Regions’ role in the formative phase of technological innovation systems

Anne Nygaard Madsen
PhD Candidate
anne.nygaard@risoe.dk

Innovation Systems and Foresight,
Department of Management Engineering,
Technical University of Denmark
Agenda

1. Background - Roads2HyCom (www.roads2hy.com)
   ▪ with comments and examples

2. PhD project [under development]
   ▪ research question, empirical and analytical strategy
What is HFC – hydrogen and fuel cells

- **Hydrogen**
  - $H_2$ is an energy carrier
  - Green $H_2$ from renewable energy

- **Application types**
  - transport
  - stationary
  - portable (mobile, laptops)

- **Disruptive technology**
  - Potential to change the energy system

- **Fuel cell**
  - generates electricity from $H_2$

**However – not in the nearest future!!**
Background

- and my motivation for choosing the field of research

- **Roads2HyCom**: "Research co-Ordination, Assessment, Deployment and Support to HyCom"
- **A project to co-ordinate, assess and monitor research in the field of Hydrogen and Fuel Cells**
  - R2H is supporting
    - European Commission,
    - HFP – Hydrogen Fuel Cells Platform
    - JTI on Hydrogen and Fuel Cells
    - HyRaMP
    - and other stakeholders
- **Brings together 29 partners from a broad cross section of areas**

- **The latest task I have worked on:**
  
  **POLICIES AND SOCIO ECONOMIC ASPECTS TOWARDS FURTHER DISSEMINATION OF HYDROGEN COMMUNITIES IN THE EU**
Regional Innovation Systems and emerging H2&FC clusters

• R2H WP7.4 study:
  • Aim: To clarify what characterise regions with a high HFC activity level

• Hypotheses
  1. existing H2 infrastructure (pipelines) and production sites have a positive influence on regions’ engagement in HFC innovation
  2. innovative regions are more likely to become engaged in hydrogen and fuel cell development
  3. certain industrial clusters are favourable for the emergence of any full-scale hydrogen economy

• Data
  • R2H data
  • The European Regional Innovation Scoreboard
  • The European Cluster Observatory
    all at a NUTS II level
The regional perspective

Which regions are the most active within the field of HFC?

**Data:**
- HFC demonstration projects
- Hydrogen fuelling stations
- Registration of interest (96)

**Results – 16 regions**
- Stuttgart
- Oberbayern
- Berlin
- Hamburg
- Düsseldorf
- Köln
- Danmark
- Comunidad de Madrid
- Nord - Pas-de-Calais
- Iceland
- Piemonte
- Lombardia
- Toscana
- Agder and Rogaland
- Västsverige
- Wales

![H2&FC activity level in Europe](image)
Hypothesis 1: Is hydrogen infrastructure a precondition for becoming an active HFC region?

Result: Not possible to verify hypothesis 1
Hypothesis 2: Innovative regions are more active

Data:
- Regional Innovation Scoreboard 2006 (Maastricht Economic and social Research and Training centre on Innovation and Technology, MERIT)
- measure innovation performance - Human resources in science and technology, participation in life long learning, public and private R&D, patent applications, employment in medium-high and high-tech manufacturing
- For the purpose of study, the scoreboard was split into three categories: bottom third, middle third, highest third

<table>
<thead>
<tr>
<th>Score in the Regional Innovation Scoreboard</th>
<th>Numer of high level HFC regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest third</td>
<td>10</td>
</tr>
<tr>
<td>Medium third</td>
<td>5</td>
</tr>
<tr>
<td>Bottom third</td>
<td>1</td>
</tr>
</tbody>
</table>

Result:
- Clear correlation between innovativeness and activity in the field of HFC
- Confirms endogenous growth theory
Hypothesis 3: certain industrial clusters favour HFC activity

Data:
• European Cluster Observatory

Cluster quotient:
• Compares a cluster’s presence in the active HFC regions with EU average
• CQ > 2 shows that the cluster is more frequently located in the active regions than in the rest of Europe
• Pointed out 9 clusters with relevance for HFC development

Results
• Clusters with CQ > 2 are generally more innovative
• Of the nine clusters with high relevance for H2FC technology seven have a CQ > 2. Only transportation and heavy machinery have a CQ < 2
Overall conclusion of R2H’s WP7.4

• Shows that some regions are more active in HFC innovation
• That existing HFC infrastructure is not an important driver
• Statistical correlation between regions highly engaged in HFC development and innovative regions hosting innovative clusters
• Which indicates that a well-functioning innovation system is important for HFC innovation

» Large difference between regions
» Why do they play a role?
» Who is driving this process?
» How do regions play a role?
Scales of HFC activity

• Hydrogen initiatives reflect different scales of activity (Hodson et al)
  – Hydrogen Nations → US, Canada, Iceland
  – Hydrogen Islands → Iceland, Hawaii
  – Hydrogen Cities → London, San Francisco
  – Hydrogen Regions → California, NRW, NY
  – Hydrogen City Networks → CUTE initiative
  – Hydrogen Lighthouses and Mini-Networks
  – Hydrogen Corridors → California H2 highway + BC H2 highway

• Nevertheless my assumption is: the location are not solely test-beds
  – The context is not just passive
  – Regions reposition themselves to gain competitive advantage
  – Stakeholders form place-based coalitions (NRW, Aragon)
  – Regions engage in HFC discourses and debates (e.g. HyRamp)
Research Question

What role do regions play in the formative phase of a hydrogen and fuel cell innovation system?

- First part
  - Delimit and describe the HFC technological field
  - SNA of patent data, bibliometrics, and linked internet pages

- Second part
  - Comparative study of 4 regions
  - Desk study of strategies, visions, a.o. documents
  - Interviews with key stakeholders
  - Development of hypotheses
  - Survey to test hypotheses
  - Refine SNA on regional level

- 1st Article: Can SNA contribute methodologically to a better understanding of formation of IS?

- 2nd and 3rd article: Regional Comparison of HFC activities, actors and policies

- 4th article: Hypotheses and survey results
Analytical model

Regional factors and prerequisites
- Policy (innovation-, specific HFC policies)
- Actors (leadfirms, advocacy coalitions, technological gatekeepers)
- Institutions, formal/informal
- Production structure (clusters, knowledge base)
- Universities/Res. Inst. (knowledge generation)
- Labour skills
- External interaction (policy, knowledge and production interaction)

Regional based HFC innovation
Long term goals
- Products
- Processes
- Services
- Organisations

Short term goals
- Knowledge production
- Start-ups/spin-offs
- Network-building
- Deployment

Hydrogen and fuel cell innovation system

Social Network Analysis
Thank you for your attention!
Back-up slides
Cluster Quotient

The Cluster Quotient is calculated as

\[ C_{Qi} = \frac{(A_i/B)}{(C_i/D)} \]

where

i is a cluster according to the Cluster Observatory, e.g. Automotive

Ai is the number for I clusters in all high level H2&FC regions

B is the number of all high level H2&FC regions (=19)

Ci is the number of all I type clusters (e.g. automotive) in all regions analysed by the Cluster Observatory

D is the number of all regions analysed by the Cluster Observatory (=258)
NUTS (Nomenclature d'Unités Territoriales Statistiques)

Classification of geographical units used for statistics across the EU.

Source: http://www.histoire.ac-versailles.fr/old/geographie/Nterrit/NUTS.htm
<table>
<thead>
<tr>
<th>Cluster categories</th>
<th>Industries examples</th>
<th>Examples from European H2FC Technology Platform’s NEW-IG members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil &amp; Gas Products and Services</td>
<td>refineries</td>
<td>Statoll Hydro ASA, Gaz de France, Shell Hydrogen BV, Total France</td>
</tr>
<tr>
<td>Automotive</td>
<td>motor vehicles and components</td>
<td>Daimler, Adam Opel GmbH, Volkswagen, Centro Ricerche Fiat, AVL List GmbH</td>
</tr>
<tr>
<td>Power Generation and Transmission</td>
<td>generators</td>
<td>Siemens, E.ON Sverige AB, EWE AG, GAMESA Corporacion Tecnologica</td>
</tr>
<tr>
<td>Heavy Machinery</td>
<td>tractors, locomotives</td>
<td>Wärtsilä Finland, Gruppo Sapio, Ansaldo Fuel Cells</td>
</tr>
<tr>
<td>Chemical Products</td>
<td>chemicals, industrial gases</td>
<td>Linde Gas, BASF Fuel Cells GmbH, ILT Technology</td>
</tr>
<tr>
<td>Production Technology</td>
<td>tanks</td>
<td>Topsoe Fuel Cells ?</td>
</tr>
<tr>
<td>Transportation and Logistics</td>
<td>air transport</td>
<td>Rail Safety and Standards Board?</td>
</tr>
</tbody>
</table>