Procedure for selection of the Sustainability Indicators

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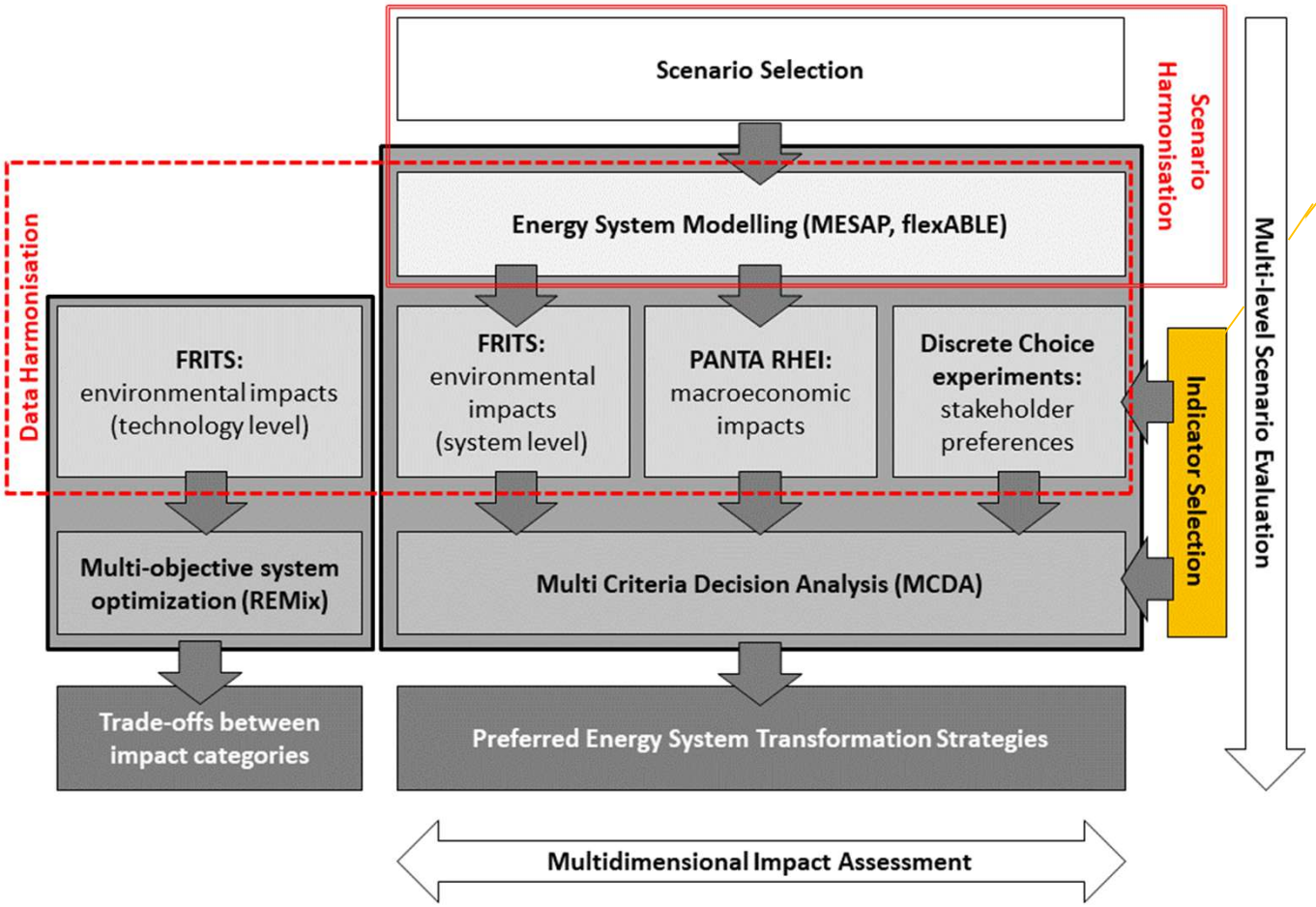
Step 2 – Procedure for selection of sustainability indicators

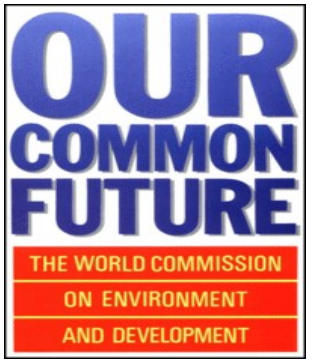
Structure and Workflow of InNOSys



Procedure of indicator selection

Background of the modern Sustainable Development Debate

- **Brundtland-Definition 1987**:
  „Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs“



- Ethical basis for the responsibility:
  Justice between present and future generations and within generations
- Starting point for UN Environmental and Development program

Millenium Development Goals

RIO+20
United Nations Conference on Sustainable Development

2015:
Sustainable Development Goals

Sustainable Indicators – Literature Research and Analysis (I)

- Considering international and national important publications on Sustainable Development
  - UN Commission on Sustainable Development (UNCSD). Indicators of sustainable development: guidelines and methodologies

  - Germany's Sustainability Strategy based on the UN Sustainability Development Goals

- National projects in the field of energy transformation
  - Helmholtz Association Alliance Project “EnergyTrans” 2011-2016 (Monitoring of the Energy Transformation)

  - Kopernikus Project Energy Transition Navigation System (ENavi) 2016-2019

Sustainable Indicators – Literature Research and Analysis (II)

Karlsruhe Institute of Technology

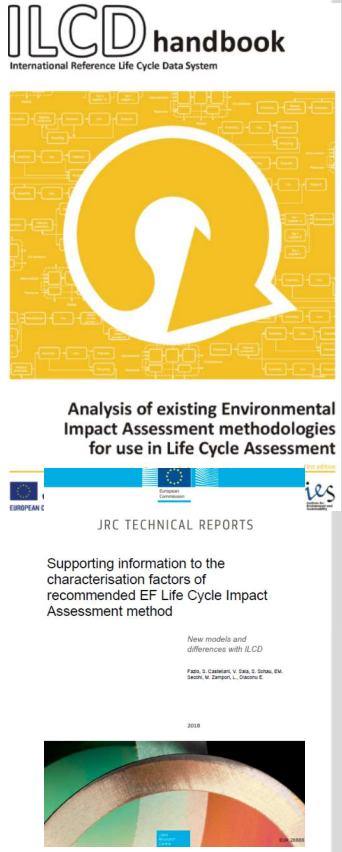
Literature on specific subjects

- Project “Nordwest 2050”: Resilience as guiding concept for climate adaptation strategies
- European Commission Joint Research Centre, Institute for Environment and Sustainability (IES) published ILCD Handbook

  - Recommendations for Life Cycle Impact Assessment in the European context-based on existing environm. impact assessment models and factors [2011]

  - Update of new characterisation factors for new models in 2018 [Fazio et al, 2018]

  - Update of new characterization factors for abiotic resource depletion [van Oers et al, 2019]



More than 300 Sustainable Indicators

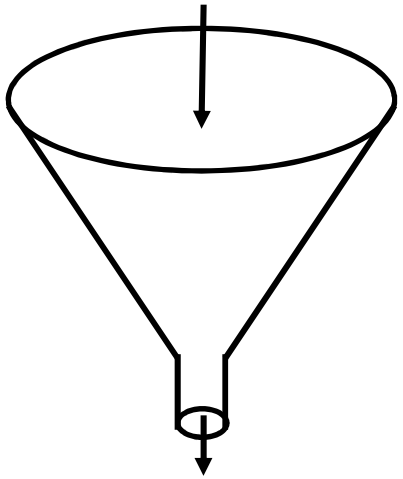
InNOSys

ITAS Institute for Technology Assessment and Systems Analysis

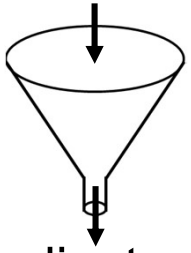
Selection criteria for indicators

- Relevance to the current sust. Discussion
- Full set addresses the ecologic, economic, and social dimension of sust. and additionally takes into account system-related aspects
- All indicators have different impact mechanism of sust. development
- Future development of the indicator can be estimated satisfying with available models FRITS, PANTA RHEI, flexABLE
- It must be directionally safe concerning the measured sustainability aspect
- Depends on the development of the supply side of future technology mix

> 300 Sust. Indicators



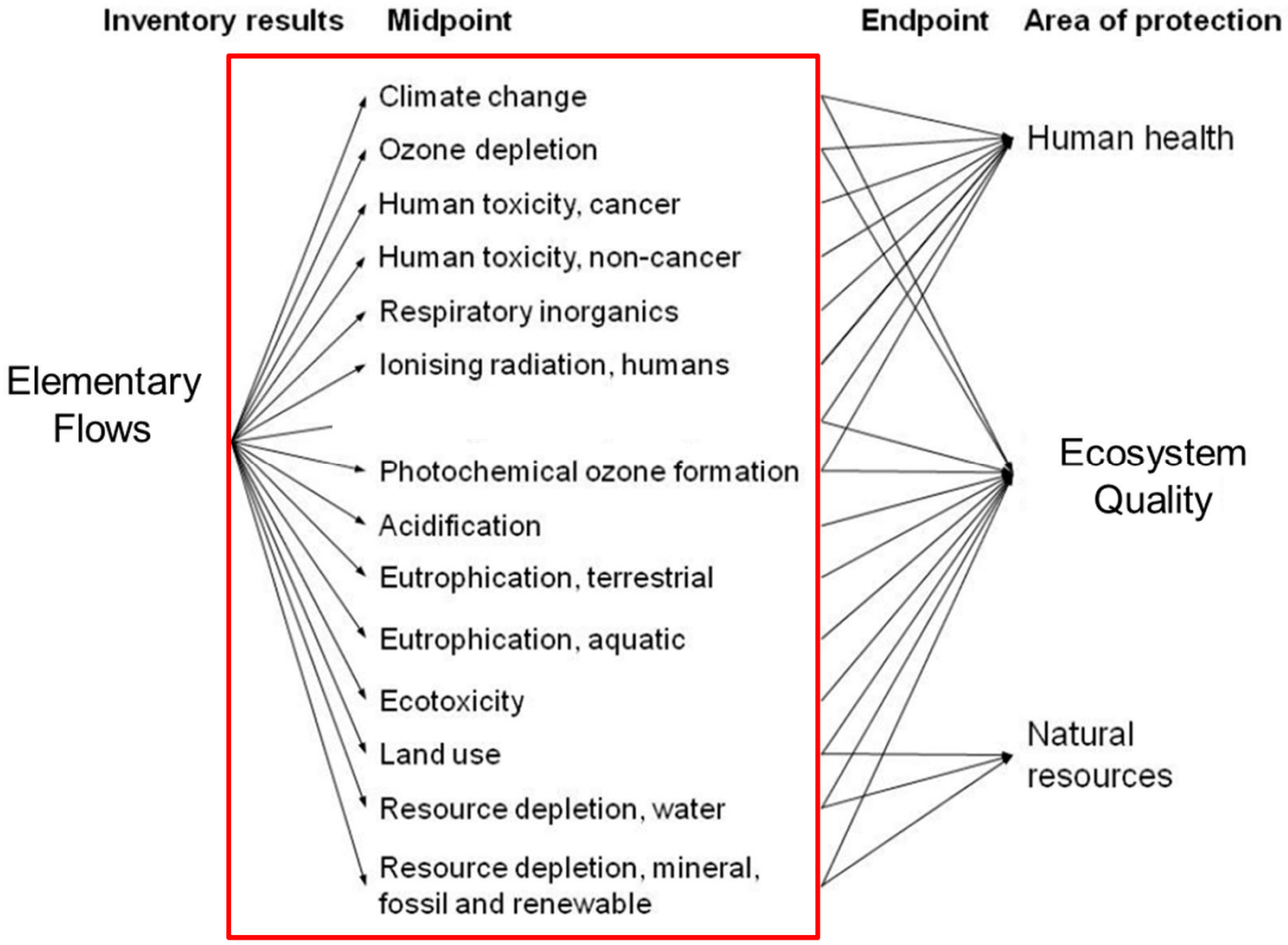
23 Sust. Indicators for Ex-post assessment of scenarios



13 Indicators for:

- Discrete-Choice-Experiment
- Multi-Criteria-Decision-Analysis

Ecological Sustainable Indicators



Decreasing value of the indicator ↘ means increased Sustainability

Socio-economic and Systemic Sustainable Indicators

System costs: Total costs of the energy transition for the society
Decreasing Syst. Costs ↘ means increasing Sustainability ↗

GDP: Reflect real economic development of the energy transistion
Increasing GDP ↗ means increasing Sustainability ↗

Employment: Employment as an important basis for individual livelihood security and for the social security systems of the state
Increased total employment ↗ means increased sustainability ↗

Structural Change: Number of jobs created and lost as a result of the energy transformation leads to structural changes in labour market
Decreasing total number of jobs created and lost ↘ means increased sustainability ↗

Regional Inequality: Variation for GDP per Capita in federal States
Decreasing regional inequality ↘ means increased sustainability ↗

Security of elec. Supply: Calculated by the Stirling Index which describes the diversity of power supply system as aspect of potential reslience
Increasing Stirling Index ↗ means increasing Sustainability ↗

Final list of selected Sustainability Indicators

Category	Sub-Category	Indicator	Unit	Calculated with	Used in MCDA	Used in DCE	Methdod/Reference
Ecological	Climate Change	Climate Change	kg CO2 eq.	FRITS	CUM	X	ILCD 2018
	Ecoystem Quality	Freshwater & terr. Acidific.	mol H+ eq.	FRITS			ILCD 2018
		Freshwater ecotoxicity	CTUe	FRITS			ILCD 2018
		Freshwater eutrophication	kg P eq.	FRITS			ILCD 2018
		Marine eutrophication	kg N eq.	FRITS			ILCD 2018
		Terrestrial eutrophication	mol N eq.	FRITS			ILCD 2018
	Resources	Dissipated water	m^3 Water eq.	FRITS			ILCD 2018
		Land use	points	FRITS	CUM	AGG	ILCD 2018
		Fossil energy carriers (CED)	MJ	FRITS	CUM	AGG	ILCD 2018
		Minerals and metals	kg Sb eq.	FRITS	CUM	AGG	ILCD 2018 (updated)
	Human Health	Carcinogenic effects	CTUh	FRITS	CUM	AGG	ILCD 2018
		Non-Carcinogenic effects	CTUh	FRITS	CUM	AGG	ILCD 2018
		Ionising radiation	kg U235 eq.	FRITS	CUM	AGG	ILCD 2018
		Ozone layer depletion	kg CFC-11 eq.	FRITS	CUM	AGG	ILCD 2018
		Photochem. ozone creation	kg NMVOC eq.	FRITS	CUM	AGG	ILCD 2018
		Respiratory effects, inorg.	disease incidence	FRITS	CUM	AGG	ILCD 2018
Socio-Economic		System costs	Bn €	MESAP	CUM	X	
		Gross domestic product	Bn €	PANTA RHEI			
		Structural change	-	PANTA RHEI			
		Regional inequality	-	PANTA RHEI			
	Employment	People in employment	-	PANTA RHEI		X	
		Unemployment rate	%	PANTA RHEI	X		
System-related		Security of electricity supply	-	flexABLE and Tech. Charac.	X	(X)	MCDA: Stirling Index DCE: Expert judgement

Methodological limitations of indicators and the selection procedure

- The selection of indicators requires an early intensive coordination between all parties involved. The goal is to define a common set of indicators whose future development can be well estimated by model instruments, but which is also well usable and understandable for stakeholder engagement.
- A conflict has to be resolved that for a comprehensive analysis as many (relevant) indicators as possible should be considered, but for MCDA the number of indicators should not become too large for practical reasons.
- It is still a research task to identify social indicators beyond economic and health aspects that can be implemented in a model in regard to reasonably included in a quantitative prospective impact assessment of energy scen.
- Regarding systemic indicators, a first step has made by the Stirling index. However, a more detailed approach to assessing the resilience of energy systems requires further methodological developments and a significantly expanded set of models (e.g. power grid simulation models) to describe the diversity of the power supply as an aspect of its potential resilience.

Conclusions

- The selected sustainable indicators copes ecological, economic, social and system-related aspects of sustainable development, but for an integrative sustainability assessment a number of methodological challenges still remain
- In particular, research approaches for the inclusion of social aspects as quantitative indicators in energy system models for prospective impact assessment

Thank you for your attention!

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