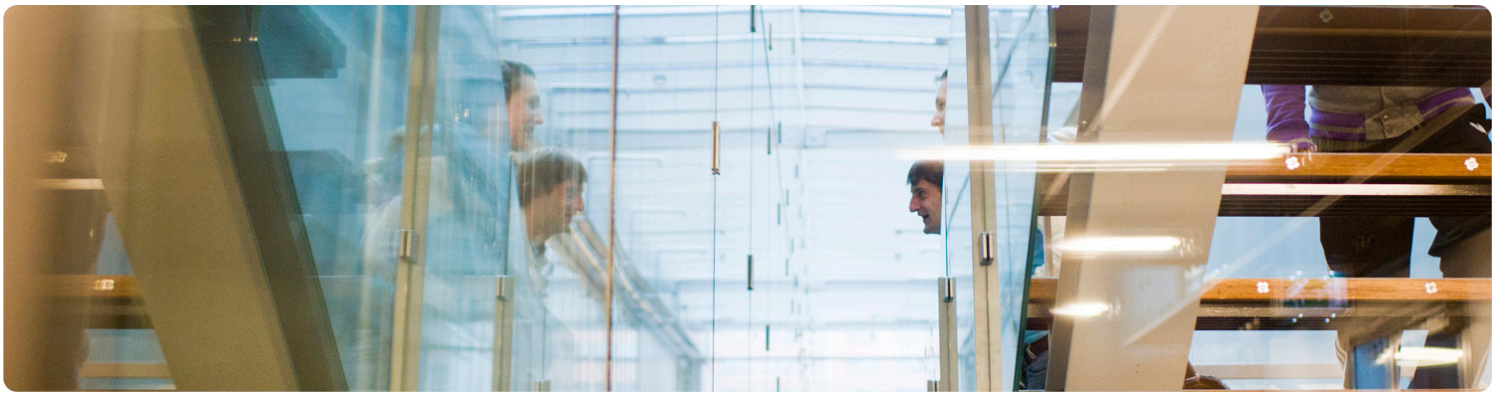

Carbon footprint of SURFnet 2012

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Version: 1.1

Date: 16-01-2014

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Nederlandse samenvatting

Dit rapport beschrijft het energiegebruik en daarmee de CO2-uitstoot van SURFnet en laat zien hoe deze getallen berekend zijn. Deze manier van rapporteren voldoet aan de ISO14064-standaard, een algemeen gebruikte standaard voor soortgelijke rapportages. Dit rapport verschijnt nu voor het derde jaar. Dit rapport is niet gevalideerd door een externe partij.

De totale CO_2-eq uitstoot van SURFnet en haar diensten in 2012 is 1469 ton CO_2-eq.

English summary

SURFnet wants to account for its energy consumption in a way that it can compare itself to other National Research and Education Networks (NRENs) in Europe. To that end, an assessment was held to account for the Green House Gas (GHG) emission in 2012, according to the ISO 14064:2006 part 1 standard. SURFnet starting reporting on GHG emissions in 2010.

The quantitative assessment is limited to Scope 1 (direct emissions) and Scope 2 (indirect emissions related to bought energy) and certain parts of Scope 3 emissions (e.g. emissions related to the production of bought products, travel, waste). The total GHG emission under Scope 1, Scope 2, and Scope 3 accounted for by SURFnet in 2012 is equal 1469 ton CO_2-eq.

This report was not submitted for independent validation by a third party.

1 Introduction

1.1 Background

Starting in 2009 SURFnet started an investigation to get more insight in the energy consumption of the SURFnet network and the energy consumption of its customers. This investigation, targeted at electrical energy consumption of the SURFnet network, resulted in a report 'Energy consumption of the SURFnet network'.

SURFnet has the ambition to report on its energy consumption in the annual reports and to lower the carbon dioxide emission and the environmental footprint. Energy consumption is also subject of the GN3 research programme (http://www.geant.net/research/environmental_impact/Pages/home.aspx), which is a collaborative effort of European Research and Education Networks (NRENs). SURFnet considers it valuable to be able to compare itself to other NRENs using similar methods.

1.2 Scope

The primary goal of this assessment is to account for the Green House Gas (GHG) emission according to the ISO 14064:2006 part 1 standard. This means that Scope 1 (direct emissions), Scope 2 (indirect emissions related to bought energy), and Scope 3 emissions (e.g. emissions related to the production of bought products, travel, waste) are all included in this assessment.

1.3 Purpose and Profile

SURFnet has three goals with respect to reporting on carbon dioxide emission footprint.

- Accountability with respect to the stakeholders of SURFnet. SURFnet has set the ambition to report henceforth on its energy consumption and to lower carbon dioxide emissions and environmental footprint.

- Creating awareness at the institutions that use the SURFnet network.

- Achieving the same level of accountability and comparing carbon dioxide emission levels to other research networks in Europe. Environmental impact is part of the GN3 research programme, a collaboration of European NRENs, such as SURFnet. Other European Research network providers (NRENs) have started to report carbon dioxide emissions.

2 Inventory Design and Development

2.1 Organisational boundaries

SURFnet is responsible for the connectivity services of higher education and research institutions of the Netherlands. To deliver these connectivity services, network equipment is installed and used in a variety of locations. Some of these locations are solely used by SURFnet, some are shared.

The 'operational boundaries' of SURFnet include the office located in Utrecht, and the backbone, which is the SURFnet computer network. The computer network consists of

- network equipment like switches, routers and optical network equipment.
- Computer servers and other equipment owned by SURFnet

The GHG emissions of SURFnet are consolidated into three categories (the office, services and the network), and each is measured in a controlled and documented manner. In this way, SURFnet will account for all GHG emissions and removals from facilities over which it has financial and operational control.

2.2 Responsible Party

This inventory report was prepared by SURFnet. Primary contact is Albert Hankel, email: albert.hankel@surfnet.nl

2.3 Reporting Period Covered

The period covered by this inventory is the year from January 2012 to December 2012, both inclusive.

2.4 Base Years

The first GHG inventory for SURFnet, covering the year January 2010 to December 2010 serves as historical base year as well as base year for this inventory.

2.5 Base Year Changes and Recalculations

In scope of this GHG emission assessment of SURFnet are the SURFnet computer network, SURFnet computer equipment, the office located in Utrecht and transport.

The most relevant changes are to be expected from the growth of the SURFnet network itself. It is very unlikely SURFnet will change its type of business, and start other services. Since 2010, SURFnet owns an asset database in which all SURFnet network equipment is registered. This asset database gives details of each item of equipment, including its type, its manufacturer, model number, physical location etc. The purpose of the asset database, besides serving as an authoritative source of information for the GHG emissions report, is to be the central repository to record company assets. It is the ambition of SURFnet and their company policy to keep the database updated with new acquisitions, disposals and movement of equipment. By having this company policy in relation to the asset database, the accuracy of the information used for the purpose of the GHG emission report is ensured.

2.6 Impact of Uncertainties on the Accuracy of the Data

This section describes the impact of uncertainties on the accuracy of the GHG emissions and removals data. SURFnet has started, in 2010, to measure and report on GHG emissions. The approach is to begin with the simplest methods available, which include invoiced amounts of power consumed, systematic sampling and projection of equipment power consumption. Having reported through this baseline inventory and having engaged senior management in the process of implementing the environmental policy of the organisation, more accurate procedures and systems to measure energy consumed will be used.

Nonetheless, the methodologies used in conducting this inventory have been discussed and agreed by the team responsible. We believe that they give a reasonably accurate indication of the level of GHG emissions by the organisation in the reporting period.

At more detailed level, uncertainties in data could be caused by several factors. The following paragraphs describe these factors.

Incorrect network/computer asset (device type) count: Starting in 2010 SURFnet owns and uses an asset management system, which contains accurate information on the installed base of network equipment. For this assessment, this asset database was used to provide equipment type counts. While preparing this report we visited several sites to check for deviations from this database, which are minimal. Therefore we expect deviations in network equipment counts to be minimal (less than ten devices). SURFnet does not have an asset management system for their computer systems, used to deliver services over the network.

Deviations in Operational boundaries: As mentioned in the previous paragraph, SURFnet owns an asset management system. In this system the location of network equipment is included in this database. A change in the number of locations is tracked in this system. For computer systems SURFnet does not own an asset management system.

Power measurement instead of consumption counts: The energy consumption of the SURFnet network is based on two power measurements from a part of SURFnet network equipment (January and December 2012). These measurements were necessary because no electrical power/consumption meters were installed in facilities. The task of installing electrical consumption meters (which is the most accurate measurement method) was not done because of complexity and costs. This is caused by the large number of locations, and the variation in power distribution per location. At this moment SURFnet is working on software based energy consumption monitoring in it's network.
The deviation in energy consumption caused by doing power measurements is described in our previous report (appended in file B7), which includes an error calculation in sections 3.4 and 3.5. Based on this discussion we expect a deviation of the total energy consumption of approximately 4%. This results in GHG emissions in chapter 7 to be expressed in two digits.

Uncertainties related to the office: The amount of GHG emissions related to services, heating, cooling the SURFnet office in Utrecht are a source of inaccuracy since no power or energy measurement devices are available for heating, cooling and servicing (lifts, security, lighting corridors in the complex) the office. Correct measurements are only available for the electricity meter of the office itself. Due to a lack of meters, the GHG emissions are derived from the service costs in relation to the total GHG emission of the building complex (Hoog Catharijne). The impact of deviations in this area is minor due to the fact that the size of emissions is small compared to emissions related to the SURFnet network.

Uncertainties related to transport: The amount of GHG emissions related to transport: commuting, and on-mission travel are a source of inaccuracy since a travel log is not available for all types of transport (only for airplane flights). In cases where not enough data is available, GHG emissions related to transport are derived from the known travel distance (by train) for each employee, and a questionnaire. The impact of deviations in this area is expected to be small, due to the fact that size of emissions is relatively small compared to that of the SURFnet network. It should also be noted that the SURFnet office is located at the railway station in Utrecht and that all employees do their daily commuting to SURFnet by train. In this case, travel distance can be estimated with little error.

2.7 Compliance Statement

This section confirms that the GHG report has been prepared in accordance with the appropriate part of ISO-14064. This GHG inventory has been prepared in accordance with ISO 14064-1.

2.8 Verification Statement

This section describes whether the GHG inventory, report or assertion has been verified, including the type.

This report was not submitted for independent validation to assure that the report is in accordance with ISO 14064. The method of collecting and processing the data has been validated in 2011 and this report follows the same steps as in 2011. For the 2013 report we will change the way we the energy consumption of our network (software based instead of extrapolated clamp measurements) and this will be reason for us to verify the next report.

3 Calculating GHG emissions

Green house gasses and CO_2-eq definition

The green house gasses (GHGs) are:

- Carbon dioxide (CO_2).
- Methane (CH_4).
- Nitrous Oxide (N_2O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulphur Hexafluoride (SF_6).

When GHG emissions are calculated, the impact of each GHG is transformed to a CO2 equivalent. This is done by multiplying the emissions of a GHG by a factor that represents the effect of the GHG on climate change. These effects are based on the IPCC GWP100 factors. The effect of CO2 is 1, since by definition effect of CO2 is 1 CO2-eq.

3.1 Data used for calculating GHG emissions

In order to calculate the GHG emissions, different data sources are used. For the GHG emission of heating with a natural gas boiler, ecoinvent unit process data has been used. The emission of 1 MJ “Natural gas, burned in boiler modulating <100kW/RER U” is 0,0734 kg CO2-eq.

Based on the “achtergrondsgegevens stroometikettering 2011” (backgrounddata energy labelling 2010) published by CE Delft, the average CO2-eq caused by 1 kWh of electricity in the Netherlands is 300g CO2-eq in 2011. This applies for the total energy demand in the Netherlands. The data for 2012 are not known, therefore this data is the most actual and hereby used.

In the Netherlands, the choice of energy contract is free. Individual customers can decide to have a renewable or non-renewable energy contract. For renewable energy (31% market share in 2011) are no CO2-eq emissions accounted. The non-renewable energy (69% market share in 2011) is accounted for 434g CO2-eq/kWh. (300g is equal to 69% of 434g)

The CO2-eq emissions related to travelling between train station and home/office is taken as the average of CO2-eq emissions for each non-train transportation method (based on http://www.milieucentraal.nl/themas/schoon-en-zuinig-op-weg/auto-ov-of-fiets). The average CO2-eq emission of 1km travel between train station and home/office is 85 g/km.

4 Scope 1: Direct GHG Emissions

Direct (Scope 1) GHG emissions are defined as emissions caused by the combustion of fuels by SURFnet or direct emissions of GHGs. These emissions are characterized as Scope 1 according to ISO 14064.

- The SURFnet office (Radboudkwartier 273, 3511 CK, Utrecht) is located in a multi-tenant building (Hoog Catharijne) with a central heating and cooling system (powered by natural gas) used for heating and cooling the offices located in the building. Since no data for 2012 are available, direct emissions were derived from an overview of the service costs for the entire complex for the year 2011. The proportional GHG emission was related to the SURFnet office based on the service costs. The calculation available in appended file B3 estimates that 737GJ should be attributed to SURFnet. This corresponds to 54 tons CO2-eq (based on 0,0734 kg CO2-eq per MJ).

- SURFnet does not own any car or other form of motorised transport which causes direct or combustion related emissions of the GHGs listed.

- SURFnet makes use of approximately 290 locations varying in size from a small computer room (a few square meters) to locations with more than 100 square meters. Typically the larger datacentres make use of diesel powered generators as a backup for mains electricity. The use of those diesel powered generators is generally restricted to outages and interruptions of mains electricity and periodic operational testing. Therefore it was decided to not take into account the emissions related to the use of these generators.

4.1.1 GHG Removals

SURFnet is not responsible for any GHG removals.

4.1.2 Exclusions

As is described in the introduction of this section, the diesel powered backup generators are excluded from this inventory. The underlying reason is that use of these generators is restricted to outages and interruptions of mains electricity and operational testing.

4.1.3 Direct CO2 Emissions from the Combustion of Biomass

SURFnet is not responsible for any combustion of biomass.

4.1.4 Total CO2-eq under Scope 1

The total Scope 1 CO_2-eq emission is 54 tons.

5 Scope 2: Indirect GHG Emissions

This section covers the methodology use to quantify energy-indirect GHG emissions, by sector, within SURFnet boundaries. Indirect GHG emissions are caused by using energy produced by others (e.g. electricity or heat).

This section provides the Scope 2 GHG emissions for the SURFnet office (section 5.2), the SURFnet network (5.3), and the SURFnet services (5.4).

5.1 Quantification Methodologies

In this inventory, only recurrent emissions are considered. The embedded energy and consequent GHG emissions from building and production of facilities and equipment are not included. SURFnet does not produce any GHGs by direct emission (see previous chapter). Indirect emissions are calculated from activities in two areas:

The office: the SURFnet office at Radboudkwartier 273, 3511 CK, Utrecht which serves as the company's sole premises and where all staff are employed. Indirect emissions in this area originate from:

- Electricity usage for the office itself. Electricity is used for lighting, desktop/laptop computers (not the network), coffee machines, displays, beamers, etc.

- Electricity for building services. The SURFnet office is located in a multi-tenant building. Outside the office energy is spent in lifts, lighting and security.

- The SURFnet office hosts a small part, eight network components plus an air-conditioning, of the SURFnet computer network (Ut002A). Six of these eight network components are passive and do not consume electrical energy. In order to avoid double counting of energy consumption, the consumed energy of this small part of the network is subtracted from the office electricity usage. This is corrected under exclusions.

The Network: the network (or backbone) comprising all facilities, PoPs (points of presence) where network equipment, owned by SURFnet is located. Equipment that is included in the network is:
- The IP routers (located at two PoP sites in Amsterdam)
- The "photonic layer" which is the optical network consisting of optical amplifiers, (de)multiplex devices, wavelength switches, optical controllers and DWDM equipment
- Edge network equipment like switches
- A limited number (smaller than ten) utility server systems all located in the Amsterdam (Asd001A) datacentre. These systems are installed for various purposes: network management, testing, probing, time service (NTP), and troubleshooting.

The Services: the services comprising all facilities, PoPs (points of presence) where computer equipment, owned by SURFnet is located. Equipment that is included in this category are: webservers, storage systems, local network switches.

In 2009 TNO conducted a study on behalf of SURFnet with the goal to make an estimation of energy consumption of the SURFnet network. The final report of this study is available in appended file B7. The methodology of estimating the energy consumption of the SURFnet network is described in this document. In short, the method is based on conducting sample power measurements of operational network components. These measurements are converted into average power figures (including

statistical error) for each type of network equipment, and based on that estimated power for individual sites and the SURFnet network as a whole. For the whole SURFnet network the expected deviation was rated at 4%.

5.2 The Office

5.2.1 Facilities

The only office facility accounted for is the office in Utrecht (Radboudkwartier 273, 3511 CK, Utrecht), the electricity used by the office is accounted for as well as the proportional amount of electricity used for building services inside and outside the office (lifts, security, lighting).

5.2.2 Exclusions

A small part of electricity consumption in the office is excluded. This is done in order to avoid double counting. This is a small part of the SURFnet computer network accounted for in section 5.3. The excluded parts are eight network components plus an air-conditioning system. Six of these eight network components do not consume any energy (passive optical equipment) and two systems do consume electrical energy (UT002A_O5 and UT002A_OME01). The estimated energy consumption of these systems including air conditioning is 10494 kWh. The detailed calculation is included in appended file B4. Therefore the 10494 kWh used by the UT002A pop in the office causes an indirect emission of **3** ton CO_2-eq (10494 multiplied by 300, see section 5.2.4).

5.2.3 Sample

The electricity bill for the year 2012 received from the electricity company Eneco (Eneco, PO Box 666 3000 AR, Rotterdam, The Netherlands) is available in appended file B2. An overview of the energy spent in building services, heating and cooling is available in appended file B1.

5.2.4 Measurement Method

The electricity bill (appended in file B2) lists 229918 kWh (122749 kWh + 107169 kWh) used by the office for the year 2012. The 229918 kWh used by the office causes an indirect emission of **69** ton CO_2-eq (229918 multiplied by 300g per kWh).

The SURFnet office hosts a small part of the SURFnet computer network (The office is identified by Ut002A in appended file B5).

Appended file B1 provides an overview of the energy consumption needed for building services (lifts, security, lighting) of the ‘Hoog Catharijne’ complex where the SURFnet office is located. The proportional energy consumption was related to the SURFnet office based on service costs. The calculation available in appended file B3 estimates that 113494 kWh should be attributed to SURFnet for services. This amount is multiplied by the Dutch average CO_2-eq for 1 kWh (300g per kWh), which results in an emission of **34** tons.

In section 5.2.2 the SURFnet office hosts a small part of the SURFnet network. In order to avoid double counting (the network is accounted for in 5.3), the emissions of this part of the network are **-3** ton CO_2-eq.

5.3 The SURFnet network

5.3.1 Facilities

SURFnet makes use of approximately 290 locations that vary in size. Each location houses a part of the SURFnet network in the form of computer network equipment (switches, optical network equipment, etc.).

- Most locations are small (a few square meters) computer rooms located at customer-premises: office buildings or schools.

- A few locations are larger computer rooms or part of a data centre. Size is up to 100 square meters.

- All locations provide a housing service to SURFnet. At each location, network equipment owned by SURFnet is installed. The housing service provides energy in the form of electricity needed to power all systems, and cooling to condition the environment of installed devices.

Energy consumption and GHG emissions of the SURFnet network is influenced by the following factors:

- *Energy consumption of installed network equipment:* The installed base of network equipment per location, and their corresponding electrical energy consumption over the measurement period.

- *Energy consumption of the facility:* Additional energy consumption of the facility required for the housed network equipment. Energy consumption is predominantly caused by cooling systems, but also the power distribution network, and additional services (security, lighting).

- *Energy source:* The type of energy source per facility: renewable or non-renewable. Facility owners can choose to select a 'green' electrical energy contract, which corresponds to electrical energy generated by renewable sources only.

5.3.2 Exclusions

Network and server equipment not owned by SURFnet is excluded from this report.

5.3.3 Sample

Included in appended file B5 is an excel sheet containing the measurement results of power consumption of individual network equipment devices. This excel is a log of power measurements of individual network equipment. Also included in B5 is an export from the asset management system that contains a list of all components in the SURFnet network.

It is not possible to track down all energy suppliers for each location used by SURFnet. This is caused by the large number of locations, each with the freedom to choose their own supplier, which makes it a complex task to retrieve all energy suppliers and the corresponding energy contract type (based on renewable or non-renewable energy).

5.3.4 Measurement Method

No facilities are equipped with energy consumption meters, which solely measure the amount of energy used by SURFnet equipment. At time of preparing this document no reports were available of periodic measurements.

The approach taken here is to use the asset inventory of SURFnet (available in B5, worksheet inventory), and take sample measurements for all available network equipment types being used at SURFnet. For these sample measurements, a number of locations were visited (ASD001A, DT001B, RT001A, UT001A). Based on these measurements, the total power consumption of SURFnet equipment can be estimated. In order to get an indication of the measurement error, the estimated power consumption is compared to the total power consumption for locations where total power consumption is known. Detailed information on the used methodology, the measurements and the estimation of total energy consumption is available in a separate report. This report is appended in file B7.

Per location the amount of additional energy spent on cooling, power distribution, lighting and security is derived from the Power Usage Efficiency (PUE) factor per location. PUE stands for the relation between the total amount of energy used by a data centre, and the amount of energy actually supplied to computer systems hosted in the data centre. The PUE factor is only known for a very limited number of data centres. Therefore an above average PUE factor of 2 is assumed for all locations, except for those where the PUE value is known.

5.3.5 GHG emission of the SURFnet network

Details of the calculation of CO_2-eq is provided in a separate excel sheet available in appended file B5.

The total energy consumption of the SURFnet network, including the overhead of all facilities, is 2890493 kWh in 2012. This amount is multiplied by the GHG emission factor (300 g/kWh) and corresponds to **867** tons CO_2-eq.

5.4 SURFnet services

5.4.1 Facilities

SURFnet makes use of approximately 290 locations varying in size. Five of these locations house computer systems used to deliver services over the SURFnet network.

These locations provide a housing service to SURFnet computer equipment. At each location, computer equipment owned by SURFnet is installed in rack cabinets. The housing service provides energy in the form of electricity needed to power all systems, and cooling condition the environment of installed devices.

Energy consumption and GHG emissions of the SURFnet network is influenced by the following factors:

- *Energy consumption of installed computer equipment:* The installed base of computer equipment per location, and their corresponding electrical energy consumption over the measurement period.

- *Energy consumption of the facility:* Additional energy consumption of the facility required for the housed computer equipment. Energy consumption is predominantly caused by cooling systems, but also the power distribution network, and additional services (security, lighting).

- *Energy source:* The type of energy source per facility: renewable or non-renewable. Facility owners can choose to select a ‘green’ electrical energy contract, which corresponds to electrical energy generated by renewable sources only.

5.4.2 Exclusions

Network and server equipment not owned by SURFnet is excluded from this report.

5.4.3 Sample

Included in appended file B6 is an excel sheet containing the measurement results of the five locations where computer equipment owned by SURFnet is installed. These locations are NIKHEF (Amsterdam), SARA (Amsterdam), Radboud University (Nijmegen), UMC Utrecht (Utrecht), and Tilburg University (Tilburg). Energy consumption is calculated per rack cabinet containing computer equipment. The rack cabinets at SARA, Radboud University and UMC Utrecht are equipped with energy consumption counters. In this case energy consumption is based on an export received from the staff on site. Rack cabinets at other locations are not equipped with energy consumption counters so that energy consumption is calculated from power measurements on site done in 2011. All measurement data is available in the worksheet measurements of B6.

It is not possible to track down all energy suppliers for each location used by SURFnet. This is caused by the large number of locations, each with the freedom to choose their own supplier, which makes it a complex task to retrieve all energy suppliers and the corresponding energy contract type (based on renewable or non-renewable energy).

5.4.4 Measurement Method

The approach taken here is to calculate energy consumption per computer rack or site instead of individual component. This is primarily caused by the fact that at the time of writing this report, no asset database for computer equipment is available.

Three locations (SARA, Radboud University and UMC Utrecht) were equipped with energy consumption counters. Energy consumption for these sites were calculated based on an export received from the staff on site.

The other locations were visited in 2011 to conduct power measurements (like was done for the network) and derive energy consumption from this data. Because no more recent data is available, the data from 2011 is used for these sites.

5.4.5 GHG emission of the SURFnet services

Details of the calculation of CO_2-eq is provided in a separate excel sheet available in appended file B6.

The total energy consumption of the SURFnet computer systems, including the overhead of all facilities, is 737281 kWh in 2012. This amount is multiplied by the GHG emission factor (300 g/kWh) and corresponds to **221** tons CO_2-eq.

5.5 Total CO2-eq under Scope 2

The total GHG emission under Scope 2 is the sum of 69, -3, 34, 867 ton (for the network) and 221 ton (for the service) CO_2-eq, which is equal to **1188** ton CO_2-eq.

6 Scope 3: Other indirect GHG emissions

Indirect GHG emissions in Scope 3 are emissions of GHGs caused by transport (commuting and on mission using other than own transport vehicles) and network operations.

In Scope 3 GHG emissions for SURFnet are caused by: Transport (commuting by predominantly train, train trips and airplane flights on mission) and Network operations.

The sources of these emissions related to transport arise from the following sources:
- Gasoline and diesel fuel: used by private cars, motorbikes, taxis, buses, and trains
- Aviation fuel: used by aircraft for air travel
- Electricity: used by trains, trams, and metros

6.1 Transport

6.1.1 Scope

In this section, GHG emissions due to forms of transport are considered in two categories, concerning all employees of SURFnet: commuting to and from work, and travel "on mission" as part of one's duties to SURFnet

6.1.2 Exclusions

There are no exclusions from either category of transport

6.1.3 Sample

Appended to this report is excel document B8 'B8 - Transport.xlsx' which includes an export from the travel agency (in worksheet 'on mission – air travel') an export from the SURFnet employee database was inserted in worksheet 'commuting'.

6.1.4 Measurement method

The SURFnet office is located very close to the railway station in Utrecht. This means that all employees commute by train (if not traveling from Utrecht itself). Worksheet 'commuting' in B8 contains a list of all employees, their place of residence and the corresponding round-trip distance by train to the Utrecht railway station, as well as the round-trip reference travel distance of 10.2km (based on two times the average of 5.1km for the Netherlands in 2008, from compendium voor de leefomgeving, http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl2092-Woonafstand-tot-treinstation.html?i=38-187).

Via a questionnaire, SURFnet employees were asked about their working at home behaviour (Question 1: "Hoe vaak werk je thuis?"). Based on the answers to this question, it was estimated that on average, each employee works at home 27.9 days a year.

The same questionnaire was used to get insight in the amount of on-mission travelling (Question 2: "How many trips per month?"). Based on the answers to this question a total number of 1998 trips was calculated. The average trip distance was derived from the list of institutions (clients) connected to SURFnet and their travel distance (by train to Utrecht). Also each on mission trip includes 10.2 km traveling on location (based on two times the average of 5.1km for the Netherlands in 2008, from compendium voor de leefomgeving).

Data for air traveling was supplied by the travel agency, which is supposed to arrange all air traveling trips. A list of trips, and their corresponding emission is listed in B8 (worksheet 'on mission – air

travel'). In order to correct for the (in)completeness of this list a third question was added to the questionnaire (Wie boekt de vliegtrip?). Based on the answers to this question it was estimated that the amount of air trips should be increased by 38%.

6.2 Network operations

The activity of network operations (daily management of the SURFnet network) is outsourced to another organization: Telindus-ISIT. The sources of the emissions related to network operations are expected to arise from various sources. We expect the most important emission sources are:

- Gasoline and diesel fuel: used by cars for transport of network equipment and engineers.
- Natural gas: used for heating Telindus-ISIT offices.
- Electricity: used by network management equipment and for the Telindus offices (cooling, lighting)

SURFnet asked Telindus-ISIT to report on their energy consumption/GHG emissions. At this moment no data has been received, so that it cannot be included in this scope.

6.3 Total CO2-eq under Scope 3

The total GHG emission under Scope 3 is the sum of 46, 12 (for commuting), 14, 2 (for on-mission travel) and 153 (for air-travel) ton CO_2-eq, which is equal to **227** ton CO_2-eq.

7 Summary of GHG Emissions

The total GHG emission under Scope 1, Scope 2, and Scope 3 accounted for by SURFnet in 2012 is equal 1469 ton CO_2-eq.

Item	Energy Source	Energy consumption	CO2 Factor	Total (tons CO2)
Scope 1				
Office – Heating & Cooling	Natural gas	737 GJ	0,0734 kg/MJ	54
Scope 2				
Office – electricity	Electricity	229918 kWh	300 g/kWh	69
Network excluded in the Office	Electricity	10494 kWh	300 g/kWh	-3
Office – service	Electricity	113494 kWh	300 g/kWh	34
Network	Electricity	2890493 kWh	300 g/kWh	867
Services	Electricity	737281 kWh	300 g/kWh	221
Scope 3				
Transport – Commuting (trains)	Passenger km	929414 km	49.1 g/km	46
Transport – Commuting (…)	Passenger km	142514 km	85 g/km	12
Transport – On mission (trains)	Passenger km	282118 km	49.1 g/km	14
Transport – On mission (…)	Passenger km	20380 km	85 g/km	2
Transport – On mission (flight)	Passenger km	1247044 km	-	153
Network Operations	Mixed	-	-	-
Totals				
				1469

8 Appendices

This section provides an overview of the files appended to this report with detail information like: measurements, calculations, sample bills, etc. In this report each file is referred to by an identifier. The corresponding filename and a brief description of the contents is listed in the following table:

Identifier	Filename	Description
B1	B1 – office services	This is a scan from a report that contains energy usage numbers received from the owner of the whole complex "Hoog Catharijne", including the SURFnet office.
B2	B2 – office energy invoice.pdf	Scan of the electricity bill of the SURFnet office.
B3	B3 – office services.xlsx	Excel sheet containing the calculation of converting service costs into GHG emission.
B4	B4 – Correction for network in surfnet office.xlsx	Excel sheet containing the calculation of energy consumption of the SURFnet network that is located in the SURFnet office.
B5	B5 – Network energy consumption.xlsx	Excel sheet containing the calculations of the energy consumption of the SURFnet network, the measurement data and exports from the network asset database.
B6	B6 – Server Energy consumption.xlsx	Excel sheet containing the calculations of the energy consumption of the SURFnet services, and measurement data.
B7	B7 – Energy Consumption of the SURFnet Network.pdf	Report describing the method of energy measurement in the SURFnet network.
B8	B8 – Transport.xlsx	Excel sheet containing the data and calculations of transport, commuting and on mission.
B9	B9 – Questionaire.pdf	Results of a questionnaire held among SURFnet employees in order to gather information about their traveling behaviour.

Because of privacy issues, these appendices will not be published on the internet.