



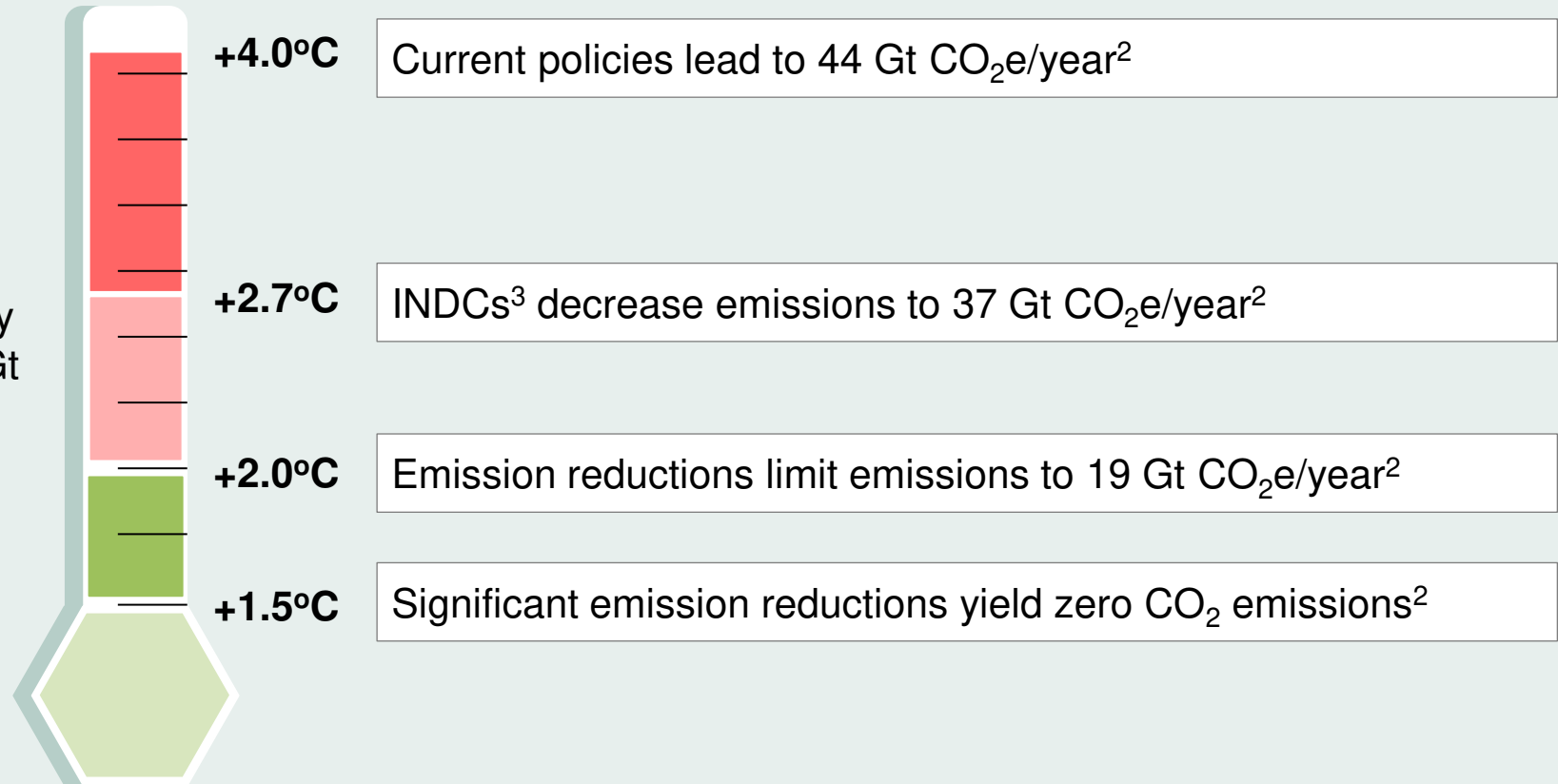
# How Hydrogen empowers the Energy Transition

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HYDROGEN COUNCIL | SEPTEMBER 2017

# Current efforts are not enough to limit climate change to below 2°C

**Temperature increase**  
by 2100 due to global energy  
related GHG emissions, in Gt  
CO<sub>2</sub>e/year<sup>1</sup>



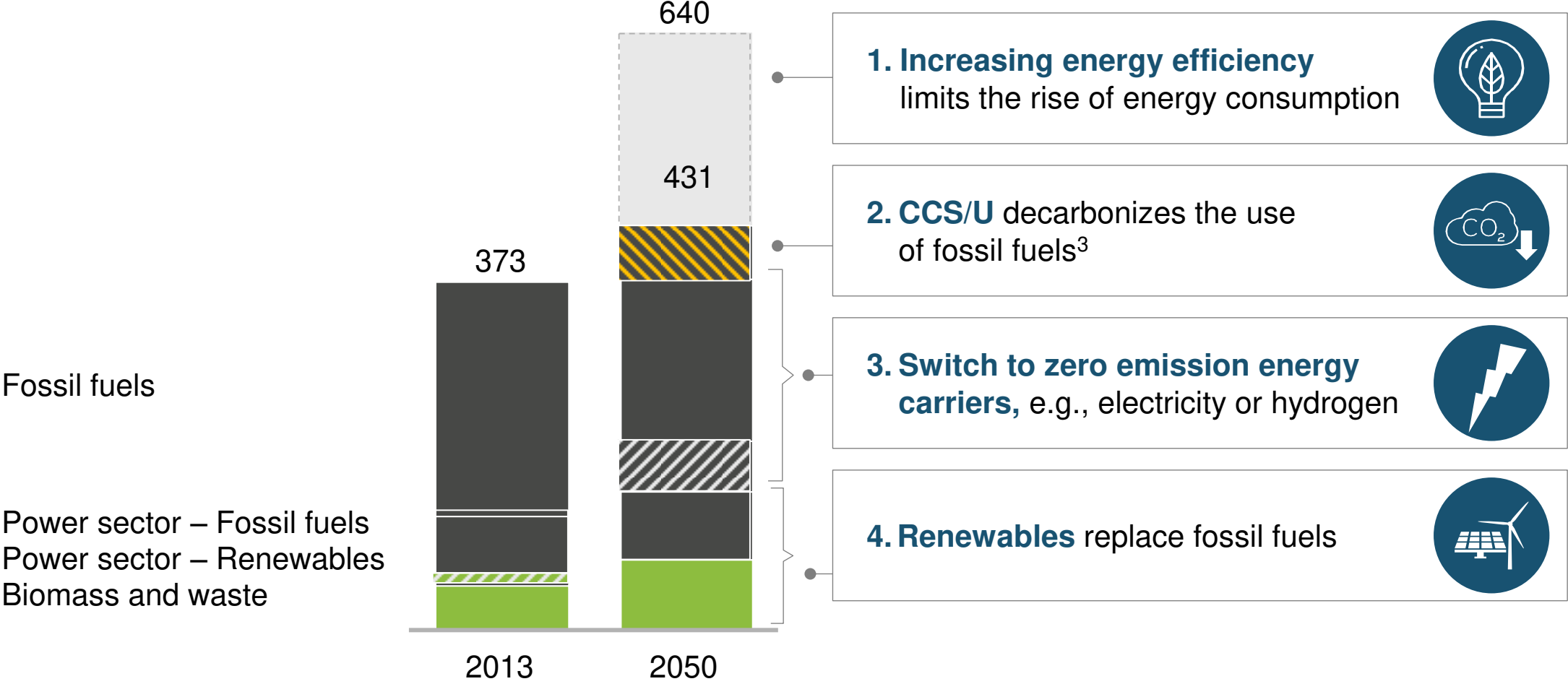
<sup>1</sup> The GHG emissions in 2013 were 34 Gt CO<sub>2</sub>e/year

<sup>2</sup> The GHG emissions forecasted for 2040 within the specified scenario

<sup>3</sup> Intended Nationally Determined Contributions. The climate actions communicated in these INDCs help estimate whether the world achieves the long-term goals of the Paris Agreement

# Four major levers are needed to enable the energy transition

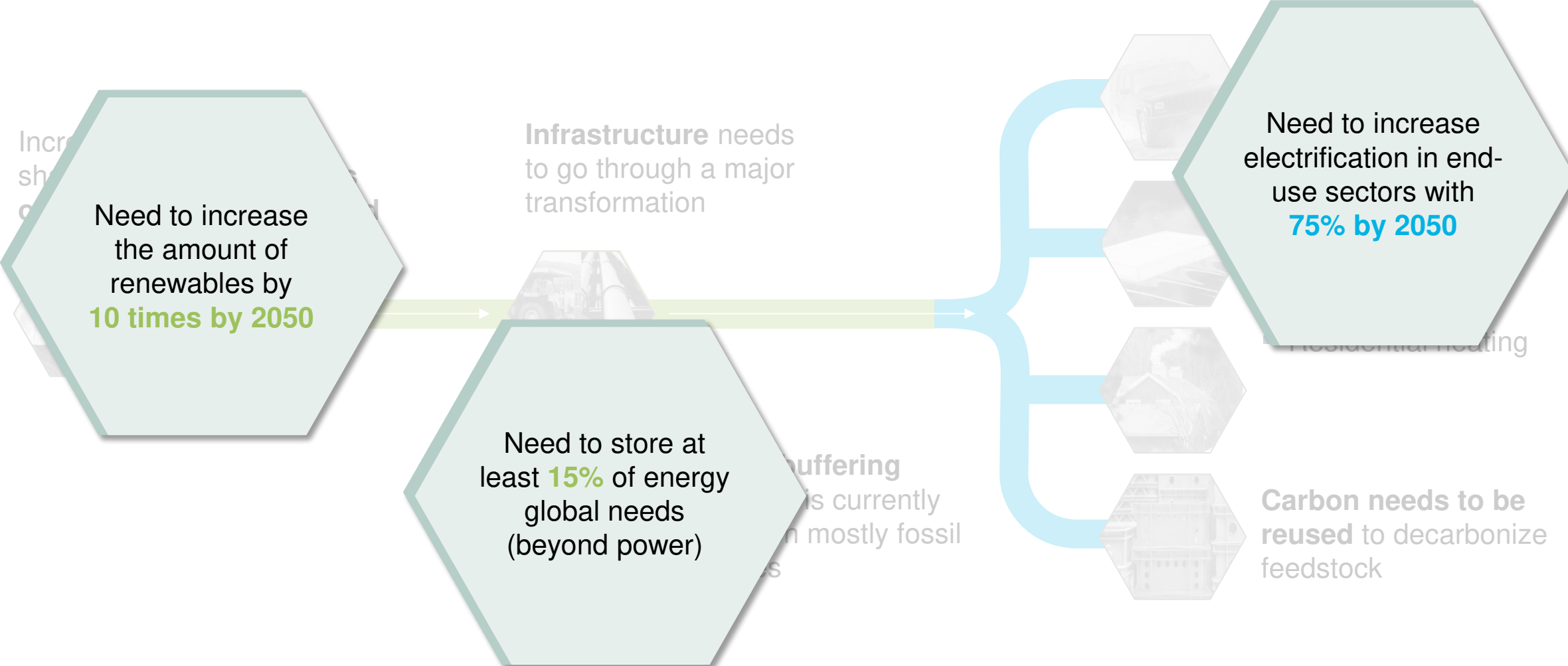
Final energy consumption<sup>1,2</sup>, 2013 and 2050, in EJ



1 Final energy consumption within the 2DS of the IEA  
 2 Increase of energy demand is determined via the relative increase of CO<sub>2</sub> emissions w/o energy efficiencies  
 3 The fossil fuels amount processed using CCS/U was determined to be 25% of the total amount of fossil fuels by relating the CO<sub>2</sub> emission reduction compared for the 2DS and 6DS  
 4 The fossil fuel power sector also includes nuclear energy

# The energy transition creates multiple challenges

Enable the renewable energy system → Decarbonize end uses

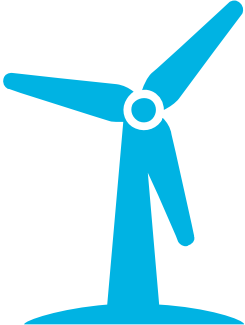
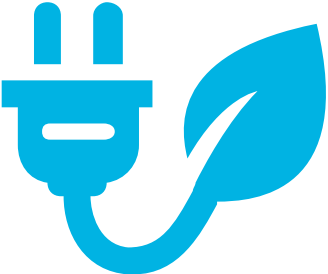


# Hydrogen is a clean, safe and versatile energy carrier

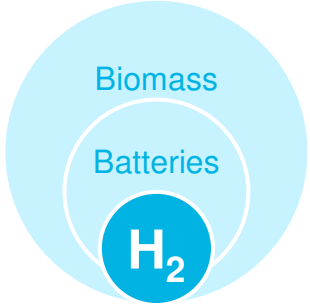
**Can be transported over long distances,**  
allowing the distribution of energy between countries



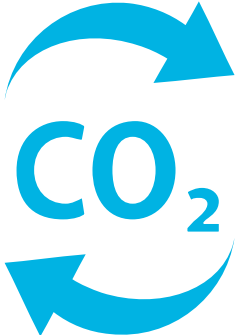
**Produces clean power and/or heat**  
for transport and stationary applications



**Can be produced without a carbon footprint** through electrolysis or SMR + CCS



**Has a high energy density,** making it suitable for long-term storage



**Required as a clean feedstock in industry** when recycling captured CO<sub>2</sub>

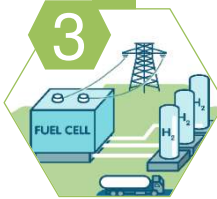
# There are seven roles for hydrogen in the energy transition

Enable the renewable energy system → Decarbonize end uses

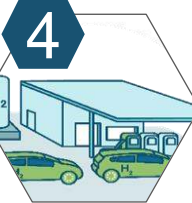
Enable **large-scale renewables integration** and **power generation**



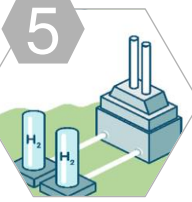
**Distribute** energy across sectors and regions



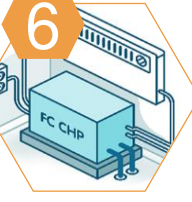
Act as a **buffer** to increase system resilience



Decarbonize **transportation**



Decarbonize **industry energy use**



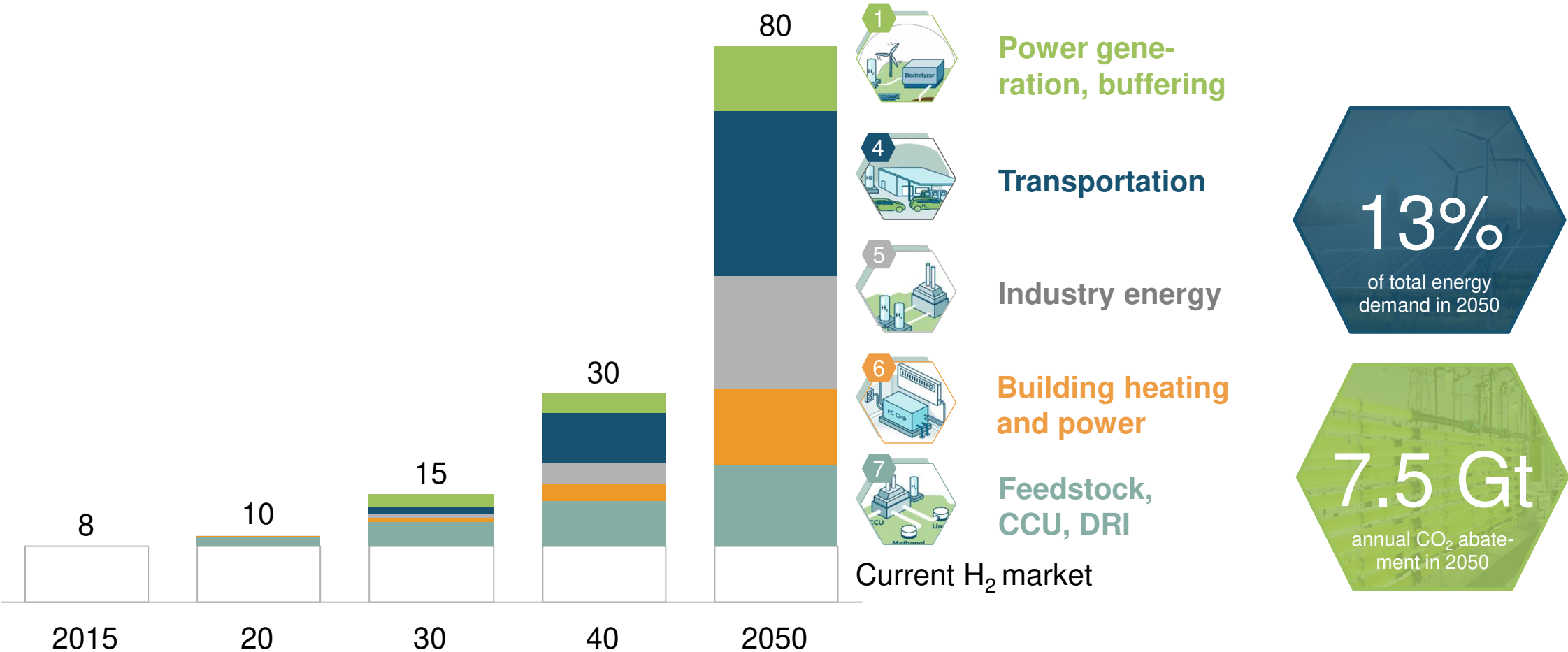
Help decarbonize **building heating and power**



Serve as **feedstock**, using captured carbon

# By 2050, hydrogen can enable major CO<sub>2</sub> emission reductions

Global Energy demand supplied with hydrogen, Exajoule (EJ)



1 Excluding feedstock

SOURCE: Hydrogen Council, IEA ETP Hydrogen and Fuel Cells CBS, National Energy Outlook 2016"

# Hydrogen is a topic of focus – a collection of articles since January

Bloomberg the Company & Its Products

Met Re

CN

TRUCKS.COM

10MW REFINERY HYDROGEN PROJECT WITH SHELL

1ST SEPTEMBER 2017

0:1

Trucking powered

En fil

Par

ship-build

Aboard the first hydrogen commuter train