



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA



# Ripensare Circolare

## Presente e futuro dello sfruttamento delle fonti energetiche rinnovabili

**Arturo Lorenzoni**

**Università degli Studi di Padova**

13 aprile 2021





UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

# La scaletta di oggi

## **Ripensare Circolare Presente e futuro (dello sfruttamento) delle fonti energetiche rinnovabili**

*introduce e modera*

**Arturo Lorenzoni**

*ne parlano*

**Davide Del Col**

Professore ordinario Dipartimento di Ingegneria Industriale  
Università di Padova, docente di Energie rinnovabili

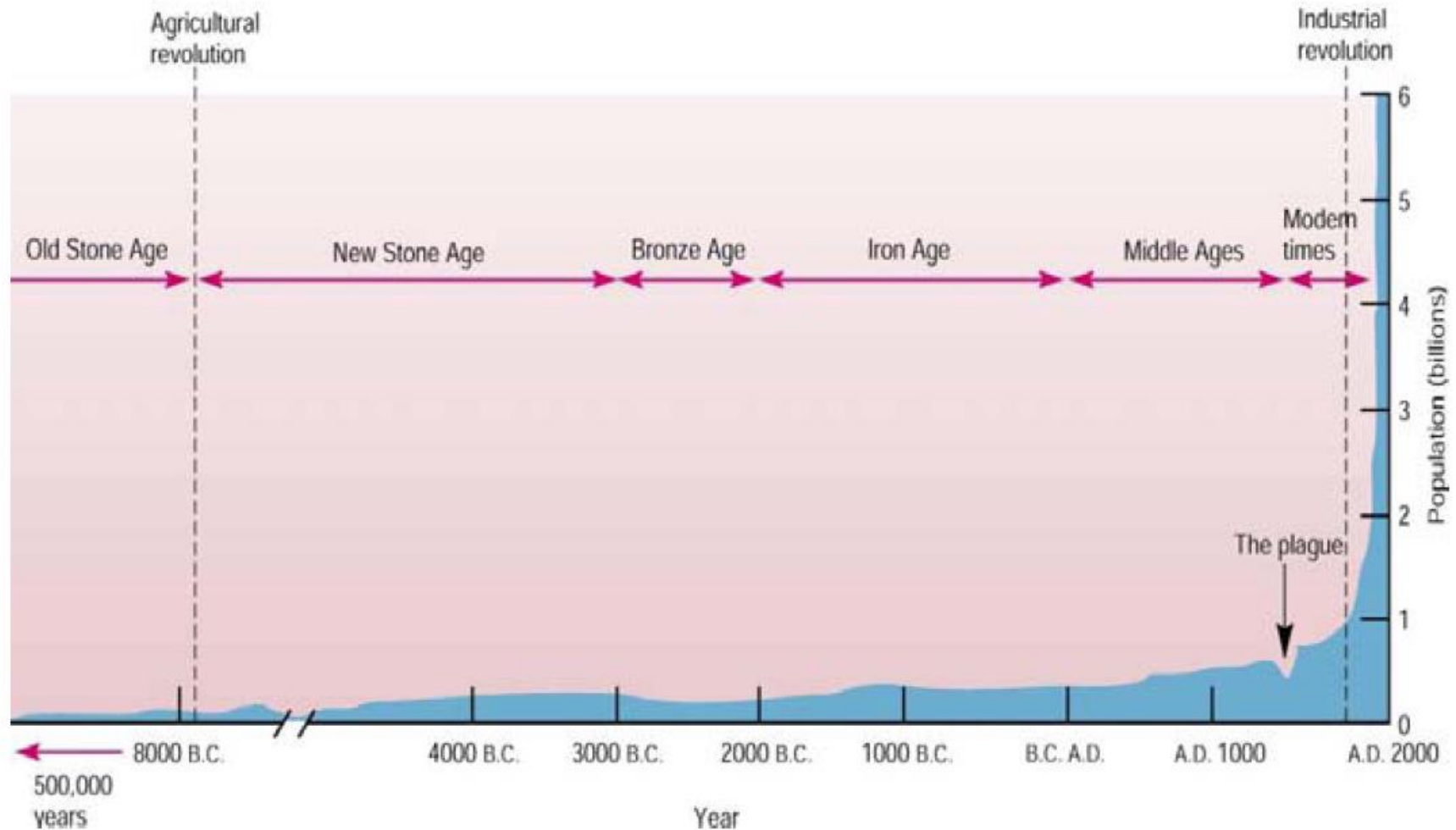
**Antonio Volpin**

Senior Partner Leader Electric Power Practice, McKinsey&Company





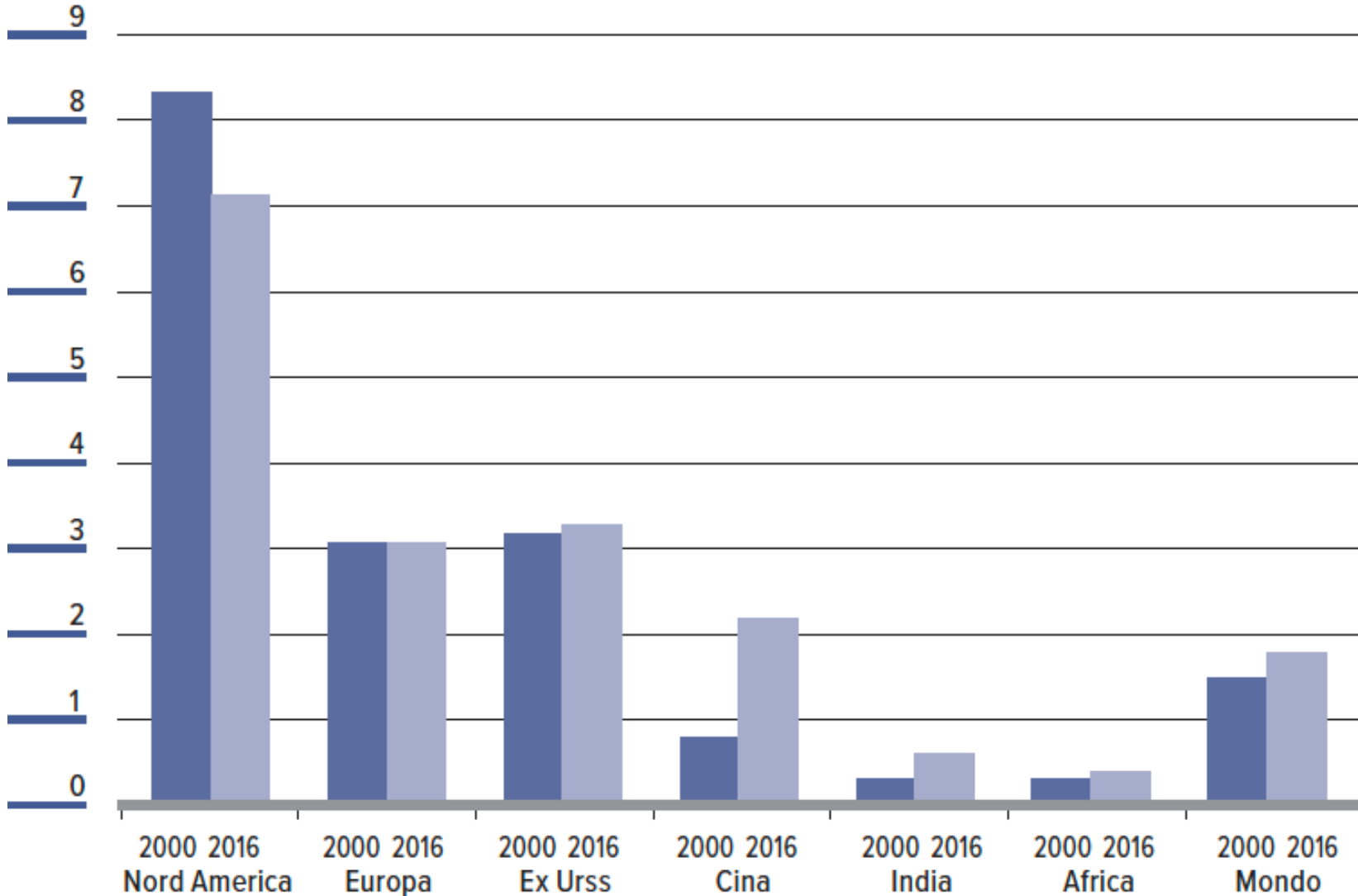
# L'andamento della popolazione





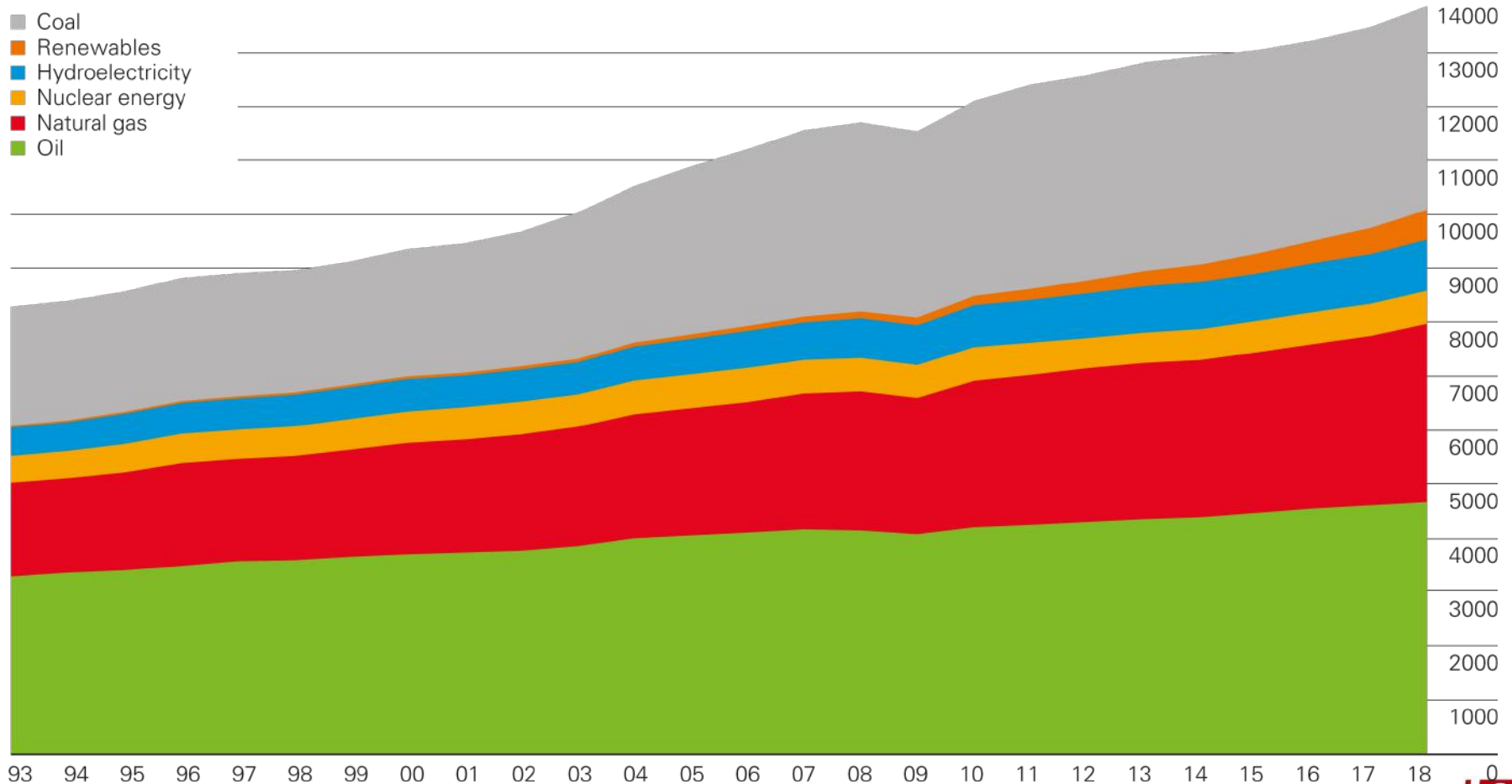
UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

# I consumi pro capite (tep/capite)





# Il consumo di energia nel mondo (Mtep): tantissimi fossili!



Fonte BP

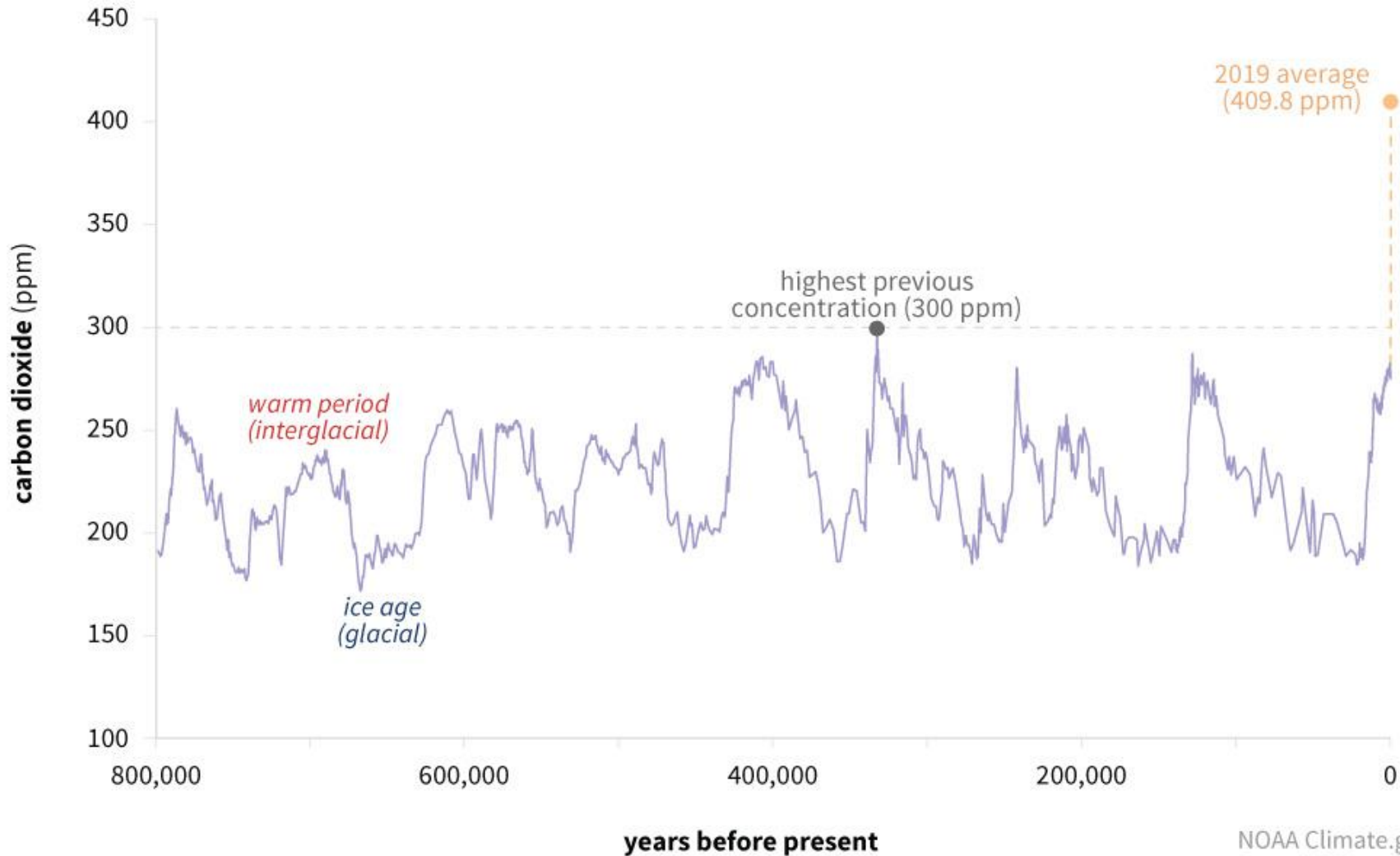
Ogni cambiamento deve fare i conti con un'inerzia enorme del sistema





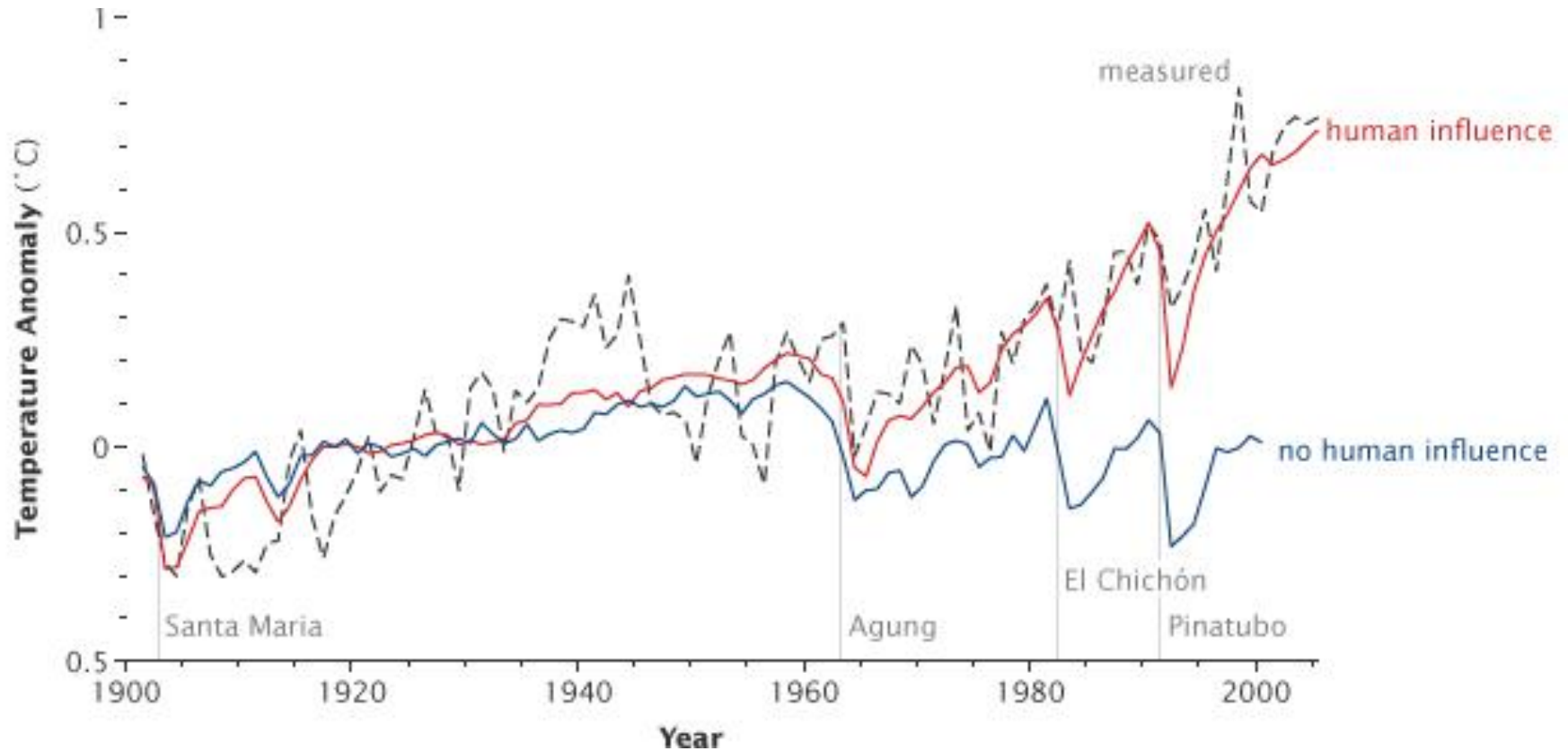
# L'andamento della CO<sub>2</sub> in atmosfera

## CARBON DIOXIDE OVER 800,000 YEARS





# Il contributo dell'uomo è mostrato chiaramente dai modelli

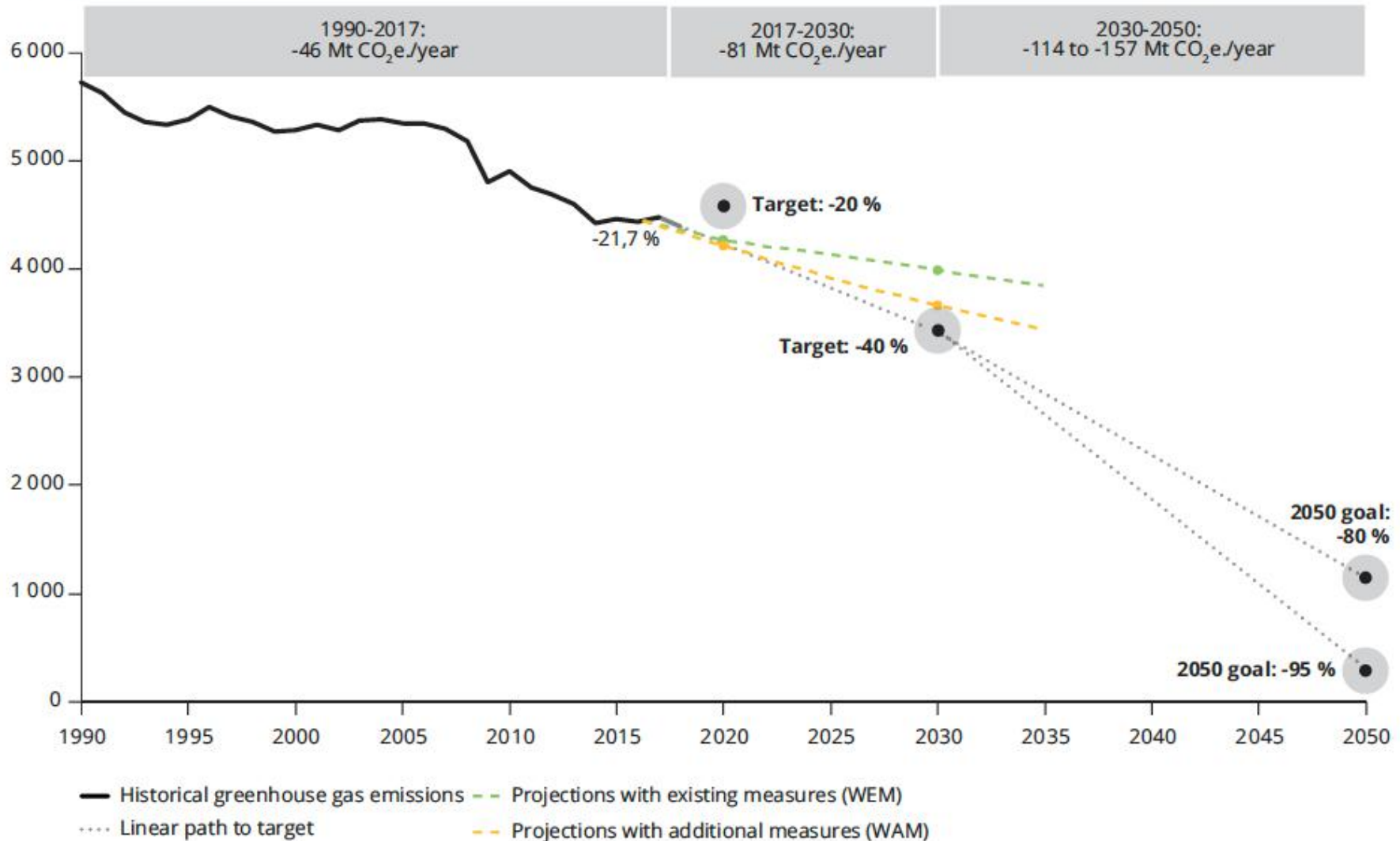




# I target europei al 2050

Fonte: FFA

Million tonnes of CO<sub>2</sub> equivalent (Mt CO<sub>2</sub>e)





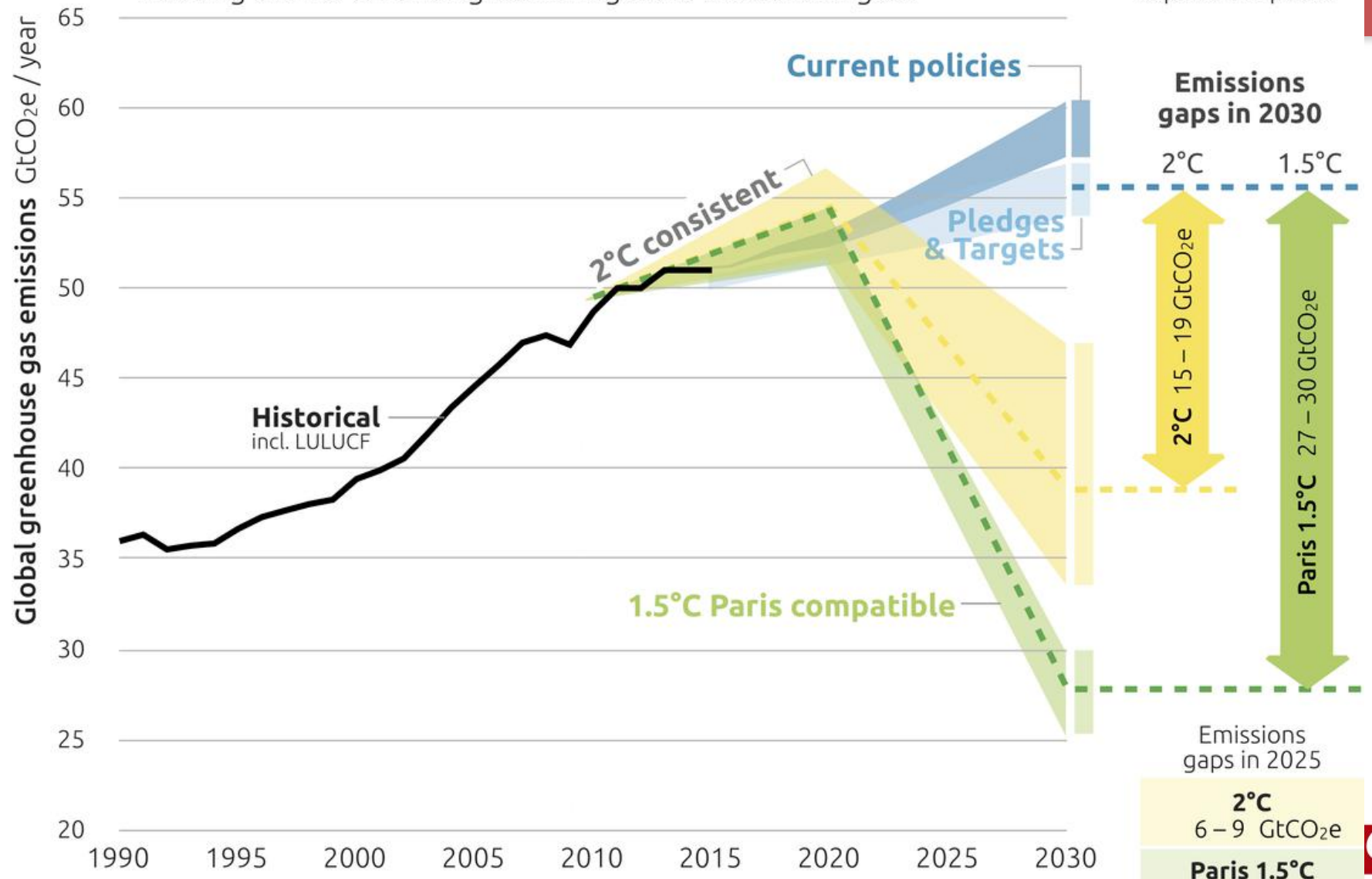


# 2030 EMISSIONS GAPS

CAT projections and resulting emissions gaps in meeting the 1.5°C Paris Agreement goal vs 2°C Cancún goal



Sept 2019 update



The "gap" range results only from uncertainties in the pledge projections. Gaps are calculated against the mean of the benchmark emissions for 1.5°C and 2°C.

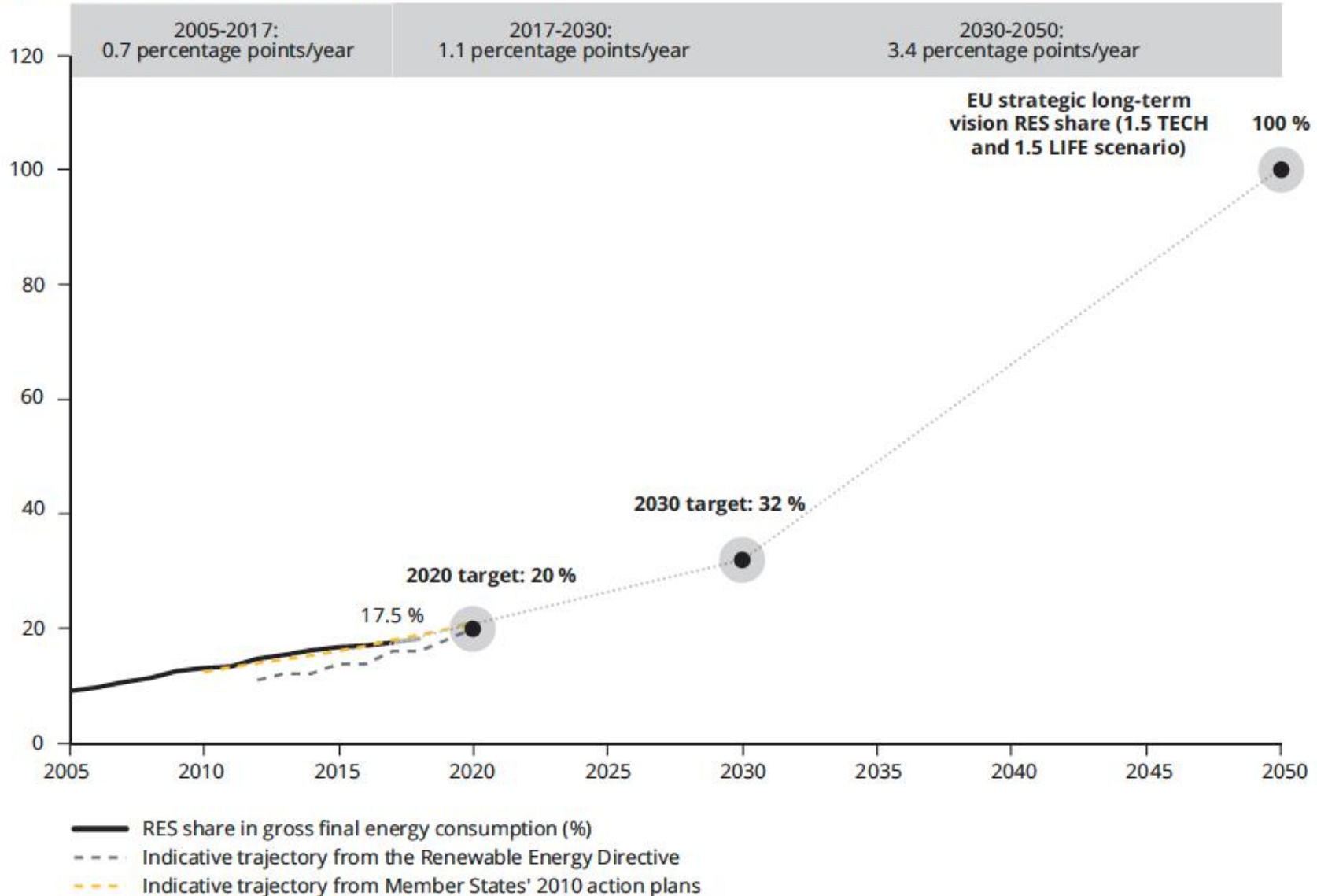
<b>2°C</b>	6 – 9 GtCO <sub>2e</sub>
<b>Paris 1.5°C</b>	12 – 14 GtCO <sub>2e</sub>





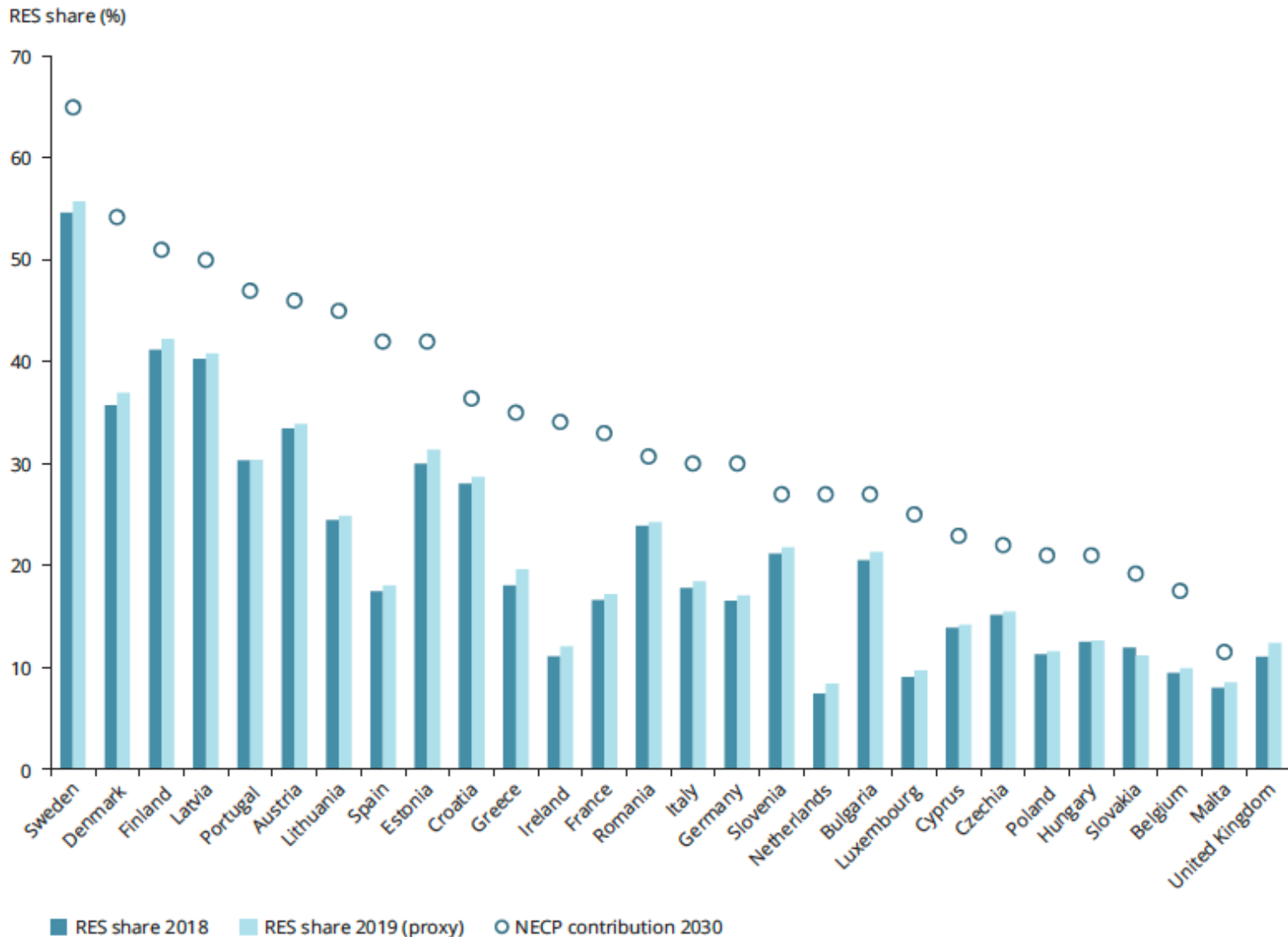
# La crescita delle Fonti rinnovabili in EU

RES shares in gross final consumption (%)





# Il Target 2030 paese per paese in EU



NECP = national energy and climate plan





# L'Europa si è mossa con il Clean Energy Package

The EU was an early mover on clean energy: it was the first major power in the world to set, in 2009, ambitious energy and climate targets for 2020 (20% greenhouse gas emission reduction, 20% in renewable energy and 20% energy efficiency). Ten years later, the EU is broadly on track to achieve these 2020 objectives, proving it is possible to reduce emissions and achieve GDP growth at the same time.



## EU Energy targets by 2030

- At least **40%** cuts in greenhouse gas emissions
- At least **32%** renewables in energy consumption
- At least **32.5%** energy efficiency





# Il pacchetto Clean energy for all Europeans

	European Commission Proposal	EU Inter-institutional Negotiations	European Parliament Adoption	Council Adoption	Official Journal Publication
Energy Performance in Buildings	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>17/04/2018</u>	<u>14/05/2018</u>	<u>19/06/2018 - Directive (EU) 2018/844</u>
Renewable Energy	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>13/11/2018</u>	<u>04/12/2008</u>	<u>21/12/2018 - Directive (EU) 2018/2001</u>
Energy Efficiency	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>13/11/2018</u>	<u>04/12/2018</u>	<u>21/12/2018 - Directive (EU) 2018/2002</u>
Governance of the Energy Union	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>13/11/2018</u>	<u>04/12/2018</u>	<u>21/12/2018 - Regulation (EU) 2018/1999</u>
Electricity Regulation	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>26/03/2019</u>	<u>22/05/2019</u>	<u>14/06/2019 - Regulation (EU) 2019/943</u>
Electricity Directive	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>26/03/2019</u>	<u>22/05/2019</u>	<u>14/06/2019 - Directive (EU) 2019/944</u>
Risk Preparedness	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>26/03/2019</u>	<u>22/05/2019</u>	<u>14/06/2019 - Regulation (EU) 2019/941</u>
ACER	<u>30/11/2016</u>	<u>Political Agreement</u>	<u>26/03/2019</u>	<u>22/05/2019</u>	<u>14/06/2019 - Regulation (EU) 2019/942</u>





# Energy Roadmap EU 2050: la riduzione delle emissioni di CO<sub>2</sub>

GHG reductions compared to 1990	2005	2030	2050
Total	-7%	-40 to -44%	<b>-79 to -82%</b>
Sectors			
Power (CO <sub>2</sub> )	-7%	-54 to -68%	-93 to -99%
Industry (CO <sub>2</sub> )	-20%	-34 to -40%	-83 to -87%
Transport (incl. CO <sub>2</sub> aviation, excl. maritime)	30%	+20 to -9%	-54 to -67%
Residential and services (CO <sub>2</sub> )	-12%	-37 to -53%	-88 to -91%
Agriculture (Non-CO <sub>2</sub> )	-20%	-36 to -37%	-42 to -49%
Other Non-CO <sub>2</sub> emissions	-30%	-72 to -73%	-70 to -78%

Europe aims at decarbonising ENTIRELY its economy by 2050

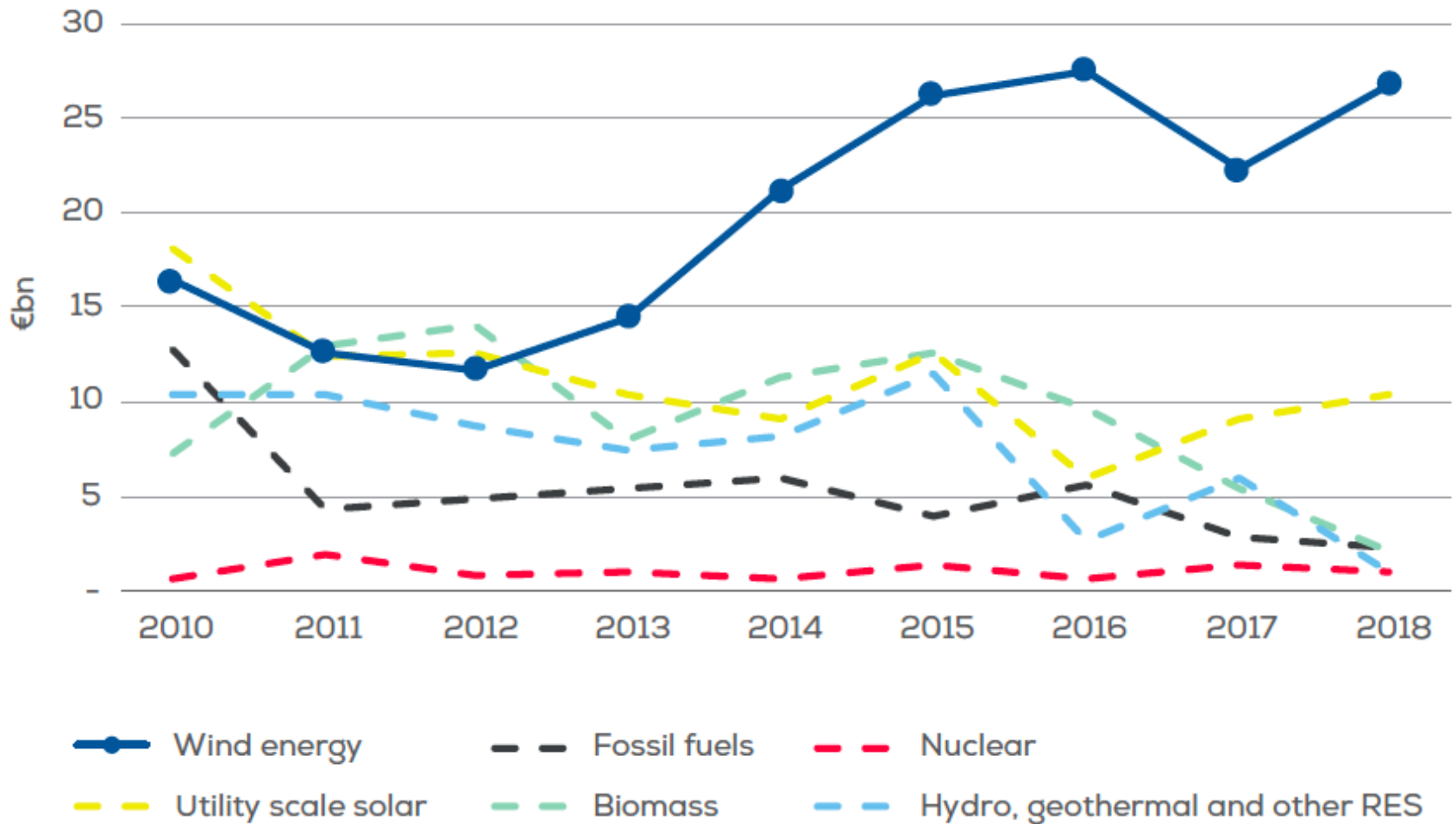






# Dove investe l'industria elettrica europea

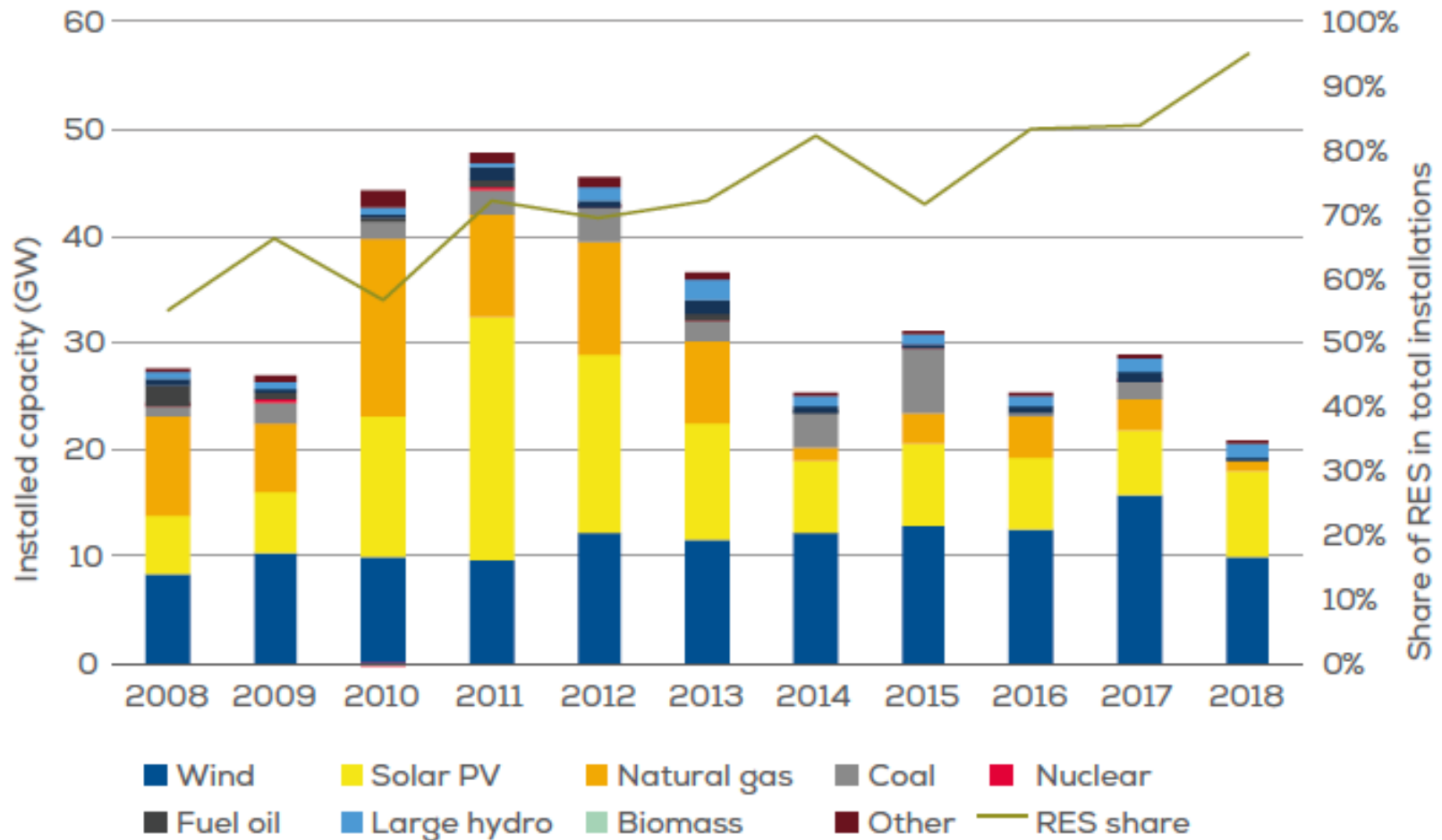
Investments in new power capacity in Europe, 2010 – 2018 (€bn)





# Il trend in Europa (GW/anno)

Annual installed capacity and renewable share in EU-28



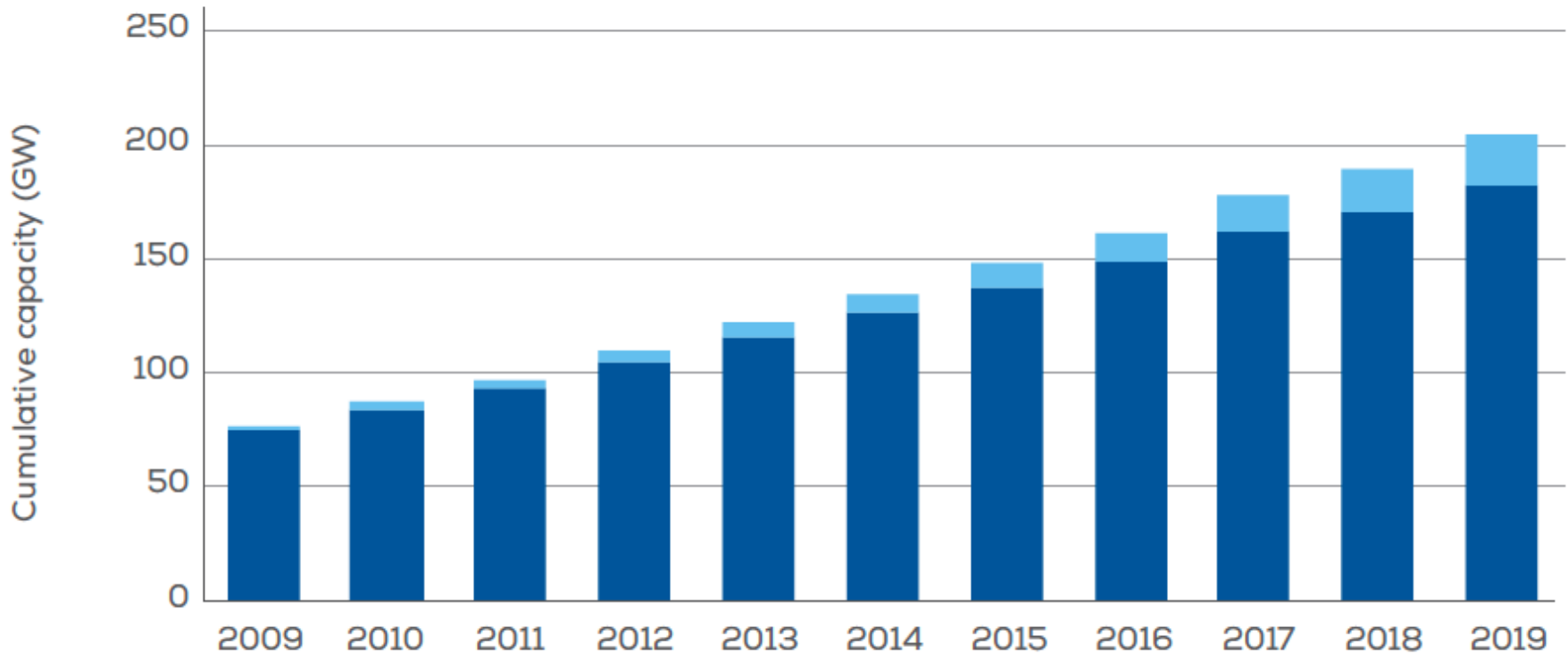
Source: Platts, SolarPowerEurope, WindEurope







# L'eolico cumulato in UE

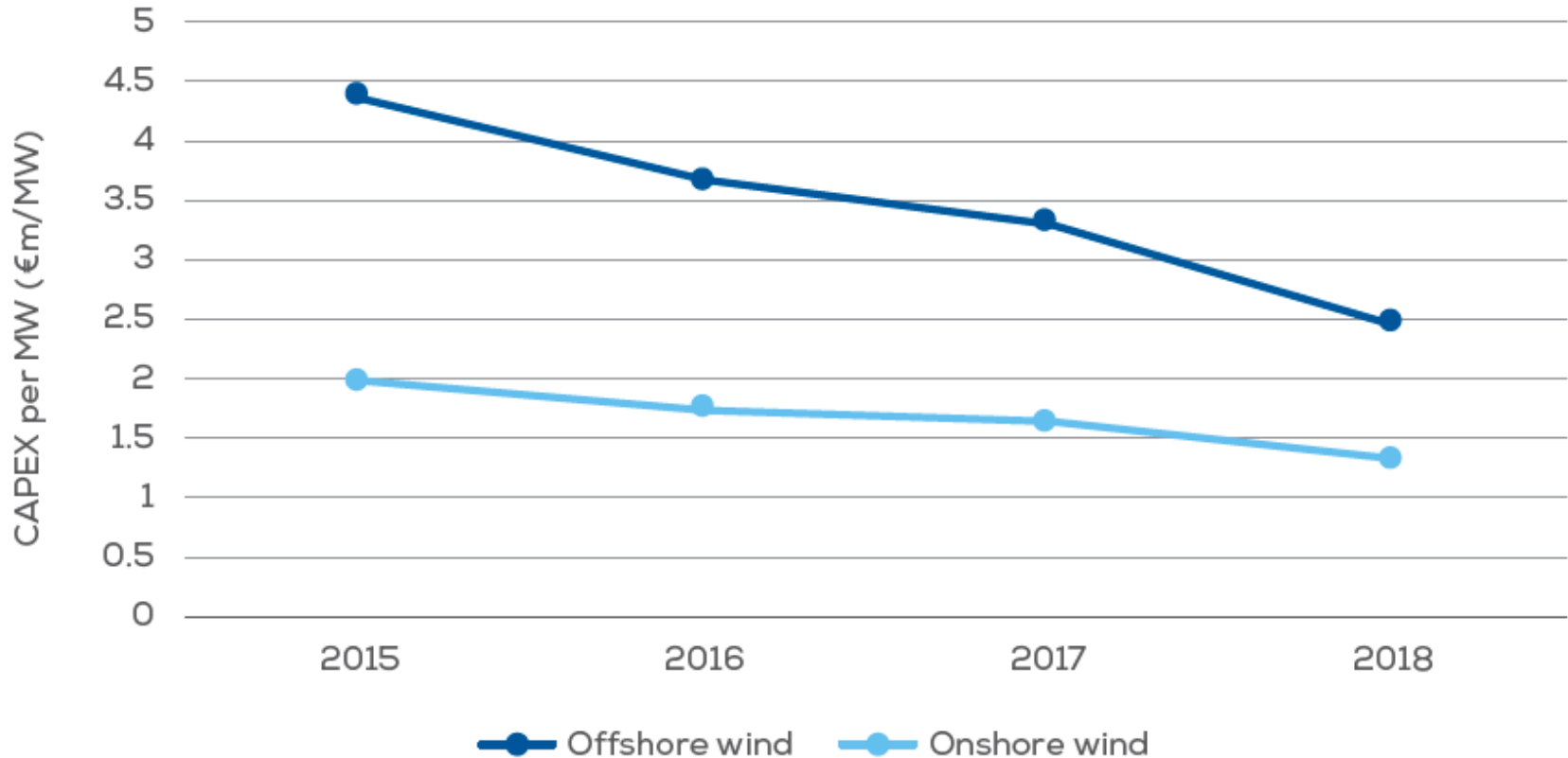


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
<b>Offshore</b>	2	3	4	5	7	8	11	13	16	18	22
<b>Onshore</b>	75	84	93	105	115	127	137	149	162	171	183
<b>Total</b>	77	87	97	110	122	135	148	162	178	189	205



# Il costo di investimento negli impianti eolici

Capital expenditure per MW financed in wind energy, 2015 – 2018 (€m/MW)



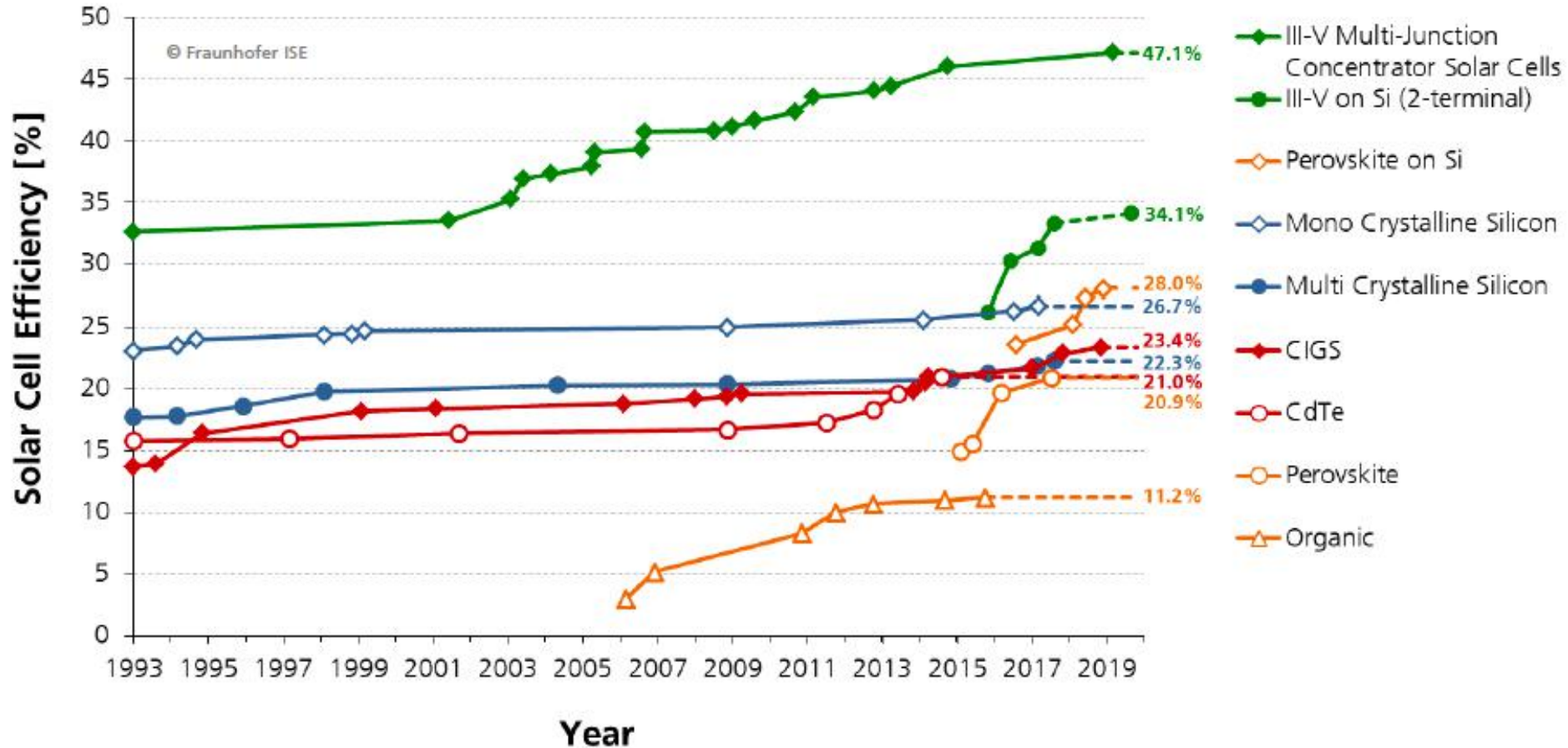
Source: WindEurope

Una continua evoluzione tecnologica



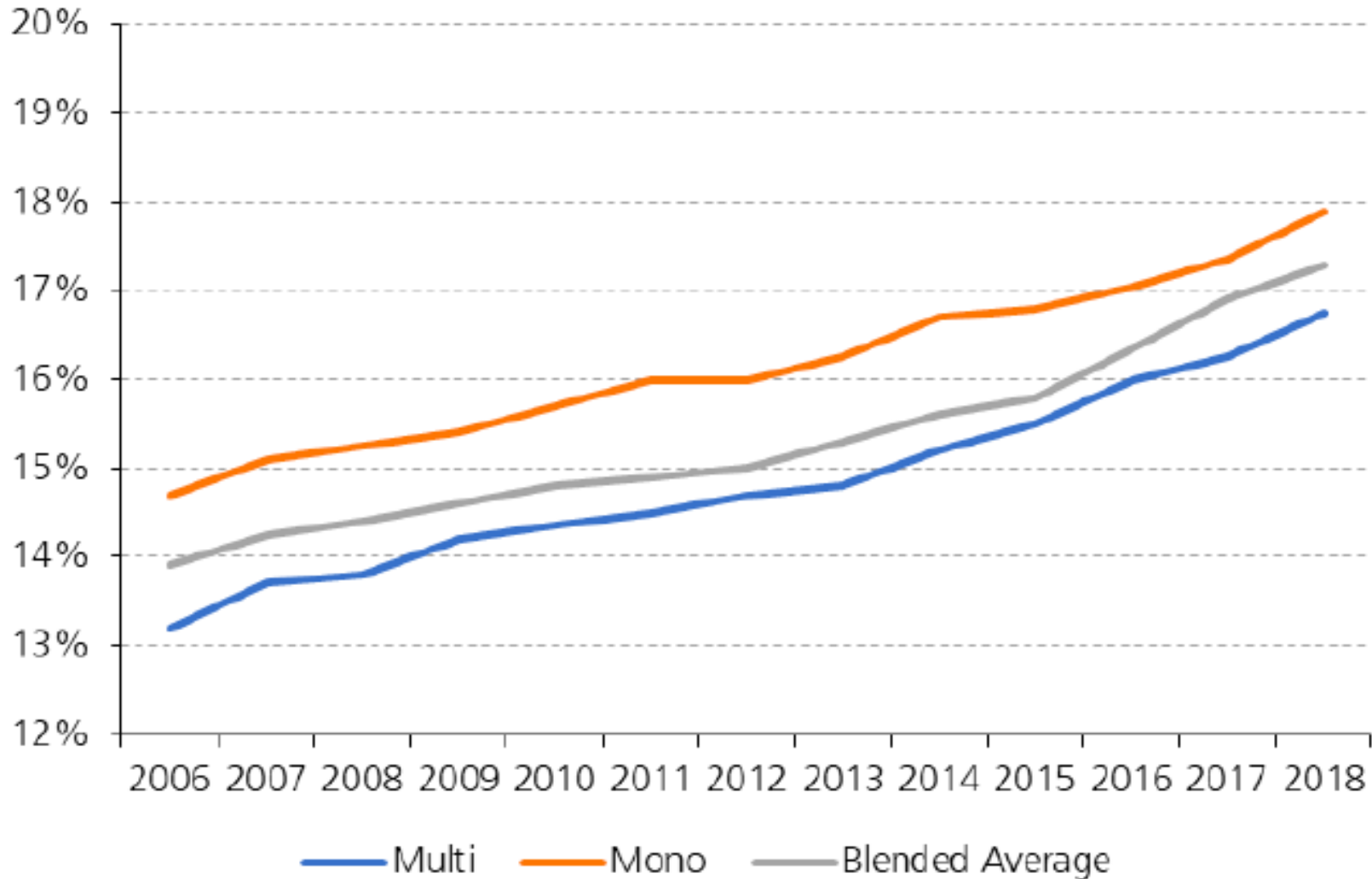


# Le prestazioni delle celle FV

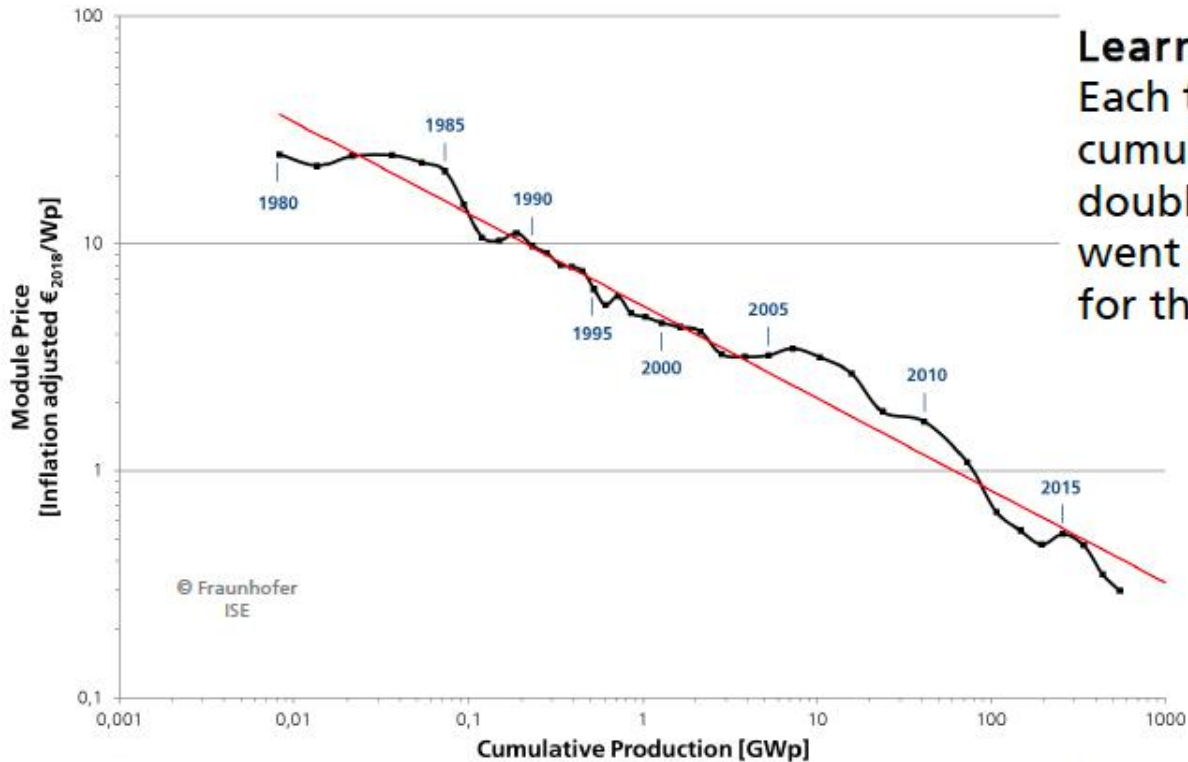




# La crescita dei rendimenti dei moduli



# La curva di apprendimento

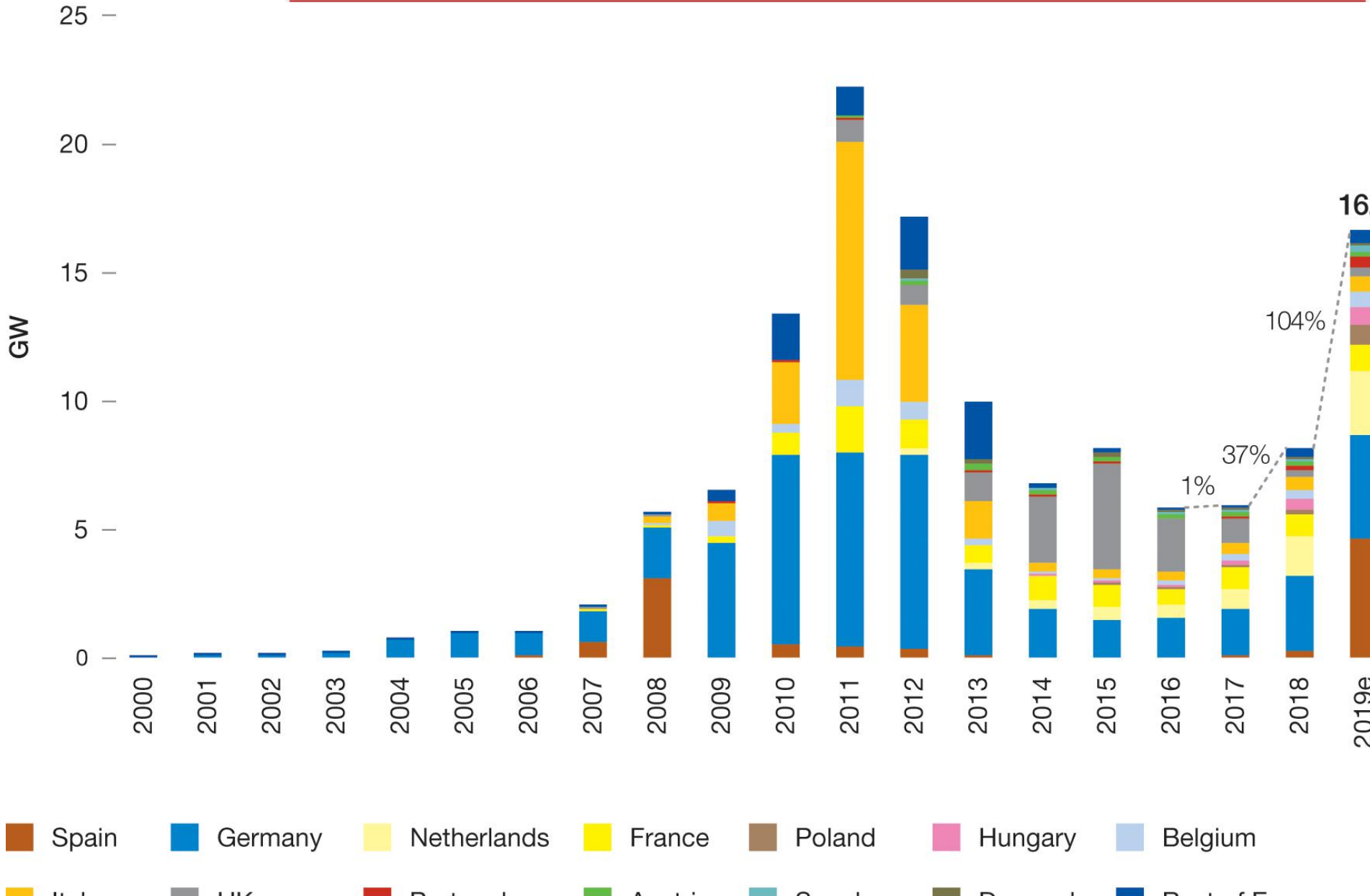


**Learning Rate:**  
Each time the cumulative production doubled, the price went down by 24 % for the last 38 years.

Data: from 1980 to 2010 estimation from different sources : Strategies Unlimited, Navigant Consulting, EUPD, pvXchange; from 2011: IHS. Graph: PSE GmbH 2019

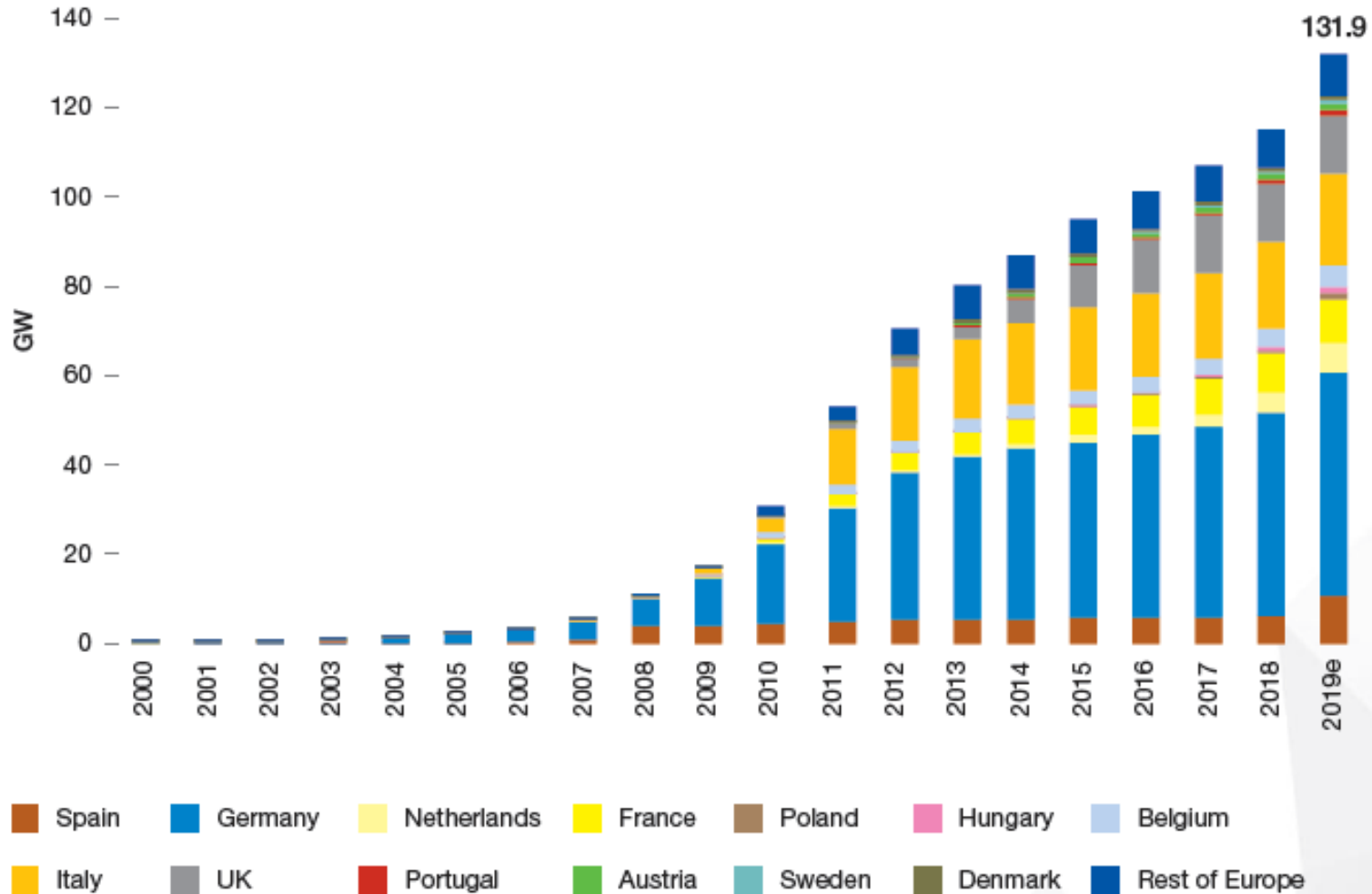


# Il solare FV installato in Europa





# L'installato FV in Europa





# Le imprese e la decarbonizzazione

The binding constraint of CO<sub>2</sub> reduction in a short time span has imposed a change in the strategy of energy companies, refocusing on low carbon activities. Electricity is emerging as a key vector to replace fossil fuels in many final uses and utilities are changing the business model from energy supply to energy services







# L'energia di domani

- Le innovazioni in atto nel settore dell'energia stanno cambiando radicalmente gli equilibri economici e sociali
- Le alternative sul piano tecnologico sono disponibili e accessibili, è sul piano culturale che siamo deboli
- Modificare l'industria più capitalizzata del mondo è un'impresa delicata, ma i benefici sono concreti
- La trasformazione avviata non appare reversibile, perché offre risposte adeguate ai due temi da cui è partita la mia presentazione

