



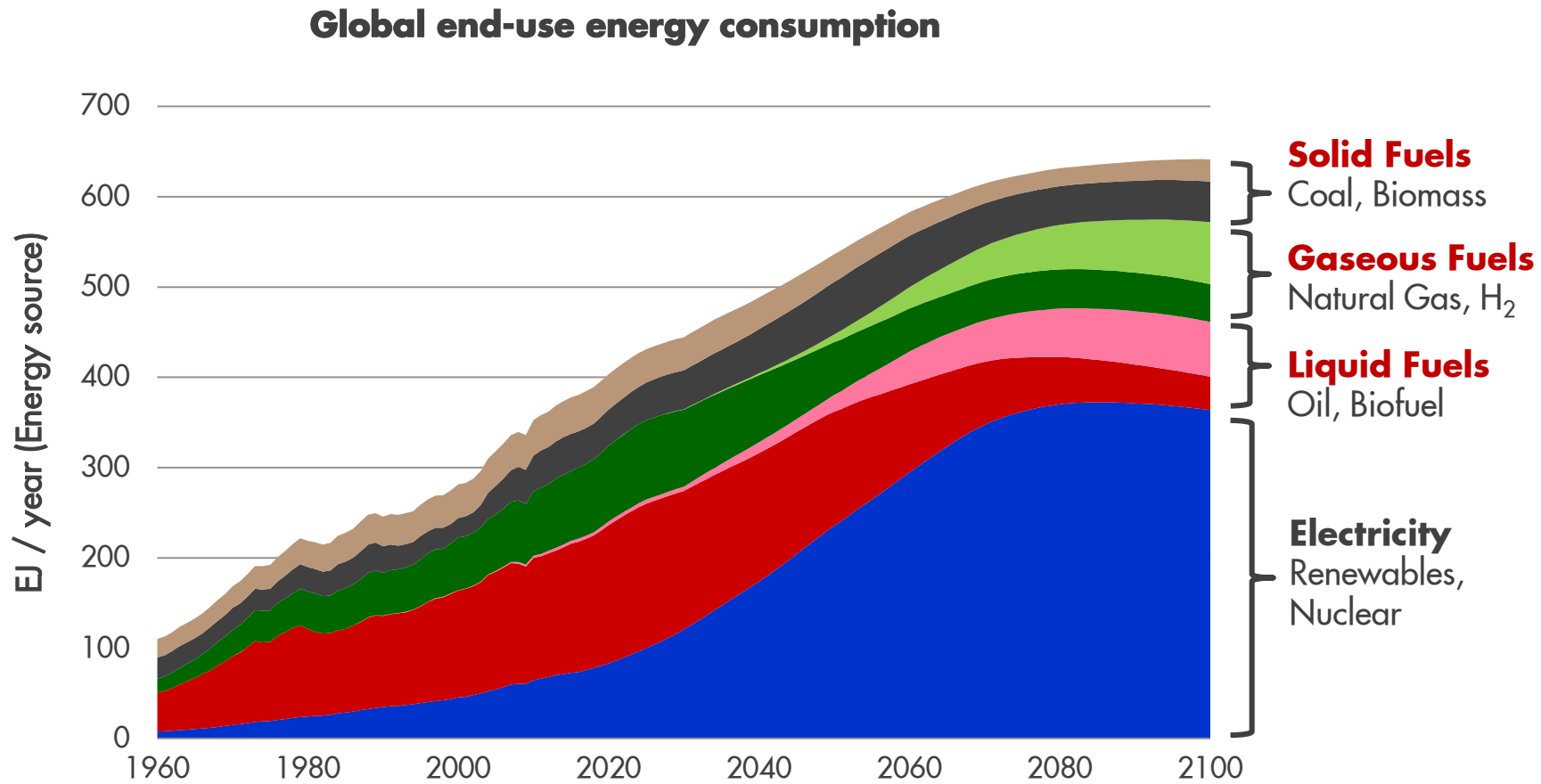
# The Enduring Role of Hydrocarbons for Climate Change Measures

IEEJ/APERC International Energy Symposium  
Tokyo, 18 September 2020

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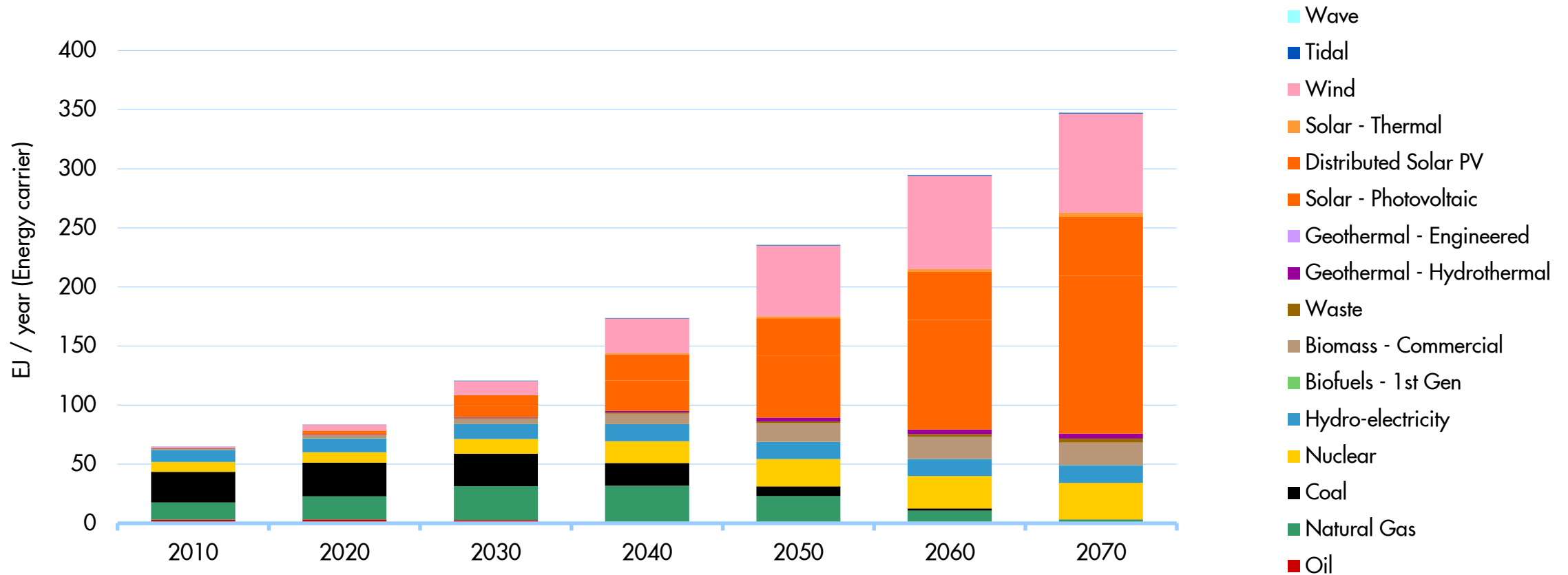


# Sky: Deep electrification, but molecules remain important

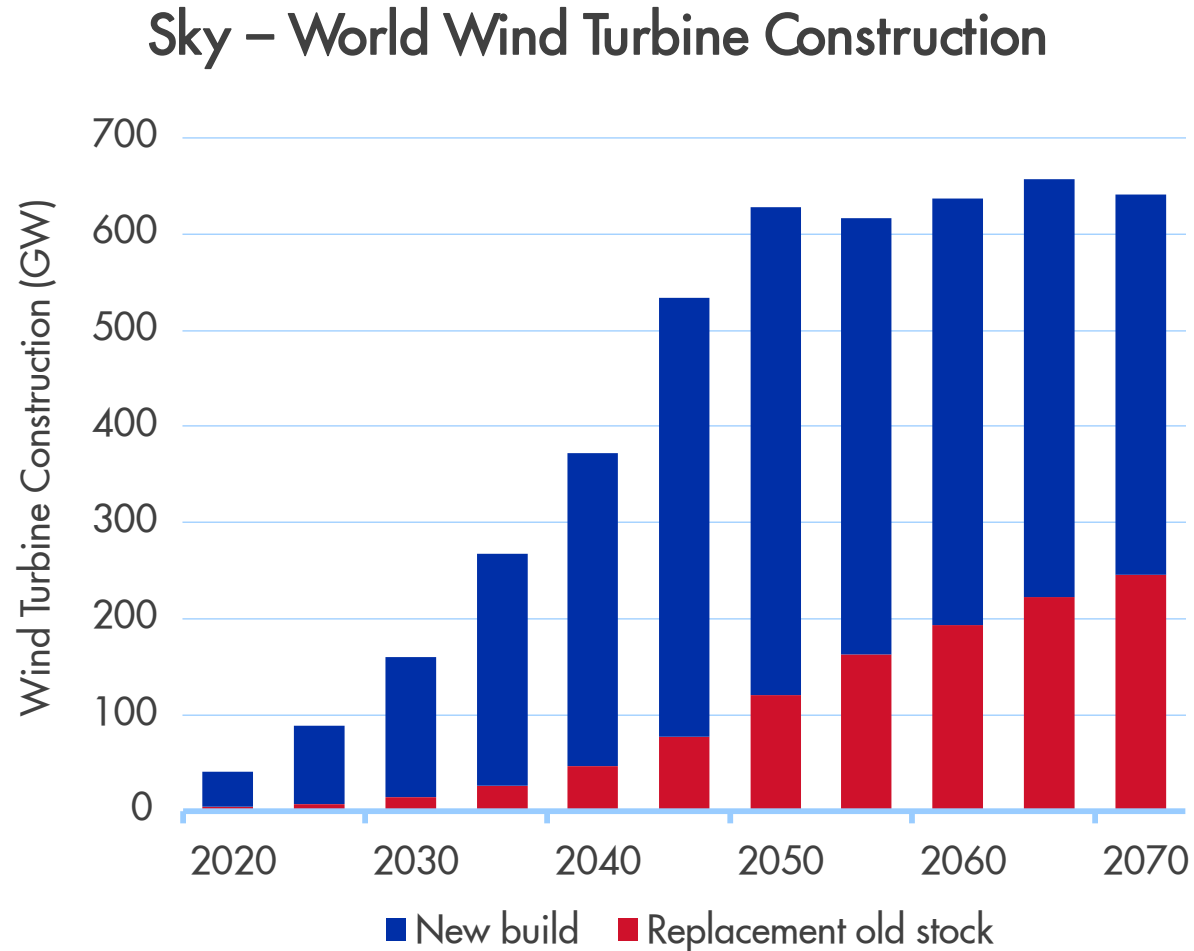


# Wind will be an important part of the new global energy system

## World - Total Final Consumption - By Source - Total Electricity



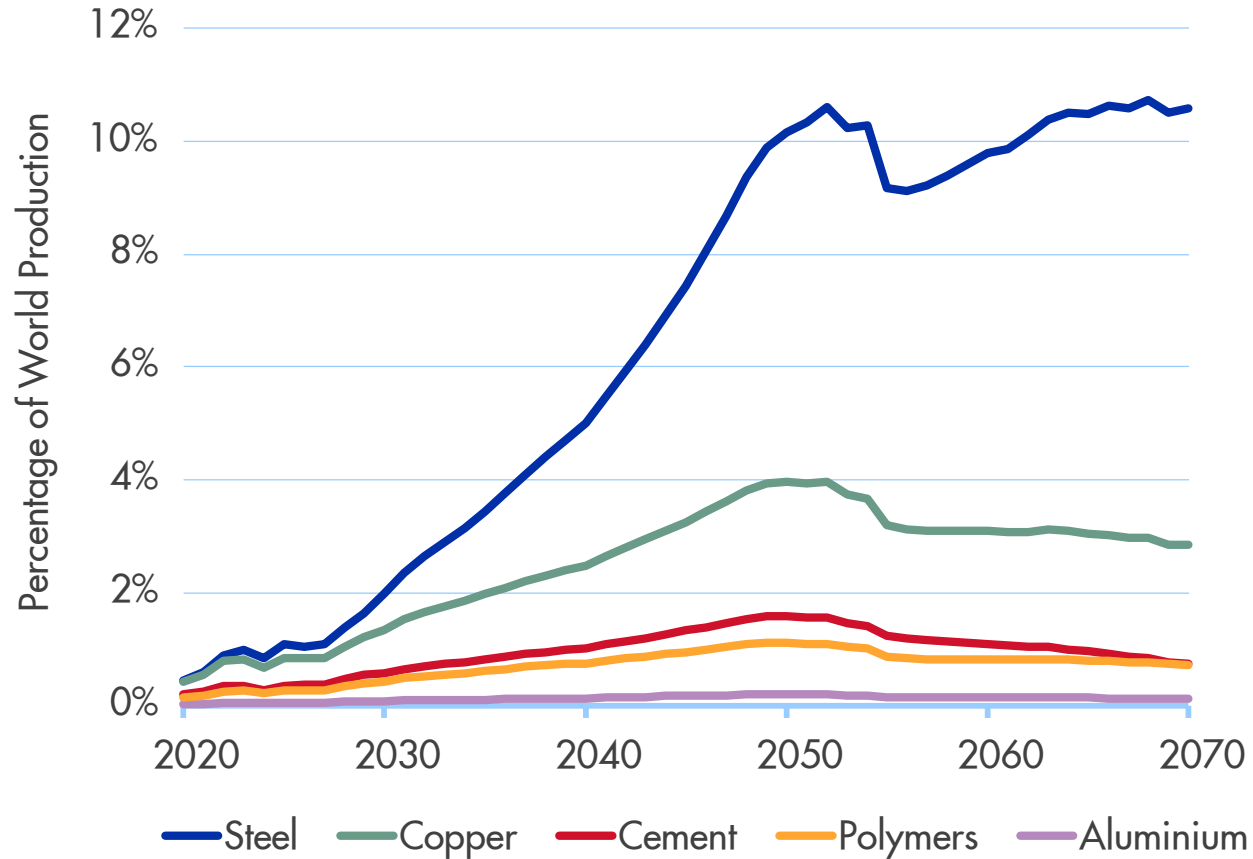
# How much Wind will we need to construct each year?



- Today, about 90% of the market for wind is new builds, while by 2070 around 40% will be to replace old turbines
- Installed capacity will quadruple between today and 2030, and will be 16 times more by 2050.
- Capacity will grow by 15% pa to 2030, slowing to 8.5% in the 40s and 6.5% in the 50s.

# What proportion of material production will be required for Wind?

Sky - % World Material Production for Wind Turbine Construction



- ❑ Significant redirection of material requirements towards Wind construction
- ❑ Market shares for key materials will double between now and 2025, ...
- ❑ increasing fivefold thereafter by 2050;
- ❑ except steel that will be tenfold
  
- ❑ Offshore wind's share goes from around 10% today to 80% by 2070, requiring more steel, but less cement than onshore wind.

Source: Shell analysis, Sky scenario  
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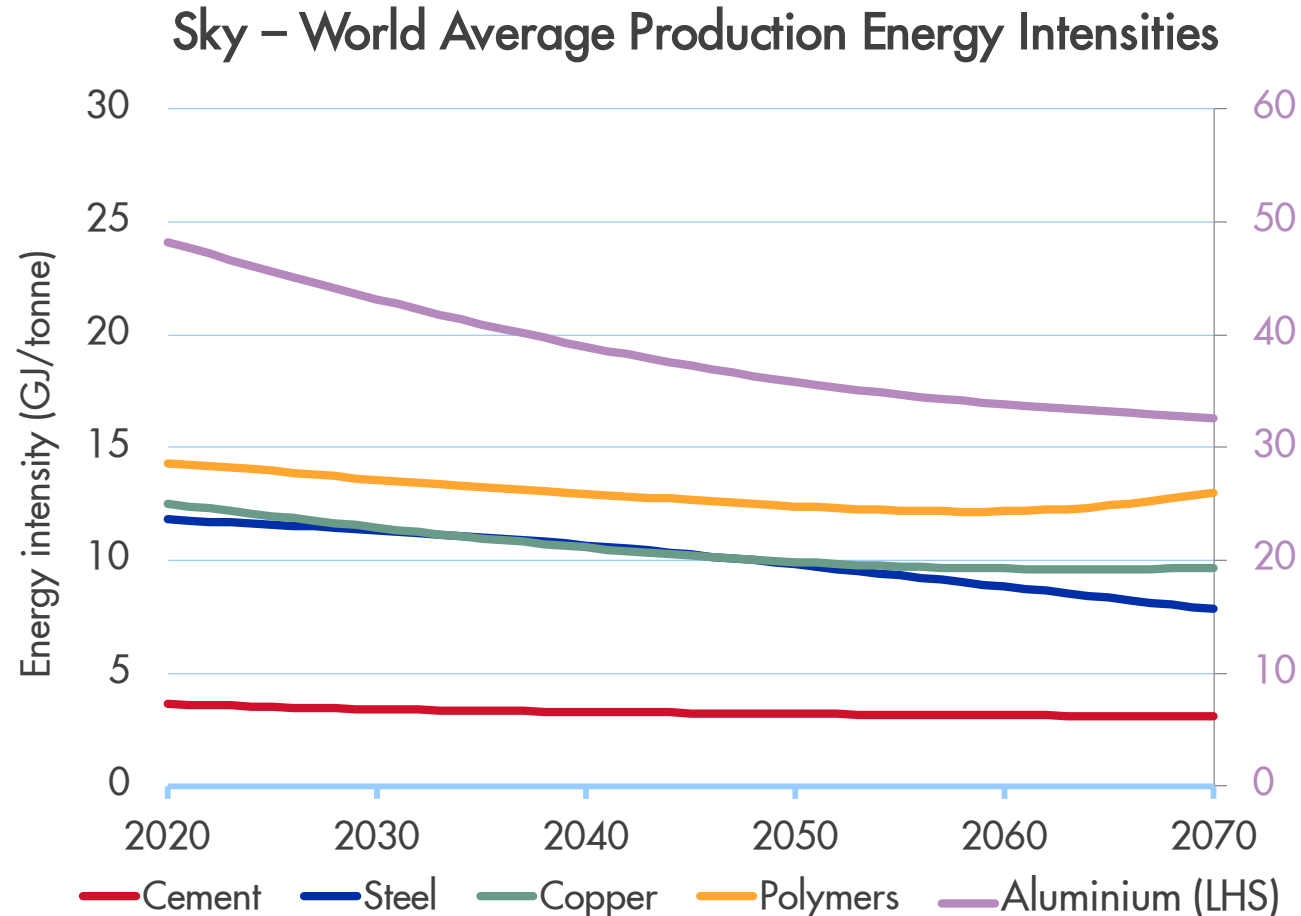


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# How much further scope in Energy Efficiency?

Key is recycling, but practical limits

Energy and emissions reduction do not always go hand-in-hand



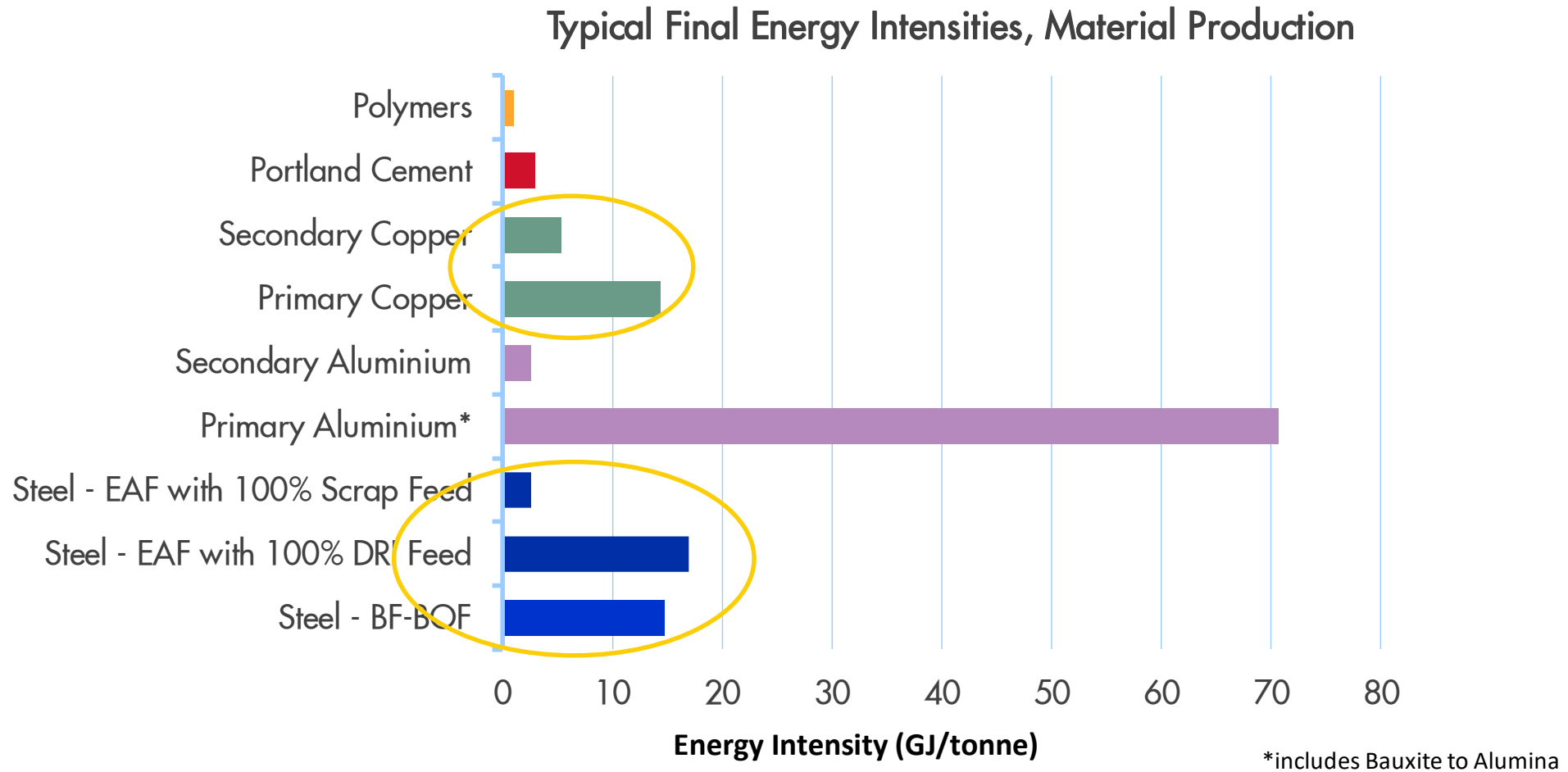
- Steel – increase use of Electric Arc Furnace and % scrap feed, but practical limits
- emissions reduction through CCS and H<sub>2</sub> Direct Reduction of Iron, but
- H<sub>2</sub> route uses 15% more GJ/tonne (source-to-product)
- Cement – approaching theoretical efficiency,
- emissions reduction through CCS
- Non-Ferrous Metals – increase % scrap feed,
- emissions reduction through increasing renewables share of electricity generation.
- Polymers – chemical recycling, biomass upgrading to feedstock,
- emissions reduction through H<sub>2</sub> and electricity

Source: Shell analysis

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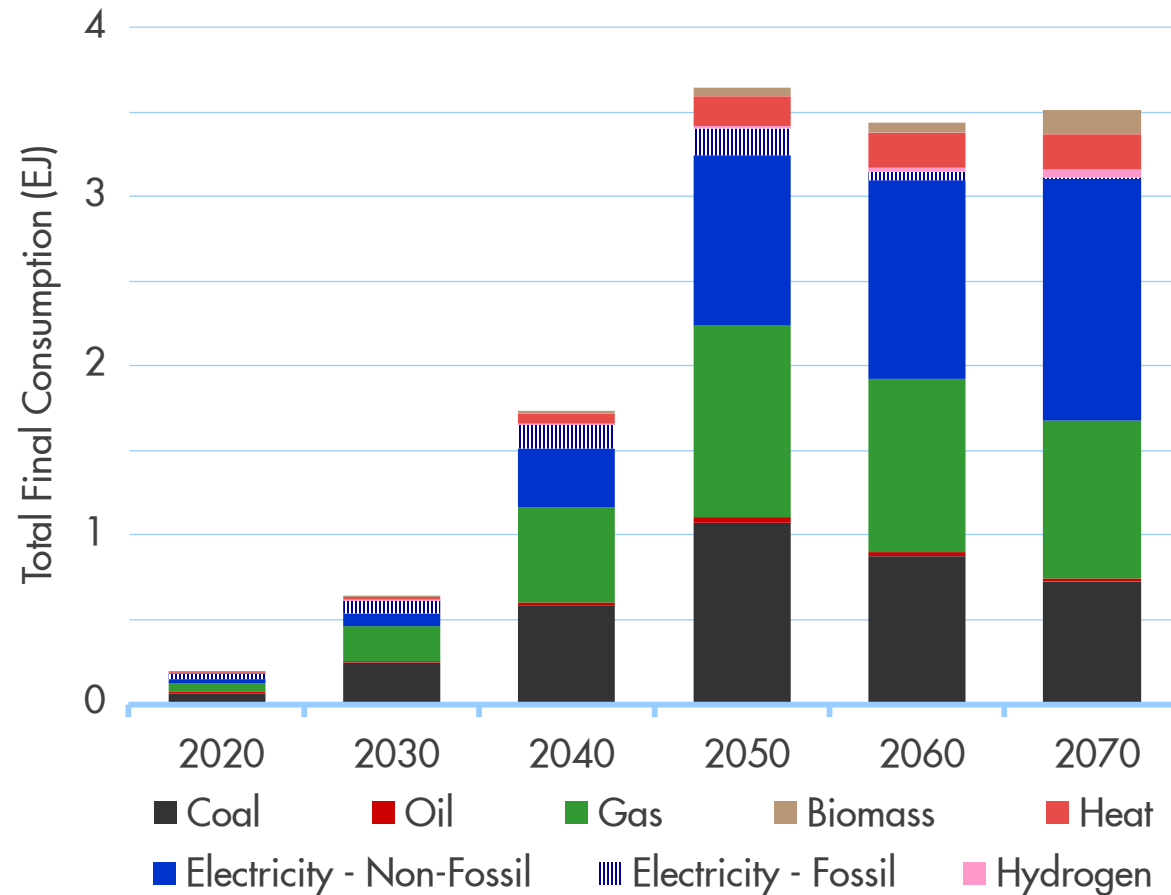
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# Increasing recycling is key for increasing energy efficiency in material production



# What type of energy is required for producing wind turbines?

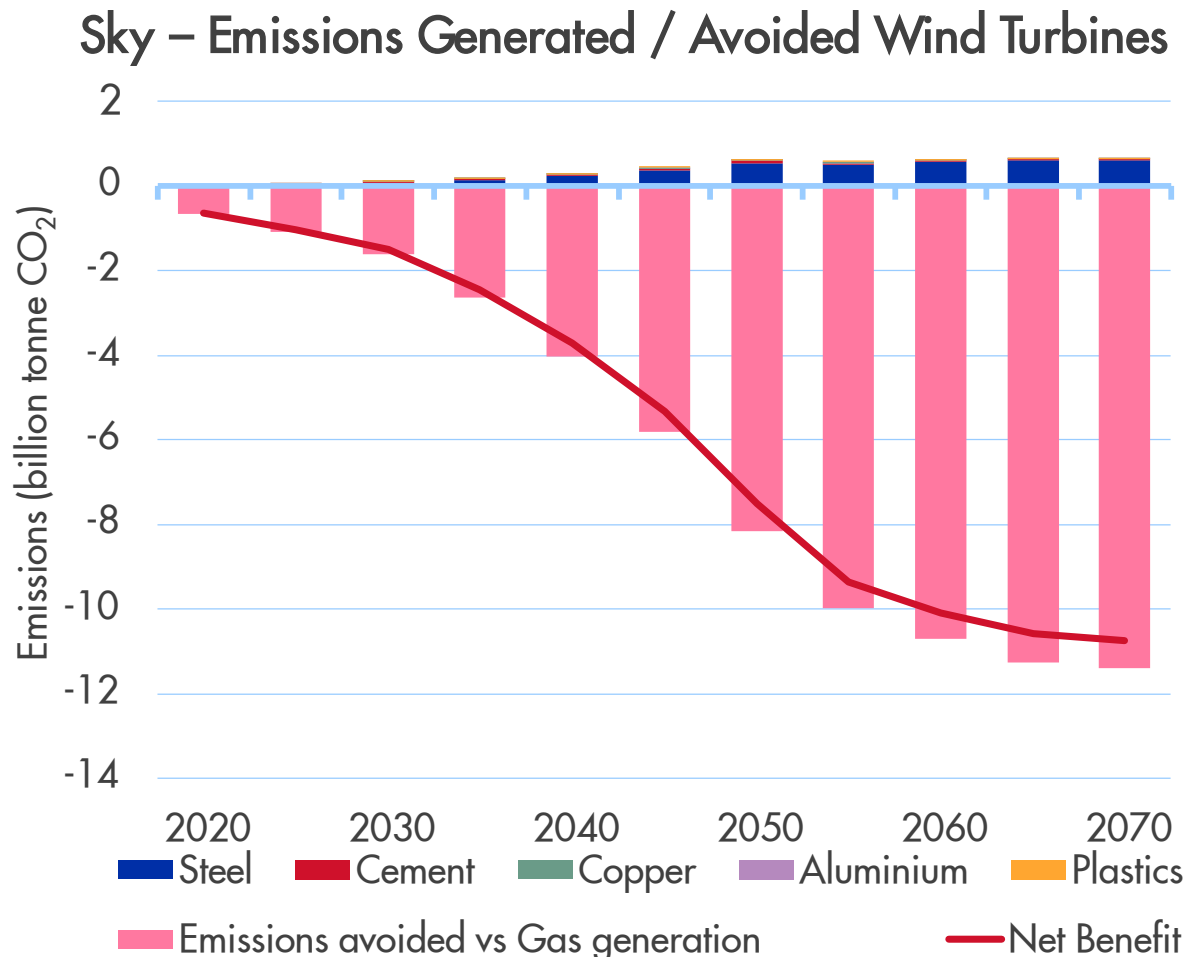
Sky – Energy Requirements for Wind Turbine Production



- ❑ Fossil fuels will remain an important contributor to build Wind Turbines due to limitations for efficient material production (Steel, Cement, Non-ferrous, Resins)
- ❑ Over 80% of energy used comes from fossil today, but will be half by 2070
- ❑ Two-thirds of electricity used today comes from fossil, but will drop to 1% by 2070

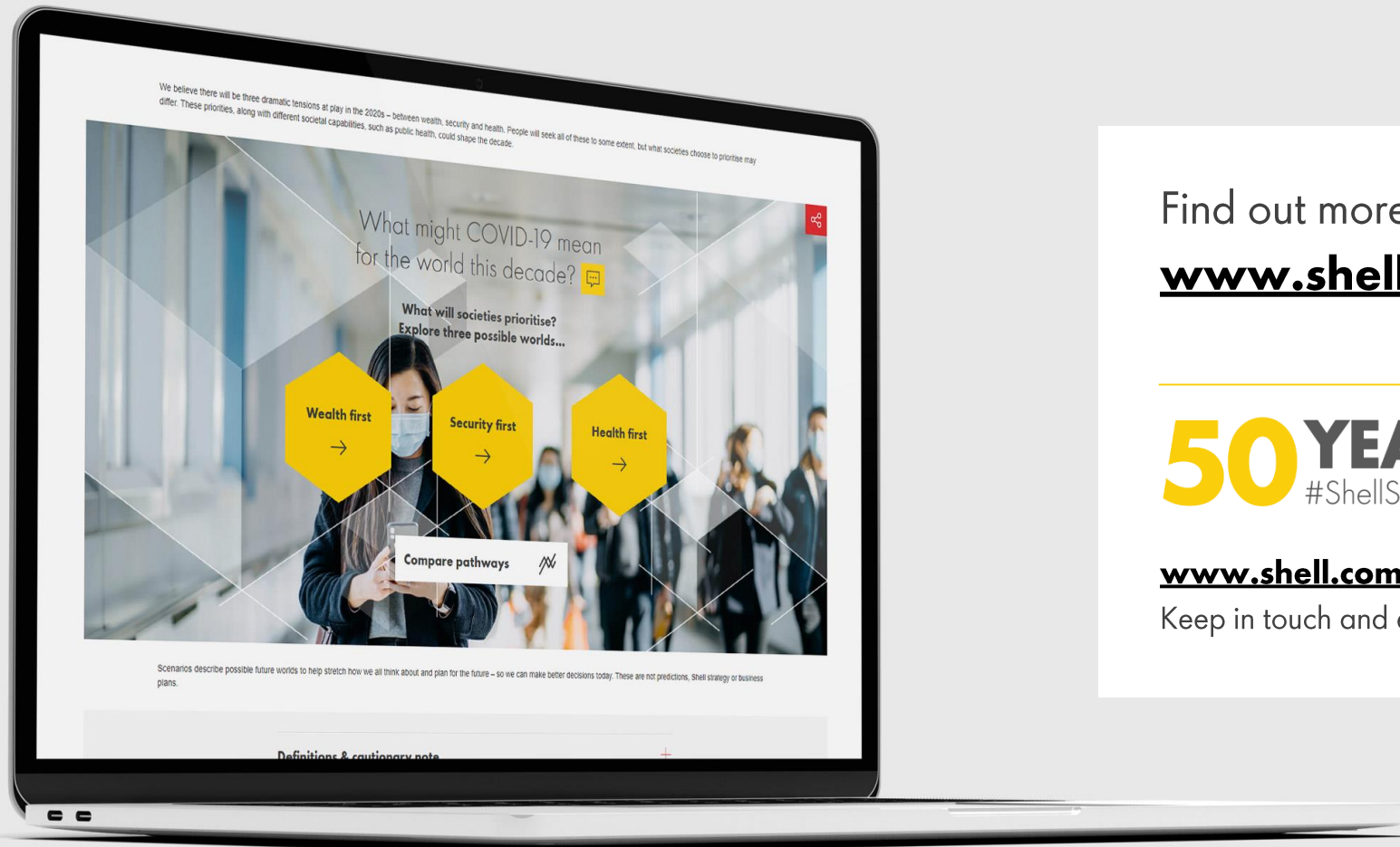


# How is the continued use of fossil fuels to construct wind turbines stack up against CO<sub>2</sub> emissions avoided?



- Today, 68% emissions come from Steel, 20% from Cement, 9% from Plastics and 3% from Non-ferrous.
- With increasing share of (floating) offshore wind, over 90% of emissions will come from Steel, 4.5% from Plastics and 2.5% from Cement by 2070 if unabated.
- Some \$650 bln pa abatement (CCS) costs might be avoided by wind generation compared with gas generation by 2070.

# Digital experience tour



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