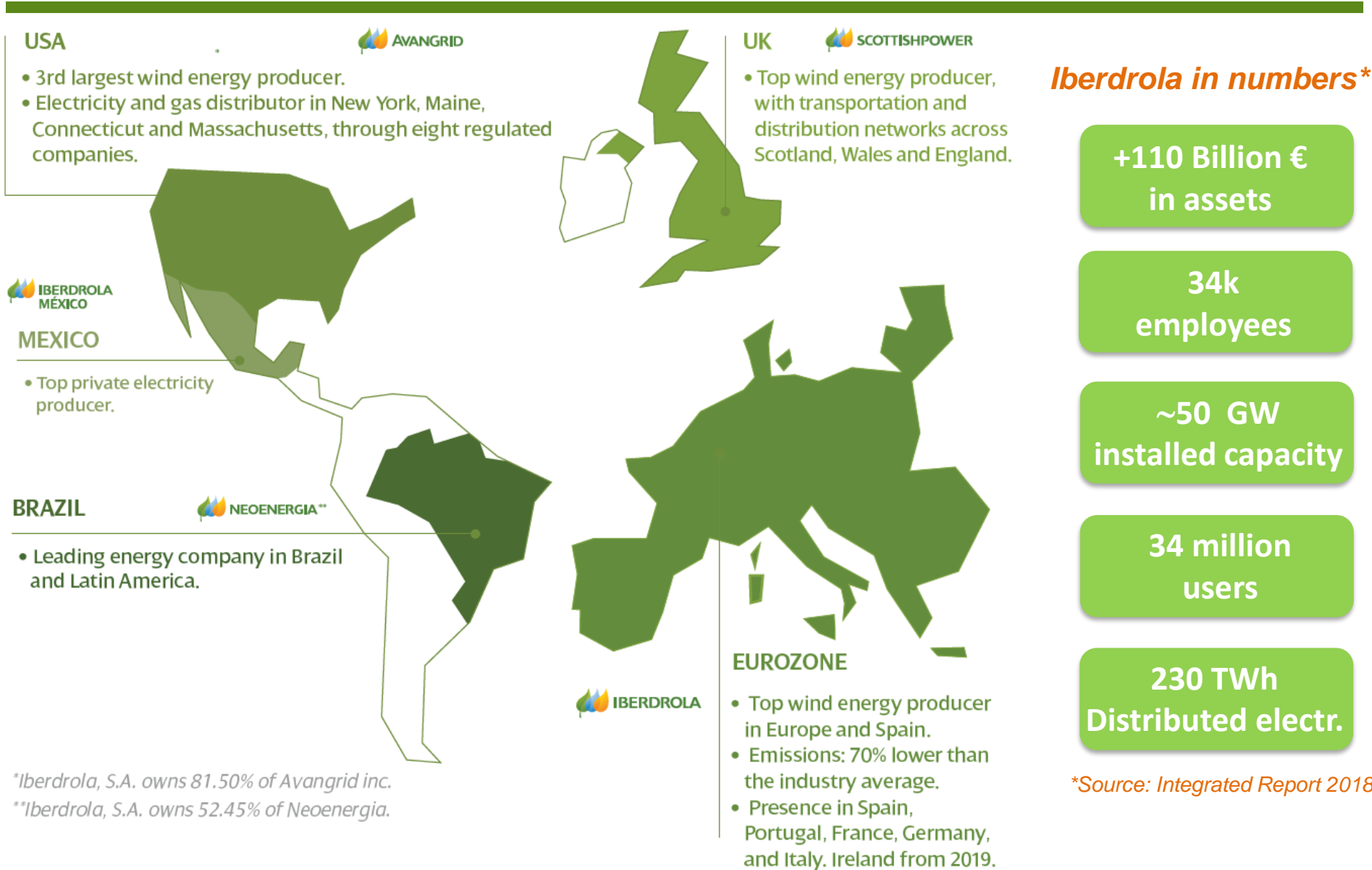




# Technologies shaping the energy transition

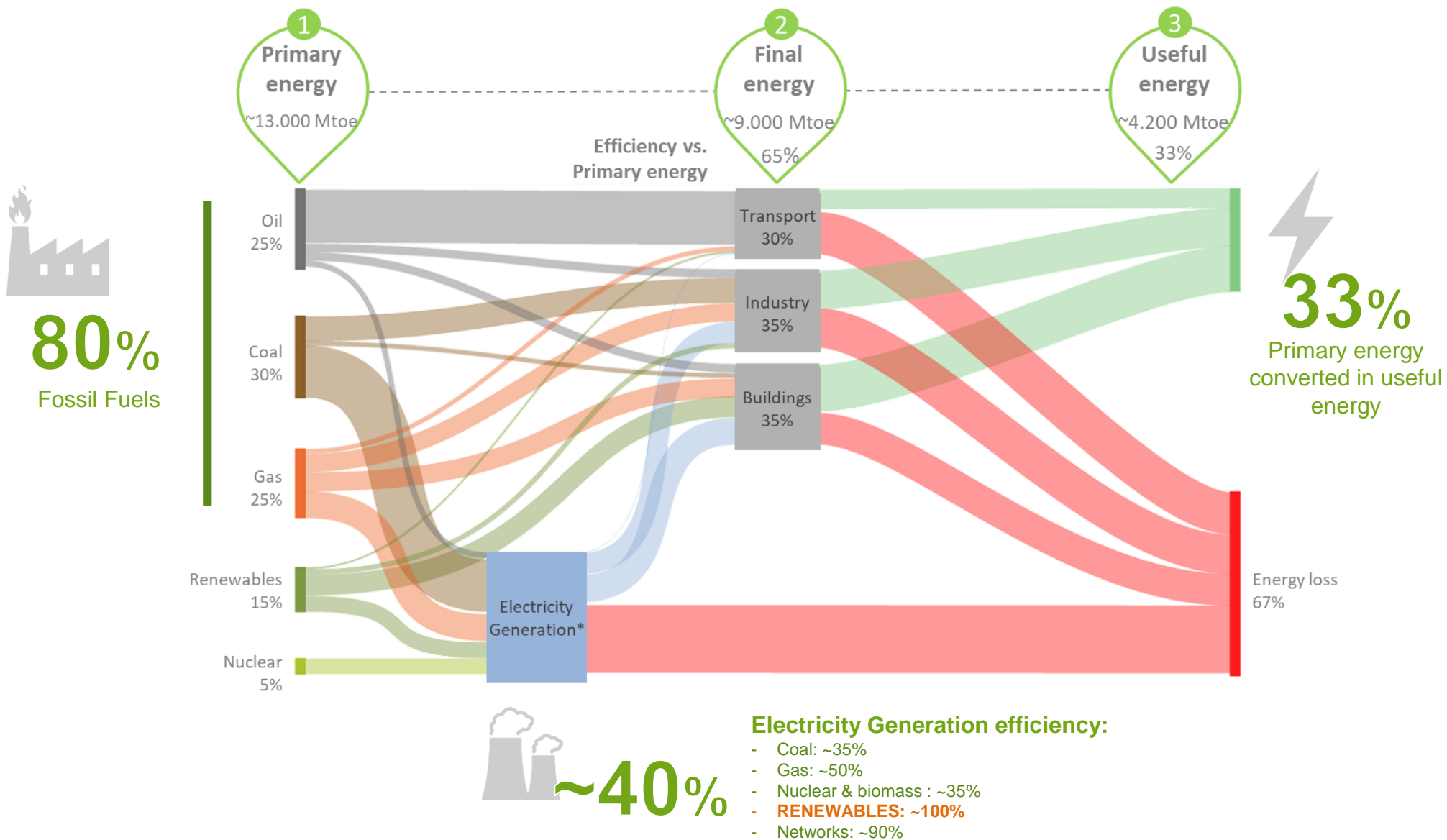
# Iberdrola: An international energy leader



\*Iberdrola, S.A. owns 81.50% of Avangrid inc.

\*\*Iberdrola, S.A. owns 52.45% of Neoenergia.

# The current energy model



# The future energy model

## Unprecedented challenge



**CLEAN:** reduce greenhouse gas emissions



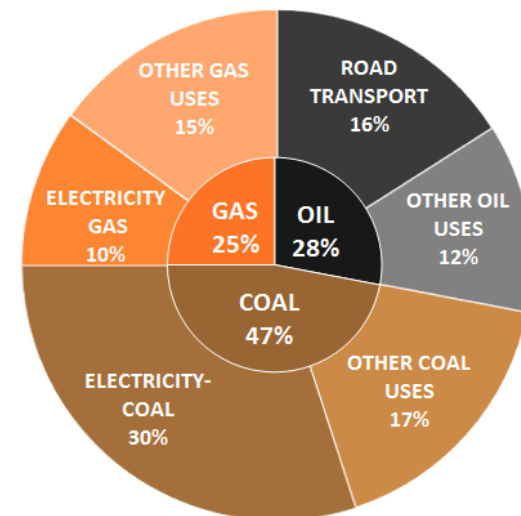
**RELIABLE:** secure and good quality of supply,  
avoiding strong external dependency



**AFFORDABLE:** cost competitive technologies

### Global CO<sub>2</sub> emissions by primary energy source and segment

International Energy Agency (2017)



Coal: 47% of emissions but only 25% of global useful energy  
Oil: 28% of emissions but only 17% of global useful energy

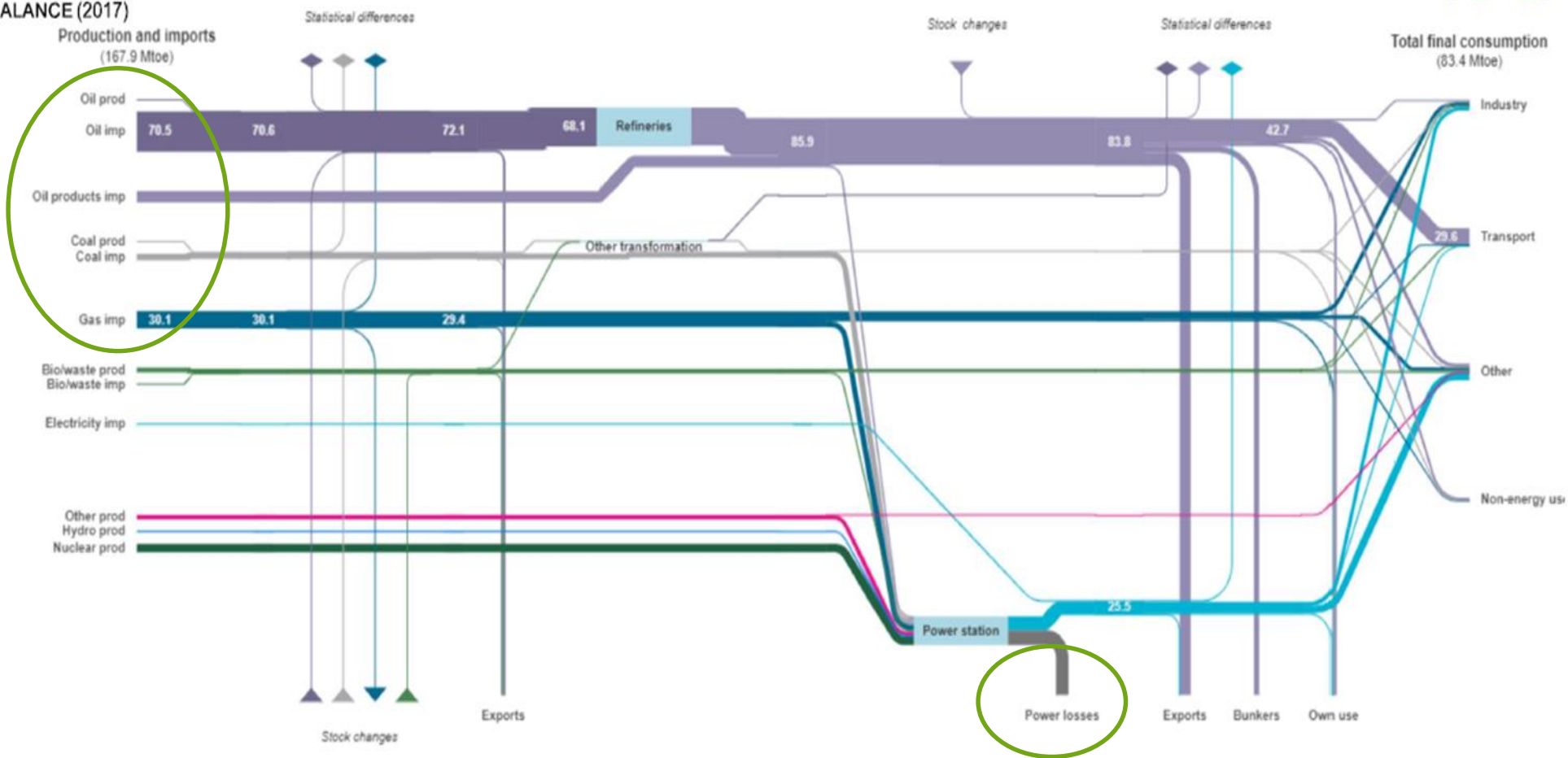
The five warmest years ever recorded have all taken place after 2010  
Increasing demand: Demography, economic growth and universal access

# The current energy model

Spain

BALANCE (2017)

Millions of tonnes of oil equivalent



# The current energy model

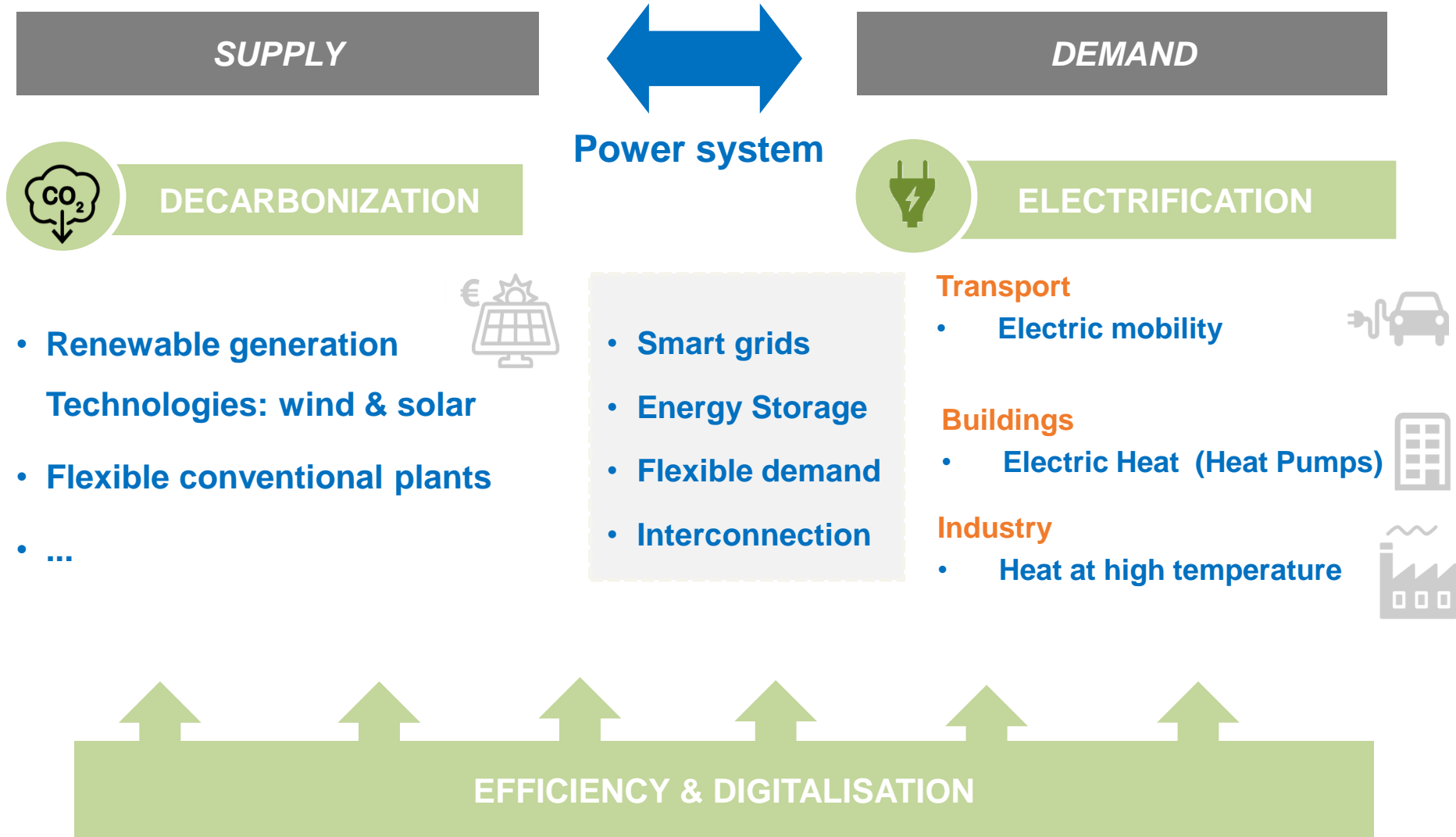
## Brazil

### BALANCE (2017)













Millions of tonnes of oil equivalent



# How to transform the energy model by 2030



# Technologies will drive the transformation of the energy model

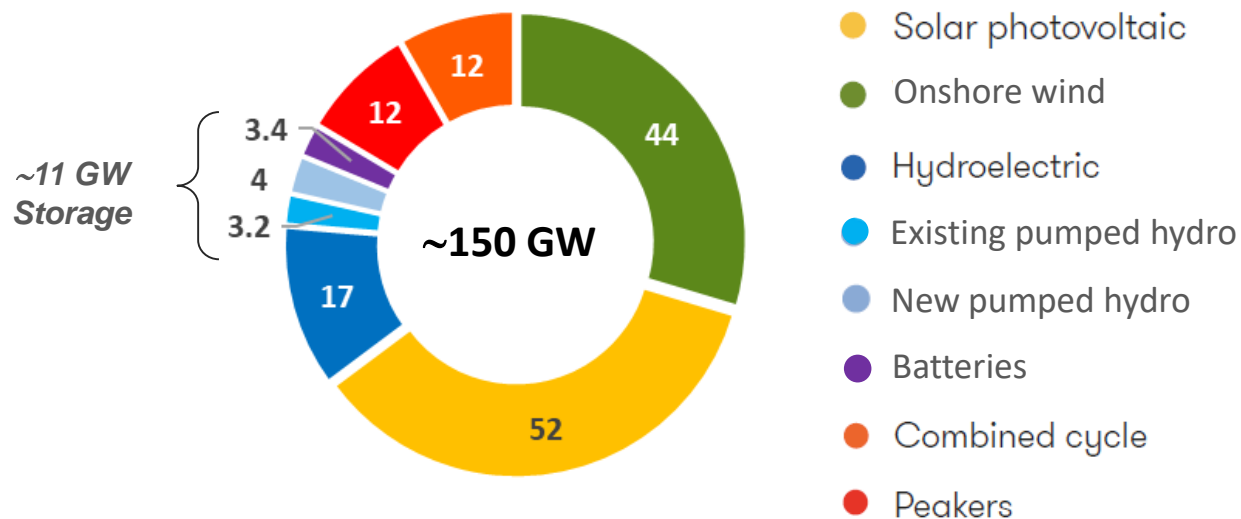
Global Outlook 2019-2030			<u>Growth</u> <u>2019-30</u>	<u>COST*</u> <u>%var. 2019-30</u>
	PV Solar		x 4	- 30%
	Onshore Wind		x 2,5	- 30%
	Offshore Wind		x 6	- 40%
	Batteries		x 65	- 50%
	EVs		x 30	- 20%
	Heat Pumps (EU)		x 2,5	- 20%



# The electricity system of the future (I)

- The evolution of technologies will lead to a highly decarbonised electricity system: **wind and solar** the cheapest sources in most geographies.
- The increased need for flexibility to integrate variable renewables will be provided by **energy storage and flexible demand**.
- The amount and duration of energy storage needed depends heavily on the energy mix (wind-solar-hydro) and on existing pumped hydro storage in the system.

## 2030 Optimal **greenfield** electricity mix: Southern country (GW)



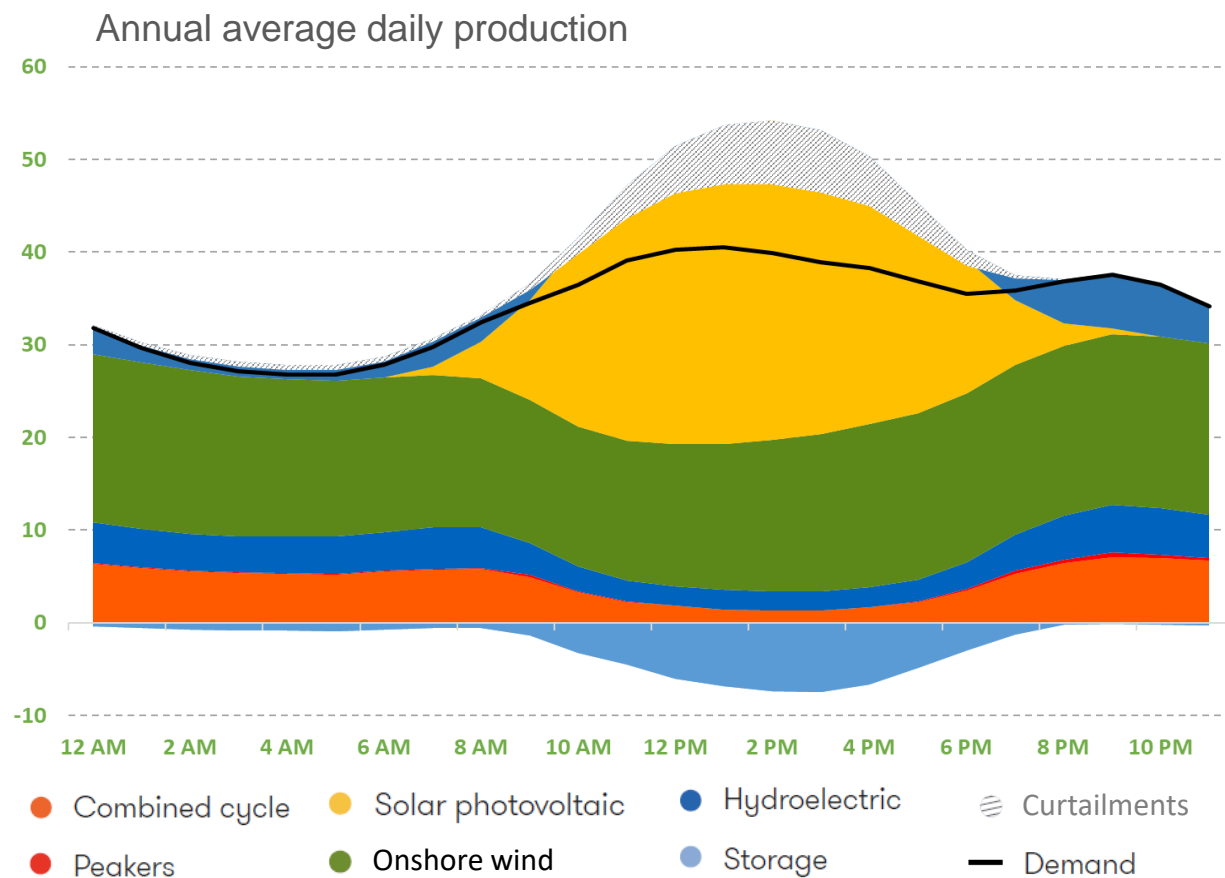
## The power systems planning model used:

- determines **cost-optimal** mix to meet demand in a future year
- greenfield system (no legacy plants other than hydro and pumped hydro)
- Hourly granularity
- Isolated system
- Capacity factors and demand: *Spain*

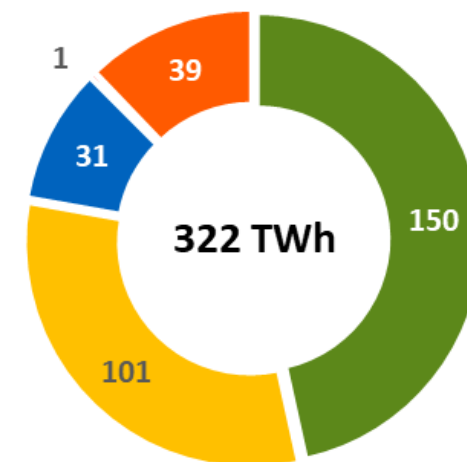
# The electricity system of the future (II)

The combination of technologies will shape the future energy mix  
Even in geographies with high solar resource, onshore wind needed (production profile)

Southern Europe geography, greenfield energy mix 2030 (GW)



Annual energy production



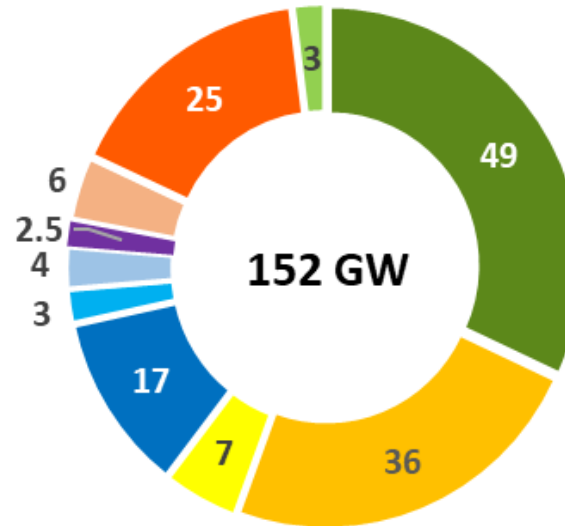
Decarbonization level

# Example: Spain's national energy plan to 2030 (I)

By 2030, Spain is set to have one of the most decarbonised electricity systems in the world: **74%** of electricity from renewable sources

## Power energy mix 2030

- Onshore wind
- Solar photovoltaic
- Solar Thermal
- Hydroelectric
- Existing pumped hydro
- New pumped hydro
- Batteries
- Cogeneration
- CCGTs
- Nuclear



*Renewable  
Generation: 74%*

By 2030 power mix dominated by **solar, wind and hydro**  
( no coal plants and most nuclear fleet closed)

## Example: Spain's national energy plan to 2030 (II)

The 2030 energy plan delivers **ECONOMIC, SOCIAL & ENVIRONMENTAL** benefits

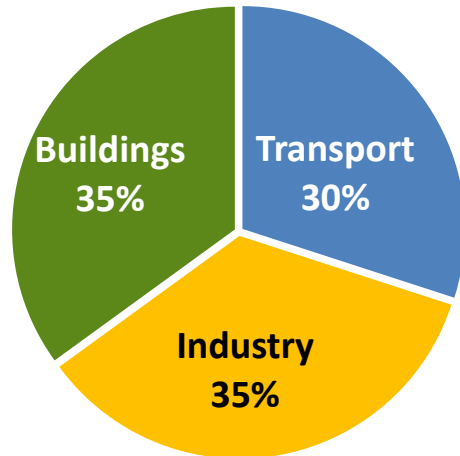
- ✓ **Increases decarbonisation** ~100 MtCO<sub>2</sub> avoided (2020-2030)
- ✓ **Increases renewable penetration** 74% RES (electricity generation)
- ✓ **Increases energy efficiency** 39.6%
- ✓ **Reduces final energy consumption** 37 Mtoe (2020-2030)
- ✓ **Savings in fossil fuel consumption** 75 Bn € (2020-2030)
- ✓ **Increases GDP and creates jobs** 20-25 Bn € & 250k-360k Jobs (2020-2030)
- ✓ **Building stock renovation** >1.2 million households (2020-2030)
- ✓ **Reduces number of deaths** 2,200 deaths avoided in 2030

# The energy system of the future: From 25% towards 80%?!

Energy model  
today



Only ~25% of final energy demand  
covered with electricity (EU)



Energy uses difficult to electrify	% of EU final energy demand
Aviation & Maritime Freight	1,1%
Heavy Road Transport	8%
High Temperature Industry	7%
<b>TOTAL</b>	<b>~16%</b>



Evs & Heat Pumps can help us electrify most of transport, buildings and low temperature industry

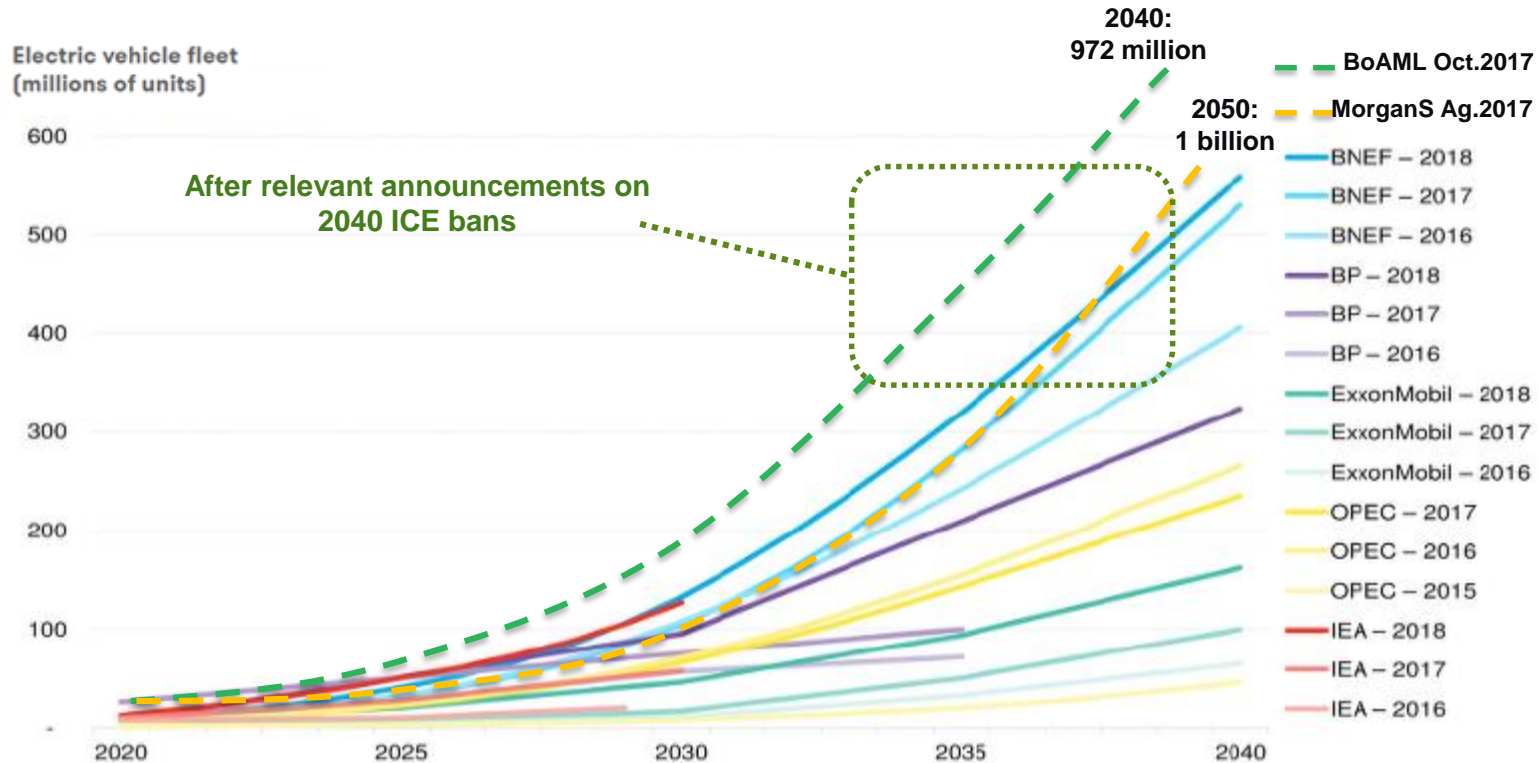


Energy model  
of the future



With the evolution of current technologies  
electricity could reach up to +80% of final  
energy demand

After UK and France announcements (July 2017), the reaction of analysts has been very significant adjusting with higher EV sales their own previous 2040 forecast



**Announced sales ban for ICE vehicles:** Norway (2025), Netherlands (2030), Slovenia (2030), Ireland (2030), Scotland (2032), France (2040), United Kingdom (2040), Spain (2040)

**Fleet without ICEs:** Sweden (2045)

**ICEs restrictions in local jurisdictions:** Paris (2024), Rome (2024), Athens (2025), Madrid (2025), Mexico City (2025), Barcelona (2030), Copenhagen (2030), London (2030), Los Angeles (2030), Milan (2030), Oxford (2030), Stockholm (2030),...

## Key takeaways:

---

**The evolution of technology will lead to a deeply decarbonized electricity system, with a majority of energy provided by renewables**

---

**Both wind and solar PV are needed for cost effective decarbonization; increased need of flexibility will be provided by storage and flexible demand**

---

**Networks are the essential platform for decarbonization of electricity and electrification of demand**

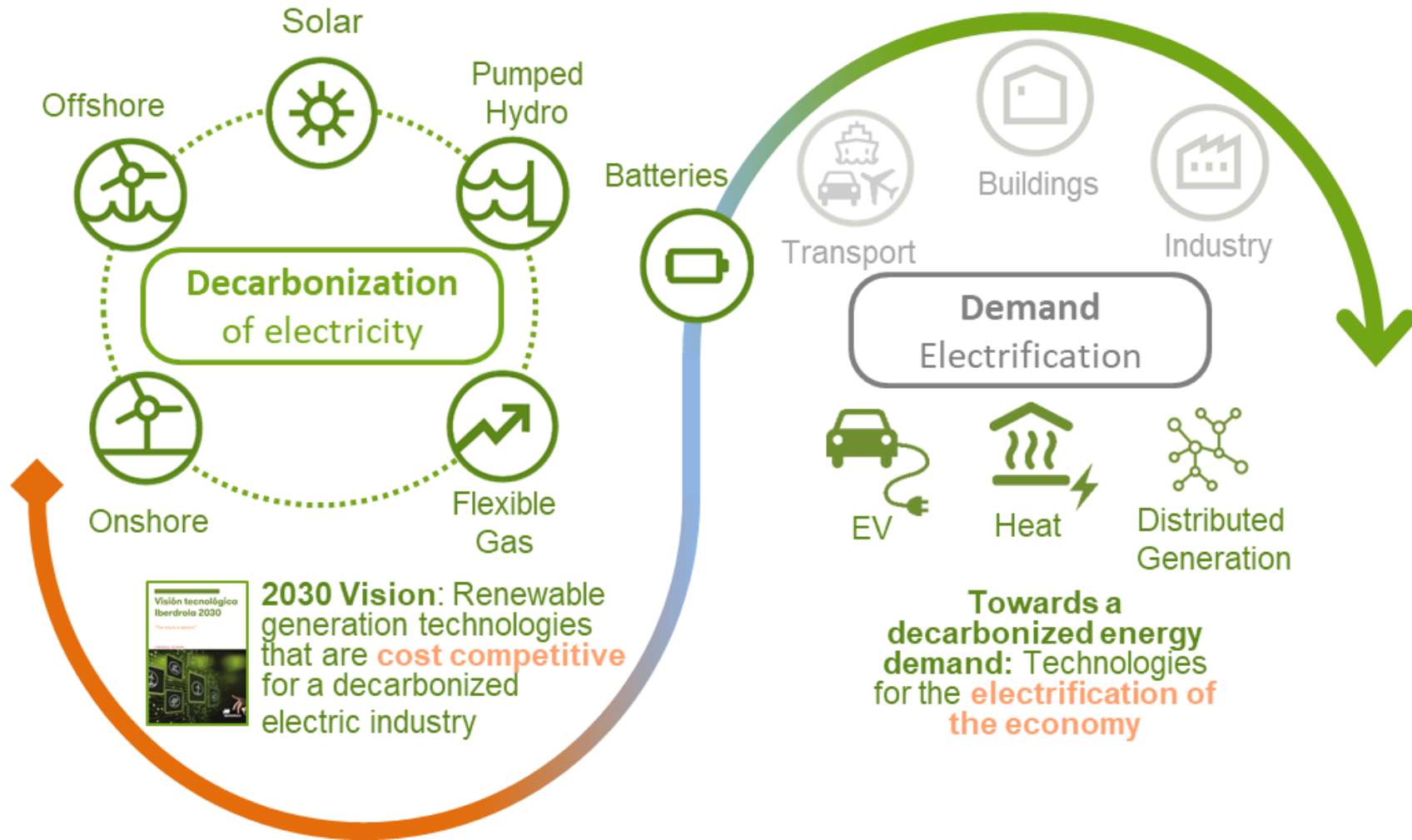
---

**Iberdrola's strategy focused on developing renewables, smarter networks, energy storage and empowering smarter customers.  
Digital strategy supporting overall corporate strategy**

---

*The electrification and decarbonization of most of our energy system will be driven by technologies that already exist TODAY*

# From Utility of the Future towards Energy Company of the Future



Electricity Networks are the platform that will facilitate demand electrification