

Technological contribution of MNEs to the growing energy greentech sector in the early post-Kyoto period

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The determinants of cleaner energy innovations of the
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Research Aims

- We focus our attention on MNEs technological activity in the field of **energy green technologies** (energy greentech or greentech thereafter) in order to quantify both their *contribution* and *evolution*.
- This paper uses a large data set related to the patenting activity from the worldwide 946 **largest R&D operators** mainly MNEs.
- Picture if there is a difference between before and after Kyoto agreements (Protocol 1997) in terms of MNEs **commitments in favor of energy greentech**
- **First step of a larger project: tracking innovative capacity of worldwide large firms in the field of energy greentech**

Context of the study

- The climate change issues have become a global concern imposing pressure on decision makers in both governments and corporations.
- Since 1992 obligations were taken to address climate change issues through enhanced scientific and technological cooperation, assessment of sources of greenhouse gas (GHG) emissions and removals, policies and measures to mitigate GHG and to promote adaptation to climate changes (Borghesi & al., 2002).
- The Kyoto Protocol (1997) established emission reduction targets but was rejected in 2001 by the US
- But many new regional and national policies followed the signing of the Kyoto P.

Evidence for development in greentech

- Popp (2002) identified increasing prices of energy in the oil crisis as the significant driver of energy-saving inventions.
- Lanjouw & Mody (1996) empirical evidence that regulation triggers eco-innovations
- Jaffe & Palmer (1997) take the R&D process into account as well as the outcomes of inventive processes (measured with patent applications) and do not find any statistically significant effect of pollution-control expenditures on patenting activities.
- Brunnermeier & Cohen (2003) find a link between pollution-abatement spending and successful patent applications related to environmental technologies.
- Johnstone (2010) gives evidence that these R&D programs lead to increases in patenting activity for the targeted technologies.

Evidence

The leading role of multinational companies in the growth of the green sector was assessed by OECD (Kalamova, 2011; Corsatea, 2014) as well as the importance of clear and continuous national public policies to promote both greentech technology development and market demands.

A gap

- The correlation between political decisions resulting from the Kyoto Protocol signature and the take-off of clean-energy technologies **was largely documented in particular the efficiency of the various instruments set up to promote environmental technologies** (Jaffe, 2003; Johnstone, 2010; Veugelers, 2011).
- A large strand of literature investigates and compares the **capacity of countries** to promote greentech innovation, **only scarce information** on the relative contribution of the different actors from the **business sector** to green technology innovation

Four questions addressed

- 1. **Measuring the contribution of large firms** involved in energy green technologies across countries and investigate their evolution
- 2. Did **large innovative firms increase their inventive** production in energy greentech after the Kyoto protocol. We **compare their *relative* volume of patents** in energy greentech in the pre- and post-Kyoto periods of time.
- 3. In order to compare the efforts of large firms, ***we rely on their specialization*** in energy greentech. We assess **the scale and evolution of the large firm relative specialization** in green technologies through a green specialization index.
- 4. Finally, we identify the **sectors of energy greentech in which the large firms are the most active**. For this, we detail the green **specialization of firms at the level of green subsectors** and follow their evolution over time.

Data set

- From the Patstat database (2011) We select priority patent applications for two periods of time **1994 to 1996** and **2003 to 2005**, and use information pertaining to applicant names and application filing date.
- The list of firms studied was provided by the Industrial R&D Investment Scoreboard 2008
- The energy cleantech patents were identified using the new CPC classification (Y02) set up by EPO in 2010 to tag technologies which *"control, reduce or prevent GHG emissions of anthropogenic origin"*.
- Firm patents are **priority patents applied** for by a legal entity that belongs to a set of **946 large firms** with sustained patenting activity (threshold of 5 patent applied for during each of the two periods of time)

Four Indicators of energy greentech specialisation

1. Volume of firm patenting in energy greentech inventions
2. Firm contribution to energy green tech (relative patenting)
3. Firm Index of specialization in energy green technologies (comparison with the relative average)
4. Index of specialization in a subsector of energy green

Energy greentech patents of firms across greentech sectors (1994-2005)

Energy greentech subsectors	Distribution (%)
Renewable energy sources	17.71
Combustion technologies (CHP, CCPP)	3.13
Nuclear energy	3.07
Efficient electrical power	2.02
Biofuels	2.86
Energy storage (batteries), hydrogen tech, fuel cells	70.62
Total	100.00
Total number of patents	72 565

Share of firms active in energy greentech across countries before/after Kyoto (%)

Country	Share of large firms in greentech (%)	
	1994-1996	2003-2005
United States	27	32
Japan	70	77
Germany	29	44
United Kingdom	19	27
France	36	46
Switzerland	22	44
Sweden	11	26

Share of greentech patents in firm patent portfolios across countries before/after Kyoto (means 1.6/2.3)

Country	Share of green patents (%)	
	1994-1996	2003-2005
United States	1.01	1.14
Japan	1.82	3.08
Germany	1.48	1.51
United Kingdom	0.64	0.87
France	1.43	2.59
Switzerland	2.88	1.08
Sweden	0.71	0.56
Netherlands	0.54	1.36
Finland	0.70	0.36
Korea	0.40	0.57

Firm greentech specialization index across countries before/after Kyoto

Country	Greentech specialisation index of large firms	
	1994-1996	2003-2005
United States	0.62	0.50
Japan	1.13	1.34
Germany	0.91	0.66
United Kingdom	0.40	0.38
France	0.88	1.13
Switzerland	1.78	0.47
Sweden	0.44	0.24
Netherlands	0.33	0.59
Finland	0.43	0.16
Korea	0.25	0.25

Firm greentech specialisation index in main subsectors of energy greentech

Country	Renewable energy		Combustion		Nuclear energy		Non fossil fuel		Batteries, fuel cell, hydrogen	
	94_96	03_05	94_96	03_05	94_96	03_05	94_96	03_05	94_96	03_05
United States	0.54	1.23	1.95	1.78	2.56	0.84	0.24	0.33	0.93	0.95
Japan	1.09	1.03	0.61	0.73	0.64	0.75	1.12	1.10	1.04	1.01
Germany	0.71	0.65	3.75	1.90	3.08	0.00	0.80	0.68	0.61	1.03
United Kingdom	1.20	2.98	6.44	4.92	1.48	1.39	1.04	0.00	0.54	0.51
France	0.42	0.70	4.57	4.03	4.50	9.58	0.31	0.23	0.51	0.85
Switzerland	0.43	1.20	6.61	0.74	5.54	0.00	0.23	1.69	0.22	0.48
Sweden	0.00	3.37	3.24	10.31	1.48	0.00	0.00	0.00	1.23	0.24
Netherlands	2.07	1.09	2.10	1.05	0.00	0.00	0.00	0.60	0.75	1.01
Finland	0.34	1.09	6.36	2.32	0.00	0.00	3.24	10.60	0.96	0.65
Korea	0.80	0.45	0.00	2.04	0.51	3.90	0.00	0.00	1.24	1.06 ¹⁵

General Findings

From our MNEs appear a **massive** trend over the period **1994-2005**, in favour of the diffusion of energy green tech:

* A growing number of firms produce energy greentech inventions

**the overall share of greentech has increased significantly – a tendency that has already been identified by Veugelers (2014)

The sector of the transport energy (battery, fuel cell) is the sector where the firm commitment is the strongest.

- Japanese and US firms are highly committed to renewable energies

There is a large heterogeneity across European actors in terms of shares of greentech, index and profile of greentech specialisation

Findings: before/after Kyoto

- *Pre-Kyoto period*: the leadership of Japanese firms in energy greentech/ US and most of the European countries were much less committed (lower share of firms applying for greentech patents, lower share of greentech patents in patent portfolios).
- *Post-Kyoto period*: leadership of Japanese firms not challenged/ Japanese specialisation in energy greentech was twice that of European firms (only 1.5 time ten years before) and 2.7 that of US firms (twice ten years before). **But firms in western countries have started to move**: the share of firms filing greentech patents and the share of greentech patents in firm portfolios have significantly increased in most countries (and industries).

Findings: National Policies and Firms Strategy

- **In post-Kyoto period**, the issue of the impact of energy on climate change has been addressed differently by firms according to their geographic locations.
- European firms were more prone to diversification than US ones but they still lag far behind Japanese firms that strongly diversified much earlier.
- The patent portfolios of firms became greener; its trend remained “light green” in western firms. EU firms and even more US firms are losing ground.
- This apparent relative decreasing specialization of US and EU firms has to be considered with care. It results mainly from the de-commitment from Nuclear energy and Combustion in many (but not all) countries.
- Signals of an commitment to Renewable energy and Energy storage is evident in most western countries. Its intensity is more pronounced in the US