sweet swiss energy research for the energy transition

PATHFNDR

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ETH zürich Empa PAUL SCHERRER INSTITUT PSI zh aw HOCHSCHULE LUZERN UNIVERSITÉ DE GENÈVE EPFL

PATHFNDR project kick-off

Project Team
31 May 2021

Overview: **Funding Programme**

SWEET Call 1-2020: Integration of renewables

Guiding theme:
Integration of renewables into a sustainable and resilient Swiss energy system.

Research challenges:
- Improve renewable energy system efficiency through flexibility and sector coupling.
- Integrate decentralised supply of renewable energy into the Swiss energy system.
- Enable renewables for heating and cooling.

SWEET Call 1-2021: Living & Working

Guiding theme:
Evolving future energy consumption due to new ways of living and working, different mobility behaviour or, increasing environmental awareness.

Research challenges:
- Investigate how energy supply and distribution can be ensured efficiently and cost-effectively.
- Explore how energy consumption and emissions can be minimised.
- Human behaviour, social norms, acceptance and changing values of the various actors also play a key role.

Deadline: 6 April and 16 June 2021

Overview: **Funding Programme**

SWEET Call 1-2020

PATHFNDR

Pathways to an efficient future energy system through flexibility and sector coupling

Host Institution:
ETH Zurich

EDGE

Enabling decentralized renewable generation in the Swiss cities, midlands, and the alps

Host Institution:
EPFL

DeCarbCH

Decarbonisation of cooling and heating in Switzerland

Host Institution:
University of Geneva

SURE

Sustainable and resilient energy for Switzerland

Host Institution:
Paul Scherrer Institute PSI

Overview: **Funding Programme**

SWEET Call 1-2020

PATHFNDR	EDGE	DeCarbCH	SURE

Joint activity coordination
May 2021– May 2023

Overview: **PATHFNDR in a nutshell**

Project title: PATHways to an Efficient Future Energy System through Flexibility aND SectoR Coupling

Project sponsor: Swiss Federal Office of Energy (SFOE)

Duration: 72 months (starting on 1 May 2021)

Host institution: ETH Zurich

Partner institutions: 7 partners – ETH Zurich, Empa, PSI, ZHAW, HSLU, UNIGE, EPFL

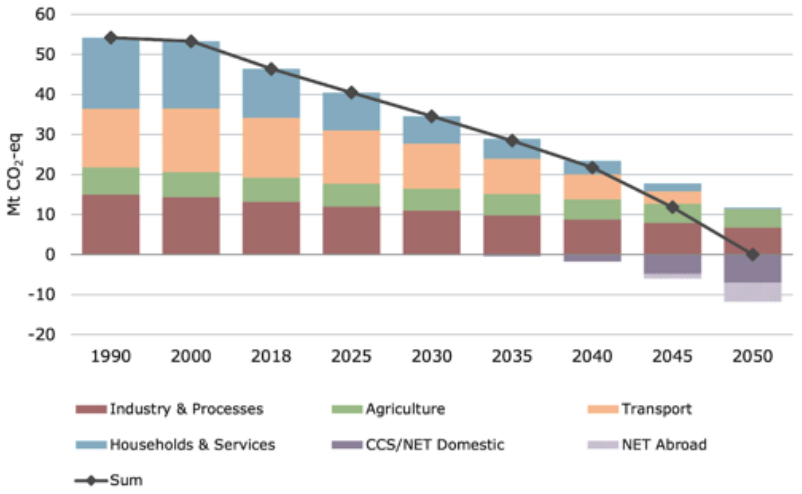
Cooperation partners: 25 partners from industry and research

Work packages: 10 work packages

In line with the vision of net-zero GHG emissions we imagine …

an efficient, flexible, resilient, cost-effective, and sustainable Swiss energy system by 2050.

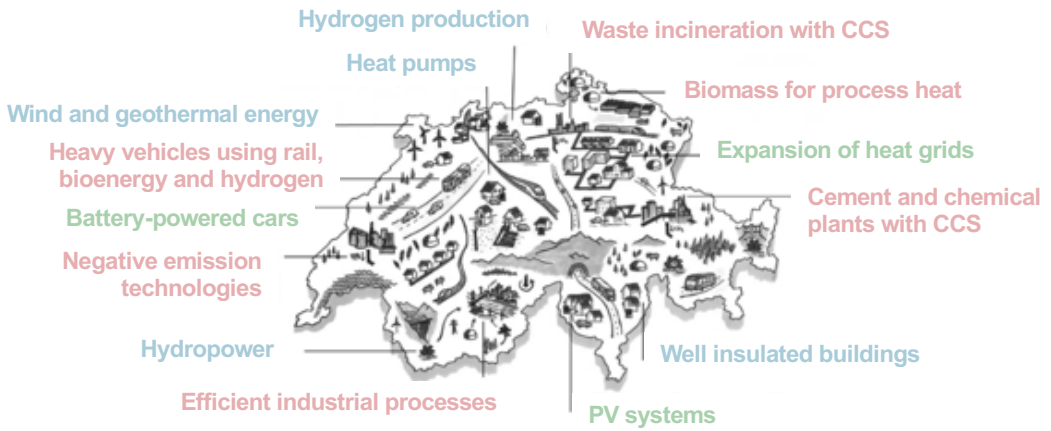
Climate-related emissions in Switzerland: net-zero scenario until 2050



Source: Energy Perspectives 2050+ (SFOE), Prognos AG / TEP Energy GmbH / INFRAS AG (2020)

Within this future, our main goal is to …

develop and analyze transition pathways for renewable energy integration in Switzerland.



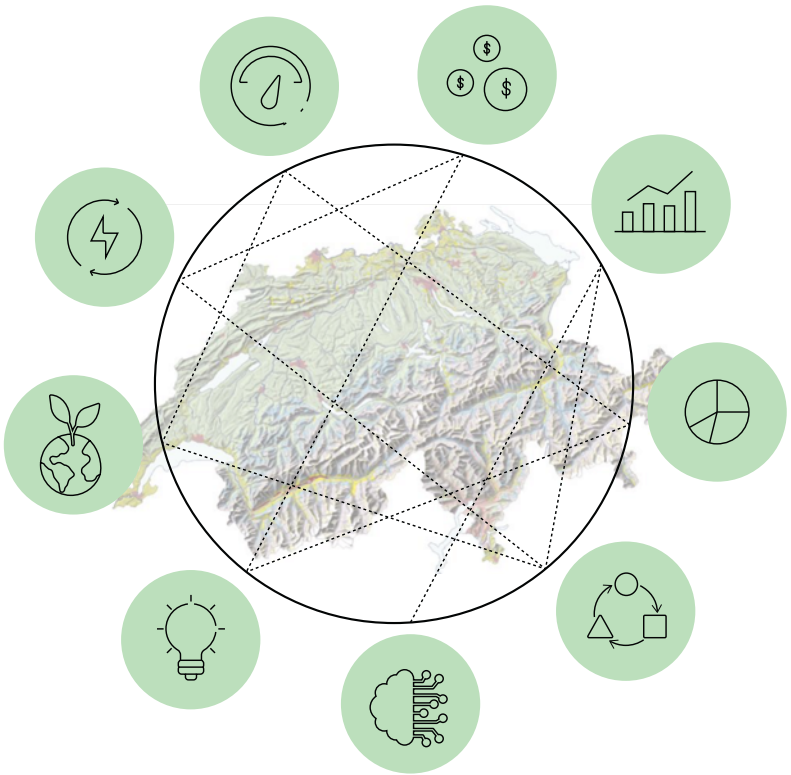
Source: based on Prognos AG, https://www.bfe.admin.ch/bfe/en/home/policy/energy-perspectives-2050-plus.html

What is our focus?

1. Improving performance
2. Enabling flexibility
3. Fostering sector coupling

1. Improving performance

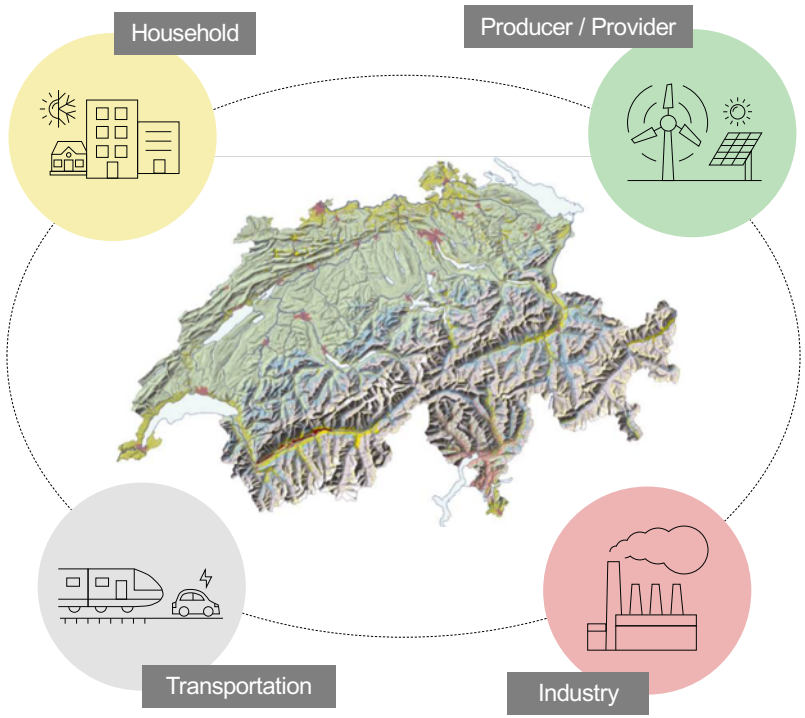
Identify synergies and tradeoffs between efficiency, resilience, cost-competitiveness, and sustainability of the Swiss energy system.



Source: Lea Ruefenacht (2021)

2. Enabling flexibility

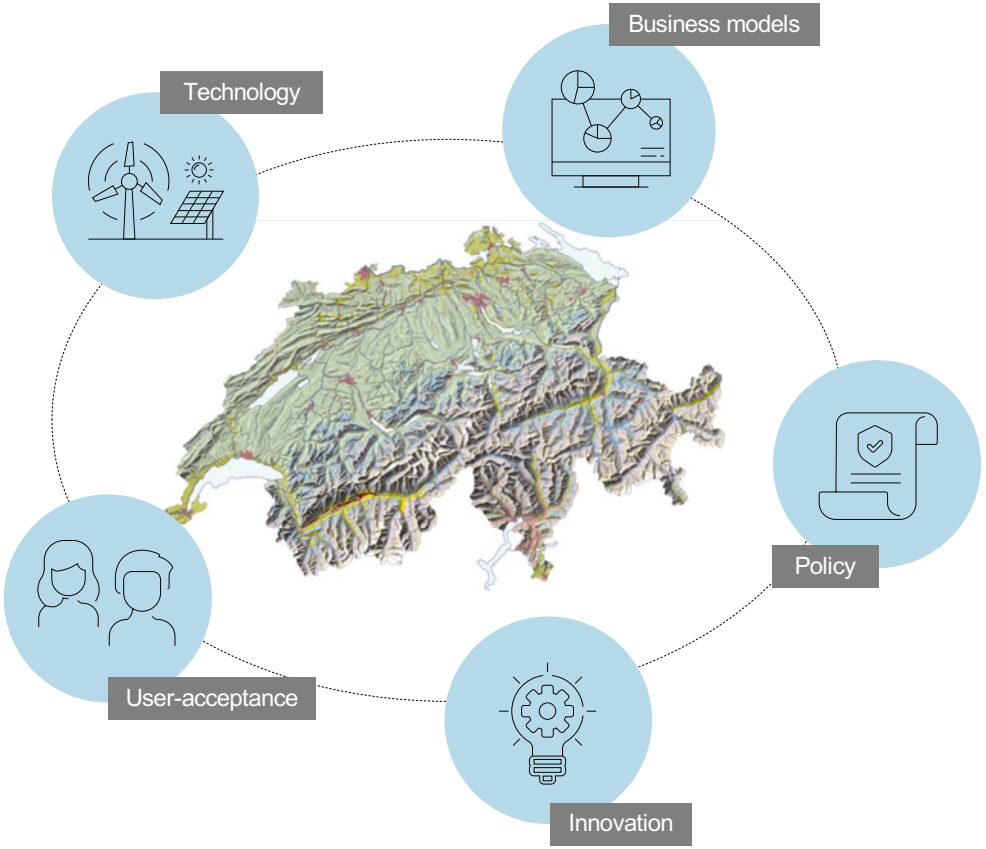
Assess flexibility options across various sectors and along various spatiotemporal scales to integrate renewable energy.



Source: Lea Ruefenacht (2021)

3. Fostering sector coupling

Evaluate technologies, business models, innovation strategies, policies and end-user acceptance for sector coupling.



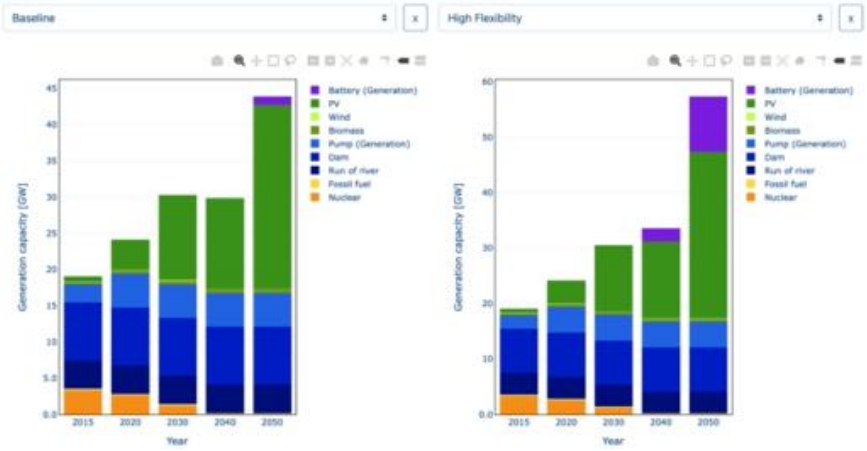
Source: Lea Ruefenacht (2021)

What results do we expect?

1. Feasible pathways
2. Planning and operation tools
3. Pilot and demonstration projects
4. Identifying new business opportunities and innovation strategies
5. Analysis of potential policies

1. Feasible pathways

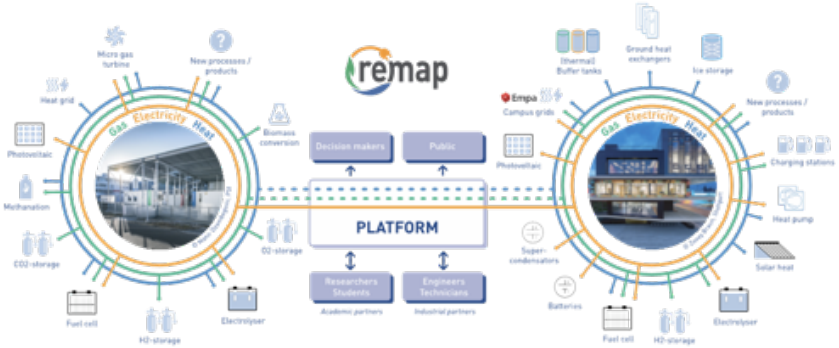
Pathways for the energy transition at international, national to city and district scales that enhance flexibility and sector coupling.



Source: Nexus-e Tool, https://nexus-e.org/results-flexibility-providers/

2. Planning and operation tools

Tools for planning and operation of distributed flexibility in multi-energy systems.



Source: ReMaP Platform, https://remap.ch

3. Pilot and demonstration projects

Pilot and demonstration projects of different flexibility market designs for existing and new technologies.

Source: NEST project EMPA, https://www.empa.ch/web/nest/urban-mining

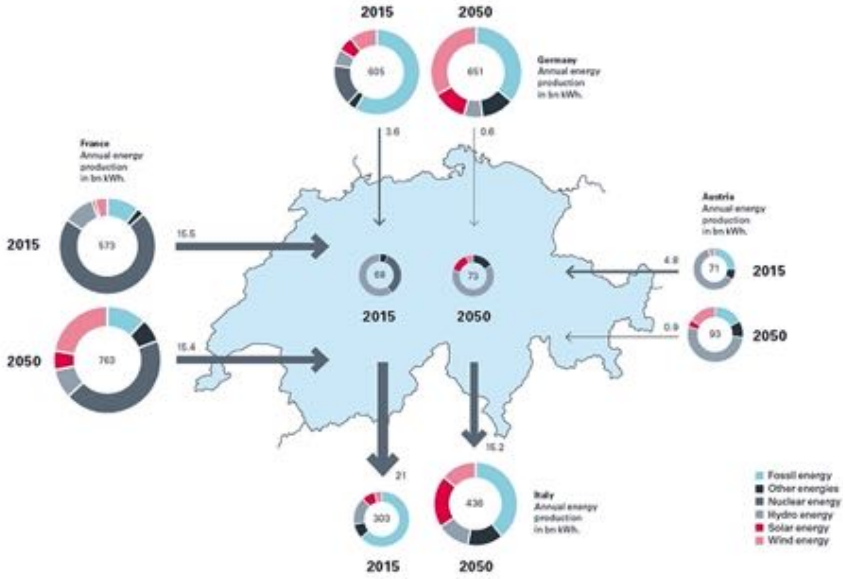
4. Identifying new business opportunities and innovation strategies

New business opportunities and innovation strategies to exploit novel flexibility and sector coupling options.

Source: Energyzed, https://www.energyzed.ch/2018/06/04/energiebarometer2018/

5. Analysis of potential policies

An analysis of potential policies for the energy transition and decarbonization of the Swiss energy system.



Source: Energy Transition, https://www.unibas.ch/en/News-Events/Uni-Nova/Uni-Nova-125/Uni-Nova-125-Swiss-electricity-flows-before-and-after-energy-transition.html

7 research partners

Stakeholders: **Steering Committee**

Prof. André Bardow
ETH Zurich
Project Director

Christian Schaffner
ETH Zurich
Deputy Director

Peter Richner
Empa
cc K. Orenhoenig, P. Heer

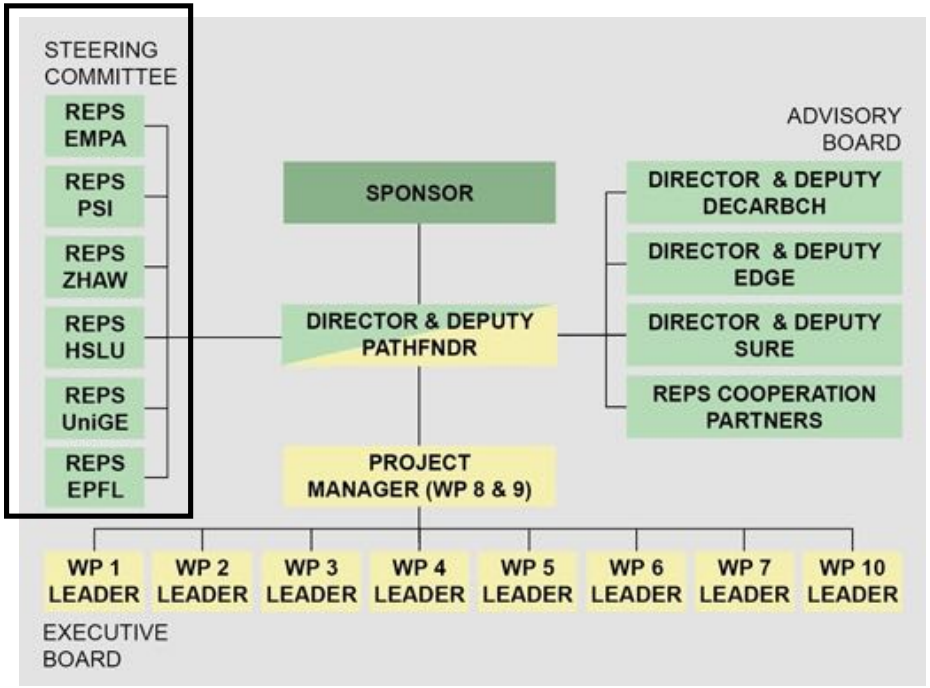
Thomas Schmidt
PSI
cc F. Büchi

Andreas Bergmann
ZHAW
cc C. Winzer, I. Schlecht, J. Markard

Willy Villasmil
HSLU

Evelina Trutnevyte
UNIGE

Mario Paolone
EPFL



Stakeholders: **Executive Board**

Prof. André Bardow
ETH Zurich
Project Director
WP 10 Leader

Christian Schaffner
ETH Zurich
Deputy Director
WP 8 & 9 Leader

Prof. Stefan Pfenninger
TU Delft
WP 1 Leader

Turhan Demiray
ETH Zurich
WP 2 Leader

Philipp Heer
Empa
WP 3 & 5 Leader

Kristina Orehounig
Empa
WP 3 & 5 Leader

Christian Winzer
ZHAW
WP 4 Leader

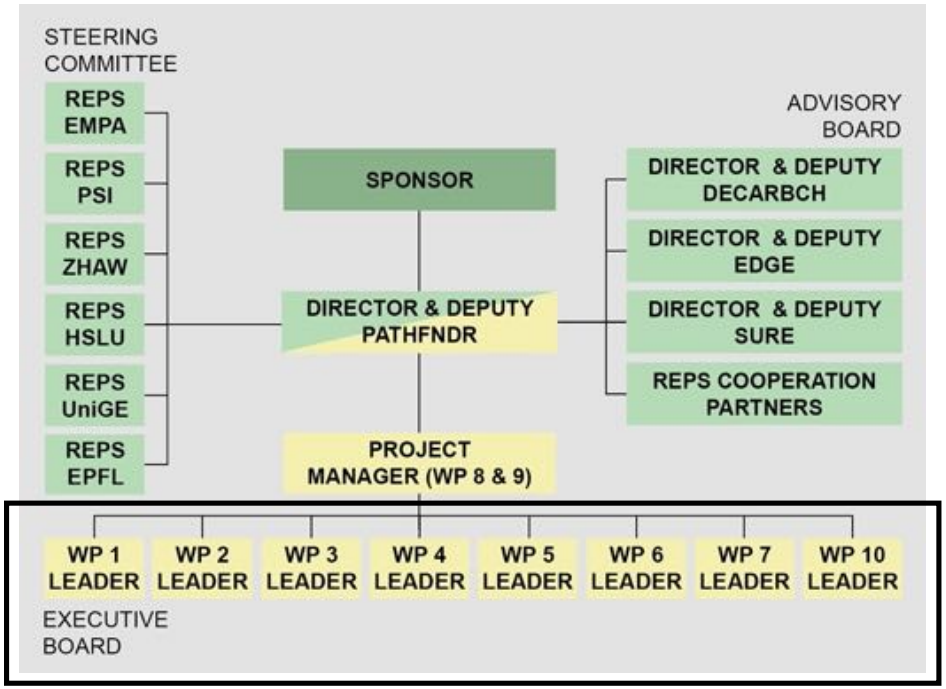
Ingmar Schlecht
ZHAW
WP 4 Leader

Annegret Stephan
ETH Zurich
WP 6 Leader

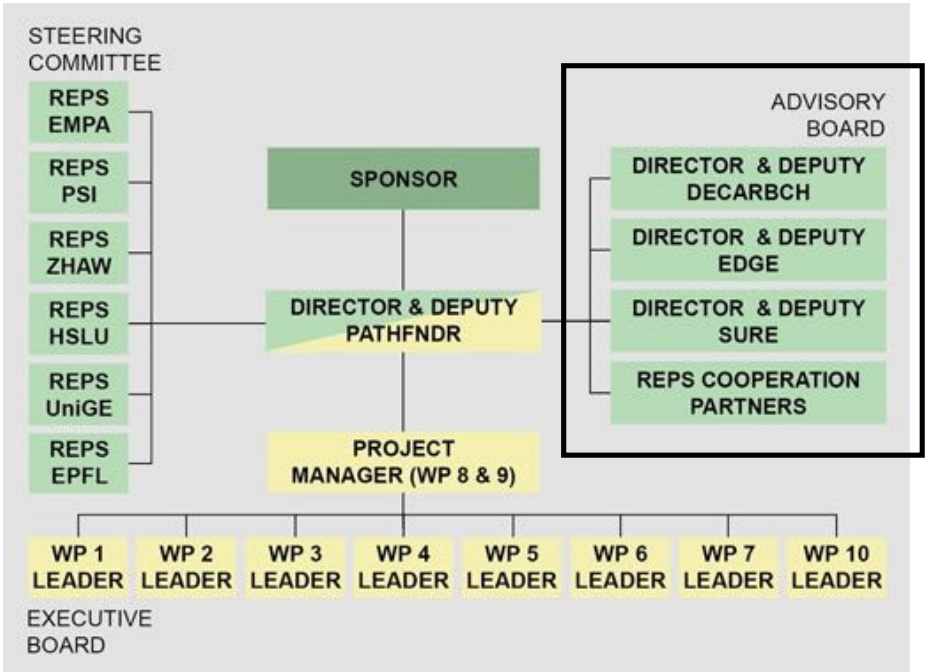
Jochen Markard
ZHAW
WP 6 Leader

Prof. Anthony Patt
ETH Zurich
WP 7 Leader

Lea Ruefenacht
ETH Zurich
Project Manager
WP 8 & 9 Leader



Stakeholders: **Advisory Board**



Stakeholders: **PI and WP Leaders** *(current state)*

Prof. André Bardow
ETH Zurich
Project Director

Christian Schaffner
ETH Zurich
Deputy Director

Prof. Volker Hoffmann
ETH Zurich

Prof. Gabriela Hug
ETH Zurich

Prof. Giovanni Sansavini
ETH Zurich

Prof. Anthony Patt
ETH Zurich

Prof. Marco Mazzotti
ETH Zurich

Turhan Demiray
ETH Zurich

Prof. Stefan Pfenninger
TU Delft

Annegret Stephan
ETH Zurich

Lea Ruefenacht
ETH Zurich
Project Manager

Kristina Orehounig
Empa

Martin Rüdisüli
Empa

Andrew Bollinger
Empa

Philipp Heer
Empa

Felix N. Büchi
PSI

Jochen Markard
ZHAW

Ingmar Schlecht
ZHAW

Christian Winzer
ZHAW

Willy Villasmil
HSLU

Prof. Evelina Trutnevyte
Université de Genève

Prof. Tobias Brosch
Université de Genève

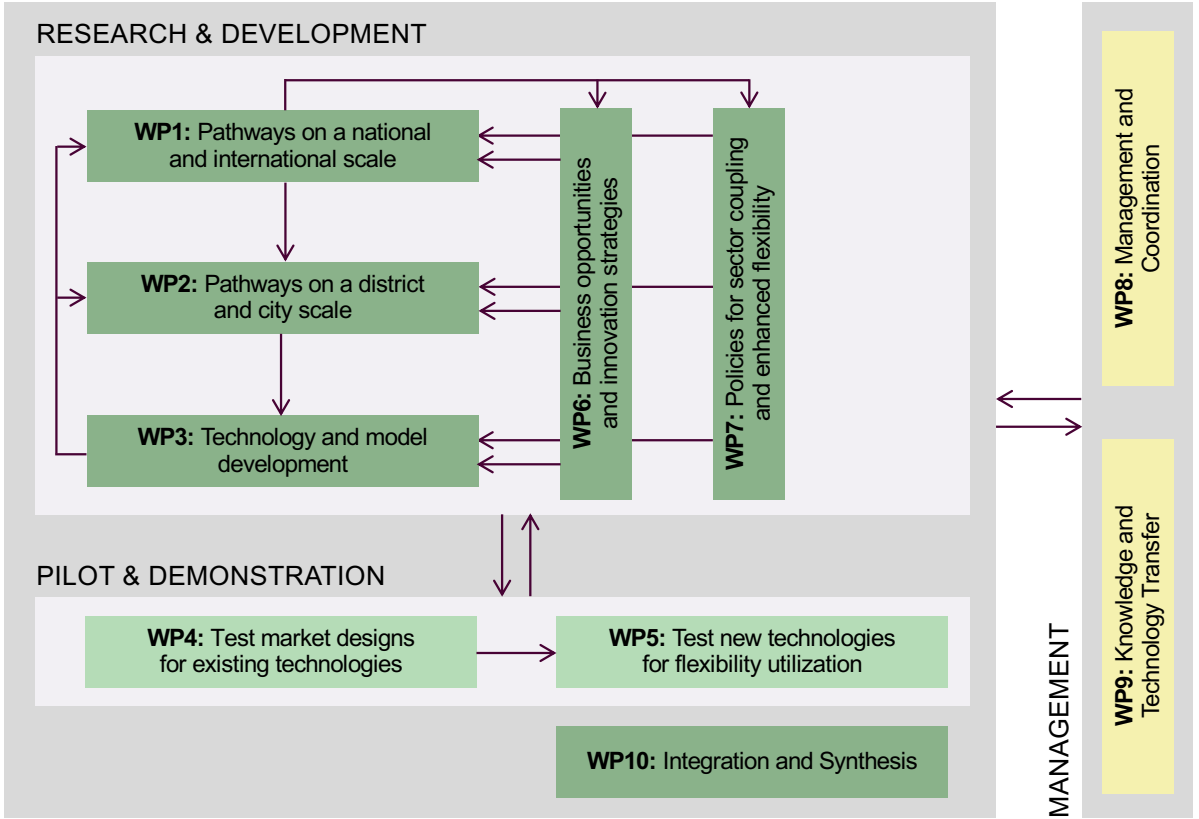
Prof. Mario Paolone
EPFL

25 cooperation partners

Stakeholders: **Cooperation Partners**

- **4 areas** of collaboration
- **Workshops** to identify expectations and needs
- **Non-Disclosure Agreement** (based on a template)

Goals: **Work package overview**



Research & Development

WP1: Pathways on a national and international scale

Leader: Stefan Pfenninger (ETH Zurich/TU Delft)

Type: Research & Development

Objectives:

- Quantify large-scale energy scenarios for Switzerland embedded within its European context
- Understand trade-offs between different Swiss pathways
- Deliver methodological advances in multi-level modelling

Expected outcomes:

- Detailed scenarios for use in decision support
- Models and data for use by the consortium and third parties
- Methodological advancements in energy system modelling

Start (Duration): Month 1 (60 months)

Source: https://en.wikipedia.org/wiki/Switzerland#/media/File:Europe-Switzerland.svg

WP2: Pathways on a district and city scale

Leader: Turhan Demiray (ETH Zurich)

Type: Research & Development

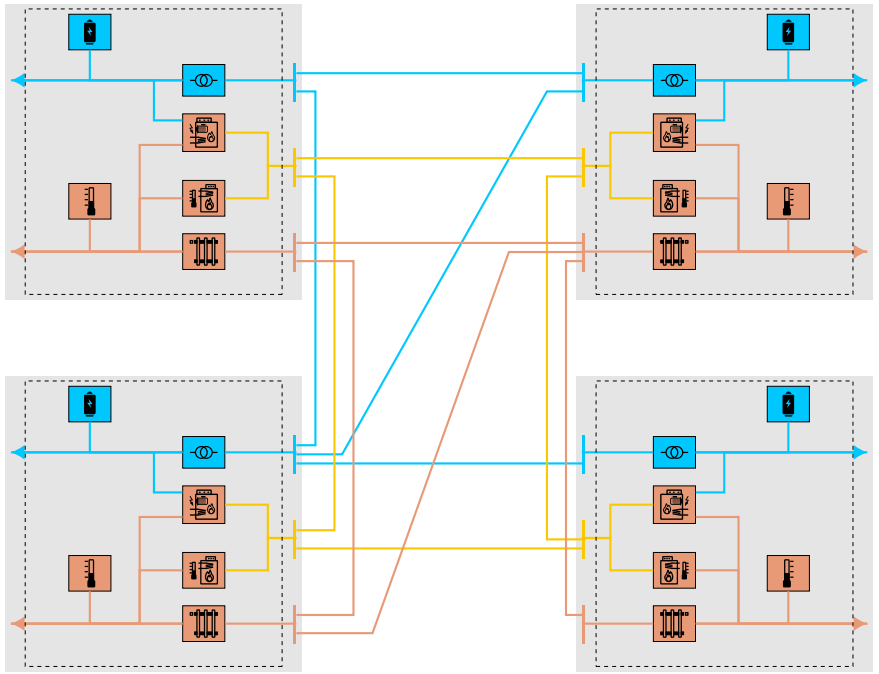
Objectives:

- Determine an optimal pathway to a renewable flexible energy system at local/regional level
- Enable the holistic utilization of the distributed and abundant flexibility, stemming from all energy carriers
- Propose optimal infrastructure expansion and operational strategies for Swiss local energy utilities

Expected outcomes:

- Devise future investments and operational strategies for energy networks leveraging the value of flexibility
- Devise appropriate targets and regulations towards achieving the targets of the Energy Strategy 2050
- Provide validated use-cases with ready-to-use guidelines exploiting flexibility

Start (Duration): Month 1 (60 months)



Source: Turhan Demiray (2018)

WP3: Technology and model development

Leader: Philipp Heer (Empa) & Massimo Fiorentini (Empa)

Type: Research & Development

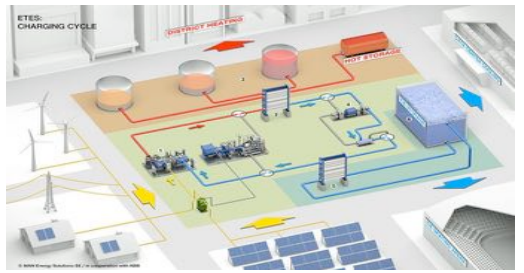
Objectives:

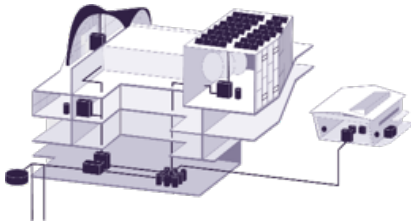
- Methodology development
  - Develop and implement a generalized composable method for the decentralized control of coupled energy networks
  - Develop multi-period flexibility envelope methodology for online control of districts
- Technology development
  - High-capacity seasonal thermal storage technologies
  - Advanced thermal management of Power-to-X
  - Assessment of Carnot Batteries for the Swiss context
- Model development
  - H2/O2 to H2/air hydrogen and thermal energy storage
  - Sector coupling technologies, borehole thermal energy storage
  - Development of systemic flexibility aware technology models
- Experimental validation on
  - EPFL Smart Grid campus infrastructure
  - Empa ehub, NEST and move platforms
  - PSI ESI demonstrator

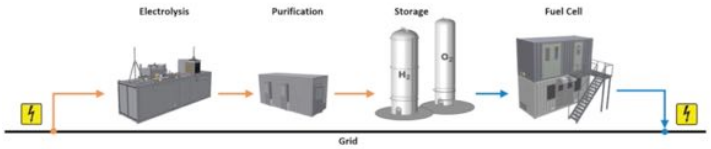
Expected outcomes:

- Technology model quantify an energy systems' capability for a flexible operation

Start (Duration): Month 1 (48 months)







Source: (from top to bottom) Paolone Mario (2021), MAN Energy Solutions (2021), Heer Philipp (2021), Büchi Felix (2021)

WP6: Business opportunities and innovation strategies

Leader: Annegret Stephan (ETH Zurich) & Jochen Markard (ZHAW)

Type: Research & Development

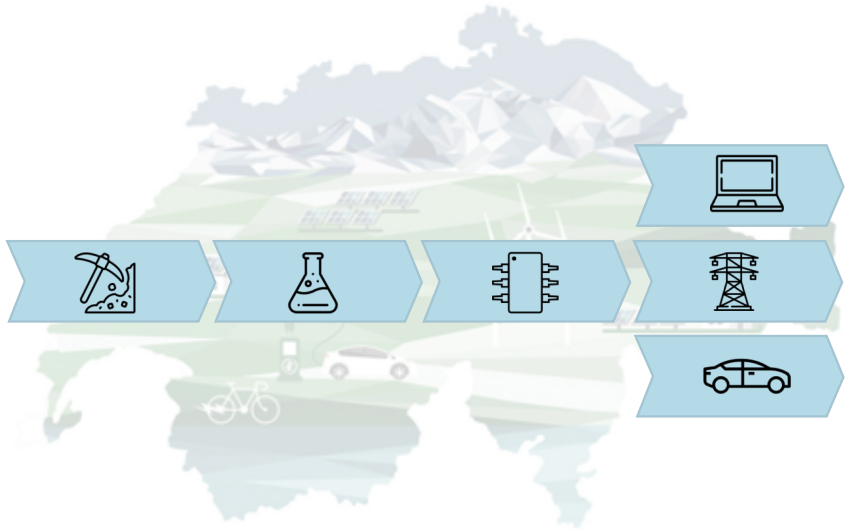
Objectives:

- Systematically map potential disruptions and business interests
- Identify coordination challenges and strategies to address them
- Develop new insights and tools to support strategic decision-making at the firm level

Expected outcomes:

- System level: disruptions, business interests, and response strategies to cross-sector disruption
- Value chain level: value chain linkages, value chain processes, and innovation processes
- Firm level: technology overviews, innovation strategies, and business models and decision-making tools

Start (Duration): Month 1 (60 months)



Source: Annegret Stephan (2020)

WP7: Policies for sector coupling and enhanced flexibility

Leader: Anthony Patt (ETH Zurich)

Type: Research & Development

Objectives:

- Analyze the policy mix, political feasibility and effects of energy transition policies across Europe
- Appraise the economic, social, and environmental consequences of these policies for decarbonizing the Swiss energy system
- Identify the factors leading to greater or lesser public acceptance of alternative policy approaches

Expected outcomes:

- Identify policy mixes addressing specific barriers to change.
- Identify the distribution of economic and social outcomes associated with different policy instruments and mixes.
- Informed citizen panels identify politically feasible policy options.

Start (Duration): Month 13 (48 months)

Source: Swiss National Council (2020), https://www.htr.ch/story/nationalrat-will-der-reisebranche-in-der-corona-krise-helfen-28834.html

WP10: Integration and Synthesis

Leader: André Bardow and Christian Schaffner (ETH Zurich)

Type: -

Objectives:

- Develop a joint position of the involved research groups
- Synthesize and integrate the activities in WP1-7

Expected outcomes:

- Integrated scenarios
- Synthesis view of the consortium on the research challenge
- Two P&D proposals

Start (Duration): Month 1 (72 months)

Source: Name Lastname (YYYY), link

Pilot & Demonstration

WP4: Test market designs for existing technologies

Leader: Christian Winzer and Ingmar Schlecht (ZHAW)

Type: Pilot & Demonstration

Objectives:

- Demonstrate benefits of optimal flexibility dispatch and investment for multi-energy systems
- Test the impact of different flexibility market designs and incentives
- Explore approaches for linking local flexibility markets with surrounding markets

Expected outcomes:

- Optimal multi-energy dispatch algorithms
- Performance of local flexibility market designs and incentives
- Suggestions for avoiding strategic bidding in coupled markets

Start (Duration): Month 22 (48 months)

Source: Istockphoto

WP5: Test new technologies for flexible use

Leader: Kristina Orehounig (Empa) & Philipp Heer (Empa)

Type: Pilot & Demonstration

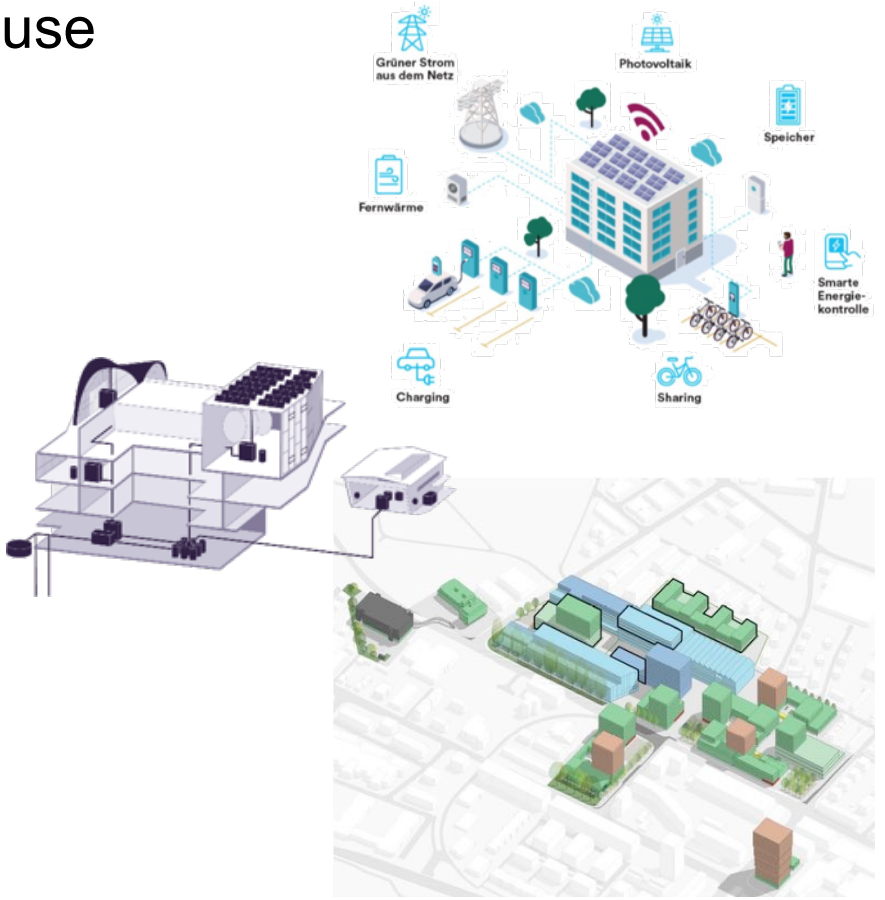
Objectives:

- Developments of WP 1-3. 6&7 concretized for industry needs
- Prototypical validation of novel flexibility concepts
- Propagation of flexibility solutions to partners and into the market

Expected outcomes:

- Core developments of WP 1-3 implemented in industry setting (TRL 7)
- Feasibility of R&D developments evaluated

Start (Duration): Month 25 (48 months) → *Shaping of project will start in Month 3*



Source: (from top to bottom) Primeo Energie (2021), Heer Philipp (2021), Frei Tobias (2021)

Management

WP8: Management and coordination

Leader: Christian Schaffner and Lea Ruefenacht (ETH Zurich)

Type: Management

Objectives:

- Whole project management
- Progress monitoring and control
- Data, risk and quality management

Expected outcomes:

- Progress and final reports
- Progress monitoring platform
- Project management plans (e.g., scope, communication, quality, risk, data management plan)

Start (Duration): Month 1 (72 months)

Source: PATHFNDR (2021)

WP9: Knowledge and technology transfer (KTT)

Leader: Christian Schaffner and Lea Ruefenacht (ETH Zurich)

Type: Management

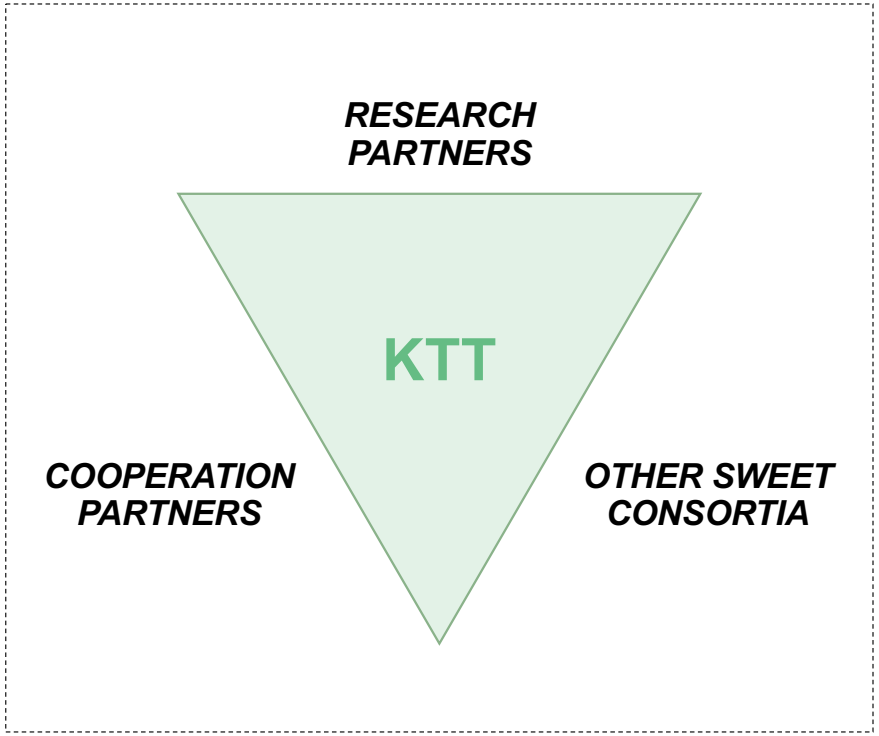
Objectives:

- Ensure the KTT between research partners, cooperation partners, and other SWEET consortia
- Disseminate and exploit the project results nationally and internationally
- Identify KT gaps for future research

Expected outcomes:

- Publications (synthesis reports, articles, newsletters)
- Communication (events, website, social media)
- Open-access database

Start (Duration): Month 1 (72 months)



Source: PATHFNDR (2021)

Goals: **Next deliverables** *(next 12 months)*

WORK PACKAGE	MILESTONE ID	DELIVERABLE	OWNER INSTITUTION	OWNER NAME	DEADLINE	TIME LEFT	PROGRESS
WP1	M1.1.2.1	Initial quantification of hourly end-energy demands and their shifting potentials across Europe	EMPA	Rüdisüli	30.04.2022	11 months	0%
WP1	M1.2.2.1	Conceptual model on how to integrate the transportation sector into the existing Nexus-e platform	ETHZ	Schaffner	30.04.2022	11 months	0%
WP1	M1.2.3.1	Development of the gas network model at the national scale	ETHZ	Sansavini	30.04.2022	11 months	0%
WP1	M1.3.2.1	Define test-cases for the typical incentive problems arising from coupling local markets to zonal markets	ZHAW	Winzer	30.04.2022	11 months	0%
WP6	M6.2.1.1	Technology value chains identified and understood, linkages due to sector coupling identified and analyzed	ETHZ	Stephan	30.04.2022	11 months	0%
WP6	M6.3.1.1	Strategically important technologies (physical vs. digital; core vs. peripheral) identified and analyzed	ETHZ	Stephan	30.04.2022	11 months	0%
WP9	M9.1.1	SWEET knowledge sharing workshop	ETHZ	Schaffner/Ruefenacht	30.04.2022	11 months	0%
WP9	M9.3.1	Website online	ETHZ	Schaffner/Ruefenacht	31.10.2021	5 months	0%
WP9	M9.4.1	PATHFNDR on social media	ETHZ	Schaffner/Ruefenacht	31.10.2021	5 months	0%
WP9	M9.4.2.1	Newsletter available	ETHZ	Schaffner/Ruefenacht	31.10.2021	5 months	0%
WP9	M9.5.1	Annual synthesis reports	ETHZ	Schaffner/Ruefenacht	30.04.2022	11 months	0%
WP10	M10.2.1	Consortium-wide workshops on research questions Q1-Q5	ETHZ	Bardow	31.01.2022	8 months	0%

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