Limiting global warming to 1.5°C through major transformations on the consumption side while improving overall service levels

Summary of the Low Energy Demand (LED) scenario study published in Nature Energy in 2018 by IIASA researchers and colleagues

The future storyline of the Low Energy Demand (LED) scenario puts societal, business and behavior transformation in the focus of mitigating climate change and alleviating social inequalities. It builds on examining and fulfilling the actual needs of people. People do not need energy, but they need decent living conditions, in particular shelter, mobility, consumer goods, and essential services. In effect, the purpose of the global energy and material systems is to provide these useful services to consumers.

Scientific and public recognition of the reality and urgency of human-induced climate change is already high, and society realized that the actions so far prove to be insufficient. Powerful data and visuals (like Figure 1) have encapsulated the need for policy action in the public discourse, confirmed by the landmark Paris Agreement in 2015, and the target to limit warming to 1.5°C average global temperature increase compared to pre-industrial levels became widely accepted.

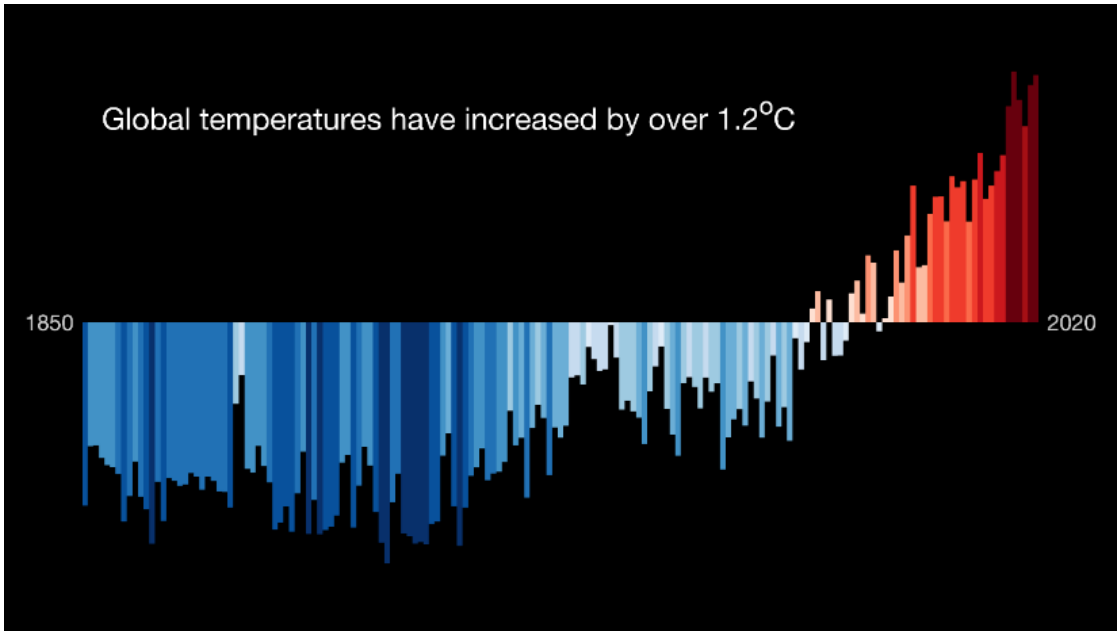

Figure 1. The warming stripes by leading climate scientist Ed Hawkins replaced the polar bear on a floating iceberg and visualized climate change as a complex system change without complicated data communication. Source: Ed Hawkins

In classic climate scenarios, the energy system is largely described through the supply of fuels and production processes, and economic and industrial changes are considered predestined drivers of demand for energy. Global climate mitigation policies also tend to focus on supply-side solutions, which brings with it large-scale negative emission technologies (such as bioenergy with carbon capture and storage, or direct air capture) to stay within the emission budgets for 1.5°C warming. These technologies have been critically assessed in terms of limitations, costs and uncertainty.

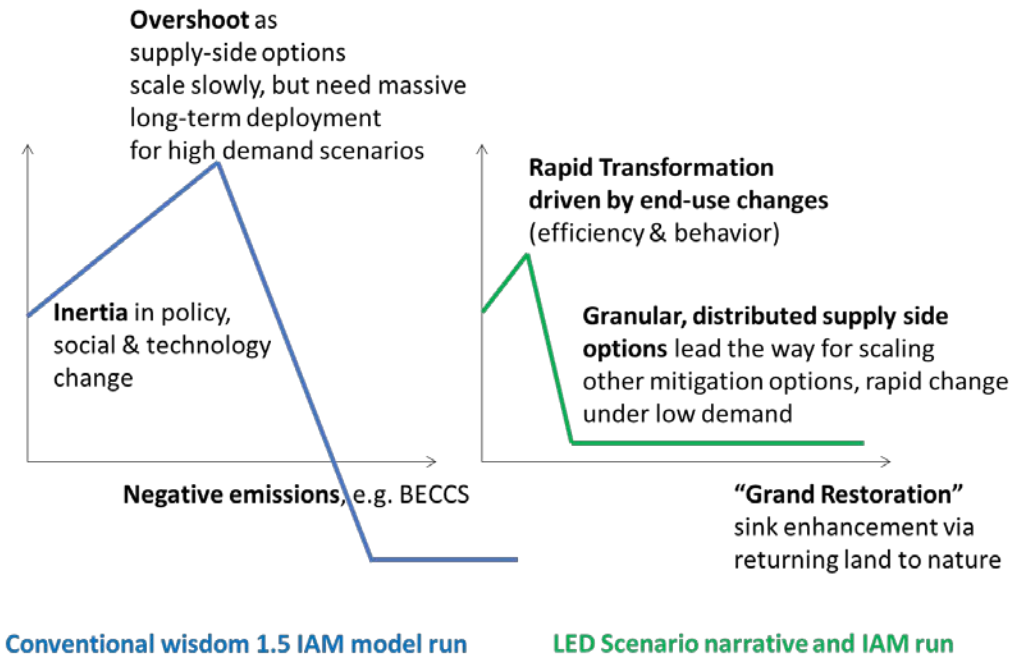

Figure 2. Conventional energy system modelling assumptions

Deviating from this focus on energy supply, the LED scenario assumes major transformations in the way we move around, heat and cool our homes, and buy and use devices and appliances in our cities. Changes in the ways that the consumers of energy go about their daily lives also influence the ways in which goods are manufactured and transported, offices and malls are built and used, and how food is grown (Figure 2.). The LED Scenario shows how the global community – from world leaders and multinational corporations down to individual consumers and citizens – can develop innovative service provision models and reduce energy use to avoid dangerous climate change while improving human wellbeing.

The future under the Low Energy Demand scenario is transformed through five main drivers of long-term change in energy end-use. The scenario shows how abundant, available, and actionable energy end-use options can reduce emissions rapidly and pervasively while improving quality of life in the global North and South. The scenario is constructed based on major trends clearly observable today which can lead to dramatic decreases in global energy demand by 2050. These five drivers are clearly observable today as major trends (see Figure 3):

- Quality of Life: continued push for higher living standards, clean local environments, and widely accessible services and end-use technologies.
- Urbanisation: continued rapid urbanisation particularly in mid-size cities in developing countries.
- Novel Energy Services: continued historical trend of end users demanding novel, more accessible, more convenient, cleaner, and higher quality energy services.
- End-User Roles: continued diversification of end-user roles in the energy system away from passive consumption and towards engagement as consumer, producer, citizen, designer and community member.
- Information Innovation: continued rapid improvements in cost and performance of information and communication technologies (ICTs) supporting widespread diffusion and digitalisation.

These five drivers of change interact to generate five additional elements of the LED scenario narrative. Each element is constituted by social, technological and institutional changes in how energy services are provided and consumed.

- Granularity: proliferation of small scale, low unit cost technologies enabling experimentation, rapid learning and equitable access.
- Decentralised Service Provision: decentralisation and localisation of energy generation, distribution and end-use, with piecewise expansion or adaptation of centralised infrastructure.
- Use Value from Services: move away from ownership of single purpose goods to 'usership' with flexible, multi-purpose services delivered through digital platforms or sharing economies.
- Digitalisation of Daily Life: integration of sensors, processors, wireless communication, and control functionality into energy-using technologies and daily routines.
- Rapid Transformation: acceleration in the changing form and quality of energy-service provision demanded by end users as incomes and aspirations rise.

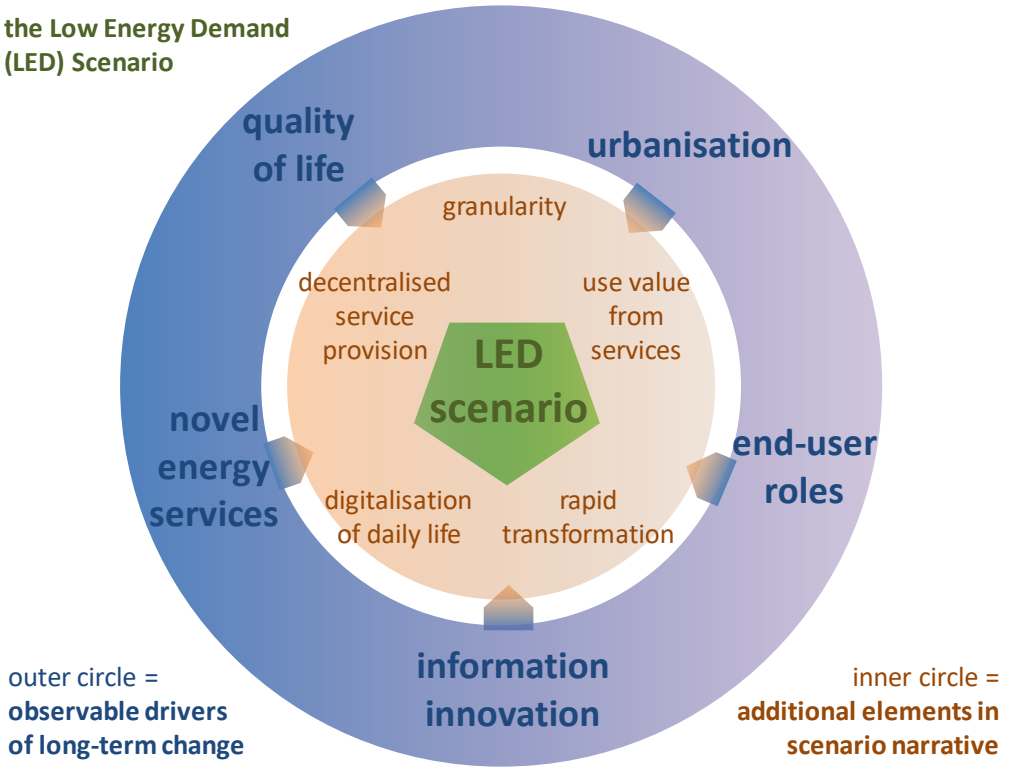

Figure 3. The observable drivers of long-term change and the additional elements of the LED scenario narrative. Source: Grubler et al. 2018.

The LED study found that global final energy demand by 2050 could reduce to 245 EJ, around 40% lower than today's levels despite rising population, income and activity levels. These changes in energy end-use lead to a supply-side transformation, as has been the case historically. Consistent with the LED scenario narrative, granular energy-supply technologies like heat pumps, fuel cells, and solar PV proliferate. Granularity, decentralisation and intermittent renewables pose significant challenges for system management and balancing addressed via 'smart' transformation of physical networks and control systems and scaled-up storage and load management options. Indeed, the Low Energy Demand scenario is among the few that show – based on real data and real examples – that a

reduction and transformation of the energy system to a level that is inevitable for avoiding harmful levels of climate change can be powered.

The decreased demand for energy translates into important benefits for many of the 17 UN Sustainable Development Goals (SDGs) especially when compared to other scenarios. The SDGs involve multiple indicators and targets, and have important distributional aspects, which we could not analyse in detail. Nonetheless Figure 5 indicates a few important positive effects of LED on SDG2 (Hunger), SDG3 (Health), SDG6 (Water), SDG7 (Energy), SDG12 (Resources), SDG13 (Climate) and SDG15 (Land).

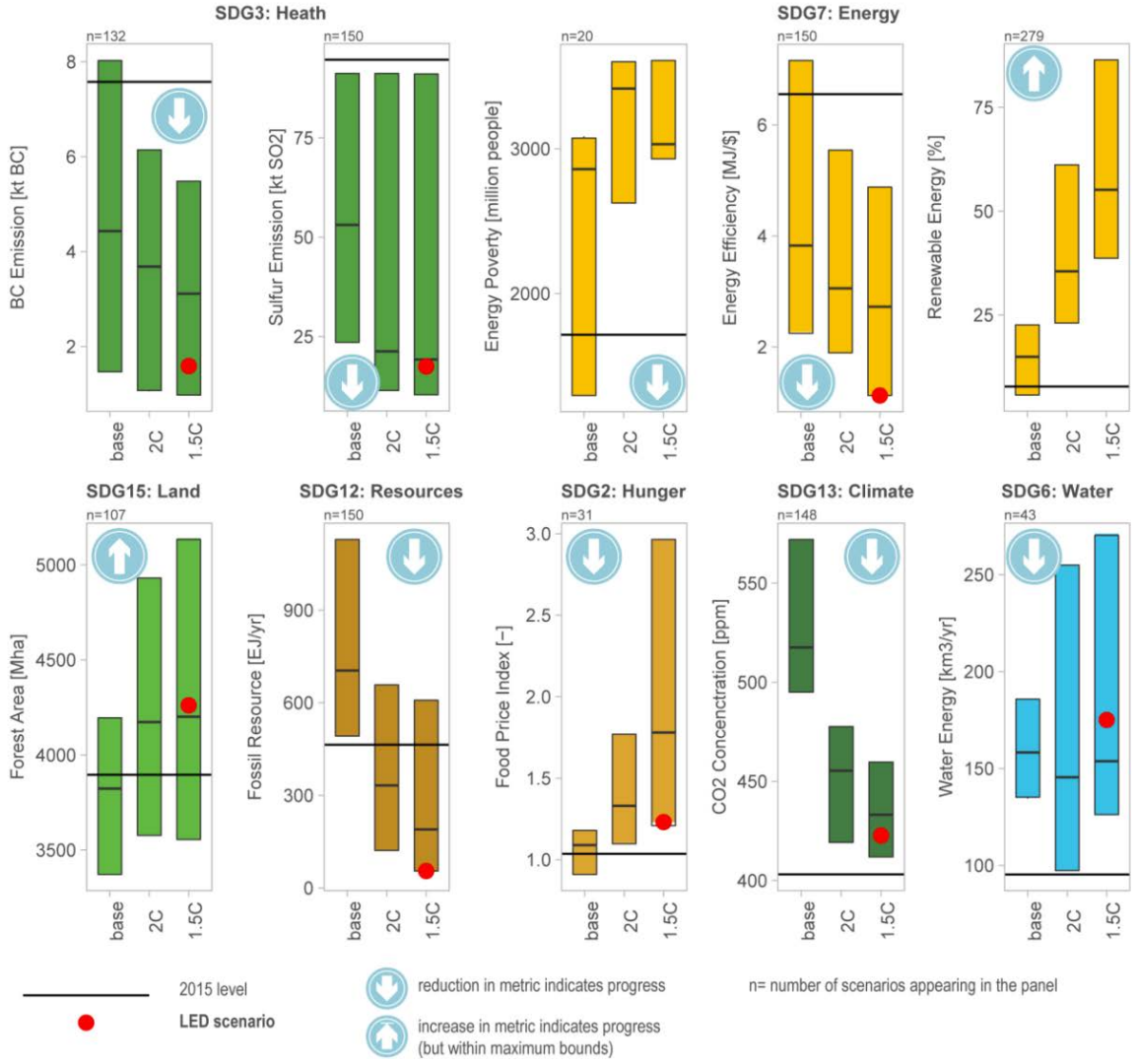

Figure 4. SDG benefits of the LED scenario in comparison to baseline, 2°C and 1.5°C scenarios assessed in the IPCC Special Report on Global Warming of 1.5°C. Illustration of the multiple benefits of the LED scenario for achieving Sustainable Development Goals (SDGs) by 2050 globally. Progress towards SDG goals achievement (indicator in-/decrease) is denoted by arrow symbols. 2015 values or other target levels are shown for comparison as well. Source: Grubler et al. 2018.

The changes of daily life in the LED Scenario are multi-faceted (see Figure 6.). The reduction in energy demand is largely based on improvements in energy efficiency driven by technological and social innovations, both in the Global North and the Global South. For example, shared and 'on-demand' fleets of electric vehicles with increased occupancy could reduce global energy demand for transport by 60 per cent by 2050 while reducing the number of vehicles on the road. Meanwhile the

use of single digital devices such as smartphones, which provides a wide range of functions, combined with a growing preference for accessing services instead of owning goods, could limit the growth in global energy demand from consumer goods to just 15 per cent by 2050. Strict standards for the energy performance of new buildings as well as renovations of existing buildings can reduce energy demand from heating and cooling by 75 per cent by 2050. In addition, shifting to a healthier diet with less red meat and more fruit and vegetables can significantly reduce emissions from agriculture. This is in spite of agricultural intensification to expand by one-third the global food supply globally to feed growing populations and to eradicate hunger in the developing world, while increasing forest cover equivalent to the size of Italy and Bangladesh combined, by 2050.

Table 2 | Impact of the LED scenario on final energy demand in 2050

		Region	% change in activity levels (2020–2050)	% change in energy demand (2020–2050)	Activity levels in 2050	Energy demand in 2050 (EJ)	Total energy demand in 2050 (EJ) (GJ capita^{-1})
End-use services	Thermal comfort	North	6	−74	47×10^{9} m^2	8	16 (1.8)
		South	63	−79	218×10^{9} m^2	8	
	Consumer goods	North	79	−25	67×10^{9} units	13	41 (4.5)
		South	175	54	186×10^{9} units	28	
	Mobility	North	29	−60	25×10^{12} passenger km	16	27 (3.0)
		South	122	−59	73×10^{12} passenger km	12	
	Contingency reserve						8
Upstream	Public and commercial buildings	North	49	−64	35×10^{9} m^2	5	8 (0.9)
		South	77	−82	68×10^{9} m^2	3	
	Industry	North	−42	−57	1.0×10^{9} t	26	107 (11.7)
		South	−12	−23	5.4×10^{9} t	82	
	Freight transport	North	109	−28	31×10^{12} tkm	11	27 (3.0)
		South	75	−12	51×10^{12} tkm	17	
	International aviation and shipping (bunker fuels)						10
Total		North[a]		−53		82	245
		South[a]		−32		153	

All sub-totals and totals are rounded (lower integer at numerical values <0.5, to upper integer ≥0.5). [a]Contingency reserve of 8 EJ is allocated equally to the global North and global South. Bunker fuels are reported at the global level only, consistent with current energy balances and emission accounting frameworks.

Figure 5. Changes in the end-use and upstream sectors in services levels (activity) and energy demand expected in the global north and in the LED scenario. Source: Grubler et al. 2018.

Making this Low Energy Demand scenario a reality will require unprecedented efforts from policymakers to tighten standards, from businesses to develop and roll out low-carbon innovations, and from individuals and households to embrace new ways of doing things into their daily lives.

Recommended links to learn more about LED:

- The original scientific paper and its supplementary information
- Comprehensive slide-deck
- Policy brief
- EDITS network to deepen and extend the LED scenario
- Video summaries