WHEN THEORIES OF CHANGE ARE NOT ENOUGH: USING THEORETICAL APPROACHES OF SYSTEM INNOVATION TO EVALUATE LARGE, TRANSFORMATIVE PROGRAMMES

The Case of the 7th Energy Research Programme in Germany

INTRODUCTION

• The energy system is an area of specific concern for a sustainability transformation of our society as it produces at least two-thirds of total greenhouse-gas (GHG) emissions (cf. Ritchie and Moser 2020)
  - The EU aims to be climate-neutral by 2050
  - An economy with net-zero greenhouse gas emissions is at the heart of the European Green Deal & the EU’s commitment to global climate action under the Paris Agreement.
• The 7th EFP is an example of governmental R&I programmes for a sustainability energy transition at the national level.
  - The 7th EFP is assigned a key role in the German energy system transition by establishing a link between the long-term goals of the Federal Government and the time horizons of business technology research.
OBJECTIVES OF THE 7TH ENERGY RESEARCH PROGRAMME

- Tackling the energy system transformation through three instruments:
  - R&I projects
  - Living Labs
  - Accompanying Measures

- Collectively geared towards supply of new technologies (technology push), speeding up of new knowledge, technology transfer (demand pulls), and system development efforts.

- Targeting practices within:
  - the renewable energy supply system and their system integration,
  - the energy consumption sectors (e.g. industry, transport, buildings and neighbourhoods), and
  - the development of green substitutes for carbon-based technologies, e.g. fuel cell technologies.
Against the increasing need to frame R&I programme evaluation in a system transformation context, the key research questions are:

- How can theories of change set the basis for an understanding of impact mechanisms and programme learning?
- How can concepts of change in socio-technical systems extend theories of change to better capture transformation processes?

We investigate and test how a programme-theory based evaluation approach (Funnell and Rogers 2011; Rogers 2014) can be combined with

- a multi-level perspective of system innovation (Geels et al. 2017)
- the concept of transformative outcomes (Ghosh et al. 2020, 2021).
Define strategic and operational objectives and design principles / instrumental setting (based on policy goals)

Elaborate a theory of change for each instrument

Identify main impact pathways that intend to transform the energy system

Position the 7th EFP in the context of the energy system transformation: a multi-level perspective

Investigate usability of the concept of transformative outcomes to better understand the impact mechanisms of the programme and increase its evaluability
The Multi-Level-Perspective was designed as a broad heuristic to capture transitions in different socio-technical systems such as mobility, energy or food (EEA 2018; Geels et al. 2017).

The MLP argues that transitions come about through dynamic processes within and between three analytical levels (see Köhler et al. 2019):

- **Niches**, which are protected spaces and the locus for radical innovations
- **Socio-technical regimes**, which represent the institutional structuring of existing systems leading to path dependence and incremental change; and
- **Exogenous socio-technical landscape developments**
BENEFITS OF THE MULTI-LEVEL PERSPECTIVE (MLP) IN THE EVALUATION

• Close correspondence between programme theory (objectives and intervention mechanisms) and perspectives of programme managers.

• Integrating considerations of production and consumption sectors.

• Elaboration of sector-specific hypotheses concerning the relevance and coherence of objectives and appropriateness of challenges addressed by R&I portfolios.

• Highlighting scopes and limits of R&I funding within the toolbox of innovation policy geared at enabling transformational change.
## PATHWAYS TO IMPACT

<table>
<thead>
<tr>
<th>R&amp;I Projects, Pilots &amp; Demonstrators</th>
<th>Living Labs</th>
<th>Accompanying Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activities</strong></td>
<td><strong>Pathways</strong></td>
<td><strong>Activities</strong></td>
</tr>
<tr>
<td>Individual R&amp;I projects on single technologies</td>
<td>Knowledge creation &amp; capacity development</td>
<td>Collaborative R&amp;I in Living Lab contexts related to:</td>
</tr>
<tr>
<td>Collaborative R&amp;I projects on single technologies</td>
<td>Networking</td>
<td>• Digitalisation, ICT development</td>
</tr>
<tr>
<td>Pilot Projects &amp; Demonstration projects</td>
<td>Economic valorisation</td>
<td>• Reflection of experimentation clauses</td>
</tr>
<tr>
<td>Transdisciplinary research projects on systemic and cross-systemic issues of the energy transition</td>
<td>Transfer</td>
<td>• Developing and building industrial plants</td>
</tr>
<tr>
<td>Transdisciplinary research projects on systemic and cross-systemic issues of the energy transition</td>
<td>System development</td>
<td>• Test / pilot operation / demonstration</td>
</tr>
<tr>
<td>Living Lab Coordination</td>
<td></td>
<td>• Supplementary R&amp;D on individual issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pathways</strong></td>
<td><strong>Activities</strong></td>
<td><strong>Pathways</strong></td>
</tr>
<tr>
<td></td>
<td>Establishment and support for Energy Transition Research &amp; Innovation Platform and Research Networks</td>
<td>Synthesizing knowledge</td>
</tr>
<tr>
<td></td>
<td>Accompanying research and studies</td>
<td>Knowledge circulation &amp; and transfer</td>
</tr>
<tr>
<td></td>
<td>Research Communication</td>
<td>Enabling cooperation</td>
</tr>
<tr>
<td></td>
<td>Public Relations at programme level</td>
<td>Increasing qualification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increasing transparency</td>
</tr>
</tbody>
</table>

24.10.2022
THE MULTI-LEVEL PERSPECTIVE & PATHWAYS TO IMPACT I

• Pathway 1: Knowledge creation and capacity building
  • Which actors are performing the research and development work in the programme? How are they anchored in the socio-technical innovation system?
  • Does capacity building encompass only existent regimes or does it prepare for niches and their training and qualification needs?
  • Are skills and procedures, ways of working, rules and regulations objects of research? How is this knowledge being transferred?

• Pathway 2: Network creation
  • Are actors involved that are of particular importance for the transformation of the energy sector? (E.g. energy communities, the again increasing number of municipal energy providers/utilities, IT companies, start-ups).
  • How do incumbent regime actors position themselves vis-à-vis transformation processes in the socio-technical innovation system?
TRANSFORMATIVE OUTCOMES

- Specific understanding of dynamics of change in socio-technical systems
- Gosh et al (2021) define three general spatially-bounded macro processes
  1. Building and nurturing niches
  2. Expanding and mainstreaming niches
  3. Opening up and unlocking regimes
- In each of these 3 macro-processes, four sub-processes were identified which means a total of 12 transformative outcomes (TO) that actors can have control over
- The TO are not in any particular order and can “co-evolve through time and space”
IMPACT PATHWAYS & TRANSFORMATIVE OUTCOMES

Building & Nurturing Niches

<table>
<thead>
<tr>
<th>R&amp;I Projects</th>
<th>Living Labs</th>
<th>Accompl. Measures</th>
<th>Transformative Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Generation</td>
<td>Innovation</td>
<td>Knowledge Circulation &amp; Transfer</td>
<td>Shielding: protecting new and more sustainable practices from external influences and helping them grow</td>
</tr>
<tr>
<td>Network Creation</td>
<td>Enabling cooperation</td>
<td>Synthesising Knowledge</td>
<td>Learning: providing regular opportunities for discussing experiences, obstacles and needs related to a new practice as well as challenging related values and assumptions that people might have</td>
</tr>
<tr>
<td>System development</td>
<td></td>
<td></td>
<td>Networking: protecting and progressing new practices by gaining interest of more people and creating connections between them</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Navigating expectations: navigating and converging expectations of different actors the legitimacy of new practices is developed and their potential explored</td>
</tr>
</tbody>
</table>

• **Shielding of R&D activities** a key function of direct R&D funding and Living Labs.

• **Network creation** through R&I projects and specific instruments of the “Accompanying Measures”: gather research, user and policy communities and facilitate collective learning and networking.

• **Navigating expectations**: a deliberate result of the Accompanying Measures and System Development.
IMPACT PATHWAYS & TRANSFORMATIVE OUTCOMES

Expanding & Mainstreaming Niches

<table>
<thead>
<tr>
<th>R&amp;I Projects</th>
<th>Living Labs</th>
<th>Accompl. Measures</th>
<th>Transformative Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic valorisation</td>
<td>Upscaling</td>
<td></td>
<td><strong>Upscaling:</strong> conducting deliberate action to get more users involved into new and more sustainable practices</td>
</tr>
<tr>
<td>Transfer</td>
<td>Diffusion</td>
<td>Increasing</td>
<td><strong>Replicating:</strong> transferring the new and more sustainable practices to another location</td>
</tr>
<tr>
<td></td>
<td></td>
<td>qualification</td>
<td></td>
</tr>
<tr>
<td>Diffusion</td>
<td></td>
<td>Enabling cooperation</td>
<td><strong>Circulating:</strong> exchange of knowledge, ideas and resources between multiple related alternative practices</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Upscaling** in the living labs should turn into novel standard operations at the regime level and contribute to cost-reductions of these novel technologies.
- **Replicating:** Knowledge Transfer and Diffusion of R&I projects should enable transfer of new and more sustainable practices to other locations.
- **Circulating:** Activities of accompanying measures should speed up exchange of ideas and resources between multiple related alternative practices.
### IMPACT PATHWAYS & TRANSFORMATIVE OUTCOMES

#### Opening-Up and Unlocking Regimes

<table>
<thead>
<tr>
<th>R&amp;I Projects</th>
<th>Living Labs</th>
<th>Accomp. Measures</th>
<th>Transformative Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>De-aligning and destabilising regimes: disrupting and weakening dominant practices. This can be done by changing one of the dominant dimensions for example through the introduction of new policies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unlearning and deep learning of regime actors: dominant actors question their assumptions and change their view on the potential of new and more sustainable practices and the ability of the dominant practice to respond to threats and opportunities, such as climate change and digitalisation</td>
</tr>
</tbody>
</table>

- System development
  - Avoiding CO2 emissions: Transparency

- Network creation
  - Enabling cooperation: Strengthening regime-niche interactions: Frequency and quality of interactions between empowered actors from the niche and the regime on a non-competitive basis
  - Synthesising knowledge: Changing perceptions of landscape pressures: dominant actors to reach the point of view that immediate action is warranted, and new emerging more sustainable narratives need to be promoted

- Be aware that R&I policies and instruments might not be the most powerful tool to rely upon.
- Regulatory policies, changes in fiscal policies (prices/taxation) may challenge and trigger the search for new solutions much more effectively than technologically open R&I programmes.
OPERATIONALISIERUNG DER TRANSFORMATIVE OUTCOMES

• 53 Items in 13 Subskalen (4-5 Items pro Subskala)
  • Förderung und Schutz von neuen Innovationfeldern [Shielding]
  • Lernen und Erfahrungsaustausch [Learning 1]
  • Förderung des Bewusstseins für Problemstellungen und neue Lösungswege [Learning 2]
  • Vernetzung zwischen jungen Innovationsfeldern [Networking]
  • Management von Erwartungen und Förderung gemeinsamer Visionen [Navigating Expectations]
  • Ausweitung neuer Innovationsfelder [Upscaling]
  • Replikation innovativer Lösungen in neuen Kontexten [Replicating]
  • Verbreitung und Diffusion innovativer Lösungen und Konzepte [Circulating]
  • Institutionalisierung neuer Strategien und Normen [Institutionalising]
  • Aufbrechen von veralteten Strukturen und Strategien [De-aligning and destabilising regimes]
  • Aufgabe veralteter Gewohnheiten und Regeln [Unlearning and deep learning in regimes]
  • Austausch zwischen “alten” und “neuen” Wissensgebieten [Strengthening regime-niche interactions]
  • Flexible Reaktion auf veränderte Rahmenbedingungen [Changing perceptions of landscape pressures]
Erste Ergebnisse der Validierung des Transformative Outcomes Fragebogens:

- Ca. 2600 TeilnehmerInnen aus verschiedenen Fachgebieten der deutschen Energieforschung
- Konfirmatorische Faktorenanalysen bestätigen die angenommenen Subskalen
  - 13-Faktoren-Modell hat sehr gute Modellanpassung (SRMR/RMSEA < .03, CFI > .95), deutlich bessere Modellanpassung als 1- oder 3-Faktoren-Modell
- Alle Subskalen korrelieren positiv ($r = 0.30 – 0.48$) mit der zuvor erhobenen Einschätzung, ob Transformation insgesamt im eigenen Fachgebiet stattfindet.
REFLECTIONS AND NEXT STEPS

• Predominantly linear theories of change can be enhanced by integrating a multi-level perspective and transformative outcomes.
• The multi-level perspective facilitates…
  • a more dynamic perspective on the intervention mechanisms,
  • better integrating external factors at the regime and landscape level,
  • framing hypotheses and questions concerning the impact creation process.

• A key challenge remains the definition of indicators that reflect the complexity of transformation processes, while specifically detailing the contribution of a programme towards these processes.

AND NOW: 8th ENERGY RESEARCH PROGRAMME IS LOOKING AROUND THE CORNER, which will likely be mission-oriented …
THANK YOU!