

## The reality of bridging the gap

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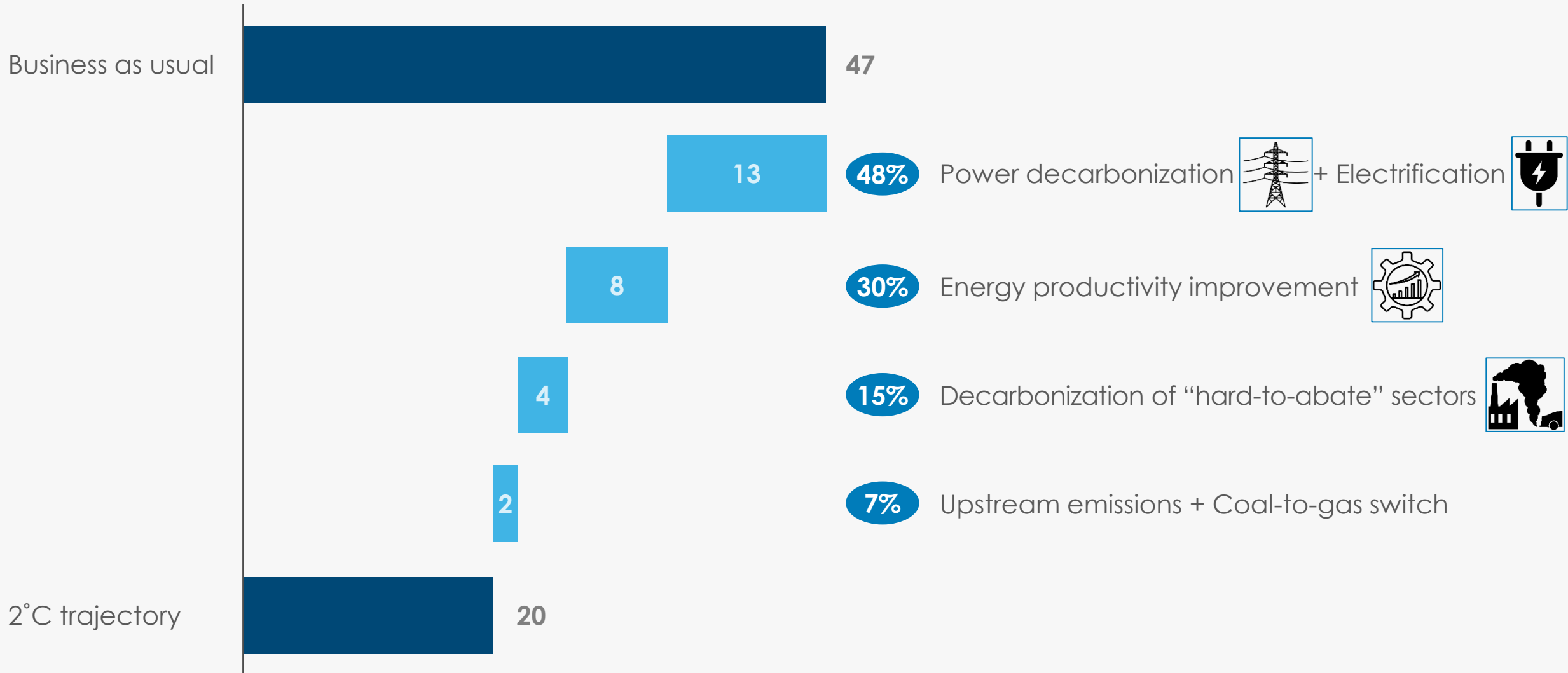


# Halving carbon emissions by 2040 is within our reach if we act now to implement 4 interdependent transition strategies

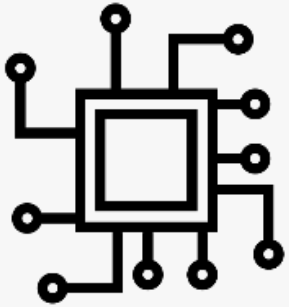


## Annual carbon emissions from the energy system by 2040

Gt CO<sub>2e</sub>



# This energy transition is technologically feasible and financially manageable



Technologically feasible



## No complete unknowns

Can identify one or several plausible decarbonization technologies for each emitting activity, even if they are still at R&D stage or not yet cost-competitive

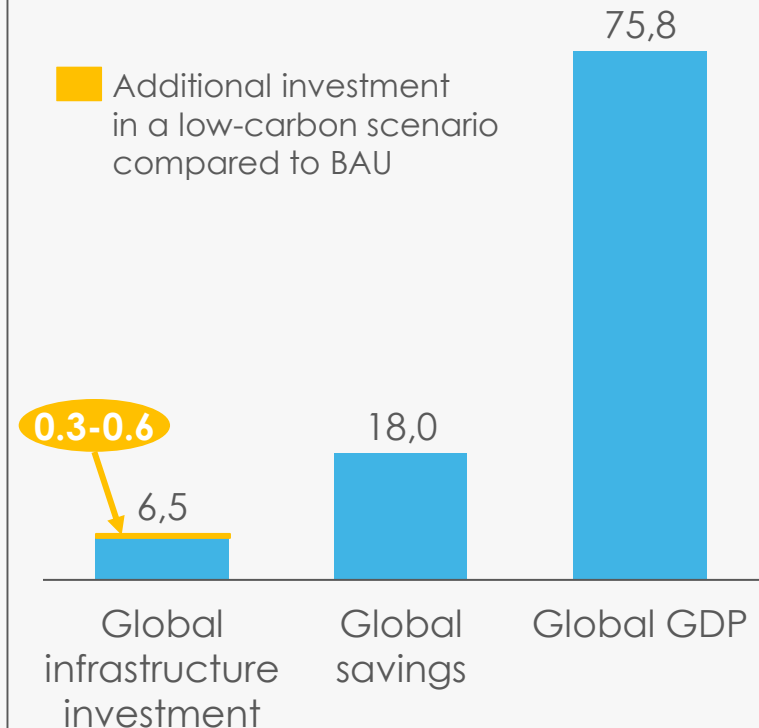


Financially manageable



\$ trillion per year

Additional investment in a low-carbon scenario compared to BAU



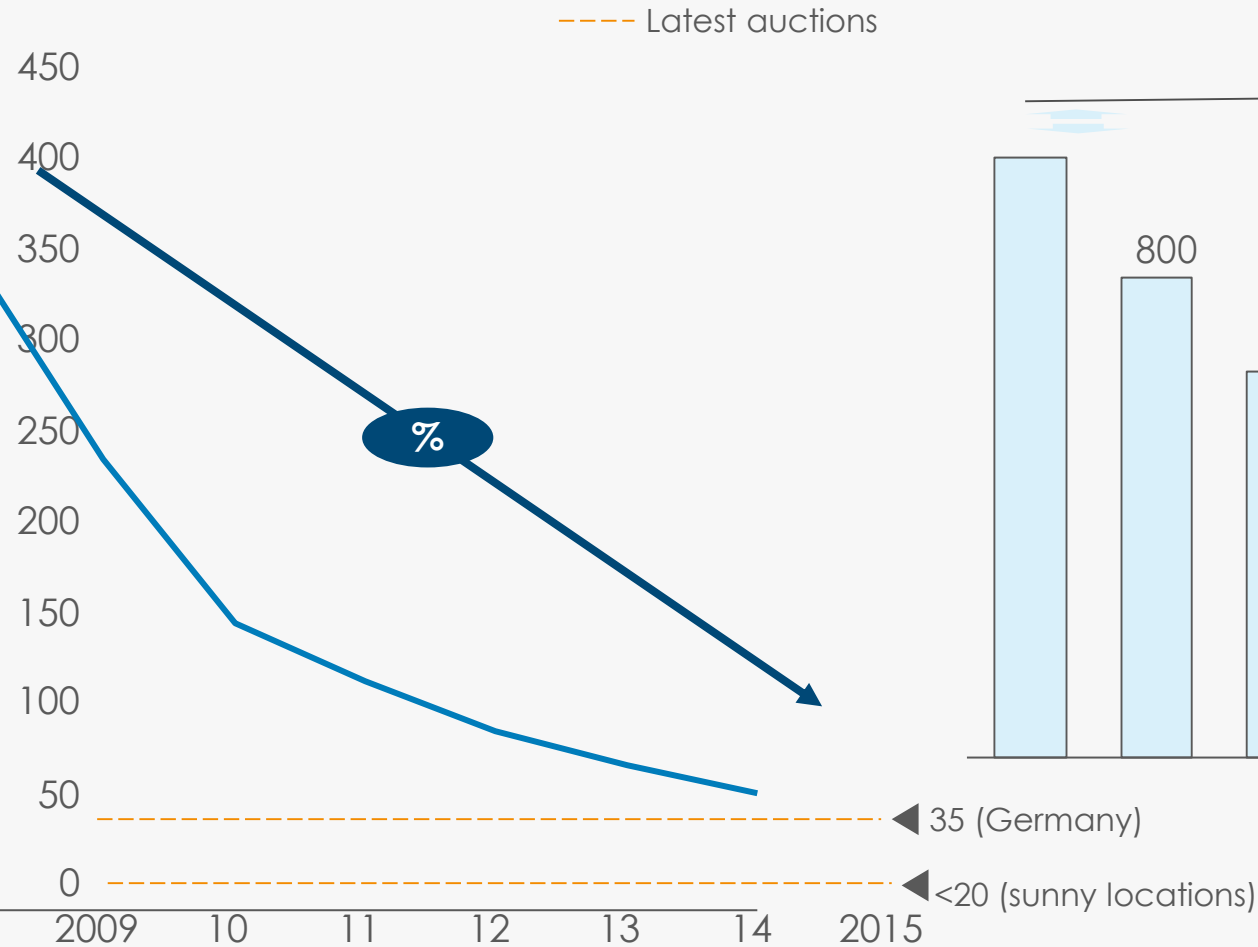
## What is happening in the energy world?

- **Solar PV** is on track to be the cheapest source of new electricity in many countries
- **Decline in battery prices** are pointing to solar + battery becoming the cheapest source of 24-hour electricity
- The future is **electrifying**, spurred by cooling, electric vehicles & digitalization
- Increased gas use in industry and buildings is driving global demand
- Hydrogen is increasingly likely to be the fuel of the future

# Cost of wind and solar electricity has decreased significantly; battery costs are also plummeting. This will enable the cost-effective integration of variable renewables into the grid

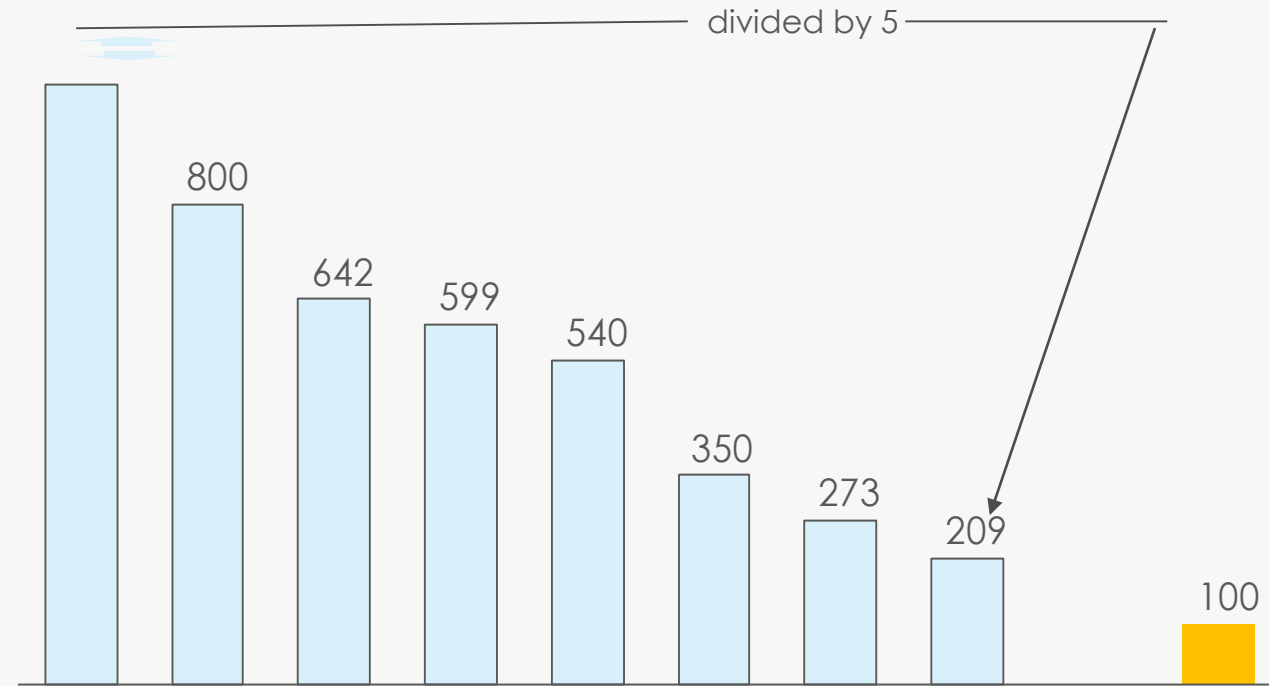
## Levelized Cost of Utility-Scale PV

USD/MWh, Unsubsidized



## Battery prices

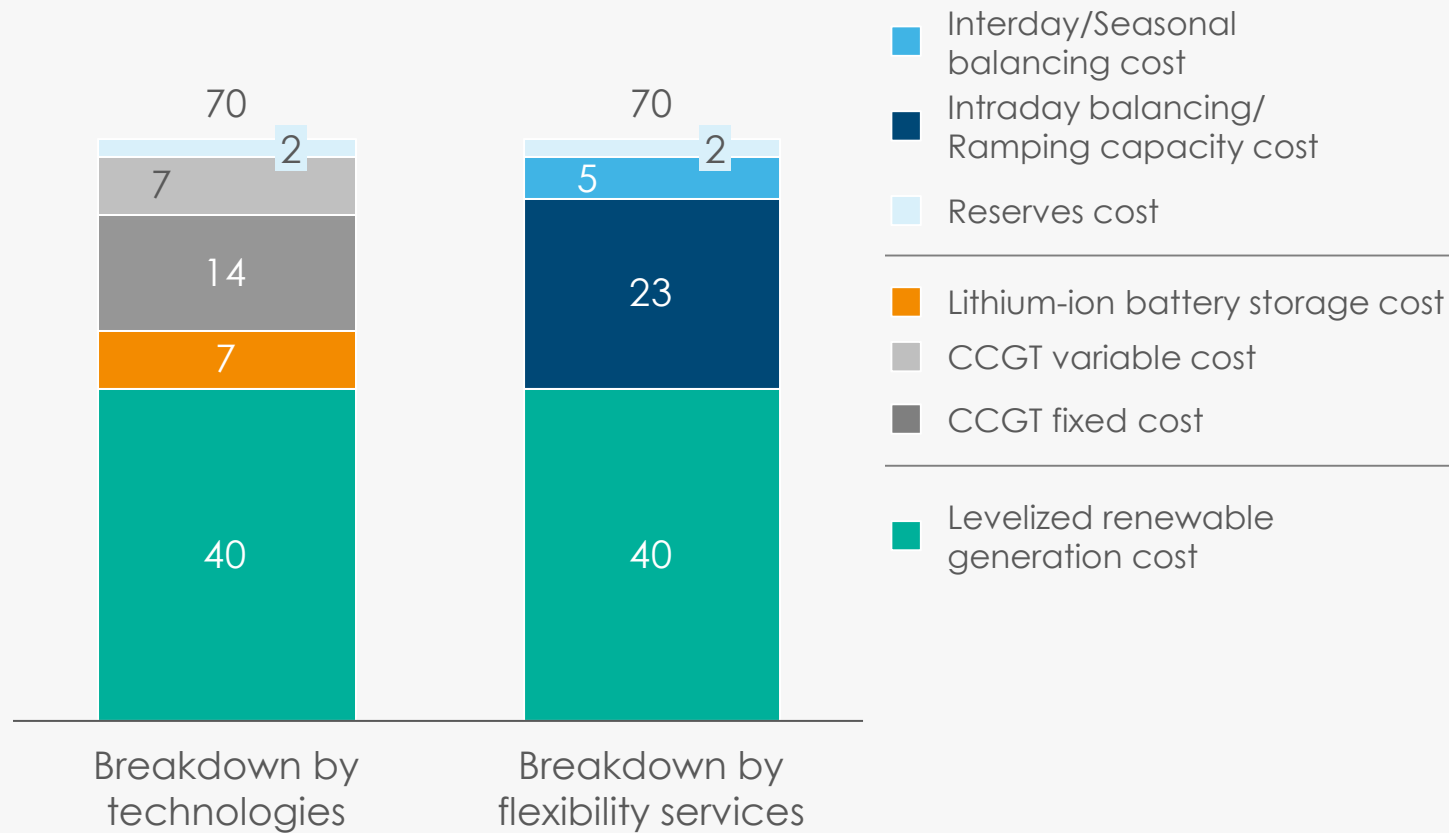
USD per kWh of storage



# A near-total-variable-renewable power system can be competitive with one based on coal or gas-fired power generation

## Maximum all-in cost of power generation in a near-total-variable-renewable power system by 2035

USD/MWh



**\$70/MWh**

**Maximum all-in cost of a near-100% renewable power system**

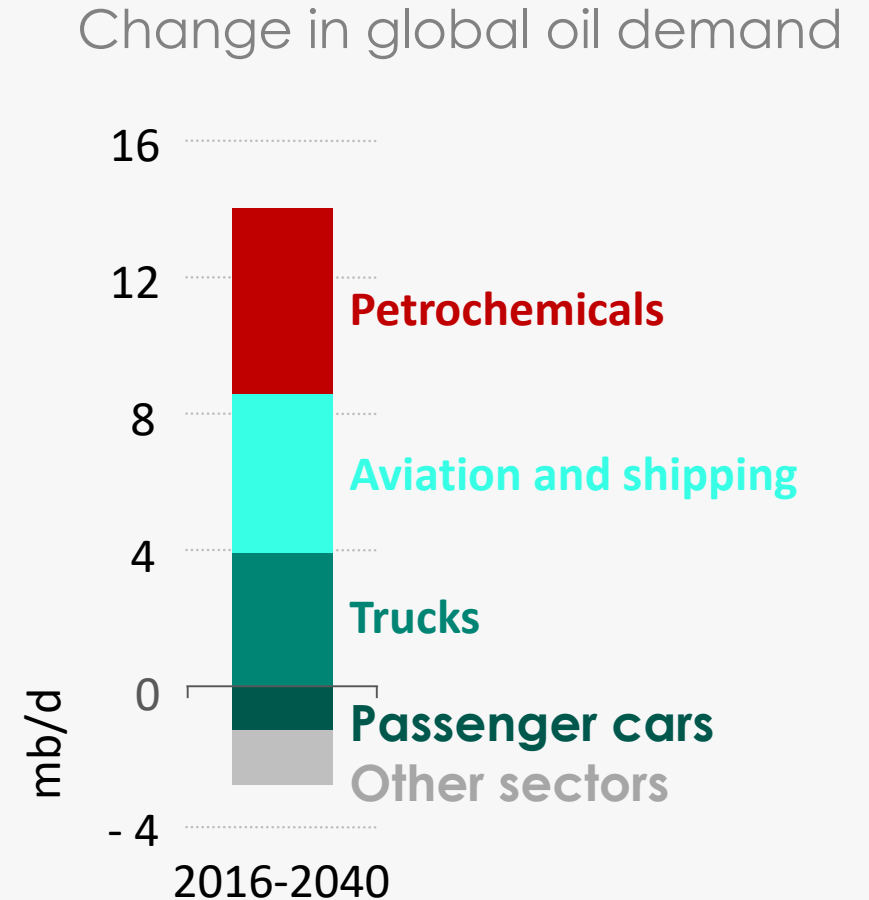
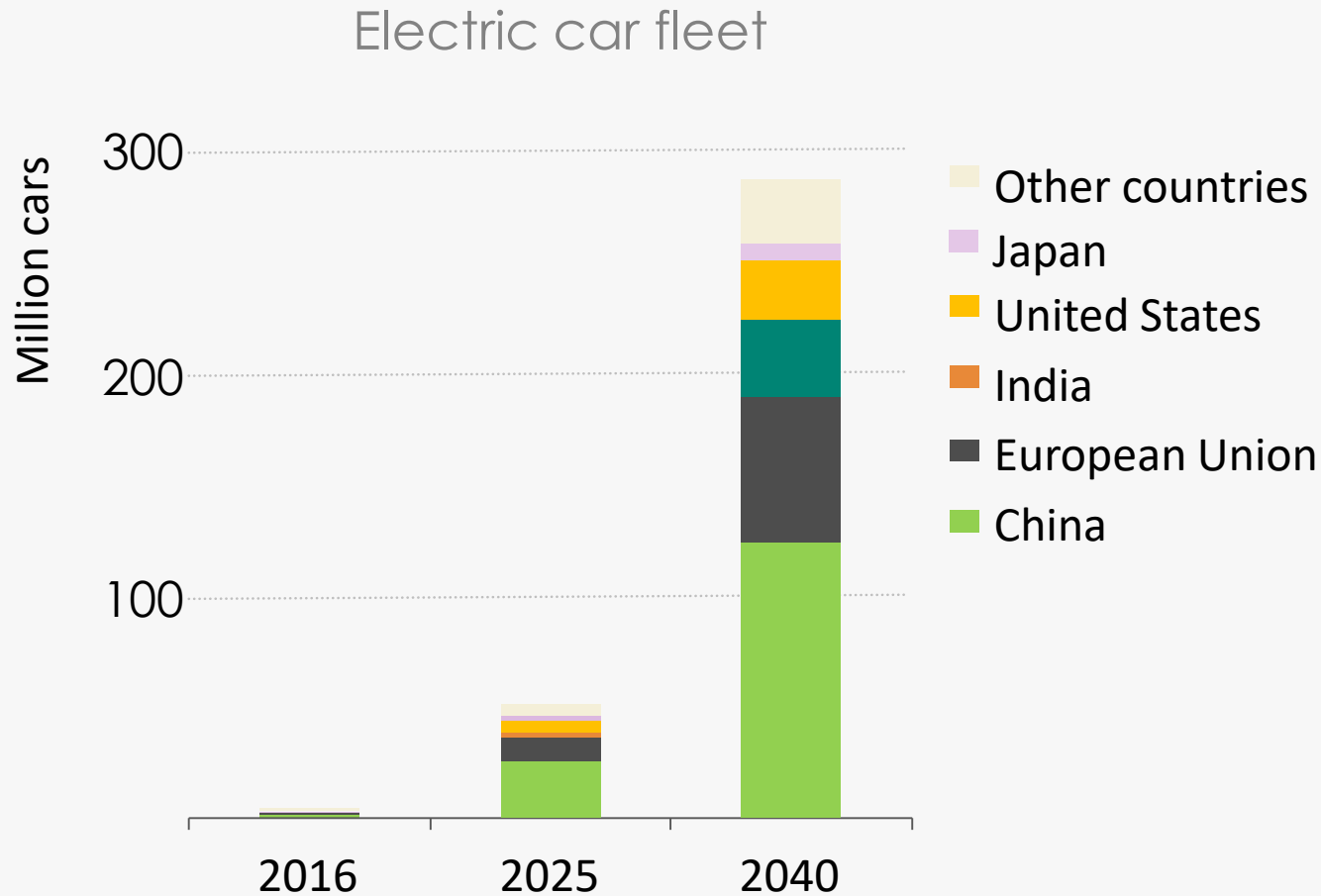
Likely lower if:

- Generation cost lower than \$40/MWh
- Other sources of flexibility used (e.g. dispatchable hydro, interconnections, demand management...)

NOTE: Based on Germany resource and load profile. / Considers only 2 flexibility technologies: CCGT & Li-ion batteries / Levelized renewable energy generation cost includes all energy potentially produced, including amount curtailed or stored/shifted.

SOURCE: Climate Policy Initiative & ETC, 2017, Low-cost, low-carbon power systems.

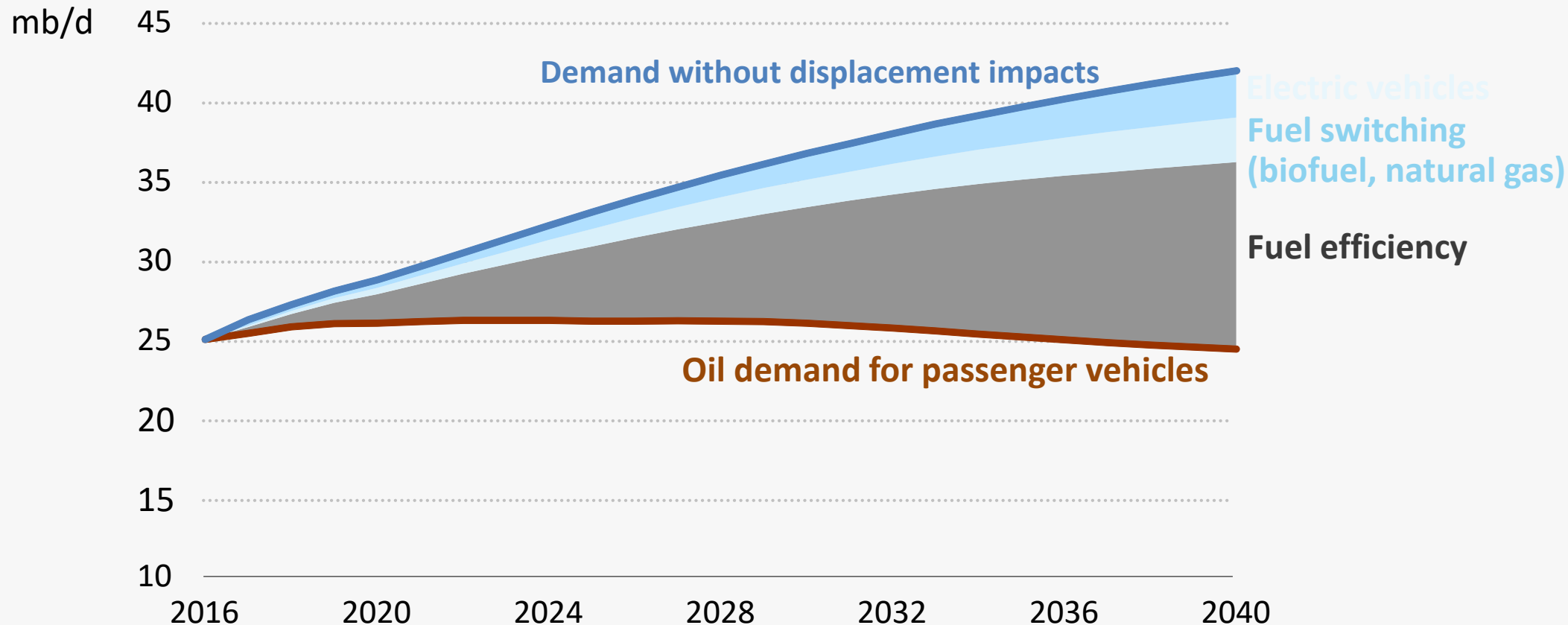
# EVs are on the way, but oil demand is still rising



Electric cars are helping to transform energy use for passenger cars, slowing the pace of growth in global oil demand; however, trucks, aviation, shipping & petrochemicals keep oil on a rising trend.

# Future passenger vehicle oil demand is most affected by improvements in fuel efficiency

Oil demand for passenger vehicles



By 2040, electric vehicles, fuel switching and efficiency improvement displace 19 mb/d of oil demand for passenger vehicles

SOURCE: IEA Analysis





# Broader electrification with low-carbon power could increase electricity requirements by 25% by 2040



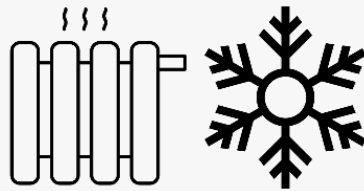
80 EJ today



50% electrified by 2040



+3,320 TWh



40 EJ today

1/3 electrified by 2040



30 EJ today

1/3 electrified by 2040



30 EJ today

1/3 electrified by 2040



+3,080 TWh



+6,400 TWh

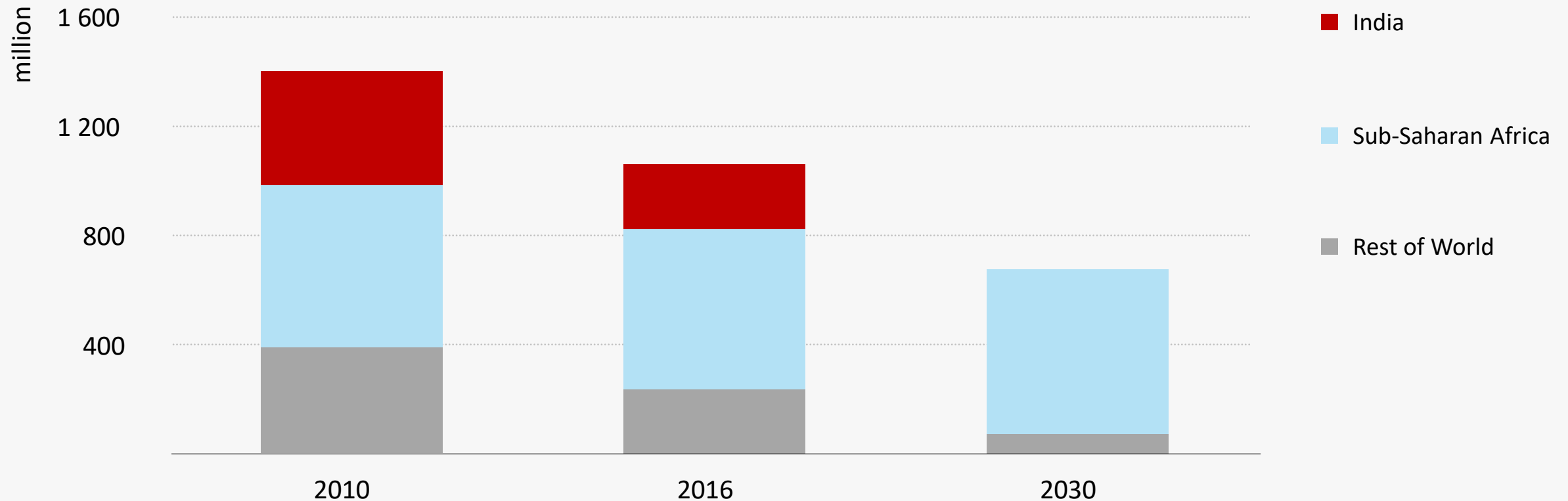
→ **32,890 TWh total power demand**  
vs. 18,970 TWh today → +75%  
vs. 26,490 TWh 2040 BAU<sup>1</sup> → +25%

NOTE: 1. Additional power demand in a high-electrification scenario compared to a business-as-usual / low-electrification scenario by 2040.  
SOURCE: Energy Transitions Commission (2017), Better Energy, Greater Prosperity.

# Universal electricity access: a key strategic challenge for all of us



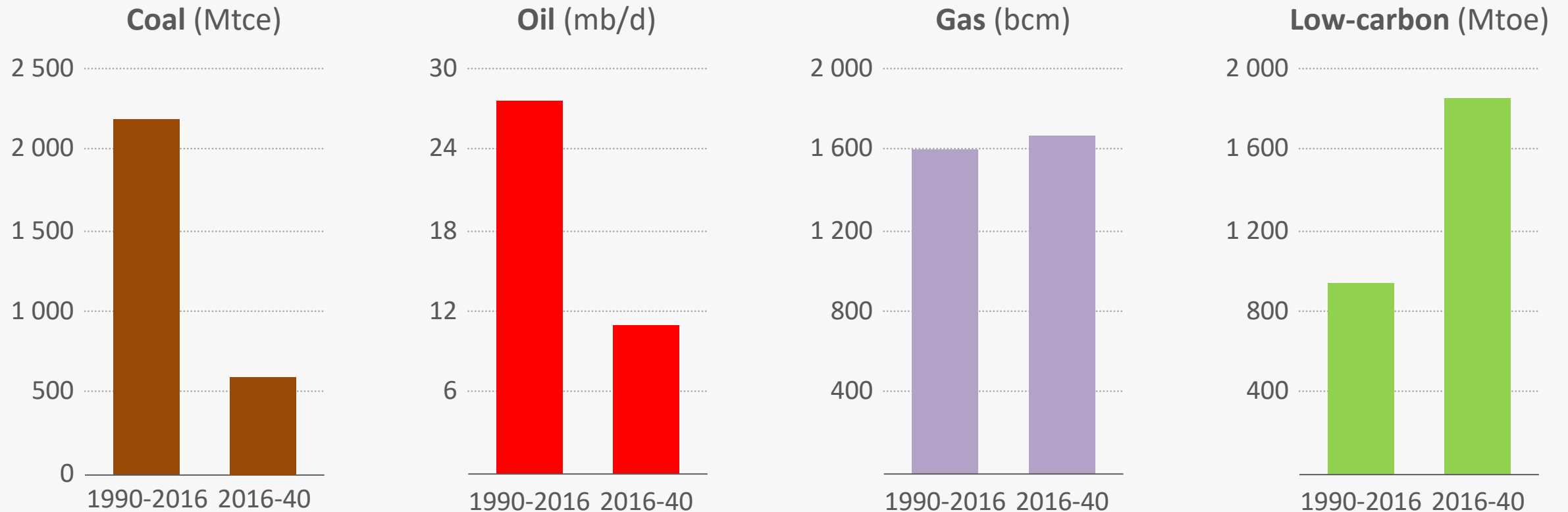
Number of people without electricity access



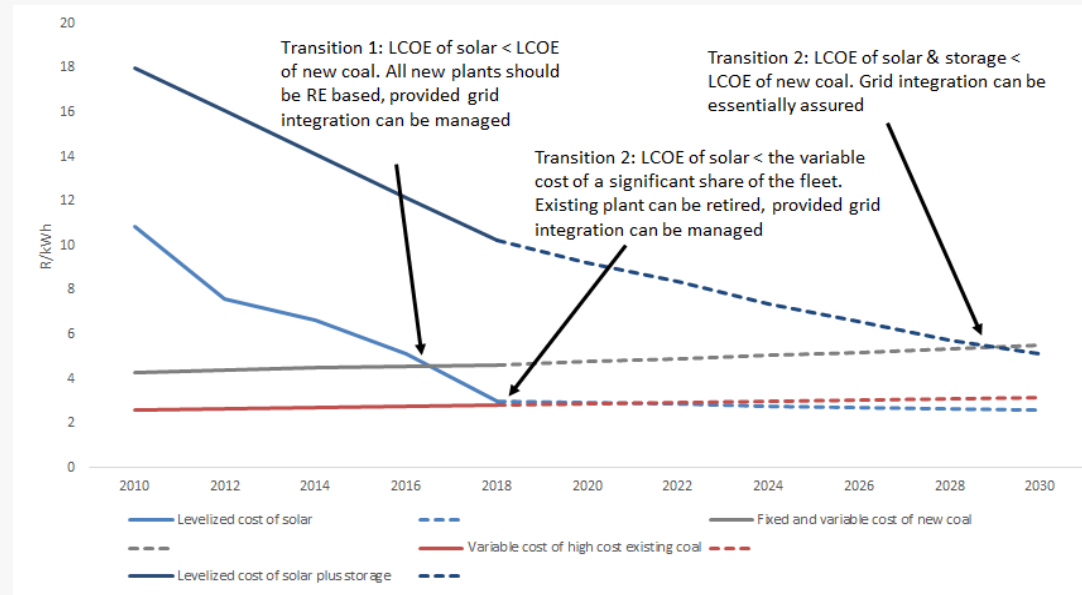
**Strong policy support in India in recent years has brought the goal of universal access within reach, although more effort will be required to reach the worldwide target of 'energy for all' by 2030**

# Low carbon sources – renewables and gas could meet over 70% of global energy demand. However, this is a generational transition

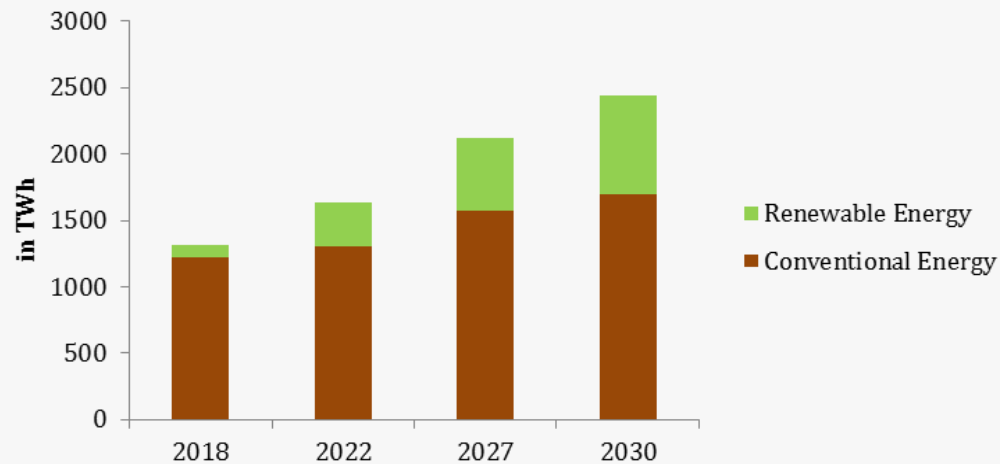
## Change in world energy demand by fuel



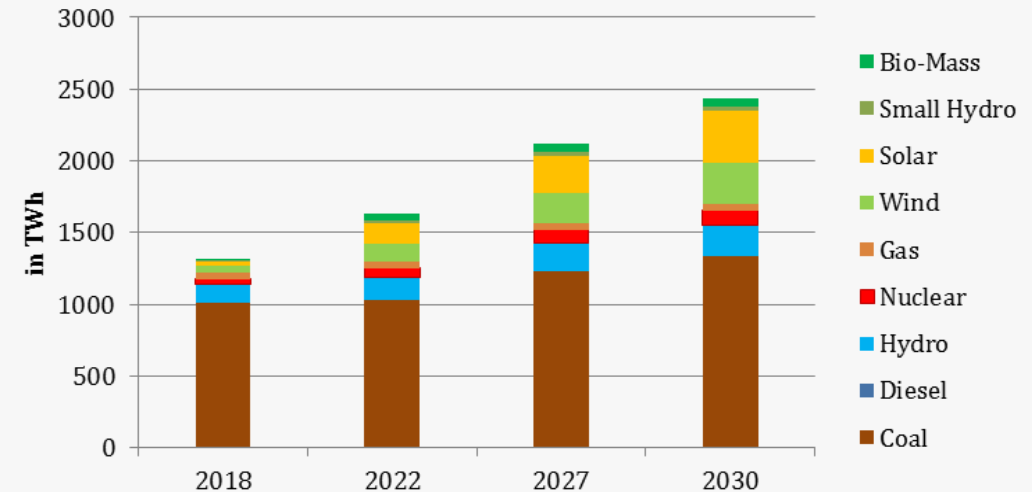
# The solar takeoff in India will depend on battery price; till then coal use will increase albeit solar utilization will be more rapid



**Power Generation in India (By 2030)**

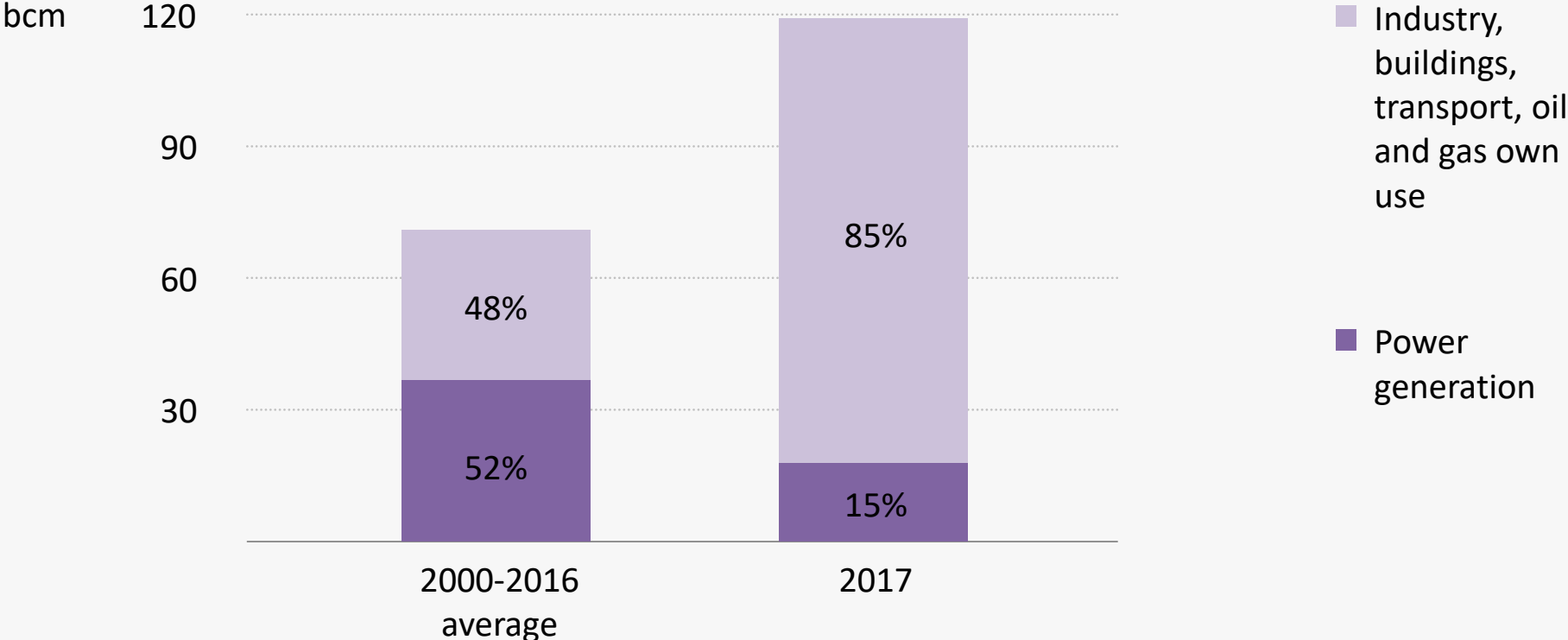


**Source-wise Power Generation in India (By 2030)**



# Natural gas consumers are responding to lower prices

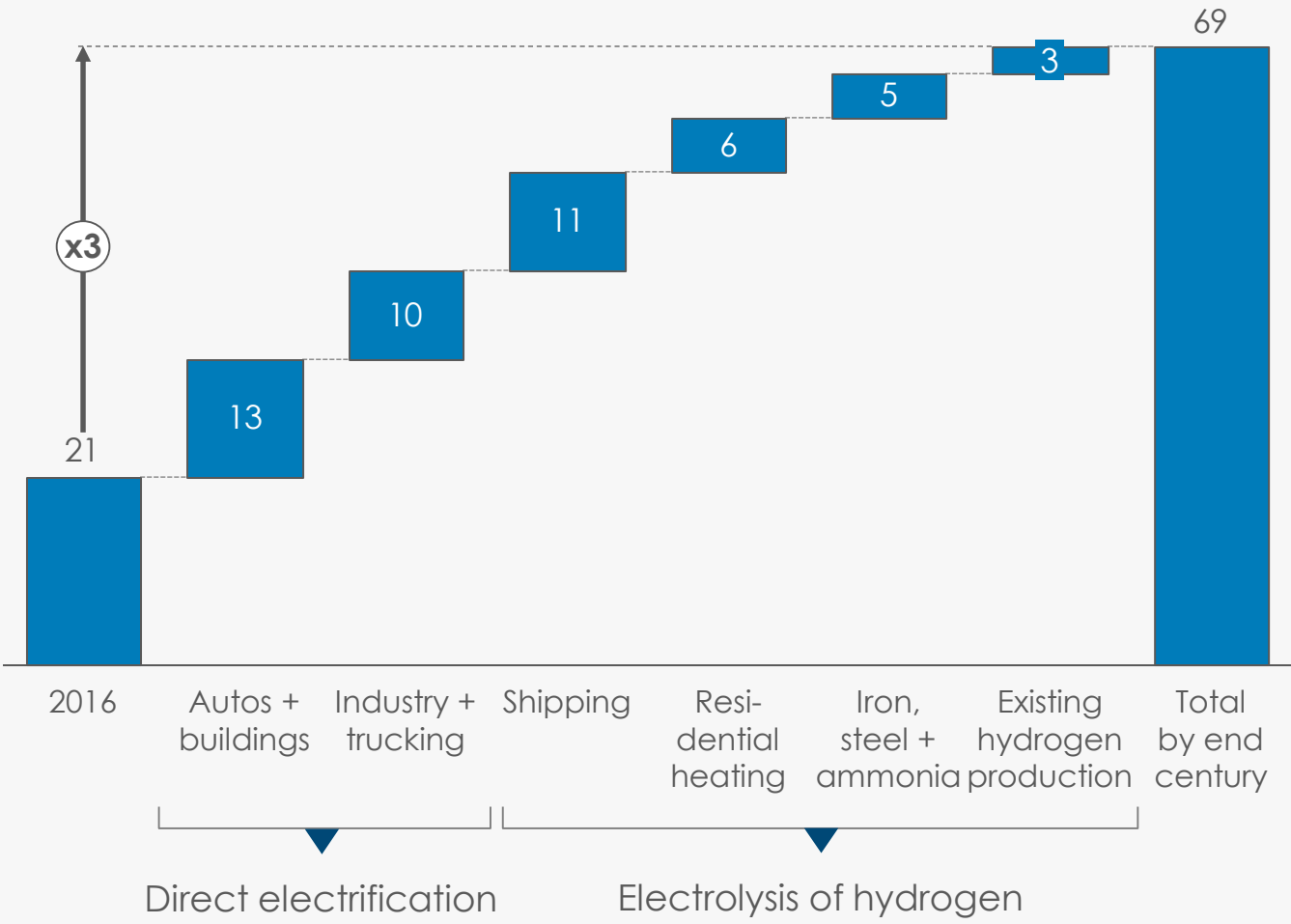
Growth in global gas demand



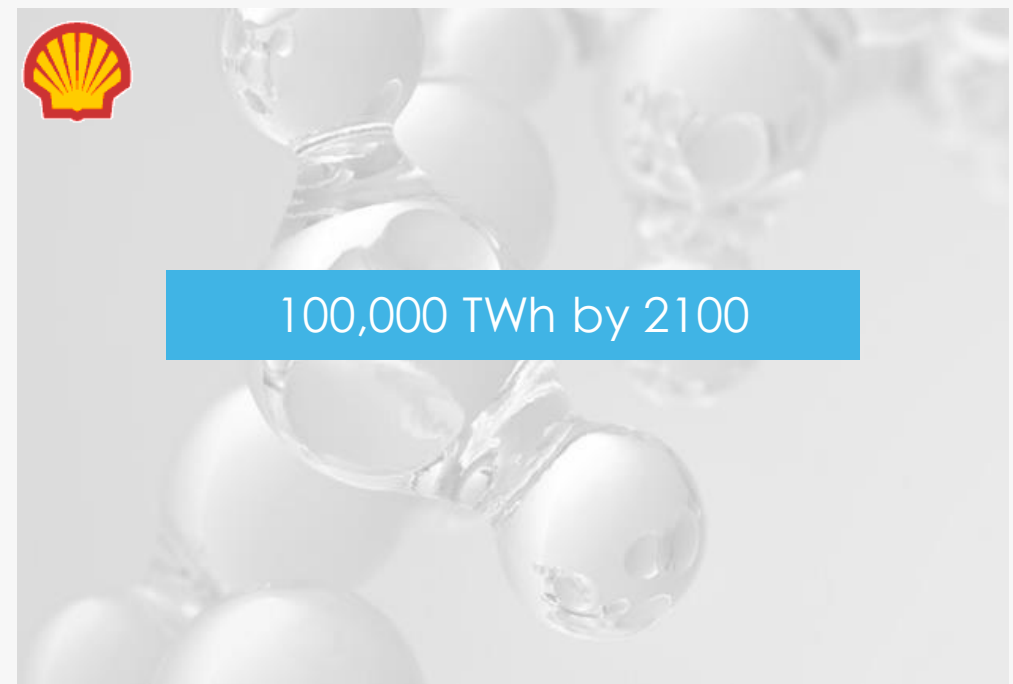
The strong growth in gas demand in 2017 was not driven by the power sector, but by greater use in industry & buildings; China accounted for 30% of the increase in global gas demand

# Direct electrification and indirect electrification (through hydrogen) of the economy will significantly increase power demand, which could be multiplied by 3 to 5 in the second half of the century

**ETC illustrative scenario**  
'000 TWh



**Shell Sky Scenario**  
Million tonnes



SOURCE: Energy Transitions Commission analysis

**Preliminary**

# Key Messages

- **Transition to renewables is inevitable in electricity sector**
  - timing depends on speed of price reduction of batteries
  - coal use will plateau before declining
- **Low carbon electricity will drive electrification**
  - Will substitute oil in the urban transport, industry and buildings sectors
  - Low price, low carbon electricity could stimulate hydrogen (from water splitting) as the main fuel of the low-carbon world.
- **Gas is emerging as a bridging fuel**
  - In industry and buildings – till low carbon electricity is cost effective?
  - Could be a source of hydrogen till splitting for low carbon electricity is cost effective.