The Importance of Gas Infrastructure for the Energy Transition

A framework for analysis

05 May 2018

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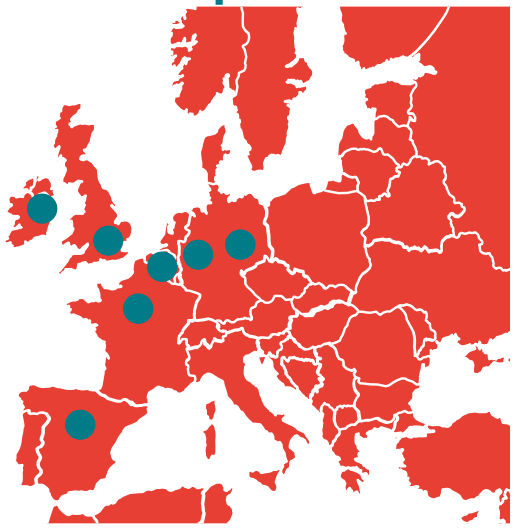

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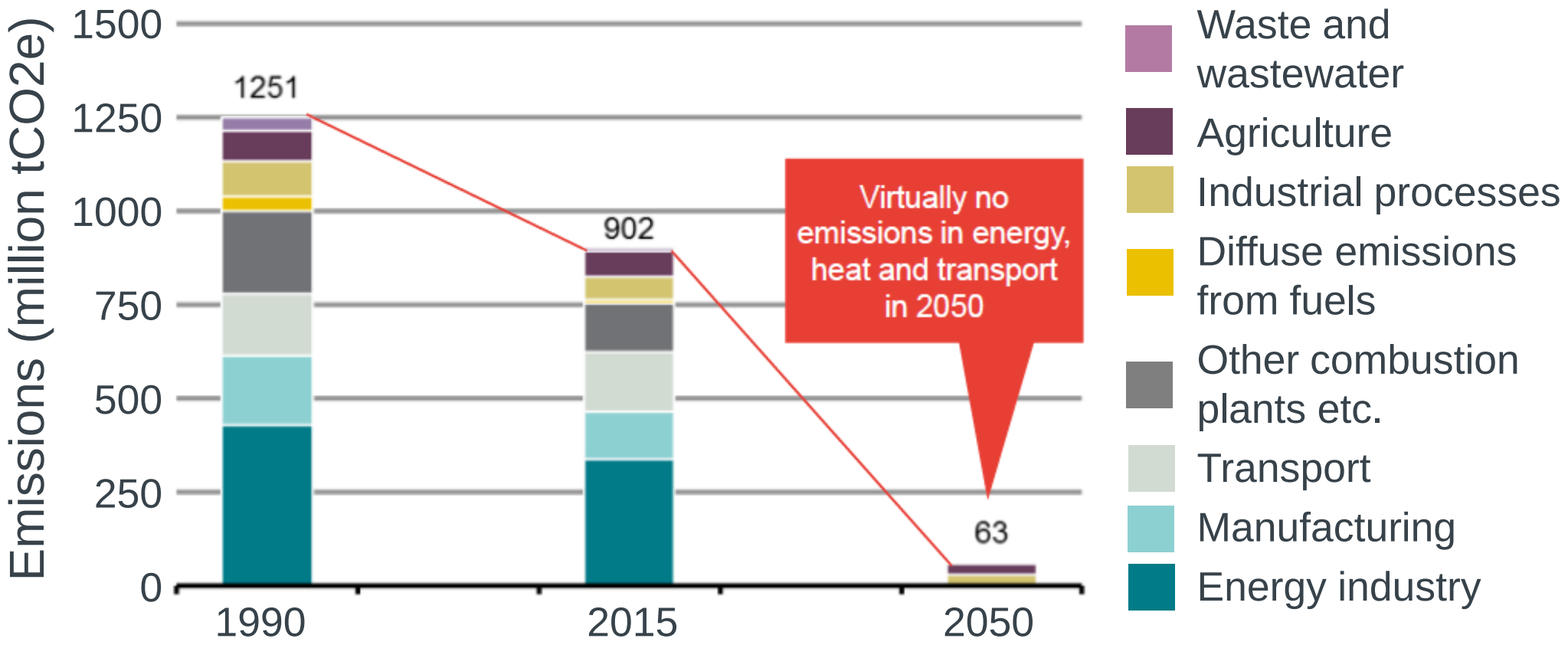
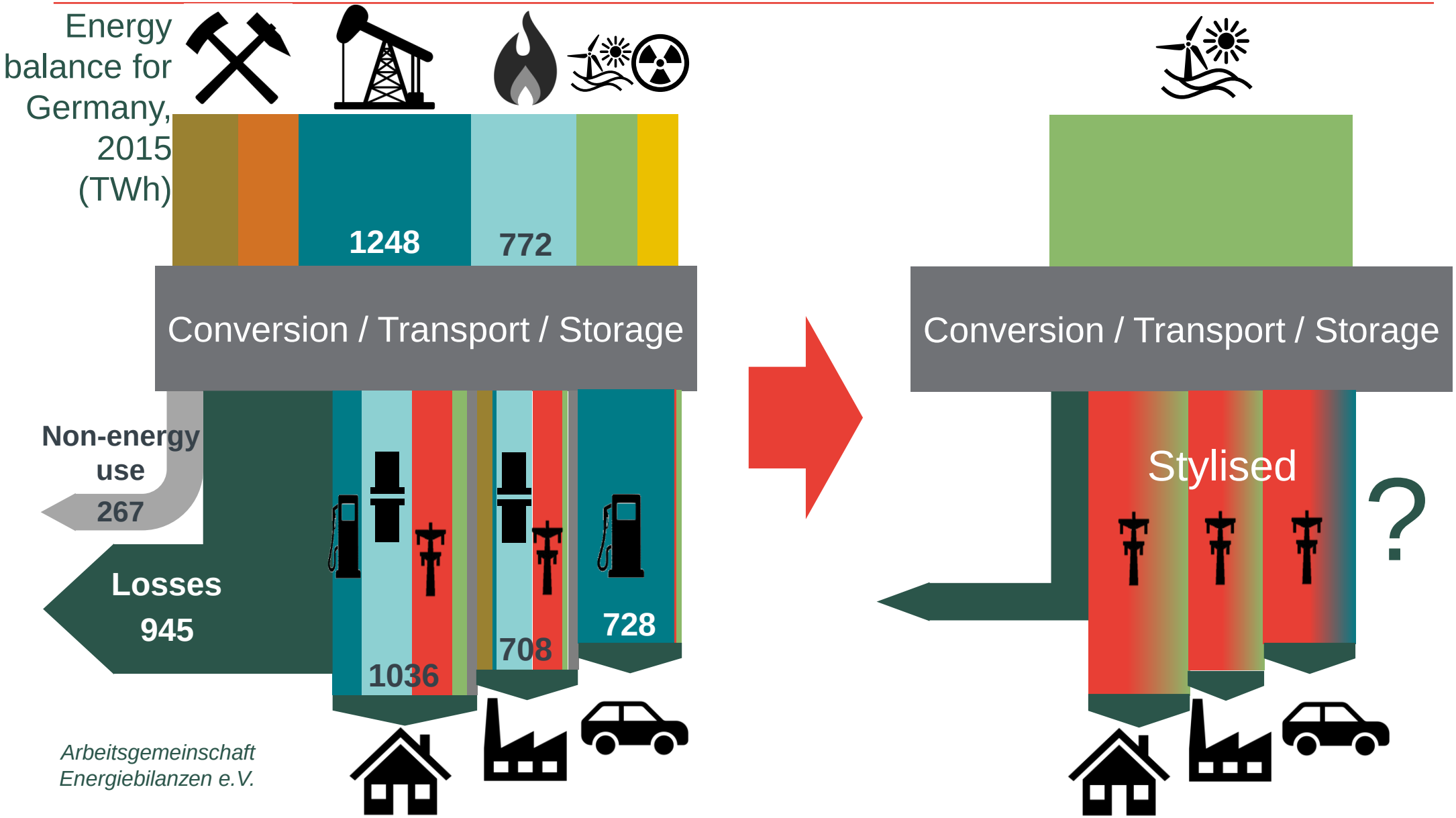
Germany is targeting an 80 to 95% reduction in greenhouse gases by 2050



Target estimated by Frontier
Historical values based on information from the Federal Environmental Agency: National greenhouse gas inventory 2017

… this requires a transition to renewable energy for electricity generation, and the heat, transport and industrial sectors

Current thinking is to reduce energy consumption and to switch heat, transport and industry to renewably produced electricity



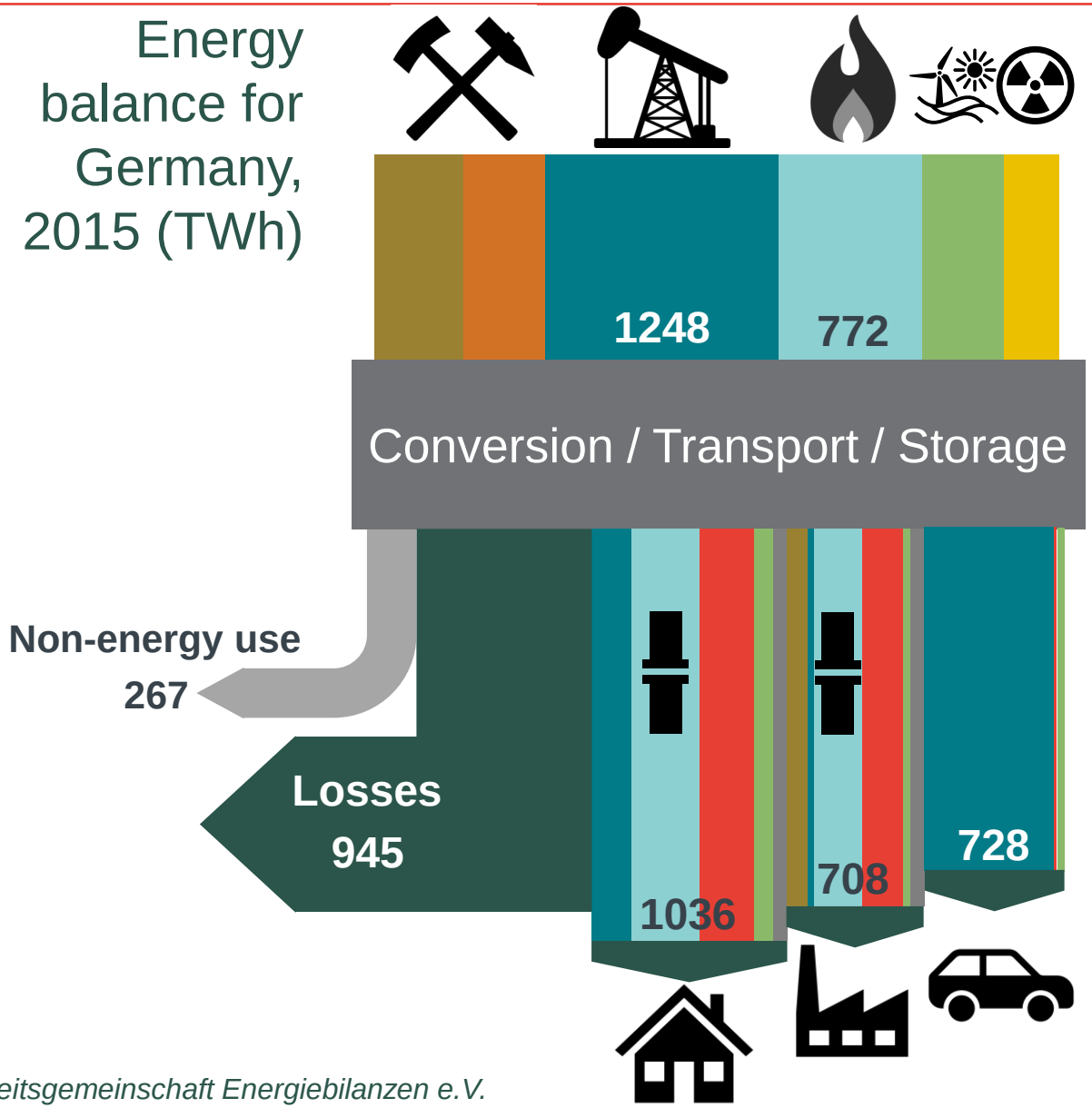
THE UNRESOLVED QUESTIONS

How should energy be transported from where it is produced to the end-consumer?

How should energy be stored?

Gas makes up almost 25% of Germany's final energy consumption and almost 45% of final energy consumption in the heat sector

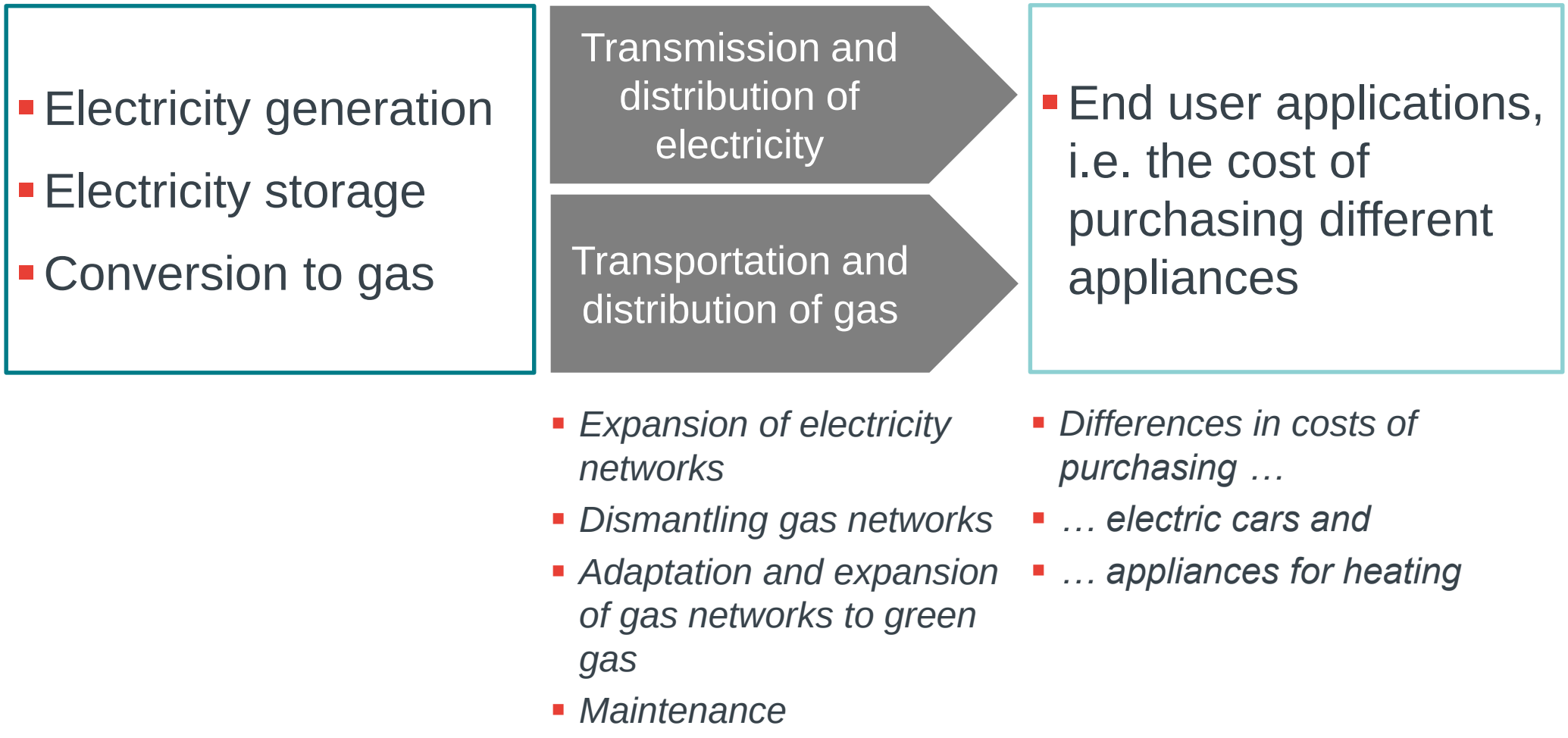
Energy balance for Germany, 2015 (TWh)



Arbeitsgemeinschaft Energiebilanzen e.V.

Can gas pipelines and storage play a role in decarbonisation?

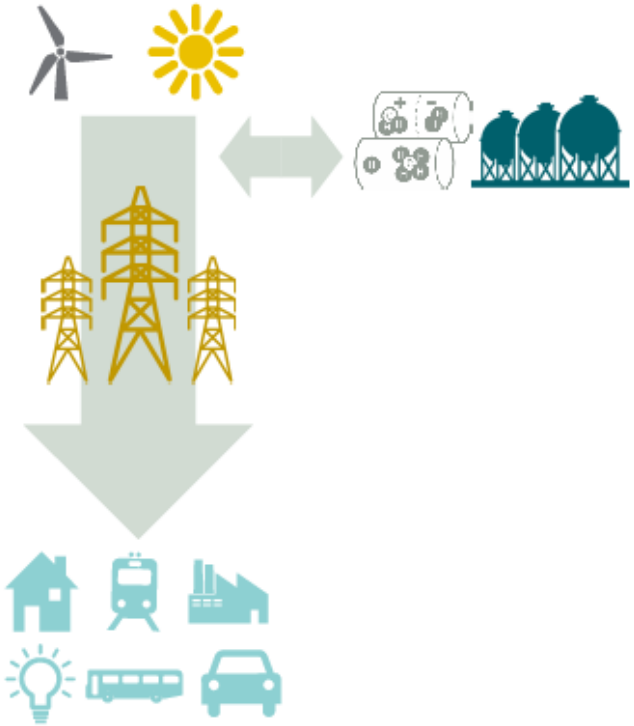
The comparison of system costs focuses on Germany in 2050, taking account of major costs along the supply chain



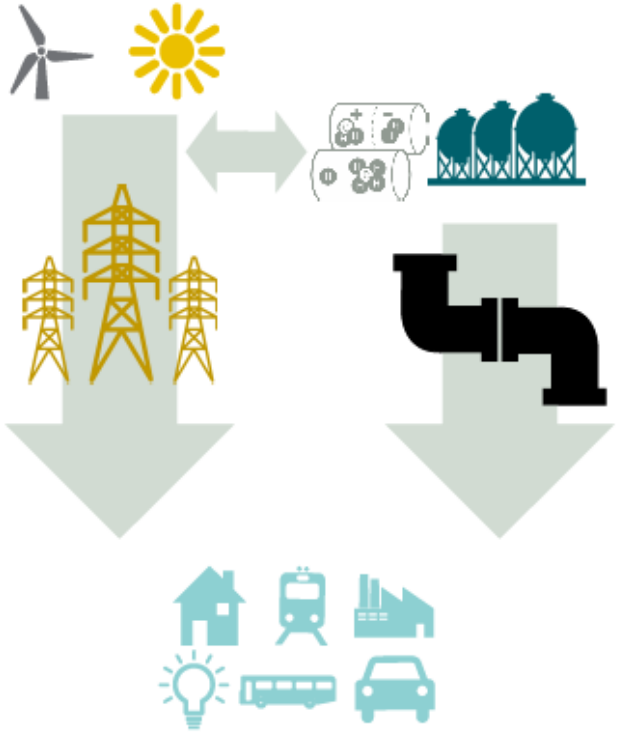
To answer the question, we compare system costs for 3 scenarios of decarbonisation

Electricity only

Electricity and gas storage



Electricity and green gas



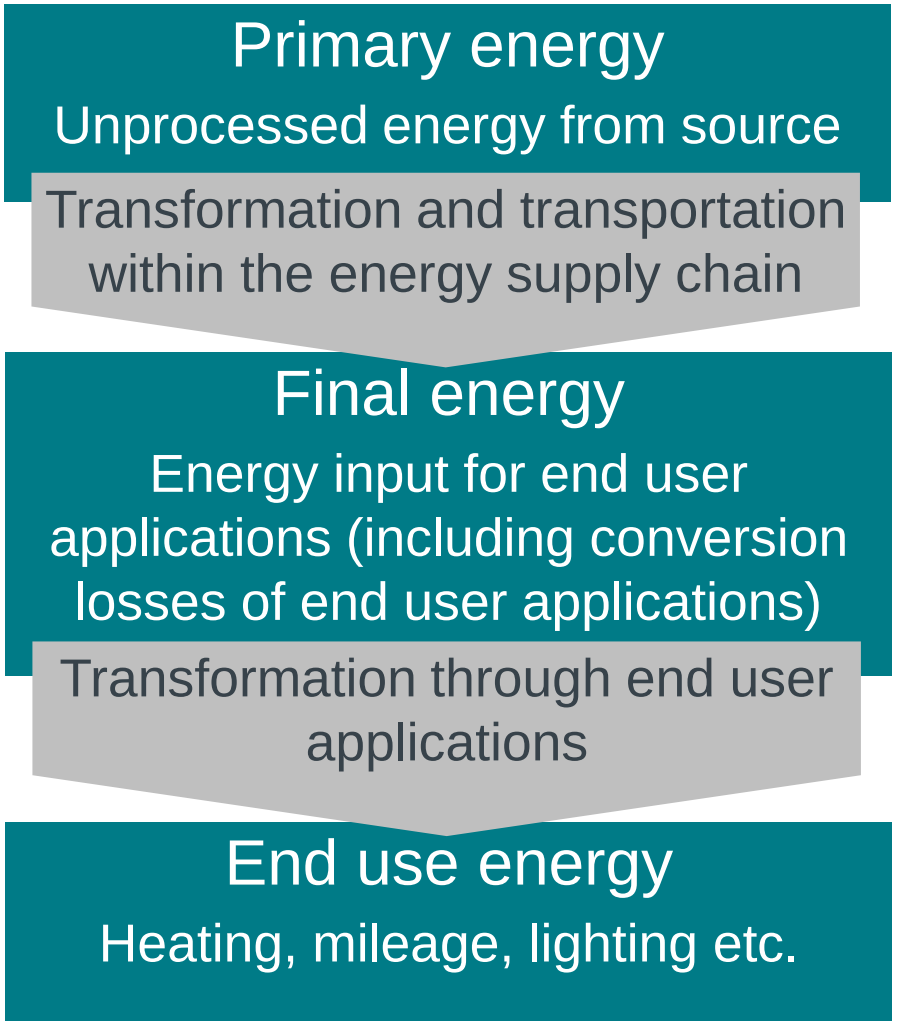
All 3 scenarios achieve a 95% reduction in GHG emissions in 2050

More details about the 3 scenarios for decarbonisation

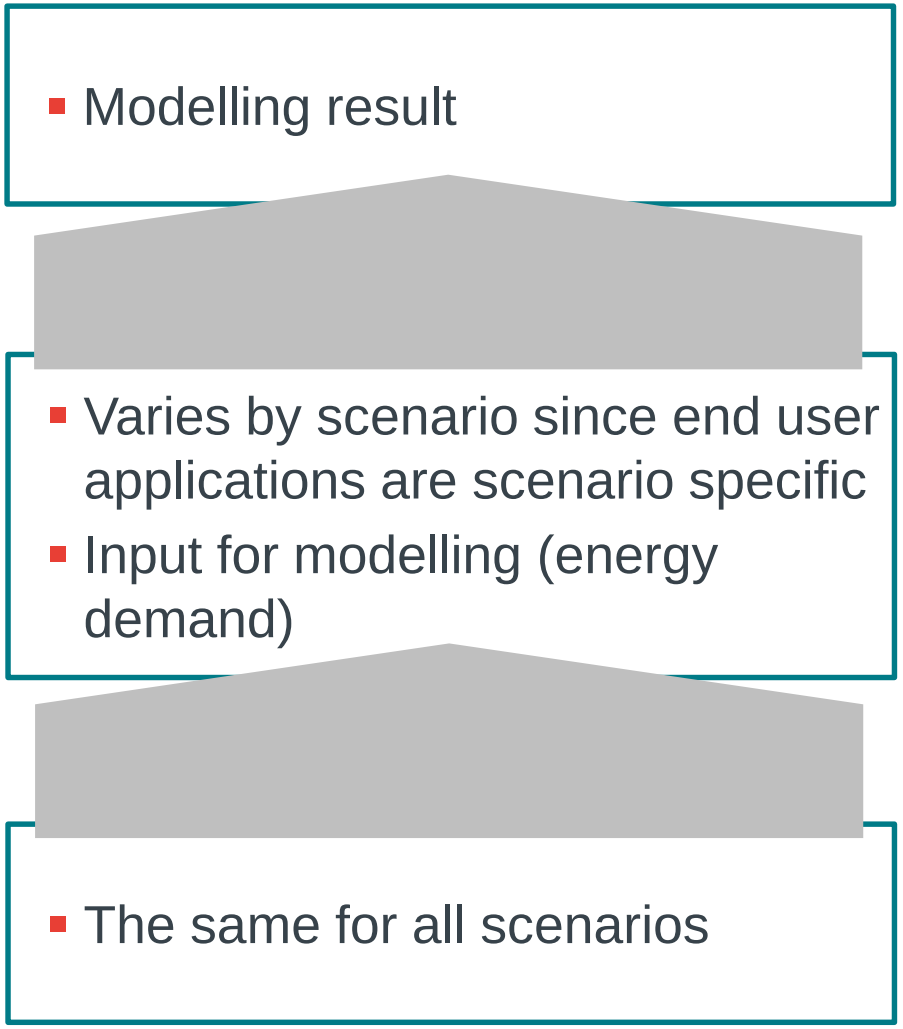
Scenario	Electricity only	Electricity and gas storage	Electricity and green gas
End user applications	Most end-user applications directly electrified (e.g. e-vehicles, heat pumps, direct heating systems) No gas-based end-user applications	End-user applications the same as for the Electricity-only scenario	Some of the end-user applications directly electrified (e.g. e-vehicles or heat pumps in new buildings) Partly based on green gas (e.g. gas boiler or gas-based vehicles)
Power to gas	No PtG	Possibility to store renewably generated electricity in the form of gas via PtG temporarily, then feed it back to power plants (“power-to-gas-to-power” or PtGtP) Helps to smooth out seasonality of final electricity consumption, particularly in the heating sector, and supply electricity during dark periods with little wind	Possibility for PtGtP Furthermore, green gas used for end-user applications must be synthetically produced in PtG plants in Germany Assumption that 50 per cent of the green gas is directly transported and used as H2 (PtH_2) in the transport and industry sectors), while the remaining half is converted to methane ($PtCH_4$) and transported via distribution networks to heat consumers
Energy transport	Connection between energy generation and final energy use only through electricity networks and electricity storage systems Gas infrastructure no longer required (with the exception of transit pipelines)	Connection between energy generation and final energy use only through electricity networks Use of some of the gas storage for PtGtP Gas transport and distribution networks not used (with the exception of transit pipelines and pipelines between PtG plants, gas storage systems and gas power plants)	Continued use of the gas infrastructure (partly converted to H_2) alongside the electricity network

We start with the same energy needs for end consumers and derive the final energy consumption and primary energy needs for Germany

Energy flow

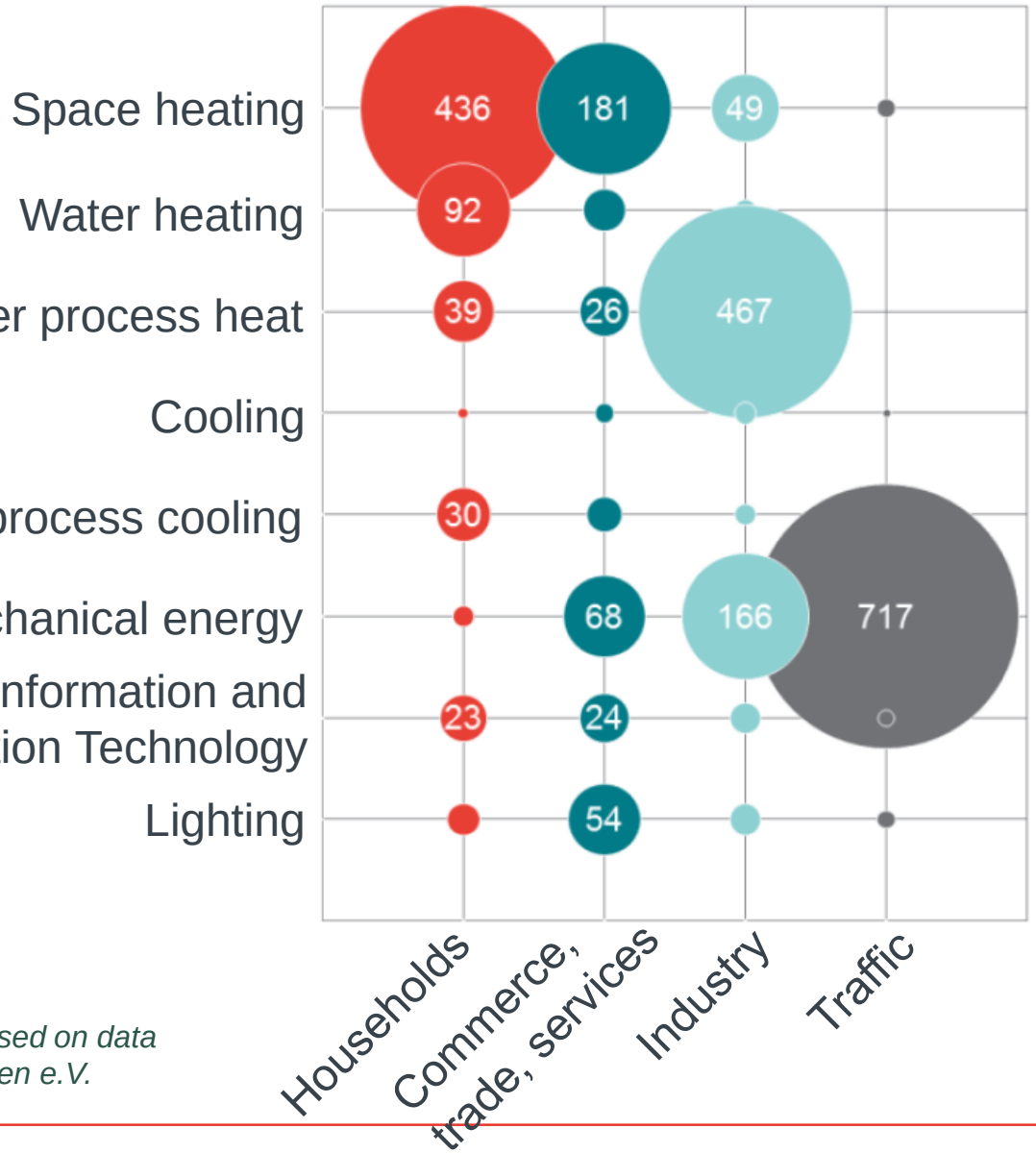


Approach to the analysis



Final end user energy demand in 2015 is projected to 2050

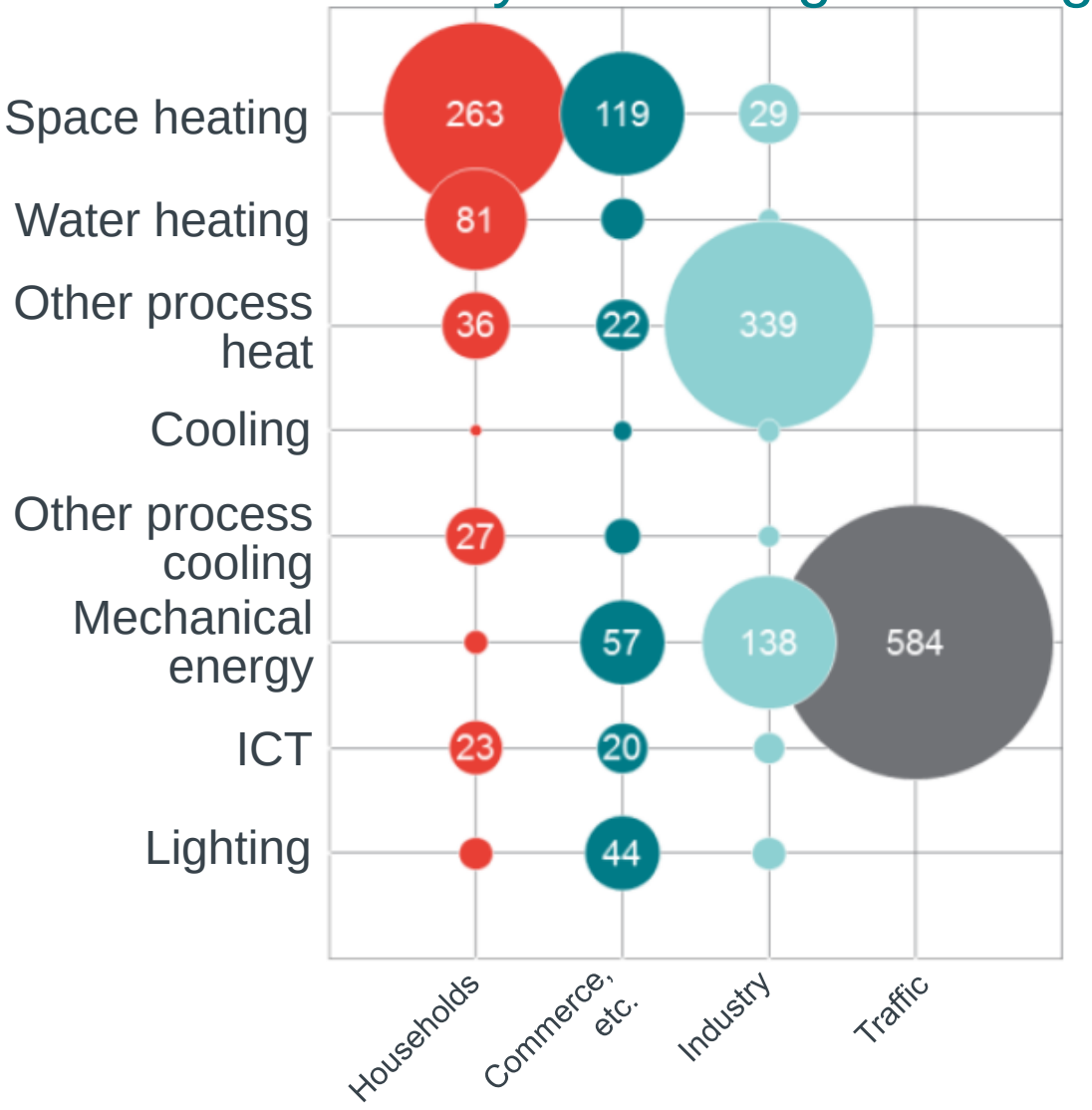
Germany, 2015 (TWh)



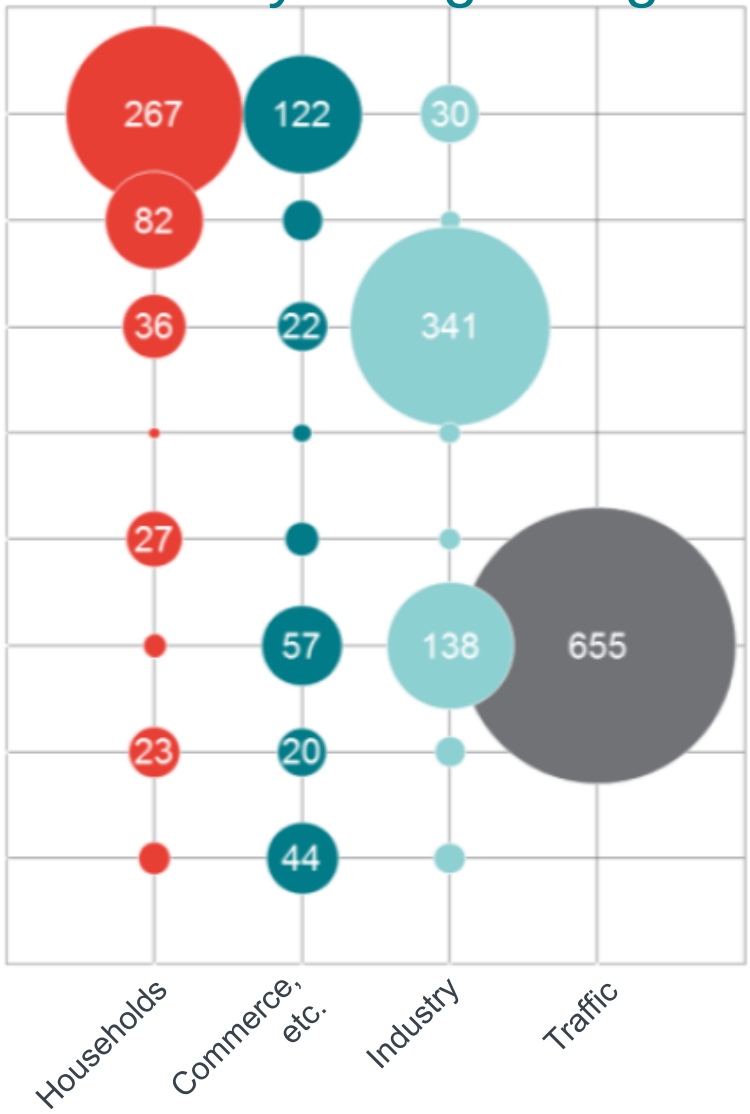
Frontier Economics based on data from AG Energiebilanzen e.V.

Final end user energy demand in 2050 varies due to conversion efficiency of end user applications

Elec. Only / Elec. & gas storage

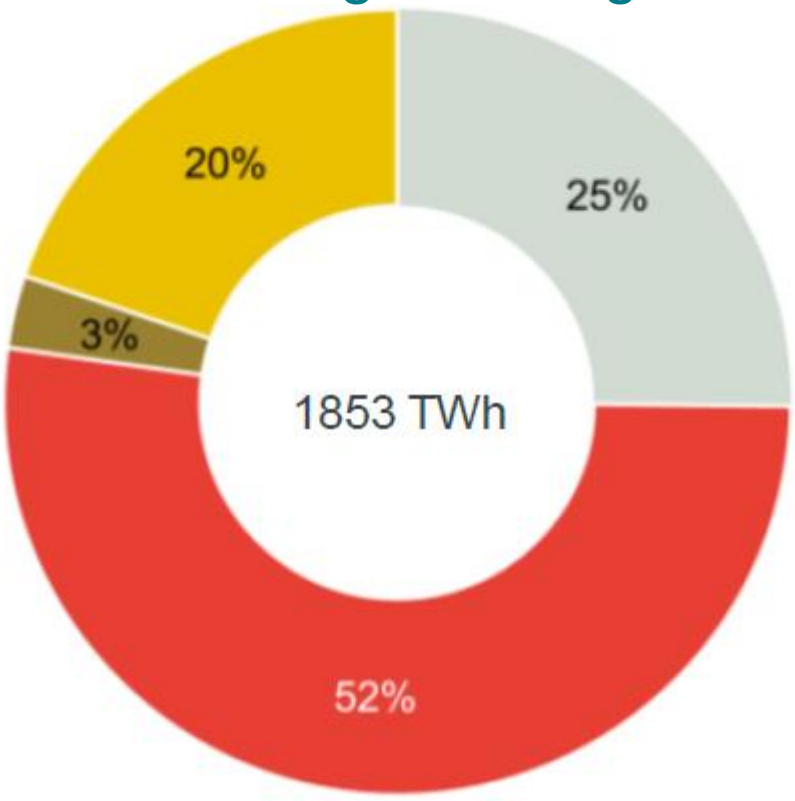


Electricity and green gas

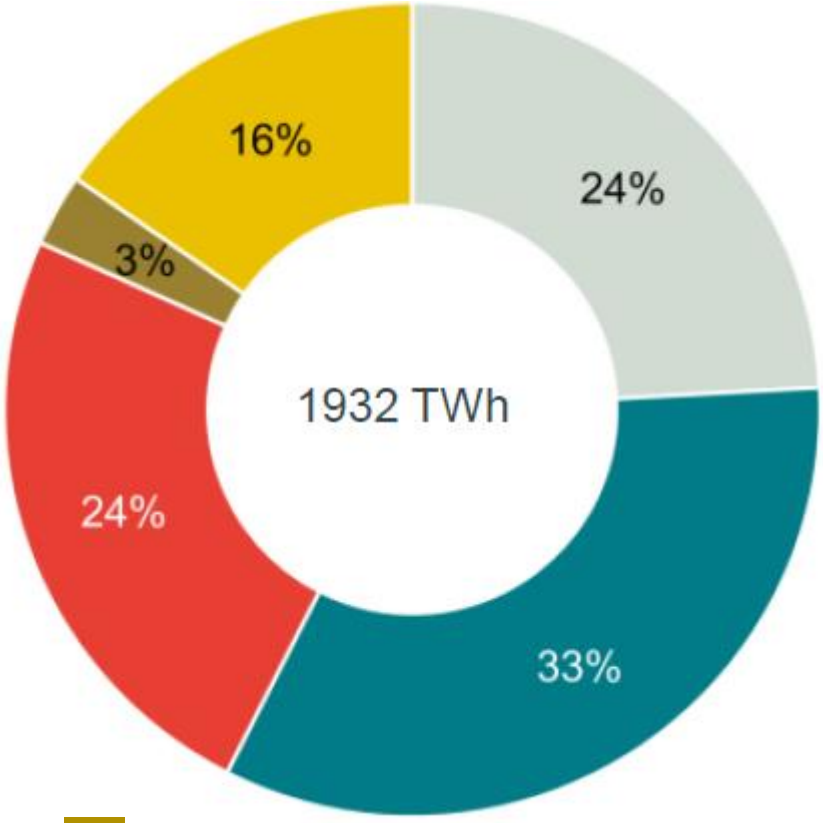


Demand for electricity is significantly higher where gas is not available to the end user

Elec. only / Elec. & gas storage



Electricity and green gas

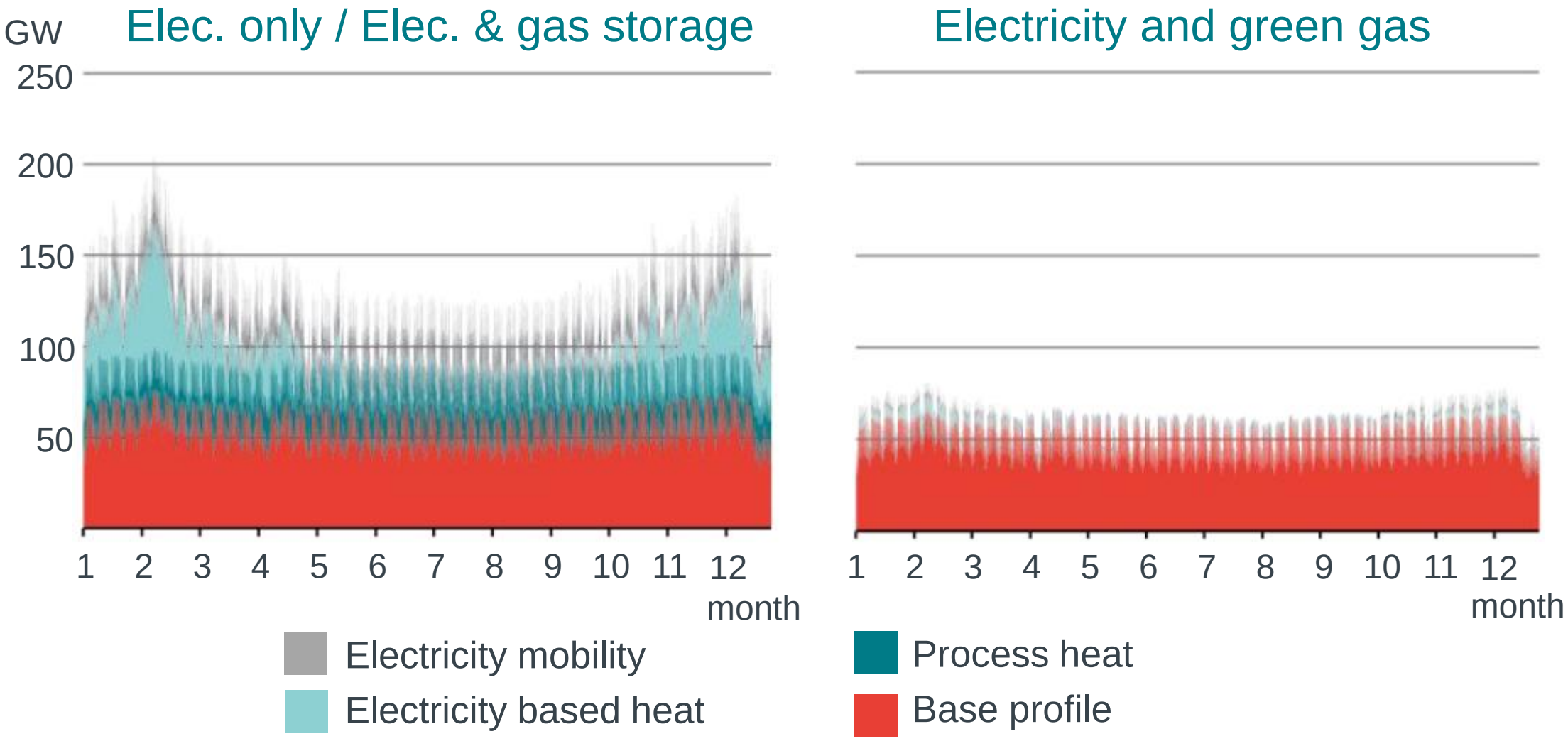


- Power to liquids
- Green gas
- Electricity
- District heating
- Renewables (ambient heat and biomass)

Demand for electricity is almost double today's demand where gas is not available to the end user

Scenario	End user demand for electricity	End user demand for gas
Electricity only	965 TWh	0 TWh
Electricity and gas storage	965 TWh	0 TWh
Electricity and green gas	468 TWh	645 TWh
Germany in 2015	515 TWh	601 TWh

Demand for electricity is very seasonal in scenarios where gas is not available to the end user

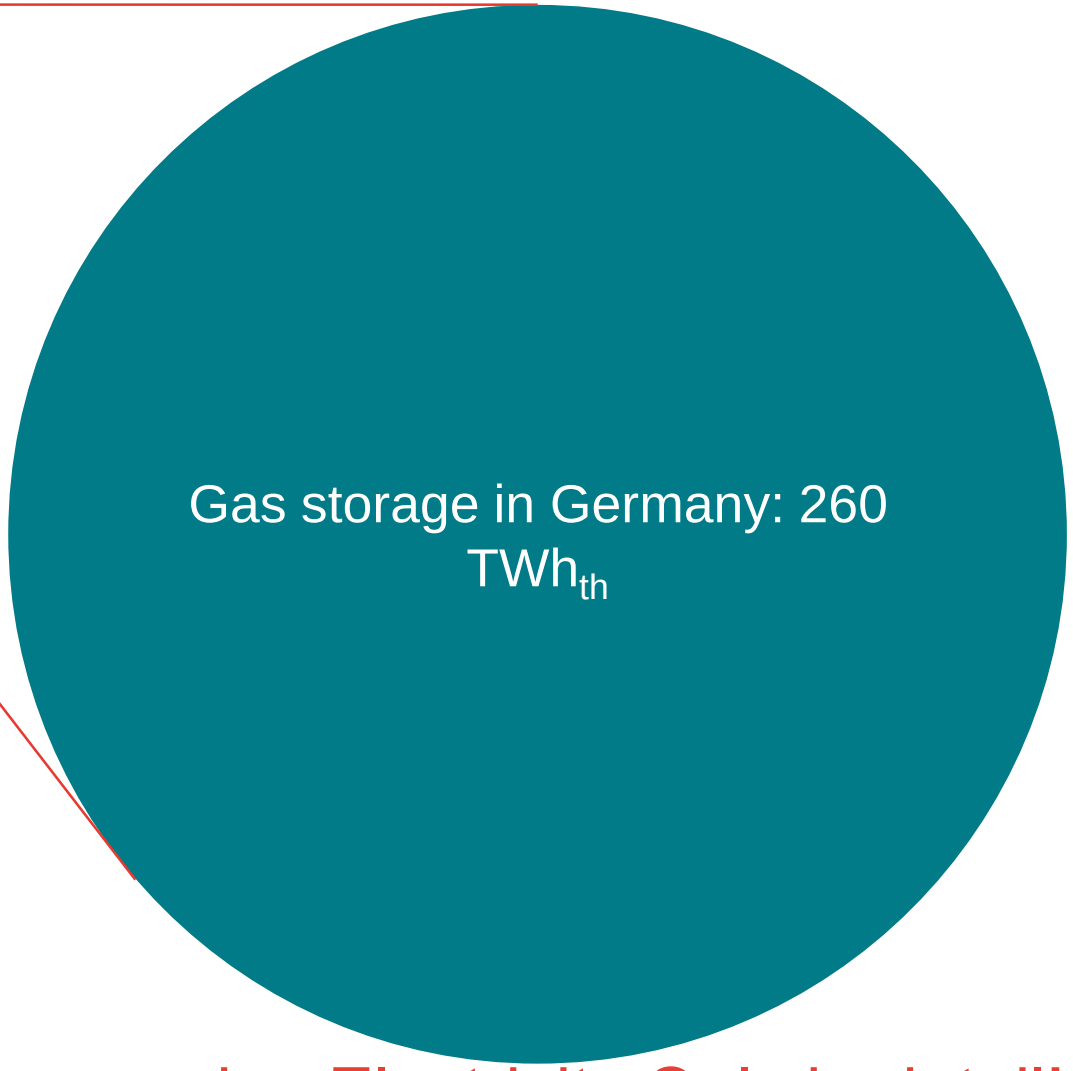


Seasonal demand for energy means the electricity option would be prohibitively expensive due to the need for seasonal storage

Electricity storage in Germany, 2012: 0.04 TWh_{el}

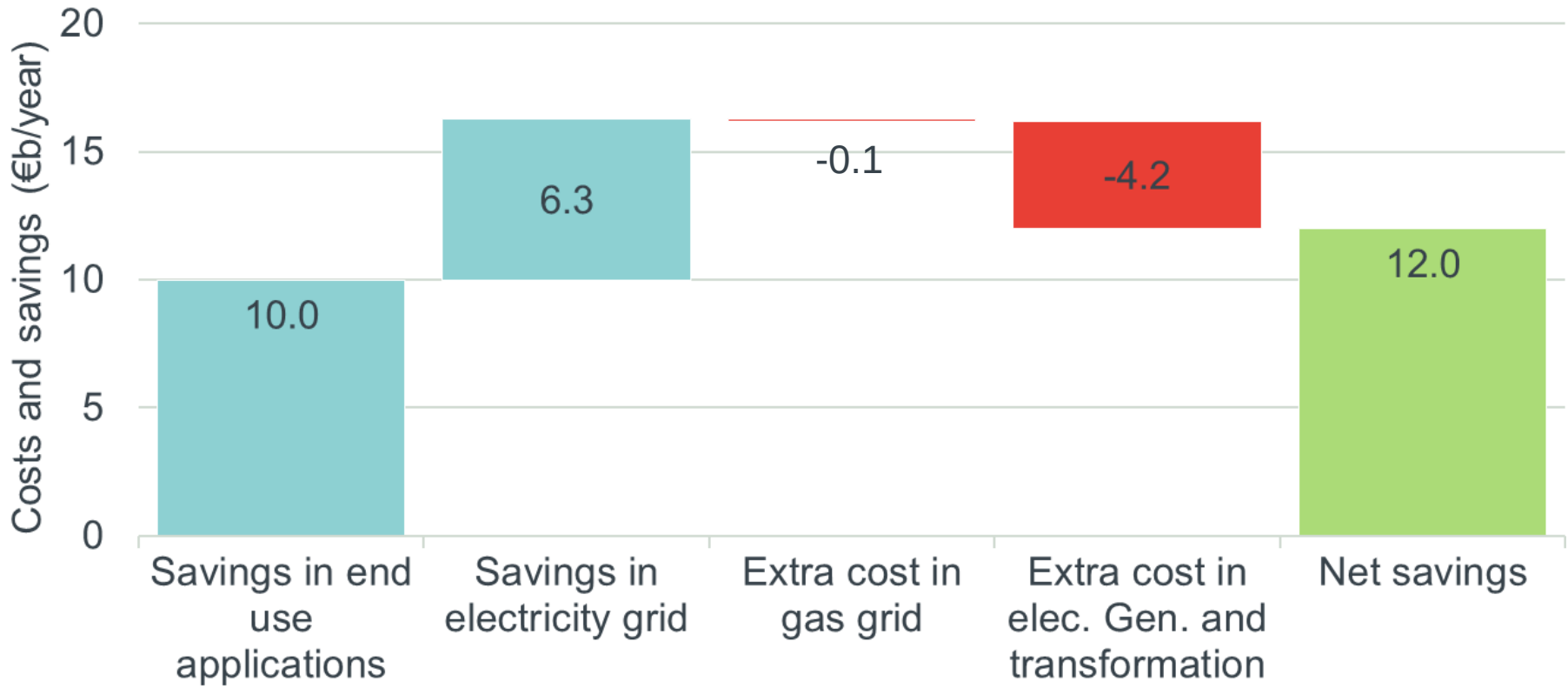
Currently, 6,500 times more gas storage

In 2050, Electricity Only would require ~35 TWh of electricity storage (800 times more pumped hydro electricity storage than today or 18m shipping containers full of batteries)



… no need to examine Electricity Only in detail!

The use of gas networks reduces system costs due to reduced electricity network costs and cheaper end user appliances



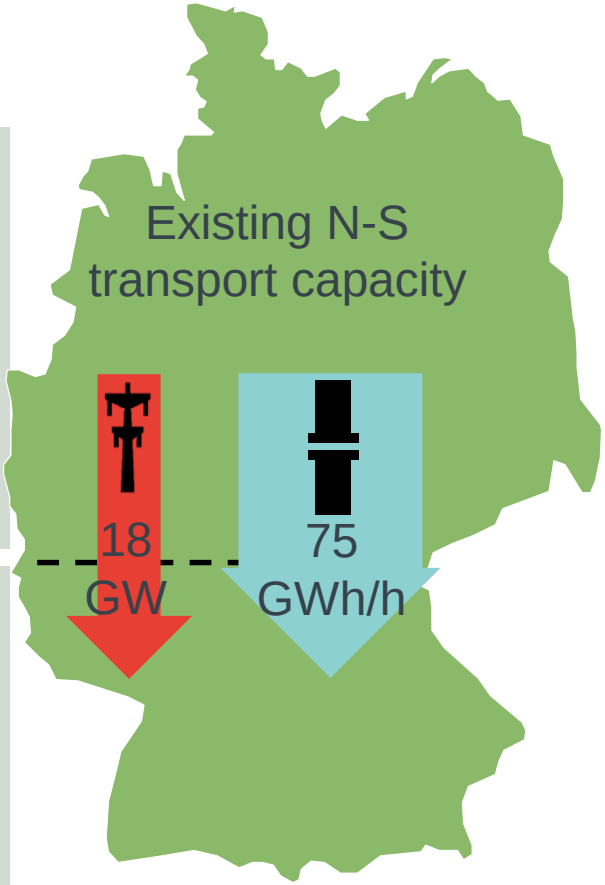
The use of gas networks will also improve security of supply and public acceptance of the energy transition

Improved acceptance of energy transition

- Using existing gas networks avoids need to expand or upgrade 17,800 km of transmission circuits and 500,000 km of distribution circuits
- Using gas avoids the need for end users to change their appliances

Improved security of supply

- Gas pipeline network offers gas import options, which may reduce system costs and improve security
- Gas storage helps to meet seasonal energy needs



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The full report is available here:

https://www.fnb-gas.de/files/fnb_gas_study_-_value_of_gas_infrastructure_-_english_translation_1.pdf