“Local clusters forecasting model, applied to new renewable energy emerging technologies, through Network Theory”

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Manchester International Summer School on Emerging Technologies,
Manchester Business School, University of Manchester, UK
8-13th June 2014

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Research Background & Context (I)

Globalization

The tendency to create local clusters is gathering strength as a key factor for the economic development of “smart cities”.

The competitiveness of a sector can be measured by its technology clusters.

Challenge of “Smartcities”

To combine the ability of the innovation networks shared by the main actors involved, through collaborative relationships at several sectors.
ALSO at emerging and multidiscipline renewable energy (RE) sector.

Research Background & Context (II)

Emergent (Sub) sector: Renewable Energies and Energy Efficiency

European objective: to increase the percentage of RE in the energy mix to 20% by 2020 (European Commission communication 2011). Effects:

- the scientific production in RE to double in size at European and worldwide levels between 2002 and 2007 (Romo-Fernandez et al. 2011)
- the boost of a new multi-discipline industrial sector

Incorporation of a greater percentage of different technologies (including not so well-developed ones such as wave, tidal and small wind) within the **new structures** of energy generation and distribution **in cities** -> local participation increasingly important in terms of industrial development.

Research Background & Context (II)

Investments in RE will generate a multiplying effect in the economy.

The creation of **new organizational structures** such as **local clusters** will become necessary (Marques and Fuinhas 2012).

The extensive and speedy evolution of RE enterprises shows that local clusters as well as industry based on knowledge will grow exponentially in the next few years.

Clusterization at local level in this emergent RE sector is an industrial **hallmark**.

But, …

Research Questions

1. Is RE (sub)sector well delimited?

2. Is there a relationship between R&D collaborative networks and local RE new clusters?

3. What kind of relationship is there between RE clusters and Smart-cities?

4. Is there a scientific model to forecast the success of these clusters?

5. Which should be the role of policy makers in terms of local cluster creation and promotion?

Research Objectives

Main Objectives:

- To make a contribution towards the understanding of new emerging RE sector in terms of industry and innovation.

- Both organisational and evolutionary patterns to be used by policy makers when drawing efficient and long lasting policies for emergent RE sector.

Second Objectives:

- Understanding of the initial phase of creation of technological clusters in RE.
- Understanding how to forecast a model for anticipatory approaches for these clusters.

Research Methodology

The methodological strategy will be developed in three phases:

1. Theoretical study will be addressed focusing on:
   - Technological clusters.
   - Collaborative-innovation networks.
   - Network Analysis tools with large-scale data models.

2. Empirical study:
   1. Selection of data source (Structured or Semi-structured Data Bases)
   2. Delimiting of RE sector and its Network Analysis process

3. Finally, a model for both organisational and evolutionary patterns will be empirically evaluated, with case study process.

Potencial Difficulties and Challenges

1. Baseline data:
   - o no consensus within the public administration on how to define RE sector
   - o lack of official and standardized data at local level owing to multidisciplinary diversified industrial activities in no-mature technology
   - o Semi-structured data bases

2. Relational data of the sector: A difficulty for companies' managers to provide sensitivity information such as their relationships with others within clusters.

3. Wide range of methods to national and regional clusters analysis; applying these methods to local level, inaccuracies in several result-factors might appear.

Early Findings I

1. Theoretical study addressed on: Technological clusters, Collaborative-innovation networks and Network Analysis tools with large-scale data models.

- **RE local clusters** are currently **in their first phases** (embryonic) being their success largely determined by the growth potential of their small and medium sized industries.

- Social Network Analysis (**SNA**) together with Competitive Advantage Analysis (**CAA**) seem to be **the most recommended methods**.

Social Network Analysis (SNA) will specifically provide information that enables possible actors to be aware of the existence, needs and ability requirements of others, including help to develop new alliances (Gulati et al. 2000). This becomes a key element in the **study of relationships at an organizational level**, inside and outside the clusters (Johannisson 1995; He and Fallah. 2011).

Its **objective** is to **detect and interpret patterns in the links between the different actors in the network**, which are represented as vertices (De Nooy et al. 2011). In addition, attributes (characteristics of the actors, which are not based on their structural position within the network, and calculated statistically) provide added value to the interpretation of the structure.

Early Findings II

Table 1 Some examples of European Renewable Energy Local Clusters (2011)

Cluster	Creation year	Phase	Members (companies)	Comments (Employment)
Hamburg (Germany)	2010	Embryonic	163	Local: 14.563; expected growth (2008-2015): 40%
Freiburg (Germany)	2009	Established	107	Region: 12.000
Copenhagen (Denmark)	2010	Embryonic	36	Local expected growth (2010-2013): +1000
San Sebastian (Spain)	2009	Embryonic	85	Local: 1.800

Source: http://en.erneuerbare-energien-hamburg.de/, http://www.greencity-cluster.de/, http://www.cphcleantech.com/, and http://www.fomentosansebastian.org/

Early Findings III

2. Empirical study:
    1. Selection of data source (Structured Data Bases)
    2. Tech-mining (TDA) and Social Network Analysis (SNA) process

- Using the criteria of amount of information and its availability (Garechana et al 2012), the **Community Research and Development Information Service (CORDIS) database**, which stores and centralises all the information about research and development (R&D) projects financed from the EU, **was chosen for this research**.

- Even though it is a **partially structured database**, there is the **need to develop** a **strategy to capture the information** on RE projects. -> **TDA + VP**

- According to this research, an **increase** in **information flows and innovation networks** in RE sector **depends more on the type of organisation** rather than country, role or even period of time. Although universities and research centres remain the **centrality** and influence, **firms tend** to become **key actors** which play a crucial “bridge” role in **innovation**.

Early Findings IV

Renewable Energy European R&D projects (1980-2013)

Period	Nª of active projects	Wind	Solar	Biomass	Geothermal	Tidal/Wave energy	Bioenergy	Hydroelectric
1980-1990	2155	423	1224	344	274	1	0	0
1990-2000	3493	721	1759	466	215	19	31	29
2000-2013	2301	301	932	320	47	37	30	9

Early Findings V

DB partially structured. **Strategy**:

- utilising various **filtering**:

o Selecting “Energy” in the Subject Index Classification Codes (SID) field
o Removing all entries corresponding to “Nuclear Fusion”, “Nuclear Fission” and “Fossil Fuels”, 29,728 projects.
o Including: “Renewable Sources of Energy”, “Energy Storage, Energy Transport”, “Energy Savings”, “Biofuels”, “Hydrogen and Fuel Cells”, and “Other Energy Topics”.

- Since the objective is to determine only the specific areas of RE, **TDM** is applied.

Bearing in mind the limitations of the different works (Ozcan and Islam 2014) and how they are implemented for a specific technological area (Kostoff 2006), a combination of “Boolean Search Logic” together with “Specific Area Classification Sources” have been chosen.

In addition to what has been proposed by Porter et al. (2008), the **fields** to be used will be **Keywords**, **Title** and **Activity Area** (more entries: 52%, 100% and 76% of the total entries respectively).

Early Findings VI

"Compilation of terms, adjusting retrieved items to renewable energies and final structure" as well as the "precision and recall process" were obtained **by adapting the methodology** developed by Garechana et al. (2012) to the area of RE, **using VantagePoint TDM software**.

Wind, Solar, Biomass, Geothermic, Tidal/Wave and Hydroelectric sectors were analysed (discarding Hydrogen sector since, from the 350 projects for the whole period, 95% are not related to RE)

To identify the **type of organisation** according to the classification defined by Leydesdorff and Etzkowitz (2003) as **university, firm, government, research centre** and others, the official codes used by each European country will be applied, due to the fact that currently 66.15% of 163,664 partners has not available.

The **database** being created contains **6,703 R&D projects** with an average of 9.76 partners per project.

Using **SNA**: 2-mode matrix is converted into a one-mode matrix (Kang and Park 2013), allowing to analyse **185,815 partner-partner relationships** for the yearly **crucial interval 2000-2013** (a pan-European policy frame was fully introduced by all European members to achieve the 20-20-20 target) (Kitzing et al 2012).

Comparison of **centrality indicators**, that are determinant in social network analysis, such as **degree**, **betweenness** and **structural hole** to measure the importance, influence and prominence of actors within the network (Kang and Park 2013).

Early Findings VII

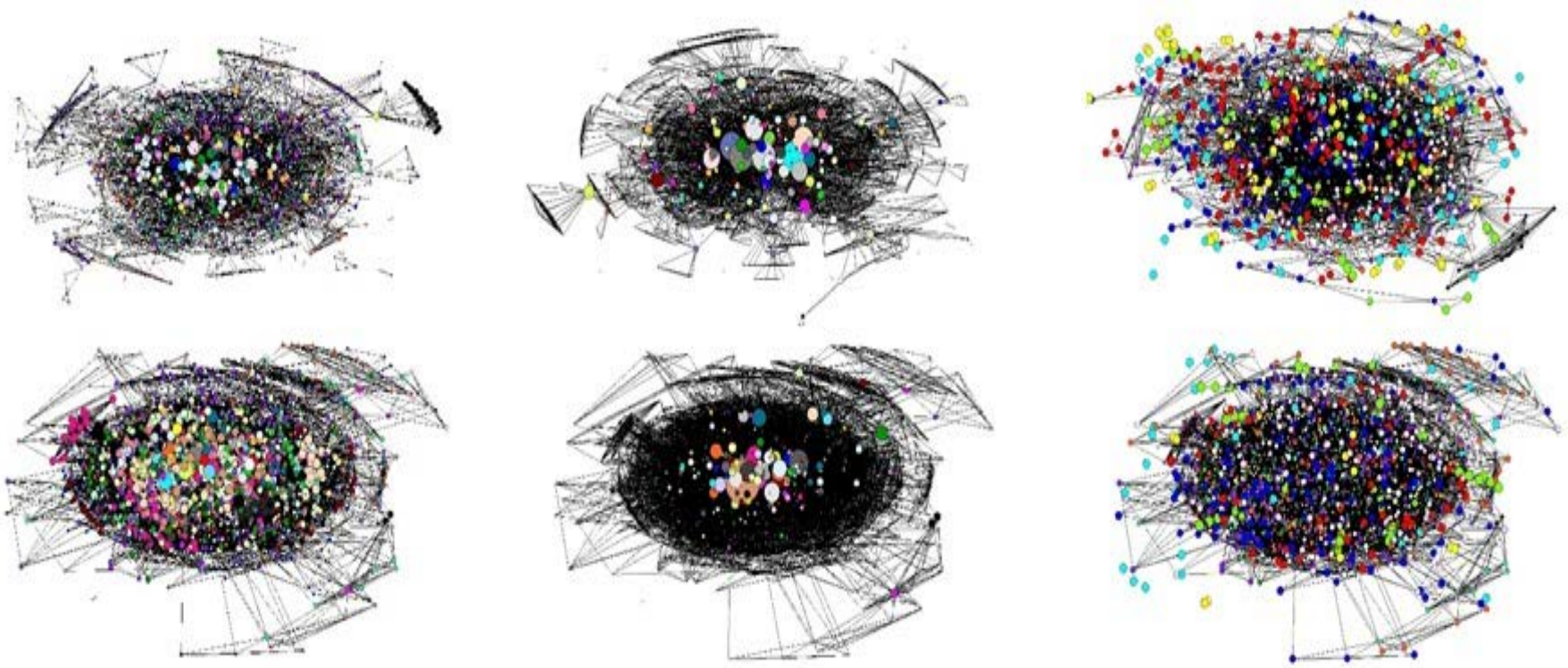

Fig. 1 Evolution of RE Network of R&D in Europe. In rows 2000 and 2013 years. In columns network degree partition in terms of degree, betweenness and structural hole centrality.

Early Findings VIII

Table 2 Network indicators in Renewable Energy R&D projects (2000-2006)

Net Indicator	2000	2001	2002	2003	2004	2005	2006
Centrality degree	0.083	0.089	0.118	0.122	0.157	0.143	0.141
Centrality betweenness	0.110	0.073	0.088	0.095	0.144	0.123	0.138
W-S Coef.	0.889	0.896	0.903	0.901	0.914	0.920	0.924
Cluster Coef.	0.378	0.469	0.501	0.480	0.513	0.527	0.532
Nº actors	1356	1648	1925	1999	2240	2260	2431
Nº links	18296	29491	40855	42975	51996	52177	63995
Density	0.018	0.020	0.021	0.021	0.020	0.020	0.021
Average degree	26.985	35.790	42.447	42.996	46.425	46.174	52.649

Early Findings IX

Table 3 Network indicators in Renewable Energy R&D projects (2007-2013)

Net Indicator	2007	2008	2009	2010	2011	2012	2013
Centrality degree	0.135	0.114	0.097	0.139	0.177	0.179	0.218
Centrality betweenness	0.159	0.137	0.128	0.162	0.162	0.153	0.208
W-S Coef.	0.920	0.919	0.928	0.929	0.925	0.920	0.916
Cluster Coef.	0.533	0.536	0.556	0.520	0.471	0.417	0.394
Nº actors	2602	2580	2588	2530	2182	2468	2094
Nº links	65535	65535	64847	57784	49544	58168	48897
Density	0.019	0.019	0.019	0.017	0.020	0.018	0.021
Average degree	50.373	50.802	50.114	45.679	45.412	47.138	46.702

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Thank you very much for your attention

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