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Revealing trajectories towards a sustainable energy future

Introduction: Methodological Overview and Past Development Trajectories of the Icelandic Energy System: Lessons for the Future

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Overview

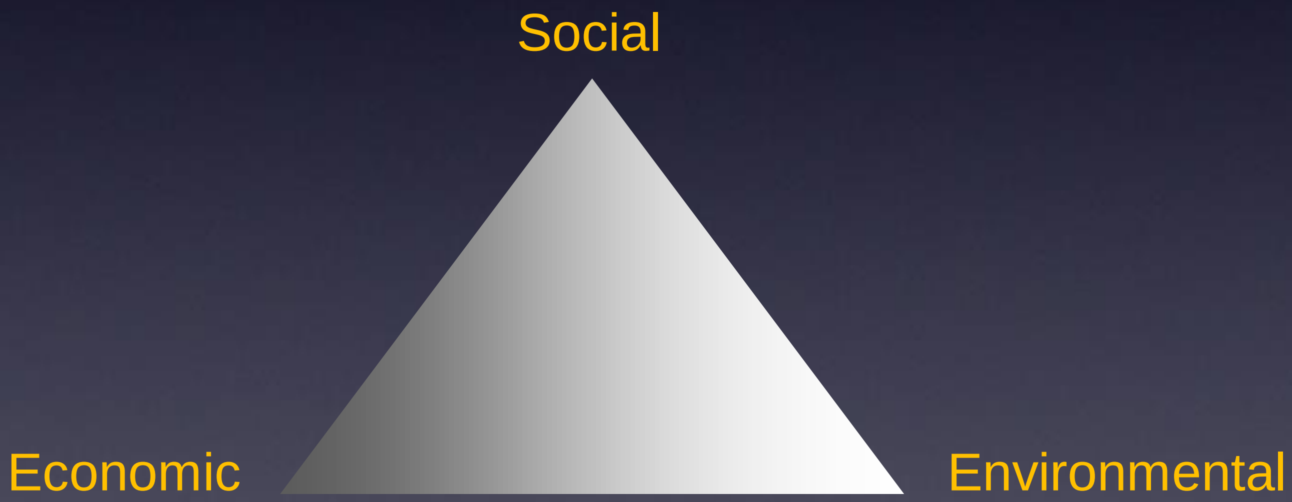
1. Background
2. Past energy transitions in Iceland and current status
3. Analyzing the fourth transition
    - Research objective
    - Methods - overview

1. Background – Energy and sustainable development

Sustainability challenges

The challenge: Balancing economic development with social and environmental objectives

Energy is central to this challenge



Link to energy?

Energy plays a key role in the three dimensions:

- A principal motor of economic growth and economic development
- A source of environmental stress (e.g. climate change)
- A prerequisite for meeting basic human needs and securing human wellbeing

=> Must get the energy dimension right to enable sustainable development; Sustainable energy development

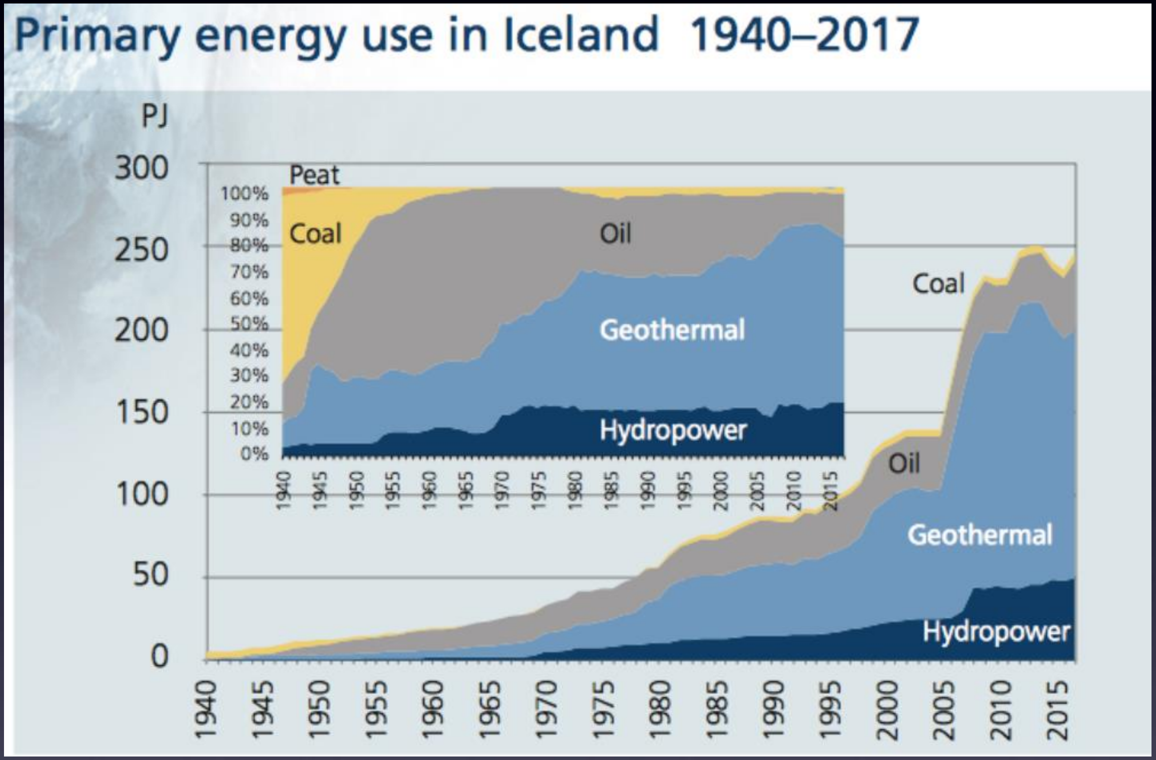
GOAL 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

Sustainable energy development

Defined as “the provision of adequate energy services at affordable cost in a secure and environmentally benign manner, in conformity with social and economic development needs” (IAEA/IEA 2001)

2. Iceland
Energy transitions in the past and current state

Development of primary energy use



Source: The Icelandic Energy Authority

Hydro 20%; Geothermal 61%; Oil 17%; Coal 2%

Electricity 99,9% renewable; Heat 96% geothermal

How did this happen?
Past transitions

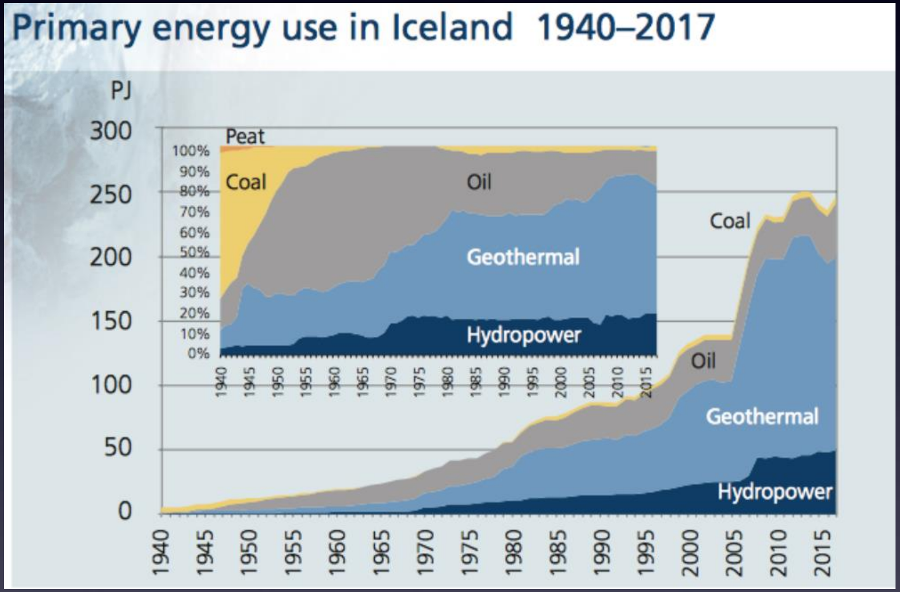
The three transitions

1. 1900 - 1940; From biomass based to coal (84% coal 1940)

2. 1940 - 1965; From coal to oil and renew. energy (oil 65%)

3. 1965 - now; From oil to renewable energy - for electricity generation and heat

4. Future; Pending fourth transition



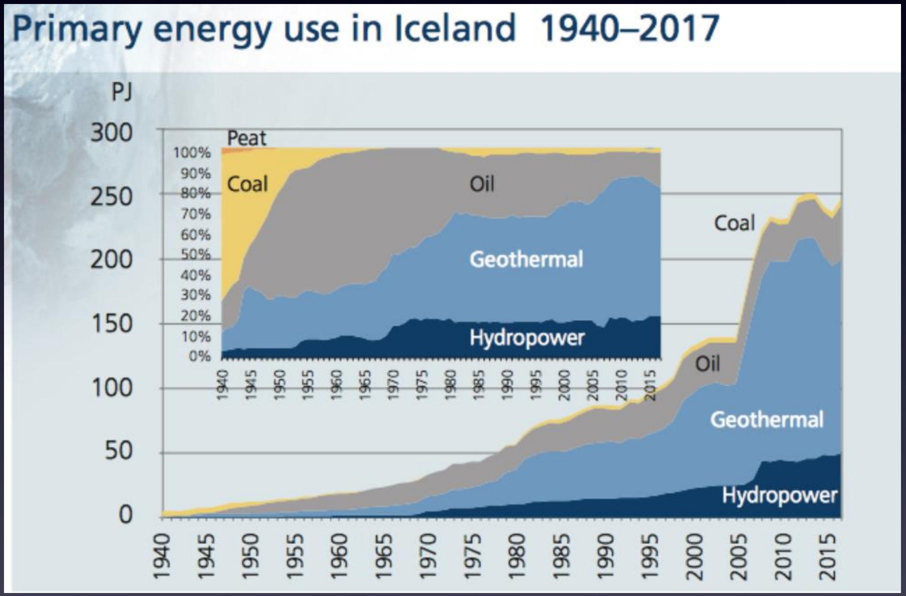
Source: Energy in Iceland,
The Icelandic Energy Authority

Third Transition (1965 - 1980) – Transition to geothermal district heat

Drivers: Oil price shocks; Pollution in Reykjavik; Forward thinking by local decision-makers

Result: Large scale district heating. Currently over 96% heat for house heating from geo.

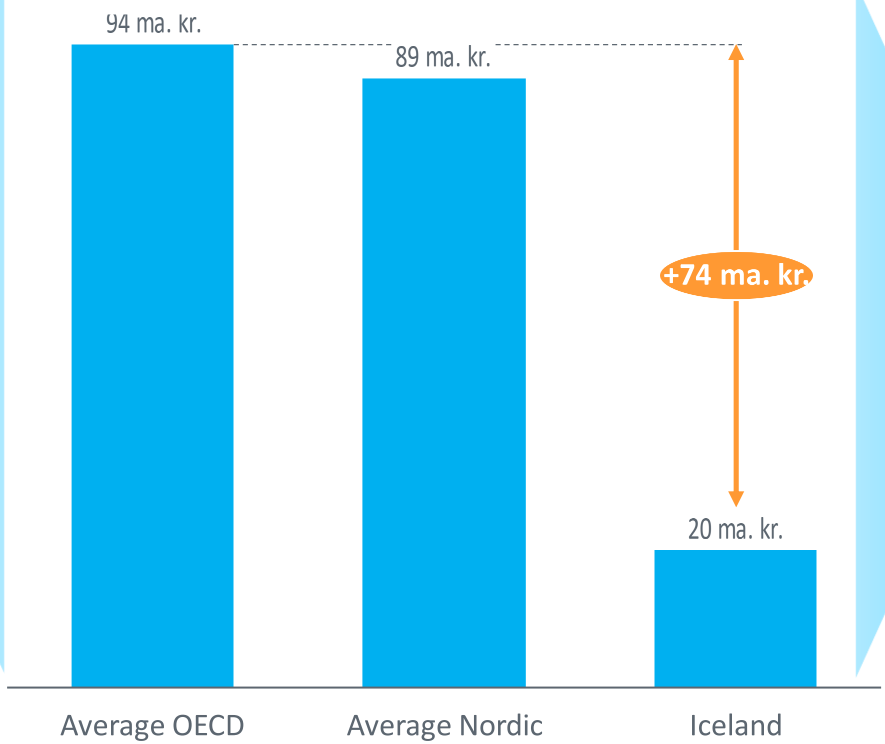
Benefits: Led to significant cost savings and reduced air pollution and GHG emissions



Source: Energy in Iceland, The Icelandic Energy Authority

Direct use of geothermal heat - significant savings for each household as well for the nation

Heating houses: Comparison based on house heating – Iceland vs using other means
Billion ISK



Yearly savings of

5200 EUR

Per household!

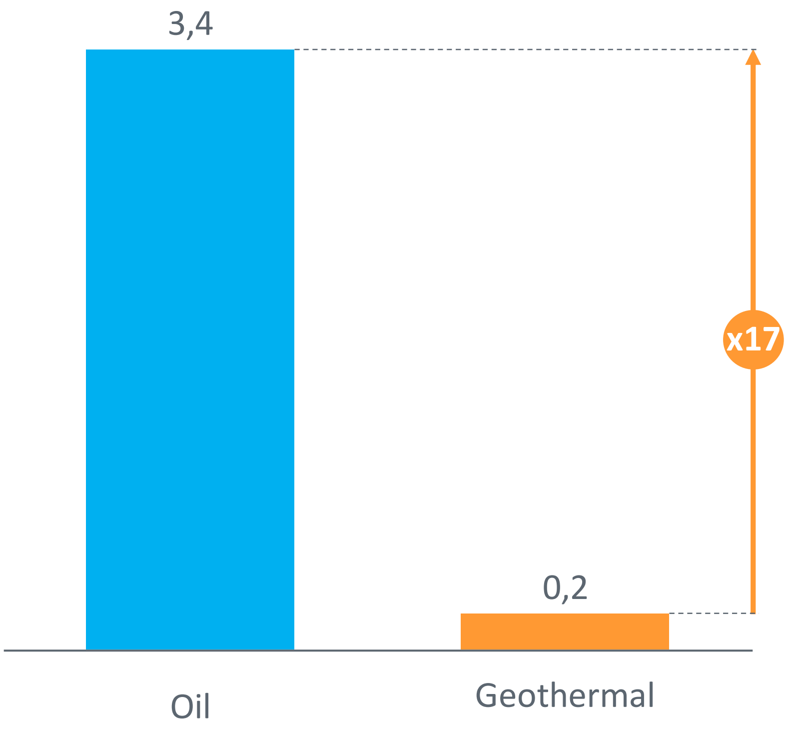
Yearly national savings - **Equal to government spending on education**

Source: Source: Ásdís Kristjansdottir; Energy Authority, Samorka, Confederation of Icelandic Enterprise

[1] Miðað við notkun á árinu 2014 og á verðlagi ársins 2014. Miðað við að óendurnýjanleg orka sé olía fyrir húshitun.

Less pollution and Greenhouse gas emissions – not to mention the well-being benefits!

House heating: Savings in CO_2 emissions if oil was used instead – Million tons CO2 per 2014



Savings close to total Icelandic emissions in 1990

Source: Ásdís Kristjansdottir; Energy Authority, Samorka, Confederation of Icelandic Enterprise

The Current State

81% of the primary energy is renewable

61% geothermal

20% hydropower

17% oil

2% coal

99,9% electricity from renewable energy

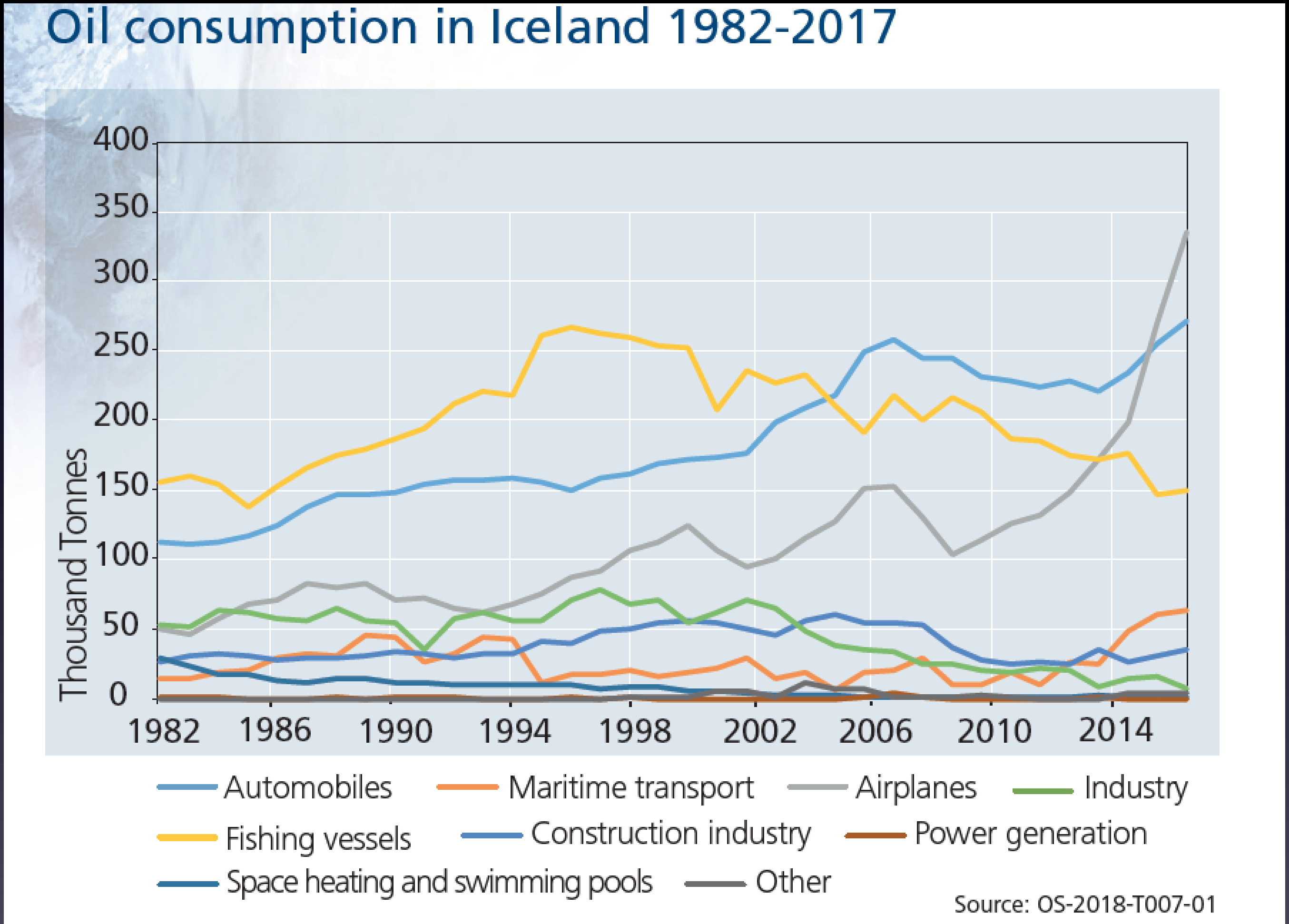
27% geothermal

73% hydropower

Less than 1% wind energy (has not been cost-competitive)

96% heat from geothermal

Oil consumption in Iceland



This is where there is still much work to do

3. Revealing trajectories towards a (more) sustainable energy future

How to transition to a fully renewable energy economy?

Considerations

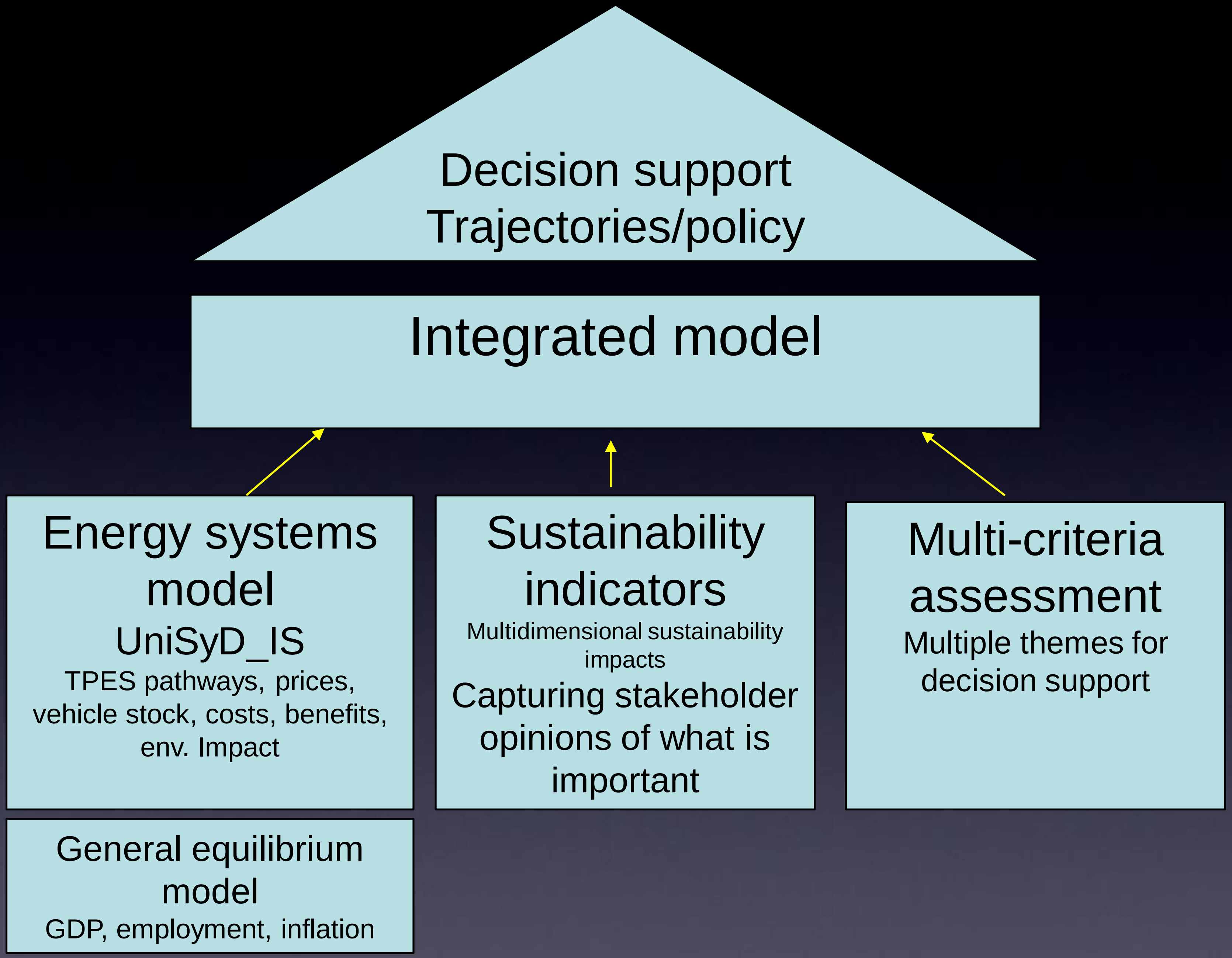
- Supply possibilities – what should we choose?
  - Electricity from renewable sources; hydrogen (electrolysis), biofuels/gas (from energy crops; organic waste, CH_4 from landfills, CO_2 converted to methanol)
- Resource dynamics
  - Impact of climate change on hydropower and biomass
  - Resource limitations of geothermal resources (drawdown)
  - Physical limitations of biofuel supply

Considerations

- Demand considerations (price impact e.g.)
  - Expected increase in electricity demand – what are the implications for transition options?
    - Energy intensive industries
    - Electric cable to Europe
  - Must ensure affordable supply
- Minimizing environmental impact
  - Mitigating GHG emissions, impact on land etc..

Aim of the transition analysis

- ✓ Answer: How to transition to fully renewable and domestic energy in transport and fisheries - with a focus on:
  1. Revealing possible transition pathways:
     - Accounting for resource dynamics, limitations and different demand scenarios; options must be robust across different futures
     - Compare pathways in terms of multidimensional sustainability impacts:
       - E.g. Micro and macroeconomic costs and benefits, GHG emissions, air quality, energy security, affordability…
  2. Draw policy insights for both supply and demand – what are the policies we need to achieve the desired pathway?
- Provide direct decision support to local and national authorities


Decision support
Trajectories/policy
Integrated model
Energy systems model
UniSyD_IS
TPES pathways, prices, vehicle stock, costs, benefits, env. Impact
Sustainability indicators
Multidimensional sustainability impacts
Capturing stakeholder opinions of what is important
Multi-criteria assessment
Multiple themes for decision support
General equilibrium model
GDP, employment, inflation

Presentations

- Implications of Fiscal-induced Electro-mobility Transition on Iceland's Energy-economic System, Presenter: E. Shafiei Finnish Environmental Institute
- Modelling Geothermal Resource Utilization By Incorporating Resource Dynamics, Capacity Expansion, and Development Costs, Presenter: N. Spittler University of Iceland.
- Stakeholder Engagement for the Development of Indicators for Sustainable Energy Development, Presenter: I. Gunnarsdottir University of Iceland.
- Identifying Robust Development Trajectories for the Icelandic Energy Systems Towards Carbon Neutrality Using MCDA, Presenter: R. Fazeli University of Iceland.
- Conclusion – the use of the modeling efforts to support decision-making, Presenters: H. Stefansson; E.I. Asgeirsson Reykjavik University.

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vi) Icelandic society of women in academia