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Deliverable D3.3

Initial Multivariate Statistical Analysis

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Table of contents

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 857831

Index of tables

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1. Task description

D3.3. Initial Multivariate Statistical Analysis (18 month)

This deliverable provides analysis on the causal impact of GPPs on innovative SMEs financial constraints and how LCA of RES-technologies influence financing conditions. Indicator for success: Results from the multivariate analysis are available and a discussion containing the results is published and made available to a broader audience.

2. Keywords

Green public procurement (GPP), innovative SMEs financial constraints, firm growth

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3. Green Public procurement

The European Union published a "Communication" on July 16th, 2008 which mentions the first time a Green public procurement policy[1] in the European Union. In 2008, the Competitiveness Council of the EU described this voluntarily policy as: "…an effective tool to encourage improvement in the environmental, energy and social performance of products and services and to facilitate the promotion of sustainable works, goods and services within the market, whilst avoiding additional burdens on public finances, taking the full life-cycle of products into account."

In 2010, the EU sets the goal that by 2010, 50% of all public tendering procedures should be green, where 'green' means compliant with endorsed common core EU GPP criteria for ten priority product/service groups such as construction, transport, cleaning products and services[2]. The EU also asked PricewaterhouseCoopers, Significant and Ecofys to perform a study of "Collection of statistical information on Green Public Procurement in the EU". They developed indicators to quantify GPP outcomes in terms of procurement value, number of contracts, CO2, and Life Cycle costs (LCC)[3]. Their outcome was focused on "the Green 7", the seven most green countries in 2010 (Austria, Denmark, Finland, Germany, the Netherlands, Sweden and the United Kingdom). In 2010, these countries reached a GPP share of 45% in the total procurement value and 55% of all GPPs. GPP has been responsible for a 25% reduction in CO2, and a 1% reduction in LCC. Top categories were cleaning services, electricity, paper, office IT and furniture. Also, the lowest results belonged to the categories of transport, construction and gardening.[4]

[1] https://ec.europa.eu/environment/gpp/gpp_policy_en.htm
[2] https://ec.europa.eu/environment/gpp/studies_en.htm
[3] Their methodology is here: https://ec.europa.eu/environment/gpp/pdf/summary_methodology.pdf
[4] Their methodology and the whole survey-based study of public authorities are available, https://ec.europa.eu/environment/gpp/pdf/summary_methodology.pdf and https://ec.europa.eu/environment/gpp/studies_en.htm

In 2011 the EU promoted an additional survey-based study on the previous goals stated in 2009 by considering ten procurement categories in 2009 and 2010. In 2014, the EU published a manifesto and policy recommendation[5] to achieve a resource-efficient economy and society by 2020.

4. Impact of Green public procurement on financial constraints of innovative SMEs

The majority of the research in public procurement has focused on increasing the participation of SMEs in tenders and measuring the probability of winning a tender (Di Mauro et al. 2020; Plaček et al. 2019). Based on an earlier study done by Levin and Smith (1994) on the role of explanatory variables in winning in an auction, Di Mauro et al. (2020) find the positive impact of entry costs, firm size, perceived benefits, and competitive advantages on participation, and winning a tender. Plaček et al. (2019) use the path dependency theory and did logistic regressions to measure the impact of different variables such as number of bidders, type of procedure, and number of previous wins on winning a tender. However, there are only a few examples of research that consider financial outcomes as one of the consequences of winning a public procurement tender (e.g., Aschhoff, & Sofka 2009; Czarnitzki et. al. 2018; Ghisetti 2017).

Public procurement has the potential to stimulate firm's innovation (Appelt and Galindo-Rueda, 2016; Aschhoff, & Sofka 2009; Czarnitzki et. al. 2018). Also, innovative public procurement has a crucial role in improving innovation success measured in terms of turnover achieved with new products (Ghisetti 2017). Czarnitzki et al. (2018) find that the turnover with new products and services benefits from public procurement of innovations. Their study considers the effect of changes in policy innovation enforced in 2009 on turnover changes in three years after 2009.

In a study for the US, the effect of awarding a tender is positive on stock returns (Larson and Picou, 2002). They divide contracts into subgroups of federal, military, municipal, and foreign contracts. They find that revenues exceed expenses, and that the net present value from contracts awarded by foreign governments are higher than those awarded by the US government.

5. Matching techniques and regression

There are various techniques to test the impact of a policy on intended outcomes. One of these techniques is difference-in-differences (DiD). This technique is useful when the number of groups

5 https://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendations_31-03-2014.pdf

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is small and there are some fixed variables in each group (Donald and Lang, 2007). This regression technique provides the possibility to check the effect of a policy on all entities in a group. Also, doing regression using DiD makes it possible to use different control groups, and different control variables which reduce the number of required dummy variables (Angrist and Pischke, 2008).

This method can be combined with different matching techniques to find the best pair of treatment and control entities. Propensity score matching (PSM) is one of the well-known matching techniques to find the best pair. For instance, Ghisetti (2017) uses PSM to match public procurement data in which innovation was part of it with procurement data without innovation. Coarsened exact matching (CEM) is another technique to find the matching samples. CEM is a flexible and widely used technique and it is already used in combination with difference-in-difference technique (Cattaneo, Galiani, Gertler, Martinez, & Titiunik, 2009; Fazekas and Tóth 2017). For instance, Fazekas and Tóth (2017) use DiD with the CEM matching algorithm.

This study shows that increasing the number of bidders, lowering the number of single bids, decreasing the market share of local winners, and boosting price savings results in opening the public procurement market.

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6. Data preparation

EuroSTAT community innovation survey defines product innovation as: "A product innovation is the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems." This is the definition used in finding and analysing the TED data.

In this study, we chose the year 2015 to year 2018 as observation period of the sample. This is because the reporting of public procurement contracts involving SMEs became compulsory only after the publication of the EU PP Directives 2014/24/EU and 2014/25/EU. The tenders with a high level of green initiative and innovation are selected in this study with help of common procurement vocabulary (CPV) codes and NACE codes.

6.1. CPV codes

The tenders are selected based on the tender's topic. This section is then completed with a ranking system of 1, 2 or 3 in which 1 indicates the highest priority ("Green tenders") and 3 specifies the lowest ("Brown tenders"). For instance, priority 1 means that the tender is a green public procurement tender and it is related to a high level of innovation in the area of renewable energy sources.

6.2. NACE codes

NACE is the statistical classification of economic activities in the European Community (NACE, 2008). The study further focusses on the NACE code 35 which is electricity, gas, steam and air conditioning supply and its groups due to its relevance and importance for renewable energies. The NACE codes used in the estimation sample are listed in appendix.

7. Model building

Demand for renewable energy sources is modelled with public procurement of renewables and the outcome of the public procurement is regressed on the variables that indicate the firm's financial strength or weakness (e.g. turnover, sales growth, long-term and short-term debt). The financial strength variables indicate easiness of accessing external funds, and are thus proxies for a firm's financial constraints.

We apply a Probit model capturing the chance to win a TED contract award depending on the firm's financial constraints. In addition, we use a difference-in-difference approach (DiD). The DiD approach reveals whether "treated" firms develop differently in the years after winning the contract award compared to the non-treated firms from the control group.

In order to create the treatment and control groups, we created a dummy variable called "treated" with values of 0 and 1. A zero value for this variable means that the company did not win a tender and it belongs to the control group, and the value of 1 shows the company has won a public procurement contract between year 2015 and 2019. Then, to capture the period effect that applies to both to treated and non-treated firms, we create another dummy called "post-treatment period". This variable takes on the value zero in the years before the treatment and zero after the treatment.

The hypothesis is that winning a tender has an impact on the firm financial constraints in the years after the contract award. Accordingly, our main variable of interest is the "Treatment effect". This dummy variable represents the interaction between the variables "treated" and "post-treatment period". The "Treatment effect" is zero if, and only if, the dummy variable "treated" is 0. It is 1 if the dummies "post-treatment period" and "treated" are 1. Table 1 shows the main treatment variables used in DiD regression equation:

TREATMENT EFFECT	DUMMY VARIABLE	VALUES
Winning a tender	treated	0: no win; 1: winning at least one tender in 2015 and 2018

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Period effect for both the treated and the non-treated firm(s)	Posttreatment period	0 for treatment and matched control firm before the contract award win; 1 for both firm types one year after winning a tender, and then it repeats afterwards. A maximum of three years after winning a tender between 2015 and 2018 is considered.
Interaction between winning a tender and post treatment effect	Treatment effect (i.e. treated # Post-treatment period)	0: no effect; 1: effect Full interaction effect between winning a tender and the period after the treatment

Table 1 - Treatment effect

Previous studies propose various control variables. Aschhoff, & Sofka (2009) include control variables capturing market innovation. Fazekas and Tóth (2017) use country labels and indicators of market level interventions. Ghisetti (2017) adds control variables for environmental innovation. The TED dataset provides a variety of candidates for control variables. Those variables can be categorized as variables coming from the tender document, as variables indicating the firm type, SMEs or large firms, and as country dummies. In this study, country code, firm type and NACE codes are selected as control variables.

To meet the goals of this deliverable, two main outcomes are studied:

- The likelihood of winning a public procurement because of distinct financial constraints.
- The impact of winning a public procurement tender on financial constraints.

Four subsamples are considered to investigate how financial constraints affect the likelihood of winning a public procurement tender. These four subsamples are listed in Table 2. The dependent variable TEDyear indicates the year of winning the TED contract award.

DEPENDENT VARIABLE	DESCRIPTION
1 (TEDyear)	Probability of all firms winning a tender
2 (TEDyear)	Probability of winning a tender among SMEs
3 (TEDyear)	Probability of winning a tender among all firms winning a green public procurement (prio 1)

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4 (TEDyear)	Probability of winning a tender among all SMEs winning a green public procurement (prio 1)

Table 2 - Outcome or dependent variables in four subsamples, the likelihood of winning a public procurement because of financial constraints

The financial variables used in these multivariate regressions are listed below in Table 3. These variables are calculated for one year before winning a public procurement tender.

VARIABLE	DESCRIPTION
Equity ratio	Equity divided by total assets
LTDB ratio	Noncurrent liabilities: long term debt (LTDB) to total assets
STDB ratio	Short term debt ratio: sum of loan and credits divided by total assets
LOAN ratio	Loan divided by total assets
Credit ratio	Trade credit divided by total assets
TURN ratio	Turnover divided by total assets

Table 3 - Main financial variables used as independent variables, the likelihood of winning a public procurement because of financial constraints

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In considering the effect of winning a public procurement tender on the firm's financial strength, we studied the impact of winning different combinations of public procurement tender on nine variables that indicate financial strength and constraints (Table 4).

VARIABLE	DESCRIPTION
Log Turn	Logarithmic transformation of turnover
Log Empl	Logarithmic transformation of number of employees
Log prod	Logarithmic transformation of turnover divided by number of employees
Equity ratio	Equity divided by total assets

LTDB ratio	Noncurrent liabilities: long-term debt (LTDB) to total assets
STDB ratio	Short-term debt ratio: sum of loan and credits divided by total assets
LOAN ratio	Loan divided by total assets
CRED ratio	Trade credit divided by total assets
TURN ratio	Turnover divided by total assets

Table 4 - Outcome or dependent variables, impact of winning a public procurement tender on indicators of the firm's financial strength

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The control variables used in the estimations are the following: year dummies for the success year, an SME dummy, industry dummies and country dummies. The next section includes the results of the analysis for these two outcomes.

8. Results

8.1. Likelihood of winning a public procurement tender

We estimate four regression models to find the determinants of the probability of winning a public procurement tender. As stated earlier, previous studies considered different variables such as number of employees, number of wins in previous years, and financial constraints to estimate the probability of winning a tender. Incorporation of all parameters in one model will make the estimations and interpretations difficult, and we used five control groups.

8.1.1. The impact of the equity ratio on the likelihood of winning a TED contract award

The first regression model, among other determinants, considers the how the equity ratio affects the chance for a contract award. The other factors considered in building the Probit regression model are total assets, company size, year, industry code, and country code. Results show a significant and negative effect of the equity ratio. Detailed results are in Table 5.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
Equity ratio (t-1)	-0.392***	-0.406***	-0.354**	-0.503**
log(Total Assets)	0.0771***	0.0479***	0.0126	-0.00884
2015	-0.113*	-0.0871	-0.0242	-0.0437
2016	-0.0832	-0.0914	-0.331**	-0.327**
2017	0.026	0.0997	0.0584	0.00863
SME	0.130*	0	0.259**	0
3500.industry	0.106	0.0358	0	0
3510.industry	0.206	0.274	-0.428	-0.391
3511.industry	0.0523	0.0572	-0.0934	0.0677
3512.industry	0.259	0.283	0	0
3513.industry	0.18	0.192	0	0
3514.industry	0.430***	0.376***	-0.610***	-0.670***
3520.industry	-0.265	-0.172	0	0
3521.industry	-0.337	-0.259	0	0
3522.industry	0.0554	0.144	-0.197	-0.0829
3523.industry	0.418*	0.183	0	0
3530.industry	-0.0936	-0.0837	-0.587	-0.507
DE	0.0746	0.00832	-0.387	-0.411
DK	0.0798	0.0417	0.0284	-0.052
ES	0.0756	0.0489	-0.0291	-0.1
GB	0.152	0.158	-0.158	-0.219
IT	-0.0805	-0.0784	0.0124	-0.0522
NO	-0.246*	-0.269**	-0.237	-0.348
PT	0.163	0.143	-0.027	-0.157

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SE	-0.116	-0.13	-0.111	-0.31
SK	0.375**	0.284	-0.697	-0.706
_cons	-2.348***	-1.696***	-1.812***	-1.092**
lnsig2u	-1.442***	-2.017***	-2.673**	-2.498**
N	5341	3865	2827	2072
# firms	1382	1060	729	570

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 5 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged Equity ratio

The equity ratio one year before the contract award has a negative and significant effect on the probability of winning a tender. Studying the impact in different subsamples shows that the weight of this indicator of the firm's financial strength is strong and significant (-0.392***, -0.406***, -0.354**, -0.503**). The findings reveal that the chance of winning a tender is the higher the lower the lagged equity ratio is. A possible explanation for this result could be that companies which have a higher debt in their balance sheet as they are in an expanding phase are more likely to participate in the public procurement market and win tenders than more conservative firms with more equity. The effect is stronger for SMEs (-0.406***, -0.503**). Those results are in line with the findings from the univariate analysis (see D 3.5).

The total assets variable has a significant but weak effect on winning a tender (0.0771***, 0.0479***), but the effect is insignificant in winning tenders green tenders, those with priority one. Obviously, size measured in total assets is no strong determinant of winning a tender. SMEs have higher chances of winning public procurement tenders compared to the non-SMEs (0.130*, 0.259**).

Companies active in industries with code 3514 "trade of electricity" have a higher chance of winning tenders in the considered sub samples. But focusing on the subsamples of priority 1 shows that the likelihood of winning for firms active in "trade of electricity" is lower in these subsamples than it is in the All firms and the All SMEs samples (0.430***, 0.376***, -0.610***, -0.670***).

Being registered in Norway can have a negative and significant impact on the chance to win a tender (-0.246*, -0.269**, -0.237, -0.348). However, the impact of Norway is non-significant in the subsamples of the priority 1 firms.

8.1.2. The impact of the long-term debt ratio on the likelihood of winning a TED CA

The ratio of long-term debt (LTDB) to total assets indicates the firm's non-current indebtedness. The effect of the lagged long-term debt is negative but mainly insignificant for the chance of winning tenders (-0.283*, -0.119, -0.0408, 0.0859). The total assets indicator is to some extent a significant factor for the probability of winning a tender (0.0861***, 0.0550***, 0.00421, -0.0172). Also, the industry code 3514 ("trade of electricity") has a significantly positive effect on winning a tender when all firms or all SMEs are considered but the effect is negative and

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significant when the estimation is restricted to only priority 1 TED firms and the respective control group (0.464***, 0.371***, -0.499**, -0.558**). These results propose that long-term indebtedness does not impair the firm's chance to win a contract award in general, but it reduces the green firms' chances. Results are shown in Table 6.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
LTDB ratio (t-1)	-0.283*	-0.119	-0.0408	0.0859
log(Total Assets)	0.0861***	0.0550***	0.00421	-0.0172
2015	-0.0673	-0.0248	-0.0782	-0.099
2016	-0.0156	-0.00253	-0.305**	-0.295*
2017	0.0443	0.152**	0.0638	0.0114
SME	0.0842	0	0.231*	0
3500.industry	0.107	0.0326	0	0
3510.industry	0.186	0.237	-0.445	-0.422
3511.industry	0.0401	0.0152	-0.137	0.0161
3513.industry	0.167	0.162		
3514.industry	0.464***	0.371***	-0.499**	-0.558**
3520.industry	-0.287	-0.21	0	0
3521.industry	-0.318	-0.274	0	0
3522.industry	0.0869	0.176	-0.0605	0.102
3523.industry	0.575**	0.32	0	0
3530.industry	3.8E-06	-0.0145	-0.529	-0.428
BE	0	0	0	0
DE	0.107	0.0189	-0.32	-0.347
DK	0.22	0.191	0.171	0.133
ES	0.0925	0.0615	0.0991	0.0582

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GB	0.11	0.0754	-0.0863	-0.147
IT	-0.0484	-0.0448	0.0934	0.062
NO	-0.104	-0.129	-0.0701	-0.121
PT	0.169	0.114	0.0423	-0.098
SE	-0.173	-0.206	-0.0229	-0.262
SK	0.335*	0.279	-0.624	-0.594
_cons	-2.643***	-2.013***	-1.819***	-1.209**
lnsig2u	-1.342***	-1.941***	-2.700**	-2.481**
N	4688	3340	2483	1798
# firms	1271	953	673	515

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 6 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged LTDB ratio

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8.1.3. The impact of the short-term debt ratio on the likelihood of winning a TED CA

The short-term debt ratio is calculated as the sum of loan and trade credits divided by total assets. The effect is positive and significant on winning a public procurement tender except if only tenders are studied which are labelled as highly renewable. For those tenders the effects are insignificant (0.369***, 0.332**, 0.278, 0.199). The significant coefficients show that companies which have higher loan and trade credits in their balance sheets are more likely to win tenders. In other words, firms which are in the expansion phase and use heavily trade credits and loans to grow the company are more likely to win a tender. Total assets show partially significant results which is consistent with the previous results (0.0760***, 0.0463***, 0.0186, -0.000767). Also, being SME is a significant determinant of winning tenders (0.115*, 0.258**). Trade of electricity is still a significant industry code for winner companies but reduces the chance to win in case of priority one tenders (0.440***, 0.382***, -0.619***, -0.667***). Results are shown in Table 7.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
STDB ratio (t-1)	0.369***	0.332**	0.278	0.199
log(Total Assets)	0.0760***	0.0463***	0.0186	-0.00077
2015	-0.109*	-0.0749	-0.0571	-0.0655
2016	-0.0846	-0.0858	-0.338**	-0.338**
2017	0.0185	0.0995	0.00225	-0.0649

SME	0.115*	0	0.258**	0
3500.industry	0.157	0.0785	0	0
3510.industry	0.174	0.232	-0.381	-0.381
3511.industry	0.0602	0.0475	-0.0628	0.0801
3512.industry	0.468	0.484	0	0
3513.industry	0.15	0.152	0	0
3514.industry	0.440***	0.382***	-0.619***	-0.667***
3520.industry	-0.307	-0.229	0	0
3521.industry	-0.379	-0.316	0	0
3522.industry	0.0776	0.138	-0.151	-0.029
3523.industry	0.38	0.189	0	0
3530.industry	-0.104	-0.0966	-0.563	-0.488
DE	0.189	0.13	-0.394	-0.407
DK	0.236	0.201	0.119	0.0438
ES	0.121	0.0721	0.0216	-0.064
GB	0.149	0.151	-0.173	-0.231
IT	-0.032	-0.0314	0.0767	0.03
NO	-0.0455	-0.0655	-0.0593	-0.129
PT	0.198	0.177	-0.00349	-0.127
SE	0.039	0.0254	0.0885	-0.0662
SK	0.268	0.251	-0.628	-0.623
_cons	-2.591***	-1.949***	-2.130***	-1.479***
lnsig2u	-1.409***	-1.902***	-2.621**	-2.386**
N	5192	3748	2756	2012
# firms	1366	1044	721	560
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 7 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged STDB ratio

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8.1.4. The impact of the loan ratio on the likelihood of winning a TED CA

The LOAN ratio is calculated as loans divided by total assets. The LOAN ratio has only a significant effect on winning a tender in the subsample of all firms (0.387**). In other words, the higher the loan share in the balance sheet of companies the higher is the chance of winning a tender. Total assets are again a decisive factor in winning a tender, but not for tenders exclusively in priority 1 (0.0757***, 0.0461***). SMEs are advantaged in winning tenders compared to bigger companies (0.119*, 0.263*). Companies belonging to the industry code 3514 are again advantaged in winning tenders in the sub samples 1, and 2, but not with tenders of priority one (0.471***, 0.414***, -0.588***, -0.644***). Results are shown in Table 8.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
LOAN ratio (t-1)	0.387**	0.287	0.0907	0.089
log(Total Assets)	0.0757***	0.0461***	0.0193	-0.00109
2015	-0.107*	-0.0717	-0.0546	-0.0633
2016	-0.0786	-0.078	-0.341***	-0.340**
2017	0.0177	0.098	0.00055	-0.0674
SME	0.119*		0.263**	
3500.industry	0.123	0.0344		
3510.industry	0.168	0.228	-0.375	-0.376
3511.industry	0.0306	0.0208	-0.0858	0.0699
3512.industry	0.433	0.448		
3513.industry	0.141	0.149	0	0
3514.industry	0.471***	0.414***	-0.588***	-0.644***
3520.industry	-0.324	-0.244	0	0
3521.industry	-0.398	-0.331	0	0
3522.industry	0.0778	0.152	-0.126	-0.00038

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3523.industry	0.413*	0.236	0	0
3530.industry	-0.129	-0.115	-0.589	-0.508
DE	0.121	0.0602	-0.459*	-0.454
DK	0.194	0.147	0.0887	0.016
ES	0.0664	0.0162	-0.0173	-0.0926
GB	0.0871	0.0928	-0.204	-0.258
IT	-0.0458	-0.0457	0.0642	0.0197
NO	-0.0985	-0.122	-0.101	-0.159
PT	0.16	0.135	-0.0157	-0.141
SE	-0.0208	-0.0398	0.0377	-0.102
SK	0.285	0.274	-0.642	-0.632
_cons	-2.493***	-1.852***	-2.067***	-1.420***
lnsig2u	-1.394***	-1.875***	-2.480**	-2.281**
N	5214	3770	2763	2019
# firms	1366	1044	721	560

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 8 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged LOAN ratio

8.1.5. The impact of the trade credit ratio on the likelihood of winning a TED CA

The CRED ratio is calculated as trade credit divided by total asset. Taking out the effect of loan and measuring the effect of the trade credit ratio supports the results obtained for the short term debt ratio to a great extent. It shows that the results are driven mainly by the trade credits (0.366**, 0.421**, 0.429*, 0.308). The year 2016 obtains a significant coefficient showing that the likelihood of winning a contract was negatively impacted during that year (-0.340***, -0.341**). The effect of the total assets variable is restricted to the All firms and All SMEs subsample (0.0778***, 0.0459***, 0.0163, -0.00574). SMEs are advantaged in winning tenders compared to bigger companies (0.117*, 0.267**).

The previous results on industry code 3514 are repeated in this regression indicating that companies belonging to subsample 1 and 2 are advantaged in winning tenders, but not if only the tenders of priority one are studied (0.439***, 0.378***, -0.637***, -0.680***). Results are shown in Table 9.

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	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
CRED ratio (t-1)	0.366**	0.421**	0.429*	0.308
log(Total Assets)	0.0778***	0.0459***	0.0163	-0.00574
2015	-0.115*	-0.0872	-0.0498	-0.054
2016	-0.0962	-0.102	-0.340***	-0.341**
2017	0.0185	0.0915	0.0289	-0.031
SME	0.117*		0.267**	
3500.industry	0.158	0.0707		
3510.industry	0.183	0.233	-0.39	-0.382
3511.industry	0.0559	0.0494	-0.0589	0.0778
3512.industry	0.42	0.44	0	0
3513.industry	0.171	0.152	0	0
3514.industry	0.439***	0.378***	-0.637***	-0.680***
3520.industry	-0.299	-0.227		
3521.industry	-0.368	-0.312		
3522.industry	0.0765	0.144	-0.153	-0.0308
3523.industry	0.438*	0.2	0	0
3530.industry	-0.0663	-0.0525	-0.542	-0.475
DE	0.166	0.138	-0.369	-0.383
DK	0.249	0.239	0.198	0.178
ES	0.122	0.0893	0.043	-0.0439
GB	0.181*	0.19	-0.135	-0.207
IT	-0.0285	-0.0226	0.0895	0.0422
NO	-0.0595	-0.0637	-0.0502	-0.116
PT	0.208	0.197	0.0196	-0.107

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SE	0.0687	0.0703	0.0891	-0.0706
SK	0.366**	0.272	-0.655	-0.64
_cons	-2.596***	-1.935***	-2.118***	-1.418***
lnsig2u	-1.388***	-1.922***	-2.787**	-2.524**
N	5235	3768	2773	2023
# firms	1371	1048	722	562

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 9 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged CRED ratio

8.1.6. The impact of the turnover ratio on the likelihood of winning a TED CA

The turnover ratio (TURN ratio) is calculated as turnover divided by total assets. Results do not show a significant impact of the turnover ratio on winning a tender. The results also show the positive impact of total assets on winning a tender except tenders with priority one which is in accordance with previous results (0.0706***, 0.0596***, 0.0152, 0.0102). The year 2016 is again an important year showing that the turnover ratio negatively impacts the chance of winning a tender for sub samples with priority one (-0.343**, -0.371**). The industry code 3514 delivers again results that are entirely consistent with the previous estimations, positive and significant in the estimations for subsample 1, and 2 and negative and significant in estimations for the priority 1 subsamples (0.516***, 0.422***, -0.550**, -0.637***). Also, companies which belong to industry code 3522 (distribution of gaseous fuels through mains) have higher chances of winning tenders in all subsamples (0.388***, 0.403**, 0.929***, 1.142***).

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
TEDyear				
TURN ratio (t-1)	-0.00101	-0.00102	0.0175	0.0212
log(Total Assets)	0.0706***	0.0596***	0.0152	0.0102
2015	-0.0479	-0.0188	-0.0293	0.00048
2016	0.00402	-0.0269	-0.343**	-0.371**
2017	0.0165	0.102	0.0645	0.0384
SME	0.0101	0	0.205	0
3500.industry	0.228	0.203	0	0
3510.industry	0.213	0.285	-0.257	-0.29

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3511.industry	0.019	0.0222	-0.0506	0.0559
3513.industry	0.0167	0.0556	0	0
3514.industry	0.516***	0.422***	-0.550**	-0.637***
3520.industry	-0.311	-0.226	0	0
3521.industry	-0.376	-0.302	0	0
3522.industry	0.388***	0.403**	0.929***	1.142***
3523.industry	0.577**	0.309	0	0
3530.industry	-0.086	-0.0516	-0.506	-0.454
DE	0.138	0.00497	-0.424	-0.42
DK	0.13	0.00788	0.236	0.241
ES	0.0653	0.0119	0.0924	0.0222
IT	-0.0339	-0.0592	0.168	0.121
NO	-0.0929	-0.146	-0.0032	-0.0596
PT	0.178	0.145	0.097	-0.0146
SE	0.0234	-0.00267	0.124	-0.00727
SK	0.380**	0.298	-0.535	-0.519
_cons	-2.353***	-2.082***	-2.042***	-1.699***
lnsig2u	-1.301***	-1.692***	-11.44	-14.7
N	3770	2836	1966	1502
# firms	980	756	509	400

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 10 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged TURN ratio

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8.2. Impact of winning a public procurement tender on the firm's financial strength

In this section, we estimate nine regression models to assess the impact of winning a CA in a public procurement on the firm's financial strength variables. We use the financial strength indicators that we tested already in the previous section dealing with the effect of financial strength on the likelihood of winning public procurement tenders.

As stated in the model building section, to measure the impact of winning two dummy variables are used. The first variable is labelled post-treatment period. This variable is a period effect that applies both to treated and non-treated firms. The post-treatment period dummy variable takes on the value one starting from year t+1 where t is the year of success. The success years' range from 2015 to 2018.

The second dummy variable is the interaction effect between being a firm that has succeeded in a tender and the period after the CA success. This dummy variable is labelled "Treatment effect". It takes on the value one in the post-treatment period if, and only if, the firm has won a CA. For the control firms the interaction variable "Treatment effect" takes on the value of zero in all years. The interaction variable represents the treatment of successful firms vis-à-vis the control group of firms with no CA award over the complete observation period. We hypothesize that winning a CA affects the financial strength indicators of successful firms in the post period differently than the financial strength indicators of control firms.

We also include other variables such as time dummies for the years between 2011 and 2019, and the total assets to control for size. We abstain from incorporation of all parameters to keep the model as simple as possible. We constructed four subsamples to examine important subgroups separately.

8.2.1. Impact of winning a TED CA on the turnover ratio

We use the logarithmic transformation to represent the turnover in the Difference in Difference estimation (DiD). Winning a tender and the interaction between winning a tender and period of financial constraints has no effect on the firm's turnover. The year 2015 has been a partly significant predictor on turnover improvement when the full sample and the SME sample is examined (0.0444*, 0.0669**). Total assets show a positive and strongly significant effect on turnover in every specification (1.004***, 0.948***, 1.023***, 0.964***). Results are shown in Table 11.

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	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.0319	0.0426	0.0404	0.0988
posttreatment period	-0.0114	-0.0279	0.0483	0.0106
log(Total Assets)	1.004***	0.948***	1.023***	0.964***
2011	0.0135	0.0253	0.0248	0.0382
2012	0.00371	-0.00104	-0.00578	-0.0189
2013	0.0227	0.0374	0.00987	0.00861
2014	0.0284	0.0561*	0.0329	0.0579
2015	0.0444*	0.0669**	0.0289	0.0436
2016	0.0116	0.0578*	-0.0372	0.00946
2017	0.0109	0.046	-0.0297	0.0184
2018	-0.0116	0.0307	-0.0921**	-0.0297
2019	0.00736	0.0568	-0.108*	-0.0369
Constant	-0.0437	0.892	-0.444	0.532
Observations	8604	6122	4999	3621
R2	0.511	0.475	0.5	0.452
# firms	999	804	563	457

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 11 - DiD – log(TURN) for different samples, post-treatment period 3 year

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8.2.2. Impact of winning a TED CA on the firm size

Firm size is captured by the number of employees (EMPL). We apply again the logarithmic transformation in the Difference in Difference estimation (DiD). This variable shows whether winning a tender result in changes of the company size. The treatment and interaction and the interaction variable are insignificant meaning that successful firm do not grow more than the control firms in the post treatment period neither in the short nor in the medium term (3 years period). But the years 2013 up to 2019 have a positive and significant effects on the number of employees. In order words, breaking down the cumulative effects to years shows a significant impact on firm size. Total asset is once again an important determinant of the number of employees (0.453***, 0.437***, 0.474***, 0.460***). Results are shown in Table 12.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.0102	0.0219	0.0762	0.0749
posttreatment period	0.0376	0.0383	0.0327	0.0186
log(Total Assets)	0.453***	0.437***	0.474***	0.460***
2011	0.0154	0.00946	0.0187	-0.00214
2012	0.0139	0.0176	0.0222	0.0164
2013	0.0633***	0.0843***	0.0771**	0.0796**
2014	0.0883***	0.127***	0.116***	0.142***
2015	0.100***	0.138***	0.122***	0.147***
2016	0.0986***	0.138***	0.116***	0.145***
2017	0.0948***	0.131***	0.113***	0.143***
2018	0.0797**	0.106***	0.106**	0.139***
2019	0.0757*	0.0948**	0.0744	0.109**
Constant	-3.581***	-3.824***	-3.976***	-4.201***
Observations	11219	8180	6553	4857
R2	0.241	0.263	0.242	0.262
# firms	1382	1110	786	641
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 12 - DiD – log(EMPL) for different samples, post-treatment period 3 year

8.2.3. Impact of winning a TED CA on productivity

Productivity is defined as turnover divided by number of employees. This variable shows how productive employees are. We use the logarithmic transformation of the ratio. Although the treatment variables are insignificant the post-period years show a significant, but negative impact of productivity starting from year 2013. In other words, the companies in general became less productive over the years.

Size measured in total asset significantly increases productivity regardless of what sample we analyse (0.441***, 0.501***, 0.404***, 0.474***). Results are shown in Table 13.

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	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.0283	0.0278	0.0245	0.0194
posttreatment period	-0.0485	-0.0543	-0.0103	-0.0152
log(Total Assets)	0.441***	0.501***	0.404***	0.474***
2011	-0.0147	-0.0147	-0.00781	-0.0047
2012	-0.0259	-0.037	-0.0406	-0.0556
2013	-0.0676**	-0.0720**	-0.0946**	-0.104**
2014	-0.0861***	-0.0976**	-0.103**	-0.118**
2015	-0.0873***	-0.101***	-0.115**	-0.143***
2016	-0.112***	-0.117***	-0.153***	-0.168***
2017	-0.102***	-0.123***	-0.136***	-0.159***
2018	-0.100***	-0.117**	-0.166***	-0.192***
2019	-0.0906**	-0.108*	-0.153***	-0.179***
Constant	5.570***	4.992***	6.118***	5.323***
Observations	8011	6119	4660	3620
R2	0.133	0.173	0.117	0.164
# firms	991	804	556	457
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 13 - DiD – log(Prod) for different samples, post-treatment period 3 year

8.2.4. Impact of winning a TED CA on the equity ratio

The equity ratio is shareholder funds over total assets. The interaction effect between winning a tender and the post-period indicator is for all firms (1) and for priority 1 firms (3) significant and negative (-0.0188**, -0.0239**). In the other samples the interaction variable reveals no statistically different effect on the equity ratio between CA firms and control firms in the post-treatment years.

The significantly negative coefficient on the treatment variable (the interaction effect) reveals that winning a CA appears to lower the equity ratio of successful firms versus control firms in two

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cases, when the estimation covers all firms or when only the priority 1 firms are examined. This DiD results in these subsamples mirror the finding of the Probit analysis that the lower the equity ratio of the firms is the higher the chance of winning a tender. Likewise, the negative relation emerged also in the univariate analysis conducted in D 3.5 and seems to be quite robust. The financial years show mainly significant and to some extent weak positive effects on the equity ratio. The firm size measured in total assets reduces the equity ratio (-0.0505***, -0.0437***, -0.0463***, -0.0399***) across all examined samples. Results are shown in Table 14.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	-0.0188**	-0.0135	-0.0239*	-0.0103
posttreatment period	0.0042	0.00613	-0.00823	0.000542
log(Total Assets)	-0.0505***	-0.0437***	-0.0463***	-0.0399***
2011	0.00559	0.00743*	0.00788*	0.00699
2012	0.0166***	0.0202***	0.0159**	0.0192**
2013	0.0244***	0.0294***	0.0235***	0.0318***
2014	0.0436***	0.0510***	0.0455***	0.0518***
2015	0.0627***	0.0623***	0.0666***	0.0640***
2016	0.0519***	0.0617***	0.0602***	0.0676***
2017	0.0519***	0.0602***	0.0637***	0.0668***
2018	0.0557***	0.0619***	0.0713***	0.0703***
2019	0.0704***	0.0740***	0.0868***	0.0786***
Constant	1.144***	1.002***	1.064***	0.935***
Observations	12350	8172	7234	4855
R2	0.066	0.059	0.07	0.067
# firms	1382	1111	786	642
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 14 - DiD – Equity ratio for different samples, post-treatment period 3 year

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8.2.5. Impact of winning TED CA on the long-term indebtedness

The long-term debt ratio is long-term debt over total assets. The impacts of the treatment variables on the long-term debt indicator are insignificant. Treatment and control groups are statistically non-different from each other after one group received the treatment. Significant coefficients are also rare when the years and the firms size variable is considered. Results are shown in Table 15.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.00167	-0.00847	-0.00778	-0.00735
posttreatment period	0.0071	0.00991	0.00661	0.00824
log(Total Assets)	0.0113*	0.0147	0.0152*	0.0151
2011	0.00516	0.00331	0.000889	0.00012
2012	0.00107	-0.00578	0.00165	-0.00226
2013	0.0022	-0.00918	0.00195	-0.00804
2014	0.00307	-0.00866	0.00257	-0.005
2015	0.00519	-0.00692	0.00226	-0.00191
2016	-0.00293	-0.0146*	-0.00383	-0.00706
2017	-0.00799	-0.0191**	-0.00858	-0.0138
2018	-0.00804	-0.0202**	-0.0108	-0.0177
2019	-0.0112	-0.0226**	-0.00964	-0.014
Constant	-0.0848	-0.123	-0.144	-0.134
Observations	10788	7053	6386	4240
R2	0.004	0.007	0.007	0.007
# firms	1308	1029	748	598

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 15 - DiD – LTDB ratio for different samples, post-treatment period 3 year

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8.2.6. Impact of winning a TED CA on the short-term debt ratio

The short-term debt ratio (STDB ratio) is calculated as the sum of loans and trade credits divided by total assets. The treatment variables of winning a tender and its interaction with the post treatment period have mainly insignificant coefficients. No effect of the CA on the share of the short-term debt in the company's balance sheet can be observed except for the subsample of SMEs Prio1 firms. When only SMEs Prio1 firms are studied the results propose that treated SMEs of priority 1 have a significantly lower STDB ratio in the post treatment period than non-treated firms control firms of the same type. The year dummies have mainly significant and negative effects on the short-term debt ratio. Size significantly increases the short-term debt ratio (0.0433***, 0.0453***, 0.0436***, 0.0408***). Results are shown in Table 16.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.00482	-0.00386	-0.0217	-0.0273*
posttreatment period	-0.00807	0.00678	0.0109	0.0228**
log(Total Assets)	0.0433***	0.0453***	0.0436***	0.0408***
2011	-0.00386	-0.00991	-0.0067	-0.0171**
2012	-0.00986*	-0.0120*	-0.0148**	-0.0239***
2013	-0.0258***	-0.0293***	-0.0258***	-0.0370***
2014	-0.0332***	-0.0411***	-0.0416***	-0.0528***
2015	-0.0332***	-0.0435***	-0.0437***	-0.0551***
2016	-0.0264***	-0.0464***	-0.0404***	-0.0609***
2017	-0.0223***	-0.0475***	-0.0509***	-0.0765***
2018	-0.0185**	-0.0431***	-0.0465***	-0.0725***
2019	-0.0186	-0.0450***	-0.0472***	-0.0728***
Constant	-0.476***	-0.454***	-0.470***	-0.368**
Observations	12002	7965	7034	4728
R2	0.035	0.034	0.041	0.039
# firms	1378	1098	784	633
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 16 - DiD – STDB ratio for different samples, post-treatment period 3 year

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8.2.7. Impact of winning a TED CA on the loan ratio

The LOAN ratio is calculated as loans divided by total assets. The treatment variables have insignificant effects on the loan ratio of a company. In other words, winning a tender does neither change the loan ratio of the treatment group after the treatment nor the loan ratio of the control group. The year dummies obtain mainly significant and negative coefficients. Size has a positive and significant effect on the loan ratios (0.0177***, 0.0179***, 0.0198***, 0.0230**). Independently of the considered subsample, it seems that the more assets a company has the higher is the share of the loans in the company's balance sheets. Results are shown in Table 17.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	-0.000543	-0.00195	-0.0071	-0.013
posttreatment period	-0.00324	0.00329	0.00462	0.00935
log(Total Assets)	0.0177***	0.0179***	0.0198***	0.0230**
2011	-0.00241	-0.00367	-0.00488	-0.00804
2012	-0.00616*	-0.00834*	-0.00724	-0.0110*
2013	-0.00959**	-0.00897*	-0.00890*	-0.0107*
2014	-0.0114***	-0.0110**	-0.0160***	-0.0158**
2015	-0.00877*	-0.00883	-0.0137**	-0.0130*
2016	-0.00359	-0.00672	-0.0110*	-0.0137
2017	-0.000681	-0.00608	-0.0149**	-0.0205**
2018	-0.00203	-0.00877	-0.0146*	-0.0211**
2019	-0.00192	-0.00962	-0.0132	-0.0195
Constant	-0.215***	-0.207**	-0.247***	-0.282*
Observations	12045	8007	7058	4751
R2	0.012	0.009	0.014	0.014
# firms	1378	1099	784	634
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 17 - DiD – LOAN ratio for different samples, post-treatment period 3 year

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8.2.8. Impact of winning TED CA on the trade credit ratio

The trade credit ratio (CRED ratio) is an important instrument for many companies to manage their liquidity needs. It is calculated as trade credit over total assets. The treatment effect is insignificant in general indicating that treated and non-treated firms display the same trade credit development path after the CA success. The year dummies show mainly significant and negative coefficients meaning that most years are relevant for the trade credit ratios. Size tends to increase the trade credit ratio (0.0250***, 0.0261***, 0.0230***, 0.0160**). Results are shown in Table 18.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	0.00483	-0.00233	-0.0154	-0.0151
posttreatment period	-0.00481	0.00395	0.00682	0.0140*
log(Total Assets)	0.0250***	0.0261***	0.0230***	0.0160**
2011	-0.00179	-0.00651	-0.00236	-0.00996
2012	-0.00403	-0.0039	-0.0079	-0.0134**
2013	-0.0160***	-0.0198***	-0.0170***	-0.0267***
2014	-0.0215***	-0.0294***	-0.0253***	-0.0367***
2015	-0.0244***	-0.0346***	-0.0304***	-0.0427***
2016	-0.0223***	-0.0394***	-0.0302***	-0.0482***
2017	-0.0210***	-0.0412***	-0.0364***	-0.0567***
2018	-0.0168***	-0.0349***	-0.0331***	-0.0527***
2019	-0.0159*	-0.0348***	-0.0337***	-0.0531***
Constant	-0.248***	-0.225**	-0.210**	-0.0572
Observations	12093	8012	7070	4753
R2	0.025	0.03	0.029	0.033
# firms	1378	1100	784	634
* p < 0.10, ** p < 0.05, *** p < 0.01				

Table 18 - DiD – CRED ratio for different samples, post-treatment period 3 year

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8.2.9. Impact of winning a TED CA on the turnover ratio

The treatment effect of winning a tender is insignificant, and, thus, winning a tender has no impact on the turnover ratio (TURN ratio). The year dummies are mostly insignificant. The year 2014 has a positive and significant effect on the turnover ratio. The coefficient of total asset is significant (-0.238*) in the subsample of SMEs from the renewable energy sector. Otherwise, its effect on turnover ratio is insignificant. Results are shown in Table 19.

	(1) ALL FIRMS	(2) ALL SMES	(3) ALL FIRMS PRIO1	(4) SMES PRIO 1
Treatment effect	-0.109	0.154	0.0951	0.286
posttreatment period	0.39	0.264	0.188**	0.0796
log(Total Assets)	-1.617	-3.292	0.00796	-0.238*
2011	0.142*	0.115	0.199*	0.136**
2012	0.241	0.328	0.0883	0.0901
2013	0.333	0.439	0.123*	0.093
2014	0.312**	0.388*	0.206**	0.232**
2015	1.213	1.724	0.134*	0.163*
2016	0.313	0.66	0.00932	0.0961
2017	0.285	0.748	-0.0394	0.0829
2018	0.264	0.785	-0.151**	-0.00268
2019	0.175	0.728	-0.206**	-0.0387
Constant	29.09	55.63	1.309	5.410***
Observations	8733	6165	5099	3659
R2	0.009	0.019	0.007	0.02
# firms	1001	808	565	461

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 19 - DiD – TURN ratio for different samples, post-treatment period 3 year

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9. Firm Growth - Does Green Public Procurement Matter?

This section provides evidence relevant to policy makers and real economy on the potential advantages and disadvantages for SMEs from participating to EU Public Procurements. Using a unique firm-level database on EU Public Procurements covering 10 EU Members States countries, between 2015 and 2018, we investigate the effect on growth rates of firms participating and winning EU public tenders on Renewable energy sources. We use ***total asset growth*** as *proxy for firm growth rate*. We show that the relationship between participation to EU Public Procurement and firm growth depends on *firm size, size of the contracts and number of winning public contracts per year*. Our results show that, in comparison with other SMEs, the SMEs who win EU Public Tenders show on average significant lower firm growth rates unless they are exporting SMEs.

The information provided by the EU TED[6] (Tenders Electronic Daily) database allows us to go beyond earlier papers by developing a cross-country study on specific green sectors and investigating several specific features of the EU Public Procurements between 2015 and 2018 across 10 EU Member States. This study analyses how firms in specific green sectors and legal systems benefit from winning EU procurements. It is important to understand how the firm characteristics and national legal frameworks affect firm growth. Our study provides benchmark growth rates by controlling for firm and country characteristics and assess whether some features of the EU Green Public Procurements affect firm growth in comparison. Our study uses indicators of firm financial statements, NACE[7] sectors, and size as firm-level controls. As the selected sample includes firms from various green industries, our study controls for industry effects by including industry dummy variables. Our study also includes dummy variables that identify firms as SMEs or large firms. We focus on firm size in order to identify whether this factor impact on firm growth for firms who are winning EU green public procurements. Small firms may encounter more difficulties from executing EU public procurement contracts on RES and also higher difficulties when dealing with a number of contracts in various countries. We model firm size as a dummy variable which takes the value of 1 for SMEs[8].

Firm growth is considered as an important indicator of company success and has been studied from various angles. There are several quantitative and qualitative factors which may contribute to firm growth. The main firm specific characteristics which might affect growth are based on financial ratios and include *profitability, leverage ratio, level of innovation, liquidity and solvency*. Besides these financial ratios, other possible determinants of firm growth include *age, size, sector, legal form, legal environment and region*. Our study includes most of these endogenous and exogenous determinants as control variables.

[6] https://ted.europa.eu/TED/browse/browseByMap.do
[7] The Statistical classification of economic activities in the European Community, abbreviated as NACE
[8] Medium-sized enterprises are defined as enterprises that employ fewer than 250 persons and either have an annual turnover that does not exceed EUR 50 million, or an annual balance sheet not exceeding EUR 43 million (https://ec.europa.eu/regional_policy/sources/conferences/state-aid/sme/smedefinitionguide_en.pdf)

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Friedman (1953) shows that the relationship between profitability and growth is explained by theoretical models supporting the importance of investment budgets. Nelson and Winter (1982) find that profitable firms will be more motivated to grow, because they will not only have the financial means to expand, but their ongoing profit creation will also make it possible to sustain growth. Goldratt (1990) shows that firms without profits and retained earnings to invest (as internal capital, instead of allocating all profits to the shareholders) are not able to finance their growth and end up disappearing. Capon et al (1990) highlight that firm growth is related to high financial performance but only significant in some of the sectors. Glancey (1998) find a positive correlation between the profitability and growth. However, some studies show an inverse relationship between profitability and growth. For example, Dobson and Gerrard (1989) and Reid (1995) find a significant negative relationship between growth and profitability and this finds support on the classical Ricardian Theory of comparative advantage (Ricardo, 1817) that showed that the more profit a firm makes, the more it wants to grow with plausible less profitable projects. Markman and Gartner (2002) do not find any statistically significant relationship between growth and profitability. Goddard et al (2004) show that firm profitability and growth are not necessarily linked to each other. Beck et al (2005) find that non-financial constraints may weaken the boosting effect of profitability on firm growth. Coad and Hölzl (2010) show that the relationship between firm growth and profitability is still unclear.

As external financing is more limited for young firms without experience and reputation and they pay a higher price for it, the capacity for young firms to grow is often limited. The information asymmetry is important. Myers and Majluf (1984) show that firm managers have information that investors do not have, and that both sides are conscious of this. Fazzari et al (1988) find that as firms mature, this information asymmetry diminishes. Heshmati (2001) and Honjo and Harada (2006) identifies a positive impact of leverage on firm growth. Banks do not have the historical financial track records of start-ups or young firms so debt financing is difficult: Huyghebaert and Van de Gucht (2007) show that young firms have a higher failure risk. Churchill and Lewis (1983) show that younger firms are less experienced and organizationally inefficient whereas larger firms have sufficient experience and are more efficient. Phillips & Kirchhoff (1989) find that young companies without growth or negative growth are more likely to fail. Ahlström (1998) highlights the importance of growth competence and resources, growth potential and growth ambitions. Oliveira and Fortunato (2006) show the importance of firm age. Andersson et al (2007) showed that firms that make an effort to build or develop their competences are more likely to grow.

Innovation is an important determinant of firm growth, creating competitive advantages through innovative operating methods and products. Geroski and Machin (1992), Roper (1997), Cainelli et al (2006), Corsino (2008) and Le Bas et al (2011) show that innovating firms perform better than non-innovating firms in terms of growth. However, Bottazzi et al. (2001) do not find any significant relationship between innovation and firm growth. Kolaskar et al. (2007) focus on the relationship between innovation intensity and growth with data from both SMEs and large firms in India for the periods from 2001 to 2002 and from 2005 to 2006 for two distinct sectors, namely manufacturing and services, showing that the innovation intensity is clearly higher in the case of manufacturing firms than for services firms (for both SMEs and large firms).
Segarra and Teruel (2011) show that the impact of both internal and external R&D is higher in the service sector than in the manufacturing sector, when the dependent variable is measured in terms of sales. If the chosen dependent variable is the number of employees, then the impact of

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internal R&D is still higher in the services sector, but the impact of external R&D is higher in the manufacturing sector. Aldemir (2011) studies the relationship between intangible assets and firm growth in firms producing renewable energy, distinguishing between smaller and larger firms, showing a positive significant impact of the intangible assets on firm growth for smaller firms, while there was no significant relationship for larger firms. In contrast, Schimke and Brenner (2011) show a positive relationship between R&D expenditures and firm growth for large firms and no significant relationship for other firm sizes, namely small firms, medium firms, SMEs and very large firms.

Despite firm growth has been widely investigated in the literature, very few studies have studied the effect of participating and winning green public procurements as an additional determinant factor.

Data and Methodology

We study, using multivariate regression, the impact on firm growth of the event of winning green public procurement contracts. We regress firm growth rates on a number of variables modelling various aspects of green public procurement. We examine the extent to which participating in public tenders and winning public procurement contracts influence the firm growth rates. For this purpose, we calculate one main measure of firm growth such as total assets value controlling at the same time for firm and country characteristics. We then assess whether winning a TED contract influence firm growth when comparing firms who actually won these contracts with other similar firms who did not win (control group). Since most of the firms in our sample are not publicly traded, we do not have firm-level measures of investment opportunities, such as Tobin's Q. Instead, we use indicators of firm legal form, financial ratios and industry codes as firm-level controls. Since the selected sample includes firms from manufacturing, services, construction, agriculture, and other industries, we control for industry effects by including industry dummy variables.

We initially introduce public procurement characteristics, financial ratios and macroeconomic indicators one at a time and, to conclude, we assess the impact of this set of variables as a whole. In subsequent regressions, we also consider the interaction between some of these variables. All regressions are estimated using firm-level data across 10 EU countries and country random effects. The regressions are estimated with controls for country and firm-specific variables. The country control variables are *yearly GDP growth* and *yearly unemployment rate*. More specifically, the equations we estimate are as follows:

SME TED winners and firm growth (Total Assets) -Table 20

$$TAgrowthrate_{it} = \ln(TA)_{it} - \ln(TA)_{i(t-1)}$$

This variable indicates the first differences in firm Total Assets.

t=2014, 2015, 2016, 2017, 2018, 2019

$$\begin{aligned} TAgrowthrate_{it} \\ = \alpha + \beta_1 \mathrm{TED}_{t-1} + \beta_2 \mathrm{TED}_{t-2} + \beta_3 \mathrm{TED}_{t-3} + \beta_4 r\mathrm{Loans}_{it} + \beta_5 \mathrm{rCreditors}_{it} \\ + \beta_6 lnr\mathrm{Employment}_{it} + \beta_7 r\mathrm{Turnover}_{it} + \beta_8 \mathrm{Unemployment}_{t} \\ + \beta_9 \mathrm{GDPgrowth}_{t} + f_i + y_t + e_{it} \end{aligned}$$

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f_i and y_t are firm and year fixed effects.

, The variable TED_t is a dummy which takes value of 1 if a firm wins a TED contract in year t. It is zero otherwise.

A firm is labelled "SME" according to the EU definition if has less than 250 employees and has Annual balance sheet value lower than €43MLN.

$$rLoans_{it} \equiv \frac{Loans_{it}}{TA_{it}}$$

$$rCreditors_{it} \equiv \frac{Creditors_{it}}{TA_{it}}$$

$$lnrEmployment_{it} \equiv \ln\left(\frac{Employment_{it}}{TA_{it}}\right)$$

$$rTurnover_{it} \equiv \frac{Turnover_{it}}{TA_{it}}$$

Exporting firms, financial value of TED contracts and firm growth (Total Assets) –Tables 21 and 22

$Exportingfirm_{it}$ is a dummy variable which takes value of 1 if its export turnover is >0. This variable is equal to zero otherwise.

$$\begin{aligned} TAgrowthrate_{it} &= \alpha + \beta_1 TED_{t-1} rTEDAwardValue_{it-1} Exportingfirm_{it-1} \\ &+ \beta_2 TED_{t-2} rTEDAwardValue_{it-2} Exportingfirm_{it-} + \beta_3 rLongTermDebt_{it} \\ &+ \beta_4 rLoans_{it} + \beta_5 rCreditors_{it} + \beta_6 lnrEmployment_{it} + \beta_7 rTurnover_{it} \\ &+ \beta_8 Unemployment_t \end{aligned}$$

Priority, winning times and firm growth (Total Assets) -Table 23

$$\begin{aligned} TAgrowthrate_{it} &= \alpha + \beta_1 Priority_{low} * win_{x=1} + \beta_2 Priority_{low} * win_{2\le x\le 5} + \beta_3 Priority_{low} \\ &* win_{x>5} + \beta_4 Priority_{medium} * win_{x=1} + \beta_5 Priority_{medium} * win_{2\le x\le 5} \\ &+ \beta_6 Priority_{lmedium} * win_{x>5} + \beta_7 Priority_{high} * win_{x=1} + \beta_8 Priority_{high} \\ &* win_{2\le x\le 5} + \beta_9 Priority_{high} * win_{x>5} + \beta_{10} rLongTermDebt_{it} + \beta_{11} rLoans_{it} \\ &+ \beta_{12} rCreditors_{it} + \beta_{13} lnrEmployment_{it} + \beta_{14} rTurnover_{it} \\ &+ \beta_{15} Unemployment_t + \beta_{16} GDPgrowth_t + re + y_t + e_{it} \end{aligned}$$

Where the variable win_x signals the number of time a specific firm won a GPP contract per year and the variable Priority takes value "high" for TED contracts whose content is strictly related to RES technologies and/or services.

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Main results

The estimations are based on the matched sample as has been described in previous sections. Table 20 shows the relationship between a GPP[9] (TED) contract winner and firm growth. We split the overall sample on the basis of firm classification[10]: SMEs (columns 1 to 3) , Large Firms (columns 4 to 6); and "All firms" (columns 7 to 9), studying firm growth.

1. Initially, we compare TED winners with non-TED winners (i.e. firms who either participated in EU public procurement and never won or never participated). We find that the event of being a SME who won a GPP (TED) contract has a negative effect on firm growth after 1 year and after 3 years. On the contrary, larger firms seem to benefit from participating and winning GPP contracts. This might be a reflection of the barriers faced by SMEs when winning GPP contracts. This is in line with the information collected by the XPRESS partnership as results of relevant case studies (see deliverable D3.1).
2. We then add *endogenous financial variables* such as *loans, credit, turnover* (as a ratio over Firm Total Assets) and *size* as control variables. Once again, our results show negative and statistically significant at 5% of winning a GPP contract on firm growth after 3 years of the event. The *ratio of creditors on total assets and the number of employees on total assets* (log) show a negative impact on firm growth. Their coefficients are negative and statistically significant respectively at 5% and at 1%. We therefore find evidence of the fact that for SMEs who won GPP contracts, higher levels of external financing (sometimes to support the investments to deliver the TED contract) may be detrimental for their respective growth. Inversely, the turnover ratio shows a positive impact on firm growth as its coefficient is positive and statistically significant at 10%. To summarise our findings, internal financing via sales and retained earnings is beneficial for firm growth while financial obstacles may hamper the growth of SMEs winning GPP contracts.
3. To conclude, we add *macroeconomic variables*, namely *GDP Annual Growth and Unemployment Annual Rate*, as well as *yearly time indicators*. While the previous results still hold, we also find that the macroeconomic variables are statistically significant for larger firms only.

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[9] With Priority 1 to 3

[10] A firm is labelled "SME" according to the EU definition if has less than 250 employees and has Annual balance sheet value lower than €43MLN
https://ec.europa.eu/regional_policy/sources/conferences/state-aid/sme/smedefinitionguide_en.pdf

	SMEs			Large Firms			All firms		
	TAgrowthrate			TAgrowthrate			TAgrowthrate		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TED_{t-1}	-0.047**	-0.027	-0.064**	0.026*	0.038***	0.027*	-0.012	0.003	-0.011
	(0.023)	(0.025)	(0.029)	(0.013)	(0.013)	(0.016)	(0.013)	(0.013)	(0.015)
TED_{t-2}	-0.015	-0.022	-0.075*	-0.018	-0.001	-0.018	-0.016	-0.006	-0.024
	(0.027)	(0.031)	(0.039)	(0.015)	(0.016)	(0.021)	(0.014)	(0.016)	(0.020)
TED_{t-3}	-0.082**	-0.108**	-0.146**	0.010	0.026	0.027	-0.015	-0.008	-0.003
	(0.040)	(0.046)	(0.060)	(0.028)	(0.027)	(0.034)	(0.024)	(0.025)	(0.033)
rLoans		-0.165	-0.172		-0.227*	-0.236*		-0.249***	-0.244***
		(0.116)	(0.122)		(0.132)	(0.131)		(0.091)	(0.090)
rCreditors		-0.451**	-0.415**		-0.153	-0.128		-0.378**	-0.356**
		(0.203)	(0.204)		(0.142)	(0.142)		(0.148)	(0.149)
lnrEmployment		-0.012***	-0.012***		-0.003	-0.003		-0.007***	-0.007***
		(0.003)	(0.003)		(0.003)	(0.003)		(0.002)	(0.002)
rTurnover		0.081*	0.082*		0.086***	0.083***		0.083***	0.083***
		(0.043)	(0.044)		(0.017)	(0.017)		(0.022)	(0.022)
GDPgrowth			0.845			1.470*			1.150
			(1.064)			(0.765)			(0.709)
Unemployment			0.260			0.906**			0.657*
			(0.588)			(0.397)			(0.348)
2014			0.071**			0.012			0.033
			(0.035)			(0.022)			(0.021)
2015			-0.020			-0.013			-0.024
			(0.040)			(0.028)			(0.025)
2016			0.035			0.016			0.018
			(0.042)			(0.029)			(0.027)
2017			0.092*			0.046			0.050
			(0.054)			(0.030)			(0.032)
2018			0.081			0.044			0.033
			(0.055)			(0.033)			(0.032)
α	0.094***	0.647***	0.583***	0.021***	0.271	0.140	0.056***	0.536***	0.428***
	(0.006)	(0.126)	(0.169)	(0.004)	(0.290)	(0.308)	(0.003)	(0.147)	(0.165)
Firm fixed effects									
Year fixed effects									
N	1580	1346	1346	1765	1542	1542	3345	2888	2888
Within R^2	0.006	0.105	0.124	0.003	0.068	0.081	0.001	0.074	0.085

Standard errors in parentheses
*** p<0.10 ** p<0.05 *** p<0.01**

Table 20 - SME TED winners and firm growth

Table 21 shows the impact of the financial value of the TED contracts on firm growth for firms who won a GPP (TED) contract.

1. We test the relationship between the relative annual values of TED contracts (as a ratio with respect to Annual Total Assets) and firm growth. As before, we use Annual Growth of Total Assets as proxy for firm growth and we test our model for SME and large firm subsamples, as well as the entire sample. We test the impact of the ratio of total annual values of TED contracts over total asset value on firm growth and we show that the relation is positive and statistically significant at 5% only for the entire sample. The result holds after adding control variables. The relative financial value of TED contracts influences firm growth. Moreover, the effect of the impact on firm growth of the relative financial value of the TED contract when the firm is a TED contract winner is negative and

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statistically significant at 1% only for large firms the year after they actually won such contracts. However, this last effect does not hold when adding control variables.

	SMEs				Large Firms				All firms			
	TAgrowthrate				TAgrowthrate				TAgrowthrate			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
rTEDAwardValue	0.018	0.111	0.034	0.035	-0.154	0.182	0.175	0.180	-0.102	0.116	0.149**	0.149**
	(0.085)	(0.103)	(0.092)	(0.092)	(0.128)	(0.164)	(0.165)	(0.167)	(0.072)	(0.087)	(0.073)	(0.073)
TED_{t-1}		-0.045*	-0.062*	-0.063*		0.033**	0.031*	0.032*		-0.009	-0.003	-0.002
		(0.024)	(0.032)	(0.032)		(0.014)	(0.017)	(0.017)		(0.013)	(0.016)	(0.016)
rTEDAwardValue*TED_{t-1}		0.061	0.090	0.100		-0.645***	-0.275	-0.257		-0.194	-0.218	-0.204
		(0.365)	(0.391)	(0.390)		(0.241)	(0.216)	(0.218)		(0.217)	(0.191)	(0.190)
TED_{t-2}		-0.011	-0.077*	-0.077*		-0.018	-0.017	-0.015		-0.014	-0.020	-0.018
		(0.028)	(0.043)	(0.043)		(0.015)	(0.022)	(0.022)		(0.014)	(0.021)	(0.021)
rTEDAwardValue*TED_{t-2}		-0.137	0.217	0.206		0.243	0.459	0.479		-0.119	0.194	0.185
		(0.399)	(0.444)	(0.443)		(0.340)	(0.324)	(0.317)		(0.324)	(0.335)	(0.333)
TED_{t-3}		-0.090**	-0.135**	-0.136**		0.016	0.037	0.040		-0.018	0.011	0.012
		(0.043)	(0.063)	(0.063)		(0.029)	(0.035)	(0.035)		(0.025)	(0.034)	(0.034)
rTEDAwardValue*TED_{t-3}		0.289	-0.258	-0.245		-0.532	-0.912	-0.911		0.240	-0.392	-0.366
		(0.312)	(0.539)	(0.544)		(0.448)	(0.603)	(0.579)		(0.378)	(0.307)	(0.304)
rLoans			-0.175	-0.171			-0.225*	-0.229*			-0.256***	-0.247***
			(0.122)	(0.122)			(0.135)	(0.134)			(0.092)	(0.091)
rCreditors			-0.425**	-0.420**			-0.168	-0.137			-0.375**	-0.362**
			(0.205)	(0.206)			(0.142)	(0.141)			(0.149)	(0.151)
lnrEmployment			-0.013***	-0.013***			-0.003	-0.003			-0.007***	-0.007***
			(0.003)	(0.003)			(0.003)	(0.003)			(0.002)	(0.002)
rTurnover			0.082*	0.082*			0.086***	0.084***			0.084***	0.083***
			(0.043)	(0.044)			(0.018)	(0.018)			(0.022)	(0.023)
2014			0.084***	0.071**			0.031*	0.011			0.048***	0.032
			(0.029)	(0.035)			(0.017)	(0.022)			(0.017)	(0.021)
2015			-0.002	-0.021			0.003	-0.016			-0.011	-0.028
			(0.024)	(0.040)			(0.019)	(0.029)			(0.016)	(0.026)
2016			0.045*	0.033			0.019	0.011			0.020	0.013
			(0.027)	(0.043)			(0.020)	(0.029)			(0.018)	(0.028)
2017			0.100***	0.088			0.041**	0.038			0.043**	0.039
			(0.034)	(0.057)			(0.019)	(0.031)			(0.019)	(0.033)
2018			0.081*	0.075			0.020	0.032			0.012	0.019
			(0.042)	(0.058)			(0.026)	(0.034)			(0.024)	(0.034)
GDPgrowth				0.847				1.522**				1.160
				(1.068)				(0.767)				(0.711)
Unemployment				0.223				0.874**				0.624*
				(0.599)				(0.401)				(0.350)
α	0.082***	0.089***	0.625***	0.597***	0.050***	0.020***	0.262	0.150	0.065***	0.054***	0.521***	0.440***
	(0.001)	(0.007)	(0.127)	(0.171)	(0.000)	(0.004)	(0.293)	(0.308)	(0.000)	(0.004)	(0.149)	(0.166)
Firm fixed effects												
Year fixed effects												
N	5249	1580	1346	1346	6041	1765	1542	1542	11290	3345	2888	2888
Within R^2	0.000	0.008	0.125	0.125	0.000	0.010	0.079	0.085	0.000	0.002	0.085	0.087

Standard errors in parentheses
* p<0.10 ** p<0.05 *** p<0.01

Table 21 – Financial value of TED contracts and firm growth

Table 22 shows the impact on firm growth of the financial value of the TED contracts for on firm growth for firms who won a GPP (TED) contract and who have a positive export turnover ratio (over Total Assets).

1. For each subsample, namely SMEs and Large Firms as well as for the entire sample, we test the impact on firm growth of winning a TED contract for firms who have a positive export turnover ratio (over Total Assets). This impact is positive and statistically significant at 1% for SMEs two years after they won such TED contracts independently from the financial value of the contract. For larger firms, the only important factor is the award value of TED contracts. This effect is negative and statistically significant at 5% one year they won such contacts.

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2. We then add endogenous financial variables on loans, credit, size and turnover as control variables. The previous results still hold but for SMEs only. The *ratios of loans on total assets, creditors on total assets and number of employees on total assets* show a negative impact on firm growth. These ratios are statistically significant, respectively at 5%, 5% and 1%. Inversely, the *turnover ratio* shows a positive impact on firm growth and its coefficient is statistically significant at 5% for SMEs. At the same time, only the *ratio of loans on total assets* (negative estimated coefficient) and the *turnover ratio* (positive estimated coefficient) are statistically significant at 5% and 1% respectively.
3. Finally, we add *macroeconomic variables*, namely *GDP Annual Growth and Unemployment Annual Rate*, as well as *yearly time indicators*. While the previous results still hold for SMEs, we also find that the macroeconomic variables are statistically significant for large firms only.

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	SMEs			Large Firms			All firms		
	TAgrowthrate			TAgrowthrate			TAgrowthrate		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TED_{t-1}	-0.049**	-0.026	-0.044	0.033**	0.037***	0.028*	-0.019	0.002	-0.008
	(0.024)	(0.026)	(0.028)	(0.013)	(0.013)	(0.016)	(0.013)	(0.014)	(0.015)
rTEDAwardValue	0.084	0.052	0.024	0.135	0.199	0.140	0.072	0.096	0.085
	(0.097)	(0.075)	(0.089)	(0.170)	(0.166)	(0.170)	(0.081)	(0.065)	(0.072)
$rTEDAwardValue*TED_{t-1}$	0.188	0.250	0.209	-0.582**	-0.327	-0.282	0.003	-0.031	-0.082
	(0.427)	(0.494)	(0.454)	(0.226)	(0.211)	(0.230)	(0.249)	(0.233)	(0.215)
ExportingFirm	0.067	0.225**	0.200***	-0.019	-0.058	-0.001	-0.004	0.048	0.089
	(0.068)	(0.088)	(0.074)	(0.046)	(0.104)	(0.111)	(0.041)	(0.058)	(0.058)
$ExportingFirm*TED_{t-1}$	0.069	0.065	0.095	-0.019	-0.006	-0.018	-0.006	-0.029	-0.025
	(0.093)	(0.089)	(0.089)	(0.049)	(0.056)	(0.056)	(0.043)	(0.047)	(0.048)
ExportingFirm*rTEDAwardValue	0.119	0.385	0.455	0.207	0.312	0.290	0.228	0.347	0.342
	(0.372)	(0.426)	(0.371)	(0.274)	(0.320)	(0.312)	(0.302)	(0.317)	(0.289)
$ExportingFirm*rTEDAwardValue*TED_{t-1}$	-0.121	-0.291	-0.402	-1.513	-11.213	-1.338	-0.007	0.108	-0.022
	(0.672)	(0.761)	(0.696)	(5.715)	(15.869)	(15.786)	(0.453)	(0.448)	(0.410)
TED_{t-2}	-0.029	-0.037	-0.048	-0.016	-0.002	-0.019	-0.019	-0.008	-0.018
	(0.030)	(0.033)	(0.039)	(0.014)	(0.015)	(0.020)	(0.015)	(0.016)	(0.020)
$rTEDAwardValue*TED_{t-2}$	-0.253	-0.075	0.008	-0.252	-0.239	0.104	-0.330	-0.166	0.006
	(0.441)	(0.514)	(0.500)	(0.275)	(0.300)	(0.325)	(0.340)	(0.347)	(0.348)
$ExportingFirm*TED_{t-2}$	0.250**	0.299***	0.294***	0.018	-0.037	-0.046	0.071	0.046	0.052
	(0.108)	(0.099)	(0.111)	(0.042)	(0.066)	(0.060)	(0.044)	(0.070)	(0.069)
$ExportingFirm*rTEDAwardValue*TED_{t-2}$	0.446	-0.197	-0.430	0.080	10.355	-0.972	0.744	0.484	0.226
	(0.554)	(0.660)	(0.643)	(5.357)	(15.541)	(15.572)	(0.462)	(0.481)	(0.465)
rLoans		-0.237**	-0.233*		-0.289**	-0.277**		-0.292***	-0.309***
		(0.113)	(0.123)		(0.116)	(0.123)		(0.084)	(0.087)
rCreditors		-0.335**	-0.352*		-0.193	-0.132		-0.306***	-0.325**
		(0.153)	(0.185)		(0.136)	(0.154)		(0.114)	(0.141)
lnrEmployment		-0.011***	-0.012***		-0.003	-0.004		-0.007***	-0.007***
		(0.002)	(0.002)		(0.002)	(0.002)		(0.001)	(0.002)
rTurnover		0.079**	0.073*		0.076***	0.085***		0.072***	0.081***
		(0.031)	(0.039)		(0.017)	(0.018)		(0.018)	(0.022)
GDPgrowth			0.419			1.500**			0.959
			(1.046)			(0.749)			(0.686)
Unemployment			0.628			0.845**			0.806**
			(0.589)			(0.398)			(0.352)
2014			0.086**			0.008			0.036*
			(0.035)			(0.021)			(0.021)
2015			0.006			-0.021			-0.020
			(0.040)			(0.028)			(0.025)
2016			0.055			0.013			0.026
			(0.043)			(0.028)			(0.028)
2017			0.105*			0.037			0.050
			(0.057)			(0.031)			(0.033)
2018			0.048			0.045			0.035
			(0.053)			(0.032)			(0.032)
α	0.092***	0.545***	0.522***	0.022***	0.255	0.191	0.058***	0.564***	0.410***
	(0.007)	(0.094)	(0.156)	(0.005)	(0.209)	(0.275)	(0.004)	(0.119)	(0.150)
Firm fixed effects									
Year fixed effects									
N	1898	1617	1420	2182	1850	1640	4080	3467	3060
Within R^2	0.008	0.099	0.124	0.007	0.065	0.091	0.003	0.074	0.087

Standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

Table 22 - Exporting firms, financial value of TED contracts and firm growth.

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Table 23 shows the impact on firm growth of the content of TED contracts (contracts with high Priority have RES technologies and services at their core) together with the number of times a firm won such contracts per year.

1. For each subsample, namely SMEs and large firms as well as for the entire sample, we test the impact on firm growth (using Total Asset growth as a proxy) of winning a number (higher than 5) of energy related "green" (high Priority) TED contracts per year. The effect is negative and statistically significant at 1% for both SMEs and large firms. Moreover, for energy related "green" TED contracts (high priority), when SMEs win between 2 and 5 of these contracts per year, the impact is also negative and statistically significant at 5%. Inversely, for "not so green" energy sources (i.e. low priority), the impact of winning between 2 and 5 contracts per year is positive and statistically significant at 1% for both SMEs and large firms. These results show that winning a number of Public Procurement contracts on RES (high priority) per year can be *financially costly* for firms of any size as these contracts have a negative impact on firm growth. This conclusion can be explained considering the number of barriers still faced by firms who have to fulfil such contracts as highlighted by the XPRESS case studies (see ***deliverable D3.1*** for details).
2. The *ratios of loans on total assets, creditors on total assets and number of employees on total assets* show a negative impact on firm growth and statistically significant at 1%. Inversely, the *turnover ratio* shows a positive impact on firm growth and its coefficient is statistically significant at 1%.
3. Finally, we add *macroeconomic variables*, namely *GDP Annual Growth and Unemployment Annual Rate*, as well as *yearly time indicators*. While the previous results still hold, we also find that only *Unemployment Annual Rate* is statistically significant at 1% for SMEs only.

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	SMEs		Large Firms		All firms	
	TAgrowthrate		TAgrowthrate		TAgrowthrate	
	(1)	(2)	(3)	(4)	(5)	(6)
$Priority_{low}*win_{x=1}$	0.019	0.042	0.034	0.031	0.022	0.034
	(0.051)	(0.053)	(0.035)	(0.036)	(0.036)	(0.036)
$Priority_{low}*win_{2\leq x\leq 5}$	0.109***	0.122***	0.066***	0.062***	0.070***	0.076***
	(0.032)	(0.043)	(0.013)	(0.019)	(0.025)	(0.027)
$Priority_{low}*win_{x>5}$			-0.018***	0.017*	-0.030***	0.006
			(0.004)	(0.010)	(0.004)	(0.009)
$Priority_{medium}*win_{x=1}$	-0.007	0.014	0.013	0.022	-0.002	0.016
	(0.019)	(0.019)	(0.013)	(0.014)	(0.011)	(0.011)
$Priority_{medium}*win_{2\leq x\leq 5}$	-0.060	-0.015	-0.026	-0.008	-0.032*	-0.006
	(0.042)	(0.041)	(0.017)	(0.018)	(0.017)	(0.017)
$Priority_{medium}*win_{x>5}$	-0.025	0.042	-0.020	-0.007	-0.017	0.009
	(0.122)	(0.111)	(0.022)	(0.020)	(0.029)	(0.027)
$Priority_{high}*win_{x=1}$	-0.013	-0.005	0.005	0.011	-0.002	0.010
	(0.042)	(0.042)	(0.037)	(0.037)	(0.030)	(0.030)
$Priority_{high}*win_{2\leq x\leq 5}$	-0.254**	-0.220**	0.004	-0.003	-0.107*	-0.093
	(0.115)	(0.111)	(0.036)	(0.037)	(0.059)	(0.058)
$Priority_{high}*win_{x>5}$	-0.384***	-0.380***	-0.131*	-0.132***	-0.220***	-0.175***
	(0.014)	(0.021)	(0.072)	(0.046)	(0.079)	(0.058)
rLoans	-0.034	0.004	-0.135***	-0.140***	-0.059**	-0.046
	(0.051)	(0.058)	(0.038)	(0.050)	(0.029)	(0.035)
rCreditors	-0.187***	-0.137**	-0.133***	-0.110**	-0.114***	-0.090***
	(0.054)	(0.055)	(0.037)	(0.043)	(0.029)	(0.033)
lnrEmployment	-0.003***	-0.001***	-0.000	-0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
rTurnover	0.037***	0.035***	0.026***	0.023***	0.026***	0.024***
	(0.008)	(0.009)	(0.005)	(0.005)	(0.004)	(0.004)
GDPgrowth		0.068		1.314***		0.660*
		(0.584)		(0.456)		(0.364)
Unemployment		0.209*		-0.114		0.078
		(0.126)		(0.078)		(0.069)
2014		0.037*		-0.030*		0.003
		(0.022)		(0.016)		(0.014)
2015		-0.026		-0.061***		-0.044***
		(0.024)		(0.020)		(0.015)
2016		-0.011		-0.036*		-0.023
		(0.025)		(0.019)		(0.016)
2017		-0.005		-0.036*		-0.021
		(0.027)		(0.020)		(0.016)
2018		-0.050**		-0.042**		-0.044***
		(0.025)		(0.020)		(0.015)
α	0.210***	0.092***	0.030*	0.060**	0.100***	0.081***
	(0.027)	(0.035)	(0.016)	(0.024)	(0.011)	(0.018)
Random effects						
N	4351	3043	4509	3319	8860	6362
Between R^2	0.004	0.010	0.005	0.005	0.040	0.029

Standard errors in parentheses

*** p<0.10 ** p<0.05 *** p<0.01**

Table 23 – Priority, winning times and firm growth.

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10. Firm growth and environmental impact of RES technologies

Product environmental footprint and Climate change indicators

In this section we focus on the on environmental impact of the RES technologies produced as a result of a number of TED contracts and the interaction with firm growth. For this purpose, we consider two main indicators for environmental impact:

1. *Climate change*
2. *Product Environmental Footprint*

Climate change[i] (see Levasseur A. (2015) Climate Change) is defined as the warming of the climate system due to human activities. Emission of greenhouse gases (GHGs), which cause an increase in radiative forcing, is the main contributor. This is also the only climate forcing agent currently considered in life cycle impact assessment (LCIA) methodologies. The direct consequence of GHGs is an increase in the temperature of atmosphere and oceans, which leads to several types of higher-level impacts such as sea level rise, extreme meteorological events and perturbations in rainfalls, which in turn cause damages to human health and ecosystem quality. All the LCIA methodologies focus on GWPs (Global Warming Potentials), developed by the Intergovernmental Panel on Climate Change (IPCC), as midpoint characterisation factors based on state-of-the art and peer-reviewed publications and have a relatively low associated uncertainty. Recent new developments are addressing the accounting of biogenic CO2 emissions, the timing of GHG emissions, and the development of characterisation factors for terrestrial albedo changes induced by human activities.

Environmental Footprint *v3.0* derives from a methodology developed by the European Commission within the *Product Environmental Footprint* (PEF) initiative. For our specific case, the results have been adjusted on the basis of the availability of local wind resources for ten countries to achieve a specific impact referring to a specific country. We finally carried out a normalization and weighting step of the environmental impact categories covered by the EF method, using the average factors of a world-mean person in 2010 for the normalization and the weighting set developed by the JRC for the second.

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Impact category	Global 2010 person-average (IC unit/person) Normalization factor	Weighting factor	IC unit (EF v3 method)
Climate change	8097.2	0.2106	kg CO2 eq
Ozone depletion	0.05	0.0631	kg CFC11 eq
Ionising radiation	4219.4	0.0501	kBq U-235 eq
Photochemical ozone formation	40.6	0.0478	kg NMVOC eq
Particulate matter	5.95E-04	0.0896	disease inc.
Human toxicity, cancer	1.69E-05	0.0213	CTUh
Human toxicity, non-cancer	2.30E-04	0.0184	CTUh
Acidification	55.6	0.062	mol H+ eq
Eutrophication, freshwater	1.6	0.028	kg P eq
Eutrophication, marine	19.5	0.0296	kg N eq
Eutrophication, terrestrial	176.7	0.0371	mol N eq
Ecotoxicity, freshwater	42680.3	0.0192	CTUe
Land use	819672.1	0.0794	Pt
Water use	11469.2	0.0851	m3 depriv.
Resource use, fossils	65019.5	0.0832	MJ
Resource use, minerals and metals	0.06	0.0755	kg Sb eq

Table 24 Components of Product Environmental Footprint indicator

WIND POWER

Following the codes (CPV – Common Procurement Vocabulary) in the TED[11] (Tenders Electronics Daily) database, the following categories have been selected for wind power and the related procurement of products and services. The Table below gives a description of the codes and their content:

CPV code	Description	Comment
31121300	Wind-energy generators	Consider as the same "Wind turbines"
31121320	Wind turbines	Available
31121330	Wind turbine generators	Consider as the same "Wind turbines"
31121331	Turbine rotors	Consider as the same "Wind turbines"
31121340	Wind farm	Consider as the same "Wind turbines"

For sake of simplicity, we have considered that all codes refer to the same infrastructure and therefore we have selected the process "Wind turbine, 2MW, onshore {GLO}| construction | Cut-off, U" from the Ecoinvent[12] database to represent the environmental impacts of such procurements. This dataset characterises the environmental impact of the construction of a wind

[11] https://ted.europa.eu/TED/browse/browseByMap.do
[12] https://www.ecoinvent.org/

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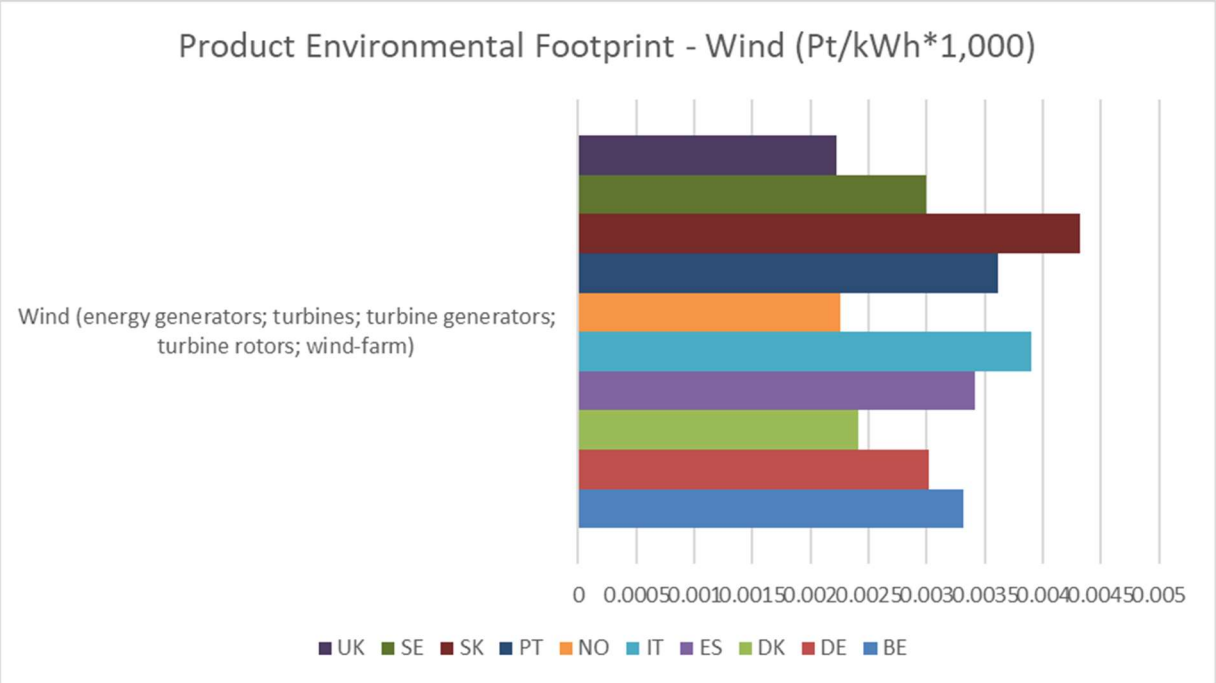
turbine with a capacity of 2MW for onshore use. The dataset includes moving parts such as nacelle, rotor, rotor blades, transition piece as well as fixed parts such as the tower and the foundation. The LCA model is based on the environmental assessment of this turbine in, in which the Danish wind park Tjaerborg with eight turbines of differing capacities is analysed, among them the Vestas V80/2 MW. This type can be taken as reference technology of the wind turbines class with a capacity between 1 and 3 MW. From the transformation of pasture land to industrial site, and from the reception and treatment of building materials and turbine parts. This activity ends with the decommissioning of the wind turbine and the treatment of the resulting materials in the end of the lifetime. This dataset includes all materials for the construction of the wind turbine and their treatment (not energy used for assembling), land transformation and use energy needed for erection and dismantling of the wind turbine. This dataset does not include the connection to the grid, which is modelled in a separate dataset the operation and maintenance of the fully finished wind power plant. It is assumed that all parts will hold for the lifetime of 20 years and do not have to be replaced auxiliary materials neither the energy used for assembly of the different wind turbine parts nor their transportation from manufacture to the construction site.



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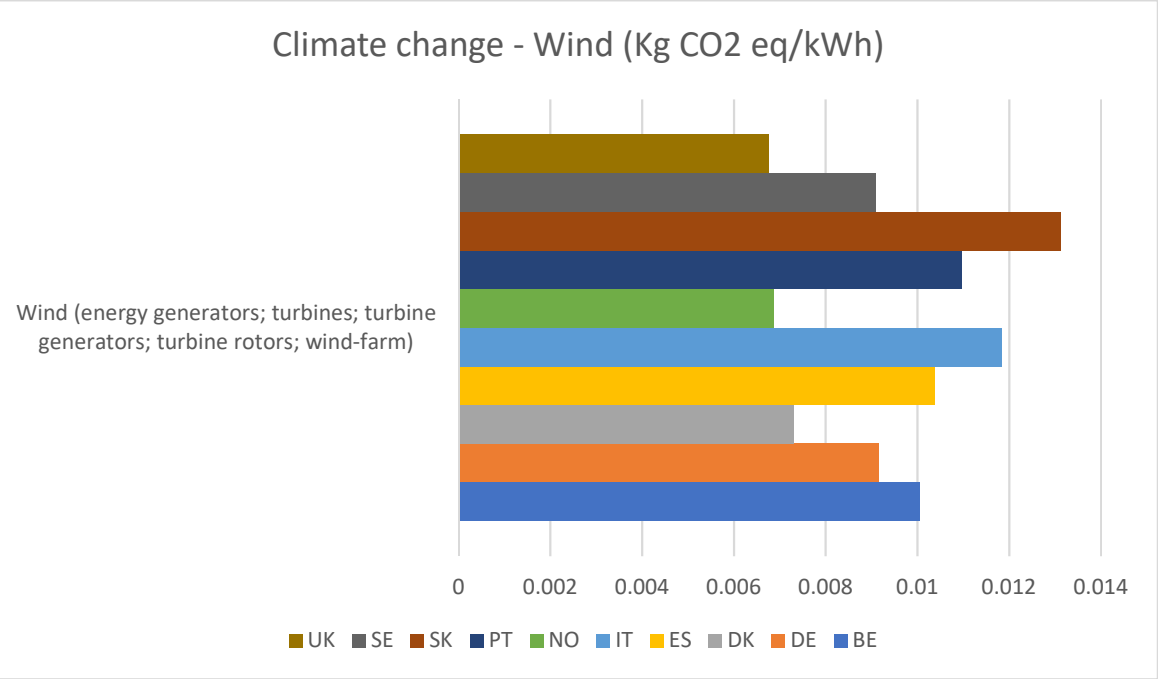

SOLAR POWER

Using the CPV codes in the TED database, the following categories have been selected within solar power and the related procurement of products and services. The table below gives a description of the codes and their content:

CPV code	Description	Comment
9330000	Solar energy	Process built with inverter, PV panel, roof infrastructure (slanted roof) and electric installation
9331000	Solar panels	Available
9331100	Solar collectors for heat production	Available
9331200	Solar photovoltaic modules	Consider the same as "solar panels"
9332000	Solar installation	Available
31712347	Power or solar diodes	Not available
45261215	Solar panel roof-covering work	Not available
31712331	Photovoltaic cells	Consider the same as "solar panels"

For "Solar energy", the XPRESS partners (led by eAambiente) have built a specifically tailored process because it was not immediately available within the Ecoinvent database. The XPRESS

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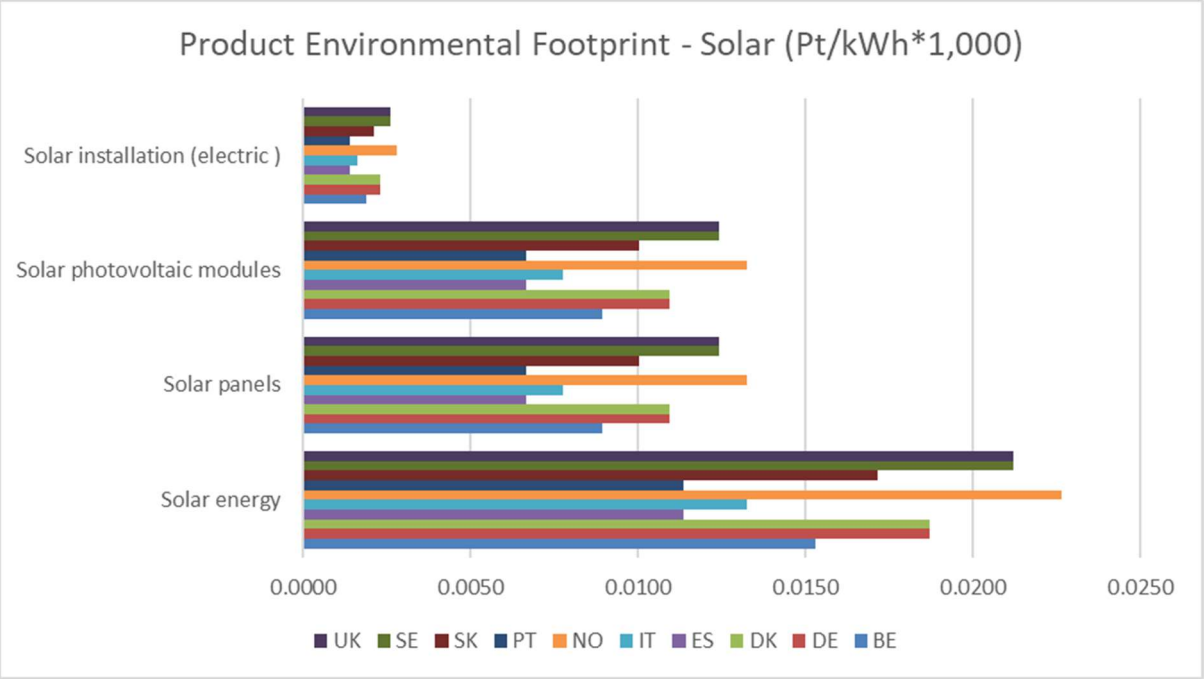
partners have then chosen the process for inverter, PV panel, roof infrastructure and electric installation. For the electric installation we selected the process “Photovoltaic plant, electric installation for 3kWp module {CH}| photovoltaics, electric installation for 3kWp module, at building | Cut-off, U”. The electric installation includes all parts between the panel and the grid, but not the inverter as it is modelled in a separate dataset due to its importance. The different parts considered are lightning protection, cabling in the PV panel area, fuse box, cabling from the PV panels to inverter and cabling from the inverter to the electric meter. We selected also: “Inverter, 2.5kW {GLO}| market for | Cut-off, U” for the inverter, “Photovoltaic panel, multi-Si wafer {GLO}| market for | Cut-off, U” for the PV panel and “Photovoltaic mounting system, for slanted-roof installation {GLO}| market for | Cut-off, U” for the roof infrastructure.

This process includes production and disposal of the complete solar system (excluding auxiliary heating). It includes also different components, heat exchange fluid, installation copper pipes, transports of parts to CH, delivery with a van and montage on the roof. For this process, material data have been investigated for a collector produced in 2002 and data for energy uses during production have been investigated for 2001.

“Solar panels” and “Solar installation” have been considered as part of the same process describing PV panel and roof installation.

We considered “Photovoltaic cells” as the same “Solar panels”. For modelling “Solar collectors for heat production” we selected the process “Solar collector system, Cu flat plate collector, multiple dwelling, hot water {CH}| solar collector system installation, Cu flat plate collector, multiple dwelling, hot water | Cut-off, S”.



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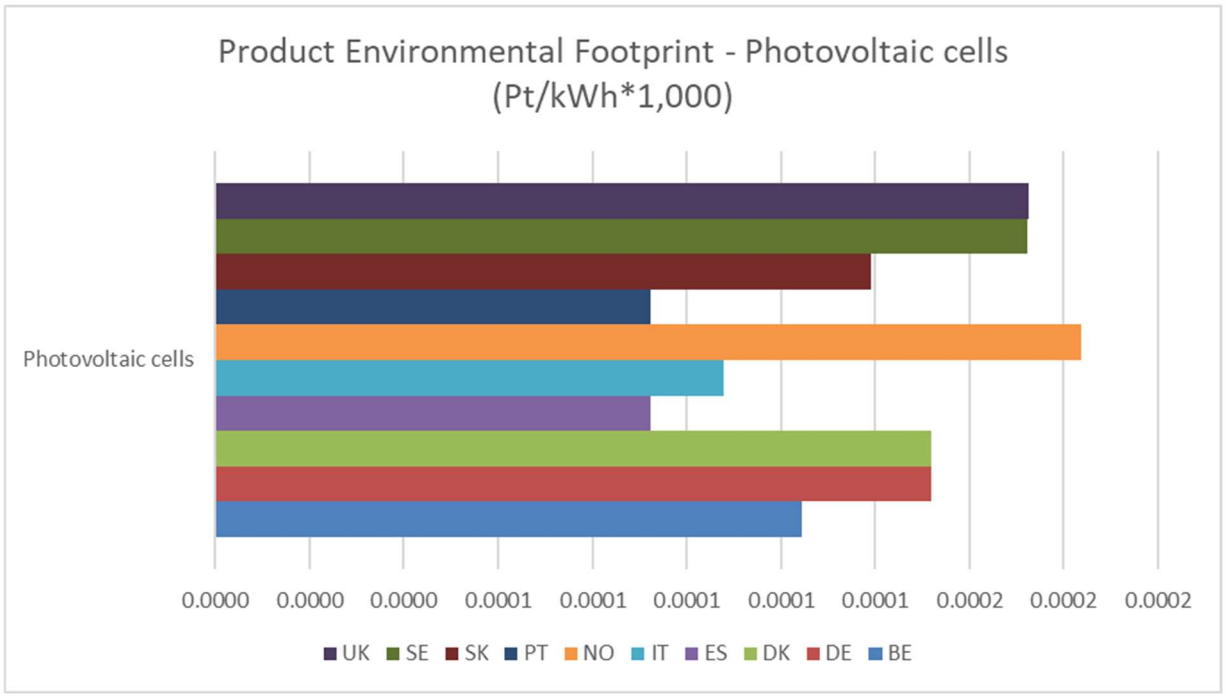

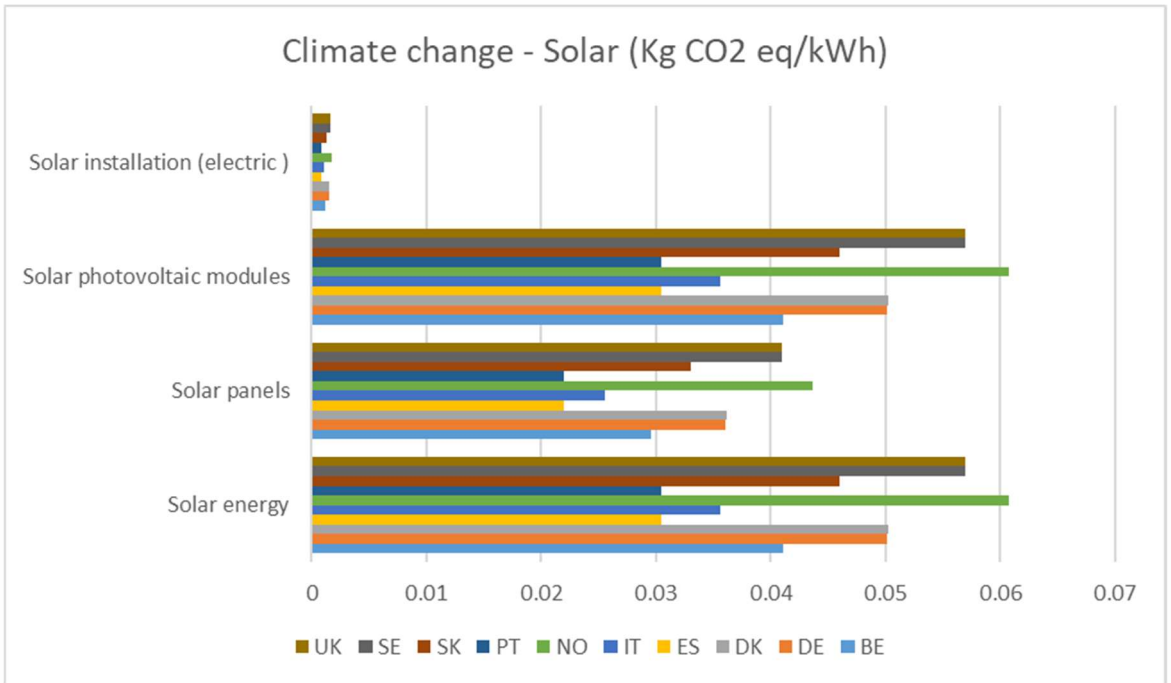

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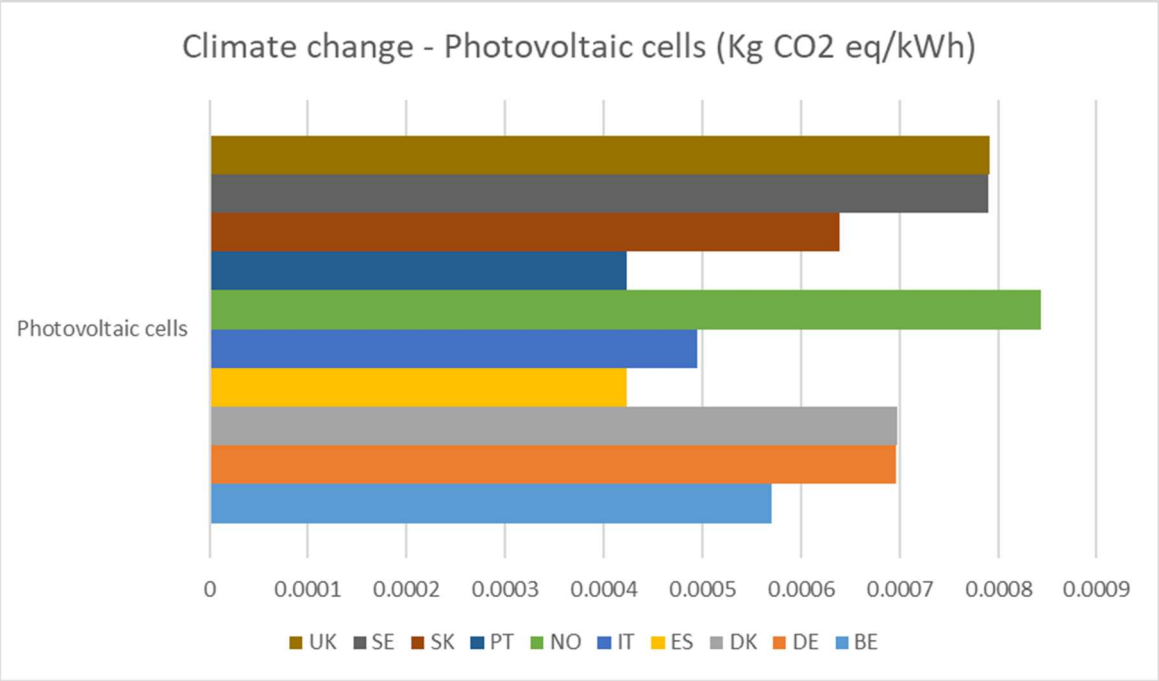

ELECTRIC VEHICLES

Using the CPV codes in the TED database, the following categories were selected for electric vehicles and related procurement of products and services. The table below gives a description of the codes and their content:

CPV code	Description	Comment
34144900	Electric vehicles	Available
34144910	Electric buses	Available
51111000	Installation services of electric motors, generators and transformers	Not available
51111100	Installation services of electric motors	Not available
31100000	Electric motors, generators and transformers	Consider the same as "electric motor"
31110000	Electric motors	Available
31160000	Parts of electric motors, generators and transformers	Not available
31161000	Parts for electrical motors and generators	Not available
50532100	Repair and maintenance services of electric motors	Not available

Electric vehicles are modelled considering the process "Transport, passenger car, electric {GLO}| processing | Cut-off, U" is modified with the electric grid mix specific for each country. This dataset describes a journey of 1 km with an electric passenger car. The dataset is parametrized with respect to the vehicle mass, the battery mass, the consumption and lifetimes of vehicle and

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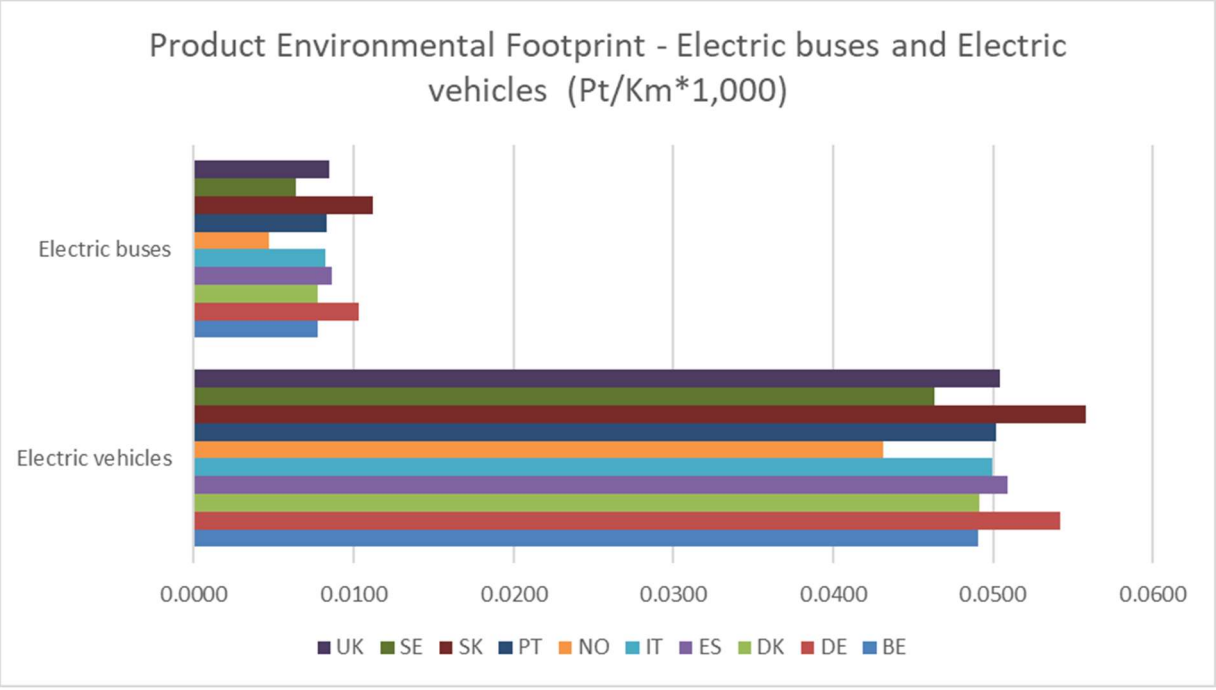
battery. The vehicle is studied as vehicle without battery plus the battery. The amount of battery includes battery exchange due to maintenance. Currently, default values for a compact size car with a weight without battery of 918.22 kg and a battery of 262 kg are given. The assumed life expectancy for a car is 150000 km as mileage and the assumed average lifetime for the battery is 100000 hours. The dataset is based on averages over modern car technologies, which are expected to be representative until year 2015.

This dataset describes a journey of 1 km for 1 passenger in an electric city bus. The dataset is parametrised with respect to vehicle mass, the battery mass, the consumption and lifetimes of vehicle and battery. This dataset combines the electric passenger inventory with a modified passenger coach inventory taken from Ecoinvent v3. Taking a full diesel coach weight of 11000 kg, we estimated a full bus weight of 10696 kg and an empty bus (without battery and without engine) of 8991 kg. The size of the electric engine has been extrapolated from that of the e-car, which is 53 kg for the latter and 472 kg for the former. An average life expectancy of 1 Mkm was assumed for the bus and an average EU passenger load of 30 persons per trip was considered for all countries.

The dataset of "Operation, trolleybus (CH)" was also used to derive the non-combustion emissions from tyre and brake wear, as well as for the consumption estimate of electricity (3.04 kWh/km), which was then distributed among the passenger load.

For modelling electric motor we choose the process "Electric motor, electric passenger car {GLO}| electric motor production, vehicle (electric powertrain) | Cut-off, S" and a weight of 53 kg.



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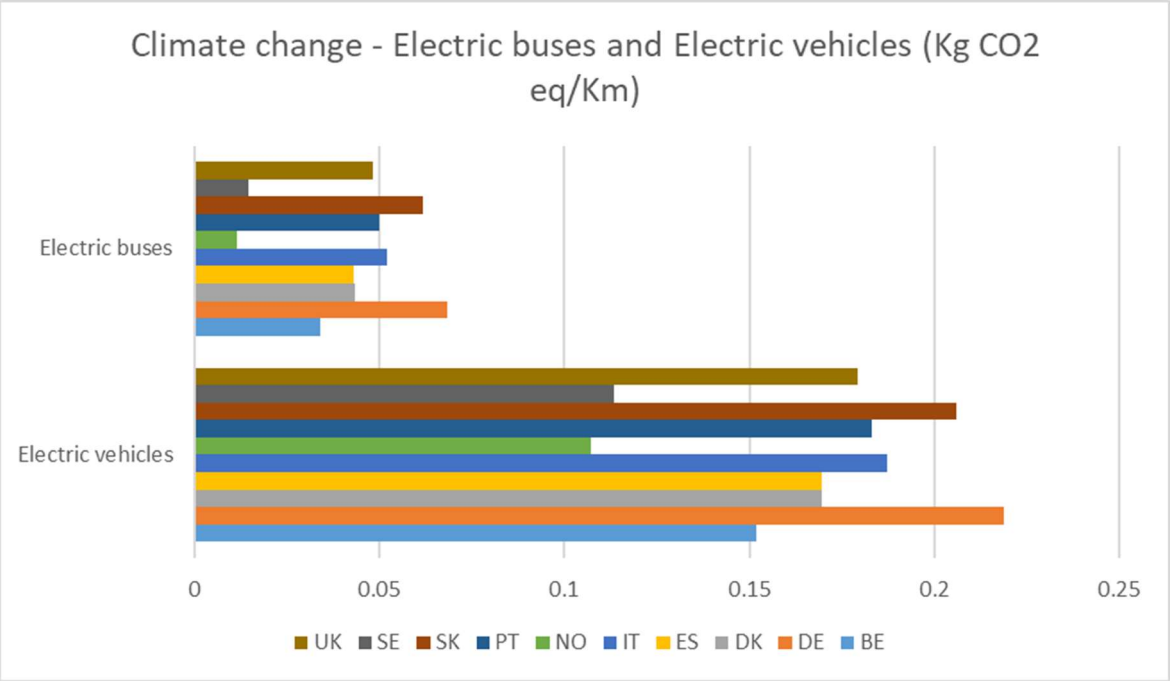

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HEAT PUMPS

Following CPV codes in the TED database, the following categories have been selected for heat pumps and related procurement of products and services. The table below gives a description of the codes and their content:

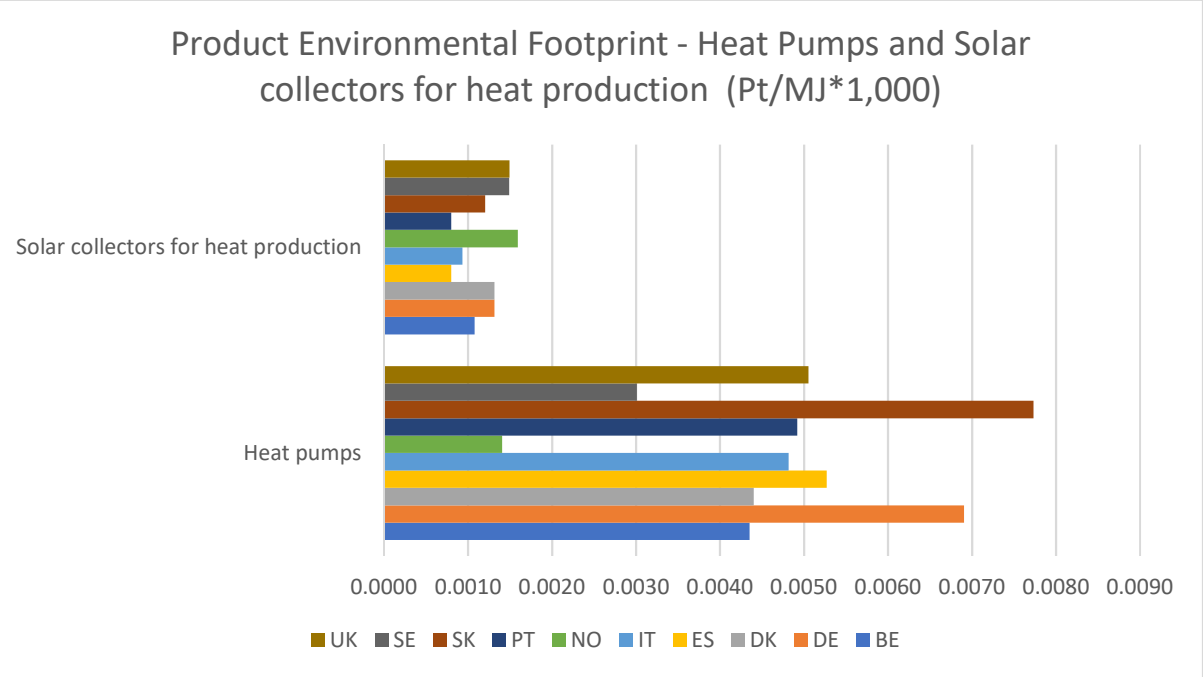
CPV code	Description	Comment
42511110	Heat pumps	Available
42530000	Parts of refrigerating and freezing equipment and heat pumps	Not available
42533000	Parts of heat pumps	Not available

We modelled "Heat pumps" in three ways: air-water heat pump, central heat pump and borehole heat pump.

For air-water heat pumps the process selected is "Heat, air-water heat pump 10kW {CH}| production | Cut-off, U". This dataset represents the production of heat with an air-water heat pump for an average one family house in the Swiss midland. Switzerland is assumed to represent an average climatological and geological location in Europe. The air-water heat pump has a heat capacity of 10 kW and a Seasonal Performance Factor (SPF) of 2.8 (for the year 1998). For this dataset, the infrastructure of a brine-water heat pump with 10 kW is used. Differences in infrastructure between the two types of heat pumps are considered by a scaling factor. Data for the estimation of SPF is based on a field study for Swiss heat pumps an on various literature. Life

time is assumed to be 20 years. This dataset is based on the following reference values: for the average one family house a heating requirement of 10 kW, a heat distribution system (low-temperature system) of 50/40°C and a heat supply of approximately 20.000 kWh with 2.000 operating hours were assumed. The assumption is that the system is operated without an auxiliary heating mechanism. This activity ends with heat at the air-water heat pump unit with a life time of 20 years. This dataset includes emissions of refrigerant R134a during operation. This dataset doesn´t include the heat distribution in the one family house, nor a buffer heat storage.

For central heat pump we selected the process "Heat, central or small-scale, other than natural gas {Europe without Switzerland}| heat production, at heat pump 30kW, allocation exergy | Cut-off, U". This database considers the production of heat from 30 kW heat pump installed at 160kW cogeneration unit. As before, this dataset includes heat pump infrastructure, the electricity for cogeneration unit and the emissions of refrigerants R134a during operation.



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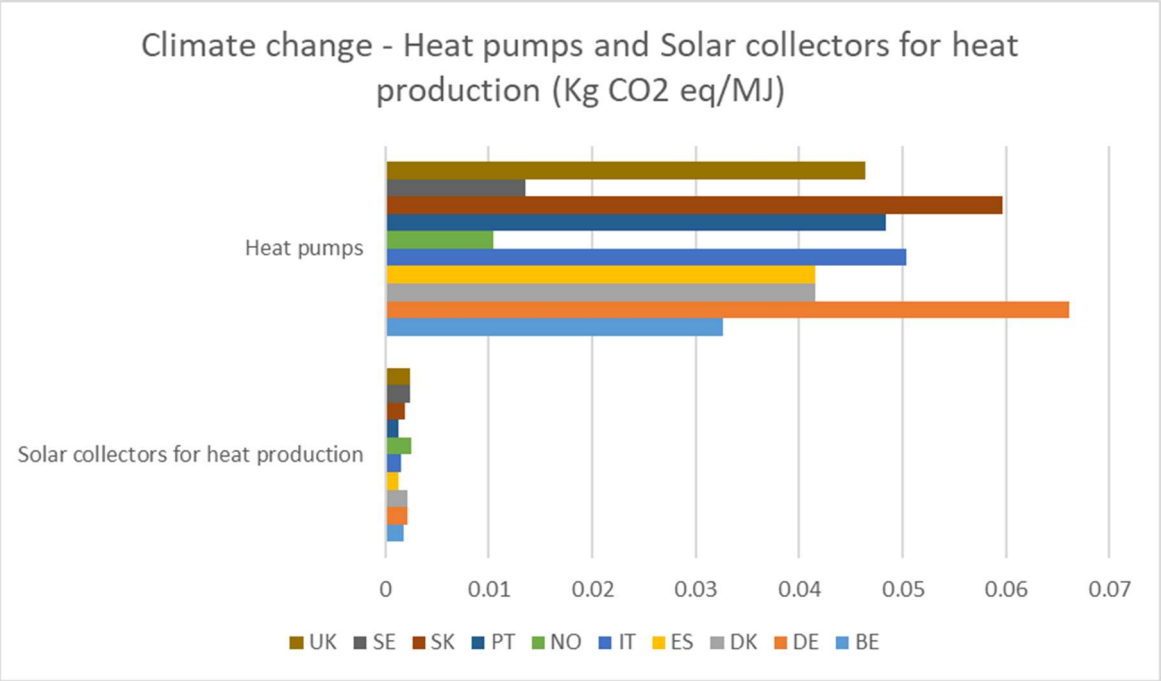

HYDRO POWER

Using the CPV codes in the TED database, the following categories have been selected for hydro power and related procurement of products and services. The table below provides a description of the codes and their content:

CPV code	Description	Comment
42121000	Hydraulic or pneumatic power engines and motors	Not available
42121100	Hydraulic or pneumatic cylinders	Not available
42121200	Hydraulic power engines	
42121400	Hydraulic power motors	
42122210	Hydraulic power packs	Not available
42124150	Parts of hydraulic power engines or motors	Not available
42124221	Parts of hydraulic power packs	Not available
45251120	Hydro-electric plant construction work	Not available

BIOENERGY

Using the CPV codes in the TED database, the following categories have been selected for bioenergy and related procurement of products and services. The table below gives a description of the codes and their content:

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CPV code	Description	Comment
9134230	Biodiesel	Available
9134231	Biodiesel (B20)	Not available
9134232	Biodiesel (B100)	Not available
9111400	Wood fuels	Available
3416000	Wood waste	Not available
3413000	Fuel wood	Consider the same as "wood fuel"
45251142	Wood-fired power station construction work	Not available

We modelled "Biodiesel" in two different ways: biodiesel from recycled vegetable cooking oil and soy biodiesel. For the first way we choose the process "Vegetable oil methyl ester {FR}| treatment of waste cooking oil, purified, esterification | Cut-off, S". Treated vegetable oil consists of 93.7% triglycerides and 6.7% fatty acid methyl ester. Process refers to the acid-catalysed esterification of free fatty acids and includes water removal, glycerine washing and methanol recovery. This process includes the collection of waste vegetable oil and delivery to the treatment plant, treatment of impurities and water removal, conditioning and oil storage. Treatment of effluents is taken into account. The calculation includes also the gross calorific value of the biomass and the carbon dioxide credit. System boundary is at the oil refining facility.

Soy biodiesel is modelled though the process "Soy biodiesel, production, at plant/kg/RNA" that is originated from USCLI database.

For modelling "Wood fuels" we choose "Wood pellet, measured as dry mass {RER}| market for wood pellet | Cut-off, S". This dataset represents the inputs and outputs of materials and energy for wood pellets production. Pellets are produced in a wood pellets factory which uses wood residue from sawmills and woodchips as raw materials. The raw materials are firstly pre-treated and dried, then mixed. In the final stage they are pelletized, cooled and bagged. Pellets packed in 15 kg-bags account for 20% of the production. The remaining 80% of the production is sold unpacked. The pellets produced match the characteristics of the German standard of quality DIN-plus (certification). There is no waste attributed to packaging film and maize starch, since these inputs will be part of the final product. Data collection for this RE goes from the receipt of the raw material at the pellet factory to the final product.

We modelled "wood fuels" in two different way: with dry wood waste and with wet wood waste. Below are report the processes of wood we have chosen:

- Residual hardwood, wet {GLO}| market for | Cut-off, S
- Residual softwood, wet {GLO}| market for | Cut-off, S
- Residual wood, dry {GLO}| market for | Cut-off, S
- Saw dust, wet, measured as dry mass {GLO}| market for | Cut-off, S
- Shavings, hardwood, measured as dry mass {GLO}| market for | Cut-off, S
- Shavings, softwood, measured as dry mass {GLO}| market for | Cut-off, S
- Bark chips, wet, measured as dry mass {GLO}| market for | Cut-off, S
- Wood chips, dry, measured as dry mass {RER}| market for | Cut-off, S

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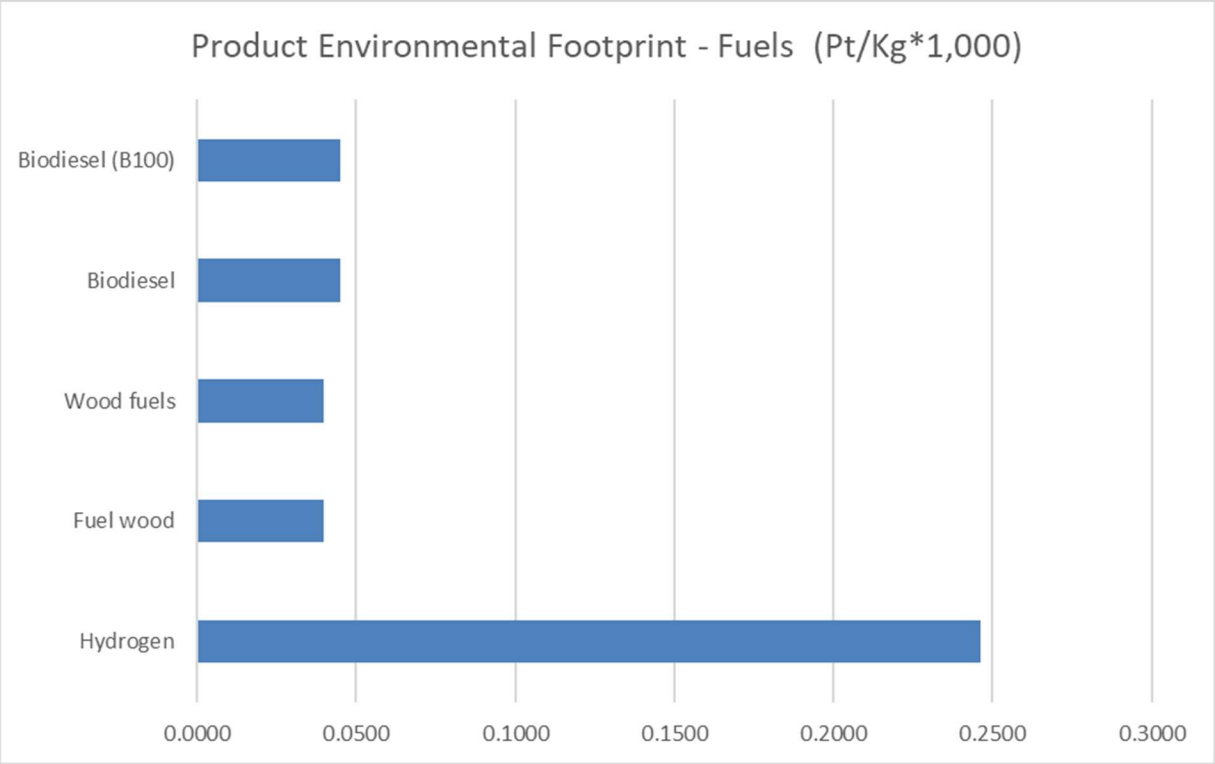
- Wood chips, from post-consumer wood, measured as dry mass {GLO}| market for | Cut-off, S

For modelling "Wood waste", we considered three types of wood. Below we report the processes of wood we have chosen:

- Residual hardwood, wet {GLO}| market for | Cut-off, S
- Residual softwood, wet {GLO}| market for | Cut-off, S
- Residual wood, dry {GLO}| market for | Cut-off, S



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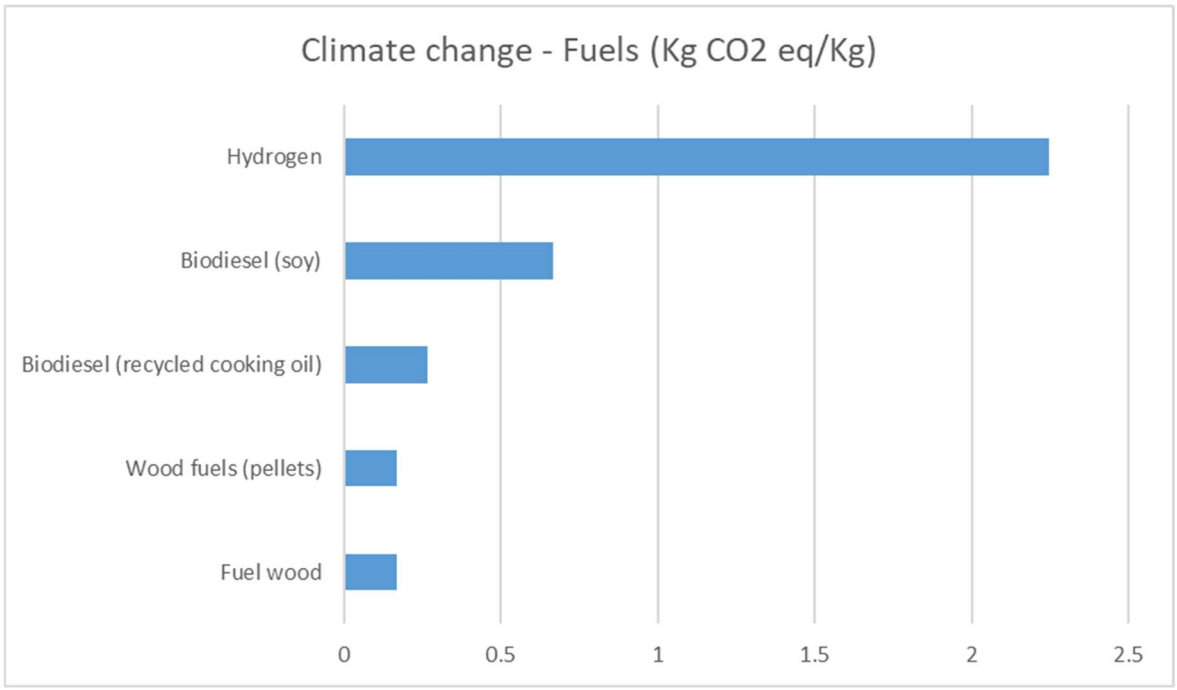

OTHER

In this category, we collect relevant types of Public Procurement contracts with the following CPV codes:

CPV code	Description	Comment
31124000	Steam-turbine generator and related apparatus	Available
24111600	Hydrogen	Available
9323000	District heating	Not available
42320000	Waste incinerators	Available
51135110	Installation services of waste incinerators	Not available

For "Stream-turbine generator and related apparatus" the "Gas turbine, 10MW electrical {GLO}| market for | Cut-off, S" process was selected, while for "Hydrogen" the European average production and distribution of "Hydrogen, liquid {RER}| market for | Cut-off, S" was taken. Finally, we took the "Municipal waste incineration facility {GLO}| market for | Cut-off, S" to represent the environmental impacts of "waste incinerators".

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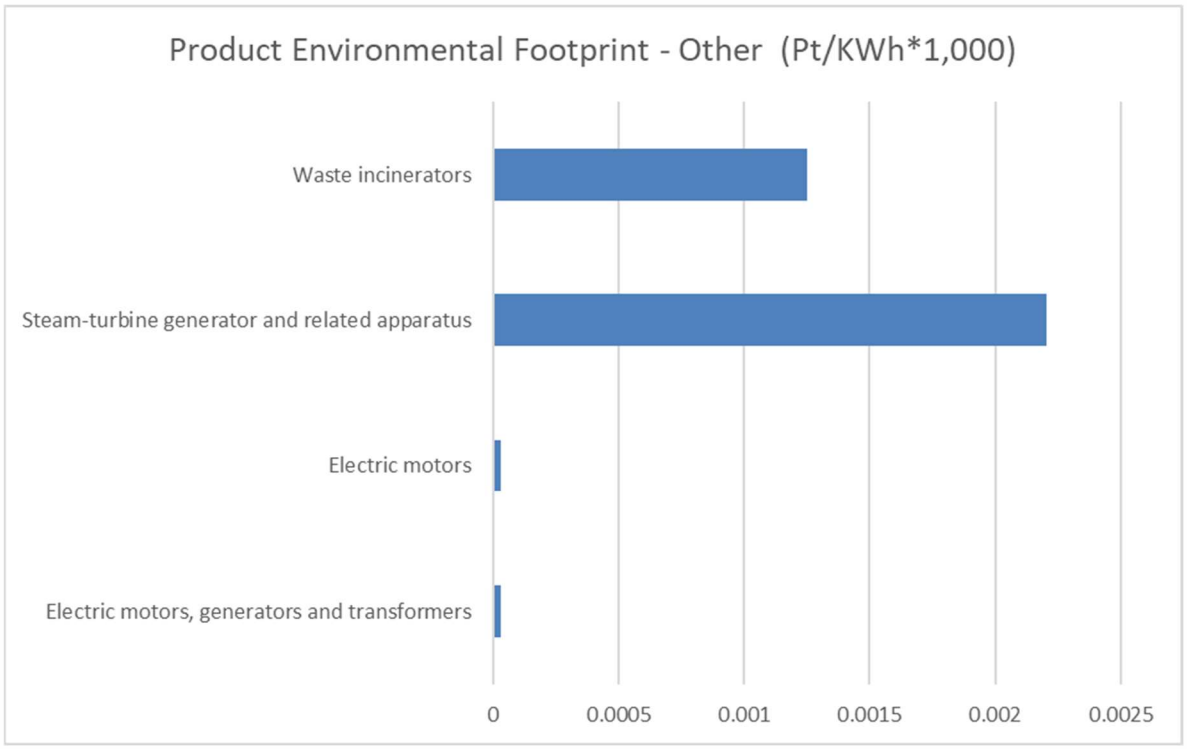

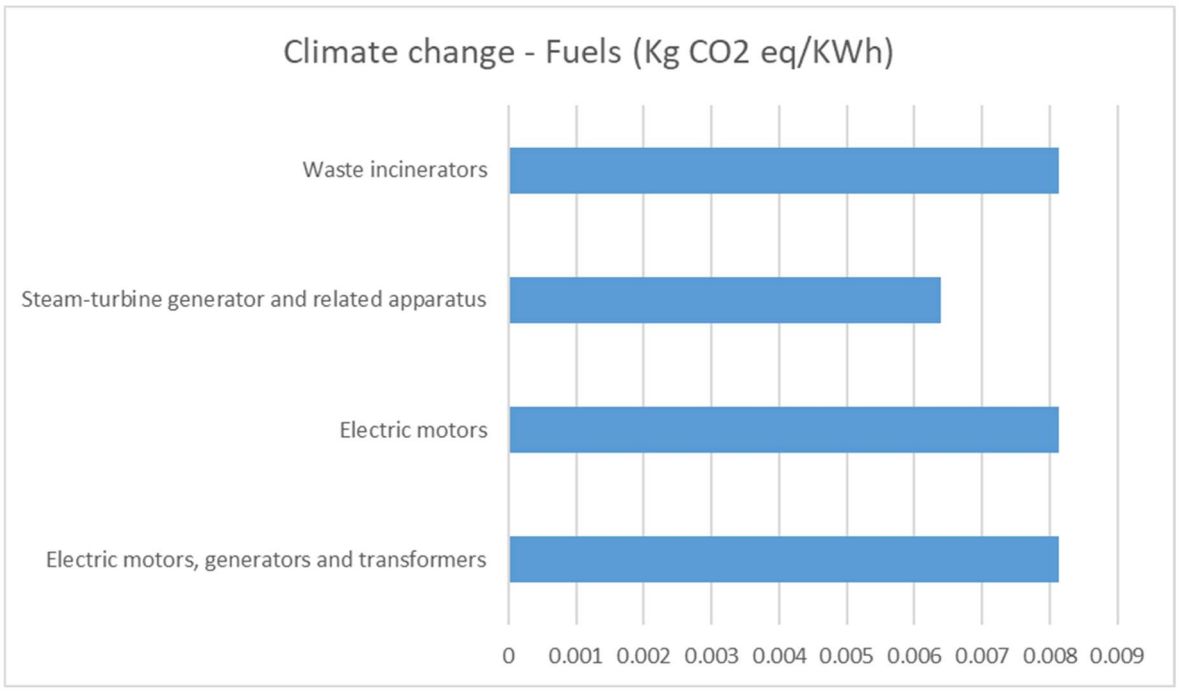

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LCA and firm growth

In this section we analyse the relationship between the environmental impact of the RES technologies and services at the core of a selection of relevant TED contracts and the growth of the firms who won such contracts. In our analysis, we consider all the categories described above for which we have enough data with the exception of electric buses and vehicles (for which the available data is currently inconclusive).

These are the two equations that we are estimating:

$$TAgrowthrate_{it} = \alpha + \beta_1 ProductEnvironmental + re + y_t + e_{it}$$

$$TAgrowthrate_{it} = \alpha + \beta_1 ClimateChange + re + y_t + e_{it}$$

Table 25 shows the relationship between firm growth and Product Environmental Footprint (PEF) and Climate change. The effect of PEF on firm growth is positive and statistically significant when considering the entire sample of firms.

This result indicates that currently, more polluting (from a LCA perspective) energy technologies and services, at the core of TED public procurement contracts, have a positive impact on firm growth. This is again in line with our expectations as currently, the *lowest price rather than the lifetime environmental impact of the energy technologies* is the main criterion that public authorities use for choosing the winning contract. Further analysis is needed with this respect in order to make our results more robust.

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	SMEs		All firms	
	TAgrowthrate		TAgrowthrate	
	(1)	(2)	(4)	(5)
ProductEnvironmental	0.985		1.127*	
	(2.353)		(0.611)	
ClimateChange		-0.257		0.107
		(0.508)		(0.069)
2016	-0.075	-0.068	-0.050	-0.045
	(0.104)	(0.102)	(0.074)	(0.073)
2017	0.095	0.102	0.109	0.112
	(0.098)	(0.098)	(0.080)	(0.080)
2018	0.095	0.104	0.056	0.061
	(0.108)	(0.111)	(0.100)	(0.101)
α	-0.007	0.013	-0.025	-0.020
	(0.076)	(0.075)	(0.055)	(0.054)
Random effects				
N	64	64	95	95
Between R^2	0.045	0.046	0.062	0.058

Standard errors in parentheses
*** p<0.10 ** p<0.05 *** p<0.01**

Table 25 – Firm growth and environmental impact: Product environmental footprint and Climate changes

11. Conclusions

As stated in model building, in the first part we developed two main research questions, firstly, how is the likelihood of winning a public procurement tender affected by the firm's financial strength (or weakness), and secondly, what is the impact of winning a public procurement award on the firm's financial strength. To capture the causal effect of the CA success on financial strength we apply the Flex-panel DiD approach. In addition, in the second part, we investigate the effect on growth rates of firms winning EU public tenders on Renewable energy sources using total asset growth as proxy for firm growth rate. Furthermore, we focus on the environmental impact of the RES technologies produced as a result of a number of TED contracts and on the interaction of such impact with firm growth. For this purpose, we consider two main indicators for environmental impact: climate change and product environmental footprint.

The findings show that the equity ratio has a significant and negative impact on the chance to win a tender. A negative association between the equity ratio and a TED CA has already emerged in the univariate analysis. Accordingly, we infer that a lower equity ratio rather increases the likelihood to be successful. One explanation could be that the equity-rich companies might fall victim of the fat cat syndrome and exert less effort to be successful in challenging public procurements as the firms with low equity do.

Short-term debt ratio has a significant and positive effect on winning a tender when specific firm types are analysed separately. This impact shows that firms with higher loans and trade credits shares in their balance sheet are more likely to win tenders. The effect may be due to the high liquidity needs of expanding firms. Those firms may be more willing to engage heavily in winning public procurement tenders.

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The size of the company often shows a positive and significant impact on the likelihood of winning a tender. Larger firms may have more resources to deal with the challenges of successfully participating in a public procurement tournament.

Companies active in the industry "trade of electricity" have a higher chance of winning a tender only if all firms are included in the estimation sample or at least all SMEs are included. Among the firms that are active in green areas there is no specific procurement advantage for those in the trade electricity segment.

Being an SME is also a determinant of winning. The SME characteristic appears to be a significant factor for winning a TED CA in combination with the following main variables, short term debt ratio, equity ratio, trade credit ratio, loan ratio, and long-term debt ratio (subsample 3). Table 26 summarizes the results of the estimations studying the likelihood of winning a tender dependent on the financial strength indicators.

FINANCIAL STRENGTH VARIABLES	OUTCOME
Equity ratio: significant and negative impact Short-term debt ratio: significant and positive impact (in subsample 1, 2)	Likelihood of winning a TED CA
Industry code 3514: positive and significant impact (subsamples 1,2), negative and significant impact (subsamples 3, 4). Industry code 3522 combined with turnover: positive and significant	
Being a SME combined with: Short term debt ratio Equity ratio Loan ratio Long-term debt ratio (subsample 3)	
Total assets: often positive and significant impact (subsample 1, 2).	

Table 26 - DiD – Llikelihood of winning a tender dependent on the firms' financial strength' variables

Studying the causal effect of the CA success on the individual firm's financial strength shows some significant impact.

Both the logarithmic turnover and the turnover ratio are not affected by winning a public procurement tender. The number of employees which can be interpreted as an indicator of company growth is positively affected by wining in a tender. However, productivity is reduced because of winning a tender.

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Short-term debt ratio, short-term loan ratio, and the trade credit ratio are lower when the firm wins a CA. The same result emerges for the equity ratio in certain subsamples (1, 3). The time dummies are frequently significant and affect the equity ratio significantly positive.

Total assets show mainly a significant impact on the indicators of financial strength except for the productivity variable and the equity ratio. The summary of the findings is listed in Table 21.

WINNING A PUBLIC PROCUREMENT TENDER	FINANCIAL STRENGTH
No impact	Turnover (ratio) turnover (logarithmic transformed)
Positive impact (year dummies from 2013 on) No cumulative impact (Treatment effect)	Firm size (logarithmically transformed)
Negative impact (year dummies from 2013 on) No cumulative impact (Treatment effect)	Productivity (logarithmically transformed)
Negative impact (year dummies) Negative cumulative impact (Treatment effect) in subsample 4	Short-term debt ratio
Negative impact (year dummies) No cumulative impact (Treatment effect)	Short-term loan ratio
Negative impact (year dummies) No cumulative impact (Treatment effect)	Trade credit ratio
Positive impact (year dummies) Negative cumulative impact (Treatment effect) in subsamples 1, 3	Equity ratio
Total asset	Turnover (logarithmically transformed) (+) Firm size (logarithmically transformed) (+) Productivity (logarithmically transformed) (-) Equity ratio (-) Short-term debt ratio (+) Trade credit ratio (+) Loan ratio (+) Turnover (ratio) (insignificant)

Table 27 - Impact of winning public procurement tender on financial constraints

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We find that the effect on growth rates of firms winning EU public tenders on Renewable energy sources depends on firm size, financial value and number of TED contracts won each year (Table 28). For SMEs, winning TED contracts on RES has a negative impact on firm growth and this effect is visible for the following three years after winning. However, when these SMEs are also exporting firms, winning TED contracts on RES has a positive effect on firm growth and this effect is visible two years after winning. We also show that large firms benefit from winning TED contracts on RES: this effect is visible only during the first year after winning. Regarding the financial values of TED contracts, higher values show to be positive for the growth of firms when they are considered all together. Another factor to consider is the number of TED contracts won by firms in each year. For TED contracts on not so green energy sources, winning between 2 and 5 TED contracts per year has a positive impact on firm growth for all types of firms. On the contrary, for TED contracts on green energy sources, winning more than five TED contracts per year has a negative impact on firm growth for all types of firms. Furthermore, when considering the environmental impact of the RES technologies on firm growth, we find that winning a TED contract on RES with high environmental impact (Product Environmental Footprint) has a positive impact on firm growth when firms are considered all together. This is in line with our expectations as currently, the *lowest price rather than the lifetime environmental impact of the energy technologies* is the main criterion that public authorities use for choosing the winning contract.

		SMEs	Large Firms	All firms
Winning a TED contract on RES one year before	**Table 20**	**negative****	**positive***	
Winning a TED contract on RES two years before	**Table 20**	**negative***		
Winning a TED contract on RES three years before	**Table 20**	**negative****		
Financial value of the TED contract on RES award	**Table 21**			**positive****
Being an exporting firm who won a TED contract on RES two years before	**Table 22**	**positive*****		
Winning between two and five TED contracts per year on not so green (Low Priority) energy sources	**Table 23**	**positive*****	**positive*****	**positive*****
Winning more than five TED contracts per year on green (High Priority) energy sources	**Table 23**	**negative*****	**negative*****	**negative*****
Winning a TED contract on RES with high environmental impact (PEF)	**Table 25**			**positive***

*** high significant results, ** medium significant result, * low significant results

Table 28 – Effects of various features of TED contracts on firm growth

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13. Appendix 1

CODE SELECTION	SHORT CODE SELECTION	DESCRIPTION	PRIORITY (1=HIGH, 2=MEDIUM, 3=LOW)
31121300-3	31121300	Wind-energy generators	1
31121310-6	31121310	Windmills	3
31121320-9	31121320	Wind turbines	1
31121330-2	31121330	Wind turbine generators	1
31121331-9	31121331	Turbine rotors	2
31121340-5	31121340	Wind farm	1
38126400-8	38126400	Wind surface observing apparatus	3
45251160-0	45251160	Wind-power installation works	1
09300000-2	9300000	Electricity, heating, solar and nuclear energy	1
09330000-1	9330000	Solar energy	1
09331000-8	9331000	Solar panels	1
09331100-9	9331100	Solar collectors for heat production	1
09331200-0	9331200	Solar photovoltaic modules	1
09332000-5	9332000	Solar installation	1
31712347-4	31712347	Power or solar diodes	2
38126200-6	38126200	Solar radiation surface observing apparatus	3
45261215-4	45261215	Solar panel roof-covering work	1
31712331-9	31712331	Photovoltaic cells	1
45251120-8	45251120	Hydro-electric plant construction work	1
45251140-4	45251140	Thermal power plant construction work	3
45251141-1	45251141	Geothermal power station construction work	1
45248000-7	45248000	Construction work for hydro-mechanical structures	3
42511110-5	42511110	Heat pumps	1
42530000-0	42530000	Parts of refrigerating and freezing equipment and heat pumps	1
42533000-1	42533000	Parts of heat pumps	1
09134230-8	9134230	Biodiesel	1
09134231-5	9134231	Biodiesel (B20)	1
09134232-2	9134232	Biodiesel (B100)	1

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31124000-1	31124000	Steam-turbine generator and related apparatus	2
42112100-8	42112100	Steam turbines	3
42112200-9	42112200	Hydraulic turbines	3
42113100-5	42113100	Parts of steam turbines	3
51130000-2	51130000	Installation services of steam generators, turbines, compressors and burners	3
42113200-6	42113200	Parts of hydraulic turbines	3
42112210-2	42112210	Water wheels	3
42113400-8	42113400	Parts of water wheels	3
42121000-3	42121000	Hydraulic or pneumatic power engines and motors	2
42121100-4	42121100	Hydraulic or pneumatic cylinders	2
42121200-5	42121200	Hydraulic power engines	2
42121400-7	42121400	Hydraulic power motors	2
42122210-5	42122210	Hydraulic power packs	2
42124150-0	42124150	Parts of hydraulic power engines or motors	2
42124221-9	42124221	Parts of hydraulic power packs	2
09111400-4	9111400	Wood fuels	1
03416000-9	3416000	Wood waste	1
03413000-8	3413000	Fuel wood	1
24327200-4	24327200	Wood charcoal	3
45251142-8	45251142	Wood-fired power station construction work	1
34144900-7	34144900	Electric vehicles	1
34144910-0	34144910	Electric buses	1
51111000-3	51111000	Installation services of electric motors, generators and transformers	2
51111100-4	51111100	Installation services of electric motors	2
31100000-7	31100000	Electric motors, generators and transformers	2
31110000-0	31110000	Electric motors	2
31160000-5	31160000	Parts of electric motors, generators and transformers	2
31161000-2	31161000	Parts for electrical motors and generators	2
50532100-4	50532100	Repair and maintenance services of electric motors	2
71314000-2	71314000	Energy and related services	2
65400000-7	65400000	Other sources of energy supplies and distribution	2

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09000000-3	9000000	Petroleum products, fuel, electricity and other sources of energy	2
09310000-5	9310000	Electricity	2
31200000-8	31200000	Electricity distribution and control apparatus	2
31682000-0	31682000	Electricity supplies	2
24111600-1	24111600	Hydrogen	2
09323000-9	9323000	District heating	2
42515000-9	42515000	District heating boiler	3
45251250-8	45251250	District-heating plant construction work	3
45232140-5	45232140	District-heating mains construction work	3
42320000-5	42320000	Waste incinerators	2
45252300-1	45252300	Refuse-incineration plant construction work	3
51135110-1	51135110	Installation services of waste incinerators	2
90513300-9	90513300	Refuse incineration services	3

Table 29 – Tender types

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14. Appendix 2

NACE CODE	DESCRIPTION
D35	Electricity, gas, steam and air conditioning supply
D35.1	Electric power generation, transmission and distribution
D35.1.1	Production of electricity
D35.1.2	Transmission of electricity
D35.1.3	Distribution of electricity
D35.1.4	Trade of electricity
D35.2	Manufacture of gas; distribution of gaseous fuels through mains
D35.2.1	Manufacture of gas

D35.2.2	Distribution of gaseous fuels through mains
D35.2.3	Trade of gas through mains
D35.3	Steam and air conditioning supply
D35.3.0	Steam and air conditioning supply

Table 30 – NACE code

15. Appendix 3

COUNTRY CODE	DESCRIPTION
BE	1
DE	2
DK	3
ES	4
GB	5
IT	6
NO	7
PT	8
SE	9
SK	10

Table 31 – Country code

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APRE Agenzia per la Promozione della Ricerca Europea

eambiente

University of York

elementenergy

DIW BERLIN

NTNU Norwegian University of Science and Technology

ovgroup green economy industry

Linnæus University

LOBA CUSTOMER EXPERIENCE DESIGN

INSME LOCAL STRENGTH - GLOBAL REACH International Network for SMEs

circe RESEARCH CENTRE FOR ENERGY RESOURCES AND CONSUMPTION

European Green Cities

Alleanza per il Clima Italia onlus

Climate Alliance

SLOVENSKÝ ŽIVNOSTENSKÝ ZVÄZ

eurada

XPRESS