Disruptive consumer innovations for transforming energy services

Dr Charlie Wilson
RITE-IIASA workshop ‘Rethinking EnergyDemand’
Nara, September 2018
Conventional wisdom for meeting the 1.5°C target says ...

**Overshoot** as energy supply technologies scale slowly, but need massive long-term deployment to meet high levels of energy demand.

**Inertia** in policy & technological systems

**Negative emission technologies**

IPCC Special Report on Limiting Global Warming to 1.5°C
Is the conventional wisdom for meeting the 1.5°C target right?

**Overshoot** as energy supply technologies scale slowly, but need massive long-term deployment to meet high levels of energy demand.

**Inertia** in policy & technological systems.

**Negative emission technologies**

**Rapid Transformation** in energy services and efficiency, with rising activity levels.

**Distributed energy supply** scales rapidly in a down-sized energy system.

'Low Energy Demand' (LED) scenario.


emergence of novelty?

energy service transformation?

Sources:

a Wilson & Grubler (2014)
b EC (2017)
c Kramer & Haigh (2009)
d Bento & Wilson (2016)
Disruptive innovations offer novel attributes to end users ... and can rapidly change markets

_Sustaining innovations_ -> improve currently valued attributes

power - speed -
storage -
low cost per MB -

portability -
versatility -
accessibility (coding) -
low cost per unit -

_Disruptive innovations_ -> offer novel attributes, create new value
Is disruptive innovation relevant for low-carbon transitions?

potentially **disruptive** consumer innovations

e-bikes 'taxi-bus' ride-share car-share bike-share MaaS VR & tele-presence
potentially *disruptive* consumer innovations

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- VR & tele-presence

- P2P goods
- P2P homes
- internet of things
- smart appliances
- pre-fab retrofits
- smart homes
- heat pumps
potentially **disruptive** consumer innovations

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- VR & tele-presence

- P2P goods
- P2P homes
- internet of things
- smart appliances
- pre-fab retrofits
- smart homes
- heat pumps

- PV + storage
- P2P electricity
- vehicle-to-grid
- disaggregation
- feedback
- time-of-use pricing
- demand response
- energy service co.s
(1) From ownership to **usership**
(2) sharing economy (inc. peer-to-peer, P2P)

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- VR & telepresence
- P2P goods
- P2P homes
- internet of things
- smart appliances
- pre-fab retrofits
- smart homes
- heat pumps
- PV + storage
- P2P electricity
- vehicle-to-grid
- disagg. feedback
- time-of-use pricing
- demand response
- energy service co.s
(3) from atomised to **connected** (relational)

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- VR & tele-presence

- P2P goods
- P2P homes
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- smart appliances
- pre-fab retrofits
- smart homes
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- PV + storage
- P2P electricity
- vehicle-to-grid
- disagg. feedback
- time-of-use pricing
- demand response
- energy service co.s
currently **commercial** - and growing rapidly

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- VR & tele-presence

- P2P goods
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- PV + storage
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- disagg. feedback
- time-of-use pricing
- demand response
- energy service co.s
included in **LED scenario** (1st order estimations)

- e-bikes
- ‘taxi-bus’
- ride-share
- car-share
- bike-share
- MaaS
- telepresence

- P2P goods
- P2P homes
- internet of things
- smart appliances
- pre-fab retrofits
- smart homes
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- PV + storage
- P2P electricity
- vehicle-to-grid
- disagg. feedback
- time-of-use pricing
- demand response
- energy service co.s
<table>
<thead>
<tr>
<th>Technology Lifecycle</th>
<th>Basic Research</th>
<th>Applied Development</th>
<th>Demonstration</th>
<th>Market Formation</th>
<th>Rapid Diffusion</th>
<th>Exponential</th>
<th>Maturity Materiality</th>
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<td>1.5°C Mitigation Options in Global IAMs</td>
<td>bioCCS</td>
<td>fossilCCS</td>
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<td>public transport</td>
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<td>Consumer-facing Low-carbon Innovations</td>
<td>mobility-as-a-service</td>
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<td>EVs &amp; vehicle-to-grid</td>
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<td>smart home technology</td>
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<td>pre-fab low-energy retrofits</td>
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<td>Sources:</td>
<td>Wilson &amp; Grubler (2014)</td>
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Low Energy Demand (LED) scenario: standards, service efficiency, service transformation, granularity ...

Low Energy Demand (LED) scenario

Rapid Transformation in energy services and efficiency, with rising activity levels

Distributed energy supply scales rapidly in a down-sized energy system

'Low Energy Demand' (LED) scenario
Is the conventional wisdom for meeting the 1.5°C target right? ... no! ... (or not always!)

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

Arnulf Grubler 1,2,10, Charlie Wilson 1 10, Nuno Bento 1,2, Benigna Baz-Kiss 3,5, Velker Krey 4, David L. McCollum 1,6, Nara Simha D. Rao 6, Keywan Rish 6, Joeri Rogelj 5, Simon De Stercke 5,10, Jonathan Cullen 1,6, Stefan Frank 1,6, Oliver Fricko 1,6, Fei Guo 1, Robert Schiemenz 6, Peter Havlík 4, Daniel Husmann 6, Georg Kiese 10, Peter Raff 10, Wolfgang Scheep 10 and Hugo Vail 10

Scenario 1: The Low Energy Demand (LED) scenario

The purpose of the global energy system is to provide useful services to end users. This can determine the size of the energy system and the challenges of mitigating climate change. Low energy demand can be an even greater barrier to emissions reductions on the supply side of the energy system. Global emissions trends currently focus on a supply-side approach. The conventional wisdom is to focus on a specific supply-side solution, such as nuclear power or renewable energy. This paper describes an integrated assessment model that assesses the potential of a low-energy demand scenario.

Scenario narrative of low energy demand

Our scenario narrative is called the LED scenario. The LED scenario narrative has four main drivers of change: changes in energy use; a new quality strategy; the development of new energy systems, such as electric vehicles and energy-efficient buildings; and the development of new energy services (e.g., heating, cooling, and water). These drivers are observed in the context of the LED scenario, which shows that a transition to a low-energy demand system is possible and necessary.

Distributed energy supply scales rapidly in a down-sized energy system
Disruptive consumer innovations for transforming energy services

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Nara, September 2018
**mobility**

**service efficiency**

e.g., increase vehicle occupancy

**conversion efficiency**

e.g., improve fuel efficiency
mobility

service efficiency
e.g., increase vehicle occupancy

conversion efficiency
e.g., improve fuel efficiency

- technological innovation
- social or institutional innovation
- organisational or business model innovation
- behavioural innovation

- technological innovation (mainly)
consumer goods

service efficiency
e.g., device convergence

cconversion efficiency
e.g., improve device efficiency

5 Watt = 2.2 Watt

Power consumption

449 Watt

72 Watt Stand-by

ENERGY STAR
consumer goods

service efficiency
e.g., device convergence

technological innovation
social or institutional innovation
organisational or business model innovation
behavioural innovation

conversion efficiency
e.g., improve device efficiency

technological innovation (mainly)
heating & cooling buildings

service efficiency
e.g., diversify use to increase occupancy

conversion efficiency
e.g., improve energy efficiency
heating & cooling buildings

service efficiency
e.g., diversify use to increase occupancy

conversion efficiency
e.g., improve energy efficiency

--

technological innovation

social or institutional innovation

organisational or business model innovation

behavioural innovation

Ask WeWork what makes it so special and they will say it is about so much more than office space. It is about the “We Generation” – a largely Millennial workforce who demand more from their work than just a job ... they value experiences over material goods, crave a sense of community and fulfilment, and want to be part of something greater than themselves. [WIRED, Jun 2018]
Examples of potentially disruptive innovations to mobility: alternatives to car ownership

*Sustaining innovations* -> improve currently valued attributes

*based on ownership*
  - upfront cost
  - in-car ‘features’
  - status signalling

Disruptive innovations -> offer novel attributes, create new value

*based on ‘usership’*
  - care-free
  - relational
  - choice variety
‘Most disruptive’ and ‘lowest C’ innovations: novel attributes valued by end users?

<table>
<thead>
<tr>
<th>novel attributes?</th>
<th>mobility</th>
<th>cities &amp; housing</th>
<th>food &amp; agriculture</th>
<th>energy supply &amp; distribution</th>
</tr>
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<tbody>
<tr>
<td>pay per use</td>
<td>electric vehicles</td>
<td>net zero-energy building design</td>
<td>reduced meat diet</td>
<td>large-scale electricity storage</td>
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<td>service-based</td>
<td>mobility-as-a-service</td>
<td>internet-of-things</td>
<td>vertical farming</td>
<td>solar PV</td>
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<td>multiple uses</td>
<td>car-sharing</td>
<td>building energy management systems</td>
<td>greenhouses + LED lighting</td>
<td>smart grids</td>
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<td>choice variety</td>
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<td>relational</td>
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<td>ease of use</td>
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<td>control, autonomy</td>
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<td>active involvement</td>
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<td>clean at point of use</td>
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Conclusions: disruptive low C innovations can engage (or even potentially excite) consumers

**Disruptive innovations** offer **novel attributes** valued by consumers  
(a missing constituency of low C transformation)

Disruptive innovations are primarily about **business models and users**  
(not radical technological breakthroughs)

Novel attributes of potentially disruptive low C innovations in different domains include:

- **pay-per-use** *(rather than ownership)*
- **multiple uses & functionality** *(rather than single purpose)*
- **relational & active involvement** *(rather than isolation & passivity)*
- **control & autonomy** *(rather than dependence on systems)*

**Digitalisation of daily life** enables many of these novel attributes
## Potential emission reductions from ‘scaling up’ innovations out of current early-adopting niches

<table>
<thead>
<tr>
<th></th>
<th>Potential emission reductions (MtCO₂e p.a.) at population level</th>
<th>... as % of sectoral emissions</th>
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<tbody>
<tr>
<td><strong>mobility</strong></td>
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<tr>
<td>car-sharing</td>
<td>0.8 - 0.9</td>
<td>1%</td>
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<tr>
<td>e-bikes</td>
<td>0.04 - 0.08</td>
<td>0.1%</td>
</tr>
<tr>
<td>e-bike sharing</td>
<td>0.09</td>
<td>0.1%</td>
</tr>
<tr>
<td>mobility-as-a-service (MaaS)</td>
<td>1.4</td>
<td>1.5%</td>
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<tr>
<td><strong>food</strong></td>
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<tr>
<td>cultured meat</td>
<td>0.02</td>
<td>0.05%</td>
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<tr>
<td>food waste reduction</td>
<td>2.6 - 3.6</td>
<td>5 - 7%</td>
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<tr>
<td>urban farming</td>
<td>2.1</td>
<td>4%</td>
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<tr>
<td>reduced meat in diet</td>
<td>0.7</td>
<td>1.5%</td>
</tr>
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</table>
Next steps: **systems modelling** of emission reductions from consumer-facing innovations

MtCO$_2$ estimates depend on:

- robust *evidence of behaviour changed* (and emissions reduced) as a result of adopting and using the innovation

- understanding *adopter heterogeneity* (segmentation)

- characterising a *dynamic counterfactual* (baseline)
  - especially welfare-enhancing access to *new goods and services* (‘bottom-of-the-pyramid’ consumers, macroeconomic rebound)

--> **systems modelling** possible, but requires much more evidence