

11/10/2022, Angers

# Hâtons-nous lentement:

## Urgence et inertie dans la transition énergétique

**Greg De Temmerman**

*Managing director, Zenon Research*

*Associate researcher, Mines Paris PSL*

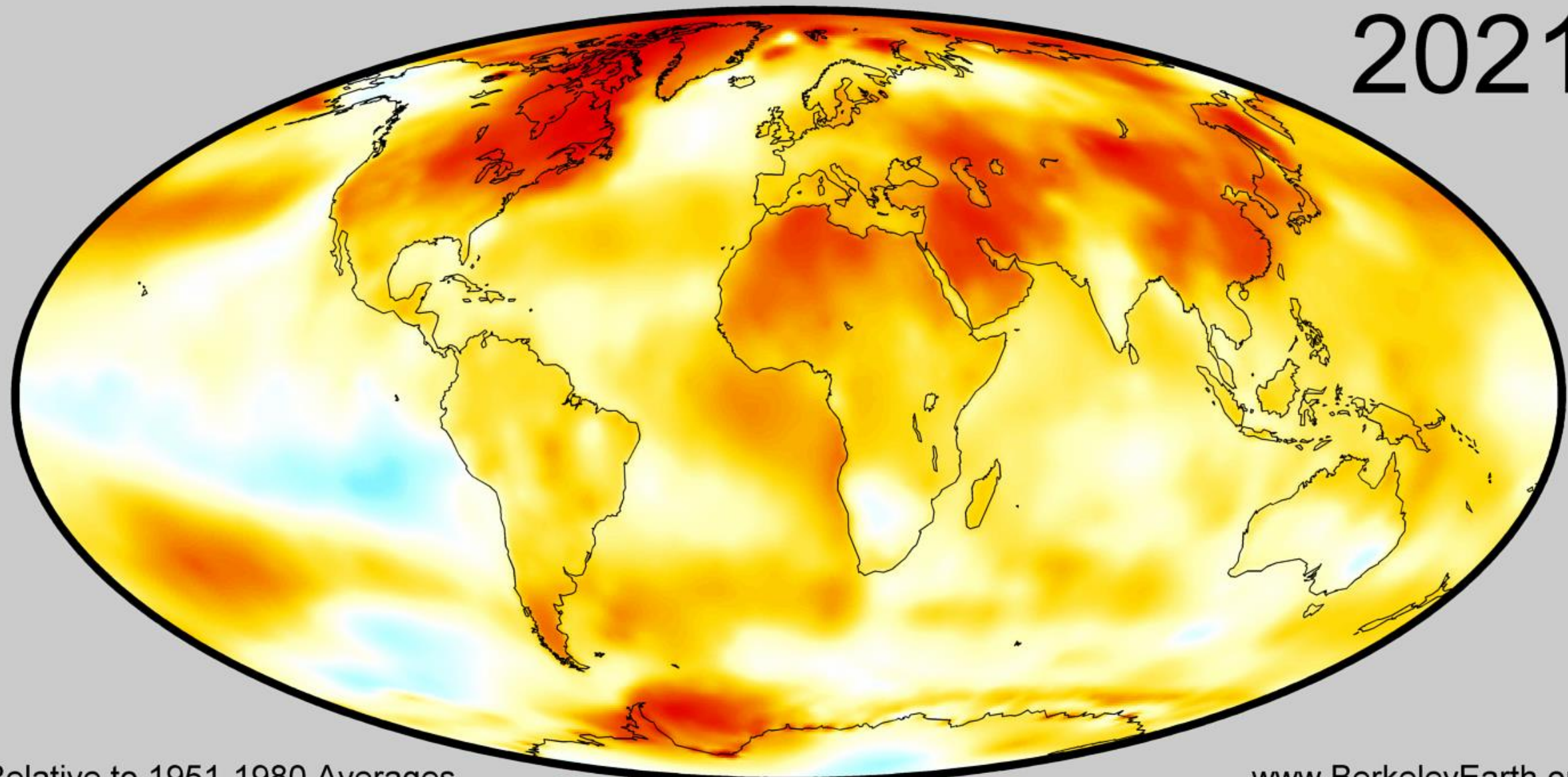
[greg@zenon.ngo](mailto:greg@zenon.ngo)

**Zenon**  
Research

  
MINES PARIS

PSL 

2021



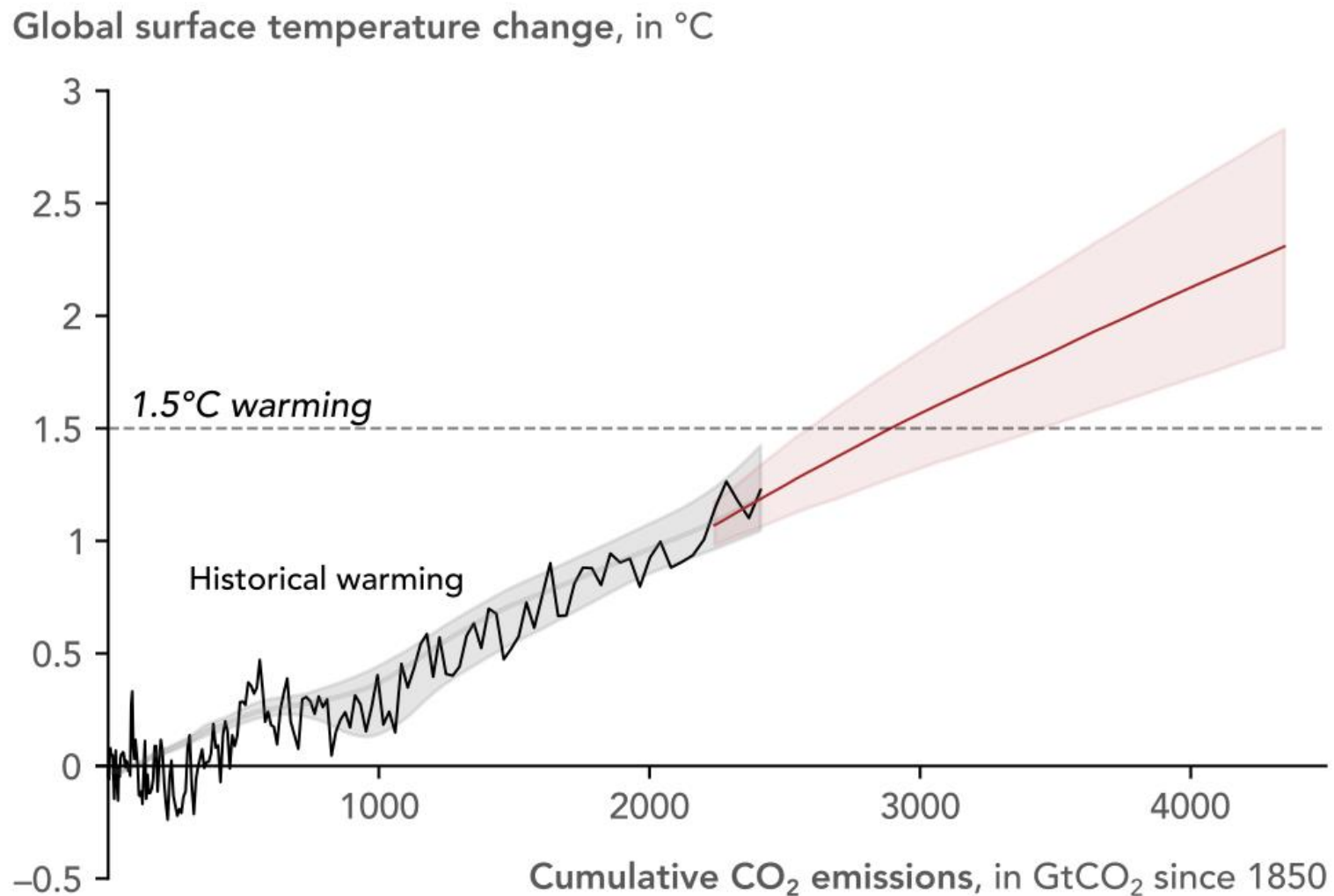
Relative to 1951-1980 Averages

[www.BerkeleyEarth.org](http://www.BerkeleyEarth.org)

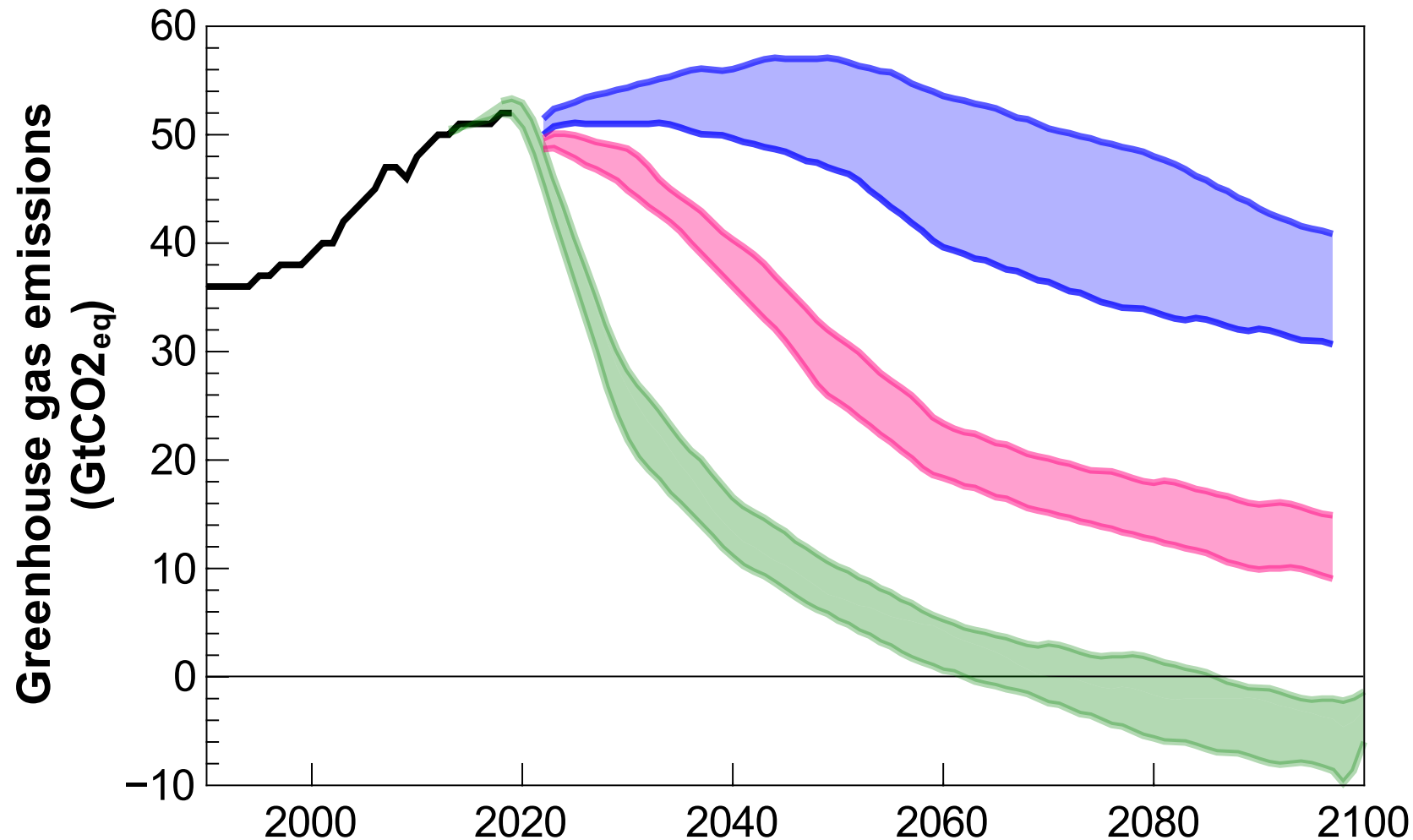


Temperature Anomaly ( $^{\circ}$  C)

# Le réchauffement dépend des émissions



# Trajectoires d'émission



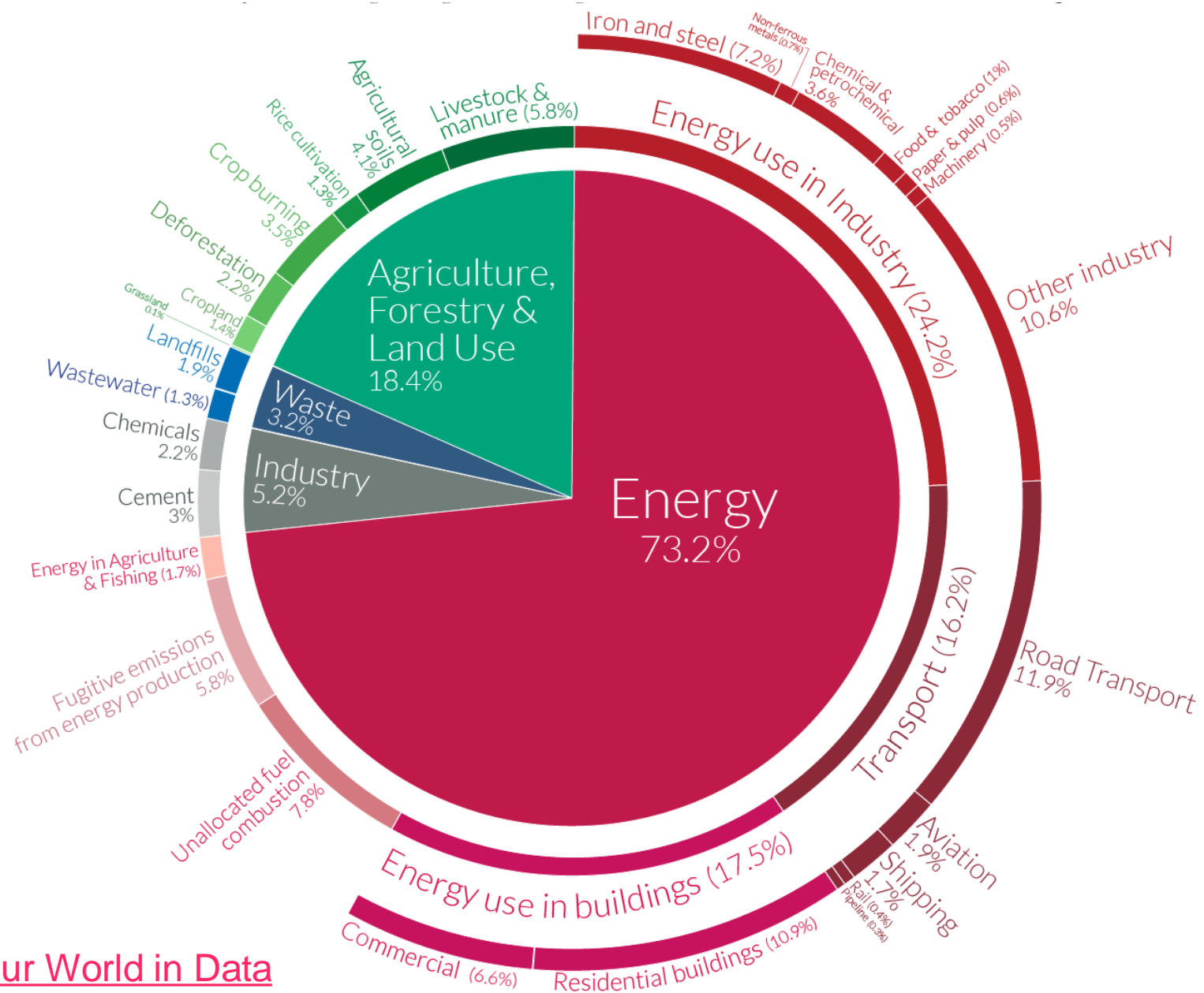
**Politiques en cours (+2.5-2.9°C)**

**Promesses COP 26 (+1.8-2.1°C)**

**1.5 degrés COP 21**

Source data: [Climate Action Tracker](#)

# Emissions de CO<sub>2</sub> par secteur (Monde)



Source: Our World in Data

# Emissions de CO<sub>2</sub> par secteur (France)

Les émissions territoriales de gaz à effet de serre de la France sont estimées à 436 Mt éqCO<sub>2</sub> pour 2019.



## Transports = 136 Mt éqCO<sub>2</sub>



## Industrie = 84 Mt éqCO<sub>2</sub>



## Agriculture = 83 Mt éqCO<sub>2</sub>



## Bâtiments = 75 Mt éqCO<sub>2</sub> (79 Mt éqCO<sub>2</sub> après correction des variations météorologiques)

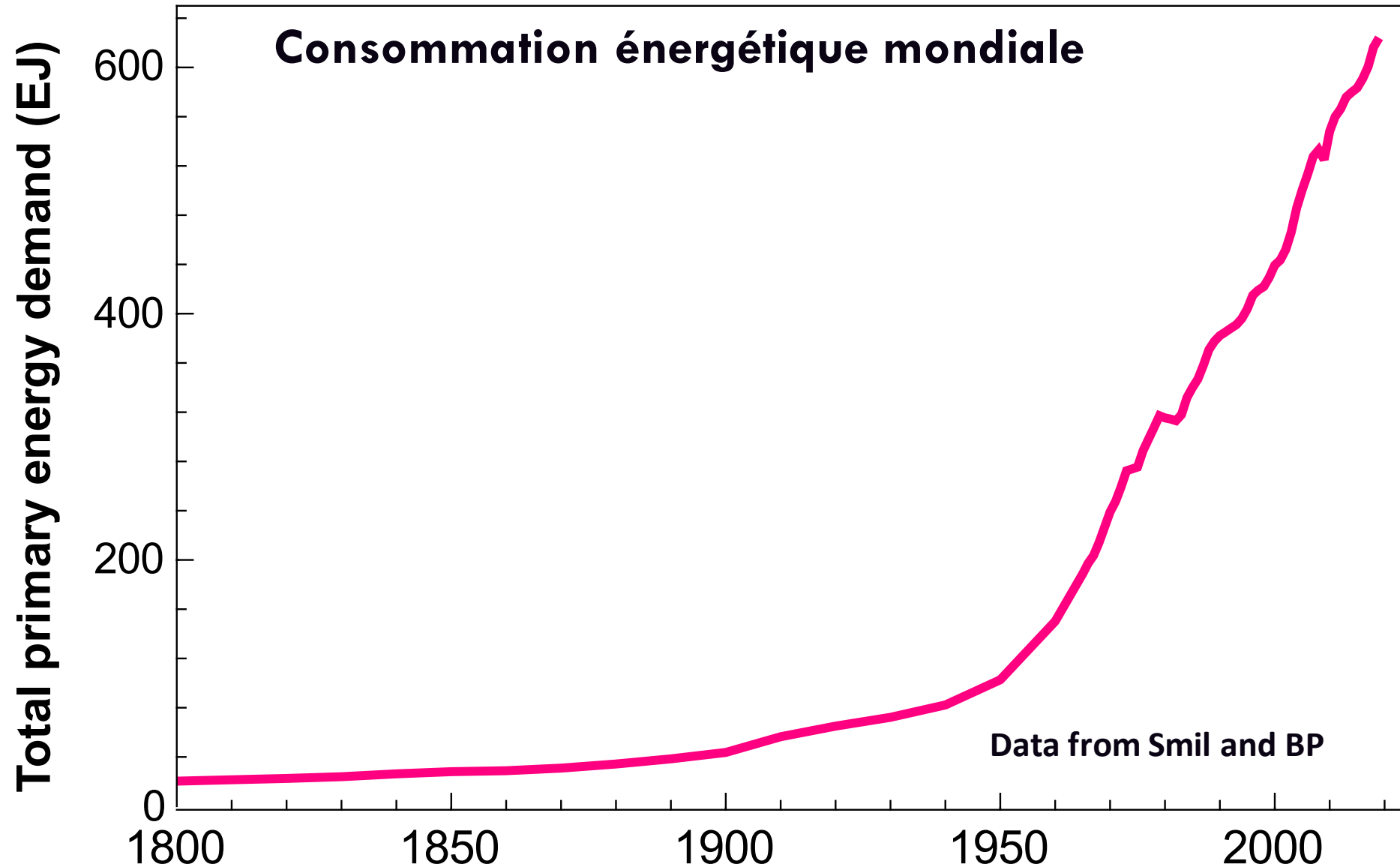


## Transformation d'énergie = 42 Mt éqCO<sub>2</sub>



## Déchets = 15 Mt éqCO<sub>2</sub>





**Emissions 2019: 12Gt eqC**

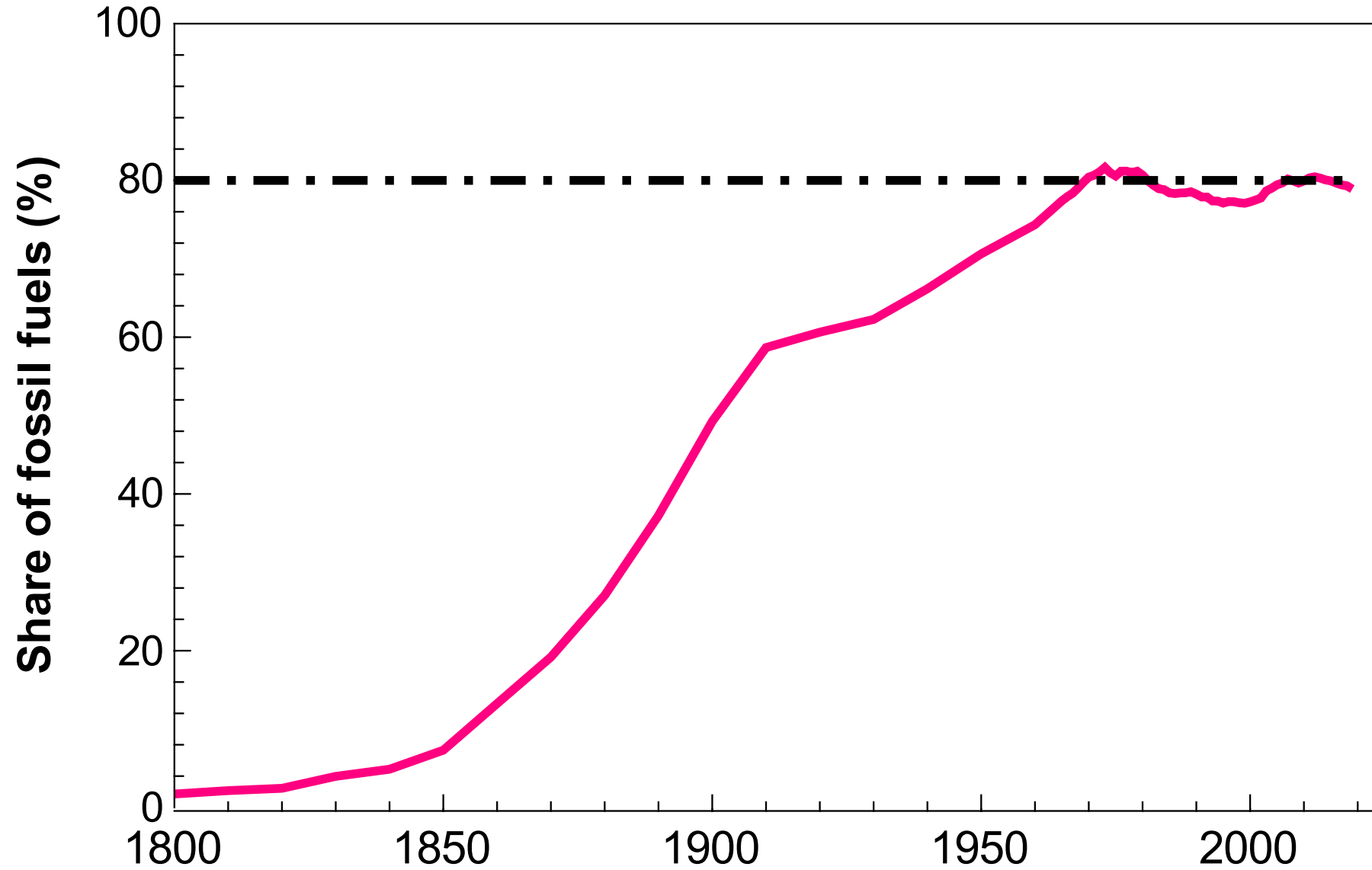
**1700 par  
an!!!**

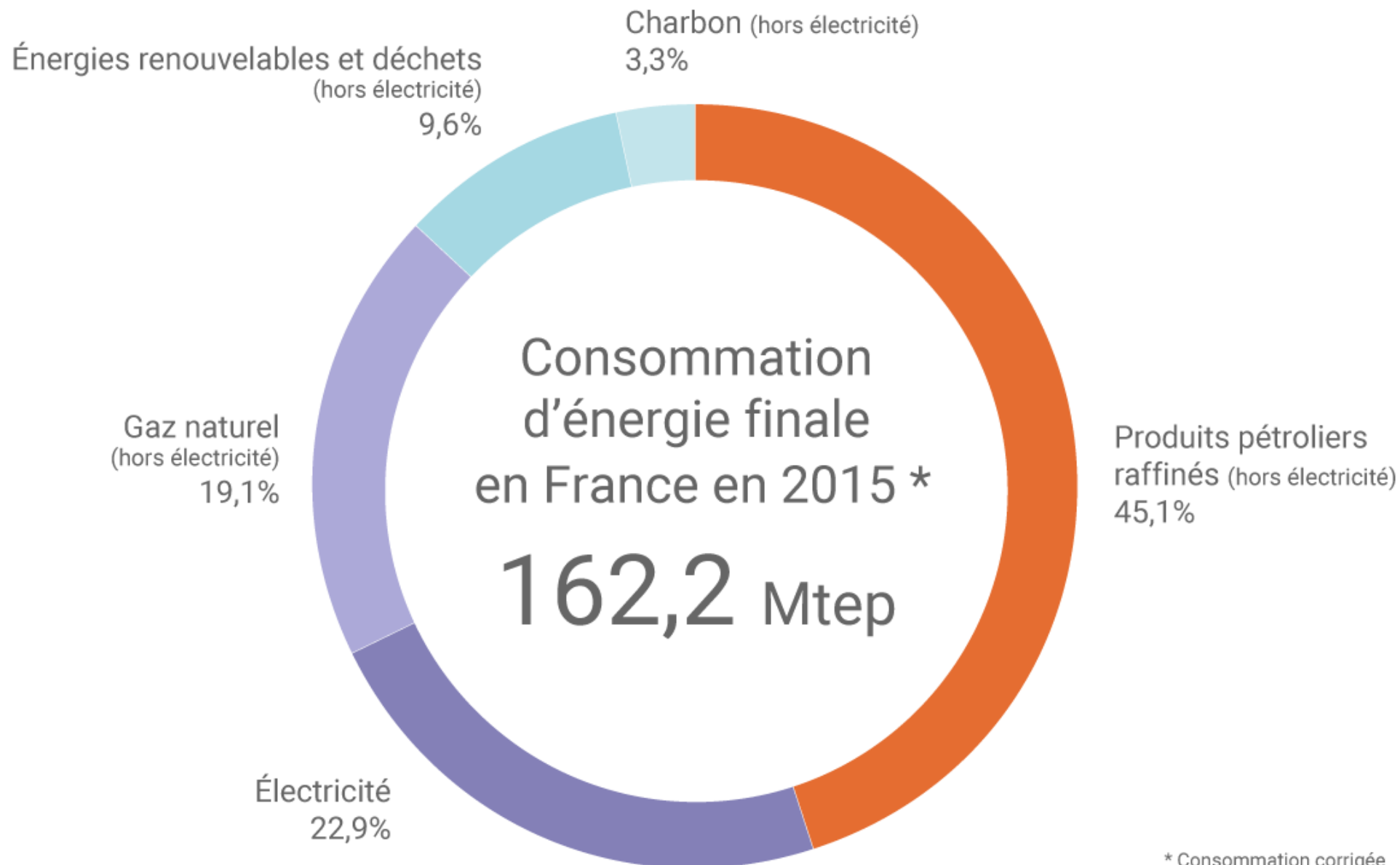


**G. De Temmerman, Chroniques énergétiques, 2021**

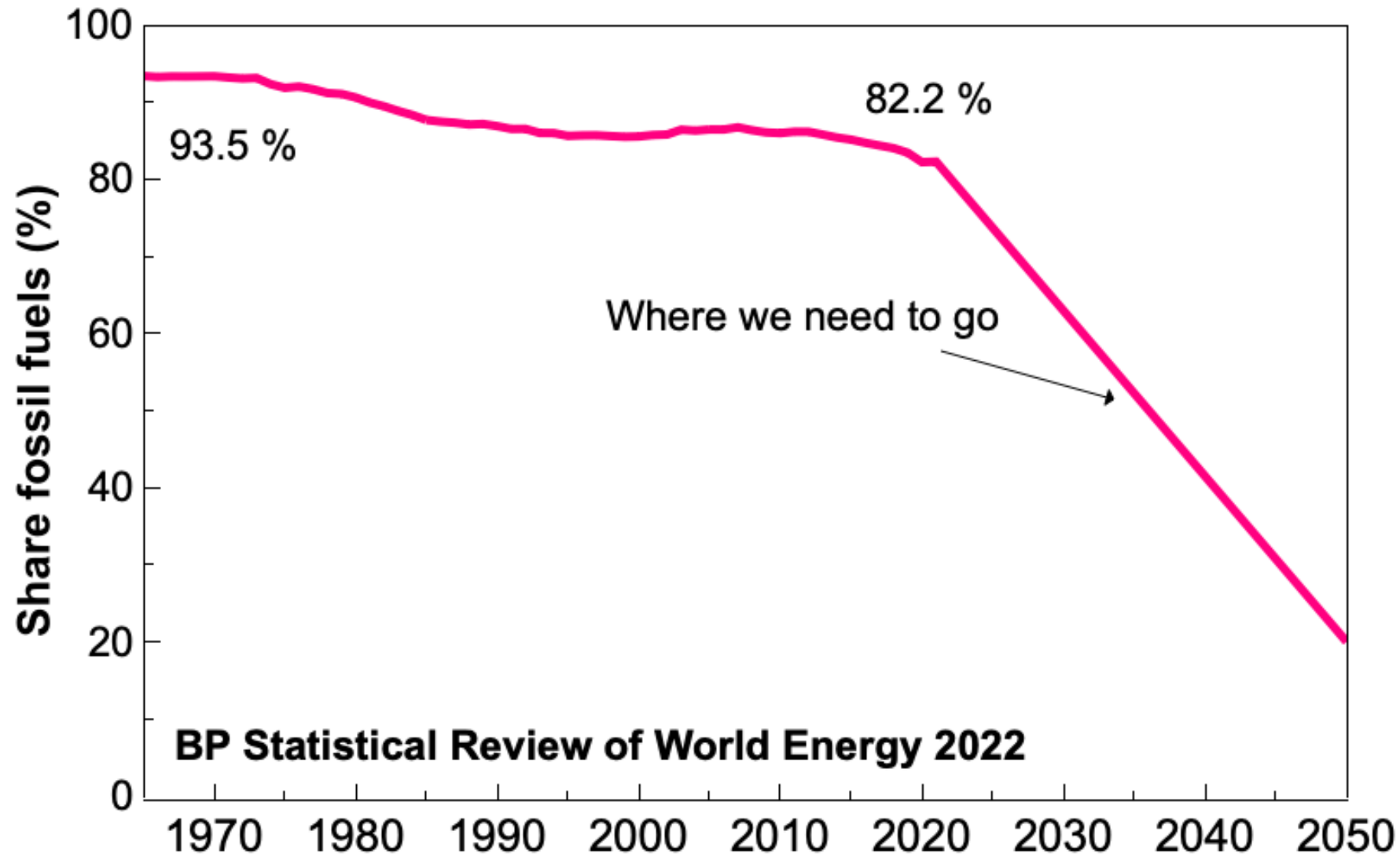


# Une énergie majoritairement fossile

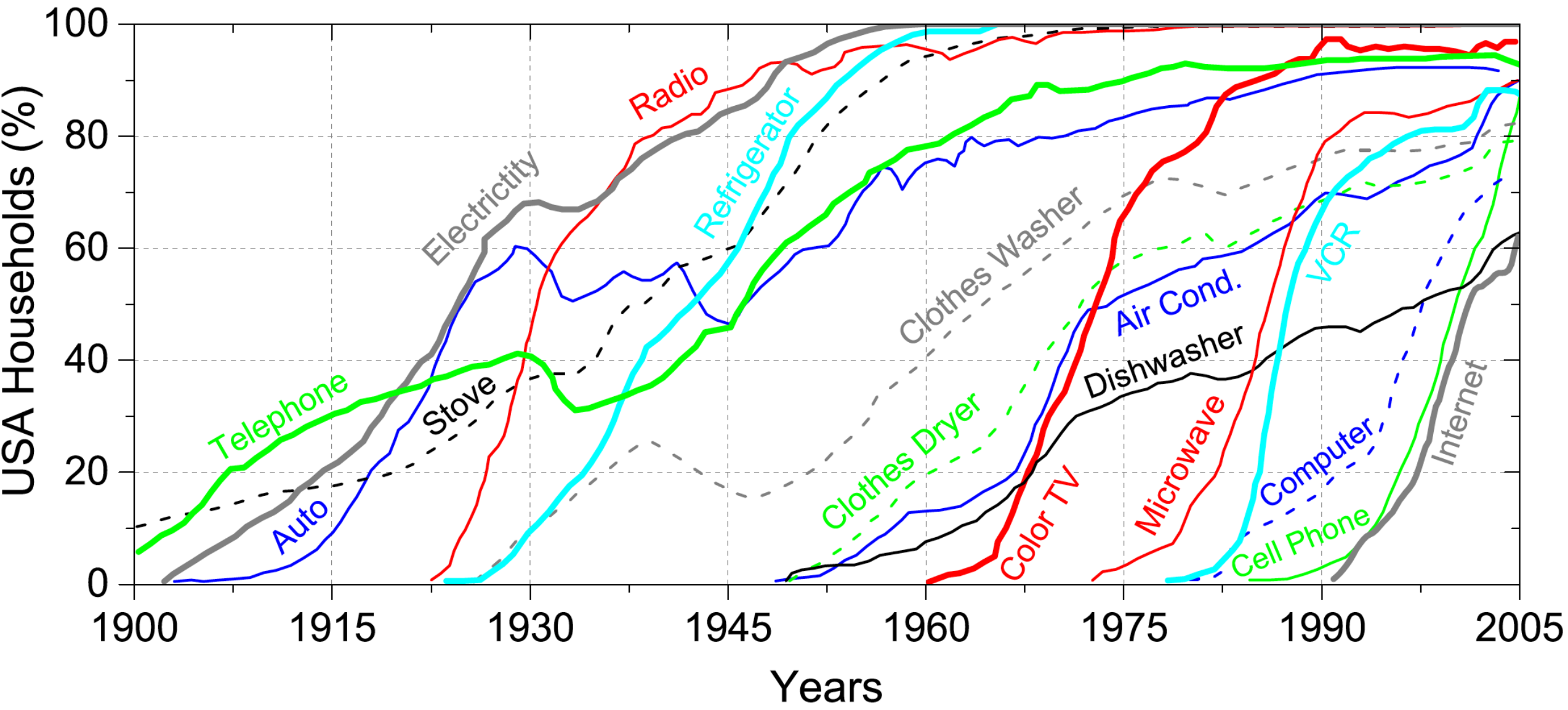


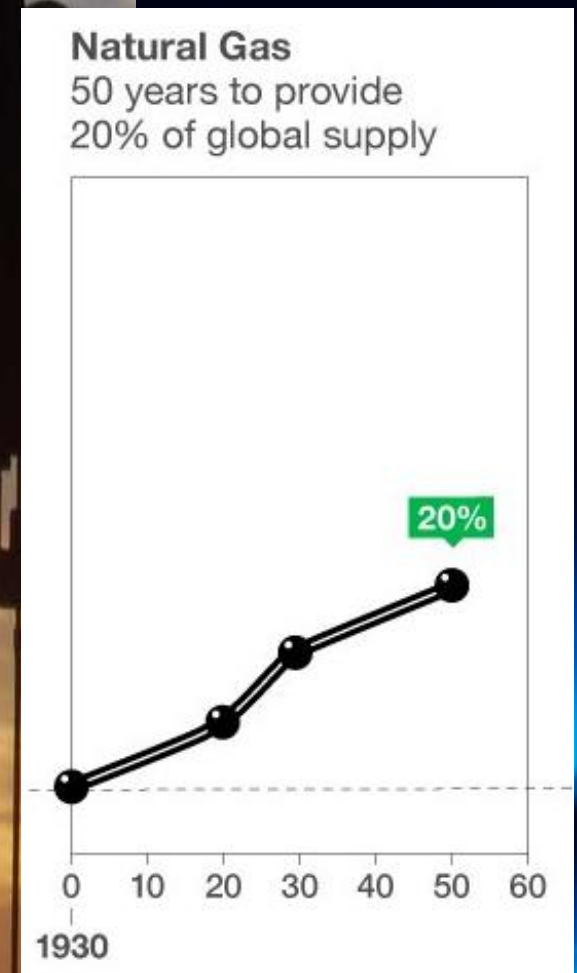
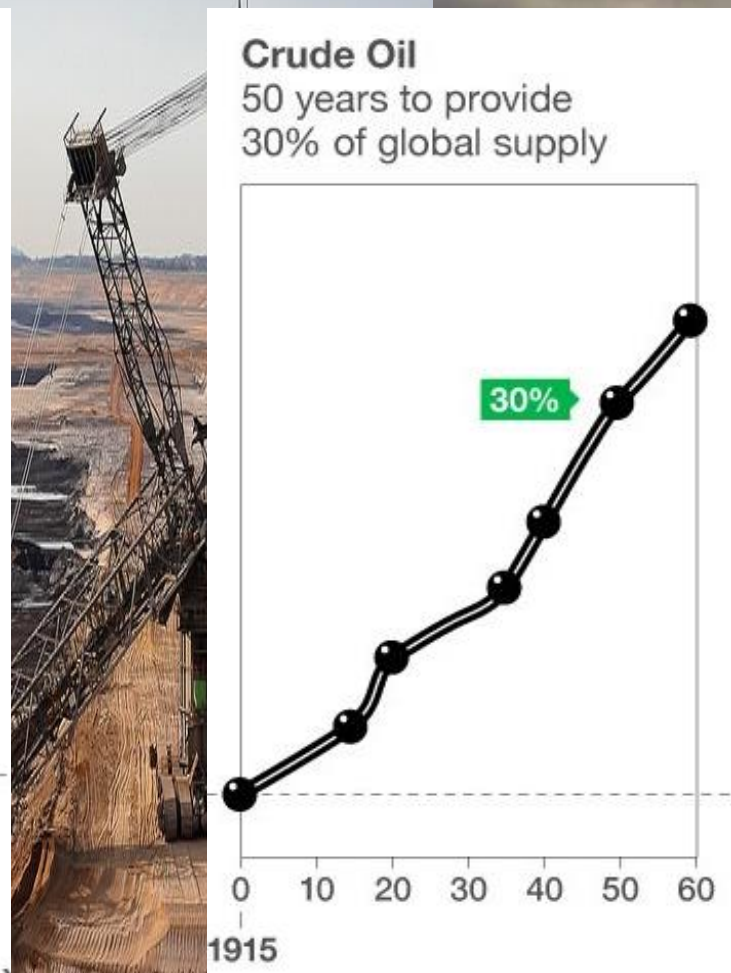
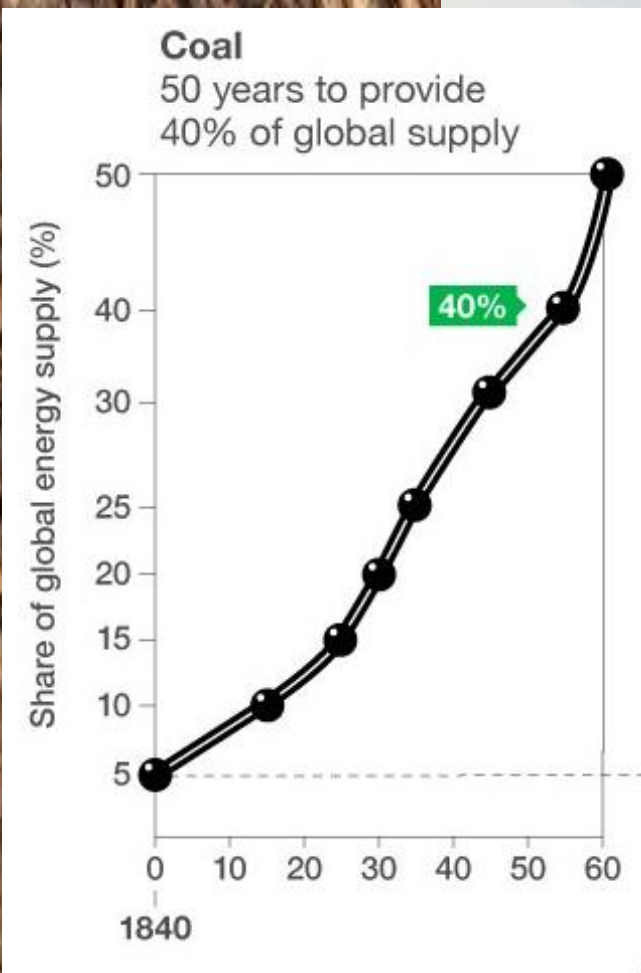


# Un sevrage rapide est nécessaire

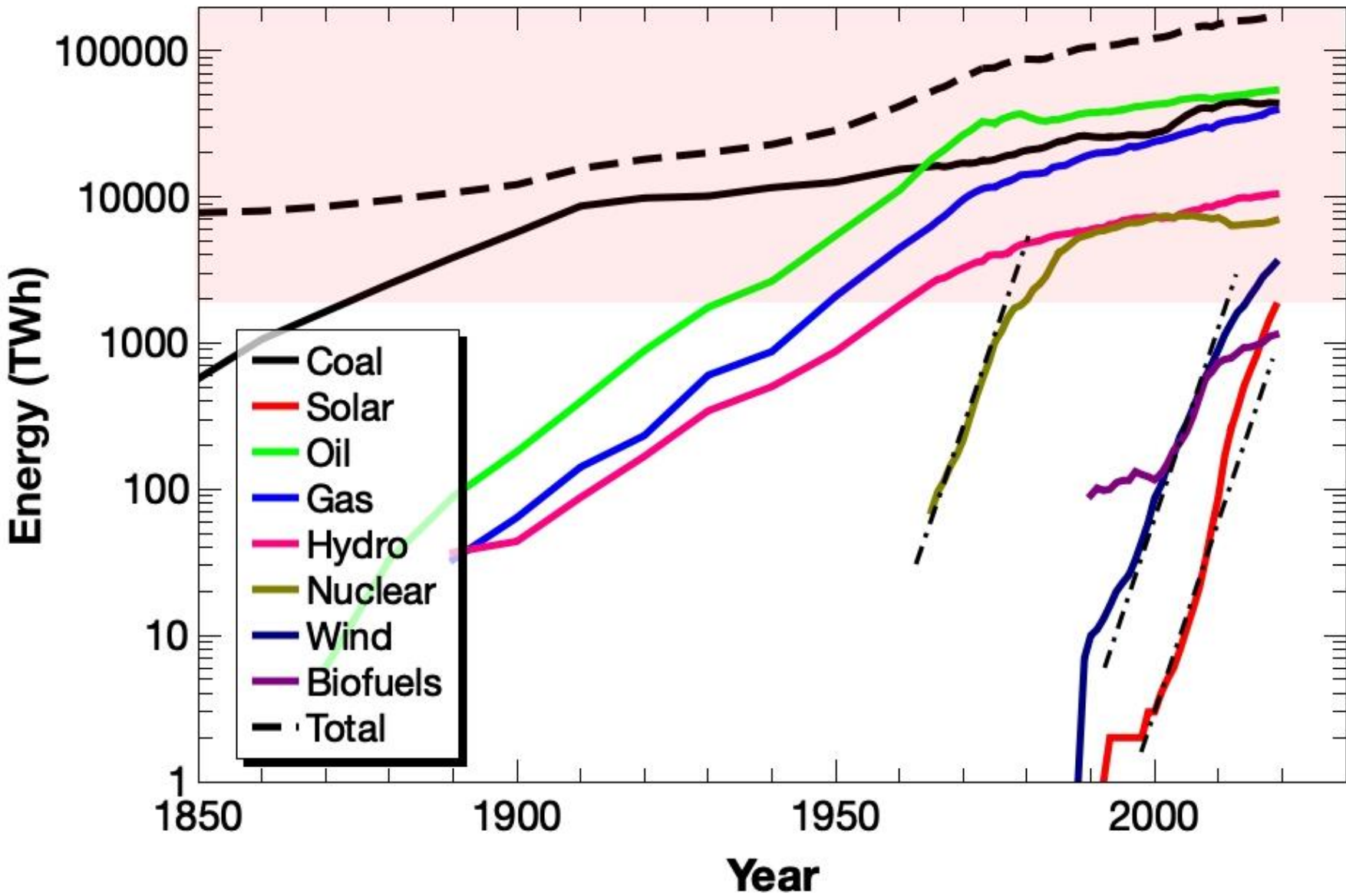


# Diffusion rapide de certaines technologies

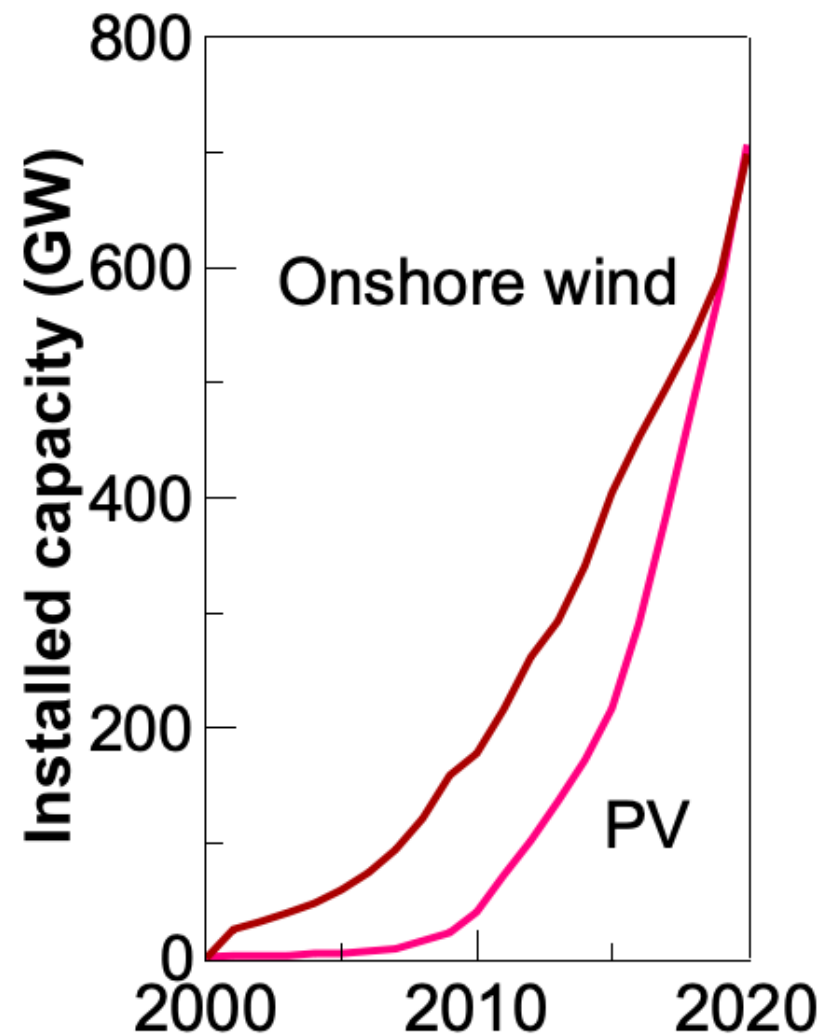
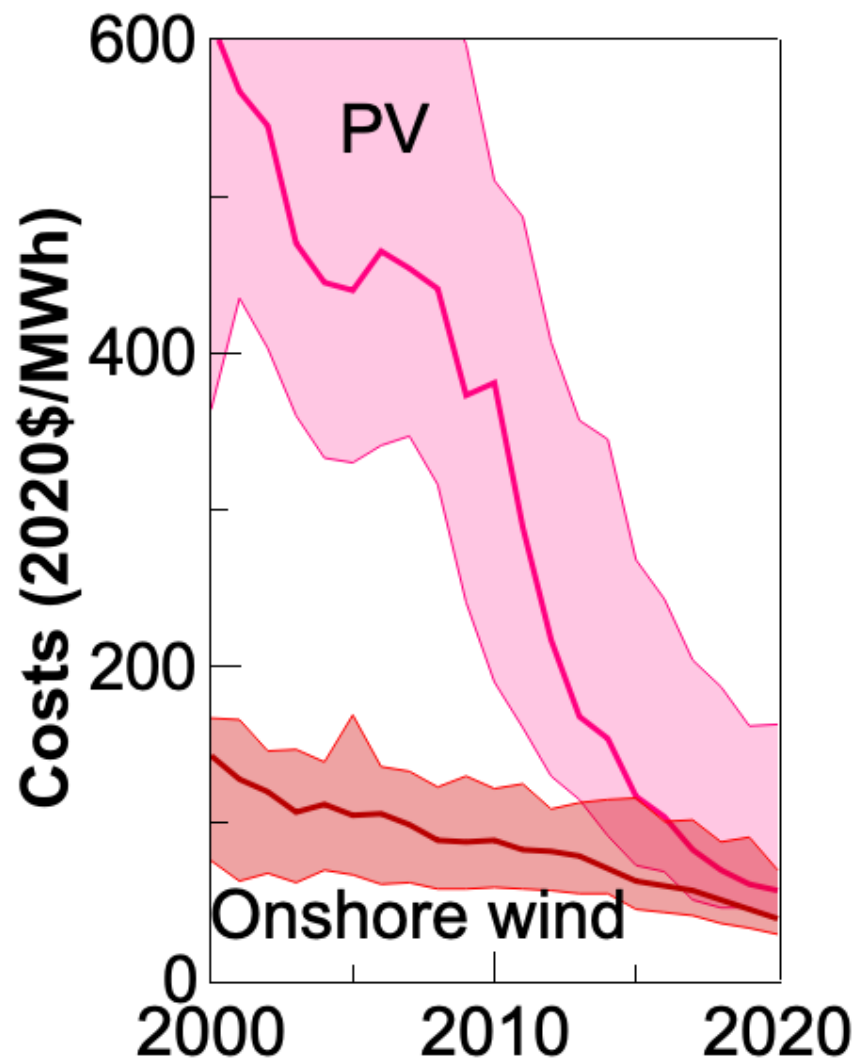




# Une accélération aussi dans l'énergie

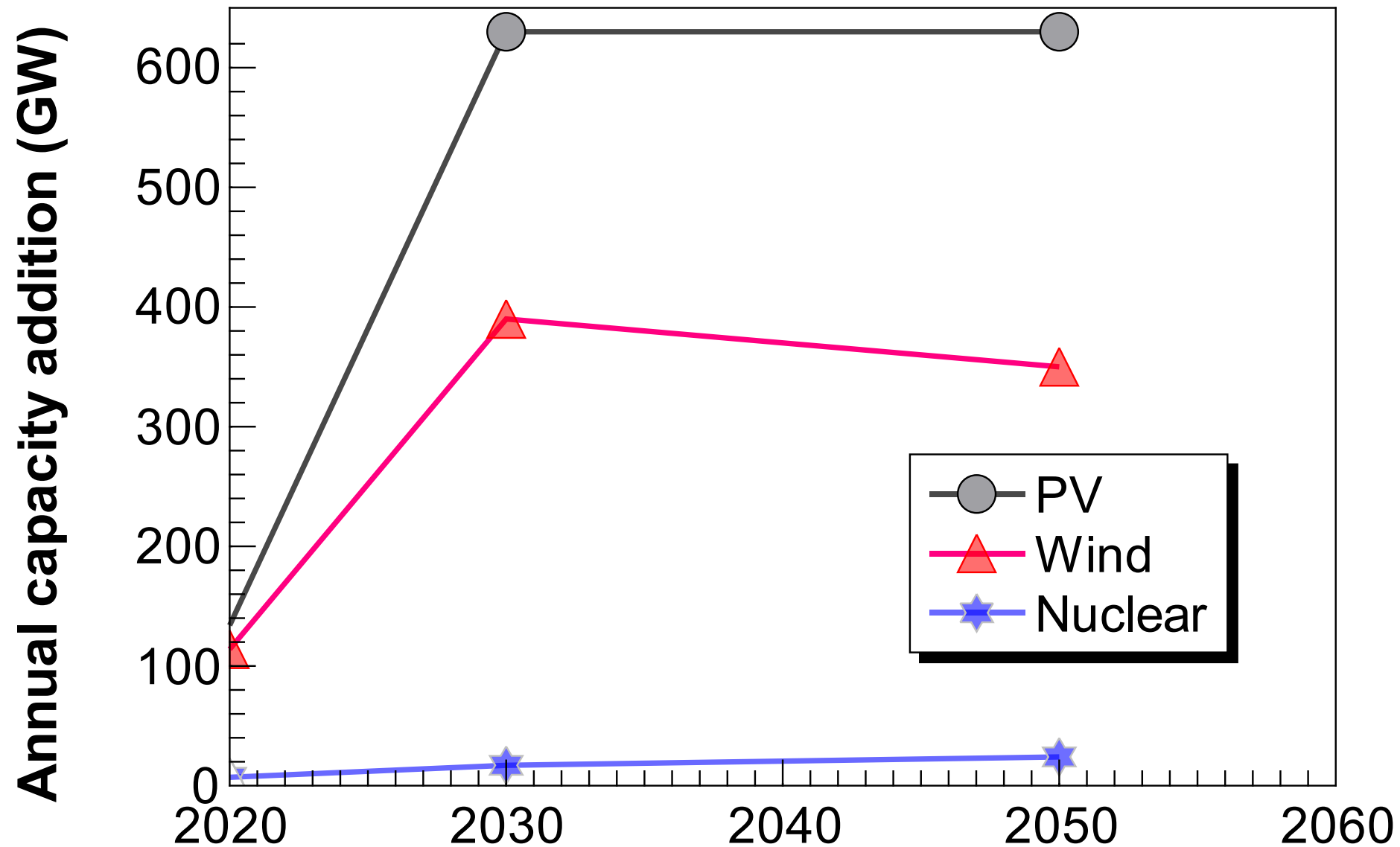


# Déployer les technologies existantes



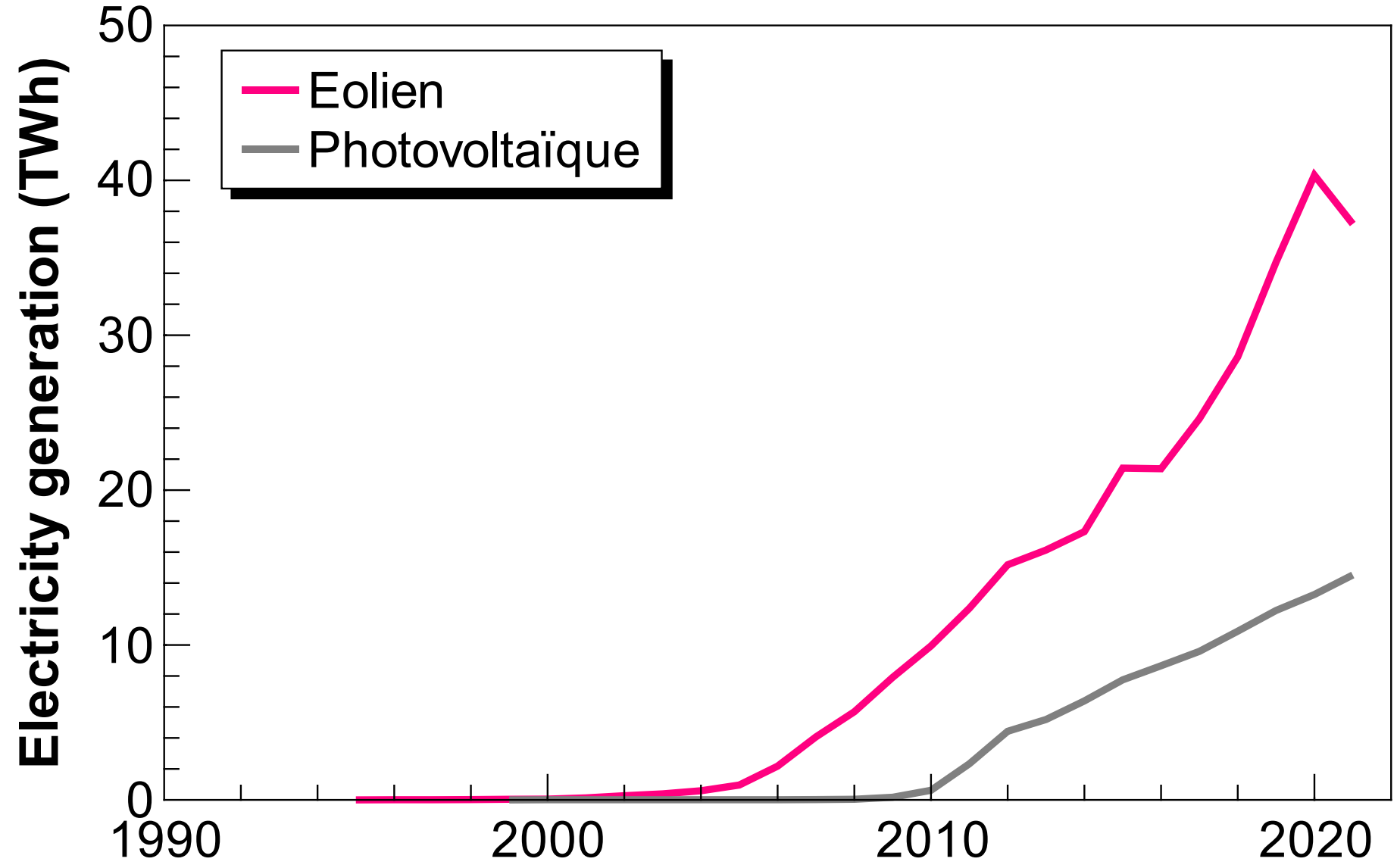
Since 2015  
**+26%/an**  
**+13%/an**

# Un déploiement qui doit encore accélérer





# Déploiement des EnR en France



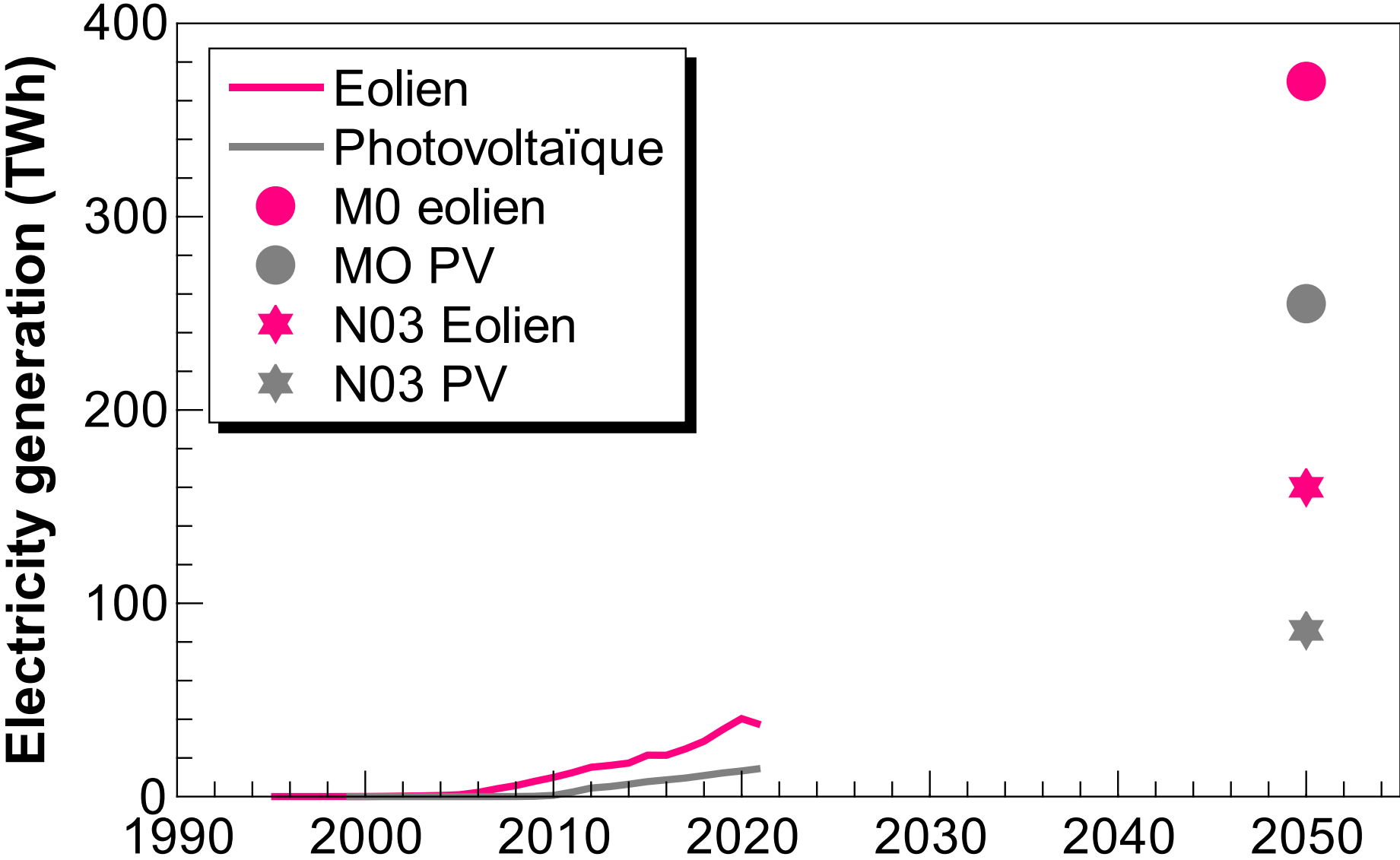
Environnement

## Les premières éoliennes en mer de France, à Saint-Nazaire, ont commencé à produire de l'électricité

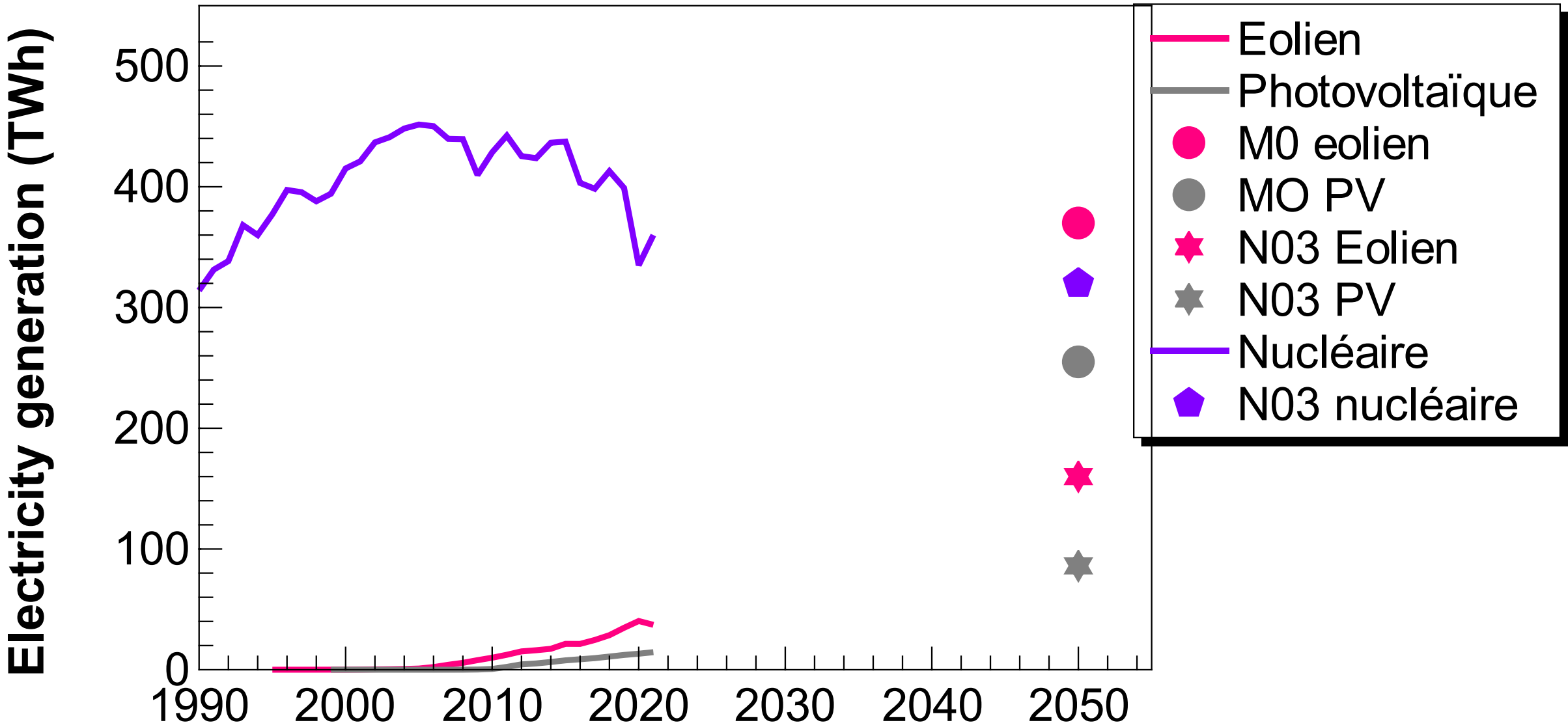
De l'électricité provenant d'éoliennes en mer, au large de Saint-Nazaire, a été produite pour la première fois en France cette semaine, annoncent ce vendredi l'opérateur et le gestionnaire du réseau.

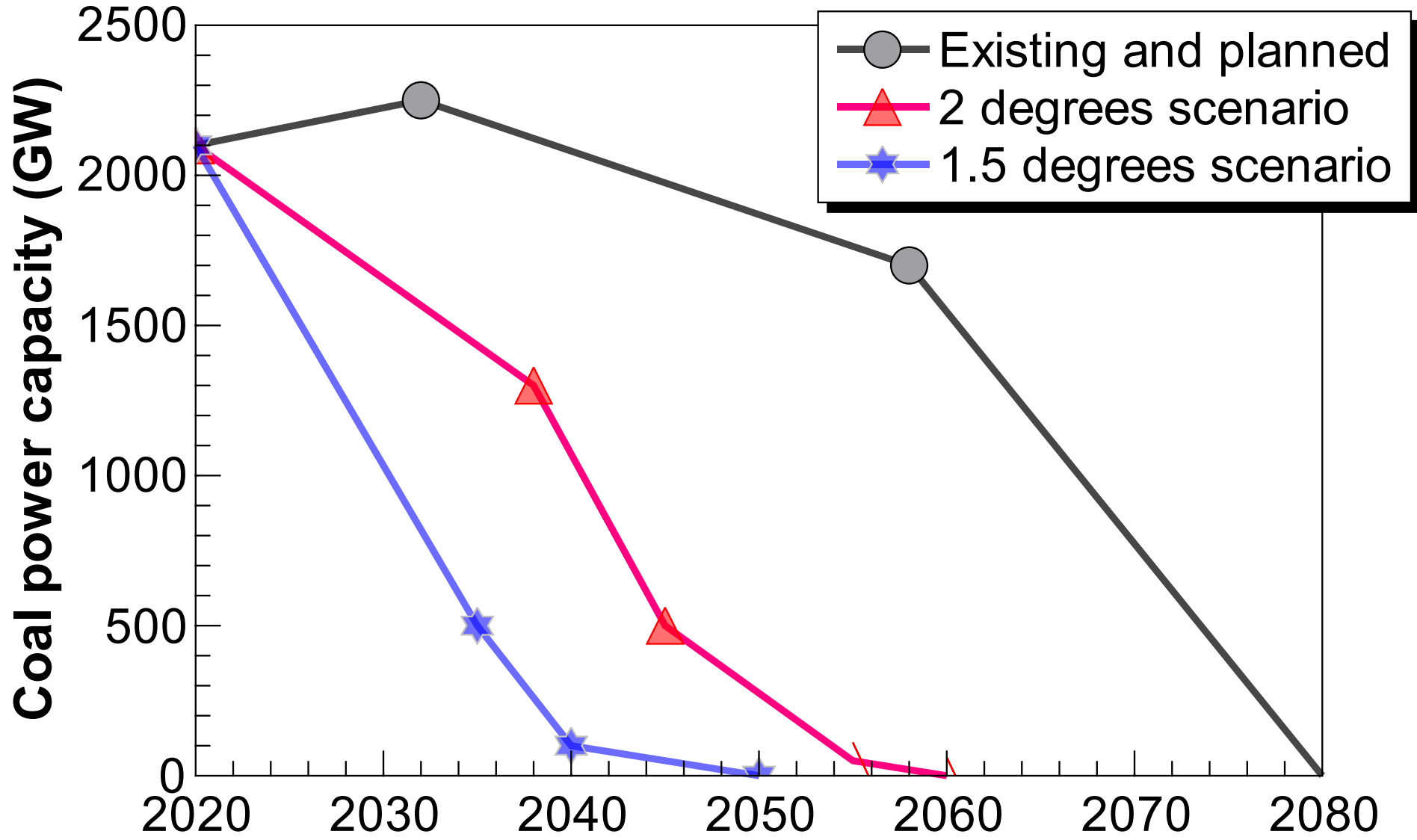


# Différents scénarios et ambitions



# Des EnR qui prendront plus de place

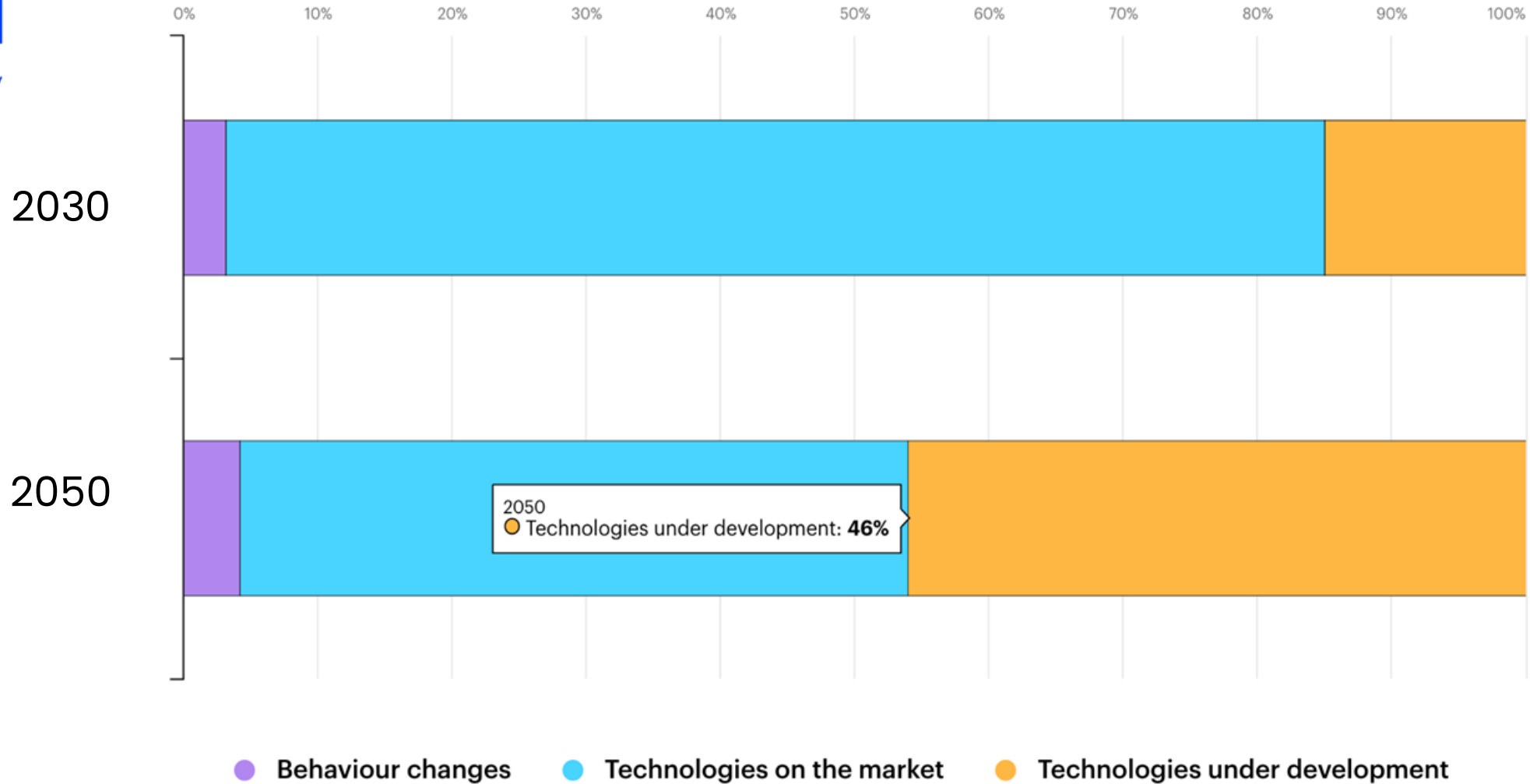




Adapted from: M.R. Edwards et al, Env. Res. Lett 2022



# L'innovation est nécessaire

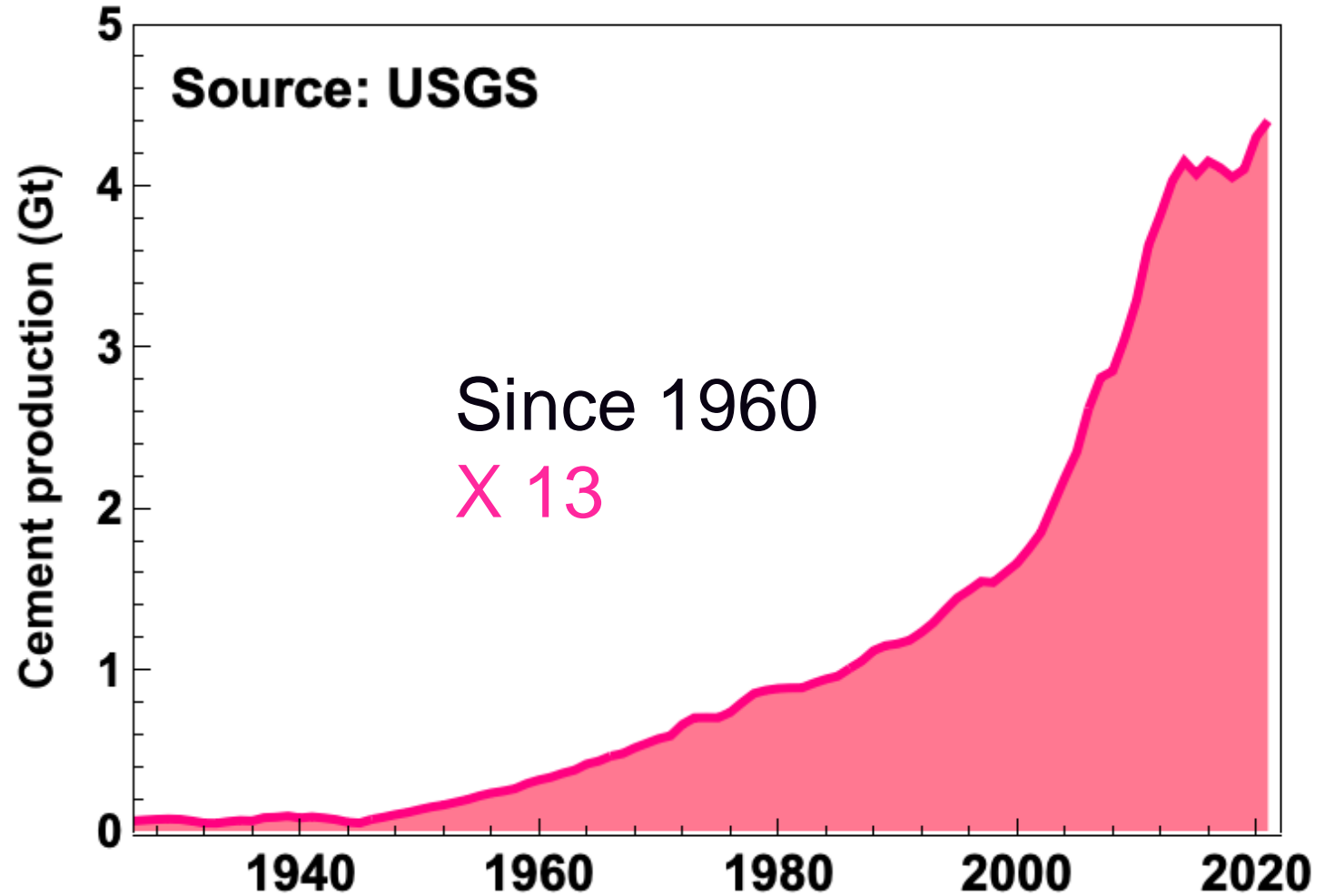


Source

# Les piliers de la civilisation moderne (1/3)



6.5%  
of global  
CO<sub>2</sub>  
emissions

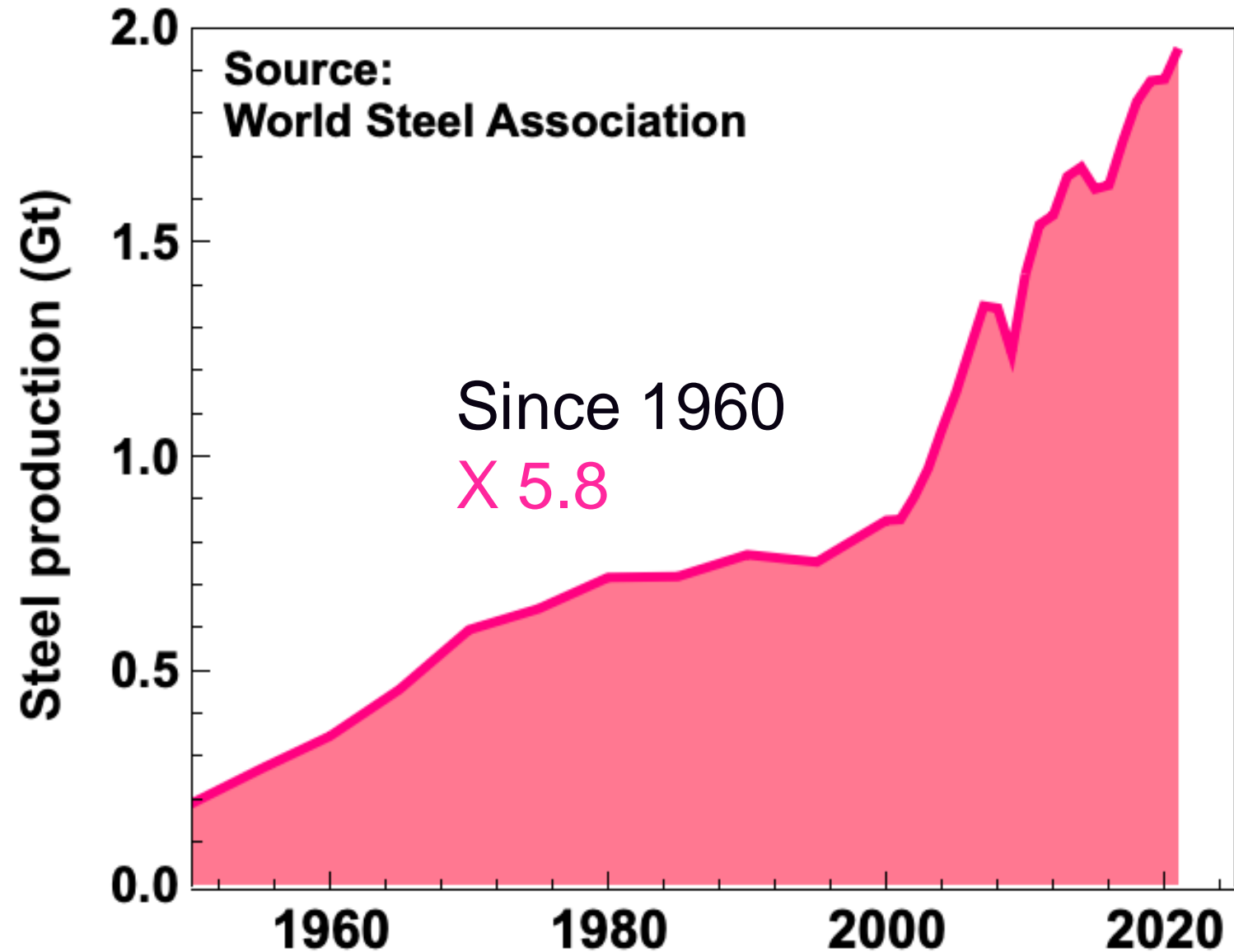




# Les piliers de la civilisation moderne (2/3)



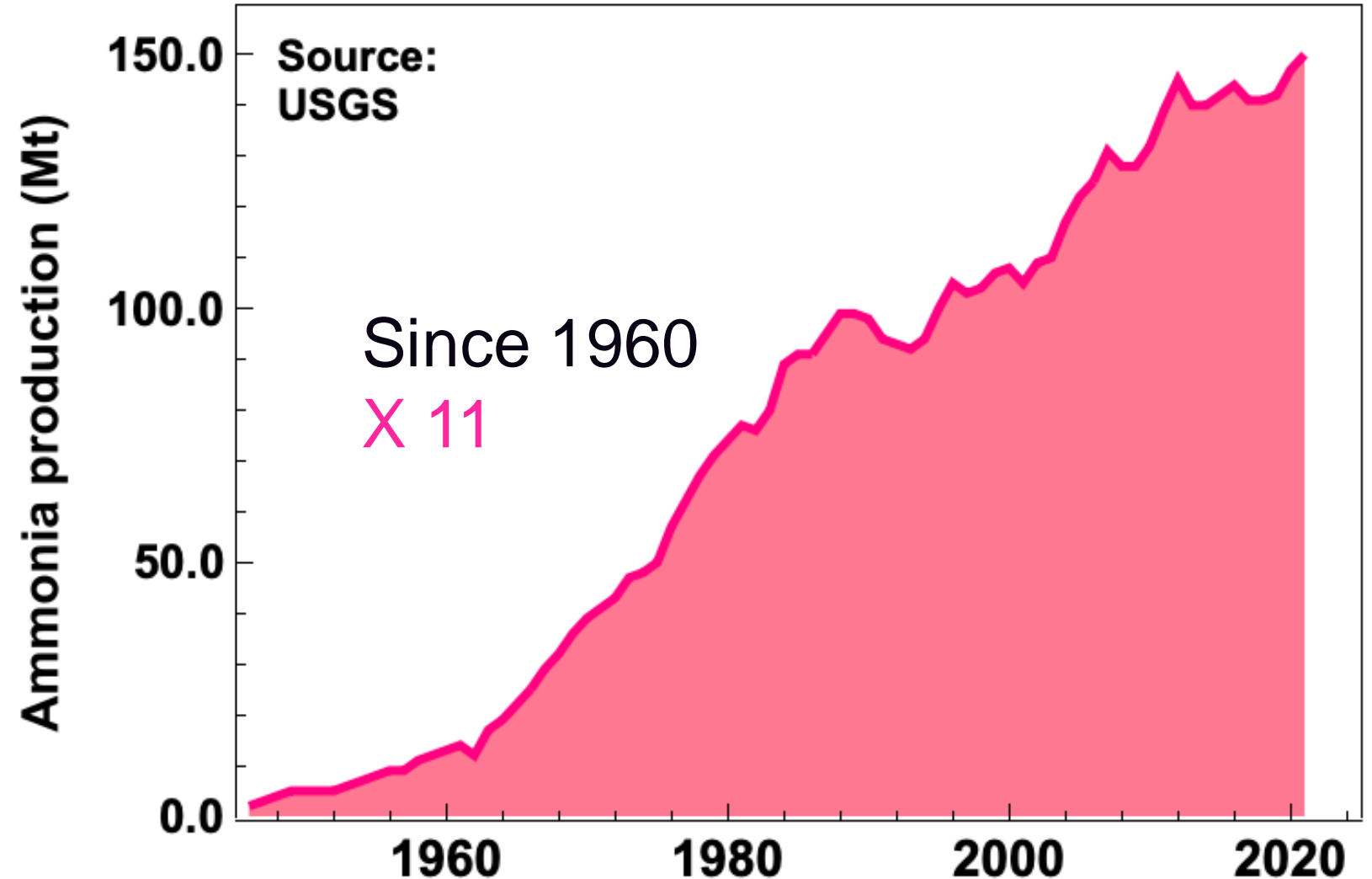
7%  
of global  
CO<sub>2</sub>  
emissions





## Ammonia

2%  
of global  
CO<sub>2</sub>  
emissions





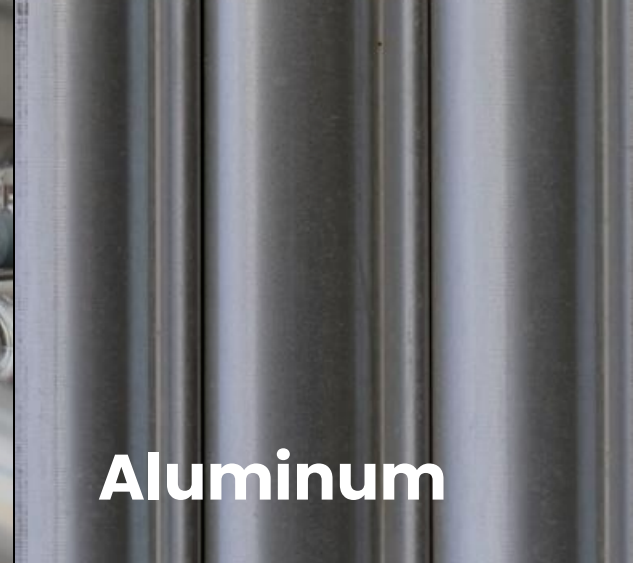
**Mining**



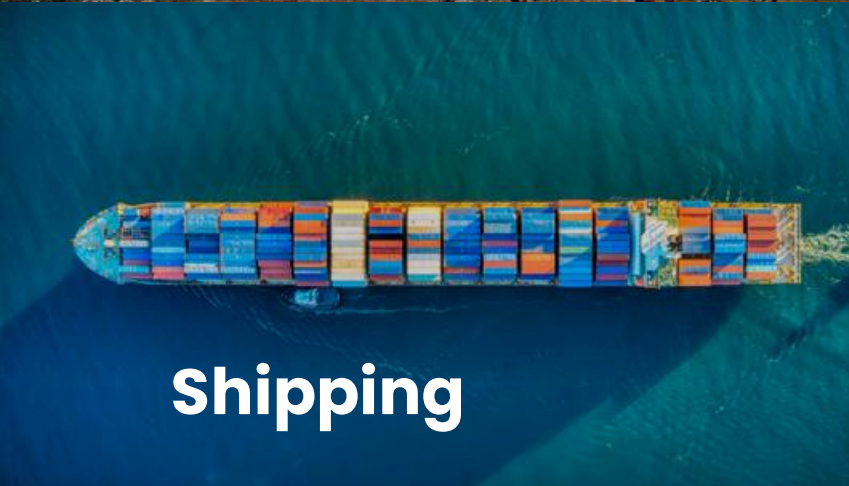
**Hydrogen**



**Chemicals**



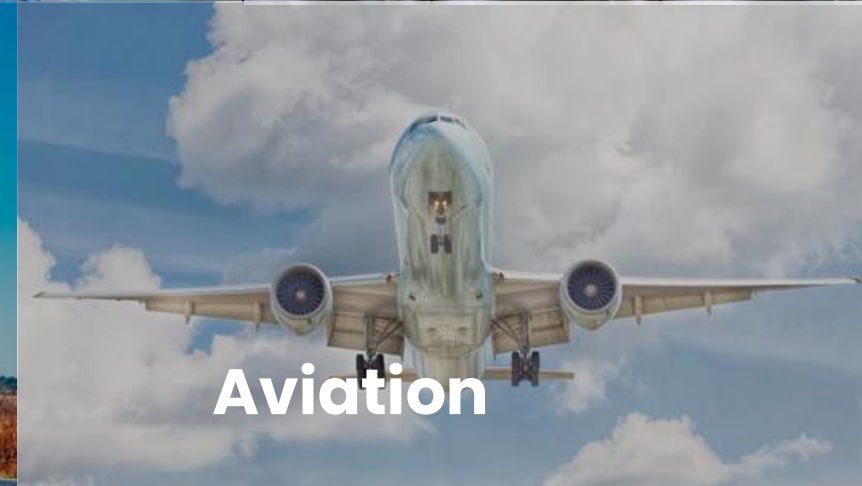
**Aluminum**



**Shipping**



**Trucking**



**Aviation**



**Agriculture**



**Energy  $CH_4$**

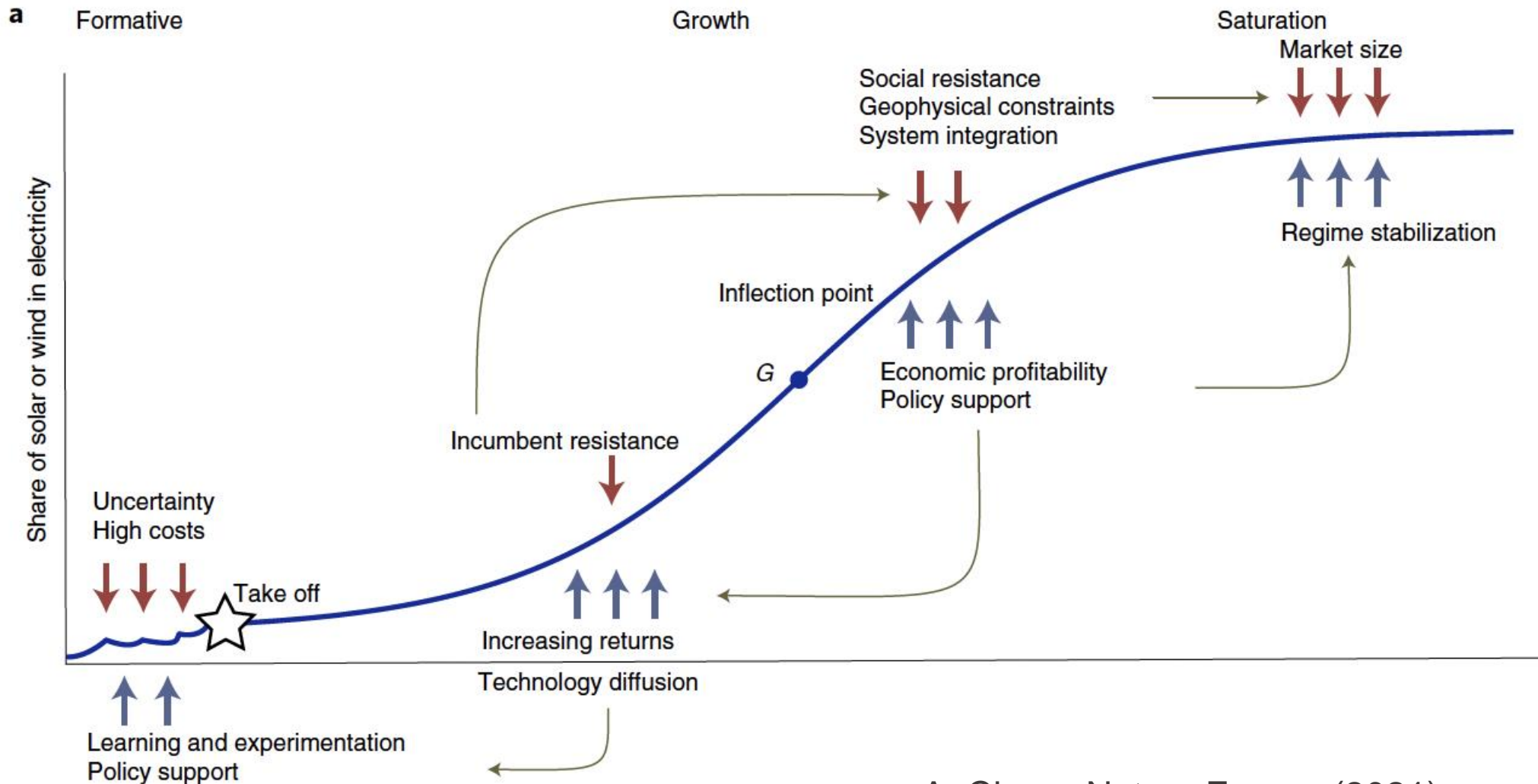


**Landfill  $CH_4$**



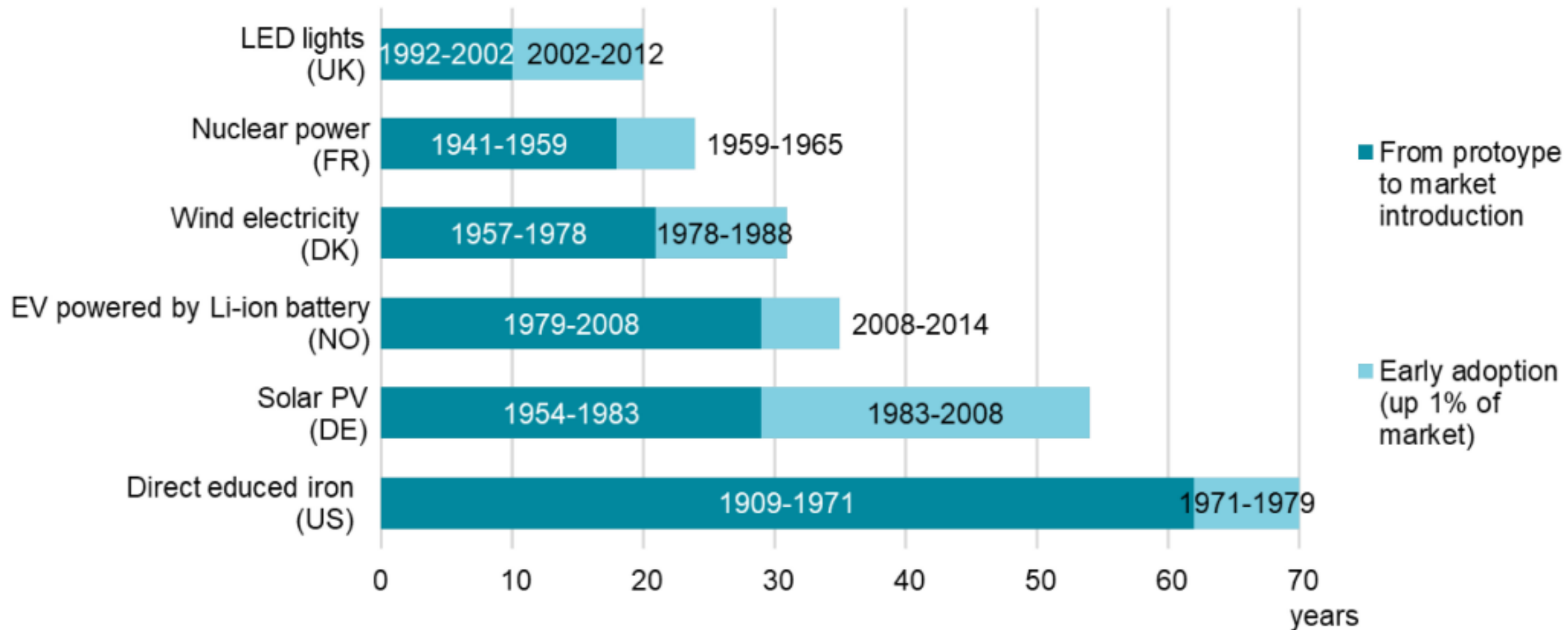
**Wastewater**

# Transition: 'festina lente'?



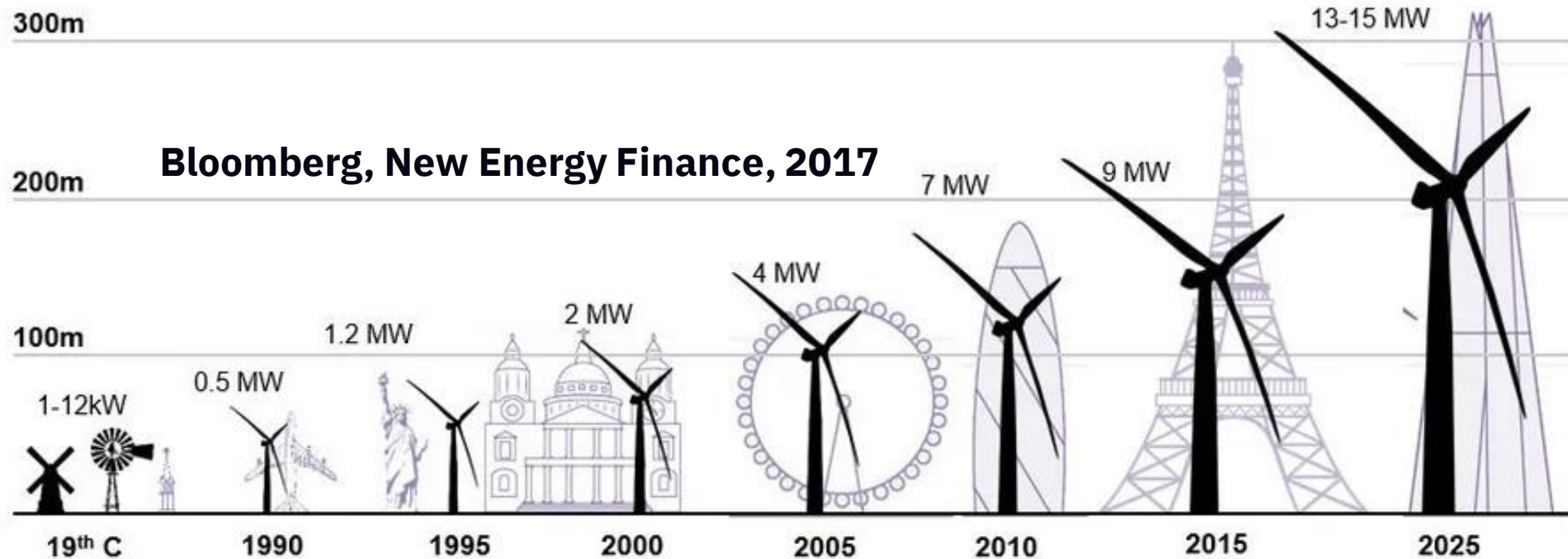
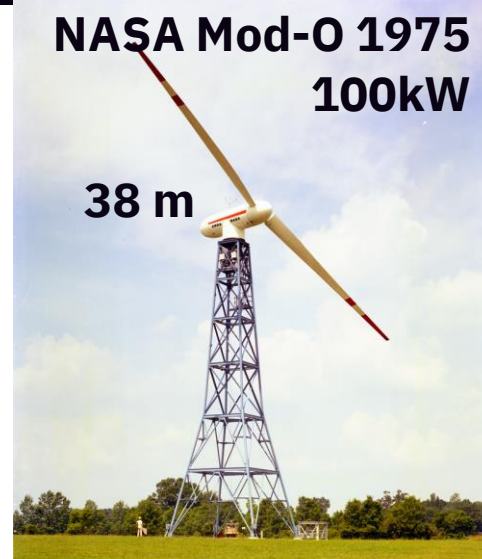
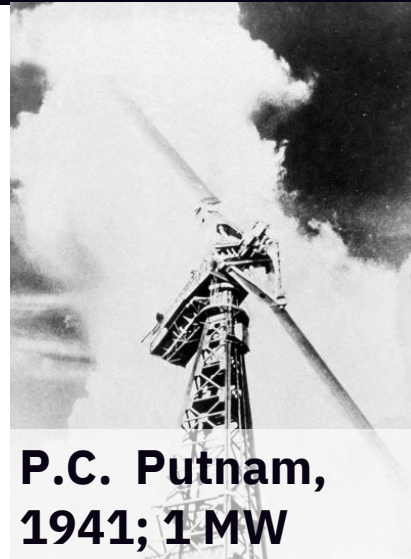
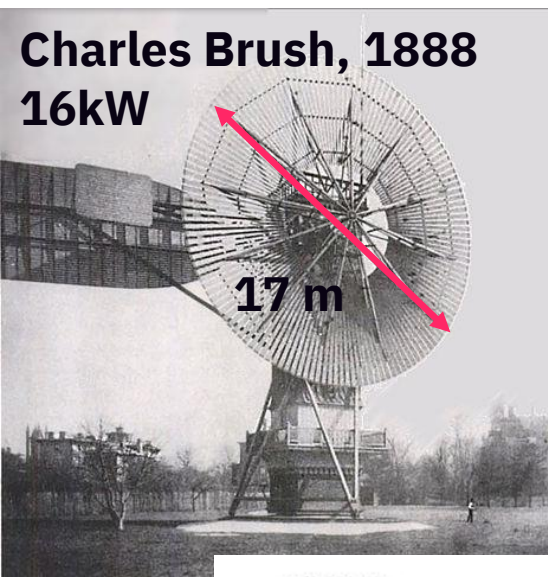
A. Cherp, Nature Energy (2021)

# Un long process de développement



IEA 2020. All rights reserved.

# Développement de l'éolien



[Published: 21 June 1974](#)

## Prospects for hydrogen as an energy resource

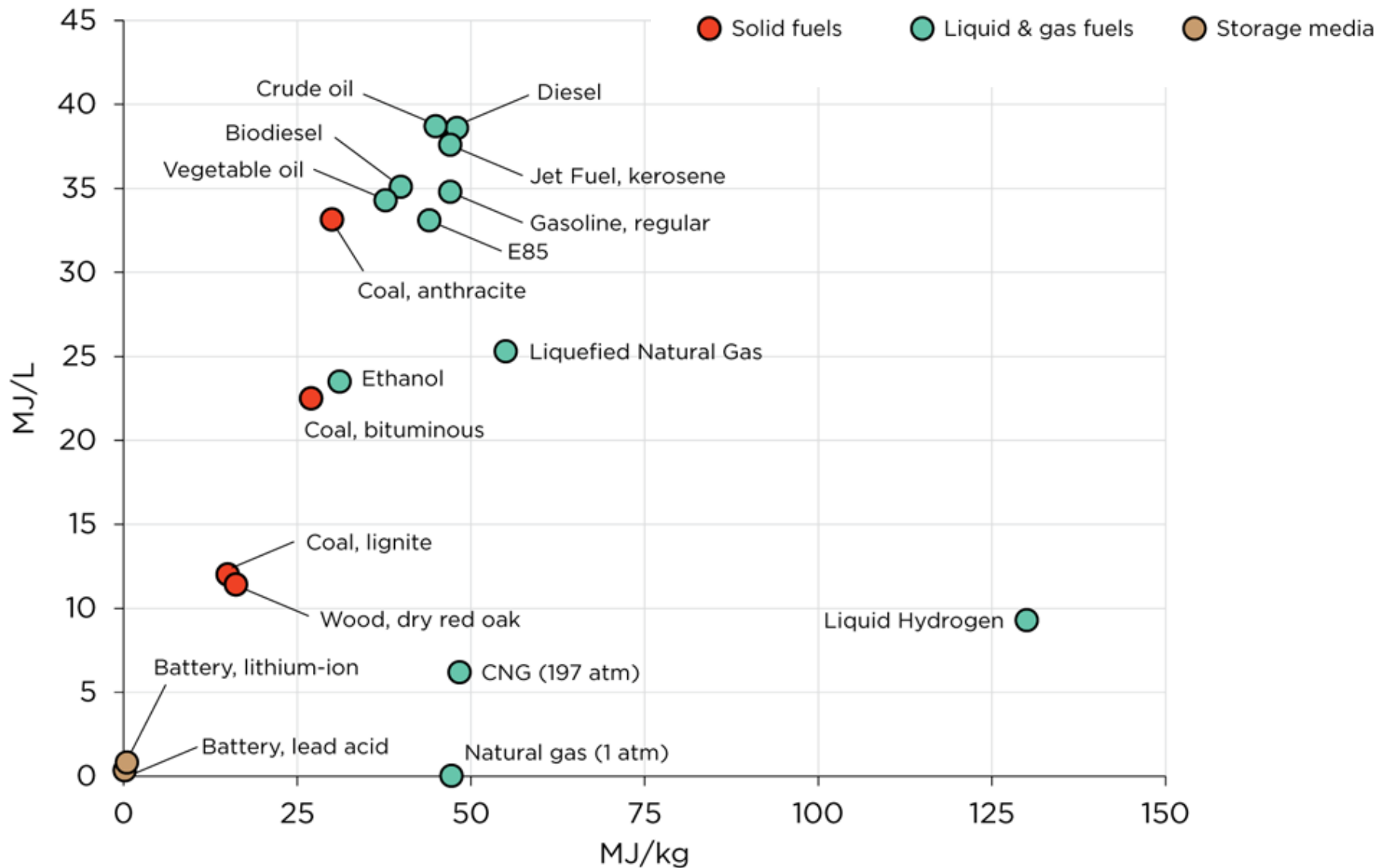
[J. K. Dawson](#)

[Nature](#) **249**, 724–726 (1974) | [Cite this article](#)

**583** Accesses | **35** Citations | **5** Altmetric | [Metrics](#)

**Storing energy in the form of hydrogen is an attractive possibility to provide fuel for transport and the reduction of iron ore. The main obstacle is the expense of the electricity needed to synthesise hydrogen.**

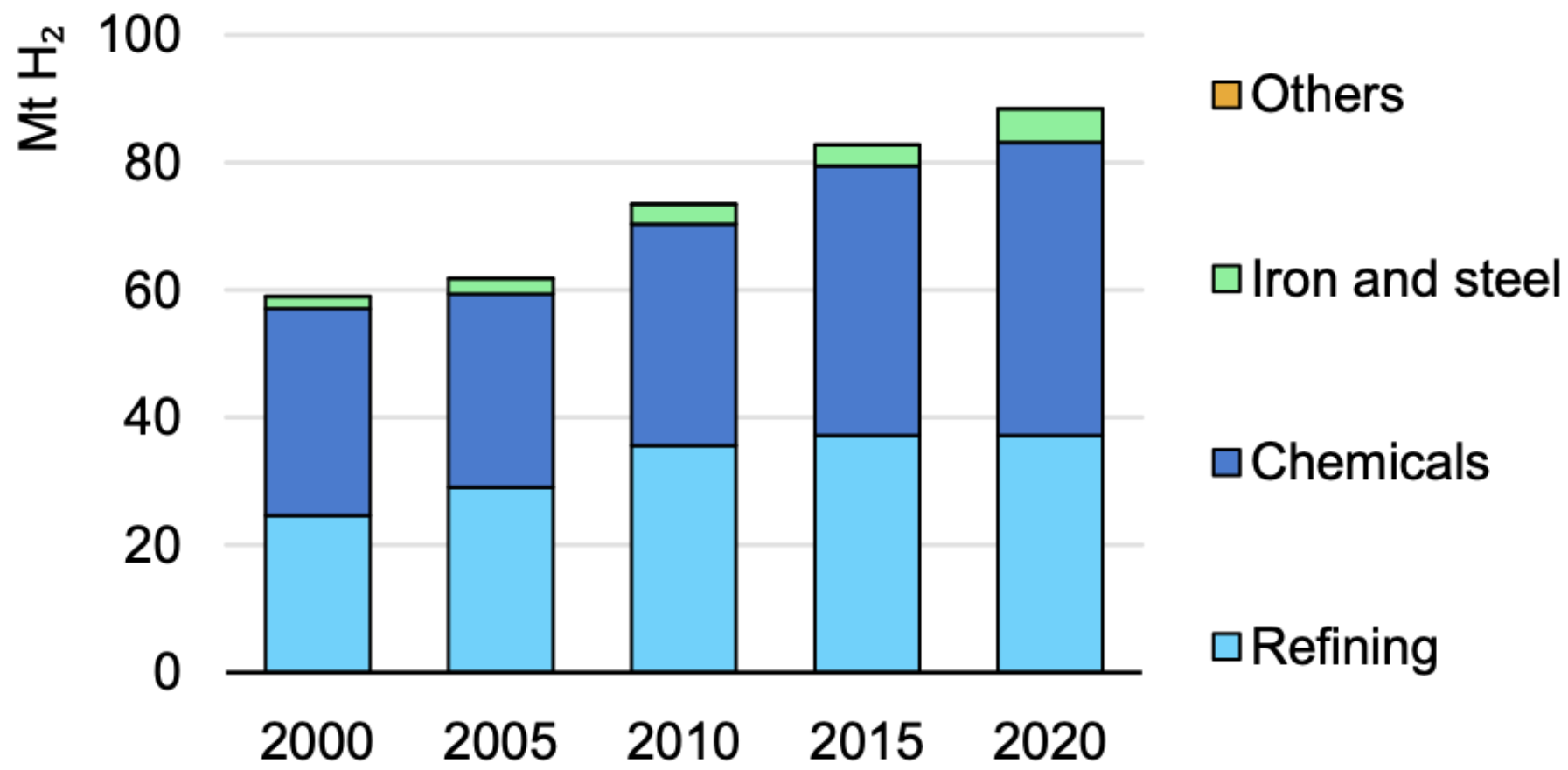
# Densité énergétique



Sources: R. Heinberg, "our renewable future"



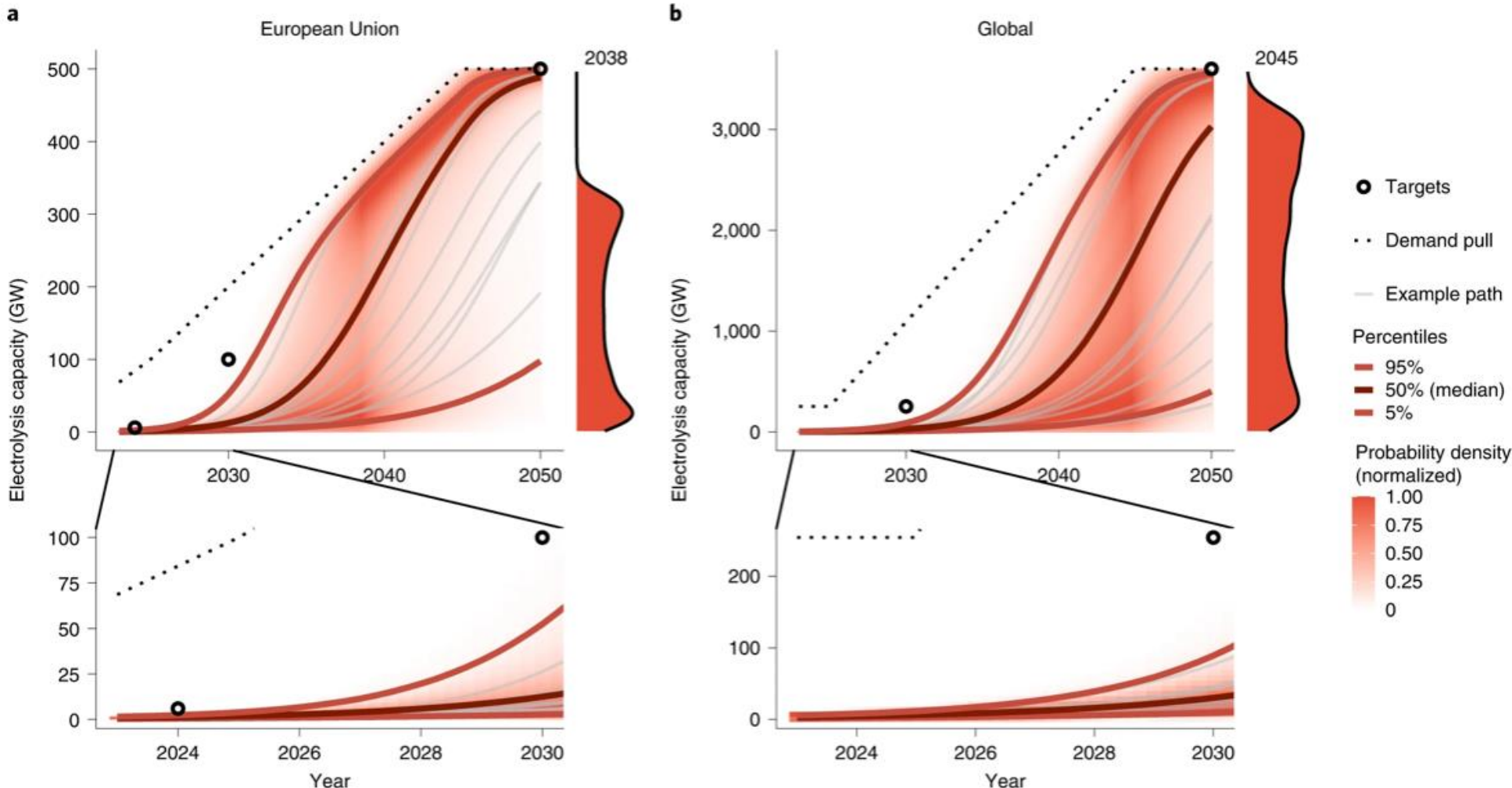
## Hydrogen demand by sector, 2000-2020



IEA. All rights reserved.

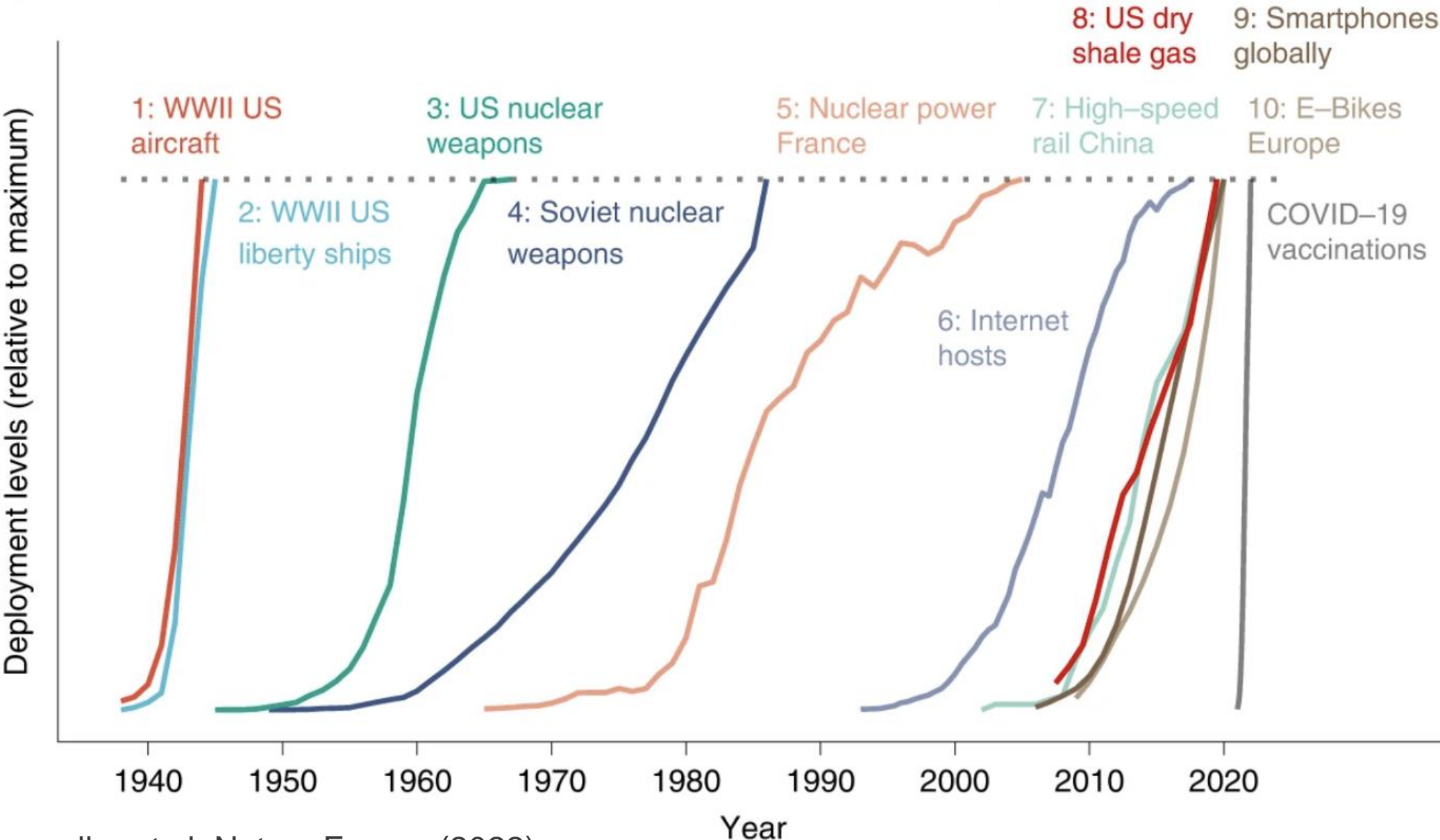
# Assez d'hydrogène vert?

Growth rates similar to those of wind and solar are insufficient to scale H2 production



A. Odenweller et al, Nature Energy (2022)

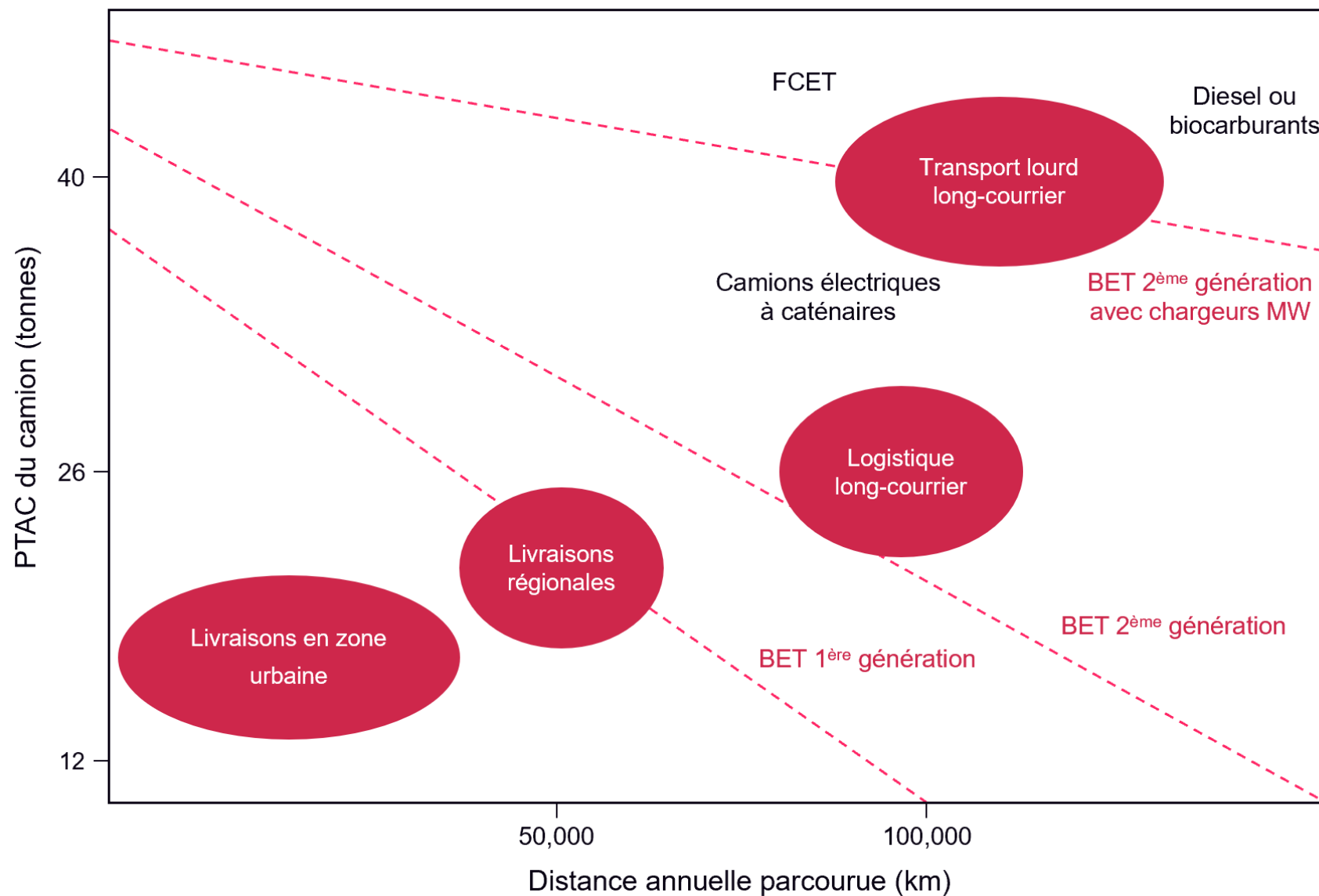
# Besoin d'un déploiement très rapide



A. Odenweller et al, Nature Energy (2022)

# Ex: hydrogène pour les camions?

Adapté de Plötz, P. Nat Electron 5, 8–10 (2022)



**D'ici 2030, les solutions existent mais doivent être déployées très rapidement**

**Atteindre la neutralité carbone sera impossible sans le développement de nouvelles technologies**

**Il est nécessaire d'accélérer le développement et la mise à l'échelle de ces technologies émergentes**

**Nécessiter de prioriser les utilisations des vecteurs bas-carbone**