

# Technical and Institutional Solutions for the European Transmission and Distribution Systems in the Energy Transition Towards Renewable Energy

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Forum on future electrical energy system vision, Hongo Campus, Univ. of Tokyo, 18 April 2018

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# Overview

1. **Introduction: ENTSO-E, ETIP SNET**
2. Future vision for Europe's power grid around 2050:
  - a) ETIP SNET Vision: Efficient markets, sector coupling, customer choice
  - b) eHighways 2050: Grid architectures
  - c) TYNDP 2018 scenarios and system needs for 2040
3. Technical and political issues of cross-border energy transfer for a RES-dominated system:
  - a) Network Codes as prerequisite for integrated system and market enabling more RES
  - b) Windless winter weeks and Gas for Climate (Ecofys study, Feb. 2018)
  - c) Clean Energy for All Europeans Package incl. TSO/DSO cooperation
4. Summary

# ENTSO-E and legal mandates



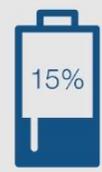
43 TSOs in 36 countries



300 000 km of transmission lines

7 times the earth's circumference

3300 TWh electricity consumption



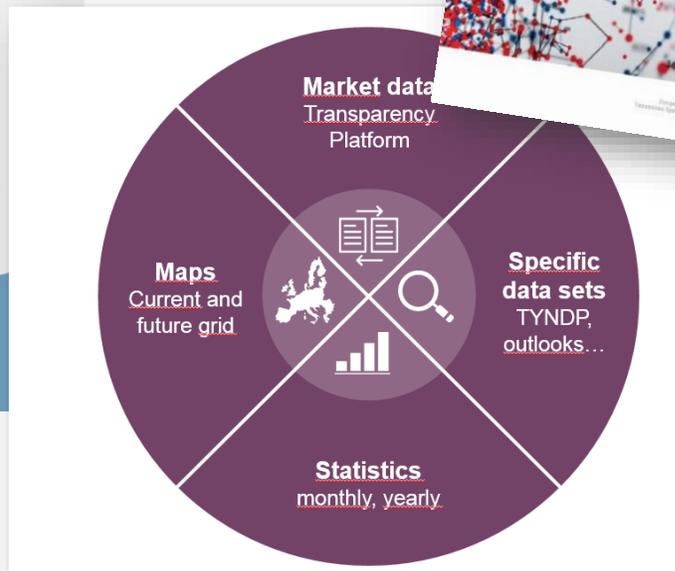
15% of the global electricity consumption



over 500 million customers served



network codes



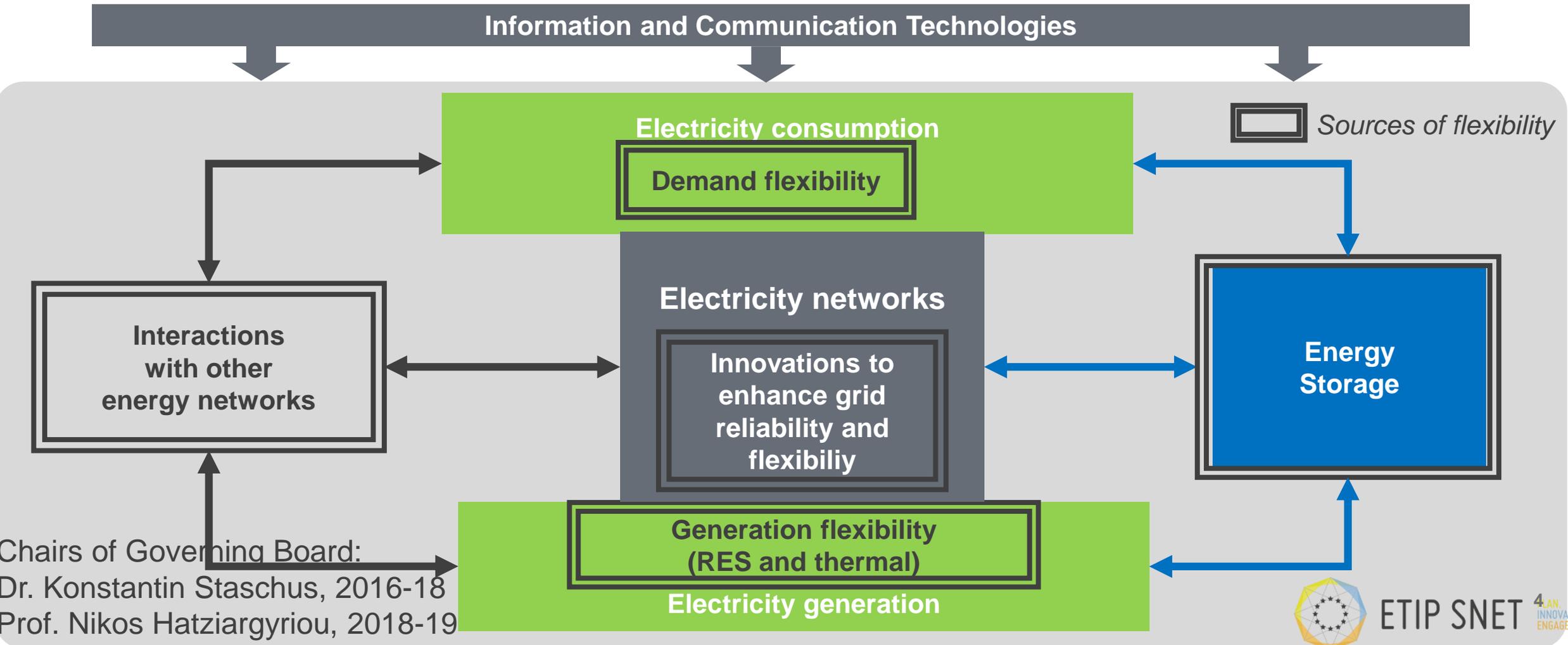
Secretaries-General:  
Konstantin Staschus, Ph.D., 2009-2017  
Laurent Schmitt, beginning 2017

# ETIP SNET: European Technology & Innovation Platform

## “Smart Networks for Energy Transition” - RD&I prioritisation

**Electricity network = backbone of the overall, sector-coupled energy system**

**Offers flexibility solutions, enables the integration of all flexibility means and decarbonizing other sectors**



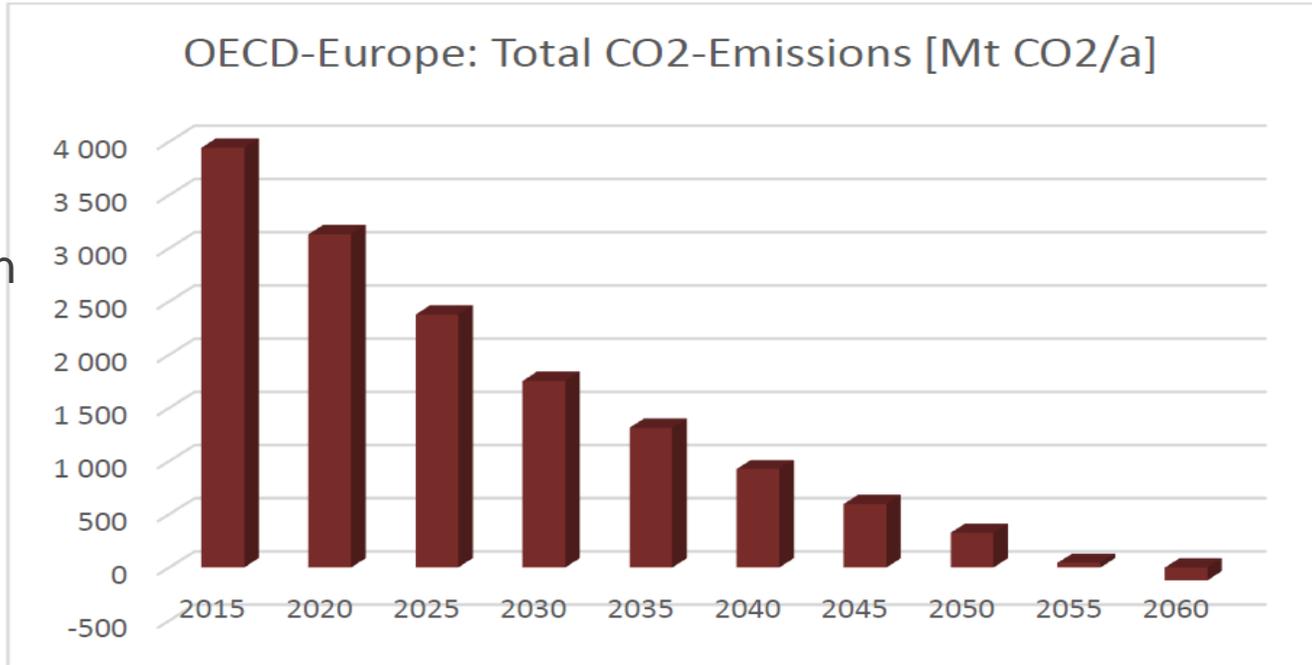
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# ETIP SNET Vision, to be published June 2018

A low-carbon, secure, resilient, accessible, cost-efficient, market-based pan-European **integrated energy system**,...

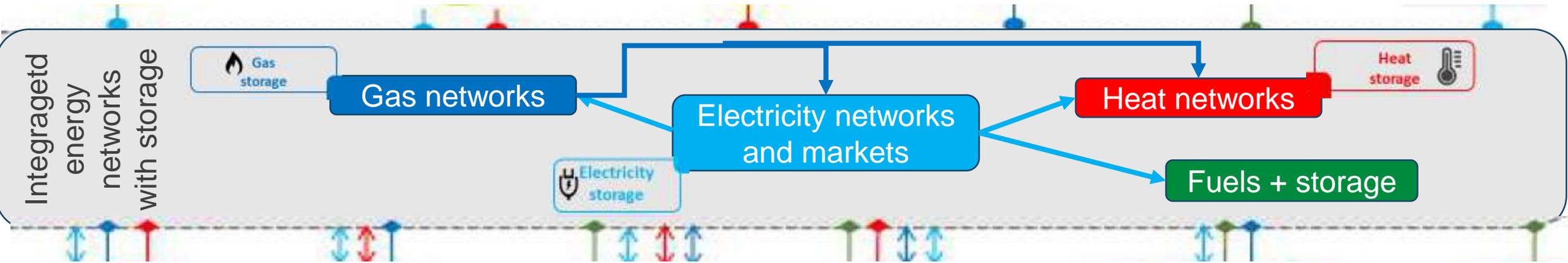
paving the way for a CO<sub>2</sub>-neutral and circular economy beyond 2050.



The goal of **efficient markets** is met by means of:

- Informed prosumer choices
- Tailored info services
- Procurement of any energy-related needs anytime
- Automatic, market-based balancing of unplanned deviations in real-time
- Integrated infrastructure for all energy vectors with electricity system as backbone

Renewable electricity, heat/cooling, gas, fuel; nuclear



Households. tertiary sector. industry agriculture. transport

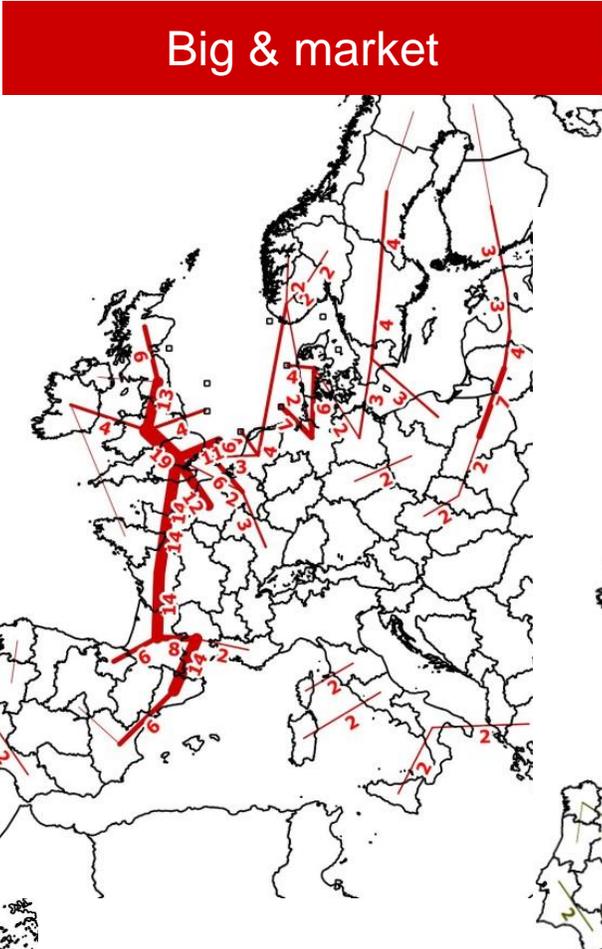
# eHighway2050 study: 2012-15, Grid architectures

Small & local

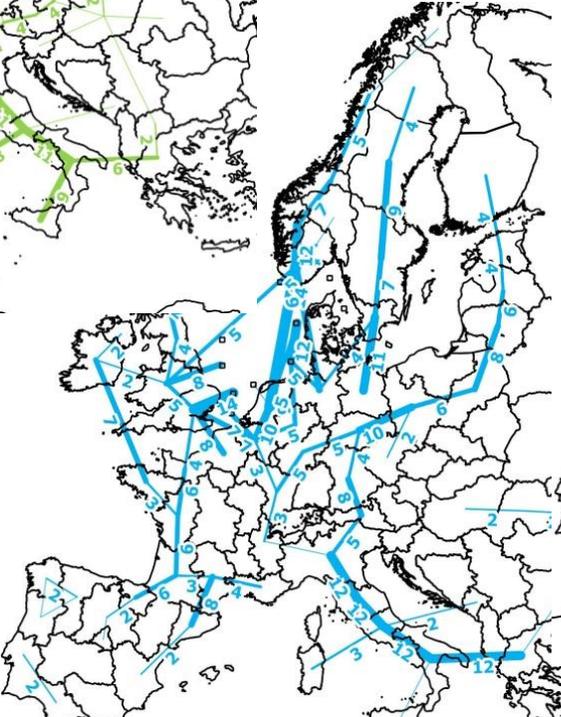
Large scale RES



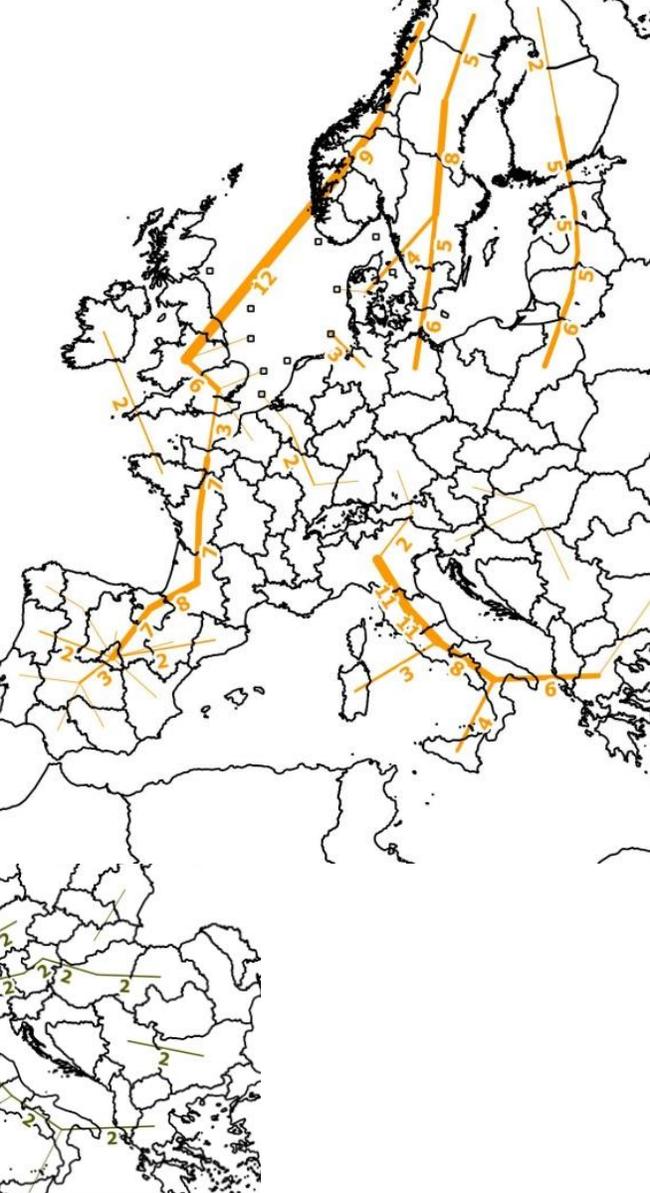
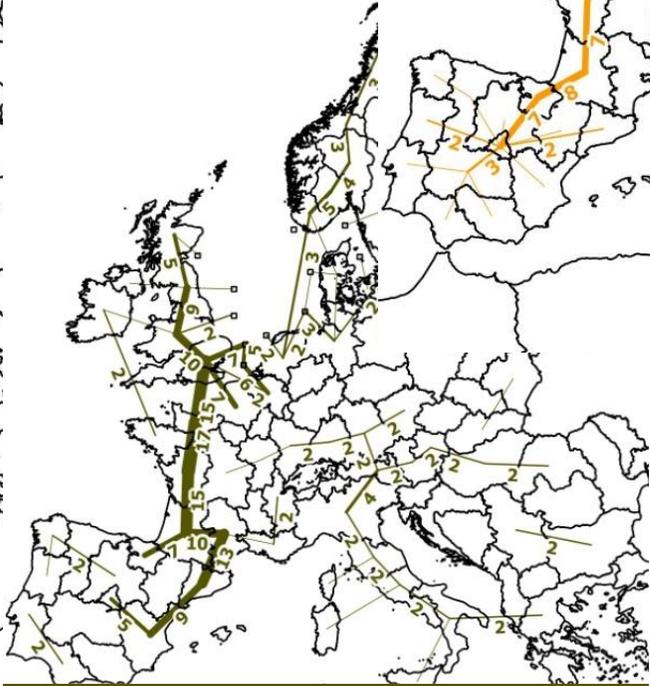
Big & market



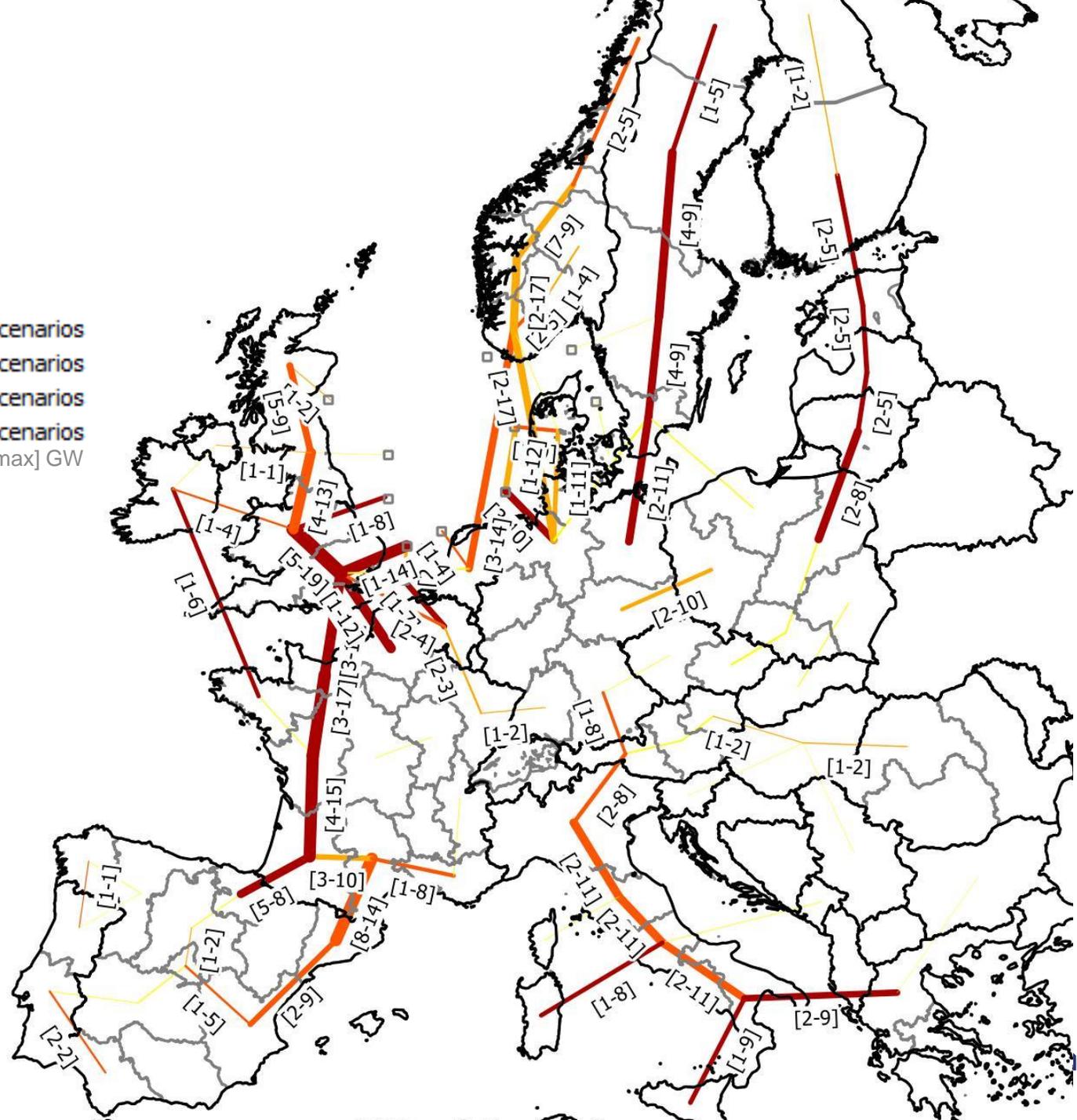
100% RES



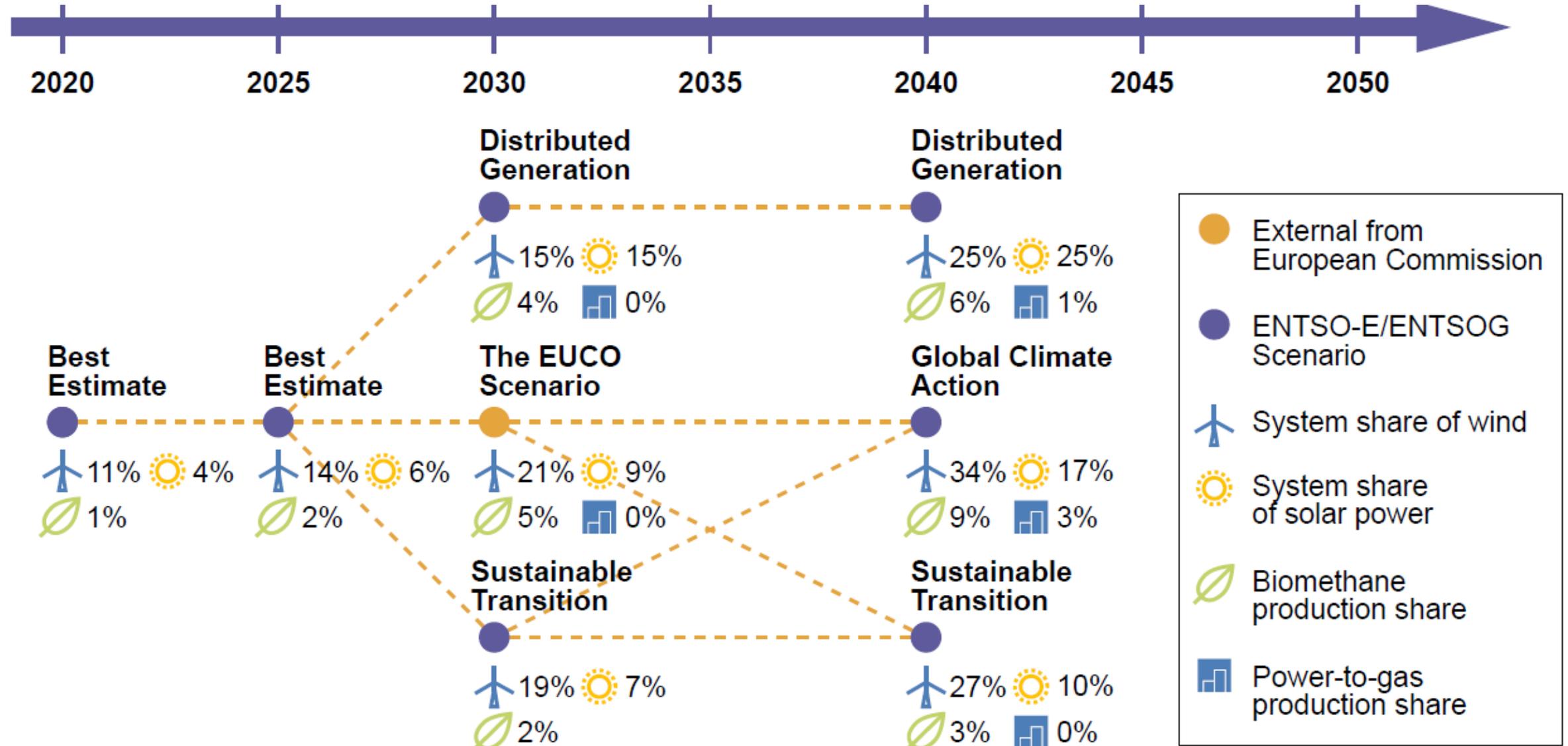
Fossil & nuclear



# eHighway2050: Robust grid extensions for different scenarios, at 500-550 kV, from Europe's periphery to the center

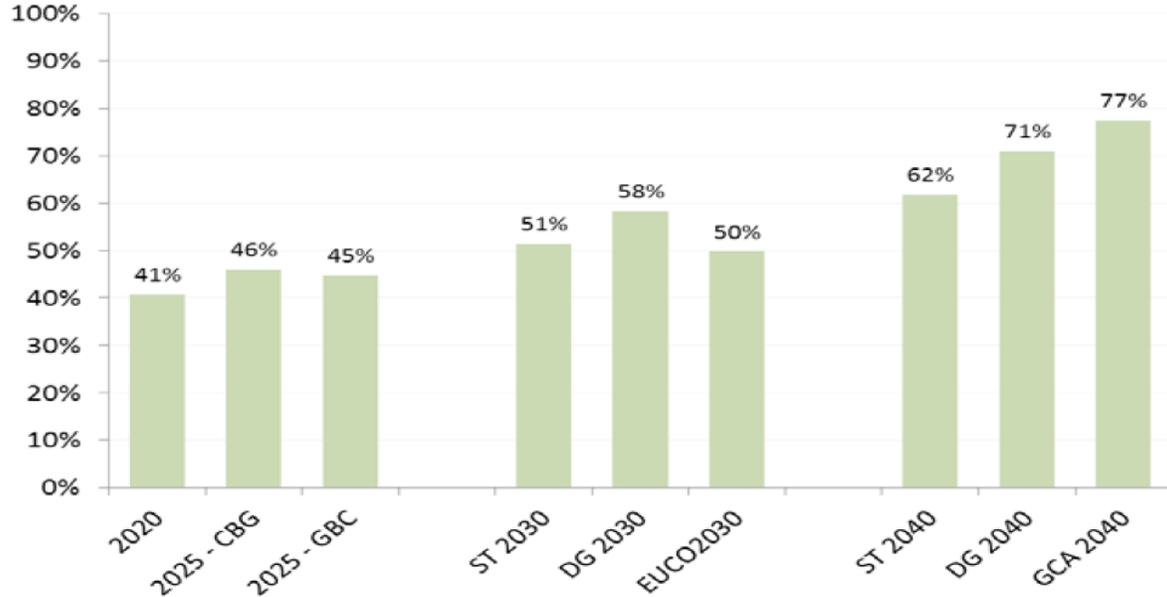


# TYNDP 2018: Scenarios to 2040

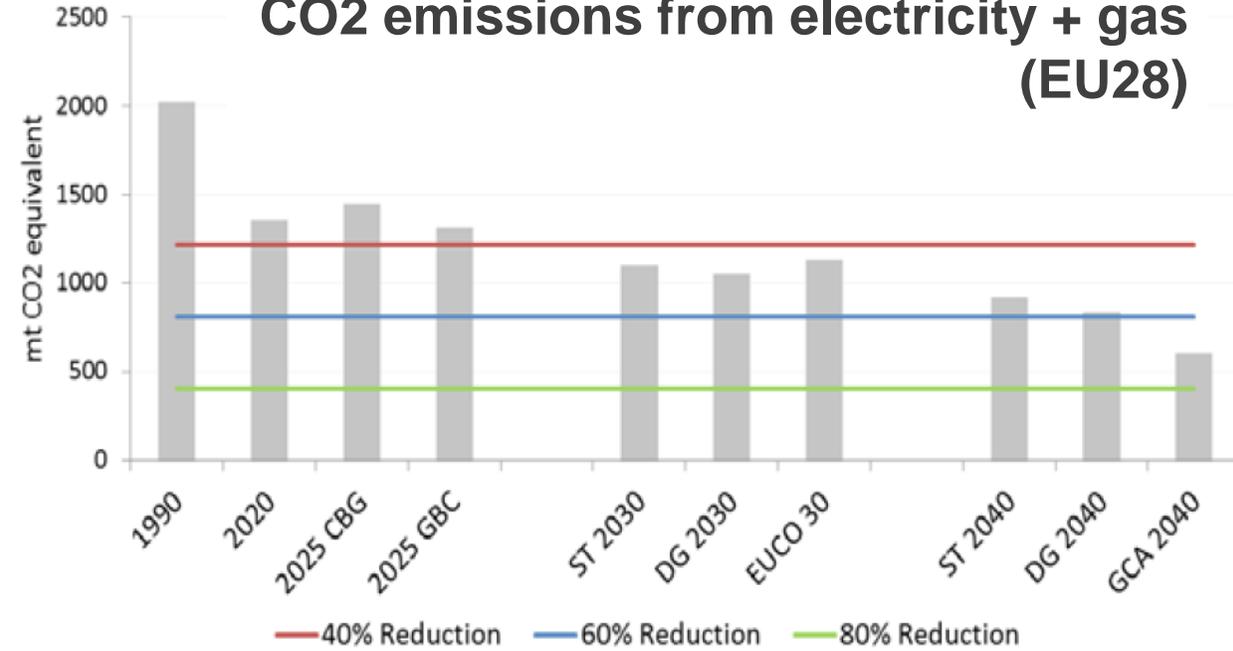


# TYNDP from 2020 to 2040: RES, CO<sub>2</sub>, EVs, HPs

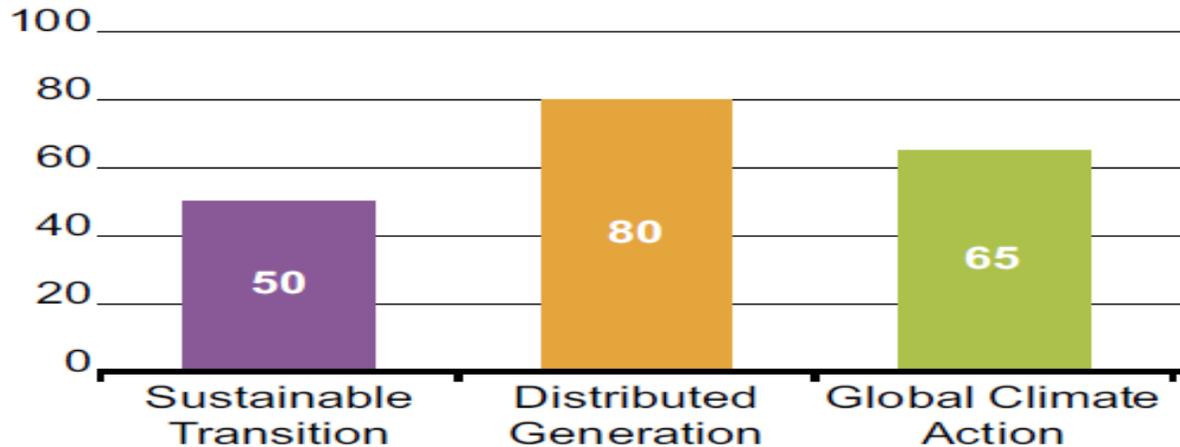
## Electricity RES - % of TWh demand



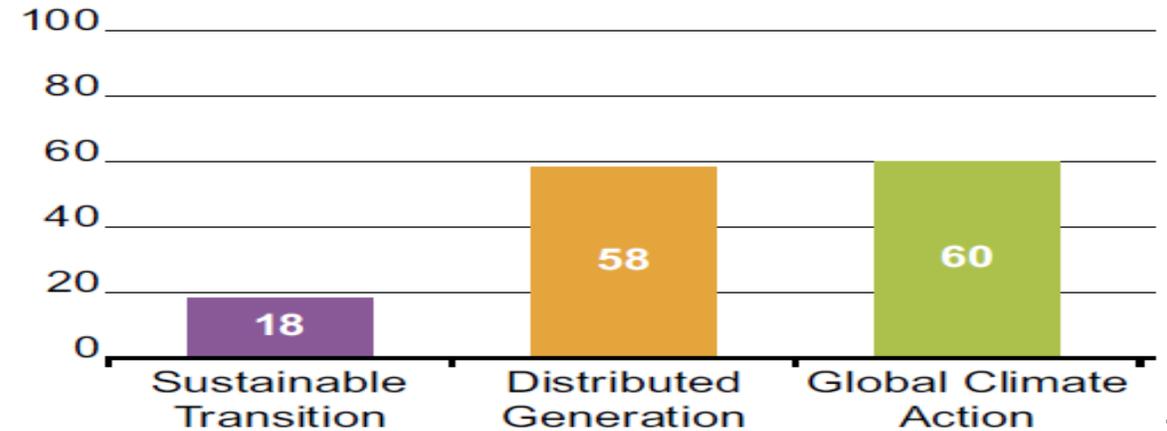
## CO<sub>2</sub> emissions from electricity + gas (EU28)



## Electric vehicles in millions



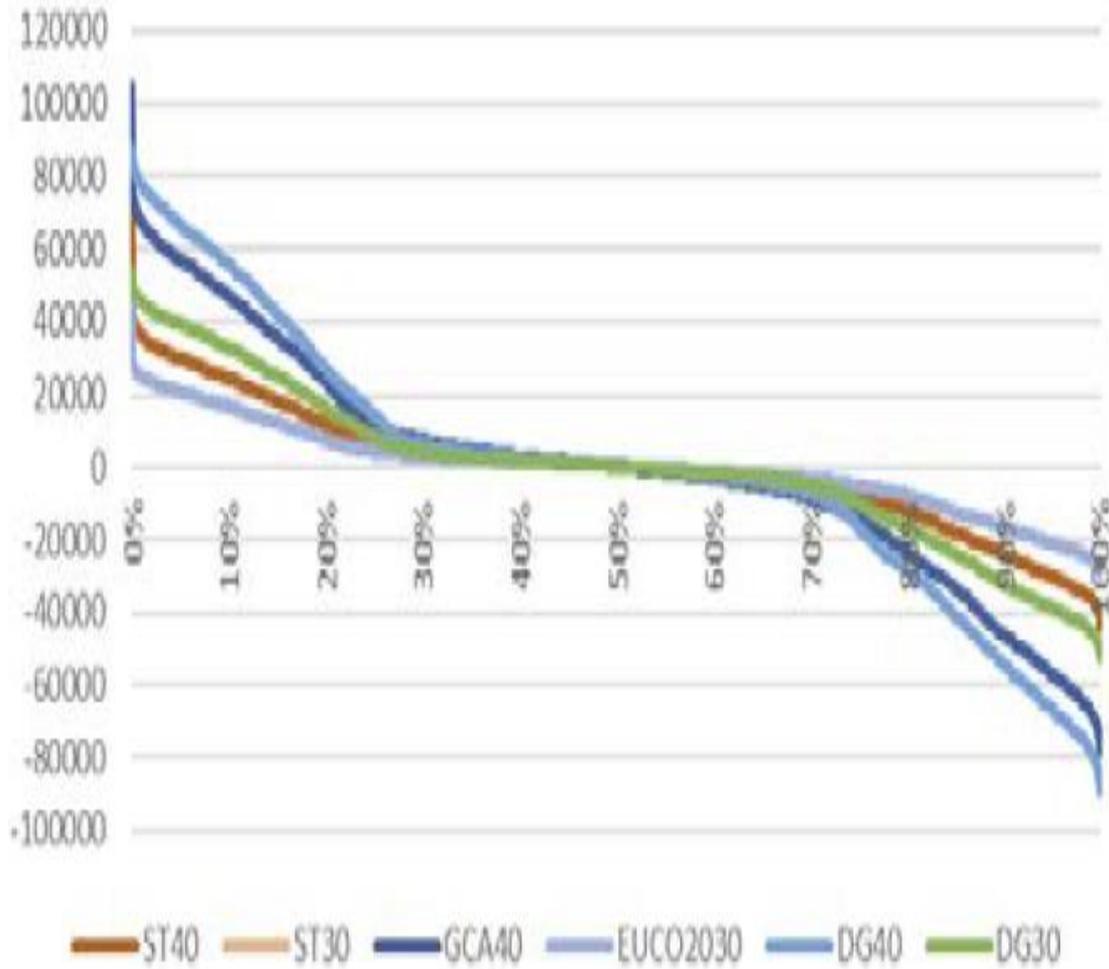
## Electric heat pumps in millions



# Flexibility needs: Hourly ramps, inertia

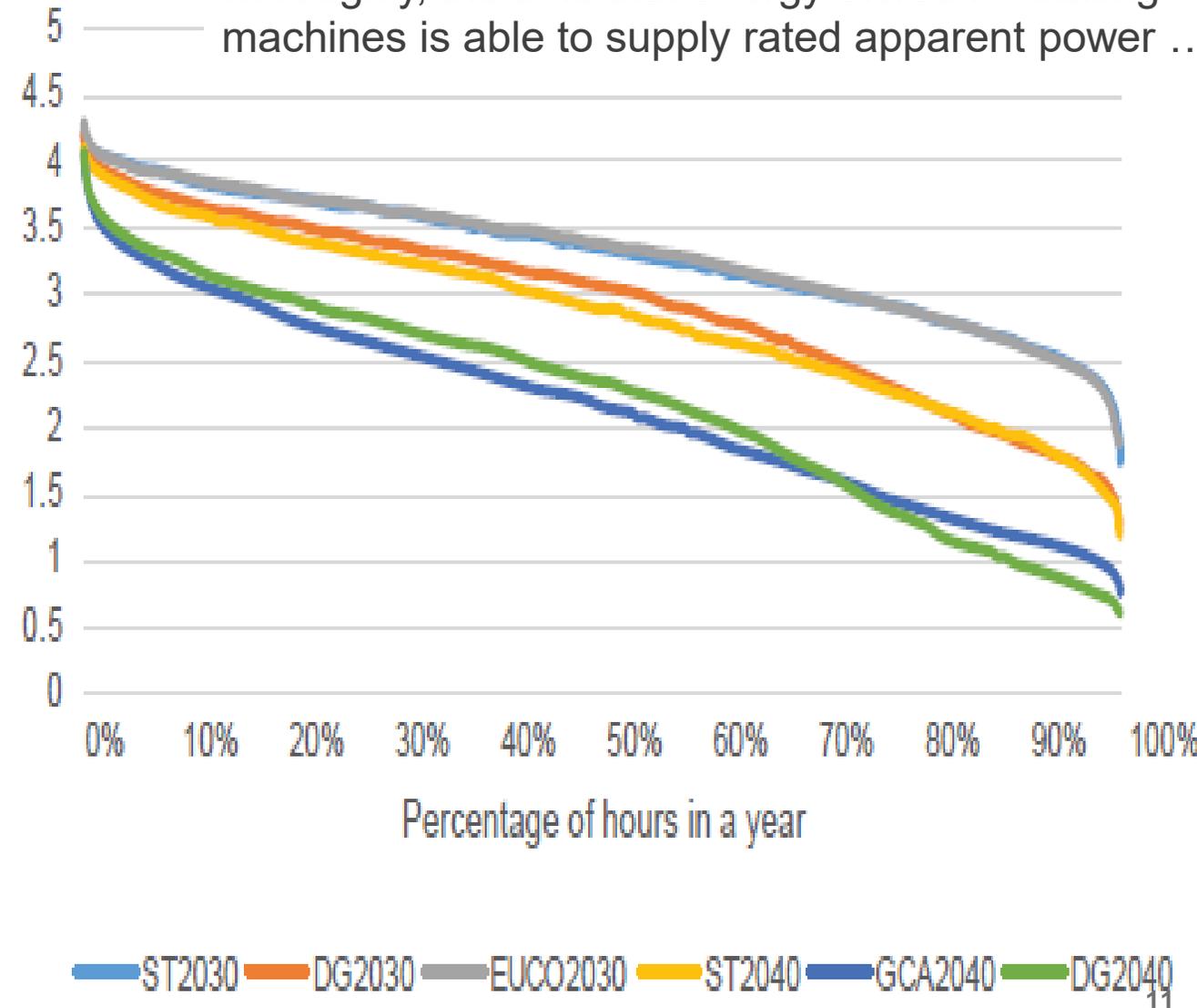
Hourly ramps of residual load [MW/h]

CE



Synchronous Area Inertia (H(s)) – CE

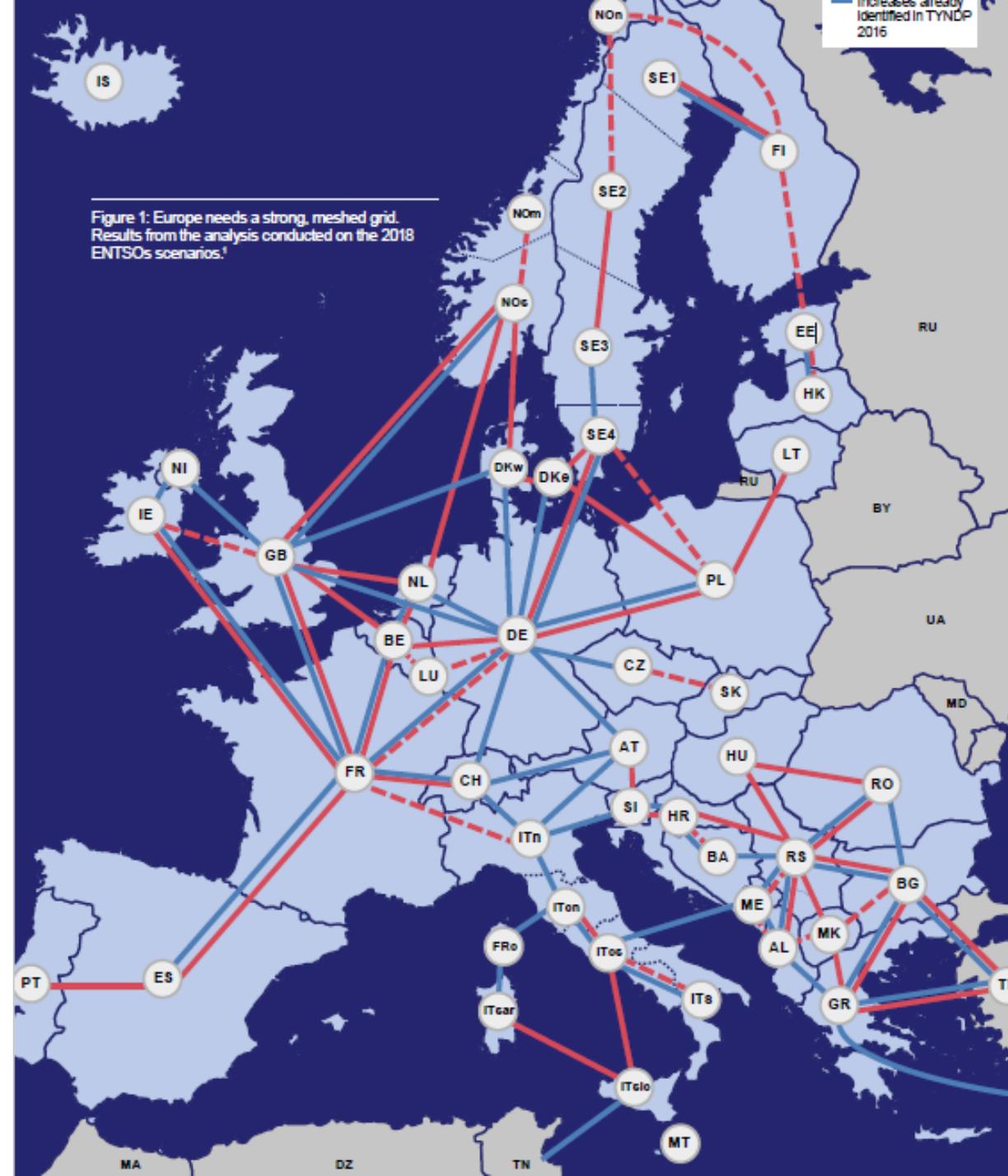
... roughly, the time that energy stored in rotating machines is able to supply rated apparent power ...



# TYNDP 2018: System needs 2040

-  Needs already identified 2016 for 2030
-  Increases beyond 2030 in only 1 scenario
-  Increases beyond 2030 in  $\geq 2$  scenarios

- Centralised and decentralised energy coexist
- Grid costs: 150 billion € in total (TYNDP2016); new investments needed after 2030
- “No grid” in 2040: extra bill by 2040: 43 billion €/yr
  - ❖ Would threaten reliable access to electricity
  - ❖ 156 TWh/yr of RES wasted
- eHighways2050 architectures becoming visible
- Flexibility challenges: ramps, inertia



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# NETWORK CODES/GUIDELINES: THE FOUNDATIONS OF THE INTERNAL ENERGY MARKET

## 3 CONNECTION CODES

### Requirements for:

- Generators
- Demand side
- HVDC connections

...paving the way for  
offshore wind...

## 3 MARKET CODES

### Rules for:

- Capacity calculation
- Day ahead / Intraday
- Forwards
- Balancing

...market coupling...

## 2 OPERATIONAL CODES

### Rules for:

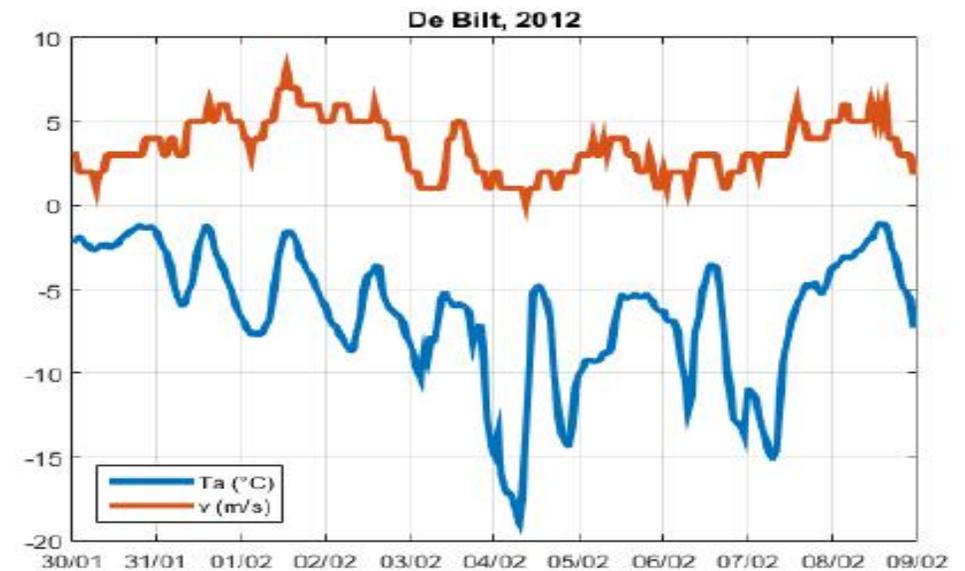
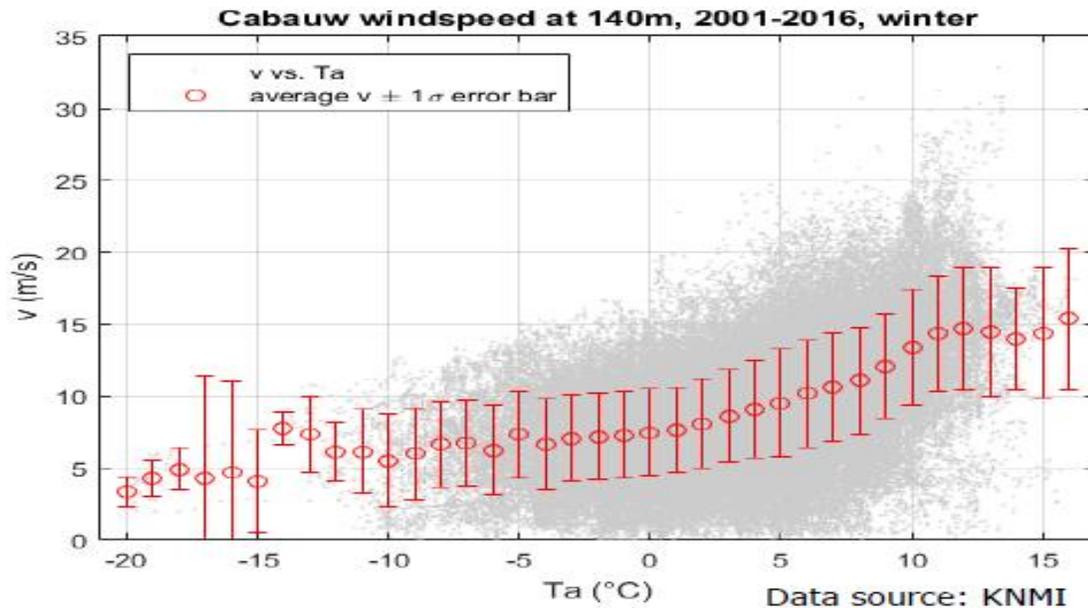
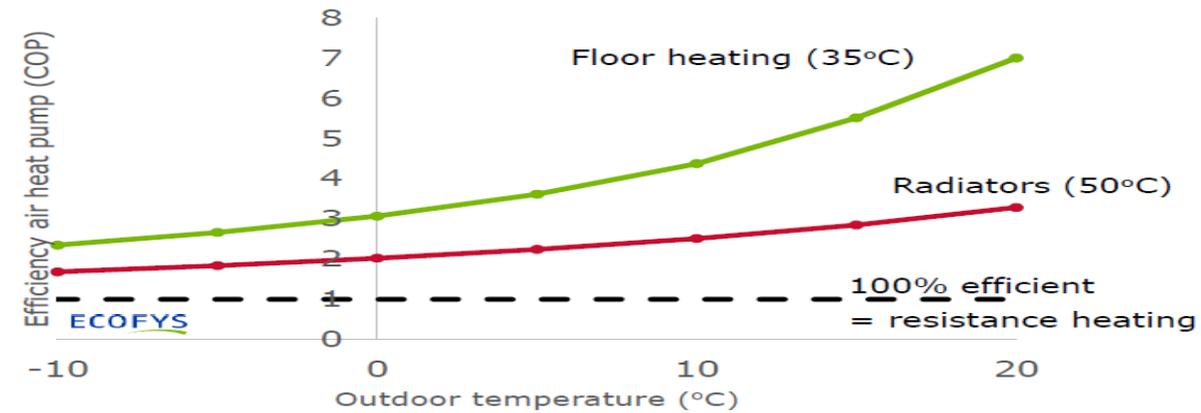
- System Operation
- Emergency situations

...regional cooperation  
to increase security...

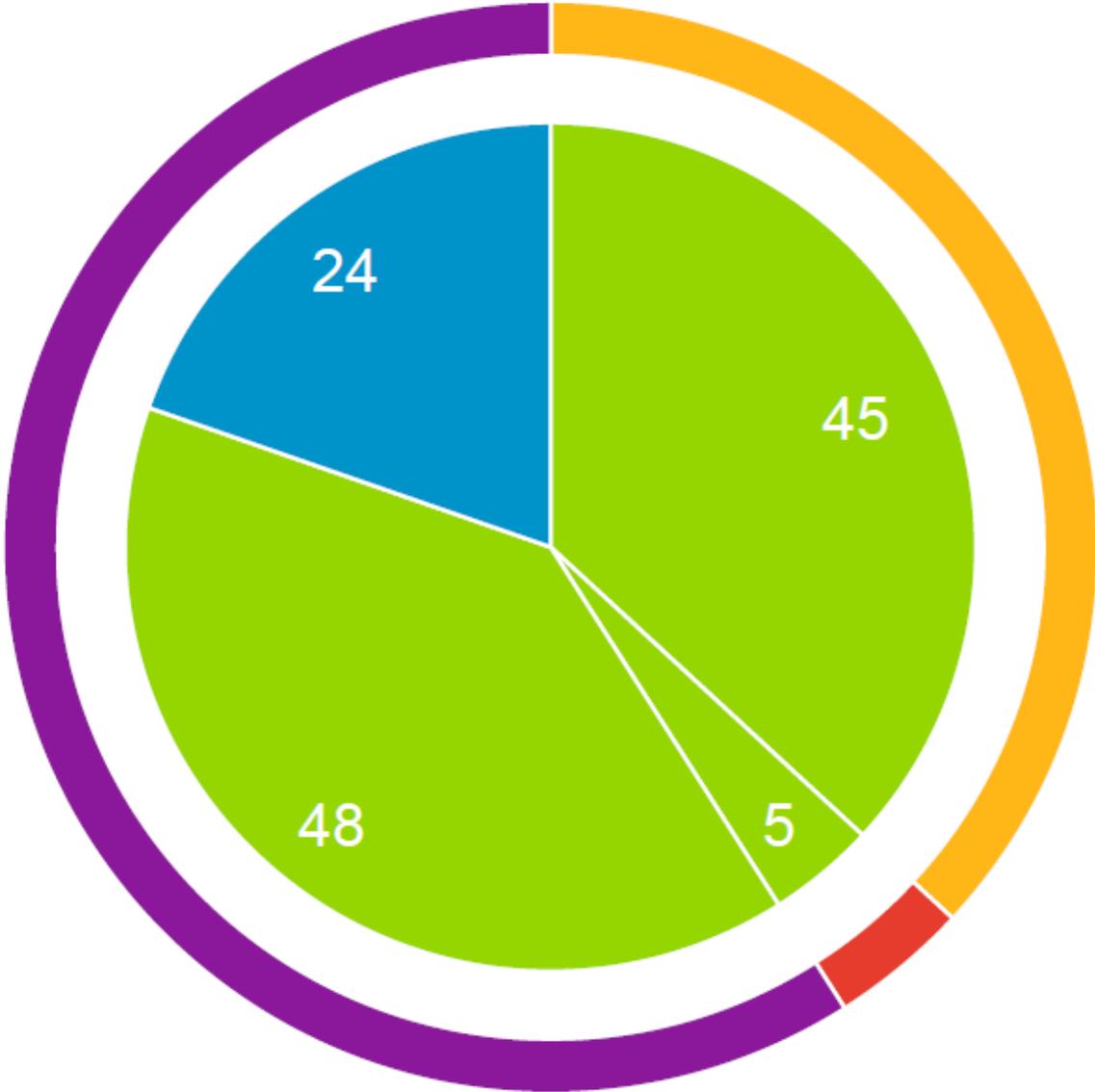
# When it's really cold in the Netherlands, there's less wind...



> Air-source heat pumps are applied a lot, but perform poorly at low ambient temperature:



# Ecofys „Gas for Climate“ Study, 2/2018



- Biomethane
- Power to Gas
- Industry
- Transport
- Buildings and Power generation

**Combining electricity with gas can allow Europe to achieve the Paris Agreement at the lowest cost: 122 billion m<sup>3</sup> of EU-produced renewable gas**

# THE EU'S "CLEAN ENERGY PACKAGE" AIMS AT DEEPENING EUROPEAN INTEGRATION IN THE FIELD OF ENERGY



## Governance Regulation

Each Member State is required to present a national energy and climate action plan for 2021 - 2030



## Revision of the Renewable Energy Directive

Includes general principles that Member States should follow when designing support schemes



## Revision of the Energy Efficiency Directive

Binding EU-wide target of 30% by 2030, commitment to put energy efficiency first



## Electricity market design

Set course for free price formation in Europe (scarcity pricing) to generate investment & create greater flexibility; integration retail-wholesale; TSO-DSO coordination

# Summary

## Future vision:

- EU committed to Paris Agreement & energy system decarbonisation
- Electricity T&D grid central to decarbonisation & sector coupling
- System plans / TYNDPs / adequacy studies considering flexibility, ramp rates, inertia more explicitly

## Technical and institutional issues:

- 8 market, connection, operations Network Codes form the basis
- Biogas, power-to-gas possible solutions to windless winter weeks
- Empowered customer and digitalisation at the center

## TSO/DSO:

- Joint planning needed: E+G (ENTSOs), T+D (TSOs/DSOs)
- TSO balancing – DSO congestion management: institutional challenge
- Align TSO + DSO incentives, (smart meter) data exchange, data hubs

# THANK YOU FOR YOUR ATTENTION



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For more information:

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