

Notes on the importance & limitations of Integrated Systems Analysis

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A recent word from my first UCT boss



No job is too important to be created or sustained at the expense of the well being of our children and their future

Mamphela Ramphele

Toolbox & research interests

Prof. Harro von Blottnitz (Pr.Eng.)



Toolbox:

- ▶ Systems thinking
 - ▶ Concept maps, Causal Loop Diagrams, archetypes, leverage
 - ▶ Technology innovation systems & transitions theory
- ▶ Industrial ecology
 - ▶ Life cycle assessment
 - ▶ Material flow analysis
- ▶ Interdisciplinary skills
- ▶ Sampling statistics
 - ▶ My doctoral thesis
 - ▶ Applied to wastes

Experience:

- ▶ 20 years of teaching, research, engagement
- ▶ ~ 1500 chemical engineering graduates
- ▶ 55 Masters & 7 PhD supervised

Research interests:

- ▶ Engineering for/in sustainable development
- ▶ Bio- and geo-resources: cradle-to-grave / cradle-to-cradle
- ▶ Waste management, energy from waste; urban infrastructure
- ▶ Biogas, Biofuels
- ▶ Prevention of plastic accumulation in the environment

Who's in the room?

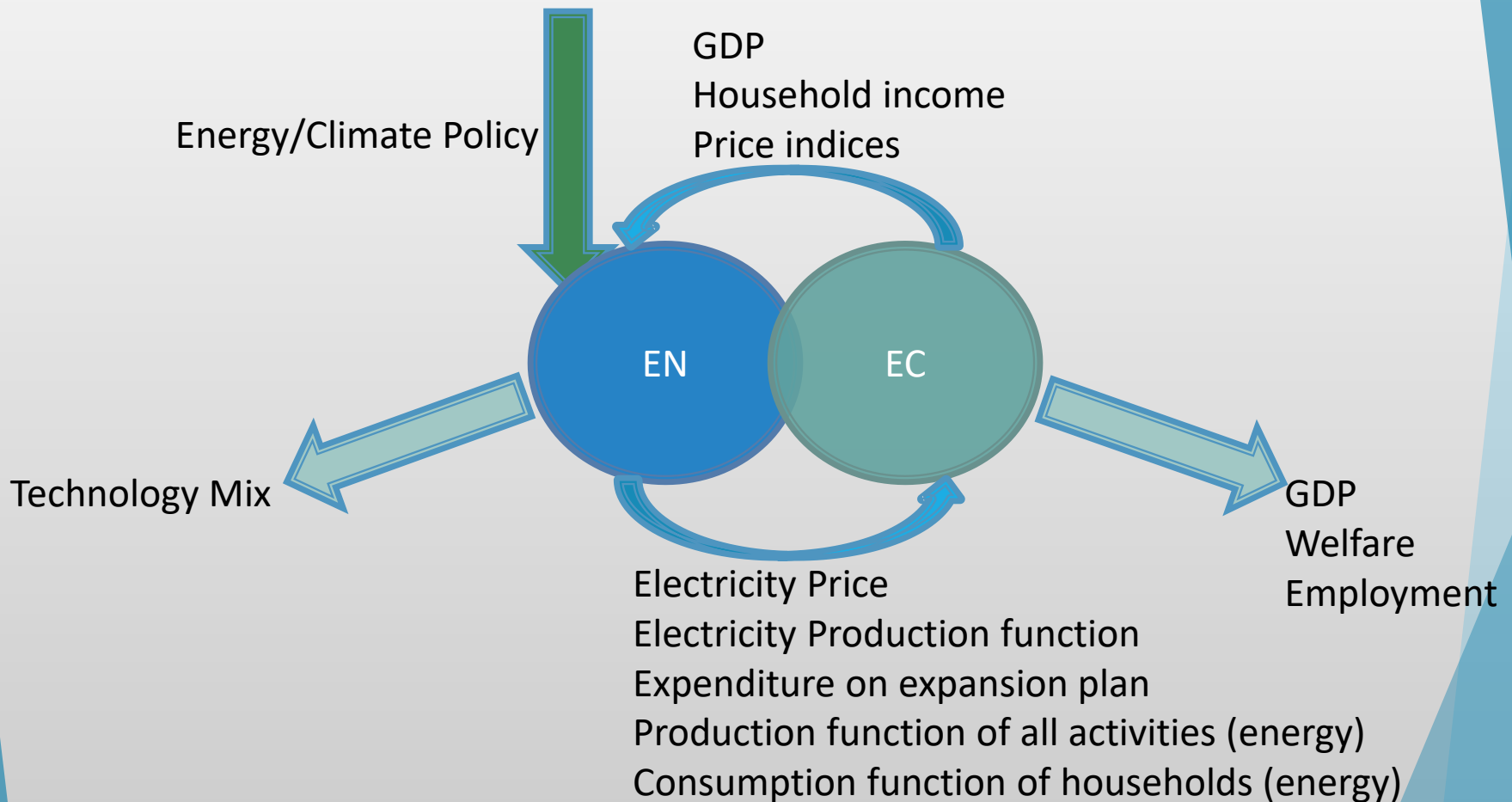
- ▶ Any systems analysts?
- ▶ Any energy modellers?
- ▶ Any users of evidence generated by the above?
 - ▶ Bringing your own skills, experiences, knowledges & identities

Complexity & Determinism

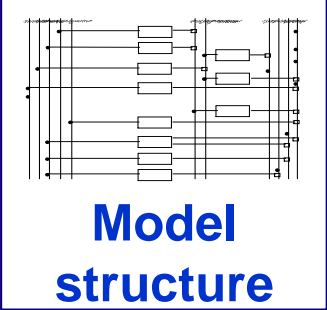
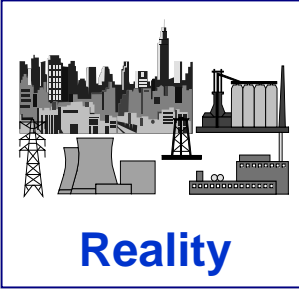
- ▶ Why it's called an 'Energy Transition'
- ▶ The impossibility of having a plan
 - ▶ Yet planning remains essential
- ▶ Reading the future
- ▶ Value of evidence

Integrating two complex models

- ▶ Bottom-up energy systems model (engineering-based)
- ▶ Top-down macro-economic general equilibrium model



Components of an Energy Model

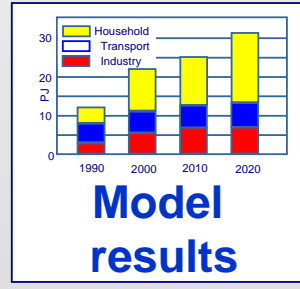


$$P_{BHKW_S} = \eta_{BHKW} \cdot P_{Coal_BHKW}$$

$$O_{BHKW_CO_2} = \varepsilon \cdot P_{Coal_BHKW}$$

$$Q_{BHKW_H} = \eta_{2_BHKW} \cdot P_{Coal_BHKW}$$

Mathematical description



Entwicklung der Stromerzeugung in Deutschland von 1990 bis 2020 (TWh)

Erzeugungstyp	Einheit	2000	2010	2020
1.1	Erzeugung	100	110	120
1.2	Verbrauch	100	110	120

2a) Entwicklung der Kohleerzeugung (Netto-Bruttogeneration von Jahresmittel) in Deutschland bis 2020 (TWh)

Erzeugungstyp	Einheit	2000	2010	2020
2a.1	Erzeugung	100	110	120
2a.2	Verbrauch	100	110	120

3) Entwicklung der Kapazitäten und der Erzeugung aus regenerativen Energieträgern (Wirkungsgrad in %)

Erzeugungstyp	Einheit	2000	2010	2020
3.1	Wind	100	110	120
3.2	Sonne	100	110	120
3.3	Wasser	100	110	120
3.4	Biomasse	100	110	120

4) Energie- und Umwandlung in Deutschland bis 2020

Größe	Einheit	2000	2010	2020
4.1	CO ₂ -Emissionen	100	110	120
4.2	CO ₂ -Absorptionen	100	110	120

Data

Why run complex models at a University-based research group?

- ▶ Investigate unknown phenomena, effects
- ▶ Enhance modelling tools for use in public decision-making
 - ▶ Wise use of scarce public finances for maximum socio-economic development gains
- ▶ Training future modellers: developing systems modelling capacity for government and industry
- ▶ Create an enabling environment to critique policy formulation/direction
- ▶ Provide a counterpoint to officially endorsed models
 - ▶ more comprehensive, covering all energy products, not just electricity

Limitations of integrated systems models

- ▶ Reflect only costs and benefits thought of by model builders
- ▶ May come across as ‘technocratic’
 - ▶ So requires a team that can do grounded research for inputs, & communicate assumptions, results & limitations well
- ▶ Long term planning models require regular revision more so given the era of technological disruption we're experiencing
 - ▶ Assumptions about costs and demand are frequently outdated two years later.

About energy (systems) research at UCT

- ▶ Energy Research at UCT is being restructured
- ▶ Energy Systems Research at UCT is alive and active
 - ▶ as you'll witness today
- ▶ The Energy Systems Research Group (as we're currently calling them) is relocating to Chemical Engineering
- ▶ Relationships between the energy sector and various industrial sectors are expected to change strongly over the coming years, from a rather linear "supplier to customer" model towards multiple inter-linkages ("sector coupling"). This repositioning of energy systems research at UCT is also aiming to be forward-looking, building necessary competencies.

Open for research business