

# **IEA Analysis on Grid and Energy Systems Integration**

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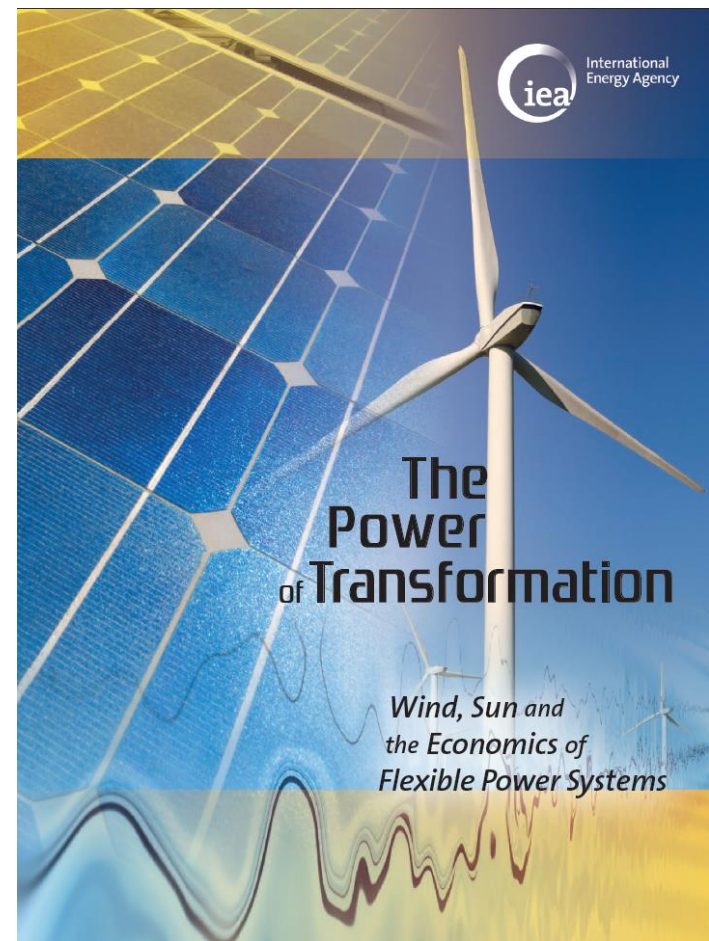


# The Grid Integration of Variable Renewables Project - GIVAR



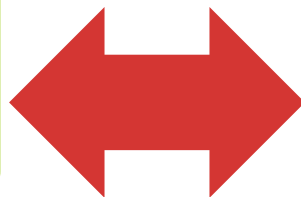
## ■ Third project phase

- 7 case studies covering 15 countries, >50 in-depth interviews
- Technical flexibility assessment with revised IEA FAST tool 2.0
- Detailed economic modelling at hourly resolution

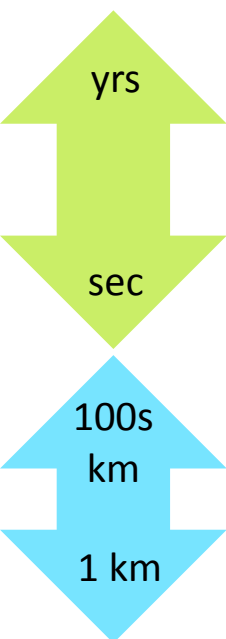


# Interaction is key

**Properties of variable renewable energy (VRE)**



**Flexibility of other power system components**

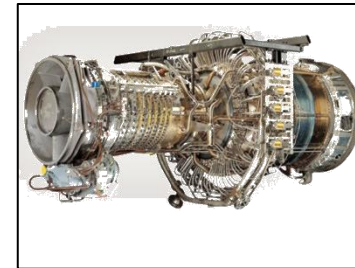


- **Variable**
- **Uncertain**
- **Non-synchronous**
- **Location constrained**
- **Modularity**
- **Low short-run cost**

**Grids**



**Generation**



**Storage**



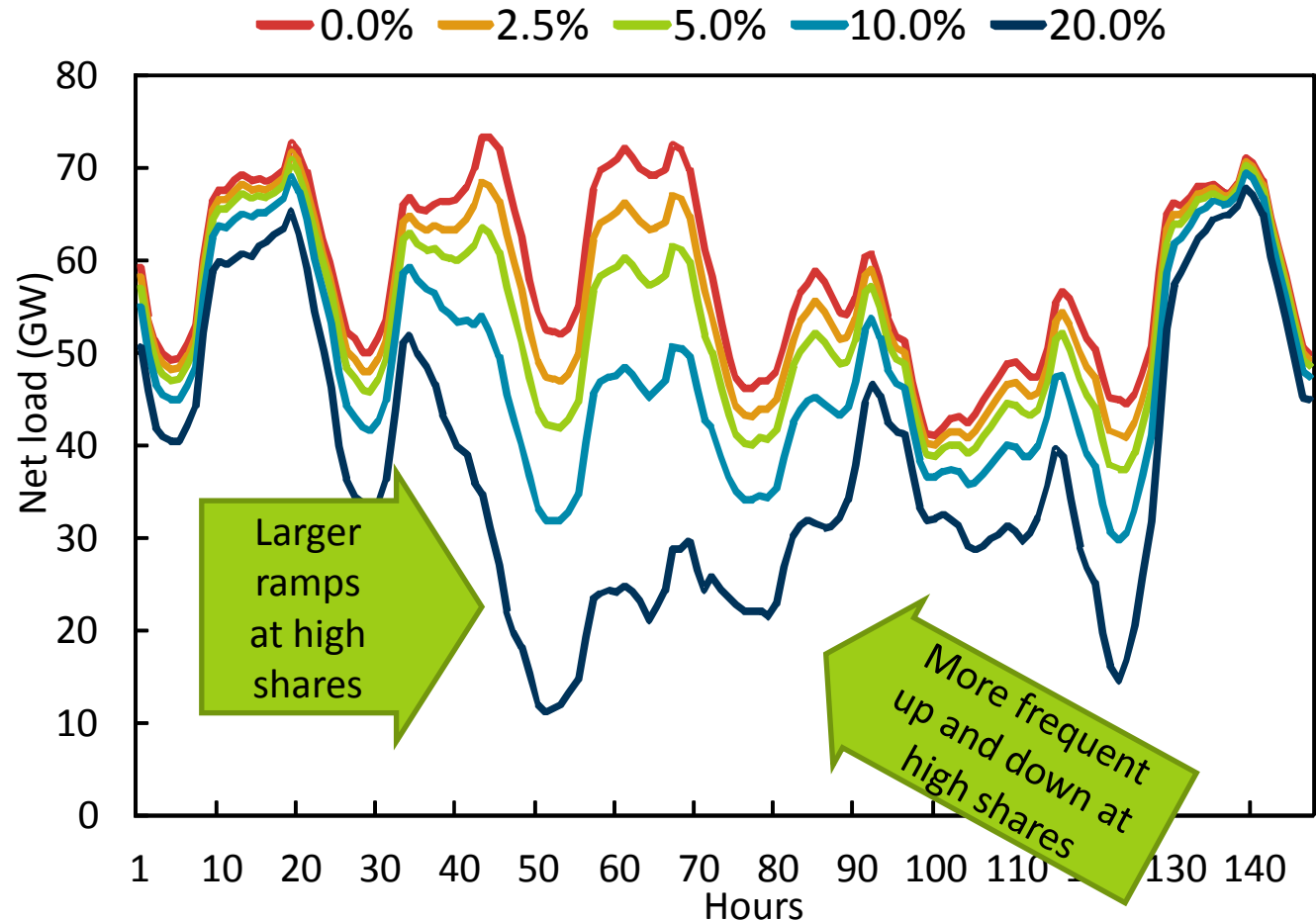
**Demand Side**



# Main persistent challenge: Balancing

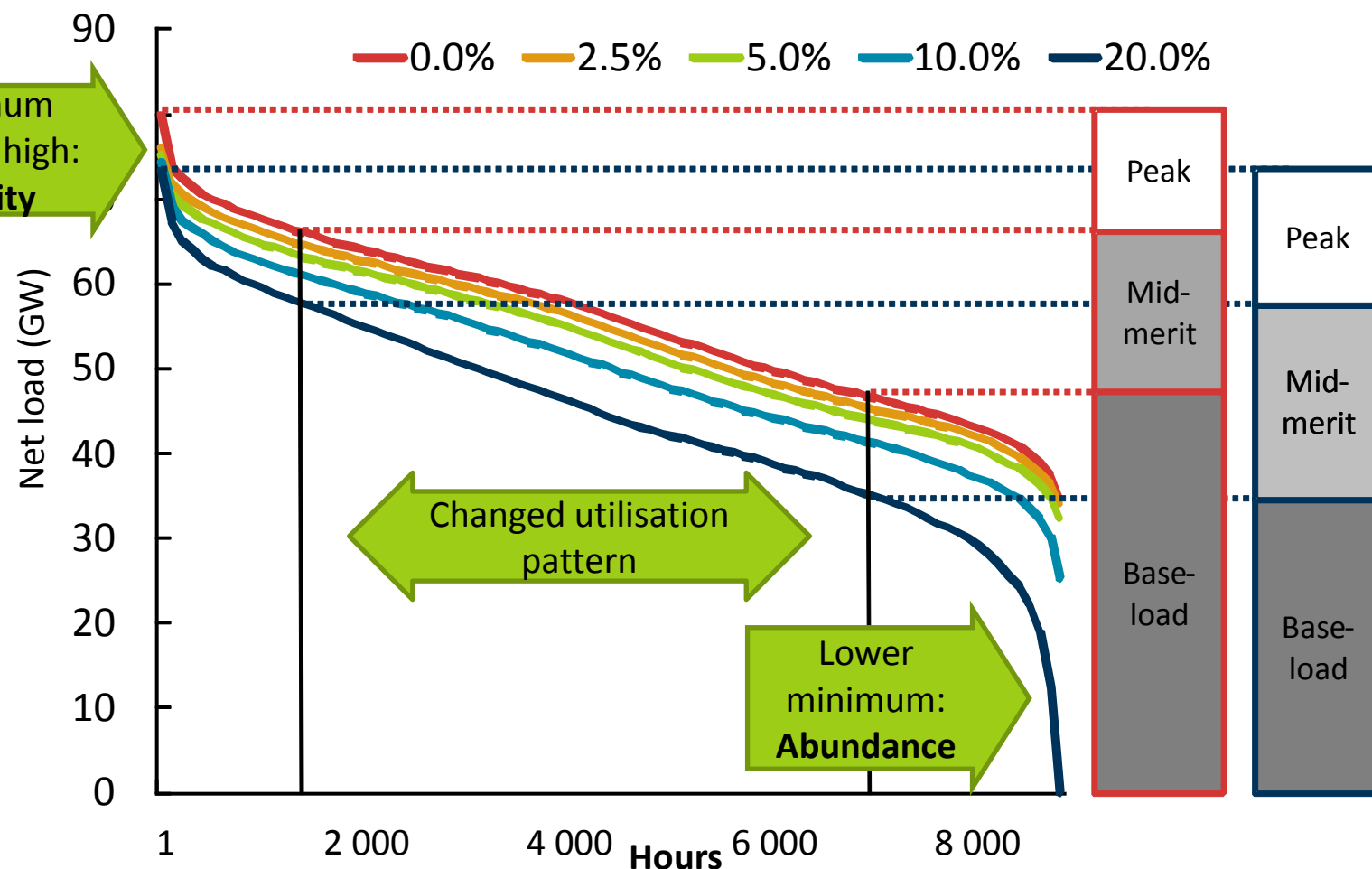
- Higher uncertainty
- Larger and more pronounced changes

*Illustration of Residual power demand at different VRE shares*



# Main persistent challenge: Utilisation

## ■ Netload implies different utilisation for non-VRE system



Note: Load data and wind data from Germany 10 to 16 November 2010, wind generation scaled, actual share 7.3%. Scaling may overestimate the impact of variability; combined effect of wind and solar may be lower, illustration only.



# Three pillars of system transformation

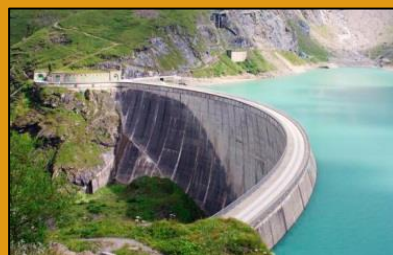
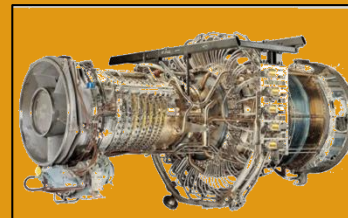
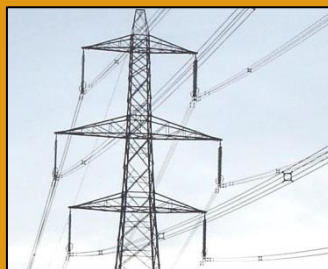


Technology  
spread

Geographic  
spread

Design  
of power  
plants

System  
friendly  
VRE



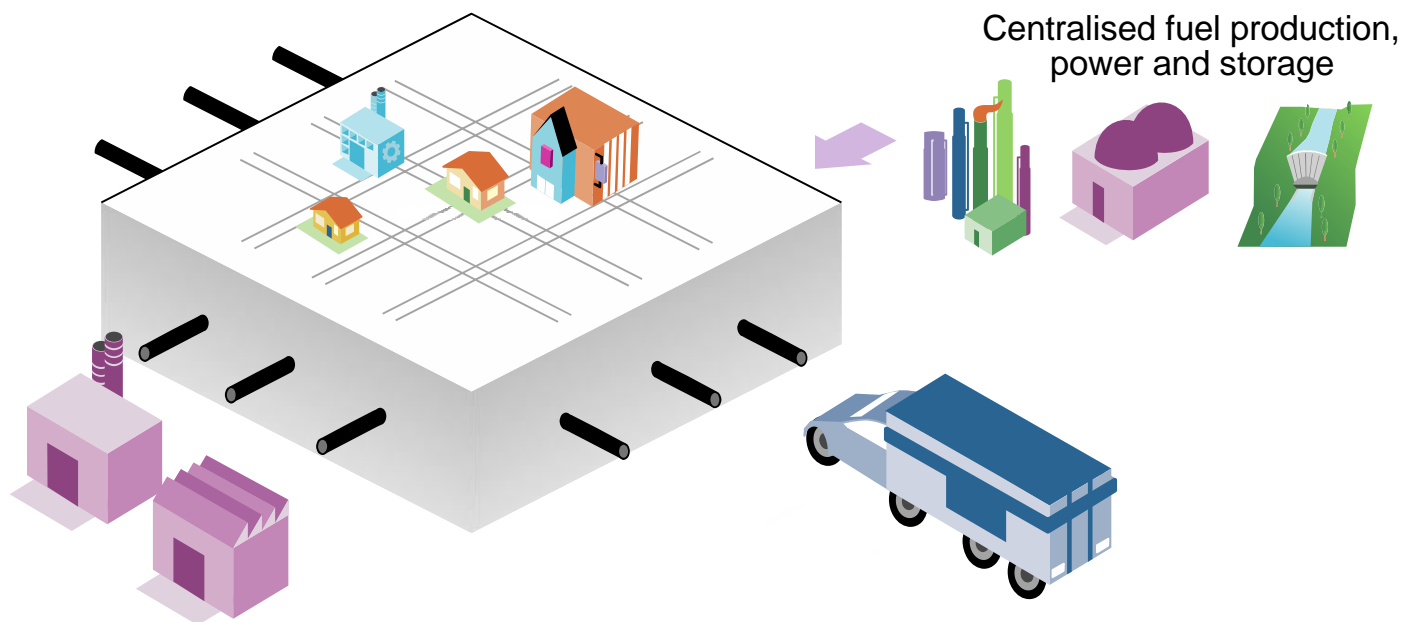
*Investments*



*Operations*

# ETP Systems Integration Analysis

## Changing energy system paradigms

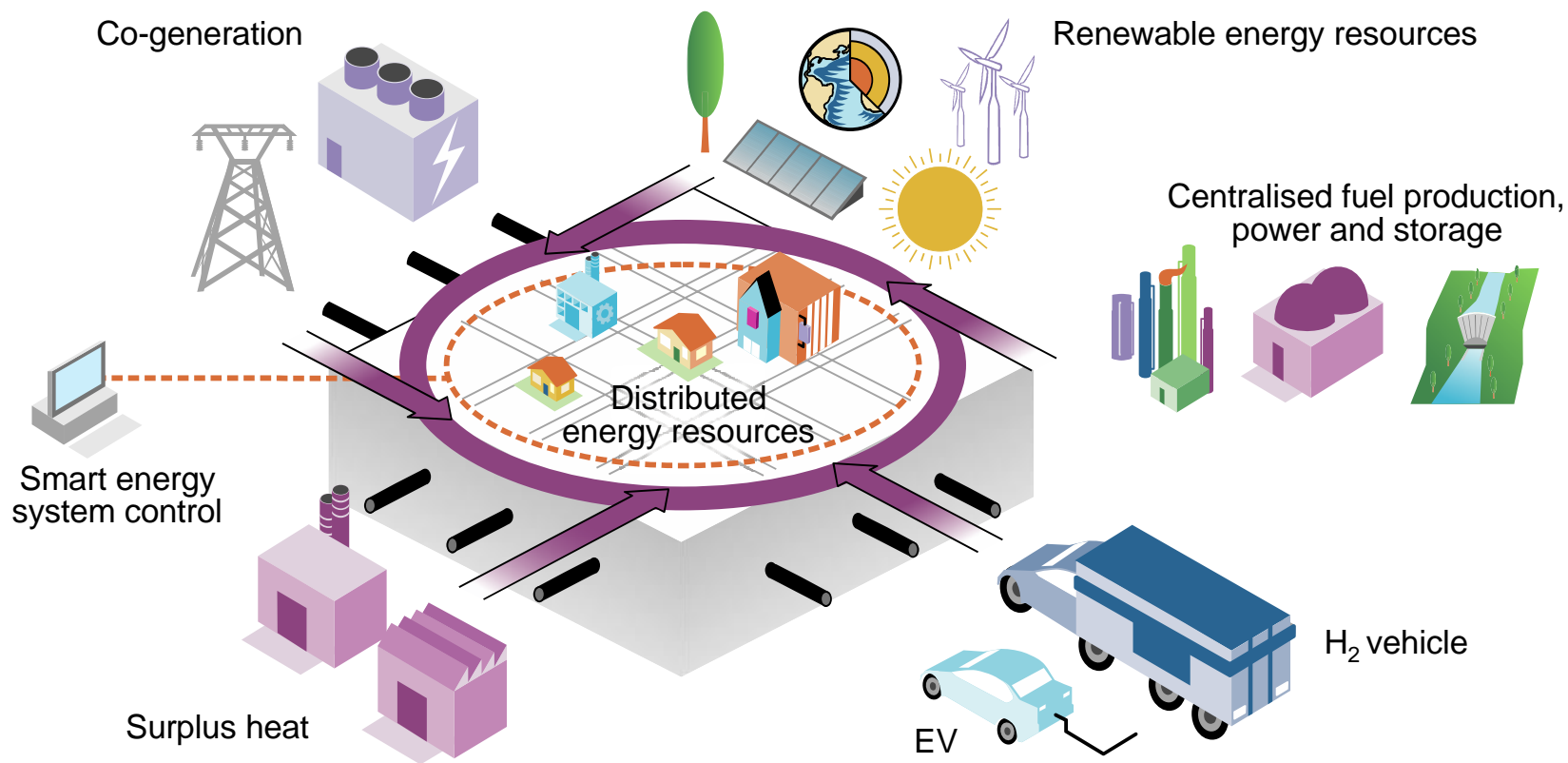


*Today's energy system paradigm is based on a unidirectional energy delivery philosophy*

ETP  
2014

# ETP Systems Integration Analysis

## Changing energy system paradigms

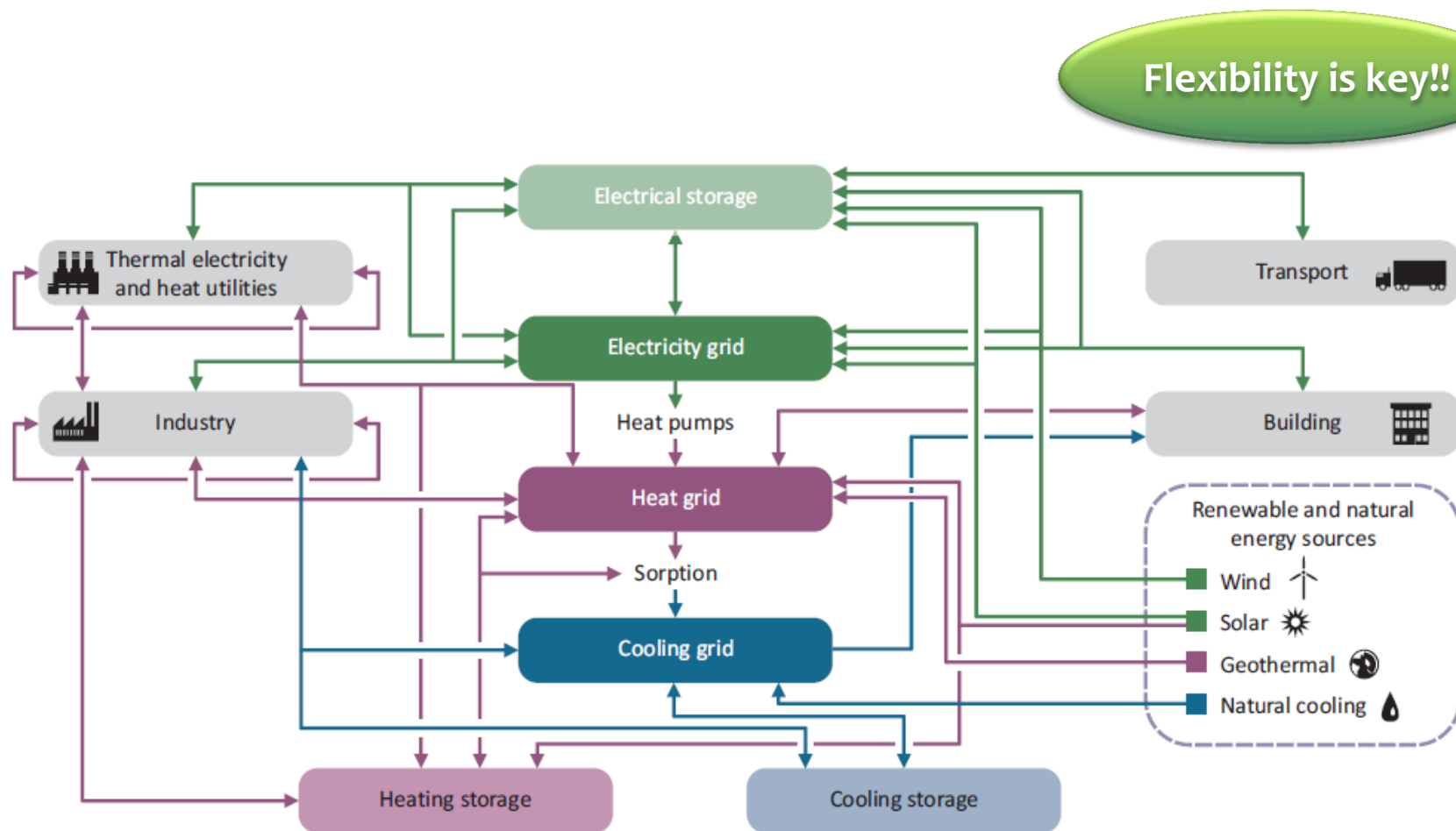


*A sustainable energy system is a smarter, multidirectional and integrated system that requires long-term planning for services delivery*



# Electricity and thermal systems

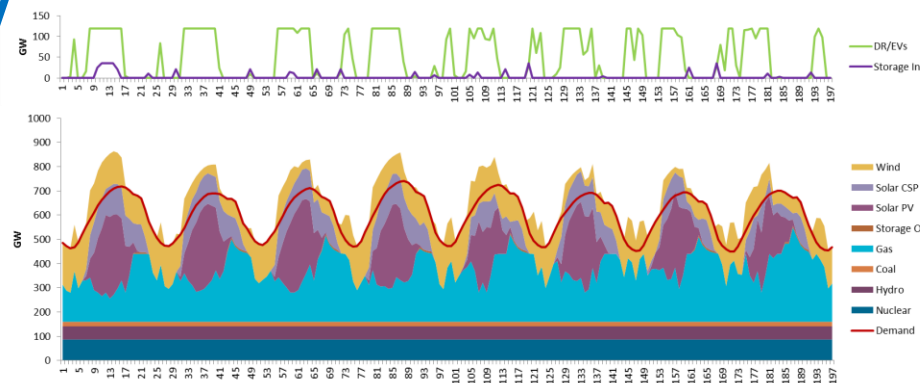
## Opportunities for deep integration



Source: Linking heat and electricity systems: Co-generation and DHC solutions for a clean energy future. IEA, 2014.

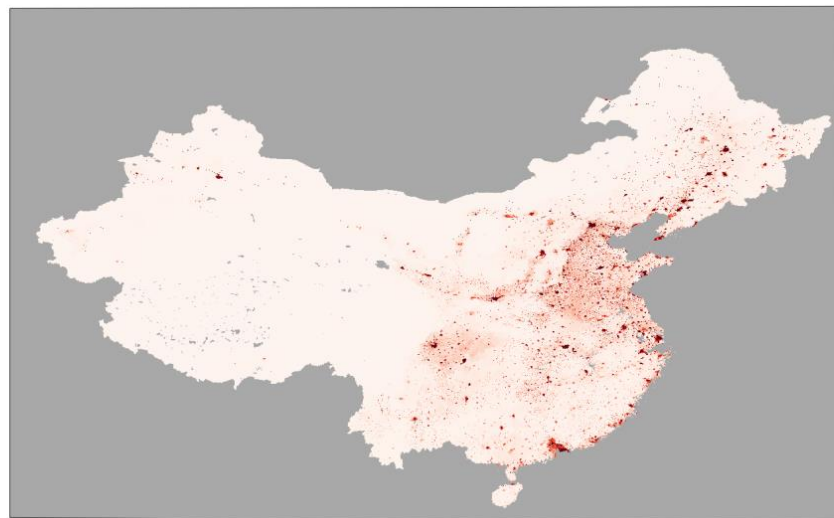
## ■ Holistic assessment of flexibility options with detailed time-resolved system models

- E.g. demand response from heat pumps with heat storage/flexible district heating)

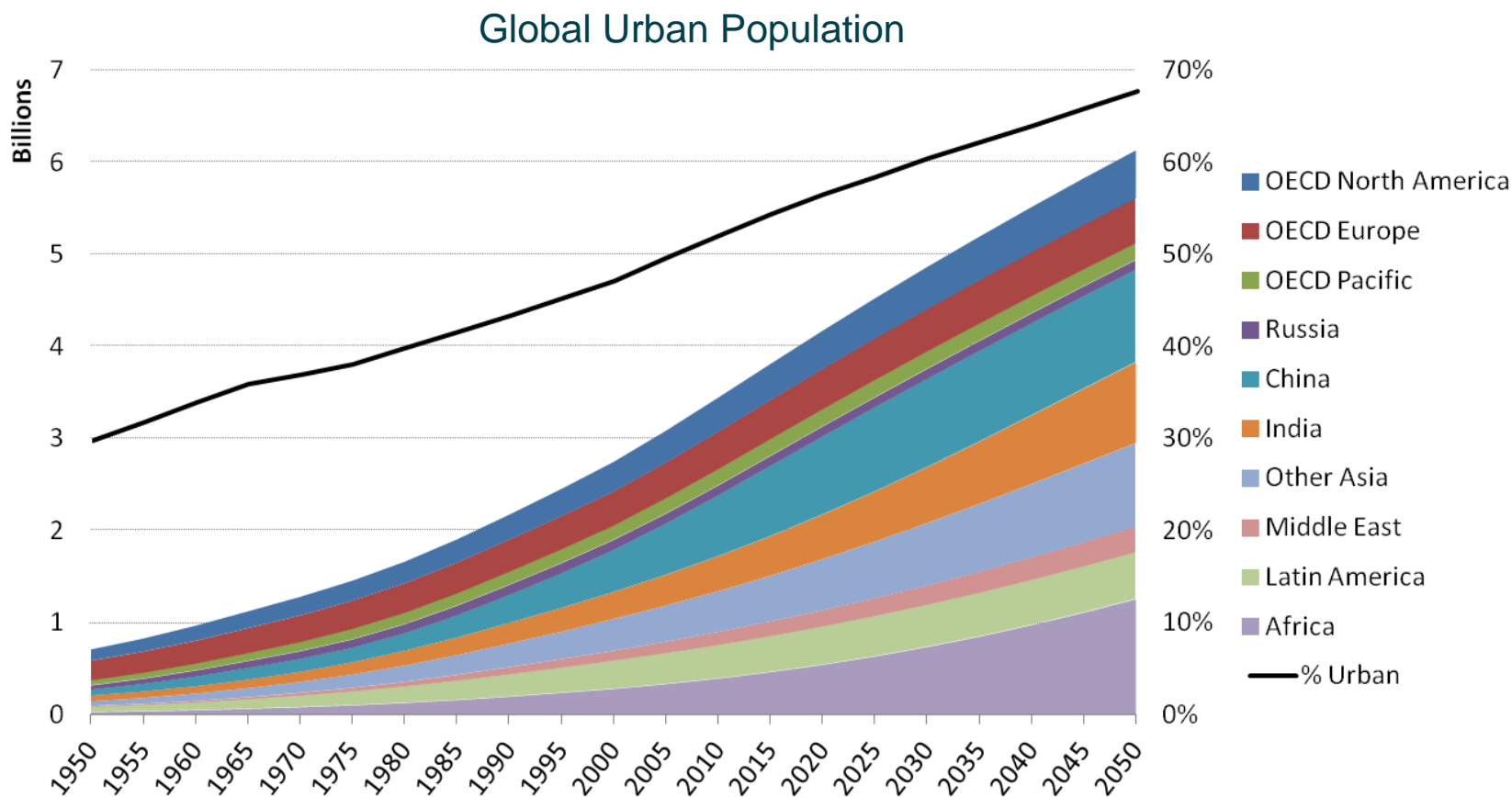


## ■ Heat mapping to evaluate global economic potential for DH

- Spatial distribution of heat demand based on bottom-up projections
- Part of energy system scenarios looking at all technology options for heating buildings



# ETP 2016: A Tale of Sustainable Cities

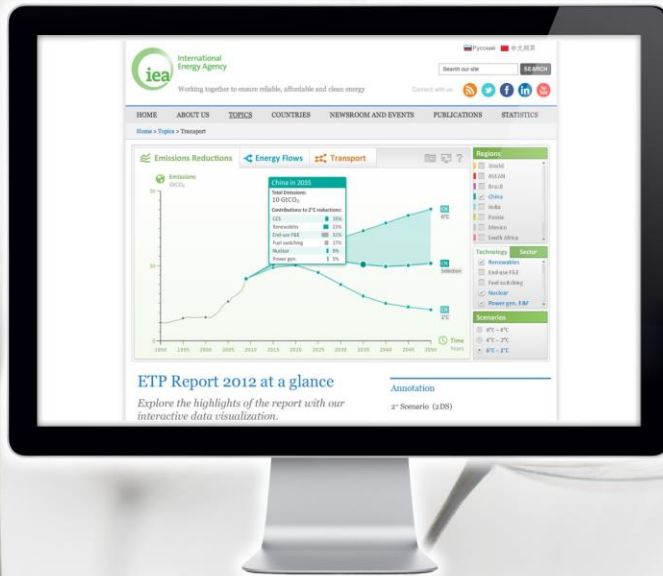


Source: UN DESA, 2012

*Global urban populations are growing rapidly,  
and with them demand for energy in cities*



# Explore the data behind *ETP*



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