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EVALUATION

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A TRANSFORMATION-ORIENTED THEORY OF CHANGE: The accompanying evaluation of the 7th Energy Research Programme in Germany

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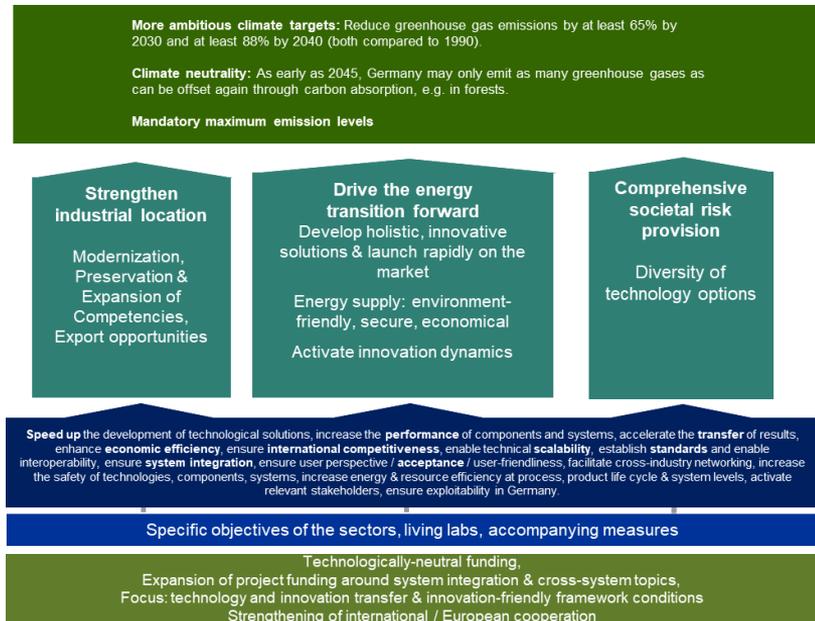
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INTRODUCTION

- 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 outstanding 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.

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

Delineation of strategic objectives, operational objectives and design principles/instrumental setting

Elaboration of a theory of change for each instrument

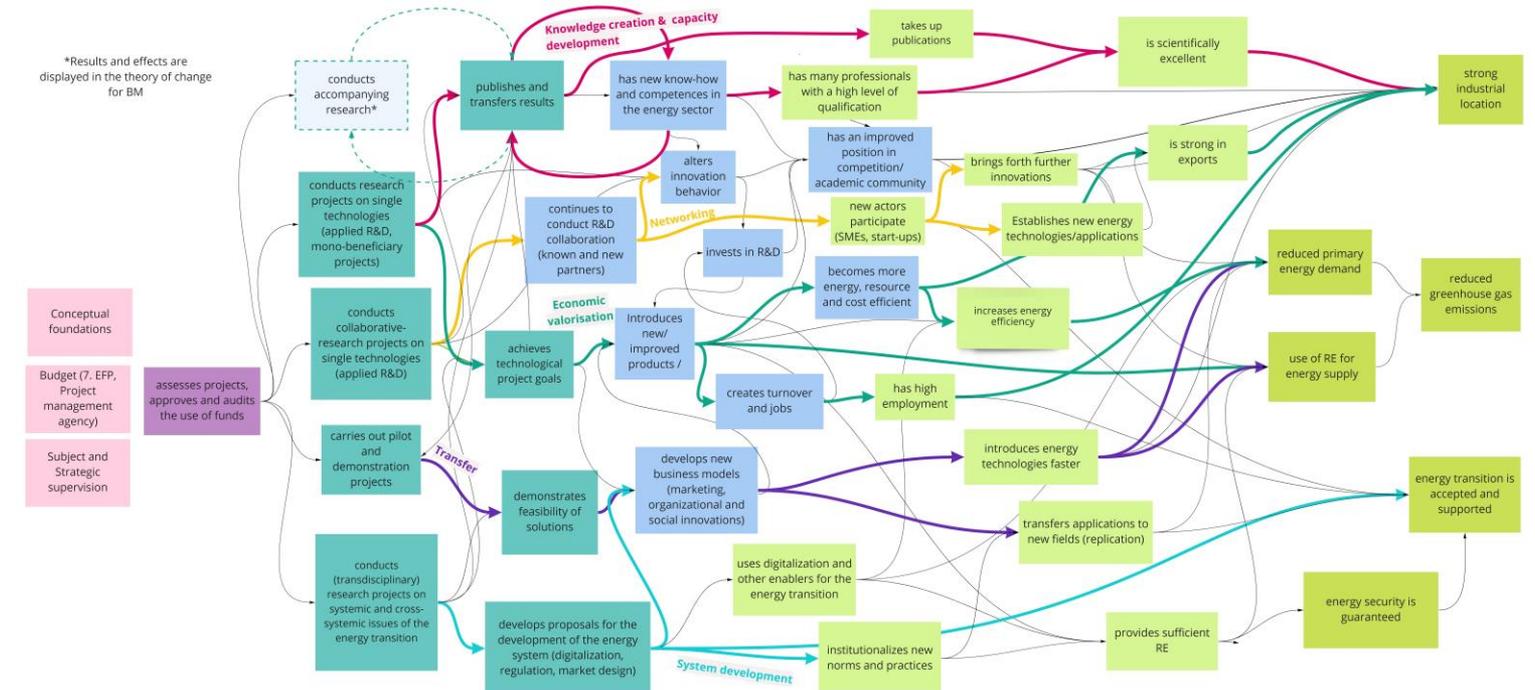
Identification of main impact pathways that intend to transform the energy system

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

Investigation of usability of concept of transformative outcomes to better understand the impact mechanisms of the programme and increase its evaluability.

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
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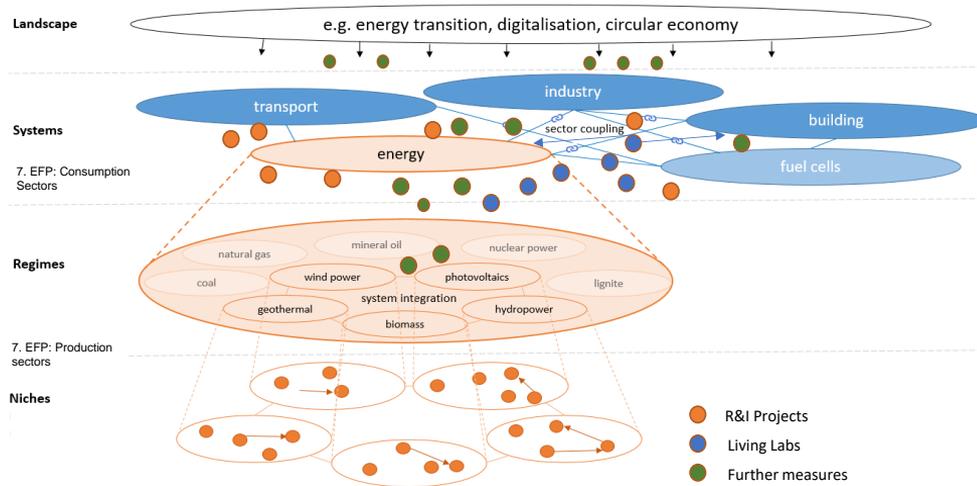
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PATHWAYS TO IMPACT

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:	Innovation	Establishment and support for Energy Transition Research & Innovation Platform and Research Networks	Synthesizing knowledge
Collaborative R&I projects on single technologies			Upscaling		Knowledge circulation & and transfer
Pilot Projects & Demonstration projects	Networking	<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 	Avoiding CO2 emissions	Accompanying research and studies	Enabling cooperation
Transdisciplinary research projects on systemic and cross-systemic issues of the energy transition	Economic valorisation		Diffusion		Research Communication
	Transfer		Living Lab Coordination		Public Relations at programme level
	System development				

THE 7TH EFP FROM A MULTI-LEVEL PERSPECTIVE



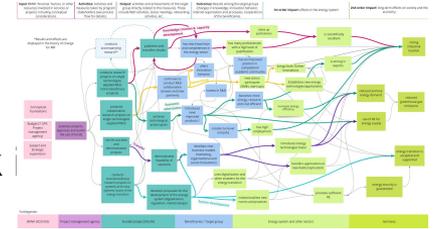
- The Multi-Level-Perspective was designed as a broad heuristic to capture transitions in different socio-technical systems such as mobility, energy or food (EEA 2018; Geels et al. 2017).

- 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
 - 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.
- Consideration of sector-specific targets reflecting challenges at the regime and system level.
- 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.

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 regime actors 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

Institutionalisin
g

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.
- Knowledge Transfer and Diffusion of R&I projects should enable transfer of new and more sustainable practices to other locations.
- 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.

RESEARCH DESIGN

- **3 survey rounds**
 - One project-lead per person > If there is more than one project leader per person, only one project will be surveyed
 - Two surveys during the project > Maximum of three surveys including the outline/application phase
 - Enables intertemporal comparison and consideration of project duration
 - Generally identical questions, possible exception: project and organisational data
- **Only necessary data is collected**
 - Organisational and socio-demographic data are provided by the client as far as possible
- **Implementation of the survey**
 - Online survey
 - Automated filtering
 - Automatic invitations and reminders

RESEARCH DESIGN

Operationalisation of transformative outcomes at system level

- Measurement of transformation process at the level of sectors
 - Climat-neutral/energy optimized buildings and quarters
 - System solutions for energy efficiency and renewable energy
 - Efficiency and reliability of thermic storages
 - Energy efficient technologies for local energy systems

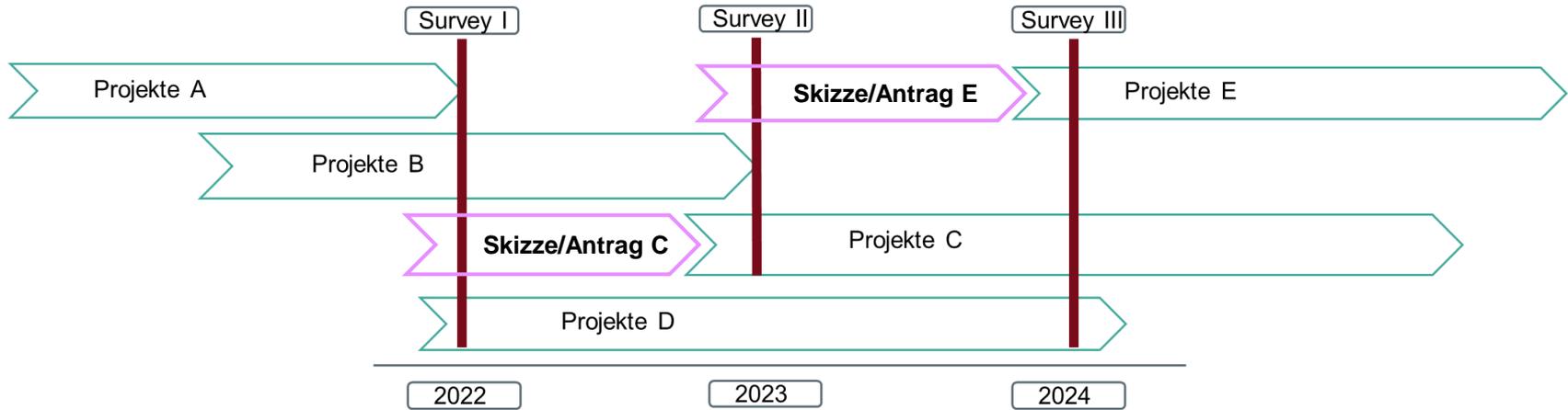
Intertemporal Comparison

- Identical formulation of questions allows direct comparison between Measurement times
- Identification of causal impact via control of common trends and consideration of project runtime

Control Group

- First questionnaire in phase of project development (Project exposes)
- Allows to compare the success between successful applicants and their projects in the second survey

RESEARCH DESIGN



OPERATIONALISATION OF TRANSFORMATIVE OUTCOMES

Before answering questions about the energy research programme itself and your project, please assess from your personal perspective the extent to which the following developments for the energy transition in Germany are taking place in your field [insert sector].

→ 53 Items in 13 subscales, e.g.:

Establishing and promoting new fields of innovation

- Development of new, ground-breaking solutions
- Establishment of new fields of knowledge
- Protecting new fields of innovation from dominant interests
- Protecting new fields of innovation from market influences
- Supporting pioneers

Learning and exchange of experience

- Learning about subject-specific problems
- Exchange of experience on innovative solutions
- Reflection on new solutions and their application
- Promotion of professional competences
- Open communication of failures

Promoting awareness of problems and new ways of solving them

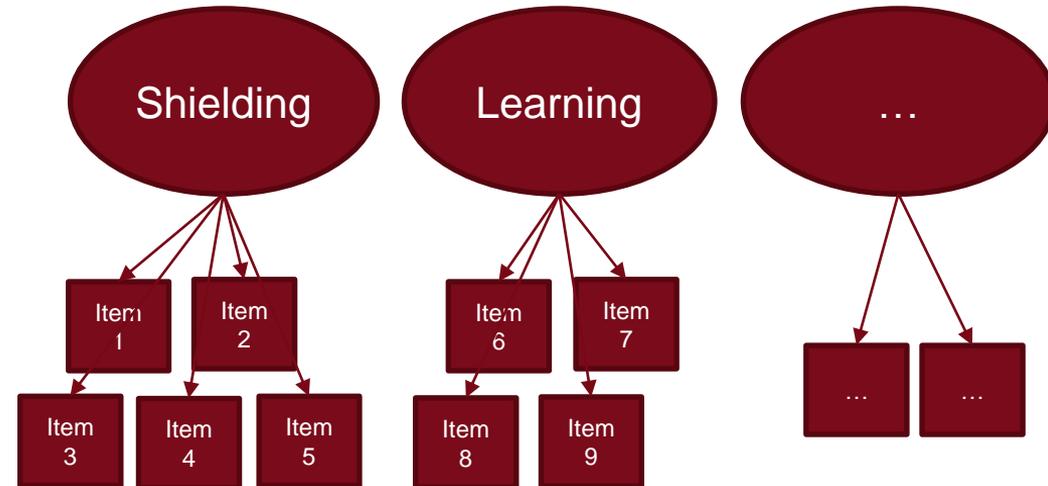
- Critical questioning of established basic assumptions
- Awareness of new ways of solving problems
- Questioning conventional ways of solving problems
- Breaking down established ways of working

Networking between young innovation fields

- Networking between young innovation fields
- Networking between new innovation actors
- Synergies between young innovation fields
- Cooperation between pioneers

OPERATIONALISATION OF TRANSFORMATIVE OUTCOMES

- Responses from ca. 2600 participants from various research and innovation fields.
- Confirmatory factor analysis supports assumed 13-factor model
 - SRMR/RMSEA < .03, CFI > .95
 - Much better fit than alternative specifications, such as 1- or 3-factor models
- Positive correlations of all subscales with item presented before on the perceived overall transformation in own field.



REFLECTIONS

- 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 on the one hand, while specifically detailing the contribution of a programme towards these processes on the other.
 - Inductively generated impact pathways can be looked at through the lens of transformative outcomes.
 - This theoretical embeddedness enhances evaluability of transformation-oriented R&I programmes and comparability with other transformative RTI programmes.

THANK YOU!

