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UCL-CIRED workshop
26-27 March 2014, London
Innovative techniques for Quantitative SCeanrios in ENergy and Environmental research (IQ SCENE)

Constructing hybrid scenarios to enhance socio-technical system understanding and to improve coupling stories with quantitative modelling.

An approach applied on a regional energy system case study

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Overview

- Methods to handle future uncertainties
- The Problems
- Our proposal: CIB and Simulation
- Context scenarios in ENERGY TRANS
- Concept – Context scenarios 2050: South West Thuringia
  - CIB step I and II: Factors and Hypothesis
  - CIB step III: Expressing factor dependencies using CIB framework
  - CIB step IV: CIB analysis results: context scenarios South West Thuringia 2050
- Improvements through CIB and Simulation
- References

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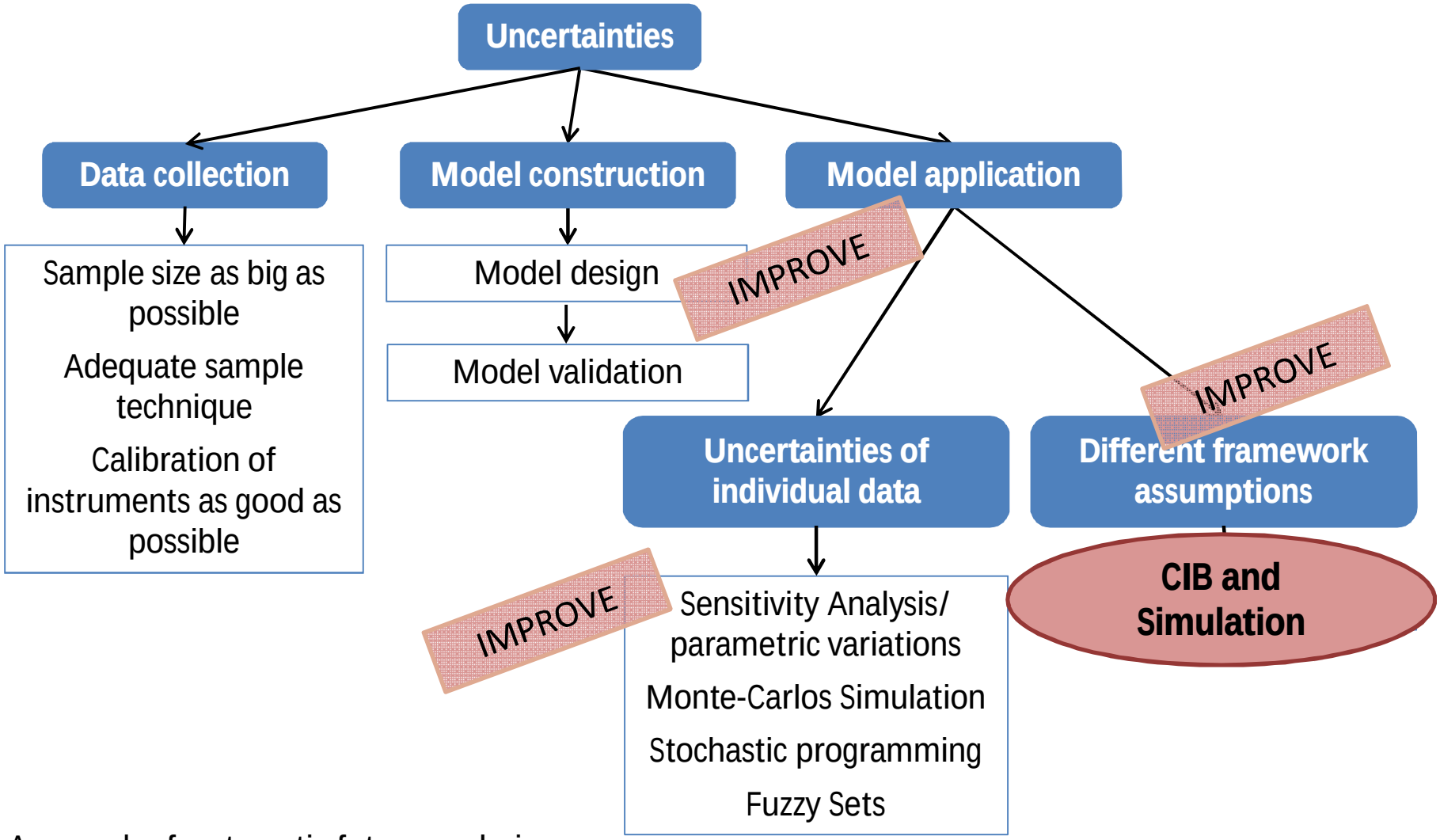
Methods to handle future uncertainties



Approach of systematic future analysis

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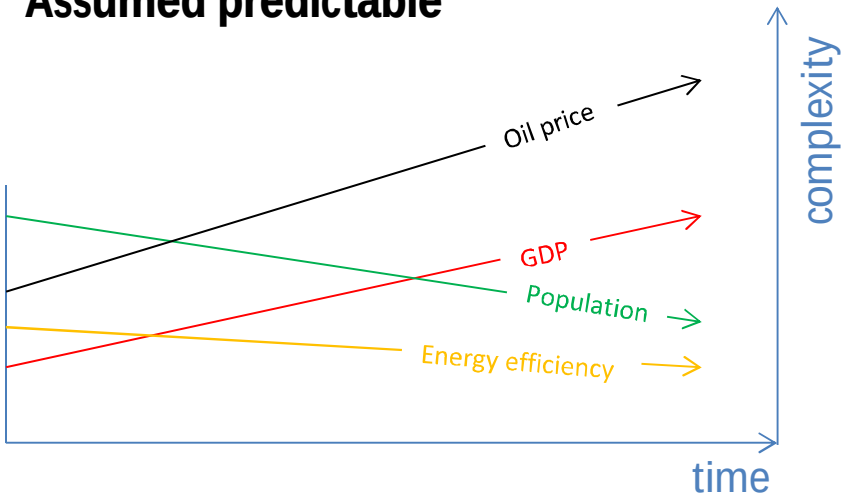
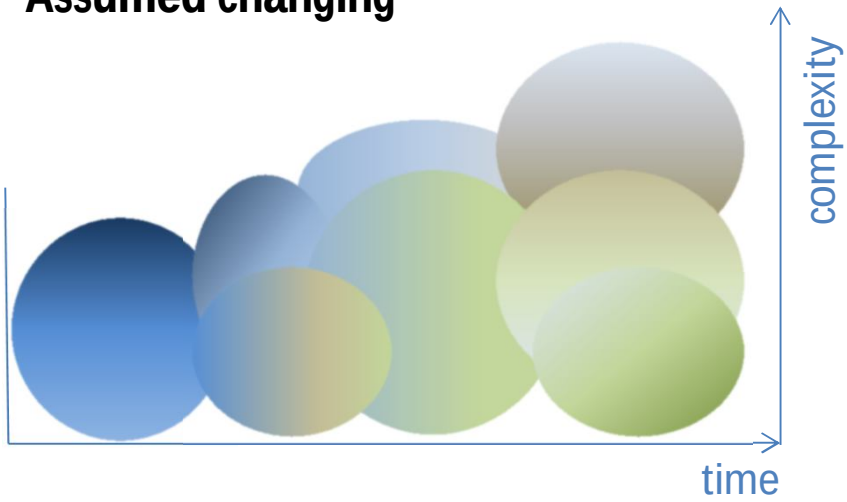
The problem I

Context unadressed –
Assumed predictable



Context adressed –
Assumed changing



Transformation process
e.g. energy system

Transformation process
e.g. energy system

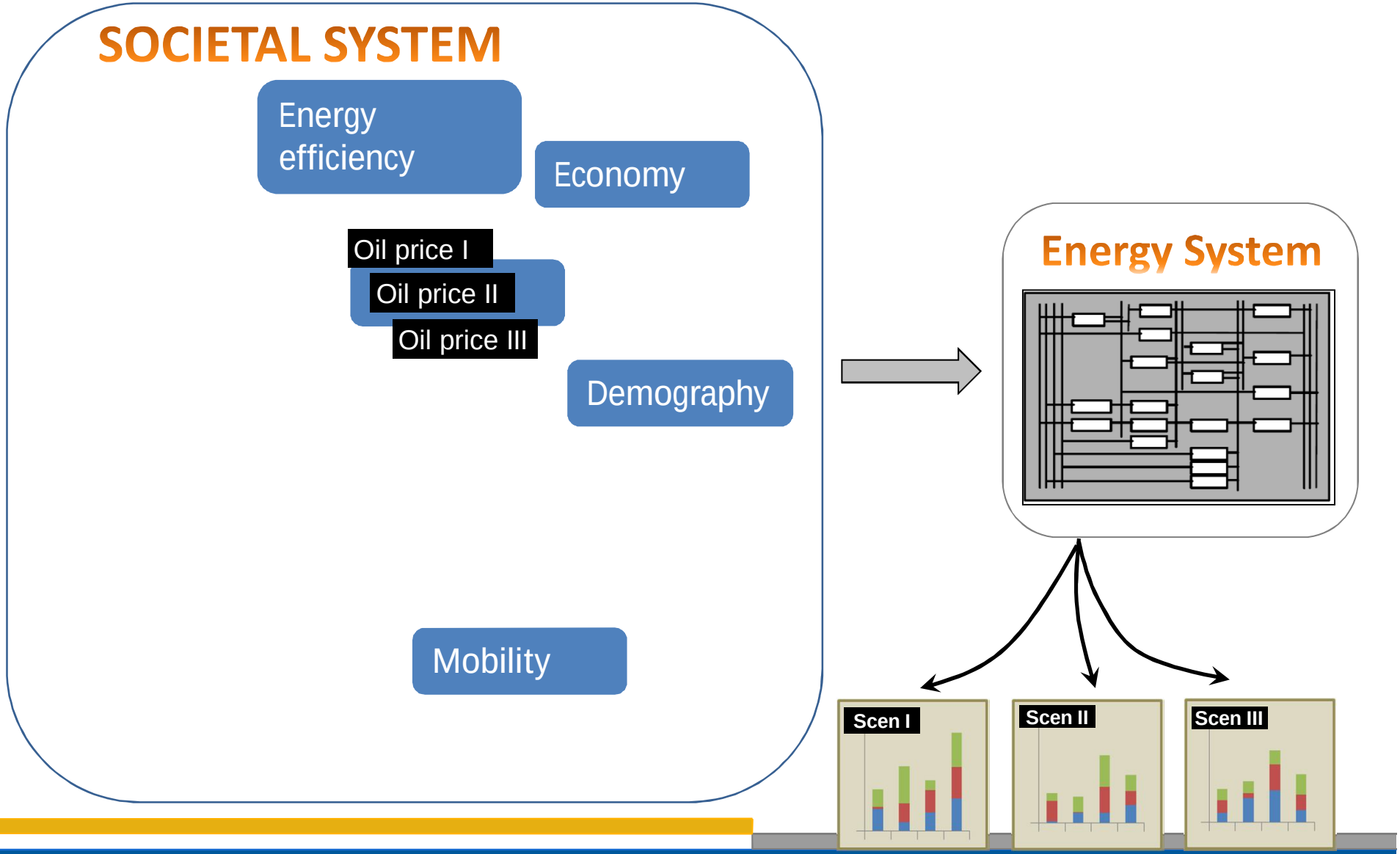
Addressed uncertainty / Risk

Low **High**

ENERGY SYSTEM MODELLING should address uncertainty more comprehensively

The problem II – Framework assumptions

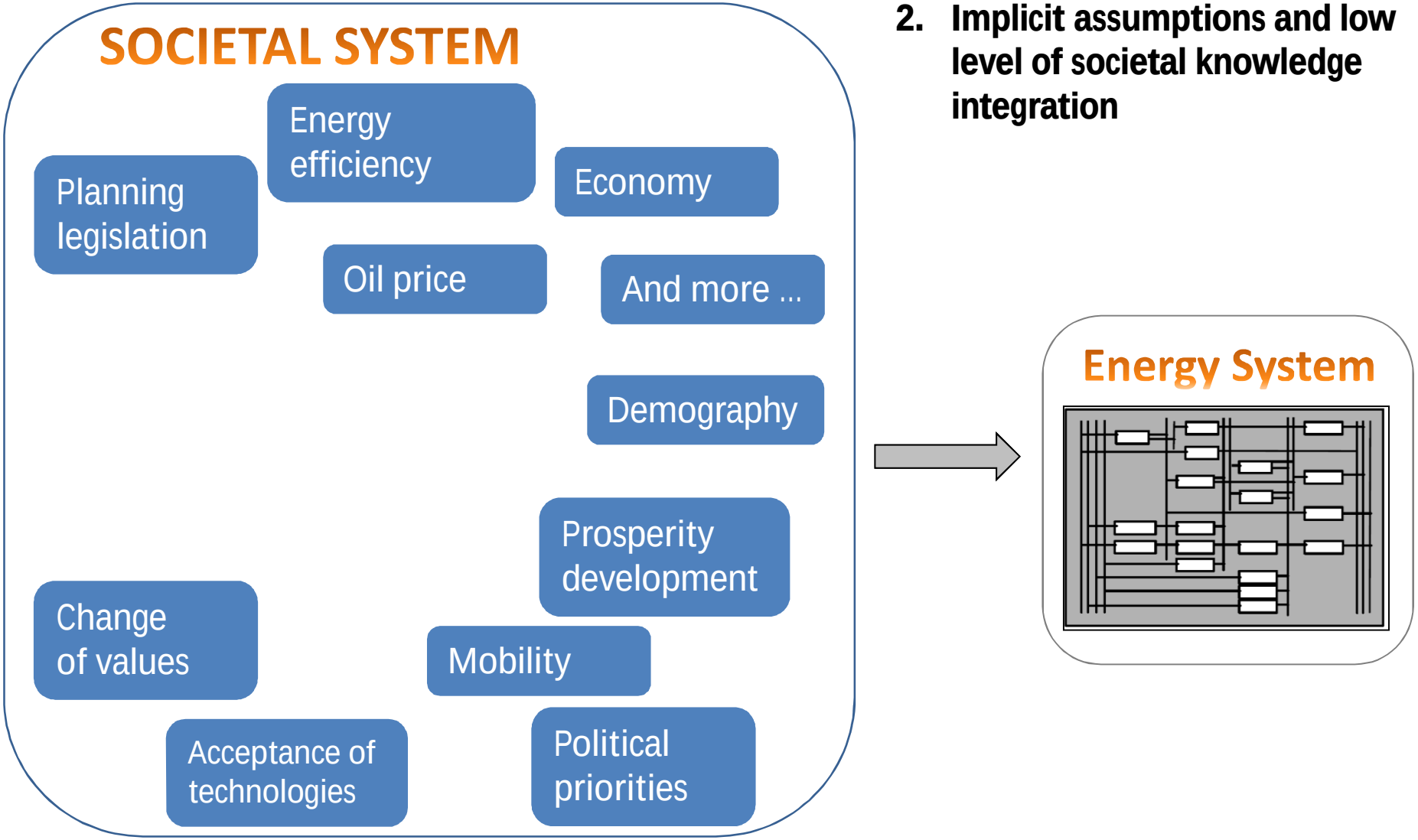
1. Framework assumptions



** Slides 5-8 adapted after: Weimer-Jehle, Prehofer & Vögele 2012: Kontextszenarien - Ein Konzept zur Behandlung von Kontextunsicherheit und Kontextkomplexität bei der Entwicklung von Energieszenarien. TATuP 22(2), 27–36.

The problem III – Implicit assumptions

1. Framework assumptions
2. **Implicit assumptions and low level of societal knowledge integration**



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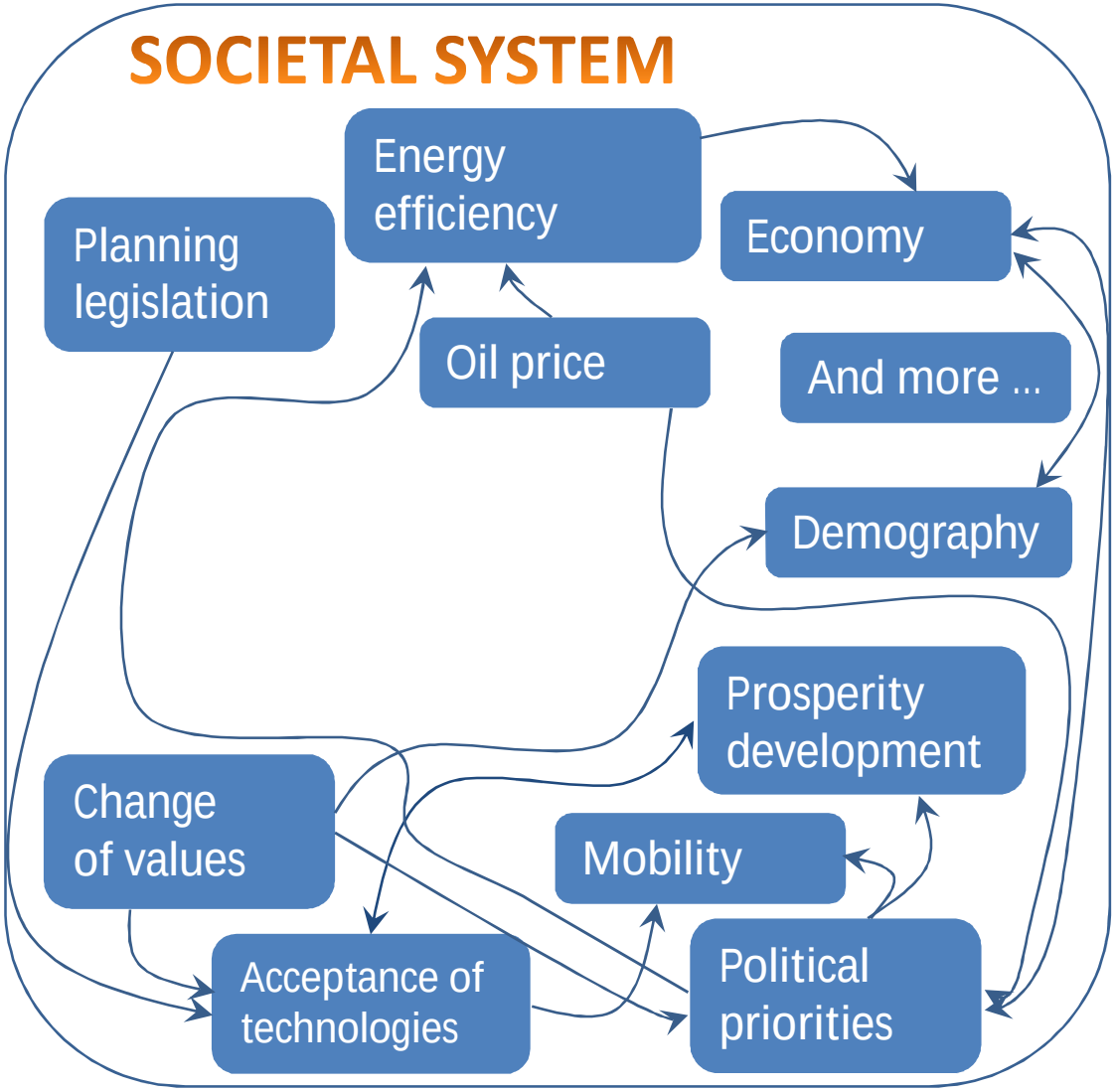
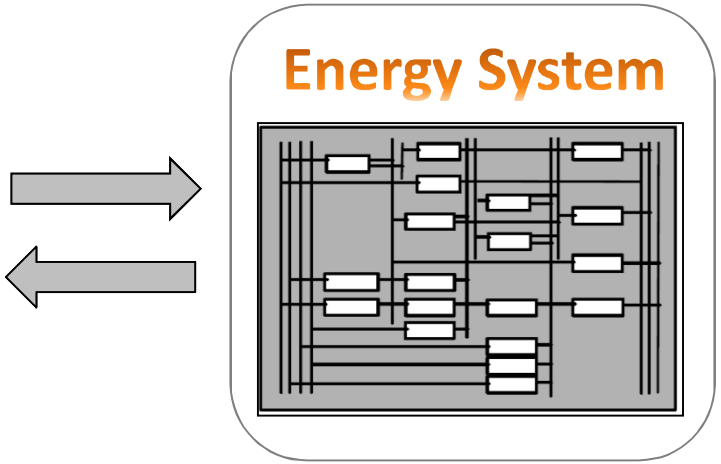
The problem IV - Interdependencies



1. Framework assumptions
2. Implicit assumptions and low level of societal knowledge integration
3. **Interdependency of framework assumptions, implicit assumptions and the energy system**



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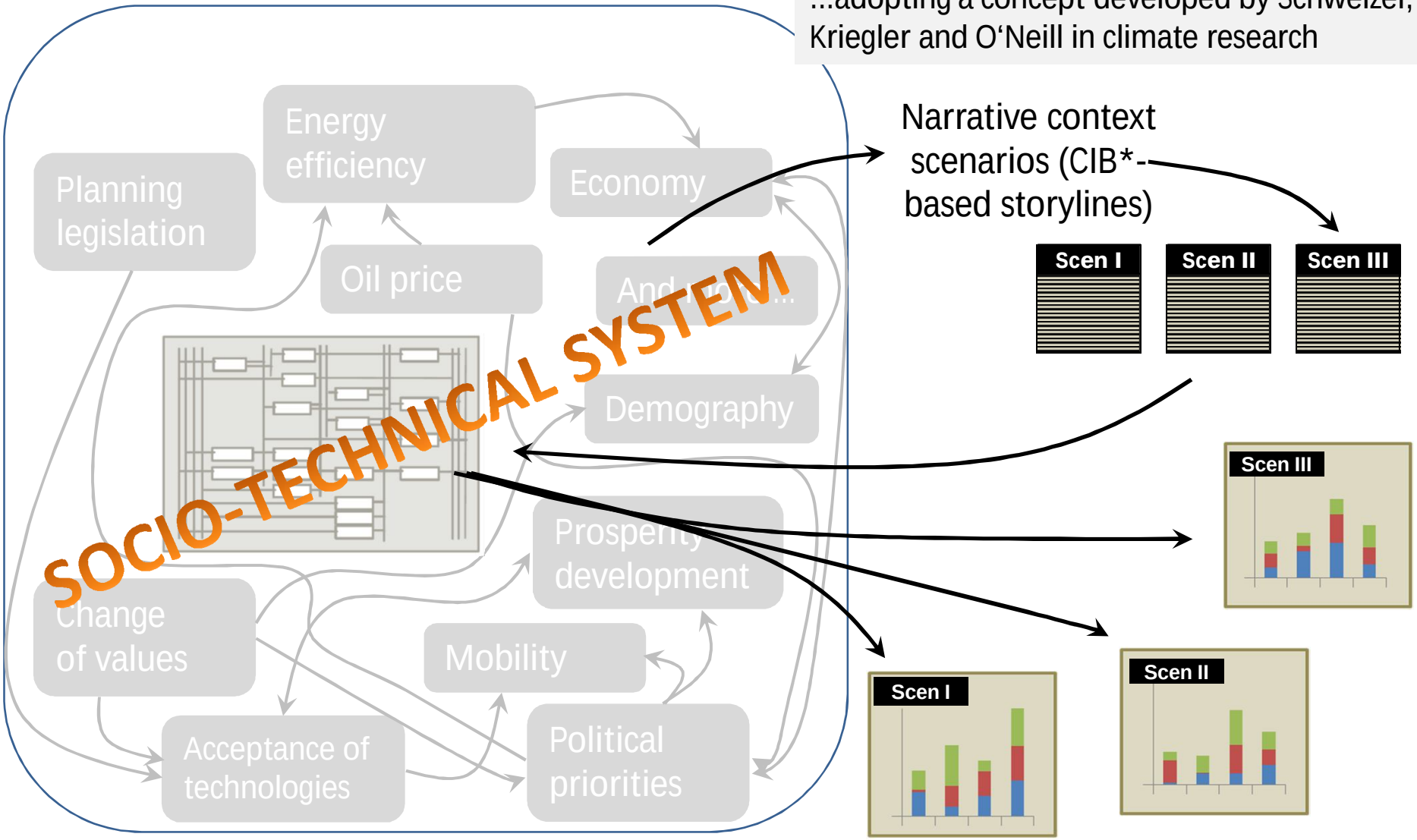
Our proposal: Cross-Impact-Balance Analysis (CIB) and Simulation

...adopting a concept developed by Schweizer, Kriegler and O'Neill in climate research



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CIB to construct context scenarios

CIB*...

- is a **qualitative type** of systems analysis
- is used to construct qualitative scenarios in a **semi-formalized** way
- method can **include qualitative as well as quantitative knowledge**
- supports making **mental models explicit**
- provides **consistent framework assumptions**
- is used **before** simulation

The core of the method is a **balance-algorithm** defining **internally consistent** configurations of impact networks (i.e. scenarios).

* Weimer-Jehle W.: Cross-Impact Balances - A System-Theoretical Approach to Cross-Impact Analysis. Technological Forecasting and Social Change, Vol. 73, No. 4, pp. 334-361, 2006.

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Context scenarios in ENERGY-TRANS

ENERGY-TRANS projects developing context scenarios:

A1 - Technology potentials. Focus: societal influences on technology development
(Multi-level context scenario analysis completed*)

A2 - Integrated scenarios. Focus: societal influences on technology implementation
(Demonstrator completed, context scenario construction ongoing)

A3 - Regional modeling. Focus: societal influences on regional transformation
(First context scenario analysis completed, another one ongoing)

- Regional development is different! Take into account individual framework conditions of different regional areas
- Develop regional scenarios consistent with the upper spatial scales like national and international level
- Urban and rural region (South West Thuringia) for in-depth study on the regional transformation process

* Vögele S. (2012): Entwicklung der Rahmenbedingungen für neue Energietechnologien. STE Research Report 4/2012.
Hansen P., Pannaye C., Vögele S.: The Future(s) of the Energy Consumption of Private Households in Germany - A Multilevel Cross-Impact Analysis. STE Research Report 4/2013.

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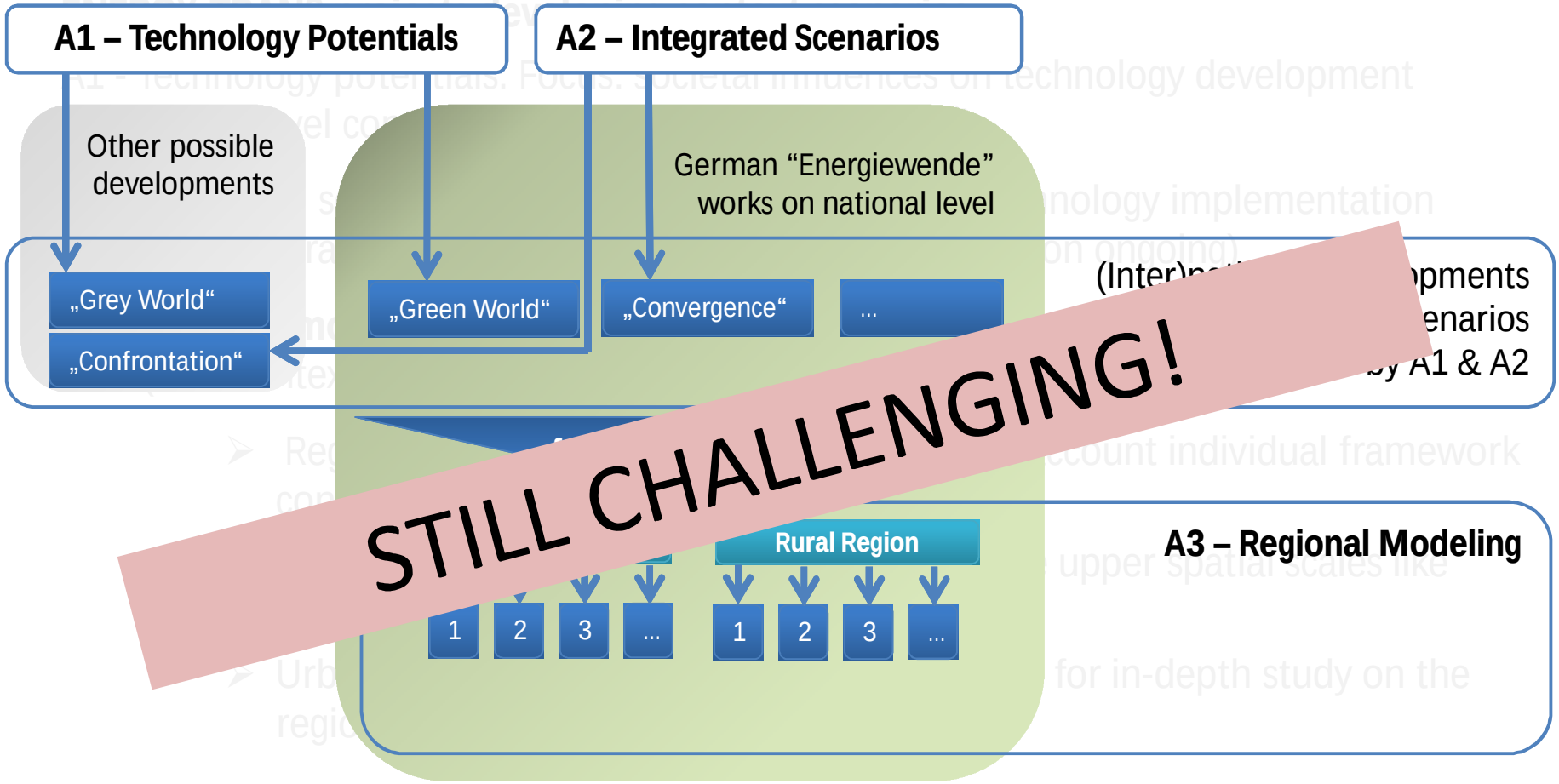
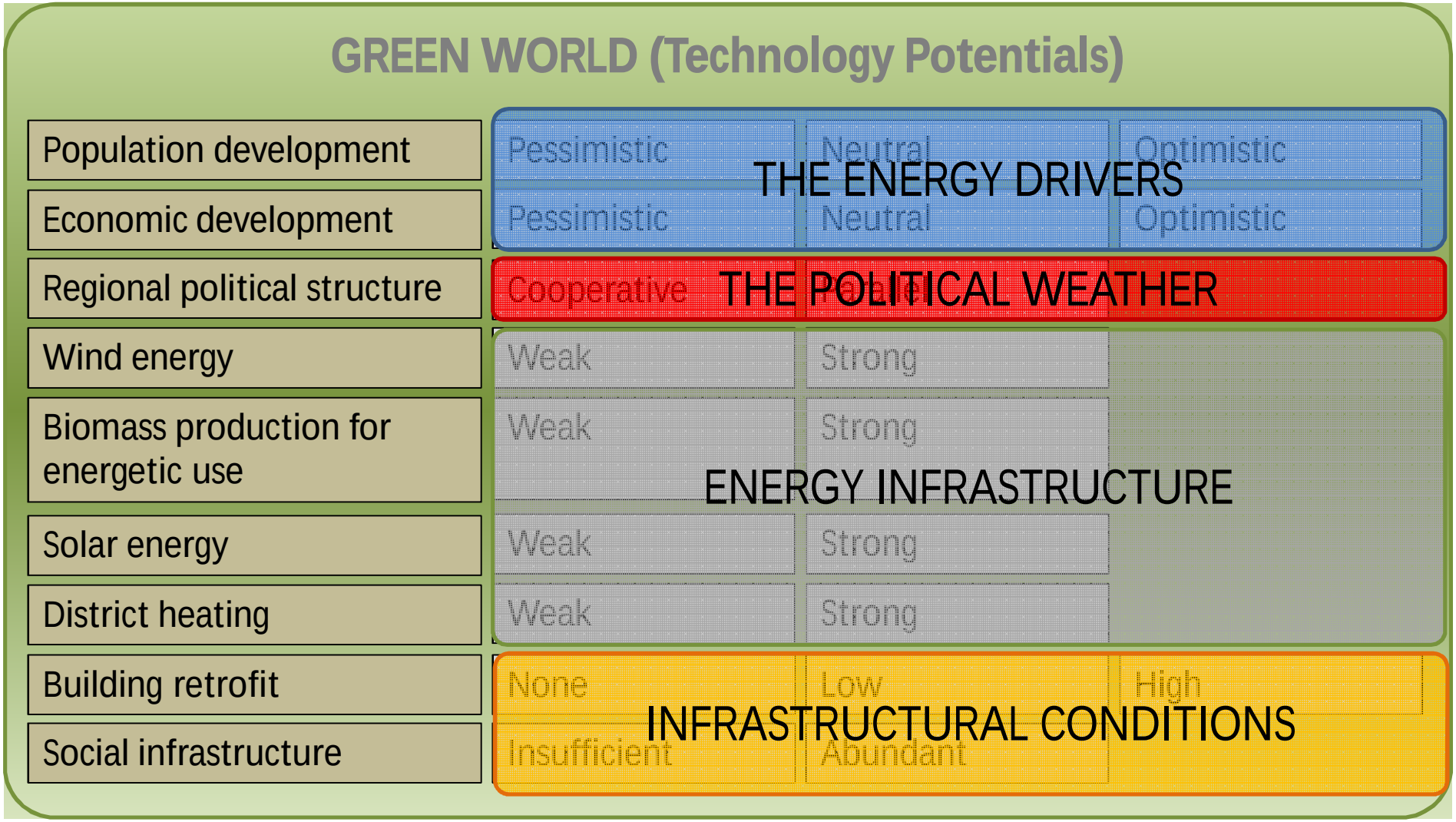
Context scenarios in ENERGY-TRANS



* Vögele S. (2012): Entwicklung der Rahmenbedingungen für neue Energietechnologien. STE Research Report 4/2012.

Hansen P., Pannaye C., Vögele S.: The Future(s) of the Energy Consumption of Private Households in Germany - A Multilevel Cross-Impact Analysis. STE Research Report 4/2013.

CONCEPT - Context scenarios 2050: South West Thuringia
CIB step I and II: Factors and Hypothesis



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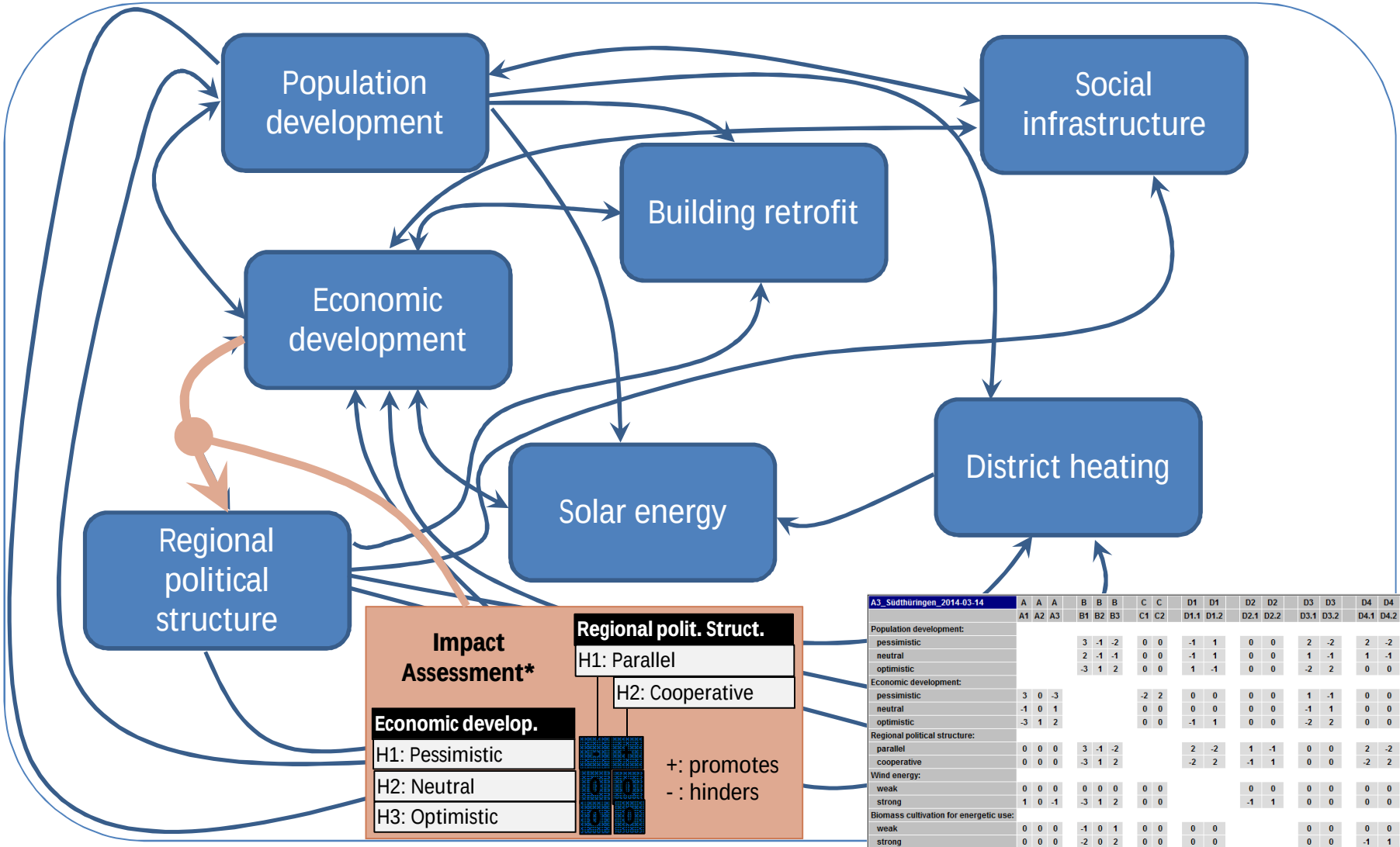
Step III: Expressing factor dependency using CIB framework



A3_Südthüringen_2014-03-14	A	A	A	B	B	B	C	C	D1	D1	D2	D2	D3	D3	D4	D4	E	E	E
	A1	A2	A3	B1	B2	B3	C1	C2	D1.1	D1.2	D2.1	D2.2	D3.1	D3.2	D4.1	D4.2	E2	E2	E3
Population development:																			
pessimistic				3	-1	-2	0	0	-1	1	0	0	2	-2	2	-2	3	-1	-2
neutral				2	-1	-1	0	0	-1	1	0	0	1	-1	1	-1	2	-1	-1
optimistic				-3	1	2	0	0	1	-1	0	0	-2	2	0	0	-2	1	1
Economic development:																			
pessimistic	3	0	-3				-2	2	0	0	0	0	1	-1	0	0	3	-1	-2
neutral	-1	0	1				0	0	0	0	0	0	-1	1	0	0	-1	0	1
optimistic	-3	1	2				0	0	-1	1	0	0	-2	2	0	0	-3	1	2
Regional political structure:																			
parallel	0	0	0	3	-1	-2			2	-2	1	-1	0	0	2	-2	0	0	0
cooperative	0	0	0	-3	1	2			-2	2	-1	1	0	0	-2	2	-2	1	1
Wind energy:																			
weak	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0
strong	1	0	-1	-3	1	2	0	0			-1	1	0	0	0	0	0	0	0
Biomass cultivation for energetic use:																			
weak	0	0	0	-1	0	1	0	0	0	0			0	0	0	0	0	0	0
strong	0	0	0	-2	0	2	0	0	0	0			0	0	-1	1	0	0	0
Solar energy:																			
weak	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0
strong	0	0	0	-1	0	1	0	0	0	0	0	0			0	0	0	0	0
District heating:																			
weak	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
strong	0	0	0	0	0	0	0	0	0	0	0	0	1	-1			0	0	0
Building retrofit:																			
none	0	0	0	3	-1	-2	0	0	0	0	0	0	0	0	0	0			
low	0	0	0	-1	0	1	0	0	0	0	0	0	0	0	0	0			
high	0	0	0	-3	1	2	0	0	0	0	0	0	0	0	0	0			

* Additionally, impact strength is assessed using three categories (weak / medium / s

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Step IV: CIB analysis results: Context scenarios South West Thuringia 2050

	Scenario No. 1	Scenario No. 2	Scenario No. 3	Scenario No. 4	Scenario No. 5	Scenario No. 6
Population development	Pessimistic		Neutral		Optimistic	
Economic development	Pessimistic	Neutral	Optimistic			
Regional political structure	Cooperative		Parallel			Cooperative
Wind energy	Strong				Weak	Strong
Biomass cultivation for energetic use	Strong		Weak	Strong	Weak	Strong
Solar energy	Weak		Strong			
District heating	Strong		Weak			Strong
Building retrofit	None		High			
Social infrastructure	Insufficient				Abundant	

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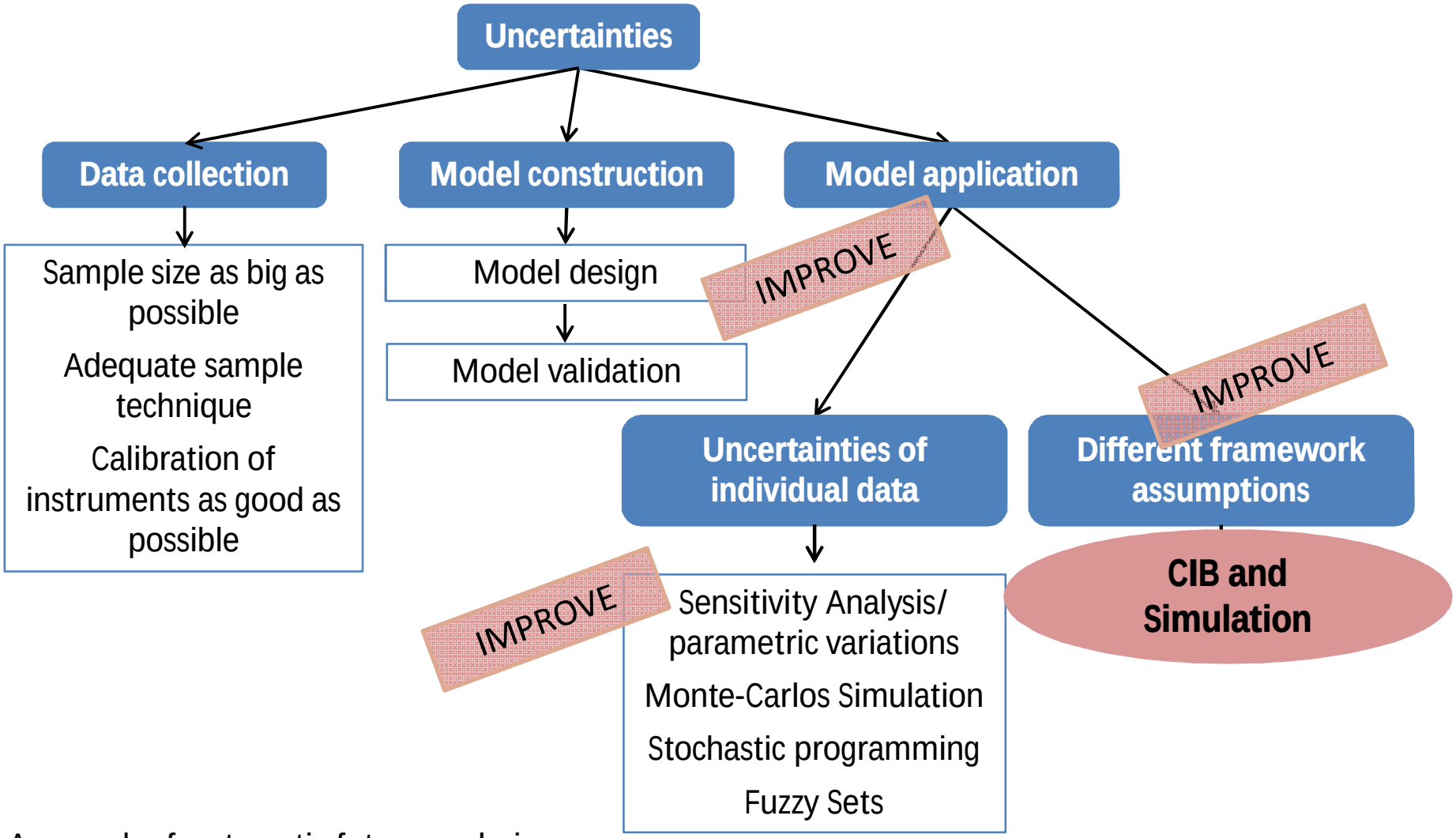
Methods to handle future uncertainties



Approach of systematic future analysis

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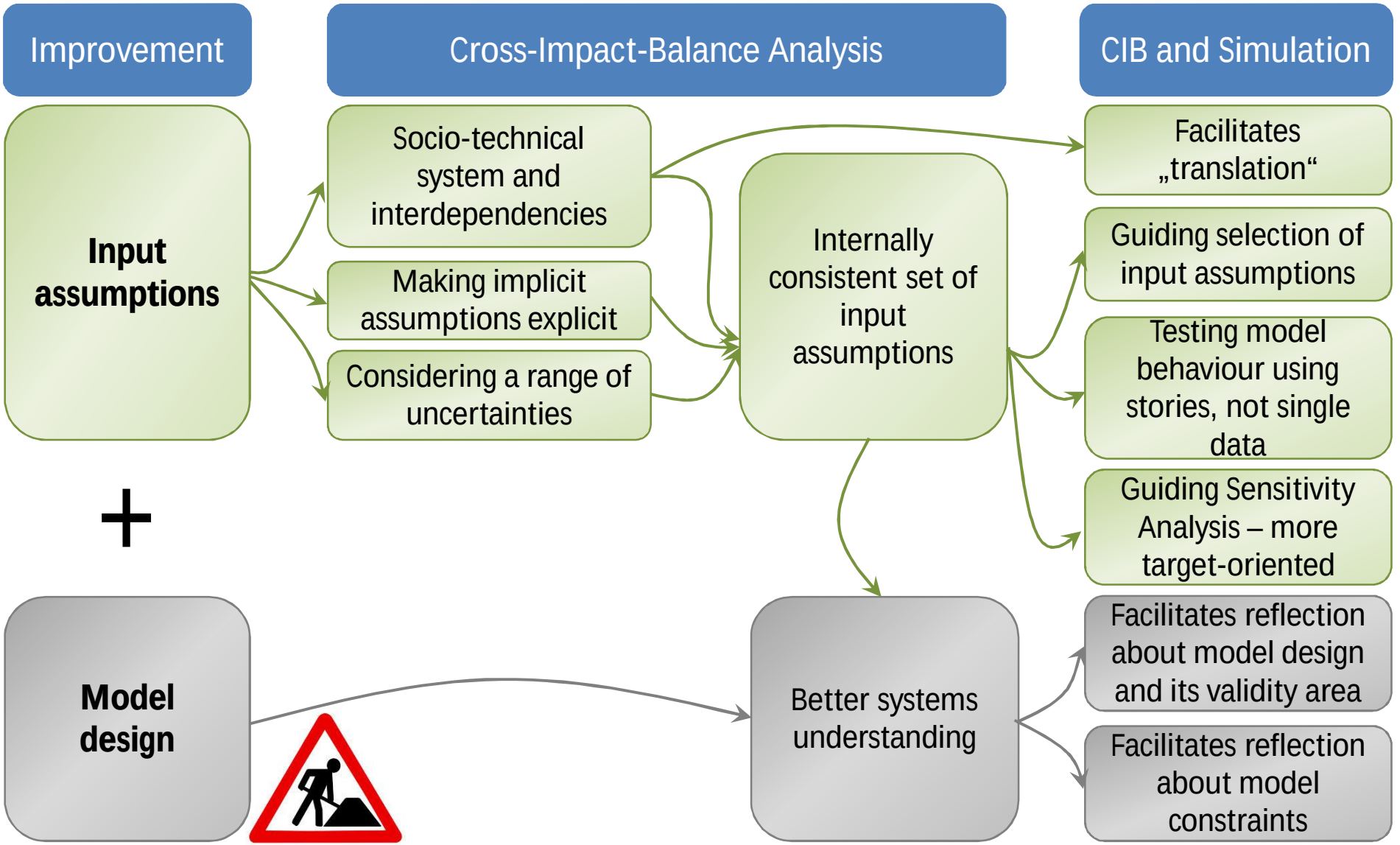
Improvements through CIB and Simulation I



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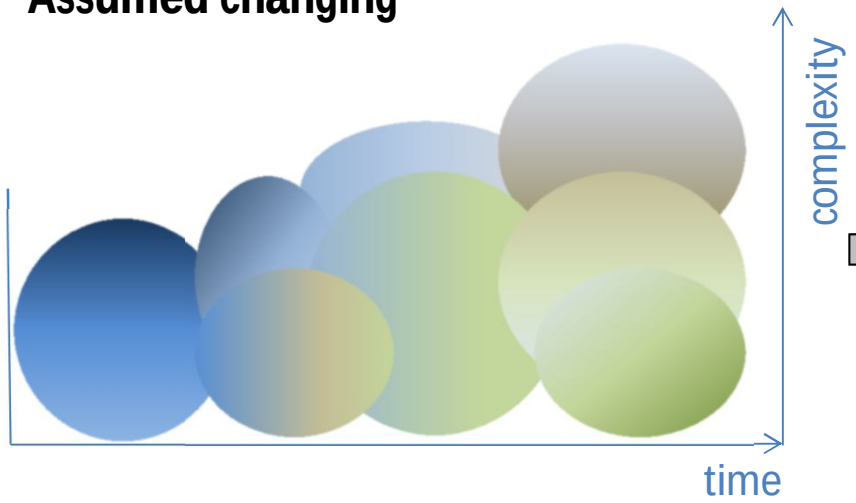
Improvements through CIB and Simulation II

Improvement	Cross-Impact-Balance Analysis	CIB and Simulation

Product = Context scenarios + Energy scenarios

= **HYBRID SCENARIOS**

Context adressed –
Assumed changing



Comprehensively addressed uncertainty

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- Weimer-Jehle W. (2006): Cross-Impact Balances: A System-Theoretical Approach to Cross-Impact Analysis. Technological Forecasting and Social Change, 73:4, 334-361
- www.cross-impact.de

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Thank you for your attention!

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