# EU Power Roadmap 2050

## How to get to a prosperous, low-carbon Europe

partner in Smart Energy Collective

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April 16, 2013

KEMA DNV

# The changing world of energy

# Macro trends driving change

**Complexity** **Globalisation** **Energy transition**

# The energy transition playing field

**The energy transition is taking shape in the context of political, technological and economic trends.**

## Political

Political trends reflect the major elements of energy policies.

- Liberalization, Gas & Electricity Directives (and related legal and regulatory framework and arrangements)
- Regional integration and harmonization
- Climate policy (support of renewable energies, CO2 emission trading, energy efficiency)
- Security of supply

## Technological

Technological trends are mainly driven by the climate policy and technological progress.

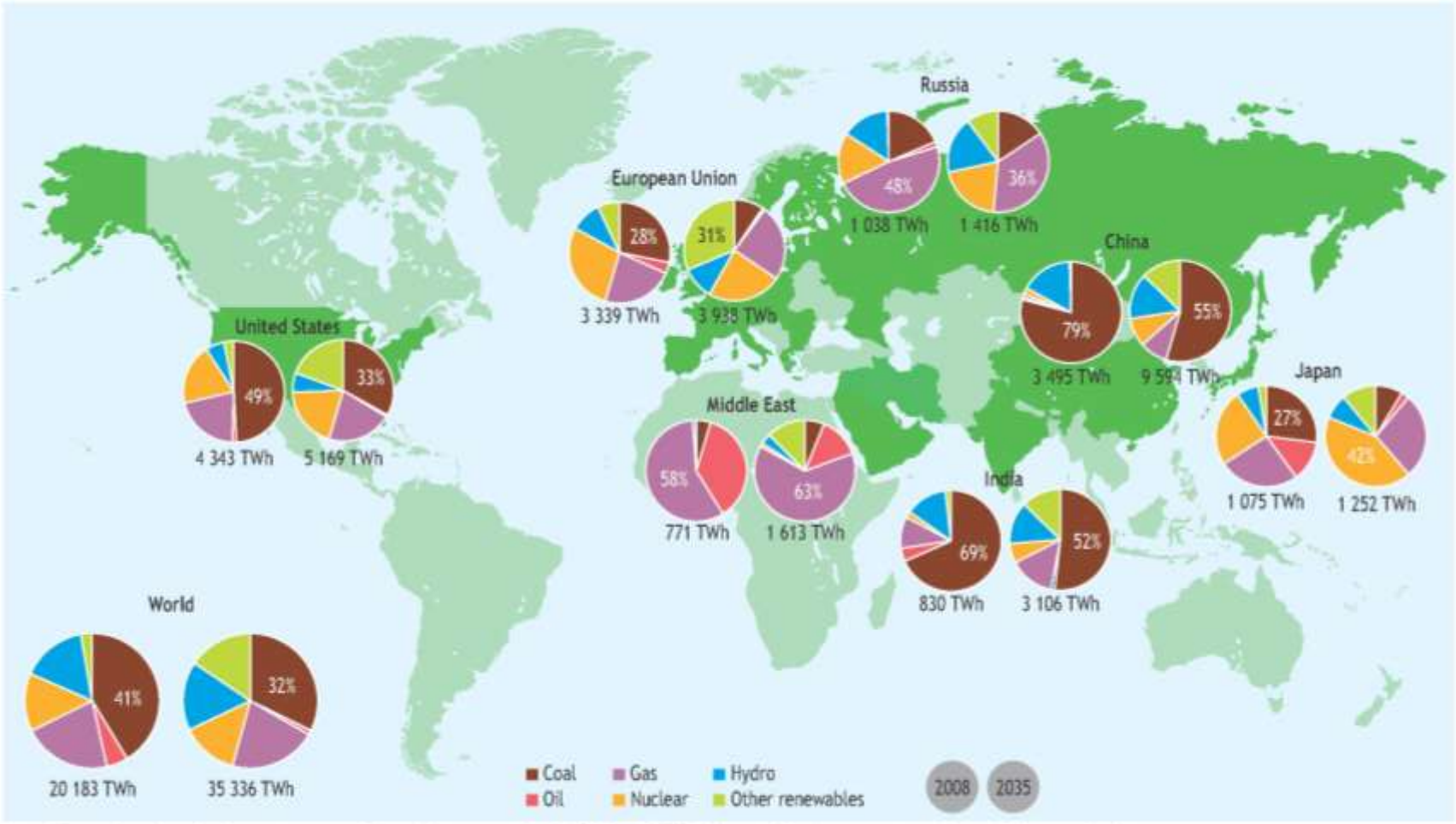
- Enhancement of renewable technologies
- Increasing efficiency (conventional generation)
- End-use energy efficiency
- Network technology (DC)
- Electric vehicles
- Dispersed generation
- Smart metering / smart grids
- Energy storage

## Economic

Economic trends are mainly driven by general economic development, sector specifics and energy policy.

- Aging assets & replacement needs
- Increasing regional trade but still fragmented markets
- Demand growth
- Regional harmonization
- Corporate consolidation
- Convergence of gas and electricity markets

# Electricity generation by fuel and region in IEA's New Policies Scenario in 2035 vs. 2008 (WEO 2010)

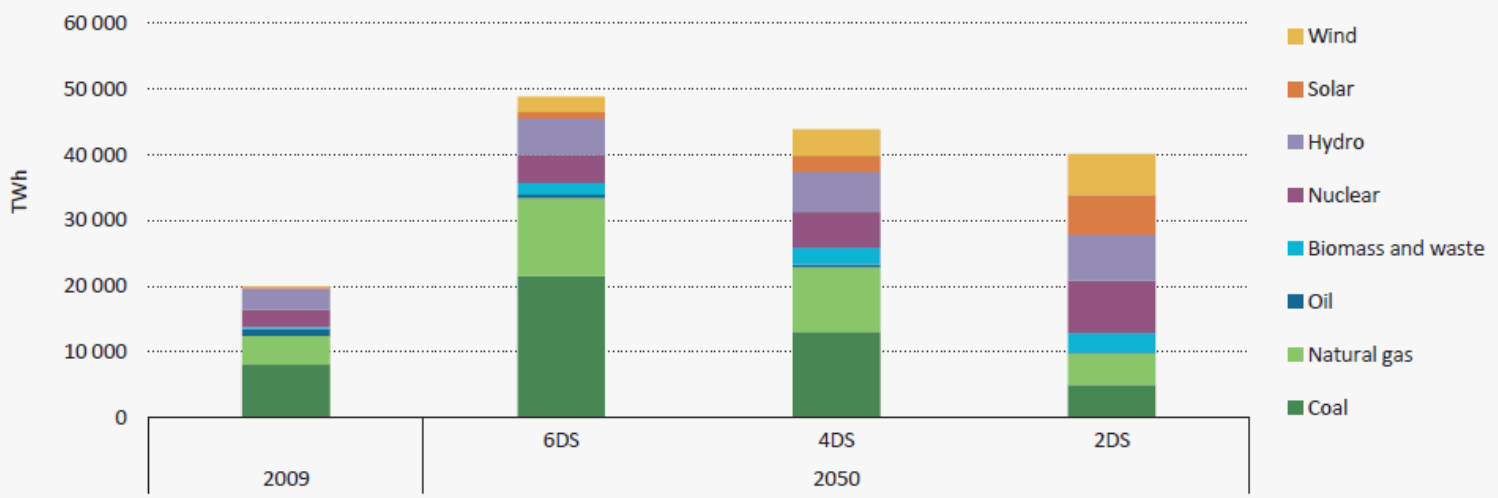



Note: For each region, the largest source of electricity generation in 2008 and 2035 is denoted by its percentage share of the overall mix.

Source: IEA World Energy Outlook 2010

# Share of renewable energy sources in electricity generation

## Fuel mix in electricity generation, by scenario




**Key point** *Diversification of fuels and increased use of low-carbon sources in the 2DS achieves a high degree of decarbonisation in electricity generation by 2050.*

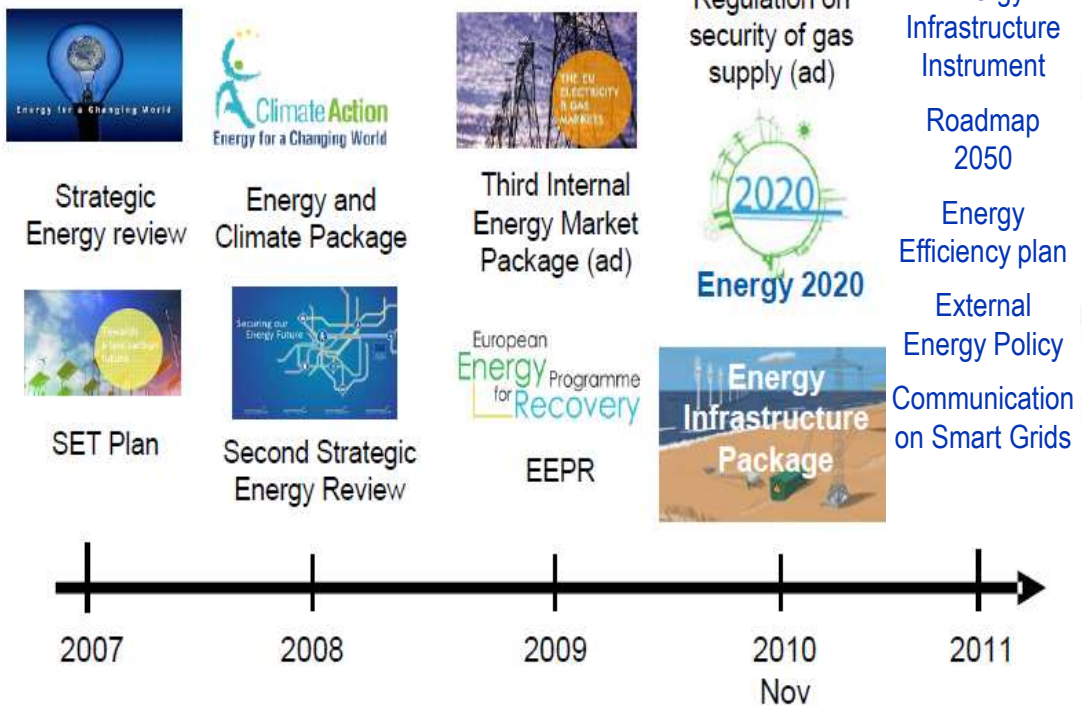
**Source**: IEA Energy Technology Perspective from 2012 (June 11)

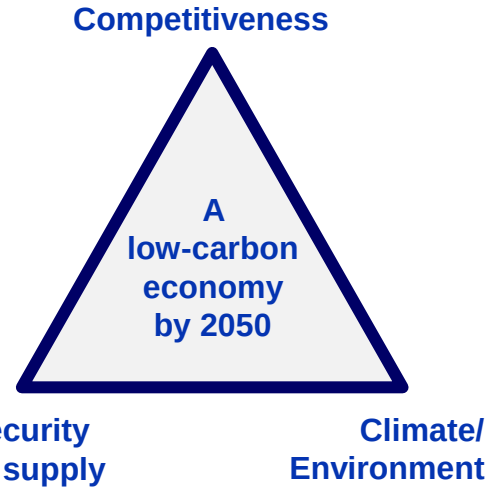
# From fossil fuels to renewables

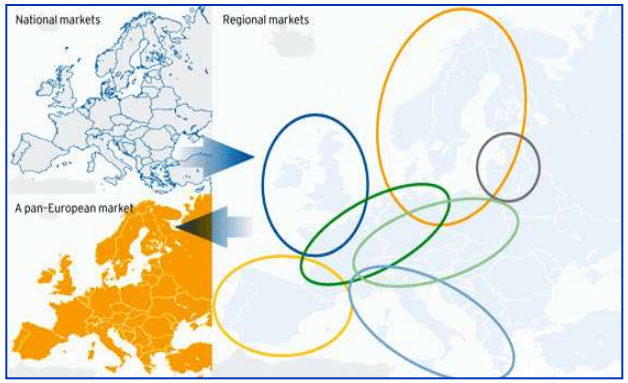
- Concerns about our global environment

- Europe wants to be less dependent on energy imports

# EU Energy policy development



# Europe's focuses

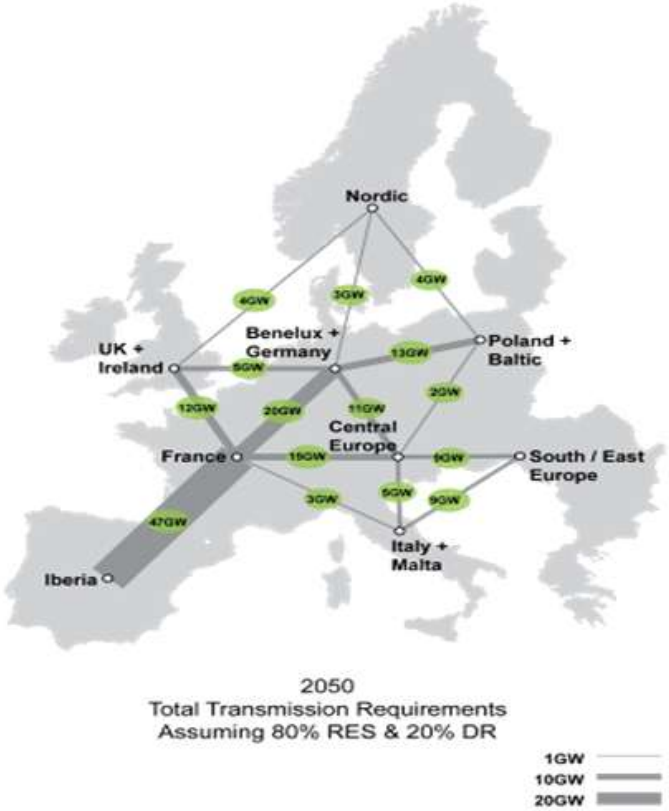
- Clear distinction between public and private activities: ***unbundling***


- Competitiveness of Europe in global market: ***sustainability***

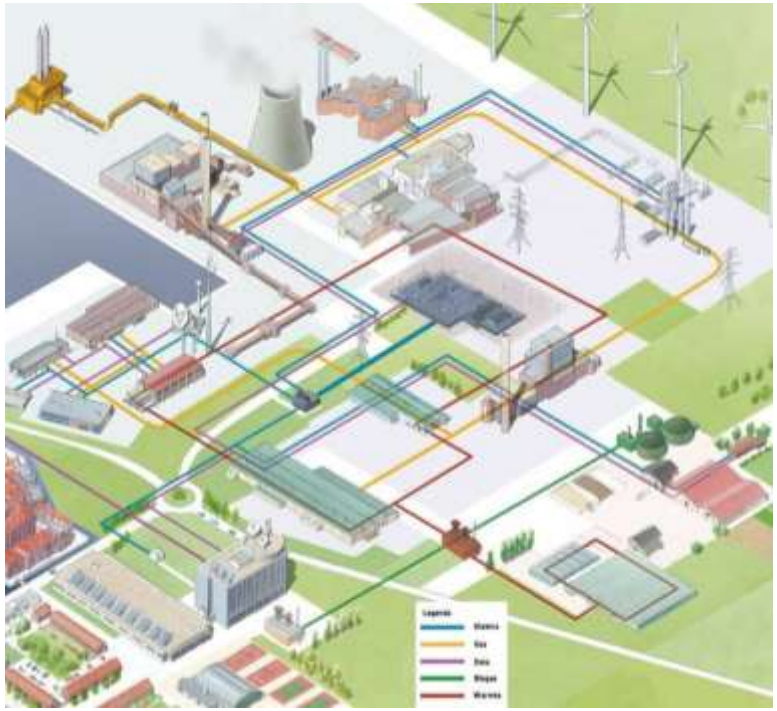

- Empowering customers: ***smartening***

# The scale, and the priority of the business is shifting …

- **Europeanization**: increase of interconnection capacity and of cross-border trading; cooperation between European industries and institutions




- **Decentralization**: local energy (DG); new initiatives from small companies, citizens, and municipalities; innovative business models



# … and dependency on data in a digital world is increasing

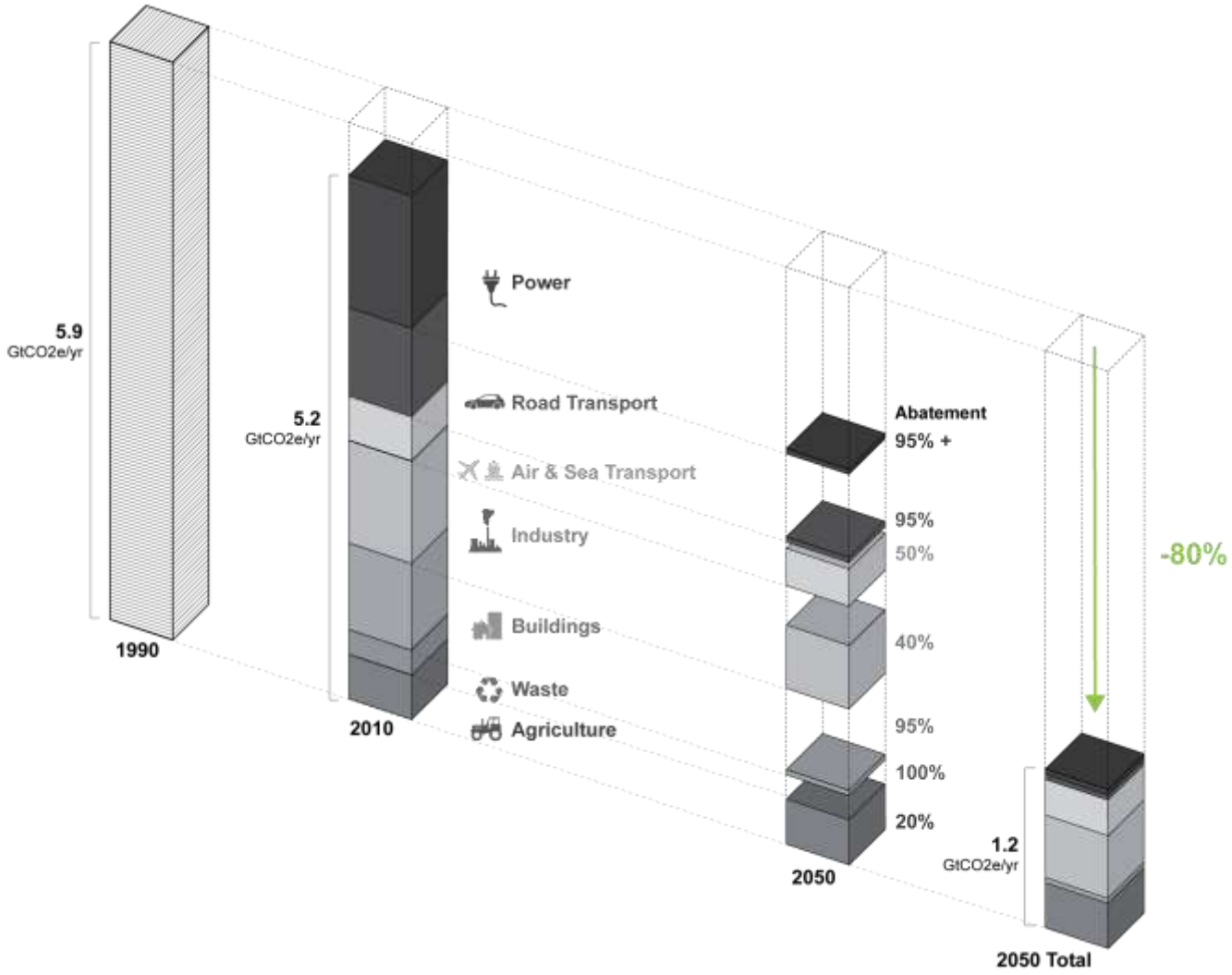
- Both work and private life has become digitalized which offers many advantages …
- … however, also creates larger dependencies on data or power interruptions

# Many developments influencing the energy transition system

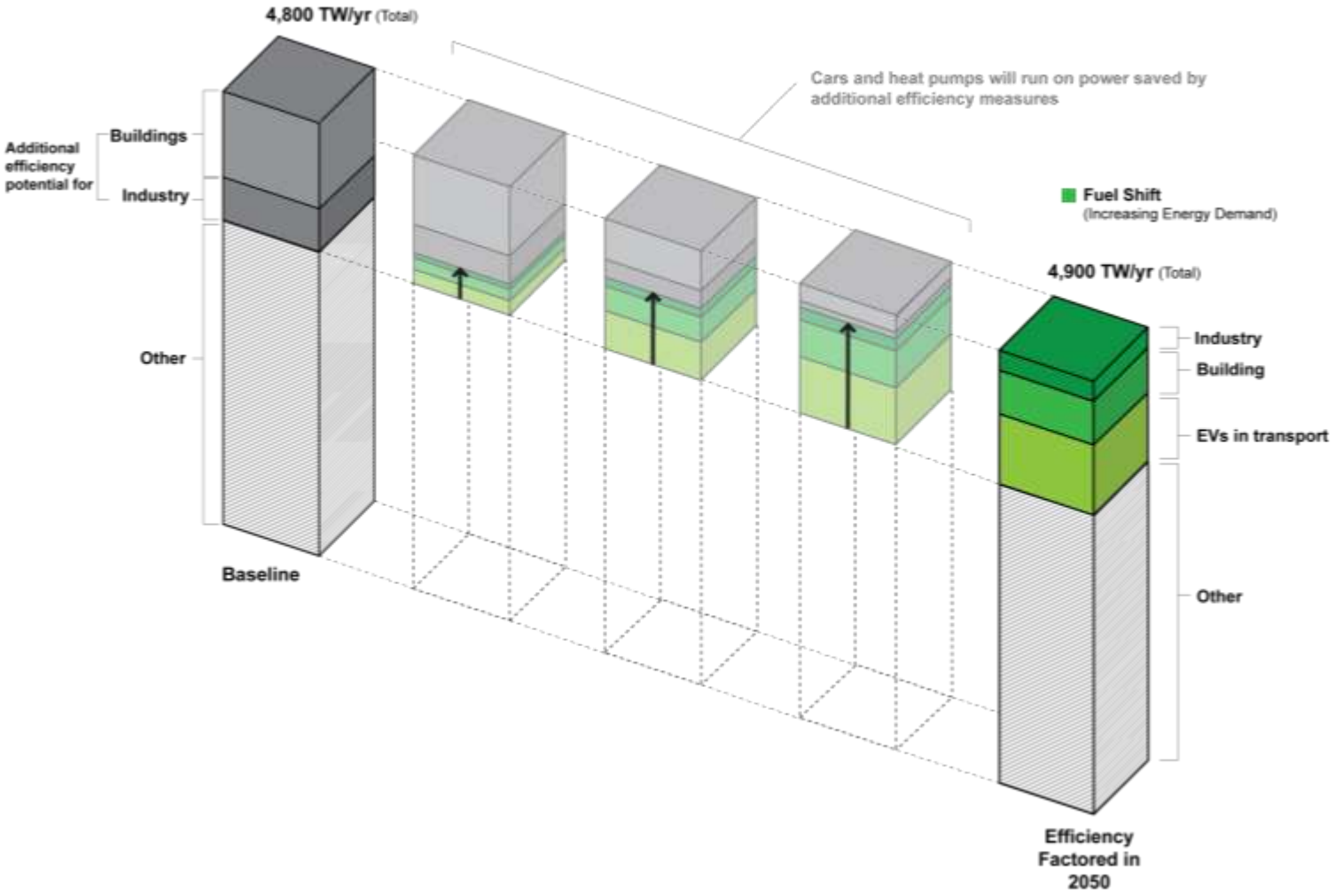

**HOW DO WE GET THERE FROM HERE?**

# Europeanization: One internal market, decarbonization

# 80% Decarbonization overall means nearly full decarbonization in power, road transport and buildings

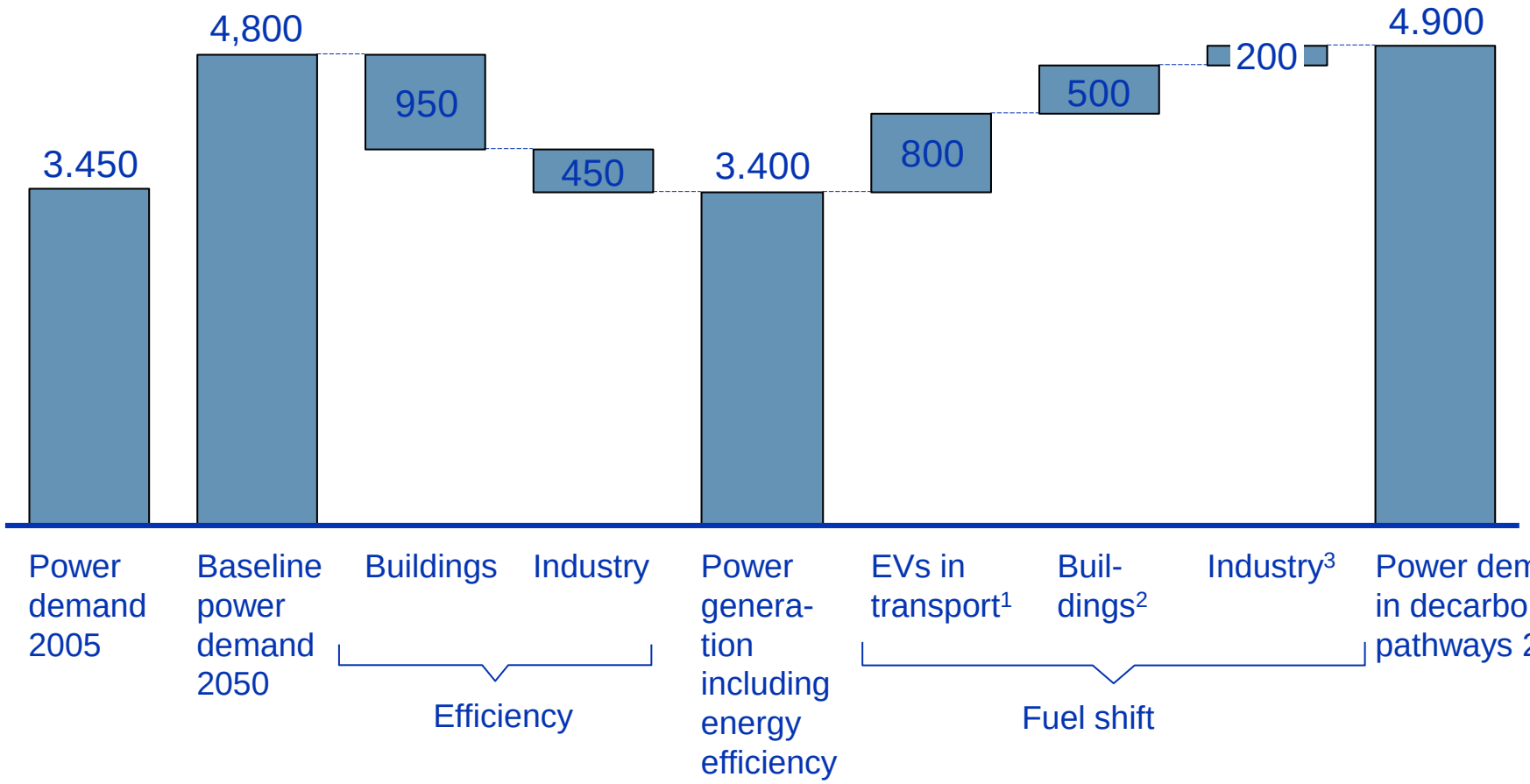


# Power demand will go down due to higher efficiency and up due to additional demand from transport and building heating



# Power demand will go down due to higher efficiency and up due to additional demand from transport and building heating

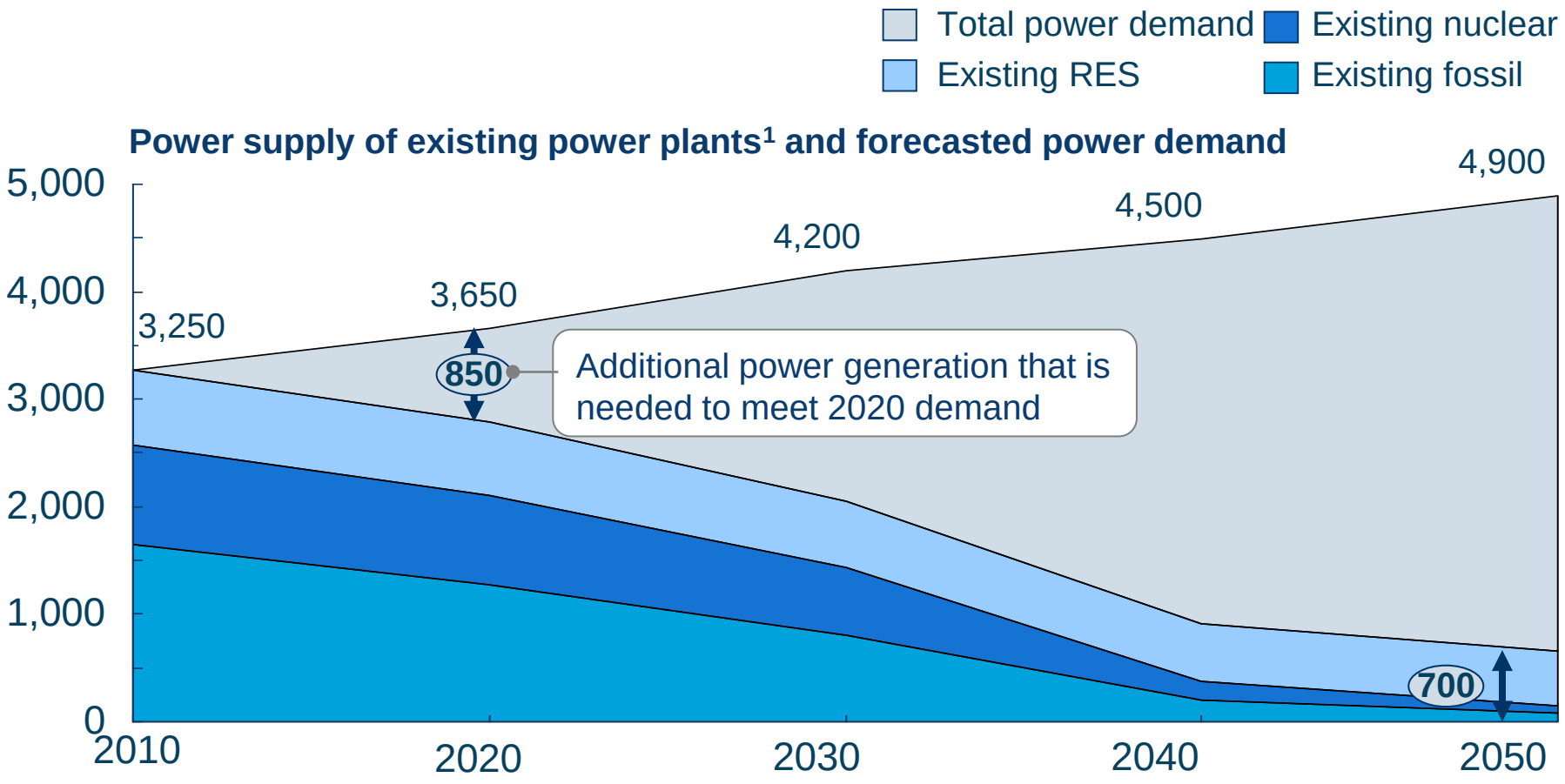
EU-27 plus Norway and Switzerland power demand, TWh per year




1 Electrification of 100% LDVs and MDVs (partially plug-in hybrids); HDVs remain emitting ~10% while switching largely to biofuel or hydrogen fuel cells
2 90% of remaining primary energy demand converted to electricity (heating/cooling from heat pumps); assumed 4 times as efficient as primary fuel
3 10% of remaining primary energy demand for combustion converted to electricity (heating from heat pumps); assumed 2.5 times as efficient as primary fuel

# Additional 850 TWh/yr of production is required by 2020, and even 4,200 TWh/yr in 2050

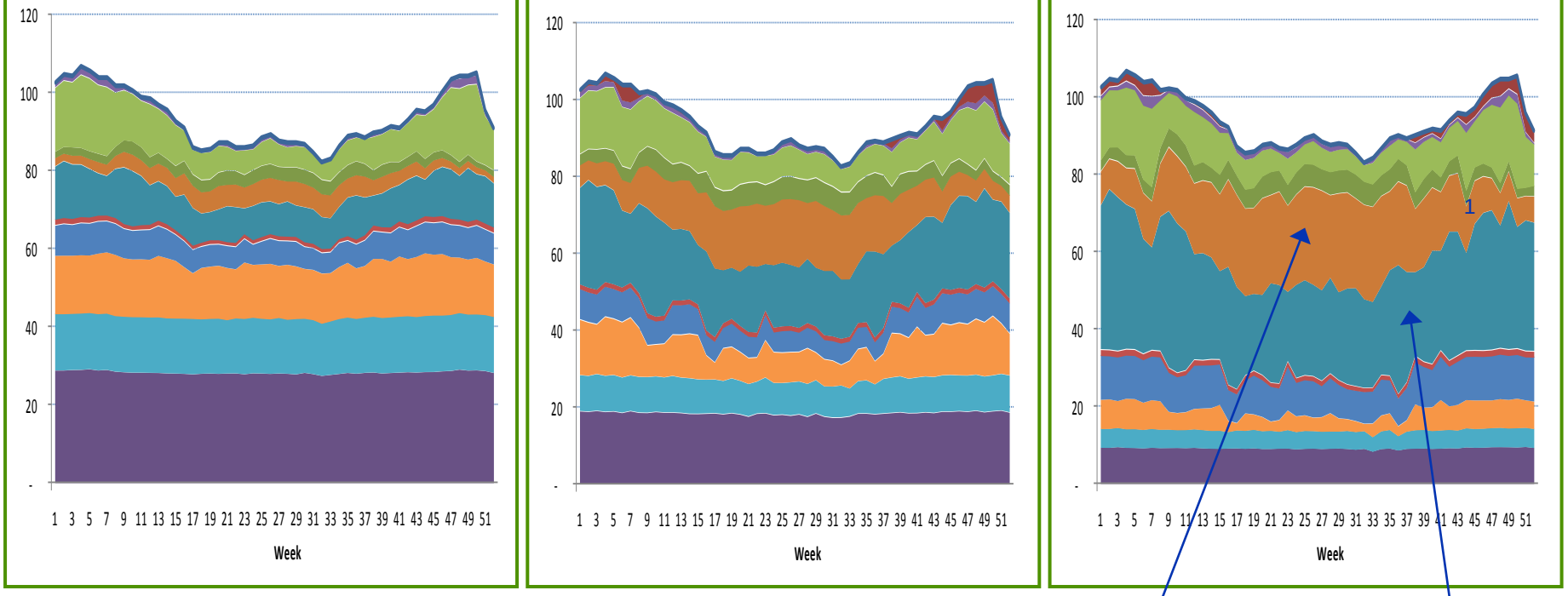
EU-27 plus Norway and Switzerland, TWh[1]




1 Assumes no change in reserve margin from 2010 to 2050
2 Existing capacity includes new builds until 2010

# A combination of solar & wind is beneficial for balancing purposes

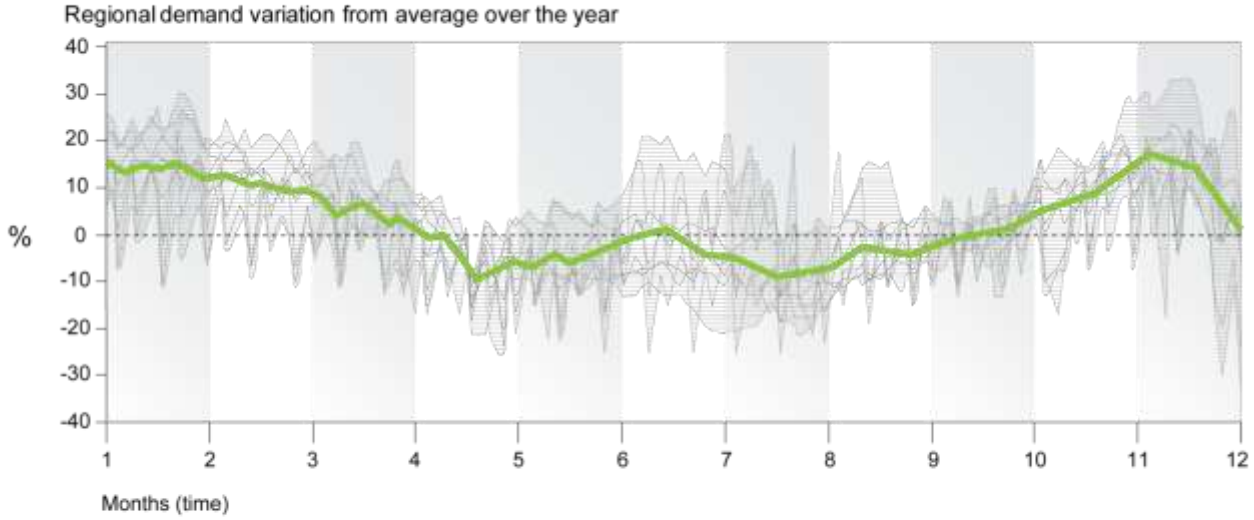
| 40% RES<br>30% CCS<br>30% nuclear | 60% RES<br>20% CCS<br>20% nuclear | 80% RES<br>10% CCS<br>10% nuclear |
|---|---|---|



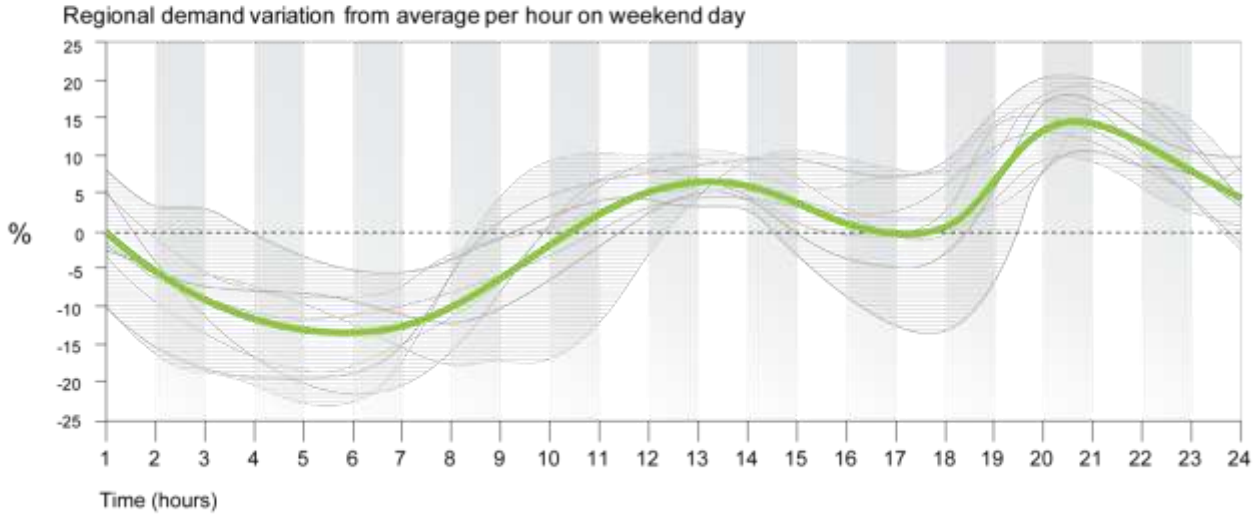

Energy production mix over the year, TWh per week

Demand
OCGT
CSP
Geothermal
Gas
Storage[1]
PV
Biomass
Coal
Hydro
Wind
Oil
Nuclear

# Grid capacity reduces variability in both daily & seasonal demand fluctuations

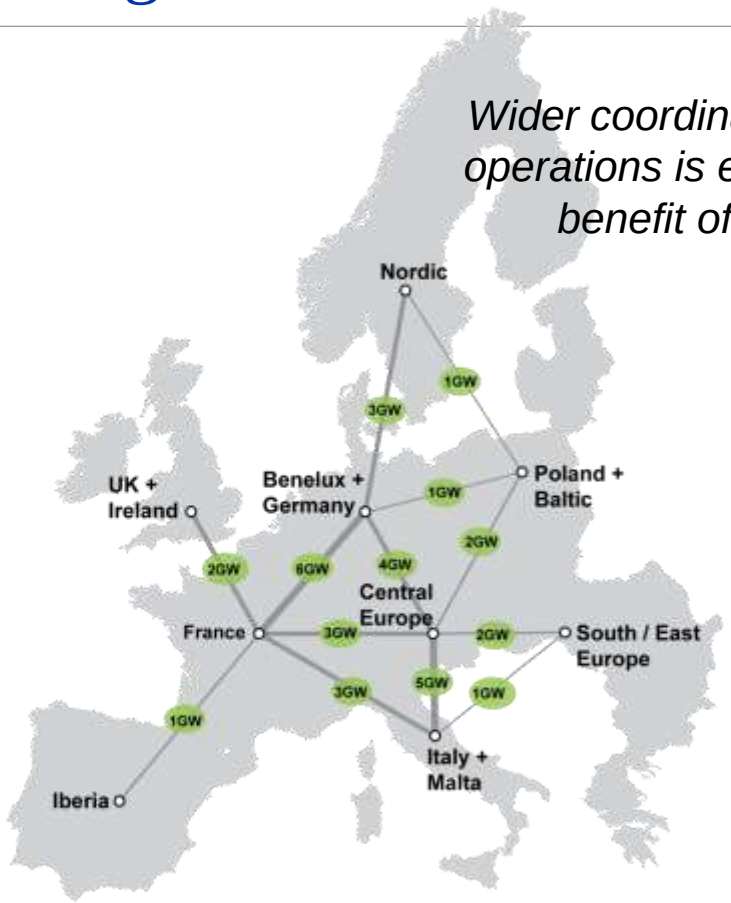




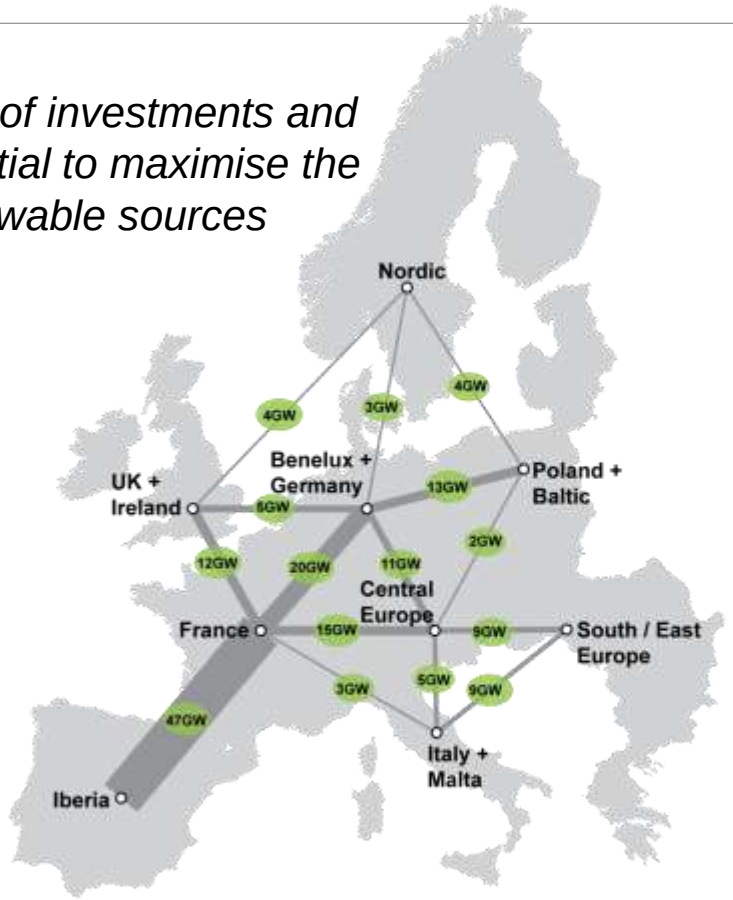



# Inter-regional transmission requirements

*Wider coordination of investments and operations is essential to maximise the benefit of renewable sources*



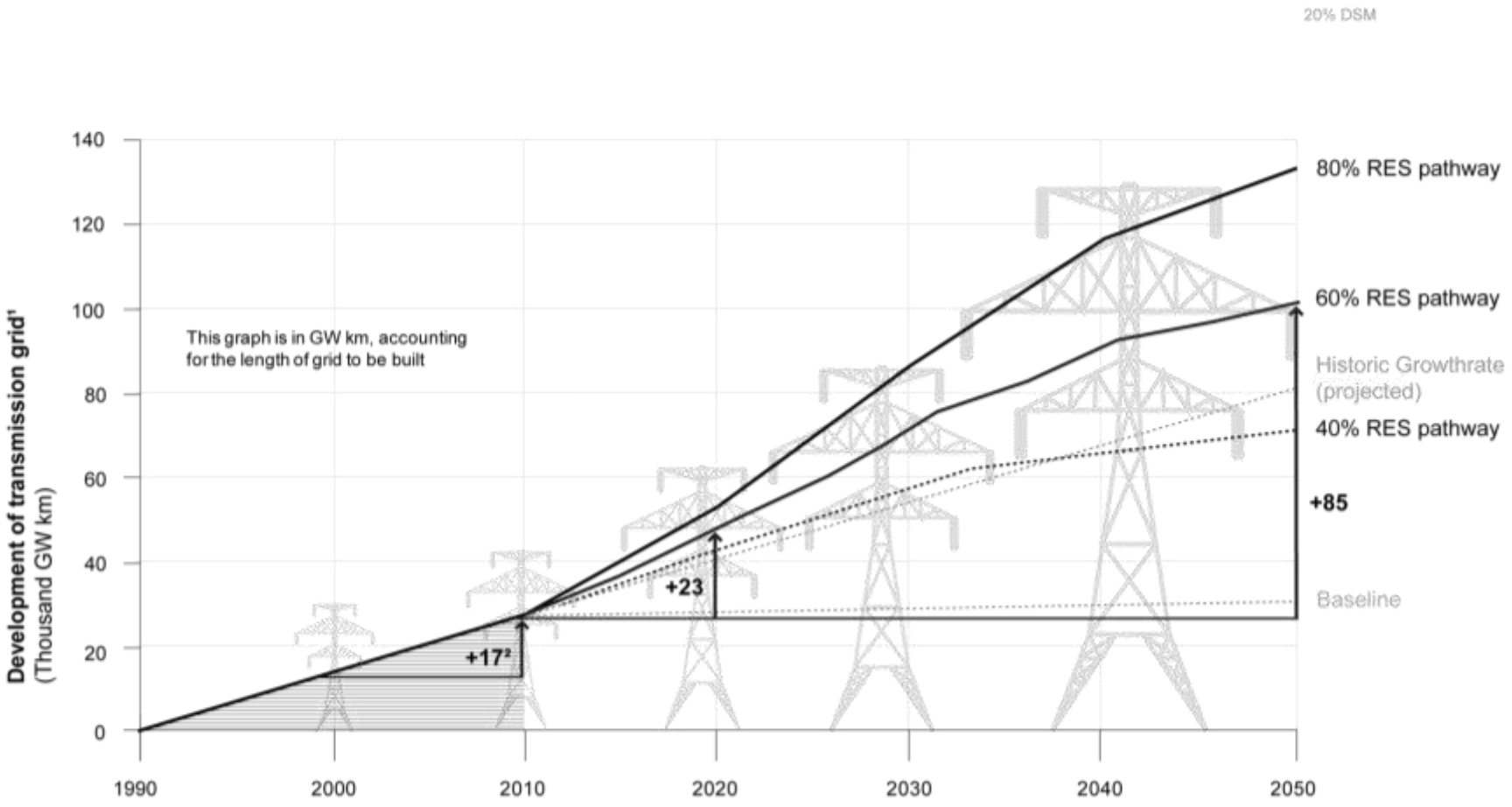

2010
Existing Capacity



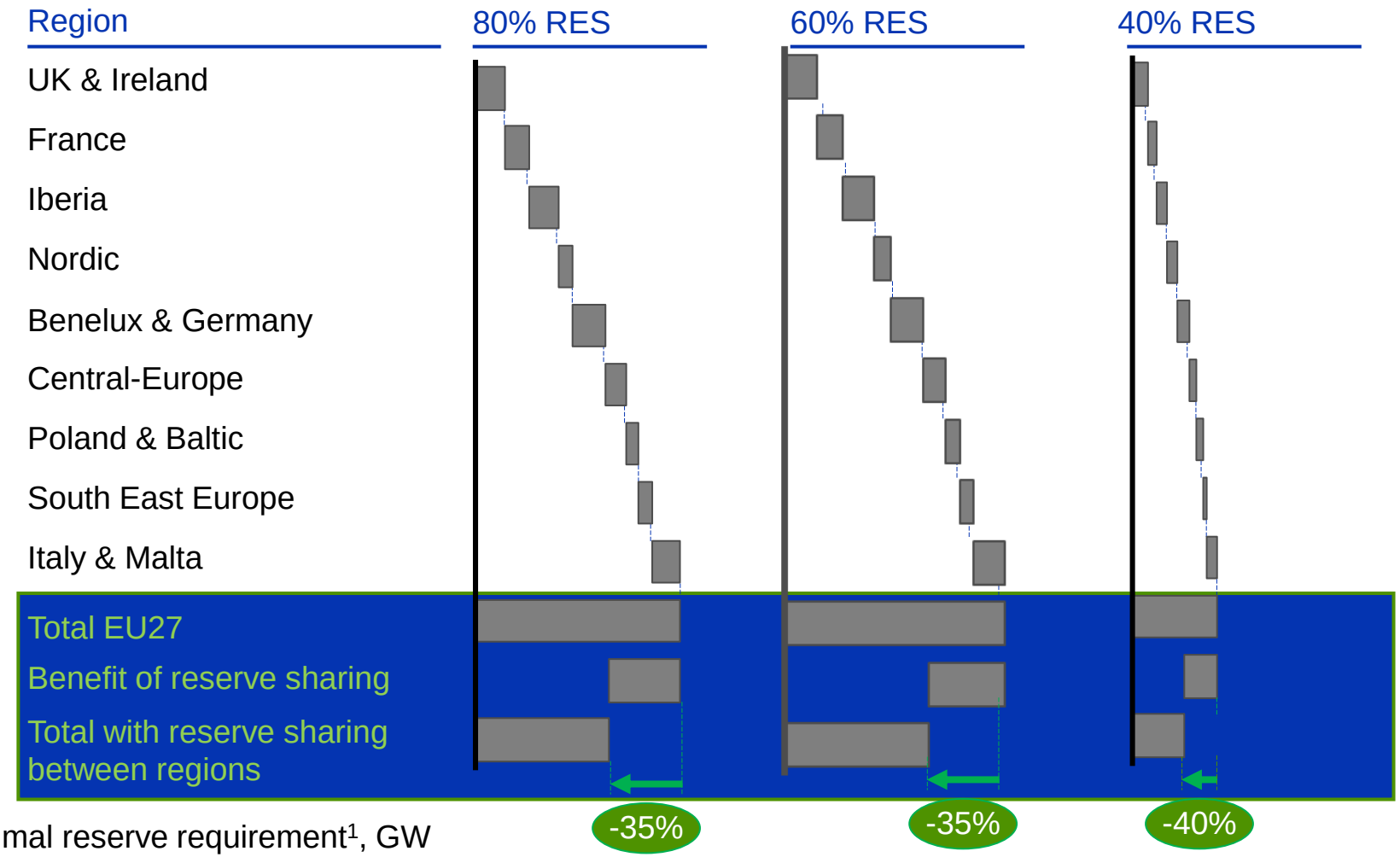

2050
Total Transmission Requirements
Assuming 80% RES & 20% DR

1GW
10GW
20GW

# The rate of grid investments compared to historic levels

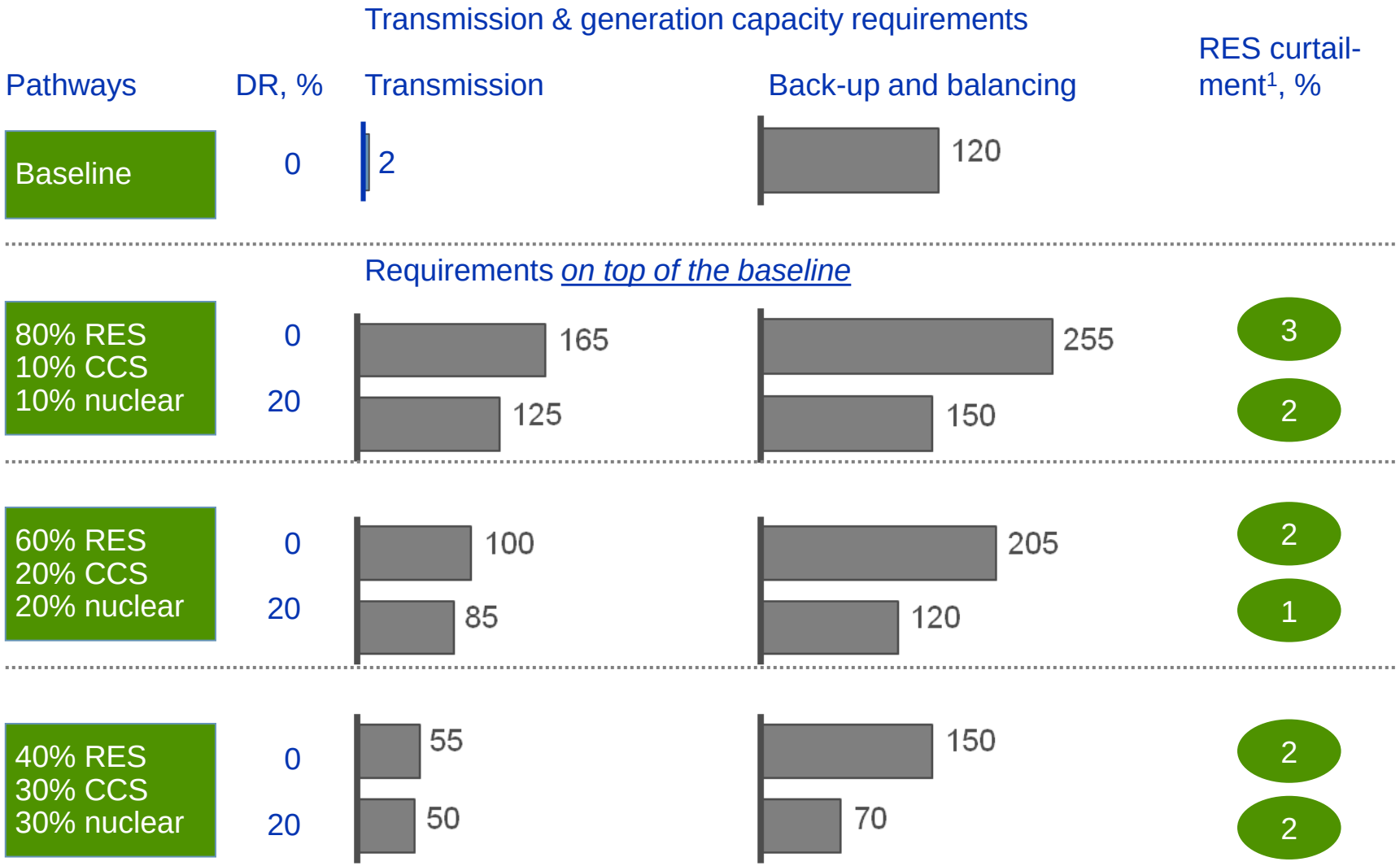


# An EU approach requires about 40% less reserve capacity




Maximal reserve requirement[1], GW

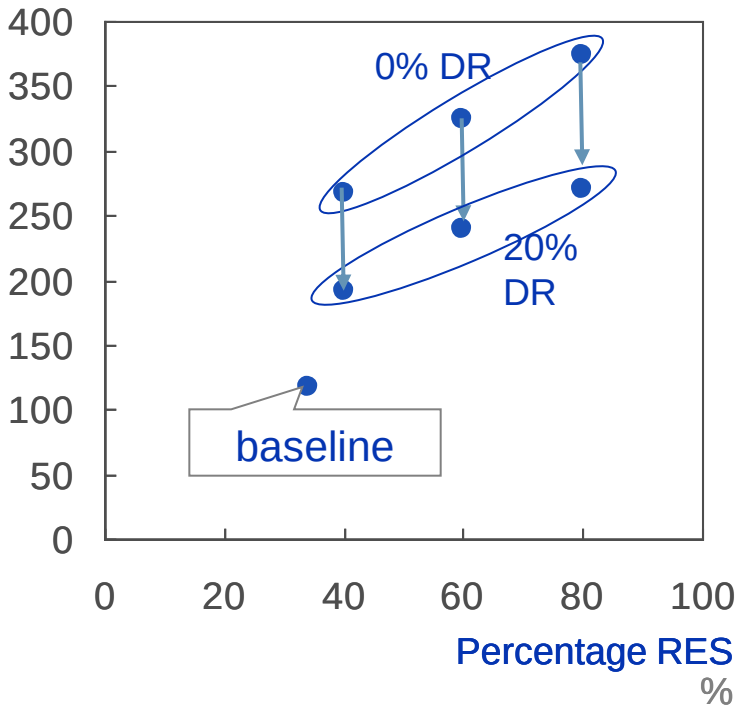
# Curtailment is kept low through grid expansion and back-up capacity



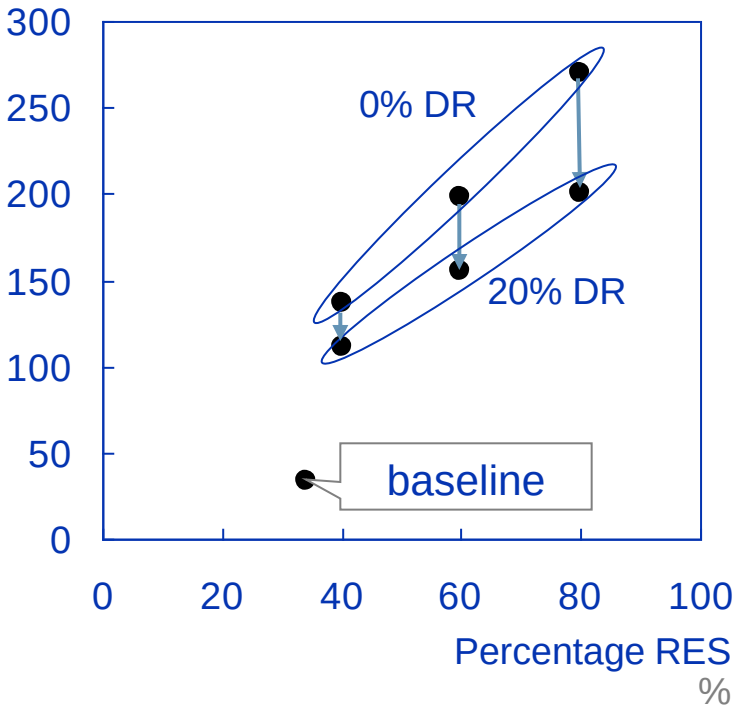

2050 figures, in GW

# Demand response can reduce grid and back up investments by 20–30%

Additional back up capacity
GW

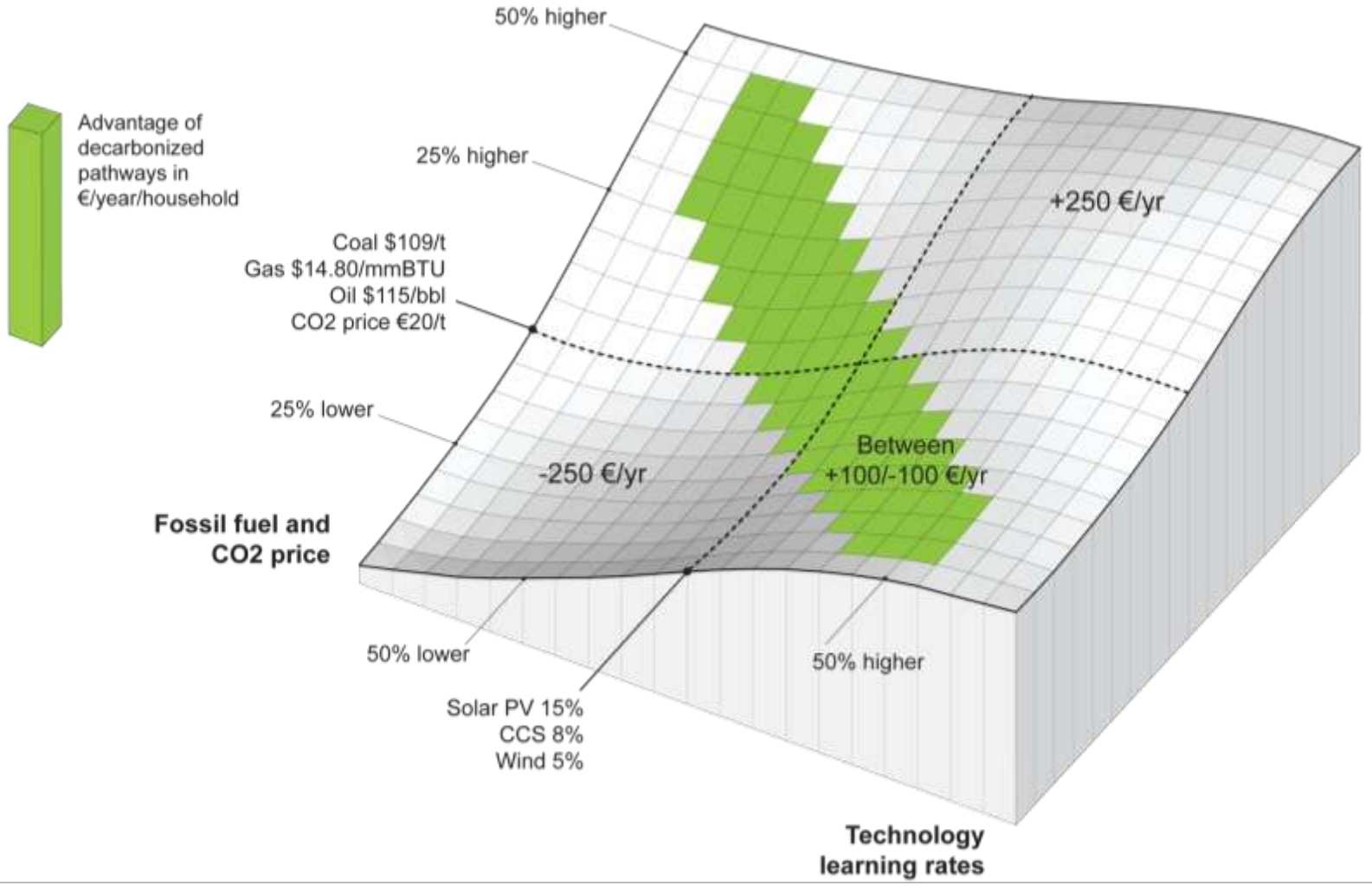



Additional transmission and and back up capex
EUR bn over 40 years

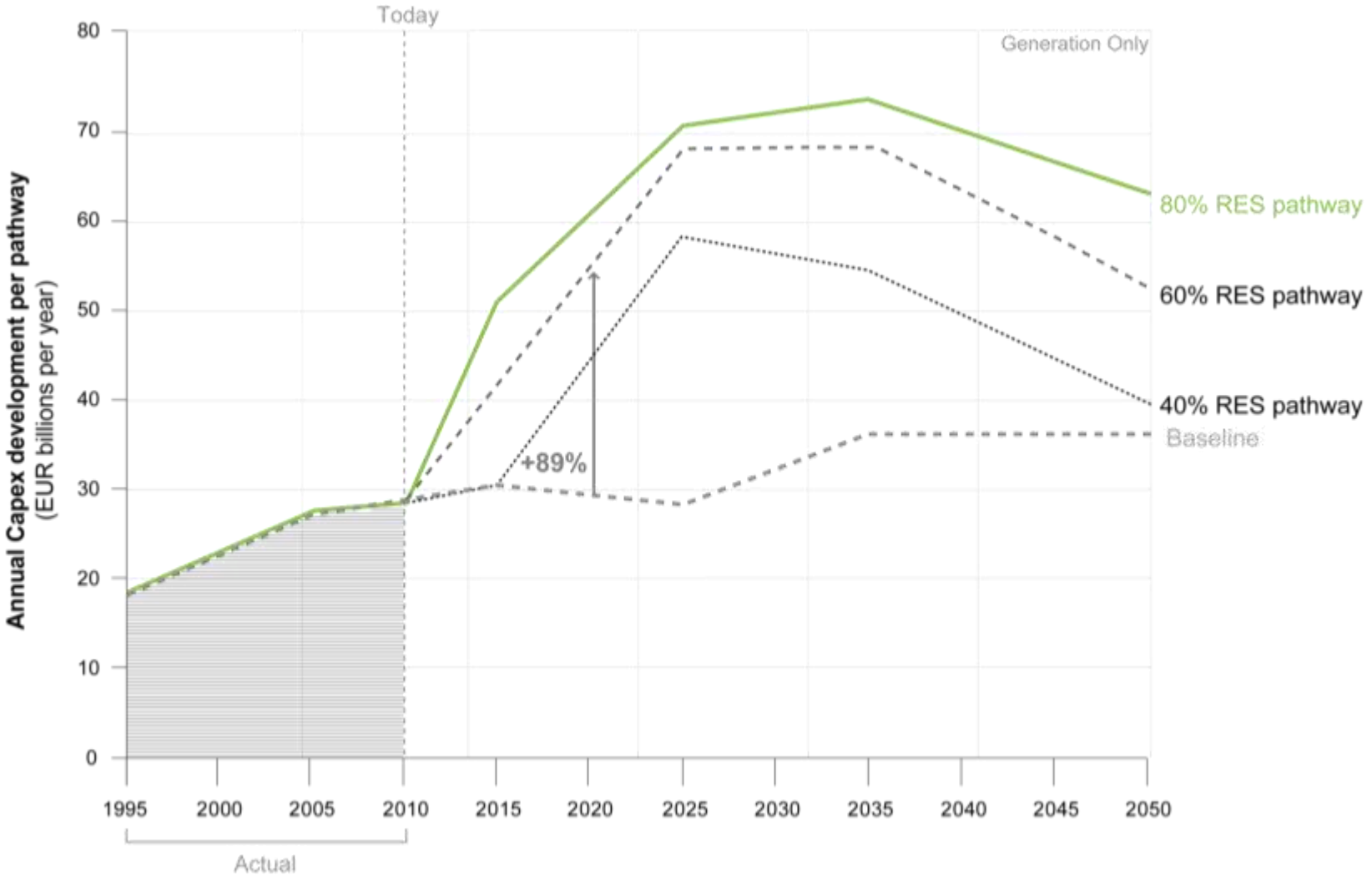



Optimized, DR assumptions: Baseline – 0%, 40, 60 & 80% RES - 0% to 20%

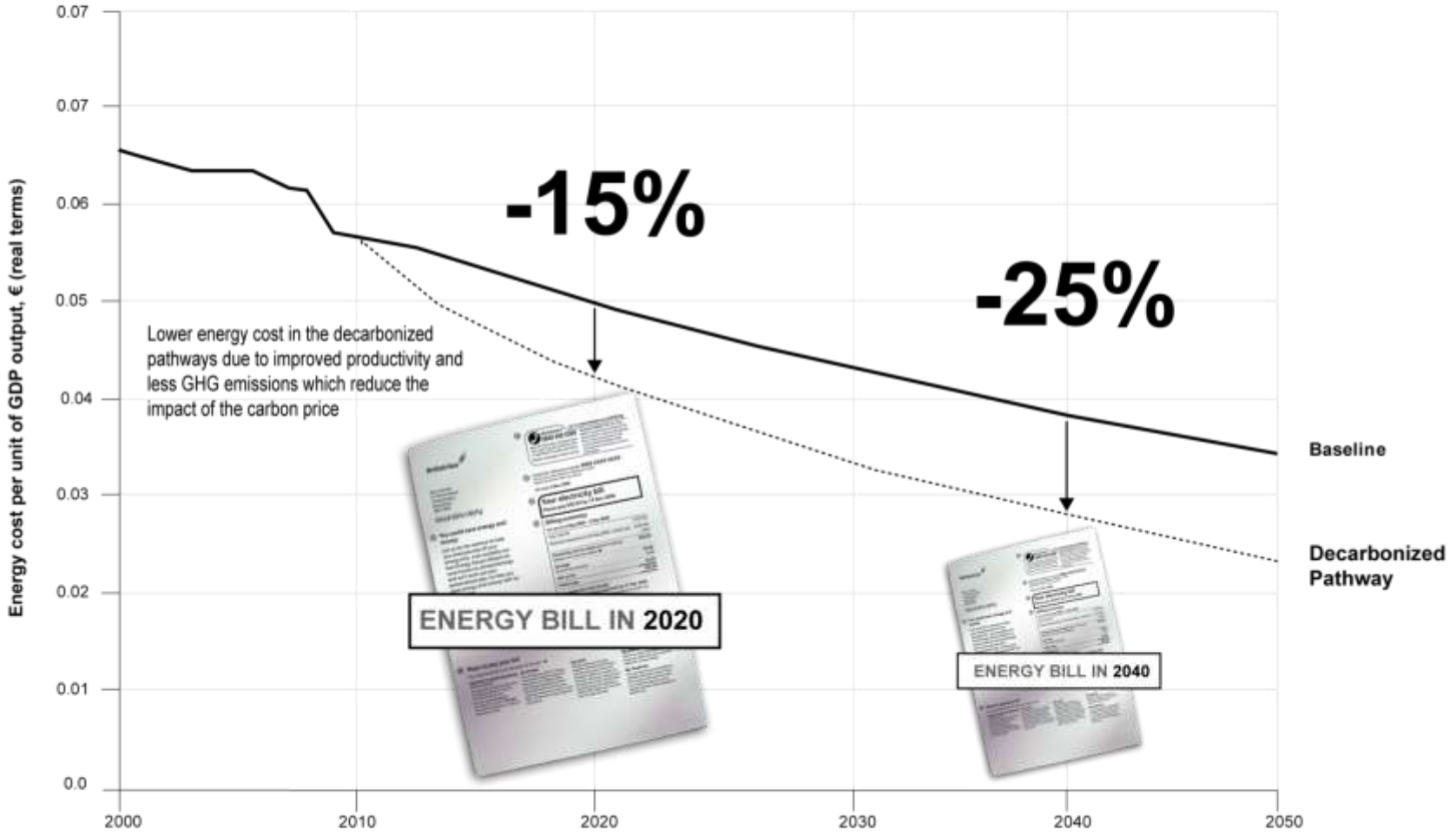
# The cost of the decarbonized pathways and the baseline are likely to differ less than € 250 per year per household



# Capital for power generation would more than double in the next 15 years

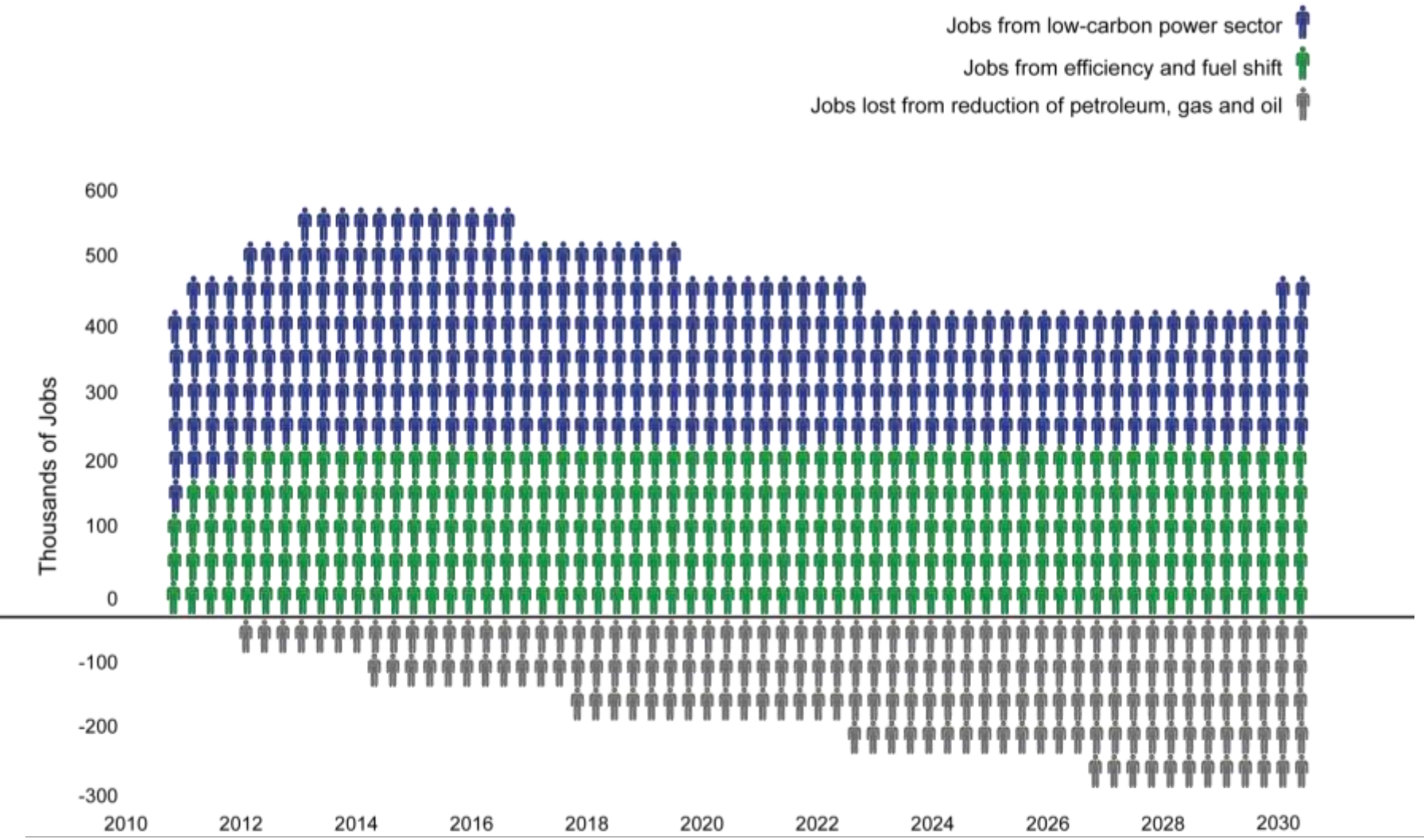


# Efficiency and fuel shift could result in a lower energy bill on the long term



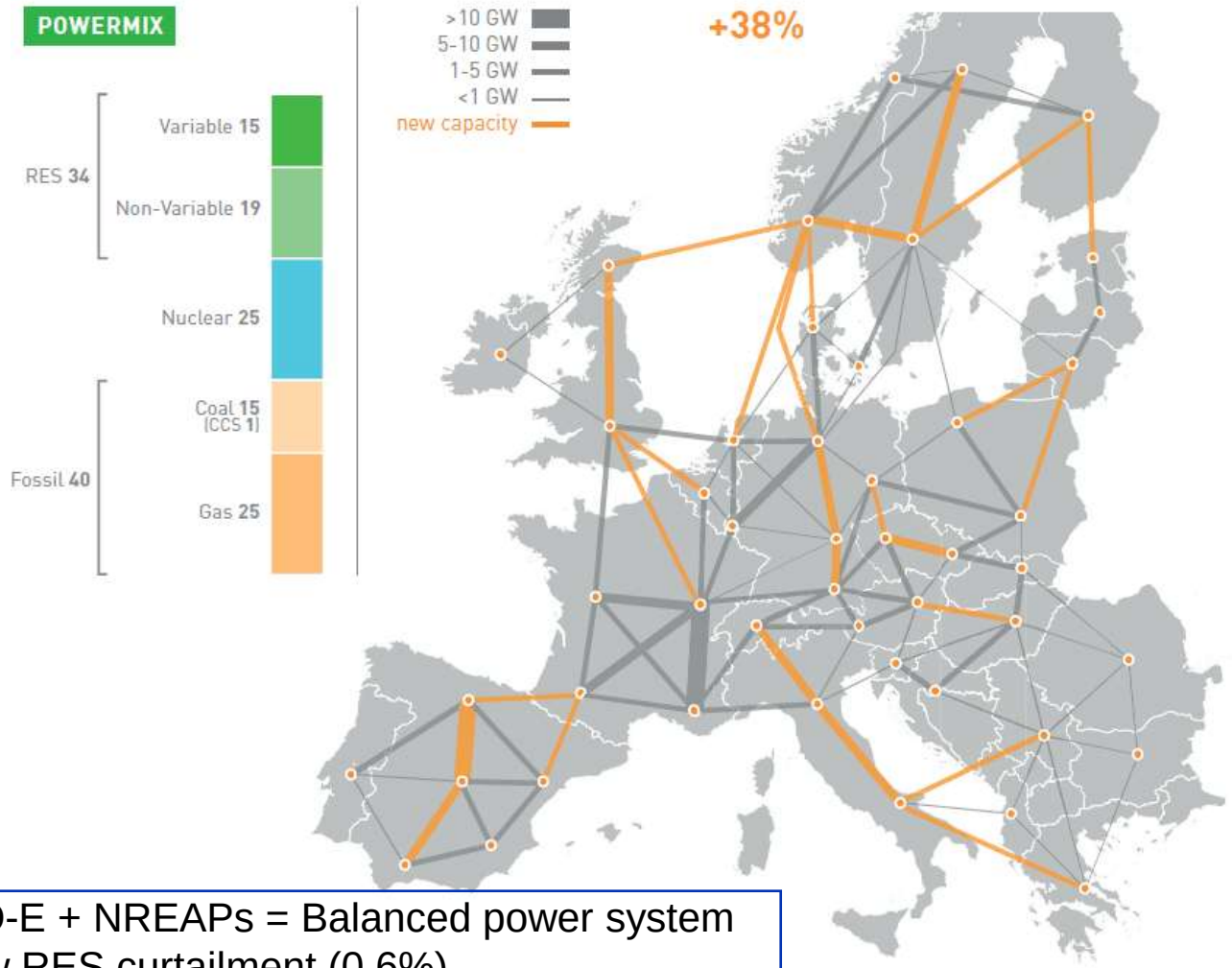

NOTE: Energy prices are a weighted average of prices faced by consumers weighted by the shares of consumption of different fuels

# About 400,000 jobs are created in clean tech, versus potentially 250,000 job losses in fossil fuel supply chains



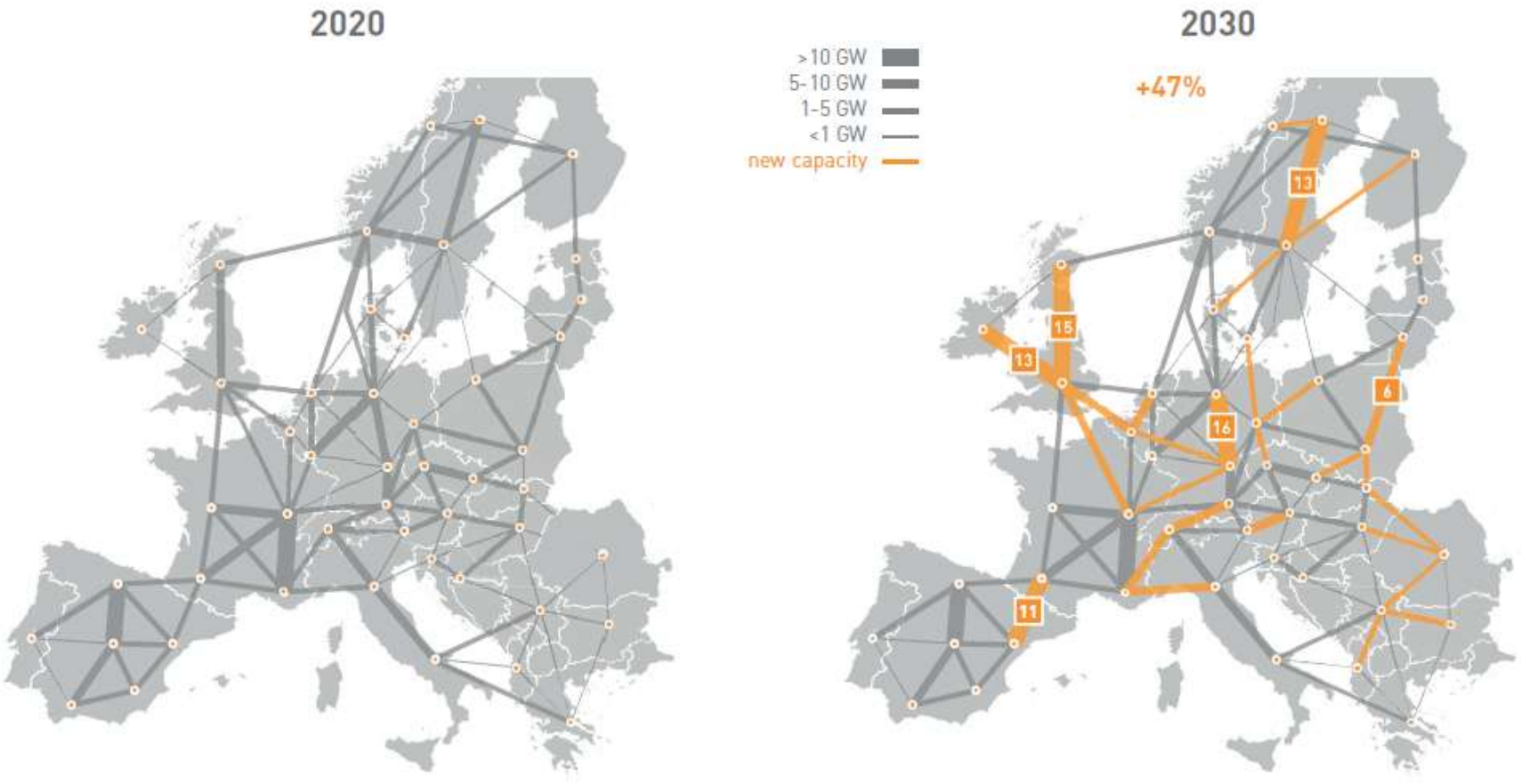
# Power perspectives 2030

# Current plans for 2020 are an adequate first step

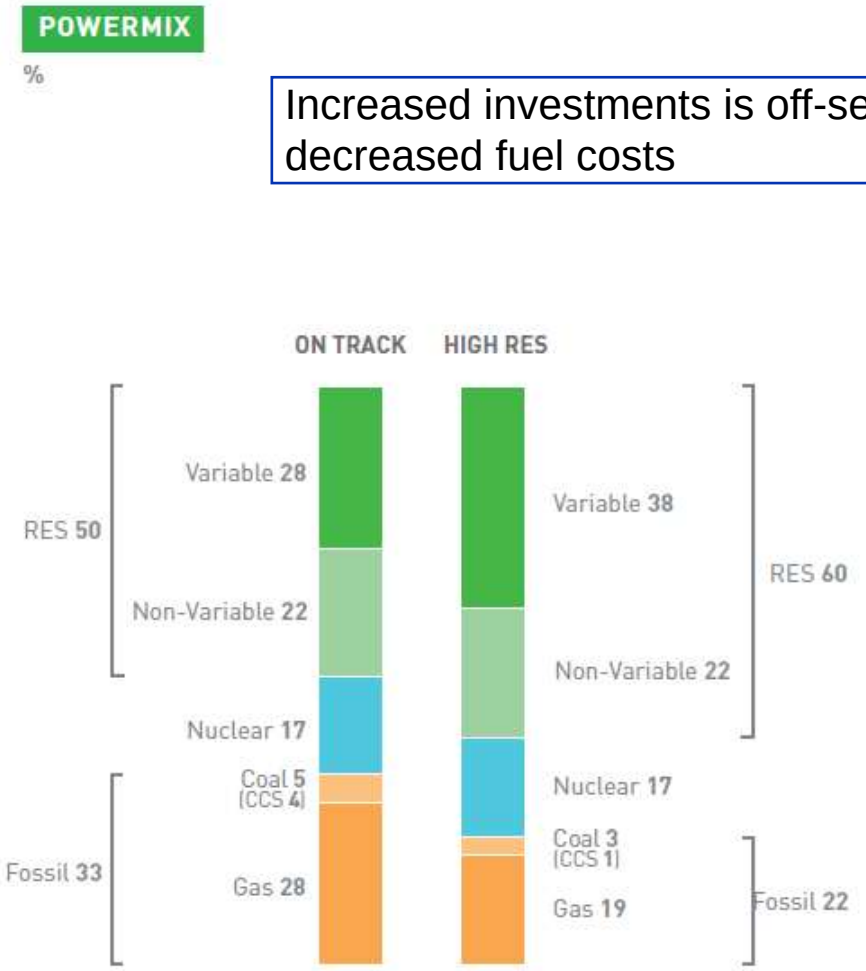



ENTSO-E + NREAPs = Balanced power system with low RES curtailment (0.6%)

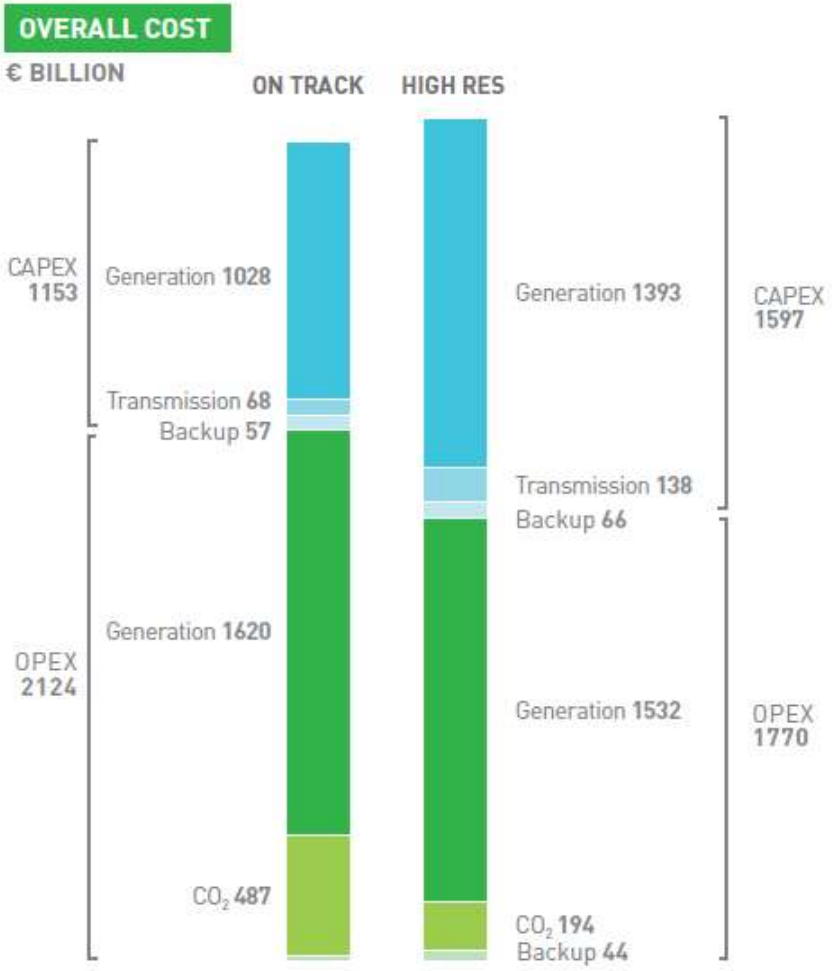
# Transmission grid needs to be extended by another 47% in the next decade



# Higher shares of RES is technically possible at similar cost




Increased investments is off-set by decreased fuel costs



# Demand response and energy efficiency make a real difference in overall cost

# Decentralization: Flexibility, cooperation, interoperability, consumer participation

# Flexibility of our energy system

- Fast controllable power generation, including curtailment of e.g. wind power
- More grid capacity, including interconnection capacity, and cross-border trading
- Energy storage, small-scale and large-scale systems and services
- Smart local energy, including integration of DG, demand response, and active participation of end-users

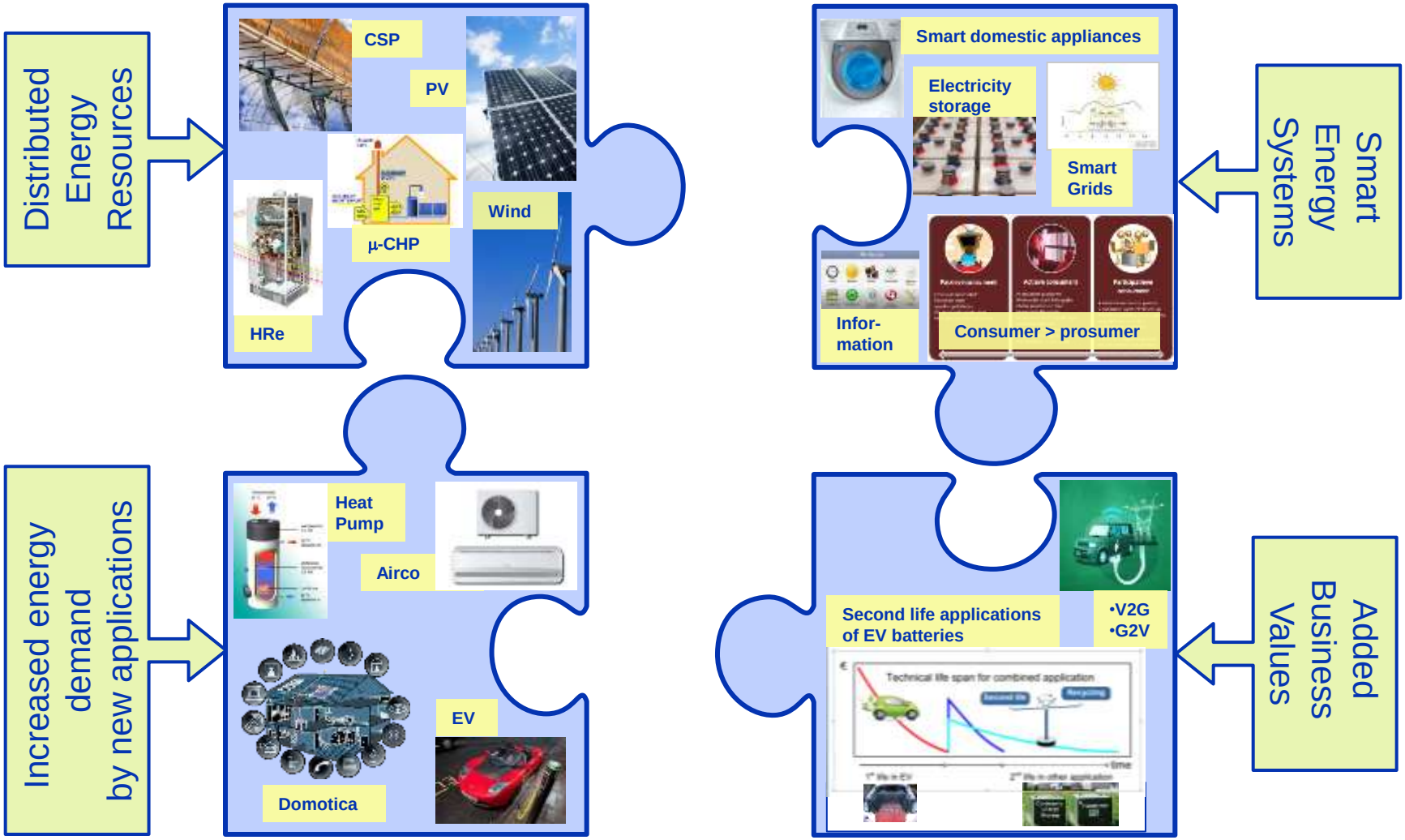
# Cooperation, e.g. between energy industry, housing & transportation

| Transportation | Local energy | Housing |
|---|---|---|
| Electric vehicles will become mainstream | E.g. micro CHP's: local heating and electricity production | Smart home appliances, innovative services, etc. |

Green gas application

- Significant reduction in $CO_2$ emissions globally (e.g. in Europe 80% by 2050)
- Electricity makes up half of our total energy demand
- Energy use is reduced overall
- Renewable energy sources compose the majority of our portfolio
- Fossil fuels are used in the most efficient and clean way possible

# Interoperability



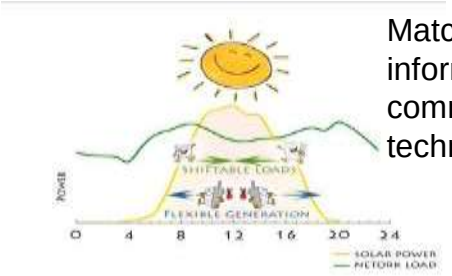
# Interoperability

# Consumer participation

We like electric cars

Smart home appliances

We are participating producers of energy (prosumers)




Matched by information and communication technology

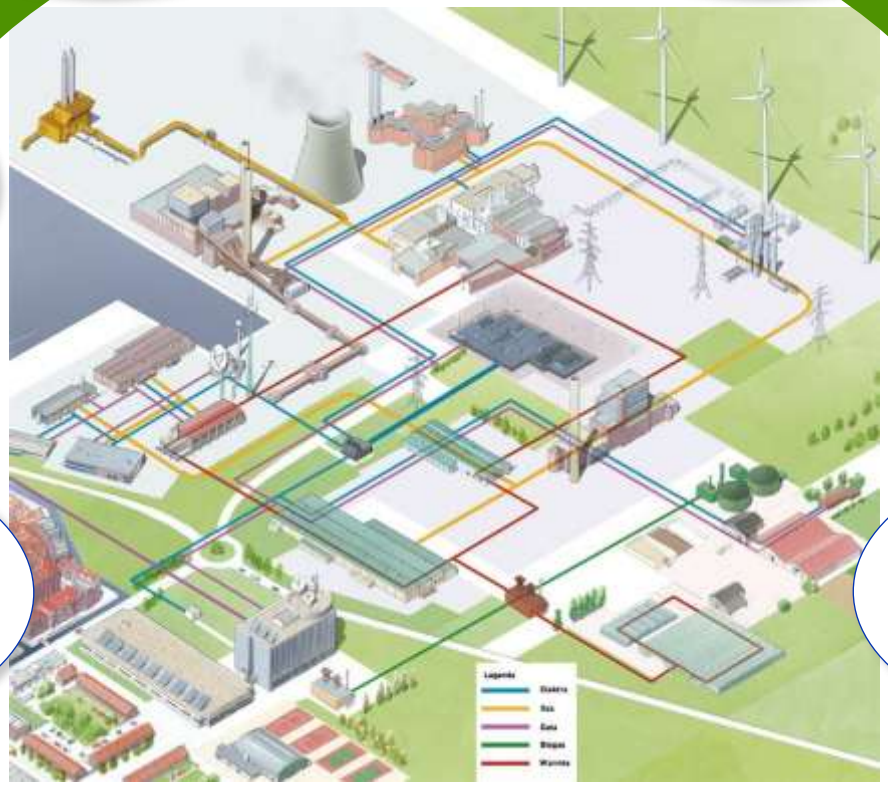
Save money with smart use of energy

# Ultimately moving to Smart Energy Cities

Integrate energy infrastructures

Apply ‘open innovation’ to accelerate developments

Transfer energy consumers to energy down- and uploaders

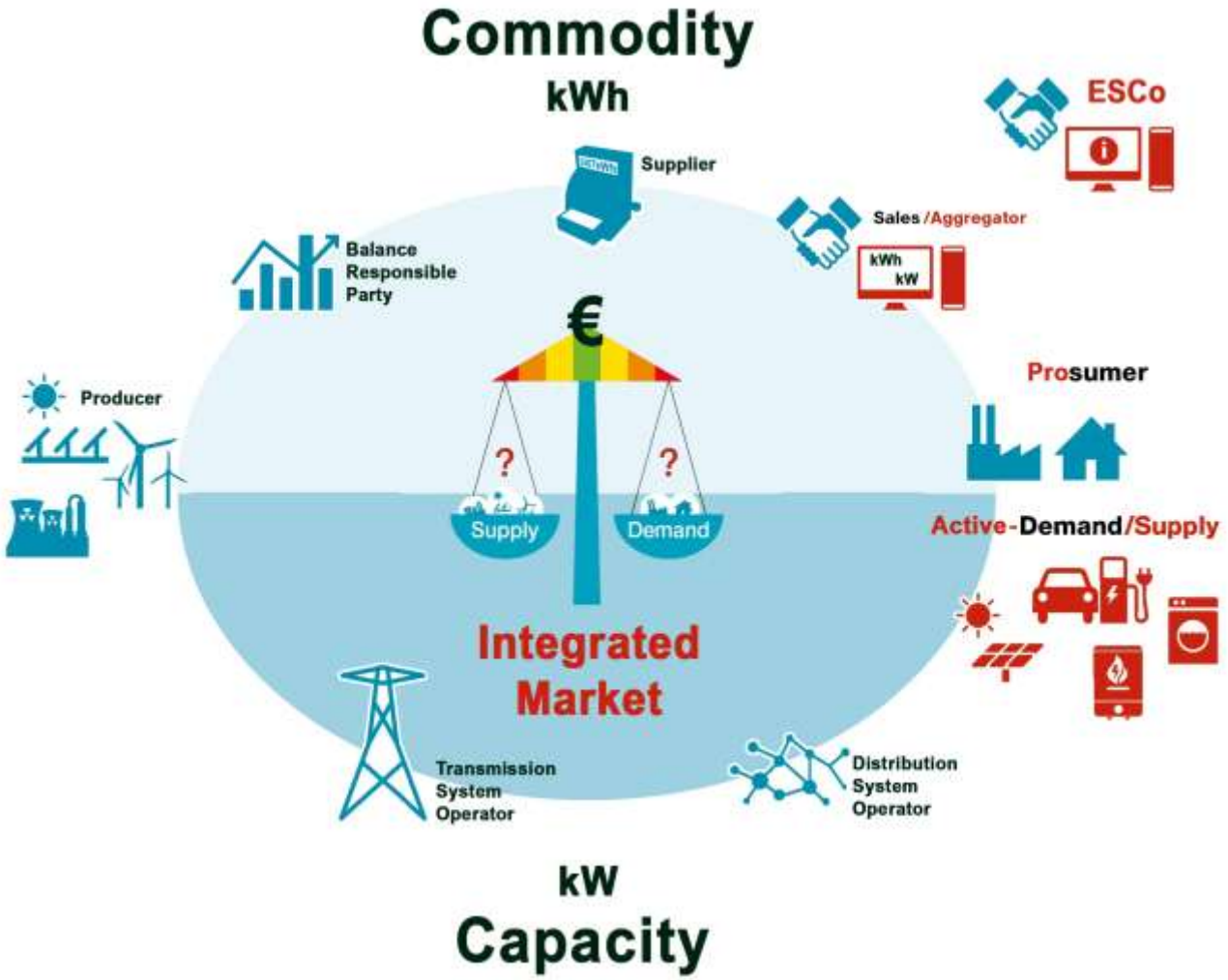


Organize local energy markets

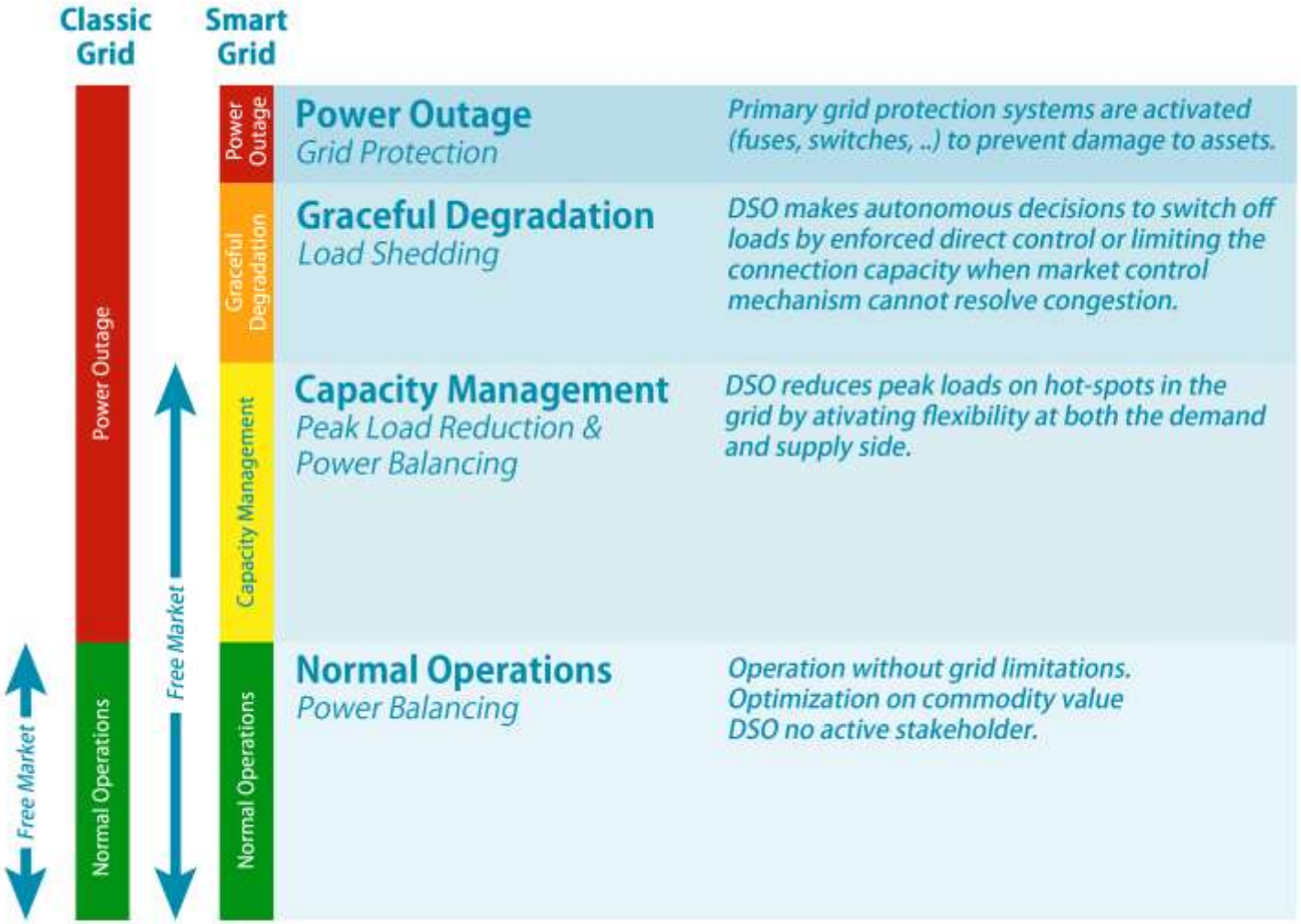
Join forces, and be willing to really cooperate

Install ICT systems to enable local control

# New Market Roles



# ‘Yellow is the new green’



# Concluding remarks

**Energy Transition**

- From a centralized, one-directional energy system
- To a partly decentralized, two-directional system

**Energy Sector**

- The future energy system will embrace
  - Automotive industry and transportation sector
  - Building industry
  - End-users, and its behavior

**'Soft' Enablers**

- A common vision
- Collaboration, and open innovation
- Societal permission

# Thank you

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