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Techno-Economic Analysis of a Grid-Connected Hybrid Biogas/Photovoltaic Power Generation System in the Mediterranean Region

Kasım Zor, Çukurova University, Turkey
Özgür Çelik, Adana Science and Technology University, Turkey
Ahmet Teke, Çukurova University, Turkey

The European Conference on Sustainability, Energy & the Environment 2016
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Abstract
Depletion of fossil fuels and oncoming impacts of global warming reveal the vitality of utilizing renewable power generation systems for future generations of humanity. Investing in those systems also has several incentives in Europe for domestic equipment usage or selling produced electricity to the grid with advantageous tariffs in recent years. Reciprocating internal combustion engine based biogas cogeneration provides simultaneous heat and electricity with respect to a single fuel input that is obtained by the anaerobic digestion of renewable energy resources such as animal manures and regenerative raw materials. A biogas cogeneration plant with a photovoltaic (PV) system that transforms inexhaustible sunlight into electricity is an energy efficient and reliable alternative in order to produce heat and electrical energy at the same time for both on-grid systems in urban areas and off-grid systems in rural areas.

In this study, techno-economic analysis of a grid-connected hybrid biogas/PV power generation system settled in the Mediterranean Region is performed by investigating the scenario of selling the produced electricity to the national grid with the advantageous tariff price and evaluating heat energy within the plant.

Keywords: Hybrid, Biogas, Cogeneration, Photovoltaic, Power Generation.

Introduction

According to predictions, by 2050s crude oil reserves will exhaust. By 2120s natural gas reserves and by 2220s coal reserves will also be exploited. Therefore, there are some about 34 years to replace oil by other energy carrier (Chasnyk et al., 2015). Recent years, energy production technologies based on renewable resources are prominent depending upon the depletion of fossil fuels (Zor, 2015). From all the renewable energy sources, the most promising is the solar energy which the most powerful and biomass energy that is most stable (Chasnyk et al., 2015).

Manure and wastewater have been used for energy purposes for millennia, with the earliest records of biogas utilization dating back to about 2000 years ago in Asia. By the 1800s, China and India burned biogas for heating water. Improved technology boosted production before the First World War was already feeding bio-methane into the gas distribution network in the 1920s. Since 1949, compressed biogas is being used as car fuel. After the Second World War, comparatively cheap oil made biogas unprofitable and many plants were closed down until the oil crisis in the early 1970s. As oil got costlier in the aftermath, biogas for heating, electricity or cogeneration became popular and production started to grow again. Energy production systems from biogas, which is the one of the most important renewable energy technologies, will have a worldwide installed capacity rating of 22 GW by 2025 (Mohammadi Maganaki et al., 2013).

Biogas is a flammable gas that is the main product of biodegradation of organic substances in an anaerobic environment (Toma et al., 2012). In biogas production process, organic matters such as animal manures or human waste, raw materials, and biomass, and solid wastes such as sewage. Biogas is mainly composed by 35% of carbon dioxide (CO_2) and 60% of methane (CH_4) that is a greenhouse gas with global warming potential 20 times greater when compared to carbon dioxide and, therefore, its emission to the atmosphere should be avoided. 5% of other gases like nitrogen (N_2), hydrogen (H_2), ammonia (NH_3), hydrogen sulphide (H_2S), carbon monoxide (CO) and volatile amines (Garcilasso et al., 2011).

Biogas is created by the digestion or fermentation of organic materials. The basic material is often slurry or solid manure. Regenerative raw materials or waste from the food industry are generally used as cofermentates. 50 – 70 % of the gas produced this way is composed of the high-quality fuel methane. A multiplicity of organic materials can be used in a biogas plant. Some systems run entirely on slurry and solid manure, while others exclusively use regenerative raw materials. Frequently, a mixture of materials is used. The principle of a cogeneration system based on biogas is demonstrated in Figure 1 (MTU, 2016). The biogas is used to generate power in a manner that is both economical and saves resources. The power produced can either be used to supply the operator's own requirements, or it can be fed into the public power grid (MTU, 2016).

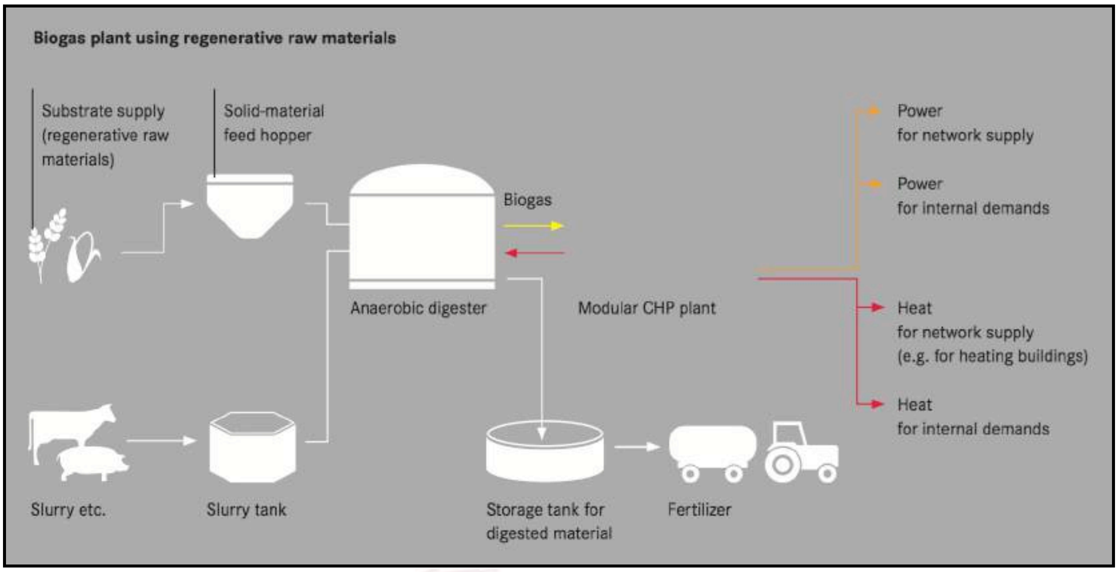

Figure 1: The principle of a cogeneration system based on biogas from regenerative raw materials and animal waste.

Electrical, heat, and the overall efficiencies of a 999kW, 400V, 50Hz biogas based cogeneration plant operating with animal manures are shown in Figure 2. While calculating efficiencies, whole electricity that is generated in the plant is assumed to be sold to the grid and heat outputs (heat recovery from exhaust gas, high-temperature (HT) circuit, and low-temperature (LT) circuit) produced by heat recovery is assumed to utilize in the biogas complex totally. Electrical output is 999kW, heat outputs are 1075kW (heat recovery from exhaust gas and HT circuit) and 86kW (LT circuit) respectively. Energy input of the biogas cogeneration plant is 2407kW. Methane content of the biogas is at least 60% of its volume (MTU Specification, 2016).

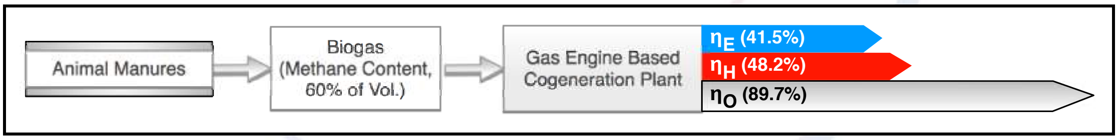

Figure 2: Efficiencies of GR999B5-12V4000L62 Biogas Cogeneration Plant (MTU Specification, 2016).

In Turkey, biogas based cogeneration plants are encouraged to sell electricity to the grid with an advantageous tariff price shown in Table 1 (Zor et al., 2015).

Table 1: Applicable tariff prices for power plants generating electricity based on renewable energy sources (RES) in Turkey

Type of Plants	Applicable Tariff Prices (¢/kWh)
Hydraulic Power Plant	7.3
Wind Power Plant	7.3
Geothermal Power Plant	10.5
Biomass Power Plant (incl. Landfill gas)	13.3
Solar Power Plant	13.3

13.3 ¢/kWh, tariff price can be increased by using fluidized bed boiler, gasification and gas purification group, internal combustion engine (ICE), generator and power electronics, and cogeneration system manufactured domestically as demonstrated in Table 2 (Zor et al., 2015).

Table 2: Extra addition for ICE based cogeneration plants contain domestically manufactured equipment.

Domestically Manufactured Equipment	Extra Additions to Applicable Tariff Prices (¢/kWh)
Fluidized Bed Boiler	0.8
Gasification and Gas Purification Group	0.6
Internal Combustion Engine (ICE)	2.0
Generator and Power Electronics	0.5
Cogeneration System	0.4

In Turkey, 20% of cogeneration and trigeneration plants use biogas as input fuel. Regional capacities of biogas cogeneration and trigeneration plants can be sorted such that Marmara Region 83.305MW, Central Anatolia Region 64.948MW, Mediterranean Region 23.593MW, Southeast Anatolia Region 8.966MW, Black Sea Region 7.731MW, Aegean Region 6.701MW, and Eastern Anatolia Region 4.421MW by January 2015 as shown in Figure 3 (Zor, 2015).

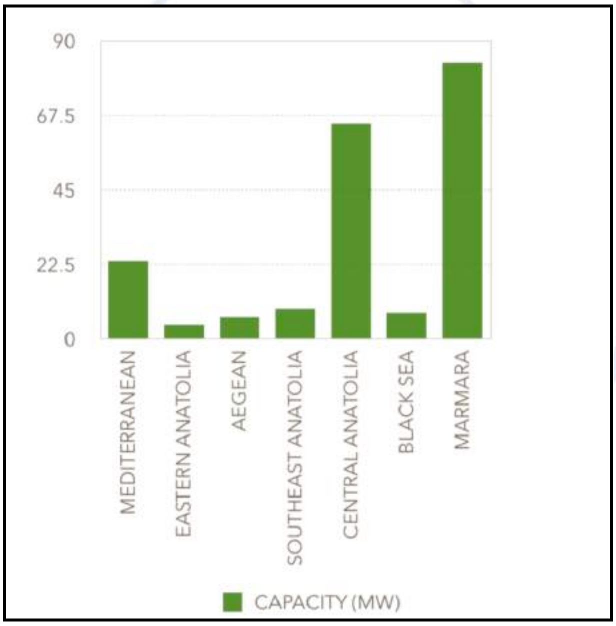

Figure 3: Regional capacities of biogas cogeneration and trigeneration plants in Turkey.

PV is a technology that directly converts solar radiation into electricity by using solar cells. These cells absorb photons and due to the photoelectric effect, electrons are liberated from p-n junction. These free electrons are forced to fill the holes on a path and an electric current occurs. Because of this operation principle, PV systems have so many advantages like no noise, almost maintenance free, inexhaustible, sustainable, abundant and environmentally friendly. However, these systems suffer from the initial cost of purchasing and installing PV modules. Furthermore, being inefficiency, which dramatically affects the payback period of the plant, is the most significant problem of these systems (Çelik, 2015).

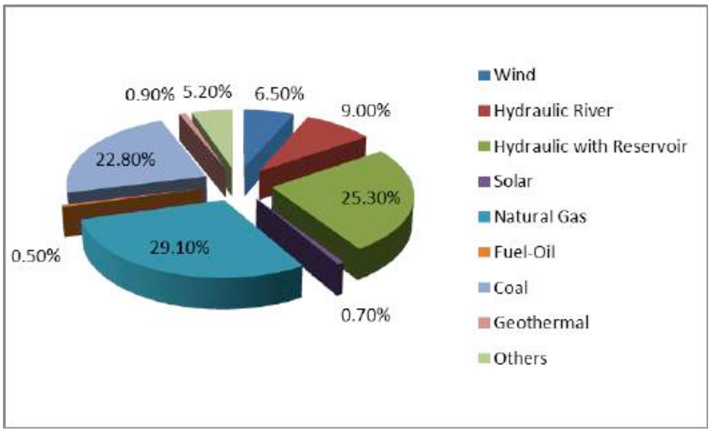

Figure 4: Total installed power ratings according to source usage in Turkey (EI, 2016).

According to the International Energy Agency's 2016 report, solar energy is the world's fastest-growing form of renewable energy, with net solar generation increasing by an average of 8.3% per year. It is also estimated that the solar generation grows by 15.7% per year on average from 2012 to 2040 (EIA, 2016). Despite being abundant in terms of renewable energy sources, in Turkey these sources are not utilized effectively. When Figure 4 is investigated, it can be seen that the distributions of the resources in terms of the installed power ratings are not in the desired level. In Turkey, total installed solar power reached to 248.8MW at the end of 2015 and it is aimed to attain at least 3GW of PV installed power until the 2023 (YEGM, 2016).

In the following sections, overview of the study area where hybrid power generation system is planned to install, proposed operational scenario of the system, discussions and results of the techno-economic analysis are presented sequentially.

Overview of Study Area

Figure 5: Map of the study area (Çelik et al., 2016).

The Mediterranean Region is one of the seven main regions in Turkey. Adana is the most populated province in the Eastern Mediterranean Region (EMR) that is under the Mediterranean Climate. The Mediterranean coasts have cool, rainy winters and hot, moderately dry summers. Geographical parameters belong to Adana is shown in Table 3 (Çelik et al., 2016).

Table 3: Geographical parameters of the province in the Mediterranean Region.

Province	Longitude (E)	Latitude (N)	Altitude (m)	Daily Average Sunshine Duration (h)	Daily Average Air Temperature (ºC)
Adana	35º19′	37º0′	27	7.34	19.29

Hybrid biogas/PV power generation system is planned to be situated in a dairy cow farm contains 7,500 cows. Manures of the cows will feed a biogas degradation system with an anaerobic digester unit, and the obtained biogas will utilize as input fuel of the cogeneration plant. On the roof the cogeneration plant building, 60 PV modules, each is $250W_p$, will be settled by a tilt of 30º as demonstrated in Figure 6.

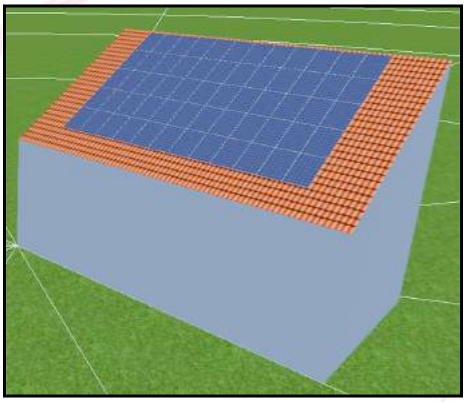

Figure 6: Biogas cogeneration plant building with 60 PV modules on the roof (PV*SOL, 2016).

Proposed Scenario

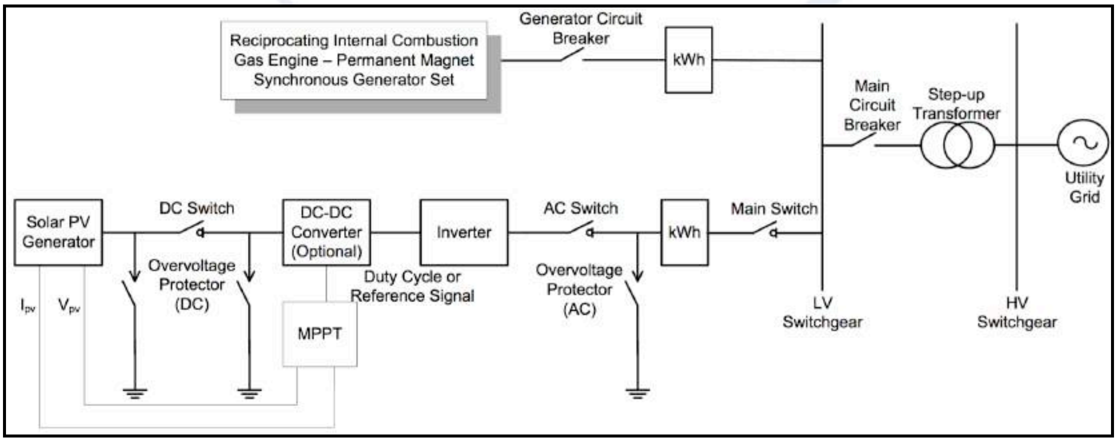

Figure 7: The proposed scenario for the hybrid biogas/PV power generation system.

In the proposed scenario, as shown in Figure 7, biogas cogeneration plant produces electrical energy and sells all of the energy to the grid with a 13.3¢/kWh tariff price via a 0.4/31.5kV step-up transformer. Similarly, PV plant generates electricity and sells all of the energy to the grid with the same tariff price via the same transformer.

Internal electricity consumption of the whole farm (dairy farm, houses, hybrid power generation system, and the biodegradation complex) is provided by purchasing electricity with a low tariff price from the local grid.

Heat outputs of the biogas cogeneration plant are utilized in the biodegradation complex, houses, kitchens, and baths.

According to GE Jenbacher, manures of 7200 dairy cows can feed in an anaerobic digester, which also feeds in a 1MW biogas cogeneration plant. As biogas cogeneration plant, a GR999B5-12V4000L62 biogas engine-alternator set is planned to use. The plant can generate 999kW electric power at full load (MTU Specification, 2016). As PV plant, 60 modules of SF(P)60 are utilized. The PV plant will have total peak capacity rating of 15kW (Solarfield, 2016). For the hybrid biogas/PV power generation system, investment and maintenance costs are offered by MTU Onsite Energy and Solarfield.

Discussions and Results of the Techno-Economic Analysis

Table 4: Financial viability of the proposed scenario.

	Biogas Cogeneration	PV	Hybrid
Investment Cost ($)	1,450,000	36,000	1,486,000
Annual Revenue ($)	700,000	3,640	703,640
Payback Period (year)	2.07	9.89	2.11

For PV plant modelling, calculations and feasibility analyses, PV*SOL Expert 6.0 software program is used (PV*SOL, 2016). Savings for selling electricity to the grid is taken into account in the PV*SOL. Expenses for maintenance and cleaning of modules are subtracted from the annual revenue of the PV plant.

For biogas cogeneration plant and degradation complex, heat outputs are utilized in the complex, hence there’s no savings for heat recovery from the plant. Savings for selling electricity to the grid is taken into account in the analysis. Expenses for internal electricity consumption, annual chemical desulphurization, service and spare parts for maintenance, and operators’ salaries are considered and also subtracted from the annual revenue of the biogas cogeneration plant.

Consequently, a hybrid 999kW biogas/15kW roof-mounted PV plant power generation system which is settled in a dairy cow farm complex of 7,500 cows in Adana in the Mediterranean Region has a payback period of 2.11 years, and installation of such a system is also reliable, financially feasible and ecologically sustainable.

Conclusions

Extinction of fossil fuels and impacts of global warming indicates the importance of using renewable power generation systems for future generations. Investing in those systems also has several incentives in Europe for domestic equipment usage or selling produced electricity to the grid with advantageous tariffs in recent years. In Turkey, it is also advantageous because of the fact that tariff prices for selling the electricity which is produced by renewable power generation is higher than the grid's tariff price.

Engine based biogas cogeneration provides heat and electricity at the same time according to a single fuel input which is obtained by the anaerobic digestion of renewable energy resources such as animal manures. A biogas cogeneration plant with a PV system that converts abundant sunlight into electricity is an energy efficient and reliable option for producing heat and electrical energy simultaneously.

For a hybrid biogas/PV power generation system in Turkey, investment costs are higher, but payback periods are about 2-3 years especially for systems over 500kW for the biogas part. Therefore, installing those hybrid plants seems to be very beneficial with actual incentives in the current legislation.

In this paper, techno-economic analysis of a grid-connected hybrid biogas/PV power generation system planned to settle in Adana in the Mediterranean Region is investigated by performing the scenario of selling the produced electricity to the national grid with the advantageous tariff price and evaluating heat energy within the plant.

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Contact email: kzor@adanabtu.edu.tr

Environmental Justice and Sustainability: Evaluating the Built Environment Professional Practices in the Nigerian Context

Evelyn Lami Ashelo Allu, University of Jos, Nigeria

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Abstract
Elsewhere environmental justice and sustainability goals have been mainstreamed, guided and enforced by sustainable developmental practices and policy implementations. Furthermore, environmental justice plays a major role in; conceptualizations, planning and operations that promote sustainability particularly in the urban built environments. This study highlights the importance of incorporating environmental justice into environmental sustainability operations. Findings from this discourse suggest that in the Nigerian context, environmental justice is yet to be conceptualized. As such, the concept of environmental justice is non-operational amongst the built environment sector professionals. Yet, earlier researchers have identified the sector as the lead for achieving environmental sustainability. Thus, this study concludes by suggesting; a redefinition of the environmental law, the need to incorporate environmental justice concerns by the government and for the built environment professional institutions to enshrine and guide professional practice operations within the sector in order to control the practices of its members.

Keywords: built environment; environmental justice; Nigeria; sustainability

Introduction

Environmental law and justice are international strategies for actualising environmental sustainability in all developments. Sustainable development is a term that was promoted by the Brundtland Report (WCED, 1987), this report shaped the world outlook towards all developmental strides guided by the three concepts; environmental growth, economic models and social well-being without depriving the future generations' development. These guided principles channel all the processes of any development particularly for the environment, in order that any development becomes mindful of its impacts the environment and the future generations. This background underpins the emergence of environmental law and development.

Since 1972 when the first UN Conference on the human environment was held in Stockholm, environmental concerns became a matter for policy and law internationally. Implementing Sustainable Development (SD) responsibly is a requirement for environmental justice through operations of governance at national and international levels. This study presents a review on the subject of study as the first part of a two parts study, the later is proposed to present an inductive enquiry amongst the built environment professionals within the same research context.

The overall aim of the study is to promote the synergy between environmental justice and environmental sustainability as an essential strategy for enhancing and ensuring SD practices amongst the built environment professional practices in the Nigerian context. Although environmental justice and sustainability is the subject, the underpinning perspective to the discourse is the environmental law. This is because the environmental law is the premise and central to resolving environmental justice.

This study is presented in six sections. Preceding this introduction is the second section which presents a discourse on the environmental law and justice. The third section deals with the study's context. Whilst the fourth section gives a brief on the built environment and its professionals and the fifth section discusses the need for mainstreaming of environmental law and justice. The last section highlights and discusses the theoretical contextual premise in general and particularly to Nigeria. The conclusion recalls this study's focus and reiterates the importance of towards achieving environmental sustainability and justice through an integrative synergy of practices within the built environment.

The environmental law and justice

It was at the United Nations Conference on Sustainable Development (Rio + 20), held at Rio de Janeiro, Brazil June, 2012, that the Rio + 20 Declaration "The Future We Want" was declared. This declaration is the international seal that emphasise the importance of the synergy for environmental law and justice. During the world congress on justice, governance and law for environmental sustainability, it was also agreed that at that point very little has been achieved in the adjudication of environmental justice and that also the development of new concepts and approaches were needed (Benjamin, 2012).

On the other hand Steiner (2012) notes that there are efforts made by the international organisations and some governments but also stated that there remains "a significant gap between humanity efforts and the reality of its impacts on the earth (environment)." Steiner observed that despite the negative impacts of climate change and the exponential growth production activities which destroy the environment, yet the discourse on SD is treated with scepticism. Furthermore, Steiner notes that the 2012 world congress is an avenue for stakeholders to share experiences and to draw up policies that are proactive in order to correct, shape and implement the present environmental sustainability for the future.

This study argues that both Benjamin (2012) and Steiner (2012) opinions are tenable and important but there is need for some realignment, firstly with the definition and understanding of what the environmental law represents. Secondly, is to ascertain its intentions and relationship with environmental justice.

Environmental law is one of the multidisciplinary courses in an academic setting. It has also been viewed as a strategy for protecting the environment. According to UNEP (2016, p.3), "*Environmental law is essential for the protection of natural resources and ecosystems and reflects our best hope for the future*." Going by this premise, environmental law seem to be salient or excludes the built environment.

The environmental law emanated from the United Nations Environmental Programme (UNEP) and the world summit on SD held in Johannesburg in 2002. This was affirmed by both the congresses held in Kuala Lumpur in 2011 and Buenos Aires, Argentina in 2012 and according to UNEP's Report, the environmental law - *"Emphasizing the importance of societies based on the rule of law and standards of transparency and accountability."* The Report also notes that the environmental law was also intended amongst other things to also promote "*... a lasting effect on improving social justice, environmental governance and the further development of environmental law, especially in developing countries."* What then is environmental justice?

Environmental justice *"Is the fair treatment and meaningful involvement of all people, regardless of race, colour, national origin, or income with respect to the development, implementation and enforcement of* ***environmental laws,*** *regulations and policies*." US Environmental Protection Agency (EPA), 2016, p. 1.

Although it is apparent that environmental law and justice are components of ensuring environmental sustainability, the environment is incomplete without the built environmental – which serves as the domain of humans which the environmental law and justice seeks to improve.

Altogether, environmental law protects the environment, environmental justice advocates for environmental sustainable practices within the law. This study argues that, these two components of environmental sustainability have not been clearly included the built environment and hence, created a gap that this study seeks to address. Although the environmental law is geared towards protecting the natural environmental, environmental justice deals with enforcements and the control on the human societies and activities. How then would the practices within the built environment and the practitioners be treated fairly when the law is not all encompassing?

Some developed economies have successfully mainstreamed environmental laws and justice in their developmental strides. Brazil, Argentina, Peru, South Africa, and a few other developing economies were also identified as the developing countries that were able mainstream environmental law and justice. In their study Monno and Conte (2015) notes that design, planning, implementation of environmental development practices are guided by SD processes in order to achieve urban environmental sustainability and yet it is still elusive. They however, suggested the integration of environmental dimensions amongst other approaches. For the Nigerian context attempts towards environmental sustainability seem to rest squarely on the definition of the environmental law and thus, no known regulations or guide is provided for the built environment. In order to further the direction of this study's argument for the clear inclusion of the built environment sector, the sector is briefly discussed.

Environmental sustainability, built environment and its professionals – a brief

Amongst the limiting factors for achieving environmental sustainability climate change is foremost. Climate change is caused largely due to the unsustainable human activities on the environment and particularly by the built environment. These have been acknowledged by earlier researchers (IIPC, 2007; Ogbonna and Allu, 2011; Pyke et al, 2012; Ebohon et al., 2013; Allu, 2014). Again the built environment is noted to be the major contributor to carbon emissions leading to climate change (Altomonte, 2008; Janda, 2011) this is even more so in the developing economies like Nigeria (OECD, 2011; Allu, 2014).

The built environment is a part of the environment. It constitutes the man-made surroundings and the supporting infrastructures and represents a significant part of the natural environment. *"The built environment is made up of existing and newly constructed buildings including the man-made surroundings such as green and blue spaces."* Scotland's Climate Change Adaptation Framework (2011), p. 1. Consequently, strategies employ to promote sustainable practices within the built environment sector would also largely promote environmental sustainability. Furthermore, the built environment sector and the practices of its professionals is a key factor to achieving environmental sustainability (Alkadiri et al, 2012; Allu, 2014). The professionals who are involved with the built environment developmental practices include; architects (design landscape, interior), building engineers, planners, structural engineers, surveyors and other relevant information technologies (WBDG, 2012).

Therefore, it is without question that in order to achieve environmental sustainability these professionals need to be involved in sustainable actions and implementations (Sherman and Ford 2013; Allu and Ebohon, 2015). According to Pillay (2012) in reference to environmental law, and justice relation to human right suggested that the closest essential component to human right is health and a healthy environment. There cannot be a healthy environment without sustainable practices within the built environment. Additionally, earlier studies have position the built environment sector as the most potentially and key to achieving environmental sustainability (Butt, 2010; Akadiri et al., 2012; Allu et al., 2013; Allu, 2014). This study therefore aligns its arguments with the conclusion of Kibert (2016) who opined that the only route to ascertain the future of sustainability is to ensure the sustainability of the built environment. In order to evaluate the practices of the built environment professionals, their practice domain needs to be presented.

The study's context

Nigeria is developing Sub-Saharan African country, the most populace black nation and has a very active construction sector. In Nigeria the 'construction sector' the most significant activity in the built environment many times the term is used interchangeably with the built environment (Allu, 2014). Environmental law in Nigeria was formulated specifically to guide and control issues relating to the natural environmental (Eneh, 2011; Eneh and Agbazue 2011). Before the formulation of the law in 1988, there was an environmental act which only deals with sanitation (Otu, 2010; Iyanya and Joseph 2014). The first law formulated as a result of dumping of toxic waste (3,888 tonnes) at Koko Port, Lagos State from Italy. Subsequently, the first environmental governance commenced (Ibrahim and Imam, 2015). The Nigerian environmental law according to Eneh and Agbazue (2011) was formulated to implement the following:

i. To control the various environmental pollutions that include; toxins, other chemicals and noise.
ii. To control the activities of mining, power generation, and
iii. To provide in general terms the protection of natural environment (air, land and water)

Over time seven (7) national environmental law enforcement agencies were also established and are summarised in Tables 1 which has revealed that like the underpinning reasons for the Nigerian environmental none of these eight agencies has the mandate to oversee the practices of the built environment. Furthermore, out of these eight national 27 environmental regulations emerged and 13 national guidelines and standards were also formulated, which have been observed to sometimes have overlap functions.

Table 1 Nigeria's national environmental laws enforcements agencies

s/n	Agency	Responsibility	Year
1	Environmental Impact Assessment (EIA)	Set out to the general principles, procedures, methods of environmental assessment issues	2004
2	Endangered Species Act	Protects the conservation and management of Nigeria's wild life and endangered species	2004
3	Harmful Waste Act	To prohibit carrying, depositing and dumping of harmful waste on land and territorial waters of Nigeria	2004
4	National Park Service Act	Makes provisions for the conservation and protection of national resources and plants	2004
5	Water Resources Act	To promote the optimum development, protection and use of Nigeria's water resources	2004
6	National Oil Spill Detection and Response Agency (NOSDRA)	Establish to ensure the implementation of the blue print developed to control oil spillage	2006
7	Nigeria Mining and Mineral Act	To regulate all aspects of solid mineral resources and other related matters	2007

Sources: Author's arrangement from Eneh and Agbazue (2011) and Ibrahim and Imam (2015).

Many of the environmental law support agencies are further duplicated at states and local governments (Eneh and Agbazue, 2011). In 2007, the National Environmental Standards and Regulations Enforcement Agency (NESRA) was formulated as the overall agency backed by law for the protection and development of technologies, policies, research, compliance, set standards, public investigations, monitoring of all aspects of environmental.

Notably also in the Nigerian context governance is the provision of environmental justice which lays with the Police who are engaged with issuance of search warrants and the Judiciary which is saddled with the enforcement mechanism and persecution (Eneh and Agbazue; 2011). The question here is can these two bodies effectively enforce sustainable practices in the built environment sector? Hence, the need for the professionals to be involved in the processes of compliance and enforcement strategies.
As much as the effort by the Nigerian government to comply with environmental law and justice is noted, it is obvious that the face value definition of this international law played a major rule in misinformation as to what an environmental encompasses as a whole. It is also worth noting that the interpreters did not also think outside the box.

How then can the practices of the built environment professionals be evaluated? Tosun and Knill (2009) and Walker (2010) have noted that evaluation does not always match environmental and social justice both in theory and practice. On one hand Gay (2010) suggests that practices can only be measured by their sustainable performance. On the other however, Shariff and Murayama (2013) notion that measurement can be achieved only through assessment tools. This study aligns with the later study given the Nigerian scenario.

Mainstreaming environmental law and justice

Environmental law and justice need to be synergised to achieve environmental sustainability at all levels. Environmental law need the sound processes of justice are components of achieving environmental sustainability as noted in the preceding sections. The two actions can therefore not have much value when treated as standalone strategies. From the Brundtland Report (1987) definition it deducible to suggest that operating the sustainability mandate would require "both intergenerational and intragenerational equity" (Kibert et al, 2010, p.11) and thus, making sustainable justice for environmental sustainability an ethical pursuits. In agreement Amantova-Salmane (2015) opined that sustainability can only be achieved through ethical dimensions in its operations. These suggestions further advance the need to mainstream by environmental law and justice in Nigeria in accordance with the Rio + 20 Declaration.

Mainstreaming environmental law and justice is attainable in Nigeria. Through the engagement of citizens and governments in the environment law and justice discourse (Steiner, 2012). The position of this study therein, is to engage the active participation of all stakeholders and governance is necessary for the achievement of holistic environment sustainability. The summation of Coote (2014) caps all *"We can't have social justice without environmental sustainability."*

Discussion

In this study the discourse of environmental justice and sustainability lies in how the understanding of environmental law precedes how practices may be subjected to ethical issues. The Nigerian scenario on the built environment clearly shows that the environmental law operatives have undoubtedly overlooked the practices within the built environment sector. This is despite the fact that, the sector is an active economy and known to largely contribute to the cause climate change. Even though research has proved that climate change is the greatest challenge to achieving environmental sustainability. However, in the discourse and the underpinning reasoning suggest that, the limitation in the definition or and the incorrect interpretation of environmental law is evident in Nigeria. Thus, by implication the situation has created an uncertainty on the sustainable practices and viz a viz the moral right and ethical considerations for sustainable justice in Nigeria. Notably, similar economies were noted to have recorded some success stories even though these countries are operating with the same definition of environmental law.

For these uncovered reasons this study questions firstly, the capacity of the built environment professional to practice sustainable within the content of the operational environmental law currently in use. Secondly, the moral premise or fairness employed by the government to persecute none compliant sustainable practices amongst the built environment professionals. Thirdly, the enforcement processes adopted by the numerous agencies saddle with the tasks of operating the environment justice mechanism. Fourthly, the use of a universal measurement scale to evaluate the performances of sustainable practices in any given environmental developmental growth generally.

Examining the aforementioned questions suggest that the challenge lies with simplifying and redefining environmental law. Collective decisive actions by all stakeholders and the inclusion of the built environment professionals in the processes that precede environment justice are necessary for achieving environmental sustainability. A specific sustainable evaluation framework formulation is necessary, as it is the only way to measure the level of sustainable achievement (Sharifi and Murayama, 2013). As such an innovation would clearly position countries on scorecard and to encourage adjustments by countries like Nigeria to fully mainstream environmental law and justice.

Conclusion

This study is focused on promoting environmental sustainability through the twin strategy of synergising environmental law and justice. The study uncovered the current position of environmental justice and sustainability in Nigeria as it relates to the built environment. Also, this study notes that environmental law and justice are components of achieving environmental sustainability. Hence, this study advocates for the mainstreaming of these two components into the Nigerian strategic efforts towards achieving environment sustainability.

Government should not only exercise their governance by documenting and formulating passive actions/strategies but to create active and workable strategies, generated by the collaborative contributions by all stakeholders, who must be guided and well informed about the environment sustainability law and justice dimensions.

Although, achieving environment sustainability is still a challenge due to the current uncertainty in the sustainable practices within the built environment professions in Nigeria. It is however, possible to evaluate the sustainable practices within the built environment, when specific measurement tools are developed. Also, the various professional institutes of the professionals involved in the built environment sector do need to re-strategise its membership towards sustainable practices.

This theoretical discourse further propels the need for second part of this study, which proposes an inductive inquiry amongst the built environment professionals in Nigeria. Findings from the inductive study would further uncover the true knowledge and understanding of environmental sustainability and justice.

Contact email: evelynallu28@yahoo.com

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The Unlikely Pollution Haven

Elina Berghäll, VATT Institute for Economic Research, Finland

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Abstract
According to the pollution haven hypothesis more stringent environmental policy adversely affects international competitiveness in a polluting industry, and may shift production to environmentally lax countries increasing global pollution. To avert such impacts, Finnish energy intensive firms are entitled to a substantial refund on excise taxes paid on energy use. I explore its potential impact on exports, applying firm level data on energy and other firm-specific factors with instrumental variables methodology. Estimation results show insignificant, if any impacts from the energy tax refund. Results are consistent with the literature, and enjoy broader relevance in countries seeking to implement indirect fiscal devaluation measures.

Keywords: Competitiveness; energy taxes, export performance, fiscal devaluation, import substitution.

Introduction

In countries with fixed exchange rates, such as within the Eurozone, policy-makers cannot restore competitiveness by means of exchange rate adjustments. As an internal devaluation[1] is dauntingly difficult with institutionalized downward rigid wages and prices, governments may be tempted to experiment on various forms of fiscal devaluation to combat the effects of overvalued exchange rates. At the same time, fiscal devaluation is constrained by EU and World Trade Organization (WTO) regulations, which prohibit most subsidies directly linked to the volume of exports. Since pure fiscal devaluation[2] with export subsidies and import taxes over all products and services traded cannot therefore be imposed, indirect export subsidies in the form of tax reductions, present an imperfect alternative. Various attempts at fiscal devaluation may proliferate in inflation prone Eurozone countries. Indeed, despite EU goals to reduce subsidies and enhance the workings of the common market, direct subsidies have increased by 50 % over 2002 - 2012 (TEM 2013). This is particularly true in countries where large scale cost competing energy intensive industries, such as chemical, forestry and metal industries, which form the backbone of Finnish exports. The effectiveness of partial indirect measures is doubtful and may have undesirable side effects with respect to the environment.

Although one of the largest direct subsidies granted to firms rising to €320 million in 2011 (TEM, 2012), in practice there is little if any evidence that the subsidy fulfils its task. Based on a recent statistical analysis for 2010-2014, VATT researchers found no significant effects (2016). Another relevant recent study is TEM (2013), which groups the energy tax refund to "other subsidies" that not only delay positive structural renewal, but have negative productivity effects. As for efficiency, a comparison of Finnish industries to a sample from OECD countries, showed Finnish energy intensive industries to have lagged well behind the technology frontier when the subsidy was introduced in 2003 (Berghäll 2014).

The argument in favor of the refund draws on the pollution haven hypothesis, which postulates more stringent environmental policy to harm competitiveness in pollution-intensive industries and cause them to concentrate in countries implementing weaker environmental policy. Governments may similarly weaken their environmental standards to attract polluting industries (Copeland 2010).[3]

Earlier work found environmental regulations to have little impact on trade and investment flows (Jaffe et al., 1995, Tobey, 1990; Harris and al., 2002), with

[1] Subsequently, the refund and wages were formally linked. In 2011, the refund limit was further reduced to 0.5 % of value added. This increase of the refund was part of a collective corporatist deal in which employers' accepted wage raises, in return, among other things, to an increased energy tax refund to maintain competitiveness and employment. http://eur-lex.europa.eu/Notice.do?mode=dbl&lang=en&ihmlang=en&lng1=en,fi&lng2=en,fi,sv,&val=679466:cs and (HE 129/2011) http://www.finlex.fi/fi/esitykset/he/2011/20110129). In addition, the reduction in the limit was motivated by the crowding out concern to level the playing field for fair domestic competition. The government's commitment to the Kyoto protocol played no role.

[2] See e.g. Keynes (1931).

[3] The main alternative to the competitiveness hypothesis is the Porter hypothesis (Porter and van der Linder 1995) which argues that more stringent environmental policy can raise international competitiveness and shift supply curves outward.

exceptions such as Grossman and Krueger (1995) and Van Beers and van den Bergh (1997), but improved data and methodology has shown them to have been biased by unobserved heterogeneity, endogeneity and aggregation issues (Levinson and Taylor 2008). Panel data, fixed effects and instrumental variables methodology have tended to produce statistically significant evidence of pollution havens (Brunnermeier and Levinson 2004; Copeland and Taylor 2004). On the other hand, Arlinghaus' (2015) review of empirical evidence on carbon price impacts on competitiveness found most studies to show little impact even if the methodology applied is more advanced. The few ex post evaluation papers on carbon taxes arguing causality are limited to show short-run policy effects. Flues & Lutz (2015) find electricity tax subsidies in Germany to have no impact on sales, exports, value-added, investment or employment. Martin et al. (2014) find no competitiveness impacts on output, productivity, employment, or exit of firms from the UK Climate Change Levy. In contrast, according to Arlinghaus (2015), the empirical evidence in favor of significant energy intensity or other environmental benefits is fairly consistent.

To explore the potential contribution of the energy tax refund to the international competitiveness of Finnish firms, I estimate its potential impact on exports in 2004 – 2009. While competitiveness is a fairly broad concept, the use of exports is justified by the trade dependency of a small open economy. Meanwhile domestic demand for major export goods is relatively small and insignificant, but there may be crowding out effects. Since data on investments is limited to the home country, overseas production relocation impacts cannot be included. To what extent imports of intermediate goods substitute for domestic production is, however, estimated with separate regressions on domestic value-added. I build a panel from firm-level data on energy tax refunds, energy use and exports from several databases, and apply instrumental variables methodology to control for potential endogeneity. Results suggest the absence of an exports enhancing effect, consistent with the literature on the competitiveness impacts of environmentally related taxes.

I contribute to the literature on energy taxes and competitiveness, with a case example that shows how indirect attempts at fiscal devaluation[4] may prove to be counter effective, while having adverse side effects. The issue has broader relevance to those Eurozone countries in which pressures for fiscal devaluation have accumulated. The second section presents the methodology and third the data. Results are presented and discussed in section four. Section 5 summarizes the conclusions and policy implications that can be drawn from the evidence.

Data

The micro-level data is drawn from the VATT Institute for Economic Research (VATT), the Finnish Environment Institute (SYKE) and the Finnish Customs Office (Tulli). Reliable data is available only from 2004 to 2009. For brevity, a detailed description of the data and variables has been moved to the Appendix, and is available from the author upon request.

[4] In the absence of nominal exchange rate devaluations, misalignments in the euro can be readjusted by changing the relative tax burden on exports and imports or internal devaluations (see e.g. IMF 2011 or Keynes 1931).

On average, the recipients of the energy tax refund are large exporting firms concentrated into four export intensive industries, though not all firms that receive the refund export. To control for industry-specific impacts, the sample is reduced to them, i.e., to the wood, paper and pulp, chemical and metal industries.[5] In 2010, they accounted for altogether 87 % of total energy consumption in manufacturing.[6] Within these industries, the consumption of energy is further concentrated in about 100 firms which consume 60-80 % of all industrial energy. Industry-wise there are less than 20 large energy consumer firms. The robustness of the analysis is stirred, but not shaken by the fact that many of them are also energy producers, particularly in the paper and pulp industry. This effect is not fatal to the analysis, however, since it means that paper and pulp firms do not receive a refund on energy produced as a by-product, such as heat generated in the industrial process, [7] while the focus of the analysis is on export competitiveness.

The chief justification for the energy tax refund has been the desire to support the competitiveness of Finnish energy intensive firms. Competitiveness is a fairly broad concept, which can be measured by sales, survival, investment, value-added, growth, etc. Jaffe et al. (1995) claim the appropriate competitiveness indicator to be net exports, but this variable is not available due to the lack of data on respective imports. Hence the main dependent variable is exports (Exp_{it}) obtained from the YRTTI database (Figure 1). The choice is justified by the export reliance of the energy intensive firms in a relatively small open economy. That is, other competitiveness indicators may include crowding out effects of domestic competition due to the refund, while their overall impact is in any case limited in a small export oriented and specialized economy. To what extent imports of intermediate goods substitute for domestic production is, however, estimated with separate regressions on domestic value-added. Value-added is estimated by subtracting purchases and change in inventories (material use) from total sales available in the YRTTI database.

For energy efficiency impacts, the association of the refund with energy intensity is analyzed. The energy input (Figure 4) is based on total energy consumption, calculated as a sum of various types of energy use obtained from the SYKE database. Firm-level datasets were constructed by aggregating the plant level data according to the firm identifier number. Energy efficiency is computed by dividing deflated value-added with energy use. Logarithms were taken to moderate the impact of differing scale between energy input and monetary variables. Observations with zero or negative value-added were replaced by zero energy efficiency.

The main explanatory variable is the energy tax refund to firms. Since 2003, Finnish energy intensive industries have been entitled to a refund of energy taxes if they

[5] The largest net recipients of energy tax refunds are also likely to be involved in emissions trade. Ample quotas have however mitigated the emissions price impact.

[6] Firms in other industries are too few and diverse to be controlled for industry specific effects.

[7] Power generators are taxable only if their capacity exceeds 2MVA (Megawatts). To avoid dual taxation Customs office data on the energy tax refund does not include refunds for those firms with no power production, as related energy taxes are paid and the energy tax refund received by the company that generates or supplies the energy to the consuming firm. In these instances the taxes are incorporated in the price paid for the energy supply. Firms receive either a reduction in the energy price or the tax refund. Power generators are taxable only if their capacity exceeds 2MVA (Megawatts).

exceed 3.7% of its value-added. This refund is at most 85% of the energy taxes paid minus a lump sum of €50 000[8] (Equation 1). Since observations for the energy tax refund are available only from the year 2004 onwards, the final sample was restricted to the period 2004 – 2009[9]. Missing refund observations were recoded as zero, since with the exception of outright mistakes, in practice a missing observation signifies that the firm has not received a refund of its energy taxes. Also zero observations that went missing after logarithms were taken were recoded as zero. These raised the number of observations significantly.

Energy tax refund = (Energy taxes paid – 0.037*Value-Added)* 0.85 - €50000 (1)
As is apparent, the refund declines with value-added, but increases with energy use. Hence, it provides an incentive to increase energy use or abstain from energy efficiency reductions. The incentive to reduce value-added encourages imports of intermediates instead of their local production. Hence, it actually acts against the original purpose of the refund, i.e., of maintaining domestic production competitive. As Table 2 shows, exports and the refund are significantly and positively correlated with value-added, labor use and efficiency.

The labor variable is based on the number of employees drawn from the YRTTI database to control for firm size effects. Data on investments is available only with respect to the home country. These proved too infrequent to analyze as a dependent variable with the time span available. Instead a capital stock (X_{1t}) measure is estimated from machinery and equipment investments in the YRTTI database. See the data appendix for more detail.

Firm efficiency (Figure 4) is estimated from value-added, capital and labor with the robust semiparametric order-m methodology proposed by Cazals et al. (2002). This method is more reliable and accurate than labor productivity or other simple productivity or efficiency measures. See the data appendix for more detail.

Profitability is included as an explanatory variable, since it is related to competitiveness and competition. The refund is granted on the assumption of competition being too intense. If this is true, profits should be approximately zero. Profitability is estimated from profits per value-added.

Renewables intensity (Figure 4) is the share of renewables in energy consumption. Their share is rather small and highly industry-specific, since the wood, paper and pulp industries maintain a natural resource advantage with respect to renewables such as forest chips (metsähake/murske)[10]. The share of non-fossil fuels or non-fossil fuel

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[8] In 2008, about €5.5 million were refunded to less than 10 firms. Source: Hallituksen esitys eduskunnalle laiksi sähkön ja eräiden polttoaineiden valmisteverosta annetun lain 8 a §:n muuttamisesta, HE 129/2011.

[9] The 2012 reduction of the refund limit from 3.7% of value-added to 0.5% raised the number of observations significantly, but towards non-exporting firms and industries, such as agriculture. The largest recipients in absolute terms were the same industries with the largest firms: paper and pulp, chemicals and chemical products, metals and metal products.

[10] Renewables is calculated as the sum of steam, metsä-, kuori, sahaku and puutähdeke.

intensity was also tested. It includes electricity, heat, etc. that are not necessarily produced with fossil fuels.

All variables are deflated with domestic or exports price deflators. Other variable transformations are presented in the data appendix. Descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics of deflated variables, with and without logarithms

	N	Minimum	Maximum	Mean	Std. Deviation
Energy tax refund	140	0	10061690	930362	2019430
Energy tax refund lag1	110	0	10061690	1128999	2228577
Energy tax refund lag2	82	0	10061690	1377523	2395676
Log energy tax refund	770	0.00	16.12	1.44	4.12
Log energy tax refund lag1	76	9.37	16.12	12.99	1.83
Exports	706	869	3437304291	133645480	390206698
Exports lag1	645	333	3437304291	146045634	405062052
Log exports	706	6.77	21.96	16.37	2.66
Log exports lag1	645	5.81	21.96	16.51	2.68
Export intensity (per sales)	705	0.00	4.62	0.48	0.36
Value-added	770	-1113861	25617978	831847	2459081
Log value-added	770	0.00	17.06	11.98	2.09
Capital stock	770	21	33801060	917784	3064551
Log capital stock	770	3.06	17.34	11.65	2.17
Personnel	770	1	9082	380	881
Log personnel	770	0.00	9.11	4.96	1.42
Efficiency (m700output)	769	0.00	2.95	0.63	0.33
Efficiency (m600output)	769	0.00	3.70	0.64	0.35
Profitability (profits/va)	766	-455.61	8.12	-0.61	16.48
Energy efficiency (va/e)	770	-13861	87924967	334859	5277011
Non fossil fuel intensity	770	0.00	1.00	0.81	0.29
Sales	770	0	5212649945	196785569	552736774

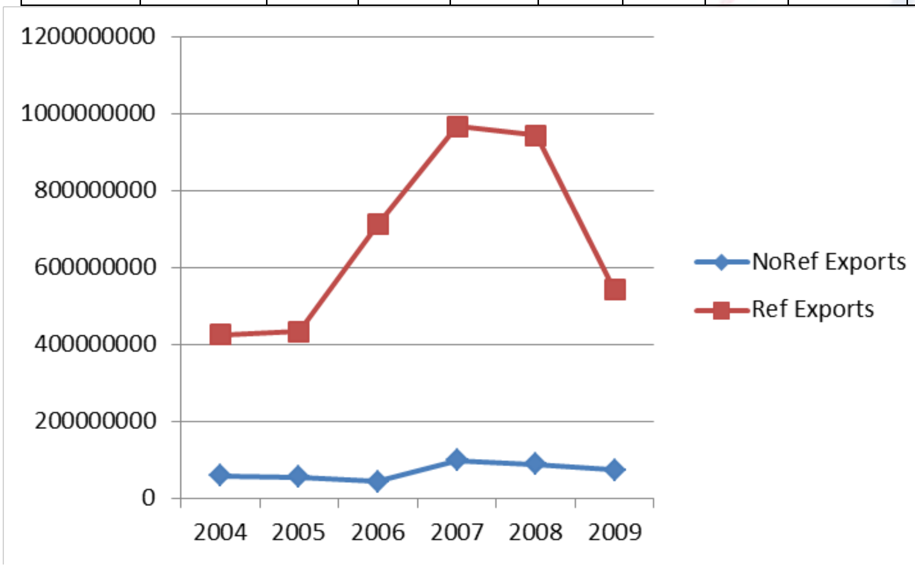
Variation by firm with respect to the impact of the refund on exports is unlikely to be driven by selection or sorting, because firms have limited control over these variables and there is no discretion in refund allocation. Yet, firms that receive the energy tax refund may differ from non-recipients in ways directly related to the terms and conditions of the refund. In addition to energy intensive industries, a distinguishing factor is mere size. Large energy intensive firms are more likely to be eligible as their energy taxes paid are more likely to exceed the value-added threshold. Recipient and non-recipient firms for which data is available in the sample, are compared in the figures below. As they and Table 2 show, the refund correlates significantly and positively with personnel, value-added and exports. Variables related to firm size, such as labor, value-added, exports, capital and industry dummies should capture such differences and no selection correction is included.

Table 2. Pearson correlations, significance (2-tailed), number of observations[11]

		Log of exports	Log lag of exports	Log of refund	Log lag of refund	Log value-added	Log labour	Efficiency (m700 out)	Energy efficiency (vad/e).	Non fossil fuel intensity
Log of exports	Pearson Correlation	1	.960**	.339**	.044	.714**	.738**	.131**	.004	-.101**
	Sig. (2-tailed)		0.000	.000	.715	.000	.000	.000	.923	.007
	N	706	637	706	72	706	706	705	706	706
Log lag of exports	Pearson Correlation	.960**	1	.334**	-.013	.723**	.708**	.127**	-.003	-.101*
	Sig. (2-tailed)	0.000		.000	.912	.000	.000	.001	.933	.010
	N	637	645	645	73	645	645	644	645	645
Log of refund	Pearson Correlation	.339**	.334**	1	.449**	.388**	.282**	.082*	-.022	-.118**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.023	.541	.001
	N	706	645	770	76	770	770	769	770	770
Log lag of refund	Pearson Correlation	.044	-.013	.449**	1	.242*	.081	.041	.065	.004
	Sig. (2-tailed)	.715	.912	.000		.035	.486	.723	.576	.973
	N	72	73	76	76	76	76	76	76	76
Log value-added	Pearson Correlation	.714**	.723**	.388**	.242*	1	.771**	.235**	.019	-.073*
	Sig. (2-tailed)	.000	.000	.000	.035		.000	.000	.590	.042
	N	706	645	770	76	770	770	769	770	770
Log	Pearso	.738	.708	.282	.08	.77	1	-.087*	.033	-

[11] ** Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

labour	n Correlation	**	**	**	1	1**				.079*
	Sig. (2-tailed)	.000	.000	.000	.486	.000		.016	.366	.028
	N	706	645	770	76	770	770	769	770	770
Efficiency (m700 out)	Pearson Correlation	.131**	.127**	.082*	.041	.235**	-.087*	1	-.028	.008
	Sig. (2-tailed)	.000	.001	.023	.723	.000	.016		.441	.827
	N	705	644	769	76	769	769	769	769	769
Energy efficiency (vad/e).	Pearson Correlation	.004	-.003	-.022	.065	.019	.033	-.028	1	.042
	Sig. (2-tailed)	.923	.933	.541	.576	.590	.366	.441		.246
	N	706	645	770	76	770	770	769	770	770
Non fossil fuel intensity	Pearson Correlation	-.101**	-.101*	-.118**	.004	-.073*	-.079*	.008	.042	1
	Sig. (2-tailed)	.007	.010	.001	.973	.042	.028	.827	.246	
	N	706	645	770	76	770	770	769	770	770



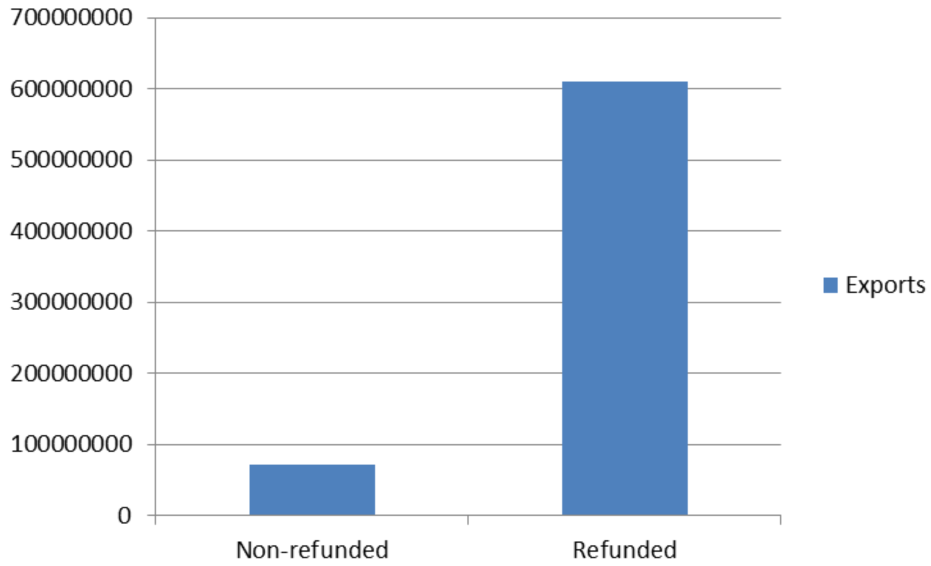
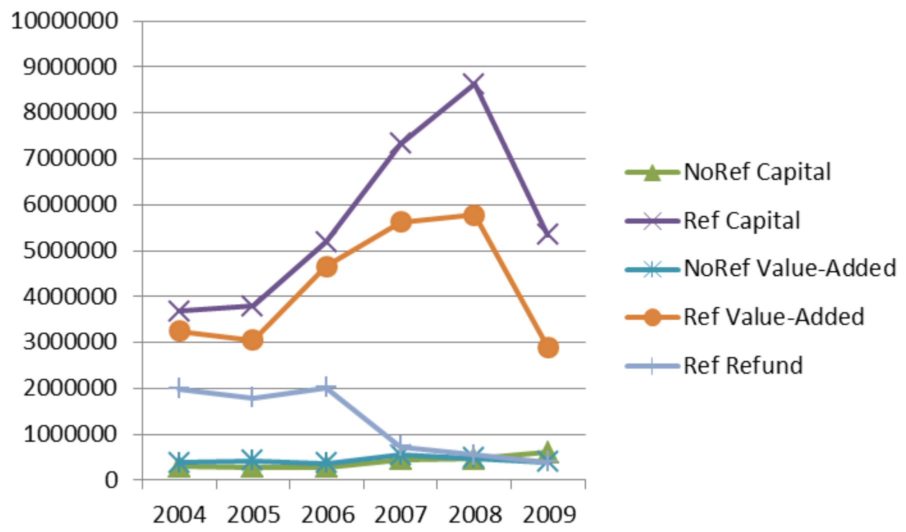


Figure 1. Average exports of refunded (Ref Exports) and non-refunded (NoRef Exports) firms 2004 – 2009.



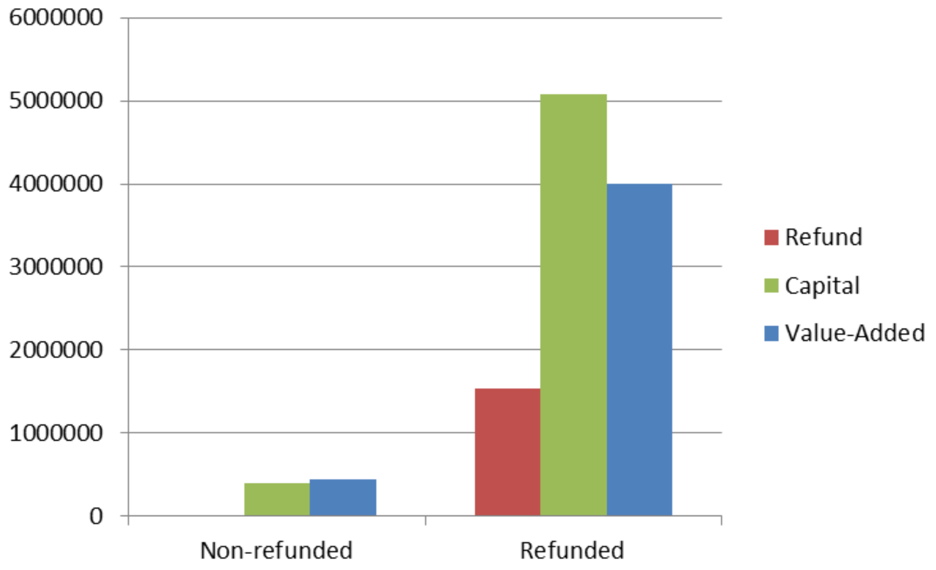
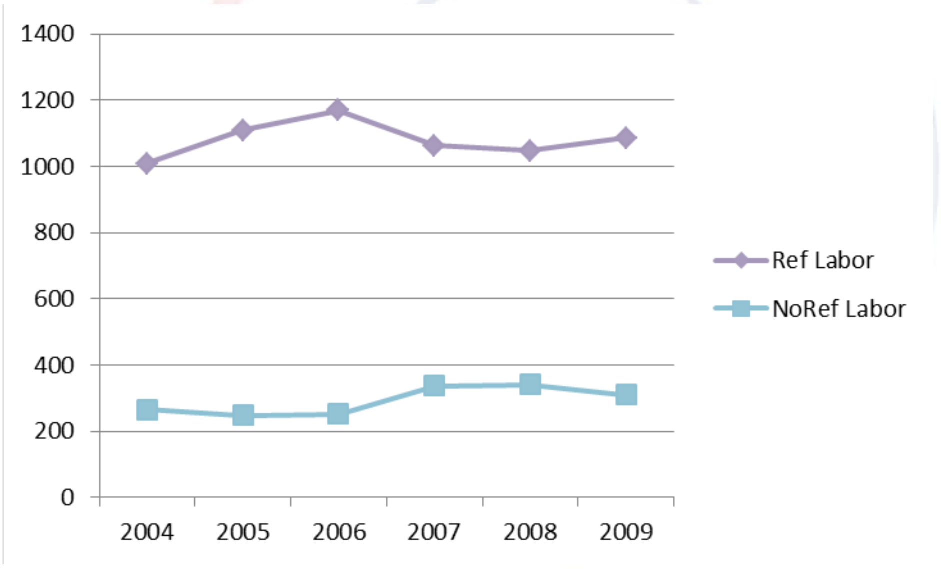


Figure 2. Average capital stock and value-added of refunded (Ref) and non-refunded (NoRef) firms 2004 – 2009.



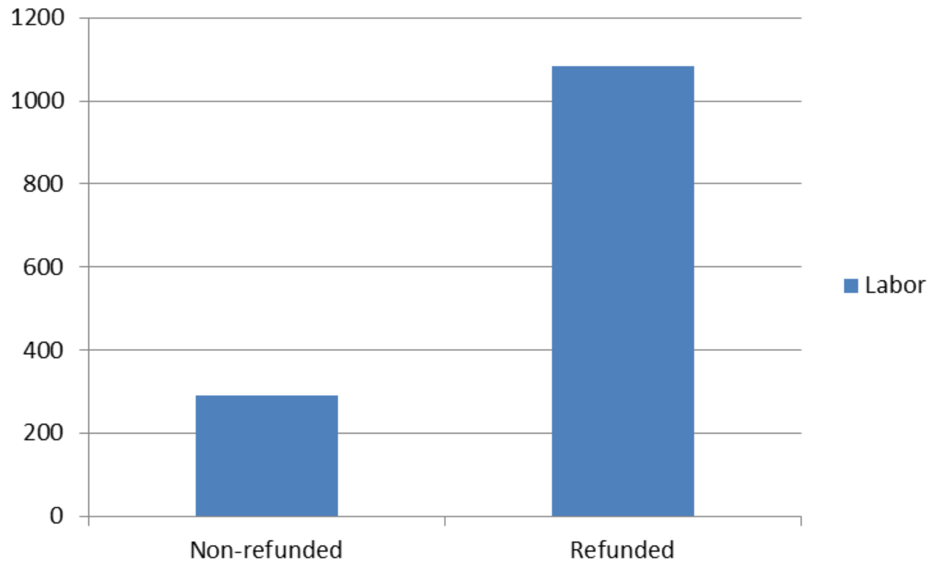
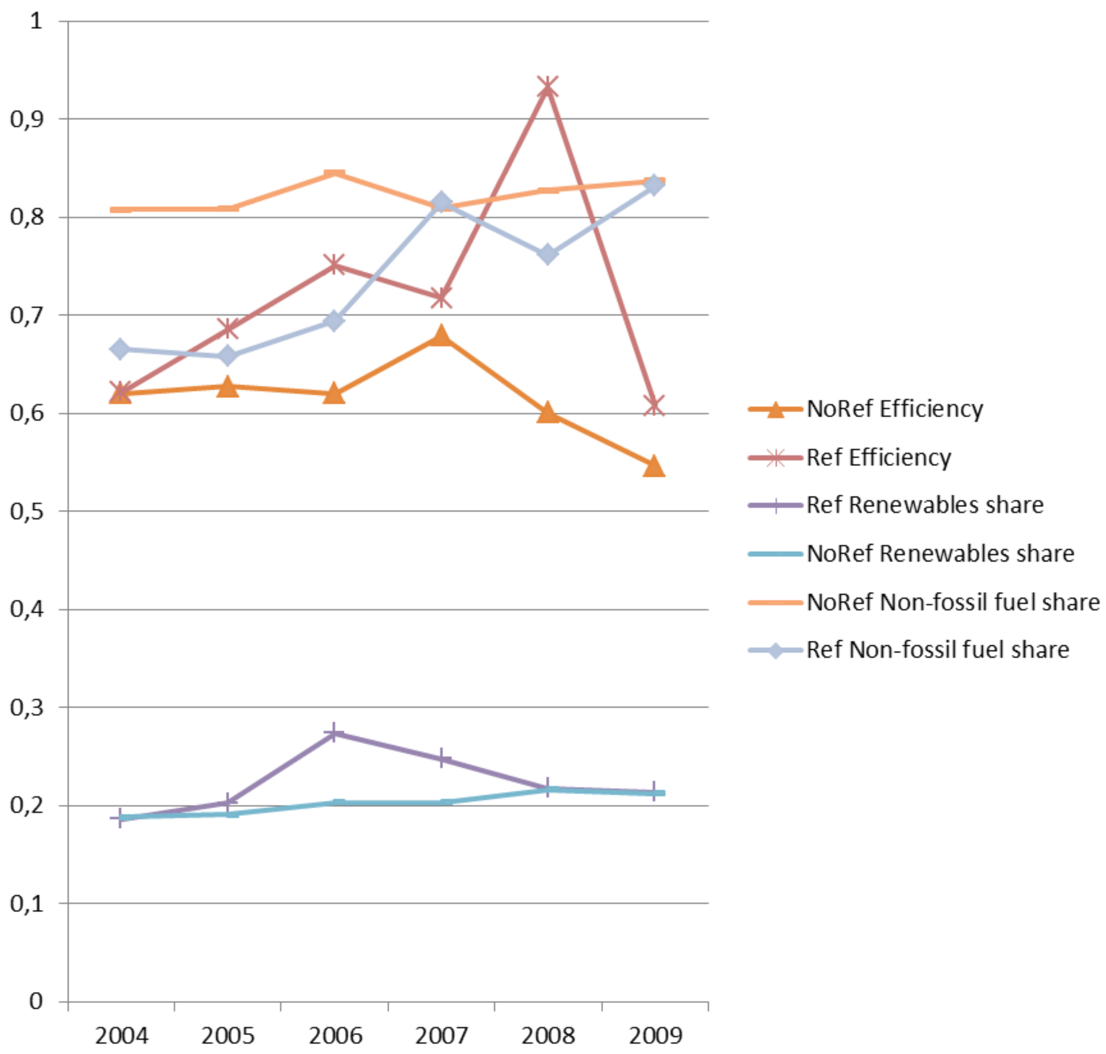


Figure 3. Average personnel refunded (Ref) and non-refunded (NoRef) firms 2004 – 2009.



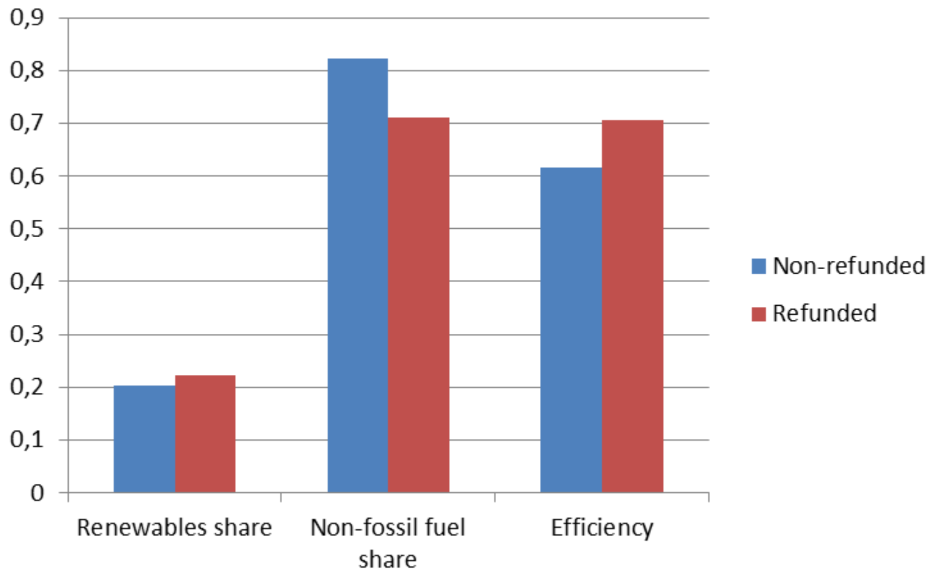


Figure 4. Average efficiency, renewables and non-fossil fuel shares in refunded (Ref) and non-refunded (NoRef) firms 2004 – 2009.

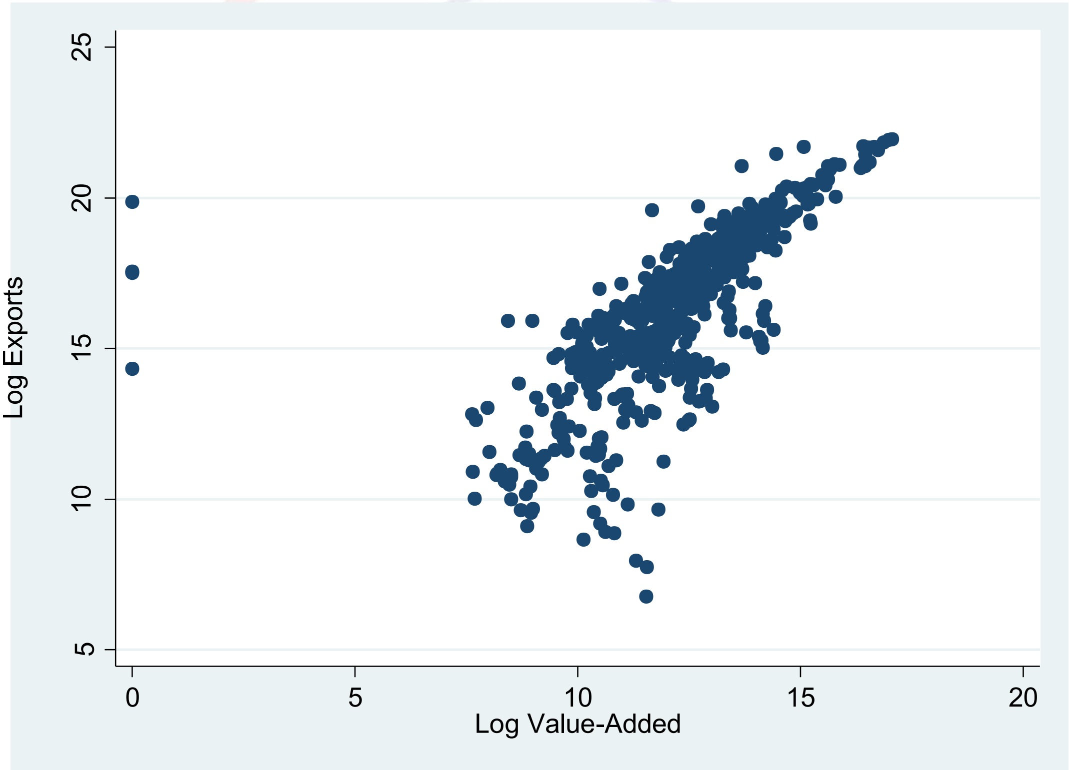


Figure 5. Log exports and log value-added.

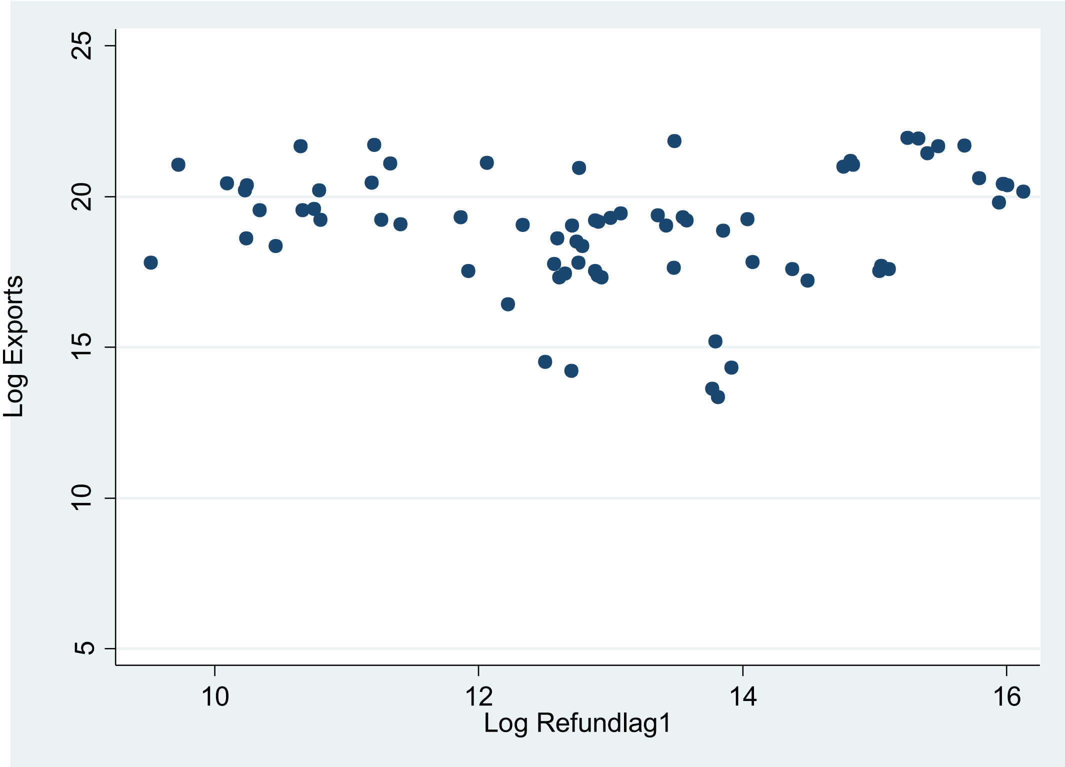


Figure 6. Log exports and the lag of log value-added.

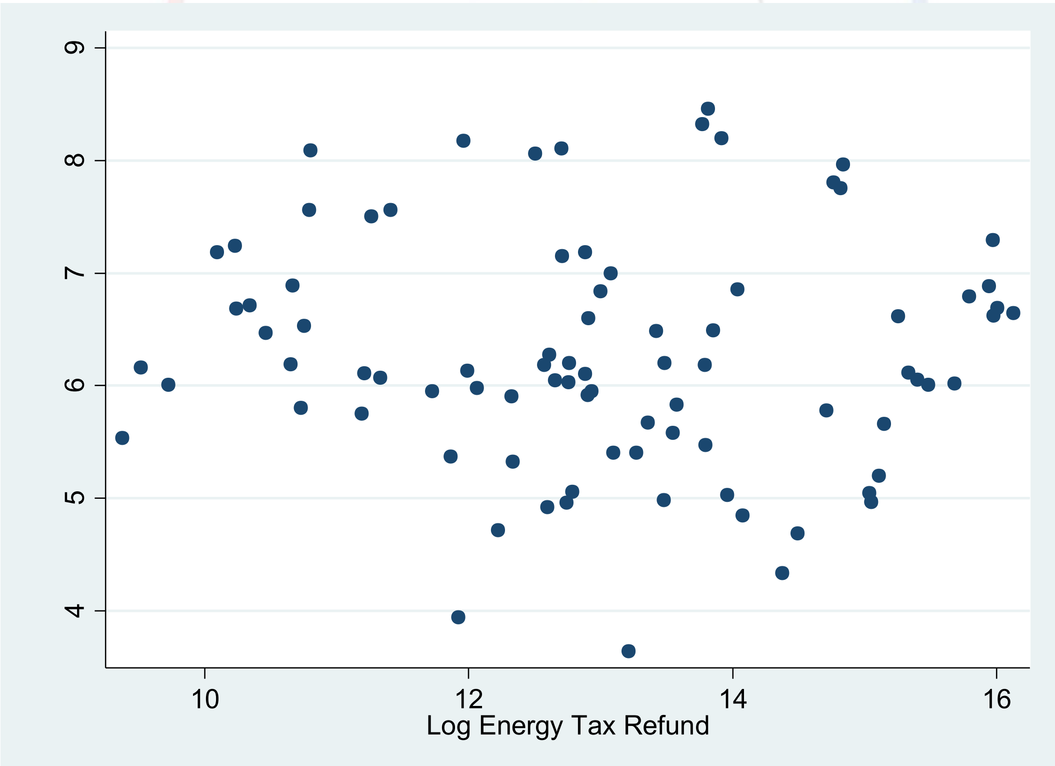


Figure 7. Log energy efficiency and log energy tax refund.

Methodology

As is characteristic of production data, the data suffers from multicollinearity and autocorrelation. Potential endogeneity issues loom at the outset. By design the refund increases with energy use, which increases with firm size in energy intensive export industries. That is, the positive correlation of the refund and exports may be due to firm size. Moreover, it is entirely possible that the positive correlation between the refund and exports represents in fact reverse causality, since an increase in exports may encourage firms to raise output in the hope of exporting more, resulting in more energy use and a higher refund of energy taxes. As is apparent in Table 2, lagged exports correlate with the current energy tax refund, the energy tax refund correlate with value-added, labor and efficiency. The methodology therefore needs to control for endogeneity.

In the absence of randomized experiments, most methodology for elaborate causal analysis requires large datasets and clear policy changes during the sample period. In smaller samples, provided that good instruments are available, the quasi-experimental instrumental variables (IV) method is applicable. In the absence of better options, I resort to the lagged values of the energy tax refund for an instrument.

As pointed out e.g. by Angrist and Pischke (2010), to be a valid as an instrument, the lagged refund needs to satisfy the relevance and the exclusion condition. The relevance condition refers to the correlation of the lagged refund and exports, which must be zero. Test results show that the coefficients on lags of the refund regressed on exports, are generally very small, close to zero, and hence this condition is satisfied. Hence, the lagged values satisfy instrument test results and the requirement for using an IV approach in linear models, i.e., the instrument is correlated with the endogenous explanatory variable (the refund), conditional on the other covariates.

The exclusion condition is more demanding, since it requires that the lagged refund (the instrument) influences current exports (the endogenous variable) only through its effect on current refunds. By applying several lags on the refund, the concern that the instrument has causal effect on the outcome, in ways other, than through the channel of interest, should be mitigated.

Various production related control variables, time and industry dummies are introduced to control for omitted variable bias. When growth and demand conditions were strong, the overall demand for energy and raw materials increased and raised their prices. During 2004 – 2009, energy and raw material prices rose particularly due to expanding Chinese production and needs, further fueled by China's current account surplus induced liquidity boom in the Western Hemisphere.[12] This boom was associated with increased demand for energy intensive Finnish exports, particularly basic metals. Time dummies are therefore necessary to capture business cycle effects, reflecting demand conditions on global markets, and industry dummies to (imperfectly) control for technological differences between industries.

[12] Source: http://www.vox.com/2014/12/16/7401705/oil-prices-falling.

Due to persistent autocorrelation, lags of the dependent variable and several lags of the instrument are included in the regression. As a robustness checks, various model forms are tested shifting dependent and independent variables.

Since the instrument is not randomized and internal validity cannot be guaranteed, I cannot prove causality. Nevertheless, while it is important not to dismiss correlation as not suggesting causation at all, correlation is necessary for causality in the first place. That is, significant correlation is necessary for the refund to have any causal effect at all. To begin with, I seek correlational evidence from several angles.

In the interests of replicability, and to reduce the scope for errors, I select a simple and transparent research design, i.e., identification strategy. Exports are considered a function of production function variables such as capital and labor, and productivity related variables. According to international trade models, see e.g. Melitz (2003) or Helpman, Melitz and Yeaple (2004), only the most productive firms engage in foreign activities, including exporting. Hence, several productivity-related, but little correlated variables are included as explanatory variables, i.e., technical efficiency, energy efficiency (energy intensity) and profitability. Value-added is excluded from estimates on exports, as it is directly related to capital and labor and would be similar to double-counting them as explanatory variables. In addition, I include energy related variables of interest, i.e., energy efficiency and renewables intensity. The model estimated with instrumental variables (IV) is presented in equation (4) below.

$$y_{it} = \alpha_1 y_{it-1} + \alpha_2 r_{it} (r_{it-1,} r_{it-2}) + \beta_1 x_{1it} + \beta_2 x_{2it} + \ldots + \beta_6 x_{6it} + d_t + d_j + e_{it} \quad (4)$$

The dependent variable, y_{it} stands for exports in year t by firm i. The explanatory variables include a lag of exports, as well as the energy tax refund, $r_{it,}$ instrumented by its lags $r_{it-1,}$ r_{it-2}. In addition, logs of capital, labor, efficiency, profitability, energy efficiency and renewable (or non-fossil-fuel-intensity) for firm i, in industry j in year t are included in $x_{1it}, \ldots, x_{6it.}$ I include time dummies (d_t) for each year from 2004 to 2009 to capture business cycle effects and industry dummies (d_j) to capture industry characteristics. Lastly, e_{it} is the error term. Robust standard errors are computed to control for potential heteroscedasticity. Reduced forms of the model are estimated also with ordinary least squares (OLS) and fixed effects (FE).

The long-term equilibrium impact of the refund[13] is calculated by adjusting the coefficient to the impact of the lagged dependent variable in the model

$$\alpha_2 / (1 - \alpha_1) \quad (5),$$

where α_2 is the coefficient on lagged exports, and α_1 is the coefficient on the refund.

Results

Provided that the instrument is valid, the lagged refund is exogenous to the dependent variables. Tables 3 to 7 below present results from models including all variables satisfying most test results, with the exception of the endogeneity test, which generally failed to reject the H_0 of exogeneity. OLS and FE are more efficient than IV. Yet, fixed effects results tend to fail the F-test, while OLS results cannot be relied upon due to the size impact. Hence IV results are referred to in the following. The

[13] See e.g. Greene (2003).

differences between IV, OLS and FE results should stem from the inclusion of lagged control and exclusion of dummy variables in the IV estimations.

On average, the results show no significant correlation between the lagged refund and exports (Table 3) or between the refund and employment (Table 5). With respect to exports, the signs and small magnitudes of the coefficients in various robustness checks are fairly consistent, i.e., the refund has no impact on exports. In some models, the relationship is negative. As a further robustness check a simplified model is estimated, i.e., excluding value-added, labor, capital, energy related variables and profitability. This is to check the potential impact of double counting of the variables in exports. Profitability is excluded as the refund may directly contribute to profits. If firm size is controlled for by the number of employees, while the capital stock and industry dummies control for the technology, it appears that technical efficiency is significantly associated with exports, consistent with Helpman et. al (2004) finding that more productive firms export. Indeed, in several other forms of the model, exports appear to be linked to efficiency as trade theory suggests.

In contrast, value-added is significantly and positively related to the refund (Table 4). The insignificant impact of the refund on exports suggests that the positive link between value-added and the refund is not due to exports. Hence, it is possible that the refund crowds out smaller producers, not eligible to the refund. Alternatively, since the domestic market is small, it may also substitute imports of intermediates with domestic produce. That is, the refund may be able to maintain value creating production in Finland through import substitution. The relationship between value-added and the refund is endogenous, since they are linked by design. Current refund increases with the decline of current value-added, i.e., the link is inverse. Yet the correlation of the refund, including its lag, is positive with value-added. This positive significant correlation between the refund and value-added may emerge from autocorrelation. That is, the lagged refund influences current value-added through the current refund or the lagged value-added.

By design the energy tax refund is also related to energy use. The negative association of the refund with energy efficiency is as one would expect. The failure of the endogeneity test, suggests that there may be causality from the refund to energy inefficiency. In any case, the recipients are more energy intensive or inefficient in their energy consumption than non-recipients even after controlling for time and industry effects. This contrasts with the energy efficiency argument that industry proponents have put forward.

Table 3. Instrumental variables estimates of the refund's impact on exports[14]

Model Explanatory variables	Exports with 1 lag, refund 3 lags	Exports with time and industry dummies, refund 3 lags	Exports with 1 lag, refund 2 lags	Exports with time and industry dummies, refund 2 lags	FE cluster (id)	OLS	OLS
Log energy tax refund	.000038	-.0137934	-.0030009	-.0069513	.0153864*	.0152166	.0147036
Lag log energy tax refund					-.0022753	-.0134645	-.0112937
Lag2 log energy tax refund					.0060069	-.0009845	-.0040157
Lag log exports	.8189***		.7443203***		.1120361	.7576543***	.7638246
Log capital	.0206947	.3313339***	.0999509**	.4978928***	-.0093365	.1135976**	.1172132
Log labor	.244597***	1.018216***	.2656024**	.84334***	.780291**	.0551548	.2325463
Efficiency (m700output)	.3723143***	1.106536***	.3554223**	1.001428***	.5646483***	.233704**	.3573152
Profitability	.0861565**	.0082802	.0530219	-.0696948	.0753354	.3204607**	
Log energy efficiency	-.0098705	-.1249506	-.0028747	-.0639667	.1454453	-.0003029	
Renewables intensity	.1982381	.777454***	.278812*	1.007253***	-.1335679	.2870547*	
y2005	0	0	0	0		0	0
y2006	0	0	.23934***	.0848445		.263615***	.1314499
y2007	.137638	.118313	.089729	.092931		.149466	.021724

[14] *** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

	2*	7	8	4		5*	9
y2008	.1236052	.0985735	.1043411	.0641862		.1311639*	0
y2009	0	0	0	0		0	-.1383848
tala17	.3337889***	1.071521***	.2378541**	.8914167***		.2281321**	.1425066
tala20	.2810326**	.6969112***	.1784335	.6407669***		.17228	.088043
tala24	.0967573	-.3351308	-.1633682	-.2756675		-.1356623	-.2519049
Constant	.9431674*	6.799017***	1.193771*	5.339552***	9.374788**	.9442895	1.049513
Observations	255	258	380	387	393	393	383
F-test	409.97	88.74	477.67	107.43	3.26	403.46	467.38
Kleibergen-Paap p-val	0.0000	0.0000	0.0000	0.0000			
Hansen J p-val	0.3625	0.7540	0.7883	0.5751			
Endogeneity test of log refund, p-val[15]	0.8761	0.8959	0.2843	0.6616			
R2 overall					0.6629	0.9376	0.9367
No. of groups/ clusters					132	132	132
Eq. impact[16]	0.00021		-0.01174		0.017328	0.062789	0.062257

[15] H_0: The specified endogenous regressors can be treated as exogenous.

[16] Long-term equilibrium impact from equation (4).

Table 4. Instrumental variables estimates of the refund's impact on value-added[17]

Model Explanatory variables	Value-added with 1 lag, refund 3 lags	Value-added with time and industry dummies, refund 3 lags	Value-added with 1 lag, refund 2 lags	Value-added with time and industry dummies, refund 2 lags	FE cluster (id)	OLS
Log energy tax refund	.01446**	.0221975***	.0148056***	.0252657 ***	.0058135	.0100385
Lag log energy tax refund					.0187424 **	.0066188
Lag2 log energy tax refund					.0147204 *	-.0028425
Lag log of value-added	.2888226***		.3985867***		-.002534	.4481666***
Log of exports	.0421156 **	.0665452 ***	.0439704 ***	.0767365 ***		.0469341 **
Log capital	.2648659 ***	.3837667 ***	.2239137 ***	.3980999 ***	.1363051 **	.2228922 ***
Log labor	.4360131 ***	.5610984 ***	.3302142 ***	.5026795 ***	.7129651 ***	.1291165 ***
Efficiency (m700output)	.7668597 ***	.9562707 ***	.7174801 ***	1.005323 ***	.8793068 ***	.2686902 ***
Profitability	.1472851 ***	.1652683 ***	.1340857 ***	.1591492 ***	.0091377 ***	.6685181 ***
Log energy efficiency	.0719179 ***	.0798037 ***	.0416099 **	.0537624 **	.1424682	.0457608 **
Renewables intensity	-.0364588	-.0418817	-.0365526	-.0854309	-.4891801 **	-.0449744
y2005	0	0	0	0		0
y2006	0	0	.0878308 **	.0374063		.1151186 ***
y2007	.0209814	.001138	.0797446 **	.0573617		.11801***
y2008	-.0556755	-.0285632	-.0229686	.0219125		0
y2009	0	0	0	0		.0173763
tala17	.0846762	.0992236	.0030023	-.0134264		-.0195096
tala20	.0536125	.0939231	.0174879	.0405454		-.01667
tala24	-.036742	-.0522072	-.0815651	-.0841459		-.0979427

[17] *** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

Constant	1.567727 ***	2.461125	1.488197 ***	2.629739 ***	5.457198***	1.157353 ***
Observations	258	258	387	387	422	400
F-test	724.32	552.03	1041.23	525.10	6127.51	550.38
Kleibergen-Paap p-val	0.0000	0.0000	0.0000	0.0000		
Hansen J p-val	0.2418	0.2396	0.7970	0.3424		
Endogeneity test of log refund, p-val	0.9298	0.6357	0.4853	0.1545		
R2 overall					0.8639	0.9677
No. of groups/ clusters					142	134
Eq. impact[18]	0.020332		0.024618		0.005799	0.018191

*** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

[18] Long-term equilibrium impact from equation (4).

Table 5. Instrumental variables estimates of the refund's impact on employment[19]

Model / Explanatory variables	Labor with 1 lag, refund 3 lags	Labor with time and industry dummies, refund 3 lags	Labor with 1 lag, refund 2 lags	Labor with time and industry dummies, refund 2 lags	OLS
Log energy tax refund	-.0121336	-.0069573	-.0167665	-.0047987	.0021898
Lag log energy tax refund					-.0225329
Lag2 log energy tax refund					.0163733
Lag log of labor		.7118043***		.8346947***	.8607748***
Log of exports	.258807***	.0804934**	.2360397***	.0430718*	.0331607
Log capital	.3902284***	.1242729***	.3562332***	.0692184**	.0608515**
Efficiency (m700output)	-.7509991***	-.281376**	-.6409823***	-.1187899	-.1167501
Profitability	.0132223	.0204643	.0513442	.0177968	.0228173
Log energy efficiency	.1790586***	.0885977***	.1109831***	.0351383**	.0337158**
Renewables intensity	-.1069564	.0405469	-.1557123	-.0187987	.019359
y2005	0	0	0	0	0
y2006	0	0	.1471519	.1584881***	-.0959738*
y2007	.204134**	.2401568***	.2597516***	.255572***	0
y2008	.2099447**	.124888***	.1682344*	.1096554***	-.1455657***
y2009	0	0	0	0	-.2477216***
tala17	-.7210007***	-.2828869*	-.6860535***	-.2350102**	-.1932533*
tala20	-.6085025***	-.2392132*	-.5560283***	-.1714339*	-.1314425
tala24	-.1258803	-.1031402	-.0880513	-.077542	-.0575838

19 *** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

Constant	-4.288944 ***	-1.753915 ***	-3.101106 ***	-.8664748 ***	-.5166813 *
Observations	258	258	387	387	400
F-test	64.39	545.57	63.93	931.56	752.59
Kleibergen-Paap p-val	0.0000	0.0000	0.0000	0.0000	
Hansen J p-val	0.9745	0.4993	0.7750	0.2317	
Endogeneity test of log refund, p-val	0.7537	0.6595	0.8084	0.2669	
R2 overall					0.9476
No. of groups/ clusters					134
Eq. impact[20]		-0.02414		-0.02903	0.015728

*** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

[20] Long-term equilibrium impact from equation (4).

Table 6. Instrumental variables estimates of the refund's impact on energy efficiency[21]

Model Explanatory variables	Energy efficiency with 1 lag, refund 3 lags	Energy efficiency with time and industry dummies, refund 3 lags	Energy efficiency with 1 lag, refund 2 lags	Energy efficiency with time and industry dummies, refund 2 lags	OLS
Log energy tax refund	-.0173068	-.051736**	-.0171456**	-.061773***	-.0108991
Lag log energy tax refund					.0230149*
Lag2 log energy tax refund					-.0279016**
Lag log energy efficiency	.5767545***		.6934496***		.7266445***
Log of exports	-.0228421	-.0979489*	.0070017	-.0607723	.0039049
Log capital	-.2117921***	-.4102329***	-.1181161**	-.2609714***	-.0936278**
Log of labor	.254454***	.5365661***	.1169588**	.3543449***	.1354766***
Efficiency (m700output)	.8100176***	1.344851***	.4696552***	.9944198***	.1013434*
Profitability	.0999756***	.1310401***	.1405679***	.2052413***	.4489777***
Renewables intensity	-.4865582***	-1.167432***	-.4660026***	-1.392337***	-.4158714**
y2005	0	0	0	0	0
y2006	0	0	.1617906	.1104722	.1781442
y2007	-.0909553	-.0523696	-.058833	-.1676045	0
y2008	-.1430756*	-.1801102	-.0965297	-.1631887	-.0429504
y2009	0	0	0	0	.0345183
tala17	-.1579982	-.370439	-.2231614*	-.5266884**	-.1787838
tala20	.0530418	.5094789	.0200668	.4238119	.0198299

[21] *** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

		***		**	
tala24	.0678408	.1005012	-.0365942	.0472366	-.0173923
Constant	4.348066 ***	10.86***	2.807878**	9.417735 ***	2.354657 ***
Observations	258	258	387	387	400
F-test	110.95	27.3	120.19	22.48	100.22
Kleibergen-Paap p-val	0.0000	0.0000	0.0000	0.0000	
Hansen J p-val	0.2437	0.6124	0.0776	0.6500	
Endogeneity test of log refund, p-val	0.5696	0.6583	0.3610	0.2556	
R2 overall					0.7831
No. of groups					134
Eq. impact[22]	-0.04089		-0.05593		-0.03987

*** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

[22] Long-term equilibrium impact from equation (4).

Table 7. Instrumental variables estimates of the refund's other impacts[23]

Explanatory variables	Exports with 3 lags	Exports with 2 lags	Exports with 2 lags	Value-Added with 2 lags	Value-Added with 3 lags	Employment with 2 lags	Energy efficiency with 2 lags
Log energy tax refund	-.040905*	-.037841*	.0139688*	.02639***	.02286***	-.0335***	-.0631***
Lag log exports			.91931***				
Log exports				.07479***	.06633***	.05197***	-.1409***
Log value added	.816154**	.88692***				.932977***	.611927***
Log labor	.513522***	.3438225**		.506418***	.560805***		.0789937
Log capital	.0034253	.1297293		.395141***	.382980***	-.178357***	-527622***
Efficiency (M700)	.3571191	.1308637	.1920999	1.00079***	.954595***	-1.27907***	.3098739
Profitability	-.1323874*	-.2191473**		.161366***	.166612***	-.123196***	.1441841*
Log energy efficiency	-.2342***	-.1484797**		.0561587**	.081282***	.0106242	
Non fossil fuel intensity	-.4185709	-.4872759**		.0504119	.0484695	-.0424323	.697881***
y2005	0	0	0	0	0	0	0
y2006	0	.0222391	.27156***	.0375005	0	.0458985	.0965759
y2007	.0687307	.0095312	.1553113**	.0593846	.0042162	.0814426	-.160047
y2008	.0399707	-.0199165	.1546183*	.0231805	-.026415	.0704817	-.1476585
y2009	0	0	0	0	0	0	0
tala17	.556201	.410580	.092568	.027362	.124714	-	.081479

[23] *** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

	***	5**		4	**	.365107 ***	7
tala20	.2979161	.2163135	.0094171	.0733321	.1122648**	-.338783 ***	.8807603
tala24	-.769611 ***	-.758334 ***	-.1961728	-.0353121	-.0208372	.023878	.8298073
Constant	5.49802 ***	3.63481 ***	1.055281	2.57081 ***	2.39666 ***	-4.09112 ***	6.91521
Observations	258	387	380	387	258	387	387
F-test	108.99	27.70	462.15	534.39	557.86	176.10	18.50
Kleibergen-Paap p-val	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Hansen J p-val	0.7540	0.6556	0.3599	0.2766	0.2361	0.7303	0.8385
Endogeneity	0.8959	0.4990	0.7282	0.1134	0.5169	0.2730	0.4909
Eq. impact[24]			-0.0409				

*** Correlation is significant at the 0.01 level; ** Correlation is significant at the 0.05 level; * Correlation is significant at the 0.1 level.

Omitted variable bias is controlled for by including dummies for year, industry, and various firm variables. Once the interactions of year and industry dummies are included, FE test results are no longer satisfied suggesting that the number of variables is too small. Since significant results could be obtained in other model forms, the insignificance of the refund is not deemed to be due to small sample size. In sum, while causality cannot be established, the absence of significant correlation between the energy tax refund and exports strongly points towards the absence of a competitiveness enhancing effect.

Discussion

The endogeneity test showing exogeneity of the refund is sufficient to allow for causal interpretation of the results provided that the lagged refund is a valid instrument, i.e., as good as random. This is constrained by the fact that lagged variable effects may be biased by omitted variables. Hence, various control variables, as well as dummies for year, industry, and firm fixed effects were included. Their interactions reduced the number of variables excessively and results did not pass test results in FE estimations. Meanwhile in IV the overall impact was insignificant. Significant results could be obtained with respect to other variables and models. The refund reduces costs, which should be reflected in improved export performance, but the near zero negative coefficients indicate the absence of a competitiveness enhancing effect.

[24] Long-term equilibrium impact from equation (4).

Cost competition, related to wages and/or exchange rate manipulation, is intense in mature industries, such as the paper industry or the steel industry. The refund aims to reduce energy costs of the producers and raise cost competitiveness, and therefore acts as a form of fiscal devaluation[25]. Why this does not show up in exports can be due to several reasons: pass-through to inefficiencies, demand conditions or the shape of the demand curve. The steel industry, a key recipient of the refund, has been feared to shift production overseas particularly to China. The 2000's witnessed an extraordinary economic boom related to rising competition and off-shoring to emerging economies. The inflationary growth accelerating liquidity boom raised prices of raw materials (Plumer 2015), including Finnish steel prices already in 2002 before the energy tax refund was introduced. The demand for Finnish steel collapsed only in 2007, China's production lead to overcapacity. Also the paper industry suffered from overcapacity induced by technological change and structural shifts in market demand. That is, the subsidy may have maintained excess capacity, where hindsight suggests that it should have been reduced. In sum, the cost reducing impact of the refund may be insignificant compared to exogenous market and/or technological developments.

The refund may not be as effective as currency depreciation since it is indirect, affecting only part of energy costs. In the long run, the refund may be diverted into higher wages or profits distributed as dividends to shareholders, or structural inefficiencies. If significant at all, the refund can be expected to reallocate resources towards the subsidized input, energy. Hence, the refund may not work due to inefficiencies, a misallocation of resources and structural effects on energy consumption and imports that subsidies tend to generate. The reduced pressure from environmental regulation may also generate dynamic effects as the incentives to seek more energy efficient means of production or innovate are reduced. In the long term, this may result in lost competitiveness relative to firms in countries with stricter regulations, as the Porter hypothesis postulates. Indeed, energy intensity proved to be positively associated with the subsidy, while exports are strongly associated with technical efficiency consistent with the Helpman et al. (2004).

Investments are too large scale and infrequent to be studied for the location of production for pollution haven considerations, while the lack of data on imports of respective intermediates rules out the possibility of studying the impacts of the refund on net exports. Nevertheless, the significant positive impact of the refund on value-added suggests that the refund may help to maintain production in Finland. The refund is directly linked to value-added, but inversely. Hence, an increase in value-added reduces the current refund, but cannot influence the lagged refund. Reverse causality is therefore ruled out. The lagged refund appears to raise value-added, i.e., the use of domestic labor and capital. This may represent a crowding out effect of domestic competition, since the impact does not appear to be due to increased exports. But it can also represent a crowding in effect of domestic production through reduced imports of intermediates. Given exogenous demand, a marginal cost factor such as the refund, may have an effect on the cost competitiveness of domestic intermediates relative to imported intermediate goods. What can be established is that the refund

[25] In the absence of nominal exchange rate devaluations, misalignments in the euro can be readjusted by changing the relative tax burden on exports and imports or internal devaluations (see e.g. IMF 2011).

does not promote exports. Since import substitution policies are vulnerable to inefficiencies and a misallocation of resources, the refund is likely to represent suboptimal policy.

Conclusion

The energy tax refund does not appear to raise competitiveness in terms of export performance. The positive correlation of the refund with exports appears to emerge from the large size of the recipients. At best, the refund may have an import substitution effect by reducing imports of intermediate goods, but the analysis is constrained by endogeneity issues and lack of data on imports. Consistent with the Helpman et al. (2004), exports are strongly associated with technical efficiency. As for pollution haven effects, energy intensity increased with the refund.

Since the instrument is not randomized, I cannot prove a causal relationship despite the various controls. Nevertheless, significant results could be obtained, suggesting that insignificance is not due merely to small sample size. The small magnitudes of the coefficients strongly suggest the absence of an export performance enhancing effect. As such results are fairly consistent with recent literature on the impact of environmental taxes on competitiveness. I contribute to the accumulation of such evidence, enjoying broader relevance to countries combatting overvaluation with indirect fiscal devaluation.

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Modeling Sustainable Futures: Cultural Shift Strategies for Sustainability Leaders Case Study New York City's Department of Education's Office of Sustainability

Maya Camou, Birmingham City University, UK; Time Equities, USA
Lawrence Green, Birmingham City University, UK

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Abstract
Recognition of detrimental effects of rapid industrialization have resulted in the development of sustainable policies designed to promote and ensure a greener future for all. These measures have motivated organizations in both public and private sectors to create sustainable leadership positions to help manage these new mandates. This paper examines New York City's sustainable policies, governed by two mayors, in hopes to make NYC "the most sustainable, resilient city in the world"[1] Current research shows that policy is the driving force motivating organizations to create leadership positions that lead sustainability actions. The research suggests that these new sustainable leaders will require strategies in creating cultural and behavioral shifts, in both their organizations and communities, to be able to execute these new directives.
The research examines the New York City Department of Education's (DOE) Office of Sustainability's Initiatives, and recommends necessary strategies that are starting to be implemented by DOE's Director of Sustainability. The proposed framework provides sustainability leaders with guidelines that help to sponsor organizational cultural change. NYC's Public schools district is the largest school system in the United States and comprises of over 1800 public school buildings serving over a million students. This is a nascent movement in the United States; New York City's Director of Sustainability position was only developed in 2009.

Keywords: Sustainability, Design Thinking, Policy, Culture, Change Management, Innovation, New York City, Conservation, Social Responsibility

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[1] Information from One New York Vision 3: Sustainability plan - http://www1.nyc.gov/html/onenyc/visions/sustainability.html

Introduction

Only in recent decades has the issue of global warming and environmental health become part of mainstream conversations.[2] Scientists, civic leaders and experts have been trying to educate the public, industry and policy makers on the need for changing behaviors and ameliorating the impact the industrial revolution has had on our social and environmental health. It is argued that business and civil institutions need to recognize the impacts that industrialized nations' limitless use of fossil fuels, massive resource consumption and huge emission of greenhouse gases have implied for social and ecological systems (Gore, 2006). Companies have not fully grasped how they can transform existing systems and harmful practices affecting both human and ecological systems to positive ones (Rogers, 2010). Experts argue that organizations suffer from system blindness where they cannot comprehend the fundamental economic restructuring that is needed to ensure their own survival. They state that most companies try to solve problems without understanding the complex nature of connections, relationships, and influences that are involved (Goleman, 2013).

Organizations are looking at different models and frameworks that can help them direct their mission, vision and goals along more sustainable pathways. These prototypes focus on large and small areas of operation. They help organizations conduct structured, achievable, and strategic conversations around new or existing business initiatives. Successful organizations, for example Nespresso, have developed business models that have had a powerful effect on the sustainability-oriented transformation of their markets and supply chains (Osterwalder, 2013). The newly developed business models or frameworks are designed to function differently, based on a logic of how an organization operates, creates, and captures value for stakeholders in a specific marketplace (Casadusus-Masanell & Ricart, 2011) .
Design is an important component of an organizations' strategic approach and its competitiveness since it allows the synthesis and integration of external knowledge with existing organizational capabilities (Cooper and Kleinschmidt, 1987, Gardiner and Rothwell, 1985) . Experts in the field began to focus on how design can influence organizations' decision making and their efforts to build a competitive advantage. Grob and Dumas (1987), and Borja de Mozota (1990) regard design as strictly intertwined with an organizations' strategic management concerns. Kotler and Rath (1984) suggest the importance of design as a strategic process which seeks to optimize consumer satisfaction and company profitability, via different levers such as improved performance, form, durability, and value in connection with products, environments, or identities.
The current research investigated the understanding of the necessary strategies needed to create cultural shifts in the sustainability domain that can be utilized by change agents in all sectors. A suggested "Integral Design Thinking" framework was developed in initial stages of the research.

[2] After years of environmental and business analysis the author has found that the main culprits of the damage to our health and environment is in our business practices, our built environment and our land development.

1. The Case in a Nutshell – Analysis of Strategies needed for Sustainability Leadership and Leaders in a "Change Agent" role to Implement Organizational Cultural Shifts

1.1 Case Study History

This case involves the efforts of the New York City's (NYC) Department of Education's (DOE) efforts to implement sustainability mandates to its 1800 schools. NYC is the largest school district in the US and is unique in its structure: it is divided into many interrelated agencies. The study evaluated the efforts of the DOE's Office of Sustainability (located in the Division of School Facilities [DSF]) efforts to embed sustainability into its school system culture.

In American society businesses have the power to impact the economy, and affect laws and policies that have been implemented and passed by government officials. As global warming and the environmental agenda has come into mainstream in past decades they have had influence to transform environmental, business, and social issues affecting business practices. This new way of thinking has helped the growth of markets, such as, green buildings development and organic and ecofriendly products. The term Sustainability as defined by Goodall (2012) "is about calculating the limits humankind has to live within, and then using our scientific genius to give us all a good life within those boundaries." He attempts to show demonstrate the necessity of understanding our limits and knowledge to develop healthier systems that can be implemented in all aspects of what is done, how it is done, and understanding all the connections. This holistic understanding was also suggested by McKibben (2011), where he argues that society, business and government need to change behaviors in thinking, acting, or working, as well as, modification of values in this new era of climate change. These modifications lead to culture change where sustainable practices become imbedded in businesses strategic planning and initiatives.

As businesses have seen the need for reevaluating current systems, so have municipalities. In 2007, New York City's PlaNYC was an unprecedented effort undertaken by Mayor Bloomberg to prepare the city for one million more residents, strengthen the economy, combat climate change, and enhance the quality of life for all New Yorkers. The plan was designed through the collaboration of more than 25 City agencies and is run by the Long-Term Planning and Sustainability (OLTPS) office. OLTPS monitors the effectiveness of the plan and reports on progress every year (NYC the Office of the Mayor, 2011)._ The "PlaNYC 2014" progress report shows how the design of the plan includes sustainability indicators to help "monitor current conditions and relate them to our long term goals."[3] These indicators were designed to provide quantifiable metrics to realize if goals are met, and to provide transparency and accountability as reported by the NYC office of the mayor (2014). The report argues that, as systems are designed and implemented, quantifiable metrics should be included in the equation as this will aid in the ability to monitor the performance of the model or framework that is being designed and developed (PlaNYC Progress Report, 2014).

[3] Information from *PlaNYC 2014 Progress Report* pg 33

PlaNYC has influenced NYC's government agencies to push for sustainability measures. Since the implementation of the plan, the DOE's Division of School Facilities has been developing sustainability initiatives so that school staff, students, and the overall community can become aware of different sustainable methods.[4]Analysis of how this large governmental agency seeks to understand and implement sustainable frameworks that create culture change would be a great asset to understanding the strategic design and planning of cultural shifts.

The 21st Century is witnessing the rise and merging of different movements in global corporate responsibly and sustainability efforts. Horrigan (2010) argues that corporate social responsibility (CSR) is one of the most important issues and developments of the last decades. He asserts that it will play a significant part in determining the shape and fate of the world for generations to come. As organizations redefine their image and brand, they look to the Social Capital theory of branding, in which organizations engage in rich, varied and frequent dialogues, and shared thinking and engagement with their internal and external customers as a means of developing trust and loyalty. Champniss and Rodes Vila (2011) show how there is a link between social capital and sustainability. They (Champniss, & Rodes Vila, 2011) argue that when sustainability is embedded in an organization, social capital thinking develops, making it more intuitive, engaging and durable. A conclusion formulated is that in today's consumer market, organizations need to recognize that society is its principal supplier and needs to be protected, and nurtured for the long term to secure its own survival.

Through this preliminary research, it shows that Mayor Bloomberg's PlaNYC was the catalyst that propelled the sustainable, green movement to the next level. The policies and mandates that were introduced started a chain reaction that has pushed public agencies, as well as, private organizations to create positions to manage the compliance requirements set by new laws and regulations. The Department of Education, Sustainability team has been in existence for just seven years. In 2007, New York City released PlaNYC[5], an aggressive sustainability plan aimed at reducing the City's greenhouse gas emissions by 30% by 2017. The plan was upgraded in April 2011 (PlaNYC 2030). Integral to this agenda is a plan to reduce energy consumption in municipal buildings and, particularly in public schools. In September 2014, Mayor de Blasio committed New York City to reducing its greenhouse gas emissions by 80 percent over 2005 levels by 2050, stated in his vision, *One City, Built to Last: Transforming New York City's Buildings for a Low-Carbon Future*.[6] This initial plan has created thousands of new jobs for New Yorkers and aided in the development of the green jobs market. This makes New York the largest city to commit to the 80 percent reduction by 2050. In 2015 the mayor again passed ONE New York plan that has pushed for even more stringent sustainability mandates for the city. One example is the mandate that all New York City Schools will be Zero Waste schools, where they have to divert 90% of their waste stream from landfills.[7]

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[4] Information from DOE website http://schools.nyc.gov/community/facilities/sustainability/about/
[5] PlaNYC PDF 2007.
http://www.nyc.gov/html/planyc/downloads/pdf/publications/full_report_2007.pdf
[6] *One City, Built to Last: Transforming New York City's Buildings for a Low-Carbon Future*. 2014
http://www.nyc.gov/html/builttolast/pages/home/home.shtml
[7] ONE New York Vision 3 Sustainability, April 2015.
http://www1.nyc.gov/html/onenyc/visions/sustainability.html

Public schools comprise 40% of all municipal buildings and are responsible for 25% of the City's carbon emissions and its total light, heat and power spending, costing New Yorkers an estimated $233 million per year. [8] All these directives being pushed by city government are shaping the future of the sustainability market and helping in the creation of Sustainability Leadership positions to meet these demands. An example of this is the Zero waste initiative ordinance as of April 2015, this has opened 8 new positions for waste coordinators to help manage this process at the DOE's Office of Sustainability.

New York City is unique in its structure, division of agencies and how they work and rely on each other. The DOE itself is divided into many divisions that have to work and rely on many other city agencies to get their work done, this is illustrated in Figure 1. The Sustainability team is located in the Division of School Facilities (DSF).

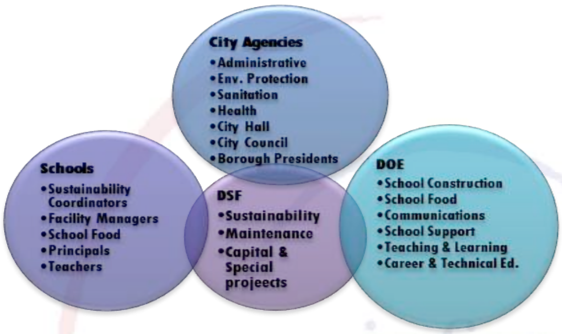

Figure 1: Organization of Sustainability Stakeholders

Leaders of sustainability are being added to organizational models because their top sustainable initiatives such as energy efficiency and waste management mandates have the most comprehensible payback to the organization. These individuals are starting to assess and apply measurements so that they can implement policy regulations that are being decreed from city, state and federal levels. This is a young movement in New York City and at the same time one of the oldest in the US. For example, Washington DC school district hired their first Director of Sustainability in 2015, while New York City's position was developed in 2009. In NYC other government agencies also added Directors of Sustainability to their organizations at the same time; such as, Department of Buildings, hired a Sustainability Director to design and develop a system of accountability of buildings in both the public and private sectors. A timeline of the Office of Sustainability's function is illustrated in Figure 2.

Figure 2: Timeline for the DOE Office of Sustainability

[8] NYC DOE Sustainability Initiative Corp Leadership Council Concept DRAFT DOC 12/13/2013

1.2 Sustainability Team and Organizational Connections

Although DSF chairs the sustainability efforts for the DOE, various other DOE divisions (such as School Food and School Construction Authority (SCA) and City agencies, such as the Department of Sanitation (DSNY), Department of Citywide Administrative Services (DCAS), and Division of Energy Management form a cooperative group of stakeholders (see Figure 3). School sustainability coordinators play a vital role in the structure of the Office of Sustainability, as they are in charge of relaying information and lead sustainability efforts within their school. Non-profit partners are also key players that help in the education, support and implementation of strategies the sustainability team is mandated to execute. These various organizations and individuals play an integral part in helping to achieve a more sustainable New York City school system. [9]

Figure 3: Sustainability team is the Bridge to all Stakeholders

1.3 Objective

The objective of the case study was to understand in detail what measures were essential in creating cultural shifts towards sustainability in the NYC's Public Schools. Key issues and questions included: how and why were sustainability positions/functions formed; how have they evolved; what challenges have been presented; how have the latter been addressed; what strategies were attempted; and, what can be learned (for innovators in the public and private sectors, and for policy-makers at service, national and supra-national levels) from the experience.

[9] Information from 2013-2014 Annual Sustainability Report.

2. Methods

The case study focused on the exploration of the subject of sustainability; an examination of its effects, implementation and tools that are needed to embed the theory and concepts into organizational culture. The research examined the use of and need for design thinking, innovation and creative strategic planning in the metamorphosis of organizational culture.

This research used an exploratory methodology at its core. As Stebbins, 2001 (p6) suggests "To explore effectively a given phenomenon, they must approach it with two special orientations: flexibility in looking for data and open-mindedness about where to find them". The case study was conducted in an emerging market and its findings suggest that there has not previously been a clear definition or answers to the research questions. The exploratory methods relied on qualitative approaches such as case studies and interviews. Additional data gathering methods included review of reports, white papers, journal articles, and books. The study followed an inductive data collection method to generate insight and assist in building theory, to help aid in the development and understanding of the research case study.
In a single instrumental case study (Stake, 1995), the researcher focuses on an issue or concern, and then selects one bounded case to illustrate this issue. A Case Study commonly involves time in the field, interviews, transcription and analysis (Zucker, 2009). Action research was also utilized in this study. By becoming a part of the case study environment, more in-depth analysis of the surroundings, communications channels and key stakeholders took place: this assisted in establishing the baseline for the environment and research. The researcher worked closely with key stakeholders and suggested recommendations for implementing change in the DOE. The next steps taken were monitoring the effects of change and analyzing information on how to develop and improve the process.

The research was of multi-strategy design and utilized mixed methods and multiple methods of data collection. Qualitative data was gathered to facilitate an in-depth understanding of behaviors in the organizations, and an understanding of what might be required to support botto-up organizational culture shifts.The following methods were used in the generation of qualitative and quantitative data:

- Semi-structured interviews – questionnaires with basic thematic questions to start conversations, that lead to elucidation of interviewee-led materials information from each person. Targeting key personnel both internally and externally in the organization.
- Questionnaire/Surveys –Were used to target a larger population for data gathering.
- Brainstorming – created opportunities where large groups of people were able to collaborate, share ideas and feel part of the change/development process
- Observation – this aided in gathering information on behavior, communication methodologies, and interactions at all levels. The aim was to see what needs to be developed to build trust and a foundation for cultural shifts.
- Written literature on the subject – analysis of existing expert points of view to aid in formulating the findings and conclusions.

3. Findings and "Integral Design Thinking" Framework for Sustainability Leaders

It doesn't matter if you are in a public agency or a privately held one, any organizational change agent will need the right tools and strategies to be able to push any agenda forward. The research shows that, all stakeholders need to start defining sustainability in the same way; learn what are the best ways to work together; learn what is needed for each team members organization to succeed in their goals; how sustainability initiatives can become second nature to be easier on all as more stringent regulations and mandates keep coming to combat climate change. As a result an integral design thinking framework was developed by the research, illustrated in Figure 6. The next sections demonstrate how the design thinking framework strategies will aid Sustainability Leaders in implementing cultural shifts into their organizations:

3.1. Design Thinking

Some strategies of the design thinking part of the framework are as follows:

- Seeing beyond the naysayers and finding solutions.
- Holistic thinking.
- Developing and innovating existing systems.
- Prototyping, testing and improving.

As part of the research Working Groups were developed with internal stakeholders, external stakeholders and school based stakeholders. Through the working groups' introduction to Design Thinking / Creative Thinking Exercises was initiated.
Design Thinking is the ability to apply creativity to the formulation and resolution of the problems and challenges. It helps create incremental changes by bringing together participatory, human-centered and integrated design approaches to help play a pivotal role in transforming individuals and collective attitudes and behaviors (Chick & Micklethwaite 2011). The concept of 'Design Thinking' became a portal for the whole design area to contribute to innovation, and design thinking enabled innovation to supersede strategic management as a way to deal with a complex reality (Johansson-Skoldberg, Woodilla & Centinkaya, 2013). In 1984 the first mention of design as a strategic tool was made by Kotler & Rath (1984), but it took 20 years for the concept to come to mainstream environments and have any sustained discussion (cf., Fraser, 2007; Junginger,2007; Martin, 2007a) with 'wicked problems' (Camillus,2008) and design thinking (Brown,2009; Holloway,2009).
It has taken 20 years for the concept to come to mainstream, and brought about many sustained discussions about "wicked problems" and design thinking.

3.2. Branding

Some strategies of the branding part of the framework are as follows:

- To internal stakeholders
- To external stakeholders
- Development of transparency / reporting

Other research leads to claims that creating alignment in an organization is one of the most important work leaders need to develop. They conclude that companies that enjoy enduring success have core values and core purpose that remain fixed while their business strategies and practices endlessly adapt to a changing world. Strategies to build brand image and company reputation can enhance business customers' perception of product and service quality, and value thereby increasing customer? loyalty (Cretu and Brodie, 2007). It is advised that the first step for an organization is to recast their vision and mission into effective context for building a sustainable visionary future. One strategy would be to install performance measures and reward structures tied to both internal and external goals. This would help teams build a sense of local responsibility, camaraderie and ensure the proper collaboration of internal operations in in line with the corporate mission. Senior management must establish a hands-on presence; create opportunities for collaboration between all organizational members to encourage them to have a 'big picture', more holistic thinking. (Collins and Porras 1996, Levy 2001)

Branding and communication connections are a necessity when developing this strategy. Brand image and vision need to be connected to the definition of what all involved would understand and identify with. Branding is a technique to build a sustainable organization, that's takes on a differential advantage by playing on the nature of human beings. Essentially, the purpose of branding is to build the product's image among the consumers (Cleary, 1981). For the DOE's sustainable team, branding a new image was all about getting the internal customers on board, as well as the external customers, the schools.
They created a department motto and new brand image as part of the communication strategies. Working with internal staff a tag line of "The Power in Your Hands" was developed to give the schools, to include every student, teacher and individual the understanding that they have the power to make positive change in their environments. This was adapted to also work with the larger organization where another tag line was designed "One DSF = One Team = One Unit."[10] Figure 4 illustrates some examples of the marketing that was used:

Figure 4: Brand and Message Development Examples

Further strategies were being developed with the Communications and Training Coordinator to come up with ways in which the logo could be marketed to schools that have become sustainable. For example, creating a certification program that the

[10] This logo is associated with suggested DOE Framework for Sustainable Schools, as there are 8 doorways or topics that define sustainable schools and there are 8 colors the hand, each will represent a topic – the fingers and the movable parts and the palm is the solid foundations, such as inclusion, community and global community.

schools can go through. Each year the schools must become recertified in order to be able to use the logo on their letterhead and market that they are a sustainable school.

3.3. Communication Development

Some strategies of the communication part of the framework are as follows:

- Opening communication channels both internally and externally.
- Developing standards to convey same message.
- Develop accountability.

This phase establishes communications development that helps build moral and open communication and collaboration within the organization. Creative thinking workshops were developed for the leadership of the organization, external third party stockholders and school based stakeholders. As leadership in sustainability positions attempt to execute and modify systems they will need to understand the stresses of everyone involved in their organization and beyond. Sustainability leaders need to be able to communicate the ways they will:

- Assist each level of the organization with their tasks
- How these sustainability strategies will improve their work?
- How they will assist them with their desired outcomes?

Sustainability leadership will have to understand empathy and how to use it as a strategy in their work. Having the perception of how sociocultural factors have shaped others experiences and understanding of the world, will helps leaders develop better strategies that are crucial in building a working alliance (Neukrug, E., Bayne, H., Dean-Nganga, L. & Pusateri, C., 2013). The quality of empathy is suggested to be the greatest contributor in strengthening social interaction through its ability to motivate individuals to cooperate, to share resources and to help others (de Vignemont and Singer 2006; Hosking and Fineman 1990; Van Lange 2008).

From these initial interviews, findings show that proper internal communication strategies will have to be designed and implemented. Understanding of these barriers will be essential to the success of any cultural shift attempted. Several forms of barriers can impede the communication process. Longest, Rakich, and Darr (2000) classify these internal barriers into two categories: environmental and personal. Environmental barriers are characteristic of the organization and its internal environmental setting. Examples of this can be connected to workplace, mission, vision and goals. Personal barriers arise from the nature of individuals and their interaction with others. Both barriers can block, filter, or distort the message as it is encoded and sent, as well as when it is decoded and received. Strategic internal communication is simply a step towards helping the organization achieve its aims more effectively. A good team should evaluate the outcomes of the internal communication strategy and ensure that continuous improvements are being made (Stegaroiu, I. & Talal, M., 2014).

3.4 Community Building

Some strategies of the community building part of the framework are as follows:

- Stakeholder Engagement Internal.
- Stakeholder Engagement external.
- Education development and advocacy.

By identifying and considering a range of stakeholders, firms can gain competitive advantage by engaging with customers and other partners and encouraging inter-group engagement (Brodie, et al., 2006; Luschet, et al., 2007). The initial findings showed that all internal staff worked in silos. There was limited communication and information sharing between departments or teams. For any change initiative to be able to happen there needs to be collaborative efforts within the organization. Each stakeholder in the network confers a particular knowledge set to its relationship with the principal firm and an increase of interest and collaboration (Antanacopoulou and Méric, 2005).

The classification of community concerns particular features (Putnam, 2000;Harting, et al., 2006; Podnar and Janc, 2006), such as the place of community affiliation; the country where a community develops; the group of people with whom one carries out some activity and shares interests with; and the virtual community one takes part in. To create a sense of community and collaboration within organizations proper communication channels need to be developed. For example, part of the research with the Sustainability team was to help develop the advisory council and see if there could be strategies for implementation of cultural shifts with this larger group of stakeholders. The Council was composed of about 52 people all from diverse backgrounds and groups. The council had representatives from City Agencies, City Unions, Sustainability Coordinators, Principals, Parents, Facility Managers and non-profit Partners, and universities The first community based advisory meeting was in March 2015. This consisted of two working sessions, one with internal organization members and the second session with external stakeholders. The sustainable community group is based(Community based what?) on elements of interaction (face-to-face or electronic) that consists of people developing social relationships, whether they are living in the same place or not (Godwin, 1997).

3.5 Speaking the same language

Some strategies of the speaking the same language part of the framework are as follows:

- Defining Sustainability for the organization.
- Connecting all stakeholders to the message (Internal & External).
- Developing tools and messages to promote and spread the vision.

One of the biggest disconnects that exists in the case study organization and similarly other public and private sector organizations, is the lack of communication and connections to a defined sustainability vision. To address this the researcher designed and developed multiple strategies that addressed this issue on a multi-level approach. The initial workshop introduced design thinking ideas, innovation and looked for a definition to what sustainability is to NYC public schools.

3.5A Universal Definition of Sustainable Schools

Research finding disclosed that that there was no true universal definition of sustainable schools in NYC public schools and that this is creating major communication barriers between agencies. For the channels to open a true definition of what sustainable schools are and what resources are needed to be developed and adopted by all associated with the schools. A suggested definition based on the UK's Sustainable Schools Framework was established to align with both our Mayor's and School Chancellors visions. Figure 5 Sample of drafted Sustainable Schools Framework.

Figure 5: Draft of suggested definition of Sustainable Schools NYC

3.5B Unified Pledge for all Public Agencies and Unions involved in schools to work together under the proposed definition.

A pledge was developed to open communication channels and understanding of what needs to be done on all levels. This was modeled after District of Columbia's (DC) Mayor's College and Universities Sustainability Pledge.[11]

3.5C– Unified Pledge for all Stockholders involved in schools to work together under the proposed definition.

Following the same concepts, as above, a pledge was also developed to be administered at the School level. This was designed to help teachers, principals and students develop a culture of sustainability.

[11] Sample of this pledge can be found at http://sustainable.dc.gov/sites/default/files/dc/sites/sustainable/publication/attachments/CUSP.signatures.pdf

Conclusion

Figure 6: Integral Design Thinking Framework

Sustainability leaders are put to the task of making sustainability part of their organizations strategic plan. Government agencies and businesses are all already starting to analyze how they should become more sustainable, or how they might stimulate and progress sustainability initiatives in their practices and communities. The purpose of this study was to understand in detail what measures or strategies are essential for sustainability leaders to utilize in creating cultural shifts towards sustainability in their organization. The research developed a framework based on 'Integral Design Thinking" that consists of five strategic categories that were undertaken by this study, they are as follows: Design Thinking, Branding, Community Building, Communication Development and Speaking the Same Language. As seen in figure 6 above.

This research reflected on strategies to help organizations understand the need for a cultural metamorphosis when talking about sustainability and understanding the tools and environment necessary to achieve success. As in most cases, organizations tend to implement sustainability initiatives in a singular and isolated manner. This research aspires to provide another option in the field, a more holistic approach, where true culture change is necessary for the longevity of sustainability in an organization. The researcher continues to analyze the suggested Integral Design Thinking Framework on other case study organizations. As well as, continued research in organizational sustainable best practices.

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Contact email: mcamou@timeequities.com
Lawrence.green@bcu.ac.uk

Upward Flow Analysis of Methanol in Hydrofracking

Serdar Celik, Southern Illinois University Edwardsville, USA
Vineel Busa, Southern Illinois University Edwardsville, USA

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Abstract
Energy resources and generation of energy have always been popular topics since the industrial revolution. While the necessity for increased energy generation stands out clearly, debates have been arising pertaining to different energy resources, methods of extraction of resources, and processing techniques with environmental and health safety concerns. Shale gas is one of those resources, which became more favored after the application of hydraulic fracturing (hydrofracking) method for extraction of it. However concerns came along with this technique due to high-pressure injection of fracking fluid which consists of water, sand, and numerous chemicals some of which have high toxicity such as methanol. This study investigates the upward flow of methanol from the hydrofracking zone. Three case studies are conducted for the shale basins in Marcellus, Pennsylvania and Bakken, North Dakota in USA, and Bowland in UK. Theoretical analysis was conducted employing governing equations for incompressible, turbulent flow of methanol. Numerical analysis of the flow was also performed through a computational fluid dynamics (CFD) software using finite volume method. Stratigraphic data including layer thickness, permeability, porosity, and inertial resistance for all three basins were implemented into the model. Analysis was done on a transient basis and pressure and velocity distributions of methanol were obtained for all pilot basins studied.

Keywords: shale gas, hydrofracking, methanol, migration, CFD analysis

Introduction

Shale is a fine-grained, sedimentary rock which is a mix of clay and small fragments of other minerals. Shale gas is an important source of natural gas trapped within the shale formation. The residual amount of oil and gas within shale can be predicted using existing quantitative evaluation method of source rocks. The hydrocarbon content in the shale varies, depending upon the depositional environment, and the abundance, type, maturity, and expulsion efficiency of organic matter. Shale gas is difficult to exploit when compared to conventional gas and oil because of tight nature, low porosity and low permeability. To extract shale gas lot of chemicals, water and sand are pumped through pipes into the shale. Some portion of the chemicals cannot be recovered back. The left over chemicals which cannot be recovered can travel upwards. Shale has low matrix permeability, so production requires fractures to provide permeability. Hydraulic Fracturing (fracking) is the most common way of extracting natural gas and oil from shale formations. This technique involves injecting fracking fluid into the shale to create fractures in the body of rock from which natural gas and oil can be extracted.

Fracking is done both vertically and horizontally. Vertical fracking does not use extensive lateral components. The term vertical fracking can also refer to conventional fracking methods that preceded horizontal fracking. Horizontal fracking on the other hand allows wells to move laterally instead of going straight down. Larger area can be covered without boring as many holes into the surface. A horizontal well can stretch up to two miles along a shale deposit, unlike a vertical well. High volume hydraulic fracturing is possible with the lateral structure of the horizontal drilling. The high volume hyraulic fracturing uses less gelling agents and more friction reducing chemicals. Initially after completing the drilling work and wellbore casing installation a perforating gun is sent into the wellbore for the purpose of making perforated holes into the target rock.

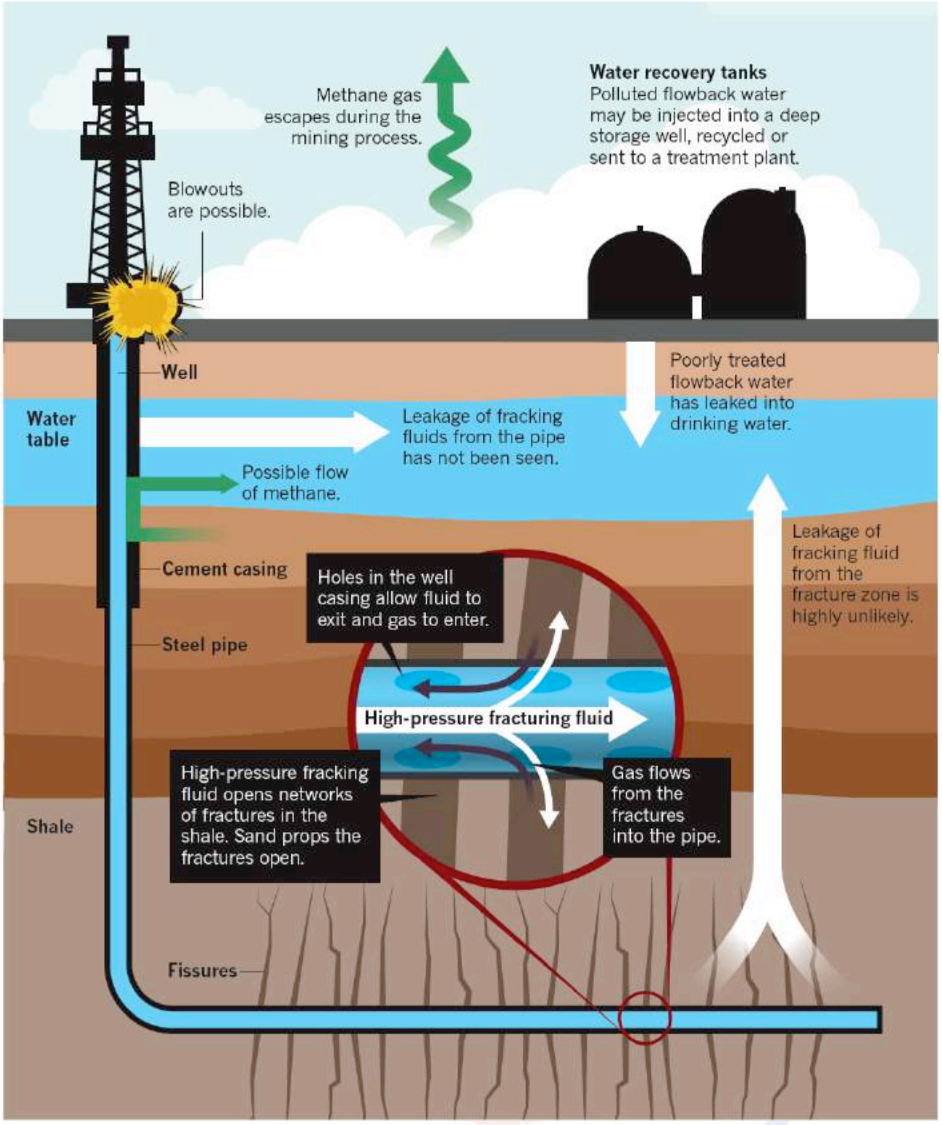

Figure 1: Hydrofracking process [1].

Natural fracture development can affect recovery potential of shale gas reservoir and can also determine the quality of shale gas reservoir and gas production. Fracture development is conducive to the volumetric increase of free natural gas, desorption of adsorptive gas and the increase of total gas accumulation in shale. Fracture development in shale is controlled by non-tectonic and tectonic factors [2].

The major non-tectonic factors that can influence fracture development are lithology and mineral composition, rock mechanism, total organic carbon and abnormal high pressure [3-5].

The conditions which are helpful for fracture formation are single shear strength, dual shear strength, triple shear strength, strain energy density and maximum tension stress strength. The most widely accepted among these conditions is the Coulomb-Mohr generalized single shear strength principle and Griffith generalized maximum tension stress strength principle [6]. The parameters such as Young's modulus, shear strain modulus, volumetric elastic modulus and Poisson's ratio, which reflects rock tensile strength, shear strength, compressive strength and lateral relative compressibility, respectively are used to describe elastic deformation of the rocks. Rock shear rupture depends on both shear stress and normal stress on the rupture surface. The stress condition at each point can be determined by tectonic stress field.

High-volume hydraulic fracturing technique is used to extract shale gas from the reservoir. Large amount of water, sand and chemicals are pumped at high pressure into the shale to induce fractures in the rocks to initialize the gas flow. Within few days after injection, a certain amount of water returns to the surface as a flow-back. The flow-back water is accompanied by high quantities of methane [7].

Table 1: Methane emissions over the lifecycle of a well [8].

	Conventional gas	Shale gas
Emissions during well completion	0.01%	1.9%
Routine venting and equipment leaks at well site	0.3 to 1.9%	0.3 to 1.9%
Emissions during liquid unloading	0 to 0.26%	0 to 0.26%
Emissions during gas processing	0 to 0.19%	0 to 0.19%
Emissions during transport, storage, and distribution	1.4 to 3.6%	1.4 to 3.6%
Total emissions	1.7 to 6.0%	3.6 to 7.9%

The above table gives the information about the methane emissions during well completion, liquid unloading, gas processing, transport, storage, distribution and routine venting and equipment leaks at well site. The significant difference in the methane emissions between conventional gas and shale gas can be observed during well completion. The emissions from conventional natural gas wells during well completion are very low as they have no flow-back and no drill out. Considering all the emissions during life cycle of an average shale gas well, about 3.6% to 7.9% of total production of the well is emitted as methane into the atmosphere, which is twice as great as the methane emissions from the conventional gas wells, 1.7% to 6%. Methane gas has more potential as greenhouse gas when compared to CO_2. The effect of methane gas on global warming attenuates more rapidly as it has shorter residence time in the atmosphere. The greenhouse gas footprint of shale gas is larger than conventional gas, due to methane emissions with back-flow and drill outs [8].

Faults are the naturally existing fissures, which are long and narrow line of breakage in the earth. The hydraulic fracturing process activates the dormant fractures and faults present in the area between the shale gas reservoir and aquifers, creating the pathway for the upward migration of the fracturing fluid and gases into the aquifers [9].

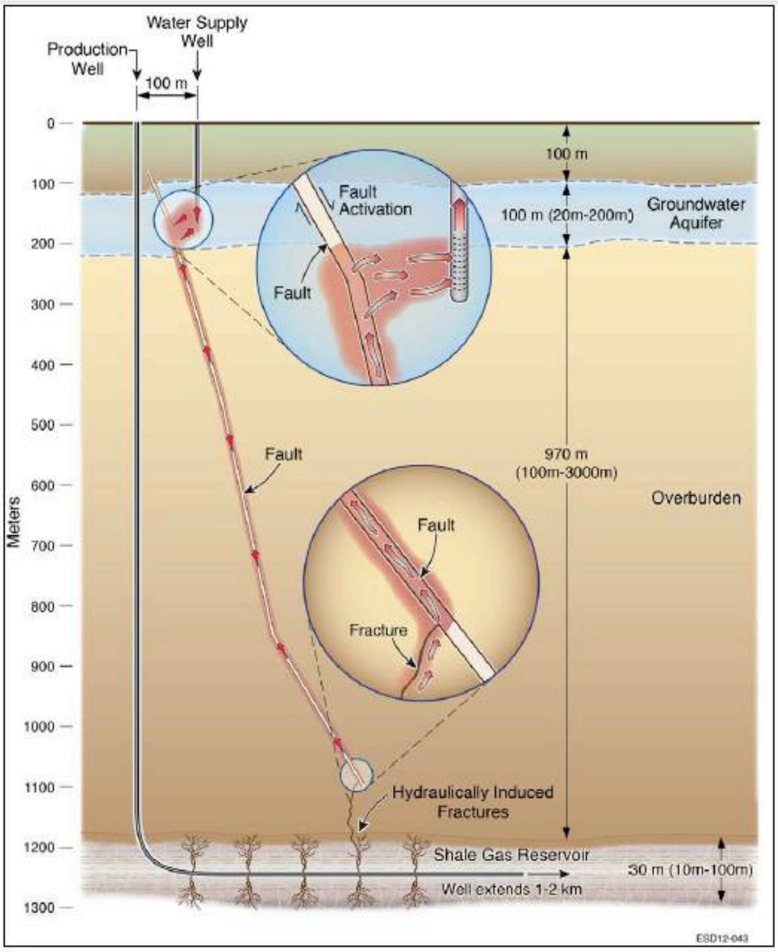

Figure 2: Faults and dormant fractures model [9].

This paper focuses on the potential upward flow of methanol present in the fracking fluid. Three shale gas basins are considered as the case studies:

1. Marcellus formation, Pennsylvania, USA
2. Bakken formation, North Dakota, USA
3. Bowland formation, UK

Theoretical Analysis

Solid matrix combined with voids is present in the porous medium. The arrangement of pores in a natural porous medium is irregular proportional to the size and shape of the porous medium [10]. In hydraulic fracturing technique the flow of the unrecovered fracturing fluid upwards from the shale gas reservoir can be considered as the flow through porous medium as, it is related to ground water hydrology, oil reservoir engineering and soil mechanics [11]. The flow through porous medium can simply be described by the Darcy's law for laminar flow. Darcy's law is the proportion between the flow rate and the applied pressure difference, which can be expressed as

$$V = -\frac{k}{\mu}\Delta P \qquad (1)$$

where, V is Darcy-Velocity or flow rate per unit area, ΔP is applied pressure difference in the flow direction, μ is Dynamic viscosity of the fluid and k is Specific permeability of the medium. The value of k is independent on the nature of the fluid, it is related to the geometry of the medium and is scalar for isotropic medium [10]. Homogenization techniques are used to derive Darcy's equation from the Navier-Stokes equations. The conservation of mass equation along with Darcy's equation defines the groundwater flow equation. Gas, oil and water flow through petroleum reservoirs can also be explained by Darcy's Law.

Continuity, Navier-Stokes and energy equations govern the incompressible turbulent flow of methyl alcohol. Reynolds number through the porous media is

$$Re = \frac{\rho v D}{(1 - \phi)\mu} \tag{2}$$

where, ρ is density of fluid flowing through porous media, v is velocity of fluid in the porous media, D is diameter of particles in the porous media, ϕ and μ are porosity and dynamic viscosity respectively. Equation 3.2 represents the Reynolds number for determining the flow regime in fluid flow through porous media. The critical value of Reynolds number at which flow begins to change to turbulent flow from laminar flow approximately ranges from 3-10. Reynolds number for Marcellus, Bowland, and Bakken formations are 633, 1270 and 2576 respectively, indicating turbulent flow. The equations can be solved using a suitable turbulence model. These governing equations of a flow can be expressed as following:

Continuity Equation:

$$\frac{D\rho}{Dt} + \rho\frac{\partial U_i}{\partial x_i} = 0 \tag{3}$$

For incompressible flow, as the density is constant the equation becomes

$$\frac{\partial U_i}{\partial x_i} = 0 \tag{4}$$

Momentum Equation:

$$\rho\frac{\partial U_j}{\partial t} + \rho U_i\frac{\partial U_j}{\partial x_i} = -\frac{\partial P}{\partial x_j} - \frac{\partial \tau_{ij}}{\partial x_i} + \rho g_j \tag{5}$$

$$\tau_{ij} = -\mu\left(\frac{\partial U_j}{\partial x_i} + \frac{\partial U_i}{\partial x_j}\right) + \frac{2}{3}\delta_{ij}\mu\frac{\partial U_k}{\partial x_k} \tag{6}$$

Energy Equation:

$$\rho c_\mu\frac{\partial T}{\partial t} + \rho c_\mu U_i\frac{\partial T}{\partial x_i} = -P\frac{\partial U_i}{\partial x_i} + \lambda\left(\frac{\partial}{\partial x_i}\left(\frac{\partial T}{\partial x_i}\right)\right) - \tau_{ij}\frac{\partial U_j}{\partial x_i} \tag{7}$$

Numerical Analysis

Domain geometries for three different cases were created in ANSYS. The data includes the porosity, permeability, thickness and inertial resistance of each layer between the aquifer and the shale gas extraction layer. Stratigraphic information for each basin including physical properties of the layers are presented in Figures 3-5.

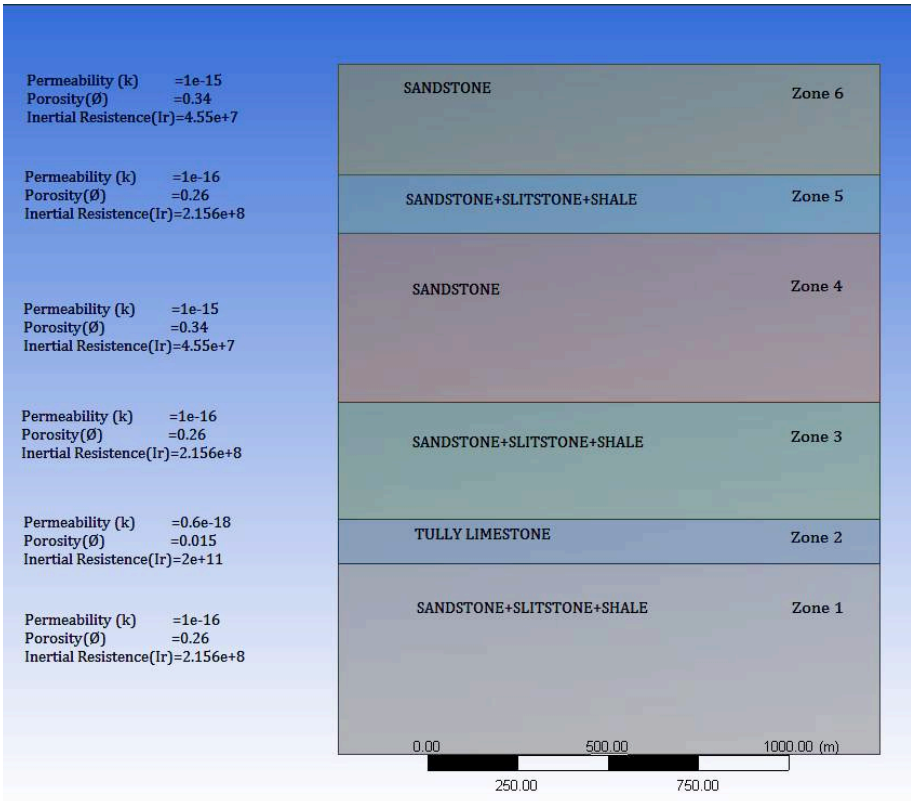

Figure 3: Marcellus stratigraphy.

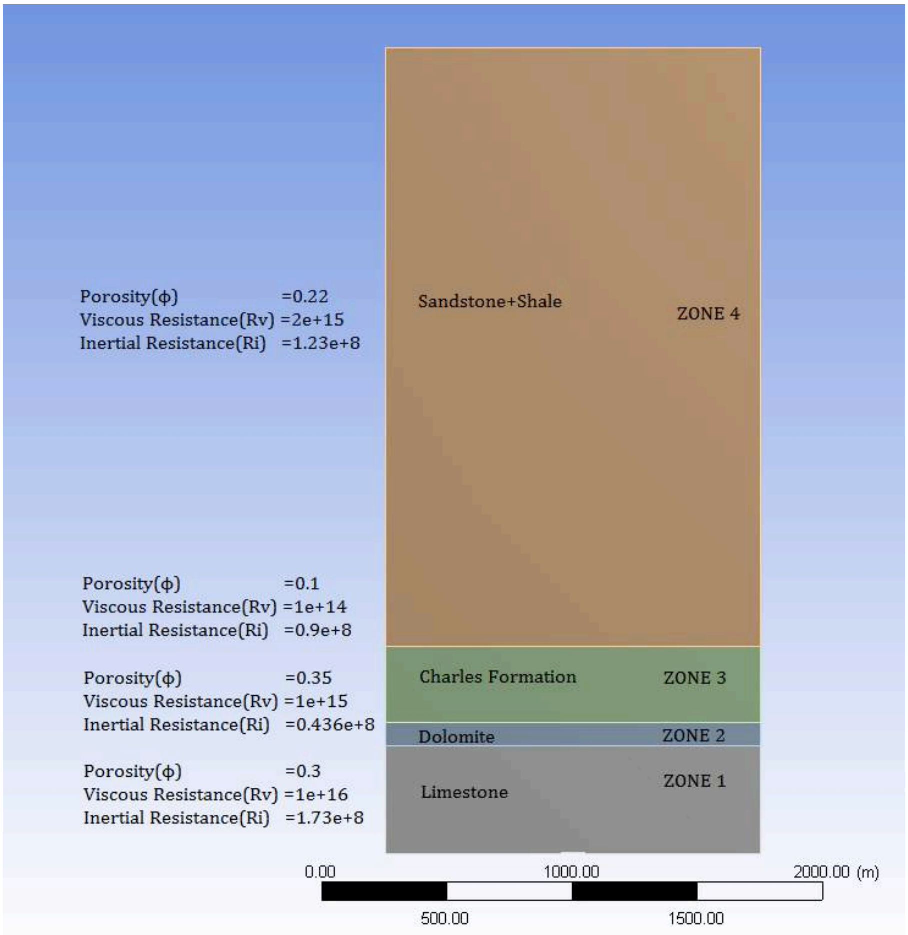

Figure 4: Bakken stratigraphy.

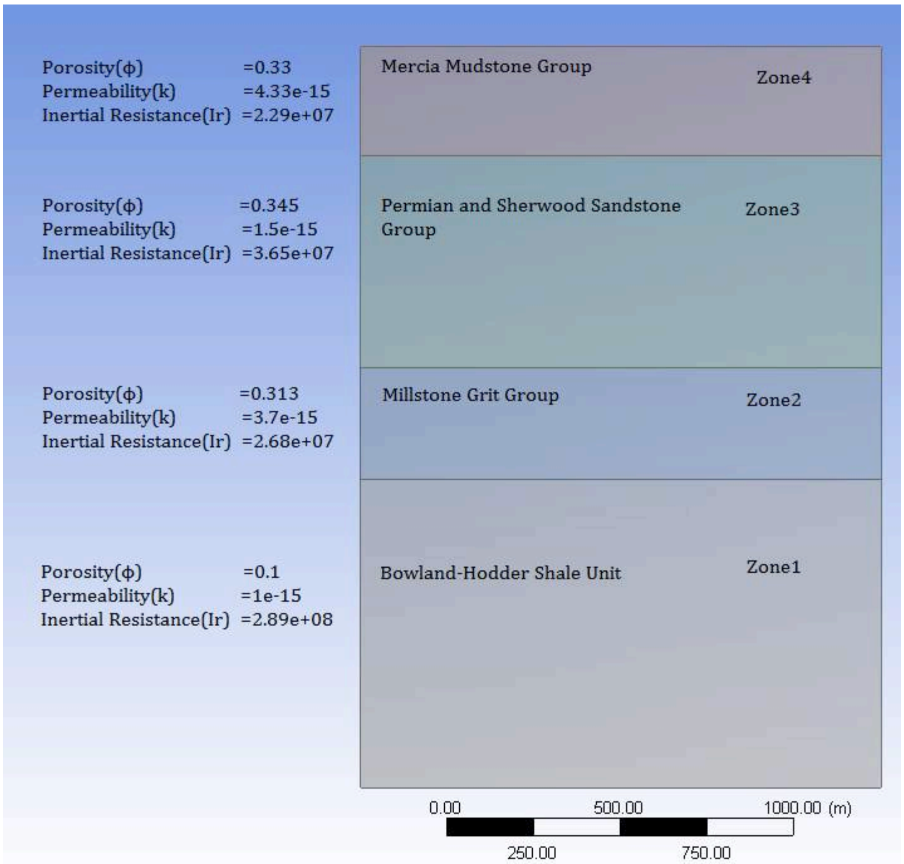

Figure 5: Bowland stratigraphy.

Computational Fluid Dynamics (CFD) analyses for all three geographic locations considering the cases of formations with and without fault are listed in Figure 6.

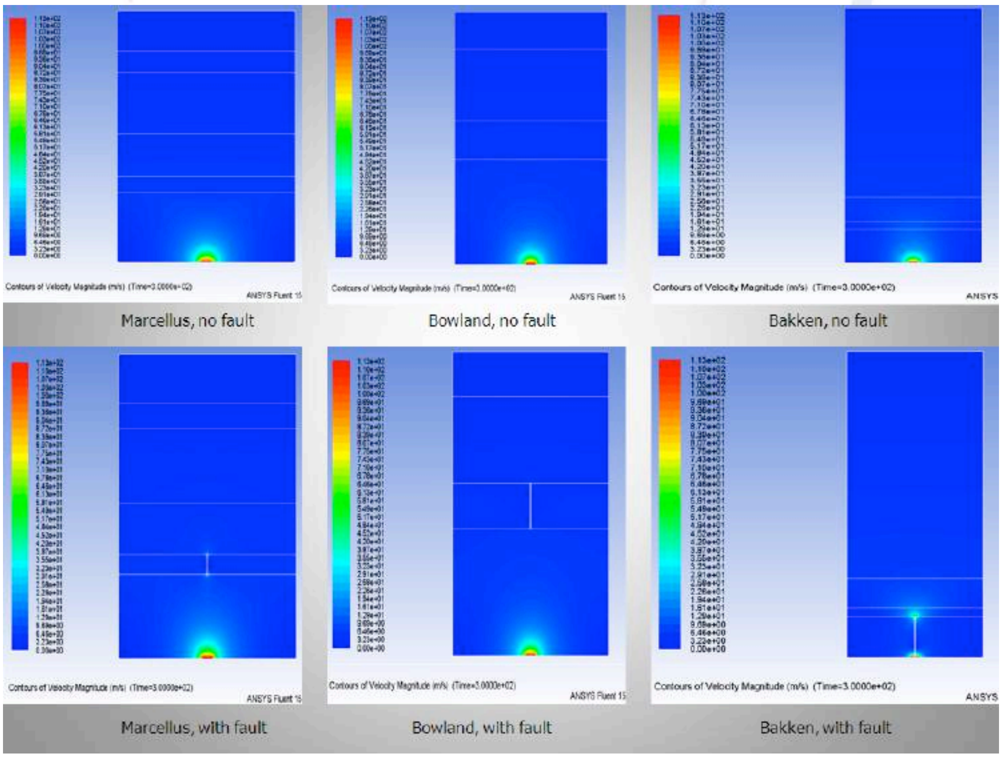

Figure 6: CFD results.

As can be concluded from the velocity distributions of methanol originating from the hydrofracking zone which is the horizontal pipeline at the bottom center of each domain presented in Figure 6, methanol was not observed to reach the water aquifers for the assumed cases of with and without fault. However, it should be noted that this study does not account for additional and/or unexpected faults and fractures in the overburden, nor does it consider the migration of the fluid in the long run.

Conclusion

Three different geological locations were investigated for their stratigraphies and rock properties such as permeability, porosity and inertial resistance. In each geological location types of rock layers, thickness of each layer and depth of the layers beneath the groundwater aquifers were estimated. Stratigraphic models for each case were designed in the ANSYS with appropriate data, so that the flow behaves as the flow through the porous media. A fault was introduced in the most resistant layer of each stratigraphy to study the flow in the presence of a naturally occurring fault. Numerical simulations have been proposed for the estimation of the velocity range of methyl alcohol between the shale reservoir and the ground water aquifers of Marcellus (USA), Bakken (USA), and Bowland (UK) formations.

In this study methanol is taken into consideration among all the chemical additives used in the fracking fluid, as it is one of the toxic chemicals used in the hydraulic fracking technique and also it can be a potential source for methane gas, which is very harmful to the atmosphere (greenhouse effect). In real time the fracking fluid is injected into the shale rock with certain velocity for small period of time to create fractures, so user defined function was introduced in such a way that the inlet-velocity after certain time period becomes zero. The simulation results suggest that, as methyl alcohol travel upwards its velocity decreases rapidly at each layer until 300 seconds and after 300 seconds, methyl alcohol doesn't travel upwards which means its velocity is completely zero. This also means that methyl alcohol is trapped in the layers with zero velocity after 300 seconds and also this scenario is similar with other toxic chemicals.

When a fault was introduced in the most resistant layers of the stratigraphies a little high velocities are observed when compared to the no-fault model, but methyl alcohol doesn't reach to the top layer in all the three cases. This consolidates that there should be more than one naturally occurring fault present in the stratigraphy for the chemicals to reach the groundwater aquifer else the chemicals cannot travel all the way up to the aquifers.

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Contact email: scelik@siue.edu

US, UK and EU Firms Reporting to The Carbon Disclosure Project: The Effect on their CO2 emissions

Adéla Turková, University of Fribourg, Switzerland
Laurent Donzé, University of Fribourg, Switzerland

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Abstract
Carbon Disclosure Project is a non-profit organization allowing companies to report and manage their emissions, climate risk and reduction goals. In the last few years, firms are under increasing pressure from their investors to participate to the Carbon Disclosure Project and improve their yearly ranking. In this article we investigate the impact of this program on a firms' emissions, and in particular we focus on three geographic regions: United States, United Kingdom and the rest of European Union. To measure the impact of the Carbon Disclosure Project we use a relatively new method called "synthetic control approach", which allows us to estimate the treatment effect and to evaluate the significance of our estimates. Based on a unique database we constructed, we found no significant difference between the three geographic regions in term of reduction of CO_2 emissions. However, we approve with the inference tests highly significant positive effect of the Carbon Disclosure Project for eight companies from our sample.

Keywords: Carbon Disclosure Project, CO_2 emissions, Program evaluation, Synthetic control methods, Treatment effect.

Introduction

Whoever is not "green" is not "in". That's the latest trend of the market. This environmental movement pushes the companies to review their policies and assure a sustainable development by reducing their carbon dioxide (CO2) emissions and use of natural resources or in general show eco-friendly behaviour.

The main purpose of this paper is to evaluate the pertinence of environmental policy introduction at the business level. In particular, we analyse whether there is a positive effect of signing up to the Carbon Disclosure Project (CDP)[1], as one of the binding reporting standards, on the firm's emissions. These results are then compared on an international level. In particular, we concentrate our attention on the companies from United States (US), United Kingdom (UK) and the rest of the European Union (EU) that started to report in years 2009 and 2010. We employ a unique database that we built with contribution from South Pole Group[2]. For normalisation purposes we consider the CO2 emissions per employee as a main outcome variable to be studied.

In order to assess the treatment effect of the policy, we use a relatively new program evaluation method called "synthetic control method" (SCM) introduced by Abadie and Gardeazabal (2003). Almer and Winkler (2012) used this method in environmental problematic, but to our knowledge it has not been applied to evaluate a firms' policy such as environmental programme at a company level.

We have chosen the synthetic control method for different reasons. First of all, it allows researchers to analyse phenomena that occur in a limited population or that apply to only a small number of firms, which is perfectly suited to our problematic. Additionally, this method allows performing inference analysis and supporting quantitatively the results.

We are not the first to evaluate the firm's environmental disclosures, but other studies have slightly different emphasis on the problematic. Already in early 90's Wiseman (1982) assesses the environmental disclosures made in corporate annual reports, and reveals the poor quality of reported data. Other studies focusing on the quality of disclosed data, as for example Dragomir (2012) or Andrew and Cortese (2011), found similar deceiving features of disclosed environmental information.

Different categories of findings in environmental accounting are for example due to Al-Tuwaujri et al. (2004) or Clarkson et al. (2008). These studies found a positive association between environmental performance and the level of environmental disclosure. Nevertheless these articles centre more on building and evaluating the so-called disclosure index and less on the actual policy evaluation.

Luo and Tang (2014) is the closest study to ours, since they evaluate the Carbon Disclosure Project. But again, their focus is on the relationship between the degree of disclosure and carbon performance, rather than on the program evaluation itself. They

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[1] www.cdp.net
[2] South Pole Group is a specialist provider of climate action solutions that is, among other solutions, offering consulting services, data and products for investors in the area of assessing investment climate impact.

conclude that the firms' voluntary carbon disclosure in the CDP is indicative of their underlying actual carbon performance, and that the firms with good performance are likely to disclose more to distinguish themselves for investors and other stakeholders. The limit of their research is that the analysis is merely a snapshot of reporting practice over a single year.

Finally, Abrell et al. (2011) assess the impact of the EU Emission Trading System (ETS) using firm level data. This study is very close to our analysis, with the difference being they focus on a different program and use another method to evaluate the effect. Even though they found positive results of the program on firm's emissions, they conclude that the result has to be interpreted with caution, as the counterfactual build (similar companies that are not part of EU ETS) is not of very good quality.

Comparing to all these studies, we bring a new light to the evaluation of the CDP over a longer period of time with a more reliable method to assess the effect of the program.

Carbon Disclosure Project

Carbon Disclosure Project is an international non-profit organisation founded in 2003 and based in the United Kingdom. The CDP collaborate with investors, companies, cities, government and policymakers from all over the world. From the firm's perspective, CDP's main objective is to help companies to take an action toward a more sustainable world. Reporting companies get help in building environmental strategies that improve the management of environmental risk. That is, the focus is on reduction of CO2 emissions, use of energy, investment in new lower pollution production, improvement of supply chain and many other pro-environmental tactics.

If we compare CDP to the Kyoto protocol, CDP concentrates on individual companies rather than nations, with the same objective of driving sustainable economies. Today, CDP works with 827 institutional investors, government and policymakers holding US$95 trillion in assets. In 2003, CDP included only 253 reporting institutions, and this number increased to 5600 in 2015, including companies and cities.

CDP proposes four main programs, focusing on firms: climate change, water, supply chain and forest. These programs have different objective. *CDP's climate change program's* target is the reduction of companies' greenhouse gases emissions and the mitigation of the climate change risk. The *CDP's water program* main objective is to mobilise action on corporate water management in order to secure water resources and alleviate the global water crises. *CDP's supply chain program* objective is to achieve sustainable supply chain management for firms and their suppliers by optimising the risks and opportunities that climate change pose to the globalised supply chain. And finally, *CDP's forest program* intends to manage companies' impact on the deforestation risk and as a consequence regulate the land use change for agriculture as being the main driver of deforestation.

CDP believes that companies that are aware about the scope of their environmental risk can better manage the environmental strategies and improve their "green" footprint. CDP is convinced of crucial importance of firm's carbon disclosure transparency and the necessity to provide the environmental information to the decision makers in order to drive the appropriate action in sustainable development.

Moreover, since October 2010, CDP ranks companies with high-quality disclosure as top scoring companies in the Climate Disclosure Leadership Index (CDLI). The leading firms with high performance score figure on the "Climate or Water A list". These companies are gaining competitive advantage and commercial benefits over their competitors and can potentially count on more investors or government help. For many investors, the CDLI has become a standard and they may expect the companies not only be reporting to the CDP, but also to have a certain index position.

Data

As we mentioned, our database is unique. It contains personally collected panel data with contribution from South Pole Group[3]. We added different firm's characteristics to the initial database that was provided by them[4]. We present the main quantitative information concerning our databases in table 1.

Number of companies: 135
Number of participating companies: 73
Number of non-participating companies: 62
Period: 2005 - 2013
Regions: EU (48, 29, 19), US (53, 28, 25), UK (34, 16, 18)
Sectors: Consumer Discretionary (22, 10, 12), Consumer Staples (16, 12, 4), Industrials (36, 18, 18), IT & Telecommunications (14, 12, 2), Energy (8, 3, 5), Materials (11, 5, 6), Financials (12, 3, 9), Health Care (10, 7, 3), Utilities (6, 3, 3)

Note: In parenthesis you find number of observations for total, participating companies and non-participating companies respectively.

Table 1 Main database characteristics

In total, the database contains 135 companies observed over a period of 9 years, from 2005 to 2013. Unfortunately we were not able to get the information on longer longitudinal scale as the provided data by South Pole Group contains information for these years only. Moreover, our main study variable, which is a company's greenhouse gas emission, could not be tracked for additional years. Even though we can easily find this information for the majority of the countries - for example World Bank provide the data going to 1960, the firm's level emissions are not so easily attainable.

The sustainable behaviour of firms received closer attention only in the last two decades and since then the companies started slowly reporting their CO2 emissions. At the beginning, the reported values were highly inaccurate and the firms needed a better guidance in how to collect and disclose the data. The companies did not have to wait long for this help and many governments and private companies are now proposing a multitude of programs to this effect.

[4] As the primary database had missing data, we needed to complete the missing values via verified sources as CDP database, Thomson Reuters, Statista, YCharts, companies' annual reports or corporate social and sustainability responsibility report.

Nevertheless, the fact is that to our knowledge there is no existing publically reachable database containing firms' CO2 emissions for a longer period of time. Even the individual survey would not help, because the companies are usually not holding past data on their emissions, as it is to some degree a fairly new measurement. We believe that this fact is not due to the companies' intention to purposely hide the correct numbers, but because of lack of interest in the past.

Our database contains 22 variables capturing company's characteristics for each of nine periods. We describe the main variables in the table 2. Moreover, our data are classified as balanced panel data, which means that no missing value is observed for any of the variables.

Variables	Description
NAME	Name (nominal);
CDP	Reporting to the CDP (binary)
COUNTRY	Headquarter (nominal);
SECTOR	Sector (nominal);
GHG	CO2 emissions in metric tons (digital);
R	Revenue in mio CHF (digital);
GP	Gross profit in mio CHF (digital);
COGS	Cost of goods sold in mio CHF (digital);
FA	Fixed assets in mio CHF (digital);
EMP	Number of employees (digital);
P	Share price (digital);
RI	Return on investment (digital);
KL	Capital labor ratio (digital);
GHG_EMP	CO2 emissions in metric tons per employee (digital);

Table 2 Main variables

The data comprehend two big categories of companies. The first group contains the firms that started to report to the CDP in 2009 and the second group contains only companies that don't report to the CDP.

Additionally, the data covers three geographic regions: United States, United Kingdom and the rest of European Union. The regions were defined with respect to the company's headquarters, being primarily responsible for company policy, including sustainability. We have selected these regions not only because of their similarities in economic development, but also and especially because of the similarities in corporate social responsibility policy. We can name the most common regulations in these regions, which are the EU Emission Trading System, the UK Carbon Reduction Commitment Energy Efficiency Scheme and the US Environmental Protection Agency's Mandatory GHG Reporting Rule. UK is not purposely included in the EU, because of its specificity in sustainable development strategy.

Moreover, we used the Global Industry Classification Standard to categorise companies in nine sectors: consumer discretionary (CD), consumer staples (CS), energy (ENGY), financials (FINA), health care (HC), industrials (INDU), information technology and telecommunications (ITTE), materials (MATR), utilities (UTIL). As for the geographic region, this firm's characteristic will be one of the decisive factors in the level of the carbon emissions. For example companies belonging to the energy sector will have most likely higher emissions than the one from health care sector.

As previously mentioned, the main study variable is the company's greenhouse gas (GHG) emission. Collecting the data on all of these gasses would be very difficult, that's why we used as proxy the carbon dioxide, i.e. the major greenhouse gas. Moreover, the reported values contain SCOPE 1[5] and SCOPE 2[6] emissions.

CDP report (2014) recognises a positive effect of return on investment and stock price on the level of CO2 emissions. This finding is approved by Matsamura et al. (2011). In their study, they found a negative association between carbon emission level and firms' value. Besides Cole (2012) suggests that the capital labour ratio and firm size are key determinants of CO2 emissions. South Pole Group proposes revenue and cost of goods sold as one of the elements to use for normalising purposes. All theses suggestions motivated our choice of the variables with highly predictive power of the firm's CO2 emissions. Notice then, the variables revenue and number of employee describe the size of the company.

Predictors	GHG	GHG_EMP
R	0.18****	0.62****
COGS	0.17****	0.14****
EMP	0.25****	−0.12****
P	0.65****	0.24
RI	−0.01	−0.01
KL	0.19****	0.06*

Note: non significant $p>0.05$, *$p\leq0.05$, ****$p\leq0.0001$

Table 3 Correlation and significance of the variables

Table 3 shows results that confirm the choice of the predictors. We found positive and significant relations between CO2 emissions (GHG) and revenue, cost of goods sold, share price and capital-labour ratio. The first two results suggest that a bigger firm usually has higher emissions. The positive relation between CO2 emissions and share price seems unexpected, as we would anticipate that the market would punish firms with increasing emissions. This result could be due to the strong positive correlation that we found between share price and revenue. And as the market reflects immediately the financial result to the share price, this relation could be potentially stronger that the one with the emissions. Furthermore, the positive relationship of CO2 emissions with the capital-labour ratio advocates that the firms that are heavily dependent on machinery and equipment tend to be more polluting than those that are labour intensive.

Still, based on table 3, a negative correlation was found between CO2 emissions and return on investment. This result was expected, but not significant. The number of employees showed a positive correlation with the CO2 emissions. Again, this approves the theory that emissions are generally growing with the size of the firm. Although we found that the large firms try to be less pollution intensive than smaller firms, which can be associated to the economics of scale. That is, we detect negative

[5] GHG emissions from sources that are owned or controlled by the reporting entity.
[6] GHG emissions from consumption of purchased electricity, heat or steam, that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.

and significant relationship between number of employee and CO2 emissions per employee (GHG_EMP), and the relationship was even more evident in each sector. Our results support most of the previous research.

Methodology: Synthetic control method

Synthetic control method is one of the program evaluation methods that intend to assess the causal effect of exposure of a set of units to a program or treatment on some outcome. By the term "unit", we generally mean "economic agents" such as individuals, household, schools, firms or countries. The term "treatment" refers for example to laws, regulations, environmental or technology exposure. And finally, the term "causal effect" denotes the comparisons of so-called potential outcomes, pairs of outcomes defined for the same unit given different levels of exposure to the treatment (see figure 1).

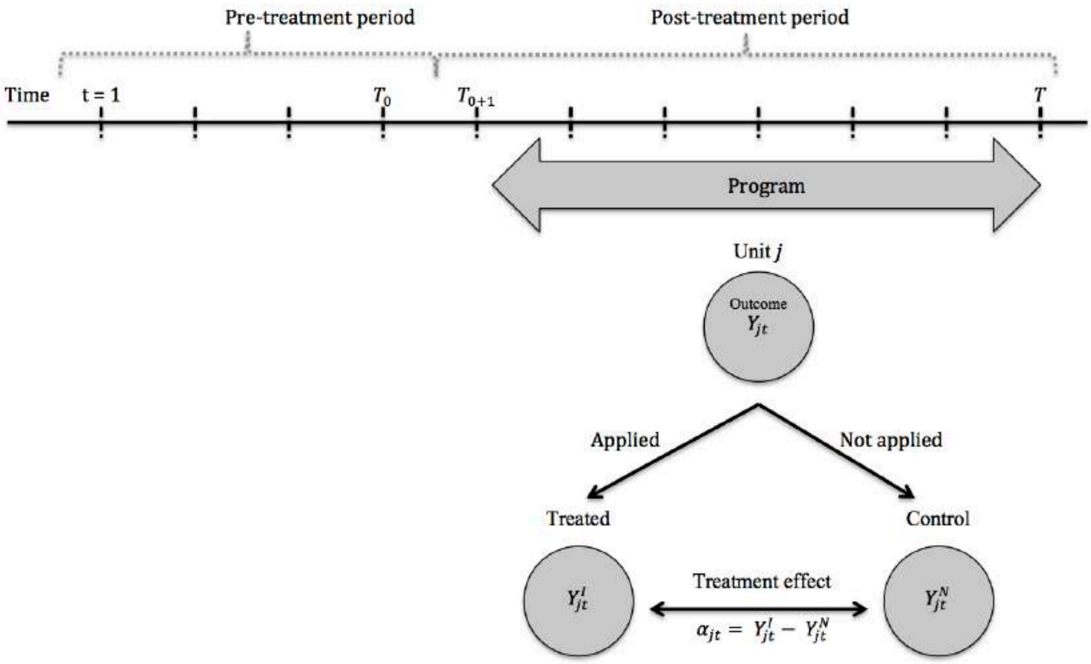

Figure 1 Treatment effect

As we cannot observe the same unit exposed and not exposed to the treatment, only one of the potential outcomes is realisable. In order to evaluate the treatment effect we have to make use of the counterfactual outcome, which is the non-realised potential outcome that has to be estimated.

To motivate our model, we suppose balanced sample of $J + 1$ companies, indexed by $j = 1, \ldots, J + 1$, that are observed at time periods, $t = 1, \ldots, T$. We suppose a positive number of pre-treatment periods T_0 and of post-treatment periods T_1, with $T_0 + T_1 = T$ and $1 < T_0 < T$. In our case we observe the companies between years 2005-2013, where the treatment year is 2009. The variable Y_{it} is so-called "potential outcome" and measure the impact of the CDP. We denote by Y_{jt}^N the CO2 emissions per employee of company j at time t without treatment, and similarly Y_{jt}^I with treatment. Without lost of generality, we assume that only the first company is exposed to the

CDP and the rest of companies, that are not exposed, constitute the so-called "donor pool" of J control companies. That is, the actual emissions path Y_{1t}^{I} is observed only for the treated company and we do not have any observations for the same company in absence of the CDP program after the treatment. Thus, we have to estimate the Y_{1t}^{N} and find the effect α_{1t} of the CDP for company j at time t:

$$\alpha_{1t} = Y_{1t} - Y_{1t}^{N}.$$

Our method intends to construct a synthetic control group providing an estimate for this missing potential outcome. Abadie and Gardezabal (2003), Abadie et al. (2010) propose to make use of the observed characteristics of the units from the donor pool. The idea is to find weights associated to each control unit, $W = (w_2, \ldots, w_{J+1})'$, with $w_j \geq 0$, for $j = 2, \ldots, J+1$, and $\sum_{j=2}^{J+1} w_j = 1$, such that the weighted average of all companies from the donor pool resembles the treated company with respect to CO2 emissions per employee in the pre-treatment period and all other relevant characteristic $Z = (R, COGS, EMP, P, RI, KL)$. These weights are obtained by a constrained quadratic optimisation that minimises the difference between the pre-treatment characteristics of the treated unit and a synthetic control. That is, the synthetic control, $W^* = (w_2^*, \ldots, w_{J+1}^*)'$, is chosen to minimise the size of the distance measured in terms of the mean squared prediction error:

$$(X_1 - X_0W)'V(X_1 - X_0W),$$

where the X_0 denotes a $(k \times 1)$ vector of pre-treatment characteristics of the treated unit, which may include the pre-treatment emission path, and X_0 denotes $(k \times J)$ matrix of the same variables for the J companies in the donor pool and V is a diagonal matrix reflecting the relative importance of the different pre-treatment characteristics (for more details see Turková and Donzé (2016)). The figure 2 represents the treatment effect estimation.

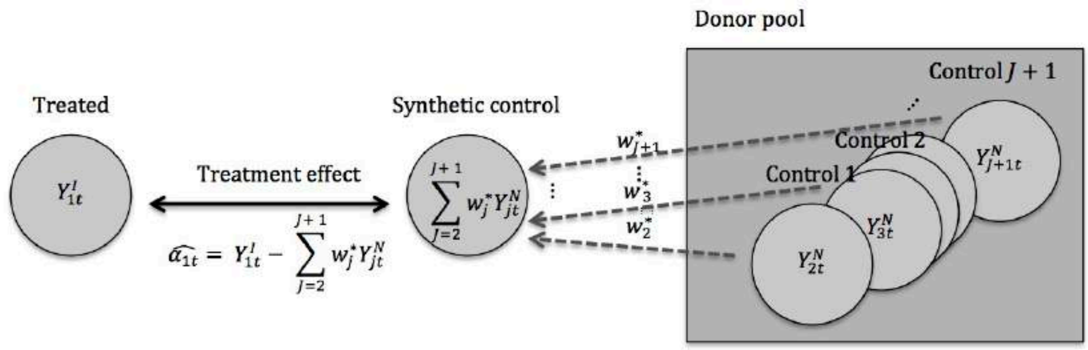

Figure 2 Treatment effect estimation

Synthetic control method provides an alternative mode of qualitative and quantitative inferences. The systemised process of estimating the counterfactuals in SCM enables us to conduct falsification exercises, so called "placebo studies". One more way to measure and test the misspecification of the model is to use the root mean squared prediction error (RMSPE). Both methods are explained in Turková and Donzé (2016).

Firstly, the idea of placebo studies is to predict the counterfactual outcome path for the units in the donor pool. We suppose that the treatment effect estimated for the company that participate to the CDP reflects the impact of the program. Replication of synthetic control analysis for the companies that did not participate to the CDP should not generate a significant divergence between synthetic and actual outcome. In our study, we apply so-called in-space multiple placebo tests, where we implement synthetic control methods to all controls in the donor pool. The pseudo p-value, constructed for placebo test, represents the probability of obtaining an estimate at least as large as the one obtained for the unit of interest when the intervention is reassigned at random in the data set. Smaller is the pseudo p-value, more significant is the treatment effect.

The second types of measures to evaluate the estimates are the RMSPE and RMSPE-ratio. The second calculates a ratio of the post-treatment prediction errors to the pre-treatment prediction errors and provides a scale-free measure of the extremity of the hypothetical treatment on each control unit. Its p-value gives us proportion of units with higher RMSPE-ratio to total number of tested units. We search for results with small RMSPE, high RMSPE-ration with small p-value.

The three measures together, pseudo p-value, RMSPE and RMSPE-ratios, will imply highly significant treatment effect. For inference analyses Abadie et al. (2015) recommend to use the units from the donor pool with RMSPE that is smaller than three times RMSPE of the unit under investigation. In our study, we used five times RMSPE rule.

Results

Table 4 reports the key descriptive statistics for our sample. We observe different values of the variable GHG for both CDP and Non-CDP companies, with high average CO2 emissions and associated extremely big range. On the other side, the CO2 emissions per employee have much lower values and relatively to absolute emissions, this intensity measure consider the size of the firm and thus is more comparable across firms and also between different reporting periods. We suggest thus considering the variable GHG_EMP as the measurement of carbon performance.

Variables	Mean	Median	Std. Dev.	Min.	Max.	N
CDP companies						
GHG	2055589	192362	6888017	1910	56739464	657
R	8290	3714	15061	86	108000	657
COGS	5337	2058	12261	0.16	103000	657
EMP	26785	9590	35561	67	171400	657
P	56	23	234	0.04	3117	657
RI	37559	1148	164030	7	1389152	657
KL	756718	145336	1910218	1376	11384492	657
GHG_EMP	168	13	587	1	7432	657
Non-CDP companies						
GHG	887478	96676	1727858	228	9842151	558
R	16013	2395	84223	15	6950000	558
COGS	4599	1248	11226	4	88012	558
EMP	14884	6206	29635	6	2470000	558
P	39	16	78	0.08	932	558
RI	3889	505	15652	6	193627	558
KL	1877658	129950	6505555	2370	58158299	558
GHG_EMP	217	15	673	1	6030	558

Table 4 Summary statistics (panel data on 9 years)

Figure 3 presents the average emissions per employee without extreme values. The four quadrants show the nine years path not only for all companies, but also per region. The green line denotes the Non-CDP companies, the blue one all companies and the red one the participating companies. These graphs represent only tendencies in evolution of emissions per employee and cannot be used for final conclusion to approve that there is a positive effect from the CDP program, even if the graphs would suggest otherwise.

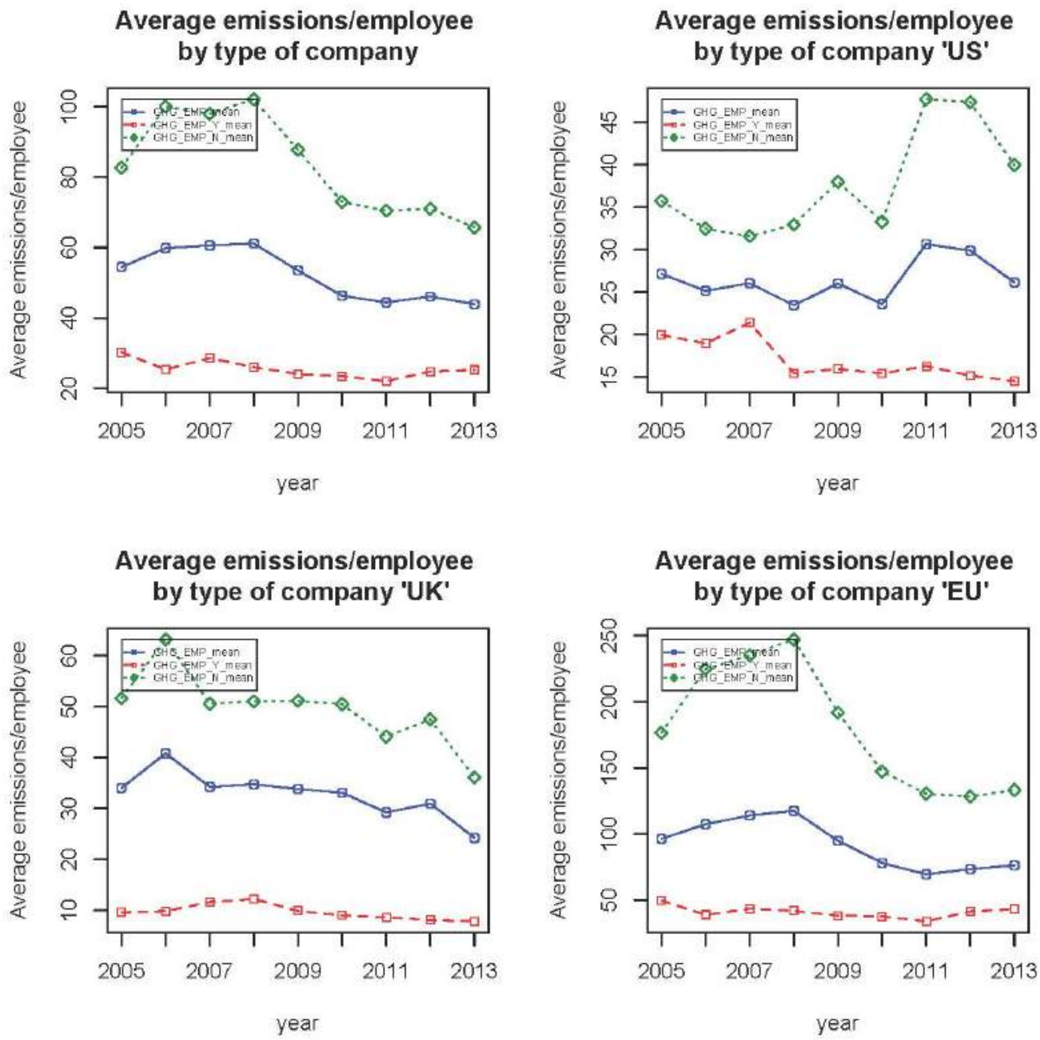

Figure 3 Average emissions per employee (company and regions)

In order to evaluate the treatment effect, we run individual analyses for each company. To find the best counterfactual unit for a specific treated unit, we restricted the control group to Non-CDP firms that belong to the same sector as the respective treated company. This analysis by sector takes into account the potential shock effects and the heterogeneity in CO_2 emissions intensity, for example the health care sector will be less polluting than the energy sector.

Our data contains 73 treated and 62 potential control companies, divided into 9 sectors. We have observed 6 extremely large treated companies that did find any matching synthetic control. Their pre-treatment RMSPE was higher than 200 and so we removed these firms from our analysis. The rest of the companies performed relatively well and, with exception of two firms, their pre-treatment RMSPE was lower than 10. This shows the good matching results between the treated and its synthetic control. Out of the remaining 67 companies, 49 companies show decrease of CO2 emissions per employee after signing to the CDP. This result would suggest the 73% success rate of the program. Table 5 shows the summary results of our analysis distributed by region.

EU	UK	US	
29	28	16	Companies
-1	-3	-2	Extreme
28	25	14	Treated
-7	-7	-4	No effect
21	18	10	Decline in CO2
(75%)	(72%)	(71%)	Success in decrease of CO2 per employee

Table 5 Summary results by region

Table 6 presents overall results after the tests. And table 7 shows detailed inference test results for all companies with a positive average treatment effect.

Total	49	companies with decrease in CO2 emissions per employee
(−)	9	without significant change with respect to pre-treatment period
(+)	12	with at least 10% decrease of CO2 with respect to the pre-treatment period
(∗)	20	with at least 10% decrease of CO2 with respect to the pre-treatment period and significant placebo test results
(∗∗)	8	with at least 100% decrease of CO2 with respect to the pre-treatment period, and highly significant placebo test and RMSPE test results

Table 6 Summary of significant treatment effects

Out of the 49 companies with evident decline in CO2 emissions per employee, 9 have RMSPE-ratios lower than one. This means that their CO2 emissions per employee were no different from before the company signed to the CDP. Thus for these companies we cannot approve the improvement in carbon performance regardless of the decrease in emissions. This result leaves us with 40 companies showing positive change in the post-treatment period.

Out of the 40 companies about 70% have relatively small pseudo p-value, which indicates the significant improvement from the pre-treatment period. The remaining 12 companies are considered as non-significant.

20 companies have relatively small RMSPE-ratios, with high RMSPE-ratios p-values indicating no significant improvement from the pre-treatment period. For these 20 companies we couldn't approve with placebo tests and RMSPE-ratios a significant and positive treatment effect, so we classify them as low significant.

On the other side, 8 companies outperform the other ones in the values of the tests. They all have relatively high RMSPE-ratio with respect to the rest of the firms. This high ratio shows large decrease in CO2 emissions per employee. The results are supported by both low placebo and RMSPE p-values for all eight companies, showing that other placebo treated companies did not perform as well as the treated companies under investigation.

Region	Sector	Tr.effect	RMSPE	RMSPE-ratio	RMSPE-ratio p-value	Placebo p-value
United States	CD	-14.15^{*}	8.53	1.84	0.84	0.08
	CD	-0.93^{-}	3.24	1.06	1.00	0.41
	CD	-0.68^{-}	0.87	1.04	0.92	0.40
	CS	-4.87^{**}	0.62	14.13	0.18	0.07
	CS	-0.61^{**}	0.14	15.71	0.06	0.25
	CS	-7.32^{*}	4.87	1.61	0.82	0.06
	CS	-4.12^{*}	1.73	2.41	0.64	0.15
	INDU	-0.24^{+}	0.05	6.67	0.11	0.50
	HC	-0.32^{+}	0.67	4.76	0.20	0.75
	HC	-4.16^{**}	0.36	12.26	0.20	0.17
	ITTE	-9.17^{*}	5.56	2.18	0.56	0.07
	ITTE	-1.02^{*}	0.02	8.95	0.47	0.23
	ITTE	-1.95^{*}	0.23	8.48	0.60	0.10
	ITTE	-17.25^{**}	0.45	50.18	0.14	0.13
	ITTE	-0.79^{-}	2.09	0.89	1.00	0.76
	MATR	-6.05^{-}	11.80	1.00	0.91	0.36
	ENGY	-6.24^{*}	3.10	6.93	0.50	0.12
	UTIL	-2.25^{+}	0.80	2.56	0.64	0.70
United Kingdom	CD	-0.72^{*}	0.16	5.47	0.46	0.28
	CD	-0.62^{-}	0.36	0.61	0.62	0.52
	CS	-4.47^{**}	0.03	23.03	0.11	0.15
	INDU	-0.06^{+}	0.33	3.36	0.57	0.42
	INDU	-1.57^{**}	0.08	19.19	0.10	0.18
	HC	-13.85^{*}	7.41	1.87	0.30	0.11
	HC	-3.28^{*}	2.21	2.34	0.40	0.12
	ITTE	-0.39^{+}	0.38	1.26	0.92	0.77
	ITTE	-1.15^{+}	1.15	1.33	0.78	0.67
	FINA	-1.66^{-}	4.25	0.80	0.90	0.54
European Union	CD	-0.41^{-}	0.73	0.83	1.00	0.43
	CD	-28.75^{*}	24.86	6.24	0.38	0.08
	CD	-2.10^{*}	0.25	3.77	0.54	0.23
	CS	-6.14^{*}	2.57	2.65	0.64	0.09
	CS	-0.56^{+}	0.10	4.77	0.41	0.55
	CS	-2.85^{*}	2.44	1.44	0.82	0.08
	INDU	-4.18^{**}	0.45	11.59	0.26	0.07
	INDU	-0.76^{-}	2.97	0.25	1.00	0.31
	INDU	-1.07^{+}	0.37	4.75	0.47	0.81
	INDU	-2.13^{*}	1.24	1.77	0.79	0.11
	INDU	-3.59^{*}	1.62	2.22	0.47	0.05
	INDU	-1.09^{*}	0.04	2.30	0.74	0.36
	INDU	-3.72^{**}	0.33	14.57	0.21	0.06
	HC	-2.29^{*}	1.09	2.10	0.60	0.20
	ITTE	-0.82^{*}	0.14	6.55	0.21	0.38
	ITTE	-8.18^{*}	1.22	7.96	0.42	0.09
	ITTE	-1.09^{+}	0.56	2.45	0.78	0.45
	FINA	-0.43^{+}	0.41	1.24	0.70	0.54
	FINA	-3.34^{-}	0.56	0.88	0.90	0.54
	ENGY	-3.96^{+}	0.44	4.80	0.64	0.66
	UTIL	-4.30^{+}	1.67	1.47	0.88	0.61

Note: (−) rmspe-ratio <1.1,,(+) rmspe.ratio >1.1, (∗) rmspe-ratio >1.1 and placebo p-value <0.3, (∗∗) rmspe.ratio >10 and rmspe-ration <0.2 and placebo p-value <0.2.

Table 7 Placebo test results

The Figure 4 presents the examples of synthetic matching and permutation tests for three companies from consumer staples sector. These companies are from US, UK and EU respectively[7].

The first column of figure 4 shows the graphs of the gaps of the CO2 emissions per employee for three treated companies and their synthetic controls. The almost parallel lines in pre-treatment period, before the vertical line, for the first two companies indicate a good match between the treated company and its synthetic control with respect to the CO2 emissions per employee. This result is approved by small pre-treatment RMSPE for the two companies. The third company has a relatively bigger gap that is also reflected in relatively higher RMSPE. The gap between the treated and synthetic control in post-treatment period indicates treatment effect: the bigger is the gap, the larger is the effect. We observe positive treatment effects, supported by high RMSPE-ratios, indicating large decreases in CO2 emissions per employee in the post-treatment period for the first two companies. Moreover, we detect smaller RMSPE-ratio for the third company, as the pre-treatment RMSPE is higher.

The second column of figure 4 shows the treated units and their relative placebo treated units. We can see almost all placebo treated units sitting above the treated units under investigation. This means that the positive treatment effect of the treated unit is not random. The results for the first two companies are approved by low placebo and RMSPE p-values, this means that rest of the placebo treated companies did not do as well as the treated companies under investigation. The last company has higher p-values, but again, this is due to the higher RMSPE in pre-treatment period.

Conclusion

The objective of our study was to assess the effect of the CDP on the companies' emissions. To do so, we made use of the synthetic control methods that allowed us to generate the treatment effect for each of the studied companies, and perform statistical inferences. This method is highly appropriate to our study and can be used for further similar research, for example to analyse introduction of other green policies or evaluation of the disclosure methods.

We found that out of the 67 companies evaluated over 5 years and covering 9 sectors, 49 show decrease in CO2 emissions per employee after starting to report to the CDP. Only 28 show significant and positive treatment effects. This result could be due to the fact that other non-participating companies are also under another strong institutional regulation of CO2 emissions.

We did not find a significant difference between US, UK and EU. In all three regions, the firms show about 70% success rate in reduction of CO2 emissions, but in the majority of cases they are not highly significant. Indeed, our statistical inferences put into evidence a low-significant positive treatment effect for 20 companies. It is worth mentioning that 8 firms prove highly significant treatment effect on emissions of reporting companies to the Carbon Disclosure Project.

[7] In table 7, US observation 4, UK observation 3 and EU observation 4.

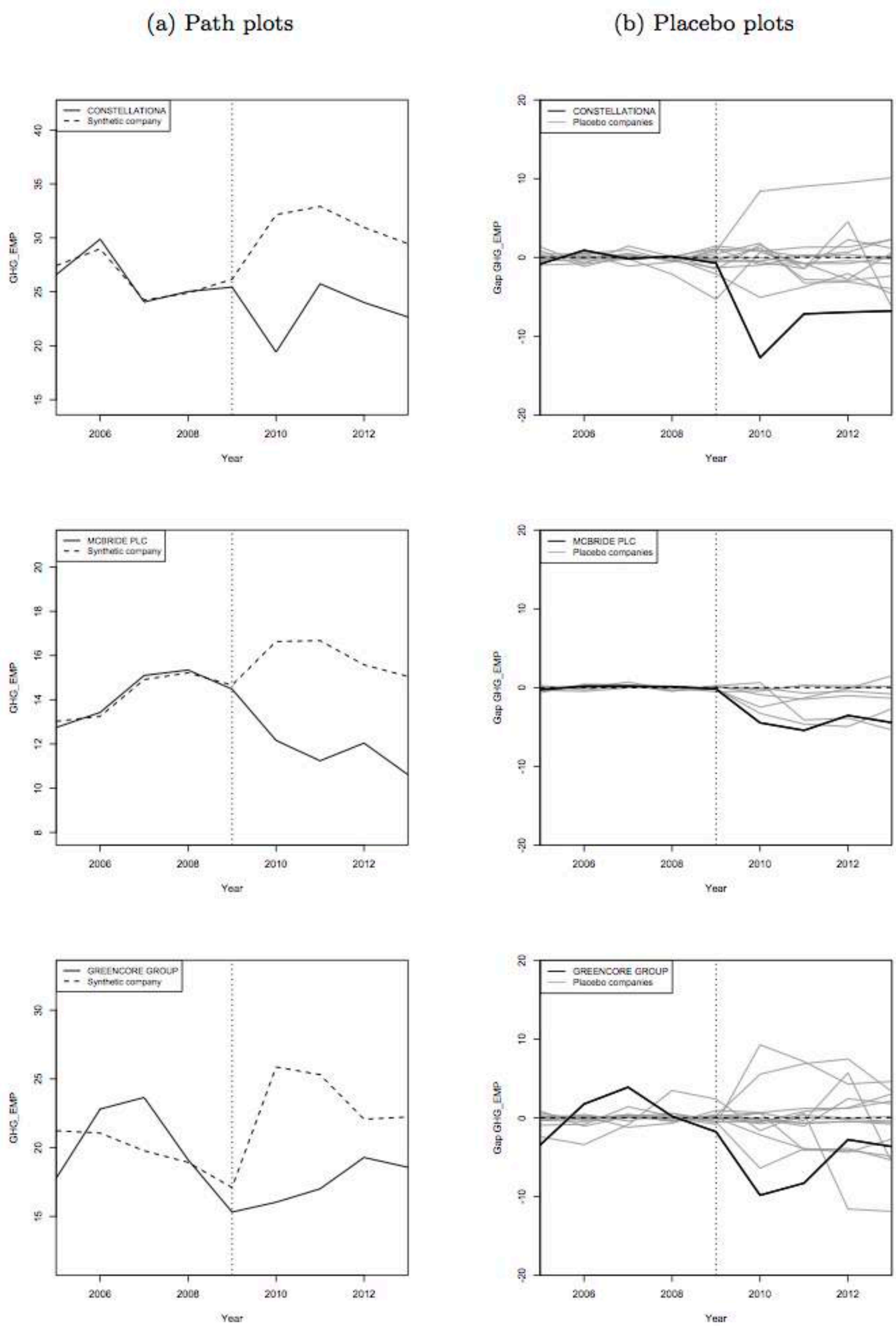

Figure 4 a) Synthetic matching and b) permutation tests for companies from consumer staples sector and US, UK, EU respectively

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Contact email: adela.turkova@unifr.ch

What Drivers Determine CSR Strategies in the Energy Industry? Evidence from Italy

Francesca Mapelli, Politecnico di Milano, Italy
Marika Arena, Politecnico di Milano, Italy
Giovanni Azzone, Politecnico di Milano, Italy

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Abstract
This paper moves from the awareness that companies in the energy sector are increasingly stimulated to deal with the growing societal challenges – like scarcity of resources and high political instability. Hence, companies in this industry are more and more pushed to fit their Corporate Social Responsibility (CSR) strategy to the pressures of the external contexts.
The ways how these companies develop and implement their CSR strategies is however highly diversified, leading to the objectives of this paper.
Referring to the Italian context, different configurations of CSR can be identified and classified, when analysing different energy companies that compete in the energy value chain. In details, the goal of this paper is to investigate if a link exists between key features of companies' profile and key dimensions of CSR, thus defining fixed categories of adopted CSR configurations for certain energy companies' profiles. The investigation is carried out through a case study methodology, concerning three Italian energy companies. Data were collected from a documental analysis and from exploratory interviews with CSR mangers and other informants. The investigation highlighted significant differences in terms of CSR configurations considering larger versus smaller enterprises due to the different stakeholders addressed and the different challenges to be faced.

Keywords: CSR, energy sector, social enterprises

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1. Introduction

A wide range of academic authors and practitioners have recognized that many of the models companies currently employ are changing and some novel practices are becoming more and more diffused due to the deep modifications the external business environment is experiencing. Indeed, over the last decade, "the business environment has changed dramatically and businesses must manage these changes" (WBI,2008; Spitzeck et al.,2013). Considering different sectors, businesses are more and more impacted by social and environmental issues, and several international agencies and regulatory bodies have started asking for a new approach to business (EC,2015). Even further, businesses are getting aware their contribution is a key factor to tackle societal challenges and, at the same time, including challenges within companies' strategies could help them to remain competitive and increase their economic profit (WBI,2008). Specifically, this work focuses on innovative business strategies for large companies in the energy sector including also social goals, which here go under the label of advanced Corporate Social Responsibility (CSR), an emerging paradigm which needs to be investigated (Spitzeck and Chapman,2012). It is worth to remark that advanced CSR is just a label used to refer to a wide range of models and practices related to Corporate Sustainability and Corporate Social Responsibility which are rapidly growing and on which there is not agreement in terms of terminology.

The energy sector is particularly impacted by this kind of issues and, therefore, this work focuses on that industry. The demand for energy is keeping increasing, both in developed and in developing countries, while political instability is becoming an influencing factor on the availability of resources. What is more, an increasing pressure is put on the issue of climate change, that is strongly related to the efficiency of the usage of energy resources. Besides, a shift from traditional sources to renewable ones is becoming reality but it implies new processes, such as the communization of the energy infrastructures. Therefore, the traditional models are affected by the arising challenge of resources' scarcity and the necessity to investigate if and how it should be included in the firms' strategies is increasing.

The topic of advanced CSR has been already investigated by several authors, both academic and practitioners, in the energy field as well as in other fields, but a comprehensive framework to analyse the shift from traditional CSR to advanced CSR is not yet available in literature. Hence, a need for further and more complete studies has been highlighted (Haffar and Searcy,2015;Maon et al.,2015). In the following section (Section 1.1), an overview of the available literature regarding the shift from traditional CSR to advanced CSR is shown. Once defined the context, the goals of the work are defined and consequently the methodology for the research is fixed (Section 2). After that, the main dimensions characterizing the possible configurations are defined and the framework is developed (Section 3). Then, a focus on the energy sector is provided since, given its peculiarities, it is particularly interesting for this kind of analyses (Section 4). Finally, the cases selected from the Italian energy industry are positioned within the framework and the results are discussed (Sections 5, 6 and 7).

1.2. A different perspective for CSR

Most companies have long practiced some form of corporate social and environmental responsibility with the general goal of contributing to the well-being of the communities and society they affect and on which they depend, or, simply, to improve their images towards external stakeholders, thus trying to manage the so-called reputational risk. However, due to the increasing external challenges, there is an increasing pressure to manage CSR as a business discipline and an increasing demand that every initiative delivers business results.

In order to investigate the trend from CSR to advanced CSR, a big body of literature is examined and it is worth to begin with the definition of traditional Corporate Social Responsibility. Traditionally CSR was defined as "the obligations of businessmen to pursue those policies, to make those decisions, or to follow those lines of action which are desirable in terms of the objectives and value of our society" (Bowen,1953) but it is a very "dynamic concept" (Argandona and von Weltzien Hoivik,2009,pp.229) and it has changed during the decades. Indeed, in particular in the 60s and the 70s different definitions of CSR have proliferated even if the main focus remained on discretionary and voluntary activities (Carroll,1999). However, in the 80s the focus moved to the relevance of measurement systems for CSR performances. Then, in the 90s CSR related to stakeholders' theory, business ethics theory, and sustainable development (Carroll,1999;Kleine and von Hauff,2009). Finally, McWilliams et al., 2006 define CSR as a condition in which a company "goes beyond compliance and engages in actions that appear to further some social good, beyond the interests of the firm and that which is required by law" (McWilliams et al.,2006). Traditional CSR has been often linked to the resource-based theory since "resource-based perspectives are useful to understand why firms engage in CSR activities and disclosure." (Castelo Branco and Lima Rodrigues,2006,pp.111). Indeed, CSR could bring benefits, both internally and externally, to the companies themselves. Internal benefits are mainly related to the development of new intangible resources or to the enhancement of the already existing ones, while external benefits are mainly linked to the management of the corporate reputation, that can be meant as an intangible resource as well (Castelo Branco and Lima Rodrigues,2006). Building on that, there is a great attention on the issue of communication for traditional CSR: Snider et al. (2003) highlight the "importance of trust gained through the use of honest, inclusive, and timely communications" (Snider et al.,2003,pp.185).

However, CSR is a "dynamic concept" (Argandona and von Weltzien Hoivik,2009, pp. 229) that has changed in the last decades and is going to change in the next years, not only due to the contribution of the experts but also due to real life conditions (Argandona and von Weltzien Hoivik,2009). In particular, the need for a stronger stakeholders' engagement and a more proactive approach in the environmental issues is highlighted by Alt et al. (2014) still basing on the resource-based theory. Again, building on the resource-based theory, some authors recognize that a shift can be seen in CSR approaches: "a firm in possession of a unique combination of resources and capabilities, under environmental (and resource) constraints, will resort to sustainability strategies that develop these resources/capabilities in a way that enhances its competitiveness in the long term" (Haffar and Searcy,2015,pp.19). Particularly prominent in the last years has been the concept of shared value: it implies that the social dimension is no longer merely an additional concern, but it becomes part of the core business (Porter and Kramer,2011) and the for-profit company integrates within its business model social and environmental issues, proactively addressing them. Through shared value creation, the company cannot only contribute to tackle societal challenges, but also further increase its economic impact (Porter and Kramer,2011).

As a natural consequence, a need for innovative schemes has emerged, referring both to *ex-ante* strategies definition and *ex-post* evaluation of the results (Michelini and Fiorentino,2012;Hahn and Figge,2016). This push to innovate has been particularly relevant in the energy sector due to the regulatory framework as well as due to the significantly growing socio-environmental issues (Berkowitz et al.,2016). However, referring to these new schemes, within the energy sector as well as in the other fields, they are at a nascent stage and "It is, therefore, important to provide shared value with meaning and organizations with guidance of how to implement it" (Dembek et al., 2015,pp.15).

Hence, a transformation from CSR to advanced CSR can be recognized in many sectors, and different configurations and stages exist. Nonetheless, CSR results to be a complex multi-perspective concept and several heterogeneous practices can be referred to it: it is hard to collect under a single definition, having a large consensus among both academics and practitioners, all these issues (Okoye,2009). In the literature it has not been possible to identify a generally recognized framework for the shift from traditional CSR to advanced CSR, even if many authors define the peculiar features which characterize this new paradigm.

2. The goals and the research method

Therefore, the goals of this work are, first of all, to define a framework which allows to analyse the shift from traditional CSR to advanced CSR, and then to evaluate the most adequate positioning for different energy companies. To validate the framework, some case studies taken from the Italian energy sector are investigated. To reach the purpose, as a first step, an extended literature review is carried out. Building on the existing literature, from both practitioners and academic sources, a comprehensive framework for analysing the shift from traditional CSR to advanced CSR is built. As a second step, the dimensions and the links that compose the framework are tested through three case studies (Yin,1981), taken from the Italian energy sector. Specifically, all of the selected cases are from the utilities segment.

3. From traditional CSR to advanced CSR

In this section, through an analysis of the literature, including both academic and managerial sources, the most relevant dimensions of advanced CSR are collected and then summarized. The main dimensions are presented as grouped referring to three different aspects of CSR: definition of the target, implementation phase, and reporting stage.

3.1. Target setting

As a first step, the goals of the company in terms of CSR need to be identified and fixed. Within the definition process, some new trends can be recognized as well as novel influencing factors.

3.1.1. Balancing of objectives

Referring to the definition of the objectives related to CSR a company sets, new processes are diffusing. If traditionally companies were used to define economic objectives and, then, to identify how they can fit with socio-environmental requirements and issues and how to manage related risks, now an ex ante integration of socio-environmental objectives is gaining importance. Indeed, different authors recognize the need to better integrate socio-environmental objectives together with economic goals in for-profit companies' strategies (Varga,2016). The concept of the Triple Bottom Line, which has been often linked with the measurement of social, environmental and economic results of a company, is evolving into a new concept that is the so-called shared value (Porter and Kramer,2006). Shared value has been defined first by Porter & Kramer as "policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter and Kramer,2011, pp.9). It is focused on expanding the connections between societal and economic progress to enhance the positive economic results for the company and, at the same time, positive impacts on the society.

3.1.2. Long-term and global/local perspective

This kind of integrated planning usually requires a horizon that is longer than the one usually employed by companies. "Several companies engage in such strategies in order to build or develop a social innovation friendly eco-system, which can create more favourable conditions for strategic business returns in the long run" (Varga, 2015,pp.21). Even if an approach of this kind implies also a major effort for the company, it appears an appropriate way to reach shared value for society and the company itself (UNGC,2015). In the same way, it is plain that the context within which today firms are operating is a global one. Hence, a corporate designing its strategies has to account for not only the impacts it has on the final customers' market, but also on all the areas that are directly or indirectly affected by its activities. In a complex and interconnected world, corporations should be able to understand global as well as local contexts (Porter and Kramer,2006,2011;Visser,2010;Visser, 2011;Visser,2012). Considering firms working with natural resources, such as energy, this is particularly relevant referring to the regions where non renewable sources are most present, and these regions are often located in developing countries or emerging ones (Oxman,2013;Saipem,2007). Besides, the possibility to create new profit opportunities by integrating the core business with social and environmental requirements applies equally to advanced economies and developing ones, even if the latters often appear to be more promising (Porter and Kramer,2011). Hence, companies, above all if operating in the field of energy, are driven to care also about developing countries as well as emerging ones even if they are not their main market given the relevance of these regions for their supply chain (Spitzeck et al.,2013; UNGC,2014;Zhang,2008;Jamali,2007). However, moving along this dimension, a continuum of configurations can be found, from those firms which are more focused on local territories to those ones that have a larger scale of interest.

3.1.3. Stakeholders' involvement

Further, a deeper involvement of the stakeholders is required. A tool that has been often used to that purpose is the materiality matrix (Spitzeck and Hansen,2010). It allows a company to take into account social and environmental topics that the stakeholders themselves evaluate as prominent. However, traditionally non-economic stakeholders were used to be involved only ex-post, to define how to structure the sustainability report of company or how to adjust its strategy so that to efficiently manage socio-environmental risks, but now a continuous engagement of the stakeholders is becoming more common. Indeed, the role that stakeholders could play is central: multiple stakeholders' engagement provides CSR with the needed multifaceted perspectives (Athanasopoulou and Selsky,2015) to effectively tackle sustainability challenges. Stakeholders' engagement can also enable more relevant processes leading to an actual blending of social and economic value creation, thus making those strategies more effective in pursuing shared value creation (Kleine and von Hauff,2009;Mason and Simmons,2014;Boesso et al.,2015). In addition, some authors are recommending not just one-to-one dialogue among the company and single stakeholders, but they are proposing private companies in the role of facilitator for a dialogue among different stakeholders to actually have a multi-stakeholder perspective.

3.1.4. Proactivity

Finally, another element that is necessary to better balance socio-environmental objectives with the economic ones are the willingness of companies to proactively address emerging needs of the communities they interact with. It means that the company is not merely focused on the compliance with imposed standards, as it is for a reactive approach, but it aims to tackle the issues affecting communities and contexts in which it is inserted. This is particularly relevant in the field of energy and, hence, some authors examine the concept of environmental integrity. It is a specific attention not only to limit damages, but also to contribute to tackle environmental issues, such as resources' scarcity, waste and inefficient management, and climate change (Porter and Kramer,2006;Porter and Kramer,2011;Spitzeck et al.,2013; UNGC,2014;Visser,2010;Visser,2011;Visser,2012;Lai et al.,2016). That is quite consolidated within CSR practices but its relevance is keeping growing due to the increasing pressure connected with energy issues.

3.2. Implementing advanced CSR

Having investigated how the objectives are fixed by companies, how these aspects are implemented needs to be analysed.

3.2.1. Partnerships and external engagement

As said above, a company operating in the current scenario should understand the social, environmental and economic impacts created in all the regions affected by its business. In order to be able to operate on both global and local scale, reaching actual long-term impacts, the collaboration with external organisations, both profit and no-profit ones, could help large firms to gain authority, add competences, increase credibility within all the involved communities, above all in the local ones. These partners can be: local government and citizen groups, training institutions, international and local development organizations, NGOs, other companies, or social enterprises (Martin,2014;Oxman,2013;Porter and Kramer,2006;Porter and Kramer, 2011;Sharp and Zaidman,2010;Spitzeck et al.,2013;UNGC,2014;Visser,2010;Visser, 2011;Visser,2012;van den Buuse,2012). Among them, particularly interesting is proving to be the role that social enterprises could play with that purpose (Spitzeck, 2012;Spitzeck et al.,2013). Several authors are studying the possible configurations for this kind of collaborations (Sakarya et al.,2012;ACUMEN,2015). What is more, also many forms of corporate venturing are becoming more and more diffused. Different authors have discussed the relevance of "impact investing as a way to overcome a traditional approach to CSR, thus stimulating businesses and investors to generate those innovations necessary to change the way in which they operate" (Vecchi et al.,2014,pp. 2;Sparkes and Cowton,2004). It means that impact investing could become an enabling instrument to foster social enterprises to evolve and corporation to advance their CSR strategies. Currently, impact investing and CSR have evolved on a "parallel trajectory" even though many concepts they are based on are overlapping. Also support to start-ups and of bottom-up initiatives coming from companies' employees is attracting attention as a powerful tool to actually reach shared value creation. All these initiatives are a real example of a multi-stakeholder engagement not only *ex-post* but as an actual strategy to implement advanced CSR.

3.2.2. Organizational structure

Considering how a company can implement CSR strategies, that is influenced also by the organizational structure of the company itself. Some authors have already investigated this issue and a gradual modification of configurations can be recognized (Zollo et al.,2013). In particular, some of these aspects can be considered as a proxy of the shift from traditional CSR to advanced CSR (Molteni et al.,2015). A first key factor which represents the evolution of the CSR approach is the existence of an organisational unit dedicated to CSR or in general to sustainability. Indeed, traditionally many CSR activities were under the unit dedicated to the communication, that shows the relevance of the communication within traditional CSR. However, moving towards more advanced forms of CSR, generally a unit dedicated to CSR is created (Molteni et al.,2015). However, some critics have emerged about the idea of creating CSR dedicated units: some authors argue that restricting all the CSR activities under a single unit would reduce the attention on the issue coming from the other units of the company. Besides, another proxy of the advancement of CSR is the level of reporting of the CSR unit towards the CEO of the companies: the more the CSR level of reporting is directly connected with the CEO level, the more CSR is relevant for the company. It is plain that if the CSR activities are managed by a non-specific unit – i.e., communication unit – the reporting level is an indirect one.

3.3. Reporting of CSR

Finally, it is worth to note that in a complex context, such as the one in which energy companies are working nowadays, a mono-dimensional perspective is no longer adequate. More variables need to be integrated and the socio-environmental aspects require more than one dimension to be properly evaluated. Therefore, the need for more comprehensive reporting systems is arising. In addition, different authors (Lai et al.,2016;Business for 2030,2016) present integrated reporting as adequate proxy indicators of the advancement of CSR even if there is not agreement on that. Indeed, in some cases integrated reporting is presented as a “green washing tool” where sustainability is used as a marketing strategy, not reflecting the actual corporate engagement in sustainability (Lai et al.,2016). However, given the growing influence of international agencies, such as for instance the Global Reporting Initiative (GRI, 2016), and of the responsible investors, the need for producing adequate reporting documents on CSR is increasing. What is more, given the increasing attention on this issue, an adequate reporting could be used as a leverage to foster CSR practices' diffusion within the companies. To develop adequately the report, a real involvement of many different functions within the company is needed and, hence, the attention and the awareness on the issue grows together with the completeness of the CSR reporting.

To sum up, the dimensions that constitute the framework are synthesized in Figure 1.

Figure 1: framework of the elements constituting CSR strategies

Nonetheless, it is worth to notice that there is not an optimal configuration for the above presented dimensions, but each corporation should position itself within this framework to reach its optimal configuration according to the external environment and the resources it has internally. In the following sections, some cases are analysed with a specific focus on the energy sector and are positioned against this framework.

4. A focus on the energy sector

As anticipated, all business sectors are impacted by growing societal challenges. However, particularly companies in the energy industry are increasingly stimulated to deal with the social and environmental issues – like high political instability and scarcity of resources. Hence, companies in this industry are more and more pushed to fit their CSR strategies to the pressures of the external contexts. Referring to the critical issues present in the energy sector, different paths can be identified, considering growing demand, need for major efficiency, and environmental implications (van der Berg et al.,2016), and the framework presented above is here discussed in relation to these issues.

First, in today's world, it is generally recognized that energy is essential for social and economic growth, both in the developed world and in emerging or developing countries. Indeed, energy supply should serve the needs of a growing population, that is expected to reach nine billion by 2050, and support its economic progress and industrial rebirth (IEA,2016). The global economy is estimated to grow four times from now and 2050; this growth could reach ten-fold in emerging countries, such as China and India. This could contribute to economic benefits and huge improvements in people's standards of living, but it also implies a greater use of energy. Specifically, referring to developing areas, there are more than 1.2 billion people who still lack access to modern energy, while energy can help people move out of poverty, support businesses and grow local economies. It means that for energy companies the challenge of resources' scarcity is deeply connected with their core business and, hence, CSR could help to manage it though a better integration of economic and socio-environmental goals.

What is more, "a slow but steady shift from a predominantly carbon-based system towards a renewable sources based one can be seen" (Shell,2014). That poses a challenge for policymakers: how to provide people with affordable energy while reducing carbon emissions? Sustaining growth in renewable energies and improvements in energy efficiency could be an option, but no simple answer or single approach are sufficient. The energy sector requires tailored policies for countries at different stages of development, significant improvements in technologies are expected and even a novel approach to business is envisaged (Shell,2014; PwC, 2016). Particularly referring to energy supplies, high instability can be recognized for energy prices and geographical availability. Indeed, a changing geopolitical balance should be reached among the instability present in African and Asian regions, where many fossil fuels sources are present (World Energy Council,2016). Hence, the need to focus not only on final markets but also on emerging or developing countries is becoming more and more prominent. At the same time, the diffusion of renewables is also posing the challenge of commoditization of energy market, specifically of the electricity market, in developed countries: energy companies are pushed to relate with customers and stakeholders not only with the aim of managing risk reputation but deeply engaging with them thus becoming an unavoidable actor for them.

Finally, the global energy system is under pressure due to environmental concerns related to the need to tackle climate change. There is an urgent need to reduce global carbon dioxide emissions: the Intergovernmental Panel on Climate Change (IPCC) in one of the 2014 reports stated that the "warming of the climate system is unequivocal

and unprecedented, with emissions rising faster than ever before" (IPCC,2014). As a consequence, the companies which are operating in this industry are more and more pushed to include environmental integrity and proactivity within their strategies.
Therefore, energy-related companies cannot disregard the above mentioned issues (Forbes,2013;Porter and Kramer,2011;Rangan et al.,2015) and it is plain that an increasing pressure is put on them.

Given that, some cases taken from the Italian context are here positioned against the framework.

5. Cases from the Italian context

The companies here analysed are presented in Table 1.

Alpha	It is an Italian based multinational company in the field of electricity and gas; its main markets are Europe and Latin America and it is among the top 10 utilities in the world according to Global Fortune 2015, reaching 61 million of users. The installed capacity is over 89 GW and it manages around 1.9 million of kilometres of electrical grid around the world. Within the whole holding, around 68.000 people are employed. It has been selected given the significant investments the management decided to put on sustainable strategies.
Beta	It is an industrial holding dealing with waste and water, in addition to energy. It has a main corporate office handling strategic, development, coordination and monitoring activities, while the operating companies work in the sectors of electricity production, distribution and sale, thermal energy production and sale, and gas distribution and sale. *Beta* has offices and operating units in several cities of Northern and Central Italy.
Gamma	It is a holding born out of the merging of two previously independent companies operating in the North of Italy. It is among the biggest Italian utility companies, dealing with energy but also water and waste management. Its activities are organized into five production chains which stem: energy power production, trading, heating and services, environment, and networks, in addition to the corporate activities and services.

Table 1: three Italian energy compnaies selected as case studies

Then, the three energy utilities are analysed in accordance with the framework shown before (Table 2).

	Alpha	*Beta*	*Gamma*
Target setting	During the interviews carried out with representatives of *Alpha*, the issue of new balancing of target objectives has been deeply discussed. Indeed, in the last years, the sustainability planning was almost completely separated from the strategic one but during the last months, also because of some changes in top management of the company, the perspective has changed significantly. In 2015 Sustainability Report it is stated that: "The integration of the	Considering planning strategies, currently *Beta* does not have a planning process which actually includes different perspectives, as clearly stated during the interviews. Nonetheless, one of the Vice-Presidents of the Group is supporting a new approach to CSR and socio-environmental goals. During the interview, he declares: "It is necessary to consider […] CSR with a new perspective, a new culture is necessary" (Vice-president of the Group) Besides, the top management	One of the main proxies of the advancement of the CSR practices a company adopts is the degree of integration of the socio-environmental objectives with the economic ones. Referring to Gamma, currently they do not have significant correlations between sustainability planning and strategic planning. However, in a recent declaration by the company's CEO (July 2016), he expressed the commitment of the

	Creating Shared Value model was started with Conventional Generation and in particular with Business Development, the first stage of the value chain, to then continue in the subsequent stages of the realization and management of assets. A program was realized which was focused on participation and saw the involvement and taking on of responsibility, through a joint 8-week 'learning by doing' program, of the Sustainability and Business Development teams from 11 countries. From the existing processes, the program led to the application of Creating Shared Value instruments on 37 business projects, establishing an integrated and modular model where Sustainability interacts with Business, thus translating into a competitive advantage." Furthermore, during the interviews it emerged that, to define the strategic planning, *Alpha* is going toward the direction of employing a perspective based on long-term time horizon and both global and local scales. Indeed, *Alpha*'s Communication Manager has highlighted the need for the company to connect its businesses to novel markets: for instance, in accordance with the theory of Base of Pyramid (BoP) theory, *Alpha* is supporting the socio-economic development of some African communities, which could become new customers for the company itself while at the same time improving life quality for them. To do that, *Alpha* should invest on various sectors which are essential to support the development of the communities, such as the health sector or the telecommunication ones.	is aware of rapid changes the context is experiencing and of the great importance of being able to maintain a strong long-term relationships with the customers: "The change in consumption models and technological acceleration in network services, together with the dematerialisation of communication channels and innovation in the digital sphere, are gradually transforming the traditional "user" into an attentive customer." (Sustainability Report 2015) A first step that *Beta* is moving to tackle this issue is a strong involvement of the local non-economic stakeholders to identify the most relevant issues for them through the definition of a materiality matrix. Even if today the most relevant topics are used to define only what to include into the sustainability report (*ex-post* stakeholders' involvement) and not as an *ex-ante* tool. *Beta* is strongly investing to improve the relation with the customers and this theme is considered among its top priorities. Indeed, some of these stakeholders are involved not only as passive actors but also as active ones. The mechanisms that *Beta* employs for that is quite peculiar and worthy to be analysed more in depth. First, stakeholders are invited to communicate their requirements and advices to the company through an on-line portal that is open access. Then, *Beta* supports the existence and the active life of territorial committees - made up of citizens' representatives and local authorities – that are consulted on the issues related to the territory they live in. In particular, the main non-economic stakeholders of *Beta* are members of these territorial committees, as clearly stated in the Sustainability Report 2015:	company to increase and boost the linkages between economic goals and social and environmental concerns for the next years: "Moving from the new competitive dynamics and the evolution of the market, the Industrial Plan and the Sustainability Plan are two factors that are strictly linked to reach a long-term success for our Group. […] The delivery of this plan represents a historic turning point for our company. It shows a vision of the future founded on the sustainability that can be translated into real commitments, which can be quantified and measured, of which we will account for on an annual base" (The CEO) Considering current planning strategies, a strong focus on the local level can be recognized, while the awareness on the global scale impacts is low. Indeed, given the peculiar nature of the company – strongly rooted on the territory – having partnerships with local institutions is a key element of its strategy. "The nature of the work of the Group requires constant dialogue and a comparison of notes with the institutions of the government, with parliament, the regions and local entities, in an active participation to produce shared interests." (Sustainability Report 2015) Therefore, the company is investing on multi-stakeholders engagement at the local level. The tool they are employing is the delivery of multi-stakeholder forums. At

	"There 6 hundred billion people in Africa who do not have access to electricity and those are the people who are currently still suffering from malaria and who are still dying for that. So, health experts believe we can finish off malaria in a lifetime but only if we electrify those communities. Who is going to electrify those communities? it's not health experts, it's us. … Once we have electrified the community, what can we do with electricity? We can sell them things, for instance washing machine: without electricity washing machines were completely useless." (Communication Manager). The above mentioned example of how to tackle malaria, a disease which is among the major causes of deaths around the world, and, at the same time, to enlarge the business by electrifying a rural community, is a meaningful example to show how it is possible to blend social value creation for local communities and economic value for the shareholders. In the meanwhile, *Alpha* can make its business grow and can contribute to foster, on the long term, the global development of the communities it affects in developing countries. In addition, *Alpha* is also boosting the relation with the local communities of the main markets where it is present: a networking platform is under development to allow to better connect different stakeholders of the addressed Italian communities. *Alpha* is trying to actually develop a strategic plan integrating socio-environmental goals and basing on a long-term global-local perspective. To do that, a strong	"The 60 Associations/Institutions that make up the Local Committees involved represent the main categories of Stakeholders of *Beta*: consumers/customers, employees, suppliers, institutions, shareholders, environment, local communities, future generations." (Sustainability Report 2015) Moving from the existence of these territorial committees in all the key regions in which *Beta* operates, it is plain that the company pays great attention to the local level. Indeed, for its intrinsic configuration *Beta* is strongly rooted on the territory and an adequate management of those issues is a key element for its strategy. "The development of local communities is one of the strategic pillars of the Group that identifies in the local areas of reference, current and future, the focus for future growth and shared economic and social development." (Sustainability Report 2015) Hence, minor attention is put on the global value chain of the energy *Beta* provides to the Italian citizens, thus reducing the awareness on the global scale. Given the main sectors of operation of the company – energy, water, and waste - another key topic for them is the environmental concern. The approach they declares to adopt is a proactive one: "[Referring to] Compliance with laws and regulations, this issue is important because the Group considers proactive management of compliance essential, through monitoring and debate with regulatory Authorities, to anticipate scenarios and regulatory changes, as well as, to carry out an effective assessment of risks." (Sustainability Report 2015) However, even if they declare	the moment of writing, a first multi-stakeholder forum has been already held in a territory where Gamma has been historically a key actor. As reported by the Head of the CSR during the interview: "We have involved around forty stakeholders, including different categories such as customers, civil society, suppliers, partners and entities that are interested in environmental topics. During the forum, we discussed with them the priorities in respect to what the Group could do on the local territory." (Representative of the CSR function) And in the Sustainability Report 2015: "The decision [is] to continue the experience launched with the first multi-stakeholder forum held in 2015. This model of involvement will be extended to include seven new territories during the two years 2016-17. The forums will become an essential tool by which to interpret the needs of the communities and cause project ideas to be conceived that are able to create shared value. The company will provide a transparent disclosure on these interventions with the publication of local sustainability reports." (Sustainability Report 2015) In addition to that, Gamma is going towards the direction of working on a long-term perspective as both the declarations of the CEO and the Sustainability Report 2015 confirms. "The Group has undertaken to define a

	involvement of the stakeholders' is envisaged (Athanasopoulou and Selsky, 2015). *Alpha* already employs the materiality matrix to collect the priorities expressed by the different stakeholders. However, the company is also trying to increase the interaction with different shareholders with an on-line platform and a more interactive website, as described in the following paragraph. Considering proactivity - the capacity and willingness of a company to plan initiatives to tackle socio-environmental issues even before they negatively affect the firm itself - *Alpha* is showing to be very committed with this issue. The global Communication Manager declares: "Our mission and vision are based on four pillars: trust, responsibility, innovation and proactivity." (Communication Director). To reach the goal, several projects have been implemented. For instance, through the usage of digital instruments and social media, they are developing a network which can be used to be continuously in touch with a great range of stakeholders, so that their requirements can be taken into account "in real time". Besides, referring specifically to environmental issues, *Alpha* is strongly investing on renewable energies, thus anticipating the regulatory requirements in terms of environmental integrity.	to pursue a proactive behaviour, both concerning social and environmental issues, during the interviews and from the Sustainability Report it emerges that most of the projects they support are financed not in the logic of the shared value but with a philanthropic approach. The section dedicated to territorial development deals with: "Gifts, Donations and Sponsorship", "Infrastructures and services for the communities", "Emergency management" and "Assistance to communities" (Sustainability Report 2015). Nonetheless, the role that territorial committees play could be key to propose, and then implement, projects that are not purely philanthropic ones, but with a more integrated perspective.	Sustainability Policy in 2016, which would indicate the sustainability objectives to be achieved in the next fifteen years, and a Sustainability Plan that lays them out into feasible actions and concrete results in the medium-term (2016-2020)." (Sustainability Report 2015) Finally, considering the proactivity of the approach to CSR that Gamma adopts, it appears to be not yet developed with this regard. Indeed, within the Sustainability Report many references are made to the compliance with the environmental standards. However, in some cases, Gamma overcomes the requirements imposed by the regulation, especially for what concerns renewable energies and energy efficiency. Nonetheless, the overall approach is still quite reactive.

	Alpha	*Beta*	*Gamma*
Implemen-tation phase	With reference to the need for external collaborations, *Alpha* is trying to include within the development of its strategies external actors. Indeed, *Alpha* is supporting the spread of a novel internal approach, called "Open power", that involves a wide range of different actors, such as universities, research institutions, start-ups, incubators, and NGOs. The Manager of the Communication states: "We take all this 96 GW of installed capacity and this 1.9 million km of grid and open them up, in the same way HP opened up. In 1990s, then more 90% of their innovation was done in house, now it is less than 50%. They opened up. We need to do the same and we need to collaborate with people, partners, the companies that are the best in the world for what they do. Because we are the best in the world for what we do, but what we do on our own, in an isolated way is not going to win in this new energy paradigm. We need to partner with universities, we need to partner with technological companies, we need to partner with health care companies." (Communication Manager). However, that is clearly stated into official documents but the actual implementation has not been held yet. In addition, in 2014 *Alpha* has launched several projects to support incubators for start-ups, some of which having social goals, thus employing different impact investing instruments. From that all, it is plain that *Alpha* is working to open up towards collaborating with external actors to improve its performances as well as to	It has been already described the key role of the territorial committees in the target setting phase. Considering the implementation of the CSR practices, through these committees *Beta* is able to build strong partnerships and collaborations with many local actors, such as local authorities and schools, academic entities, and NGOs. However, again, the approach *Beta* employees while collaborating with these external entities is not actually integrated since they are usually involved only in the *ex-ante* stages. Nonetheless, the model of impact investing for communities is diffusing: "The Group, in fact, undertakes to promote a new local area development model focused on the innovation of the process and product and social innovation: 98% of the planned investments in the Business Plan are aimed at local area development, generating an important growth driver for local economies, with positive effects also in social and environmental terms. The operational application of the strategic guidelines translate into important industrial projects that represent the Group's tangible effort in terms of sustainability and that contribute to creating infrastructures, services and employment." (Sustainability Report 2015) Besides, *Beta* has started to financially support some start-ups, through a competition, in order to	Referring to the relevance of the external collaborations for implementing CSR strategies, Gamma does not have significant collaborations with social enterprises but they are experimenting two interesting practices. First, Gamma is trying to include into its core strategies some of the main principles of the circular and sharing economy, as written in the Sustainability Report as well as declared by the CEO. However, there is not a clear distinction between the principles belonging to one or to the other of these economic theories, thus showing that they are still moving their first steps in this direction. Second, Gamma has been using a financial tool similar to impact investing to support local communities ("Responsible investments in the community"). However, despite the innovative concept on which they are building on, their actual approach is still quite a philanthropic one: "In 2015, the Group's investment in the community came to approximately 4.3 million euros including contributions made in sponsorships, donations and support of the Group Foundations." (Sustainability Report 2015) Indeed, this issue emerged also during the interview with the Head of the Sustainability: only during the last months of 2015, some initiatives of active involvement of non-

	support the spread of impact investing, however, it has not reached a mature stage yet. Considering the organisational structure of *Alpha*, it has changed recently, again, due to a turnover in the top management. As many of the interviewed informants clearly express, till last year the CSR activities were under the Communication Unit, while a new unit dedicated to sustainability issues has been recently created. This unit deals with all the activities related to sustainability, CSR and philanthropy and is part of the function "Innovation and Sustainability". Particularly, in the Sustainability Report 2015 is stated that: "The organizational model sees a dedicated Innovation & Sustainability unit reporting directly to the Chief Executive Officer, in order to highlight that these two areas and their specific activities make an integral contribution to the creation of a new business model and to the Company's competitiveness." (Sustainability Report 2015) Nonetheless, either the Sustainability Manager and the Head of Sustainability Planning and Performance Management report that many different functions are involved in the phases of CSR strategies definition, implementation, and reporting. However, this configuration has been recently modified and, therefore, it is not possible to evaluate its effects.	get potential sources of innovation for its core business activities. "The company strongly believes in the strategic role of innovation and research in the Italian industry. For this, as a main sponsor, it supported the 2015 National Innovation Award, believing that the development and growth of its businesses can surely benefit from the comparison and collaboration with start-ups that are innovative, ambitious and supported by strong business projects." (Sustainability Report 2015) However, the collaboration with social enterprises has not be experimented yet. Referring to the organisational structure of the group, sustainability and CSR initiatives are under the function "Corporate Social Responsibility and Territorial Committees" which reports to one of the Vice-Presidents. Hence, there is a second level reporting. Currently, the main duties of the function are to manage the relationships with the territorial committees and to collect the data for the sustainability report's delivery. Finally, it is worthy noticing that some changes in the organisational structure are under development within the company.	economic stakeholders have been undertaken. "For the first time, we not only listen to the stakeholders, but also a co-participation, a co-participation not only for communication initiatives but even for those activities which can slightly make a groove in the business. So, we overcame this step in the process of stakeholders' engagement." (Representative of the CSR function) The main reason for which the stakeholders were and still are mainly involved just into communication initiatives is that the CSR function is under the Communication and External Relations unit. "We are a function under the Communication and External Relations unit and we are organised in this way since the foundation of the CSR function, that at the beginning in the 2009 was just a working group and so it was neither a function, the unit has been structured as it is today. We are three of us working on these issues, including our responsible who deals with CSR activities and with other activities under the Communication area." (Representative of the CSR function) Hence, it is a natural consequence that most of the CSR initiatives Gamma has realized still now are mainly related to communication, and the first steps towards a new approach are quite recent.

	Alpha	*Beta*	*Gamma*
Reporting phase	Finally, considering the reporting of CSR, *Alpha* has been publishing the sustainability report since 2003 and they are keeping improving the layout used to make it more interactive and, again, useful to engage with stakeholders. Currently, they are monitoring a set composed by almost 600 indicators dealing with social, environmental and governmental issues but, in order to make the sustainability report readable by a wide range of stakeholders, only a certain selection is reported on it. The indicators are defined and filled in in accordance with the Global Reporting Initiative (GRI, 2016) standards, an internationally recognized agency for sustainability reporting. However, as the Head of Sustainability Planning and Performance Management has stated, *Alpha* does produce a combined report, putting together economic and socio-environmental data, and not an actually integrated report due to the Italian regulation's restriction that still requires to produce separate economic-financial documents. "Other topics, related to the materiality analysis, such as not only economic-financial, but also social and environmental ones, are included in the sustainability report. By doing this, we have created a system which is actually a combined report […] and not an integrated report." (Head of Sustainability Planning and Performance	First, the process of data collection is analysed. The topics to be included in the report are selected in accordance with the relevance defined by the materiality analysis. Again, the members of the territorial committees are involved in this analysis and are the main influencers in the process. Once defined the issues to be evaluated, appropriate monitoring indicators are filled in. However, *Beta* currently has a very broad set of indicators which are not easy to be managed: "It was born as a scorecard to monitor strategies, not only with an economic-financial perspective, but also environmental and so on… Eventually, it has become a set of indicators having different perspectives, economic-financial , technical, infrastructural, about performances, … […] Today, we have different models which are often not compatible one to the other […] they are a very huge amount, actually not usable." (Head of Sustainability) Given that, the company is working to develop an internal instrument to improve the procedures for data collection, in order to enhance the quality of the sustainability report they publish annually. In addition, for the first time in 2015 they adopted a new approach to the report's structure, employing for the first time the GRI standards. However, the structure of the report is still far from integrated ones.	Given the strong relation of the CSR initiatives with the Communication Unit, it is plain that the sustainability reporting practices *Gamma* employees are quite advanced. Indeed, *Gamma* publishes annually its sustainability report and in 2015: "The Group publishes the eighth Sustainability Report prepared on the basis of the "Sustainability Reporting Guidelines G4" of the Global Reporting Initiative (GRI) and, together with the Sustainability Report – Supplement, of the Electric Utilities Sector Supplement – G4 Standard Disclosure. With a view to ensuring continuous improvement with respect to previous editions, the Group has also embarked upon a progressive adhesion to the Integrated Reporting Framework (IR Framework), as outlined by the International Integrated Reporting Council (IIRC)" (Sustainability Report 2015) Particularly, there is a great attention on the issue of reporting since *Gamma* is pushed to be transparent as much as possible by the Institutions on the local territories where it operates, and also because of the presence of Social Responsible Investors: Nonetheless, even in this case the report is still far from being an integrated one or to be used as a leverage to enhance the CSR practices within the company.

	Management) However, at the moment, no indications have been found of how the reporting system is employed as a leverage to enhance CSR in the company.		

Table 2: analyses of three cases from Italian energy sector

6. Discussion

Moving from the analysis of the three Italian energy companies, some trends and differences among them are highlighted. The companies, having different dimensions and operating in different markets, present different strategies, even for what concerns CSR.

Starting from the engagement with the stakeholders - mainly non-economic ones - a difference between the strategies followed or at least planned for the next years by *Alpha* or *Beta* and *Gamma* can be recognized. Given that *Alpha* is a multi-national company operating in many different countries and markets, while *Beta* and *Gamma* are smaller firms, working mostly in some Italian regions, their approaches are quite diversified. *Beta* and *Gamma* are greatly investing on non-economic stakeholders' engagement at the local scale and, out of them, *Gamma* seems to be at a more advanced level than *Beta*. The practices that are most employed are the involvement of the stakeholders in territorial committees or in *ad hoc* forums. Besides, the usage of on-line portals is diffusing. *Alpha* is not strongly investing on this kind of practices. The reason for that can be found if the markets where *Alpha* is operating are considered: *Alpha* works on a global scale and, hence, the relationship with the territory and the local stakeholders is less relevant for its long-term sustainability.

Then, the global/local scale of operation is considered. Again, *Beta* and *Gamma*, due to their intrinsic nature and history, are strongly rooted on the local territory, and, hence, they are naturally more focused on the local scale. Nonetheless, many authors (Porter and Kramer,2011) report that a certain amount of attention should be put even on other regions, for instance the countries where energy is processes before arriving in Italy. With this regard, *Alpha* puts a great attention on the global scale: a number of projects are under development and also the planning perspective has a strong focus on the global dimension and on Developing Countries. What is more, *Alpha* is also trying to enlarge its market involving the so-called Base of the Pyramid, thus reducing the risks they could have on the long-term.

Specifically to work in these contexts, the collaboration with different entities is necessary to have all the different competences that are required and, hence, the opening towards different actors is a priority for *Alpha*. *Alpha* recognizes as it is essential to open up to innovative collaborations to be able to tackle the issues typical of the energy sector which are becoming more and more complex and interconnected. On the other side, *Beta* and *Gamma* are still focused just on local level and local stakeholders, such as local institutions or associations. Even if they are collaborating, the partnerships are more oriented towards a kind of passive involvement of stakeholders. Nonetheless, they are experimenting innovative mechanisms of stakeholders' engagement, not only as an *ex-ante* tool for the definition of priorities for the sustainability report, but also in the form of partnerships with non-economic stakeholders for the implementation phase of CSR.

To sum up, three main drivers can be identified. First, those companies that operate on local markets (e.g., only Italian markets) are committed to build strong relations with local non-economic stakeholders since they are becoming more and more aware of the risks connected with the commoditization of energy sources in developed markets. Hence, for these companies the multi-stakeholder's engagement is a key element for strategy. On the other hand, in those companies, such as *Alpha*, that operate on a larger scale, there is a great attention for global scale and in particular on how to reach shared value in emerging markets and developing countries. Finally, more in general, the companies that are more pushed to invest on advanced CSR initiatives are the ones that have a larger scale of operation, but even smaller energy companies are getting aware of the increasing need for that.

7. Conclusion

The aim of the paper was to define a framework for the shift from traditional to advanced CSR, highlighting the most peculiar features. The framework has been defined together with its main characteristics, which are grouped into target setting – balancing of socio-environmental goals and economic objectives, multi-stakeholder's engagement, long-term and global/local scale, and proactivity; implementation stages – focusing on collaboration with external partners and internal organisation of the company; and the reporting phase. Having defined the framework, three cases have been placed on it, thus testing it.

Through the case studies analysis, the framework results adequate to describe the positioning of the companies for what concerns their CSR strategies, thus highlighting the differences between bigger companies working on larger scale and smaller firms focused on local stakeholders.

This work has several implications. Referring to theoretical implications, the paper can contribute to fill the gap identified in the literature for what concerns a framework of configurations for the shift from traditional CSR to advanced CSR. At the same time, it also highlights some peculiarities of the advanced strategies for CSR adopted by different companies. Besides, as a practitioners contribution, the analysis could provide some inputs to foster the advancement of the diffusion of more advanced CSR practices in the Italian energy sector.

Nonetheless, the need for more interviews, not only with few managers, but also with other players are needed. Indeed, the CSR activities can be designed by the dedicated unit, but then it has to be put in practice and shared by many other actors inside and outside the company. What is more, another limitation which can be identified in this work is that other cases would need to be investigated. Specifically, other Italian energy companies taken from other segments of the energy sector should be examined, such as the Oil and Gas segment, to reach a more comprehensive overview of the issue. Finally, an adequate measuring systems to identify which are the actual returns, for both the company and the society, would be needed. Moving from this consideration, the design of a set of indicators for the evaluation of economic and social value creation appears an interesting research stream.

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Contact email: francesca.mapelli@polimi.it

Curbing Suburban Sprawl: Adding the Education Variable to the Housing + Transportation Model

Rebecca Tudor, Twinrose Investments LLC, USA

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Abstract
In urban planning, there is considerable discourse about how to curb suburban sprawl, increase densities in the urban core and reduce the need to develop greenfields while accommodating population growth in metropolitan areas. One economic model that helps quantify the cost of suburban living versus urban living within US metropolitan areas is the "H + T Affordability Index" as developed by CNT. While this is a good tool for understanding the two variables, if the goal is to actually change housing decisions, other important variables that weigh heavily in this very personal choice must be considered. In many United States metropolitan areas, one such variable is whether the middle income and upper income population relies on private or public education within a specific neighborhood. When looking at urban neighborhood income statistics versus the income statistics of the neighborhood school, there is often a disparity (i.e., considerably higher poverty in the school versus the neighborhood as a whole) which is an indication that the upper income and middle income residents are choosing to pay for private education and have opted out of the neighborhood school. While the origins of these patterns may differ, studies indicate that there is a tipping point of poverty within schools above which all students suffer academically. Using Dallas Texas, USA and its first, second, and third ring suburbs as my study area, I demonstrate the impact of the education variable on the H + T + E model. This additional level of analysis can be useful to urban planners as they attempt to make urban living more conducive to all demographic groups while simultaneously improving the sustainability of the existing suburban footprint.

Keywords: urban planning, real estate development, suburban sprawl, education

Introduction

In the field of sustainable urban planning, we are often looking for ways to curb suburban sprawl, increase densities in the urban core and reduce the need to develop greenfields while accommodating population growth in metropolitan areas.

However, urban planners, real estate developers, and city planners who are focused on sustainability sometimes ignore important variables that are pulling our cities outward. There is a tendency to focus on idealistic goals as though they will naturally occur and the assumption that most people must share the vision of the livable dense core. Urban development is envisioned as a kind of high-quality, utopian society that is transit oriented, with cultural and ethnic diversity, interspersed income and wealth all of which are living in harmony. When children are part of the vision at all, they are tightly controlled and participating in high-quality educational programs, enhanced by ready access to cultural amenities including the arts, entertainment and sports. Jobs and shopping are accessed by walking, transit, or bicycle. Relatively few people have need or desire for a personal automobile.

Yet, as we transition from mid-20th century development to the urban utopia of the future, we experience an urban reality that is quite different: outdated and deteriorated utility systems and poor transit coverage, with no financial ability to maintain the first or expand that later. Private automobiles are prized possessions and remain necessary for daily life; the added density creates congestion and pollution. The population is often self-segregated by economic factors, zoning or both, with the wealthy abandoning the impoverished public school districts while the middle class families flee to the suburbs. Racial and ethnic tensions can be high, particularly when they are correlated to income disparity. Antiquated zoning and resident resistance to change prevents implementation of redevelopment solutions.

Understanding the complexity of the consumer decision-making process for individual households and corporations is necessary before a wide-spread cultural shift toward urban density can occur.

Housing and Transportation Costs

One important factor cited as a reason for suburban expansion is the affordability of housing. The incremental cost of workplace transportation much be factored into the cost of living of the suburban landscape. The disparity in transportation costs is often most notable in dense urban settings with good public transit that still serve as a centralized business district for professional jobs versus outlying areas that are not transit served. CNT, a USA based consultancy, has taken the first step toward quantifying these costs and have developed an online tool that can be used for corporate relocation purposes when looking at the need to house a significant workforce. However, the actual practical use of the index routinely includes a first step of identifying which school districts the employment base will find acceptable and once the shortlist of cities is identified, the relative affordability of the housing plus transportation can be applied to determine locations that fit the demographic mix and compensation structure of the company.

I have looked a means of incorporating the Education variable to the index in such a way that will incorporate this first step into the model while giving greater guidance to cities and school districts as they attempt to stay viable in attracting high-quality jobs.

H + T Affordability Index as developed by CNT

The purpose of the H + T Affordability Index is stated below:

> "By taking into account the cost of housing as well as the cost of transportation, H+T provides a more comprehensive understanding of the affordability of place. Dividing these costs by the representative income illustrates the cost burden of housing and transportation expenses placed on a typical household. While housing alone is traditionally deemed affordable when consuming no more than 30% of income, the H+T Index incorporates transportation costs—usually a household's second-largest expense—to show that location-efficient places can be more livable and affordable."
> http://htaindex.cnt.org/map/

What the index tells us is useful. It is true that where commuters have viable options of public transportation, eliminating the cost of a personal automobile can remove a significant expense from household budgets. As suggested by their model, these two factors should be considered as a whole. However, in metropolitan areas that were largely developed after the widespread use of personal automobiles, public transportation was not effectively built into their urban plans, therefore, rather than encouraging people to move into the urban core, the data results promote establishing business nodes far into the suburban landscape because there is no effective urban core where transit works without supplement by a personal automobile.

Complexity of Housing Decisions

While the H + T Affordability Index is a good tool for understanding the two variables, if the goal is to actually change housing decisions, other important variables that weigh heavily in this very personal choice must be considered.

Some of those variables include:

- Proximity to Employment
- Rent versus Own
- House and Lot Pricing/Value
- Transportation Options
- Friends and Family
- Neighborhood Safety
- Quality, Age, and Condition of the Built Environment
- Proximity to Shopping Centers
- Public School Quality

Some of these factors can be said to fall into the price of housing or the cost of transportation. In addition, if all school districts were equal, that factor would be included in the taxation structure. But all public school districts are not equal and families must choose their best option.

Three School Options

For most USA families, the choice of education is between 1) urban tax-funded schools, 2) private tuition schools, and 3) suburban tax-funded schools. Let us consider characteristics of each.

USA Urban Tax-Funded Schools

- High population density [(1)]
- Large district [(1)]
- Inexperienced Teaching Staff [(1)]
- District-wide economic disparity [(1)]
- Higher racial, ethnic, and religious diversity [(1)]
- Factionalized infighting on school boards (1)
- Poor urban students experience more health problems (1)
- Higher student, teacher, and administrative mobility (1)
- Higher immigrant population (1)
- Higher linguistic diversity (1)
- Transportation problems (1)
- Teachers are less likely to live within the neighborhood (1)

(1) Kincheloe 2010

USA Private Tuition Schools

- Families pay for tuition and extracurricular activities and supplies
- Strong PTA organizations
- Strong Performance
- High Parental Involvement
- Good Community Involvement
- Limited Scholarships
- Minimal Ethnic and Cultural Diversity
- Highly Like-Minded Communities Based on School Selection
- Many Include Religious Instruction

USA Suburban Tax-Funded Schools

- Tax-Funded/Families pay only for extracurricular activities and supplies
- Strong PTA organizations
- Strong Performance
- High Parental Involvement
- Good Community Involvement
- Some Ethnic and Cultural Diversity
- Like-Minded Communities
- Generally considered acceptable across multiple demographic segments

The Tipping Point

"… there is evidence that such (middle-class) students learn less when they attend high-poverty schools – those where more than 50 percent of the students are poor." [(2)] "The Coleman Report found the tipping point to be 40 percent poor. That's the guideline used by some school districts when they seek to keep their schools economically balanced." [(2)]

(2) Michael J. Petrilli, The Diverse Schools Dilemma: A Parent's Guide to Socioeconomically Mixed Public Schools, 2012

The references cited above, and specifically the Coleman Report findings, are still used today when school districts attempt to balance schools from an economic perspective. Whether the number is 40% or 50%, evidence exists to suggest that above a threshold, schools are dealing with socioeconomic issues related to poverty so much of the time that all of the students scores suffer, including those of middle-class students.

Metropolitan Dallas Example

Using Dallas, Texas, USA and the first, second and third ring suburbs in a northeasterly direction as the study area, I demonstrate the impact of the education variable on the H + T + E model. The chart below shows the percent of economically disadvantaged students attending high school campuses in the Dallas ISD (Urban), Garland ISD, Richardson ISD, Plano ISD, Wylie ISD, Frisco ISD, and Allen ISD.

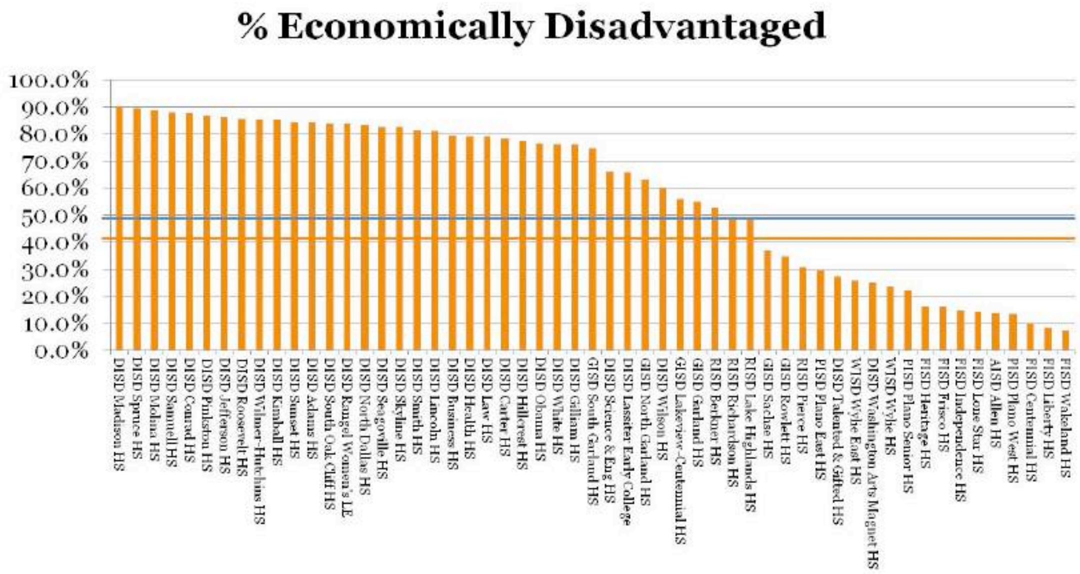
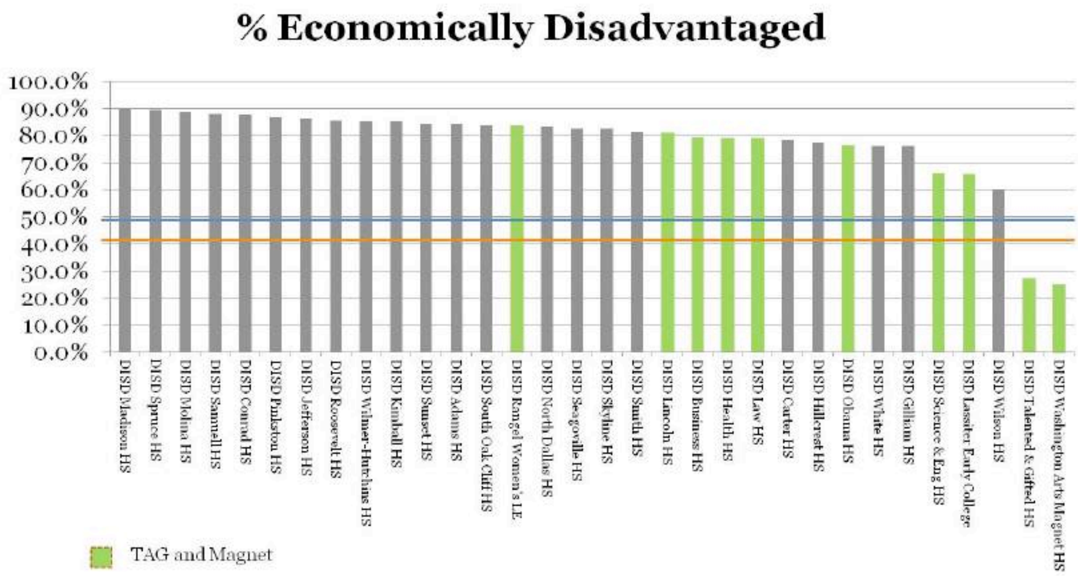


Figure 1: Economically Disadvantaged Students (3)
(3)https://rptsvr1.tea.texas.gov/perfreport/src/2015/campus.srch.html

The horizontal lines indicate the 40% to 50% markers as indicated by Coleman and Petrilli. Many of the schools are well above the Tipping Point and several are operating well below the threshold.

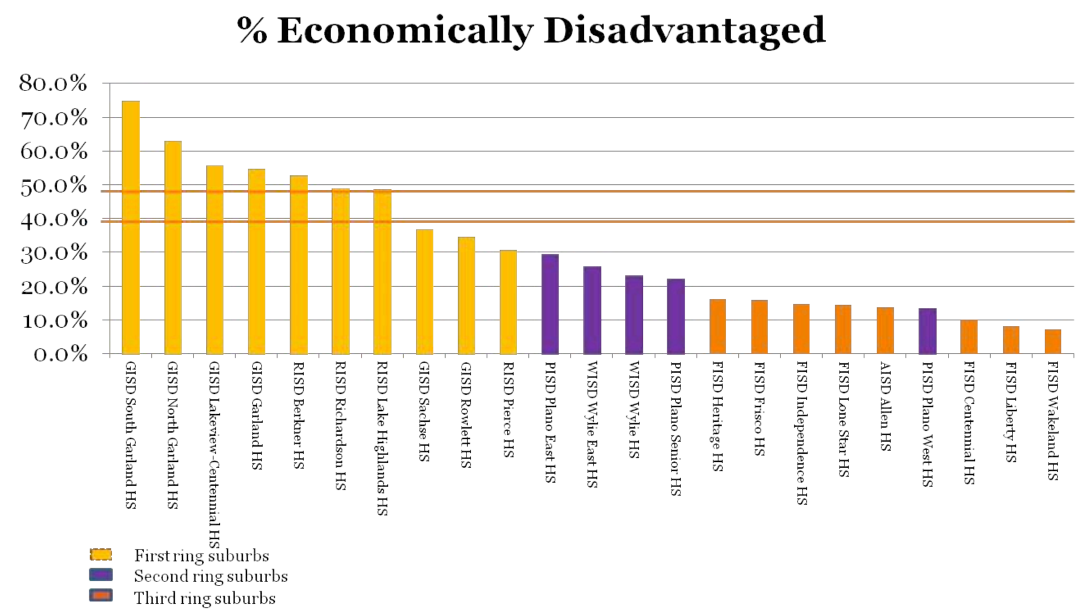
The next chart demonstrates this same data for the Dallas ISD alone.



Economically Disadvantaged Students – Dallas ISD only [3]
(3)https://rptsvr1.tea.texas.gov/perfreport/src/2015/campus.srch.html

The data shows only two schools, the talented and gifted and arts magnet schools, operating within an acceptable range of impoverished students. The remainder of the district includes high schools with 60% to 90% economically disadvantaged students which marks campuses for which those who can do so have and will continue to avoid.

The next chart shows the same data for the suburban districts.



Economically Disadvantaged Students – Suburban ISDs [3]
(3)https://rptsvr1.tea.texas.gov/perfreport/src/2015/campus.srch.html

What is telling about the suburban chart is that, without intervention, the suburban districts are susceptible to the same fate as the urban district, forcing the school choice further and further from the center.

Application to the Index

Adding the variable to the index, for broad use for corporate relocation and urban planning purposes, we can take the following steps:

- Determine the Average Cost of Private Education Within the Region.
- Determine Whether the % Economically Disadvantaged is Above 40% Threshold For the Neighborhood School or District if District Wide School Choice is Offered.
- If Above 40%, add Average Private Tuition for typical household for average number of children.

$$H + T + E$$

- If Below 40%, the cost of tax-funded schools is already included in the cost of real estate, so do not make an adjustment.

$$H + T = H + T + E$$

Index Application Example: Dallas and Suburban ISDs [4]

- Average Texas Private-Tuition School Cost: $8,278
- Total Number of Children Aged 5 – 17: 666,823
- Total Households: 1,165,595
- Children Per Household: 0.572

(4)www.census.gov/quickfacts/table/PST045214/48085,48113

Average Annual Cost Per Household

	Housing	Transportation	H + T	Education	H + T + E
Dallas	$15,120	$11,267	$26,387	$4,735	$31,122
Garland	$15,060	$12,380	$27,440	$4,735	$32,175
Richardson	$18,336	$12,026	$30,362	$4,735	$35,097
Plano	$20,676	$12,543	$33,219		$33,219
Wylie	$18,984	$13,775	$32,759		$32,759
Allen	$22,620	$13,659	$36,279		$36,279
Frisco	$24,372	$13,469	$37,841		$37,841

(5) http://htaindex.cnt.org/ (6) Education variable not from index.

In the example above, the Dallas ISD as well as the first ring suburban districts, having surpassed the threshold, require an adjustment, whereas, the second and third ring suburban areas do not require the private school adjustment. Adding the index adjustment negates any savings in household expense by choosing urban and first ring districts.

This methodology works from the perspective of corporations and municipalities looking at household averages, where not every household has school-aged children. However, individual housing decisions are not made based fractions of children. When a full tuition for each child is applied to the model, the more school-aged children a family has, the more economic incentive they have to choose an outlying school district.

	H + T	Education Cost Per Child	H + T + E	With 2 Children	H + T + E	With 3 Children	H + T + E
Dallas	$26,387	$8,278	$34,665	$16,556	$42,943	$24,834	$51,221
Garland	$27,440	$8,278	$35,718	$16,556	$43,996	$24,834	$52,274
Richardson	$30,362	$8,278	$38,640	$16,556	$46,918	$24,834	$55,196
Plano	$33,219		$33,219		$33,219		$33,219
Wylie	$32,759		$32,759		$32,759		$32,759
Allen	$36,279		$36,279		$36,279		$36,279
Frisco	$37,841		$37,841		$37,841		$37,841

In this example, one can easily see that the cost of educating becomes almost as large a cost as housing and transportation combined if a family has three or more children. In these cases, opting for a suburban household may be the only viable choice.

Conclusions and Opportunities

In looking at this data, one might conclude that the case for suburban sprawl is well-supported by the addition of the education variable. The purpose of bringing this to light, however, is to more closely model consumer behavior so that as policy-makers, urban planners, and real estate developers, we can understand and seek to reverse the pattern in ways that will incentivize individuals to choose the urban setting for their families. Education options play a major role in consumer choice for families with children.

This additional level of analysis can be useful to urban planners as they attempt to make urban living more conducive to all demographic groups while simultaneously improving the sustainability of the existing suburban footprint.

Some opportunities include:

H + T Index as a Sustainability Tool
- Add the Education Variable to make the model more closely resemble actual decision-making

School District Resiliency
- Focus on economic balance by campus.
- Parent training and support beginning at Early Childhood.

City Resiliency
- Use zoning to ensure a diversity of income levels by school.
- Streamline the approval process for urban redevelopment.
- Be a strong partner to the school district.
- Attracting the middle-class back to the urban core must include a focus on income balance within the tax-funded schools.

Sustainable Real Estate Development
- Seek opportunities for gentrification in areas nearing the 40% threshold.

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http://htaindex.cnt.org/

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www.census.gov/quickfacts/table/PST045214/48085,48113

Contact email: Rebecca@twinroseinvestments.com

Industry Sector Specific Remanufacturing Processes

Steffen Butzer, University of Bayreuth, Germany
Sebastian Schötz, Fraunhofer Project Group Process Innovation, Germany
Rolf Steinhilper, University of Bayreuth, Germany

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Abstract
Today, remanufacturing is a key industrial discipline at the end of a product's life or use cycle. In terms of the economic potential, remanufacturing facilitates multiple use of the added value from new production by several life cycles. For preserving work, material and energy effort costs of the new production can be avoided. Ecologically, this leads to corresponding resource savings as well as avoidance of emissions and waste. Unfortunately, there is a lack of knowledge, both in industry and science, when it comes to an understanding of industry sector specific remanufacturing processes. Therefore, scientists from Bayreuth analyzed remanufacturing companies across Europe. The paper shows the main results of the study. At the end of the day, the paper supports the remanufacturing industry by creating a better understanding of remanufacturing processes in different industry sectors.

Keywords: Remanufacturing; Industry Sector Specifics; Processes

Introduction

Due to increasing competitive constraints, the corporate landscape has changed in the recent years [1]. Furthermore, the profitability of enterprises are endangered due to increasing resource scarcity and increasing commodity prices [2]. A system changing approach to face these challenges is the *circular economy*.

The circular economy aims to "close the loop" of product life cycles through recycling and re-use. Europe's transition towards a circular economy will boost global competitiveness, foster sustainable economic growth and generate new jobs. [3] The overall idea of the circular economy is illustrated by the Ellen MacArthur Foundation (EMF) in their circular economy system diagram [4].

One key element of the circular economy is remanufacturing. Today, remanufacturing is a key industrial discipline at the end of a product's life or use cycle. Remanufacturing is performed due to economic, ecological and / or policy reasons [5].

Hauser and Lund describe remanufacturing as the process to restore nonfunctioning, discarded or traded-in products to a condition as new [6]. Also according to Nasr and Thurston, the condition of remanufactured products is "as-new" [7].

Figure 1 illustrates the remanufacturing system, according to Östlin [8].

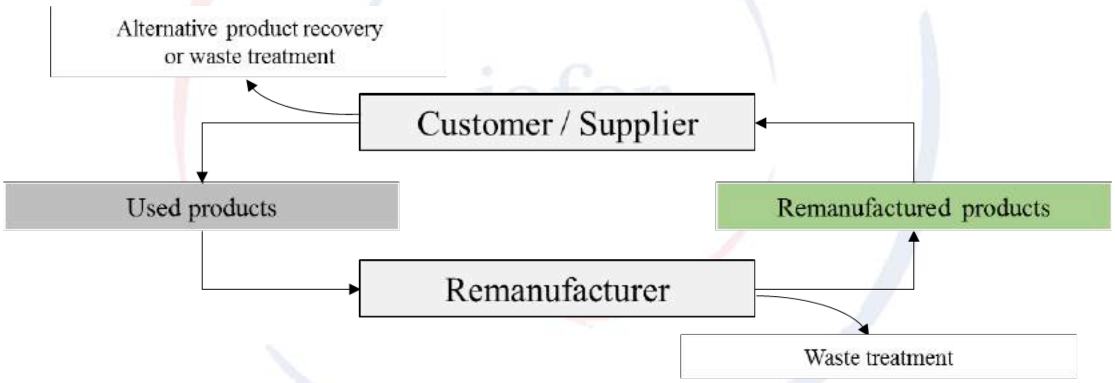

Figure 1: The remanufacturing system. Modified from: Östlin [8].

Used products are collected by suppliers, e.g garages, and sent to a remanufacturing company via the reverse supply chain. After the remanufacturing process, the remanufactured product is distributed via the forward supply chain.

The ecological and economic advantages of remanufacturing have been shown in many studies, e.g. by Köhler [9] and Kara [10]. Sundin and Lee have condensed studies which show the ecological and economic advantages of remanufacturing in a paper in 2012 [11].

State of the Scientific Knowledge and Need for Action

Remanufacturing is performed in many industry sectors, e.g automotive, rail and heavy duty industry. Depending on the industry sector, the number and sequence of the remanufacturing process steps may vary.

According to Steinhilper, mechanical and electromechanical products have to be separated from mechatronic products. For mechanical products five main steps have to be proceeded. [12]

According to Freiberger, it is useful to add the entrance diagnosis of the product as a sixth step, for mechatronic and electronical products. Thus, failures which are not based on mechanical wear out can be identified directly [13].

The five respectively six process steps of remanufacturing according to Steinhilper and Freiberger are illustrated in figure 2.

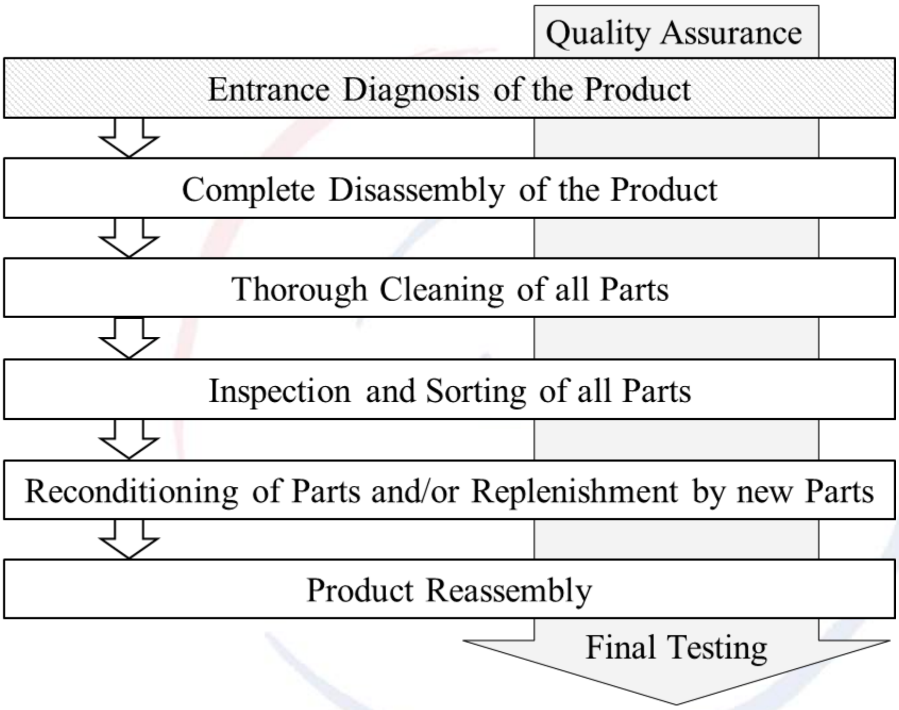

Figure 2: The process steps of remanufacturing according to Steinhilper [12] and Freiberger [13].

In the following, the five process steps for mechanical systems according to Steinhilper are described in more detail [12].

Disassembly

The old products, termed cores, are disassembled completely into their single parts. Parts which cannot be reused or remanufactured are sorted out. The disassembly is mainly done manual, due to variety of contaminations and different degrees of corrosion.

Cleaning

The cleaning step includes the degreasing, deoiling and derusting of the parts. Different cleaning technologies and processes are deployed in sequence or in parallel.

The cleaning results are depending on the chemical application time, action of heat, mechanical exposure and process time.

Inspection and Sorting
The parts are classified regarding their applicability to be remanufactured respectively to be reconditioned. The parts can be classified e.g. as following:

- Reusable without reconditioning
- Reusable after reconditioning
- Not reusable / to be replaced

Besides optical inspection procedures, also mechanical and electronical inspection procedures as leak tests, voltage tests or three-dimensional measurements are applied. Functional components are inspected regarding their mechanical and / or electronical functionalities also. Unlike in the new production of parts and products, within remanufacturing normally all parts are inspected.

Reconditioning
Worn out parts are reconditioned by using metal treatment processes e.g. as drilling, milling and grinding. Despite the treatment and the consequently changes of the geometry, the differences still stay within the original tolerances or have no influence on the functionality. If the functionally is influenced by changing the geometry, additional process steps as surface treatments are applied to restore the original geometry. Parts which cannot be reconditioned are replaced by new spare parts.

Reassembly
The reassembly is done on assembly lines for small batches with the same tools and equipment as applied in the new production. After the reassembly, a functional test of all parts is performed to guarantee a 100 per cent quality.

Within remanufacturing operations, the same quality assurance and testing procedures as in the new production are deployed. In addition to that, remanufacturing products can be updated within the remanufacturing processes.

Besides the above mentioned descriptions of remanufacturing process steps, there is a lack of knowledge when it comes to the understanding of industry sector specific remanufacturing processes. Therefore, scientists from the University of Bayreuth have analyzed remanufacturing processes, performed within remanufacturing companies across Europe.
The study has two aims. The first aim is to analyses the industry sector specific remanufacturing processes. The second aim is to identified similarities and differences between the industry sectors regarding their specific remanufacturing processes. The main results of the study are shown in this paper.
The overall goal of the study is to support the remanufacturing industry by providing a base for cross sectoral learning.

Methodology
In the first step, the scope of the study was defined. The scope of the industry sectors covered within the study is based on the importance of the industry sectors within Europe, in terms of significance of remanufacturing activities.

Therefore, the following nine industry sectors are covered within the study [14]:
- Automotive industry
- Consumer goods / Electronic products industry
- Machinery industry
- Heavy duty / off road equipment industry
- Medical equipment industry
- Aerospace industry
- Marine industry
- Furniture industry
- Rail industry

In the second step, a questionnaire was designed and send to remanufacturing companies across Europe. The question related to remanufacturing processes was designed as an open question. Therefore, the participants were asked to describe the remanufacturing processes, performed in their company, in their own words. Thus, the participants were not influenced by any predefined reply possibilities. The study about remanufacturing processes was conducted as part of the remanufacturing market study, which was done within the EC-funded project ERN – European Remanufacturing Network [14]. This approach yielded 105 responses mainly from remanufacturing companies across Europe. Besides the open question about the remanufacturing processes, the participants had to choose, in which industry sectors their remanufacturing activities take place. Some of the companies are active in more than one industry sector, e.g. automotive and marine industry. Therefore, 144 indications were made by the 105 participants. Thus, the coverage factor is 1.37.

Figure 3, 4 and 5 provide and impression of the companies which have participated in the study.

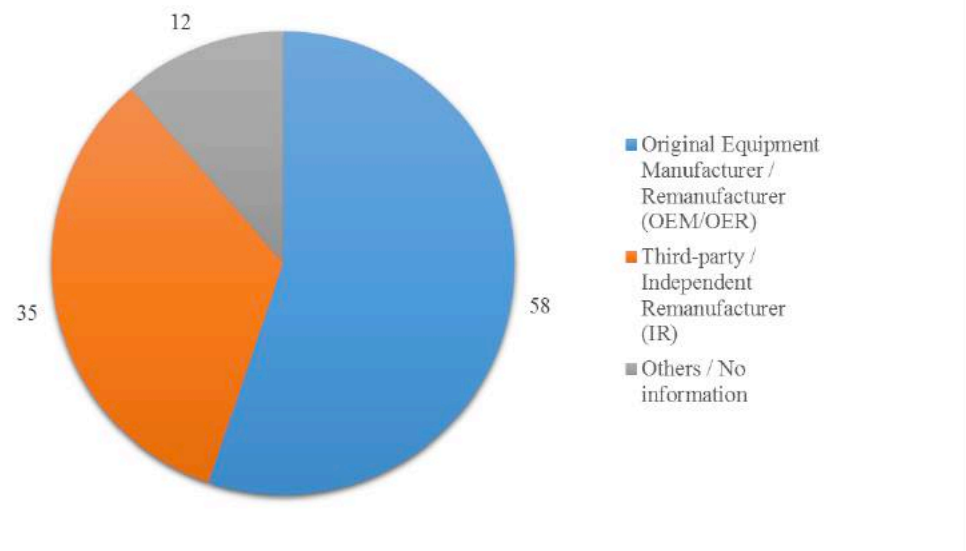

Figure 3: Number of responses sorted by the business model.

In figure 3, it is illustrated that the participating companies are mainly Original Equipment Manufacturers (OEMs) or Original Equipment Suppliers (OESs) followed by Third-party or Independent remanufacturers (IR). 12 of 105 participating companies have a different business model or did not specify their business model.

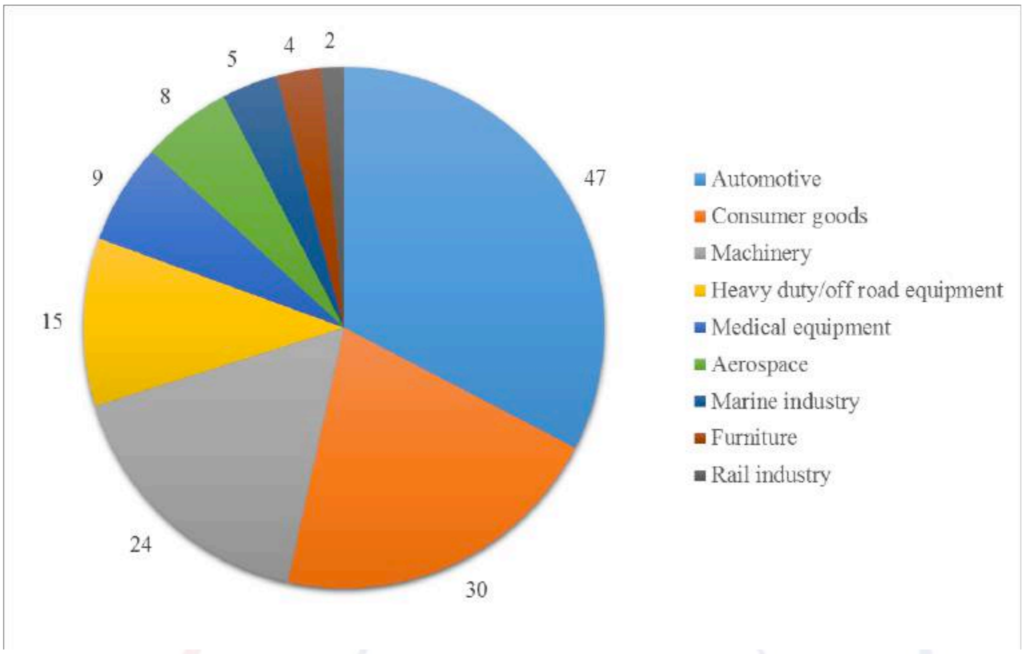

Figure 4: Number of responses sorted by the industry sectors.

Figure 4 illustrates the distribution of the participants by their industry sector. The automotive industry sector is the most mentioned industry sector with 47 indications followed by the consumer goods industry sector with 30 indications and the heavy duty / off road equipment industry sectors with 15 indications.

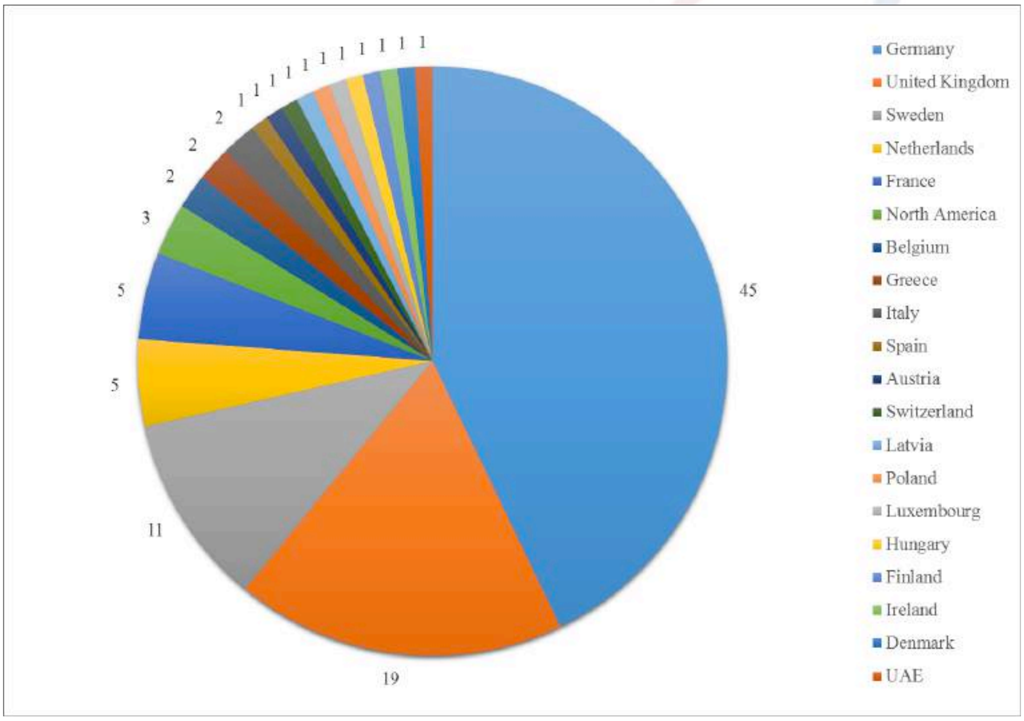

Figure 5: Number of responses sorted by countries (headquarter).

In figure 5, the participating companies are illustrated, sorted by the country of the headquarters. Most of the companies have their headquarter in Germany, followed by the United Kingdom and Sweden.

In the third step, the data were analyzed. Due to the open question asked, within the questionnaire, the data received had to be normalized. That was done in a three-step approach. In the first steps, the process descriptions were analyzed and the terms of the generic process steps described were noted. In the second step, the descriptions indicated the most, were identified. The following eleven generic process steps were identified:

1. Incoming Inspection
2. Disassembly
3. Cleaning
4. Inspection
5. Reconditioning
6. Replace of worn parts with new ones
7. Erase Data
8. Software Installation
9. Consumables Refill
10. Reassembly
11. Final Check

In the third step, all process descriptions were normalized due to the defined descriptions. For example, the text "We have to test and disassemble the parts before we clean them…" was normalized to the following process description and order: Incoming inspection, disassembly, cleaning. Thus, it was possible to aggregate the data gathered.

Results

In this chapter, the main results of the study are presented.
Figure 6 illustrates the distribution of the generic process steps performed in the 105 participating remanufacturing companies.

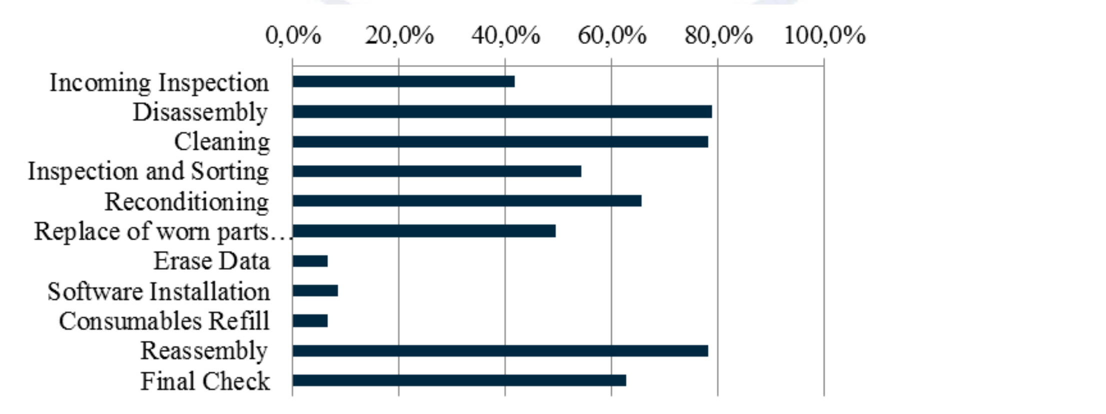

Figure 6: Distribution of generic remanufacturing process steps in remanufacturing.

The generic process steps *disassembling, cleaning and reassembly* are performed in nearly 80 per cent of the companies. The generic process steps *disassembly, cleaning, reconditioning, reassembly* and *final check* are performed at 60 per cent of the

companies, at least. The generic process steps Erase data, software installation and consumable refill aren't performed in more than 10 per cent of the companies.
Following, the distribution of the generic process steps for each of the analyzed industry sectors are shown.

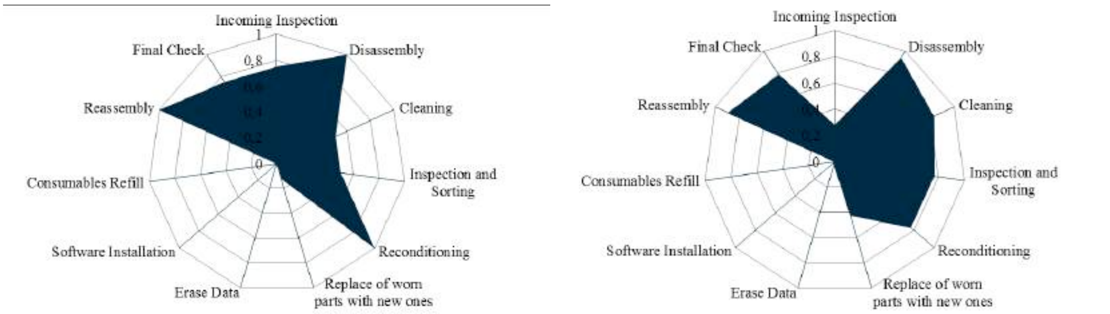

Figure 7: Generic remanufacturing process steps in the aerospace industry (left chart) and the automotive industry (right chart).

The generic process steps, which are performed in at least 60 per cent of the companies in the aerospace industry are: *Incoming inspection, disassembly, reconditioning, reassembly* and *final check*.
In the automotive industry, the generic process steps, which are performed in at least 60 per cent of the companies, are: *Disassembly, cleaning, inspection and sorting, reconditioning, reassembly* and *final check*.

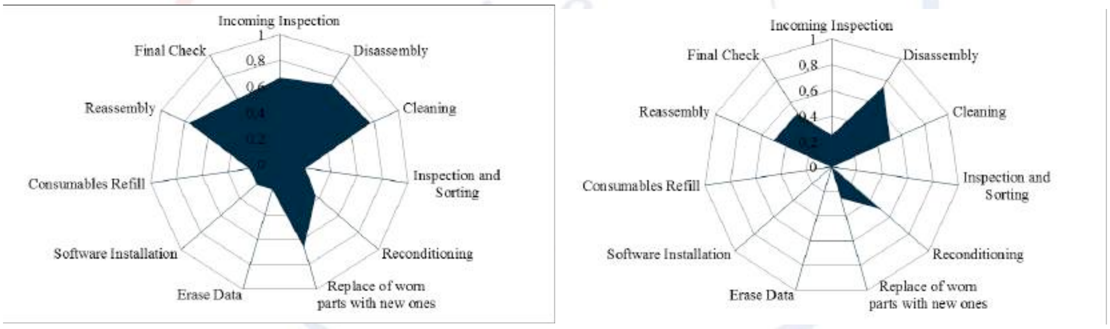

Figure 8: Generic remanufacturing process steps in the consumer goods industry (left chart) and the furniture industry (right chart).

In the consumer goods industry, the generic process steps, which are performed in at least 60 per cent of the companies, are: *Incoming inspection, disassembly, cleaning, replace of worn parts with new ones, reassembly* and *final check*. The generic process steps, which are performed in at least 50 per cent of the companies in the furniture industry are: *Disassembly, cleaning, reconditioning, reassembly* and *final check.*

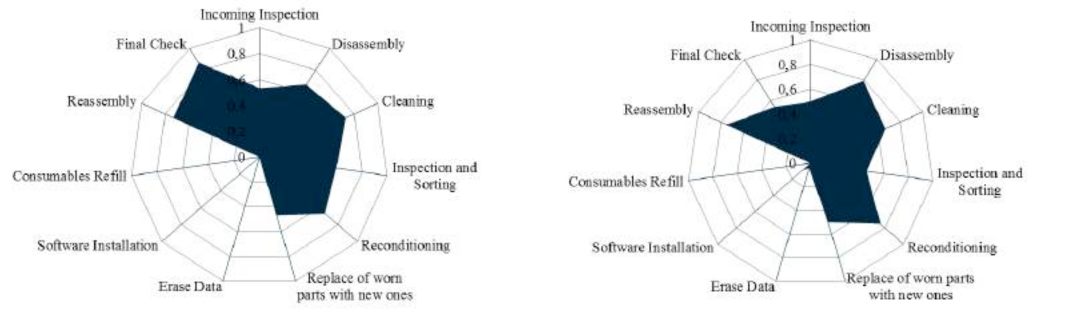

Figure 9: Generic remanufacturing process steps in the heavy duty/off road industry (left chart) and the machinery industry (right chart).

The generic process steps, which are performed in at least 60 per cent of the companies in the heavy duty / off road industry are: *Disassembly, cleaning, inspection and sorting, reconditioning, reassembly* and *final check*.
In the machinery industry, the generic process steps, which are performed by at least 60 per cent of the companies, are: *Disassembly, cleaning, reconditioning and reassembly*. The *final check* is done by 54 per cent of the companies.

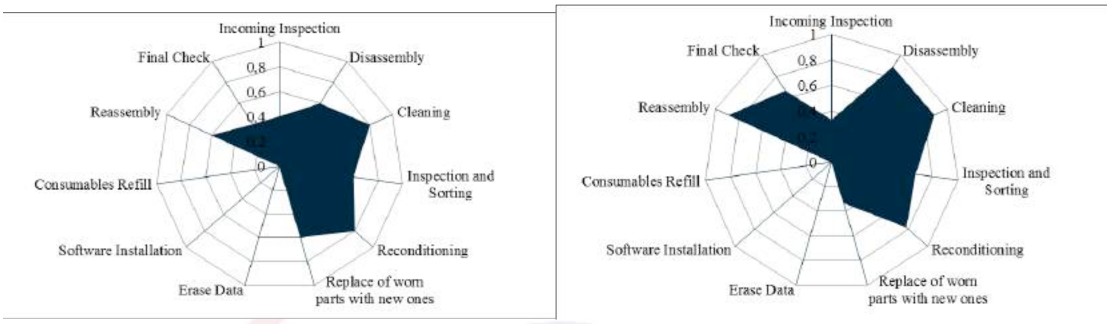

Figure 10: Generic remanufacturing process steps in the marine industry (left chart) and the medical industry (right chart).

In the marine industry, the generic process steps, which are performed by at least 60 per cent of the companies, are: *Disassembly, cleaning, inspection and sorting, reconditioning, replacement of worn parts with new ones* and *reassembly*.
The generic process steps, which are performed in at least 60 per cent of the companies in the medical industry are: *Disassembly, cleaning, inspection and sorting, reconditioning, reassembly* and *final check.*

The result of the rail industry aren't illustrated as only two companies from this industry sector participated in the study. That is not enough to present representative results.

In the figures 11, 12 and 13, the distribution of the generic remanufacturing process steps, depending on the business model, is illustrated.

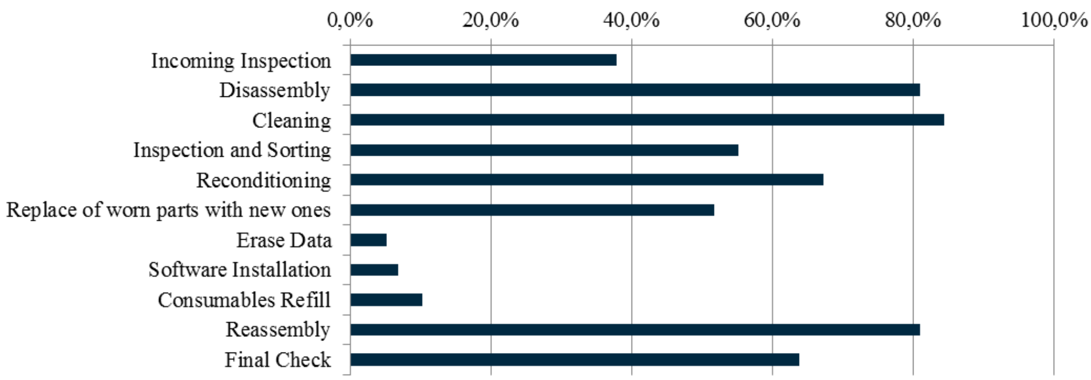

Figure 11: Generic remanufacturing process steps performed within OEMs / OESs.

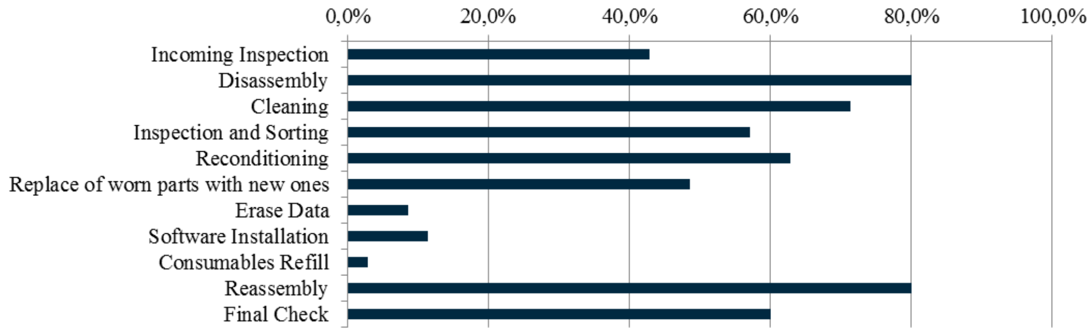

Figure 12: Generic remanufacturing process steps performed within Third-party / Independent Remanufacturers (IR).

According to figure 11 and 12, there is no big difference between the generic remanufacturing processes performed in OEMs/OESs and Third-party / Independent Remanufacturers (IR), besides the role of technical cleanliness. That seems to play a bigger role for OEMs/OESs than it does for Third-party / Independent Remanufacturers (IR).

In the following, the distribution of the generic remanufacturing process steps are presented in more detail.
Figure 13 illustrates, that the generic remanufacturing process step *incoming inspection* is performed mainly in the aerospace industry sector, followed by the consumer goods industry sector. Furthermore, less than 30 per cent of the companies in the automotive and the furniture industry and none of the companies in the rail industry sector perform *incoming inspections.*

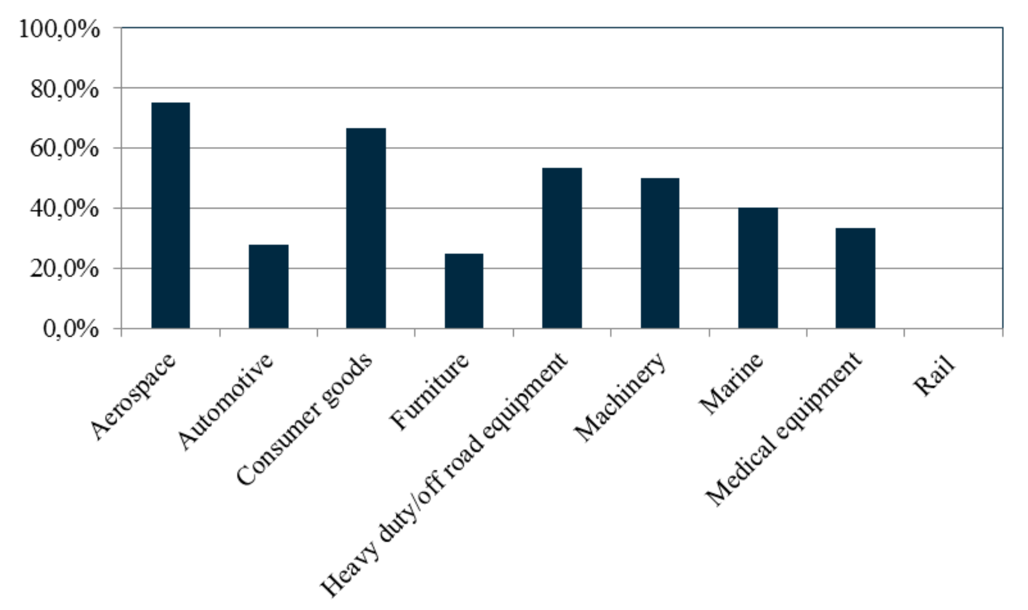

Figure 13: Distribution of the generic remanufacturing process step *incoming inspection.*

In figure 14, it is illustrated, that more than 60 per cent of the companies disassemble their products. It seems, that it is not necessary to disassemble all products in all industry sectors within the remanufacturing process.

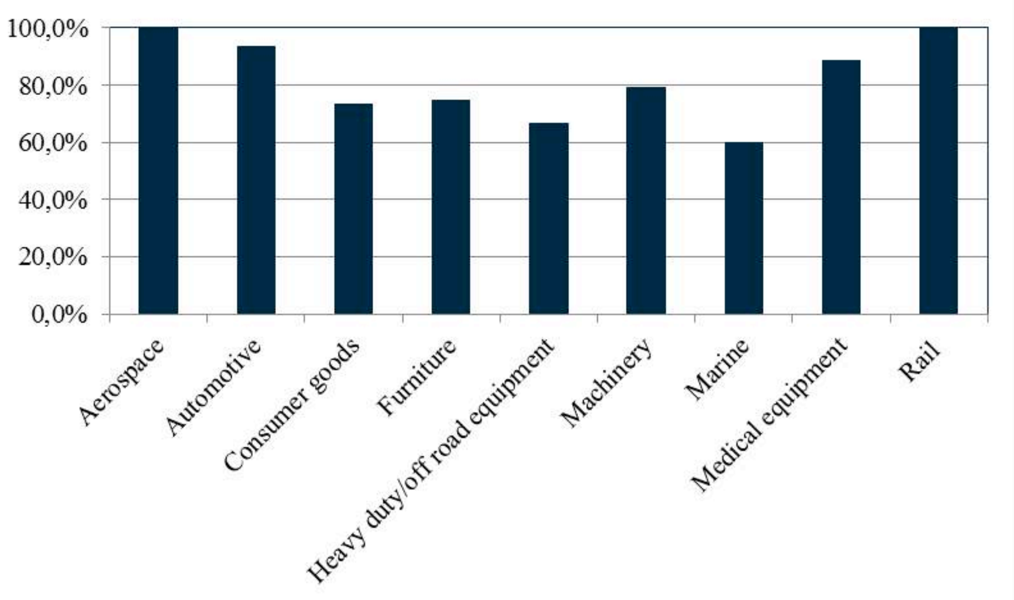

Figure 14: Distribution of the generic remanufacturing process step *disassembly*.

The generic remanufacturing process step *cleaning* is performed at all participating companies in the rail industry sector, probable due to the dirty cores. Furthermore, cleaning is also a big issue in the medical equipment industry sector, probably due to the requirements regarding technical cleanliness in this sector. In the automotive and furniture industry sector only 50 per cent of the companies indicated *cleaning* as one of their generic remanufacturing process steps.

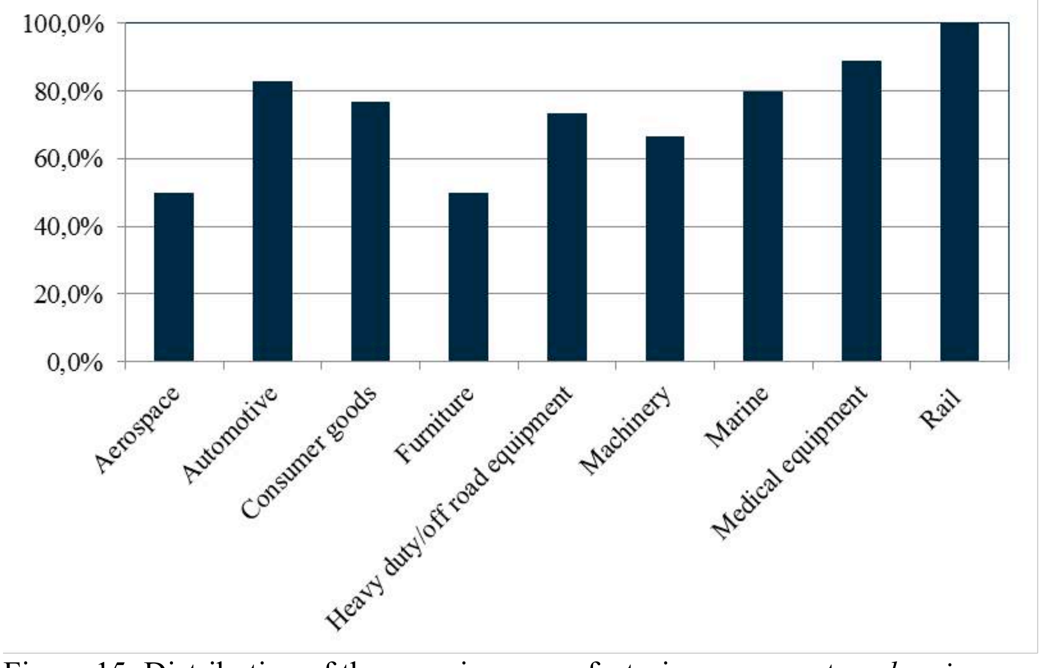

Figure 15: Distribution of the generic remanufacturing process step *cleaning*.

In figure 16, it is illustrated that the generic remanufacturing process step *inspection and sorting* is performed at 100 per cent of the companies in the rail industry sector, but at none of the companies in the furniture industry sector. Also only 20 per cent of the companies in the consumer goods industry sector indicated that process step as a generic remanufacturing process step performed in their companies.

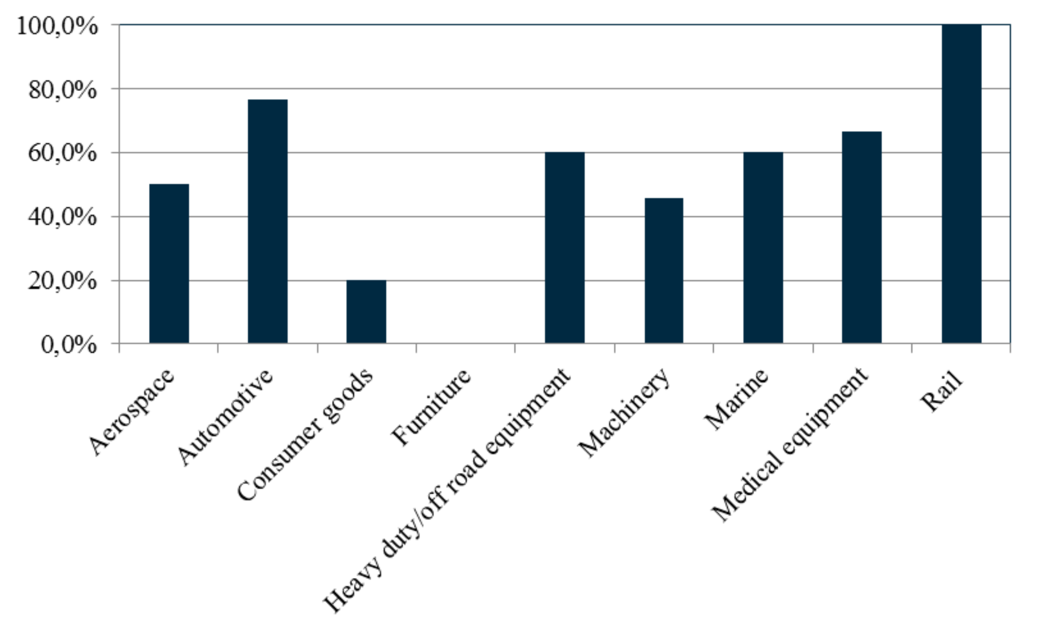

Figure 16: Distribution of the generic remanufacturing process step *inspection and sorting.*

Figure 17 illustrates, that *reconditioning* is performed in all companies in the rail and the aerospace industry sector, but only in less than 50 per cent in companies of the furniture and the consumer goods industry sector. The reason might be, that the remanufacturability of products in the aerospace and the rail industry sector is higher as in the furniture and consumer goods industry sector.

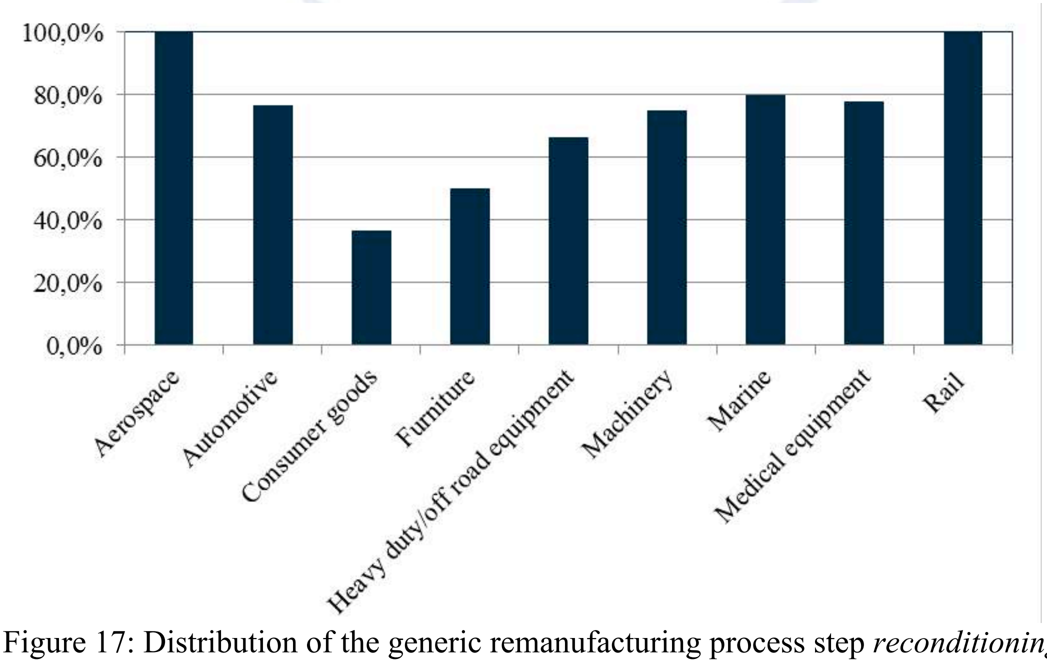

Figure 17: Distribution of the generic remanufacturing process step *reconditioning*.

The *replacement of parts* is mainly indicated as generic remanufacturing process step in the consumer goods industry sector, which is in line with the results shown in figure 17. The relatively high indication within the marine industry sector can be argued with the high wear of the parts in the marine environment.

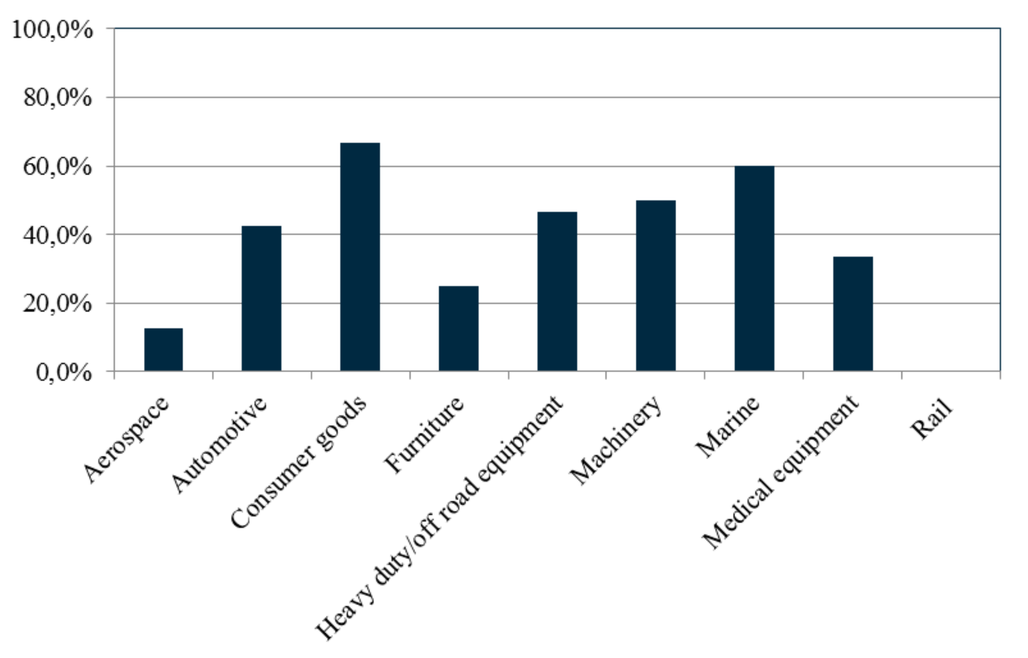

Figure 18: Distribution of the generic remanufacturing process step *replace of worn parts with new ones*.

The generic remanufacturing process step *reassembly* is performed in at least 60 per cent of the companies besides the furniture industry. The reason for that might be, that the products in the furniture industry are assembled at the customers' facilities and not in the facilities of the remanufacturing companies. It also seems, that not only reassembled products are sold but also single parts or components are sold.

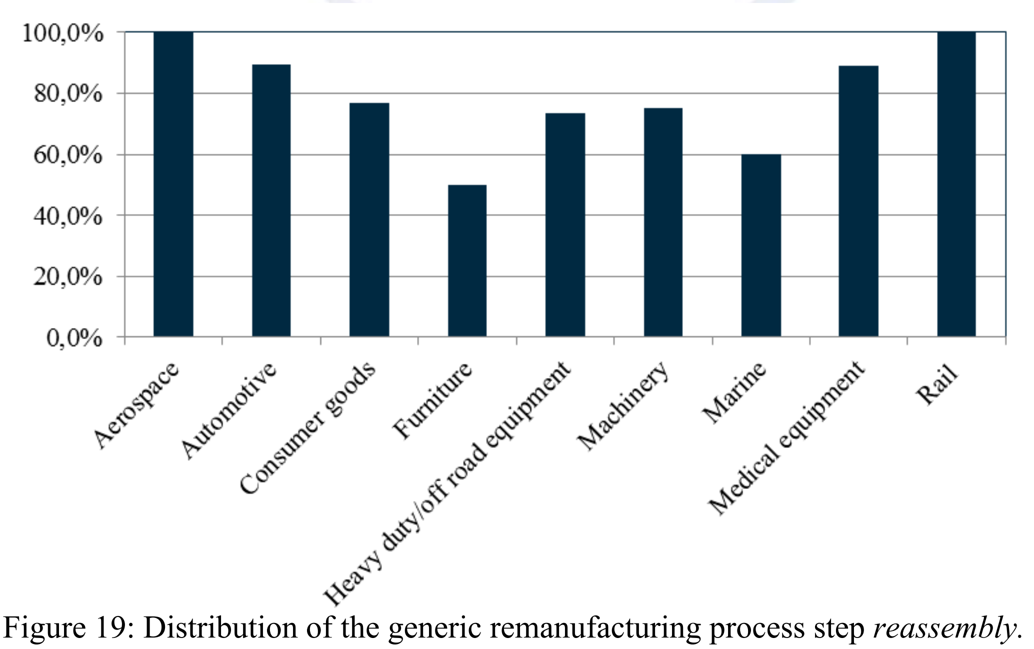

Figure 19: Distribution of the generic remanufacturing process step *reassembly*.

The generic remanufacturing process step *final check* is performed at 100 per cent of the companies within the rail industry sector but only at 40 per cent within the marine industry sector. It might be, that the quality assurance is performed within other generic remanufacturing process steps and thus was not mentioned as a single generic remanufacturing process step.

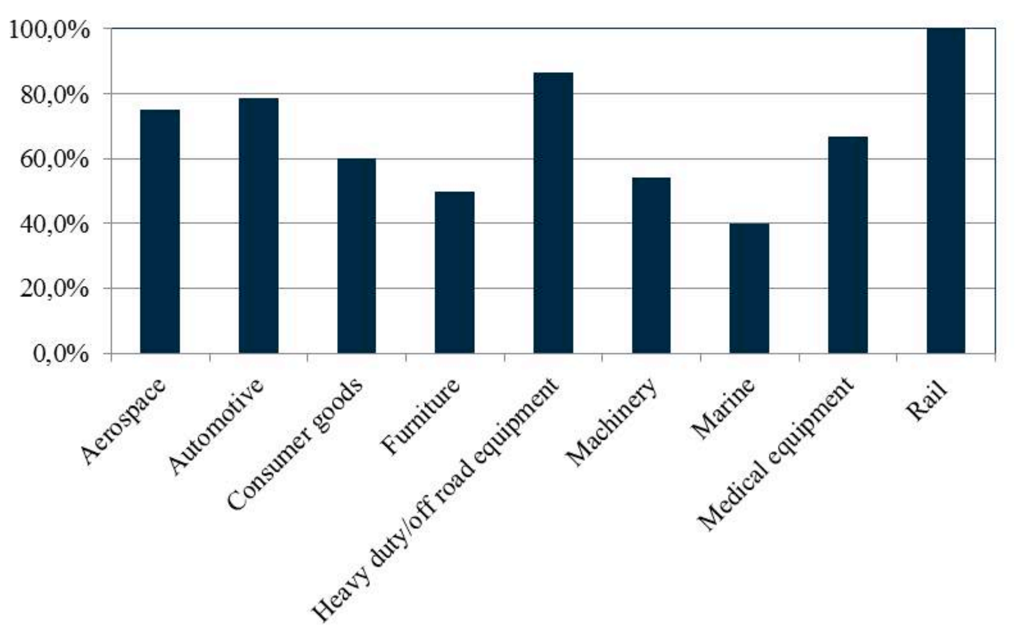

Figure 20: Distribution of the generic remanufacturing process step *final check*.

The generic remanufacturing process step *erase data* is only performed in the consumer goods sector at around 20 per cent of the companies and very little in the machinery and automotive industry sectors. The generic remanufacturing process step *software installation* is performed also in the consumer goods industry sector, the furniture industry sector and the medical equipment at around 20 per cent of the companies each. Furthermore, also very little in the machinery and the automotive industry sector. The *consumables refill* is only indicated as generic remanufacturing process step in the consumer goods industry sector at around 20 per cent of the companies.

Conclusion and Outlook

The aims of the study are to present the industry sector specific remanufacturing processes as well as the similarities and differences of these processes.
Therefore, the data of 105 replied questionnaires, mainly from European remanufacturing companies, were analyzed.

The main results of the study are, that there are differences regarding the generic remanufacturing process steps between the industry sectors. But the generic process steps disassembling, cleaning and reassembly are performed in nearly 80% of the participating companies. The generic process steps disassembly, cleaning, reconditioning, reassembly and final check are performed at 60 per cent of the participating companies, at least.
Furthermore, there is no difference regarding generic remanufacturing process steps performed at OEMs/OESs and Third-party / Independent Remanufacturers.

At the end of the day, the paper supports the remanufacturing industry by creating a better understanding of remanufacturing processes in different industry sectors. The results are the base for workshops with industry representatives to discuss opportunities of cross sectoral learning and exchange of know how.

In future research, we aim to analyze remanufacturing processes in more detail, e.g. production planning and control, disassembly or cleaning. Furthermore, we aim to analyze industry sector specific challenges and potential solutions in more detail. Thus it will be possible to initiate targeted research projects to face todays and tomorrows challenges in the field of remanufacturing.

Acknowledgement
Parts of the data were gathered within the EC-funded project ERN – European Remanufacturing Network. Funded by the Horizon 2020 Framework Programme of the European Union, grant agreement no. 645984.

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Improving Management and Technology Selection Process for Petroleum Hydrocarbon-contaminated Sites by Innovation of 3D Mapping Technology for Soil Characterization

Hamad Almebayedh, University of Salford, UK
Chuxia Lin, University of Salford, UK
Yu Wang, University of Salford, UK

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Summary

To apprehend the decision framework for technology selection, it is important to comprehend the universal principles of applicable technologies for the remediation of petroleum hydrocarbon-contaminated sites. One of the distinguishing characteristics of environmental technology is that the state-of-the-art continually changes.

In this paper, we illuminate the fact that sound strategies for contaminated site remediation must be developed based on comprehensive site investigation and soil characterization. The treatment technologies have been segregated into two major groups, which have also been sub-segregated into three minor groups, and that of which have been segregated into various numbers of treatment technologies.

In this paper we sanctioned that Innovation of 3D soil mapping and site characterization technology for hydrocarbon contaminated sites have a major contribution in gathering field data required to understand the soil spatial variation for both chemical and physical characteristics and properties under and adjacent of the hydrocarbon contaminated sites. Moreover, this have a significant reduction in time, effort, and the cost of the remediation strategy development, and provides exceptional support to the environmental technology selection process and procedure.

This paper assists the remediation projects decision makers for hydrocarbon contaminated sites in the following;

1- To cultivate and support their remediation strategies decisions.

2- To evaluate the technologies on the base of the contaminants and soil characterization

3- Introducing Soil characterization and soil treatment technology screening process and procedure

4- To develop functional hydrocarbon contaminated site project management process and frame work.

5- Screen for possible hydrocarbon contaminated site treatment technologies.

6- Assign a relative probability of success based on available performance data, field use, and engineering judgment.

7- provides rigorous and robust bias-free decision making procedures for remediation of contaminated sites in general and selecting the right remediation technology in specific..

8- Combined generic computational procedures and practical application for soil characterization, and technology selection process for remediating hydrocarbon contaminated sites.

9- The methods developed in this paper would be capable of handling the “relative importance” of decision factors criteria and involves developing a DSS for environmental technology selection.

The remediation technologies of soil contaminated by hydrocarbon and heavy metals, including physical remediation, chemical remediation and biological remediation were focused based on contaminants, and innovative soil and site characteristics technology.

Keywords: 3D Mapping, Soil Characterization, Oil Pollution, Environmental Remediation, Technology Selection .

1. Introduction

Site characterization, contaminant perspectives and site investigation are the major elements in any site remediation strategy decision, they are the gate opener in the process of developing the best environmental and economic treatment options for any hydrocarbon-contaminated site.

Furthermore, soil characteristics is a very important element in the remediation technologies selection process as site soil conditions frequently limit the selection of a treatment process. Soils are inherently variable in their physical and chemical characteristics throughout the contaminated site for some extent, and effected by internal and external conditions.

In any hydrocarbon-contaminated site, the environmental damages require intensive, characterization of the impact and spatial extent of the problems. This can be achieved through the formation of comprehensive and inclusive soil maps that define both the spatial and vertical variability of key soil properties. Detailed three-dimensional (3D) digital soil maps can be readily used and embedded into environmental models, this environmental models will assist in defining the best remediation technology and strategy to tackle complicated hydrocarbon contaminated sites.

For instance, if the 3D mapping illustrates that the soil composed of large percentages of silt and clay all over the hydro-carbon contaminated site and in various level (depth), Soil washing may not be effective because of the difficulty of separating the adsorbed contaminants from fine particles and from wash fluids. Fine particles may delay setting and curing times and can surround larger particles, causing weakened bonds in solidification/stabilization processes. Clays may cause poor performance of the thermal desorption technology as a result of caking. High silt and clay content can cause soil malleability and low permeability during steam extraction, thus lowering the efficiency of the process. Microbial diversity and activity in bioremediation processes also can be affected by extreme pH ranges and high temperature.

The first step for any remediation strategy of hydrocarbon-contaminated sites in analyzing the problem is site investigation and soil characterization, section Two below describe the top edge hydrocarbon site management and the initial concept in developing remediation strategy for hydrocarbon contaminated sites.

2. Contaminated Site Management and Technology Selection Process

The Contaminated Site Management Process and technology selection consists of seven steps from the time that contamination is discovered to final site remediation and closure. The following steps defines the overall management process in the technologies screening and selection process.

Step 1: Initial Notification.
Step 2: Initial Site Assessment and site characterization.
Step 3: Chose Technology Group (In Situ-EX Situ).
Step 4: Technology screening within the chosen group, (Treatment Technology Screening Matrix, http://www.frtr.gov/matrix2/section3/table3_2.pdf , May 2014). https://frtr.gov/matrix2/section3/table3_2.pdf
Step 5: Prepare and submit Remedial Action Plan.
Step 6: Remedial Action Plan Implementation.
Step 7: Closure Report and issuing letter advising that no further remedial action is required, (Remediation of Petroleum-Contaminated Soils, National Cooperative Highway Research Program, David J. Friend, 1996).

These steps are summarized at Figure 1 below Contaminated Site Management and Technology Selection Process (CSM&TSP) (Hamad Almebayedh,2014).

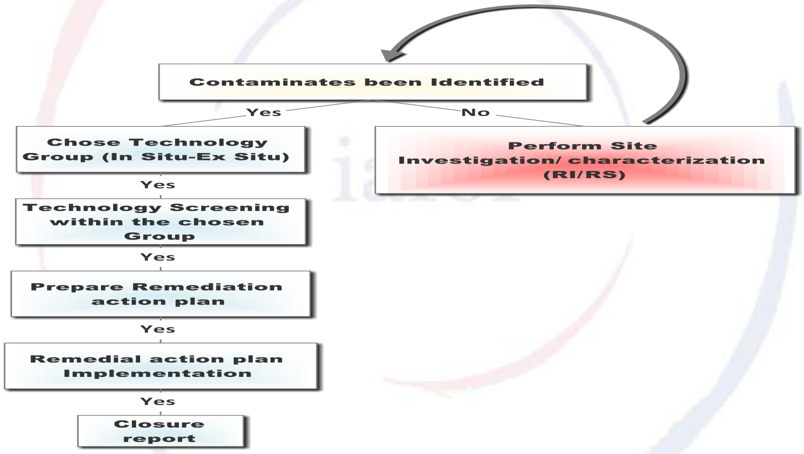


FIGURE 1 Contaminated Site Management and Technology Selection Process (CSM&TSP)

As described above site investigation and soil characteristics is the main element in the remediation technologies selection process, site soil conditions frequently limit the selection of a treatment process.

For all remedial investigation and cleanup sites, the vertical and horizontal contaminant profiles (Contaminant perspectives section below) should be defined as much as possible. Information on the overall range and diversity of contamination across the site is critical to determine the most efficient and effective treatment technology (The 3D mapping technology presented section below) is a major element in the site investigation and soil characterization. Obtaining this information generally requires taking samples and determining their physical and chemical characteristics (Sampling procedure and data requirement section below) describe the need for each of the element and data of the sampling information require with examples on the remediation technology selection and eliminating process. If certain types of technologies are candidates for use, the specific data needs for these technologies can be met during the initial stages of the investigation as provided on https://frtr.gov/matrix2/section3/table3_2.pdf (Remediation Technologies Screening Matrix and reference Guide, Version 4.0), May 2014.

3. Contaminant Perspectives

This is the first step in any site investigation process, addresses contaminant properties, their behavior and preliminarily identification of potential treatment technologies based on their applicability to specific contaminants and media. There are eight contaminant groups, as determined by the Federal Remediation Technologies Roundtable (FRTR), FRTR (Remediation Technologies Screening Matrix and reference Guide, Version 4.0), May 2014:

- Nonhalogenated Volatile Organic Compounds (VOCs).
- Halogenated Volatile Organic Compounds (VOCs).
- Nonhalogenated Semivolatile Organic Compounds (SVOCs).
- Halogenated Semivolatile Organic Compounds (SVOCs).
- Fuels.
- Inorganics.
- Radionuclides.
- Explosives.

More details concerning contaminant groups provided at FRTR (Remediation Technologies Screening Matrix and reference Guide, Version 4.0), May 2014.

4. Data required

For any hydrocarbon contaminated site a specific sampling procedure must be developed. In this research paper we are introducing one of the most cost-effective with a major consideration to the quality of the data.

a. Soil particle-size distribution;
b. pH, Soil homogeneity and isotropy;
c. Particle density,
d. Soil permeability,
e. $\mathbf{E_h}$ areas,
f. $\mathbf{K_{ow}}$,
g. Humic content,
h. Total organic carbon (TOC),
i. Volatile hydrocarbons,
j. Biochemical oxygen demand,
k. Electron acceptors,

The required data above could be determined by data collected from the field investigations, and lab analysis to be then implemented on our 3D mapping hydrocarbon contaminated soil technology.

5. Technology Treatment Groups

In this paper we have segregated the remediation technology in to Tow groups, these groups are In Situ and Ex situ, these Two groups have been segregated in to Three groups, this is to enhance our technology decision screening process and to eliminate the non-suitable technology. The in situ and Ex situ technologies are categorized into three major groups based on the primary mechanism by which treatment is achieved:

- Physical/Chemical Treatment Technologies
- Biological Treatment Technologies
- Thermal Treatment Technologies

Table 1, (Remediation of Petroleum-Contaminated Soils, National Cooperative Highway Research Program, David J. Friend, 1996).

General Category	Type of Process	Technology applied in-Situ	Technology Applied Ex-Situ
Treatment	Biological	• Passive biodegradation • Bioventing • In-Situ Biodegradation	• Biopiles • Land treatment or landfarming • Slurry biodegradation • Composting
	Physical	• Soil Venting - Conventional - Hot air or steam stripping • Soil flushing	• Soil washing • Coal tar agglomeration
	Chemical	• Chemical Oxidation/reduction	• Chemical Oxidation/reduction • Solvent extraction
	Thermal	• Radio frequency (RF) heating • Vitrification	• Thermal desorption by: -Low and high temperature. -Thermal strippers - Hot-mix asphalt plants • Virification
Containment	Other	• Solidification/stabilization • Capping	• Solidification/stabilization • Microcantaminated by cold-mix asphalt • Capping or re-use • Land disposal or Land filling

Table 1 Technology Treatment Groups

6. 3D mapping technology for soil characterization of hydrocarbon contaminated sites

Fabio Veronesi (2012) concluded that high resolution 3D mapping technology can be used to estimate soil properties achieving a reasonable accuracy even with relatively poor data support, thus minimizing the cost of the survey, and which can practically be applied over large areas. In the first stage the primary objective was the development of a new method for accurately mapping soil properties in 3D; a method that was easier to use than 3D geostatistics and sufficiently flexible to be used with less dense datasets. The method was extensively tested, validated and compared to the established method of 3D ordinary kriging. This stage of research concluded that a novel method had been developed, which can obtain high level of accuracy in mapping soil compaction, performing much better than 3D ordinary kriging. This method is much easier to use compared to 3D geostatistics, because it relies on bi-dimensional interpolation; it is also flexible as it can be used with much less analytical data losing only a fraction of its accuracy.

7. Hydrocarbon contaminated soil Treatment Technology recommended according to data acquired

Site soil conditions frequently limit the selection of a treatment process. Process-limiting characteristics such as pH or moisture content may sometimes be adjusted. In other cases, a treatment technology may be eliminated based upon the soil classification (e.g., particle-size distribution) or other soil characteristics presented at section 4 above and presented below.

- Soil particle-size distribution is an important factor in many soil treatment technologies. In general, coarse, unconsolidated materials, such as sands and fine gravels, are easiest to treat. Soil washing may not be effective where the soil is composed of large percentages of silt and clay because of the difficulty of separating the adsorbed contaminants from fine particles and from wash fluids. Fine particles also can result in high particulate loading in flue gases from rotary kilns as a result of turbulence. Heterogeneities in soil and waste composition may produce nonuniform feedstreams for many treatment processes that result in inconsistent removal rates. Fine particles may delay setting and curing times and can surround larger particles, causing weakened bonds in solidification/stabilization processes. Clays may cause poor performance of the thermal desorption technology as a result of caking. High silt and clay content can cause soil malleability and low permeability during steam extraction, thus lowering the efficiency of the process.
- Soil homogeneity and isotropy may impede in situ technologies that are dependent on the subsurface flow of fluids, such as soil flushing, steam extraction, vacuum extraction, and in situ biodegradation. Undesirable channeling may be created in alternating layers of clay and sand, resulting in inconsistent treatment. Larger particles, such as coarse gravel or cobbles, are undesirable for vitrification and chemical extraction processes and also may not be suitable for the stabilization/solidification technology.
- Particle density is the specific gravity of a soil particle. Differences in particle density are important in heavy mineral/metal separation processes (heavy media separation). Particle density is also important in soil washing and in determining the settling velocity of suspended soil particles in flocculation and sedimentation processes.
- Soil permeability is one of the controlling factors in the effectiveness of in situ treatment technologies. The ability of soil-flushing fluids (e.g., water, steam, solvents, etc.) to contact and remove contaminants can be reduced by low soil permeability or by variations in the permeability of different soil layers. Low permeability also hinders the movement of air and vapors through the soil matrix. This can lessen the volatilization of VOCs in SVE processes. Similarly, nutrient solutions, used to accelerate in situ bioremediation, may not be able to penetrate low-permeability soils in a reasonable time. Low permeability may also limit the effectiveness of in situ vitrification by slowing vapor releases.
- The pH of the waste being treated may affect many treatment technologies. The solubility of inorganic contaminants is affected by pH; high pH in soil normally lowers the mobility of inorganics in soil. The effectiveness of ion exchange and flocculation processes may be negatively influenced by extreme pH ranges. Microbial diversity and activity in bioremediation processes also can be affected by extreme pH ranges.

➢ Total organic carbon (TOC) provides an indication of the total organic material present. It is often used as an indicator (but not a measure) of the amount of waste available for biodegradation. TOC includes the carbon both from naturally-occurring organic material and organic chemical contaminants; however, all of it competes in reduction/oxidation reactions leading to the need for larger amounts of chemical reagents than would be required by the contaminants alone.

Furthermore, the effectiveness of technology section 5.3 must be considered during the technology selection process.

8. Case Study: Characterization of Soils beneath Oil Lakes in Kuwait

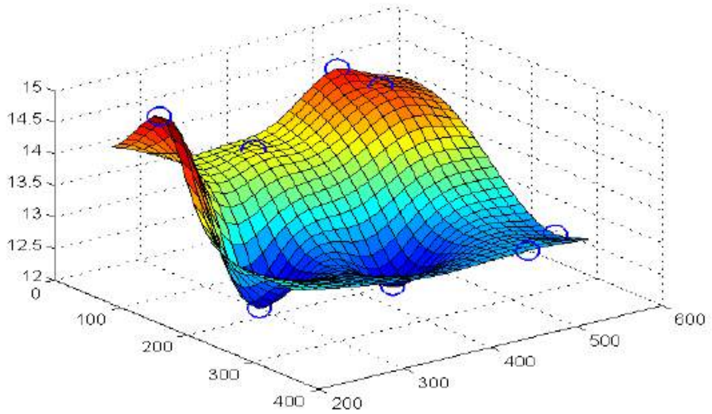
There are currently a few thousand oil lakes in Kuwait, which represent a serious threat to human health and ecosystems. The soils underneath and adjacent to the oil lakes were heavily contaminated by petroleum hydrocarbons and therefore requires remediation.

Selection of appropriate soil remediation methods and techniques needs to be informed by accurate soil characterization. Currently, soil investigation into petroleum hydrocarbon-contaminated soils in oil lake area involves grid sampling with a high horizontal sampling density. However, vertical variation in petroleum hydrocarbon concentration along the soil profile is not sufficiently considered. This approach could lead to substantial costs due to intensive horizontal sampling on one hand and inaccurate estimation of the volume of soils that need to be treated.

Our proposed methods to improve the cost-effectiveness of soil characterization include: (a) taking into account the vertical variation in both total petroleum hydrocarbon and various hydrocarbon species; and (b) using 3-D mapping technology to establish models for spatial distribution of petroleum hydrocarbons in oil lake-affected soils with markedly reduced sampling density.

Figure2

The *Inverse Distance Weighting* (IDW) is an effective method for spatial interpolation. IDW method estimates the degree of contamination by weighting of values of sampling data in each cell. This method assumes that value of variables on the map decreases with the increase of the distance from their sampling sites (*N. Drešković and S.Đug, 2012, Application of the Inverse Distance Weighting and Kriging methods of the Spatial Interpolation on the mapping the Annual Amount of Precipitation in Bosnia and Herzegovina, International Environmental Modelling* *and Software Society (iEMSs) 2012 International Congress on Environmental Modelling and Software Managing Resources of a Limited Planet, Sixth Biennial Meeting, Leipzig, Germany R. Seppelt, A.A. Voinov, S. Lange, D. Bankam (Eds.)*). In this case, the spatial distribution of contamination value influence decreases directly proportionally with the increase of the distance from the sampling points. Using this method, we can control sampling sites in terms of the importance of known points. In addition, IDW method can take account the influences of different variables together. Seeing that the contamination degree closely related to the geo-composition and geo-transportation parameters, These factors will be incorporated into the mapping algorithm in our research.



3D Mapping Technology for Soil Characterization of Hydrocarbon Contaminated Sites
(Figure 3)
Figure 3 above demonstrates the IDW interpolated hydrocarbon distribution in the highly hydrocarbon contaminated areas in Red which required a remediation treatment technology, the volume and the contamination distribution easily could be calculated. Soil particle-size distribution, pH, Soil homogeneity and isotropy, Particle density, Soil permeability, Eh areas, Kow , Humic content, Total organic carbon (TOC), volatile hydrocarbons, Biochemical oxygen demand, electron acceptors, Oil and grease. This all could be determined by the data collected from the field, and lab investigations analysis obtain through our sampling procedure provided in 5.1. This 3D mapping innovative technology will provides great information to develop our cost and time effective remediation strategy. Subsequent to analyzing the information provided from our 3D hydrocarbon contaminated mapping technology our segregation and technology selection process will be generated by excluding the not acceptable remediation technology for the related contaminated site as per section 7of our research.

6. Effectiveness of Technologies

There are many applicable technologies for treating sites contaminated with petroleum hydrocarbon as demonstrated in section 5 below, Table 1, and section 7. The effectiveness of these technologies, however, is dependent on contaminant and site characteristics, regulatory requirements, cost and time limitations (Figure 4). This guideline describes the process that is used to manage (e.g. identify, assess, remediate) contaminated or potentially contaminated sites. In some cases, it is possible to focus on specific remedies technology that have been proven under similar conditions.

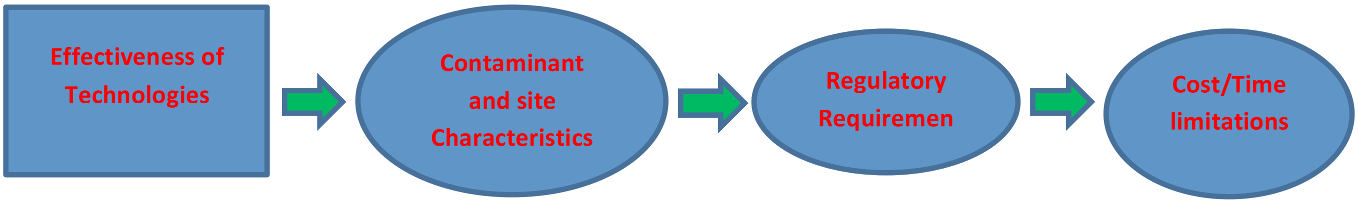


FIGURE 4 Effectiveness of Technologies Dependency (ETD)

Conclusions

In this research paper we concluded that to build up any remediation strategy for any hydrocarbon contaminated site the steps presented in this research paper must be followed to achieve the optimum QA/QC, cost effective and time objective of remediation project This concludes the fact that for all remedial investigation and cleanup sites the following information are needed; site characteristics, site contaminants, regulatory acceptance of technology, technology availability, treatment time objectives, and project life-cycle costs/time. The specific data needs for screening these technologies can be met during the initial stages of the investigation as presented on section 2 of this to support and develop the environmental technology selection process and procedure

The developed 3D mapping for hydrocarbon contaminated soil innovative technology presented in this paper provides great information to develop cost and time effective remediation strategy. Subsequent to analyzing the information provided from our 3D hydrocarbon contaminated mapping technology our segregation and technology selection process will be generated by excluding the not acceptable remediation technology for the related contaminated site as per section 7 of our research paper. The remediation technologies of soil contaminated by hydrocarbon including physical remediation, chemical remediation and biological remediation presented in this research. This research project provides a reference and guide to evaluate the technologies in scientific and engineering manors, developing novel environmental remediation strategies and risk based approach for environmental remediation projects in general, and provide novelty in screening the right technologies for a certain environmental problem.

This research provides rigorous and robust bias-free decision making procedures by selecting the best projects/options to get best value. This research project combine development of generic computational procedures and/or practical application based on the case studies. The methods developed capable of handling the “relative importance” of decision factors criteria and involves developing a DSS for environmental technology selection.

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Contact email: H.Almebayedh@edu.salford.ac.uk,
C.Lin@salford.ac.uk,
y.wang@salford.ac.uk

Low Cost Taxis – An Environmentally Friendly Low Cost Transport. A Study made at the City of Lisbon, Portugal

José Miguel Aragão Celestino Soares, ISEG Lisbon School of Economics & Management, Universidade de Lisboa, Portugal
Fernanda Maria de Almeida Santos Mendes, Laureate International Universities, Portugal

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Abstract
This project, nesting in the entrepreneurism area, aims to develop an innovative road transport network for passengers (TAXI) at the city of Lisbon, Portugal, combining energy efficiency with the reductions of costs associated with the operation of the network.
This research highlights the importance of entrepreneurism and the role of the entrepreneur in the Portuguese economic conjuncture, showing its influences and contributes, as well as the main blockage factors to the creation of new ventures.
The research presents some means that encourages the practices of entrepreneurism and venture creation, through the demonstration of a legal investment solutions set, as well as managerial formation.
The analysis of the type of fuel that is used, leads us to conclude that the electric car is the most beneficial solution to passenger transportation. Nowadays, the most feasible solution, taking into account the economic conjuncture and the environment protocols, is the hybrid car transportation.
We checked that it is possible to create, using the electrical car, a road transport network for passengers (TAXI) at substantial lower costs for the driver, as well as for the passenger. Likewise, we also verified that it is possible to reduce the levels of pollutant gases emissions to near zero, without any loss of competitiveness in the exercise of the activity.

Keywords: Entrepreneurism, Taxi, Environmental friendly transport, electric car, zero gases emissions.

Introduction

The choice of an entrepreneurial project in the area of passenger transportation arises for two reasons:

• The importance of emphasizing environmental aspects, trying to find a sustainable and plausible solution to reduce CO_2 emissions in the urban environment;

• The attempt to change the current perspective of how prices are charged to passengers in passenger transportation of Lisbon (TAXI), finding alternative solutions to generate wealth.

The objective of the project is to evaluate and compare the different types of motor vehicles on the market, namely Gasoline, Diesel, Liquefied Petroleum Gas (LPG) or Natural Gas, Hybrid and Electric vehicles.

The choice of Lisbon for the implementation of a new concept of passenger transportation is obvious to someone who moves daily in Lisbon, given the size of the market, road traffic and passenger traffic registered every day. On the other hand, it is due to the growing environmental concern of State institutions, including the Municipality of Lisbon.

Literature review and research questions

Entrepreneurship is not a new phenomenon in history. It exists since the first innovative human action, in order to improve man's relationship with others and with nature (Dolabella, 2008), and is also seen in a perspective of uncertainty inherent to all human action (Miles, 1949 apud Kirzner, 1997).

Jean-Baptiste Say, who is considered "the father of entrepreneurship", associates entrepreneurs to innovation, and saw them as agents of change (Filion, 1999). We can say that the entrepreneurial spirit in man dates back to pre-history, from the invention of the wheel. In fact, the human species is entrepreneurial, and we can even consider that it is something that is born with Man (Dolabella, 2008).

However the word entrepreneurship goes beyond a mere invention, it refers to how to do things differently in the realm of economic life (Schumpeter, 1999). It is the manifest and willingness of individuals (on their own or in teams, within or outside existing organizations) in perceiving and creating new economic opportunities (e.g.: new products, new production methods, new organizational schemes and new market combinations) (Wennekers & Thurik, 1999).

Hart (2003) defines entrepreneurship as a process of starting and continuing to expand new businesses. In fact, entrepreneurship is defined as any attempt to create a new business or initiative that, whether in temporal or spatial context, influences the economy (GEM, 2004; Kirzner, 1997).

Entrepreneurship can play an important role in the global economy. Its absence in the theories of markets, companies, organizations and changes makes the understanding of the business landscape incomplete (Shane & Venkataraman, 2000).

Some authors argue that entrepreneurship has little contribution to economic growth and development, especially in poorer countries and might even be socially useless (De Meza & Southey, 1996; Shane, 2009; Naudé, 2011). Others argue that there is a positive interaction between economic growth and entrepreneurship as a business activity, and therefore that they are not an independent phenomena (Dejardin, 2000).

In addition, for the Global Entrepreneurship Monitor (GEM), entrepreneurship is itself a driver of employment and economic growth. The creation of new businesses implies an investment in the local economy, creating new jobs, promoting competitiveness and the development of innovative business tools (GEM, 2004a).

The European Commission, through the Green Paper program (European Commission, 2003), which encourages entrepreneurship in Europe, points out as important reasons for the practice of entrepreneurship: economic growth, job creation, competitiveness improvement, the use of individuals' potential and the exploitation of society's interests (for example, environmental protection, education and social security services, and production of health services).

Entrepreneurship has been considered as a strong driver of business development. Schumpeter emphasizes the entrepreneur's role as the main agent and responsible for the introduction and development of new technologies, contributing to the redesign or replacement of outdated processes and products. The entrepreneur is seen as an agent of change (Schumpeter, 1999), the agent that brings together all the means of production, taking advantage of opportunities with the prospect of profit, taking calculated risks. Entrepreneurship is then the ability to design and establish something from very little or almost nothing (Filion, 1999).

Entrepreneurship comes primarily through two types of impulses of economic nature (Baptista, Teixeira & Portela, 2008), the so-called "necessity" entrepreneurship and "opportunity" entrepreneurship (Ferrão, Conceição & Baptista, 2005).

"Necessity" entrepreneurship results mainly from the lack of employment opportunities or unfavorable conditions in the labor market. It is a social reaction to the lack of stable employment opportunities (GEM, 2004a). The individual, by being "pushed" to the creation of his own business, finds the solution for his survival (Ferrão et al., 2005).

Naudé (2011) argues that necessity entrepreneurship does not focus much in business creation and economic development, as its concern is of a more personal nature in an attempt to generate wealth.

On the other hand, the "opportunity" entrepreneurship appears from the detection and use of an innovative new business idea (Ferrão et al., 2005). It is usually developed by individuals who have greater personal skills and capabilities of economic nature, whether rooted in the individual (personality, attitudes, self-esteem, etc.), whether acquired at work or through training and education (skills, knowledge and experience) (Man & Lau, 2005). Statistically, in the vast majority of countries "opportunity" entrepreneurship is greater than the new business creation arising from necessity (GEM, 2004a).

In a simplified definition, opportunities are no more than situations in which new goods, services, raw materials and organizing methods can be marketed and sold above their cost of production (Casson, 1982 apud Shane & Venkataraman, 2000).

Ducker cited by Shane and Venkataraman (2000), describe three different categories of opportunities: (1) creation of new information, as in the invention of new technologies; (2) exploitation of market inefficiencies, as happens over time and geography; (3) reaction to the changes, as with political, legislation, or demographic changes.

Individuals with greater entrepreneurial capacity, more information on products, markets, processes and technology, and with lower risk aversion, anticipate more easily a particular business opportunity that will be potentially lucrative (Portela, Hespanha, Nogueira, Teixeira & Baptista, 2008). The individual should play a proactive role to better identify and recognize the opportunities, and thus individual and situational differences can influence this recognition process (Ardichvili, Cardozo & Ray, 2003).

However, the concept of entrepreneurship in a broader perspective is not only about creating new businesses (Antončič & Hisrich, 2001).

If, on the one hand, there are entrepreneurial strategies that seek new opportunities by creating new organizations, we find the existence of that search for opportunities in existing organizations (Figure 1). Once the surrounding environment is constantly changing, opportunities may arise not only as a new design but also as a reformulation of what already exists (Plummer, Haynie & Godesiabois, 2007).

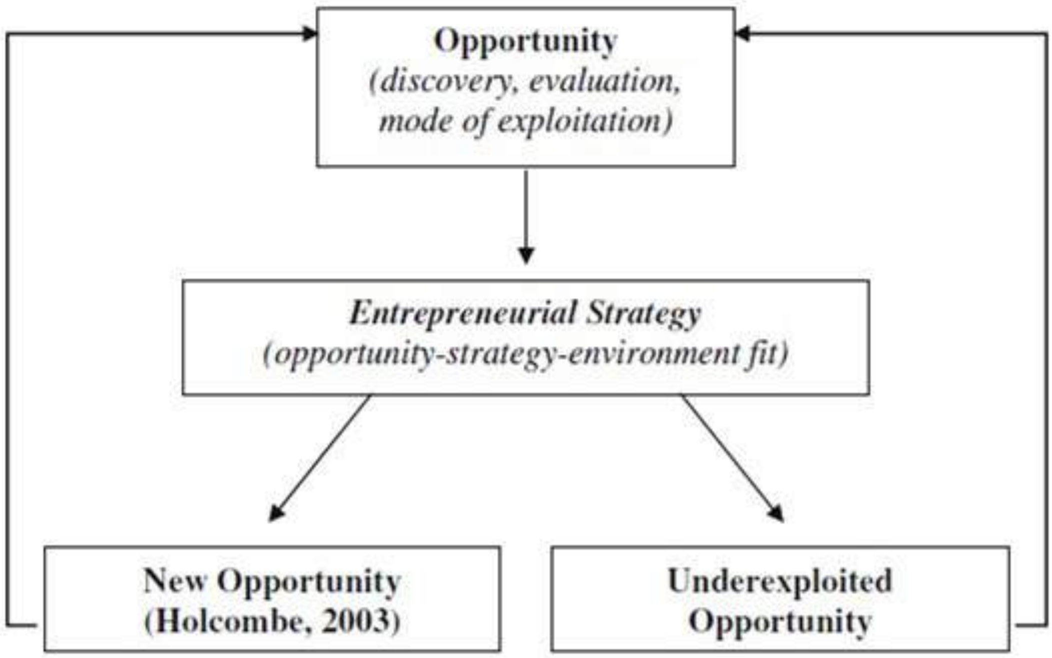

Figure 1: Basic Structure of Business Process
Source: Plummer et al., 2007

Entrepreneurship thus assumes an important role within organizations, finding new solutions to meet the challenges of the moment (Antončič & Hisrich, 2001), and is part of the management function within existing companies (Hitt, Ireland, Camp & Sexton, 2001). In a study by Stevenson and Jarillo (1990), entrepreneurship is seen as a process in which individuals within organizations do new, and out of the ordinary, things in search of new opportunities.

Given that the market is increasingly competitive, companies require their professionals to have entrepreneurial attitudes and characteristics (Dolabella, 2008). These characteristics play a necessary role in the development and growth of the various business sectors (Pasquini, Rodrigues, Vendrame, Sarraceni & Ribeiro, 2009), not only by the creation of new projects, but also by the creation of other innovative activities and guidelines, such as: developing new products, services, technologies, administrative techniques, competitive strategies and positioning (Antončič & Hisrich, 2001).

In an attempt to clarify the explanation, Figure 2 shows the entrepreneurial process in existing organizations, defined as "Intrapreneurship".

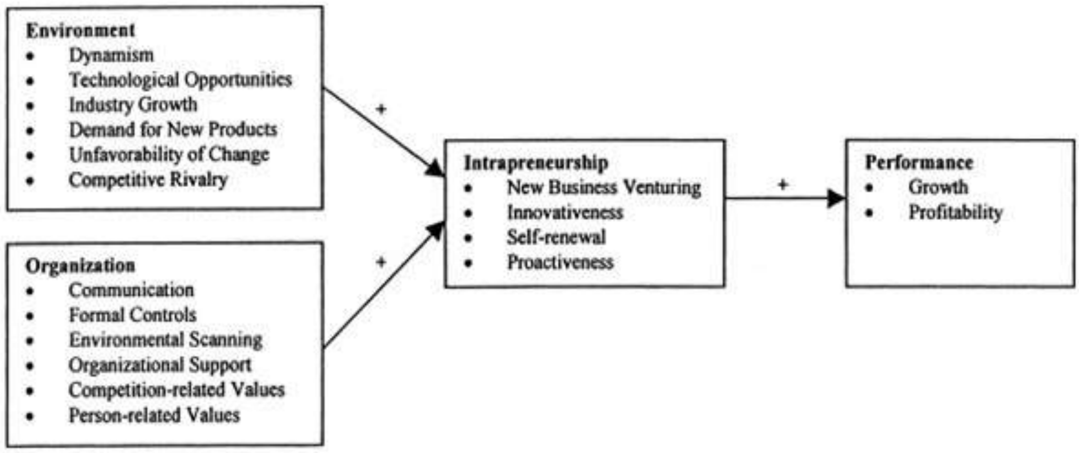

Figure 2: Intrapreneurship model and direct effects
Source: Antoncic & Hisrich, 2001

New firms are a key element for technological development and balance of markets, through new and more technologically advanced investments, exploring new business opportunities and a more efficient use of resources (Statistics Portugal, 2007).

For Wood (2011) entrepreneurship initiatives allow to develop opportunities to generate revenues, which are needed to help stimulate the economy. Simultaneously, at the social level, new companies can play an equally important role in job creation.

The entrepreneur is the one who presents his ideas to the market, and given the uncertainty and obstacles, makes decisions about the location, manner and use of resources and methods (Wennekers & Thurik, 1999). It is a creative person, marked by the ability to set and achieve goals, where his views serve as motivation to achieve success (Filion, 1999). The entrepreneur is someone who can identify, grasp and seize an opportunity, turning it into a successful business. The entrepreneur is basically a person who sees the change as the norm and explores it as being an opportunity (Pasquini et al., 2009).

Entrepreneurs' behavior, attitude, belief, intelligence, knowledge and skills are essential to respond and resolve the demands he sets to himself (Bonnstetter, 1999). Given adverse conditions, it is in the best configuration of these characteristics that entrepreneurs find ways that allow them to take advantage of their ideas (United Nations, 2004).

The entrepreneur is the person who takes risk, by investing his own money. It is also the agent that brings together all the means of production (e.g.: product, investment, wages, rents, etc.) in order to obtain profit, power and prestige (Baumol, 1990). Entrepreneurship is the result of the strategic merge of analytical and creative intelligence and successful practice, and what makes it different is his success, so the entrepreneur not only needs to create product or services ideas, he is also demanded to come up with the type of product or service (Sternberg, 2004).

Entrepreneurs are people who feel the opportunities before others, take risks and act proactively, taking the uncertainty of operating in new markets, they develop new products and form innovative mechanisms or processes to provide services. Entrepreneurs are important agents of economic growth, marketing new products, new production methods, new methods of exploration and innovations that stimulate economic activity (Ferreira, 2009).

Schumpeter (1999) considers the innovative role of the entrepreneur as a determinant of economic development. By creating new forms and combinations of the using knowledge and capital, it is the entrepreneur who runs and changes the economic order.

The entrepreneur also has certain behavioral traits and some attitudes that drive his action. For Filion (1999) the entrepreneurial action is based on four key factors: the vision, energy, leadership and relationships within the market. Dornelas (2001) goes further and considers that entrepreneurs are individuals who make a difference. They are people dedicated to work, passionate about what they do, builders of their own destiny, independent, dynamic and determined, with a leadership capabilities above the ordinary. Possessors of knowledge, planning very well every step of a business, who know how to exploit the opportunities, who take calculated risks and create added value for society seeking solutions that improve people's lives.

The entrepreneur has some special characteristics, with differences among them. There are some entrepreneurs who create and manage a business with the main objective to get profit and growth, and others whose main objective is personal promotion (Carland, Hoy, Boulton & Carland, 1984).

The success or failure of the business depends heavily on the competence of the person (Capaldo, Iandoli & Ponsiglione, 2004). An entrepreneur should be a permanent student, have a great capacity to share information, be transparent, have a high propensity to work, take risks and be receptive to error.

According to Ruth (2006), an entrepreneur should be able to do, i.e., to have "management skills". The creative spirit must not be destroyed due to bad financial decisions, wrong investments or defective budgets. Knowing how to make a business plan can be a useful tool for the implementation of projects, but education should not influence their skills, nor change the entrepreneurial intentions of individuals (Graevenitza, Harhoffa & Weberd, 2010).

Miraldes and Garcia (2009) also emphasize this idea, claiming that having good ideas is not enough. An entrepreneur, more than having the capacity to implement his ideas, needs to know who will buy it (identify the target client), check if such target is able to purchase the product, and set the price that will be charged.

The entrepreneur keeps a high level of awareness of the environment in which he lives, using it to detect business opportunities, and should have an attentive attitude towards his surrounding environment. He needs to continually learn, not only about what happens in his environment to detect opportunities, but also about what he does to act properly on a given situation (Filion, 1999).

The impact and the size of the exploited opportunity, which determines its expected value, depend greatly on its characteristics. For example, a cure for lung cancer will have a greater dimension than a solution to the need to create meals in a particular high school (Shane & Venkataraman, 2000). The entrepreneur, by exploring an opportunity, should believe that the expected profit will be sufficient to offset the costs, loss of leisure time, and the associated uncertainty (Kirzner, 1997).

A study conducted by the Statistics Portugal (2007) points out as some of the main motivations for the establishment of new businesses in Portugal, the prospect of making more money, and the desire for new challenges. Most of the new entrepreneurial actions require some funding and support, an issue that has been identified as one of the most significant determinants for the low initiative rates and growth of new companies, both in creation (size of the initial investment) and survival (resources required for business growth in the early years) (Ferrão et al., 2005).

In this study were identified the following research questions:

• Is it possible to exist a TAXI model that reduces CO_2 emissions in Lisbon?

• Is it possible to exist a TAXI model, in Lisbon, that reduces the price paid by passengers?

Methodology

Based on the literature review presented above, we can consider that entrepreneurship becomes somewhat important for any economy. Its value is transversal, both the concept of creating new companies or activities, and in the implementation and development of an innovative concept within the existing companies. The goal remains the same, to introduce in the market something innovative and with added value.

This project also aims to be transversal either in implementing a new "brand" in the market, and in exploring this innovation in the existing structure. The project has the purpose to achieve two main objectives:

• First, the environmental concern that is, try to reduce CO_2 emissions (and other polluting components) in the TAXI network of Lisbon.

• Second, the concern with customers, which is, try to reduce the price paid by passengers using a TAXI.

As the two goals assume a change in the system in place, its implementation can be transversal (changing or creating a new passenger transport system).

Concerning the reduction of gas emissions, the goal involves the change of vehicles (TAXI) currently circulating in Lisbon, by others whose CO_2 emissions are substantially lower.

Concerning the price reduction for the passengers, the goal is based on the substantial reduction in the cost of fuel. The research provides a comparison between different vehicles, those powered by gasoline, Diesel, Liquefied Petroleum Gas (LPG) or Natural Gas, Hybrid and Electric.

This analysis aims to realize to what extent the reduction in the cost of fuel compensates the initial investment, and assess the possibility of reducing the price charged to passengers.

Costs with vehicle maintenance (mechanics, tires, cleaning, etc.) were not taken into account, since all have similar costs, except for the electric car that has an additional cost with batteries.

Therefore, it becomes crucial to develop a detailed analysis of mobility in the city of Lisbon, of the legislation applicable to transportation by TAXI, of pollutant emissions statistics and of the respective protocol policies, which allow us to answer the two research questions listed above.

Results analysis and discussion

In a comparative analysis on the population density in Portugal, we easily conclude that the Lisbon Metropolitan Area (LMA) is without any doubt the area with greatest population concentration (26.4% of national concentration) and largest commuting. It means that LMA is where the daily movements between place of residence and place of work or study are higher.

The city of Lisbon is of course the destination of most commuters, both workers and students (Figure 3).

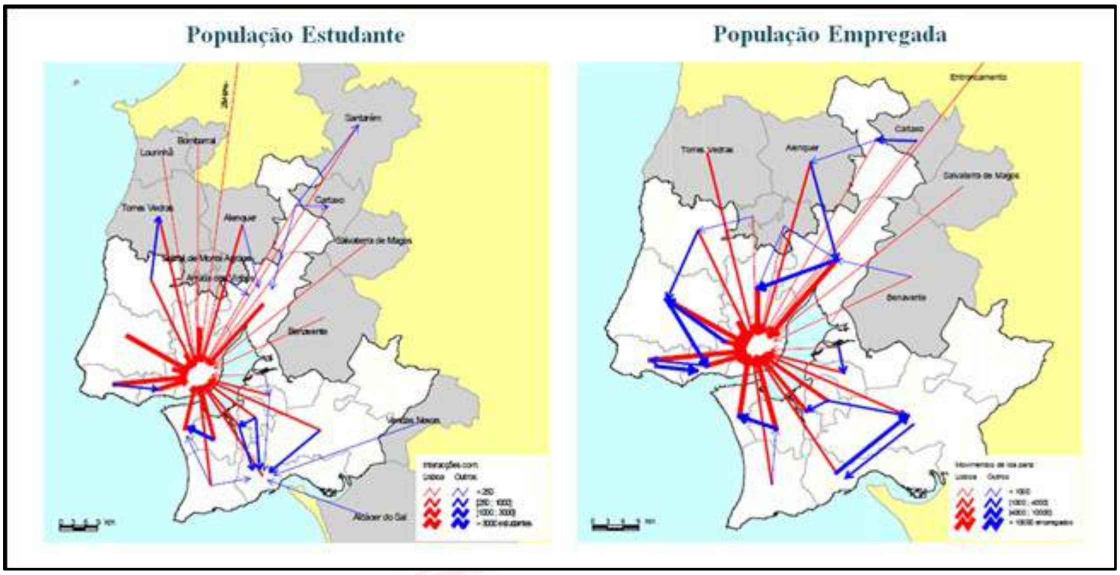

Figure 3: Major student and employed population movements, in the Lisbon Metropolitan Area in 2001
Source: Instituto Nacional de Estatística, 2003

Analyzing in detail the most popular means of transportation, we can see some significant changes comparing the years 1991 and 2001 (Figure 4).

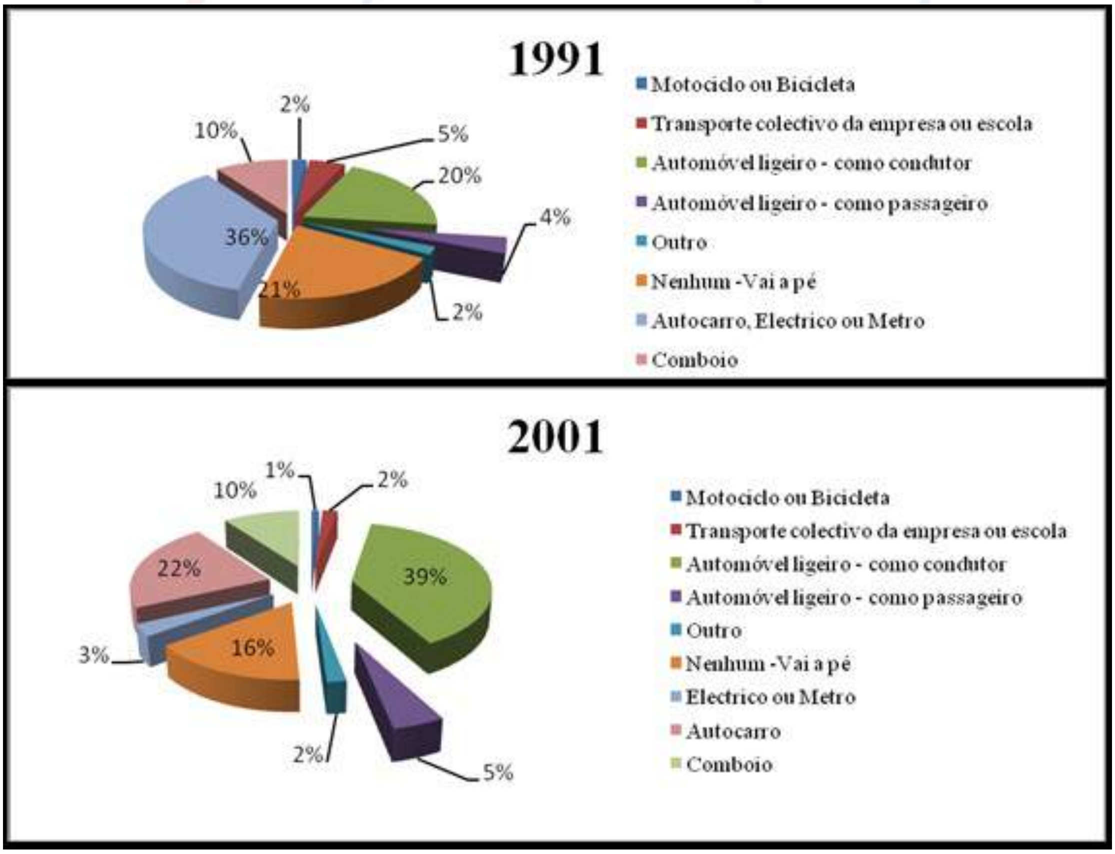

Figure 4: Main modes of transportation used by individual active residents in LMA, 1991 and 2001
Source: Instituto Nacional de Estatística, 2003

The most prominent aspect is the increase in the use of private transportation (passenger car - as a driver) in detriment of using public transportation (bus, tram and subway). Also worth noting, the slight increase in the use of transportation by TAXI (passenger car - as a passenger), although not very significantly.

Under the Framework Directive of Air Quality, stipulated by the European Commission, all Member States shall take measures to ensure that they plans and programs for the "Air Quality Improvement" are developed and implemented in areas where pollutant levels are greater than the limit value (Diário da República, 2007).

For proper compliance with the European and national protocols, the Portuguese State and, in particular, the Lisbon Municipal Council (CML, 2009) have adopted some measures to promote, implement and encourage the reduction of greenhouse gas emissions, such as the commitment, through partnerships with competent authorities, to promote the use of vehicles with clean technology locally (electric vehicles, natural gas, hydrogen and compressed air), with the implementation of charging points for electric vehicles, the commitment to put Portugal as a reference country in the field of sustainable mobility development, and restrictions on the access to certain areas of Lisbon, the so-called Reduced Emissions Zones (REZ).

Features and specifications of the vehicles studied

As mentioned above, the comparative analysis is made with five different vehicles (Gasoline, Diesel, LPG, Hybrid and Electric). The choice of the vehicles was carried out taking into account certain requirements that were identical within vehicles, such as the cost of initial investment (with the exception of the LPG vehicle), factory characteristics, new vehicles (0 kilometers), identical luggage capacity and similar dimensions (with 5 seats). The data collected will form the basis for future conclusions, especially fuel consumption and CO_2 emissions to the atmosphere.

The characteristics and specifications of the vehicles studied are shown in Tables 1 to 5.

Gasoline - Mercedes-Benz B 180 Blue EFFICIENCY	
Features	
Power	122cv / 90kW
CC	1595 cc
Carrying capacity	486 L
Places	5
Investment	
Initial investment	21.524,76 €
Taxes	2.983,44 €
VAT	5.636,89 €
Final price	30.145,09 €
Consumption and CO2 emissions	
Combined consumption	6,2 L/100km
CO2 emissions	138 g/km

Table 1: Gasoline - Mercedes-Benz B 180 Blue EFFICIENCY
Source: Authors

Diesel - Mercedes-Benz B 180 CDI Blue EFFICIENCY	
Features	
Power	109cv / 80kW
CC	1796 cc
Carrying capacity	486 L
Places	5
Investment	
Initial investment	22.327,26 €
Taxes	4.335,41 €
VAT	6.132,41 €
Final price	32.795,08 €
Consumption and CO2 emissions	
Combined consumption	4,6 L/100km
CO2 emissions	115 g/km

Table 2: Diesel - Mercedes-Benz B 180 CDI Blue EFFICIENCY
Source: Authors

LPG - Chevrolet Aveo BI-FUEL 4 Ls 1.2	
Features	
Power	62cv/84kW – 81cv/60kW
CC	1206 cc
Carrying capacity	350 L
Places	5
Investment	
Initial investment	9.481,40 €
Taxes	429,17 €
VAT	2.279,43 €
Final price	12.190,00 €
Consumption and CO2 emissions	
Combined consumption (Gasoline)	5,5 L/100km
Combined consumption (LPG)	7,2 L/100km
CO2 emissions	130 g/km
CO2 emissions	116 g/km

Table 3: LPG - Chevrolet Aveo BI-FUEL 4 Ls 1.2
Source: Authors

We assume that the Chevrolet Aveo will use 90% of LPG fuel, and only 10% gasoline (mainly to start the engine and in emergency situations).

Hybrid - Toyota Prius	
Features	
Power	99cv
CC	1798 cc
Carrying capacity	446 L
Places	5
Investment	
Initial investment	21.649,63 €
Taxes	1.493,15 €
VAT	5.322,84 €
Final price	28.465,62 €
Consumption and CO2 emissions	
Combined consumption (Gasoline)	3,9 L/100km
Electric consumption	Auto Recarregável
CO2 emissions	89 g/km
CO2 emissions (electric)	0 g/km

Table 4: Hybrid - Toyota Prius
Source: Authors

Electric - Nissan LEAF	
Features	
Power	80kW
CC	-
Carrying capacity	330 Litros
Places	5
Investment	
Initial investment	29.260,16 €
Taxes	0 €
VAT	6.729,84 €
Final price	35.990,00 €
Consumption and CO2 emissions	
Electric consumption	24 kWh
Autonomy	175 Km
CO2 emissions (electric)	0 g/km
CO2 emissions (indirect)	1,687 g/km

Table 5: Electric - Nissan LEAF
Source: Authors

It is estimated that the batteries installed in the electric vehicle has a life span (100%) of 5 years or 160,000 km. After reaching that number, the battery only reaches a loading capacity and autonomy of 80% of the original.

A Taxi, in a concrete definition of the word, means “A car that carries passengers to a place for an amount of money that is based on the distance traveled” (Merriam-Webster’s online dictionary [online], 2016). It is a public mean of passenger transportation, and is equipped with a taximeter that calculates and charges the traveled distance, and the time of occupation of a vehicle.

The operation of a TAXI service has some tax benefits in the replacement of old vehicles for new ones, either at the time of purchase or in the circulation tax.

Therefore, we can calculate the purchase price of new cars intended to perform TAXI service (Table 6).

	Gasoline	Diesel	LPG	Hybrid	Electric
Normal	30.145,09€	32.795,08€	12.190,00€	28.465,62€	35.990,00€
TAXI	27.576,34€	29.062,30€	11.662,12€	26.629,04€	35.990,00€

Table 6: Acquisition Cost Differences
Source: Authors

Taxi transport in the city of Lisbon

In order to compare the different costs of fuel (gasoline, diesel and LPG) of TAXI vehicles in Lisbon, an average of the prices in the last quarter of 2013 was made. Concerning the cost of electricity the tariff in the simple regime of EDP for 2013 has been taken into account. The collected data were:

Gasoline 95 to 1.563 € / L

Diesel - € 1.439 / L

LPG - € 0.785 / L - The calculation took into account the spending of 90% in LPG system and 10% in the gasoline regime.

Hybrid - € 1.563 / L (referring to the price of gasoline 95).

Electric - € 0.1679 / kWh - Amount corresponding to the tariff of electricity in 2013 (€ 0.1365 + VAT 23% per kWh).

A study conducted by the Institute of Mobility and Land Transport (IMTT) (Instituto da Mobilidade e dos Transportes Terrestres, 2006) weighting the number of TAXI by the working days in a week, concluded that there is an average daily supply (vehicles in circulation) of about 3100 vehicles in the city of Lisbon.

Tables 7 to 10 discriminates some relevant data for later comparison. All data was taken from the same study on the conditions of transportation in TAXI in Lisbon, prepared by IMTT. Also, note that some data have been updated for purposes of comparison.

Number of vehicles	3.103
Kms traveled/year	235.028.694
Kms traveled year/by TAXI	75.743
Kms traveled/day	643.914
Kms traveled day/by TAXI	208

Table 7: Kilometers travelled (totals)
Source: adapted from IMTT, 2006

	2005	2011 (Updated data)
Liters consumed/year	18.507.515	18.507.515
Fuel expenses/year (€)	17.378.557	26.632.314

Table 8: Total consumption
Source: adapted from IMTT, 2006

NOx	235
Particles and hydrocarbons	24
CO	118
CO_2	49.600
NOx – 1gr / Km	
Particles and hydrocarbons – 0,1 gr / Km	
CO – 0,5 gr /Km	
CO_2 – liters consumed * 2,68 = Kg	

Table 9: Gas emissions (Ton. / Year)
Source: adapted from IMTT, 2006

Services/day (weighted average)	16
Service hours number (weighted average)	17

Table 10: Daily service hours
Source: adapted from IMTT, 2006

CO_2 emissions comparison

The computed values presented in Table 11, result from the combination of CO_2 emission values (depending on the specifications of the models presented above), the number of kilometers/year traveled by a TAXI vehicle, and the total of 3103 cars. The analysis should be done separately, assuming that all TAXI vehicles use the same type of fuel.

	CO_2 emissions by TAXI	CO_2 emissions from 3103 TAXIS
Current values	16 ton.	49.600 ton.
Gasoline	10,5 ton.	32.510 ton.
Diesel	8,7 ton.	27.091,67 ton.
LPG (combined) (1)	8,91 ton.	27.657,06 ton.
Hybrid	6,76 ton.	20.966,60 ton.
Electric (2)	0,13 ton.	397,39 ton.

Table 11: CO2 emissions estimate of TAXI vehicles in a year (ton.)
Source: adapted from IMTT, 2006

(1) – Combined values of CO2 emissions (10% related to Gasoline and 90% to LPG).
(2) – CO2 emission values in the production of electricity by EDP (2006 values), since the car itself does not produce any polluting gas.

Fuel cost comparison

Table 12 displays the liters consumed and the cost of the different types of fuel. The "current values", referred to in the table, take into account the consumption close to 8 liters per 100 km, representative of the majority of the current TAXI fleet. The values computed in vehicles powered by LPG/Gasoline refer to the use of 90% LPG and 10% gasoline used mainly at the start and in case of emergency. The computation for the vehicle powered exclusively by electricity is based on the kWh necessary to travel 208 km.

	Kms/day	Fuel spent (day)	Daily cost	Annual cost
Current values	208	16,34 Litros	23,51 €	8.581,39 €
Gasoline	208	15,81 Litros	24,70 €	9.016,61 €
Diesel	208	9,57 Litros	13,77 €	5.024,64 €.
LPG/Gasoline	208	14,98 / 11,44 Litros	12,37 €	4.514,42 €
Hybrid	208	8,11 Litros	12,68 €	4.626,94 €
Electric	208	28,5 kWh	4,79 €	1.748,10 €

Table 12: Annual cost of fuel comparison
Source: Authors

Table 13 shows that annual savings are considerable in case the vehicle is powered by electricity, about 80% less than what is currently spent. Out of curiosity, and in the possibility of replacement of an old Diesel vehicle with a newer range, we see a possible reduction of 46% in fuel spending.

	Annual fuel cost	Possible annual savings
Current values	8.581,39 €	
Gasoline	9.016,61 €	(435,22 €)
Diesel	5.024,64 €.	3.556,74 €
LPG/Gasoline	4.514,42 €	4.066, 97 €
Hybrid	4.626,94 €	3.954,44 €
Electric	1.748,10 €	6.833,28 €

Table 13: Possible savings with fuel
Source: Authors

Considering the number of services per day (on average), coupled with the number of kilometers traveled on each trip, and using the price list stipulated by law, we easily calculate the value gained in passenger transportation (Table 14).

Number of trips per day	16
Estimated Kms per trip	13,00 kms
Price charged per trip (1)	7,75 €
Total revenue per day	124 €
Total revenue per year	45,260 €

Table 14: Gross Revenue by TAXI
Source: Authors

(1) – Value calculated according to the Tariff System TAXI 2013

Taking into account the values calculated in Table 14 we can determine the annual balance of the TAXI services (Table 15).

	Fuel expense	Revenue	Annual profit
Current values	8.581,39 €	45.260,00 €	39.659,43 €
Gasoline	9.016,61 €	45.260,00 €	36.243,39 €
Diesel	5.024,64 €	45.260,00 €	40.235,36 €
LPG/Gasoline	4.514,42 €	45.260,00 €	40.745,58 €
Hybrid	4.626,94 €	45.260,00 €	40.633,06 €
Electric	1.748,10 €	45.260,00 €	43.511,90 €

Table 15: Annual balance between expenditure and revenue (by TAXI)
Source: Authors

Final considerations

Table 16 shows the required number of trips and working days to recover the investment made in the acquisition of any type of vehicle.

	Number of trips required	Number of working days
Current values	3.558	222
Gasoline	3.750	234
Diesel	1.505	94
LPG/Gasoline	3.436	215
Hybrid	3.669	229

Table 16: Number of days required to recover the initial investment
Source: Authors

Transportation in an electric vehicle is the alternative that may offer greater advantages with certain costs. Despite showing some noticeable drawbacks, focusing on this type of mobility can become quite plausible. The disadvantages are primarily based on the low autonomy of the vehicle, which requires replenishment more than once per day.

After obtaining the analyzed results, we can see that there are no major differences in the acquisition price of new vehicles for the TAXI service, with the exception of the LPG vehicle. In fact, the return on investment of a LPG vehicle is much faster compared to others, whose time required recovering the acquisition investment is quite identical.

Concerning the cost of fuel, we find that the electric vehicle is advantageous when compared to the other vehicles examined. Despite having a slightly higher acquisition cost and an additional cost with battery replacement (after traveled 160,000 kilometers or after 5 years), the charging cost is quite advantageous.

While we can conclude that the idea of electric TAXI vehicles would be a good solution for Lisbon, there may still be some significant obstacles, namely the lack of charging infrastructures. Additionally, it may still be premature to bet on this technology, as it is quite recent and there are still no guarantees of reliability for a service as demanding as TAXI.

Collected data show that replacing the existing fleet with a newer fleet (same range) substantially reduces the costs of fuel and CO_2 emissions. Disregarding the electric vehicle, the hybrid vehicle is the offering better in reducing the costs of fuel and CO_2 emissions. The LPG vehicle can also be taken into account, as its acquisition price is much lower compared to others.

Conclusions and recommendations

After completion of this project we can draw some conclusions regarding the objectives proposed initially, being able to state that:

• Entrepreneurship can be a solution and a strong booster of the Portuguese economy, especially in times of crisis;

• There is a clear intention of the Portuguese Government and in particular of the Lisbon Municipal Council, to reduce greenhouse gas emissions. The laws and protocols already approved somehow limit the use of more polluting vehicles;

• In a TAXI service, costs associated with fuel can become less bearable, taking into account the means available today (vehicles that consume 8L/100km);

• The TAXI service in electric vehicles may be a plausible solution, although it may have some reservations, particularly with the implementation costs of charging infrastructures;

• The concept of electric TAXI can still offer some resistance in its implementation, so that hybrid vehicles can be a good option (considering consumption and CO_2 emissions), without major structural changes;

• The scenario of price reduction for passengers only becomes feasible amending current legislation (legal requirement), or being a transportation company other than TAXI (without State intervention) and necessarily giving up the associated advantages (e.g.: circulation in exclusive "bus" lanes).

To conclude, and in response to the first research question, we can say that there are TAXI models (those running on LPG, the hybrid and the electric models) that reduce CO_2 emissions in Lisbon.

In response to the second research question, we can also say that there is a TAXI model (that powered by electricity) that can decrease the price paid by passengers.

As a final recommendation, based upon data presented above, we can say that the choice of electric vehicles is the one that will best serve both the environment because it yields zero CO_2 emissions, and the consumer because it is the only one whose annual fuel cost will allow to reduce the price paid by passengers.

However, as we are dealing with a new technology, there are several restrictions that prevent its immediate adoption, the main one being the short battery life, (vehicle autonomy), which would always imply more than one daily charge. Moreover, as there are still no charging infrastructures across the country, trips out of the Lisbon area would be very problematic, or even impossible.

As a proposal for future studies, including the analysis of costs considered to be constant in this project (for example, staff costs, maintenance costs and the evolution of energy prices) will enrich the approach and allow greater detail, thus a conclusion based on a higher number of data and information.

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Contact email: josesoares@iseg.ulisboa.pt

Migration Flows and Municipal Waste Analysis Using the Spatial Panel Durbin Model - The Case of Poland

Elżbieta Antczak, University of Lodz, Poland

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Abstract
The aim of the paper is to examine the impact of migration processes (mainly the emigration and immigration) and economic prosperity on the quantity of municipal waste. The data used in this research concerned the quantity of collected mixed municipal wastes during the year (an endogenous variable), the number of registrations and de-registrations (to and from rural, urban areas), expenditures on waste management, population density and revenue of NUTS-4 budget (exogenous variables). The analysis covered 379 Polish NUTS-4 (poviats) and the time span from 2005 to 2014. Assuming that, migration processes, quantity of collected wastes and socio - economic development are characterised by spatial heterogeneity and spatial autocorrelation, there were used spatial econometric methods, such as: ESDA (Exploratory Spatial Data Analysis) and spatial panel Durbin model based on Environmental Kuznets Curve.

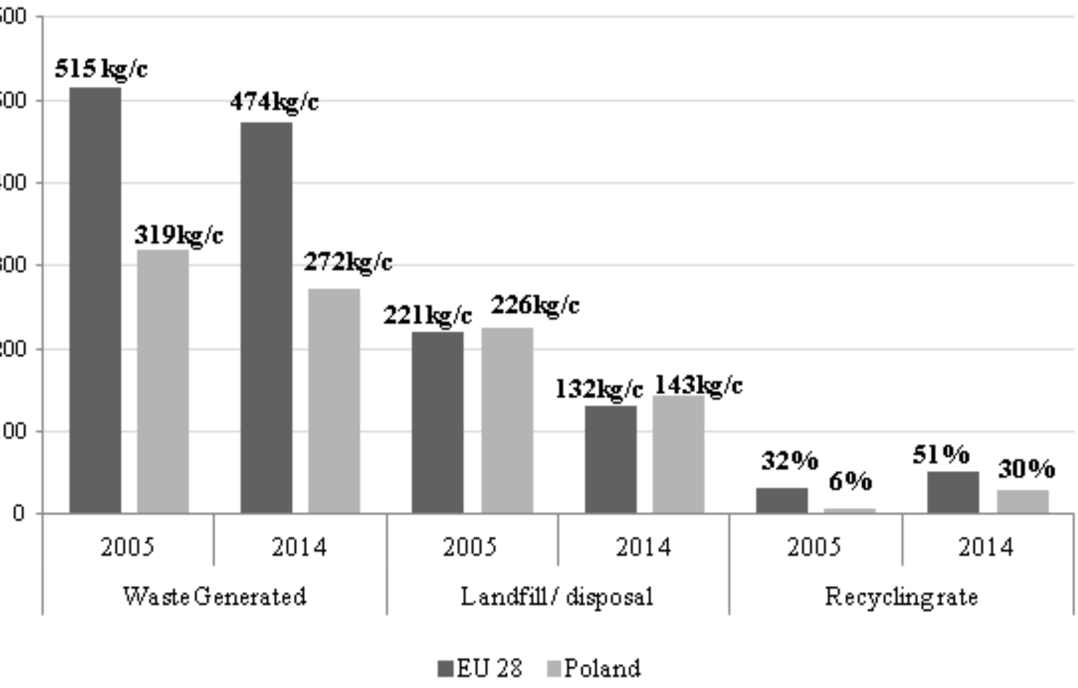
Keywords: municipal wastes, migration processes, ESDA, EKC, spatial panel Durbin model

1. Introduction

Both the Polish[1] and European Union[2] laws define municipal waste as waste mainly generated by households (although it also includes, to a much smaller extent, waste from sources such as shops, enterprises, office buildings and educational, healthcare and public administration institutions). The National Waste Management Plan revision puts a particular emphasis on carrying out tasks in the municipal sector, including intensifying undertakings connected with recycling and disposal of municipal waste (ME, 2015). The principal objective of the tasks is to minimise the quantity of landfilled waste.

Poland is a country situated in Central Europe, of the surface area of over 312 square kilometers (which makes it the 70th and 9th biggest country in the world and Europe respectively), with the population of about 40 million (CSO, 2015). In the 1990s, Poland underwent economic transformation and since 2004 the country has been a member of the European Union. Nonetheless, Poles still struggle with increasing environmental degradation, including huge quantities of generated waste and problems with its recycling. Over 272 kg of unsorted municipal waste was collected *per capita* in Poland in 2014 (only 17% less than in 2005). As much as 168 kg of waste *per capita* came from households. In turn, the ratio of landfilled waste to collected unsorted waste reached as much as 53% with the 30% recycling rate (only 28% of waste was landfilled with the recycling rate at 51% in the European Union-28 in the same year)[3], Figure 1.

Figure 1. Municipal waste (generated, landfilled/disposed, recycling rate) in Poland and EU-28 in selected years



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[1] The Act of 14 of December 2012 on waste, http://dziennikustaw.gov.pl/du/2013/21/1, accessed on: 2.05.2016.

[2] Framework Directive 2008/98 / EC on waste from 19 November 2008.

[3] Eurostat data: Municipal waste generation and treatment, by type of treatment method, accessed: 2.05.2016.

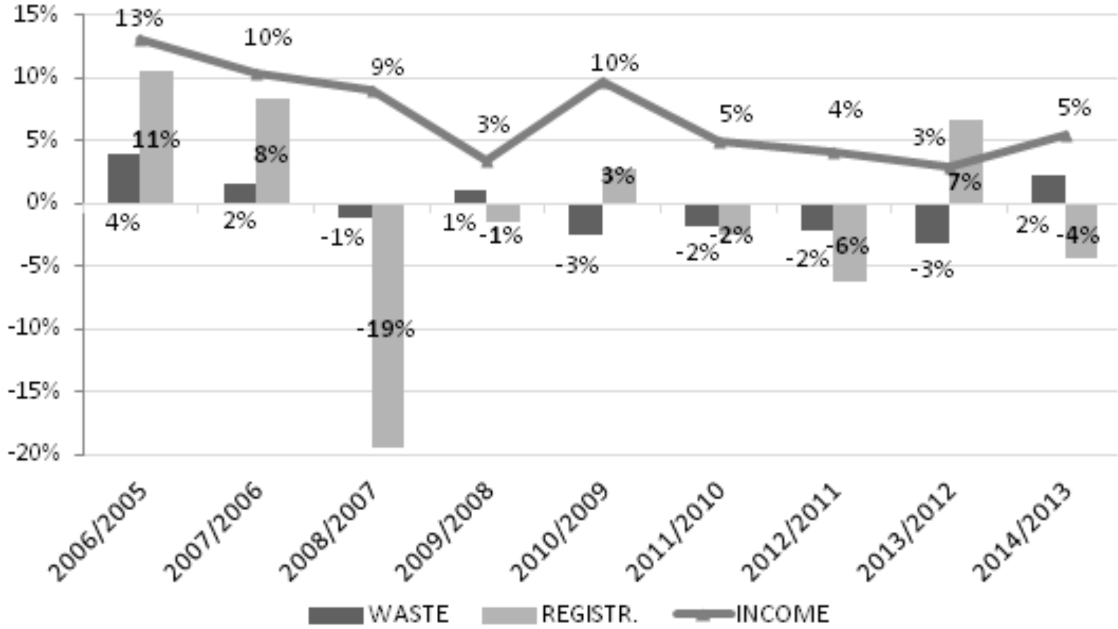
Note: kg/c - kilograms per capita.
Source: own elaboration based on Eurostat.

Main factors determining the quantity and quality of generated municipal waste include, among others: the place of waste generation, wealth of the society, level of the consumption of products, season of the year, ecological awareness and educational level, “type of the area (urban, rural) where it is generated, population density, type of housing (detached, multi-family), presence of public facilities as well as presence, type, size and number of commercial, small industry or service-providing facilities” (ME, 2014). The specialist literature also offers a theory explaining the relationship between migration of people and natural environment (the so-called ecological theory of migration).[4] This article attempts to verify assumptions of the above-mentioned theory at the level of Polish poviats (NUTS-4). The main assumption coincides that the migration processes (internal migration as well as by type and direction) and economic prosperity determine the quantity of municipal waste. The data used in this research concerned the volume of collected mixed municipal wastes during the year (an endogenous variable), the number of registrations and de-registrations, expenditures on waste management, population density and revenue of NUTS-4 budget (exogenous variables). The analysis covered the time span from 2005 to 2014.

As already mentioned, the quantity of municipal waste collected in Poland in 2014 fell by 2% compared to 2005; the number of registrations for residence dropped by 9%, too (including from urban and rural areas by 12% and 3% respectively). On the other hand, budget incomes of poviats *per capita*, investment expenditures on waste management and numbers of registrations for residence from abroad increased. Figure 2 indicates trends in the analysed phenomena. Provisionally, it confirms the legitimacy of the formulated research assumption. It can be observed that the falling number of registrations for residence was accompanied by a decrease in the quantity of collected municipal waste in the studied period. In turn, a fast rise in poviats’ budget incomes *per capita* was accompanied by a growth in the number of registrations for residence, whereas a decelerated increase in incomes entailed the slower dynamics of changes in the number of registrations for residence. Such a relationship seems correct. From the economic point of view, a rise in budget incomes (the unit’s wealth) is favoured by an increase in the local economic base possible to be achieved through, among others, carrying out investments aimed at the location of new and further development of existing business activity as well as development of housing, which results in a potential population growth in a given unit (Dańska-Borsiak, 2013). That, however, whether changes in the quantity of collected municipal waste were directly associated with changes in the described demographic and economic variables will be explained by results of the carried out econometric analysis (see: *Results of analysis and discussion*).

[4]This theory assumes that the environmental factors are the determinants of migration processes, but on the other hand, population movements cause changes in the natural environment, too, more eg. in: (Sobczak 2012; Janicki 2014; Bremner i Hunter, 2014).

Figure 2. The dynamic of the level of municipal waste, the number of registrations and the revenue budgets of poviats in Poland in the years 2005-2014 (indexes in %)



Note: REGISTR. - the number of internal registrations per 10 thousand of people.
Source: own elaboration.

Assuming that, migration processes, quantity of collected wastes and socio-economic development are characterised by spatial heterogeneity and spatial autocorrelation, there were used spatial econometric methods, such as: ESDA and Durbin spatial model based on Environmental Kuznets Curve (EKC). The EKC assumes a relationship between various indicators of environmental degradation and income per capita.[5]

1. Spatial Panel Durbin Model - research method and applications

The spatial panel Durbin model (SPDM) is a tool simultaneously taking into account spatial autoregression and cross regression, *i.e.* the impact of spatially non-lagged and lagged exogenous variables, drawing at the same time on the panel data (Anselin *et al.*, 2008; Elhorst, 2003).

This study uses a spatial panel Durbin model with specified fixed effects and autoregression of the endogenous variable:

$$y_{it} = \alpha_i + \rho \mathbf{W} y_{it} + \mathbf{x}_{it}^T \boldsymbol{\beta} + \mathbf{W}\mathbf{x}_{it}^T \boldsymbol{\gamma} + \varepsilon_{it},\ \varepsilon_{it} \sim N(0,\sigma_u^2) \quad (1),$$

where: $i = 1,2, ..., N$, $t = 1,2, ..., T$, α_i – individual specific fixed effects, constant in time and different for different cross-sectional categories, y_{it} – vector of observations

[5] In the early stages of economic growth degradation and pollution increase. Beyond some level of income per capita the trend reverses, so that at high-income levels economic growth leads to environmental improvement. This implies that the environmental impact indicator is an inverted U-shaped function of income per capita. Typically the logarithm of the indicator is modeled as a quadratic function of the logarithm of income (Stern, 2003). About the empirical spatiotemporal research on different types of Environmental Kuznets Curve in EU (e.g.: Antczak 2012);

on the endogenous variable, $\mathbf{x}_{it}^{T} = [x_{1it}, x_{2it}, \ldots, x_{Kit}]$ – vector of observations on K explanatory variables for the i cross-sectional unit in the t period, ε_{it} – pure random error, $\boldsymbol{\beta} = [\beta_1, \ldots, \beta_K]^T$ – vector of parameters at explanatory variables, ρ – spatial autoregression parameter, $\mathbf{W}$ – spatial weights matrix of NxN dimensions and zero diagonal elements, standardised in rows, $\boldsymbol{\gamma}$ – vector of spatial parameters of selected spatially lagged independent variables.

The group of commonly applied spatial panel Durbin models also includes models with specified fixed effects or random effects and spatial autocorrelation of the random element, random effects and autoregression of the dependent variable, as well as mixed models (Suchecki *et al.*, 2012).

Spatial panel Durbin models enjoy an established position in the specialist literature (especially international one), although results of research on migration of people and the impact of its processes on the environmental quality (particularly the quantity of generated waste) have not been popularised. The described models were applied, among others, in analyses of the impact of socio-economic processes (including migration flows) on the quantity of municipal waste generated in Turkey (Keser, 2010) and a well-known city in China (Lin, 2015). In turn, Cox *et al.* (2013) applied the spatial panel Durbin model in looking for factors affecting the volume of solid waste generated in Ecuador. For that purpose, they also used GIS tools. An interesting publication is an article by Yang *et al.* (2016) where the Durbin model was applied to evaluate the impact of migration flows, ecological factors (including the quantity of generated waste) and adjacency of regions on population mortality rates in US poviats. So far, no scientific article has been published in Poland describing the research issue raised in this paper.

2. Database

The research hypothesis put forward at the beginning of this article has been verified based on statistical data concerning:

- quantity of mixed municipal waste collected in kg *per capita*, WASTE, (endogenous variable),
- and a set of exogenous variables:
  - ✓ number of de-registrations for residence to rural areas from other poviats per 10 thousand of the population, DC;
  - ✓ number of registrations for residence from urban areas to other poviats per 10 thousand of the population, RC;
  - ✓ budget incomes in PLN *per capita*, I;
  - ✓ investment expenditures of poviats in the Municipal Services Management and Environmental Protection section in PLN *per capita*, EX;
  - ✓ number of de-registrations for permanent residence abroad per 10 thousand of the population, FD;
  - ✓ population density, D;
  - ✓ and spatially lagged selected variables.

The said socio-economic factors determining the quantity of annually collected municipal solid waste were chosen based on the formal criterion (correlation coefficients) and in accordance with the above-mentioned ecological theory of migration. Data were collected for poviats (NUTS-4) from the CSO of Poland. Table 1 displays the summary statistics of the data.

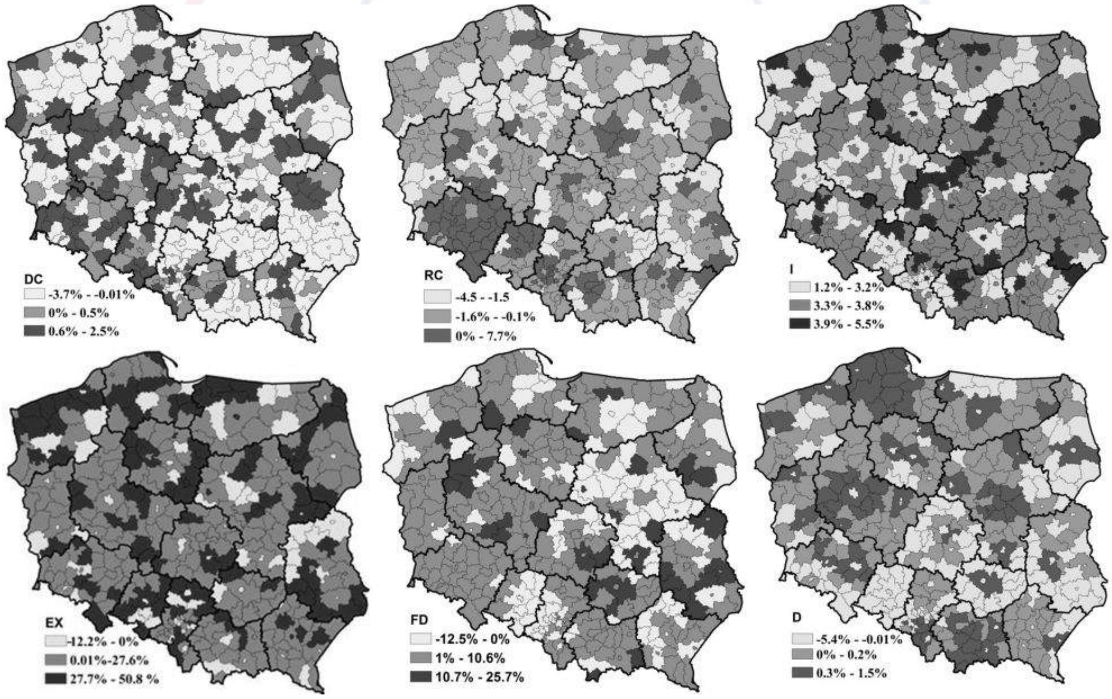
Table 1. Summary statistics of the collected data

Variable	Mean	Max	Min	Median	Stand. Dev.	CV
WASTE	203.9	971	30	197	91	45%
DC	30	120	9	25	16	53%
RC	48	305	12	35	38	79%
I	2836.7	8506	1415	2755.5	805.7	28%
EX	20.5	799.8	0	4.2	40.5	198%
FD	67	755	0	44	78	116%
D	2837	8506	1415	2756	806	28%

Source: own elaboration.

In the years 2005-2014, there were changes in the volumes of the analysed variables. The studied phenomena were also characterised by significant spatial diversification (high values of coefficients of variation). Undoubtedly, the above-described processes determined the specificity of a given region and influenced the development of a unit and annual volume of collected waste. Maps in Graphs 1 and 2 show the mean rates of changes in the studied variables and evaluate those changes.

Graph 1. Average pace of change of the exogenous variables and time span: 2005-2014 on NUTS-4 level

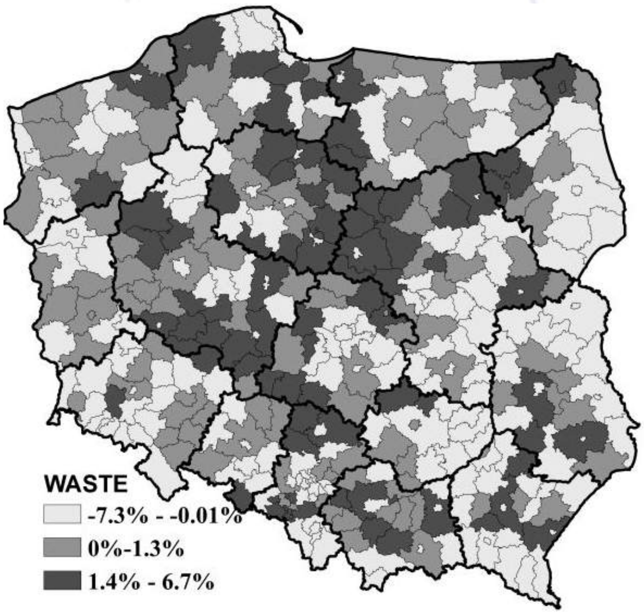


Source: own elaboration in ArcMap.

In the studied period, all poviats of Poland experienced an annual rise in incomes *per capita*, which may indicate a rise in wealth, improved financial situation of the population and economic development of the country. In the years 2005-2014, the highest mean rate of increase was observed in units of the Łódzkie and Mazowieckie regions – central Poland (denoting of voivodships, see App. 1). The mean rate of changes in the number of de-registrations for residence to rural areas was negative in a large proportion of analysed poviats. In turn, the rates of registrations for residence from urban areas and de-registrations for residence abroad were positive in a majority of units. That may be connected with, among others, a better situation on the labour market of both urban areas and other developed countries as well as des-urbanisation trends. In the case of both the variables, the highest rate of changes was reported in the Dolnośląskie (and selected poviats of the Łódzkie, Świętokrzyskie and Lubelskie voivodships). On the other hand, a negative rate of changes (fall) in the number of de-registrations for residence abroad was observed in the Mazowieckie and poviats of the Łódzkie, Kujawsko-Pomorskie and Warmińsko-Mazurskie voivodships adjacent to its borders (which confirms the strong economic position and attractiveness of the Mazowieckie voivodship, and Warsaw in particular, which encourages Poles to stay in that area). The rate of changes in investment expenditures on waste management was positive in a majority of analysed poviats. In turn, the rate of increase in population density in urban areas was negative in the years 2005-2014, which confirms the common European trend of the so-called urban depopulation.

A significant improvement in the situation associated with the quantity of annually collected municipal waste occurred mainly in urban areas. The rate of changes in the phenomenon was negative in those units, *i.e.* there was a fall in the quantity of waste in the years 2005-2014. A similar trend was also observed in poviats situated in Eastern, South-Eastern and South-Western Poland, Graph 2.

Graph 2. Average pace of change of the endogenous variable and time span: 2005-2014 on NUTS-4 level



Source: own elaboration in ArcMap.

The application of the spatial panel model will allow considering those diversification of objects and dynamics of phenomena in the estimation process. However, an integral part of the applicability of panel models is examining the stationarity of its variables. That characteristic was verified using the Levin-Lin-Chu panel test of the following set of hypotheses: H_0: panels contain unit roots and H_1: panels are stationary. Table 2 presents the results of the Levin-Lin-Chu test.

Table 2. Levin-Lin-Chu unit-root test for variables

Adjusted t*	*WASTE*	*DC*	*RC*	*I*	*EX*	*FD*	*D*
Without trend	-24.8***	-29.5***	-24.2***	-28.2***	-32.4***	-44.4***	-4.8***
With trend	-41.3***	-69.9***	-65.6***	-37.4***	-32.3***	-10.7***	-17.6***

Note: significance levels: α = 0.10*, 0.05 **, 0.01 ***.
Source: own elaboration in STATA 11.

Based on information contained in Table 2, it can be stated that both the waste quantity determinants and endogenous variable were stationary. Hence, some long-term stability of processes and elimination of spurious regression were observed.

An important stage in creating spatial models is examination of the spatial autocorrelation. In order to identify that, global Moran's *I* statistic was applied.[6] The intensity of spatial interactions were displayed in the matrix **W** of the first order of contiguity using queen criteria (row standardised, the elements of the matrix take values between zero and one and the sum of the row values is always one). The choice of this type of matrixes was determined by shipment of waste to the landfill and the relevant companies as well as by population flows within the districts.[7] The Moran's *I* statistics was significant for the selected years. Most of the autocorrelation coefficients were positive, but some were negative therefore the adjacent poviats tended to cluster according to the all variables, but the polarisation could have occurred in terms of the de-registrations on rural areas, DC. Certain values fluctuated over time, and the changes had no clear pattern, Table 3.

Table 3. Values of global Moran's *I* statistics for outflows, inflows and other variables using the W matrix

Year/Variable	*WASTE*	*DC*	*RC*	*I*	*EX*	*FD*	*D*
2005	0.33***	-0.05	0.19***	0.16***	0.02	0.69***	0.22***
2006	0.32***	-0.06*	0.21***	0.17***	-0.002	0.59***	0.23***
2007	0.35***	-0.05*	0.16***	0.22***	0.07**	0.69***	0.23***
2008	0.35***	-0.01	0.18***	0.19***	0.15***	0.63***	0.23***
2009	0.40***	-0.05*	0.17***	0.15***	0.11***	0.60***	0.23***
2010	0.39***	-0.06*	0.20***	0.18***	0.09***	0.57***	0.23***
2011	0.37***	-0.07**	0.20***	0.13***	0.05**	0.59***	0.23***
2012	0.41***	-0.08***	0.19***	0.15***	0.001	0.59***	0.23***
2013	0.48***	-0.07***	0.21***	0.14***	0.15***	0.61***	0.23***
2014	0.50***	-0.06***	0.21***	0.13***	0.14***	0.57***	0.23***

Note: significance levels: α = 0.10*, 0.05 **, 0.01 ***.
Source: own elaboration in OpenGeoDa.

3. Results of analysis and discussion

[6]more see, e.g.: LeSage (2008).
[7]CSO provides that most of the flows of individuals who were commuting from their place of residence to a workplace were very close to the border of a given unit (e.g., 20% to 50% of the intensity of the work-related population flows to voivodship capitals, subregions, and counties were very close to the border), CSO, 2014. On the other hand, in Poland, due to lower costs of waste shipment, the short-distance transport still dominates, http://ekotechnologie.org/download/3_Rozdzial.pdf, accessed: 3.05.2016.

Statistically significant spatial interactions, stationarity of series forming the panel and confirmed correlation of variables are conditions for creating a spatial panel Durbin model. Out of many possible variants of spatial models, the spatial panel model with specified fixed effects and autocorrelation of the error term described by formula (1) was chosen to be analysed.[8] The estimation results of the presented model allowed indicating characteristics determining the quantity of municipal waste annually collected in poviats from 2005 to 2014 (Table 4). Moreover, the strength and direction of the impact of those factors on the studied variable were estimated and direct and indirect effects for particular variables were also added. The mean *direct effect* captures the effect of a unit change in an explanatory variable in a focal county on the dependent variable in this county. This measure includes also the feedback effect. The feedback effect arises when the impact of an increase in an explanatory variable in a focal unit affects the neighbouring states, passes through them and returns to this initial focal unit. The average *indirect* (*spillover*) *effect* is the effect of a unit change in an explanatory variable in a focal county on the dependent variable in the neighbouring poviats[9]. The total effect of an explanatory variable consists of the *direct effect* of the increase in the explanatory variable on the dependent variable in the focal unit and the *indirect effect* of the increase in the explanatory variable (spillover effect) on the dependent variable in the contiguous units (LeSage and Pace 2009).

Table 4. Results of the estimation of the non-spatial and spatial SAR-FEM Durbin model of the collected municipal waste in Polish NUTS-4

$$lWASTE_{it} = \alpha_i + \alpha_1 lDC_{it} + \alpha_2 lRC_{it} + \alpha_3 lI_{it} + \alpha_4 (lI_{it})^2 + \alpha_5 lD_{it} + \alpha_6 lEX_{it} + \alpha_7 lFD_{it} + e_{it}$$

parametr	*value*	*t-Student*	*Std.error*	*direct*	*indirect*
α_0	-12.3***	-5.8	2.1	-	-
α_1	0.03	1.6	0.2	-	-
α_2	0.05**	3.4	0.02	-	-
α_3	3.9***	7.2	0.5	-	-
α_4	-0.3***	-7.2	0.03	-	-
α_5	0.4***	4.2	0.09	-	-
α_6	-0.05**	-2.4	0.002	-	-
α_7	0.002	0.44	0.004	-	-

pseudo R^2=0.31; Chow's test of fixed effects, *F*=42.42 ***, residuals normality: Shapiro-Wilk, W = 0.88***, Levin-Lin-Chu, without trend: *t** = -38.9***, with trend: *t** = -57.1 ***;

$$lWASTE_{it} = \beta_i + \beta_1 lDC_{it} + \beta_2 lRC_{it} + \beta_3 lI_{it} + \beta_4 (lI_{it})^2 + \beta_5 lD_{it} + \beta_6 \mathbf{W} lEX_{it} + \beta_7 \mathbf{W} lFD_{it} + \rho \mathbf{W} lWASTE_{it} + e_{it}$$

parametr	*value*	*t-Student*	*Std.error*	*direct*	*indirect*
β_0	-1.8***	-3.2	0.6	-	-
β_1	-0.03*	-1.7	0.02	-0.03*	-0.04*
β_2	0.06**	2.4	0.03	0.06**	0.07**
β_3	1.14***	3.7	0.3	1.2***	1.3***
β_4	-0.2***	-3.6	0.05	-0.17***	-0.19***
β_5	0.4***	4.2	0.09	0.37***	0.42***
β_6	-0.01***	-3.3	0.003	-0.01***	-0.01***
β_7	0.01**	2.5	0.005	0.01**	0.01**
ρ	**0.5*** **	**13.5**	**0.04**	**-**	**-**

[8] The carried out tests verifying the quality and usefulness of spatial panel Durbin models showed the highest efficiency of models with fixed effects and autocorrelation of the random component. The properties of other spatial panel Durbin models are available via e-mail: wiszniewska@uni.lodz.pl.

[9] The second possible interpretation of the indirect effect reflects the change in the dependent variable in a focal unit as a result from an increase in the independent variable in the adjacent units (Seldadyo et al. 2010).

pseudo R^2=0.75; Chow's test of fixed effects, F=16.89 ***, residuals normality: Shapiro-Wilk, W = 0.84, Levin-Lin-Chu, without trend: t^* = -21.6***, with trend: t^* = -36.1 ***; Chow's test of spatial effects: $F_{SD\text{-}FEM}$=6,23 ***, SD-FEM better than FEM;

Note: significance levels: α = 0.10*, 0.05 **, 0.01 ***.
Source: own elaboration in RCran.

Based on the received results, it was confirmed that migration processes influenced the quantity of waste generated in poviats. A 1% rise in the number of registrations for residence from urban areas resulted in a 0.06% increase in the endogenous variable *ceteris paribus*. In turn, an average increase in the scale of de-registrations for residence to rural areas led to a 0.03% decrease in the annual volume of collected waste. Thus, in cities and towns, where service-providing and commercial facilities are located, the quantity of generated waste was larger than in rural areas and on the outskirts of urban areas. The quantity of municipal waste per one rural inhabitant was, on average, twice as small as that per one urban inhabitant. Rural houses are not infrequently equipped with individual hearths and part of waste is incinerated (Tyralska-Wojtycza, 2015). The immigrants from urban areas (urban population) usually has greater wealth, which results in an increase in the amount of waste generated, especially glass and plastic (Ibanez et al. 2011). A rise in the dependent variable was contributed to by an increase in population density (by 0.4% on average) and a rise in poviats' budget incomes *per capita* (by 1.14% on average). That was directly connected with wealth, a higher level of industrialisation and urbanisation as well as increased consumption by the population. It is, however, worth drawing attention to meeting the Kuznets curve assumptions in selected poviats of Poland. The value of the extremum of the cubic function (income *per capita*) was above PLN 3.2 thousand *per capita*, which means that an increase in income above that level did not cause an increase in municipal waste in a given administrative unit.[10] Therefore, in the analysed period, there were poviats in which the rate of an increase in income *per capita* was positive but generated a slower or even negative rate of increase in waste quantity (that group included most cities with poviats rights but also the Policki, Słupski or Wrocławski poviats). Higher budget incomes of poviats also resulted in higher investment expenditures, which is indicated by the significance of estimation of the parameter at the spatial image of the EX variable. A 0.01% fall in the quantity of waste in a given poviat was determined by an increase in the said expenditures in adjacent poviats (defined in the **W** matrix as units directly adjacent to a given poviat – having a common border with that). On the other hand, a 1% rise in the number of de-registrations for residence abroad from adjacent poviats resulted in an about 0.01% increase in the quantity of waste collected in a given poviat (*ceteris paribus*).

The direct and the indirect effects were consistent for certain variables. The indirect effects were generally stronger than direct ones. For example, a 1% increase of the deregistrations to rural areas in the given local unit decreased the volume of the collected municipal waste in this unit by 0.03%; and it decreased the endogenous variable in each poviats by 0.04% (excluding the focal one).

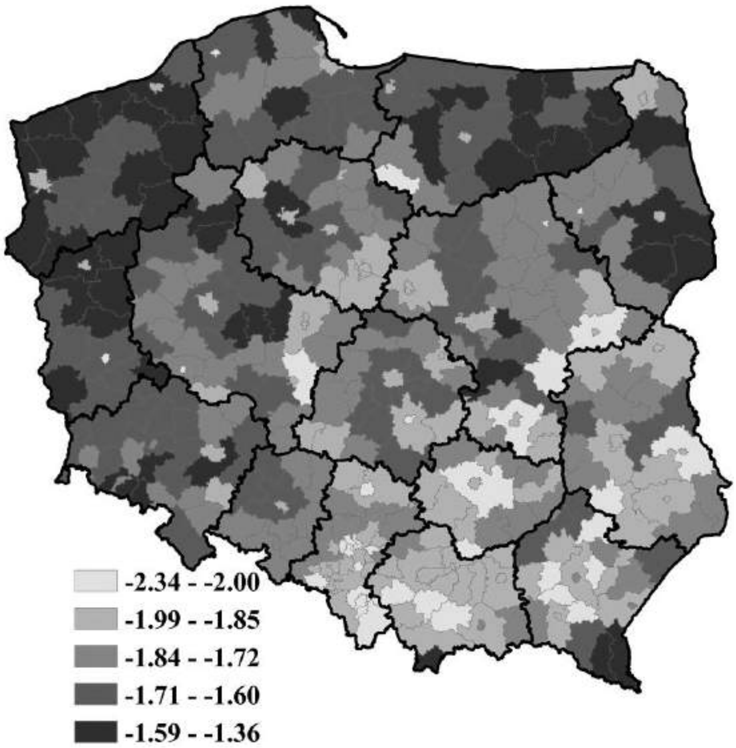
Statistics characterising the properties of the spatial Durbin model reflect the effectiveness of the applied instrument. The inclusion of spatial effects enhanced the quality of the model. The pseudo-determination coefficient for the Durbin model was higher than the goodness of fit to empirical data of the non-spatial model. What is

[10] more about several implementing EKCs in the continuation of research.

more, the Chow spatial effects test indicated the higher quality of the spatial model as well as its correctness and usefulness in application in that kind of analyses. Results in the spatial model were substantially correct. Results of modelling without spatial interactions indicated two variables which proved to be of no importance to the quantity of municipal waste, *i.e.* the numbers of de-registrations for residence to rural areas and de-registrations for residence abroad. Furthermore, in the classical model, the value of the absolute term was significantly higher than in the spatial model, whereas an increase in income *per capita* had a significantly stronger effect on the quantity of waste than other factors (Table 4). Thus, the consideration of spatial interactions in the form of the **W** matrix proved to have been justified. The significance of the spatial autocorrelation parameter estimation confirmed the impact of spatial relationships on the quantity of annually collected municipal waste in the analysed period. In turn, the positive ρ sign indicated the clustering of poviats with similar (low or high) values of the dependent variable in the geographical space. The value of ρ assessment means that an increase of 1% in the volume of waste generated in adjacent units resulted in an average increase of 0.5% in that phenomenon in a given poviat in the years 2005-2014.

The estimation of values of fixed effects for each analysed unit allowed obtaining additional information about the specificity of poviats. Thus, units were identified whose conditions to the largest and smallest extent affected changes in the mean quantity of waste collected in Poland in the studied period (Graph 3).

Graph 3. Fixed effects estimated from spatial panel Durbin model



Source: own elaboration in ArcMap.

The map in Graph 3 shows that, in the years 2005-2014, the greatest impact on the mean level of the dependent variable was exerted by poviats situated in the Northern and Eastern parts of the country. Nevertheless, in those parts of Poland, there were urban units which simultaneously showed noticeably lower significance for the quantity of annually collected municipal waste than their surrounding areas. The least impact on the level of the analysed phenomenon was exerted by poviats of Sothern and Eastern Poland.

4. Summary and directions of further research

This article attempted to verify relationships between population migration, economic development and quantity of municipal waste annually collected in Polish poviats in the years 2005-2014. The study applied the spatial panel Durbin model which proved to be an effective tool in that kind of analyses (which was indicated by the quality of the model, substantial accuracy of received results, extensiveness and thoroughness of information).

Results of the conducted analysis indicated that the quantity of waste was associated with the economic condition of poviats, wealth of the population and population density. Nevertheless, internal processes and foreign migrations (their intensity and direction) considerably influenced the value of the analysed endogenous variable. The application of an appropriate spatial model enabled verifying the occurrence and inclusion of inter-poviat relations in the analysis. As a result, it appeared that spatial autocorrelation also determined the volume of the studied phenomena not only in a given poviat but also in adjacent ones. Moreover, the carrying out of the Kuznets curve assumptions confirmed a strong non-linear correlation between the economic development of poviats and quantity of municipal waste. However, the form of the estimated function indicated that there were urban units in Poland whose faster economic growth led to a fall in the dependent variable value, *e.g.* through investment expenditure on waste management also in adjacent poviats.

Due to the generality of statistical information, the received results should be regarded as a starting point for further research. The next stage in the analyses will be an attempt at building models describing the impact of population flows on the quantity of produced waste divided into categories as well as searching for environmental factors determining migration processes (and then the analysis will look at how environmental degradation might stimulate or force migration). Moreover, a special emphasis will be placed on the evaluation of the phenomena in urban units. In turn, the models will be enriched with different kinds of spatial weights matrices (also asymmetrical, directional) and based on different environmental Kuznets curves. However, taking into account the diversification of occurring environmental and economic processes and local determinants of poviats, it is worth applying geographically weighted regression (GWR) in future, too.

Appendix 1.
Map of the NUTS-2 and NUTS-4 of Poland

Note: 0- warmińsko-mazurskie, 1 - pomorskie, 2 - zachodniopomorskie, 3- podlaskie, 4 - kujawsko-pomorskie, 5- wielkopolskie, 6 - lubuskie, 7 - lubelskie, 8 - łódzkie, 9 - mazowieckie, 10 - dolnośląskie, 11 - świętokrzyskie, 12 - śląskie, 13 - opolskie, 14 - podkarpackie, 15 - małopolskie.

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Investment, Energy Consumption and CO_2 Emissions: An Analysis on the Strategy of Industry Development

Chung-Huang Huang , Taiwan Research Institute & Taiwan Association of Environmental and Resource Economics, Taiwan
Cheng-Yih Hong, Chaoyang University of Technology, Taiwan
Han-Pang Su, Taiwan Research Institute, Taiwan
Chin-Wen Yang, Taiwan Research Institute, Taiwan
Jian-Fa Li, Chaoyang University of Technology, Taiwan

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Abstract
Taiwan has exposed the vulnerability of its economy during the 2008 financial crisis. The issues on democratization, the rise of citizen's consciousness and environmental protection have received well attention. The symbiosis of economic activity and environment has failed to meet current needs. We combine the Habitat Segregation Theory and the Spiral Pattern of Economic Development to serve as a mode of the co-evolution of economic activities and environment. Furthermore, this study employs a dynamic industry-related model to estimate the economic spillover effect and the CO2 emissions from both R&D of government and private equipment investment. We classify the industries into four subgroups which are the high economic effect with high emission coefficient, low economic effect with high emission coefficient, low economic effect with low emission coefficient and high economic effect with low emission coefficient. The present study attempts to measure (1) the investment multiplier of government R&D and private equipment investment, (2) the difference in the employment creation effect of government R&D and private equipment investment and (3) The CO2 emission of both governmental R&D and private equipment investment, and further to propose the direction of Taiwan's industrial development.

Keywords: Government R&D Investment, Private Equipment Investment CO_2 Emission Coefficient, Dynamic Industry-Related Model

Introduction

Economic growth and environmental protection seem to have presented themselves as two incompatible paths. Indeed, the economic growth in Taiwan has incurred environmental damages that are ongoing. How to minimize environmental pollution while sustaining economic growth has become a critical issue in the course of forming a quality society in the country. Under the influence of liberalization in the 1990s, Taiwan was pressured by the international community to relax control on trade and the financial market. To address the issues of slow economic growth and environmental protection needs, the government launched a six-year National Development Plan (1991-1996) to achieve full-scale balanced development. Nevertheless, Taiwanese industry structures have remained unadjusted because of insufficient domestic investment and massive capital outflows. The global financial crisis in 2008 has resulted in a severe economic downturn in Taiwan, highlighting the enduring failure in industrial restructuring and the necessity of a policy review.

Numerous studies have shown that energy price fluctuations can cause tremendous economic loss when economic growth hinges excessively on energy consumption (Bruno & Sachs, 1985; Hamilton, 1983 & 1996; Davis and Haltiwanger, 2001; Lee and Ni, 2002). Therefore, the stability of energy prices does not only affect production costs but also constitutes a vital factor influencing economic development (Huang et al., 2015a and 2015b). How to achieve economic development given these conditions in Taiwan warrants discussion?

Over the past two decades, high technology has become the driver fueling economic growth in Taiwan. Nevertheless, sustained research and development (R&D) is imperative for maintaining competitiveness in high technology industries. Effective R&D can boost productivity and create added values. Improved productivity can increase profits by reducing energy consumption while achieving the objective of environmental preservation. Furthermore, added value creation can increase the R&D funding of businesses, thereby achieving industry upgrading, which can yield more mature economic constitution and ultimately achieve sustainable economic development. Although energy prices and demands are asymmetrical (Fan et al., 2007; Ma et al., 2008; Roy et al., 2006), R&D-enabled technological advances can reduce energy demands (Dowlatabadi et al., 2006; Boone et al.,1996). By dividing productivity of the energy sector into efficiency and technical changes, Kumar et al. (2009) analyzed the relationship between technological advances in R&D and energy price fluctuations.

Huang et al. (2015a, 2015b) found that following its entry into the World Trade Organization, Taiwan has exhibited increasingly high imported-energy intensity and considerably heightened sensitivity to energy prices, implying the Taiwanese economy has become more restricted by its reliance on energy. Achieving sustainable economic development in a country necessitates advances in energy saving technologies and energy efficiency, which enable a country to adapt to changes in the international economic environment and realize industrial restructuring.

Achieving industrial restructuring by engaging in high technology R&D can be used as a means for resolving the economic problems in Taiwan and for achieving environmental preservation. In addition, effective industrial restructuring can drive economic development and create more job opportunities. Taiwanese economic growth relies heavily on exportation and is highly subject to the influence of the global economy, thereby resulting in a vulnerable economic constitution. Furthermore, the developments of the high technology industries, which can yield high added values, are incomplete due to the serious lack in capital, equipment, and technology. These factors have hindered Taiwanese industry upgrading, preventing industrial restructuring. The static-efficiency in market allocation and the dynamic gain of productivity are two vital factors powering structural economic changes, ultimately enabling economic development. These ideas are consistent with the concept of creative destruction developed by Joseph A. Schumpeter, a celebrated economist in the twentieth century. Specifically, the transfer and acquisition of knowledge and technology enhances production potential, which is realized through investment. Well-adjusted industry structures can improve the environment; hence, economic development can be achieved while satisfying Taiwanese people's expectation of environmental protection.

The government, which plays a vital role in R&D, is responsible for leading the industrial development and restructuring in Taiwan. Nevertheless, amid the rapidly changing global economic environment, many countries are catching up with Taiwan economically. Consequently, previous R&D pace and strategies can no longer prepare Taiwan for the economic challenges posed by other countries. Considering the current industrial development and economic structure in Taiwan, developing high technology industries matches future development trends. High technology industries, which can act as a driver fueling economic growth, can reduce CO_2 emissions and achieve the objective of environmental protection. Hence, we used high technology industries as the subject of this study to calculate the economic effects of R&D investment before using the results to estimate CO_2 emissions. We divided the investing sectors into the government and private enterprises. Specifically, the government invests in R&D while private enterprises invest in equipment. Differing ways of investment yield differing economic benefits and environmental impact, and the same investment can also result in varying effects on differing industries. In previous studies, economic effects and CO_2 emissions have been estimated primarily using the static model, which is suitable for conducting short-term analysis. Nevertheless, investment results cannot be explained effectively based on short-term analysis. Therefore, we developed a dynamic model that features investment as an endogenous factor to estimate economic effects and CO_2 emissions.

The dynamic industry-related model was employed to estimate the economic spillover effects and CO_2 emissions of various industries. Subsequently, we compared the results with the economic benefits and CO_2 emissions of various industries to analyze the current industrial development in Taiwan.

Literature Review

The literature on investment is focused heavily on the influence of government public spending on economy (Roller and Waverman, 2001; Romp and de Haan, 2005; Heintz et al, 2009; Reinhart & Rogoff, 2009; Fishback and Valentina, 2010; Ramey, 2011; Parker, 2011; Hong and Li, 2015). Ramey (2011) estimated that the temporary investment multiplier devised by the U.S. government was between 0.5 and 2.0. Fishback and Valentina (2010) found the highest public investment multiplier during the U.S. New Deal period was 1.7. Parker (2011) confirmed that the effect of investment multiplier is optimal when the economy of a country is in recession. Furthermore, Romp and de Haan (2005) concluded the elasticity of the output of high-income countries over public capital was between 0.1 and 0.2. Heintz et al. (2009) indicated that every US$1 billion can generate 18,000 jobs in various industry sectors. Hong and Li (2015) examined a plan the Taiwanese government implemented during the 2008 Financial Crisis to increase public investment, and the empirical results showed the investment expenditure multiplier was approximately 1.94 and 314,826 jobs were created.

When investment reaches the limit of the economies of scale, R&D is an effective way for overcoming the economic limits. Engaging in R&D to create economies of scale is an effective approach employed in Taiwan to overcome economic difficulties. The scope of R&D is diverse, and relevant studies have adopted diverse perspectives in examining the issue. Based on the stage of development, R&D can be divided into the following stages: basic research, applied research, development, demonstration, buy-down, and deployment. Specifically, the first three stages are R&D and the latter three stages are in the field of marketing. Additionally, R&D is regarded as technology push and marketing as demand pull. In other words, R&D should be reviewed using an overall chain-linked model (Rothwell, 1977 and 1994; Rothwell & Gardiner, 1985; kline, 1990). R&D must undergo a learning process (Rosenberg, 1976, 1982; Lundvall, 1988 and 1992), where the experience of learning can yield novel methods (learning by searching) and enhance efficiency (learning by doing; learning by using). The knowledge accumulated over an extended period can create benefits for research institutes (Terleckyj, 1974; Griliches, 1979; Mansfield, 1980). Furthermore, the information exchange between R&D staffers and people with market demands can yield unexpected discoveries (learning by interacting). In other words, because the technology creation resulting from R&D must match market demands, governments must build a supply-demand formation mechanism before implementing technology-related policies to effectively improve R&D results (Margolis and Kammen, 1999; Banales-Lopez and Norberg-Bohm, 2002; Margolis, 2002).

Additionally, building a R&D mechanism can not only yield more efficient economic results but also induce social progress, ultimately achieving a symbiotic evolution of technology and society. When technological advances boost industrial development, a favorable social environment is created (Nelson and Winter, 1982; Hughes, 1983; Elzen et al., 2004). This environment can only be achieved by promoting energy technology R&D and appropriate industrial development. Hence, numerous studies have contended the necessity of including R&D as a perspective in environmental policy-making (Heaton and George, 1990; Wallace, 1995; Banks and Heaton, 1995; Kemp, 1997; Hemmelskamp, 1997).

Nevertheless, promoting R&D is difficult because R&D knowledge is public goods, which can result in inefficient resource allocation (Arrow, 1962). Furthermore, the influence of R&D on future research results is uncertain and irreversible. Consequently, the process of promoting R&D can be marred with numerous obstacles (McDonald and Siegel, 1986; Bertola, 1988; Pindyck, 1988; Dixit and Pindyck, 1994). Empirical studies on R&D equipment investment and the uncertainty of R&D include Pindyck and Solimano (1993), Ferderer (1993), and Huizinga (1993). Considering the uncertainty and irreversibility of R&D, particular scholars have proposed that R&D

should be handled by governments (Carmichael, 1981; Lichtenberg, 1984). Empirical results obtained by Levy and Terleckyj (1983) indicated the primary effect of government R&D is that government-commissioned research can induce private investment. Carmichael (1981) also shared this view. Lichtenberg (1984) revealed partial positive effects on inducing private investment. Mamuneas and Nadiri (1996) analyzed the direct effects of government R&D investment and the indirect effect this investment has on private investment. The empirical results showed the spillover effects resulting from the technology accumulated through R&D can reduce the costs producing factors of production. Productivity can be increased by combining the R&D results obtained by the public sector and investments made by private enterprises (Cockburn-Henderson, 1997).

Government R&D investment has diverse effects: In addition to the direct rewards of knowledge and economic benefits, government R&D investment can also motivate enterprises and universities to engage in R&D. Furthermore, from the perspective of additionality, government R&D investment can increase R&D investment and induce behavioral additionality, ultimately yielding additional results (Buisseret et al., 1995). Using 17 OECD member countries as the subject of analysis, Guellec and Pottelsberghe (2000) found every US$1 of R&D subsidy can attract an average of US$1.7 in private R&D investment.

Regarding energy R&D, research conducted by National Research Council (2001) showed investments in energy technology R&D can yield economic, environmental, and social security benefits. By conducting further analysis on the same issue, Davis & Owens (2003) estimated, by employing a bidding method, that the development of renewable energy technologies in the United States had a market value US$26.3 billion. Regarding the relationship between economic development and energy environment, numerous studies have indicated economic growth resulted in increased energy consumption. However, particular scholars have contended energy consumption was not necessarily proportional to GDP growth (Costanza, 1980; Costanza and Herendeen, 1984; Fallahi, 2011; Lee, 2006). Costanza (1980) and Costanza and Herendeen (1984) used government spending and the household sector as two endogenous variables to estimate energy consumption induced by the production of a unit of commodity.

Among studies that employed the input-output model to analyze the relationship between environment and energy consumption, Kagawa and Inamura (2000) analyzed why the energy consumption in Japan must undergo structural changes and examined structural changes in the energy input of Japan. Particular studies have divided the factors of energy consumption (Kagawa and Inamura, 2000; Hunt and Ninomiya, 2005; IEEJ, 2011). Hunt and Ninomiya (2005) used econometric models to investigate why energy demand has changed and used the time series of energy demand to estimate the future energy demand and CO_2 emissions of Japan.

Simultaneously, scholars have examined environmental issues occurring as the Chinese economy developed. For example, Ying Fan et al. (2007) used data in 1997 as a baseline to estimate the energy consumption and CO_2 emissions in China in 2020. Liu et al. (2010) further adopted a trade perspective to analyze the energy consumption in China.

Empirical Model

To estimate CO_2 emissions and the economic effects of R&D investment, we developed a dynamic industry-related model, where consumption (C) and investment (K) were used as two endogenous variables. To compare the differences in the investments made by the private and public sectors, we compiled the following equilibrium equations for the dynamic industry-related model:

$$\boldsymbol{X(t) = AX(t) + C^p + C^G + K[X(t+1) - X(t)]} \quad \textbf{……(1)}$$

Based on the value-added rate, the earning of enterprises and laborers ($\boldsymbol{y(t)}$) can be estimated using

$$\boldsymbol{y(t) = V^t \cdot X(t)} \quad \textbf{……(2)}$$

$\boldsymbol{V^t}$ is the vector of the value-added rate.

$$\boldsymbol{C^p = H_c \cdot c \cdot y(t) =}$$
$$\boldsymbol{H_c \cdot c \cdot V^t \cdot X(t)} \quad \textbf{……(3)}$$

$\boldsymbol{c}$ is the consumption rate, and $\boldsymbol{H_c}$ is the vector of consumption patterns.

$$\boldsymbol{X(t) = AX(t) + (C^p + C^G)X(t) + (k^p + k^G)[X(t+1) - X(t)]}$$
$$\boldsymbol{X(t+1) = [K^{-1}(I - A - C) + I]X(t)} \quad \textbf{……(4)}$$
$$\boldsymbol{C = C^p + C^G} \quad ; \boldsymbol{K = k^p + k^G},$$

where $\boldsymbol{C^p}$ is private sector consumption and $\boldsymbol{C^G}$ is government sector consumption; $\boldsymbol{k^p}$ is private sector investment and $\boldsymbol{k^G}$ is government sector investment. $\boldsymbol{k^p}$and $\boldsymbol{k^G}$ are the investment coefficient matrixes of the private and government sectors, respectively, as shown in the following equations:

$$\boldsymbol{k^p} = \begin{pmatrix} \boldsymbol{k^p}_{\boldsymbol{11}} & \cdots & \boldsymbol{k^p}_{\boldsymbol{1n}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{k^p}_{\boldsymbol{m1}} & \cdots & \boldsymbol{k^p}_{\boldsymbol{mn}} \end{pmatrix}, \quad \boldsymbol{k^G} = \begin{pmatrix} \boldsymbol{k^G}_{\boldsymbol{11}} & \cdots & \boldsymbol{k^G}_{\boldsymbol{1n}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{k^G}_{\boldsymbol{m1}} & \cdots & \boldsymbol{k^G}_{\boldsymbol{mn}} \end{pmatrix}$$

Specifically, the scale of government consumption ($\boldsymbol{C^G}$) is determined by budgetary planning. Therefore, $\boldsymbol{C = H_c \cdot c \cdot V^t \cdot X(t) + C^G}$**.**
Assuming $\mathrm{D} = \boldsymbol{I - A - C}$, the dynamic model can be written as

$$\boldsymbol{X(t+1) = (K^{-1}D + I)X(t)} \quad \textbf{……(5)}$$

In this study, we adopted an industry-related model featuring open competition. $\boldsymbol{X(t) = [I - A(I - \bar{M})]^{-1}[E + (I - \bar{M})F^d]}$. Therefore, the dynamic industry-related model **is**

$$\boldsymbol{X(t+1) = (K^{-1}D + I)[I - A(I - \bar{M})]^{-1}[E + (I - \bar{M})F^d]} \quad \textbf{……(6)}$$

When estimating the intrinsic value and intrinsic vector of $\boldsymbol{(K^{-1}D + I)}$ in (6), let $\boldsymbol{\eta}$ be the intrinsic value of $\mathbf{D}^{-1}\boldsymbol{K}$ and the intrinsic vector be $\boldsymbol{\tau}$:

$$\boldsymbol{D^{-1}K\tau = \eta\tau} \quad \textbf{……(7)}$$
$$\boldsymbol{\frac{1}{\eta}(K^{-1}D)(D^{-1}K)\tau = K^{-1}D\tau}$$
$$\boldsymbol{\frac{1}{\eta}\tau = K^{-1}D\tau}$$
$$\boldsymbol{(K^{-1}D + I)\tau = (\frac{1}{\eta} + 1)\tau}$$

$(\frac{1}{\eta}+1)$ is the intrinsic value of $(K^{-1}D+I)$, and τ is the corresponding intrinsic vector.

Dynamic Environmental Industry-related Model

$X(t+1)=\hat{E}(K^{-1}D+I)[I-A(I-\bar{M})]^{-1}[E+(I-\bar{M})F^{d}]$……………………..…..(8)

Where the emissions coefficient $e_j = {CO_2}_j / x_j$, and $\hat{E}$ is the diagonal matrix of the elements of the emissions coefficients for various industries.

$$\hat{E}=\begin{pmatrix} e_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & e_n \end{pmatrix}$$

Empirical Results

The empirical results presented in this section were obtained using an investment of NT$100 billion as the baseline of estimation. We analyzed the economic spillover effects of government R&D investment and private equipment investment as well as the number of jobs created. We divided the industries into seven categories to summarize the differing characteristics of the industries.

Economic Spillover Effect of R&D Investment

Economic Spillover Effects

Table 1 shows the production induced, crude value-added, and income from employment resulting from government R&D investment. Specifically, the economic spillover was NT$140.472 billion, NT$69.472 billion, and NT$39.378 billion, respectively; and the investment multiplier was 1.4. In addition, the economies of scaled induced in the first and second spillover was approximately NT$40 billion.

Table 1 The Economic Effects from Government R&D Investment

	Production Induced Value	Gross Induced Added Value	Induced Income of Employment
Direct Spillover Effects	100	57.64	32.340
First Spillover Effects	28.417	7.666	0.459
Second Spillover Effects	12.056	4.167	2.579
Total Spillover Effects	140.472	69.472	39.378
Multiplier	1.40		

Note: Unit: billion New Taiwanese dollars.

Using the electronics industry as a subject, the economic effect of equipment investment is shown in Table 2. Specifically, the economic effect of private investment was significantly weaker than that of government R&D investment.

Specifically, the production induced, crude value-added, and income from employment resulting from private investment were NT$107.315 billion, NT%14.457 billion, and NT$10.950 billion, respectively; and the investment multiplier was 1.07. In other words, the economic effect of government investment was stronger than that of private investment. Specifically, the production induced, crude value-added, and income from employment associated with private investment was 1.31, 4.81, and 3.60 times that of government investment, respectively. The differences in the economic spillover effects of private and government investments exist because the direct economic effect of government investment is stronger than that of private enterprises. This is because electronics manufacturing relies heavily on importation; consequently, the investment multipliers differed.

Table 2 The Economic Effects from the investment on electronics industry

	Production Induced value	Gross Induced Added Value	Induced Income of Employment
Direct Spillover Effects	64.492	7.186	4.904
First Spillover Effects	34.316	4.331	4.225
Second Spillover Effects	8.508	2.94	1.82
Total Spillover Effects	107.315	14.457	10.95
Multiplier	1.07		

Note: Unit: billion New Taiwanese dollars.

Furthermore, private investment resulted in less satisfactory crude value-added and income from employment primarily because the electronics sector exhibited less satisfactory crude value-added and income from employment compared with that resulting from relevant sectors handling government R&D.

As shown in Table 3, government R&D investment created more jobs than private investment, the numbers being 29,400 and 20,872, respectively. A further observation of the number of jobs created in raw materials industries as a result of the two economic spillovers showed that government investment had stronger effects than private equipment investment, with a difference of 8,528 jobs. This is primarily because the electronics sector has less impact on service-related industries and is thus unable to provide considerable job opportunities. This issue will be further elaborated in a subsequent paragraph.

Table 3 Employment Creation

	Raw Material Induced Value	First Spillover Effects	Second Spillover Effects	Total
Government R&D investment	13,439	10,058	5,903	29,400
private Equipment	10,258	6,448	4,166	20,872

Investments				
Difference in Employment	3,181	3,610	1,737	8,528

Note: Unit: Persons.

Economic Spillover Effects for Industries

Based on the nature of the industries, we divided the 166 sectors listed in The Report on 2011 Input-Output Tables into seven major industries. Table 4 shows the economic effects of government R&D investment on various industries. The results indicate the effects were most prominent in the machinery and service industries, accounting for 36% and 33.69% of the overall effects, respectively. This is primarily because R&D involves the purchase of raw materials used to produce machinery and electronics-related products, indirectly increasing the crude value-added and income from employment in relevant industries. This triggers subsequent demands for the machinery and electronics industries and the service industry.

Table 4 Economic Effect of Government R&D Investment

Sector	Raw Material Induced Value	First Spillover Effects	Second Spillover Effects	Total	Percentage
Agriculture-related	84.32	-91.91	1,750.71	1,743.12	2.10%
Light Industry	821.07	-192.17	724.98	1,353.87	1.63%
Chemical-related	4,562.62	5,429.43	1,481.23	11,473.27	13.85%
Iron, Non-Iron	1,337.05	-810.85	172.42	698.62	0.84%
Machinery-related	17,106.58	7,723.94	4,985.54	29,816.07	36.00%
infrastructure	958.60	9,778.06	-894.86	9,841.81	11.88%
Service-related	17,490.07	6,580.07	3,835.51	27,905.64	33.69%
Total	42,360.31	28,416.57	12,055.53	82,832.41	100.00%

Note: Million New Taiwanese Dollars

Regarding the economic effects of private equipment investment on various industries, private investment had the most significant economic spillover effects on machinery-related industries and the infrastructure industries, as shown in Table 5. Specifically, the economic effects on machinery-related industries accounted for 50.92% of the overall economic spillover effect. The effect on the infrastructure industries accounted for 26.77% of the overall effect. The results differed slightly from the effects of government sector investment. This is primarily because private investments in electronics-related industries are equipment investment. Although improving production technologies can enhance productivity, 30% of the equipment is imported. Consequently, the direct economic spillover is minor. However, compared with government R&D investment, private investment had a greater effect on raw material induction. In addition to increasing the quantity of machinery appliances, private equipment investment accounted for 26.77% of the economic effects on the infrastructure industries. Increasing investment in the infrastructure industries mean that private equipment investment and production will affect sectors such as plant construction, power demand, waste disposal and recycling, and pollution remediation.

Table 5 Economic Spillover Effects of Private Equipment Investment

Sector	Raw Material Induced Value	First Spillover Effects	Second Spillover Effects	Total	Percent (%)
Agriculture-related	11.42	-2,101.21	1,235.47	-854.32	-0.85
Light Industry	480.95	-77.55	511.61	915.01	0.91
Chemical-related	2,906.40	3,996.54	1,045.29	7,948.23	7.94
Iron, Non-iron	2,269.12	-1,220.53	121.69	1,170.28	1.17
Machinery-related	43,906.21	3,561.69	3,518.30	50,986.20	50.92
Infrastructure	828.23	26,606.72	-631.51	26,803.44	26.77
Service-related	6,903.73	3,550.17	2,706.73	13,160.63	13.14
Total	57,306.07	34,315.83	8,507.58	100,129.48	100

Note: Million New Taiwanese Dollars

Both government R&D investment and private equipment investment exhibited decreased first economic spillover effects on agriculture-related industries and the light industries. Nevertheless, the ultimate economic spillover effect of government R&D investment increased whereas private equipment investment had negative economic effects on agriculture-related industries.

Test 6 Employment Creation on Industries

	Government R&D Investment		Private Equipment Investment		Difference in Number of Employment (person)
	Employment Creation (persons)	Coefficient of Employment (persons per million dollars)	Employment Creation (person)	Coefficient of Employment(Person per million)	
Agriculture-related	804	0.46	-1,338	1.5	2,142
Light Industry	669	0.49	135	0.15	534
Chemical-related	3,082	0.27	1,258	0.16	1,824
Iron,	402	0.58	603	0.52	-201

Non-Iron					
Machinery-related	6,483	0.22	7,483	0.15	-1,001
Infrastructure	3,378	0.34	5,731	0.21	-2,353
Service-related	14,582	0.52	7,000	0.53	7,582
Total	29,400	0.35	20,872	0.21	8,528

Estimations regarding the number of jobs created in various industries by government R&D investment and private equipment investment are shown in Table 6. Although the economic spillover effect of government R&D investment was most prominent in machinery-related industries, the largest number of jobs created was in service-related industries (14,582 jobs) because the employment multiplier was greater. By contrast, the largest number of jobs created by private electronics equipment investment was in machinery-related industries (7,483 jobs). Nevertheless, the economic spillover effect on agriculture-related industries was negative; consequently, the number of jobs created decreased by 1,338. The gap between the number of jobs created by government R&D investment and private investment was most significant in service-related industries, with a difference of 7,582 jobs. However, compared with government investment, private investment created more jobs in infrastructure industries and machinery-related industries, with a difference of 2,353 and 1,001 jobs, respectively. In addition to reflecting the difference in the economic spillover effects, the difference in the number of jobs created also showed government R&D investment and private investment differed in employment multiplier. Overall, the employment multiplier of government R&D investment was 0.35 jobs per NT$1 million whereas that of private investment was 0.21 jobs per NT$1 million. Except for the employment multiplier in agriculture-related industries, the employment multipliers resulting from government R&D investment were all greater than those resulting from private investment. This result indicates that the employment effect of R&D investment was superior to that of private investment in high technology equipment.

Energy consumption and CO_2 emissions resulting from government R&D investment and private equipment investment

Results presented in previous paragraphs show that investment yields numerous economic benefits. However, the consequent CO_2 emissions remain an issue discussed extensively during the process of economic development. Table 7 shows the CO_2 emissions resulting from investments in six major sectors. Overall, government R&D investment resulted in 793,204.70 tons of CO_2 emissions, which was 69.46% of the 1,141,991.12 tons resulting from private investment. The CO_2 emissions of the energy sector was the most significant whether it be government R&D investment or private equipment investment, accounting for 67.86% and 76.31% of the overall emissions, respectively. The two types of investments did not differ substantially in the CO_2 emissions of the industrial sector. However, compared with private investment, government R&D investment resulted in a higher level of CO_2 emissions in the transport sector.

Table 7 CO_2 Emissions of investments in Sectors

Industry	Energy	Industry	Transportation	Agriculture	Service	Residence	total
Government R&D Investment	538,271.32	118,185.40	134,690.79	22.95	14,243.99	-12,209.75	793,204.70
Percentage	67.86%	14.90%	16.98%	0.00%	1.80%	-1.54%	100.00%
Private Investment	871,465.86	190,059.23	52,136.03	-721.48	46,425.54	-17,374.07	1,141,991.12
Percentage	76.31%	16.64%	4.57%	-0.06%	4.07%	-1.52%	100.00%
A/B	61.77%	62.18%	258.34%	-3.18%	30.68%	70.28%	69.46%

Note: Unit: tons

Differing from the categorization of six industry sectors, government R&D investment and private investment also resulted in differing CO_2 emissions in the seven major sectors. Table 8 shows the CO_2 emissions spillover effects of government R&D investment on various industries. Specifically, the CO_2 emissions resulting from raw material induction was 270,751.85 tons, the most of which was emitted by chemistry-related industries (approximately 132,643.62 tons, accounting for approximately 49%). However, the most significant CO_2 emissions resulting from the first spillover was by the infrastructure industries, which amounted to 174,604.01 tons.

Test 8 CO_2 emissions of Government R&D investment

sector	Raw Material Induced Value	First Spillover Effects	Second Spillover Effects	Total	Percent (%)
Agriculture-related	613.96	-9,243.86	18,534.05	9,904.14	1.25
Light Industry	2,916.81	-682.69	2,575.46	4,809.58	0.61
Chemical-related	132,643.62	157,843.47	43,061.97	333,549.06	42.05
Iron, Non-Iron	4,749.83	-2,880.51	612.52	2,481.83	0.31
Machinery-related	60,770.55	27,439.04	17,710.98	105,920.57	13.35
infrastructure	19,807.35	174,604.01	564.47	194,975.84	24.58
Service-related	49,249.73	53,504.49	38,809.46	141,563.68	17.85
Total	270,751.85	400,583.94	121,868.91	793,204.70	100

The CO_2 emissions of agriculture-related industries, the light industries, and the ferrous and non-ferrous metal industries decreased primarily because the first economic spillover effects declined. As shown in Table 8, the CO_2 emissions resulting from government R&D investment were most significant in chemistry-related and infrastructure industries, accounting for 42.05% and 24.58% of the total, respectively. Therefore, the rankings of CO_2 emissions by industry and economic spillover effect by industry differ.

Table 9 Energy consumption resulting from Government R&D investment

Energy	Industry	Transportation	Agriculture	Service	Residence	total
1,707,151.89	227,484.49	205,150.88	883.81	42,300.71	-31,668.86	2,151,302.91

Table 9 shows the energy consumption resulting from R&D investment in energy technologies, the most significant being the energy sector (1,707,151.89 kiloliters of oil equivalent). By contrast, the energy consumption of the household sector decreased by 31,668.86 kiloliters of oil equivalent.

Table 10 CO_2 Emissions of Private Investment

sector	Raw Material Induced Value	First Spillover Effects	Second Spillover Effects	Total	Percent (%)
Agriculture-related	332.04	-37,389.64	13,079.34	-23,978.27	-2.10
Light Industry	1,708.56	-275.49	1,817.48	3,250.54	0.28
Chemical-related	84,494.45	116,186.73	30,388.49	231,069.67	20.23
Iron, Non-Iron	8,060.98	-4,335.89	432.3	4,157.39	0.36
Machinery-related	155,975.30	12,652.78	12,498.64	181,126.73	15.86
infrastructure	18,334.77	672,153.13	398.22	690,886.12	60.50
Service-related	23,704.21	4,386.61	27,388.12	55,478.94	4.86
Total	292,610.31	763,378.22	86,002.58	1,141,991.12	100

Table 10 shows the CO_2 emissions resulting from private investment in electronics-related industries. Specifically, machinery-related industries yielded the most significant CO_2 emissions in raw material induction, the amount being 155,975.30 tones. Among the CO_2 emissions resulting from the total spillover, the infrastructure industries yielded the most significant CO_2 emissions, which was 690,886.12 tones, accounting for 60.5% of the total emissions. It is worth noting that the CO_2 emissions of agriculture-related industries decreased by 23,978.27 tones because the CO_2 emissions resulting from the first spillover decreased by 37,389.64 tons.

Table 11 Energy Consumption of Private Investment

Energy	Industry	Transportation	Agriculture	Service	Residence	total
1,546,365.06	257,668.75	79,409.68	-2,069.09	8,625.79	-45,063.73	1,864,936.46

Table 11 shows the energy consumption of the six major industries of private investment. Specifically, the energy sector exhibited the highest energy consumption and the agriculture and residential sectors exhibited decreased energy consumption.

Concluding Remarks

In addition to boosting economic growth, government R&D investment and private equipment investment can reduce CO_2 emissions. The effects of economic growth involve crude value-added for enterprises, income from employment, and job opportunities. Crude value-added, as a basis of capital accumulation, can increase the level of subsequent investment. In addition, the technologies accumulated can contribute to a virtuous cycle of investment, further driving economic growth and reducing CO_2 emissions. Furthermore, increased income from employment and job opportunities can improve spending power, ultimately increasing market demands. The following paragraphs present the empirical results obtained in this study:

(1)The investment multiplier of government was 1.40, which was greater than that of private equipment investment (1.07). The main difference lies in the size of the direct economic spillover effects. Both types of investments had the greatest economic spillover effects on machinery-related industries. The value of investment multiplier reflects the economic spillover effects of investment. In addition to purchasing equipment, government R&D investment is also spent on human resources cultivation. These factor input can be satisfied using domestic resources, and the economic spillover effects of the spending can be easily formed domestically. By contrast, private investment in equipment relies considerably on importation. In particular, a large proportion of the high technology equipment necessary in capital-intensive industries is imported. Consequently, the economic spillover effect of private investment was not comparable to that of government R&D investment.

(2) Government R&D investment created the most job opportunities in service-related industries, whereas private investment created the most job opportunities in machinery-related industries. Overall, government R&D investment created more jobs than private investment. The number of jobs created is determined by the size of investment and the employment coefficient of an industry. In this study, we used NT$100 billion as the initial investment for all industries; therefore, job creation is determined by employment coefficients. Generally speaking, employment coefficient is a key indicator employed to differentiate between capital- and labor-intensive industries. The value of employment coefficient determines the number of jobs created by an investment. The results of this study show government R&D investment evidently had a greater effect on job creation. This is because increased value-added for enterprises and increased income from employment affected the economic spillover effects on service-related industries, which had relatively high employment coefficients.

(3) The CO_2 emissions resulting from private equipment investment were higher (1.44 times) than those resulting from government R&D investment. Generally speaking, CO_2 emissions is determined by the size of economic activities and CO_2 emissions coefficient. Part of private equipment investment is spent on equipment upgrading. Although new-technology equipment might reduce CO_2 emissions, the novel technologies might improve productivity and competitiveness, ultimately increasing yield and indirectly increasing CO_2 emissions. In the case of government R&D investment, industry growth might also increase CO_2 emissions. Nevertheless, government investment had the greatest economic spillover effect on service-related

industries, where the emissions coefficient and CO_2 emissions are lower than those of other industries.

After further analyzing the empirical results stated in previous paragraphs, we divided the industries into four types based on the size of economic spillover and CO_2 emissions. The categorization enabled us to develop objective evaluations of the effects of government and private investments. The four types are strong economic effect-high emissions coefficient, weak economic effect-high emissions coefficient, weak economic effect-low emissions coefficient, and strong economic effect-low emissions coefficient, as shown in the following paragraphs.

Type I is strong economic effect-high emissions coefficient industries, which primarily include chemistry-related and infrastructure industries. Representative industries in the quadrant include plastics (synthetic resin), synthetic rubber, gas, and refined petroleum products. These industries involve intermediate goods necessary for producing raw materials or the fuel necessary for production. To achieve Taiwanese economic growth, these industries are vital sectors that cannot be removed at this stage. Consequently, CO_2 emissions remain high.

Type II is weak economic effect-high emissions coefficient industries, which primarily include chemistry-related industries. These industries are not the core industries driving economic growth, and a significant proportion of these industries have moved overseas or rely on importation. The representative industries of Type II are coke and other coal products, other man-made fibers, cleaning supplies, and cosmetics. The majority of these industries are encountering problems with restructuring. A necessary practice for achieving sustainable business is to improve productivity or value added by engaging in R&D.

Type III is weak economic effect-low emissions coefficient industries, which primarily include agriculture-related and light industries. Agriculture was a vital contributor to the economic miracle in Taiwan in terms of foreign exchange acquisition and cheap labor supply. As industry structures evolved, agriculture no longer acts as a vital booster of economic development; instead, it became a crucial leading force in environmental preservation. Representative industries of Type III include agriculture-related industries, other horticultural crops, animal products, and forest products.

Type IV is strong economic effect-low emissions coefficient industries, primarily including machinery- and service-related industries. These industries are the main forces driving the economic development in Taiwan. Specifically, machinery-related industries are high-technology industries, which the government has been actively promoting since the 1970s. Currently, these industries have become the dominant industries of the Taiwanese economy. Service-related industries are the main industries on which domestic demand expansion relies. Representative industries of Type IV include semiconductors, passive electronic components, circuit board for printing, photoelectric materials and components, financial intermediation, and healthcare services. Compared with industries in the first quadrant, these industries yielded significantly lower CO_2 emissions coefficients and considerably reduced CO_2 emissions.

In conclusion, the economic development and environmental maintenance in Taiwan can be achieved by engaging industrial restructuring. The success of the restructuring hinges on R&D and equipment investment. We can conclude that investment is essential food for realizing economic growth, and R&D is the leaven of economic development.

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Just Transition and the Renewable Energy Industry – To What Extent Does the German Energiewende Consider Decent Work and Job Quality?

Michael Krug, Freie Universität Berlin/Environmental Policy Research Centre, Germany

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Abstract
The paper refers to the concept of Just Transition and examines the corresponding interface of energy and labor policies in the German renewable energy sector, a subject which has received only little attention in the political and scientific debates surrounding the German *Energiewende*. On the one hand, the renewable energy industry directly and indirectly benefits from various forms of state support. On the other hand, unions criticize below-average wages, widespread agency work, underdeveloped employee representation and co-determination, low coverage of collective agreements, a poor gender balance and low apprenticeship ratios. Several manufacturing and other companies have been even blamed for trade union busting. Focusing on wind turbine manufacturing, the paper explores to what extent labor and other social sustainability concerns get integrated into energy policy formulation, implementation and monitoring. It examines perspectives of good governance and "sustainable content policies" seeking to link financial support for enterprises to socially and environmentally sustainable production. The findings suggest that current energy policy strategies and principal renewable energy support schemes do only marginally address job quality and decent work. Social conditionalization of financial support, as demanded by unions and other stakeholders, have not entered the political agenda so far. However, job quality criteria are increasingly integrated into regional structural assistance support and public procurement, but have not the potential (yet) to noticeably influence working conditions and collective labor relations in the renewable energy industry.

Keywords: energy policy, renewable energy, green jobs, Just Transition, social sustainability

Introduction

Many studies are available analyzing the quantitative gross or net employment effects of the "green transition" including the transition from a fossil fuel based economy to a renewable energy based one. However, our knowledge about the qualitative employment effects including working conditions and collective employment relations including employee representation and participation within the renewable energy industry is fairly limited (Littig 2012, 585; Mattera et al., 2009). Generally, engagement with the wider issues of equity, justice and vulnerability within energy systems is still a new and emerging field (Hall, Hards & Burkey, 2013). An interdisciplinary research project involving two research organizations at the Freie Universität Berlin, the Environmental Policy Research Centre and the Management Department, seeks to improve our understanding of these specific issues. The purpose of the research project supported by the Hans Böckler Foundation is to examine the process of institutionalization of collective employment relations[1] in the German wind turbine manufacturing industry. One of the items under scrutiny refers to the concepts of "Just Transition" and "Good Governance" and the perspectives of "Sustainable Content"[2] policies (Adolf & Corbach, 2012). This paper presents selected findings of this research project and explores to what extent labor concerns are linked to renewable energy policies in order to support fair working conditions and the institutionalization of collective labor relations in the renewable energy industry.

Methodology

The paper is based on a policy analysis and explores to what extent renewable energy policies are linked to labor issues in order to facilitate the development of fair working conditions and the institutionalization of collective labor relations in the renewable energy industry. It has a special focus on the principal renewable energy support scheme in Germany, the Renewable Energy Sources Act, and asks to what extent the recent amendments adopted in July 2016 consider employment issues and, specifically, to what extent financial support is linked to job quality/decent work criteria („social conditionalization"). Methodologies applied include primary and secondary literature analysis and the findings of 30 semi-structured, qualitative stakeholder interviews with with elected politicians, policy makers, policy advisory organizations, representatives from trade unions and associated research and advisory organizations, Chambers of Labor, wind turbine manufacturing enterprises and business associations.

The wind turbine manufacturing industry in Germany

Germany is Europe's leading wind energy market with an installed capacity of almost 45 Gigawatt (EWEA, 2016). The number of employees almost constantly increased

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[1] The main processes of the (collective) employment relations system include co-determination at the workplace and enterprise levels, collective bargaining and industrial disputes (Keller & Kirsch, 2016:187).

[2] The term „sustainable content" policies was introduced by Adolf and Corbach (2012) suggesting to link financial support for enterprises to socially (e.g. employee-friendly) and environmentally sustainable production. The term has been used as an analogism to „local content" policies which have been adopted by several countries requiring or encouraging the use of locally manufactured technology in domestic wind energy projects, e.g. by mandating a certain percentage of local content for wind turbine systems installed in some or all projects within one country (Lewis & Wiser, 2007: 1851).

from approximately 46.000 in 2002 to 149.200 in 2014 (BWE 2016). In 2014, 130,500 persons were employed in the onshore segment and 18,700 in the offshore segment (O'Sullivan et al., 2015). The wind energy sector includes, inter alia, manufacturers of wind turbines, suppliers of components, service companies, wind farm developers and operators, financing institutions, certification and other service companies.

Within the last 20 years wind turbine manufacturing has developed as a significant part of the German mechanical engineering sector. In 2015, the leading six companies Enercon (28.2%), Siemens (25.6%), Vestas 16.1%), Senvion (13.6%), Nordex (8.9%) and GE (5.5%) accounted for roughly 98 per cent of the newly installed capacity (onshore and offshore). In the onshore segment, Enercon (37.3%), Vestas (21.3%), Senvion (18.0%), Nordex (11.8%) and GE (7.3%) are the leading market players, whereas Siemens dominated the offshore segment covering 100% of the market (DEWI 2016).

Besides pioneering companies like Enercon, Vestas Nordex, or Senvion (formerly REpower), which have established themselves over the last twenty to thirty years being exclusively dedicated to wind energy, the spectrum of companies active on the German market includes transnational technology corporations (e.g. Siemens, GE), for which renewable energy represents one element of their overall corporate strategy. Manufacturing companies from Asia are increasingly active on the German market, as the following examples illustrate: in 2008, the Chinese company Goldwind, global market leader in 2015, acquired a majority stake in the manufacturing company Vensys, whereas in 2007 REpower (now Senvion) became (temporarily) a subsidiary of the Indian group Suzlon Energy.

The German wind equipment manufacturing industry, which holds a 20 per cent share of the global market, exported two-thirds of its production in 2015 (GWEC, 2016). However, Germany plays still a key role as reference market. With the growing internationalization of the industry, competition has been steadily increasing. Market consolidation and company mergers are ongoing, as the recent mergers of Nordex and Acciona or Siemens and Gamesa illustrate.

Some turbine manufacturers only produce parts of the turbines in-house (e.g. the blades), whereas other key components are outsourced and provided by suppliers (e.g. the direct drive or the gears). The German market leader for onshore wind turbines Enercon is known for its high level of vertical integration producing almost all of its components in-house. Its business model comprises not only manufacturing and installation of wind turbines, but also service, operation and maintenance, project development, logistics, operation of wind power plants, storage solutions, electric grid operation and electricity sales to final customers.

The wind power industry in Germany has evolved over the last thirty years in a politically-driven market. The development of wind energy was a mutually reinforcing process of innovation and targeted state support (Ohlhorst, 2009). State support helped to trigger both technological development and market uptake (ibid.:237). The wind turbine manufacturing industry directly and indirectly benefits or benefitted from various support measures, including:

- Federal and federal state research and development programs,

- Early demonstration programs, including the 100/250 MW wind energy program,
- Low interest loans by state owned banks,
- Measures promoting market deployment through feed-in-tariffs and premiums under the Electricity Feed-In Law (*Stromeinspeisungsgesetz,* 1990) and later under the Renewable Energy Sources Act (*Erneuerbare Energien-Gesetz,* 2000),
- Amendments to the Federal Building Code in 1997 (*Baugesetzbuch*) providing wind turbines a privileged status in spatial planning,
- Investment, settlement and infrastructure support (e.g. under the regional structural assistance programs of the federal states),
- Export promotion.

Depending on their individual business models, the wind turbine manufacturing companies benefit indirectly and directly from the Renewable Energy Sources Act being the principal support scheme for electricity from renewable energy sources in Germany. The law has been regularly updated and fine-tuned with the most recent amendments adopted by both parliamentary chambers on 8 July, 2016. The latest amendments mark a fundamental change from guaranteed feed-in tariffs and feed-in premiums to a support system based on competitive bidding and tenders.

Retarded institutionalization of collective labor relations in the wind energy industry

For several years, trade unions (IG Metall, 2013; IG Metall Vorstand, 2011; 2014), Chambers of Labor (Arbeitnehmerkammer Bremen, 2012; 2015), research and advisory organizations (Gemeinsame Arbeitsstelle RUB/IGM, 2007; Dribbusch, 2013, Behrens & Dribbusch 2014, Winter & Wagener, 2014; Agentur für Struktur- und Personalentwicklung, 2014), environmental organizations, media and policy makers have criticized the comparatively poor working conditions in parts of the wind turbine and solar panel manufacturing industries, like below-average wages, excessive overtime work, non-typical employment including widespread agency work and contract work, underdeveloped co-determination[3], low coverage of collective bargaining agreements[4], a poor gender balance and low apprenticeship ratios.

[3] A dual structure of interest representation is typical of the German industrial relations system which means that workers' representation at workplace and enterprise levels is separated from the collective bargaining system at industry level. Works councils represent employees of one company and can by law be elected if a firm has five or more employees. The works councils have the right of information by management and the right of consultation in terms of e.g. planning of human resources. Board-level co-determination at the enterprise level applies only for corporations. Generally, one can differentiate between parity representation in corporations with 2,000 employees or more, and one third representation in corporations with 500 to 2,000 employees (ibid.). Special rules apply for the coal, iron and steel industries. The second pillar of interest representation includes collective bargaining. Unions and employers' associations (or individual employers) engage in collective bargaining in order to regulate pay and other working conditions. (Müller-Jentsch, 2016). Instead of adhering to an industry-wide agreement, some enterprises – particularly SMEs – conclude their own enterprise agreements. IG Metall is by far the dominant trade union in the metal and electrical industry and negotiates terms and conditions for employees with the relevant employers' associations. Sectoral collective agreements are considered the norm in the metal and electrical industry, however, a number of collective agreements at company level also exist (Vogel & Kraemer, 2010).
[4] See FN 3.

Several manufacturing companies like the domestic market leader in onshore wind turbine manufacturing Enercon were blamed for their anti-union practices and trade union busting. Enercon was heavily criticized for exerting massive pressure on employees willing to organize in trade unions or seeking to establish works councils, and for obstructing the election and practical work of works councils.

Trade unions blamed Enercon also for systematic curtailment or avoidance of enterprise-level and workplace level co-determination, e.g. by splitting up the enterprise into hundreds of smaller companies. Other companies like Nordex and REpower (now: Senvion) were criticized for evading parity co-determination in the company's board by splitting up the company or by transforming the legal status of the company to a European Company (*Societas Europaea*, SE) when the number of employees reached critical thresholds (EWC, 2011).

The evolution of collective labor relations has been rather heterogeneous so far: in the field of non-specialized component supply (e.g. steel, mechanical parts, electrical equipment), trade union representation, co-determination and collective bargaining are rather widespread, whereas in the field of specialized component supply and genuine wind turbine manufacturing the institution-building has been fairly slow so far, although the situation is improving since a couple of years. Particularly, in those turbine manufacturing companies with roots in shipbuilding or steal production where trade union representation is traditionally high and co-determination and collective bargaining well developed, works councils and company level agreements were generally faster established.

In the meantime, thanks to targeted and effective organizing campaigns, which started in 2010, manifold networking activities, public campaigns, and political lobbying performed by the trade union IG Metall, works councils were widely established in the turbine manufacturing industry. The industry currently undergoes a process of "retarded formalization" (*nachholende Formalisierung*) (Gemeinsame Arbeitsstelle RUB/IGM, 2007) and "maturation referring to the social dimension of sustainability" (Nicklich & Krug, 2015). Besides path-dependencies and trade union organizing activities, there are several other drivers which might further facilitate the institutionalization of collective labor relations and improvement of working conditions: the deficit of and growing competition for skilled labor and the decision of Siemens, a global player with traditionally well-developed co-determination structures and collective bargaining agreements to construct a new facility for manufacturing nacelles of offshore wind turbines. Siemens decided to invest €200 million with the new production facility offering jobs for up to 1,000 employees in Cuxhaven (Lower Saxony) (Siemens AG, 2015). Recently the company, the corresponding works council, the regional administration of the trade union IG Metall and employers' association concluded an agreement envisaging to apply the existing sectoral collective agreement of the metal and electrical industry to the employees of the new facility. Trade unions expect that this will likely increase the pressure on other manufacturing companies to adjust the level of wages and other labor standards (IG Metall Küste, 2016).

Trade union demands– social conditionalization of public support?

In Germany, trade unions, employers' associations and public institutions play a key role in the governance of the employment relationship, working conditions and industrial relations structures. They are interlocking parts in a multilevel system of governance that includes the European, national, sectoral, regional (provincial or local) and company levels. Trade unions and employers and their associations engage in collective bargaining largely without any state interference (Keller & Kirsch, 2016). The state has mainly the role of legal framework setting. It may take a more active role through corporatist arrangements where governments include unions and employers' associations in processes of socio-economic policy making (ibid. 186). There is growing evidence, however, that decisions on working conditions are increasingly taken beyond the traditional and established forms of bilateral negotiations between employers and employees, with the state playing a more active role (Jaehrling, 2015).

This leads us to the question, if at all and to what extent sectoral policies, like e.g. energy and/or industrial policies integrate social considerations and can support the development of fair working conditions and the further institutionalization of collective labor relations. Already for several years, the trade unions including IG Metall and the Confederation of German Trade Unions (DGB)[5] in numerous statements and opinions have called for a social conditionalization of financial support, i.e. to link financial support for the renewable energy industry to the compliance with social minimum standards and the principles of decent work (IG Metall, 2016; Thomas, 2016; DGB Bundesvorstand, 2014a; 2014b; 2015; 2016). In their argumentation German trade unions refer increasingly to the concept of "Just Transition" (IG Metall Vorstand, 2015) which shall be shortly explained in the following section.

"Just Transition": from a trade union concept to an imperative of global climate governance

The concept of "Just Transition" originated in the US trade union movement of the 1970s and 1980s initially referring to the protection of vulnerable jobs in industries affected by environmental legislation (Newell & Mulvaney, 2013). The concept evolved as an instrument for workers and communities to claim and ensure attention for their transitional needs in the transformations towards a low-carbon and climate-resilient society (Rosemberg, 2010). "Just Transition" can be understood as the conceptual framework in which the labor movement captures the complexities of the transition towards a low-carbon and climate-resilient economy, highlighting public policy needs and aiming to maximize benefits and minimize hardships for workers and their communities in this transformation (ibid.). The concept has been broadened aiming to "take appropriate measures to protect jobs in vulnerable high- carbon sectors and to ensure that new jobs created in low-carbon sectors provide 'decent' jobs" (cf. Newell & Mulvaney, 2013; Bird & Lawton, 2009).

[5] Traditionally, the industry unions engage in collective bargaining, while the umbrella organization, the German Trade Union Confederation (Deutscher Gewerkschaftsbund, or DGB) which represents eight trade unions, is responsible for political activities including lobbying (Keller & Kirsch, 2016).

From a concept that was known to just a handful of activists, it slowly took root at the international level (Rosemberg 2013). "Just Transition" was gradually adopted by other community and NGO groups, by national governments, by the European Commission, and several UN organizations and agencies including ILO, UNEP, UNCSD and the UNFCCC. The latest achievement to date was the recognition of the concept by the UN Framework Convention on Climate Change. Building on the Cancun Agreement of 2010 (Rosemberg, 2010) and subsequent initiatives, the Paris Agreement[6] adopted by 195 countries in December 2015 acknowledges in its preamble the "imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities" (UNFCCC, 2015), however, without stipulating any further commitments.

Until recently, the translation of the concept into policies has been poor (Stevis & Felli, 2015). However, the International Labour Organization, the only tripartite UN agency, recently adopted Guidelines for A Just Transition Towards Environmentally Sustainable Economies and Societies for All (ILO, 2015). Those guidelines contain, inter alia, policy recommendations for a number of policy areas. Referring to the policy implications of the "Just Transition" concept, the significance of good governance and cross-sector policy integration was highlighted by Lena Olsen (2010): "A just transition is primarily about good governance. It is about applying the right policies in consultation and with the involvement of those concerned. Ideally, involvement must take place from the policy development stage to that of the monitoring of progress. (…). In this regard, for climate change policies to be socially sustainable, one requirement is that they should be linked to employment and labor market policies and take into account industrial relations. Governments have to involve trade unions in addressing the needs of industries and communities at large in order to ensure that the transition to a carbon friendly future is just and fair to all – that development is sustainable".

In the following we will present selected findings of our research exploring the interface of (renewable) energy policies and labor policies. We will examine to what extent renewable energy support policies take into account labor issues, particularly job quality and industrial relations, and to what extent renewable energy policies might support a Just Transition in the renewable energy industry.

Target architecture of the *Energiewende* and the role of labor

The term "Energiewende" (energy turnaround, energy transition) is commonly used to describe the decision of the German federal government under Chancellor Angela Merkel taken after the Fukushima nuclear accident in 2011 to phase-out nuclear power by 2022 and to accelerate the expansion of renewable energy. However, the nuclear phase-out marks only the latest in a series of policy initiatives in response to a long history of nuclear skepticism, growing awareness of potential peak oil, and concern over climate change and sustainable development issues that have been prevalent in the country for decades, not only in terms of energy (Quitzow et al., 2016).

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[6] The 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015 adopted the Paris Agreement. This includes a long-term goal to keep the global temperature increase well below 2°C above pre-industrial levels and to pursue efforts to keep it to below 1.5°C.

In 2011, the Ethics Commission which was set up by the government to provide advice on the risks of nuclear power emphasized: "In the course of the energy transition, numerous new businesses will be established and existing ones will expand their capacity and create new jobs. These must be committed to the successful principles of social partnership. Respecting the rights of the workers and their representatives is also an ethical pre-requisite for a sustainable energy transition" (Ethik-Kommission, 2011).

However, up to now energy policy strategies and concepts at federal level do only marginally address employment issues, specifically job quality and decent work. The Energy Concept of 2011 remains rather vague when it comes to employment issues. The federal government's target architecture for the *Energiewende* includes more than 20 quantitative energy policy targets, and six qualitative objectives (Bundesministerium für Wirtschaft und Energie, 2015). The qualitative objectives include "Investment, Growth, Employment", an item which is further specified by "Securing jobs in Germany and laying the foundations for sustainable growth and quality of life". Job quality is not explicitly addressed. However, industrial and employment policy objectives tend to play a more prominent role in the energy strategies of the federal states.

The federal government's regular monitoring and progress reports on the *Energiewende* cover almost exclusively quantitative employment effects. Qualitative effects including working conditions, labor relations, or current employment challenges such as shortage of qualified labor or training and qualification needs are not addressed. The accompanying opinions of an independent expert commission do not pay any attention to those issues either.

Likewise, the Renewable Energy Sources Act, the key support scheme for renewable energy, does not include any employment related objectives. Its key rationale is to "enable the energy supply to develop in a sustainable manner in particular in the interest of mitigating climate change and protecting the environment, to reduce the costs for the economy not least by including long-term external effects, to save fossil energy resources and to promote the further development of technologies to generate electricity from renewable energy sources".

Social conditionalization of renewable energy support?

In some areas of public support policies, in particular in the field regional structural assistance provided by the federal states, employment-related criteria are increasingly incorporated as a funding condition. Examples include adherence to collective bargaining agreements or maximum quotas for temporary work. However, many of these criteria have been either recently established or they are part of bonus systems. Hence, the potential of such criteria to noticeably influence working conditions and to facilitate the institutionalization of collective labor relations in the wind industry is very limited. Furthermore, manufacturing companies have different financing options. Their market power and the competition among federal states and regions for industry settlements often makes it difficult to impose demanding social or job quality criteria.

The Renewable Energy Sources Act has promoted the use of electricity from renewable energy sources by feed in tariffs and feed in premiums by requiring the grid operators to connect renewable energy installations and remunerate the electricity fed into the power grid. The difference between the wholesale market price on the electricity exchange and the higher remuneration rate for renewable energy is generally borne by the electricity customers via a surcharge included in the electricity price.

Despite continuous demands formulated by the trade unions to make financial support for renewable energy conditional on the compliance with decent work criteria (see above), up to now the German Renewable Energy Sources Act contained only few and marginal provisions addressing job quality[7].

The Renewable Energy Sources Act was amended on 8 July, 2016. The latest amendments mark a fundamental change from guaranteed feed-in tariffs and feed-in premiums to competitive bidding and market-based tenders. From 2017 onwards, remuneration rates for renewable energy based electricity will no longer be fixed by the federal government, but will be determined through a tendering scheme. Under a tendering scheme, governments solicit bids to install a certain capacity (or to produce a certain quantity) of renewable-based electricity. Project developers submit offers which are evaluated on the basis of the price per unit of electricity, energy output or other criteria (IRENA 2013, 58). The tendering system was introduced to comply with the corresponding EU Guidelines on State Aid for Environmental Protection and Energy 2014-2020 (2014/C 200/01). The federal government decided to implement an auction design which is based on a purely price only selection process, i.e. the only award criterion is the support level for the renewable electricity. The tenders are expected to stabilize the costs for renewable energy and to provide the mechanism for adhering to specific growth corridors by auctioning a specific amount of capacity volume each year.

Already during the policy formulation process, the trade unions in several opinions pointed to the risk of a "race to the bottom" regarding the implications of a purely price-based auctions for labor standards at the expense of labor standards and with the risk to drive companies with higher labor standards and collective bargaining agreements out of the market. (IG Metall, 2016; DGB Bundesvorstand, 2016; Thomas, 2016).

It is at least conceivable to link financial support to the compliance with certain social or labor requirements, either as a pre-qualification criterion to participate in the bidding process, or as additional award criteria to select winning bids in the frame of a multi-criteria selection. Multi-criteria selection, however, was never considered by the Federal Ministry of Economy and Energy. Its priorities were clearly to control the growth dynamics and cost of renewable energy and to ensure market liquidity under the tendering scheme. Generally, there are only very few international examples for

[7] Electricity-intensive companies can qualify for exemptions from the renewable energy surcharge if they fulfil certain criteria, e.g. exposure to international competition, high electricity consumption, and high electricity costs reaching a certain percentage of gross added value. In order to avoid misuse, the Renewable Energy Sources Act of 2014 contained a provision according to which electricity-intensive enterprises in order to qualify for the exemptions were not allowed to deduce the staff costs for temporary agency work in their calculations of gross value added.

the integration of social and employment related criteria in the context of renewable energy support schemes, like South Africa and Portugal (del Rio, 2016a, del Rio, 2016b).

Labor issues featured marginally in the public, political and scientific discourses surrounding the revision of the Renewable Energy Sources Act. These were rather dominated by the general implications of tendering systems for the renewable energy industry, renewable energy targets, expansion corridors, and annual tendering volumes for each sub-sector. Furthermore, employment issues were outweighed by other issues of social justice such as the question how to safeguard actor variety under a tendering system, providing equal opportunities for small developers and citizen and community energy, social acceptance of renewable energy, or the affordability of electricity prices.

Trade unions failed to concretize their demands regarding social conditionalization of financial support. They also failed to mobilize sufficient political support for their demands. Furthermore, the pressure for state interference has decreased through the continuous, albeit delayed institutionalization of co-determination and (company level) collective bargaining in the renewable energy industry.

The future auctions will certainly increase the cost pressure along the entire industrial value chain affecting also wind turbine manufacturing and component supply. However, it is unclear yet, to what extent they will affect the manufacturing companies' human resources strategies, induce a „race to the bottom" regarding wages and labor standards and jeopardize the further institutionalization of co-determination and collective bargaining in wind turbine manufacturing and other renewable energy industries.

Conclusion

There are both drivers facilitating and barriers inhibiting the institutionalization of collective labor relations in the wind turbine manufacturing industry. Path dependencies and traditions of co-determination and collective bargaining in parts of the industry, particularly those rooted in shipbuilding or steel production, effective organizing campaigns and accompanying actions launched by the trade unions, first and foremost IG Metall, led to a continuous establishment of works councils and an increasing number of company level collective agreements. The increasing competition for skilled labor can be regarded as a further driver. On the other side, the internationalization and consolidation of the industry, the persistent pressure to reduce the levelized cost of electricity, and the overall tendency towards more market based support instruments, including competitive bidding, provide certain risks for the further stabilization of collective labor relations. It is unclear yet, to what extent the future auctions will lead to a "race to the bottom" regarding wages and labor conditions as expected by the trade unions.

The concept of "Just Transition" is closely related to good governance and inter-sectoral policy integration. In this context, trade unions and other stakeholders demand to link financial support for the industry to job quality/decent work criteria. However, our research findings suggest that integration of renewable energy support and labor policies has been fairly poor so far. So far, renewable energy support policies in the electricity sector did only very marginally address job quality and decent work. Social conditionalization did not enter the political agenda as policy responsiveness has been very low so far. Labor issues featured marginally in the discourses surrounding the revision of the Renewable Energy Sources Act.

Translating our findings into recommendations for policy, the federal government might consider to

- integrate job quality/decent work criteria into the target architecture of the *Energiewende.*
- extend the existing monitoring system for the *Energiewende* to consider qualitative employment effects, including development of working conditions, job quality, co-determination and collective bargaining, education and qualification needs, gender balance, health and occupational safety,
- effectuate social impact assessments of legislative proposals to include working conditions,
- intensify the social dialogue with trade unions and employee associations in order to foster a “Just Transition” in line with the Paris Agreement under the United Framework Convention of Climate Change, and the recently published guidance of the International Labour Organization,
- depending on the outcomes of the tendering system, to consider introducing multi-criteria selection covering decent work criteria,
- ensure a stable and predictable policy framework.

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Contact email: mikru@zedat.fu-berlin.de

The International Academic Forum (IAFOR)
Sakae 1-16-26-201
Naka Ward, Nagoya, Aichi
Japan 460-0008
www.iafor.org