A low energy demand scenario for meeting the 1.5 °C target and sustainable development goals without negative emission technologies

Arnulf Grubler, Charlie Wilson, Nuno Bento, Benigna Boza-Kiss, Volker Krey,David L. McCollum, Narasimha D. Rao, Keywan Riahi, Joeri Rogelj, Simon De Stercke,Jonathan Cullen, Stefan Frank, Oliver Fricko, Fei Guo, Matt Gidden, Petr Havlík, Daniel Huppmann, Gregor Kiesewetter, Peter Rafaj, Wolfgang Schoeppand Hugo Valin

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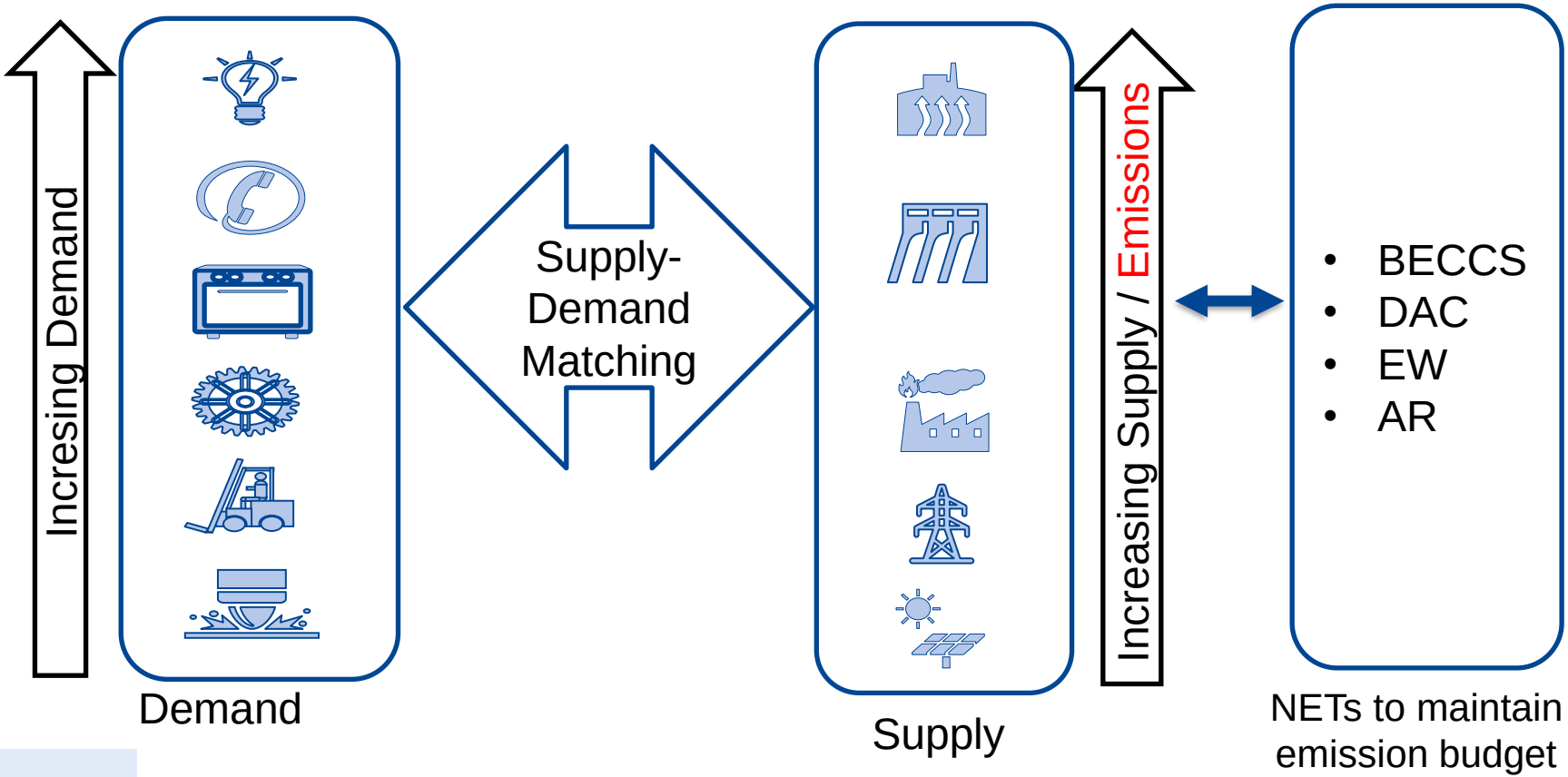
Nelson Manjong

NTNU

Introduction

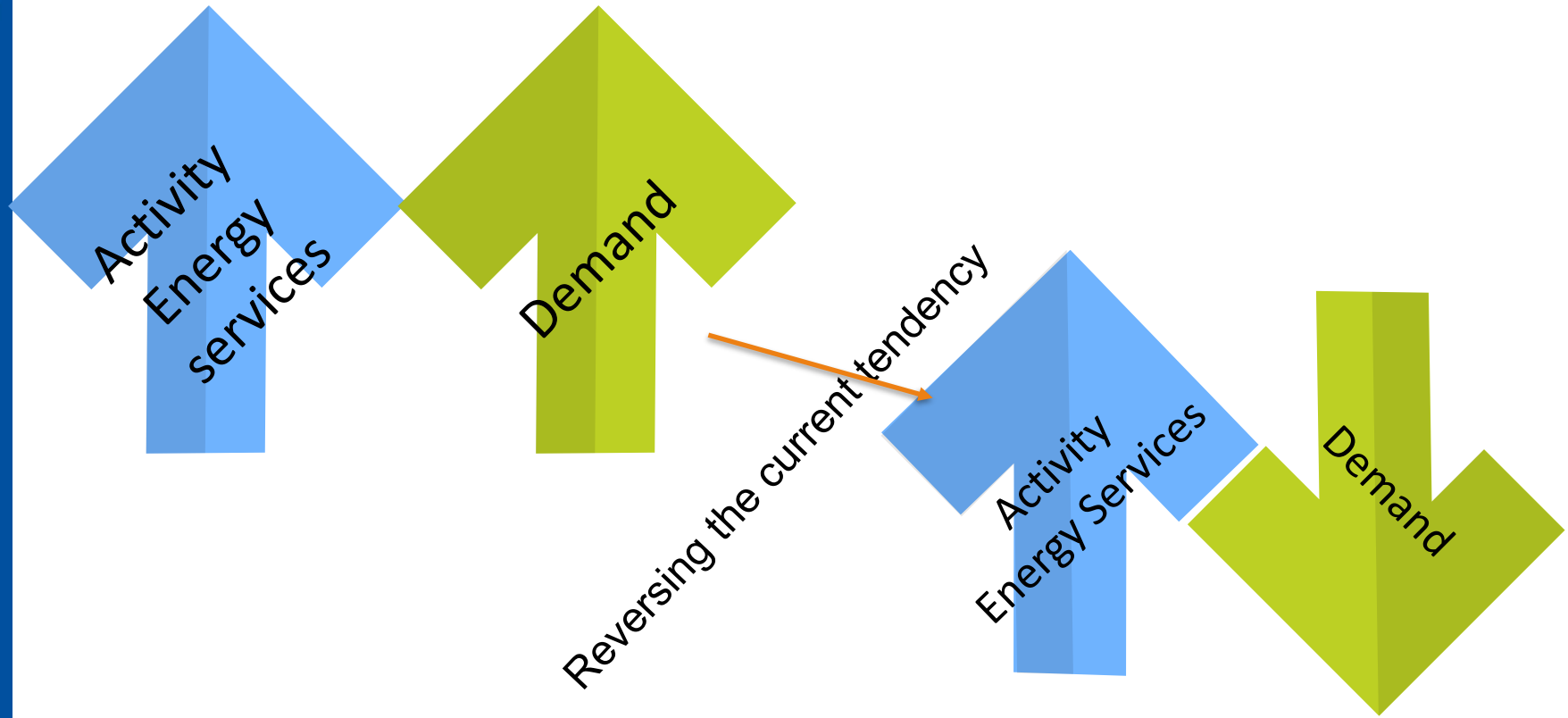
Energy System Modelling



Research Question

Can the global energy system be scaled down to create the necessary space for a feasible supply-side decarbonization within a 1.5 °C emission budget without the need for negative emission technologies and with significant sustainable development co-benefits?

Underlying Challenges

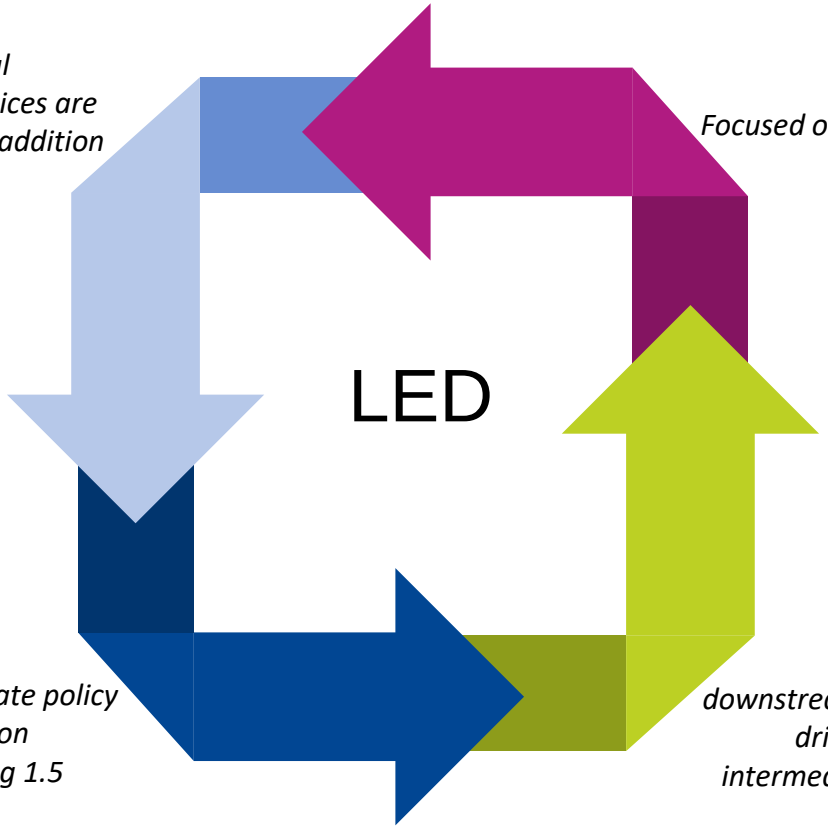


Low Energy Demand Scenario (LED)

What makes an LED Scenario Different?

rapid social and institutional changes in how energy services are provided and consumed, in addition to technological innovation

Focused on energy end-use and energy services



less reliant on stringent climate policy than comparable low-emission scenarios but targets meeting 1.5 scenario

downstream changes in LED, in turn, drive structural change in the intermediate and upstream sectors

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Material and Methods

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LED Scenario Development

1

Bottom-up assessment of activity, intensity and energy demand for four end-use services and five intermediate and upstream sectors. LED is developed by varying efficiency assumptions of activity and intensity for the Global Energy Assessment (GEA) Efficiency Scenario.

Supply Modelling

2

Use of MESSAGEix-GLOBIOM to assess the energy supply and land use configurations following the disaggregated LED demand: Modelling constraints

1. Energy demand must be met
2. Energy system cannot install any NETs (no DAC, no BECCS)
3. Cumulative Carbon Emissions must be below 390 Gt CO2 from 2020-2100

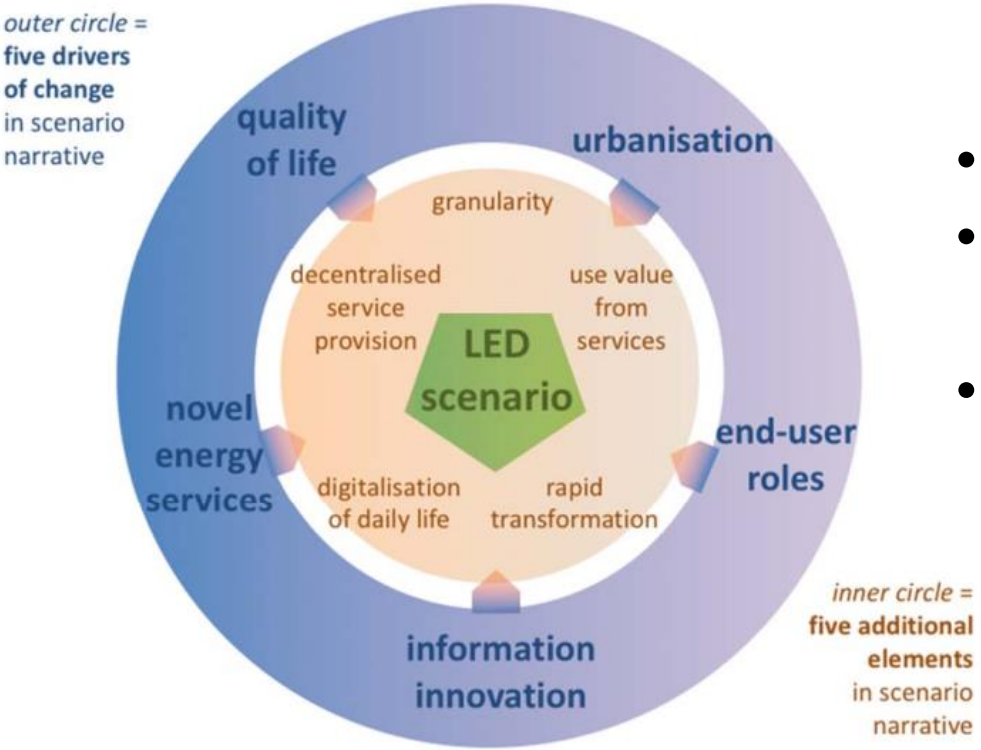
Air-quality and health impacts were quantified by linking MESSAGEix-GLOBIOM with GAINS

Impacts on LED Scenario on SDGs

3

outcomes of the LED scenario are evaluated against relevant SDGs

Scenario Narrative for LED



- 5 drivers of change
- 5 elements of scenario narrative
- Two regions
  - ➢ Global North
  - ➢ Global South

Drivers of Change in LED

Quality of Life	Urbanisation	Novel Energy Services	End-User Roles	Information Innovation
↑ Income and purchasing power	↑ Urban Population	↑ demand for performance improvement pdts	↑ Energy Market Liberalisation	↓ Cost of general purpose ICT
↑ SDG Efforts	↑ number of mid-size cities	↑ Market transformation by disruptive innovations	↓ Cost of residential PV/storage	↑ ICT performance
↑ health needs	↕ property size, good ownerships	↑ smart energy service provision	↑ Residential scale energy production	↑ Mass production leading of units

Modelling Assumptions

Thermal comfort	
Activity	Roughly Constant
Energy intensity	reduces by 75% to 160-170MJ/m2

Consumer goods	
Activity	doubles to 42 devices per capita
Energy intensity	reduces from 93 to 82kWh/device

Mobility	
Activity	20% reduction
Energy intensity	70% reduction in global energy intensity

Food	
Activity	70-100% global increase in food production
Energy intensity	Energy intensity impact not quantified

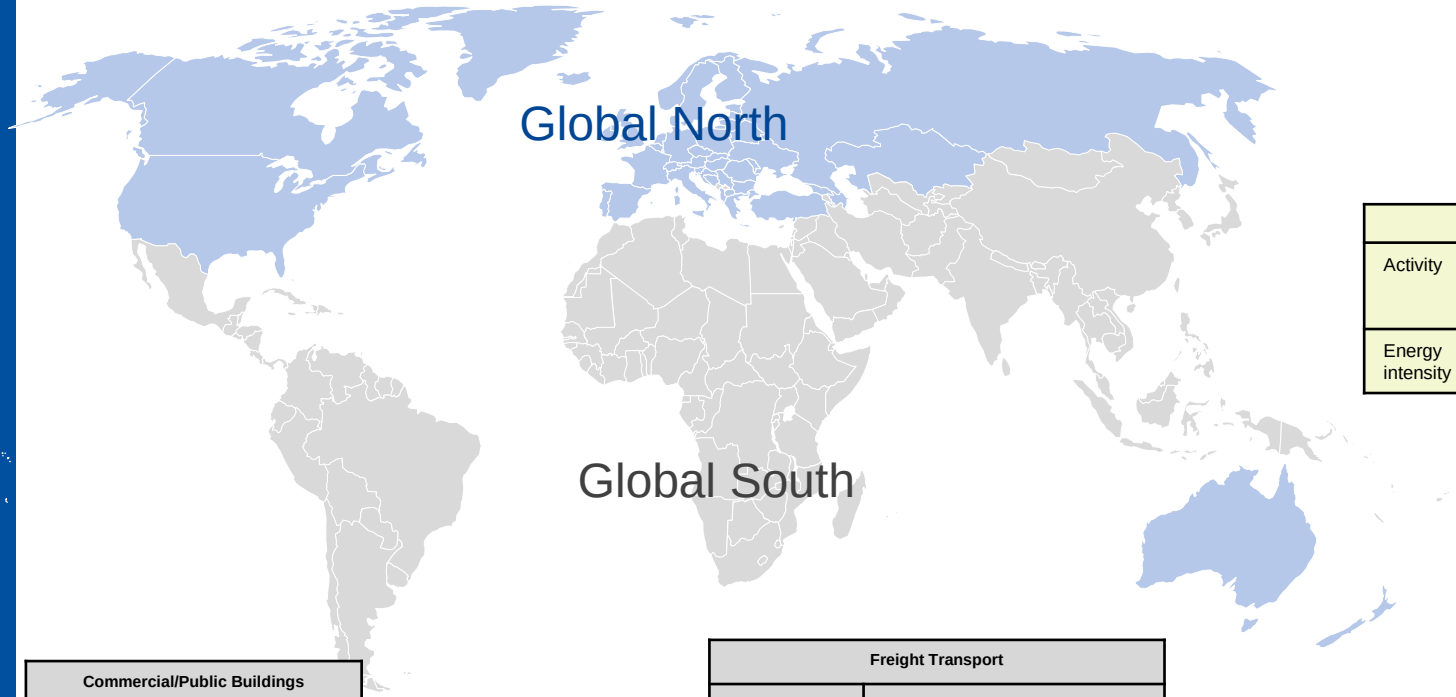
Thermal comfort	
Activity	32% increase to 30 m2/capita
Energy intensity	reduces by 86% to 40MJ/m2

Consumer goods	
Activity	triples to 24 devices per capita
Energy intensity	reduces from 93 to 82kWh/device

Mobility	
Activity	doubles
Energy intensity	70% reduction in global energy intensity

Commercial/Public Buildings	
Activity	43% increase to 23m2/capita
Energy intensity	76% reduction to 139MJ/m2

Freight Transport	
Activity	20% increases 64*10^12 tkm
Energy intensity	50% reduction to 0,5-0,7 MJ/tkm for trucks and 10% to 0,2MJ/tkm for rail.

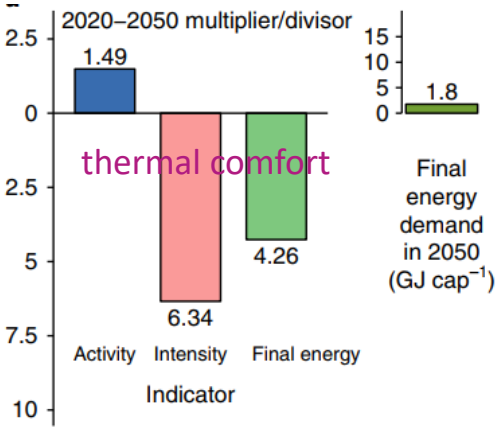


Industry	
Activity	15% global material demand reduction to 6.4Gt
Energy intensity	20% global reduction to 16.7GJ/ton

Commercial/Public Buildings	
Activity	50% increase to 9m2/capita
Energy intensity	76% reduction to 139MJ/m2

Freight Transport	
Activity	70% increases 58*10^12 tkm
Energy intensity	50% reduction to 0,5-0,7 MJ/tkm for trucks and 10% to 0,2MJ7tkm for rail.

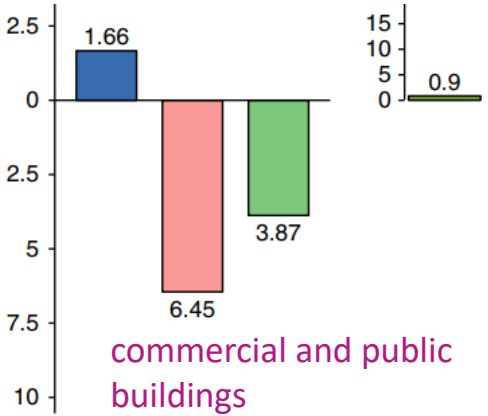
Summary of Assumptions



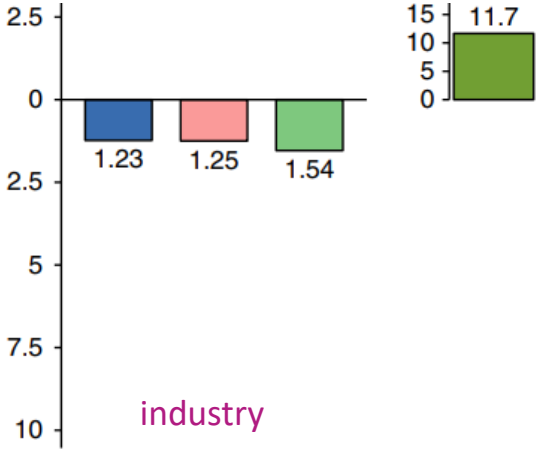
thermal comfort

consumer goods

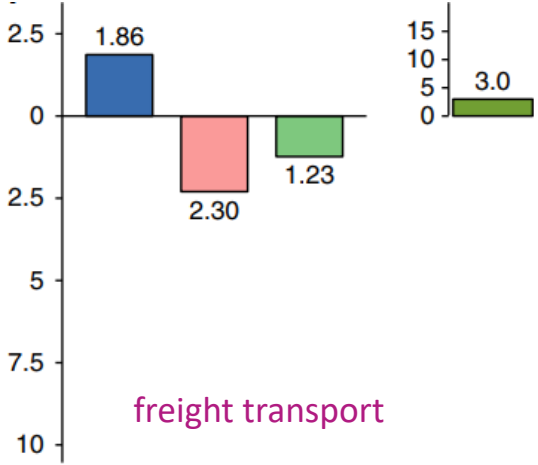
Mobility



commercial and public buildings



industry



freight transport

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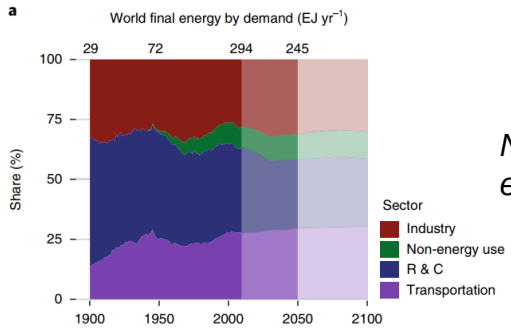
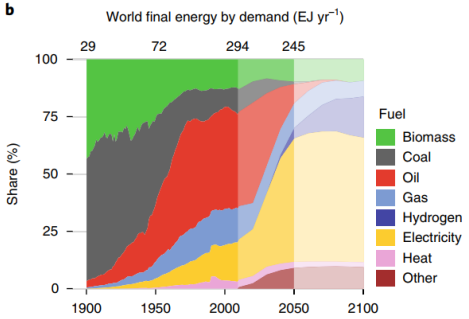
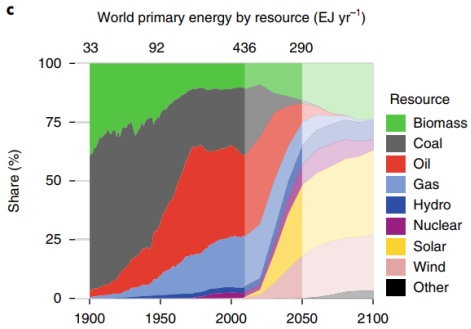
Results



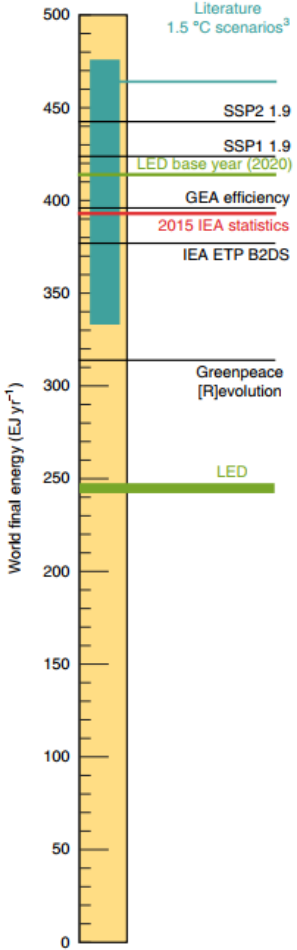
No major change in sectoral energy demand

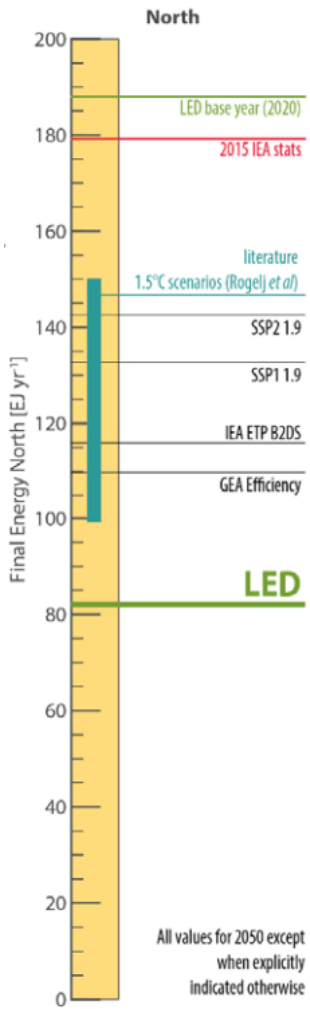


Electricity and hydrogen, major energy carriers (>60%)

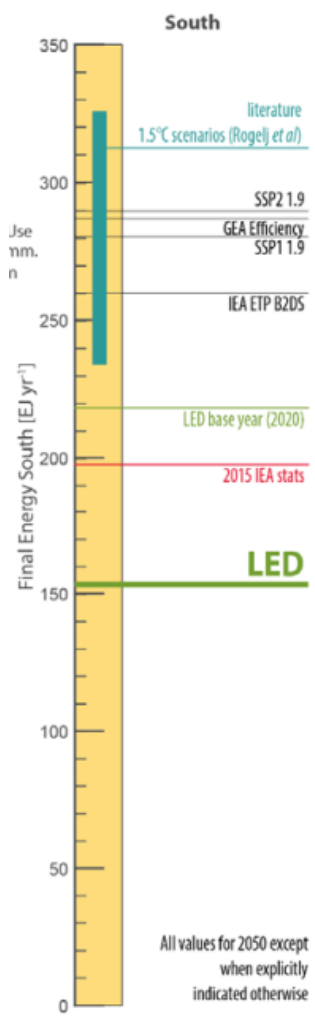


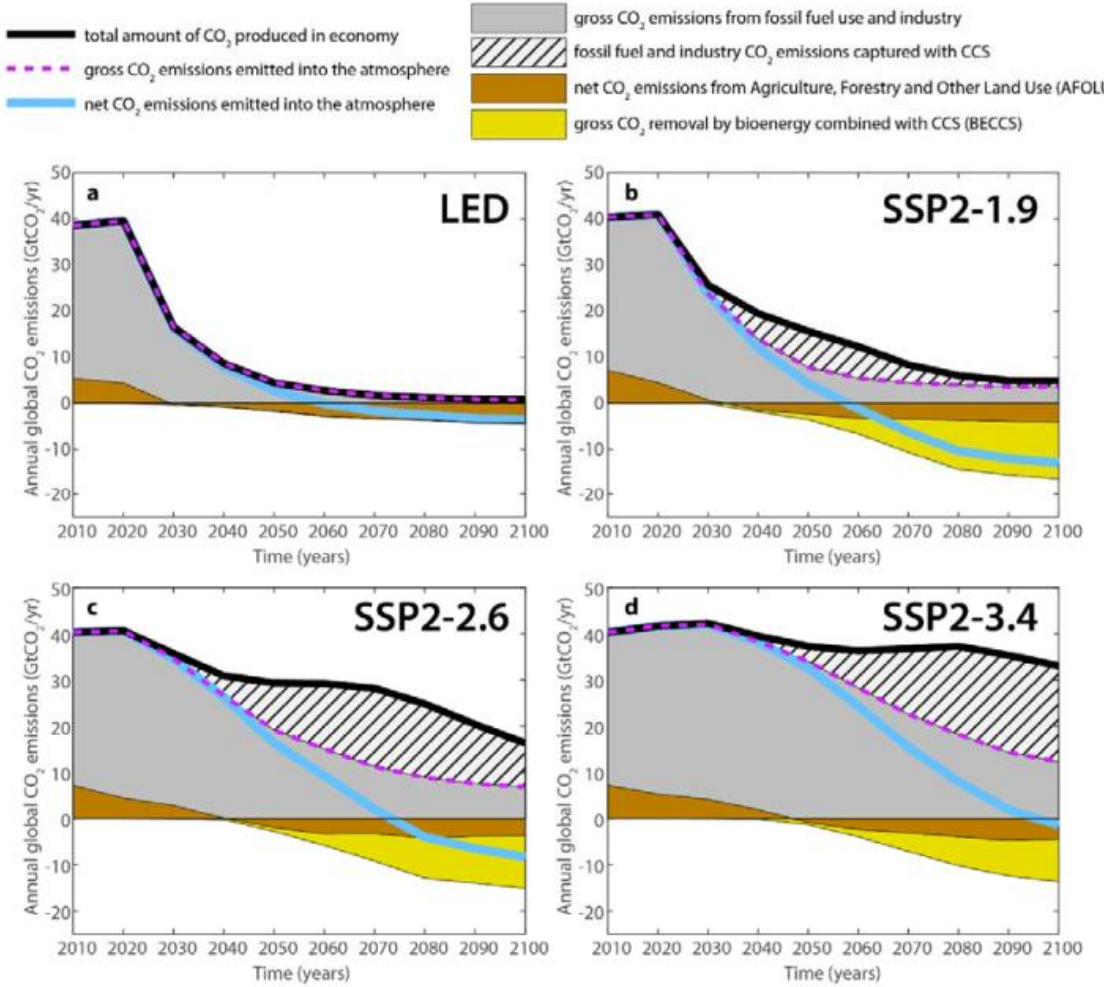
Flexible supply options dominated by Solar and wind; fossils are progressively phased out





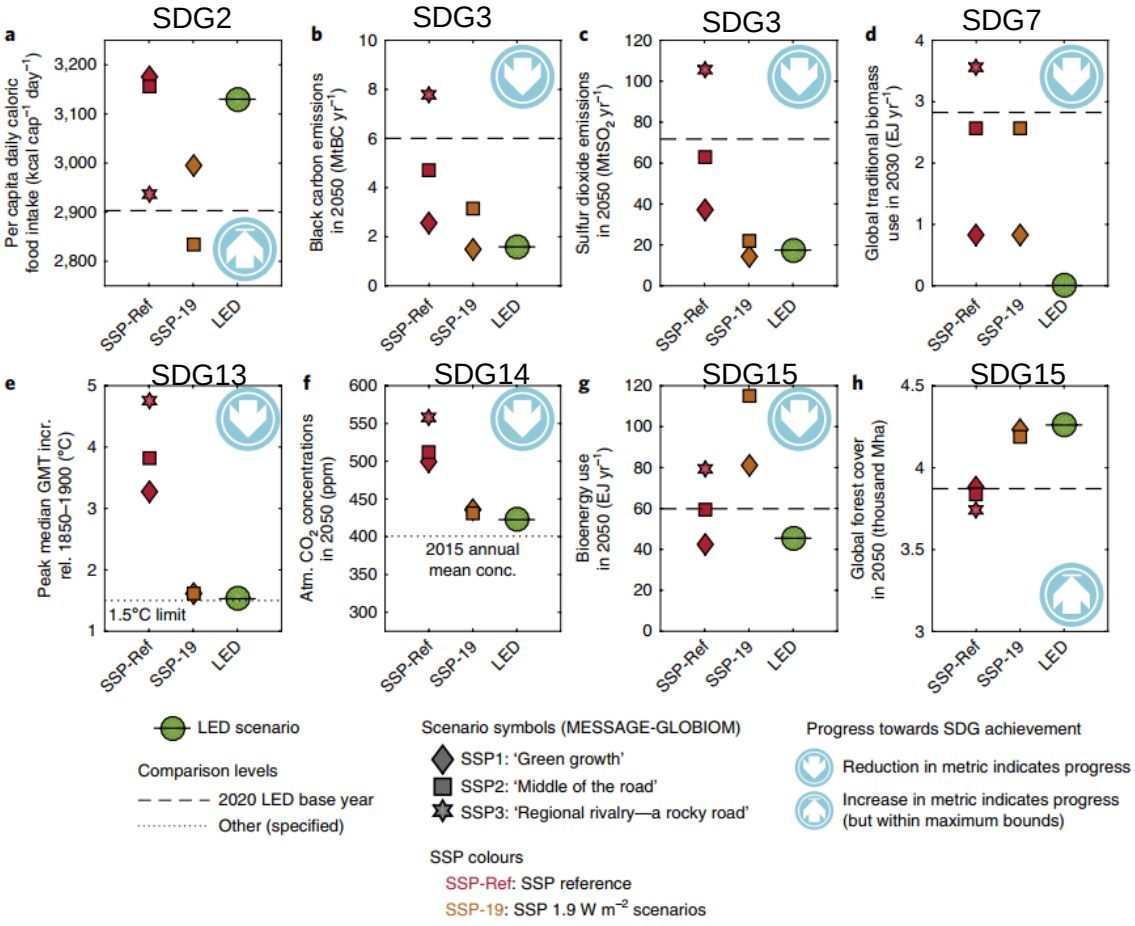
- Total final energy in Global South almost doubles the Global North by 2050.
- This is driven by a high population in the Global South rather than an increase in Energy per capita.
- Energy per capita in the Global North is about 4-8 times higher than the Global South for all end-use services and upstream industries





- LED meets climate targets without use of NET
- CO2 removal in LED is driven by natural occurrence of agriculture, forestry and other land use factors rather than investments in NETs

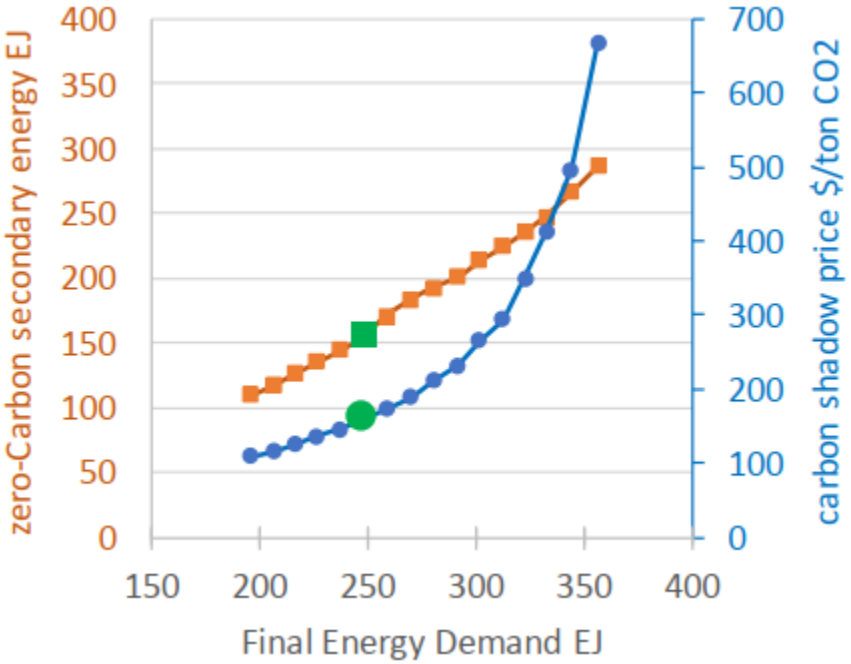
Implications of LED on SDGs



LED is competitive with the best-in-class scenarios across all the SDGs

DEALING WITH «REBOUND EFFECT» IN LED

1. Historical evidence of demand saturation in activity levels
2. Policy adjustment of taxation levels to offset efficiency improvements and so hold energy-service prices roughly constant
3. Sensitivity analysis on LED (-25% to +50% change in demand)



REFLECTIONS/CONCLUSIONS

- The LED requires aggressive execution and integration at all layers of the economy. LED drives structural changes in intermediate and upstream sectors
- Energy demand in 2050 in a LED scenario reduces by 40%
- Behavioral changes, technological innovations and policy play a vital role in achieving LED
- LED scenario competes with other 1.5-degree scenarios
- Supply investments are 2-3 times lower than comparative scenarios, however, investments cost in implementing LED is not accounted, which is a potential caveat of the scenario
- Rebound effect if/when it does happen could alter the whole narrative. A large rebound effect imply a new kind of scenario (100% RES)

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Questions?