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Energy transition in Belgium – Choices and costs

30/01/2017, updated 16/03/2017 to align with report

updated 16/03/2017

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This study was commissioned by Febeliec, the federation of Belgian industrial energy consumers. The steering committee for this study provided valuable insights from an industry perspective and was instrumental in defining the sensitivity scenarios which were analysed in this study.

This study aims to provide facts and figures regarding technology choices and consequential impacts on the energy system as a whole. The study does not predict directly or indirectly electricity prices in general or for certain sectors, but focuses on energy system costs. The scenario analysis with the Belgium TIMES model is based on a system cost optimization approach. It provides a technical and economic analysis framework to evaluate choices and resulting cost for the energy system of Belgium and can contribute valuable insights into consequences certain policy choices might have for the future.

A complete report providing details about the model input parameters, scenario definitions and more detailed results is available as a download on the websites www.EnergyVille.be and www.Febeliec.be.

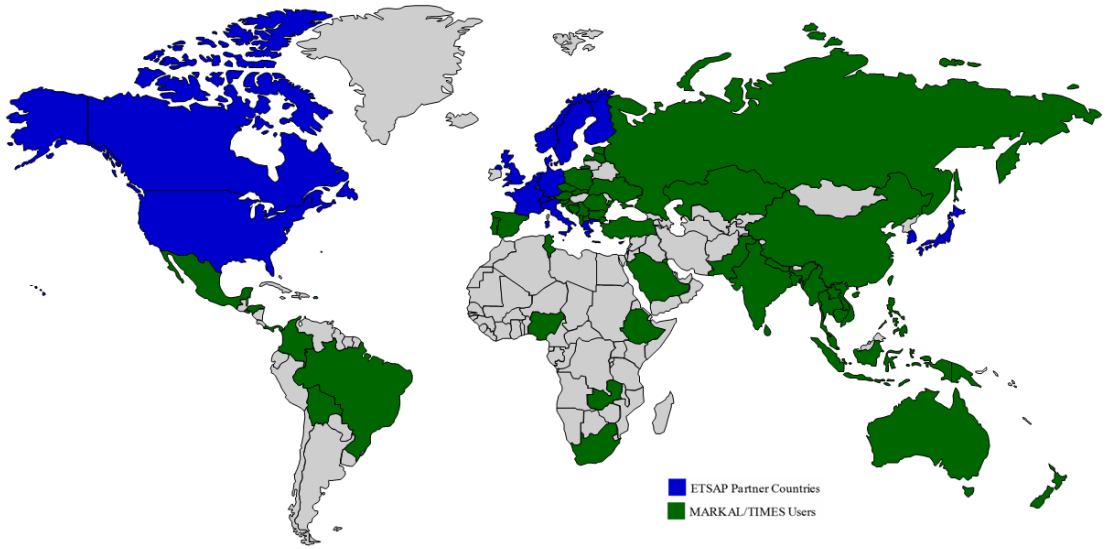
Energy system model – TIMES

Background

TIMES is a Model Generator for
'techno-economic energy system models'

Developed by the

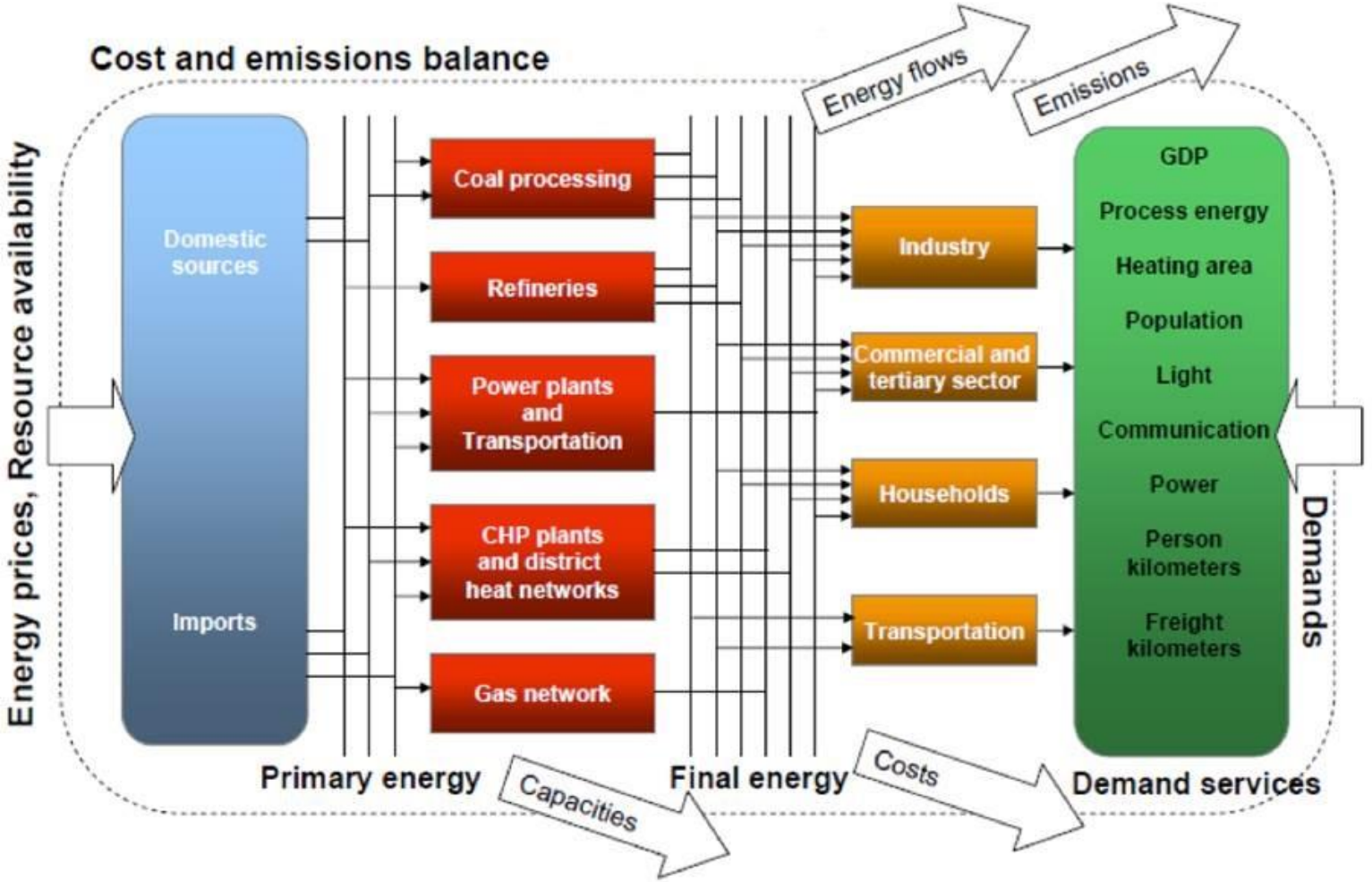
- Energy Technology Systems Analysis Programme (**ETSAP**)
- Coordinated by the **IEA** (International Energy Agency, Paris)
- Members of ETSAP and TIMES (or MARKAL) users all over the world
- VITO/EnergyVille is a contracting partner of ETSAP for over 20 years
- More information under http://www.iea-etsap.org



Energy system model – TIMES

Background

- Representation ‘reference energy system’ (by process)



Energy system model – TIMES

Building and using a TIMES model

The EnergyVille TIMES model for Belgium

- Belgium as geographic region with interconnections to neighbouring countries
- Energy Statistics from 2014 (corrected for 2016 data where available) as the base for the model
- Reporting years in the study are 2016, 2020 and 2030,
  but the model calculates outcome for every year over the horizon
- The model balances supply and demand during every moment in time. This applies to the whole energy system:
  - Electricity
  - Heat
- and sector:
  - Industry
  - Commercial
  - Residential
  - Agriculture
  - Transport
- To capture variations in balancing demand and supply a 2-hourly time resolution is used.

Energy system model – TIMES

Building and using a TIMES model

Defining base assumptions and scenario definitions

- In collaboration with the Febeliec steering committee EnergyVille defined base assumptions and scenario definitions
- EnergyVille calculates possible development paths (scenarios) of the energy system
- The model chooses for the overall energy system the cost-minimizing solution; for the central scenario and each sensitivity scenario till 2030.
- Existing support mechanisms (subsidies, green certificates, …) are not taken into account as these are a way of financing.

Energy system model – TIMES

Assumptions - Technologies

Technology Name	Existing Capacity (GW, 2014)	Model Assumptions Central scenario	Sensitivity Analysis
Gas Power Plants	4.54	• no restrictions	
Coal Power Plants	0.56	• no new investments	
Combined Heat & Power (CHPs)	2.37	• no restrictions	
Biomass Plants	0.39	• no restrictions	
Solar PV	2.93	• no restrictions	
Wind Onshore	1.51	• up to 8.6 GW total capacity possible	
Wind Offshore	0.712	• < 2.2 GW: existing grid infrastructure sufficient • >2.2 GW: additional grid investments required	
Nuclear	5.93	• Complete nuclear phase-out according to Belgian policy from 2022 to 2025	<u>Nuclear Extension Scenario:</u> • 2.0 GW capacity till 2035
Interconnections to neighbouring countries	3.5	• Investments under execution: increase to 6.5 GW total capacity by 2020 (ALEGrO, NEMO, Brabo II and III) • Additional investment possible	<u>Import Restriction Scenario:</u> • max. 10% compared to Belgian generation allowed from electricity imports on every time period

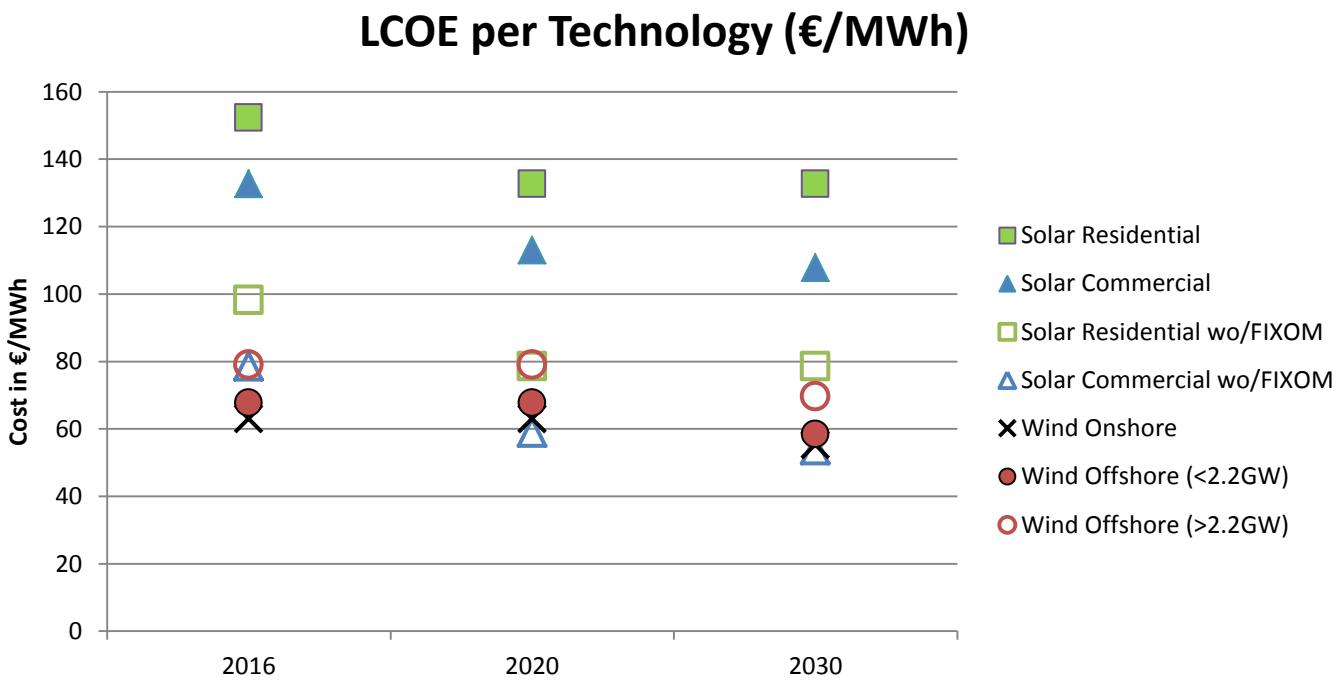
Energy system model – TIMES

Assumptions – Policies & Fossil Fuel Prices

Other Assumptions	Current status	Model Assumptions Central scenario	Sensitivity Analysis
Share of renewable generation in final energy consumption (EU Policy goal)	Belgian target: 13% in 2020	• Target of 13% in 2020 and 2030	
CO_2 price assumptions for ETS sector		• EU ETS: 17€/ton in 2020 and 33€/ton in 2030	
Natural gas and oil prices	Observed market prices for 2014 and 2016	• Prices projections based on World Energy Outlook 2015 (OECD): • Crude oil: 60 €/bbl in 2020 and 85 €/bbl in 2030, • Natural gas: 20 €/MWh in 2020 and 27 €/MWh in 2030	<u>Low Fuel Price Scenario:</u> • crude oil at 35 €/bbl in 2020 and 2030, • natural gas at 13 €/MWh in 2020 and 2030 <u>High Fuel Price Scenario:</u> • crude oil at 90 €/bbl in 2020 and 2030, • natural gas at 30 €/MWh in 2020 and 2030

Technology assumptions

- EnergyVille screens international literature/papers to make use of the latest available cross checked figures (see also our fact checks)
- Taking into account learning rates for technologies



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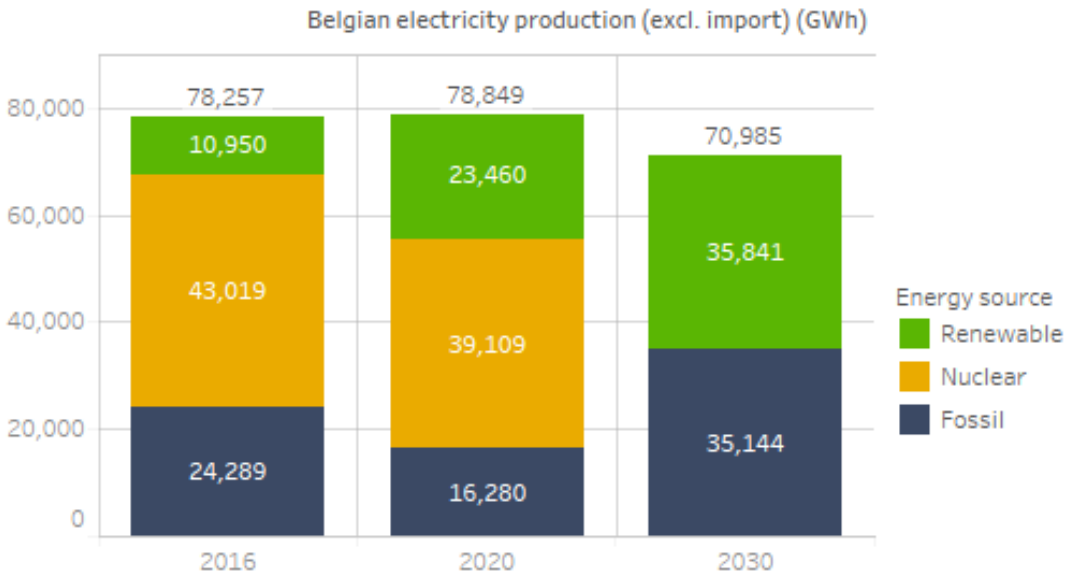
Model Results

Central Scenario

Model Results Central Scenario – the Big Picture

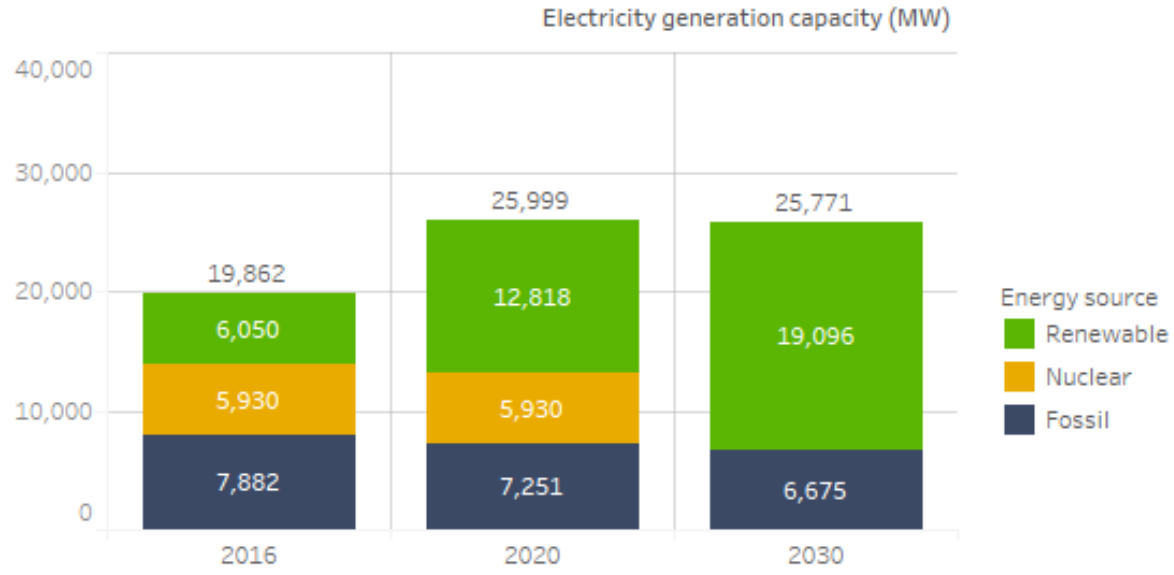
Electricity generation transition, 2016 to 2030:



- Fossil-fuel generation grows from 24 to 35 TWh
- Nuclear phases out from 43 (55% of the total) to 0 TWh
- Renewable generation increases from 11 to 36 TWh
- 50% of Belgian generation originates from renewable sources in 2030

Model Results Central Scenario – the Big Picture

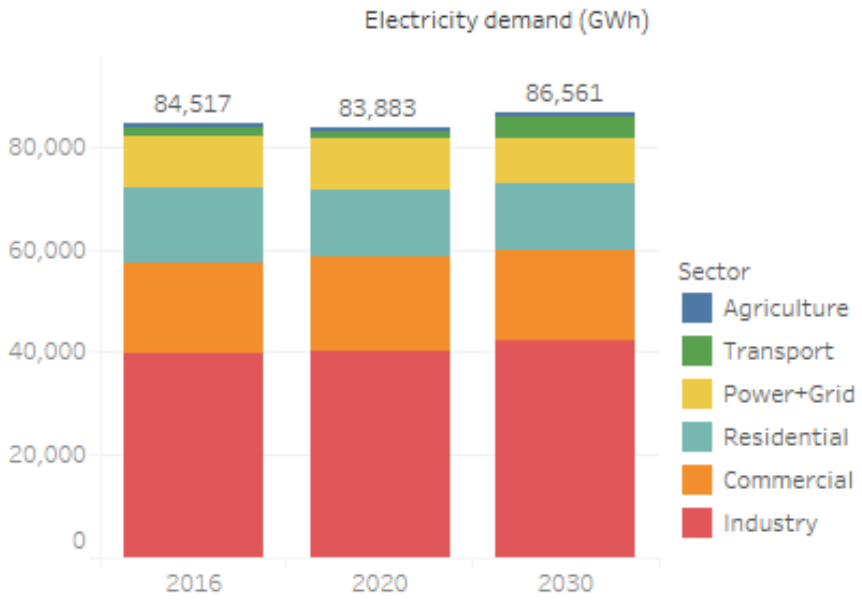
Electricity generation *capacity,* 2016 to 2030:



- Fossil-fuel generation *capacity* close to stable (mostly natural gas)
- Nuclear phases out
- Renewable *capacity* grows from 6 to 19 GW (x3)

Model Results Central Scenario – the Big Picture

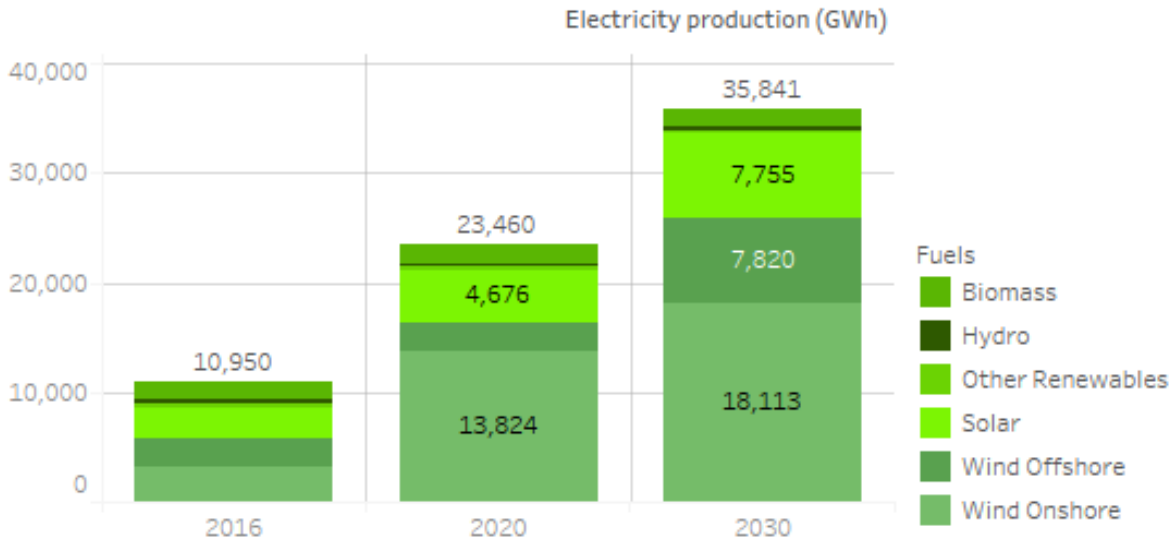
Electricity demand, 2016 to 2030:



- Fairly stable demand for electricity
- Projections see slight reduction in commercial and residential sector
  - Mostly due to energy savings measures, in contrast with projected growth
- By 2030 demand of 4 TWh for electrical road transport (electrical cars)

Model Results Central Scenario – in depth

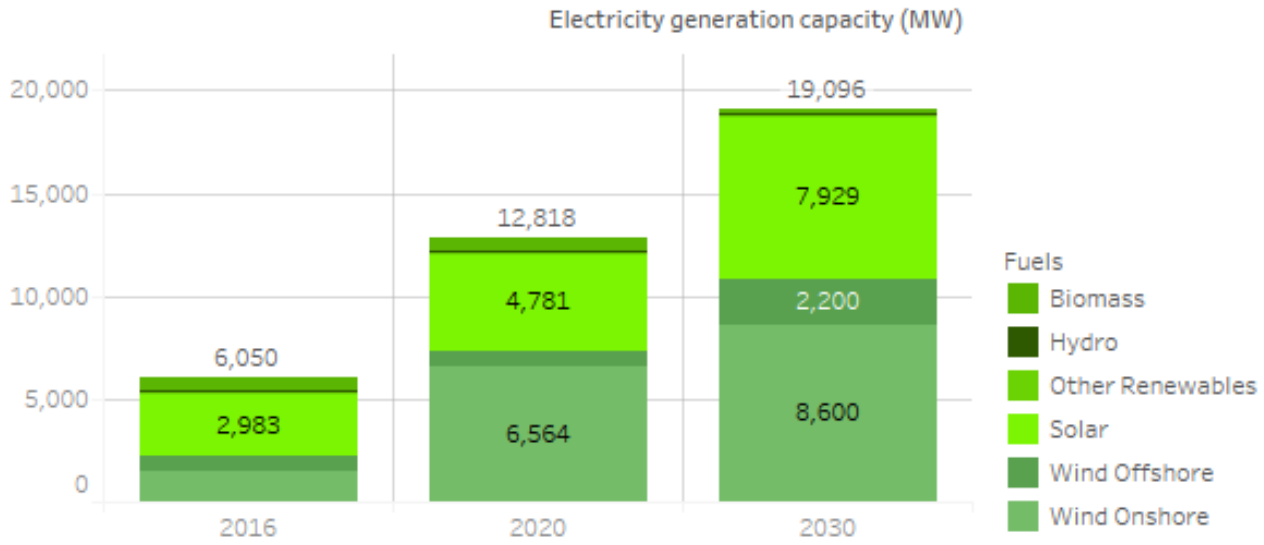
Renewable electricity generation, 2016 to 2030:



- Wind Onshore: from with 3,2 to 18,2 TWh (x5,7)
- Wind Offshore: from 2,5 to 7,8 TWh (x3)
- PV Solar: from 2,9 to 7,8 TWh (x2,7)

Model Results Central Scenario – in depth

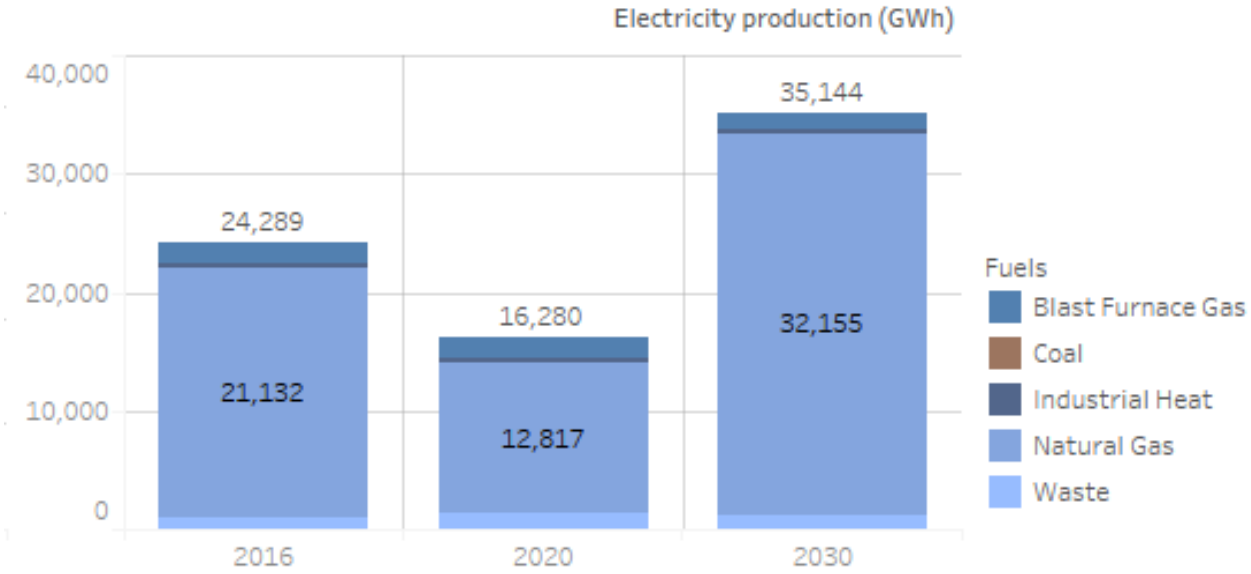
Renewable generation *capacity*, 2016 to 2030:



- Wind Onshore: from 1,5 to 8,6 GW (x5,7)
  - 8,6 GW set as a max. capacity expansion limit (and selected 100%)
- Wind Offshore: from 0,7 to 2,2 GW (x3)
  - 2,200 MW = current concessions
- PV Solar: from 3,0 to 7,9 GW (x2,7)
- 74% of generation *capacity* is mainly intermittent renewable based by 2030

Model Results Central Scenario – in depth

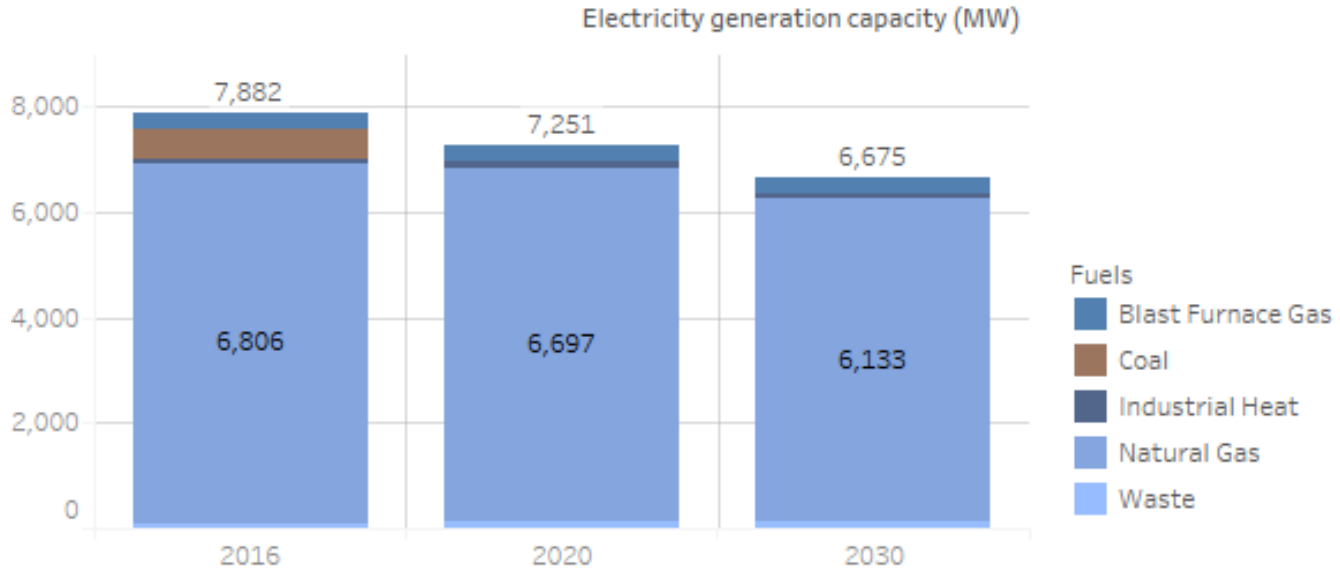
Fossil fuel electricity generation, 2016 to 2030:



- Natural gas plants increase generation from 21 to 32 TWh

Model Results Central Scenario – in depth

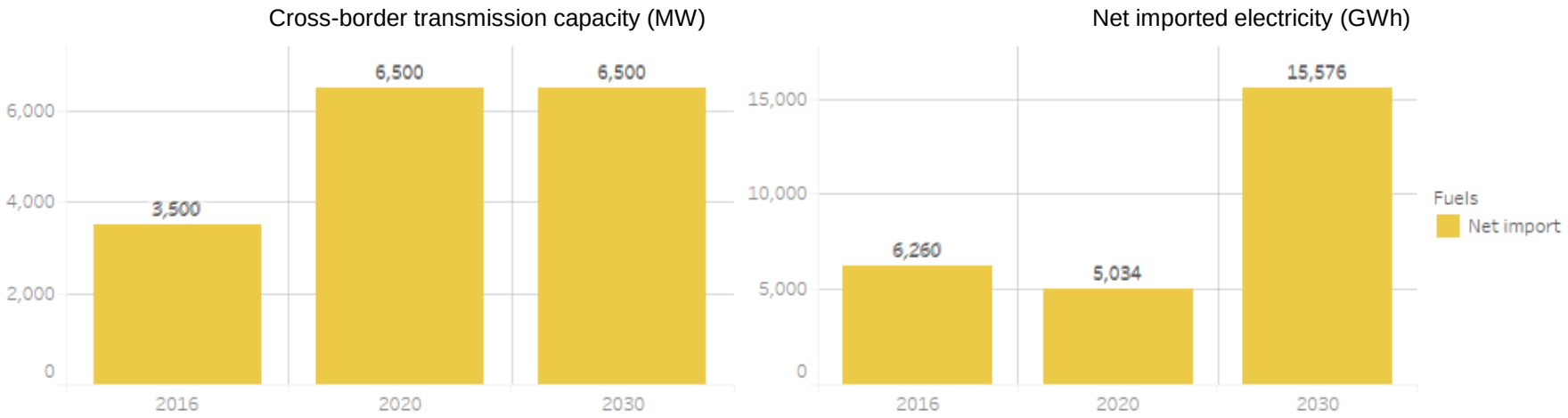
Fossil fuel generation *capacity*, 2016 to 2030:



- Natural gas plant capacity remains above 6 GW
  - Same capacity provides more generation output (= more operating hours)

Model Results Central Scenario – in depth

Electricity Net import, 2016 to 2030:

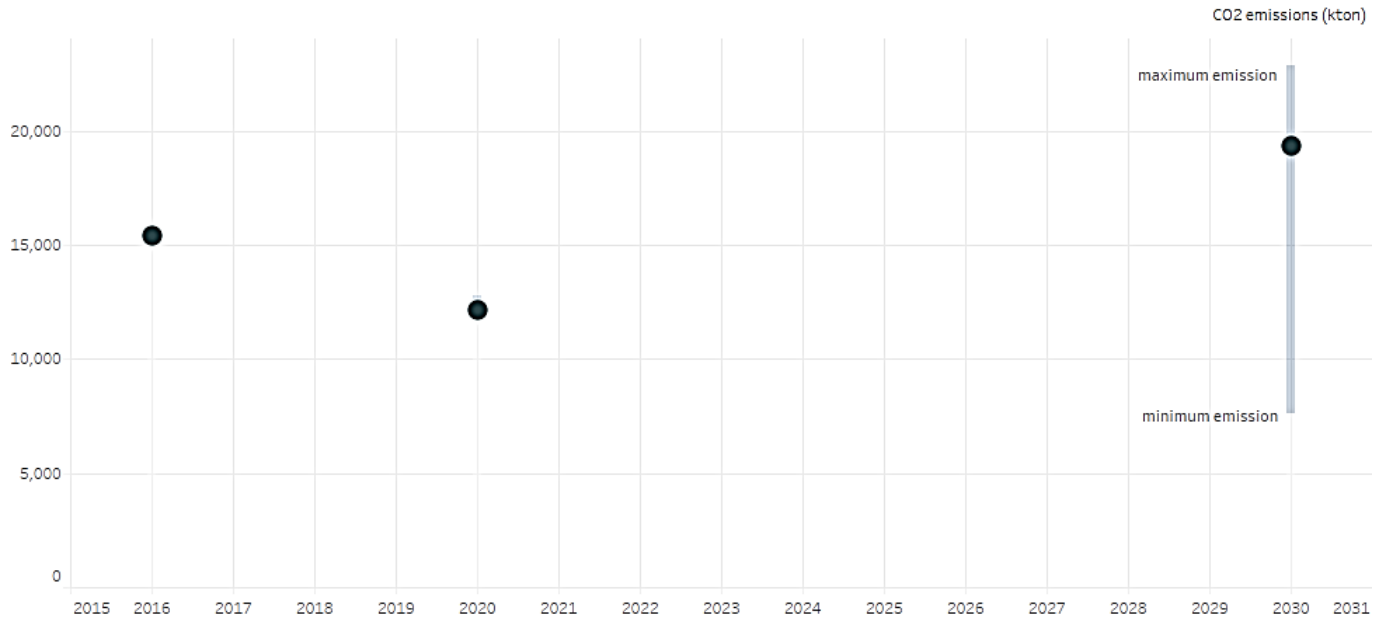


- Interconnection *capacity* increases from 3,5 to 6,5 GW till 2020
- Increase of electricity net import from 6,3 to 15,6 TWh (x2,5)
  - See 10% import scenario for sensitivity analysis

Model Results Central Scenario – in depth

CO_2 emissions, 2016 to 2030

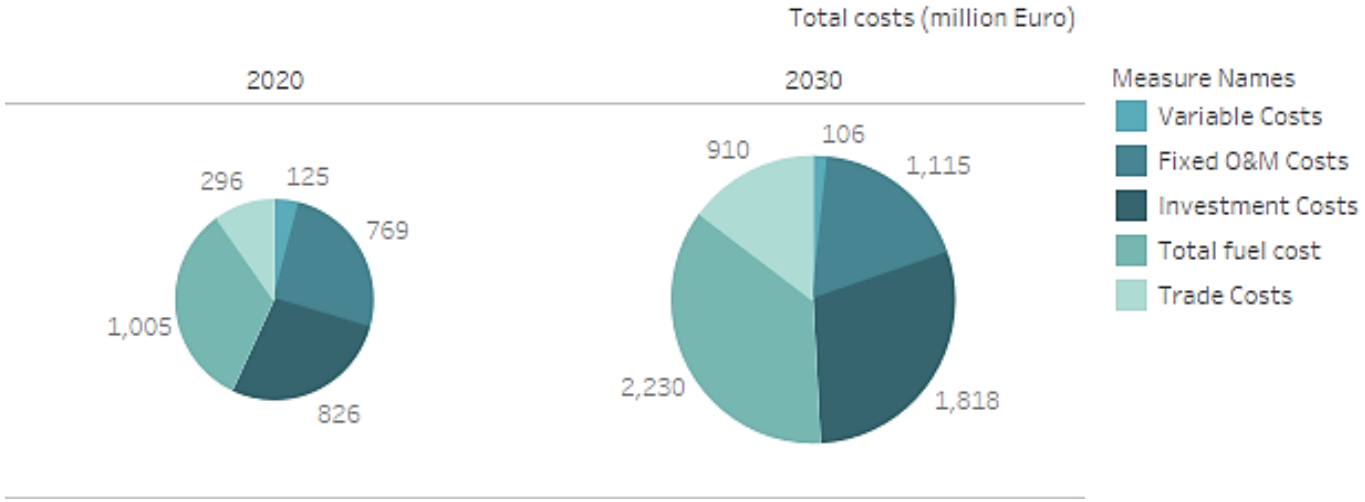
- CO_2 Emissions for public electricity & heat generation (IPCC, CRF sector 1.A.1.a)



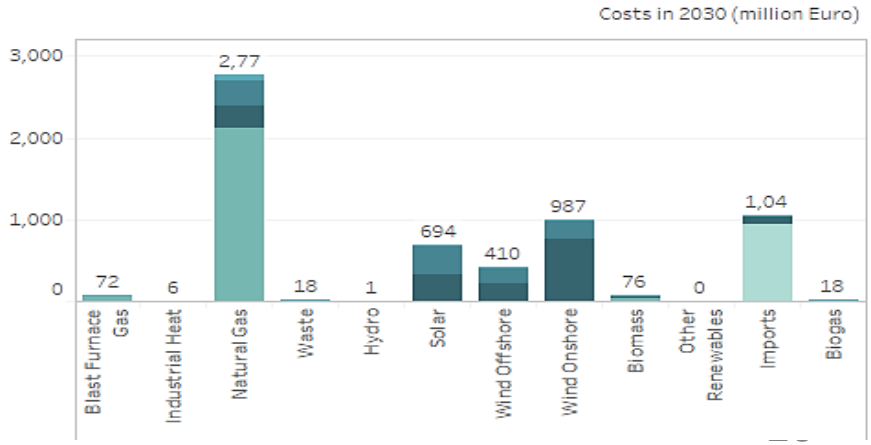
- Decreases from 15 to 12 Mton/y CO_2 emissions till 2020
- Increase to 19 Mton/y in 2030 due to increased natural gas usage
  - CO_2 reduction due to electrification in other sectors not shown

Model Results Central Scenario – in depth

Annual costs electricity production + import, 2020 - 2030



- Total cost increase from 2,7 (2020) to 6,1 (2030) billion Euro (x2,3).
- Highest cost increases in
  - Electricity import costs (x3.3)
  - Fuel costs (x2.2)
  - Investment costs (x2.2)



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Model Results

Scenario comparison overview

Conclusions

updated 16/03/2017

Comparison of Scenarios in 2030

Scenario Power sector	2016	Central	10% Import restriction	Fuel price high	Fuel price low	Nuclear extension 2 GW
Capacities (GW)	19.9	25.8	27.2	27.7	25.3	25.8
RES total	6.1	19.1	18.2	23.5	17.4	18.9
solar PV	3.0	7.9	7.0	12.1	6.2	8.3
wind onshore	1.5	8.6	8.6	8.6	8.6	8.6
wind offshore	0.7	2.2	2.2	2.5	2.2	1.6
nuclear	5.9	0	0	0	0	2.0
fossil	7.9	6.7	9.0	4.1	7.9	4.9
import	3.5	6.5	6.5	7.5	6.5	6.5
Production Belgium (TWh)	78.3	71.0	79.1	55.7	78.0	72.2
RES	11.0	35.8	34.9	40.9	34.2	34.2
nuclear	43.0	0	0	0	0	15.0
fossil	24.3	35.1	44.2	14.8	43.9	23.2
net import	6.3	15.6	6.2	28.4	7.9	14.4
Annual electricity system cost 2030 (billion Euro)	/	6.18	6.19	6.43	4.82	5.57
Additional annual electricity system costs (2030 to 2016, billion Euro)	/	4.49	4.50	4.74	3.13	3.88
CO_2 emissions (Mton)	15.4	19.3	22.5	11.6	22.9	14.7

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