Renewable Energy in The Netherlands
September 2019, 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 summer 2019, various models have been improved to reflect the changing conditions in the energy market.

From August 2019, more data from ENTSO-E are used to estimate flows in the Dutch electricity system.

From September 2019, day-ahead natural gas and power prices are added.
The fraction renewable energy has been calculated using EU/IPCC regulations. In September, the Netherlands produced on average 9.3% of its final energy consumption in the form of renewables. The 12.2% is an estimate for the average renewable energy in 2020 by PBL in its KTR report of January 25th 2019.
In September 2019, the fraction renewable energy was 9.3%, compared to 8.0% last year

In September:

➢ Solar PV generation was 1.7 PJ, 50% more than last year
➢ Onshore wind generation was 2.2 PJ, 15% more than last year
➢ Offshore wind generation was 1.1 PJ, 5% more than last year
➢ Gross final energy demand was 137 PJ, 1% less than last year
➢ Energy related CO2 emissions were 10.4 Mton, 7% less than last year
➢ The percentage renewable power was 20%, up from 18% last year
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SELECTED ENERGY DATA FROM SEPTEMBER 2019
Renewable Energy is produced in various forms. The most important contributors are biomass (biogas, waste, wood and bio-oil) and wind energy. In September 2019, calculated according to the EU/IPCC rules, 9.3% 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 September have been natural gas for industry and oil for various forms of transport.
In September 2019, the national CO2-eq. emissions excluding non-energy related emission and calculated using the official methods, are estimated at 10.1 Mton, about 8% less than in September 2018. 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 September 2019, power consumption, including transmission losses, has been estimated at 9,6 TWh, 1% more than September last year.
The daily CO2 emission per kWh produced varies due to variations in the power mix. In September 2019, the average CO2 emissions from power generation, including renewables and cogeneration, are estimated at 325 g/kWh, up from 317 g/kWh in August 2019.
SELECTED MONTHLY PROFILES

(using daily data)
The daily contributions of renewable energy, according to the classification by CBS. In September the average daily gross final energy demand was 1260 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 is dependent of 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.

In September, on several days, the Dutch coal-fired power stations were not used.
September 2019 was rather sunny, while the average wind speed was relatively low. The average utilization rate of onshore wind turbines was 24% and for offshore wind, it was 43%. For solar PV, average utilization rate was 12%.

1 GWh is sufficient to provide power for a year for 300 households.
In September, the percentage of renewable power varied between 12% and 33%, with an average of 20%. The average percentage of renewable energy was 9.3%. These percentages have been calculated using the formal EU/IPCC methodology.
In September, gas prices were low and hence, gas was an attractive source for electricity production. With a gas price of 10 €/MWh and a CO2-price of 25 €/ton, power can be produced for about 30 €/MWh.
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 demand, excluding gas-to-power 2019 (and 2018)

Gas consumption in September, excluding gas-to-power, was similar to last year.
Dutch natural gas production is structurally in decline, due to the gradual closure of the Groningen gas field and lower production of the so-called small fields.
Dutch power demand in September, including transmission losses, has been estimated 1% higher than in September last year.
In September 2019, onshore wind production was 2.1 PJ, 15% more than last year. Offshore wind production was 1.0 PJ, 5% more than last year. The average utilization of wind capacity was 24% for onshore and 43% for offshore.
In September 2019, Solar PV reached 1.7 PJ. This is 30% more than in September last year. The result of the increase in Solar PV capacity in the Netherlands. In September, the average utilization rate of solar PV capacity was 12%.
In September 2019, coal-fired power generation has been estimated to be much lower than in September 2018, due to unavailability of some coal-fired power stations and more biomass co-firing.
In September 2019, gas-fired power generation (including CCGT’s and Cogen) was 40% higher than last year.
This figure depicts the amount of LNG injected into the gas grid. Since October 2018, LNG imports by the Netherlands are at a very high level. The figure excludes the usage of LNG as transport fuel.

1 PJ is equal to about 30 million m3 gas
In September 2019, renewable energy production was 15% higher than last year.
In September, the percentage of renewable energy was 9.3%, compared to 8.0% in September last year. The increase was entirely caused by more renewable energy production, since gross final energy consumption was stable.
CO₂ emissions in September 2019 were 8% less than in September 2018.
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 activity 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$_2$ emissions from low temperature heat, mainly buildings and green houses, vary with ambient air temperature. September was a relatively warm month and hence, energy demand from buildings was relatively low. The figure excludes the CO$_2$ emissions due to the production of electricity used for low temperature heating.
Dutch CO$_2$ emissions High-Temperature heat

CO$_2$ 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. When gas storages are being filled, this is represented by negative values. Gas supplies in this figure are used both for Dutch consumption and for exports.
Domestic gas demand in September peaked at 52 GW. In this graph, the term “industry” is defined as the 400 direct connections to the high pressure Gasunie grid including Zebra. The term “distribution” includes households, offices, commercials and small and medium size industries that are connected to the gas distribution grids.
In September 2019, Dutch gas imports were 130 PJ while Dutch gas exports were 80 PJ. Thus, this month, the Netherlands was a net importing gas country.
In September 2019, power imports (mainly from Germany and Norway) were 5.1 PJ, while the power exports (mainly to Belgium and UK) were 4.3 PJ. This graph presents the actual power flows, i.e. both intended (traded) and unintended.
September 2019 was characterized by a varying production of wind energy; the average utilization rate of the wind turbines was 24% onshore and 43% offshore. The installed wind power capacity was about 4500 MW in total.
September was very sunny; the utilization rate of solar PV installed was 12%. At the beginning of September, the installed solar power capacity in the Netherlands was about 5500 MW. 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, onshore wind and solar PV.
The following set of graphs presents for each month in 2019 the hourly contributions of various energy sources to total power consumption in The Netherlands.
May 2019

Data are added

MW

Entrance

Net import
Nuclear
Other
Renewables
Coal
NatGas

1-mei
8-mei
15-mei
22-mei
29-mei

Energy Academy Europe
Dutch power supplies September 2019

Graph showing power supplies from various sources over the course of September 2019. The x-axis represents dates from 1st to 29th of September, and the y-axis represents power in MW. Different sources are color-coded: Net import (blue), Nuclear (red), Other (gray), Renewables (green), Coal (brown), and NatGas (light blue).
The following set of slides presents for each week in 2019 the hourly contributions of wind and solar PV to the total power consumption in The Netherlands.
Electricity in The Netherlands 2019
Electricity in The Netherlands 2019

The graph shows the electricity production in The Netherlands for the month of January 2019. The graph includes data on different sources of electricity such as solar-PV, Wind-onshore, and Wind-offshore. The production is measured in MW (megawatts). The graph highlights the differences in electricity production across different days and times, with peaks and troughs indicating periods of high and low production. The data provides insights into the energy production patterns and the contribution of various sources to the overall electricity supply.
Electricity in The Netherlands 2019

[Diagram showing electricity production sources for different days of the week in January 2019, with labels for Rest, solar-PV, Wind-onshore, and Wind-offshore.]
Electricity in The Netherlands 2019
Electricity in The Netherlands 2019

2019

Entrance

Rest, solar-PV, Wind-onshore, Wind-offshore

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Electricity in The Netherlands 2019

2019

MW

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

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

5-mrt 6-mrt 7-mrt 8-mrt 9-mrt 10-mrt 11-mrt

Entrance

Rest  solar-PV  Wind-onshore  Wind-offshore

Energy Academy Europe

Hanzehogeschool Groningen
University of Applied Sciences
Electricity in The Netherlands 2019

The chart displays the electricity production by various sources in The Netherlands over a week in 2019. The sources include Rest, solar-PV, Wind-onshore, and Wind-offshore. The graph shows the trend of electricity production during different days from 12-mrt to 18-mrt, with peaks and troughs indicating variability in energy generation.
Electricity in The Netherlands 2019

[Diagram showing electricity production from different sources over a week in 2019, including Rest, solar-PV, Wind-onshore, and Wind-offshore.]
Electricity in The Netherlands 2019

![Graph showing electricity production from different sources in 2019. The x-axis is labeled from 2-apr to 8-apr, with days of the week labeled from Tuesday to Monday. The y-axis measures MW (megawatts). The graph includes lines for Rest, solar-PV, Wind-onshore, and Wind-offshore.](image)
Electricity in The Netherlands 2019

The graph shows the electricity generation from different sources in The Netherlands over a period of five days in April 2019. The x-axis represents the days of the week from Tuesday to Monday, while the y-axis represents the MW (megawatts) of electricity generation.

The sources include:
- Rest
- Solar-PV
- Wind-onshore
- Wind-offshore

The graph indicates fluctuations in electricity generation daily, with peaks and troughs corresponding to the different days of the week.
Electricity in The Netherlands 2019

![Graph showing electricity production by source and day of the week in 2019. The graph displays the production levels for rest, solar-PV, wind-onshore, and wind-offshore throughout the week.](image-url)
Electricity in The Netherlands 2019

2019

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

Tuesday Wednesday Thursday Friday Saturday Sunday Monday
7-mei 8-mei 9-mei 10-mei 11-mei 12-mei 13-mei

Rest solar-PV Wind-onshore Wind-offshore

EnTrance Centre of Expertise Energy
Electricity in The Netherlands 2019

The diagram shows the electricity production in MW from May 14th to May 20th, 2019, for different sources: Rest, solar-PV, Wind-onshore, and Wind-offshore.
Electricity in The Netherlands 2019

![Graph showing electricity generation in The Netherlands in 2019](image)

- **Source**: EnTrance Centre of Expertise Energy
- **Date**: 2019
- **Graph Key**:
  - Grey: Rest
  - Orange: Solar-PV
  - Green: Wind-onshore
  - Light Green: Wind-offshore

**Note**: The graph illustrates the weekly electricity generation patterns, with specific emphasis on the contributions from various sources.
Electricity in The Netherlands 2019
Electricity in The Netherlands 2019

![Graph showing electricity generation by source from Tuesday to Monday, June 2019. The graph includes contributions from Rest, solar-PV, Wind-onshore, and Wind-offshore sources.](image-url)
Electricity in The Netherlands 2019

- **2019**
- **MW**
- **Tuesday** 18-jun
- **Wednesday** 19-jun
- **Thursday** 20-jun
- **Friday** 21-jun
- **Saturday** 22-jun
- **Sunday** 23-jun
- **Monday** 24-jun

- **Entrance**

- **Rest**
- **solar-PV**
- **Wind-onshore**
- **Wind-offshore**
Electricity in The Netherlands 2019

![Graph showing electricity production in 2019 by day and energy source](#)
Electricity in The Netherlands 2019

The diagram shows the electricity generation in the Netherlands over a period from Tuesday, 2nd July to Monday, 8th July, 2019. The graph compares different sources of electricity generation:

- **Rest**: Gray area
- **solar-PV**: Yellow area
- **Wind-onshore**: Green area
- **Wind-offshore**: Green area

The data indicates fluctuations in electricity generation throughout the week, with the highest generation on Monday and the lowest on Friday. The generation from solar-PV and wind-onshore is relatively consistent, whereas the wind-offshore generation shows a slight variation.
Electricity in The Netherlands 2019

Graph showing electricity generation from different sources from 23-jul to 29-jul 2019.

- Rest
- solar-PV
- Wind-onshore
- Wind-offshore
Electricity in The Netherlands 2019

The graph shows the energy production in The Netherlands for the year 2019, categorized by day of the week and the type of energy source. The energy sources include Rest, solar-PV, Wind-onshore, and Wind-offshore. The production is measured in MW (megawatts).
Electricity in The Netherlands 2019

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

2019

MW

13-aug 14-aug 15-aug 16-aug 17-aug 18-aug 19-aug

Tuesday Wednesday Thursday Friday Saturday Sunday Monday

Entrance
Electricity in The Netherlands 2019

The diagram shows the electricity generation in The Netherlands from August 20th to August 26th, 2019. The x-axis represents the days of the week, and the y-axis represents the power output in MW. The generations from Rest, solar-PV, Wind-onshore, and Wind-offshore are indicated by different colors and line styles.
Electricity in The Netherlands 2019

![Graph showing electricity production in the Netherlands in 2019 with data for different types of energy sources such as solar-PV, Wind-onshore, and Wind-offshore.]
Electricity in The Netherlands 2019

Graph showing electricity generation sources from 10-16 September 2019 (MW):
- Rest
- Solar-PV
- Wind-onshore
- Wind-offshore
Electricity in The Netherlands 2019

The graph illustrates the electricity generation from different sources in The Netherlands for the month of September 2019. The data is represented in megawatts (MW). The graph shows a breakdown of electricity generation from Rest, solar-PV, Wind-onshore, and Wind-offshore. The peaks and troughs indicate the variation in production across different days of the week.
MISCELLANEOUS
In September 2019, the average daily effective temperature (temperature, including wind shield factor) was 15.0 °C, slightly lower than in September 2018 (15.4 °C)
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: 396 g/kWh
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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