Social tipping dynamics to accelerate the energy transition

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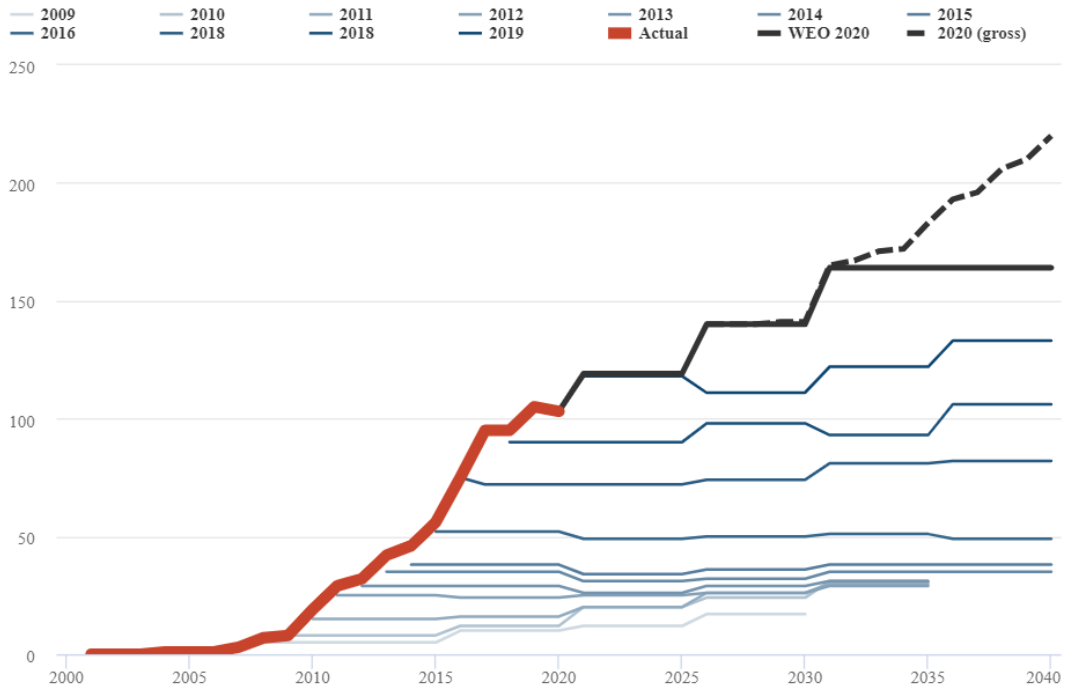
Why this research

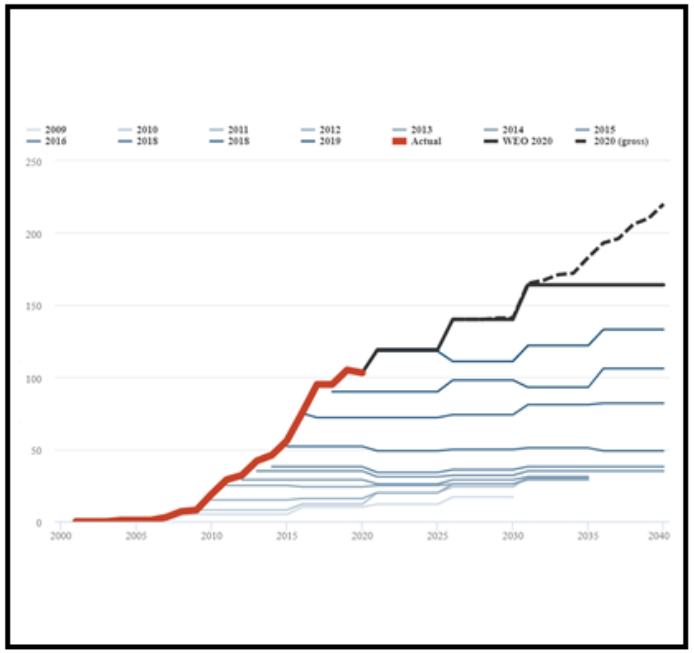
- Models of the energy transition are inaccurate
- Inaccurate predictions hamper the energy transition
- This jeopardises meeting the goals of the Paris Agreement



Source: IEA, Carbonbrief, Auke Hoekstra

Problem

Current models of the energy transition are inaccurate



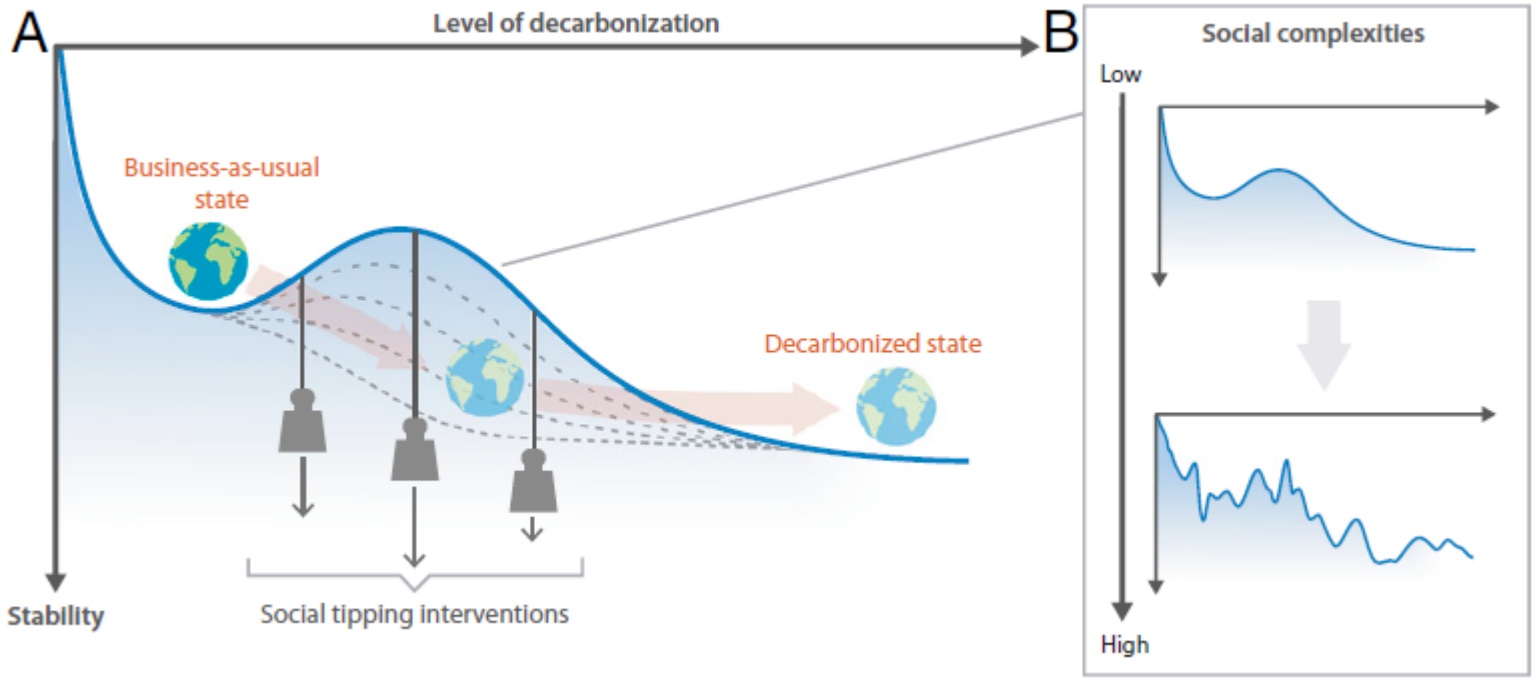
Cause?

Societal dimension energy transition is missing

Examples:

- Societal acceptance
- Policy feedbacks
- Changing norms
- Climate protests
- Green finance
- Energy security

At the same time…social tipping dynamics



Otto et al., (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. Proceedings of the National Academy of Sciences, 117(5), 2354–2365. https://doi.org/10.1073/pnas.1900577117

Internal, reinforcing (positive) feedbacks that speed up change, and dampening (negative) feedbacks that slow down change (**Lenton et al., 2022**). These are **mathematically** positive or negative feedbacks, not to be confused with **normatively** positive or negative tipping points.

Sustainability transitions field has studied many of these interactions

- Motors of innovation
- Typology of pathways
- Social tipping dynamics

Here we review the empirical evidence for underlying feedbacks & look for policy leverage points

Alkemade, F., de Bruin, B., El-Feiaz, A., Pasimeni, F., Niamir, L., & Wade, R. (2023). Social tipping dynamics in the energy system. *Earth System Dynamics Discussions*, *2023*, 1-20.

T. M. Lenton, D.I. Armstrong McKay, S. Loriani, J.F. Abrams, S.J. Lade, J.F. Donges, M. Milkoreit, T. Powell, S.R. Smith, C. Zimm, J.E. Buxton, E. Bailey, L. Laybourn, A. Ghadiali, J.G. Dyke (eds), 2023, The Global Tipping Points Report 2023. University of Exeter, Exeter, UK.

Geels, F. W., & Ayoub, M. (2023). *Technological Forecasting and Social Change*, 193, 122639. https://doi.org/10.1016/j.techfore.2023.122639

Suurs, R.A.A. 2009. Motors of Sustainable Innovation: Toward a Theory on the Dynamics of Technological Innovation Systems. PhD thesis, Utrecht University

Main ‘positive’ feedback loops in the energy transition

- Learning curves
- Policy feedbacks

What about

- behaviour change
- social influence
- changing norms?

Some evidence – but does it stick?

Cost reduction – learning feedback

- Learning curve
- More-granular technologies are empirically associated with
  - faster diffusion, lower investment risk, faster learning, more opportunities to escape lock-in, more equitable access, more job creation, and higher social returns on innovation investment.

  - Sensitive leverage points – carrots then sticks
    - Selfsustaining (depends on policy feedback, global developments but can be quite early)

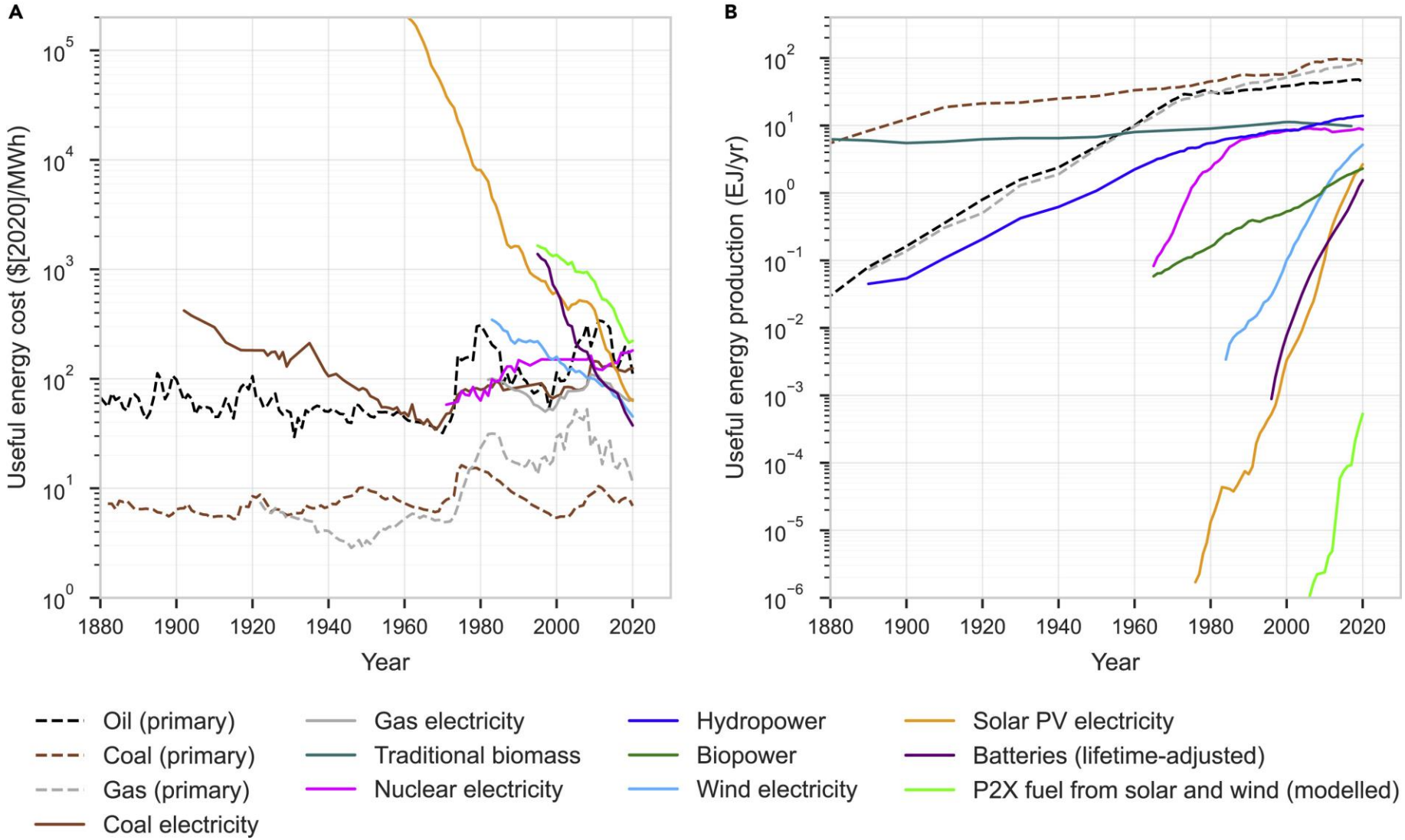
Granular technologies to accelerate decarbonization C. Wilson, A. Grubler, N. Bento, S. Healey, S. De Stercke, and C. Zimm Science, 368 (6486), . DOI: 10.1126/science.aaz8060

Meckling, J. (2019). Governing renewables: Policy feedback in a global energy transition. *Environment and Planning C: Politics and Space*, 37(2), 317–338. https://doi.org/10.1177/2399654418777765

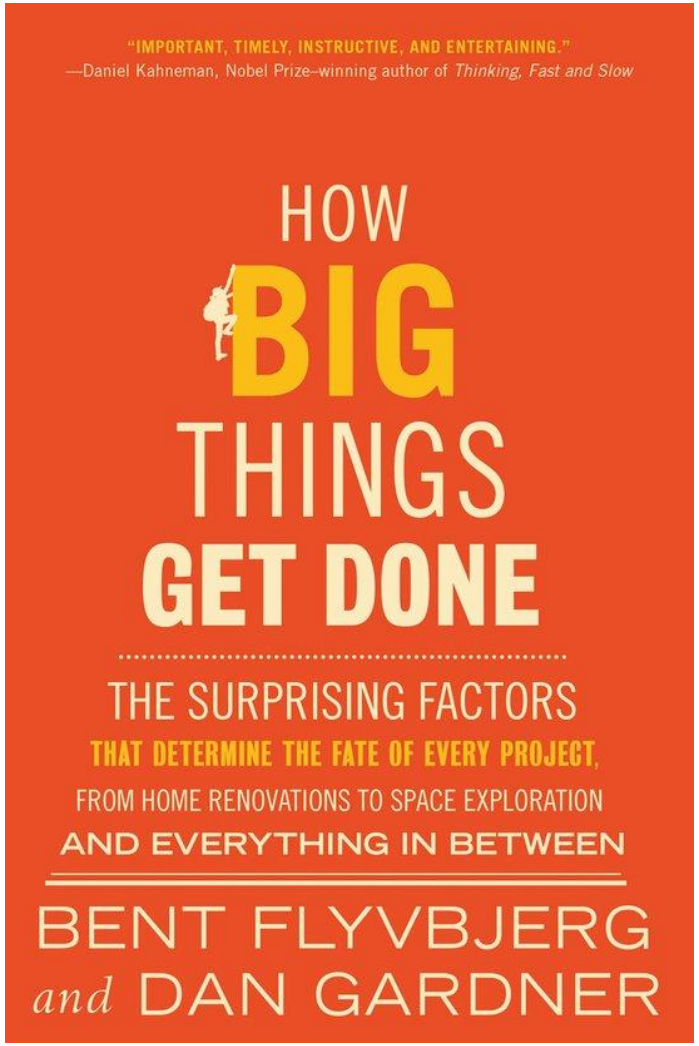
Learning curves

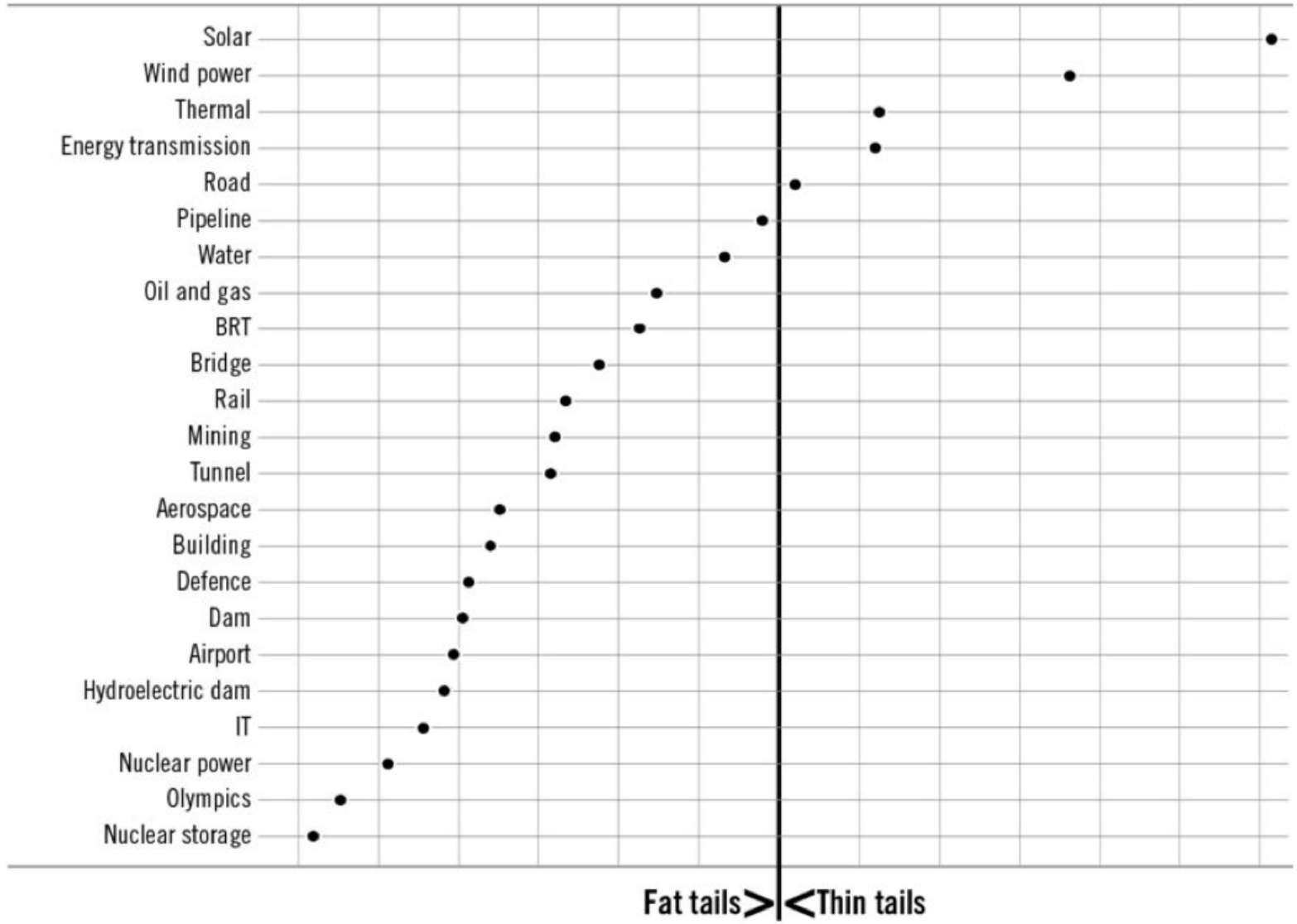
- Describe cost reductions over time / or with cumulative production
- More-granular technologies are empirically associated with
  - faster diffusion,
  - lower investment risk,
  - faster learning,
  - more opportunities to escape lock-in,
  - more equitable access,
  - more job creation,
  - and higher social returns on innovation investment.

Granular technologies to accelerate decarbonization C. Wilson, A. Grubler, N. Bento, S. Healey, S. De Stercke, and C. Zimm Science, 368 (6486), . DOI: 10.1126/science.aaz8060



Way, R., Ives, M. C., Mealy, P., & Farmer, J. D. (2022). Empirically grounded technology forecasts and the energy transition. *Joule*, *6*(9), 2057-2082. https://doi.org/10.1016/j.joule.2022.08.009


"IMPORTANT, TIMELY, INSTRUCTIVE, AND ENTERTAINING."
—Daniel Kahneman, Nobel Prize–winning author of *Thinking, Fast and Slow*
HOW
BIG
THINGS
GET DONE
THE SURPRISING FACTORS
THAT DETERMINE THE FATE OF EVERY PROJECT,
FROM HOME RENOVATIONS TO SPACE EXPLORATION
AND EVERYTHING IN BETWEEN
BENT FLYVBJERG
and DAN GARDNER


Solar
Wind power
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Tunnel
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Building
Defence
Dam
Airport
Hydroelectric dam
IT
Nuclear power
Olympics
Nuclear storage
Fat tails>
<Thin tails

Policy feedbacks

- When government support builds an industry -> That industry can lobby for support (Meckling – 2019)
- The IRA spurs additional subsidy opportunities in the EU, etc

Meckling, J. (2019). Governing renewables: Policy feedback in a global energy transition. Environment and Planning C: Politics and Space, 37(2), 317–338. https://doi.org/10.1177/2399654418777765

Feedbacks in the social system

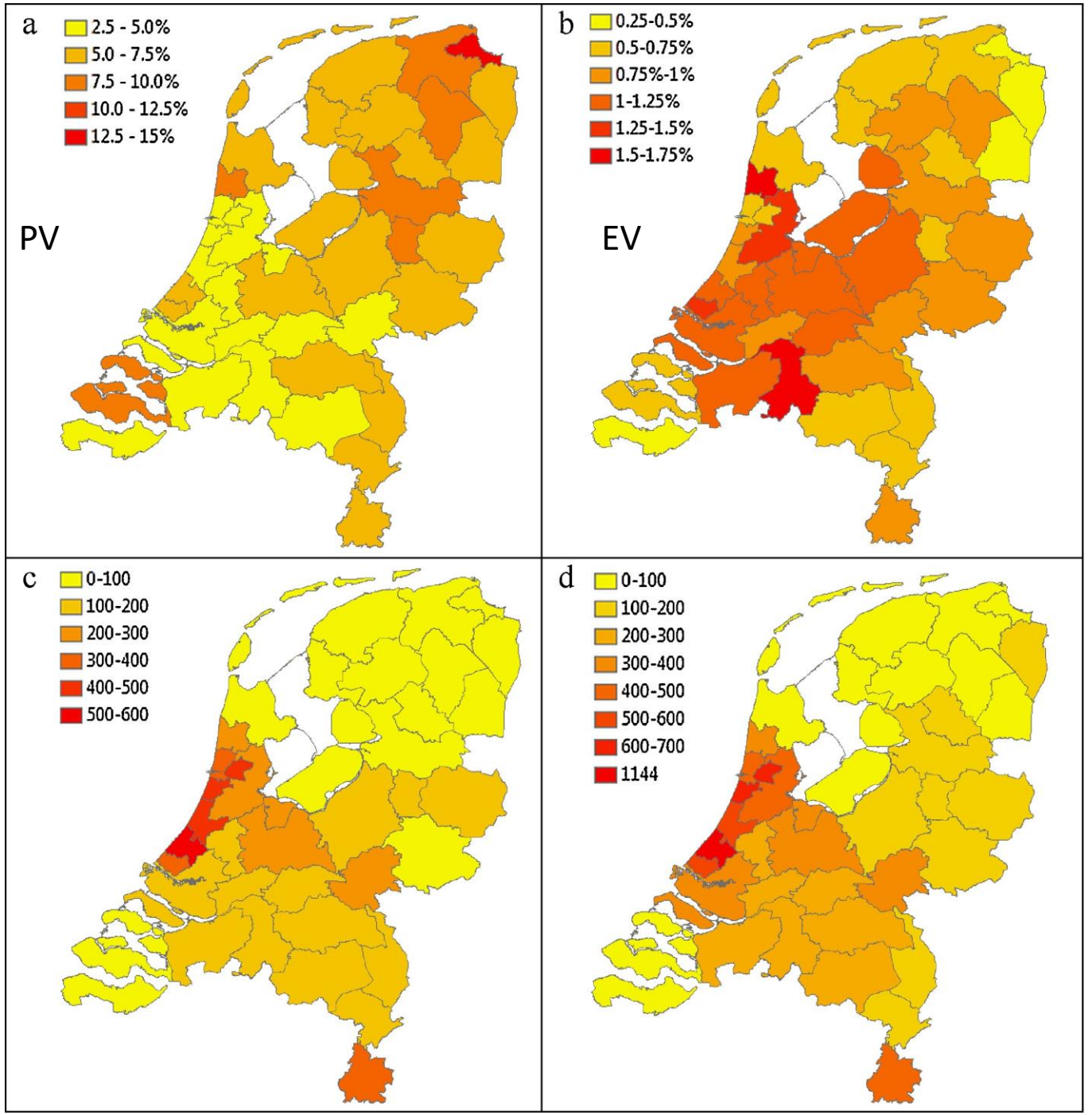
- Some evidence
- Wide range of estimates when feedback becomes self-sustaining
- How to make it stick?
- Policy intervention typically only legitimate when norm has already shifted

Nisa, C. F., Bélanger, J. J., Schumpe, B. M., & Faller, D. G. (2019). Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change. *Nature communications,* 10(1), 4545. https://doi.org/10.1038/s41467-019-12457-2

Social processes

PV and EV cluster in space

- Visibility
- Trialability
- Word of mouth



van der Kam, M. J., Meelen, A. A. H., van Sark, W. G. J. H. M., & Alkemade, F. (2018). Diffusion of solar photovoltaic systems and electric vehicles among Dutch consumers: implications for the energy transition. Energy Research and Social Science, 46, 68-85. DOI: 10.1016/j.erss.2018.06.003

So…

- Many reinforcing feedbacks!
- But…
  - Balancing feedbacks
  - It is not enough
    - Increase renewable generation
    - Match renewable generation with demand
    - Reduce demand (in the face of electrification)
- How to go from tipping dynamics to tipping cascades

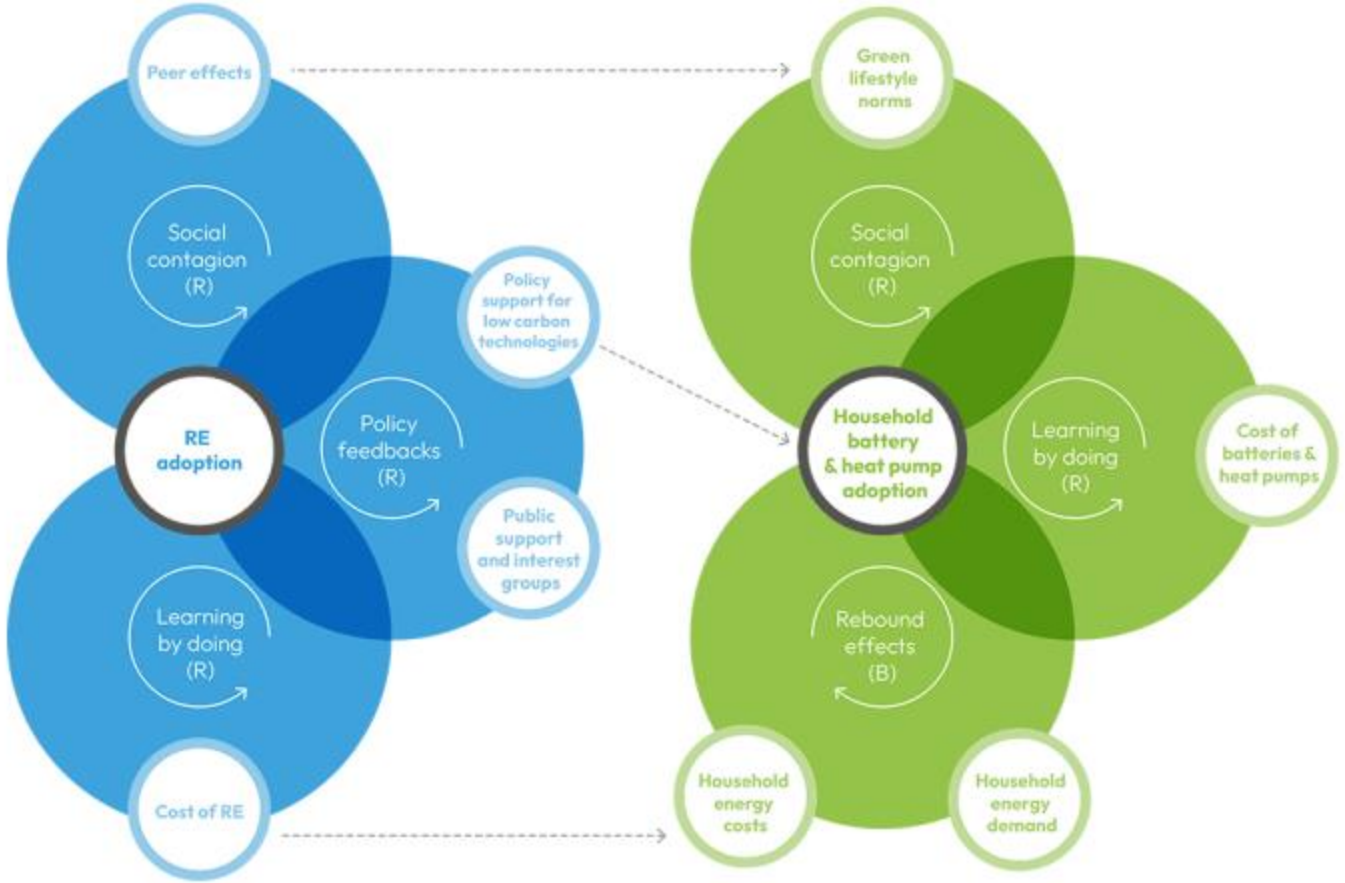


Figure 4.3.2: Cascading effects from renewable energy supply to household energy demand. The feedbacks that led to the strong growth in distributed renewable energy supply, can also strengthen the feedbacks that help reduce household energy demand when policy support is in place. R = reinforcing feedback, B = balancing/dampening feedback.

T. Powell, S.R. Smith, C. Zimm, E. Bailey (eds) 2023, 'Section 4: Positive Tipping Points in Technology, Economy and Society' in [T. M. Lenton, D.I. Armstrong McKay, S. Loriani, J.F. Abrams, S.J. Lade, J.F. Donges, M. Milkoreit, T. Powell, S.R. Smith, C. Zimm, J.E. Buxton, E. Bailey, L. Laybourn, A. Ghadiali, J.G. Dyke (eds), 2023, The Global Tipping Points Report 2023.] University of Exeter, Exeter, UK.

Sensitive intervention points

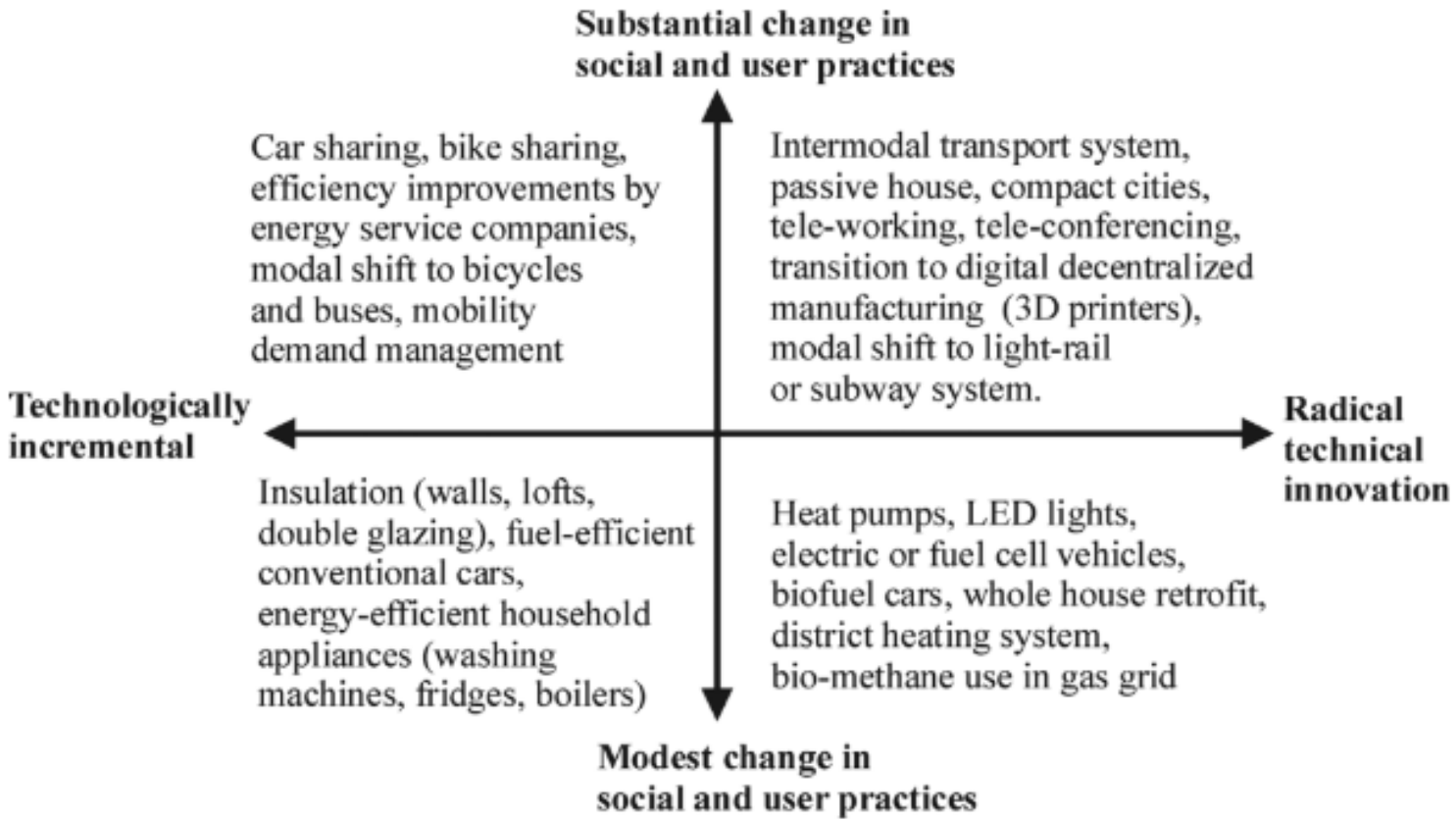
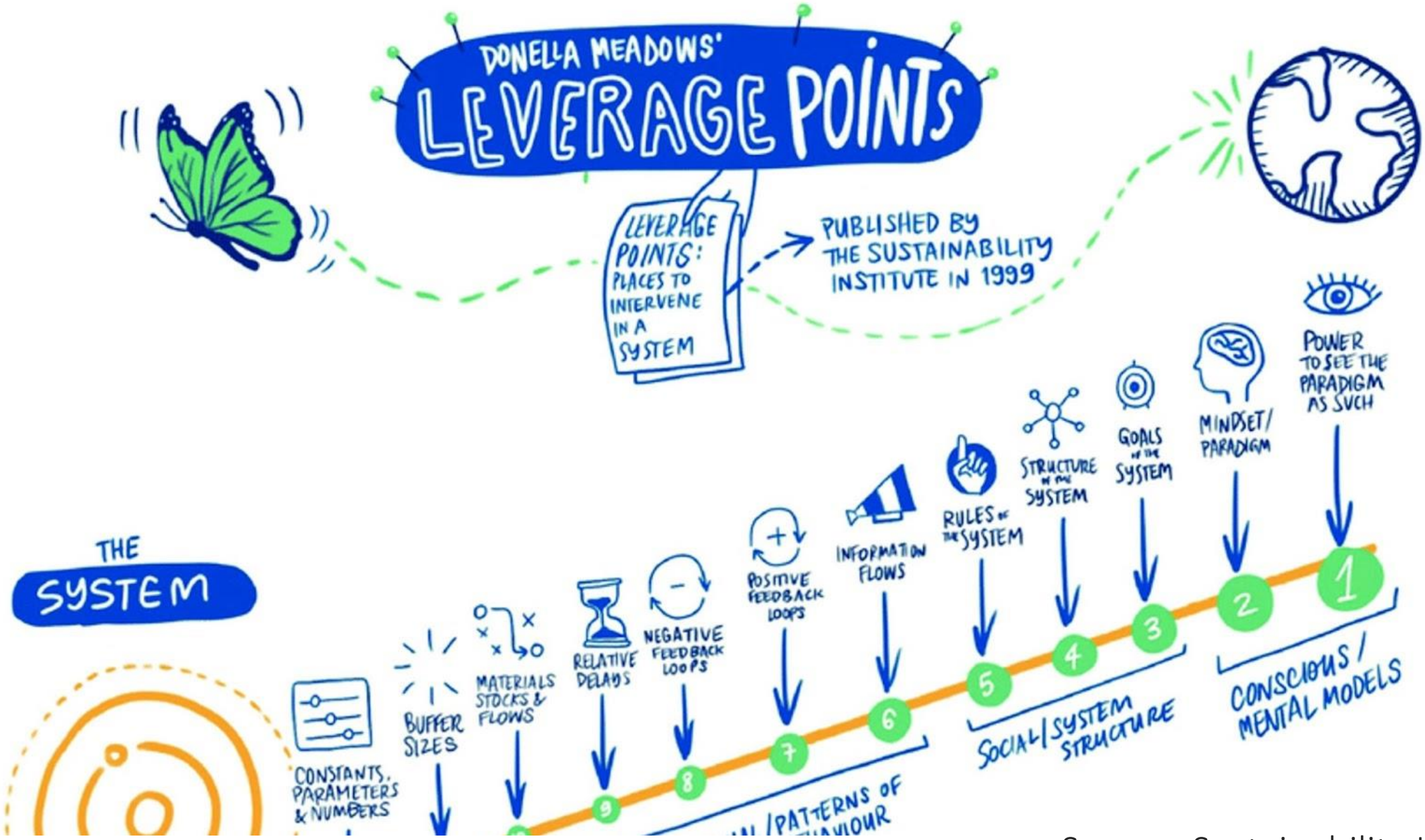


Fig. 1. Variety of low carbon innovations with different degrees of social and technical novelty.

Geels (2018)



Source: Sustainability Institute

Implications for policy & design/engineering

- So far, we have mostly focused on low-impact intervention points
  - (taxes, subsidies)
- Consistent and aligned policy mixes are needed that (systems approach)
  - Target both demand and supply
  - Go for fast learning (experimentation space)
  - Have sustainability as core goal
  - Target both reinforcing and balancing feedback loops (carrots and sticks)
- In design/engineering
  - Include the use context!
  - Go for modularity & fast learning

Summary & closing remarks

- How to create cascading effects?
- How to target balancing feedback loops?
  - To make social changes stick (sticks are needed but tend to disappear from policy packages)

- Foresight methods and impact assessments like prospective LCAs to identify targets for early-stage financing (new materials/recyclability/ design to reuse and recycle)
- Deployment: Infrastructure & skills build-up need to keep pace
- Demand policies – digitisation promises to reduce demand without reducing service levels – but will it fulfil that promise?

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Thank you

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