



## Carbon footprint of SURFnet 2010

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### ***Samenvatting***

TNO heeft voor SURFnet gemeten hoeveel energie het SURFnet-netwerk en het SURFnet-kantoor jaarlijks gebruiken. Dit rapport beschrijft het energiegebruik en daarmee de CO<sub>2</sub>-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.



# Summary

## Introduction

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 2010, according to the ISO 14064:2006 part 1 standard.

The quantitative assessment is limited to Scope 1 (direct emissions) and Scope 2 (indirect emissions related to bought energy). Accounting for Scope 3 emissions (e.g. emissions related to the production of bought products, travel, waste) is not included in this assessment. Only a qualitative assessment of the GHG emissions in Scope 3 emissions was done.

This report was submitted for independent validation by FORCE technology to assure that the report is in accordance with ISO 14064. This resulted in a positive evaluation statement on April 18 2011.

## About the data

Emissions in scope 1 were derived from the service costs in relation to direct emissions for the entire complex (which SURFnet shares with other tenants).

Emissions in scope 2 comprise emissions related to energy consumption in the SURFnet office (mainly electricity) and the SURFnet network (energy consumption of network equipment, IP routers, switches etc.). Energy consumption in the SURFnet network, the largest contributor, was estimated by comprehensive power measurements of operational network components.

Due to lack of data, the analysis of GHG emissions in Scope 3 has only been done partially. The Scope 3 GHG emissions for SURFnet included in this report are: transport (airplane flights, train and car) and network operations.

A number of uncertainties must be taken into account regarding the accuracy of the data: incorrect network asset count, deviations in operational boundaries, power measurement instead of consumption counts and uncertainties related to the office.

## Results

The emission of GHGs caused by SURFnet calculated within this report is as follows:

- The emissions under scope 1 are 50 ton CO<sub>2</sub>-eq.
- The emissions under scope 2 are 1110 ton CO<sub>2</sub>-eq, mainly caused by the SURFnet network.
- The final figure for GHG emissions by SURFnet in the year 2010 is 1160 tons of CO<sub>2</sub> equivalent.

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# 1 Introduction

## 1.1 Background

At the end of 2009 SURFnet started an investigation to get more insight in the energy consumption of the SURFnet6 network and the energy consumption of its customers. This investigation, targeted at electrical energy consumption of the SURFnet6 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[1], which is a collaborative effort of European Research and Education Networks (NRENs). While SURFnet is not participating in this particular area of the GN3 programme, 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 limited to Scope 1 (direct emissions) and Scope 2 (indirect emissions related to bought energy).

This means that accounting for Scope 3 emissions (e.g. emissions related to the production of bought products, travel, waste) is not included in this assessment. However, a qualitative assessment of the GHG emissions in Scope 3 emissions is included in this document in chapter 6. This information can be used for comparison with other NRENs, and for use by SURFnet and GHG assessments for following years.

## 1.3 SURFnet: 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.

Equipment such as servers (for example web servers) and other equipment located at customer's premises are beyond the operational boundaries of SURFnet. Server equipment is strictly speaking not part of the network, which is the core business function of SURFnet. At this moment the task to get a correct overview of all the server equipment is complex. This is difficult due to a number of things such as virtualisation of servers, equipment that is used but not owned by SURFnet, servers used by other organizations besides SURFnet, etc.

The GHG emissions of SURFnet are consolidated into two categories (the office, 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 TNO on behalf of SURFnet. Primary contact for SURFnet is Albert Hankel, email: [albert.hankel@surfnet.nl](mailto:albert.hankel@surfnet.nl)

### **2.3 Reporting Period Covered**

The period covered by this inventory is the year from January 2010 to December 2010, both inclusive.

### **2.4 Base Years**

This is the first GHG inventory for SURFnet, covering the year January 2010 to December 2010. This period will serve 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, the office located in Utrecht and transport. Out of scope of this assessment are the SURFnet services delivered over the network such as web services, streaming, etc.

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 equipment is registered. This asset database gives details of each item of equipment, including its type, its manufacturer, model number, physical location, service status etc. The purpose of the asset database, besides serving as 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 just 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 asset (device type) count:** At time of preparing our previous report (available in appended file B7) SURFnet did not have an up-to-date asset database from which network device counts could be deduced. The device count number in report B7 was based on partly out-dated design documents and visual inspection of SURFnet sites. In 2009/2010 SURFnet conducted a separate project that resulted in a new 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. At this moment we expect deviations in equipment counts to be minimal (less than ten devices).

**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.

**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 2010). These two 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 planning to gradually introduce electrical consumption meters in the 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.

## **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 submitted for independent validation by FORCE technology to assure that the report is in accordance with ISO 14064. This resulted in a positive evaluation statement on April 18 2011.



## 3 Calculating GHG emissions

### 3.1 Green house gasses and CO<sub>2</sub>-eq definition

The green house gasses (GHGs) are:

- Carbon dioxide (CO<sub>2</sub>).
- Methane (CH<sub>4</sub>).
- Nitrous Oxide (N<sub>2</sub>O).
- Hydrofluorocarbons (HFCs).
- Perfluorocarbons (PFCs).
- Sulphur Hexafluoride (SF<sub>6</sub>).

When GHG emissions are calculated, the impact of each GHG is transformed to a CO<sub>2</sub> 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 CO<sub>2</sub> is 1, since by definition effect of CO<sub>2</sub> is 1 CO<sub>2</sub>-eq.

### 3.2 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 CO<sub>2</sub>-eq.

Based on the "achtergrondsgegevens stroometikettering 2009" (background data energy labelling 2009) published by CE Delft, March 2010, the average CO<sub>2</sub>-eq caused by 1 kWh of electricity in the Netherlands is 364g CO<sub>2</sub>-eq in 2009. This applies for the total energy demand in the Netherlands. The data for 2010 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 (21% market share in 2009) are no CO<sub>2</sub>-eq emissions accounted. The non-renewable energy (79% market share in 2009) is accounted for 461g CO<sub>2</sub>-eq/kWh. (364g is equal to 79% of 461g)

In the context of this assessment we tried to estimate the market share of renewable energy, and the corresponding CO<sub>2</sub>-eq. factor, for the SURFnet locations where network equipment is installed. The energy contract type (renewable vs non-renewable) was requested from location managers (see appended file B5). Based on our request we found that 9.15 locations were making use of renewable energy, and 15.85 locations were using non-renewable energy. For the remaining 219 locations the energy contract type is still unknown. Based on this limited coverage we decided to use the same average CO<sub>2</sub>-eq emission factor of 364g per kWh (for the source see second paragraph of this section).

## **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 system (powered by natural gas) used for heating the offices located in the building. Direct emissions were derived from an overview of the service costs for the entire complex (appended file B1). The proportional GHG emission was related to the SURFnet office based on the service costs. The calculation available in appended file B3 estimates that 687GJ should be attributed to SURFnet. This corresponds to 50 tons CO<sub>2</sub>-eq (based on 0,0734 kg CO<sub>2</sub>-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 GHG Removals**

SURFnet is not responsible for any GHG removals.

### **4.2 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.

### **4.3 Direct CO<sub>2</sub> Emissions from the Combustion of Biomass**

SURFnet is not responsible for any combustion of biomass.

### **4.4 Total CO<sub>2</sub>-eq under Scope 1**

The total Scope 1 CO<sub>2</sub>-eq emission is 50 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) and the SURFnet network (5.3).

### 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.
- Electricity for cooling the building and offices (also SURFnet) in the form of air-conditioning and ventilation.
- The SURFnet office hosts a small part, eight network components plus an airconditioning, 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 (Asd001) datacentre. These systems are installed for various purposes: network management, testing, probing, time service (NTP), and troubleshooting.

In the case of facilities owned by other organisations, SURFnet accounts for its share of GHG emissions. In each case, SURFnet has referred to the owner of the facility to determine the method of consolidation of GHG emissions to be used by all organisations that use that facility.

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 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) and cooling (air conditioning, ventilation).

### **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 part 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 unit. Six of these eight network components are passive (optical equipment) and two systems do (UT002A\_O5 and UT002A\_OME01). The estimated energy consumption of these systems including air-conditioning is 10956 kWh. The detailed calculation is included in appended file B11. Therefore the 10956 kWh used by the UT002A pop in the office causes an indirect emission of 4 ton CO<sub>2</sub>-eq (10956 multiplied by 364). These emissions are subtracted here, because they are accounted for in the network (see section 5.3).

### **5.2.3 Sample**

The electricity bill is received from the Electricity Company (Eneco, PO Box 666 3000 AR, Rotterdam, The Netherlands) is available 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 258973 kWh used by the office for the year 2010. On page one the bill refers to a measurement period from 01/01/2010 to 31/01/2011. We assume this 13 month period is an error because

of the fact that the monthly consumption details on page two refer to exactly one year (twelve months).

The same bill mentions the words 'Toeslag Groen Mix'. This could stand for a renewable (green) energy contract which corresponds to a factor of 0g CO<sub>2</sub>-eq per kWh. The energy provider 'Eneco' was contacted to confirm the renewable source of the energy. At the time of preparing this report Eneco was not able to confirm the renewable source of energy. This is caused by the fact that Eneco changed names and branding of their energy contract types. Therefore the amount of kWh used by the office is multiplied by the Dutch average CO<sub>2</sub>-eq for 1 kWh. Therefore the 258973 kWh used by the office causes an indirect emission of 94 ton CO<sub>2</sub>-eq (258973 multiplied by 364).

The SURFnet office hosts a small part of the SURFnet computer network (The office is identified by Ut002A in appended file B8).

Appended file B1 provides an overview of the energy consumption needed for cooling and 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 143402 kWh should be attributed to SURFnet for services, and that 338 kWh should be attributed to SURFnet for cooling. These amounts are multiplied by the Dutch average CO<sub>2</sub>-eq for 1 kWh (364g per kWh), which results in an emission of 52 tons and 123 kg CO<sub>2</sub>-eq. respectively.

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 (4 ton CO<sub>2</sub>-eq) are subtracted from the total emissions of the office.

## **5.3 The SURFnet network**

### **5.3.1 Facilities**

SURFnet makes use of approximately 290 locations varying 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 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.

### **5.3.2 Exclusions**

Equipment such as servers (for example web servers) and other equipment located at customer's premises are outside the operational boundaries of SURFnet and therefore excluded. Server equipment is not part of the network, and at this moment the task to find out which server equipment belongs to SURFnet is too complex.

### **5.3.3 Sample**

Included in appended file B6 is an excel sheet containing the measurement results of power consumption of individual network equipment devices. This excel sheet was used as a logbook during energy measurements in the datacentre. Also included is an export from the asset management system that contains a list of all components in the SURFnet network. This export is available in appended file B8.

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.

### **5.3.4 Measurement Method**

Only a very limited number of facilities are equipped with power 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, and take sample measurements for all available network equipment-types being used at SURFnet. 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. It is important to note that the amount of equipment is different from the amounts listed in appended file B5. This is caused by the fact that at the time of preparing the previous report, SURFnet was not able to provide a correct list of all network assets. Since then, SURFnet

has introduced an asset management system. As an example an export of assets from this system is available in appended file B8.

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 average PUE factor of 2 is assumed for all locations.

As can be seen in appended file B5, the total energy consumption of the SURFnet network is based on two power measurements: January 2010 and December 2010. For all measured devices, the measured power consumption was logged in appended file B6. The averages per device type are listed in file B5. Changes in power consumption are primarily caused by changing equipment (in case of OME and CPL) or switching off unused equipment (in case of Other and KAST).

The equipment counts in January 2010 per device type were received from Telindus/SARA, the organizations responsible for operational management of the SURFnet network. The list (see appended file B10) is an export from the CMDB managed by Telindus/SARA. This source was used because of the fact that at the beginning of 2010 the new asset database of SURFnet was in development phase, and not yet operational.

The equipment counts in December 2010 per device type were derived from an export of the SURFnet asset database. This export in the form of an excel sheet is available in appended file B8.

In order to check the correctness of the equipment counts available in the asset databases, sites were visited at the beginning and end of 2010 to check the reported device type counts. This task was conducted while doing per device measurements. In both cases this led to the addition of the device type 'Kast' and 'Other' which were found in Amsterdam (Asd001). This is caused by the fact that this location is also used as a central hub, with more old (unused) equipment. The site is also used for experiments and testing. Not all equipment for these purposes is included in the asset database of SURFnet. At this moment SURFnet is investigating this issue, and if needed extends the asset database to the correct situation. While visiting other SURFnet sites, no deviations from the asset database were found. Therefore we are sure that the deviations are only needed for Amsterdam (Asd001).

The counts per device type for January 2010 (from appended file B10) and December 2010 (from appended file B8) were corrected after visiting the sites, which is described in the previous section. The corrected equipment counts, including the source of data is available in appended file B5.

#### 5.3.5 GHG emission of the SURFnet network

Details of the calculation of CO<sub>2</sub>-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  $2.7 * 10^6$  kWh in 2010. This amount is multiplied by the GHG emission factor (364 g/kWh) and corresponds to 967 tons CO<sub>2</sub>-eq.

### **5.3.6 Discussion**

When comparing this data ( $2.7 * 10^6$  kWh) to the previous report on energy consumption of the SURFnet network (appended file B7), the total energy consumption is roughly doubled. This is caused by the fact that the factor 'Energy consumption of the Facility' was not included in the previous calculation. The doubling in power consumption is a result of the PUE factor with a value of 2. Also, it should be noted that the amount of each type of network equipment (in report B7) is different from the amounts used for this calculation. This is caused by the fact that at the time of preparing the previous report, no correct asset database was available, and equipment counts were based on partly out-dated design documents.

Also can be seen (in appended file B5) that the total power consumption in January 2010 and December 2010 was lowered significantly. This caused by two main reasons:

- Some (old) equipment in the category 'Other' and a part of 'Kast' seemed to be running without purpose and was switched off or removed.
- Equipment in the category 'OME' (Optical Multiservice Edge) and CPL were upgraded with increased capacity, more energy-efficient, with a smaller energy impact.

## **5.4 Total CO<sub>2</sub>-eq under Scope 2**

The total GHG emission under Scope 2 is the sum of 94, -4, 52, 0.12 (all for the office) and 967 ton (for the network) CO<sub>2</sub>-eq, which is equal to 1110 ton CO<sub>2</sub>-eq.



## **6 Scope 3: Other indirect GHG emissions**

Indirect GHG emissions in Scope 3 are emissions of GHGs caused by transport (other than own transport vehicles). Due to the lack of data, the analysis of GHG emissions in Scope 3 is done qualitatively.

In Scope 3 GHG emissions for SURFnet are caused by: Transport (airplane flights, train and car) and Network operations.

### **6.1 Transport**

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

All commuter traffic is done by train. Since it is currently not possible to register individual trips, detailed information on total distance travelled by employees of SURFnet cannot be given.

At this moment, only data for air travelling is available. The included excel sheet contains a list of airplane flights in 2010 by SURFnet staff. The list is expected to include the majority of airplane flight. However, it is uncertain if all airplane flights are included. The total GHG emission of airplane flights is 93 ton CO<sub>2</sub>-eq. Data for airplane travel is included in appended file B9.

### **6.2 Network operations**

The activity of network operations (daily management of the SURFnet network) is outsourced to another organization: Telindus/SARA. 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/SARA offices.
- Electricity: used by network management equipment and for the Telindus/SARA offices (cooling, lighting)

SURFnet asked Telindus/SARA to report on their energy consumption/GHG emissions. At this moment (April 15th) no data has been received.

## 7 Summary of GHG Emissions

The emission of GHGs caused by SURFnet calculated within this report is as follows.

- The emissions under scope/tier 1 are 50 ton CO<sub>2</sub>-eq.
- The emissions under scope/tier 2 are 1110 ton CO<sub>2</sub>-eq, mainly caused by the SURFnet network.
- The emissions under scope/tier 3 are largely unknown. Part of flight travel is registered and this results in 93 ton CO<sub>2</sub>-eq.
- The final figure for GHG emissions by SURFnet the year 2010 is 1160 tons of CO<sub>2</sub> equivalent.

Item	Energy source	Energy consumption	CO <sub>2</sub> Factor	Total (tons CO <sub>2</sub> )
<b>Scope 1</b>				
Office – Heating	Natural gas	687 GJ	0,0734 kg/MJ	50
<b>Scope 2</b>				
Office – electricity	Electricity	2.6 * 10 <sup>5</sup> kWh	364 g/kWh	94
Network excluded in the Office	Electricity	1.1 * 10 <sup>4</sup> kWh	364 g/kWh	-4
Office – cooling	Electricity	3.4 * 10 <sup>2</sup> kWh	364 g/kWh	0.12
Office – service	Electricity	1.4* 10 <sup>5</sup> kWh	364 g/kWh	52
Network	Electricity	2.7 * 10 <sup>6</sup> kWh	364 g/kWh	9.7* 10 <sup>2</sup>
Services	Electricity	TBD	364 g/kWh	TBD
<b>Scope 3 (not validated)</b>				
Transport – commuting (trains)	Electricity	TBD	364 g/kWh	TBD
Transport – on mission (trains)	Electricity	TBD	364 g/kWh	TBD
Transport – on mission (flight)	Fuel	-	-	93
Network operations	Mixed	TBD	-	TBD
<b>Totals</b>				
As validated by FORCE				<b>1160</b>
Incl. non-validated emissions				<b>1253</b>

## Separate 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	overzicht_servicekosten.pdf	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	office energy invoice.pdf	Scan of the electricity bill of the SURFnet office over the year 2010
B3	servicekosten_SURFnet.xlsx	Excel sheet containing the calculation of converting service costs into GHG emission (related to B1).
B4	Scope 2 - PUE and Energy source.xls	Background data for locations hosting SURFnet equipment. This sheet contains a PUE (if available) and contract type (if known).
B5	Scope 2 - calculations - Surfnet Network.xls	Calculations of the energy consumption and GHG emissions of the SURFnet network.
B6	Scope 2 - Power Consumption Network Equipment - Measurements.xls	Excel sheet containing the results of measurements of individual devices
B7	Energy Consumption of the SURFnet Network.pdf	Report describing the method of energy measurement in the SURFnet network.
B8	installed-base-7december2010.xlsx	Export of the SURFnet asset database as of 7 December 2010.
B9	Scope 3 - Airplane travel.xls	Overview of GHG emissions related to Airplane travel.
B10	FW afronding nulmeting.txt	Text dump of email from SURFnet to TNO containing the amounts of network equipment at the start of 2010
B11	Scope 2 - Correction SURFnet office.xls	Excel sheet containing the calculation of energy consumption of the SURFnet network which is located in the SURFnet office

## References

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<sup>i</sup> GÉANT website - Environmental Impact,  
[http://www.geant.net/About\\_GEANT/Environmental\\_Impact/Pages/EnvironmentalImpact.aspx](http://www.geant.net/About_GEANT/Environmental_Impact/Pages/EnvironmentalImpact.aspx)