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Introduction to Sustainability Transitions

Jochen Markard

NEST Webinar Series
May 26, 2020

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Outline

1. Grand sustainability challenges
2. Sustainability transitions
3. New research topics around acceleration
4. COVID-19 and climate change

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1 Grand sustainability challenges

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Need for Change

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Grand sustainability challenges: wicked problems

	Climate change	Flying to the moon
Problem characteristics	Complex, ill-defined, interdependent causes, multi-dimensional, evaluative, socially constructed, moving target	Clearly defined, scientific and technological problem, shared understanding, stable target
Solutions	Technological and non-technical elements, broad array of potential solutions, no immediate tests, unwanted effects	Technical, based on science/engineering, testable, supply-side
Scope	Global, sectoral or cross sectoral, several decades	National, technological, one decade
Actors & coordination	Broad range of distributed actors with conflicting interests, networks and coalitions	State as primary customer, hierarchy, defined roles
Public policies	Broad range of policy goals and instruments, policy interaction (policy mix) and potential conflicts, different levels	Public funding, R&D, national level

[Ferraro et al. 2015; Levin et al. 2012; Mowery et al. 2010; Reid et al. 2010]

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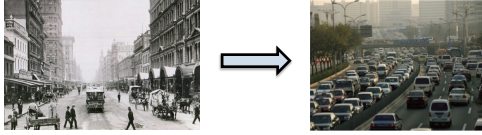
2 Sustainability transitions

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Socio-technical transition - example



Development of (core) technology

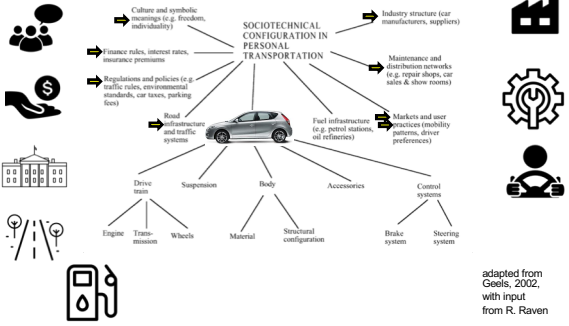


Development of infrastructure

Geels 2005

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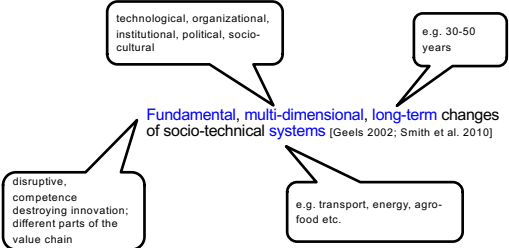
Central concept: Socio-technical system



adapted from Geels, 2002, with input from R. Raven

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Socio-technical transitions



Fundamental, multi-dimensional, long-term changes of socio-technical systems [Geels 2002; Smith et al. 2010]

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Sustainability Transitions

- are **socio-technical transitions** that are **associated with sustainability targets** [and 'guided' by **public policies**] [Markard et al. 2012]
- In other words: Sustainability transitions can be viewed as a **response** to the grand sustainability challenges discussed above.
- Implicit **normative** assumption that **sectors** such as energy, transport, agri-food etc. are unsustainable and **have to change** e.g. to achieve SDGs




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Particularities of sustainability transitions

- Value-laden & **contested**
→ e.g. trade-offs such as low-carbon vs. nuclear risks; conflicting views
- Key role for **public policies**
→ purposive transitions, associated with sustainability targets
- Power & **politics** central
→ vested interests; winners & losers; coalitions & alliances
- Complex, **uncertain**, long-term
- Context dependent**: different pathways in diff. sectors & places
- Multi-dimensional, **systemic** interaction
→ e.g. interaction of multiple technologies

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STRN community



Report 2019 Sustainability Transitions: Policy and Practice

Winter school on Methods Karlsruhe, Germany

#NEST2020

NEST conference Lisbon, Portugal

Impact factor 7.5

Environmental Innovation & Societal Transitions

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3 Research topics around acceleration



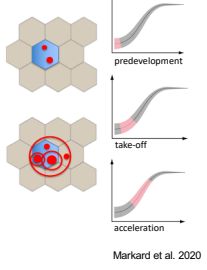
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Different transition phases

- Phase 1:
Cleaner technologies, sustainable **innovation**
- Phase 2:
Whole systems, **acceleration & decline**
[McMeekin et al. 2019; Rosenbloom, 2018; Turnheim & Geels, 2012]
- Phase 3:
System interaction, sector coupling / new lock-ins, dead end pathways
[Konrad et al. 2008; Papachristos et al. 2013; Andersen et al. 2020; Rosenbloom 2020]
- Phase 4:
Difficult to decarbonize industries such as cement, steel, aviation [Davis et al. 2018]

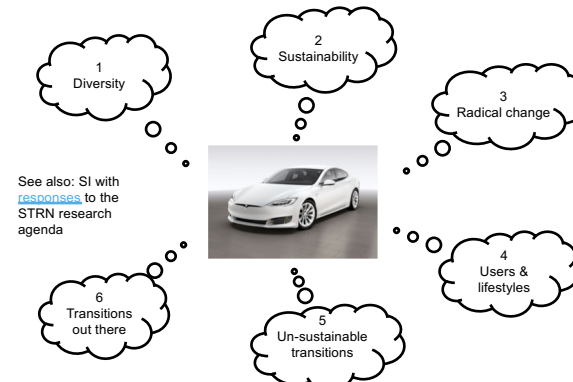


Markard et al. 2020

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See also: SI with responses to the STRN research agenda


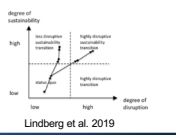
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Acceleration & Diversity

- Pay **more attention** to diversity [Stirling 2011]
competing technologies/ configurations
e.g. electric vs. fuel cell cars
individual vs. public transport
- Acceleration**: diversity is even more important
→ econ. of scale, standardization, new infrastructure, **risk of a new lock-in!**
- Plurality and feasibility of transition **pathways**;
associated **politics** [Stirling 2014; Turnheim & Nykvist 2019]

Lindberg et al. 2019


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Sustainability

- How sustainable is the transition?
„problem shifting” [vd Bergh et al. 2015]
- Challenge 1: everything we **scale up**, creates **new problems** elsewhere
e.g. Car batteries
(Lithium extraction, e-waste)
- Challenge 2: often, we only concentrate on **a single sustainability issue**
- Challenge 3: SDGs and **trade-offs** between sustainability goals



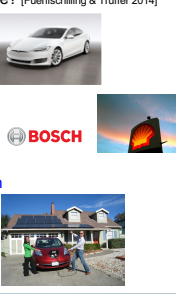
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Radical change

- How radical is the transition?
- Which **regime rules** still intact? How strong is the regime? [Fuentischilling & Truffer 2014]
EV: speed, acceleration, status, freedom, sport, price, business model
- Disruption by e-mobility? [Dijk et al. 2016]
→ primarily a threat for supply industries & oil firms
- Transition studies: **bias** towards **technology substitution**
→ Solves one problem, creates new ones
→ Not much change required from users




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Users, lifestyles

- How important are changes in routines & practices?
EVs (or solar PV):
no major changes in consumer perspectives [Dijk et al. 2016]
→ transitions are nice, if they don't disrupt our lives ☺
- But: potential for **wider change**
 - mass transit, commuting, city planning [Geels 2018]
 - home-office, lifestyles
 - sharing economy / platforms
 - user communities [Meelen et al. 2019]
- Transitions research
→ practice theory, psychology, ...



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Unsustainable transitions

- We focus on **hopeful developments**, but: what about the things **getting worse**?
[e.g. Shove & Walker 2007; Antal et al. 2020]
- Who is pushing /benefiting** from these developments?
- Larger **trends** behind this? ... convenience, lifestyle, status and how to break these trends?



Figure 1.1 World Passenger Air Travel by Volume, 1950–2012

Car Collapse
In U.S. SUV sales rose, passenger cars head to

10M vehicle sales

2005 2010 2015 2020

Source: Bloomberg

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Other “transitions out there”

- Our “pet” systems: energy, transport, water, food
- Risk to overlook interaction with **major systemic changes out there**
[Schot & Kanger 2018; Kanger 2020]
 - Technological: AI, digitalization, automation
 - Political: Populism, nationalism, „fake news“, migration, geopolitics [Cetkovic & Hagemann 2020]
 - Economic: Trade wars, increasing inequality, economic crises
- Challenge: **dynamics**, feedback loops
Eg. political systems may change for the worse in times of crisis
→ We **can't just “landscape”** these developments
- Also: Engage with (needed) **transitions in economic and political systems**
e.g. degrowth, new economics, beyond capitalism [Feola, 2019; Kallis et al. 2012; Schor 2014]

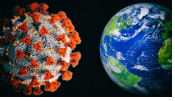
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4 Climate change & COVID-19

together with Daniel Rosenbloom, U Toronto



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We cannot wait & we need a combined response

Rosenbloom & Markard 2020

- Time is running out** wrt to climate change [Lund & Byrne 2020; Levin et al. 2012]
→ irreversible damages, **tipping points** [Lenton 2011]
- COVID-19 recovery programs of unprecedented scale
→ resources will be missing, if we don't leverage them for climate
- Should be simple, right? BUT
We know from past experiences:
Policymakers tend to **re-stabilize incumbent industries** (& jobs)
instead of using opportunity for sustainable transformation [Geels 2013]
→ 2008 financial crisis: Germany: premium to buy new cars
→ Millenium drought Australia: large scale desalination [Fuenfschilling & Truffer 2016]

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Key challenge: lock-in & vested interests

- Example: five elements that constitute our dependence on cars
[Mattoli et al. 2020]
→ auto industry, infrastructure, urban sprawl, public transport, culture
- Lock-in and path-dependence:
core of **socio-technical regimes** / transition theory [Geels 2002; Rip & Kemp 1998]
- Two conditions to initiate transitions
 - I. Disruption (shocks, ext. pressure)
 - II. Alternatives (niche technologies)

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I. Harness disruption to accelerate decline

- COVID-19: major disruption, **landscape level event**
- use disruptive forces to accelerate decline
coal, oil & gas, conventional cars, fossil heating, inefficient buildings, long-distance flights, commuting ...
- Don't bail out carbon-intensive businesses; this only delays **transformation** that is **necessary anyway**
- Channel recovery to people & regions: retraining, relocation, early retirement, build alternatives ...

Based on Rosenbloom et al. 2020

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II. Promote low-carbon innovation

- Lay foundations for sustainable industries & practices
renewables, e-mobility, public transit, virtual meetings & conferences, sustainable agriculture, meat alternatives ...
- Rethink lifestyles:
what do we really need?
reduced pace of living, home cooking and baking, working remotely, use bike instead of car, limiting non-essential travel, non-exotic vacations etc.
- Current changes: **transient or lasting?**
→ support more sustainable practices to last

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Wrap up

- We are confronted with grand sustainability challenges
- Sustainability transitions research can provide orientation & policy insights
- As transitions are accelerating, new research challenges emerge
- Disruption by COVID-19 can be leveraged to advance the climate agenda

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Thank You!

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Andersen, A.D., Steen, M., Mäkitie, T., Hanson, J., Thune, T.M., Soppe, B., 2020. The role of inter-sectoral dynamics in sustainability transitions: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34, 348-351.

Antal, M., Mattioli, G., Rattile, I., 2020. Let's focus more on negative trends: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34, 359-362.

Binz, C., Coenen, L., Murphy, J.T., Truffer, B., 2020. Geographies of transition—From topical concerns to theoretical engagement: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34, 1-3.

Četković, S., Hagemann, C., 2020. Changing climate for populists? Examining the influence of radical-right political parties on low-carbon energy transitions in Western Europe. *Energy Research & Social Science* 66, 101571.

Davis, S.J., et al. 2018. Net-zero emissions energy systems. *Science* 360.

Dijk, M., Wells, P., Kemp, R., 2016. Will the momentum of the electric car last? Testing an hypothesis on disruptive innovation. *Technological Forecasting and Social Change* 105, 77-88.

Feola, G., 2019. Capitalism in sustainability transitions research: Time for a critical turn? *Environmental Innovation and Societal Transitions*.

Ferraro, F., Elzoin, D., Gehman, J., 2015. Tackling Grand Challenges Pragmatically: Robust Action Revisited. *Organization Studies* 36, 383-390.

Fuenschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes - Conceptual foundations from institutional theory. *Research Policy* 43, 772-791.

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case study. *Research Policy* 31, 1257-1274.

Geels, F.W., 2005. The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology Analysis & Strategic Management* 17, 445-476.

Geels, F.W., 2018. Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). *Energy Research & Social Science* 46, 86-102.

Kallis, G., Kerschner, C., Martinez-Alier, J., 2012. The economics of degrowth. *Ecological Economics* 84, 172-180.

Kanger, L., 2020. Neglected systems and theorizing: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34, 352-354.

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Köhler, J., et al. 2019. An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions* 31, 1-32.

Konrad, K., Truffer, B., Voß, J.-P., 2008. Multi-regime dynamics in the analysis of sectoral transformation potentials: evidence from German utility sectors. *Journal of Cleaner Production* 16, 1190-1202.

Levin, K., Cashore, B., Bernstein, S., Auld, G., 2012. Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Sciences* 45, 123-152.

Lindberg, M.B., Markard, J., Andersen, A.D., 2019. Policies, actors and sustainability transition pathways: A study of the EU's energy policy mix. *Research Policy* 48, 103668.

Markard, J., Geels, F.W., Raven, R.P.J.M., 2020. Challenges in the acceleration of sustainability transitions. *Environmental Research Letters*, online/ in press.

Markard, J., Raven, R., Truffer, B., 2012. Sustainability Transitions: An emerging field of research and its prospects. *Research Policy* 41, 955-967.

Markard, J., Rosenbloom, D., 2020. A tale of two crises: COVID-19 and Climate. *Sustainability: Science, Practice and Policy*.

McMeekin, A., Geels, F.W., Hodson, M., 2019. Mapping the winds of whole system reconfiguration: Analysing low-carbon transformations across production, distribution and consumption in the UK electricity system (1990–2016). *Research Policy* 48, 1216-1231.

Meelen, T., Truffer, B., Schwanen, T., 2019. Virtual user communities contributing to upscaling innovations in transitions: The case of electric vehicles. *Environmental Innovation and Societal Transitions* 31, 98-109.

Mowery, D.C., Nelson, R.R., Martin, B.R., 2010. Technology policy and global warming: Why new policy models are needed (or why putting new wine in old bottles won't work). *Research Policy* 39, 1011-1023.

Papachristos, G., Sofianos, A., Adamides, E., 2013. System interactions in socio-technical transitions: Extending the multi-level perspective. *Environmental Innovation and Societal Transitions* 7, 53-69.

Reid, W.V., Chen, D., Goldfarb, L., Hackmann, H., Lee, Y.T., Mokhele, K., Ostrom, E., Raivio, K., Rockstrom, J., Scheinlhuber, H.J., Whyte, A., 2010. Earth System Science for Global Sustainability: Grand Challenges. *Science* 330, 916-917.

Rosenbloom, D., 2018. Framing low-carbon pathways: A discursive analysis of contending storylines surrounding the phase-out of coal-fired power in Ontario. *Environmental Innovation and Societal Transitions* 27, 129-145.

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- Rosenbloom, D., 2020. Engaging with multi-system interactions in sustainability transitions: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34, 336-349.
- Rosenbloom, D., Markard, J., 2020. A COVID-19 recovery for climate. *Science* 368, 477.
- Rosenbloom, D., Markard, J., Geels, F.W., Fuernschilling, L., 2020. Why carbon pricing is not sufficient to mitigate climate change — and how “sustainability transition policy” can help. *Proceedings of the National Academy of Sciences* 117, 8664-8668.
- Schor, J.B., 2014. Climate discourse and economic downturns: The case of the United States, 2008–2013. *Environmental Innovation and Societal Transitions* 13, 6-20.
- Schot, J., Kanger, L., 2018. Deep transitions: Emergence, acceleration, stabilization and directionality. *Research Policy* 47, 1045-1059.
- Shove, E., Walker, G., 2007. CAUTION! Transitions ahead: politics, practice and sustainable transition management. *Environment and Planning A* 39, 763-770.
- Smith, A., Voß, J.-P., Grin, J., 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy* 39, 435-448.
- Stirling, A., 2011. Pluralising progress: From integrative transitions to transformative diversity. *Environmental Innovation and Societal Transitions* 1, 82-88.
- Stirling, A., 2014. Transforming power: Social science and the politics of energy choices. *Energy Research & Social Science* 1, 83-95.
- Turnheim, B., Geels, F.W., 2012. Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913-1997). *Energy Policy* 50, 35-49.
- Turnheim, B., Nykvist, B., 2019. Opening up the feasibility of sustainability transitions pathways (STPs): Representations, potentials, and conditions. *Research Policy* 48, 775-788.
- van den Bergh, J., Folke, C., Polasky, S., Scheffer, M., Steffen, W., 2015. What if solar energy becomes really cheap? A thought experiment on environmental problem shifting. *Current Opinion in Environmental Sustainability* 14, 170-179.