ESTONIAN OIL SHALE INDUSTRY

YEARBOOK 2016

100 YEARS MINING OIL SHALE

The yearbook of the Estonian oil shale industry was issued by:

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ESTONIAN OIL SHALE INDUSTRY

YEARBOOK 2016

Estonian oil shale industry in 2016

Income into the state treasury	Total investments	Investments into the environment	Positions for	Sales revenue
103 million	63 million	26 million	6400 people	602 million

Estonian oil shale industry in 2015

Income into the state treasury	Total investments	Investments into the environment	Positions for	Sales revenue
120 million	199 million	82 million	7411 people	669 million

Estonian oil shale industry in 2014

Income into the state treasury	Total investments	Investments into the environment	Positions for	Sales revenue
312 million	266 million	43 million	7774 people	933 million

Toward a smarter Estonian oil shale industry

Hando Sutter
chairman of the management board of Eesti Energia

Lower prices confront energy producers with one of their greatest challenges: operating efficiently in open market conditions. The cogeneration of oil, gas and electricity ensures optimum enhancement of oil shale and low environmental impact. Eesti Energia's new oil production record of 51,000 tonnes, posted in the last quarter of 2016, shows that the Enefit technology developed in Estonia allows us to make maximum use of the potential of our natural resources.

Harnessing modern technologies represents a major opportunity for us. One example of the many developments taking place at Eesti Energia is the 2016 pilot project for taking real time measurements of moisture and caloric value of oil shale at the Eesti power plant. The data make it possible to improve management, and more effective and cleaner production.

In September last year, the Estonian oil shale sector won significant international acclaim for the oil shale symposium held in Tallinn and Ida-Viru County. Close to 300 leading experts, researches and entrepreneurs in the field, representing more than 20 countries, gathered to mark the centenary of the oil shale industry in Estonia. We received reaffirmation from several continents that Estonia's know-how in conducting oil shale research and developing technologies is unique in the world. We are global oil shale

The oil shale industry's roller-coaster ride

Ahti Asmann
chairman of the management board of Viru Keemia Grupp (VKG)

The 100th anniversary of oil shale industry in Estonia was celebrated at a turbulent economic juncture. Due to changeable global oil market prices, the year started off with a steep decline, but the second half brought hopes of recovery and stability. The trying circumstances tested the market participants' strengths, competitiveness and readiness to respond to the changes.

Although we were operating at curtailed capacity in the first half of the year, we held on to the leader position in the Estonian oil shale sector, producing a total of about 451,300 tonnes of shale oil products. In spite of the complicated market situation, the Eesti Energia Group continued investing into the environment, operational reliability and development of the existing technology. We channelled the main part of our investments into environmental projects, above all into ambient air protection. New tech development trends will help make production smarter and offer solutions to boost efficiency.

The backbone of our entire activity is people. We would therefore like to extend our heartfelt thanks to the chemists, engineers, energy specialists – everyone working for the group who contribute each and every day to the development of the country's most important industrial sector. Last year proved that together, we can overcome the difficulties and that everything is achievable.

The Estonian state cares about the oil shale industry

Andreas Laane
chairman of the management board Alexela Group

The dramatic decline in the oil price in recent years posed a threat to an Estonian industry with decades-long traditions, and led to the risk of unemployment for thousands of people. For all of 2015 and the first half of 2016, the owners of Kiviõli Keemiatööstus (KKT) pumped assets into production to stem the losses and keep the industry in operation. In spite of the efforts, our oil shale sector reached a dangerous breakpoint where the industry appeared certain to buckle under the existing tax burden.

The Government of the Republic showed leadership qualities and, taking rapid decisions, created a tax environment that helped the industry overcome the difficult times. We thank the state for its foresight and wisdom.

Since that time, KKT has posted new production records, improving its efficiency indicators and investing into environmental conservation.

2016 proved that at difficult junctures, the sector's companies and the state are able to work together. The aim, as always, is to preserve tax revenue and guarantee jobs for people. We are confident that if we continue in the same vein, we will take Estonian oil shale industry to the next development level.

Research and development is the guarantee of oil shale's future

Kalle Pirk
director of the Oil Shale Competence Centre at the Tallinn University of Technology Virumaa College

To mark the centennial of oil shale mining, we have delved into the history, looked back at the development of technologies and equipment, and borne witness to key changes in environmental impacts of the oil shale industry. At the same time, we will continue to look to the future with ever greater enthusiasm.

Over the last 100 years, close to a billion tonnes of oil shale has been mined and used. In discussing the future of the oil shale sector, a question that inevitably comes up is how long it will take us to use our second billion tonnes of oil shale. Simple mathematics tell us that if 20 million tonnes of oil shale is mined every day, there would be enough to last for at least 50 years. This formula takes into account natural resources, people and equipment. But in actuality, it is not possible to determine the future of oil shale using such a simple formula. The right equation should be more multifaceted, and it has to incorporate also petroleum, carbon dioxide, sulphur and other variables that impact the sustainability of the industry. While various forecasts do try to model potential scenarios in different forecasts, their outcomes vary.

We have to continue to support research and development work to enhance the value of oil shale to the maximum degree. This is the security backing the future of our "brown gold".

ROLE OF THE OIL SHALE INDUSTRY IN THE ECONOMY

State revenue from the oil shale industry

In early 2016, the oil shale sector faced extremely complicated times, with oil prices having fallen to the lowest level in years. Nevertheless, oil shale companies made a noteworthy contribution to state revenue – a total of 103 million euros, the majority of which was resource fees and pollution charges and taxes on workforce.

A total of 63 million into development projects

Estonian oil shale enterprises continued implementing large-scale development projects in 2016. Their investments over the year totalled around EUR 63 million.

Energy products for export

Electricity and shale oil are significant export products for Estonia. Approximately 90% of shale oil production was exported. More than half of it was sold to Belgium and the Netherlands.

Although electricity exports decreased more than 12% in 2016 compared to 2015, production still exceeded consumption and Estonia continues to be a net exporter. The most important power trading partners were Latvia and Finland, as in previous years.

A total of EUR 103 million flowed into the state treasury from the oil shale industry

THE ESTONIAN OIL SHALE INDUSTRY IN FIGURES IN 2016

	Sales revenue (millions of EUR)	Average number of employees	Oil shale mined (thousands of tonnes)	Energy content of mined oil shale (MJ/kg)	Tax footprint 2016 (millions of EUR)**
Companies related to Eesti Energia's oil shale industry	420.4	4 032	9 731.8	7.9*	78.4
Viru Keemia Grupp	117.4	1 573	1 791.0	9.9 and 10.9	16.8
Kiviõli Keemiatööstus	25.0	610	1 581.3	9	4.9
Kunda Nordic Tsement	39.0	185	0	–	3.1
TOTAL	**601.8**	**6 400**	**13 104.1**		**103.2**

** Calorific value of commercial oil shale*

*** Workforce taxes, resource and pollution charges, corporate income tax, customs duty, land tax*

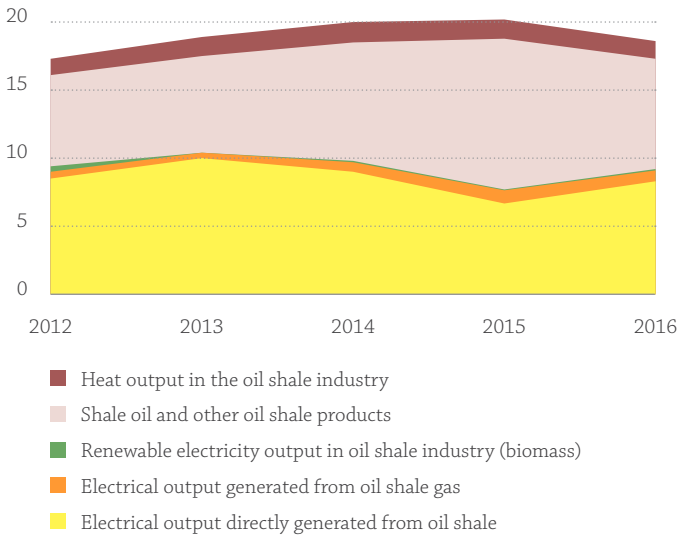
Competitiveness of the oil shale industry

Estonia – the most energy-independent country in Europe

According to the latest survey from Eurostat, Estonia was only 7.4% dependent on energy imports in 2015. This is the lowest level in the whole European Union and far under the European Union's average, which is 54%. With this result, Estonia beat out the long-term leader in energy independence for the second year running. Denmark's figure was 13.1% in 2015.

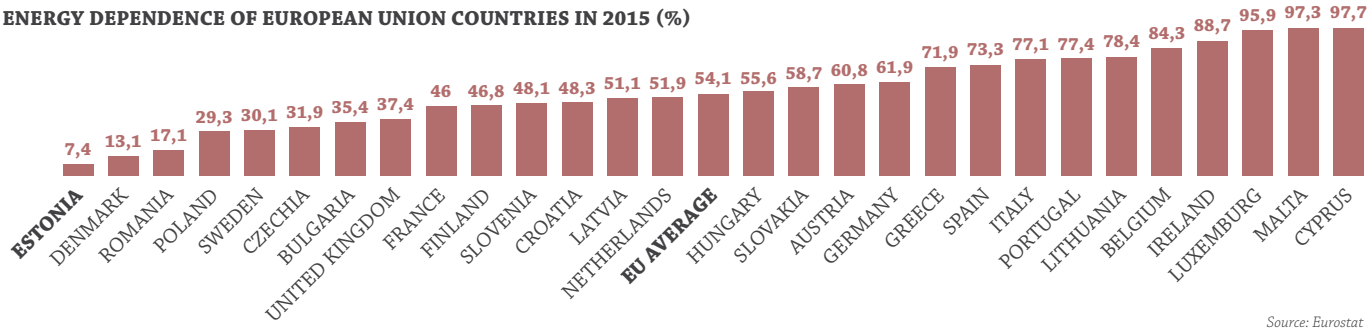
The decrease in Estonia's import dependence level primarily points to a robust domestic energy industry. Consumption of imported energy sources dropped, but the electrical output produced directly from oil shale increased.

ENERGY OUTPUT OF OIL SHALE ENTERPRISES (TWh)



Source: Eesti Energia, Viru Keemia Grupp, Kiviõli Keemiatööstus, Kunda Nordic Tsement

ENERGY DEPENDENCE OF EUROPEAN UNION COUNTRIES IN 2015 (%)



Source: Eurostat

Operating framework in Estonia

The legal environment connected to the oil shale industry is constantly being updated and supports better enhancement of oil shale and reduction in environmental charges. The goal of the state and oil shale sector is to ensure that the use of oil shale is as clean and economically efficient as possible. The environmental impact report drafted by the Organization for Economic Cooperation and Development (OECD) in 2016 praised Estonia's noteworthy progress toward decoupling economic growth from air pollution and energy consumption. It also concluded that the state should set even more ambitious objectives in this field.

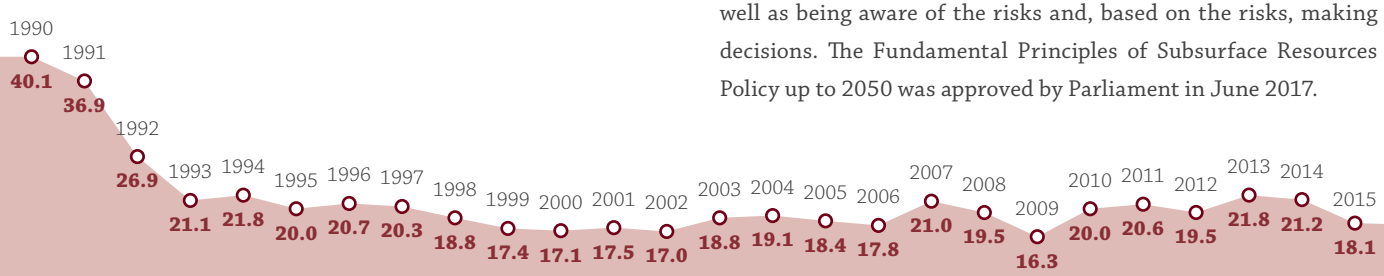
Reducing dependence on oil shale is the most important economic, environmental and social challenge in the energy sector. In spite of the efforts, Estonia is still the most carbon-intensive national economy in the OECD. The first strategic steps have been made by the state for giving up this dubious title. In January 2017, a new version of the Earth's Crust Act entered into force and some policies for guiding environmental conservation and efficiency developments in the field were prepared – the National Development Plan for Use of Oil Shale, Fundamental Principles for Subsurface Resources Policy up to 2050 and the Fundamental Principles for Climate Policy up to 2050.

Oil shale development plan 2016-2030

In March 2016, the Estonian Parliament approved the oil shale development plan 2016-2030. This strategic document with vital importance for the state defines the strategic objectives for development of use of oil shale and describes the necessary measures and activities to be undertaken to achieve them. The main goals of the development plan are to ensure maximum environmental conservation and efficiency in mining and use of natural resources as well as to develop education and research activities in the field.

Subsurface resources policy up to 2050

In 2016, the state continued cooperation with research institutions and experts for developing the fundamentals of Estonia's policy on its subsurface mineral resources. The objective of the framework document is to find ways of using the natural resources in a way that generates greater value for society, while factoring in socioeconomic, security, geological and environmental influences. It also defines the priority development areas for the decades to come, and the role and interests of the state as the main owner of the earth's crust and natural resources in exploring the earth's crust, and granting use and using natural resources. Great emphasis is laid on basing activity on research and the importance of research activity for making better use of existing resources as well as being aware of the risks and, based on the risks, making decisions. The Fundamental Principles of Subsurface Resources Policy up to 2050 was approved by Parliament in June 2017.



JOONIS: GREENHOUSE GAS EMISSIONS IN ESTONIA, 1990-2015 (MILLIONS OF TONNES)

Source: Eurostat

Estonian climate policy up to 2050

In December 2016, the Government of the Republic approved the Fundamental Principles for Climate Policy up to 2050 and sent it to parliamentary committees for discussion. Estonia's long-term objective is to make the transition to a low-carbon-emission economy, which means gradually transforming the economic and energy system into a more resource-efficient, productive and environmentally cleaner one. Development and adoption of innovative clean technologies also has an important role in the document.

The principles of Estonian climate policy stem from those of the European Union's climate policy. By 2050, Estonia aims to reduce greenhouse gas emissions by 80 percent compared to 1990 levels. The Parliament approved the Fundamental Principles of Climate Policy up to 2050 in April 2017.

Change made to environmental charges

In June, Parliament approved an amendment to the Environment Charges Act that elaborates further the principles for taxation of the right to use natural resources and more clearly brings out the nature of the charges based on the value of natural resources to the state. The law differentiates the principles of establishing environmental charges for natural resources with energy value, such as oil shale and peat, and natural resources used in construction.

In accordance with the legislative amendment, the market value of energy products or replacement products became the basis for remuneration of oil shale and peat. In addition, the resource charge for oil shale was retroactively lowered effective July 2015, from 1.58 euros to 0.275 euros per tonne of oil shale. The amendments significantly alleviated the extremely complicated situation, as linking resource charges to the price of fuel oil on the world market resulted in a more flexible taxation system. The new approach helps companies ride out the slump on markets and retain jobs, while ensuring the state higher tax revenue at times when the market price is higher.

Linking the resource fee to the world oil price reduces the impact of large price fluctuations on the oil shale industry

OIL SHALE VALUE CHAIN:

FROM MINING TO FINISHED PRODUCT

Mining permits and volumes

Enough oil shale energy to last at least half a century

Estonia started oil shale exploration and use already a hundred years ago. Over the last century, slightly over a billion tonnes of oil shale have been mined in Estonia. Of the current 4.8 billion tonnes in oil shale reserves, there is 1.3 billion tonnes of active oil shale remaining that can be mined without restrictions. At today's rate of consumption and current efficiency, and presuming responsible use, that oil shale will last for another 50 years or more. This period may even be extended further if new technologies are introduced to enable mining of oil shale deposits that are currently inaccessible due to geological conditions and restrictions.

Estonia's two main oil shale deposits are located in north-eastern Estonia. The thickest oil shale strata lie in an area between Rakvere and Narva, in the so-called "Eesti" site where industries have established both underground and opencast mines to access the up to 2.9 metre thick oil shale layer. Because the oil shale in the so-called "Tapa" site between Väike-Maarja and Ambla is of low quality and lies deep, no oil shale is currently being mined there.

In 2016, a record low of 13 million tonnes of oil shale, out of 20 million tonnes allowed, was mined

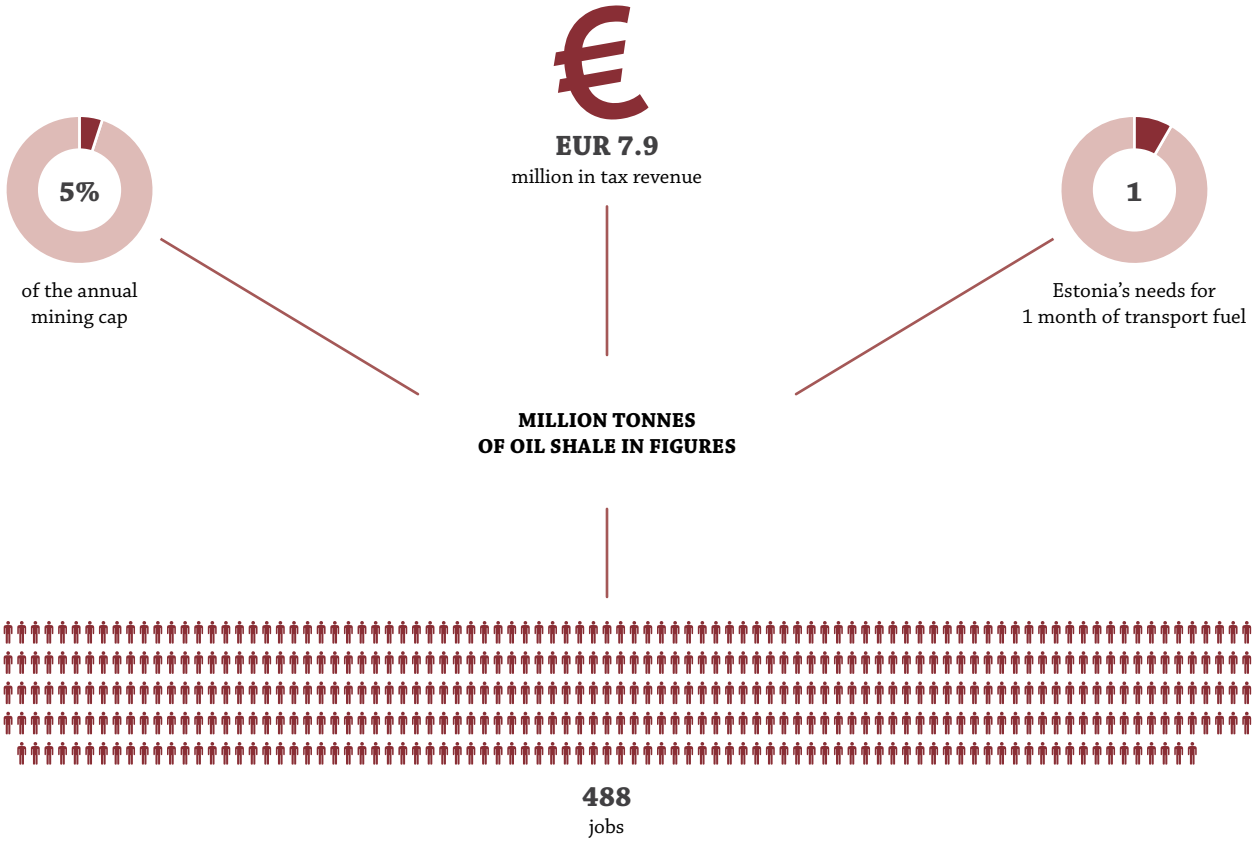
Mining volumes lowest in last five years

In Estonia, four companies hold a permit to mine oil shale – Eesti Energia (EE), Viru Keemia Grupp (VKG), Kiviõli Keemiatööstus (KKT) and Kunda Nordic Tsement (KNT). Pursuant to the state's long-term development programme, companies between them are allowed to mine 20 million tonnes of oil shale each year in Estonia. Eesti Energia is allowed to mine 15 million tonnes of geological oil shale a year, VKG, 2.8 million tonnes, KKT, close to 2 million tonnes and KNT, 0.2 million tonnes.

In recent years, oil shale companies have mined approximately one-fourth less due to low market prices. In 2016, a record low was set, with only 13 million tonnes of oil shale extracted from the earth's crust. Eesti Energia and VKG used 65% of their annual mining quota and relied more on their already mined stocks. KKT mined 1,6 million tonnes of oil shale, which is 80% of the annual quota. Kunda Nordic Tsement did not mine oil shale in 2016 and their production relied on previously accumulated stocks.

MINING METHODS

- **Opencast mining** – in places where the oil shale layer lies up to 30 metres deep, the oil shale is mined in opencast mines, after removal of the overburden. Opencasts in use: Narva opencast mine (Eesti Energia), Põhja-Kiviõli opencast mine (KKT), Ubja opencast mine (KNT)
- **Underground mining** – if the oil shale layer lies deeper than 30 metres, an underground mine has to be built – mine shafts have to be established, reinforced and the necessary systems for extracting the rock put in place. Current underground mines: Estonia mine (Eesti Energia) and Ojamaa mine (VKG)



OIL-SHALE MINING (2012–2016)

	Annual volume allotted, thousands of tonnes	Actual amount mined (thousands of tonnes)*, share of the allowance used (%)										Average % 2012–2016
		2012		2013		2014		2015		2016		
Eesti Energia	15 010	13 124	87%	11 830	79%	11 614	77%	11 083	74%	9 732	65%	76%
Viru Keemia Grupp	2 772	1 097	40%	2 344	85%	2 483	90%	2 637	95%	1 791	65%	75%
Kiviõli Keemiatööstus	1 980	615	31%	755	38%	1 058	53%	1 350	68%	1 581	80%	54%
Kunda Nordic Tsement	238	110	45%	97	41%	103	43%	117	49%	0	0%	36%
TOTAL	**20 000**	**14 946**	**75%**	**15 026**	**75%**	**15 258**	**76%**	**15 187**	**76%**	**13 104**	**66%**	**63%**

** Geological reserves without considering losses*

Investments continue

In spite of the complicated market situation, oil shale enterprises continued investing into technologies to make mining more efficient and cleaner for the environment. At Narva opencast, Eesti Energia adopted the biggest light-metal-alloy shovels in the Baltics, which increase mining efficiency by 10%. At the same time, the company simultaneously upgraded the excavator control systems, which increased the machinery's lifespan by 10 years.

VKG uses a unique 18-kilometre aboveground and underground conveyer system that handles transport of raw material from the mine to the shale oil plants. In 2016, the conveyer control programme was upgraded with laser sensors. Now VKG can use the technology developed by the engineers to calculate the quantity of natural resource being fed in, adjust the speed of the main conveyer and ensure an even feeding rate, which in turn increases efficiency throughout the production chain. The company simultaneously increased the number of the mine's feeder-crushers to nine machines, which cover about 85% of the entire conveyer system.

Oil shale enterprises invested EUR 63 million in 2016. Most of it was channelled into developing technologies.

KKT renovated the opencast's pumping station in 2016 and increased the capability of its mining equipment, acquiring a new excavator, bulldozers and two rotating loaders. The company also leased four additional trucks in addition to its existing nine modern trucks.

Smarter industry

It is hard to imagine contemporary industry without constant development and new technological possibilities. Similarly to other fields, the oil shale sector is becoming smarter thanks to new technologies. In 2016, VKG installed readers that use radio frequency ID (RFID) in sites for off-loading mined material and maps on shovel loaders and dumpers. The new technology allows the number of work cycles of the transport machinery to be tracked and thereby make the work process and reliability more efficacious.

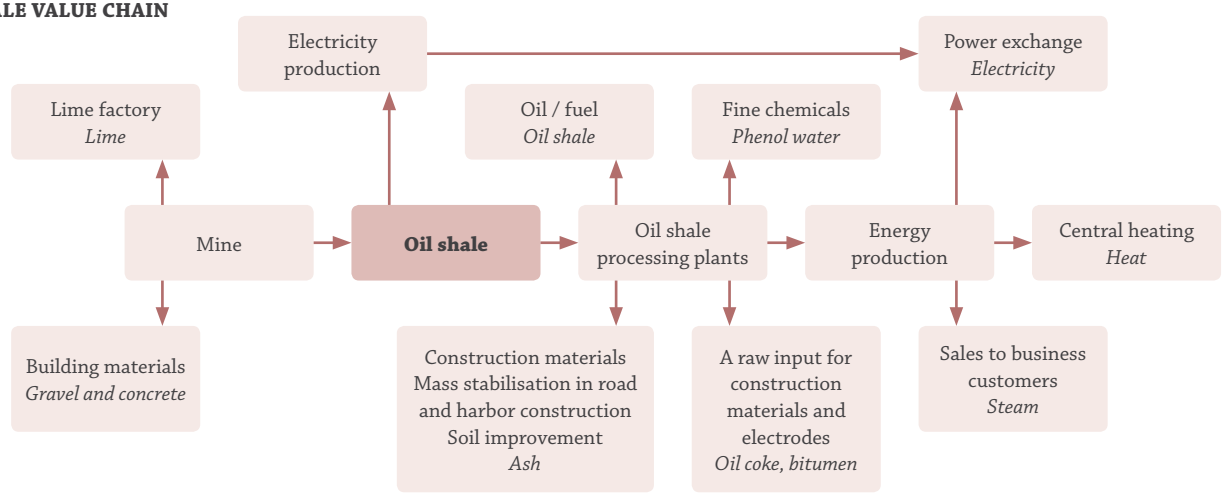
As part of the industrial digitalization programme, Eesti Energia will soon start installing equipment at its power plants, oil refineries and mines, for taking real-time measurements of the caloric value and moisture of oil shale. The results of the pilot project spanning 2016 confirmed that more effective data analysis will make mining and production more flexible, efficient and environmentally friendly, which will be a major edge for strengthening competitiveness in changeable market conditions.

Use of oil shale

Estonia's unique energy sector is based on the multifaceted use of oil shale. The majority of it – 73% – is used to generate electricity. The rest is used to produce shale oil (23%) and generate heat (3%). Oil shale has uses in the chemical industry and a few percent of the mined volumes are used for producing cement and road construction.

Although the value chain of oil shale is longer than ever before, the depressed fuel prices are forcing companies to invest even more into research and testing to find novel opportunities for the use of oil shale and its by-products.

OIL SHALE VALUE CHAIN



IN 2016:

- the average market price of electricity rose 6%
- 7% less shale oil than in 2015 was produced
- the cheapest municipal heat continued to be produced from oil shale
- the average oil price fell 20% compared to 2015

73% of Estonian oil shale is used to generate electricity

Electricity

In recent years, Estonia has been the most energy-independent country in the EU, thanks largely to energy generated from oil shale.

Power output on the rise

In 2016, a total of 12.05 TWh of power was generated in Estonia – 14% more than a year earlier. Three-fourths of it came from oil shale companies' output, which reached slightly over 9 TWh. Of this, 90% was produced by Eesti Energia in its power plants by direct combustion of oil shale.

The growth of output was bolstered by a favourable competition situation, higher prices on the power exchange and a drop in the production cost of oil shale. Production was also favoured by lower CO_2 allow- ance prices and the drop in the water level in the Nordics' hydro reservoirs.

In 2016, Estonian domestic power consumption made up 7.67 TWh – slightly more than in the four years before that.

In 2016, the average price of electricity rose 22%

ELECTRICITY OUTPUT AND ELECTRICITY CONSUMPTION IN ESTONIA, 2012–2016 (GWh, %)

	2012	2013	2014	2015	2016
Eesti Energia	9 201	10 278	9 343	7 312	8 695
of which oil shale electricity	8 524	9 965	9 003	6 745	8 203
Viru Keemia Grupp	210	190	217	311	352
Kiviõli Keemiatööstus	42	38	39	41	44
TOTAL POWER OUTPUT	**9 453**	**10 506**	**9 599**	**7 664**	**9 091**
of which oil shale electricity	*8 776*	*10 193*	*9 259*	*6 754*	*8 212*
Consumption of electricity in Estonia	7 407	7 332	7 417	7 440	7 672
Share of oil shale electricity of total consumption of electricity in Estonia	*118%*	*139%*	*125%*	*95%*	*107%*

Source: EE, VKG, KKT, Statistics Estonia

ELECTRICITY PRICES ON THE NORD POOL SPOT POWER EXCHANGE 2015–2016 (€/MWh)

Average price	2015	2016	Change
System price	21.0	26.9	▲ 21.9%
Finland	29.7	32.5	▲ 8.6%
Estonia	31.1	33.1	▲ 6.0%
Latvia	41.8	36.1	▼ -15.8%
Lithuania	41.9	36.5	▼ -14.8%

Source: Nord Pool

Renewable energy made up 13.6% of total electrical output. Compared to the previous year, generation of power from renewable energy decreased by 6%. 15% less wind energy was generated while the amount of power generated from biomass, biogas and waste remained on the same level. The volumes of hydroelectric energy produced jumped – up to one-third more electricity was generated from water than in 2015.

Electricity in high demand

In 2016, the average prices of electricity rose in all Nordic power market bidding areas. Compared to 2015, when a decline was seen, the system price – which expresses the ideal price level – rose 22% and the average price for the year was 26.91 €/MWh.

The average price in the Nord Pool Spot (NPS) in the Estonian bidding area in 2016 was 33.06 €/MWh, which is 6% lower than in 2015. Overall for the year, one megawatt-hour in the NPS Estonian bidding area cost 6.15 euros more. The price difference has decreased compared to 2015, when a megawatt-hour cost 10 euros more than the system price.

In 2016, the average monthly prices of electricity on the Nord Pool Spot Estonia bidding area ranged from 28-40 €/MWh. During 53% of the hours, the power market price of electricity was lower than 30.70 €/MWh – in other words, less than the regulated price in effect up to the end of 2012. The year's lowest hourly price, 4.02 €/MWh, was recorded on 25 December. The highest hourly price was on 21 January – 200.06 €/MWh. A year earlier, the corresponding indicators were 0.32 €/MWh and 150.06 €/MWh.

In 2016, the export of electricity in Estonia decreased by 12% and import fell 35%. The most important power trading partners continued to be Latvia and Finland – Estonia sold 86% its export electricity to its southern neighbours and the other 14% went to Finland. Of total imports, 93% came from Finland and 7% from Latvia.

AVERAGE MONTHLY PRICES OF ELECTRICITY ON THE NORD POOL SPOT ESTONIA POWER MARKET (STARTING 1 APRIL 2010), €/MWh

Source: Nord Pool

Estonia has the capacity to supply its own electricity needs through oil shale

Liquid fuels

Estonia is one of the world's biggest producers of shale oil. Shale oil has lower viscosity, a lower solidification point and lower sulphur content than heavy fuel oil from petroleum. Oil produced from shale is mainly used as an input in the chemical industry, impregnation oil, fuel for boilers and industrial furnaces and marine fuel additive.

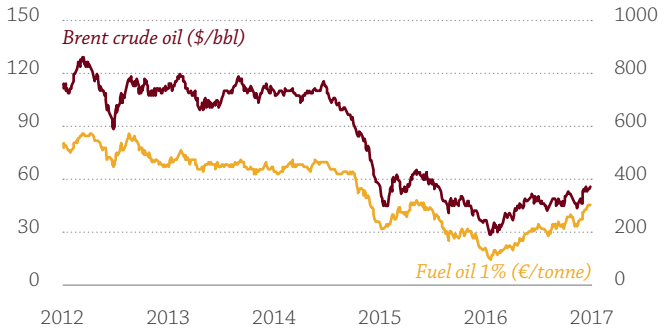
The Petroter and Enefit technologies employed for shale oil production in Estonia have a high energy efficiency – up to 85% – due to their low CO_2 emissions can be considered environmentally clean. Oil producers are actively developing possibilities to refine shale oil into fuels with higher value. Eesti Energia plans to establish a system for extracting petrol from shale gas. The corresponding investment decision will be made in 2017.

THE ESTONIAN OIL SHALE INDUSTRY'S LIQUID FUEL OUTPUT, 2012-2016 (THOUSANDS OF TONNES)

	2012	2013	2014	2015	2016
Eesti Energia	209	214	265	337	318
Viru Keemia Grupp	325	358	433	506	451
Kiviõli Keemiatööstus	62	56	62	72	83
TOTAL	**596**	**628**	**760**	**915**	**852**

In 2016, Estonia produced 852,000 tonnes of shale oil, which is 7% more than a year ago. As in previous years, 90% of the output was exported. Shale oil of Estonian origin was sold mainly to Netherlands and Belgium, as well as to Sweden, Malta, Denmark and Finland.

PRICES OF LIQUID FUELS ($/BBL)



Source: Thomson Reuters

FUEL OIL AND BRENT CRUDE OIL CRACK SPREAD

Source: Thomson Reuters

Continued drop in oil prices

The first half of 2016 was a complicated period for oil shale companies as the market prices of oil and energy remained very low. The year began with a drop in oil prices and in January, a barrel of Brent crude reached a decade-low 27.10 USD. The price of crude oil rose to 50 USD per barrel in summer, and reached the peak of 57.89 USD per barrel at the end of the year. The average price of crude oil in 2016 was thus 45.13 USD per barrel, which is 16% lower than in 2015.

In the first half of the year, oil shale companies had to adapt to a complicated market situation. VKG halted its two Kiviter-technology-based oil refineries. The distillation and dephenolization equipment connected to the Ojamaa mine and oil plants operated at a lower load than usual.

From June, oil prices started growing, which allowed VKG to relaunch refineries and increase mine production volumes. The government's decision to institute a flexible system for taxing oil shale resources – the resource fee for use of oil shale was linked to the world oil price – also had a positive effect.

For the first time in many decades, KKT launched both of its solid heat carrier reactors in 2016, allowing the oil produced from fine-grade oil shale to be increased compared to previous years.

In 2016, Estonia produced 852,000 tonnes of shale oil, which is 7% more than a year ago. Approximately 90% of it was exported.

Heat

In 2016, a total of 7.4 TWh of power was generated in Estonia – 0.7 TWh more than a year earlier. Because it is not technologically possible to efficiently store or transport thermal energy, Estonian heat output remains more or less equal to consumption. The demand for residential heat has declined in the past five years in Estonia. The production of heat from oil shale has also decreased. In 2016, oil shale companies generated 1.33 TWh of municipal heat, which is around one-fifth of local consumption.

Oil shale by-products used for residential heat

A majority of the residential heat produced in Estonia is from more renewable CHP plants. At Balti power plant near Narva, Eesti Energia generates municipal heat from oil shale and biomass. The thermal energy produced here is supplied by Narva Soojusvõrk to more than 60 000 consumers in the area. The company maintains an approximately 75-kilometre long district heating network, manages renovation projects and makes investments to ensure the network's reliability.

Thermal energy produced by VKG Soojus comes from co-generation of shale oil, power, and heat. It is delivered to consumers in the Kohtla-Järve and Jõhvi areas via an 18.5-kilometre long trunk line. In this manner, Ida-Viru County industries and consumers in the area can use the heat generated in the oil shale industry; and the power produced by CHP plants is used all across Estonia.

Co-generation of heat and power at KKT covers heat demand from the whole city of Kiviõli and the needs of the company itself.

Heat for less

In 2015, the ceiling for the consumer price of heat approved by the Competition Authority averaged 61 euros per MWh. Residential heating was still more affordable than the average in the cities and towns where it is generated as a by-product of the oil shale industry. The most inexpensive residential heat was in Narva, where customers pay 35.62 euros/MWh for heat from Eesti Energia. Kiviõli consumers buy heat from KKT at a price of 46.44 €/MWh. The price in the VKG Soojus heating network district in Ahtme, Jõhvi and Kohtla-Järve is 55.22 euros per MWh.

Residential heating is more affordable in cities where it is generated as a by-product of the oil shale industry

OIL SHALE COMPANIES' HEAT OUTPUT AND HEAT CONSUMPTION IN ESTONIA, 2012–2016 (GWh)

	2012	2013	2014	2015	2016
Enefit Energiatootmine	599	584	603	614	596
Viru Keemia Grupp	365	650	581	532	506
Kiviõli Keemiatööstus	93	90	107	108	123
Kunda Nordic Tsement	214	188	191	97	104
TOTAL	**1271**	**1512**	**1482**	**1351**	**1329**
Consumption of thermal energy in the form of district heating in Estonia	8598	8098	8015	7789	6235

Source: EE, VKG, KKT, KNT, Statistics Estonia

Fine chemical industry

Oil shale chemicals are in widespread use in various fields. They can be found in the tyre, cosmetics, plywood, perfumery, textile and electronics industries. Fine chemicals are often used for dyeing textile and tanning hides. Chemicals produced in Estonia can be found in dyed textiles and tanned furs, the hair dyes marketed by L'Oréal, Wella and Schwarzkopf, and facial creams and suntan lotions. They are also used to produce Samsung TV screens and Lexus and Toyota automotive parts.

Oil shale phenol fractions are used as epoxies in the tyre, plywood and oil industry and as base chemicals for making paints and lacquers. Starting in 2012, the so-called red resin is also produced from Estonian oil shale, which is used to make automotive tyres – it is used by the world's leading tyre manufacturers.

Customers all over the world

VKG is today the only company in Estonia that distils prized fine chemicals from the shale oil plants that use the Kiviter technology. VKG is capable of producing extremely pure (more than 99%) chemicals that can fetch up to several hundred euros per kilogram.

The biggest consumers of oil shale chemicals are companies in the EU, Japan and India. Fine chemicals made in Kohtla-Järve are also sold to Latin American countries and Iran. In 2016, VKG sold about 400 tonnes of fine chemicals and phenol products.

Oil shale chemicals produced in Estonia are used by the world's leading tyre manufacturers as well as in the cosmetics and perfume industries

Uses for by-products of the energy generation process

Everywhere in the world, demand is growing for carbon-free materials, as they are called. Transforming industrial waste to valuable, environmentally friendly products is currently a field of great interest in the European Union and elsewhere in the world.

Use of by-products in other manufacturing fields reduces the environmental impact of industry, increases competitiveness of the sector and creates economic benefits. The recovery and re-use of materials also helps promote a circular economy. Each year, close to 20 million euros of by-products are generated in Estonia in the course of energy generation. These include mine waste created in processing and upgrading oil shale and the ash that results from power generation.

Recycling mine waste

In 2016, the oil shale industry generated around 10.3 million tonnes of mine waste, which consists mainly of limestone with a small quantity of oil shale as well. Over one-third of this was used in place of traditional crushed limestone for road construction, landscaping and filler. Due to the high cost of transport, crushed stone from oil shale mines has been used only in Ida-Viru County construction sites so far. As mine waste is essentially limestone, recovery of mine waste means less demand for limestone quarrying – fewer opencast mines designated specially for limestone have to be opened.

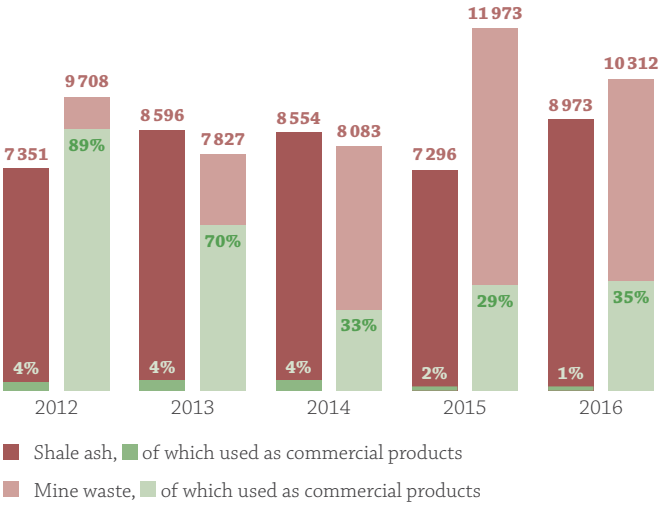
A place for sport, shaped out of mine waste

In 2016, Eesti Energia continued to develop a theme park in Mäetaguse Parish offering various sport and recreational opportunities on a mine waste hill near the Estonia mine. Crushed stone made from mine waste generated in the course of upgrading oil shale is used in constructing the park. The theme park will be ready in 2018.

Houses and roads made from ash

In 2016, the Estonian oil shale industry generated 8.97 million tonnes of ash. Instead of being dumped in an ash heap, it can now be used as an input for producing construction materials. At the same time, the potential of oil shale ash as a recoverable material has not yet been completely realised. In 2016, only 1.4% of the ash generated was recovered. For this purpose, companies are constantly on the lookout for ways of making successful use of fly ash in other production fields. The first tests in this field have already borne fruit.

BY-PRODUCTS GENERATED BY THE OIL SHALE INDUSTRY (THOUSANDS OF TONNES) AND THEIR USE AS COMMERCIAL PRODUCTS (%)



Even though the ash resulting from the process of power generation is considered a hazardous waste in Estonia, a number of products made from the ash are now standardized. This allows the ash to be used as a construction material instead of being deposited in heaps. Today oil shale ash can be used for producing cement, concrete and cellular concrete in Estonia and other countries. Fly ash can also be used to produce masonry units and other construction materials and plastics. Until the end of 2016, VKG produced environmentally friendly Roclite construction blocks, made from a mix of recovered fly ash, sand and water. They are ecologically clean and do not release any harmful compounds into the environment. In early 2017, VKG sold this subsidiary to the leading maker of aerated concrete in the Nordics, Aeroc International.

In 2016, Eesti Energia concluded its five-year-long OSAMAT project, designed to test the suitability of fly ash in road construction. The pilot project conducted in natural conditions with the Road Administration and Nordecon confirmed that fly ash is a competitive material for use in road construction and other major infrastructure projects, such as port construction. The results of the pilot project confirmed that the test segments constructed of oil shale ash had high strength and load-bearing capacity indicators and that there was no negative impact on the environment. The results gave assurance that fly ash's stabilizing and binding properties make it a good replacement for cement in road construction in Estonia and its near vicinity. For example, fly ash could be used in major infrastructure projects like Rail Baltic or the Tallinn-Tartu highway.

Making fields more fertile with ash

For decades now, oil shale ash has been used as a lime substitute to raise the pH of farmland. Eesti Energia separates the fine particles (PM2.5) and calcium-rich fly ash from smoke gases generated during the high-temperature combustion of oil shale, and uses it as a fast-acting neutralizer of acidic soil. In 2016, the company launched a fly ash based product called Enefix. The major interest on the part of farmers is understandable: besides neutralizing properties, fly ash has a number of microelements that promote the growth of plants and reduce the need for fertilisers. Because of Enefix's rapid neutralisation capacity, the effect can be seen already in the first year of use.

ASH GRANULES FOR THE PLASTICS INDUSTRY

In 2016, the company Mineralplast launched tests for producing granules consisting of 85% fly ash from electric filters at Eesti Energia power plants.

The tests have shown that granules based on ash instead of chalk have higher stability and rigidity when being processed. The material's temperature stability is also superior, and it mixes better.

Ash granules can be used in the packaging and automotive industry, such as for manufacturing dashboards and plastic pallets.

OIL SHALE INDUSTRY AND THE ENVIRONMENT

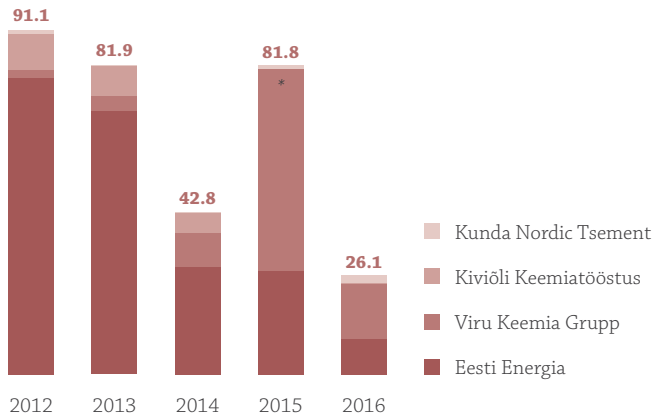
Investments into the environment

Manufacturing and the environment go hand in hand

Companies paid the state close to 58 million euros in environmental charges in 2016. One-third of it was comprised of resource fees for mining oil shale and use of water. Pollution charges for emissions and deposition of waste related to mining and processing of oil shale made up around 40 million euros. Direct and indirect investments into the environment amounted to more than 26 million euros.

During the last five years, oil shale companies have invested approximately 324 million euros into environmental conservation. Only capital allocations directly intended for reducing mining or production-related emissions are considered environmental investments in the oil shale sector. In fact, most of the investments made into the production process are more or less dictated by environmental interests.

ESTONIAN OIL SHALE COMPANIES' DIRECT AND INDIRECT ENVIRONMENTAL INVESTMENTS IN 2012–2016 (MILLIONS OF EUROS)



** Includes indirect environmental investments in connection with expanded production volumes and the establishment of the Petroter III shale oil plant*

In 2016, a key additional impetus for Eesti Energia's oil production came from the Enefit280 liquid fuel and power plant. The environmental emissions from the new Enefit280 are much lower than previous generation factories and thanks to the use of residual heat to generate electricity, the plant is also more efficient than past ones.

In 2016, KKT channelled around 3 million euros into technological upgrades. A heavy-oil cleaning system was replaced and in the near future, KKT will be installing electric filters at its production complex for the first time in its history, ensuring cleaner air.

A "gift" from previous generations

Alongside future-oriented environmental investments, the oil shale industry is forced to deal with eliminating residual pollution from the past decades. In 2016, active discussions continued regarding the future of the Kukruse mine waste hill in Kohtla Municipality in Ida-Viru County. Over the years, some 1.3 million tonnes of mine waste have been deposited in the 5-hectare waste site. The Ministry of the Environment has categorized Kukruse as a category A waste depository – meaning that it poses a high risk to the environment and human health.

Of the solutions proposed by experts for reconditioning the site, the best one was considered to be partial removal of the waste and reshaping the remaining 790,000 m^3 of material into a new hill. The government allocated 9.7 million euros for this purpose last year.

Environmental impacts associated with mining

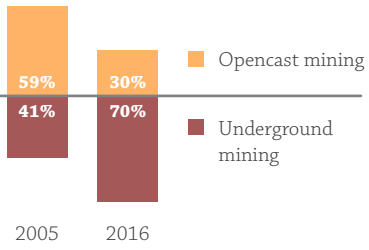
Any kind of mining sooner or later has an environmental impact. Although oil shale mining in Estonia does not cover huge swathes of territory, it does have a visual and ecological influence on the quality of landscapes.

Two methods are in use for extracting oil shale from the earth's crust – underground and aboveground mining. The mining method and technologies in use largely dictate the manner and extent of the effect on surrounding ecosystems.

Lower environmental impact and less waste

The direct impact of underground mining on the environment and the inhabitants of the mining area is lower than in the case of opencast mining. Transportation of oil shale from underground mines using conveyors means less wear on local roads and does not generate noise and dust. Oil shale enterprises are always looking for ways to fully utilize the potential of the mine waste generated by underground mining, and one already proved use is in road construction as a soil amendment. Although underground mining conserves existing soil and ecosystems, it does have an impact on the water regime in the vicinity of the operations, above all on groundwater and surface water.

OPENCAST AND UNDERGROUND MINING OF OIL SHALE (%)



In opencast mining, oil shale can be extracted with less waste, and this type of operation also generates less mine waste that will later have to be deposited somewhere. Nearly all of the limestone generated by strip mining is recovered and used to recondition the extraction sites and shaping a new landscape.

Adoption of the newest technologies helps to reduce local environmental impact around mines as well. Eesti Energia's specialists have in recent years improved the historical longwall mining technology, with a larger area being mined simultaneously. This ensures more even subsidence of the ground surface and prevents the formation of mounds. 2016 was a key year for this technology, as after a thorough environment impact assessment, the company received permission to start using the method in Narva opencast mine.

Trend toward underground mining

Today oil shale is mined using the underground method at VKG's Ojamaa mine and Eesti Energia's Estonia mine and using the opencast method in KKT's Põhja-Kiviõli opencast mine, Eesti Energia's Narva opencast mine, and Ubja opencast mine operated by KNT.

As recently as 2015, underground and opencast mines had equal proportions in the oil shale industry, but now the opencast mines are declining in importance. As mining is moving progressively deeper into the earth's crust, forecasts predict that opencast mining will be a thing of the past by 2030 and most of the today's opencast mines will have shut down and been reconditioned. As one example, starting in 2019, Eesti Energia plans to launch underground mining at Narva opencast mine to reach the deeper layer of oil shale.

Water and the oil shale industry

The role of water in the oil shale industry is central from the standpoint of the environment, encompassing both precipitation and groundwater and the water used in daily life by residents.

During mining operations, the mine must be kept dry. Any water that accumulates is pumped out and suspended solids are filtered out. After treatment, the water is returned to nature, primarily flowing into the Gulf of Finland; some of it into Lake Peipus as well. In 2016, 159 million cubic metres of water were pumped out of opencast and underground mines.

Taxes on mining water

According to the Estonian Geology Centre, the main source of mining water is rainwater. It makes up 80% in opencast mines and close to 50% in underground mines. A smaller portion of mine water comes from closed mines in the vicinity and groundwater. The quantity of water pumped out is directly linked to the amount of precipitation. It is thus difficult for the oil shale sector to forecast the amount of tax that will be levied by the state for pumping the water as it depends on local weather, not mining volumes. Starting in 2016, companies have to pay 19.09 euros for every 1000 m^3 they pump out of opencast mines, and 53.25 euros/1000 m^3 for water pumped out of underground mines. In 2016 oil shale enterprises paid a total of 8.4 million euros in water special use fees.

The first underground sedimentation basin

Oil shale enterprises are constantly seeking new possibilities of reducing the environmental impact on the regional water system. In 2016, Eesti Energia established Estonia's first underground sedimentation basin, as a result of which suspended solids have more time to settle and higher-quality water is directed back to the surface. The two-square-kilometre underground basin is environmentally friendlier, conserving valuable above-ground forest and cropland. The new underground system is also more cost-effective than its above-ground counterparts as the maintenance and operating costs are lower.

In 2016, 159 million cubic metres of water were pumped out of oil shale mines and oil shale enterprises paid a total of 8.4 million euros in water special use fees

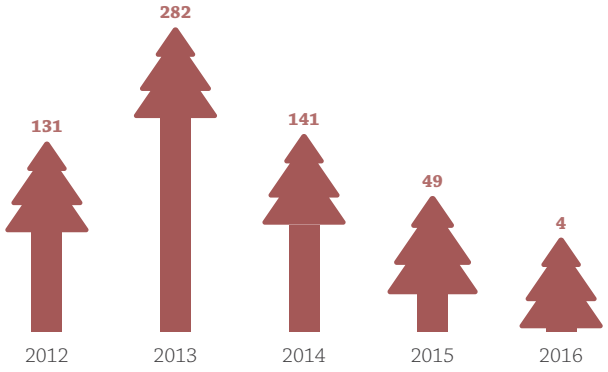
Restoring the landscape

Green and outdoorsy Ida-Viru County

Oil shale mining has had a significant visual impact on the landscape of Ida-Viru County over the decades. The highest artificial hill of semi-coke in the Baltics, afforested pine stands, ash heaps and artificial lakes offer diverse places for outdoor pursuits and relaxation. The oil shale industry supports Ida-Viru's ambition to be Estonia's most "adventure-filled" county. "Holiday while exploring, have an adventure on your holiday", goes the county's slogan.

One of the newest tourist magnets here is the Estonian Mining Museum in Kohtla-Nõmme, which was nominated for the 2016 annual awards handed out by the Union of Estonian Architects, Estonian Association of Interior Architects and the Cultural Endowment of Estonia's annual architecture prize. A ski and adventure tourism centre established on the Kiviõli ash heap is now one of the most important attractions in the region. As a result of the development project initiated in 2016, new attractions have been built, such as aerial adventure trail built on pylons, a disc golf course, traffic city and a summertime ski circuit with an escalator lift. The former Aidu opencast mine is undergoing a makeover, as a result of which it will become an aquatic sport centre along with a rowing channel and a network of kilometres of artificial bodies of water.

AFFORESTATION OF FORMER OPENCAST AREAS (HECTARES)



High-quality new woodland

Reconditioning former opencast mine areas is an integral part of oil shale mining. To restore the exhausted mines in as natural a form as possible, they are filled in and graded, and young trees are planted. Concerted efforts to replant opencast areas started back in the 1960s at Kohtla mine. Today full-fledged forests thrive on most of the former oil shale mining areas.

From 2012 to 2015, the State Forest Management Centre was commissioned by Eesti Energia to forests on 600 hectares of opencast mine area. Four more hectares of mining area accrued in 2016, planted with young pine trees.

POTENTIAL HABITATS FOR FLYING SQUIRRELS

Logging, declining share of mixed forests and more intensive human activity have led to a steep drop in the number of flying squirrel habitats and brought this rare rodent to the brink of extinction in Estonian forests. In recent years, flying squirrels have only been spotted in the northeast.

Observations conducted in 2016 found that mixed forests planted in former opencast mine areas would increase the ecological diversity in the area and could prove a suitable habitat or nesting site for the flying squirrels.

Emissions into ambient air

In connection with ever more stringent environmental requirements, the oil shale industry is trying to find additional solutions for reducing atmospheric emissions and filtering out undesirable substances.

Consistent investments made by oil shale companies into reducing ambient air emissions have paid off. In 2016, solid particulate emissions fell by one-third and SO2 emissions were 6% less than in 2015. Compared to five years ago, the solid particle count in air has dropped by 60%, NO2 emissions by 35% and SO2 by 25%.

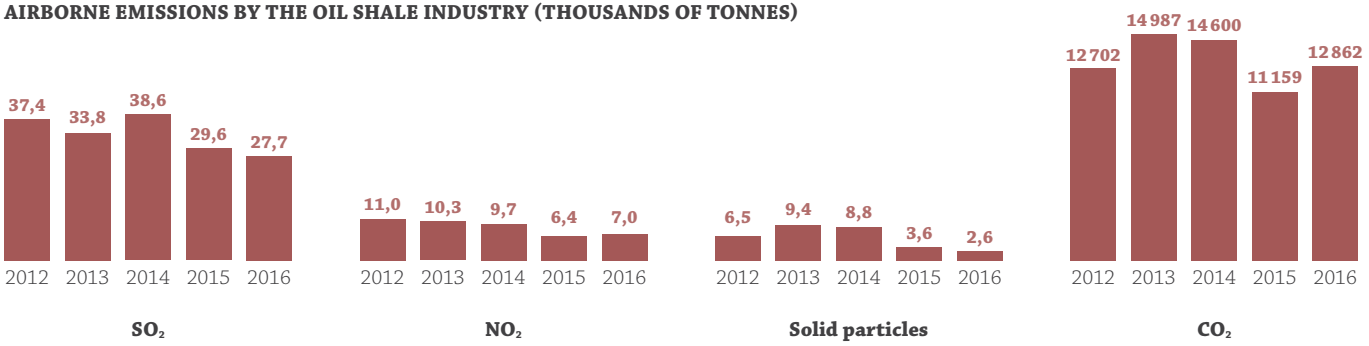
As of 2016, power generation from oil shale meets the more stringent air emissions limits set forth in the Industrial Emissions Directive. The European Union climate and energy package obliges member states to reduce greenhouse gas emissions by 40% by 2030 (with respect to 1990 levels). In addition, more stringent European Union requirements are coming into effect for many other airborne emissions, the aim in all cases being to improve ambient air quality.

Cleaner air through modern technology

As in years past, oil shale enterprises continued introducing noteworthy innovations in their production and environmental technology to contribute to improving ambient quality in their area.

VKG Energia was the first company in Estonia to introduce the use of desulphurization equipment for smoke gases, in 2008. Today the company has three modern systems, the latest of which, a flue-gas desulphurization (FDG) technology based device, went online in 2016. Over the last nine years, the new equipment has allowed VKG to reduce its sulphur dioxide emissions threefold.

AIRBORNE EMISSIONS BY THE OIL SHALE INDUSTRY (THOUSANDS OF TONNES)



Kunda Nordic Tsement's data include all of the company's ambient air emissions, of which most are from combustion of WTE fuels.

In 2016, Eesti Energia installed an ambient air quality monitoring station in Vaivara Municipality, allowing to track the effect of operations on ambient air in different weather conditions. The information from the modern monitoring station makes it possible for the company to make changes in its activities for ensuring the best possible air quality in the area.

Last autumn, Eesti Energia started preparations for converting unit no. 8 of the Eesti power plant with the goal of increasing the proportion of retort gas used as a fuel to 50%, alongside oil shale. Retort gas is a by-product of the process of producing liquid fuels from oil shale, and its use in power generation helps to reduce emissions into ambient air. Thanks to the lower costs and increased profitability of power generation, the company has a stronger position in competing against Nordic power companies.

At KKT, the thermal power plant's combined fuel boilers underwent thorough renovation. The updated boilers, operating at the same capacity, use more environmentally friendly gaseous fuel and less oil shale fuel. Modernization of the technology reduced direct combustion of oil shale, which led to a marked improvement in the quality of fuel gases from the thermal power plant.

Consistent investments made by oil shale companies into improving air quality have paid off. Over the last five years, the solid particle count in air has dropped by 60%, NO_2 emissions by 35% and SO_2 by 25%.

OIL SHALE AND ESTONIAN SOCIETY

Oil shale industry's contribution to society

In 2016, 103.2 million euros flowed into state treasuries from oil shale enterprises in the form of taxes. In spite of the complicated market conditions, companies provided 320,000 euros in support for various national and local Ida-Viru county education, science, innovation and culture projects.

Jobs in the oil shale industry

The low prices on energy markets in 2016 forced oil shale companies to look for additional ways of saving costs and raising efficiency. Even though the sector shed about 1,000 employees due to restructuring during the year, the oil shale industry continues to be one of the biggest employers in Ida-Viru County.

The companies paid close to 35 million euros in workforce taxes and premiums into the state treasury in 2016, and 6,400 people were employed in the sector. A much larger number of people are indirectly related to the industry in customer service, construction, transport and lodging services.

The average gross wage paid to oil shale companies' employees in 2016 was 1,403 euros, which is more than one-third more than the average gross wage in Ida-Viru County.

EMPLOYMENT IN THE ESTONIAN OIL SHALE SECTOR (2016)

Total employees	6 400
Average number of years worked	13
Annual decrease in number of employees (%)	13.6
Average gross monthly wage (EUR)	1 403

With 6,400 employees, the oil shale industry continues to be one of the biggest employers in Estonia

Supporting education

Training a new generation of engineers

Ensuring a steady supply of talented young engineers entering the job market is of key importance for the development of the energy sector. The sustainability of the field depends on the solutions that future players come up with and implement. For that reason, oil shale enterprises have initiated a great deal of projects to popularize hard-science subjects and educate a new generation of engineers.

Eesti Energia, VKG and Eastman Specialties helped Jõhvi Gümnaasium, a gymnasium in a major hub in the northeast, to carry out a science, technology, engineering and maths (STEM) course in 2016. The elective was structured as a whole, integrating the science fields with real-life problem-solving and giving students their first experience in a field of interest. Besides guest lecturers who came from the oil shale industry to speak at the school, students could participate in study trips to the companies.

For the fifth year in a row, VKG has helped to organize Estonia's oldest intermural science tournament – the Competition of Five Schools – and the company again provided support for the best gymnasium students in Ida-Viru County to participate in the competition.

With Eesti Energia's support, Europe's biggest robot competition, Robotex, was held in 2016, as was a competition called CADrina, related to use of the international drafting software. To promote the energy sector, the travelling exhibition "Energia" was put together, and a study programme called Smart Engineers was prepared for schoolchildren.

In 2016, over 2,800 children visited the exhibition Estonian Energy at the Tallinn University of Technology Museum, as part of an energy and environment themed educational programme. The interactive exhibition gave an overview of the role of the energy sector in Estonia, oil shale mining, fuels used and the production and consumption of heat and power. A real oil shale deposit can be visited and, if desired, pieces of oil shale from Estonia mine can be taken home as a souvenir. The exhibition runs until the end of 2017.

Scholarships to the best and brightest

The best students in the field were again recognized with scholarships last year. Eesti Energia contributed to promoting education and innovation in the energy sector through the Insenergia fund. The fund aims to support engineering education to increase youth interest in the field and making the content of study more interesting to them. In 2016, eight projects submitted by universities and organizations received a total 21,159 euros in support.

As it has done a number of years in a row, VKG handed out scholarships through the Tallinn University of Technology Development fund for students studying in technology and energy related specialities. In 2016, VKG scholarship recipients were six bachelor's and master's degree students from the Tallinn University of Technology and its affiliate Virumaa College, of whom three are now employed by VKG. VKG was awarded the Tallinn University of Technology's gold sponsor title for its long-term support and productive cooperation.

Supporting innovation and knowledge export

Knowledge-based development

Estonia has become one of the world leaders in oil shale excellence thanks largely to its long-term research and strong cooperation with research institutes and the energy industry.

Valued know-how

In a situation where the world's energy needs are ever increasing, the hundred years of know-how in the use of oil shale is an important export article for the Estonian state. Eesti Energia has shared oil shale know-how with more than ten countries. The company has performed oil shale investigations and engaged in cooperation in Egypt, India, the US, Morocco, Mongolia, China, Serbia, Uruguay, Thailand, Kazakhstan, Turkey, Myanmar, Israel and Jordan.

NEW STANDARD FOR UNIVERSAL FUELS

The Estonian Centre for Standardisation's new standard "Solid mineral fuels. Determination of the gross calorific value using the bomb calorimeter method and calculation of the net calorific value" came into effect in May 2016. With the coordination of the Oil Shale Competence Centre, the standard was transposed from the English-language standard ISO 1928:2009 *„Solid mineral fuels – Determination of gross calorific value by bomb calorimetric method and calculation of net calorific value"*, supplemented by a description of the methodology used in Estonia.

Estonia's biggest ever know-how export project in the field of oil shale wound up in 2016. In the course of the project, the Kingdom of Jordan's first oil shale power plant and opencast mine along with the necessary infrastructure will be established. Numerous Estonian geologists, engineers and scientists worked on the project, which ran ten years and involved a 2.1 billion USD investment. The approximately 3,000 samples collected from Jordanian oil shale deposits in the course of geological site investigations from 2008 to 2013 were analysed at the Tallinn University of Technology Oil Shale Competence Center fuels technology science and test lab in Kohtla-Järve. The 554 MW power plant to be launched in central Jordan in 2020 will cover 10–15% of the country's energy needs and employ thousands of people.

Cooperation with scientists and researchers

The Estonian oil shale energy sector's development and environment related activity is based on scientific studies. Science-based research being done at universities allows the government to make intelligent and informed decisions so that the oil shale sector can be sustainable and innovative and continue to bring benefits for society.

THE MOST IMPORTANT GENERAL ANALYSES

Research and development activity	Commissioned by	Implemented by	Financed by
Study on optimum remuneration in the oil shale sector	Government Office	Ernst & Young Baltic	EU structural funds
Corporate innovation. Analysis of companies in Ida-Viru County		Oil Shale Competence Center	

THE MOST IMPORTANT SPECIFIC RESEARCH STUDIES

Research and development activity	Implemented by	Financed by
Study of cave-ins in areas where oil shale has been mined from below	Tallinn University of Technology	Environmental Investment Centre (EIC)
Preparing the report on compliance with the National Development Plan for Use of Oil Shale 2008–2015	Tallinn University of Technology	Ministry of the Environment
Valorising fly ash as a filler substance in products based on recovered plastic	Tallinn University of Technology	EIC
Conducting a study to determine MgO content in oil shale and cyclone ash	Tallinn University of Technology	Eesti Energia
Determination of the heat rate of 8 energy units of the Eesti power plant	Tallinn University of Technology	Eesti Energia
Tests at reception of VKG Energia OÜ's Kohtla Järve power plant deSOx equipment	Tallinn University of Technology	VKG Energia
Resolution of technical thermal issues and environmental problems related to operation of oil shale fired power plants	Tallinn University of Technology	Enefit Energiatootmine
Resolution of thermal technical problems in the ENEFIT-280 equipment	Tallinn University of Technology	Eesti Energia Oil Industry
Studies to ensure safe operation of pressurized equipment at Eesti Energia's Narva Elektrijaamad AS	Tallinn University of Technology	Enefit Energiatootmine
Study investigating heavy metal content in the ash generated in thermal processing and combustion of solid mixed fuels – oil shale, retort gas, biomass etc	Tallinn University of Technology	EIC
Environmental impacts on groundwater and surface water as well as on landscapes from potential mining of Virumaa natural resources, analyzed with environmental and geological models together with alternative remediation measures	University of Tartu	EIC
Recovery of secondary polymer waste and oil shale ash as a raw input for construction materials. Composite peat-based material with pretensioned polymer rebar	University of Tartu	EIC
Estonian glauconite sandstone as a raw material for K-thermofertilliser I: Properties and feasibility of processing glauconite	University of Tartu	EIC
Standardization of the description of Estonian earth's crust	University of Tartu	EIC
Analysis of the leachability of the blend of NORM residue and fly ash generated in NPM Silmet AS production process, and developing of technologies for diffusion of NORM residues and fly ash	University of Tartu	NPM Silmet
Oil shale mining and plant and animal life	Estonian Naturalists' Society associated with the Estonian Academy of Sciences	EIC
Use of granulated oil shale fluidised bed boiler ash as a soil amendment – leachate study	Institute of Chemical and Biological Physics	EIC
Determining priority areas for oil shale mining based on natural environment and economic conditions	Ministry of the Environment	EIC
Commissioning preparation of a reconditioning project and cleanup works for the shaft opening of the former Käva 2 mine located in Kohtla municipality, Peeri village, Soo land unit (cadastral code 32002:002:0144)	Environmental Board	EIC
Ex post monitoring and maintenance of the Kiviõli industrial waste and semi-coke landfill 2017–2018	Ministry of the Environment	EIC
Reconditioning and safety management of the category A waste disposal site at Kukruse	Ministry of the Environment	EIC, EU structural funds
Aerial supervision of mining activity	Estonian Land Board	EIC

Giving back to the community

A large share of the oil shale enterprises' sponsorship and charity projects are carried out in Ida-Viru County, to contribute to the preservation of traditions in the region and to create more diverse opportunities for youth development.

In 2016, Eesti Energia provided 10,100 euros in support for a total of 49 school-age children (aged 7 to 19) through the Ida-Viru County Talented Youth Energy Fund. The fund aims to assist youths who lack opportunities to participate in sports tournaments or art exhibitions, purchasing supplies related to their areas of interest, or participation in competitions and academic tournaments. The fund's annual volume is 9,000 euros, of which 5,000 euros is contributed by Eesti Energia, and the rest by the Union of Ida-Viru County Municipalities.

The oil shale industry provided 320,000 euros for various CSR projects. The majority of them were implemented in the Ida-Viru County.

Honouring sport

Many initiatives by oil shale companies are now traditions for the people of Ida-Viru County and looked forward to eagerly for the entire year. Eesti Energia, an enthusiastic supporter of healthy lifestyles and recreational sports, supports the Narva Energy Run each year in June. The race, which is the biggest public sports event in Ida-Viru County, each year draws close to 4,000 runners and Nordic walkers and highlights the importance of the county on the Estonian culture and sports landscape.

In 2016, KKT continued supporting the children's football teams in Kiviõli, helping young people take part in a number of international competitions all year around.

Cleaning up the surroundings

2016 did not go by without VKG's traditional community volunteering day. The company's employees helped with yard work and groundskeeping at Kiikla Children's Home.

KKT also helped establish a new asphalt road leading into the city of Kiviõli from the west. In cooperation with the Lions Club, the city was given a swing as a present.

To encourage the charity outreach to continue, VKG and Eesti Energia have joined the initiative "We're Donating our Time" ("Annetame aega") where the company's employees will donate one work day each year to charity.

A SELECTION OF EVENTS IN THE OIL SHALE SECTOR IN 2016

JANUARY

Eesti Energia set a power generation record, posting the highest output at Narva Power Plants seen in the past 25 years – 1,982 MW

Due to the record low world oil price, VKG temporarily shut down two Kiviter technology-based shale oil plants

Eesti Energia created the Insenergia fund to promote engineering education, with an annual amount of 20,000 euros

MARCH

The OSAMAT research project wound up. Trials confirmed the suitability of fly ash for road construction

FEBRUARY

Eesti Energia established the first underground sedimentation basin in Estonia mine

VKG subsidiary Viru RMT's metrology laboratory received accreditation, which defines the general competence requirements for calibration of experiments and taking of samples

APRIL

Eesti Energia launched wholesale of a soil additive made from oil shale ash, marketed to agriculture and horticulture companies

Thanks to its long years of productive cooperation, VKG was awarded Tallinn University of Technology's gold sponsor title

MAY

An historic agreement was signed, under which Eesti Energia sells 45% of its shares in the Jordanian oil shale power plant and opencast mine to the PRC-owned Yudean Group

JUNE

Eesti Energia consolidated its renewable energy production into one company, Enefit Taastuvenergia, as it plans to increase the use of alternative energy sources in energy generation in coming years

JULY

VKG re-launched two Kiviter technology based oil refineries

AUGUST

The annual major Ida-Viru County event, Miners Day, took place

SEPTEMBER

The international symposium "Oil Shale 100" organised by Eesti Energia, the Tallinn University of Technology and the University of Tartu drew 300 energy experts from 21 countries

The Ministry of the Environment approved the amended mining permit for Narva opencast mine, which will allow Eesti Energia to adopt underground mining technology there in 2019

NOVEMBER

The Oil Shale Competence Centre conference was held for the eighth time in Jõhvi, this one was called "Põlevkivi 100+"

The VKG shale oil plant Petroter III marked the processing of its millionth tonne of oil shale and posted an annual output figure of 136,000 tonnes of shale oil

OCTOBER

Enefit Energiatootmine, Eesti Energia's power generation arm, signed an agreement for converting the unit no. 8 of the Eesti power plant to increase the capacity for using shale gas for power generation and thus reducing environmental impact

DECEMBER

KKT signed a new sale agreement with Eesti Energia for supplying fine-grade oil shale


PÕLEVKIVI BENSIIN

ESTONIAN OIL SHALE

100

A hundred years of oil shale industry in Estonia

2016 was a year of great importance for the oil shale industry. A hundred years ago near Pavandu, the first test mining of oil shale took place, laying the foundation for one of the most important industries in Estonia over the past century. Today oil shale mines, power plants and refineries ensure the country's energy independence, provide work for thousands of people and make a substantial contribution to the state budget.

A colourful jubilee year

The oil shale industry's birthday calendar had room for many distinguished activities. The major event of the year was the international symposium, "Oil Shale 100", which brought close to 300 energy experts from 21 countries to Tallinn's Creative Hub venue. The industry's traditional conference in Jõhvi and the Estonian Mining Society's geological conference in Kukruse also had a celebratory tinge this year.

Eesti Post issued a special postage stamp to mark the centenary. The design depicts miners from the 1920s in Kukruse mine. The Mining Society honoured 162 mining engineers, technicians and technical staff with a silver medal of service for their outstanding contribution to developing the field over the years.

Witnessing the power – and beauty – of oil shale

The KAΦEDRA exhibition in Narva, produced by students at the Department of Jewellery and Blacksmithing at the Estonian Academy of Arts, showed off jewellery that were inspired by oil shale. The Estonian Natural History Museum and Eesti Energia joined together to produce an exhibit, "458 Million Years of Oil Shale in Estonia, 100 years of Mining." which gave visitors in the interior courtyard of the museum an overview of the formation, discovery, study, mining and processing of oil shale.

An open house event organised by Eesti Energia and VKG allowed over 200 people to see for themselves the process of mining oil shale at Narva opencast mine and production of power and oil at Eesti power plant and Petroter plant, respectively. The Estonian Geology Centre organized a tour of oil shale related sites in Ida-Viru County to mark the centenary. The event calendar also included the festive instalments of the traditional Miners' Day and the city of Kiviõli's annual day and Chemists' Day.

To preserve the memory of industry, a large amount of historical footage of oil shale mining was sorted and digitalized with the assistance of Jaak Eelmets. The Oil Shale Competence Centre for collected recollections and stories from many of the long-serving workers in the sector and included them in the special anniversary edition of its newsletter.

Estonian oil shale industry in 2016

Income into the state treasury
103
million

Total investments
63
million

Investments into the environment
26
million

Positions for
6400
people

Sales revenue EUR
602
million

In comparison with 2015

Use of oil shale for energy production
+18%

The market price of electricity
+6%

The average oil price
-16%