Transition research: The role of science in transitions towards sustainable energy systems

Willington Ortiz, Magdolna Prantner
Outline

- The Wuppertal Institute
  - Motivations. Why are Energy Transitions needed?
  - Transition Research (applied to energy systems)
    - Type of knowledge
    - Iterative nature of transformation processes
    - System innovations
  - Key messages & Advertisements
Mission of the Wuppertal Institute
Inter- and transdisciplinary Sustainability Research

- The WI explores and develops models, strategies and instruments to support a sustainable development at local, national and international levels.
- Sustainability research at the WI focuses on ecology and its relation to economy and society.
- Our research analyses and initiates technological and social innovations that decouple economic growth from nature use.

Scientific policy consulting (think tank): no university

Independent connecting point between basic science (universities) and policy/business
Science Company Wuppertal Institute
Locations

Where we are?

Wuppertal headquarter

Berlin Office
Integrated perspective requires interdisciplinary staff
The Team in 2014

ca. 200 Staff members
President Prof. Dr. Uwe Schneidewind

Scientific Disciplines
- Natural sciences
- Environmental sciences
- Geography
- Systems sciences
- Engineering sciences
- Planning sciences
- Economics
- Political science and law
- Social sciences

Further team members
- Scientific Services
- Administrative Services
- Ph.D. students
- Research students and trainees
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Motivations to Energy Transitions [towards low-carbon energy systems] – Globally

- **Climate change**
  - Energy sector responsible for ca. 30% of total global GHG emissions by 2010 [IPCC report 2014]

- **Energy poverty**
  - 0.9 billion people lack access to reliable electricity
  - 2.4 billion people relies on non-solid fuels as main source of energy [SE4All tracking framework 2013]

- **Geopolitical stability**
  - A significant part of the global supply of fossil energy carriers is coming from political instable regions
Co-benefits from increasing share of renewable energy in the system

Security policy significance of renewable energies

- Reduced import dependency
  - Germany is already very dependent on imports at present (nuclear 100% / mineral oil 97% / natural gas 83%).

- Reduced vulnerability
  - Phasing out of high-risk technologies (nuclear power)
  - Decentralisation of supply structures (transmission grids and generation facilities)

- Reduced consequences of climate change
  - Renewable energy reduces the emission of greenhouse gases
  - Extreme weather, a deterioration of fertile soil, and reduced accessibility to water aggravate regional resource conflicts - developing countries are hit particularly hard

- Diversification of energy carriers and producing countries
  - Increase security of supply with various options and locations for energy generation
  - Defuse potential for conflict between countries that export and import petrol

- Creation of new possibilities for development
  - Energy access for resource-poor countries (rural electrification)
  - Regionally more just distribution of the profits from the export of energy resources
  - Mitigation of the adverse social and health effects in underdeveloped countries

Source: IFEU after Wuppertal Institute and Adelphi Consult

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Transition research: knowledge that enables system transformation

Understanding the System

- Policies
- Society
- Technology
- Climate
- Resources
- Land-use
- Economy
- Infrastructure

Enabling Transitions

Multilevel Experiments

Transitions to what?
Defining Targets

- Climate
- Land Use
- Resources
- Wealth
- Global Equity

System-Knowledge
(Understanding socio-technical systems in their natural environment)

Transformation-Knowledge
(Enabling complex societal transitions)

Target-Knowledge
(Defining socio-ecological targets for a sustainable world: identification of trade off’s and synergies)
Understanding the System

System-Knowledge
(Understanding socio-technical systems in their natural environment)
Schematic view of a generalized energy system

**Socio-economic structure**

- **Primary energy**
  - Conventional energy: Extraction, Processing
  - Renewable Energies

- **Final energy**
  - Mineral oil processing
  - Natural gas supply
  - Electricity production (power plant)

- **Usable energy**
  - New energies carriers: Biofuel, Methanol, Hydrogen
  - New, decentralised production techniques: renewable Energies, fuel cell, micro gas turbine, BHKW

**Energy policy**

- Liberatisation
- EEG
- KWK-Law
- Association agreement
- Kyoto mechanism
- EnEV

**Natural environment**

- Climate
- Hydrological systems
- Landscapes

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Target Knowledge

Transitions to what? Defining Targets

Climate

Land Use

Resources

Global Equity

Wealth

Target-Knowledge
(Defining socio-ecological targets for a sustainable world: identification of trade off’s and synergies)
Scenarios are images of the future, they illustrate development possibilities of an specific system in a roughly way. They are not predictions! Scenarios are asking “what happens if ...?”

- Thinkable/expected Events and Developments operates on single elements of system model
- These events/developments can have different characteristics.
- A cone of **thinkable and plausible futures** emerges
Example: Paths towards a carbon-free future for Munich in 2058
Energy demand and related CO₂ emissions in “target scenario”

Reference (2008) „Target“ Scenario (2058)

Full report available at:
Transformation knowledge

Understanding the System

Enabling Transitions

Transitions to what? Defining Targets

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Understanding (socio-technical) Transitions
From a linear to a cyclical Transition Model

„Reality is made of circles. But we see straight lines“ Peter Senge, The 5th discipline

The linear technological model

- Environmental Analysis
- Technological Solutions
- Political Frameworks/Measures
- Environmental Output

Natural and technical science driven (focus on market and state-transformation-modes)

The cyclical transition model

- Learning
- Problem - Problem assessment, establishment and further development of the transition arena
- Assessment
- Vision - Developing sustainability visions and transition agendas
- Experiments
- Development

Social Science driven (embedded technologies, variety of societal transformation modes)
Trajectory of innovations emerging from iterative ‘learning’ cycles

Elements of socio-tech. system

Actors

<table>
<thead>
<tr>
<th>Institutional</th>
<th>Physical &amp; practical</th>
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<td>(rules, norms, cognitive)</td>
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Powerful actors joint

Assumptions about problems align to innovative alternatives

Dominant, robust designs arise

Price and performance of innovations improves

Network of involved actors grows

New ‘inputs’:
- Entrance of new actors
- New perspectives
- Additional resources
- ...

Innovation ‘breaks through’
Regime emergence/adjustment

Reflection:
- Locally and
- Aggregated

Local projects (‘experiments’) Improved concepts

Germinating ideas

Reflection:

• Locally and
• Aggregated

T1

T2

T3

T1.2

T3.2

Txy

Innovation trajectory

Learning Cycles

Refleciton:

• Locally and
• Aggregated

T1

T2

T3

T1.2

T3.2

Txy

Innovation trajectory

Learning Cycles
The central role of ‘real experiments’ in the transformation process: e.g. from communal to state-level

Problem - Assessment

Large scale implementation

Learning

Problem assessment, establishment and further development of the transition arena

Local climate protection and air quality assessments

Developing sustainability visions and transition agendas

Mobilizing actors and executing projects and experiments

Evaluating, monitoring and learning

Experiments

Vision - Development

100% RE communities

Climate Protection Plan NRW

Initiativkreis Ruhr®

"Low Carbon Ruhr – Innovation City"

Sustainable Urban Infrastructure

Climate Protection Plan NRW

100% RE communities

Climate Protection Plan NRW

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Messages

• Transition research comprise the generation of three types of knowledge:
  • System
  • Target
  • Transformation

• Transformation process can be better understood as iterative learning process (rather than straightforward induced reactions to science and technology innovation)

• Transformation knowledge can be better (only!) be obtained by reflecting on ‘real experiments’.
Mapping RES Initiatives in the Danube Region

Are there ‘real experiments’ out there in the Danube Region?

... we are sure there are a lot of them!

Help us by mapping interesting examples you know (e.g. projects, programs, etc.) how to tap renewable energy sources in the Danube Region
Interactive Workshop:

Identifying research gaps for the energy transition in the Danube Region

- Think on research topics that you consider the most relevant in order to advance towards broader application of RES in your national/professional context...

- ... We need your ideas and skills

- ... Today from 16:30 to 18:00
Thanks for your attention!