Rigorous Soft Method

The National Nuclear Power Issue

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The Issue

- The following scenario is real: the identity of the industrialized country has been omitted, along with many factors contributing to the issue.
- Broadly, the issue is one of concern about future energy supplies and global warming, exacerbated by fossil fuel CO_2 emissions.
- The national government has already committed to dismantling its nuclear energy industry within a decade, while at the same time signing up to the 1997 Kyoto protocol, aimed at the international reduction in greenhouse gas emissions.

Article

- *"There is uncertainty about the future of nuclear power. Activists are protesting about both the dangers from power stations and the difficulty of waste disposal. Illnesses, particularly infantile leukemia, are being ascribed to radiation from power stations, although scientists are unable to detect any causal relationship.*
- *"Government is concerned, both about public opinion and about the massive costs of decommissioning power stations. The alternatives seem uncertain, too. Fossil fuel is problematic, with the cost of coal rising slowly but inexorably. The availability and cost of oil is always a problem, associated as ever with a volatile Middle East.*
- *"Government has committed, too, to reducing greenhouse gas emissions, and has signed up to the international Kyoto Accord. The major generator of CO_2 is fossil fuel. If CO_2 emission control is to be realized, it seems inevitable that fossil fuel burning will have to be reduced, but how, and if there is to be no nuclear industry, what is the future source of energy going to be?*
- *"A new factor has arisen: the rail link to the continent. This promises to reduce the cost and time of freight, but it also carries the threat of ingress from undesirable elements.*
- *"What to do? There seems to be no sensible way forward" (Anon.)*

Issue Symptoms?

- Reading through the situation, there seems to be no obvious solution and, in addition to that, precious few symptoms; that is, indications of change from a prior, supposedly satisfactory state. A short list follows:

List of Symptoms

Symptom	*Description*
1	Activists are protesting. Although the topics of protest may not be new, the act of protesting appears to be, and government is concerned over public opinion
2	There is a concern that radiation may be causing infantile leukemia, although there is no scientific evidence
3	Nuclear power stations are widely seen as dangerous and expensive, especially when decommissioning is considered
4	The cost of coal is rising slowly, while the international cost of oil fluctuates wildly and is quite beyond control
5	The government has committed, under the Kyoto Accord, to reduce greenhouse gases; mainly CO_2
6	The new rail connection to the European continent is seen as a two-edged sword

Public Concern

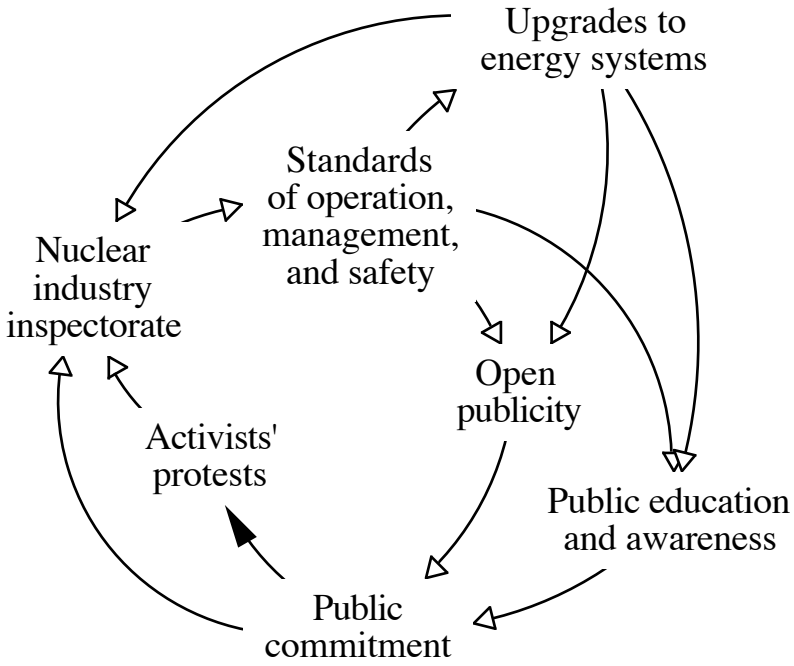
Politics
Organization
Economics
Technology
Inertia/inactivity
Culture

Possible Causes — *Symptom*

Fear of nuclear accidents/weapons
Fear of radiation illnesses (e.g., leukemia)
Concern over environment
Wish to bypass democratic process
Wish to impose minority viewpoint

→ Activists' protests

Causal Loop Model



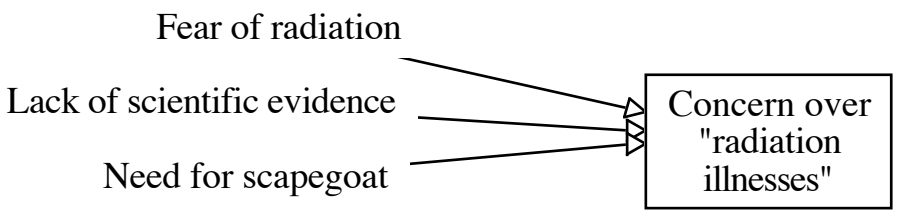
Imbalanced Systems

System for…		System for…
Nuclear inspection	↔	Standards
Standards	↔	Upgrades
Upgrades	↔	Public education
Public education	↔	Public confidence
Public confidence	↔	Public commitment
Public commitment	↔	Nuclear inspection

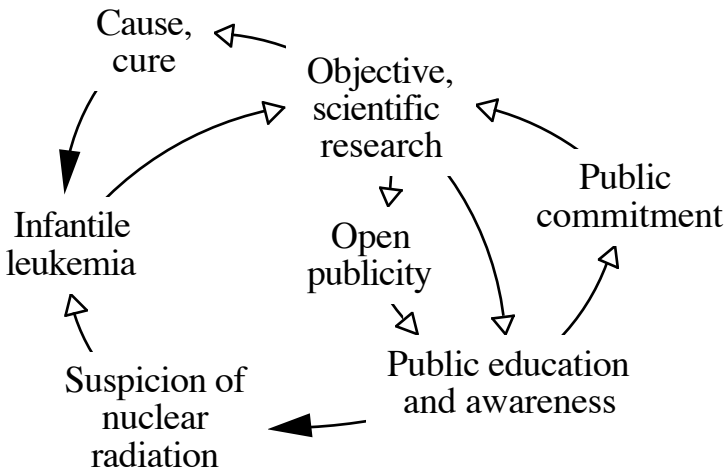
Leukaemia Scares

Politics
Organization
Economics
Technology
Inertia/inactivity
Culture

Possible Causes *Symptom*



Causal Loop Model

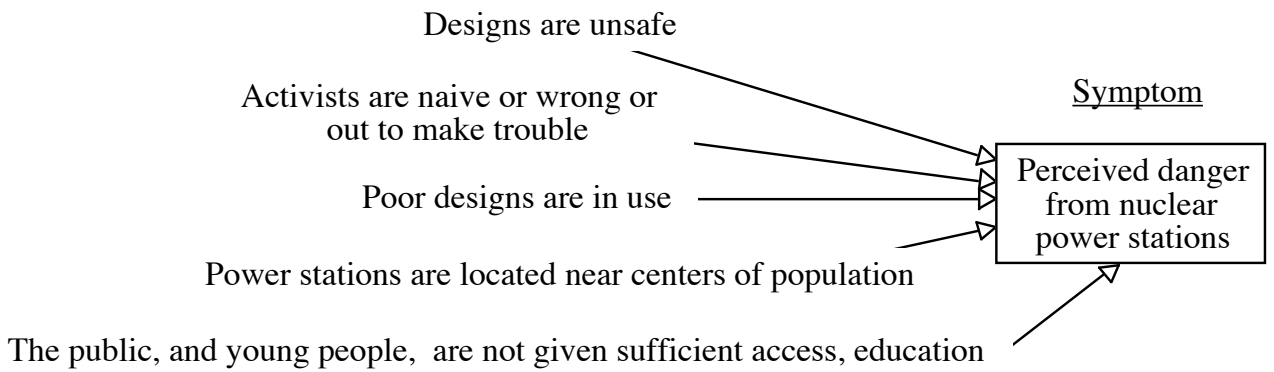


Imbalanced Systems

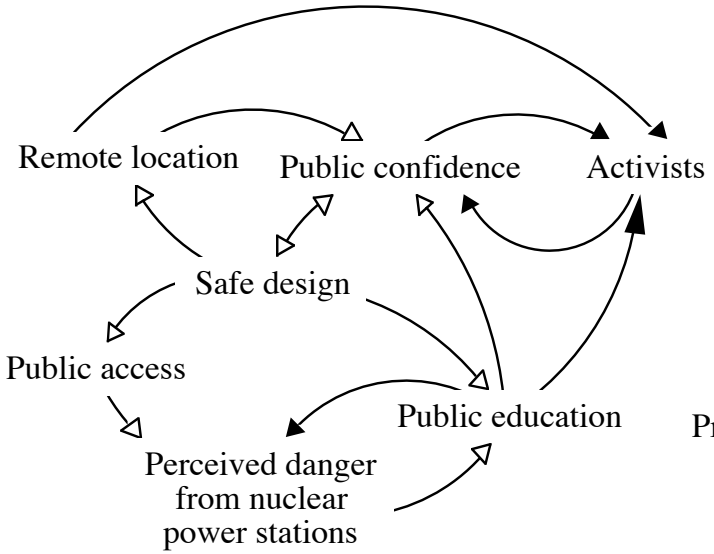
System for…		*System for…*
Objective research	↔	Medical understanding
Medical understanding	↔	Public understanding
Public understanding	↔	Public commitment
Public commitment	↔	Objective research

Nuclear Dangers

Laundry List of Possible Causes



Causal Loop Model



Imbalanced Systems

Systems for…

Designing PSs safely ⟷ Publicizing designs

Publicising designs ⟷ Educating public

Educating Public ⟷ Promoting public confidence

Promoting public confidence ⟷ Locating power stations

Fossil Fuel Costs

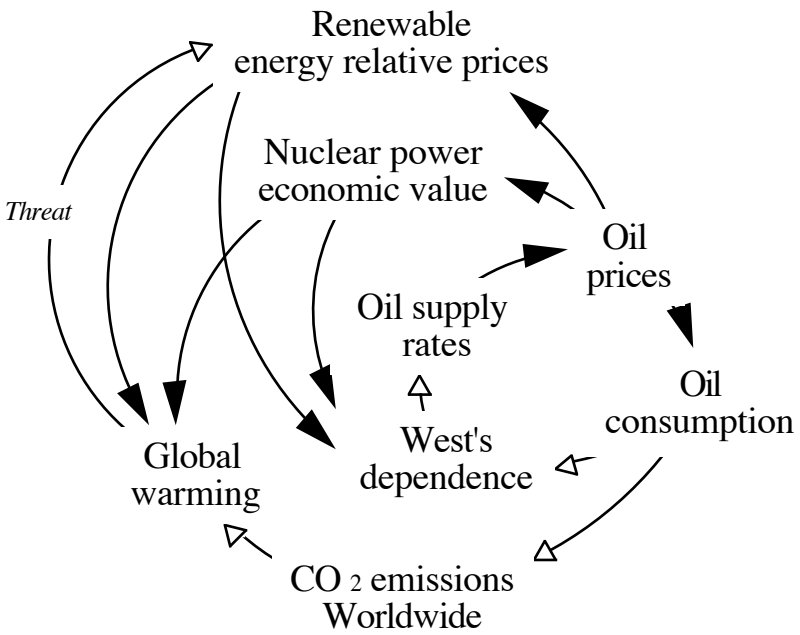
Politics
Organization
Economics
Technology
Inertia/inactivity
Culture

Possible Causes *Symptom*

Perception of dwindling resources
Supply countries restricting flow to raise prices
Supply countries' view of current inelastic market
Supply countries' awareness of west's move away from fossil fuels
Government-imposed tax to encourage alternative energy sources

→ Rising costs of fossil fuels

Causal Loop Model



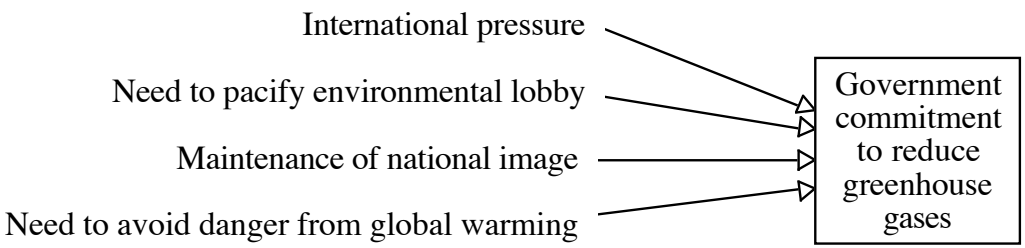
Imbalanced Systems

System for…		*System for…*
Supplying oil	↔	Consuming oil
Consuming oil	↔	CO_2 emission control
CO_2 emission control	↔	Continued global warming
Continued global warming	↔	Renewable energy sources
Renewable energy sources	↔	Sustained nuclear power
Sustained nuclear power	↔	Supplying oil

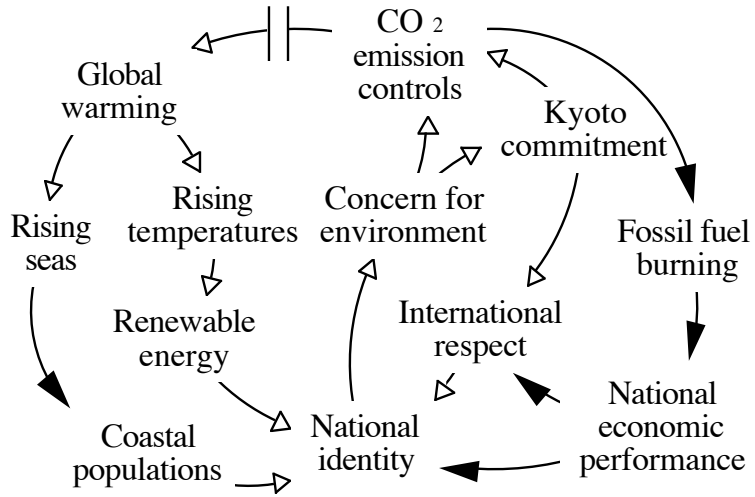
Kyoto Accord

Politics
Organization
Economics
Technology
Inertia/inactivity
Culture

Possible Causes *Symptom*



Causal Loop Model



Imbalanced Systems

System for…		*System for…*
Maintaining national Identity	↔	Environmental concern
Environmental concern	↔	Controlling CO_2 emissions
Controlling CO_2 emissions	↔	Reduced fossil fuel burning
Reduced fossil fuel burning	↔	Meeting increasing energy needs
Meeting increasing energy needs	↔	Maintaining economic credibility
Maintaining economic credibility	↔	Maintaining national identity

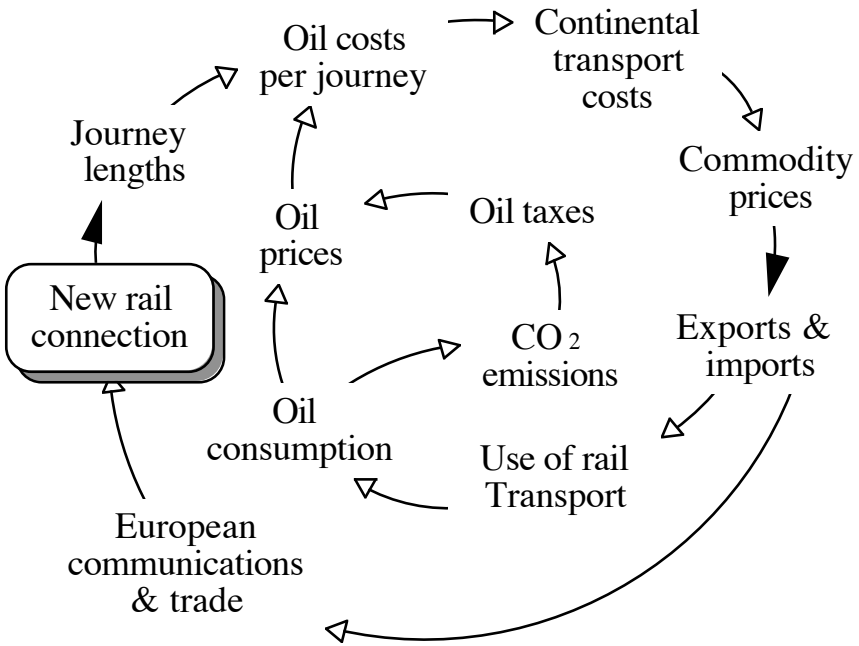
Rail Link

Politics
Organization
Economics
Technology
Inertia/inactivity
Culture

Possible Causes *Symptom*

Desire for closer European association →
Desire for cheaper, faster transport → New rail link to continent

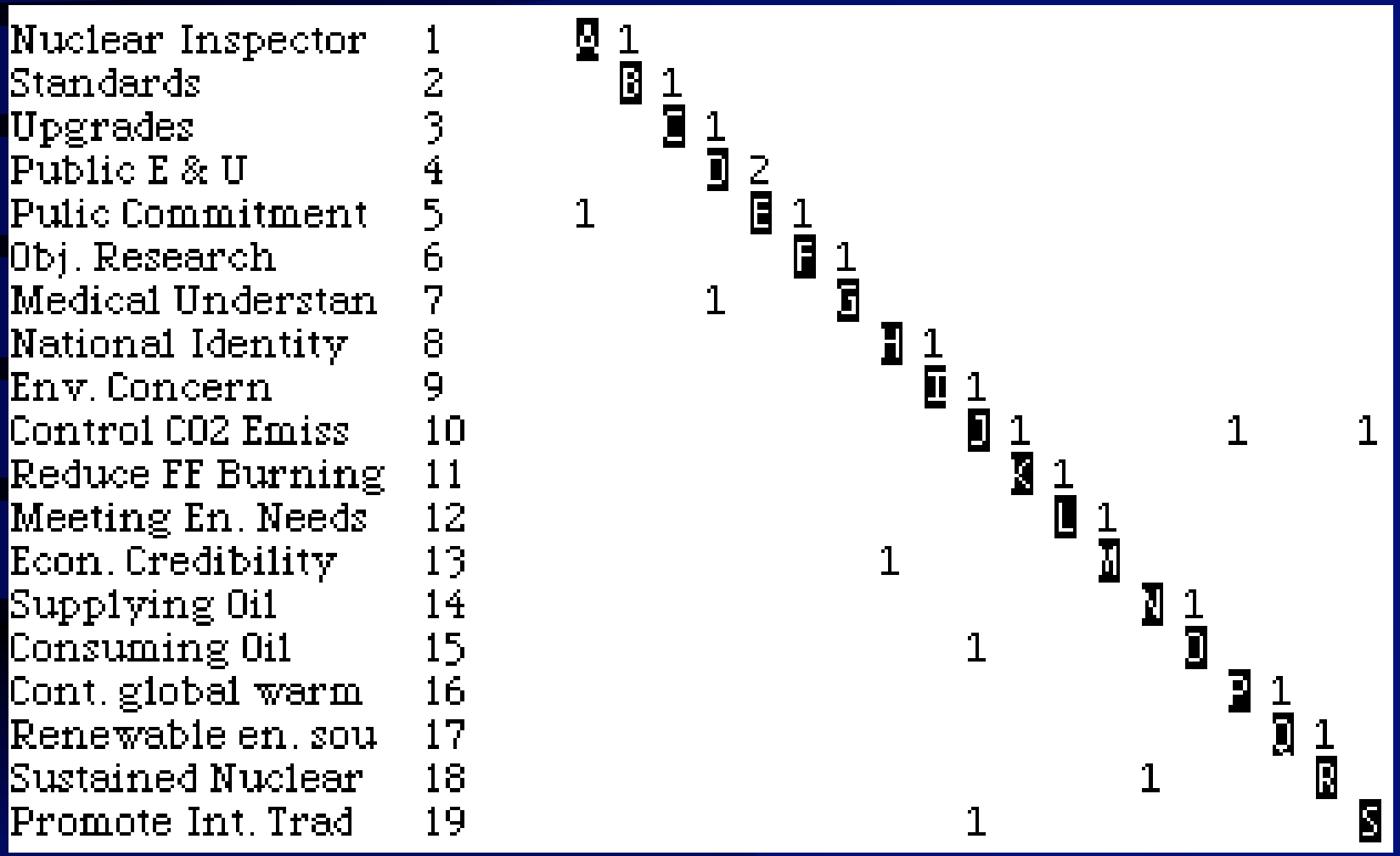
Causal Loop Model



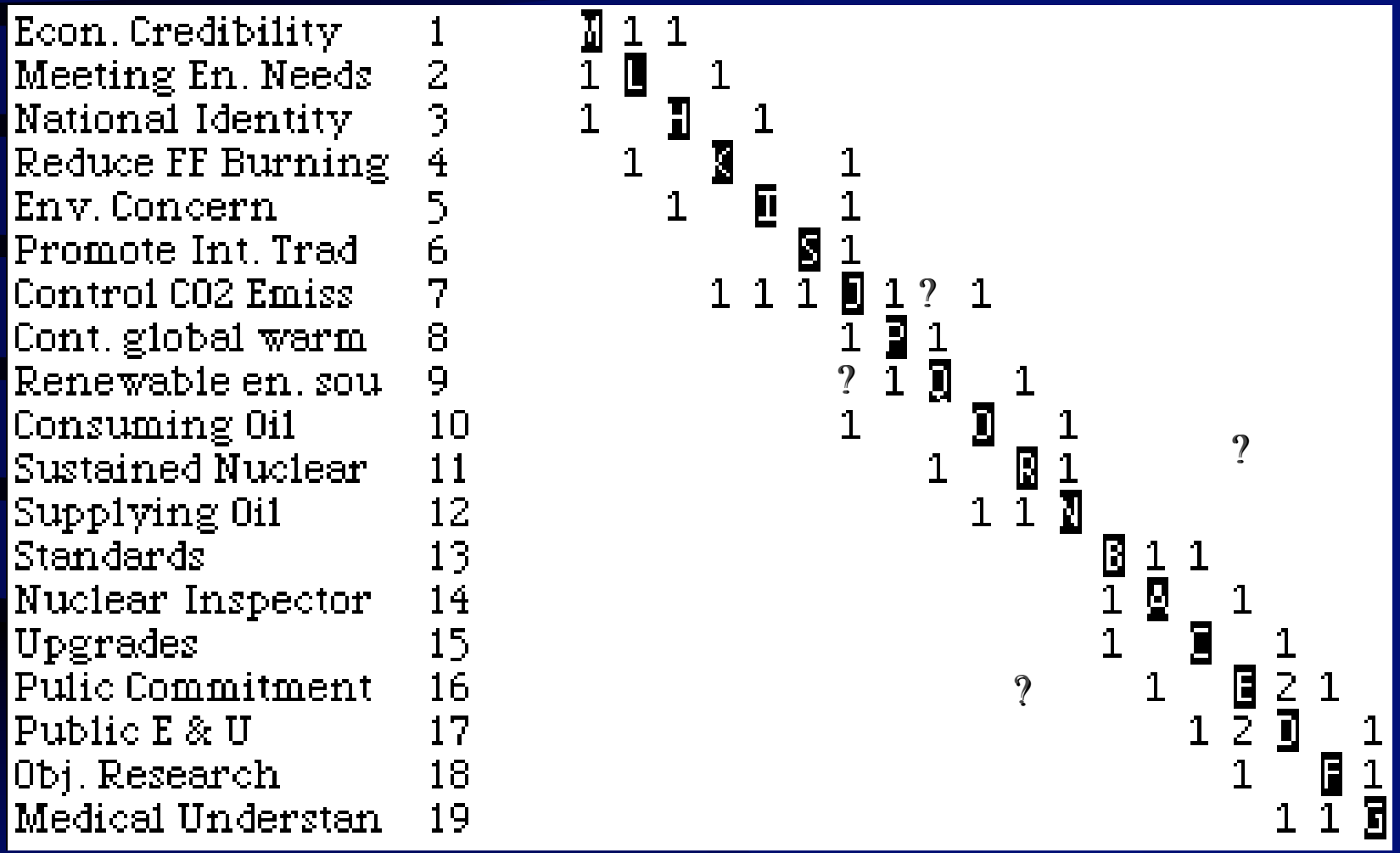
Imbalanced Systems

System for…		*System for…*
Promoting international trade	↔	Controlling CO_2 emissions
Controlling CO_2 emissions	↔	Promoting international trade

Implicit Systems in N2 Chart



Clustered N2 - with Omissions

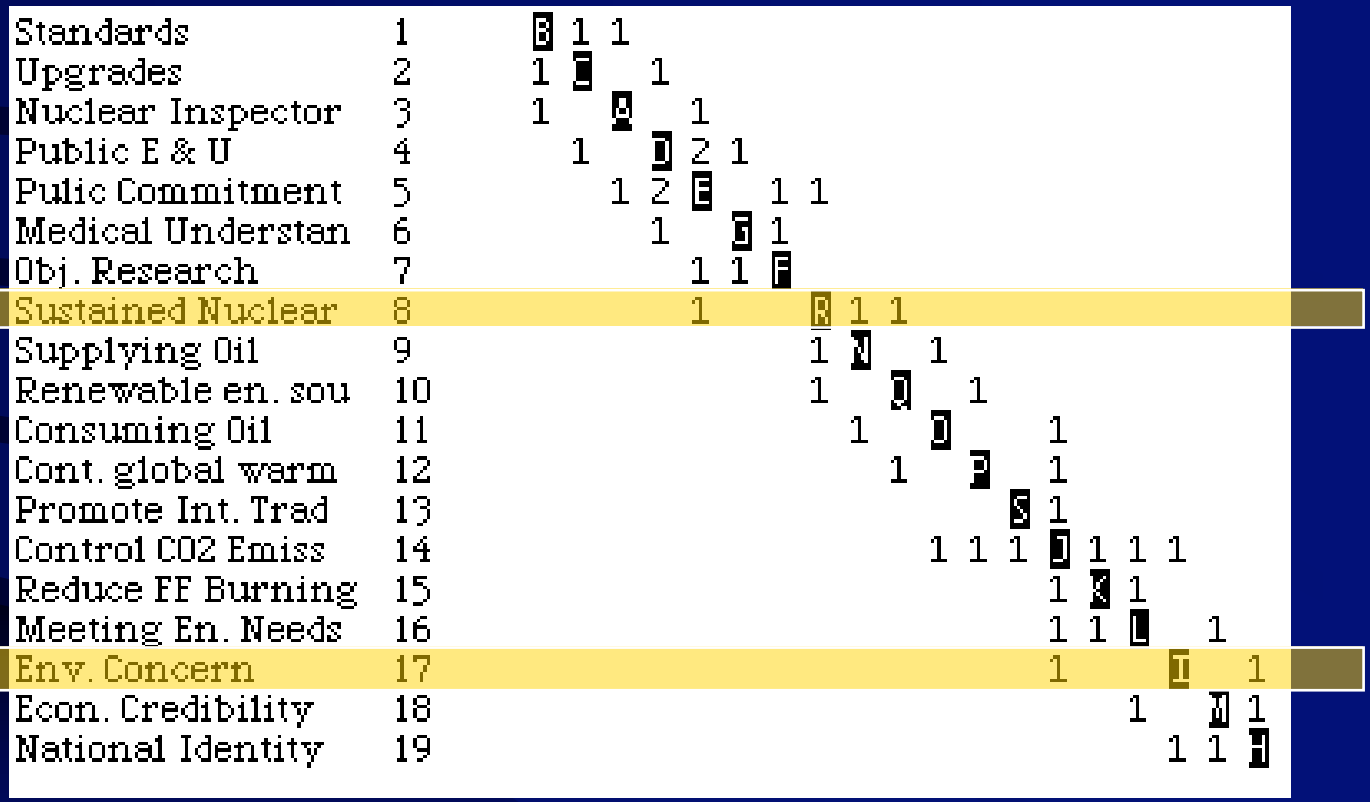


Systems and Nexus

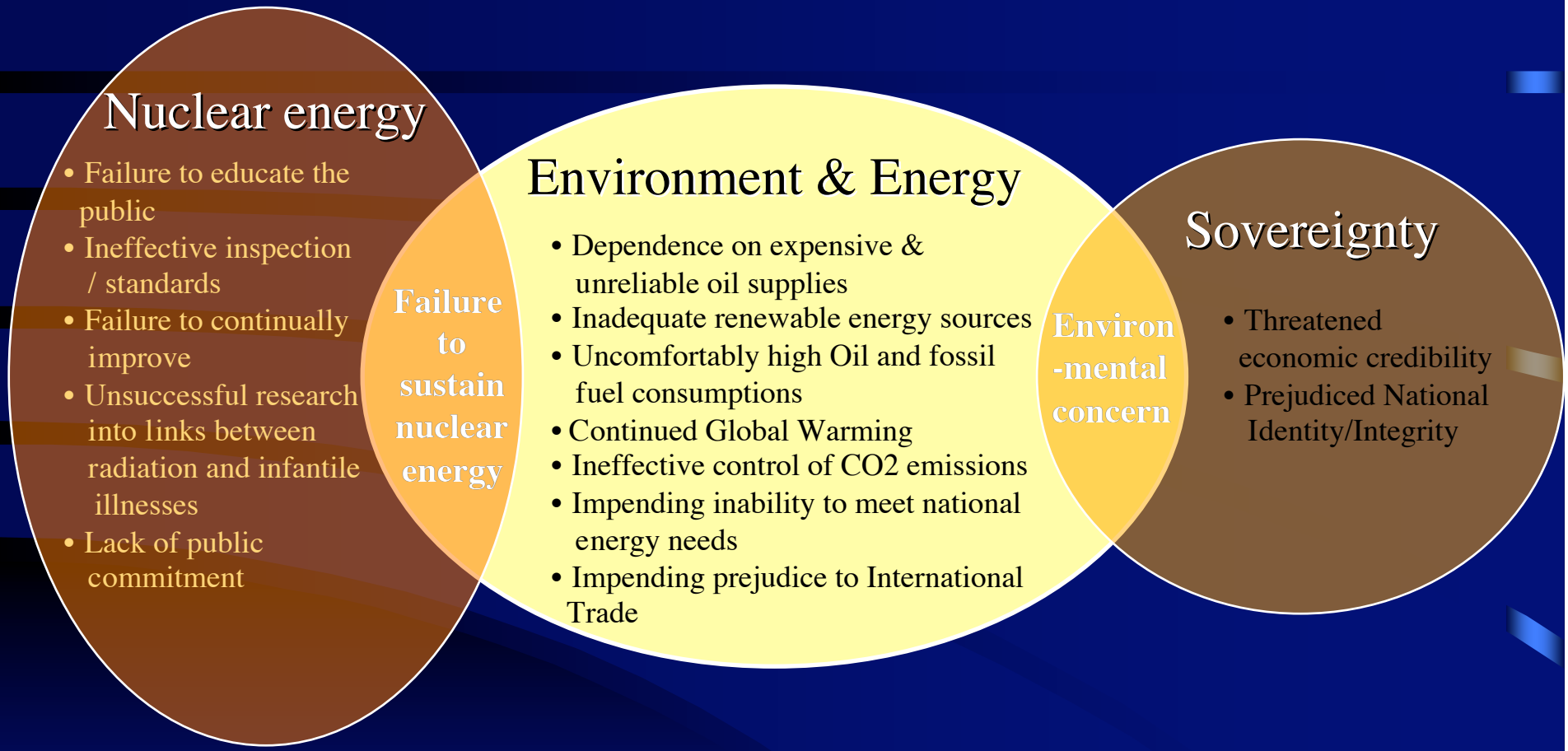
Nuclear Energy

Environment & Energy

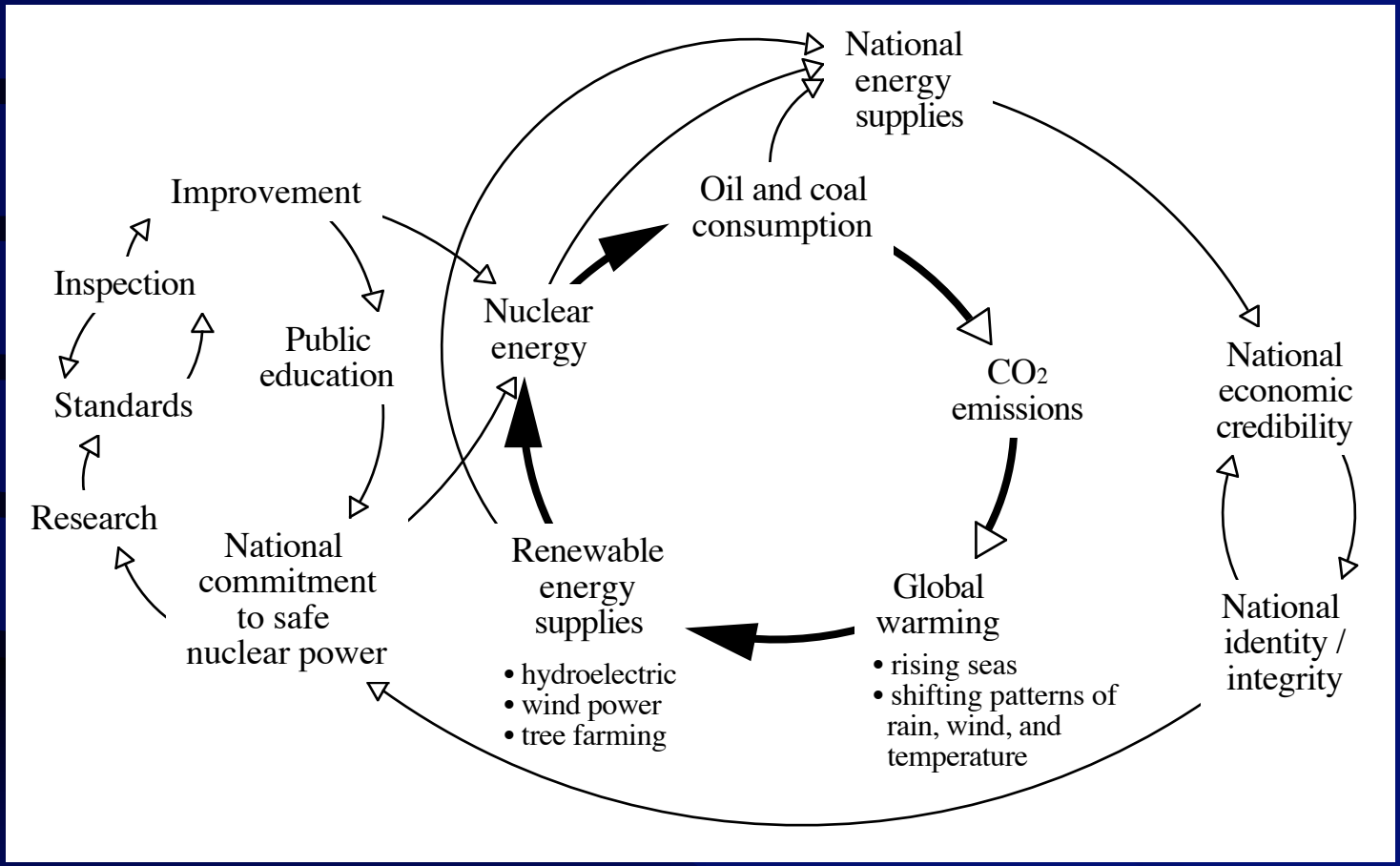
Sovereignty



Systems Interaction Diagram (SID)



High Level CLM



Reveals fallacy. Global warming will change weather patterns.
May well negate current renewable energy sources
Central loop breaks…

National Options

1. **Continue/increase using fossil fuels**:
   - Phase out nuclear power; increase CO_2 emissions;
   - Maintain international trade, national economic performance using increasing amounts of fossil fuels;
   - Renege on the Kyoto Accord.
2. **Retain, sustain, and enhance nuclear energy**:
   - Reduce oil, and reduce greenhouse gas emissions, using mixed energy sources;
   - Maintain international trade national economic performance;
   - Educate the public to the advantages and safety of modern/future nuclear power;
   - Introduce a new generation of nuclear power stations of safer design, remotely sited and under even tighter control;
   - Ratify the Kyoto Accord.
3. **Phase out nuclear and fossil energy, and control CO_2 emissions**:
   - Accept reduced industrial and transport capability;
   - Accept reducing international trade and national economic performance;
   - Ratify the Kyoto Accord.
4. **Retain nuclear energy as in 2, but**:
   - Seek alternative sources of energy that do not prejudice the environment or the people;
   - Inform the public of the reasons and research progress;
   - Educate the public to the advantages of retaining nuclear power in the near term, and of switching to advanced energy sources when available;
   - Ratify the Kyoto Accord.

Symptoms and Factors	**Option 1** Continue with fossil fuels	**Option 2** Retain and enhance nuclear energy	**Option 3** Phase out nuclear and fossil fuels; depend on alternative energy	**Option 4** Retain nuclear energy until clean source available; e.g. solar umbrellas, nuclear fusion
Activists are protesting	4	2	3	1
Concerns about radiation and leukemia	4	2	3	1
Nuclear energy seen as dangerous	4	2	3	1
Fossil fuel prices rising and fluctuating	4	1.5	3	1.5
Government signed up to Kyoto agreement	4	1.5	3	1.5
New rail connection to the Continent	4	2	3	1
Factors				
Alternative energy inadequate to sustain economy *and* threatened by Global Warming	3	2	4*	1
Intent to maintain national sovereignty, identity and integrity	3	2	4*	1
	30	15	26	9
	4th	2nd	3rd*	1st

Assessing Energy Options

Rank Matrix Analysis

Options ranked in order of goodness.

Ranks are summed Lowest sum gives preferred option…

*

A non-viable option for economic and global stability

Conclusion

- Retain/enhance nuclear fission energy until clean source available
- Increase research effort into clean sources:
  - Dyson spheres—use solar nuclear fusion
  - Solar umbrellas—use solar nuclear fusion
  - Nuclear Fusion energy
    - Hot
    - Cold?
- No other option meets the national and global need…