



**December 18<sup>th</sup>, 2017**

**Electricity system flexibility – What is the future role of energy storage?**

**Dr Matthew Rowe**



# DNV GL – Global Leaders in Energy Storage Advisory Services



DNV·GL

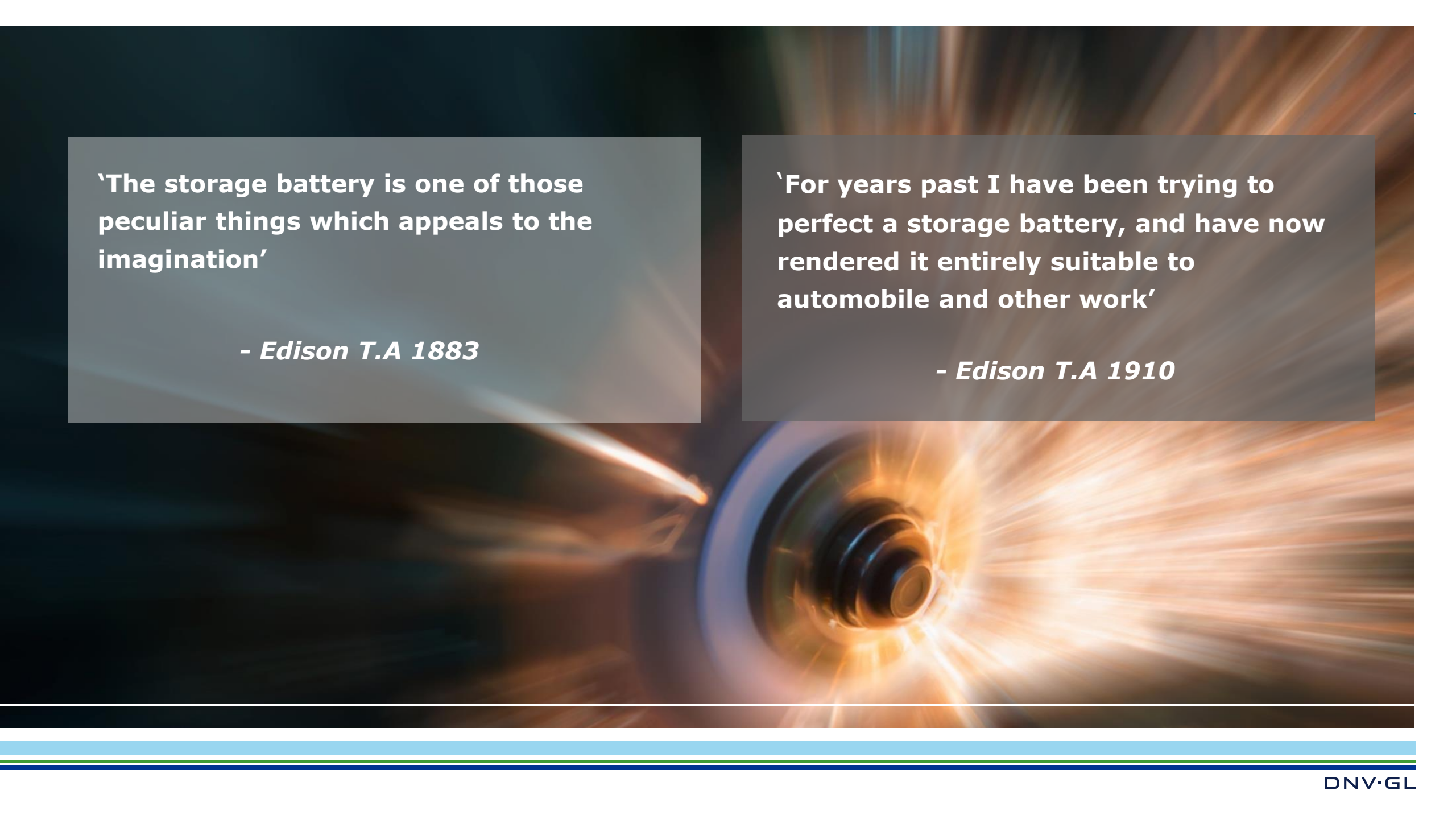


**Storage Applications**

**Access to Global Storage Experts**

**Leverage Experience from multiple sectors**

**Example projects across the entire value chain**



**'The storage battery is one of those peculiar things which appeals to the imagination'**

**- Edison T.A 1883**

**'For years past I have been trying to perfect a storage battery, and have now rendered it entirely suitable to automobile and other work'**

**- Edison T.A 1910**





# ENERGY TRANSITION OUTLOOK 2017

A global and regional forecast  
of the energy transition to 2050




$$S(x) = \frac{1}{1+e^{-x}} = \frac{e^x}{e^x+1}$$





DNV·GL




**RENEWABLES, POWER  
AND ENERGY USE  
FORECAST TO 2050**

Energy Transition Outlook 2017

SAFER, SMARTER, GREENER

DNV·GL




**OIL AND GAS  
FORECAST TO 2050**

Energy Transition Outlook 2017

SAFER, SMARTER, GREENER

DNV·GL



**MARITIME  
FORECAST TO 2050**

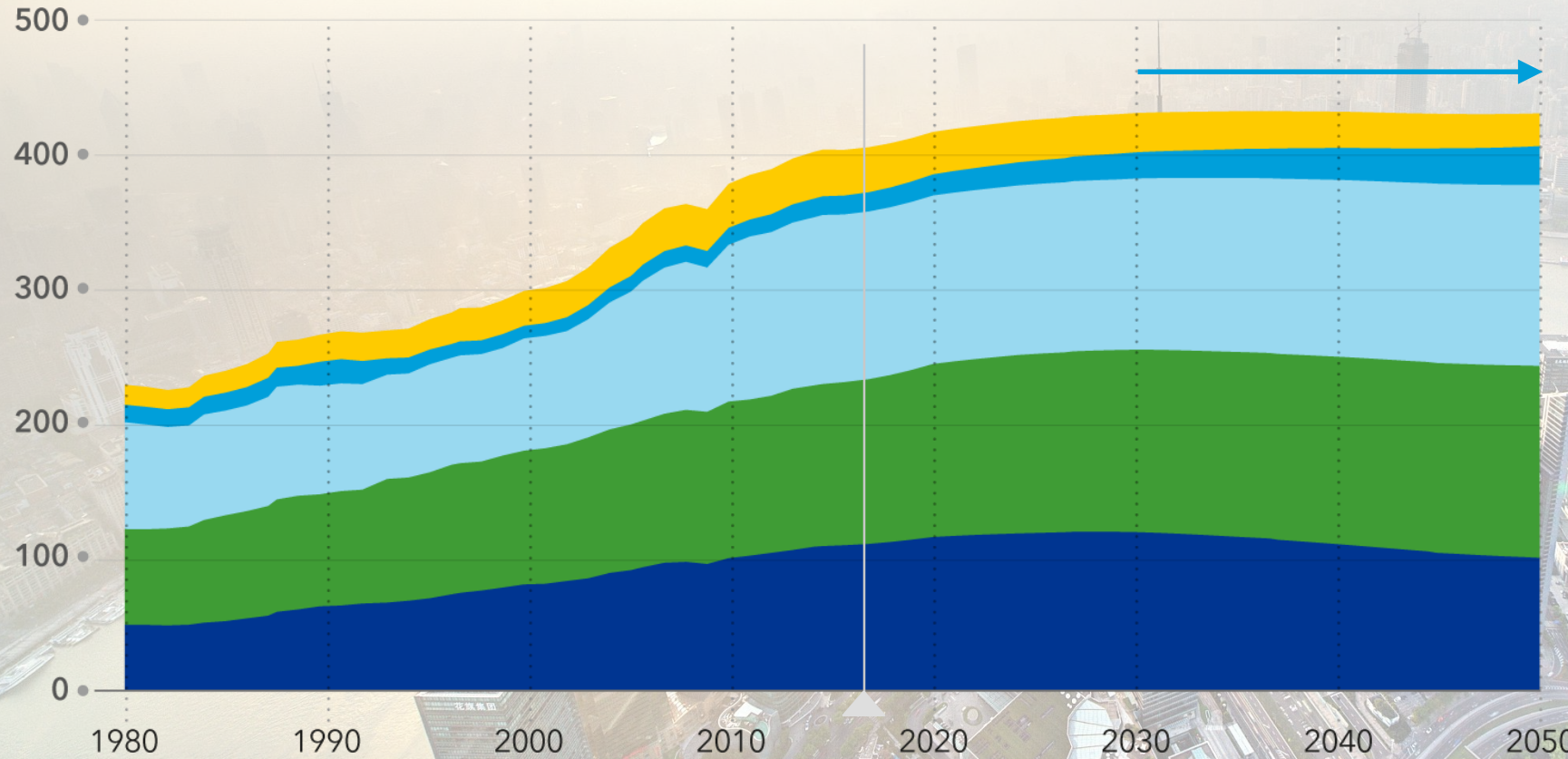
Energy Transition Outlook 2017

SAFER, SMARTER, GREENER



# World final energy demand by sector

Units: EJ/yr



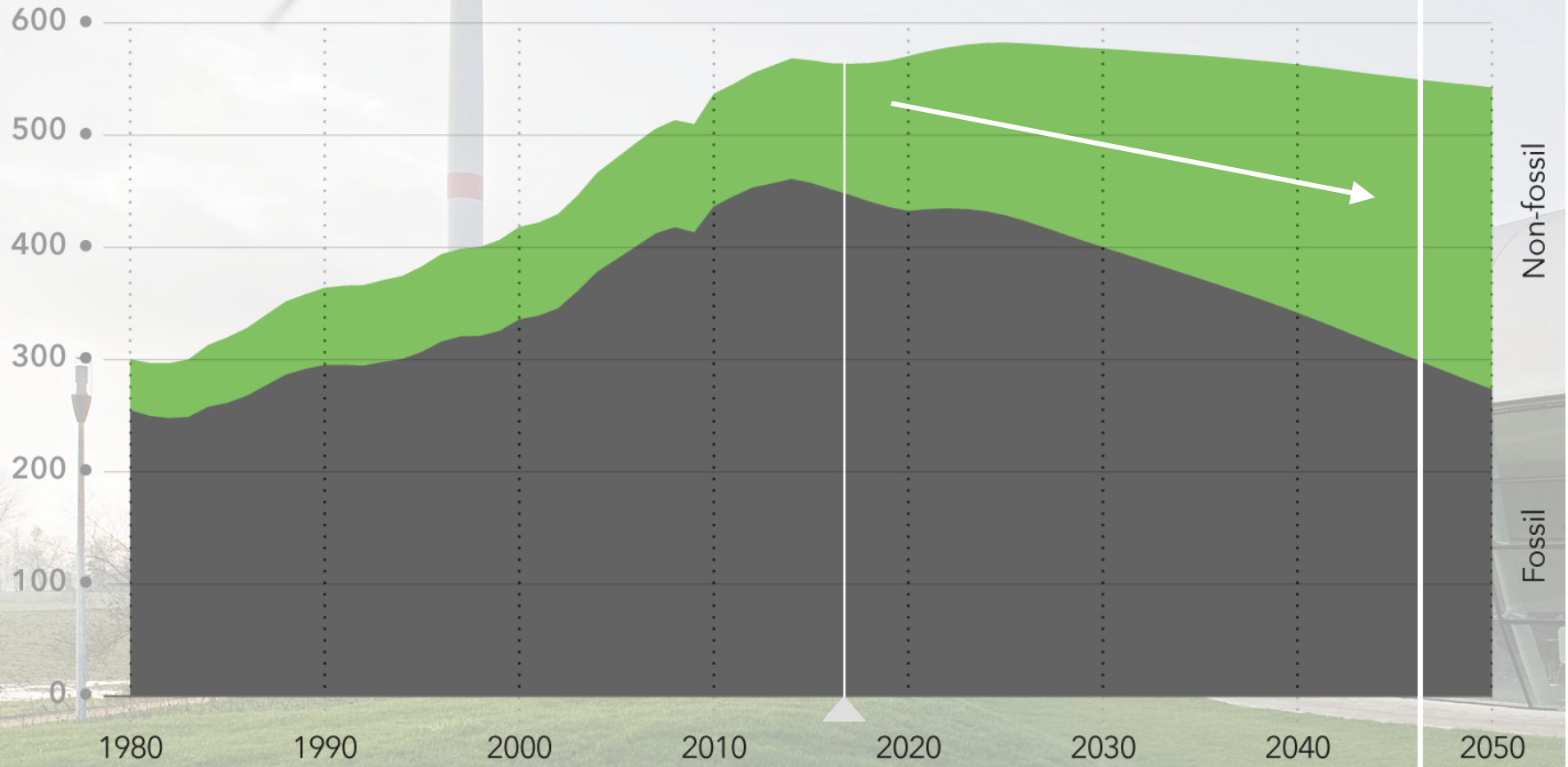
**Primary energy demand plateaus around 2030** at 430 exajoules (EJ), 7% higher than in 2015, due mainly to greater efficiency of end-users, less use of fossil fuels at relatively low thermal efficiency, and slower population and productivity growth.

## Sector

- Non energy
- Other
- Manufacturing
- Building
- Transport

# Forecast world primary energy supply

Units: EJ/yr



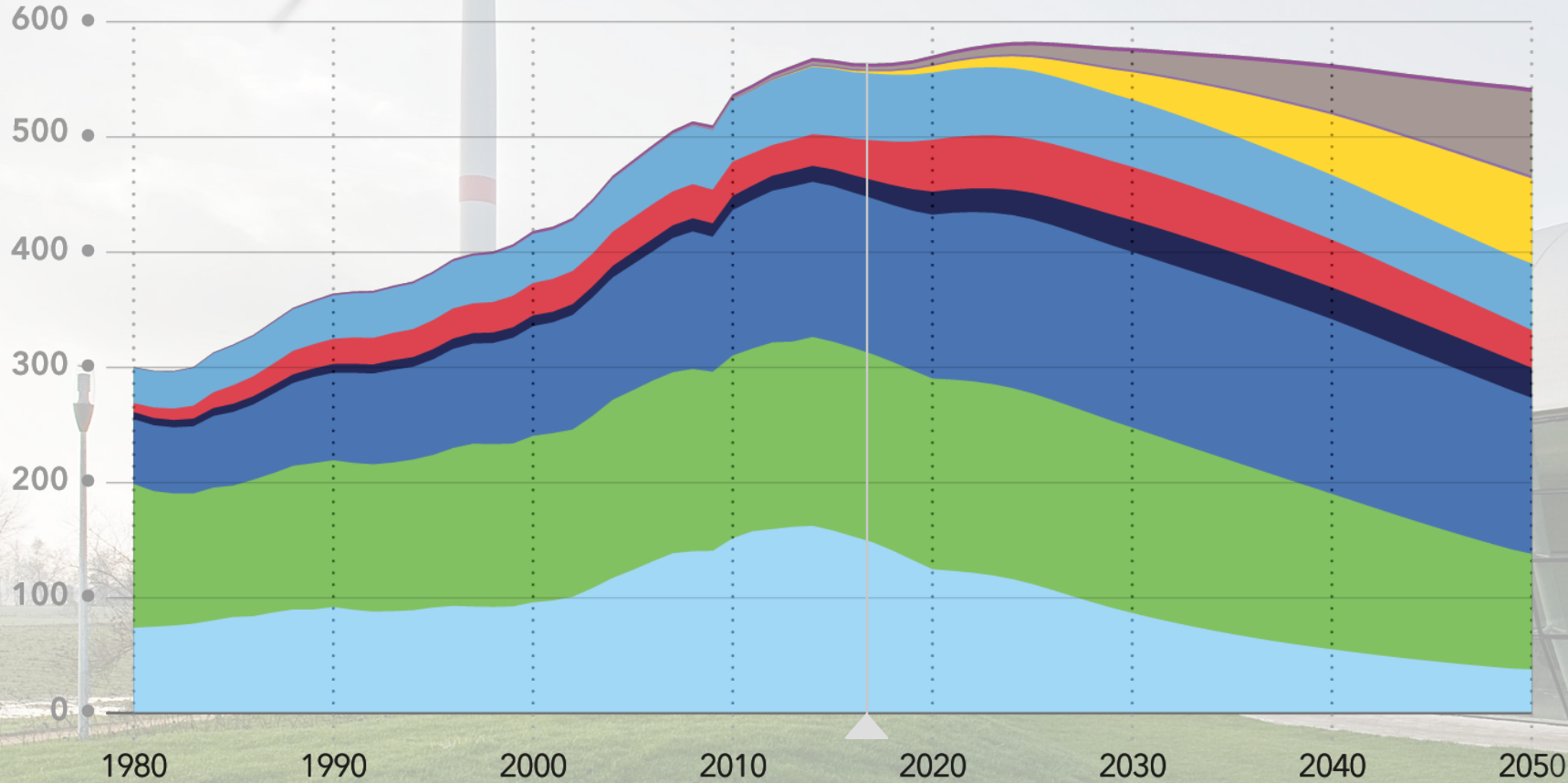
Non-fossil

Fossil



# Forecast world primary energy supply by source

Units: EJ/yr

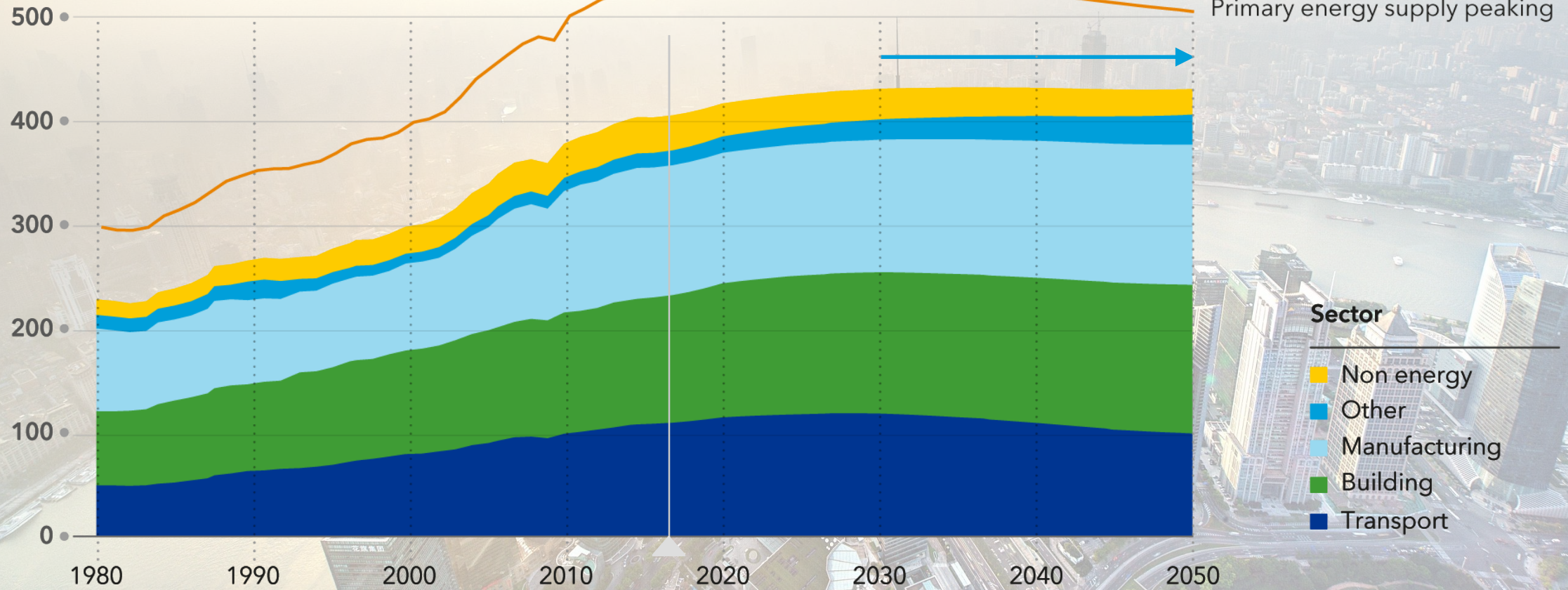


Energy source

- Geothermal
- Wind
- Solar thermal
- Solar PV
- Biomass
- Nuclear
- Hydro
- Gas
- Oil
- Coal

# World final energy demand by sector

Units: EJ/yr



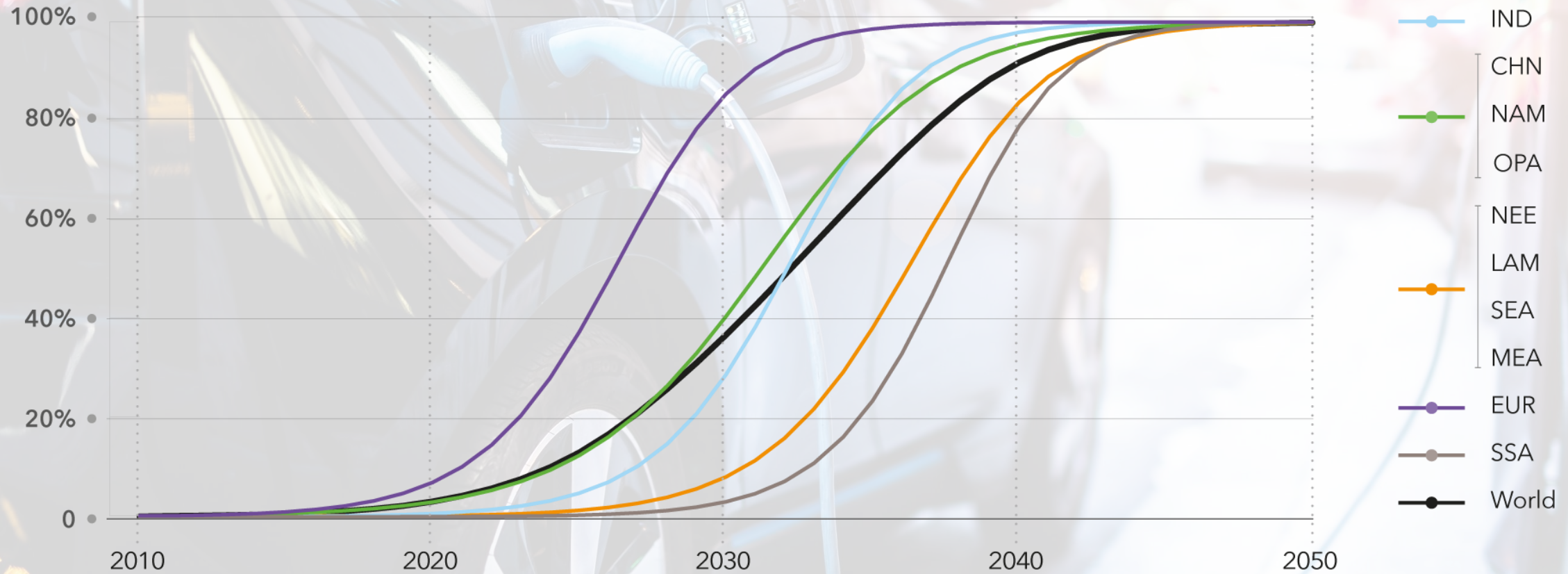
Sector

- Non energy
- Other
- Manufacturing
- Building
- Transport



# Market share of electric vehicles in new light vehicle sales

Units: Percentages



” *...humanity will start to use less energy*

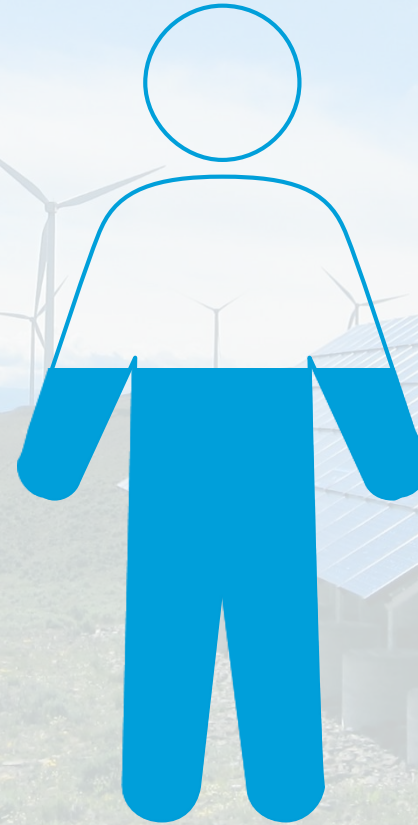
*Energy efficiency is going to improve at a faster rate than growth in Global World Product.*



**2015**  
**135 GJ/year**

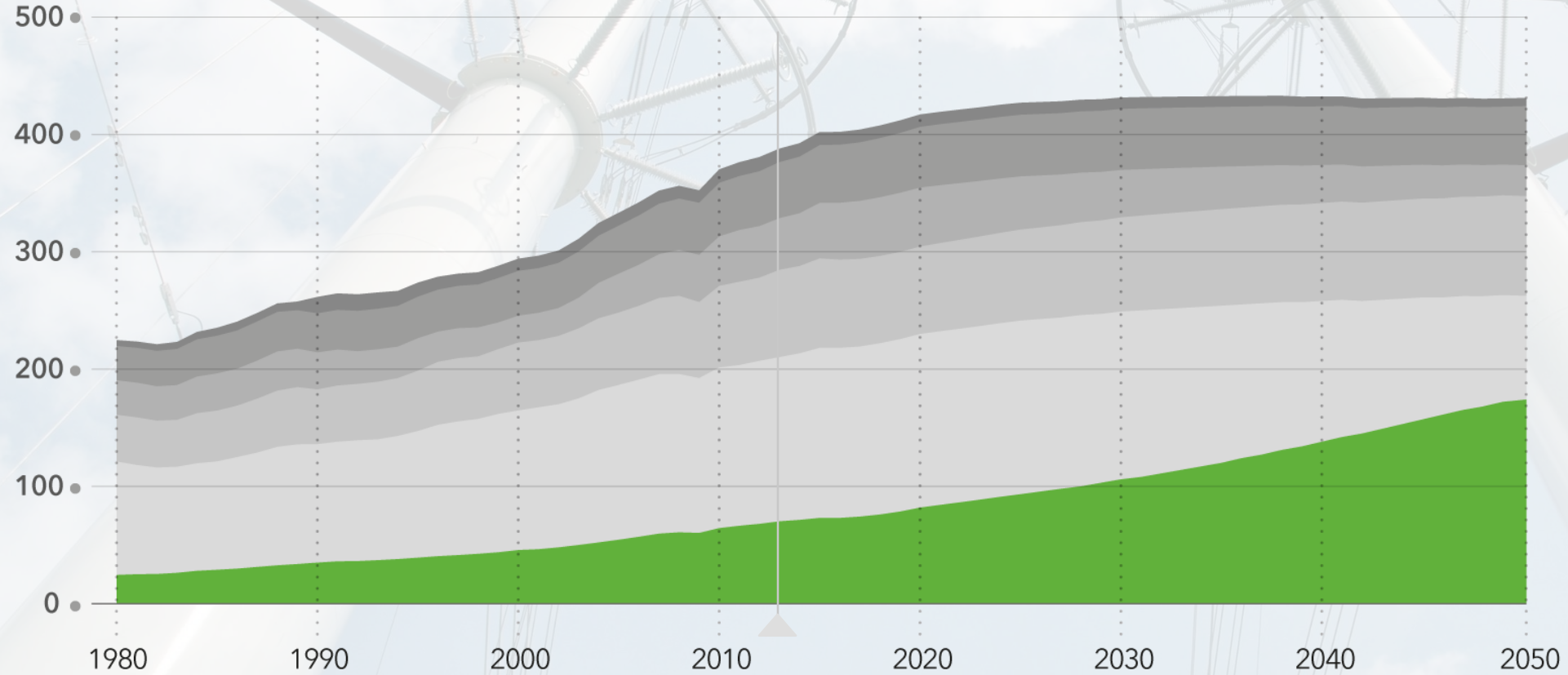


**2050**  
**76 GJ/year**



# World final energy demand by energy carrier

Units: EJ/yr



Energy carrier

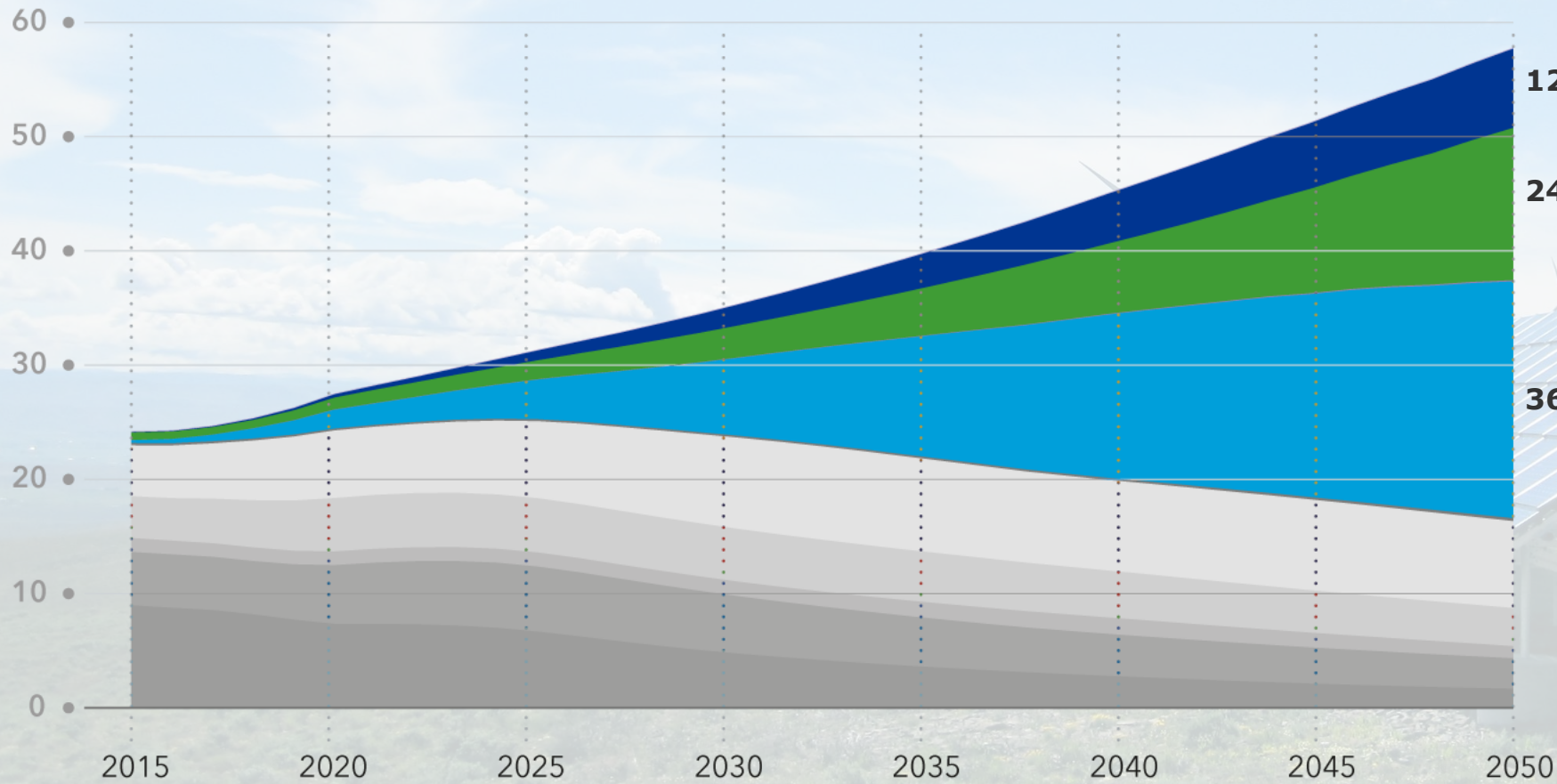
- Direct heat
- Biomass
- Coal
- Natural gas
- Oil
- Electricity

**Electricity** consumption increases by 140% and it **becomes the largest energy carrier at the point of final consumption**



# Massive growth of solar and wind by 2050

Units: PWh/yr



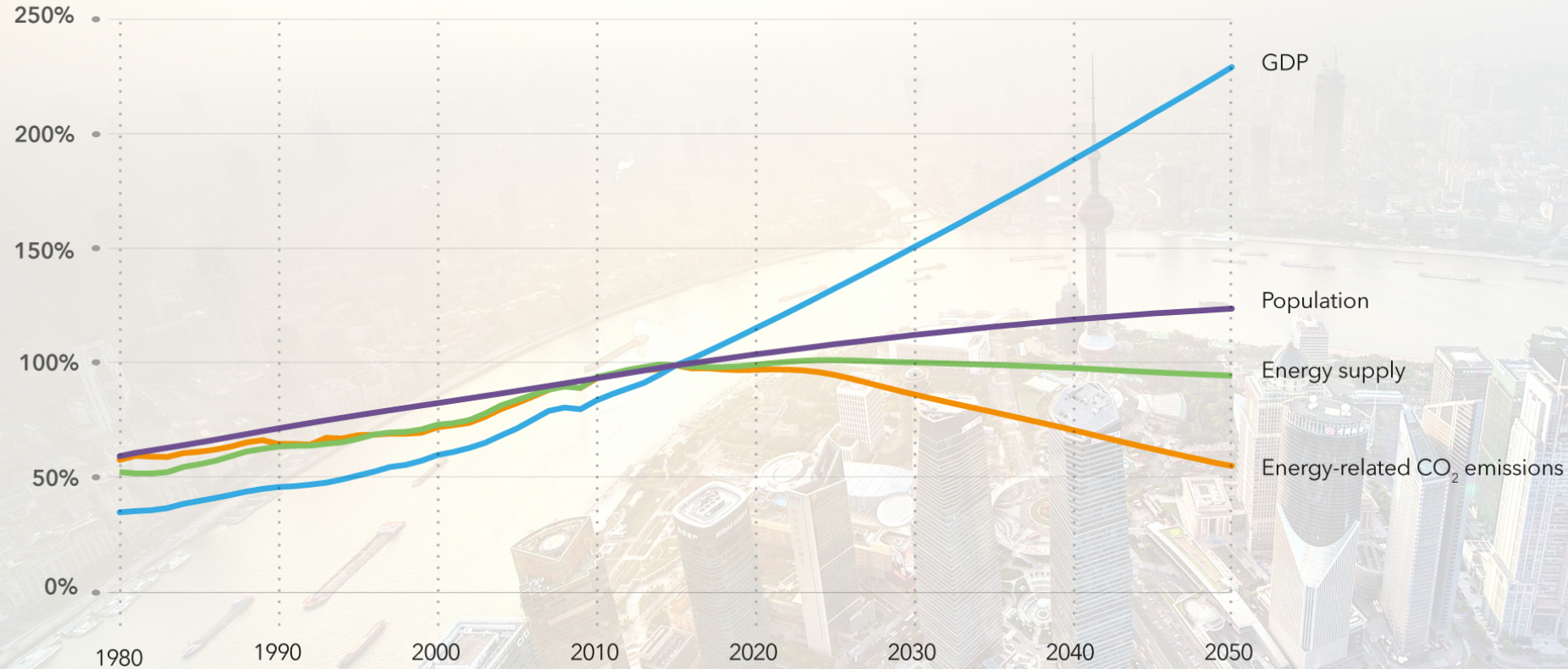
Electricity generation source

- Offshore wind
- Onshore wind
- Solar PV
- Hydro
- Gas-fired
- Nuclear
- Coal-fired
- Other



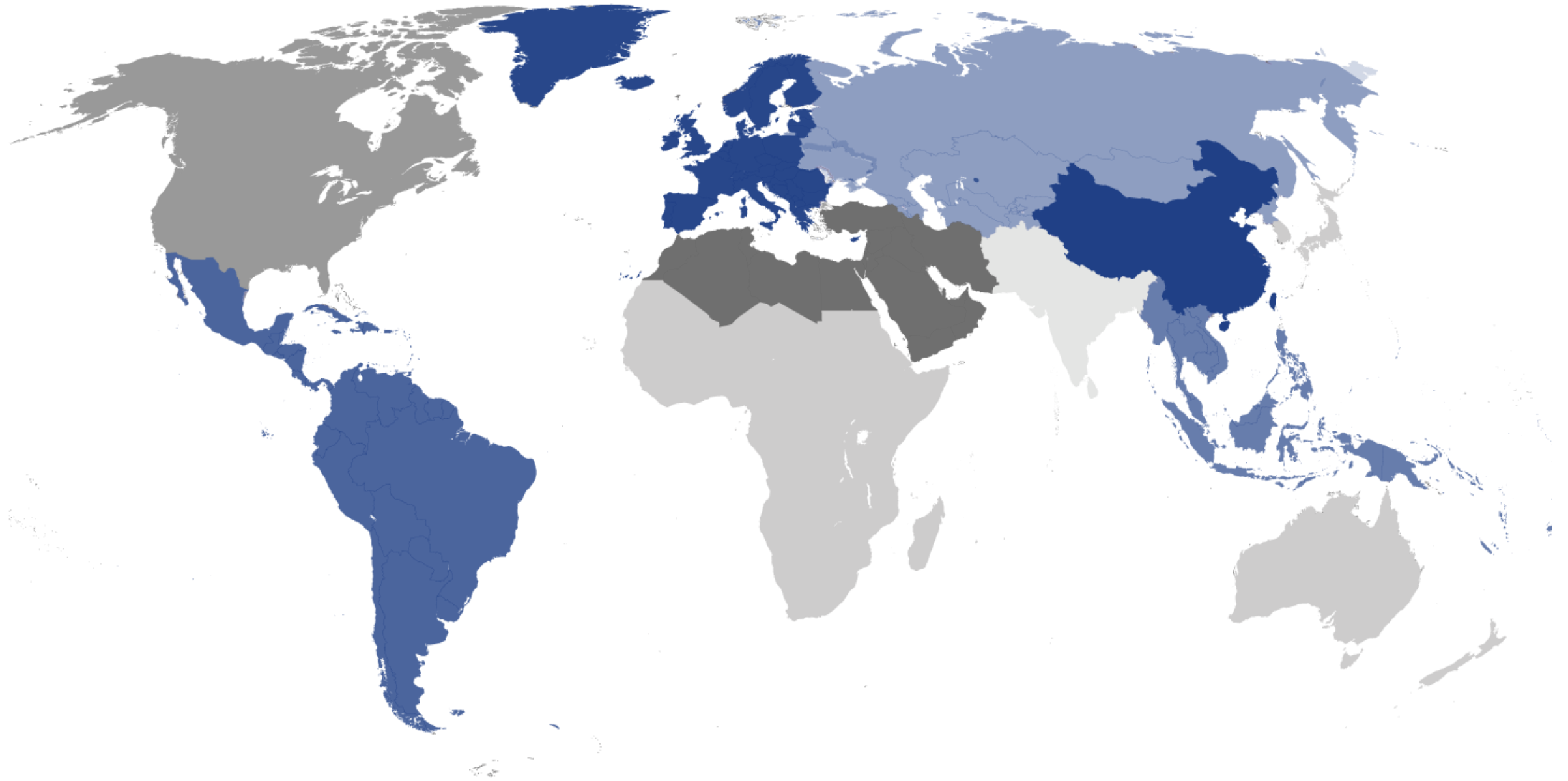
# Economic growth vs. energy efficiency growth

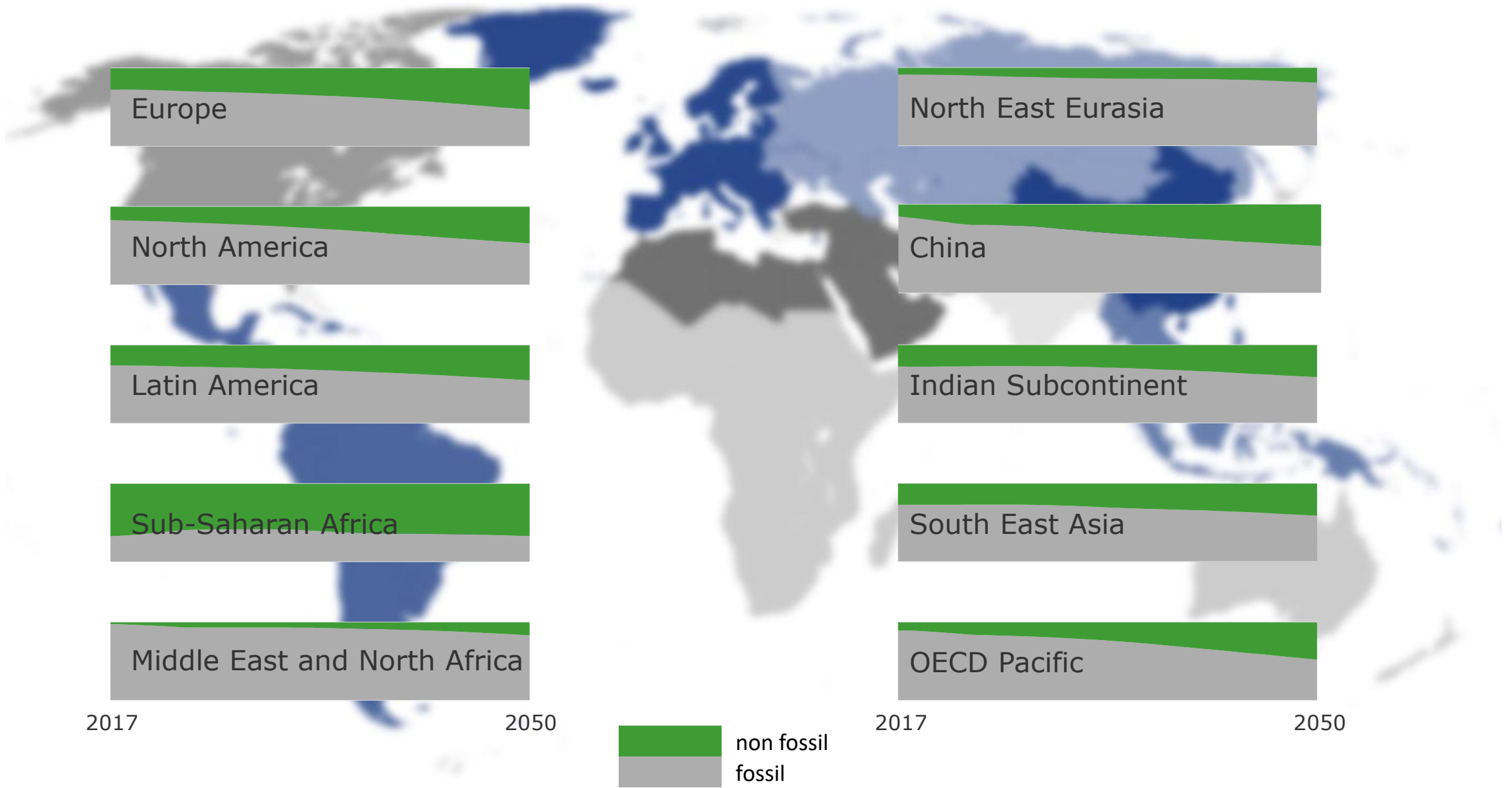
Units: Percentage of 2015 level



- Global energy **production** will peak before 2030
- Coal has peaked, then oil, then gas
- Global energy **demand** is flat from around 2030
- Despite growing population and growing GDP

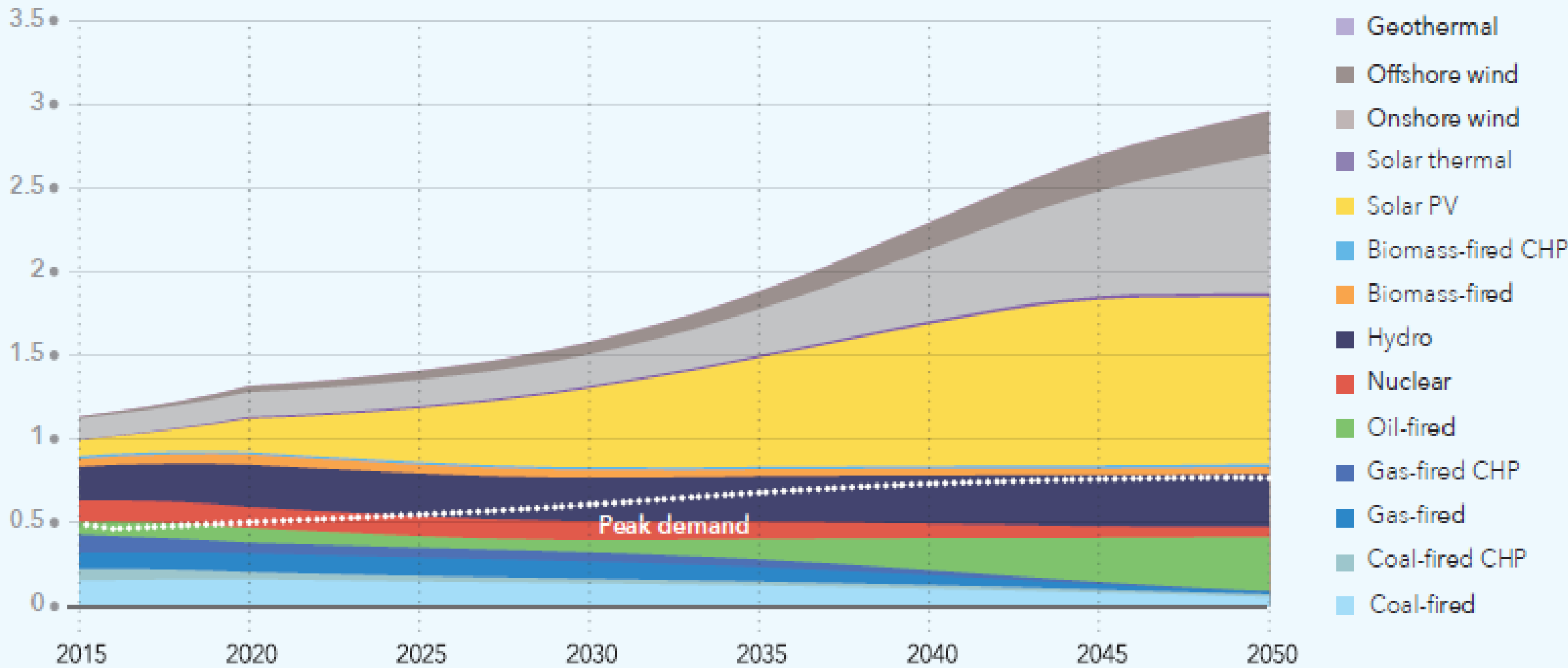








# Europe Electricity Capacity (Units TW)



# TSOs and DSOs

## WE PREDICT:



Difficulties in controlling new capacities

Need for analysis & forecasting

Change in funding models



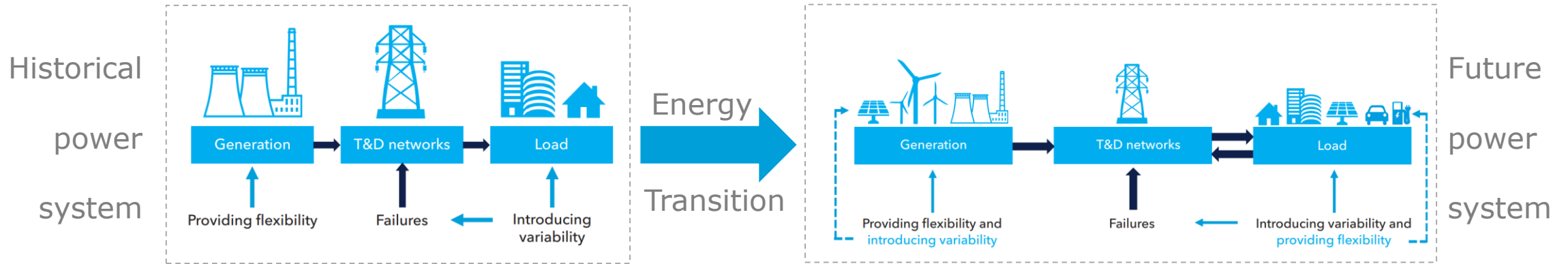
Larger & more interconnected transmission networks



Increased need to be cyber secure



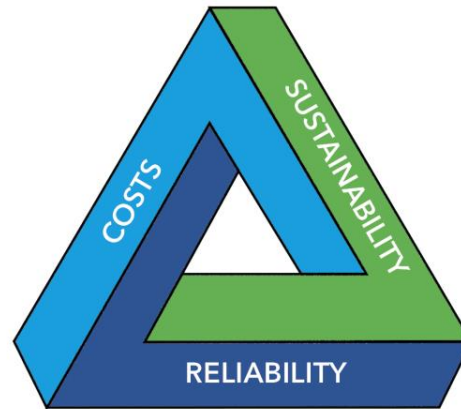
# Flexibility in the Power System, DNV GL White Paper 2017



## What is driving this transition?

Historically, reliability and considerations were the main drivers to develop the electricity system.

However increasingly over the last 2 decades, sustainability is becoming a dominating factor which is impacting how the electricity system operates.

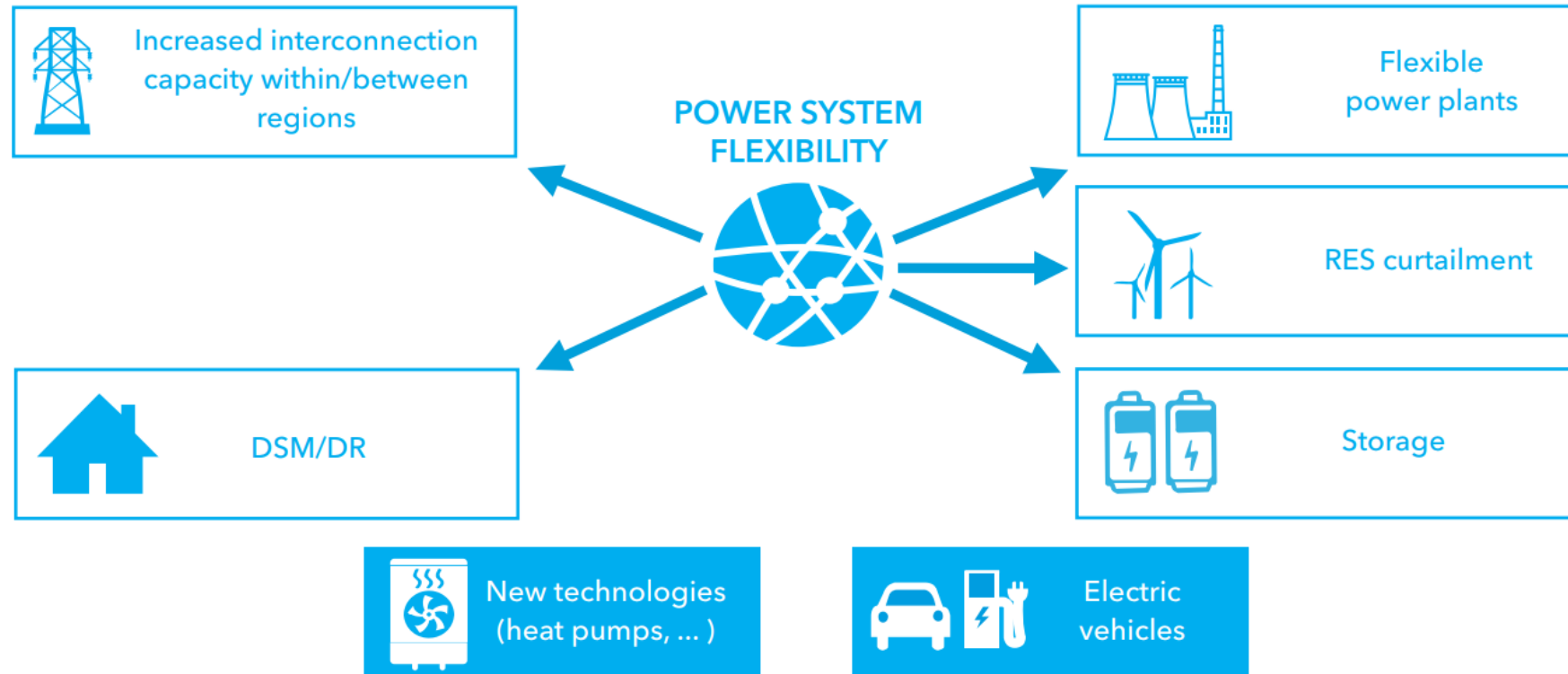


Energy Trilemma

## Major trends driving adaptations in electricity system include:

- Increasing uptake of renewable energy;
- Increasing network interconnectivity;
- Dynamic behaviour at the distribution and consumer side – trend of consumers becoming “Prosumers” (producers and consumers);
- Uptake of Electric Vehicles (EV’s) and the electrification of heat;
- Increasing electrical efficiency;
- Development of smart grids.

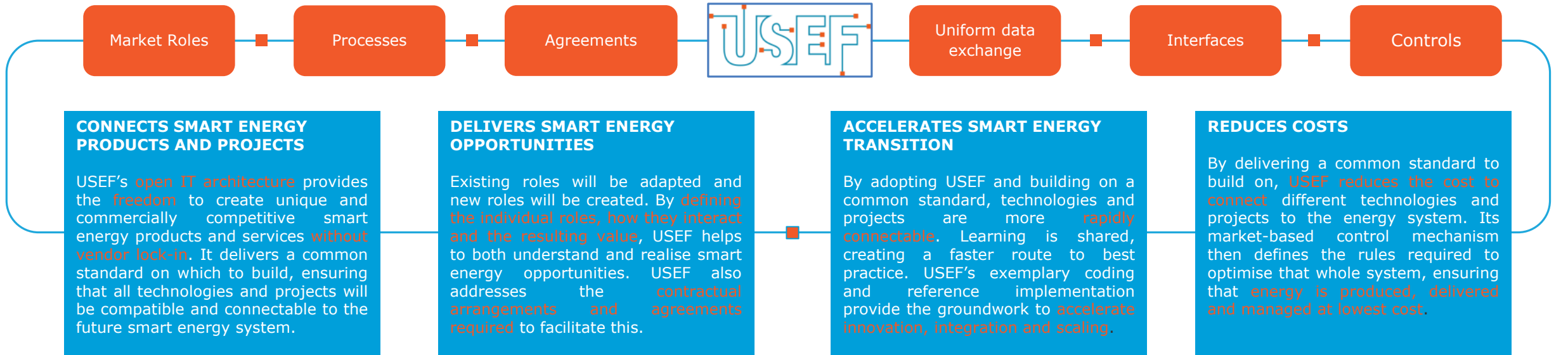
# How is flexibility provided?



Need to balance flexibility service with flexibility requirement – Each have their own timescale ranging from years (Generation and transmission planning) to seconds (balancing generation and demand forecast error).

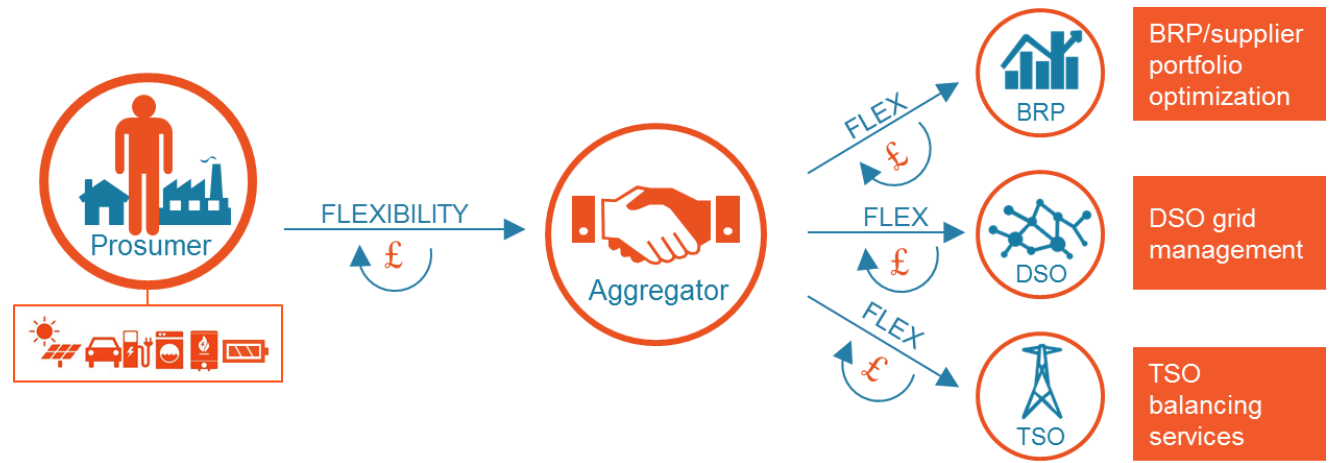


# The Universal Smart Energy Framework (USEF)



USEF provides the international common framework for a unified smart energy market.

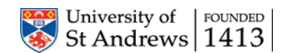
It turns flexibility into a tradeable commodity and delivers the market structure and associated rules and tools required to make it work effectively.



# The Universal Smart Energy Framework (USEF)

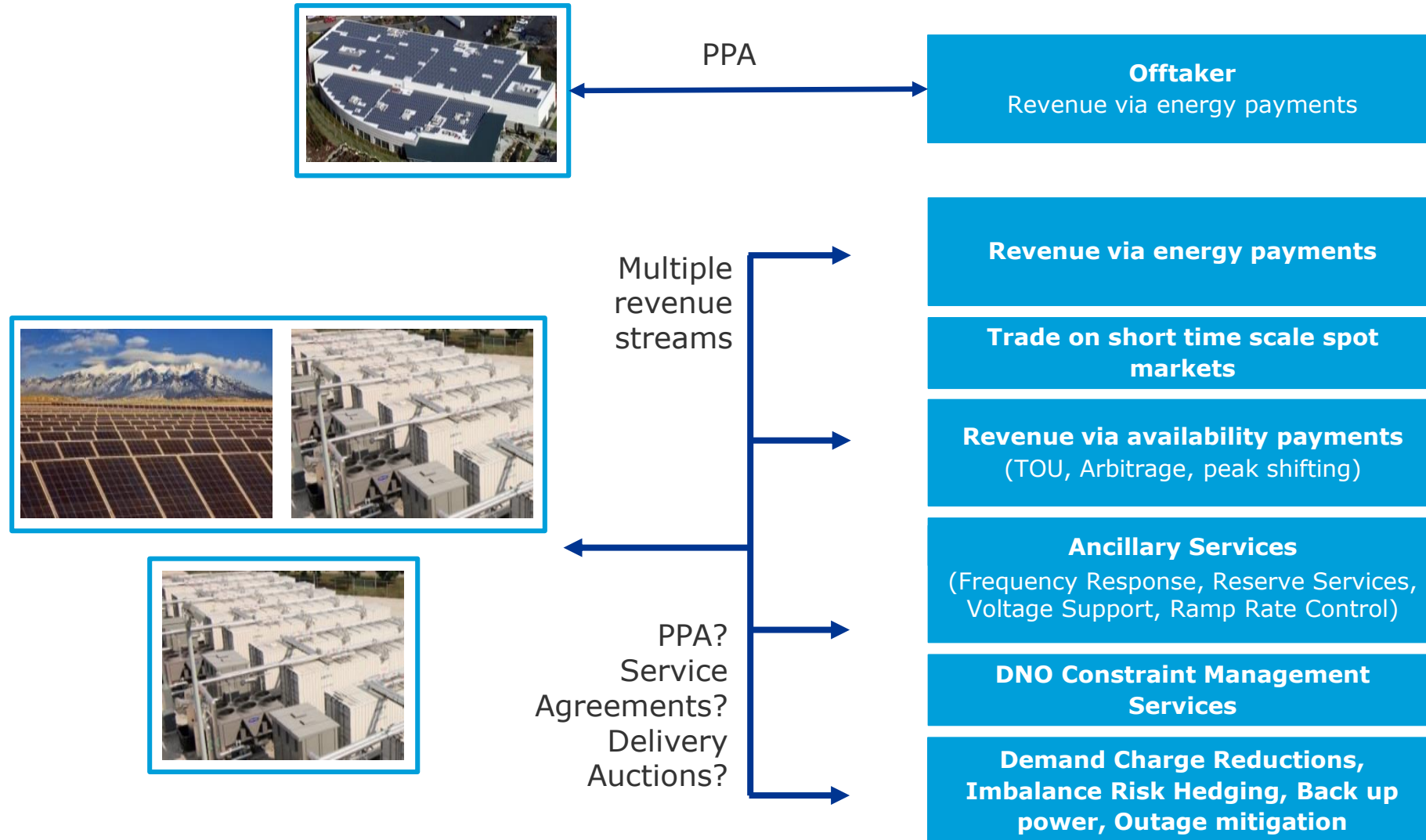


- Ofgem has approved funding for SP Energy Networks five-year innovation project, called FUSION, a submission under the 2017 Electricity Network Innovation Competition (NIC).
- FUSION plans to implement and trial an innovative smart energy network solution, as an economic alternative to manage DNO network constraints.





# Potential revenue streams and energy cost savings from stacked applications





**Energy Storage  
Technologies and Costs**

**Technology  
Vs.  
Application**

**Technology Maturity, Risks  
and Standards**

**Hybrid Systems**

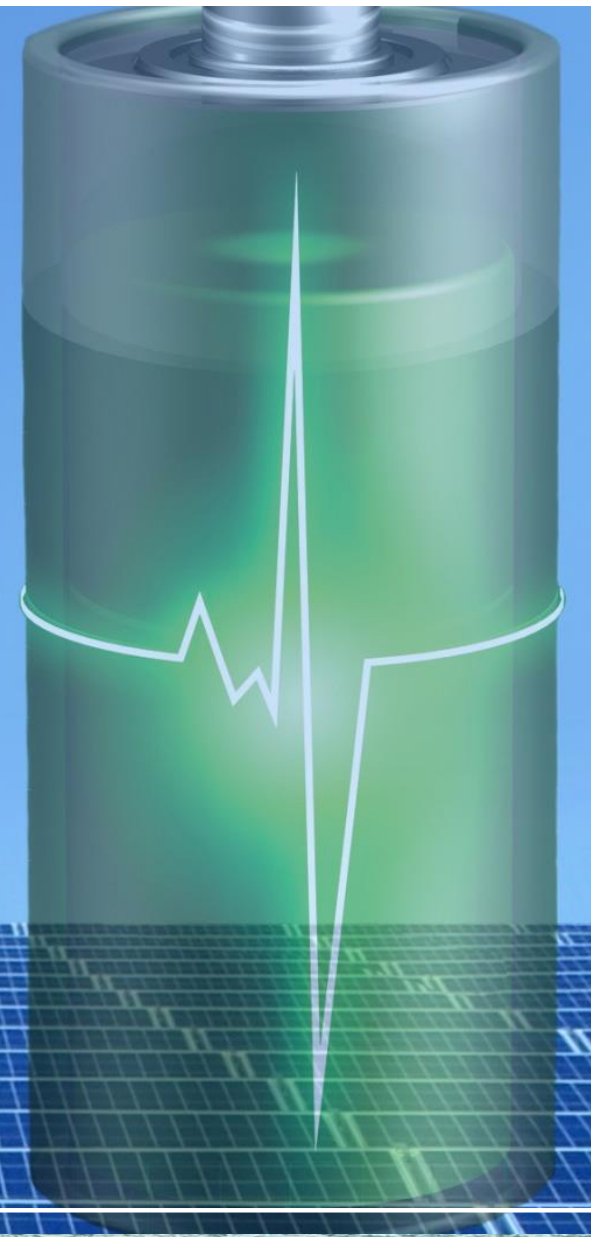


**Commercial and Regulatory Uncertainty**

**Opportunities and Revenue Streams for Storage**

**Globally, transformative and disruptive technologies have forced us to rethink existing business models and strategies**

**Disruption is either going to happen to you or because of you**  
*@briansolis*





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