Explanatory notes on TNO’s carbon footprint

Introduction

TNO calculates its carbon footprint annually and reports on this in the annual report, following the guidelines of the Greenhouse Gas (GHG) Protocol. This document provides a concise rationale for the approach and methodology used. The alignment between the emissions categories used by TNO and the GHG Protocol categories is shown in the table at the end of this document.

1 Objective and approach

TNO's carbon footprint is determined as part of TNO's Corporate Social Responsibility (CSR) policy and for the purpose of monitoring the effect of measures taken regarding TNO's climate footprint. TNO's footprint consists of direct emissions (scopes 1 and 2) and emissions and raw material consumption that are associated with the production of energy, materials & products, and services purchased by TNO (scope 3). TNO can influence all these matters, which is why TNO determines its carbon footprint at the level of scope 1 to scope 3[1]. TNO has been publishing its footprint since 2009. The year 2019 has been chosen as the base year against which ambitions and plans are measured, because this was the year in which TNO more actively collected data for the carbon footprint and TNO’s climate neutral policy is measured against.

2 Method

The carbon footprint is calculated for TNO (see section 2.1 for the company boundaries) by multiplying annual figures on the use of products and services (see section 2.2) by the corresponding carbon emissions (see section 2.3). All CO_2 equivalent emissions are included in the calculations, which are CH4 , N2O, HFCs, PFCs, SFe, and NF3.

2.1 Company boundaries for reporting purposes

TNO reports on its own carbon footprint, excluding its participations. TNO's majority participations are TNO Japan KK and Peregrion BV. Both participations are not significant in 2023 and therefore not in scope. TNO's other participations are minority participations with only an economic interest.

2.2 Data on annual usage

The annual amount of substances with direct emissions (natural gas, fuels, and other process gases), energy (electricity and district heating), commuting, business travel, and waste was determined on the basis of 'physical' consumption: travel kilometres, kWh electricity, m^3 (natural) gas, kg waste, etc. Consumption of other products and services was determined on the basis of purchase expenditure.

Consumption data based on physical units is preferred to financial consumption data because financial data is affected by inflation and price negotiation, while price does not (directly) affect the carbon footprint of the service purchased. TNO has opted to use physical data if available in TNO's records and to supplement them as much as possible with financial data from the procurement records. For example, there are no records of all the different office supplies used (type and quantity). For this group of products, an average environmental profile was drawn up for the environmental impact of office supply production per euro (see environmental profile section). Multiplying the expenditure on office supplies by this environmental profile gives an estimate of the environmental impact of office supply production. Because TNO purchases many different office supplies throughout the year, the average over the year represents a good basis for determining total carbon emissions.

The items used by TNO in its procurement records were copied and categorised to give an overview of TNO's carbon footprint. For example, all purchases for desk research have been clustered, as have all purchases for lab research. This approach does not take into account any build-up or reduction of inventories due to a difference between quantities purchased and quantities used. TNO does not have easily accessible records for figures regarding water and for waste from 3 TNO locations[1]. Average waste and water figures of government organisations per employee were used for this purpose [10] [11]. These were multiplied by the number of employees at TNO. This analysis showed that water and waste hardly contribute to TNO's carbon footprint when compared to the other categories. Due to the limited contribution of waste and water, the impact of uncertainty in these figures on TNO's carbon footprint is limited and this approach has been retained. The effort to collect specific figures for TNO is disproportionate to the impact of water and waste on its carbon footprint.

For electricity use, as part of scope 2, both the market based method as well as the location based method are reported. TNO uses the market based method as the basis. This market based method takes the sustainable electricity (certificates) purchased by TNO, or TNO’s lessors into account. The generated electricity technology type of the certificates is a mix of electricity generated by the Sun, Wind and Biomass. Currently, electricity generated by biomass is not reported separately.

2.3 Carbon emissions per consumption category

A carbon-equivalent emission per unit of product has been determined for the production of goods and services. The SKAO Handbook [12] and the carbon emission factors list [13] were used for scope 1 and 2. For the other categories in scope 3, Ecoinvent’s LCA database was used, which contains data on emissions and raw material consumption in the production of products, processes, and services. The Ecoinvent database is the ***state-of-the art*** inventory database most widely used by the LCA community and valued for its transparency. In Ecoinvent, emissions and resource consumption are modelled from 'cradle to gate': from raw material extraction and transport to energy use, emissions, and waste disposal in production processes.

The USA input-output database [2] was used for the environmental profiles per euro. An input-output database is a database that combines a sector's emissions (known from the emissions register) and the sector's total turnover with the deliveries made between sectors (economic databases and models). For example, the butchery sector produces emissions themselves and they purchase from meat farmers, who in turn emit and purchase feed from other farmers and the food industry. In this way, the average environmental impact of an average product from a sector can be calculated across the entire chain. The USA input-output database was chosen because it is the most detailed (five hundred sectors). Danish research [3] has shown that a high level of detail is more important in reducing the uncertainty margin than the geographical origin of the figures. This is partly because the diversity between sectors is relatively high and this is lost at a high level of aggregation. Also, as the world’s economy is global, many products in Europe are similar to products in America because they are produced in Asia for both continents.

TNO’s procurement data is sometimes at a higher level of aggregation than the input-output database data. Based on the experience of TNO's procurement organisation, the average environmental profiles of products (processes and/or services) falling within a certain category and representative of the products and services purchased by TNO were created for the procurement data.

[1] Data is available for almost all TNO locations for 'physical' consumption, except for the Amsterdam, Geleen, and Eindhoven locations.

2.4 Missing data

No data was collected for water and for waste from three TNO locations (scope 3), due to their low impact on total emissions. Quantities were estimated based on the number of employees. To calculate the number of kilometres travelled for business travel by public transport (scope 3), CBS [14] data was used for the cost per passenger kilometre for second-class rail travel, because public transport kilometres are not yet available.

3 Interpretation of the results

3.1 Monitoring annual development

3.1.1 Impact of internal policies

TNO monitors carbon emissions annually, starting in the 2013 annual report. Data from 2009 onwards has been included to provide historical insight. For the stated ambition of Climate Neutrality by 2040, 2019 is used as the base year.

3.1.2 Comparability versus update

Because TNO's carbon emissions are compared with previous years, it is important that the calculation method is the same for all years. Therefore, the method for calculating the carbon footprint has not been adjusted to maintain comparability between them. However, key carbon emission figures have been adjusted where necessary. This adjustment was applied according to the carbon emission factors list [13] and the SKAO Handbook [12]. For electricity, for example, because every year the electricity mix changes a little and, in particular, becomes greener, changing the key carbon emission figure with it. The databases used to determine the carbon emission factors are subject to updates. Carbon emission factors per euro can be adjusted at least for inflation.

3.2 Uncertainties

Uncertainties in reported carbon emissions stem from:

- uncertainties in input data;
- any recalculations required to derive consumption figures from the input data;
- uncertainties in the carbon factor per unit of consumption. Furthermore, uncertainties differ by scope and are highest for scope 3.

3.2.1 Uncertainties for scope 1 carbon emissions

Scope 1 includes direct emissions from the consumption of fuels, such as (natural) gas, petrol, and diesel. At this level, we estimate that the uncertainties are relatively small. Carbon emissions are calculated directly from the fuel consumption (petrol, diesel) of (lease) cars, process gases, and gas consumption in buildings, and multiplied by a carbon emission factor.

For some data points, actual data from a year earlier is used. Given TNO's consumption profile, this can be considered a good indication but remains an assumption. This is, for example, the case for natural gas consumption data from TNO rented locations. The data of the reporting year is not always known and verified by the landlords in the first months of the year.

3.2.2 Uncertainties for scope 2 carbon emissions

Scope 2 includes indirect emissions from purchased energy. Uncertainties in scope 2 consist of the carbon emission factor for purchased electricity for both electric vehicles and buildings. The carbon emission factor was calculated from the sustainable electricity certificates purchased by TNO and the carbon emission factor for the energy mix for grey energy in the Netherlands based on the SKAO Handbook [12] and carbon emission factors list [13]. The latter factor is not specific to TNO's supplier.

Other uncertainties in the scope 2 calculations differ per calculation method applied: market based method or location based method.

For the market based method, the CO_2 emissions factor for purchased electricity is applied to both electricity use in buildings as well as for electric vehicles. The CO_2 emissions factor calculated, is based on the sustainable electricity certificates (EACs) that TNO purchases (mix of electricity generated by Wind, Sun, and Biomass), the electricity generated by TNO's own solar panels and the CO_2 emissions factor for the electricity grid mix (residual mix) in the Netherlands from the SAO handbook [12] and the CO_2 emissions factor list [13]. The latter is not specific to TNO electricity suppliers. For the sustainably purchased electricity and self-generated electricity, TNO uses emission factors including end-of-life emissions. TNO takes, as part of Scope 2, responsibility for this part of emissions given its circularity policy.

For the location based method, only the CO_2 emissions factor for the electricity grid mix (residual mix) in the Netherlands from the SAO handbook [12] and the CO_2 emissions factor list [13] is applied. This is not specific to TNO electricity suppliers.

3.2.3 Uncertainties for scope 3 carbon emissions

Scope 3 includes other indirect emissions from commuting, business travel, and the products and services purchased by TNO. Uncertainties in scope 3 consist of:

- Uncertainties in emission factors for purchased services and products. TNO collects data on annual expenditure in various purchasing categories. For each category, a carbon emission factor was calculated from the USA input-output database [2]. This is where the uncertainties are greatest. If suppliers increase their prices, the calculated carbon emission factor also increases while inflation does not directly affect carbon emissions. The emission factors for procurement were calculated in 2009 for TNO's first annual sustainability report and have not changed since then. Furthermore, it is also unknown to what extent the calculated figures are representative of the actual products or services provided.
- Conversion of air travel input data. TNO collects data on air travel to a number of different regions of the world. For each region, an assumption was made of the average flight distance from the Netherlands to that region. The calculated flight distance per region is multiplied by average carbon emission factors for short-, medium-, and long-haul aircraft. These carbon emission factors are not specific to the type of aircraft actually flown and the exact distance of the flights. Because TNO employees fly relatively frequently with different airlines, the uncertainty by using the average carbon emission factor of the aviation sector is relatively small, provided the figures used are updated sufficiently with developments in the sector.
- Conversion of input data for business train journeys. TNO collects data on the cost of train journeys taken. Based on a calculated average cost per kilometre, the number of passengers per train is calculated. This is then multiplied by the average carbon emission factor per passenger kilometre. Price fluctuations in train journeys, annual or otherwise, are not factored into the calculation.
- For some data points actual data from a year earlier is used. Given TNO's consumption profile, this can be considered a representative estimate for the missing data.

4 Overview TNO carbon footprint & GHG protocol categories

Scope	TNO categories	GHG protocol categories

1	Combustion Natural gas	Stationary combustion
1	Direct lab-emissions	Process emissions, Fugitive emissions
1	Lease cars	Mobile combustion
1	TNO Vehicles	Mobile combustion
2	Electricity use	Purchased electricity
2	District heating	Purchased heat
2	Lease cars, Electricity use	Purchased electricity
3	Mobility	Category 6 - Business travel, Category 7 - Employee commuting, Category 9 - Transportation and distribution
3	Buildings	Category 1 - Purchased goods & services
3	Offices	Category 1 - Purchased goods & services
3	Labs	Category 1 - Purchased goods & services
3	Printed matter and client relations	Category 1 - Purchased goods & services
3	Contracting research and staff	Category 1 - Purchased goods & services
3	Facilities, waste and water	Category 1 - Purchased goods & services, Category 5 - Waste generated from operations
3	Fuels and energy (not included in scope 1 and 2)	Category 3 - Fuel and energy related activities (not included in scope 1 and 2)

5 References

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