Energy System Modelling and Energy Justice - Incompatible Concepts?

Session 5: Justice in energy systems

Workshop @ Meccanica Feminale,
Stuttgart, 18.02 – 20.2.2025

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Workshop Sessions

Day 1: Introduction to Energy Modelling			
10:00	11:30	Session 1	Basics of Energy Modelling
14:00	15:30	Session 2	Open Energy Models
16:00	17:30	Session 3	Oemof-Tutorial

Day 2: Introduction to Justice Concepts			
8:30	10:00	Session 4	Social aspects of energy systems
10:30	12:00	Session 5	Setup: pycharm, oemof
14:00	15:30	Session 6	Programming excercise oemof

Day 3: Co-Creation at the Intersection of Energy Modelling & Justice			
8:30	10:00	Session 7	Justice in energy systems
10:30	12:00	Session 8	Case Studies Development

Repitition

- Basics of energy systems and general stability requirements
- Energy system modelling
- Current discussions and trends in energy transition
- Energy transition trends

Excercise: Justice concepts

- What is „justice“ for you?
- What is „justice“ for you in the energy transition context?
- Which justice concepts have you heard of?

Excercise: Impacts of energy transition

Go through the current issues of the energy transition and find an example each:

- How can the topic impact individuals?
- How can the policies impact social justice issues?

Discuss!

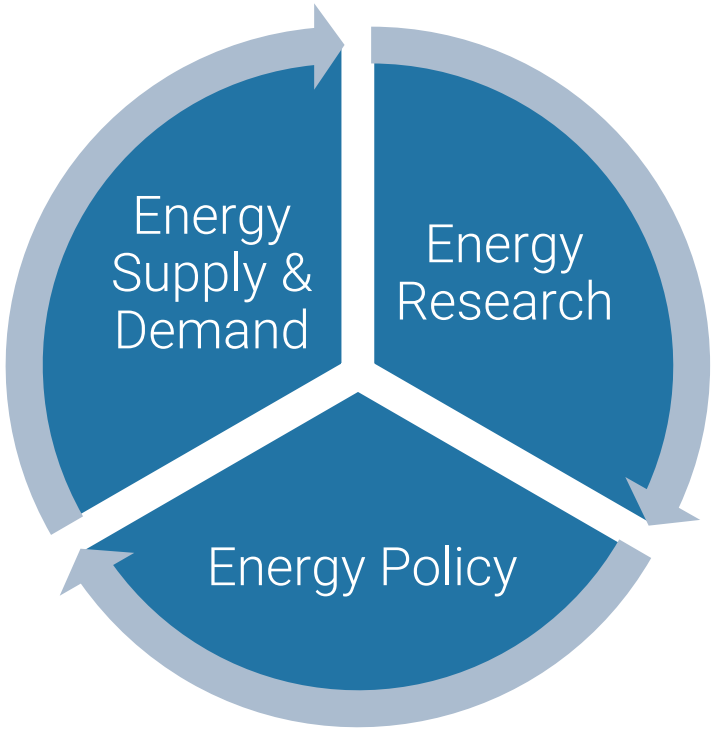
- Vision
- Goals
- Participation and Partaking
- Just Transition
- Industry Transition
- Electricity market design
- Heating Transition
- Transport: Shift and avoid
- Transport: Improve
- Electricity Grid and Stability
- Green Hydrogen

Energy Models Informing Policy

Energy policies are often shaped by energy models

→ Linking desired policy outcomes with measures

- Modelling provides data-driven insights into the potential impacts of energy policies
- Policy-makers need to distribute resources effectively



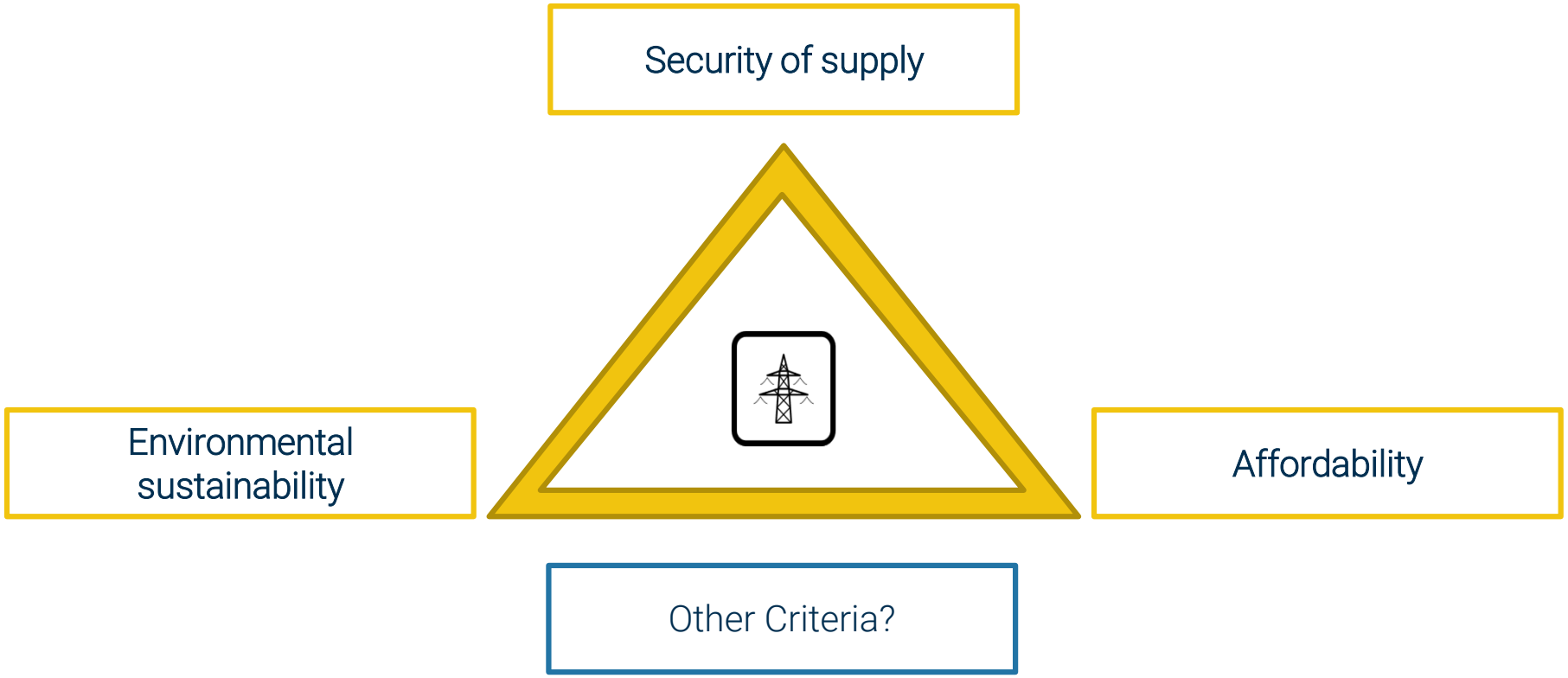
But what is the best solution?

What are the stakeholders of the specific case study?

What are criteria of a good energy system or policy?

Do the results of ESM directly define policies?

Traditional targets of energy supply systems



Justice Concepts

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Environmental justice

- Foundational concept
- Environmental burdens and vulnerable populations
- Often local issues

Climate Justice

- Distribution of future impacts of climate change
- Global / North-South
- Climate financing

Energy Justice

- Current or future impacts and injustices along energy supply chain
- Usually limited to countries or regions
- Impacts of energy transition

Just Transition

- Strictly speaking not a concept
- Adressing structural changes during energy transition
- Often focussed on future employment changes

Social justice issues, selective focus on topics and temporal/spatial scale

Justice dimensions (tenders)

Distributional	Recognition	Procedual
• Benefits and Burdens • Mostly health and monetary	• Representation in models and policy	• Policy making process • Legislative rights • Structural injustice

Restorative	Cosmopolitan	Intergenerational
• Historical injustices • Reparation	• International responsibility • Cross-border impacts	• Impacts over a larger timeframe • Often environmental/climate

- Dimensions can be found in each of the justice concepts
- Predominant in energy models is distributional justice, as it is easily measurable

Vizualizing dimensions of justice

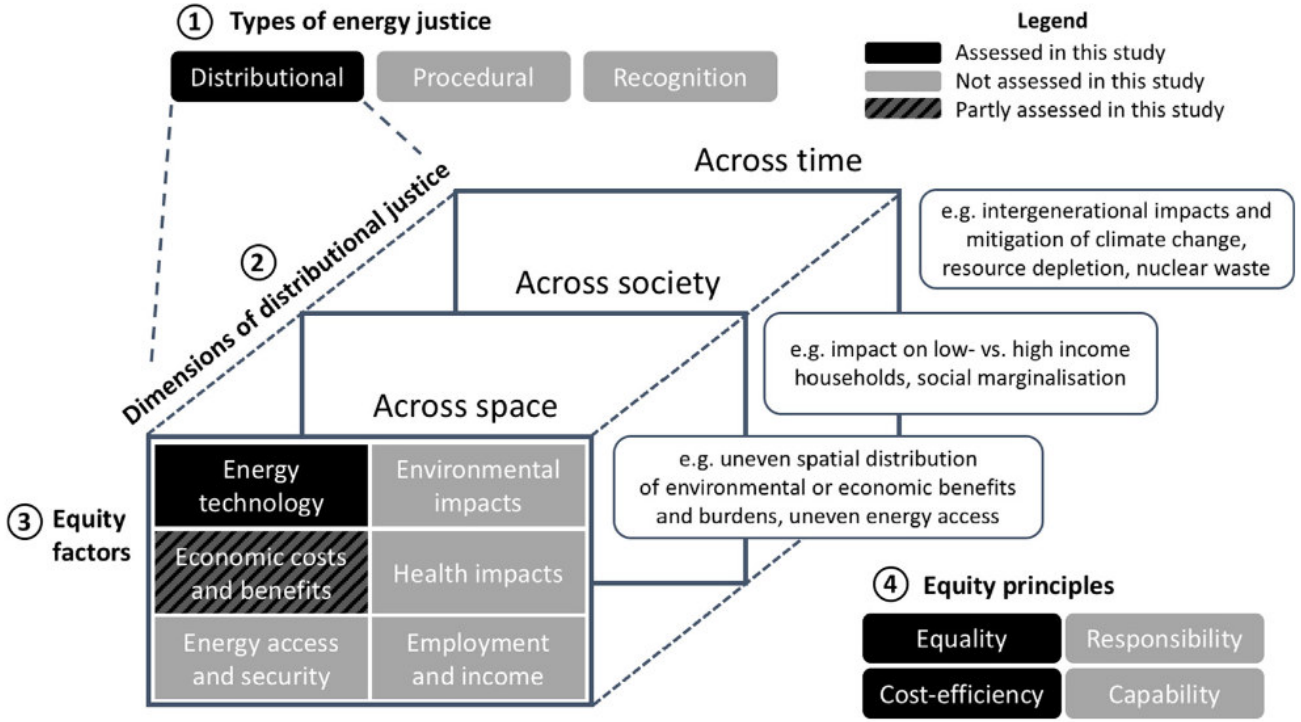


Fig. 1. Energy justice framework including energy justice types (1) and dimensions (2), equity factors (3), and equity principles (4).

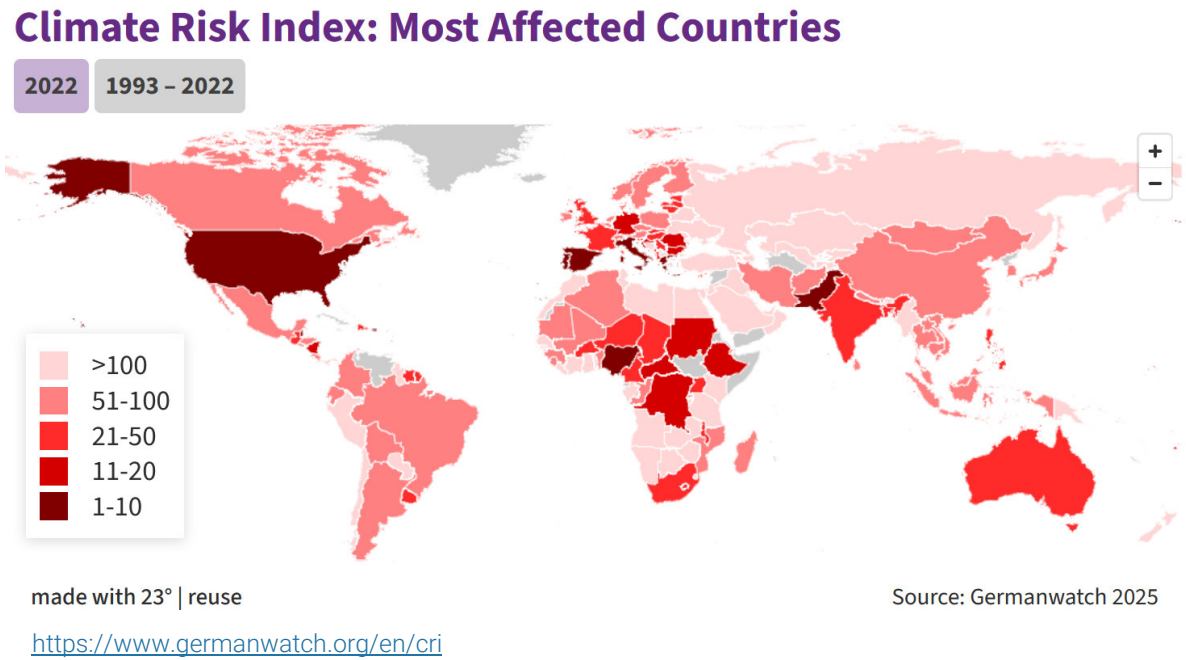
Source: Sasse: 2019. Distributional trade-offs between regionally equitable and cost-efficient allocation of renewable electricity generation
https://doi.org/10.1016/j.apenergy.2019.113724

Justice Databases

- The US has been leading in mapping spatial injustices. However, under the Trump administration, some of the interactive maps are down:
  - LEAD Low Energy Affordability Dataset https://www.energy.gov/scep/slsc/low-income-energy-affordability-data-lead-tool
  - Environmental Justice Screening and Mapping Tool → https://www.epa.gov/ejscreen
- An initative provides backups of prioritized databases: https://screening-tools.com/

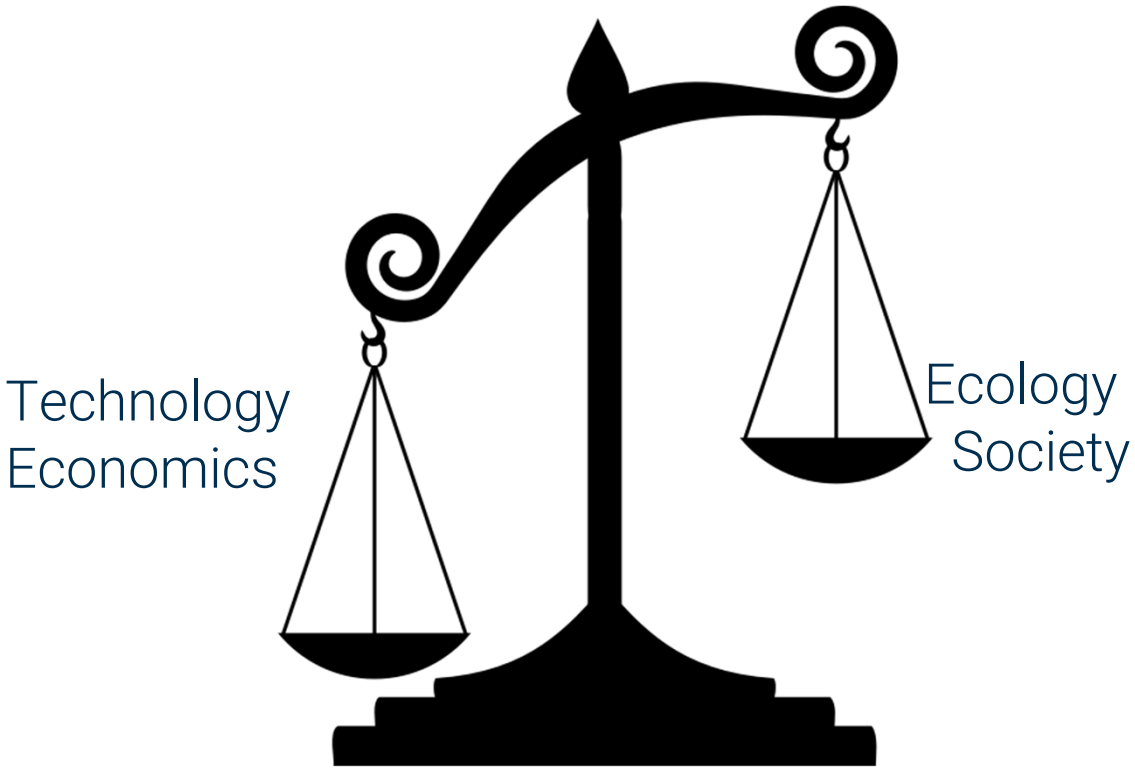
Climate Risk Index

- Impacts of extrem weather events
- Illustrates the uneven distribution of climate change burdens



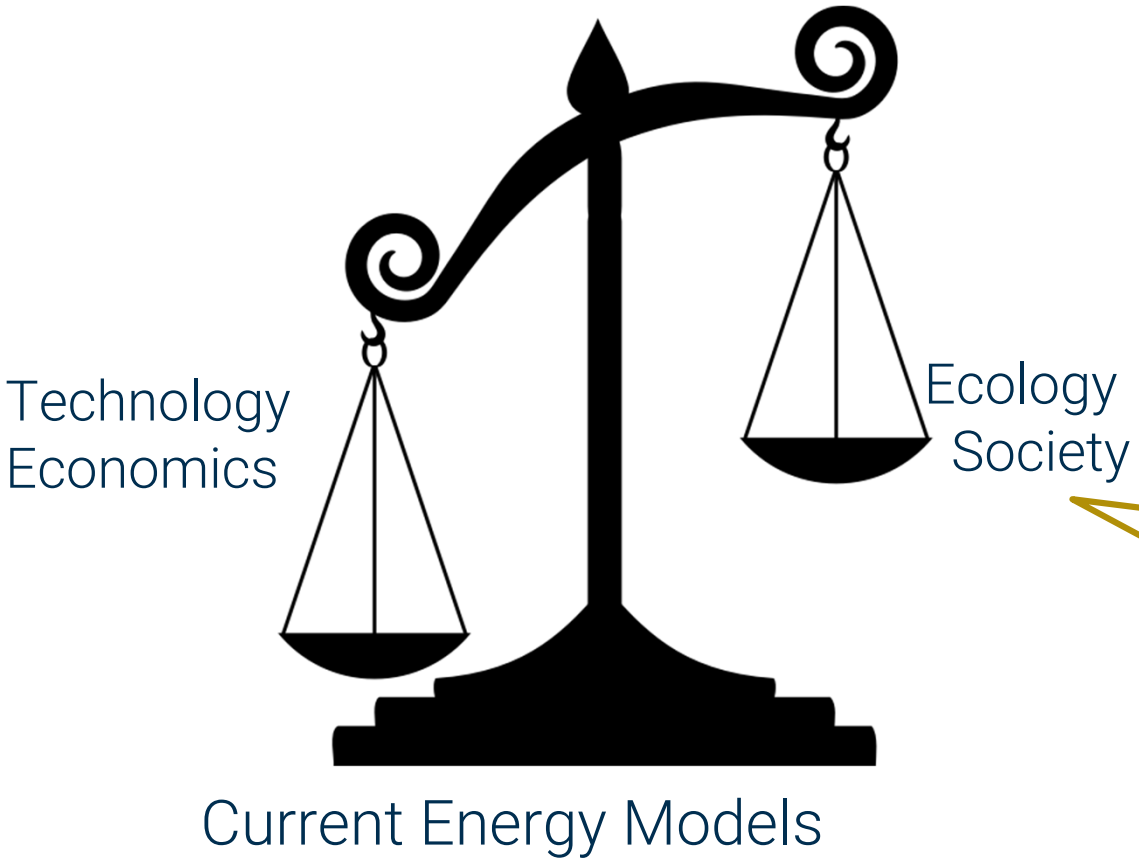
https://www.germanwatch.org/en/cri

Energy System Models – Research Questions



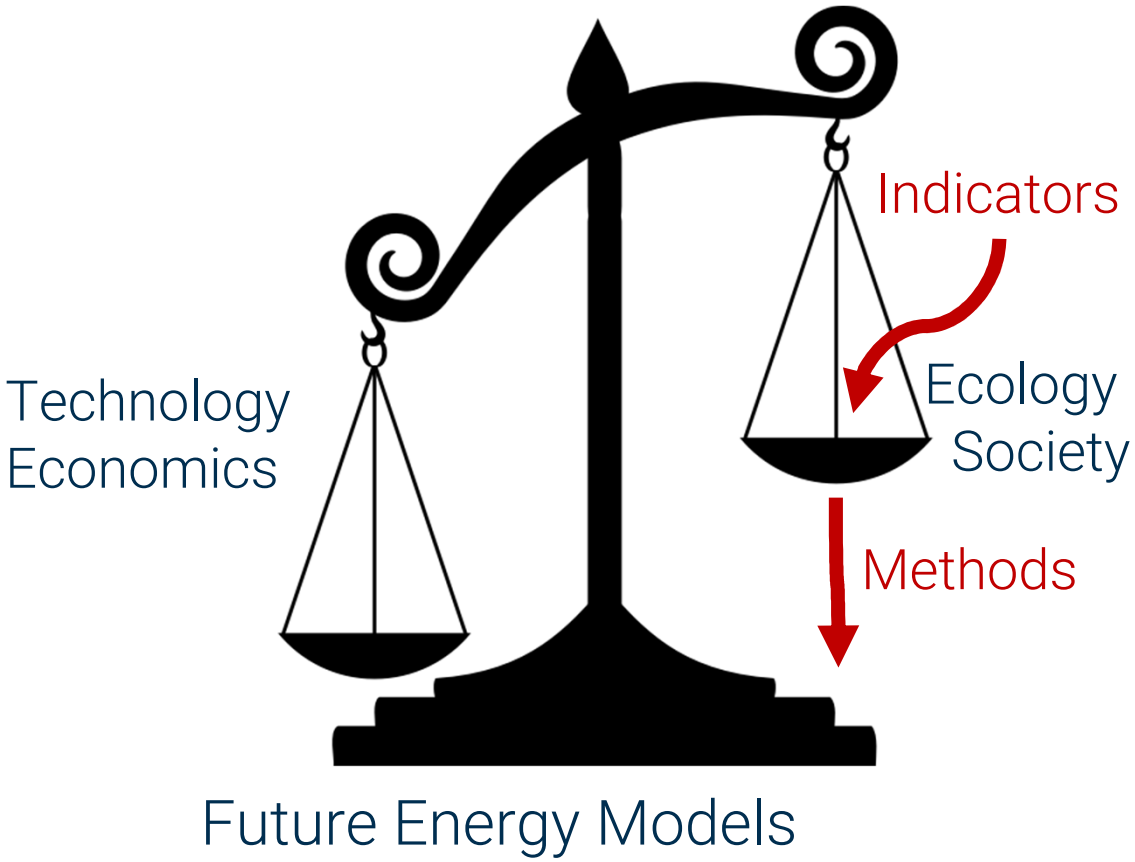
Current Energy System Models

Energy System Models – Research Questions

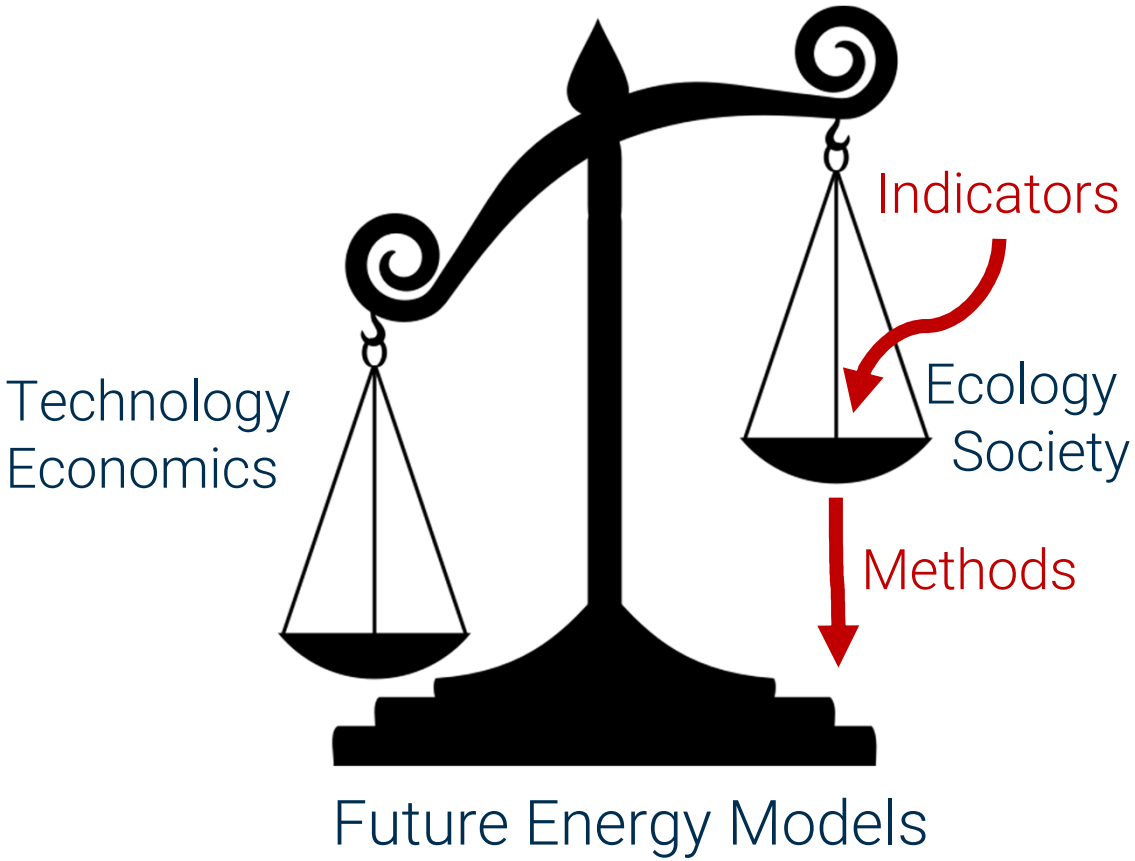


How can we represent justice implications of the energy transition in energy models?

Energy System Models – Research Questions



Energy System Models – Research Questions



- Indicators help to „translate“ concept of justice
- Methods integrate these indicators in the modelling process

Methodology

Definition
- Semi-structured assessment of justice concepts
- Focus: Energy/Environmental/Climate justice, Just Transition

Literature base
- Structured literature review (only scientific papers)
- Definition of keywords, search in WebofScience
- Inclusion/Exclusion citeria

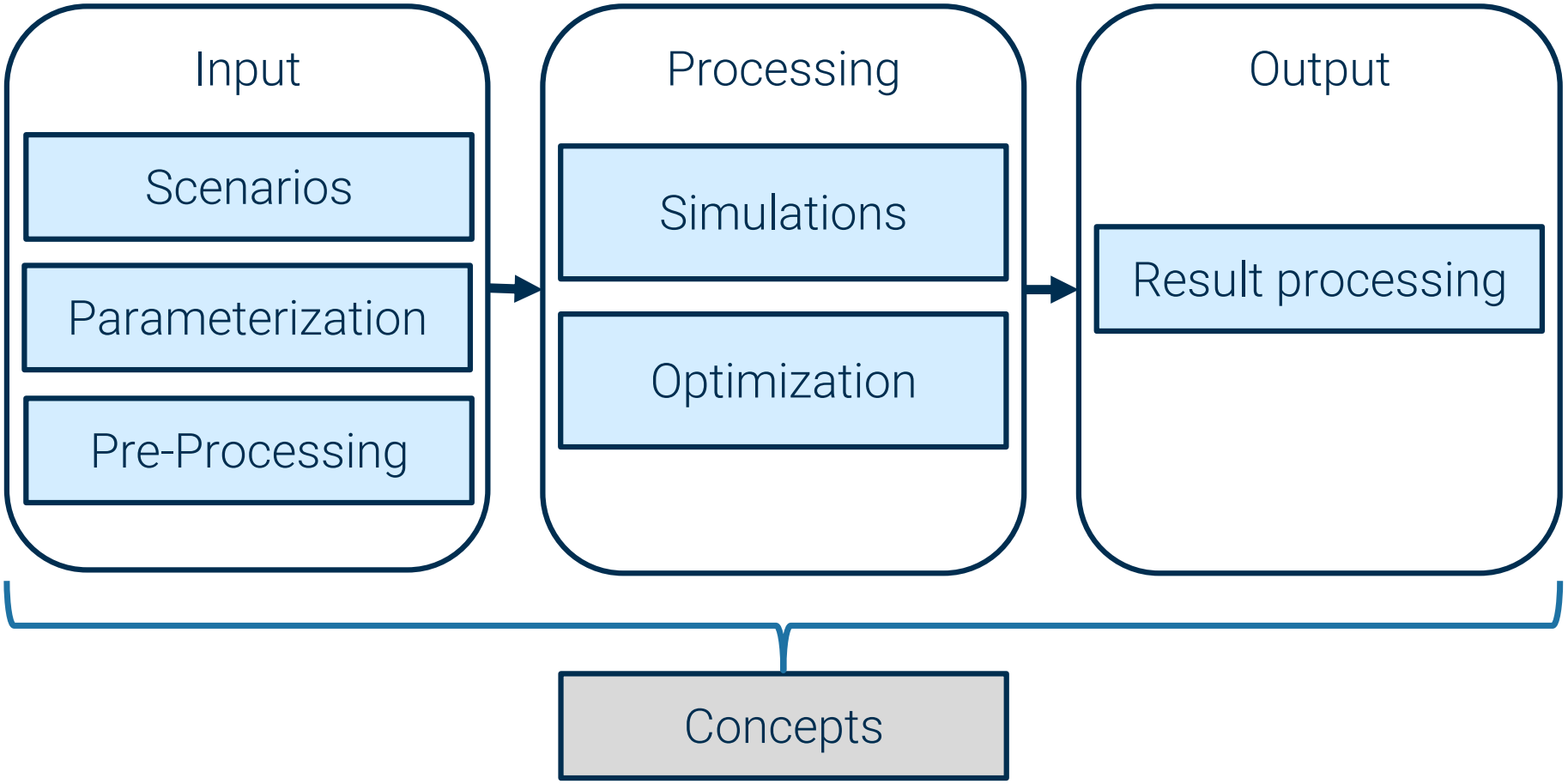
Evaluation
- GoogleForm used as assessment matrix
- Focus: Concepts, scopes (field, scale, time), input, output, methods

Overview for including justice in energy modelling

Defining the Search String: Keywords

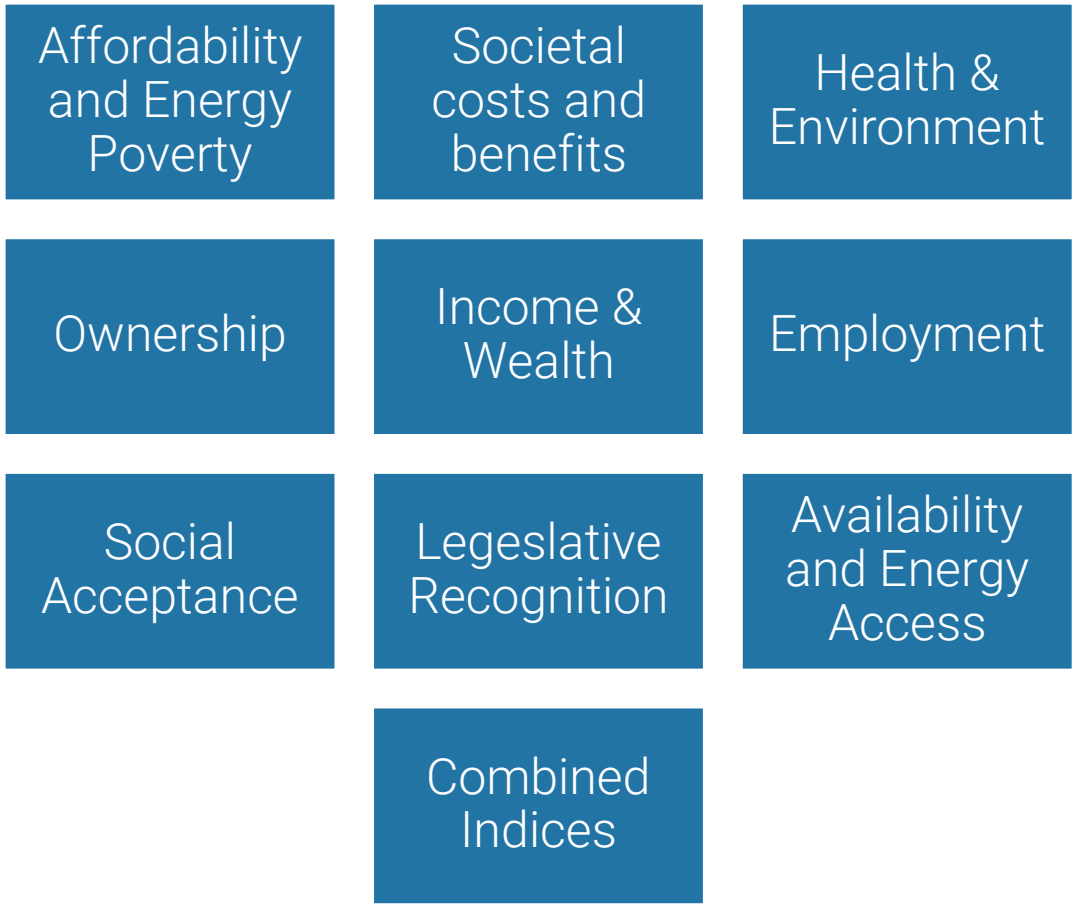
Search term group name	Search terms
Energy service	Energ* OR electricit* OR heat*
Environmental argument	Climate* OR *carbon* OR sustainab* OR renewable* OR environment*
Planned system change	transition* OR transformation* OR pathway* OR strateg* OR polic* OR planning
Methodology	model* OR indicator* OR simulation* OR optimi* OR tool* OR framework* OR scenario*
Justice elements	*justice* OR *equit* OR *equalit*
Representation of consumers	consumer* OR household* OR prosumer* OR soci* OR population OR communit* OR people OR minorit*

Modelling steps as a framework for our results



Indicator Groups

- ~84 assessed papers
- Energy model types
  - ESM, IAM, Economic models, ABM, Others
- Many indicators that can express justice in models!



Excercise: Justice indicator groups

- Find a policy intervention that results in an inpact on each of the indicator groups!
- Find an indicator that highlights pre- and post intervension!

Affordability and Energy Poverty	Societal costs and benefits	Health & Environment	Ownership
Income & Wealth	Employment	Social Acceptance	Legeslative Recognition
	Availability and Energy Access	Combined Indices	

Results I: Adressed indicator groups

	Indicators		Papers	% of indicators		
	#	%	#	Inputs	Optimization /Simulation	Output
Affordability and Energy Poverty	69	25%	37	54%	20%	64%
Societal costs and benefits	49	18%	27	31%	16%	76%
Health and Environment	35	13%	18	26%	23%	66%
Ownership	25	9%	12	60%	52%	44%
Income and Wealth	19	7%	11	37%	21%	84%
Employment	12	4%	10	33%	33%	58%
Social Acceptance	13	5%	8	77 %	77%	31%
Legislative recognition	24	9%	12	100%	42%	38%
Availability and Energy Access	13	5%	7	15%	8%	62%
Combined Indices	17	6%	9	71%	41%	71%
Total	276	100	/	51%	29%	62%

Table 13: Distribution of Papers across indicator groups and integration steps [2025-01-22]

Adressing justice issues of the indicator groups

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- Deciding factors
- Energy burden
- Community energy
- Policy impacts

Affordability and energy poverty

- Deciding factors
- Actor preference
- Policy cost
- Welfare impacts
- Policy impact
- Policy success

Societal costs and benefits

- Natural science
- Relative costs
- Burdens
- Policy impacts
- Trends
- Indices

Health & Environment

- Ability to participate
- Trends
- Equity

Ownership

- Socio-economic data
- Inequality coefficients

Income & Wealth

- Number of jobs
- Change in employment

Employment

- Agency
- Public preferene
- Public opinion

Social Acceptance

- Actor preference
- Right to energy
- Equity
- Awareness

Legeslative Recognition

- Energy supply
- Access inequity

Availability and Energy Access

- Assets
- Impacts
- Equity

Combined Indices

Results II: Examplary Indicator Group

Subgroups	Indicators	Models
Actor preference	inequality-aversion [14, 30, 37, 66], importance of policy aim [39], commitment to concept [33]	FC [33] [37], ESM [66, 39], IAM [14], EMF [30], Multi-Criteria Decision Making [33]
Right to energy	Sufficient energy consumption for well-being [67, 75, 16, 25]	FC [75, 67], IAM [16], ABM [25]
Equity	Allocation principles [27], intergenerational vs. intra-generational equity [14, 33], time preference [14]	FC [27, 33], IAM [14], Multi-Criteria Decision Making [33]
Awareness	Governance [59, 33], accountability [33], labor rights [59], intersectionality [33]	FC [33, 59], Multi-Criteria Decision Making [33], Life Cycle Assessment [59]

Table 22: Indicator Group: Legislative Recognition [2024-12-21, 2025-01-29]

Results III: Methods

Concept

Scenario Building

- Stakeholder input
- Groups
- Thresholds

Inputs and penalty factors

- Monitization of harms
- Stakeholder input

Objective function

- Optimization goal
- Constraints

Inequality assessment

- Inequality distribution
- Quantiles
- Inequality factors

Statistics

- Statistical analysis
- Regressions
- Geospatial analysis
- Stochastic

WebApp: Justice in Modelling Database Explorer

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Literature Review Database

Justice in Modelling Database Explorer

https://jim.rl-institut.de/

Including justice in energy models

...is an ambitious goal, that can not be tackled without the appropriate methods.

To provide Energy Modellers with necessary**Justice Indicators and Methods** we created a literature database which connects them with the respective

How can this database help?

The database provides modellers with a large set of reference literature on the state-of-the art assessment of justice issues in the context of energy research.

PAPERS In total, about 90 papers wh
which can be explored based

Work in progress!

SCAN ME

Excercise: Working with JIM WebApp

- Look at the tools previously presented
- Experiment with the webtools
- Find an indicator for
  - each justice tender (distributional, recognition, procedual, cosmopolitan, intergenerational, restoration)
  - each model type

Individual work

Excercise: Group building

- Fill post-its:
  - Three policy topics of interest
  - Three most intriguing indicator types
- Find groups of 1-3 people with similar interest
- Discuss potential case study
  - Policy
  - Location
  - Tool

Group building

Learnig Outcomes of this Session

- Oemof packages, oemof.solph
- Objective function
- Limitations

Thank you for your participation ☺

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