Renewable Energy in The Netherlands
December 2018, by Martien Visser
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This analyses contains information of various sources and own analyses, including estimates. Readers are encouraged to add and improve the quality of the information provided.
The Entrance database on Renewable Energy is regularly improved by the creation and/or refinement of (sub)models

Recent improvements:

In September, an improved version of www.energieopwek.nl was launched, including adapted models for various types of biomass, heat pumps and geothermal energy.

In December, various small improvements in the models for oil consumption have been implemented.
The fraction renewable energy has been calculated using EU/IPCC regulations. In December, the Netherlands produced on average 7.6% of its final energy consumption in the form of renewables. Please note that in the EU statistics, the amount of wind energy is based on the average wind availability during a consecutive number of years, and not on the actual availability of wind.
In December, the fraction renewable energy was 7.6%, up from 6.6% a year ago

- Solar PV generation was 0.3 PJ, 60% more than last year
- Onshore wind generation was 3.0 PJ, 10% less than last year
- Offshore wind generation was 1.4 PJ, 5% less than last year
- Gross final energy demand was 208 PJ, 6% less than last year
- Energy related CO2 emissions were 14.9 Mton, 7% less than last year
- The percentage renewable power was 16.4%, up from 14.9% last year
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SELECTED ENERGY DATA FROM December 2018
Renewable Energy is produced in various forms. The most important contributors are biomass (biogas, waste, wood and bio-oil) and wind energy. In December 2018, calculated according to the EU/IPCC rules, 7.6% of the gross final energy consumption in the Netherlands was renewable energy.
Contribution of various sources of renewable energy y-o-y.
Energy is used for many various purposes. The most important energy applications in December have been natural gas for industry and oil for various forms of transport.
In December 2018, the national CO2-eq. emissions excluding non-energy related emission and calculated using the official methods, are estimated at 14.9 Mton, 7% less than in December 2017. Non-energy (human created) CO2-eq. emissions, mainly agricultural, are estimated at 2.3 Mton.
The capacity in this figure is the so-called name-plate capacity. In practice, not all capacity is available for the market due to planned and unplanned maintenance and mothballing.
In December 2018, power consumption, including transmission losses, has been estimated at 11,2 TWh, 3% less than last year.
The daily CO2 emission per kWh produced varies due to variations in the power mix. In December 2018, the average CO2 emissions from power generation, including renewables and cogeneration, are estimated at 400 gr/kWh, down from 410 gr/kWh in November. Main reason was maintenance in the coal-fired power plants.
SELECTED MONTHLY PROFILES

(using daily data)
The daily contributions of renewable energy, according to the classification by CBS. In December the average daily gross final energy demand was 1850 GWh per day. One GWh is one million kWh. An average production of 1 GWh/day requires 55 onshore wind turbines of 3 MW each.
Daily energy consumption shows a typical weekday-weekend pattern. Gas demand scales with ambient temperature.
Conventional power generation is affected by wind and solar production, variations in electricity demand, maintenance (mainly coal and nuclear) and the balance between power imports and exports.
December 2018 was rather sunny, while the average wind speed was relatively low. The average utilization rate of onshore wind turbines was 34% and for offshore wind, it was 53%. For solar PV, average utilization rate was 3%.

1 GWh is sufficient to provide power for a year for 300 households.
In December, the percentage of renewable power varied between 7% and 30%, with an average of 16.4%. The average percentage of renewable energy was 7.6%. These percentages have been calculated using the formal EU/IPCC methodology.
SELECTED MONTHLY ENERGY DATA
The gross final consumption of energy is a quantity used to calculate the percentage of renewable energy. This quantity excludes the energy consumed in the energy sector (mainly due to the generation of electricity); in international shipping; in feedstock; and the energy used for (international) aviation above 6.18% of the total.
Gas consumption in December, excluding gas-to-power, was slightly higher than last year, partly due to slightly lower ambient temperatures.
In December, Dutch natural gas production was lower than last year.
In December, Dutch power demand, including transmission losses, was 3% lower than last year.
In December 2018, onshore wind production was 3.0 PJ, 10% less than last year. Offshore wind production was 1.4 PJ, 5% less than last year. The average utilization of wind capacity was 34% for onshore and 53% for offshore.
In December 2018, Solar PV reached 0.3 PJ. This is 60% more than in December last year. This is the result of a more than 50% increase in Solar PV capacity in the Netherlands and more sunshine. In December, the average utilization rate of solar PV capacity was 3%.
In December 2018, coal-fired power generation has been estimated to be lower than in December 2017, due to unavailability of some coal-fired power stations. Note that coal-fired power in the first half of 2018 was lower than in 2017 due to the closure of two coal-fired power plant at the end of June 2017.
In December 2018, gas-fired power generation (by CCGT’s and Cogen) was slightly higher than last year.
This figure depicts the amount of LNG injected into the gas grid. The figure excludes the usage of LNG as transport fuel. In December, significant LNG imports occurred.

1 PJ is equal to about 30 million m³ gas
In December 2018, renewable energy production was 10% higher than last year.
In December, the percentage of renewable energy was 7.6%, 1.0% higher than in December last year. The increase is caused by higher contributions of almost all sources of renewable energy.
CO2 emissions in December 2018 were 7% lower than in December 2017. The structural reduction of CO2-emissions in the first half of 2018 is due to the closure coal-fired power capacity on June 30th 2017.
ENERGY DEMAND IN A NUTSHELL
Dutch government has allocated Energy Demand in four categories. These categories (and this figure) do not take into account energy demand for international shipping, aviation and feedstock. (1 GWh is equal to the average daily energy production of 55 onshore wind turbines of 3 MW each)
The primary energy requirement for Low Temperature Heat, mainly buildings and green houses, varies with ambient temperature.
The primary energy requirement for High Temperature Heat (mainly industry) varies with the economic activities in the Netherlands.
The primary energy requirement for Transportation (excluding international shipping and aviation) varies with the economic activity in the Netherlands. Fuel purchases abroad, e.g. because of lower taxes, are not included in this figure.
The primary energy requirement for the Dutch power sector varies with power demand, the import/export balance and the production of renewable power. The figure excludes the primary energy demand associated with power imports.
This figure presents the daily CO₂ emissions of each of the four energy demand sectors. The figure does not take into account the CO₂ emissions by international shipping and aviation and from the energy for feedstock. (1 kton CO₂ is equal to the average daily CO₂ emission of 95,000 households, each using 1400 m³ gas and 3000 kWh electricity annually.)
The CO\textsubscript{2} emissions from low temperature heat, mainly buildings and green houses, vary with ambient air temperature. December was a relatively warm month and hence, energy demand from buildings was low. The figure excludes the CO\textsubscript{2} emissions due to the production of electricity used for low temperature heating.
Dutch CO₂ emissions from high temperature heat, mainly industry, vary mainly with the economic activity in the Netherlands.
This figure presents the formal CO₂ emissions from Transportation (thus excluding international shipping and aviation). These emissions vary primarily with the economic activity in the Netherlands. CO₂ emissions from fuel that is bought abroad, are, according to international conventions, not included in this figure.
CO₂ emissions from the power sector vary with power demand, the fraction of coal used for power generation, the amount of renewable power produced, and the level of power exports and imports.
SELECTED HOURLY ENERGY DATA
Gas supplies are related to ambient temperatures. In the beginning of December Dutch gas storages were still being filled, represented by negative values in this graph. In December, substantial LNG was supplied to the Dutch gas system. Gas supplies are used for Dutch consumption and exports.
Domestic gas demand in December peaked at 90 GW. In this graph, the term “industry” is defined as the 400 direct connections to the high pressure Gasunie grid. The term “distribution” includes households, offices, commercials and many small and medium size industries that are connected to the gas distribution grids.
In December 2018, Dutch gas imports were 170 PJ while Dutch gas exports were 155 PJ. Thus, the Netherlands was a net importing gas country.
In December 2018, power imports (mainly from Germany and Norway) were 6.7 PJ, while the power exports (mainly to Belgium and UK) were 6.3 PJ. This graph presents the actual power flows, i.e. both intended (traded) and unintended.
December 2018 was characterized by a varying production of wind energy; the average utilization rate of the wind turbines was 34% onshore and 53% offshore. The installed wind power capacity was about 4350 MW.
December was not very sunny; the utilization rate of solar PV installed was just 3%. At the beginning of December, the installed solar power capacity in the Netherlands was about 4150 MW. Currently, solar power capacity in NL increases by about 150 MW per month (equal to one solar panel every 5 seconds)
This graph shows the combined renewable electricity production by offshore wind, on shore wind and solar PV.
The following set of graphs presents for each month in 2018 the hourly contributions of various energy sources to total power consumption in The Netherlands.
January 2018

MW

Net import  Nuclear  Other  Renewables  Coal  NatGas

Data are added
June 2018

MW

-2000
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000

1-jun  8-jun  15-jun  22-jun  29-jun

Net import  Nuclear  Other  Renewables  Coal  NatGas

Data are added
October 2018

MW

1-okt 8-okt 15-okt 22-okt 29-okt

- Net import  Nuclear  Other  Renewables  Coal  NatGas

Data are added

Entrance
December 2017

MW

-2000

2000

4000

6000

8000

10000

12000

14000

16000

18000

20000

1-Dec

8-Dec

15-Dec

22-Dec

29-Dec

Net import
Nuclear
Other
Renewables
Coal
NatGas

Entrance

Data are added
The following set of slides presents for each week in 2018 the hourly contributions of wind and solar PV to the total power consumption in The Netherlands.
Electricity in The Netherlands 2018

![Graph showing electricity production by day and source]
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

[Graph showing electricity production by source for February 2018, with categories for Rest, solar-PV, Wind-onshore, and Wind-offshore, with daily and weekly trends indicated.]
Electricity in The Netherlands 2018

[Graph showing electricity production by source over a month, with categories for Rest, solar-PV, Wind-onshore, and Wind-offshore]
Electricity in The Netherlands 2018

The graph shows the electricity production in The Netherlands for the month of March 2018, with data for Monday through Sunday. The categories include Rest, solar-PV, Wind-onshore, and Wind-offshore. The graph indicates variations in production across different days and shows the contribution of each category to the total electricity production.
Electricity in The Netherlands 2018

![Graph showing electricity production by day and source in 2018. The graph indicates the contribution of solar-PV, Wind-onshore, and Wind-offshore to the total energy production. The x-axis represents days from 2-Apr to 8-Apr, and the y-axis represents MW.]
Electricity in The Netherlands 2018

![Graph showing electricity production in The Netherlands for 2018. The graph displays the production levels in megawatts (MW) for different days of the week and days of April 2018. The production sources include Rest, solar-PV, Wind-onshore, and Wind-offshore.]
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

The diagram shows the electricity generation in The Netherlands for the month of May 2018. The graph plots the MW generation by day of the week from Monday to Sunday. The data is color-coded to represent different sources: Rest, solar-PV, Wind-onshore, and Wind-offshore.

- **Rest**: This category includes all other forms of generation not attributed to solar or wind energy.
- **Solar-PV**: Solar photovoltaic generation.
- **Wind-onshore**: Onshore wind energy generation.
- **Wind-offshore**: Offshore wind energy generation.

The graph displays the variability in electricity generation across the week, with peaks and troughs indicating changes in demand and availability of renewable sources.
Electricity in The Netherlands 2018

![Graph showing electricity production in 2018 with categories for rest, solar-PV, wind-onshore, and wind-offshore.]
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

Graph showing electrical production by type from 25 June to 1 July 2018. The types are:
- Rest
- Solar-PV
- Wind-onshore
- Wind-offshore
Electricity in The Netherlands 2018

The diagram above illustrates the electricity generation in The Netherlands from July 16th to July 22nd, 2018. It shows the contribution of different energy sources, including:

- **Rest**
- **solar-PV**
- **Wind-onshore**
- **Wind-offshore**

The data indicates a fluctuating pattern with peaks and troughs, reflecting the variability in energy production throughout the week.
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

The graph illustrates the electricity production in The Netherlands in August 2018, categorized by different sources:

- **Rest**
- **Solar-PV**
- **Wind-onshore**
- **Wind-offshore**

The data shows fluctuations over the week, with each day and date marked on the x-axis. The y-axis represents the MW (megawatts) of electricity produced.
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

The chart shows the electricity production over the course of a week in November 2018. The data is divided by day of the week and includes contributions from Rest, solar-PV, Wind-onshore, and Wind-offshore sources.

- **Rest**: The category labeled 'Rest' includes all non-renewable energy sources.
- **Solar-PV**: Represents solar photovoltaic energy production.
- **Wind-onshore**: Wind energy produced from onshore turbines.
- **Wind-offshore**: Wind energy produced from offshore turbines.

The graph highlights the variability in electricity production across different days and energy types, providing insights into the energy mix and production patterns in The Netherlands during that period.
Electricity in The Netherlands 2018
Electricity in The Netherlands 2018

![Graph showing electricity production by source and day in December 2018](image-url)
Electricity in The Netherlands 2018
MISCELLANEOUS
In December 2018, the average daily effective temperature (temperature, including wind shield factor) was 3.8°C, about 2°C higher than in December 2017.
Specific CO2 Emissions used in this presentation

- Natural gas: 181 g/kWh
- Oil: 254 g/kWh
- Coal: 322 g/kWh
- Solid biomass: 395 g/kWh
- Power: 424 g/kWh
- Cogen: 509 g/kWh
- Hoogovengas: 798 g/kWh
- Gas-fired: 396 g/kWh
- Coal-fired: 798 g/kWh

The chart compares the specific CO2 emissions of different fuels in both entrance and power generation stages.
This presentation is based on numerous sources about energy demand, supply, conversion and production in The Netherlands. Unfortunately, these sources do not cover the entire Dutch energy system, nor do these sources provide the insights needed for this presentation. Thus, various approximations and scaling factors have been derived and are used. The author would like to thank students from Hanze University of Applied Sciences in Groningen and various consulted energy experts for their feedback on the methods used and results derived. Currently, the aggregated results of this work (e.g. monthly and annual data) are in good agreement with data from the Dutch National Office of Statistics (CBS) and Eurostat and consequently, it is believed that this presentation gives a fair presentation of the complex reality of the Dutch energy system.

The author invites readers to comment on the data provided to further improve this work. After all, good and reliable data are at the heart of any successful policy to make our world more sustainable.

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