The Electric Power System

- Finland -

Basic facts

- Area: 338 424 km^2
- Population: 5.5 million
- Number of electricity consumers 3 521 200 (2016):
- Number of TSOs: 1, Number of DSOs: 77 (2016)
  - Also 12 regional grid companies with 110 kV grid
- Peak load 2017: 14 374 MW
- Average interruption of electricity:
  - 2017 TSO connection point SAIFI: 0.07 interruptions / connection point, TSO connection point SAIDI 2.2 min [1)]
  - 2017 DSO customer SAIFI 5.50, SAIDI: 1.50 h/a [2)]

1) https://www.fingrid.fi/globalassets/dokumentit/fi/sahkomarkkinat/sahkon-siirtovarmuus/siirtovarmuus-2017.pdf
2) https://energia.fi/ajankohtaista_ja_materiaalipankki/materiaalipankki/sahkon_keskeytystilastot_2010-2017.html#material-view

The Finnish interconnections

- Sweden
  - Two 400 kV AC lines
  - Two HVDC links
- Russia
  - HVDC back-to-back link
- Estonia
  - Two HVDC links
- Norway
  - One 220 kV AC line

The map: https://docstore.entsoe.eu/Documents/Publications/maps/2018/2018_Map_Northern-Europe-3.000.000.pdf

Lines

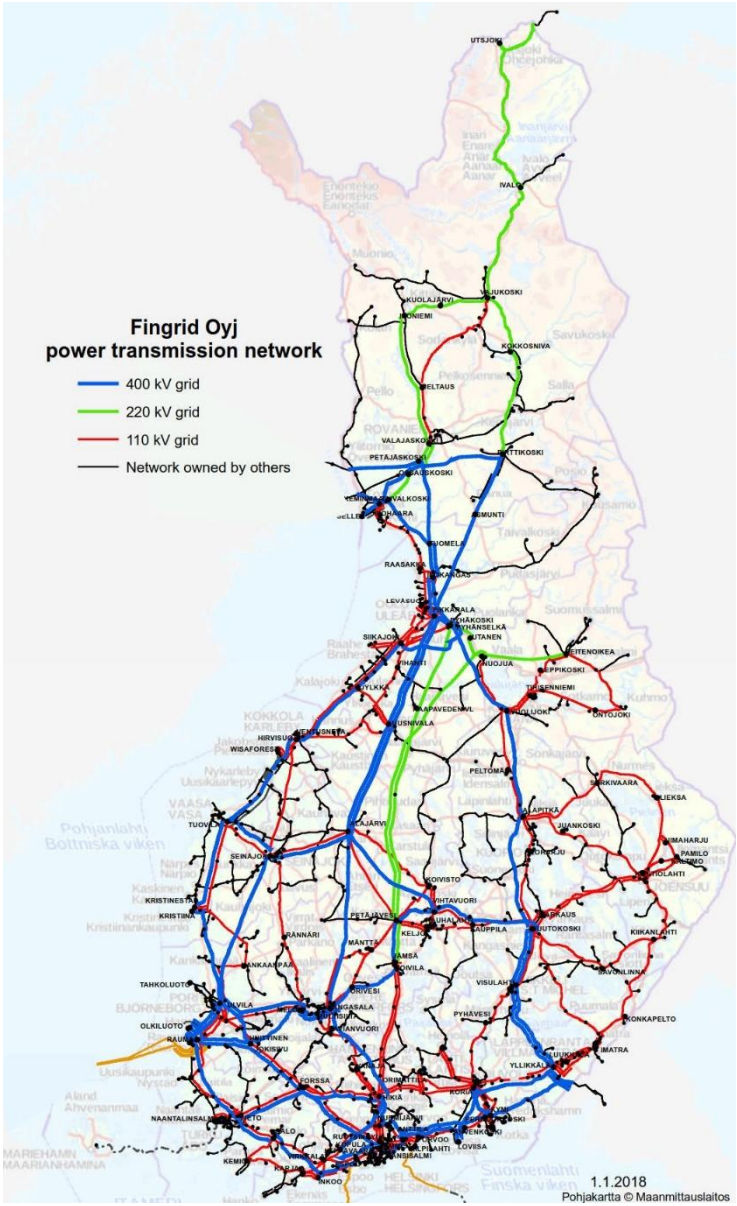
	Voltage Level	Total length (approx.)	Responsibility
Transmission grid[1)]	400 kV OH lines HVDC submarine cable	5200 km 300 km	TSO TSO
Transmission grid[1)]	220 kV	1600 km	TSO
Transmission[1)] and subtransmission grids[2)]	110 kV	7300 km (TSO) 8900 km (DSO)	TSO DSO
Distribution grid[)]	20 kV	146 000 km	DSO
Distribution grid [2)]	400 V	243 000 km	DSO

1) https://www.fingrid.fi/globalassets/dokumentit/fi/sijoittajat/rahoitus/fingrid-debt-investor-presentation-2018-march-id-141146.pdf
2) https://www.energiavirasto.fi/sahkoverkkotoiminnan-tunnusluvut-2016

Structure of power system

- Fingrid:
  - System responsibility, 110–400 kV, 115 substations
- Regional networks
  - Connected to the transmission grid, usually 110 kV lines
- Distribution networks
  - 0.4–110 kV, connected either directly to the transmission grid or use the grid services via a regional network
- Power plants and loads
  - connected to a distribution, regional or to the transmission grid, depending on each individual case

The main grid in 2018



https://www.fingrid.fi/en/grid/electricity-system-of-finland/power-transmission-grid-of-fingrid/

Information on the TSO

- Name: Fingrid Oyj
- Network length (km): 14 400 km
- Served area (km²): 338 424 km² (Finland)
- In 2017 Fingrid transmitted in its own network approximately 76 % (66 TWh)
- Website: http://www.fingrid.fi

Responsibilities of TSO & DSOs

- TSO:
  - The TSO is responsible for system supervision, operation planning, balance service, grid maintenance, construction and development, and promotion of the electricity market http://www.fingrid.fi/en/
- DSOs:
  - The local distribution grid is a natural monopoly, and requires a permit from the Energy Authority. The grid operator has to connect electricity consumers and producers into the grid and transmit electricity and take care of the voltage quality.

Installed capacity with reference to primary resources

- Installed capacities (GW), year 2018
  - Biomass 2.0
  - Coal 2.3
  - Peat 1.8
  - Gas 1.5
  - Hydro power 3.2
  - Nuclear 2.8
  - Oil 1.3
  - Wind power 2.0
  - Solar 0.0036
  - Other 0.4
  - Total 17.3

Electricity by energy source in 2017

- 85.5 TWh in 2017
  - Net import 23.9 %
  - Biomass 12.8 %
  - Coal 7.2 %
  - Peat 3.1 %
  - Gas 3.8 %
  - Hydro power 17.1 %
  - Nuclear 25.2 %
  - Oil 0.2 %
  - Wind power 5.6 %
  - Waste 1.1 %

https://energia.fi/en/news_and_publications/publications/energy_year_2017_-_electricity.html#material-view

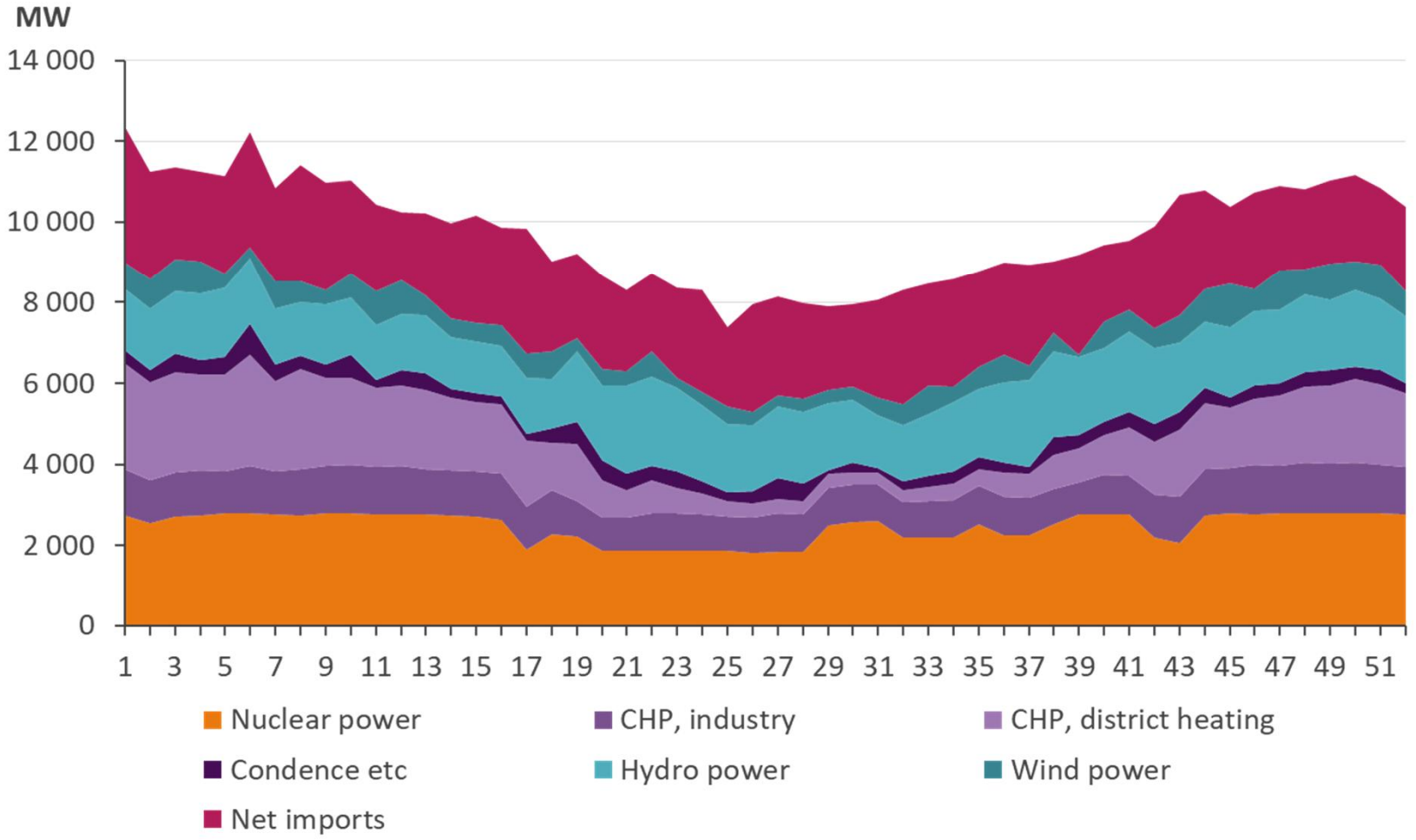
Electricity generation in Finland by energy source in 2017

- 65.0 TWh in 2017
  - Biomass 16.8 %
  - Coal 9.5 %
  - Peat 4.1 %
  - Gas 4.9 %
  - Hydro power 22.5 %
  - Nuclear 33.2 %
  - Oil 0.2 %
  - Wind power 7.4 %
  - Waste 1.4 %

- Renewables 47 %
- Carbon dioxide free 80 %
- Domestic 52 %

https://energia.fi/en/news_and_publications/publications/energy_year_2017_-_electricity.html#material-view

Variation of Electricity Supply in 2017



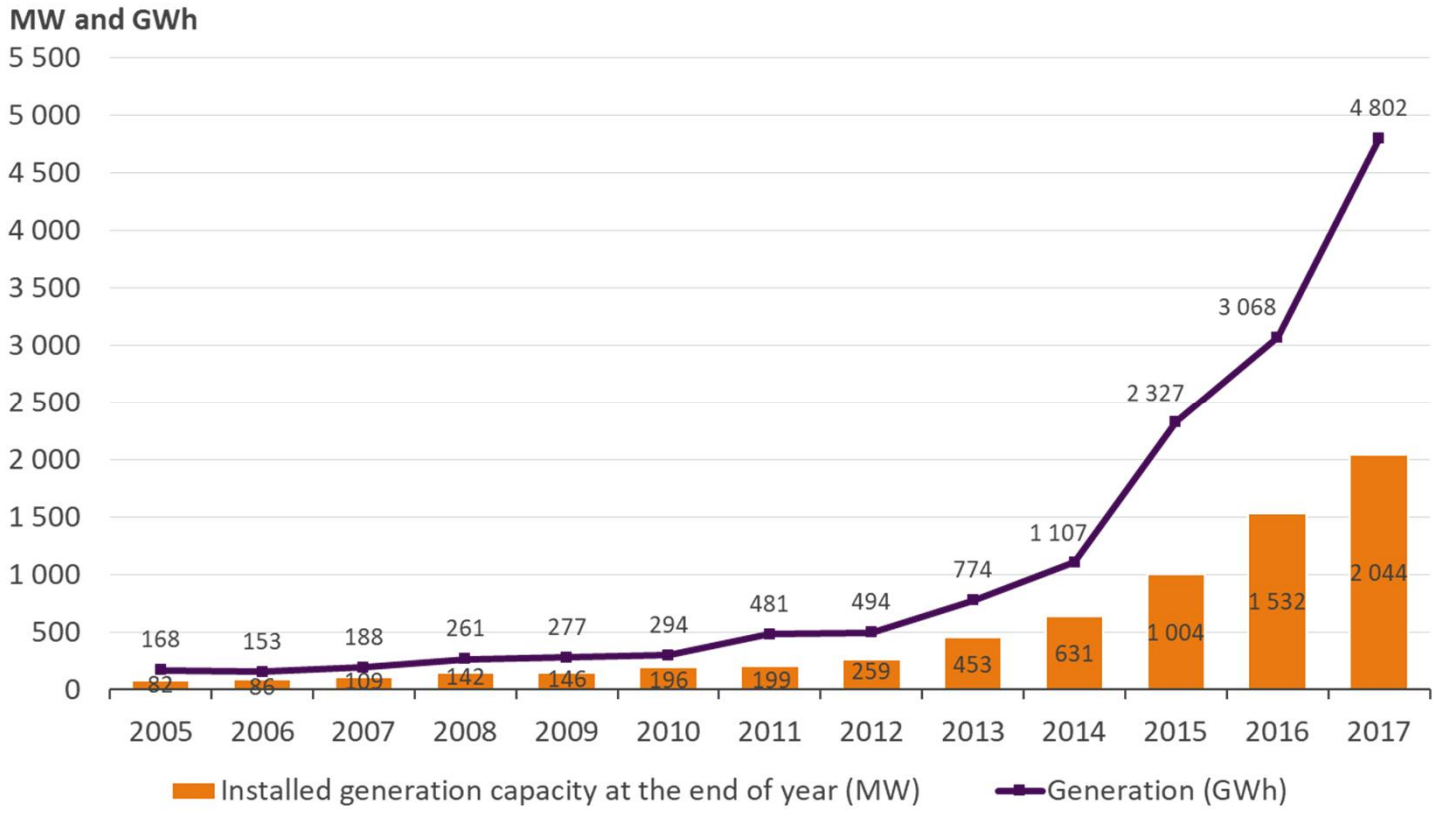
https://energia.fi/en/news_and_publications/publications/energy_year_2017_-_electricity.html#material-view

Comsumption per customer groups

- Total consumption: 85.5 TWh in 2017
  - Household, agriculture 28%
  - Services, building 22%
  - Industry 47%
    - Forest industry 23%
    - Chemical industry 8%
    - Metal industry 10%
    - Other industry 6%
  - Losses 3%

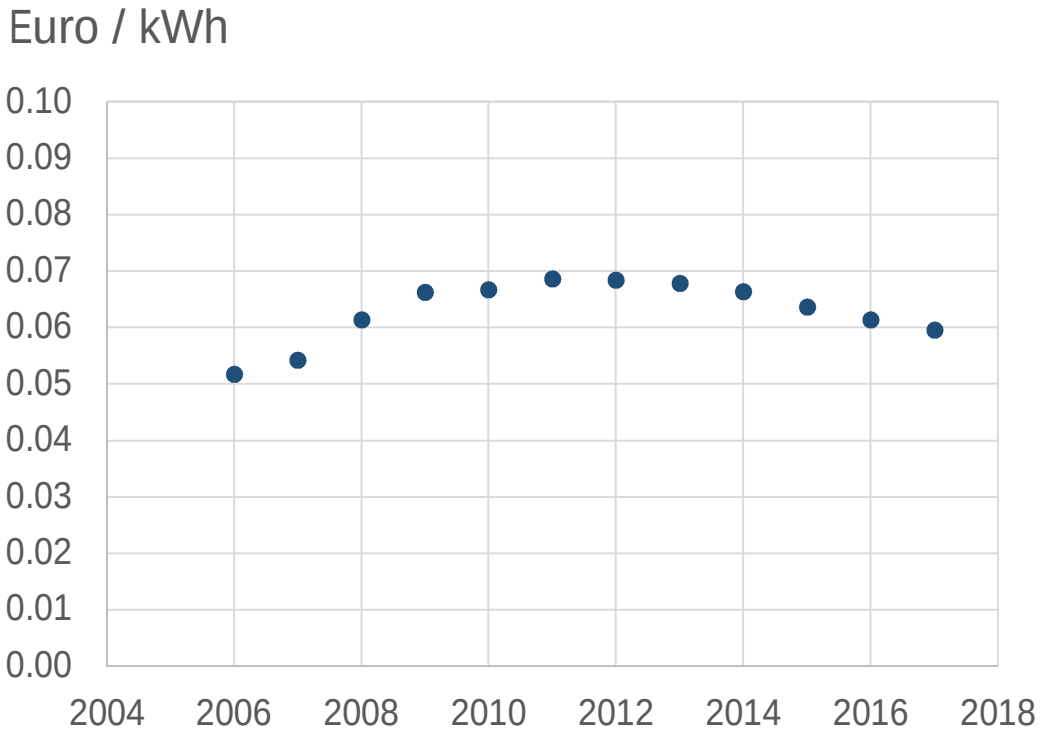
https://energia.fi/en/news_and_publications/publications/energy_year_2017_-_electricity.html#material-view

Generation and capacity of wind power



https://energia.fi/en/news_and_publications/publications/energy_year_2017_-_electricity.html#material-view

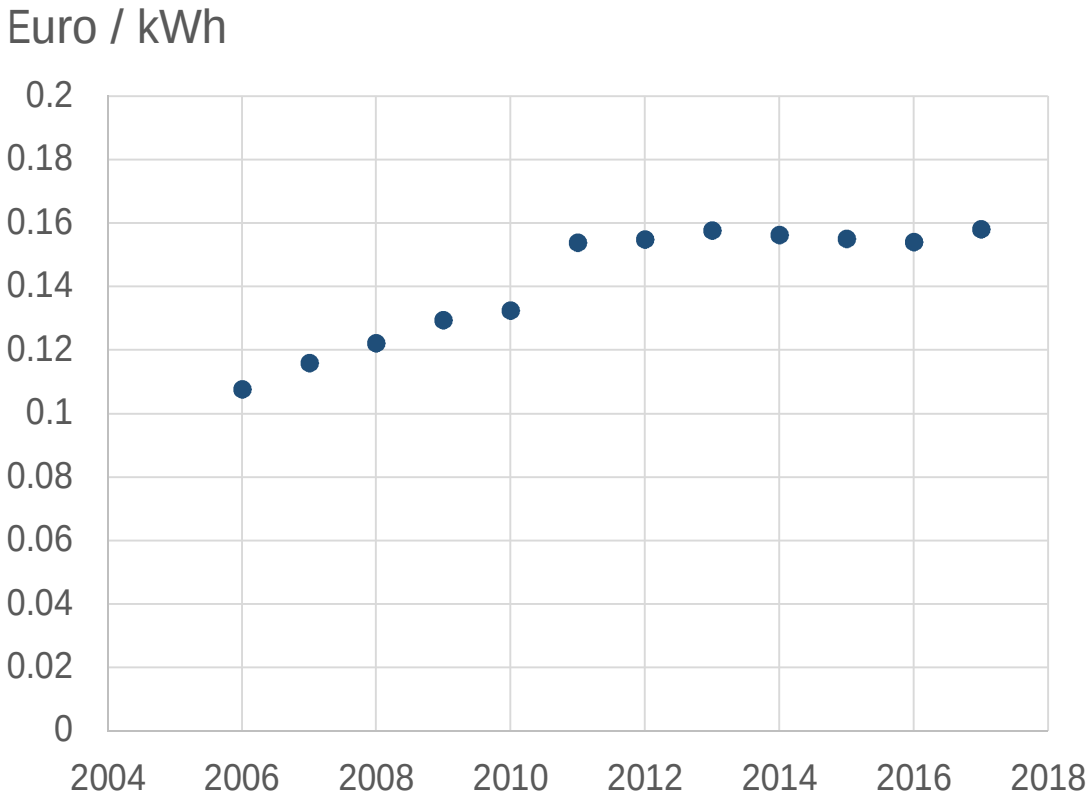
Price development for industry consumers



This indicator presents electricity prices charged to final consumers. Electricity prices for industrial consumers are defined as follows: Average national price in Euro per kWh without taxes applicable for the first semester of each year for medium size industrial consumers (Consumption Band Ic with annual consumption between 500 and 2000 MWh). Until 2007 the prices are referring to the status on 1st January of each year for medium size consumers (Standard Consumer Ie with annual consumption of 2 000 MWh).

Source: http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00117&language=en

Price development for medium size household consumers



Electricity prices for household consumers are defined as follows: Average national price in Euro per kWh including taxes and levies applicable for the first semester of each year for medium size household consumers (Consumption Band Dc with annual consumption between 2500 and 5000 kWh). Until 2007 the prices are referring to the status on 1st January of each year for medium size consumers (Standard Consumer Dc with annual consumption of 3500 kWh).

Source: http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00117&language=en

Electricity market organisation

- Finland belongs to the Nord Pool Spot electricity market
- Nord Pool Spot provides Elspot day-ahead market and Elbas intra-day market
- Nord Pool Spot offers a day-ahead market in the Nordic, Baltic and UK, as well as an intraday market in the Nordic, Baltic, France, Belgium, Netherlands, Germany, Austria and UK.

More information: https://www.nordpoolgroup.com/

Power balance in 2017

- Generation (TWh) 65.0
- Consumption (TWh) 85.5
- Net imports (TWh) 20.4
- Losses (TWh) 2.6 (3%)

http://energia.fi/tilastot-ja-julkaisut/sahkotilastot/sahkontuotanto/sahkon-hankinta-energialahteittain

Energy exchanges

- No distinction between commercial and physical flows
- State of the power system, flows, and electricity prices in Finland is here: https://www.fingrid.fi/en/electricity-market/power-system/

Specific aspects of the electricity market

- Finland belongs to the Nord Pool Spot electricity market (see page 21)
- Fingrid maintains a balancing energy market together with the other Nordic transmission system operators.
  - In the balancing energy market, production and load owners can give balancing energy bids for their adjustable capacity.
- The Nordic TSOs activate bids on the balancing energy market whenever necessary during normal operation or disturbances. Activation is done manually from Fingrid's Main Grid Control Center.

https://www.fingrid.fi/en/electricity-market/reserves_and_balancing/balancing-energy-and-balancing-capacity-markets/