



**Statistics Netherlands**

Division EBN  
ENR

*P.O.Box 24500  
2490 HA Den Haag  
The Netherlands*

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# **Quantifying CO<sub>2</sub>-emissions according to the control-criterion**

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**Final report**

**Maarten van Rossum, Cor Graveland, Sjoerd Schenau and Bram Edens  
(Statistics Netherlands)**

Remarks:

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## QUANTIFYING CO<sub>2</sub>-EMISSIONS ACCORDING TO THE CONTROL- CRITERION

### *Summary:*

*Different ways exist of attributing greenhouse gas emissions to individual countries. Well-known are the territory based approach which underlies Kyoto Reporting and the production based approach which is followed in Environmental Accounts (SEEA). Also well-known is the consumption based approach using environmentally-extended input-output analysis (EE-IO).*

*Due to the advancement of globalisation, these different perspectives yield increasingly different estimates. The phenomenon of “carbon leakage” (IPCC, 2007) already has been explored extensively in research for countries with (carbon) mitigation policies and either emission ceilings in place. Intuition here was that in a globalising world, the controlling units not only are most likely to receive most of the profits, but they also decide on the location of polluting activities. The extension of activities by enterprises and persons abroad and accountability of emissions may pose additional challenges for research and statistics.*

*In this research project we have explored a new approach to account for responsibility for emissions based on the criterion ‘span of control’ (ultimate controlling institute, UCI).*

*In this research project we first allocated total Dutch production emissions to Dutch span of control and foreign control. Subsequently we compiled figures for emissions related to Dutch span of control production activities abroad.*

*Emissions of Dutch controlled companies are equal to 242 billion kg CO<sub>2</sub>. Approximately 43 percent of these Dutch controlled emissions are emitted by Dutch residents and 57 percent are emitted by foreign residents in foreign economies. Approximately 38 percent of all SEEA-type emissions from production in the Dutch economy (production approach) are emitted by foreign controlled companies in the Netherlands. The other 62 percent are emitted by Dutch controlled companies in the Netherlands.*

*CO<sub>2</sub> emissions of Dutch controlled companies in the Netherlands and abroad together are 44 percent larger than the CO<sub>2</sub> emissions according to the SEEA production approach (excluding household). CO<sub>2</sub> emissions of Dutch controlled companies in the Netherlands and abroad are 27 percent larger than the CO<sub>2</sub> emissions according to the consumption approach.*

*For the Dutch economy particularly the emissions of the industries ‘electricity and gas supply’, ‘manufacture of basic chemicals’, ‘air transport’ and ‘manufacture of petroleum products and basic metals’ are foreign controlled. Dutch ‘controlled emissions’ in foreign economies are very much concentrated in a few industries like ‘mining and quarrying’ and ‘manufacture of chemicals and chemical products’.*

*Regarding the quality of the produced figures, quality of the assessment of foreign controlled emissions in the Netherlands is better than the quality of the data on emissions of Dutch controlled emissions in foreign economies. The former is mainly based on observations and partly on modelling making use of some rule of thumb assumptions. The latter is not directly based on observed data; instead we make use of computing techniques using data on different emission coefficients and economic information on foreign control which is available at Statistics Netherlands and Eurostat.*

*In order to enhance policy relevance it is recommended to compile time series data for emissions based on the criterion 'span of control'. These time series data can also be very useful for analysis of the 'carbon leakage' phenomenon. This study is experimental and is still in the learning phase.*

*Keywords: Air emissions, carbon dioxide, globalisation, foreign control, domestic controlled emission, Ultimate Control Unit (UCI), air emission accounts, production emissions (SEEA), territory emissions.*

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## 1. Introduction

There are different ways of attributing responsibility for greenhouse gas emissions to individual countries (Peters 2008; Peters and Hertwich 2008). Well-known are the territory based approach which underlies Kyoto Reporting, the production based approach which is followed in the SEEA (UN et al 2012) and the consumption based approaches using environmentally-extended input-output analysis. Due to the advancement of globalisation, these different perspectives yield different estimates. There is by now a large literature (around “carbon leakage”) which investigates whether developed economies, regularly with adopted carbon mitigation policies and national emission ceilings settled, shift environmental burden towards developing economies.

Moreover globalisation affects air emissions and the allocation of it. Globalisation has become a well-discussed topic over the last two decades. Particularly for a small and open economy like the Netherlands, international developments have major consequences (Internationalisation Monitor 2011, (CBS, 2011)). Globalisation clearly does affect the System of National Accounts (SNA) and Accounting compilation practices. Globalisation poses a number of challenges for allocation of emissions according to the different approaches.

In this report we have explored a new approach to account for responsibility by attributing emissions by the criterion ‘span of control’ or ultimate controlling institute (UCI). The main intuition here is that in a globalising world, the controlling units not only are most likely to receive most of the profits, but they also decide on the location of polluting activities. In that sense, this approach would be closer to an income perspective<sup>1</sup>.

A country with an open economy in a globalising world, like the Netherlands, is in two ways responsible for economic activities worldwide. That is via company control, both domestically and abroad. Economic activities under Dutch control both generate economic value but cause (CO<sub>2</sub>) emissions as well. The value added of a ‘span of control’ analysis in a globalisation context is that the economic meaning and the global effect on the environment of Dutch company control can be evaluated.

In the System of National Accounts, residency is defined in terms of predominant economic interest. In practice this means that a Dutch resident is a company or person ‘predominantly’ present within the Netherlands. Following the SEEA production approach (UN, 2012); pollution of these companies is accounted for as emissions caused by and to be assigned to the production of the Dutch economy. In this way these emissions can be compared with economic aggregates like GDP.

However, many of the residents engaged in polluting activities are not *controlled* by Dutch residents. Companies can be controlled by foreign residents. In such cases foreign residents often receive income (for example dividends in the case of securities) from the companies controlled in the Netherlands. Still, emissions are assigned to the domestic economy following the SEEA approach instead of allocated to the foreign economy (or ‘controlling’ economy).

In theory one can correct conventional statistics on emissions, like Kyoto, for ‘span of control’ by allocating only emissions of companies which are controlled by Dutch residents. This is only one side of the case. On the other hand, one should then also

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<sup>1</sup> In the SNA national income is an aggregate which takes also income transfers with the rest of the world into account.

correct for the emissions of foreign companies (non-residents) which are controlled by Dutch residents.

Aim of this study is to compile and supply extra relevant information in a globalising world on the issue of 'span of control' in an environmental-economic context.

The research question of this study is as follows:

*How much CO<sub>2</sub> emissions does the Netherlands emit according to the criterion span of control and to what extent do these 'span of control emissions' deviate from other emission aggregates like the production approach and consumption approach?*

This paper is set up as follows. In chapter 2, scope and used concepts are explained. Hereafter in chapter 3 the methodology and actions for calculating Dutch span of control emissions are described. Chapter 4 discusses compilation techniques for calculating domestic emissions related to Dutch span of control. Chapter 5 describes compilation techniques and results of Dutch span of control emissions abroad. Finally chapter 6, on the basis of the project results, draws conclusions and presents some recommendations for future research.

This study is experimental and is still in the learning phase.

## **2. Scope and concepts of the project:**

Globalisation can be monitored using the concept of company control. Company control is based on the concept of the Ultimate Controlling Institute (UCI), as defined by the Foreign Affiliates Trade Statistics (FATS) Regulation<sup>2</sup>. The UCI is defined as an institutional unit, starting from a foreign affiliate's chain of control, which is not controlled by another institutional unit. Therefore, foreign controlled enterprises have a centre of control outside the Netherlands, whereas Dutch controlled means that the locus of control is in the Netherlands. 'Control' is defined as the ability to determine general corporate policy by appointing appropriate directors.

The UCI is determined on an annual basis by combining enterprise information from various sources<sup>3</sup>, a combination of CBS conducted surveys (SFGO: Survey Financial Statistics of Large Enterprise Groups, and CIS: Community Innovation Survey) and external sources (Dunn & Bradstreet database). This merger of enterprise information with registered jobs in the Social Statistical Database<sup>4</sup> results in a match for more than 90 percent of the total population of enterprises for which the locus of control can be determined,<sup>5</sup>(Internationalisation Monitor 2011, (CBS, 2011)). This results in a disaggregation of enterprises according to country of control. Although it is imaginable that the UCI of a small firm is not correctly determined, this does not have a significant impact on the results.

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<sup>2</sup> Based upon Common legal framework of FATS in the EU by: Regulation(EC) No.716/2007 of the European Parliament and of the Council of 20 June 2007 on Community statistics on the structure and activity of foreign affiliates. In the past referred to as: "Foreign Affiliates' Trade in Services". Today FATS has been extended to: "Foreign Affiliates Statistics".

<sup>3</sup> See also: Internationalisation Monitor 2011 (CBS, 2011).

<sup>4</sup> In Dutch: SSB, 'Sociaal Statistisch Bestand'.

<sup>5</sup> Note that the direct investor(s) is/are not necessarily the ultimate controlling institutional unit (UCI). For example, if a Dutch enterprise controls a German enterprise that controls an Austrian enterprise, the UCI of the Austrian enterprise is Dutch, but the direct investor in Austria is German.

Focus in this study is primarily on carbon dioxide (CO<sub>2</sub>) emissions, as the main greenhouse gas. The chosen reporting year is 2008, as this is the most recent reporting year for which all the required data is readily available. Results of the aforementioned correction exercises are presented at meso level according to the industry classification NACE Rev.2.

### **3. Methodology and description research actions**

This chapter describes, in broad lines, the methodologies applied and research steps undertaken in order to compile figures on CO<sub>2</sub> emissions related to ultimate control. In chapter 4 and 5 the necessary actions are discussed in more detail.

Two steps need to be taken in order to be able to calculate emissions attributed to Dutch span of control.

#### **A. Determine the domestic emissions related to Dutch span of control**

#### **B. Determine Dutch span of control emissions abroad**

In this chapter the required actions are defined and described in brief.

For determining domestic emissions related to Dutch span of control, the subsequent steps are taken:

- A1:** Identify companies (residents) which are foreign controlled;
- A2a:** Calculate stationary emissions of the foreign controlled firms based on micro information;
- A2b:** Calculate emissions mobile sources of companies analysed in step A2a;
- A3:** Identify lacking emissions and split these in foreign controlled and Dutch controlled;
- A4:** Aggregate the results of step 2 and step 3.

These steps are subsequently described in detail in chapter four.

For determining the Dutch span of control emissions abroad, the next subsequent steps are taken:

- B1:** Identify economic information for Dutch controlled companies in foreign economies;
- B2:** Calculate emissions of foreign companies controlled by Dutch residents (Dutch emissions factors);
- B3:** Fine-tuning emissions by implementing foreign emission-factors.

These subsequent steps are described in detail in chapter five.

#### **4. Compilation of domestic emissions related to Dutch span of control and foreign control**

This chapter describes the compilation activities how domestic emissions related to Dutch span of control are calculated using a number of steps and also subsequently presents the results.

##### **Step A1: Identify companies (residents) which are foreign controlled by foreign companies**

The identification of companies (residents) which are foreign controlled by foreign companies was done by using the official statistic on UCI (ultimate controlling institute). This database is already available for the residential enterprises in the Netherlands which are foreign controlled. For almost every single company, at KAU-level ('Kind of Activity Unit') we have information on whether the company is foreign controlled or not.

##### **Step A2a: Calculate emissions of foreign controlled firms on micro level**

Following the identification of relevant companies, the next step is to compile statistics on the emissions of these companies. First we make use of existing micro level data on emissions from stationary sources. This data is used for compilation of national environmental statistics and for the National emission inventories (i.e. NIR) containing a number of air pollutants, as for greenhouse gasses predominantly emitted at the territory ('territory emissions')<sup>6</sup>. This is data based upon individual data on energy-related emissions, both from energy combustion and process related emissions. This data is based on energy use data at micro level that is available at company level. This data is collected in the context of the compilation of the energy statistics.

The quality of the emissions data is quite good. The micro data on emissions have been matched with the business register. By means of this coupling we exactly do know for which individual companies data is present in the emission-inventory and for which is not. Enterprises with stationary air emissions that indeed have Annual Environmental Reports (AER) (so being part of the emission inventory) that could ('technically') be linked with the business register were coupled with the business register manually.

On micro basis the companies assigned as foreign controlled can now be coupled with the micro database of the emission inventory via connection with the business register. As a result, the micro-based emissions can be assigned to either the category of foreign controlled companies or to the Dutch controlled companies.

With this micro approach, 89.5 Mton of CO<sub>2</sub>-emission from production (excluding emissions from households) can be allocated to individual enterprises out of a total figure of 127 Mton of CO<sub>2</sub> from production, generated by stationary sources within the Dutch economy. As a result 71 percent of the CO<sub>2</sub>-emissions can be assigned for UCI purposes.

For companies not covered by the AER reporting requirements another methodology has been developed in order to assign the emissions to the right industry and UCI (foreign or domestically controlled). This will be explained later in this study.

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<sup>6</sup> Dutch Pollutant Release and Transfer Register (PRTR), [www.emissieregistratie.nl](http://www.emissieregistratie.nl).

### Step A2b: Add emissions from mobile sources

In context of air emissions reporting distinction is made between stationary sources and mobile sources. The latter constitute primarily of transportation activities. The emissions caused by economic units under specified control are calculated by means of the following methodology:

- First using from existing statistics the ratios of mobile / stationary emissions at the industry level (NACE) are derived;
- Secondly these ratios are multiplied with the information already available namely the stationary and related process CO<sub>2</sub> emissions at micro level.

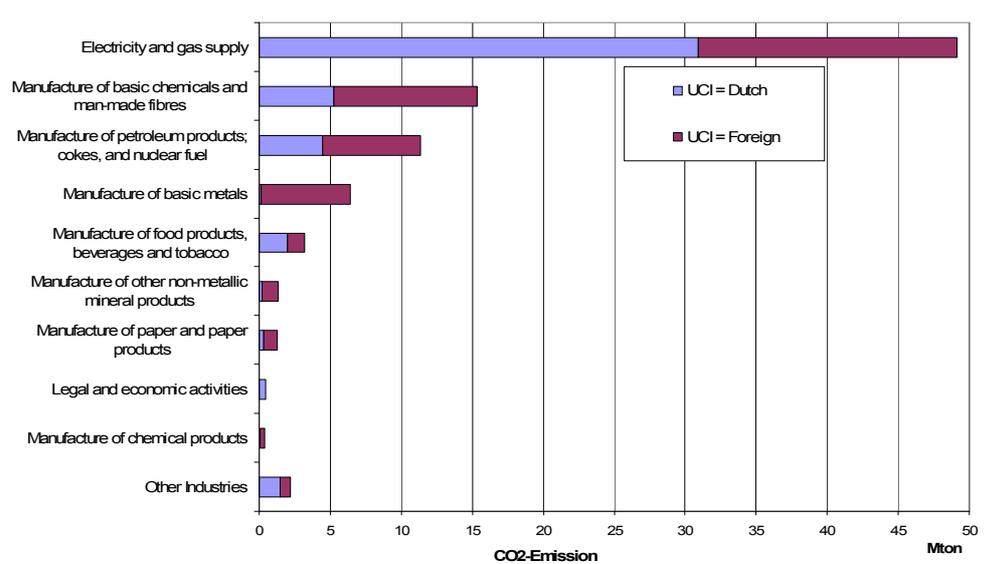


Figure 4.1 Total CO<sub>2</sub> Emissions (stationary & mobile) & UCI, micro approach, 2008

Based upon micro-level information, the Domestic – Foreign UCI ratio is equal to 50 - 50 percent for emissions. Particularly the large and heavy emission intensive industries, as one may well expect, are to a large extent foreign controlled and cause a substantial amount of emissions.

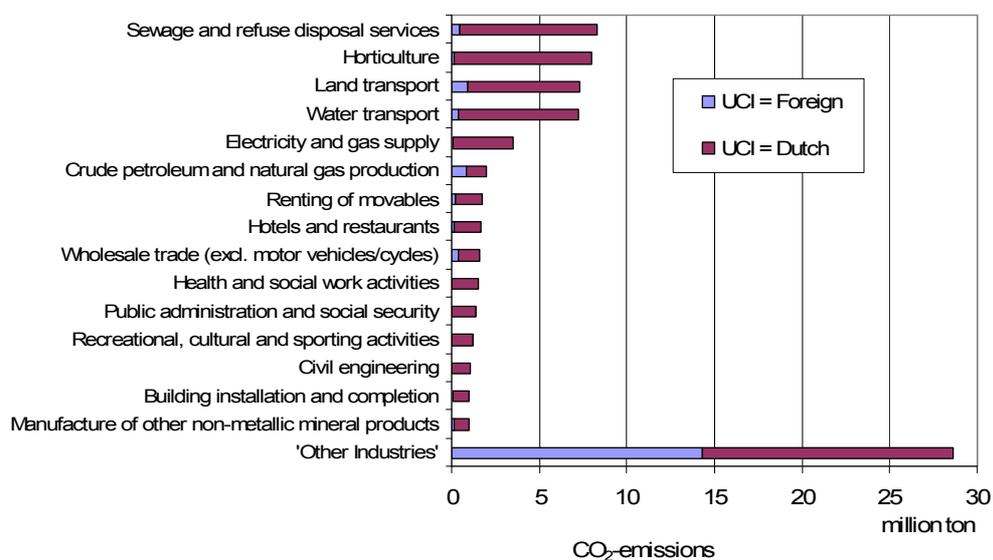
Unfortunately not all air emissions that result from the Dutch economy can be attributed using this micro based approach. This is due to the fact that some companies which are indeed foreign controlled are not reporting their emissions to the emission inventory.

Some companies are not covered by the emission inventory. Examples are inland shipping, marine transportation (outside the territory), and air transportation (i.e. large part of continental and intercontinental flights). The remainder of the emissions and the related ultimate controlling institute is dealt with in step A3.

### Step A3: Identify remaining emissions and split these in foreign controlled and Dutch controlled

For remaining activities and related emissions, not based on the micro approach, another methodology was required and is developed to assign the remaining emissions to the different industries. First the ‘remaining emissions’ are calculated per NACE level. These remaining emissions are calculated as follows: total SEEA air emissions per NACE class minus the already handled (stationary and mobile) emissions of step A2 per NACE class.

All companies not dealt with in step A2a are linked to the business register and employment register. By doing this we can calculate the ‘remaining employment’ per NACE class. At micro level we do know the total number of employed people at company (ID) level for these NACE classes. Connection of ‘remaining emissions’ with ‘remaining employment’ leaves the emissions / employment ratio by NACE class for the remaining units. We do know for the ‘remaining companies’ and ‘remaining employment’ whether these are foreign controlled or not. In the next step for the ‘remaining companies’ we derive emission numbers for both UCI-categories, namely foreign and non-foreign emissions. Finally, aggregates by industry can be calculated.



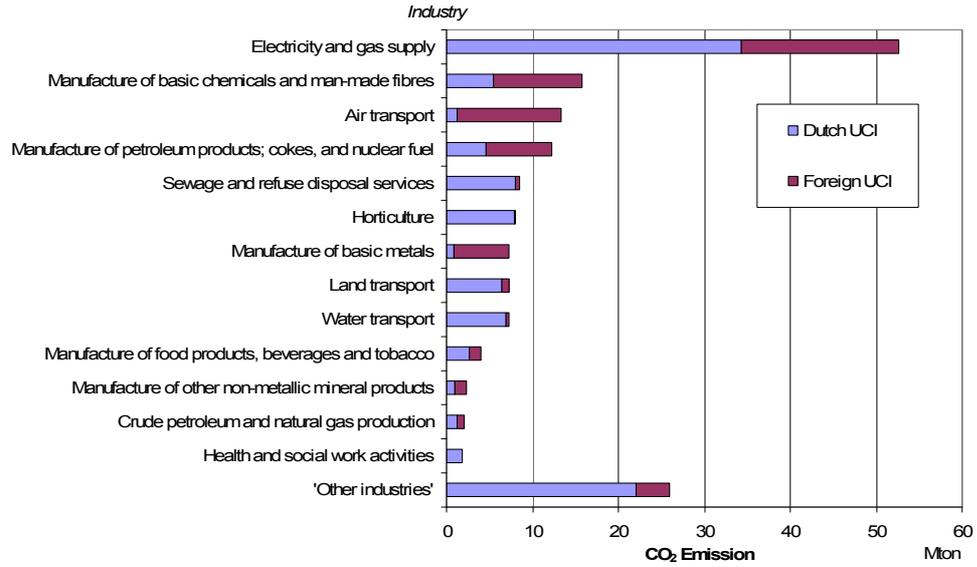
**Figure 4.2 Remaining CO<sub>2</sub>-emissions (stationary & mobile) & UCI, by industry**

The emissions of the remaining enterprises generated by the Dutch residential production sectors of 77 million ton of CO<sub>2</sub> for 2008, are for 24 percent emitted by foreign controlled companies. These foreign controlled companies represent only 9 percent of employment of the remaining companies.

#### **Step A4- aggregate the results of step A2 and step A3**

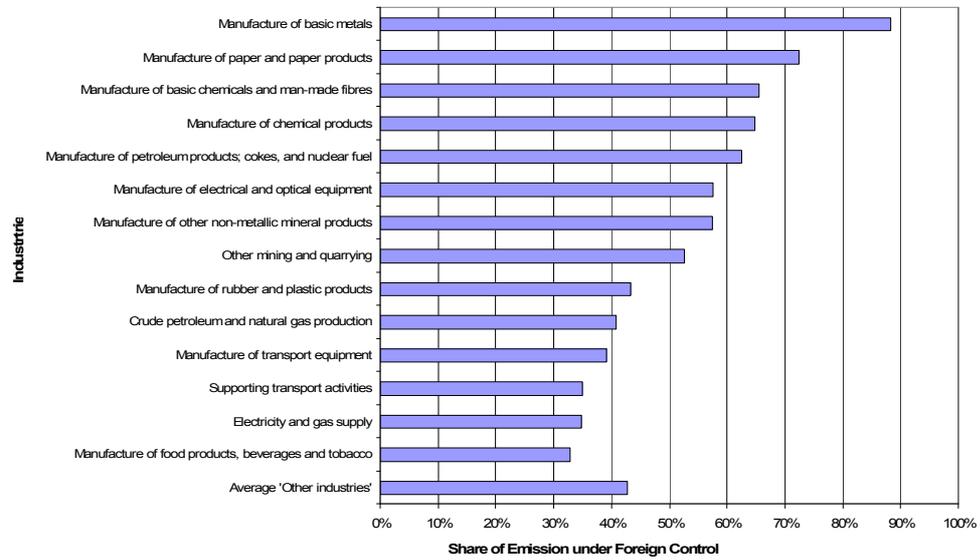
Total emissions of residents in the Netherlands can now be split in foreign controlled emissions and Dutch controlled emissions.

Here the results of assignment of CO<sub>2</sub>-emissions obtained via mentioned approaches in step A2 and A3 are combined. This gives the CO<sub>2</sub>-emissions by industry within the Dutch Economy according to span of control (UCI), either Dutch or foreign.



**Figure 4.3 CO<sub>2</sub> Emissions of Dutch Economy with span of control (UCI)**

Figure 4.3 shows that within electricity production and the more emission intensive manufacturing industries, significant emissions are caused by production activities and entities that are under foreign span of control. For the Dutch economy as a whole the production activities being under foreign control are responsible for 38 percent (64 Mton) of the overall emission caused by production activities within the Dutch economy.



**Figure 4.4 Shares of CO<sub>2</sub> Emissions by industry under foreign control, by industry\***

\* Selection of industries with largest shares of CO<sub>2</sub> emissions under foreign span of control.

## 5. Compilation of the Dutch span of control emissions abroad

This chapter describes the subsequent compilation activities for assessment of the Dutch span of control emissions abroad and it will present results of these activities. We will use employment information by country and industry as supporting information.

In a first exercise we collect economic information for Dutch controlled companies in foreign economies (step B1). In a second exercise (step B2) Dutch emission coefficients have been applied to the economic activities abroad controlled by Dutch residents. In a third exercise (step B3), emission coefficients that were most relevant for the country (or region) of concern have been applied to these economic activities. The compilation applies a number of basic steps. Results of the different compilation steps are presented as well.

### **Step B1: Identify economic information for Dutch controlled companies in foreign economies**

By means of already existing data we can identify the companies which are Dutch controlled. Official statistics already exist to monitor this topic. Statistics Netherlands has data on the number of people that work in foreign economies at Dutch controlled firms outside the EU. Eurostat has similar information about Dutch controlled firms inside the EU. The NACE class of the relevant companies is also already known. Lay out and classification systems differ between these databases on foreign control (EU and extra EU).

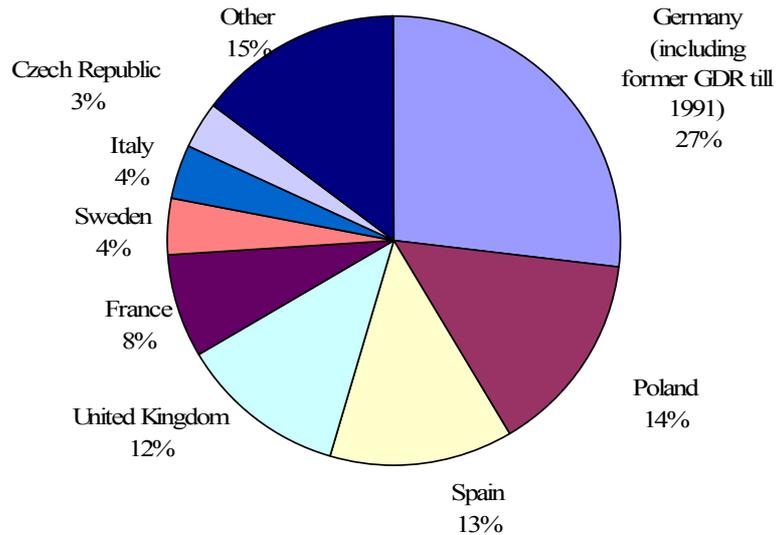
#### *Dutch control in European countries*

Eurostat has data available on Dutch controlled companies in intra EU countries for the variables employment and turnover. This data is available for approximately 35 NACE classes by making use of so called inward FATS<sup>7</sup>.

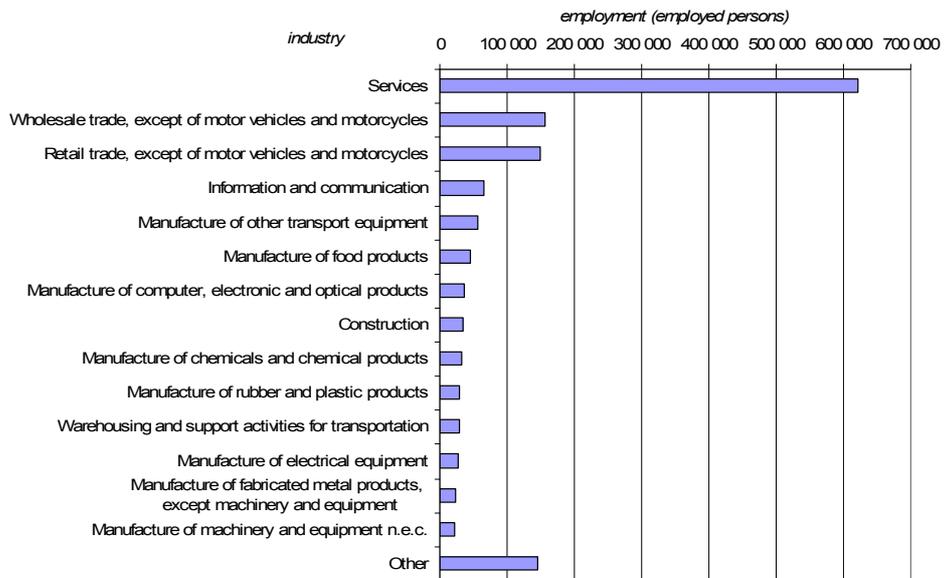
In total approximately 1.5 million people are working in companies controlled by Dutch companies in foreign EU economies. In 2008 numerous people were employed at companies controlled by Dutch companies in Germany, Poland, Spain, UK, France and Sweden. Most people do work in the industries 'other services, wholesale, retail, information and communication, manufacture of food products.

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<sup>7</sup> As an official statistic, the Foreign Affiliate Statistics (FATS) describes activities of foreign controlled enterprises that reside in the Netherlands (Inward FATS), as well as activities of Dutch controlled enterprises in foreign countries (Outward FATS). FATS present detailed data on the activities of foreign affiliates, like turnover, value added and employment. Inward FATS cover the private sector excluding the financial sector, the outward FATS cover the whole private sector.



**Figure 5.1 Employment in Europe, Dutch controlled**

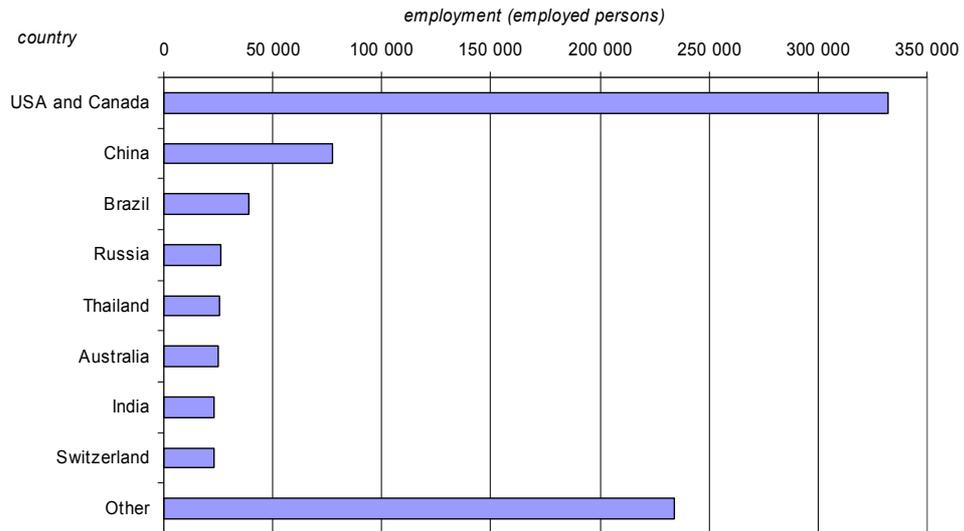


**Figure 5.2 Employment in Europe by industry, Dutch controlled**

*Dutch control in non-European countries*

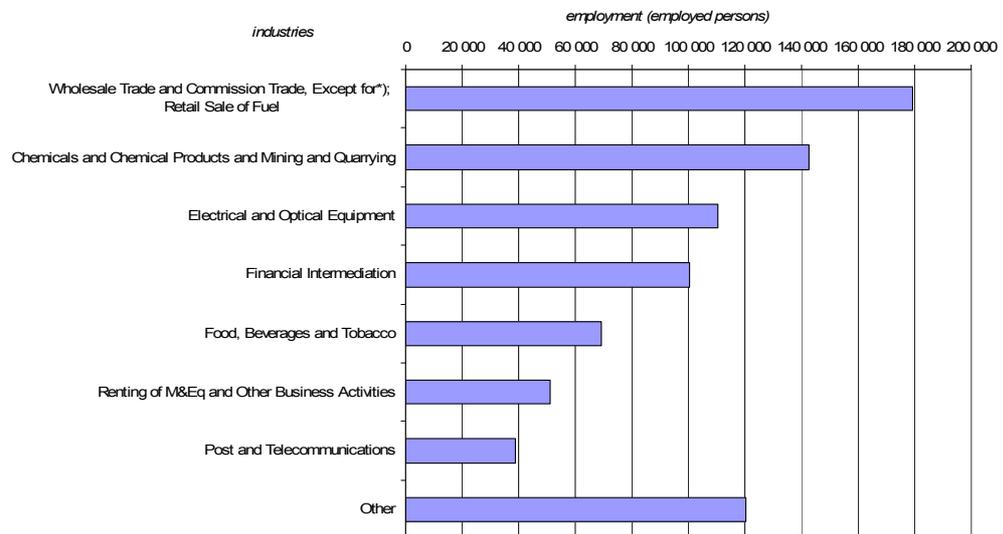
Statistics Netherlands has data available on Dutch controlled firms in countries outside the European Union for the variables employment and turnover. This data is available for approximately 35 NACE classes by making use of the so called Outward FATS.

Outside the EU, a large number of people were employed at companies controlled by Dutch companies in 2008. Examples are employed people at companies in the USA, China, Brazil, Canada and Russia. In total approximately eight hundred thousand people worked in companies controlled by Dutch companies in foreign non-EU economies.



**Figure 5.3 Employment extra EU, per country, Dutch controlled**

Many people employed in Dutch controlled companies outside the EU work in the industries wholesale, chemicals and chemical products, electrical and optical equipment, financial services and food, beverages and tobacco. It is very important to have the information by industry because this information enables us to estimate the level of emissions associated with the activities executed by these Dutch controlled companies. Some industries are very emission-intensive while others are less emission intensive. In general, one employee in the chemicals and chemical product industry generates more emissions than an employee in the financial intermediation industry.



**Figure 5.4 Employment extra EU, per industry, Dutch controlled**

\*) Except of Motor Vehicles and Motorcycles & Sale, Maintenance and Repair of Motor Vehicles and Motorcycles

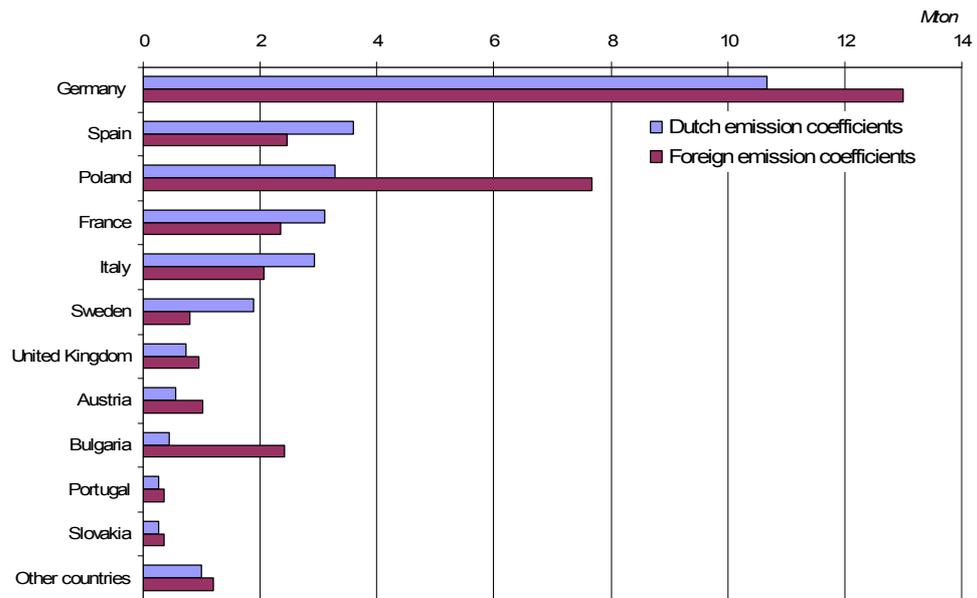
### **Step B2 and B3: Calculate emissions of foreign companies controlled by Dutch residents (Dutch emissions factors and foreign emission factors)**

Direct information on emissions by these companies abroad is not available and thus has to be derived using a number of assumptions. Emissions per NACE class are known by making use of the Dutch environmental accounts. Per NACE class one can calculate the emissions per unit employment ('emission-intensity'). In step B1 therefore it is assumed that the emission intensity of Dutch controlled companies abroad is the same as the emission intensity of the similar industry in the Netherlands (see also below). Emissions of foreign companies controlled by Dutch residents can now easily be calculated by multiplying the emission-intensity (based upon employment) with employment already calculated in step A2. This exercise is done for both intra EU and for extra EU.

From an environmental-economic point of view, the manufacturing industries have been prioritised to analyse because these are more emission-intensive than the average industry. Also the energy companies are important to analyse in depth, because this industry is by far the most emission-intensive industry. Eurostat data makes explicit to what extent Dutch companies have control over foreign European energy companies. It is quite important to determine whether these companies indeed produce electricity (emission intensive) or distribute gas and or electricity or execute network activities (far less emission intensive). After consulting a few experts and via internet search we concluded that the Dutch controlled energy companies in foreign economies predominantly deal with distribution and network activities rather than with electricity production. Emissions of these activities are limited. Therefore we assume that Dutch controlled energy companies in Europe solely engage in distribution activities and network activities. Mining is also responsible for large amounts of emissions. Dutch controlled companies engaged in exploration activities also belong to the NACE class Mining. Unfortunately the NACE class Mining is not homogenous. Extraction activities particularly cause a lot of emissions while exploration activities are emission-extensive. Companies engaged in exploration are very active abroad and indeed do control a lot of companies in foreign economies. For these specific activities we use a low emission-intensity.

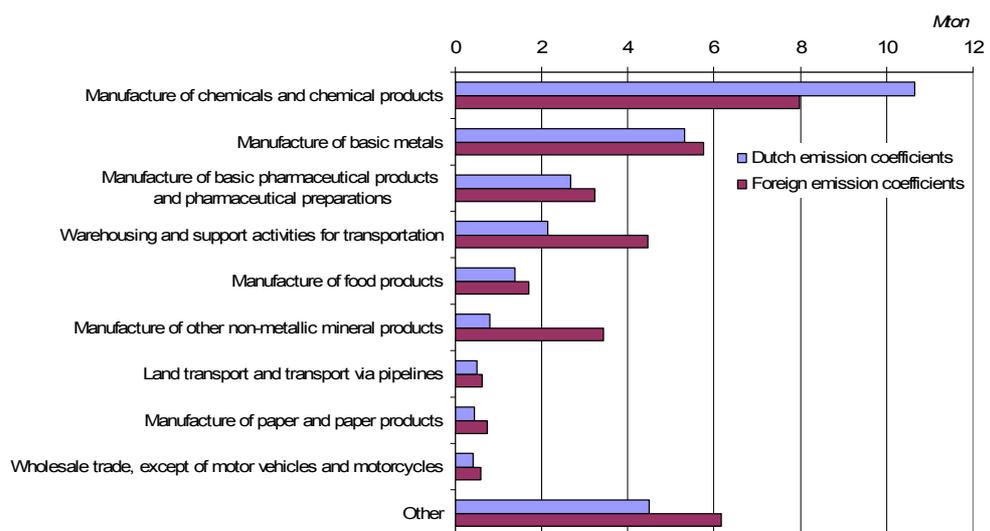
Apparently, Dutch emission factors may not be representative for foreign economies. Therefore, a correction has been made to the calculated emissions earlier on via multiplying with correction factors. The correction factor is an index number (Netherlands = 100). The index number is based upon the ratio of emission intensities in foreign economies and the emission-intensity in Netherlands for each NACE class. The index numbers are therefore NACE and country specific.

The correction factors have been calculated using World Input Output Database (WIOD, 2012) on emissions and production. Based upon these intensities we have computed index-intensities (NL=100). Based upon these indices one can calculate the emissions for European countries and for countries outside Europe.



**Figure 5.5 CO<sub>2</sub> emissions of Dutch controlled companies in EU**

Emissions attributed to Dutch controlled companies in Europe equalled 28 billion kg CO<sub>2</sub> in 2008, using Dutch emission-factors. Especially in Germany there are a lot of emissions associated by activities of Dutch controlled companies. This is due to the fact that a lot of Dutch controlled employment is located in Germany. It is also partly explained by the emission-intensive nature of the activities in Germany under Dutch control. Activities like Manufacture of basic metals, Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations and Manufacture of food products are very important in this respect. In Spain the activities Manufacture of chemicals and chemical products and Manufacture of basic pharmaceutical products and pharmaceutical preparations play a relative big role. In Poland the industries Manufacture of basic pharmaceutical products and pharmaceutical preparation, Manufacture of food products and Manufacture of other non-metallic mineral products are important.



**Figure 5.6 Emissions of Dutch controlled companies in EU, by industry**

Emissions attributed to Dutch controlled companies outside the European Union equalled 49 billion kg CO<sub>2</sub> in 2008, using Dutch emission-factors. Especially in the USA a large number of emissions stem from Dutch controlled companies. This is largely due to the fact that a substantial part of Dutch controlled employment was located in the USA. Moreover is partly explained by the emission-intensive nature of the activities in USA under Dutch control. Activities like Manufacture of chemicals and chemical products, Manufacture, Mining and Food, Beverages and Tobacco were all very prominent in this respect.

Also in Brazil, China and Canada there were a lot of emissions controlled by Dutch companies. In China and Brazil the Chemicals and Chemical Products industry is mainly responsible for these emissions.

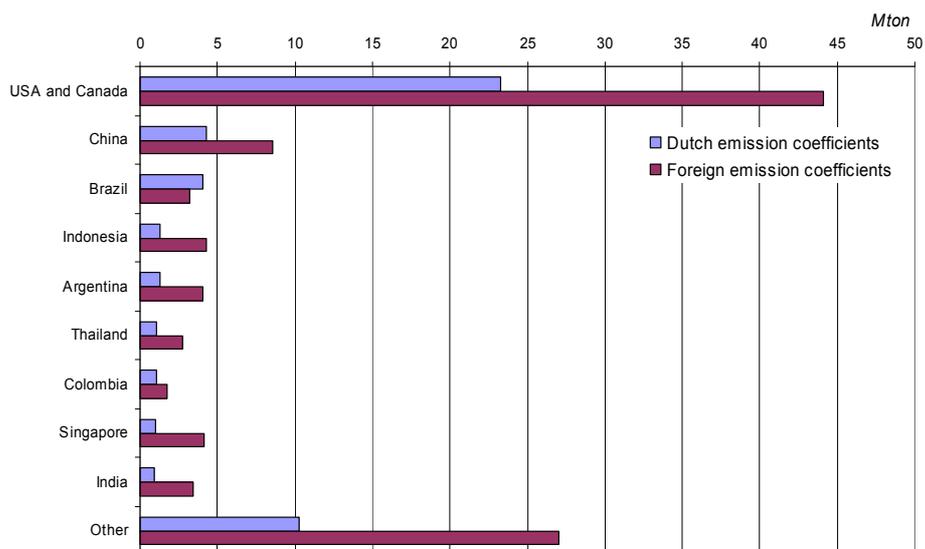


Figure 5.7 CO<sub>2</sub> Emissions of Dutch controlled companies in non-EU countries

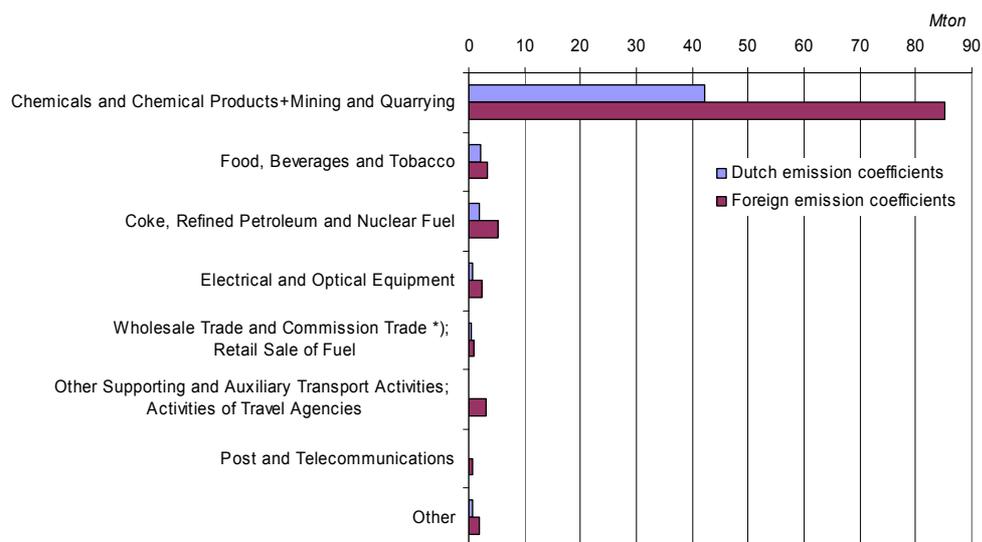


Figure 5.8 CO<sub>2</sub> Emissions of Dutch controlled companies in non-EU countries, by industry\*

\*) Excluding Motor Vehicles and Motorcycles & Sale, Maintenance and Repair of Motor Vehicles and Motorcycles.

Using foreign emission-factors, total emissions of Dutch controlled non-residents can now be calculated. Emissions attributed to Dutch controlled companies outside EU equal 103 billion kg CO<sub>2</sub> while emissions attributed to Dutch controlled companies in EU equal 35 billion kg CO<sub>2</sub>. Together this makes 138 billion kg CO<sub>2</sub> attributed to activities of Dutch controlled companies in foreign economies (77 billion kg CO<sub>2</sub> using Dutch emission factors). In the end, in presenting the total picture we advocate to use the foreign emission-factors instead of the Dutch emission factors because otherwise we would underestimate the emissions of Dutch controlled foreign companies. Still there is substantial uncertainty in the outcomes, especially for countries outside the EU.

## 6. Conclusions and recommendations for further research

### 6.1 Conclusions

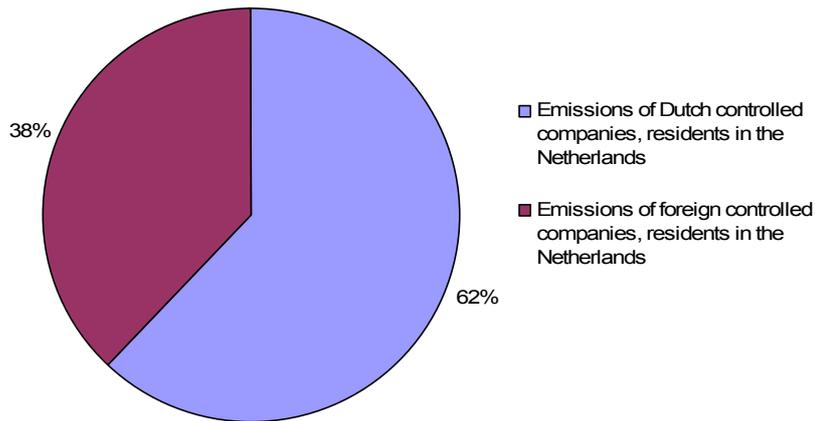
The research question of this study can be answered with use of the information presented in this research document. The research question can be answered in two parts.

*How much CO<sub>2</sub> emissions does the Netherlands emit according to the criterion span of control? To what extent do these 'span of control emissions' deviate from other emission aggregates like the territory approach (Kyoto), production approach and consumption approach?*

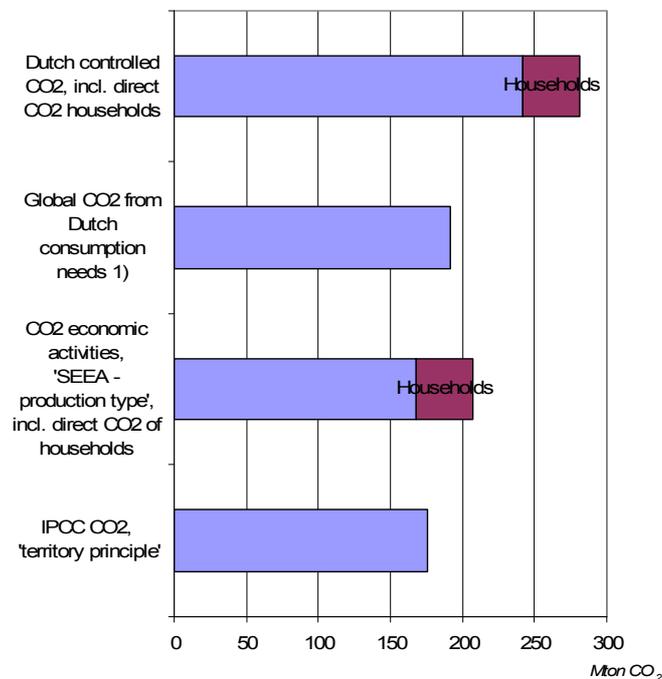
		2008 Mton CO <sub>2</sub> emissions	
I	Emissions of Dutch controlled companies, residents in the Netherlands	104	
II	Emissions of Dutch controlled companies, foreign residents	138	II=V-IV
III	<b>Total emissions of Dutch controlled companies</b>	242	III=I+II
IV	Emissions of foreign controlled companies, residents in the Netherlands	64	
V	<b>Emissions according to the residents principle (SEEA type emissions)</b>	168	V=I+IV

**Table 6.1 Total emissions of Dutch controlled companies in the Netherlands and abroad**

Table 6.1 shows that emissions of Dutch controlled companies are equal to 242 billion kg CO<sub>2</sub>. Approximately 44 percent of these Dutch controlled emissions are emitted by Dutch residents and 56 percent is emitted by foreign residents in foreign economies. Approximately 38 percent of all SEEA type emissions (production approach) are emitted by foreign controlled companies in the Netherlands. Approximately 62 percent of all SEEA type emissions (production approach) are emitted by Dutch controlled companies in the Netherlands.



**Figure 6.1 Allocation of emissions of Dutch residents**



**Figure 6.2 'Dutch' CO<sub>2</sub> emissions following different frameworks and concepts, 2008**

<sup>1)</sup> Figure based upon actual figure for emissions by residents in 2008 and the surplus of the 'Emission balance of trade' in 2009.

*Compare different approaches for emissions*

The different approaches and aggregations for assessment of CO<sub>2</sub> emissions yield considerable different and interesting results. Emissions of Dutch controlled companies in the Netherlands and abroad equal 242 million ton CO<sub>2</sub>. This figure is 44 percent larger than the CO<sub>2</sub> emissions from the Dutch economy according to the production approach (SEEA) and 27 percent larger than the consumption approach (including direct emissions of households). For this 242 million ton of Dutch controlled CO<sub>2</sub> emissions, 43 percent is indeed emitted by Dutch residents, while 57 percent is emitted by foreign residents in foreign economies.

An approximated 38 percent of all emissions from production in the Dutch economy (production approach) are emitted by foreign controlled companies active in the Netherlands. As a consequence, 62 percent of emissions stemming from Dutch production (SEEA type) are still controlled by Dutch companies in the Netherlands.

#### *Foreign controlled industries in the Netherlands*

For production in the Dutch economy, emissions stem from industries that are for substantial part foreign controlled. For nine industries, more than half of their emissions stem from foreign controlled activities. Particularly the emissions of air transport, and several manufacturers like basic metals, paper and paper products, basic chemicals and man-made fibres, chemical products, petroleum product, electrical and optical equipment, other non-metallic mineral products, rubber and of transport equipment. Air transport has the highest share, while other transport means like land transport and water transport show only limited foreign controlled shares.

#### *Dutch controlled industries abroad*

Dutch ‘controlled emissions’ in foreign economies in Europe are concentrated in a few industries, particularly in some manufacturing activities like ‘manufacture of chemicals and chemical products’ and ‘manufacture of basic metals’. Outside Europe it is pretty much dominated by ‘manufacture of chemicals and chemical products’ and to lesser extent to ‘mining and quarrying’.

#### *Large impact results from emission coefficients*

For emissions from Dutch ‘controlled activities’ in foreign economies it is a challenge to find and select proper emission factors. Activities in a certain industry may be similar but can also be completely different (not homogeneous). The selection for the one, Dutch based, or other, foreign based coefficients had large impact on results on Dutch ‘controlled activities’ abroad. The impact was strongest for Dutch controlled activities outside Europe.

#### *Uncertainty of the results*

The quality of the assessment for the foreign controlled emissions in the Netherlands is quite reasonable. Since a significant part of these domestic activities via the ‘micro-based approach’ could be assessed in detail with micro-data (observation) and with well-developed emission factors. Also the assessment of emissions from mobile sources (transportation activities) and from remaining activities could be done with acceptable result.

The certainty of the results for Dutch controlled emissions in foreign economies lags behind. This is due the fact that assessment cannot directly be based on observed data (which exists, but is not available at the required firm-level), but data modelling is required with use of different and not at all straightforward emission coefficients.

#### *Policy relevance*

The data presented in this study can be very useful for analysing the ‘carbon leakage’ phenomenon. Having information on both the economy as well as the environment-taken into account that economies and power do not stop at borders-can help policy makers in fact based decision-making dealing with environmental

issues in a globalising world. This study is still in the learning phase. In paragraph 6.2 we discuss some recommendations for further analysis.

## **6.2 Recommendations**

### *1. Time series*

The study presents a ‘span of control’ analysis for emissions for one single year. Dynamics in activities relevant for span of control abroad and domestically are very interesting to monitor over time. Changes over time cannot be analysed appropriately with data for 2008 only. In order to gain insight in the dynamics of span of control (changes in UCI), in quality of the data and the methods applied it is recommended to repeat the analysis for another year. To enhance relevance for policy it is recommended to compile time series data for emissions based on the criterion ‘span of control’. Such time series data can eventually help in answering questions regarding ‘carbon leakage’.

Globalisation and development in privatisation can presumably be monitored over time with time series data. This may well be an interesting application for industries operating globally and for policy makers.

### *2. Emission coefficients*

In study we used WIOD data to calculate emissions abroad of Dutch controlled companies. It is recommended to explore more alternative data sources for emission coefficients. Such emission coefficients can be more detailed and/or accurate for certain activities in certain regions / countries.

### *3 Link UCI and income transfers*

Emission intensity of an economy is nowadays very often monitored over time in many countries. For example the Green Growth framework of the OECD recommends monitoring this ratio indicator over time. As an extension to emission intensities calculated from production type emissions and GDP, we recommend monitoring emission-intensity based upon a quite different concept for both the ‘physical’ part as well as the ‘economy’ part.

In this study we made an attempt to calculate emissions related to span of control. These ‘span of control emissions’ will be the new numerator. These ‘foreign controlled’ emissions can best be confronted, from a conceptual point of view, with national income of a country. National income will in this case be the new denominator.

So from an analytical point of view it would be very useful to have information on income transfers with destination ‘the Netherlands’ by industries in foreign economies which are Dutch controlled (inflow of income). Vice versa, we also need information on income transfers from foreign controlled companies in the Netherlands having destination ‘abroad’ (outflow of income).

### *4. Status of the figures*

The figures presented in this study have the status of additional experimental analytical information which can potentially be used as basis for further in depth research in the field of globalisation and air emissions. The figures may complement already existing information on emissions to air like aggregates such as the Kyoto

figures and SEEA type of emissions. The figures may be used as supplementary analytical background information that can be input for economic-environmental decision making and policy.

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