

Digital and Distributed Technologies in Clean Energy Transitions



Charlie Wilson

March 2020

Second International Forum:
Long-Term Energy Scenarios for the Clean Energy Transition

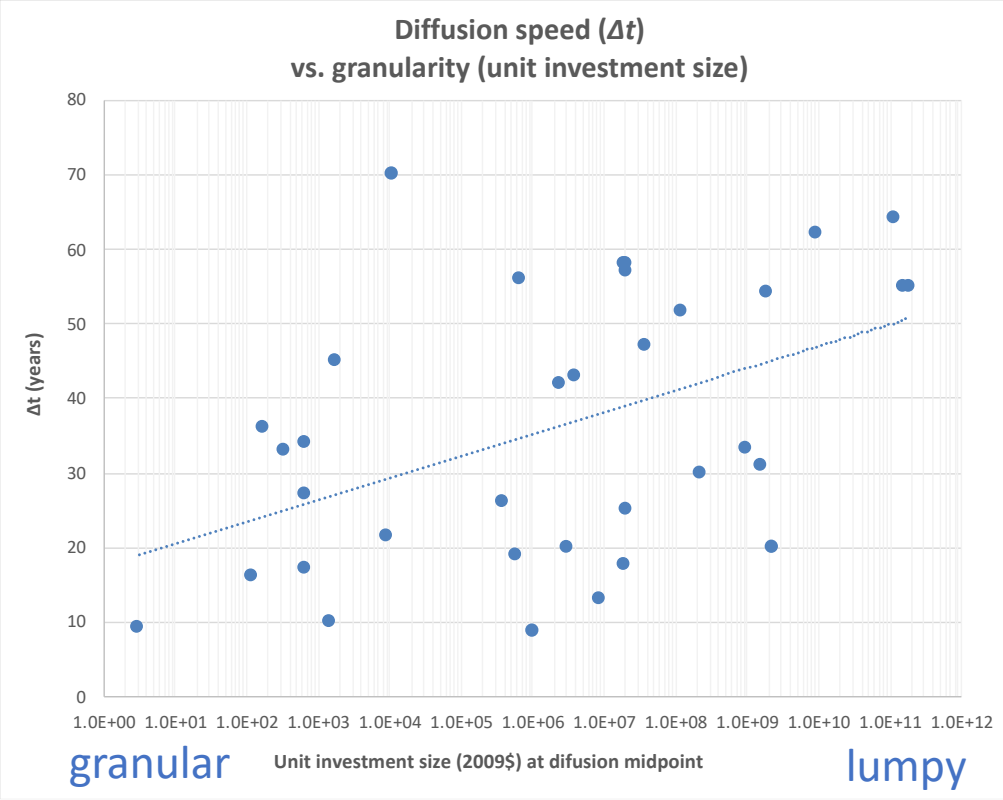
IIASA International Institute for Applied Systems Analysis

Tyndall Centre for Climate Change Research

SILCI Social Influence and *disruptive* Low Carbon Innovations

ERC Grant #678799 silci.org

How does the **uptake of new digital and decentralised technologies** impact LTES from the **demand-side perspective**?



More 'granular' decentralised energy technologies …

… diffuse faster

… have lower investment risk

… improve (learn) faster

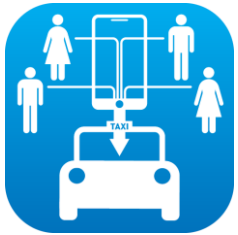
… turnover more rapidly

… create more jobs

… are more widely accessible


car-share


ride-share



shared ride-hailing

MaaS


AVs

bike-share


virtual meetings


smart heating


smart lighting


HEMS

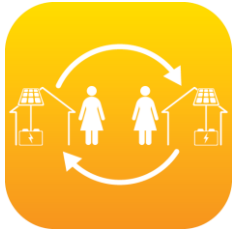

heat pumps


pre-fab retrofits


P2P goods


disaggregated feedback


PV + storage


P2P electricity


vehicle-to-grid

time-of-use pricing


demand response

ESCOs

third-party financing

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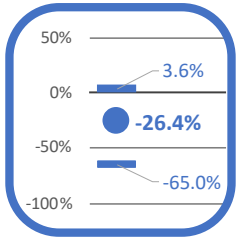
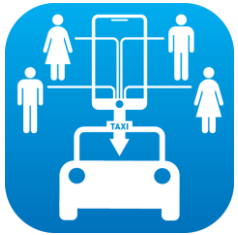


car-share

ride-share



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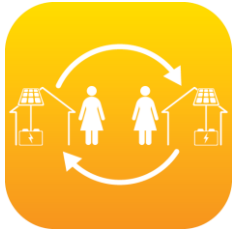

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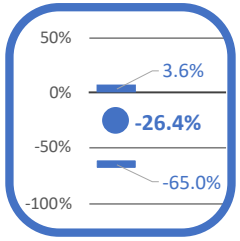

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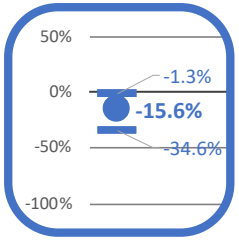
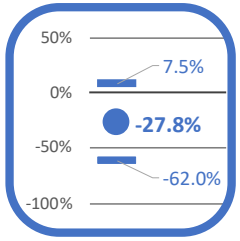


ride-share



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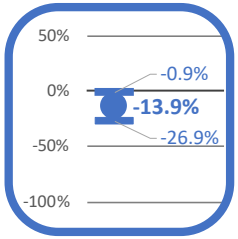

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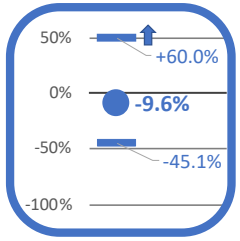
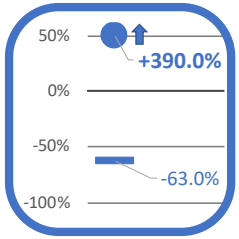
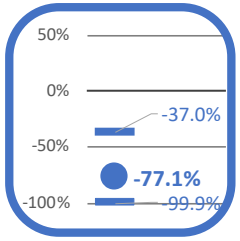


AVs



bike-share



virtual meetings

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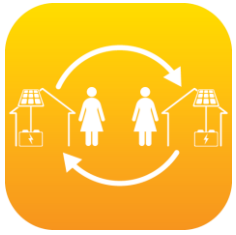
PV + storage



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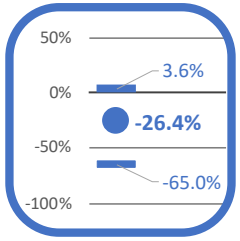

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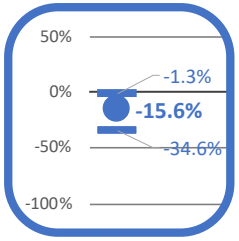

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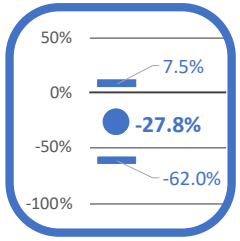

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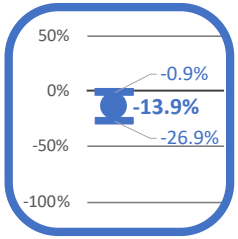

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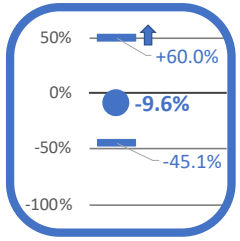

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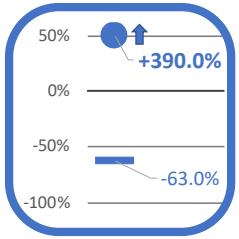

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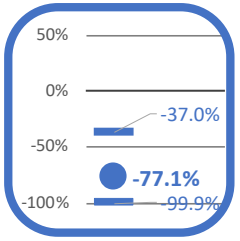

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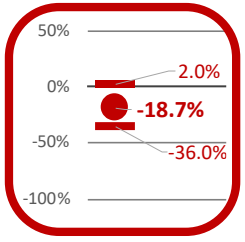
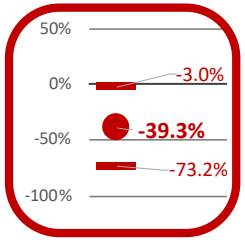


smart heating



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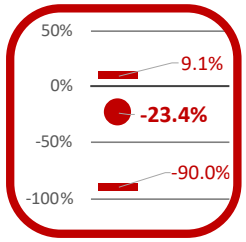
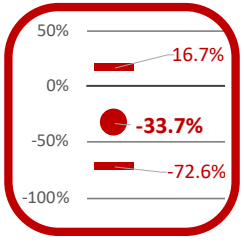
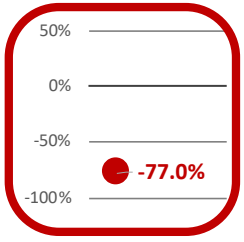


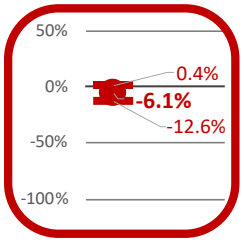
HEMS



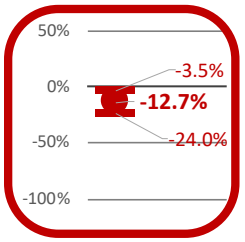
heat pumps



pre-fab retrofits

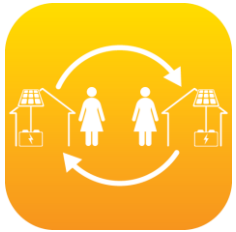


P2P goods



disaggregated feedback

PV + storage



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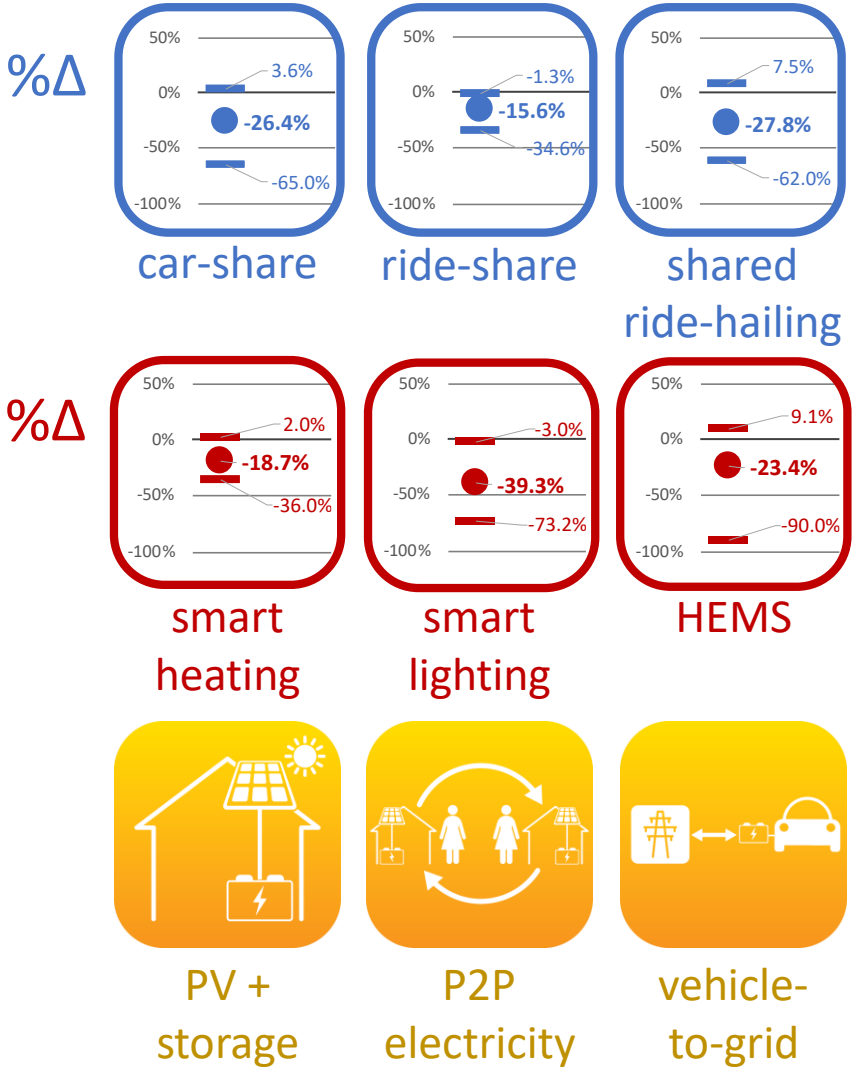


Change (Δ) in energy or emissions can be direct, indirect, embodied and induced

substitution effects (e.g., bike-share)
induced demand (e.g., AVs)

indirect + embodied emissions
upstream in digital infrastructure

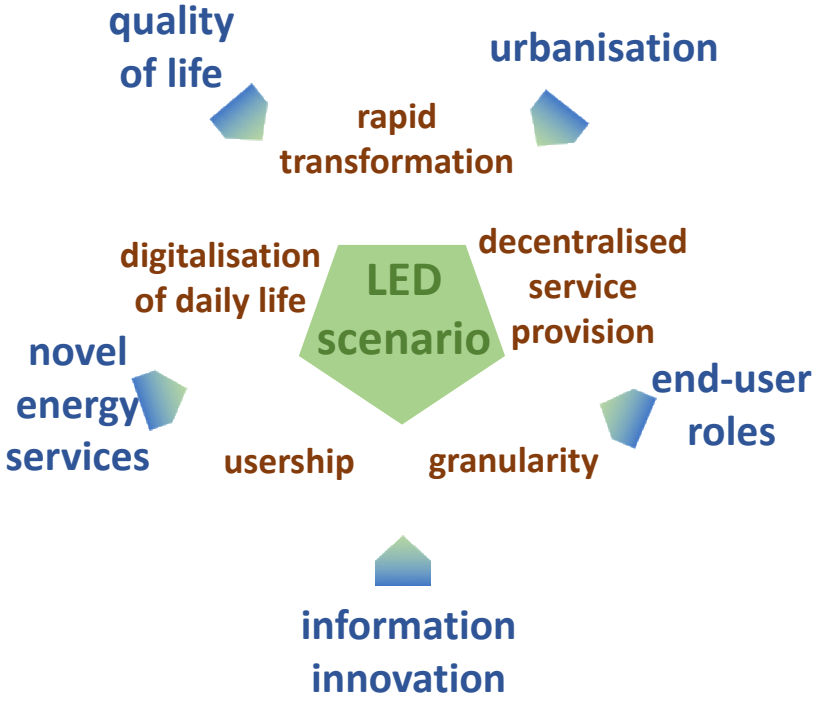
* *policy for 'steering' digitalisation* *

Hittinger & Jaramillo (2019). *Science* 364: 326–328.
Masanet et al. (2020). *Science* 367: 984-986.

What **tools, methods and approaches** need to be developed to help represent **consumer behaviour** in **model-based LTES**?

digitalisation & decentralisation of energy demand:

the ‘LED’ scenario of future change to 2050



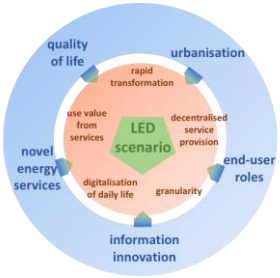
Grubler, Wilson et al. (2018). *Nature Energy* 3: 515-527.

scenario narrative

quantification of energy services *and* energy intensity (decomposition analysis)

drivers of change

downstream … then upstream



thermal comfort → commercial buildings

consumer goods → industry & manufacturing

mobility → freight transport

food → freight transport

Grubler, Wilson et al. (2018). *Nature Energy* 3: 515-527.

scenario narrative

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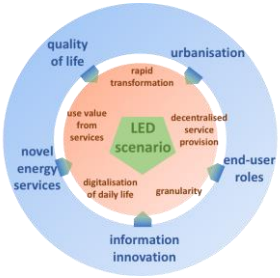

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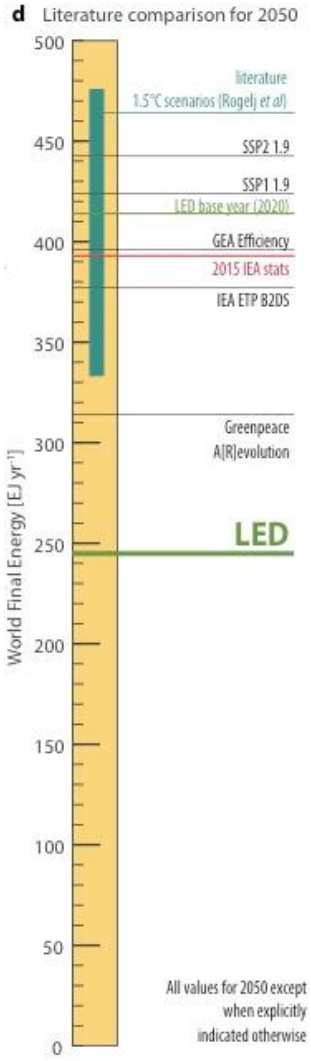


global energy demand reduces by 40% to 2050

Grubler, Wilson et al. (2018). *Nature Energy* 3: 515-527.

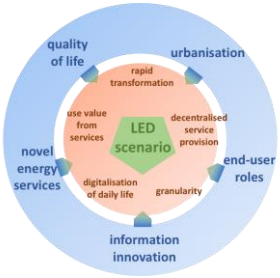
scenario narrative → quantification of energy services *and* energy intensity (decomposition analysis) → integrated modelling of system consequences

drivers of change

downstream … then upstream

energy supply & land-use

climate & health



thermal comfort → commercial buildings

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food

MESSAGE (energy-system model)

GAINS (air pollution)

MAGICC (climate)

GLOBIOM (land-use model)

1.5°C global warming + strong co-benefits for SDGs

Grubler, Wilson et al. (2018). *Nature Energy* 3: 515-527.

How does the **uptake of new digital and decentralised technologies** impact LTES from the **demand-side perspective**?

1. Decentralised technologies are essential for accelerated decarbonisation
2. Digitalisation of consumer goods and services can also help
3. (… but) Demand can go up as well as down

What **tools, methods and approaches** need to be developed to help represent **consumer behaviour** in **model-based LTES**?

1. A scenario narrative can explore a very wide possibility space … use it!
2. Systems models may not be designed to analyse decentralised, digital demand
3. Off-model analysis of demand can be coupled with supply-side optimisation



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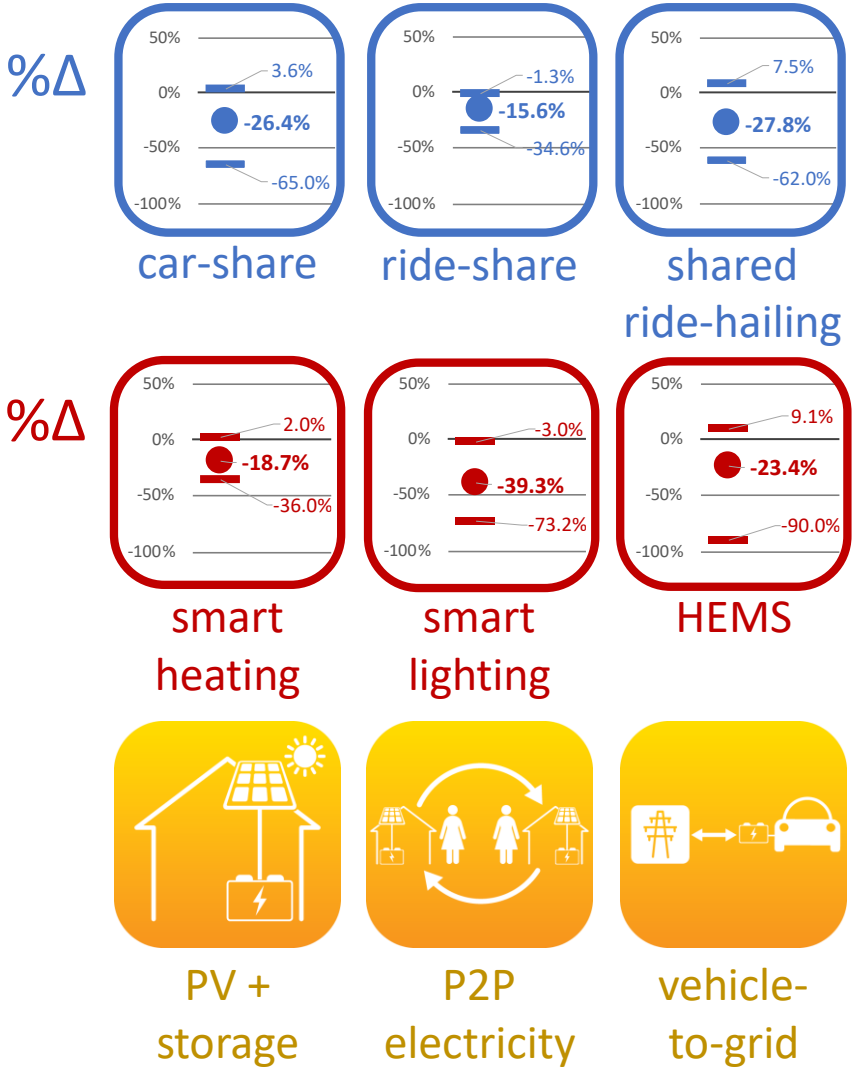
extra slides



Digitalised and decentralised demand: *common themes*

platforms of **exchange**
from atomised to **networked**
blurring **boundaries** (private-public)

control by or for users
customisation & choice **flexibility**
'**usership**' not ownership

transforming energy services requires **concerted action**, strategies, and policies

pervasive **electrification of energy end-use** (e.g. EVs, heat pumps)

convergence on **multi-functional** devices or business models

consumption shift from ownership of goods to **accessing services**

increase **utilisation rate** of goods, infrastructure, vehicles

push homes, appliances & transport modes to the **efficiency frontier**

user-oriented innovation to deliver new appealing energy services