



Systems thinking to reduce energy waste

Energy efficiency is the avoidance of ‘energy waste’. Historical thinking about reducing energy waste has been focussed on individual products, processes and practices at the point of final energy use. However, energy is wasted at all stages of the chain to supply energy services, from resource acquisition through to final use. The energy waste at different stages is inter-dependent, and therefore a whole system analysis is required. This insight is critical when thinking about fundamental change in energy systems, in particular in the transition to zero-carbon system.

Electrification is critical to the elimination of direct use of fossil fuels. The main changes in the energy system after large-scale electrification with renewables include big reductions in energy waste in power generation, transportation and fossil fuel processing. Waste reductions in buildings are smaller, but there is a major increase in the use of ambient energy (via heat pumps), which can be thought of as the opposite of waste, allowing efficiencies to rise (perhaps counterintuitively) to above 100%. Maximising electrification of end use therefore has efficiency effects across the energy chain. We show that it can halve global primary energy demand to provide the existing level of energy services.

Electrification is therefore critical to future efficiency goals, as it will be the main ‘provider’ of energy efficiency improvement over the next two decades. This requires changes to both the way energy supply analysts typically think about electrification – as a supply side change – but also to its conceptualisation by energy demand analysts as something additional to energy efficiency.

Research and policy have not yet adequately adapted to the changed reality. It has some important implications. For example,

- taxes on electricity tend to deter electrification and therefore energy efficiency,
- improving the energy efficiency of fossil fuel use is at best a short term option, perhaps even in some cases counterproductive,
- minimum energy performance standards should switch focus from lights and appliances to the new large electricity loads – heating, vehicles and industrial processes.