ENTSOE
PAC Scenario Workshop

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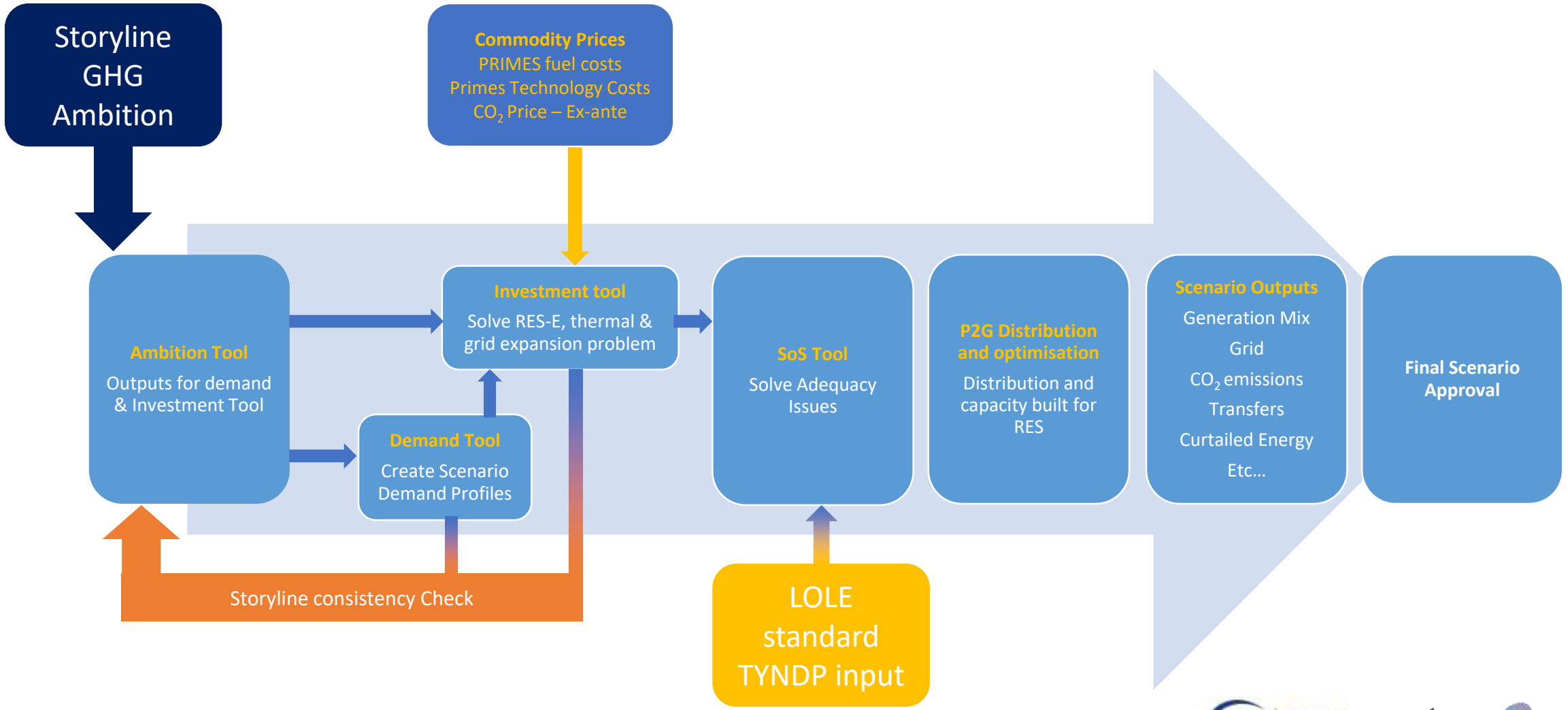
Agenda

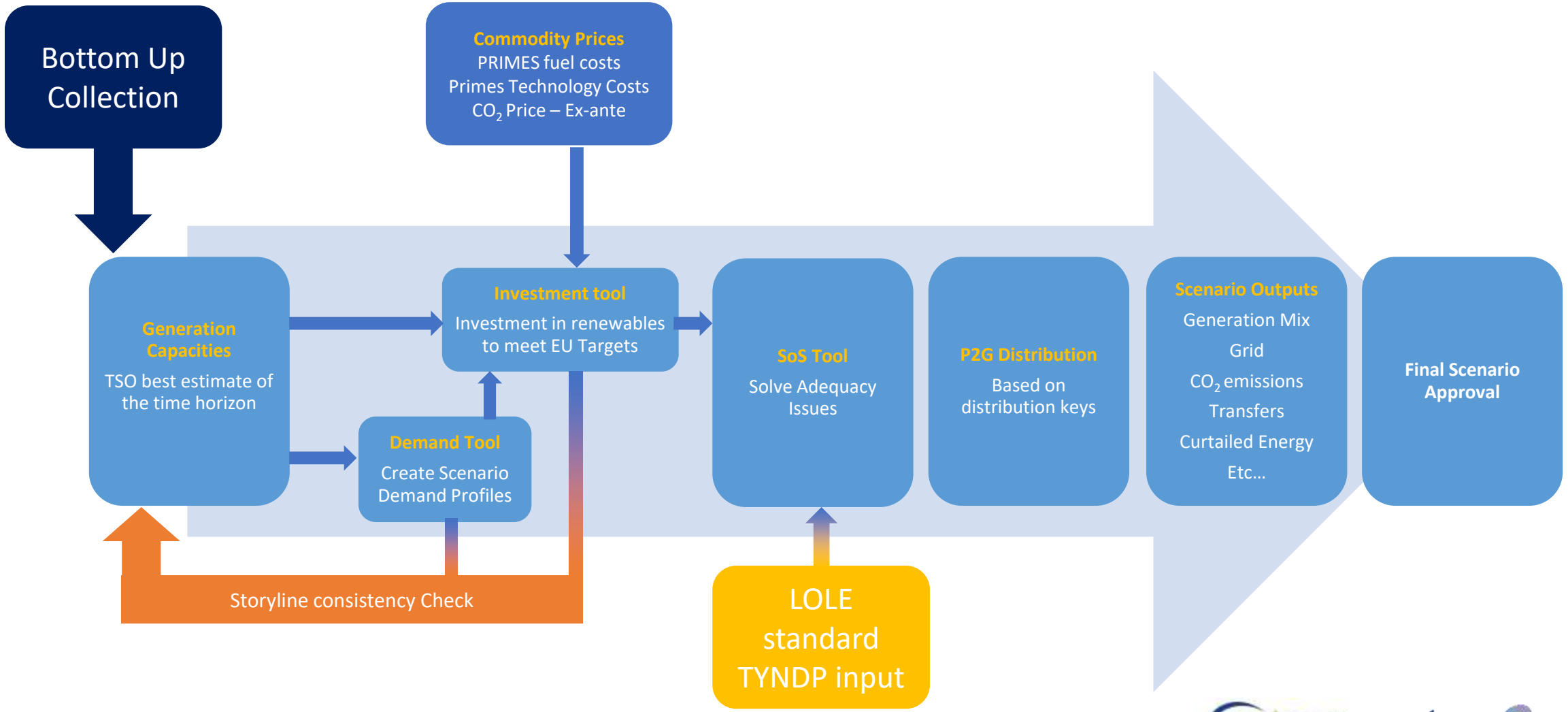
1. Scenario Building High Level Architecture
2. ENTSOs Scenarios
3. Supply and Demand Quantification (method)
4. Carbon Budget Approach
5. Demand

Scenario Building high level architectyre

Top-down Process Steps

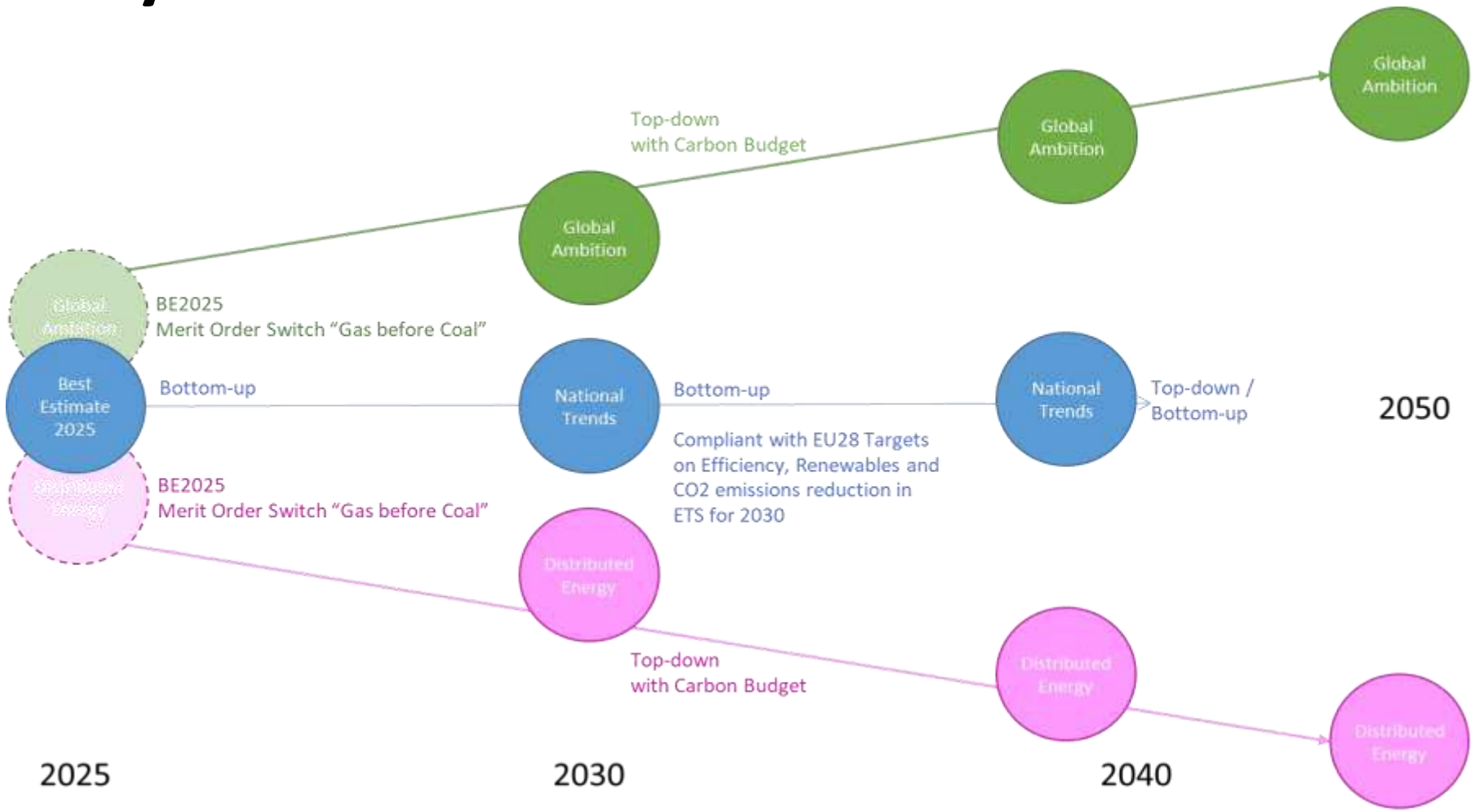


Bottom-Up Process Steps



ENTSOs Scenarios

Storyline to Scenarios



National Trends

- National focus on climate change, driven by ETS and national subsidies
- Moderate economic growth
- Growth of RES but dependent on National Policies
- Gas-fired generation provides the necessary flexibility to balance renewables in the power system

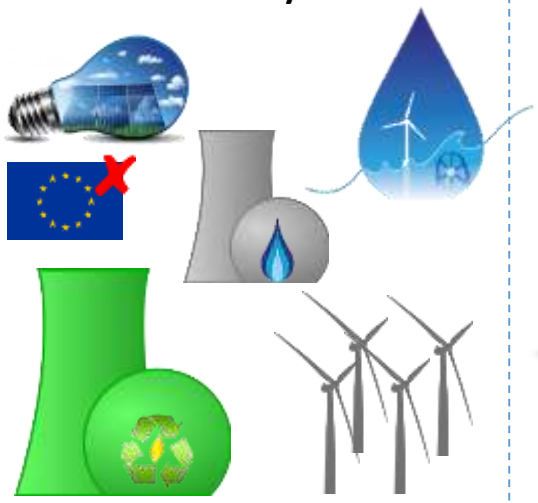
- Low growth of storage, P2G develops after 2030
- Heat pump technology common in new buildings and moderate growth of the gas condensing boiler
- Electrification of heating and the light transport fleet sees stable development
- Gas sees a growth in the heavy goods transport sector depending on the country
- Low surplus capacity in generation portfolio

Macroeconomic Trends

SLIGHTLY BEHIND

Industry

Electricity



Gas Supply

Storage Systems

Residential

Transport

Global Ambition

- Paris Compliant
- Global emission trading
- Low-carbon technologies competitive without subsidies
- Wind & solar are the leading sources of generation
- Carbon-free gases substitutes natural gas, centralised production from P2G

- P2G and batteries are key storage technologies
- Electricity generation remains mainly centralised
- Fossil fuels replaced with electricity and renewable and decarbonized gases in heating & industrial sectors
- Electric vehicles used in passenger transport while gas used in heavy duty & shipping
- Bio energies sustainably managed

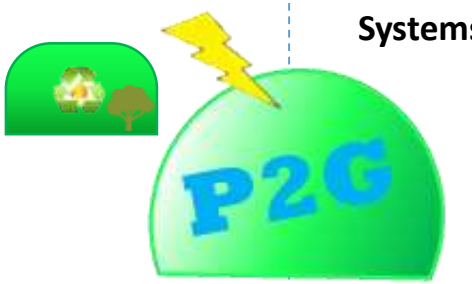
Macroeconomic Trends

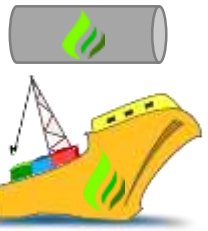
ON TARGET

Industry

Electricity

Gas Supply





Storage Systems

Residential

Transport

Distributed Energy

- Paris Compliant
- Prosumers engaged in decarbonisation but also selecting price competitive solutions
- Decentralised RES growth, driven mainly by small scale PV
- Electrification in combination with renewable gases decarbonises heating residential sector, utilising hybrid solutions

- Significant leaps in innovation of small scale generation and storage technologies
- Smart digital solutions develop at all scales
- Home energy storage systems become more common, with smart technology management
- Rapid increase in electric vehicles with smart charging
- Decarbonised and Renewable gas solutions for heavy transport & shipping

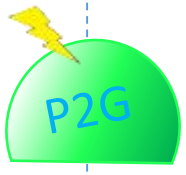
Macroeconomic Trends

ON TARGET

Industry

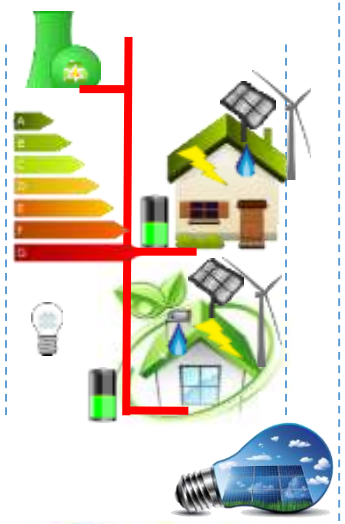
Electricity

Gas Supply



Storage Systems

Residential

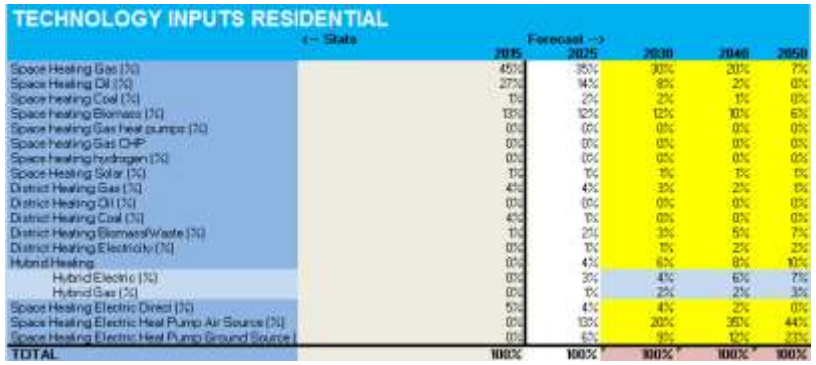


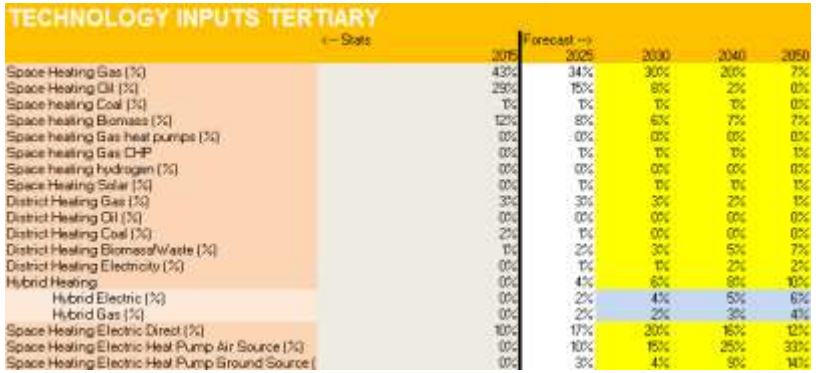
Transport

Supply & Demand Quantification

Primary Energy Quantification

Parameter	2015	2025	2030	2040	2050
Electricity share in private transport	5%	24%	34%	67%	75%
Electricity share in freight	5%	6%	6%	25%	38%
Electricity share in aviation	0%	1%	1%	2%	3%
Gas share in private transport	1%	4%	5%	6%	7%
Gas share in freight	1%	4%	5%	10%	25%
Hydrogen share in private transport	0%	1%	2%	7%	18%
Hydrogen share in freight	0%	3%	5%	25%	27%
Hydrogen share in aviation (also as liquid)	0%	3%	5%	20%	40%
Biofuel share in private transport	5%	2%	0%	0%	0%
Biofuel share in aviation	0%	3%	5%	30%	57%
Oil share in private transport	90%	69%	59%	20%	0%
Oil share in freight	90%	86%	84%	35%	0%
Oil share in aviation	100%	93%	89%	48%	0%





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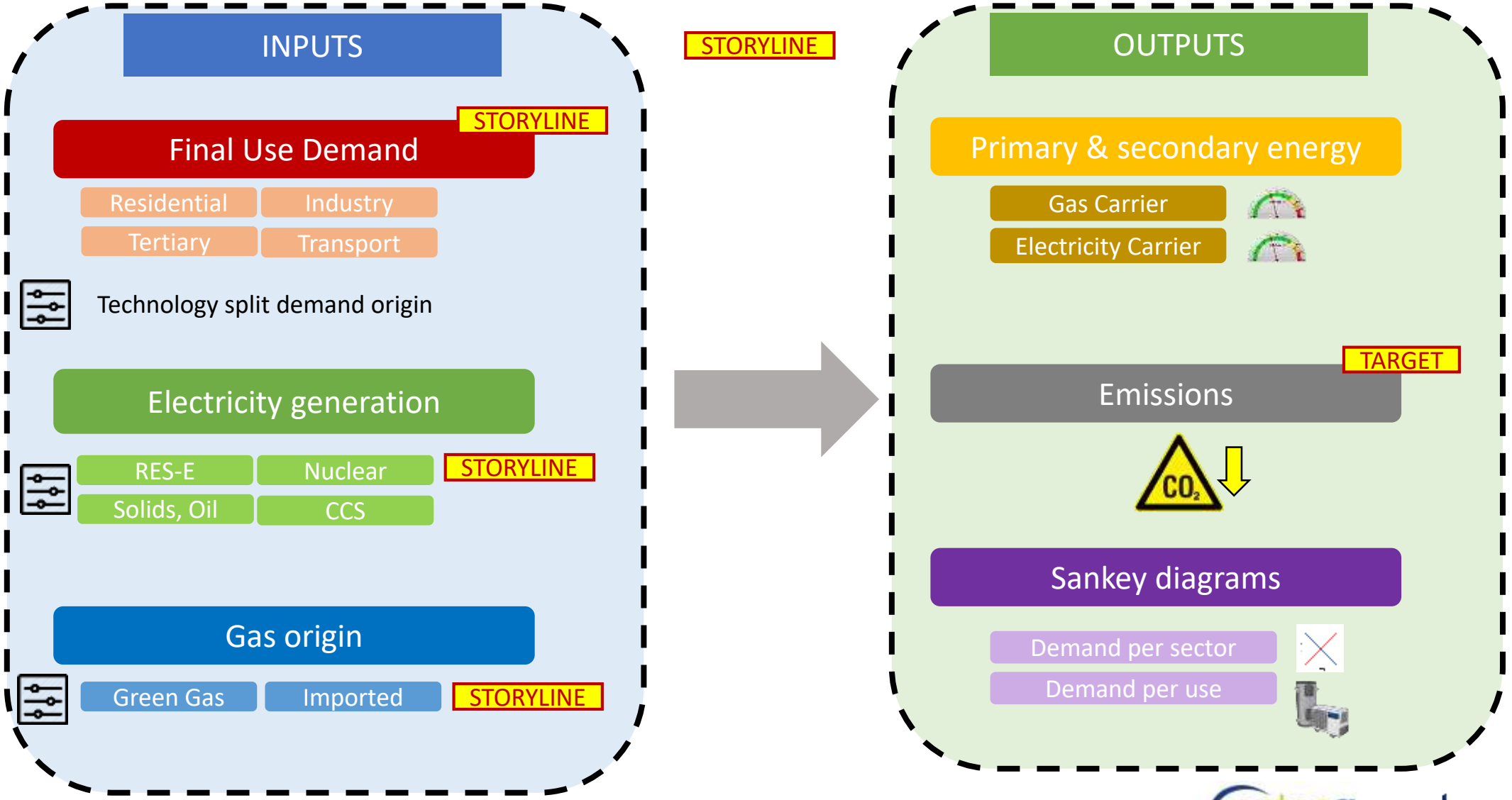
Reliable Sustainable Connected

Excursus: Ambition Tool



Carbon Budget Approach

ENTSOs Scenario's Carbon Budget

- Carbon budget for the EU:
  - is 1.5°C compatible;
  - has the highest possible likelihood (66%);
  - and are shared across countries taking into account their current population share
  - to convert the CO2 budgets into greenhouse gas budgets including non-CO2 emissions using a multiplication with 125% (according to SR1.5 Coordinating Lead Author Joeri Rogelj)

For the ENTSOs' Scenarios, a EU28 GHG budget of 48,5 $GtCO2_{eq}$ for the timeframe 2018 to 2100 will be taken into account

Demand Side

Demand Side

- Demand side values are given by the TSOs
  - How they are calculated is not always established
- Difficult to make Top Down assumptions as it depends on the different industries and infrastructure of each individual country
  - Time was the constraint
  - Didn’t have the time to do deep analysis

DSR in Electric Vehicles (V2g)

- Assume % of vehicles available to contribute to V2g (capacity)
  - 10:00 – 16:00 → 50% of people can charge at work, should be left with 80% capacity at 16:00
  - 19:00 – 00:00 → 70% of people can/are willing to charge at home, should be left with 50%
- Set activation price for V2g, could be the same or different for each capacity band
- Take into account readiness of infrastructure
  - 2030 * capacity by 20%
  - 2040 * capacity by 50%

DSR in Heating

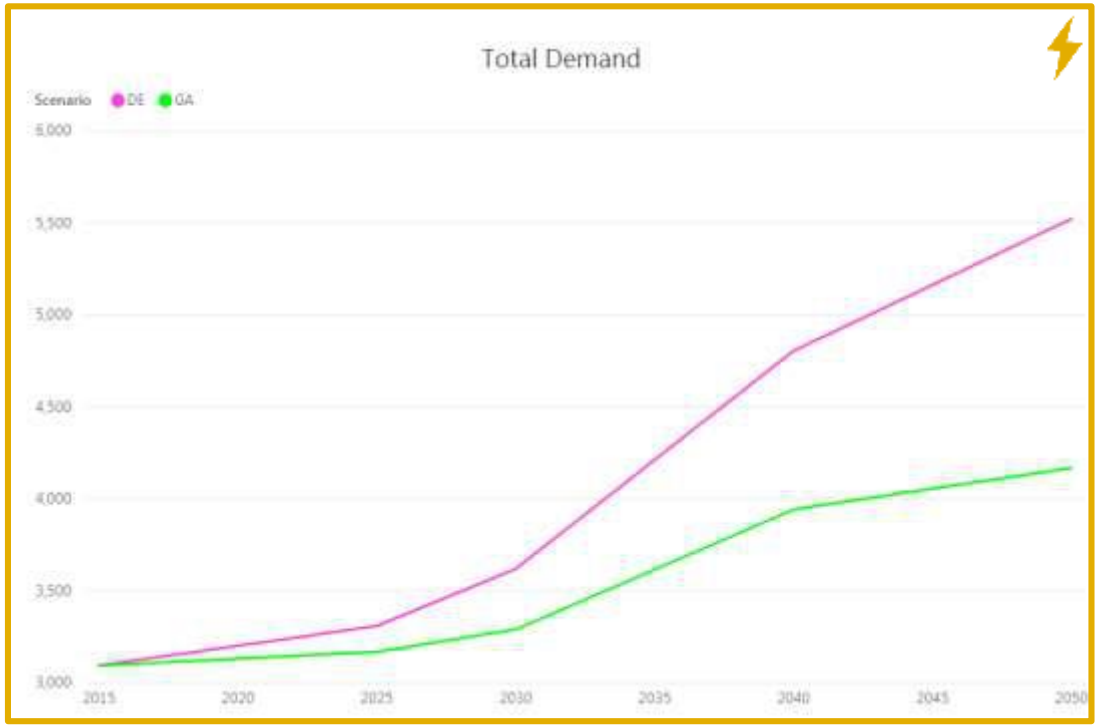
- Quantify simultaneous **peak demand** of all **heat pump systems** (electric load) and all **direct electric heating** systems (electric load)
- Assume % of systems willing and able to replace their heat demand with other means
- Assume how many hours per day this flexibility is available. If consumer has a hot water tank, number of hours can be considered larger compared to direct heating.
- Monthly profile corresponds monthly peak heating demand (i.e. less flexibility available during summer) If some countries have large residential cooling demand, it could be factored in

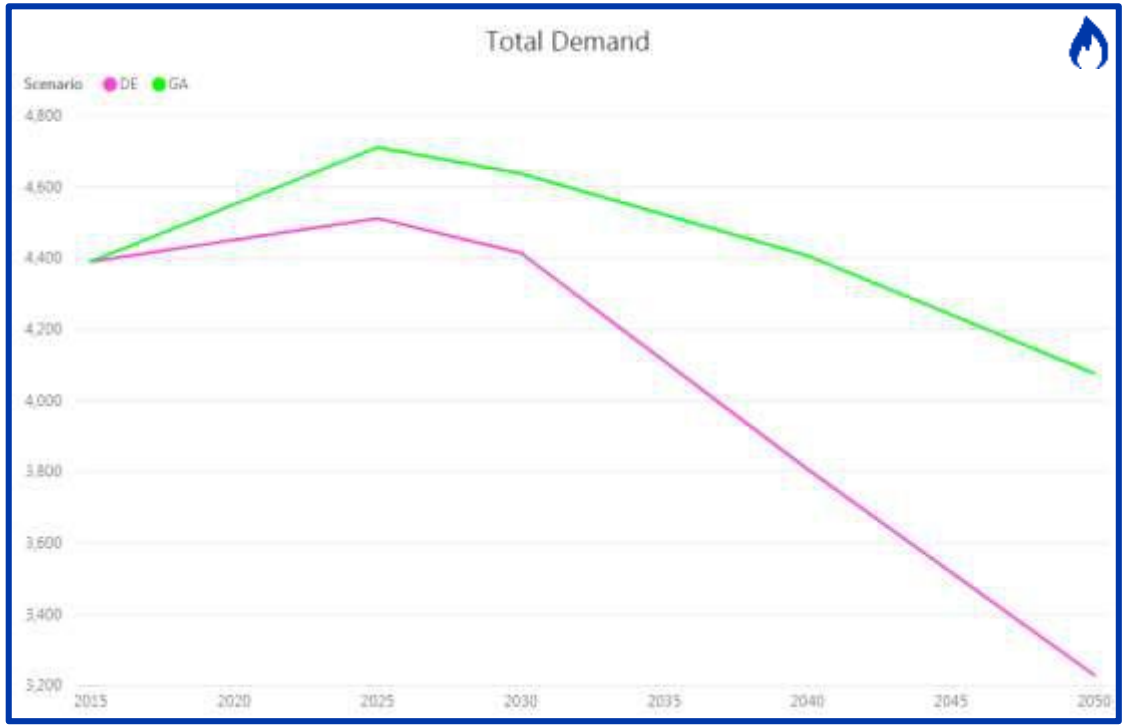
DSR in Industry

- Quantify industrial peak demand
- Assume % of demand willing and able to reduce load at a given activation price
- Monthly profile is flat (reflecting industrial load curve) and DSR can be activated 24 hours per day
- Activation price is a guess; basically it reflects a level where someone is expected to react e.g. producing industrial heat demand with heat-only boilers or using steam-reformed hydrogen instead of electrolysis, hence it does not necessarily mean shut-down of industrial process.

Demand

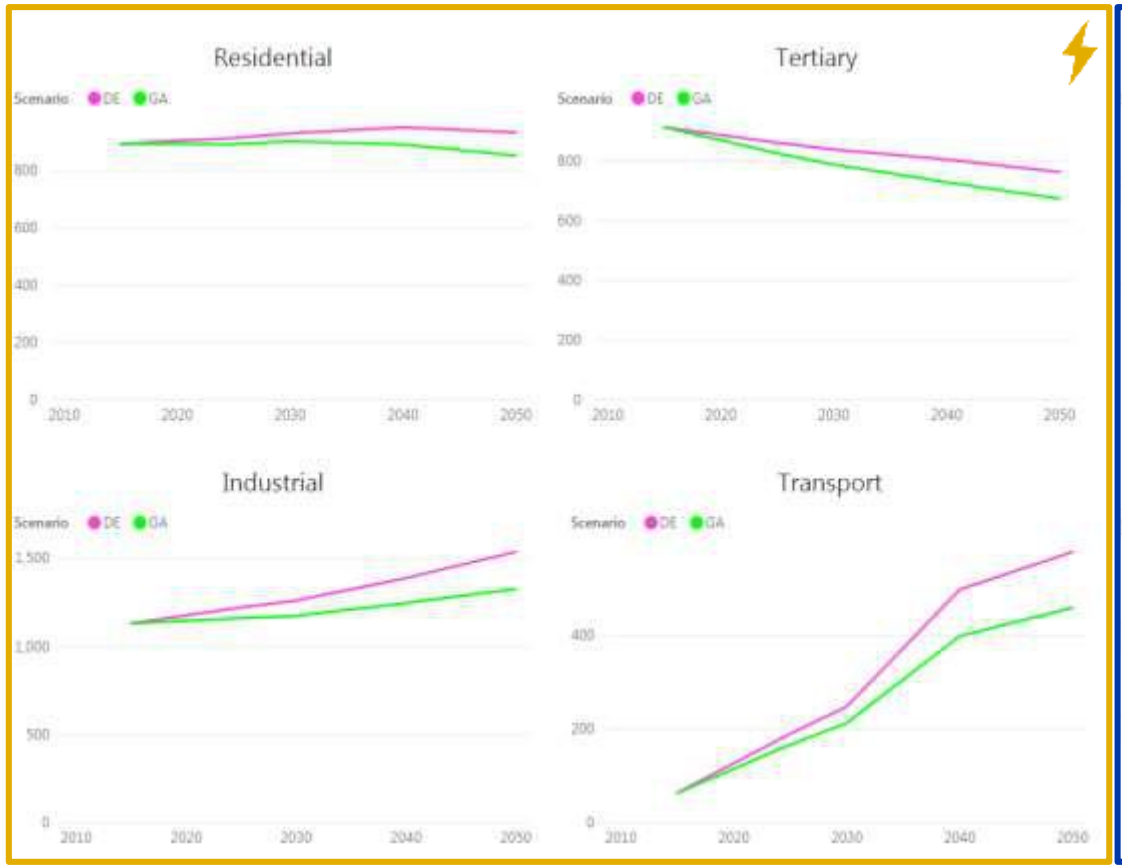
Demand: Total Demand (2015 – 2050)

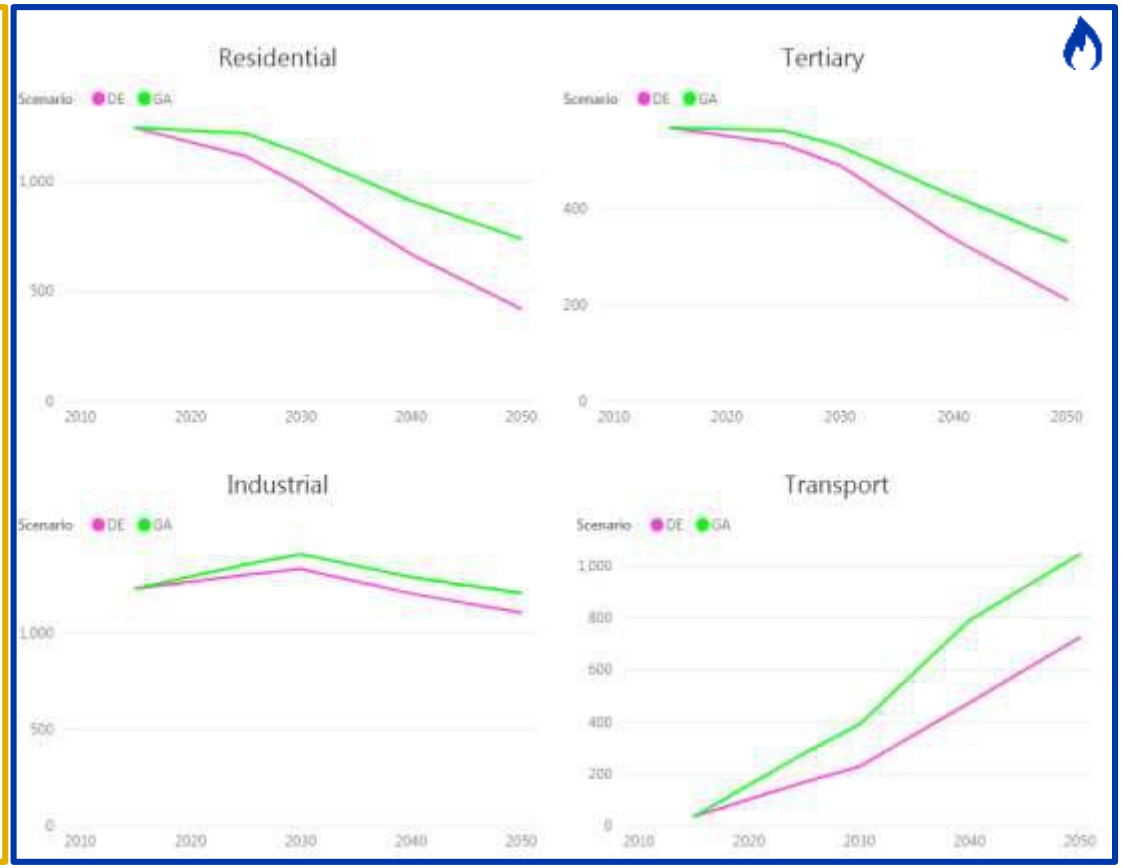




- to Gas Distributed Energy see's a large increase in electricity demand and reduction in gas demand.
- EU28 Power to Gas would show a further increase of 1540 TWh of electricity demand in 2050.

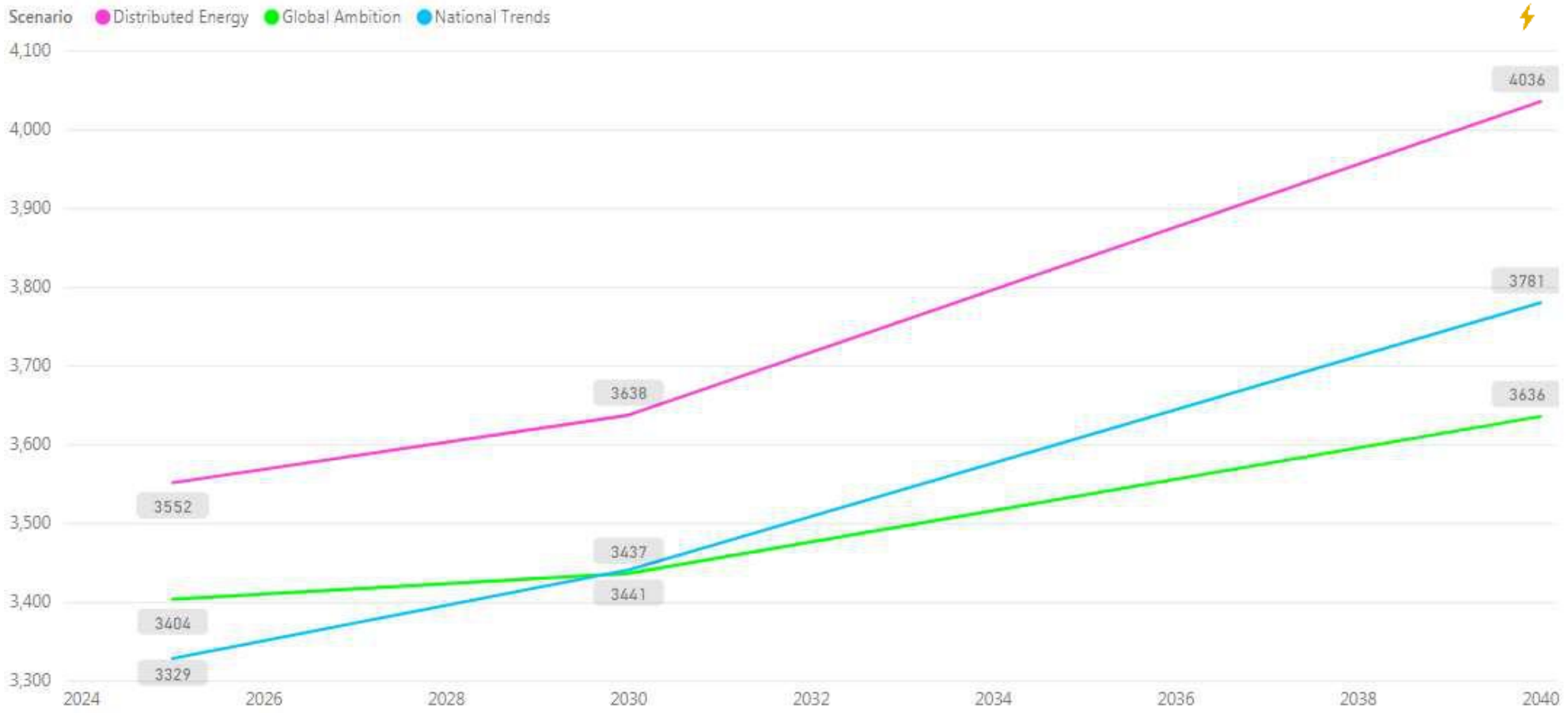
Demand: Sectoral Breakdown (2015 – 2050)



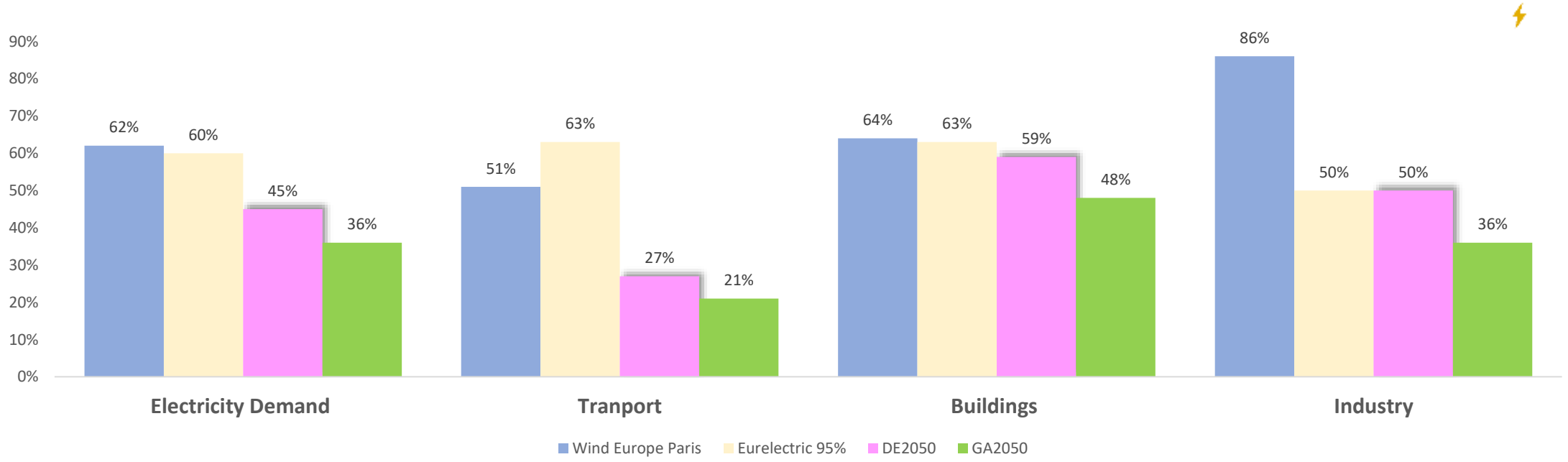


- Largest increases are transport

Demand: EU28 Comparison (2025 – 2040)

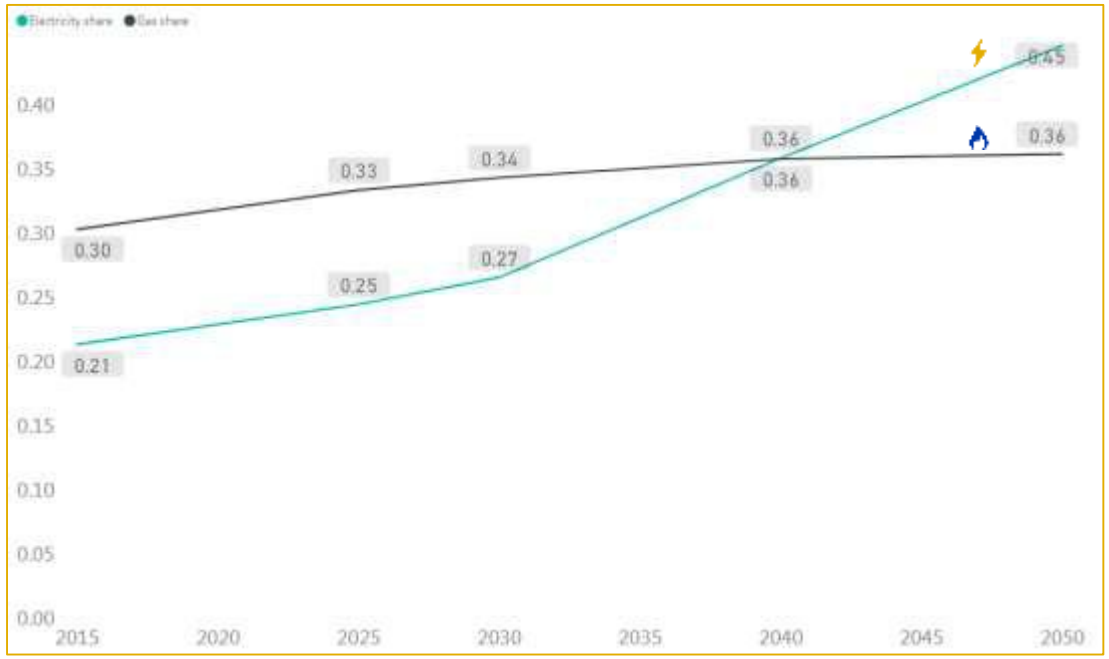


Demand: ENTSO, Eurelectric, Wind Europe

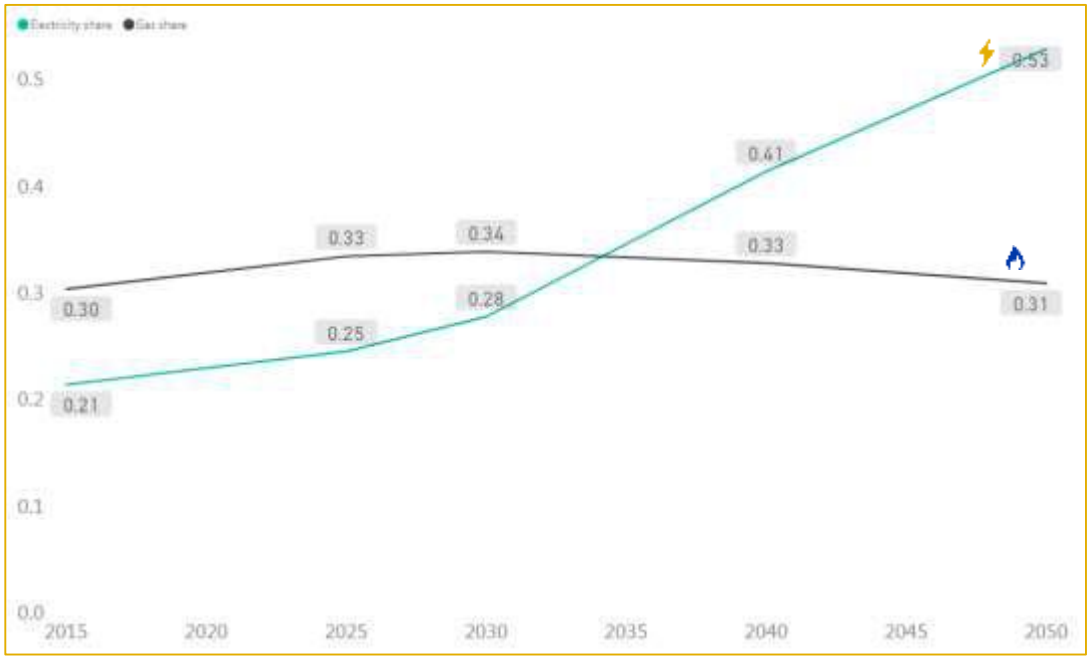


- Electrification of the Distributed Energy is around 45% (ENTSOs most electrified scenario).
- Electrification is relatively low compared to other Paris scenarios
- TSOs may be underestimating the potential for electrification of transport (HV).

Demand: Electricity and Gas Share (DE)



Without Power to gas



With Power to gas

- Power to gas adds 5% in 2040 and 8% in 2050