Renewable Energy in The Netherlands
October 2018
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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 July/August, the models for the consumption of renewable heat have been refined.

In July/August, the calculation to estimate the daily final energy consumption have been improved.

In August, an improved version of www.energieopwek.nl has been launched.
The fraction renewable energy has been calculated using EU/IPCC regulations. In October, the Netherlands produced on average 7.3% 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 October, Solar PV generation was 0.9 PJ, twice as much as a year ago

- The fraction renewable energy was 7.3%; down from 7.6% last year
- Solar PV generation was 0.9 PJ, 100% (!) higher than last year
- Onshore wind generation was 1.8 PJ, 40% less than last year
- Offshore wind generation was 1.3 PJ, 20% less than last year
- Gross final energy demand was 161PJ, equal to last year
- Energy related CO2 emissions were 13.1 Mton, 2% more than last year
- The percentage renewable power was 15.3%, down from 17.5% last year
• October 2018 data
• Monthly profiles
• Monthly data
• Energy demand in a nutshell
• Hourly data
• Miscellaneous
SELECTED ENERGY DATA FROM OCTOBER 2018
Renewable Energy is produced in various forms. The most important contributors are biomass (biogas, waste, wood and bio-oil) and wind energy. In October 2018, calculated according to the EU/IPCC rules, 7.3% 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 October have been natural gas for industry and oil for various forms of transport.
In October 2018, the national CO2-eq. emissions excluding non-energy related emission and calculated using the official methods, are estimated at 13.1 Mton, 2% more than in October 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 October 2018, power consumption, including transmission losses, has been estimated at 10.2 TWh, 1% less than last year.
The daily CO2 emission per kWh produced varies due to variations in the power mix. In October 2018, the average CO2 emissions from power generation, including renewables and cogeneration, are estimated at 450 g/kWh, up from 440 g/kWh in September.
SELECTED MONTHLY PROFILES

(using daily data)
The daily contributions of renewable energy, according to the classification by CBS. In October the average daily gross final energy demand was 1440 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.
October 2018 was rather sunny, while the average wind speed was relatively low. The average utilization rate of onshore wind turbines was 20% and for offshore wind, it was 49%. For solar PV, average utilization rate was 9%.

1 GWh is sufficient to provide power for a year for 300 households.
In October, the percentage of renewable power varied between 8% and 24%, with an average of 15.3%. The average percentage of renewable energy was 7.3%. 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 October, excluding gas-to-power, was slightly lower than last year, due to slightly higher ambient temperatures.
In October, Dutch natural gas production was much lower than last year.
In October, Dutch power demand, including transmission losses, was similar to last year.
In October 2018, onshore wind production was 1.8 PJ, 40% less than last year. Offshore wind production was 1.3 PJ, 20% less than last year. The average utilization of wind capacity was 20% for onshore and 49% for offshore.
In October 2018, Solar PV reached 0.9 PJ. This is 100% more than in October last year. This is the result of a more than 50% increase in Solar PV capacity in the Netherlands and more sunshine. In October, the average utilization rate of solar PV capacity was 9%.
In October 2018, coal-fired power generation has been estimated to be slightly higher than in October 2017. In the first half of 2018, coal-fired power was lower than last year due to the closure of two coal-fired power stations at the end of June 2017.
For October 2018, gas-fired power generation (by CCGT’s and Cogen) was 5% higher than last year, mainly due to the low availability of wind.
This figure depicts the amount of LNG injected into the gas grid. The figure excludes the usage of LNG as transport fuel. In October, significant LNG imports occurred.

1 PJ is equal to about 30 million m³ gas
In October 2018, renewable energy production was slightly lower than last year.
In October, the percentage of renewable energy was 7.3%; this is 0.3% lower than in October last year. The decrease is mainly caused by lower wind availability, which was not entirely compensated by the increase in solar energy and more co-firing.
CO2 emissions in October 2018 were 2% higher than in October 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
The 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 CO2 emissions from low temperature heat, mainly buildings and green houses, vary with ambient air temperature. October was a relatively warm month and hence, energy demand from buildings was low. The figure excludes the CO2 emissions due to the production of electricity used for low temperature heating.
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 October the Dutch gas storages were being filled, represented in the graph by negative values. In October, LNG was supplied to the Dutch gas system. Gas supplies include Dutch consumption and exports.
Domestic gas demand in October peaked at 70 GW. In this graph, the term “industry” is defined as the direct connections, about 400 major industries, 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 October 2018, gas imports were 170 PJ while gas exports were 110 PJ. Thus, the Netherlands was a net importing gas country.
In October 2018, power imports (mainly from Germany and Norway) were 6 PJ, while the power exports (mainly to Belgium and UK) were 7 PJ. This graph presents the actual power flows, i.e. both intended (traded) and unintended.
October 2018 was characterized by a varying production of wind energy; the average utilization rate of the wind turbines was 20% onshore and 49% offshore. The installed wind power capacity (onshore and offshore) was about 4350 MW.
October was very sunny; the utilization rate of solar PV installed was 9%. At the beginning of October, the installed solar power capacity in the Netherlands was about 3650 MW. Currently, solar power capacity in the Netherlands increases by about 100 MW per month (equal to one solar panel every 7 seconds).
This graph shows the combined renewable electricity production by offshore wind, onshore 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.
In the second week of January, gas-fired power generation peaked, due to low wind availability and net exports (negative numbers in the graph) occurring simultaneously.
In February, gas-fired power generation peaked several times, due to low wind availability and net exports (negative numbers in the graph) occurring simultaneously.
In March, gas-fired power generation peaked several times, due to low wind availability and net exports (negative numbers in the graph) occurring simultaneously.
In April, gas-fired power generation was relatively low, due to high electricity imports.
In May, significant power imports occurred. Actually, there was not a single day with net exports. Since May 9\textsuperscript{th}, the Borssele nuclear power station has been off line (maintenance).
In June, significant power imports occurred. Actually, there was not a single day with net exports. From October 10th, the Borssele nuclear power station is on line again.
In July, there was not much wind energy and significant power imports occurred, although with significant volatility.
In August, significant there was not much wind, no nuclear and various coal-fired power stations were under maintenance. Hence, gas-fired power generation peaked on various days.
In September, significant power exports to Belgium occurred. From September 16\textsuperscript{th}, the Borssele nuclear power station came on line again. On September 22\textsuperscript{nd}, a new transmission (‘import’) connection with Germany was opened.
In October, significant power exports to Belgium occurred, hence, the Netherlands experienced many days of net power exports. These are depicted as negative values.
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.
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

8-Jan 9-Jan 10-Jan 11-Jan 12-Jan 13-Jan 14-Jan

Rest solar-PV Wind-onshore Wind-offshore

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses
Hourly Solar PV and Wind Generation 2018

- MW
- Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses

Energy Academy Europe
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, KNMI, PolderPV.nl, etc., own analyses
Hourly Solar PV and Wind Generation 2018

MW

Sources: TenneT, CertiQ, KNMI, PolderPV.nl, etc., own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, etc., own analyses
Hourly Solar PV and Wind Generation 2018

2018

MW

22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0

26-Feb 27-Feb 28-Feb 1-Mar 2-Mar 3-Mar 4-Mar

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Rest solar-PV Wind-onshore Wind-offshore

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

![Graph showing hourly solar PV and wind generation in 2018]

- Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018


Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

![Graph showing hourly solar PV and wind generation from 19-Mar to 25-Mar, 2018. The graph includes data from various sources such as TenneT, CertiQ, PolderPV.nl, KNMI, and own analyses.]
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018

22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

23-Apr 24-Apr 25-Apr 26-Apr 27-Apr 28-Apr 29-Apr

Rest solar-PV Wind-onshore Wind-offshore

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Graph showing daily MWh generation from May 1st to May 13th, 2018, with categories for Rest, Solar-PV, Wind-onshore, and Wind-offshore. Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses.
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
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Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018

18-jun 19-jun 20-jun 21-jun 22-jun 23-jun 24-jun

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

2018

MW

22000

20000

18000

16000

14000

12000

10000

8000

6000

4000

2000

0

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

25-jun	26-jun	27-jun	28-jun	29-jun	30-jun	1-jul

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

![Graph showing hourly solar PV and wind generation for July 2018](image)

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses

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Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

2018

MW

22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

23-jul 24-jul 25-jul 26-jul 27-jul 28-jul 29-jul

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Graph showing daily generation of solar PV and wind energy from Monday to Sunday for the week of 13th to 19th August 2018.

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

MW

2018

0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000 22000

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

3-sep 4-sep 5-sep 6-sep 7-sep 8-sep 9-sep

Rest solar-PV Wind-onshore Wind-offshore

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
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Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
Hourly Solar PV and Wind Generation 2018

Sources: TenneT, CertiQ, PolderPV.nl, KNMI, own analyses
MISCELLANEOUS
In October 2018, the average daily effective temperature (temperature, including wind shield factor) was 12 °C; slightly higher than October 2017.
Fuel Specific CO2 Emissions

Characteristic CO2 emissions used in this presentation.
This presentation is based on numerous sources about energy demand, supply 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. Currently, the aggregated results of this work are in good agreement with data supplied by the Dutch National Office of Statistics (CBS) and it is believed that this presentation gives a fair presentation of the complex reality of the Dutch energy system. Nevertheless, 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.