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## Outline

- ➔ Definition and scope
- ➔ Quality criteria
- ➔ Typical uses
- ➔ Typology
- ➔ The process
- ➔ Approaches for energy scenarios

# Energy Scenarios

## Definition and scope

*“Scenarios are consistent and coherent descriptions of alternative hypothetical futures that reflect different perspectives on past, present, and future developments, which can serve as a basis for action”.* (Van Notten, 2006, p.2)

## Energy Scenarios

### Definition and scope

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**descriptions** of alternative hypothetical futures that reflect different perspectives on past, present, and future developments, which can serve as a basis for action”. (Van Notten, 2006, p.2)

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## Energy Scenarios

### Definition and scope

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(Van Notten, 2006, p.2)

### Scenarios...

- ...are **NOT** prediction or forecast (most likely state) about the future
- ...are „*plausible descriptions of a possible future state*” (IPCC, 2013)
- e.g. „The limits to Growth“ (Meadows et al. 1972)

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## Energy Scenarios

### Quality criteria

(Based on **Kosow and Gaßner, 2008**)

- **Plausibility:** presented possibilities of development are possible  
(Note: nor probable or desirable!)
- **Consistency:** aspects within a path not mutually contradictory  
(e.g. fossil fuel use and decreasing CO<sub>2</sub> emissions)
- **Comprehensibility and traceability:** detailed enough to be comprehensible,  
not over-complex
- **Distinctness:** clearly different “futures”
- **Transparency:** all assumptions open -> including own normative positions!



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## Energy Scenarios

### Typical uses

- Guide **decision making/makers** in a given context
- **Understand interdependencies** between a set of factors
- Develop different possible **transition paths** for a given “goal” or final state
- Sensitivity analysis, contingency plans, policy-making, ...

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# Energy Scenarios

## Typology: Scenario characteristics

- ...differ on their
  - **Geographic coverage** (regional, local, national, global)
  - **Time horizon**
  - **Sectoral coverage** (e.g. technology, economy, policy, societal aspects,...)
  - **Basis:** model-based, expert-based, combined approaches (Paltsev, 2016)

# Energy Scenarios

## Typology

	Broad "macro" characteristics	Detailed "micro" characteristics
<b>Why?</b>	<i>The goals of scenario studies</i> Exploration – Pre-policy research	<i>The function of the scenario exercise</i> Process – Product <i>The role of values in the scenario process</i> Descriptive – Normative <i>The subject area covered</i> Issue-based – Area based – Institutional based <i>The nature of change addressed</i> Evolutionary – Discontinuity (Abrupt – Gradual discontinuity)
	<i>Design of the scenario process</i> Intuitive – Analytical	<i>Inputs into the scenario process</i> Qualitative – Quantitative <i>Methods employed in the scenario process</i> Participatory – Model-based <i>Groups involved in the scenario process</i> Inclusive – Exclusive
<b>What?</b>	<i>Content of the scenarios</i> Complex – Simple	<i>The role of time in the scenario</i> Chain – Snapshot <i>Issues covered by the scenario</i> Heterogeneous – Homogeneous <i>Level of integration</i> Integration – Fragmented

# Energy Scenarios

## Typology

### Why?

### How?

### What?

#### Broad "macro" characteristics

*The goals of scenario studies*

Exploration – Pre-policy research

*Design of the scenario process*

Intuitive – Analytical

*Content of the scenarios*

Complex – Simple

#### Detailed "micro" characteristics

*The function of the scenario exercise*

Process – Product

*The role of values in the scenario process*

Descriptive – Normative

*The subject area covered*

Issue-based – Area based – Institutional based

*The nature of change addressed*

Evolutionary – Discontinuity (Abrupt – Gradual discontinuity)

*Inputs into the scenario process*

Qualitative – Quantitative

*Methods employed in the scenario process*

Participatory – Model-based

*Groups involved in the scenario process*

Inclusive – Exclusive

*The role of time in the scenario*

Chain – Snapshot

*Issues covered by the scenario*

Heterogeneous – Homogeneous

*Level of integration*

Integration – Fragmented

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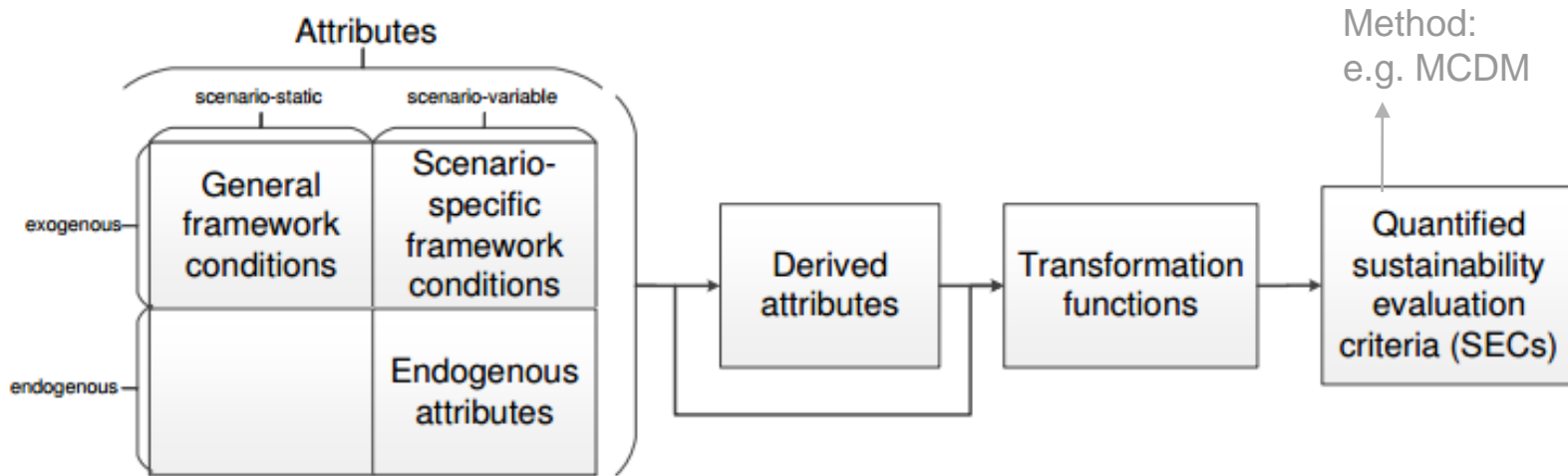
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# Energy Scenarios

## The process

Processes (data flows) and steps for scenario development



Source: Scharz et al. 2017 (modified)

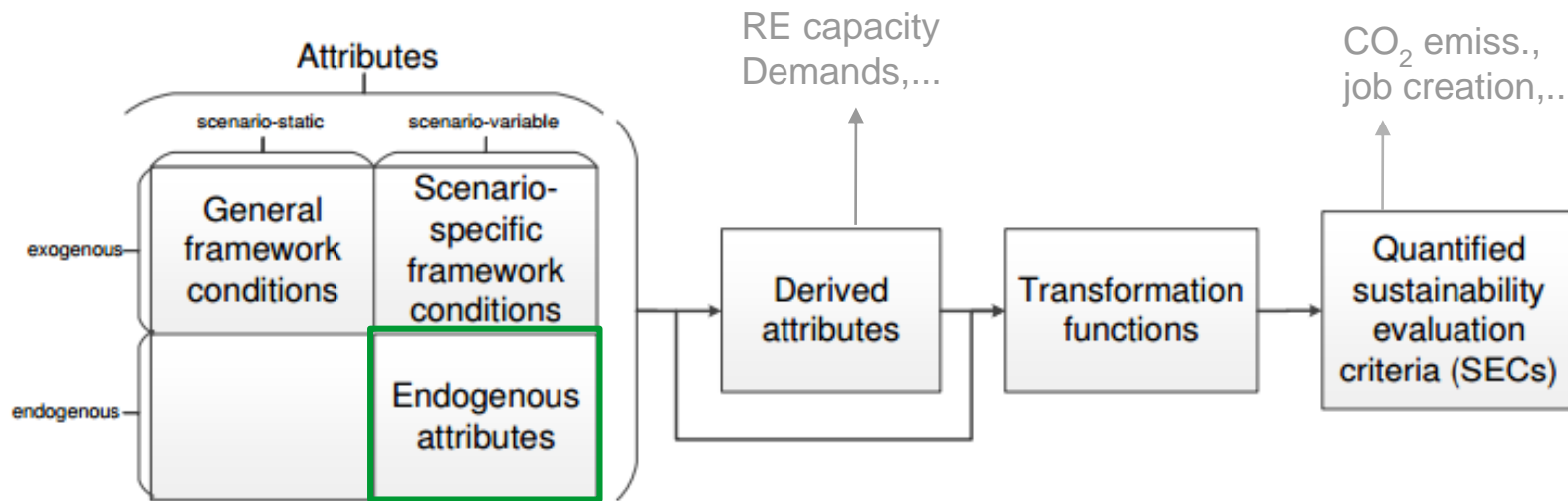
Often the **first step** in scenario planning!!  
 Develop future scenarios: qualitative or/and **quantitative** descriptions

Method: e.g. Story-and-Simulation approaches (SAS)

# Energy Scenarios

## The process

Processes (data flows) and steps for scenario development



Source: Schwarz et al. 2017 (modified)

Possible  
future state

**Attributes:** indicators, characteristics

e.g. population, mobility demands and trends,...

**Endogenous:** decision makers can decided upon their values

e.g. prices for E-vehicles, investment on infrastructure,...

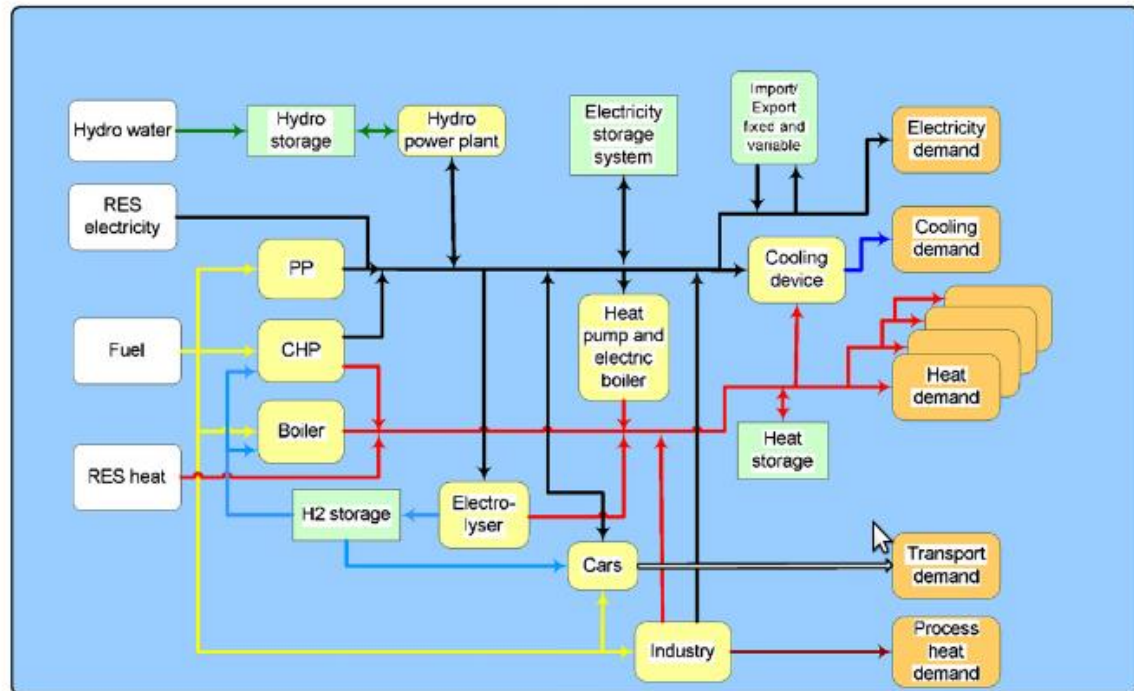
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- **SOME** Approaches for energy scenarios

# Approaches for Energy Scenarios

## Techno-Economic approach

- Input-output model
- Data on capacities for different technologies, technology and system efficiencies: hourly!
- Energy balances approach



Source: Lund, Kempton, 2008

# Approaches for Energy Scenarios

## Techno-Economic approach

### High resolution models in time and /or space

- Input-output: energy balances approach
- **Room discretization:** combined with GIS data
- **Time discretization:** detailed dynamic description of the technology behaviour (hourly, minutewise,...)



Source: <http://web.mit.edu>

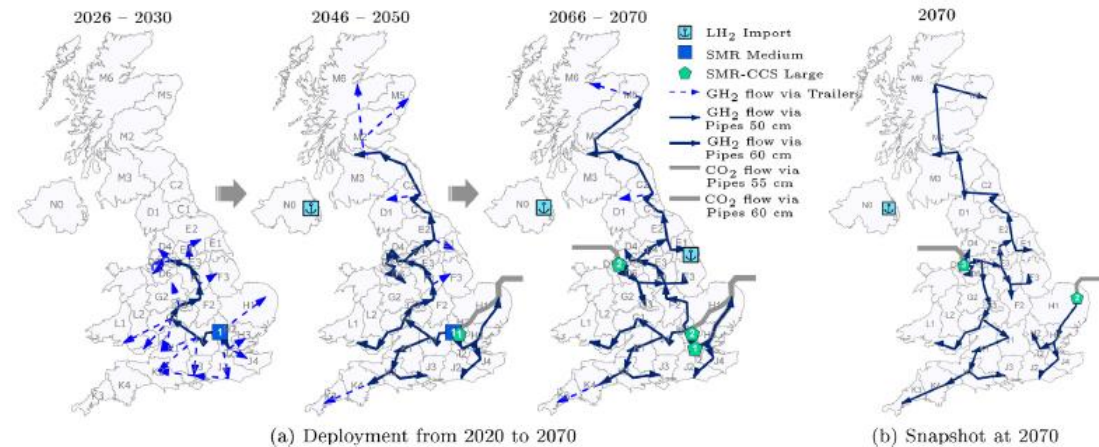
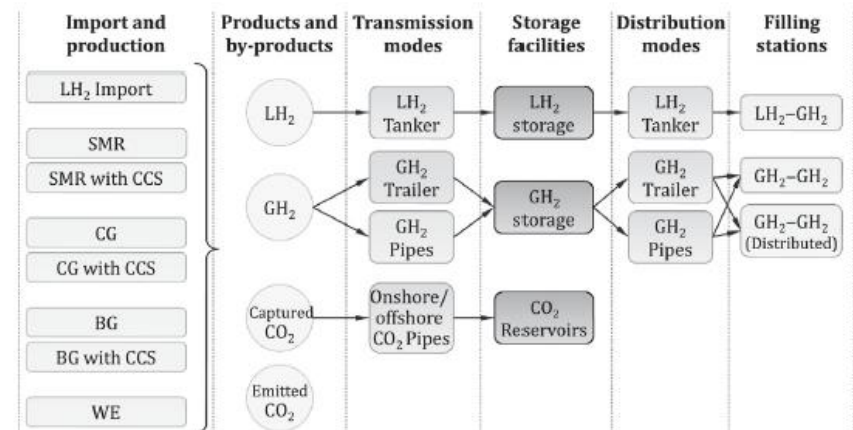


# Approaches for Energy Scenarios

## Techno-Economic approach

### Intertemporal models

- Input-output: energy balances approach
- Lower resolution in time and space
- Longer time periods
- Often combined with linear optimization/fit



# Approaches for Energy Scenarios

## Agent-based scenarios

- Include the interaction of different groups / stakeholders (agents)
- Agents= autonomous, heterogeneous, active, adaptative
- Influence of agents for development of system/goal: heuristics, decision algorithms
- Can be combined with any other approaches

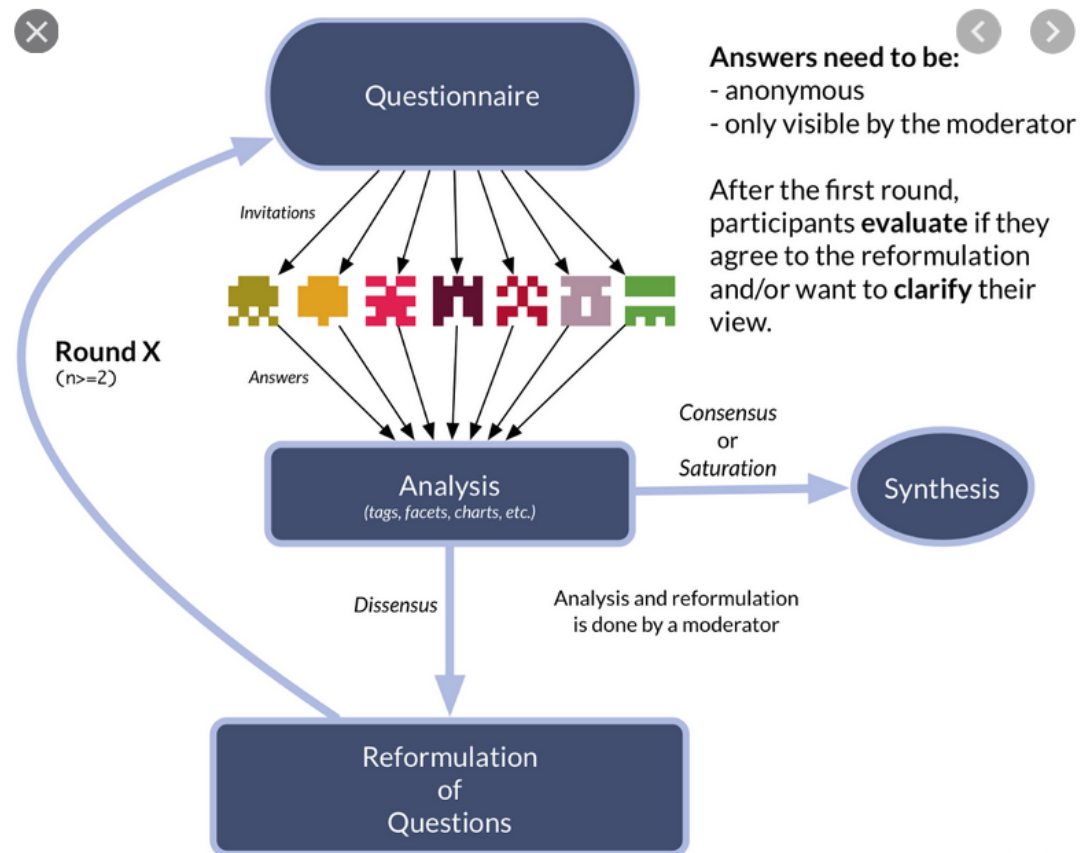


<https://www.titanmodel.org/what-is-agent-based-modelling/>

# Approaches for Energy Scenarios

## Delphi-study

- Forecasting process based on questionnaires and expert judgements
- Include the interaction of different groups / stakeholders -> sharing judgements: „consensus-based“
- Quantitative / Descriptive



# References

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