Belgian Long Term electricity system scenarios

Central scenario

Nuclear operation extension 10y-20y

09 September 2020

EnergyVille long-term electricity system scenarios

Capitalising on insights from multiple stakeholders …

2017 Horizon 2030

- ‘Energy Transition in Belgium: choices and costs’ ordered by Febeliec
  - Central scenario including nuclear phase-out by 2025
  - High-Low gas price scenario, limited import, 2GW - 10 year nuclear lifetime extension

2018 Horizon 2040

- Updated scenarios post 2030 ordered by Greenpeace, BBL, IEW
  - 2040 outlook including nuclear phase-out by 2025 and with 2GW - 10 year nuclear lifetime extension

2020 Horizon 2050

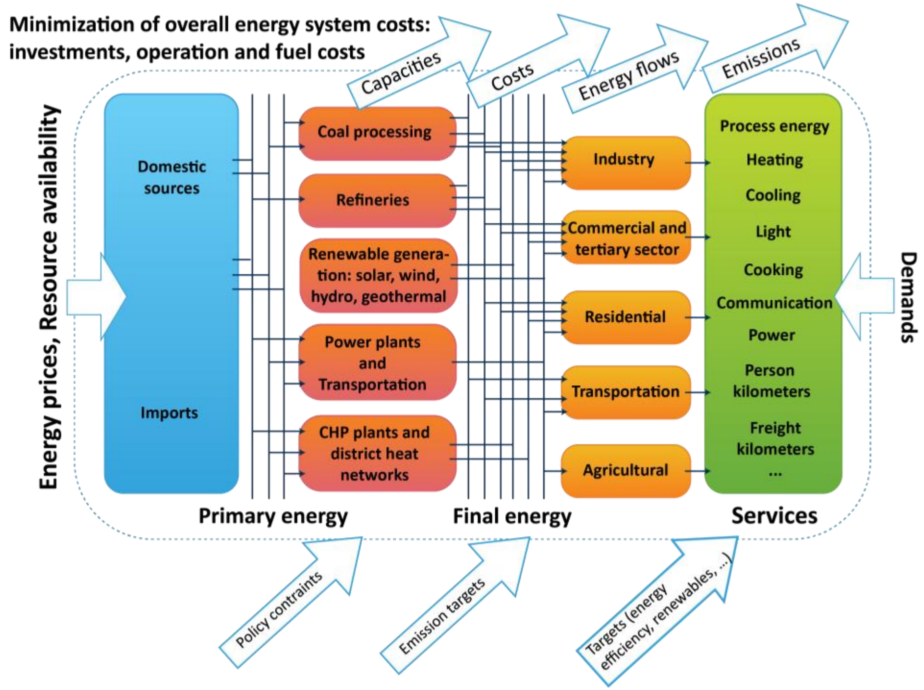
- 2050 scenarios ordered by Engie
  - ‘Current’ and ‘High’ renewable ambition pathway including 3 scenarios each
    - Central scenario including nuclear phase-out by 2025
    - 2GW - 10 and 20 year nuclear lifetime extension
  - Updated import/export model including cross border impacts

2 pathways of scenarios

- Current renewable ambition
  - Central scenario Nuclear closure 2025
  - 2 GW Nuclear extension: 10y
  - 2 GW Nuclear extension: 20y
- High renewable ambition
  - Central scenario Nuclear closure 2025
  - 2 GW Nuclear extension: 10y
  - 2 GW Nuclear extension: 20y

Updated assumptions and model framework

- TIMES model generator for 'techno-economic energy system models' assuming Perfect Foresight
  - Updated energy statistics to 2019 where available
  - Updated to 2019 process and commodity assumptions
  - Belgium as geographic region with explicitly modelled interconnections and electricity system in Nl, De, Fr, UK
  - Reporting years 2020-2050 with 5-year intervals, 2023-2026 modelled on yearly basis, to improve accuracy during nuclear closure
  - The model minimizes overall system costs (investment, operation,fuels costs…)
  - Existing support mechanisms (subsidies, green certificates, Capacity Remuneration Mechanism, …) are not taken into account
- No adequacy-flexibility study, but
  - Cost optimisation over the full time horizon
  - 2-hourly resolution, 10 representative days



Changes in the electricity system – Current RE ambition scenarios Neighbouring countries

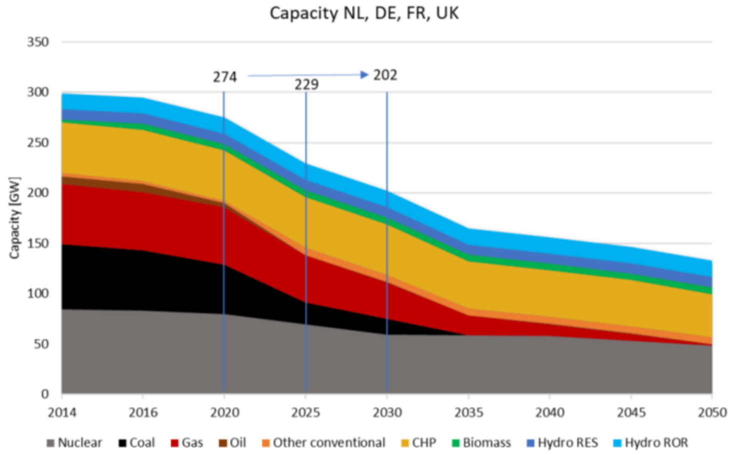
2020 | 2025 | 2030 | 2050

Decreasing thermal capacity

2015-2020: Transparancy platform + Eurostat energy balance

2020-2040: TYNDP-DE scenario + EnergyVille assumptions on aging and gradual closure of existing gas units

>2040: extrapolation



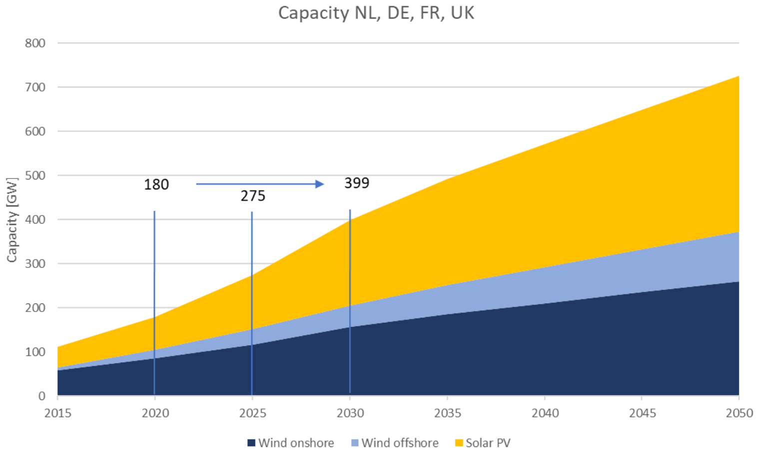
Increasing renewable capacity

2015-2020: Transparancy platform

2020-2040: DE: Netzentwicklungsplan Strom, UK/FR: TYNDP-DE, NL: TYNDP-NT

>2040: extrapolation

Including pumped hydro (90 GWh 2050), battery storage (104 GWh 2050)



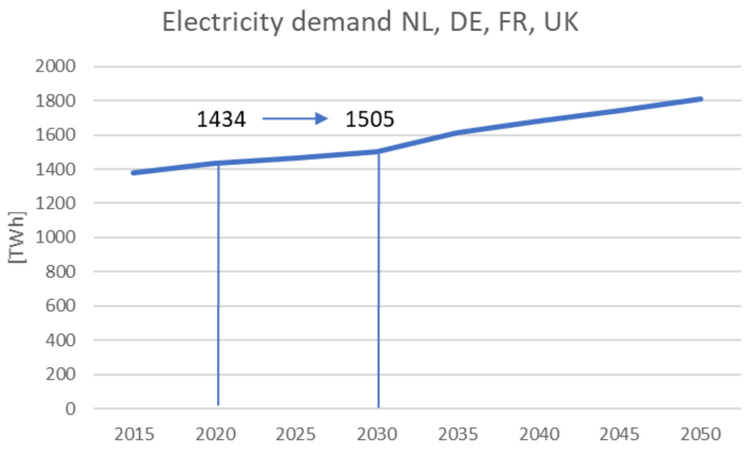
Increasing electricity demand

2015-2020: Transparancy platform

2020-2040: DE: Netzentwicklungsplan Strom, UK/FR: TYNDP-DE, NL: TYNDP-NT

>2040: extrapolation

Including demand side flexibility (67 GWh 2050)



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Changes in the electricity system – Current RE ambition scenarios Belgium

2020		2025	2030	2050
Be	**Capacity [GW]**	**Model assumptions**		
Gas	3,78	<2020 existing capacity: 3,76 GW New investments possible	<2020 existing capacity: 2,37 GW New investments possible	<2020 existing capacity: 0 GW New investments possible
Coal	0	No new investments possible		
Biomass	0,39	Biomass limited to current level		
CHP	2,37	New investments possible		
Nuclear	5,93	Central scenario: Phase out Alternative: 10y–20y extension	Lifetime extension: 80% annual availability, no flexibility taken into account	
Solar PV	4,83	New investments possible		
Onshore	2,28	Annual max. growth rate '20-'30: +250 MW	Annual max. growth rate >2030, including replacement old turbines: +450 MW	Tech.max.potential 8,6 GW
Offshore	2,26	Annual max. growth rate '20-'25: +250 MW	Tech.max.potential 4,6 GW	Tech.max.potential 2040: 4,6 GW
Interconnection	6,5 Simultaneous avail. cap.	6,5	6,5	6,5
Distribution grid	7,0 Peak load cap.	Linear depreciation over 50 years New capacity: 4300 MEUR/GW		
Gas price €/GJ	6,1	6,1	6,0	6,0
CO_2 price €/ton	25	40	84,3	160

Scenario results
Current renewable ambitions

Central – 10y/20y nuclear extension

Key figures – 2030 results

Belgium 2030	Central	10y LTO	20y LTO
Gas [GW], CCGT + CHP	7,8	6,7	6,1
Generation gas [TWh]	36,9	27,1	25,6
Operating new CCGT [h/y]	6350	5600	6200
Nuclear [GW]	0	2	2
Solar PV [GW]	12,6	11,3	11,4
Onshore [GW]	4,6	4,6	4,6
Offshore [GW]	4,6	4,6	4,6
Net import [TWh]	8,8	6,5	8,0
Electricity demand [TWh]	89,3	89,5	89,5
CO2 emissions power sector ETS [Mton]	14,1	10,9	10,4
Annual electricity system cost [MEUR]	4067	3933	3960

Key messages (1)

CAPACITY & GENERATION

- Expected *thermal capacity decrease* in NW-Europe from today till 2030 has a major impact on the electricity system
- Expected *renewable capacity increase* from today till 2030
  - DE, FR, UK, NL: + 219 GW solar, wind
  - BE: cost effective uptake of
    - Onshore wind: +2,3 GW leading to 4,6 GW by 2030
    - Offshore wind: +2,4 GW leading to 4,6 GW by 2030
    - PV: +7,5 GW leading to 12,6 GW by 2030

- Full nuclear closure in Belgium creates the need for additional investment in new gas plants – the optimal level defined by the model is 3.85 GW new gas based capacity by 2025, or almost 5 large 800 MW units
- 2 GW nuclear operation extension leads to
  - 10y extension: 2,7 GW new CCGT, -1150 MW compared to central
  - 20y extension: 2,1 GW new CCGT, -1800 MW compared to central
  - No impact on investments in renewable capacity

- 50% of Belgian electricity generation based on renewables by 2030 in all scenarios
  - Belgium is net importer >2025: annually 10% of electricity demand (8,8 TWh)
  - 2 GW nuclear operation extension lowers net import by 10-20% to 7,4 - 9% of electricity demand (6,5 – 8 TWh)

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Key messages (2)

CO_2 EMISSIONS

- Belgian CO_2 emissions from power sector will peak by 2026: +5,6 Mton or 35% compared to 2020, but decrease with 1 Mton by 2030 compared to 2020
- 2 GW nuclear operation extension leads to
  - 10y extension: - 3,2 Mton CO_2 emissions in the power sector in 2030, -25 Mton over the full lifetime extension
  - 20y extension: - 3,7 Mton CO_2 emissions in the power sector in 2030, -45 Mton over the full lifetime extension

POWER SYSTEM COST

- Annual power system cost amounts to 4 G€ by 2030 in the Central scenario

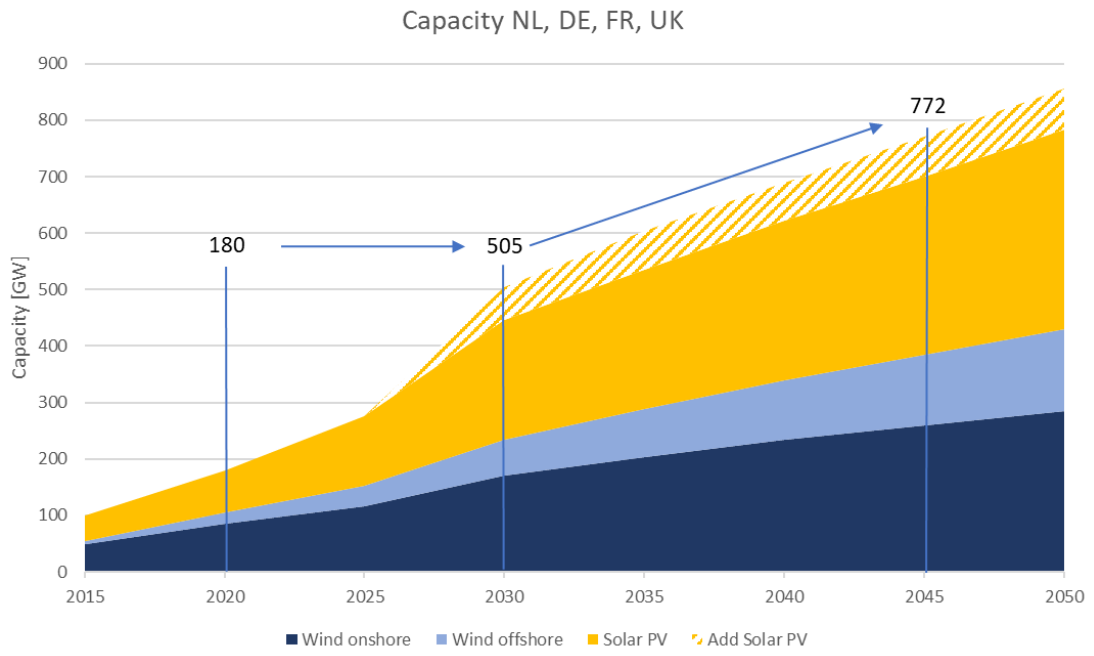
  2 GW nuclear extension decreases annual power system cost by 106-134 M€/y (2,6-3,3%)
- Nuclear extension has a limited impact on the wholesale price of electricity in Belgium

Scenario results
High renewable ambitions (High RES)

Central – 10y/20y nuclear extension

High RES - Changes in assumptions

- Exogenous renewable capacity neighbouring countries
  - Highest available TYNDP scenario results
  - Additional 266 GW renewables from 2020-2030 = solid area in graph
- Endogenous changes
  - PV
    - Investment cost PV: lower estimate IRENA projections
      - 2030: 306 €/kW (vs 540 €/kW)
      - 2050: 148,5 €/kW (vs 324 €/kW)
    - Allow investments in all countries, in neighbouring countries on top of exogenous capacity = 'Add solar PV" in graph (result from model)
  - Batteries
    - Lifetime extension from 10 to 20y starting from 2035
    - Allow investments in all countries
  - Onshore wind Belgium
    - Post 2030 annual capacity *increase* max. 500 MW/y → maximum capacity 12,5 GW by 2050
  - Offshore wind Belgium
    - Maximum potential implemented: 6 GW from 2040 onwards



High RES - Changes in the electricity system – Belgium

Difference with ‘Current renewable ambition pathway’ *highlighted*

Be	Capacity [GW]	Model assumptions		
	2020	2025	2030	2050
Gas – Coal – Biomass - CHP		Same as Current renewable pathway		
Nuclear	5,93	High RES Central scenario: Phase out High RES Alternative: 10y–20y extension		
Solar PV	4,83		*Investment cost commercial PV: 306 €/kW** *Allow investments in BE and other countries* (Current renewable pathway: 540 €/kW)	*Investment cost commercial PV: 148,5 €/kW** *Allow investments in BE and other countries* (Current renewable pathway: 324 €/kW)
Onshore	2,28	Annual max. growth rate ’20-’30: +250 MW	***Annual **additional** max. growth rate >2030, **excluding** replacement old turbines: +500 MW*	***Tech.max.potential 12,5 GW* (Current renewable pathway: 8,6 GW)
Offshore	2,26	Annual max. growth rate ’20-’25: +250 MW	Tech.max.potential 4,6 GW	***Tech.max.potential 2040: 6 GW implemented* (Current renewable pathway: 4,6 GW)
Interconnection	6,5 Simultaneous avail. cap.	6,5 Same as Current renewable pathway	6,5	6,5
Distribution grid	7,0 Peak load cap.	Same as Current renewable pathway		
Battery storage			***Lifetime extension from 10y to 20y from 2035 onwards* *Allow investments in BE and other countries*	
Gas price €/GJ	6,1	6,1 Same as Current renewable pathway	6,0	6,0
CO_2 price €/ton	25	40 Same as Current renewable pathway	84,3	160

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*Source: IRENA, Future of Solar Photovoltaics – Deployment, investment, technology, grid integration and socio-economic aspects, Nov.2019
** EnergyVille assumption

Key figures – 2030 results

Belgium 2030	Central	High RES Central	High RES 10y LTO	High RES 20y LTO
Gas [GW], CCGT + CHP	7,8	6,7	5,7	5,4
Generation gas [TWh]	36,9	20,6	16,3	15,4
Operating new CCGT [h/y]	6350	3650	3360	3400
Nuclear [GW]	0	0	2	2
Solar PV [GW]	12,6	20,1	19,7	19,7
Onshore [GW]	4,6	4,6	4,6	4,6
Offshore [GW]	4,6	4,6	4,6	4,6
Net import [TWh]	8,8	19,5	11,2	12,1
Electricity demand [TWh]	89,3	91,1	91,4	91,4
CO2 emissions power sector ETS [Mton]	14,1	9,5	8,1	7,8
Annual electricity system cost [MEUR]	4067	4305	3978	3979

High RES Key messages (1)

CAPACITY & GENERATION

- Expected *thermal capacity decrease* in NW-Europe from today till 2030 has a major impact on the electricity system
- Expected *renewable capacity increase* from today till 2030
  - DE, FR, UK, NL: + 325 GW solar, wind
  - BE: cost effective uptake of
    - Onshore wind: +2,3 GW leading to 4,6 GW by 2030, growing to 10 GW by 2045
    - Offshore wind: +2,4 GW leading to 4,6 GW by 2030, growing to 6 GW by 2045
    - PV: + 1500 MW/year → +15,3 GW leading to 20,1 GW by 2030, growing to almost 44 GW by 2045
- Need for substantial day/night storage technology
  - Home batteries + Medium Voltage grid connected batteries : more than 10 GW by 2040

- Full nuclear closure in Belgium creates the need for additional investment in new gas plants – the optimal level defined by the model is 2,7 GW new gas based capacity by 2025, or almost 4 large 800 MW units
- 2 GW nuclear operation extension leads to
  - 10y extension: 1,8 GW new CCGT, -940 MW compared to central
  - 20y extension: 1,4 GW new CCGT, -1300 MW compared to central
  - No impact on investments in renewable capacity

High RES Key messages (2)

- 66% of Belgian electricity generation based on renewables by 2030 in all scenarios
  - Belgium is net importer >2025: annually 21% of electricity demand (19,5 TWh)
  - Higher renewable generation in BE and other countries leads to more cross border trade
  - Nuclear lifetime extension leads to lower net import: annually 12,6-13,6% of electricity demand (11,2-12,1 TWh)

CO_2 EMISSIONS

- Belgian CO_2 emissions from power sector will peak by 2026 but the increase is only half of the ‘current renewable ambition central scenario’: +2,7 Mton or +17% compared to 2020.
  Emissions strongly decrease with 6,3 Mton or 42% by 2030 compared to 2020.

POWER COST

- Annual power system cost amounts to 4,3 G€ by 2030 in the Central scenario
- Wholesale electricity price will be 64 €/MWh or 9% lower than in the current renewable ambition central scenario by 2030 and will decrease further to 46 €/MWh by 2040.
- Number of hours with marginal electricity production cost <20 €/MWh increases to 4300 h/y from 2040 onwards

ELECTRIFICATION OF END USE SECTORS

- Lower wholesale electricity price leads to stronger electrification of end use demand in most sectors: electrification of passenger transport, heat pumps for heating buildings, electrification in industry sectors
- Electricity demand in 2040 will be 106 TWh which is 28% higher than today, or 10% higher than ‘current renewable ambition pathway’.

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Summary 2030 results

Belgium 2030	Current RES ambition			High RES ambition		
	Central	**10y LTO**	**20y LTO**	**Central**	**10y LTO**	**20y LTO**
Gas [GW], CCGT + CHP	7,8	6,7	6,1	6,7	5,7	5,4
Generation gas [TWh]	36,9	27,1	25,6	20,6	16,3	15,4
Operating new CCGT [h/y]	6350	5600	6200	3650	3360	3400
Nuclear [GW]	0	2	2	0	2	2
Solar PV [GW]	12,6	11,3	11,4	20,1	19,7	19,7
Onshore [GW]	4,6	4,6	4,6	4,6	4,6	4,6
Offshore [GW]	4,6	4,6	4,6	4,6	4,6	4,6
Net import [TWh]	8,8	6,5	8,0	19,5	11,2	12,1
Electricity demand [TWh]	89,3	89,5	89,5	91,1	91,4	91,4
CO2 emissions power sector ETS [Mton]	14,1	10,9	10,4	9,5	8,1	7,8
Annual electricity system cost [MEUR]	4067	3933	3960	4305	3978	3979

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