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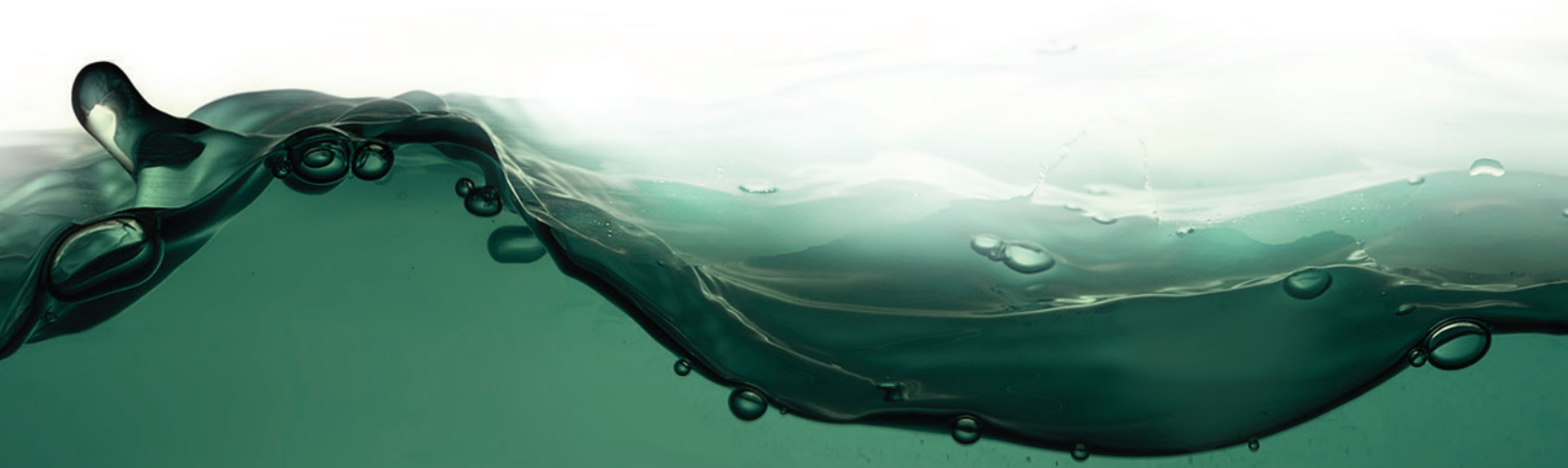

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This review article assesses renewable energy (RES) market potentials in Russia and the emerging co-operation potential between Finland and Russia in RES trade. The article presents three level assessment: political, individual RES type and company level reviews.

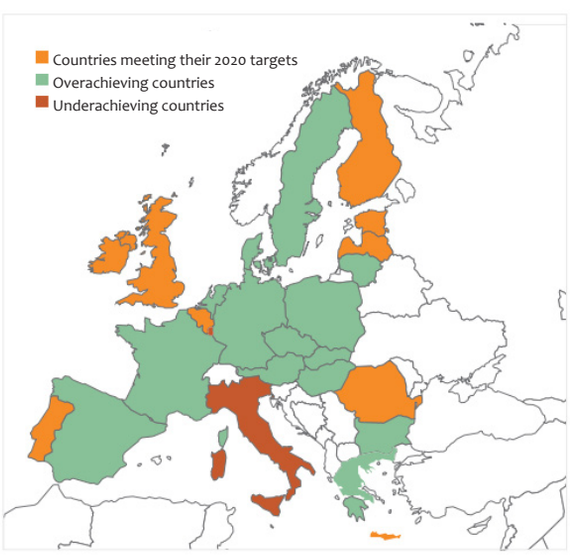
Political framework for RES development in Finland and Russia

Finland

Finland's RES policy is driven by the EU's so called 20-20-20 RES directive which aims at 20 percent RES share of energy consumption by 2020. The directive sets for each member state mandatory national targets for the overall share of renewable energy sources (RES) in gross final energy consumption as well as a mandatory share of 10% RES in transport.

The EU forecasts to surpass its 20% target. With 1,179.5 Mtoe in 2020 as overall energy consumption and 244.5 Mtoe as RES consumption, the share of RES will amount to 20.73%. This is rather low compared to the national RES industry roadmaps, which estimate a share of 24.4% renewable energy by 2020 to be feasible.

MAP 1
European Map showing NREAP Projections for 2020

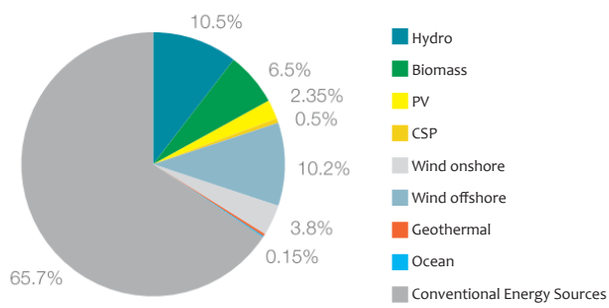


Source: EREC

According to the National Renewable Energy Action Plans (NREAP), more than one third of European Union electricity consumption will come from renewable energy sources in 2020. The share of renewable energy sources in electricity is forecast to increase from 14.9% in 2005 to 34.3% in 2020. According to the national RES industry roadmaps, renewable electricity (RES-E) can reach a higher share of 42.3% electricity consumption in 2020.

According to the EU NREAPs, wind energy will represent 14.1% of the electricity generation in 2020, hydropower 10.5%, biomass 6.5%, photovoltaics 2.35%, concentrated solar power 0.5%, geothermal energy 0.3% and ocean power 0.15%.

RES shares in total EU energy consumption by 2020:



Source: EREC bsed on the NREAPs

All EU Member States have introduced or are planning to introduce dedicated support mechanisms for RES-E. Most Member States appropriately differentiate between the different technologies. All four main types of support mechanisms (feed-in tariffs, premium tariffs, green certificates, and tenders) can be found in the various national renewable plans. The heterogeneity of the RES support mechanisms can and probably will create inefficiencies within integrated European power markets (target 2014) as these affect the costs of RES generation.

The Finnish National Renewable Energy Action Plan (NREAP) splits the overall 38 percent renewable energy target into 32.9 percent RES-Electricity, 47.5 percent RES-Heating & Cooling and 20 percent RES-Transport. The action plan indicates that Finland intends to be above its indicative trajectory throughout the period and meet its 2020 target. Achieving the target is, however, very challenging considering the high level of energy efficiency already in practice.

The Finnish NREAP aims at considerable increase in Biomass use (especially in heating) and wind power. The NREAP target shares in Finland for different renewable shares are illustrated in below three figures.

The Finnish Action plan includes a specific plan on measures needed to achieve the renewable energy targets contained in the resubmitted NREAP-FIN. It has a focus on bioenergy and also contains information about the administrative responsibilities and supporting organisations (Table below, Source: NREAP table 5).

MEE (Ministry of Employ-ment and Economy)
MAF (Forestry Centre, forestry management associations)

Promotional measure	Type	Target group(s)	Promoting responsibility
Biofuel distribution obligation	Regulatory	Use of biofuels in transport	MEE, other ministries
Sustainability criteria for biofuels and bioliquids	Regulatory	Biofuel producers and distriputors, biobased fuels and liquid fuels	MEE, other ministries
Production support for biogas	Financial support	Energy producers, biogas	MEE, other ministries
Production support for wood chips	Financial support	Energy producers, forest owners, woodchips	MAF
Production support for small CHP plants using renewable energy sources	Financial support	Energy producers, especially wood fuels	MEE General energy information
Fixed production support for electricity produced by renewable energy	Financial support	Energy producers, wind power, biogas, wood chips, small-scale hydropower	MEE General energy information
Energy subsidies for producers of renewable energy recources	Financial support	Energy producers, and users, all measures increasing RES production and use	MEE General energy information
Promotion of biofuels in transport through fuel taxes	Financial support	Energy producers and end users	MEE General energy information
Investment aids for farms using renewable energy resources	Financial and informative support	Thermal energy plants and biogas plants at farms that use RES or residual heat	MAF Farming consulting bodies
Investment aid for biogas plants	Financial support	Thermal energy plants and Promotion of construction of biogas plants in conjuction with farming in areas with large number of animals	MEE, MAF
Farm energy programme	Financial and informative support	Promotion of energy efficiency at farms and the production and use of renewable energy by means of energy efficiency agreements and suported energy plants	MAF
Energy subsidies for small sized wood	Financial support	Increasing the production of wood chips from young forest stands and first thinning sites	MAF
BioRefine	Financial / R&D	Biomas refining and 2nd generation biofuels	MEE, other ministries
Bioenergy end wood energy advisers	Informative	Companies, organisations and consumers, advice on the development of wood based and other bioenergy	MEE
Selected other measures targeting renewable energy investments within household sector	Financial support	Households, concerning energy efficiency and promoting use of RES in renovations	MEE General energy information
Selected other informative measures targeting efficient use of energy and renewable energy	Financial/Research, development and training	Energy, environmental and researching bodies and actors	MEE General energy information
Qualification scheme for installers	Informative	Installers, end users ordering	MEE General energy information

Finland: Clean energy program

This autumn (2012), Jyri Häkämies, Minister of Economic Affairs, presented a clean energy program[1] to the Government as part of the Finnish energy and climate strategy update. The program aims at balancing Finland's current account by investing in the production of clean domestic energy and reducing the import of energy by one third. Finland will be the first country in Europe to abandon the use of coal almost completely by 2025, and to reduce the use of natural gas by 10 and the use of oil by 20 per cent.

The main investment goals of this clean energy policy together with estimated employment effects are given in below table:

Clean energy program investment	Investment	Employment
Nuclear	> 10 bn €	3000
Wind power (9TWh target)	> 2 bn €	15 000
Bioenergy	~ 4 bn €	20 000
Energy efficiency	> 1 bn €	7000
Solar Power	0,2 bn €	1000
Electric Traffic	3 bn €	2000
Other (R&D)	0,5 bn €	2000
Total (estimate)	> 20 bn €	50 000

The clean energy program aims at reduction of CO_2 emissions by 20-25 % (compared to 2011 level). The construction part of these projects involve considerable positive employment effects (estimated at 80.000 annual work days) in addition to the above new job creation effect.

The main actions of the clean energy program include the following targets:

- Oil fuel usage is reduced by 20 %
- Coal is replaced by renewable energy sources
- electricity imports are reduced
- 10 % of gas is replaced by biogas

The program was announced using trade deficit as one argument i.e. new RES technologies could spin off new export goods and services. This argument is little bit odd but the program itself is welcomed in the Finnish energy/environmental policy.

The clean energy (RES) policy is likely to develop slower due to the possible (although far from certain) new nuclear units in Finland.

There are currently four nuclear reactors in operation:

Olkiluoto 1 and 2 (1765 MW)
Loviisa 1 and 2 (976 MW)

One more reactor is currently under construction Olkiluoto 3 with 1720 MW capacity.

Two more reactors have been given green light by the government:

Olkiluoto 4 (1000-1800 MW)
Fennovoima 1 (1600-1700 MW)

The realization of Olkiluoto 4 and Fennovoima 1 are not economically feasible if the Nordpool spot wholesale electricity price is staying at current levels (requirement of over 50 euro per MWh).

[1] http://www.tem.fi/files/34056/Puhdas energia ohjelma esittely 100912.pdf

In Finland the use of so called Mankala principle allow owners of co-owned power plants (typically nuclear) to use transfer pricing of electricity at generation cost instead of normally applicable market pricing. If transfer pricing was at market quotation, owners would pay income taxes in the generation company. It is unclear how EU will handle Mankala principle in the long run. From economic point of view the principle has no arguments.

Russia's RES policy

This section presents the Russian policy framework on the renewable energy. Power generation in the Russia is dominated by gas, coal and oil. Russia is one of the world's leading energy giants. It can satisfy it's own energy demand and is large exporter of energy. According to some experts[2] Russian natural resources account for 40 % of coal and 13 % of oil in world's reserves.

The majority of the Russian population is connected to heat and electricity network of the Unified Energy System (see map below). Most of the territory (70%), with a population of about 10 million people, is not, however, covered by the centralized power grid.

The Unified Energy System of Russia

In 2008 the relevant ministries and agencies of the Russian Federation started preparation of the legal basis for the development of Renewable Energy Sources (RES) in Russia. In early 2009, the government issued Decree of the Government of the Russian Federation[3] according to which the RES share would be 4.5 % of electricity consumption in Russia by 2020. The RES would consist of: biological, geothermal, wind, solar and small hydro resources. For Russia, which has traditionally focused on fossil fuel energy production, this was a revolutionary policy goal.

In the presence of legal and economic support from the state RES in Russia could have the potential to become a major energy sector with a real contribution to the total energy production. According to a recent report[4] the share of renewable energy in the total energy production could be as high as 35% by 2030. The projected RES shares would be: 15-20% of hydropower, 5.7% of wind power, 10% of bioenergy and 5% of geothermal and solar energy.

There are number of reasons why interest in developing more localized energy systems using local and renerwable energy sources have risen. One reason is the abovementioned fact that the unified power system covers only part of the Russian territory and the power grid simply cannot cover the vast area. Other reasons include: the 'greening' of the world energy policy (especially in Europe) and of course the fact that fossil fuel reserves are at some point has to be substituted with some other forms of energy as the known reserves end.

One of the central policy objectives of the newly elected president Putin and his new government is to transform Russia into an "economy of leadership and innovation", as stated in the Concept for Long-Term Social and Economic

[2] Безруких П.П., Арбузов Ю.Д., Борисов Г.А. и др. Ресурсы и эффективность использования ВИЭ в России. – СПб.: Наука, 2002

[3] Распоряжение Правительства РФ №1-р от 08.01.2009. «Об утверждении основных направлений Государственной политики в сфере повышения энергетической эффективности в электроэнергетике на основе использования возобновляемых источников энергии, на период до 2020 года».

[4] Перспективы развития возобновляемых источников энергии в России. Результаты проекта TACIS Europe Aid/116951/C/CV/RU. Николаев В.Г., Ганага С.В., Кудряшов Ю.И., Вальтер Р., Виллемс П., Санковский А.Г.. М.: Изд. «Атмограф», 2009, -456 с.

Development to 2020 ("the Concept"). The Concept envisages that Russia will not only remain a key producer and exporter of raw materials, but that it will also develop high-tech sectors and make its economy "competitive worldwide". It states that there will be several aspects to the transition to an innovative economy, including "winning leading positions in the development of renewable energy sources". Russian Government Resolution No. 1-r also states that the use of renewable energy contributes to the "integration of innovative high technology and equipment in the energy sector". Notably, the Russian policy document, "List of Priorities for the Development of Science and Technology", approved in 2006, identifies energy and energy efficiency as priorities[5].

President Putin also signed a decree "about long-term state economic policy" which envisages the investments in Russia to grow to 25 percent of the gross domestic product (GDP) by 2015 and to 27 percent by 2018. Currently the share is less than 18 percent. According to the decree Russia should also take the 50th place in the World Bank "Doing Business" rating by 2015 and 20th place by 2018, according to the decree. Currently, Russia occupies 120th place in that rating.

As it pursues its objective of making the Russian economy globally competitive, the government is accounting for the global trend towards "greening" of energy supply and use. Driven by the climate change challenge and energy security concerns, more and more countries are turning their attention to renewable energy sources. In its World Energy Outlook 2010 the International Energy Agency (IEA) projects that the share of fossil fuels in global primary energy demand will fall from 81 per cent in 2008 to 74 per cent in 2035, while the share of renewables increases from 7 per cent to 14 per cent over the same period in its New Policies Scenario[6].

The policy objectives above are very challenging but the political signal is that the Russian economy should diversify its trade structure from raw-material based exports towards more 'value-added' exports. The key question is how to redistribute the oil and gas based incomes efficiently into development of the Russian industrial base that would start producing more intermediate or final consumption or investment goods and/or services. Renewable energy is one promising way of achieving this: for example, generating biogas or biofuels from vast forest/wood processing stock or from agricultural flows, rises the export value added and diversifies the current technological knowhow in Russia. More generally, innovation policy and its implementation 'top-down' so that new technologies are adopted efficiently in co-operation with European partners could and should be one central focus of the current Russian government.

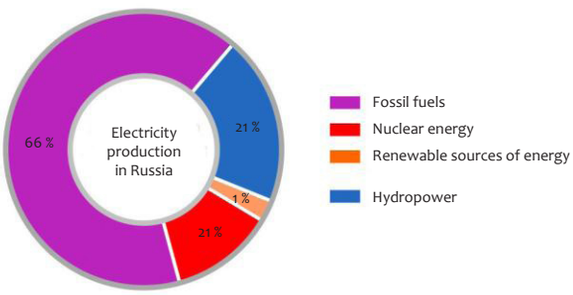
Russian energy ministry, the System Operator[7] (SO) and various research Institutions have published reports on economic scenarios until 2020 and 2030. The energy strategy on development 2017) of the unified power system in Russia can be found in the Russian Energy Ministry's web page[8]. The Energy Forecating Agency (public agency) produces long term (2020 and 2030) prognoses[9] or 'schemas' on the development of conditions affecting the Russian power sector.

The reports include prognoses of the electricity demand and generation capacity both regionally and at Russian Federation level. In addition there are forecasts of development of fuel prices.

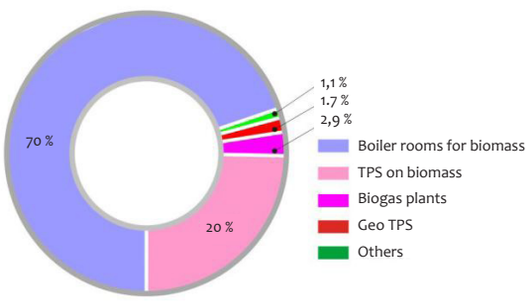
[5]Pr-843 Priorities for Science, Technology and Engineering in the Russian Federation, approved by Russian President Vladimir Putin, 21 May 2006.
[6]This is the scenario that takes into account the policies and measures already implemented and also
[7]those that have been announced. IEA, World Energy Outlook (IEA, Paris, 2010).
so-ups.ru and there document Отчет о функционировании ЕЭС России в 2011 году
[8]http://www.minenergo.gov.ru/documents/fold13/index.php?ELEMENT_ID=9471&sphrase_id=258593
[9]http://www.e-apbe.ru/scheme/

The Russian power market is driven by gas, coal and nuclear power. Renewables are still at roughly one percent of total generation. Of these the majority of renewable generation is based on biomass.

Electricity production 2011

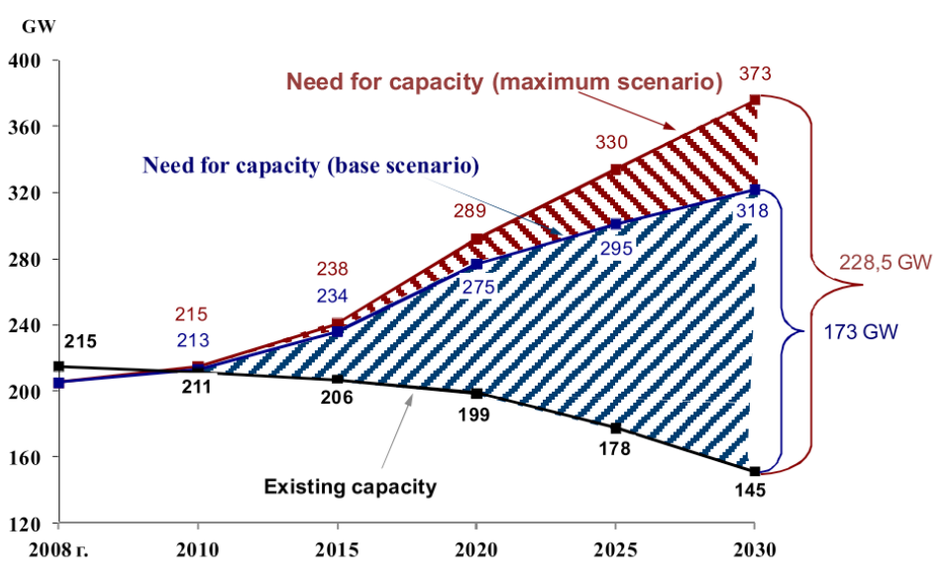


Renewable generation 2011



The generation capacity is ageing and a huge investment program has been initiated by the Russian government. The Investment need even in the base scenario is estimated to be 173 GW of new capacity. In the North-West Russia the need is roughly 23 GW. The next section discusses the role of renewables in this modernization plan.

The basecase scenario in the forecast agency's scenario assumes roughly 2,2 percent annual electricity consumption increase. This is fairly optimistic figure (given that there is also energy efficiency improvement goals on reduced heat and electricity losses). In general the scenarios seem to be based on trends based on fairly rapid growth during recent years[10].



Source: http://www.e-apbe.ru/scheme/

[10] FAO recent report on Russian Forest Outlook tends to confirm this: paper and pulp demand is assumed to growth at a rapid pace, requiring ten or so Greenfield new pulp and paper factories – if the scenario is realised. Few experts consider this as realistic scenario.

All scenarios seem to predict a steady rise of domestic Russian gas price. A one strategic goal of the government is to ensure the equal profitability both for domestic and export gas supplies - it means that domestic prices will be set on a netback basis (i.e. export price in EU minus transit fees and duties). The Russian Academy of Sciences Energy Research Institute (ERI RAS) forecast the following development of the coal and gas prices:

Forecasts of coal and gas prices in Russia in 2010 Roubles per tce (=0.7toe) L= low, H= high:

2015	2015	2020	2025	2030
GAS H	3594*	4864	5360	5794
GAS L	3377	4523	4988	5391
COAL H	2231	2386	2510	2664
COAL L	2138	2262	2417	2541
*89 euros				

There are also large regional differences in gas prices within Russia. According to one study the 2011 lowest gas max price is in Yamnenets region (Siberia) 64 €/1000m3, which is equvalent to 5,5 €/MWh. In S-Petersburgh region the same price is 113 €/1000m3 or roughly 10 €/MWh .

Assuming 40 % efficiency ratio gas condensing marginal price would then be 25 €/MWh. As the gas prices rise the marginal cost rise and other forms of capacity become also feasible.

Finland's bioenergy potential

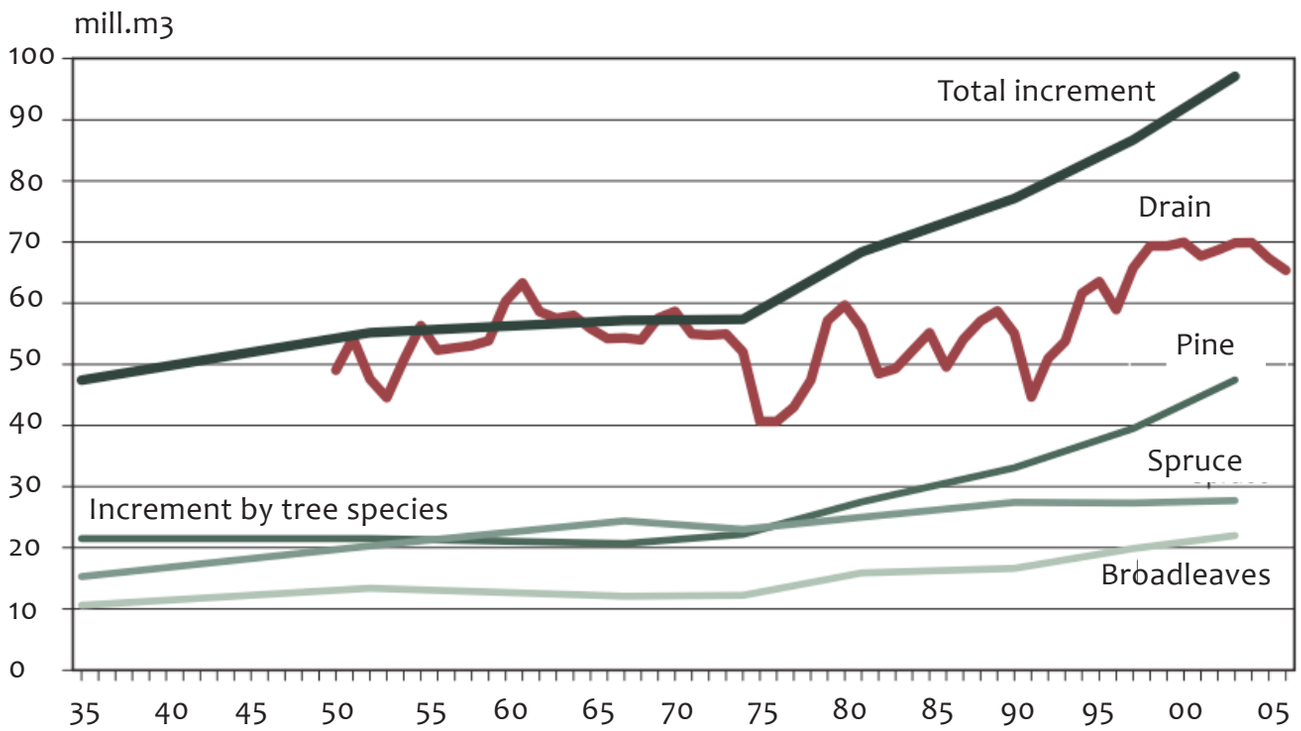
The main source in Finland's bioenergy potential lies in its forests. The wood based biomass dominate other sources (Table below).

Sector of origin	2006		
	Estimated amount of domestic resource	Net amount (considering import and exports)	Primary energy production (ktoe)
Direct supply of wood biomass from forests and other wooded land for energy generation			
Felling	0		
Residues from felling (tops, branches, bark)	2.2 million m³	2.2 million m³	358
Landscape management residues	0	0	
Other (including firewood for one family houses)	6.1 million m³	6.1 million m³	1,063
Indirect supply of wood biomass for energy generation			
Residues from sawmilling, woodworking, furniture	11.7 million m³	11.7 million m³	1,839
By-products of the pulp and paper industry	22.0 million m³	22.0 million m³	3,821
Processed wood fuel	259,000 t	66,000 t	106
Post consumer recycled wood (including recycled wood burnt in households)	1.0 million m³	1.0 million m³	167
Other	0	0	0
Agricultural crops and fishery products directly provided for energy generation			
Arable crops (cereals, oilseeds, sugar beet, silage maize)	Oats 700 t Spring turnip, rape 730 t	700 t 730 t	0,32 0,45
Reed canary grass	67,500 t	67,500 t	34.8
Agricultural by-products/processed residues and fishery by-products for energy generation			
Straw	-	-	-
Manure	-	-	-
Animal fat	8,359 t	15,150 t	13,38
Meat and boned meat	+6,800 t	44,00	9.46+9.02
Biodegradable fraction of municipal solid waste including biowaste and landfill gas			127.4
Biodegradable fraction of industrial waste including paper, carboard, pallets	(Included in the row above)		
Sewage sludge	21 million m³	21 million m³	10

Source: Resubmitted NREAP-FIN, Table 7

The total volume of Finland's forest stock is roughly 2 200 million m3. The growing stock volume has been increasing for a long time as the growth of the forests in volume exceeds the harvesting volumes and natural drain. For example in 2007 the total drain was 72.9 million m³ while the total growth of stock 98.8 was million m³. The total drain includes cutting removals, harvesting losses and natural mortality.

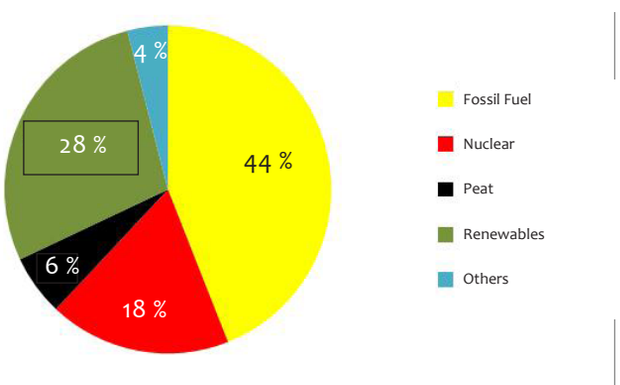
Increment of growth of stock (1935–2005) and drain (1949–2006) Source: Finnish Forest Research Institute, National Forest Inventory and Forest Statistics Information Service.



Over half of Finland's forests are owned by private individuals, 1/3 by the state and over 10% by private forest companies and other owners. The average size of a forest holding owned by private individuals is small, about 24 hectares. About one in every six Finns is a forest owner (920,000 owners and 440,000 holdings).

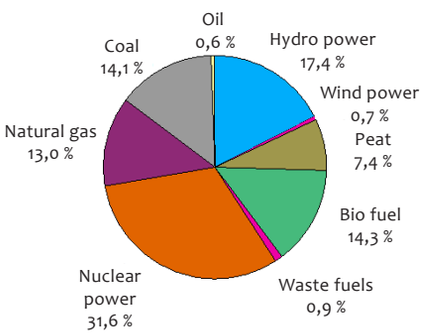
Currently the largest consumer and producer of the renewable energy in Finland is the forest industry. The share of biogas, energy from heat pumps and other recycled fuel based solutions have increased steadily since early 1990s, but their share in the total energy balance remains still fairly small.

Share of RES of total energy procurement in 2011



Source: Statistics Finland

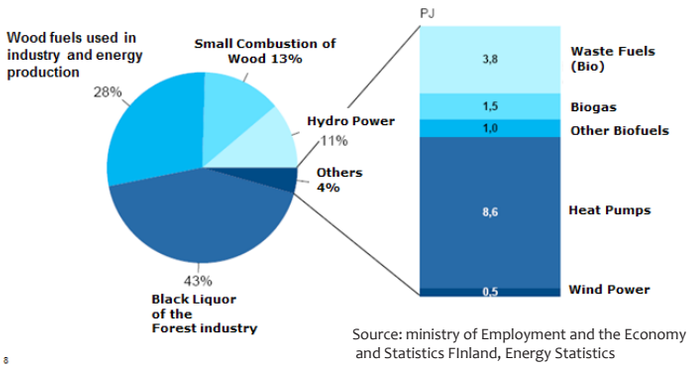
In electricity generation the Biofuel and hydro generation have roughly equal shares. Electricity generation in Finland by energy source in 2011 is illustrated below.



Renewable 33%
Carbon dioxide free 64 %

Source: Finnish Energy Industries

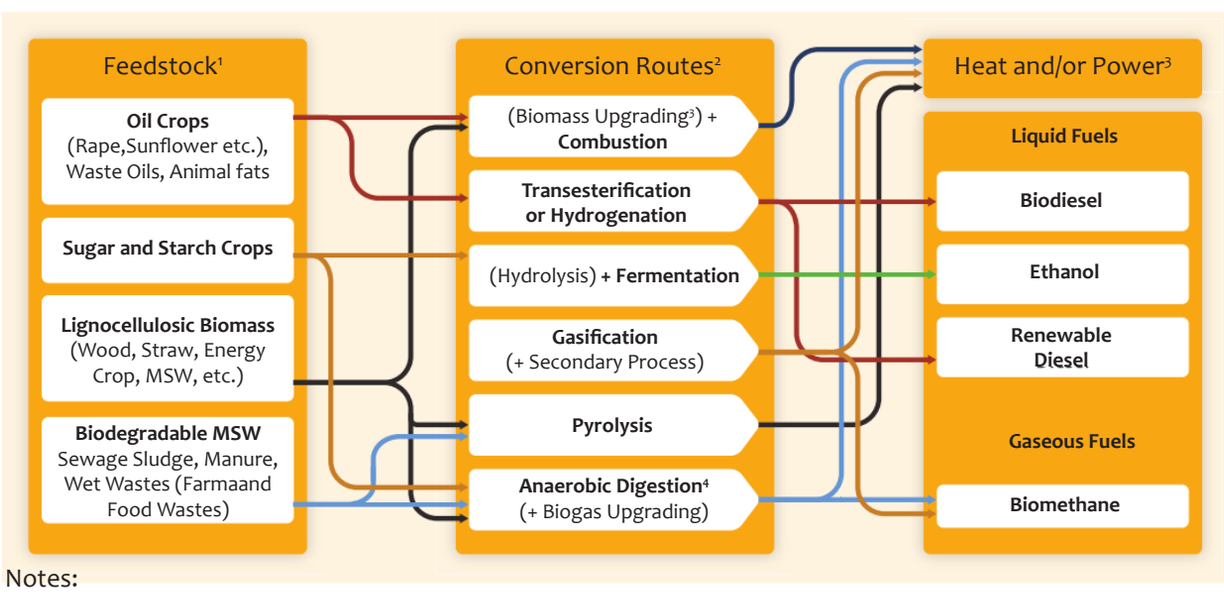
The Structure of RES energy sources in Finland (2006)



Source: ministry of Employment and the Economy and Statistics FInland, Energy Statistics

Bioenergy technology

Commercial bioenergy routes are shown in diagram below and start with feedstocks such as forest- or agriculture based crops or industrial, commercial or municipal waste streams and by-products. These routes deliver electricity or heat from biomass directly or as CHP, biogas and liquid biofuels, including ethanol from sugarcane or corn and biodiesel from oilseed crops. Commercially scalable processes of liquid biofuels can produce a limited range of products compared with fossil fuel sourced products.



Notes:
1. Parts of each feedstock, for example, crop residues, could also be used in other routes.
2. Each route also gives co-products.
3. Biomass upgrading includes any one of the densification processes (pelletization, pyrolysis, etc.).
4. Anaerobic digestion processes release methane and CO_2 and removal of CO_2 provides essentially methane, the main component of natural gas; the upgraded gas is called biomethane. Source: IPCC (2011)

Because biomass is mostly available in low-density form, it demands more storage space, transport and handling than fossil equivalents, with consequent cost implications. Biomass often needs to be processed (pretreated) to improve handling. For most bioenergy systems and chains, handling and transport of biomass from the source location to the conversion plant is an important contributor to the overall costs of energy production. The different processes (Thermochemical, Biochemical and Chemical) used for converting Biomass into Biofuels are shown below.

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