Decarbonization via electrification

Pathways for Europe

Kristian Ruby

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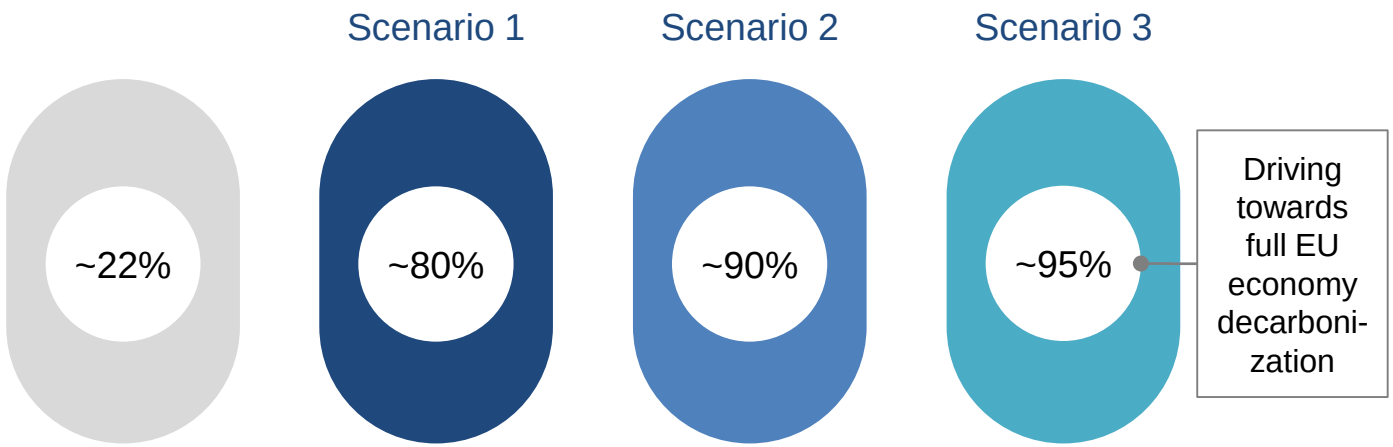
Eurelectric designed 3 deep EU decarbonization scenarios

2015 - Baseline | 2050 scenarios

EU economy decarbonization achieved vs. 1990[1,2]



4 underlying pre-requisites and drivers per scenario:
level of ambition, technology development, consumer behavior and regulation

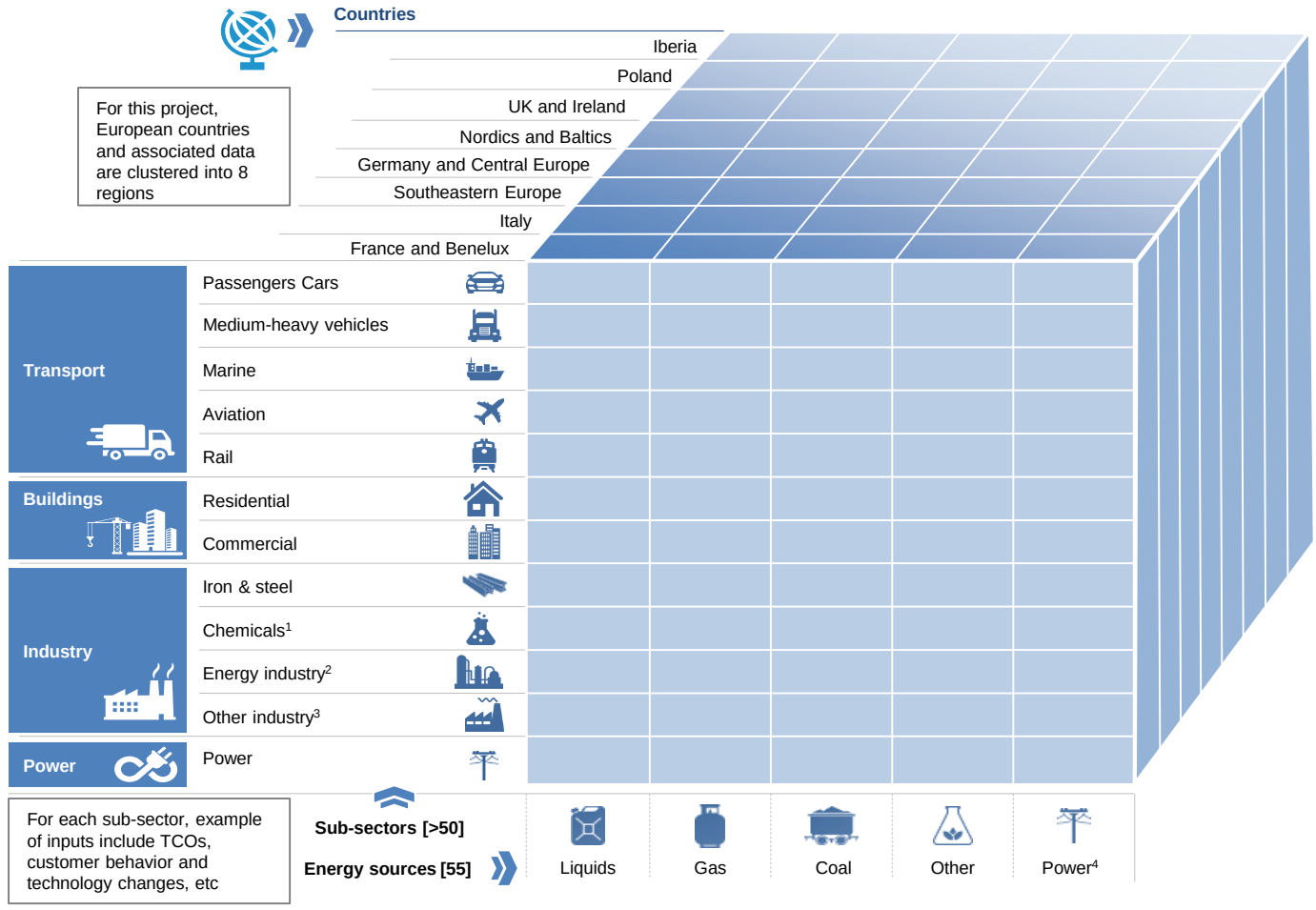
1 Emissions out of scope are expected to contribute proportionally to the decarbonization effort required in each scenario
2 Decarbonization will be different by sector depending on relative costs and available technologies, industry contributing least with below 80% of emission reduction in all scenarios

Detailed inputs collected bottom-up contribute to the robustness of the demand forecasts of energy and electricity

Bottom-up inputs from:

- National associations and their members
- Eurelectric committees and working groups
- External stakeholders from different perspectives: NGOs, industry associations, etc

Demand model snapshot

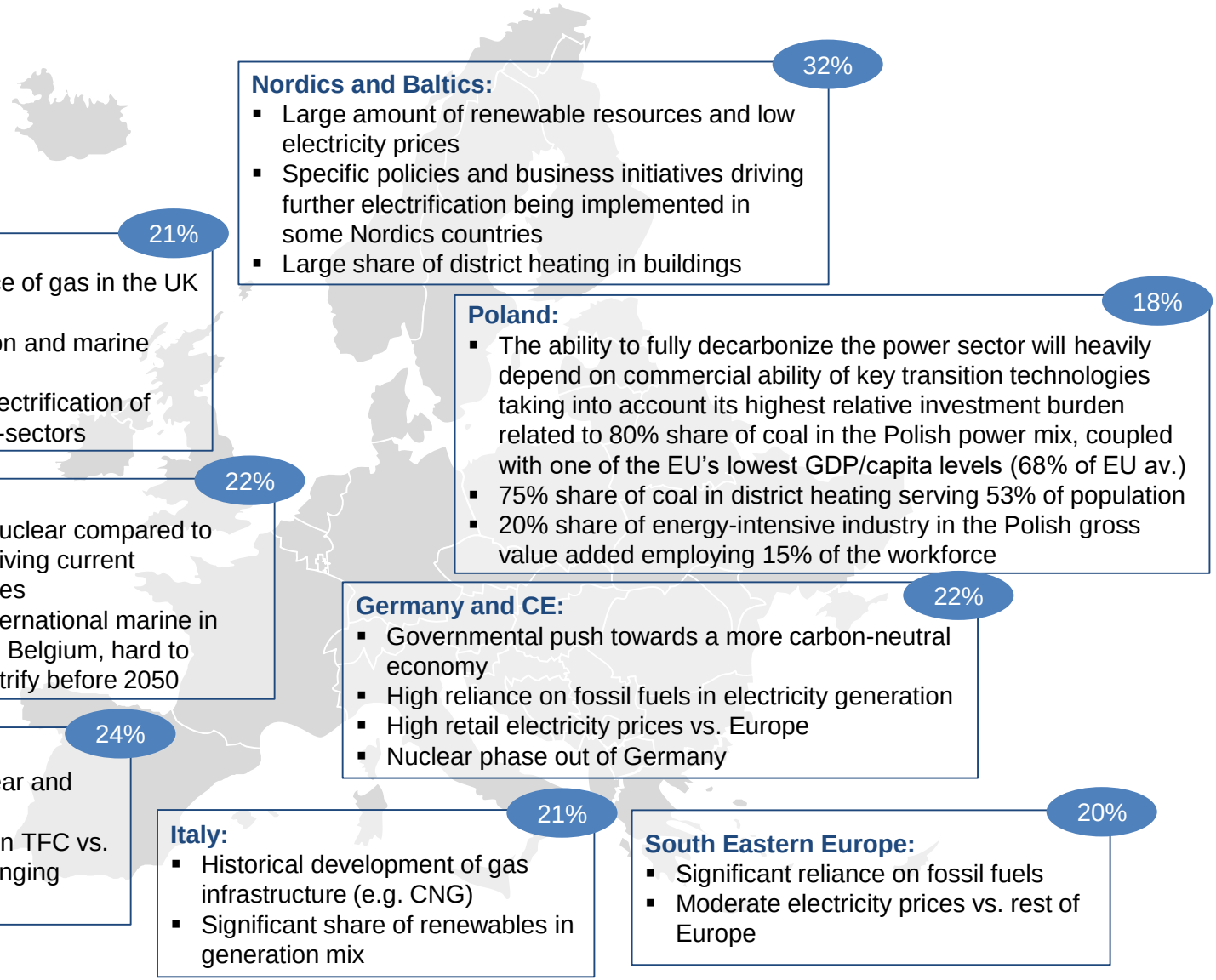


1. Organic, Ammonia, Other; 2. Oil & Gas, Own use, Other 3. Construction, Food & Agriculture, Manufacturing, Materials, Mining, Non-Energy, Other; 4. Separate global granular model

SOURCE: Energy Insights, a McKinsey Solution – Global Energy Perspective

Different starting points in the energy transition

2015 baseline – direct electrification rate



Nordics and Baltics: 32%
- Large amount of renewable resources and low electricity prices
- Specific policies and business initiatives driving further electrification being implemented in some Nordics countries
- Large share of district heating in buildings

UK - Ireland: 21%
- Historical importance of gas in the UK and oil in Ireland
- Low share of aviation and marine within TFC mix
- High potential for electrification of some industrial sub-sectors

Poland: 18%
- The ability to fully decarbonize the power sector will heavily depend on commercial ability of key transition technologies taking into account its highest relative investment burden related to 80% share of coal in the Polish power mix, coupled with one of the EU's lowest GDP/capita levels (68% of EU av.)
- 75% share of coal in district heating serving 53% of population
- 20% share of energy-intensive industry in the Polish gross value added employing 15% of the workforce

France - Benelux: 22%
- Large share of nuclear compared to other regions, driving current electrification rates
- High share of international marine in Netherlands and Belgium, hard to significantly electrify before 2050

Germany and CE: 22%
- Governmental push towards a more carbon-neutral economy
- High reliance on fossil fuels in electricity generation
- High retail electricity prices vs. Europe
- Nuclear phase out of Germany

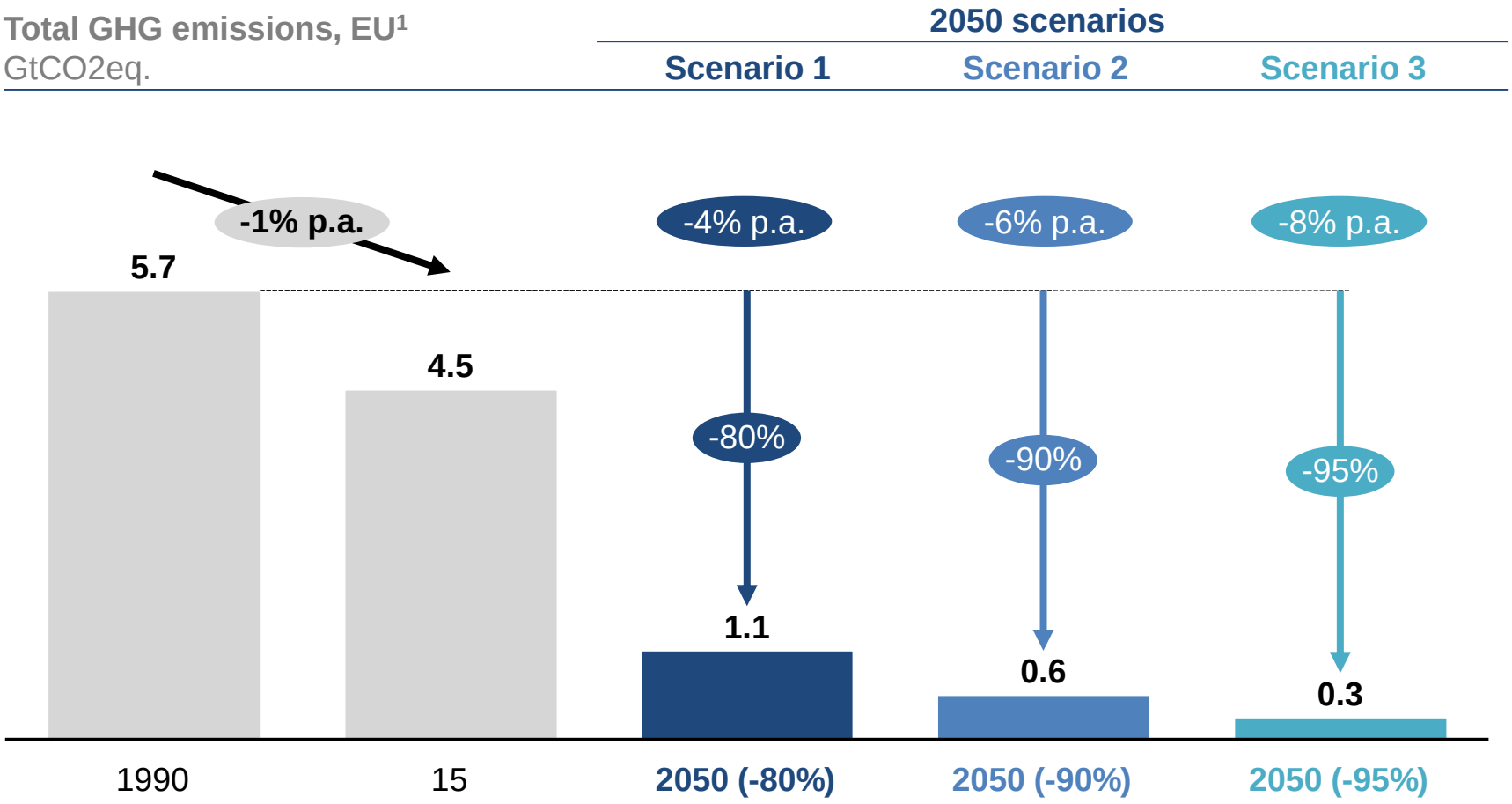
Iberia: 24%
- Significant share of nuclear and renewables
- Highest share of marine in TFC vs. other regions, with challenging electrification

Italy: 21%
- Historical development of gas infrastructure (e.g. CNG)
- Significant share of renewables in generation mix

South Eastern Europe: 20%
- Significant reliance on fossil fuels
- Moderate electricity prices vs. rest of Europe

The 3 scenarios deliver unprecedented but necessary reductions in CO2 emissions

-x% p.a. Required annual emission reduction rate between 2015-2050 to achieve target



SOURCE: Energy Insights, EuroStat

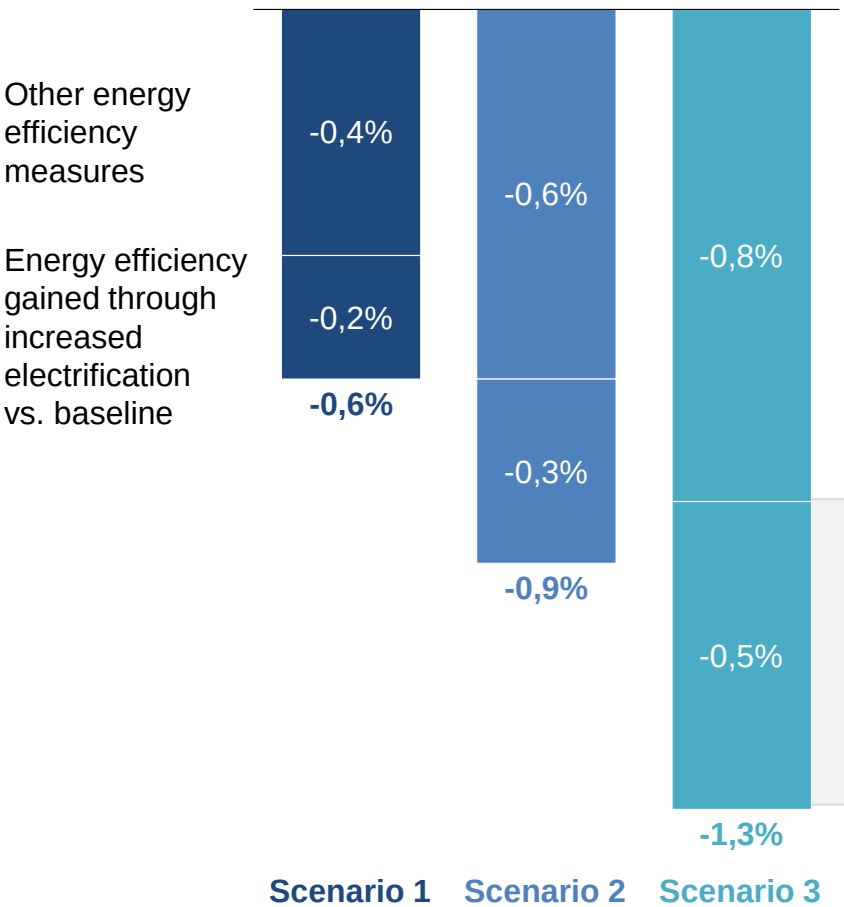
eurelectric

NOT EXHAUSTIVE

Deploying electric solutions is strongly contributing to the total energy efficiency gains

Drivers of energy efficiency gains

2015-2050 YoY reduction in TFC



Illustrations by sector

Transport

- In passenger cars, EVs consume 25% of ICE vehicles' energy consumption
- For trucks, e-trucks consume ~50% of their diesel equivalents' own energy consumption

Buildings

- In space heating, heat pumps' coefficient of performance (COP[1]) is 4-5x higher than the COP for typical gas boilers
- In cooking, the energy intensity of electric solutions is 10% lower than for gas and down to 1/5 of the energy intensity of charcoal and wood

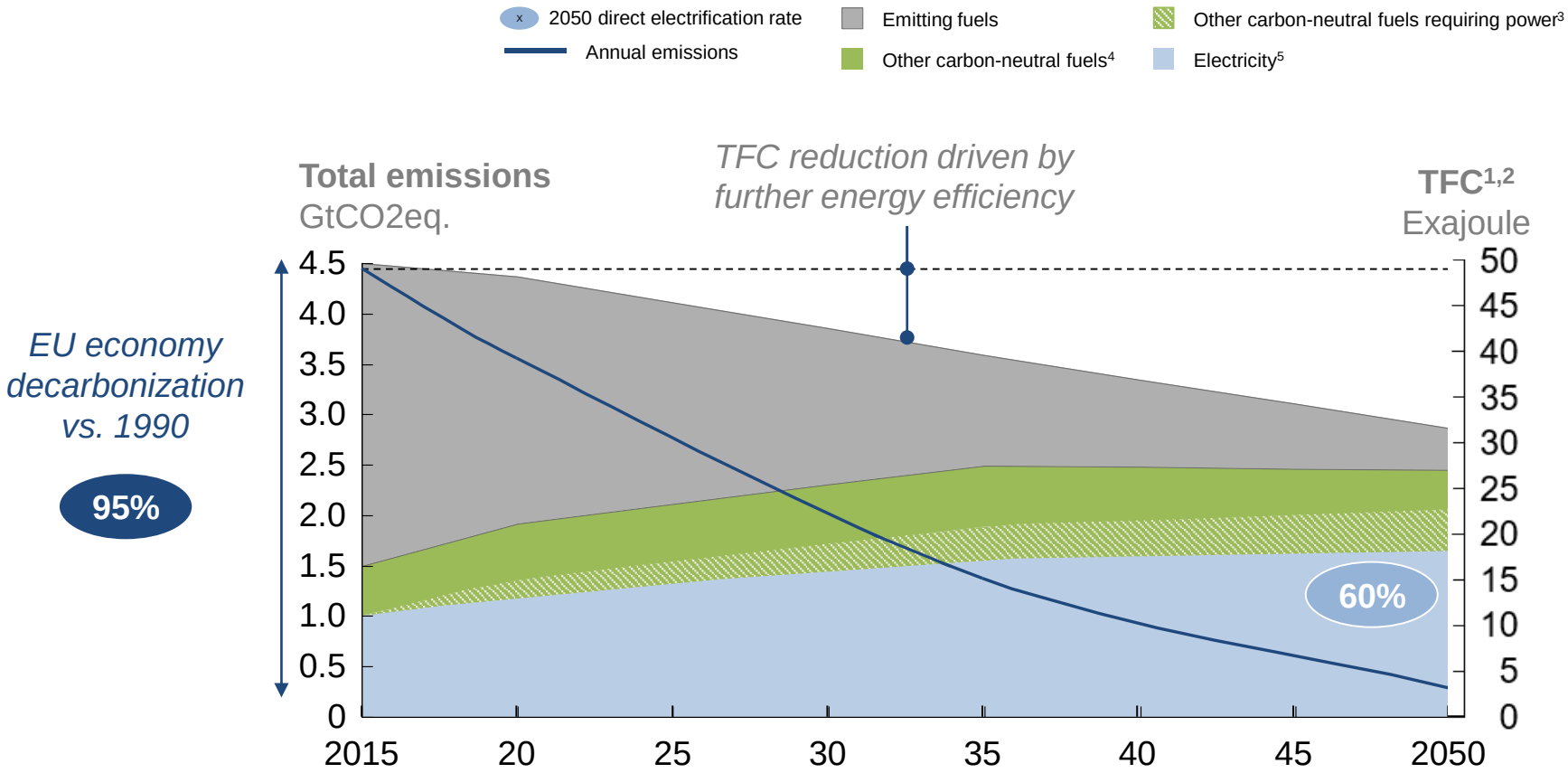
Industry

- For steel, electric arc furnace route using recycled steel is 5-6x less energy intense than traditional coal-based (blast furnace) production routes
- In other industry, electric solutions (e.g., heat pumps, hybrid boilers) can be between 100-300% more energy efficient for low temperature grades then their gas equivalents

1 Coefficient of performance (COP) = ratio of heat delivered vs energy needed as input

95% decarbonization through strong electrification, energy efficiency, and support from other non-emitting fuels

Impact of electrification on Total Final Energy Consumption (TFC) and EU economy emissions



1 Includes 32 countries in scope: EU28 + EEA; ENTSOE report additionally includes Turkey and other Eastern European countries adding up to a total of ~3,300 TWh
2 Electricity consumption from transformation sectors not included; 3 Includes non-emitting fuels that trigger indirect electrification through power-to-X (H2, synth fuels) as well as non-emitting fuels that trigger increased electricity demand to be produced such as biofuels; 4 Includes all other non-emitting fuels/sources such as geothermal, solar thermal, and others; 5 Direct electricity consumption

Direct electrification results by scenario

		2015 Baseline	2050 Scenario 1	2050 Scenario 2	2050 Scenario 3
Total EU economy	EU economy decarbonization vs 1990	22%	80%	90%	95%
	Direct electrification rate	22%	38%	48%	60%
Total transport	Direct electrification rate	**1%**	29%	43%	63%
Total buildings	Direct electrification rate	**34%**	45%	54%	63%
Total industries	Direct electrification rate	**33%**	38%	44%	50%