

Cycle : Pour le Développement des Sciences et de l'Innovation (PDSI) au service des Transitions

Jeudi 27 janvier 2022 à l'Hôtel de l'Industrie



Transition énergétique : pourquoi ? comment ?



Philippe Charlez, expert de l'Institut Sapiens, auteur de nombreux ouvrages sur l'énergie



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Modération par Sylvianne Villaudière

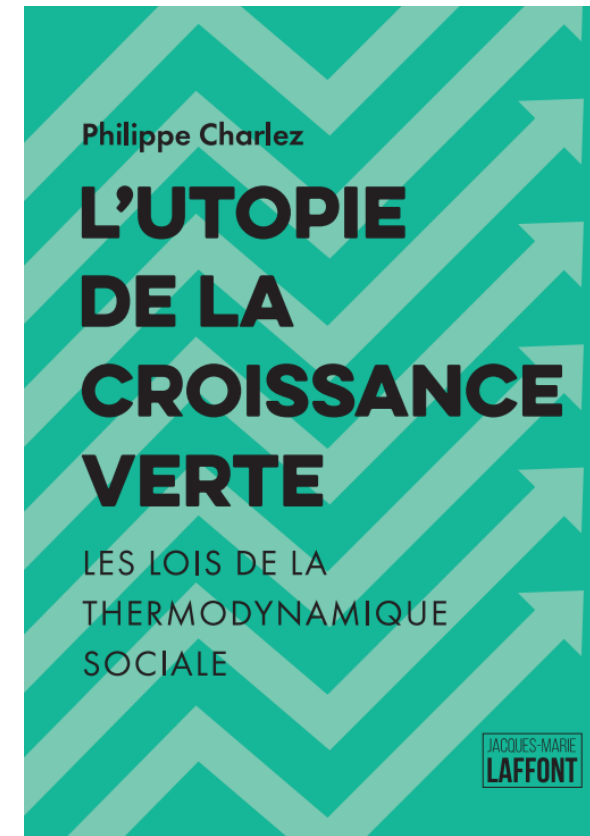
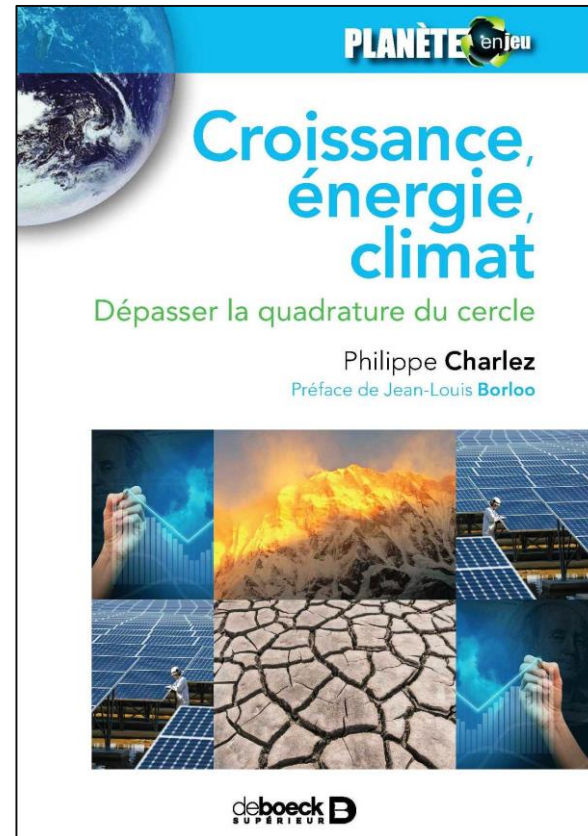
Vice-Présidente de la Société d'Encouragement pour l'Industrie Nationale
Co-fondatrice du Cercle de l'Expertise à Mission (CEM)



Philippe Charlez

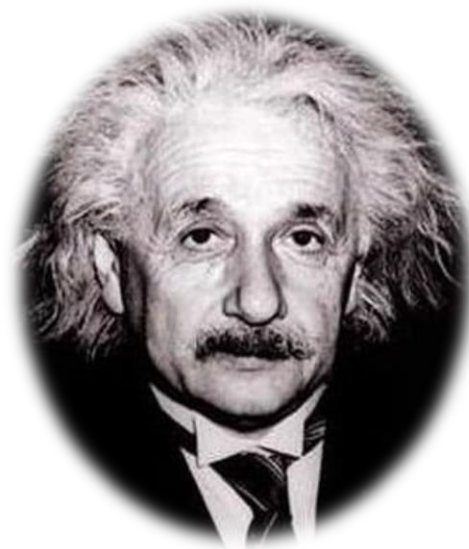
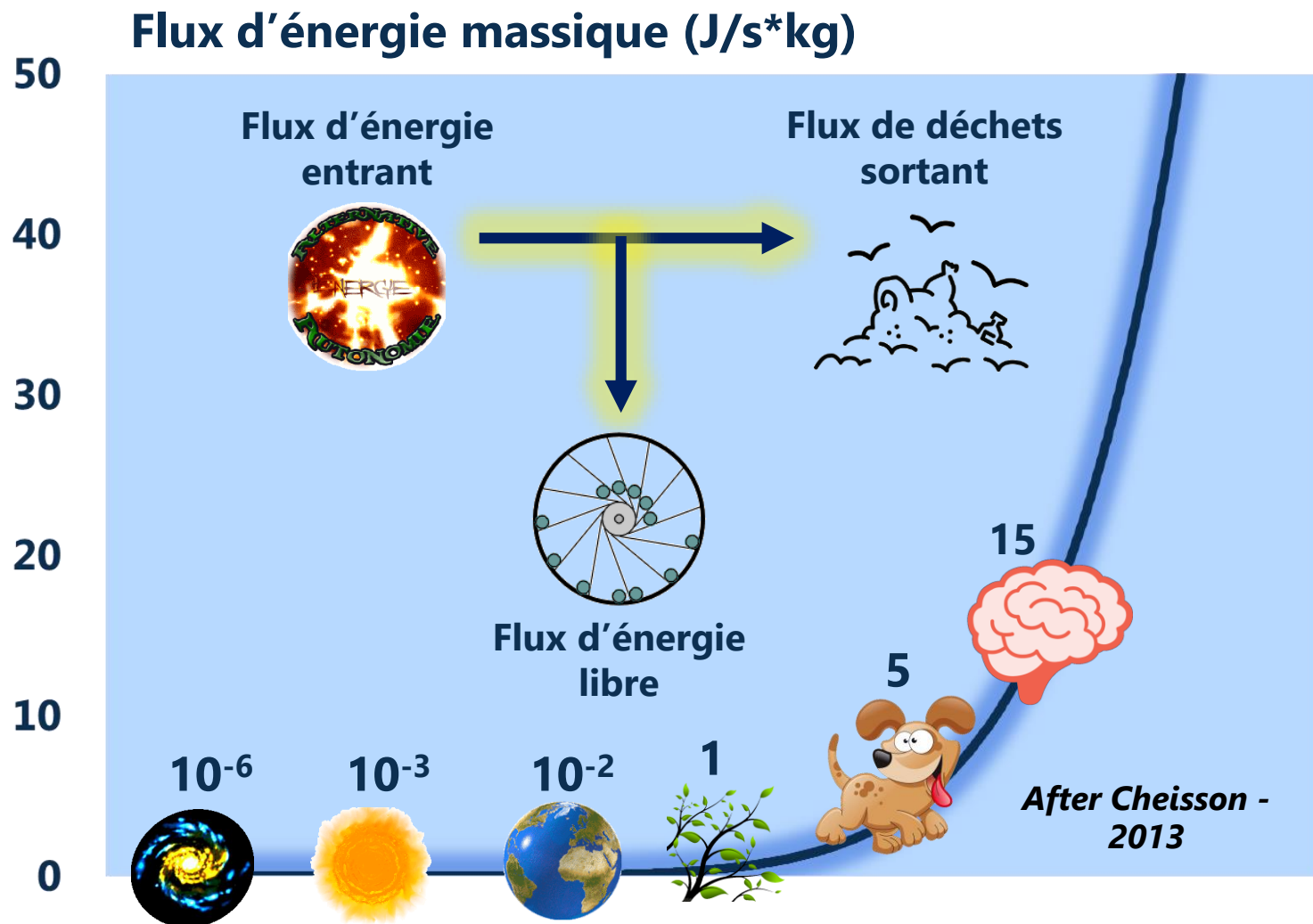
Expert de l'Institut Sapiens, auteur de nombreux ouvrages sur l'énergie

Quelle croissance pour quel mix énergétique 2050 ?



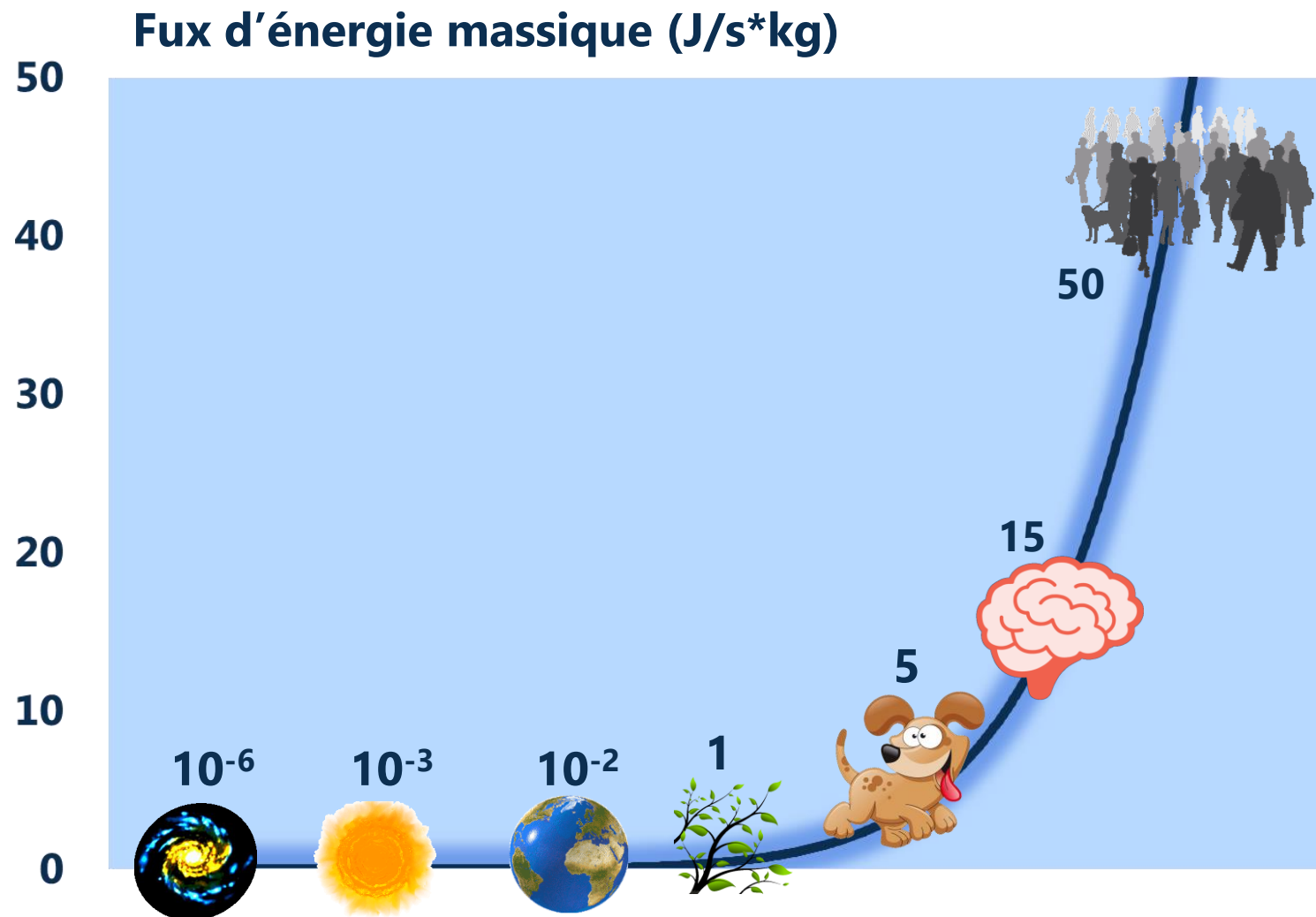
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Tous les systèmes naturels sont des structures dissipatives

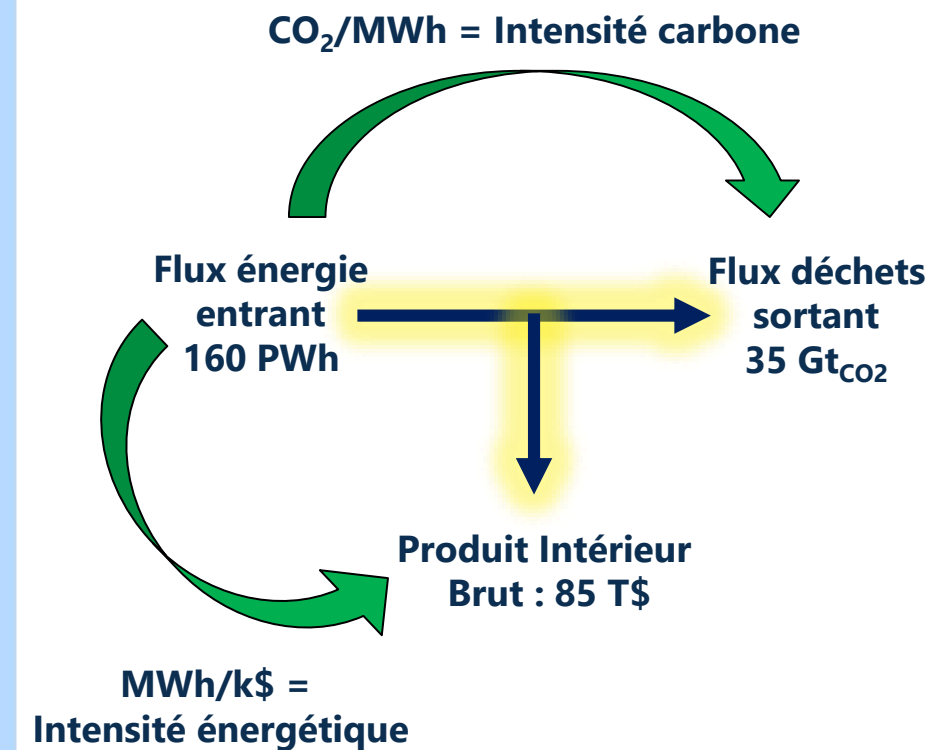


La thermodynamique est la seule science au contenu universel
(Albert Einstein)

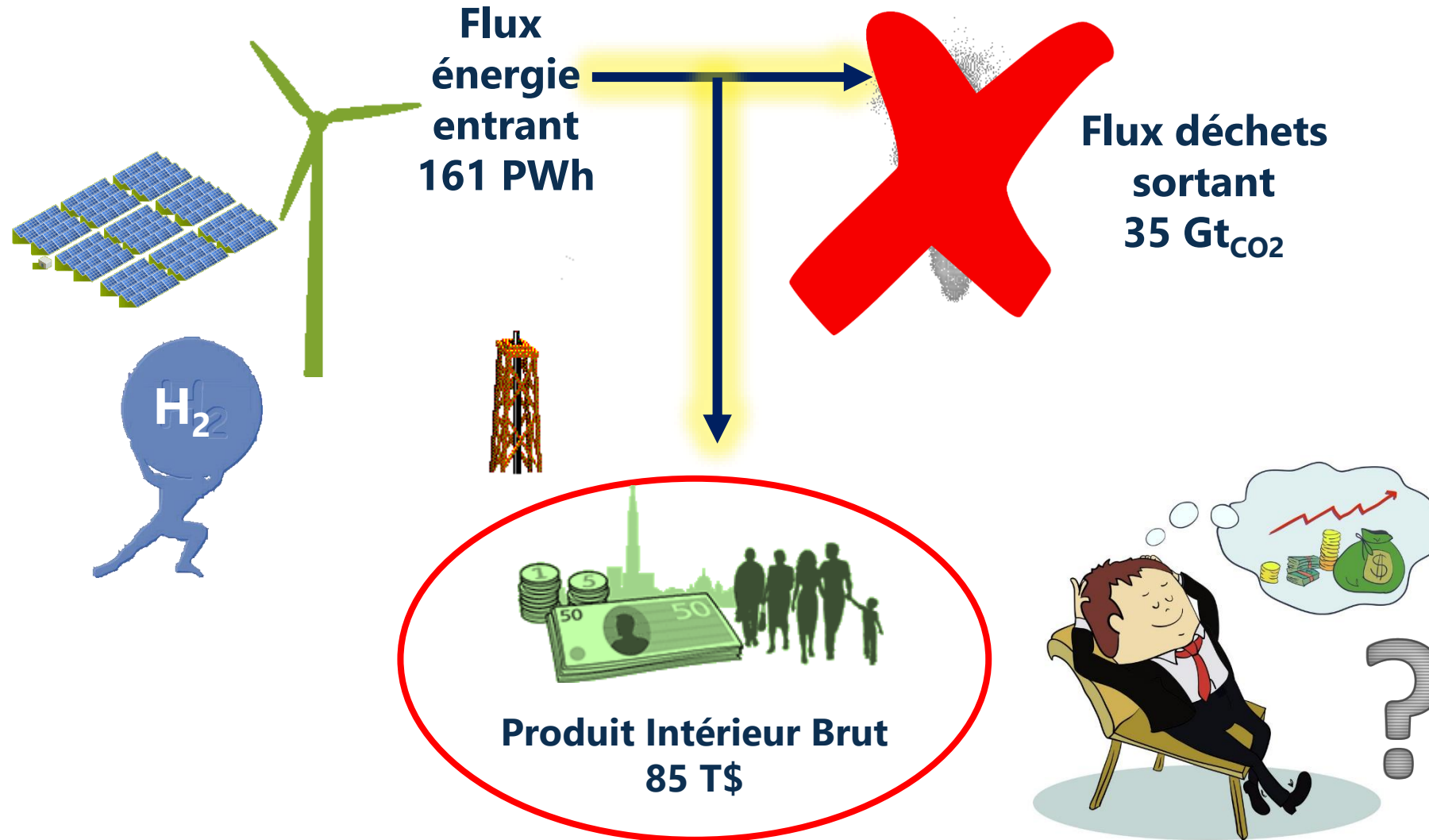
La société de croissance sur l'échelle des structures dissipatives



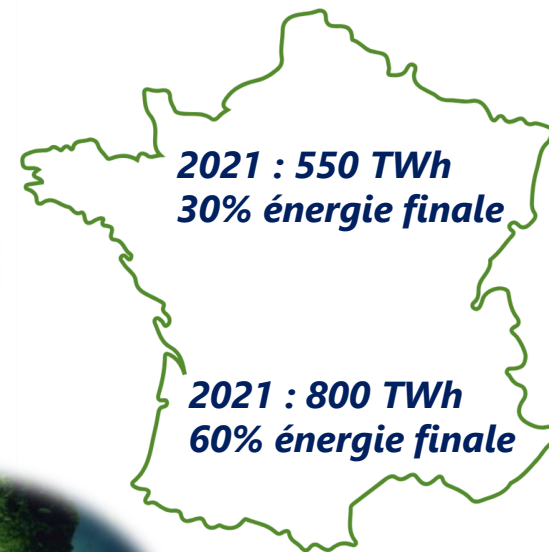
La société de croissance est une structure dissipative



Le rêve d'une croissance verte



Transition énergétique = « *grand remplacement* »



**D'où viendra
cette
électricité ?**

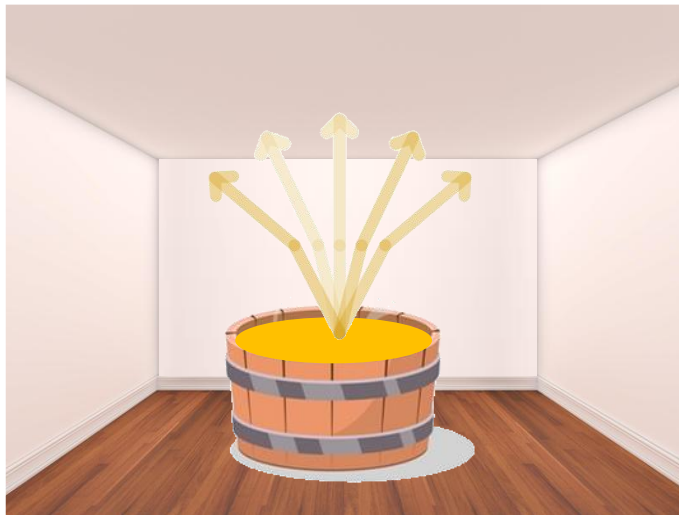


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Valeur énergies : concentration et intermittences



**Energies fortement
concentrées**



**Energie faiblement
concentrées**



Notion de pilotabilité

Où je veux
Quand je veux
Autant que je veux

Stockable et transportable

Matière stockable
et transportable

Énergie non stockable
et difficilement transportable

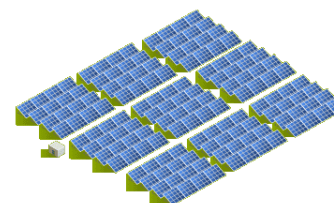


Énergies de stock (matière)

Contenu énergie libre élevé

Nucléaire/gaz/charbon/pétrole
80% à 90%
(maintenance & pannes)

#



Vent
22%

Soleil
12%

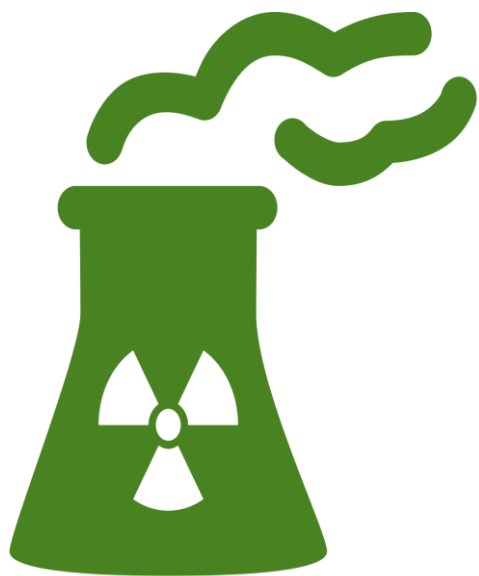
Énergies de flux (énergie)

Contenu énergie libre faible



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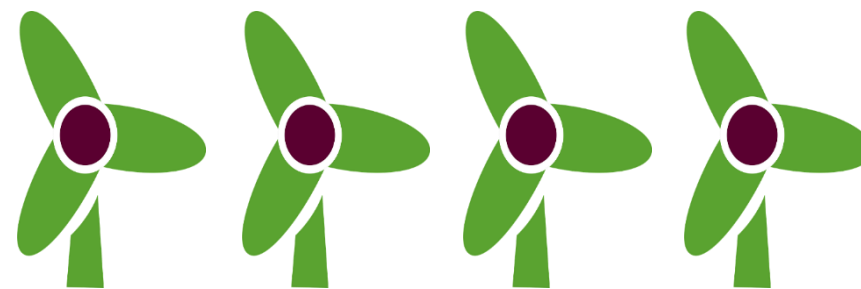
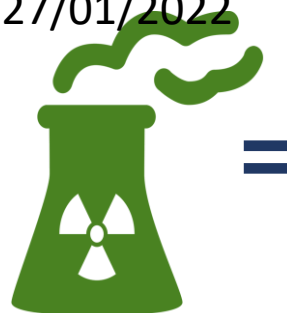
Conséquences



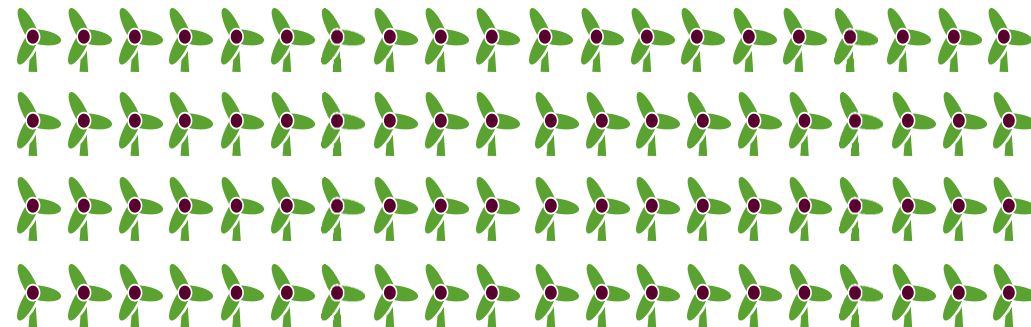
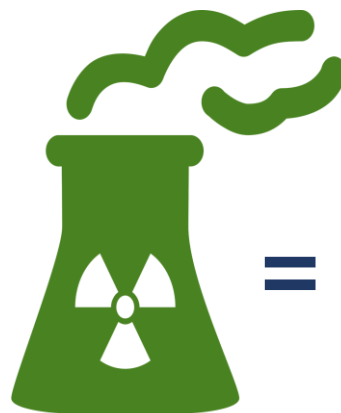
**1 GW
= 7 TWh**



**1 GW
= 1 à 2 TWh**



4 to 7 GW



**-58 GW
nucléaire**

**116 000 éoliennes T 2 MW
11 600 éoliennes M 8 MW**

800 TWh

**200 000 éoliennes T 2 MW
20 000 éoliennes M 8 MW**

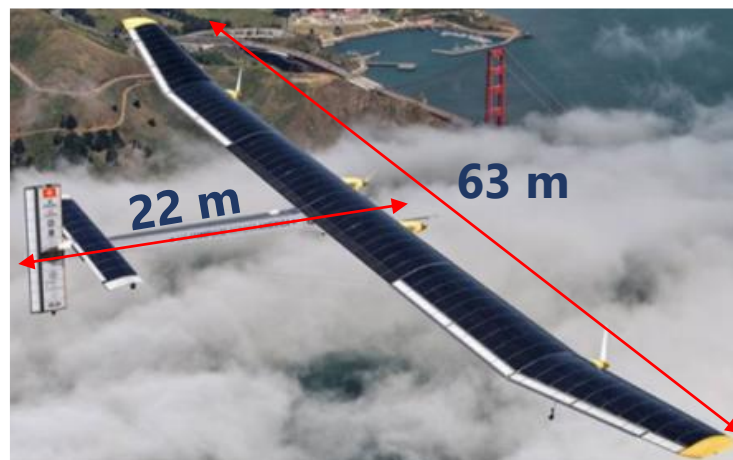


Effet d'échelle !

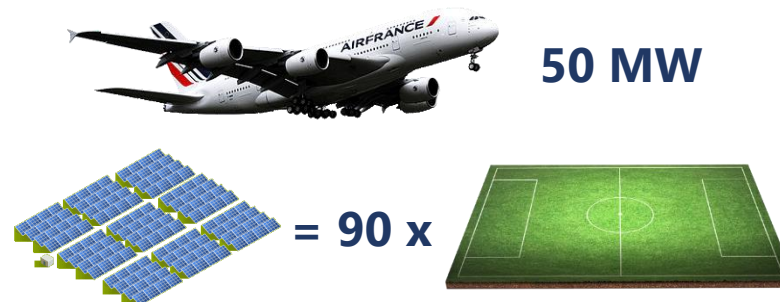


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Renouvelables et effet d'échelle



Solar cell surface	270 m ²
Engines	30 kW

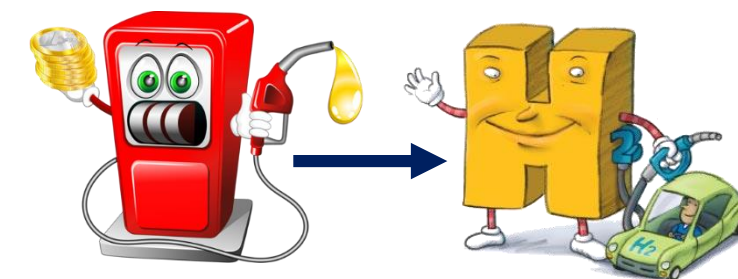


Voiture solaire (Auto-world – Brussels)



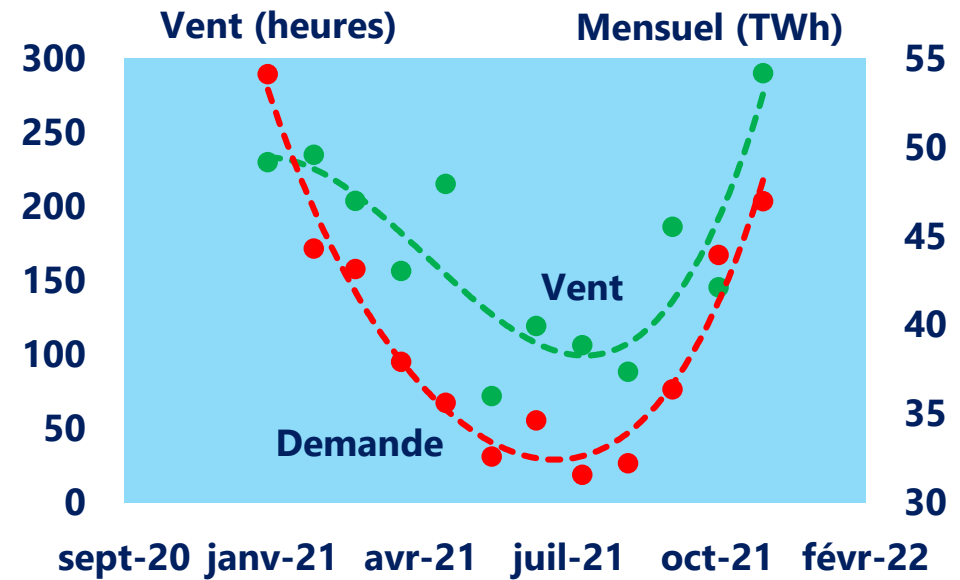
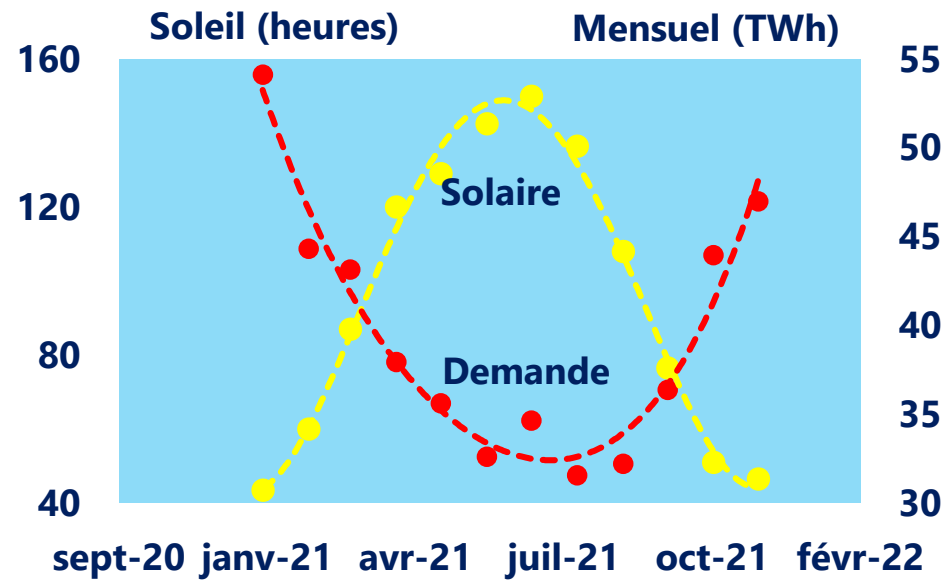
50 G litres

500 TWh



62 réacteurs nucléaires
125 000 éoliennes

Solaire et éolien en France : le problème des intermittences



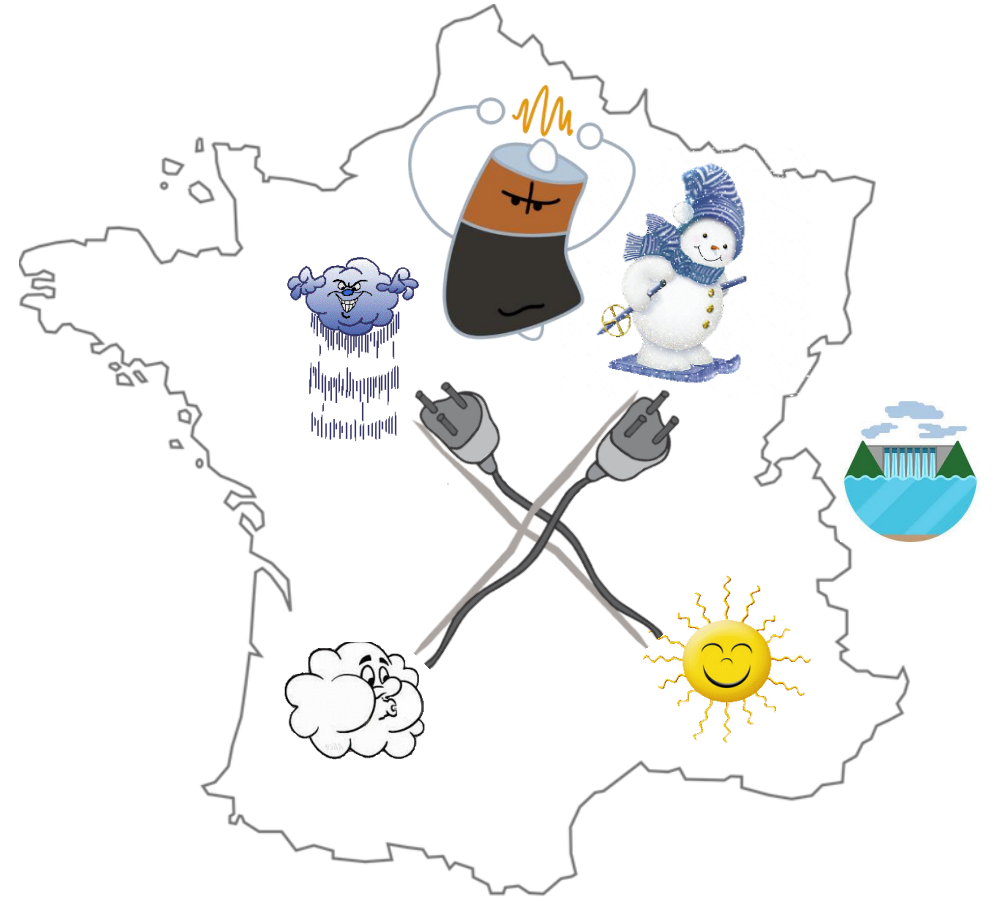
**Les intermittences sont
journalières mais aussi
saisonnières !**

D'où viendra l'électricité ?



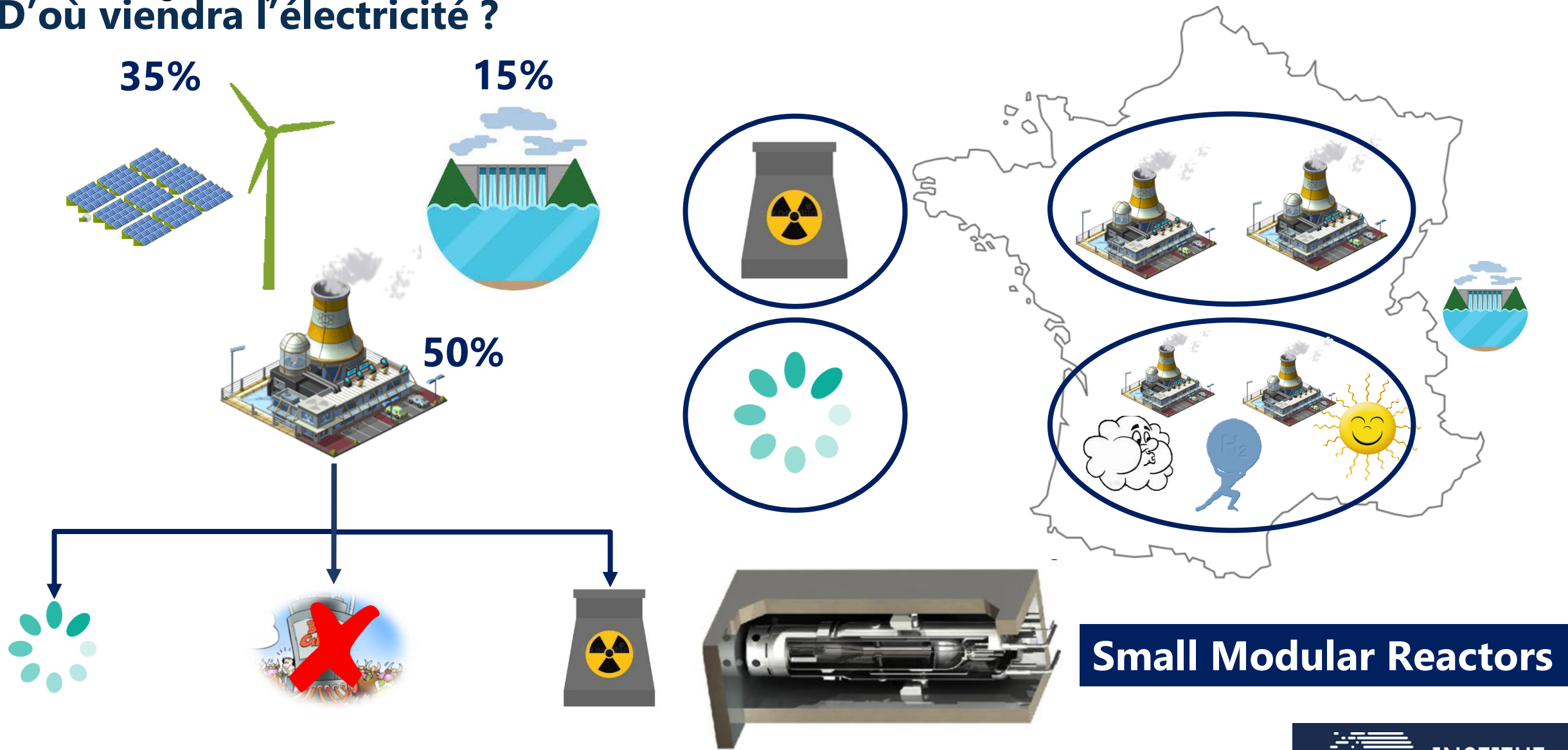
La croissance requiert

- ✓ **pas de contraintes locale**
- ✓ **pas d'intermittences**
- ✓ **énergie concentrée**
- ✓ **énergie stockable**

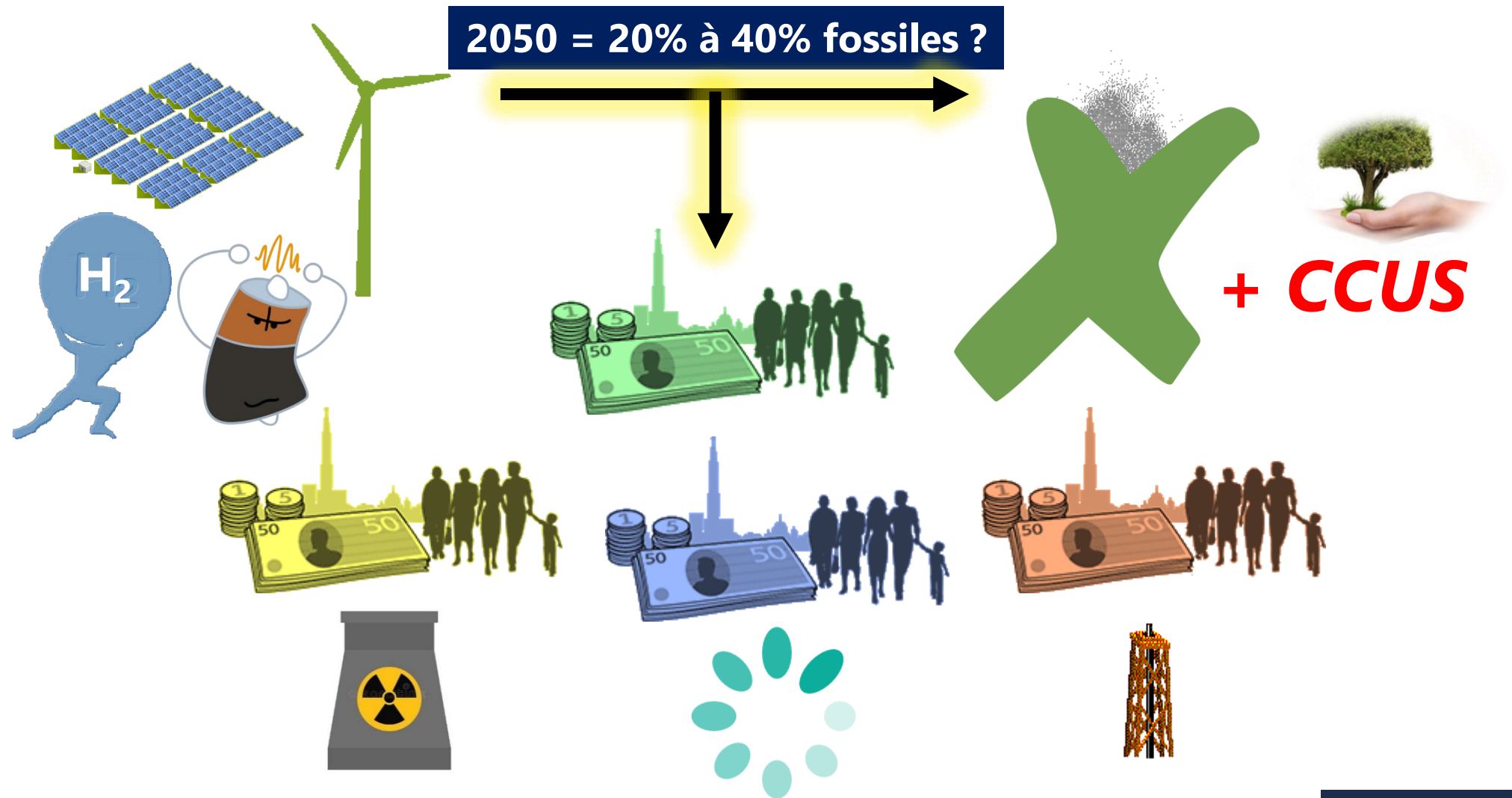


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D'où viendra l'électricité ?



La croissance 2050 sera « *arc en ciel* »



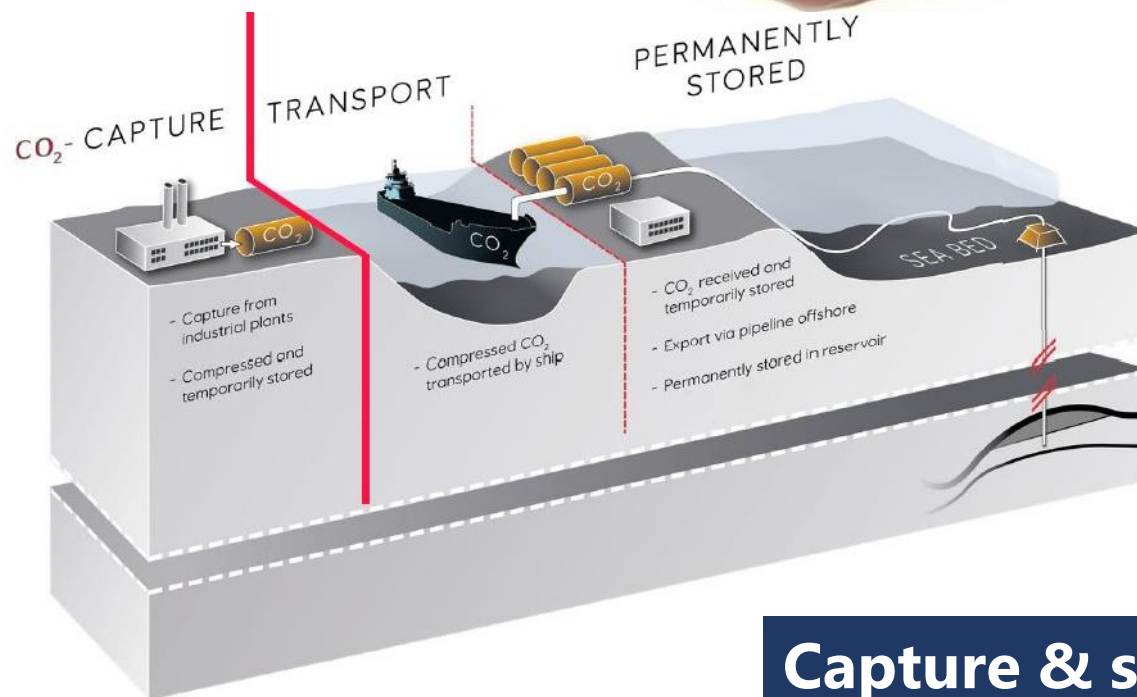
Nécessité de compenser

Bio-séquestration



1 arbre = 30 à 50 kg CO₂/an

France : 8 milliards d'arbres trees

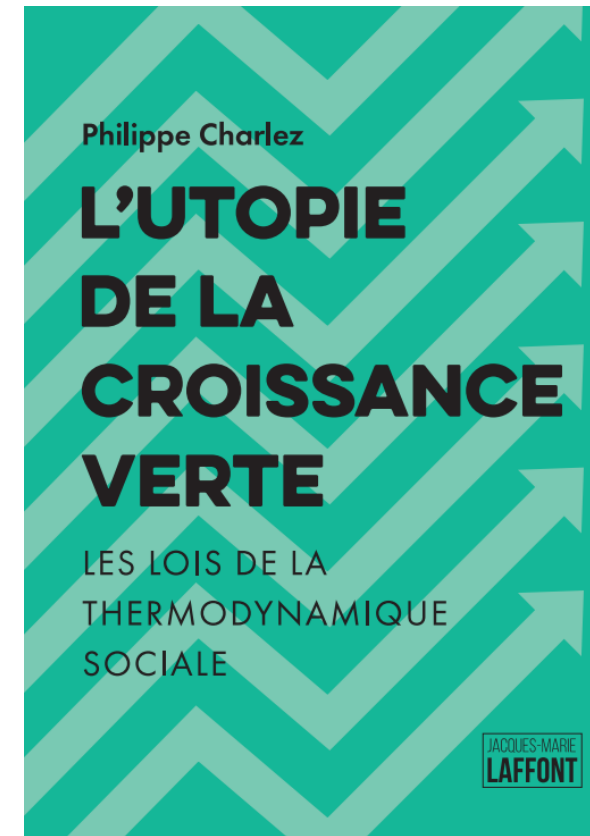
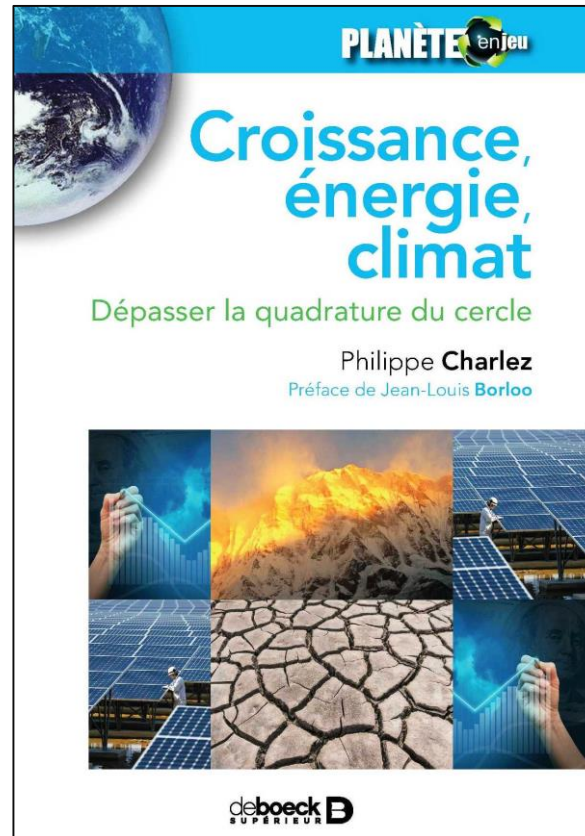


Aujourd'hui : 35 M tonnes

2050 : 5 to 10 milliards de tonnes

Capture & stockage du carbone

La transition énergétique est-elle un défi technologique ?



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Alexis Gazzo

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Energy transition

Presentation

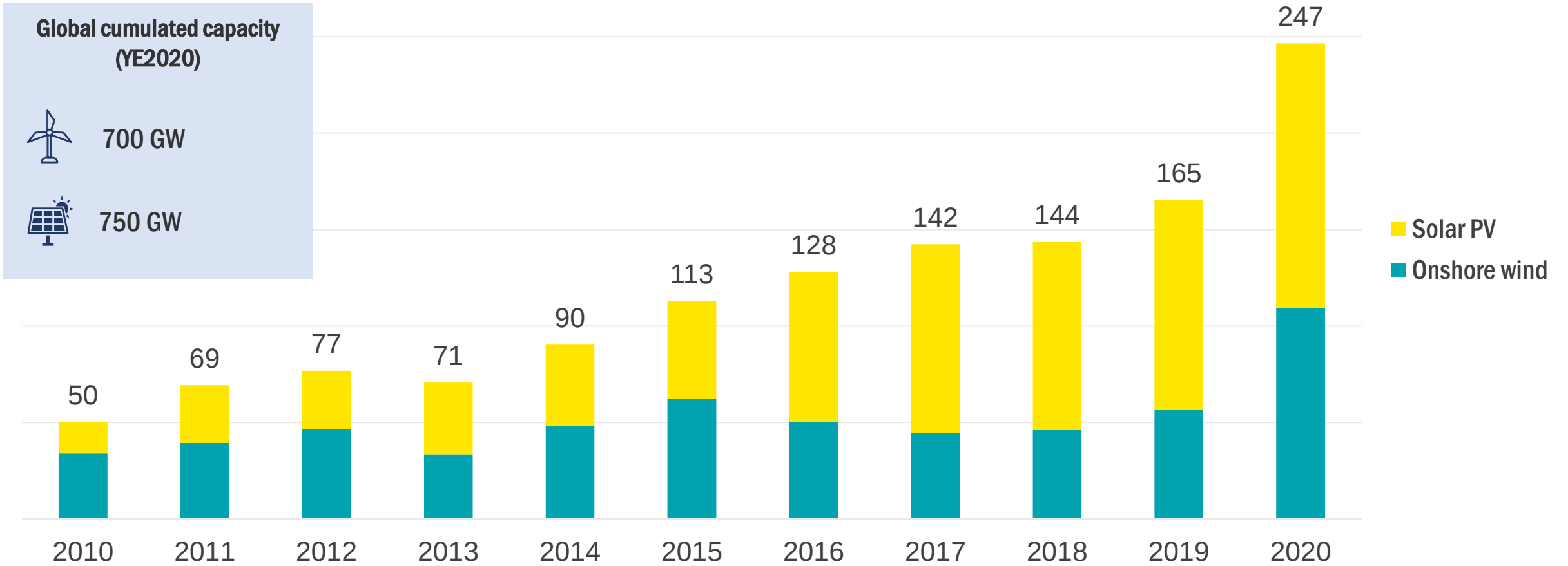
January 2022



Building a better
working world

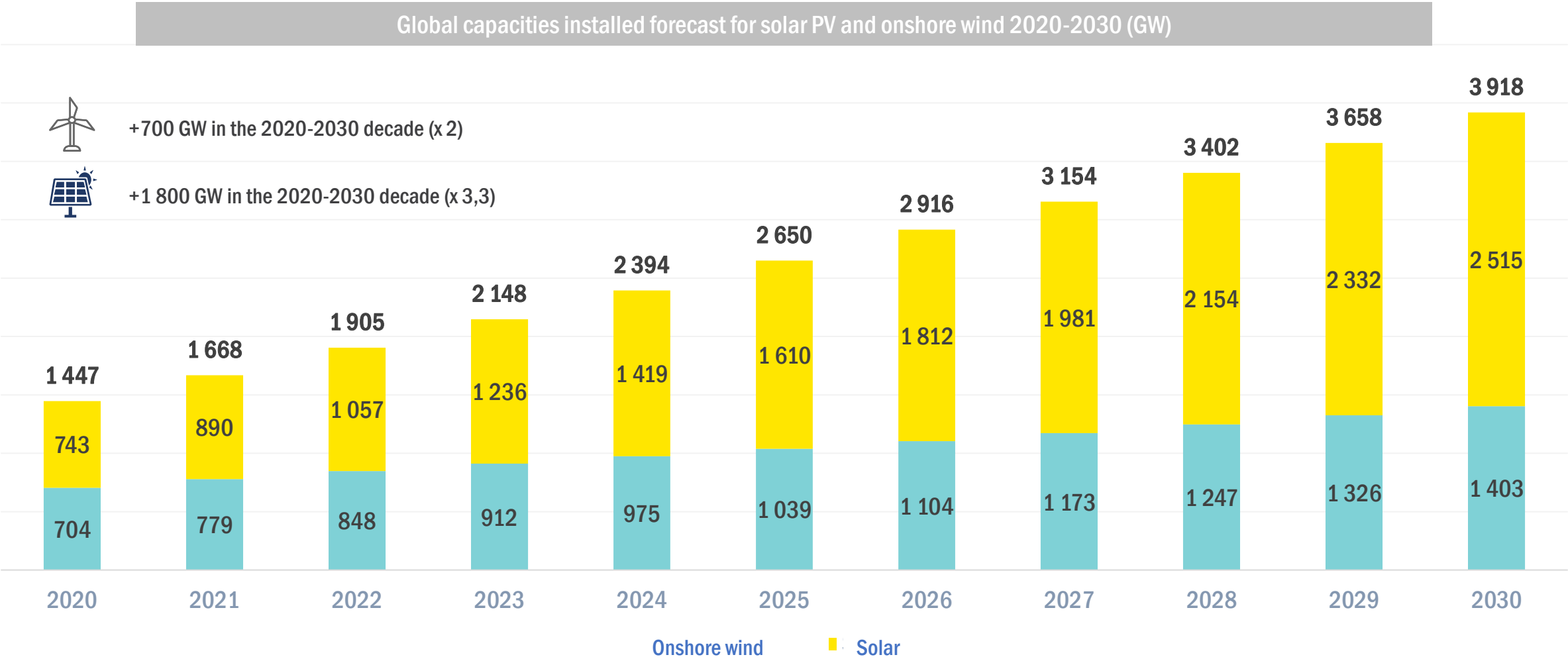
Despite the global pandemic, 2020 marked a historic record in terms of RE capacities added, with 247 GW (+49% compared with 2019)

Wind and solar annually added capacities over 2010-2020 (GW)



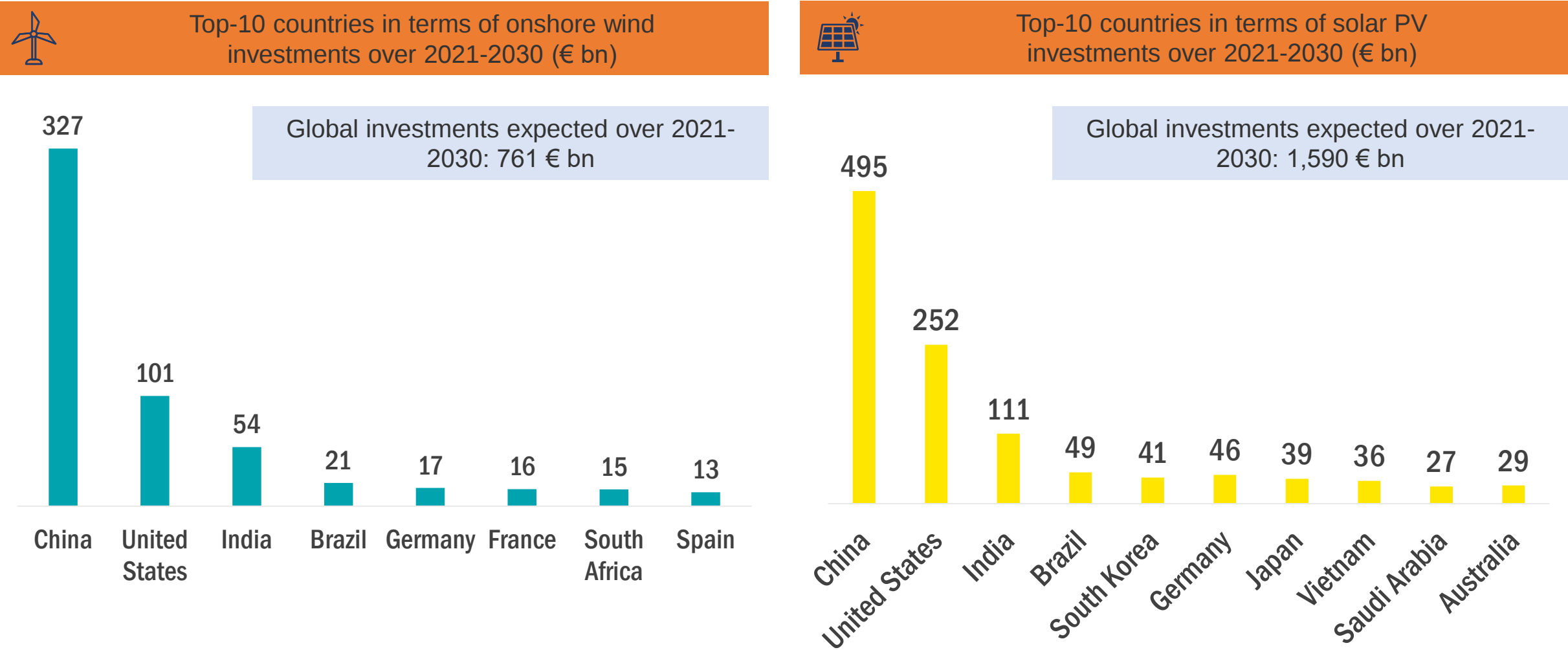
Source: WoodMackenzie

The global deployment rate of solar PV and onshore wind is expected to increase in the coming decade



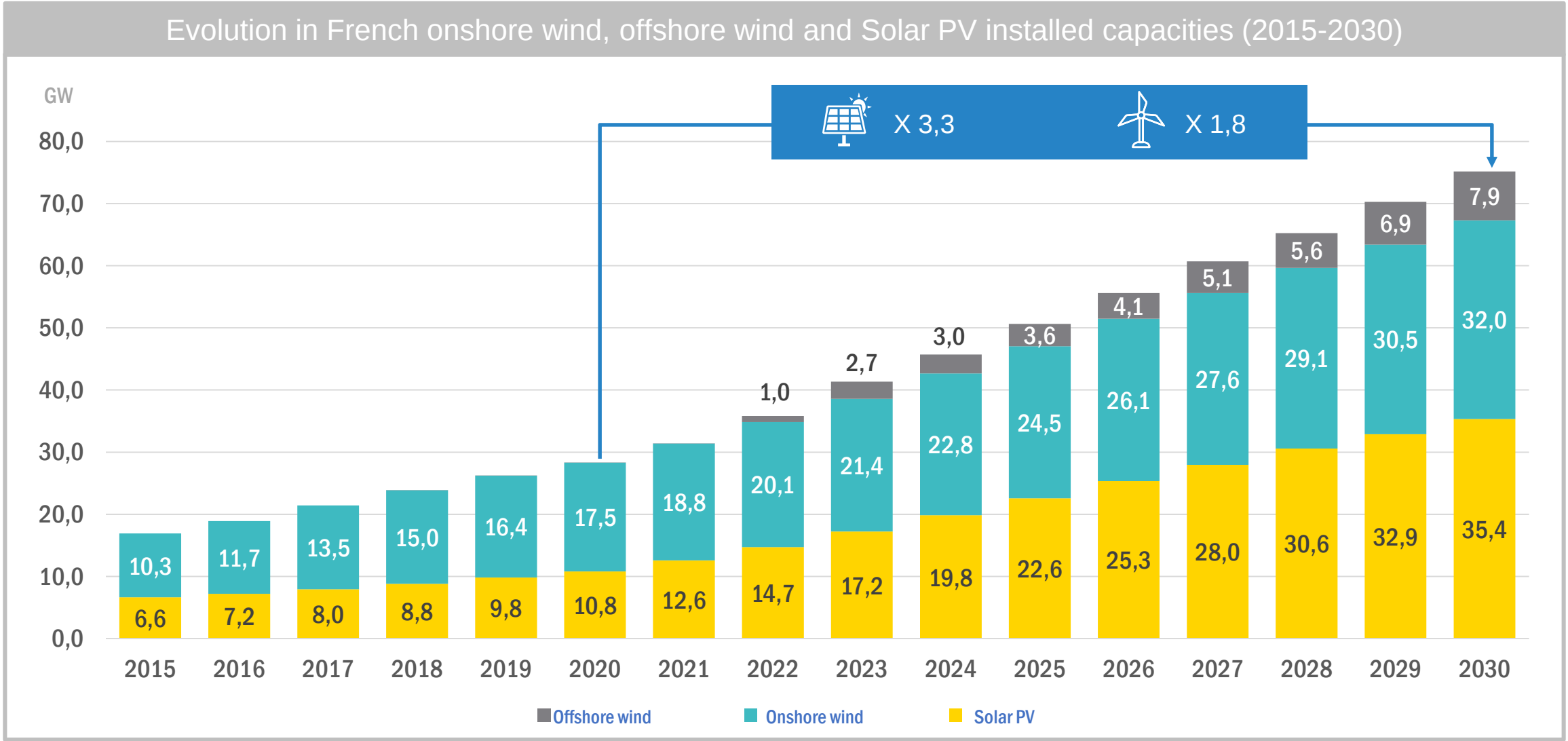
Source: WoodMackenzie

China, the United States and India represent the highest share of investments in renewables



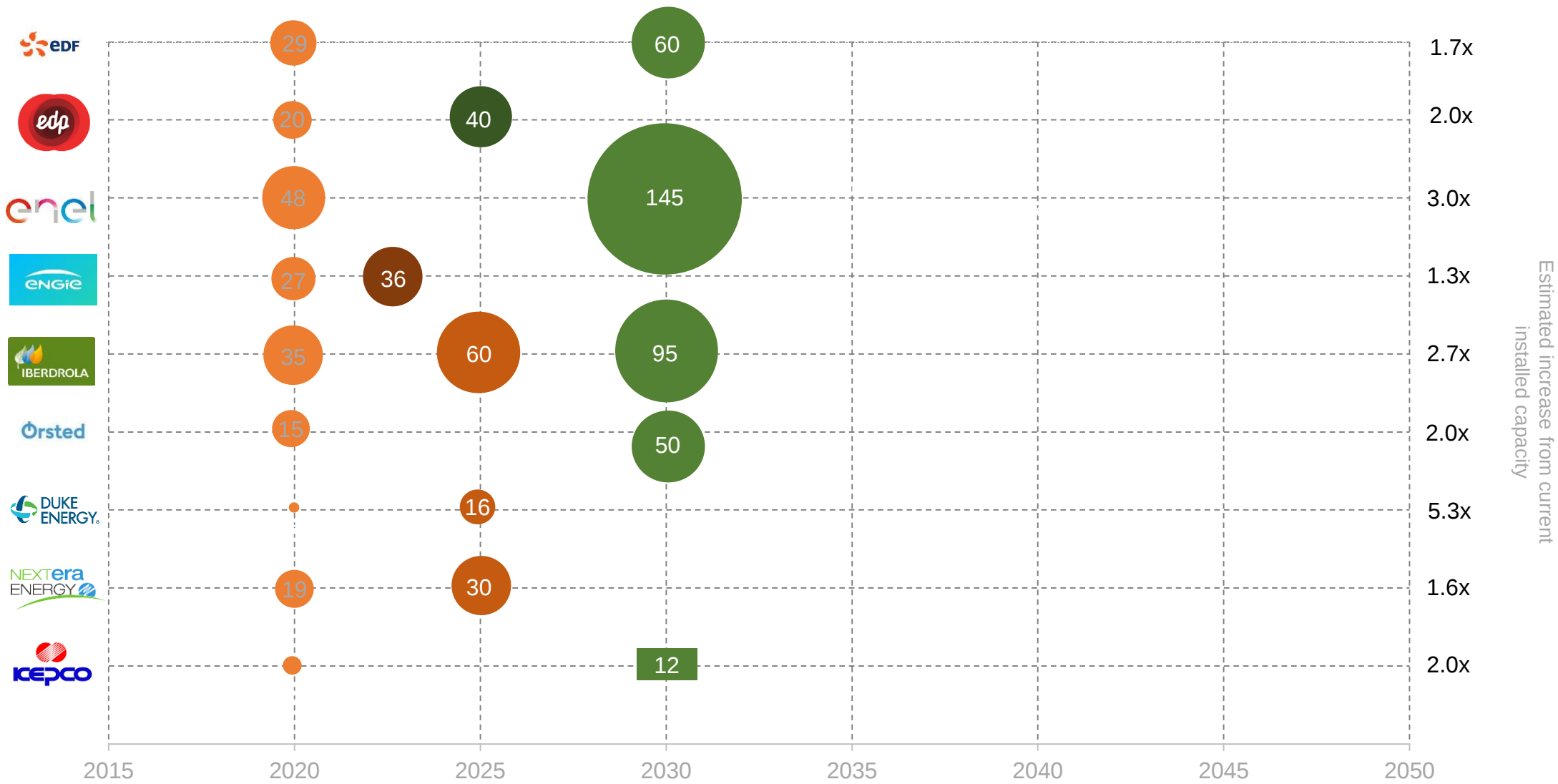
Source: WoodMackenzie

A focus on France: the expected increase in renewables capacity installed is proportional to the expected global increase



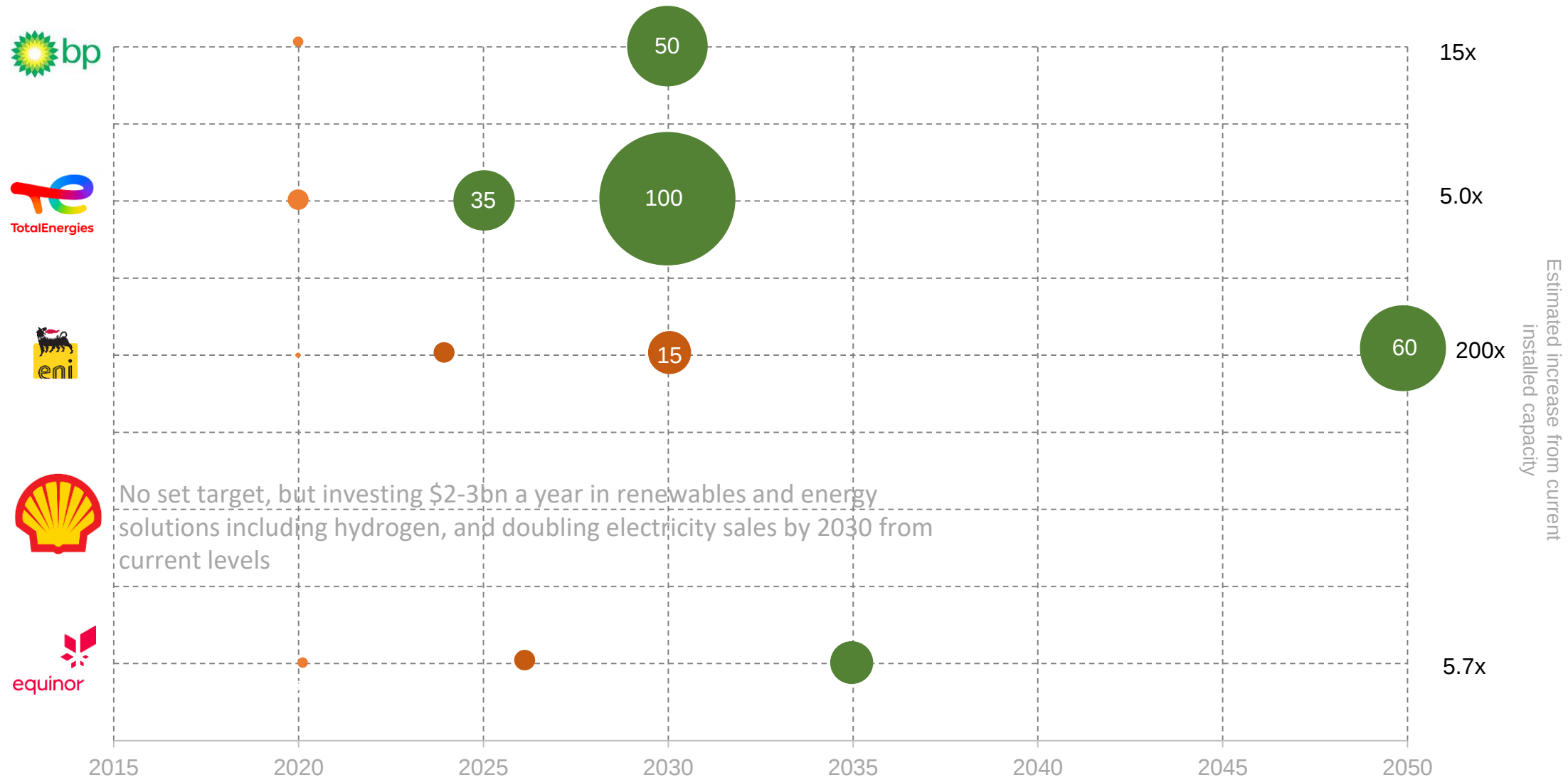
A number of utilities have put forward aggressive renewable energy targets

Illustrative and representative of leading utilities

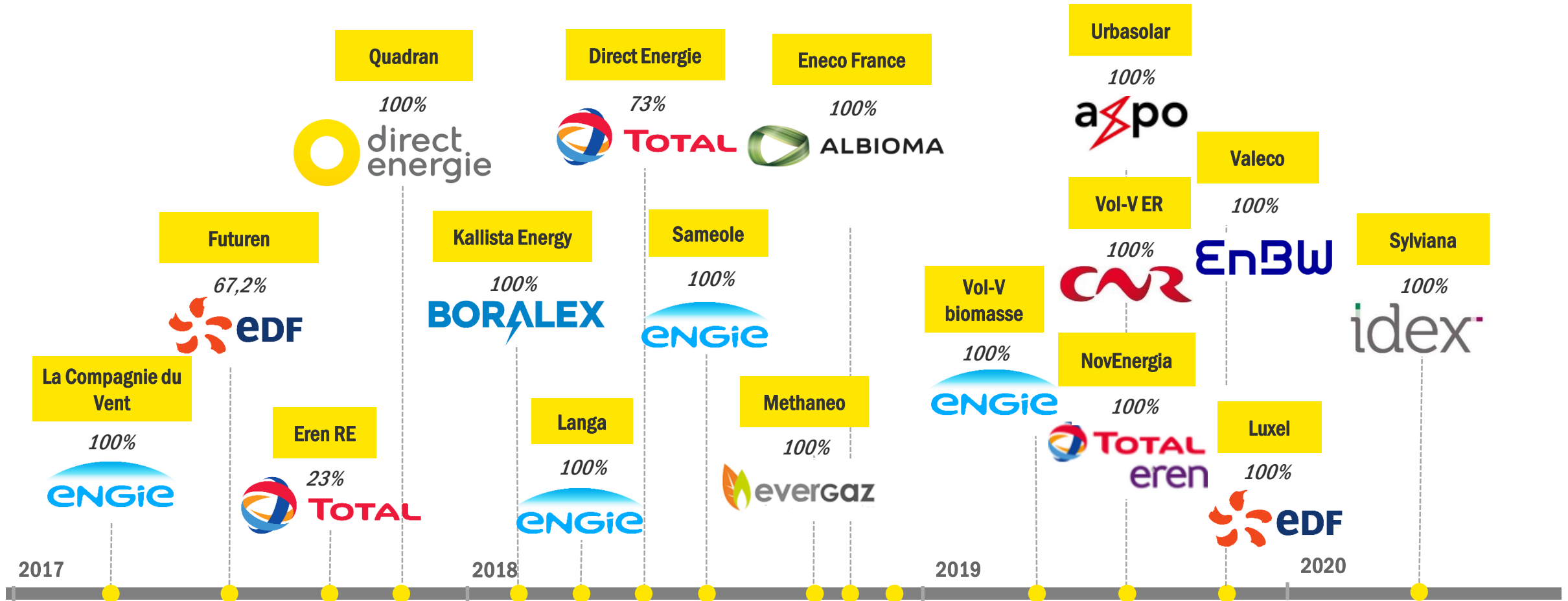


Source: Company websites, GlobalData Power Intelligence Center ,EY analysis

European oil majors are increasingly diversifying through ambitious renewable energy investments targets (over \$13 bn of investment since 2016)



New entrants such as O&G players are increasing the sector concentration



Emerging technologies and innovation business models should contribute to RE development in the next decade and offer additional investments opportunities

Emerging technologies



Innovative business models

Corporate PPAs

To meet their sustainability goals and edge against energy markets volatility, corporates seek to procure power directly from RE plants

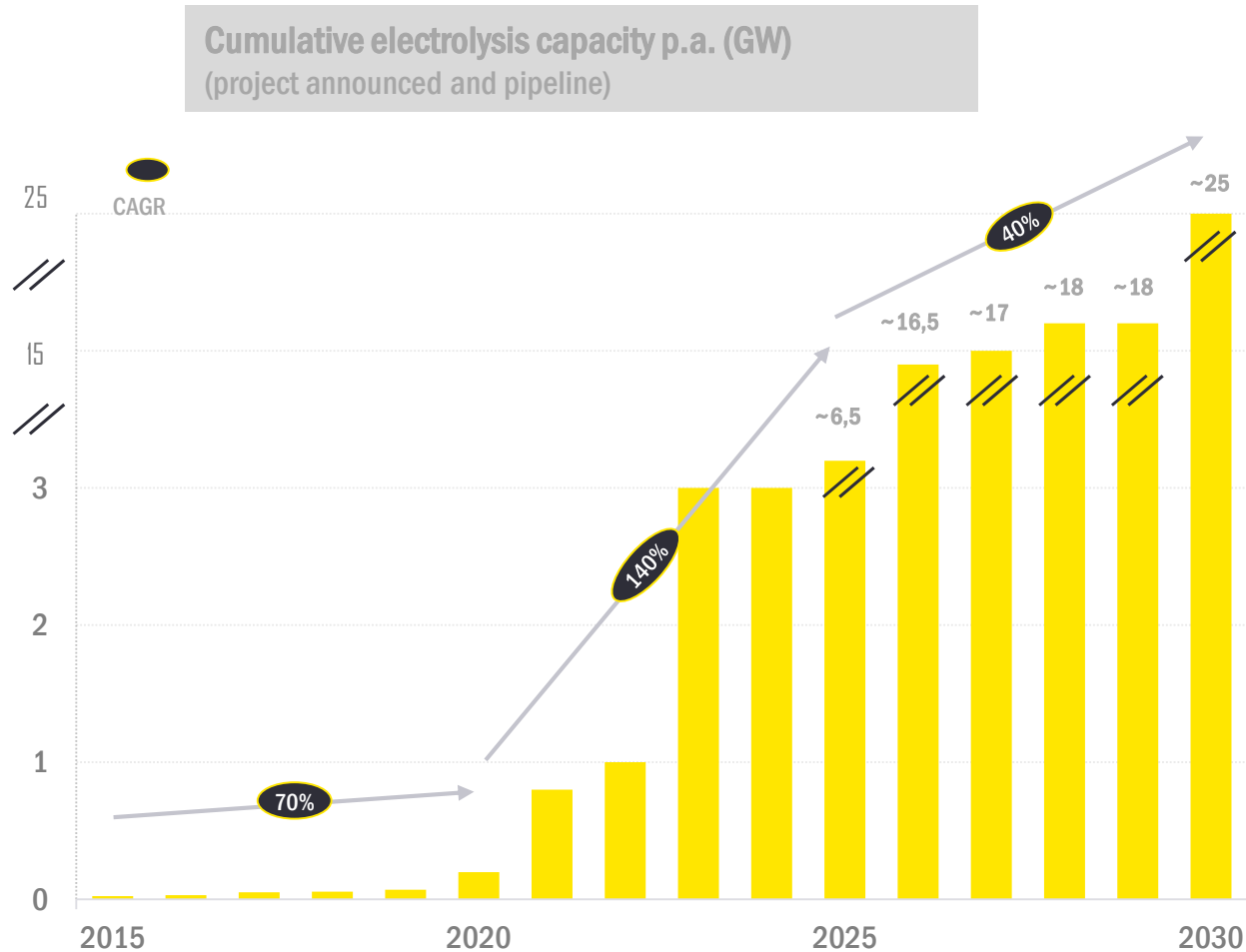
Merchant

As RE technologies competitiveness is improving, merchant model is emerging as a viable option for projects developers and owners

Grid services

With the increasing penetration of non-dispatchable renewables, TSOs and DSOs are looking for services such as reserve, frequency regulation, etc.

Electrolyser capacity should strongly increase after 2025, due to the industrial scale up of equipment manufacturers



Most ambitious electrolyzers targets, EU Countries

1 France:
6.5 GW by 2030

2 Germany:
5 GW by 2030

3 Italy:
5 GW by 2030

€180-470 bn
Cumulative investments in
green hydrogen production
in Europe by 2050

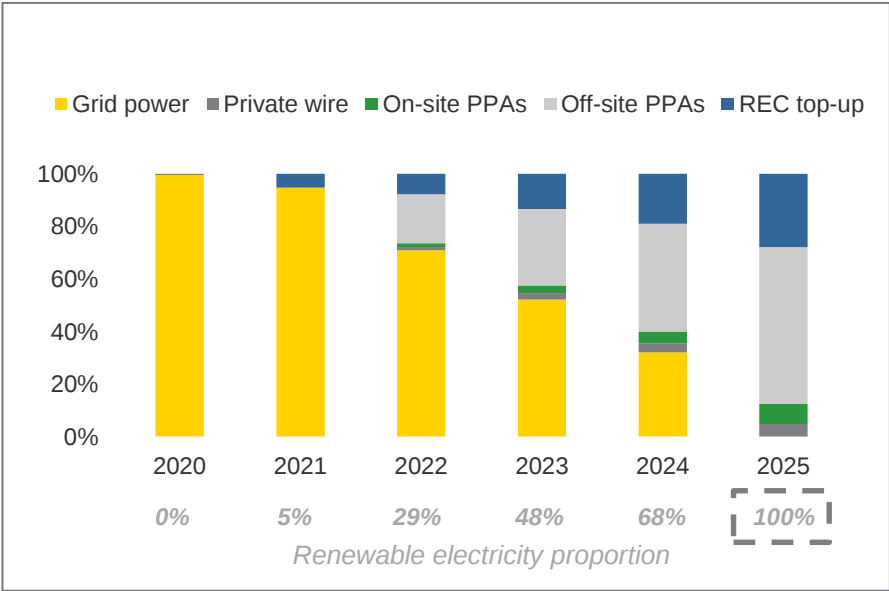
- Electrolysers' capacity will burst during the second half of the 2020 decade due to improvements in efficiency, technological learning curve and economies of scales
- CAGR peaks in 2020-25 due to scale difference compared to pre-2020 levels (projects' capacity to go from MW to GW scale)
- The European Commission estimates Europe to be responsible for around 35-40% of the total electrolyser capacity by 2030

**New business models focusing on : on-site production,
corporate PPAs, etc.**



Corporate PPAs are one of the possible options likely to be required reduce Scope 2 emissions

Renewable electricity supply road map



Illustrative program of activities based on market analysis and EY experience

Portfolio of options

Option	Description	Benefits
On-site generation	- Build and operate renewable energy generation on-site - Typically only very small scale (<10%) is achievable	- Financial - Carbon - Brand
Off-site power purchase agreements (PPAs) ¹	- Green power directly from third-party generators, or sleeved and virtual PPAs "Additionality" reputation benefits and achieve large scale	- Financial - Carbon - Brand
Tariffs or certificates	- Green certificates or a "green" tariff from existing utility - Used to top-up PPAs to 100% but an extra expense	- Financial - Carbon - Brand
Carbon offsetting	- Compensation of emissions via funding a saving elsewhere - Often used to save emissions from heat or travel	- Financial - Carbon - Brand

High

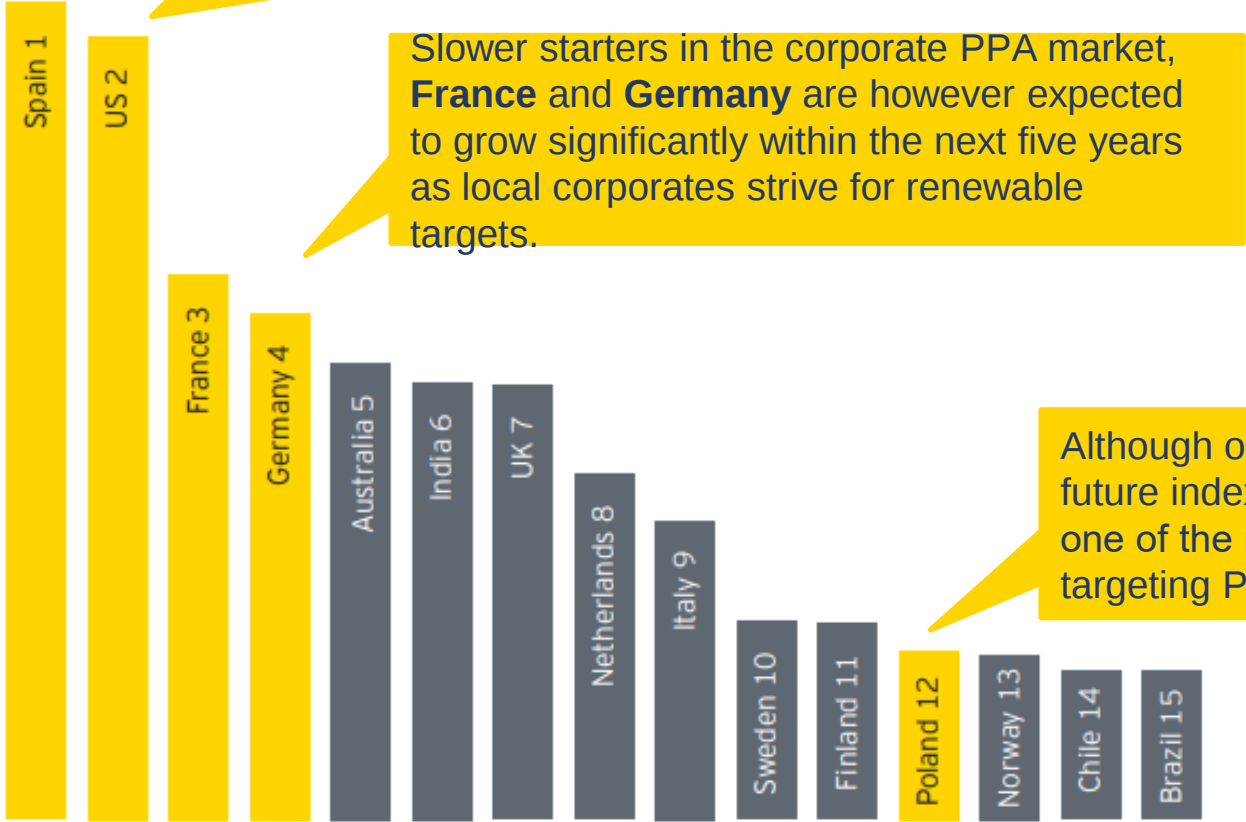
Mid

Low

Increasing portion of non-grid power in the renewable electricity supply road map supported by corporate PPAs and other procurement alternatives

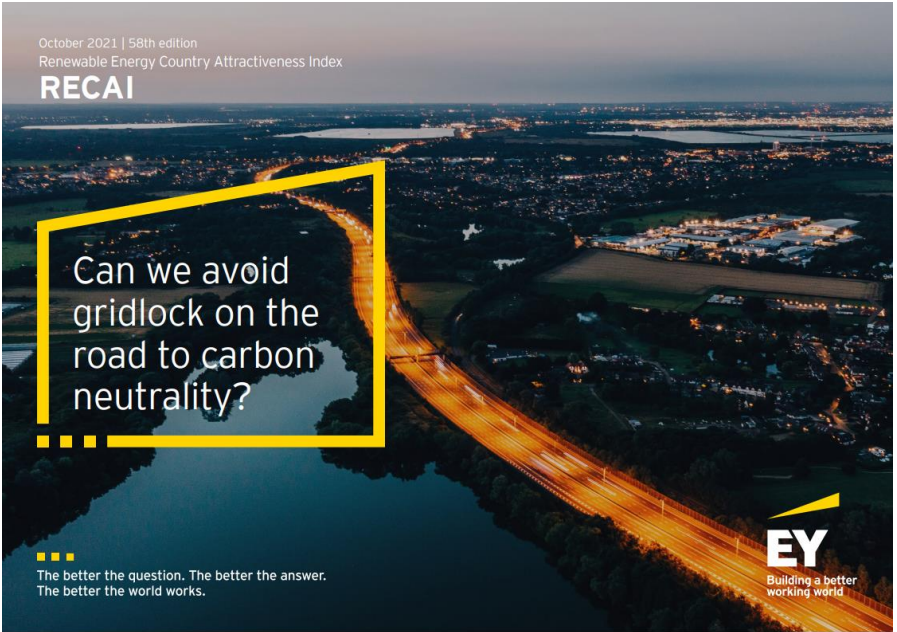
As Corporate PPAs are now one of the key drivers for renewables growth, EY has added to its RECAI report a Corporate PPA Index

The **US** started the PPA race several years earlier and was still the largest market in 2020. **Spain** currently is booming and is expected to be the hottest market for growth as pan-European Virtual PPAs often site there.



Slower starters in the corporate PPA market, **France** and **Germany** are however expected to grow significantly within the next five years as local corporates strive for renewable targets.

Although only midtable at the moment, **Poland** is expected to progress in future indexes as the largest renewables market in Eastern Europe and also one of the most expensive and “carbon-dirtiest” grids, many corporates are targeting Poland for PPAs.



Storage : the new frontier?



Offshore wind : competitive at last?



For Europe, maximising the industrial potential of the green transition implies keeping a first mover advantage



Source: Wind Europe



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QUESTIONS-REPONSES



**Transition énergétique : pourquoi ?
comment ?**

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MERCI POUR VOTRE PARTICIPATION !



Transition énergétique : pourquoi ? comment ?