IEA Bioenergy
Technology Collaboration Programme

Implementation of bioenergy in Finland - 2021 update

Country Reports

IEA Bioenergy: 10 2021

This report was prepared from the 2021 IEA World Energy Balances and Renewables Information, combined with data and information provided by the IEA Bioenergy Executive Committee and Task members[1]. Reference is also made to FAOstat and Eurostat data as well as data from national statistics. All individual country reports were reviewed by the national delegates to the IEA Bioenergy Executive Committee, who have approved the content. General background on the approach and definitions can be found in the central introductory report for all country reports.

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HIGHLIGHTS

- Renewables make up 35% of Finland's *total energy supply* in 2019. The renewable energy share in *final energy consumption* is 43%[2]. Around 85% of renewable energy is from biomass.
- Finland has a low population density and a high forest area per capita, so it has a high domestic potential of solid biomass. Most of its bioenergy (90%) comes from solid biomass.
- The main application of bioenergy in Finland is in renewable heat, both in direct heating (predominantly in industry) and in district heating. The use of solid biomass in industry is steadily increasing, while fossil fuels go down.
- Roughly half of power production in Finland is based on renewables, with equal importance of bioelectricity (mostly through CHPs) and hydropower. Wind power is still at lower level, but steadily increasing. Another third is produced through nuclear energy, while fossil electricity only represents 15%. An important share of electricity consumption in Finland is covered by electricity imports (23% in 2019).
- The use of liquid biofuels in transport is quite high, representing 10% of overall transport energy consumption, with increased focus on advanced biofuels (which can be double counted towards the European targets). Biodiesel (FAME and HVO) represented 13% by energy of diesel fuel consumption in 2019. Bioethanol represents 6.5% by energy of gasoline consumption, which is

[1] While data for 2020 are starting to become available at national level, it was decided to consider trends up to 2019 for good comparability and benchmarking between the different IEA Bioenergy member countries. Care should also be taken when using 2020 data for analysing trends as these data are distorted by the COVID19 Pandemic.

[2] The difference between the share of renewables in supply and consumption relates to unused heat from (nuclear) power plants (which is counted in energy supply, but not in final consumption).

consistent with a widespread use of E10.

COUNTRY PROFILE

Population and land use

Finland is a country in North Europe and is member of the European Union. It has a total land area of 304 thousand km² and a population of 5.5 million people, representing a low population density of 18 persons per km².

Finland lies in the boreal zone. Around three quarters of the land area is forest land (*of which 13% protected*) and only 7% is agricultural land.

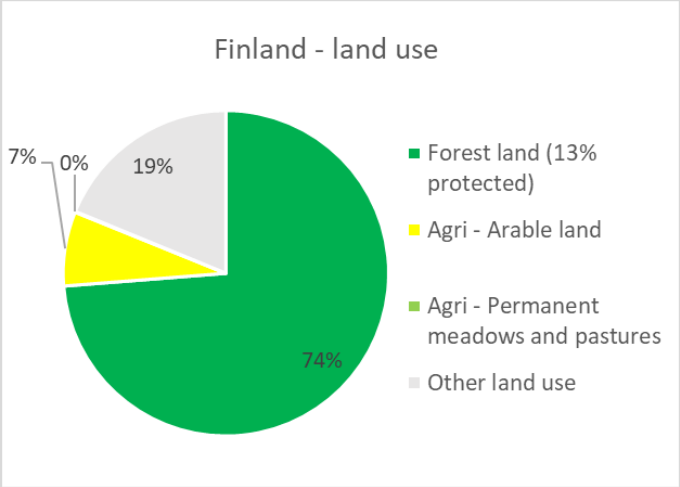

***Figure 1**: Land use in Finland (2018 figures - Source: FAOstat)*

Final energy consumption

Overall final energy consumption in Finland (*also including non-energy use of oil, natural gas, and coal in industry*) equates 4.6 tonnes of oil equivalent (toe) per capita, which is almost double the average of IEA Bioenergy member countries. Particularly energy use in Industry in high, representing a share of 49% of final consumption of energy carriers in Finland. Residential energy use is high compared to other countries, which is likely related to Finland's northern climate (higher domestic heating requirements).

***Table 1**: Distribution of the final consumption of energy carriers by sector in Finland (2019 figures - Source: IEA (2021) World Energy Balances and Renewables Information)*

Final consumption energy carriers	Toe/capita (2019)	% of total	*Median* (toe/capita)*
Industry (energy use)	1.99	43%	*0.67*
Industry (non-energy use)	0.26	6%	*0.21*
Transport	0.75	16%	*0.69*
Residential	0.92	20%	*0.57*
Commercial & public services	0.54	12%	*0.34*
other	0.17	4%	
Total	4.62		*2.34*

** Median of the 25 member countries of IEA Bioenergy*[3]

[3] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.

NATIONAL POLICY FRAMEWORK IN FINLAND

TARGETS AND STRATEGIES

It has become an established practice that every Government in Finland prepares an energy and climate strategy. The strategic theme on carbon neutrality of the Programme of Prime Minister Sanna Marin's Government, who started in December 2019, contains the following objectives[4]:

1. Finland will achieve carbon neutrality by 2035.

2. Finland aims to be the world's first fossil-free welfare society.

3. Finland will strengthen carbon sinks and stocks in the short and long term.

New strategy is being prepared to incorporate the climate and energy targets of the Government Programme of December 2019. The climate and energy strategy is prepared in coordination with medium-term climate change policy plan including an action programme to reduce emissions in the non-emissions trading sectors, i.e. the effort-sharing sector. Main focus in the new strategy and measures outlined will be around targets adopted by the EU for 2030 climate and energy and the target of Government Programme on carbon neutrality by 2035. In line with existing decisions, the Government Programme remarks a phase out of the energy use of coal by May 2029 at the latest. Planned release of the new climate and energy strategy of Finland is in autumn 2021.

According to the Government Programme a total of 13 sector-specific low-carbon roadmaps were prepared and published in 2021 in coordination by the Ministry of Economic Affairs and Employment. The results of the roadmap work will be used in the preparation of the Government's climate and energy policy, the targeting of RDI investments and the preparation of a sustainable recovery. In relation to bioenergy, roadmaps for energy industry, forest industry and bioenergy industry have been prepared.

Finland's Integrated Energy and Climate Plan (2019) outlines how Finland intends to address EU's climate and energy targets for 2030, including climate and renewable energy related targets. Accordingly, the EU has set Finland a 2030 national target for reducing greenhouse gas emissions in the non-emissions trading sector by 39% compared to 2005. Emissions from the land-use sector should be kept lower than the computational reduction in emissions from sinks. Finland aims to increase the share of renewable energy to at least 51% of the final energy use and to 30% of the final energy use in road transport.

Finland has released the first Finnish Bioeconomy Strategy in 2014. According to the vision formulated in the strategy, Finnish well-being and competitiveness will be based on sustainable bioeconomy solutions. The objective of the first Finnish Bioeconomy Strategy is to push the bioeconomy output of Finland up to EUR 100 billion by 2025 and to create 100,000 new jobs. The Finnish Bioenergy Strategy update is being prepared, and it has been set to be completed in autumn 2021. The update will adopt changes in the operational environment and the Government Programme and it will be based on the updated bioenergy strategy of the European Union from 2018, and the Council of the Europe conclusions on the Updated Bioenergy Strategy from 2019 prepared by Finland.

[4] https://ym.fi/en/climate-neutral-finland-2035

Table 2: Renewable energy and climate targets in Finland.*

Sector	Share of renewables in gross final consumption per sector	GHG reduction target compared to base year 2005
Overall target	51 % by 2030	39 % by 2030 (non-ETS) Carbon neutrality by 2035
Heating and cooling		
Electricity		
Transport	30 % by 2030	50 % by 2030

** 2030 targets mentioned in the 2019 Energy and Climate Plan are likely to be reviewed in the frame of the European Fit for 55 Package*

A description of renewable energy and climate policies and measures in Finland is available at the IEA's Policies and Measures Database: https://www.iea.org/policies?country=Finland

Specific policies related to renewable electricity, renewable heat and transport biofuels will be highlighted in the chapters about the role of bioenergy in different sectors.

THE CONTRIBUTION OF BIOENERGY IN NATIONAL ENERGY SUPPLY

TOTAL ENERGY SUPPLY

The total energy supply (TES) of Finland in 2019 amounted to 1,388 petajoule (PJ), which was quite stable in the past decade. Fossil energy represents less than half of the Finnish TES. Oil products account for a quarter (321 PJ), coal products account for 7% (90 PJ) and natural gas for 6% (89 PJ). Peat and peat products hold a share of 4% (57 PJ) and non-renewable waste 0.9% (12 PJ). The statistics also features 19% or 260 PJ of nuclear energy in nuclear power stations (which represent one third of national electricity production).

Renewable energy sources have a share of 35.1% in total energy supply or 487 PJ – 420 PJ bioenergy, 45 PJ hydropower and 22 PJ wind energy. 72 PJ of electricity is imported, which represents 23% of electricity consumption in Finland and 5.2% of Finnish TPES.

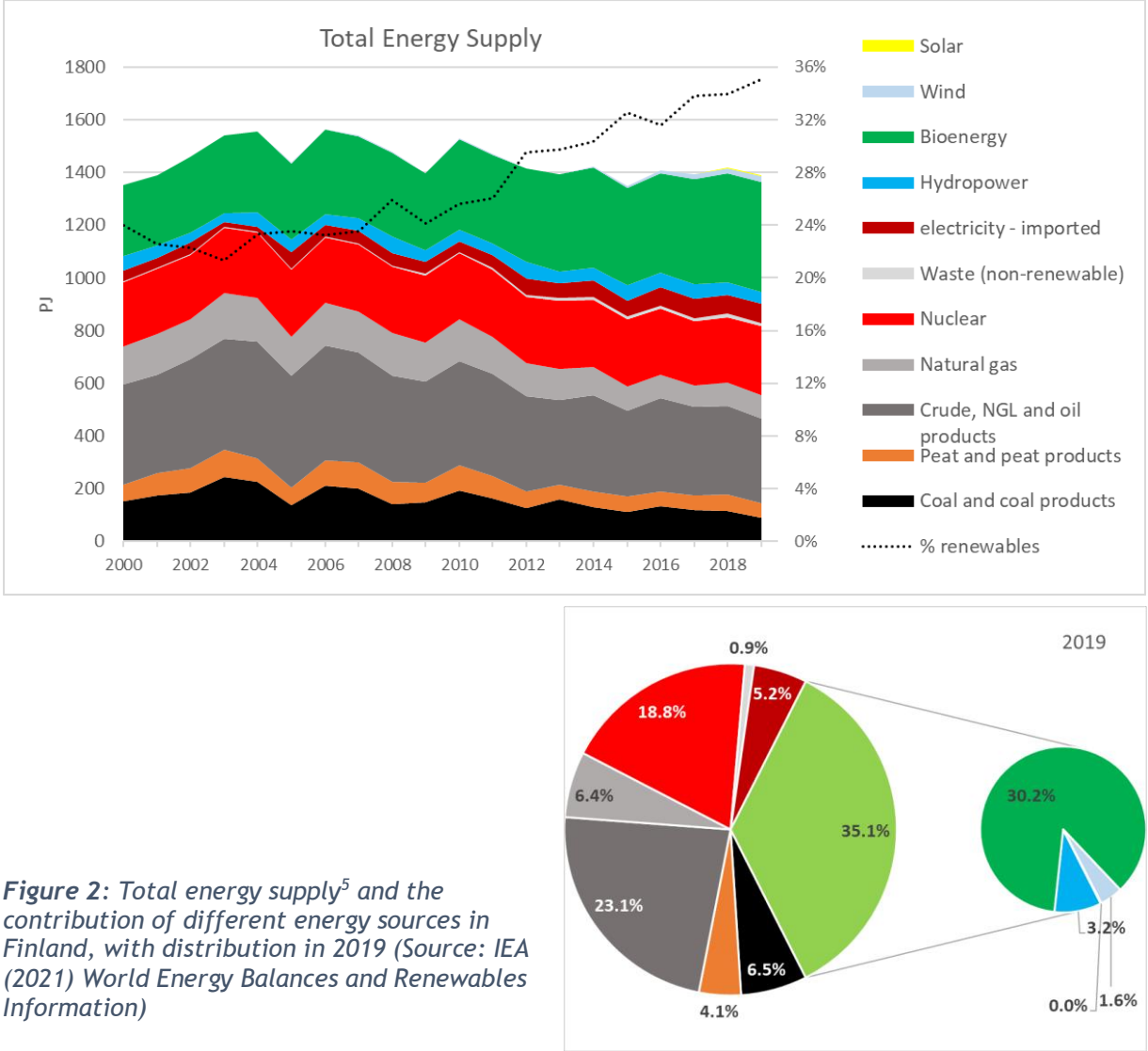

***Figure 2**: Total energy supply[5] and the contribution of different energy sources in Finland, with distribution in 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

[5] Total energy supply refers to the use of resources. In terms of the role in the energy system this distribution overestimates the role of resources producing electricity with a high share of unused waste heat (like nuclear plants).

Compared to 2010 the share of fossil fuels decreased gradually from 55% to 40% of TES. The share of coal went down from 13% to 6%; oil from 26% to 23% and gas from 10% to 6%. In the same period the share of renewable energy increased from 26% to 35% of TES.

The total supply of renewable energy sources in 2019 is still dominated by biomass, which steadily increased from 340 to 420 PJ in the past 10 years. Hydropower fluctuated between 45 and 60 PJ, and wind power increased from 4 PJ in 2014 to 22 PJ in 2019. Solar energy represents less than 1PJ.

As shown in Figure 3, bioenergy in Finland is dominated by solid biomass (377 PJ), largely in forest-based industries (chips, bark, sawdust) and pulp and paper industries (black liquor), for the production of process heat and electricity, but also in district heating plants. Around 62 PJ solid biomass is used in the residential sector. The next item is liquid biofuels (19.9 PJ), followed by renewable MSW (14.6 PJ) and biogas (7.9 PJ).

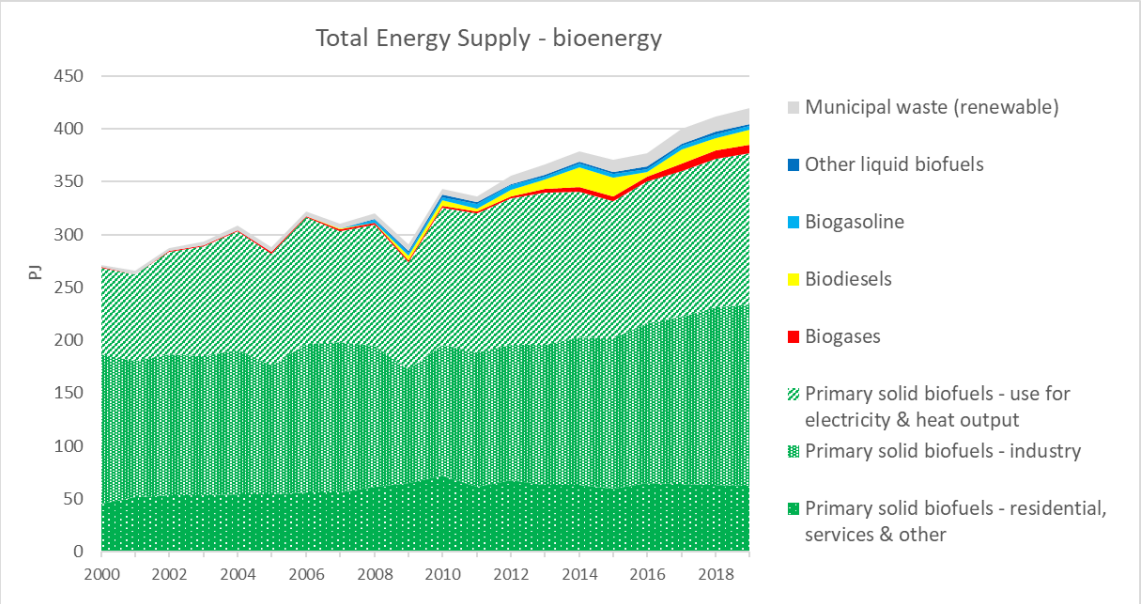

***Figure 3**: Development of total energy supply from bioenergy in Finland 2000 – 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Evolution of the bioenergy carriers:

- In the past 10 years the use of solid biofuels in industry continued to grow from 120 to 170 PJ, thereby replacing fossil fuels. The use in residential applications is fairly stable between 60 and 70 PJ. Solid biofuel use for electricity and heat output is also fairly stable between 130 and 145 PJ.
- Biodiesel was introduced in 2007 and increased up to a level of 18 PJ in 2015. There have been some downward fluctuations afterwards, but it has now recovered again to 14 PJ.
- Bioethanol was also introduced in 2007 and fluctuated between 2.5 and 4 PJ in the past 10 years.
- Biogas steadily increased from 1.7 PJ in 2010 up to 7.9 PJ in 2019.
- Renewable municipal waste increased steadily from 6 PJ in 2010 to 15 PJ in 2019.

Table 3 displays the 2019 total bioenergy supply values on a per capita basis. Compared to the other 24 member countries of IEA Bioenergy (expressed per capita), Finland ranks number one for solid biofuels and at the higher end for liquid biofuels, biogas and renewable MSW.

***Table 3**: Total energy supply per capita in 2019 for different bioenergy carriers*

	Supply per capita	*Median IEA Bioenergy members*
Bioenergy	75.9 GJ/cap	*10.6*
Solid biofuels	68.2 GJ/cap	*7.0*
Renewable MSW	2.6 GJ/cap	*0.8*
Biogas	1.4 GJ/cap	*0.7*
Liquid biofuels	3.6 GJ/cap	*1.5*

Source: IEA (2021) World Energy Balances and Renewables Information

Table 4 indicates the amounts of the different bioenergy carriers compared to some relevant reference points, namely the amount of forest in the country (for solid biomass), the amount of generated MSW (for renewable MSW used for energy), the amount of natural gas consumed in the country (for biogas) and the amount of fossil oil products consumed (for liquid biofuels).

***Table 4**: Comparison of the supply of different bioenergy carriers in 2019 to specific reference points*

	Compared to reference points			*Median**
Bioenergy	30.2 %		of total energy supply	*7.2 %*
Solid biofuels	19.3 GJ/ha_forest		compared to the domestic hectares of forest land (excl. protected)	*21.3 GJ/ha_forest*
Renewable MSW	5.35 GJ/ton_MSW		compared to the total generated MSW in the country	*1.4 GJ/ton_MSW*
Biogas	0.089 GJ/GJ_NG		compared to natural gas supply	*0.023 GJ/GJ_NG*
Liquid biofuels	0.062 GJ/GJ_oil		compared to oil products supply	*0.028 GJ/GJ_oil*

Source: energy data from IEA (2021) World Energy Balances and Renewables Information; forest figures from FAOStat; waste figures from World Bank
** Median of the 25 member countries of IEA Bioenergy*[6]

Specific comments in relation to the reference points:

- While the use of solid biofuels per capita is very high, considering the high share of forest in Finland and the low population density, the use of solid biofuels compared to the domestic forest area is modest (~1 tons_dry mass of wood per hectare[7]). Mind that growth levels in Nordic boreal areas are lower than in more moderate climates.

[6] Comparative figures of the different IEA Bioenergy member countries are discussed in the central Countries' Report.
[7] Counted with a typical calorific value of wood (dry mass) of 19 GJ/ton$_{\text{dry mass}}$

- The use of renewable MSW for energy production is high compared to other European countries with well-developed waste management systems.
- Biogas is also quite well developed and already represents a significant share of gas supply. Mind that the role of natural gas in the Finnish energy mix is quite modest (6% of TES).
- Transport biofuels are also well developed compared to other European countries and is predominantly focused on advanced biofuels.

ROLE OF BIOENERGY IN DIFFERENT SECTORS

OVERVIEW

The overall 2019 share of renewables in **final energy consumption** among electricity, transportation and heat sectors is 43%, with bioenergy making up almost 37% of the energy share (Table 5). Mind that these figures are higher than the shares in total energy supply (where unused waste heat, e.g., in fossil or nuclear power production, is also included).

***Table 5**: Role of bioenergy and renewable energy in electricity, transport energy and fuel/heat consumption in 2019*

Sector	Share of bioenergy	Share of renewable energy	Overall consumption
Electricity[8]	15.6%	37.3% *(14.5% hydro)*	85.4 TWh (307 PJ)
Transport energy (final consumption)	10.3%	11.1%	175 PJ
Overall fuel and heat consumption[9]	Direct biomass: 42.3% Biobased heat: 13.6%	56.0%	567 PJ
TOTAL FINAL ENERGY CONSUMPTION	**36.6%**	**43.0%**	**1046 PJ**

Source: IEA (2021) World Energy Balances and Renewables Information

The following paragraphs will consider the evolutions in the different sectors.

[8] Renewable electricity production compared to final consumption. Potential renewable shares of imported electricity are not included.

[9] This includes final consumption of fuels and heat in industry, the residential sector, commercial and public services and agriculture/forestry. Transport fuels are excluded. Energy used for transformation and for own use of energy producing industries is also excluded.
Electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported.

ELECTRICITY

Finland has a relatively high share of renewable electricity, representing roughly half of domestic power generation and 37% of electricity consumption. Hydropower and bioelectricity (mostly through CHPs) both represent 15% of electricity consumption and wind another 7%. The share of wind is steadily increasing. Nuclear energy has an important role, with 28% of Finnish electricity consumption. Fossil fuels (coal and gas) have a modest role (together ~11% of electricity consumption), a share which is steadily decreasing. Mind that an important share of electricity consumption in Finland is covered by electricity imports, a share that increased from 15% in 2010 to 23% in 2019.

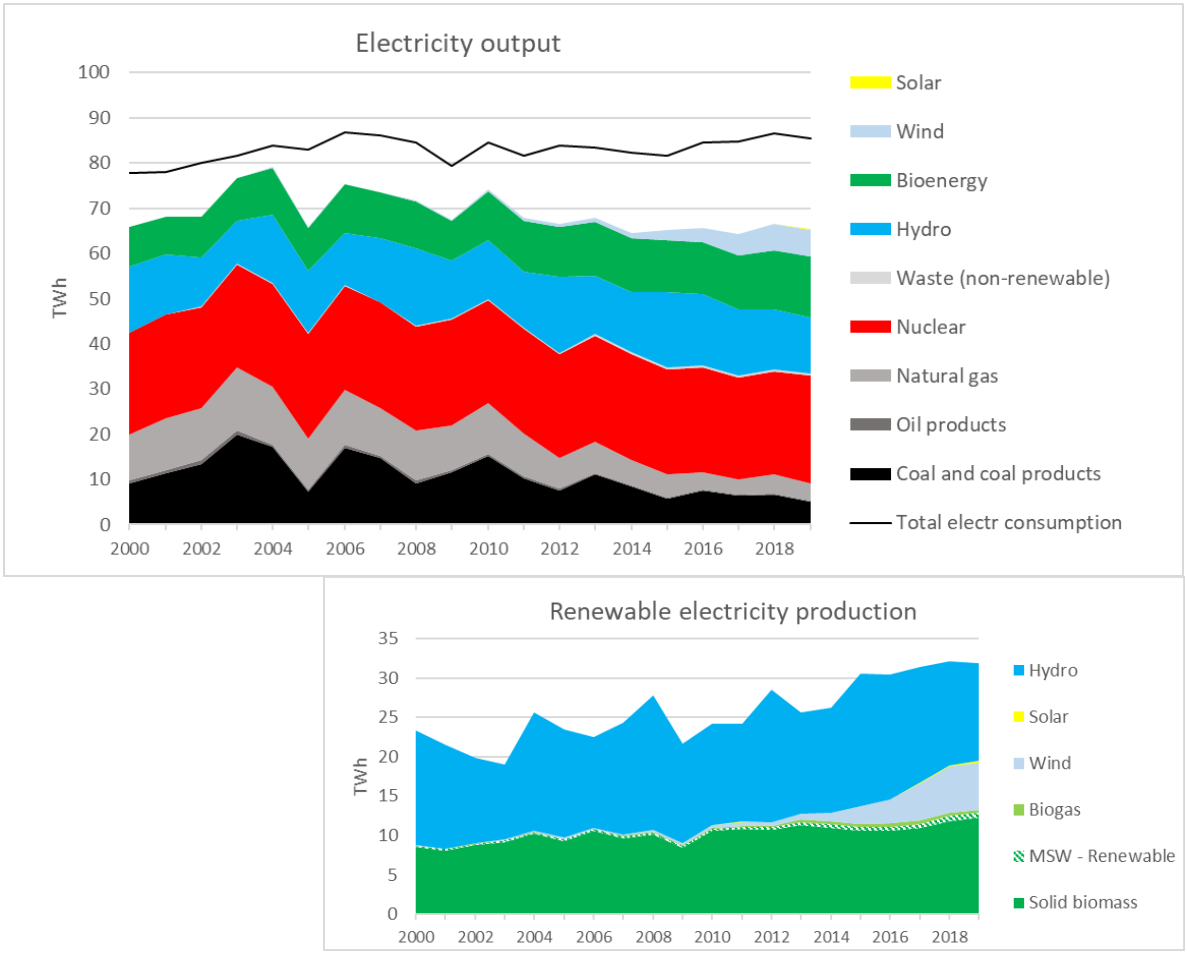

Figure 4: Evolution of the electricity mix in Finland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)

Policy framework

The main relevant policy instruments behind these evolutions are:

- Feed-in premiums for electricity from wind, biogas, forest chips and wood-based fuels have been an important instrument to reach the above-mentioned targets.
- A Feed-in tariff system was established in 2011, and it ended for different production technologies in 2017, 2019, and 2021. The feed-in tariff will be paid for 12 years after a plant has been approved to the scheme, meaning the feed-in tariff will still have an impact on the evolution of the electricity mix.

- The level of the tariff paid to wind power and plants fuelled with biogas or wood-based fuels is determined based on the difference between market price of electricity (average of three months, minimum 30 €/MWh) and the target price. Target price is 83.5 €/MWh, meaning the maximum support is 53.5 €/MWh. Further, electricity produced with biogas fuelled plants is eligible for heat premium of 50 €/MWh and wood-based fuels of heat premium of 20 €/MWh, provided they meet the efficiency criteria.
- The Feed-in tariff system was closed for new wind power plants on 1st November 2017, and new plants fuelled with biogas and wood-based fuels on 1st January 2019.
- The feed-in tariff for forest chips based plants was closed on 15th March 2021. Aid for electricity from forest chips has been a measure to promote the use of forest chips in combined heat and power generation (CHP). The variable level of the tariff is determined according to the level of excise tax of peat fuel and average of the emission allowance prices. The maximum aid has been EUR 18/MWh. In order to avoid distortion of wood availability for industrial use, the feed-in premium was restricted to 60% if wood chips were made from larger stemwood (breast diameter > 16 cm).
- Production aid for electricity from renewable energy sources (2018-2019) is a premium system based on a competitive tendering process and investments in different renewable energy sources. The auction was held in 2018 and decisions were made in March 2019. As a result, the aid was granted for seven projects with total of 1.36 TWh/a worth of annual electricity production. All granted projects were based on wind power.
- No new operating aid schemes will be introduced or auctions organised under the new climate and energy strategy.

HEAT/FUEL

Figure 5 shows the role of different fuels/energy carriers for providing heat in different sectors (industry, residential sector, commercial and public services and other). It also includes heat sold to customers, e.g., through district heating. Fuel use by energy producing industries for transformation and for own use is excluded. Mind that electric heating (direct or through heat pumps) is not included in these figures as this is not separately reported in the IEA database.

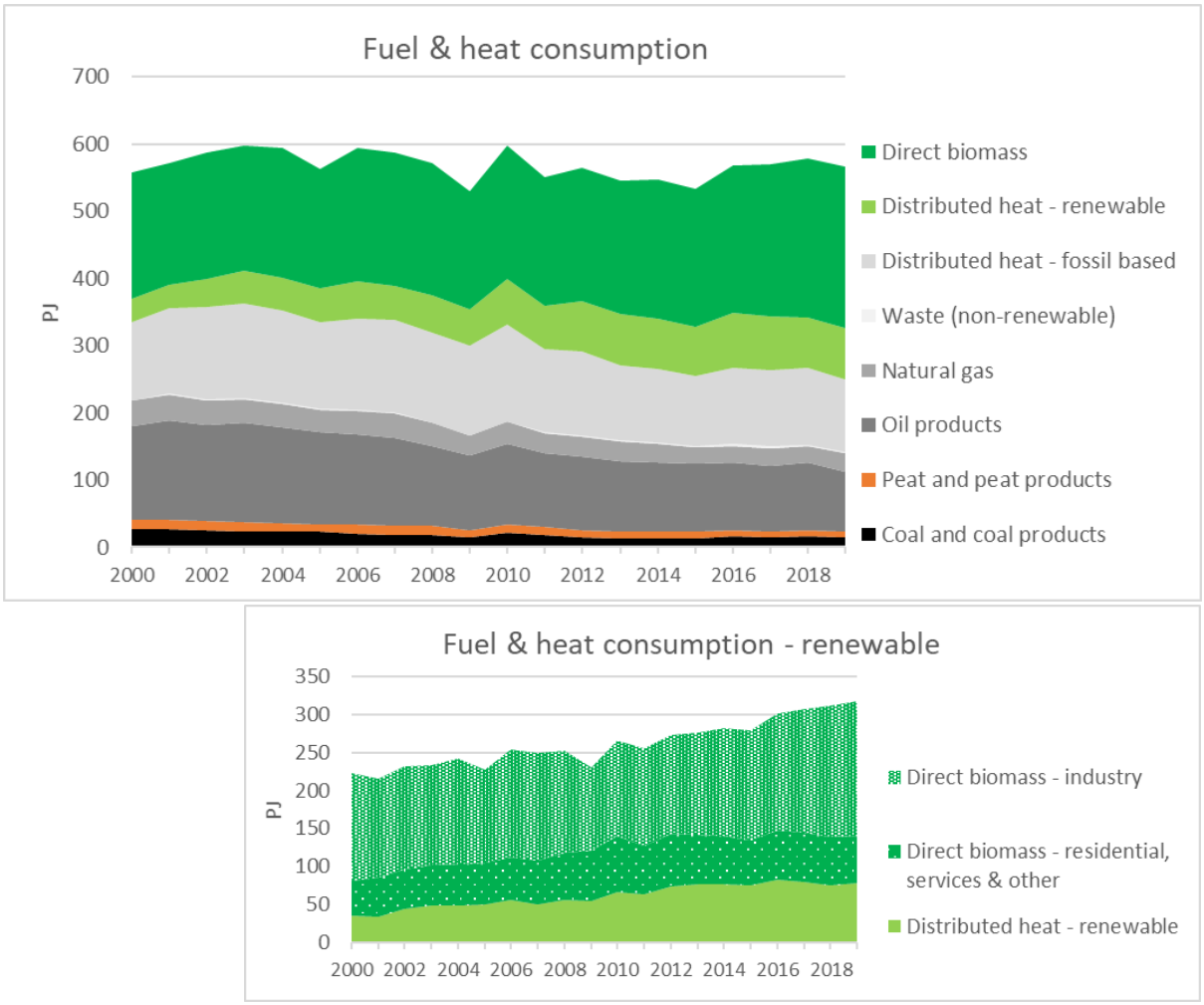

***Figure 5**: Evolution of fuel and heat consumption in Finland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

The provision of heat can be divided in three parts: 25% on fossil fuels (mostly oil and some gas, coal, and peat), 33% through heat sales (e.g., through district heating) and 42% direct biomass (two third of that in industry). Heat sales have been fairly stable since 2012, while the share of fossil fuels has decreased; this decrease was compensated by an increased direct use of biomass, particularly in industries.

Heat output generated and sold by CHP plants and heat plants represents around one third of fuel/heat provided, of which currently 42% is produced from biomass, a share which has increased steadily up to 2013 and stabilized since. Coal, peat, and natural gas each represent between 12 and 15% of heat/fuel provision. The use of residual heat and other sources has increased to significant levels (~10%) in recent years.

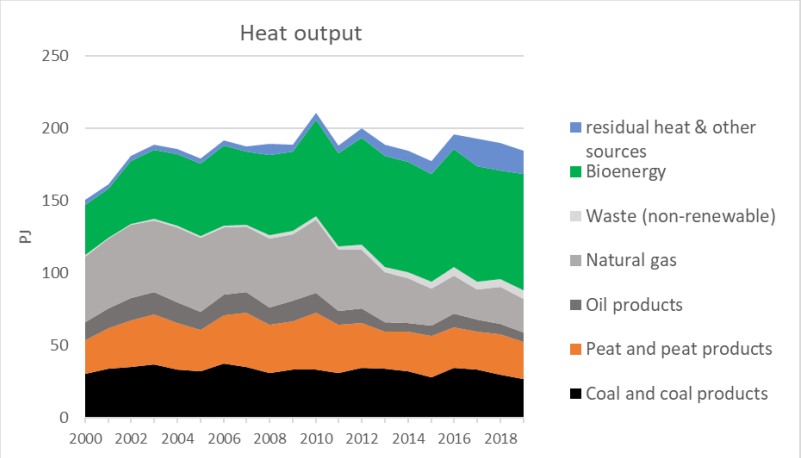

***Figure 6**: Evolution of fuels for heat output in Finland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Policy framework

The main relevant policy instruments behind these evolutions are:

- A CO_2 tax for fossil fuels in heating has been a long-term incentive to promote renewable heating.
- The CO_2 tax for fossil fuels in heat production has increased in 2018 to EUR 62/ton CO2, on a par with taxation of liquid fuels for transport. The CO_2 tax has been halved for CHP-plants.
- A number of measures target the use of renewables in heating and cooling, including
    - quota obligations for biofuels in heating to apply to light fuel oil used in heating and machinery so that the share of bioliquids must be at least 10% by 2028
    - the target of phasing out of fossil fuel oil in heating by the beginning of the 2030s.

TRANSPORT

Figure 7 shows an overview of the energy used in transport in Finland, split up by different fuels/energy carriers.

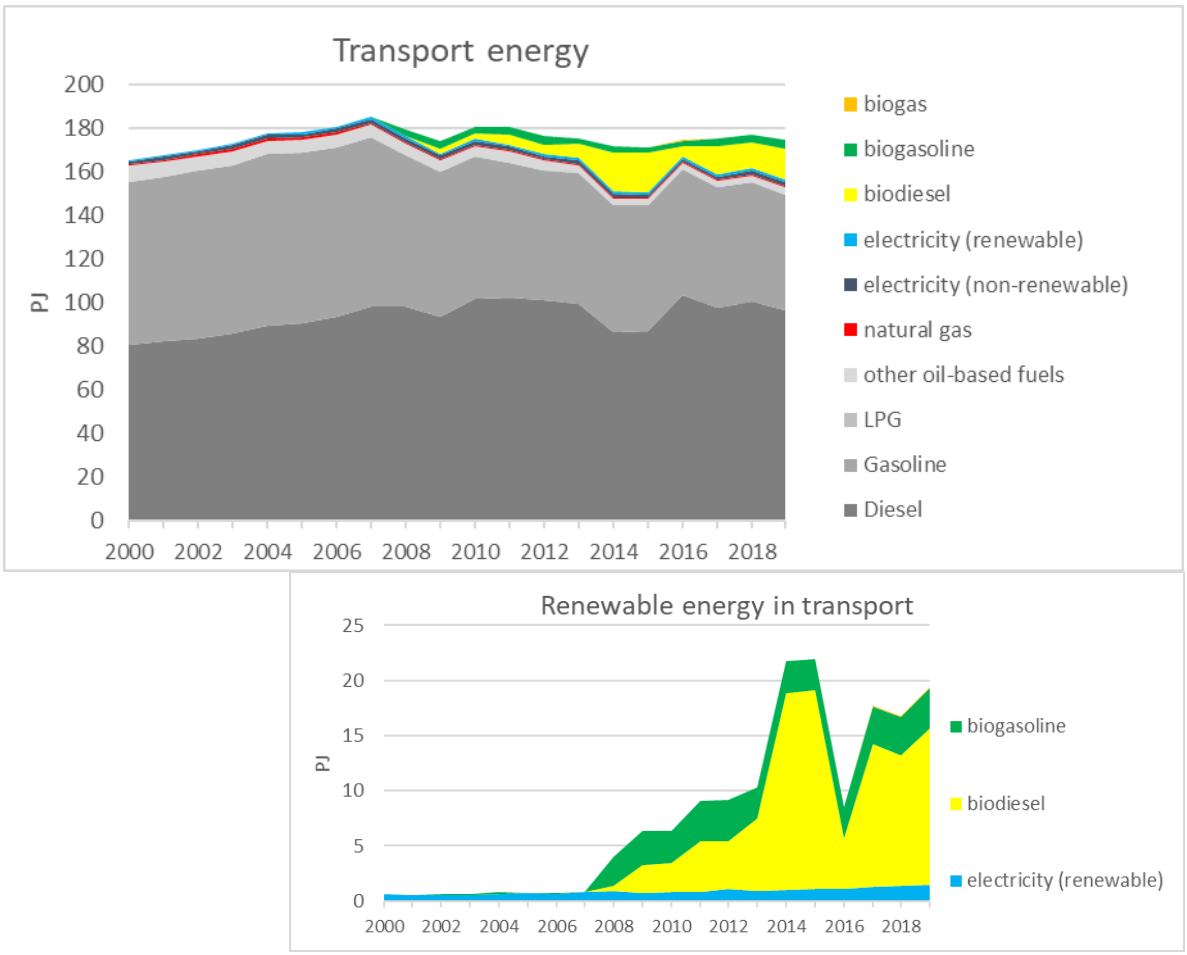

***Figure 7**: Evolution of transport fuels in Finland 2000 - 2019 (Source: IEA (2021) World Energy Balances and Renewables Information)*

Overall transport fuel consumption in Finland is relatively stable; the role of diesel steadily increased until a few years ago, while the share of gasoline went down in the past 10 years. Liquid biofuels were introduced in 2008 and its use increased gradually in the first years. From 2013 to 2014 there was a step increase of biodiesel from 6 to 18 PJ. In 2016 consumption of biodiesel dropped temporarily to 4.5 PJ, due to the flexibility mechanism set in the biofuel quota act that allows fuel suppliers to blend less than required in case of oversupply in the previous year. From 2017 biodiesel increased again to around 14 PJ and already leads to a significant drop in fossil diesel demand. Biodiesel (FAME and HVO) represented 13% by energy of diesel fuel consumption in 2019. Levels of bioethanol fluctuated in the past 10 years between 2.5 and 3.5 PJ. Current levels represent 6.5% by energy of gasoline consumption (which is consistent with a widespread use of E10).

Biofuel levels are slightly lower than in the 2014-2015 period due to increased focus on advanced biodiesel (which can be double counted towards the European targets).

Electricity represents a share of 1.8% of total transport energy use. This is mostly in rail - the use of electricity in road vehicles is still marginal in 2019 (0.15% of total transport energy use) but can be expected to grow in the coming years.

Policy framework

The main relevant policy instruments behind these evolutions are:

- The amendment of the biofuel distribution obligation (Act on Promoting Use of Biofuels in Transport) of 2011 increased the share of biofuels corresponding to the obligation of 20% in 2020 (15% in 2018, advanced biofuels from non-food raw material being double counted).
- Finland has an ambitious sectoral target in transport sector to reduce GHG emissions by at least 50% by 2030 compared to 2005. The final (NECP) plan identifies a broad range of measures in this sector, including:
    - transport fuel taxation,
    - increasing the use of biofuels in road transport up to 30% physical share of the energy content,
    - support for alternative fuels,
    - and the improvement of energy efficiency of vehicles and the transport system.
- The act concerning the quota obligation for biofuel use entered into force on 1 April 2019
- The energy and climate strategy (2016) included a target to increase the number of electric cars to at least 250,000 and the number of gas-powered cars to at least 50,000 by 2030.
- As stated in the Government Programme (2019), a roadmap for fossil-free transport, presenting the measures to halve GHG emissions from national transport by 2030 and to achieve net-zero transport emissions by 2045, was released in May 2021. According to the roadmap, it is recommended to substantially increase the target on number of electric cars to a level of even 600,000 – 700,000 by 2030, with the main part being fully electric.

COMPARISON WITH RENEWABLE ENERGY TARGETS

According to Eurostat[10], the following renewable energy shares in *gross final energy consumption* were reached.

__Table 6__: Share of renewables in different sectors in Finland, according to Eurostat, and compared to the 2020 target

	2005	2010	2015	2019	*2020 target*
Overall share	28.8%	31.3%	39.2%	43.1%	*38%*
In heating & cooling	39.1%	44.2%	52.5%	57.5%	*47%*
In electricity	26.9%	27.7%	32.5%	38.1%	*33%*
In transport	0.9%	4.4%	22.0%	21.3%	*20%*

[10] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_335a&lang=en

Finland already exceeded its overall renewable energy target in 2015 and will clearly exceed the targets for all sectors. Finland adopted a higher target for biofuels compared to other European countries (20% compared to 10%), with focus on advanced biofuels.

Mind that some of these figures can differ from the IEA derived data because of different accounting rules. Particularly in transport the Eurostat shares are higher, which is due to the multiple counting of advanced biofuels and renewable electricity towards the transport target. The heating & cooling figure in Eurostat also includes heat pumps.

RESEARCH FOCUS RELATED TO BIOENERGY

The objective of the Finnish Bioeconomy Strategy (published in 2014) is to generate new economic growth and new jobs from an increase in the bioeconomy business and from high added value products and services while securing the operating conditions for the nature's ecosystems. Bioeconomy refers to an economy that relies on renewable natural resources to produce food, energy, products, and services. The Bioeconomy Strategy aims to reduce Finland's dependence on fossil natural resources, prevent biodiversity loss and create new economic growth and jobs in line with the principles of sustainable development. The objective of the strategy is to increase Finland's bioeconomy output up to EUR 100 billion by 2025 and to create 100,000 new jobs. The Bioeconomy Strategy promotes bioenergy by encouraging higher exploitation of sustainably available forest biomass by forest industries and by advancing innovations in cleantech and circular economy.

The Finnish Bioeconomy Strategy will be updated in 2020-2021. The document 'Finnish bioeconomy on the global product market in 2035' serves as a background document for the update of the strategy. The document highlights the need to direct the constrained biomass resources available for the energy sector to the most valuable uses from the systemic perspective with special focus to industrial uses, and other hard to decarbonise sectors such marine and aviation. The document addresses the following areas of interest: improving the efficiency of existing biomass-based energy generation by reducing losses throughout the supply chain, bioenergy as a balancing renewable energy resource for energy systems dominated by variable renewable electricity, bioenergy enabling transition and debottlenecking hard to decarbonise sectors, and bioenergy as enabler for negative emission concepts through carbon capture and storage (CCS).

While CCS has not been in a strong focus for Finland, carbon capture combined with utilisation (CCU) together with green hydrogen from electrolysers has gained interest. Several research projects are on-going in Finland and by Finnish actors, e.g., BECCU project (www.beccu.fi), and demonstration projects for transport fuel production have been launched, e.g. by Vantaa Energy in its waste-to-energy plant (planned to be commissioned in 2025) and by Kerava Energy in its biomass CHP plant. National BioFlex project (www.bioflexfuel.fi) aims at developing solutions for production of sustainable and storable liquid fuels for flexible power generation and marine transport. The research activity in these areas also connects bioenergy developments to hydrogen and renewable energy integration related research. Hydrogen Cluster Finland (www.h2cluster.fi), a network of companies and industrial association facilitating joint ventures and information sharing to promote hydrogen economy, was established in 2021. Production of multiple products with the electricity price and biomass availability taken into account is a question under interest and was studied in FLEXCHX H2020 project (www.flexchx.eu). Biogas production, boosting the production with green hydrogen from electrolysers, and networks and business models around biogas have also gained increasing interest.

RECENT MAJOR BIOENERGY DEVELOPMENTS

The ministry of Economic Affairs and Employment can grant aid for innovative energy investment projects and for energy audits. Energy aid for investments in renewable energy use covers small-scale electricity and heat production projects, projects producing biofuels for transportation and large-scale demonstration projects with investment over EUR 5 million and taking forward future energy technologies. From bioenergy perspective, eligible for support are wood fuels based heating plant projects, small CHP projects and biogas projects. In 2021, the Ministry of Employment and the Economy opened a call for investment subsidies for large demonstration projects for new energy technology with EUR 60 million budget. The investment aid was intended for future energy solutions to meet national and EU targets for 2030. The categories of projects supported were renewable biofuels for transport, other than combustion-based heat production and other large-scale demonstration projects involving new technology. Decisions will be made in autumn 2021. In 2019 and 2020, granted demonstrations included many projects producing biogas for transport use from varying feedstock as well as a project for purification plant for pulp mill's raw biomethanol.

In addition, an incentive package of EUR 90 million was reserved for 2020-2022 to support investments supporting abandoning the energy use of coal already in 2025. One of the granted projects so far relate to biomass-based CHP.

Business Finland launched a challenge competition for leading companies in 2020. The aim is to challenge global leading companies to solve major future challenges, to increase their RDI investments, create new jobs and build new high-value business ecosystems in Finland. The maximum available funding per leading company is EUR 20 million. In addition, Business Finland can provide funding up to EUR 50 million to the leading company's partners during a period of five years. Neste is one of the leading companies and aims at developing sustainable and globally scalable technology solutions for production of transportation fuels and chemicals from waste or residue raw materials, such as forestry or agricultural residues, municipal waste, waste plastics and carbon dioxide.

UPM is among the companies who have researched the use of pine oil for feedstock of renewable diesel and commercialised their own proprietary biofuel technologies in recent years. UPM biorefinery locating next to the UPM Kaukas pulp and paper mill has produced renewable wood-based diesel and naphtha since 2015. UPM is also studying biofuels development opportunities by starting a detailed economic and technical designing of a possible biorefinery in Kotka, in south-eastern Finland. The Kotka Biorefinery would produce approximately 500,000 tonnes of advanced biofuels for transportation, made from several renewable and sustainable feedstocks. There are also prospects to make liquid biofuels (ethanol) from sawdust and/or lignin; for example, Finnish St1 biofuels Oy is currently running a plant that produces 10 million litres ethanol per year from residue saw dust in Kajaani and the next 50 million litre investments are planned in Pietarsaari.

Energy company St1 and food company Valio are establishing a joint venture to produce renewable biogas from dairy farm manure and other agricultural by-products mainly as fuel for heavy-duty transport. The target is to produce up to 1,000 GWh of biogas in 2030. Two different alternatives for producing the biogas are possible: biogas can be produced at individual farms or at a few farms in a shared biogas plant, or biogas will be produced in a larger centralised biogas plant to which the manure would be transported from local farms.

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