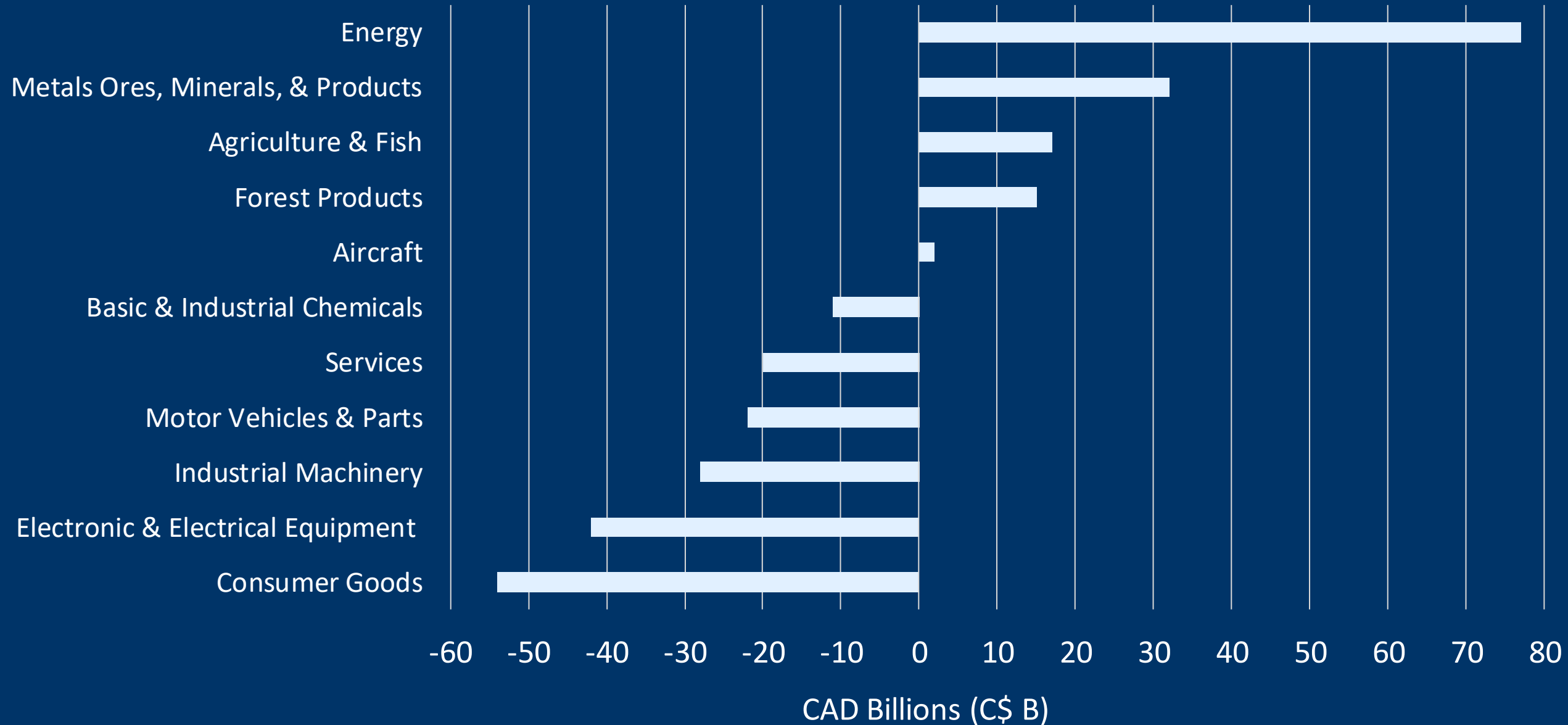


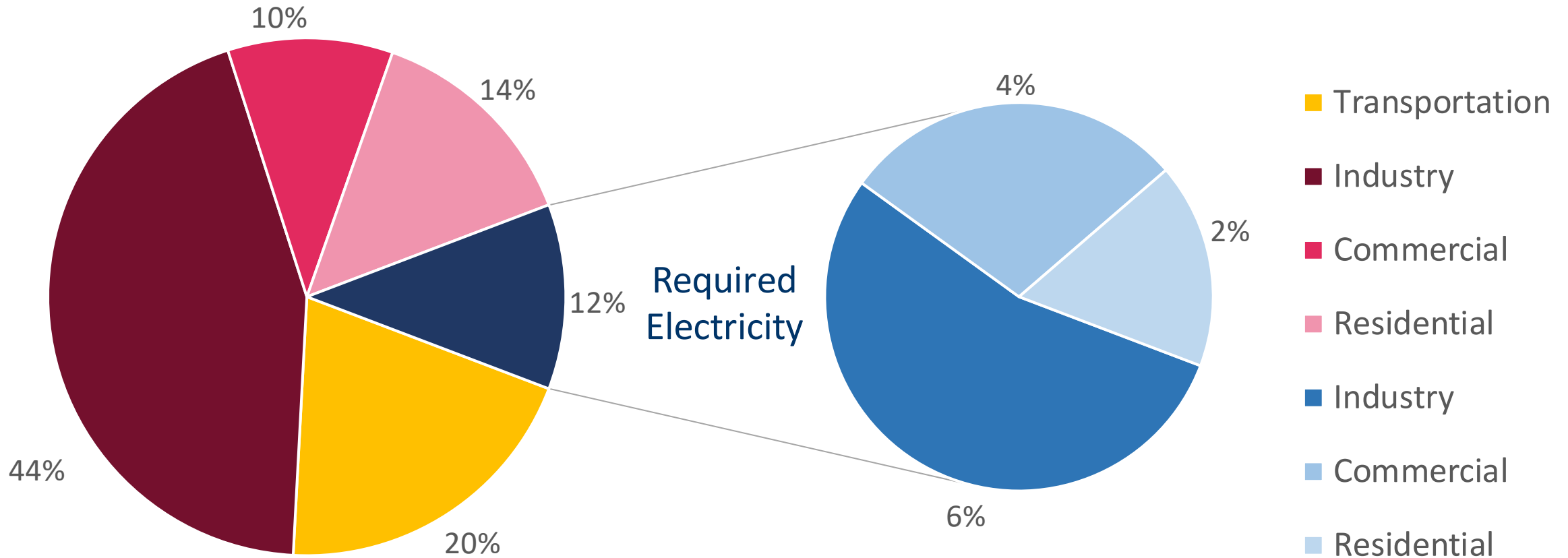
Carbon Pricing Changes Everything

Relative Value in a Low Carbon Economy

Canada Net Trade, 2019

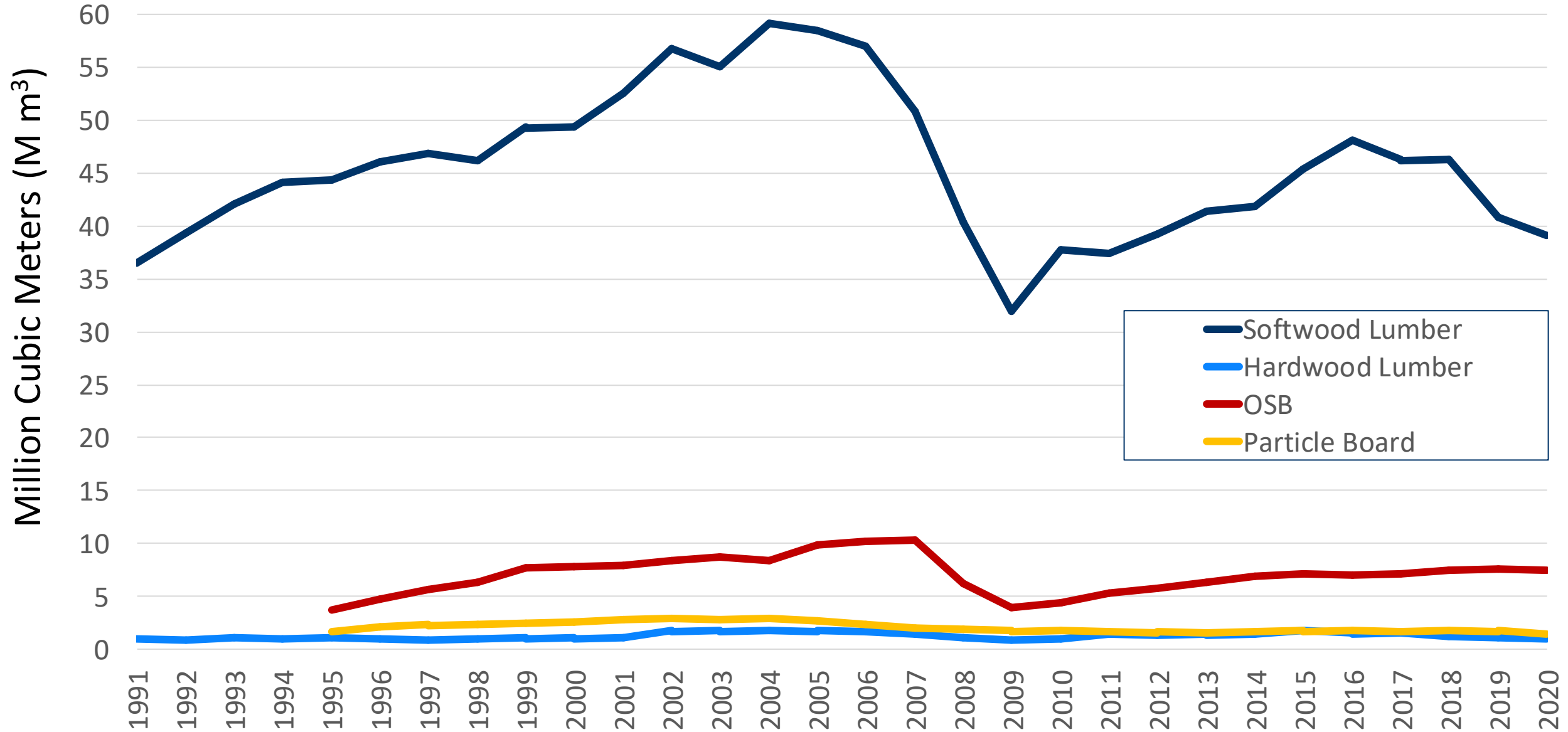


Energy Demand in Canada

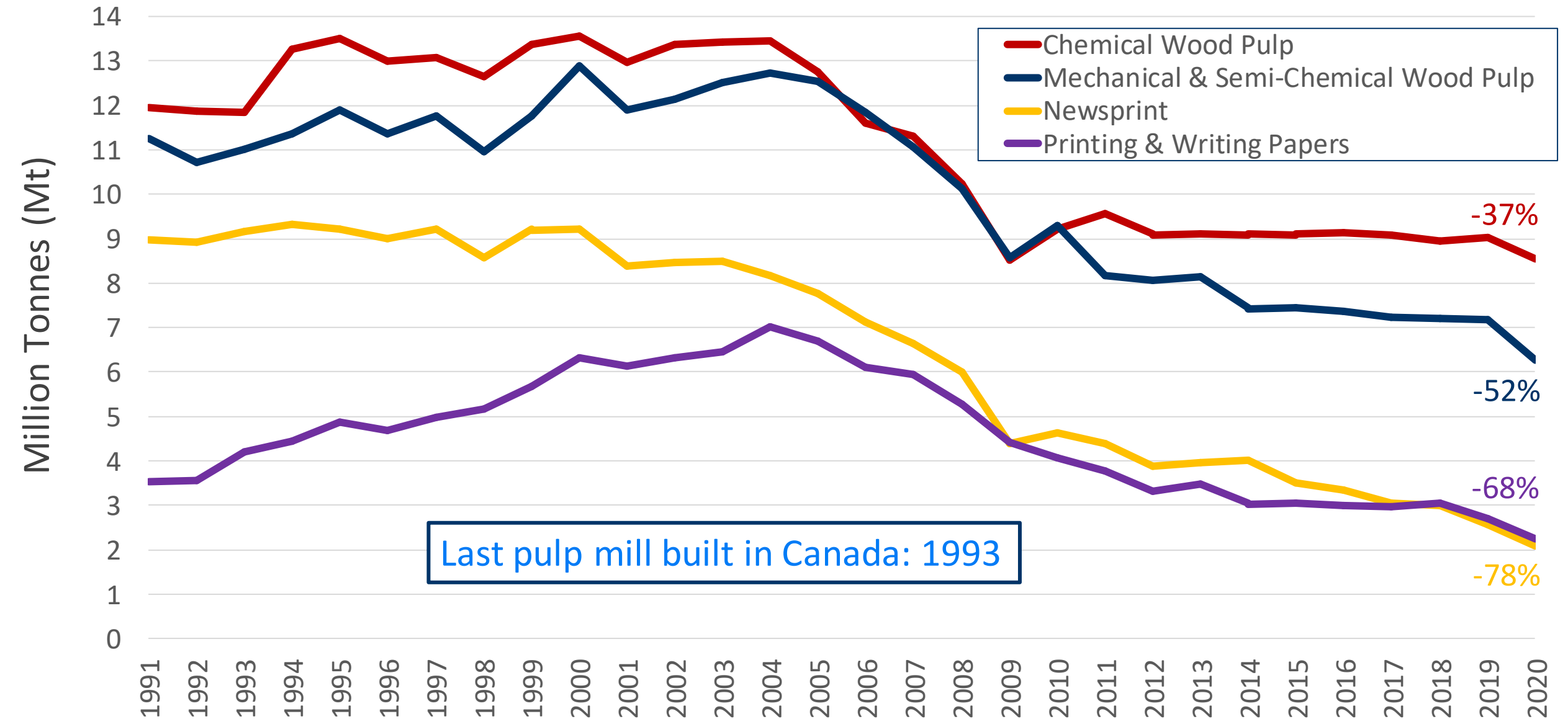


- Thermal energy (red shades) is approximately 60-65% of Canada's energy demand
- Excluding existing electrical heating, electricity (blue shades) is 12% of Canada's energy demand
- Heating residential buildings requires more energy than ALL of Canada's electricity demand

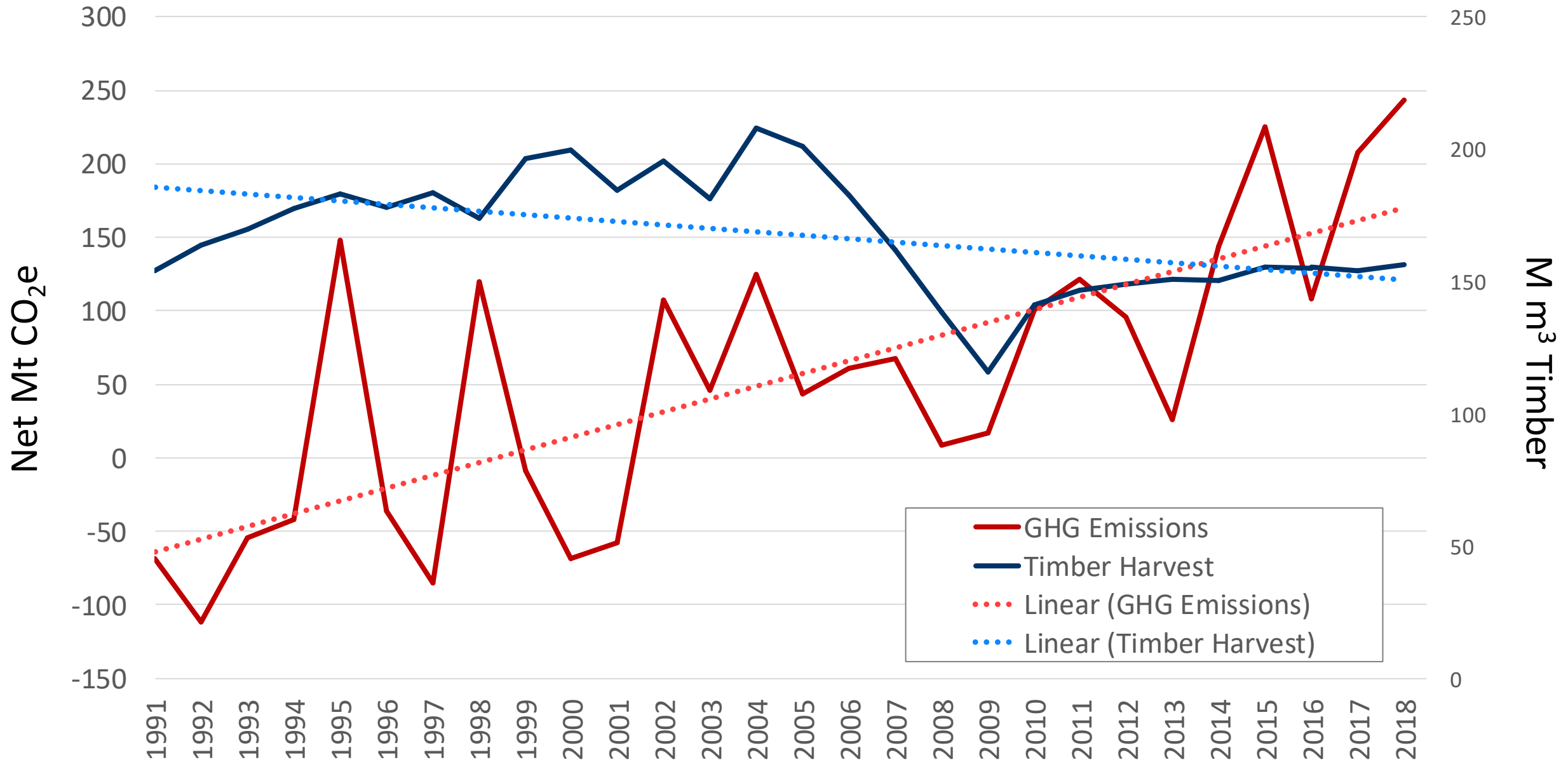
Canada Solid Wood Products Production



Low Grade/Residue Wood Fibre Market



GHGs from Canada's Forests Vs. Timber Harvest



The 'Best Use' for Biomass has Changed

Baseline matters

Location matters

Efficiency matters

(Carbon) Price matters

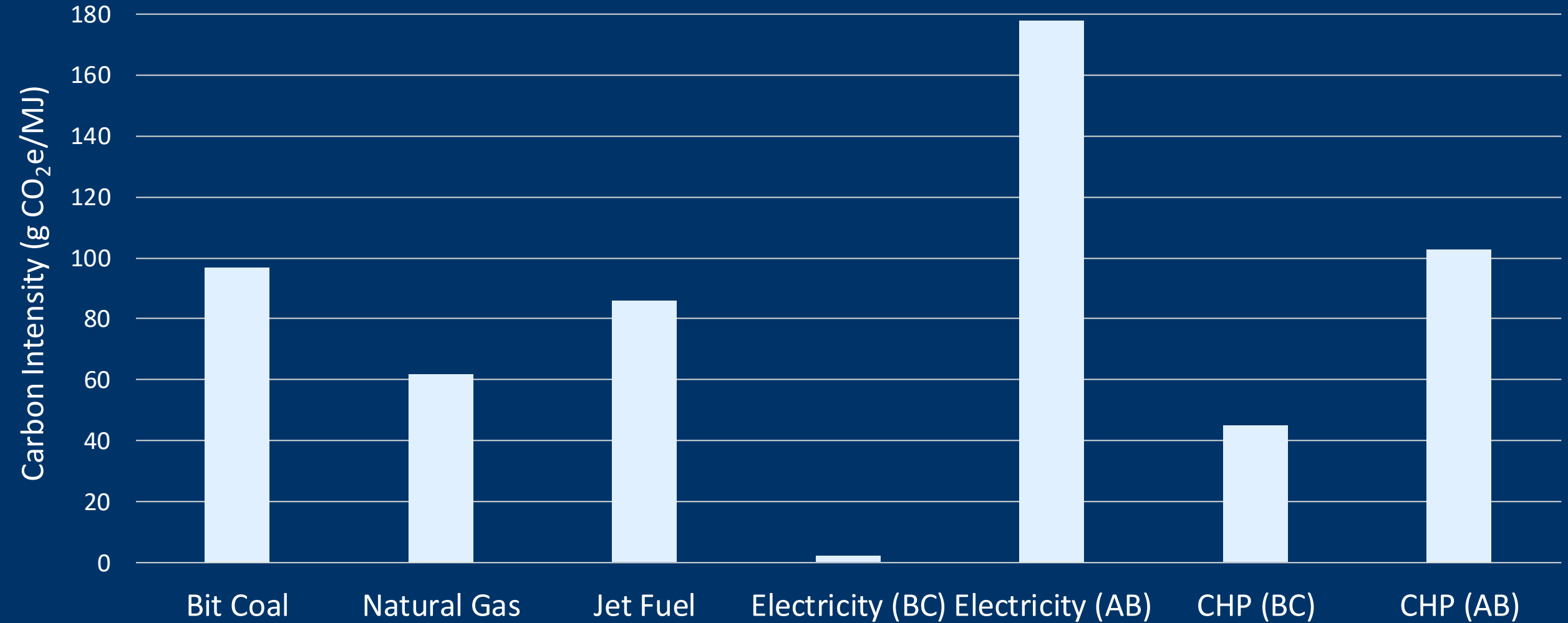
CapEx matters

Volume matters

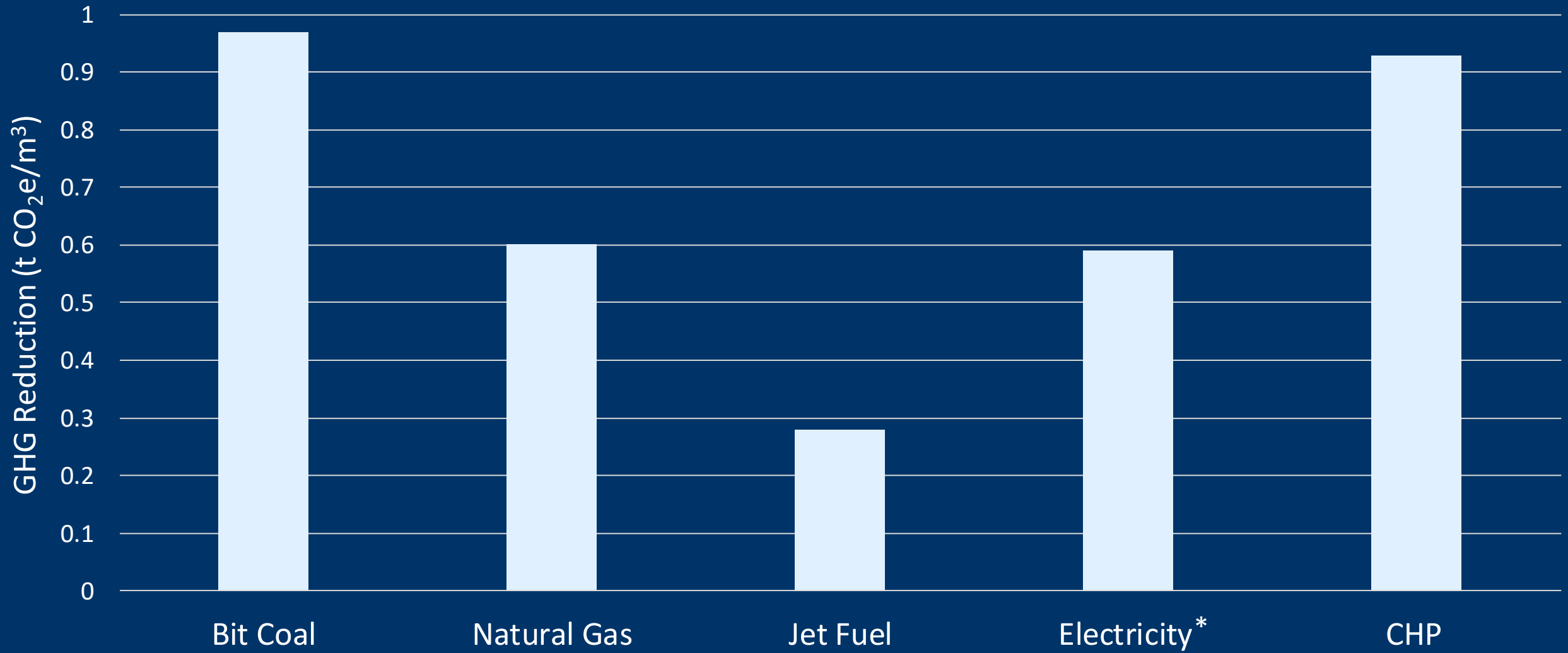
End-of-Life matters

Don't plan for tomorrow using assumptions from 5 years ago

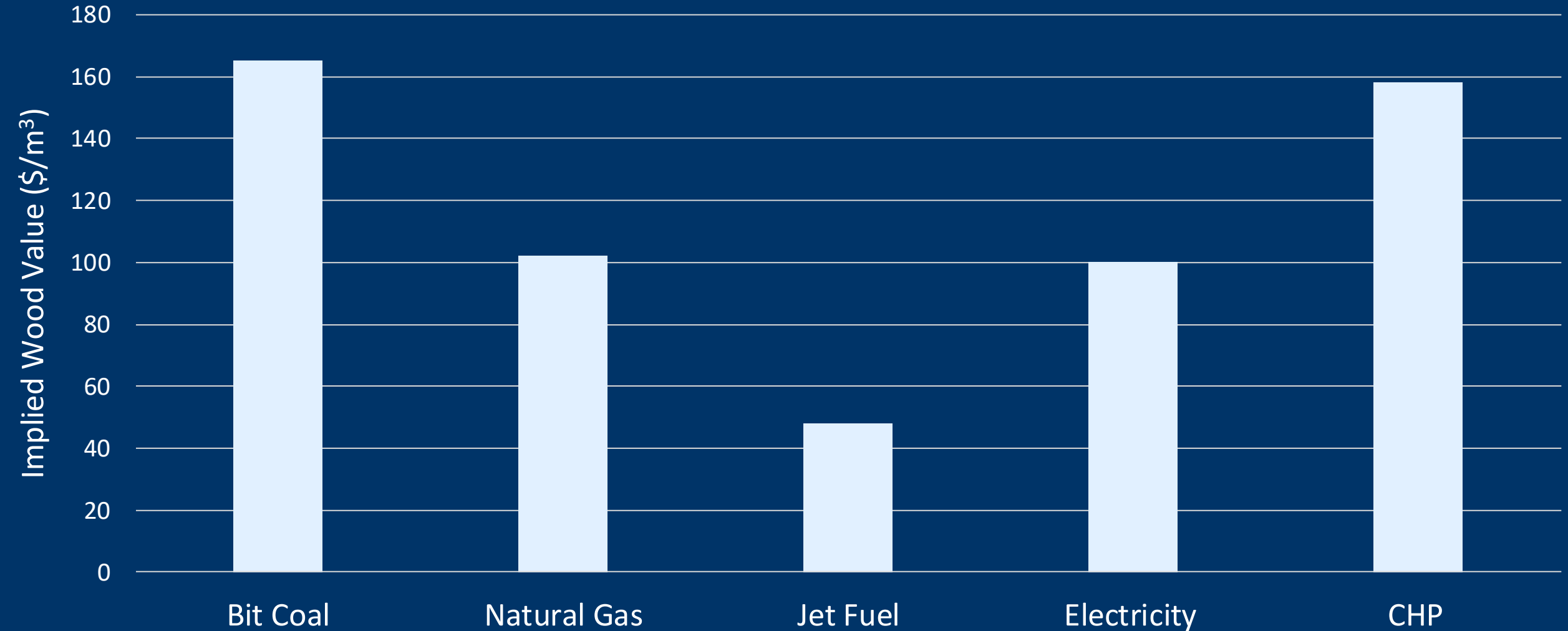
Baseline Matters



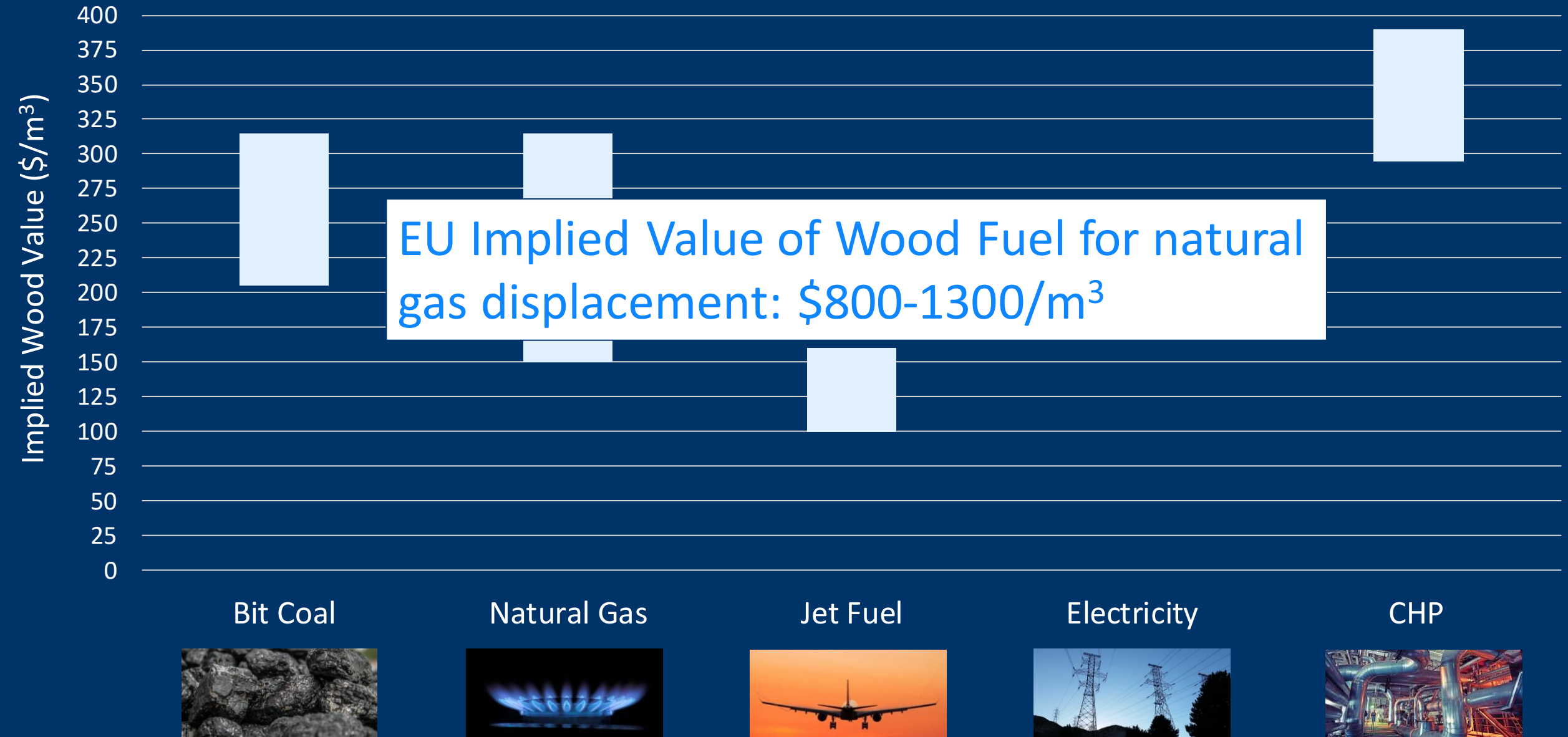
Efficiency/Yield Matters



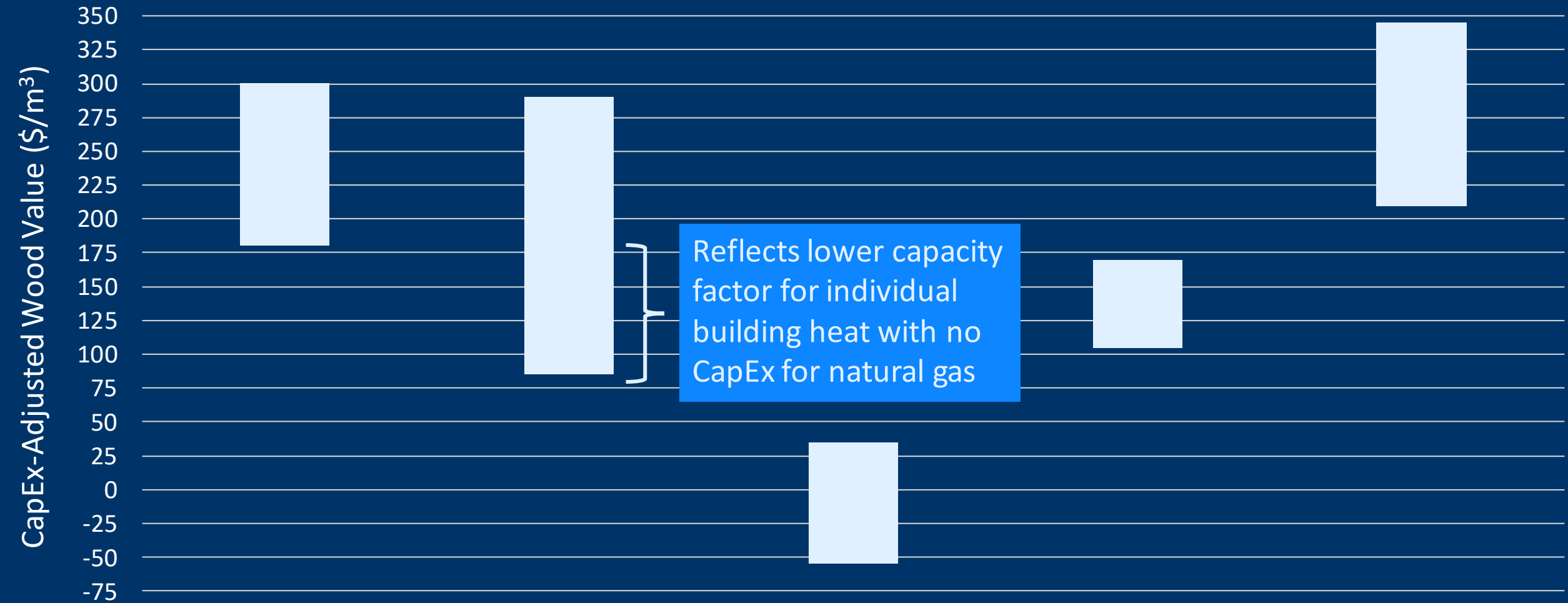
Carbon Price Matters



Market (& Carbon) Price Matters



CapEx Matters



Bit Coal



Natural Gas



Jet Fuel



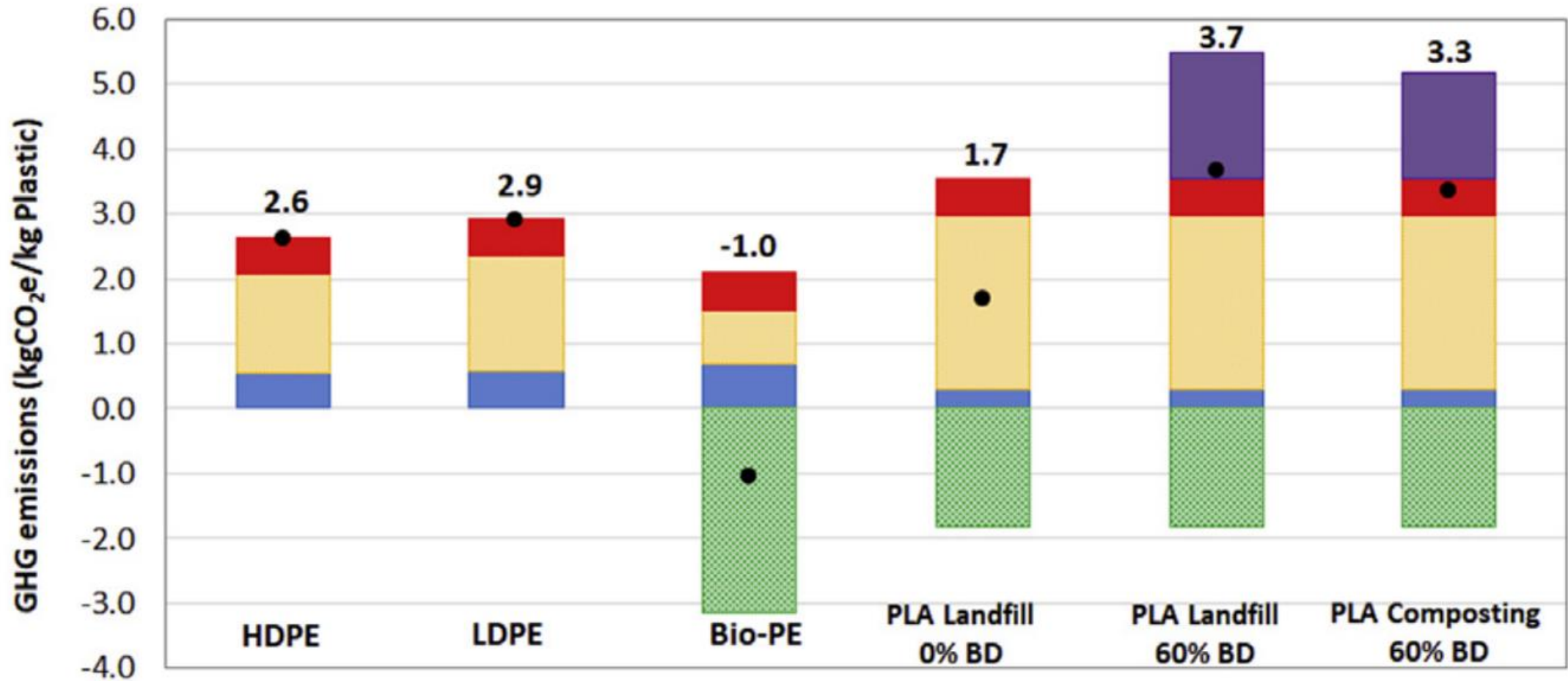
Electricity



CHP



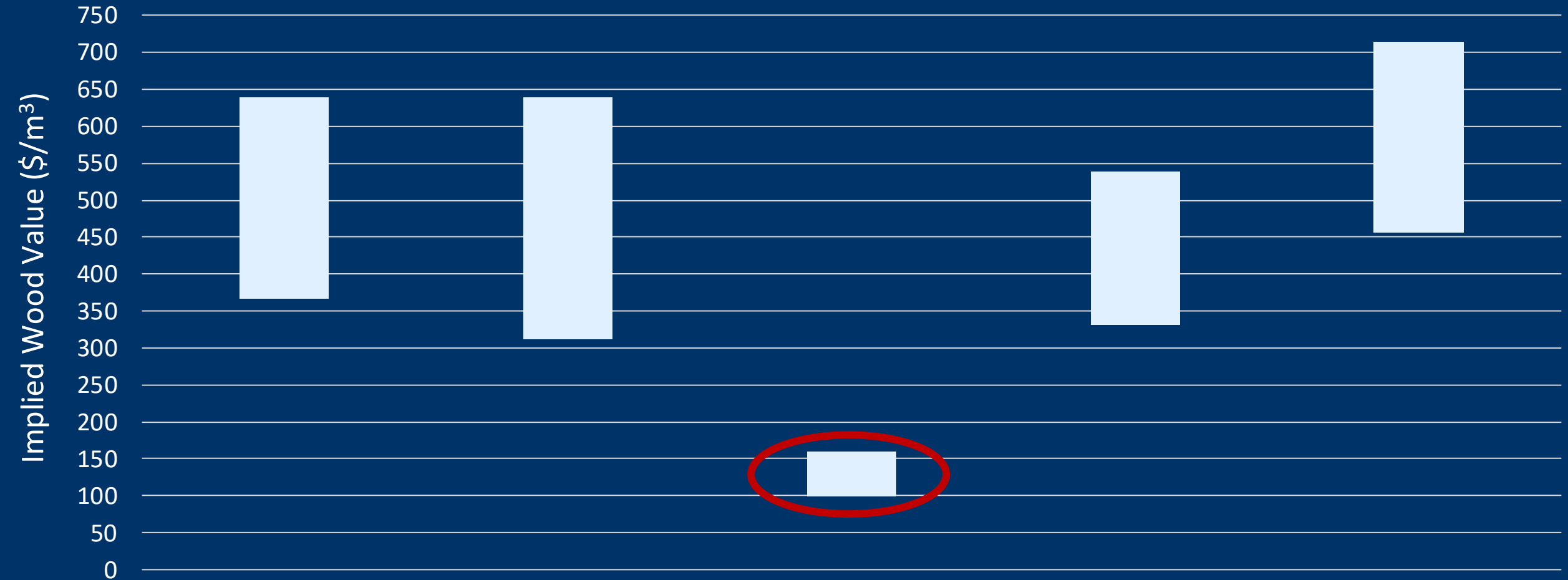
End-of-Life Matters



- Feedstock
- Processing and manufacturing plastic
- EOL
- Conversion
- Carbon uptake
- Total Emissions

Bernavides et al, 2020.
Argonne National Laboratory
United States Department of Energy

Potential for CDRs Matters



Bit Coal



Natural Gas



Jet Fuel



Electricity

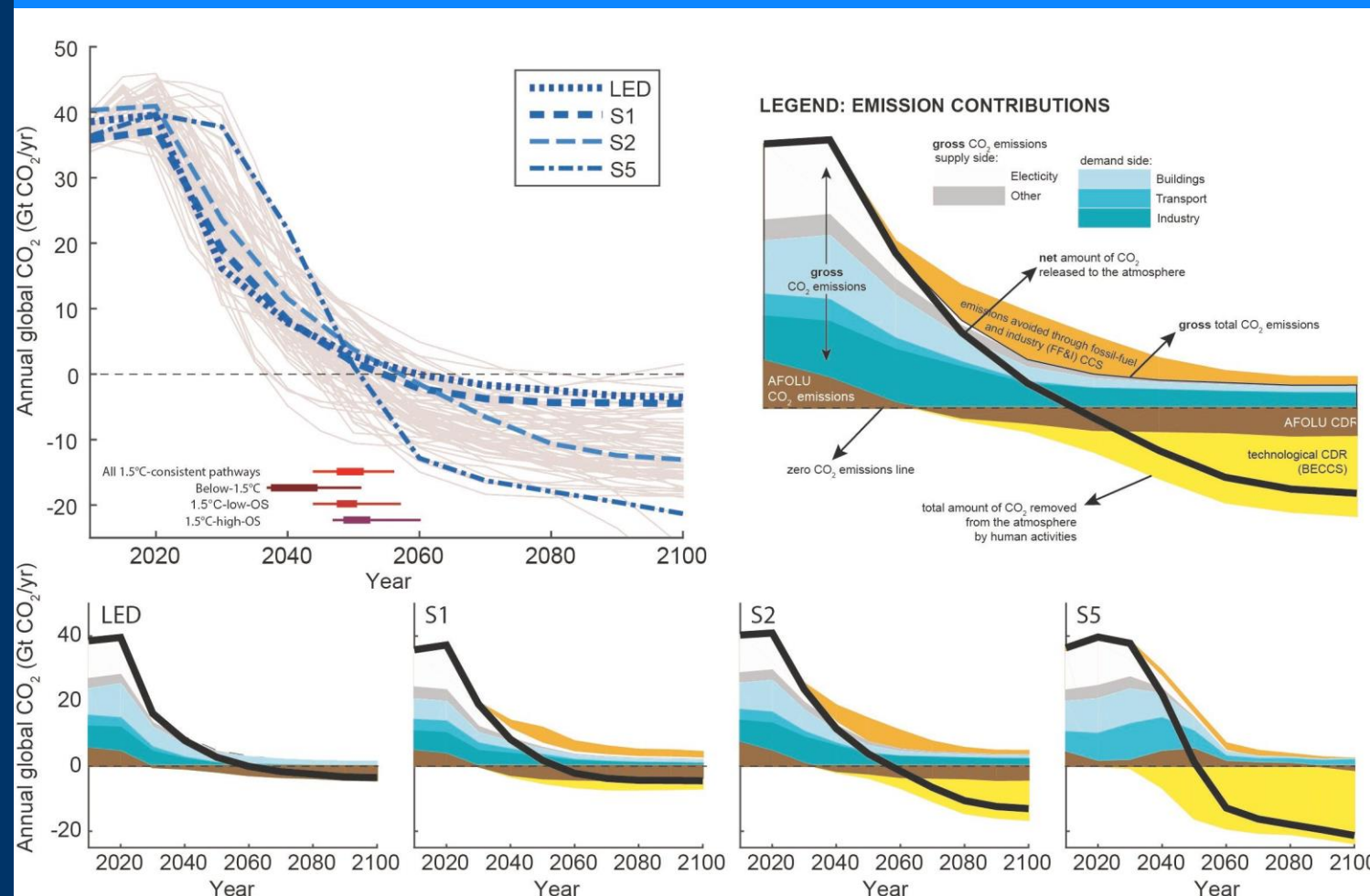


CHP



Potential for CDRs Matters

IPCC Mitigation Pathways Compatible with 1.5 C

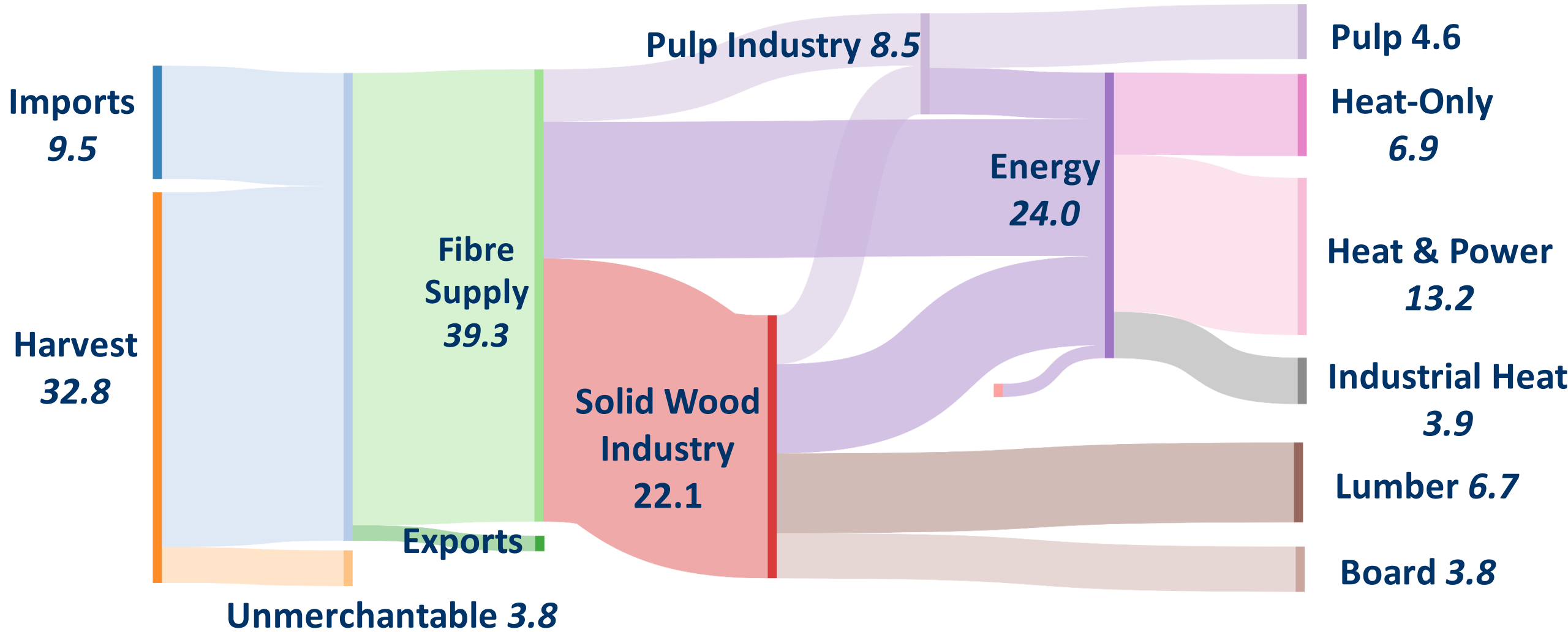


“As the carbon price increases, biomass CCS units become a negative cost generation option, where its average cost of production in 2050 is $-\$85/\text{MWh}$. Therefore, biomass CCS partially displaces all other generation technologies in Alberta and Saskatchewan.”

“At higher carbon prices, it may be economically competitive to import biomass for electricity production from other regions into Alberta and Saskatchewan, where suitable carbon storage is known to exist.”

-From *The Path Towards Net-Zero Greenhouse Gas Emissions in Canada's Electricity Sector* (CER Paper)

Austrian Forest Sector – C\$12 B/yr



Highly profitable mass timber industry supported by heat market
 Forested area: <4 M ha; highly mountainous; stocks increased 45% since 1960

All figures in M m³
Total NS Harvest ~2.5 M m³

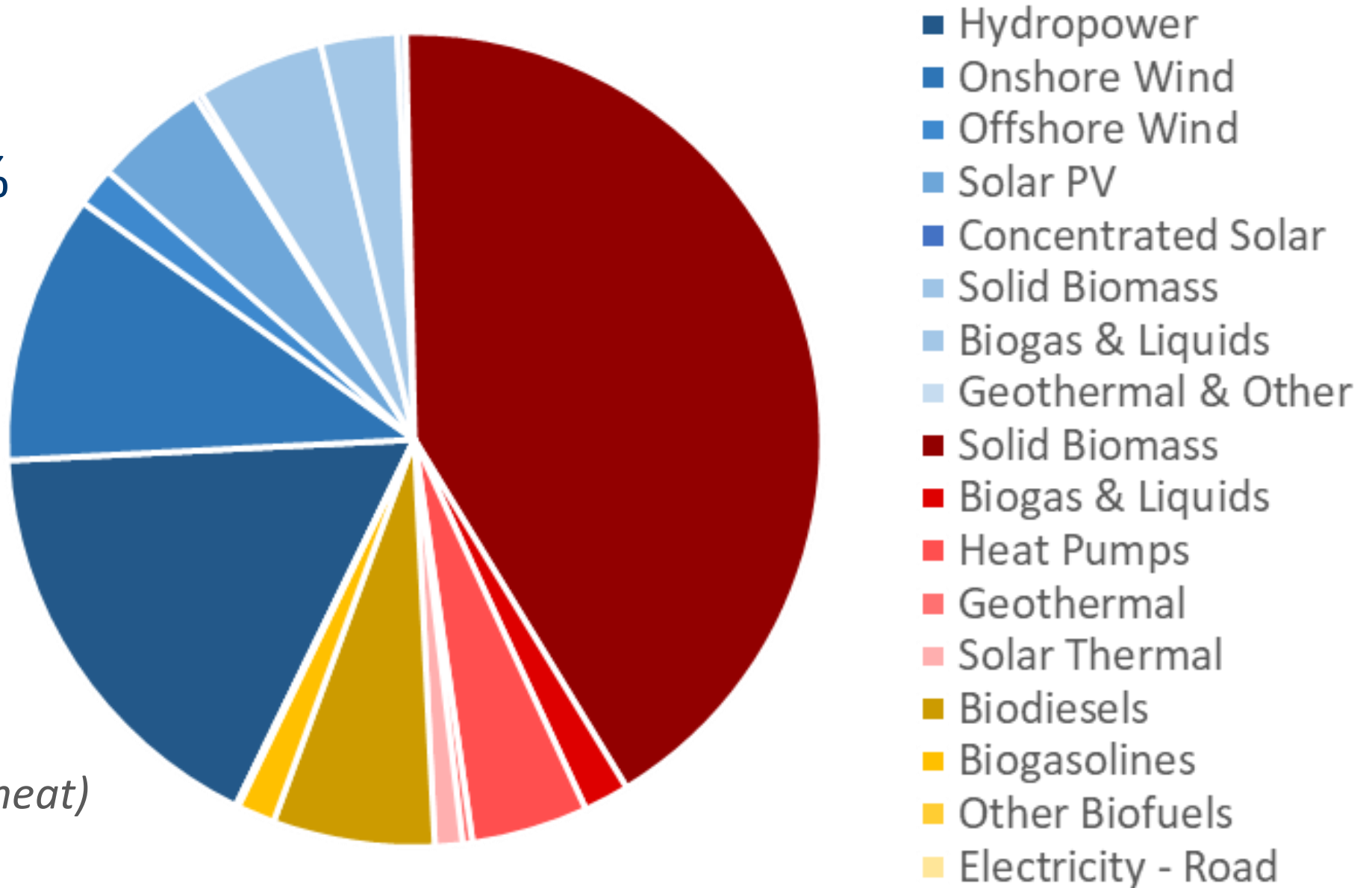
Renewable Energy in the EU

Total: 8.5 EJ

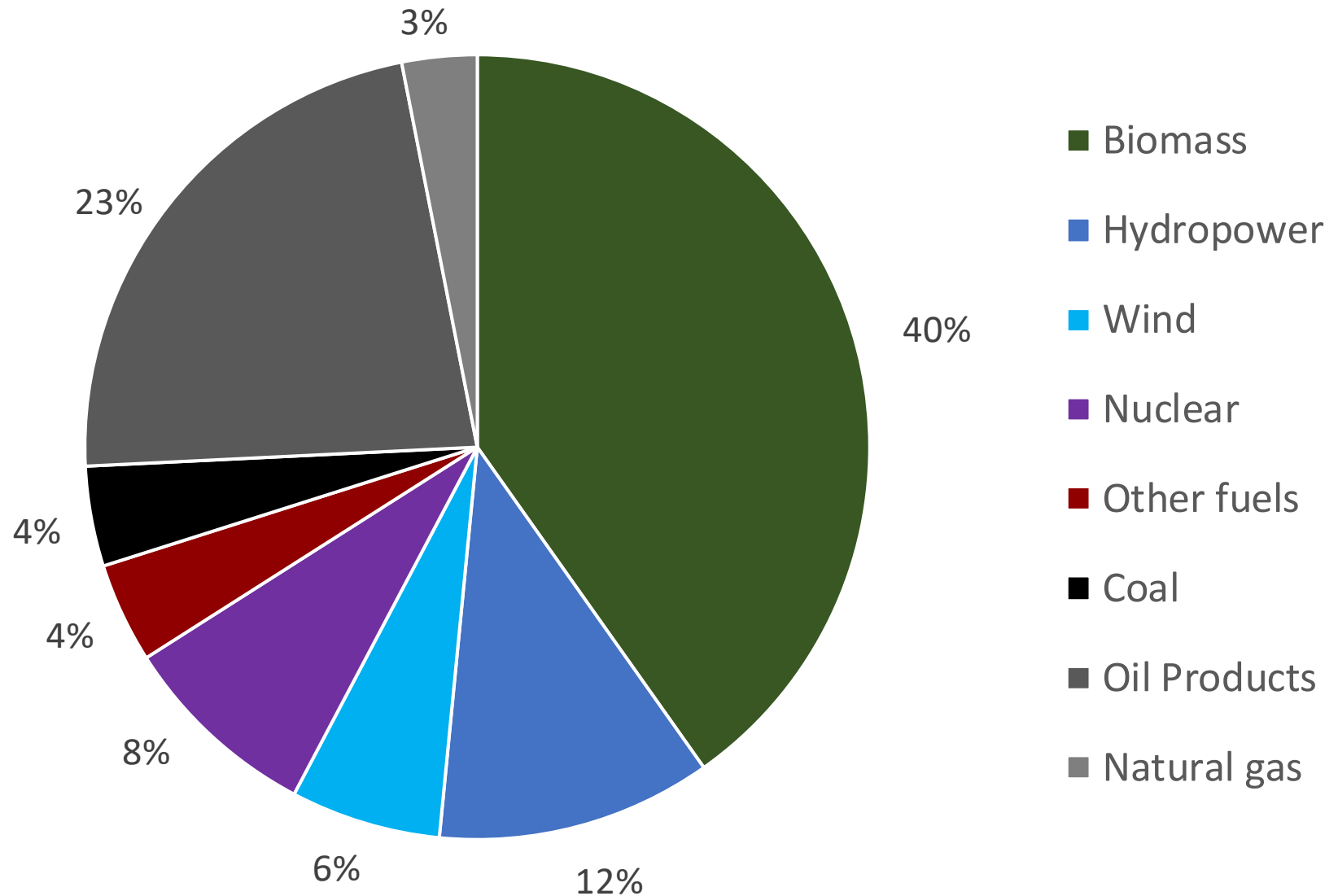
Bioenergy has 90% renewable heat market share

60% of EU renewable energy is bioenergy

- *Blue: Electricity*
- *Red: Thermal Energy (heat)*
- *Yellow: Transportation*



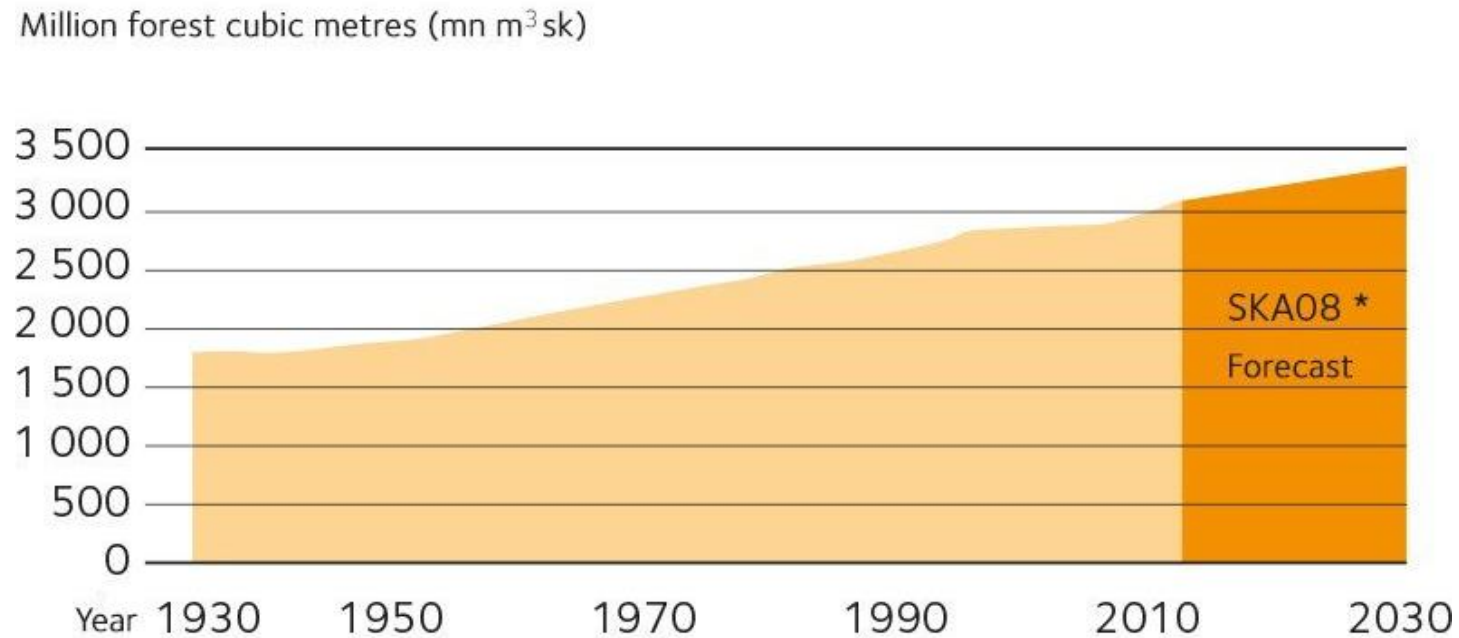
Energy Consumption in Sweden



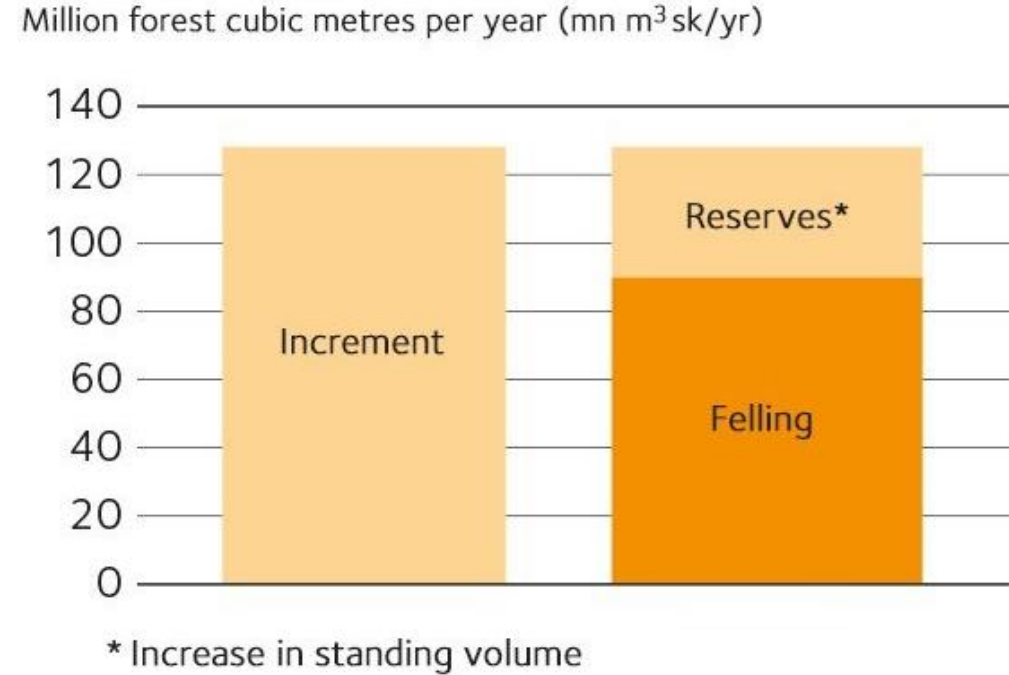
- 58% renewable energy
- >80% of biomass is forest-based

Forests in Sweden

Standing Timber

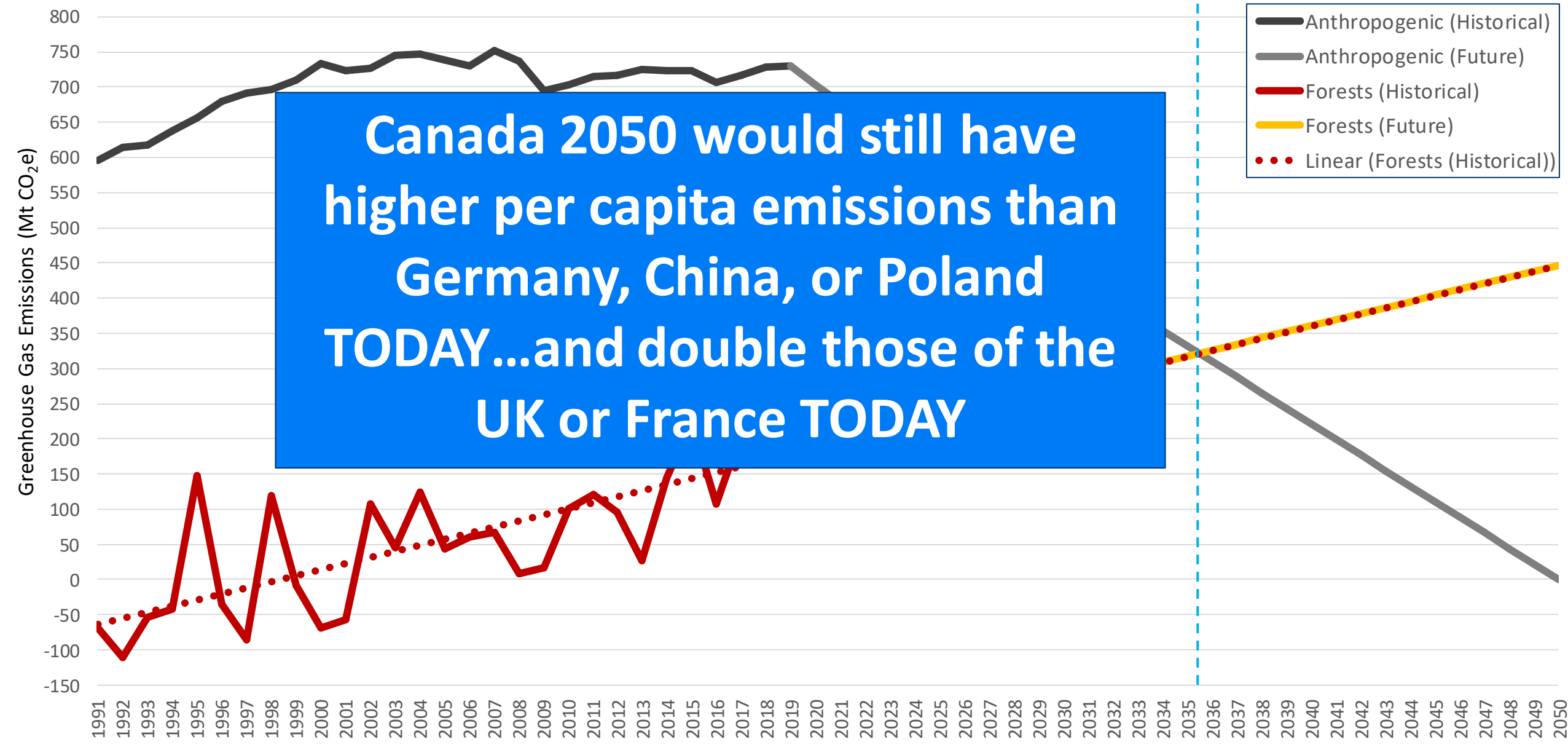


Growth & Removals



- Sweden harvest 7-8x the timber per commercial forested acre as Canada
- NET carbon uptake (increase in standing volume) reduces Sweden's national GHG emissions by 70%
- Per Capita GHG Emissions:
 - Sweden = 1.2 t CO₂e/pp
 - Canada = 26.0 t CO₂e/pp

A Parting Note: Total GHG Emissions



Carbon Pricing Changes Everything

Relative Value in a Low Carbon Economy

NS Residential Heating Cost Comparison

