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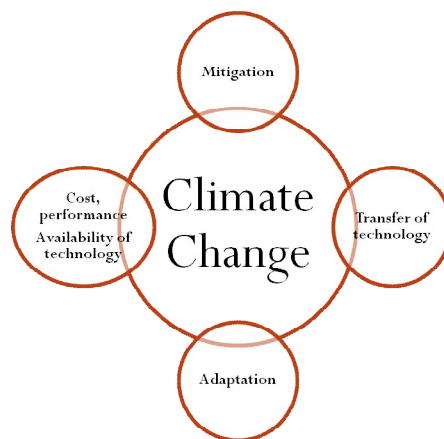


ECOINNOVATION IN CLIMATE FRIENDLY TECHNOLOGY: AN ANALYSIS THROUGH PATENT DATA

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The problem



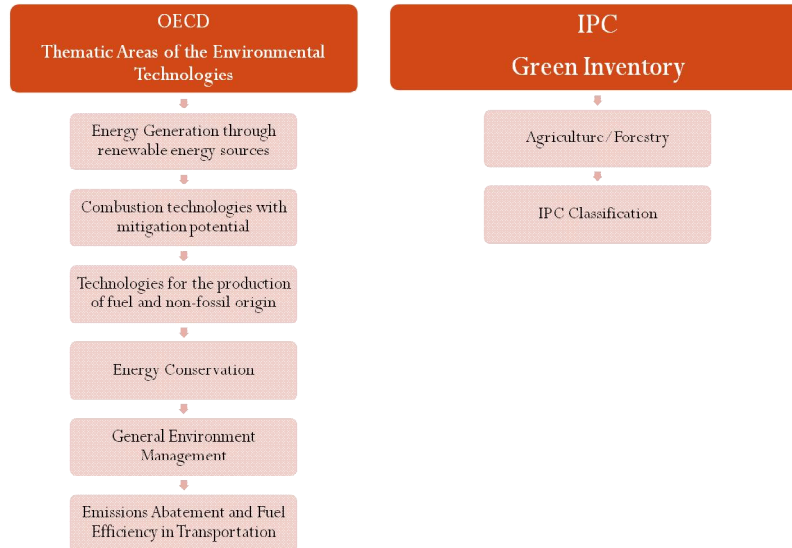
What we know?

- Environmentally-friendly innovation occurs primarily in developed countries.
- Since the Kyoto Protocol in 1997, a marked increase in the rate of patenting of environmental technologies.
- Environmental transfer is necessary for a low carbon society.
- Barriers for the diffusion of environmental technologies: Intellectual Property Rights, absorptive capacity and technological capabilities of the recipient country.
- Variations in environmentally-friendly R&D spending tell us the relative importance placed on eco-friendly innovation.

Objective of the paper

- For the period 1978-2010, to study the world map in climate-friendly technologies with the aim of answer some questions:
 - In which countries does climate-friendly innovation taken place? Environmental policy is determinant? Which are the sources of innovation?
 - To what extent is technology being transferred to developing countries? Are countries capturing technology competences in these technologies?

Method: Identification of Technological Fields



Description of environmental technological groups

	TOPIC	DESCRIPTION
Chapter 1	Energy generation through renewable energy sources	Geothermal, hydroenergy, solar energy, wind energy.
Chapter 2	Combustion technologies with mitigation potential	Alternative energy production-cycle combined, integrated gasification combined cycle
Chapter 3	Technologies for the production of fuel of non-fossil origin	Biofuels: biodiesel, bioethanol, biogas
Chapter 4	Technologies with potential or indirect contribution to GHG emissions mitigation	Fuel cells
Chapter 5	Energy conservation	Storage of electrical energy, measurement of electric consumption, storage of thermal energy, low energy lighting, thermal building insulation, recovering mechanical energy
Chapter 6	General Environmental Management	Air pollution abatement, Water pollution abatement, Waste Management, Soil Remediation, Environmental Monitoring
Chapter 7	Emissions Abatement and Fuel Efficiency in Transportation	Technologies specific to propulsion using internal combustion engine: conventional motor vehicles, hybrid vehicle, Technologies specific to propulsion using electric motor; Technologies specific to hybrid propulsion, Fuel efficiency-improving vehicle design
Chapter 8	Agriculture/Forestry	Forestry techniques, alternative irrigation techniques, pesticide alternatives, soil improvement

Source: Own elaboration.

	OURS	IPC
ENERGY GENERATION THROUGH RENEWABLE ENERGY SOURCES	1	
GEOHERMAL ENERGY	11	
Use of geothermal heat	111	
Steam, Engines Plants	111	F01K 7/00
Steam, Engines Plants	111	F01K 9/00
Steam, Engines Plants	111	F01K 11/00
Steam, Engines Plants	111	F01K 13/00
Steam, Engines Plants	111	F01K 15/00
Steam, Engines Plants	111	F01K 21/00
Steam, Engines Plants	111	F01K 23/00
Steam, Engines Plants	111	F01K 25/00
Steam, Engines Plants	111	F01K 27/00
Air conditioning	111	F24F 5/00
Other production using geothermal heat	111	F24J 3/08
Electric motors using thermal heat	111	H02N 10/00
Heat Pumps characterized by the low source heat	111	F25B 30/06
Production of mechanical power from geothermal energy	111	F03G 4/00
Production of mechanical power from geothermal energy	111	F03G 4/02
Production of mechanical power from geothermal energy	111	F03G 4/04
Production of mechanical power from geothermal energy	111	F03G 4/06
Production of mechanical power from geothermal energy	111	F03G 7/04
HYDROENERGY	12	
Water power plants	121	
Tide or wave power plants	121	E02B 9/00
Tide or wave power plants	121	E02B 9/06

Method. The database

- The data set for the different types of environmental technologies was constructed from **patents** applied to the European Patent Office (EPO) over the period 1985 to 2010.
- EPO Space Bulletin.
- Search: IPC Classifications

Patent data (Literature)

- Jaffe, Trajtenberg and Henderson, 1993
- Archibugi & Pianta, 1996
- Lanjouw and Mody, 1996
- Brunnermeier and Cohen, 2003
- Thompson and Fox-Kean, 2005
- Peri, 2005
- Popp, 2006
- Dechezleprêtre *et al.*, 2009
- Johnstone, et.al., 2010
- De Prato & Nepelski, 2012

A	B	C	D	E	F	G	H	I	J	K	L	M
CLMN+CAI	OURCLASS	DCST	APNR	PRNR	LPCY	INCY	N° Inventors	N° Nacionalidades	APCY	TIPO	APNM	
B01D53/34	611	AT BE BG CH CY CZ DE DK EE	5712924	US	542470 P	US ! GB	2	2	US ! US ! GB	EMPRESA	02Diesel Corporation	
C10L1/14	312	AT BE BG CH CY CZ DE DK EE	7763852	CA	25516 B	CA	1	1	CA	EMPRESA	1692124 Ontario Inc.	
B03C3/02	611	AT BE DE FR GB	91103399	CS	1144/90 ! CS 4422/90 ! CS	CS ! CS ! C	3	1	CZ	EMPRESA	2 E, akciová společnost	
B65F1/00	631		6110774	IT	Mi20050101	IT ! IT	2	1	IT ! IT	COEMPRESA	2001 S.r.l.	
B09B3/00	635	AT CH DE DK ES FR GB IT LI	95305122	US	285007	US	1	1	US	EMPRESA	21st CENTURY COMPANIES, INC.	
C02F1/64	621	AT BE BG CH CY CZ DE DK EE	4749194			SE	1	1	SE	EMPRESA	2Alfa Hydrotech AB	
C12P7/06	312	AT BE CH DE DK ES FI FR GB C	98905197	CH	64797	BE ! DK ! ES ! FI ! F CH ! CH	2	1	CH	EMPRESA	2B BIOTEC AG	
F24F5/00	111		4027727	DE	10357307	DE ! DE	2	1	DE	EMPRESA	2H Kunststoff GmbH	
H02K7/18	141	AT BE CH CY DE DK ES FI FR G	99958277	FR	9815718	FR ! FR ! F	3	1	FR	EMPRESA	3 D Developpement	
B01D46/00	611	AT CH DE FR LI	96119558	IT	T0950977	IT ! IT ! IT	3	1	IT	EMPRESA	3 EFPE.GI S.r.l.	
F02M31/16	711	AT BE CH DE DK ES FR GB GR	92903601	GB	9102217 ! GB 9122586 ! G	GB ! GB ! C	3	1	CA	EMPRESA	334455 ONTARIO INC.	
C02F11/08	621	DE FR GB IT NL	95940096	US	361126 NL ! IT	CA	1	1	CA	EMPRESA	3500764 Canada Inc.	
C02F1/52	621	AT BE CH CY DE DK ES FI FR G	912290	CA	226767 AT ! BE ! CH ! CY ! CA	CA	1	1	CA	EMPRESA	3C Water Systems Ltd.	
B03C3/28	611	DE FR GB	906029	US	420701	US ! US ! L	3	1	US	TNC	3M Innovative Properties Company	
B01D46/26	611	AT BE CH CY DE DK ES FI FR G	947174	US	504474 AT ! BE ! CH ! CY ! US	US ! US	2	1	US	TNC	3M Innovative Properties Company	
A01N25/28	813	DE FR IT	968588	US	426140	US	1	1	US	TNC	3M Innovative Properties Company	
C09K5/00	531	DE FR	970528	US	158462 FR	US	1	1	US	TNC	3M Innovative Properties Company	
A01N25/28	813	DE FR IT	970718	US	425636 IT ! FR	US	1	1	US	TNC	3M Innovative Properties Company	
A01N25/28	813	DE FR IT	972065	US	425761	US	1	1	US	TNC	3M Innovative Properties Company	
A01N37/12	813	DE FR GB IT	992479	US	167250 P	US ! US	2	1	US	TNC	3M Innovative Properties Company	
F01N3/28	611	AT BE CH CY DE DK ES FI FR G	1995148	JP	200035 AT ! BE ! CH ! CY ! JP ! JP ! JP	US	3	1	US	TNC	3M Innovative Properties Company	
F01N3/28	611	AT BE BG CH CY CZ DE DK EE	2078103	AT	! BE ! BG ! CH ! BE ! BE ! B	US	3	1	US	TNC	3M Innovative Properties Company	
B01D46/24	611	AT BE CH CY DE DK ES FI FR G	2079267	US	300249	US ! US ! L	4	1	US	TNC	3M Innovative Properties Company	
A01N25/22	813	AT BE CH CY DE DK ES FI FR G	2717693	US	820800 AT ! BE ! CH ! CY ! US	US	2	1	US	TNC	3M Innovative Properties Company	
B03C3/28	611	AT BE CH CY DE DK ES FI FR G	2739271	US	927976 AT ! BE ! CH ! CY ! US ! US ! L	US	4	1	US	TNC	3M Innovative Properties Company	
B01D46/26	611	AT BE BG CH CY CZ DE DK EE	2761449	US	87057 AT ! BE ! BG ! CH ! US	US	1	1	US	TNC	3M Innovative Properties Company	

Results

- Number of patents: 50,087 patents.
- *Countries*: Japan, Germany and the United States (represent almost 70% of all patents). Other important countries are France, Great Britain, Italy
- *Technological Field*: most environmental technological efforts corresponds to Emission Abatement and Fuel Efficiency in Transportation (21, 8%), Agriculture and Forestry (34, 4%) and General Environment Management(37,3%).
 - More specifically, air and water pollution abatement, material recycling and reuse, integrated emission control, post combustion emission control and forestry techniques, alternative irrigation techniques, pesticides alternatives and soil improvements are the fields with more patents. In this particular cases it remarkable the presence of China, Austria, Belgium or Australia
- *Applicant*: As expected, most of the technological activity expressed by patents is concentrated **in firms**.

Patent counts by applicant's country of residence (the ownership)

	BR	CA	CH	CN	DE	FR	GB	IN	JP	US	ZA	Total
CAPITULO 1	2	16	75	9	366	75	70	2	193	247		1433
CAPITULO 2			25		42	3	3		29	22		145
CAPITULO 3	1	8	13	1	59	21	26	1	34	129		365
CAPITULO 4		8	14		65	3	7		93	87		300
CAPITULO 5		12	14	3	159	58	39		343	262		1040
CAPITULO 6	17	249	611	36	5457	1279	944	7	2777	3227		18658
CAPITULO 7	5	57	105	12	3279	973	362	10	3745	1610		10931
CAPITULO 8	14	126	1227	27	4950	792	1061	53	1785	5081	5	17215
Total Geral	39	476	2084	88	14377	3204	2512	73	8999	10665	5	50087

The United States receive the most patent applications in absolute terms, followed by the Japan, Germany, France, Great Britain and China.

NUMBER OF INVENTIONS TRANSFERRED FROM COUNTRY A TO COUNTRY B

MATRIZ DEPOSITANTE INVENTOR

COPATENTING TIPOS:

- Domestic inventor, foreign applicant (or assignee)
- Domestic applicant, foreign inventor

Todas	OCE	AL-BR	BR	CA	US	DE	FR	GB	CH	EU-cen	EU-nord	EU-PER	EU-este	OMP	JP	CN	IN	AS	ZA	AF-ZA	Total	sum
OCE	475																				545	577
AL-BR	2	62																			177	196
BR			39																		39	42
CA	3	2	437																		476	535
US	53	25	12	151	9651	392	164	314	69	230	108	97	40	43	112	50	31	42	12	1	10665	11597
DE	22	24	92	51	594	13757	230	127	105	291	48	95	34	5	134	23	12	67	16	4	14377	15731
FR	11	6	6	17	208	101	2823	102	19	43	13	33	6	2	28	5	3	9		7	3204	3442
GB	19	4	2	11	277	52	21	2198	40	53	24	35	11	2	12	6	5	2	12		2512	2786
CH	9	3	3	12	221	357	95	84	1605	55	52	15	11	6	16	2	4	6			2084	2556
EU-cen	2	11		3	226	244	117	238	88	1900	29	60	36	7	12	3	9	2	3	1	2685	2991
EU-nord	5			7	77	49	16	50	6	28	1753	6	13	10	6	1	3	3			1902	2033
EU-PER	3	3		7	470	35	20	26	17	12	10	1813	4	8	29	3	1	8	1		2325	2470
EU-este					7	13	1	1		2	1	6	314	6							334	352
OMP	1	1		1	21	6	5	4		2	2	2	12	269	3					1	286	329
JP			2	6	101	43	6	27	12	6	7	5	1	8927							8999	9158
CN	5				3	12	3	1		1	1	2			2	75			4		88	109
IN						6		2		1							69				73	78
AS	4			6	8	8	1	3		8	2	1			6	7	1	412	1		448	468
ZA					1	1		1											5		5	8
AF-ZA						1	3	1								2				9	14	16
Sum	614	141	156	724	11984	15089	3520	3223	1971	2636	2054	2182	496	362	9294	182	142	570	111	23		
Total	595	127	153	678	11546	14847	3409	2970	1869	2540	2010	2139	474	335	9188	178	127	560	106	20		53871

Patent distribution by environmental technology and by type of applicant (%).

	I. Renewable energy	II. Combustion technologies	III. Non fossil fuel	IV. CHC Mitigation	V. Energy conservation	VI Environment	VII Emission transport	VIII Agro-forestry	Total Patents by applicant nature	Weight over total
National Enterprises	4,1	0,2	0,9	0,7	2,6	53,6	9,0	28,9	14945	-
National Enterprises Cooperation	3,6	0,0	1,8	0,0	2,1	55,3	9,4	27,7	329	-
University-Industry Cooperation	1,6	0,0	4,9	0,0	3,3	29,3	4,1	56,9	123	-
Global Corporations	1,2	0,4	0,6	0,6	1,9	25,6	31,8	37,9	27936	-
Global Corporations Cooperation	1,3	0,1	1,3	0,5	1,7	35,2	29,2	30,5	753	-
Universities and Research Centers	1,9	0,1	1,6	1,4	2,0	28,9	8,4	55,8	1946	-
Individuals	10,2	0,1	0,4	0,1	1,8	60,5	6,5	20,4	4055	-
Weight over total	2,9	0,3	0,7	0,6	2,1	37,3	21,8	34,4	50087	-
National Enterprises	43,3	17,9	35,1	32,7	37,1	42,9	12,4	25,1	-	29,8
National Enterprises Cooperation	0,8	0,0	1,6	0,0	0,7	1,0	0,3	0,5	-	0,7
University-Industry Cooperation	0,1	0,0	1,6	0,0	0,4	0,2	0,0	0,4	-	0,2
Global Corporations	23,5	77,9	46,0	55,3	50,0	38,3	81,4	61,5	-	55,8
Global Corporations Cooperation	0,7	0,7	2,7	1,3	1,3	1,4	2,0	1,3	-	1,5
Universities and Research Centers	2,6	0,7	8,8	9,0	3,7	3,0	1,5	6,3	-	3,9
Individuals	29,0	2,8	4,1	1,7	6,9	13,2	2,4	4,8	-	8,1
Total Patents by chapter	1433	145	365	300	1040	18658	10931	17215	-	50087

Source: The authors' elaboration from EPO Espace Bulletin, 1978-2010.

Some relevant firms

GENERAL ENVIRONMENT MANAGEMENT	EMISSION ABATEMENT AND FUEL EFFICIENCY	AGRICULTURE/ FORESTRY
3M	BASF	BASF
	BAYER	BAYER
	CIBA-GEIGY	CIBA-GEIGY
	CONTINENTAL AUTOMOTIVE	CONTINENTAL AUTOMOTIVE
	CORNING	CORNING
DAIMLER	DAIMLER	DAIMLER
DELPHI TECHNOLOGIE	DELPHI TECHNOLOGIES	DELPHI TECHNOLOGIES
DENSO CORPORATION	DENSO CORPORATION	DENSO CORPORATION
	DUPONT	DUPONT
	FORD GLOBAL	FORD GLOBAL

Methodology. Data analysis

- Indicator: Co-operation intensity. Number of joint patent applications with co-applicants in a Technology Field (TF)

	>1 nationality	Total
COFIRMS	70	329
FIRM	115	14945
TNC	378	27936
TNC-CO	230	753
UNICPP	41	1946
INDEPENDENT INVENTORS	68	4055
Total	923	50087

Country Coinvention Matrix

	OCE	AL-BR	BR	CA	US	DE	FR	GB	CH	EU-cen	EU-nord	EU-PER	EU-este	OMP	JP	CN	IN	AS	ZA	AF-ZA	Total
OCE		1	5	47	20	5	16	1	3	2	8	1			5	2	5				595
AL-BR	1		1	2	20	24	7	3	2	4		1	1	1	1	1					127
BR		1		1	53	72	32	2	3	6		3	1		28	9	10				153
CA	5	2	1		128	18	8	20	3	3	7	1		1	7	3	8	1			678
US	47	20	53	128		474	153	233	98	126	75	75	24	41	152	63	31	50	9		11546
DE	20	24	72	18	474		230	100	293	306	32	85	33	6	127	18	14	69	11	5	14847
FR	5	7	32	8	153	230		54	70	90	15	41	7	5	46	6	5	7	1	7	3409
GB	16	3	2	20	233	100	54		57	54	35	38	4	5	18	3	1	3	5	1	2970
CH	1	2	3	3	98	293	70	57		31	12	21	10	1	10	1	1	5			1869
EU-cen	3	4	6	3	126	306	90	54	31		19	27	10	1	6	4	4	8	3	1	2540
EU-nord	2			7	75	32	15	35	12	19		5	8	5	3	1	3	2	1		2010
EU-PER	8	1	3	1	75	85	41	38	21	27	5		2	5	14		1	1			2139
EU-este	1	1	1		24	33	7	4	10	10	8	2		12	2	1	1				474
OMP		1	1	41	6	5	5	1	1	1	5	5	12		2						335
JP			28	7	152	127	46	18	10	6	3	14	2	2			1	9			9188
CN	5	1	9	3	63	18	6	3	1	4	1		1				1	3			178
IN	2				31	14	5	1	1	4	3	1			1	1		2	2		125
AS	5	1	10	8	50	69	7	3	5	8	2	1	1	1	9	3	2				560
ZA				1	9	11	1	5		3	1					2					106
AF-ZA						5	7	1		1				1							20

Preliminary conclusions

- Climate change is determinant in country innovation programs
- Private companies owns the ecoinnovations, mainly multinationals.
- The innovative performance is concentrated mainly in US, Japan (solar energy and low energy lighting technologies) and Germany. Canada (Thermal Buildings)
- For contrast "alternative energy production" is not very representative despite their widely recognized role.
- Cross-border patenting finds that patents are primarily submitted in OECD countries, mainly US, Europe and Japan
- The cooperation is also low

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