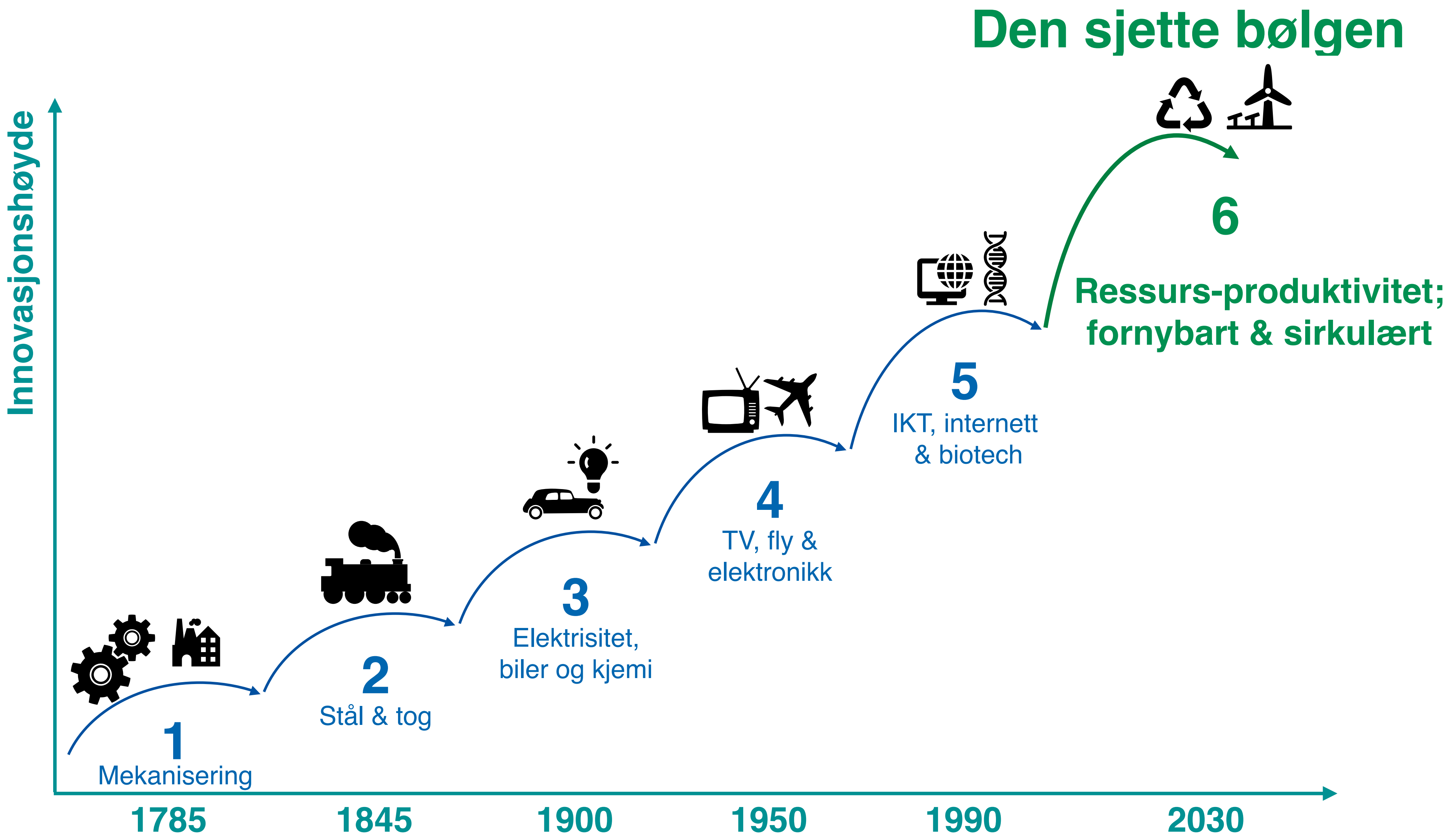
BI Centre for Sustainability & Energy

21 Radikal Innovasjoner

som vil snu opp-ned på verden

Per Espen Stoknes, twitter / insta: @estoknes



Source: Weizacker, 2009, *Factor Five*, p. 13, The Natural Edge Project,
Stoknes (2020) Grønn vekst

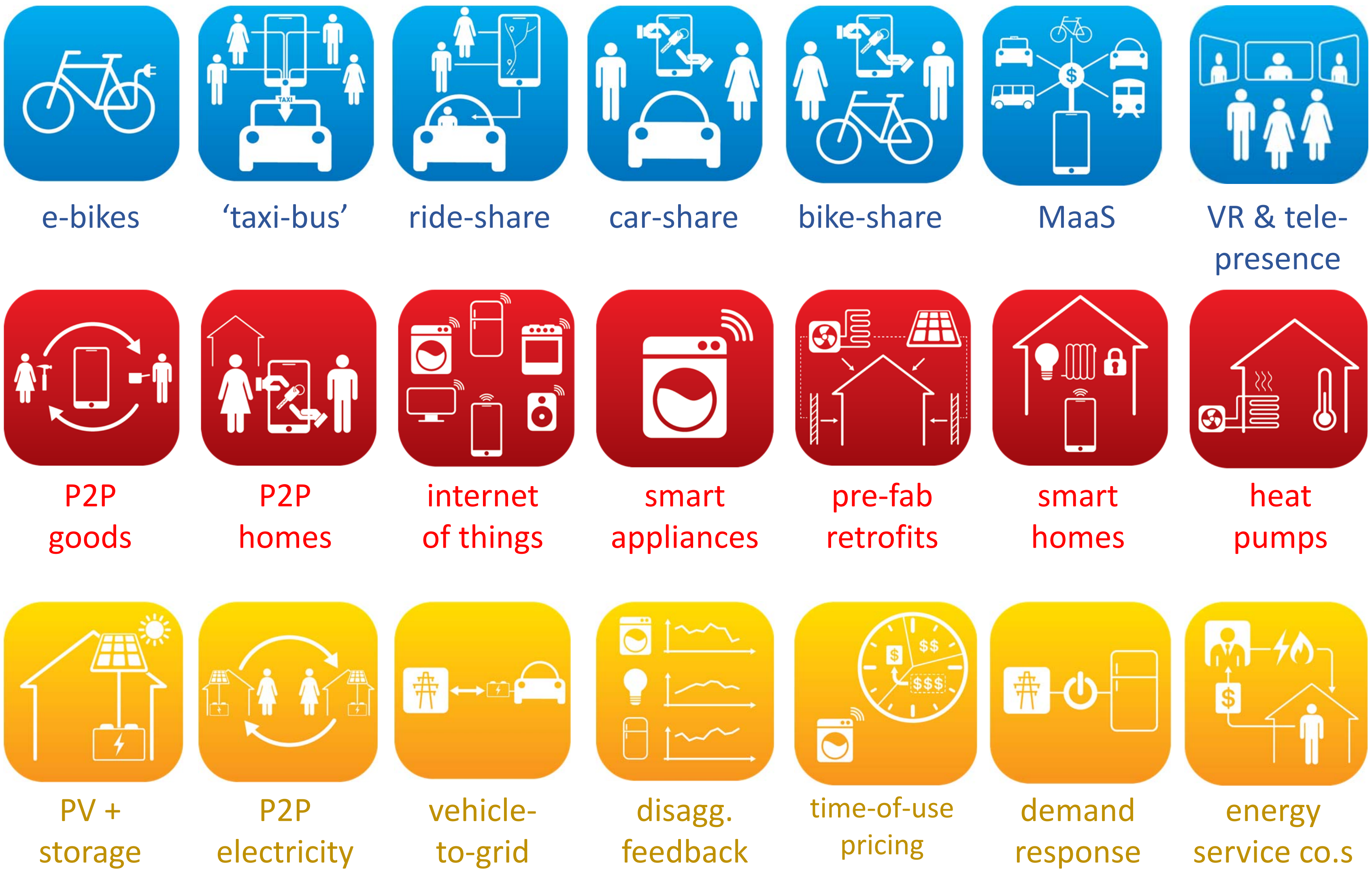
Helhetlige innovasjoner fremmer system-endring

- **Inkrementelle** (lineær tenking):
  - "A few % better here & there"
  - Cutting costs
  - Thinking 'outside the box', but within the rules

- **Radikale innovasjoner** (holistisk tenking)
  - Combine components in new ways
  - Eliminate the problem? Change rules?
  - *Change the resource-production-consumption-waste-systems to achieve multiple benefits for people and nature*

Source:, Stuchtey (2016), kap 13, Weizacker, 2009, *Factor Five*, p. 34+

Potensielt disruptive sluttbruker innovasjoner



Sources: :Charlie Wilson (nov. 2018) at IEA, "Transforming energy demand"

‘granular’

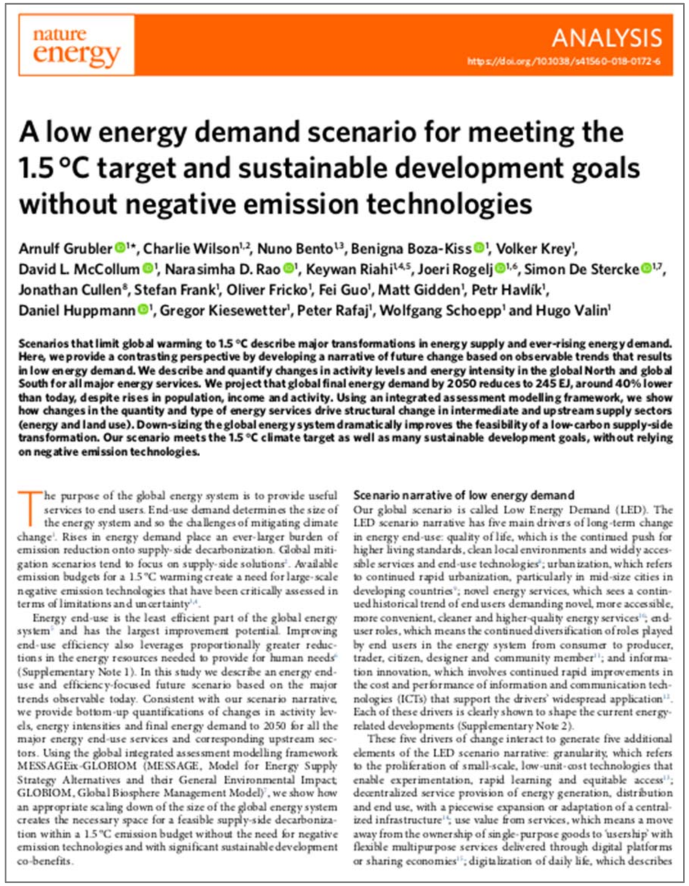
small unit size
low unit cost
modular
replication

‘lumpy’

large unit size
high unit cost
indivisible
up-scaling

Low Energy Demand (LED) scenario:

disruptive consumer innovation, granularity, energy-service transformation + *standards*



nature energy

ANALYSIS

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

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Scenarios that limit global warming to 1.5 °C describe major transformations in energy supply and ever-rising energy demand. Here, we provide a contrasting perspective by developing a narrative of future change based on observable trends that results in low energy demand. We describe and quantify changes in activity levels and energy intensity in the global North and global South for all major energy services. We project that global final energy demand by 2050 reduces to 245 EJ, around 40% lower than today, despite rises in population, income and activity. Using an integrated assessment modelling framework, we show how changes in the quantity and type of energy services drive structural change in intermediate and upstream supply sectors (energy and land use). Down-sizing the global energy system dramatically improves the feasibility of a low-carbon supply-side transformation. Our scenario meets the 1.5 °C climate target as well as many sustainable development goals, without relying on negative emission technologies.

The purpose of the global energy system is to provide useful services to end users. End-use demand determines the size of the energy system and so the challenges of mitigating climate change[1]. Rises in energy demand place an ever-larger burden of emission reduction onto supply-side decarbonization. Global mitigation scenarios tend to focus on supply-side solutions[2]. Available emission budgets for a 1.5 °C warming create a need for large-scale negative emission technologies that have been critically assessed in terms of limitations and uncertainty[3,4].

Energy end-use is the least efficient part of the global energy system[5] and has the largest improvement potential. Improving end-use efficiency also leverages proportionally greater reductions in the energy resources needed to provide for human needs[6] (Supplementary Note 1). In this study we describe an energy end-use and efficiency-focused future scenario based on the major trends observable today. Consistent with our scenario narrative, we provide bottom-up quantifications of changes in activity levels, energy intensities and final energy demand to 2050 for all the major energy end-use services and corresponding upstream sectors. Using the global integrated assessment modelling framework MESSAGEix-GLOBIOM (MESSAGE, Model for Energy Supply Strategy Alternatives and their General Environmental Impact; GLOBIOM, Global Biosphere Management Model)[7], we show how an appropriate scaling down of the size of the global energy system creates 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.

Scenario narrative of low energy demand

Our global scenario is called Low Energy Demand (LED). The LED scenario narrative has five main drivers of long-term change in energy end-use: quality of life, which is the continued push for higher living standards, clean local environments and widely accessible services and end-use technologies[8]; urbanization, which refers to continued rapid urbanization, particularly in mid-size cities in developing countries[9]; novel energy services, which sees a continued historical trend of end users demanding novel, more accessible, more convenient, cleaner and higher-quality energy services[10]; end-user roles, which means the continued diversification of roles played by end users in the energy system from consumer to producer, trader, citizen, designer and community member[11]; and information innovation, which involves continued rapid improvements in the cost and performance of information and communication technologies (ICTs) that support the drivers' widespread application[12]. Each of these drivers is clearly shown to shape the current energy-related developments (Supplementary Note 2).

These five drivers of change interact to generate five additional elements of the LED scenario narrative: granularity, which refers to the proliferation of small-scale, low-unit-cost technologies that enable experimentation, rapid learning and equitable access[13]; decentralized service provision of energy generation, distribution and end use, with a piecewise expansion or adaptation of a centralized infrastructure[14]; use value from services, which means a move away from the ownership of single-purpose goods to 'usership' with flexible multipurpose services delivered through digital platforms or sharing economies[15]; digitalization of daily life, which describes

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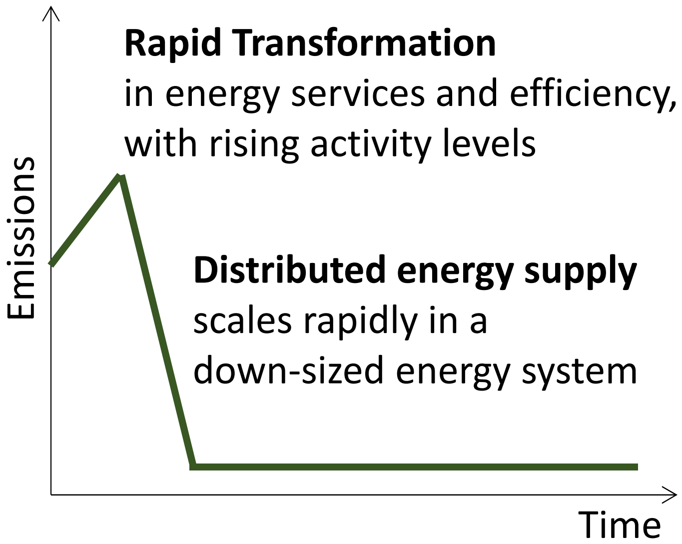
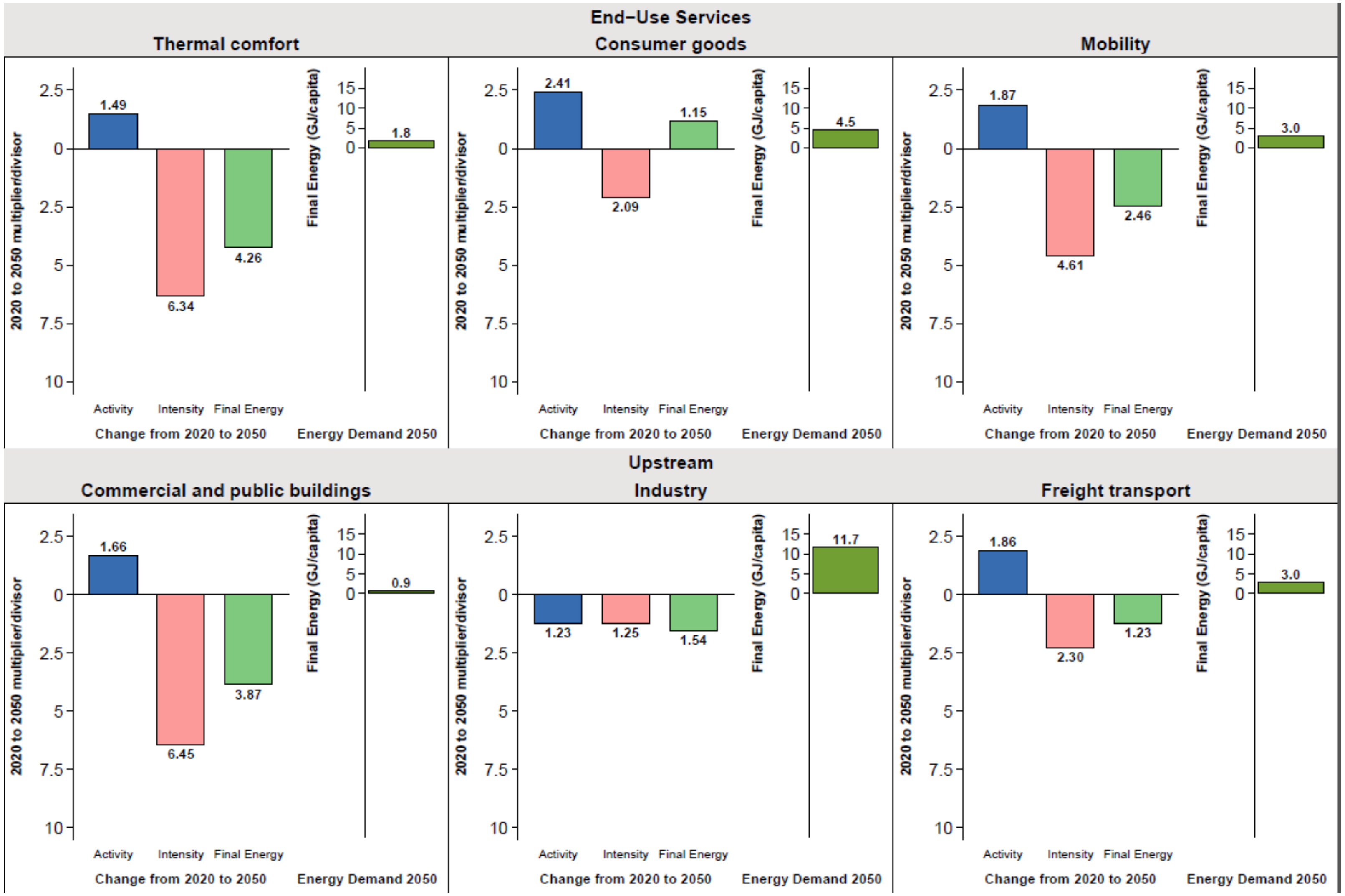


The Low-Energy-Demand scenario to 1.5C

By 2050, *more services* are provided with *less energy* … with *knock-on effects upstream*

Grønn Vekst



The Low-Energy-Demand scenario to 1.5C

Diffusjon fra tidligere bølger tok mange ti-år; raskere nå!?

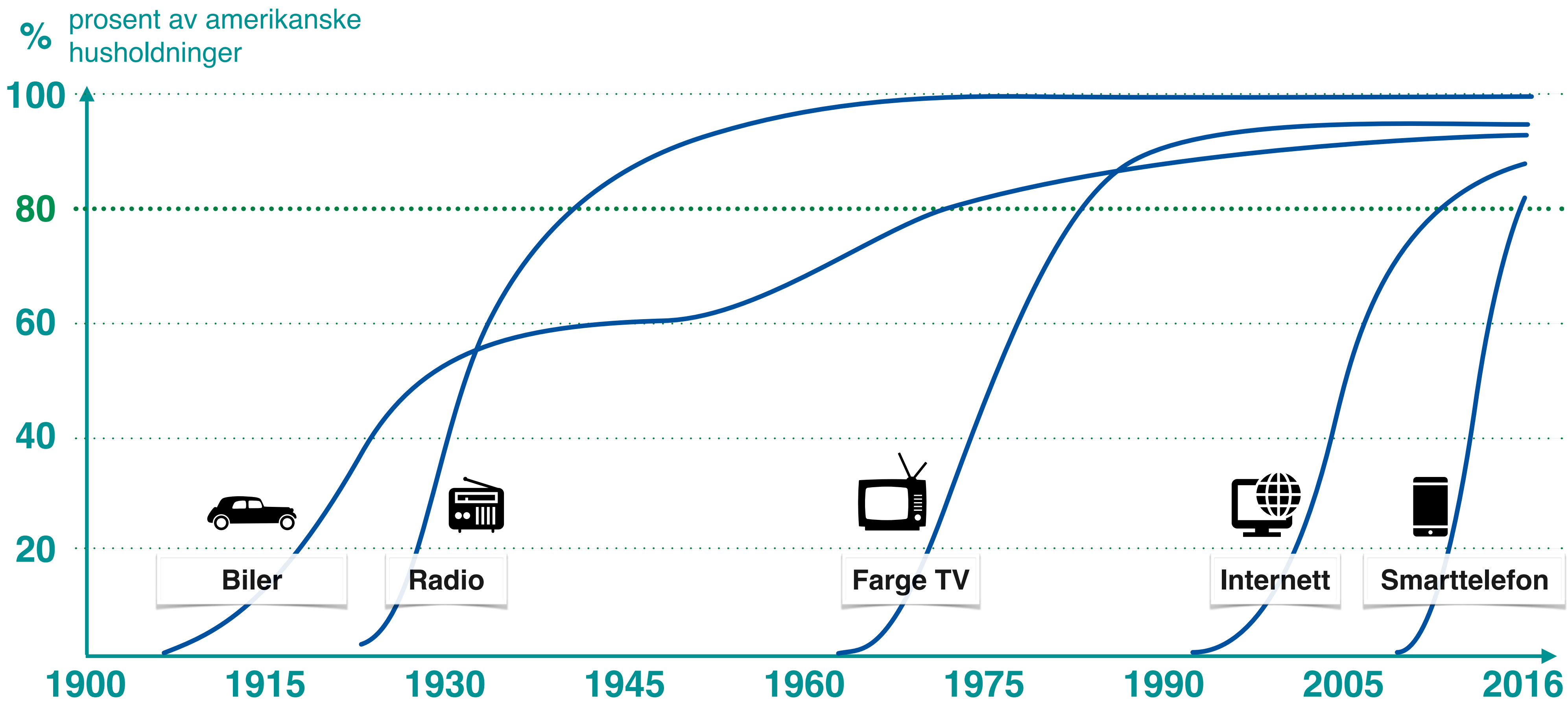
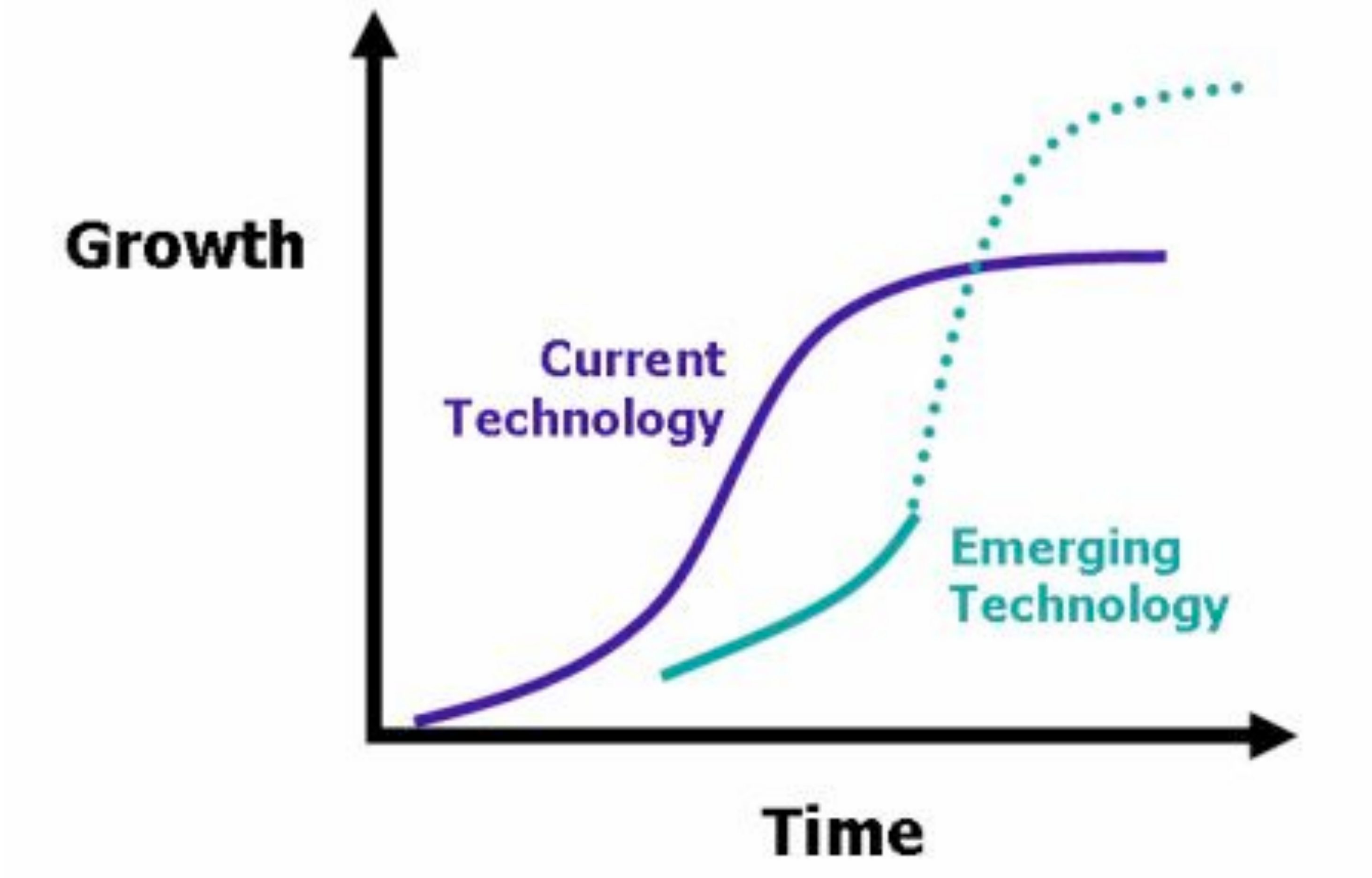


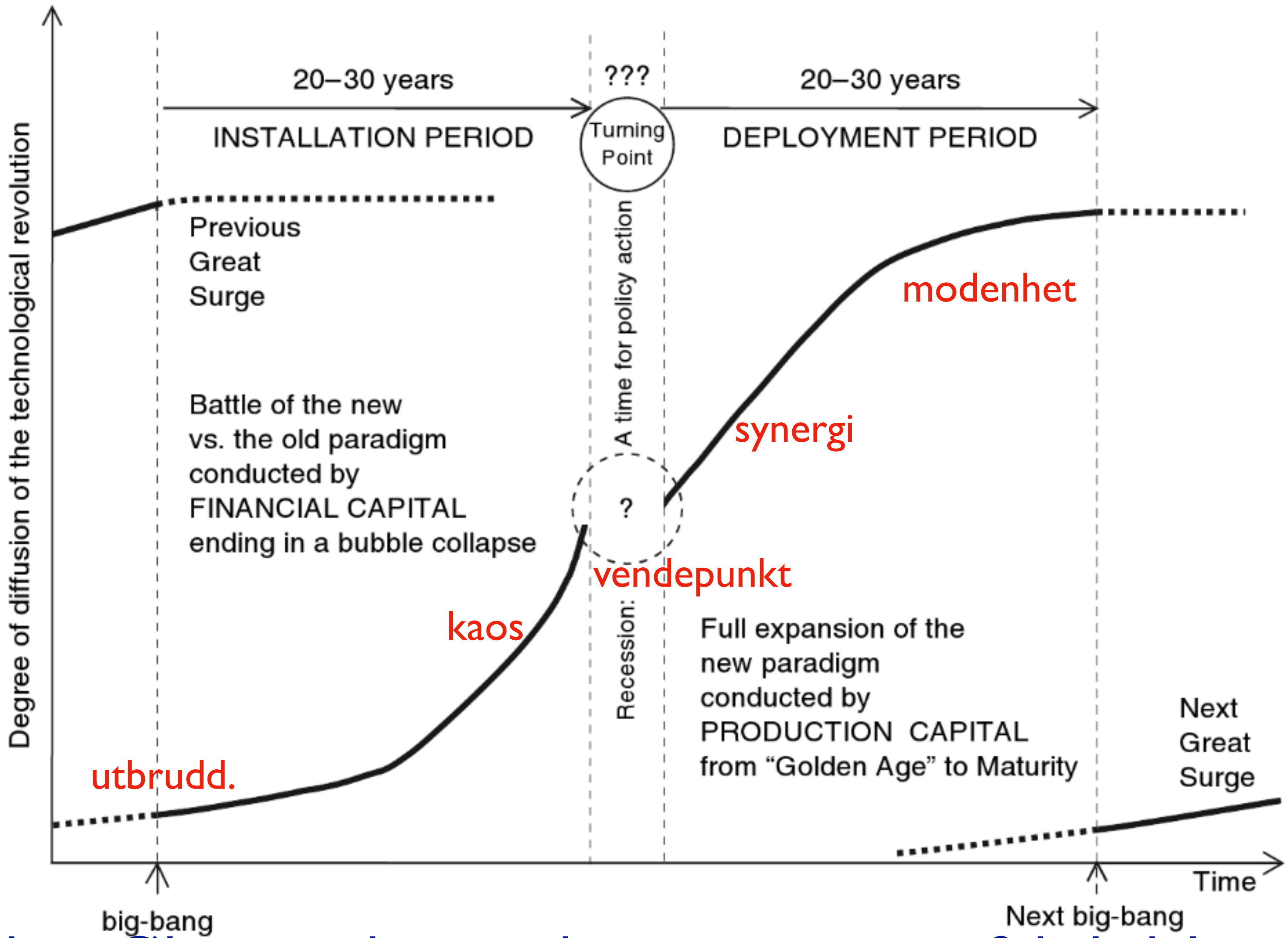
Figure 3.1

Diffusjon kritisk:
Hvor raskt kan grønne innovasjoner vokse?



Classic source: **Everett Rogers**', 1962 *The Diffusion of Innovations*

See: Karakaya (2014) "Diffusion of eco-innovations"



Tekno-Økonomiske paradigmeovergangers 2 halvdeler

Source: Based on Perez (2002), 37.

Barrierer mot innovasjon

ikke minst i ledelse…

Human history becomes more and more a race between education and catastrophe.

H. G. Wells, *Outline of History* (1920)