

Sustainability Assessment of Bioenergy

Topics 3.1 and 3.3

Philip Sinclair, Damiete Ogunkunle, Roland Clift

TSEC-BioSys

University of Surrey

14 November 2008



UniS original project goal

Sustainability Assessment framework supported by
Multi-Criteria Decision Analysis (MCDA)

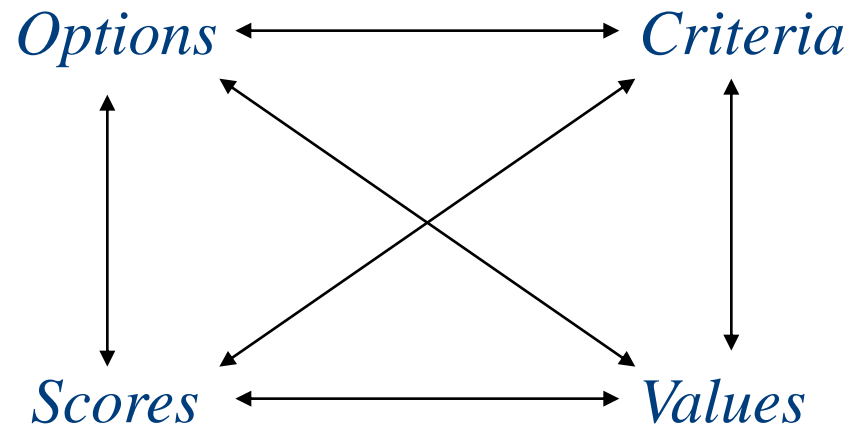
System

UK bioenergy (heat, power, biofuels for transport), 2008-2050,
no energy-from-waste.

Programme

July 2006 - Dec 2008, to include eight focus groups workshops.





Quantitative scores. The value of any option is achieved by summing each criterion value times its score.

Key weaknesses: no explicit treatment of uncertainties, weak generation of options, no explicit account taken of scenarios and objectives, no explicit inclusion of interpretation and evaluation...**integration with other methods is suggested.**

What have we done?

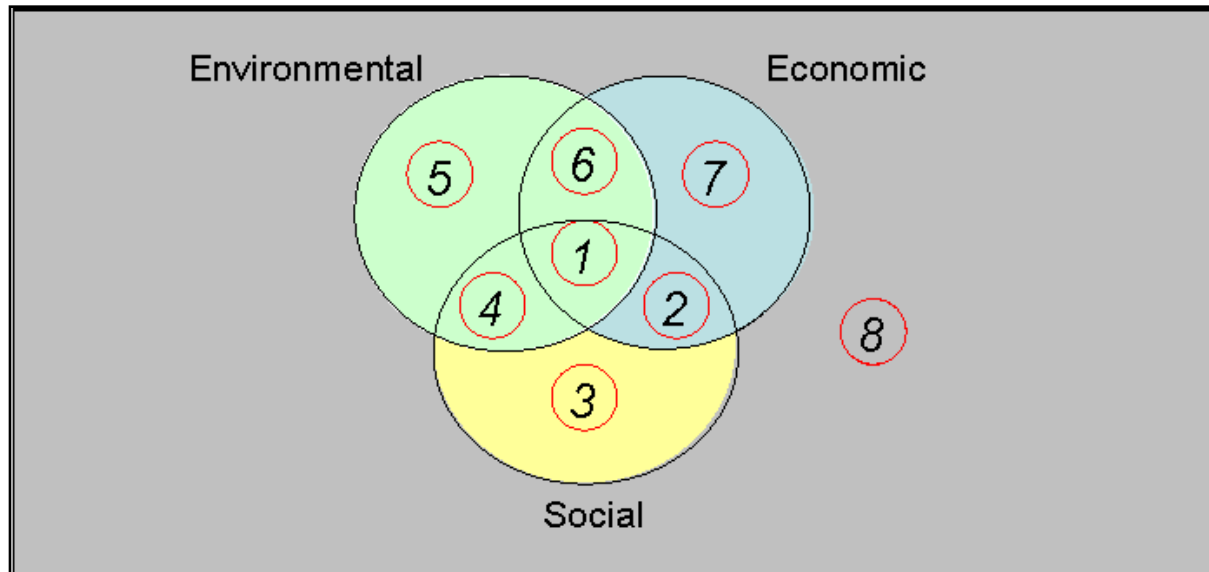
- In Theme 3 of this project, we have:
 - elicited criteria and objectives
 - formed a small and representative set of criteria and objectives
 - developed qualitative systems and narratives
 - evaluated narratives using Q methodology
 - held and evaluated communication and learning processes
 - developed more specific stakeholder criteria
 - begun construction of quantitative models

...and we are to hold more workshops with you next month.

- A goal is to explain these and other processes within a more comprehensive framework. This is work in progress.
- Today we shall review progress, particularly the most recent

Use of MCDA in the first four TSEC-BioSys focus groups

- First four focus groups: qualitative criteria and objectives at different scales
- Criteria workshop: fundamental criteria and objectives in all eight combinations of the three lobes of sustainable development:



Fundamental criteria



	Economic	Economic-comp	
Environmental	<ol style="list-style-type: none"> 1. Criterion: Level of key environmental externalities (to be incorporated into certification systems) 2. Criterion: Cost of land given to feedstock; carbon price (for heat, power etc) 3. Criterion: Development of carbon price 	<ol style="list-style-type: none"> 1. Criterion: Ecological resilience (resource depletion levels) 2. Criterion: Level of policy involvement ("quantity") and coordination ("quality") at different levels (UK - national and regional) 3. Criterion: Resources conservation - safeguarding 	Social-comp
	<ol style="list-style-type: none"> 1. Criterion: Monitoring and accountability to ensure positive impact on GHG emissions and water use 2. Criterion: Concentration of CO2 (GHG?) emissions; overall surface of land available for agricultural purposes 3. Criterion: Financial cost and adaptation to global warming 	<ol style="list-style-type: none"> 1. Criterion: Landscape (+ env. Benefits); acceptance by local people 2. Criterion: Adoption and deployment/analytical quality of life criteria - access to resources, for example (including learning, knowledge, etc) 3. Criterion: Public access to environmentally significant sites 	
Environmental-comp	<ol style="list-style-type: none"> 1. Criterion: Public engagement 2. Criterion: Job creation 3. Criterion: Job creation (numbers and skill levels) 	<ol style="list-style-type: none"> 1. Criterion: education 2. Criterion: Education, communication, awareness 3. Criterion: Level of awareness through education, training and communication; level of (effective) consultation with interested groups/stakeholders 	Social
	<ol style="list-style-type: none"> 1. Criterion: Cost-effectiveness along the supply chain (NPV? Cost/energy unit); cost of the alternative energy pathways 2. Criterion: cost effectiveness along the supply chain 3. Criterion: Evidence of profitability without subsidy 	<ol style="list-style-type: none"> 1. Criterion: Level of "green GDP" (ISEW)/Economic resilience (UK), including energy security 2. Criterion: Efficiency 3. Criterion: Pollution costs 	

Problem Structuring Workshop

- A novel problem structuring approach was used to develop a qualitative system model which describes the UK bio-energy system based on the problem statement:

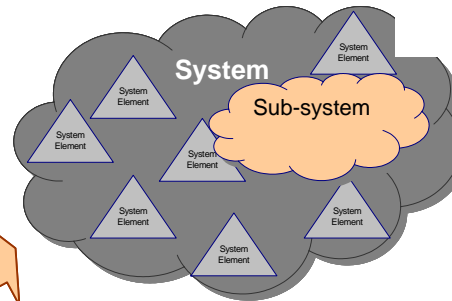
“What would a sustainable bio-energy system which can meet the UK energy requirements in 2050 look like”

- Outputs from the workshop include an agreed problem definition, a system map and a set of narratives

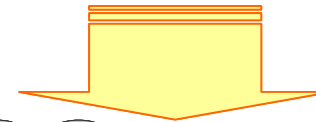


An overview of the process...

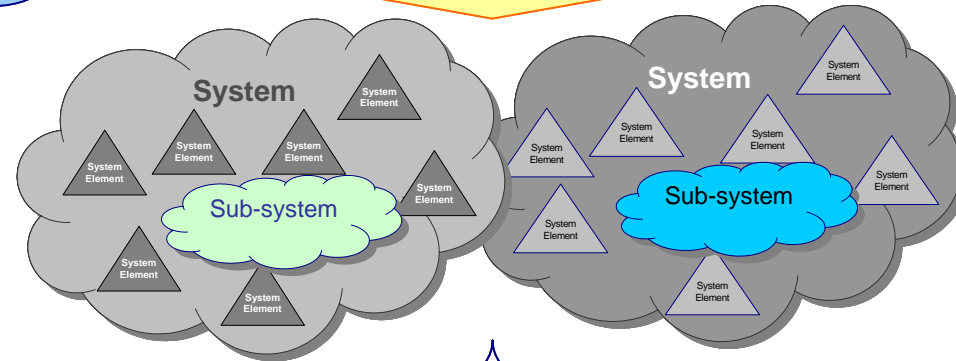
1. System representation:



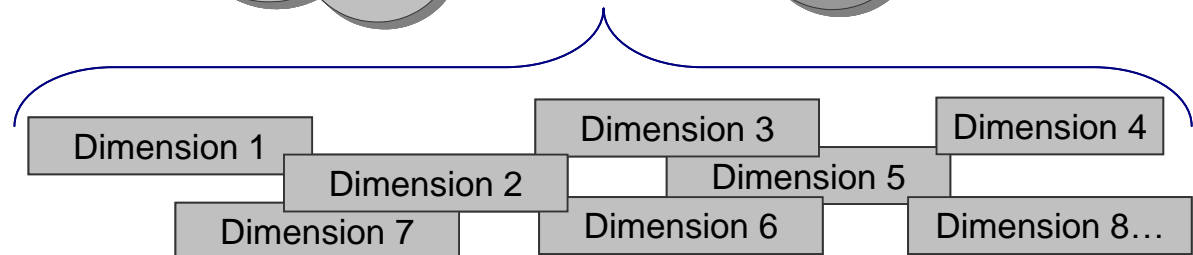
2. Define hypothetical disturbances:



3. Imagine plausible system responses:



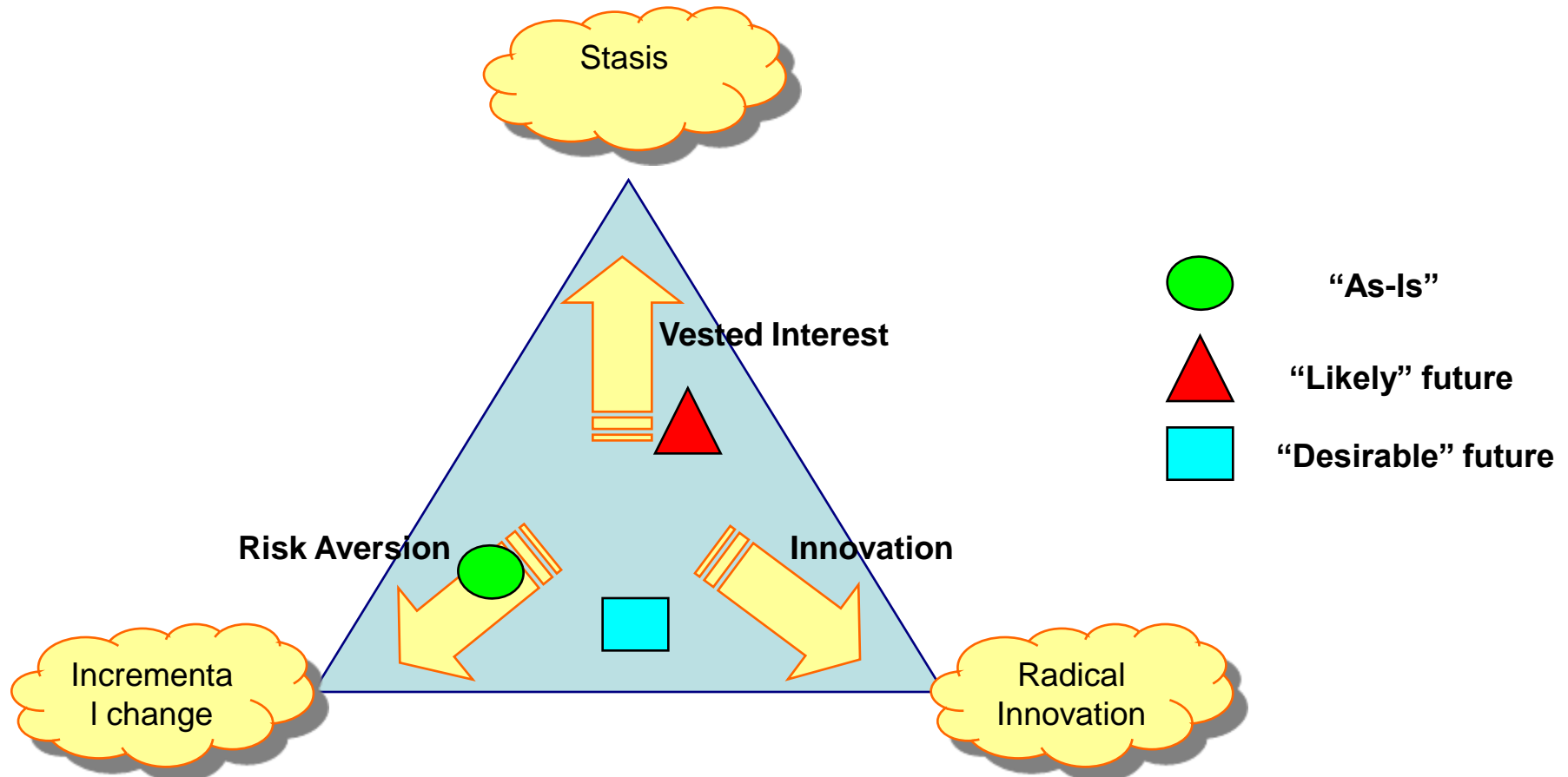
4. Multi-dimensional critique:



5. Critical discourse:

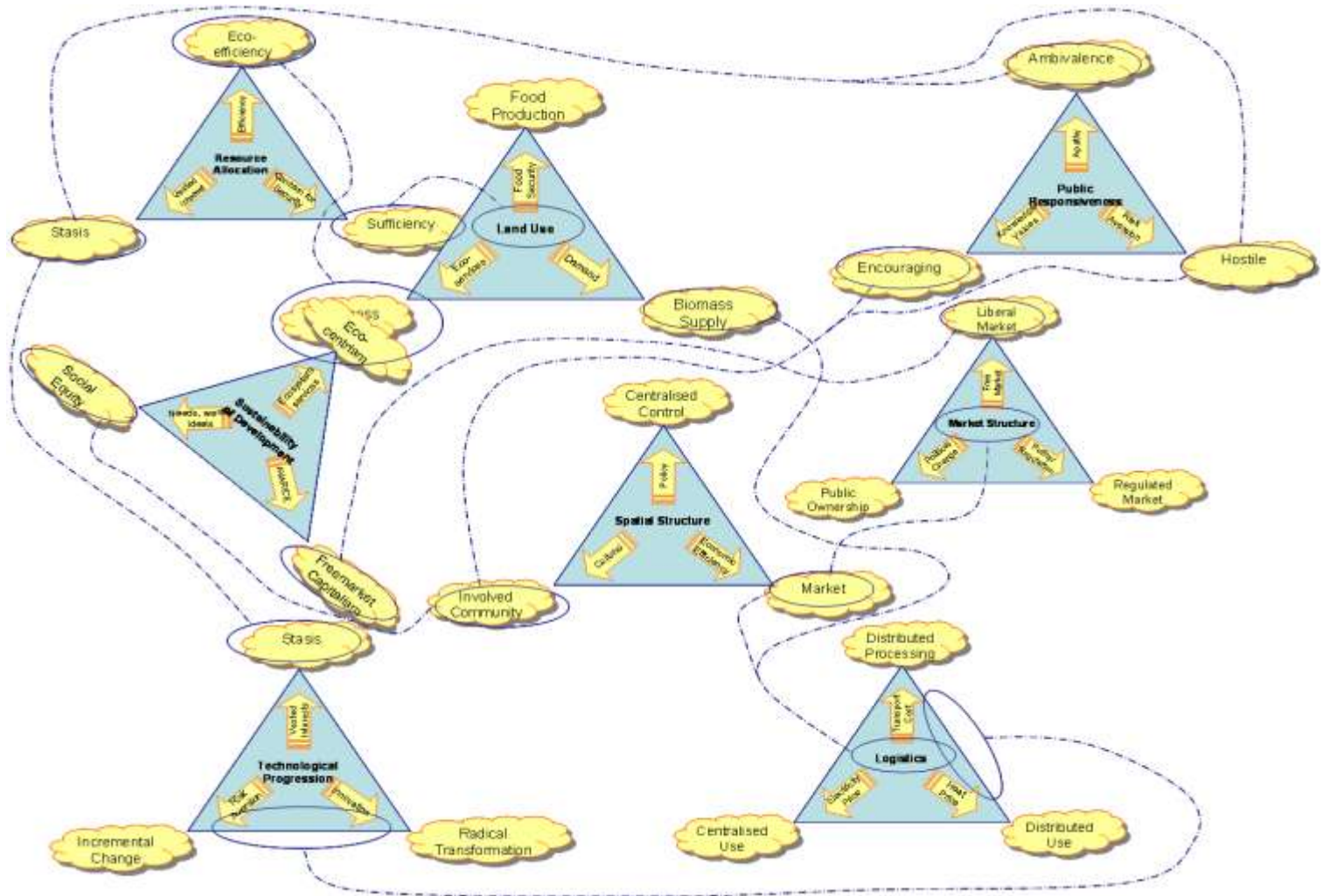


Examples of 'trilemmas' derived in the workshop...



The Technical Progression Trilemma

The Qualitative System Model



Narrative Evaluation

- The narratives described the current state, likely future response to a defined disturbance and the desired future of the UK bioenergy system.
- These were developed for different audiences namely policy makers, producers and end users, researchers and experts, the general public and civil society including NGOs.
- The effectiveness of the narratives is proven if
 - (a) their informational content is consistent irrespective of the narrator
 - (b) the learning of the reader is independent of the writing of the narrators



Content Analysis of the Narratives

- **Consistency of the narratives:** Content analysis of the narratives involved grouping the statements in the narratives into corresponding elements in the system boundary
 - Elements of the system boundary included: Physical system boundary: UK, Political system boundary: European Union, Resources, Climate change, Changes in land use, Infrastructure, Finance and capital, Technologies, Markets, Costs and environmental impacts, Policy and regulatory framework, Trade, and Logistics
- **The results** of content analysis showed that all elements were included in the different versions, thus the problem is consistently framed in all the narratives



Q methodology



- **The independence of readers from writing of the narrators** : This concept was derived from (Tversky and Kahneman, 1981) which states that

The ‘decision frame’ i.e. the concept of the acts, outcomes and contingencies a decision-maker adopts is controlled by:

- The formulation of the problem
 - The norms, habits, and personal characteristics of the decision-maker
- Thus, to determine if the reading/learning of the narratives were affected by the writing of the narrators, the Q methodology was adopted



Q methodology

- The Q methodology provides an avenue for the systemic study of perspectives, that may be present in a given policy situation (Stirling et al, 2003),

The Q methodology also

- helps to define a range of view points and value positions of different parties
- Identify areas of conflicts or agreement concerning an issue, thus helping to clarify view points.
- Identify issues that are important to participants.



The Methodology in brief



- Individuals are presented with statements derived from the narratives
- Respondents are then asked to rank these statements from their own point of view, using a seven point scale (-3 to +3) to indicate their level of agreement with the statements
- These individual rankings are the subject to factor analysis, where individuals are correlated and factorised to indicate similarities and differences in view points
- To show that Q evaluations were statistically independent of ‘writers’ narratives, a chi-square contingency test was performed



Results of Pilot study on Q methodology



- Using Q methodology, narratives were evaluated by respondents from the Centre for Environmental Strategy
- **Q evaluations independent of writers**
 - Ho: Q evaluations are independent of the writer
 - H1: Q evaluations are dependent of the writer
 - The results showed 25% level of significance on 16 readers, that is the statement 'the Q evaluations is independent of the writing process is 75% likely to be correct.
- **Reader Perspectives**
 - The results revealed two groups of respondents with opposing views relating to the impact of the UK bio-energy system on food security and biodiversity



Bioheat sub-system trilemma(s)

1. Bio-heat services
2. Biomass resources for heat
3. Bio-heat market segments
4. Bio-heat products' infrastructure
5. Bio-heat system finance
6. Bio-heat technologies
7. Management of biomass sourcing for heat

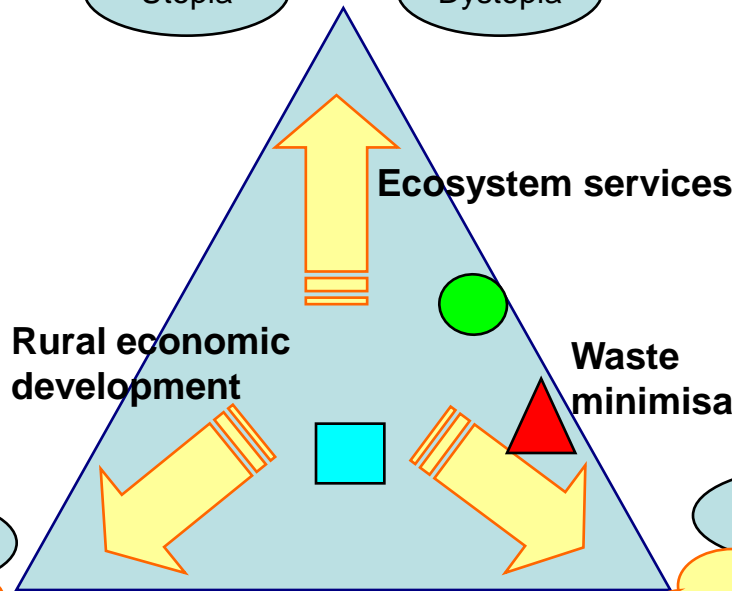


Biomass Resources for Heat

Forestry products (available for energy)
Forestry residues
Clean wood industrial by-products

Forestry biomass

Utopia Dystopia



- "As-Is"
- ▲ "Likely" future
- "Desirable" future

Agriculture biomass

Energy crops (woody and grassy)
Agricultural residues (straw and other)

Waste biomass

Organic Fraction of Municipal Solid Waste (OFMSW)
Sewage sludge
Commercial industrial waste (mainly F&D industry)
Other industrial co-products (e.g. black liquor)



Tri-lemma link to Markal Scenarios

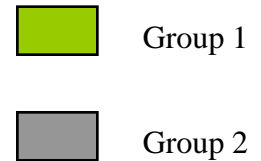
- **Provide Qualitative insights**
 - on issues where Markal is limited
 - on why parameters in the Markal scenarios change
 - to enrich the qualitative storylines of the scenarios and to understand the forces behind the scenarios
 - to modulate the outputs of Markal



	<i>Products</i>	<i>Products</i>	<i>Services</i>	<i>Services</i>	
<i>Private</i>	Producer Farming RD	Producer power NB	Expert haulage SW	Expert non-food crops HS	<i>Biomass</i>
<i>Private</i>	Producer Biofuels MC	Producer CHP AS	Expert facilities (housing) JD	Expert power JT	<i>Bioenergy</i>
<i>Public</i>	Biomass wastes AMc	Transport Planner AM	Government regional GP	Regulator power CB	<i>Bioenergy</i>
<i>Public</i>	Forestry ML	Bioheat JL	Government national RC	Regulator biofuels AB	<i>Biomass</i>
	<i>Supply</i>	<i>Demand</i>	<i>Demand</i>	<i>Supply</i>	

Producers (B)	Experts (C)
Public (D)	Policy (A)

Specialisms.



Observers: PN, RC, PS
Facilitation: DO, HS
Host: CB



TSEC-BioSys workshops: participation.

Process conditions

- No information supplied by the research team
- References and sources to be given for any specific information quoted by participants
- Proceedings recorded
- Evaluation interviews



Vision Statement

“To sustain the developments of the present, we must learn from our aspirations for the future”

System

UK bioenergy (heat, power, biofuels for transport), 2008-2050, no energy-from-waste.

Case

Dunfold Park CHP development.

Process

Policy development.

Goals

We must learn from each other; we must make choices.

Developing policy

Where are we now?

e.g. “ENERGY PRICES are HIGH”

What are our likely futures?

e.g. “CO₂ eq ppm, 2050 < 500”

Where do we want to go in this case?

e.g. “CO₂-eq emissions over life cycle, near to 0”

What are our required actions in this case?

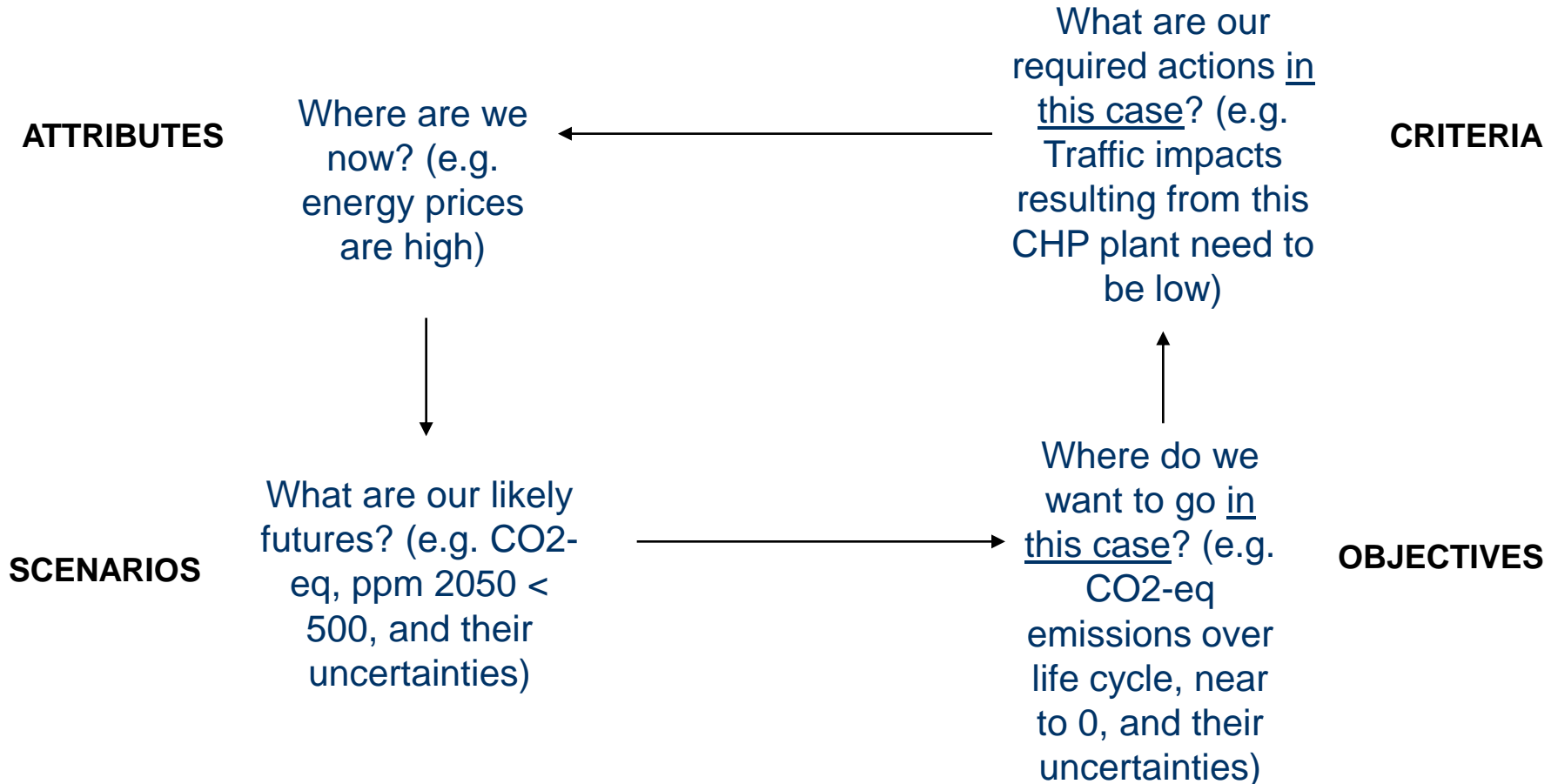
e.g. “TRAFFIC IMPACTS RESULTING FROM THIS CHP PLANT need to be LOW”



Policy development process - Oct 2008



System: UK bioenergy, 2008-2050; Case: Dunsfold Park CHP plant



¹Belton, V and Stewart, T (2002) Multi-Criteria Decision Analysis: An Integrated Approach, Kluwer, Boston.

²Greening, L and Bernow, S (2004) Design of co-ordinated energy and environmental policies: use of multi-criteria decision-making, Energy Policy 32: 721-735.

Oct 2008 workshops – participant evaluations



- Bellagio principles¹ for the assessment of sustainable development
- The process was felt by nearly everyone to have potential to contribute to sustainability. The specific implementation was criticised in certain ways (representation, topics discussed, slightly rigid methods)
- Some felt that the narratives partly determined the outcome
- “Matrix” approach to participatory discussions (first smaller groups, then larger groups) was praised
- The use of Q methodology and subsequent discussions; comparisons of quantitative estimates of system scenario and case objective attributes; and the development of criteria using the “matrix” approach were generally regarded as successful on this occasion



¹Hardi, P and Zdan, T (1997) Assessing Sustainable Development: Principles in Practice, IISD.

December 2008 workshops: PLEASE COME UNIVERSITY OF SURREY

- 4 December 2008 at University of Surrey: Themes 2 & 3 workshop
 - To develop Theme 2 narratives of the state of the UK bioenergy system and research landscape. A variant of the method used to develop the Theme 1 narratives in May 2008 will be used
- 9 December 2008 at Imperial College: all Themes workshop
 - Prior to this workshop, all participants will read and form measures of agreement with the current Theme 1 and Theme 2 narratives, using the Q methodology
 - The October 2008 sustainability assessment workshop methodology will be followed for the UK bioenergy system. The goal will be to derive as comprehensively as possible, criteria for the development of the UK bioenergy system including that of the research agenda



¹Hardi, P and Zdan, T (1997) Assessing Sustainable Development: Principles in Practice, IISD.