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# Application of Sustainability Assessments for (Bio)energy Options: Merging expert knowledge and participation using Multi-Criteria Analysis


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Woody Biomass Energy Research Symposium for the Northern Forest

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# Realizing bioenergy…

HOME / NEWS / LOCAL / MASS.

## Biomass power plant is rejected

The Boston Globe

Regulators cite truck traffic

By Maddie Hanna
Globe Correspondent / August 28, 2008

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Plans for a controversial 50-megawatt wood-burning power plant in Russell were dealt a setback by the state Department of Public Utilities, which ruled that the facility would cause "significant, disrupting, and lasting" impacts on the town.

 

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# Failure of bioenergy systems

- In UK, 27 percent of researched bioenergy plants rejected in the planning stage (Upreti and Horst 2002).
- In India, 250 small-scale gasifiers for power production ran for an average total of 160 hours only (Ghosh et al. 2003).
- In India, Gasifiers ran for 25% of the time solely on diesel (Ravindranath et al. 2004).

**Failure due to social factors**

 

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# What is sustainability?

- Bruntland Commission (1987): "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"
- Holling (2001):"Sustainability is the capacity to create, test, and maintain adaptive capability"

 

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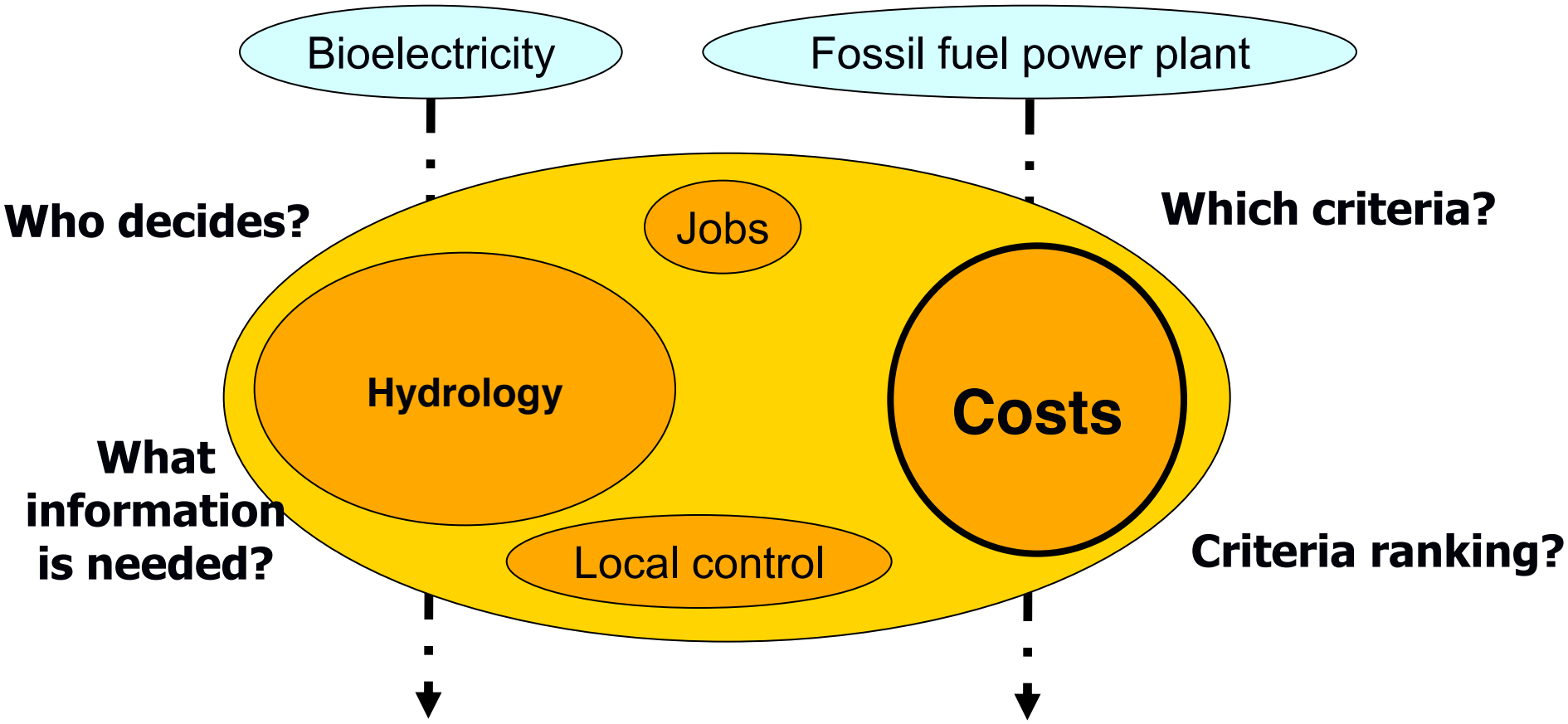
# Why participation in bioenergy sustainability assessments?

- Sustainability is a process of knowledge production and norm creation (Rametsteiner 2009)
- Local stakeholders
  - Are impacted most directly
  - Can effectively communicate with each other
  - Often in the best place to implement solutions
- Normative values can rarely be assessed by experts
- Experts can differ in their opinions as well
- Local knowledge provides critical insights for evaluating impact and potential solutions
- Stakeholders are the 'adaptive' core component of bioenergy systems
- **Involve them early: Participation supports later success**

# Multi- Criteria Analysis



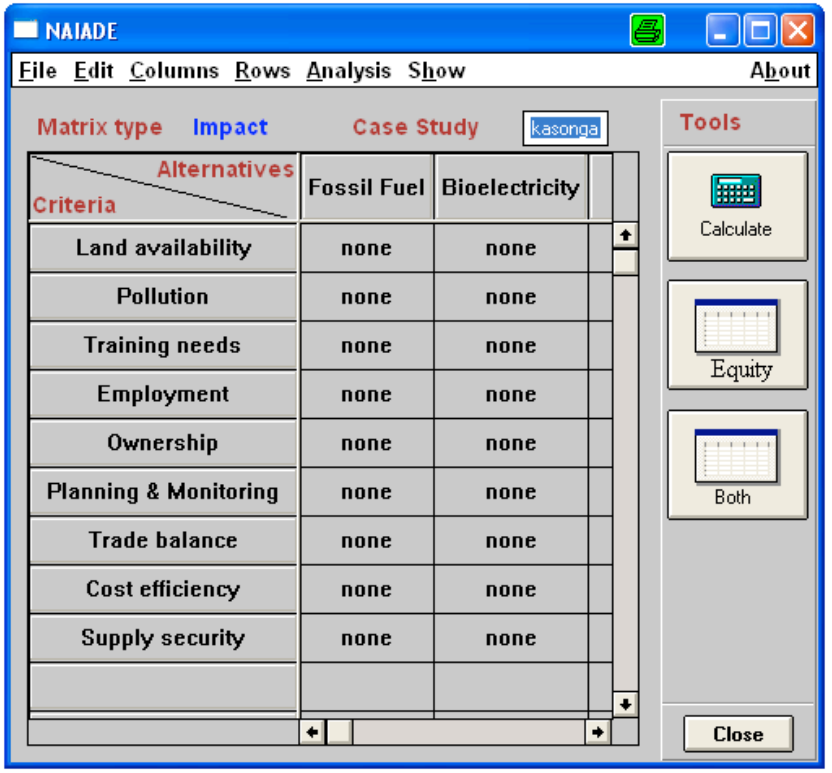

Performance of alternatives?

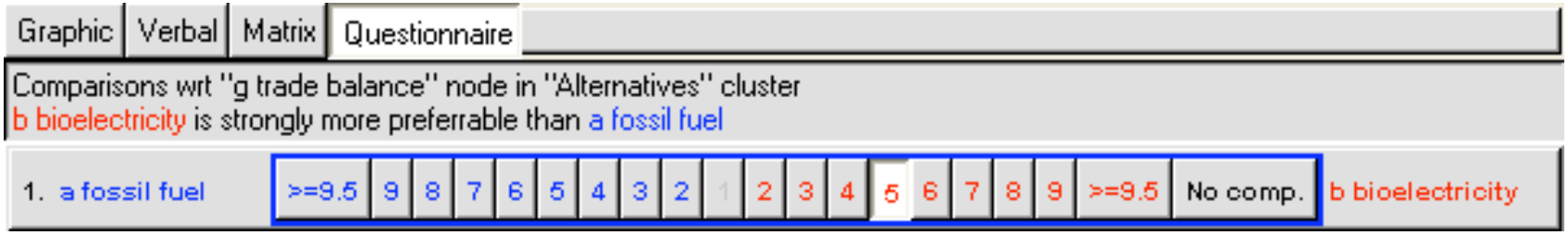
Preferred/more sustainable alternative?

# Multi-Criteria Analysis to assist participatory assessments

- Software based decision tools to assist in complex decisions
- Use of criteria (criteria weights), and alternatives
- Criteria performance assessment
- Ranking of alternatives
- Sensitivity analysis




Pairwise comparisons with *Super Decisions*

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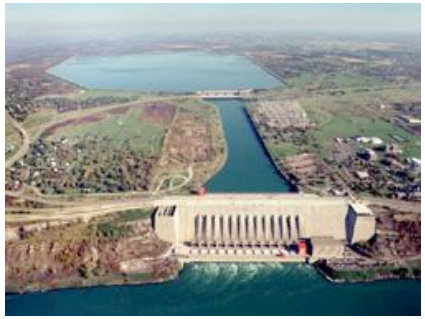
# A participatory framework for bioenergy sustainability assessments

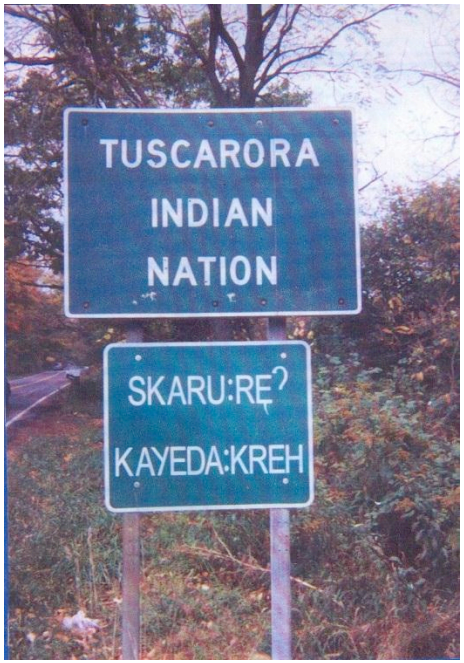
- A formal approach helping individuals or groups to structure and explore complex decisions
- Uses sets of criteria to structure, model and analyze problems, various outcomes and alternatives
- Focuses on multiple objectives and alternatives rather than single objective optimization
- Similar assessments widely applied in e.g. natural resources management (Mendoza and Martins 2006 study ~ 60 applications)

# Case study I: Electricity Options for an Iroquois Nation

- Tuscarora Settlement Agreement (2005)
  - 1 MW Firm Power from Niagara Falls
- ~350 Residential & Small Business Users
  - 3.4 Million kWh (2006)
  - Single Provider (National Grid)
- Focus on home electricity use
- Energy Independence?
- Traditional Biomass?







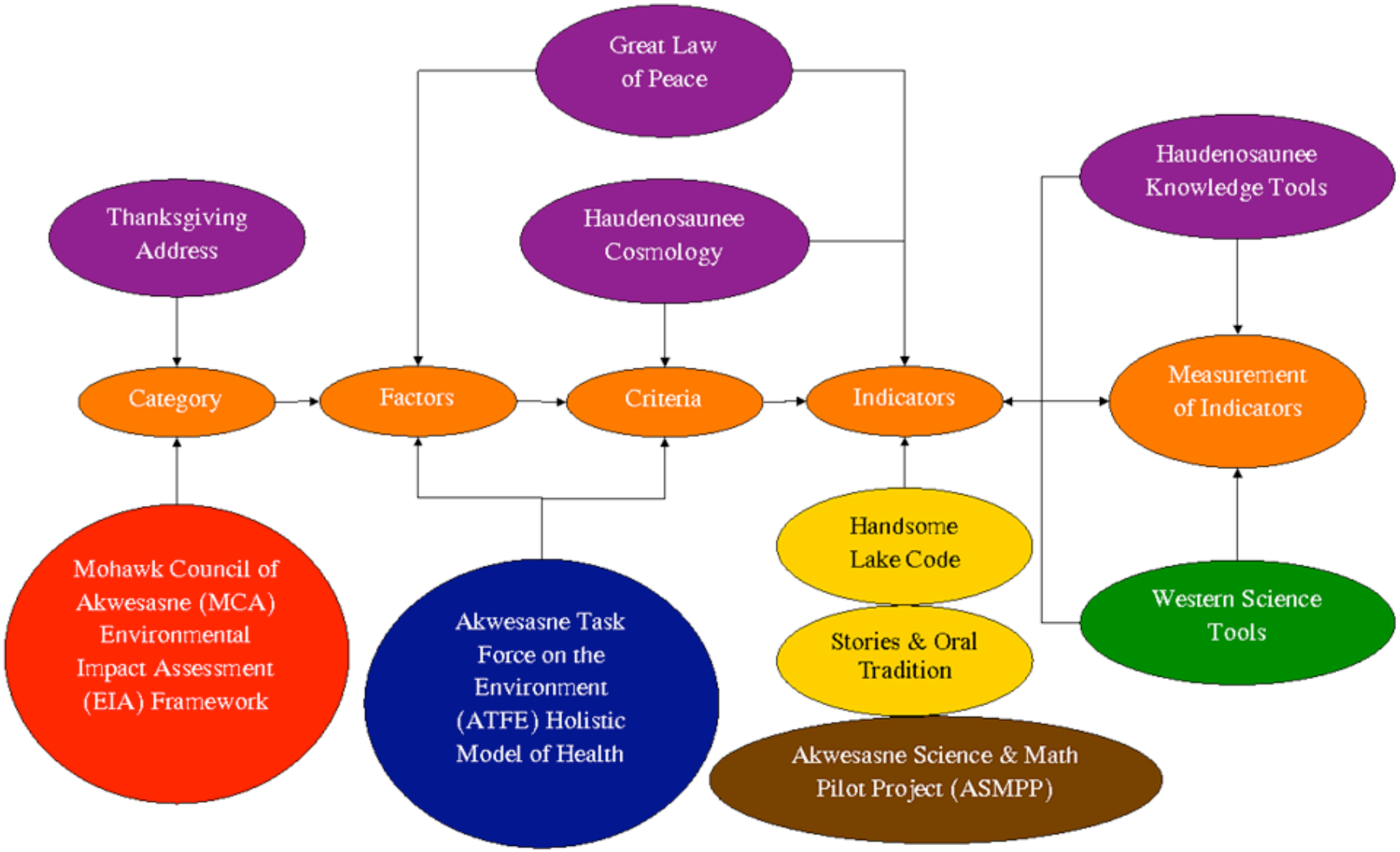

 

# Tuscarora Electricity Production

| | Option | How? | Electricity Produced |
|---|---|---|---|
|  | Food Plants (Soybeans) | Around 1,400 acres of soybeans grown in rotation and burned in a cogeneration plant. | ~44,000,000 - 63,000.000 kWh (19-28%) |
|  | Grasses (Switchgrass) | Around 1,400 acres of switchgrass grown in rotation and burned in a cogeneration plant | ~1,845,000,000 - 2,636,000,000 kWh (800 -1100%) |
|  | Trees (Shrub Willow) | Rotations of over 1,400 acres of perennial willow shrubs burned in a combined heat and power facility. | ~167,000,000 – 218,000,000 kWh (180-1000%) |
|  | Trees (Forests) | Wood sustainably harvested from 1,400 acres of forest burned in a local cogeneration plant. | ~24,000,000 -29,000,000 (10-13%) |
|  | Wind (turbines) | One large 1 MW wind turbine at 35-50% efficiency | ~123,000,000 – 175,000,000 kWh (55-78%) |
|  | Sun (solar panels) | 4-kW PV solar arrays installed on 351 Tuscarora homes. Each array is estimated to be at least 48 square feet. | ~60,000,000- 1,000,000,000 kWh (26-44%) |
|  | Business As Usual | No change in source of electricity. Provided from coal, oil, nuclear, and hydroelectric. | ~222,000,000 kWh (100%) |

Source: Patterson 2009

# Traditional Iroquois Decision Framework




Source: LaFrance and Costello 2008

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# Case study II: Sustainability assessment of a wood to electricity system in Uganda

- Trading centre in rural Uganda (~500 inhabitants, serving 20,000)
- **Current situation:** individually owned fossil fuel powered generators
- **Biopower alternative:** wood gasification with grid
- Identification of key stakeholders, workshop setting
- Criteria selection, voting on criteria weights and assessments of alternatives


Cell phone charging service, Kyangwali, Uganda

# Adaptive participatory sustainability assessment framework for energy systems

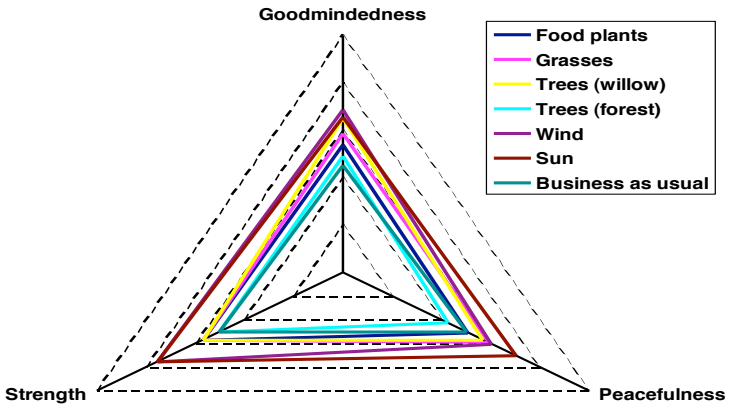
**Stakeholder identification**

preconditions

Social
Economic
Environmental

**Model building & identification of alternatives**

**Energy Decision cycle**




Own criteria

**Criteria selection**

Basket of expert criteria (e.g. BioenergyWiki)

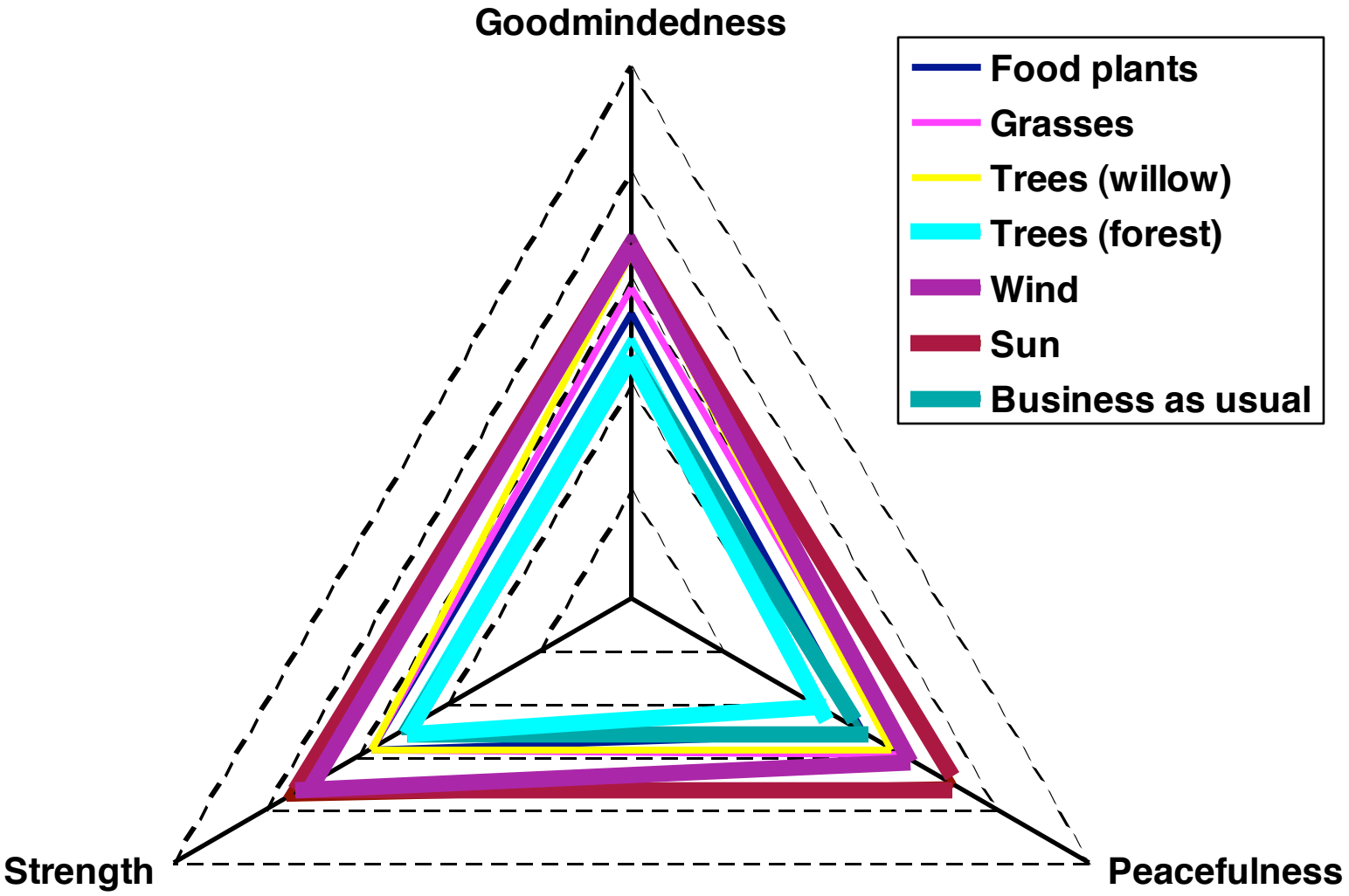
**Criteria weighting**

Criteria A

Criteria B

Criteria C

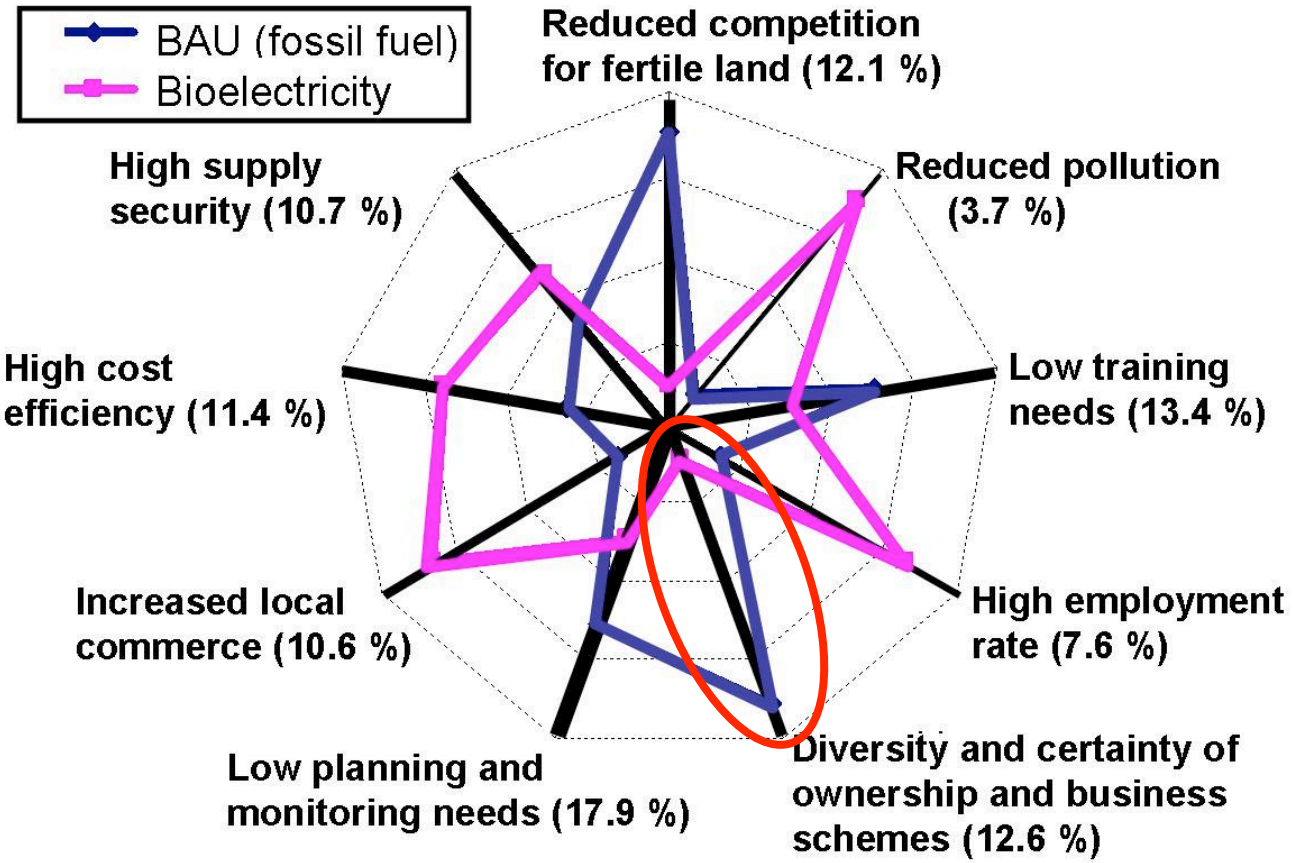
# Iroquois case study: Assessment of Electricity Options



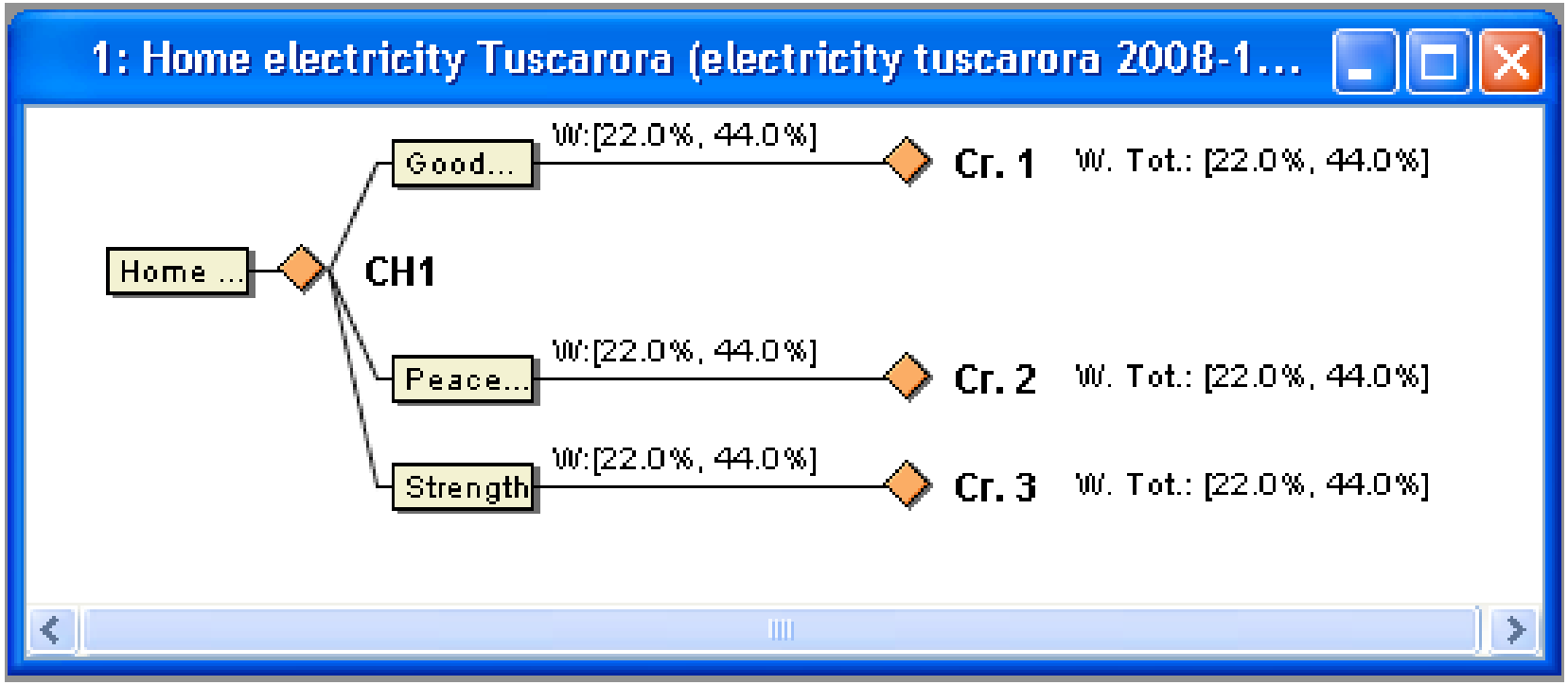
# Uganda case study





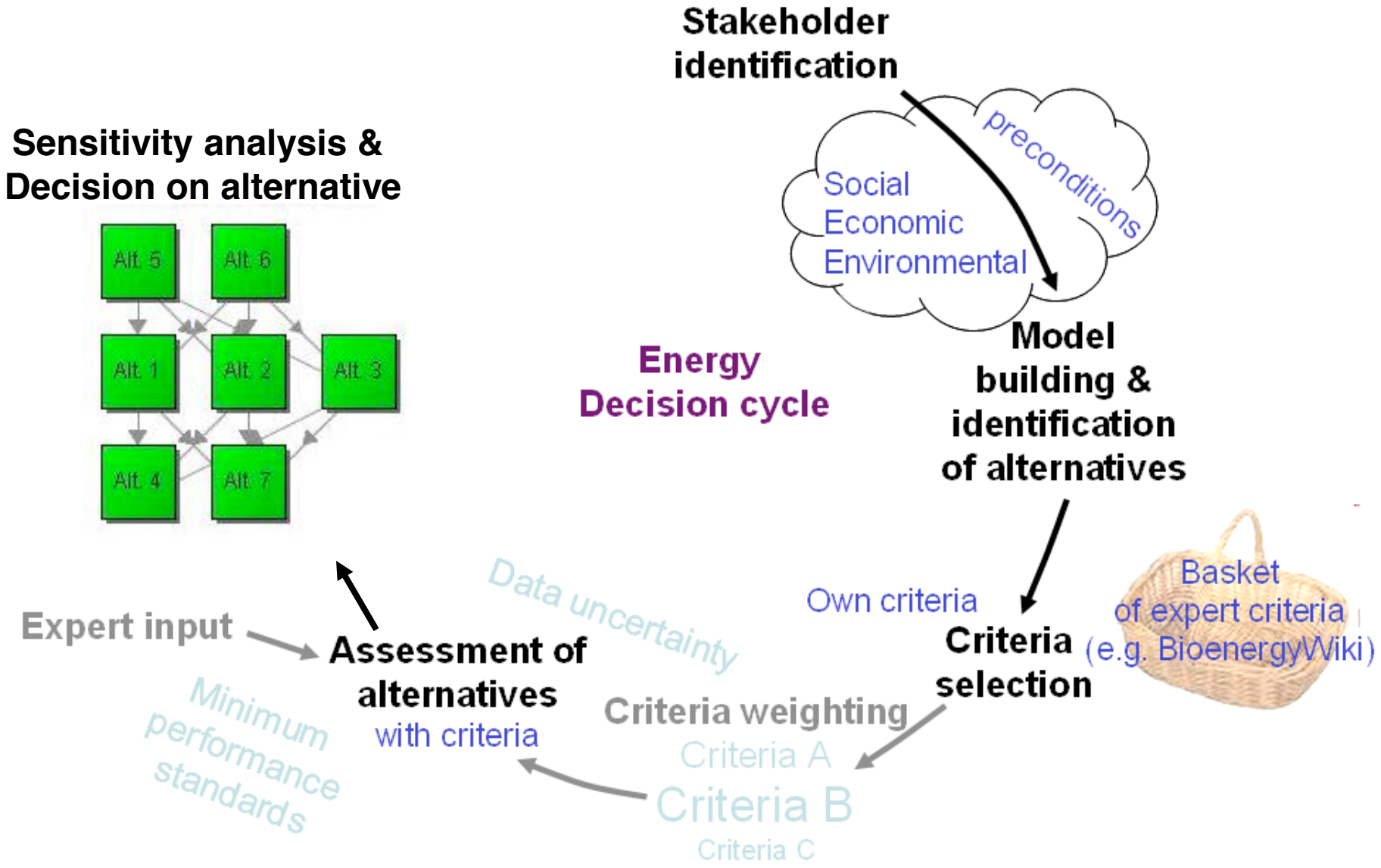
# Iroquois case study: Multi-Criteria Analysis software - *DecideIT*



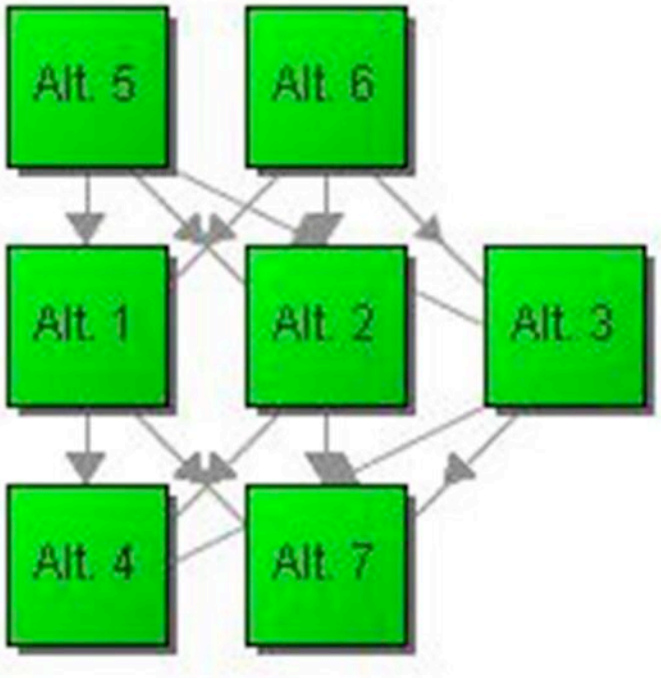

**Other MCA software we used:**
***SuperDecisions*** **(AHP),** ***NAIADE, Decision Lab*** **(Promethee)**

# Adaptive participatory sustainability assessment framework for energy systems



# MCA Software *DecideIT*




**Electricity production options at Tuscarora:**

Option 1: Electricity from food plants

Option 2: Electricity from grasses

Option 3: Electricity from trees (willow)

Option 4: Electricity from trees (forest)

Option 5: Electricity from wind

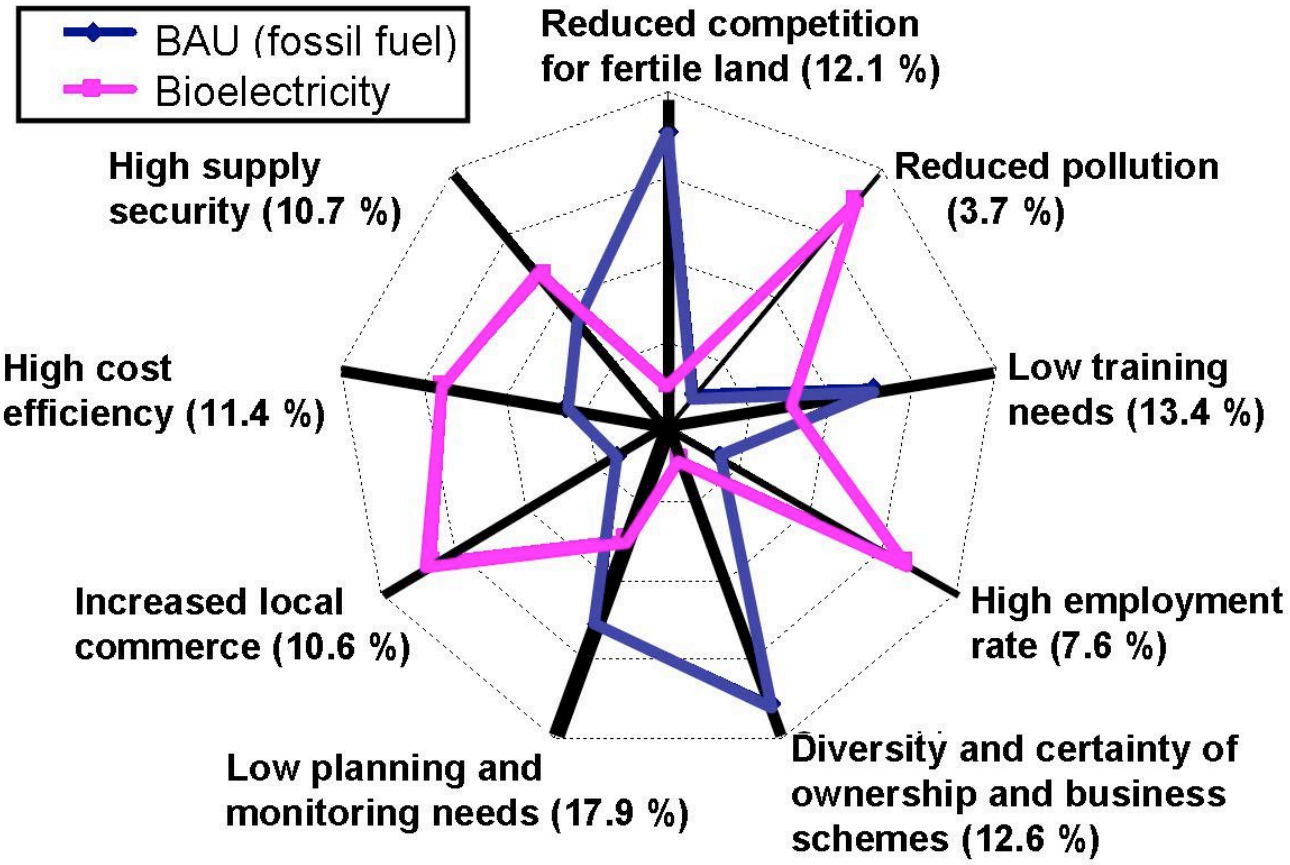
Option 6: Electricity from sun

Option 7: Business as usual

**Indifference Interval: 10 %**

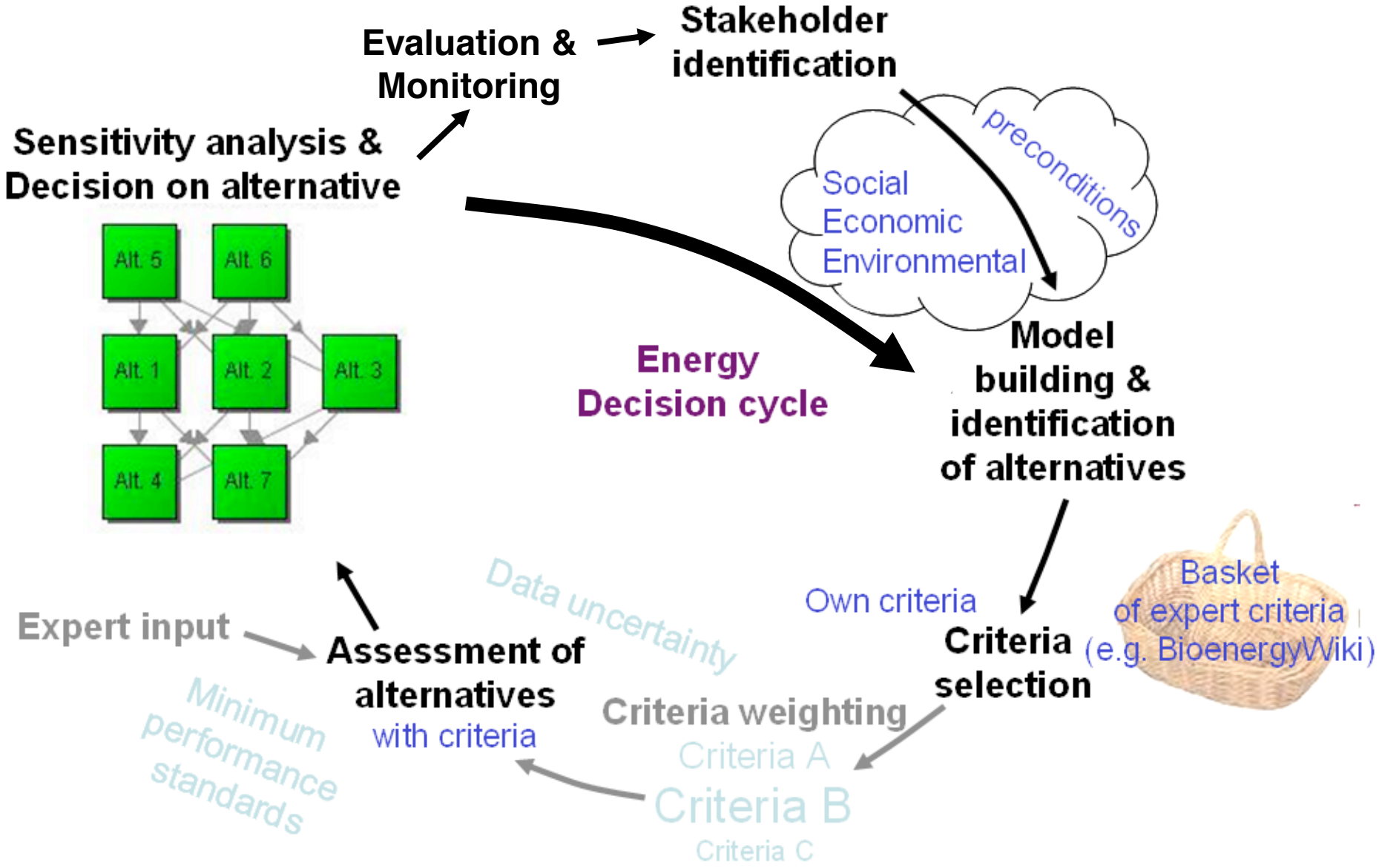
# Uganda case study




**Fossil fuel alternative was preferred over alternative biopower system**

# Adaptive participatory sustainability assessment framework for energy systems



# Comments…questions!

## Thank you for your attention!

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