


An integrative view on the energy transition

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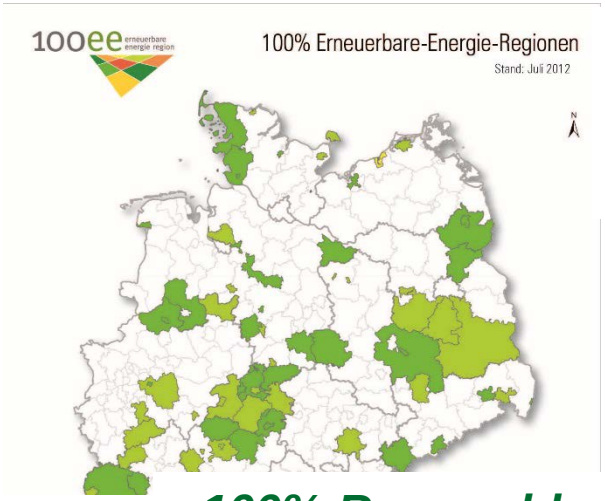
The issue



100% Renewable Energy Regions

Vision The region flourishes

Bürgermeister pessimistisch

Durchhänger beim Projekt Energiewende?

Mayors pessimistic:
Sagging in the energy transitions?

LANDKREIS BAD TÖLZ-WOLFRATSHAUSEN

Integriertes Klimaschutzkonzept für den Landkreis Bad Tölz-Wolfratshausen

2013

Concept for climate protection does not affect politicians

The issue

- Technological, institutional, and social “lock ins”
- Technological innovations alone are not sufficient for a transition towards more sustainable energy systems
- Social innovation is required:
  - New actor constellations and governance
  - Behavioral changes
- Necessity to study co-evolution of socio-technical systems (STS)
- Interdisciplinary research is required at theory, framework, methodological, and empirical level

Goal and Research Questions

Goal

Integrative and interdisciplinary analysis of energy transitions considering: (i) “technical” energy system; (ii) institutional development; (iii) individual behavior.

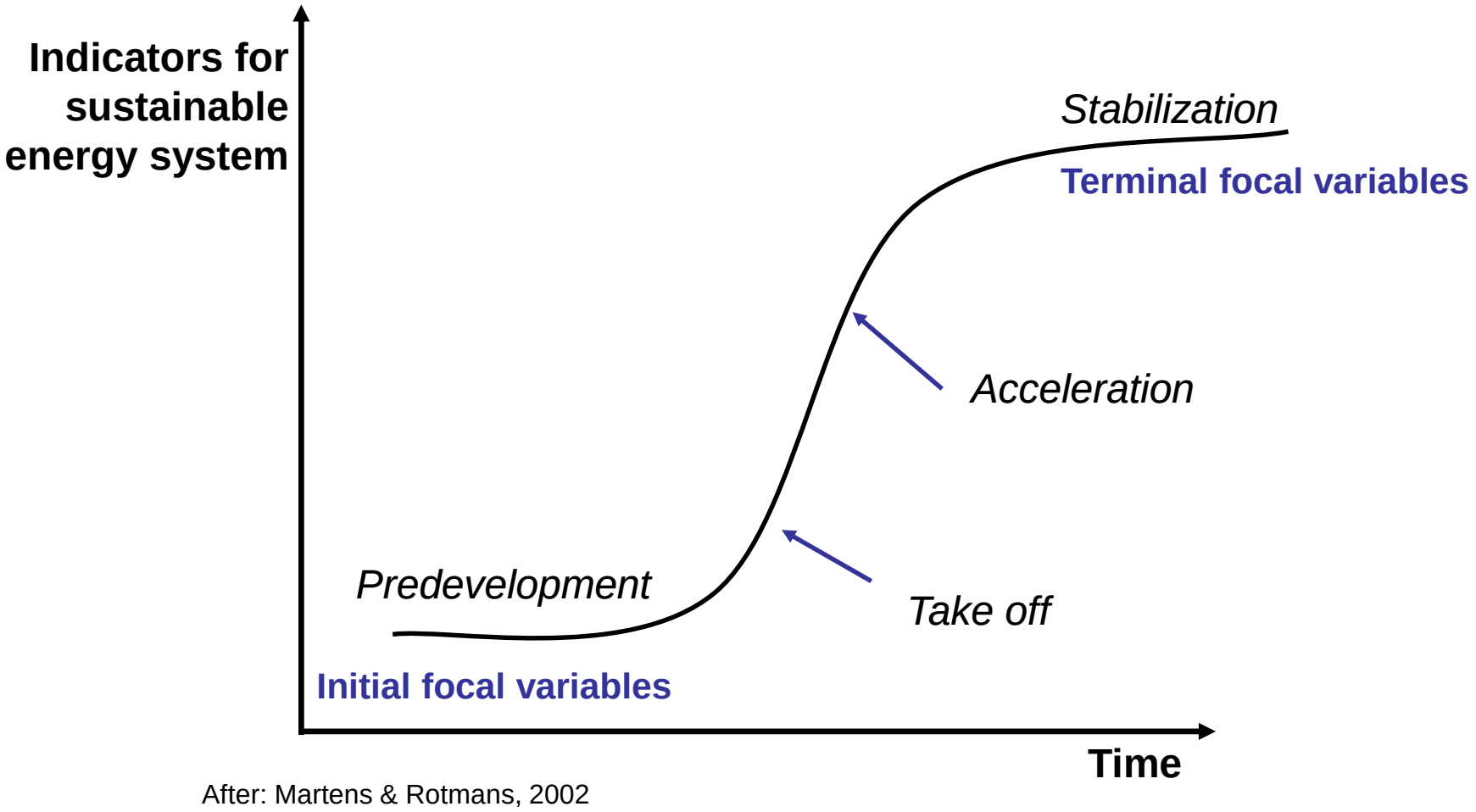
Focus: regional level

Research questions addressed

1. Which factors and behaviors affect(ed) the transition of the energy region?
2. How can these behaviors (buildings) be explained?
3. How can we conceptualize the resilience of the transition?

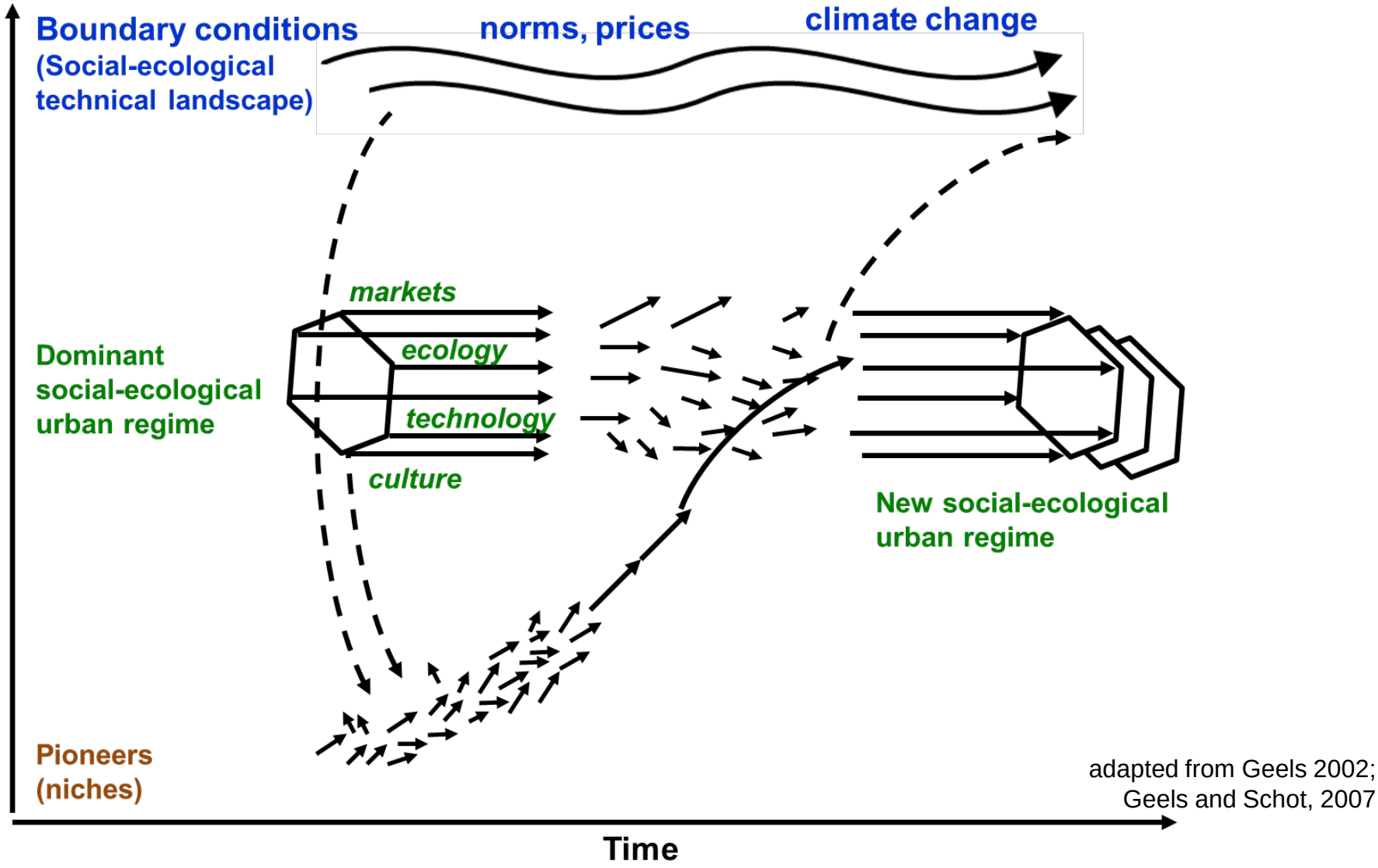
Conceptual approach

The transition process



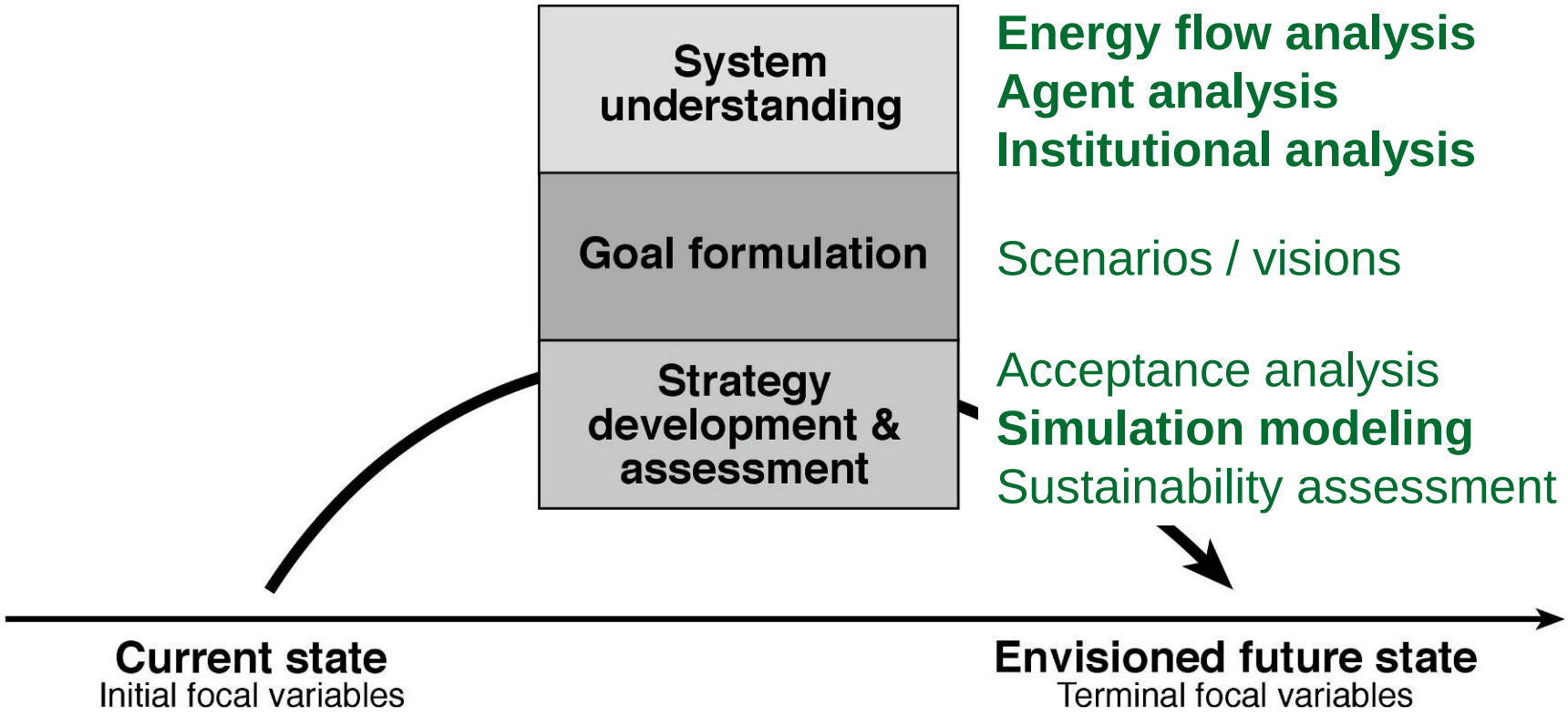
After: Martens & Rotmans, 2002

The transition process

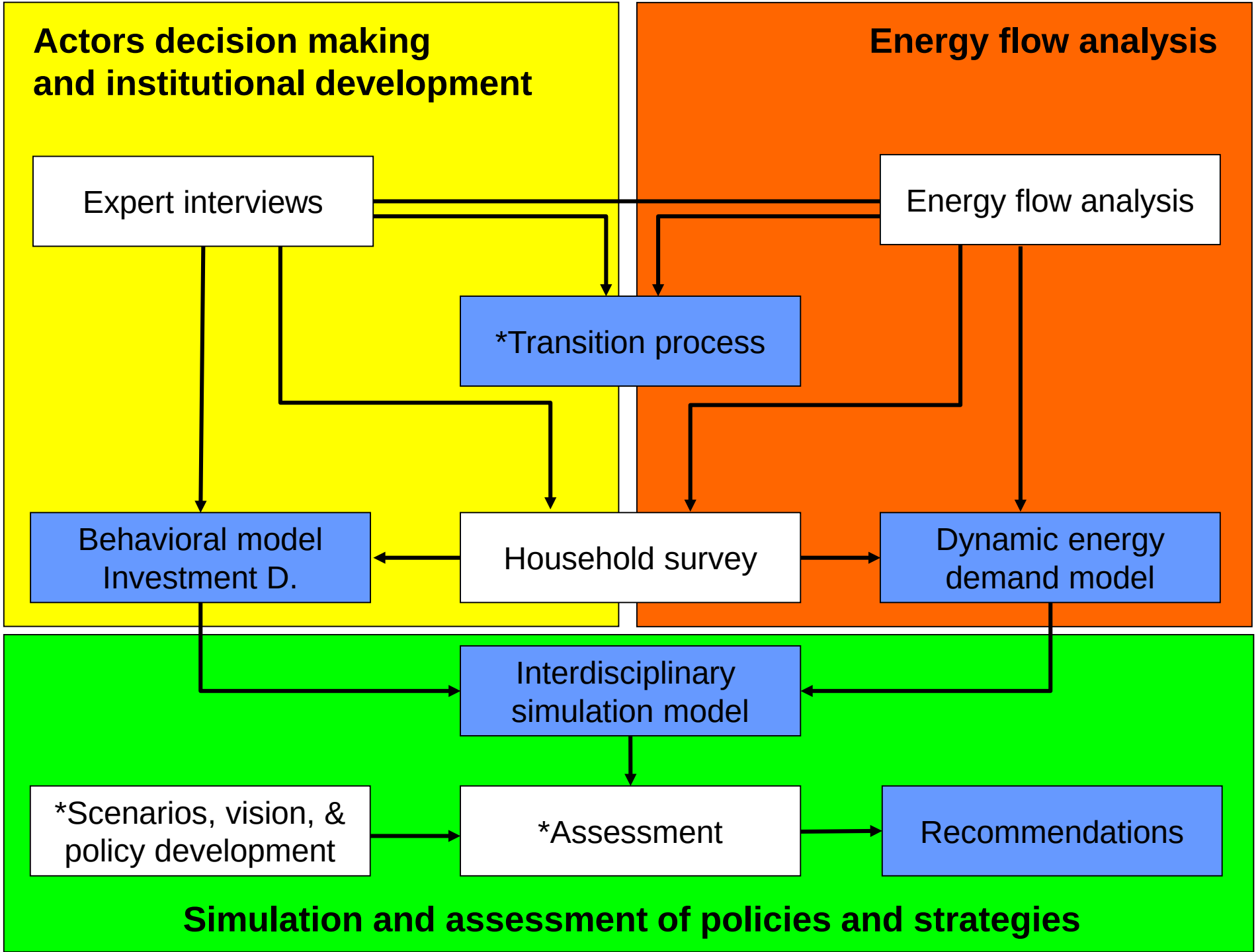


adapted from Geels 2002;
Geels and Schot, 2007

Elements of transition analysis and management



After: Binder et al., 2004


Actors decision making and institutional development
Energy flow analysis
Expert interviews
Energy flow analysis
*Transition process
Behavioral model Investment D.
Household survey
Dynamic energy demand model
Interdisciplinary simulation model
*Scenarios, vision, & policy development
*Assessment
Recommendations
Simulation and assessment of policies and strategies

Study areas

Study areas

- ökoEnergieland / Güssing
  - Burgenland (AT)
  - 14 communities
  - Founded 1990 (2005)
  - Biomass
  - High unemployment and migration
- Energy region Weiz-Gleisdorf
  - Steiermark (AT)
  - 18 communities
  - Founded 1996
  - Energy technologies
  - Good employment possibilities

ÖkoEnergieland

Decentralized local energy production

http://www.eee-info.net

Hecher, 2012; PSI, 2008

Weiz-Gleisdorf
Light-house projects


Gemini Haus (2001)


Solar tree (1998)

Fueling station


Plus energy house (1997-2001)

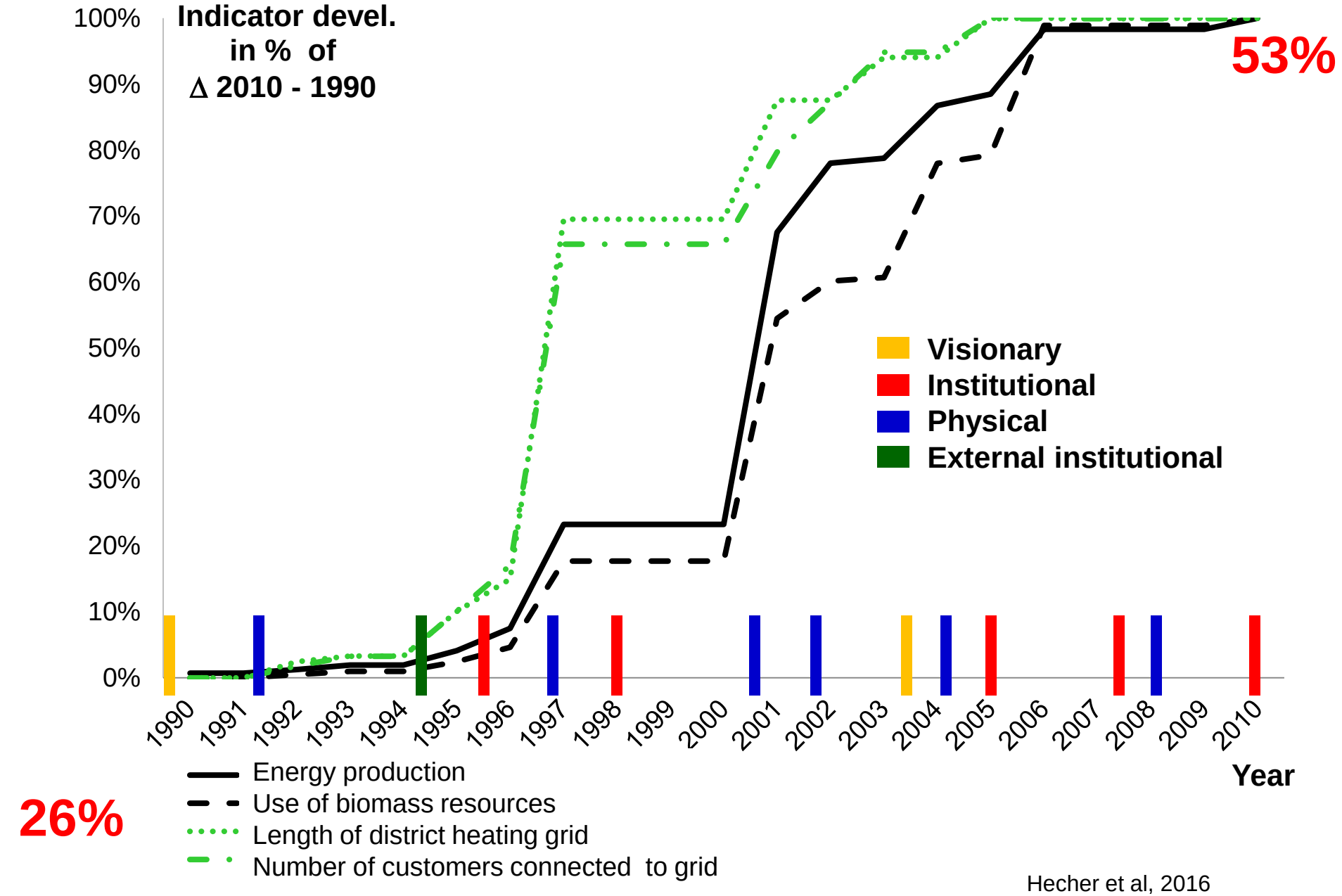
Bezirkshauptmanschaft (2010-11)

Source: Bedenik and Hecher, 2012

Research questions

1. Which factors and behaviors affect(ed) the transition of the energy region?
   - **Energy flow parameters and milestones**
   - **Future energy demand from buildings and regional supply**
2. How can these behaviors be explained?
3. How can we conceptualize the resilience of the transition?

Milestones in the energy transition



Hecher et al, 2016

Linking energy demand to energy supply

Scenarios for regional energy demand

Bottom up simulation of 15 scenarios
- Envelope renovation rate
- Legislative standards
- Heating technologies

Entities
- Individual buildings (SFH, MFH, NRB)
- Construction period
- Heating system

Data source
- Statistical office Austria

Regional supply of renewable energy

Top down scenarios for supply potential
- Technical maximum
- Competing use
- Spatial accessibility

Entities
- Forest
- Agriculture
- Solar energy (PV, solar-thermal)

Data source
- Statistical office Austria

Binder et al, 2016

Energy standards and energy demand in 2050

BAU

Ren. rate: 0.8%
Energy standards
New B.: 80 kWh/m²a
Ren. B.: 100 kWh/m²a

REN

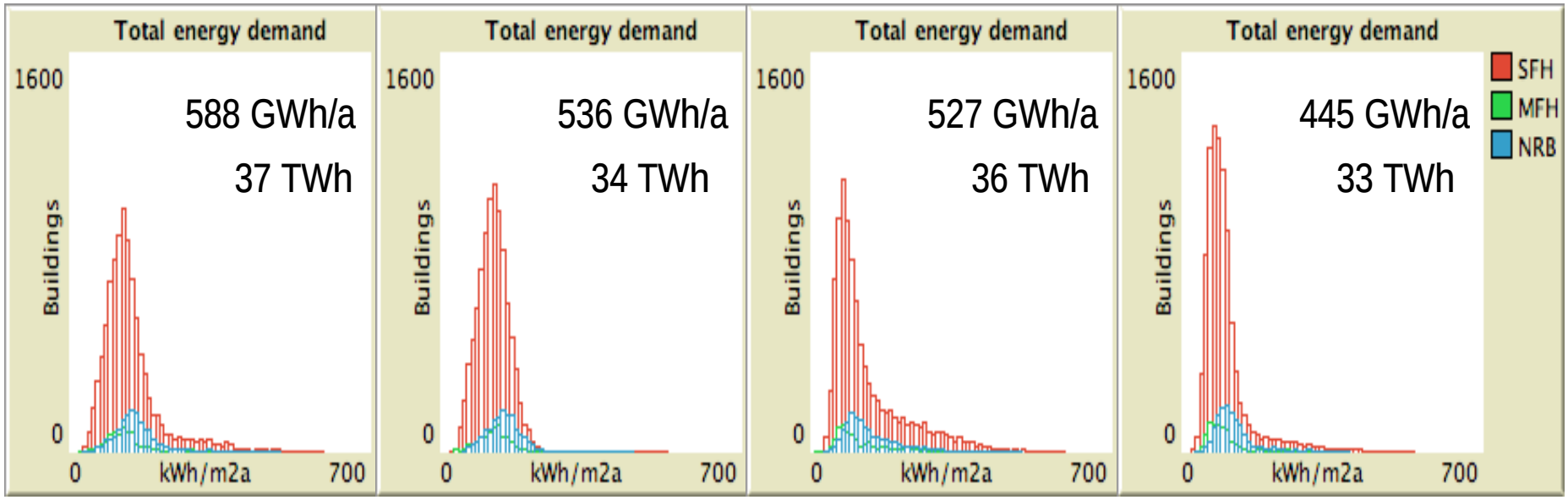
Ren. rate: 1.6%
Energy standards
New B.: 80 kWh/m²a
Ren. B.: 100 kWh/m²a

LEG

Ren. rate: 0.8%
Energy standards
New B.: 25 kWh/m²a
Ren. B.: 50 kWh/m²a

TRANS

Ren. rate: 1.6%
Energy standards
New B.: 25 kWh/m²a
Ren. B.: 50 kWh/m²a

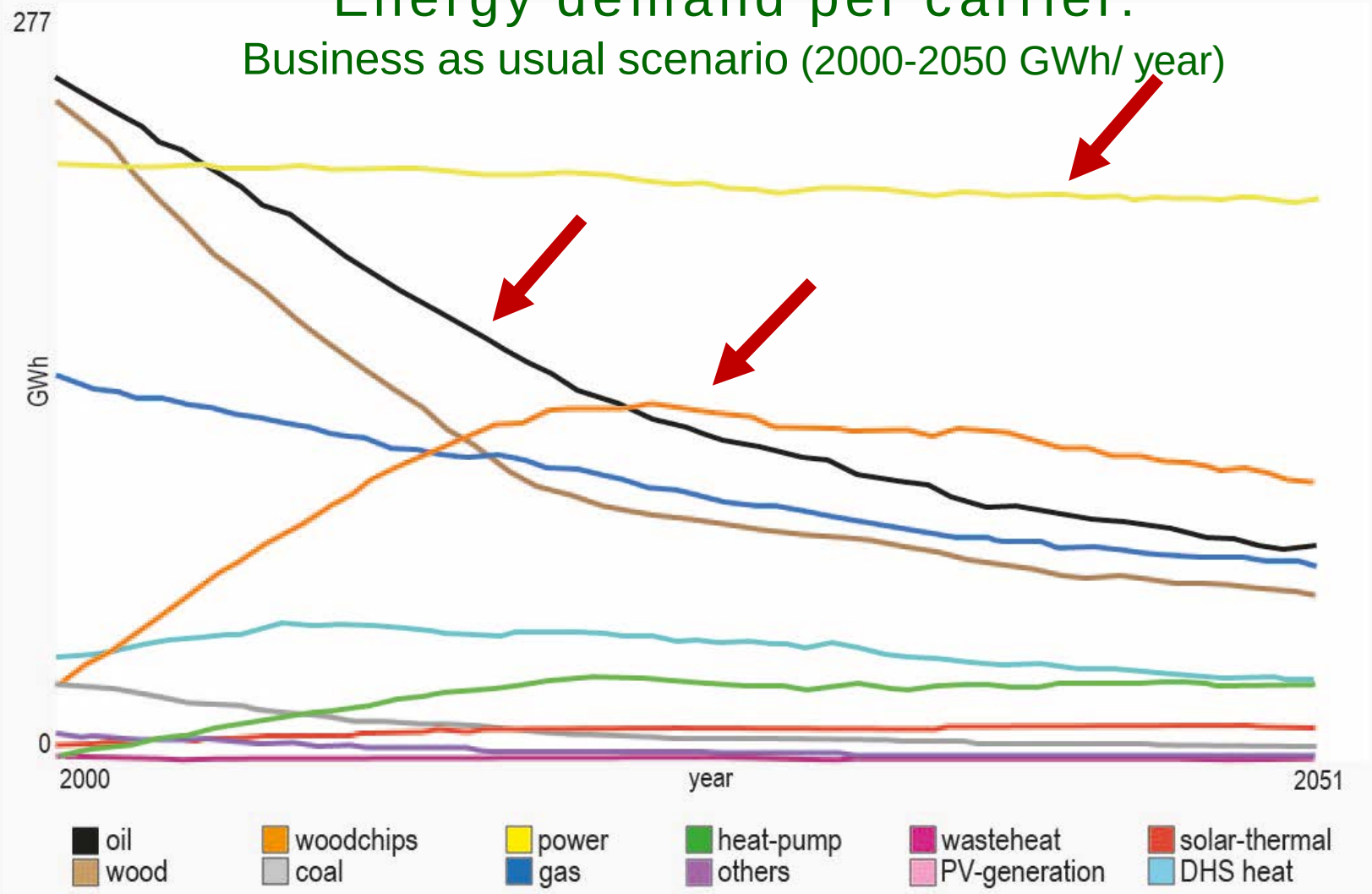


Single family houses | Non residential buildings | Multiple family houses

Binder et al., 2016

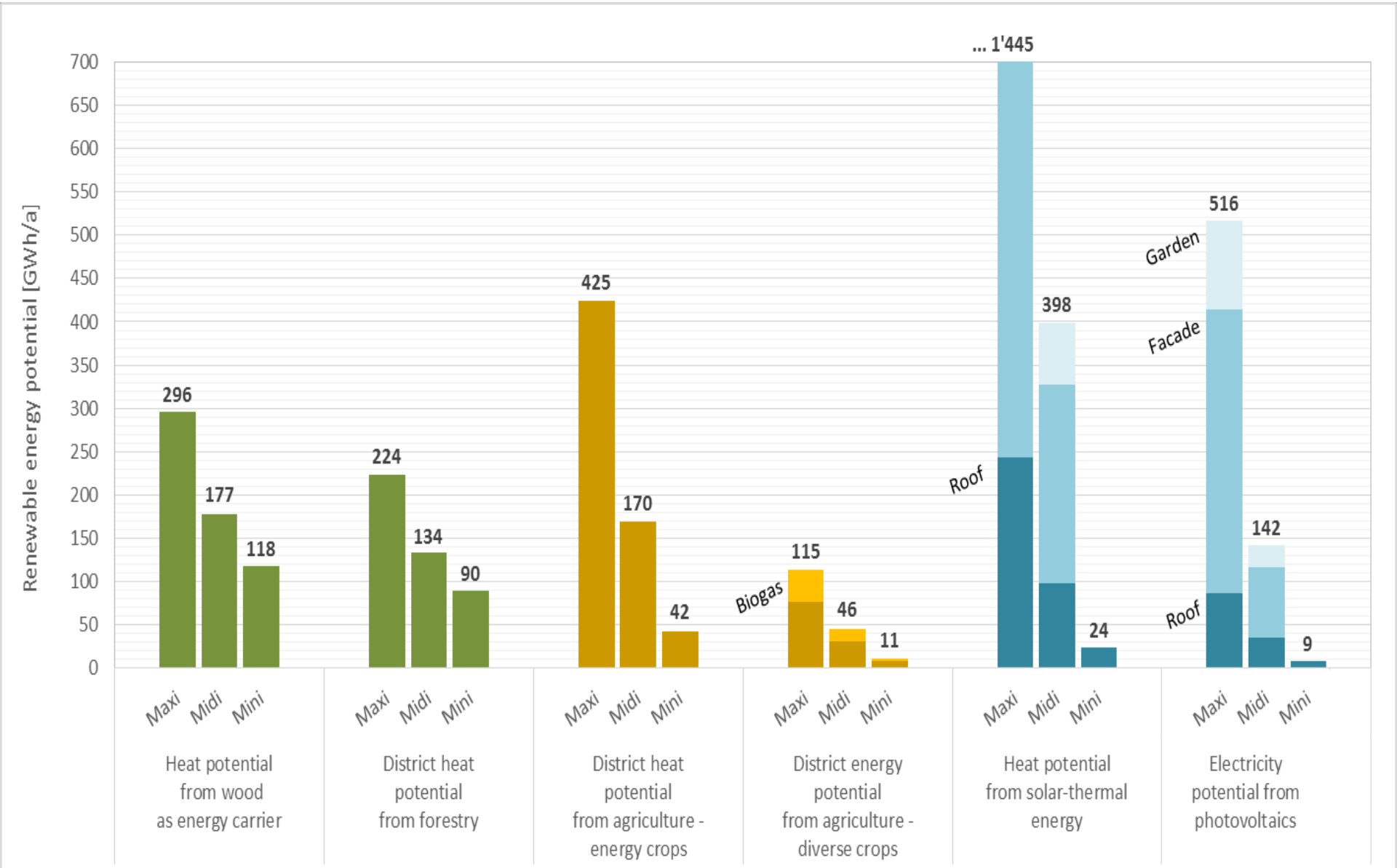
Energy demand per carrier:

Business as usual scenario (2000-2050 GWh/ year)



Binder et al., 2016

Supply from different sources



Aligning supply and demand

	DEMAND			SUPPLY POTENTIAL	
Demand scenarios	BAU			MINI	MAXI
Heating systems scenarios	BAU	ALT	BIO		
Wood & Woodchips (2050) [GWh/a][1]	161	105	264	118	296
Solar-thermal (2050) [GWh/a][2]	11	24	6	24	1445
Heat from DHS (2050) [GWh/a][3]	29	30	27	42 (11)	425 (114)
Electricity (2050) [GWh/a][4]	206	229	196	9	516 (F:64%)

Binder et al., 2016

Summary (I)

- Visionary leaders, political agents at **regime level** were key for creating a vision and promoting the transition.
- **Co-evolution** of the STS ⇒ **Visionary** and **institutional** milestones precede **physical** milestones.
- **Path dependency** of technical strategies selected linked to infrastructural measures such as district heating grid
- **Trade-off** between “faster” transition and “stock” of high energy efficient houses.
- Energy supply has to be planned in a flexible way.
  - Regional versus short distance?
  - Electricity supply

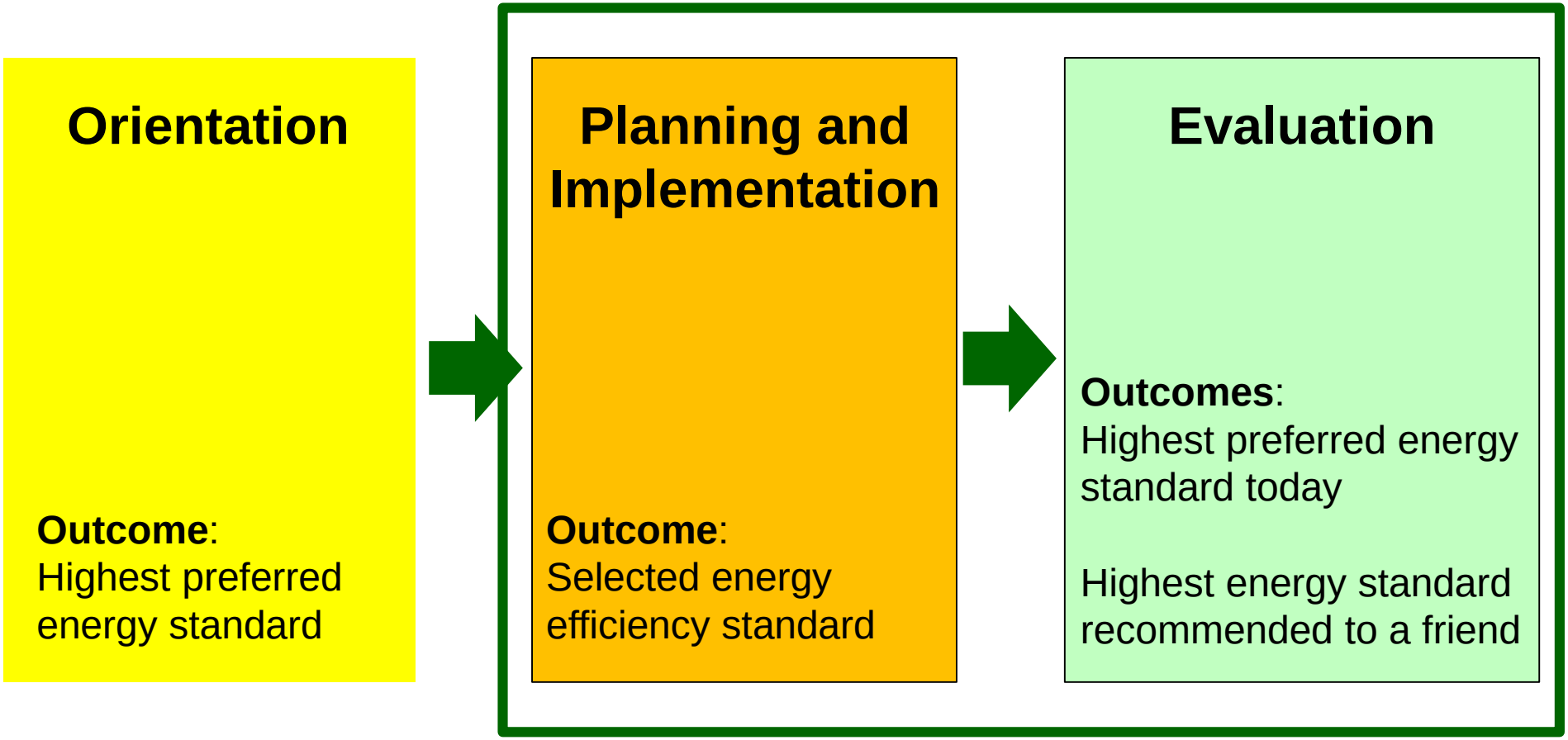
Research questions

1. Which factors and behaviors affect(ed) the transition of the energy region?
2. How can these behaviors be explained?
   - **Decisions on energy efficiency in the building sector**
3. How can we conceptualize the resilience of the transition?

Methods

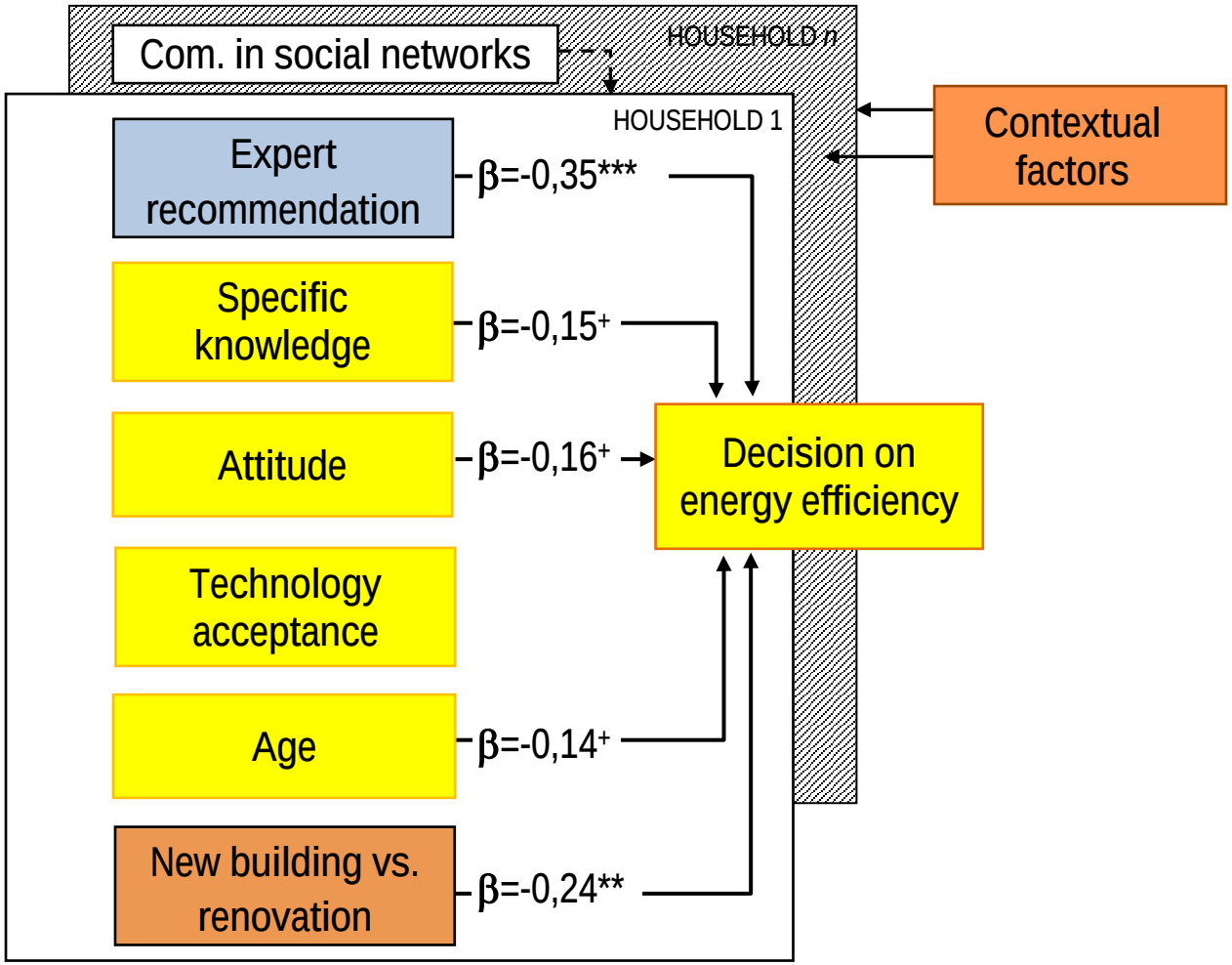
- Explorative expert interviews
  (owners and experts)
- Survey (N=127 valid questionnaires)
  random sample from list of building permits (2008-2013)
- Multiple regressions
  - Decision on **own energy efficiency** standard
  - **Preferred** energy efficiency standard **today**
  - Energy efficiency standard **recommended to a friend**

Three phases in selecting and evaluating energy efficiency in renovation and new buildings



Factors affecting decision on energy efficiency

Energy efficiencies: A^{++} = 10kWh/m²a, A^{+} = 15kWh/m²a, A = 25kWh/m²a, B = 50kWh/m²a, C = 100kWh/m²a

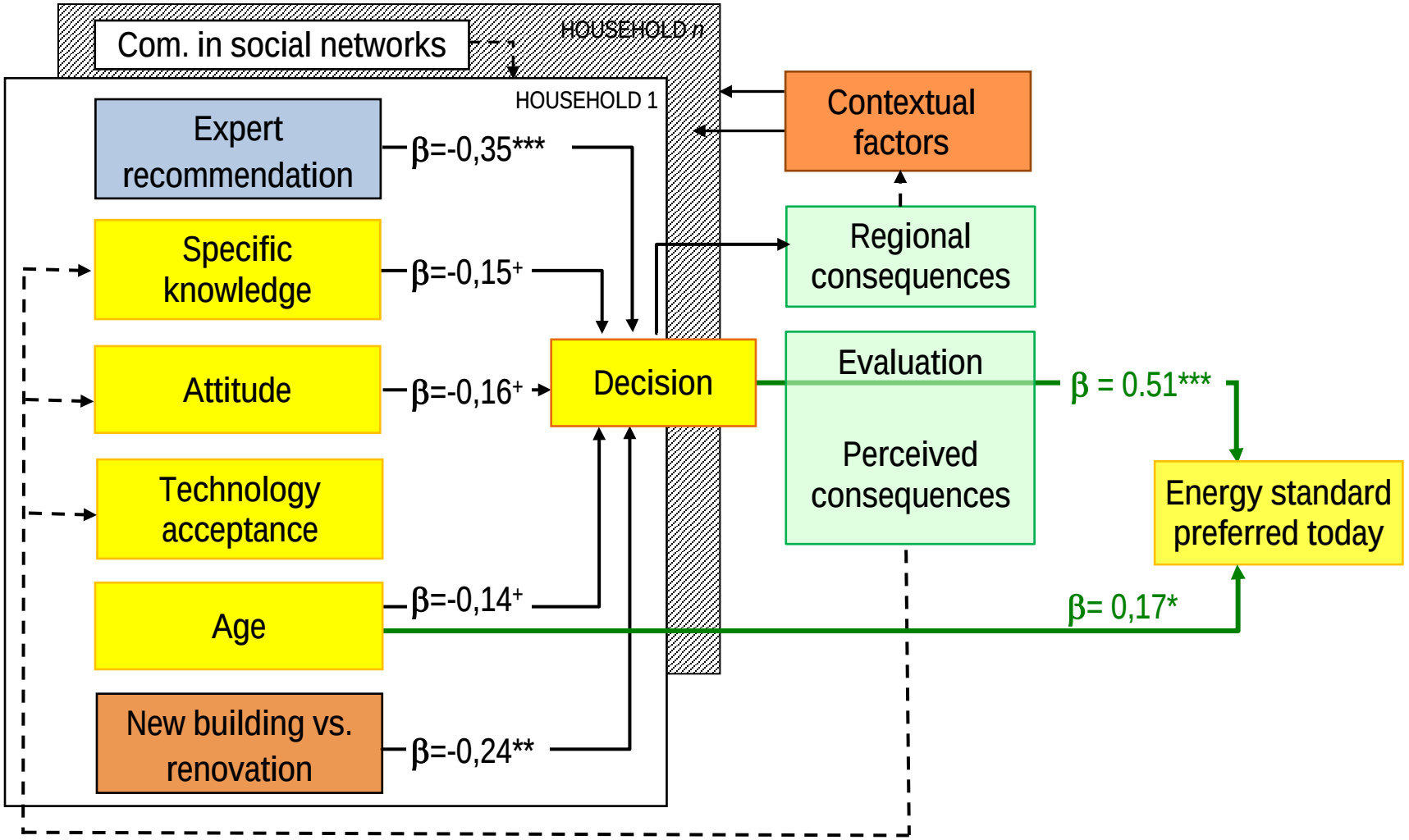


N=127 / *** p< 0.001, ** p< 0.01, * p< 0.05; + p< 0.1 ; Overall model, p < .001, R^2 = 0.31 (Adjusted R^2 = .28)

Bedenik et al., 2015

Energy efficiency standard preferred today

Energy efficiencies: A^{++} = 10kWh/m²a, A^{+} = 15kWh/m²a, A = 25kWh/m²a, B = 50kWh/m²a, C = 100kWh/m²a

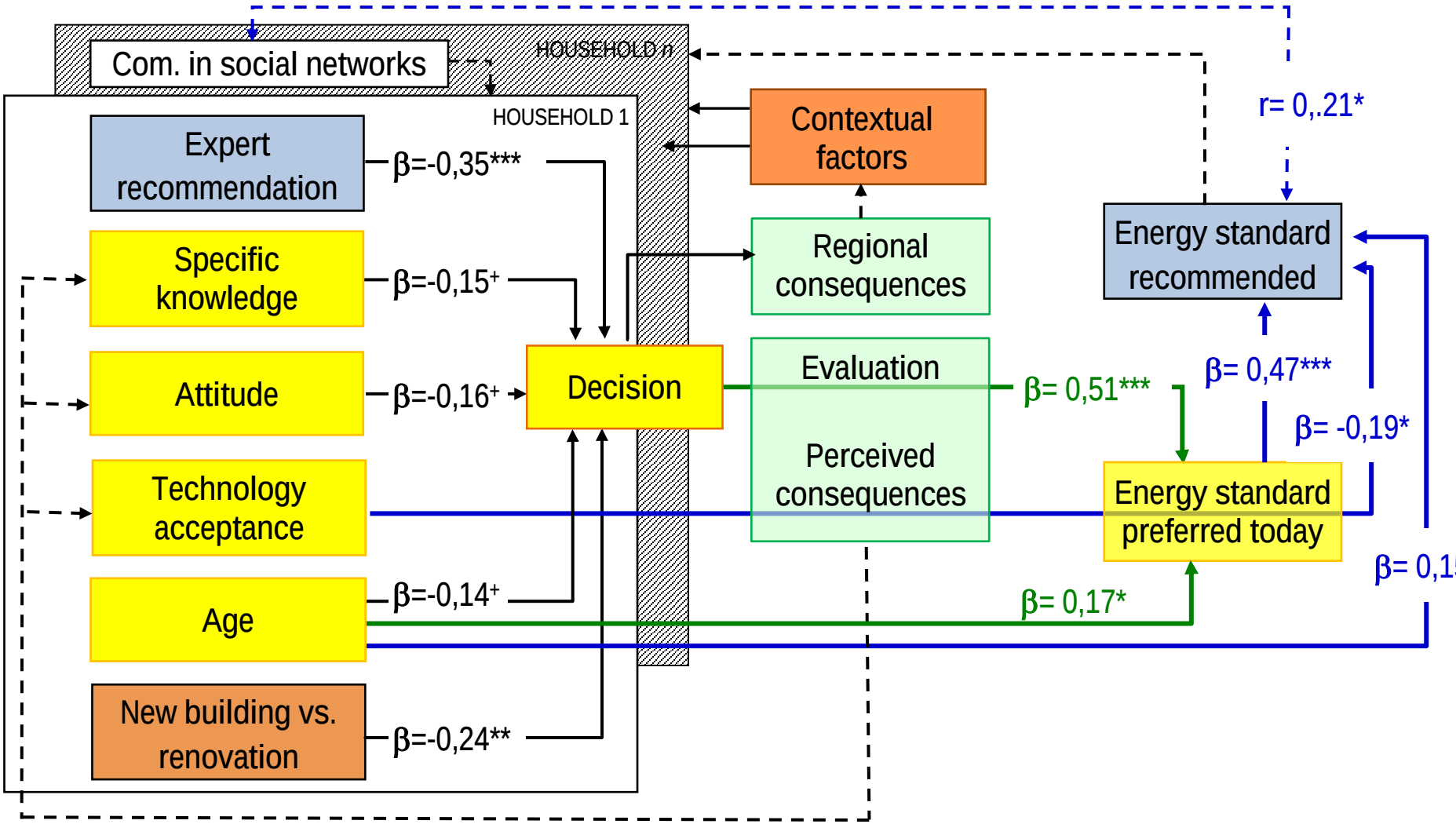


N=127 / *** p< 0.001, * p< 0.05; Overall model, p < .001, R^2 = 0.30 (Adjusted R^2 = .29)

Bedenik et al., 2015

Energy efficiency standard recommended

Energy efficiencies: A^{++} = 10kWh/m²a, A^{+} = 15kWh/m²a, A = 25kWh/m²a, B = 50kWh/m²a, C = 100kWh/m²a



N=127 / *** p< 0.01, * p< 0.05, + p< 0.1, Overall model, p < .001, R^2 = 0.31 (Adjusted R^2 = .29)

Bedenik et al., 2015

Summary (II)

- Between the orientation phase and the final decision the desired energy efficiency decreases.
- Key decision factors are: expert recommendation > age > attitude and knowledge.
- The energy efficiency aimed at today and recommended to a friend are higher than the one the owners implemented themselves.
- We could not measure that social networks play a significant role when including other factors in the analysis

Research questions

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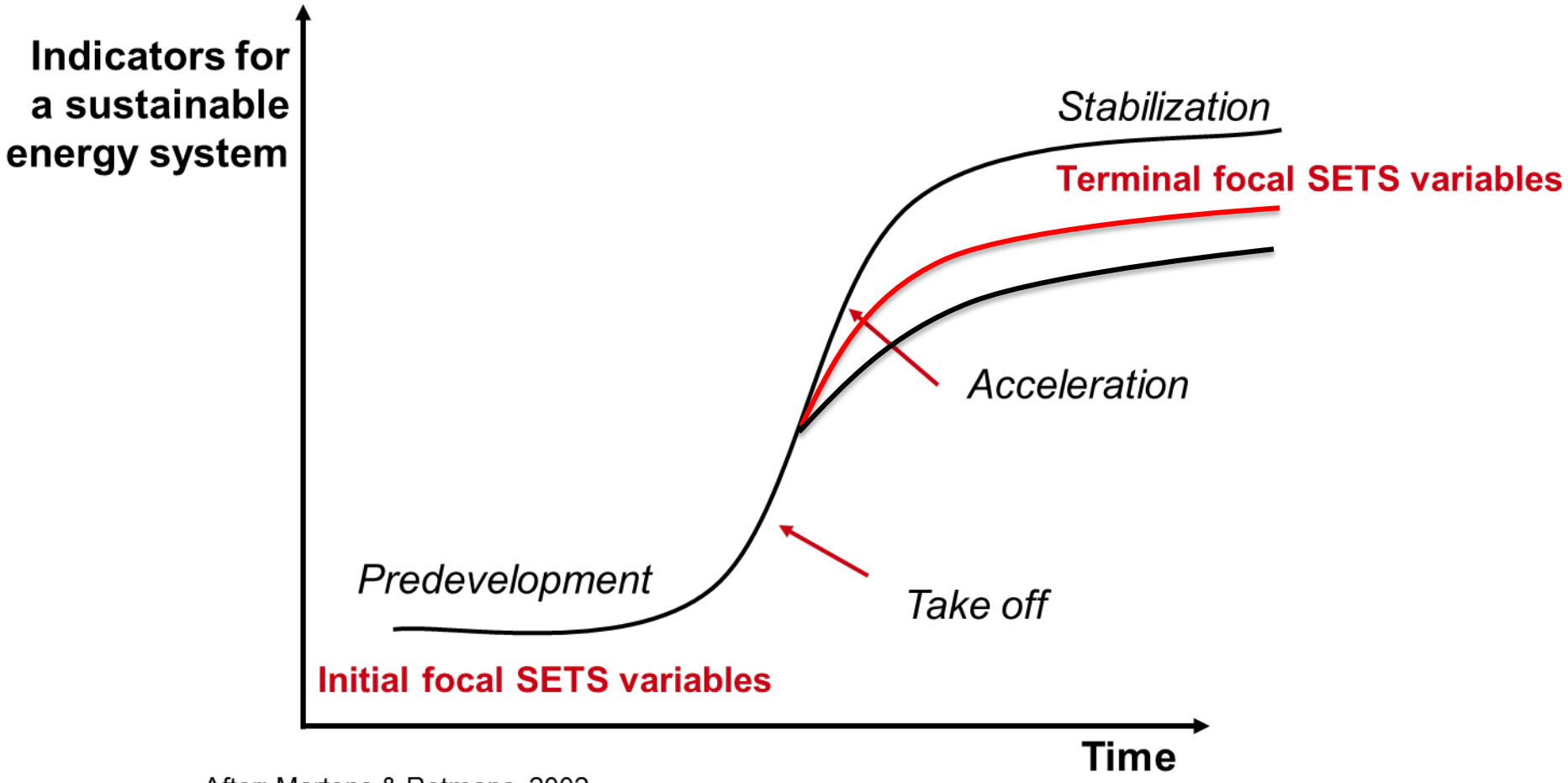
3. How can we conceptualize the resilience of the transition?



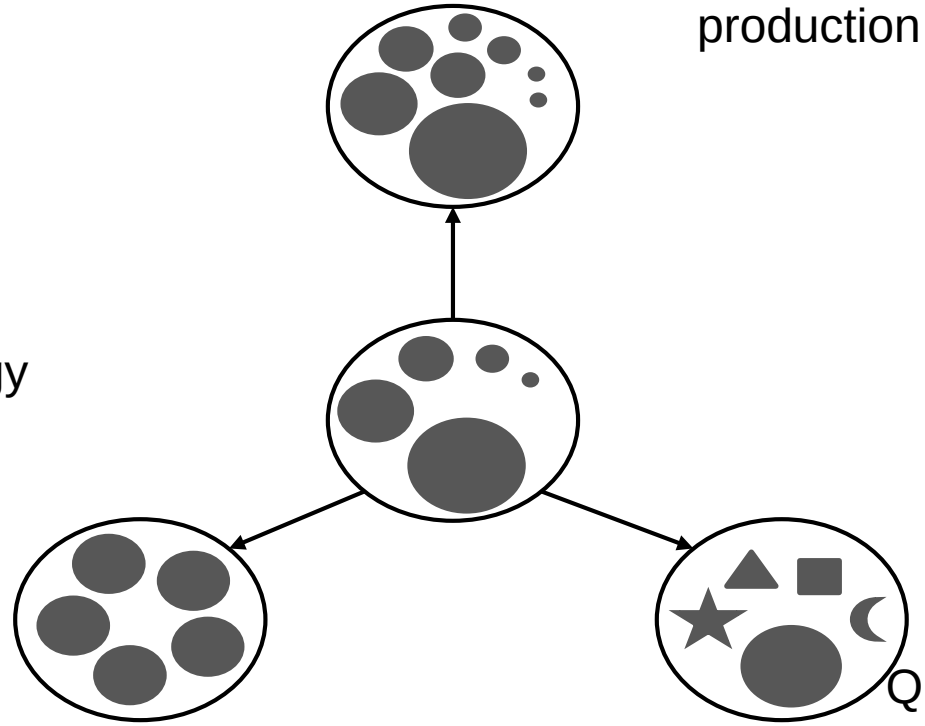
After: Martens & Rotmans, 2002

- What determines the continuity or resilience of the transition process?
- What are useful indicators to monitor the energy transition process itself?

Diversity to measure resilience

Variety

Number of groups of technologies present in the local energy production system.



Share of technology groups in overall energy production.

Balance

Disparity

Qualitative differentiation between technologies

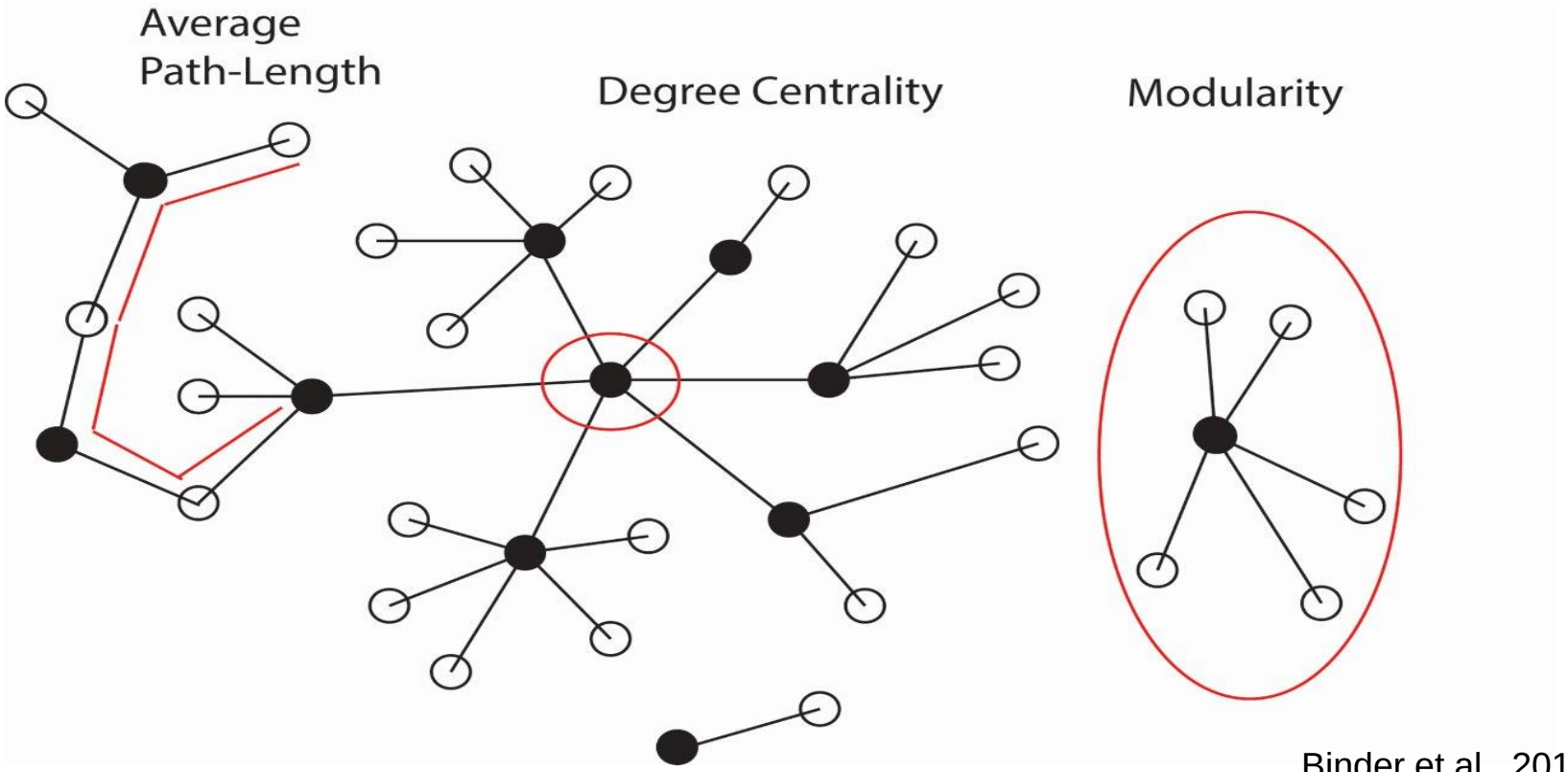
After Stirling 2007

Connectivity to measure resilience

Length of the transmission lines between production and consumption sites.

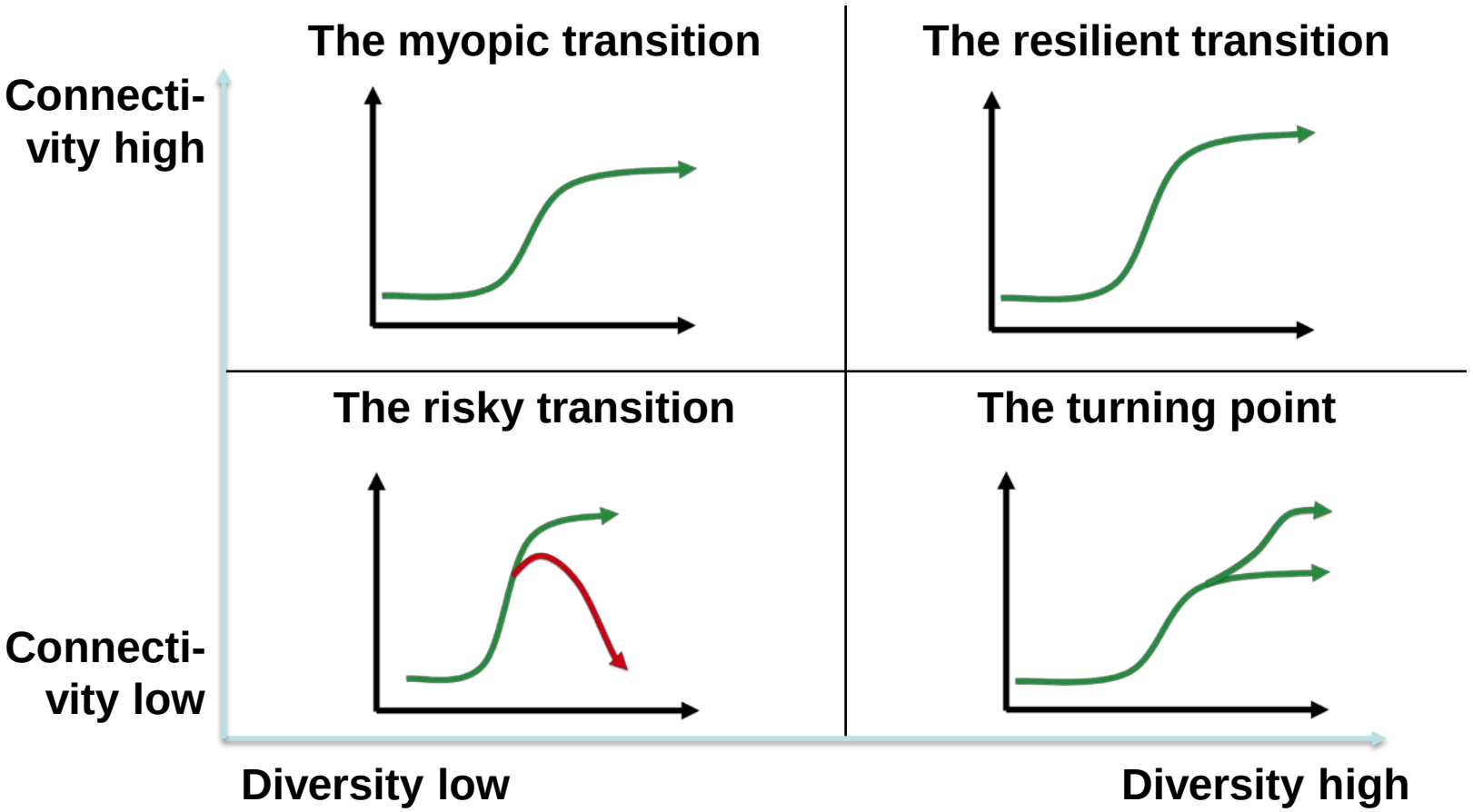
Number of connections to other producers or/and consumers in the distribution network.

Measure of autonomy of certain parts of the distribution network



Binder et al., 2017

Key insights



Binder et al., 2017

Conclusions (I)

- Delay between institutional development and technical energy system
- Path-dependency / socio-technical lock ins
- Supply has to be aligned to changes and dynamics in energy demand, otherwise recommendations might lead to "overshoot" or inflexible supply structures
  → need to include space in supply analysis
- Experts are key to change behavioral patterns
  → role of universities and higher education
- Feedbacks between decisions and social environment not measurable yet.
- The resilience of a transition can be studied by using a set of 6 indicators depicting the diversity and connectivity

Conclusions (II)

- An integrative perspective combining qualitative and quantitative research approaches is relevant for an understanding of the transition and the dynamics within coupled social and the technical systems.

- There is a need for:
  - developing a framework to make case studies comparable
  - studying more in depth feedback effects between the social, technical and environmental systems

Thank you for your attention!

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