Measuring the technological coherence of environmental technologies with the industry knowledge base

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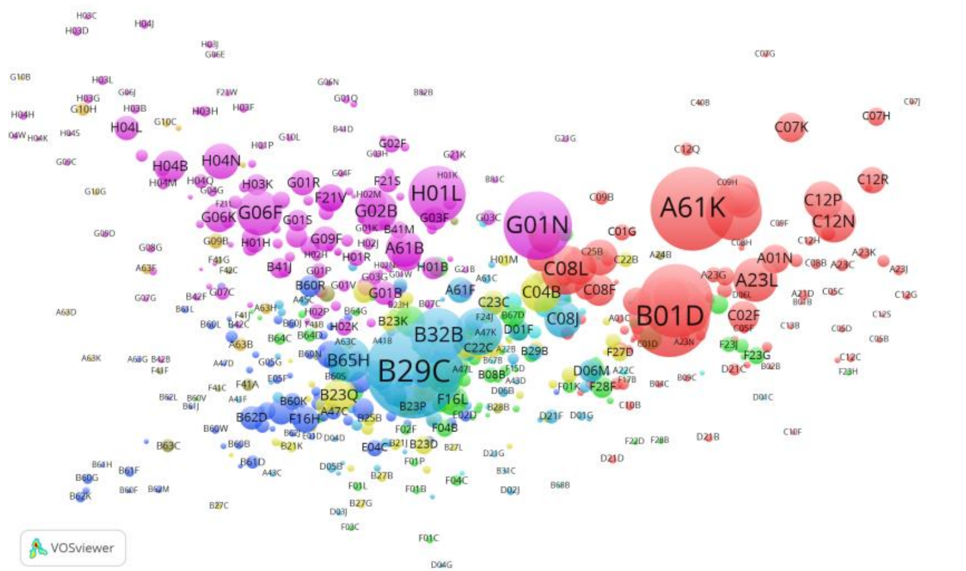
Knowledge as a network



The dynamic aspects of the network of knowledge

- Knowledge-base lifecycle:
  - Emergence of new knowledge types: few connections;
  - Maturity: new links and increasing connectivity;
  - The network density reflects different phases of the KB lifecycle.

(Saviotti, 2009; Krafft, Quatraro e Saviotti, 2008; 2011)

Proposal

Studying knowledge combination in a network:

- Network structure: which nodes are connected?
- Strength of connections: which relations are more frequent?
- Nodes centrality: which nodes are more important?

The strategy is to

- Identify the patterns of the search for competences in the technological knowledge-base;
- Understand the results of knowledge combination;
- Apply this methodology to identify how the search for competences happens.

Objective

Evaluate the coherence of pieces of knowledge from the environment related technologies inside the industrial knowledge base considering:

-Its centrality into the industrial base of knowledge;

-Its relatedness with other pieces of knowledge.

Questions

Environmental technologies (ET) are:

Complex – linked to complex products

Pervasive – linked to a wide set of industries;

Recent – linked to new technological paradigms (renewal energies, bio-production, electric car, ...)

How ET inserts into the industrial bases of knowledge?

What kind of competences involve?

- *Central*? – associated with competitive advantages or new business
- *Background*? – associated with complementary assets
- *Marginal*? - sporadic

As ET are recent, would measures based on frequency capture the real role of this technologies into the industrial base of knowledge?

Measuring technological coherence as centrality in a network

Page Rank as a measure of centrality considers:

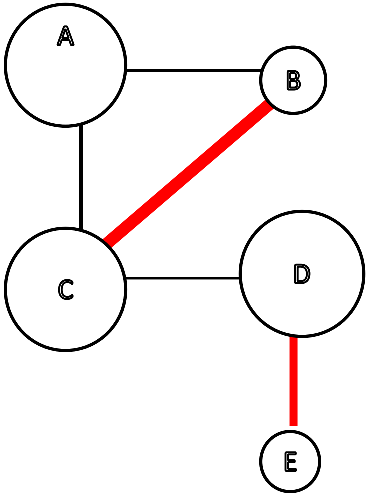
Frequency of nodes (UTK)

Number of links of one node to other UTKs (co-ocorrence)

Weights each UTK by the number of links that connect it with other UTKs in the network

Page-Rank ranks (orders) the UTKs in each base of knowledge

Centrality in a structure (base) of knowledge



A UTK can have low frequency and still have a strategic position in network if it is highly connected (Example: B or E)

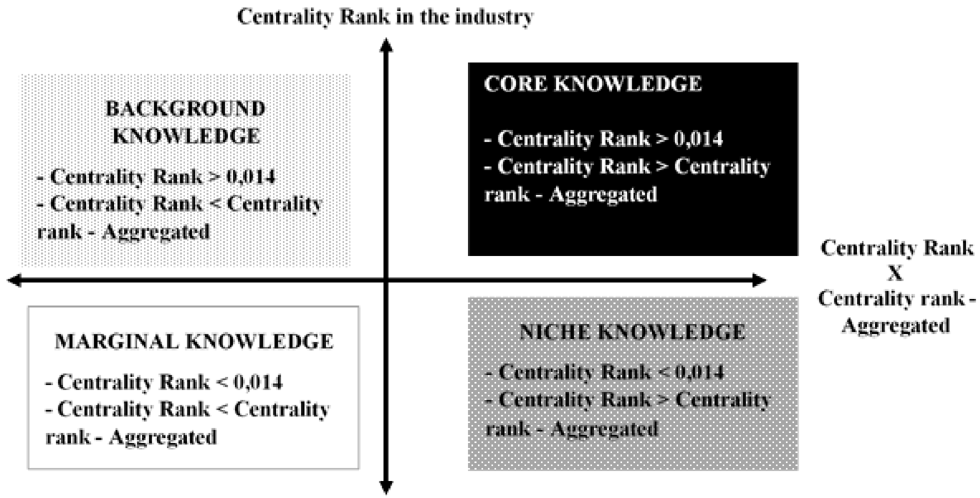
Measuring technological coherence

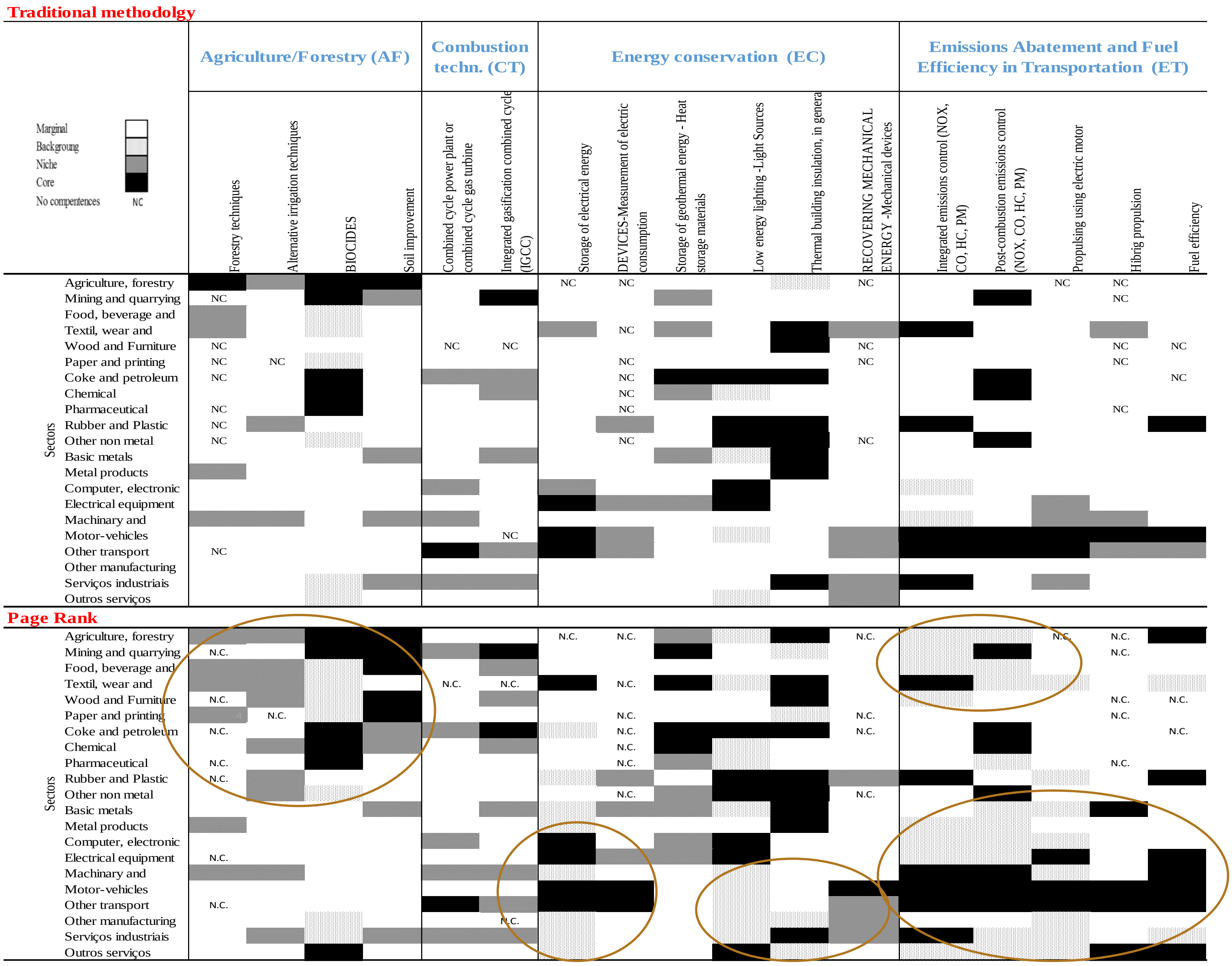
- We calculate a Centrality Rank for each industrial base of knowledge CR_j and for the whole industry CR_T
- We calculate the above indicator using the PRK values:

$$P_{ij} = {}^{p_{ij}}/_{p_j} \equiv \frac{1}{n} = 0{,}014$$

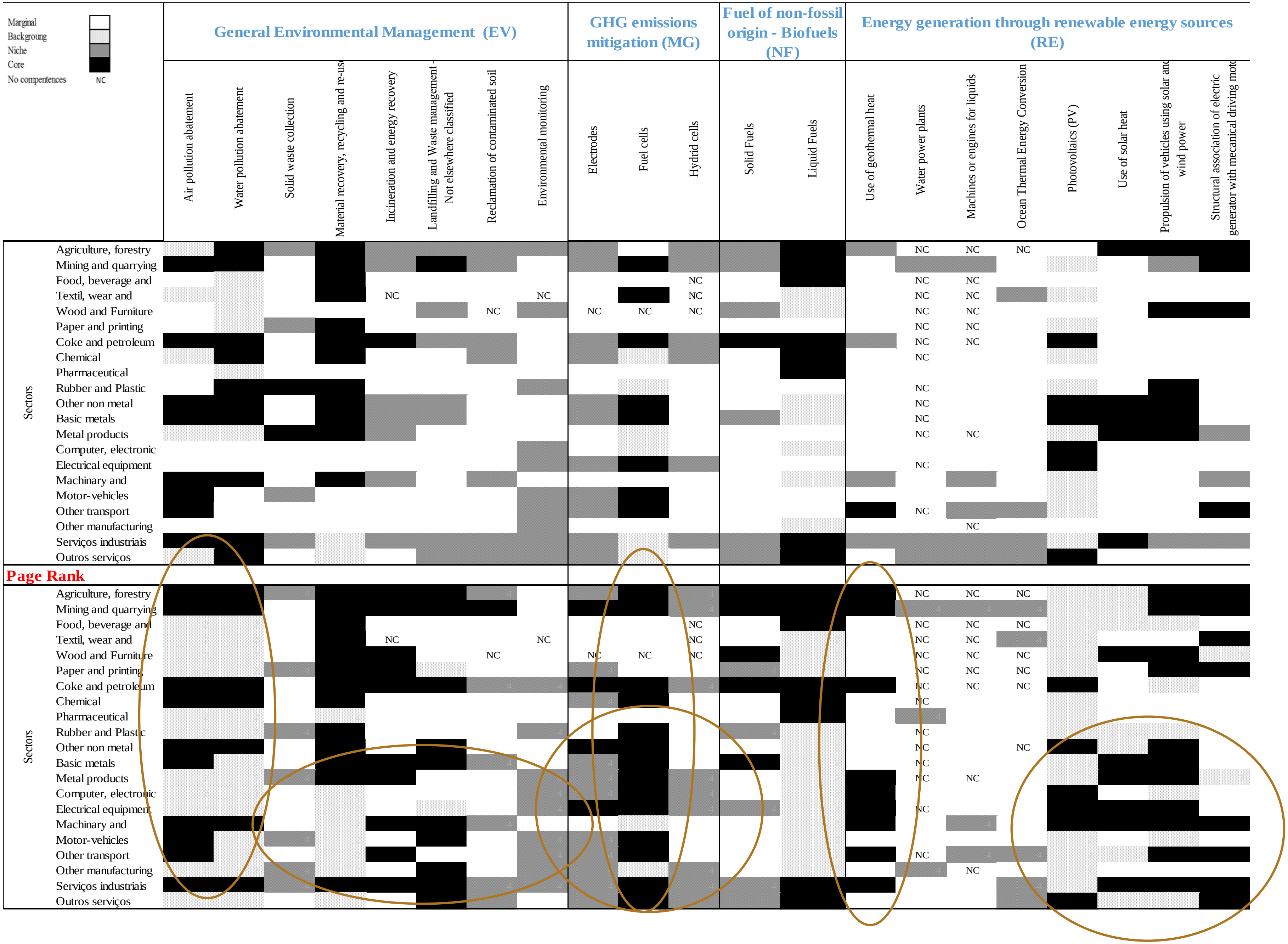
And instead RTA:

$$CR_j \quad \leq\geq \quad CR_T$$





Traditional methodolgy
Agriculture/Forestry (AF)
Combustion techn. (CT)
Energy conservation (EC)
Emissions Abatement and Fuel Efficiency in Transportation (ET)
Marginal
Backgroung
Niche
Core
No compentences
NC
Forestry techniques
Alternative irrigation techniques
BIOCIDES
Soil improvement
Combined cycle power plant or combined cycle gas turbine
Integrated gasification combined cycle (IGCC)
Storage of electrical energy
DEVICES-Measurement of electric consumption
Storage of geothermal energy - Heat storage materials
Low energy lighting -Light Sources
Thermal building insulation, in genera
RECOVERING MECHANICAL ENERGY -Mechanical devices
Integrated emissions control (NOX, CO, HC, PM)
Post-combustion emissions control (NOX, CO, HC, PM)
Propulsing using electric motor
Hibrig propulsion
Fuel efficiency
Sectors
Agriculture, forestry
Mining and quarrying
Food, beverage and
Textil, wear and
Wood and Furniture
Paper and printing
Coke and petroleum
Chemical
Pharmaceutical
Rubber and Plastic
Other non metal
Basic metals
Metal products
Computer, electronic
Electrical equipment
Machinary and
Motor-vehicles
Other transport
Other manufacturing
Serviços industriais
Outros serviços
Page Rank
N.C.



Marginal
Backgroung
Niche
Core
No compentences NC
General Environmental Management (EV)
GHG emissions mitigation (MG)
Fuel of non-fossil origin - Biofuels (NF)
Energy generation through renewable energy sources (RE)
Air pollution abatement
Water pollution abatement
Solid waste collection
Material recovery, recycling and re-use
Incineration and energy recovery
Landfilling and Waste management - Not elsewhere classified
Reclamation of contaminated soil
Environmental monitoring
Electrodes
Fuel cells
Hydrid cells
Solid Fuels
Liquid Fuels
Use of geothermal heat
Water power plants
Machines or engines for liquids
Ocean Thermal Energy Conversion
Photovoltaics (PV)
Use of solar heat
Propulsion of vehicles using solar and wind power
Structural association of electric generator with mecanical driving moto
Sectors
Agriculture, forestry
Mining and quarrying
Food, beverage and
Textil, wear and
Wood and Furniture
Paper and printing
Coke and petroleum
Chemical
Pharmaceutical
Rubber and Plastic
Other non metal
Basic metals
Metal products
Computer, electronic
Electrical equipment
Machinary and
Motor-vehicles
Other transport
Other manufacturing
Serviços industriais
Outros serviços
Page Rank

Comparing methods to reveal the importance of environmental technologies in the industry base of knowledge

Method		Agriculture Forestry (AF): Forestry techniques	AF: Alternative irrigation techniques	AF: BIOCIDES	AF: Soil improvement	Combustion technologies (CT): Combined cycle power plant or combined cycle gas turbine	CT: Integrated gasification combined cycle (IGCC)	Energy conservation (EC): Storage of electrical energy	EC: DEVICES-Measurement of electric consumption	EC: Storage of geothermal energy - Heat storage materials	EC: Low energy lighting -Light Sources	EC: Thermal building insulation, in general	EC: RECOVERING MECHANICAL ENERGY -Mechanical devices
By page-rank meth	M	8	11	8	12	14	10	7	9	11	5	8	12
	B	0	0	7	0	0	0	8	0	0	10	4	0
	N	6	9	0	4	5	7	0	3	6	0	0	4
	C	0	0	6	5	1	2	5	2	4	6	9	1
	NC	7	1	0	0	1	2	1	7	0	0	0	4
By frequency meth	M	9	17	10	16	15	13	15	10	15	12	12	12
	B	0	0	6	0	0	0	0	0	0	4	1	0
	N	4	3	0	4	4	5	2	4	5	0	0	5
	C	1	0	5	1	1	1	3	0	1	5	8	0
	NC	7	1	0	0	1	2	1	7	0	0	0	4
Maximum Value		21	21	21	21	21	21	21	21	21	21	21	21

Method		Emissions Abatement and Fuel Efficiency in Transportation (ET): Integrated emissions control (NOX, CO, HC, PM)	ET: Post-combustion emissions control (NOX, CO, HC, PM)	ET: Propulsing using electric motor	ET: Hibrig propulsion	ET: Fuel efficiency	General Environmental Management (EV): Air pollution abatement	EV: Water pollution abatement	EV: Solid waste collection	EV: Material recovery, recycling and re-use	EV: Incineration and energy recovery	EV: Landfilling and Waste management – Not elsewhere classified	EV: Reclamation of contaminated soil	EV: Environmental monitoring
By page-rank meth	M	7	4	9	12	10	0	0	14	0	10	9	13	11
	B	8	10	8	0	2	11	14	0	8	0	2	0	0
	N	0	0	0	0	0	0	0	7	0	0	0	6	9
	C	6	7	3	4	7	10	7	0	13	10	10	1	0
	NC	0	0	1	5	2	0	0	0	0	1	0	1	1
By frequency meth	M	14	15	15	12	16	8	5	15	7	12	13	13	10
	B	2	0	0	0	0	5	6	0	2	0	0	0	0
	N	0	0	3	3	1	0	0	4	0	7	7	7	10
	C	5	6	2	1	2	8	10	2	12	1	1	0	0
	NC	0	0	1	5	2	0	0	0	0	1	0	1	1
Maximum Value		21	21	21	21	21	21	21	21	21	21	21	21	21

Method		GHG emissions mitigation (MG): Electrodes	MG: Fuel cells	MG: Hydrid cells	Fuel of non-fossil origin - Biofuels: Solid Fuels	Biofuels: Liquid Fuels	Energy generation through renewable energy sources (RE): Use of geothermal heat	RE: Water power plants	RE: Machines or engines for liquids	RE: Ocean Thermal Energy Conversion	RE: Photovoltaics (PV)	RE: Use of solar heat	RE: Propulsion of vehicles using solar and wind power	RE: Electric generator - mecanical driving motor	TOTAL
By page-rank meth	M	5	4	9	11	0	12	5	10	10	0	8	4	11	303
	B	0	2	0	0	13	0	0	0	0	15	7	6	2	137
	N	11	0	9	5	0	0	3	3	5	0	0	0	0	102
	C	4	14	0	5	8	9	0	0	0	6	6	11	8	190
	NC	1	1	3	0	0	0	13	8	6	0	0	0	0	66
By frequency meth	M	9	6	12	14	6	16	5	8	11	5	16	13	14	446
	B	0	6	0	0	7	0	0	0	0	10	0	0	0	49
	N	11	0	6	6	0	4	3	5	4	0	0	2	3	122
	C	0	8	0	1	8	1	0	0	0	6	5	6	4	115
	NC	1	1	3	0	0	0	13	8	6	0	0	0	0	66
Maximum Value		21	21	21	21	21	21	21	21	21	21	21	21	21	798

Source: author calculations based on data from EPO PATSTAT / EPO (2015) and Orbis / BvD (2013).

Thank you!

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