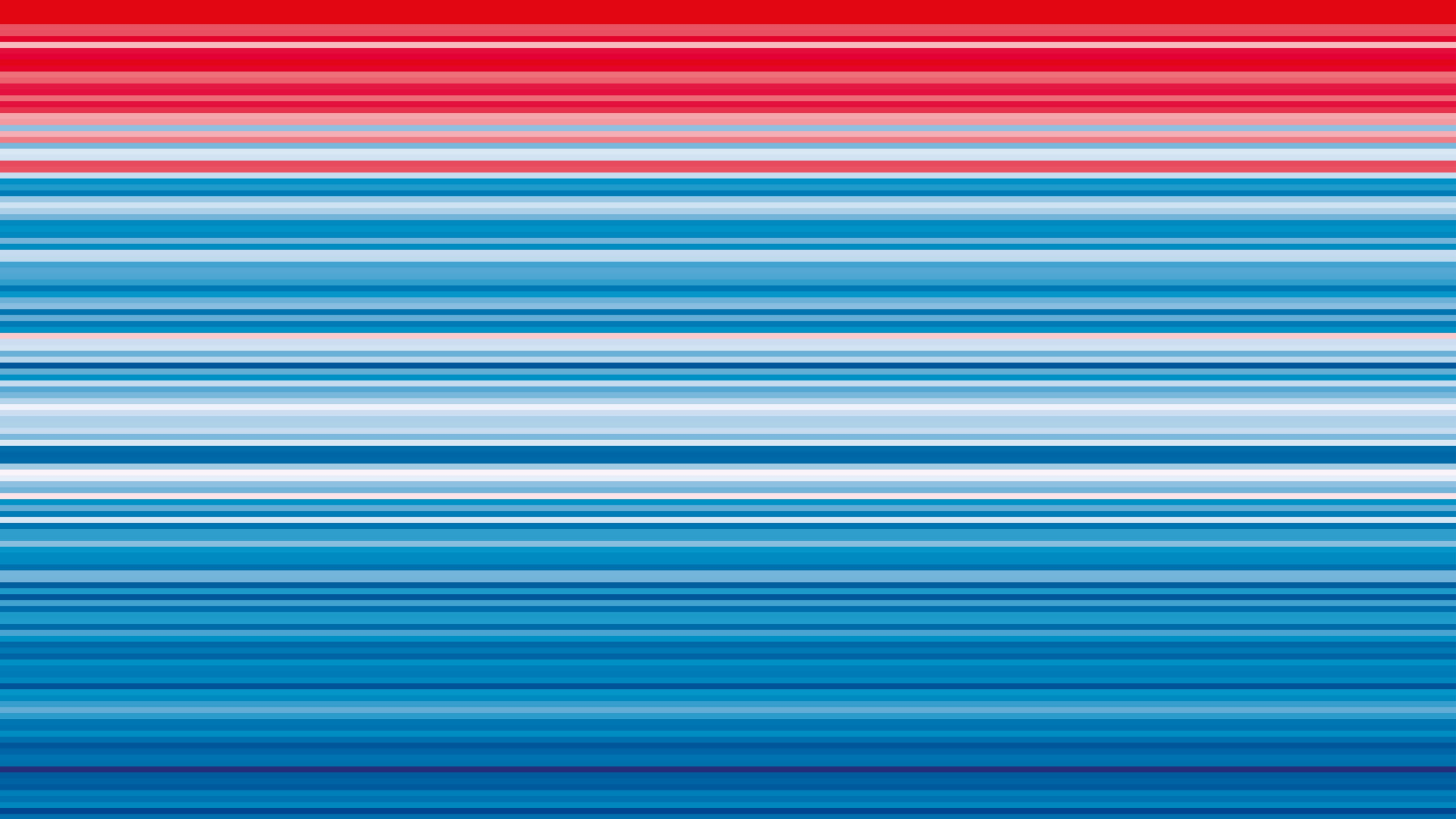


European Energy Transition: The Big Picture

CEDEC Conference

Dr. Patrick Graichen
BRUSSELS, 20.11.2019



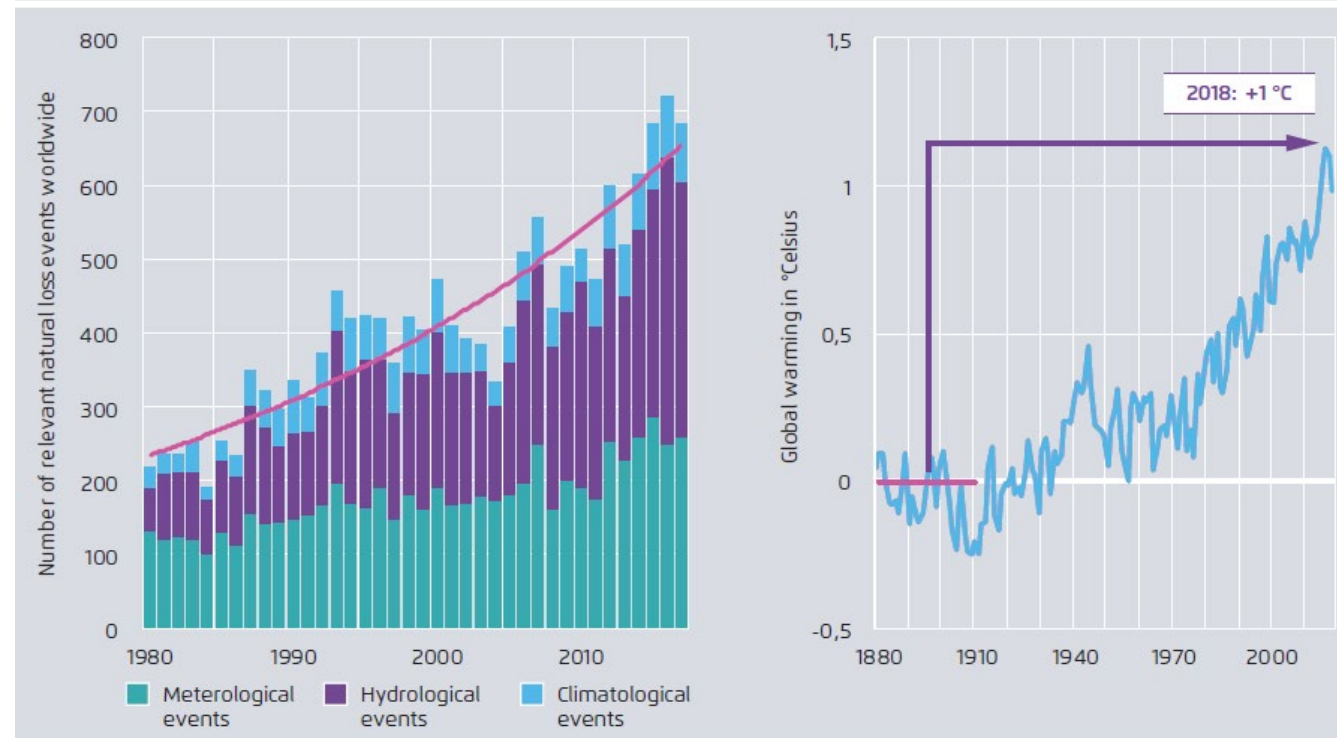
10 megatrends for the energy sector

Megatrend #1: Decarbonisation

As climate change accelerates, societal pressure to act increases

Climate change is real: since 1970 the rate of global warming has accelerated, and since 1980 extreme weather events have tripled

Figure 1



MunichRE (2018): NatCatSERVICE

WMO (2018)

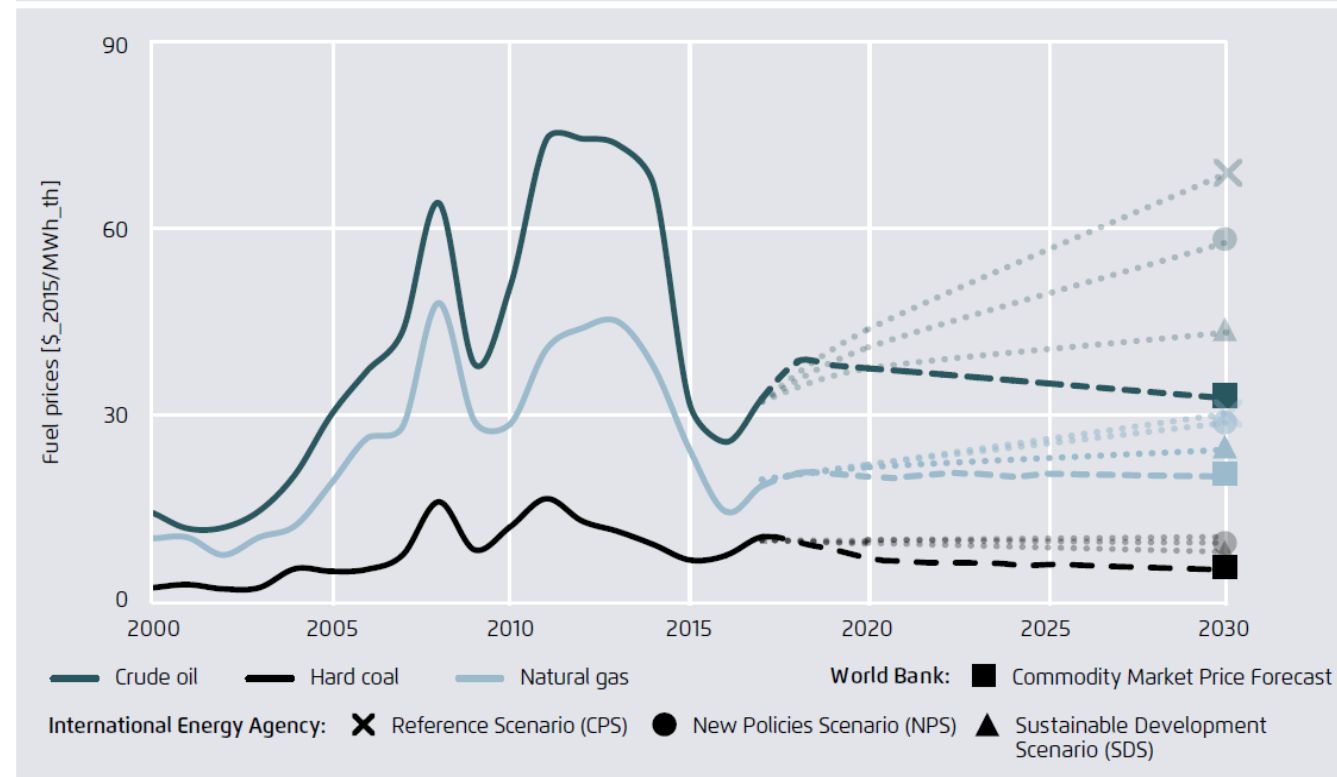
- The 2015 Paris Agreement aims to limit warming to well below 2°C
- National pledges so far are not adequate to achieve this goal
- With impacts of climate change becoming more visible, societal pressure to reduce emissions is growing
- Pressure is coming from citizens, NGOs, but also investors and businesses

Megatrend #2: Deflation of fossil fuel prices

Coal, oil and gas prices will remain low, but become more volatile

Fossil fuel price projections forecast low to moderate price levels to 2030

Figure 2



IEA (2016), World Bank (2017a) and World Bank (2017b)

Prices for fossils are in general not going to rise, as

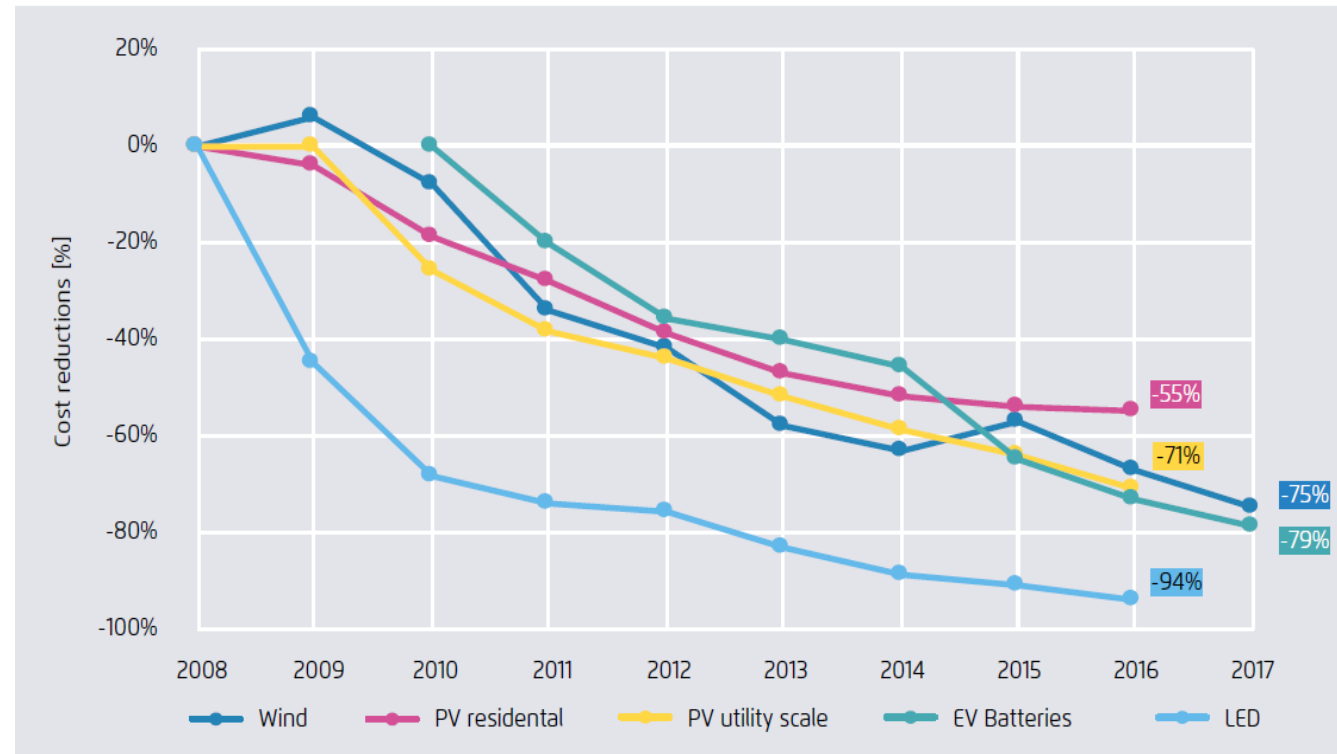
- unconventional sources of oil & gas are cheap to explore
- low-cost renewables serve as upper price limit for gas and coal
- If the world is to remain well below 2 degrees warming, there is no shortage, but an abundance of known fossil fuel reserves!

Megatrend #3: Decrease in costs for clean energy solutions

Wind, Solar, Batteries, Efficiency technologies are now cheaper than conventional and fossil technologies

Cost reductions in major clean-energy technologies from 2008–2017

Figure 3



NRDC (2018) Revolution now

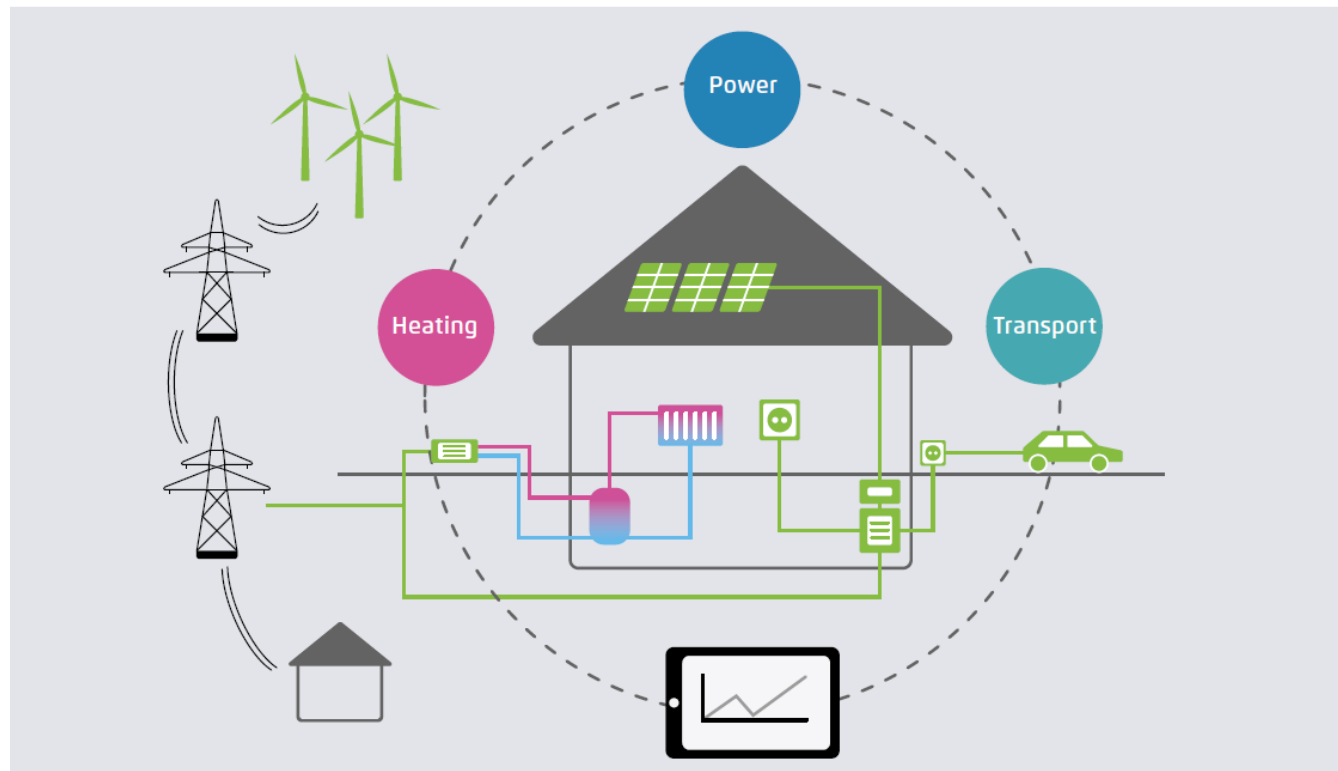
- The cost for wind and solar power has fallen dramatically over the last decade: new wind and solar plants are now cheaper than any other new built power technology
- Over the next decade, *new* wind and solar plants will become cheaper than operating *existing* coal and gas plants
- A similar drop in costs is underway for batteries and in consequence also for electric vehicles

Megatrend #4: Digitisation

Energy and transport systems are becoming smarter and better networked

Digital technology will enable the integration of the power, heating and transport sectors

Figure 4



Agora Energiewende

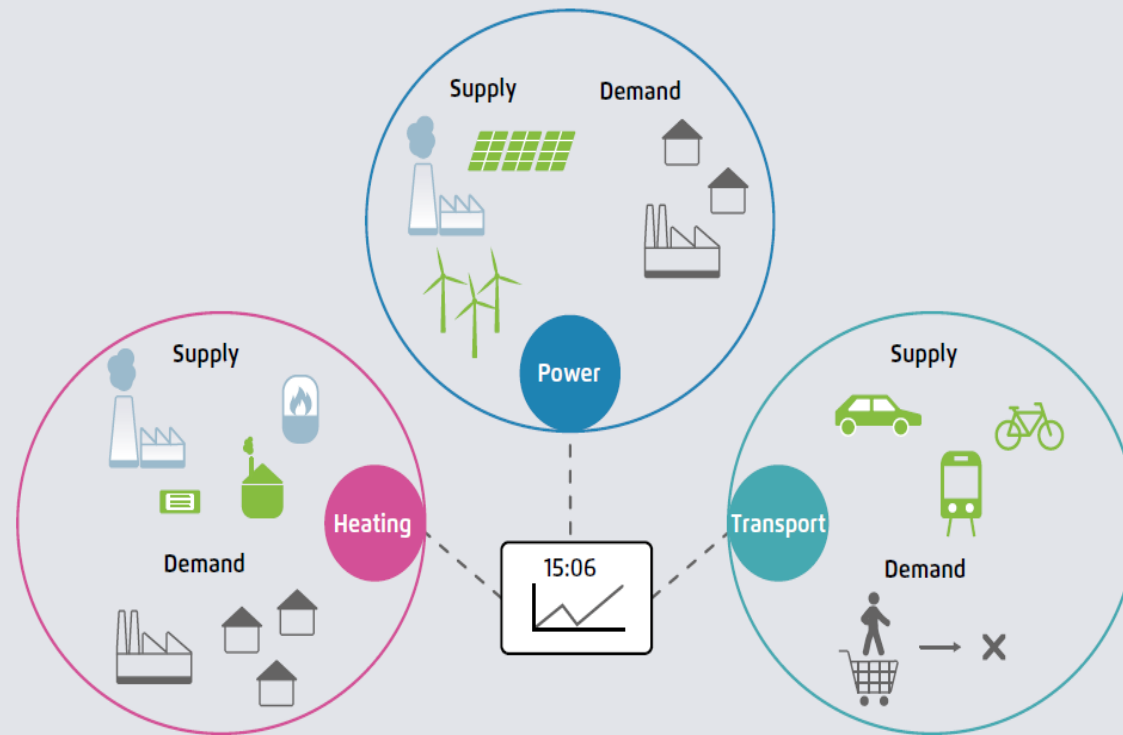
- Digitisation is a key enabler of the energy transition
- Digitisation is the backbone of new technologies and new business models from smart homes, sharing platforms, virtual power plants or autonomous cars
- Smart and interconnected devices increase power system flexibility needed to integrate high shares of variable wind and solar energy

Megatrend #5: Electrification

The power, transport, and heating sectors are increasingly interconnected

Electrification is the key driver of a stronger coupling of power, heat and transport systems

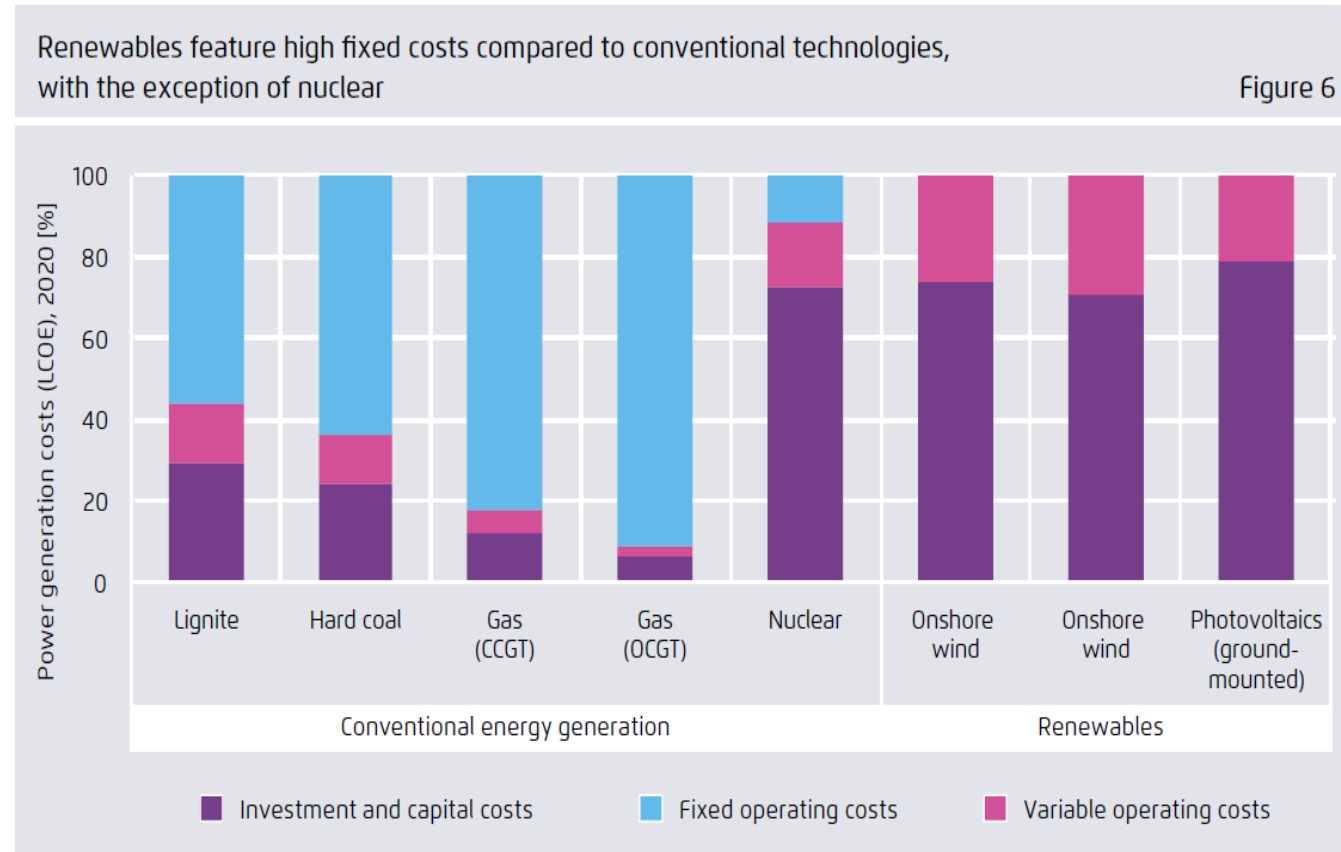
Figure 5



- The energy transition is tearing down the traditional separation between power, transport and heating sectors since the most promising low-carbon technologies are electric.
- Electric vehicles and heat pumps will likely push up electricity demand, increasing the need for energy efficiency and faster renewable energy deployment
- Synthetic fuels (PtG/PtL) will also be based on renewable power

Megatrend #6: Dominance of fixed costs

Future energy systems will be dominated by investment costs

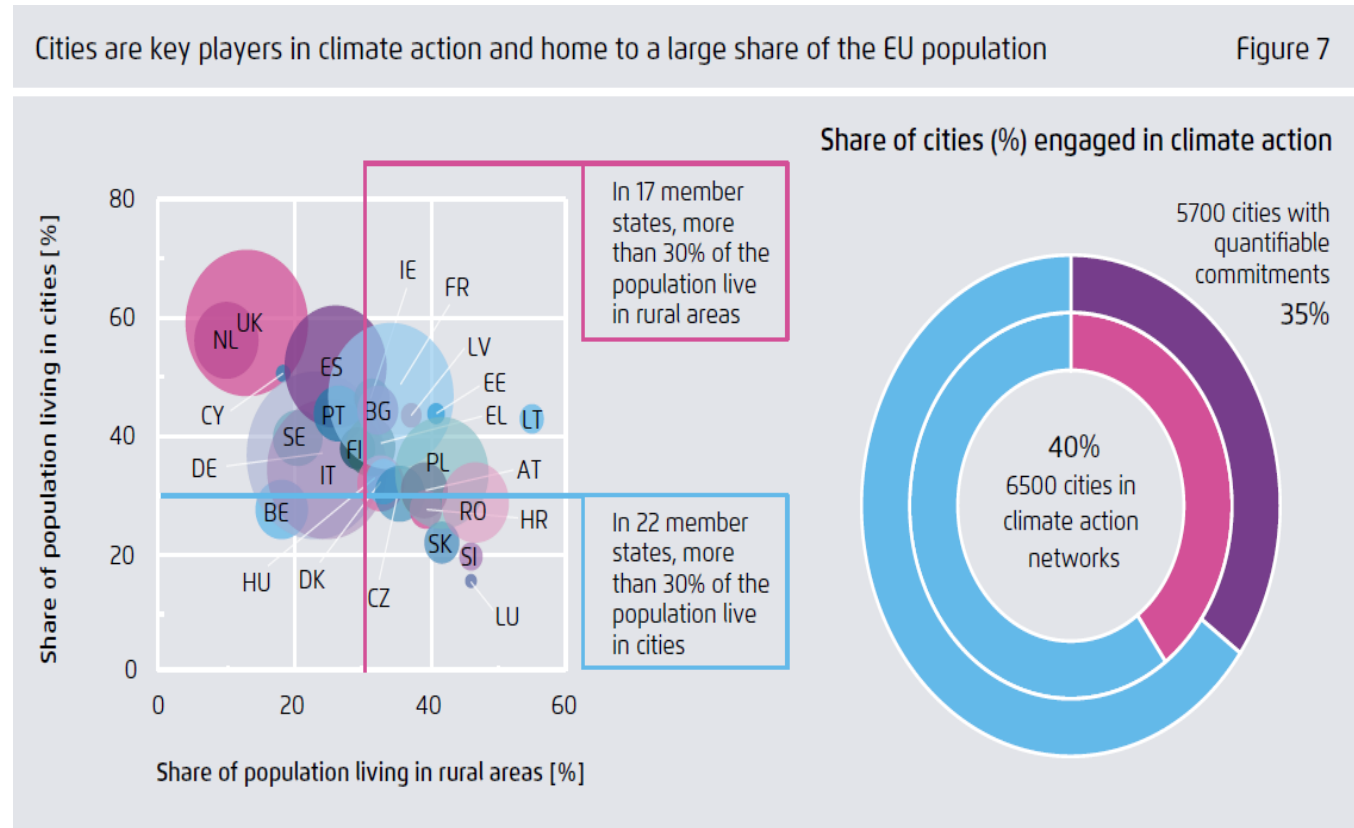


- The energy transition relies on technologies with a high share of investment costs and low share of operating costs
- That applies to wind, solar, batteries, grid infrastructure and energy efficiency measures
- This new finance structure challenges existing business models and market arrangements
- Robust and stable regulation and long-term objectives are needed to keep financing cost low

Calculations by Agora, based on IEA/NEA (2015)

Megatrend #7: Influential cities

More people in big cities means that urban decisions are becoming more important for enabling low-carbon lifestyles

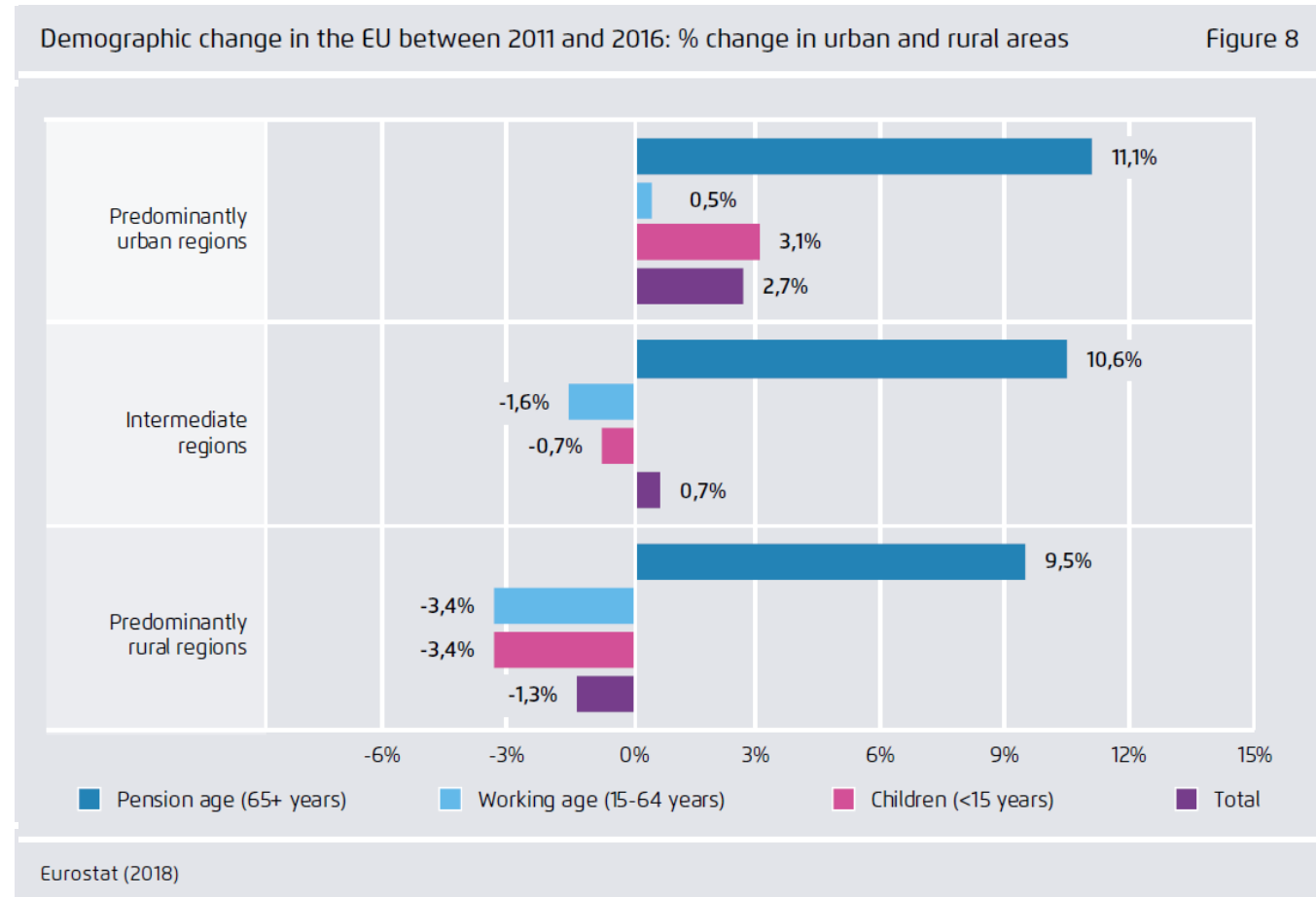


- Almost three quarter of the EU's population live in urban areas.
- Densely populated cities feel the environmental pressure from transport, industrial activity and infrastructure development
- Cities governed by ambitious mayors become laboratories for low-carbon lifestyles
- New mobility solutions such as bike, ride and car sharing, cargo bikes and electric mobility are most easily implemented in cities

Own creation based on Data Driven Yale et al (2018) and Eurostat (2018)

Megatrend #8: Demographic and economic change in rural areas

Energy transition chances and challenges arise in the countryside

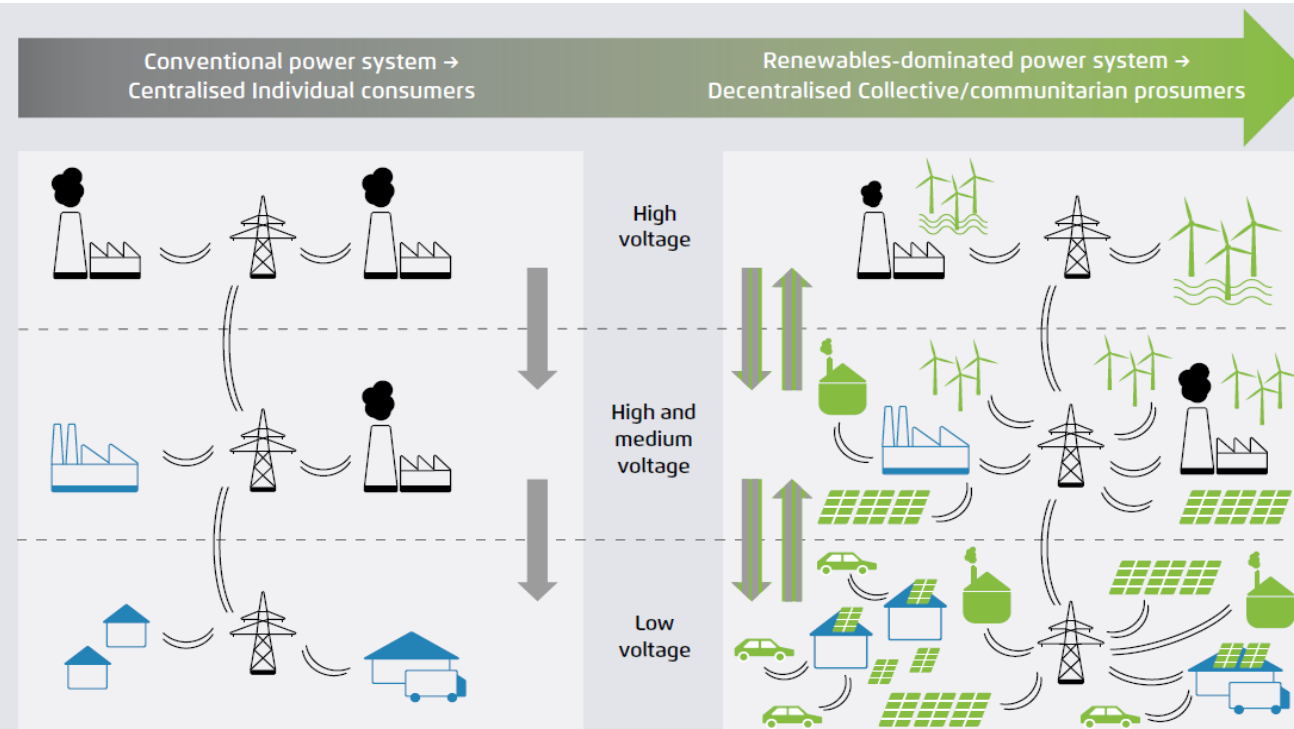


- Regions that currently live from fossil technologies (coal, gas, combustion engines) will face the challenge to re-invent themselves
- New technologies offer new job opportunities, but not necessarily where the old jobs were
- Wind, Solar and other renewables will take place in rural areas, opening up new income streams
- Especially rural areas will need a promising perspective to embrace the energy transition

Megatrend #9: Decentralization: Small-scale solutions enable but also require pro-active energy consumers

The power system's "one-way street" is replaced by a decentralised, networked structure

Figure 9



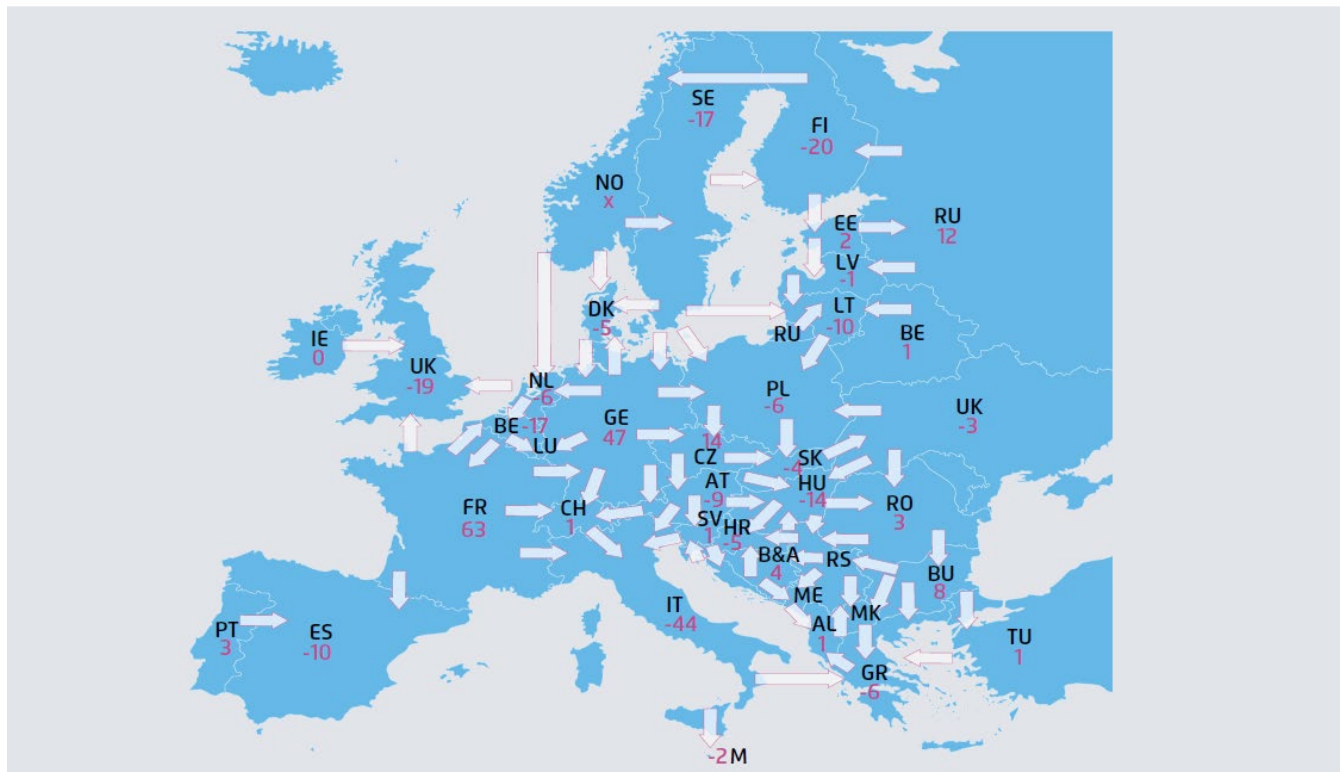
- Solar and wind are more decentralised than conventional power plants and require greater flexibility in the system
- As a consequence, the system is no longer dominated by a handful of producers, but consumers and businesses will become prosumers, generating their own heat and power at every level of the grid
- Consumerism will also be a major drive for change in the transport sector

Megatrend #10: Interdependence

Progressive integration of European economies and energy systems is demanding more coordination between countries

Net physical electricity flows between countries (TWh) in 2018

Figure 10



ENTSO-E

Note that net exports are shown as positive, net imports as negative figures

- The EU has made tremendous progress in creating an internal market for energy. Physical infrastructure links for gas and electricity and the convergence of market rules enable market coupling and converging wholesale prices
- The internal energy market means lower costs for all, but also greater inter-dependence: national energy policy choices affect neighbours and are affected by decision-making in other Member States.

**What does the
current 2030 energy
framework mean?**

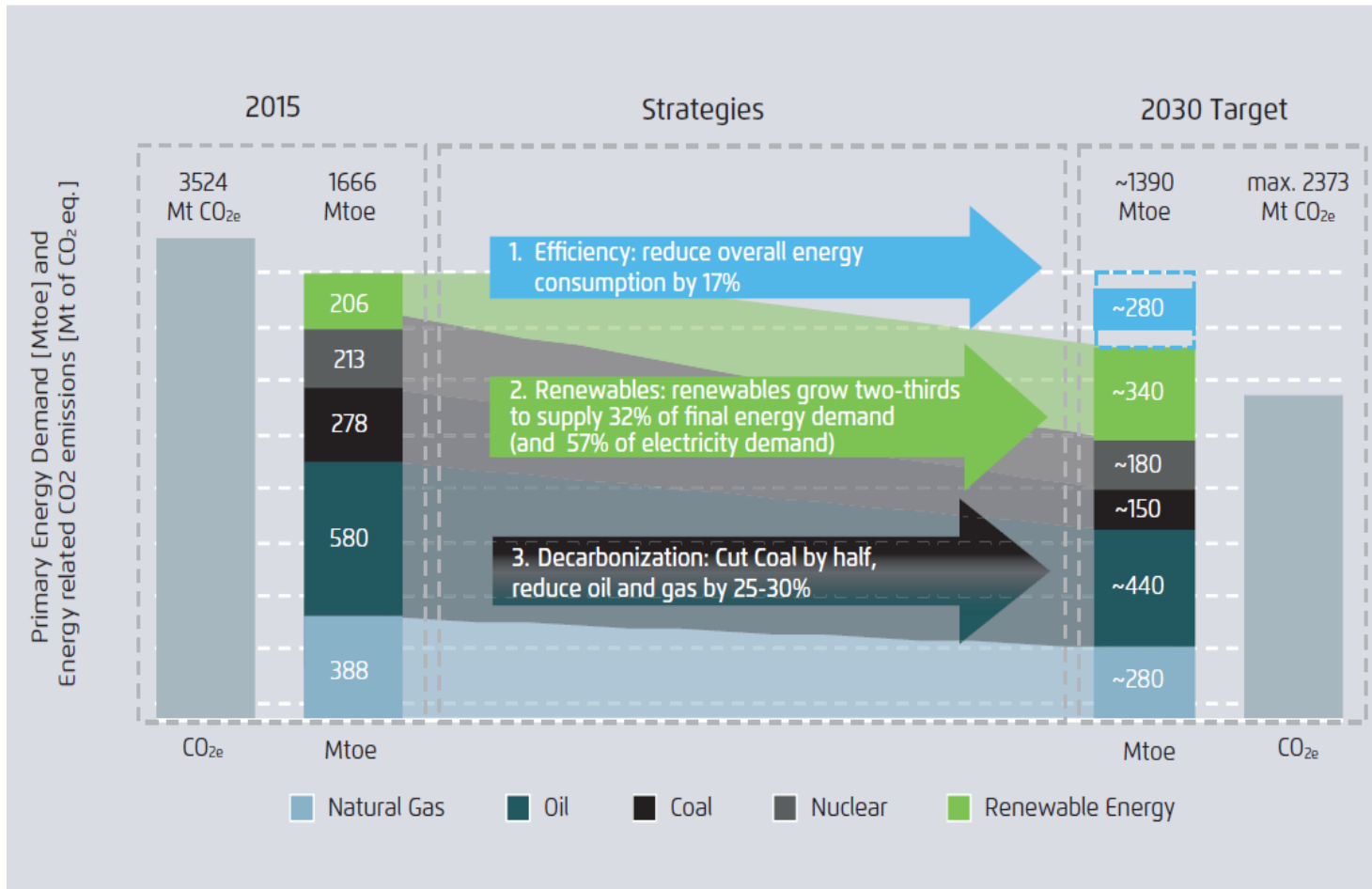
A comprehensive EU energy framework for 2030 is in place: With the 32%/32.5% decision, Europe as a continent has embarked on the energy transition

Climate	Greenhouse Gas Emissions 2030 In 2030: 40 % reduction in GHG emissions compared to 1990 levels	
	EU Emissions Trading System In 2030: 43 % reduction compared to 2005	Climate Action Regulation In 2030: 30 % reduction compared to 2005
	A Europe-wide GHG emissions cap covering Large-scale facilities in power and industry, as well as domestic aviation	28 national GHG emissions reduction targets, stretching from -40 % to 0 %, covering sectors not covered by the ETS (Road & rail transport, buildings, small industrial facilities, agriculture, waste)
Energy	Energy Efficiency 2030 32.5 % decline in primary and final energy consumption compared to a 2007 Baseline	
	Renewable Energy 2030 32 % share of renewable energy in gross final energy consumption	
	National Energy and Climate Plans (NECPs) delivering the binding EU headline targets	

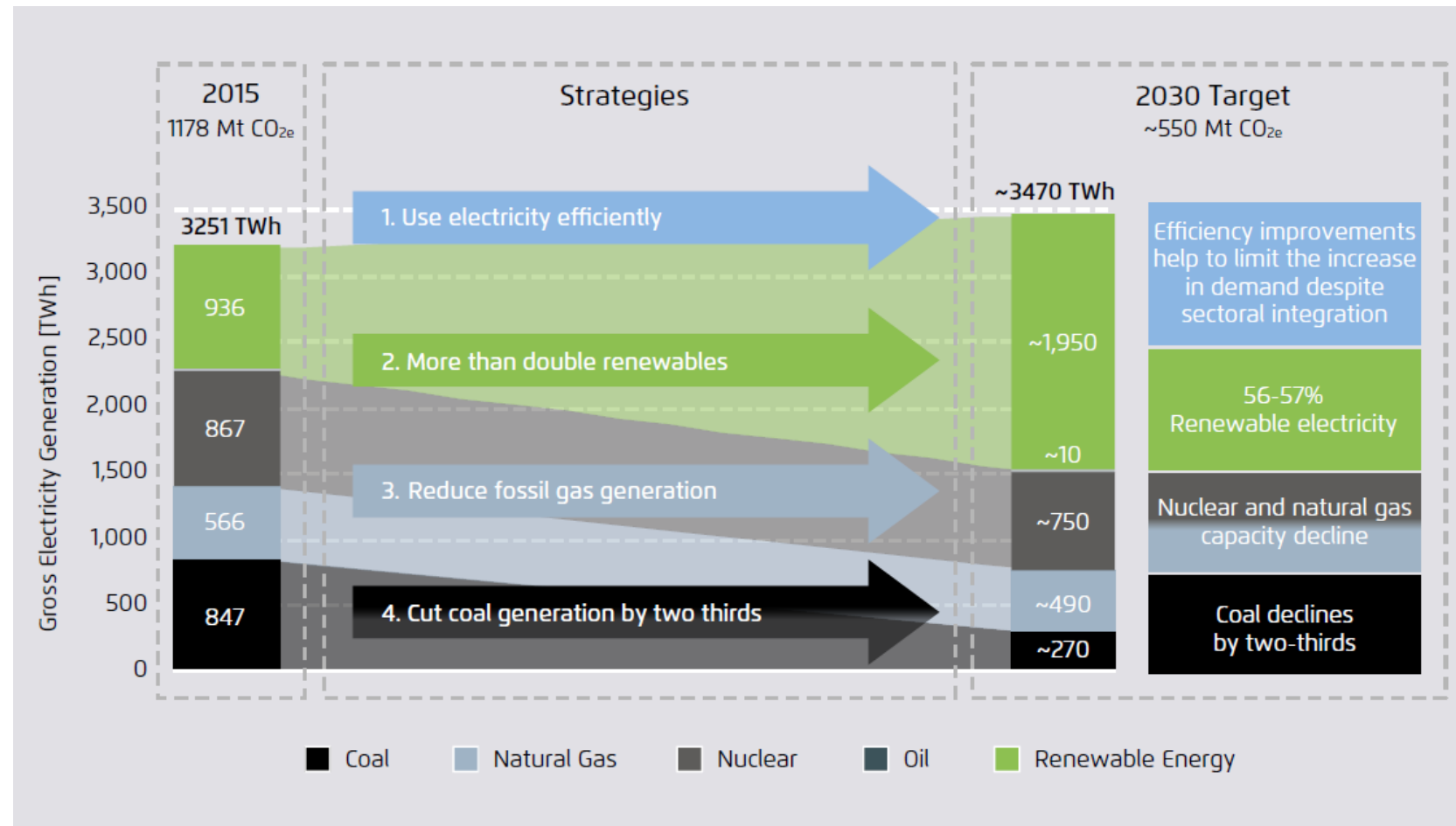
Energy Union Governance

Europe's 2030 energy targets imply: Halving coal use, reducing oil & gas by more than 25%, increasing RES to 32% and reduce energy demand

- The EU's 2030 climate and energy targets are: reducing greenhouse gas emissions by 40%, increasing energy efficiency by 32.5%, increasing the share of renewable energy to 32% of final energy demand.
- The 2030 targets require countries to develop their energy systems in the same direction in the next decade.
- This will change the way energy is produced & consumed in power, buildings, transport and industry.



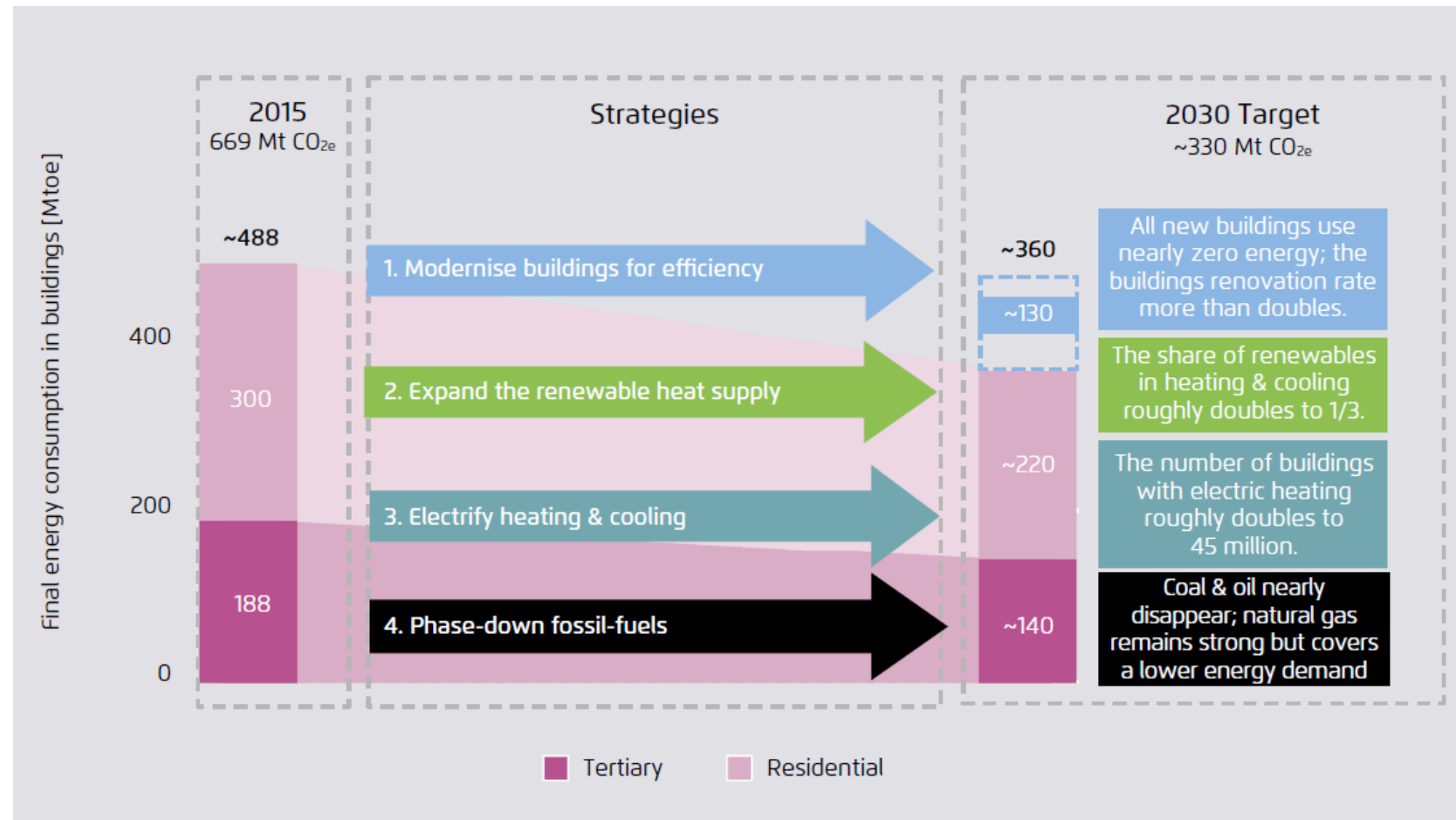
Transforming the power sector for 2030 in a nutshell: Limit the increase in electricity consumption through energy efficiency, increase the share of renewables to 57%, reduce fossil gas generation and cut coal by two thirds



Four strategies for 2030:

- *Efficiency First:* Deploy energy efficiency technologies to keep the increase in electricity consumption in check despite sector coupling.
- *More than double renewables generation:* Raise the relative share of renewables to 57%, led by wind and solar.
- *Reduce coal-fired power by two thirds* or more in terms of generation and capacity.
- *Reduce fossil gas generation:* Reduce gas capacity less in relative terms to serve as flexible back-up to wind and solar.

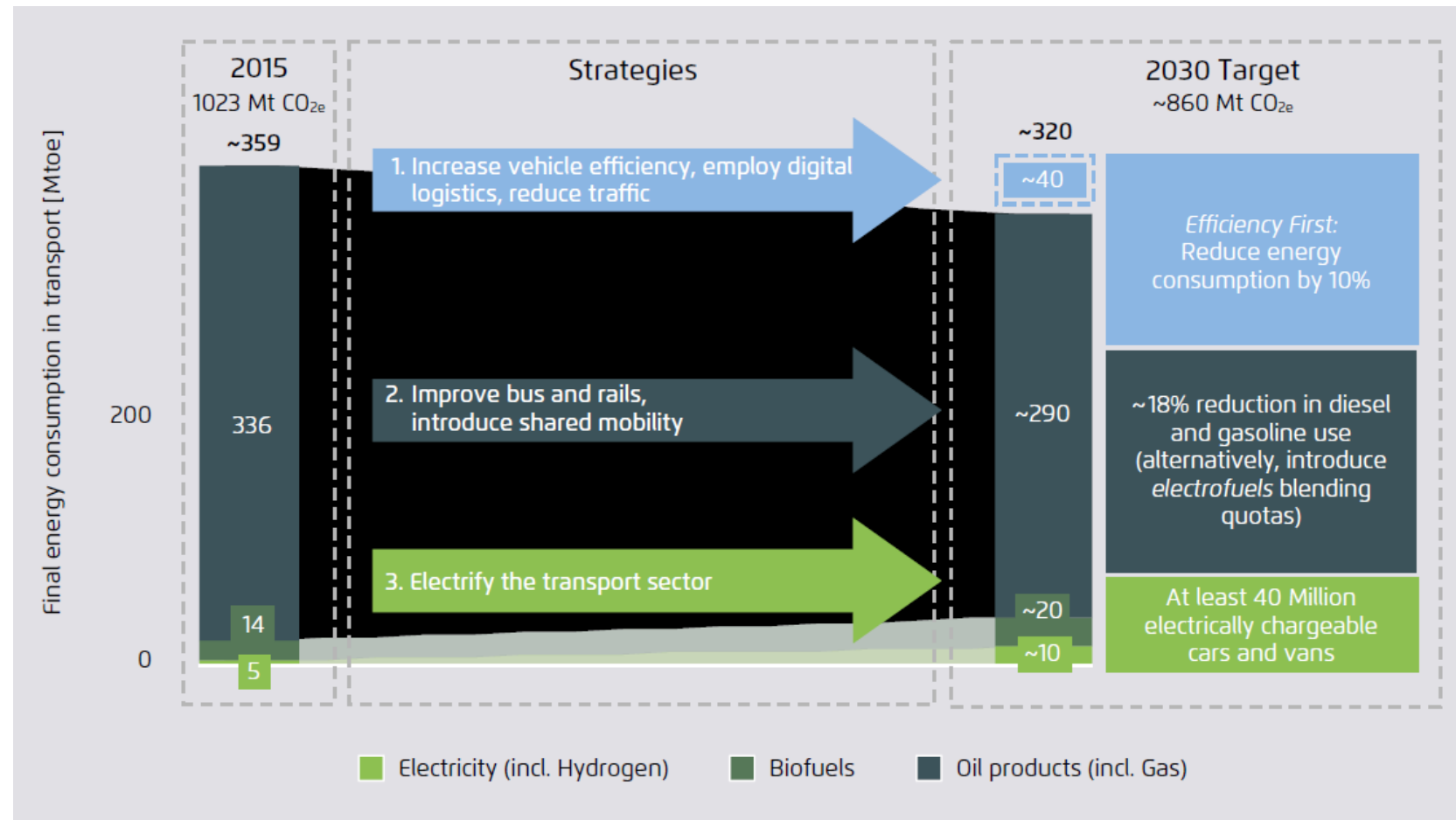
Transforming the buildings sector for 2030 in a nutshell: Double the renovation rate of buildings, the share of renewables in heating and cooling and the number of households with electric heating. Phase-down fossil fuels.



Four strategies for 2030:

- *Efficiency First*: Increase the rate and depth of annual building renovations and raise the efficiency of appliances to lower energy consumption by 1/5.
- *Fuel switching*: Raise the share of renewable heating & cooling to 1/3.
- *Smart electrification*: Double the number of households using electric heating, while increasing power system flexibility.
- *Decarbonization*: Begin to phase out oil and coal, and reduce overall gas consumption through efficiency and fuel-switching.

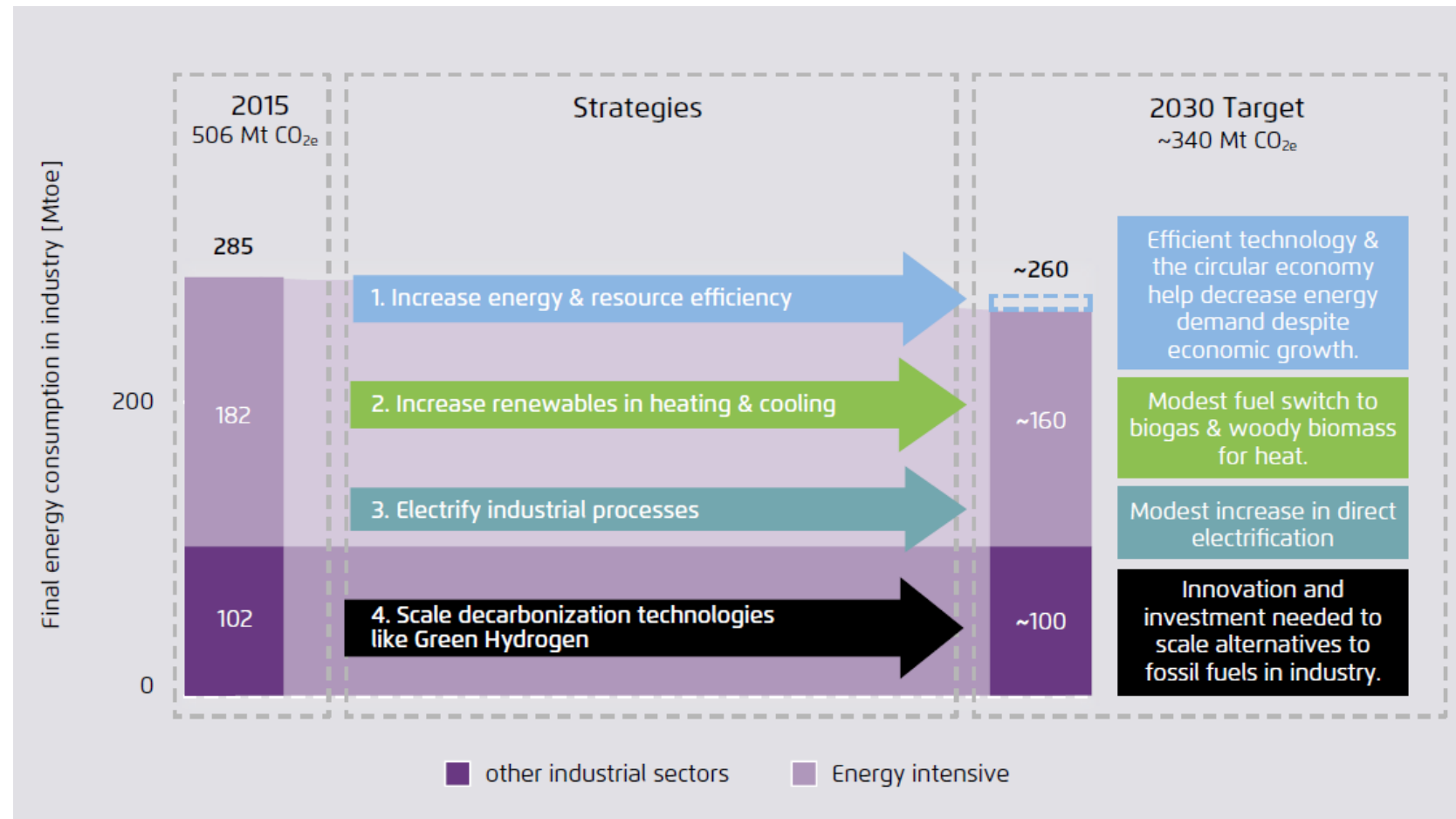
Transforming the transport sector for 2030 in a nutshell: Reduce energy consumption despite increased activity, foster a modal shift & mobility transition, electrify transport wherever possible and introduce sustainable fuels where it is not.



Four strategies for 2030:

- *Efficiency First:* Increase vehicle & system efficiency to reduce energy consumption by 10% despite increased transport activity.
- *Modal shift & mobility transition:* Improve rail, public transport and shared mobility to foster alternatives to carbon intensive transport.
- *Electrification:* Put 40 million electric cars & vans on the road; electrify more rail, buses and trucks; enhance power system flexibility.
- *Decarbonize fuels:* Reduce oil demand by 1/5, and use sustainable bio- and electrofuels as drop-in-fuels.

Transforming the industry sector for 2030 in a nutshell: Maximize energy & resource efficiency, increase the share of renewable & waste heat, electrify industrial processes directly where possible, and scale decarbonization tools where not.



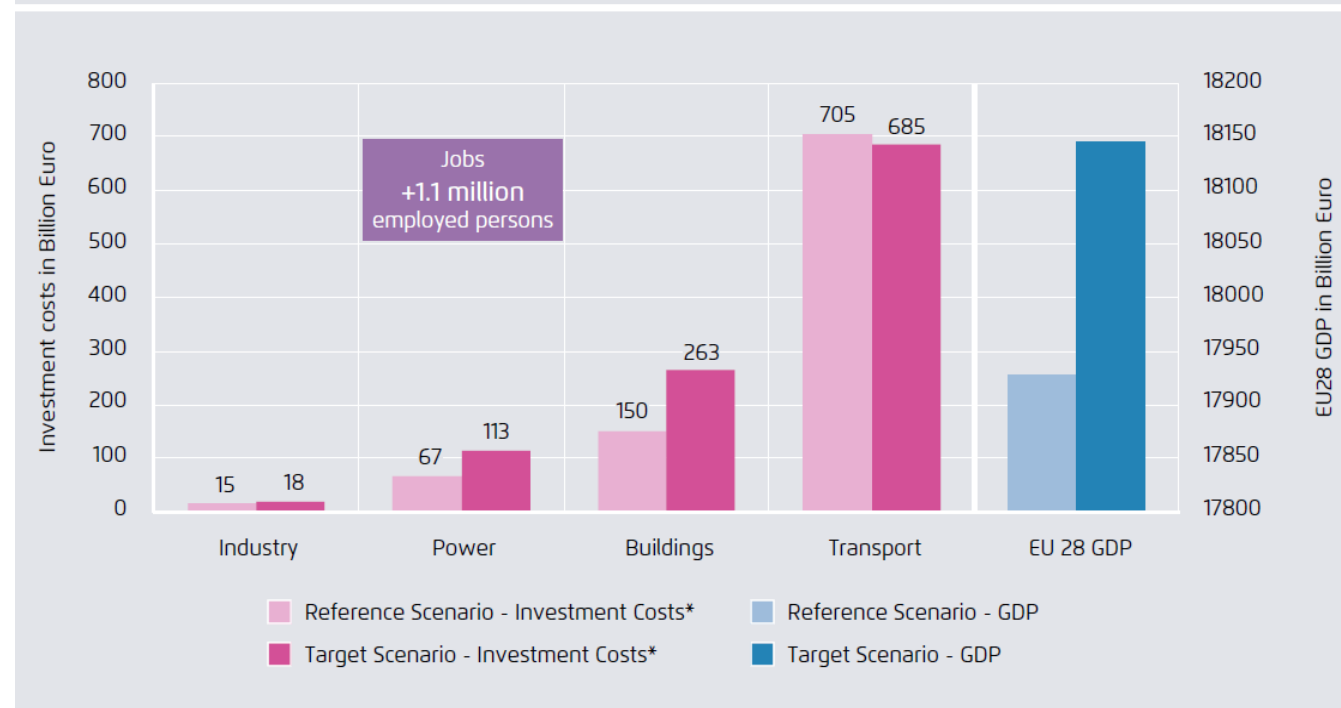
Four strategies for 2030:

- *Energy & resource efficiency:* Reduce energy use despite growing output through efficiency investments and circular economy measures.
- *Increase share of renewable (biomass, solar thermal, geothermal) & waste heat.*
- *Increase the electrification and flexibility of industry* to reduce fossil fuel use and tap into enormous potential for industrial flexibility and procurement of wind & solar.
- *Scale decarbonization tools:* Invest in alternatives to fossil fuels needed for net zero (eg. green hydrogen)

Achieving the EU's 2030 energy targets requires considerable investment, but energy system costs are comparable with current policies. The energy transition also generates significantly higher benefits.

Investment costs are higher in a target scenario vs a reference scenario, but so are growth and jobs

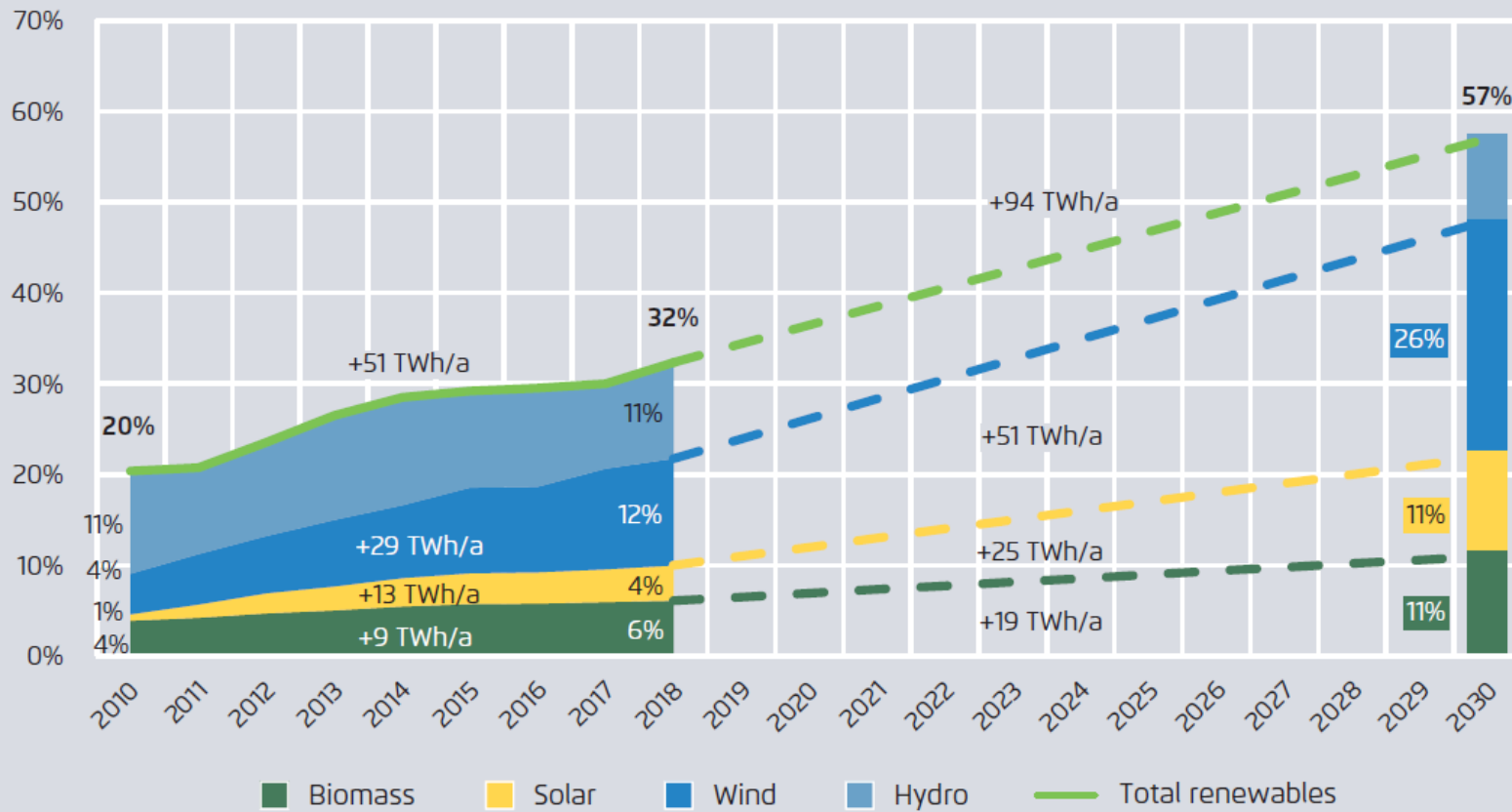
Figure 20



Own calculations based on the EU 2016 Reference Scenario and Commission modelling for the Clean Energy Package and the EU Long-term Strategy
 *Average annual investment expenditure (2021-2030) in Billion Euro (€'13)

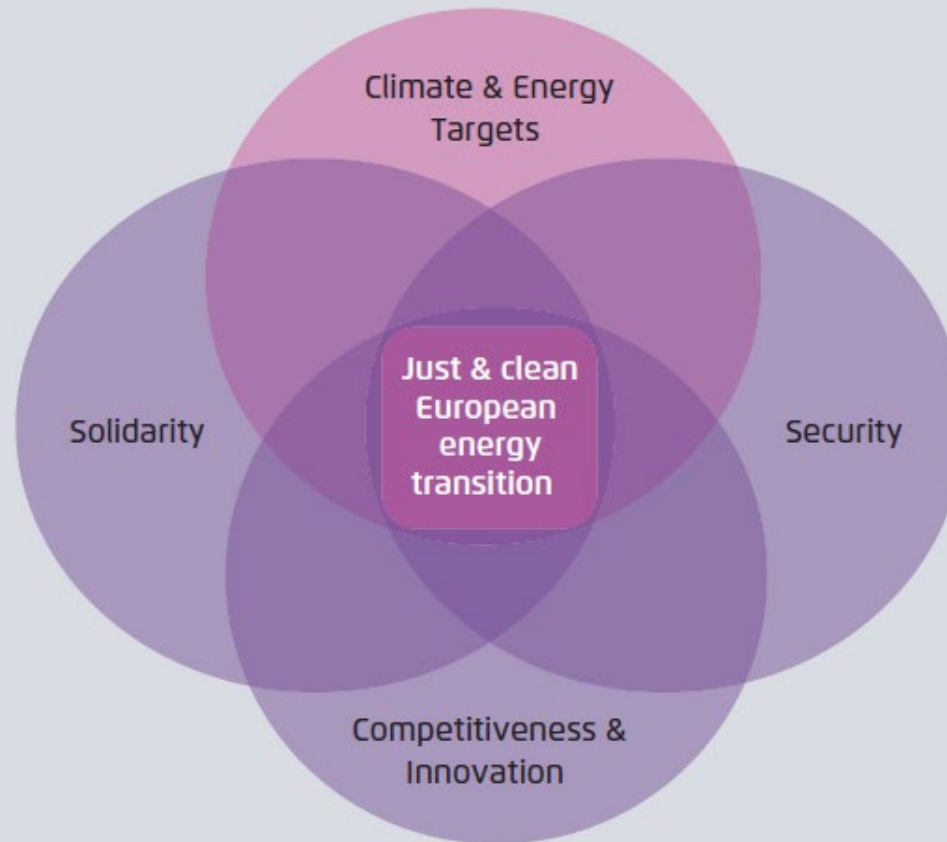
- Meeting the 2030 targets will not raise household expenses relative to the reference case.
- The energy transition will increase employment and GDP compared to reference case.
- The shift to renewables and energy efficiency increases energy security.
- Avoided health costs more than outweigh the additional costs of the transition.
- Industrial competitiveness is not at risk, but energy- and trade-intensive branches need support.

Decarbonizing the power sector cost-effectively implies doubling the annual increase of renewable power generation compared to 2010-2018 levels.



- Electrification of transport, heat and industry means electricity consumption is forecast to rise by 18% by 2030. Therefore, renewables generation must rise by 18% by 2030 just to maintain the same 32% share as now.
- To reach a share of 57% of electricity in 2030, renewables deployment needs to almost double from 51 TWh/year from 2010 to 2018 to 94 TWh/year from 2018 to 2030.

Further EU-level action will also be needed to accelerate climate action and ensure a European energy transition based on solidarity, security, competitiveness, and innovation.

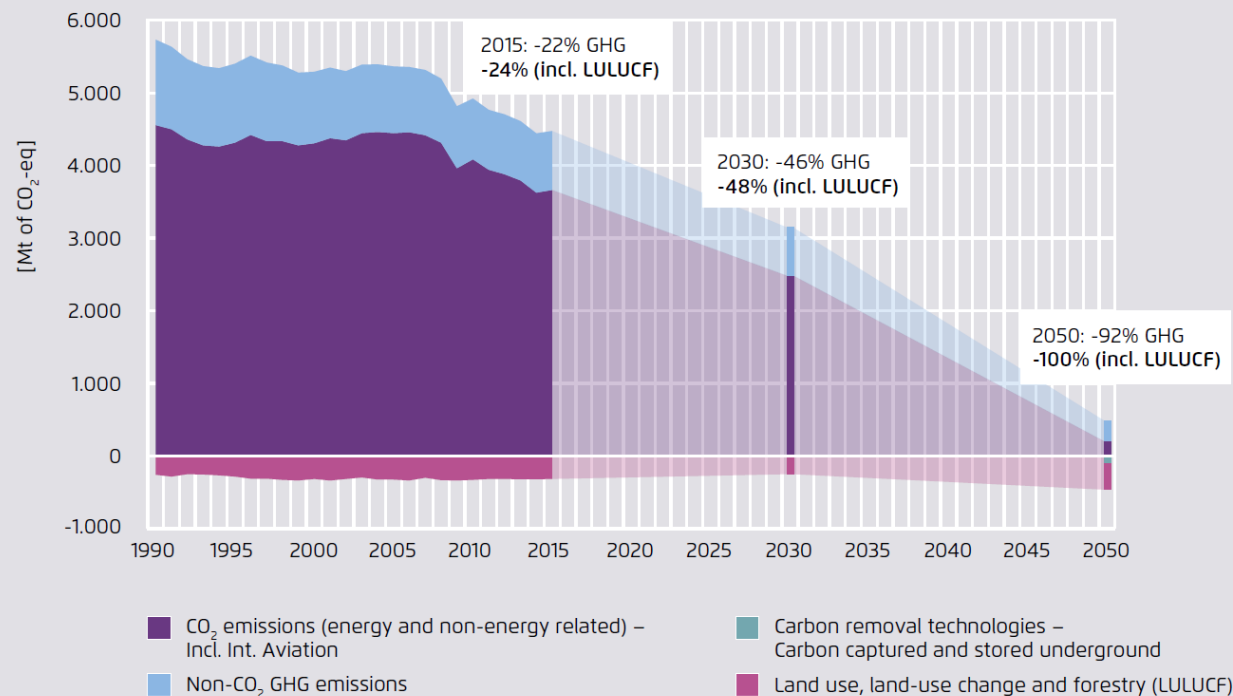


- Advancing the European energy transition is a task that primarily falls to national and regional governments. No national energy transition will be exactly alike.
- Irrespective of these differences, all Member States must find solutions for pursuing the same set of objectives over the next decade.
- On the way, strong EU-level action will be needed to help resolve issues related to **solidarity**, to the **security** of energy supply and energy systems, to **competitiveness**, and to **innovation**.

**The next frontier:
Climate neutrality
2050 and higher EU
2030 climate targets**

Commission analysis for its EU Long Term Strategy shows achieving carbon-neutrality by 2050 is possible

Greenhouse gas emissions from 1990-2015 and in 2030 and 2050 target scenarios

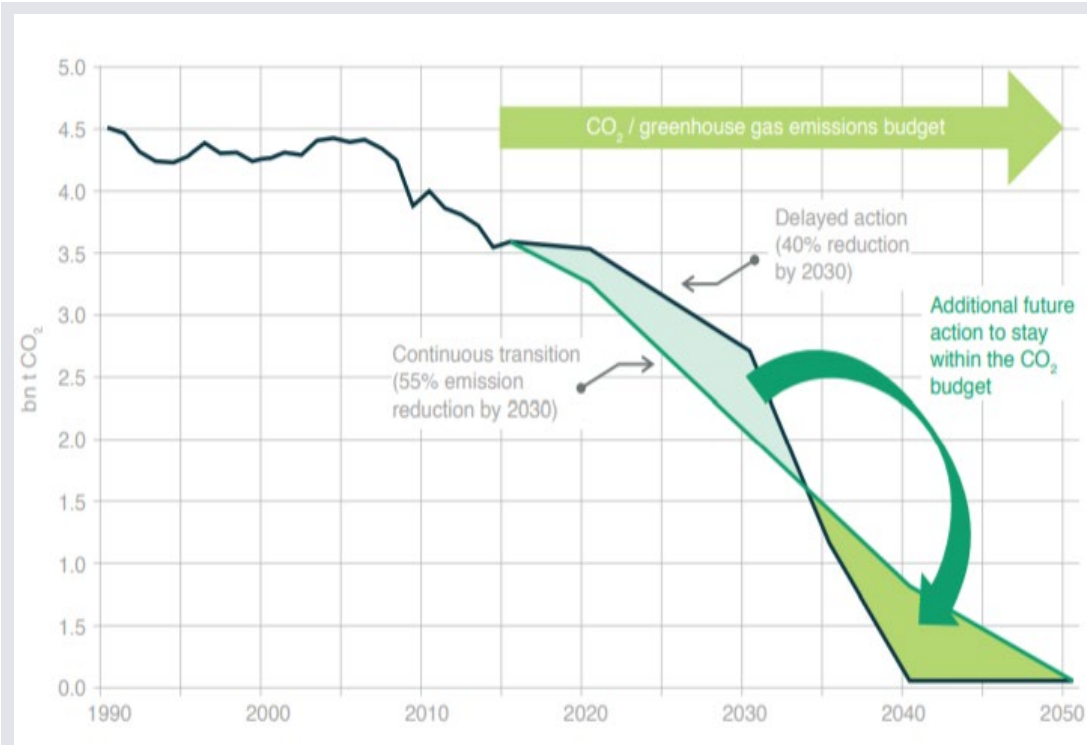


- Net-Zero 2050 requires reducing energy-related emissions to almost zero as well as a significant share of negative emissions.
- Modelling also shows that full achievement of the renewable energy and energy efficiency targets and LULUCF combined would bring EU emissions to **-48%** in 2030
- A linear path from today to 2050 would mean a target of **-50% to -55%** ghg emissions in 2030

Own analysis based on EEA (2018) and EU Long Term Strategy

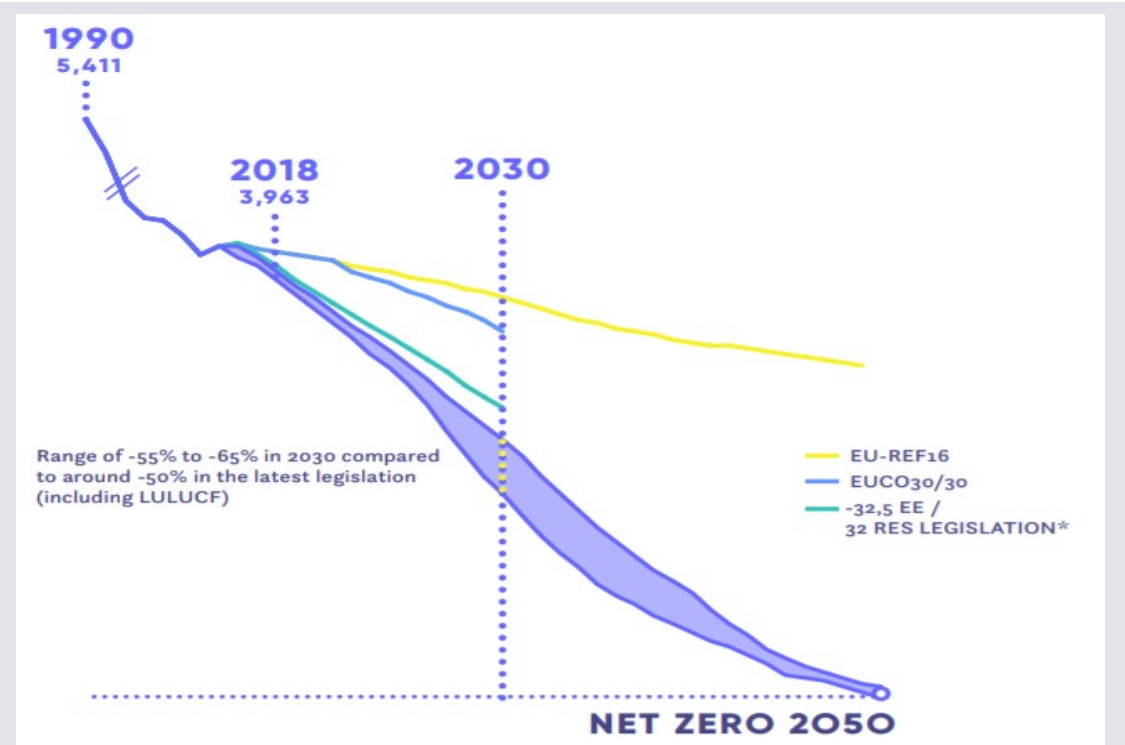
A continuous transition from today to carbon neutrality in 2050 would require a more rapid reduction by 2030 than reflected in the current EU climate target.

Emissions reductions required using a carbon budget approach



Öko Institute Vision Scenario

GHG emission reduction range in ECF/Climact net-zero scenarios



ECF/ Climact

Climate Neutral Europe 2050 and a higher 2030 target mean...

(1) Taking Implementation Seriously by initiating EU flagship initiatives



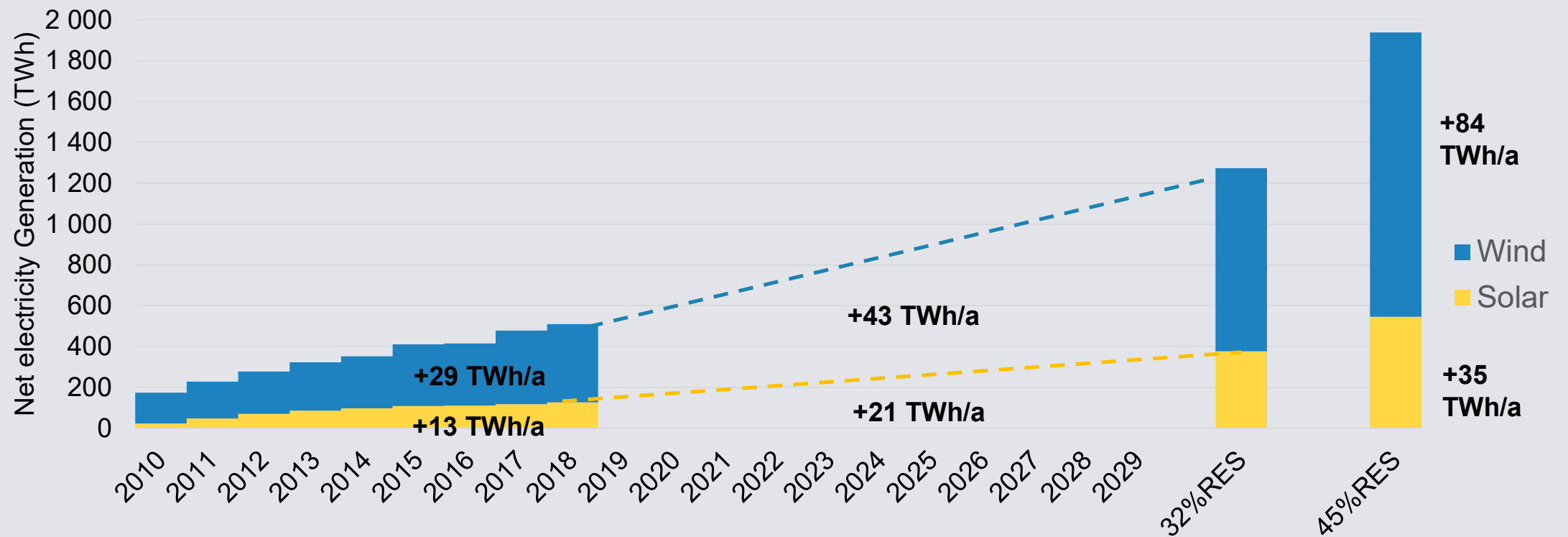
The Commission should cooperate with interested governments, regions and stakeholders to launch a range of „**EU Flagship Initiatives**“ that address the social dimension of the energy transition, help to overcome existing implementation bottlenecks and prepare the ground for increasing EU climate ambition. We propose the following 5 flagship initiatives:

1. By 2025, 1 million buildings renovated using an industrialised approach
2. By 2025, at least 10 million solar roof-tops added to houses and supermarkets throughout Europe
3. By 2025, 100 cities with strategies for decarbonising heating and cooling networks
4. By 2025, roll out „1 million charging stations“
5. By 2025, in each „Coal Region in Transition“ one open-cast coal mine is converted to a utility-scale solar PV park

The new EU Budget should financially support such initiatives; the Commission’s structural reform support service should provide on demand, tailored support.

Climate Neutral Europe 2050 and a higher 2030 target mean... (2) wind and solar will grow even further than expected – and coal will be phased out quicker.

Net electricity generation from wind and solar (in TWh) from 2010-2018 and in select Commission scenarios

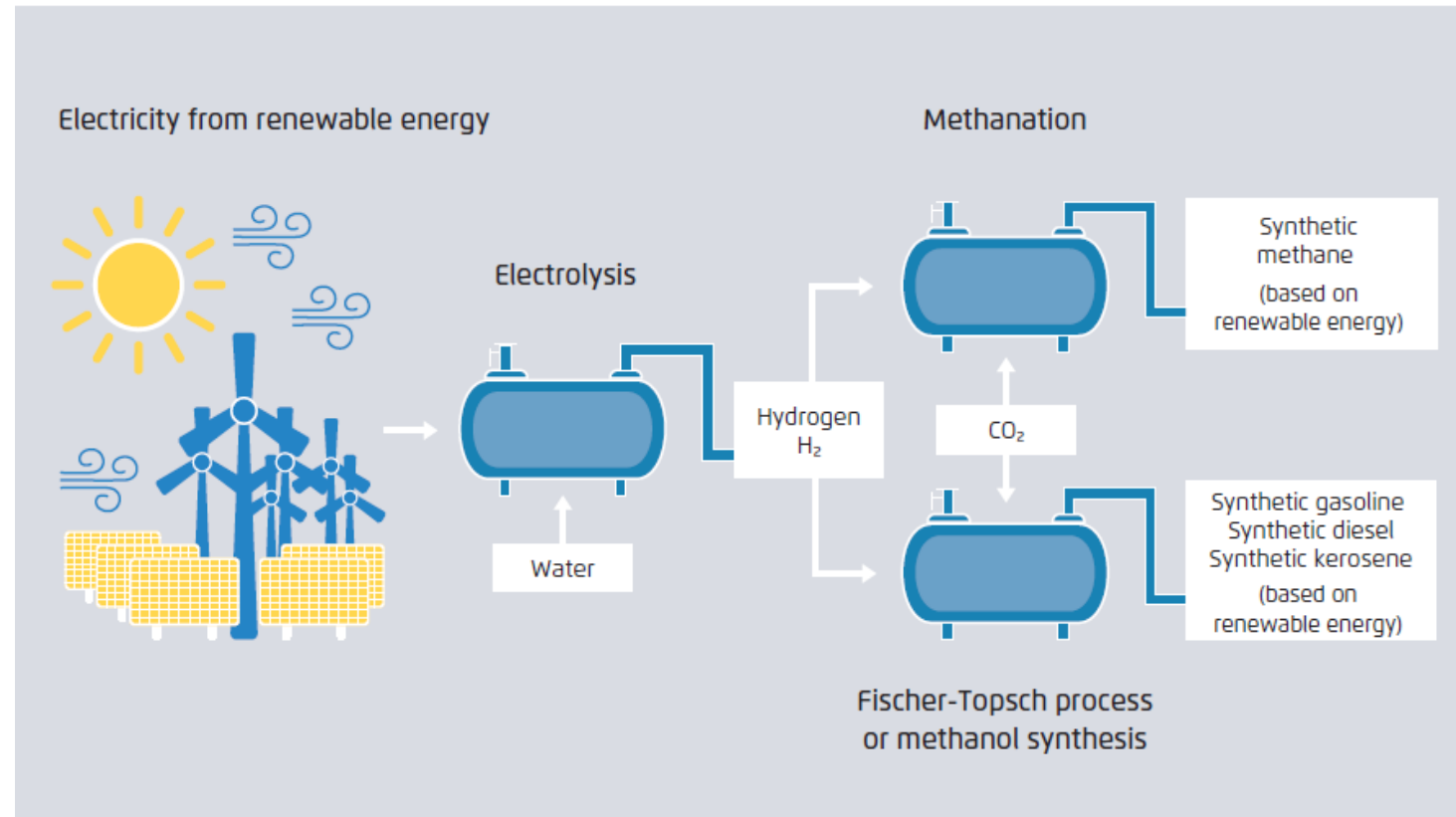


Agora Energiewende & Sandbag (2019); [European Commission \(2018\)](#); [European Commission \(2019\)](#)

Climate Neutral Europe 2050 and a higher 2030 target mean... (3) we will enter the new era of the energy transition with hydrogen as the clean fuel, needing ≥ 30 GW of electrolysers

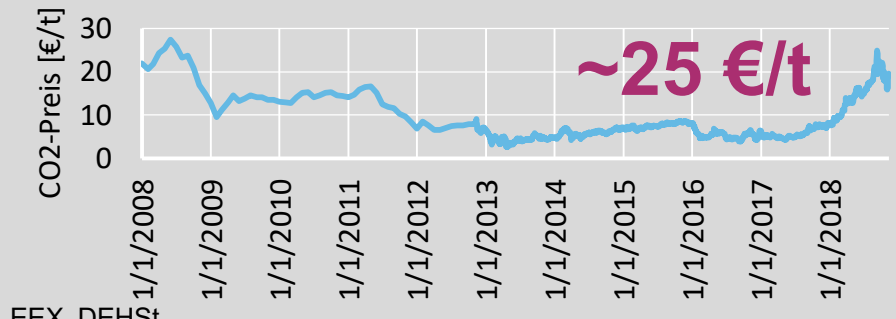
Production process for electrofuels
(hydrogen, PtG methane and PtL fuels) from sun and wind

Figure 31



- As part of its upcoming Gas Package, the Commission should propose a binding, gradually increasing EU-wide renewable gas quota for natural gas suppliers, rising from 2% of overall final gaseous fuels demand in 2022 to 10% in 2030. This is projected to equate to some 370 terawatt hours in 2030.
- A sub-quota should require at least 1/3 of the quota to be supplied by green hydrogen. This will ensure that EU green hydrogen production and electrolyzer capacity grow to at least 120-125 terawatt hours and 30 gigawatt by 2030.
- The Commission should introduce a rigorous sustainability framework for green hydrogen and CO₂-based electrofuels.
- Harmonize technical rules to allow higher shares of hydrogen in existing gas grids.

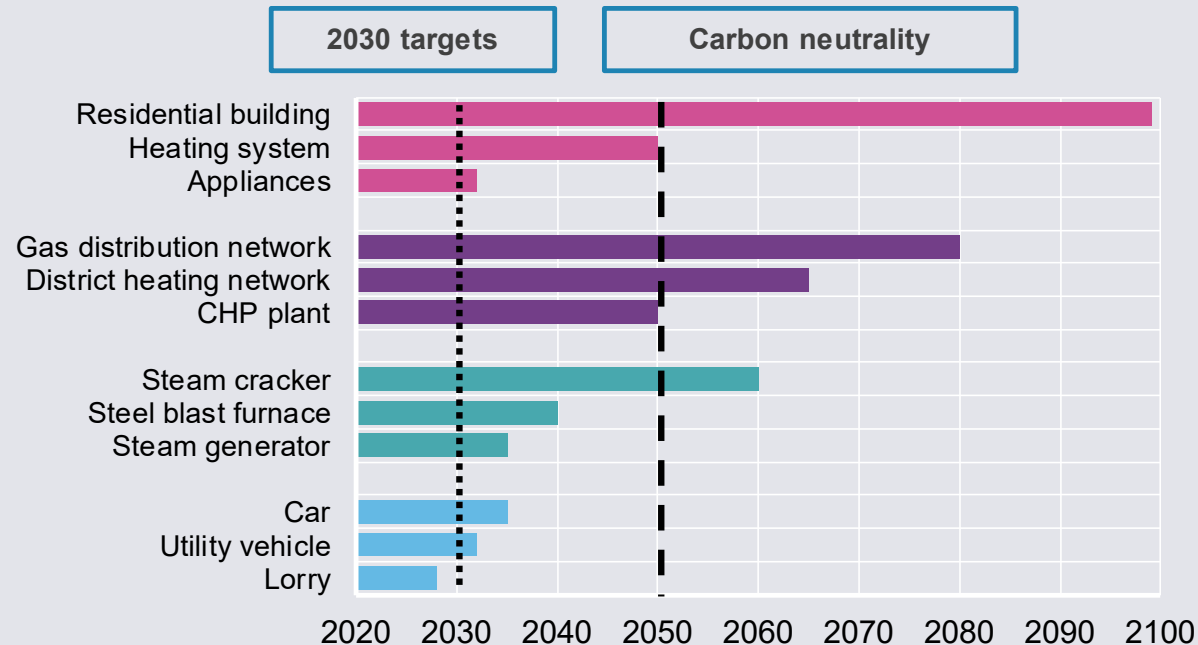
Climate Neutral Europe 2050 and a higher 2030 target mean... (4) to put CO₂-Pricing and a reform of the EU ETS back on the agenda

	European Emissions Trading Scheme (ETS)	EU <i>Climate-Action-Regulation</i>
CO ₂ -Sectors covered	<ul style="list-style-type: none"> Energy industry Energy intensive industry (inter alia the iron-, steel-, aluminium-, cement-, chalk-, paper and chemicals-industry) EU-Aviation <p style="text-align: right;">ca. 50 %</p>	<ul style="list-style-type: none"> Transport (except EU air transport) Buildings Other industries and services Agriculture <p style="text-align: right;">ca. 50 %</p>
CO ₂ -Price	 <p style="text-align: center;">~25 €/t</p> <p>EEX, DEHSt</p>	<p style="text-align: center;">X</p> <p style="text-align: center;">(so far <u>no</u> direct CO₂-pricing in many Member States)</p>

Climate Neutral Europe 2050 and a higher 2030 target mean...

(5) Smart industrial policy, considering investment cycles and enabling climate-friendly investments with a new directive

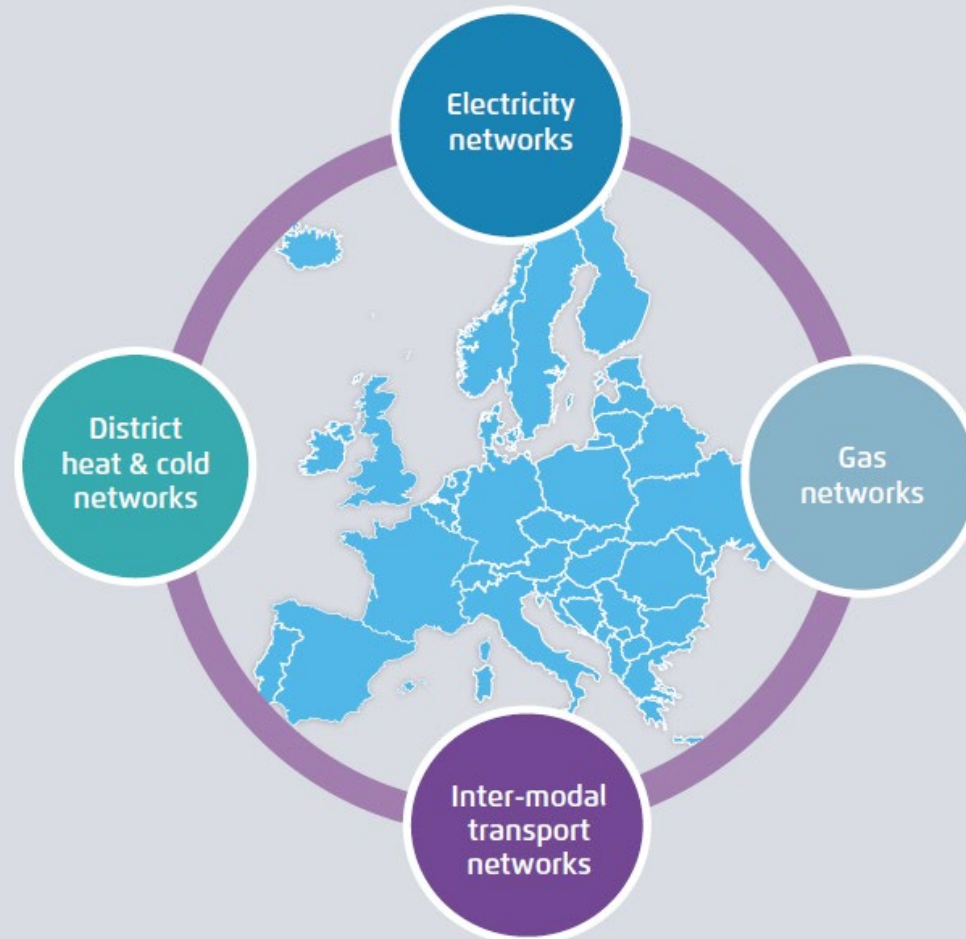
Lifetime of specific technologies if reinvestment takes place in 2020



Own illustration

- Many investments of the upcoming years will still be used in 2030 and 2050 when climate targets are evaluated.
- Houses last 80-100 years, grids 50-60 years, heating systems 30 years; industrial installations 20-40 years,
- Efficient policies take these investment cycles into account and allow for direct and intelligent investments that are climate-friendly.
- If this is not guaranteed, investments may strand and expensive scale-ups will be required. This would neither be economically sustainable nor resource-saving.
- The Commission can play an important role in supporting and encouraging cities and regions to adopt decarbonized district heating & cooling through the targeted use of EU funds.

Climate Neutral Europe 2050 and a higher 2030 target mean... (6) talking about infrastructure. What do we need in a decarbonized world 2050 and where?



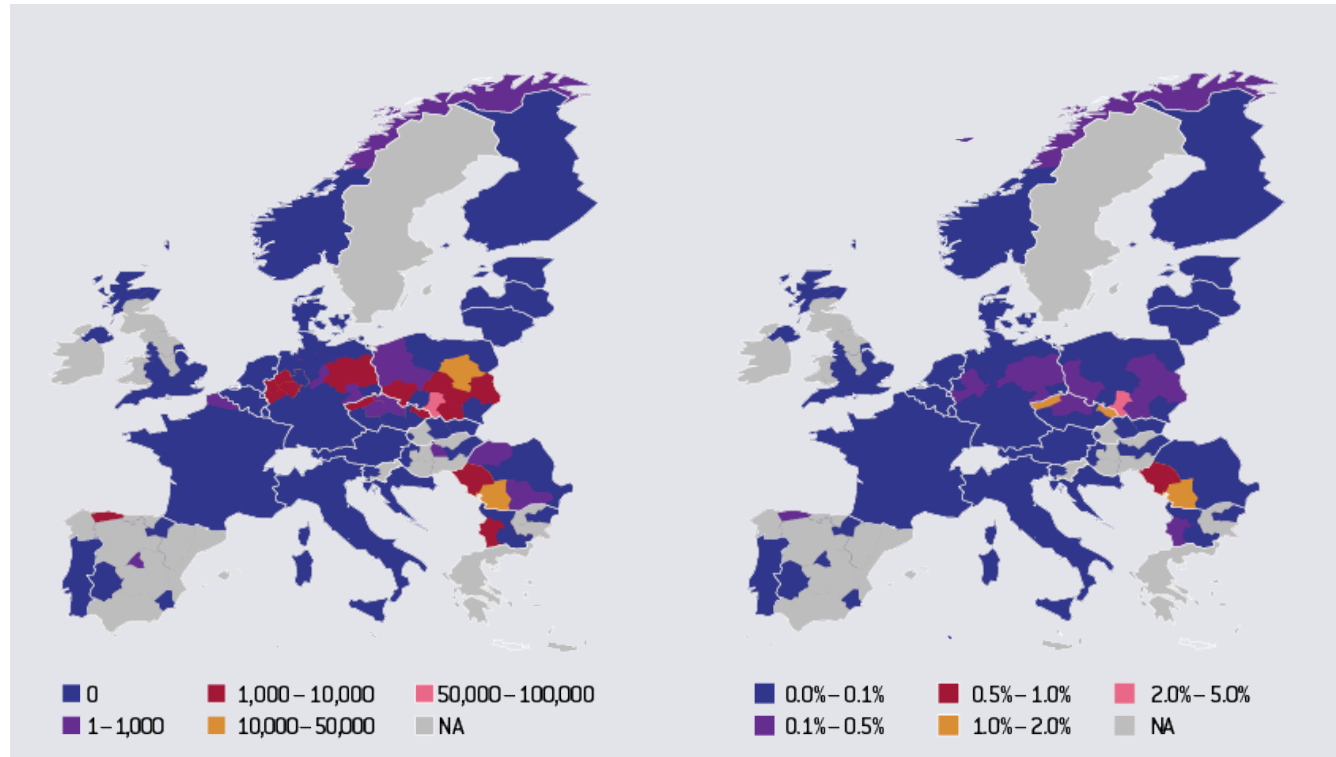
Three strategies:

- *Efficiency first:* save money and increase security of supply by prioritizing investment in reducing energy demand over increasing supply, wherever possible.
- *Integrated long-term planning:* Avoid stranded assets and make optimal use of existing infrastructure by planning for power system flexibility and target fulfilment.
- *Fair & efficient cost sharing:* Safeguard acceptance by ensuring that costs of transforming energy networks are distributed fairly and efficiently.

Climate Neutral Europe 2050 and a higher 2030 target mean...

(7) Supporting a just transition in coal regions, as this is about solidarity

Coal mining employment in EU countries and regions



Bruegel based on Eurostat (2017)

- Currently, 41 regions in 12 member states rely on economic revenues from coal mining and coal use, which provide direct employment to about 185,000 people across the EU.
- By 2030, coal-based power generation will decline by two thirds, decreasing economic revenues and eliminating a significant number of coal-related jobs in affected regions. In 2017 the Commission launched the *Coal Regions in Transition Platform* to support dialogue and sharing of experience.
- Regions committed to phasing-out coal need specific support measures to attract new employers for worker retraining and infrastructure upgrades. In some cases, it will be possible to combine the phase-out of coal-related jobs with the creation of new-energy jobs (eg. wind & solar, batteries, hydrogen).

Agora Energiewende
Anna-Louisa-Karsch-Str.2
10178 Berlin

T +49 (0)30 700 1435 - 000

F +49 (0)30 700 1435 - 129

www.agora-energiewende.de



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Thank you for your attention!

Questions or Comments? Feel free to contact me:

Patrick.graichen@agora-energiewende.de

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.