CRAG - IRGC Symposium “Uncertainty: From Insight to Action”
Lausanne, November 21, 2013

Addressing Societal Uncertainties in Energy Scenarios

Concepts and methods applied in the Helmholtz Alliance “ENERGY-TRANS”

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HGF-Alliance ENERGY-TRANS

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Helmholtz Alliance “ENERGY-TRANS”

“Future infrastructures for meeting energy demands. Towards sustainability and social compatibility"

www.energy-trans.de

Focus:

- Understanding the energy system as a complex socio-technical system
- Conducting interdisciplinary research on the systemic interactions of the envisioned energy transition in Germany

Overview:

- Total funding: 16,5 Mio. Euro
- Duration: September 2011 to August 2016
- Participants: KIT (lead centre), Univ. Stuttgart, DLR, FZJ, UFZ, Free Univ. Berlin, Univ. Magdeburg, ZEW
- Spokespersons: Prof. Armin Grunwald, Prof. Ortwin Renn
- Approx. 80 researchers involved in 17 projects

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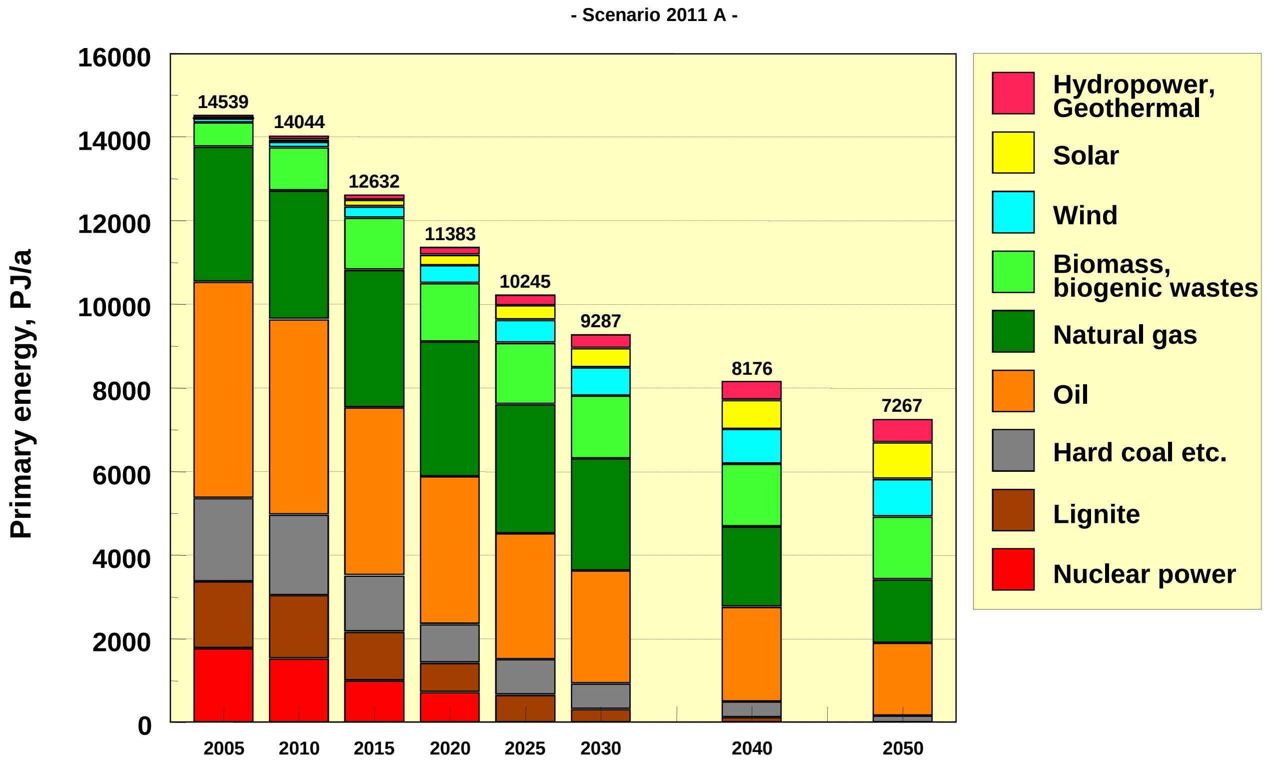
Main goals of the German “Energiewende“

GHG 1990-2050:	- 80%
PE 2008-2050:	-50%
REN (FE) 2050:	60%
REN (El) 2050:	80%
NPP 2022:	0%

GHG: Greenhouse gas emissions
PE: Primary energy demand
REN(FE): Share or Renewables in final energy demand
REN(El): Share or Renewables in electricity demand
NPP: Nuclear power production

A Blueprint for the German “Energiewende“: The BMU Long-Term Scenarios*



Calculated using the physical energy content method

* Nitsch, J.; Pregger, T. et al. (2012): Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global [Long-term scenarios and strategies for the deployment of renewable energies in Germany in view of European and global developments]. DLR, IWES, IfnE: Final report to the German Federal Ministry of the Environment (BMU).

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Why addressing societal uncertainty in energy scenarios?

The perspective of planning science*

Short-range forecast

Forecast environment is static

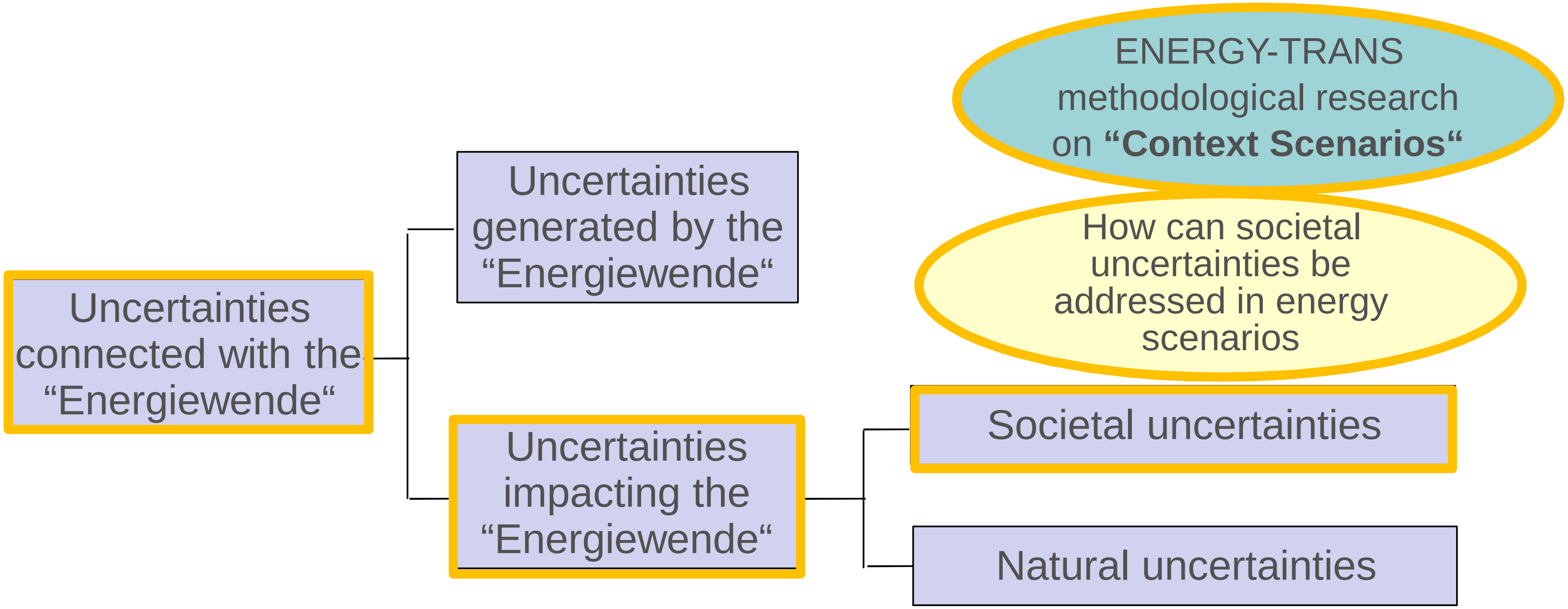
Long-range forecast

Forecast environment is changing

Time horizon of forecast

* J. Scott Armstrong, Long-Range Forecasting: From Crystal Ball to Computer, John Wiley, New York (1978).

The `Energiewende`:
Types of future uncertainty



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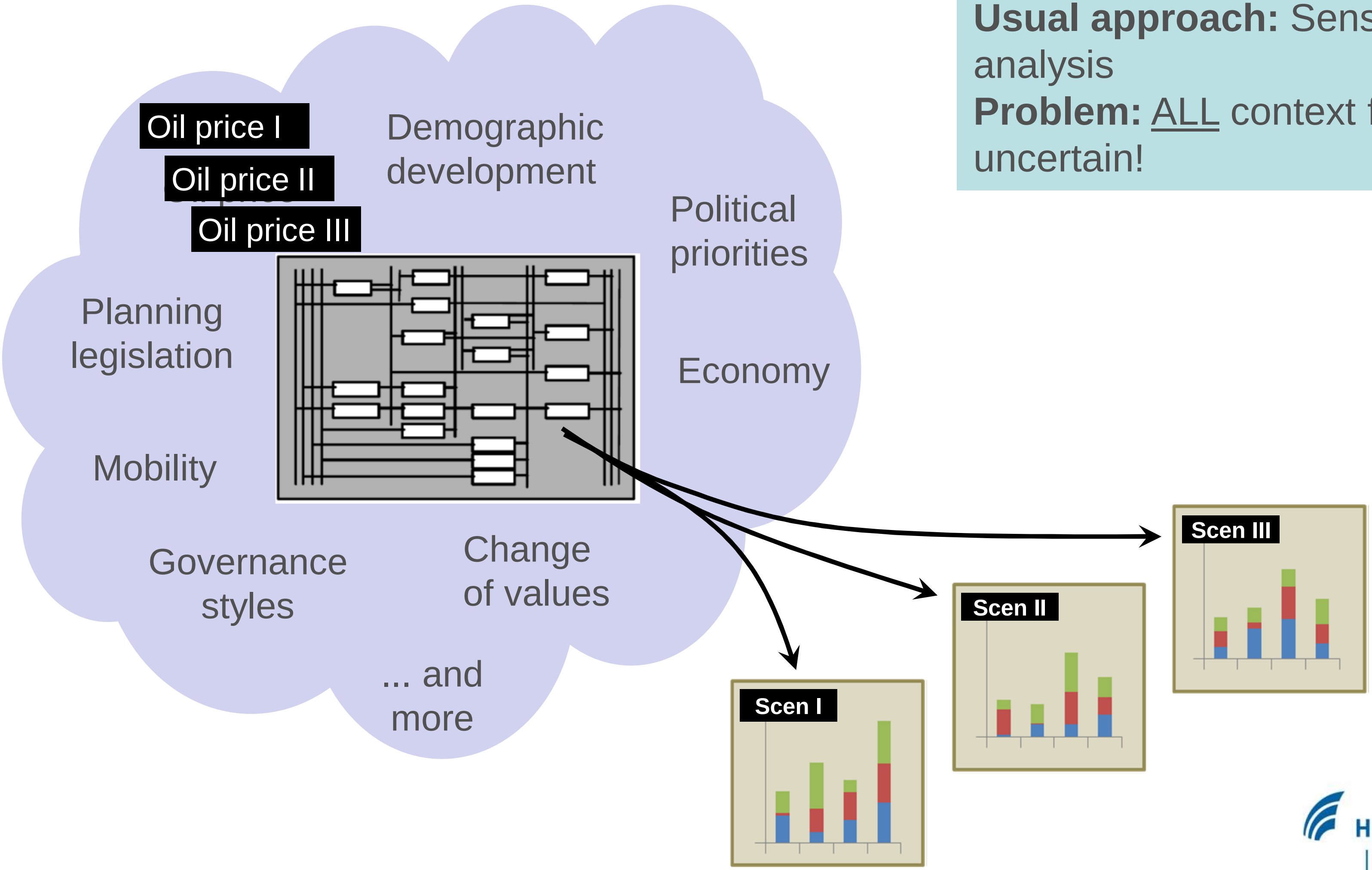
The Making of Energy Scenarios and the Uncertainty of Context Conditions - The Traditional Approach -

Usual approach: Sensitivity analysis
Problem: ALL context factors are uncertain!



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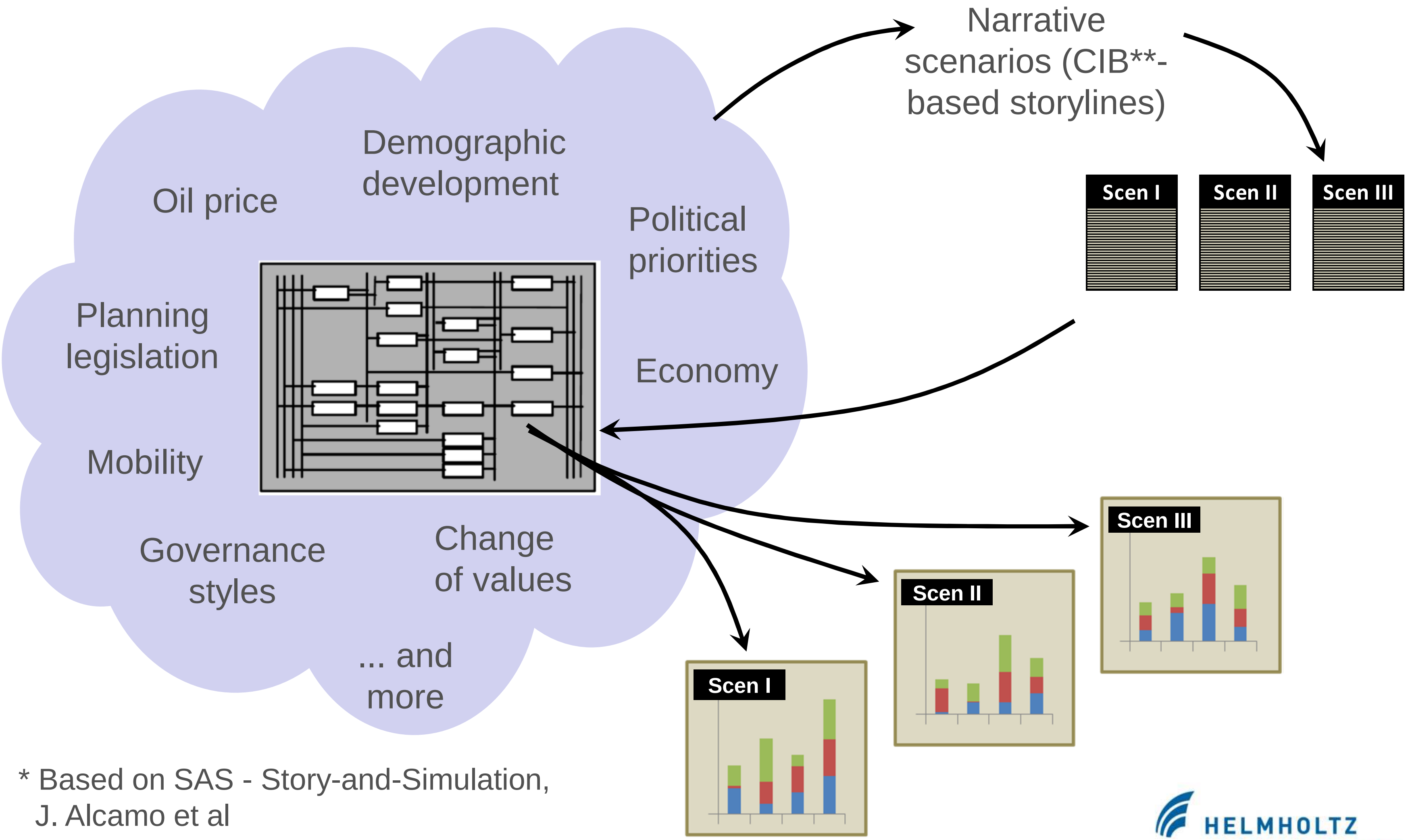
The Making of Energy Scenarios and the Uncertainty of Context Conditions
- The Context Scenario Approach* -



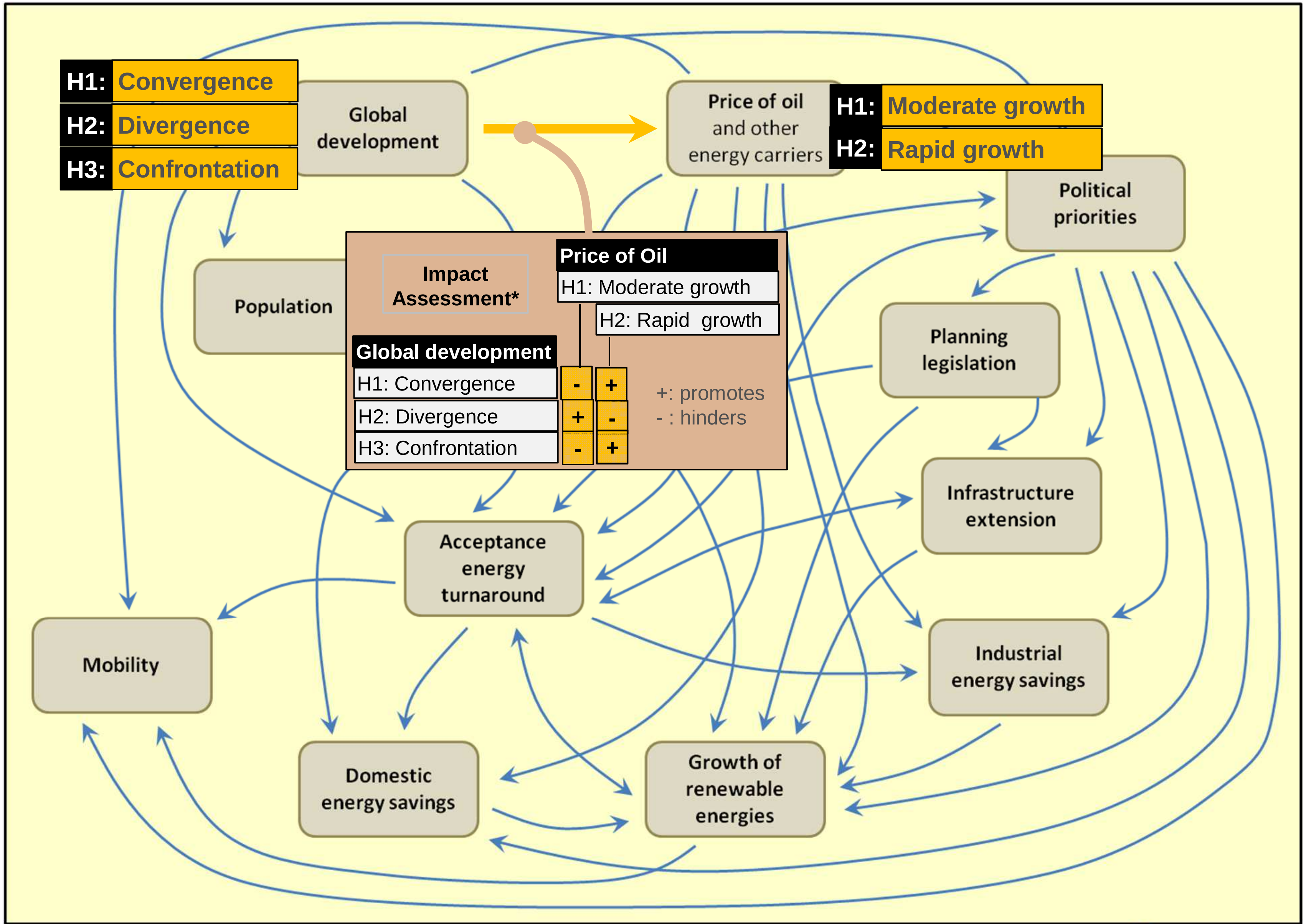
* Based on SAS - Story-and-Simulation, J. Alcamo et al

** CIB: www.cross-impact.de

Concept demonstration:
Context scenarios Germany 2040:
CIB step I and II: Factors and hypotheses

A. Global development	A1 convergence and prosperity	A2 divergence	A3 confrontation
B. Oil price	B1 moderate growth	B2 rapid growth	
C. Population	C1 slowly decreasing	C2 strongly decreasing	
D. Economic growth	D1 weak	D2 strong	
E. Political priority	E1 energy turnaround	E2 security	E3 economy
F. Acceptance energy turnaround	F1 scepticism	F2 approval	
G. Planning legislation	G1 incoherent	G2 promoting speed	G3 promoting participation
H. Infrastructure extension	H1 slow	H2 fast	
I. Growth of renewable energies	I1 slow	I2 medium	I3 fast
J. Domestic energy savings	J1 small	J2 strong	
K. Industrial energy savings	K1 small	K2 strong	
L. Mobility	L1 persistent structures	L2 downscaling	L3 downscaling and e-cars

Step III: Expressing factor interdependences using the CIB framework



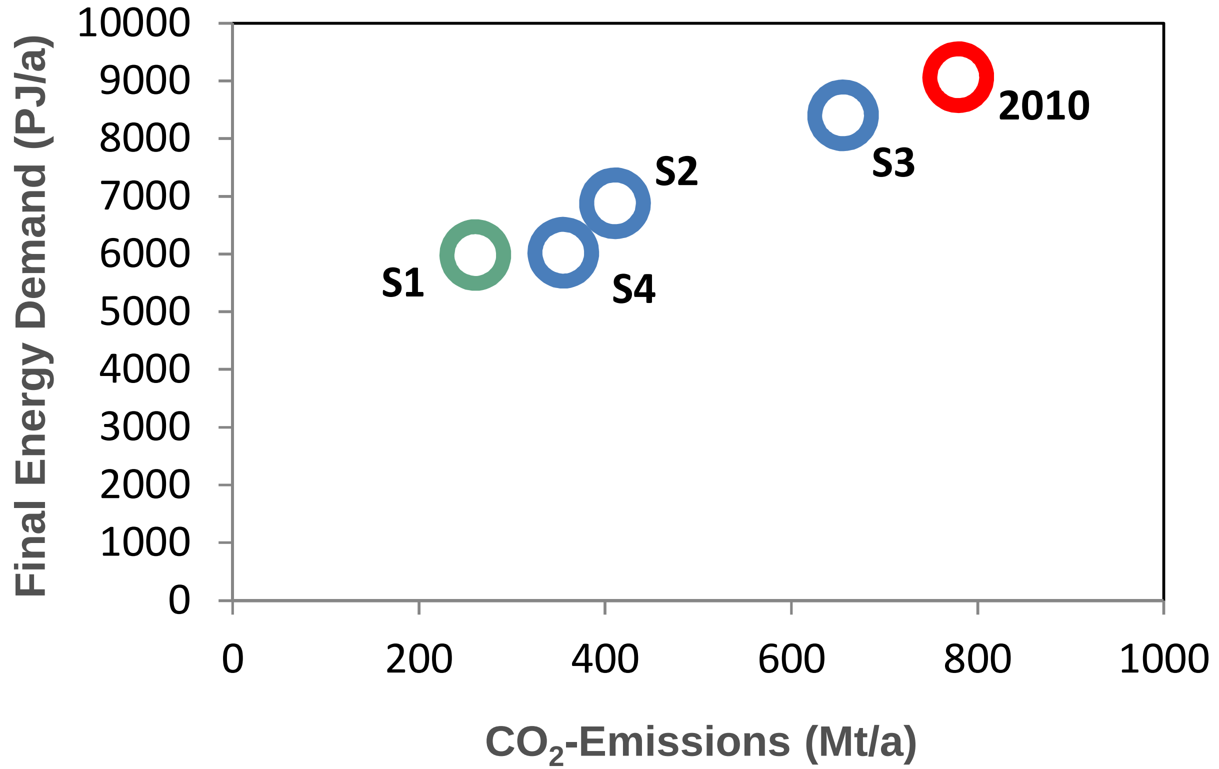
* Additionally, impact strength is assessed using three categories (weak / medium / strong)

CIB analysis results (Demonstrator): Context scenarios Germany 2040

Scenario no. I Consensus in a lucky environment	Scenario no. II D21 - Revolution from above	Scenario no. III 'It's the economy, stupid!'	Scenario no. IV Stormy waters ahead
A. Global development: A1 convergence and prosperity		A. Global development: A2 divergence	A. Global development: A3 confrontation
B. Oil price: B2 rapid growth		B. Oil price: B1 moderate growth	B. Oil price: B2 rapid growth
C. Population: C1 slowly decreasing			C. Population: C2 strongly decreasing
D. Economic growth: D2 strong			D. Economic growth: D1 weak
E. Political priority: E1 Energy Change		E. Political priority: E3 economy	E. Political priority: E2 security
F. Acceptance Energy Change: F2 approval	F. Acceptance Energy Change: F1 scepticism		
G. Planning legislation: G3 promoting participation	G. Planning legislation: G2 promoting speed	G. Planning legislation: G1 incoherent	G. Planning legislation: G2 promoting speed
H. Infrastructure extension: H2 fast		H. Infrastructure extension: H1 slow	H. Infrastructure extension: H2 fast
I. Growth of renewable energies: I3 fast	I. Growth of renewable energies: I2 medium	I. Growth of renewable energies: I1 slow	I. Growth of renewable energies: I2 medium
J. Domestic energy savings: J2 strong	J. Domestic energy savings: J1 small		
K. Industrial energy savings: K2 strong		K. Industrial energy savings: K1 small	K. Industrial energy savings: K2 strong
L. Mobility: L3 downscaling and e-cars	L. Mobility: L1 persistent structures		L. Mobility: L2 downscaling

Model results: Energy target compliance of the demonstrator context scenarios

Energy balances 2040
Estimations based on
DLR modell



Remember:
Concept demonstration!
No final results.

S1: Consensus in a lucky environment
S2: D21 - Revolution from above
S3: “It‘s the economy stupid“
S4: Stormy waters ahead

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Context scenarios:
Application in ENERGY-TRANS

Motivation:

- Understanding the German „Energy Change“ as a „socio-technical transformation“

ENERGY-TRANS projects developing context scenarios:

- A1 - Technology potentials. Focus: societal influences on technology development (FZJ, multi-level context scenario analysis completed*))
- A2 - Integrated scenarios. Focus: societal influences on technology implementation (DLR, ZIRIUS, Demonstrator completed, context scenario construction ongoing)
- A3 - Regional modeling. Focus: societal influences on regional transformation (ITAS, DLR, first context scenario analysis completed, another one ongoing)

*) 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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Summary

- Energy systems are embedded in society and their future development is interlinked with societal developments.
- Uncertainties about the societal future strongly affect long-range energy transformations (such as, for instance, the German „Energiewende“).
- In traditional Energy Scenario Analysis, the future uncertainty of the embedding society is rarely considered in depth, and, as a consequence, the resulting uncertainty of the energy future is underestimated.
- In ENERGY-TRANS, CIB-based context scenarios are used to encourage the adequate perception of societal uncertainties in model-based Energy Scenario Analysis.

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