
Buildings in a clean energy system: managing total and peak electricity demand via efficiency and flexibility

Electrifying buildings will create rapidly growing power demands

- The future is (primarily) electric. We are moving from an energy system that uses several different fuels (e.g., oil, gas and electricity) to one which is almost exclusively electric. It is technically and economically feasible to almost eliminate the direct use of gas and oil in buildings by 2050, with a reduction of around 15–20% possible by 2030.
- This means that annual electricity requirements for buildings in 2050 could be 2.5–3 times higher than today, due primarily to the electrification of heating and growing demand for cooling. Electricity use in buildings could increase from 12,800 TWh to around 35,000 TWh.
- Decarbonisation of electricity supply is therefore essential.

Electricity demand can be reduced via improvements in efficiency managed with various solutions in buildings:

- However, electrification is efficiency. Without a shift to electric technologies, total energy used in buildings could be 60% higher, due to population growth and rising incomes and living standards. Transitioning to electric technologies reduces the total energy needed in 2050 from over 57,000 TWh to 35,000 TWh.
- Energy efficiency could reduce global electricity demand in buildings by a further 50% in 2050 (to around 18,000 TWh). There are three key opportunities:
 - Shifting to efficient, best-in-class technologies in heating, AC, lighting and appliances. This could reduce electricity needed to power buildings by around 25%.
 - Building new buildings to higher standards and incorporating “passive heating and cooling techniques” such as painting roofs white and window shades, and retrofitting existing buildings.
 - Installing smart energy management systems and encouraging behaviour change (e.g., setting AC thermostats at optimal levels in high-income countries).

Demand-side flexibility must play a significant role in managing electricity at peak times:

- Electrifying building heating and cooling will mean that peak electricity demand will tend to increase even more than total demand. Heating and cooling needs fluctuate over days, weeks and months, creating balancing challenges when this does not align with when the sun shines or the wind blows. Electricity systems must be sized to meet these peaks, leading to higher costs for storage and backup power generation.
- However, these additional costs can be reduced by transforming buildings into energy assets, which can help balance the supply and demand of clean electricity. There is huge untapped potential for buildings to provide “demand-side flexibility”, shifting their energy use away from peak times via, for example, (i) pre-heating their homes before morning and evening peaks with improved insulation, (ii) pre-heating water with water storage tanks, and (iii) using rooftop solar PV, batteries and smart systems. Around 20% of buildings' energy demand could be moved to different times of the day in response to cheaper, off-peak hourly prices. Buildings can therefore complement the increasing penetration of cheap, variable renewables, varying the time at which electricity is drawn from the grid to match when wind and solar generation is abundant.

Priority actions to tip the dial:

1. Policymakers across the world should implement ambitious building regulations, which set stringent requirements on the energy performance of new buildings (e.g., the maximum amount of kWh/m² a building should consume based on typical energy needs).
2. National and local governments, energy companies and network system operators should run consumer campaigns, highlighting the benefits of smart energy management systems, rooftop solar PV, and water storage tanks.
3. Energy companies must roll out smart meters to all customers and introduce dynamic time-of-use energy tariffs which incentivise households to adjust their demand in response to higher, peak prices (e.g., charging electric vehicles overnight when electricity demand is lower).