ALTER-Net Summer School
Sept 2007, Peyresq, France

University of Sussex

The economics of ecosystem services

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The issue

Biodiversity is declining.

Changes in biodiversity due to human activities were more rapid in the past 50 years than at any time in human history, and the drivers of change that cause biodiversity loss and lead to changes in ecosystem services are either steady, show no evidence of declining over time, or are increasing in intensity.

Biodiversity benefits people through more than just its contribution to material welfare and livelihoods. Biodiversity contributes to security, resiliency, social relations, health, and freedom of choices and actions.

Exciting times …

- Addressing environmental challenges by social and natural scientists working together
- Expanding the frame of reference by perceiving society and nature as complex systems
- Improving explanatory power by making social and behavioural sciences compatible

Outline

1.0 Ecological economics
- The standard circular flow model
- Economy-environment interdependence
- Stocks and flows
- Complex adaptive systems

2.0 Environmental valuation and appraisal
- Value-articulating institutions
- Overview of environmental valuation methods
- Examples

1.0 Ecological Economics

Main thoughts on ecological economics

- The economy is dependent on a functioning environment.
- We need a framework for thinking about the interdependence of the economy and the natural environment, and the implications arising for sustainability.
- There are four classes of services that the environment provides to the economy - resource inputs, waste sinks, amenities, and life supports.
- If the economy extracts more resources from the environment, it necessarily inserts more wastes into it.
- Waste insertions at high rates have the potential to, and often actually do, reduce the environment's ability to provide renewable resource inputs, to provide amenity services, and to provide life support services.

Ecological Economics - 1

The analysis of the **interactions** between economy, society and environment.

It is at this intersection that we realise and increasingly understand the **complexity** of lifestyle, production and policy choices.

To address them ecological economists use **analytical tools** and draw on concepts coming from many **different disciplines** and fields of experience.

Usually the aim is to propose policy measures for sustainable development.

Ecological Economics - 2

‘Ecologic’ -

- ‘eco’ - Greek *oikos,* the home or dwelling place, the place where we belong
- ‘logic’ - Greek *logos*, the wisdom or the word of the *oikos*.

‘Economic’ -

- ‘eco’
- ‘nomic’ - Greek *nomos*, a system of management or law for dealing with the *oikos.*

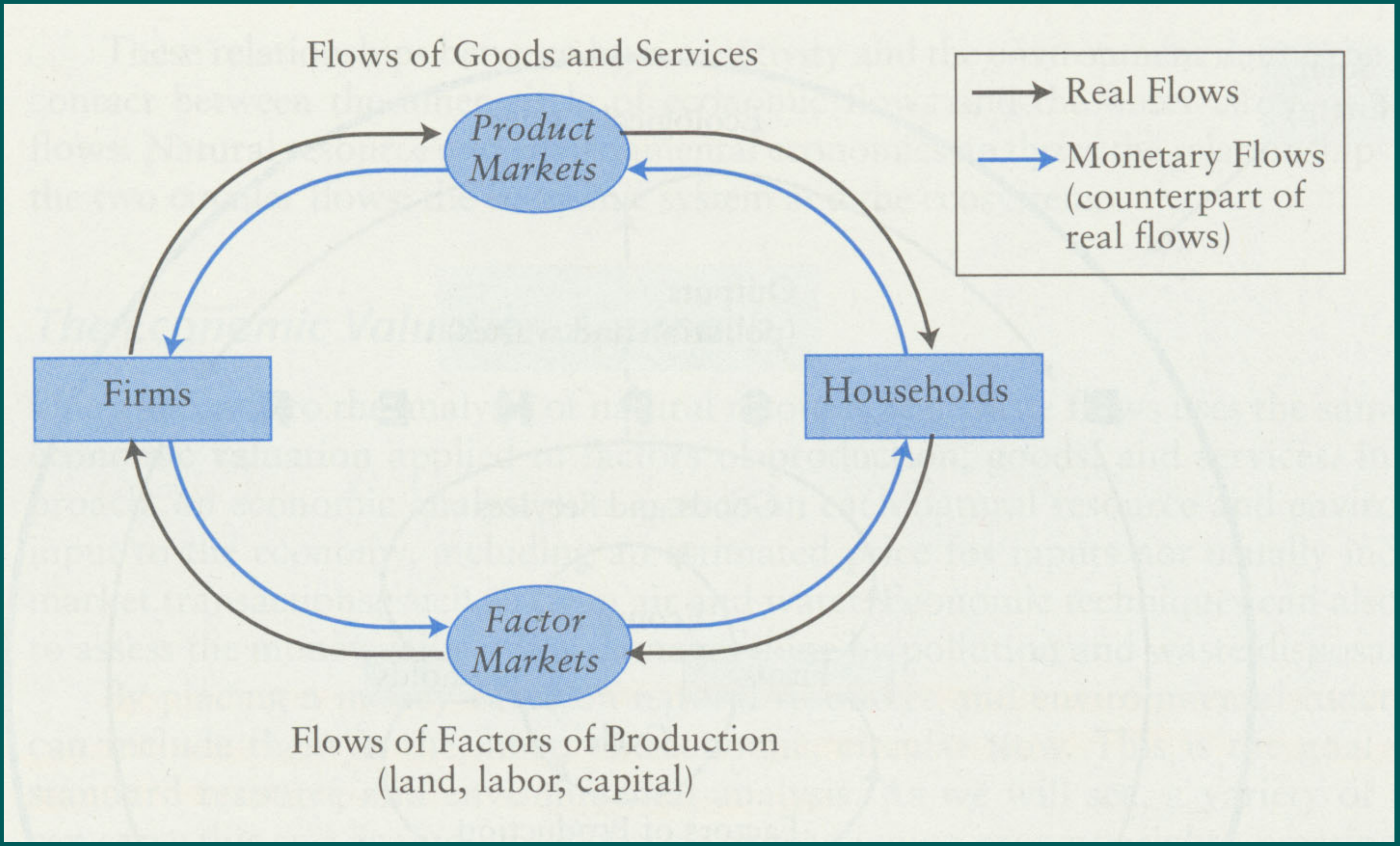
Ecological Economics – 3

Ecology is the study of the relations of animals and plants to their organic and inorganic environments.

Economics is the study of how humans make their living, how they satisfy their needs and desires.

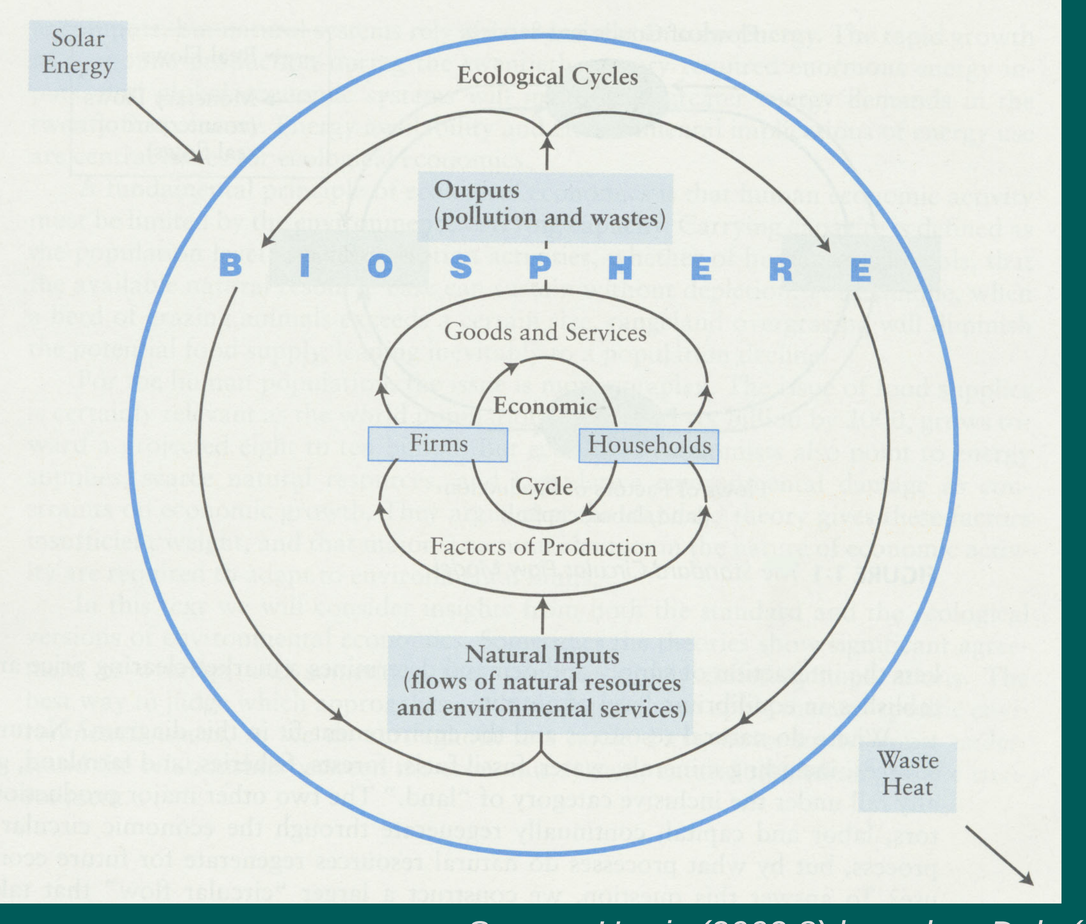
Ecological economics is the study of the relationships between human housekeeping and nature‘s housekeeping. In other words, it is about the interactions between economic systems and ecological systems.

The standard circular flow model



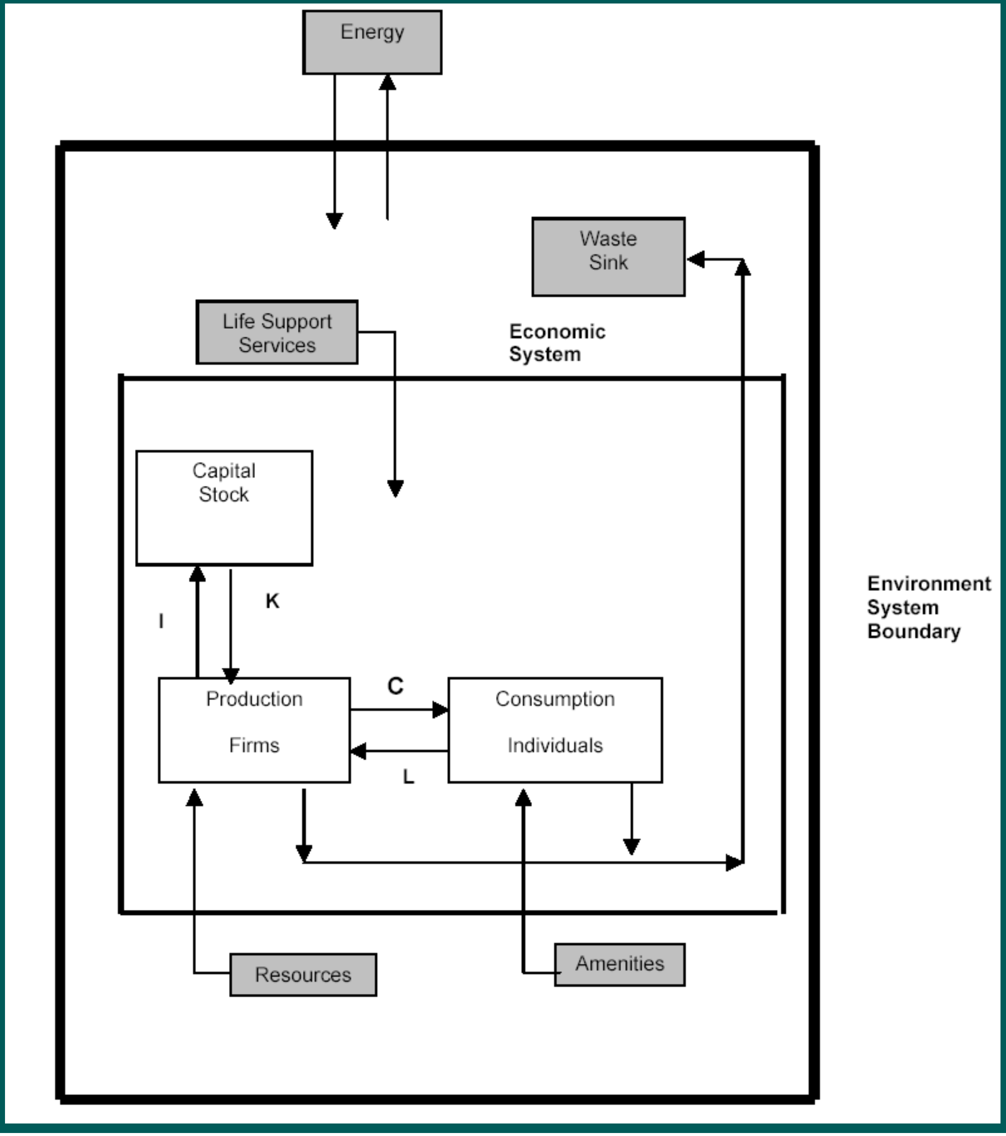
Source: Harris (2002:7).

A Broader Circular Flow Model



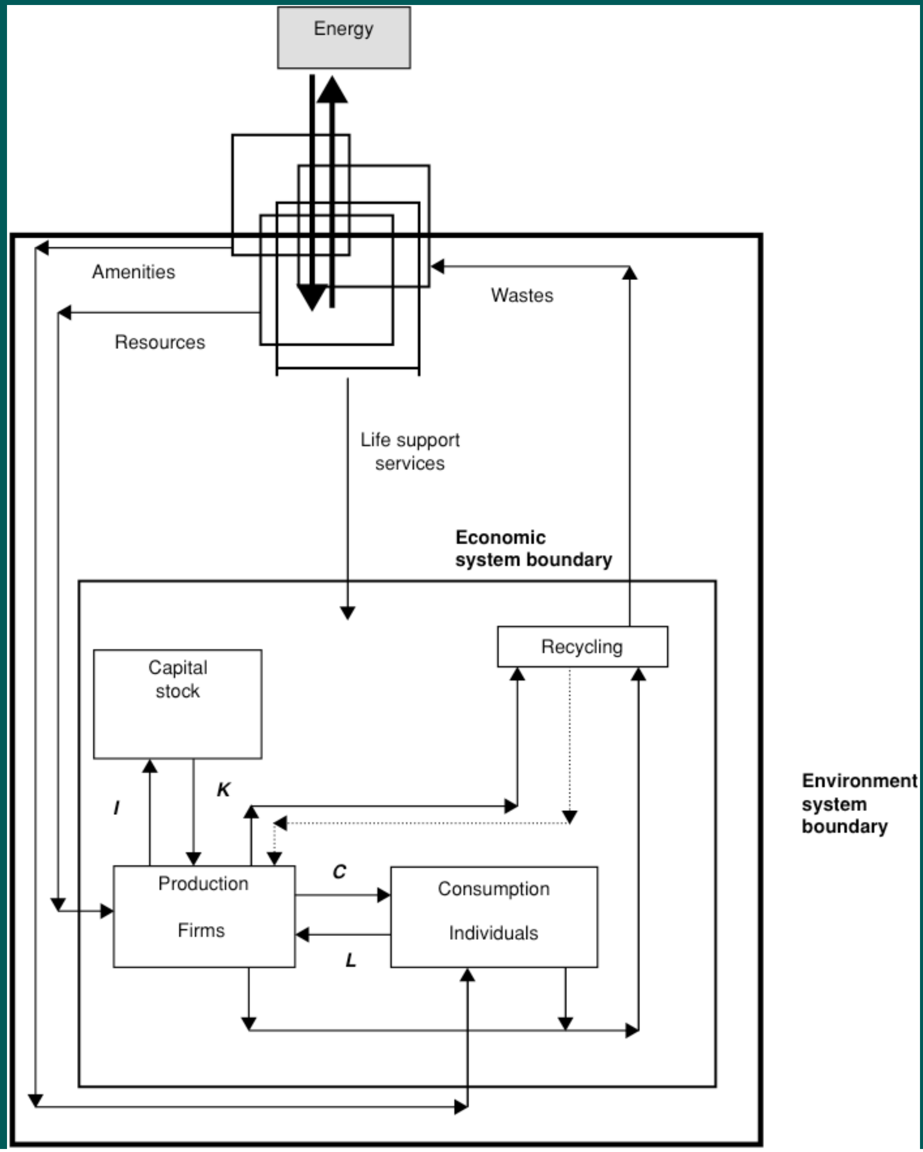
Source: Harris (2002:8) based on Daly (1977).

Economy-environment interdependence

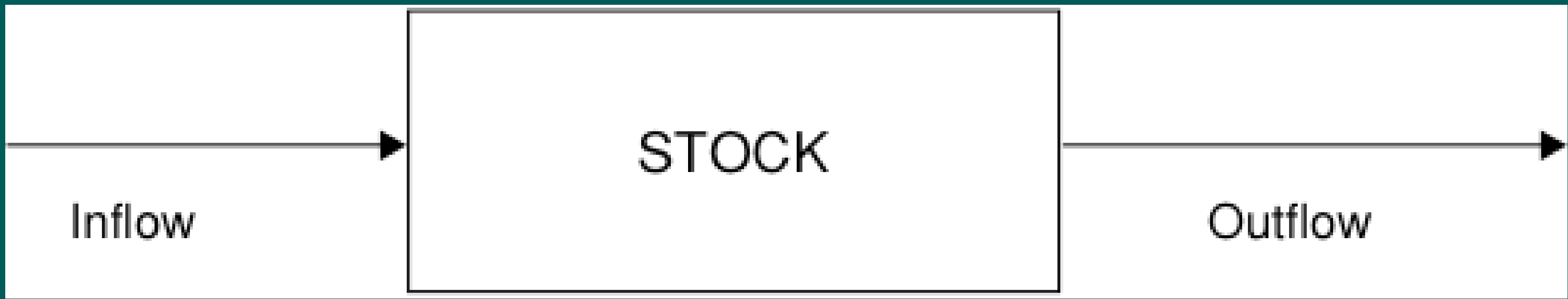


Source:
Common / Stagl 2005

Environmental service interactions



Stocks and flows



$$S_1 = S_0 + A_1 - O_1$$

$$S_t = S_{t-1} + A_t - O_t$$

$$S_t = S_{t-1} + G_t - E_t$$

Socio-ecological systems are complex and adaptive – some definitions

System

- Any coherent set of interconnected and interacting components, within a ‘boundary’ which defines the context or system ‘environment’.

Complex system

- System with a large population of interacting agents (e.g. many chemical, physical, and human agents). Or:
- System formed out of many components whose behaviours are emergent, i.e. the behaviour of the system cannot be inferred from the behaviour of its components. <u>The amount of the information necessary to describe the behaviour of such a system is a measure of its complexity.</u>

Complex adaptive system

- Complex system with adapting agents (via genetic change or via learning).

Sources: J. Ravetz 02; J. Bar-Yam 92

Evolutionary Complex Systems Approach

Aims to link the ecological, physical, and socio-economic aspects of complex systems.

Characteristics:

- Resilience (Diversity, modularity, redundancy, memory)
- adaptive and co-evolutionary processes,
- bifurcation dynamics,
- historical determinism leading to limited path-dependence and lock-in,
- positive feedback,
- embedded in culturally shaped power relations,
- hierarchical and spatial patterns.

Source: P. Allen 1997

Implications for policy

- Need for institutions which have the capacity to address (long term) economic efficiency, ecological resilience and social justice in an integrated way
- Account for / value stocks as well as flows
- Account for / value for all four services from ecosystems (resource, waste, life support and amenities)
- Base decisions on systems analyses (slow/fast variables, ecosystem services, history of the system, possible disturbances)
- Learn from controlled perturbations of the system to understand the dynamics better
- Use visions and scenarios as learning tools

2.0 Environmental valuation and appraisal

Main thoughts environmental valuation

- Formal and informal institutions can influence and enable actors to form preferences.
- Environmental valuation methods are value-articulating institutions (Vatn).
- In the context of public policy implementation we are concerned about individual and group preferences.
- In the context of public policy making we are concerned about social preferences.
- For environmental governance we need institutions that are inclusive and deliberative, allow preferences to form and change, and we need to be reflective about the designs of value-articulating institutions.

Environmental valuation

- The method / institution of inclusion of environmental resources and ecosystem services in decision processes determines how far they are taken into account with results affecting the quality of our lives and those of future generations.

- Over the last 20 years alternative environmental valuation methods have been developed. More recently novel combinations of methods (hybrid methods) were developed and used in a number of empirical applications for environmental valuation.

Value articulating institutions

Value articulating institutions (VAI) define -

- Who participates?
  - How and in what capacity (consumer, stakeholder, citizen)
- What counts as data, which form they should take?
- What kind of data handling procedures are used?
  - Processing and aggregation

A VAI defines the rationality or logic of a specific choice.

Vatn, A. (2004).
Institutions and the environment.
Cheltenham, Edward Elgar.

Value articulating institutions (cont.)

Different VAIs respond to different social contexts and rationalities

→We must ask:

What characterizes the issues involved?

How would we like specific issues to be evaluated?

Core questions:

- Is the issue or good individual or common?
- What is the degree of complexity?
- Is the issue or good characterized by one or plural value dimensions? Are preferences given or may they change?
- What is a logical aggregation procedure given answers to the above?

Value articulating institutions (cont.)

Main VAIs:

- Cost-benefit analysis (CBA)
- Multicriteria appraisal (MCA)
- Deliberative institutions (DI)
  - Citizen juries
  - Consensus conferences etc.

Value articulating institutions (cont.)

The neoclassical model (basis for CBA)

- Individualist: Decisions based on individual preferences → instrumental / strategic action

The basic assumptions:

- Rationality: Maximizing individual utility → one-dimensionality
- Stable preferences
- Unlimited calculative capacity

Value articulating institutions (cont.)

The institutional economics perspective – both individual and social rationality – ’I’ and ’We’

Basic assumptions:

- Which rationality pertains depends on institutional context
- Uses also the concept of social rationality; reciprocity and norms; communication and cooperation (→ both self- and other-regarding logics).
- Preferences are socially influenced – culture
- Understanding is largely social – language and ’models’
- People are boundedly rational – capacity constraints

Weak comparability of values as a foundation for ecological economics

Strong comparability - single comparative term by which all actions can be ranked; implying strong or weak commensurability.

Strong commensurability – a common measure of consequence exists; cardinal comparison.

Weak commensurability – a common measure of consequence exists; ordinal comparison.

Weak comparability – values irreducibly plural and cannot be uniquely ordered along a single scale; implying incommensurability.

Martinez-Alier J, Munda G, O'Neill J. Weak comparability of values as a foundation for ecological economics. Ecological Economics 1998;26(3):277-286

Challenges environmental valuation

- Social incommensurability - derived from the concepts of reflexive complexity and post-normal science; refers to the existence of a multiplicity of legitimate perspectives in society.

- Technical incommensurability - evolving complex systems, multidimensional nature of complexity; uncertainty, ambiguity and ignorance; refers to the issue of representation of multiple identities in descriptive models.

Munda, G. (2004).
"Social multi-criteria evaluation: Methodological foundations and operational consequences."
European Journal of Operational Research ***158****(3): 662-677*.

Aims and quality of deliberative processes

Making ’better’ decisions. What do we mean by ’better’?

Trouble to evaluate decision outcomes → focus on the decision process.

Key quality criteria for deliberative processes:

- Competence in the process
- Fairness
- Social learning.

Webler, T., H. Kastenholz, et al. (1995). "Public participation in impact assessment: a social learning perspective." Environmental Impact Assessment Review **15**: 443-463.

Multicriteria appraisal (MCA)

MCA allows to take into account in decisions -

- a large number of data, relations and objectives; facts and values,
- multiple criteria, measured on different scales (€, MT, ha, etc.),
- requires only weak comparability between actions,
- scientific data from various disciplines and different value judgements and interests.

→ MCA enables us to rank a finite number of alternatives, while considering several, in part conflicting criteria.

No solution optimising all criteria; compromise solution has to be found.

Hybrid value articulating institutions

- Methodologies which systematically judge how well different courses of action (options) perform when compared against a set of economic, social, environmental and ethical criteria.
- Value articulation is a process.
- Taking quantitative and qualitative information into account.
- Aim to support robust and accountable decision-making when dealing with complex scientific and technological issues.

Deliberative monetary valuation

Deliberative aspects are introduced in methods for the estimation of environmental monetary values.

(a) Input from focus groups in the design of questionnaires.

(b) Group deliberation for expressing value in monetary terms.

Recent projects:

ADVISOR (EU FP5) – water management

Ettrick Valley forest floodplain restoration - forest management

Deliberative monetary valuation

Selected references:

James, RF and RK Blamey (2004). Deliberation and economic valuation - national park management. Alternatives for environmental valuation. M Getzner, CL Spash and S Stagl. London, Routledge**:** 225-243.

Kenyon, W and N Hanley (2004). Three approaches to valuing nature - forest floodplain restoration. Alternatives for environmental valuation. M Getzner, CL Spash and S Stagl. London, Routledge: 209-224

Kenyon, W and C Nevin (2001). "The use of economic and participatory approaches to assess forest development: a case study in the Ettrick Valley." Forest Policy and Economics **3**: 69–80.

Niemeyer, S and CL Spash (2001). "Environmental valuation analysis, public deliberation, and their pragmatic syntheses: a critical appraisal." Environment and Planning C: Government and Policy **19**: 567-585.

Spash, CL (2001). Deliberative Monetary Valuation. 5th Nordic Environmental Research Conference, University of Aarhus, Denmark, 14th - 16th June, 2001.

Social multicriteria evaluation

Multicriteria evaluation (non-utility based) combined with (model-based) integrated assessment of impacts and stakeholder participation. Decision / discussion process about public policy is framed as social learning.

Recent projects:

VALSE (EU FP4) – methodology; water management

EVE (EU FP4) - methodology

MCDA_RES (EU FP5) – renewable energy

MESSINA (Interreg) – mgt of coastal erosion

DIAFIANS (Spanish Env Min) – IA of socio-econ alternatives

ADVISOR (EU FP5) – water management

ARTEMIS (Austrian Science Council) – energy futures

Tyndall Centre – policies for carbon reduction

Social multicriteria evaluation

Selected references:

De Marchi, B, SO Funtowicz, et al. (2000). "Combining participative and institutional approaches with multcriteria evaluation. An empirical study for water issues in Troina, Sicily." Ecological Economics **34**: 267-82.

Munda, G (2004). "Social multi-criteria evaluation: Methodological foundations and operational consequences." European Journal of Operational Research **158**(3): 662-677.

Russi, D, G Munda et al. (2004). “Social multicriteria evaluation of rural electrification: the case of the Montsery Natural Park”, ISEE conference, Montreal July 2004.

Madlener, R. and S. Stagl (2005). "Sustainability-guided promotion of renewable electricity generation." Ecological Economics.

Agnolucci, P, K Anderson, et al. (2005). Pathways to a decarbonised UK: achieving a 60% reduction in CO2 emissions by 2050. ESEE conference, Lisbon, June 2005.

Stagl, S, L Bohunovsky, et al. (2005). Participatory MCE of renewable energy technology scenarios on two different scale levels - the case of Austria. ESEE conference, Lisbon, June 2005.

Multicriteria mapping

Multicriteria methodology which emphasises that there is a wide range of perspectives and expertise, and produces an overview that ``maps'' the debate. It combines the transparency of numerical approaches with the unconstrained framing of discursive deliberations.

Recent projects:

Rethinking Risk (Unilever) - GMOs

UK Sustainable Hydrogen Energy Consortium – hydrogen futures

PorGrow (EU FP6) – public health (obesity)

Multicriteria mapping

Selected references:

Stirling, A (1997). Multi-criteria mapping. Mitigating the problems of environmental valuation? Valuing Nature? Ethics, economics and the environment. J Foster. London, Routledge.

Stirling, A and S Mayer (2001). "A novel approach to the appraisal of technological risk: a multicriteria mapping study of a genetically modified crop." Environment and Planning C: Government and Policy 19(4): 529-555.

Stirling, A and S Mayer (2004). Confronting risk with precaution: a multi-criteria mapping of a GM crop. Alternatives for Valuing Nature. M Getzner, CL Spash and S Stagl. London, Routledge: 159-184.

Eames, M. and W. McDowall (2005). Towards a Multi-Criteria Sustainability Appraisal of Competing Hydrogen Futures. ESEE conference, Lisbon, June 2005.

Deliberative mapping

MCM + facilitated group discussions. Combination of individual and small group judgements. Specialists and small groups of citizens to follow the same appraisal process.

Recent projects:

Kidney-Gap (Wellcome Trust) – public health

Evaluation of the Deliberative Mapping Pilot (CoRWM) – radioactive waste

(Consultation for Energy White Paper (DTI) – energy policy & sustainability)

Deliberative mapping

Selected references:

Davies, G, J Burgess, M Eames, S Mayer, K Staley, A Stirling, S Williamson (2003). Deliberative mapping: appraising options for addressing 'the kidney gap'. London, Final Report to the Wellcome Trust**:** 260.

Stagl, S. (2006). "Multicriteria evaluation and public participation: the case of UK energy policy." Land Use Policy.

MCA case studies on energy policy issues

(1) Public Participation on UK National Energy Policy (Energy White Paper 2003)

(2) Comparison of Energy Scenarios on multiple scales in AT

Methodology

Scenario building

Life-cycle analysis

Multi-criteria appraisal

Expert interviews

Stakeholder interviews

Deliberative processes (stakeholder or citizen workshops)

Case Study 1:
Public Participation on
UK National Energy Policy

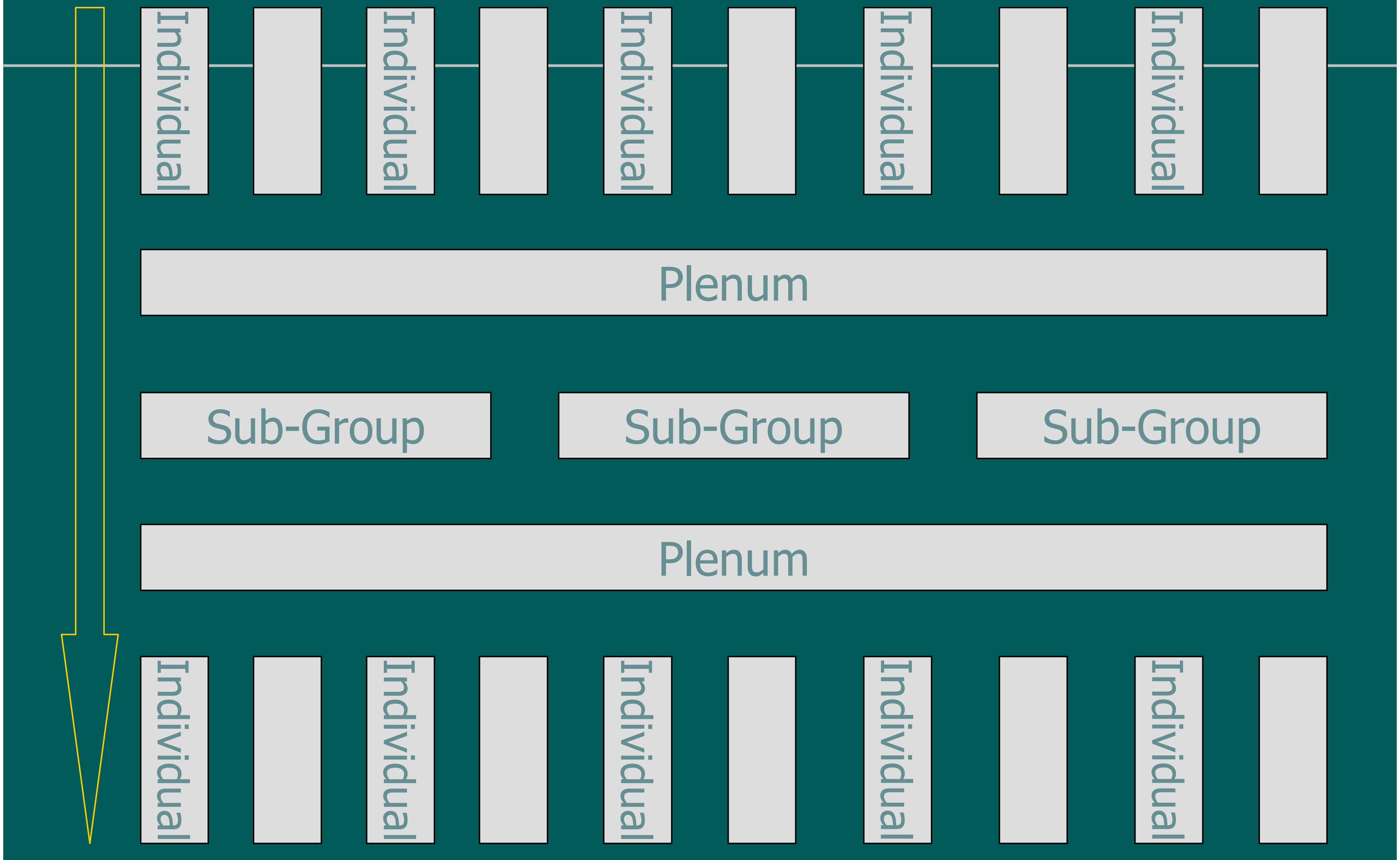
Aim:

Preparation for UK Energy White Paper (2003)

Elements

- Web-based expert consultation
- Survey-bases consultation with stakeholders with special interests
- Focus Groups
- Deliberative Workshops
  - – Participants: Citizens from three regions
  - – Process: Structuring deliberation
  - – Results
  - – Forms of learning

Process Design – Part 1



Process Design – Part 2

Recording attitudes

Votes on different scenarios

Developing criteria and weighting

Deliberation and evaluation/MCA

Comparison and reasoning for differences

Votes on different scenarios

Recording attitudes

Deliberative Workshops on UK National Energy Policy - Results

Three options for 2020 explored in groups:

- A – a continuation of current trends
- B – a focus on renewables development and reducing energy use
- C – a focus on UK based sources of energy with a focus on reducing energy use

Individual preferences for policy measures:

- Reducing energy's impact upon climate change
- Increased use of renewable energy
- More efficient use of energy
- Reliability of supply (diversity of technologies)
- Keeping energy costs low
- Helping vulnerable people to afford to keep warm.

Deliberative Workshops on UK National Energy Policy - Learning

Cognitive learning: information, local knowledge, terms

Mutual understanding: values

Learning about behaviour and preferences of others and behavioural norms: cooperation

Learning about societal needs and institutional change: integrative thinking, institutional change

Barriers to social learning: time constraint, power, scepticism of commitment

Conclusions – Case Study 1

MCA and public participation allow participants to deliberate about complex issues in an open but structured way; leading to robust decision making.

Learning processes during the participatory workshops were observed.

MCA seems useful also as a tool not only to rank options (close down), but also to open up a debate.

UK citizens consulted want greener energy policy. In part accounted for in Energy White Paper.

For more information see: Stagl, S. (2006). "Multicriteria evaluation and public participation: the case of UK energy policy." Land Use Policy, 23(1):53-62.

Case Study 2:
Energy Policy on multiple scales in AT

Assessment of Renewable Energy Technologies on Multiple Scales (ARTEMIS) - A Participatory Multi-Criteria Approach

Aim: Support discussions / decisions about energy policy on the national and community level in Austria + develop methodology further.

Environmental valuation / integrated appraisal.

Multi-level environmental governance.

Partners: SERI Vienna; CEPE, ETH Zürich and SPRU, University of Sussex, UK.

June 03 – May 06

Funded by the Austrian Science Council.

ARTEMIS

www.project-artemis.net

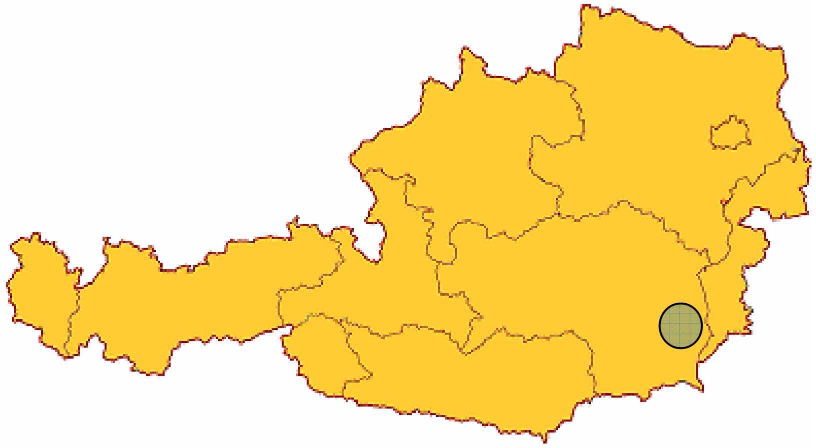
Multi-scale case study

I) Austria

- population: 8.1m
- 1,290 PJ energy demand

II) Lödersdorf & Raabau

- population: 1,290
- 94.9 TJ energy demand



Energy Scenarios

Key parameters:

(1) demand,

(2) share of renewables,

(3) focus on central or decentral energy systems,

(4) focus on short- or long-term development,

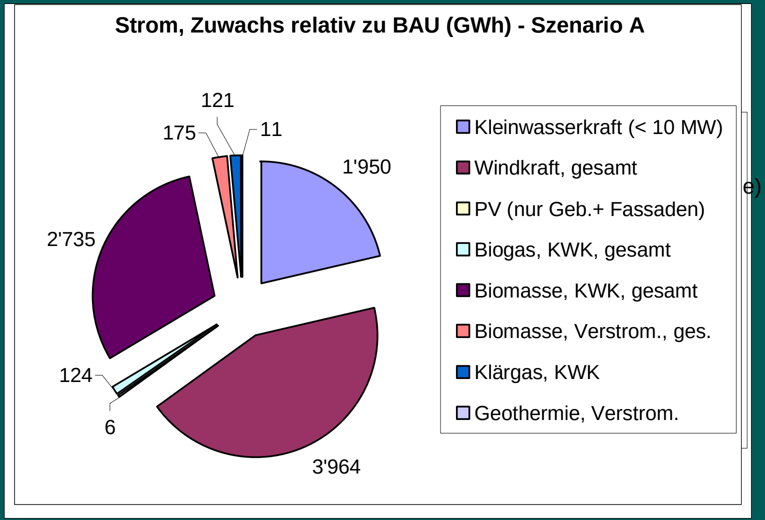
(5) requirement for institutional change,

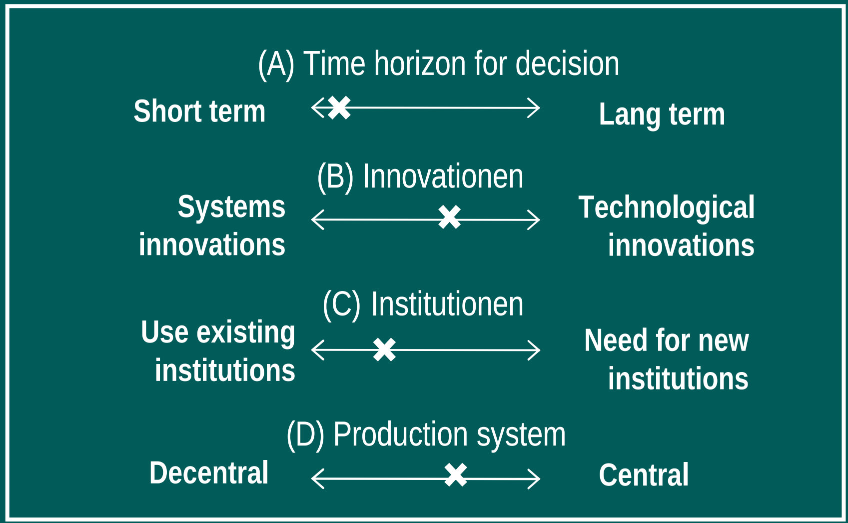
(6) system- or technological efficiency.

Scenario A:
„Rapid and familiar“

Description: Focus on technologies that have been applied successfully in the country and where rapid expansion of capacity is possible.
Key technologies: Biomass (heat and CHP), Wind, Solar thermal, biogas

- Increase of renewables compared to 2002:
  +80%
- Additional supply from renewables by 2020
  electricity **9,086 GWh**
  heat **66 PJ**

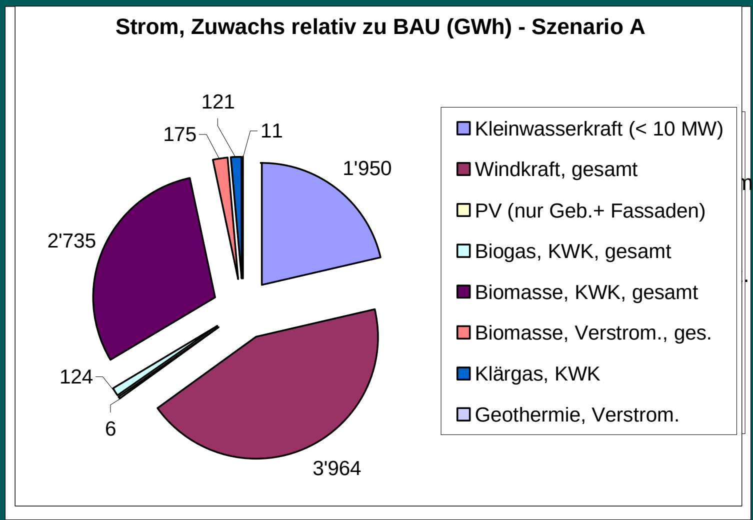


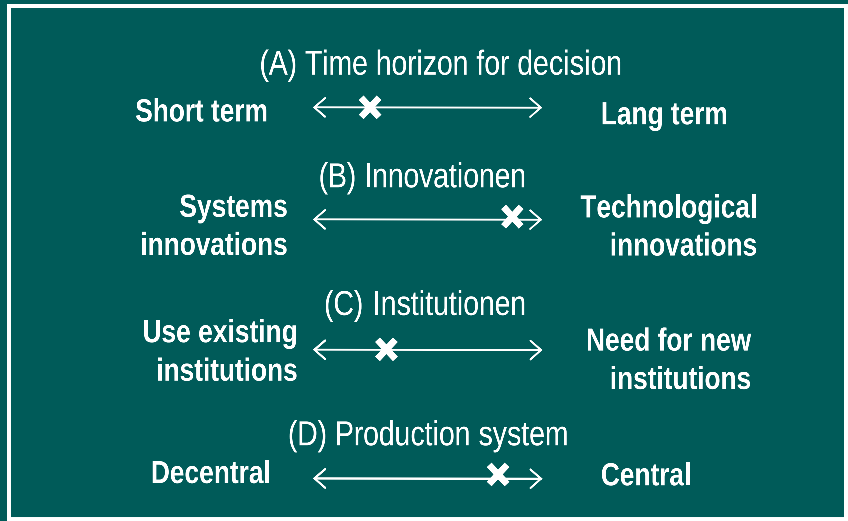


Scenario B:
„Extending competitive advantage“

Description: Focus on technologies that have been exported successfully in the past.
Key technologies: Biomass, communal CHP, Solar thermal, geothermal, small hydro, wind

- Increase of renewables compared to 2002:
  +76%
- Additional supply from renewables by 2020
  electricity **8,931 GWh**
  heat **62 PJ**

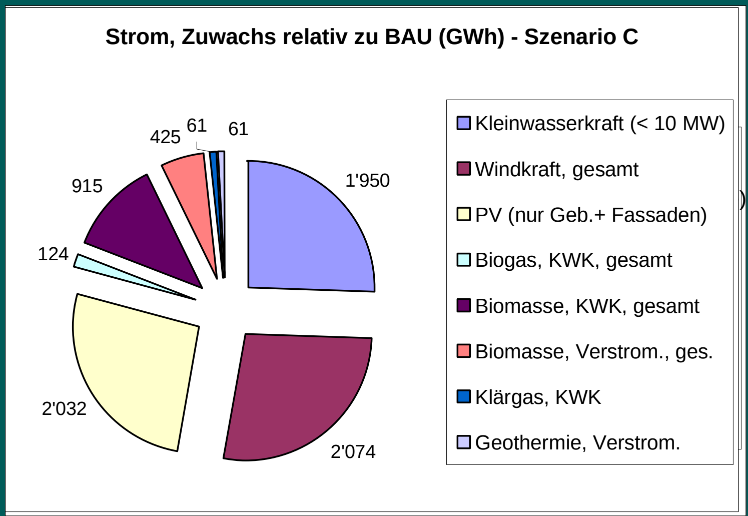




Scenario C:
„Investing in the future“

Description: Focus on decentral technologies and those that have particularly high potential in the long run, although they may require more support now (e.g. PV).

Key technologies: PV (esp. on roofs and in facades of buildings), multifunctional energy centres, biogas-feed-in, geothermal



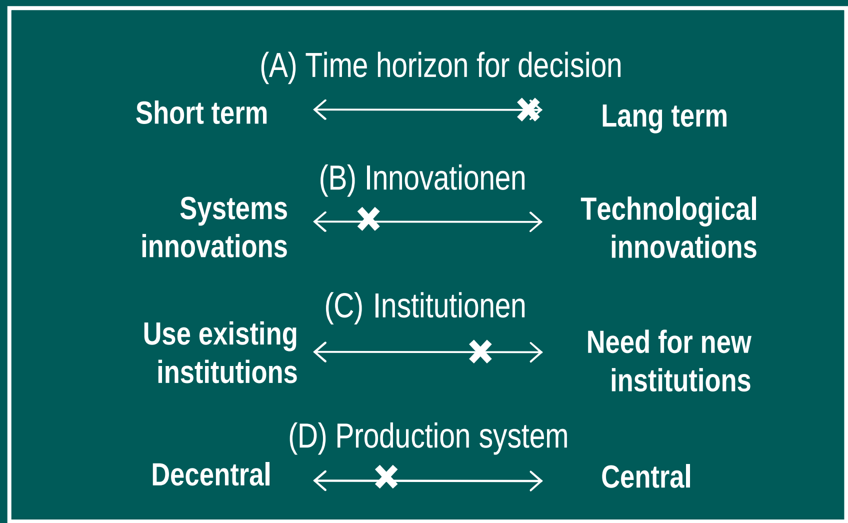
- Increase of renewables compared to 2002:

  +50%

- Additional supply from renewables by 2020

  electricity **7,642 GWh**

  heat **34 PJ**



Scenario D:
„Biomass en gros“

Description: Focus on biomass technologies of different kinds, incl. planting of new energy crops.
Key technologies: Biomass, biogas (electricyt, heat and CHP), solar thermal

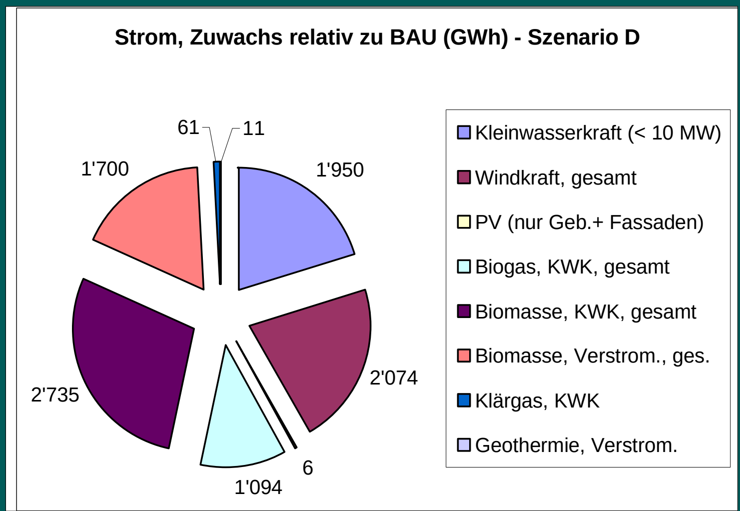
- Increase of renewables compared to 2002:

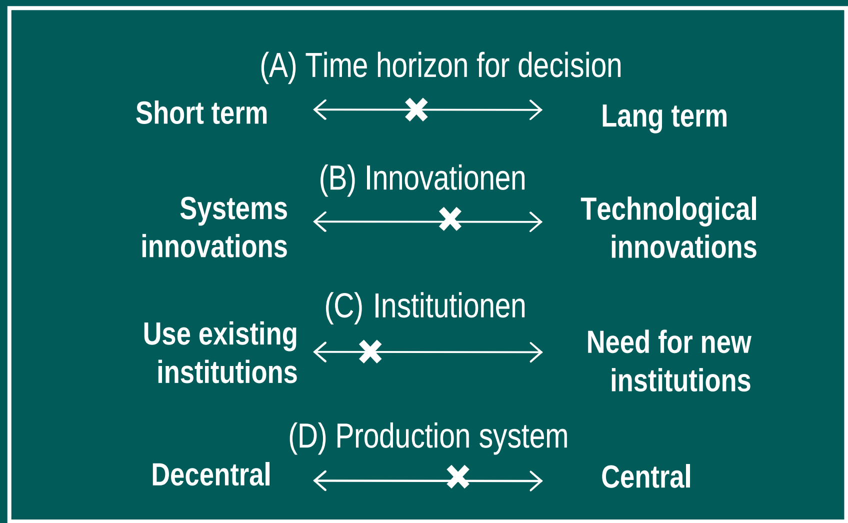
  +102%

- Additional supply from renewables by 2020

  electricity **9,631 GWh**

  heat **93 PJ**





Scenario E:
„Big on small units“

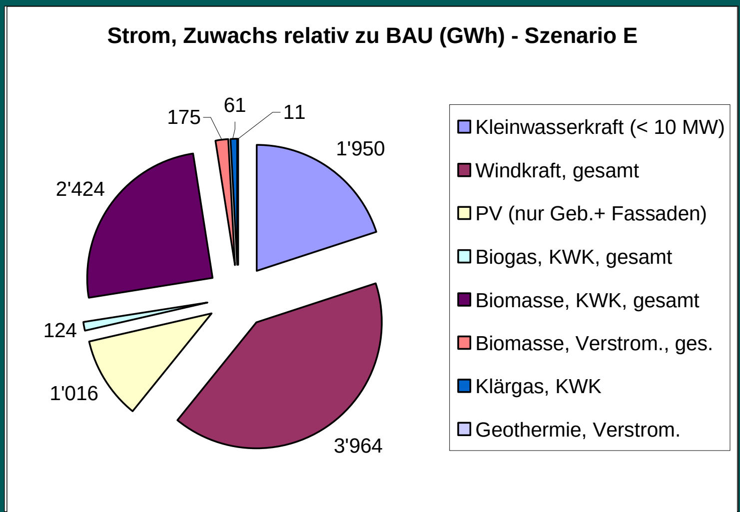
Description: Focus on technologies for local energy supply from individual and communal production units.
Key technologies: Biomass (indiv and communal CHP), biogas, heat pumps, wind, solar thermal, PV

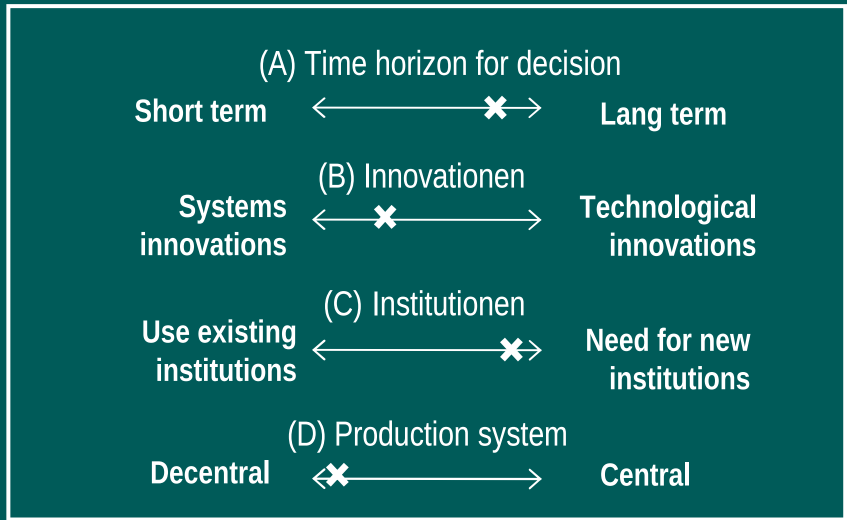
- Increase of renewables compared to 2002:

  +71%

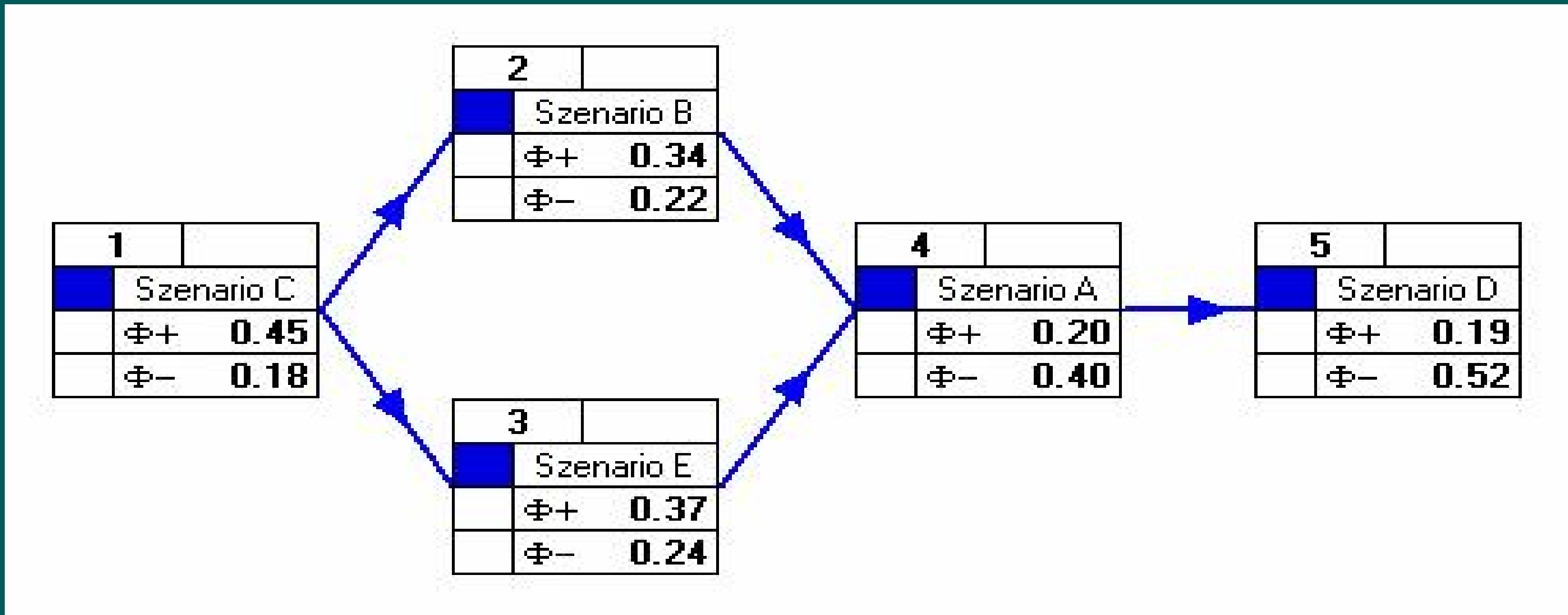
- Additional supply from renewables by 2020

  electricity **9,725 GWh**
  heat **53 PJ**





Exemplary ranking of scenarios



Social Learning ...

… encompasses a dimension of changes in values, norms, frameworks and skills that transcend the sphere of explicit cognitive knowledge; enhancing opportunities for mutual understanding, joint action and institutional change.

Main hypotheses

Hypothesis 1: There is a change in knowledge within an existing frame of reference, which involves the adoption of new facts (single-loop learning).

Hypothesis 2: There is a change in the evaluation of facts on the basis of modified values and assumptions (double-loop learning).

Hypothesis 3: People find new ways to deal with complex and conflict-ridden issue in a constructive way (incl. joint action) and contemplate to transfer this knowledge to other settings (triple-loop learning).

Data collection and analysis

- Closed-ended questionnaires based on Likert scale responses
- Completed at the beginning of the first and at the end of each of the following workshops
- Statistical analyses to study the significance of observed changes (non-parametric tests)
- Personal interviews (analysis ongoing)

Results

Single-loop learning - Participants ...

were more familiar with the different renewable energy sources
have learned to compare different energy mixes and about their relative contributions to sustainability

Double-loop learning - Participants ...

modified their assumptions (give more relevance to social parameters and values in the conflict)
did not change their perception about complexity or uncertainty; perception of the role of future generations remained high
remained at the same level of mutual understanding

Triple loop learning - Participants ...

saw participatory processes as a basis for constructive discussion after the workshop
were optmistic about the possibility for joint action
considered transferring IA and stakeholder participation to other settings

Conclusions – case study 2

- Participatory approaches with the help of scenario techniques and MCA can -
  - be a useful element of a reflexive governance approach,
  - foster SL processes that go beyond the acquisition of facts and information.
- Renn suggested that social learning should be a quality criterion for participatory processes; we think now that this criterion can be operationalised.

Implications for policy

- Use valuation methods that are consistent with assumptions about system characteristics (incommensurability)
- Decisions about public policy often require participatory processes
- Train civil servants and decision makers in novel sustainability appraisal methods