The second African Rift Geothermal Conference (ARGeo_C2).
Geothermal Energy for Sustainable Development.
Imperial Resort Beach Hotel, Entebbe, Uganda, 24th – 28th November, 2008.

Master Plan for Geothermal and Hydropower Development in Iceland

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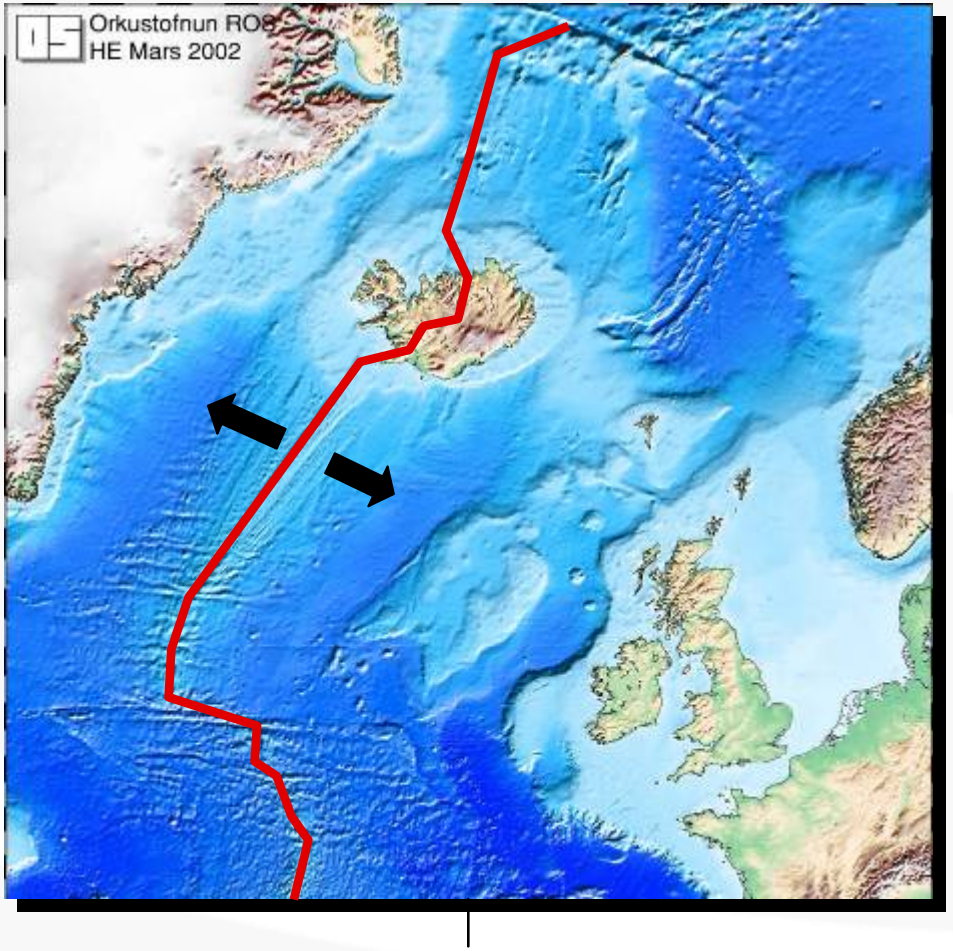
Contents

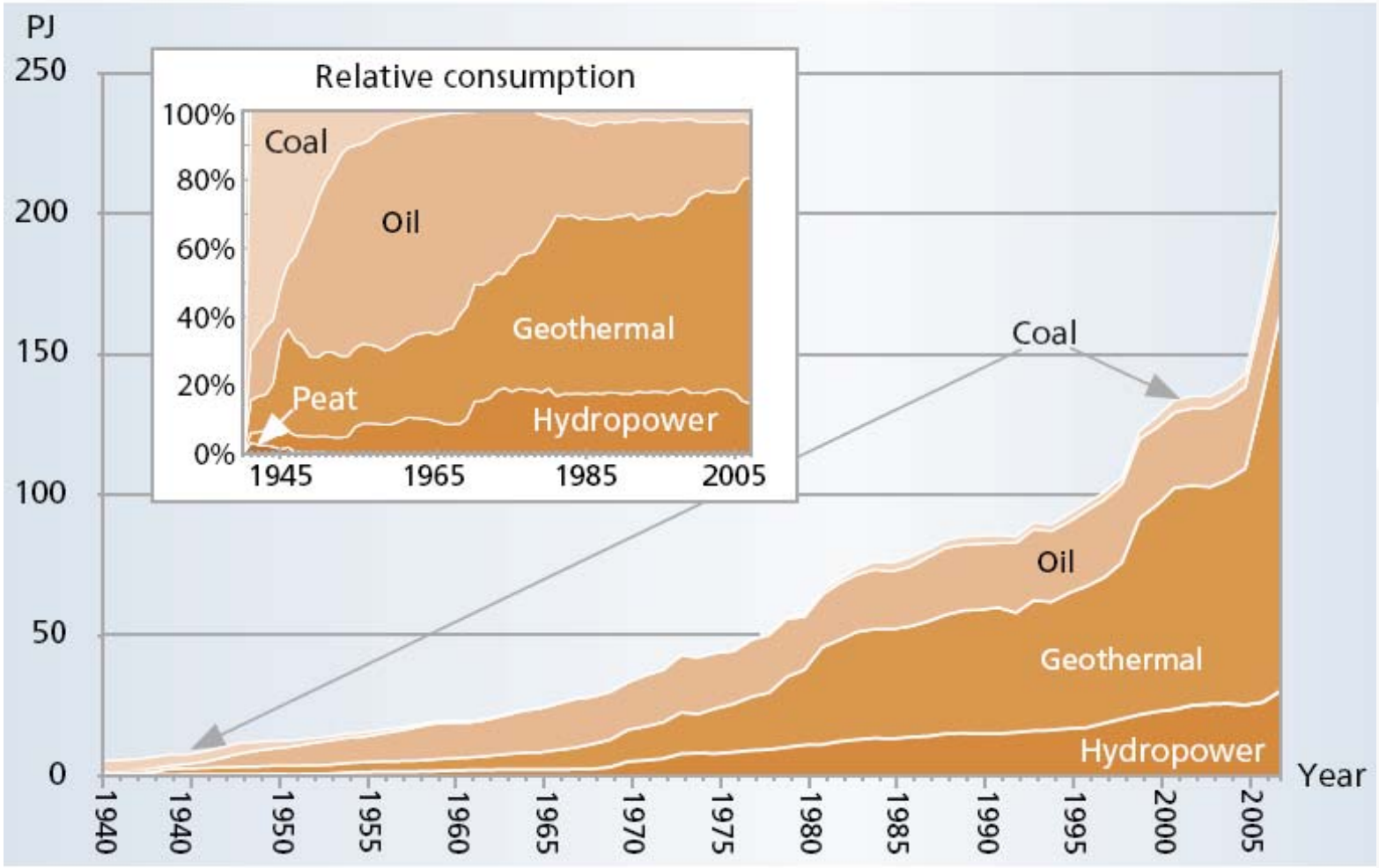
- Energy sources of Iceland
- Energy Policy –Need for a Master Plan
- The Development of the Master Plan
  - Phase I 1997-2003
  - Pase II 2004-2009

Iceland is rich in Energy Sources

- Geothermal: Due to volcanism, as the Mid-Atlantic Ridge crosses the country
- Hydro: Due to mountainous terrain and humid climate. *(the glaciers act as water storage)*



Primary Energy Consumption 1940-2007



Energy development must take not only into account energy needs

Other considerations include:

- Land use
- Regional development
- Employment
- Impact on society at large.
- Impact on Nature (Awareness of which have become more important during the last decades)

NEED FOR A PLAN THAT RANKS POTENTIAL PROJECTS NOT ONLY FROM ENERGY POLICY

Master Plan (MP)
for Utilization of the Energy Resources

- The Icelandic Government decided in 1997 to develop a Master Plan for Hydro and Geothermal Energy Resources.
- The Master Plan should give an overview on the various energy projects and rank them.
- It was expected that about 100 projects would be evaluated.

Purpose of the Master Plan

- Avoid dead ends and disputes about one project each time.
- Find those projects that are best suited from the view of economy and protection of the environment.
- Direct attention to areas which should be left untouched and protected.

Master Plan (MP)
for Utilization of the Energy Resources

Proposed power projects are evaluated and categorized on the basis of:

- Energy efficiency and economic interests
- Impact on the natural environment, cultural heritage sites, grazing, fishing, hunting and recreational activities
- Implications for regional development
- Does not go to the details required in the assessment of environmental impact

Master Plan (MP) Phase I for Utilization of the Energy Resources

Responsibility for the MP is with the Ministry of Industry, in co-operation with the Ministry for the Environment

- A Steering Committee of 16 members
- 4 working groups (about 50 experts)
- A forum for discussion and information exchange organized by the National Association for the Protection of the Icelandic Environment (NGO)

Master Plan (MP)
for Utilization of the Energy Resources

Working Group I

- Evaluates what impact proposed power projects will have on Nature, landscape, geological formations, vegetative cover, flora and fauna, as well as cultural heritage and ancient monuments.

Master Plan (MP) for Utilization of the Energy Resources

Working Group II

- Evaluates the impact on outdoor life, agriculture, re-vegetation, fishing in rivers and lakes, and hunting.

Master Plan (MP)
for Utilization of the Energy Resources

Working Group III

- Evaluates the impact proposed power projects can have on economic activity, employment and regional development.

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for Utilization of the Energy Resources

Working Group IV

- Identifies potential power projects, both hydro and geothermal, and carries out technical as well as economic evaluation of the projects.

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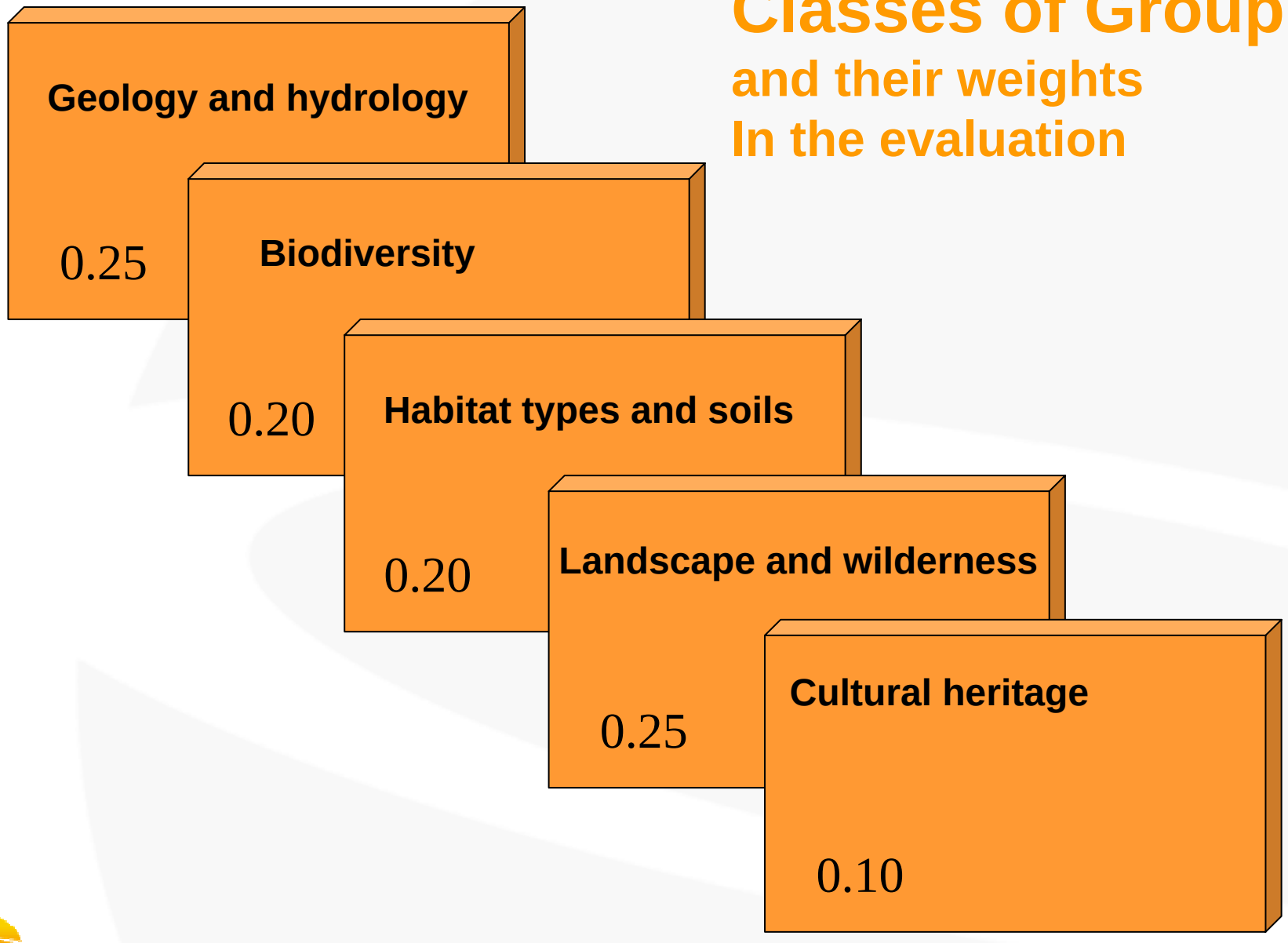
Working Group I

1. To specify and define those phenomena in Icelandic nature and cultural heritage which are considered valuable.
2. To measure and evaluate the values.
3. To assess the impact of the project on these values.
4. To find a method to compare the impacts of different projects.

Definitions

- Classes (total 5)
  - Components in nature or heritage that have considerable values
  - total 5, some divided into subclasses
- Attributes (total 6)
  - Properties or characteristics of classes that make them valuable.
  - (Richness-Diversity; Rarity; Size-Pristinity; International responsibility, Information value; Visual or scenic value)

Classes of Group I
and their weights
In the evaluation



Evaluation matrix of Group 1

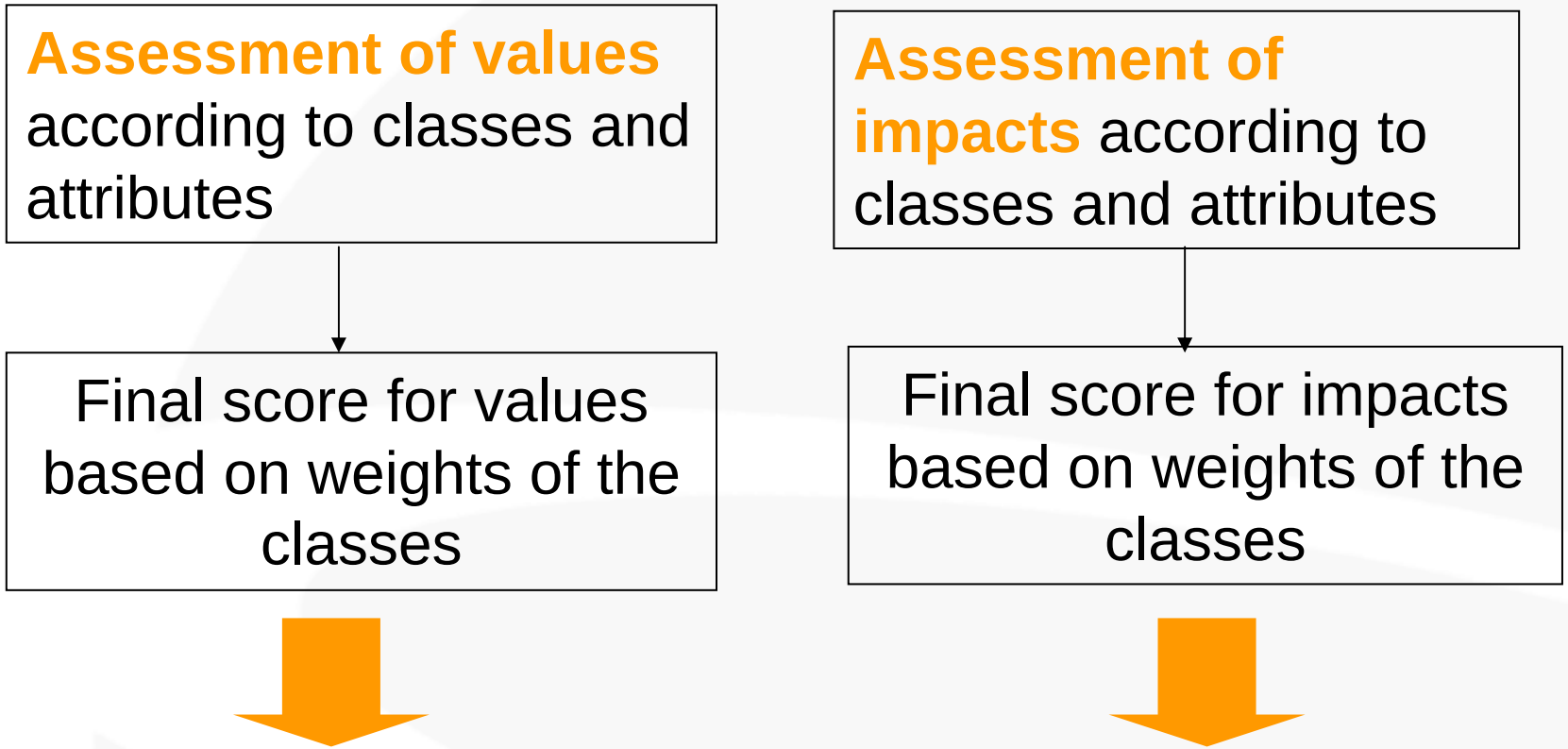
Value and impact of every attribute and class evaluated and assigned a number on a non-linear scale

Scale of value

- 1 = insignificant
- 3 = some
- 6 = large
- 10 = very high

Scale of impact

- 0 = no impact
- 1 = insignificant
- 3 = some value
- 6 = large value
- 10 = very high value


Assessment of values according to classes and attributes
Assessment of impacts according to classes and attributes
Final score for values based on weights of the classes
Final score for impacts based on weights of the classes
Final ranking of power plant options built on the final score for impacts, considering also final score for values, uncertainty and particular significance

Comparison of the Projects

- Index for environmental impact (U)
- Index for present value of total profit over 50 years of operation (H)
- Index for rate of return of initial capital costs (A)

Category Groups
On a scale 0 to 10

Index	Category (U) Environ.Impact	Category (H) Total Profit	Category (A) Rate of return
A	0-0.9	10-5	10-5
B	1.0-2.4	4.9-1.15	4.9-4.0
C	2.5-3.9	1.14-0.9	3.9-3.4
D	4.0-7.9	0.8-0.0	3.3-2.0
E	≥8	<0	<2

Master Plan (MP)
for Utilization of the Energy Resources

Results

- It is expected that a total of about 100 project proposals will be evaluated.
- A report on the first phase of the work, comparing 19 hydropower projects with an energy potential of 16.600 GWh/a and 24 geothermal projects with an energy potential of 18.000 GWh/a, was issued in November 2003

Summing up the Result of the Evaluation in phase 1 of the 43 projects. 19 Hydro 24 Geothermal

- Environmental Index A: 15 Geothermal and 4 Hydro.
- Environmental Index B: 3 Geothermal and 6 Hydro.
- Environmental Index C: 1 Geothermal and 3 Hydro
- Environmental Index D: 5 Geothermal and 2 Hydro
- Environmental Index E: 4 Hydro

Conclusion:

Geothermal projects have generally much less environmental impact on Icelandic nature than hydro.

Master Plan (MP).
Phase II 2004-2009

2004- 2009

- Explore projects not in phase I and revise the former projects.
- Additional studies of natural environment
- Assemble data for evaluation.
- Evaluate potential Mini-Hydro projects
- Evaluate and rank all projects in Phase II and re-evaluate Phase I projects
- Deliver final results March 2009.

The final ranking will be brought up in the Parliament for confirmation

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Thank you very much
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