Energy Technology Perspectives 2016

Global Perspective and Scenario Development for a Low-Carbon Energy System

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International Energy Agency
Secure Sustainable Together

IEA Energy Technology & Policy Activities

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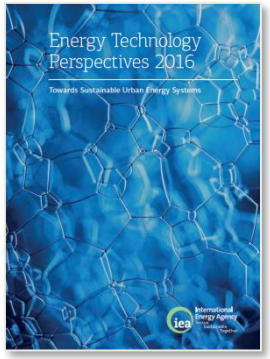
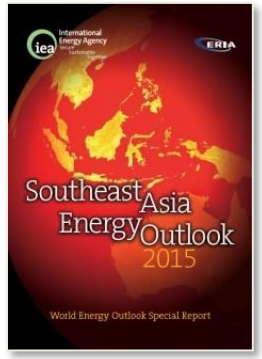
Scenarios and Modelling

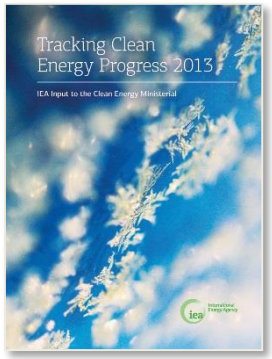
- Where do we need to go?

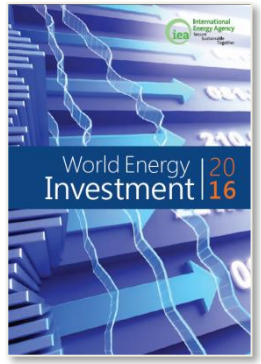




Statistics and trends

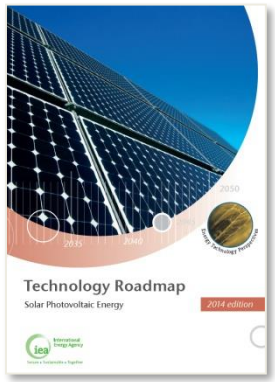
- Where are we today?

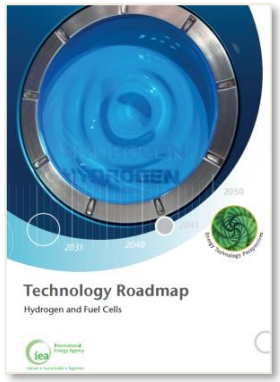




Technology Roadmaps

- How do we get there?





iea Energy Technology Network
Technology Collaboration Programmes

ETP modelling framework

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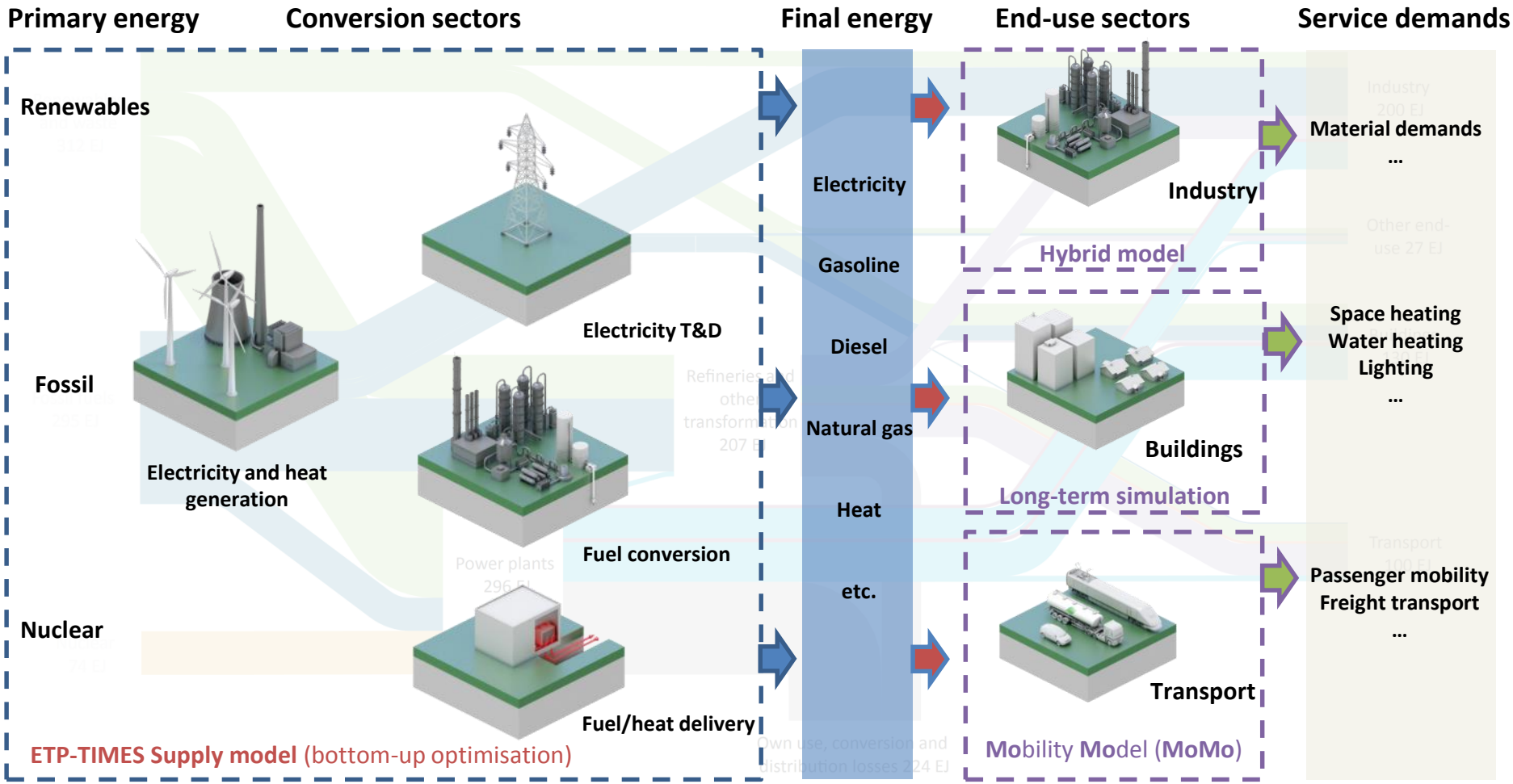

- Four soft-linked models based on simulation and optimisation modelling methodologies
- Model horizon: 2013-2050 in 5 year periods (extended to 2060 for ETP 2017)
- World divided in 28-42 model regions/countries depending on sector

Scenarios in Energy Technology Perspectives

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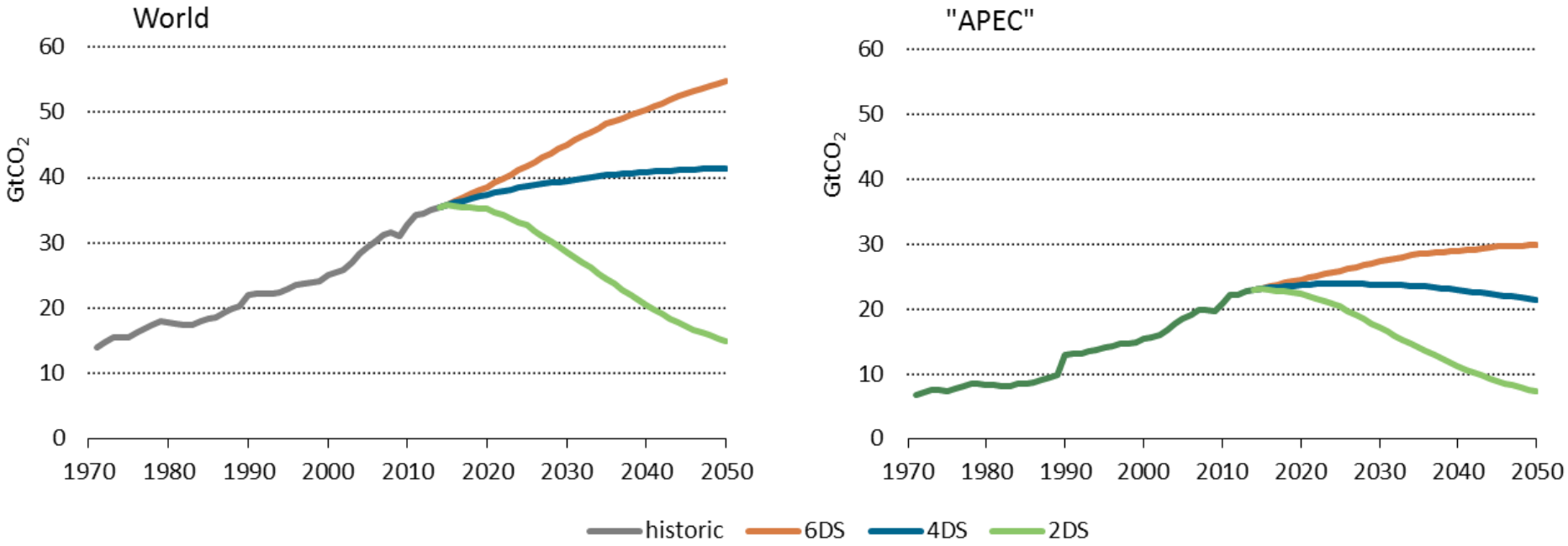
Global energy- and process-related CO_2 emissions



Notes: Prior to 1990, process emissions are not included. "APEC" region is an approximation based on the ETP model regions: Peru and Papua New Guinea are not included; Myanmar, though not part of APEC, is included as part of ASEAN region in the ETP model.

Source: Energy Technology Perspectives 2016

Global CO_2 emissions need to be more than halved by 2050 under a 2°C pathway compared to today.

Consume less energy and clean the rest

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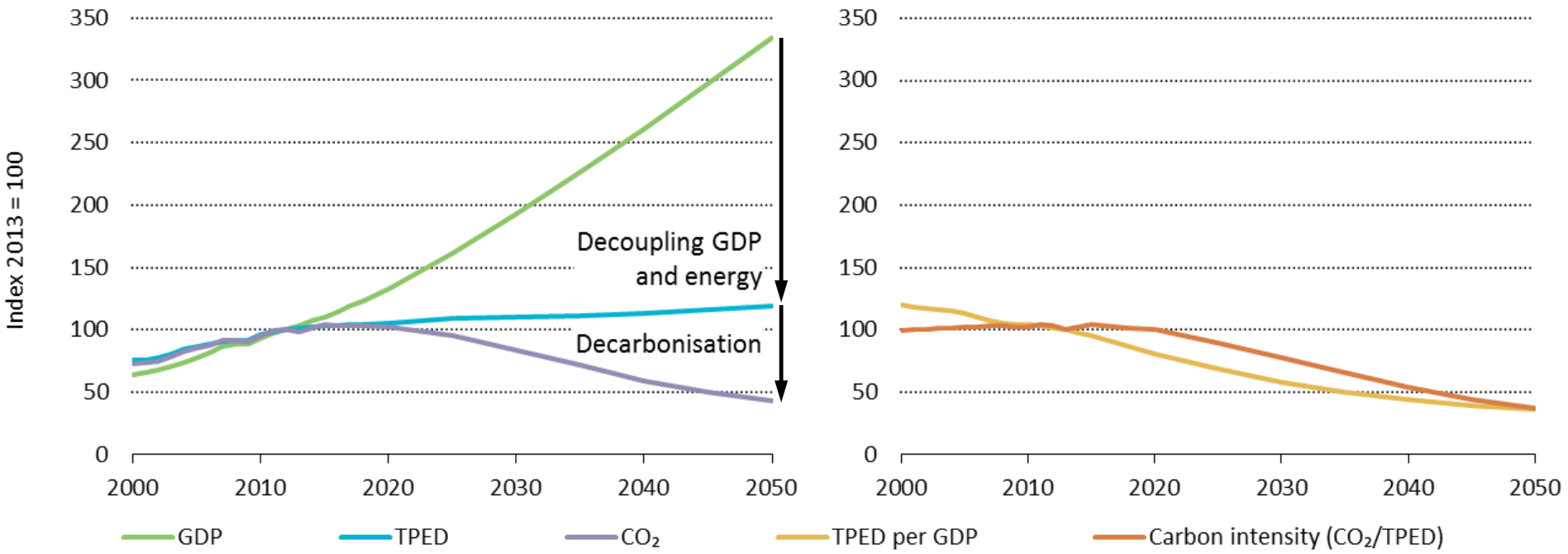
Global indicators in 2DS



Source: Energy Technology Perspectives 2016

Rate of decoupling energy use from GDP needs to be more than doubled over the next four decades, while the carbon intensity of the remaining energy use needs to drastically reduced by 2050

Portfolio of technologies and efforts in all sectors needed

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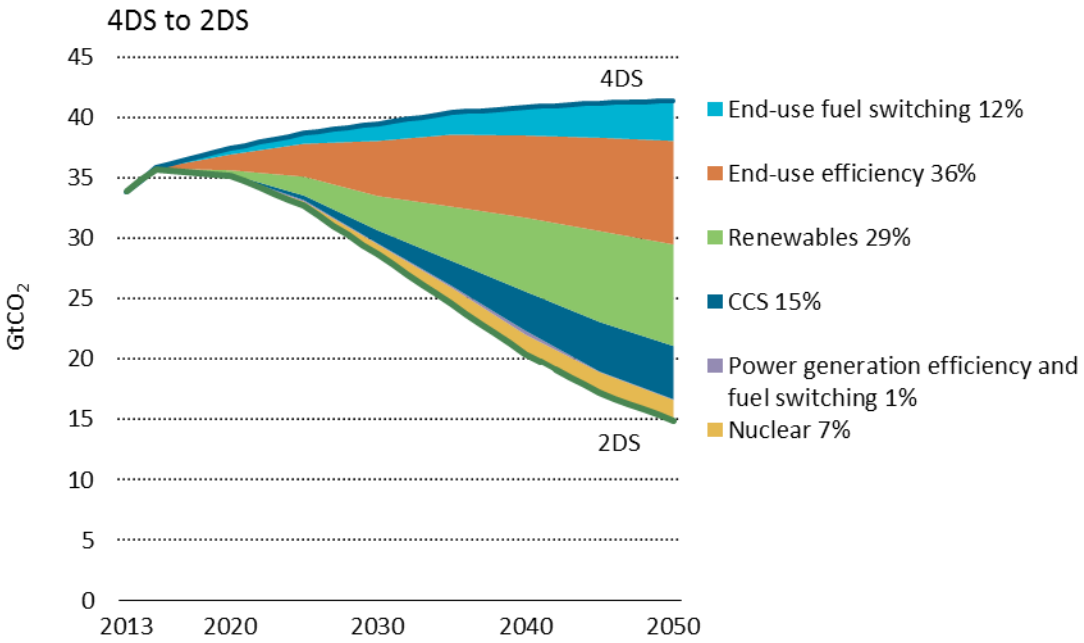
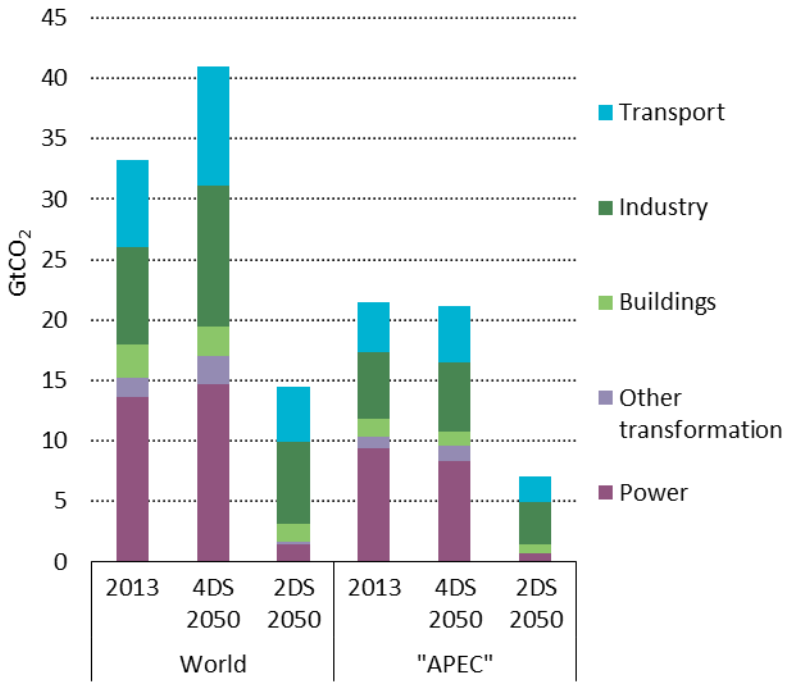
Contribution of technology area to global cumulative CO_2 reductions



Annual CO_2 emissions by sector



Source: Energy Technology Perspectives 2016

2DS requires emission reductions in all sectors, both on the demand and supply side.

Decarbonising electricity supply in the 2DS

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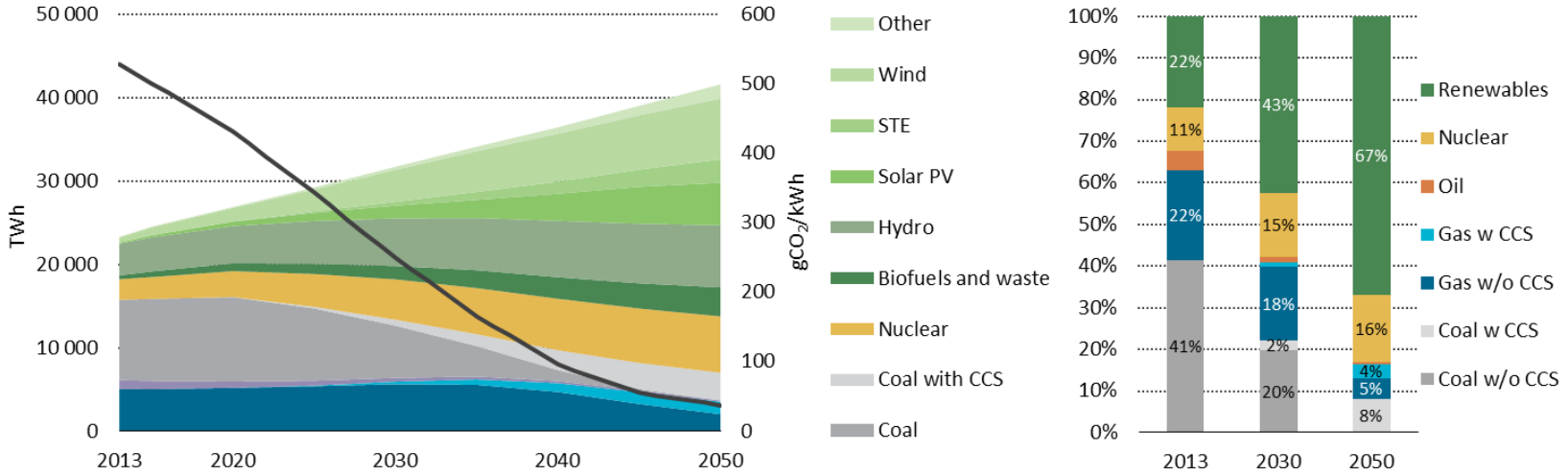
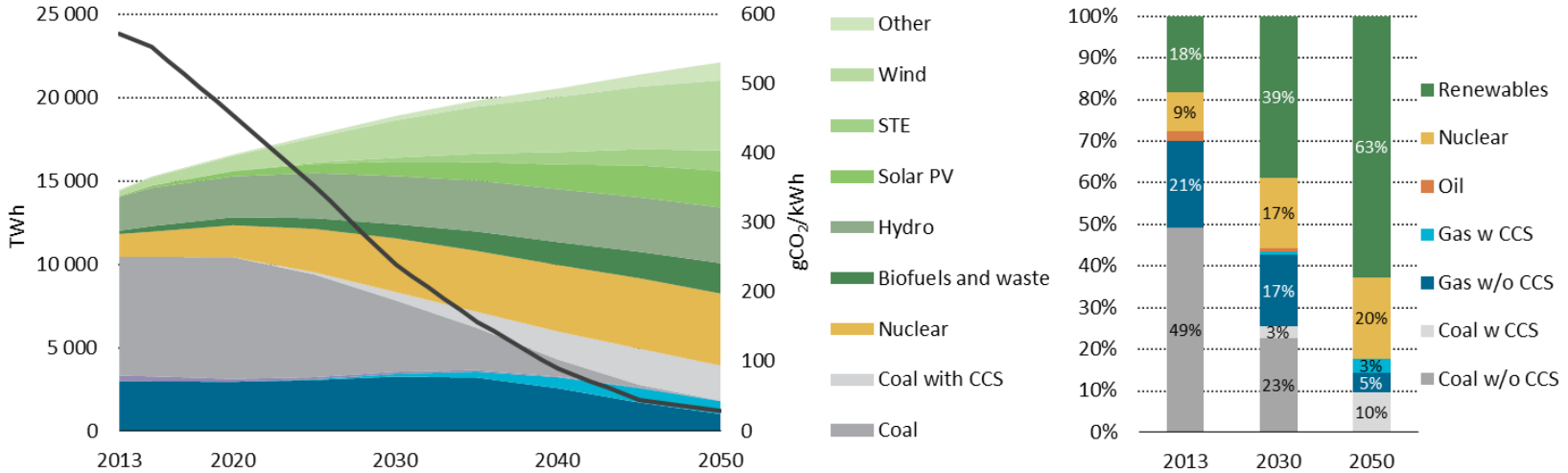
World



"APEC"



Once low-carbon, electrification of heating, cooling and mobility can also enable emission reductions in the end-use sectors

Cities in emerging/developing economies will be critical

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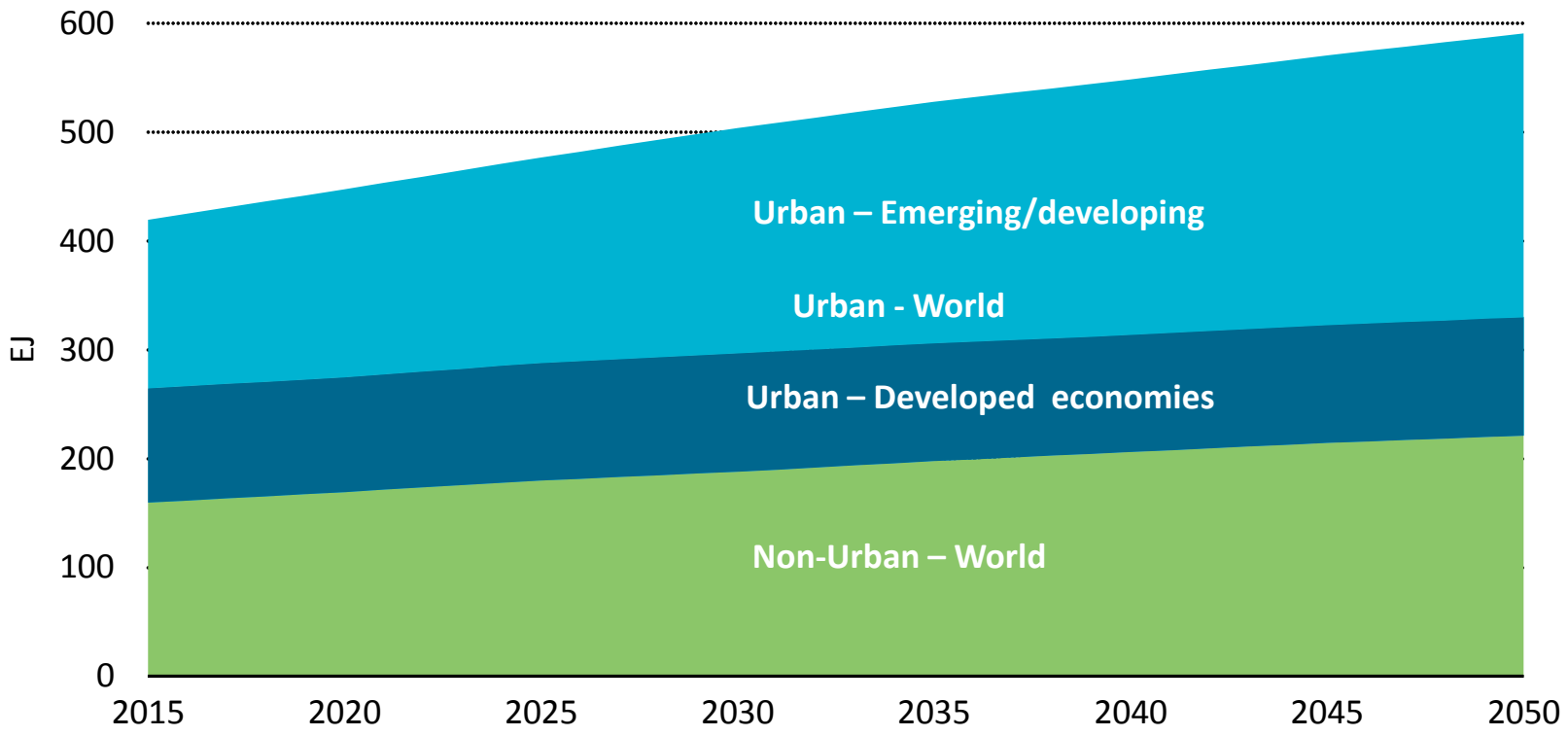
Final energy demand in the 4DS



Two-thirds of the growth in global energy demand to 2050 comes from cities in emerging and developing economies

Greater challenge for peaking transport energy demand in non-OECD in the 2DS

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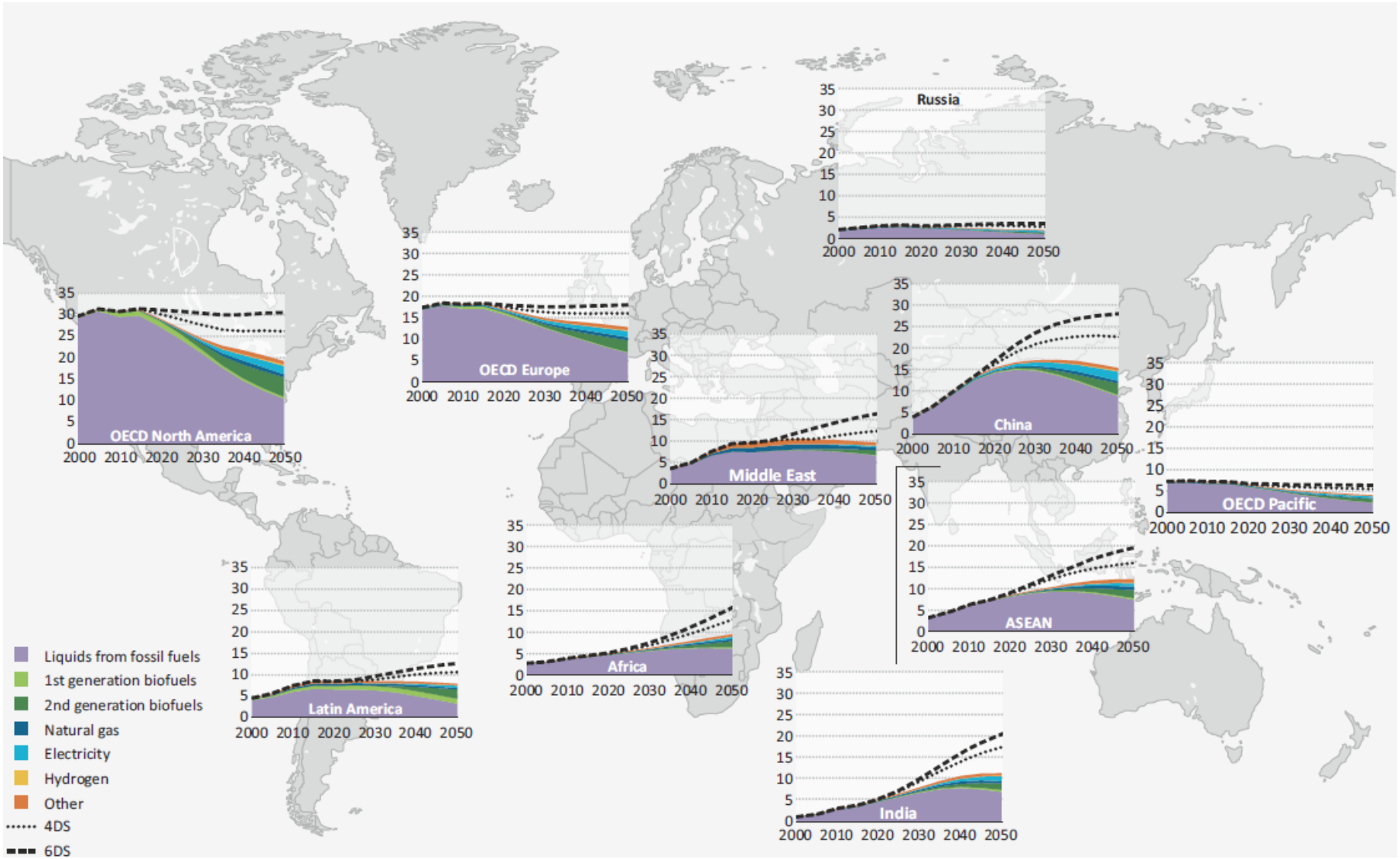

Heating and cooling: the elephant in the room

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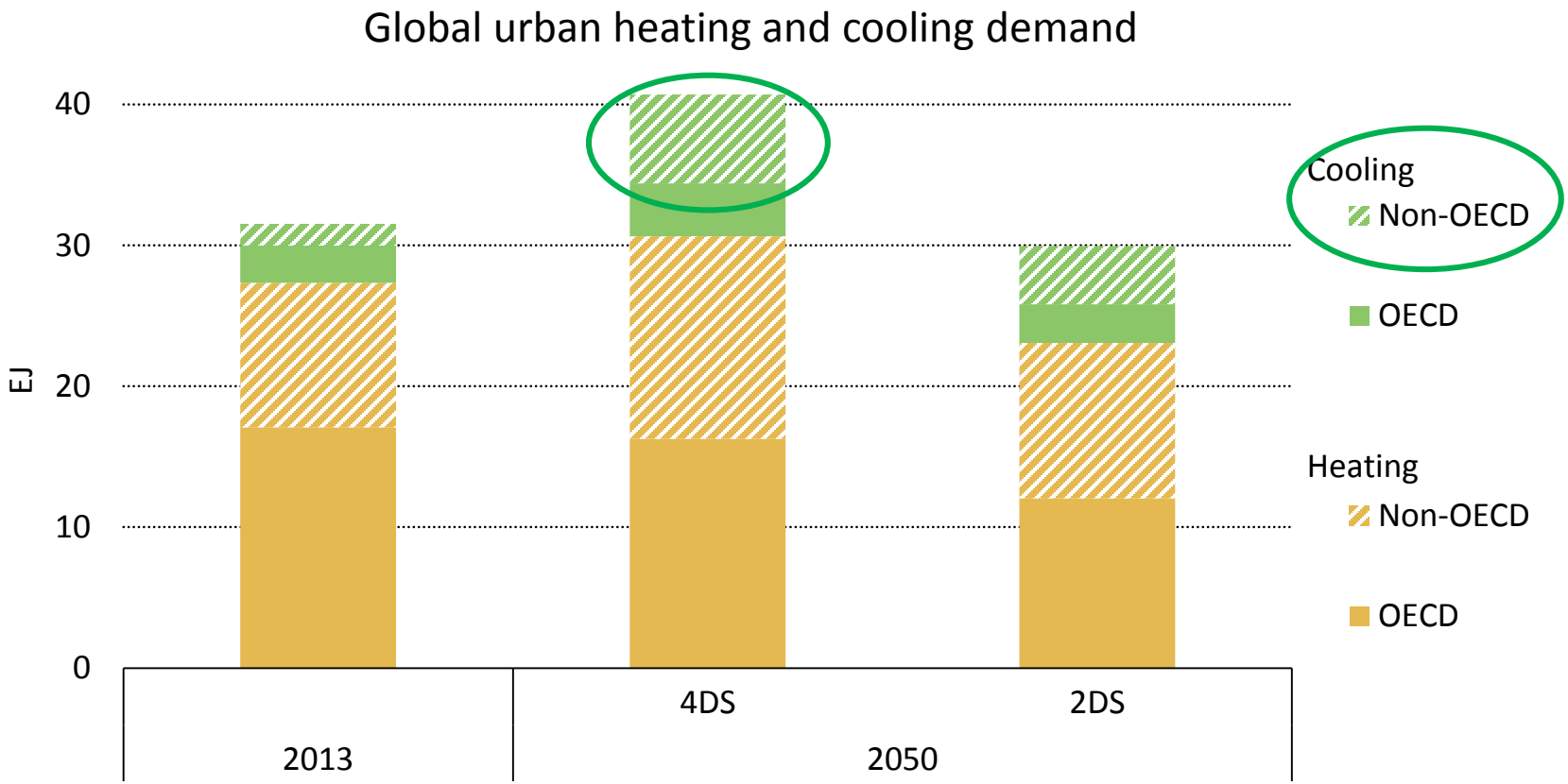

Heating and cooling energy demand in cities can be reduced by 25% without compromising thermal comfort, particularly cooling in emerging economies

Integrated and intelligent energy system of the future

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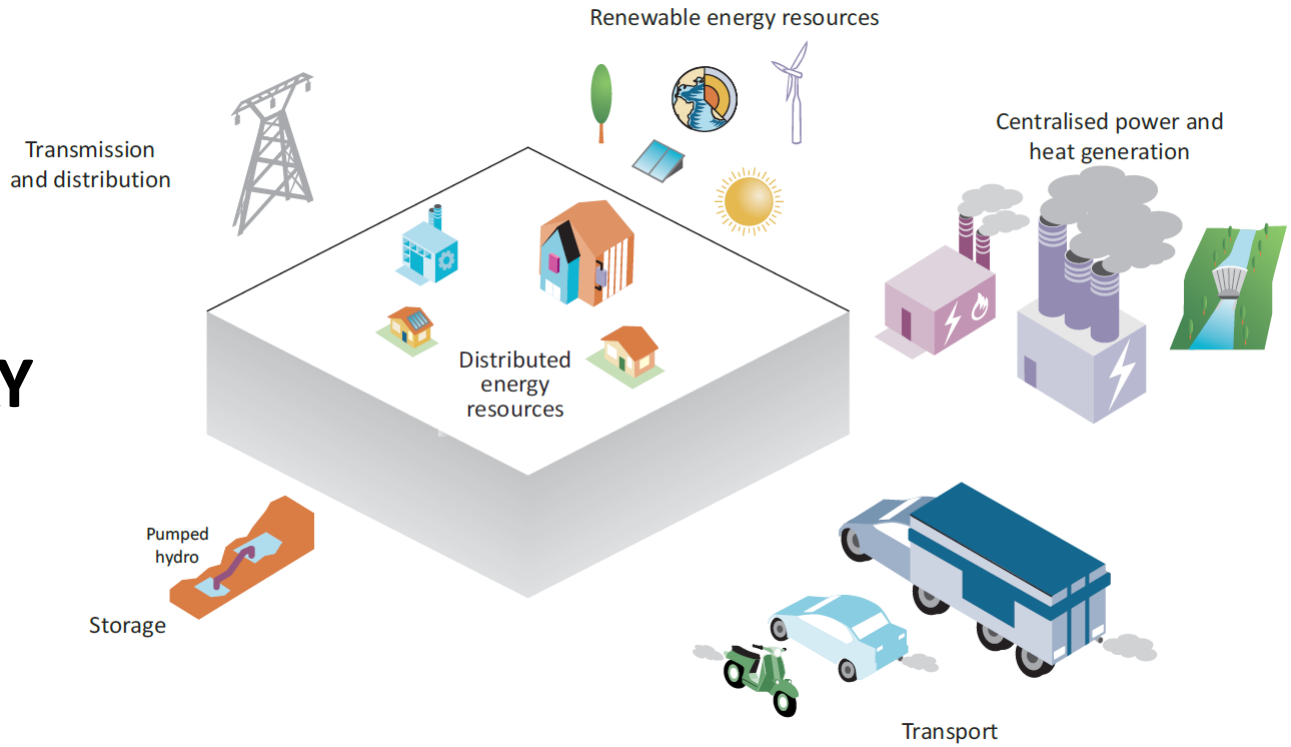
TODAY



Integrated and intelligent energy system of the future

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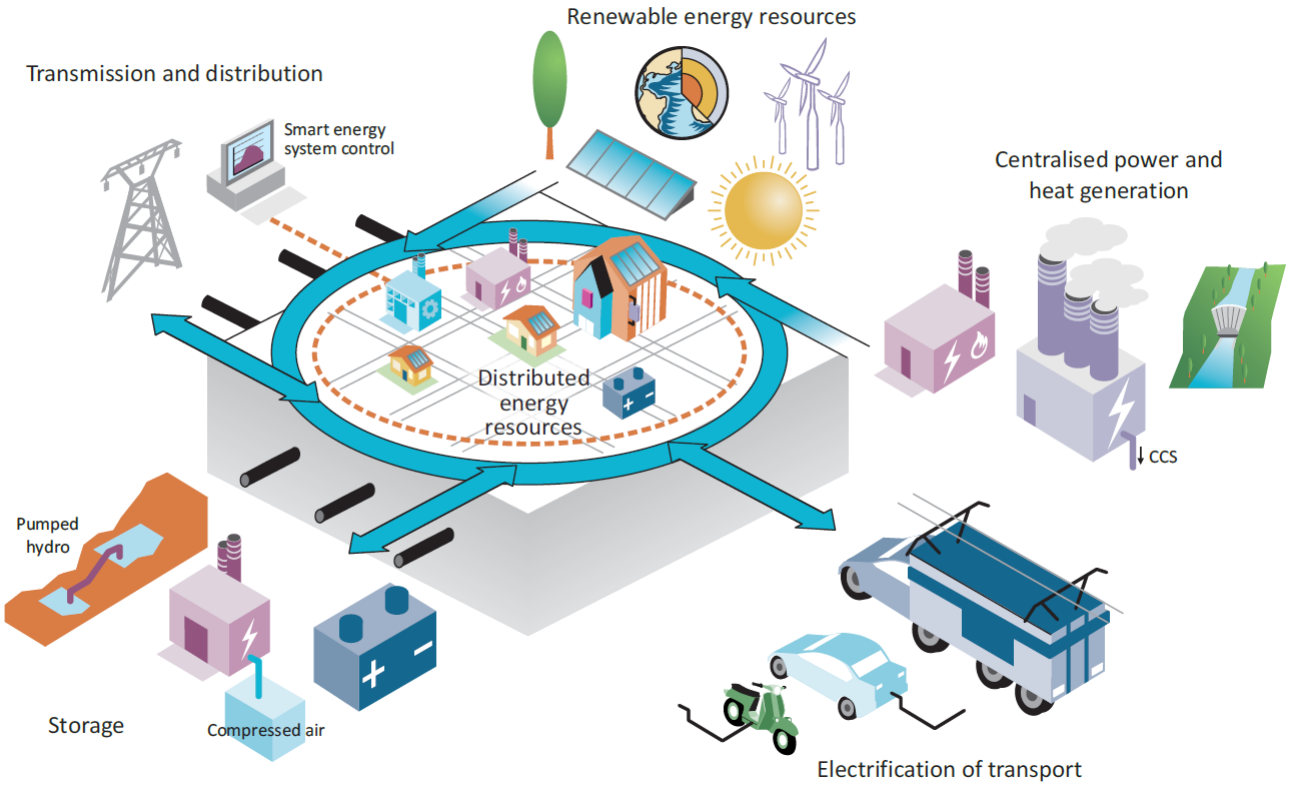
FUTURE?



Modelling challenges

- Temporal resolution, e.g. variable renewables
- Spatial location of supply and demand, e.g. decentralised generation
- Uncertainties, e.g. technology development
- Looking beyond the energy system: water, materials,…

Challenge: Temporal resolution

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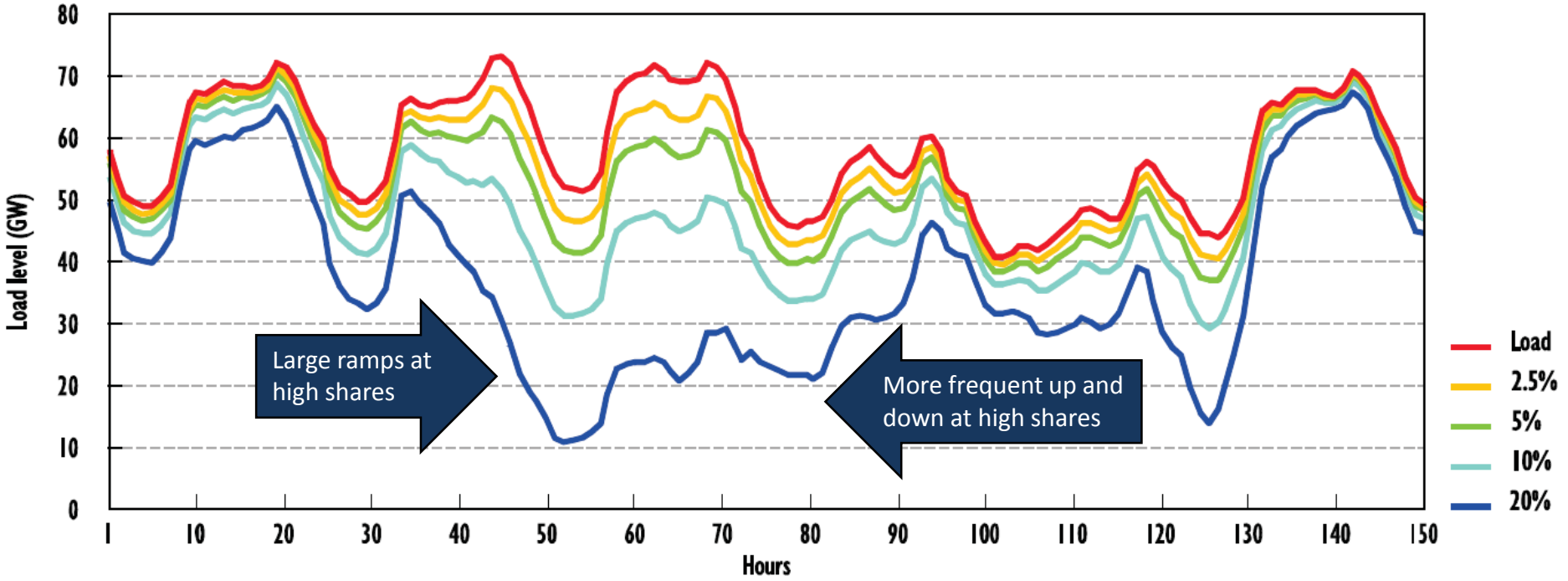
Evolution of residual load for different shares of variable renewables



Note : Load data and wind power data are for Germany from 10 to 16 November 2010. Wind power generation is scaled, actual annual share being 7.3%; scaling may overestimate the impact of variability; for illustration only.
Source: IEA, Re-powering electricity Markets, 2016

- Increased temporal resolution needed to more realistic model variable renewables and flexibility measures for their integration, e.g. storage, demand response, flexible generation

Approaches to address temporal resolution

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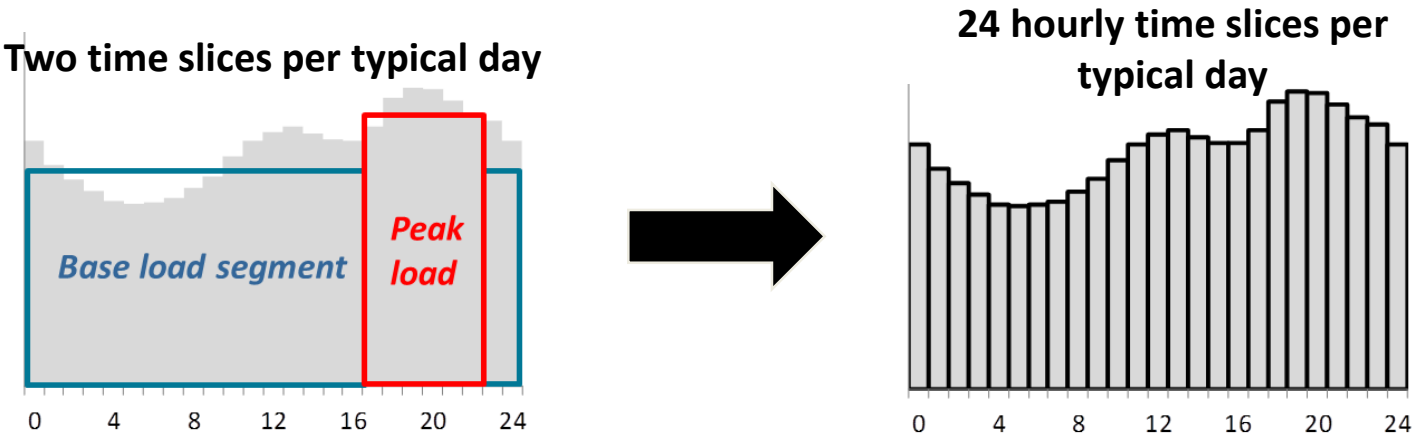
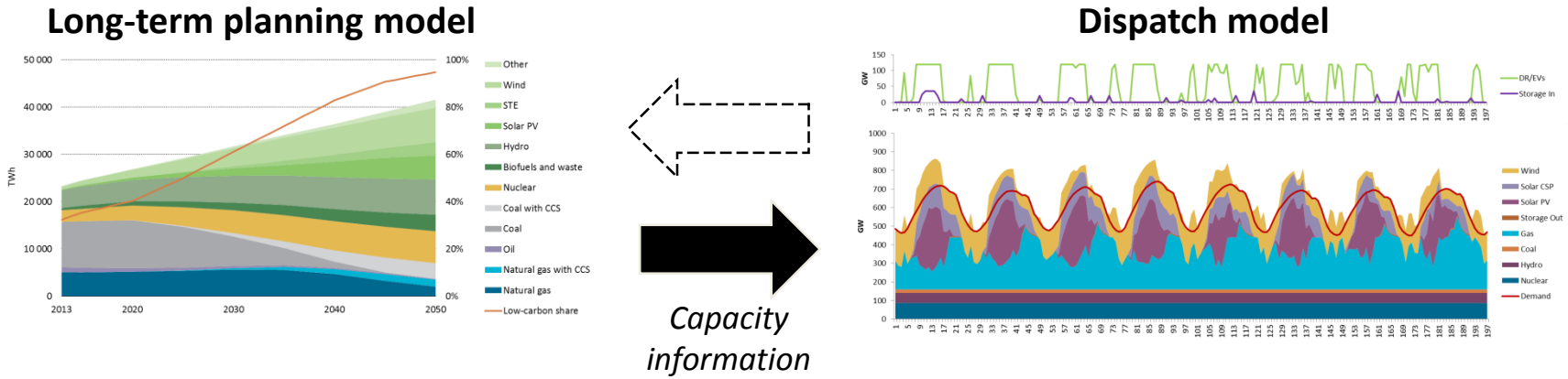
- Increasing temporal resolution in long-term planning models, but computational limits



- Two-stage modelling approach with long-term planning model for investment decisions and dispatch model to analyse system operation, but less direct representation of operational aspects in investment decisions



Challenge: Spatial resolution

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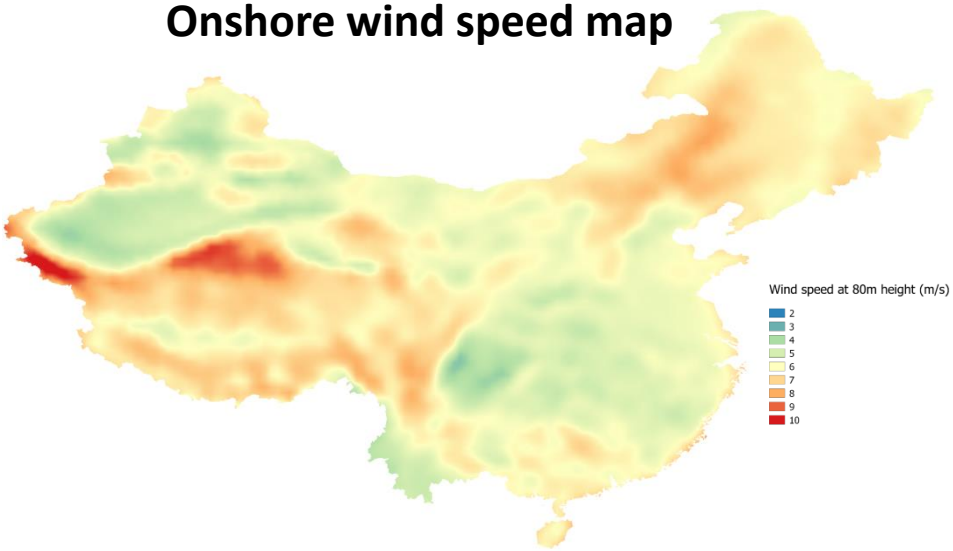
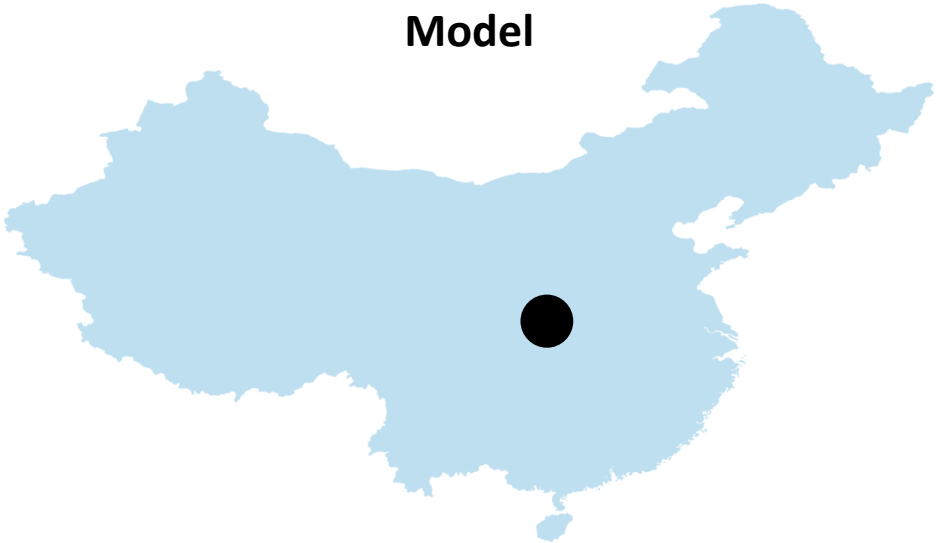
Cities

Onshore wind speed map



Model



Population and energy demand often assumed to be concentrated in a single point

Electricity system largely considered to be a "copper plate"

Approaches to address spatial resolution

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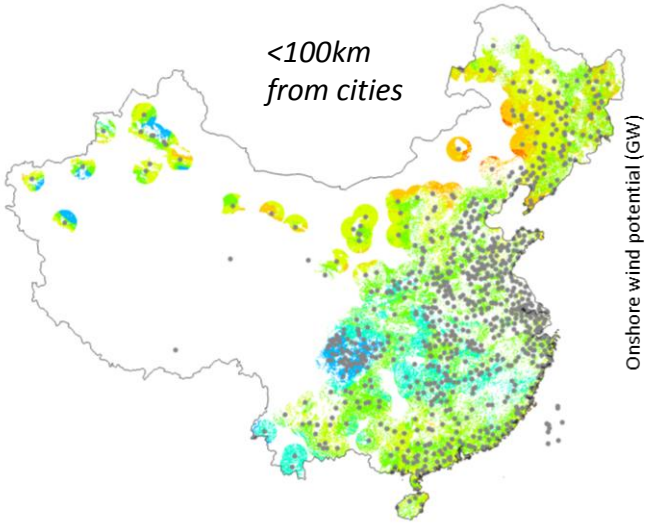
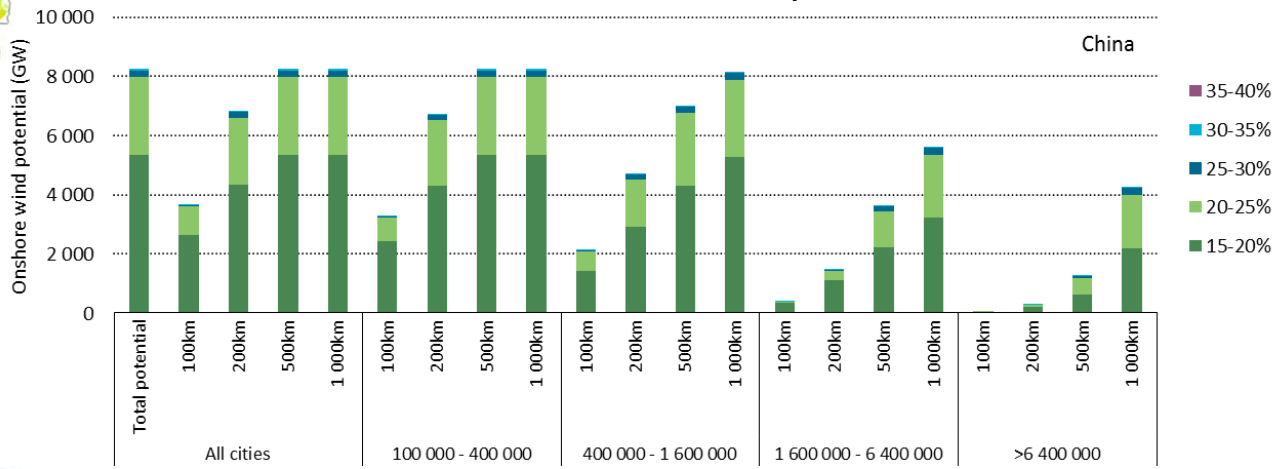
- Introducing different categories to differentiate between location



Onshore wind potential by capacity factor, distance to cities and city size



- Explicitly increasing number of model regions

NREL's ReEDS model

Source: Krishnan and Cole, Evaluating the Value of High Spatial Resolution in National Capacity Expansion Models using ReEDS, 2016

Conclusions

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- **Strategies towards a 2 degree pathway:**
  - **Untapping energy efficiency potential**
  - **Decarbonising electricity** not only cutting emissions in the power sector, but also allowing increased electrification of heating/cooling and mobility
  - **CCS an opportunity for continued use of fossil fuels** in power generation, but crucial to avoid process emissions in industry
  - **Consumer behaviour** and supporting policies important for success (e.g. avoid/shift in transport, demand response in the electricity system)
- **Challenges in the analysis:**
  - Growing electricity generation from **variable renewables** requires additional or advanced tools to analyse the **impact on system operation and flexibility**
  - **Local aspects within a region or country become more important**, e.g. population density for transport solutions in urban areas, location of renewable potentials, decentralised supply potentials
  - **Uncertainty in future evolution of input assumptions** (e.g. socio-economic drivers, technology characteristics) can be partially addressed by sensitivity analysis, but also communication challenge of too many results
  - **Defining carbon budget or emission pathway** on a regional/national level

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Explore the data behind ETP