ETH
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IED

Environmental problems, transdisciplinary research and managing sustainability transformations – the case of the energy system

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What to be dealt with?

1. Motivation – Why do we need transdisciplinarity for sustainably changing the energy systems

2. Theory

   a) Transdisciplinary research and Transdisciplinary processes? Definitions, functions, products

   b) Sustain-abilities" for designing resilient Human-Environment Systems

3. Cases

   (1) Missing "sustain-abilities" in the Swedish (2006) Bioethanol-"Oil Free Society" case

   (2) Appenzell-Ausserrhoden: Td-processes on sustainable energy strategies

   (3) Vulnerability and Potential Assessment of the Swiss Energy System

4. Conclusions

1. Motivation – Why do we need transdisciplinarity for sustainably changing the energy systems

1. Motivation – Why do we need transdisciplinarity for sustainably changing the energy systems

Any technological change in the 21st century has global impacts

Times have changed:
We live in the age of the "anthropocene"

- The anthropocene
  - "We live in the age of the anthropocene" (Crutzen 2002). Human has become a geological factor.
  - anthropocenically ≠ anthropogenically ≠ anthropocentrically
  - Holocene (1867; Greek: holos "whole" + kainos (re + ken) "new, recent")
  - Anthropocenical refers to the age of the anthropocene (contrary to anthropogenical = anthropo- + genes; born by humans)

- Anthropocenical = shaped by the impacts of the age of anthropocene (a historical/evolutionary perspective)
  - Anthropogenically = created/shaped by human

There is “no press button” solution for sustainable transitions

Sustainability/sustainable development is an

- ongoing inquiry
- on system limit management (avoiding “hard-landing”, avoidable or unwanted collapses)
- in the frame of intra- and intergenerational justice

Laws, D., Scholz, R. W., Shiroyama, H., Susskind, L., Suzuki, T. & Weber O. (2004). Expert Views on Sustainability and Technology Implementation. *International Journal of Sustainable Development and World Ecology, Vol. 11*(3), pp. 247-261

The Swedish 2006 “Oil-free society – Go for Bioethanol case

- Sweden:
  - 9.3 mill. inhabitants
  - 20.3 persons per km^2
- Governmental Decision
  - Febr. 2006: “Oil free society till 2020”
  - “Go for bioethanol”

Is this a feasible and sustainable decision?

Part 2: Theory
2a. What is transdisciplinarity?

It is essentially different from

disciplinarity

and

interdisciplinarity

Clarifying concepts: Disciplinarity, interdisciplinarity, transdisciplinarity

- **Disciplines** are characterized (defined) by (i) objects and (ii) (core) methods.
  - Mathematics: (i) Numbers, symbols (ii) proof
  - Pharmacy: (i) chemical impacts on diseases, (ii) natural science experiments
- **Interdisciplinarity** is established by the **fusion of concepts** or **methods** from different disciplines
  - The saxophone emerged from clarinet and trumpet
  - Bio-chemistry: Chemical processes in living organisms
- **Transdisciplinarity is essentially different from interdisciplinarity**!
  - Not our definition: “A transdisciplinary approach dissolves boundaries between disciplines“ http://en.wikipedia.org/wiki/Interdisciplinary#Transdisciplinarity, Jan. 14th, 2006

Definitions of transdisciplinarity

(see Scholz, R. W. (2011). *Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge: Cambridge University , p. 367)*

1. **Mode 1 transdisciplinarity**: Science becomes transdsiciplinary if it reflects on real life problems (Mittelstrass, 1996)

2. **Zurich 2000 definition**: Cooperation between non-academia and science (with different reference systems); co-leadership; mutual learning (on equal footing); knowledge integration (Scholz 2000, Häberli et al. 2001, [Gibbons et al. 1994])

3. **Post modern conception**: Similar to the Zürich 2000 definition; but science just becomes one voice/vote, approaching truth in complex contextualized settings becomes obsolete (Funtowicz & Ravetz, 2008)

4. **Charter of transdisciplinarity**: Td requires a personal moral commitment “challenging that the dignity of the human being is of both planetary and cosmic dimensions.” (Freitas et al. 1994; Nicolescu, 2002)

Zurich 2000 definition

- From a research perspective, transdisciplinarity
  (Thompson Klein et al. 2001)
  - Organizes processes of **mutual learning** among science and society
  - Is an appropriate "**research paradigm** that better reflects the complexity and multidimensionality of sustainability" (Martens, 2005)
  - **Integrates knowledge and values** (e.g. what questions to be answered) from **society** in research
- Transdisciplinarity has been declared as the appropriate methodology by which a sustainable development should be investigated and promoted (Scholz & Marks 2001)

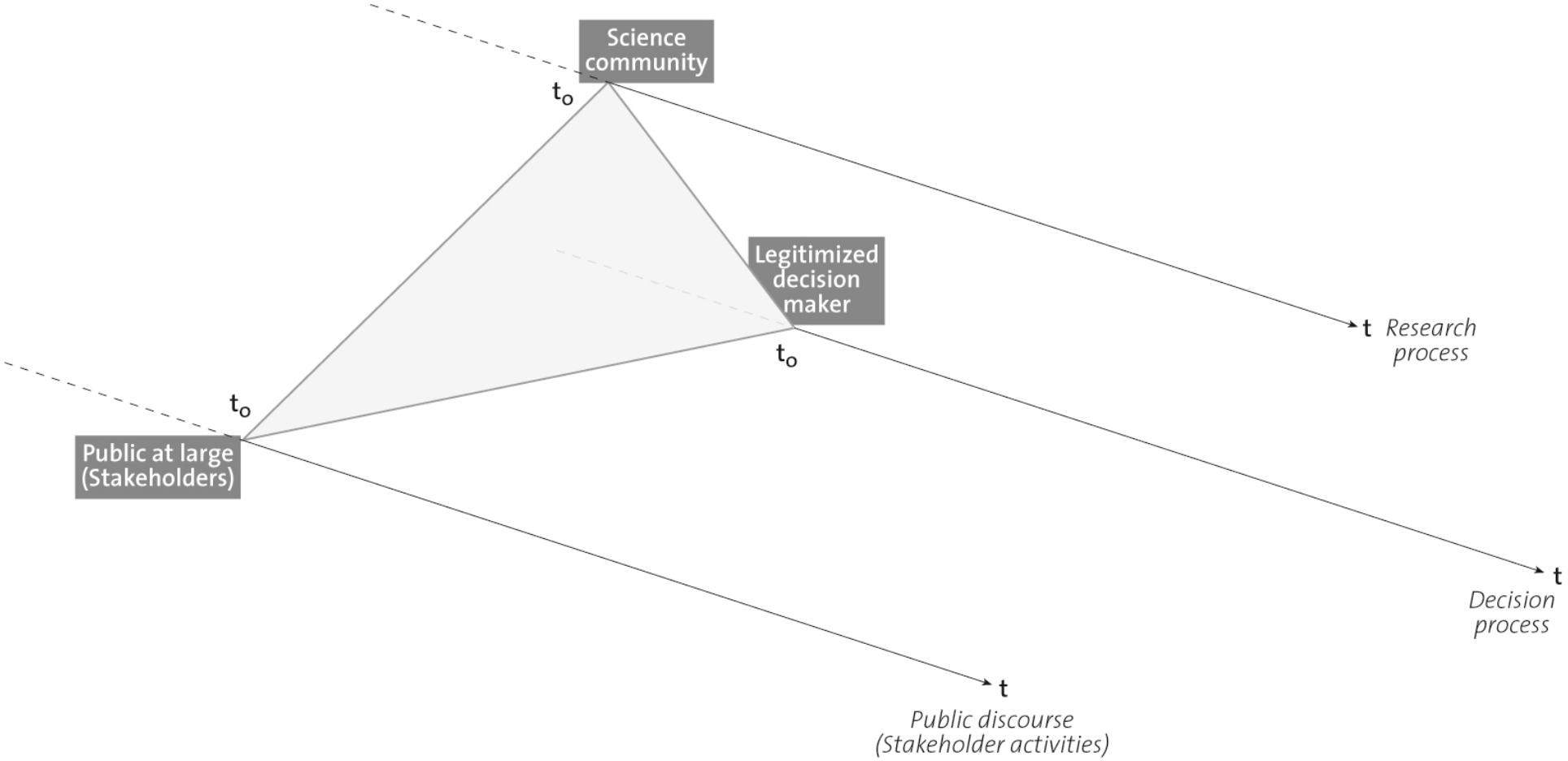
Our understanding (Zurich 2000 definition) of transdisciplinarity

- Going beyond sciences
- Aspires efficient use of knowledge available (capacity building, Thompson-Klein et al. 2000) by relating different epistemics (Scholz et al. 2006)
- Asks for integrating knowledge and values from practice in science (from a science perspective; Scholz, 2000)
- Includes certain elements of participatory research (those where knowledge integration, processes on equal eye level and co-leadership are included)
- Means doing applied research in theory-practice discourses with equal rights (no contract research, only sponsoring)
- It is a 21st century variant of the „traditional engineer mission“ (building energy systems ≠ anticipating impacts of energy systems)

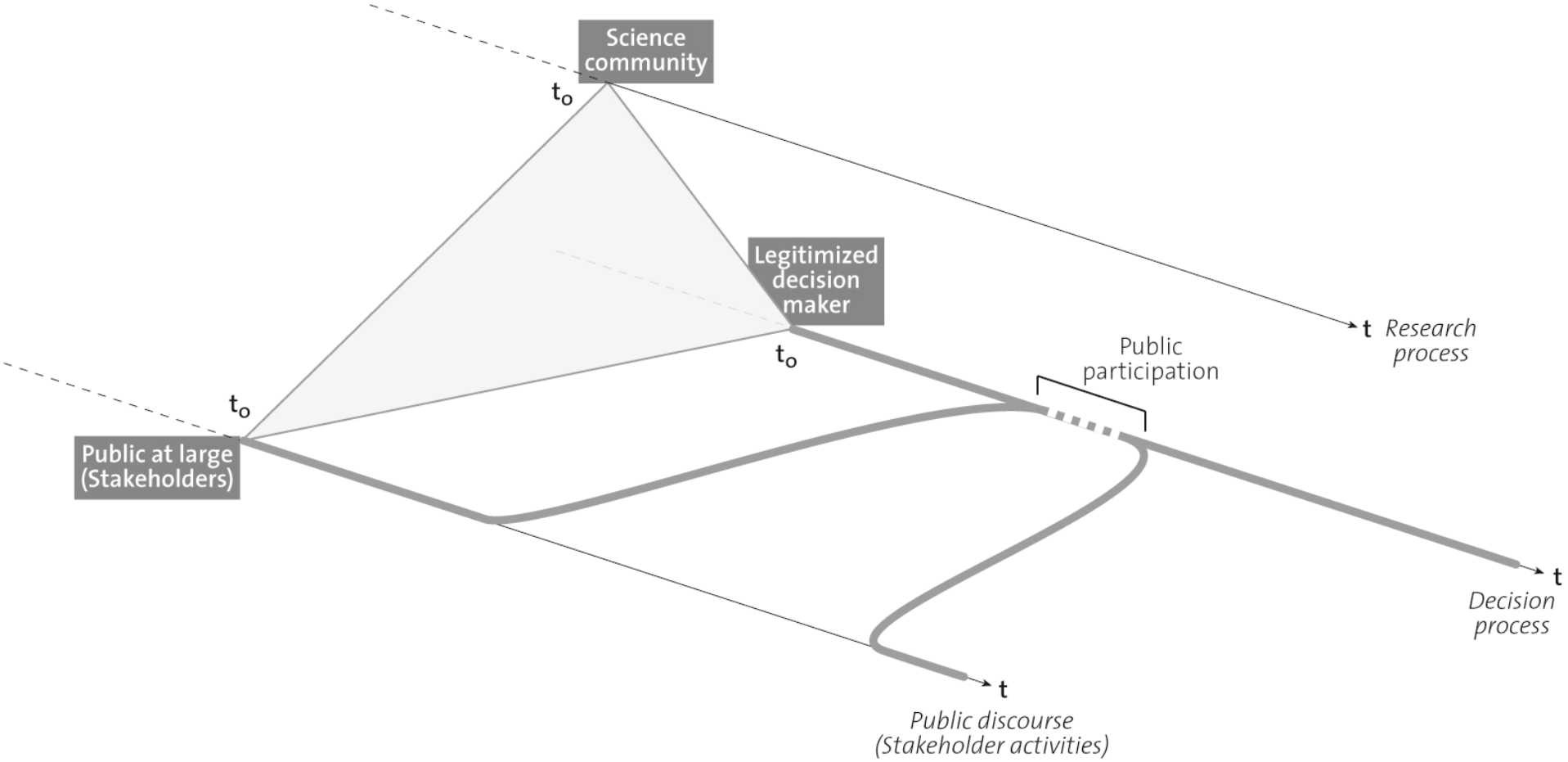
What are transdisciplinary processes?

They differ from other types of theory practice cooperation?

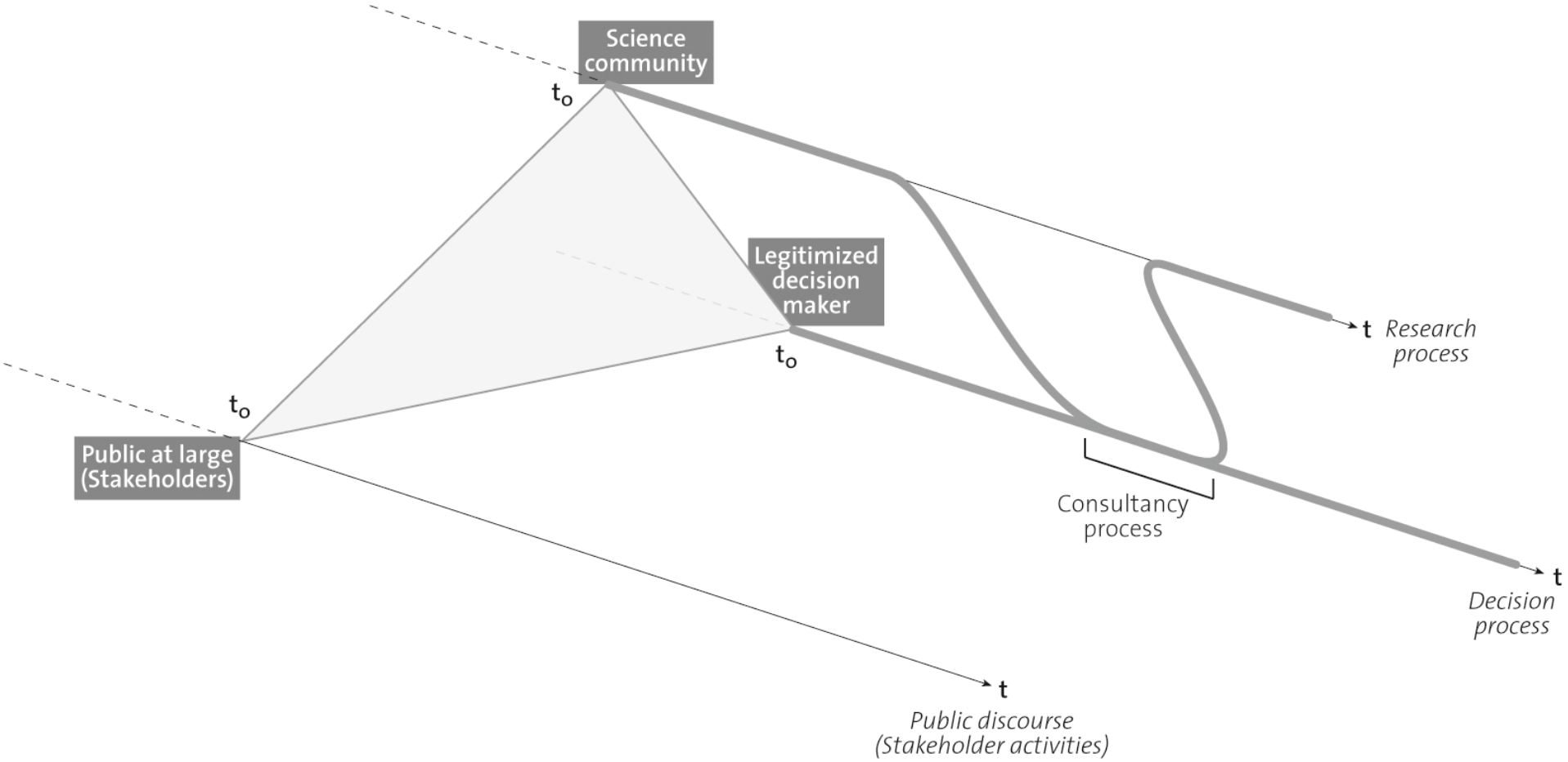
They have functions and outcomes


Science community
t_o
Legitimized decision maker
t_o
t
Research process
t_o
Public at large (Stakeholders)
t
Decision process
t
Public discourse (Stakeholder activities)

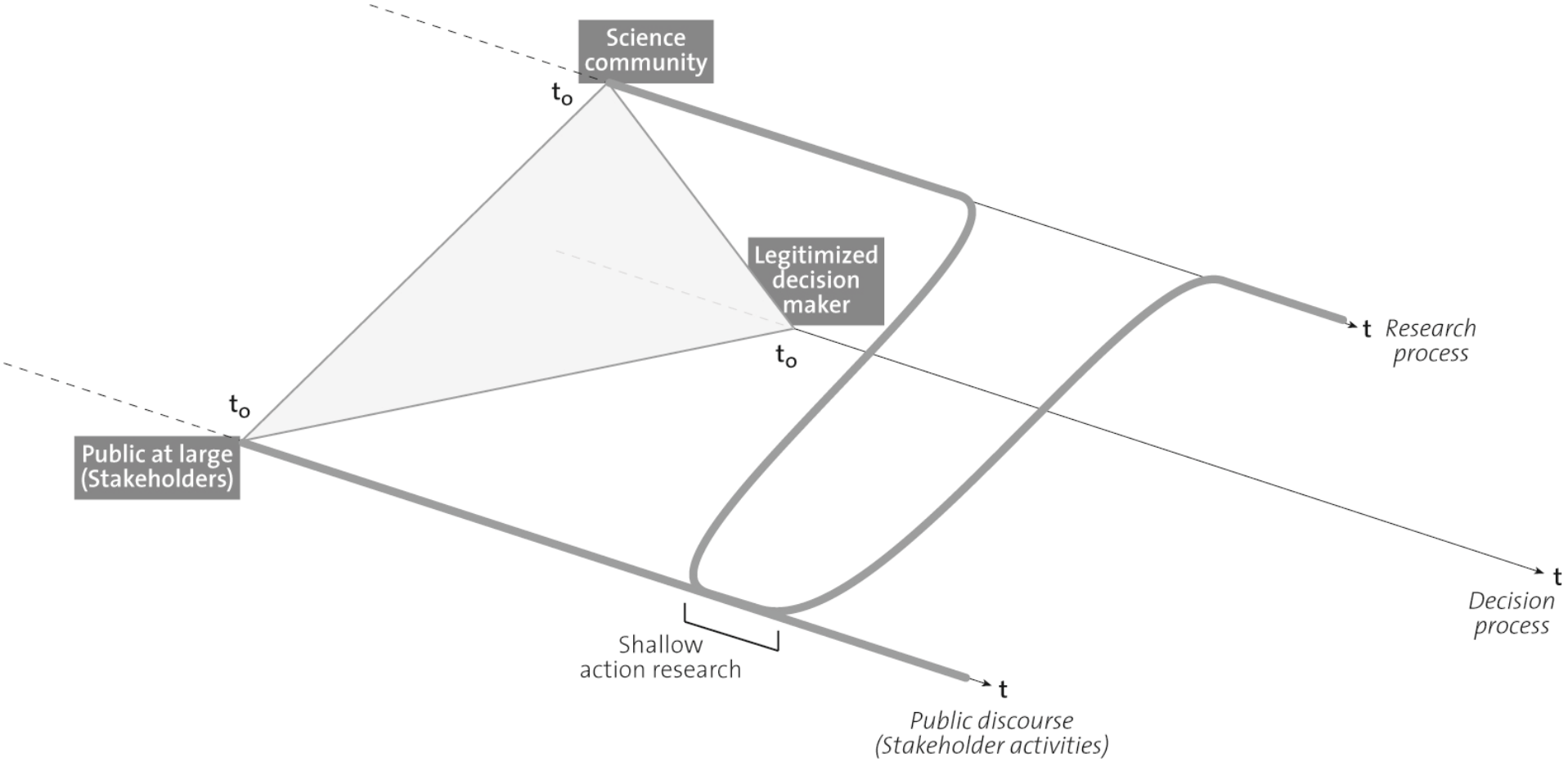
Illustrating Public Participation



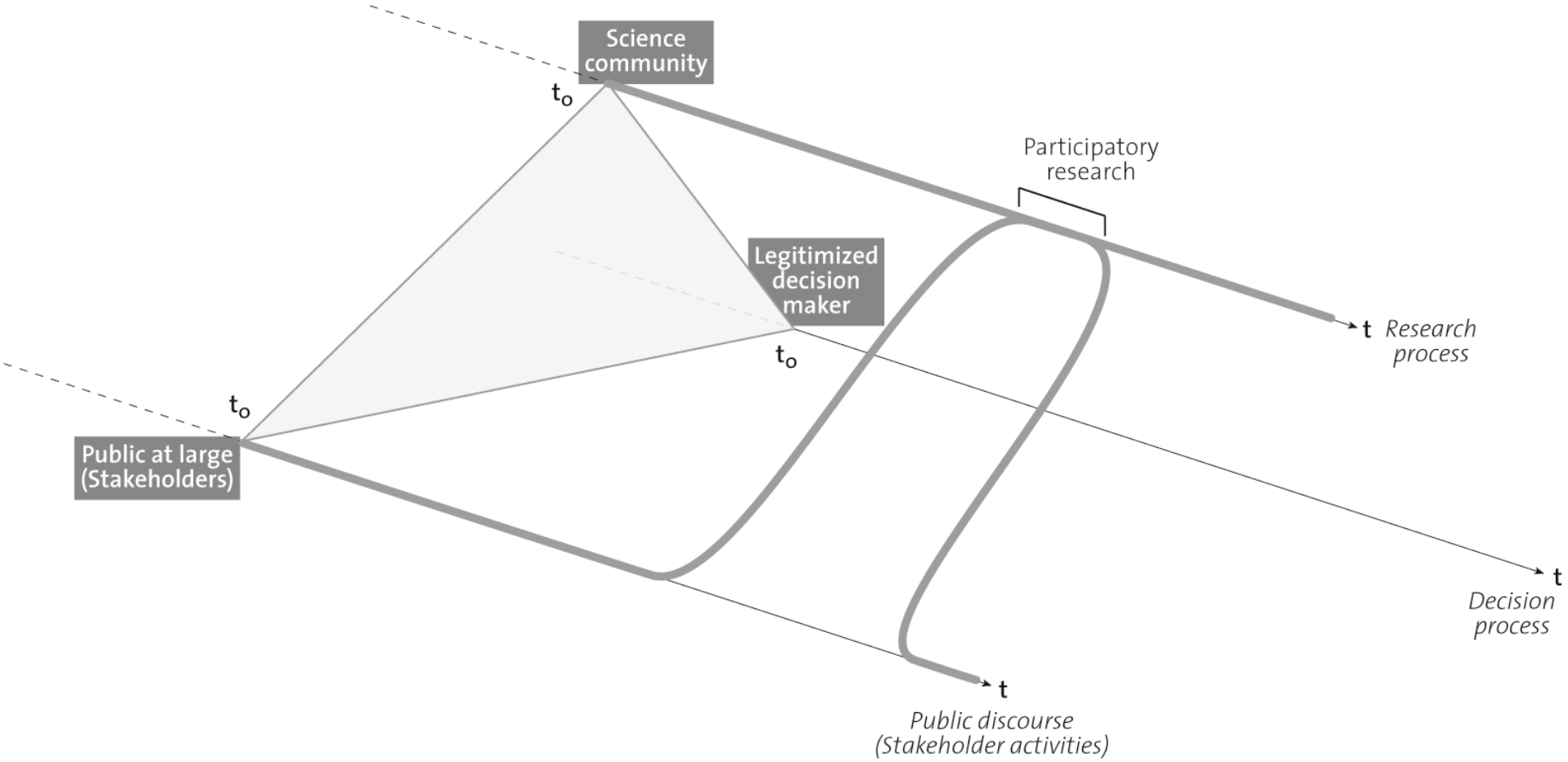
Illustrating Consultancy



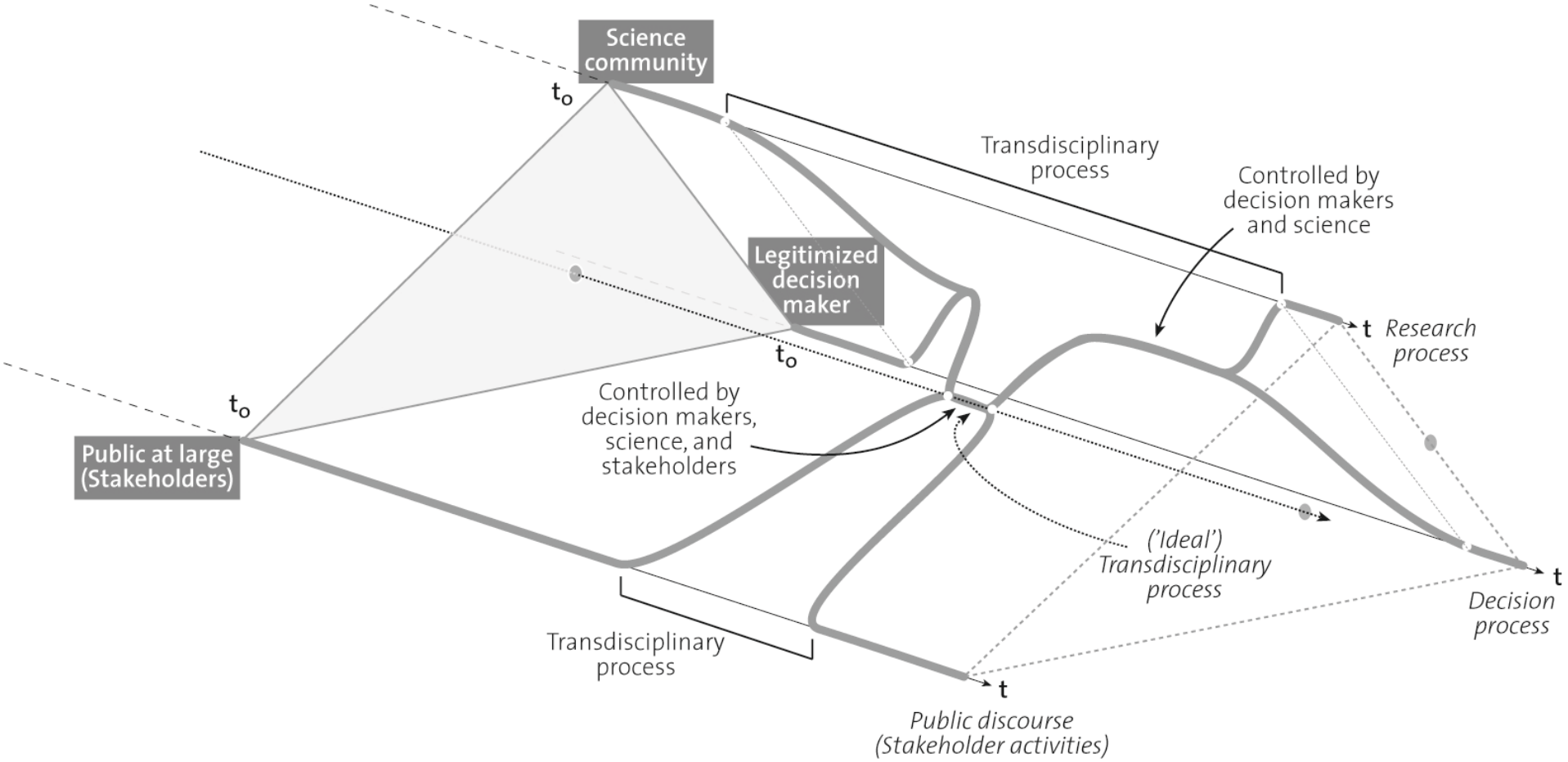
Illustrating Shallow Action Research



Illustrating Participatory Research of Public at Large



Illustrating Transdisciplinarity



Td-processes? Td case studies? How do they look like?

They establish

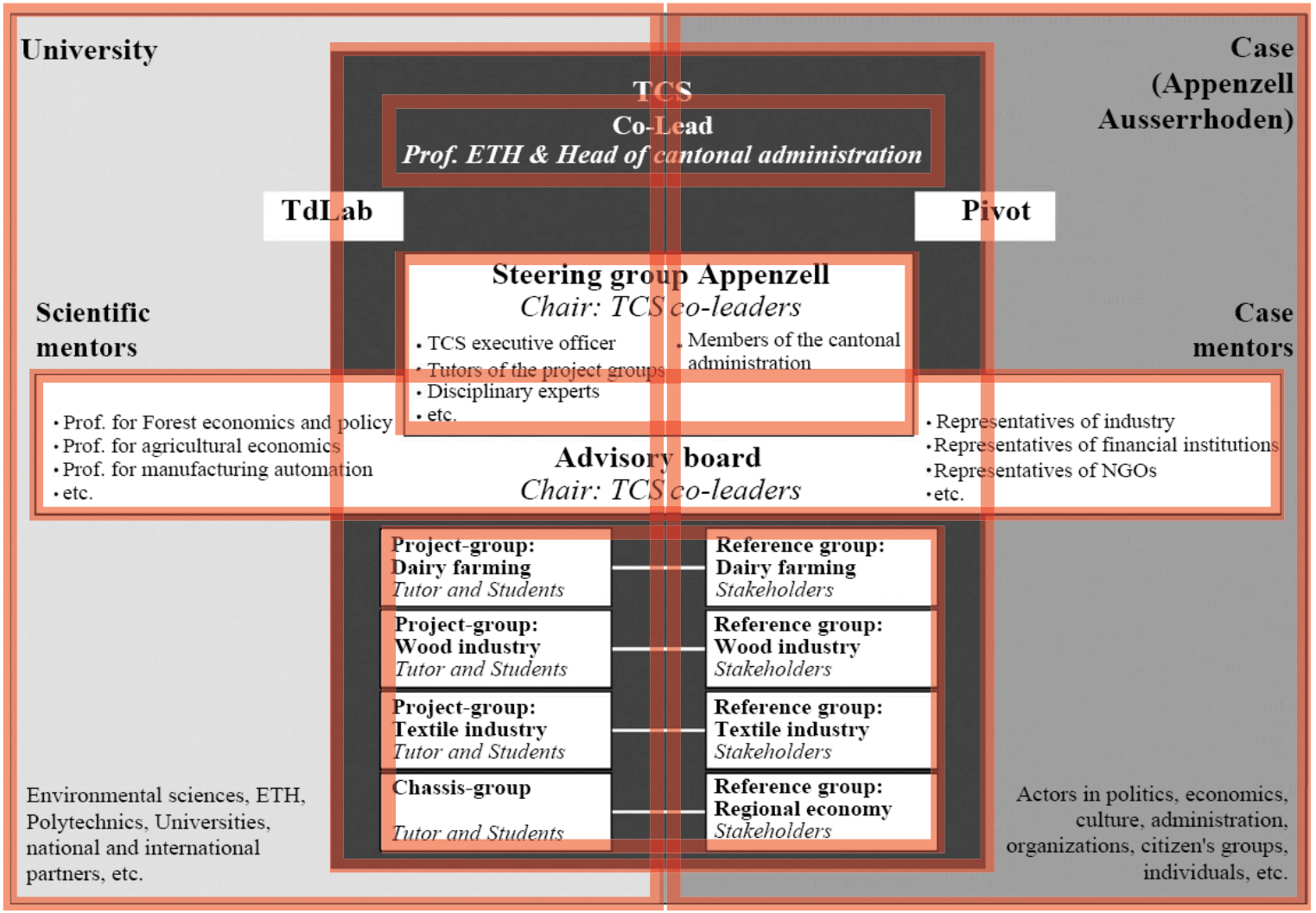
mutual learning between

science and society

Case type I: Sustainable transitions of rural areas, regional development

- Year: 2001–2003
- Case: Canton Appenzell Ausserrhoden
- Topic: Sustainable *land-scape development*, *future of traditional industries* (textile industry, sawing mills, milk industry)
- No. of inhabitants: 50,000
- Size: 242 km^2

Institutionalized collaboration between research and society on all levels



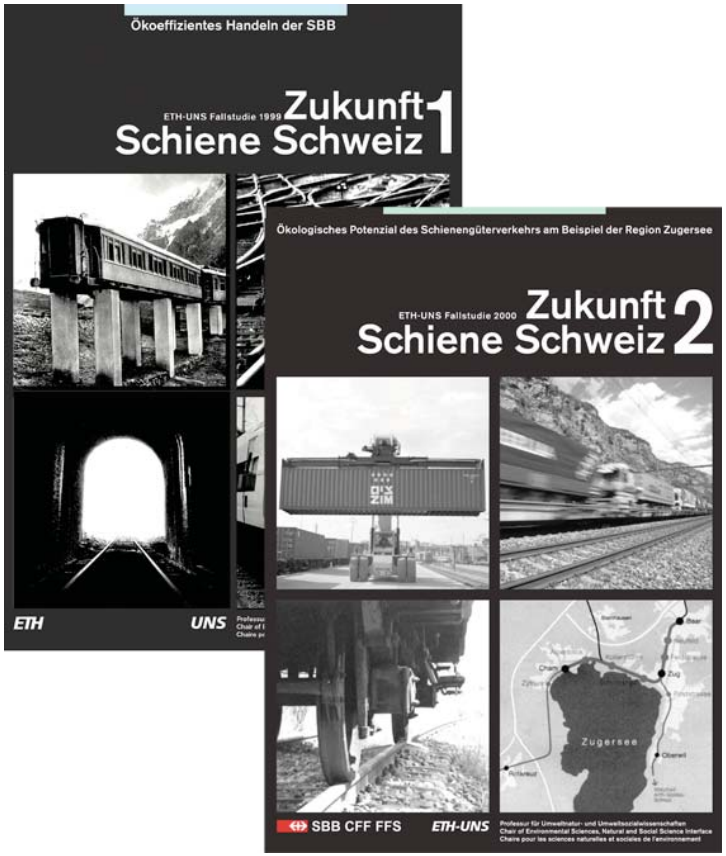
(Source: Scholz et al., 2006)

Case type II: Sustainable transitions of urban systems

- Year: 2003–2005
- Case: City of Basel
- Topic: Leisure mobility, Railways station dynamics
- No. of inhabitants
  - Basel: 180,000
  - Region: 500,000–750,000
- Size
  - Basel: 37 km^2
  - Region: 560–2,000 km^2

Case type III: Sustainable transitions of organizations (e.g. companies)

- Year: 1999–2000
- Case: Swiss Railway Company (SBB)
- Topic: Eco-efficiency, cargo transportation
- No. of employees: 30,000
- Length of railways: 3,000 km



Case type IV: Sustainable transitions of policy processes ("decision spaces")

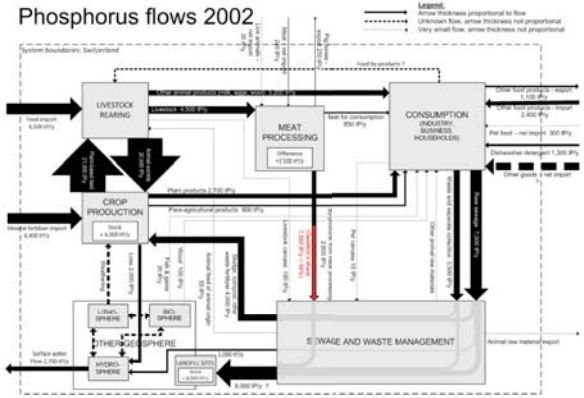
- Year: 2006–2008
- Case: Decision processes for nuclear waste repositories (Wellenberg NW; Switzerland, Sweden)
- 7 CH and 9 Sweden million inhabitants
- Topic: Radioactive waste management

Case type IV: Sustainable transitions of policy processes ("decision spaces")

- Year: 2006–2008
- Case: Decision processes for nuclear waste repositories (Wellenberg NW; Switzerland, Sweden)
- 7 and 9 million inhabitants
- Topic: Radioactive waste management

Case type V: Global TraPs –
Global Transdisciplinary processes on biogeochemical (phosphorus) cycle management

- Year: 2010–2015
- Case: Phosphorus in fertilizer and other products (detergents and industrial production)
- 7.8 billion people
- Topics: Sustainable P use Pollutant vs. scarcity, closing fertilizer loops, “getting access to P” (social justice), …



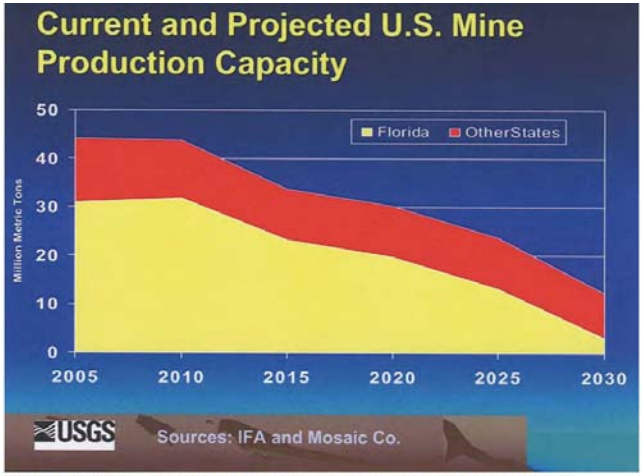


Figure 8. Current and Projected U.S. Mine Production Capacity (Jasinski, 2005)

Case type VI:
Intercultural transdisciplinary process on “cancer” (how to normal cells interact with cancer cells)

- Year: 2010–2019
- Case: Cancer in the “reconstruction” of the Ancient council of Guatemalian Elder and of the current oncology theories”
- About 5 million Mayas (x traditional ones; y oncologists)
- Topic: What knowledge to the two knowledge systems have; how can a transdisciplinary process help to relate these knowledge systems

Transdisciplinary Case Studies in ...

Switzerland | Sweden | Austria | Germany

From 1993–2010 we have conducted/participated in 25+
large scale transdisciplinary case studies
in Switzerland, Sweden, Germany, Austria, Seychelles, Bhutan

Products and functions of transdisciplinarity

Td processes provide „socially robust solutions“ (robust orientations) for sustainable transitions

Products and functions

Td-Processes (according to the Zurich 2000 definition)

- Organize processes of mutual learning between theory and practice
- Serve for
  1. Capacity building
  2. Consensus building
  3. Mediation
  4. Legitimization
- Provide socially robust orientations (“socially robust solutions”)

Scholz, R. W. (2011). *Environmental Literacy in Science and Society: From Knowledge to Decisions*. Cambridge: Cambridge University Press, Chapter 15

What are „socially robust solutions“ (robust orientations)?

A ‘socially robust orientation‘

i. Meets science *state of the art scientific knowledge*

ii. Has the potential to *attract consensus*, and thus must be understandable by all stakeholder groups

iii. Acknowledges the *uncertainties and incompleteness* inherent in any type *of knowledge* about processes of the universe

iv. Generates processes *of knowledge integration of different types of epistemics* (e.g. scientific and experiential knowledge, utilizing and relating disciplinary knowledge from the social, natural, and engineering sciences)

v. Considers the constraints given by the context both of *generating and utilizing knowledge*.

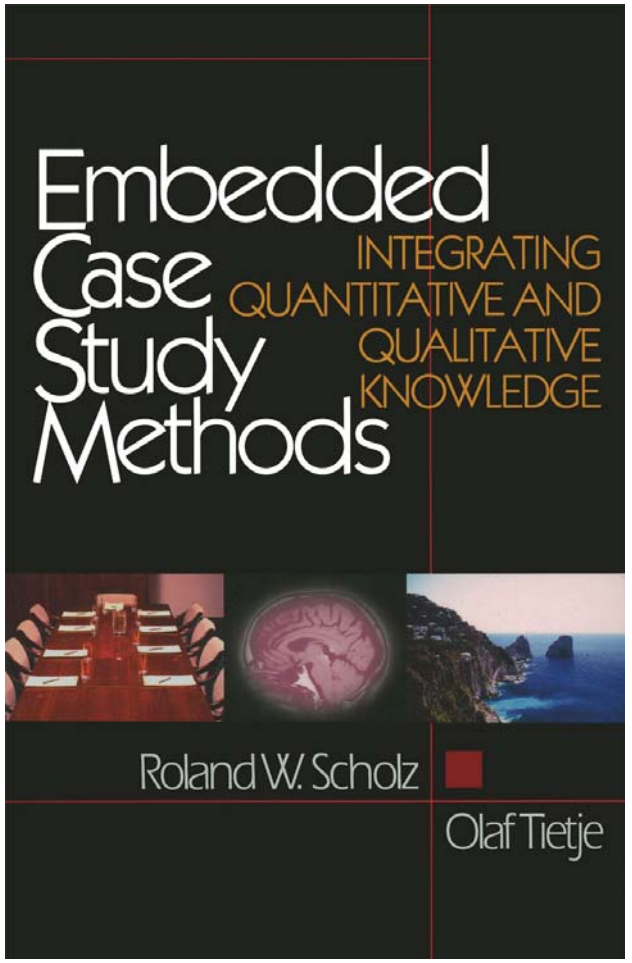
What I do not show today (in depth)

The methodology of td

There are about 15 methods for

-Case representation
- Case definition
- Case transition
- Case study team preparation
methods

Scholz, R. W. & Tietje, O. (2002). *Embedded Case Study Methods: Integrating Quantitative and Qualitative Knowledge*. Thousand Oaks: Sage.

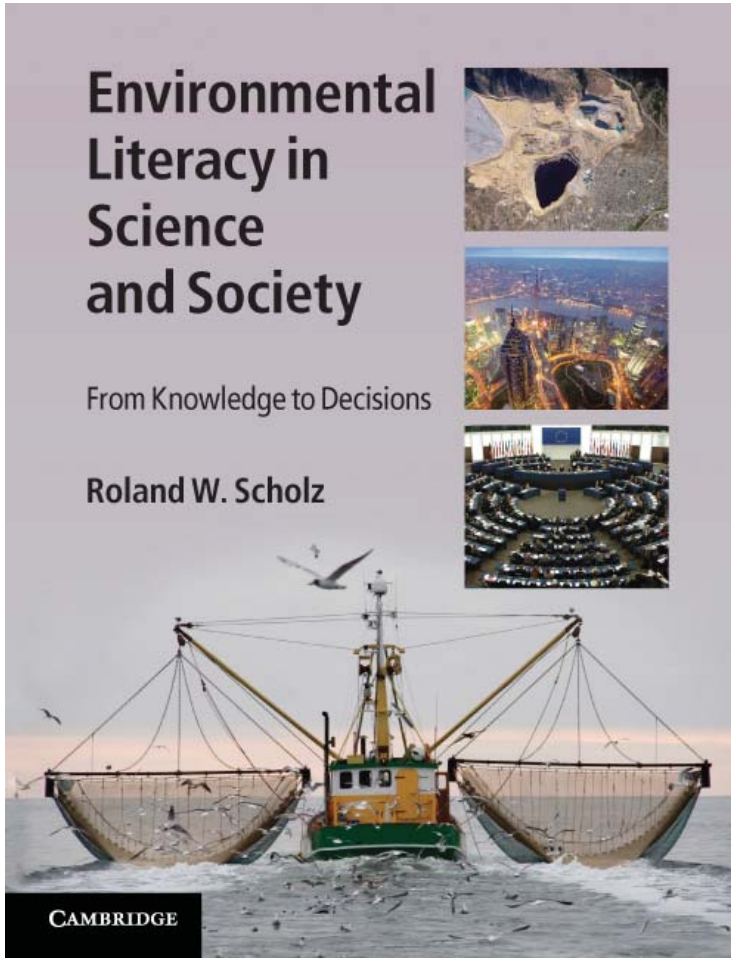


2b. Sustain-abilities”
for designing resilient
Human-Environment Systems

I do not introduce the theory of coupled Human-Environment Systems

But I use the conclusions of Chapter 20 of this book

Scholz, R. W. (2011). Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge: Cambridge University Press.



Td-processes should serve to develop capabilities – i.e. "Sustain-abilities" – to better understand transitions of complex Human-Environment Systems

(The "sustain-abilities" S-As are based on a theory of HES)

S-A1 **Properly reading the environmental potential**

S-A2 **Recognizing tipping points**

S-A3 **Identifying and coping with tradeoffs (interferences) within and between human systems** (of one of the same or of different hierarchy levels)

S-A4 **Anticipating and coping with rebound** (adverse secondary/higher ordered rebound effects)

S-A5 **Designing and realizing resilient HES systems** (in the sense of specified and general resilience)

S-A6 **Problem definition and system representation ability**

S-A 7 **Establishing inter- and intergenerational justice**

S-A 8 **Utilizing the potential complementarity of different knowledge systems**

Part 3 – Td processes

(1) “Sustain-abilities” in the Swedish (2006) Bioethanol-”Oil Free Society” case

(2) Appenzell-Ausserrhoden: Td-processes on sustainable energy strategies

(3) Vulnerability and Potential Assessment of the Swiss Energy System

(1) Missing “sustain-abilities” in the Swedish (2006) Bioethanol-”Oil Free Society” case

The Swedish 2006 “Oil-free society – Go for BioethanolE case

- Sweden:
  - 9.3 mill. inhabitants
  - 20.3 persons per km^2
  - 9.3 mill. inhabitants
- Governmental Decision
  - Febr. 2006: “Oil free society til 2020”
  - Go for bioethanol (the Brazil/US case)

The Guiding Question of an analysis

“Is Sweden’s decision to push bioethanol E85 as vehicle fuel **nationally** and **internationally** sustainable?”

Scholz, R. W. (2011). *Environmental Literacy in Science and Society: From Knowledge to Decisions*. Cambridge: Cambridge University Press, Chapter 18.3

Some facts

- Energy makes 61% of global manmade greenhouse emissions, vehicle fuel make 22% (in EU 31%)[2000]
- Worldwide, biomass and waste account to 10-11% of worldwide energy production[FAO, 2008] , 2% of these 10-11% (0.2% in total) is liquid fuel, [makes 1% of all arable land]; extending Brazil's production by factor 10 makes 10% of world's gasoline use; if we take all "bioethanol plants of the world" (= 42% of all cropland this would make 57%
- Total global photosynthesis produces about 7.5 times of the primary energy demand of 420 exajoules; plants make 1100 exajoules
- Bioethanol make 80% of biofuel worldwide[2008]
- In Sweden, 2.5 TWh of the 4.4 TWh renewable energy was ethanol-based; however 50% of the 2.5 TWh were imported from Brazil[2008]
- 2nd generation ("cellulose based") bioethanol only produced on a pilot site level
- Scenario-based calculation shows that (even for Sweden) with an Extreme Reduction Scenario of the 96 TWh for Swedish transportation p.a. only 65% could be covered by biofuel/agrofuel

Learning from history ...
Energy: Biofuels from forests

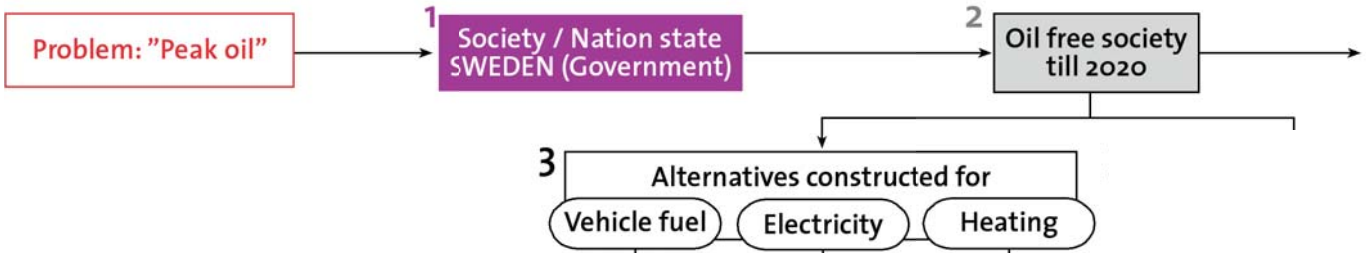
1 Human system /
Decision maker

2 Obectives /
Drivers

3 Alternatives /
Options /
Strategies

4 Side effects /
Secondary feedback loops /
Rebound effects

Learning from history
Energy: Biofuels from forests



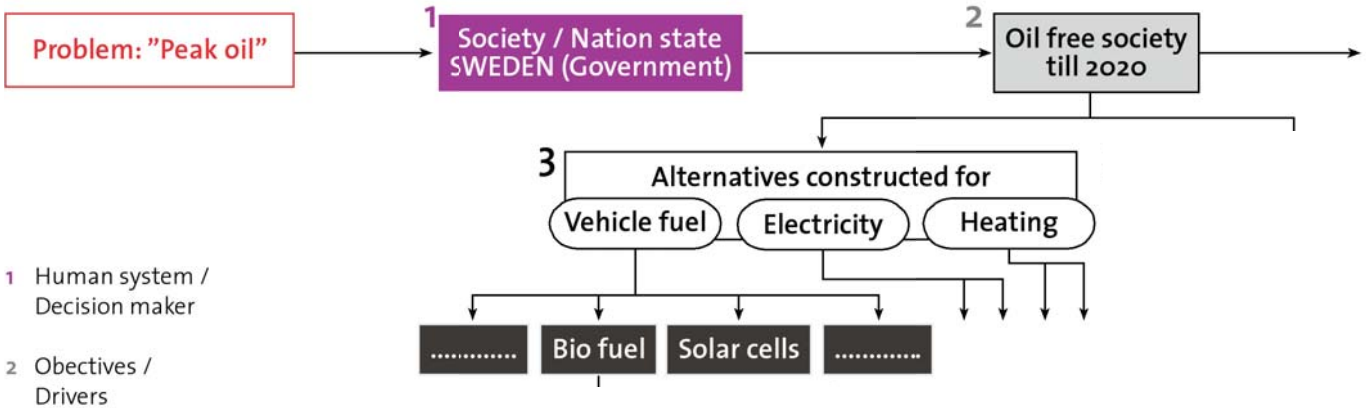
1 Human system / Decision maker

2 Obectives / Drivers

3 Alternatives / Options / Strategies

4 Side effects / Secondary feedback loops / Rebound effects

Learning from history (iii)
Energy: Biofuels from forests



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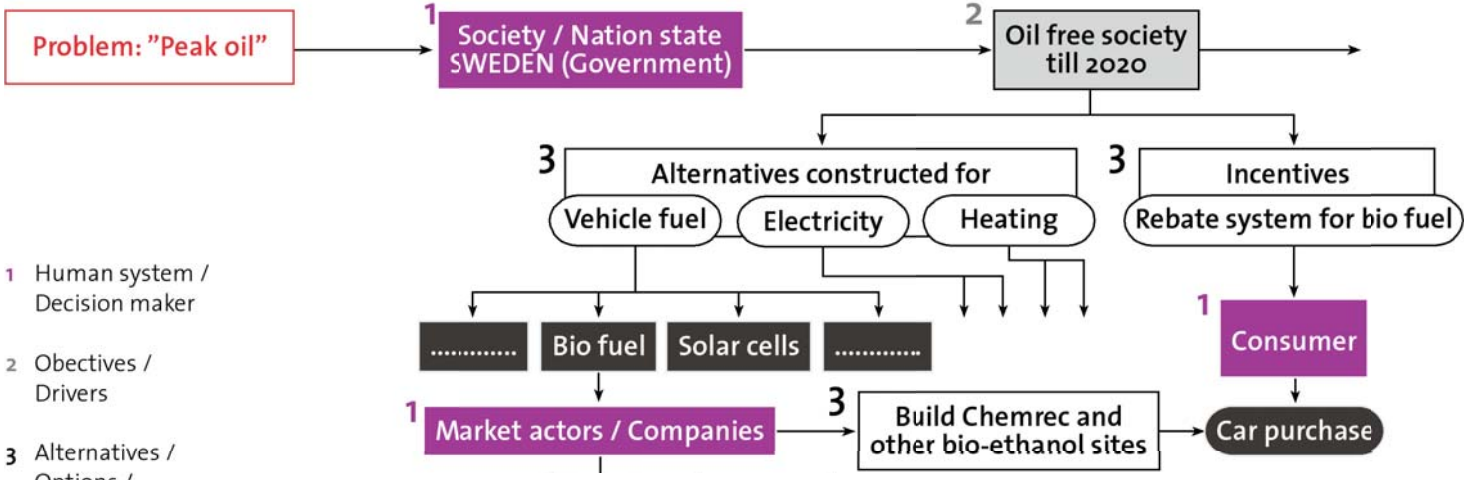
Learning from history (iii)
Energy: Biofuels from forests



1 Human system / Decision maker

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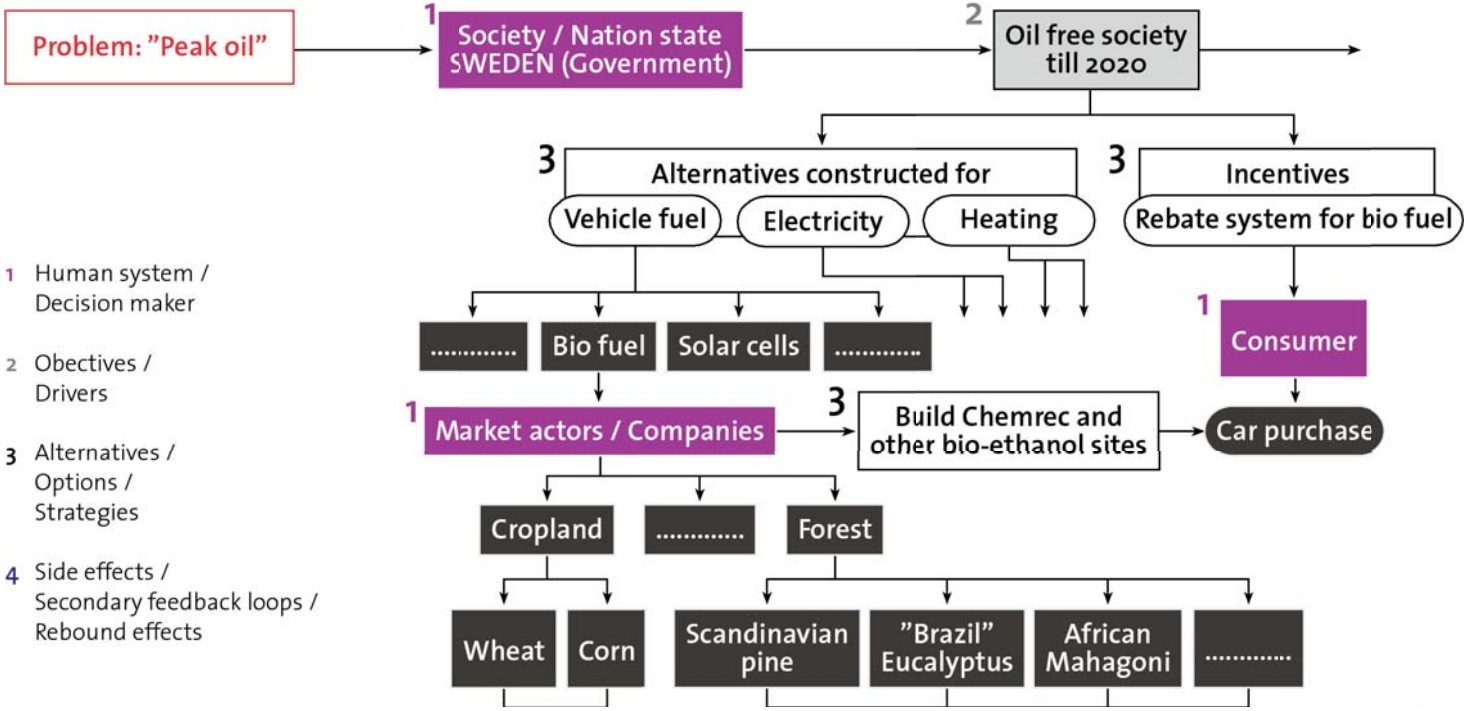
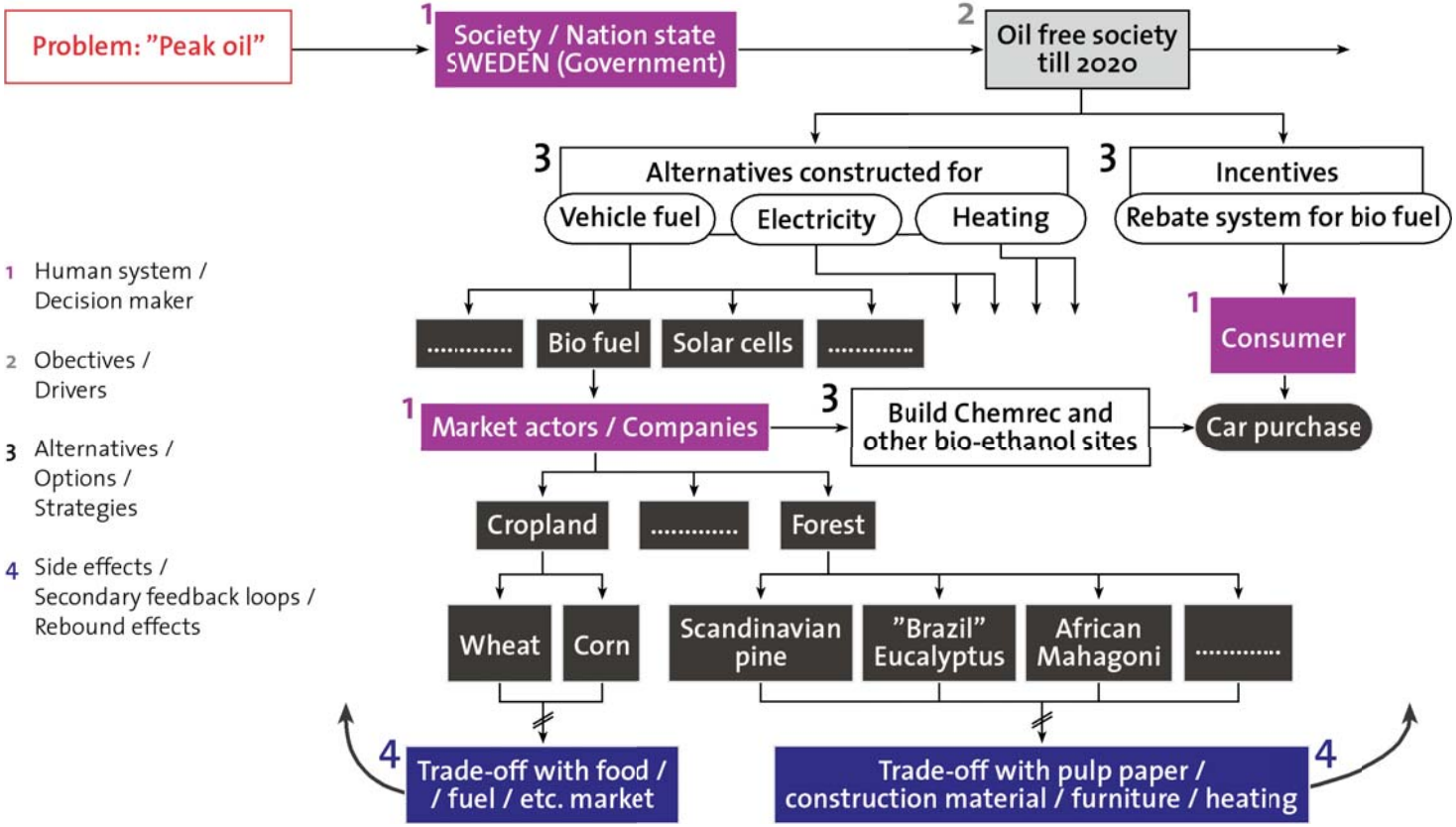
Learning from history (iii)
Energy: Biofuels from forests



Learning from history (iii)
Energy: Biofuels from forests



Lessons learned: Presumably, some "sustain-abilities" have been missing

S-A1 Properly reading the environmental potential (What may we get 10%, 50%, 90% on the world level for …)

A-A2 Recognizing tipping points (At what level does biofuel production harm ecosystems, food security, … ?)

S-A3 Identifying and coping with tradeoffs (interferences) within and between human systems

S-A4 Anticipating and coping with rebound (What rebound effects have to be considered from biofuel imports from the South?)

S-A5 Designing and realizing resilient HES systems

S-A6 Problem definition and system representation ability (Is the goal "Oil free till 2020"/"Go for bioethanol" a proper goal?)

S-A 7 Establishing inter- and intragenerational justice

S-A 8 Utilizing the potential complementarity of different knowledge systems (Can transdisciplinary processes do better?)

An additional remark

- Biofuel is not renewable as the nutrients (phosphorus [rocks] as a finite nutrient [resource] used in agro-based and forest-based) biofuel production is “not renewable

And a conclusion

- The Swedish could have done better with a transdisciplinary process (but it is an ongoing inquiry)

(2) Appenzell-Ausserrhoden: Td-processes on sustainable cantonal energy strategies

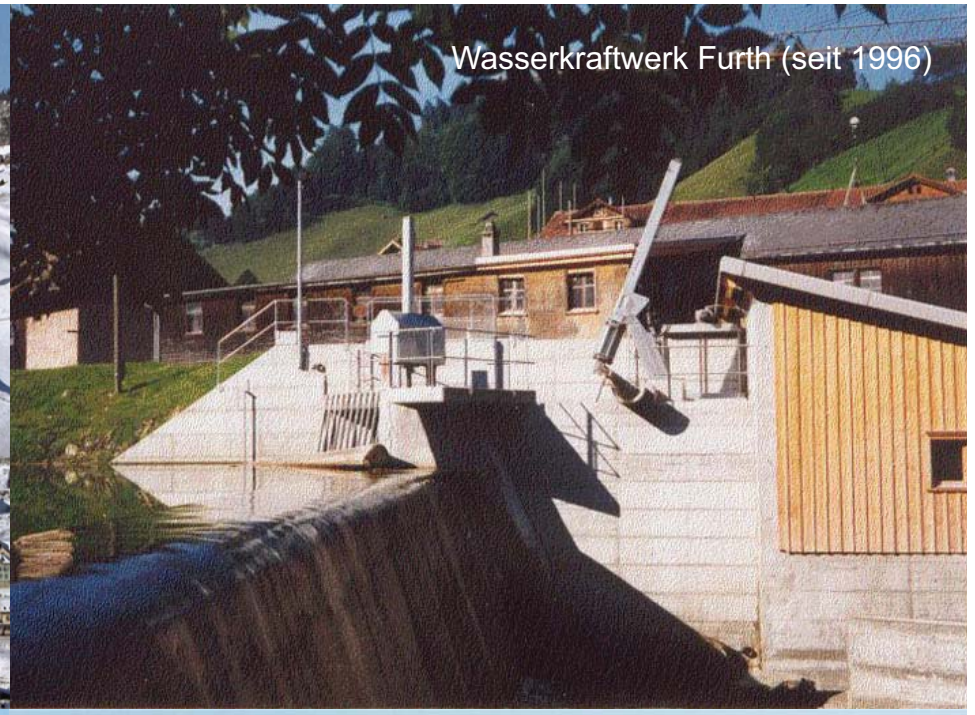
Evaluating Energy Strategies of a Canton

- Appenzell Ausserrhoden:
  242 km^2, 20 communities, 53,500 inhabitants

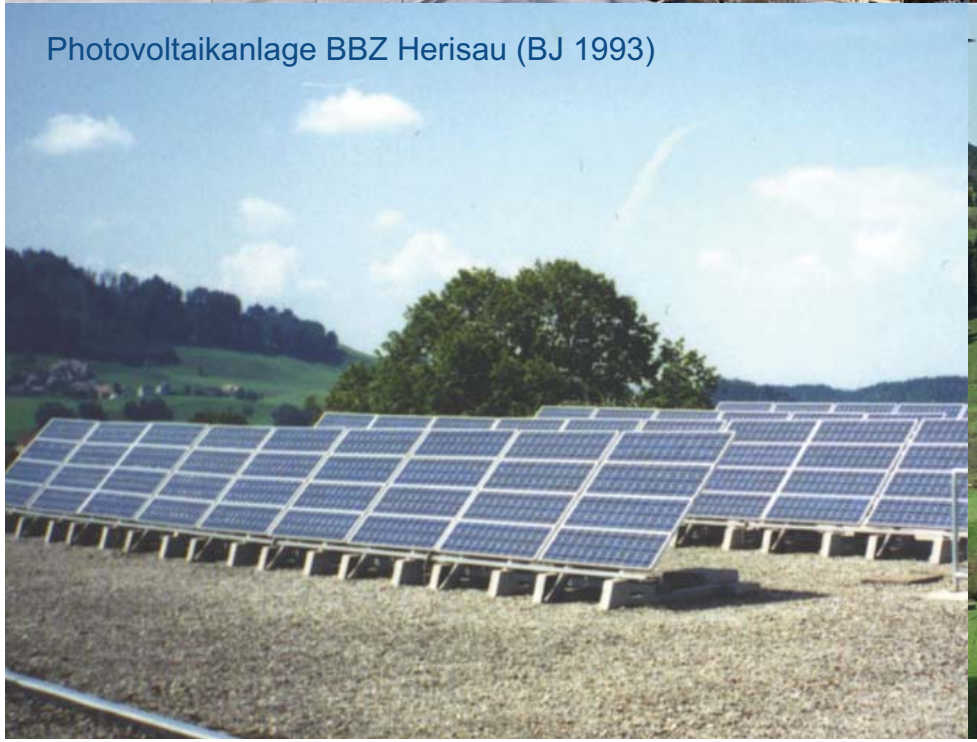
- The Cantonal Energy Strategy

- Guiding Question:
  “How we should housholds, industry and utilities adapt in the next 10 years with respect to energy?

Urnäsch



Wasserkraftwerk Furth (seit 1996)



Photovoltaikanlage BBZ Herisau (BJ 1993)

Urnäsch (2020?)

Intense Cooperation with many local key agents

Steering boards

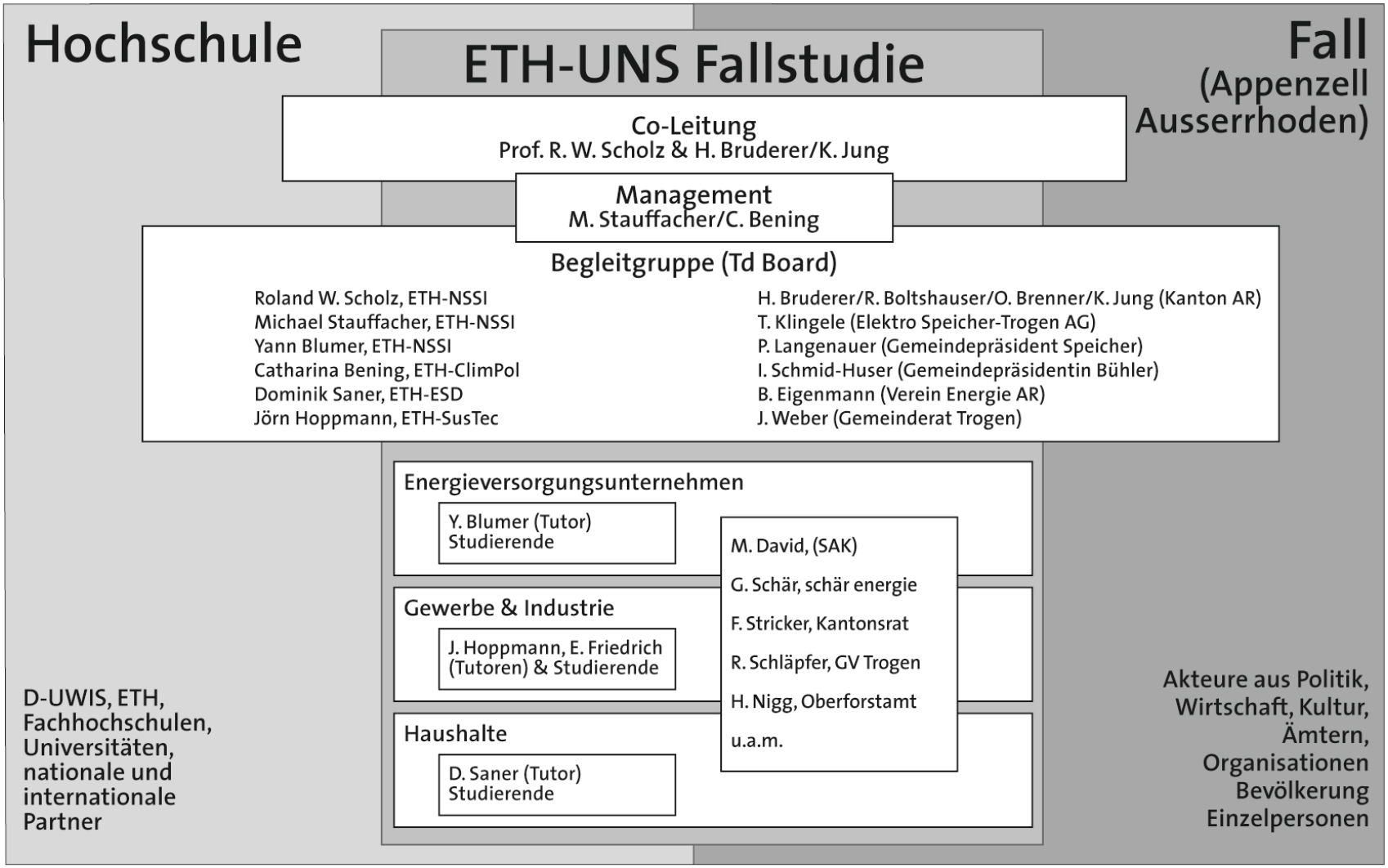
- Hans Bruderer, Ralph Boltshauser & Olivier Brenner, Amt für Umwelt, co-leader
- Karin Jung, Leiterin Amt für Wirtschaft, deputy-co-leader
- Bruno Eigenmann, Präsident Verein Energie AR
- Thomas Klingele, Elektro Speicher-Trogen AG
- Peter Langenauer, Gemeindepräsident Speicher
- Ingeborg Schmid-Huser, Gemeindepräsidentin Bühler
- Jens Weber, Gemeinderat Trogen

Many further key actors involved

- Exekutive, Ämter, Haushalte, Gewerbe, Energieberater, Energieunternehmer, Umwelt- und Naturschutzorganisationen, usw.

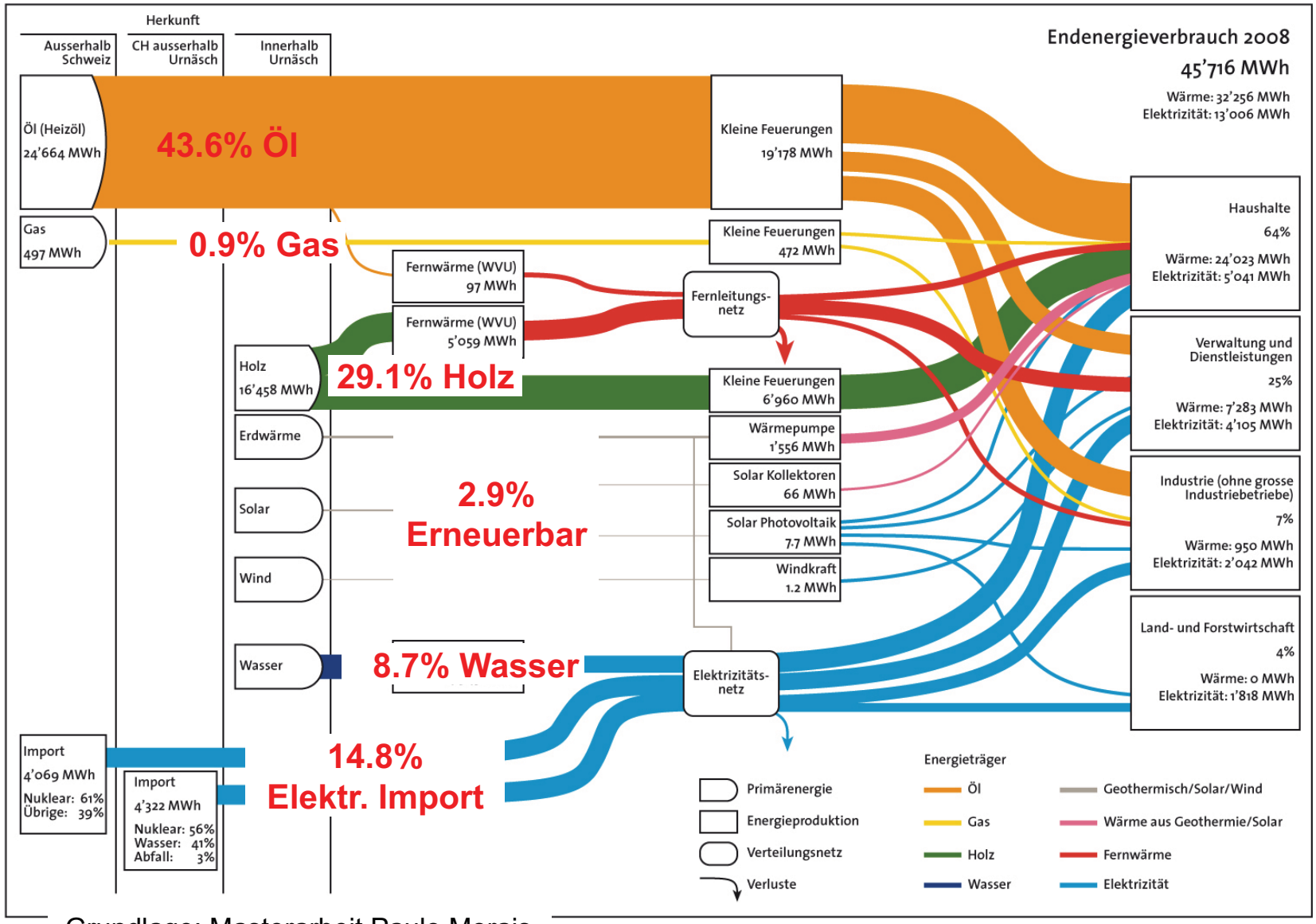
Co-Leitung Prof. Scholz & Hans Bruderer, Leiter AFU

Organization of the Case Study



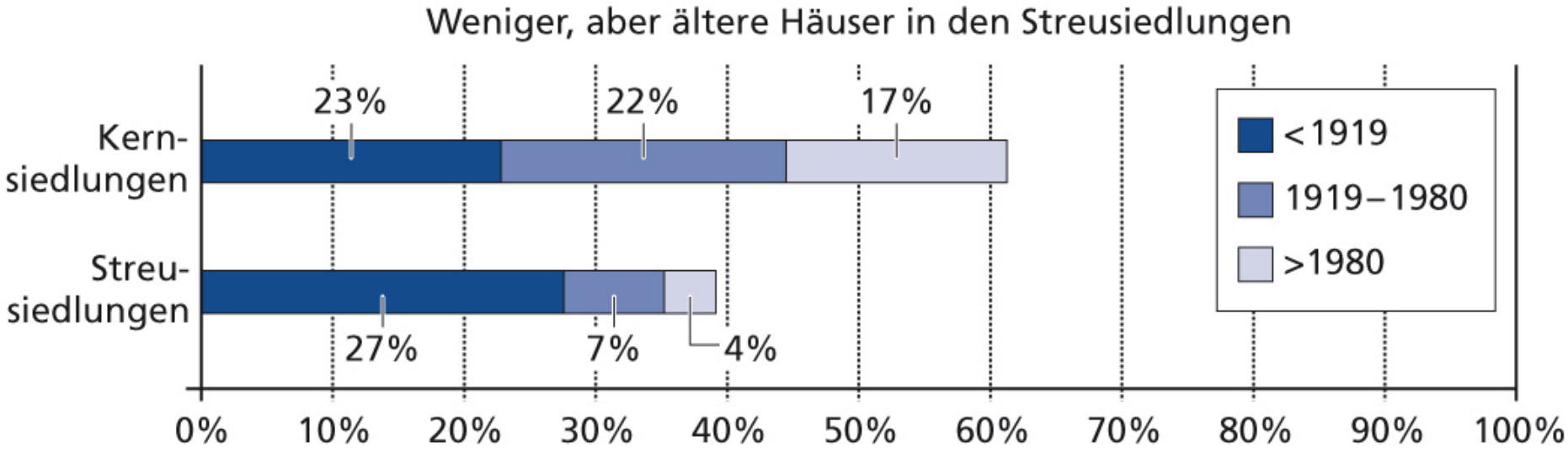
18 Studierende aus 6 verschiedenen Ländern

Ausgangslage: Energieflüsse in Urnäsch



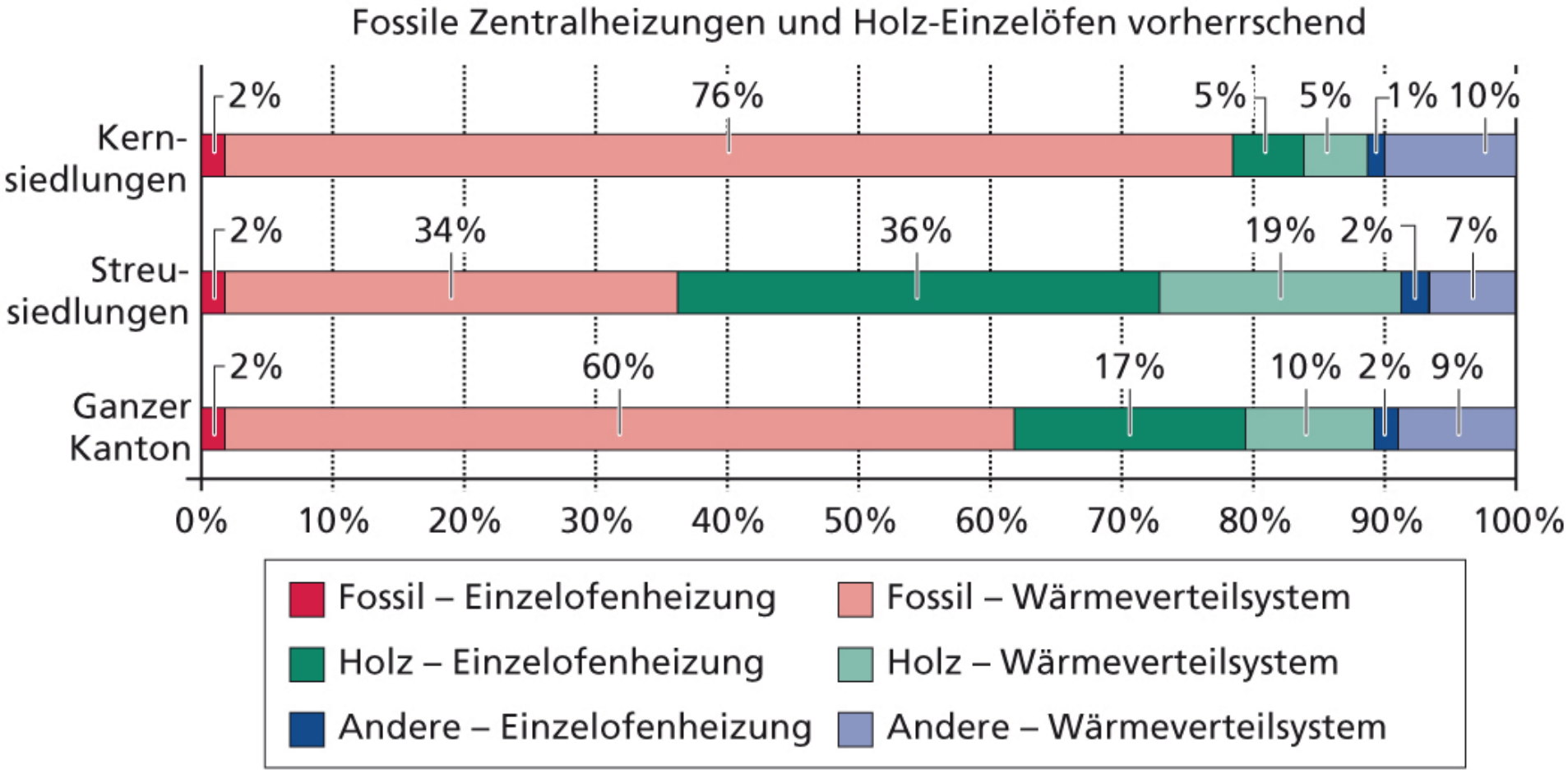
Grundlage: Masterarbeit Paulo Morais

More than half of the houses have been built before 1919



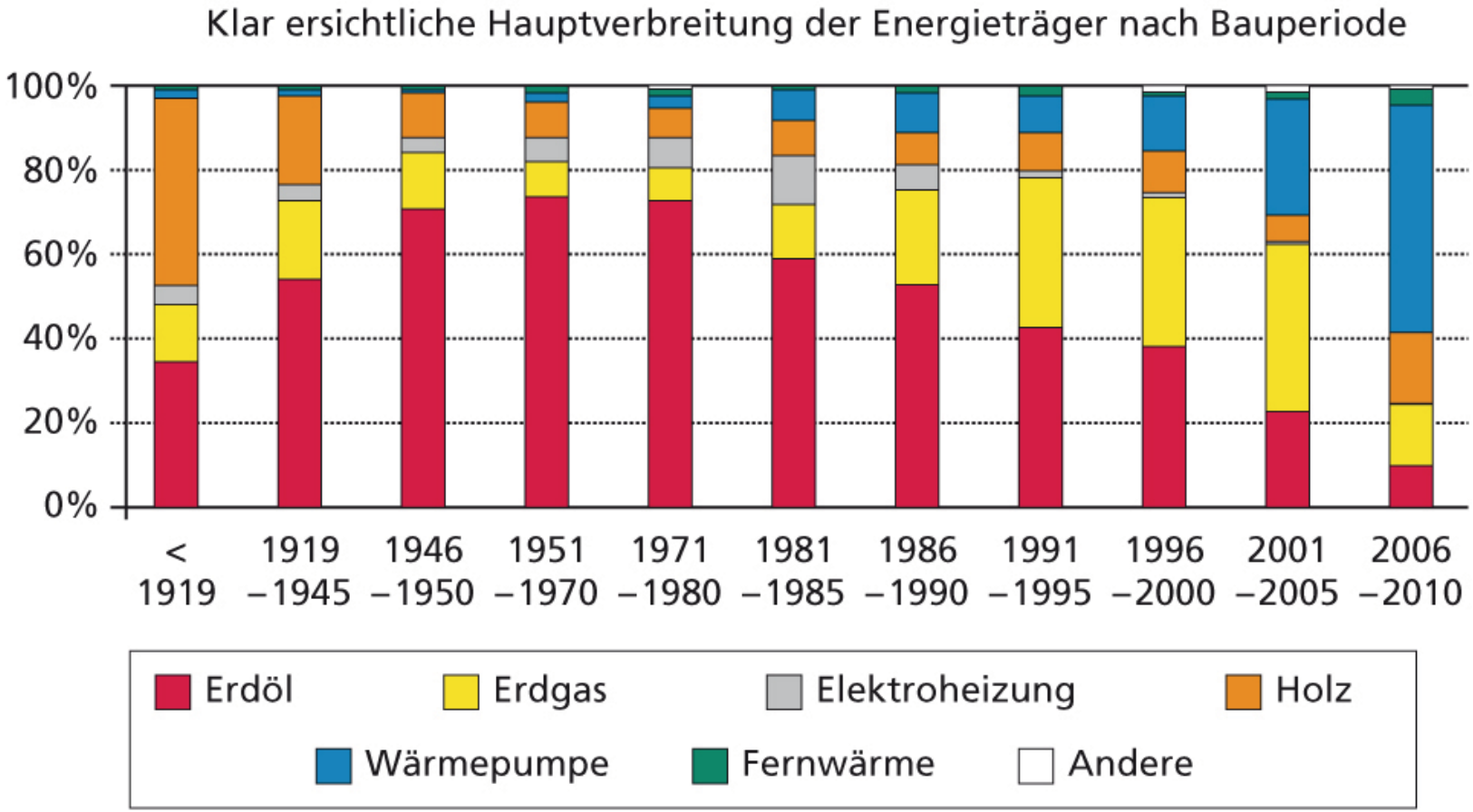
Master-Thesis von Matthias Schlegel, 2010

Houses in dispersed settlements use wood others primarily oil



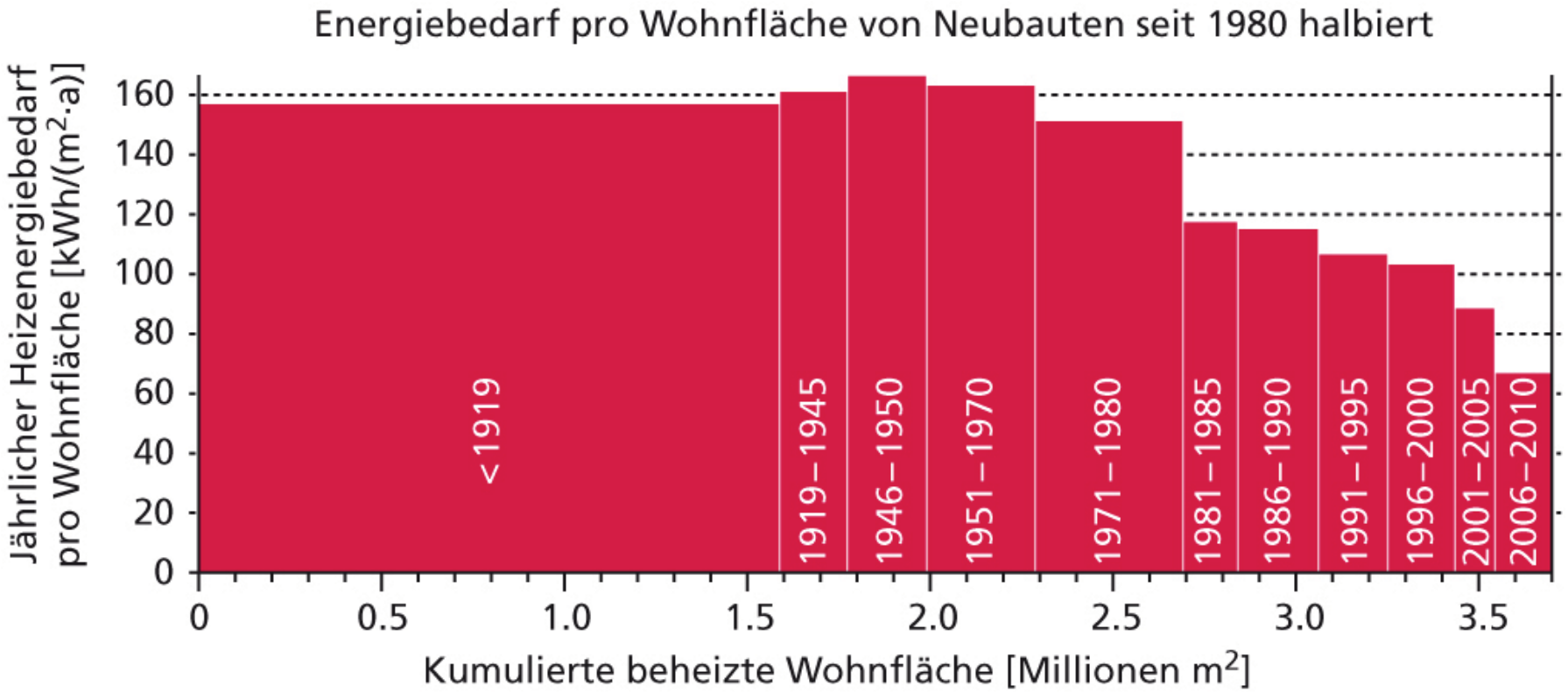
Quelle: Master-Arbeit von Matthias Schlegel, 2010

Heatpumps are coming (the blue stacks)
Oil is disappearing from heating (in 2010 only one new building asked for oil heating permission)



Quelle: Master-Arbeit von Matthias Schlegel, 2010

Heating nergy per square meter since 1980 got halved. This works one more!



Quelle: Master-Arbeit von Matthias Schlegel, 2010

Methods

- **Energy flow-models**
- **Data mining** related to census, interviews of household data
- **Social science methods** for entrepreneurial strategies 44 firms (Conjoint Analysen), surveys

- **Formative Scenario Analysis** to assess the robustness of cantonal strategies

What has been learned

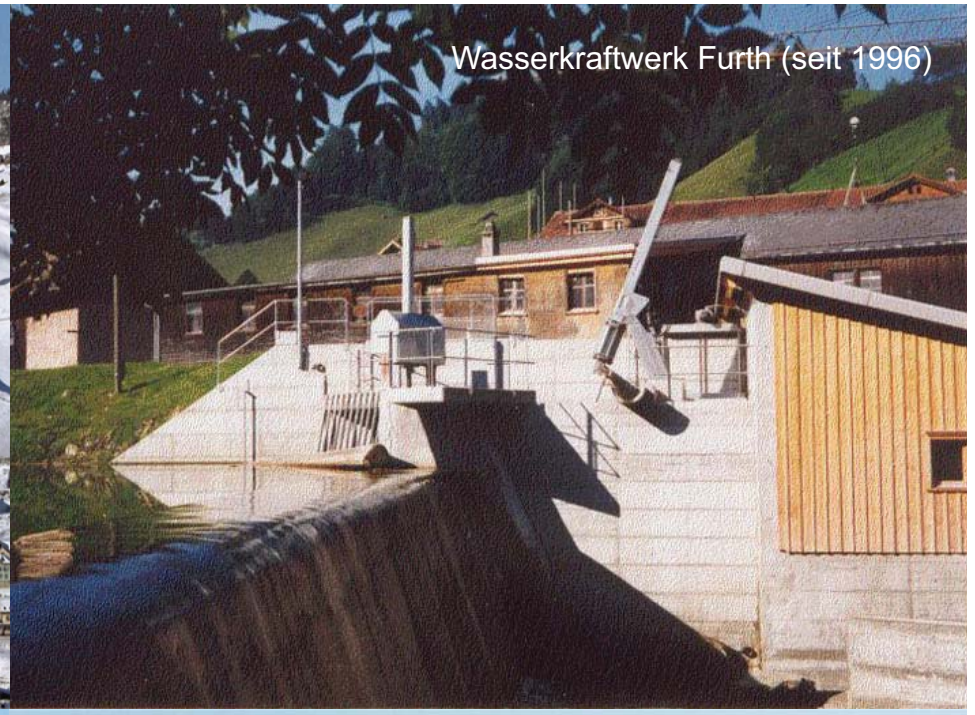
- Capacity Building:
  - Energy strategies are needed on national, state/cantonal, community and household level
- Consensus Building
  - Put the fossil plug out of „heating houses/apartments“
  - Tradeoffs and consensus building about different visions „2000 Watt, 1 ton CO2, Autarky, Efficiency, „Economic/cheap electricity“ etc.“ are necessary
- Mediation
  - There are critical tradeoffs: „cultural heritage“ vs. Solar/energy efficiency
- Legitimization
  - People have trust in results from transdisciplinary processes

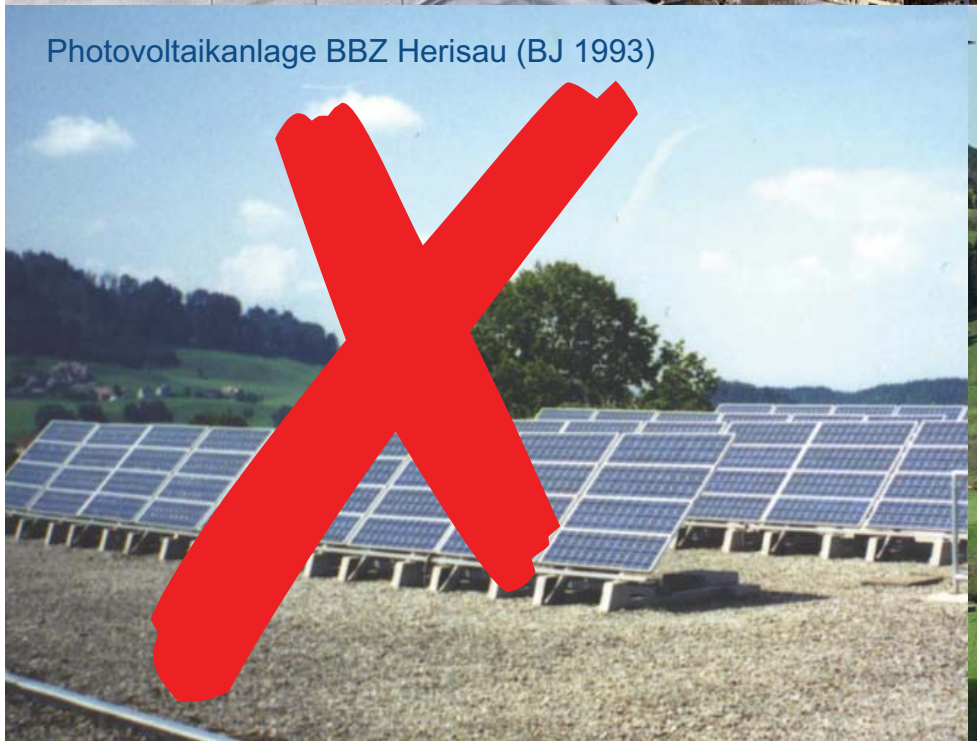
Outcomes

- Keep regional utilities (energy producers and providers)
- Consensus about „no oil in houses“
- Develop strategies not only from a house (technical side) but also from as human (house-owner/household side)
- Using renewable energy potentials
  - Water
  - Wind
  - Solar (PV & Thermal)
  - Thermal (Heat pump & enhanced thermal

Gäbris (Gais), 1921


Urnäsch


Wasserkraftwerk Furth (seit 1996)


Photovoltaikanlage BBZ Herisau (BJ 1993)

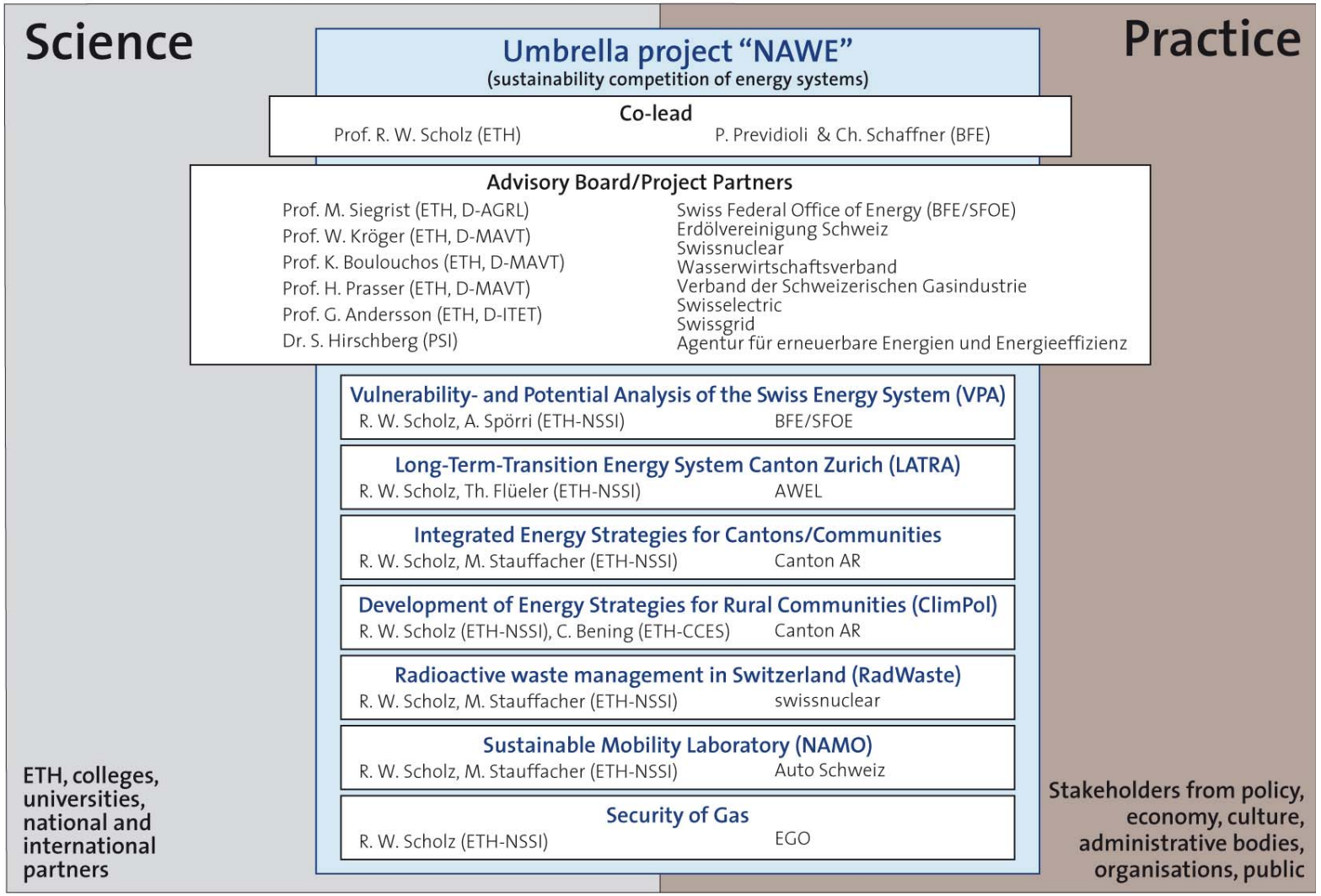

Urnäsch (2020?)

(3) Vulnerability and Potential Assessment of the Swiss Energy System

Assessing the vulnerability (supply-security) of the Swiss energy system

- The problem:
  - To avoid “hard landing”, the (change) of vulnerability of energy systems should be measured, monitored and communicated
- The guiding question
  - How can we measure the energy supply security of CH-quantitatively
  - Wie kann die Energieversorgungssicherheit der Schweiz **quantitativ beurteilt** werden?
- The goal
  - Establish a high quality transdisciplinary process (transdisciplinary think tank) involving key actors of the energy supply-demand chain

TD Processes in the Domain of Energy at NSSI: an overview

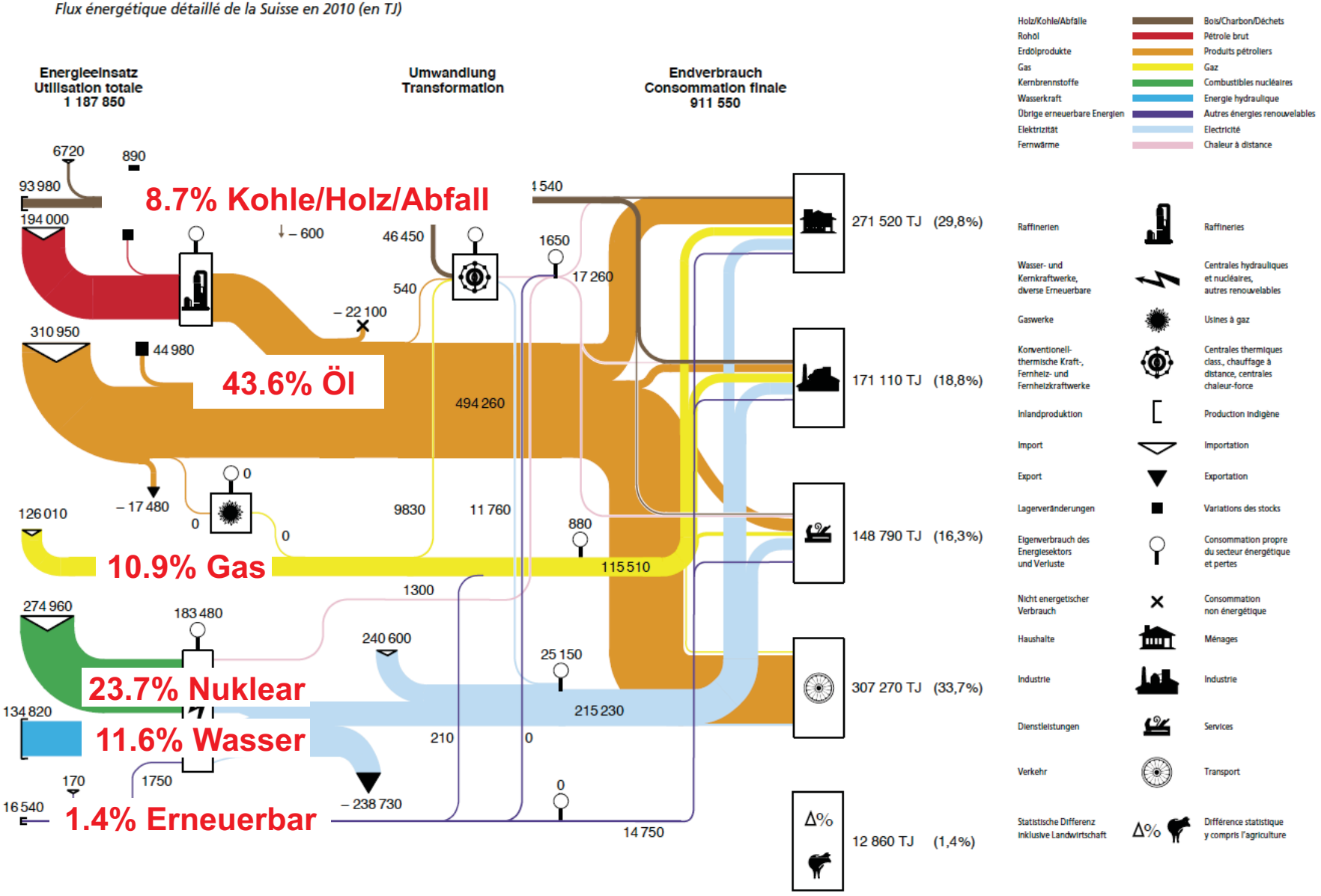


Practice members of the TD Board

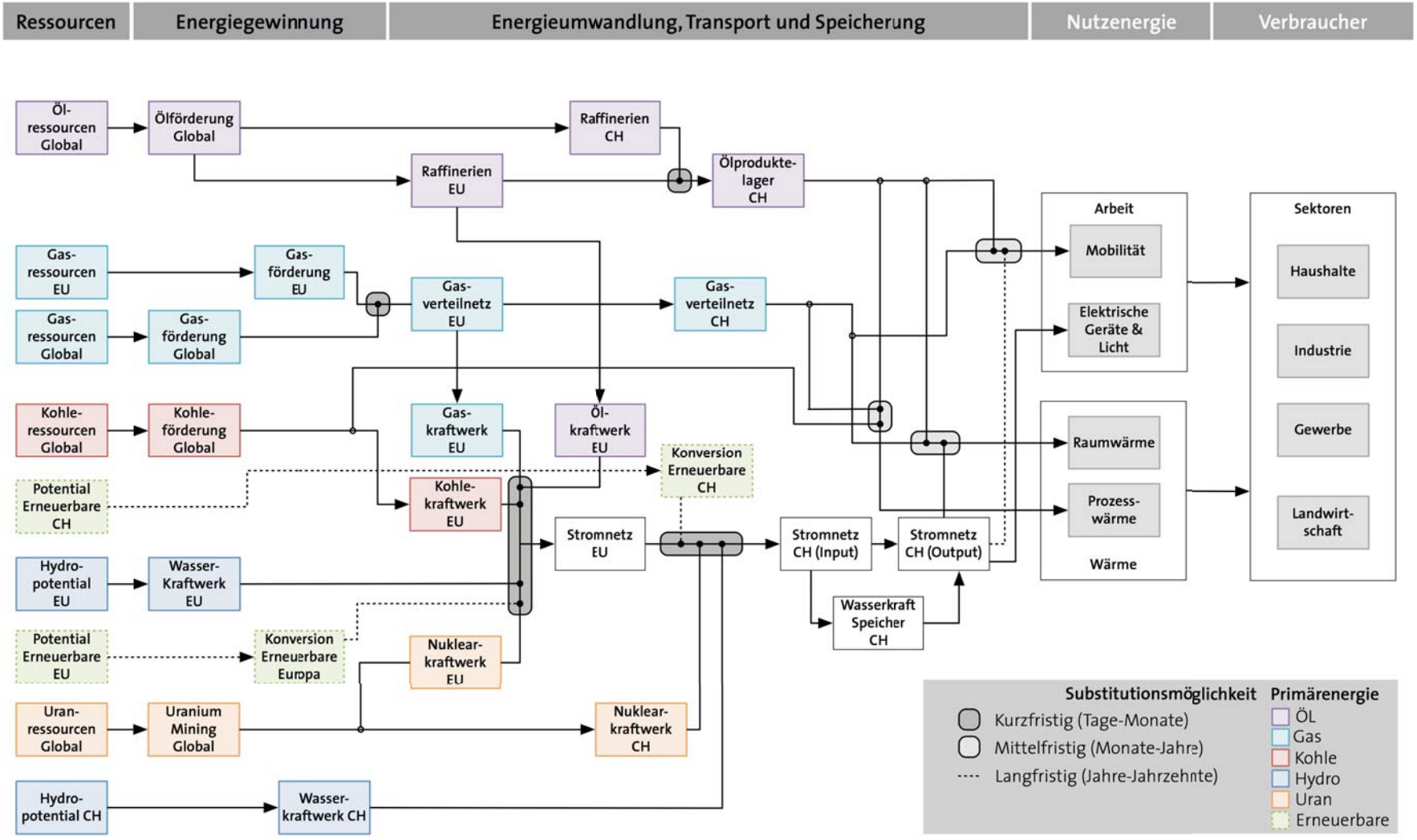
Invited organitzations	Aspect of energy system covered
Erdölvereinigung Schweiz	Oil
Swissnuclear	Nuclear energy
Wasserwirtschaftsverband	Hydropower
Verband der Schweizerischen Gasindustrie	Gas
Swisselectric	Electricity producers
Swissgrid	Electricity grid operator
Agentur für erneuerbare Energien und Energieeffizienz	Renewables
BA für Wirtschaftliche Landesversorgung/ BA für Bevölkerungsschutz und Sport	Federal offices

The Swiss Energy System (BFE Perspective)

Fig. 5 Detailliertes Energieflussdiagramm der Schweiz 2010 (in TJ)
Flux énergétique détaillé de la Suisse en 2010 (en TJ)

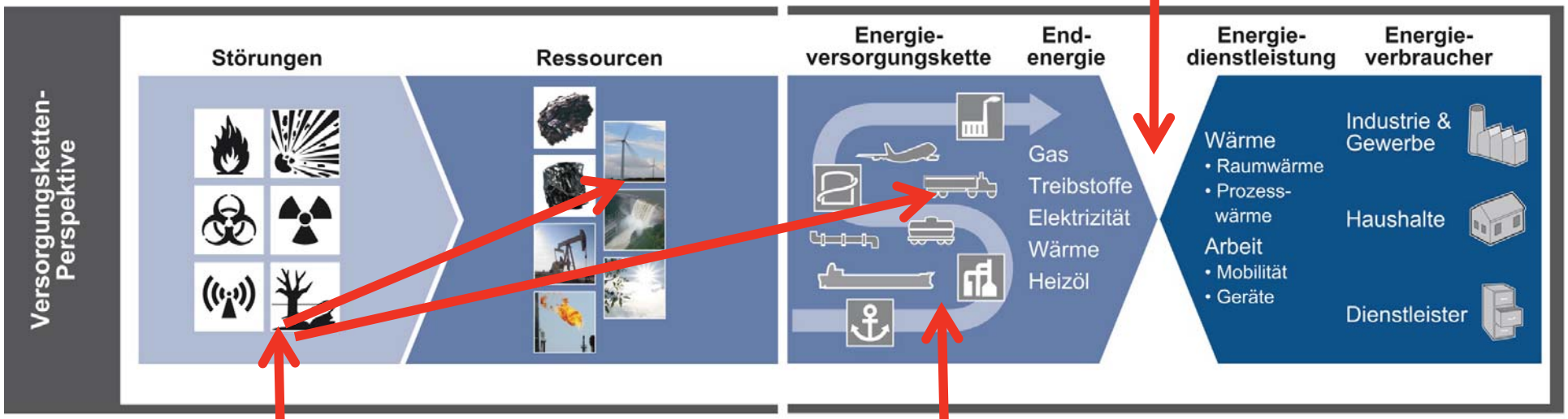


The basic model of the Swiss Energy System (primary energy bound, supply-demand driven)



Measuring the vulnerability by
- stress tests
- (structural) robustness analysis
in transdisciplinary discourses

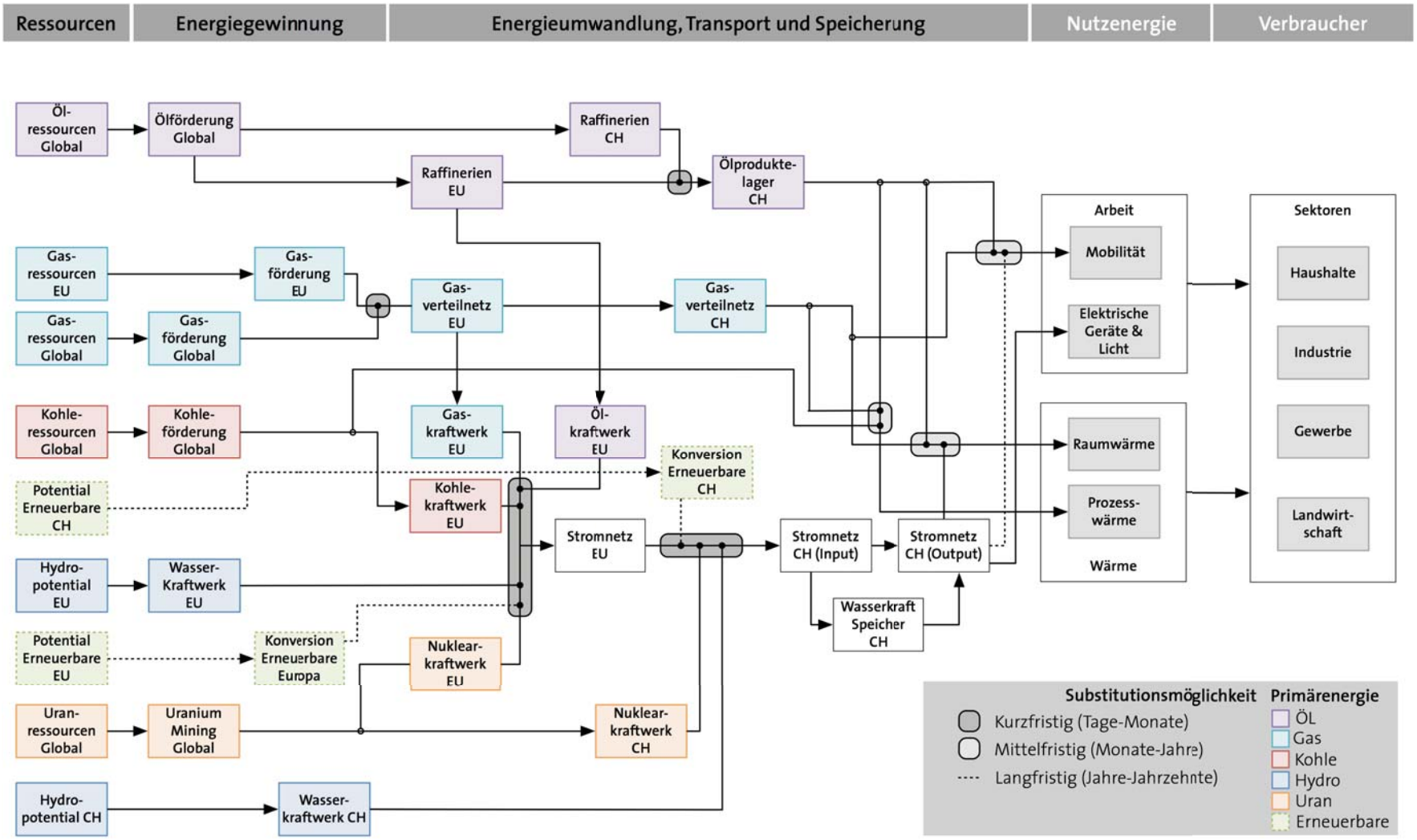
What flexibility/adaptability does the supply chain have?



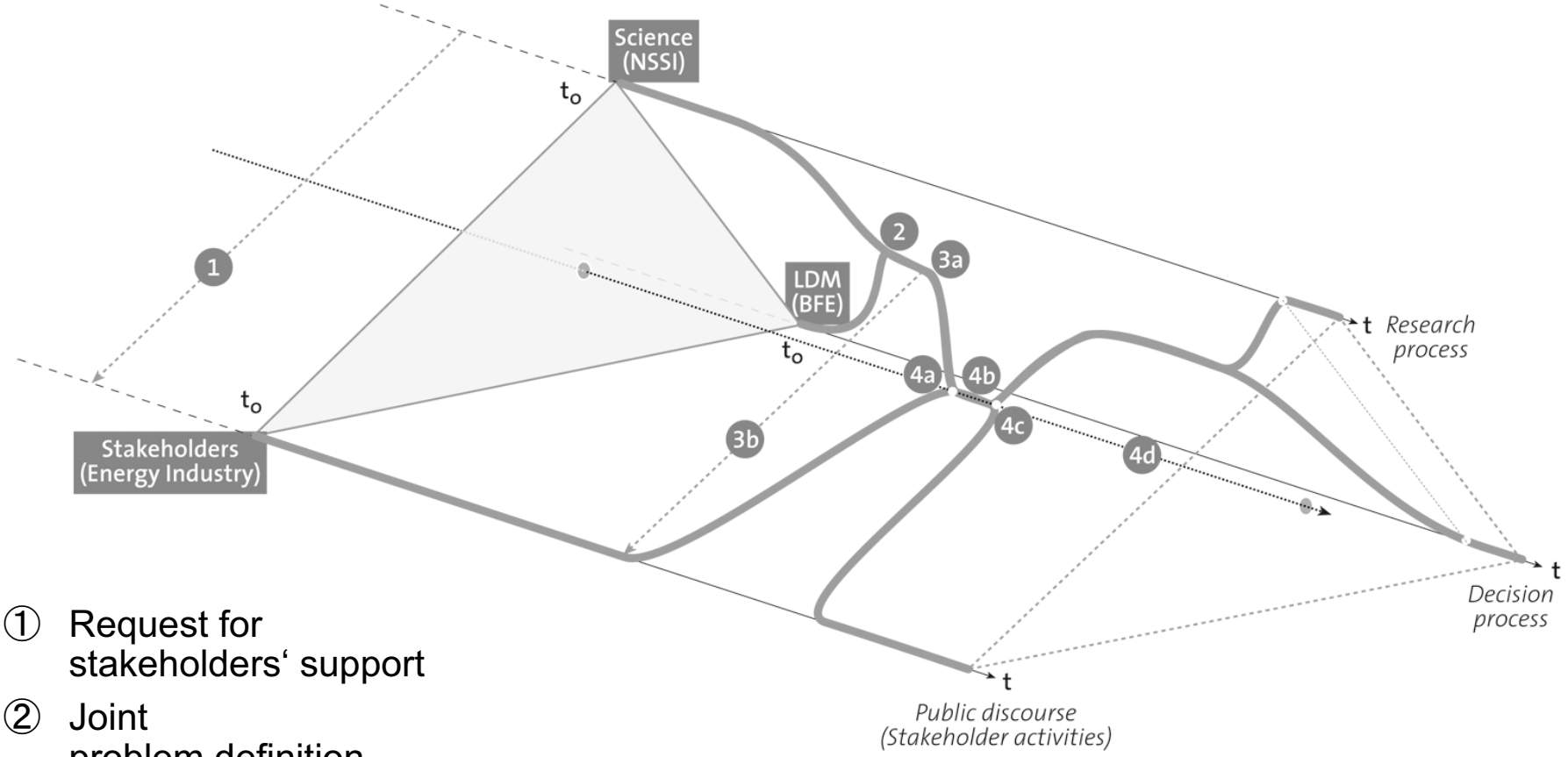
What categories (natural hazards, terroristic attacs, wars, …) and what elements must be considers as risk/disturbance agents?

What structural properties (bottlenecks, missing reduncancy, …) should be measured how?

The Swiss Energy System (VPA Perspective)



The Td process of VPA (Overview)



① Request for stakeholders‘ support

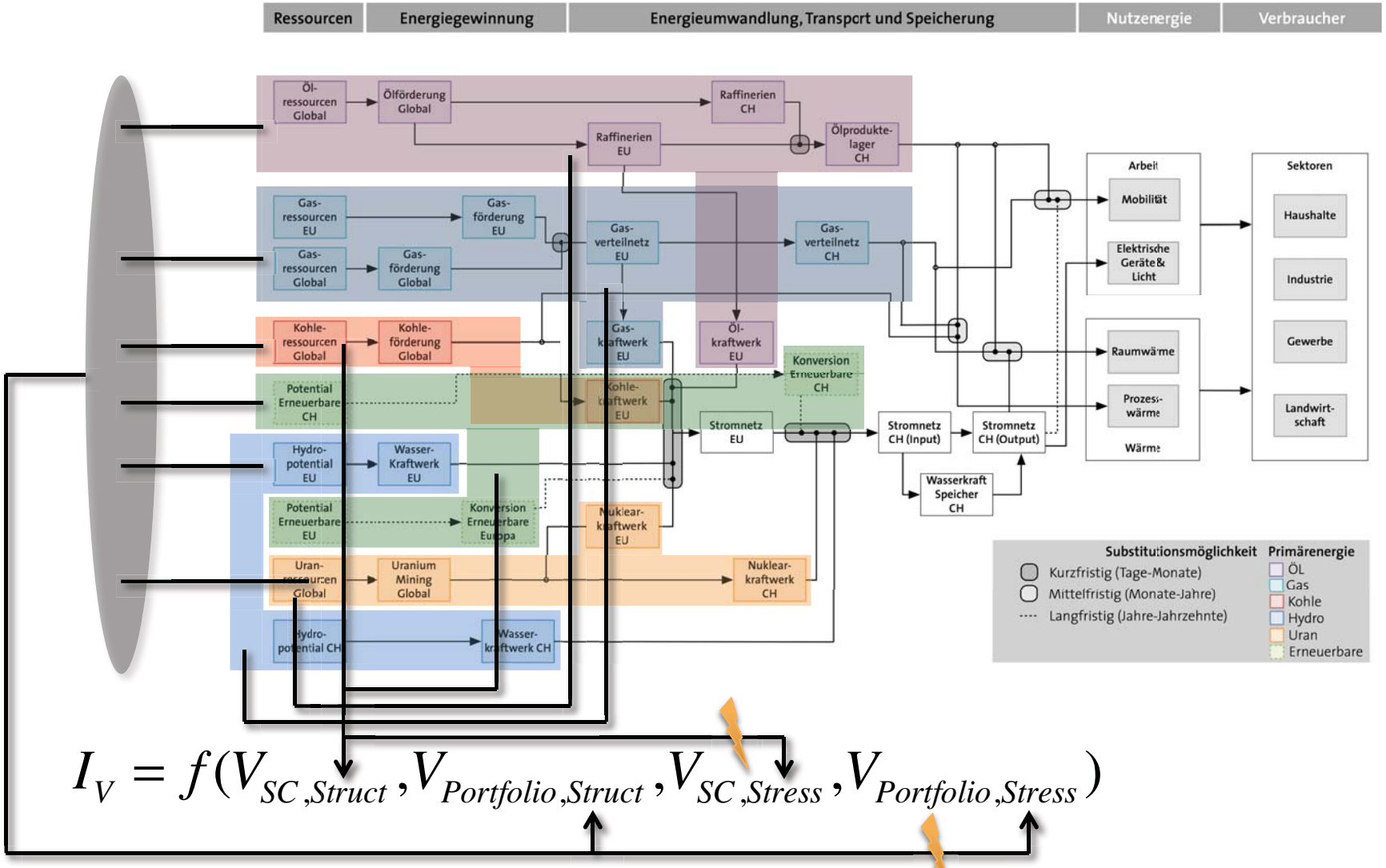
② Joint problem definition

③ Problem representation

④ Establishment of Td board

a. Meeting 1: kick-off
b. M2: Validation of 1st results, inputs for synthesis
c. M3: Synthesis, validation of results (“reality check”)
d. M4: Periodic re-evaluation of situation (decision in M3)

The Swiss Energy System (VPA Perspective)



$$I_V = f(V_{SC,Struct}, V_{Portfolio,Struct}, V_{SC,Stress}, V_{Portfolio,Stress})$$

The next steps (starting the td discourse)

Consensus about the

- goal of the project (√)
- system representation
- definition of the vulnerability indicators
- risk/disturbance agents (√)
- ...
- policy options

will be attained in a transdisciplinary (precompetetive, non-day to day politicized) discourse forum

General conclusions

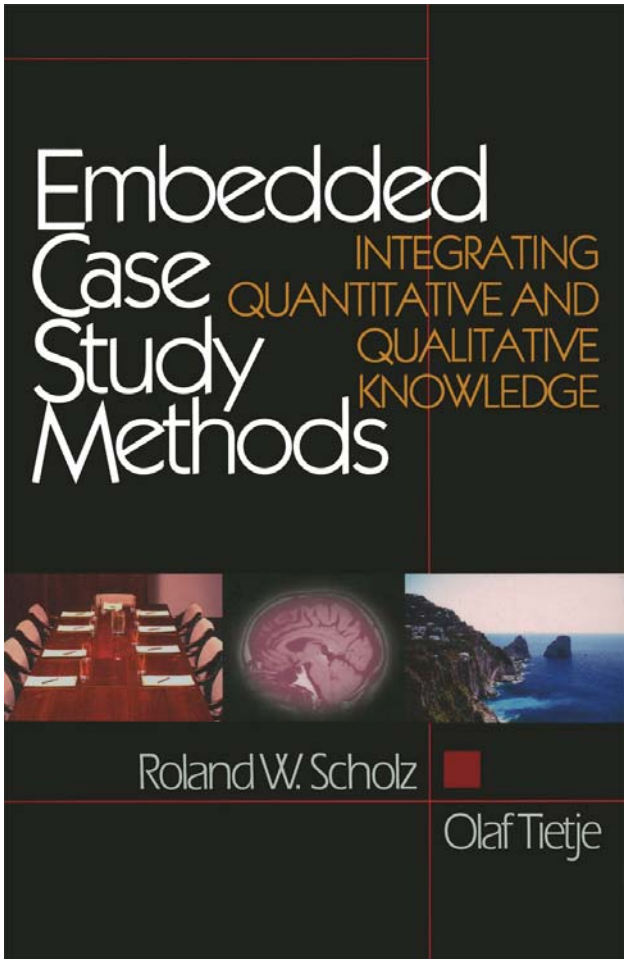
Conclusions

1. Transdisciplinarity in the terms of the Zürich 2000 definition has become a third mode of scientific research and activity supplementing disciplinarity and interdisciplinarity
2. There are a large number of successful transdisciplinary projects in which a mutual learning between science and society took place
3. Developing "socially robust solutions/orientations" for resilient human-environment systems is the key challenge for the transitioning towards sustainable energy systems; this is not a mere not a mere technical issue and asks indispensably for Td-processes relying on different types of epistemics

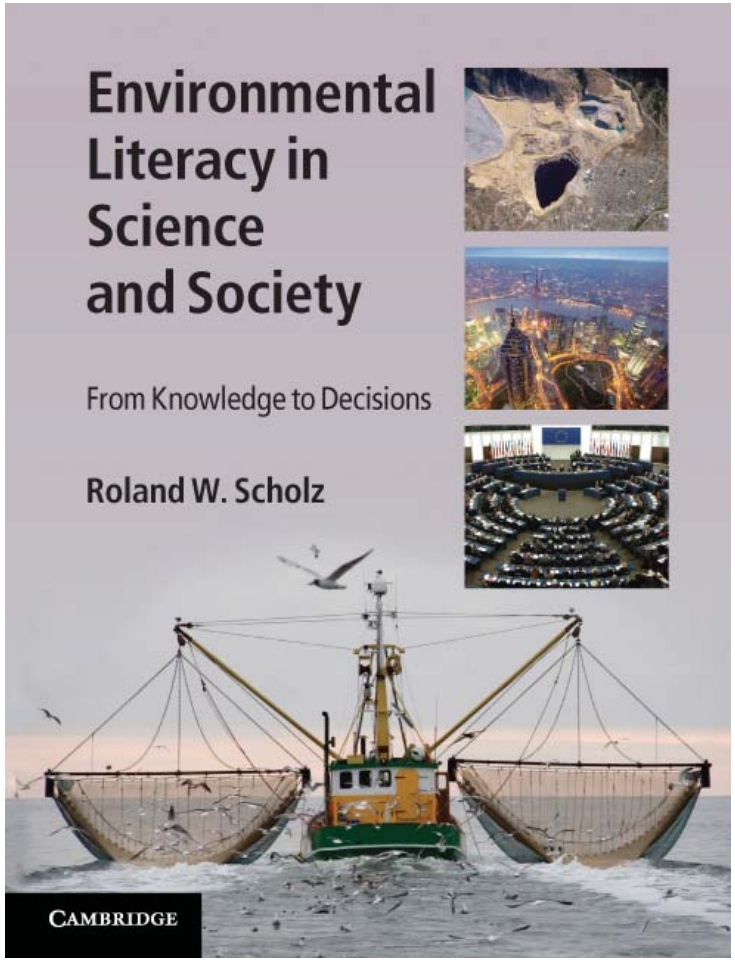
Thank you for your attention!

Two major sources: A method and a theory book

Scholz, R. W. & Tietje, O. (2002). *Embedded Case Study Methods: Integrating Quantitative and Qualitative Knowledge*. Thousand Oaks: Sage.

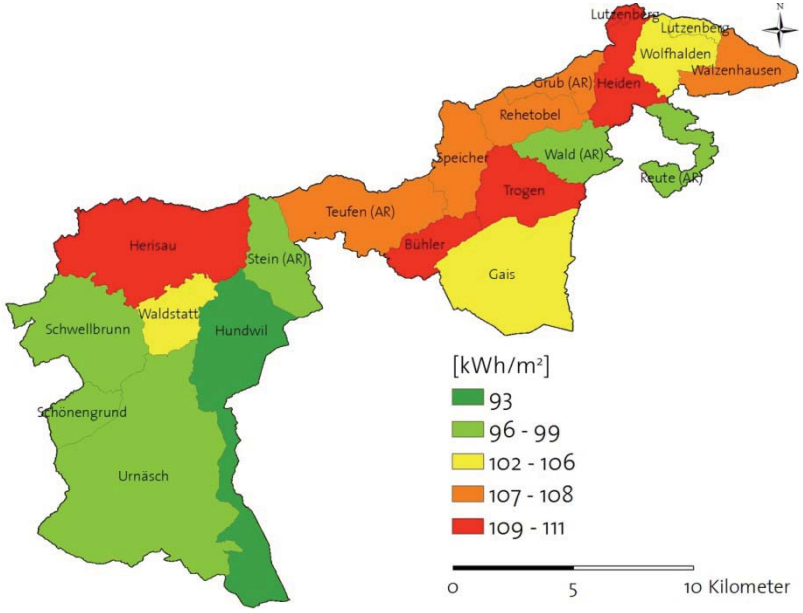


Scholz, R. W. (2011). Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge: Cambridge University Press.

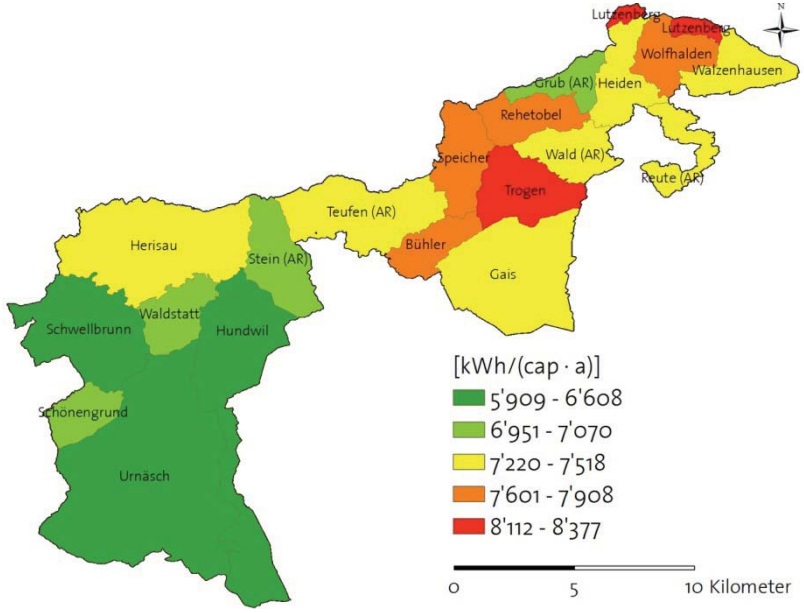


Welche Gemeinde braucht am wenigstens Energie, d.h. ist am «energie-effizientesten»?

Bezogen auf die Wohnfläche
rot=hoch=«schlecht»
grün=niedrig=«gut»



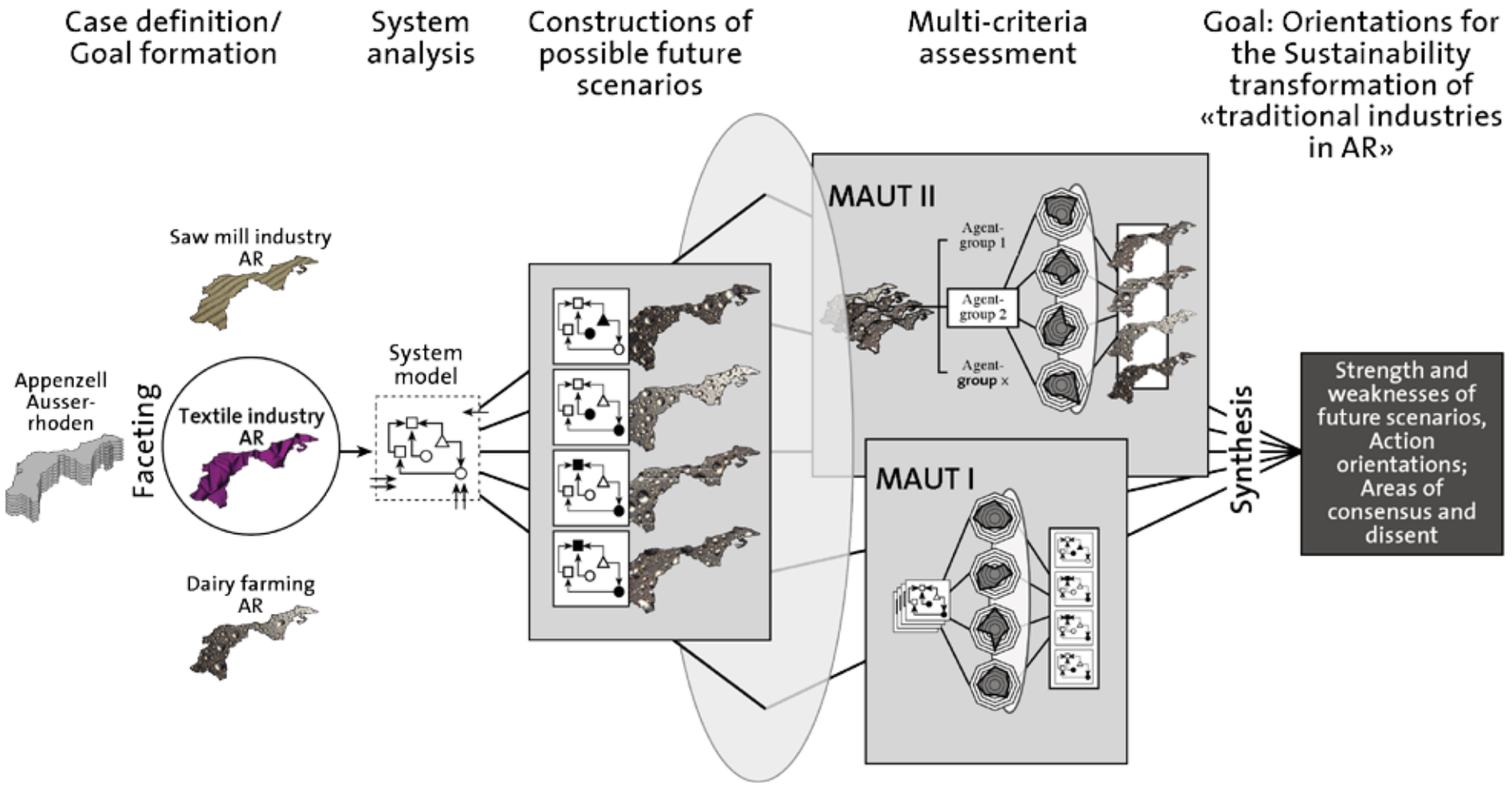
Pro Person
rot=hoch=«schlecht»
grün=niedrig=«gut»



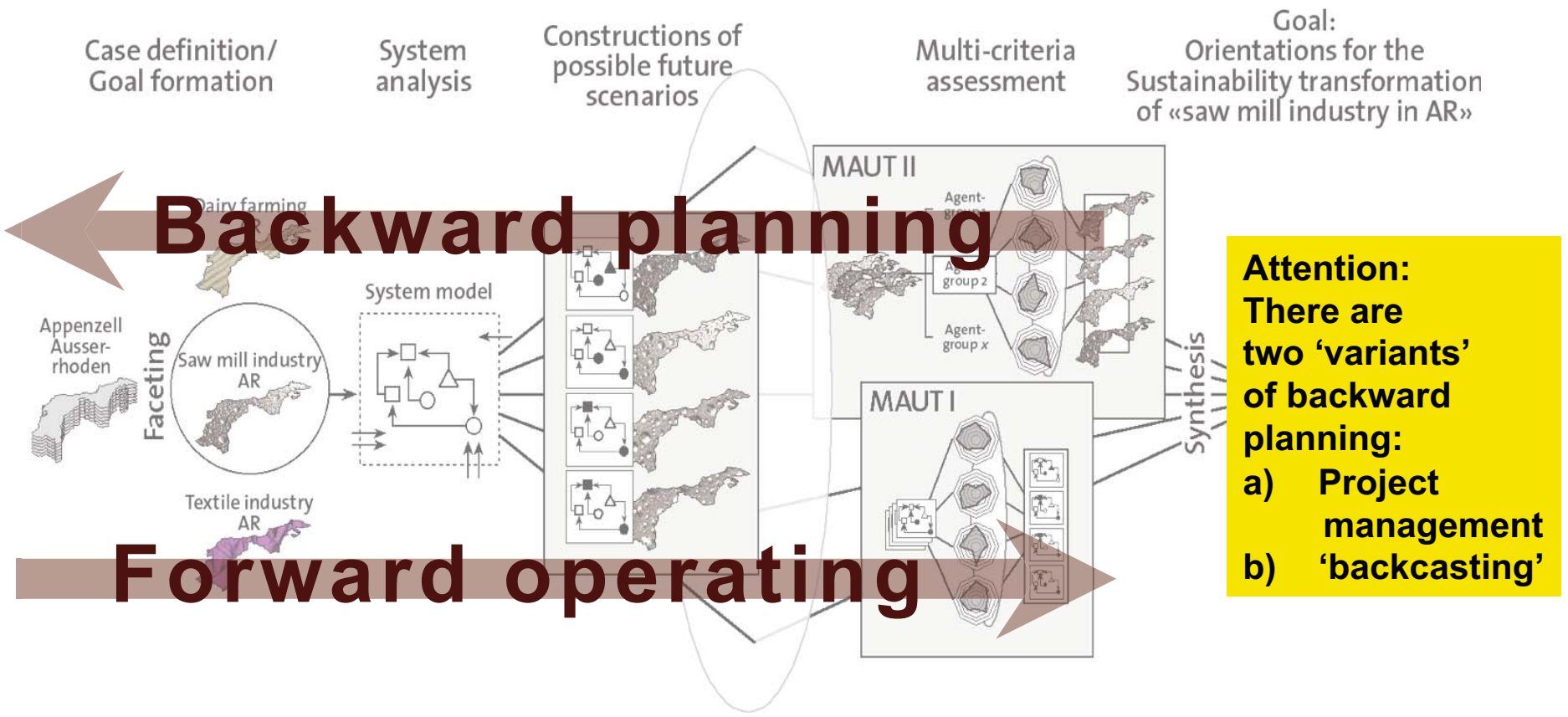
Quelle: Master-Arbeit von Matthias Schlegel, 2010

Some insight into methods of transdisciplinary research

Formative Scenario Analysis


Case definition/ Goal formation
System analysis
Constructions of possible future scenarios
Multi-criteria assessment
Goal: Orientations for the Sustainability transformation of «traditional industries in AR»
Saw mill industry AR
Appenzell Ausser-rhoden
Faceting
Textile industry AR
Dairy farming AR
System model
MAUT II
Agent-group 1
Agent-group 2
Agent-group x
MAUT I
Synthesis
Strength and weaknesses of future scenarios, Action orientations; Areas of consensus and dissent

The backward planning principle



Attention:
There are two 'variants' of backward planning:

a) **Project management**
b) **'backcasting'**

Forward operating vs. backward planning

Backward Planning

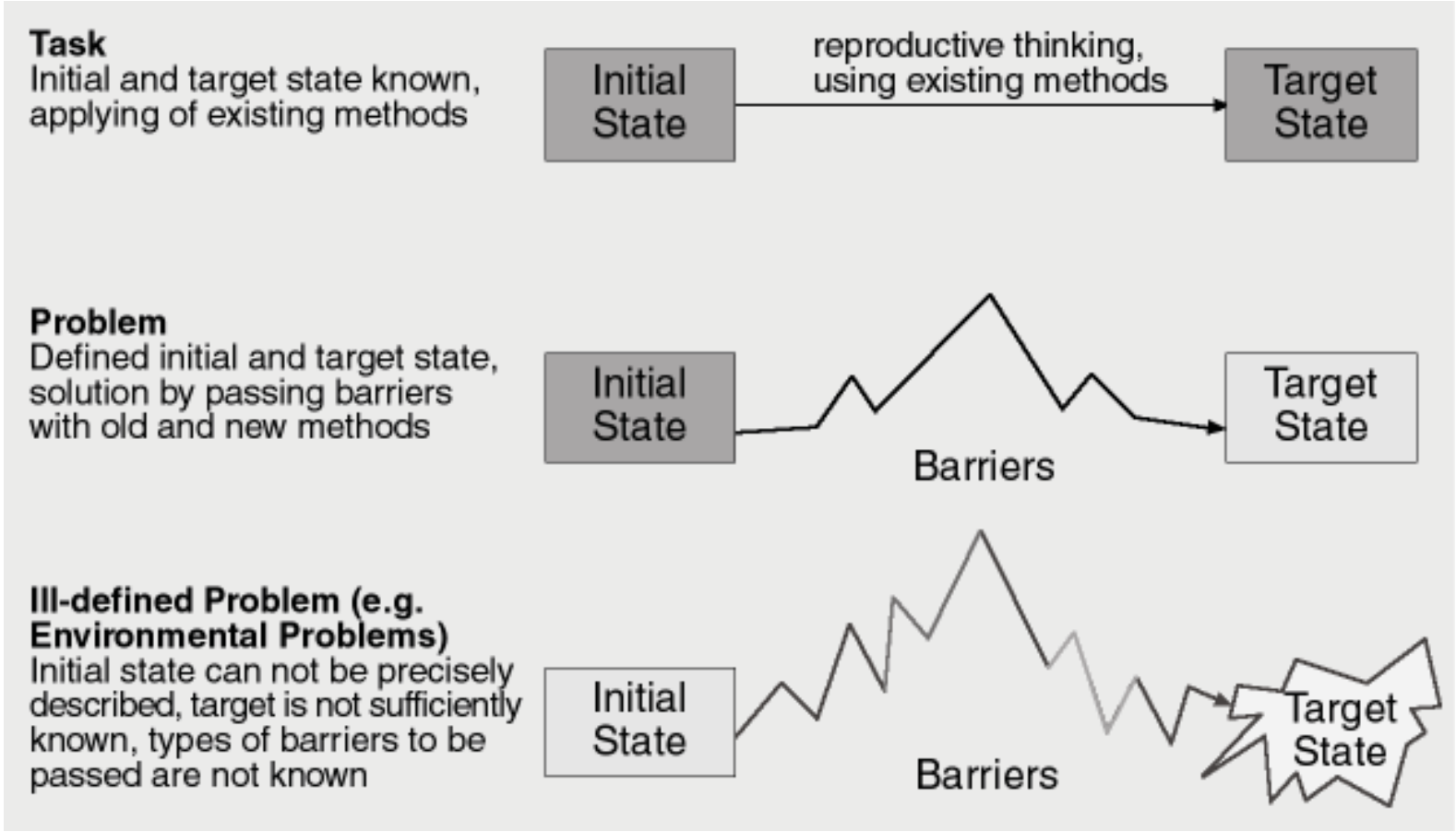
1. Goal formation (*Negotiated between theory and practice.*)
2. Faceting of the case (*What industries to look at?*)
3. Evaluation/assessment criteria (*e.g. MAUT*) and assessment procedure (*Who should evaluate?)*
4. Variants (*What comparisons can help to answer what question?*)
5. System analysis (*What impact factors are most essential?*)
6. System boundary definition (*What are appropriate case boundaries?*)

Forward Operating

(Start from your facet, e.g. Textile Industry)

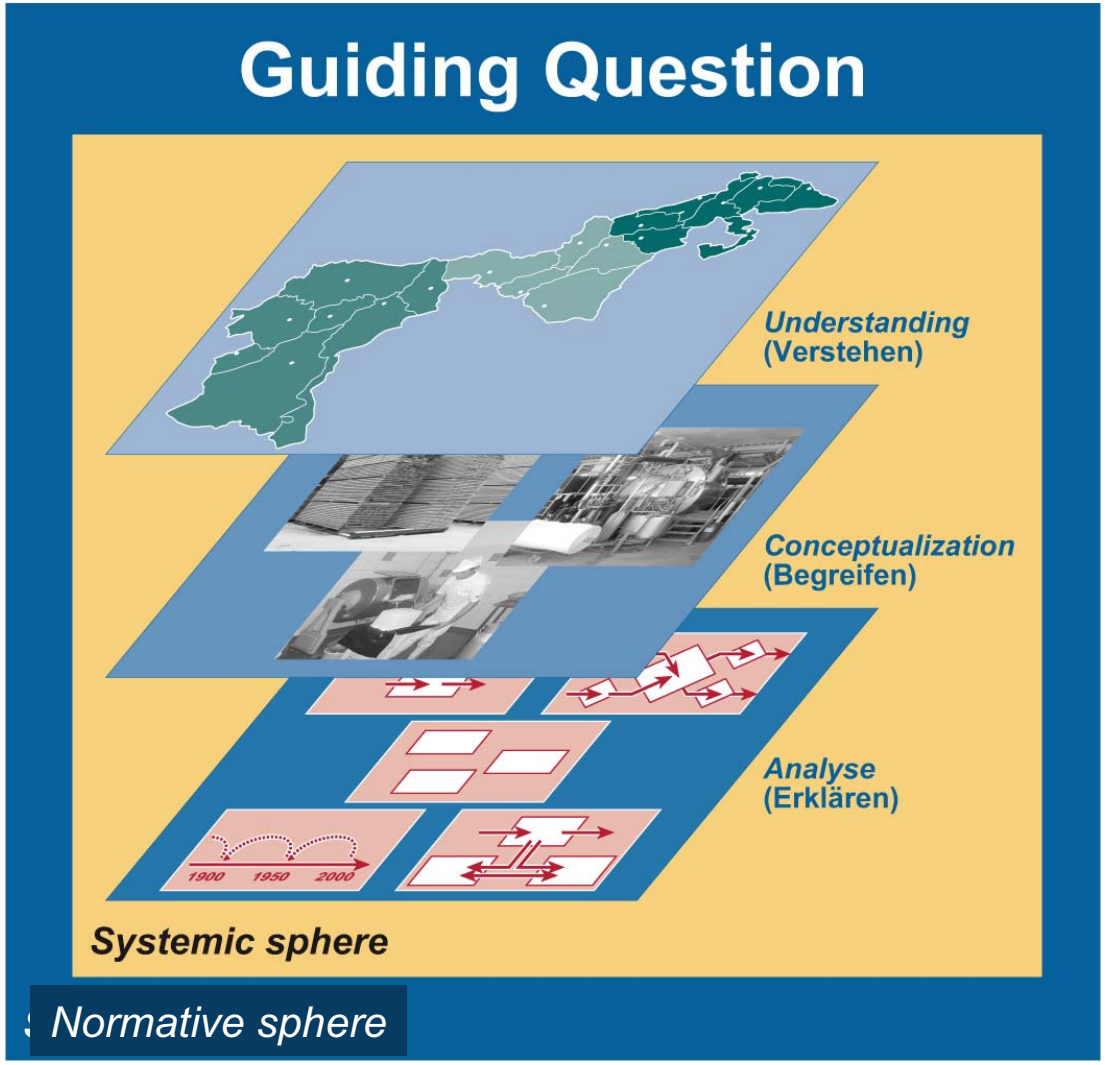
1. Define the system boundaries [6]
2. Construct a system model (*e.g. by impact factors in an FSA framework*) [4]
3. Define variants/scenarios (*e.g. by FSA*) [3]
4. Organize different evaluations (*e.g. a science/data based and a stakeholder based*) [2]
5. Derive orientations from the evaluations in the facets with respect to the goal of the case study [1]

The ontology of sustainability studies is (a) of an "ill-defined problem type"



and (b) includes normative issues

Epistemology: Different spheres and different types of knowledge have to be differentiated

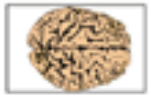


Methodology

Knowledge integration is the issue!

Methods of knowledge integration are needed for

1. Case representation (including case projection, constructing scenarios)
2. Case evaluation (evaluation of scenarios)
3. Case transformation (securing that scenarios become real)
4. Case study team methods

Case Study Methods	The Four Types of Knowledge Integration			
	Disciplines 	Systems 	Modes of Thought 	Interests 
Case representation (including case projection)				
Formative Scenario Analysis	XX	X	X	
System Dynamics	XX	X		
Material Flux Analysis	X	XX		
Case evaluation				
Multi-Attribute Utility Theory	X	X		X
Integrated Risk Management	X	X		
Life Cycle Assessment	X	XX		
Bio-Ecological Potential Analysis		XX	X	
Case transformation				
Area Development Negotiations		X	X	XX
Future Workshops			XX	X
Case study team methods				
Experiential Case Encounter			XX	X
Synthesis Moderation			X	X