OECD SME and Entrepreneurship Papers

Assessing greenhouse gas emissions and energy consumption in SMEs

Towards a pilot dashboard of SME greening and green entrepreneurship indicators

Marco Marchese and Juana Medus

This paper presents the first estimates of the OECD project "Towards a pilot dashboard of SME greening and green entrepreneurship indicators", which is part of broader work of the OECD Committee on SMEs and Entrepreneurship (CSMEE) to support governments in making SMEs active players in the green transition. The paper first explains the rationale behind this measurement exercise, which relates to the importance of monitoring carbon emissions and energy consumption in the business sector, including SMEs, as governments strive to achieve their climate objectives. Thereafter, it gives an overview of the project methodology to produce estimates on the environmental footprint of SMEs. Finally, it presents the first estimates for the first five dashboard indicators: i) SME share of greenhouse gas emissions in the business sector; ii) SME share of energy consumption in the business sector; iii) SME greenhouse gas emissions (carbon) intensity; iv) SME energy intensity; v) SME energy price burden The paper also presents evidence on real SME electricity and gas consumption in Denmark thanks to pilot work with Statistics Denmark. A final Annex explains the project methodology in detail.

JEL codes: C40; Q49; Q59; Y10
Keywords: Small and medium enterprises (SMEs); greenhouse gas emissions; energy consumption

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The series provides comparative evidence and analysis on SME and entrepreneurship performance and trends and on a broad range of policy areas, including SME financing, innovation, productivity, skills, internationalisation, and others.

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Executive summary

This paper presents the first estimates of the OECD project "Towards a pilot dashboard of SME greening and green entrepreneurship indicators", which has been developed under the aegis of the OECD Committee on SMEs and Entrepreneurship (CSMEE). This project is part of broader work of the OECD CSMEE to support governments in making SMEs active players in the green transition and in fostering green entrepreneurship, including through the analysis of relevant policies. The project also intends to raise awareness about the importance of measuring greenhouse gas (GHG) emissions and energy consumption at firm level, amidst growing pressures on companies, including SMEs in the context of global value chains, to report on their carbon emissions.

Previous work of the OECD CSMEE had observed that there is limited information on the environmental footprint of SMEs, although existing evidence suggests that, on aggregate, they account for a sizeable share of carbon emissions and energy consumption. For example, according to a recent report by the European Commission, based on the use of employment weights, SMEs account for 63% of business-driven direct carbon emissions at the EU level, while the International Energy Agency (IEA) estimates that SMEs account for 13% of global energy demand and about one-third of energy demand in industry and services.

This paper tries to help fill measurement gaps on the environmental footprint of SMEs of European OECD economies. Because the methodology underlying this paper uses structural business statistics which are published with a delay of a few years, data in the report refer to 2018. Furthermore, this paper only covers the business sector, thus excluding emissions and energy consumption related to households and some non-household activities (i.e., agriculture, financial sector, and public administration). Similarly, GHG emissions and energy consumption by informal activities may not be captured in the dashboard estimates.

Recognising the scarcity of data on direct emissions by SMEs, the paper adopts a top-down approach that disaggregates data typically available at the sectoral (activity) level, covering large firms and SMEs, to estimate the SME contribution to GHG emissions and energy consumption. The approach applies output weights (i.e., SMEs' share of value added) to aggregate environmental indicators on GHG emissions and energy consumption. To reflect very different levels of carbon emissions and energy consumption across sectors, output weights are applied at the two-digit sector level (42 sectors for GHG emissions and 37 sectors for energy consumption), which improves on many previous similar approaches computed at the one-digit sector level (12 sectors). While three- or four-digit sector estimates of output by SMEs are available and would provide for greater accuracy, the publicly available datasets of GHG emissions and energy consumption lack this level of detail and so act as a constraining factor on the degree of disaggregation.

Based on this methodology, estimates are presented for the following indicators:

- SME share of greenhouse gas (carbon) emissions in the business sector.
- SME share of energy consumption in the business sector.
- SME carbon intensity (GHG emissions intensity): i.e., SME GHG emissions per unit of SME value added, measured in terms of carbon-dioxide-equivalent per US dollar of value added. A complementary measure of this indicator relates SME GHG emissions to SME employment.
- SME energy intensity: i.e. the ratio of SME energy consumption over SME value added, measured in terms of Megawatt-hour (MWh) per US dollar of value added. A complementary measure with employment as a denominator is also produced.

- SME energy price burden: this indicator is particularly relevant following the 2022 energy crisis caused by the Russia's war of aggression against Ukraine. It measures the impact of the cost of electricity and natural gas on SME turnover and is presented in percentage terms relative to turnover.

Recognising that value-added is not a perfect instrument for identifying SME shares, especially given the still relatively aggregated grouping of activities and the high degree of heterogeneity of firms within these groupings, as well as economies of scale and higher productivities that larger companies typically have, for the first two indicators, additional estimates are developed by applying an employment weight (i.e., the SME share of employment at two-digit sector level). Comparisons of the two sets of estimates also provide a sense of potential margin of error that may be associated with either approach.

To further assess the margin of error the paper also compares results with nationally produced estimates of SME electricity and gas consumption in Denmark, based on pilot work with Statistics Denmark and the Danish Business Authority. Reassuringly, although only one case, actual electricity and gas consumption data for SMEs in Denmark, based on observable data from electricity meters and gas consumption surveys, are very close to the estimates produced in the dashboard. Some care is needed, however, in interpreting this finding to all countries as the detailed data for Denmark also reveals that more than 50% of SME electricity consumption stems from less than 1% of energy-intensive SMEs, which may not be representative of other countries.

Finally, any analysis of the dashboard estimates over time should be taken with caution. Indeed, if large firms were to lead the green transition, the top-down approach will also generate improvements in SMEs (all else being equal). Furthermore, if the improvements in larger firms came at the cost of jobs (e.g., through productivity enhancements) or profits (e.g., through initially higher adaptation intermediate costs), counter-intuitive effects might be observed through the top-down approach used in this paper.

Against this backdrop, the main results from the first vintage of the pilot dashboard, which only covers OECD European countries, are the following (all referring to year 2018 unless otherwise specified):

- The SME share of direct GHG emissions in the business sector ranges between 57% in Slovenia and 25% in Poland, with the EU aggregate figure being 37% (estimates based on the output weight only).
- The SME share of GHG emissions in manufacturing ranges between 58% in Latvia and 19% in Iceland, with the EU aggregate figure being 30% (estimates based on the output weight only).
- The SME share of energy consumption in the business sector varies between 78% (Estonia) and 28% (Sweden), with the EU figure standing at 43% (estimates based on the output weight only).
- The SME share of energy consumption in manufacturing ranges between 76% (Estonia) and 20% (Sweden), with the EU figure standing at 36% (estimates based on the output weight only).
- SME carbon intensity (GHG emissions over value added) generally varies between 0.32 carbon-dioxide-equivalent per US dollar of value added in Slovakia and 0.09 in Sweden (EU average, 0.2). However, Greece and Estonia respectively have SME carbon intensities of 0.85 and 0.53.
- SME energy intensity (energy consumption over value added) ranges between 3.65 MWh per US dollar of value added in Iceland and 0.71 MWh in Denmark, with the EU aggregate level being 1.27 MWh.
- The SME energy price burden (cost of electricity and gas over business turnover) is the highest in Portugal and Slovakia (5.3%) and the lowest in Sweden (1.1%), with the EU aggregate level being 4%. Using simple extrapolations to assess the impact of the 2022 energy crisis on SMEs, the paper finds that that this indicator more than doubled in 5 countries (Greece, Lithuania, Ireland, Italy, and the Netherlands) between 2018 and 2022.

Building on these first results, the dashboard project intends to refine these estimates and provide further guidance to policy makers by: i) expanding the coverage of countries and years covered, starting with OECD countries beyond Europe; ii) working with other pilot countries to identify more granular sources of estimates on energy consumption and carbon emissions in particular; iii) assessing the feasibility of developing indicators covering other SME environmental dimensions, including green entrepreneurship (e.g., the proportion of start-ups that are green and gender gaps in this indicator), waste generation, participation in the circular economy and biodiversity. The first line of action will directly build on the pilot results presented in this paper, whereas the other two may require, in some cases, the active collaboration of national government entities such as statistical offices and energy authorities.

1 Introduction

Climate change is a global priority which has received growing attention from the public since the finalisation of the 2015 Paris Agreement, through which 196 Parties have committed to reducing the rise in global temperatures to less than 2˚ Celsius (preferably 1.5˚) compared to pre-industrial levels. To meet this target, governments have pledged to achieve "net-zero" carbon emissions by 2050, with the path towards this goal set out in national determined contributions (NDCs) submitted every five years to the United Nations Framework Convention on Climate Change (UNFCCC).

However, the global trajectory in greenhouse gas (GHG) emissions is not yet aligned with the achievement of carbon neutrality by 2050 (D'Arcangelo et al., 2022[1]). In response, many governments have allocated significant funding from the COVID-19 recovery packages to green-transition policies – such as those that encourage investments in energy efficiency and renewable energy – and have increased taxation of emission-intensive goods and activities.

Supporting the green transition of small and medium-sized enterprises (SMEs) is important to achieve global climate targets. Because of their sheer numbers, SMEs account for a significant share of GHG emissions. However, evidence on this matter is sparse and not always comparable across countries, calling for stronger evidence to drive government policies in this area.

The trajectory towards the green transition has also been affected by the fallout of Russia's war of aggression in Ukraine, launched in February 2022, which has increased price volatility in energy markets (OECD, 2022[2]). Although the price of natural gas, which directly affects the price of electricity, returned to pre-war levels in May 2023, after its peaks in summer 2022, such energy price shock will likely have longer-lasting consequences on the business sector due to two main reasons. First, it takes some time for wholesale energy prices to be reflected in retail contracts (i.e., pass-through effects). Second, many OECD countries have introduced generous policies to relieve businesses and families from the increased cost of energy in 2022, but most of these policies are expected to be withdrawn by the end of 2023 (Marchese, 2023[3]).

Against this backdrop, it is important to monitor energy consumption and carbon emissions across countries to assess whether they can realistically deliver on their climate objectives. Two OECD ongoing initiatives contribute to this objective. The OECD International Programme for Action on Climate (IPAC) helps countries strengthen and co-ordinate their climate action through regular monitoring, policy evaluation and feedback on results and good practices[1]. The OECD Inclusive Forum on Carbon Mitigation Approaches, which was launched at the 2022 OECD Council at Ministerial level, intends to facilitate an evidence-based multilateral exchange of information about country efforts to reach net-zero emissions [2].

In order to contribute to this measurement agenda, the OECD Committee on SMEs and Entrepreneurship (CSMEE) recognised the importance of developing a "Dashboard of SME Greening and Green Entrepreneurship Indicators", including in particular indicators on the different dimensions of the environmental footprint of SMEs and green entrepreneurship. This pilot project is part of broader CSMEE

[1] For further information on IPAC, see: https://www.oecd.org/climate-action/ipac/

[2] For further information on the OECD Inclusive Forum on Carbon Mitigation Approaches, see the 2022 OECD Ministerial Council Statement: https://www.oecd.org/mcm/2022-MCM-Statement-EN.pdf

work on supporting governments in their efforts to strengthen SME participation in the green transition and green entrepreneurship, including through the analysis of relevant policies (OECD, 2021[4]) (OECD, 2022[5]) (OECD, 2022[6]).

This paper presents the first results of the pilot dashboard project. In particular, building on the use of output and employment weights at two-digit sector level, the report presents estimates for the following SME environmental indicators: i) SME share of greenhouse gas emissions (carbon emissions) in the business sector; ii) SME share of energy consumption in the business sector; iii) SME greenhouse gas emissions (carbon) intensity; iv) SME energy intensity; v) SME energy price burden (only covering the two energy sources of electricity and natural gas)[3]. The definition of business sector includes mining and quarrying, manufacturing, construction, and commercial services, while it excludes agriculture, public administration, and financial sector activities. The paper also presents evidence on real SME electricity and gas consumption in Denmark thanks to pilot work with Statistics Denmark.

Building on these results, the pilot dashboard project will advance in the near future, with the aim to consolidate evidence and broaden further the scope of monitoring. In particular, the project will aim to: i) produce estimates of the SME environmental indicators presented in this report for more years and countries, starting with OECD countries beyond Europe; ii) work with other pilot countries to generate more granular information on SME environmental indicators, notably energy consumption and carbon emissions; iii) develop, to the extent possible, new indicators covering other SME environmental dimensions, including green entrepreneurship, waste generation and participation in the circular economy.

[3] Other methods to gauge carbon emissions and energy consumption in SMEs, especially at national level, include enterprise surveys, which are more common in manufacturing (e.g., United States and Korea), and micro data built by connecting company ID numbers to smart gas and electricity meters.

2 Previous estimates on the environmental footprint of SMEs

There is limited information on the environmental footprint of SMEs, although sparse evidence - produced mainly by ad hoc studies over the past decade - suggests that, on aggregate, they represent an important share of energy consumption and carbon emissions (OECD, 2021[4]). For example, a 2010 report prepared for the European Commission found that SMEs accounted for 64% of business-driven GHG emissions at the EU level, with country values ranging between 51% (United Kingdom) and 75% (Spain and Greece) (Calogirou, 2010[7]). These estimates were produced by calculating the environmental impact per person for each country/sector and then multiplying this value by the number of employees in each firm size category for each country/sector. A more recent exercise of the European Commission reaches similar results, indicating that SMEs in the EU account for 63.3% of GHG emissions in the business sector. These estimates are built by combining environmental statistics with structural business statistics, under the assumption that environmental pollution is proportional to the number of employees at industry level (European Commission, 2022[8]).

In terms of energy consumption, the project “Leap4SMEs”, also supported by the European Commission, found that SMEs account for between 9 and 29% of gross inland energy consumption, which includes but also goes beyond energy consumption by the business sector. The project also found SME energy intensities higher in some countries (Italy, Poland, Slovakia, Greece and Croatia) than in others (Austria, Portugal, United Kingdom) (Reuter S., Lackner P. and Brandl G., 2021[9]). The estimates in this report are based on information on electricity and natural gas consumption by consumption size bands available at EU level; in particular, the authors assign energy consumption in the smallest size bands (i.e., the first two for natural gas and the first three for electricity) to SMEs. Based on another analysis by the International Energy Agency (IEA), SMEs were reported to account for at least 13% of global energy demand annually and about one-third of energy demand in industry and services (IEA, 2015[10]).

A more comprehensive overview of past estimates on the environmental footprint of SMEs is available in the OECD paper “No net-zero without SMEs” (OECD, 2021[4]).

3 Core indicators of the OECD pilot dashboard

The first phase of the pilot project to develop a dashboard of SME greening and green entrepreneurship indicators has focused on energy consumption and carbon emissions. The present chapter illustrates the methodology to generate new estimates on these dimensions. More specifically, structural business statistics, notably the SME share of value added at two-digit sector level (i.e., output weight), are used to gauge the contribution of SMEs to aggregate measures of GHG emissions and energy consumption. Furthermore, for the first two indicators (SME shares of GHG emissions and energy consumption), complementary estimates are proposed using employment weights to provide some indication of the margin of error with either approach. Further details on the methodology are provided in Annex A.

The first set of dashboard indicators are therefore:

- Share of SME GHG (carbon) emissions in the business sector
- Share of SME energy consumption in the business sector
- SME GHG emission (carbon) intensity
- SME energy intensity
- SME energy price burden

Estimates are presented for OECD European countries and for year 2018, except for the SME energy price burden for which preliminary estimates for 2022 are also shown. The time lag is due to the delay with which structural business statistics, which are used to produce the output and employment weights in the pilot dashboard methodology, are released.

The rest of this section outlines the methodology employed to produce estimates for the above indicators. For all of these, information has been collected at the two-digit sector level, with the aim to capture very different levels of carbon emissions and energy consumption across industries. In principle, information at three or even four-digit sector level would have provided more accurate estimates; however, in public databases, the finer the sector disaggregation, the greater the amount of data that is lost in terms of missing values due to data confidentiality issues, making the use of more disaggregated data not possible in the context of this paper. In addition, the publicly available datasets of GHG emissions and energy consumption lack this level of detail and, so, act as a constraining factor on the degree of disaggregation.

SME GHG emissions (share of the total in the business sector)

GHG emissions include different types of gas which are measured in terms of carbon-dioxide-equivalent (tonnes)[4].The dashboard indicator on SME GHG emissions is built using information from Eurostat's air

[4] GHG emissions include carbon dioxide, methane, nitrous oxide, and fluorinated gases. At the EU level, GHG emissions have declined over the last 12 years, especially for non-household activities (-26% between 2008 and 2020). In 2019, non-household activities accounted for 80% of total GHG emissions and household activities for the remaining 20%.

emissions database and structural business statistics (SBS) database. Because there is a match between the sector definitions in these two databases, the application of output and employment weights at two-digit sector level from SBS to the air emissions database is relatively straightforward (see the Annex for further details on the methodology).

$$SME\ GHG\ emissions\ (volume) =$$
$$(GHG\ emissions\ in\ sector\ 1) \times (SME\ share\ of\ VA\ in\ sector\ 1) +$$
$$(GHG\ emissions\ in\ sector\ 2) \times (SME\ share\ of\ VA\ in\ sector\ 2) + \cdots$$

$$SME\ GHG\ emissions\ (percentage\ of\ the\ total) = \frac{SME\ GHG\ emissions\ (volume)}{Total\ business\ sector\ GHG\ emissions\ (volume)} \times 100$$

SME energy consumption (share of the total in the business sector)

This indicator presents information on total energy consumption by SMEs (in megawatt per hour, MWh), in relation to total energy consumption in the business sector. The concept of energy used for this indicator reflects the definition in the national energy balances accounts[5]. The indicator is built using information from Eurostat's energy balances accounts and SBS. Because the two datasets follow different sector nomenclatures, applying sector weights built through SBS to energy consumption from the energy balances accounts has required merging sectors (see Annex A for further details)[6]. Once sectors from the two databases have been matched, the formula to calculate SME energy consumption is the same as that of SME GHG emissions.

$$SME\ energy\ consumption\ (volume) =$$
$$(Energy\ consumption\ in\ sector\ 1) \times (SME\ share\ of\ VA\ in\ sector\ 1) +$$
$$(Energy\ consumption\ in\ sector\ 2) \times (SME\ share\ of\ VA\ in\ sector\ 2) + \cdots$$

$$SME\ energy\ consumption\ (percentage\ of\ the\ total) = \frac{SME\ energy\ consumption\ (volume)}{Total\ business\ sector\ energy\ consumption (volume)} \times 100$$

SME GHG emissions (carbon) intensity

This indicator is generated by dividing total SME GHG emissions (volume) over SME value added or, alternatively, SME employment[7]. The first version of this indicator tells how much carbon emissions SMEs generate on average to produce one unit of output and is measured in terms of kilos of carbon-dioxide-equivalent per US dollar of value added. The second version relates carbon emissions to the number of

[5] The following energy products are considered in the energy balances accounts: solid fossil fuels; manufactured gases; peat and peat products; oil shale and oil sands; oil and petroleum products; natural gas; renewables and biofuels; non-renewable waste; nuclear heat; heat; and electricity (Eurostat, 2019[12]).

[6] For example, Eurostat's energy balances, as they measure energy supply or energy consumption at country level, do not have information on the energy sector, which is one of the one-digit sectors available in the SBS database. In addition, the transport sector in the energy balances accounts combines information from both households and non-households. On the other hand, the breakdown of manufacturing in the energy balances is relatively similar to the one in SBS (NACE sectors). Annex A explains how these issues have been addressed.

[7] In the interest of space, in the main body of the report, only information for the value-added version of SME carbon and energy intensity is presented, while employment-based intensities are presented in Annex B of the report.

people employed in SMEs[8]. To enable cross-country comparisons, the information on SME value added from national currencies is converted into US dollars at purchasing power parity (USD PPP)[9].

$$SME\ GHG\ emissions\ intensity\ (1) = \frac{SME\ GHG\ emissions}{SME\ value\ added}$$

$$SME\ GHG\ emissions\ intensity\ (2) = \frac{SME\ GHG\ emissions}{SME\ employment}$$

SME energy intensity

Similar to the indicator on SME carbon intensity, the indicator on SME energy intensity measures the amount of energy required to produce one unit of output. As such, it represents a key measure of energy efficiency at business, sector or economy level. According to the International Energy Agency (IEA), to get on track with the net zero scenario, the rate of improvement in global energy intensity needs to be two to three times higher than historical rates and to increase to just over 4% per year between 2020 and 2030 (IEA, 2022[11]) .

This indicator is calculated as the volume of SME energy consumption over SME value added or, alternatively, SME employment. The first version is measured in terms of MWh per US dollar of value added, whereas the second is expressed in MWh per SME worker. In this case, too, national currencies are converted into USD PPP.

It should be noted that this indicator offers an overview of energy efficiency at firm level, but it does not say which sources of energy are being used. For example, some countries might have high SME energy intensity, but if renewable sources of energy account for a large share of the national energy mix, the consequences for the environment would be lighter than for countries with relatively low SME energy intensity but in which the national energy mix is highly dependent on fossil fuels. Information on the national energy mix is available from OECD and Eurostat datasets and should be used to better interpret results from this indicator, bearing in mind that most SMEs have little control over which sources of energy they use.

$$SME\ energy\ intensity\ (1) = \frac{SME\ energy\ consumption}{SME\ value\ added}$$

$$SME\ energy\ intensity\ (2) = \frac{SME\ energy\ consumption}{SME\ employment}$$

SME energy price burden (electricity and natural gas)

The potential impact of the cost of energy on business activity has come to the forefront due to high energy price volatility following Russia's war of aggression against Ukraine. This indicator captures how much the

[8] SME employment includes both employees and SME owners whose main occupation is managing the company.

[9] SME carbon and energy intensities can be considered as a form of per-head consumption (i.e. in this case, per-enterprise consumption), in which case the use of purchasing power standards is recommended for spatial comparisons. Information on SME value added in national currencies is taken from the OECD Structural and Demographic Business Statistics (SDBS) database.

prices of electricity and natural gas, for which there are official annual average prices across European countries, weigh on SME turnover or SME value added. It is presented in percentage terms relative to turnover or value added.

For this indicator, a four-staged approach has been followed.

- First, the share of electricity and natural gas consumption in total energy consumption is estimated across sectors[10], adopting the same sector mergers used to calculate SME energy consumption. This is done at two-digit sector level for industry and at one-digit sector level for services[11]. In doing so, total volumes of electricity and natural gas consumption at country/sector level are obtained.
- Second, the SME share of energy consumption at two-digit sector level, which had previously been calculated, is applied in equal way to consumption volumes of electricity and natural gas to estimate SME consumption for both[12].
- Third, these two consumption volumes (SMEs' electricity and SMEs' natural gas) are multiplied by the average non-household price of electricity and natural gas, with values converted from national currencies into USD PPP to enable price comparison[13].
- Finally, the final energy cost (i.e., electricity and natural gas together) is related to total SME turnover or SME value added, which are also converted into USD PPP.

$$SME\ energy\ price\ burden\ (1) = \frac{(SME\ electricity\ consumption\ \times\ Nonhousehold\ average\ electricity\ price) + (SME\ natural\ gas\ consumption\ \times\ Nonhousehold\ average\ natural\ gas\ price)}{SME\ turnover}$$

$$SME\ energy\ price\ burden\ (2) = \frac{(SME\ electricity\ consumption\ \times\ Nonhousehold\ average\ electricity\ price) + (SME\ natural\ gas\ consumption\ \times\ Nonhousehold\ average\ natural\ gas\ price)}{SME\ value\ added}$$

[10] Based on information on final energy consumption from Eurostat's complete energy balances accounts, at the EU-level, electricity accounts for 34% and natural gas for 32% of energy consumption in industry. In services, the proportions are respectively 48% and 32%. For further information, see: https://ec.europa.eu/eurostat/web/energy/data/energy-balances.

[11] This is due to a more limited sector breakdown of services in the national energy balances accounts. For example, there is no sector disaggregation for commercial services, which are also merged with public services.

[12] It should be noted that this implies that SMEs, compared to large companies, are equal consumers of electricity and natural gas. Pilot data from manufacturing in Denmark seems to suggest that this is the case, but more real data on energy consumption would be needed to understand if there are major differences in SMEs' consumption patterns, compared to large companies, of natural gas and electricity. For example, natural gas is used as a direct source of energy in some heavy industries where large companies are overrepresented, such as chemicals, which means that the distribution of gas consumption by firm size might not be the same as for electricity.

[13] More specifically, the "price for all consumption size bands" is used, which is very close to the average of all size-band prices. In principle, using specific consumption size-band prices would provide more accurate estimates, but this would require knowing in advance how much of SME electricity/natural gas consumption falls within the different size bands (7 for electricity and 6 for natural gas), which is not possible with the dashboard methodology.

4 Estimates

As noted earlier, the dashboard estimates are produced by applying an output weight (i.e., SME share of value added) to aggregate environmental indicators (i.e., GHG emissions and energy consumption) at two-digit sector level. In addition, for the first two indicators – i.e., SME shares of GHG emissions and energy consumption – complementary estimates are produced using employment weights (i.e., SMEs' share of employment), to provide a degree of margin of error with either approach[14].

Although indicators are built through statistical information at two-digit sector level, this report only shows aggregate results for the whole business sector and manufacturing, as this is the most carbon- and energy-intensive broad sector among those where SMEs are significantly represented[15]. Future work could present information at two-digit sector level, which would be especially interesting for the carbon and energy intensity indicators and for the energy price burden indicator[16].

SME greenhouse gas emissions

Business sector

This indicator shows the SME share of GHG emissions in the business sector across OECD European countries and is affected by the size and structural composition of the domestic small business segment. Small economies with few large companies and/or economies where SMEs play a relatively large role in emission-intensive industries will tend to show higher proportions of SMEs' GHG emissions.

Figure 1 presents estimates for the SME share of GHG emissions in the whole business sector, based on output weights and employment weights, as defined above. In general, as also shown in other graphs, the use of employment weights generally results in higher estimates of the environmental footprint of SMEs, which in part reflects the average lower productivity of SMEs compared to larger companies.

However, there are a few exceptions, which are generally driven by sector specificities. The most relevant case is water transport in Norway, which accounts for almost 30% of total business-driven GHG emissions in the country and in which SMEs account for 42% of employment and 72.5% of value added, thus contributing to Norway's higher estimates of SMEs' carbon emissions in the business sector with employment weights compared to output weights.

Looking at the range of values for this indicator, based on the output weight, the SME share of GHG emissions in the business sector varies between 57% in Slovenia and 25% in Poland, with the aggregate

[14] Furthermore, large companies have higher capital intensity than SMEs, which could also imply higher levels of energy consumption and carbon emissions than those assigned through the application of an output weight.

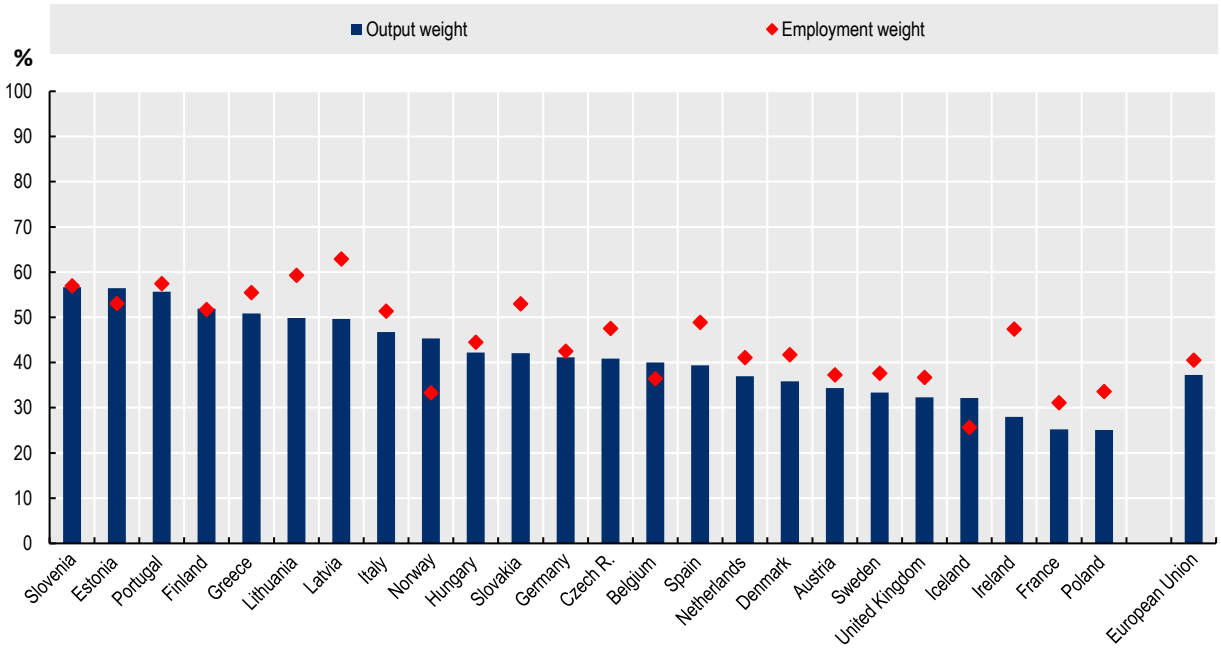
[15] The definition of business sector does not include primary activities such as agriculture, which are significant sources of GHG emissions and energy consumption.

[16] In fact, at two-digit sector level, the SME shares of GHG emissions and energy consumption are the same as the SME shares of value added, which is the output weight used in the dashboard methodology.

EU level standing at 37%[17]. Based on the employment weight, the range is between 63% (Latvia) and 26% (Iceland), with the EU aggregate level standing at 40.5%, 3.5 percentage points higher than in the first case.

Figure 1. SME share of GHG emissions in the business sector, 2018

Percentage of total GHG emissions in the business sector



Note: Output weight is the SME share of value added at two-digit sector level. Employment weight is the SME share of employment at two-digit sector level.
Source: OECD calculations based on Eurostat's Air Emissions Database and Structural Business Statistics.

Manufacturing

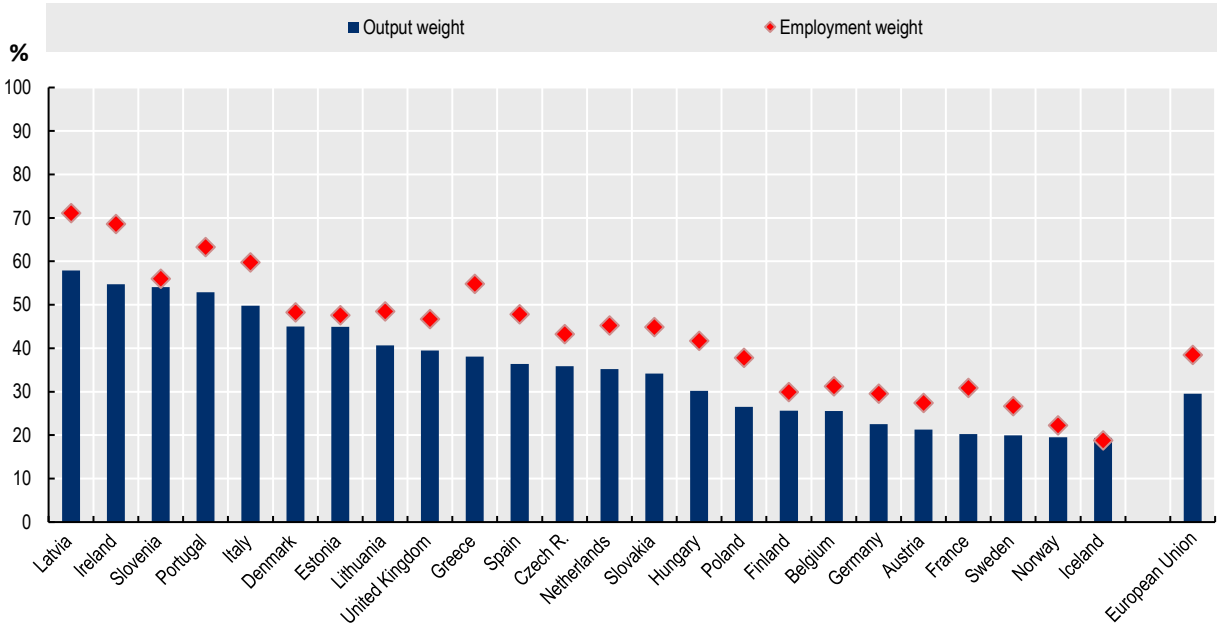
Figure 2 presents the same indicator, but only for manufacturing. In this case, figures are affected by the degree to which SMEs are represented in domestic manufacturing, especially in emission-intensive industries such as chemicals, steelmaking, and cement production, among others. Estimates based on the output weight point to an SME share of GHG emissions in manufacturing between 58% in Latvia and 19% in Iceland, with the EU aggregate figure standing at 30%. When employment weights are used, estimates are higher - between 71% (Latvia) and 19% (Iceland) - with the EU aggregate value standing at 38.5%, 9 percentage points higher than in the first case.

Although there are some exceptions (e.g., Norway), countries which rank towards the bottom in the manufacturing indicator also do so in the business sector indicator (and vice versa), pointing to the weight of manufacturing in the overall carbon emissions of the SME segment.

[17] Because data presented in the report refer to 2018, before the withdrawal process of the United Kingdom (UK) from the European Union (EU) was finalised, EU aggregate values include the UK.

Figure 2. SME share of GHG emissions in manufacturing, 2018

Percentage of total GHG emissions in manufacturing



Note: Output weight is the SME share of value added at two-digit sector level. Employment weight is the SME share of employment at two-digit sector level.
Source: OECD calculations based on Eurostat's Air Emissions Database and Structural Business Statistics.

SME energy consumption

Business sector

This indicator illustrates the SME share of energy consumption in the business sector[18]. As for the GHG emissions indicator, it is affected by the size and industry composition of the SME business segment at country level. Countries where SMEs play a larger role in terms of national production, including in energy-intensive sectors, will tend to show higher SME shares of energy consumption[19].

With respect to the overall business sector, when the output weight is applied, the SME share of energy consumption varies between 78% (Estonia) and 28% (Sweden), with the EU level standing at 43%. When employment weights are used, the range of observed values becomes slightly wider, i.e., between 81%

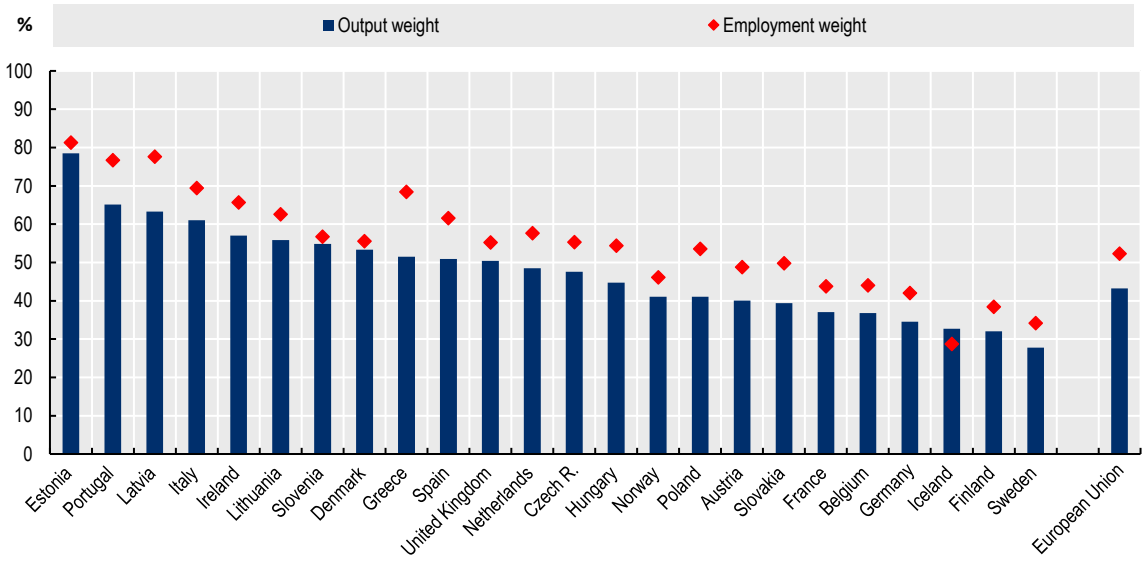
[18] Compared to the GHG emissions indicator, the construction of this indicator involved more steps due to the different sector definitions between the Eurostat's structural business statistics database, which is used to calculate the output and productivity weights, and the Eurostat's energy balances accounts, to which the two weights are applied to estimate the SME shares of energy consumption. This is especially true for the indicator covering the business sector as a whole, while the definitions of manufacturing in the two datasets are closer.

[19] It should be noted that this indicator does not consider energy consumption in the transport sector, since transport-related energy consumption from the energy balances accounts cannot be assigned to any specific structural business sector (NACE sector), making it impossible to apply our weights. Similarly, compared to the GHG emissions indicator, for obvious reasons, information on energy consumption does not include the NACE sector "electricity, gas, steam and air conditioning supply" (D). Annex A provides further details on these issues and the overall methodology.

(still Estonia) and 29% (Iceland), with the EU value standing at 52%, 9 percentage points higher than with the output weight.

Figure 3. SME share of energy consumption in the business sector, 2018

Percentage of total energy consumption in the business sector



Note: Output weight is the SME share of value added at two-digit sector level. Employment weight is the SME share of employment at two-digit sector level. Energy indicators do not include the Transport sector.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and Structural Business Statistics.

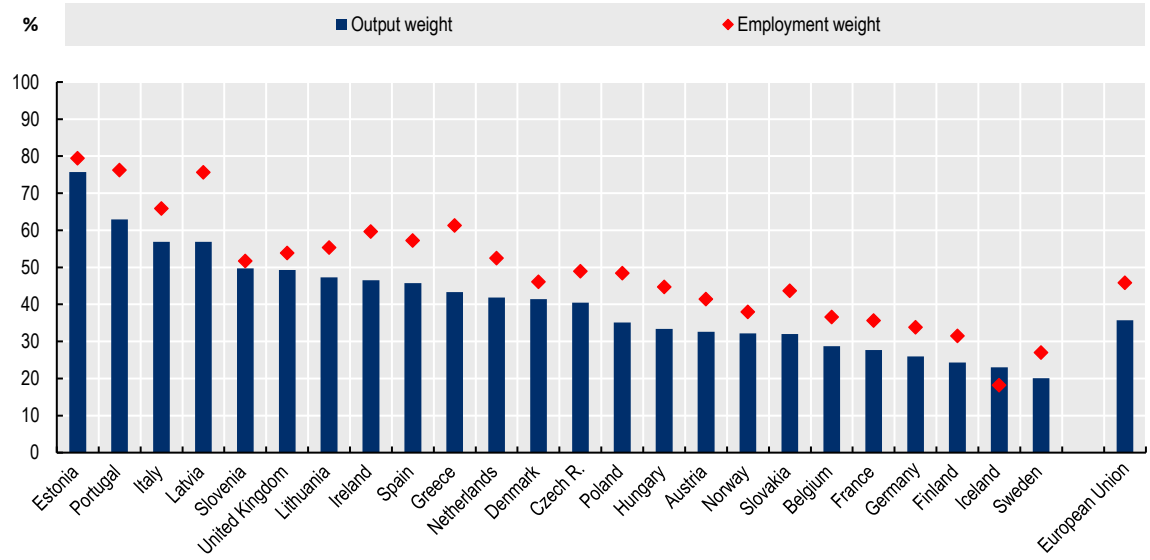
Manufacturing

The SME share of manufacturing-based energy consumption is affected by the degree to which domestic SMEs are represented in manufacturing, especially in the most energy-intensive subsectors. Overall, the SME shares of energy consumption are lower in manufacturing than in the business sector, which reflects the lower presence of SMEs in manufacturing compared to other sectors of the economy, notably services, as well as the higher capital intensity of this sector, which shifts the distribution of energy and (emissions) towards larger companies. Figure 4 shows that the SME share of energy consumption in manufacturing ranges from 76% in Estonia to 20% in Sweden (output weight), which are also respectively at the top and bottom of the ranking for SME energy consumption in the whole business sector, thus pointing to the weight of manufacturing in the overall energy consumption of SMEs. If employment weights are used, Estonia is still at the top (79%), closely followed by Portugal and Latvia, while Sweden is replaced by Iceland at the bottom (18%).

The EU aggregate values are respectively 36% (output weight) and 46% (employment weight), respectively 7 and 6 percentage points lower than for the business sector as a whole.

Figure 4. SME share of energy consumption in manufacturing, 2018

Percentage of total energy consumption in manufacturing



Note: Output weight is the SME share of value added at two-digit sector level. Employment weight is the SME share of employment at two-digit sector level. Energy indicators do not include the Transport sector.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and Structural Business Statistics.

SME GHG emissions (carbon) intensity

Business sector

As noted earlier, SME carbon intensity is defined as the ratio between SME GHG emissions over SME value added or, alternatively, SME employment. The following figures illustrate the value-added version of SME carbon intensity, while estimates for the employment-based version are presented in Annex B. To calculate this indicator, information on SME GHG emissions (i.e., the numerator) is based only on the output (value-added) weight.

SME carbon intensity, which provides a good proxy for levels of pollution by domestic SMEs, is affected by a number of factors such as the industry composition of the SME business segment (i.e. some sectors, especially in manufacturing, are more carbon- and energy-intensive than others), average efficiency in the production process (i.e. outdated methods and equipment will result in higher emissions), as well as energy sources in the national energy mix (i.e. at parity of energy consumption, a higher share of renewables will imply lower carbon intensity).

Figure 5 shows SME carbon intensity, which is measured in terms of kilos of carbon-dioxide-equivalent per US dollar of value added, across European countries. The first two countries in the ranking, Greece and Estonia, are outliers, with values (0.85 and 0.53 respectively) much higher than those of the other countries in the sample, whose values range between 0.32 (Slovakia) and 0.09 (Sweden). The EU average is 0.2.

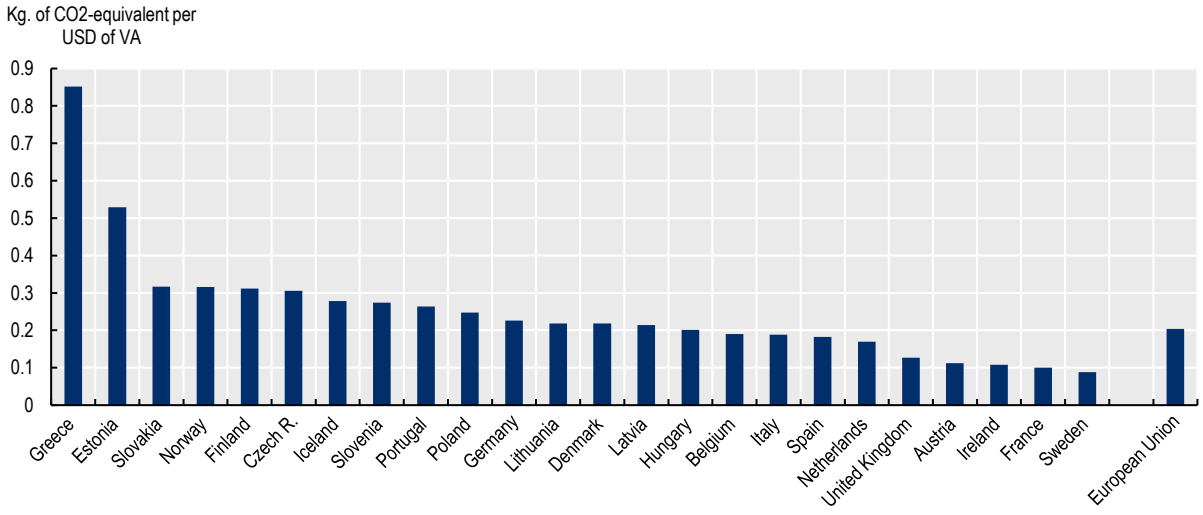
Among the top 10 countries there is mix of Eastern (Estonia, Slovakia, Czech Republic, Slovenia and Poland), Southern (Greece and Portugal) and Northern (Norway, Finland and Iceland) European countries.

While the purpose of the present exercise is not to explain the causes behind the different rankings of individual countries, relatively high SME carbon intensities across some Nordic countries may result

counter-intuitive, in light of other evidence on their environmental performance. In this respect, Statistics Iceland had already noted, in 2016, that Iceland had the highest levels of per capita pollution in Europe, mainly due to growing air traffic and heavy industry, besides shipping to and from Iceland. In that specific year, per capita carbon-dioxide emissions were 16.9 tonnes in Iceland, compared to an EU average of 7.3 tonnes per capita[20]. In addition, Iceland and Norway have significant metal manufacturing industries, including aluminium production, which are high energy- and gas-intensive, although both countries heavily rely on renewable sources of energy in their energy mix, notably hydropower and geothermal power (in the case of Iceland).

Figure 5. SME carbon intensity in the business sector, 2018

SME GHG emissions over SME value added



Note: GHG emissions computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SMEs' total GHG emissions are then divided by SMEs' total value added.
Source: OECD calculations based on Eurostat's Air Emissions Database and OECD Structural and Demographic Business Statistics (SDBS) database.

Manufacturing

In most cases SME carbon intensity in manufacturing is higher than in the business sector as a whole; at the EU aggregate level, for example, values are respectively 0.23 for manufacturing and 0.2 for the business sector (i.e., kilos of carbon-dioxide per US dollar of value added). However, there are also 9 countries where this is not the case, which is due to the fact that SME carbon intensity in the whole business sector also includes GHG emission in carbon-intensive sectors such as transport and energy supply, which can shift the balance of SME carbon intensity towards the whole business sector.

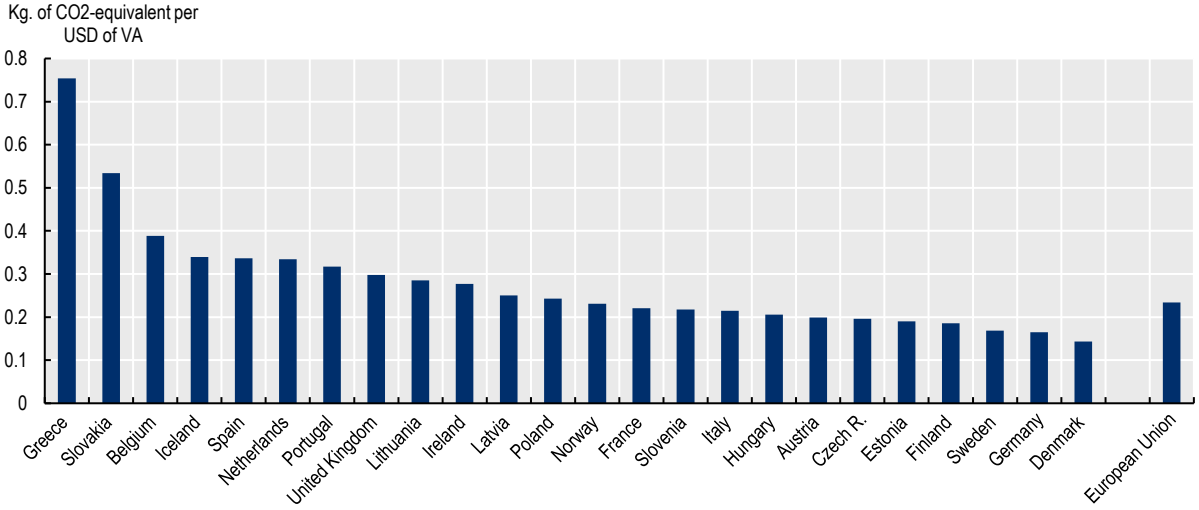
SME carbon intensity in manufacturing is affected in the same way as in the business sector as a whole, although in this case the role of industry composition is confined to manufacturing. Therefore, countries where SMEs are mostly found in non-carbon-intensive manufacturing (e.g., food and beverages, machine tools and equipment, furniture, etc.) will tend to have lower manufacturing-based SME carbon intensity

[20] See: http://www.nordiclabourjournal.org/i-fokus/in-focus-2018/theme-nordic-statistics/article.2018-12-12.9960979372#:~:text=Iceland%20has%20three%20aluminium%20plants,emissions%20than%20similar%20industry%20elsewhere.

than others. In the case of manufacturing, country values range between 0.75 kg. of carbon-dioxide per US dollar of value added in Greece and 0.14 kg. in Denmark (Figure 6).

Figure 6. SME carbon intensity in manufacturing, 2018

SME GHG emissions over SME value added



Note: GHG emissions computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SMEs' total GHG emissions are then divided by SMEs' total value added.
Source: OECD calculations based on Eurostat's Air Emissions Database and OECD Structural and Demographic Business Statistics (SDBS) database.

SME energy intensity

Business sector

Like SME carbon intensity, SME energy intensity is measured as the relation between SME energy consumption, previously calculated, and SME value added or employment. In this section, only estimates for the value-added version of SME energy intensity are presented (employment-based estimates are presented in Annex B). In addition, SME energy consumption is calculated based on the output weight only. If the employment weight were to be used, SME energy intensities would be higher across all countries. SME energy intensity is measured in terms of Megawatt-hour (MWh) per US dollar of value added.

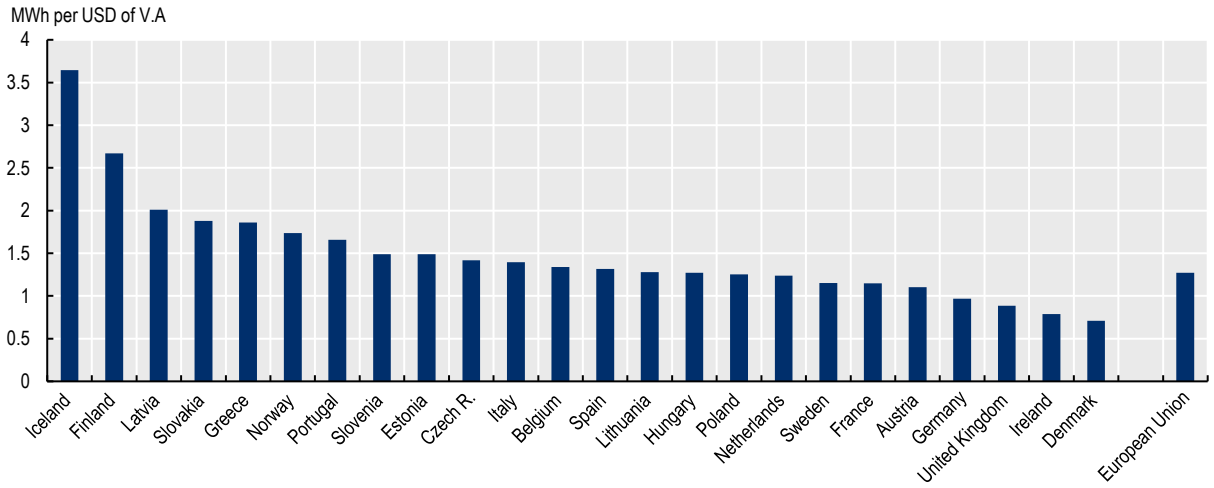
SME energy intensity is affected by similar factors as SME carbon intensity, although there are also some differences. Industry composition and energy efficiency play a similar role for the two indicators, as some industries are more energy-intensive than others and outdated modes of production typically result in high levels of energy consumption. However, the impact of the energy mix is different. Because the marginal cost of producing energy through renewables (e.g., hydropower, solar power and wind power) is lower than the same cost for finite sources of energy (e.g., coal, gas and oil), countries whose energy mix is more reliant on renewables could show higher energy intensity, as they might be less concerned about the

cost of energy[21]. This might explain why countries such as Iceland, Finland and Norway, whose national energy mix has high shares of renewables, feature high in the SME energy intensity indicator[22].

Figure 7 shows that SME energy intensity in the whole business sector ranges between 3.65 MWh per US dollar of value added in Iceland and 0.71 MWh in Denmark, with the EU aggregate level being 1.27 MWh. Apart from Iceland and Finland, all other countries are found within a range of 1.3 MWh per US dollar of value added. This might suggest small variations in terms of SME energy intensity across Europe. However, SME energy intensity in Latvia (third highest) is still three times as high as in Denmark (lowest).

Figure 7. SME energy intensity in the business sector, 2018

SME energy consumption over SME value added



Note: SME energy consumption computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SME energy consumption is then divided by SME value added.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

Manufacturing

Contrary to SME carbon intensity, SME energy intensity in manufacturing is always higher than SME energy intensity in the business sector[23]. In particular, the difference in SME energy intensity between manufacturing and the whole business sector ranges from almost twice as high in Italy to more than three times as high in the United Kingdom.

[21] For example, Iceland has the highest level of per-capita electricity use in the world, 80% higher than the second-ranked, which is Norway. More generally, all Nordic countries, with the exception of Denmark, feature in the world's top-10 countries in terms of per-capita electricity use (see: https://ourworldindata.org/grapher/per-capita-electricity-generation?tab=table).

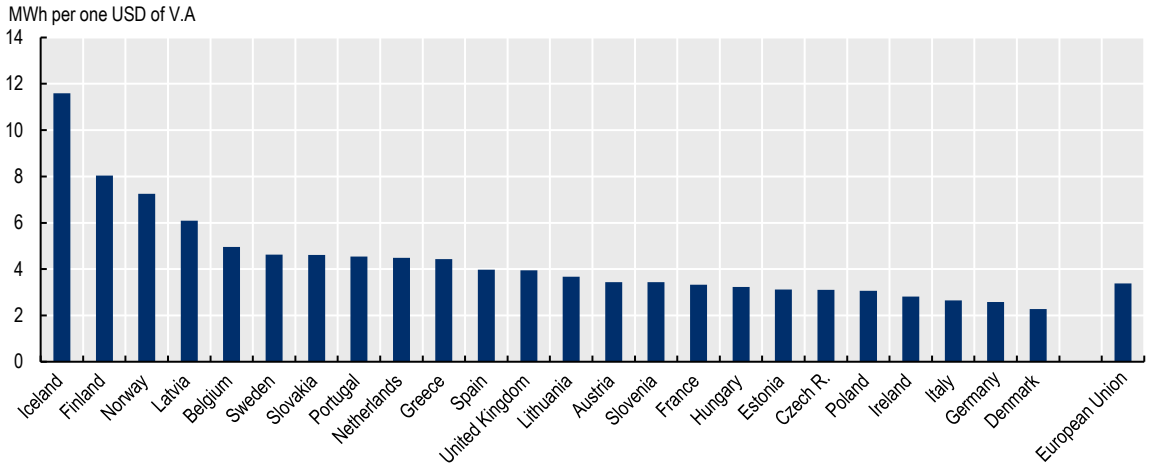
[22] Information on the national energy mix across European countries is available through the Eurostat's energy balances accounts; https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Gross_available_energy. Further information on Nordic countries is available through the Nordic energy research consortium; https://www.nordicenergy.org/indicators/.

[23] This is also partly due to the fact that energy consumption in the business sector does not include either transport-related energy consumption or the energy supply sector (NACE sector D), contrary to SME carbon intensity.

Figure 8 shows that the highest manufacturing-based SME energy intensity is found in Iceland (11.6 MWh/US dollar of value added) while the lowest figure is found in Denmark (2.3 MWh/one US dollar of value added). Both countries are also at the top and bottom of the ranking in SME energy intensity for the whole business sector (Figure 7). Manufacturing-based SME energy intensity at the aggregate EU level is 3.4 MWh/US dollar of value added, compared with 1.3 MWh/US dollar of value added in the business sector as a whole (2.5 times higher).

Figure 8. SME energy intensity in manufacturing, 2018

SME energy consumption over SME value added



Note: SME energy consumption computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SME energy consumption is then divided by SME value added.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

SME energy price burden

Business sector

The SME energy price burden measures the impact of the cost of energy on business activity. More specifically, this indicator reflects the weight of the cost of electricity and natural gas, for which there are average annual prices in Eurostat, on SME activity, which can be measured either in terms of SME turnover or SME value added[24]. It is measured in percentage terms relative to turnover or value added. Like for the other sections, in this central part of the report only one version of the SME energy price burden is presented (based on SME turnover). Information on the value-added version is presented in the Annex of the report.

Energy prices in Eurostat include four main components: energy generation and supply, network costs, value-added tax (VAT) and other taxes. To simplify the analysis, the first two items are merged into the category of "supply and network costs" and the other two items into the category of "tax-related costs". As the recent OECD paper on "SME policy responses to the energy crisis" shows, the reduction or temporary

[24] Further details on how the SME energy price burden indicator is calculated are provided in the previous section introducing the dashboard indicators and in Annex A (dashboard methodology).

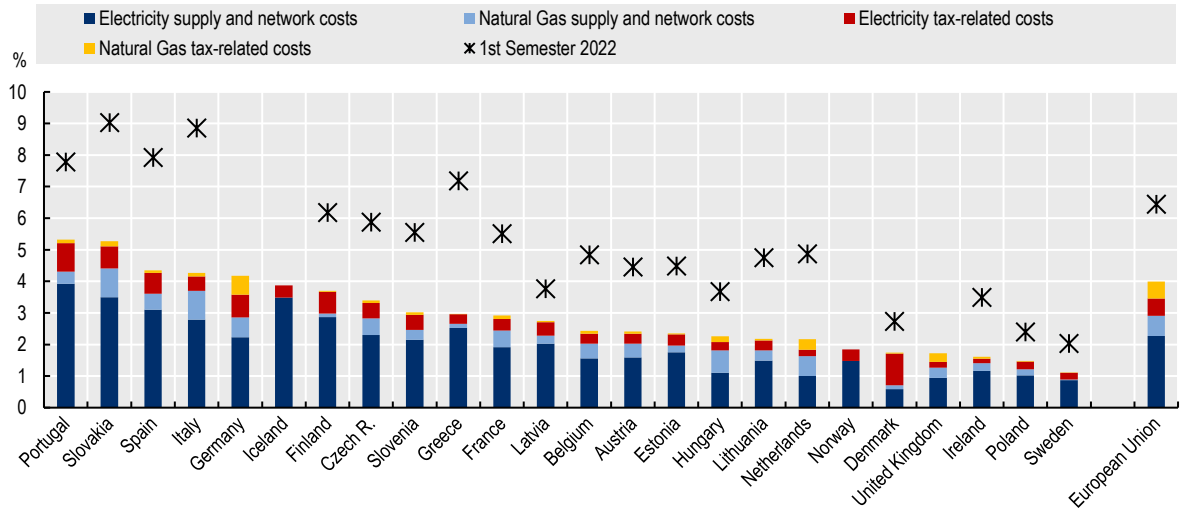
suppression of tax levies and tax duties from energy bills has been one of the policy responses that OECD countries have adopted to help SMEs cope with the 2022 energy crisis (Marchese, 2023[3]).

To assess the impact of the energy crisis on SME activity, an estimate for the first semester of 2022 is produced, which is based on 2018 levels of SME electricity and gas consumption and 2022 (first semester, S1) energy price levels. More specifically, the prices of electricity and natural gas in the first semester of 2022 are multiplied by the 2018 levels of electricity and natural gas consumption and divided by the 2018 levels of SME turnover, which are the latest available data for these variables[25]. However, given that SME turnover and energy consumption may also have changed in the face of strong energy price volatility, the 2022 estimate of the SME energy price burden should be considered as a preliminary estimate.

Against this backdrop, Figure 9 shows that the SME energy price burden in 2018 was the highest in Portugal and Slovakia (5.3% of turnover in 2018) and the lowest in Sweden (1.1%), with the aggregate EU level being 4%. On average, "electricity supply and network costs" account for almost 70% of the price burden. In principle, countries that rely heavily on renewables should perform well in this indicator, as the cost of generating energy through renewable sources is lower than through finite sources. This is the case for Sweden, Norway, and Denmark, although Iceland and Finland are partial exceptions among Nordic countries. It is also worth mentioning that this indicator could be affected by state subsidies such as those on fossil fuels, as these will lower the final energy price which consumers face.

Figure 9. SME energy price burden in the business sector, 2018 and 2022 (1st semester)

Impact of electricity and natural gas costs on SME turnover



Note: This indicator covers the cost of electricity and natural gas consumption, but not of other sources of energy such as the direct use of oil in the production process. For this indicator, we follow a four-staged approach. Firstly, we estimate the share of electricity and natural gas consumption in total energy consumption across sectors. Secondly, we apply the SME share of energy consumption at two-digit sector level, which we had previously calculated, in equal way to consumption volumes of electricity and natural gas to gauge SME consumption. Thirdly, we multiply these two volumes by the average non-household price of electricity and natural gas. Finally, we put the final energy cost (electricity and natural gas) in relation to SME turnover. There is no data for natural gas in Iceland and Norway.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

[25] Structural indicators such as energy consumption or national value added are always released with a time lag of 3-4 years.

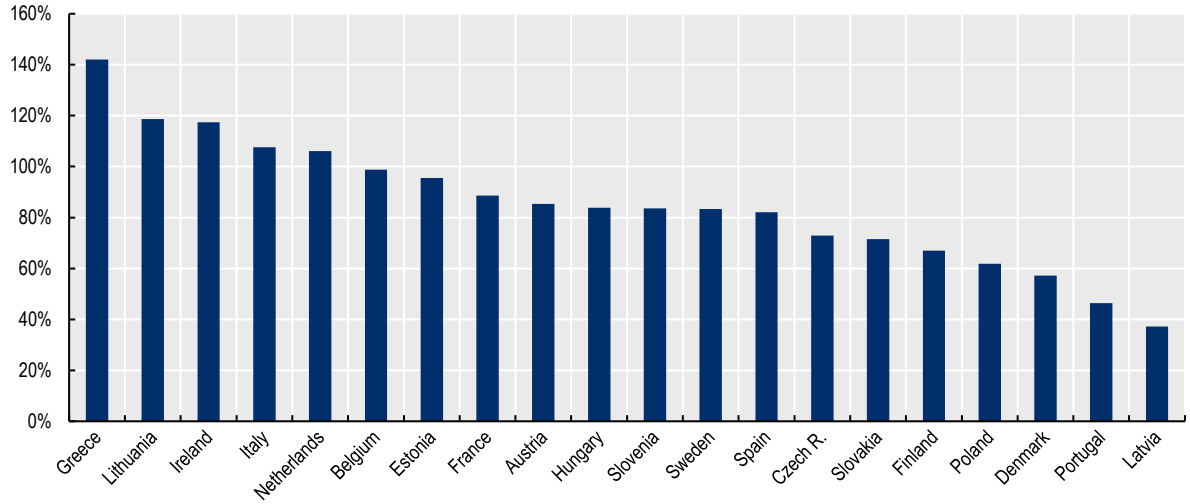
Figure 9 shows that the SME energy price burden increased significantly in the first half of 2022 across all countries[26]. In Portugal, for example, the energy price burden rose from 5.3% to 7.8%, while in Sweden from 1.1% to 2%. In 2022, the countries with the highest SME energy price burden were Slovakia (9%) followed closely by Italy (8.9%). The increase at the EU aggregate level was also remarkable, from 4% to 6.4%.

Figure 10 presents information on the increase of the price burden in percentage terms, showing that the biggest proportional surge was in Greece (+142%) while the smallest in Slovakia (+37%), which had already a high price burden in 2018. In 5 countries, the price burden more than doubled (Greece, Lithuania, Ireland, Italy, and the Netherlands).

The estimates presented in Figure 10 are affected by the policies introduced by governments to mitigate the effects of the energy crisis on businesses (Marchese, 2023[3]). Countries where the average policy response has been stronger, for example in terms of price caps and reduced energy taxation, should have experienced lower increases in the SME energy price burden. Similarly, countries which were less reliant on Russian gas at the onset of the war and/or which have a higher share of renewables in their energy mix should have been less exposed to volatile energy prices in 2022. In these countries, the SME energy price burden should have increased less, although these are also the countries which are less likely to have introduced major measures to help businesses deal with the increased cost of energy.

Figure 10. Variation in the SME energy price burden in the business sector, 2018 and 2022 (1st semester)

Percentage variation



Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

[26] As of end-October 2022, price information for the first semester of 2022 was not yet available for the following countries: Denmark, Germany, Iceland, and the United Kingdom.

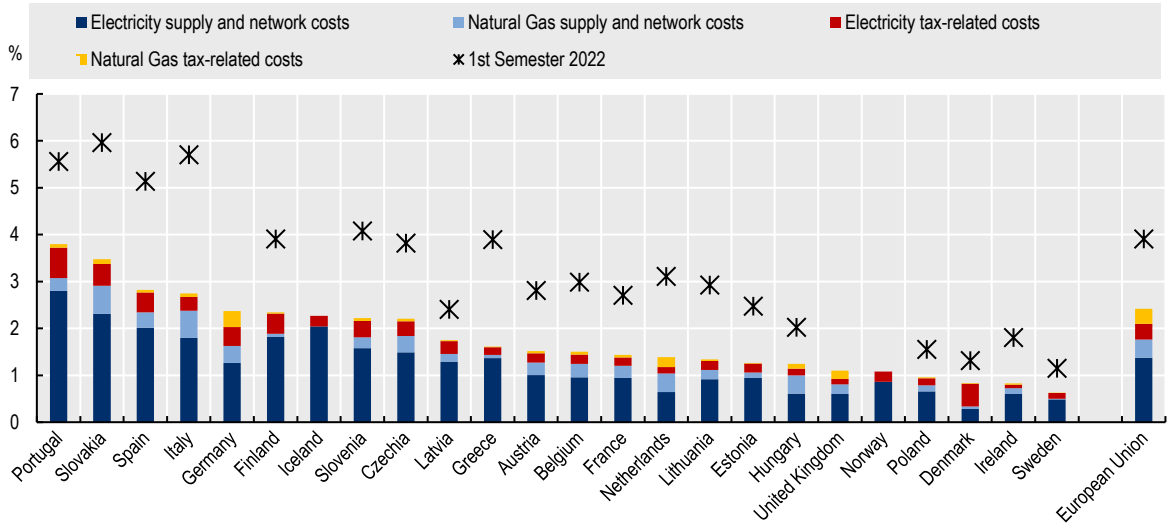
Manufacturing

In manufacturing, the SME energy price burden is always lower than in the business sector as a whole, with the difference varying between 0.5% (Sweden) and 1.8% (Germany). The reason is that higher SME turnover more than compensate higher levels of SME energy consumption in manufacturing [27].

In 2018, the SME energy price burden in manufacturing ranged between 3.8% in Portugal and 0.6% in Sweden. In 2022, it was the highest in Slovakia (6%) and the lowest in Sweden (1.1%). The country order for manufacturing and the business sector looks quite similar, with some small variations in the middle and bottom of the ranking. With respect to the percentage variation in the price burden between 2018 and 2022, this would be the same in manufacturing as in the whole business sector, since the only variables changing in the calculation are the average non-household prices for electricity and natural gas, which cannot be differentiated by sector[28].

Figure 11. SME energy price burden in manufacturing, 2018 and 2022 (1st semester)

Impact of electricity and natural gas costs on SME turnover



Note: This indicator covers the cost of electricity and natural gas consumption, but not of other sources of energy such as, for example, the direct use of oil in the production process. For this indicator, we follow a four-staged approach. Firstly, we estimate the share of electricity and natural gas consumption in total energy consumption across sectors. Secondly, we apply the SME share of energy consumption at two-digit sector level, which we had previously calculated, in equal way to consumption volumes of electricity and natural gas to gauge SME consumption. Thirdly, we multiply these two volumes by the average non-household price of electricity and natural gas. Finally, we put the final energy cost (electricity and natural gas) in relation to SME turnover. There is no data for natural gas in Iceland and Norway.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

[27] In addition, as noted before, transport-related energy consumption is not included in the energy indicators of the dashboard as it cannot be assigned to any specific sector.

[28] Real energy prices change depending on the annual amount of energy consumption, which are higher in manufacturing than in most other sectors of the economy. In the dashboard methodology, however, it is not possible to assign different energy prices across different levels of energy consumption.

5 Real SME energy consumption: A pilot analysis of Denmark

In the framework of the dashboard project, pilot work has been conducted with Statistics Denmark and the Danish Business Authority to receive more granular estimates of SME energy consumption (electricity and natural gas). In addition to the intrinsic value of collecting information on real energy consumption by SMEs, this pilot analysis can help assess the validity of the dashboard estimates.

Information in this section comes from Statistics Denmark and has been produced by linking business electricity meters to company ID numbers and through enterprise surveys covering manufacturing and partly mining in the case of gas consumption (only enterprises with 20 or more employees in the case of gas). As such, it provides quite accurate estimates of electricity and gas consumption in SMEs, where these are defined according to the standard EU definition of companies with fewer than 250 people employed. In addition, through the information provided by Statistics Denmark, the distribution of SME electricity and gas consumption can be assessed across the different consumption size bands existing at the EU level[29].

Based on data from Statistics Denmark, Danish SMEs account for 55% of total electricity consumption in the business sector and for 42% in manufacturing (Figure 12). Both figures are close to Denmark's dashboard estimates of SME shares of energy consumption based on the only use of the output weight, which were respectively 53% for the business sector and 41% for manufacturing (see Figure 3 and Figure 4)[30]. When it comes to electricity consumption by size band (Table 1), 35% of SME electricity consumption is found in Band ID (between 2 000 and 20 000 MWh/year) and 19% in band IE and above (more than 20 000 MWh/year)[31], although altogether there are less than 650 SMEs in these size brackets, corresponding to about 0.6% of the total number of SMEs in Denmark[32]. It follows that more than 50% of SME electricity consumption stems from less than 1% of energy-intensive SMEs.

[29] According to EU regulation 2016/1956, national energy agencies are required to provide Eurostat with data on electricity and natural gas consumption by different consumption size bands for both households and non-households. This information is mostly used to apply different energy prices across different levels of annual energy consumption. In the case of electricity, there are 7 consumption size bands or brackets, while in the case of natural gas there are 6. For further information see: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R1952&from=EN.

[30] However, estimates of SME energy consumption covers more than electricity consumption.

[31] Due to confidentiality issues, Statistics Denmark could not provide the split in SME electricity consumption for the three largest consumption size brackets: IE, IF and IG.

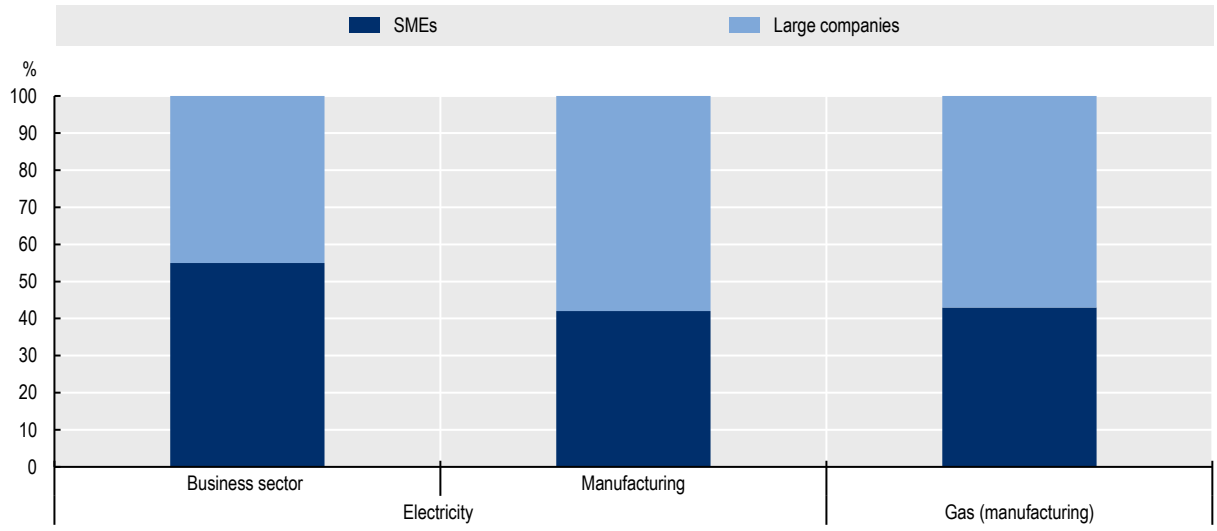
[32] Number of companies based on information from the firm-level energy database provided by Denmark. It is worth mentioning that there is a discrepancy between the number of SMEs in the Danish energy database and the number of Danish SMEs in Eurostat's structural business statistics database. After consultation with Statistics Denmark, this might be due to many SMEs, especially micro-enterprises, renting their office space in shared office buildings for which there is only one energy bill whose cost is subsequently divided among tenants based on terms and conditions set out in their location contract.

Information on natural gas is only available for manufacturing (Table 1). In this case, Danish SMEs account for 43% of gas consumption, very close to the Danish SMEs' share of electricity consumption in manufacturing (42%) and to the dashboard estimate of SME energy consumption in Denmark's manufacturing (41%). As much as 60% of SMEs' gas consumption is found the fourth size band (between 100 000 and 1 000 000 GJ/h), although only 3% of SMEs belong to this consumption size bracket. Like for electricity, therefore, Danish SMEs' gas consumption is strongly concentrated in a few gas-intensive companies. The remaining 40% of SMEs' gas consumption is mostly found in the second and third consumption size brackets (between 1 000 and 100 000 GJ/h). Finally, large companies are the only ones with gas consumption volumes above annual 1 000 000 GJ/h (i.e., 37% of total large-company gas consumption).

Overall, pilot work with Danish authorities shows the degree to which SME electricity and natural gas consumption is concentrated in a few energy-intensive companies. Furthermore, information on real electricity and natural gas consumption provides a benchmark to assess the quality of the dashboard estimates of energy consumption. Going forward, more national data on real SME energy consumption would be useful to build a more comprehensive database on SME energy use and could help refine the dashboard estimates for those countries for which information on real SME energy consumption does not exist.

Figure 12. SME electricity and gas consumption in Denmark, 2021 and 2020

Percentage of the total, based on real consumption data



Note: Data for electricity refers to 2021, data for natural gas to 2020. Gas includes both natural gas and bio gas.
Source: Statistics Denmark

Table 1. SME electricity and gas consumption by consumption size bands in Denmark, 2021 and 2020

Percentage values, annual consumption

Electricity (business sector)	**Band IA**	**Band IB**	**Band IC**	**Band ID**	**Band IE**	**Band IF**	**Band IG**
MWh	< 20	= 20 & < 500	= 500 & <2,000	= 2,000 & <20,000	= 20,000 & <70,000	= 70,000 & <150,000	= 150,000
SME electricity consumption by size band	5	25	16	35	19		
SME electricity users by size band	69	29	1	1	0		
Natural gas (manufacturing)	**Band I1**	**Band I2**	**Band I3**	**Band I4**	**Band I5**	**Band I6**	
GJ/h	< 1,000	= 1,000 & <10,000	='10,000' & < 100,000	= 100,000 &< 1,000,000	= 1,000,000 & < 4,000,000	= 4,000,000	
SME gas consumption by size band	1	13	26	60	0		
SME gas users by size band	35	51	11	3	0		

Note: Information on Band IE to IG for electricity is merged due to confidentiality issues. Data for electricity refers to 2021, data for natural gas to 2020. Gas includes both natural gas and biogas.
Source: OECD calculations based on data from Statistics Denmark.

Conclusions

This paper has presented the findings from the OECD project ""Towards a pilot dashboard of SME greening and green entrepreneurship indicators", which has been developed under the aegis of the OECD Committee on SMEs and Entrepreneurship (CSMEE). The paper proposes a methodology to assess the contribution of SMEs to GHG emissions and energy consumption and presents estimates for a related core set of indicators in OECD European countries. The main rationale behind the project lies in the need to measure and monitor the environmental performance of SMEs since, on aggregate, they account for a nontrivial share of business-driven emissions and can accordingly play an important role in the achievement of global climate objectives.

Against this backdrop, the dashboard project intends to measure the impact of SMEs on the environment and the size of green entrepreneurship at national level. To do this, the first version uses a methodology which hinges on the use of output weights at two-digit sector level to generate estimates on the following first set of indicators: SME share of GHG emissions; SME share of energy consumption; SME carbon intensity (GHG emissions intensity); SME energy intensity; and SME energy price burden. While there are some previous estimates for some of these indicators, to our knowledge, the pilot dashboard is the first project to use output weights (i.e., SME share of value-added) at two-digit sector level to generate estimates not only of carbon emissions, but also of energy consumption, which has required matching sectors from structural business statistics and energy balances accounts that follow different sector nomenclatures. Furthermore, previous estimates have typically been built at one-digit sector level, which are likely to be less accurate given very different levels of carbon emissions and energy consumption at the disaggregated industry level.

The estimates presented in this report focus on OECD European countries and show that the SME shares of GHG emissions and energy consumption at EU aggregate level are respectively 37% and 43% (value-added-based estimates). SME carbon intensity (greenhouse gas emissions over value added) mostly ranges between 0.32 and 0.09 of carbon-dioxide-equivalent per US dollar of value added, while SME energy intensity (energy consumption over value added) ranges between 3.65 and 0.71 MWh per US dollar of value added. The paper also shows that the impact of the cost of energy on business turnover (i.e., the energy price burden) more than doubled in 5 European countries between 2018 and 2022 due to the energy crisis triggered by Russia's war of aggression against Ukraine.

Building on these estimates, the dashboard project intends to strengthen its methodology by working with pilot countries to generate more granular information on the environmental footprint of SMEs, and to broaden its scope by covering more countries and years as well as by assessing the feasibility of new indicators touching on other dimensions, notably green entrepreneurship.

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Annex A. The dashboard methodology

The methodology at a glance

In the dashboard methodology structural business statistics are used to assign GHG emissions and energy consumption to SMEs and thereby generate indicators of carbon emissions, energy consumption, energy efficiency, and cost of energy for SMEs. Because carbon emissions and energy consumption vary significantly across industries, estimates are built at two-digit sector level, which is the finest level of sector disaggregation possible in structural business statistics databases without losing too much information due to missing values (mostly because of data confidentiality issues). Furthermore, publicly available datasets of GHG emissions and energy consumption do not go beyond two-digit sector level information, thus also acting as a constraining factor on the degree of disaggregation.

Overall, the dashboard estimates are built on 42 two-digit sectors for GHG emissions and 37 two-digit sectors for energy consumption. The lower number of sectors for energy consumption is the result of sector mergers due to different sector definitions between the structural business statistics database and the energy balances accounts.

The pilot dashboard only covers sectors between ISIC codes 05 (mining and quarrying) and 82 (Administrative and support service activities)[33], except for finance and insurance activities (ISIC codes, 64-66), and excluding agriculture and public administration, referred to as business sector in this paper for convenience. In the case of energy consumption, there is no information for “Energy” and information on “Transport” is excluded because it cannot be assigned to any ISIC sector. In fact, “Transport” in the energy balances accounts include transport both by households and non-households.

For the first two indicators – SME shares of GHG emissions and energy consumption – two different estimates are presented, thus resulting in a range of values: the baseline one based on the application of output weights (SME share of value added) and the alternative one based on employment weights (SME share of employment).

In the first approach, the SME share of value-added at two-digit sector level is used to measure the amount of GHG emissions and energy consumption in that given sector. Thereafter, the two-digit-sector values are summed up to obtain total GHG emissions and energy consumption by SMEs and the respective SME proportions in the whole business sector. The use of value-added weights assumes a positive relationship between value-added on the one hand, and GHG emissions and energy consumption, on the other. Whilst this relationship broadly holds for very detailed industry aggregations, it does of course vary significantly across industries. Moreover, the relationship (at least when value-added is measured in current prices) may also vary considerably over time, for example in response to significant changes in energy prices. When intermediate costs of energy rise for example, value-added relative to a given unit of emissions or energy use (in volume terms) will fall, depending on the extent to which firms can absorb or pass on the price shock. Moreover, the relationship assumes that all firms use the same technologies in production and have similar economies of scale or purchasing power (i.e., they are able to purchase a single unit of goods or services at the same price). In these respects, size matters, and there are likely to be differences between value-added and emissions or energy-use between small and large firms.

To try to provide some sense of potential margin of error around estimates based on value-added weights, employment weights are used to generate complementary estimates.

Finally, two additional methodological caveats are needed. First, while the use of sector weights does not show technological progress (e.g., with respect to energy efficiency) by SMEs over time, this is captured by variations in aggregate energy consumption or GHG emissions, to which sector weights are applied. Second, the three SME energy indicators (i.e., consumption, intensity, and price burden) do not consider which source of energy is being used. As such, as already pointed out in the main section of the report, the extent to which high energy intensity is bad for the environment will also depend on the national energy mix.

Additional methodological steps

This section presents additional details on the project methodology, notably how the project has dealt with missing values of SME value added at two-digit sector level and how NACE sectors from the structural business statistics database have been matched to a different sector nomenclature in Eurostat's energy balances accounts.

Filling missing values in structural business statistics

In some cases, country-level information on value added by firm size at two-digit sector level was not readily available. The following steps, in this sequence, have been taken to fill the information gaps.

- If only one firm-size value were missing, this has been calculated as the difference between the total and the remaining firm-size values.
- If only one value were available for the two subgroups of 10-19 and 20-49 people employed, this value has been assigned to the whole small firm-size class (10-49 people employed).
- In case of two or more missing firm-size values in 2018, but with total value-added information available, the SME share of value added in that given country/sector from the closest possible year has been used. The rationale is that SME shares of value added do not change dramatically over a short period of time.
- In case of lack of information on total value-added at two-digit sector level in 2018, the closest possible year with full information (total and by firm size), up to 2012, has been used.
- Finally, in case of full lack of information (total and by firm size) for a given country/sector as far back as 2012, the average value from the other European countries for which there was information has been applied. This method, which is the weakest, has been utilised in 56 cases out of the total 1 620 national two-digit sectors (i.e., 3% of the total), mostly for C12 (manufacture of tobacco products) and C19 (manufacture of coke and refined petroleum products). The three countries where this method has been employed the most are Latvia (7), Slovenia (5) and Hungary (4).

Finally, there are two exceptions. First, Luxembourg is not included in the analysis because of too many missing values. Second, for the same reason, one-digit sector weights are used for Transport (H) and Information and communication (J) for Ireland and Switzerland.

Matching sectors from energy balances with sectors in structural business statistics

While there is full correspondence between the sector definitions in Eurostat's air emissions statistics and structural business statistics, this is not the case with Eurostat's energy balances accounts, which follow a different sector classification. A key step in order to produce estimates of SME energy consumption has, therefore, consisted in building a match between the two different sector classifications, so that sector weights from SBS could be applied to energy consumption, which is needed to develop the two indicators

of energy intensity and energy price burden. Table A A.1 provides detailed information on the correspondence between sectors from the energy balances and structural business statistics datasets, based on information and guidance from the Eurostat Energy Balance Guide (Eurostat, 2019[12]). The rest of this section explains the main steps to match sectors from these two different datasets.

First, it should be noted that the indicator used from the energy balances accounts is "final energy consumption", and that this dataset does not include information on NACE sectors "Electricity, gas, steam and air conditioning supply" (D) and "Manufacture of coke and refined petroleum products" (NACE sector C19)[34]. In addition, information on "Transport" is not considered in the estimates because transport-related energy consumption cannot be assigned to any specific NACE sector, making it impossible to apply sector weights. Therefore, "Transport" is also removed from structural business statistics and sector weights are recomputed accordingly in the energy-related indicators of the dashboard.

In principle, it would be possible to retain transport-related information in the SME energy estimates, but this information would have to be applied to the business sector as a whole, with the SME share corresponding to the share of SME value added in the total business sector, thus losing the detail of sector-disaggregated information. The steps to do this are presented in Box A A.1, keeping in mind that the SME energy-related indicators presented in this paper currently do not integrate transport-related energy information[35].

[34] As to NACE sector D (energy supply), this is expectable since energy balances statistics deal with energy supply information, which is provided by the energy sector.

[35] Transport accounts for a sizeable share of energy consumption, i.e., about 30% at the EU-27 level.

Box A A.1. Retaining transport-related energy consumption in SME energy indicators

Transport in the energy balances accounts refers to the energy use of transport activities both for households and non-households, irrespective of the sector in which the activity occurs, making it impossible to assign transport-related energy use to any specific economic sector. Nonetheless, it would be possible to produce a gross estimate of transport-related energy consumption for the whole business sector, including its SME segment, in the following way.

First, transport activities associated with households need to be removed from transport-related energy consumption. Following the approach of the "Leap4SME" project (Reuter S., Lackner P. and Brandl G., 2021[9]), this could be done by taking the value of household transport energy use from the Physical Energy Flows Accounts (PEFA) and subtracting this value from total transport energy consumption in the energy balances accounts. This would have to be done for each of the countries covered in the database.

Second, in order to produce an estimate of transport-related SME energy use, the energy use of the business sector from the total energy use of non-households needs to be calculated, since the latter also includes activities that are not part of the business sector, such as agriculture, forestry and fishing, financial services and public sector activities. This could be done by applying the share of value added of business sector activities (ISIC4 codes 05-82, except for 64-66: finance and insurance activities) in the total economy (including agriculture, forestry and fishing, financial services, and public sector activities) to non-household transport-related energy consumption, thus retaining the corresponding volume of energy consumption as the transport-related energy use of the business sector.

Finally, to estimate the SME share of transport-related energy consumption, the share of SME value-added for the whole business sector would have to be used, since transport-related energy consumption cannot be assigned to any specific sector in the energy balances accounts.

Second, as shown in Table A A.1, some NACE sectors from the structural business statistics (SBS) database need to be merged to match a corresponding sector in the energy balances accounts. For example, C17 (manufacture of paper and paper products) and C18 (printing and reproduction of recorded media) are merged to match "paper, pulp and printing" in the energy balances. In this case, the value added of C17 and C18 in SBS has been summed up and the contribution of each to the total (i.e., percentage value) has been used as a weight to assign the corresponding share of energy consumption from the total "paper, pulp and printing" sector back to C17 and C18. This same method has been used for other merged sectors, such as C10-C12 or E37-E39.

Third, the energy balances accounts present information on energy consumption from commercial and public services together. However, only energy consumption from commercial services needs to be retained in the dashboard estimates, since public services, as well as financial services, are not part of the business sector definition which is used for SME indicators and to which sector weights are applied. In this case, for each country, the share of value added of commercial services out of the total value added of commercial, financial, and public services has been calculated. This proportion has then been applied to total energy consumption for commercial and public services from the energy balances accounts to retain only the part of energy consumption to be assigned to commercial services. Then, the estimated volume of energy consumption in commercial services has been distributed to the different two-digit subsectors (see Table A A.1), in proportion to the share of value added of each subsector in the total value added of commercial services. Finally, relevant output weights (SME share of value added) are used to estimate the SME share of energy consumption in commercial services.

Finally, there is no information on Switzerland for energy consumption; thus, the dashboard energy indicators do not include Switzerland, nor do they include Luxembourg due to too many missing values from the SBS database.

Table A A.1. Correspondence between sectors in energy balances and structural business statistics

Energy balances sectors	Energy balances subsectors	NACE corresponding sector(s) (SBS)
Industry sector	Iron & Steel	C24 - Manufacture of basic metals
	Chemical & petrochemical	C20 - Manufacture of chemicals and chemical products C21 - Manufacture of basic pharmaceutical products
	Non-ferrous metals	C24 - Manufacture of basic metals
	Non-metallic minerals	C23 - Manufacture of other non-metallic mineral products
	Transport equipment	C29 - Manufacture of motor vehicles, trailers C30 - Manufacture of other transport equipment
	Machinery	C25 - Manufacture of fabricated metal products C26 - Manufacture of computer, electronic C27 - Manufacture of electrical equipment C28 - Manufacture of machinery
	Mining & quarrying	B – Mining and quarrying
	Food, beverages & tobacco	C10-C12 - Manufacture of food products; beverages and tobacco products
	Paper, pulp & printing	C17 - Manufacture of paper and paper products C18 - Printing and reproduction of recorded media
	Wood & wood products	C16 - Manufacture of wood and of products of wood
	Construction	F - Construction
	Textile & leather	C13-C15 - Manufacture of textiles, wearing apparel, leather and related products
	Not elsewhere specified (industry)	C22 - Manufacture of rubber and plastic products C31_C32 - Manufacture of furniture; other manufacturing
Transport sector	Rail	Not applicable to NACE economic sectors
	Road	
	Domestic aviation	
	Domestic navigation	
	Pipeline transport & Not elsewhere specified (Transport)	
Other sectors	Commercial and public services	Commercial services (C33, E36, E37-E39, G45, G46, G47, H49, H50, H51, H52, H53, I, J58, J59_J60, J61, J62_J63, L, M69_M70, M71, M72, M73, M74_M75, N77, N78, N79, N80-N82) Financial services (K) & Public services (O, P, Q, R, S, T and U): Not covered in the business sector definition and our estimates
	Households	Not covered in the business sector definition and our estimates
	Agriculture & Forestry	
	Fishing	
	Not elsewhere specified (other)	

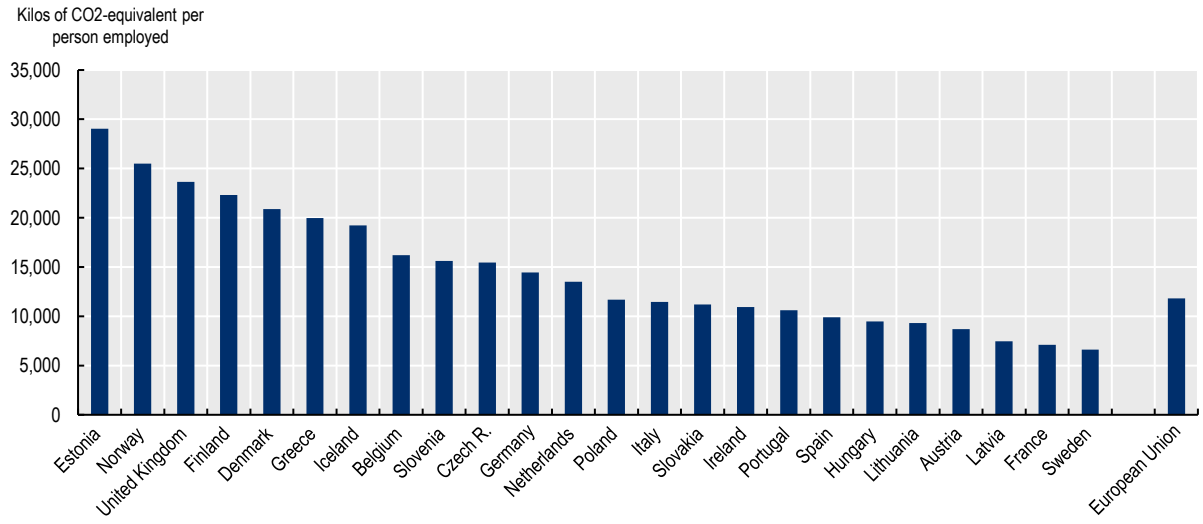
Note: Merged sector categories include: C10-C12, C13-C15, C31_C32, J59_J60, J62_J63, M69_M70, M74_M75, N80-N82 and E37-E39. The (-) means all subsectors between the two numbers are included. With respect to the NACE sectors corresponding to the commercial services in the energy accounts: C33 - Repair and installation of machinery and equipment; E36 - Water collection, treatment and supply; E37-E39 – Sewerage, waste management and remediation activities; G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles; G46 - Wholesale trade, except of motor vehicles and motorcycles; G47 - Retail trade, except of motor vehicles and motorcycles; H49 - Land transport and transport via pipelines; H50 - Water transport; H51 - Air transport; H52 - Warehousing and support activities for transportation; H53 - Postal and courier activities; I - Accommodation and food service activities; J58 - Publishing activities; J59_J60: motion picture, programming and broadcasting activities; J61 - Telecommunications; J62_J63 – Computer programming, consultancy and information services activities; M69_M70: Legal, accounting and management activities; M71 - Architectural and engineering activities; technical testing and analysis; M72 - Scientific research and development; M73 - Advertising and market research; M74_75: Other professional, scientific and technical activities, including veterinary; N77 - Rental and leasing activities; N78 - Employment activities; N79 - Travel agency, tour operator and other reservation service and related activities; N80-82: Security, services to building and office support. Transport-related sectors (H49-H51) under commercial and public services refer to energy consumption in physical locations such as airports, railway stations and ports, as well as fuels used for all non-transport activities in these sectors.
Source: OECD based on (Eurostat, 2019[12]).

Annex B. Additional dashboard estimates

The present Annex illustrates alternative estimates of the indicators presented in the report. As noted in the main section of this paper, it is possible to measure SME carbon intensity and SME energy intensity not only in terms of value added but also in terms of employment. In general, these two versions of the same indicators show good degrees of correlation, although there are some exceptions mostly driven by labour productivity considerations[36]. In addition, the SME energy price burden can be calculated not only over SME turnover but also over SME value added. These additional estimates are presented to show different possible uses of the dashboard indicators and the underlying dataset.

Figure A B.1. SME GHG emissions intensity (employment-based), business sector, 2018

SME GHG emissions over SME employment

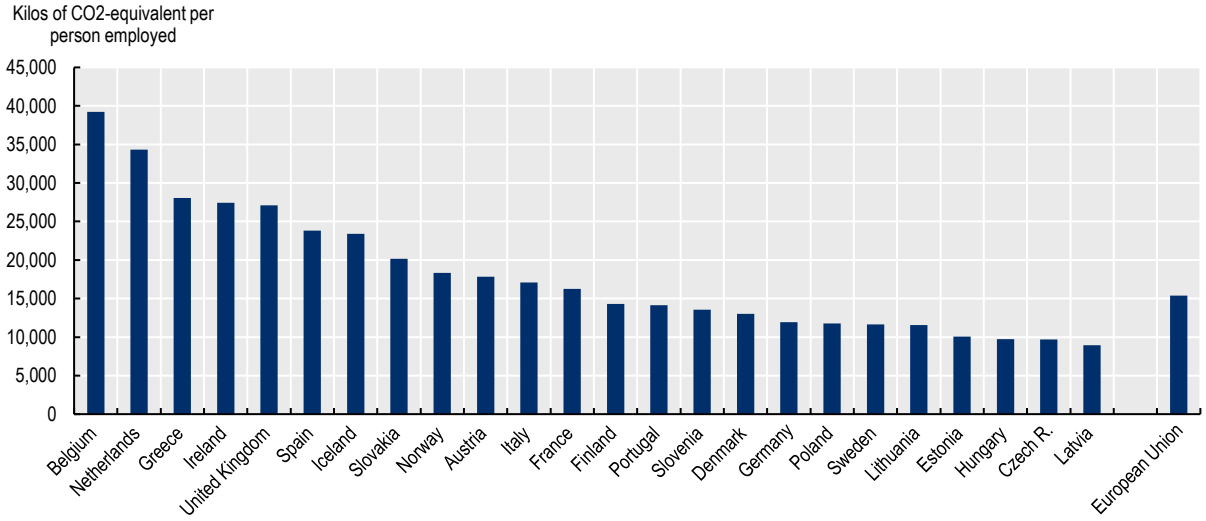


Note: GHG emissions computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SMEs' total GHG emissions are then divided by SMEs' employment.
Source: OECD calculations based on Eurostat's Air Emissions Database and Eurostat's Structural Business Statistics.

[36] For example, countries with low labour productivity levels may feature high in SME carbon intensity measured in terms of value-added, but lower in the same indicator measured in terms of employment. The opposite would be true for countries with high labour productivity levels.

Figure A B.2. SME GHG emissions intensity (employment-based), manufacturing, 2018

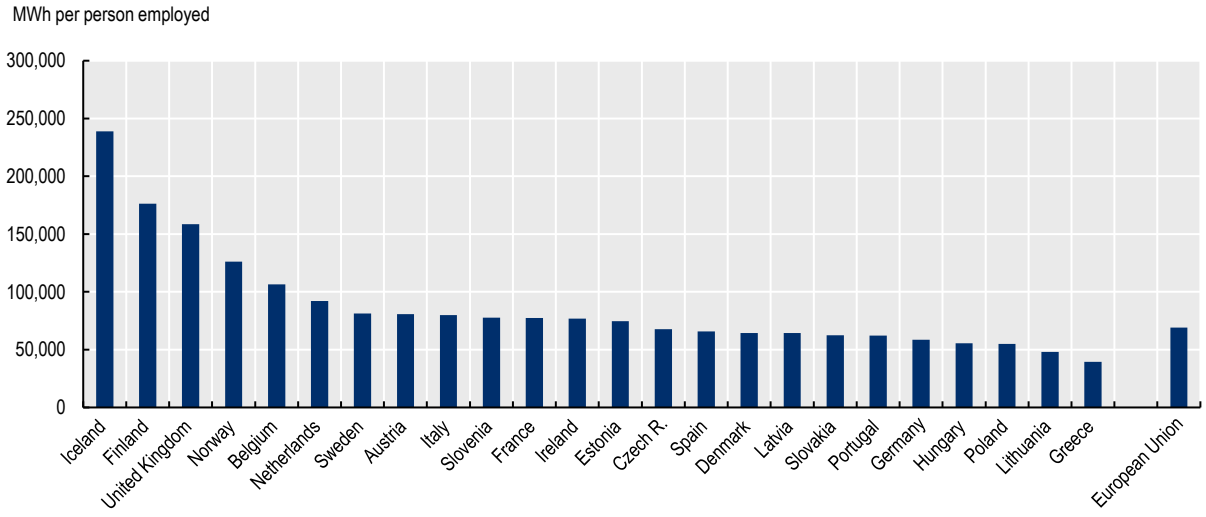
SME GHG emissions over SME employment



Note: GHG emissions computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SMEs' total GHG emissions are then divided by SMEs' employment.
Source: OECD calculations based on Eurostat's Air Emissions Database and Eurostat's Structural Business Statistics.

Figure A B.3. SME energy intensity (employment-based), business sector, 2018

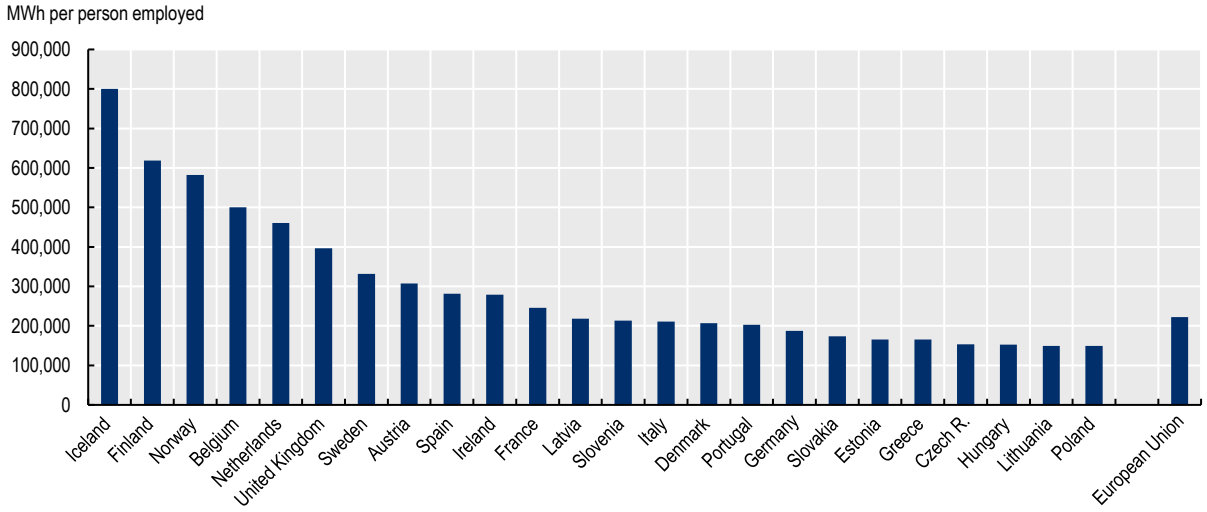
SME energy consumption over SME employment



Note: SME energy consumption computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SME energy consumption is then divided by SME employment.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and Eurostat's Structural Business Statistics.

Figure A B.4. SME energy intensity (employment-based), business sector, 2018

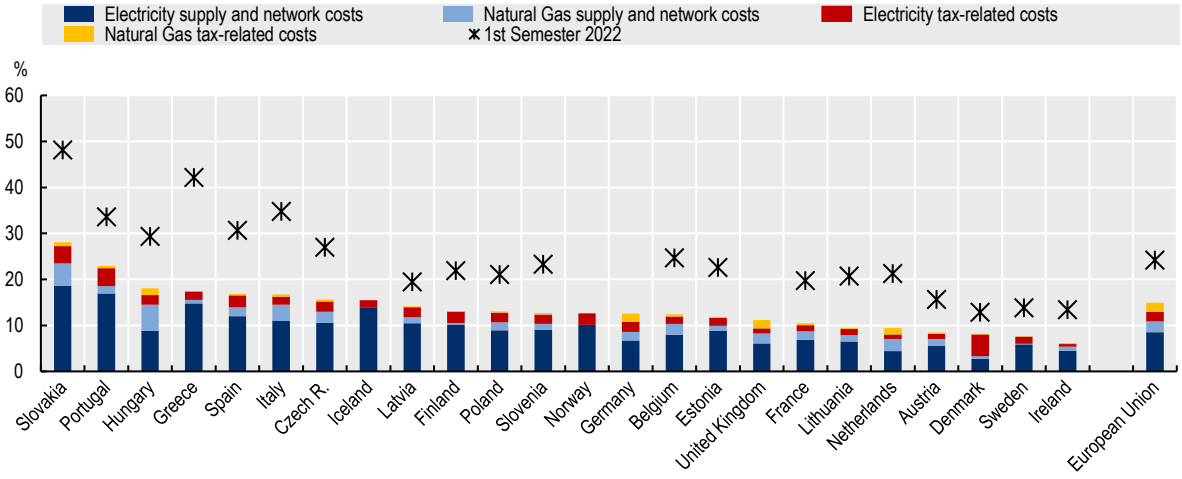
SME energy consumption over SME employment



Note: SME energy consumption computed at two-digit sector level based on the application of an output weight corresponding to the SME share of value added. SME energy consumption is then divided by SME employment.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and Eurostat's Structural Business Statistics.

Figure A B.5. SME energy price burden (value-added-based), business sector, 2018 and 2022 (1st semester)

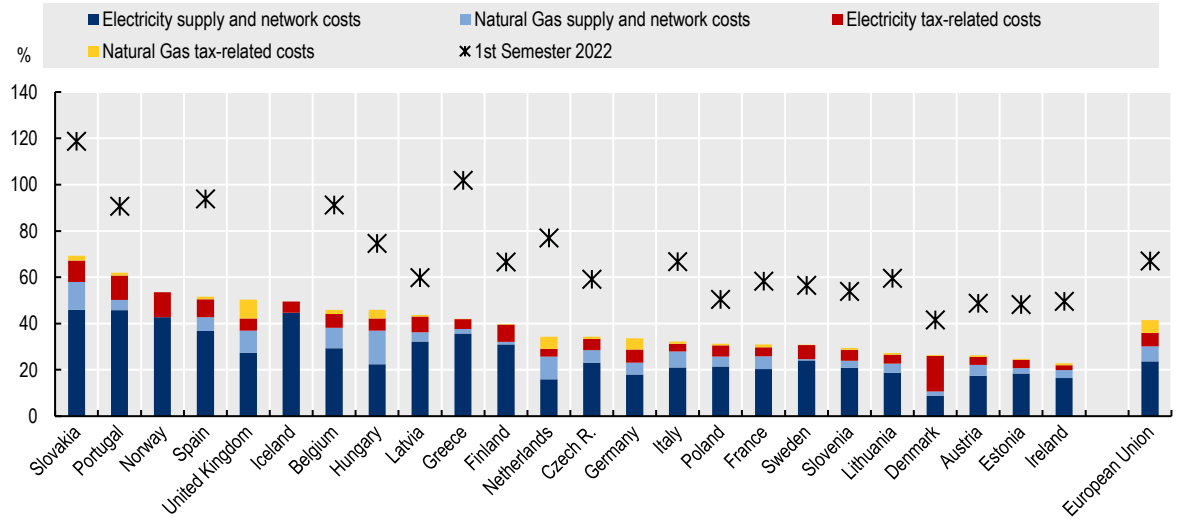
Impact of electricity and natural gas costs on SME value added



Note: This indicator covers the cost of electricity and natural gas consumption, but not of other sources of energy such as, for example, the direct use of oil in the production process. For this indicator, we follow a four-staged approach. Firstly, we estimate the share of electricity and natural gas consumption in total energy consumption across sectors. Secondly, we apply the SME share of energy consumption at two-digit sector level, which we had previously calculated, in equal way to consumption volumes of electricity and natural gas to gauge SME consumption. Thirdly, we multiply these two volumes by the average non-household price of electricity and natural gas. Finally, we put the final energy cost (electricity and natural gas) in relation to SME value added. There is no data for natural gas in Iceland and Norway.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.

Figure A B.6. SME energy price burden (value-added-based), manufacturing, 2018 and 2022 (1st semester)

Impact of electricity and natural gas costs on SME value added



Note: This indicator covers the cost of electricity and natural gas consumption, but not of other sources of energy such as, for example, the direct use of oil in the production process. For this indicator, we follow a four-staged approach. Firstly, we estimate the share of electricity and natural gas consumption in total energy consumption across sectors. Secondly, we apply the SME share of energy consumption at two-digit sector level, which we had previously calculated, in equal way to consumption volumes of electricity and natural gas to gauge SME consumption. Thirdly, we multiply these two volumes by the average non-household price of electricity and natural gas. Finally, we put the final energy cost (electricity and natural gas) in relation to SME value added. There is no data for natural gas in Iceland and Norway.
Source: OECD calculations based on Eurostat's Energy Balances Accounts and OECD Structural and Demographic Business Statistics (SDBS) database.