decades later, there are some remarkable differences from the times of the oil price increases that led to economic recession and resulted in government measures in 1974. Since the 1980s there has been an adherence to free and open markets.

The IEA is now the most important international energy organisation, with a remarkable increase of membership. New issues include the environment as well as increased international co-operation on new technologies.



By Robert Priddle

From 1994 to 2002, Robert Priddle led the IEA as Executive Director. Before taking charge at the Agency, he was a Deputy Secretary and Director General of Energy Resources in the United Kingdom Department of Energy and Trade and Industry. He has remained involved in IEA matters, holding editorial responsibility for the annual World Energy Outlook.

ERA OF ADAPTATION

By the time I took over as Executive Director, much had been done to consolidate and exercise plans for any future oil emergency. But more had to be done to adapt the emergency response mechanism to the changing conditions of the international oil market. And there was also growing acceptance among the membership that oil production and consumption needed to be managed in a more environmentally acceptable manner: sustained environmental damage would ultimately prejudice the very objective of supply security.

In the period 1994-2002, the emergency-response mechanism was made more flexible and market-oriented, and the Agency became a leading and influential voice advocating sustainability, sometimes to the surprise of an energy industry accustomed to counting on OECD governments to support uncritically the supply side of the business. The relationship with the oil producers also changed. My efforts to get to know the Secretary-General of OPEC in 1995 had to be conducted covertly: our first meeting took place not in the OPEC offices but in an obscure hotel room in Vienna. By 2002, the OPEC and IEA Secretariats were routinely meeting to exchange information and analysis; the International Energy Forum was regularly bringing together ministers from oil-producing and -consuming countries; and the new Secretary-General of OPEC and I that year gave the first-ever joint press conference by the heads of the two organisations.

The challenges have not ended, and the members continue to profit from the diverse and expert contribution the Agency can make. For example, in Europe liberalised electricity markets disclose the complexity of imposing well-designed interventions to achieve objectives not reflected in market prices, while the security of natural gas supply remains a conundrum. Even when the prime responsibility for action may lie elsewhere, the IEA Secretariat has the data, the analytical power and the enthusiasm to contribute to significantly better policy making in member countries and beyond.

By Claude Mandil

Claude Mandil was Executive Director of the IEA from 2003 until he retired in August 2007. Previously, he was Director General for Energy and Raw Materials at the French Ministry of Economy. He represented France and held the presidency at the Group of Seven's Nuclear Safety Working Group. In industry, he was Managing Director of Gaz de France before serving as Chairman and Chief Executive Officer of the Institut français du pétrole.

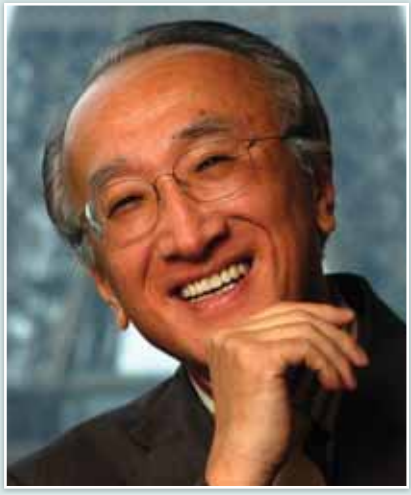
A VERY EXCITING TIME

I think that during all my professional life, I have never been happier than when I was at the IEA. I was incredibly lucky: it was a time when governments realised that energy policy was not an oxymoron, but a need, even in liberalised economies, and some remarkable events occurred during my tenure. Among them: a new momentum for dialogue with oil producers, mainly with the OPEC Secretariat and with Saudi Arabia; a successful emergency stock release after hurricanes Katrina and Rita in 2005; a strong involvement in the preparation of the Group of Eight summit meetings, resulting in a seat for the Executive Director at the summits starting from Gleneagles in 2005; and the celebration of the 30th anniversary of the Agency, splendidly organised by Turkey in Istanbul. What a busy time! But what an exciting one!

Of course there were also some difficult moments, and some very sad ones. During my time, the Agency suffered the loss of three marvellous colleagues: Loretta Ravera, Pierre Lefèvre and Gordon Duffus. They still are in my memory.

But if I try to analyse the pleasures I had, I think that the main one was working with the staff. Managing professionals of dozens of different nationalities provides a stimulus I had never experienced before. And when these professionals are of outstanding knowledge, smartness and dedication, you really enjoy going to your office each morning! I felt my role was very simple: to be their loudspeaker in order to make their reports and studies as widely known as possible.

Still now, retired since 2007, I try to stay informed of the main energy and climate issues, and I feel proud – yes, I dare say proud – when I see that the IEA is more than ever the reference for everybody: politicians, experts, media have to quote the IEA if they want to be serious, and to take its views into account if they want to be listened to.



By Nobuo Tanaka

Nobuo Tanaka was the first non-European Executive Director of the IEA, serving from 2007 to 2011 after his second tenure as OECD Director for Science, Technology and Industry. A career Japanese civil servant, he was Director-General of the Ministry of Economy, Trade and Industry's Multilateral Trade System Department. He is now Global Associate for Energy Security and Sustainability at the Institute for Energy Economics in Japan.

IEA AT A CROSSROADS

As the first Executive Director from Asia, I did my utmost to get China and India to join the IEA. Unfortunately they haven't joined the Agency, but the relationship has become much closer. Energy security is issue number one for peaceful development of the Asian region. The expertise and practices of the IEA are exactly what Asian governments need collectively. For example, emergency preparedness measures, energy efficiency and conservation policies, and cleaner coal and renewable energy technologies are very relevant for the countries' sustainable growth. The peer review mechanism provides friendly and objective foreign pressure to reform domestic policies.

I visited Beijing and New Delhi many times to actively engage ministers and secretaries for collaborative actions with the IEA. Friendship was built through these contacts and continues. I even asked for advice from former US Secretary of State Dr. Henry Kissinger, as founding father of the Agency, about how to persuade Chinese and Indian leaders. He agreed that China and India should join for the sake of their own security, adding that it would also help the IEA maintain its relevance in the rapidly changing energy market.

China and India have become very collaborative with the IEA and though short of full membership, are actively involved in the Association initiative. I noticed the recognition by a Chinese leader when I talked with then-Vice Premier Li Keqiang at the Global Think Tank Summit in 2011, just after the IEA had decided to release petroleum stocks during the Libyan crisis. He said to me, "I know the IEA is a very important organisation for China." In India, awareness of the IEA became so high that government ministers have discussed the pros and cons of joining officially.

The ball is probably now in the court of IEA member countries: are we willing to change our statutory agreement to open a way for China's and India's entrance?

A BUSINESS LEADER SPEAKS

JOE MASTRANGELO

The CEO of GE Power Conversion details what the private sector offers, and gains, through co-operation with the IEA on the future of energy.

When the IEA was created 40 years ago, energy security mainly referred to oil stocks. Today it has become a much broader concept. Many new parameters now influence the overall concept of energy security.

The mix of energy supply is evolving to new basins. As such, some countries are becoming energy-independent, leading to a change in the global balance of energy diplomacy. Energy security still has the same definition of keeping the lights on and the economy running, but the parameters of the equation have changed. Today it's about combining energy security with a sustainable production and consumption path while turning energy into an enabler for a low-carbon society. The challenges are to identify the right balance between demand, sustainable objectives and macro-trends. We need to make the best of our available resources through harmonised policies that combine energy, environment and economic development.

How GE addresses these challenges

GE focuses on addressing pressing challenges through innovation, partnering and driving the debate. We have invested heavily in research and development (R&D), successfully launching products to bring new technologies to market that respond to our customers' ever stricter environment challenges. We have partnered with universities and invested in lab facilities to ship our expertise abroad and to help train the next generation of engineers to boost energy security in emerging countries.

Moreover, every day we work with customers to make what we develop in our R&D labs a game changer for them. One of the areas where we are making big inroads is what we at GE call the Industrial Internet: how "big data" coupled with the latest in drive, propulsion or electric motor technology is changing the operating conditions of our customers. It means less downtime, higher efficiency, more flexibility and cleaner energy production and use.

Future energy security will be as much about how efficiently we use the energy we have as it will be about finding new resources. The biggest challenge we face is that demand will outgrow supply in the very near future. This, coupled with the pressure of climate change and shifting geopolitics, means that we will have to be increasingly innovative to ensure energy security. By working with partners such as the IEA, we at GE are turning these challenges into opportunities by focusing on smart inventions and the capability to create power, develop energy-efficient solutions and enhance security. GE is at the forefront of making sure that efficiency gains are seen as a precious resource and maximised. They not only make industry more efficient but also cleaner and more competitive.

GE engineers its motors for efficiency in challenging environments as part of its push to aid future energy security.

As access to energy becomes increasingly challenging and demand more diversified, we need to have a long-term vision that is coherent with the underlying market changes.

GE-IEA teamwork for effective policy

Defining an effective energy policy in today's world is no simple task. The starting point is a long-term commitment and engagement to develop and implement stable regulatory frameworks that will secure private-sector investments among other things.

The IEA has created a unique platform to promote dialogue among the key players in energy policy and in the industrial scene. The collaboration between GE and the IEA provides the opportunity to develop innovative policy solutions to respond to upcoming challenges. It is also a chance to challenge decision makers' ideas with the reality of technology and economic rationale. An example of this is how at present industry is coming to view gains in efficiency as critical to the future of energy in the same way as finding new resources, in part because of GE's technological gains in this area.

Driving the energy debate is really what is key, so that industry moves along the same lines to meet tomorrow's challenges. We need to continue building dialogue and sharing expertise while leading by example. This is perhaps the most important element of identifying upcoming

GE innovation at work at an Australian liquefied natural gas site: the firm shares ideas via an IEA research network.

challenges and developing innovative solutions and appropriate policy recommendations.

The benefits of international co-operation

Geographic diversity gives us a better understanding of priorities in terms of energy needs and business developments.

Our customers face unique challenges; it is up to us to bring them adaptable and flexible solutions. If we are not building our business where our customers are, or where they are facing these challenges, we are losing a clear competitive advantage. If GE has been so successful it is because for the past 130 years we have known how to listen to our customers.

Detailed market data analysis made by IEA experts and identification of macro-trends give us an opportunity to validate views on geographical areas coupled with our experience on the ground. Moreover, the world has different requirements for different regions and industries. By being global, while operating locally, we can adapt and make sure our products and services meet local requirements and local needs.

Industry as well as the IEA must continue their initiative to engage with non-IEA member countries, considering the increasing importance that these countries will have or have already. We must continue highlighting the importance of harmonising economic, energy and environmental policies since they are all so interlinked.

For example, we started taking part in the Energy Business Council meetings a couple of years ago. The level of expertise and the quality of exchanges have always been incredibly high, and adding in the IEA Ministerial meeting of last year proved to be a unique opportunity for concrete discussions about future energy policies.

Another very successful experience has been the Gas & Oil Technologies Implementing Agreement launched in March 2013 within the IEA technology network and operated by GE. The initiative brings together decision makers, the oil and gas industry, and the research and advocacy community for co-operative exchange supporting and encouraging innovation and improving the safety, the sustainability and the public acceptance of hydrocarbon operations. This forum provides an unprecedented international collaboration, which has created a shared global technology vision leading to safer and more sustainable development of gas and oil.

Working with the IEA is thus a win-win partnership based on mutual and open dialogue among experts to help prepare for the future in terms of energy.

How the private sector aids collaboration

Establishing a dialogue between industry and decision makers is important. But it's not enough. We also have to be able to bring concrete solutions to the table that we as an industry have identified as being able to make a difference in the energy sector.

At GE we are acutely aware of the challenges that industry is facing and we are bringing solutions. For example, we develop technologies that control the cost of resource production while increasing not only extraction efficiency but also overall energy efficiency at the production end and for the end industrial user.

We also are preparing industry for the coming skill shortage. Not only are we building capacities via our Global Growth Organization to support customers, but we are also at the forefront in terms of innovation in driving the Industrial Internet with "big data" that I mentioned earlier, as ways to predict the future operating conditions so as to offset the skill shortage over the long term.

The IEA is crucial in providing a platform for all parties to examine these challenges, discuss policies and develop technological options to help solve them. It also helps in understanding macro-trends and cost structures so that what we bring to the industry is concrete, doable and meets today's needs.

Companies such as GE can best improve and refine IEA analysis and policy recommendations through exchanging knowledge, building global presence and sharing insights on industrial trends and market development.

The IEA and GE are two of the most respected references in energy markets. By working together, we create synergies by reinforcing the message. We are credible references for each other, and we can achieve the situation where 1+1=3.

WEO OFFERS ACCURACY, DETAIL

The IEA *World Energy Outlook* (*WEO*) is a book that I always have had on my desk. It's where I turn first to cross-check a number or to better understand a trend. It has also proven to provide great input for our commercial and product development teams to help them understand macro-trends of the energy world, test our in-house scenarios and support our reflections on market developments.

The greatest strength of the *WEO* is its accuracy and the level of detail reached for each analysis. The comparative of its three scenarios provides a great sense of how meaningful policy can be for the long-term framework of our societies. The *WEO* is also very complementary with other IEA publications that look at shorter-term frameworks and technology perspectives.

GAME CHANGER FOR RECHARGING?

HARVESTING ENERGY

Energy is everywhere, as light, heat, even footsteps. The next big thing could be devices that reap what is wasted – if they can stick to a power diet.

By Vida Rozite

Vida Rozite leads the IEA Energy Efficiency Unit's work on industrial energy efficiency and information technology-related power use. Previously, she was a United Nations Industrial Development Organization consultant on sustainable development and a senior adviser at Nordic Energy Research.

Energy harvesting is a potential game changer. Sources of energy exist all around us: small amounts of ambient energy occur in nature and as a result of human activity. But most of that goes to waste, with no means of recovery. Energy harvesting offers a renewable and virtually infinite source of power, albeit often in tiny amounts, by capturing expended energy as heat, light, sound, vibration or movement. Devices can not only effectively scavenge energy and convert it into electricity, they sometimes even store and manage the power.

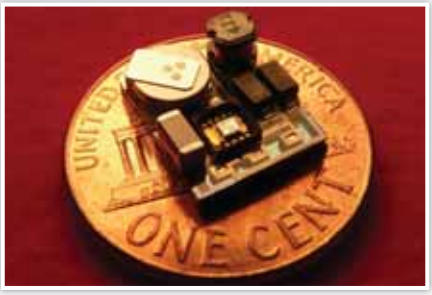
Energy harvesting is not a new concept, but there has been limited applicability for the small amounts of electricity it can generate. But practical applications have come thanks to ever more efficient electronics – for instance, best-in-class smartphones can maintain network connectivity with as little as 0.5 milliwatts (mW) and manage the rest of their operations using no more than 2 watts (W).

So instead of wasting energy while we walk, technology can capture it and power our cell phones. Instead of being annoyed at foggy days, we can be delighted as water droplets that jump away from surfaces during condensation generate enough electricity to power thermostats in our homes. Powered by kinetic or other scavenged energy, sensors and controls in homes and offices can switch off lights and other equipment in unused rooms to reduce utility bills. Cell and television towers and even Wi-Fi hotspots constantly deliver wireless communications to a host of devices: these waves can be harvested and used to power sensors and wireless devices.

A host of real-world applications

Energy harvesting can also make it economically feasible to install sensors in remote or hazardous places by removing the need for periodic battery replacement; that allows access to flows of valuable information on, for example, climatic conditions. Researchers have discovered how to convert the metabolic energy of trees into electricity that powers wireless sensor networks used to detect and control forest fires. Similarly, kinetic energy from ocean waves can power oceanographic sensors for autonomous surveillance.

Installations already recover energy around the world. Energy harvesting devices under a stretch of about 800 metres of a busy highway can generate enough electricity to power 250 homes, as is being tested along sections of road in Israel and the United States.



This energy harvester reaps power from vibrations.

From the finish line of the Paris Marathon and turnstiles at the Tokyo Metro to dance floors as far apart as the Netherlands and Australia, specially engineered tiles have recovered power from footsteps to power lights or recharge portable electronics.

A computer mouse can power itself by capturing the ball's rotational movements. In

MORE DATA, LESS ENERGY

The number of devices that interact with communication networks and with each other is increasing rapidly, as the new IEA publication *More Data, Less Energy: Making Network Standby More Efficient in Billions of Connected Devices* explains. There are already more than 14 billion devices connected to networks globally – a number projected to increase at an exponential rate.

As previewed in Issues 5 and 6 of *IEA Energy*, *More Data, Less Energy* shows that global electricity consumption of network-enabled devices currently surpasses Canada's total final electricity demand and costs consumers more than USD 80 billion a year. As more and more devices get connected and the world moves towards the much-heralded Internet of Things (see sidebar p. 33), the electricity demand of network-enabled devices in homes and offices is expected to surpass a 6% compound annual growth rate over the next decade – twice the rate of overall electricity demand growth.

Solutions to reduce electricity demand by 65% exist, but they require action across the value chain. Governments need to provide incentives for manufacturers to implement energy efficient solutions. Governments, industry and standardisation organisations need to work together to ensure the development of standards, metrics and data collection and sharing to support energy efficiency. Manufacturers need to explore opportunities to source and implement more efficient hardware and software solutions in their devices. Internet and entertainment service providers should provide more efficient devices to clients as well as guidance on how to optimise energy performance.

Even as connected homes and offices become more complex, users still have a role to play in promoting energy efficiency. Besides buying efficient products, they can, for instance, ensure that power management settings are enabled and unplug devices that are not in use, for example when leaving home for an extended period.

Download
More Data, Less Energy:
http://bit.ly/MoreDataLessEnergy

Energy harvester: photo courtesy of Dr. Erkan Aktakka, University of Michigan, all rights reserved

trials, such designs generated more than 3 mW, enough to offset the power a wireless mouse requires.

Piezoelectric, or pressure-sensitive, energy converters (or a magnet and coil) can also help power an electronic device by capturing and converting the energy expended pressing a key on the machine.

Recovering power in large amounts, too

The gains are not limited to tiny amounts of power. For example, research is under way on a thermoelectric microdevice that is capable of generating 15 W per cubic metre from changes in temperature of 10 degrees Celsius. Other applications can exploit one-fifth as little of a temperature shift, offering far more opportunities to reap the differences in the interfaces between ground and air, water and air, even skin and air. Larger-scale applications are also possible.

Harvestable energy from the motion of a typical freight train is in the region of 200 W – sufficient to power most trackside electric facilities such as signal lights, crossing gates, and axle counters. Large-scale vibration energy harvesting from tall buildings, long bridges, vehicle systems and other sources can scavenge 100 kilowatts or more.

Finally, in cases where the sources of energy harvesting methods do not meet the power requirement for a function, engineers can combine two or more harvesting techniques to deliver the necessary quantity of electricity.

But while the opportunities, large and small, are great, large-scale adoption has yet to catch on, amid concerns about cost, durability and whether the surplus electricity can be fed into to the grid.

Tiles at the Saint-Omer, France, rail station capture energy to power lighting and charge visitors' mobile phones.

How to accelerate harvesting?

While many of the barriers to developing and deploying energy harvesting have been overcome, issues remain to be addressed. Currently the technical systems standards, communication protocols and regulations that ensure interconnection and interoperability among energy harvesting and storage solutions lack sufficient coherence. Accelerating the pace of innovation and deployment of energy harvesting will require further research and development investment in the use of piezoelectric and thermoelectric materials as well as pyroelectrics, which also capture power from shifts in temperature.

But for energy harvesting to become a viable and widespread solution, the devices, sensors and controls must draw as little power as possible. Once again, as the IEA has found with everything from microelectronics to industrial processes, energy demand and supply must be managed hand in hand. Scavenging the tiny amounts of otherwise wasted energy can add up to a lot of electricity, but if each device needs less, it makes it easier to provide that power, not to mention more efficiently and reliably.

Party-goers generate electricity on the dance floor as part of the Shell Eco Marathon 2012 competition.

PLUGGING IN EVERYTHING

The new IEA publication *More Data, Less Energy* (see sidebar p. 32) focuses on the networking of electronics and appliances. But the Internet of Things also applies to other objects around us, such as e-books, lampposts, even trees, that are connected and as a result need a power source.

While an increasingly hot topic for industry, the Internet of Things is not a new concept. It emerged in the early 2000s as the then-futuristic vision of a society where all objects in daily life were equipped with identifiers and wireless connectivity and so could communicate with each other. The opportunities are huge. Besides the potential benefit to the electricity grid from sensors and controls that monitor spikes in demand or mechanical faults, devices that track and report real-time weather and soil conditions can raise agricultural productivity, while reliable tracking and reporting of traffic flow can alleviate congestion. Sensors can dramatically improve health care and other services, while industry can reap huge cost savings, for example through immediate notification of equipment failure or automated and virtually instantaneous inventory of stock.

While the Internet of Things seemed far off a decade ago, most of the technologies needed to achieve it are in place today. But alongside all these benefits there is also potentially a very steep energy cost to pay. To ensure that the step forward does not equate to the need to install a lot of new electricity generation plants, it is not enough to reduce the devices' power demand. Instead, new ways of powering these devices and things need to be explored.

LINKING ELECTRICITY AND HEAT

A NEXUS OF SAVINGS

Co-generation plus district heating and cooling offer paths to lower-carbon energy systems. An IEA look at existing projects finds ways to increase use.

By Araceli Fernández Palés

Araceli Fernández Palés is the IEA energy technology analyst for industry and co-generation. A chemical engineer, she has worked for BP among other oil and gas companies, specialising in thermal equipment design and process optimisation for refineries.

Conventional power plants and heavy industry waste significant quantities of heat every minute. Fully mature technologies exist to tap part of that surplus to directly heat or cool buildings, or both – and a handful of countries do so extensively and efficiently when local thermal demand exists. But while co-generation and district heating and cooling (DHC) can bring the world a critical step closer to a low-carbon economy, neither has been effectively pursued within energy policy and technology initiatives, much less perfectly integrated for huge savings.

Co-generation turns otherwise lost energy from electricity generation into heat, and as a result achieves greater efficiencies than conventional thermal power plants. In 2011 thermal facilities such as coal- and gas-fired plants converted about 36% of their energy input into electricity, while co-generation sites had a 58% conversion rate.

DHC systems can source their thermal supply from surplus heat recovered from industrial processes, co-generation facilities and renewable energy, giving them great appeal from an energy-saving perspective. The integration of absorption chillers can turn excess heat into cooling, which can also come from natural sources such as rivers and the ocean.

Where co-generation and DHC stand today

Co-generation projects often look attractive when analysed independently from market and regulatory conditions. In practice, implementation of the technologies has been challenging, as shown by limited penetration in the global energy market: total electricity generated from co-generation fell from 14% in 1990 to about 10% in 2000 and has since been stagnant.

Efficient DHC systems often require both very significant infrastructure investment and an established long-term urban planning strategy. So global deployment has been limited and varies greatly regionally. In 2011 Europe's more than 6 000 distributed heat systems met roughly 12% of the region's total heat demand. And 23% of Chinese residential and commercial heating demand that year was met by sales of distributed heat, one-quarter more than in 2007.

District cooling sales are highest in the United States but amount to only 6% of the country's space cooling demand in residential and commercial buildings. District cooling capacity through chilled water in Korea alone more than tripled from 2009 to 2011, and as global space cooling demand keeps rising – more than doubling by 2050 – such solutions will be important in providing efficient, low-carbon cooling supply.

A look at specific co-generation successes

A new IEA publication, *Linking Heat and Electricity Systems*, examines individual co-generation and DHC projects around the world to find ways around barriers to wider deployment.

Denmark's Marstal site pipes 100% renewable heat.

For instance, a Petróleos Mexicanos (Pemex) gas processing complex in Tabasco, Mexico, produces heat and electricity for on-site use; excess power is sent to off-site industries. The total electricity generation capacity of 300 megawatts is one-fifth more than the that of Mexico's Eurus wind farm, Latin America's largest. Co-generation saves Pemex 850 000 cubic metres of natural gas per day and cuts annual carbon dioxide (CO_2) emissions by 430 kilotonnes.

Co-generation provides heat and power to Destilerías y Crianza del Whisky in Segovia, Spain, and heat for the distillery's waste treatment process. The electricity load meets all of the facility's demand, and makes up about 5% of the co-generation plant's total electricity output, with the excess exported to the grid. Using co-generation over separate heat and power for these processes replaces 28.8% of the plant's annual energy demand and represents a 22% annual reduction in CO_2 emissions. Cost savings have topped EUR 2.47 million.

The new publication also profiles Denmark's Sunstore 4 project in Marstal, which marries renewable energy sources with a heat pump and a huge pit to store thermal energy. Either the heat pump or the bio-based boiler complement the warmth from solar collectors to supply more than 1 500 buildings. The entire Sunstore district heating plant avoids roughly 10.5 kilotonnes of CO_2 emissions annually. Including annual maintenance costs, it is expected to recover the total investment of EUR 15.5 million within ten years. Up to 4 000 visitors per year tour the facility, as the concept will be adopted in various regions of Europe.

What comes next for the technologies

Notwithstanding the case studies it presents, *Linking Heat and Electricity Systems* details significant barriers to extensive deployment and modernisation of co-generation and DHC. Most relate to poor strategic planning for heating and cooling infrastructure as well as to local energy market conditions that keep energy prices from reflecting generation costs and to a lack of long-term visibility of related energy policies.

Co-generation and DHC projects require a detailed assessment of main drivers and local conditions, identifying opportunities to use available energy sources, exploring possible financing mechanisms and setting a flexible business structure. The IEA publication offers recommendations for policy strategies and market regulation to reveal energy efficiency as cost-effective as well as to address other impediments.

Download Linking Heat and Electricity Systems – Co-generation and District Heating and Cooling Solutions for a Clean Energy Future: *http://bit.ly/LinkingHeat*

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GOING GLOBAL FOR OIL

CHINESE INVESTMENT

The IEA tracks Chinese oil firms' growing overseas investments, finding they are driven by commercial interests but may affect foreign policy.

By Julie Jiang

Julie Jiang served as IEA China Programme Officer from 2009 until this summer, co-ordinating bilateral co-operation projects with China and co-writing four publications. Prior to joining the IEA, she was a manager for the US Foreign Commercial Service's programme in China.

Chinese national oil companies (NOCs) are the new big players on the global energy scene. In the last three years, they spent a total of USD 73 billion in upstream investments and now operate in more than 40 countries to control about 7% of worldwide crude oil output, raising alarms in some quarters about supply security and price.

To address those concerns, the IEA investigated the NOCs' spending, producing two reports. The first, which in 2011 quantified the size and growth of investments, determined that the Chinese NOCs had been responsible for 61% of acquisitions by all NOCs in 2009. It also found that the Chinese companies' overseas investments had, for the most part, increased global oil and gas supplies for all importers. A follow-up report this year confirmed the 2011 findings, adding that combined overseas oil and gas production by Chinese companies totalled 2.5 million barrels per day (mb/d), reflecting a geographic diversification of assets.

A growing degree of independence

The IEA studies, *Overseas Investments by China's National Oil Companies: Assessing the Drivers and Impacts* and *Update on Overseas Investments by China's Oil Companies*, did not find cause to believe that the Chinese NOCs operate under the direct instructions of, or in close co-ordination with, the central government. Instead, the studies determined that the companies, especially the big three – China National Petroleum Corporation (CNPC), parent company of PetroChina; China Petroleum & Chemical Corporation (Sinopec Group); and China National Offshore Oil Corporation (CNOOC) – had benefitted from three decades of economic reforms to gain a great deal of power in relation to the government.

China's soaring domestic energy consumption has increased the NOCs' financial and economic impact, giving them the means to lobby for greater influence. With domestic production stalled at just over 4 mb/d for the past two years, imports meet 59% of Chinese demand – which grew 3% last year and is expected to overtake that of the United States in 2030. While the NOCs remain primarily owned by the state, the studies found that they have carved out significant operational and investment independence from the government because of their historical associations with former ministries; top company officials' high ranks within the Communist Party; the fragmented and decentralised nature of Chinese energy governance structure; and the companies' much larger sizes and lobbying power relative to the government agencies tasked with overseeing them.

No evidence emerged from the IEA research that the Chinese government requires the companies to ship back overseas production to China, as some critics have suggested. Instead, the studies found, NOCs' decisions about equity oil's marketing are mainly based on commercial considerations, the production-sharing contracts involving the investments, or both.

"The IEA report (2011) disproved the common misconception that China's NOCs were acting overseas under the instruction of the Chinese government," the 2014 study says, adding that "further research conducted for this updated publication has uncovered no evidence to suggest that the Chinese government imposes a quota on the NOCs regarding the amount of their overseas oil that they must ship to China".

Investments in countries near and far

Two big changes the IEA detected between the studies are the companies' new emphasis on investment in unconventional oil and gas, and a reorientation from high-risk regions to areas with more stable geopolitics. The recalibration has come as countries in the Americas and Australia have been more welcoming of Chinese investment, while investments in other regions have had less success amid rising nationalism and political uncertainty.

The first significant setback for Chinese investment was in Sudan. Chinese NOCs are the biggest investors in South Sudan's oil industry, but the investment was originally made before the new nation came into existence.

Sudan was among the very first countries to attract Chinese interest, with activities dating back to 1995. That involvement forced China to weather international scrutiny during the Darfur crisis, but by 2010, Chinese equity production in the country, most of whose oil fields are in the south, was 210 000 barrels per day (kb/d). After South Sudan's 2011 independence, oil transport negotiations deadlocked, and by early 2012, nearly 900 Chinese-operated wells were shut or forced to reduce production. South Sudan expelled President Liu Yingcai of the Chinese-Malaysian oil consortium Petrodar for "non-cooperation". By the end of 2013, CNPC and Sinopec reported oil production of only 84 kb/d in South Sudan and Sudan.

A CNOOC site in China. Investment abroad can bring home technologies needed to tap unconventional reserves.

Gas flare: © CNOOC Ltd

Unrest in South Sudan has not gone away, with intermittent fighting this year. But contrary to the position it adopted during the so-called Arab Spring and in Syria in particular, the Chinese government has sought to be a major mediator among the various factions.

Similarly, unrest in Iraq continues to threaten Chinese NOCs' combined 472 kb/d production entitlement – 25% of all Chinese overseas oil output. China has long viewed Iraq as a replacement for reduced flow from Iran.

From 2007 the NOCs invested no less than USD 14 billion in Iranian oil and gas fields, making the country China's third-largest oil supplier in 2010 and 2011, with 11% of total imports. But the effects of international sanctions dropped Iran to sixth place as of the end of 2013, just after Iraq and well behind top-ranked Saudi Arabia, which provides about half of all imports.

Libya also has been a deep disappointment, with fighting there cutting exports to China by more than one-third, to 0.8% of total imports in 2013. The government also had to arrange an emergency plan to evacuate 35 000 Chinese nationals from the country during the overthrow of the Qaddafi regime, and it subsequently has been involved in complex discussions concerning its pre-2011 contracts.

Then there is Syria, where Chinese companies had a total equity production of 84 kb/d, which fell to below 53 kb/d in 2011. By the end of 2013 only the small NOC Sinochem was still producing oil there, about 2.5 kb/d.

Security challenges have affected NOCs' operations in Myanmar and Nigeria and potentially in Central Asia, where the competitive edge held from early entry is threatened by growing ethnic tensions and terrorist threats in the some of the five countries through which the Central Asia-China pipelines run. More trouble may follow, as CNPC successfully bid in 2012 to be among the first companies to explore for oil and gas in Afghanistan.

Not all of the NOCs' setbacks have been the result of political unrest: some of their African investments, including in Niger and Chad, are at risk of reversal of contracts.

The companies have had greater success in Russia, Saudi Arabia and Central Asian countries such as Turkmenistan and Kazakhstan, where energy deals have been combined with other investment. Sinopec entered the refining industry in Saudi Arabia by investing USD 4.5 billion in the company's first international downstream deal. A loan-for-gas deal with Turkmenistan secured 25 billion cubic metres (bcm) of gas supply, bringing total supply capacity to 65 bcm per year.

Increased co-operation with Western firms

The uneven results of investment in high-risk regions have led to a shift in Chinese investment to more stable regions as well as closer co-operation and co-ordination with independent oil companies of Western countries. Every Chinese NOC has expanded its global production portfolio significantly, particularly in North America and Australia, usually through direct acquisition when possible. Along with smaller Chinese companies, the NOCs invested USD 38 billion in 2013 in global upstream oil and gas mergers and acquisitions, up from USD 15 billion in 2012 and USD 20 billion in 2011. This shift not only has smoothed investments and purchases, according to the IEA report this year, but also has furthered China's mastery of techniques it hopes to use for domestic production.

China's National Energy Administration addressed research,development and demonstration projects in 2012's 12th Five-Year Plan for Energy Technology, which calls for domestic development of shale gas, heavy oil and other unconventional energy sources. The Ministry of Land and Resources estimates that domestic shale gas reserves exceed the United States', and expertise from NOCs' investments in foreign companies could help develop those reserves. Global majors including Shell, ConocoPhillips, ENI and Total have co-operation accords with NOCs to conduct seismic surveys, exploration, and joint research to develop shale gas and oil blocks in China. But the new IEA study notes the significant differences between US and Chinese reserves, which will mean a potentially challenging adaptation of North American drilling technologies to China's geological specifications.

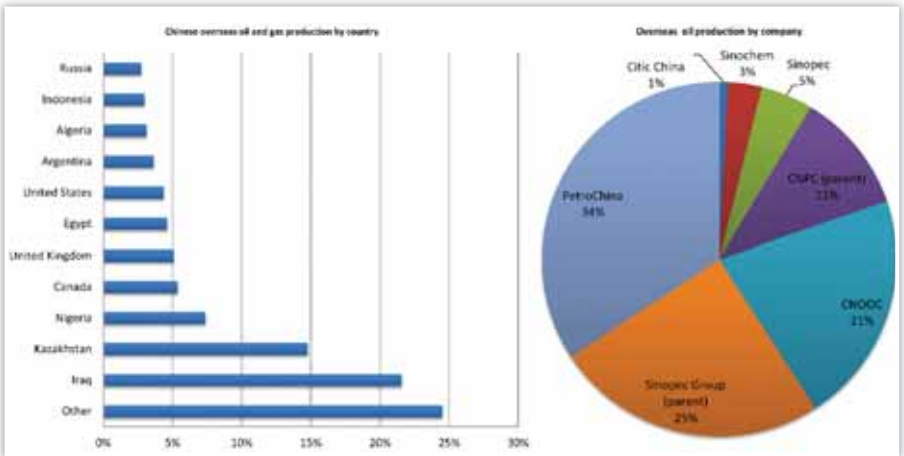
Commercial influences on foreign policy

Given 21 years of surging investment in countries around the world, it was inevitable that Chinese NOCs would run into challenges and generate concerns. The IEA studies found that the companies have relied heavily on Chinese government support in the Middle East and in Sudan and South Sudan, raising two questions: will China's commercial interests help shape the country's foreign policy in these regions, and to what extent does the existence of substantial energy and other commercial investments already influence China's diplomatic decisions? Today, perhaps the greatest challenge facing the NOCs is that their business interests are highly dependent on the evolution of Chinese foreign policy.

But the NOCs are not waiting as they charge ahead with overseas expansions and keep the pressure on both themselves and their government to garner more experience in their dealings in the international energy arena.

IEA keeps monitoring all NOCs' investments

Given the potential effect on global energy security and engagement, two of the Agency's principal concerns, the IEA carefully monitors ongoing investment by all NOCs around the world. While the Chinese companies' overseas investments may have originated as primarily commercial moves, recent events have politicised many of them, and the IEA is among many observers watching how the Chinese NOCs and their government find ways to work with each other – and other players in the global energy sector – to reconcile these political and security issues.



Three Chinese NOCs have led the surge of investment in more than 40 countries around the world.

Graph: © OECD/IEA, 2013

Download Update on Overseas Investments by China's National Oil Companies, *with a link to its predecessor:* http://bit.ly/chinaNOCs

WHAT'S NEXT FOR RUSSIAN GAS?

A MARKET IN FLUX

An IEA review of Russia's energy policies spotlights a gas market undergoing a progressive liberalisation process, and suggests best ways forward.

By Marc-Antoine Eyl-Mazzega

Marc-Antoine Eyl-Mazzega joined the IEA in 2011, first focusing on Ukraine and the Caspian region, then becoming Programme Manager for Russia. He has worked for EDF, the Robert Schuman Foundation and, in Kiev, BNP Paribas.

Russia's domestic gas market is in the midst of a significant reshuffling following key governmental decisions. Growing independent upstream production and wholesale supplies show a progressive liberalisation, so that the state-controlled Gazprom accounted for 73% of Russia's total production in 2013, a steady decrease from 83% in 2007.

This transition phase has come thanks to independents benefiting from larger access to the gas transmission system (GTS), attractive taxation and market-based wholesale price-setting as well as a progressive increase, over past years, in regulated wholesale prices. The partial liberalisation of liquefied natural gas (LNG) exports, enacted in December 2013, opens potential new gas market outlets.

While important progress has been made, major elements of the regulated system prevail. The IEA sees the need for fair and predictable regulation as well as completion of the liberalisation effort for an efficient and more competitive gas market to develop further.

Steps towards a more open market

Russian gas regulations require Gazprom to grant access to the GTS or deny independent companies' access only on a reasonable basis, *de facto* ending the company's monopoly on the system. In 2012, 25 independents received gas transportation services via the GTS. Further, Gazprom is required by law to sell gas at regulated prices to customers in the industrial and residential sectors, while independent producers can sell gas at non-regulated, market-based prices. In 2011, 2012 and 2013 gas consumption declined and independent producers, benefiting from lower production costs, sold gas profitably at prices below the regulated tariff charge. With much more gas likely to be produced by independents in a market with limited or even flat demand growth, this trend is set to continue.

An IEA in-depth review of Russia's energy policies this year found that, overall, the market broadening was effectively working, marking a major step towards a more competitive market.

Yet Gazprom continues to be the owner and operator of the GTS, giving it a key influence. Gazprom is required to provide independents with access to pipelines only if there is spare capacity from the connection zone to the gas collection zone in the proposed delivery period for the independent's contract with a buyer, and if the gas meets the technical standards.

So Gazprom can prioritise its own supplies, and regulations do not arrange for competitive bidding on capacities nor a transparent mechanism to determine the gas transportation routes and distances. And the rules do not organise effective storage operations by independents.

Gas for the residential sector and associated gas enjoy priority access, and independent producers tend to limit their sales to markets close to their production centres to reduce transportation costs. So in distant and remote regions, the state company remains the sole supplier.

Progressive liberalisation of Russia's gas market cut Gazprom's share of total national output to 73% last year.

How Russia can further improve the sector

Russian policy rightly emphasises the country's large energy efficiency potential. If energy efficiency gains are achieved, especially in the power and industrial sector, Russian domestic gas demand is likely to be measurably lower than expected, which could benefit Russia, possibly increasing gas exports. The IEA report recommends that the government ensure that long-term energy strategy guiding investment properly incorporate the expected positive developments resulting from energy efficiency.

Russia 2014 – Energy Policies Beyond IEA Countries also urges Russia to avoid stranded investment by ensuring that only the most cost-efficient resources and projects are financed and that new market outlets are developed for Russian gas, as demand in the domestic and external markets is likely to be a key constraint on production development. Options include: development of new export channels to Asia, as undertaken in Russia's 2014 gas supply agreement with China that calls for new pipelines to be constructed; making the most of LNG export liberalisation which was endorsed at the end of 2013; increasing the use of gas in the transportation sector; and developing a more competitive domestic market, with an outlook for fair market conditions for Gazprom and independents, that can contribute to ensuring the competitiveness of energy-intensive Russian industries.

For more informationa, order Russia 2014 – Energy Policies Beyond IEA Countries*:* *http://bit.ly/RusPolicies*

Gas facility: © Shutterstock.com

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RENEWABLES AUGMENT GAS

SAUDI ENERGY MIX

Saudi Arabia is hardly running low on energy, but the kingdom is moving to limit surging domestic demand's impact on exports.

By Christopher Segar

Christopher Segar joined the IEA in 2008 after a career in the British Foreign Service. In the Office of Global Energy Policy, he monitors the Middle East and North Africa, and he has represented the IEA on the Executive Board of the International Energy Forum in Riyadh.

Saudi Arabia abounds, of course, in energy resources, but a new source of demand is cutting into its oil output: domestic consumption, already high, is growing fast and threatens to crimp exports. Electricity use is increasing at about 7.5% annually, just ahead of the about 7% growth in gasoline demand.

Overall energy demand nationwide was estimated at 3.4 million barrels of oil-equivalent per day (mboe/d) in 2010. At present growth rates, that demand, which combines crude oil, gasoline, diesel, natural gas and fuel oil, could reach 8.3 mboe/d by 2028. As a number of prominent Saudi officials have pointed out, at that point an average of 3 million barrels per day (mb/d) of crude oil might have to be diverted to the power sector, potentially cutting export revenue significantly and taxing world markets that the kingdom sees as its responsibility to keep well-supplied.

Population and prices boost demand

The growth in energy demand reflects Saudi Arabia's 180% rise in inhabitants from 1980 to 2010, according to the United Nations Population Division, more than triple the global average. The population reached 28.3 million at the end of 2012, including more than 8 million foreign residents. And those people are getting richer, with the International Monetary Fund forecasting real gross domestic product (GDP) growth of 4.1% in 2014 and 4.2% in 2015. Abundant and cheap natural gas has attracted large-scale investment in energy-intensive industries over the past three decades, with the Saudi industrial sector now making up 9% of GDP as it supplies 8% of the world market in petrochemicals.

In addition, the largely arid country sustains the world's largest desalination programme, processing more than 3.5 million cubic metres of seawater a day. The programme, which is being expanded by 50%, contributes significantly to the country's high energy intensity. In 2010, energy intensity was already 0.53 tonne of oil-equivalent per USD 1 000 (2005 dollars) of GDP. That level is 20% higher than in 2000 and almost twice that of the United States, where, like in most of the rest of the world, energy intensity has been declining. Energy intensity in China fell by 67% between 1980 and 2010, while in Saudi Arabia it rose by 138%.

A principal cause of energy demand growth is very low end-user prices. Electricity costs no more than USD 0.6 per kilowatt hour (kWh), one-quarter the 2013 average for OECD households. Gasoline runs about USD 0.12 per litre – against the USD 1.71 average for premium unleaded in the OECD – to motorists' delight but overwhelming the country's 2.5 mb/d refining capacity enough to force gasoline and diesel imports in recent years.

Long- and medium-term solutions

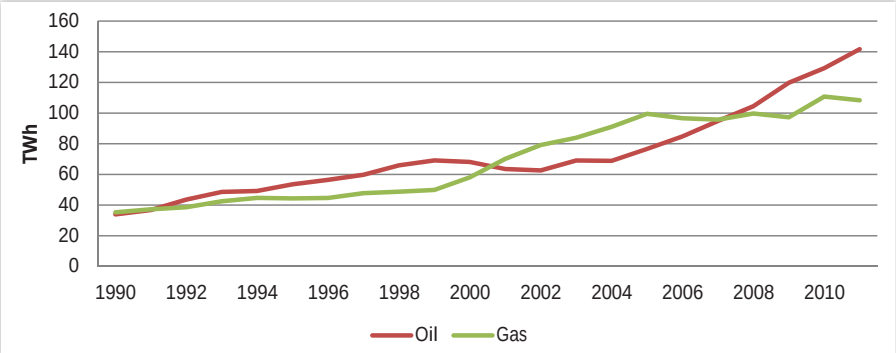
For now, total demand remains little more than a rounding error when compared with Saudi Arabia's 261 billion barrels of conventional oil reserves, nor does it make much of a dent in the current production capacity of 12.5 mb/d. But besides the impact on export potential from unabated growth in domestic oil consumption, the country's fossil fuel-based power generation system is close to saturation. So the kingdom is moving forward with both short-term fixes and long-term solutions.

How the electricity system is fuelled

Saudi Arabia has long used natural gas to fuel much of its power generation, relying on its 286 trillion cubic feet (tcf) of reserves, plus an estimated 600 tcf of unconventional reserves as well as additional conventional reserves in the northwest and offshore in the Red Sea that are beginning to be developed. Unlike many of its neighbours and despite strong demand in Asia and growing interest in Europe, the kingdom has never exported gas. Instead, from the early 1980s onwards, its Master Gas System has distributed the large quantities of gas associated with oil production around the country exclusively for electricity generation, to supply industry and as feedstock for petrochemicals.

Gas production is expected to rise progressively to 15 billion cubic feet per day (bcf/d) by 2018. Plus projects developed from 2004 to 2010 produce 750 000 barrels per day (kb/d) of natural gas liquids, much of which is blended with crude or for use as petrochemical feedstock, freeing up more gas for power generation. And the kingdom has also earmarked about USD 9 billion for exploration to increase reserves by another 50 tcf.

Saudi rainfall during summer's power demand spike.



Saudi electricity is produced using ever-growing shares of oil, including products such as diesel, and natural gas.

Gas provides around 43% of Saudi electricity, with fuel oil and diesel providing the rest. In recent years more and more crude oil has been diverted to the power sector, oil that might otherwise be sold internationally to augment national earnings. Since 2011, power generation has consumed more than 500 kb/d, with peak demand in summer now seen topping 900 kb/d.

Overtaxed power infrastructure

Demand is already running up against the kingdom's installed power generation capacity, which the *Middle East Economic Survey* listed at 58.4 gigawatts (GW) as of 2013. It is also a challenge to provide enough fuel, with demand growth in electricity already having outpaced the capacity of the gas and fuel oil sectors to supply the power stations.

In 2011, Saudi Arabia's electricity demand was 210 terawatt hours, or about 7 420 kWh per capita, comparable to Mexico's total consumption but more than three times as high on a per capita basis. Climate is a major factor: the building sector has by far the largest share of energy demand, at up to 80% of total power demand – 70% of which is for air conditioning. This adds to the seasonality of demand, with summer peak demand nearly twice the winter average.

A cause of high demand can cool it off

While higher gas output is the shorter-term solution to surging demand, Saudi Arabia intends to benefit long term from one aspect of the climate that boosts consumption: solar power. The kingdom enjoys twice the direct normal irradiance that is available in the sunniest part of Germany, according to calculations by the US National Aeronautics and Space Administration.

Saudi Arabia aims to have 41 GW of solar power by 2032, 60% of it generated at concentrated solar power plants and the rest from solar photovoltaics such as rooftop panels, at a cost of USD 109 billion. The first gigawatt of solar power, to be installed by 2020, should save at least 1 bcf/d of gas, based on a combined-cycle gas turbine unit's output when operating at average summer conditions. In addition, wind power is to provide 9 GW of capacity for electricity generation and desalination, while the kingdom also has an ambitious target of 17.6 GW of nuclear capacity by 2032.

But solar power systems present challenges in hot dusty conditions: dust impairs operations, and efficiency falls at temperatures above 30 degrees Celsius. A number of research establishments in the Gulf region are working on ways to tackle these problems.

Using power more wisely

Another way to limit consumption is increased energy efficiency, which the IEA sees as a key element of any sustainable energy strategy. As with renewables, investment in energy efficiency not only enhances the system's sustainability but also can promote local employment, foreign investment and the transfer of technology. Most of all, the energy a country does not use is not only its cheapest energy but the one that requires the least fuel and infrastructure.

> ONE ADVANTAGE OF THE SAUDI SYSTEM'S LARGE SPARE CAPACITY IN WINTER MONTHS IS ITS POTENTIAL TO SHARE POWER WITH THE TURKISH AND EUROPEAN GRIDS.

The building sector's dominant position in electricity demand makes it a good starting point for Saudi energy efficiency, and the government has already revised construction codes. Riyadh recently introduced industry standards, e.g. for buildings and appliances including air-conditioners, which if continued and diligently implemented have the capacity to deliver large savings. The government has announced plans to build 200 000 housing units per year over the next decade, offering considerable long-term savings if they are constructed to the latest insulation and ventilation standards. The Saudi Energy Efficiency Centre (SEEC) was created in 2010 at the King Abdulaziz City for Science and Technology (KACST) to work on demand-side energy efficiency programmes. In 2012, the SEEC launched the Saudi Energy Efficiency Program (SEEP).

The quickest route to reduced consumption in buildings is new appliance standards for air-conditioning units, both imported and locally produced. But while the government has announced standards, establishing and implementing them is requiring extensive capacity development. There are some recent success stories: the SEEC persuaded the Ministry of Commerce and Industry to confiscate from stores 50 000 air conditioners that did not meet the country's energy saving requirements as of early 2014. Some minimum energy performance standards have been recently issued, and mandatory insulation of new buildings is being considered. But there is clearly more to do in areas such as enforcement mechanisms in insulation and lighting, and the Saudi Building Code of 2007 is seen as complex, long and in need of updating.

Beyond the activities of the SEEC, key Saudi decision makers have made recent positive declarations which support efficiency efforts. Prince Abdulaziz bin Salman al-Saud, in an article in the May 2014 issue of *Oxford Energy Forum*, wrote that "whereas the vast majority of countries have managed to lower the energy intensity of their economies, the Kingdom's energy intensity increased significantly over the last two decades. ... [I]t is a strategic imperative for the Kingdom that energy efficiency become a major topic for all decisions related to an increase in demand for fuel and feedstock." Nevertheless, as underlined by the prince, the SEEP "does not include price reforms" even though record low energy prices make it difficult to encourage final consumers to make drastic energy savings.

On a national basis, reshaping the grid offers efficiencies. The Saudi Electric Company is already open to supply from independent power producers that bring in international investment (on a project finance basis) and offer global experience in optimising large-scale power systems. Domestically, both the Saline Water Conversion Corporation and Saudi Aramco are on track to become net producers of energy, allowing them to feed into the grid. Also, the IEA recommends introducing smart grids and smart metering as effective means to reduce peak loads in Saudi Arabia, easing the summer strain on the power system.

Sharing that benefits Saudis and others

Finally, the region offers opportunities to bolster the power system. The northern Gulf grid connection that links Saudi Arabia, Kuwait and Qatar is designed to allow the sharing of power on an emergency basis, but already can enable the participants to reduce the spinning reserve that they need to maintain to ensure the stability of their grids.

The kingdom has plans with Egypt to set up a grid connection to take advantage of differences in each national system's daily demand peaks; the connection could operate at a level as high as 3 GW.

An even more ambitious plan under consideration is to share power on a seasonal basis with the Turkish and European grids to take advantage of the very large spare capacity the Saudi system has in the winter months. Such a system could supply as much as 10 GW to help meet European peak winter demand, while sending back power in the summer to cool the Gulf as demand peaks there.

UP-CLOSE AND PERSONAL

ENERGY ACCESS

An energy-news initiative that travels to the source to report on energy poverty visits some pretty dark places – and sheds light on solutions.

By Marilyn Smith

Marilyn Smith is Executive Director of the ENERGY ACTION Project, contributing to research, scripting and video productions. Chief Editor of the IEA from 2009 to 2012, she still edits Agency publications, most recently Energy Technology Perspectives 2014 *and* More Data, Less Energy.

About 7 500 kilometres – including a two-hour trek that morphed from a steep rocky road to footpaths snaking between terraced fields of corn – separate the desk I occupied at the IEA and the hilltop village I visited in Nepal in late 2013. Yet, on many levels, the path between the two was remarkably direct.

Energy access underpinned the formation of the IEA in 1974, with a focus on member countries ensuring their own energy security first by stocking 90 days' worth of oil imports and second by agreeing to act collectively in the event of a future energy crisis.

Forty years on, energy is a global, collective concern, in part because of the threat of climate change but also because so many people and countries remain mired in staggering poverty – often despite resource riches. According to the *World Energy Outlook 2013*, nearly 1.3 billion people completely lack access to electricity and 2.6 billion people have no clean cooking facilities. More than 95% of these people live either in sub-Saharan Africa or developing Asia, and more than 80% are in rural areas. In Europe and North America, growing numbers seriously struggle to pay their energy bills – choosing to "heat or eat". After decades of energy access being about the desperately poor in the developing world, suddenly it has become a "maybe it's my neighbour" issue.

Within its Sustainable Energy for All (SE4ALL) initiative, the United Nations has made energy a core element of sustainable development, inviting the IEA Executive Director, Maria van der Hoeven, to serve on the SE4ALL Advisory Board.

Learning curve leads to idea for a platform

My time at the IEA convinced me that energy is a compelling story. But sensing that most people are simply baffled by energy, I felt the time could be right for a new vehicle for energy journalism. IEA colleagues helped me to set the framework for what has become the ENERGY ACTION Project (EnAct), which will report on advances in lifting half the world out of energy poverty while also encouraging others to become more resource-conscious.

Any worries about whether energy would appeal to media professionals – and ultimately the public – was put to rest shortly after EnAct's first team meeting. An email one morning read, "I just learned about load-shedding: how crazy is that?" The team began following energy stories around the world: riots in Pakistan over load-shedding, i.e. utilities shutting off power to avoid infrastructure damage; the enormous burden of work that falls to women as "household energy managers" in remote areas; and thousands of people (including children) in Jharkhand, India, collecting coal by hand. Innovative solutions proved equally newsworthy: a teenage boy from Malawi using scrap parts to build a windmill; a steel-smelting facility piping waste heat into a Chinese city's district heating system (prompting closure of the nearby coal-fired plant); and advances in nanotechnology that might soon slash the energy demand of all computing devices.

In my learning more about how energy touches every person on the planet, every day, one country grabbed EnAct's attention. In the 1980s, much of Liberia had electricity most of the time; today, the grid serves just 4% of the population. Here was a population that knew both sides of the access story.

Front-line state in the war on energy poverty

Like stars in a night sky, splattered bullet holes let bits of daylight into the otherwise dark and silent Bushrod Island Power Plant on the outskirts of Monrovia, evidence that energy access can be about power in a deeply political sense. Ten years after back-to-back civil wars, Joseph Mayah, deputy chief executive officer of the Liberia Electricity Company, still shakes his head in disbelief. "Somehow, the rebels thought that by destroying the energy system, they would take power away from the government. They didn't see that they were destroying the very fabric of society – a society that they belonged to."

Monrovia is pitch-black by about 18:00, save for pockets of light at service stations that become makeshift markets and study halls. In most cases, where there is light, there is high-decibel noise and the nauseating smell of diesel fuel. But none of this prepared the EnAct team for life beyond the capital. Just 260 kilometres away in Ganta, the regional

Staff at a hospital in Ganta, Liberia, have to rely on mobile phone flashlights for illumination much of the time.

Marilyn Smith; © Marilyn Smith; Liberian hospital: © Henrik Kastenskov/The ENERGY ACTION Project

hospital is powerless except for two five-hour periods a day; even so, its diesel generators guzzle a shocking USD 9 500 worth of fuel every month. During "off hours", doctors and nurses diagnose and treat patients by the light of their mobile phones. Asked about the health impacts, Administrator Patrick Mantor points to an off-road vehicle propped on blocks behind the emergency room. "Because we don't have money left to fix that ambulance, we can no longer get to village women with birthing complications. After years of decline, the rate of mother and infant mortality is rising again."

Parcelling personal energy in Asia

A few weeks later, the EnAct team is living the load-shedding craziness in Kathmandu – strategising when to charge batteries for cameras and computers, and how to best capture factories grinding to a halt or entire districts going dark. Three days on, the power company increases the load-shedding schedule from 49 to 63 hours per week. But the situation is better than last year, say the locals: cuts are now scheduled and a smartphone application lets people plan around power outages.

Then it is time for the most extreme; EnAct visits a hilltop village in Nepal with absolutely no power. As Maya swings her child onto her back, I glimpse the tendons stretching from her forearm to her neck: everything this woman does depends on the physical energy contained in her compact body. At 5:00 each morning she spends an hour grinding corn at a stone wheel, barely one metre from an open fire in a room that is about 20 square metres and has two tiny windows – both closed against the cool morning air. Everyone living here is effectively smoking two packs of cigarettes a day. Next, Maya is hauling a 30-kilogramme water jug up a steep hill. Twice a week, she forages and hauls the same weight in firewood. Other days, she helps her husband in the field or pitches in as villagers build a two-story stone house, without a single power tool in sight.

Gains in the bid to increase energy access

In every country visited, EnAct has seen that even desperately poor people will make sacrifices to capture the return on investment offered by energy: a Liberian man who earns USD 1 per day will spend USD 0.10 on candles so his children can study. Nepalese villagers will pool resources to buy one solar panel – and thus save the four-hour walk to charge mobile phones (which they use in rotation to conserve battery power). Across India, energy entrepreneurs are exploring business models that scale both energy and investment to local needs and capacity.

A kitchen in Nepal: 1.3 billion people worldwide have no electricity and 2.6 billion lack clean cooking facilities.

Nepalese kitchen: © Marilyn Smith/The ENERGY ACTION Project

Through social entrepreneurship, the organisation Selco India has been enabling the very poorest communities to own and manage local solar lighting systems, while keeping costs lower than what residents usually spend on kerosene. In remote areas or urban slums, Dr. Harish Hande encourages his team to truly understand a community's energy needs before developing a solution. Banana sellers, for example, want white light while tomato sellers prefer yellow. Slum-based shops are good spots to install a rooftop panel and set up a battery-charging station – and to recruit entrepreneurs to manage it. Locals drop off their batteries in the morning and retrieve them before the sun goes down. In some installations, the rooftop panel powers the only refrigerator for several thousand people. In more remote regions, Selco has installed solar panels on schools and seen attendance rates climb: parents who want light at night are more likely to send their kids (carrying batteries like lunch boxes) to school each morning.

"When we went to speak with a community of traditional drum makers, they showed zero interest in solar lighting," says Hande. "Over time, we learned that they faced the constant threat of eviction, so of course they weren't going to invest in energy infrastructure. We designed a solar cart that can be dismantled and moved in 15 minutes flat. They bought in, and now they can make drums into the evening, boosting their economic and social welfare."

What began as small-scale social entrepreneurship is now shaping national energy policy in India. In 2011, the government established the Solar Energy Corporation of India to court small and mid-sized companies with substantial grants, as a means of finding business models that make solar power saleable at all scales.

Online coverage of energy as it evolves

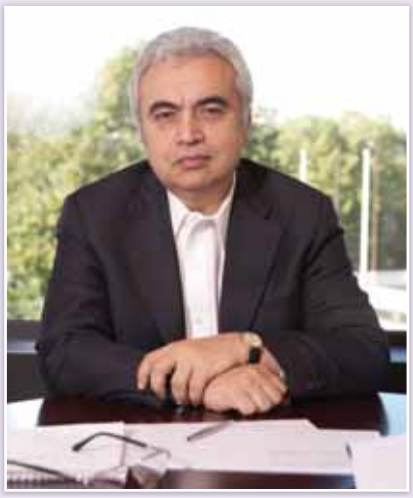
EnAct aims to report on all of these struggles and gains. Each edition of its quarterly online magazine will feature a web documentary that captures personal stories while giving voice to energy experts, and the site will also serve as the gateway to an interactive platform offering multiple levels of information.

One primary aim is to guide the general public through a primer on energy, starting with relatively simple questions such as what is energy and how do you use it. Later editions will explore more complex concepts such as energy pricing, energy security and the geopolitics of energy. The need to transform the global energy system, and ways to do so, will be featured in each edition.

EnAct also aims to bridge the gap between energy consumers and energy sector players by serving as a news source that tracks advances in technology, policy, financing and the other factors that affect energy access.

For more information about EnAct, including its first online reportage and how the news initiative aligns with energy access goals: ***www.en-act.org***

PATHWAYS TOWARDS AN ENERGISED AFRICA



By Fatih Birol

Fatih Birol, the IEA Chief Economist, is responsible for the Agency's flagship World Energy Outlook, *which is recognised as the most authoritative annual source for strategic analysis of global energy markets. He is also the founder and chair of the IEA Energy Business Council, which provides a forum to enhance co-operation between the energy industry and energy policy makers.*

Download the WEO Africa Energy Outlook: *http://bit.ly/WEOAfrica*

Economic development is not possible without an energy system that can support it, and so the IEA has turned its attention to the outlook for energy in Africa. The sub-Saharan Africa of today is not that of even two decades ago: since the turn of the century, economies there have, on average, grown more than those in any other region apart from China and India. That growth will have myriad repercussions on the subcontinent's development and its energy use. But despite a number of challenges, not least of all a global energy environment with persistently high oil prices, Africa has opportunities, including large renewables potential.

To shed light on the pathways to energy development across the continent, and to identify potential pitfalls, my team and I prepared the *Africa Energy Outlook*, a newly available special report in the *World Energy Outlook* series. Our first in-depth study of the continent, it was made with input from many African governments, as well as the African Union, the African Development Bank, the African Energy Commission, IEA member governments, other multilateral agencies and industry.

Significant resources to counter huge challenges

Currently 620 million people in sub-Saharan Africa – almost 70% of the population – have no access to electricity, which acts as a fundamental brake on development in much of the region. The governments we spoke with widely recognise that providing access to modern energy services must be a central component of their respective development plans, its importance matched by both the scale of the problem and the difficulties in trying to tackle it. The international community and major partner countries also are aware of how important energy is to development, as exemplified by the UN Sustainable Energy for All initiative. The imperative to provide universal access will put the power sector at the forefront of efforts in the coming years, through plans to expand links to the existing grid as well as by deploying increasingly innovative mini-grid and off-grid systems that exploit the abundant renewables resources. In our projections, 950 million people gain access to electricity by 2040, but that still leaves more than half a billion people without modern energy because of rapid population growth.

Reducing reliance on solid biomass, which now accounts for more than 60% of total primary energy demand in sub-Saharan Africa, will also prove difficult. About 730 million Africans use these traditional fuels for cooking, often in poorly ventilated areas where the noxious fumes can damage health. In our projections, biomass continues to play a significant role in the African energy mix, accounting for around half of total primary energy demand in 2040 as consumers who grow wealthier use modern energy sources to supplement traditional forms rather than to supplant them. As a result, we anticipate a scenario where consumption of all fuels – including bioenergy, oil, gas, and renewables – rises, contributing to a near doubling of total primary energy demand by 2040.

Refocusing energy investment to benefit African consumers

The *World Energy Outlook* shows that securing a brighter future for sub-Saharan Africa will require a greater level of regional co-operation, improved governance structures and institutions, and better resource management. These elements, if achieved, will help garner much higher levels of sustained investment than in the past. Between 2000 and 2013, two out of every three US dollars invested in sub-Saharan Africa went to produce energy for export. In our projections, this situation is reversed: energy investment rises rapidly to reach a cumulative USD 3 trillion and, by 2040, two-thirds of investments go towards providing energy to be consumed within the region.

If sub-Saharan Africa successfully charts this course, transforming its energy sector in a way that allows it to secure more reliable power for consumers and to extend access to the rural populations, it will bring the subcontinent dividends of increased economic growth and broader development.

Policies & Measures Databases

www.iea.org/policiesandmeasures

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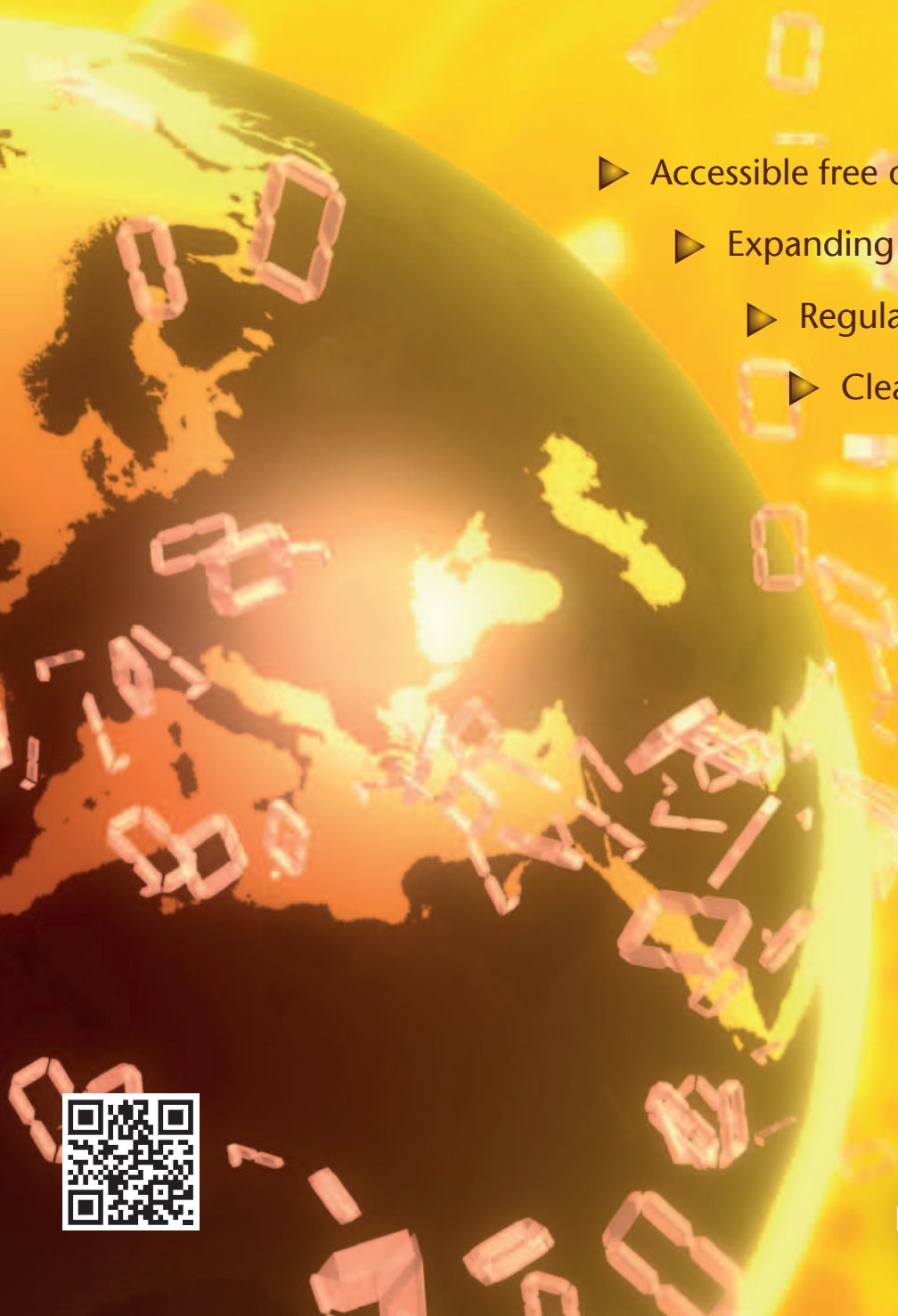

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Executive Director Maria van der Hoeven
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Oil Industry and Markets Division Head Antoine Halff
Platts Energy Week interview | Washington

Debut meeting in June
of IEA Electricity Security Advisory Panel | Paris

Saudi Aramco CEO Khalid Al-Falih, Ms. Van der Hoeven, Tesla CEO Elon Musk,
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ONS 2014 | Stavanger, Norway

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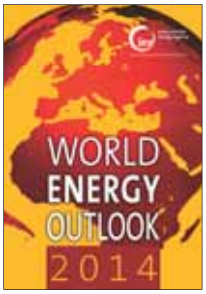
ENERGETIC READING

WORLD ENERGY OUTLOOK 2014

Language: English; **Release:** 12 November
Price: €135; **ISBN:** 9789264208049



The global energy landscape is evolving at a rapid pace, reshaping long-held expectations for our energy future. The 2014 edition of the *World Energy Outlook* (*WEO*) will incorporate all the latest data and developments to produce a comprehensive and authoritative analysis of medium- and longer-term energy trends. It will complement a full set of energy projections with strategic insights into their meaning for energy security, the economy and the environment. Oil, natural gas, coal, renewables and energy efficiency will be covered, along with updates on trends in energy-related CO_2 emissions, fossil-fuel and renewable energy subsidies, and universal access to modern energy services. Besides in-depth analyses of Africa and investment in the energy sector, the *WEO* for 2014 will examine the outlook for nuclear power amid many uncertainties: government policy, public confidence, financing in liberalised markets, competitiveness versus other sources of generation and the looming retirement of a large fleet of older plants.

MEDIUM-TERM GAS MARKET REPORT 2014

Language: English; **Release:** Available now
Price: €100; **ISBN:** 9789264211537

The *Medium-Term Gas Market Report 2014* gives a detailed analysis of demand, supply and trade developments as well as infrastructure investments to meet the 2.2% average annual growth in gas demand expected through 2019. It investigates the important changes that will transform the industry: rising regional disparities between gas-hungry regions such as China and the Middle East against weakening growth in the Former Soviet Union (FSU) and Europe; competition between FSU supplies and US and Australian liquefied natural gas, notably in Europe and Asia; the shift towards net imports in non-OECD Asia and Latin America; and uncertainty over whether Europe can ease its dependency on Russian gas. Besides enhanced coverage of gas in the power sector, the report features special focuses on the potential of gas in maritime transport; the competition between oil and gas to meet fast-growing Middle Eastern power consumption; the implications of Iran's possible return to the international gas scene; and the interplay of natural gas liquids and natural gas in the United States.

MEDIUM-TERM RENEWABLE ENERGY MARKET REPORT 2014

Language: English; **Release:** Available now
Price: €100; **ISBN:** 9789264218239

In 2013, renewable power capacity grew at its fastest pace ever, and renewable power generation neared 22% of the global mix. Investment exceeded USD 250 billion globally and is likely to stay high. Still, policy and market risks increasingly cloud the development picture. Just as renewables become a cost-competitive option in more cases, policy uncertainty is rising in some key OECD markets, while barriers to development remain in many non-OECD areas, including China. Biofuels for transport and renewables for heat continue to grow, but at slower rates than renewable electricity and with persistent policy challenges. The *Medium-Term Renewable Energy Market Report 2014* assesses market trends for renewables in the electricity, transport and heat sectors, identifying drivers and challenges to deployment, and making projections through 2020. The report presents for the first time an investment outlook for renewable power capacity, in addition to a global biofuels supply forecast and extended analysis of final energy use of renewables for heat.

CAPTURING THE MULTIPLE BENEFITS OF ENERGY EFFICIENCY

Language: English; **Release:** Available now
Price: €100; **ISBN:** 9789264220706

The traditional focus on energy savings as the main goal of energy efficiency policy has, at times, led to an underestimation of the full value of energy efficiency in both national and global economies. Energy efficiency can bring multiple benefits, such as enhancing the energy system's sustainability, supporting strategic objectives for economic and social development, promoting environmental goals and increasing prosperity. The aim of *Capturing the Multiple Benefits of Energy Efficiency* is two-fold: to build knowledge of those multiple benefits, and to demonstrate how policy makers and other stakeholders can use existing tools to measure and maximise the benefits they seek. Investigating in-depth five principal benefits areas – macroeconomic development, public budgets, health and well-being, industrial productivity and energy delivery – the book reveals compelling returns when the value of multiple benefits is calculated alongside the more traditional benefits of reductions in energy demand and greenhouse gas emissions.

Visit the online bookshop at www.iea.org
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IEA ENERGY FEATURED RESEARCH

TECHNOLOGY ROADMAP: SOLAR THERMAL ELECTRICITY

Author: Cédric Philibert

Since 2010, generation of solar thermal electricity (STE) from concentrating solar power (CSP) plants has grown strongly worldwide. Global deployment of STE is at about 4 gigawatts (GW), tiny compared with that of photovolatics (PV), at 150 GW, and costs of CSP plants have fallen less than those of PV. But new CSP components and systems are reaching commercial maturity, promising higher efficiency and lower costs. STE has advantages over PV from a systems perspective, particularly because of its built-in thermal storage capacities. This Technology Roadmap envisions STE generating 11% of global electricity by 2050. That growth does not come at the cost of growth for PV seen in the companion roadmap (below). As a result, STE and PV output combined could have solar power providing 27% of global electricity by 2050, the largest single source.

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TECHNOLOGY ROADMAP: SOLAR PHOTOVOLTAIC ENERGY

Author: Cédric Philibert

In the past three years, the world has added more solar photovoltaic (PV) capacity than in the preceding four decades, while the geographic pattern of deployment has changed rapidly. And over the past six years, PV system prices have fallen by two-thirds, and module prices by four-fifths. Such declines help lead this roadmap to envision PV providing 16% of global electricity by 2050, or 17% of all clean energy and 20% of all renewable energy. But to meet that target, PV capacity installation must accelerate even more, from 36 gigawatts (GW) in 2013 to 124 GW a year on average, peaking at 200 GW annually between 2025 and 2040. Transitional policy support mechanisms are seen as necessary in most markets, despite the drop in costs, so that PV electricity costs can reach competitive levels, unless electricity prices reflect climate change or other environmental factors.

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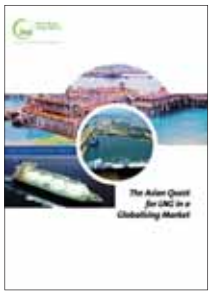
THE ASIAN QUEST FOR LNG IN A GLOBALISING MARKET

Authors: A.-S. Corbeau, A. Braaksma, F. Hussin, Y. Yagoto and T. Yamamoto



Gas producers increasingly look to Asia, as the region is the fastest-growing market given Europe's uncertain demand prospects and the near disappearance of North America from the scene for liquefied natural gas (LNG) importers. Asia will represent almost one-half of the world's incremental gas consumption from 2012 through 2019, according to the *Medium-Term Gas Market Report 2014* (facing page). Over the longer term, projections in the *World Energy Outlook 2013* show that the region will burn an additional 750 billion cubic metres of gas by 2035, which is slightly more than current US production. And because buyers in Asia pay the highest prices, producers are particularly drawn there. While this premium has led to new LNG projects that most targetly Asia, it has also spurred Asian countries to seek innovations in the LNG field to diminish their gas bills.

The Asian Quest for LNG in a Globalising Market warns, however, that the region's gas demand growth cannot be taken for granted, as it is subject to what supplies are available; the competitiveness (or lack thereof) of natural gas against coal and other sources of energy in the power sector; and the price at which natural gas reaches markets.

Asian markets are also multifaceted, with mature gas markets in Japan and Korea, energy giants such as China and India, and rapidly developing countries such as those that make up the Association of Southeast Asian Nations. The nations across the region will have different growth patterns in terms of supply and demand and different reactions to global pricing evolutions.

Indeed, gas prices play a very important role in the supply/demand balance and import picture. Even though gas may be the cleanest combustible fuel, its environmental benefits can be insufficient to push out cheaper alternatives. In Asia, the main competitor is coal, which is cheap and abundant in key countries such as Indonesia. Besides, natural gas prices have an effect on gas supply, as prices are often subsidised in non-OECD Asian countries. Low domestic gas prices disincentivise domestic production, making new imports too expensive compared with the prevailing domestic gas prices. That in turn triggers budget issues for governments or gas companies and deters investors.

This *IEA Energy*-featured Partner Country Series report analyses the market across the region and worldwide and examines how recent and future changes in the global LNG market could lead to significant modifications of the industry, affecting the pricing picture for Asian countries and, by extension, the rest of the world.

Read or download this report as of 6 November at
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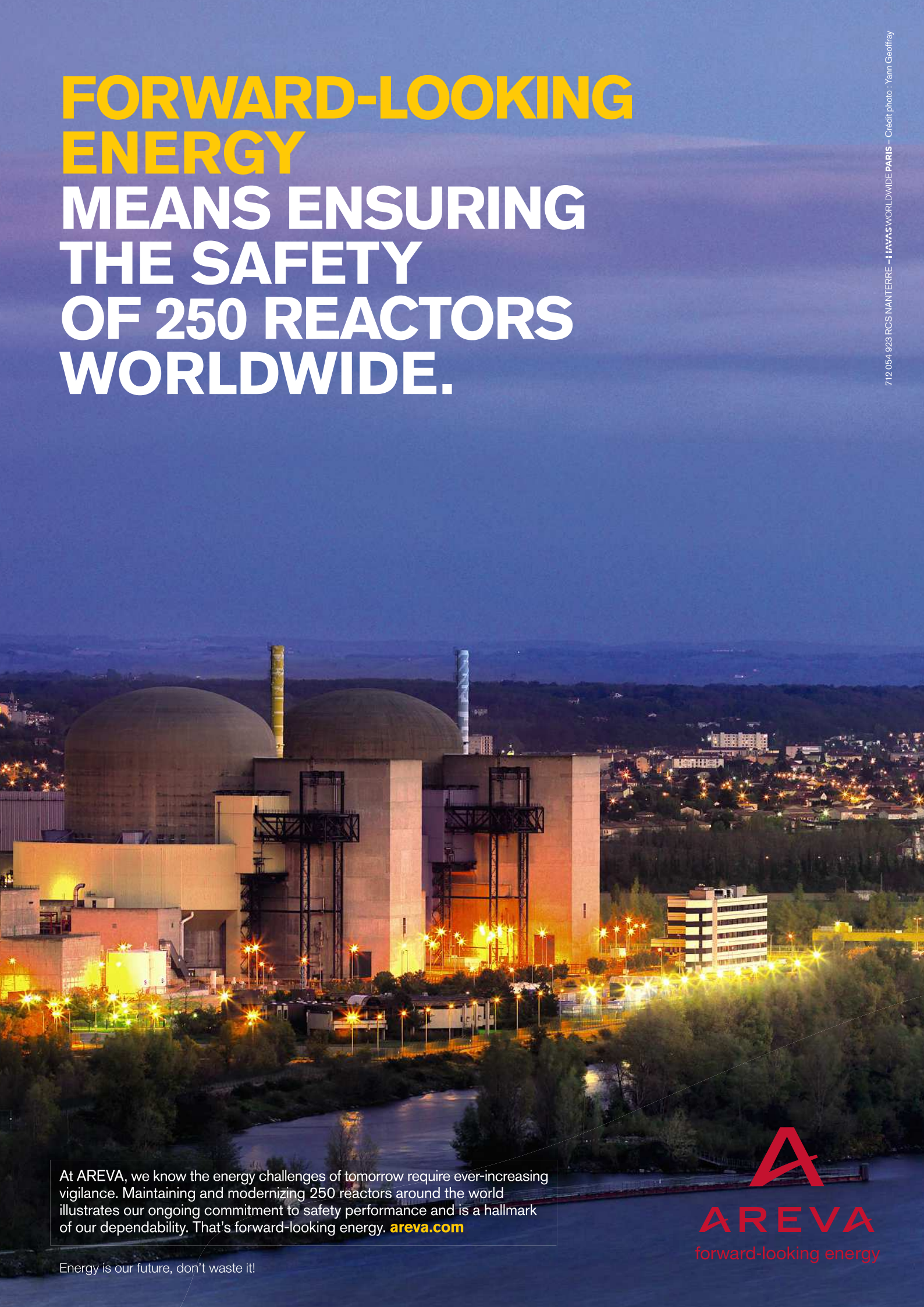

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