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The next phase of the Energy Transition A new kind of challenges?

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Outline

1. Grand challenges & sustainability transitions
2. Energy transition 2.0 – the next phase
3. Questions & Debate

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1 Grand sustainability challenges

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We are living at the edge

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Grand sustainability challenges: anything special?

	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

[George et al. 2016; Ferraro et al. 2015; Markard 2017; Reid et al. 2010]

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Some characteristics of grand challenges

- Many solutions
- Change may take decades, inertia of infrastructures
- Conflicting interests

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Sustainability Transitions

- Long-term, fundamental transformation of existing sectors (e.g. energy, transport, food) towards more sustainable production and consumption
- Implicit **normative** assumption that **sectors have to change** e.g. to achieve SDGs
- Transition studies: Rapidly growing field of research in **innovation studies** with cross-overs into **other disciplines**

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Historical transition example: automobile

Development of (core) technology

Development of infrastructure

Geels 2005

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Systems approaches & technology central

- Socio-technical system:** network of actors, institutions and technology; provides essential service for society (e.g. water, food, energy, transport) - *sector*
- Socio-technical regime:** whole complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, institutions and infrastructures (Hoogma et al. 2002) → emphasis on **coherence & inertia**
- Technological innovation system:** network of actors and institutions that contribute to the development and diffusion of novel technology (Bergek et al. 2008; 2015) → highlights **interdependence & relevance of institutions**

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Multi-level perspective

Geels 2002

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2 Energy transition

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New renewable energies diffuse rapidly

Year	Production cost (USD/MWh)
1980	24.32
1981	21.18
1982	19.67
1983	18.27
1984	17.02
1985	15.91
1986	14.92
1987	14.03
1988	13.24
1989	12.54
1990	11.93
1991	11.40
1992	10.94
1993	10.54
1994	10.19
1995	9.88
1996	9.60
1997	9.34
1998	9.10
1999	8.88
2000	8.67
2001	8.47
2002	8.28
2003	8.10
2004	7.93
2005	7.77
2006	7.61
2007	7.46
2008	7.31
2009	7.16
2010	7.01
2011	6.86
2012	6.71
2013	6.56
2014	6.41
2015	6.26
2016	6.11
2017	5.96

Production cost (USD/MWh)

Installed power worldwide [MW]

Production cost (USD/MWh) from 1980 to 2017

statisla.com

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Energy Transition 2.0

- In some places, we currently see a **new phase** of the energy transition with **new phenomena**
- The new phase comes with a set of **new challenges**
- These new challenges have **implications** for the **conceptual frameworks** we use, and for **policy making**

future energy **PERSPECTIVE**
The next phase of the energy transition and its implications for research and policy

Jacken Marchand

In every phase, the electricity sector is transforming through greater shares of renewable energy technologies. In the initial phase of the transition, a particular focus is on wind and solar, which are relatively easy to integrate into existing infrastructure. Today, the challenge is different: renewable energy is becoming increasingly grid-intensive. Energy production and distribution are becoming more integrated, and the system is becoming more complex. The next phase of the transition will be characterized by a greater emphasis on storage, grid expansion, and digitalization. This paper explores the key phases and discusses implications for research and policy-making.

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Germany: Earlier developments

Power generation in TWh (2017: 650 TWh total)

1st phase – emergence of renewable alternatives

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Germany: Last 10 years

Decline of established technologies

Accelerated diffusion of renewables

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Increasing structuration of activities in local practices

Phase 1

Phase 2

Fig. 1. Multi-level perspective on transitions (adapted from Geels, 2002, p. 1263).

Geels & Schot 2007

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New challenges of the next phase

- Multi-tech** interaction
- Decline**
- Escalating **struggles**
- Sector level** reconfiguration

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3.1 Multi-tech interaction

- Past:** focus on selected technology (and its main competitors) e.g. solar, wind, biogas, batteries
- New:**
 - interplay of diff. technologies, **complementarities, bottlenecks**;
 - value chains / networks, context, sector boundaries

Source: AEE

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3.2 Decline

- Past: could be ignored
- New:
 - Important part of the dynamics
 - How long does it take?
 - How can it be accelerated?
 - Local vs. global issues
 - What implications?
 - How to compensate losers?

Coal decline UK

isoaho & Markard, submitted

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3.3 Struggles & politics

- Past: Ignored or simplified (e.g. newcomers vs. incumbents)
- New: Systematic analysis of **strategies, positions, coalitions**

Advocacy coalitions in the Swiss energy transition

Markard et al. 2016

Pro Spending (\$ Thousands)	Con spending (\$ Thousands)
Total raised, followed by largest donors	Total raised, followed by largest donors
\$1446 total: Mostly env. orgs	\$1284 total: Excel, rural cooperatives (utilities)
\$61,886 total: \$49,581 S. Bing (film) \$2043 V. Khosla (finance)	\$34,404 total: \$38,000 Chevron \$32,824 Area Energy \$9550 Occidental Oil & Gas \$3025 ConocoPhillips

Struggles over solar PV in the US

Hess 2016

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3.4 Sector level reconfiguration

- Past: hardly affected
- New:
 - "system integration"
 - "sector level complementarities"
 - system performance
 - configurational changes, different **pathways**: e.g. centralized vs. decentralized

degree of sustainability

high

low

low

high

degree of disruption

Lindbergh et al. in press

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Expanding scope of the transition

Electricity sector

Generation

Transmission & Storage

Consumption

Coal

Nuclear

Wind

PV

Biomass

Inter-connectors

HVDC

Batteries

Smart grids

Agricultural sector

Transport sector

ICT

Manufacturing

1st phase

2nd phase

3rd phase (?)

→ Kemp / van Lente 2011
→ Schöt et al. 2016

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3 Summary

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Main lessons

- Grand sustainability challenges:** highly demanding & complex, special approaches needed "transition studies" one such perspective
- Energy transition:** In a new stage of development, new challenges:
 - multiple technologies
 - decline
 - struggles & conflict
 - sector level re-configuration

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