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EDITS

Energy Demand changes Induced by Technological and Social innovations

Background and Overview of EDITS: Energy Demand changes Induced by Technological and Social innovations

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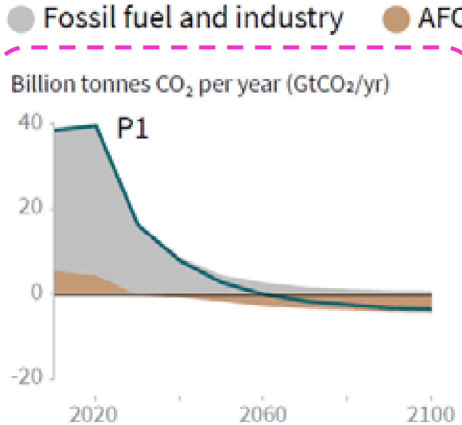
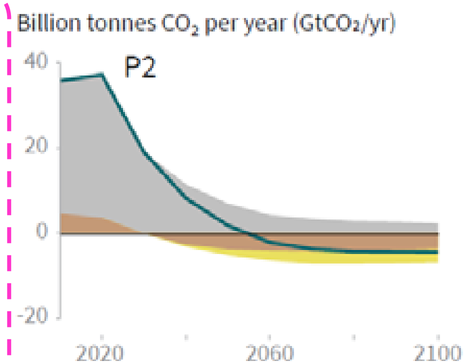
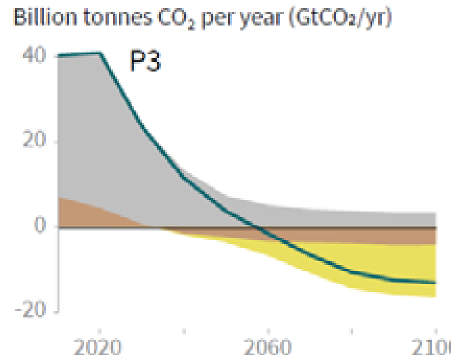
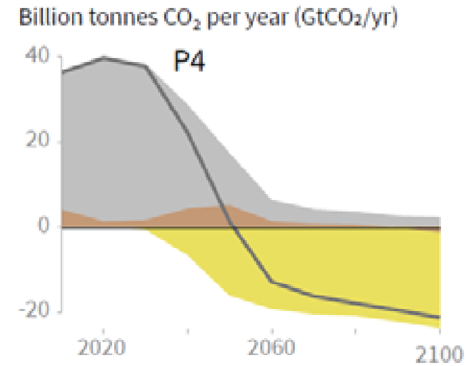
Categorization of deep emission reduction scenarios for below 1.5 °C (IPCC SR15)

Source) IPCC SR15









P1: A scenario in which social, business, and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A down-sized energy system enables rapid decarbonisation of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

Much lower energy demand scenarios than those of SSP1

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

SSP1

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

SSP2 (Middle scenario)

P4: A resource and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

SSP5

Low ⟷ High

Final energy demands

- Low energy demand is induced autonomously on economic principle through technological and social innovations
- Low carbon prices (business-based measures even without strict climate policies)

ü Comprehensive risk management is essential, and various kinds of technologies play their respective roles.

ü On the other hand, opportunities for end-use technology innovation, inducing low energy demands, and their impacts on overall climate change mitigation should be more focused. (P1)

- High carbon prices (harmonization among nations are required to avoid carbon leakage)
- Large-scale deployments of CDR, e.g., CCS, BECCS, DACS, are required.

G20 Karuizawa Innovation Action Plan on Energy Transitions and Global Environment for Sustainable Growth (June 2019)

“We recognize the importance of quantitative analysis on better understanding future energy demand and supply and the role of innovation of both sides driven by digitalization, Artificial Intelligence (AI), the Internet of Things (IoT), and the sharing economy. We encourage efforts made by the global scientific community and international organizations and frameworks to further refine and develop the full spectrum of economy-wide scenarios for energy and climate models.”

Note) This is also an annex document of the G20 Osaka Leader’s declaration.

Objectives of the EDITS Project

- To create a research community focusing on end-use, demand-side perspectives that further dialogue and cross-fertilization of research and policy analysis through the sharing of novel data, novel concepts, methodologies, and policy analyses.

- To improve the state-of-art of demand modeling in environmental and climate policy analysis via methods and model intercomparisons and assist the transfer of conceptual and methodological improvements across disciplines, sectors, and environmental domains.

- To inform better policy via structured model experiments and simulations that assess potential impacts, barriers, as well as synergies and tradeoffs to other SDG objectives of demand-side policy interventions, particularly in novel fields and service provision models such as digitalization, sharing economy, or the SDG integration and climate objectives in synergistic policy designs.

The EDITS project starts from year of 2020.

The Organization and the Research Topics of EDITS

EDITS Organization

Sectors

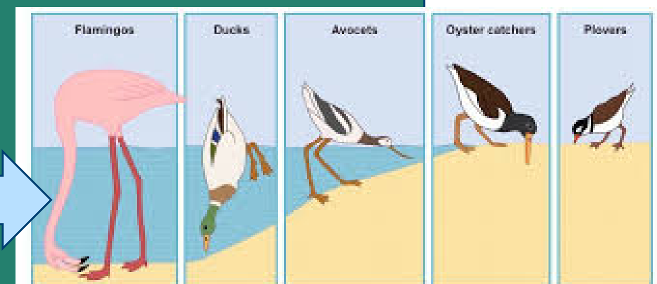
Buildings
Transport
Industry

Data

- Data repository
  Metadata, data owner, how to access
- Use existing structures (e.g. zenodo)
- Initially internal

Model comparison

Narratives
Complementarity Protocol
Synthesis



Model survey / classification

- Revise model survey
- Involve broader community
- Utility of approaches for demand side transformation
- Papers on model classification by sector

- Harmonize narrative (e.g. LED) and basic drivers
- Joint scenario development
- Show value added of diversity
- Additional insights from granularity

15

Digitalization
Equity
Lifestyles / Behavior
Business models
Theory development

Source IIASA, EDITS Quarterly Meeting (Mar. 2021)

Members of the EDITS Project

Institute	Researchers (limited lists)
RITE	Keigo Akimoto, Miyuki Nagashima, Ayami Hayashi
IIASA	Keywan Riahi, Arnulf Grübler, Bas van Ruijven, Shonali Pachauri, Benigna Boza-Kiss, Paul Kishimoto
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Stanford University	John Weyant
University of Tokyo	Masahiro Sugiyama, Yiyi Ju
Lawrence Berkeley National Labs (LBNL)	Nan Zhou, Tianzhen Hong, Wei Feng, Nina Z.Khanna, Hongyou Lu
Utrecht University	Oreane Edelenbosch, Ernst Worrell
CMCC	Massimo Tavoni, Elena Verdolini, Giacomo Marangoni
Tsinghua University	Ou Xunmin
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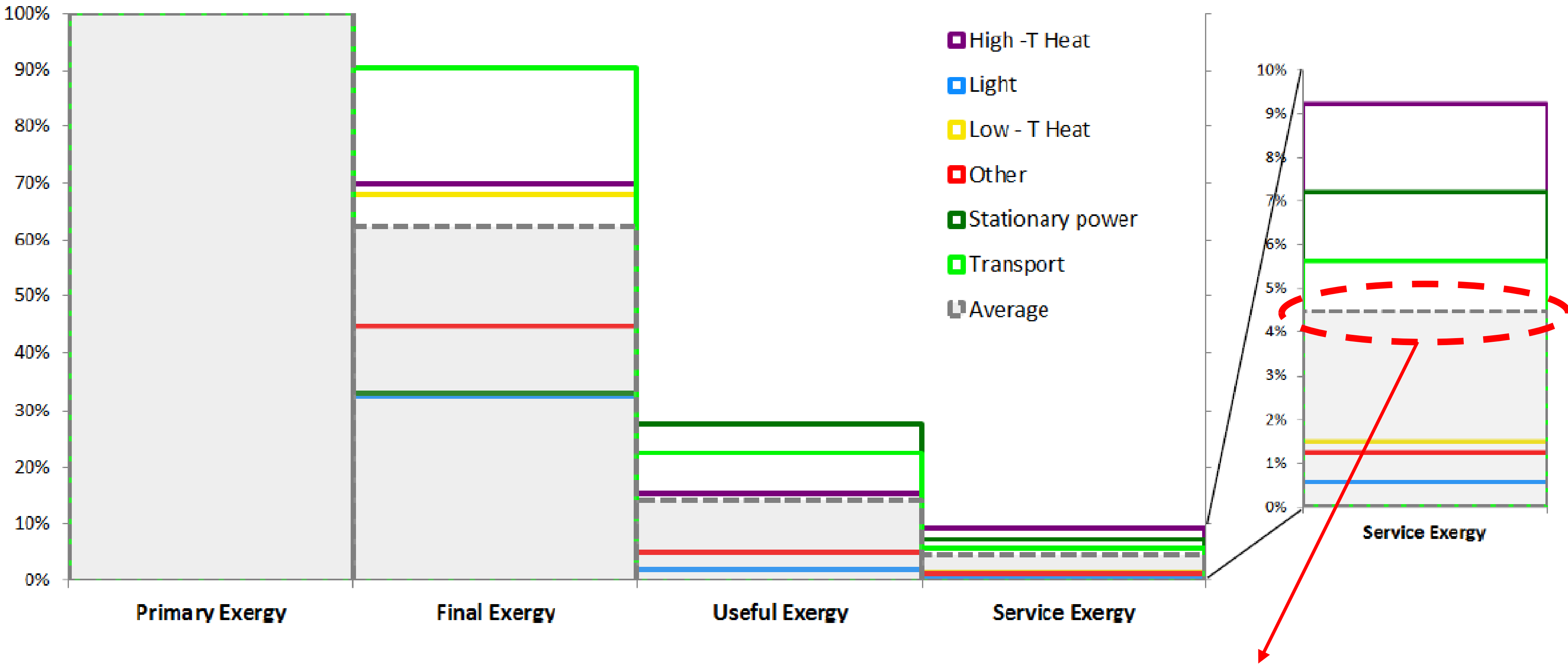
Other major contributors	Julia Steinberger, Bianka Shoai-Tehrani, Joni Jupesta, Poornima Kumar, Marta Baltruszewicz

Global Energy Consumptions and Losses by Sector

Primary energy production = 100



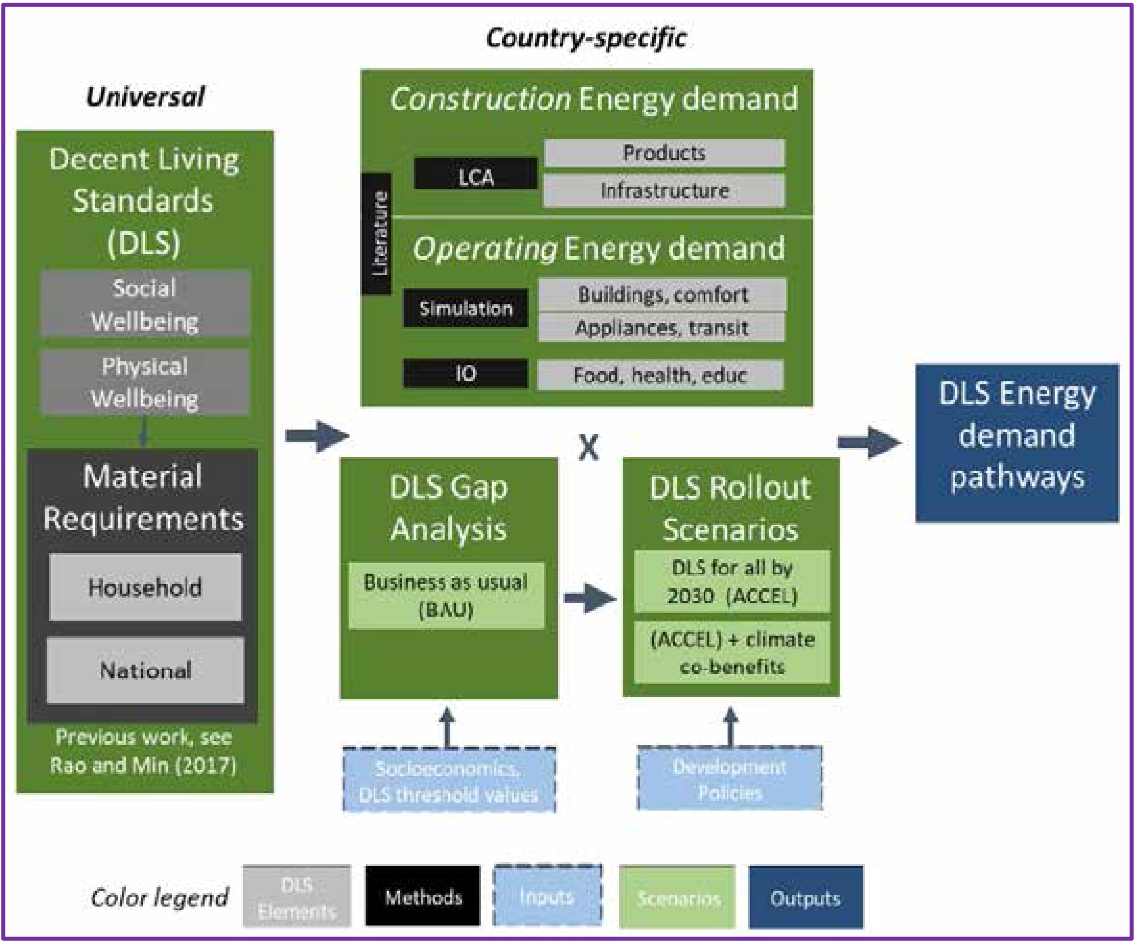
Source) A. Grubler (IIASA), ALPS International Symposium (2016)

Required services need only 4-5% of primary energy consumption.

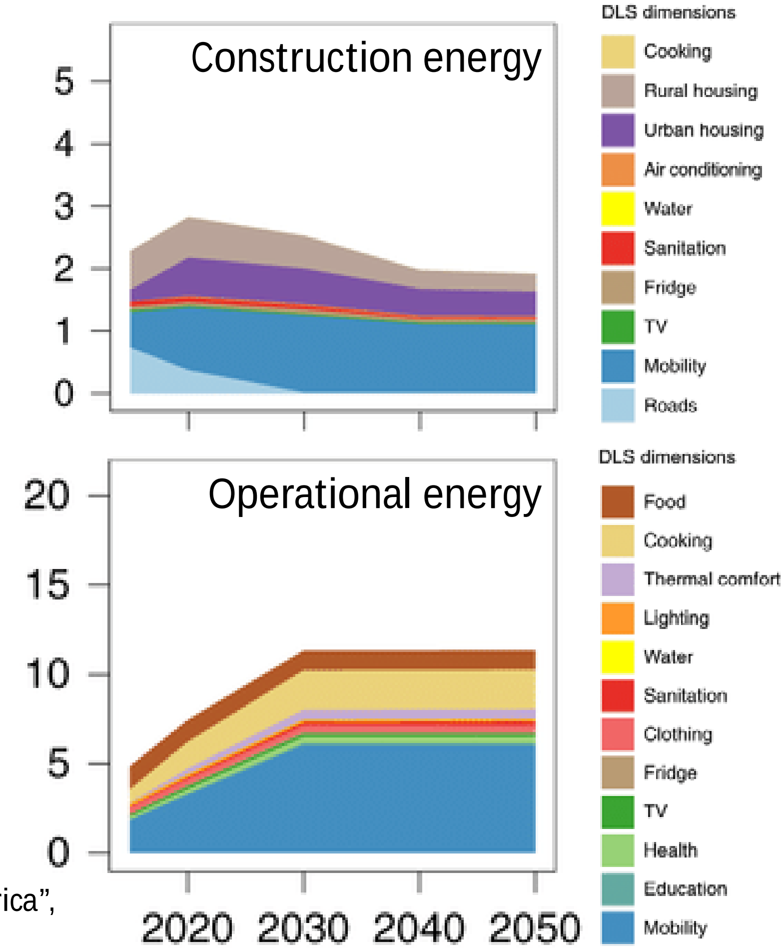
There is ample room to improve energy productivity in end-use sectors. However, currently there are significant barriers to enjoying the possible productivity improvement because of hidden costs. Nevertheless, IT, AI and other related technologies may overcome the barriers at affordable prices.

Energy Demands Estimated from Decent Living Standard (DLS)

Service-driven energy accounting model



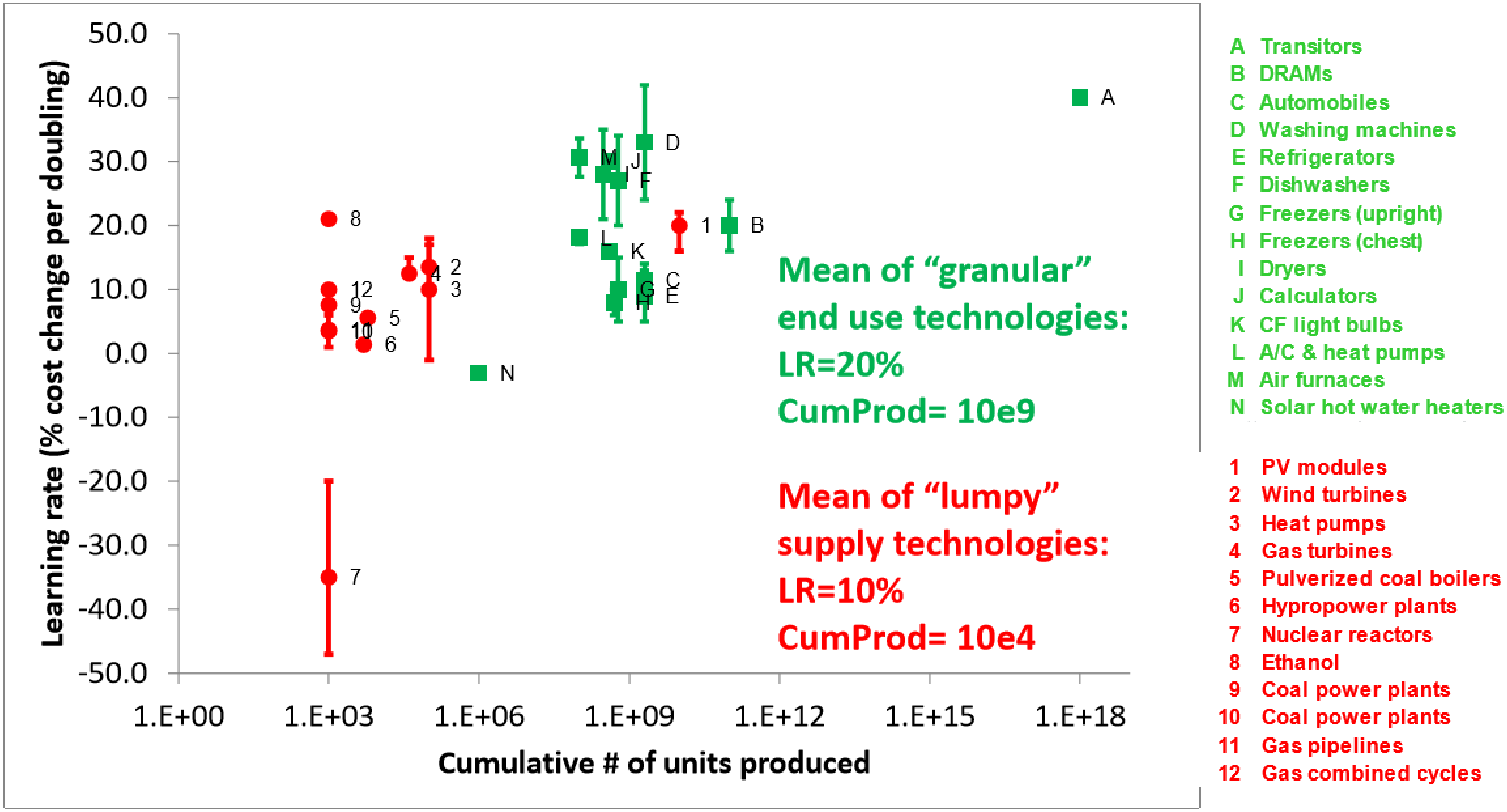
Final energy requirement in India (DLS_ACCEL) [GJ per capita]



Source) Rao et al., "Energy requirements for decent living in India, Brazil and South Africa", Nature Energy (2019)

- **Some studies tried to estimate final energy demands according to a bottom-up measure from required service demands for DLS.**
- **Much larger energies compared with those for DLS are consumed, particularly in developed countries.**

Learning Rates of Energy Technologies: Supply vs End-use

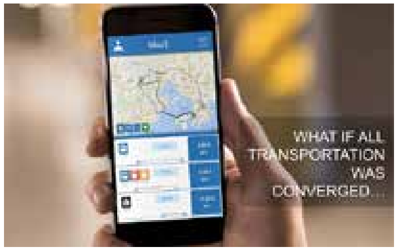


Wilson et al., Nature Climate Change, 2012

The learning rates of the "granular" end-use technologies are greater than those of the "lumpy" energy supply technologies in general.

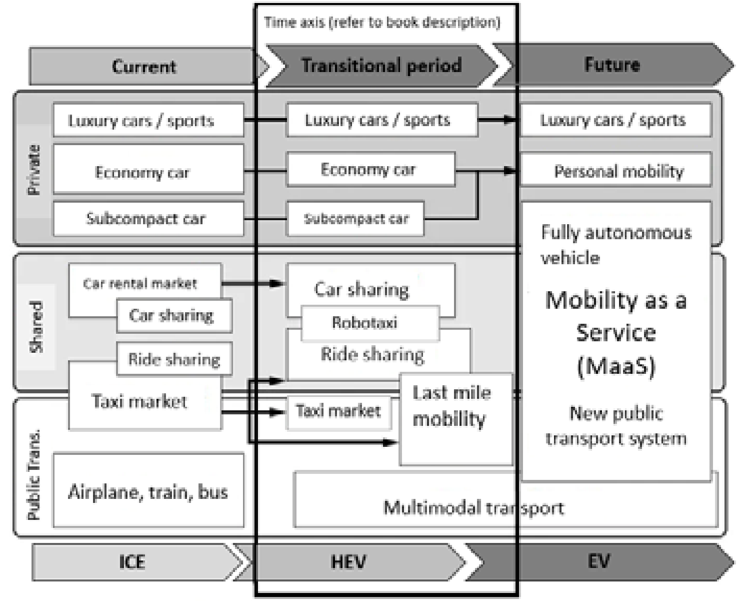
Transport: CASE

Connected; Service & Shared



Autonomous; Electric

The operation ratio of automobiles is about 5%. The large room for improvement exists by the achievement of fully autonomous cars.



Source: Nakanishi Research Institute, Co., Ltd.
"Future map of the automobile industry and mobility"

EV "e-Palette" only for Autono-MaaS

Source) Toyota

Changing the shape of cars

Possibility of integration of cars and near distance airplane

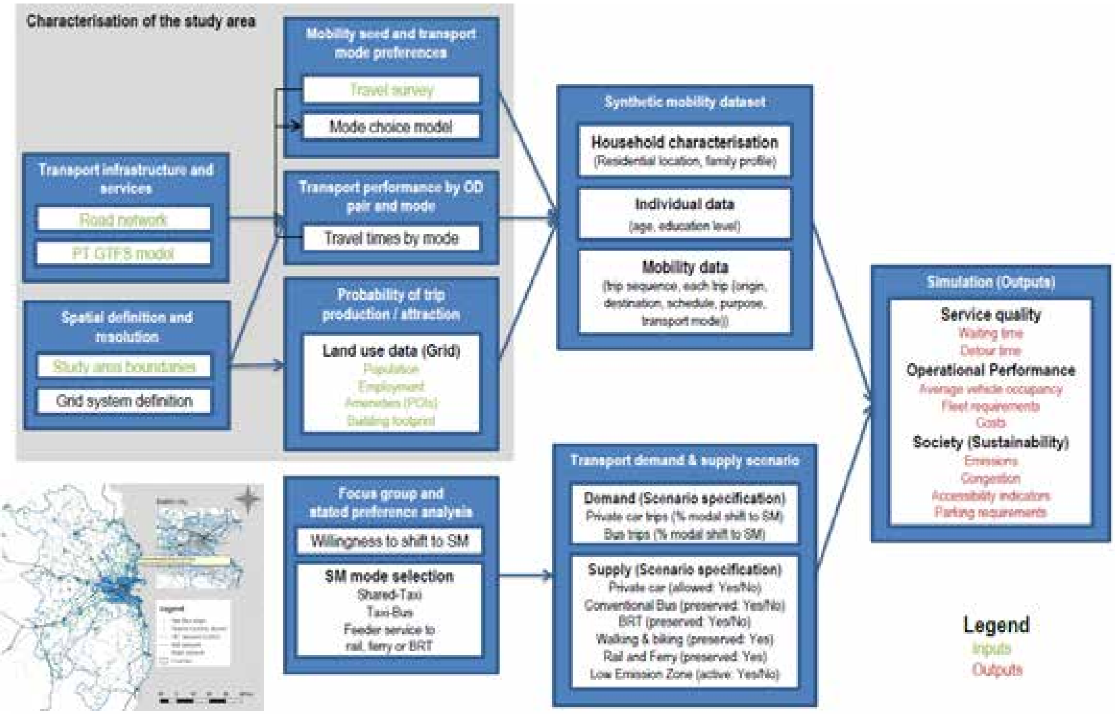
The sharing may reduce the number of cars and the consumption of materials, and change the form of cities.

Source) Airbus, Audi

Source) Nissan

Source) Jari Kauppila, ALPS International Symposium (2019)

Estimated Number of Vehicles in Sharing Car Systems: Dublin



- Build a model based on actual data (population distribution, road/public transport network, weekday trip demand (time zone, OD), trip preferences, etc.)
- In the case of Dublin, Ireland, replacing all private cars with shared cars enables to supply the current mobility with just under 2% of the number of cars.
- Replacing 20% of private cars (even without EV) reduces CO_2 emissions to ▲ 22%

Source) OECD/ITF, Shared Mobility Simulations for Dublin (2018)

Scenario			Simulation results: changes relative to Baseline [%]					
#	Bus	Car	Passenger-km	Vehicle-km	CO_2 emissions	Congestion	Travel time	Equivalent private car vehicles
1	100% Replacement	100% of trips replaced	+51	▲38	▲31	▲37	+72	▲98
2	Keep		+32	▲42	▲31	▲43	+134	▲99
4	100% Replacement	20% of trips replaced	+16	▲23	▲22	▲7	+6	▲18
6	Keep trips where Bus with headway < 5min		+13	▲25	▲23	▲9	+6	▲18

Other Impacts of Technological and Behavior Changes on Several Sectors (Examples)

[Food]

- About 30% of GHG emission (even more depending on boundaries) comes from the food system. Also, food wastes and losses are about one-third of total production globally.
- More accurate food demand forecast through AI/ICT could lead to a decrease in food wastes and losses and energy consumption, and GHG emission accordingly.
- Consequently, reducing plastic containers, store spaces in supermarkets, energy for refrigerators/freezers and transport energy could be triggered.

[Apparel]

- About 50% of clothes are unused.
- Preference changes, especially among young generations, e.g. wearing suits is not widespread among young people, and progress of E-commerce, e.g. anything is available without traveling.
- Just-in-time system using AI/ICT, enabling accurate demand forecast and not dependent on mass production.
- Large spaces for display and considerable energy for construction and air conditioning are necessary for extensive commercial facilities; however, it is possible to reduce them.

[3D printing]

- 3D printers (Additive Manufacturing: AM) are evolving.
- Compared to injection molding, it is possible to create a complicated shape and a light product with the same strength in many cases.
- It enables small batch custom manufacturing instead of mass production and avoids mass production and mass disposal.

Rebound Effects on Energy Consumptions through Digitalization (Literature Reviews)

Sector	Estimate d energy consumption; [Representative number]
E-publication	-90% to +3000%; **[-70%]**
E-news	-1400% to +550%; **[-70%]**
E-business	-91% to +179%; (Insufficient evidence)
E-music	-87% to +235%; **[-60%]**
E-videos and e-games	-70% to +450%; **[0%]**
Teleworking	-15% to -0.01%
Vehicle distance travelled	-20% to +3.9%
Person distance travelled	-19% to -11.9%

Source) Court et al., "Digitalization of goods: a systematic review of the determinants and magnitude of the impacts on energy consumption", Environmental Research Letters (2020); Hook et al., "A systematic review of the energy and climate impacts of teleworking", Environmental Research Letters (2020)

- **There can be several kinds of rebound effects on energy consumptions.**
- **Basically, reductions in energy consumptions due to improvements in digitalization technologies are estimated.**
- **However, the estimated energy consumptions vary widely according to the boundaries of rebound effects, etc.**