APPENDIX 2.

DETERMINING OUR CARBON FOOTPRINT

TNO calculates itscarbon footprint each year, and reports its findings in the Annual Report. This appendix contains a brief explanation of the approach and the method used.

1. OBJECTIVE AND APPROACH

TNO's carbon footprint is determined in order to give direction to its CSR policy and to monitor the effect of measures taken. TNO's environmental impact comes about through its emissions, both direct and indirect (scopes 1 and 2), and through emissions and the use of raw materials that takes place during the production of the energy, products and services that TNO purchases (scope 3). TNO can influence all these factors with its policies, and that is why it determines the carbon footprint across all three scopes.[3] For the sake of comparison with other organisations, TNO opted to determine its carbon footprint starting with its 2013 Annual Report. Before that, it had calculated an overall environmental footprint.

2. METHOD

The carbon footprint is calculated by multiplying annual figures on the consumption of products and services (see section 2.1) by the corresponding CO_2 emissions (see section 2.2).

2.1 Data on annual use

The annual figures for energy (electricity, gas and municipal heating), commuting and business travel have been determined on the basis of 'physical' consumption: passenger-kilometres, kilowatt hours of electricity, cubic metres of natural gas, and so on. The level of consumption of other products and services has been determined on the basis of the purchase cost in euros.

[3] The terms scope 1, 2 and 3 are used in reporting on greenhouse gas emissions [8]. Scope 1 covers the environmental impact of direct emissions, scope 2 adds the direct emissions from the generation of energy and business travel, and scope 3 further adds all emissions from the production and purchase of the energy, goods and services a company uses.

Consumption data based on physical units is preferred to financial consumption data because financial data is affected by inflation and price negotiation, whereas price does not affect thecarbon footprint of the service purchased, or at least not directly. TNO has chosen to use physical data if available in its records, and to supplement that as much as it can with financial data taken from procurement records. For example, there are no records of all the different office supplies used (type or quantity). For this group of products, an average environmental profile was drawn up for the environmental impact of the production of office products per euro (see section 2.2, Environmental profile). Multiplying the spending on office supplies by this environmental profile gives an estimate of the environmental impact of the production of office supplies. Because TNO purchases many different office products throughout the year, the average over the year represents a good basis for determining the total CO_2 emissions produced.

The accounting items that TNO uses in its procurement records have been taken over and categorised to make its carbon footprint clear. For example, all purchases for desk research have been clustered together, as have all purchases for lab research. This approach does not take into account any build-up or run-down of stocks because of a difference between quantities purchased and quantities used.

For figures on water and waste, TNO does not have readily accessible records. Average figures per employee for waste and water at government organisations have been used instead [10] [11]. These have been multiplied by the number of employees at TNO. This analysis shows that water and waste hardly contribute at all to TNO's carbon footprint, certainly compared with activities in the other categories. Accordingly, any uncertainty regarding these figures only has a minor influence on TNO's estimated carbon footprint, and this approach has therefore been kept.

The effort that would be required to collect specific figures for TNO would not be worth it, given how little water and waste influence the organisation's carbon footprint.

2.2 CO_2 emissions by consumption category

CO_2 emissions are determined per unit of product for the production of goods and services. For this purpose, the SKAO Handbook [12] has been used for scopes 1 and 2. Where similar data is used (such as for commuting), the same emissions figures are used for scope 3. For the other categories in scope 3, TNO used the life-cycle assessment (LCA) software SimaPro and various databases containing data on emissions and use of raw materials in the production of products, processes and services. Within this software, CO_2 equivalents are calculated instead of just CO_2 emissions. In order to tally up the influence of the different greenhouse gases, the emission figures are are all converted to CO_2 equivalents.

For the physical usage data, the Ecoinvent database [1] was used, while the USA input-output database [2] was used for the environmental profiles per euro. The Ecoinvent database is the state-of-the-art inventory database that is most commonly used by the LCA community. It is valued for its transparency. In Ecoinvent, emissions and the use of raw materials are modelled 'from cradle to gate': from the extraction of raw materials through transport to energy consumption, emissions and the disposal of waste related to production processes.

In an input-output database, the emissions generated within a sector (which are known from the registration of emissions) and the total turnover that sector generates are combined with the deliveries that the sectors make to each other (economic databases and models). For example, the butchery sector generates its own emissions and buys from livestock farmers, who themselves generate emissions and buy animal 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 supply chain. The USA input-output database was chosen because it is the most detailed, covering 500 sectors. Research carried out in Denmark [3] has shown that a high level of detail is more important for reducing the margin of uncertainty than the geographical origin of the figures. This is partly because the differences between sectors are relatively large, and these differences are not taken into account at a high level of aggregation. In addition, since the economy is global, many products in Europe are comparable to those in the United States, since in both cases they are produced in Asia.

TNO's procurement data is sometimes only available at a higher level of aggregation than that from the input-output database. Based on the experience of TNO's procurement organisation, average environmental profiles are made for products (including processes and services) that fall within a certain category and that are representative of those that TNO purchases.

2.3 Missing data

TNO has decided not to report the energy consumption for some of its small locations. These are rental locations that have a relatively small area (between 30 and 250 m^2) and where only a few people work (one to five people). As the energy consumption that is attributable to TNO at these sites is probably small relative to what TNO consumes overall, it was decided not to devote efforts to obtaining data on the sites. Indeed, because facilities at these locations are shared, it is debatable whether data could be obtained at all for the TNO users only.

No data were collected for water and waste (scope 3), given their small impact on total emissions. Quantities have been estimated based on the number of employees. The number of kilometres travelled by car was used to calculate the number of kilometres for business travel on public transport (scope 2). This is because the number of kilometres travelled on public transport is not available. In order to be able to include the number of kilometres thus travelled, the statistical breakdown given by Statistics Netherlands was used.

3. INTERPRETATION OF THE RESULTS

3.1 Monitoring annual trends

TNO monitors its CO_2 emissions annually; it presented this data for the first time in its 2013 Annual Report. The data from 2009 onwards are included in order to give a historical overview. In order to monitor the effect of CSR policies, the changes over the years could be compared against (yet to be determined) targets for reduced emissions.

Because TNO's CO_2 emissions are measured against those from previous years, it is important that the calculation method be the same for all years. Thecarbon-footprint profiles per unit of use have thus not been changed. That way, comparisons can still be made. Only the usage amounts are adjusted annually. Also, for the sake of a consistent comparison over the years, the figures for waste and water usage per employee have not been adjusted.

The only exception is CO_2 emissions from electricity: according to the SKAO Handbook [12], a different CO_2 parameter should be used for 2009 than for later years. One of TNO's focal points is sustainable procurement.

TNO thus aims to buy products that, among other things, have a lowercarbon footprint. However, this has not yet been included in the method TNO uses to calculate its carbon footprint. One example is the purchase of green electricity. Since 2010, TNO has been purchasing power generated from sustainable sources.

The environmental profile of a kWh of energy from a renewable source is much better than the same profile for grey energy. If TNO were to use the environmental profile for electricity from renewable sources, then based on the same usage, electricity consumption would no longer be visible in the carbon footprint. In order to avoid giving an impression that TNO no longer uses electricity, it was decided to keep basing this calculation on the environmental profile of grey electricity and to include an explanation of what method has been used.

The databases used to determine the CO_2 emissions factors are updated from time to time. CO_2 emissions factors per euro can be corrected, at least for inflation. The method for translating all emissions and the consumption of raw materials into an environmental impact is also being developed further. It is estimated that these updates will only have a minor effect on the understanding of the organisation's carbon footprint, provided that the updated calculation method is applied to all the years being compared. In order to keep up with the latest developments in databases and methods of determining environmental burdens, the method of calculation could be revised every three to five years.

3.2 Uncertainties

The uncertainties in the reported numbers for CO_2 emissions stem from:

- 1) uncertainties in input data
- 2) any recalculations needed to derive consumption from the input data
- 3) uncertainties in the CO_2 factor per unit of consumption

Furthermore, the uncertainties differ by scope and are greatest for scope 3. The uncertainties in the CO_2 emission profiles per unit of product/service do not affect the comparison of TNO's carbon footprint over the years, because the environmental profiles have for the most part been kept the same (see section 3.2.1).

3.2.1 Uncertainties for CO_2 emissions in scope 1

Scope 1 includes direct emissions from the consumption of fuels, such as gas, petrol and diesel. At this level, we estimate that the uncertainties are relatively small. CO_2 emissions are calculated directly from the petrol and diesel consumption of the lease cars and from the consumption of gas in buildings, multiplied by a CO_2 emissions factor.

3.2.2 Uncertainties for CO_2 emissions in scope 2

Scope 2 includes indirect emissions from energy purchased and business travel. The uncertainties in scope 2 consist of:

- The CO_2 emissions factor for electricity that is purchased for both electric vehicles and buildings. The CO_2 emissions factor is calculated for the energy mix for grey electricity in the Netherlands, based on the SKAO manual [12]. This CO_2 emissions factor is thus not specific to the supplier from which TNO purchases electricity.
- Conversion of input data for air travel. TNO collects data on the number of flights taken to various regions around the world. An assumption is made about the average distance by plane from the Netherlands to each region. That distance is multiplied by the average CO_2 emissions factors for short, medium and long distances travelled by air. These CO_2 emissions factors are not specific to the types of aircraft actually flown or to the exact distances involved. Because TNO employees fly relatively often with different airlines, the uncertainty involved in using the average CO_2 emissions factor for the aviation sector is relatively small, provided that the figures used are updated to keep up with developments in the sector.
- Conversion of input data for train travel. TNO collects data on the costs of the train journeys made. Based on the calculated average cost per kilometre, the number of passengers per train is calculated. This is then multiplied by the average CO_2 emissions factor per passenger-kilometre. Annual price fluctuations in train journeys are not taken into account in the calculation.

3.2.3 Uncertainties for CO_2 emissions in scope 3

Scope 3 includes other indirect emissions for commuting and for the products and services TNO purchases. The uncertainties in scope 3 have to do with:

- The conversion of input data for commuting. TNO collects data on the distance between the place of employment and the home address of each employee. By means of an employee survey, a determination is made, for each distance category, of how employees commute to work, whether on foot, by bicycle, by public transport or by car. From the number of employees per distance category, an average distribution among the modes is determined, and that is then multiplied by the total distance for commuting. For each mode, the number of kilometres is multiplied by average CO_2 emission factors for each mode. One of the uncertainties comes from the fact that it is not known what type of car is used for commuting, and thus what proportion of the cars used run on diesel, petrol or electricity. The type of public transport used – bus, tram, metro, or train – is also unknown.

- Uncertainties in emissions factors for services and products purchased. TNO collects data on annual expenditures in various procurement categories. For each category, a CO_2 emissions factor is calculated from various data sources. This is where the uncertainties are the greatest. If suppliers increase their prices, the calculated CO_2 emissions factor also increases, whereas inflation does not directly affect actual CO_2 emissions. The emissions factors for procurement were calculated in 2009 for TNO's first CSR report, and have not changed since then. Furthermore, it is not known to what extent the figures that have been calculated are representative of the actual products or services provided.

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