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Analysis

Trends in Estonian Oil Shale Utilization

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Introduction

Extensive use of oil shale is the unique and defining quality of the Estonian energy system. The oil shale sector accounts for 4% of Estonian GDP and places Estonia among the most energy independent countries of Europe.[1] These benefits, however, come with an environmental cost. Over the coming decades, Estonia must continue to balance the domestic economic and security benefits of oil shale with its increasing international environmental obligations.

This analysis examines current trends in Estonian oil shale utilization. Particular attention is paid to likely sources of disruption to oil shale use and the compatibility of continued oil shale use with national and EU environmental targets. The goal is to present a baseline forecast for future oil shale use and recommend policy changes to balance environmental obligations, energy security, and economic benefit in light of rapid and often significant changes in global energy context.

Summary of Trends

- The **total consumption** of oil shale will stabilize as the annual mining cap is approached and as other energy sources compete for electricity exports.
- The share of oil shale in **primary energy generation** will continue to decline as additional primary energy is supplied from renewable sources, primarily biomass and wind.
- Raw oil shale use for **heat generation** will continue to decline as policies continue to favor its replacement by biomass—fired in combined heat and power (CHP) plants)—and as overall demand for heat continues to decline.
- Oil shale use for **electricity generation** will plateau as overall electricity demand remains stagnant, policies continue to favor limited replacement by renewables, and as electricity exports face increased competition.
- Oil shale use for **shale oil production** is increasing, but faces a questionable future in the short to medium term. Production capacity will likely continue to increase over the coming year, but production rates in light of low oil prices are more uncertain. Oil shale previously used for heat or power generation has shifted toward shale oil and power cogeneration. This shift could be accelerated by increases in the global price of oil or increases in the price of CO_2 emissions under the EU Emissions Trading System (ETS).

In sum, oil shale will continue to be used less in applications that have lower-cost and lower-carbon alternatives. Specifically, this means eventual cessation of use for heat generation, limited replacement in electricity generation, and potentially increasing use for fuel production.

[1] International Energy Agency, *Estonia 2013* (2013), 69-72, http://www.iea.org/publications/freepublications/publication/Estonia2013_free.pdf.

Environmental Regulations

Policies and Targets

National and EU level environmental policies aim to decrease carbon emissions, curb energy demand, and optimize resource consumption. Most relevant for Estonian oil shale utilization are the following:

1. EU Climate and Energy Package and Emissions Trading System (ETS)[2]
2. Estonia 2020 Energy Objectives[3]
3. Estonian Environmental Charges Act[4]
4. Electricity Market Act[5]
5. Earth's Crust Act[6]
6. National Development Plan for the Utilization of Oil Shale[7]

The EU Climate and Energy package sets emissions and efficiency targets. The European Emissions Trading System (ETS) is the most significant policy of this package and governs greenhouse gas (GHG) emissions from power plants, heating systems, and energy intensive industries. Processes subject to the ETS consume nearly all of Estonia's oil shale.

ETS is a cap and trade system designed to reduce overall EU GHG emissions by 20% of 2005 levels by 2020 under the current phase. Though the ETS has the potential to be the driving policy force dictating Estonian oil shale use, the current effects of the ETS on oil shale are relatively insignificant due to the low price of carbon emissions under the ETS and to Estonia's exemptions as a newer member state. Until 2019, Estonia will receive free carbon allowances for power producers; therefore, if carbon prices remain low, the transition to purchasing allowances will have little effect on oil shale use.

In a context in which carbon prices are currently low and uncertain in the future, the main effect of the ETS has been to establish an expectation of a carbon-constrained future for the EU. Accordingly, the Estonian government has responded by implementing stricter national energy and environmental standards than currently required by current EU policy in anticipation of further changes. While non-binding,

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[2] "Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC," *Official Journal of the European Union* L 275, (2009): 32-46, http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02003L0087-20090625&from=EN. [EU ETS]
[3] "National Reform Programme Estonia 2020," *Europe 2020* (2013), 24-27, http://ec.europa.eu/europe2020/pdf/nd/nrp2013_estonia_en.pdf. [Estonia 2020]
[4] "Environmental Charges Act," *Riigi Teataja* (2015), https://www.riigiteataja.ee/en/eli/505022015011/consolide.
[5] "Electricity Market Act," *Riigi Teataja* (2014), https://www.riigiteataja.ee/en/eli/516052014001/consolide.
[6] "Earth's Crust Act," Riigi Teataja (2015), https://www.riigiteataja.ee/en/eli/525022015002/consolide.
[7] Ministry of the Environment of the Republic of Estonia, "National Development Plan for the Utilization of Oil Shale: 2008–2015" (Tallinn, 2008), http://www.envir.ee/sites/default/files/polevkivi_kasutamise_arengukava_2008_2015_eng.pdf.

the Estonia 2020 targets are used to determine agency directives. The following 2020 targets relate to oil shale:

- Limiting total GHG emissions to +10% of the 2005 level (6269 thousand tonnes CO_2 equivalent per year)
- Maintaining final energy consumption at 2010 level (32.8 TWh per year)
- Increasing share of renewable energies to 25% of final energy consumption

Binding EU policy also covers GHG emissions and renewable consumption. EU mandates a maximum 11% increase in GHG emissions relative to 2005[8] and a minimum 25% share of renewable energy in gross energy consumption.[9]

To facilitate the development of renewable energy, the Environmental Charges Act and Electricity Market Act provide for subsidies. The latter legislation also provides lesser support, in limited circumstances, to available oil-shale-based electricity generation capacity. The National Development Plan for Utilization of Oil Shale justifies support for oil shale capacity by the security of supply it provides.

The Earth's Crust Act establishes the process for the allocation of oil shale extraction permits and sets the overall extraction limit, which is currently 20 million tonnes per year. Meanwhile, the National Development Plan for the Utilization of Oil Shale lays out the overarching strategy for (and seeks to define the national interest in) oil shale use. Since the current plan (instituted in 2008) will expire in 2015, its replacement—which will guide oil shale policy until 2030—is currently being debated. The current plan prioritizes oil shale use for domestic consumption.

Progress

Though oil shale remains integral to the Estonian energy system, Estonia is set to meet all binding EU energy targets as well as its own more stringent 2020 objectives.[10]

Limiting total GHG emissions to 110% of 2005 emissions levels will be easily attainable due to the drop in economic output associated with the 2008 recession, as well as to the subsequent concentration of economic growth in non-energy-intensive sectors. With the brief exception of the immediate recovery period, the overall carbon efficiency of the Estonian economy has continued to improve. Though oil shale consumption continues to rise, CO_2 emissions have remained relatively constant due to upgrades to older oil shale infrastructure and replacement of outdated capacity with less carbon-intensive oil and electricity cogeneration plants.

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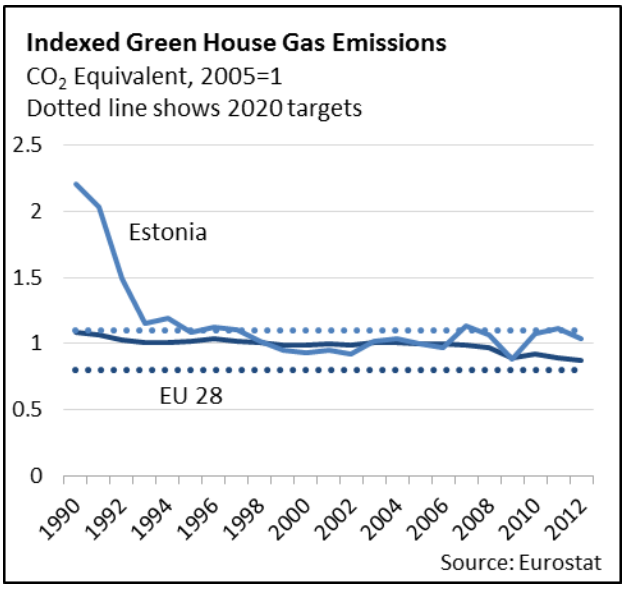
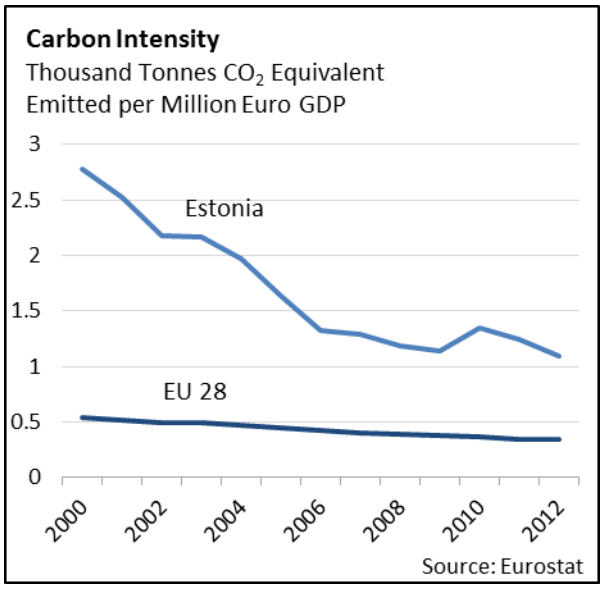
[8] "Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020," *Official Journal of the European Union* L 140/136, (2009): Annex II, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009D0406&from=EN.

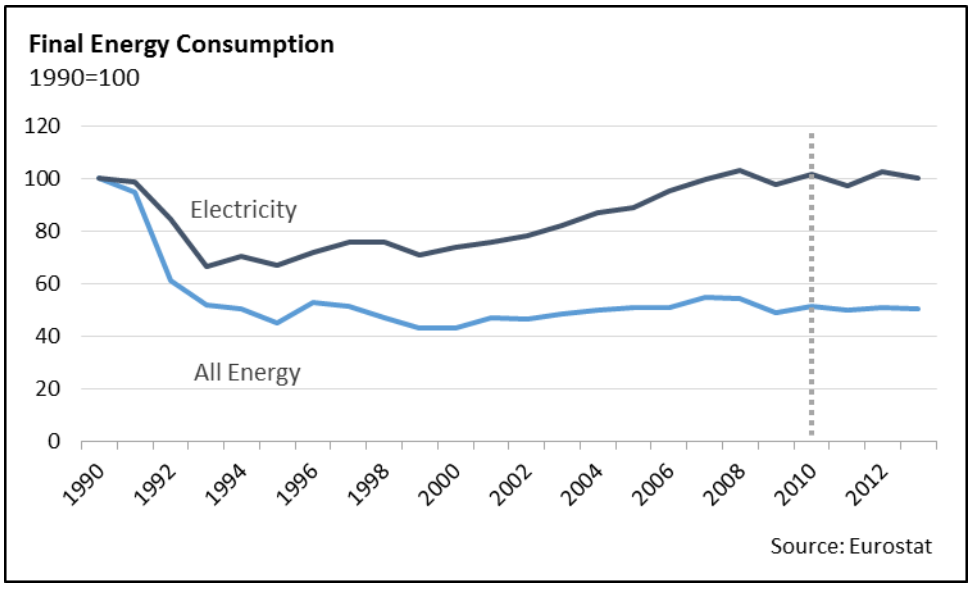
[9] "Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC," *Official Journal of the European Union* L140/16 (2009): Annex I, http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN.

[10] All data presented has been compiled by the author from the latest publicly available data published by Eurostat and Eesti Statistika unless otherwise noted.



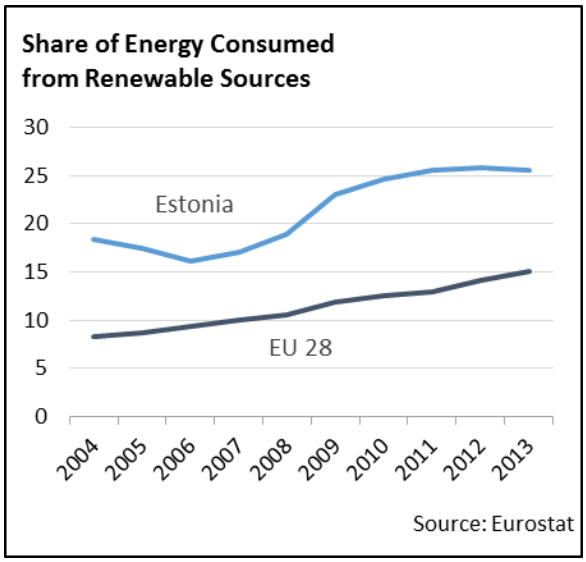


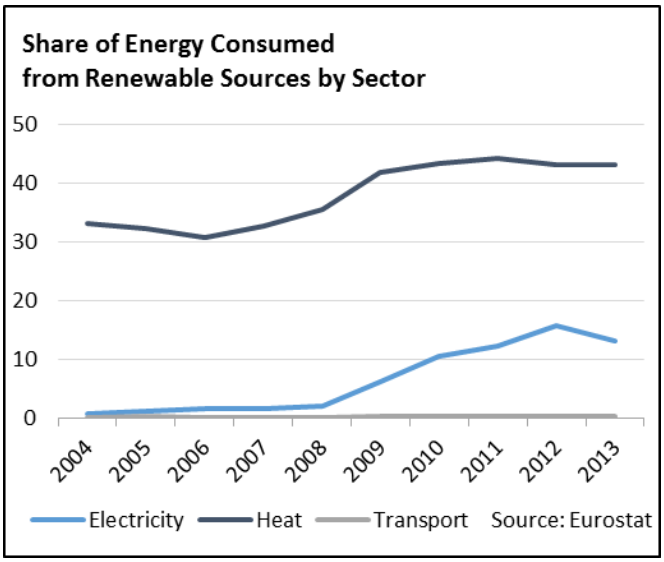
Maintaining final energy consumption at the 2010 level is also easily attainable by 2020 for similar reasons. Though improvements to oil shale technology are lowering the carbon emissions produced to generate a given amount of power, the predominant factor driving the decrease in carbon intensity is a decline in the overall energy intensity of Estonia's economy. As in other advanced economies, economic growth is beginning to decouple from energy consumption. Still, the fact that economic growth has been limited in the wake of the 2008 recession contributes to making such targets for decreased energy demand easily attainable with minimal policy intervention.



Estonia already met its 2020 goal of 25% of energy consumption from renewable sources in 2011 and continues to meet its yearly renewable targets. The success of renewables in Estonia's energy mix is primarily due to increased use of biomass in CHP plants. To a lesser extent, renewable electricity, namely wind power, contributes

to the energy mix. Biomass has benefited from the introduction of subsidies, but has actually been in use for significant heat production since the early 1990s; wind power, by contrast, only became viable in Estonia after the introduction of subsidies.



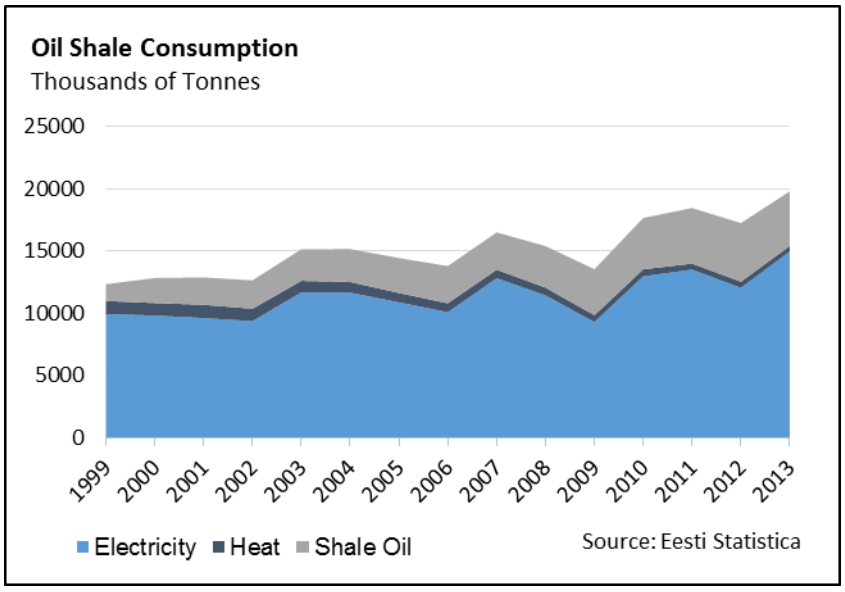


The current environmental targets are not in conflict with increased oil shale use. Though real gains have been made to the efficiency and cleanliness of the oil shale sector, the overarching reason environmental targets do not threaten oil shale use is the design of the targets. Goals for increased renewables and limited energy demand address only energy consumed domestically. Energy generated from oil shale that is subsequently exported (either in the form of liquid fuel or electricity) is outside the scope of these targets, though they of course contribute to the Estonian economy. Less progress has been made for renewable energy and energy conservation in terms of total generation. The only target that captures the effect of energy exports is the GHG emissions cap. This cap, however, has proved easily attainable without intervention. The greatest effect of environmental targets on oil shale has been the subsidizing of renewable power, which competes with oil shale in the electricity sector. While renewables are of increasing importance for electricity generation, oil shale continues to dominate the sector.

Current Consumption

Estonian final energy consumption stands at 33.4 terawatt-hours (TWh) annually. Energy consumption dropped after independence was regained in 1991, and then slowly recovered before stabilizing near its current value in 2006. Electricity consumption followed this trend, but increased more rapidly than did overall energy consumption from the late 1990s to 2006. While total energy consumption remains half that of 1991, electricity consumption has leveled off roughly at Soviet-era levels. This stabilization of energy consumption began with a dampening of demand due to the global economic recession, but stable consumption has continued despite strong economic recovery. Continued stability in energy consumption is the result of a reduction in the energy intensity of the Estonian economy brought on by a restructuring of the economy away from energy-intensive industries and efficiency gains. The national government hopes to continue these trends and aims to maintain the 2010 level of total energy consumption through 2020.

Oil shale provides 77% of energy generated in Estonia and approximately 60% of final energy consumption, doing so primarily through transformation into electricity, heat and shale oil; other non-energy uses of oil shale are negligible compared to energy use. Consumption of oil shale followed the overall trends of Estonian energy consumption, declining dramatically in the early 1990s then beginning to increase in 1999 with economic recovery and rising levels of total energy consumption. The crucial distinction, however, is that consumption of oil shale has continued to grow to feed increasing electricity exports even as domestic energy consumption remained relatively flat. As of 2013, annual oil shale consumption stood at approximately 20 million tonnes per year. Annual extraction is approximately 15 million tonnes out of a regulatory cap of 20 million tonnes per year. The discrepancy between consumption and extraction figures is due to differences in measurement of raw oil shale and oil shale prepared as a feedstock.



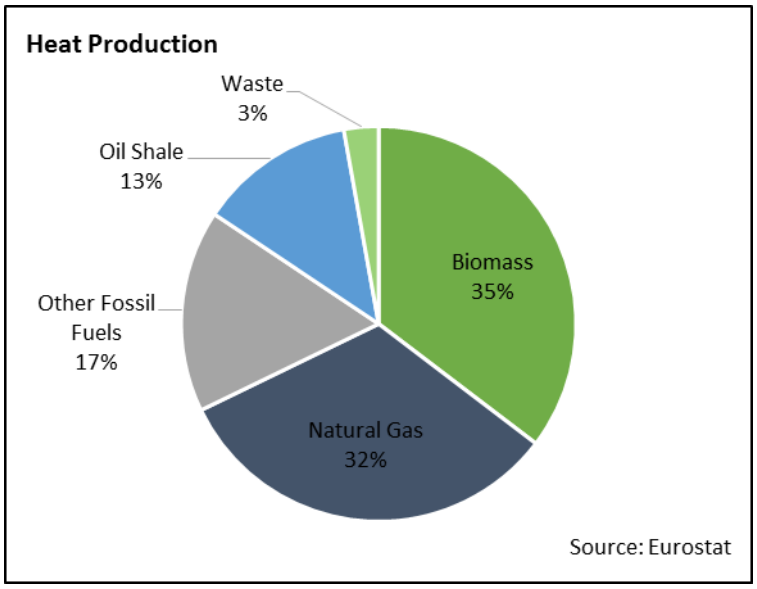
Electricity generation consumes 73% of Estonian oil shale, contributing 89% of Estonia's electricity supply. Two power plants, Eesti and Balti, generate nearly all of

this electricity. Both facilities are located in Narva and operated by the state-owned energy company Eesti Energia. Since most oil shale is used for electricity generation, changes to Estonian electricity consumption and competition from other sources of electricity will have the greatest disruptive effect on oil shale consumption in coming years.

The share of oil shale consumed for heat generation has decreased from 8% in 1990 to approximately 2%, being replaced by biomass. Over the same period, the proportion of oil shale used for production of shale oil increased from 11% to 21%.

Heat

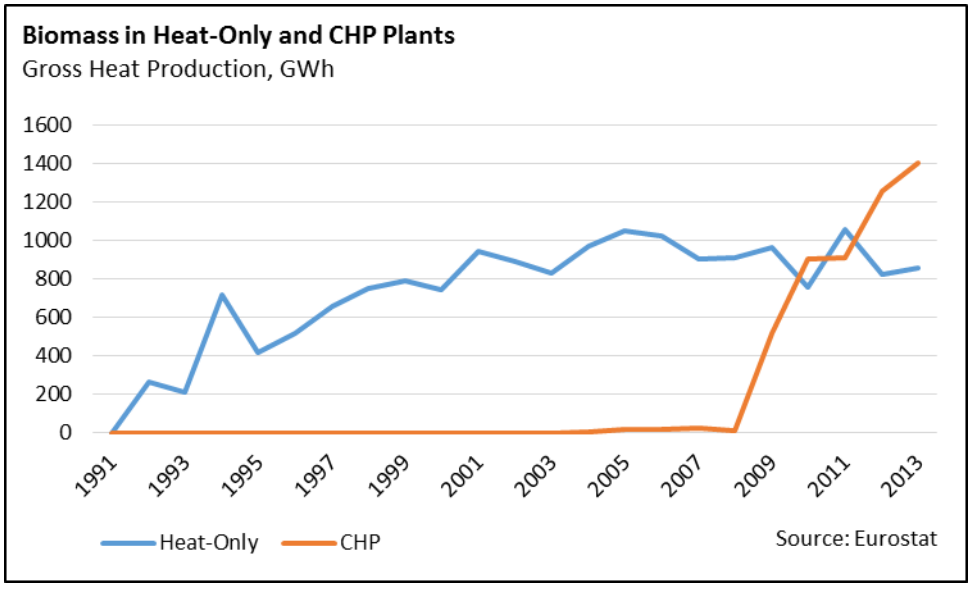
Oil shale used for heat generation has steadily declined since 2000. Currently, heat generation consumes only 2% of Estonian oil shale and supplies 13% of the nation's heat, almost all of which is supplied through combined heat and power generation. Since heat can be produced from lower quality fuels, Estonia's heat needs are supplied by a diverse set of primary energy resources.



Lower quality fuels have gradually replaced more energy-dense fuels previously consumed for heat. In the case of coal, peat, and natural gas, competition has reduced total consumption of these fuels in the energy sector while freeing oil shale resources for use in electricity generation and shale oil production. A recent addition to the Iru power plant allows the combustion of municipal waste to provide district heating for Tallinn, in this case replacing some of the natural gas that serves as the plant's primary fuel.[11] Most of the displacement, however, is from biomass—a source that Estonia, with its expansive forests, is particularly suited to utilize.

Biomass benefits both from generous national subsidies (when fired in efficient CHP plants) and from its designation under the EU ETS as a renewable, carbon neutral energy source. These national subsidies are the primary means by which Estonia is addressing EU renewable energy and emissions targets. Technically, this subsidy is paid as a feed-in-premium for the electricity produced by the biomass CHP plants, but since such plants must produce both heat and power simultaneously, heat production also benefits from the system. Buoyed by subsidies, heat from biomass fired in CHP plants has risen rapidly beginning in 2008, surpassing heat provided from biomass in conventional heat-only plants in 2010.

[11] Eesti Energia, "The Iru Power Plant," https://www.energia.ee/en/organisatsioon/iru

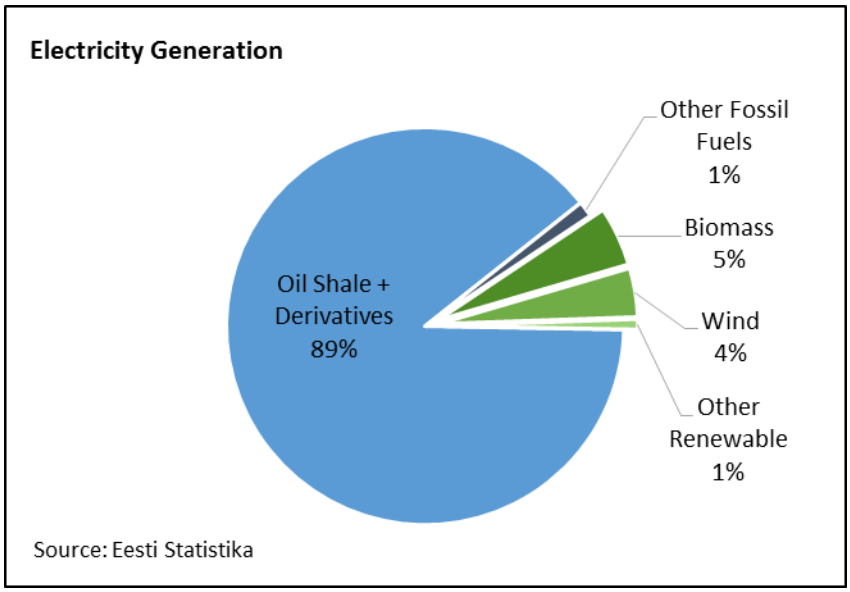


While oil shale's share of the Estonian heat market is declining due to competition with subsidized biomass, the absolute size of the heat market is also shrinking—from 9.2 TWh annually in the mid-1990s to 6.4 TWh as of 2013. Since heat cannot be stored or transported efficiently, it is consumed immediately and close to its source; therefore, Estonian heat production is a close equivalent for Estonian heat demand plus distribution losses. Such demand is declining as distribution losses decrease with the modernization of older residential buildings to improve heat retention, and as district heating systems are made more efficient. Residential heat constitutes 70% of Estonian heat demand and distribution losses sap an additional 17%, making improved efficiencies in these areas crucial for curtailing heat demand.

The 2% of Estonian oil shale used for heat production will continue to shrink due to competition from biomass and declining demand. However, since the amount of oil shale used in heat production is small in comparison to electricity generation and shale oil production, oil shale's decline in the heat sector will have only a minimal effect on either the Estonian oil shale industry or on national emissions and environmental targets.

Electricity

Generation of electricity is oil shale's primary use in Estonia. Power generation from oil shale consumes 73% of Estonian oil shale and produces 89% of the nation's electricity. Estonia consumes 6.82 TWh of electricity annually, which has remained relatively constant since 2007.

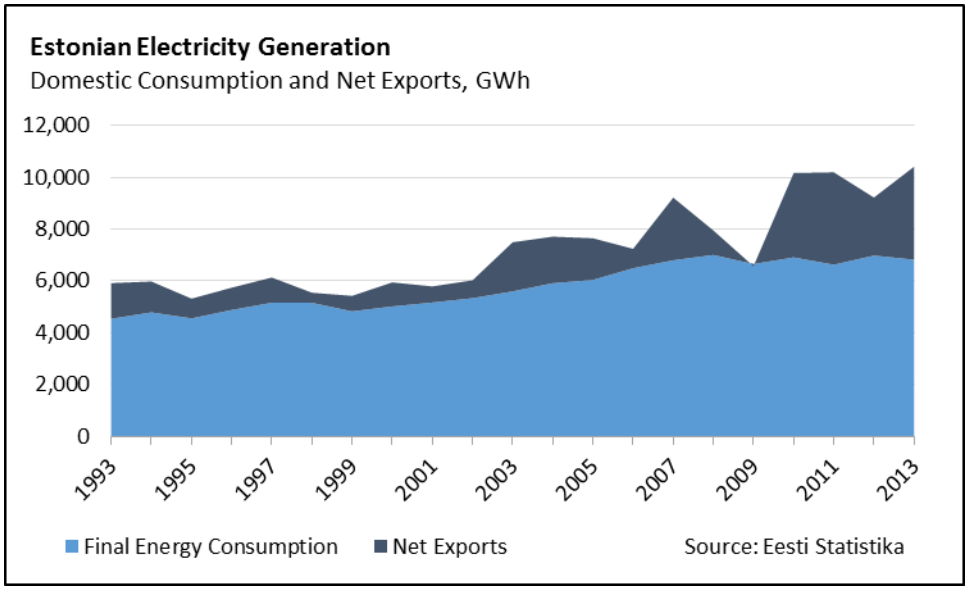


Regional Electricity Market

Estonia is a net exporter of electricity, exporting 3.6 TWh of electricity or 27% of generation, primarily to Latvia. Though Estonia has the capacity to supply its own electricity needs through oil shale, net imports from Finland amount to 27% of Estonian electricity consumption allowing consumers to take advantage of cheaper electricity from the Nordic power system. This electricity is produced at lower cost through nuclear stations and hydro stations, as well as natural gas and biomass CHP plants in Finland and is transmitted via undersea cables. EstLink 1, the first power connection between Estonia and the Nordic power system, came online in 2006, followed by EstLink 2 in 2014, increasing transmission capacity to the point of fully integrating Estonia's power system with the Nordic system such that prices have equalized between the Estonian and Finnish markets.[12]

Though domestic electricity consumption has leveled off, the use of oil shale for electricity generation continues to rise due to increasing net exports, primarily to Latvia and Lithuania. Aside from a brief drop in electricity exports associated with dampened energy demand from the global recession in 2008, net electricity exports have comprised a significant amount of Estonian electricity generation; currently net electricity exports amount to more than half the amount of domestic consumption. Increasing exports are primarily the result of the decommissioning of the Lithuanian Ignalina Nuclear Power Plant, which precipitated a drop in energy supply for the Baltic region beginning in 2010. Electricity from Estonian oil shale has replaced Lithuanian nuclear power in the Latvian electricity market.

[12] Nordpool Spot, "Elspot Prices_2015_Monthly_EUR" (2015), http://www.nordpoolspot.com/globalassets/marketdata-excel-files/elspot-prices_2015_monthly_eur.xls.



Current yearly increases in oil shale consumption for electricity generation are dependent on high electricity prices in Latvia and Lithuania. This situation, however, is unlikely to persist due to the planned NordBalt undersea power cable. NordBalt will connect the Swedish electricity market to the already integrated Lithuanian and Latvian electricity markets. Expected to come online by the end of this year, the 700 MW transmission capacity of NordBalt will likely enable cheaper Swedish power, primarily sourced from nuclear and hydro stations, partially to displace Estonian electricity.

Oil Shale Capacity

Oil shale-fired electrical capacity exceeds generation needs for domestic power consumption and exports. This excess capacity allows it to operate as a swing source of production, increasing generation at times of high electricity prices caused by lack of wind or infrastructure disruptions, such as when both EstLink cables simultaneously went offline in 2014. The overwhelming majority of this capacity is in the aforementioned Eesti and Balti power plants, 1610 MW and 765 MW respectively, which together constitute 85% of installed electrical capacity in Estonia. As available oil shale capacity already exceeds power demand, investment in oil shale power capacity has been directed towards upgrading and replacing dated equipment with cleaner and more efficient technology. The most significant upgrade to the Narva plants has been the replacement of 215 MW of pulverized firing capacity in each plant with circulating fluidized bed (CFB) technology. CFB combustion is a marked improvement over pulverized firing. CFB combustion is more efficient, requiring 20% less fuel than pulverized firing to produce an equivalent amount of energy. CFB combustion also produces fewer NO_X emissions, passively absorbs virtually all SO_2 emissions, and emits less CO_2. Older pulverized firing units have been retrofitted with deSOx technology to comply with EU regulations; deNO_X technology will be added in 2016.[13]

[13] Rain Veinjärv, “Arendustest Narva elektrijaamades” (2014), http://engine.koduleht.net/templates/estis/files/mdl_files.php/2014.06.13__Narva_elektrijaamade_arendused.pdf.

The more efficient CFB boilers are used for normal operation, while pulverized firing is reserved for periods of high electricity demand. Eesti Energia plans to commission a new 300 MW plant at Auvere, which will also feature CFB technology, in 2015. This plant will displace additional pulverized firing capacity and thus reduce overall emissions from the Narva power plants.[14]

Fuel Switching

Fuel switching gives a degree of flexibility to Estonia's oil shale capacity. Boilers designed for oil shale combustion can be used to fire other solid fuels. The newest Auvere plant was designed particularly to accommodate fuel switching with biomass. In normal operation, the Auvere plant could run on up 50% biomass. Other CFB boilers are suited for partially or completely switching to, biomass. The CFB boiler at the Balti plant is equipped with a dedicated biomass fuel feeding system that can be used if made necessary by changes in policy or unexpected oil shale supply disruptions. Other boilers could run on biomass with some changes, however, in cases where they were not specifically designed to accommodate biomass, efficiency losses would be expected.

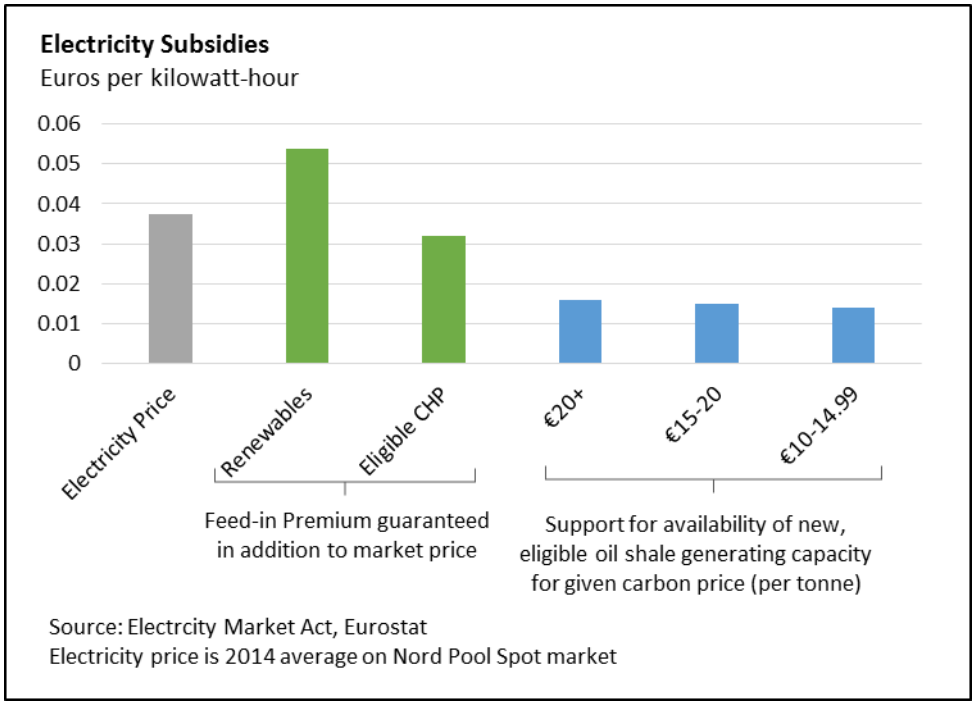
Renewables: Increasing Competition

In an effort to reduce emissions and increase the share of renewables in overall energy consumption, Estonian policy has encouraged the development of domestic renewable electricity generation. The share of electricity generated from renewable sources has grown from less than 0.5% in 2003 to 10% ten years later. Renewable electricity generation is approximately an equal division between wind power and biomass fired in CHP plants.

To facilitate the development of sources of renewable energy, provisions within in the Environmental Charges Act and Electricity Market Act serve as subsidies. The Environmental Charges act places a modest €2 fee on each tonne of CO2 emitted. Companies, however, can opt to invest the charged amount in low-carbon technologies to avoid the fee, which most energy producers do.[15] The Electricity Market Act stipulates a feed-in-premium subsidizing electricity generated from renewable sources. This feed-in-premium is the primary subsidy for Estonian renewable energy and drives investment decisions in Estonian renewable energy.

The Electricity Market Act also restates the overarching importance of security of electricity supply to Estonian energy policy and provides lower levels of financial support for new oil shale based electricity generation capacity. Support for qualifying available generation capacity is implemented should the EU carbon price rise above €10 per tonne and increases to a maximum subsidy at carbon prices in excess of €20 per tonne.[16]

[14] Rain Veinjärv.
[15] "Environmental Charges Act".
[16] "Electricity Market Act".



Despite rapid growth over the past decade and generous subsidies, growth in the share of renewables in electricity generation will slow under current policies. Subsidies for wind generation are currently limited to the first 600 GWh of electricity produced in a given year, an amount that current wind farms already produce during a typical year. Though additional proposals for wind farms have been submitted for regulatory review, the economic viability of these projects in the absence of additional subsidies is dubious. Subsidies for power generated from biomass are not subject to a generation limit like wind power, but are limited to electricity produced in efficient CHP plants. For CHP plants to run efficiently, sufficient demand for both heat and electricity must exist. Once the significantly lower demand for heat is met, additional electricity cannot be generated as efficiently from biomass and is not eligible for subsidy. In other words, biomass can only replace oil shale for electricity generation when biomass is producing the electricity as a byproduct of heat in a CHP plant. In effect, this places a limit on how much electricity can come from biomass under the current support scheme. At present, over 95% of electricity generated from biomass in Estonia is from subsidy eligible CHP plants.

Prospects for competition other than wind and biomass remain limited. With prices equalized between Estonia and the Nordic Power System, there is currently no market incentive for increased electricity imports, but eventual completion of additional nuclear capacity in Finland could disrupt this equilibrium. Expansion of natural gas is limited by high prices and lack of sufficient connectors to suppliers other than Russia. Efforts towards an LNG terminal serving Estonia and Finland have stalled. As recently as early 2011, some Estonian politicians were calling for feasibility studies for an Estonian nuclear plant, but public support for development of domestic nuclear power is weak and in the wake of the Fukushima disaster political will has evaporated.[17] While nuclear power or affordably and reliably sourced natural

[17] Eurobarometer, "Europeans and Nuclear Safety" (2010), 71, http://ec.europa.eu/public_opinion/archives/ebs/ebs_324_en.pdf.

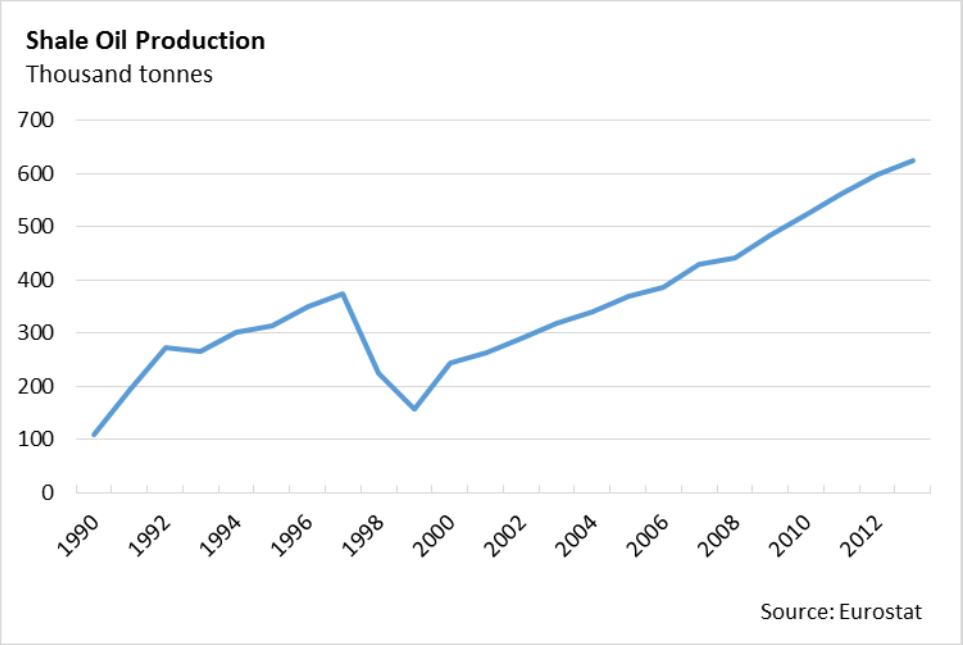
gas could eventually upset the Estonian power sector, such projects are not on the horizon.

Trajectory

Oil shale will likely persist as the primary source of Estonian electricity generation, losing some additional market share to the expansion of biomass fired in CHP plants and, should the government expand subsidies, wind power. Increased competition for electricity exports may decrease total generation, and in such a scenario, oil shale would lose market share against subsidized renewables, but should unexpected, robust economic growth surge electricity demand, unused oil shale capacity would fill the gap.

Oil

Oil shales contain a higher ratio of hydrogen to carbon than do coals. This property allows oil shales to be heated in the absence of oxygen, a process known as pyrolysis, to produce hydrocarbon chains, shale oil. Shale oil can then be further refined into many of the products produced from crude oil such as diesel fuel. Shale oil has long been produced from oil shale, but technological advances and the global push to make use of tighter sources of oil have spurred the industry in Estonia.



The largest producer of shale oil in Estonia is the private company Viru Keemia Grupp (VKG), which in 2014 produced 57% of shale oil in Estonia.[18] VKG is followed by state-owned Eesti Energia, which produced approximately a third of Estonian oil.[19] Smaller private companies produced the rest. Though in comparison to the global market, Estonia is an insignificant producer of oil, increased oil production has the potential to be the most upsetting force in the domestic oil shale industry, but its future is dependent on oil prices and domestic politics.

Electricity or Oil?

The Estonian shale oil sector has room to grow without competing for oil shale reserves used for electricity generation. Current oil shale extraction stands at 15 million tonnes out of the maximum 20 million tonnes allowed by law. Additionally, the most efficient oil processing technology, variants of which are used by both VKG and Eesti Energia, cogenerate oil and power by burning the retort gases given off during pyrolysis. The generation capacity from cogeneration is significant. Elering estimates that if the entirety of current oil shale consumption were redirected to oil and power cogeneration, oil shale would continue to produce 6 TWh of electricity

[18] Viru Keemia Grupp, "Year Book 2014," http://www.vkg.ee/aastaraamat2014/index-en.html#oil-shale-in-the-world.
[19] Enefit, "Estonia Shale Oil Industry," https://www.enefit.com/en/estonia.

per year compared to 11.4 TWh produced by current use.[20] Thus, the choice between oil production and electricity generation is not entirely dichotomous, but once the mining cap is reached increased oil production would come at the expense of additional electricity generation.

Two fundamental factors favor cogeneration over combustion for pure electricity generation: pyrolysis for oil production generates fewer CO_2 emissions than combustion, and sources of oil have fewer substitutes than sources of electricity. Currently low CO_2 prices and easily attainable emissions targets mitigate the former, while limited alternatives for electricity generation in Estonia dampen the effects of the latter. Both of these mitigating forces, however, are likely to abate in coming years. Carbon prices may rise with the next round of emissions allocation and the cessation of free allocation of CO_2 allowances in 2019, but uncertainty remains. Competition for oil shale as an electricity source will increase, particularly for electricity exports. The completion of NordBalt in 2015, eventual completion of additional Finnish nuclear capacity, and decreasing natural gas prices in Lithuania could all displace Estonian generation. Further increases to CO_2 pricing or additional competition with Estonian electricity exports would increase the competiveness of oil production relative to power generation.

Despite these underlying factors, the present Estonian situation is not conducive to further investment in shale oil production. Government policy favors electricity generation over oil production through the outgoing Oil Shale Development Plan and the mining permit allocation process outlined by the Earth's Crust Act.[21] The Oil Shale Development Plan defines the state interest in oil shale as providing secure and affordable energy to the domestic market.[22] The specific result has been to favor oil shale for electricity production rather than oil, which is exported on the global market, and to encourage oil production only with oil shale above the amount needed to provide domestic electricity needs. The mining permit allocation process exhibits this policy by favoring entrenched users of oil shale, which in practice means Eesti Energia.

Most conspicuously, though, the price of oil is not right. Under the present allocation and taxation regime, oil prices will need to rise if investment in oil producing infrastructure is to resume. Estimates vary depending on the operation. Reforms to mining permit allocation and taxation could bring this number down, but most of the difficulty is in the fact that oil from oil shale is costlier to get at than the other oil flooding the global market.

Trajectory

Despite the low oil prices, oil production could continue to rise for the next few years. Responding to lower oil prices, VKG has halted plans for future development and has closed some of its older production technology. Total processing capacity, however, should rise as new infrastructure, already financed, comes online. Oil processing center Petroter II came online in October 2014, and VKG still intends to

[20] Elering, "Elering's 2014 Security of Supply Report: Summary in English" (2014), http://elering.ee/public/Infokeskus/Uuringud/Summary_of_Elerings_2014_Security_of_Supply_Report.pdf.
[21] "Earth's Crust Act".
[22] "National Development Plan for the Utilization of Oil Shale: 2008–2015".

commission an additional unit, Petroter III, in the fall of 2015. Beyond these new units, it is doubtful VKG will be able to further increase oil production, in the short term, as they have reached the extent of their annual mining permit. As of June 2015, Eesti Energia, on the other hand, has remained committed to doubling oil production over the next five years, but will make investment decisions beyond that point in early 2016 and would need to see a slight price recovery before committing to additional expansion. Should the price of oil remain low, sustained increases in oil output will not occur.

The factors favoring oil production are deeply set, but current policy and prices restrict development. If they persist, current conditions may abate the development of oil production in Estonia. Industry and, increasingly, government, however, recognize that oil production from oil shale will likely grow in the long term. For now, current growth may continue until investment decisions already made pan out, beyond which the situation is uncertain. But, even if the most favorable conditions for oil production ultimately prevail, investment, and consequently production, will lag behind due to the uncertainty ahead.

Policy Recommendations

The expiring National Development Plant for the Utilization of Oil Shale names use of oil shale for the promotion of Estonian energy independence as its first strategic priority. The development plan goes on to define the state interest in oil shale use as such:

The state's interest is to provide Estonian consumers with electricity and heat energy without interruptions … in a way that would … grant the state's security and its sustainable development.[23]

The state interest in providing secure supplies of electricity and heat does not necessitate energy independence, but the current development plan conflates the two. As the next oil shale development plan is drafted, the state should redefine its interest in oil shale use and consider how the changed energy scene has altered the relationship between energy independence and energy security.

As oil shale use for heat generation has dwindled, the effect of the outgoing development plan has been to prioritize electricity generation over shale oil production. This prioritization is based on the implicit assumption that electricity generated from oil shale would be consumed domestically whereas shale oil would be exported. This analysis has shown that this assumption is no longer valid; increases in electricity generation have not been consumed domestically, but exported. In open, integrated electricity markets, there is no way to ensure oil shale capacity is used solely for domestic needs.

While increased integration prevents the reservation of electricity generated from oil shale for domestic use, integration increases Estonian energy security. With integration, energy independence is no longer Estonia's only path to energy security. This finding is congruent with recent conclusions reached by Elering [24] and the National Audit Office.[25] Though energy independence was key to energy security when Estonian energy supplies were either domestically sourced or imported from Russia, a single supplier, security can now be guaranteed through a combination of self-reliance and the increased diversity of energy suppliers. The Baltic Energy Market Integration Plan has already enhanced Estonian energy security, most notably through the introduction of Estlink 1 and 2. As additional planned interconnectors further integrate the Estonian electricity market with the Baltic, Nordic and Continental European markets, energy security will continue to increase. Maintenance of strategic reserves of oil shale and oil shale-fired capacity in case of disruption of electricity flows from Finland or gas supplies from Russia are still important aspects of Estonian energy security, but energy security no longer requires Estonia to rely solely on domestically sourced energy during normal periods. Given this higher level of integration, the next oil shale development plan should abandon the use of energy independence as a proxy for energy security.

Allocation of electricity generated from oil shale is determined by the market not national priority. Current sales of electricity derived from oil shale are profit

[23] "National Development Plan for the Utilization of Oil Shale: 2008–2015".
[24] "Elering's 2014 Security of Supply Report: Summary in English".
[25] Riigikontroll, "Actions of the State in Directing the Use of Oil Shale" (Tallinn, 2014).

motivated. These sales bolster the Estonian economy and provide revenue to the state; however, if Estonia is to use oil shale to maximize economic benefits, electricity production does not merit its current level of protection over alternative uses for oil shale, namely oil production. Provisions within the Earth's Crust Act favor entrenched users of oil shale, which have historically been electricity generators, and allow the denial of extraction permits conflicting with the oil shale development plan, which prioritizes energy independence. Allowing increased competition for oil shale extraction permits would open new opportunities for oil shale use. In present conditions of low oil prices, the market would likely distribute oil shale similarly to its present use. Should conditions change, though, the current system precludes profitable opportunities from being pursued.

Conclusion

Continued oil shale utilization does not conflict with EU or national environmental targets or regulations. Consumption of oil shale is increasing while Estonia exceeds both mandated and non-binding environmental and renewable energy targets. New technologies have increased efficiencies and mitigated CO_2 emissions. In combination with a low carbon price, there are few punitive measures discouraging oil shale use. Encouragement of renewable energies through subsidies and increased cross-border power transmission capacity have been more effective in curtailing oil shale use by introducing a degree of competition, however limited. In the absence of punitive measures, oil shale will remain the prominent source of Estonian energy, even as competition erodes some of its market share.

Though oil shale will remain dominant in the Estonian energy scene, it is no longer the sole guarantee of Estonian energy security. Integration with neighboring electricity markets now provides enhanced security through the diversity of available sources of electricity, and as integration continues to increase, so will Estonian energy security. Estonia can reduce prioritization of oil shale for domestic use without jeopardizing security. Even with these policy changes, Estonia would remain largely energy independent, but would also be better able to take advantage of opportunities for the more economical use of oil shale. Oil shale played a critical role in promoting Estonian energy security in the absence of integrated regional energy markets. Now that integrated markets and alternatives exist, Estonia should reconsider the role oil shale will play in the country's future.

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