Karlsruhe Institute of Technology

ITAS Institute for Technology Assessment and Systems Analysis

Scenarios

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Outline

1. Overview
2. Update
3. Reflections
4. Exercise
5. Concluding discussion

Outline

1. **Overview**
   a. Background
   b. Expectations
   c. Aims
2. Update
3. Reflections
4. Exercise
5. Concluding discussion

ITAS – Institute for Technology Assessment and Systems Analysis

ITAS

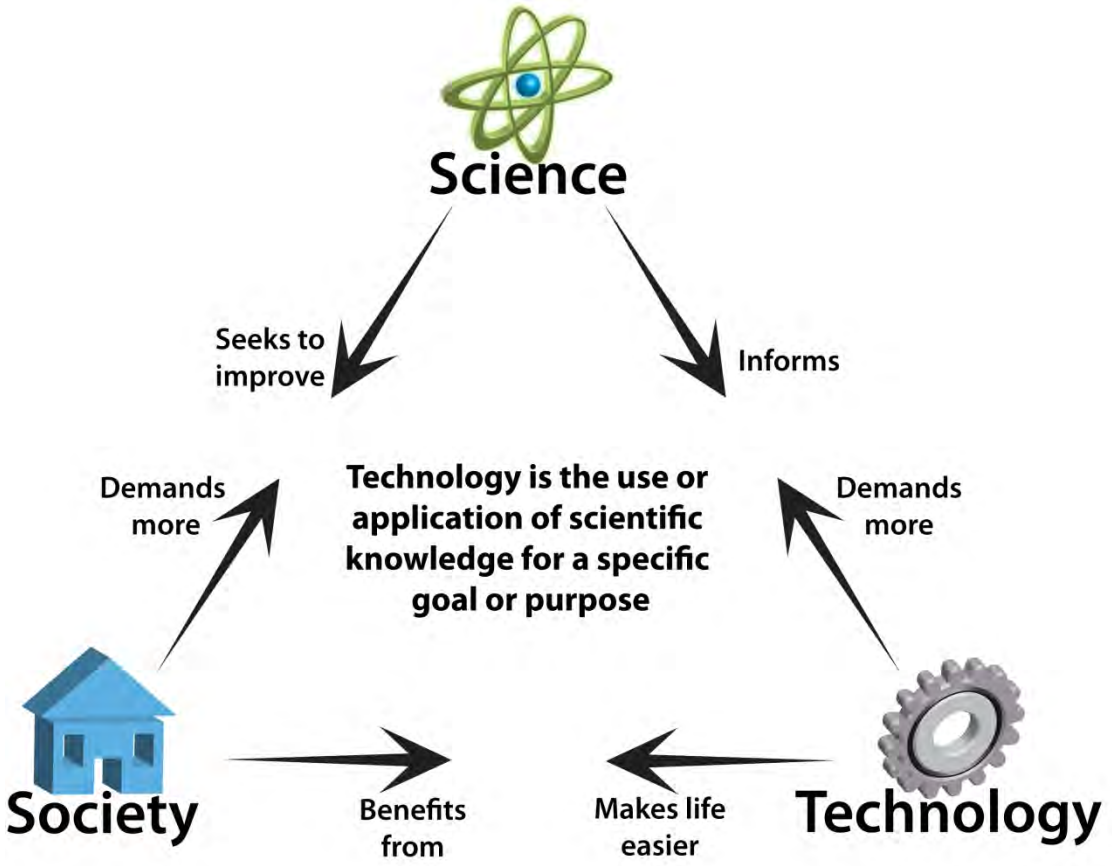
~ 300.000 habitants

Historic Downtown

- Projects: ~120 since 2005
- Employees: ~ 120
  including about 45 long-term scientific staff
- Supervised PhD students: about 25
- Post-docs: about 20

University Center

Tasks of ITAS



- Analysis, using and developing TA and Systems Analysis methods
- Development of action strategies for sustainable development
- Provision of knowledge for responsible designing and societal embedding of innovations

Characteristics of ITAS research

- Problem-oriented research with reference to the societal need for advice
- Provision of prospective knowledge
- Close relation to the value dimension, e.g. in the form of ethical analyses or sustainability assessments
- Provision of “knowledge for action”
- Development of strategies to deal with the uncertainties of knowledge
- High degree of interdisciplinarity between natural, social, economic and human scientists and engineers
- Transdiciplinarity through involvement of non-scientific actors (stakeholders, decision makers, and concerned people)

Administrative structure

Institute for Technology Assessment and Systems Analysis (ITAS)
Directors: Prof. Dr. Armin Grunwald; Prof. Dr. Michael Decker

Office of Technology Assessment at the German Bundestag (TAB)

Prof. Dr. A. Grunwald

Energy – Resources, Technologies, Systems

Heads:
Prof. Dr. G. Betz
Dr. W. Poganietz

Sustainability and Environment

Heads:
J. Kopfmüller
Dr. C. Rösch

Innovation Processes and Impacts of Technology

Heads:
Dr. A. Ferrari
T. Fleischer

Knowledge Society and Knowledge Policy

Heads:
Dr. S. Böschen
B.-J. Krings

ITAS – Research Areas (RA)

- **Knowledge Society and Knowledge Policy**

Focus on knowledge and technology policy, technological change and social dynamics, and on concepts and methods of technology assessment

- **Innovation Processes and Impacts of Technology**

Focus on digital information and communication technologies, nanotechnology, new and emerging technosciences, and key technologies for future mobility and traffic concepts

- **Sustainability and Environment**

Focus on urban areas, global changes, and renewable and non-renewable resources – above all renewable energy, land use, water

- **Energy – Resources, Technologies, Systems**

Focus on energy from biomass, new energy technologies and cross-cutting and efficiency technologies, as well as regional (energy) management strategies and on scenario analysis

(Your) Expectations

(My) Aims

- To give *some* insight in the complex world of scenario approach!
- Updates on
  - idea of scenarios – claims and limits
  - knowing the approaches – theory and practice
  - using scenario technique – claims and reality
- Reflections on model-based scenarios

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   a. **Instrument “scenario”**
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(Your) Experience

Questions

- **What are scenarios?**
- **Why do we need them?**
- **Are the really relevant? Do we use them?**

Source: http://andysrant.typepad.com/.a/6a01538f1adeb1970b017c370046b7970b-800wi; 28.05.2013

http://www.presseurop.eu/files/images/article/CHAPPATTE-nuclear-490.gif?1381824695

What are scenarios?

- **Stories about the future**

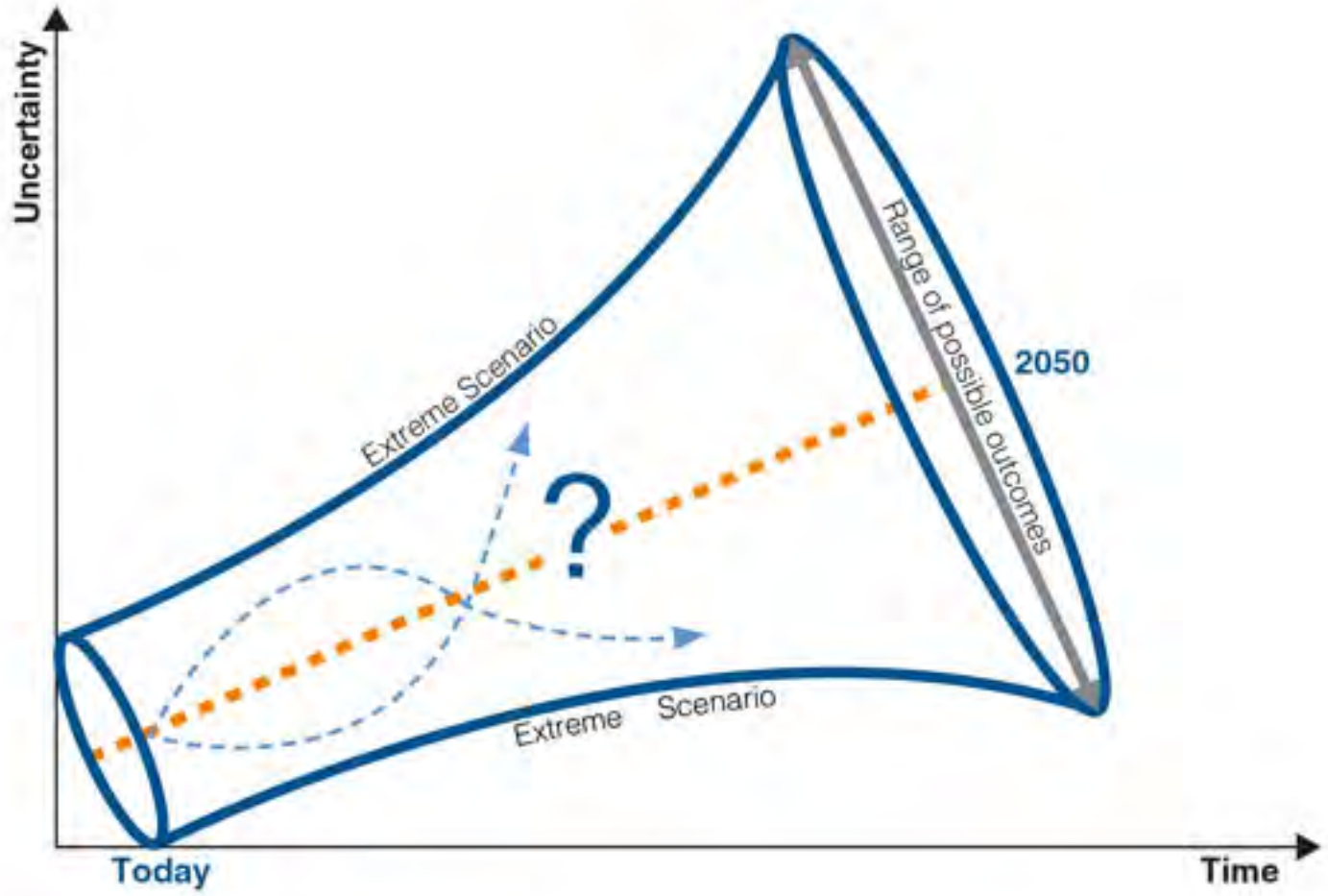
- Why think about the future?
  - Future is a consequence of our decisions and decisions done by others
  - Future is shaped by “us” (and by – mostly – undesirable shocks)

  ⇒ Strategic thinking is required, if we would like to control our life

- But, there is not one future!
  - The realized future is the composition of a set of known and unknown decisions and unknown shocks
  - To think about the future means to think in options

  ⇒ we should talk about futures

Why do we need scenarios?



bec.org.nz

Why do we need scenarios?

- Complexity of the world we are acting
- Uncertainty regarding the future (missing knowledge)
- Future pathways will be determined by todays decisions
- But,
  - future is never predictable or to some extent not pre-determined
  - full information over the future is never available

We need them to

- support strategic decisions (within companies or economies)
- improve the understanding of possible cause-effect relations
- trigger or structure a debate on certain issues

What are scenarios?

- **Stories about futures**

- Scenarios are plausible views of the future world, described in a narrative form (stories!) that provide a context in which decision makers can make decisions

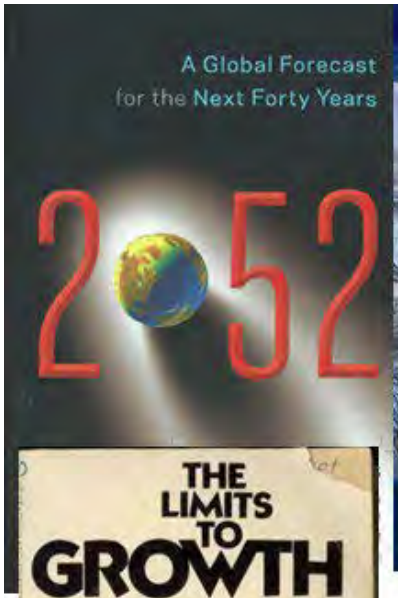
Description of “potential futures”, i.e. ways and means over a desired time horizon

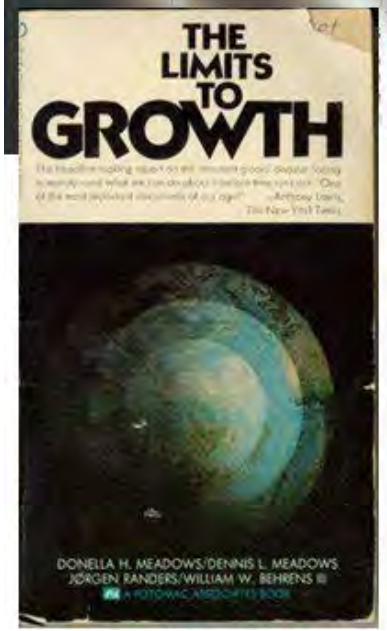
- Scenarios do not predict futures

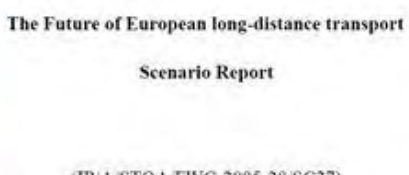
- Scenarios are part of foresight, which is an approach to
  - free up your thinking beyond the here and now
  - explore plausible futures
  - think about the implications for decisions today

But, plausible means not
- probable / likely
- desired – but it could be desired

Are scenarios really relevant?
Do we use scenarios?







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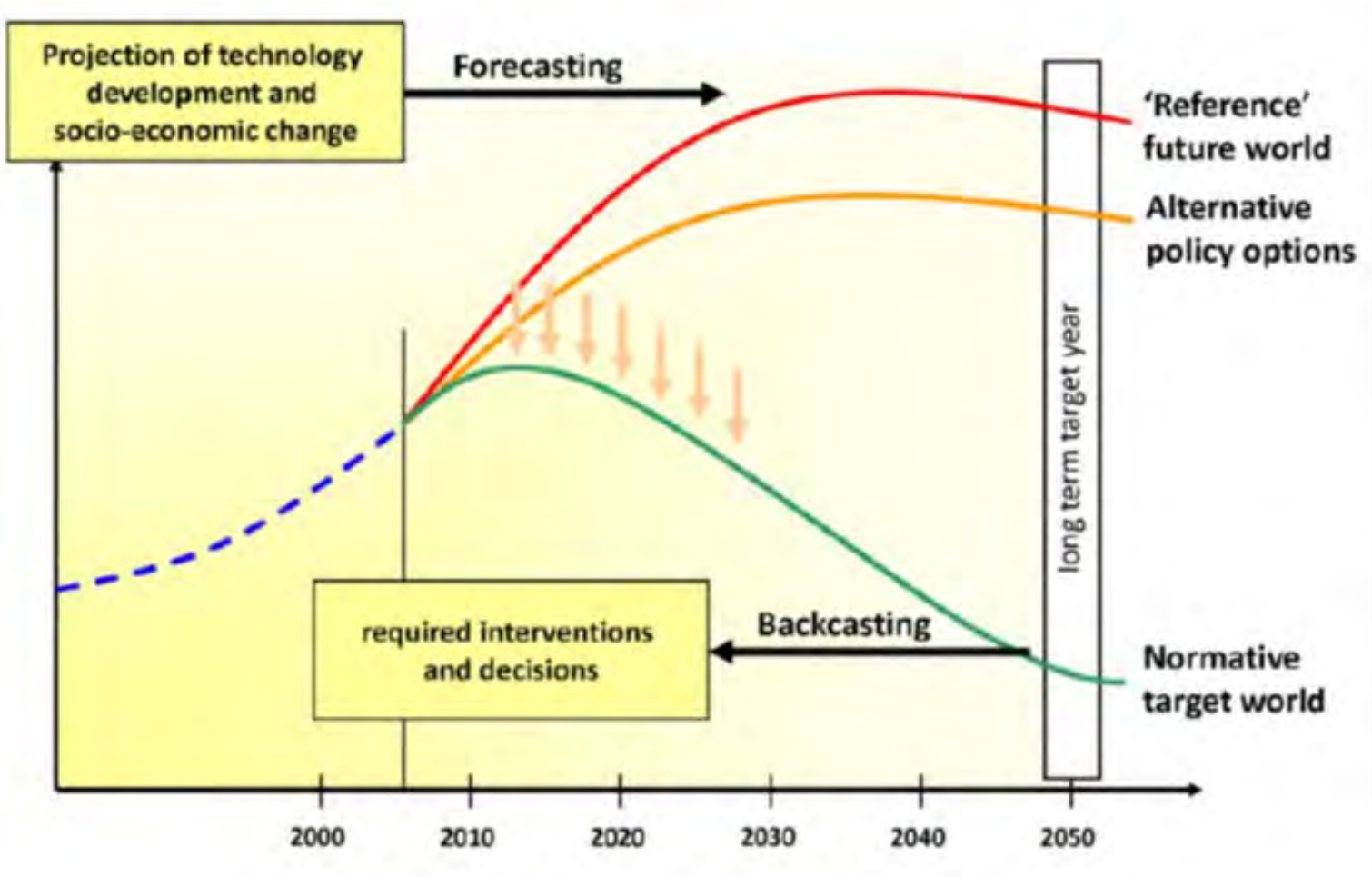
Approaches

Predictive scenarios	Explorative scenarios	Normative scenarios
• What will happen? • What could be expected?	• What can happen, if ...? • What is possible?	• How to reach a specific target?
To predict the most likely future	To analyze possible futures	To analyze paths to reach the target
• Trends • Business-as-usual	Identification of main drivers	Backcasting

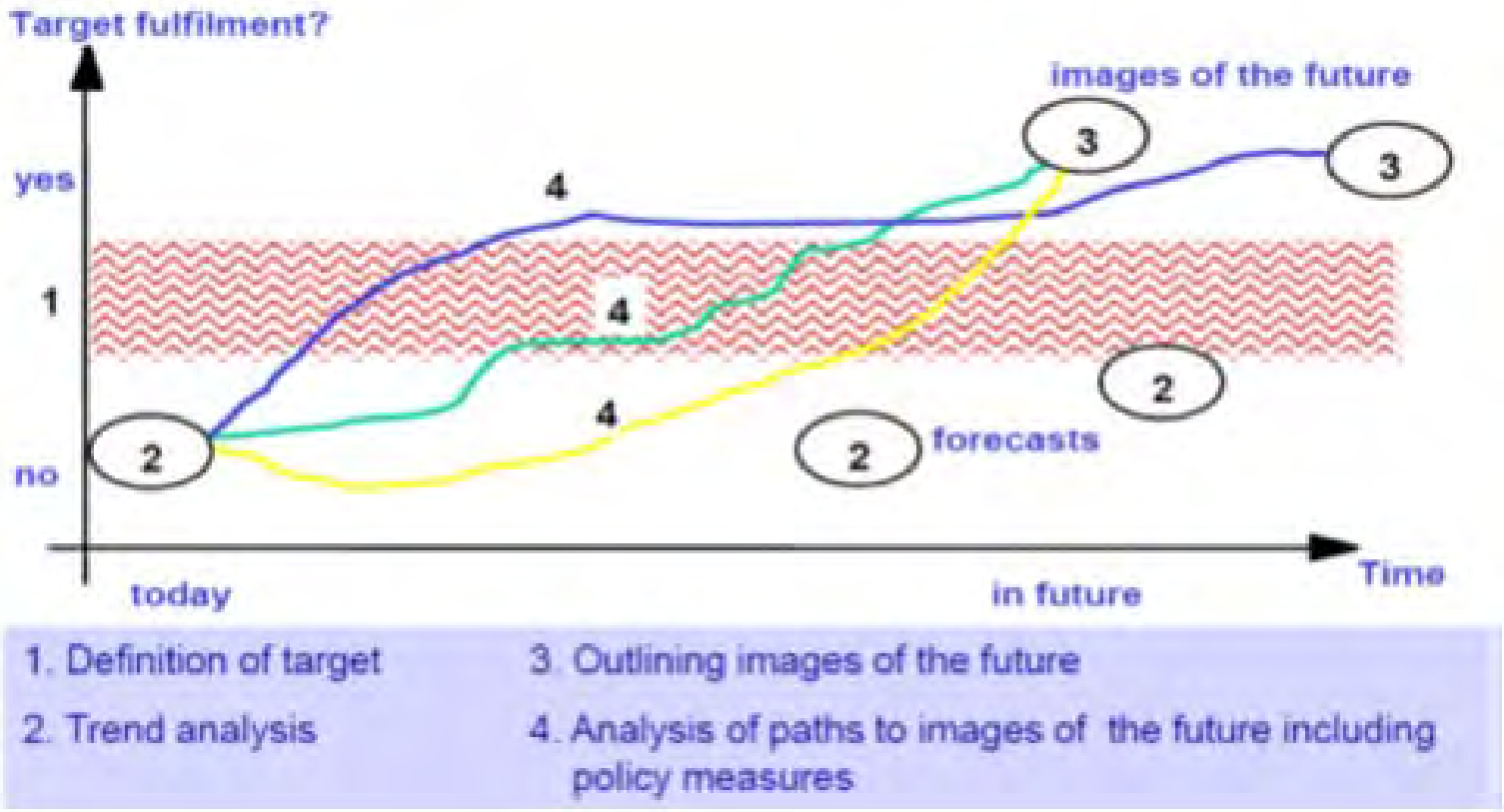
Following Börjeson et al. 2006

Approaches



Grunwald, Futures 2011, p. 822

Backcasting



Following Höjer and Mattsson, 2000 und Steen and Åkerman, 1994

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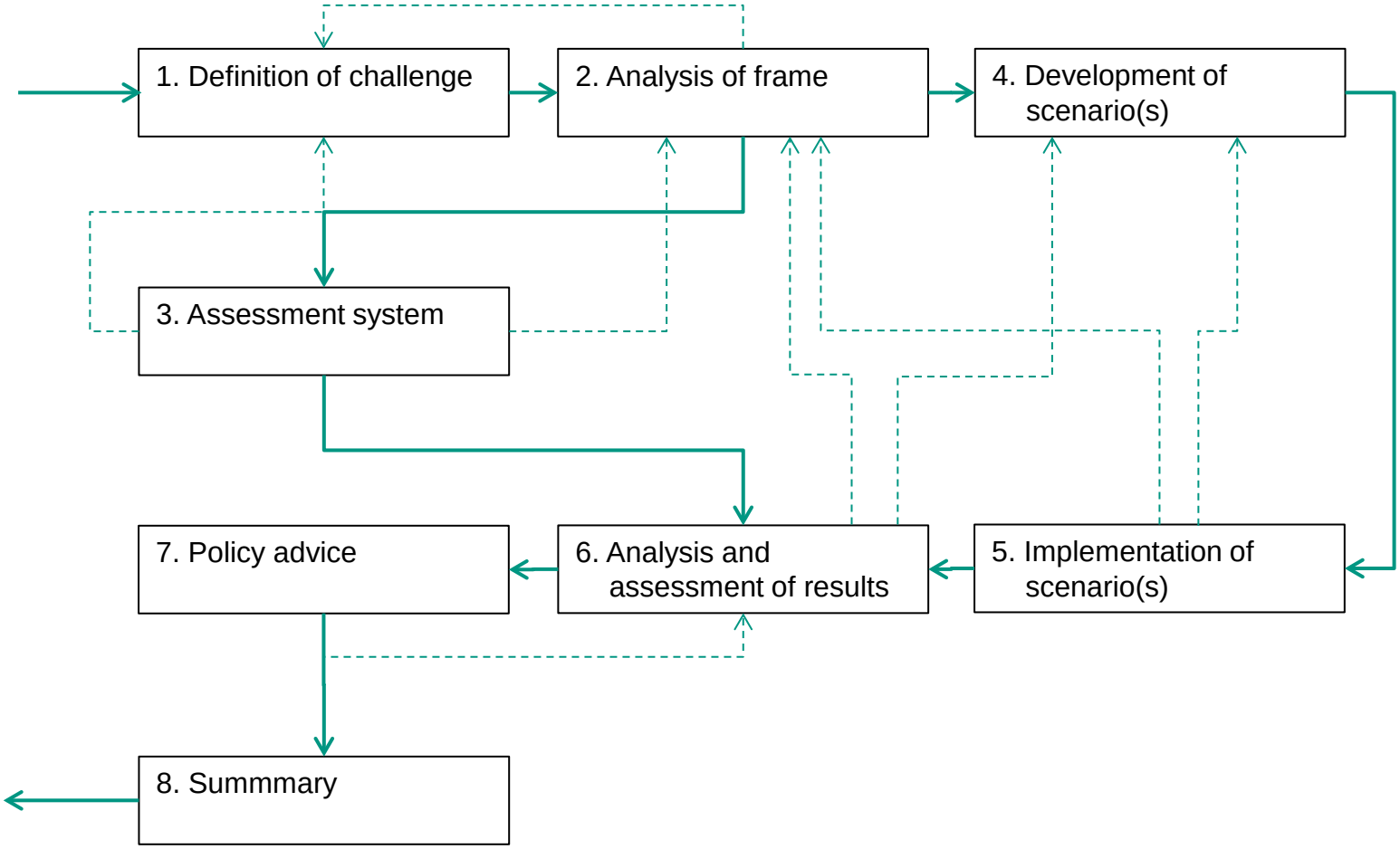
Scenario analysis – General approach



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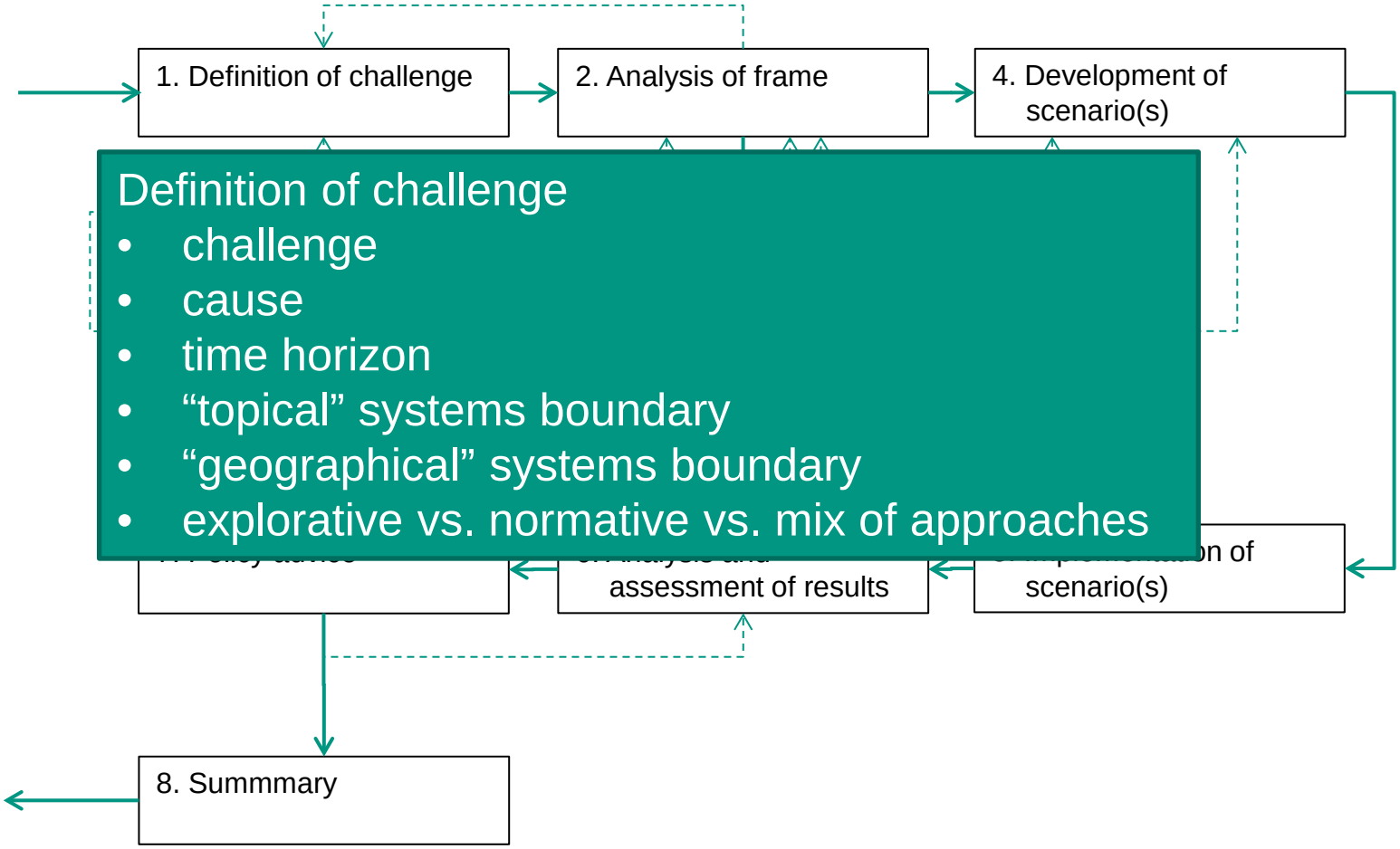

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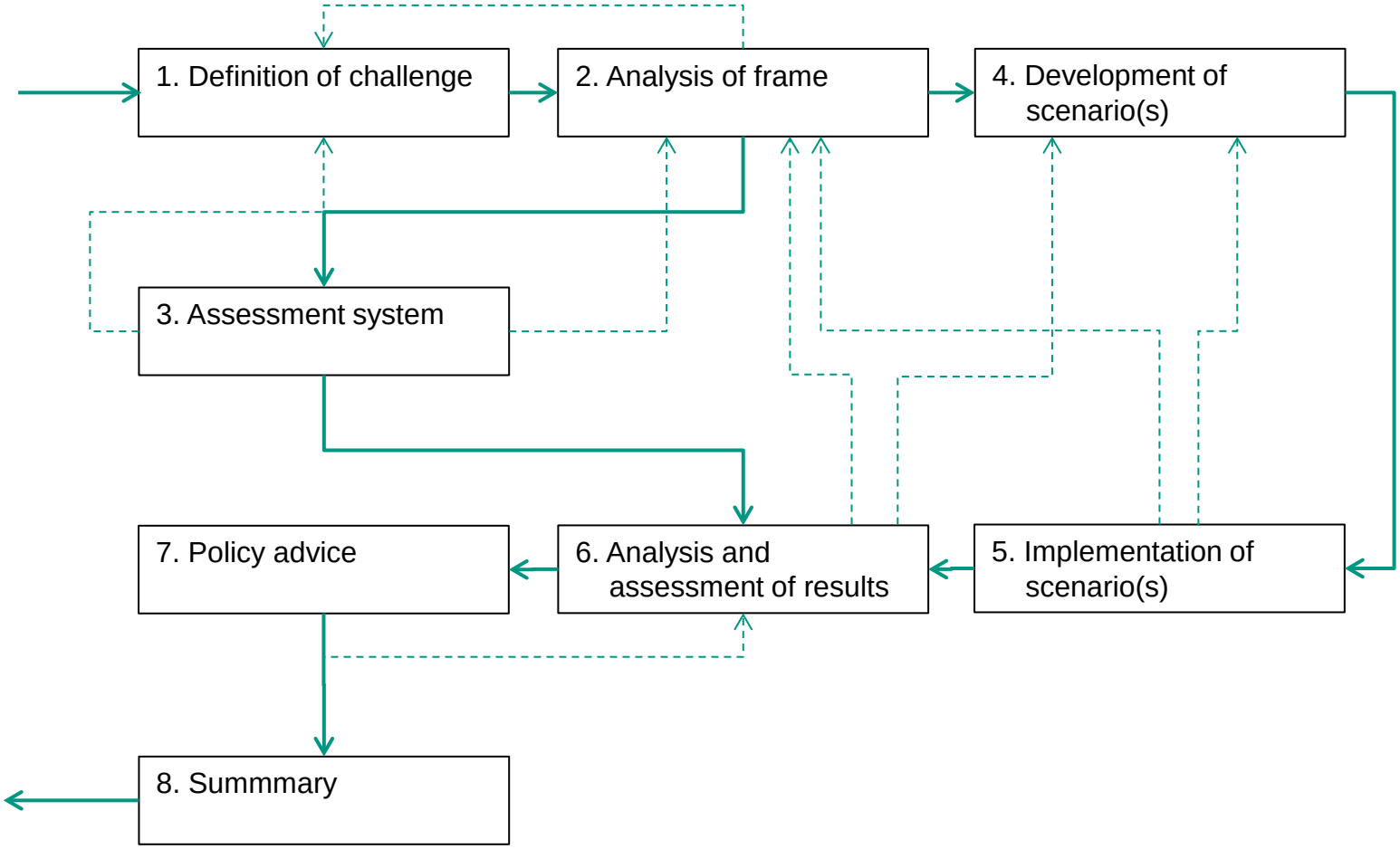

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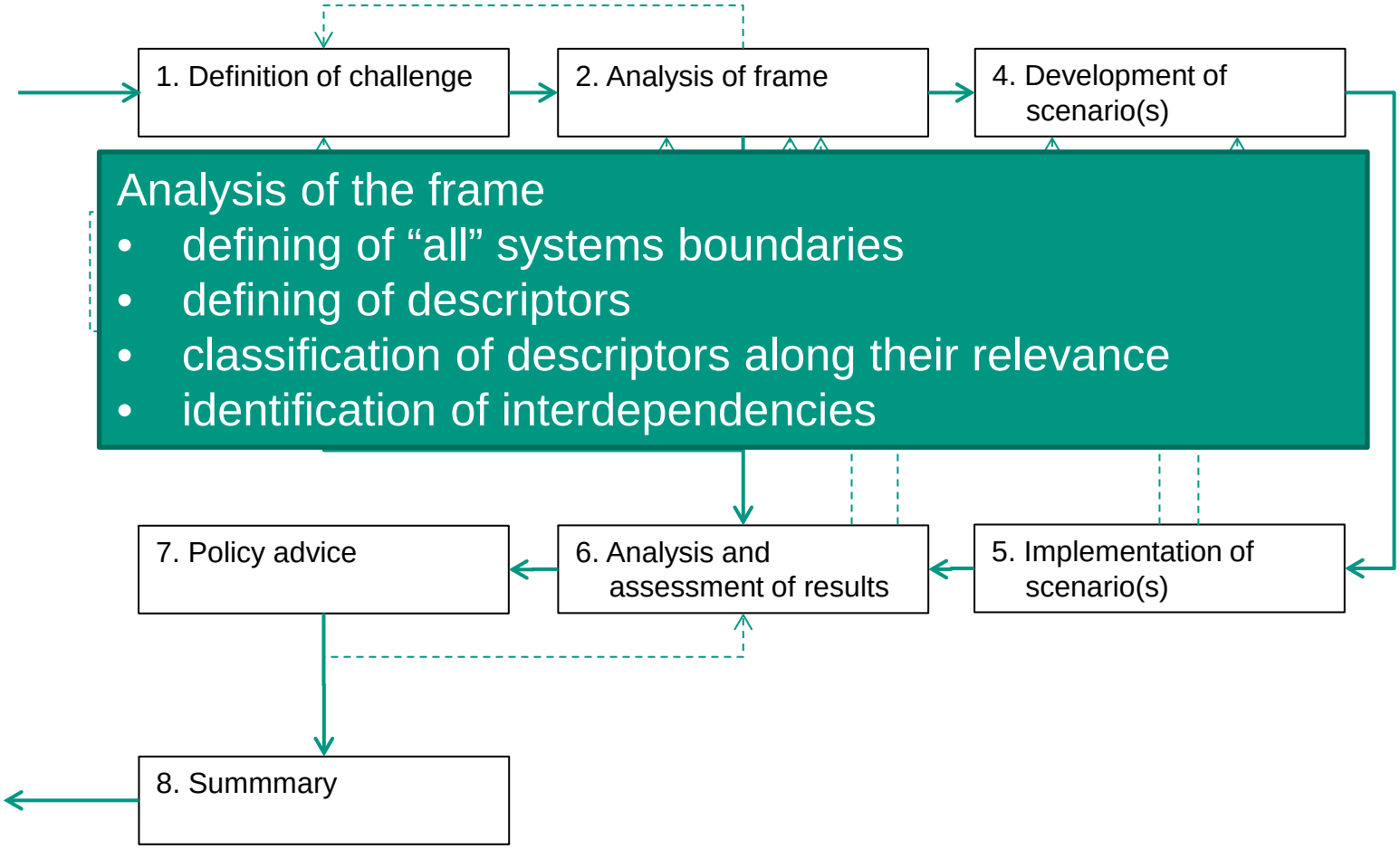

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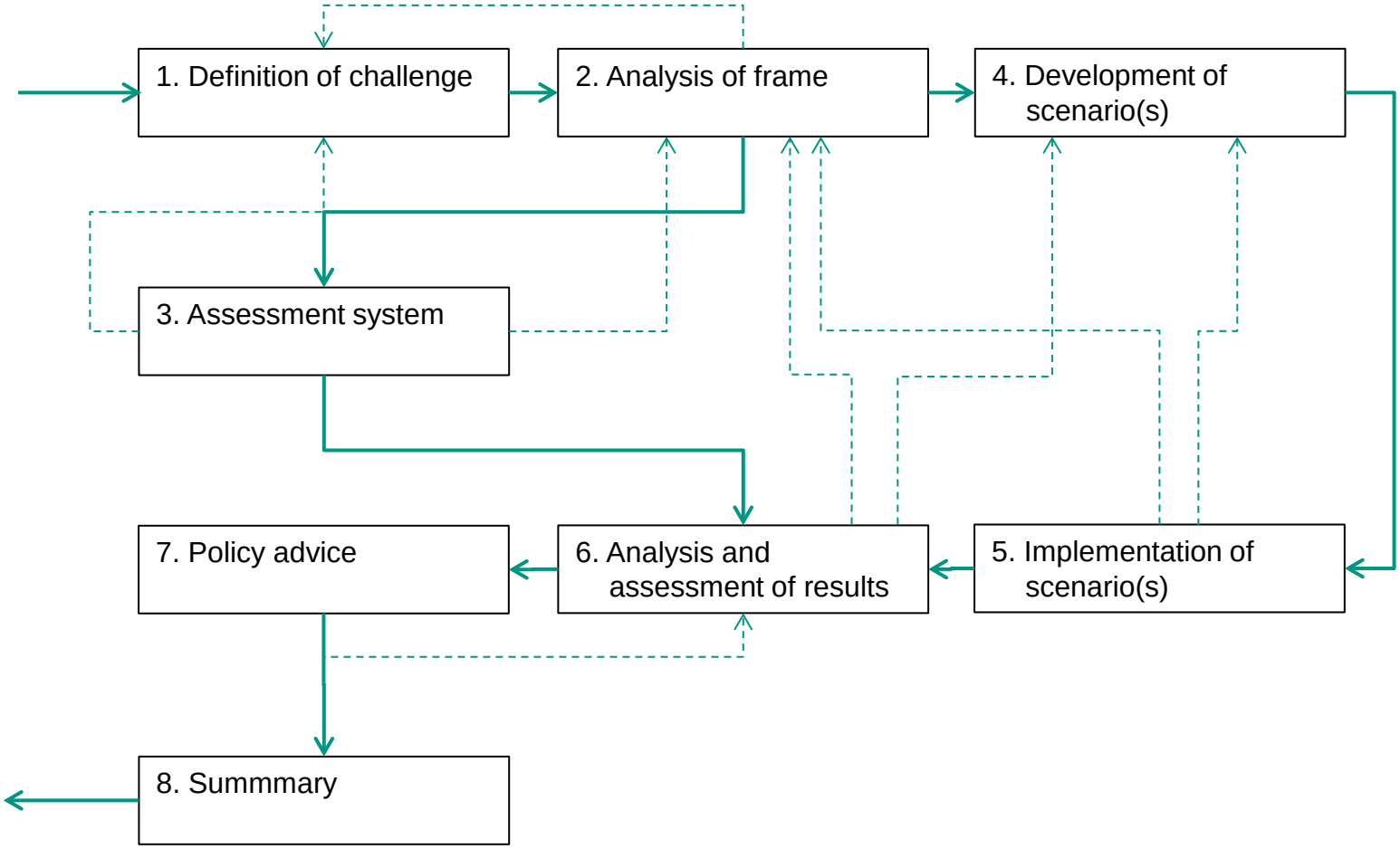

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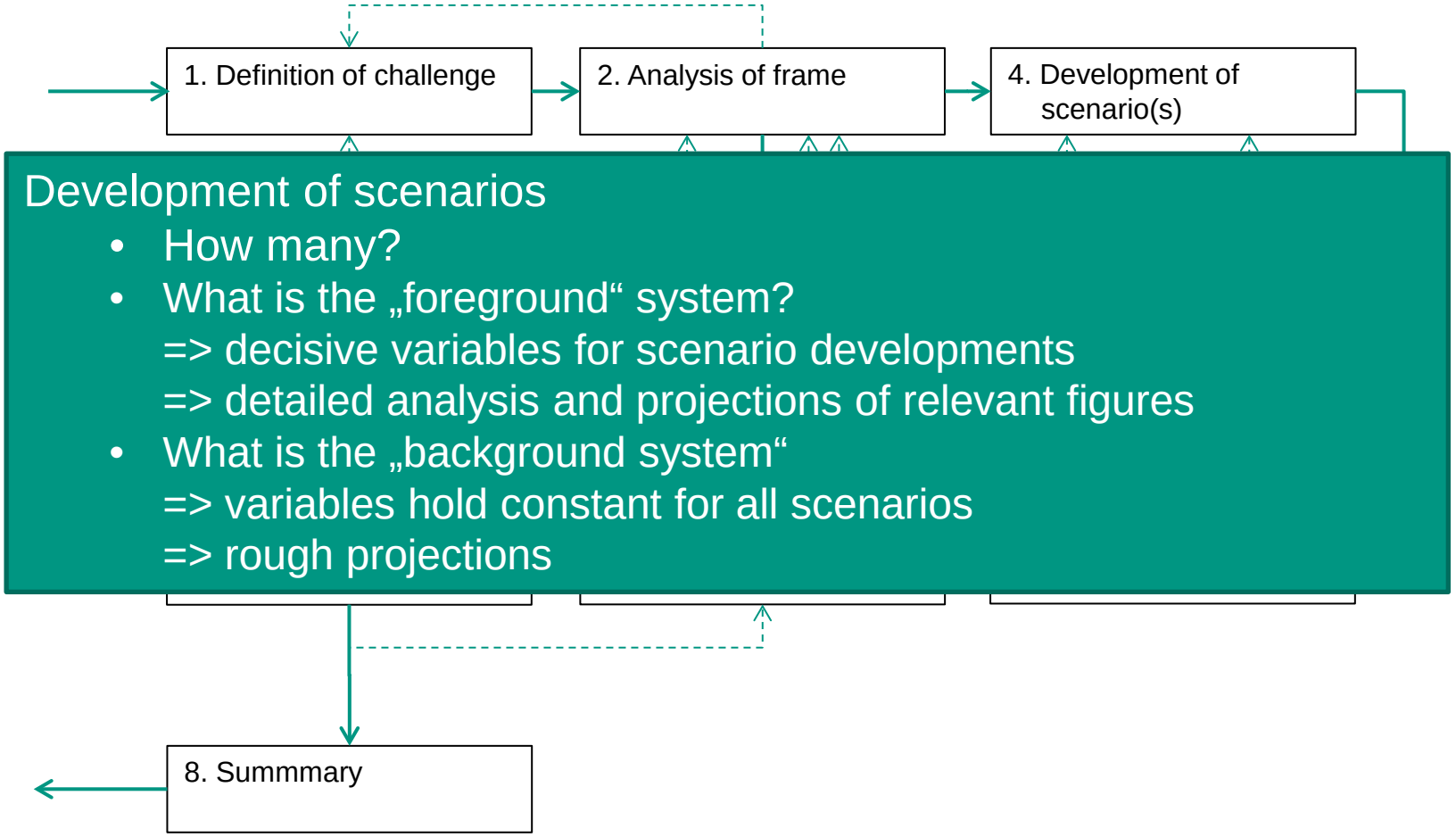

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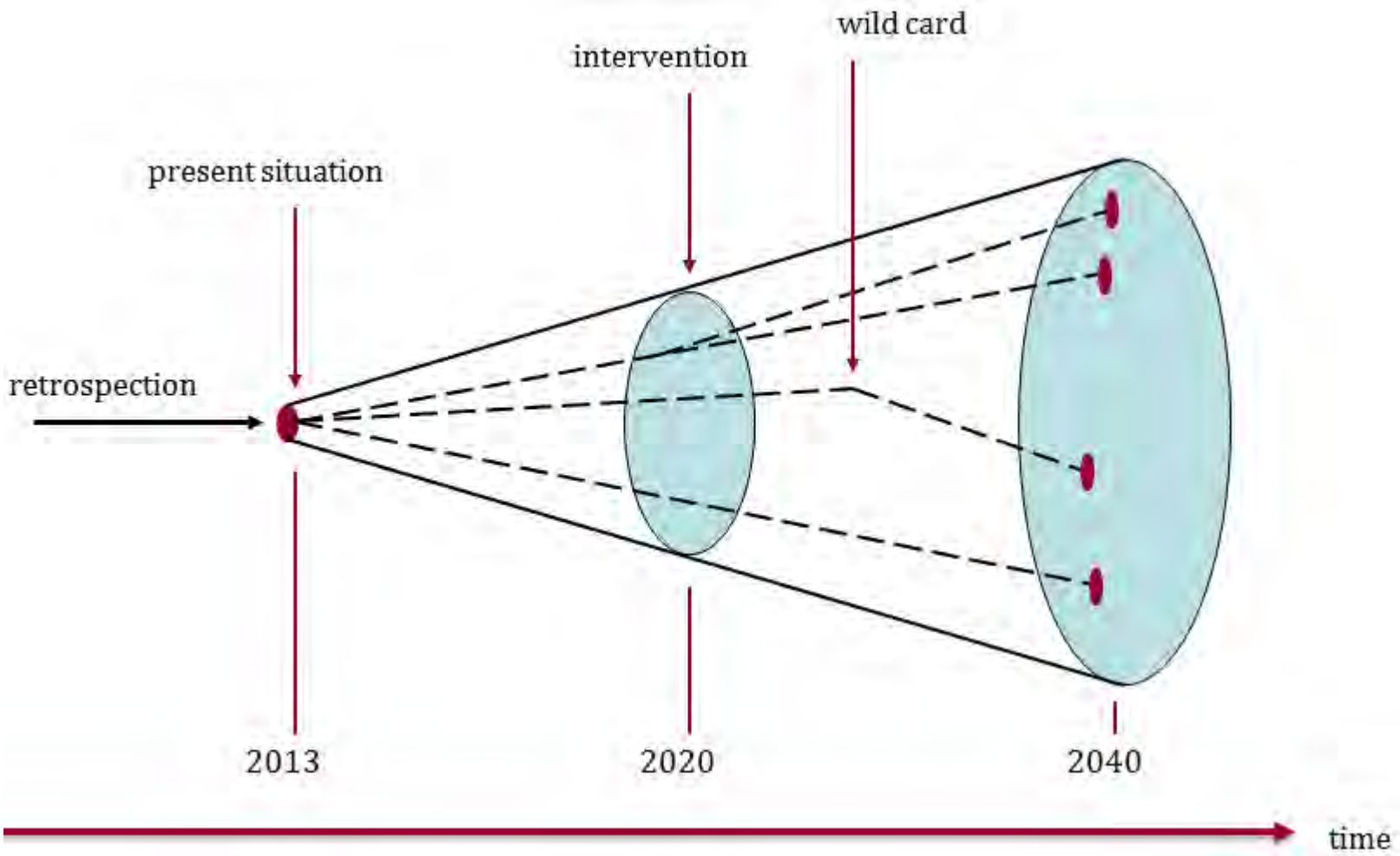
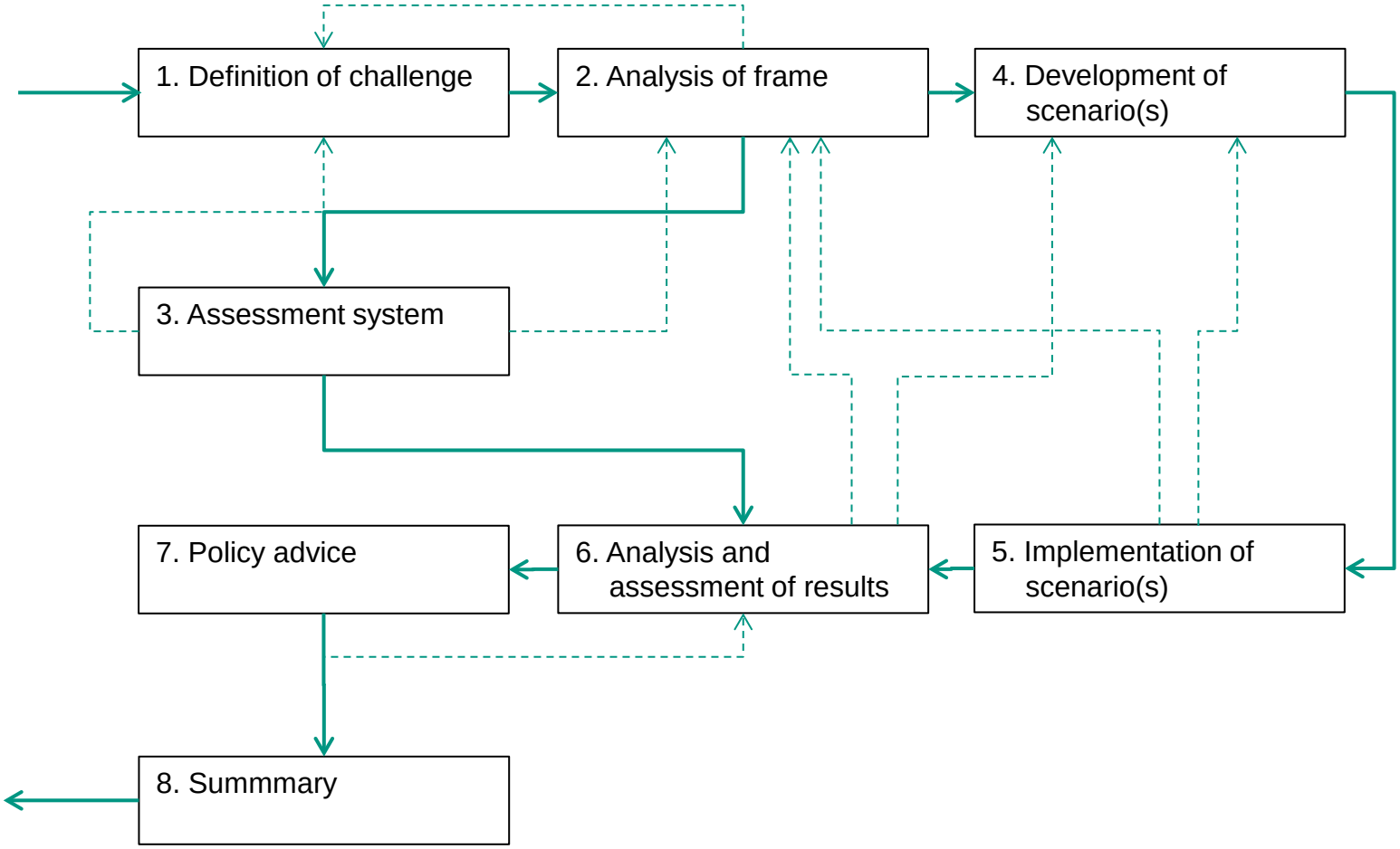


forestwiki.jrc.ec.europa.eu

Scenario analysis – General approach



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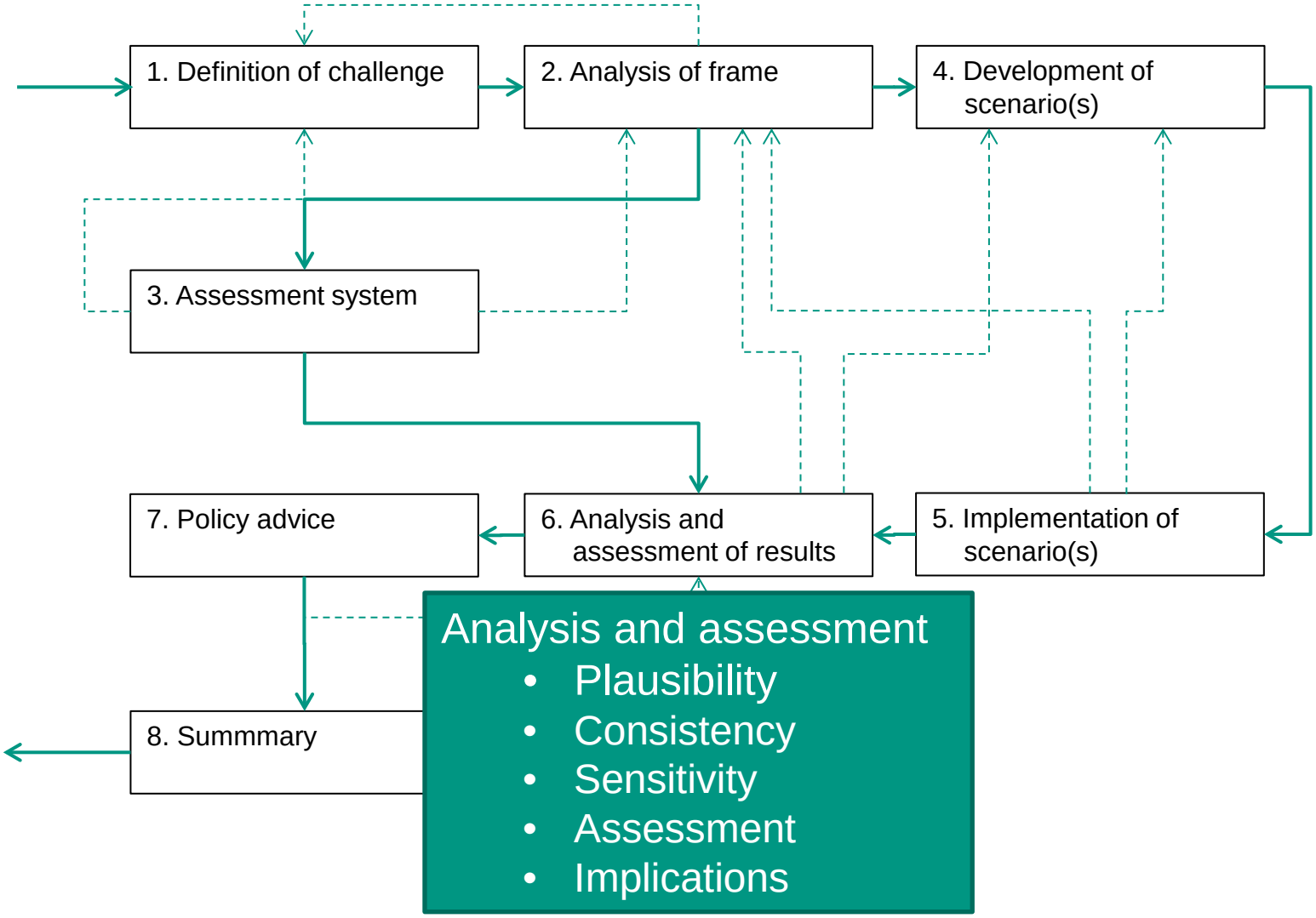

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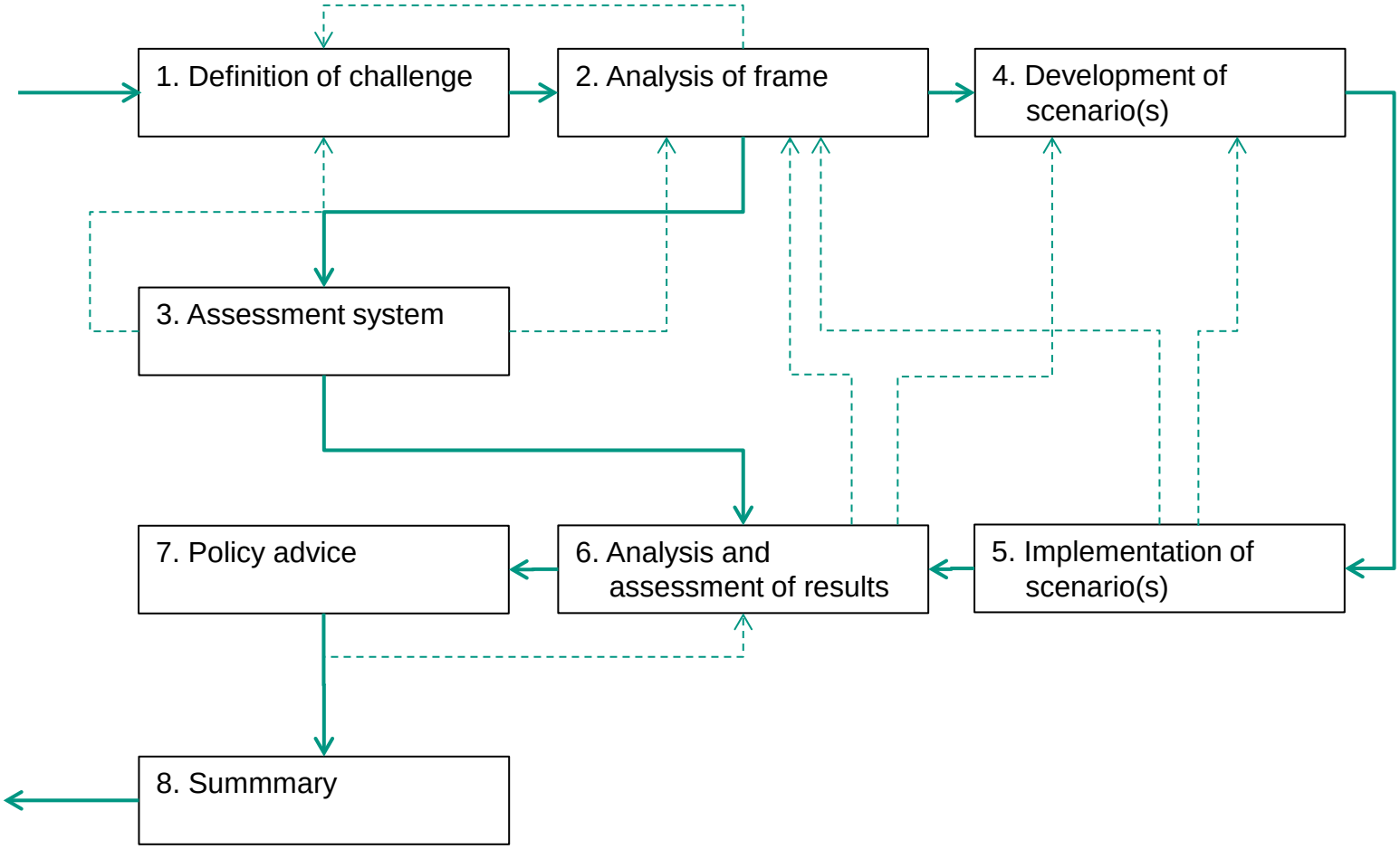

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Requirements ~ Seal of quality

- Plausible: described future shall be possible, but not necessarily likely or desirable
- Consistent: described futures shall be coherent, with no contradictions
- Comprehensibly: scenario shall be adequate to the challenge under investigation – not too complex, not too simple
- Selective: different scenarios shall describe distinguished futures
- Transparent: (explicit and implicit) assumptions (regarding amongst others interdependencies and constraints) shall be revealed

Don’t expect …

- Scenarios cannot fulfill all expectations
- Scenarios cannot predict the future
- Scenarios cannot be impartial, as they base on the assumptions of the scenario builder and his “socialization”
- Scenarios cannot offer claim of truth comparable to natural laws or scientific knowledge => the criterion of falsification cannot be applied

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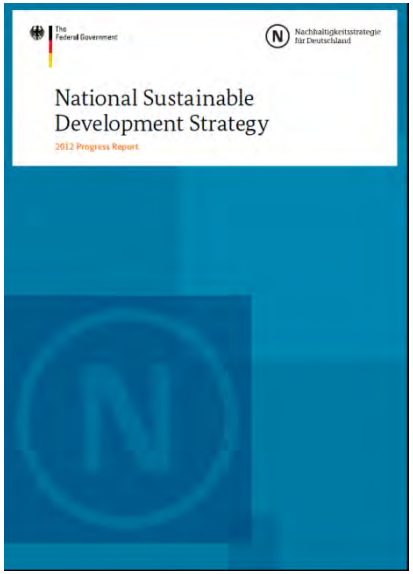
Germany’s Energiewende – overarching aims

“[… T]o make Germany one of the **most energy-efficient** and **eco-friendly economies** in the world while **maintaining affordable energy prices** and **a high level of prosperity**. **High security of supply**, **effective climate and environmental protection**, and an **economically viable energy supply** are also vital if Germany is to remain an internationally competitive industrial location in the long term.”

Source: The Federal Government (of Germany) – National Sustainable Development Strategy – 2012 Progress Report, p. 148



Germany's Energiewende – selected targets

Year	GHG (compared to 1990)	Share of renewables in FEC	Share of renewables in elec.	Energy efficiency (compared to 2008)
2030	-55%	30%	≥ 50%	n.a.
2050	-80 to -95%	60%	≥ 80%	PEC: -50% Electricity: -25% FEC transport: -40% PEC of buildings: -80%

Notes:

- Adopted on September 28 2010
- GHG: Greenhouse gas emissions
- FEC: Final energy consumption
- PEC: Primary energy consumption
- elec.: Electricity

Source: The Federal Government (of Germany) – National Sustainable Development Strategy – 2012 Progress Report, p. 146

Germany's Energiewende – selected targets

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2030	-55%	30%	≥ 50%	
2050	-80 to -95%	60%		0%
				-25%
			PEC transport:	-40%
			PEC of buildings:	-80%

Energiewende seems to be a reconstruction of the German energy system under the supervision of the society
⇒A societal driven transformation of a system?

Notes:

- September 2010
- GHG: Greenhouse gas emissions
- FEC: Final energy consumption
- PEC: Primary energy consumption
- elec.: Electricity

Source: The Federal Government (of Germany) – National Sustainable Development Strategy – 2012 Progress Report, p. 146

But, something seems to go wrong

Source: unknown

Example I:
Changing market and economic relations

- New energy conversion technologies allow to establish a small scale production of electricity and heat,
  - e.g. photovoltaic => private households
  - e.g. wind power plants => land owner
  - e.g. biogas => farmers
- Regulations and subsidies promote the market entry of small-scale suppliers,
  - e.g. 1000-Dächer-Programm (1000 roofs program)
  - e.g. Renewable Energy Sources Act (EEG)

- “Prosumer”: new consumer roles
- “Self consumption regulation”: Fragmentation of the electricity market

Example II:
Changing public awareness (I)

- Public awareness has changed, since the 1970s: the individual valuing of personal advantages and disadvantages increases
- Characteristics of saturated societies, i.e. enhanced importance of non-income factors for the individual welfare, like no interference in the current environment
- Not actually a consequence of the energy transformation, but the Energiewende has to deal with it

- NIMBY (Not in my backyard)
  - Grid extension
  - Wind power plants ("Stop Verspargelung")
  - Biogas ("Vermaisung stoppen")

Source: http://www.thehindu.com/multimedia/dynamic/00003/INDIA_GREENPEACE_3890f.jpg; 28.05.2013

Example III: Changing public awareness (II)

- Smart grid implies
  - collecting, storing and analyzing of mass data
  - to identify amongst others consumption patterns
  - to enhance the provision of energy
  - to reduce required resources and emissions

- But, “who cares for my data?”
  - hardly comprehensible willingness to provide private information to social media (e.g. Facebook; WhatsApp)
  - but, on the contrary: great reluctance to provide information to non-social media
    - “Who deals with my data?”
    - “What will be done with my data?”
    - “Do I lose my private autonomy?”

Model-based energy scenarios

- Model-based energy scenarios are a prominent tool
  - in the political, economic, societal and scientific discussion
  - to support political and economic decisions
  - to set the frame for a future energy system

  ⇒ Important contribution to the scientific based policy advice

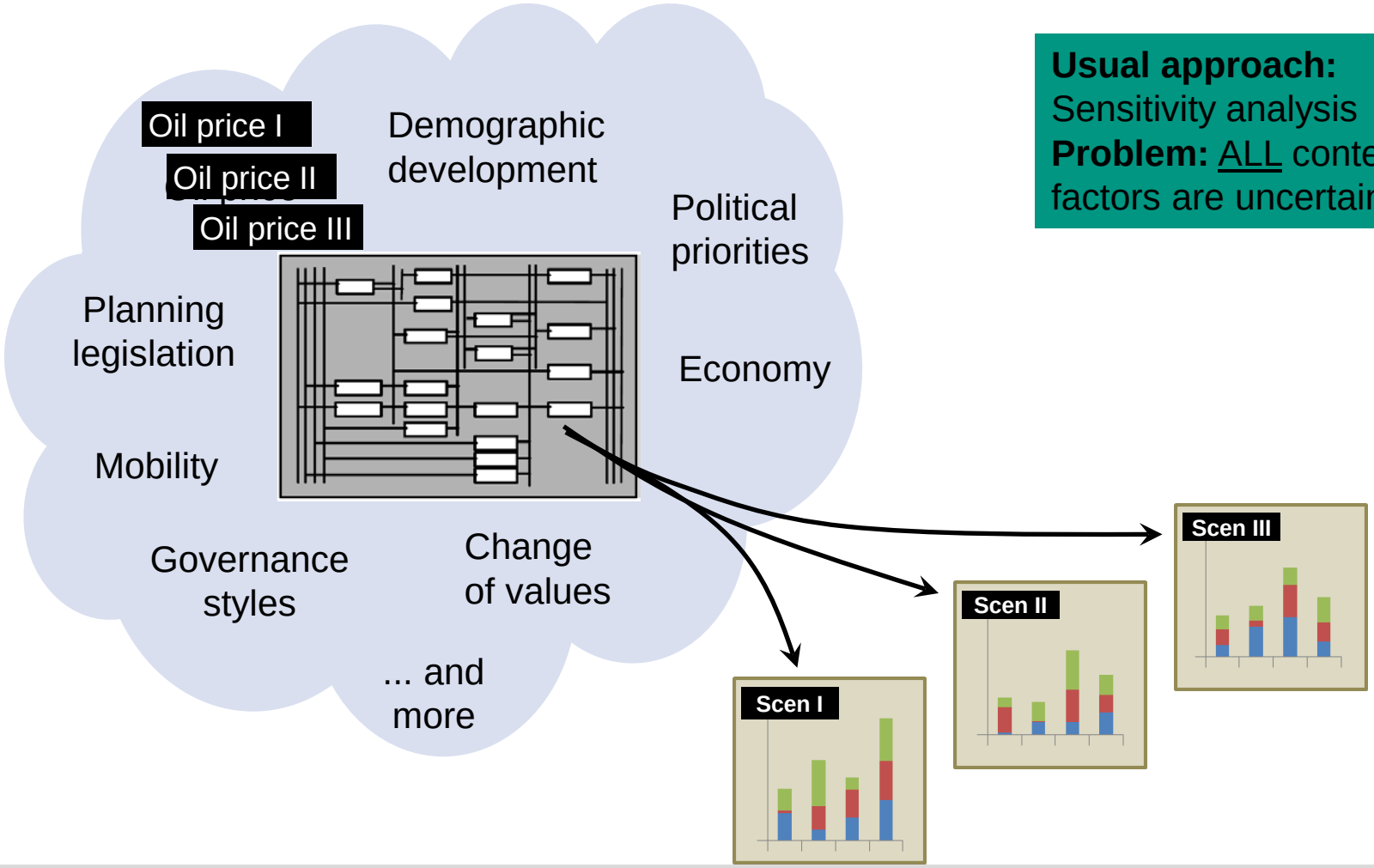
- Advantages are amongst others quantification
  - of energy flows
  - of (mainly private) welfare costs
  - of (some) environmental impacts

  of a complex system of extraction, cultivation, conversion, distribution and demand processes

⇒ Model-based energy scenarios deliver numbers, where numbers are demanded

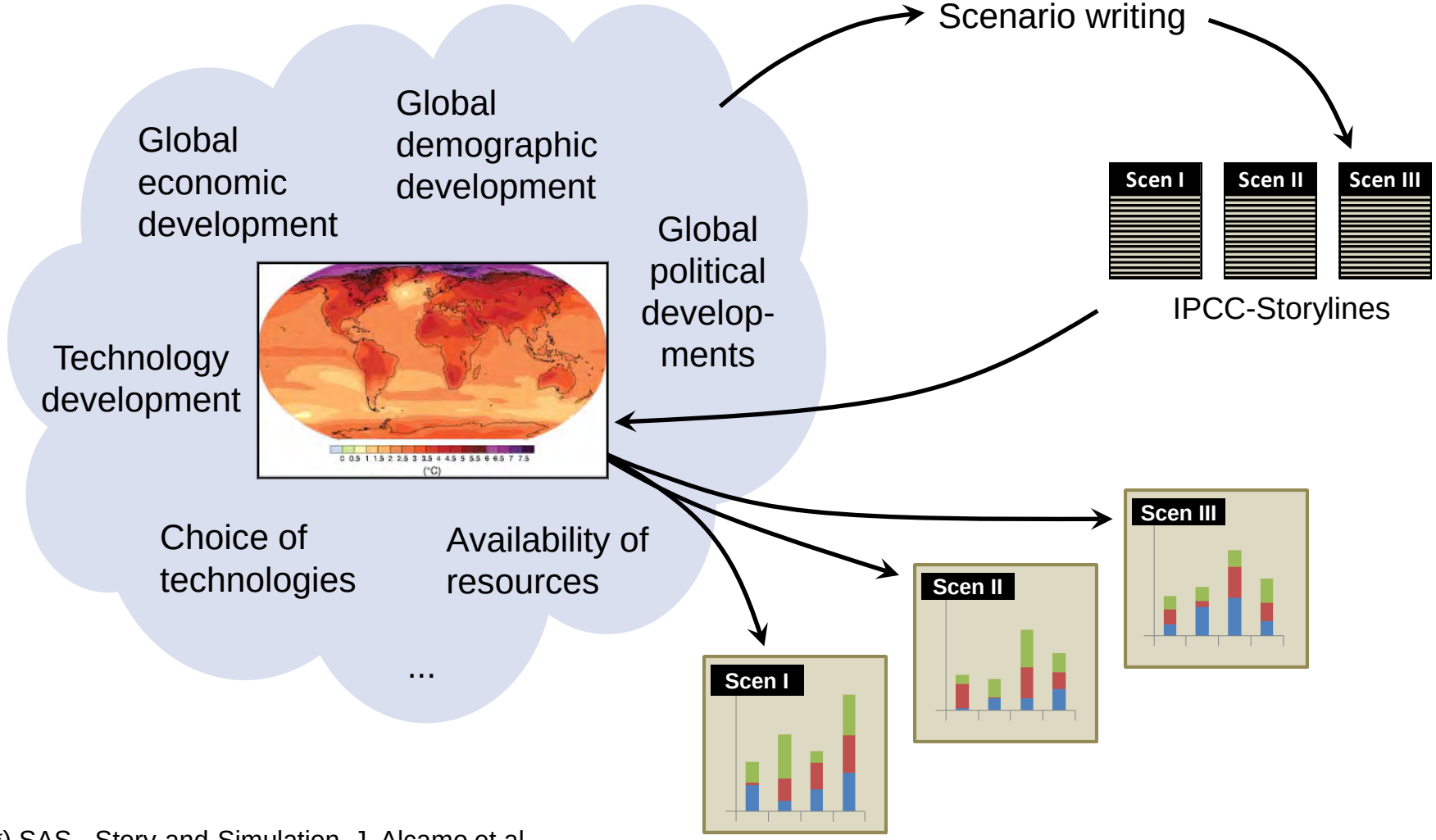
The making of energy scenarios and the uncertainty of context conditions

- The Traditional Approach -



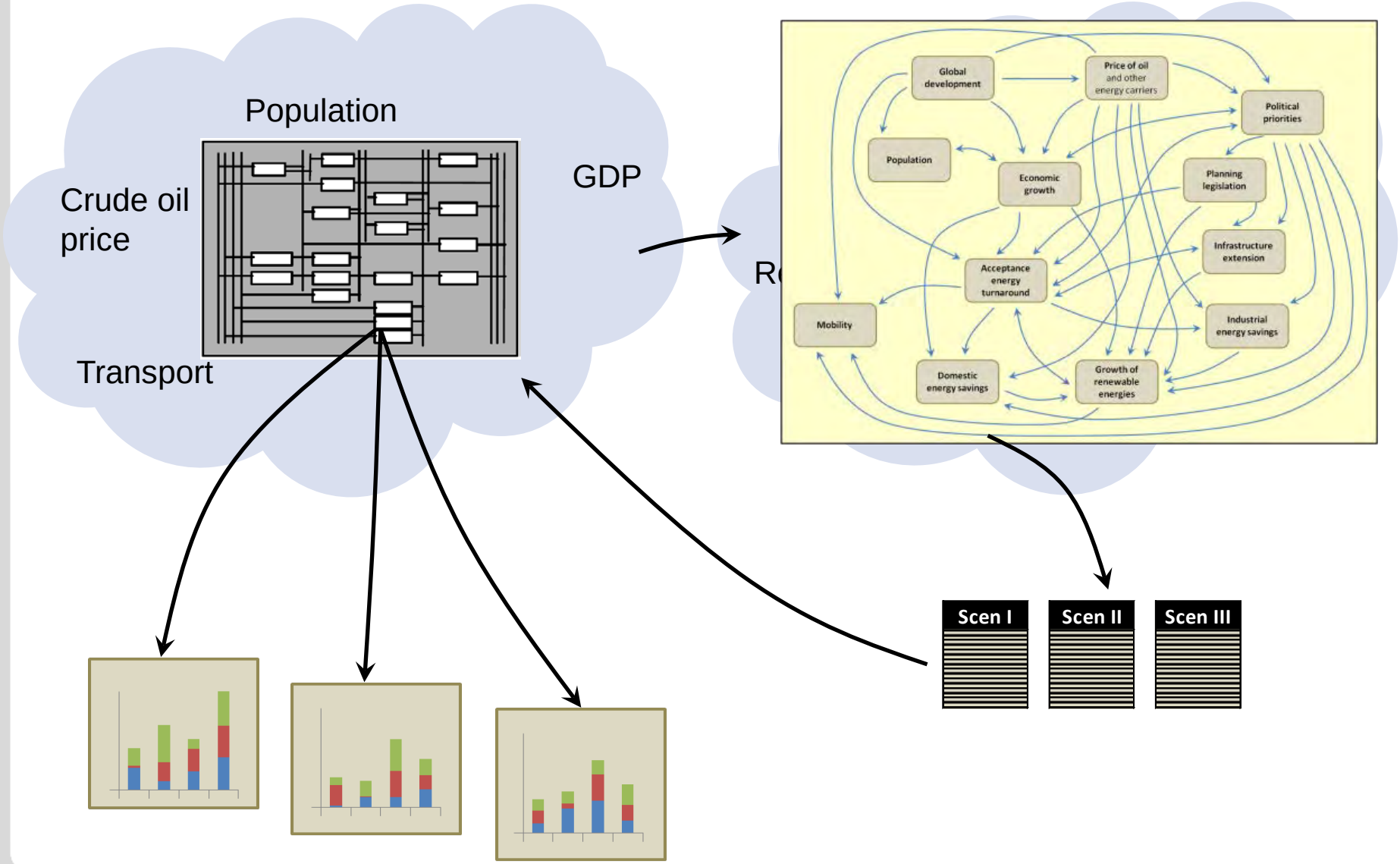
Usual approach:
Sensitivity analysis
Problem: ALL context factors are uncertain!

IPCC-climate change scenarios and the SAS*) concept

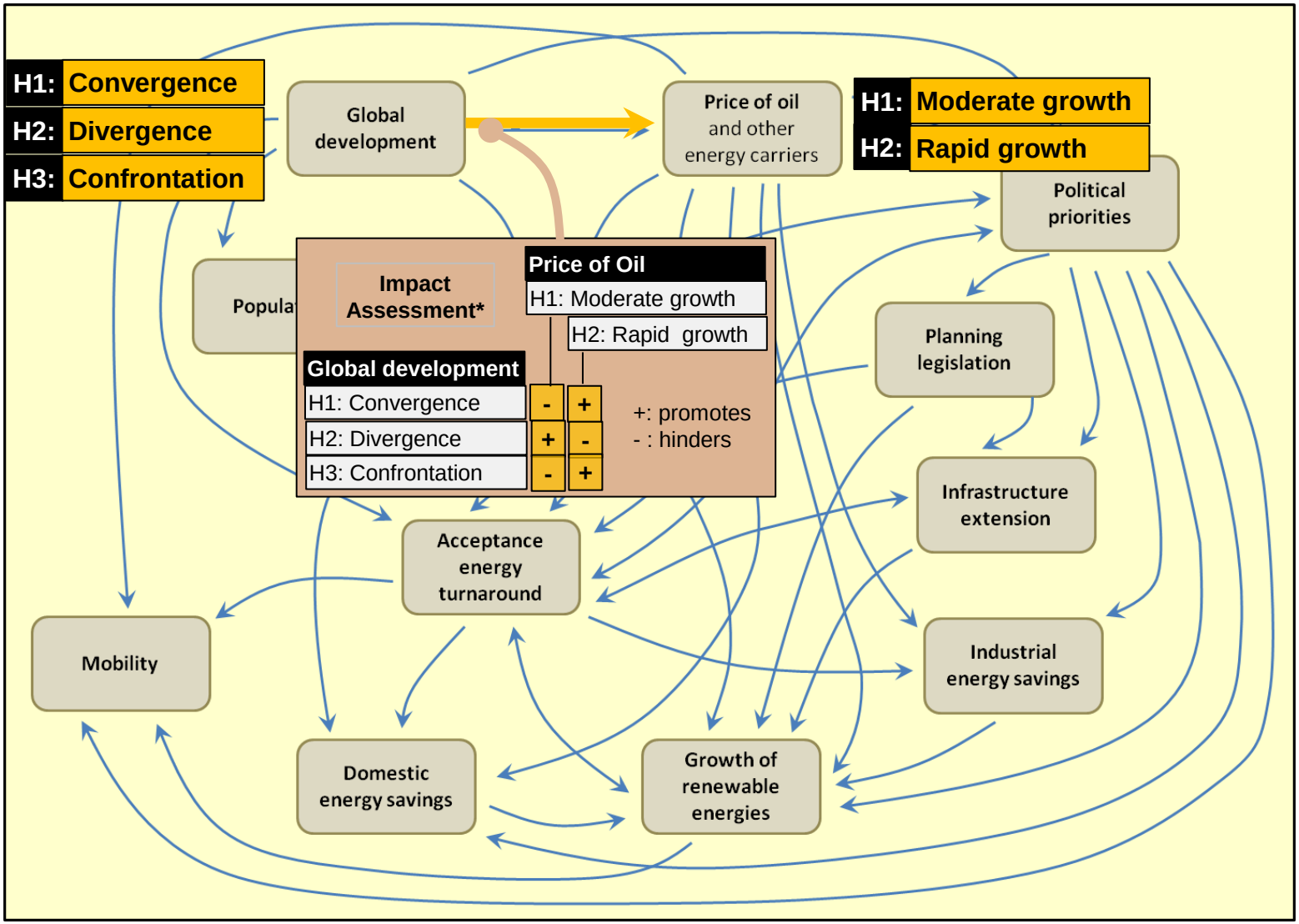


*) SAS - Story-and-Simulation, J. Alcamo et al.

Socio-technical scenarios – Concept



Descriptor interdependences using the cross-impact balance framework



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

CIB-based context scenarios Germany 2040: Descriptors and alternative futures

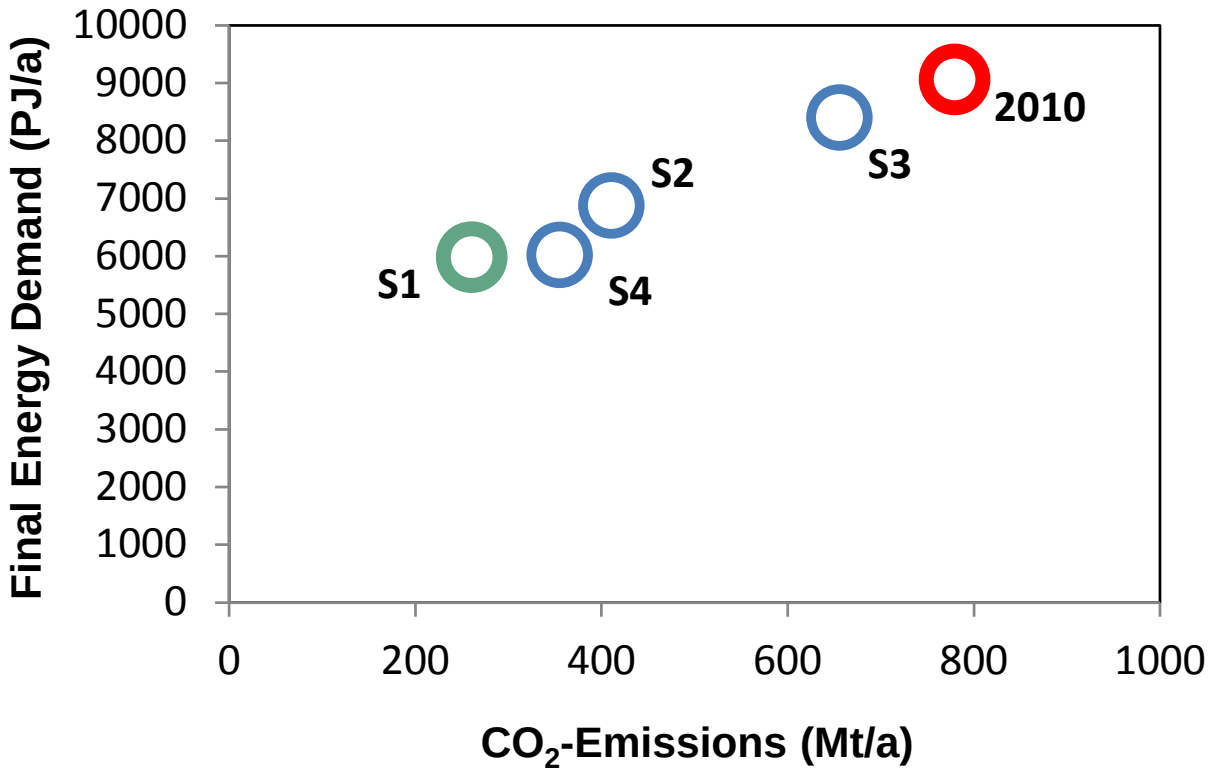
A. Global development	A1 convergence and prosperity	A2 divergence	A3 confrontation
B. Oil price	B1 moderate growth	B2 rapid growth	
C. Population	C1 slowly decreasing	C2 strongly decreasing	
D. Economic growth	D1 weak	D2 strong	
E. Political priority	E1 energy turnaround	E2 security	E3 economy
F. Acceptance 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

Context scenarios

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 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

Potentials

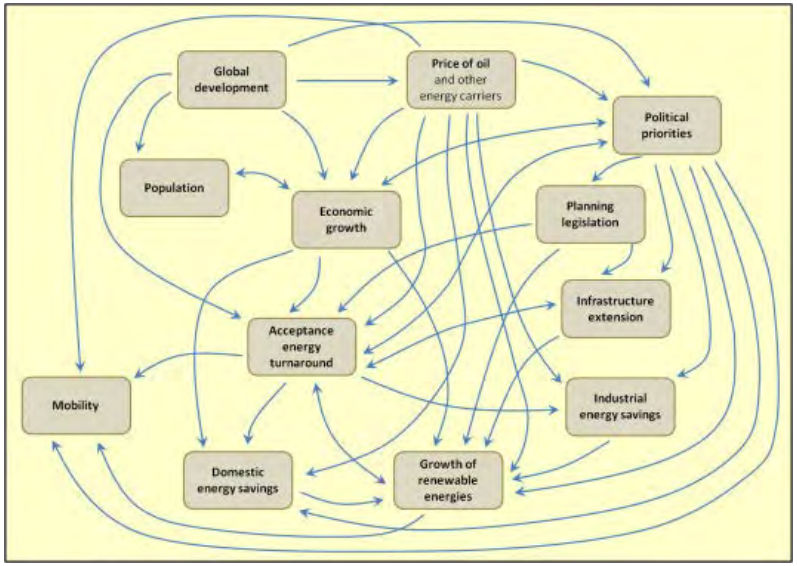
- Improved understanding of the socio-technical system
  - Systematic revealing of interdependencies between identified (societal, economic, …) drivers
  - Assignment of the revealed interdependencies into consistent scenarios
  - Changes of underlying interdependencies can be easily calculated

- Improved quality of the findings
  - Enhanced transparency of societal frames
  - Improved consistency
  - Increased robustness

Challenges

- Methodological rigor of the societal scenarios – Qualitative identification of interdependencies

Context scenarios



Challenges

- Methodological rigor of the societal scenarios – Qualitative identification of interdependencies
- Accountability – combination of qualitative and quantitative information
- Increased complexity of scenarios
- Increased number of scenarios?
  - Context scenarios represent context uncertainty by a set of alternative futures
  - Context scenarios could impede disputable framework assumptions
- Required resources
  - Increased expertise of the team
  - More time resources required?

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Exercise – Group building

- Each group min 4 p., max 5 pers.
- Each group develops at least one scenario (1 h)
  - some groups develop backcasting scenarios
  - some explorative scenarios
- Each group will present the results (á 10 min.)
- Discussion of results

Exercise – Presentation

Expectation regarding presentations

- Question
- Assumptions
- Story
- Findings
- Recommendations (if advisable)

Exercise – Questions

Q 1: How will / should a bioeconomy develop until 2040?
(explorative)

Q 2: Given a specific future how could / should a bioeconomy develop to achieve the given goal?
(backcasting)

Exercise – Economy

- Reference economy: s. next slide / handouts
- Reference year is 2005
- Further assumptions (currently valid)
  - Agricultural sector receives subsidies; without subsidies the sector is internationally not competitive
  - Feed-in tariffs for energy generation using biogenic resources or renewable energy carriers
- Additional assumptions
  - Population decreases until 2040 by 10 %
  - In the long run the entire energy sector shall receive (any) subsidies

Exercise – Reference economy 2005

			2005				
			Final demand	Trade Export	Trade Import	Intermediate demand	TOTAL (Domestic production (outputs))
			Private households				
			1	2	3	4	5
Agriculture	[1.000 t DM]	1	1.600	6.700	7.900	175.600	176.000
Forestry	[1.000 t DM]	2	0	2.900	0	79.100	82.000
Food	[1.000 t DM]	3	42.500	700	5.800	37.500	74.900
Wood	[1.000 t DM]	4	20.200	1.500	10.000	78.500	90.200
Misc. Industries and services	[1.000 t]	5	738.500	61.100	243.500	600.900	1.157.000
Bio fuels	[1.000 t]	6	0	0	0	1.200	1.200
Fossil energy	[1.000 t]	7	0	12.400	240.300	555.000	327.100
Power and heat (bioenergy)	[TJ]	8	148.400	600	0	74.700	223.700
Power and heat (renewables)	[TJ]	9	164.000	1.300	0	162.900	328.200
Power and heat (fossil)	[TJ]	10	1.939.000	13.300	0	1.707.500	3.659.800
Traffic RME (service)	[Mrd. Pkm]	11	0	0	0	0	0
Traffic fossil fuels (service)	[Mrd. Pkm]	12	900	0	0	0	900
Transport RME	[Mio. tkm]	13	0	0	0	7.700	7.700
Transport fossil fuels	[Mrd. tkm]	14	0	0	0	468.600	468.600

Exercise – Reference economy 2040

			2040				
			Final demand	Trade Export	Trade Import	Intermediate demand	TOTAL (Domestic production (outputs))
			Private households				
			1	2	3	4	5
Agriculture	[1.000 t DM]	1	2.100	9.500	11.600	256.200	256.200
Forestry	[1.000 t DM]	2	0	4.100	0	138.800	142.900
Food	[1.000 t DM]	3	56.500	1.000	8.500	60.900	109.900
Wood	[1.000 t DM]	4	34.000	2.100	15.300	117.000	137.800
Misc. Industries and services	[1.000 t]	5	983.800	86.600	328.600	815.300	1.557.100
Bio fuels	[1.000 t]	6	0	0	0	11.200	11.200
Fossil energy	[1.000 t]	7	0	17.500	294.200	407.600	130.900
Power and heat (bioenergy)	[TJ]	8	413.900	0	30.000	256.300	640.200
Power and heat (renewables)	[TJ]	9	354.200	0	183.700	1.592.100	1.762.600
Power and heat (fossil)	[TJ]	10	423.900	0	41.300	564.000	946.600
Traffic RME (service)	[Mrd. Pkm]	11	100	0	0	0	100
Traffic fossil fuels (service)	[Mrd. Pkm]	12	900	0	0	0	900
Transport RME	[Mio. tkm]	13	0	0	0	15.400	15.400
Transport fossil fuels	[Mrd. tkm]	14	0	0	0	888.700	888.700

Exercise – relevant variables

Potential variables for scenario building

- Final demand (volume and structure, i.e. preferences)
- Import / export
- Productivity

- Society / individual and public preferences
- (Domestic / foreign) Political choices

- (External / internal) Political shocks
- (External / internal) Natural disasters
- Climate change

Exercise – concluding remark

- **Stories need a hero**: Protagonists serve as our avatars, or proxies, in the future we are trying to create. They don't need to be amazing, but they should be courageous.

- **Fill your future story with conflict**: Wild cards, opposing factions, and countertrends are all a part of reality--today's and tomorrow's.

- **Beware of negativity**: In drama, negative scenarios are easier to create, but in futuring, it is a positive ending that may have more psychological impact.
  "No matter how brilliant your logic, or exhaustive your analysis," says Tankersley, "people do not change to avoid disaster. People change because they see a brighter future."

SOURCE: "Ten Tips for Creating More Powerful Future Stories" by Joseph Tankersley, FUTURETAKES (Late Fall 2006) the electronic newsletter of the World Future Society's U.S. National Capital Region chapter

Exercise – Presentations

Outline

1. Overview
2. Update
3. Reflections
4. Exercise
5. **Concluding discussion**

Concluding discussion

Exercise – concluding remark

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Source: http://andysrant.typepad.com/.a/6a01538f1adeb1970b017c370046b7970b-800wi; 28.05.2013

http://www.presseurop.eu/files/images/article/CHAPPATTE-nuclear-490.gif?1381824695

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