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Kerlen
EVALUATION

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TOMORROW TODAY

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

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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

More ambitious climate targets: Reduce greenhouse gas emissions by at least 65% by 2030 and at least 88% by 2040 (both compared to 1990).

Climate neutrality: As early as 2045, Germany may only emit as many greenhouse gases as can be offset again through carbon absorption, e.g. in forests.

Mandatory maximum emission levels

Strengthen industrial location

Modernization,
Preservation &
Expansion of
Competencies,
Export opportunities

Drive the energy transition forward

Develop holistic, innovative
solutions & launch rapidly on the
market

Energy supply: environment-
friendly, secure, economical
Activate innovation dynamics

Comprehensive societal risk provision

Diversity of
technology options

Speed up the development of technological solutions, increase the **performance** of components and systems, accelerate the **transfer** of results, enhance **economic efficiency**, ensure **international competitiveness**, enable technical **scalability**, establish **standards** and enable interoperability, ensure **system integration**, ensure user perspective / **acceptance** / user-friendliness, facilitate cross-industry networking, increase the safety of technologies, components, systems, increase energy & resource efficiency at process, product life cycle & system levels, activate relevant stakeholders, ensure exploitability in Germany.

Specific objectives of the sectors, living labs, accompanying measures

Technologically-neutral funding,
Expansion of project funding around system integration & cross-system topics,
Focus: technology and innovation transfer & innovation-friendly framework conditions
Strengthening of international / European cooperation

- 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.

RESEARCH QUESTIONS

- 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).

APPROACH

Define strategic and operational objectives and design principles / instrumental setting (based on policy goals)

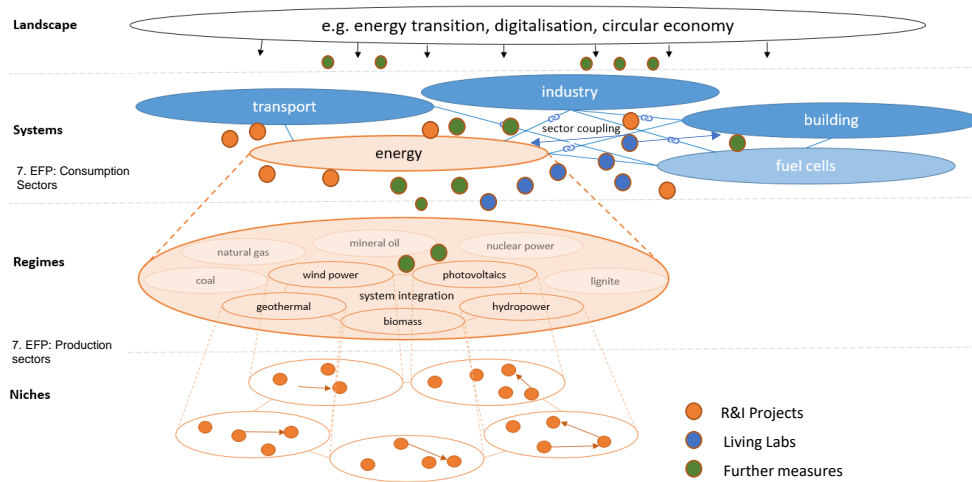
Elaborate a theory of change for each instrument

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 7TH EFP FROM A MULTI-LEVEL PERSPECTIVE



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):

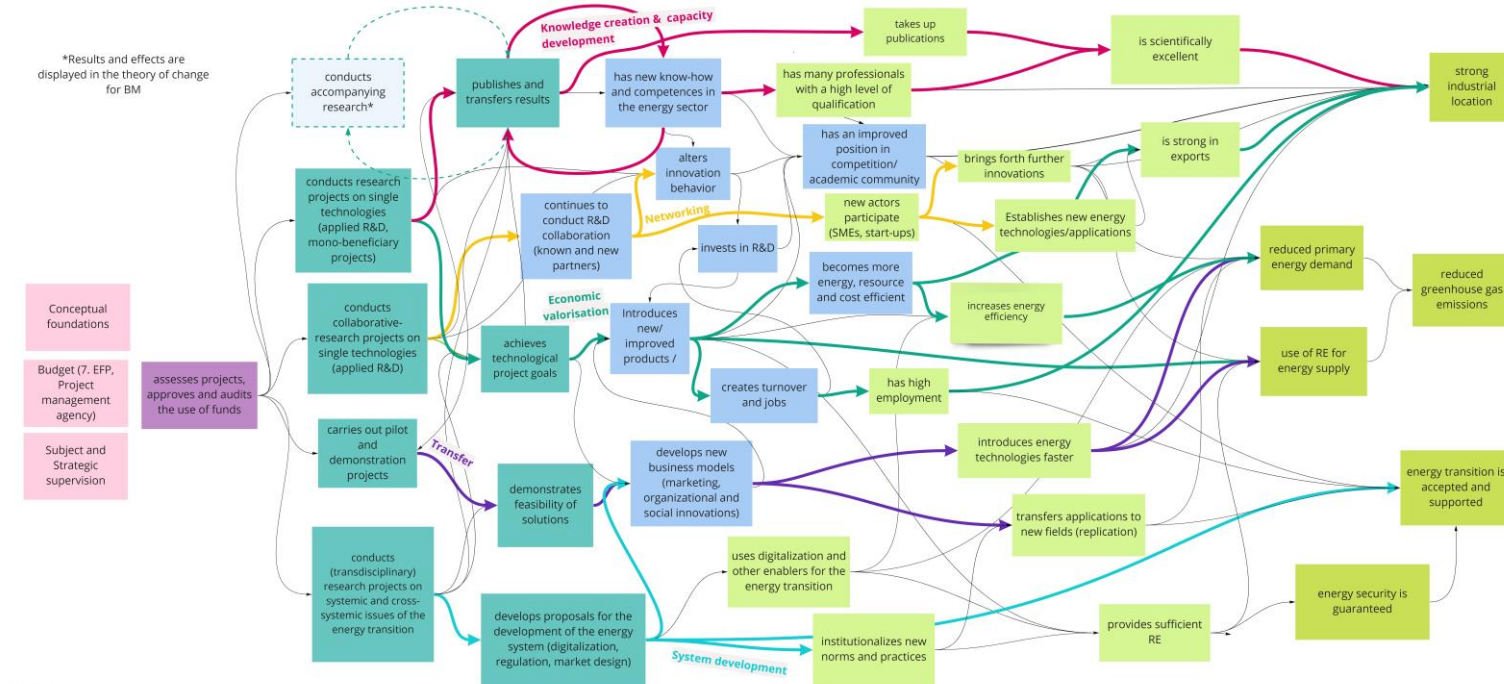
- Niches, which are protected spaces and the locus for radical innovations
- Socio-technical regimes, which represent the institutional structuring of existing systems leading to path dependence and incremental change; and

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.

THEORY OF CHANGE “R&I PROJECTS”

| | | | | | |
|--|--|---|--|---|---|
| Input BMWi: financial, human, or other resources invested in services or projects; including conceptual considerations. | Activities: Activities and measures taken by program stakeholders (see process flow for details). | Output: activities and achievements of the target group directly related to the measures. These include R&D activities, status meetings, networking activities, etc. | Outcomes: Results among the target groups (changes in knowledge, innovation behavior, internal organization and processes, cooperation) of the beneficiaries. | 1st order impact: effects in the energy system | 2nd order impact: long-term effects on society and the economy |
|--|--|---|--|---|---|



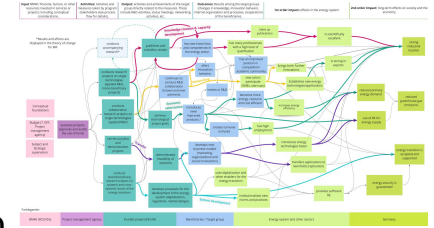
Farblegende:



PATHWAYS TO IMPACT

| R&I Projects, Pilots & Demonstrators | | Living Labs | | Accompanying Measures | |
|--|---|--|------------|--|--------------------------|
| Activities | Pathways | Activities | Pathways | Activities | Pathways |
| Individual R&I projects on single technologies | Knowledge creation & capacity development | Collaborative R&I in Living Lab contexts related to: <ul style="list-style-type: none"> Digitalisation, ICT development Reflection of experimentation clauses Developing and building industrial plants Test / pilot operation / demonstration Supplementary R&D on individual issues Living Lab Coordination | Innovation | Establishment and support for Energy Transition Research & Innovation Platform and Research Networks Accompanying research and studies Research Communication Public Relations at programme level | Synthesizing knowledge |
| Collaborative R&I projects on single technologies | | | Networking | | Upscaling |
| Pilot Projects & Demonstration projects | Economic valorisation | | Diffusion | | Enabling cooperation |
| Transdisciplinary research projects on systemic and cross-systemic issues of the energy transition | Transfer | | | | Increasing qualification |
| | System development | | | | Increasing transparency |

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”

3. Opening up and unlocking regimes

De-aligning
and
destabilising

Unlearning
and deep
learning

Strengthening
regime-niche
interactions

Changing
perceptions of
landscape
pressures

2. Expanding and mainstreaming niches

Upscaling

Circulating

Replicating

Institutionalising

1. Building and nurturing niches

Shielding

Learning

Networking

Navigating
expectations

IMPACT PATHWAYS & TRANSFORMATIVE OUTCOMES

Building & Nurturing Niches

| R&I Projects | Living Labs | Accomp. Measures | Transformative Outcomes |
|----------------------|-------------|----------------------------------|---|
| Knowledge Generation | Innovation | | Shielding: protecting new and more sustainable practices from external influences and helping them grow |
| | | Knowledge Circulation & Transfer | 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 |
| Network Creation | | Enabling cooperation | Networking: protecting and progressing new practices by gaining interest of more people and creating connections between them |
| System development | | Synthesising Knowledge | Navigating expectations: navigating and converging expectations of different actors the legitimacy of new practices is developed and their potential explored |

- **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

| R&I Projects | Living Labs | Accomp. Measures | Transformative Outcomes |
|-----------------------|-------------|--------------------------|--|
| Economic valorisation | Upscaling | | Upscaling: conducting deliberate action to get more users involved into new and more sustainable practices |
| Transfer | Diffusion | Increasing qualification | Replicating: transferring the new and more sustainable practices to another location |
| | | Enabling cooperation | Circulating: exchange of knowledge, ideas and resources between multiple related alternative practices |
| | Diffusion | | Institutionalising: turning new and more sustainable practices into more permanent and more widely available ones |

- **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

| R&I Projects | Living Labs | Accomp. Measures | Transformative Outcomes |
|--------------------|------------------------|------------------------|---|
| | | | 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 |
| System development | Avoiding CO2 emissions | Transparency | 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 |
| 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 |

- For **strengthening regime-niche interactions**, enabling cooperation (Accompanying Measures) and network creation are inherent tools, whereas Living Labs seek to deeply change the path of existing regimes through CO2 avoidance and sectoral diffusion of new solutions.
- 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.

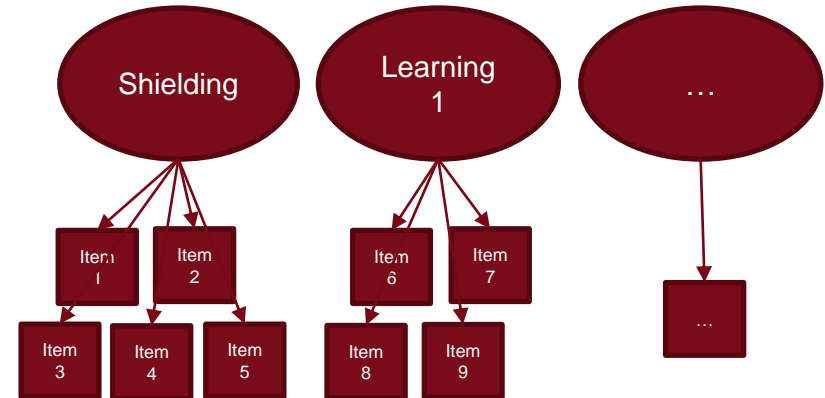
OPERATIONALISIERUNG DER TRANSFORMATIVE OUTCOMES

- 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]

OPERATIONALISIERUNG DER TRANSFORMATIVE OUTCOMES

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 ...



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THANK YOU!

