The Icelandic Geothermal Cluster: Enhancing Competitiveness and Creating a new Engine of Icelandic Growth

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Reykjavik, Iceland
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Building the Geothermal Cluster in Iceland

- How can Iceland increase the competitiveness and internationalization of its geothermal cluster?
  - Upgrading the value created by its domestic geothermal resources
  - Selling knowledge and technology, not just power

- Clusters and competitiveness: New evidence
- Options for Iceland’s geothermal cluster
- Broader implications for Icelandic competitiveness
Clusters and Economic Performance

A geographic concentration of related companies and associated institutions in a particular field, linked by spillovers and complementarities

- Competitiveness is driven by the strength of the cluster, not only the strength of individual companies

Local Externalities

- Specialized skill pool
- Specialized suppliers
- Specialized infrastructure
- Specialized institutions
- Knowledge spillovers
- Competitive pressure

Productivity

Innovation

New Business Formation
## The Composition of Regional Economies
### United States, 2008

<table>
<thead>
<tr>
<th>Share of Employment</th>
<th>Traded</th>
<th>Natural Resource-Based</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment Growth Rate, 1998 to 2008</td>
<td>27.4%</td>
<td>0.9%</td>
<td>71.7%</td>
</tr>
<tr>
<td>Employment Growth Rate</td>
<td>0.3%</td>
<td>0.6%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Average Wage</td>
<td>$57,706</td>
<td>$40,142</td>
<td>$36,911</td>
</tr>
<tr>
<td>Relative Wage</td>
<td>135.2%</td>
<td>94.1%</td>
<td>86.5%</td>
</tr>
<tr>
<td>Wage Growth Rate, 1998 to 2007</td>
<td>3.9%</td>
<td>2.9%</td>
<td>3.3%</td>
</tr>
<tr>
<td>Relative Productivity</td>
<td>144.1</td>
<td>140.1</td>
<td>79.3</td>
</tr>
<tr>
<td>Patents per 10,000 Employees</td>
<td>21.5</td>
<td>1.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Number of SIC Industries</td>
<td>590</td>
<td>48</td>
<td>241</td>
</tr>
<tr>
<td>Number of NAICS Industries</td>
<td>677</td>
<td>43</td>
<td>352</td>
</tr>
</tbody>
</table>

Specialization of Regional Economies
Leading Clusters by U.S. Economic Area, 2008

Competitiveness and the Composition of the Economy
Linkages Across Clusters

Note: Clusters with overlapping borders or identical shading have at least 20% overlap (by number of industries) in both directions.

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Clusters and Regional Prosperity

Recent Findings

Drivers of Regional Job Growth, Wages, Patenting, New Business Formation, and Success of Startups

- Specialization in **strong clusters**
- **Breadth** of position within each cluster
- Positions in **related clusters**
- Presence of a region‘s clusters in **neighboring regions**

Not significant

- Positions in “high-tech“ versus other clusters

## Clusters and Economic Performance
### Pharmaceutical Clusters

<table>
<thead>
<tr>
<th>Region</th>
<th>High Industry Specialization</th>
<th>High Cluster Specialization</th>
<th>High Related Cluster Specialization</th>
<th>High Neighboring Cluster Specialization</th>
<th>Industry Growth</th>
<th>Employment Growth 1998-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raleigh-Durham-Cary, NC</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>+29%</td>
</tr>
<tr>
<td>Greenville, NC</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>-52%</td>
</tr>
</tbody>
</table>
Strengths in Related Clusters
Pharmaceuticals in Raleigh-Durham-Cary, NC

Note: Clusters with overlapping borders or identical shading have at least 20% overlap (by number of industries) in both directions.
Clusters as a Tool For Economic Policy

- A forum for **collaboration** between the private sector, trade associations, government, educational, and research institutions
  - Brings together **firms of all sizes**, including SME’s
- Creates a **mechanism** for **constructive** business-government dialog
- A way to **organize** the implementation of economic policies
- A tool to identify **opportunities, problems** and develop a **concerted strategy** as well as **action recommendations**
- A vehicle for making public and private investments that strengthen **multiple firms/institutions** simultaneously
- An approach that fosters **greater competition** rather than distorting the market
Clusters provide a framework for organizing the implementation of many public policies and public investments directed at economic development.
The Role of Government in Cluster Initiatives

**Government should**
- Support *all* existing and emerging clusters
- Participate
- Enable data collection and dissemination at the cluster level
- Be ready to implement recommendations

**Government may**
- Initiate/Convene
- Co-Finance

**Government should not**
- Pick favored clusters
- Pick favored companies
- Subsidize or distort competition
- Define cluster action priorities
What is Different about Cluster-Based Economic Policy?

- Cluster vs. Narrow Industries
- Public-Private Collaboration
- Regional Perspective
- Focus on upgrading productivity
- Demand-driven Policy Priorities
- Build on Regional Strengths
The Icelandic Geothermal Cluster

Core functions

Geothermal Resource Exploration
Geothermal Energy Production

Transmission & Distribution

Service providers

Energy Audit & Law firms
Technical Consulting
Industry News

Drilling
Business Consulting
Financing
Construction

Knowledge

Geothermal Research
Training & Education

Equipment suppliers

Pipes
Turbines and Generators
Other Equipment

Related clusters

Mining
Oil & Gas
Other Electricity Generation

Cluster Associations
(GEORG, Samorka, Jarðhitafélag Íslands)

Local consumers (Direct)

District Heating
Agriculture
Recreation and Health, Tourism

Local consumers (Indirect)

Industry
Retail Electricity

Government

Licensing
Market Regulation
Economic Development

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The Icelandic Geothermal Cluster: Services Providers

GeoScience
- ÍSOR
- Mannvit
- Vatnaskil

Technical Consulting
- Mannvit
- Verkís
- Efla
- Reykjavik Geothermal
- Landsvirkjun Power
- Reykavík Energy Invest

Drilling
- Jarðboranir
- Ræktunarsamband Flóa og Skeiða

Construction
- ÍSTAK
- ÍAV
- Loftorka

Business Consulting
- Íslandsbanki
- KPMG
- Capacent Corporate Finance

Energy Audit & Law firms
- KPMG
- Pricewaterhouse Coopers
- Deloitte
- Lex (law firm)
- Logos (law firm)

Financing
- Íslandsbanki
- Arion banki
- Landsbankinn
- Þróunarsamvinnustofnun
Geothermal Research and Education Institutions

### Geothermal Research
- íSOR
- Mannvit
- Vatnaskil
- Utilities
- Universities

### Research funding
- Orkusjóður
- Geothermal Research Group (Georg)
- Landsvirkjun’s Energy Fund
- Orkuveita Reykjavíkur’s Energy Fund
- Rannís

### Training & Education
- University of Iceland
- Reykjavik University
- Reykjavik Energy Graduate School of Sustainable Systems
- The School of Renewable Energy Science
- Keilir, Atlantic center of Excellence
- United Nations University – Geothermal Training Programme
## Educational Programs, Geothermal Industry

<table>
<thead>
<tr>
<th>Country</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>University of Iceland</td>
</tr>
<tr>
<td></td>
<td>Reykjavík University</td>
</tr>
<tr>
<td></td>
<td>REYST</td>
</tr>
<tr>
<td></td>
<td>RES</td>
</tr>
<tr>
<td></td>
<td>Keilir</td>
</tr>
<tr>
<td></td>
<td>UNU-GTP</td>
</tr>
<tr>
<td>Germany</td>
<td>University of Applied Science’s in Bochum</td>
</tr>
<tr>
<td></td>
<td>Albert-Ludwigs-Universität</td>
</tr>
<tr>
<td></td>
<td>RWTH</td>
</tr>
<tr>
<td></td>
<td>Hochschule Biberach</td>
</tr>
<tr>
<td></td>
<td>Technischen Universität Darmstadt</td>
</tr>
<tr>
<td></td>
<td>Technischen Universität Bergakademie</td>
</tr>
<tr>
<td></td>
<td>Universitaet Karlsruhe</td>
</tr>
<tr>
<td></td>
<td>Ludwig-Maximilians-Universität, Muenchen</td>
</tr>
<tr>
<td>Hungary</td>
<td>University of Miskolc Faculty of Earth Science</td>
</tr>
<tr>
<td>Japan</td>
<td>Kumamoto University</td>
</tr>
<tr>
<td></td>
<td>Kyushu University</td>
</tr>
<tr>
<td></td>
<td>Kyoto University</td>
</tr>
<tr>
<td></td>
<td>Kanazawa University</td>
</tr>
<tr>
<td></td>
<td>Tohoku University</td>
</tr>
<tr>
<td></td>
<td>Akita University</td>
</tr>
<tr>
<td></td>
<td>Akita Prefectual University</td>
</tr>
<tr>
<td></td>
<td>Muroran Institute of Technology</td>
</tr>
<tr>
<td>Macedonia</td>
<td>St. Ciril and Metodij</td>
</tr>
<tr>
<td></td>
<td>St Kliment Ohridski</td>
</tr>
<tr>
<td>Mexico</td>
<td>CICESE</td>
</tr>
<tr>
<td></td>
<td>IIE</td>
</tr>
<tr>
<td>New Zealand</td>
<td>University of Auckland</td>
</tr>
<tr>
<td></td>
<td>Victoria University</td>
</tr>
<tr>
<td>Philippines</td>
<td>Bicol University</td>
</tr>
<tr>
<td></td>
<td>Mapua Institute of Technology</td>
</tr>
<tr>
<td></td>
<td>Adamson University</td>
</tr>
<tr>
<td></td>
<td>University of the Philippines_NIGS</td>
</tr>
<tr>
<td></td>
<td>Negros Oriental State University</td>
</tr>
<tr>
<td>Poland</td>
<td>AGH - University of Science and Technology</td>
</tr>
<tr>
<td>Romania</td>
<td>University of Oradea</td>
</tr>
<tr>
<td>Switzerland</td>
<td>University of Neuchâtel</td>
</tr>
<tr>
<td>USA</td>
<td>Stanford University</td>
</tr>
<tr>
<td></td>
<td>Cornell University</td>
</tr>
<tr>
<td></td>
<td>University of Nevada, Reno</td>
</tr>
<tr>
<td></td>
<td>Truckee Meadows Community Collge</td>
</tr>
<tr>
<td></td>
<td>Oregon Insitute of Technology</td>
</tr>
</tbody>
</table>

- Icelandic institutions are **internationally recognized** leaders in geothermal programs
- The programs at the UN University provide many **important linkages** into developing country markets
## Research Output

### Geothermal Patents, 2000-08

<table>
<thead>
<tr>
<th>Country</th>
<th>Absolute number of patents</th>
<th>Relative to country’s patents filed in the US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>2</td>
<td>1.18%</td>
</tr>
<tr>
<td>Norway</td>
<td>13</td>
<td>0.58%</td>
</tr>
<tr>
<td>Germany</td>
<td>402</td>
<td>0.44%</td>
</tr>
<tr>
<td>Japan</td>
<td>627</td>
<td>0.21%</td>
</tr>
<tr>
<td>Australia</td>
<td>15</td>
<td>0.17%</td>
</tr>
<tr>
<td>Italy</td>
<td>19</td>
<td>0.14%</td>
</tr>
<tr>
<td>US</td>
<td>475</td>
<td>0.02%</td>
</tr>
</tbody>
</table>

### GeoScience Publications, 2004-08

<table>
<thead>
<tr>
<th>Country</th>
<th>Absolute number of publications</th>
<th>Relative to country’s total research publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>148</td>
<td>13.2%</td>
</tr>
<tr>
<td>Norway</td>
<td>1,219</td>
<td>6.3%</td>
</tr>
<tr>
<td>Denmark</td>
<td>744</td>
<td>2.9%</td>
</tr>
<tr>
<td>EU-15</td>
<td>33,550</td>
<td>2.8%</td>
</tr>
<tr>
<td>US</td>
<td>29,411</td>
<td>2.7%</td>
</tr>
<tr>
<td>Sweden</td>
<td>1,144</td>
<td>2.3%</td>
</tr>
<tr>
<td>Finland</td>
<td>594</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

Source: Nordic Patent Institute, US PTO
The Icelandic Geothermal Cluster: Local Demand Structure

**Direct Use (Heat)**
- District Heating
  - Homes and organizations
  - Soil Heating (snow melting) for public and private places
- Agriculture, Fishing
  - Greenhouses
  - Fish Drying
  - Fish Farms
- Tourism, Bathing, Recreation and Health
  - More than 130 swimming pools
  - Blue Lagoon
  - Mývatn Nature Baths

**Indirect Use (Electricity)**
- Industries
  - Aluminum smelters
  - Data centers
  - Seaweed manufacturer
  - Liquid carbon dioxide and other industries
- Retail Electricity
The Icelandic Geothermal Cluster Diamond

**Context for Firm Strategy and Rivalry**

- Local energy production open to competition but dominated by **public utilities**
- Lack of overall **energy policy** in place
- No systemic geothermal **cluster policy**
- Formal **openness for FDI** from EEA, but perception of low transparency

**Factor (Input) Conditions**

+ Large **high temperature geothermal resources** available
+ Significant number of highly **experienced individuals**, many with extensive international contacts
+ Large number of specialized **educational** and **research** institutions
~ Solid patenting and publication rates, though small absolute size of R&D
~ Specialized **financial expertise** but limited capital post-crisis
– Administrative procedures governing domestic geothermal investments are considered **burdensome**

**Demand Conditions**

+ Geothermal accounts for a **large share of total energy production**
+ Well-developed local **system of direct use**, including district heating systems
~ Significant number of **energy-intensive industrial users** though aluminum industry dominates with 79% of total consumption
– Low local **energy prices**

**Related and Supporting Industries**

+ Presence of **most elements** of the core geothermal cluster
~ Significant collaboration, but **no institutional platform**
~ **Some consolidation** in previously fragmented services but local companies in the cluster **small** by international standards
– Few **related clusters**
Market Position of the Icelandic Geothermal Cluster

- Iceland is a **significant player** in the global geothermal market, with a solid cluster and the highest share of geothermal in overall energy use.

- Highly experienced companies and employees
- Well developed system for using geothermal energy in multiple ways throughout the energy system
- Strong international reputation and network

- Companies in the cluster lack critical mass and access to capital
- Domestic market environment increasingly complex
- Research activities and educational activities suffer from small size and fragmentation, despite collaborative projects
- There is a lack of formal platforms for collaboration, despite high level of connections
- Nature of resource is good for energy production but different from most other locations internationally
- Lack of related clusters limits position in some segments of the geothermal cluster
The Icelandic Geothermal Cluster: Market Opportunities

- Attract energy-intensive industries
- Direct export of energy
- Sell products and services; manage operations
## Growing the Iceland Geothermal Cluster

### Current Pipeline of Energy-Intensive Investments

<table>
<thead>
<tr>
<th>Project/Industry sector</th>
<th>Company</th>
<th>Location</th>
<th>Energy needs (MW)</th>
<th>Start of operation</th>
<th>Energy provider</th>
<th>Status</th>
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</thead>
<tbody>
<tr>
<td>Paper production</td>
<td>Icelandic paper</td>
<td>Hellisheiði</td>
<td>10</td>
<td>2010</td>
<td>OR</td>
<td>3</td>
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<tr>
<td>Data Storage I (1)</td>
<td>Verne Holding</td>
<td>Miðnesheiði</td>
<td>25</td>
<td>2010</td>
<td>Landsvirkjun</td>
<td>3</td>
</tr>
<tr>
<td>Data Storage II (1)</td>
<td>Greenstone</td>
<td>Blönduðós</td>
<td>50</td>
<td>2011</td>
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<td>Silicon production I</td>
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<td>60</td>
<td>2011</td>
<td>HS and OR</td>
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<tr>
<td>Carbon fibre</td>
<td>UB koltrefja ehf.</td>
<td>Sauðárkrókur</td>
<td>10</td>
<td>2011</td>
<td>Undefined</td>
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<td>Data Storage I (2)</td>
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<td>Miðnesheiði</td>
<td>25</td>
<td>2011</td>
<td>Landsvirkjun</td>
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<tr>
<td>Aluminum smelter (1)</td>
<td>Norðurál</td>
<td>Helguvík</td>
<td>156</td>
<td>2012</td>
<td>HS and OR</td>
<td>4</td>
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<td>Þorlákshöfn?</td>
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<td>2012</td>
<td>Landsvirkjun</td>
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<tr>
<td>Aluminum smelter - extension</td>
<td>Rio Tinto Alcan</td>
<td>Straumsvík</td>
<td>75</td>
<td>2013</td>
<td>Landsvirkjun</td>
<td>4</td>
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<tr>
<td>Aluminum smelter (2)</td>
<td>Norðurál</td>
<td>Helguvík</td>
<td>156</td>
<td>2013</td>
<td>HS and OR</td>
<td>4</td>
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<td>Aluminum smelter (3)</td>
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<td>Helguvík</td>
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<td>2015</td>
<td>HS and OR</td>
<td>3</td>
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<td>Aluminum smelter (1)</td>
<td>Alcoa</td>
<td>Bakki</td>
<td>300</td>
<td>2015</td>
<td>Landsvirkjun</td>
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<td>Aluminum smelter (4)</td>
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<td>Helguvík</td>
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<td>2016</td>
<td>HS and OR</td>
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<td>Bakki</td>
<td>300</td>
<td>2016</td>
<td>Landsvirkjun</td>
<td>2</td>
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<td>Aluminum smelter - extension</td>
<td>Norðurál</td>
<td>Grundartangi</td>
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<td>?</td>
<td>OR</td>
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<td>Silicon Production II (2)</td>
<td>BPI/Strokkur</td>
<td>Þorlákshöfn?</td>
<td>50</td>
<td>?</td>
<td>Landsvirkjun</td>
<td>2</td>
</tr>
<tr>
<td>Silicon Production III</td>
<td>Elkem</td>
<td>Grundartangi</td>
<td>100</td>
<td>?</td>
<td>No electricity secured</td>
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<td>Aluminum foil - ext.</td>
<td>Becromal</td>
<td>Akureyri</td>
<td>75</td>
<td>?</td>
<td>Landsvirkjun</td>
<td>1</td>
</tr>
</tbody>
</table>

Growing the Iceland Geothermal Cluster
A Systematic Approach to Attracting Energy-Intensive Industries

- Solid **existing base**, especially in aluminum production
- Clear **interest** from investors
- Further growth will also require a significant increase in the **capacity for electricity production**
- Traditional challenge is to set **energy costs** at a level that provides “fair” division of benefits
- Growing public concerns about the **environmental impact** of large-scale investment projects

- Most obvious **short-term opportunity**
- Need to **evaluate** all opportunities, including direct use, based on the impact on employment, exports, upgrading, etc. per unit of energy
- Iceland needs a more **transparent and efficient regulatory environment** to seize these opportunities
- But Iceland needs to move **beyond** this approach alone
Growing the Iceland Geothermal Cluster
Direct Export of Electricity to Europe

Subsea power cable

- Essentially a technical and economic question:

  “Is Icelandic electricity competitive on the European market, once construction costs and transmission losses are taken into account?”

- So far the answer has been no
- But new technological solutions and rising electricity prices in Europe might create an opportunity
## Growing the Iceland Geothermal Cluster
### Experience in Selling Knowledge and Services Abroad

<table>
<thead>
<tr>
<th>Year</th>
<th>Company</th>
<th>Country</th>
<th>Type of project/s</th>
<th>Role of company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>OR / REI</td>
<td>Slovakia</td>
<td>District heating</td>
<td>Owner/Developer</td>
</tr>
<tr>
<td>2002</td>
<td>GGE and OR/REI</td>
<td>China</td>
<td>District heating</td>
<td>Owner through Enex China’s 49% share in JV with Sinopec Star</td>
</tr>
<tr>
<td>2005</td>
<td>Enex; Verkis, Mannvit</td>
<td>El Salvador</td>
<td>Electricity Power Plant</td>
<td>Consulting and contractors</td>
</tr>
<tr>
<td>2006</td>
<td>Mannvit</td>
<td>Hungary</td>
<td>Development of low and medium temperature geothermal fields</td>
<td>Consulting</td>
</tr>
<tr>
<td>2007</td>
<td>OR/REI</td>
<td>USA</td>
<td>Geothermal project development</td>
<td>Owner/Developer</td>
</tr>
<tr>
<td>2007</td>
<td>Envent (GGE and OR/REI)</td>
<td>Philippines</td>
<td>Electricity production development</td>
<td>Owner/Developer</td>
</tr>
<tr>
<td>2008</td>
<td>EFLA and RARIK</td>
<td>Turkey</td>
<td>Electricity production development</td>
<td>Owners/Developer through EFLA and RARIK's subsidiary Turkison</td>
</tr>
<tr>
<td>2008</td>
<td>Geysir Green Energy (GGE)</td>
<td>Germany</td>
<td>Electricity production development</td>
<td>Owner/Developer through GGE's 40% share in Geysir Europe</td>
</tr>
<tr>
<td>2008</td>
<td>Mannvit</td>
<td>Germany</td>
<td>Low enthalpy basins, EGS and CO2 storage</td>
<td>Consulting through Mannvit's 35% share in the Geothermie Neubrandenburg</td>
</tr>
<tr>
<td>2008</td>
<td>arðboranir</td>
<td>Germany</td>
<td>Drilling</td>
<td>Contractor through Hekla Energy GmbH, subsidiary of Jarðboranir</td>
</tr>
<tr>
<td>2008</td>
<td>Mannvit</td>
<td>Hungary</td>
<td>Geothermal development, mainly in low and medium temperature fields</td>
<td>Consulting through Mannvit Kft.</td>
</tr>
<tr>
<td>2009</td>
<td>Mannvit</td>
<td>India</td>
<td>Development of energy systems and infrastructure in India and Sri Lanka</td>
<td>Consulting in JV with Auromatrix Holding</td>
</tr>
<tr>
<td>2009</td>
<td>Reykjavík Geothermal</td>
<td>UAE</td>
<td>Development of geothermal for air conditioning system</td>
<td>Consulting</td>
</tr>
<tr>
<td>2009</td>
<td>Mannvit</td>
<td>USA</td>
<td>Development of geothermal projects in the USA</td>
<td>Consulting in Partnership with Technip</td>
</tr>
<tr>
<td>2009</td>
<td>Verkís and ÍSOR</td>
<td>Chile</td>
<td>Development for electricity production</td>
<td>Consulting through GeoThermHydro, a subsidiary of Verkís and ÍSOR</td>
</tr>
<tr>
<td>2010</td>
<td>Reykavík Geothermal</td>
<td>Middle East and Africa</td>
<td>Geothermal power generation in emerging markets</td>
<td>Consulting in Partnership with Ambata Capital Partners</td>
</tr>
<tr>
<td>2010</td>
<td>Group of Icelandic companies</td>
<td>No specific countries</td>
<td>Geothermal projects</td>
<td>Consulting in Cooperation with Mitsubishi Heavy Industries</td>
</tr>
<tr>
<td>2010</td>
<td>EFLA</td>
<td>Croatia</td>
<td>Development of low and medium temperature geothermal fields</td>
<td>Consulting</td>
</tr>
</tbody>
</table>
Growing the Icelandic Geothermal Cluster
The Icelandic Experience

• Foreign markets are **increasingly important** for Icelandic geothermal companies

• This process is driven both by **growing opportunities** abroad and investment **delays** at home

• The experience in foreign projects has been **mixed**
  – Technical consultants have been most successful
  – Project developers/operators have been less successful financially
  – Projects drawing on specific Icelandic competence, like district heating, performed better
  – Performance has been superior in JVs with local partners or as subcontractors rather than as stand-alone operators
  – Banks were once also well placed but have now largely lost their ability to finance

![Share of revenues from international projects](Source: Survey among cluster participants)
Export Knowledge and Services for Geothermal Activities
Opportunities for Icelandic Companies

Export products
• Equipment production is currently not significant

Export knowledge

Investment to leverage expertise
• Lack of capital is a key constraint
• Could provide expertise in evaluating projects to others

Education and patents
• Educational offers exist but are so far not commercially viable
• Iceland subscale in scientific research
• Available knowledge is not codified

Export services

Technical services
• Solid capabilities and strong global network
• Currently also low price level
• Companies tend to lack size and capital to lead large projects

Operational management
• Solid practical experience
• Relevant companies largely publicly-owned
• Skills more technical than commercial
Seizing the Export Opportunities: The Next Steps for the Icelandic Geothermal Cluster

Mobilize the cluster  
Define a strategy  
Execute priority actions
Mobilizing the Cluster
Critical Success Factors for Cluster Initiatives

Creating a Platform for Collaboration

Mandate/scope of activities

• Raising the **competitiveness of the cluster** as the overarching objective
• Focus on activities where **joint efforts** across the cluster are critical
• NOT a JV for export but an institution that improves the opportunities for companies and JVs to internationalize
• NOT a research consortium but an institution that facilitates joint research
• NOT a lobbying organization but a platform for dialogue and joint action

Structure

• Solid organizational basis, including funded **core secretariat**
• **Private sector** needs to lead and set the agenda
• Government needs to be **part of the dialogue**, not be outside or just providing co-financing
• Individual **leadership** is crucial
Developing a Cluster Strategy

Defining a unique Iceland position
- What roles in the global market/value chain?
- What unique value as a home location?

Possible focus
- Focus on high temperature resource technology
- Focus on technical consulting and on provision of training/education
- Focus on integrated energy systems combining direct/indirect use
- Focus on emerging markets

Possible advantages
- Wide availability of high temperature resources
- Experience and capabilities in home market
- Experience in home market
- Significant network through educational programs; global reputation

• Positioning drives the prioritization of action initiatives most critical to support the cluster’s value proposition
Seizing the Export Opportunities: Action Priorities

• Address weaknesses in the cluster profile
  – Consolidate institutions and activities in education and research
  – Clarify the role of publicly-owned companies in exports
  – Identify potential international partners

• Strengthen the cluster-specific business environment
  – Improve government policies towards the cluster, especially in
    • Innovation policy
    • Investment attraction
    • Education
  – Enhance Iceland’s regulatory transparency and efficiency for investments in energy-production and energy-investment industries in Iceland
  – Address capital shortages; for example creation of a special financial instrument with government or foreign partners
  – Strengthen rivalry in the domestic market for energy production
Growing the Icelandic Geothermal Cluster

Conclusions

• Attracting energy-intensive industries offers the greatest short-term returns for Iceland

• Iceland needs to allocate its energy more strategically

• Moving from selling resources to selling services and knowledge will take longer to materialize, but has significant potential

• Geothermal is a clear opportunity that Iceland cannot afford to neglect

• Building advanced geothermal capacity at home and selling geothermal expertise abroad are complementary activities

• Iceland needs to transform the cluster into an engine of broader improvement in Icelandic competitiveness to maximize its impact
Iceland after the Crisis

Acute crisis response

Stabilization

?
Putting the Crisis in Perspective

Change in GDP per capita (PPP adjusted)

Argentina (1998-2002)
Latvia (2007-09)
Estonia (2007-09)
Lithuania (2008-09)
Finland (1989 - 93)
Iceland (2008-09)
Turkey (2000 - 01)
Sweden (1990-93)
Hungary (2008-09)
UK (2008-09)
Labor Productivity
Selected Countries, 2000 to 2009

Growth of real GDP per employee (PPP-adjusted), 2000 to 2009

Source: Author’s calculation Groningen Growth and Development Centre (2010)
• Macroeconomic competitiveness creates the potential for high productivity, but is not sufficient

• Productivity ultimately depends on improving the microeconomic capability of the economy and the sophistication of local competition
Iceland’s Competitiveness Profile, 2010

ISC Country Competitiveness Model

Country Competitiveness (24)

Macroeconomic Competitiveness (22)
- Political Institutions (23)
  - Rule of Law (10)
- Human Development (1)

Microeconomic Competitiveness (25)
- Macroeconomic Policy (131)
- National Business Environment (28)
- Company Operations and Strategy (18)

Iceland’s GDP per capita rank is 18th versus 123 countries

Note: Rank versus 139 countries; overall, Iceland ranks 18th in 2009 PPP adjusted GDP per capita and 24th in Global Competitiveness
Microeconomic Competitiveness: The Diamond Model

**Context for Firm Strategy and Rivalry**

- Local *rules and incentives* that encourage investment and productivity
  - e.g. salaries, incentives for capital investments, intellectual property protection, corporate governance standards

**Factor (Input) Conditions**

- Access to high quality *business inputs*
  - Efficient access to natural endowments
  - Human resources
  - Capital availability
  - Physical infrastructure
  - Administrative and information infrastructure (e.g. registration, permitting, transparency)
  - Scientific and technological infrastructure

**Demand Conditions**

- Sophisticated and *demanding* local customers and needs
  - e.g., Strict quality, safety, and environmental standards
  - Consumer protection laws

**Related and Supporting Industries**

- Availability of *suppliers and supporting industries*

- Many things matter for competitiveness

- Successful economic development is a process of *successive upgrading*, in which the business environment improves to enable increasingly sophisticated ways of competing
### Factor (Input) Conditions
Iceland's Relative Position 2010

<table>
<thead>
<tr>
<th>Competitive Advantages</th>
<th>Competitive Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Infrastructure</strong></td>
<td><strong>Relative to GDP per Capita</strong></td>
</tr>
<tr>
<td>Quality of electricity supply</td>
<td>Soundness of banks 137</td>
</tr>
<tr>
<td>Quality of telephone infrastructure</td>
<td>Financing through local equity market 128</td>
</tr>
<tr>
<td>Telephone lines per 100 population</td>
<td>Financial market sophistication 103</td>
</tr>
<tr>
<td>Quality of port infrastructure</td>
<td>Regulation of securities exchanges 97</td>
</tr>
<tr>
<td>Quality of air transport infrastructure</td>
<td>Protection of minority shareholders' interests 85</td>
</tr>
<tr>
<td>Internet users per 100 population</td>
<td>Ease of access to loans 81</td>
</tr>
<tr>
<td><strong>Science and skills</strong></td>
<td>Venture capital availability 68</td>
</tr>
<tr>
<td>Quality of the educational system</td>
<td>Getting Credit (WB ) 39</td>
</tr>
<tr>
<td>Availability of scientists and engineers</td>
<td><strong>Physical Infrastructure</strong></td>
</tr>
<tr>
<td>Quality of management schools</td>
<td>Mobile telephone subscribers per 100 population 35</td>
</tr>
<tr>
<td>Quality of math and science education</td>
<td>Quality of roads 22</td>
</tr>
<tr>
<td>Utility patents per million population</td>
<td>Personal computers per 100 population 20</td>
</tr>
<tr>
<td>University-industry research collaboration</td>
<td><strong>Administrative Infrastructure</strong></td>
</tr>
<tr>
<td>Tertiary enrollment</td>
<td>Tax Complexity (WB) 77</td>
</tr>
<tr>
<td><strong>Administrative Infrastructure</strong></td>
<td>(Low) number of procedures to start a business 23</td>
</tr>
<tr>
<td>(Low) Time required to start a business</td>
<td><strong>Science and skills</strong></td>
</tr>
<tr>
<td>(Low) Burden of customs procedures</td>
<td>Quality of scientific research institutions 22</td>
</tr>
<tr>
<td>(Low) Burden of government regulation</td>
<td>Ease of starting a new business 18</td>
</tr>
<tr>
<td>Internet users per 100 population</td>
<td>Source: WEF Global Executive Opinion Survey and Institute for Strategy and Competitiveness, Harvard University (2010)</td>
</tr>
</tbody>
</table>
Innovative Output
Selected Countries, 1998 to 2008

Average U.S. patents per 1 million population, 1998-2008


Top Icelandic Originators of U.S. Patents

<table>
<thead>
<tr>
<th>Company</th>
<th>2005 - 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSSUR HF ORTHOPEDICS</td>
<td>41</td>
</tr>
<tr>
<td>DECODE GENETICS EHF.</td>
<td>12</td>
</tr>
<tr>
<td>SILICON LABORATORIES INC. INT. CIRCUITS</td>
<td>6</td>
</tr>
<tr>
<td>MAREL H.F. FOOD PROCESSING EQUIPMENT</td>
<td>5</td>
</tr>
</tbody>
</table>

## Context for Firm Strategy and Rivalry

### Iceland's Relative Position 2010

#### Competitive Advantages Relative to GDP per Capita
- Cooperation in labor-employer relations: 4

#### Competitive Disadvantages Relative to GDP per Capita

<table>
<thead>
<tr>
<th>Category</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Openness</strong></td>
<td></td>
</tr>
<tr>
<td>Restrictions on capital flows</td>
<td>138</td>
</tr>
<tr>
<td>Business impact of rules on FDI</td>
<td>134</td>
</tr>
<tr>
<td>Prevalence of foreign ownership</td>
<td>129</td>
</tr>
<tr>
<td>Low Tariff rate</td>
<td>36</td>
</tr>
<tr>
<td><strong>Labor market</strong></td>
<td></td>
</tr>
<tr>
<td>Low Rigidity of employment</td>
<td>50</td>
</tr>
<tr>
<td><strong>Domestic market rivalry</strong></td>
<td></td>
</tr>
<tr>
<td>Market dominance by business groups</td>
<td>107</td>
</tr>
<tr>
<td>Prevalence of trade barriers</td>
<td>101</td>
</tr>
<tr>
<td>Intensity of local competition</td>
<td>67</td>
</tr>
<tr>
<td>Effectiveness of antitrust policy</td>
<td>45</td>
</tr>
<tr>
<td>Market disruption from SOEs</td>
<td>33</td>
</tr>
<tr>
<td><strong>Government incentives and regulations</strong></td>
<td></td>
</tr>
<tr>
<td>Tax impact on incentives to work &amp; invest</td>
<td>86</td>
</tr>
<tr>
<td>Strength of auditing &amp; reporting standards</td>
<td>83</td>
</tr>
<tr>
<td>Distortive effect of taxes and subsidies</td>
<td>74</td>
</tr>
<tr>
<td>Strength of investor protection</td>
<td>59</td>
</tr>
</tbody>
</table>

Note: Rank versus 139 countries; overall, Iceland ranks 18\textsuperscript{th} in 2009 PPP adjusted GDP per capita and 24\textsuperscript{th} in Global Competitiveness

National Cluster Export Portfolio
Iceland, 1997-2008

Change in Iceland’s average world export share: 0.001%

Iceland’s average world export share: 0.041%

Change in Iceland’s world export market share, 1997 – 2008

Strategic Issues for Iceland

- Continue the path to **macroeconomic consolidation** and **financial market restoration**

- Strengthen the **business environment**, particularly its openness to foreign investment, competition, capacity for innovation, and the regulatory complexity

- Deepen and upgrade **clusters**

- Define a **national economic strategy**
National Economic Strategy

**Country Positioning**

*Defining a unique position for Iceland*
- What roles in the world and regional economy?
- What unique value as a business location?
- For what range or types of business activities?

---

**Priority Policies**

*Developing unique strengths*
- What elements of the business environment are **critical** to the national value proposition?

---

**Best Practices**

*Achieving parity on necessary qualities*
- What improvements are necessary to **maintain parity** with peer countries?

---

**Others**

*Maintaining position*
- What aspects of the business environment are **acceptable** and currently not a priority?
The Geothermal Cluster as an Engine for Iceland

- A clear strategy to enhance the geothermal cluster can become a change agent for the broader economy

1. Role model for cluster mobilization
2. Catalyst for upgrading of cross-cutting policies: e.g., FDI, innovation
3. Geothermal as a core element of a new national economic strategy for Iceland
Back-Up
Cluster Employment Portfolio
Iceland, 1999-2006

Location Quotient

Change in European Share, 1999 - 2006

Source: European Cluster Observatory, 2010
Company Sophistication
Relative Position of Icelandic Companies, 2010

<table>
<thead>
<tr>
<th>Competitive Advantages Relative to GDP per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm-level technology absorption</td>
</tr>
<tr>
<td>Degree of customer orientation</td>
</tr>
<tr>
<td>Control of international distribution</td>
</tr>
<tr>
<td>Willingness to delegate authority</td>
</tr>
<tr>
<td>Prevalence of foreign tech licensing</td>
</tr>
<tr>
<td>Extent of staff training</td>
</tr>
<tr>
<td>Capacity for innovation</td>
</tr>
<tr>
<td>Reliance on professional management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Competitive Disadvantages Relative to GDP per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent of incentive compensation</td>
</tr>
<tr>
<td>Nature of competitive advantage</td>
</tr>
<tr>
<td>Value chain breadth</td>
</tr>
<tr>
<td>Breadth of international markets</td>
</tr>
<tr>
<td>Company spending on R&amp;D</td>
</tr>
<tr>
<td>Extent of marketing</td>
</tr>
<tr>
<td>Extent of regional sales</td>
</tr>
<tr>
<td>Production process sophistication</td>
</tr>
</tbody>
</table>

Note: Rank versus 139 countries; overall, Iceland ranks 18th in 2009 PPP adjusted GDP per capita and 24th in Global Competitiveness
International Perceptions About Icelandic Geothermal

Percentage of respondents

- First comes to mind in Geothermal
- Education
- Engineering & services
- Drilling
- Financing

Leading in...

Source: Islandsbanki, 2010