



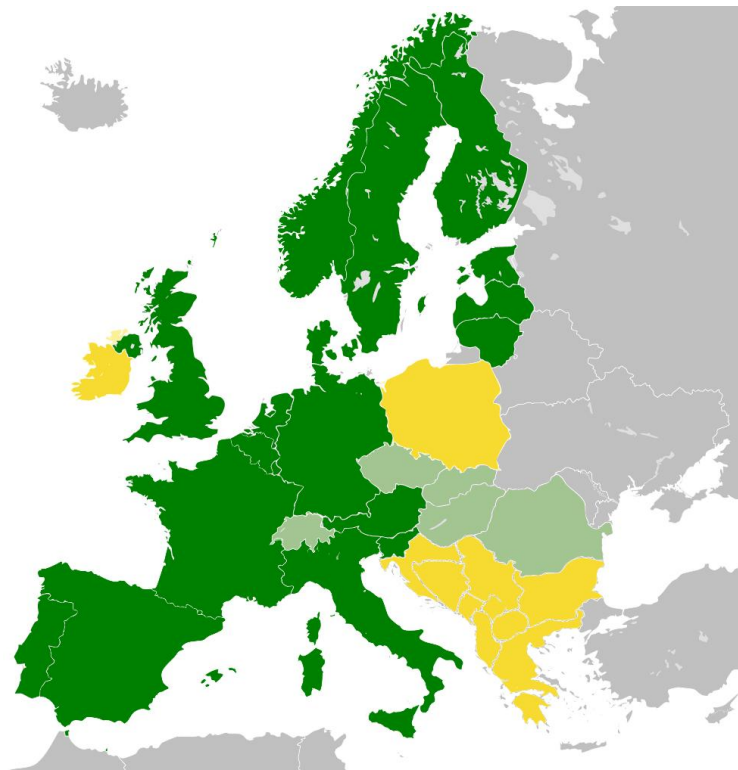
The inevitable downfall of the Belgian electrical power industry?

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March 2015

The EU electricity market

Electricity is a commodity which is **traded at the European level**, thanks to the coupling of national electricity markets. The future of the Belgian electrical industry depends on its ability to be competitive at this level.

Dark green: Countries forming the EU day-ahead electricity market - Light green: Joining soon - Yellow: Nothing decided yet but likely to join.



Belgium electrical industry, EU market and growth

Question: Can the Belgian electrical industry grow in a European market?

Assumptions: (i) We consider that power companies only compete according to a €/MWh metric (ii) We consider that the electrical network does not interfere with the market (e.g., no congestion on lines) (iii) No subsidies.

Costs and electrical energy sources

New nuclear power: (i) Expensive (deal between EDF and the UK government is valued at 110 €/MWh for two nuclear units in Hinkley) (ii) Risky projects (Areva seems to be unable to complete its two EPRs in Europe) (iii) Dismantlement of nuclear power plants may bring costly surprises. \Rightarrow Nuclear power has a bleak future.

Thermal: Mostly gas and (different types of) coal. Costs in the range of 30 €/MWh to 80 €/MWh. If ecological costs are neglected, as it is pretty much the case in Europe, coal-fired power plants are significantly cheaper to run than gas-fired ones. This is due to the fact that, in Europe coal costs around 8 €/MWh and gas more than 25 €/MWh.



Renewables: On-shore wind and photovoltaic (PV) are the big winners. They also become competitive with thermal power in good locations. On-shore wind is still cheaper than PV, though the cost of PV is dropping faster than cost of on-shore wind.

The future of nuclear, thermal and renewable energy sources in Belgium

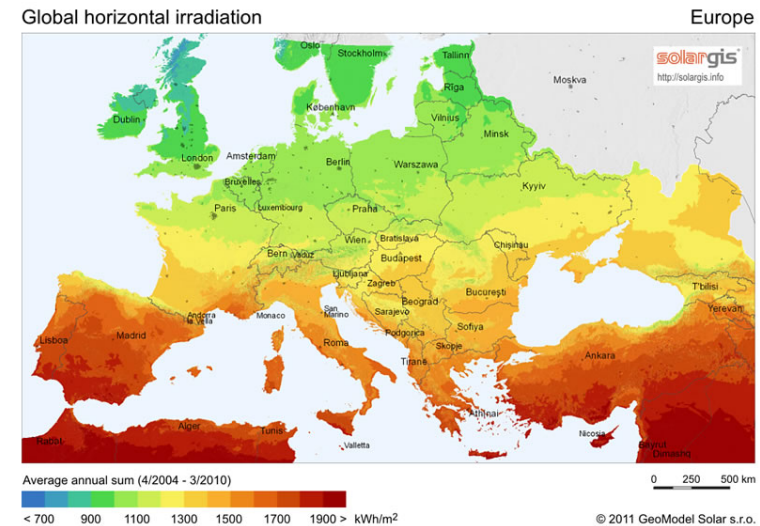
Nuclear: Not competitive; new reactors will not be built.

Thermal: Coal-fired power plants cannot be built anymore in Belgium due to environmental constraints. This is not the case in many other EU countries. As gas is not competitive with coal, thermal plants in Belgium will never be competitive at an EU level.



Picture of the E.ON coal-fired power station in Rotterdam (The Netherlands); E.ON could never obtain an environmental permit to build it in Antwerp (Belgium).

Renewables: Belgian PV power will be put out of business by PV power generated in Southern Europe, where solar irradiance levels are virtually double.



Good locations exist in Belgium for on-shore wind power, but these are limited, mostly because of the poor social acceptance of wind mills. I estimate that **10 TWh** is a loose upper bound on the potential of on-shore wind energy in Belgium. The annual Belgian consumption of electricity was 83 TWh in 2013.

Note: It is also the poor social acceptance of on-shore wind power in many other EU countries that makes these locations particularly valuable.

Answer: Given our hypotheses, only on-shore wind power as an electricity source could still expand in Belgium, provided that (i) the cost of wind power in Belgium stays below the cost of PV energy in the primary European locations **AND** that (ii) the cost of wind power falls below the cost of thermal power.

Additionally, on-shore wind energy could grow to at most 10 TWh in Belgium. This is equivalent to the energy produced over one year by a constant power source of $\frac{10 \times 10^{12}}{8760} = 1142$ MW. Assuming a load factor of 0.3 for wind mills, this corresponds to $\frac{1142}{0.3} \simeq 3800$ MW of wind capacity or around 500 Enercon E-126 wind mills (capacity 7.6 MW).

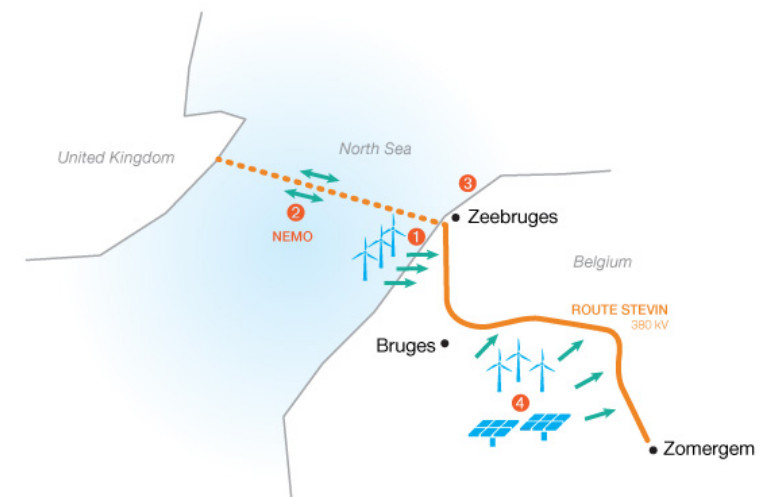


Limited import capacity of Belgium

Previous analysis was carried out based on many assumptions, among which was that Belgium could physically import all its electrical energy.

Question: What is the minimum amount of electrical energy that should still be generated in Belgium given its limited import capacity?

Assumptions: (i) Future Belgian annual consumption will remain equal to its 2013 value, that is to 83 TWh (ii) Import capacity in 2015: 4000 MW; in 2020: 7000 MW (increase due to three projects developed by ELIA: Nemo, Alegro and Brabo). Import capacity always fully available. (iii) Consumption remains constant over the year.



Since consumption is constant, it is always equal to $\frac{84 \times 10^6}{8760} = 9475$ MW.

With the 4000 MW import capacity used at its maximum value, 5475 MW of power should always still be generated in Belgium, which corresponds to a yearly energy output of **48 TWh**.

With a 7000 MW import capacity, this amount drops to **22 TWh**.

Note: If we assume that consumption always stays above the maximum import capacity rather than being constant, the same results would have been obtained.

Guaranteed capacity

Question: What about the minimum amount of guaranteed capacity needed in Belgium after 2020?

Assumption: (i) Maximum peak load 14000 MW (ii) At any time we can import 7000 MW.

Answer: $14000 - 7000 = 7000$ MW.

Minimum requirements after 2020: We can say that it will be necessary to generate at least **22 TWh** of energy in Belgium and to have at least a “guaranteed capacity” (comprising, for example, thermal plants, hydro-pumped stations and load curtailment schemes) in the country of **7000 MW**.

Belgian electrical power production sources

Nuclear (Tihange 1 and 3, Doel 4): 3050 MW (competitive)
Nuclear (Doel 1-3, Tihange 2): 2950 MW (competitive but uncertain)
Coal: 550 MW (competitive but environmental permit expires in 2016)
Liquid fuels: 250 MW (not competitive)
Gas: 4900 MW (not competitive)
Gas (strategic reserve): 750 MW (out of market; may increase soon in size)
Other (waste, gas furnace, etc.): 700 MW (partially competitive)
Water: 100 MW (competitive; load factor $\simeq 50\%$)
PV: 3 GW (load factor $\simeq 10\%$)
Wind: 2000 MW (load factor $\simeq 30\%$)
Hydro-pumped: 1150 MW

Question: How does the maximum amount of yearly energy that can be generated by this set of plants and its maximum guaranteed capacity compare with the minimum requirements computed for the 4000 and the 7000 MW import capacities?

Production	Max. Energy	Max. Guaranteed capacity
3050 MW nuclear	92 TWh	10700 MW (+ 750 Res.)
6000 MW nuclear	118 TWh	13650 MW (+ 750 Res.)
Minimum required	Energy	Guaranteed capacity
4000 MW import	48 TWh	10000 MW
7000 MW import	22 TWh	7000 MW

Observation: The minimum energy and capacity requirements in 2020 are much too low **to stop the contraction of the uncompetitive sectors of the Belgian electrical power industry**. For example, with 3050 MW of nuclear (that can generate per year $3050 \times 8760 \simeq 27$ TWh) and 1150 MW of hydro-pumped storage, it is only necessary to maintain/develop $14000 - 7000 - 3050 - 1150 = 2800$ MW of storage/thermal capacity/demand side management to meet these requirements.

An inevitably weak national electrical power industry?

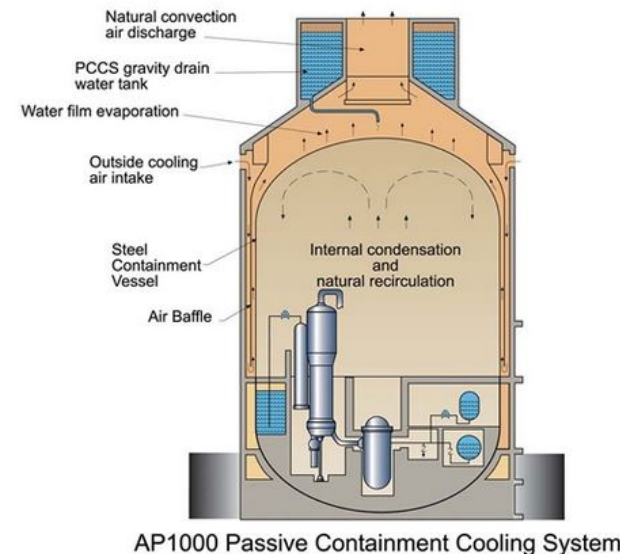
It is likely that with (among others) (i) the intrinsic lack of competition of new electrical power plants in Belgium (ii) our increasing import capacity (iii) the lack of desire of our regional and federal governments towards subsidising renewable energy sources (iv) the planned gradual exit from nuclear power in the ten next years, our electrical power industry will significantly contract in the future.

Question: Are there reasons to believe that this contraction will not happen/stop?

A few reasons why the contraction might stop:

1. Gas once again becomes competitive with coal (this could be the results of, for example, a well-functioning carbon market at the EU level) **AND** renewables plus storage no putting gas out of business.
2. Our governments conclude that it is worth subsidising our electrical power industry (it increases our security of supply and creates local jobs) **AND** the EU lets our governments support it.

3. One can build in Belgium nuclear reactors which are significantly cheaper than the EPR from Areva. Perhaps the AP1000 from Westinghouse?

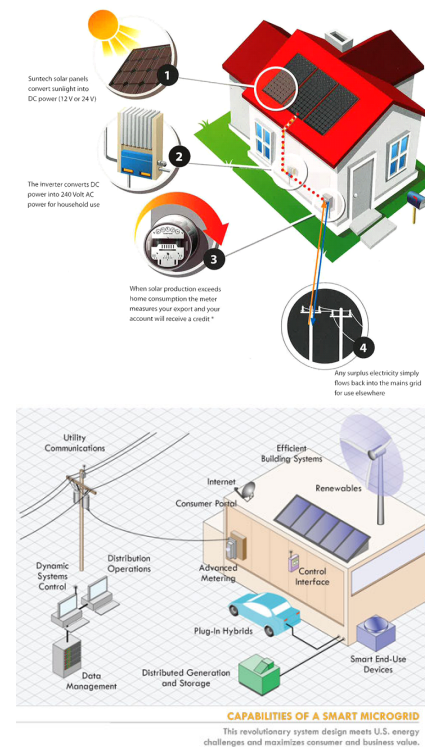
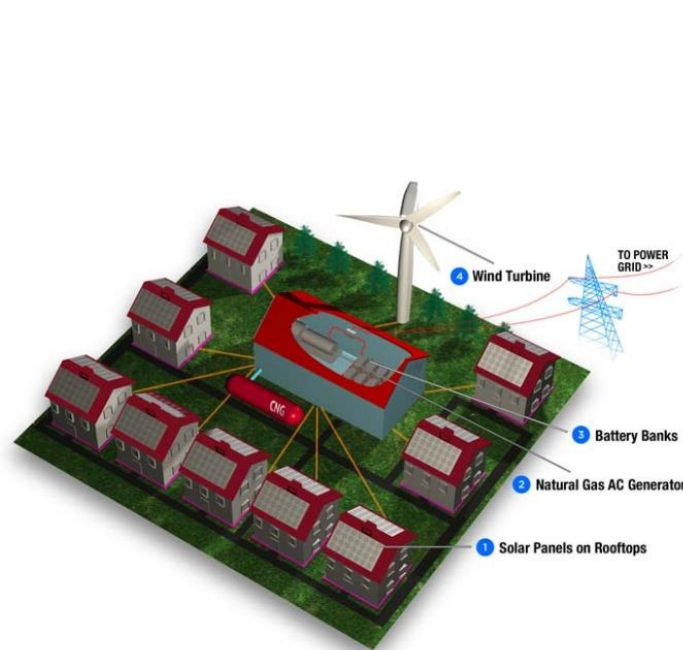


4. All new interconnection projects are not developed. The HVDC ones (Nemo, Alegro) are costly and the benefits they bring to Belgian society are questionable, especially given the way the EU electricity sector is currently organized.
5. The rise of microgrids.

Microgrids: a definition

A **microgrid** is an electrical system that includes single or multiple loads as well as one or several distributed energy sources that can be operated in parallel with the broader utility grid.

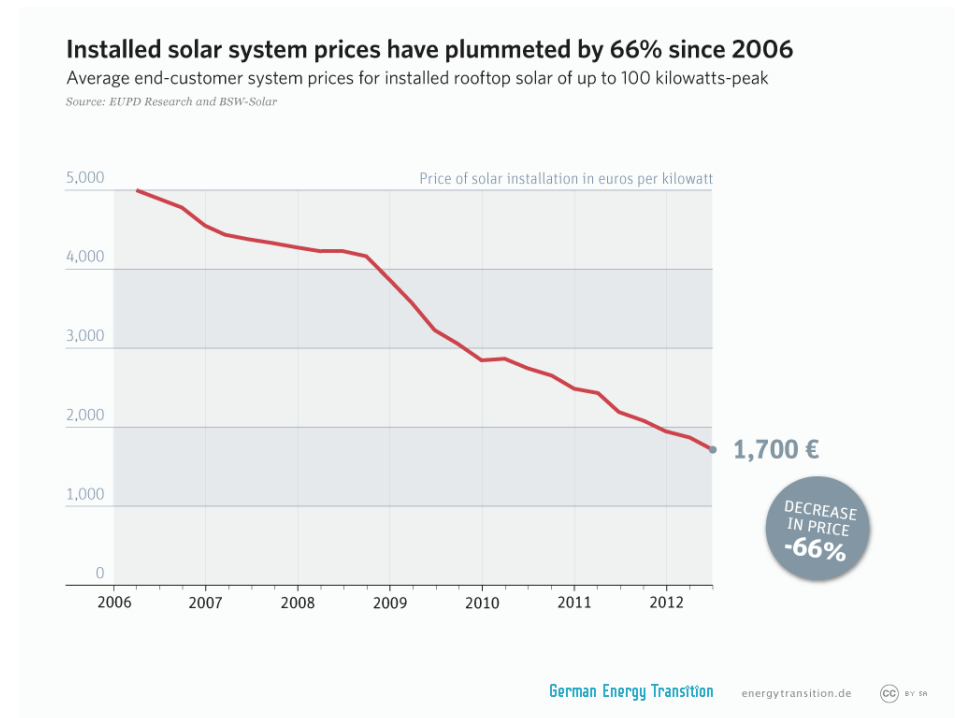
Examples of microgrids:



Two reasons why power generation through microgrids could develop in Belgium

1. This electricity bill that does not charge much for energy. An electricity bill comprises three parts: energy charges, network charges and taxes. Electricity produced and consumed locally is exempt from network charges and taxes, which may account for **more than two-thirds** of the electricity bill for domestic consumers. Consequently, even though microgrids locally produce electricity at a more expensive price than the market price, they can still be competitive.

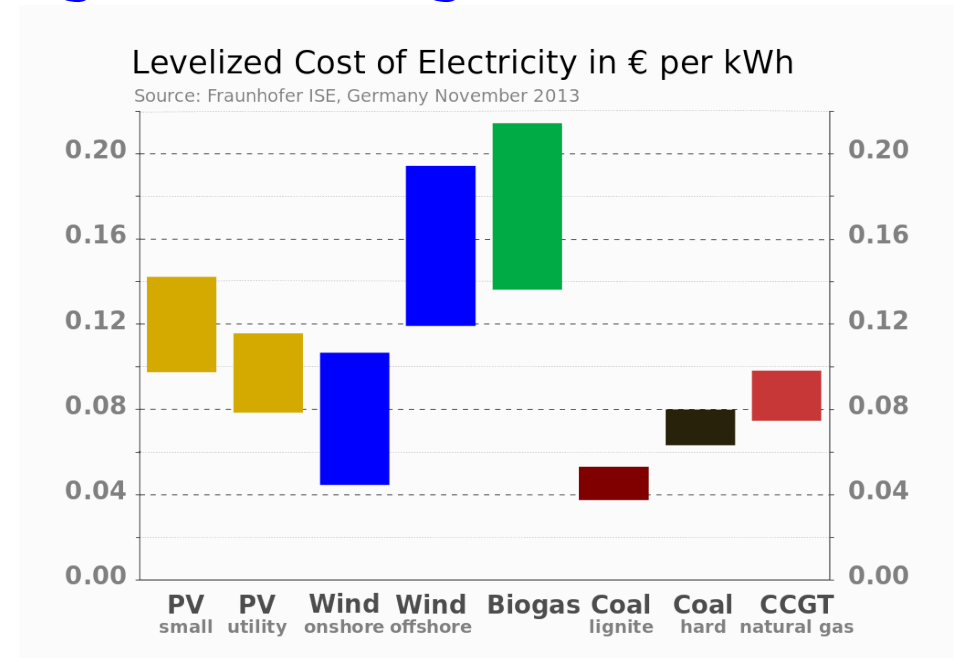
2. Technology. Technological developments have made the production of electricity by small units, that can be used to power microgrids, more and more affordable. The most striking example of this is the falling price of PV energy, which is now around 1.4 €/Wp in Belgium.



Domestic microgrids powered by PV: an example of positive business cases for microgrids in Belgium

Domestic retail price in Belgium:
230 €/MWh.

Levelized Cost Of Energy (LCOE)
for domestic PV in Belgium: In be-
tween 90 and 150 €/MWh; highly
influenced by the discount rate
used in the LCOE computation.



Domestic microgrids powered by PV are highly competitive with current regulation in the French-speaking part of Belgian. It indeed remunerates all the electricity generated by the PV panels at the retail price (provided that the net energy consumption of the house over one year is positive).

A regulation poised to become less favorable for microgrids

With current regulations, in many places in the world, network companies and governments will observe a drop in revenue with the rise of microgrids. This is likely to see **the introduction of less favorable regulations for microgrids in the years to come**. This has the potential to slow down the growth of microgrids, or even kill off growth completely.

The main asset for (renewable-powered) microgrids for circumventing adversarial regulations: **the decreasing price of storage technology**, such as batteries.

Tesla's Gigafactory May Hit \$100/kWh Holy Grail Of EV Batteries, Report Predicts

September 5th, 2014 by [James Ayre](#)

Microgrids sneaking past (adversarial) regulation

PV energy injected into the network is paid only at the wholesale market price? Install batteries to boost local consumption of your electricity.

Network tariff based on peak demand? Use batteries to do peak shaving.

High fixed network charges? Go fully off-grid with batteries for smoothing out short-term fluctuations and a hydrogen-based storage device for long-term ones (such as the pictured Fronius energy cell, which is a combined electrolyser and fuel cell system for domestic use).



Direct taxes on microgrids? Well, with this scenario, there is not much you can do.

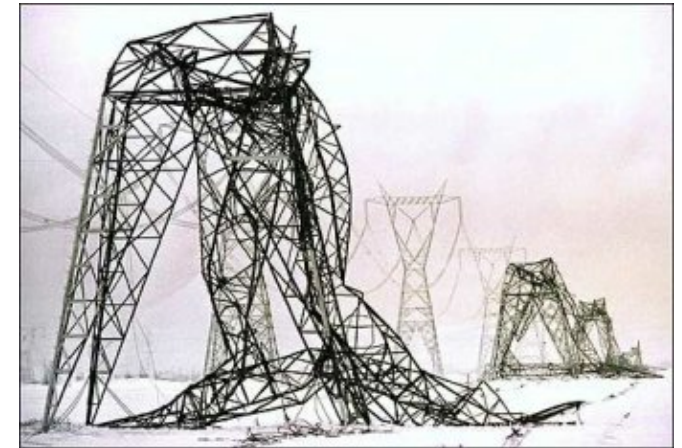
Governments and microgrids

Network tariffs and taxes are set by governments (the federal one and three regional ones for Belgium). Ultimately, they will decide the fate of microgrids.

Here are a few reasons why they may want to support them:

- 1.** Microgrids mean **local economic activities**. Installing/building microgrids will create a lot of local jobs. There is also an opportunity to grow a microgrid-related industry that would export products all over the world. Countries rapidly choosing to support microgrids will be best placed for exploiting it (as Denmark did with wind power).

2. An electrical power system with a high-penetration rate of microgrids is a structure which is **resilient** to terrorist/cyber attacks, technological failures, a global shortage of supply or disastrous meteorological conditions.



3. Microgrids may help to **postpone/avoid very costly future investments in an ageing grid**, especially at the distribution level. If well-integrated, they may also **offer very valuable services** (e.g., balancing services, blackstart capacity) to the grid that may lead to a decrease in network tariffs.

4. Without microgrids, electrical power production in Belgium is very likely to (almost) disappear.

Final word

A friend told me:

“Microgrids are easy to sell to governments. If it is a left-wing government, tell them that it is power to the people; if it is a right-wing one, just hint that it is power for the rich.”

This shows, with humor, the difficulty of effective policy-making in the energy field.

(Explanation: With microgrids, a higher percentage of the electrical power production capacity will belong directly to citizens and not big companies, but only (relatively) wealthy ones may be able to invest into their own microgrid without proper government support.)