Pioneering the Power Landscape: Unveiling Energy Markets and Grid Dynamics

Forward Thinkers Program

Nicolas Paris

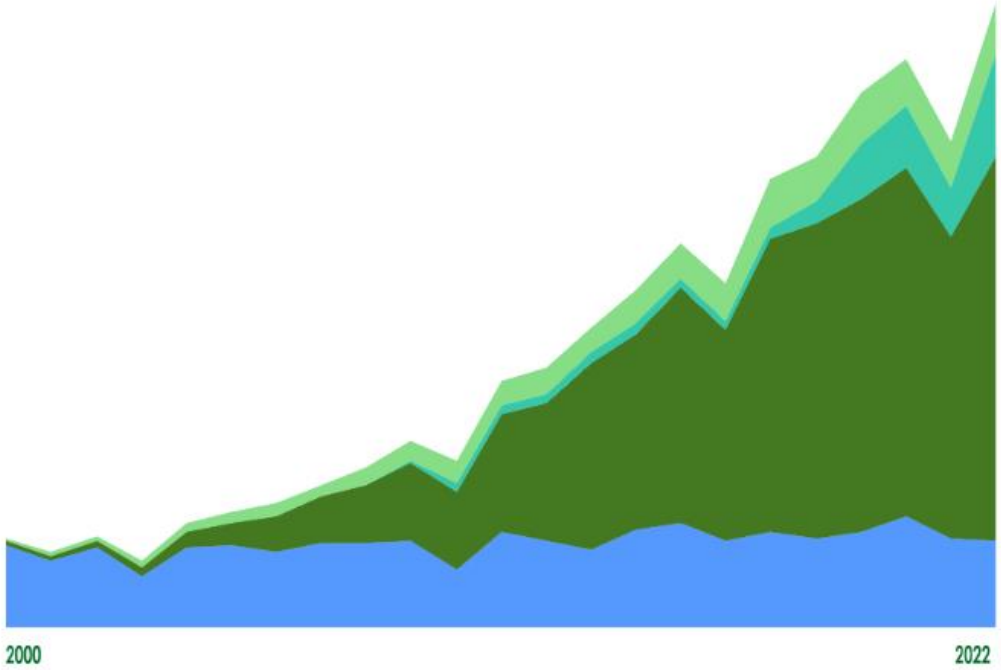
26/09/2023

PARTNER FORUM 2023

Longannet Power Plant
Scotland, Dec 2021

"This demolition is a symbolic reminder that **we have ended coal-fired power generation** in Scotland, as we work in a fair and just way towards becoming a net zero nation by 2045"

– N. Sturgeon, Prime Minister



Other
2.8 TWh

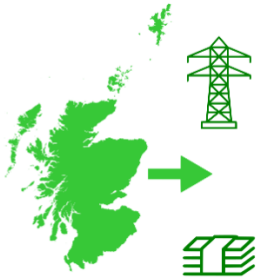
Offshore Wind
5.8 TWh

Onshore Wind
21.8 TWh

Renewable Hydro
4.9 TWh

Renewables met 97% of Scotland's electricity demand in 2020

BBC NEWS



In 2022, there was a **net export** of **18.7 TWh** of **electricity.**

This had an **estimated wholesale market value** of **£4.0 billion**

Take aways

1. We are all energy traders

2. Wind and solar are breaking the traditional electricity system

3. If you don’t go after flexibility, flexibility will come after you

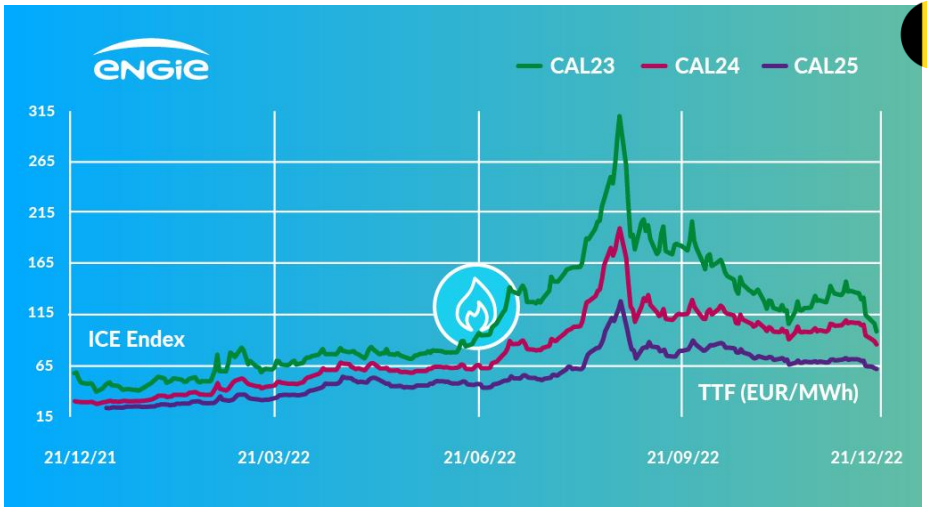
Take aways

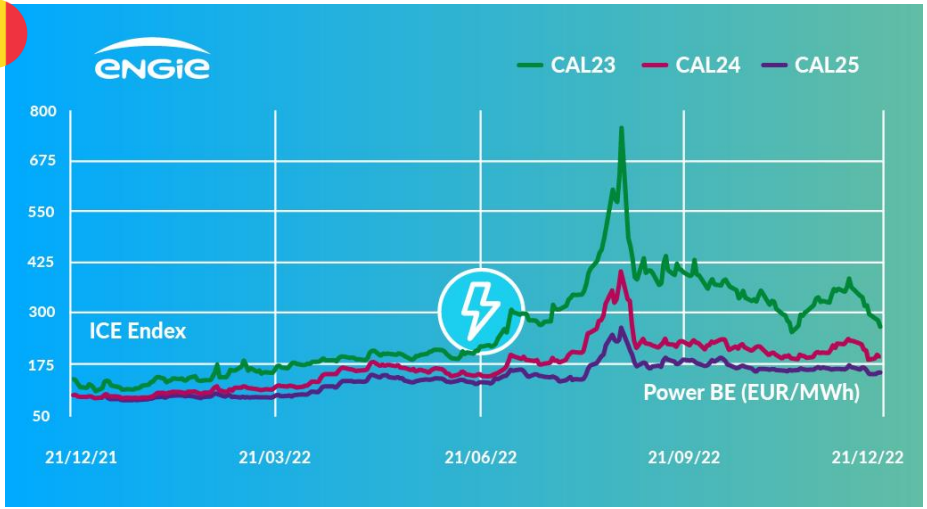
1. **We are all energy traders**

2. Wind and solar are breaking the traditional electricity system

3. If you don’t go after flexibility, flexibility will come after you

Your gas and power **contracts** are indexed on **market prices**



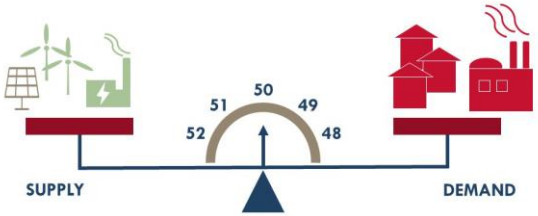


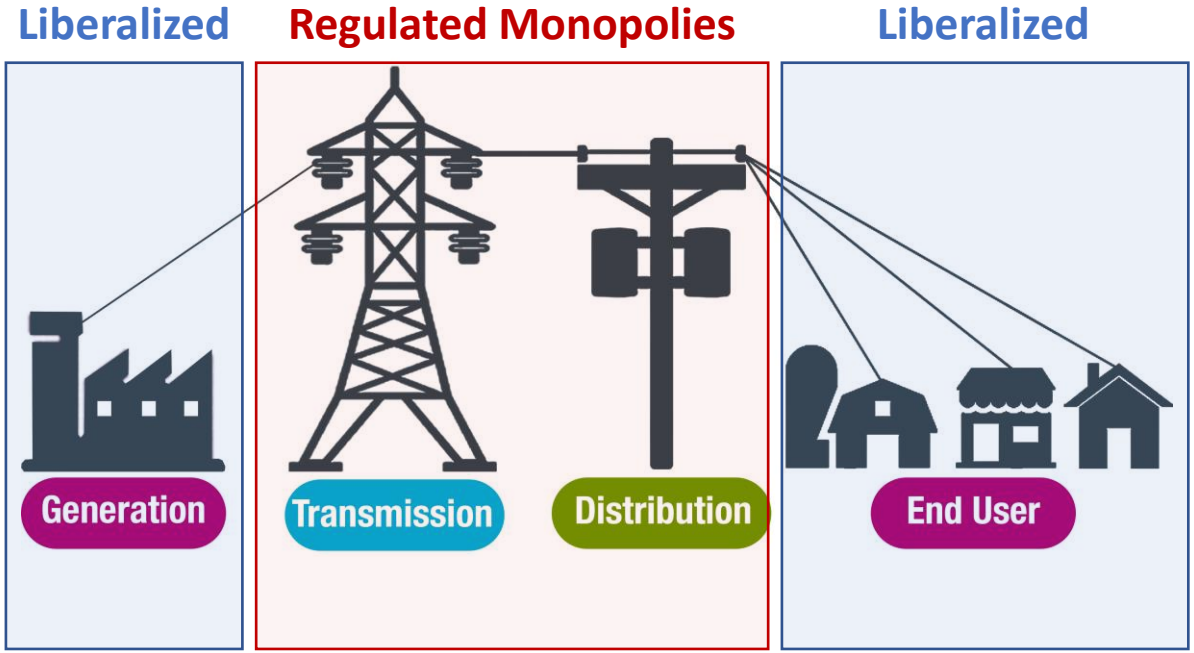
ENERGY MARKET NEWS

28 juillet 2022

- « **Gas prices** rised after the annoncement by Gazprom that flows through **Nord Stream 1** will be **divided by two** »
- « **EDF** has reviewed **downwards** its forecast of **nuclear availability**, which has also contributed to increase power prices »

Main roles in the power market





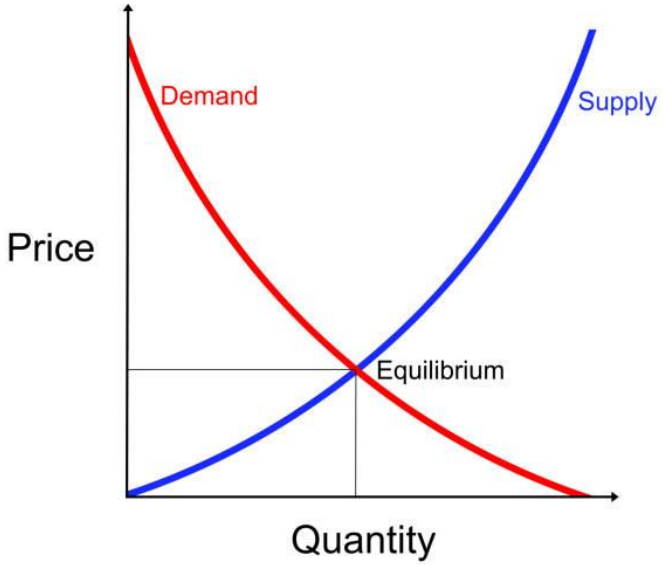
- In **non-liberalized** markets, utilities operate like « water distribution companies », **passing all costs to consumers** including potential inefficiencies

- In **liberalized** markets, utilities compete on the generation and customer sides. Only **most efficient generation units are activated**, based on their variable/marginal costs.

Mechanisms of power pricing

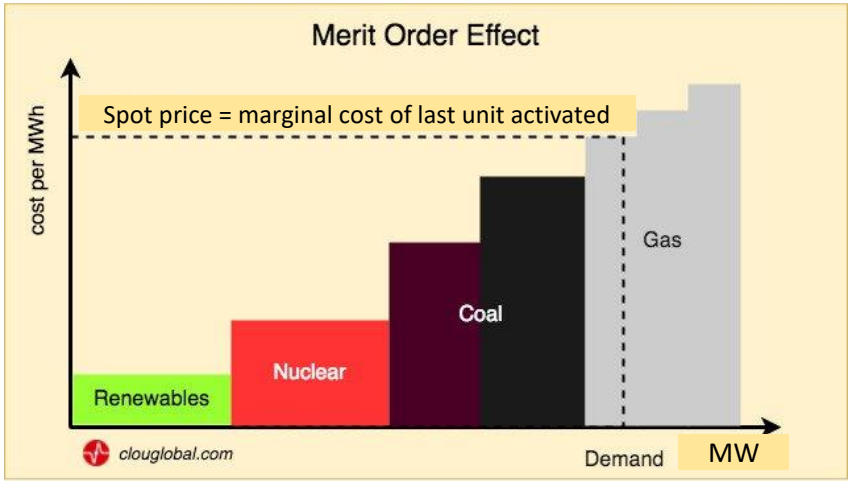
Law of Supply and Demand in Economics

Market price is the intersection of the supply and demand curves

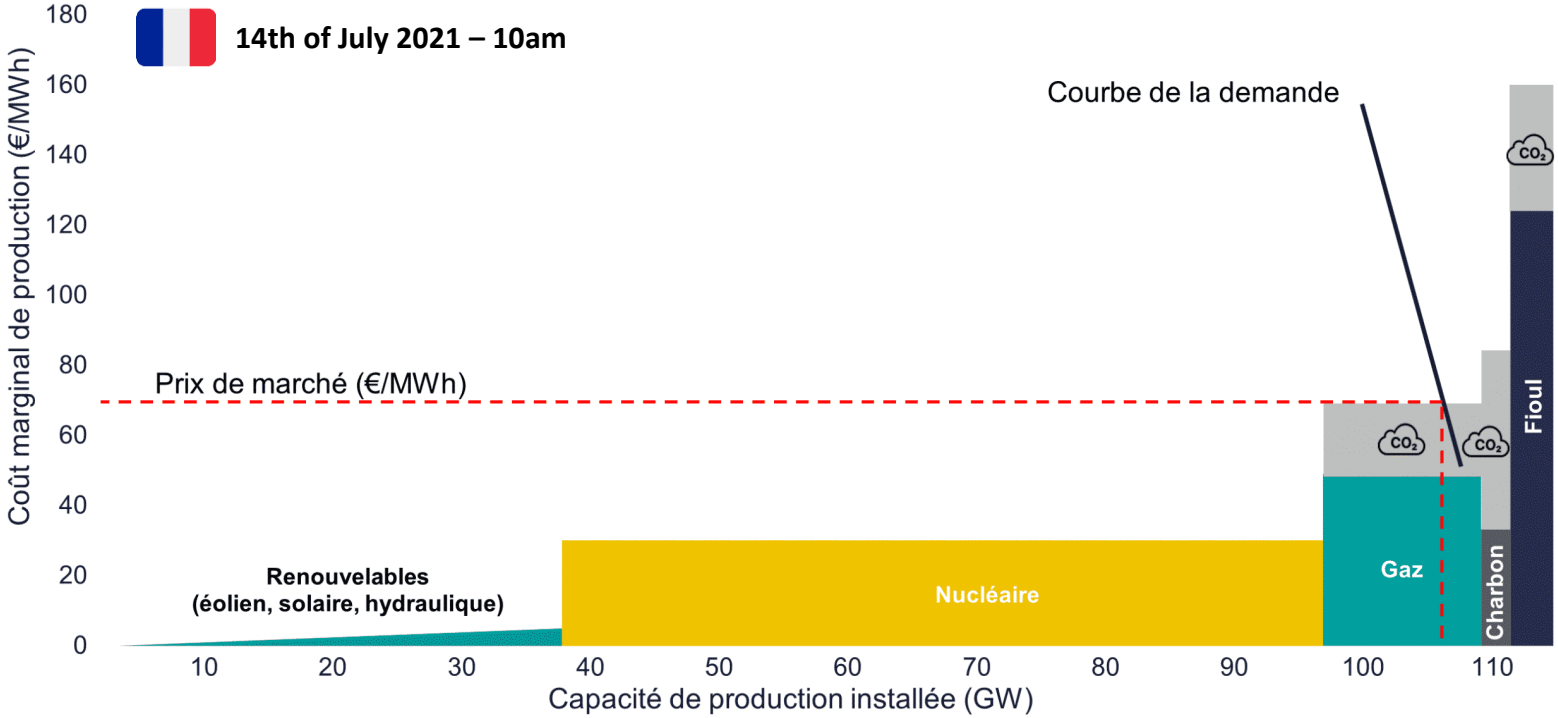


For liberalized power markets : Merit Order

Supply curve stacks variable generation costs. Demand is inelastic.



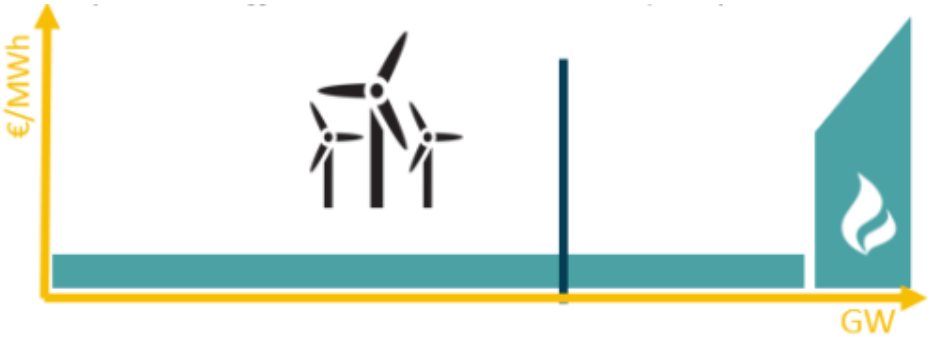
For each settlement period in each market, there is **one** price



Drivers of price volatility

Low renewable production, high power demand

➔ Many fossil generation units are "**in-the-money**" hence activated, even those with high running costs
➔ High marginal cost of the last kWh produced
➔ High market price

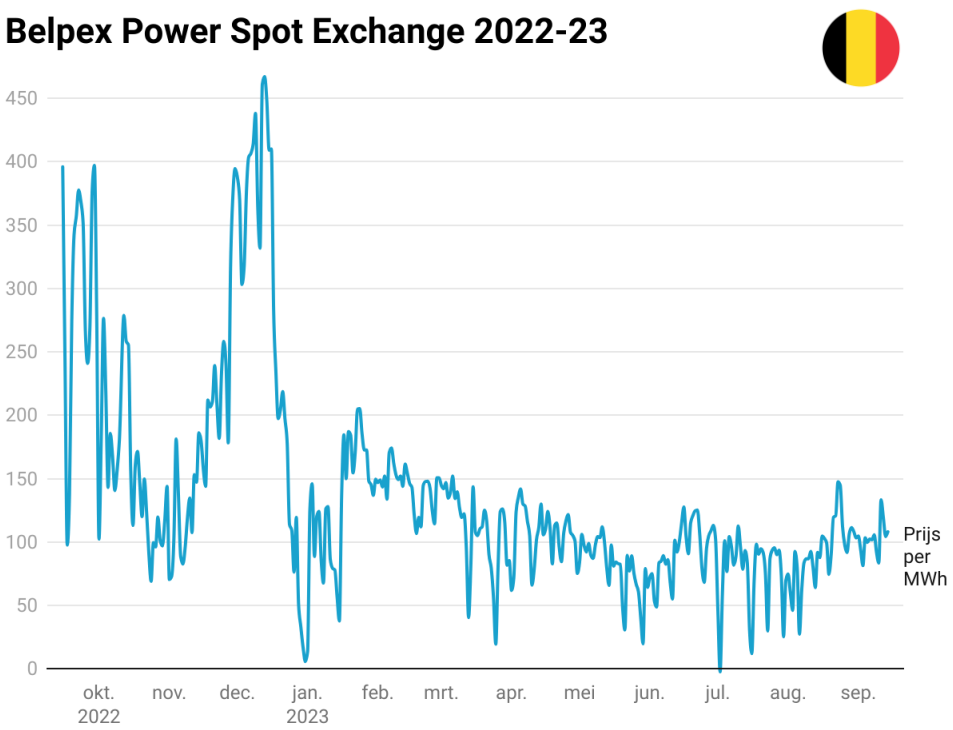


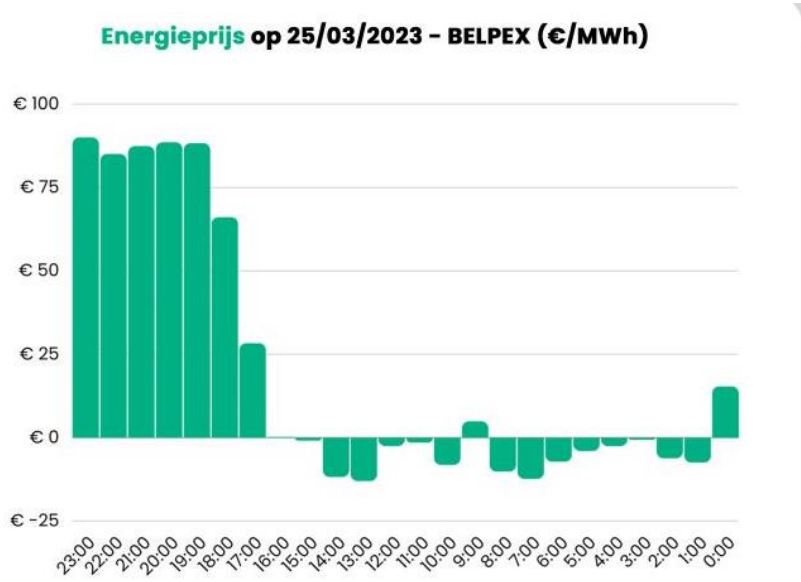
High renewable production, low power demand

➔ Demand is fully met by renewables: fossil generation units are "**out-the-money**"
➔ Low marginal cost of last kWh produced
➔ Low market price

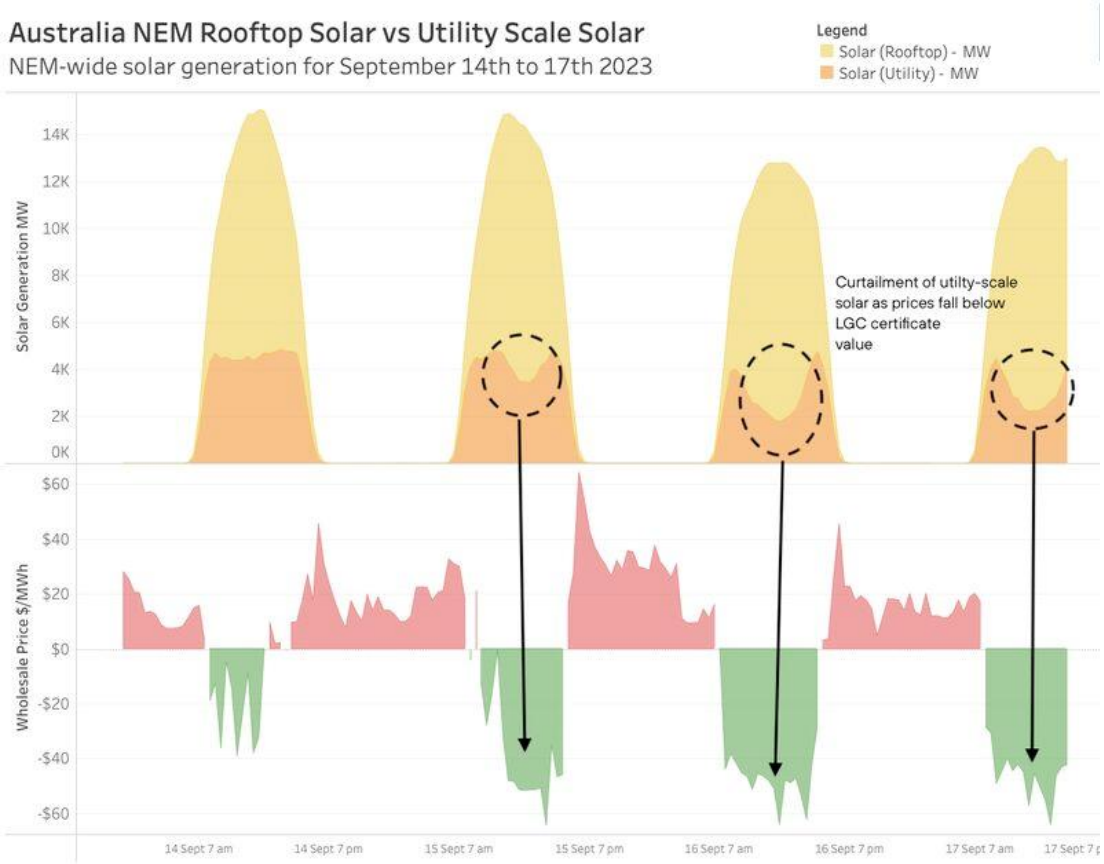
CE+T PARTNER FORUM 2023

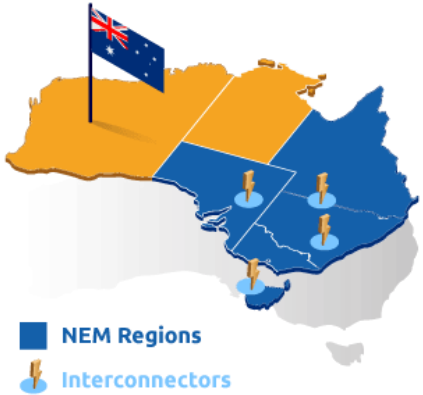
Merit Order limitations: price **volatility** and **negative prices**

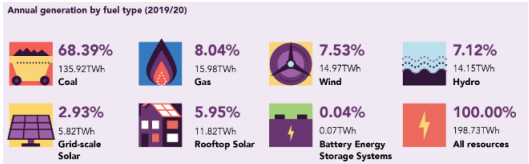




Negative prices lead to « **curtailments** » and « **price cannibalization** », lowering the value of power from renewables





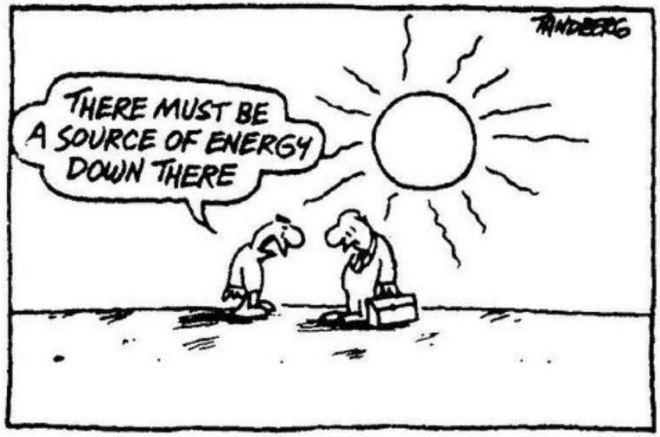


Merit Order was suited for last decades. Is it for next ones ?

- ✓ Mechanically produces a **transparent market price** that corresponds at all time to an economical optimum between supply and demand
- ✓ Provides **incentives to all competing operators to invest in cost-efficient generation units** compared to peers, to avoid the risks of having idle units
- ✓ Pushes forward decarbonation as **renewables always have priority** with their zero marginal cost and **carbon cost is included** in gas and coal generation

- ⊗ **Creates high price volatility** in power systems with high renewables combined with high fossil fuel costs
- ⊗ **Does not structurally protect security of supply** as merit order is based on marginal costs – long-term strategic investments may not be properly considered
- ⊗ Ultimately, in a power system 100% solar and wind, the **notion of marginal cost will disappear** – markets are more and more shifting towards reserve remuneration mechanisms (€/kW vs €/kWh)

Take aways

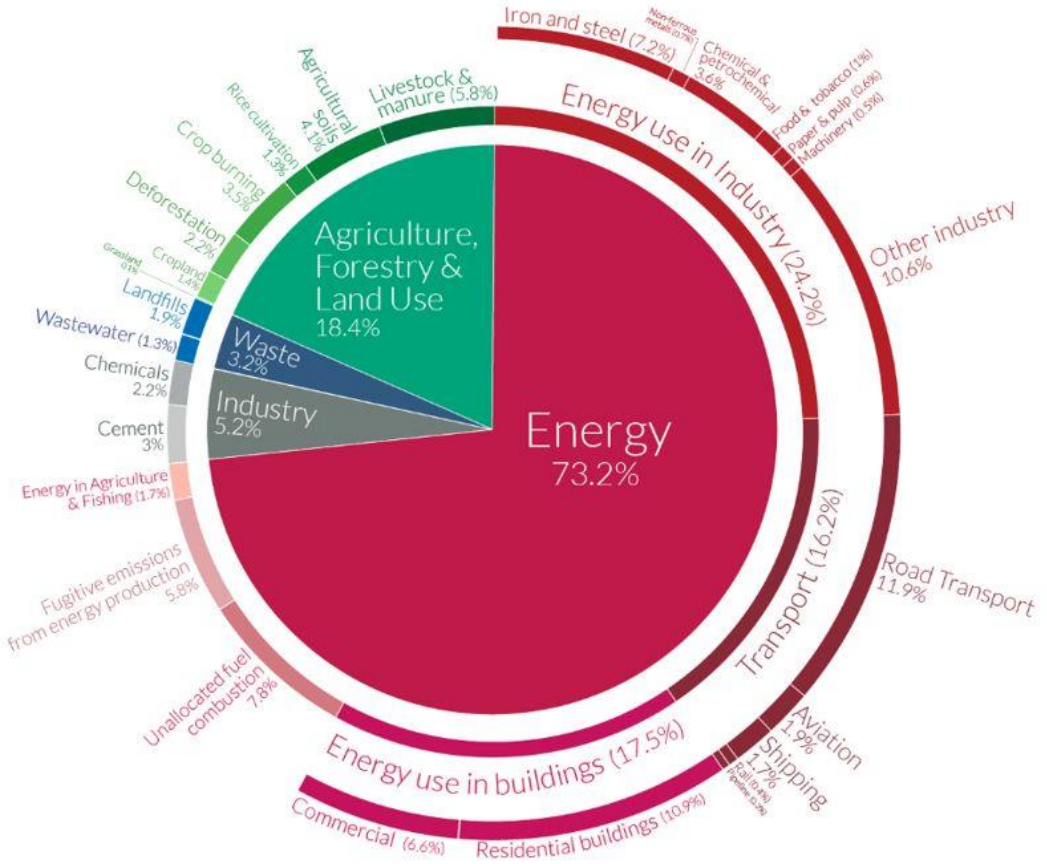


1. We are all energy traders

2. **Wind and solar are breaking the traditional electricity system**

3. If you don’t go after flexibility, flexibility will come after you

Fossil must go.

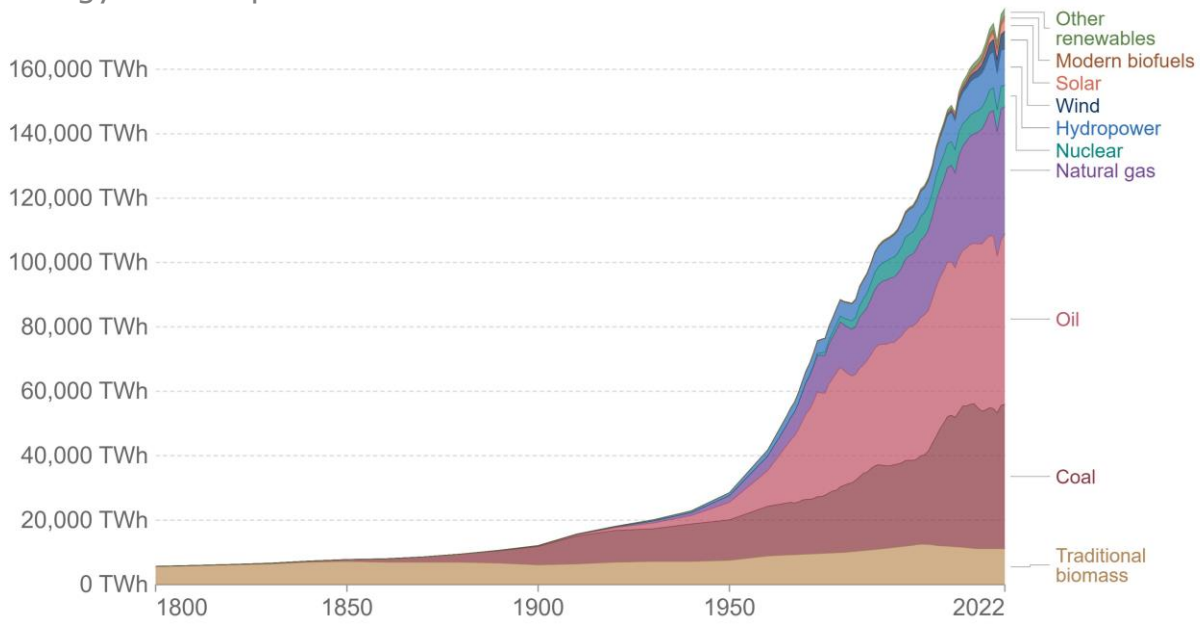


OurWorldinData.org – Research and data to make progress against the world's largest problems.
Source: Climate Watch, the World Resources Institute (2020).

Energy is by far the most emitting sector globally

Reshaping our energy system and **phasing out fossil fuels** are central to climate change mitigation efforts

Global primary energy consumption



Source: Energy Institute Statistical Review of World Energy (2023); Vaclav Smil (2017)
OurWorldInData.org/energy • CC BY

Let's face it:
energy « transition » is something new

Over the last 200 years, energy sources have **piled up** without replacing each other

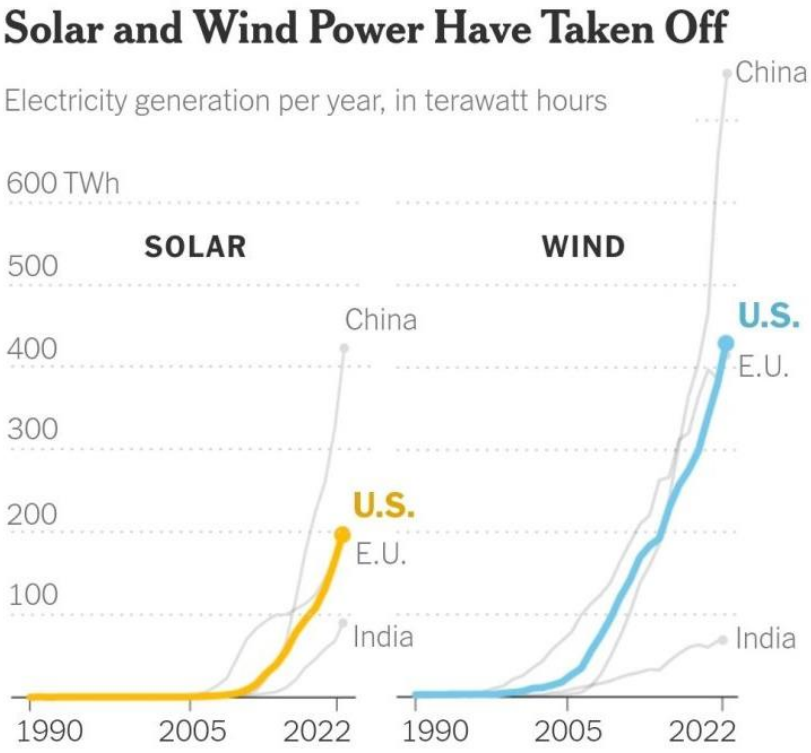
Fossil fuels remain by far **dominant**

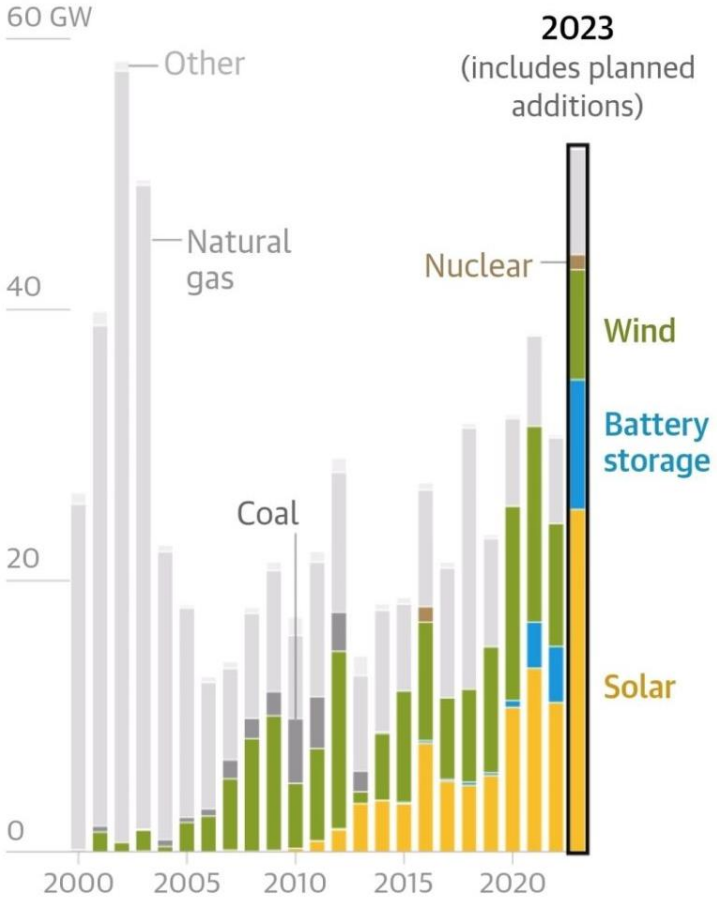
The Stone Age didn't end for lack of stone,
and the oil age will end long before
the world runs out of oil.

- Sheik Ahmed Zaki Yamani

Thanks to **steep learning curves**, **solar and wind are now cheaper than fossil** when it comes to **power generation**

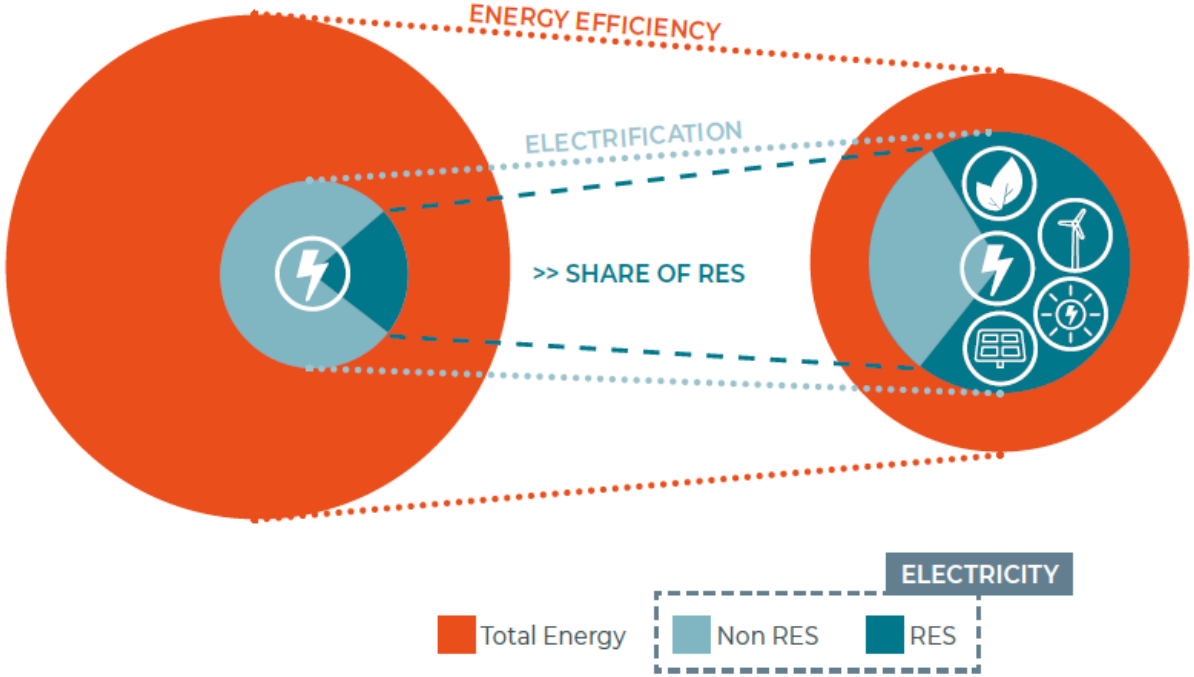
In 2023, over **80% of new power generation capacity** coming online will be **renewable**, mostly wind and solar





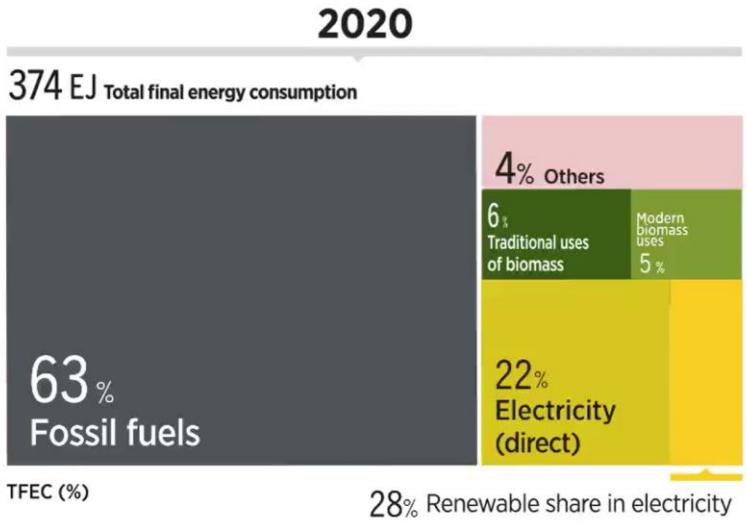
Energy Transition Masterplan

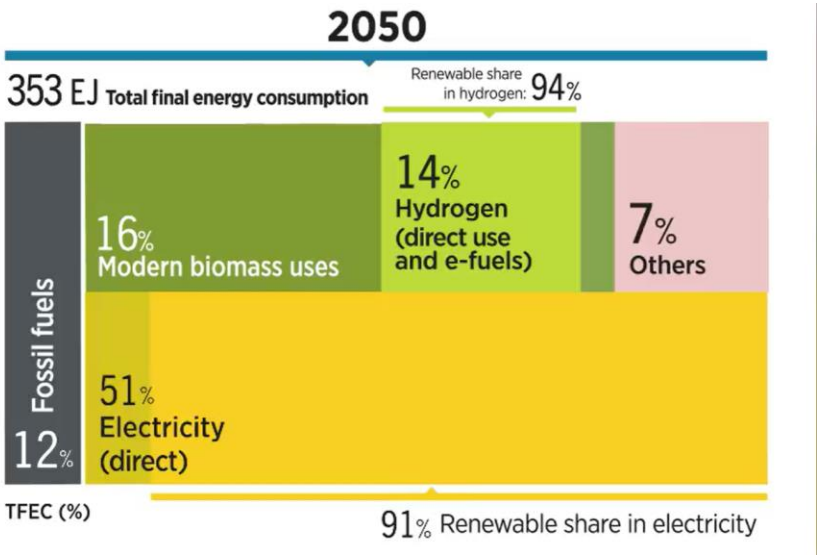
Step 1 – **Maximize energy efficiency**
Step 2 – **Electrify everything**, leading to further efficiency gains
Step 3 – **Clean up the power system**



Clear trends towards 2050

- **Fossil phase-out**
- Deployment of **renewables**
- **Electrification** of transport, heat, industry,…
- **Hydrogen** and biomass for hard-to-abate sectors



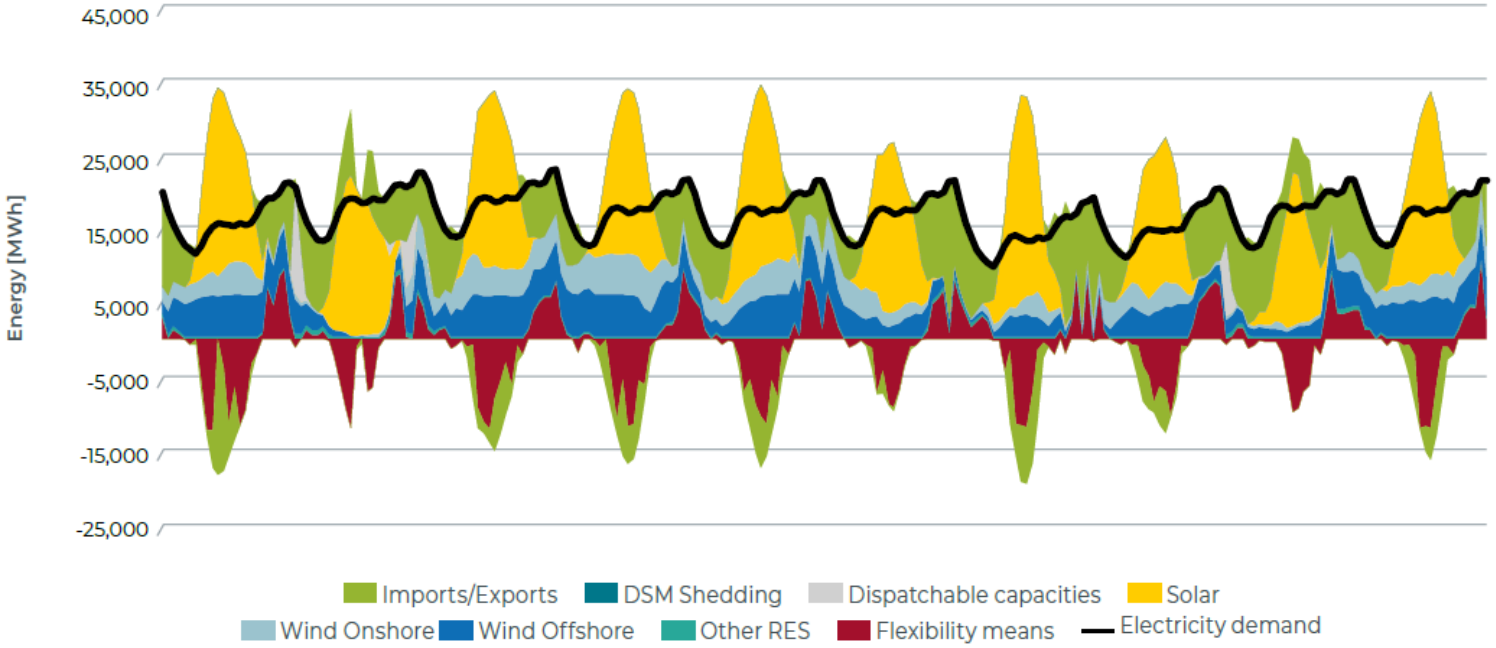


IRENA
International Renewable Energy Agency

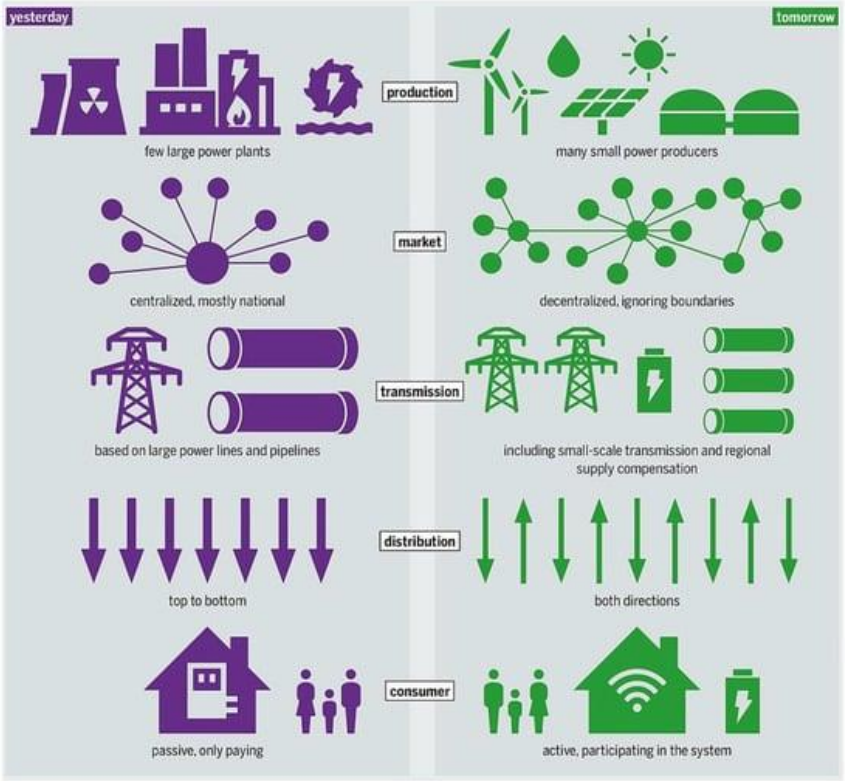
CE+T PARTNER FORUM 2023

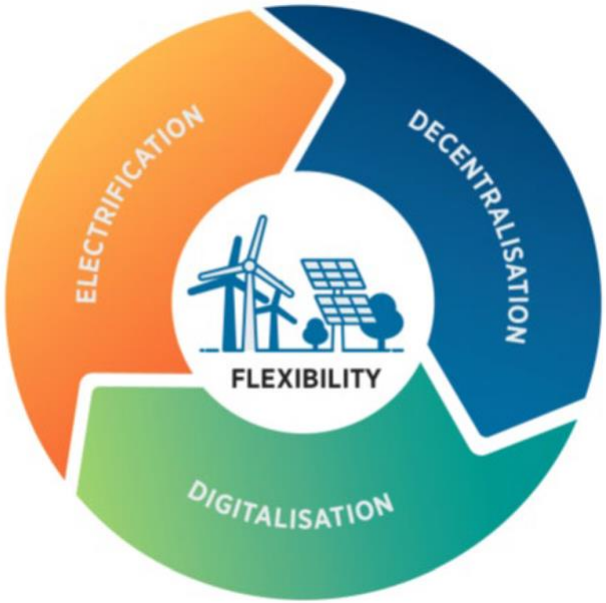
Managing a **100% renewable grid** will need more than incremental changes - new market rules are needed

FIGURE 21: EXAMPLE OF A SIMULATED DISPATCH OUTPUT FOR A SUMMER PERIOD IN BELGIUM BY 2050 (BAUX3 / ELEC), WITH A HIGH LEVEL OF FLEXIBILITY AND AN IOSN+ GRID CONFIGURATION



Easier said than done: **systemic** shift in energy needs to include **several trends** and is a **highly sensitive political issue**





Take aways

1. We are all energy traders

2. Wind and solar are breaking the traditional electricity system

3. If you don’t go after flexibility, flexibility will come after you

Can **grid operators** avoid being **bottlenecks** ?

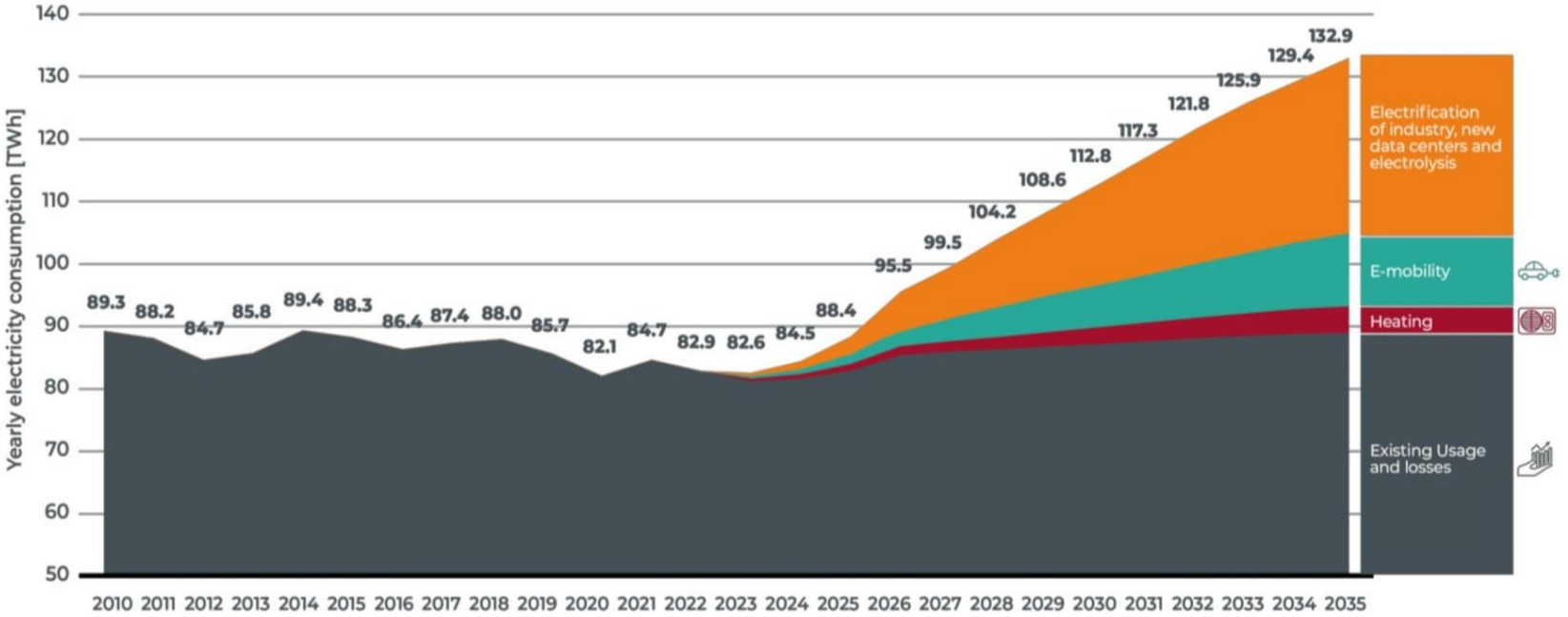
Grid operators face multiple challenges :

1. **Volume** issue: electrification means more power will need to be produced and transported

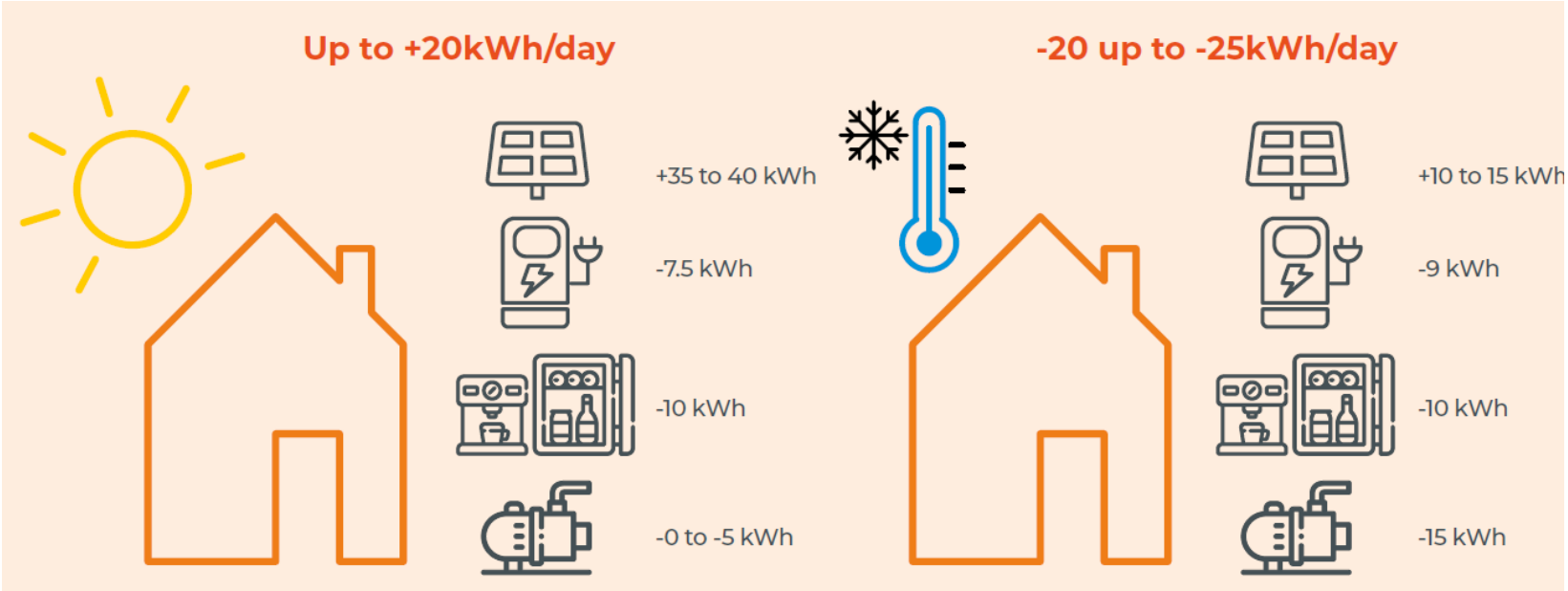
2. **Timing** issue: renewables are intermittent and weather-dependant **and** electricity needs also depend on the season (ex: heat pumps in winter)

3. **Location** issue : high-demand locations such as cities are usually not located next to wind farms and solar parks, hence requiring transmission lines

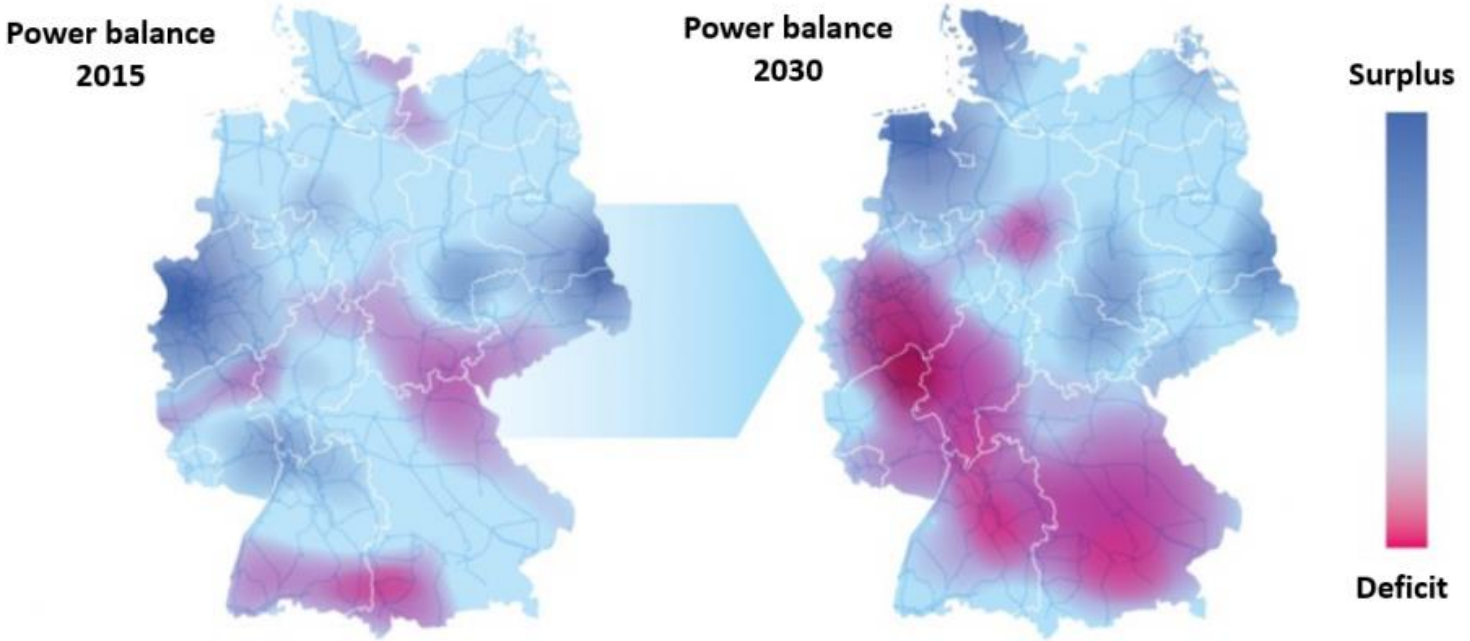
Challenge 1: **volume** – Elia forecasts an increase of **+62% power in 10 years,** mainly due to **industry** and **e-mobility**



Challenge 2: **timing** – illustration of energy balance of a **household** during a sunny day in summer vs cold day in winter



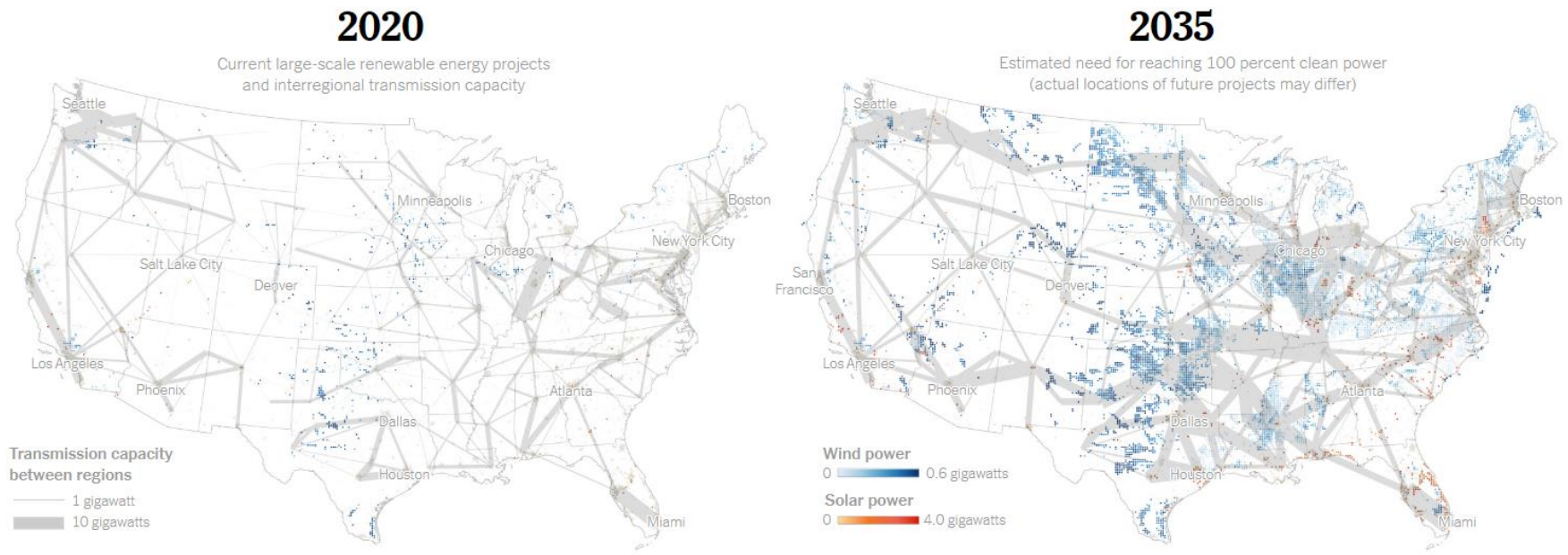
Challenge 3: **location** – illustration of Germany with « **Windy North and Industrial South** », needing new transmission lines



Schematical overview

Source: Amprion.

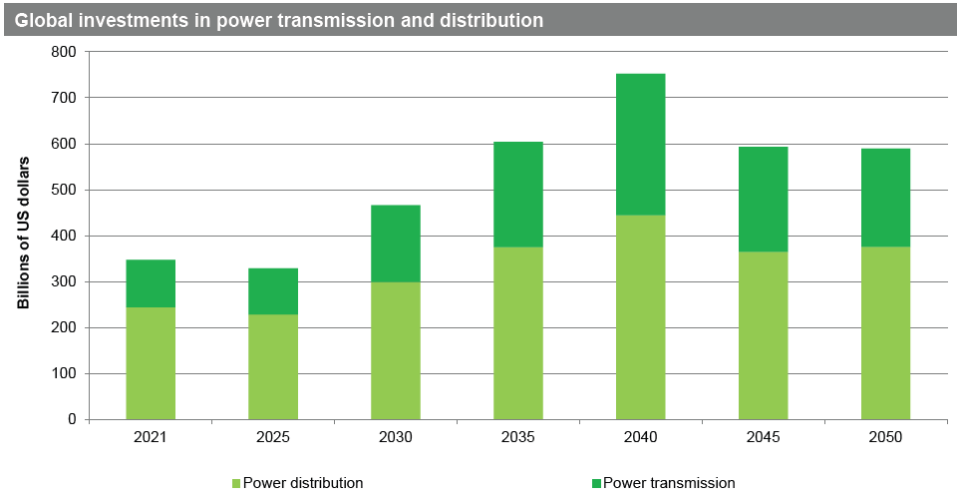
Challenge 3: **location** – illustration of **USA** grid expansion needs, posing the challenge of a **market organized per region**



"Many spots with the **best sun and wind** are **far from cities** and the existing grid. To make the plan work, the nation would need **thousands of miles of new high-voltage transmission lines** — large power lines that would span multiple grid regions. (…) In recent decades, the country **has hardly built any major high-voltage power lines** that connect different grid regions. (…) **These efforts still face plenty of resistance**. Utilities are sometimes wary of long-distance transmission lines that might undercut their local monopolies." – New York Times

CE+T PARTNER FORUM 2023

More copper will not be the sole answer - grid investments **cannot keep pace** today, and they need to double by 2040



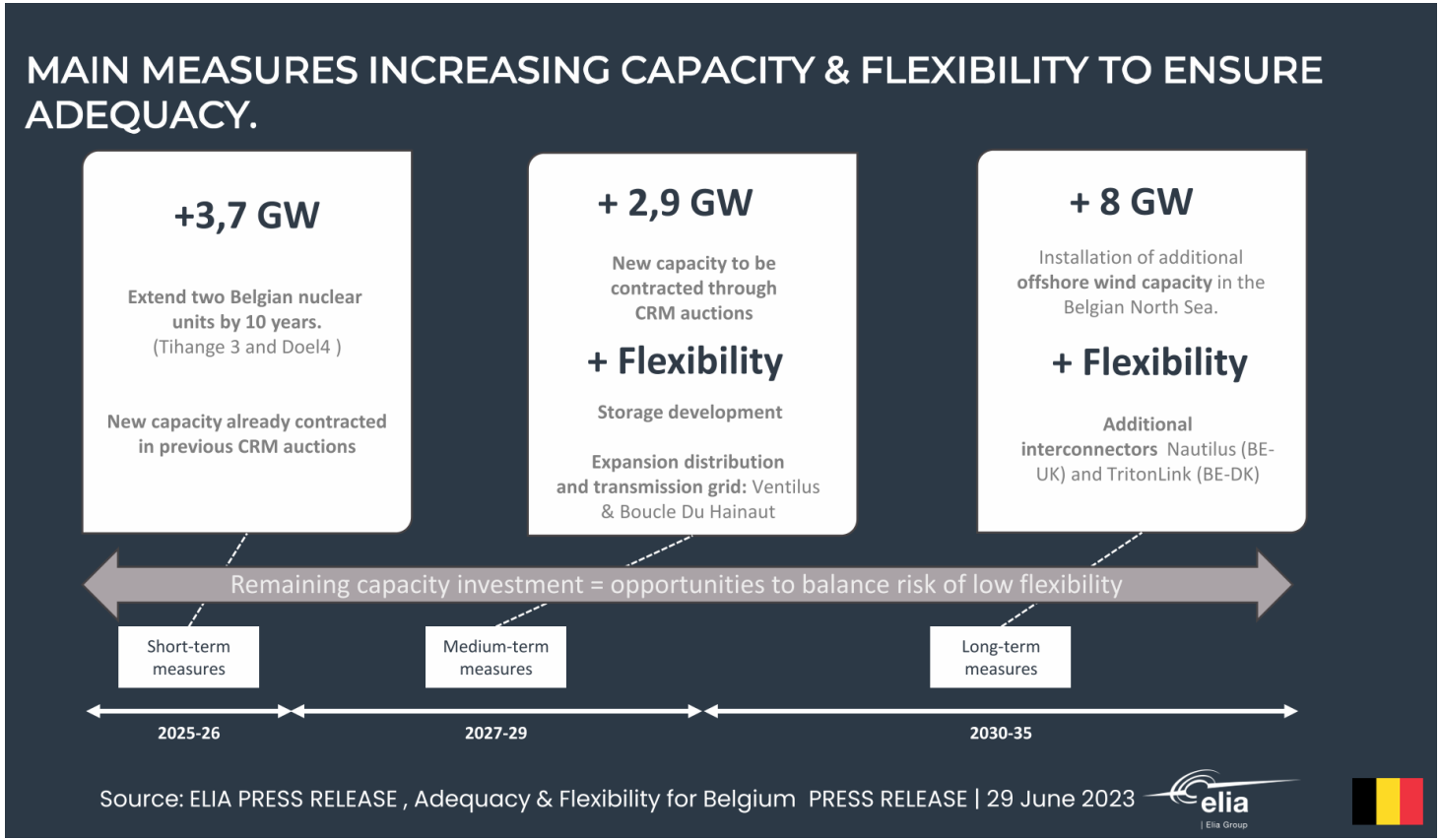
"Renewables are expanding rapidly, EVs are growing and heat pump sales are taking off. But the grid is not expanding at the same pace. **Europe needs to ramp up grid investments from €40bn to up to €80bn a year**."
- WindEurope CEO Giles Dickson

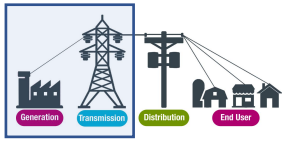
The New York Times

A Bottleneck on the Grid Threatens Clean Energy. New Rules Aim to Help.

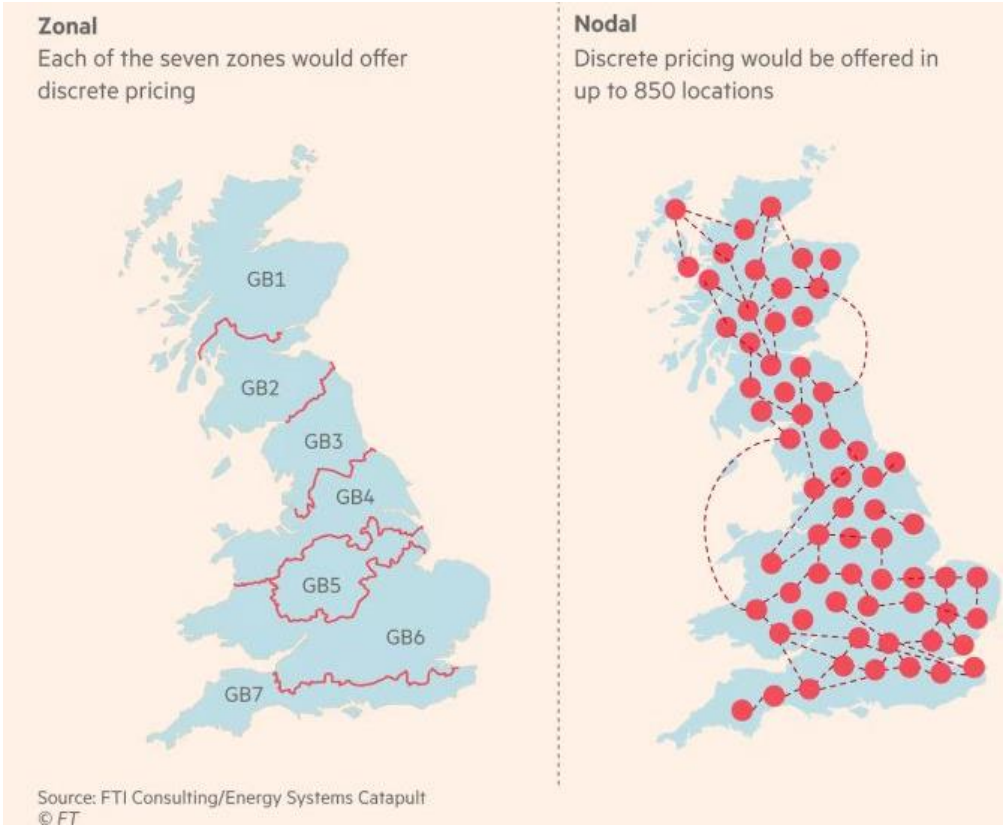
It takes five years to connect a new wind or solar farm to the electric grid. New federal rules would only partly resolve the issue, experts say.

Flexibility needs to bridge the « copper gap » - It is a central piece of Elia Adequacy study, at **Transmission Level**



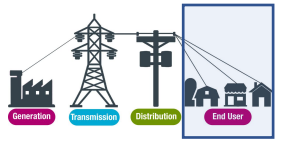


Flexibility can already be organized at **Distribution Level**, with adequate market mechanisms such as **nodal pricing**

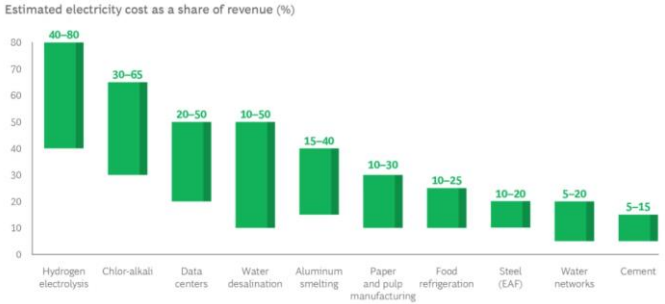


At **B2B Customer Level**, companies with **flexible** use of electricity will be able to **significantly lower their energy costs**

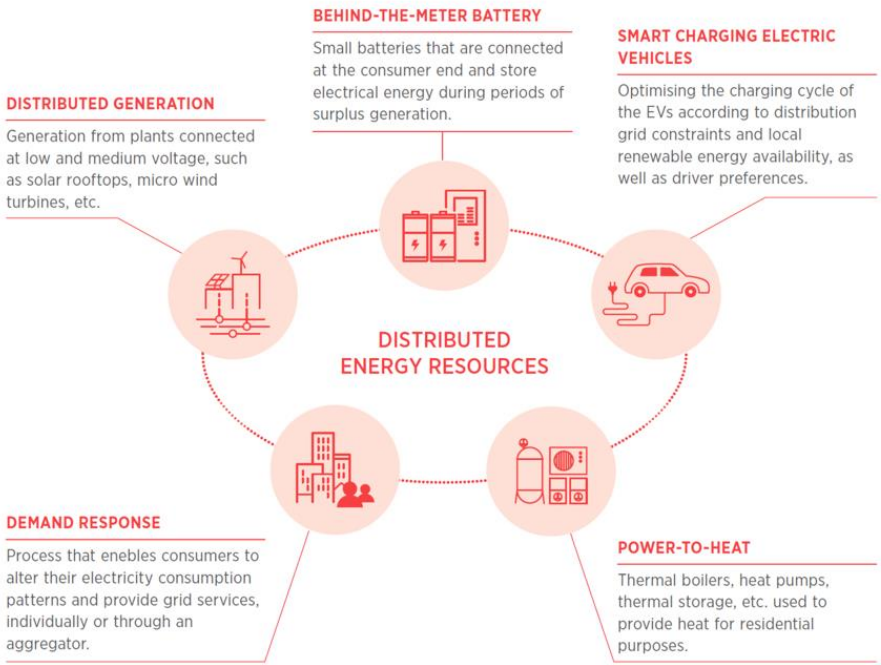
Exhibit 4 - Energy Users Can Create Value from Flexibility by Adopting a Trader Mindset



Source: BCG analysis.



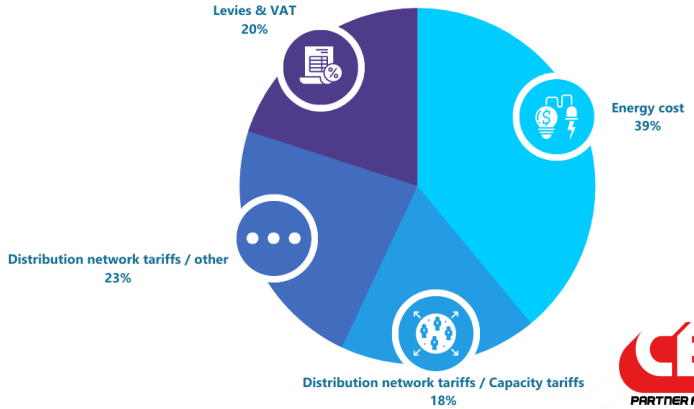
At **B2C Customer Level**, new services, technologies and business models will also be required to **pool and monetize flexibility**



New electricity tariff structure in Belgium

2020-11-06

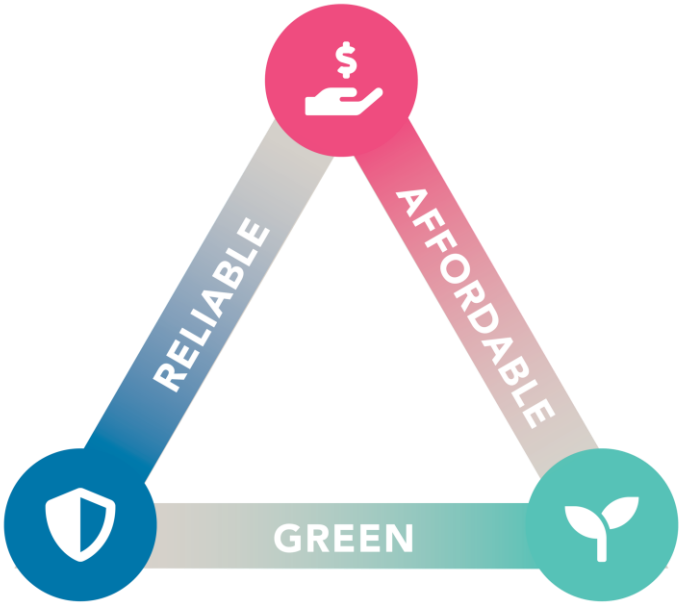
From 1 January 2022, the grid electricity costs in Belgium will no longer be determined by the total number of kilowatt hours (kWh) consumed, but by the peak power demanded from the grid. This is the so-called capacity tariff (also known as demand charge).



Harnessing flexibility would not just **remove a roadblock** for the energy transition, it is also a sizable **business opportunity**

CE+T PARTNER FORUM 2023

Energy Trilemma is no more.
We know what to do.
Let's make it work.



"What is different about this [Ukrainian] crisis is that, for the first time we can double down on proven, safe and scalable clean solutions, instead of fossil fuel.

From now on all three elements of the energy trilemma – security, affordability and sustainability – are pushing in the same direction."

- M. Liebreich for BloombergNEF, 30/09/22

CE+T PARTNER FORUM 2023

Thank you
for your attention

Check our website

www.cet-power.com

Follow us

PARTNER FORUM 2023