

Harnessing Energy Productivity for Industrial Competitiveness in a Low Carbon World

Highlights:

- Energy-intensive sectors form the backbone of modern economies—steel, aluminium, cement, plastics and chemicals, aviation and shipping—enabling housing, infrastructure, goods and global trade. Together, they account for around a quarter of global emissions.
- As economies grow, demand for materials and long-distance transport is expected to increase significantly—by 25–100% for materials, ~150% for aviation and ~45% for shipping by 2050—putting upward pressure on energy demand.
- This report shows that improving energy productivity can reduce final energy demand by 25–45% by 2050 compared to a scenario with no efficiency gains through more efficient processes and better use and reuse of materials in energy-intensive industries, while still meeting rising demand and helping decrease green premiums costs passed through business to business and business to consumers.

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- Energy productivity measures the economic output delivered per unit of energy used. Improving it strengthens industrial competitiveness by reducing energy demand, lowering system costs, and supporting decarbonisation.
- There is a major opportunity for the world to more than double global GDP by 2050, while reducing final energy demand (the energy used by appliances/vehicles) by 24% and primary energy demand (the raw energy resource, such as coal, oil, and gas, or wind or sunlight) by 36% compared to today.
- Greater energy productivity can be achieved through a combination of:
 - Technical efficiency — reducing the kWh input required to deliver the same product or service.
 - Service efficiency — reducing the volume of product or service required to deliver the same standard.
 - Material efficiency — reducing the material input to deliver a given product.
- Decarbonising energy intensive sectors through clean electricity, hydrogen, sustainable fuels and carbon capture will increase primary energy demand, as these solutions are themselves energy-intensive. Without productivity gains, this would significantly increase energy system scale and infrastructure needs.
- Improving energy productivity can offset much of this additional energy demand in most sectors, reducing the scale of required energy infrastructure and associated investment. Steel is a key exception, where hydrogen-based production increases overall energy needs despite efficiency gains.
- Energy productivity can also significantly reduce the cost of decarbonisation by lowering fuel and material requirements, it reduces exposure to “green premiums” from low-carbon fuels and carbon management solutions, while strengthening competitiveness.
 - For example, improving aircraft efficiency could reduce fuel demand by ~25%, saving around \$135 billion per year by 2050 as sustainable aviation fuels scale.
 - In shipping, energy productivity can nearly halve the cost impact of low-carbon shipping fuels—from \$0.23 to \$0.13 on a \$35 t-shirt.

- Combining energy productivity with decarbonisation can reduce “green premiums” by around 40% to 60% in shipping and aviation respectively.

Key productivity actions by industry to reduce primary energy across sectors:

- **Aluminium:** decarbonise electricity supply for smelting; use less material through lightweighting and longer product lifetimes; increase recycling—secondary production uses ~95% less energy than primary.
- **Plastics and chemicals:** Reduce demand through reuse, substitution and elimination of single-use plastics; scale recycling (mechanical and chemical); invest in collection and sorting systems.
- **Steel:** Increase scrap use and shift to electric arc furnace production; improve material efficiency across applications; hydrogen-based production supports decarbonisation but increases overall energy demand.
- **Cement:** Reduce clinker content and use less concrete through better design of buildings; improve kiln efficiency and deploy waste heat recovery; enable CCS for process emissions.
- **Aviation:** Improve aircraft efficiency (lightweighting, aerodynamics, engines) and operations (routing, utilisation); support SAF deployment through mandates and innovation.
- **Shipping:** Improve vessel design and operations (routing, speed, maintenance); digital optimisation; support fuel switching through standards and green corridor development.