ELECTRICITY SCENARIOS FOR BELGIUM TOWARDS 2050

ELIA'S QUANTIFIED STUDY ON THE ENERGY TRANSITION IN 2030 AND 2040

Additional clarifications on economic and
adequacy running hours

Starting point for the analysis: Base Case 2030

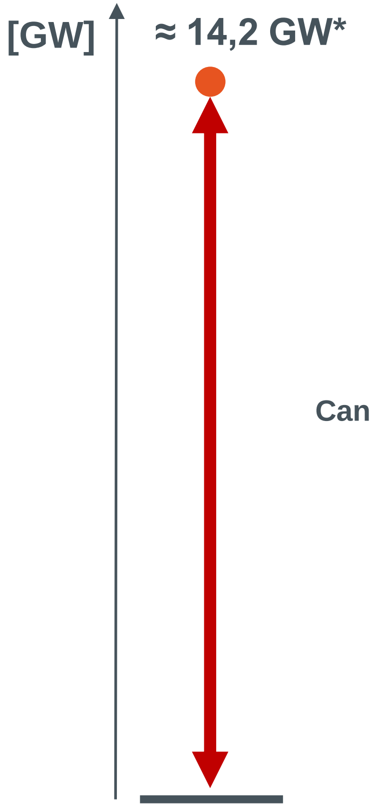
BC 2030 numbers

Overview of key assumptions
(real 2016 vs Base Case 2030)

	2016	2030 (BC)
PV	3 GW	5 GW
Onshore wind	1.5 GW	3.3 GW
Offshore wind	0.7 GW	2.3 GW
DSR	0.6 GW	1.1 GW
Exis. OCGT/CCGT	3.8 GW	2.3 GW
IC capacity	3.5 GW	6.5 GW
CHP/Biom./Waste	3 GW	3 GW
Storage	1.3 GW	1.3 GW
Nuclear	5.9 GW	0 GW

In order to guarantee adequacy, there is a need of around 14 GW in Belgium (all generation sources, flexibility options, imports,… combined)

To guarantee SoS (100% available)



Can be filled by:

TYPE	**Main limitations (installed capacity ≠ contribution to adequacy)**	
Wind/PV	Intermittency (linked to meteorology)	**Generating** electricity
Thermal/ combustion	Outages	
DSM	Activations limitations (amount, frequency)	**Shift/reduction** of consumption
Storage	Reservoir limitations. Availability of energy during other moments	
Imports	Availability of energy abroad and grid constraints	**Importing** from EU

**See figure 26 of the report for more details on the peak distribution*

x hours

Not economically dispatchable (with few exceptions)

Economically dispatchable

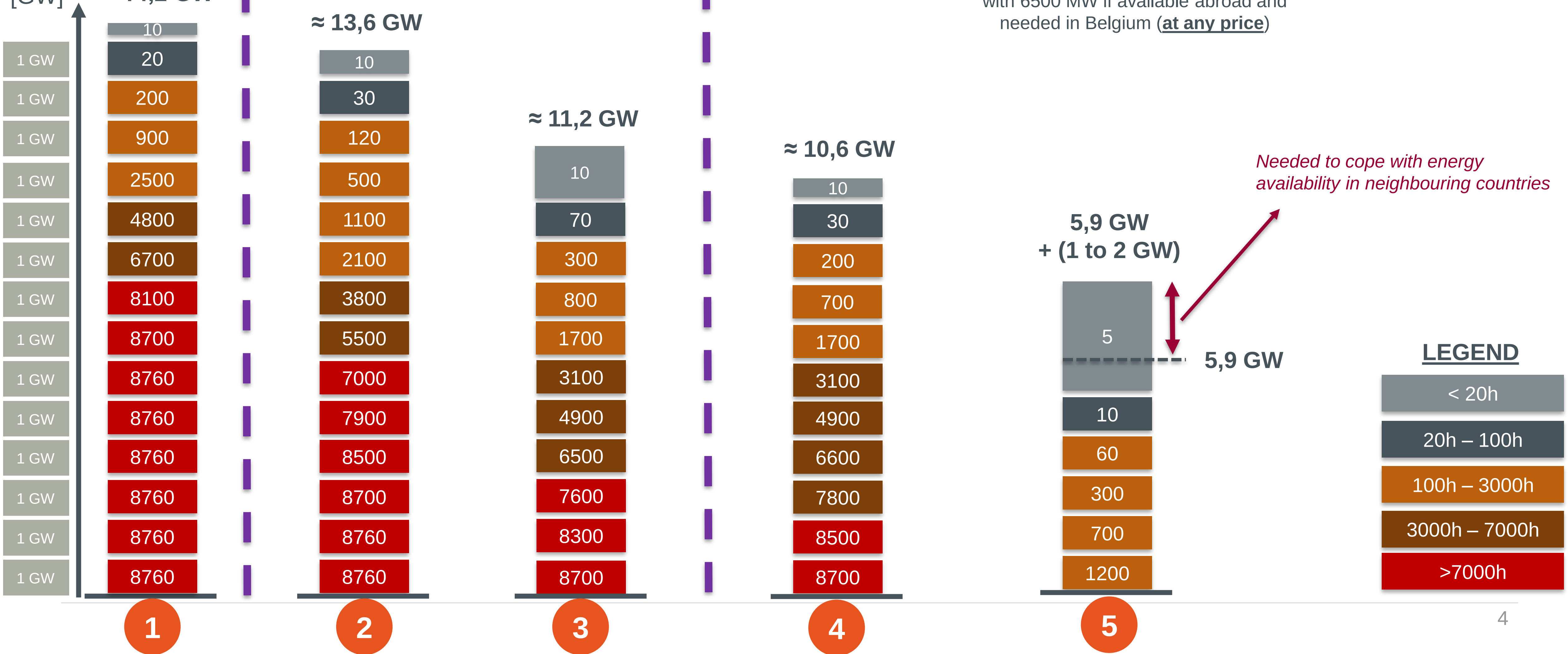
"Adequacy running hours" per **100 % available capacity** per block of 1 GW

Assuming **thermal outage** on blocks

Load

- Wind/PV - CHP/bio - DSM / Storage - Imports ≈ 45 TWh/year

Assuming imports all the year long with 6500 MW if available abroad and needed in Belgium (**at any price**)



[GW]	①	②	③	④	⑤
	≈ 14,2 GW	≈ 13,6 GW	≈ 11,2 GW	≈ 10,6 GW	5,9 GW + (1 to 2 GW)
	10				
1 GW	20	10			
1 GW	200	30			
1 GW	900	120			
1 GW	2500	500	10	10	
1 GW	4800	1100	70	30	
1 GW	6700	2100	300	200	
1 GW	8100	3800	800	700	
1 GW	8700	5500	1700	1700	
1 GW	8760	7000	3100	3100	5
1 GW	8760	7900	4900	4900	10
1 GW	8760	8500	6500	6600	60
1 GW	8760	8700	7600	7800	300
1 GW	8760	8760	8300	8500	700
1 GW	8760	8760	8700	8700	1200

5,9 GW

Needed to cope with energy availability in neighbouring countries

LEGEND

- < 20h
- 20h – 100h
- 100h – 3000h
- 3000h – 7000h
- >7000h

Explanation of the previous slide step by step

1. **Starting from the load duration curve**, one can assess the amount of hours during which a certain block of capacity (100% available) is needed during the year. The total amounts to around 14 GW for Belgium of which 8 GW are needed for more than 8000 hours a year.

2. **Removing non dispatchable renewable generation** (wind, PV and hydro Run-of-River) lead to a reduction in the total need and in running hours per block of capacity. Impact on the top blocks is smaller than on the lower ones given the correlation between PV, wind production and consumption. During peak hours (winter), PV production is 0 or very low.

3. **Removing non dispatchable thermal generation** (biomass and CHP) leads to a further reduction of the total need and in the hours per block of capacity. Given that CHP and biomass electrical output are not (or in a very limited way) dependent on meteorological variables, their contribution at peak is very high and can be compared to other thermal technologies.

4. **DSM and storage can also be removed** from the load duration curve. Those are normally dispatched economically. DSM is not usually dispatched given its high activation price. Storage usage will depend on the other generation source's prices. Both have an effect to lower the need. Storage will increase the hours in the lower blocks and decrease it in the top blocks as it will move energy from low consumption hours to higher ones.

5. **Imports and exports of energy** also depend on economic dispatch and hence on technologies in Belgium and abroad. In this case, in order to calculate the running hours for adequacy, if the energy is available abroad (whatever its price), Belgium can import the maximum capacity all the time. This leads to a steep decrease in running hours and needed capacity. **It is important to note that those imports are not economical, it is just a way to see which are the moments when Belgium could not rely on imports** (after using all available capacity). Given the uncertainty on available energy abroad, mainly during high consumption moments in Belgium, the need could be increased by 1 to 2 GW as shown in the study.

6. The last column (after all assumed available technologies) is what is called "adequacy running hours" and follows the same methodology as in the "Adequacy and Flexibility study 2017-27" of 2016. **An important distinction should be made between "adequacy" and "economic" running hours**. While the adequacy picture provides the needed capacity and hours during which Belgium has no other solution than investing in local generation/DSM/storage, **the economic picture cannot be deducted from such analysis.** Assuming that RES and CHP are usually less driven by economics (must runs), one can derive the economic picture from the 3rd column (see next slides)

Starting from the adequacy view on "non dispatchable" generation, the economically dispatched options can be evaluated

ADEQUACY VIEW

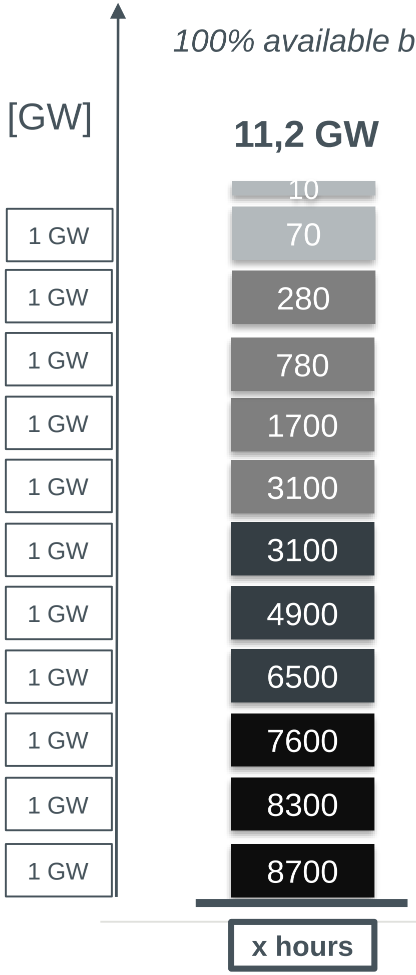
ECONOMIC DISPATCH

Load - Wind/PV - CHP/bio

Starting from the "residual demand"
(Load minus non dispatchable generation)

Economic running hours of technologies depend on the installed generation technologies abroad and in Belgium, consumption and economic parameters. A range is given here based on the simulations results from different scenarios.

100% available blocks



Can be filled with:

	Economic running hours (on EU market)
DSM	10 - 20
New OCGT	100 - 1000
Exis >25y	1000 - 2000
Exis <25y	1500 - 4000
New CCGT	5000 - 7000
Storage	1000 - 3000*
New CHP/Bio/…	6000 - 7500
	x hours

Choice Impacts → Imported/Exported energy

** Note for storage, it only represents the injection hours*

Didactic example of 2 cases to fill the need for Belgium

ADEQUACY VIEW

ECONOMIC DISPATCH (simplified view)

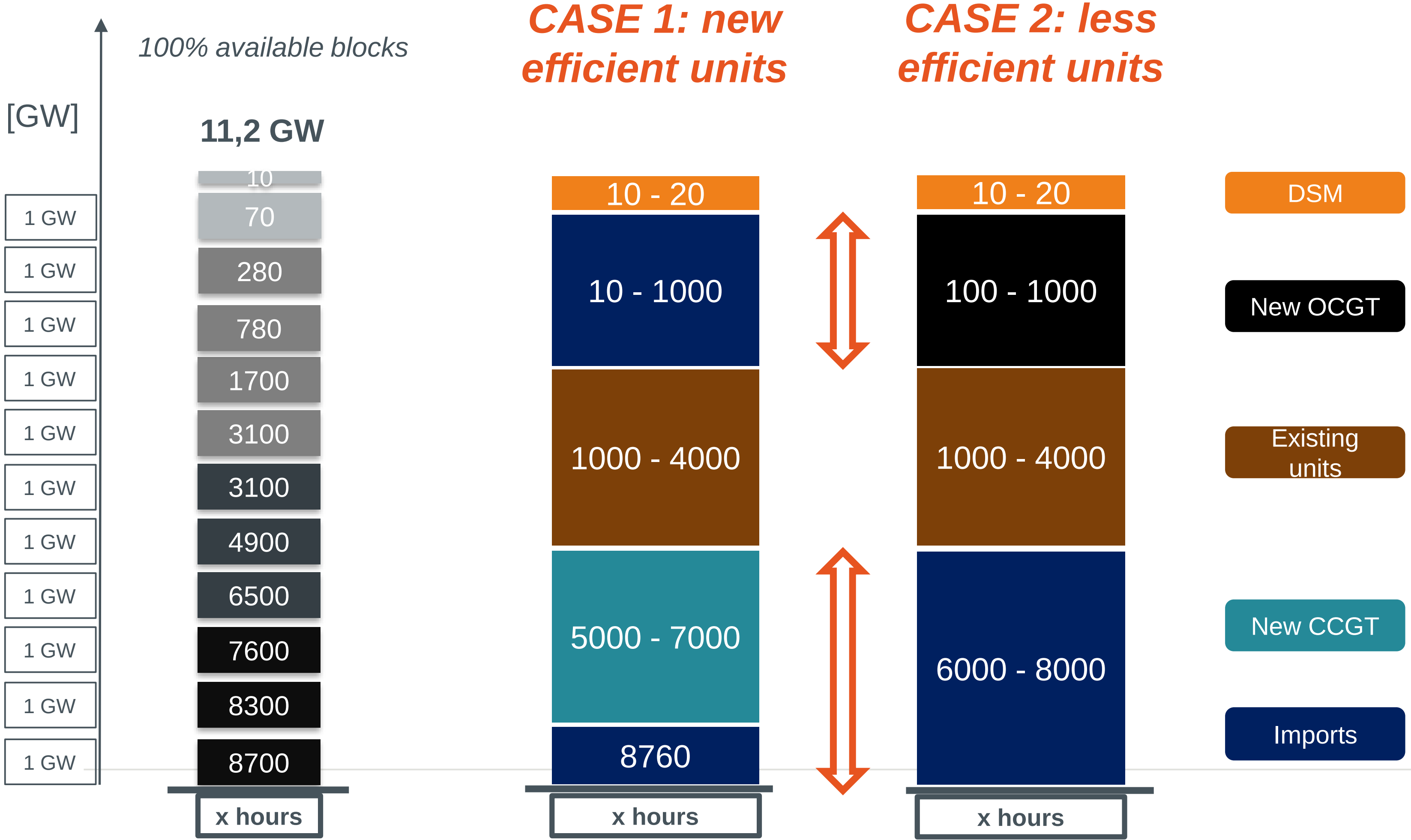
Load
- Wind/PV
- CHP/bio

5 Choices of new built in Belgium impact electricity prices hence welfare and imports of electricity (see next slide)

Note that storage was not represented as it is a shifting of energy but it also plays a role in the economic dispatch by decreasing running hours in the top blocks and increasing in the lower blocks.
It also has a contribution to reduce the total need as shown in the previous slide.

CASE 1: new efficient units

CASE 2: less efficient units



1 **Filling first the need with existing units/technologies**

2 **The rest has to be filled with new built units in BE (at least 3,6 GW) and imports**

3 **In the first case the choice is made to built efficient units, in the second, less efficient units**

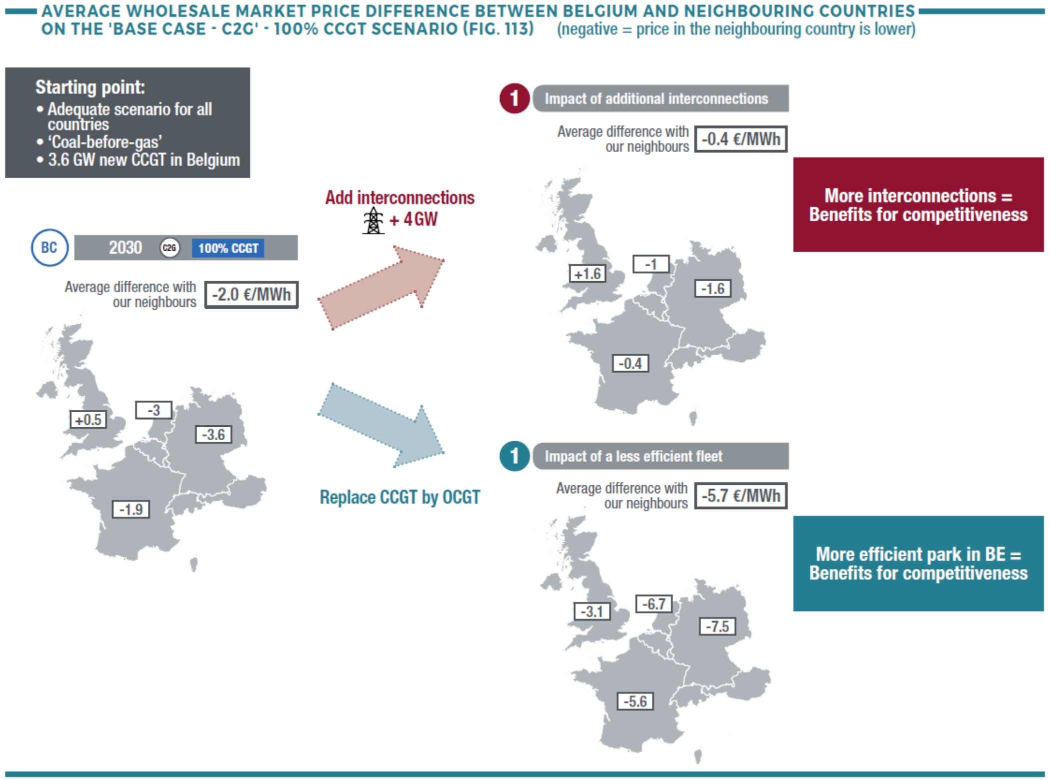
4 **The rest being “filled” by imports**

Impact on prices

We recall that the study has identified that:

- Filling in the need of 3,6 GW new capacity with less efficient technologies has a negative impact on total welfare (cf average price difference with neighbouring countries of -5,7 EUR/MWh if filled by OCGT versus CCGT);

- Without support mechanism, only 1,6GW of the needed 3,6GW will emerge on the markets. The lack of 2GW will lead to average LOLE of 17hours and to an average price difference with neighbouring countries of about 15,4EUR/MWh.

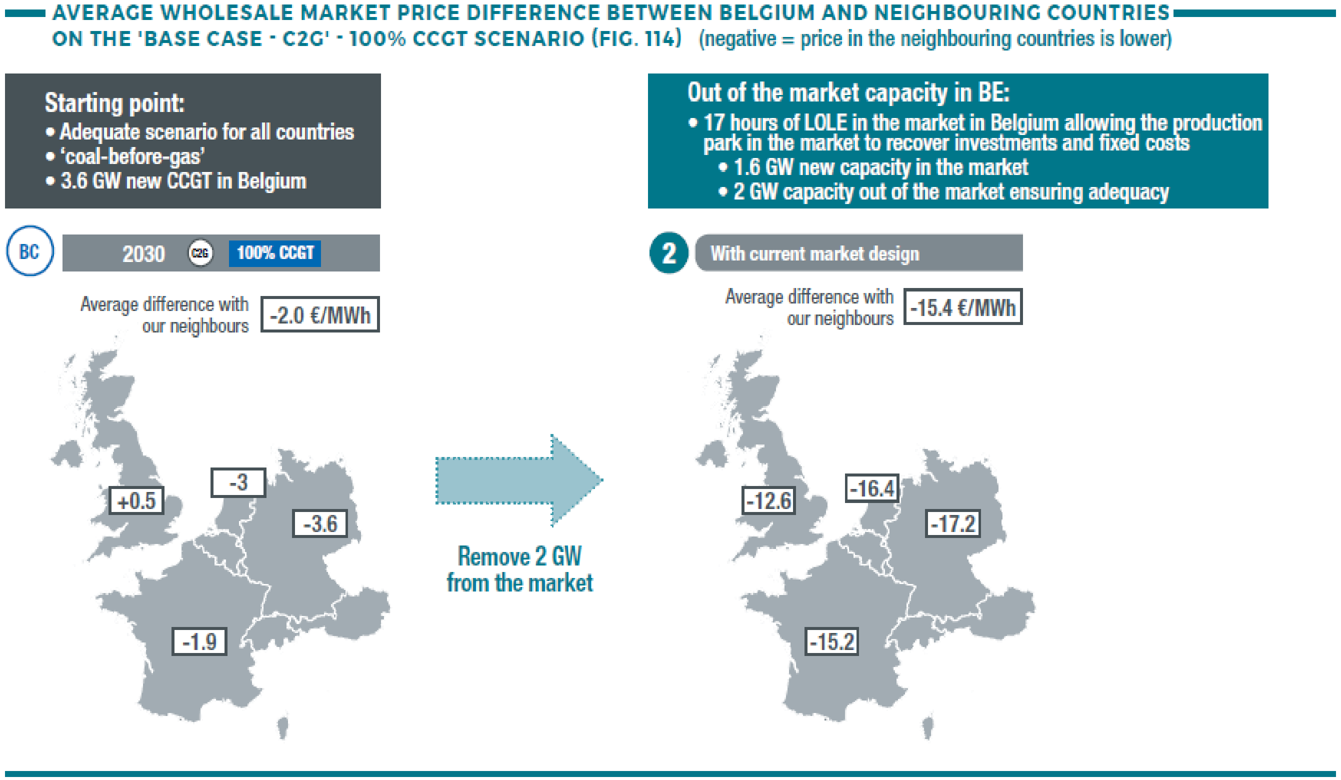


AVERAGE WHOLESALE MARKET PRICE DIFFERENCE BETWEEN BELGIUM AND NEIGHBOURING COUNTRIES ON THE 'BASE CASE - C2G' - 100% CCGT SCENARIO (FIG. 113) (negative = price in the neighbouring country is lower)

Starting point:
- Adequate scenario for all countries
- 'Coal-before-gas'
- 3.6 GW new CCGT in Belgium

More interconnections = Benefits for competitiveness

More efficient park in BE = Benefits for competitiveness



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- Adequate scenario for all countries
- 'coal-before-gas'
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Out of the market capacity in BE:
- 17 hours of LOLE in the market in Belgium allowing the production park in the market to recover investments and fixed costs
  - 1.6 GW new capacity in the market
  - 2 GW capacity out of the market ensuring adequacy

Conclusion

Adequacy

To keep the lights on, there is a need for new-built thermal capacity (new CCGT, new OCGT, new CHP, new biomass,…) in all scenarios after the nuclear phase-out and this for the whole time horizon covered by this study.

According to the study's results, this new-built capacity needs to reach at least 3.6 GW by 2025. This figure of 3.6 GW counts upon an important contribution from DSM, RES and storage, which is considered separately and comes on top of the new-built capacity needs.

Missing money

Under the current market design - while keeping prices roughly convergent with neighbouring countries - the study demonstrates that the wholesale market will not remunerate the full costs of the necessary thermal investments.

Additional measures to ensure new capacity investments will be necessary.

Economic optimum

A Belgian new thermal fleet with a higher proportion of efficient units (CCGT) is the most interesting option for the country to remain competitive with its neighbouring countries and to create industrial opportunity.