Deliverable D3.3 (DN3.3.1): Environmental Impact Report 2014

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Abstract

This deliverable describes a wide range of initiatives undertaken by the partners in GN3plus Networking Activity 3 (Status and Trends), to reduce environmental impacts in general, and emission of greenhouse gases (GHGs) in particular. It builds on the work from the previous GN3 NA3-T5 (Study of Environmental Impact) team and some of the suggested initiatives in previous deliverables.
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Executive Summary

This deliverable describes a wide range of initiatives undertaken by the partners in GN3plus Networking Activity 3 (Status and Trends), Task 3 (The Greening of ICT) (NA3, T3) to reduce environmental impacts in general, and emission of greenhouse gases (GHGs), in particular. It builds on the work from the previous GN3 NA3, T5 (Study of Environmental Impact) team and some of the suggested initiatives in previous deliverables (“DN3.5.3: Study of Environmental Impact”), expanding some of the research ideas and providing commentary on new findings.

The work plan of GN3plus NA3, T3 is to build initiatives around the following set of objectives and topics discussed in this report, including:

- Recruit NRENs in a positive drive to reduce greenhouse gas (GHG) emissions.
- Provide a forum for sharing information on green policy and practice.
- Publish baseline and longitudinal studies of NRENs’ GHG-reduction performance.
- Develop and adopt standards to measure overall NREN network environmental performance.
- Set targets for efficiency and for use of carbon offsets.
- Increase the uptake of services that are based on or that generate carbon reduction effects, such as virtualisation, teleworking, videoconferencing, etc.
- Develop NREN insights and practices on Green ICT, so that others may benefit.

The GN3plus Environmental Team’s approach to this new Task, NA3, T3, has been to generate a number of tools that will support NRENs to build their competence in environmental sustainability. In order to help stimulate other NRENs to quickly generate an environmental policy, a template has been created, which will help structure the policy components. An environmental policy usually describes the philosophy of an organisation and why it considers environmental sustainability an important process to support. Such aims must then be translated into activity or areas of focus, and a set of energetic action statements developed to indicate how each NREN will pursue its corporate responsibilities.

In order to improve daily work practices and target areas where energy usage can be reduced, it is vital to measure current activities and establish energy usage patterns. It is difficult to target a single set of equipment or location, the total network architecture and users’ needs must be considered as a whole. One of the tools to provide this background information are GHG audits, which measure how much influence to the Earth’s atmosphere is caused by the NRENs’ daily activities. To simplify the reporting of this impact, the team developed...
Executive Summary

a template model, and in GN3plus, this concept has now been extended to the creation of an online audit tool and database that will allow easy report creation and enable benchmarking of results between NRENs.

Support initiatives from the team’s efforts cover many areas of an NREN’s daily business, and campus best practice documents and test cases are being created to disseminate this knowledge. Rather than trying to incorporate such information into this report, a number of synopses from these documents are provided in Section 3.4.t.

Communication is vital to the success of the team, and much activity is concentrated on making other NRENs aware of the team’s work, which includes showcase / webinar training sessions and presentations at relevant conferences. To measure the success of these efforts, the team has set a goal that 20 NRENs from the GÉANT community should have an environmental policy by the end of the GN3plus project in March 2015.

As environmental sustainability is such a large subject, with challenges that ICT specialists can’t always envisage, but are vitally important for users to address, the team works with other organisations that promote environmental awareness, such as the Green Campus Eco-University initiative [ECOUNIVERSITY]. Such initiatives indicate that is possible to demonstrate ICT competence and show how ICT with increased user awareness of sustainability procurement and disposal practices can have a positive influence against the effects of climate change. Such effects will influence the architecture and direction of NRENs. The team will pursue and build competencies to identify the characteristics of such change, which will help NRENs to model new or re-engineered business continuity plans.

Finally, the team will also identify how these work approaches are being extended for the second year of GN3plus.
1 Introduction

The Intergovernmental Panel on Climate Change (IPCC) is about to release its fifth assessment report. The first conclusions have already been published and they are crystal clear [IPCC]:

- "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia".

- "Atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800 000 years".

- Human influence on the climate system is clear. It is extremely likely (95–100% probability) that human influence was the dominant cause of global warming between 1951 and 2010.

- "Continued emissions of greenhouse gases will cause further [global] warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions".

- "Most aspects of climate change will persist for many centuries even if emissions of CO$_2$ are stopped".
NRENs are uniquely positioned to help their organisations transition to a sustainable society. Many of the ICT solutions require central coordination, brokering or infrastructure, which is exactly the function of NRENs for research and Higher Education. Through the facilitation of NRENs, the Higher Education sector can set an example for the broader society. This is not something that is undertaken lightly, and it is important for an NREN community, to grow step by step. To express this, the GN3plus Environmental Team has defined four levels on which NRENs can contribute:

- Make the NREN’s own efforts and work practices more sustainable.
- Deliver green services to clients of the NREN that facilitate their daily activities.
- Help research and education communities use ICT to reduce energy usage or make their campuses more sustainable.
- Educate the next generation in good, environmentally sustainable, work practices.

Activities may have varying degrees of relevance to each NREN. For example, an NREN in Spain may have different priorities than one in Hungary. The former might be more focused on providing resilient, high-speed connectivity to a small number of clients, while the NIIF (Hungarian NREN) network might have to provide low-speed connectivity to thousands of schools distributed over the Hungary, as well as providing high-bandwidth connectivity to its large number of academic institutions. As a result, it would be better to try to characterise the NRENs based on their infrastructure, e.g. NRENs that own their own data centres and cloud computing infrastructure, number of PoPs in their network, and geo-location (a lower PUE value is more easily achievable in a country in the northern part of Europe).
The GN3plus Environmental Team believes that all NRENs should strive to make their own organisation as sustainable as possible, and hopes that an NREN would consider pursuing activities in more than one area. It is important to promote these lines of thinking in and around the NREN community by showing what can be done (via best practice) and sharing methods and online tools to help NRENs along the way. Policy development is vital for NRENs to demonstrate their environmental priorities and a step towards the creation of a more sustainable network. As a result, a policy template and guidelines have also been developed by the team to help promote a consistent approach (see [POLICYTEMPLATE] for more information.

The purpose of this document is to report on the progress of work at the end of the first year of GN3plus. Section 2 describes the plan of action, after which current activities are reported in Section 3. The final section outlines the expected results of this work in Y2 of GN3plus.
2 Action Plan

The GN3plus Environmental Team has started the second phase of its work, to capitalise on the work carried out in the GN3 activity NA3 T5, “Study of Environment Impact”. NRENs have a unique position that can be used to stimulate ideas and promote best practice on the adoption Green ICT for society, including research centres, the higher education community, as well as industry and government. The team realised that in order to maximise the positive impact NRENs can have, collaboration is needed between all parties, HE, industry and government. It is also the responsibility of the team to stimulate, found and support such collaborations. In other words, where the team has first learned what Green ICT means for NREN team members as part of the work undertaken in GN3, now the main task of Activity NA3, Task 3 in GN3plus, is to promote collaboration amongst all NRENs and the higher education community. Therefore, most of the work in this Activity is focused on opening up previous work for other NRENs, stimulating broad collaborations and disseminating lessons learned to the NREN community, higher education, industry and government.

The composition of the team has changed from the previous Project’s Activity, with three new NRENs: AMRES, CyNet and CESnet joining the team, while PSNC and DEIC are no longer members of the team. As of March 2014, the following NRENs are participating in this task as part of NA3,T3:

- HEAnet (Ireland)
- SURFnet (Netherlands)
- GRNET (Greece)
- UNINETT (Norway)
- NIIF/HUNGARNET (Hungary)
- AMRES (Serbia)
- CyNet (Cyprus)
- CESnet (Czech Republic).

2.1 GN3plus Environmental Team Objectives

The initial GN3plus Environmental Team’s proposal included the following objectives:

- Recruit NRENs in a positive drive to reduce greenhouse gas (GHG) emissions.
- Provide a forum for sharing information on green policy and practice.
- Publish baseline and longitudinal studies of NRENs’ GHG performance.
• Develop and adopt standards to measure overall environmental performance.
• Set targets for efficiency and for reducing emissions or compensation against future emissions of carbon dioxide or GHG).
• Increase the uptake of services, which are based on or generate carbon reduction effects, such as virtualisation, teleworking, and videoconferencing.
• Develop local NREN insights and practices on Green ICT, so that others may benefit.

2.2 Applying Previous Feedback

A reviewer of the GN3 NA3, T5 deliverable report suggested that the GN3plus Environmental Team should pursue the following objectives:

• Raise the environmental impact issues, to both the European Commission and European Institutions, and to participate in all relevant initiatives and events.
• Increase the actions of GÉANT partners within their own countries in order to promote the ideas of mitigating environmental impact.
• Ensure that ICT professionals have the required knowledge to handle the environmental impact issues and are capable of designing solutions and operating systems in accordance to the Green ICT rules.
• Mobilise the end users of ICT products in order to change habits and to ensure that they purchase and use ICT devices that are compatible with Green criteria and, in a way, are more friendly to the environment.
• Recognise (reward) enterprises or organisations that adopt and apply Green ICT.
• Promote good practices on environmental impact by adopting a Green ICT certification or a Green ICT mark/sign.

Focus on environmental policy, including the environmental impact of the GÉANT backbone, is key to GN3plus as a whole. Each NREN will have its own organisational remit, but overarching objectives and continued knowledge sharing will help to strengthen project outcomes.

2.3 Scope of NA3, Task 3

The above feedback aligns with the GN3plus Environmental Team’s own proposal for work in GN3plus, and an action plan created with the following tasks in the team’s scope of work during the two years of this project.

• Encourage NRENs to generate Environmental Policies and to live by such policies, where practical.
• Challenge NRENs to evaluate their energy usage and the sources from which they obtain their energy supplies.
• Promote good practices of such equipment usage and reduction of waste in support offices, datacentres and the network deployment locations.
• Actively demonstrate the advantages of ICT to users to help reduce their environmental impact.
• Engage staff to assess environment impact of technology selection and solution deployment reflected in their procurement and tender documents.
2.3.1 Benefits

The following benefits are expected to accrue for project participants striving for the objectives defined by following the generic task descriptions. Note that these benefits are not necessarily limited to the NRENs participating in this work, but the whole NREN community:

- Competency in good work practices for sustainability.
- Best practice guidelines to aid business implementations on top of the normal networking considerations for the NREN community.
- Ability to query the impact of energy consumption in lifecycle costing when selecting equipment.
- Promotion of waste reduction policies for energy usage.

2.3.2 Action Plan

An initial team workshop held in April 2013, identified the following actions to support the work during Year 1 of the GN3plus project:

- Increase the new GN3plus Environmental Team members’ knowledge of GN3plus NA3, T3, while encouraging co-operation between team members.
- Develop an Action Plan for test cases and research studies for 2013–14, that would be reported as individual test cases and summarised in the GN3plus Report to Reviewers (Periodic Report). Each NREN has undertaken to produce at least three test case studies during the lifetime of the project. These studies will be of similar form/extent as the Campus Best practice studies.
- Create GHG emissions reports for each NREN. Since planning, however, this action was found to consume too much manpower resource and proved difficult to compare the performance of each entity. Instead, members of GRNET who were active on the team have taken up the task to produce an online Audit Tool, not only to support team members, but the whole NREN community. The first year of the project has been used to develop the tool, whereas the second year will be used to promote the use of the tool, as well as train new NREN users.
- Develop a template for an NREN environmental policy to stimulate all NRENs to think about Green ICT and sustainability. This template was developed in the first year of the project, and will be disseminated in the second year of the project.
- Disseminate the Environmental Team’s work at several NREN gatherings (such as GÉANT symposia and TERENA Taskforce meetings, TNC, I2GS, NORDUnet conference), as well as outside the NREN community at research, practitioners and policy conferences.
- Organise a special workshop on Green ICT and Sustainability for NRENs where the Environmental Team’s work will be presented alongside the work of others (outside the NREN community).
2.3.3 Test Cases / Best Practice Documents

To show what is possible in Green ICT thinking and to inspire others, several test case or best practice studies will be carried out by the Environmental Team members. The following list includes ongoing studies that are available on the teams’ intranet site.

- An e-waste Policy for NRENs.
- A Green ICT Maturity Model for Higher Education.
- Deciding to Transport Bits or Energy.
- Virtualising Customer Premises Equipment and NREN Energy Savings.
- Steps Taken to Enhance an Asset Database (to ease the generation of an NREN’s Greenhouse Gas Report).
- Power Saving Utilising Power over Ethernet (PoE).
- Improving Energy Efficiency in Greek Schools with IPv6-enabled Smart Meters.
- GRNET Videoconferencing Services.
- Digital Exam Study with Deployment and Impact Metrics.
- Ebooks Platform Development.
Activities

3.1 GHG Emissions Online Reporting Tool

Adoption of energy efficient practices in setup, management, support and decommissioning of networks, combined with the use of ICT technology to measure the success of reducing of the energy consumption in various sectors is considered crucial for the future of all networks. In order to progress towards this direction, and given the lack of robust policies to address climate change, as stated in the GeSI’s SMARTER2020 report [SMARTER2020], NRENs can provide specific guidance to policy makers, based on detailed national studies of the GHG abatement potential in a set of countries.

In response, and within the GN3plus Environmental Team, GRNET has undertaken the initiative for the design and development of an online tool for the collection of data, calculating the annual energy consumption and greenhouse gas (GHG) emissions of NRENs. The main objectives for the development of this tool include the creation of an international database with NRENs’ energy consumption and GHG emissions data. This will provide statistics covering a wide geographical area that demonstrate the energy consumption of IT equipment in various networks and associated computing infrastructures of the NREN’s network, such as servers and storage network devices.

The tool allows network managers to deduce useful conclusions regarding the more energy-hungry parts of an NREN’s infrastructure. In addition, it can be used to help measure the environmental impact when applying energy efficiency techniques (e.g. energy efficiency achieved through virtualisation techniques, or reduction in energy consumption based on approaches to analysing behaviour).

3.1.1 Audit Tool Description

The design of the online tool is based on the widely used ISO 14064 standard for reporting GHG emissions. An adaptation of this standard for use for NRENs was developed as part of the GN3 project, which formed the basis on which the tool was developed. The existing categorisation of NRENs’ GHG emissions and energy consumption is taken into account during the design of the online tool specifications. For NRENs, GHG emissions are consolidated into four categories: the office, the data centres, the network itself and personnel travels (including commuting). Each category is measured using a predefined structure. GHG emissions reports have to be created on an annual basis, and the process of completing the report will be based on a series of webforms for each section or subsection.
3.1.2 Supported Functionalities

Access to the online tool will be based on the support of authentication/authorisation schemes, according to the eduGAIN service [eduGAIN]. Authenticated and authorised users from each NREN will be able to access the tool, view the existing reports, and edit and finalise new reports. Unauthorised users will only be able to see the finalised reports. The final report (without the detailed data for the calculation process or the process itself) will be extracted to a PDF format, and may be used for verification purposes by external bodies (this is a requirement to report an official ISO 14064 compliant report). Specific guidelines (tool-tip texts to specific fields), suggested texts and URLs to existing emission calculators (e.g. calculator for flight emissions) will be provided throughout the process of completing the report online. Text areas for describing methodologies, samples, exclusions per form/section and predefined texts will be provided. There will also be extra functionality provided regarding the ability to upload images and add references to the text in each section.

One page per country, entitled “Report-Specific Data” will also be available. On this page, each NREN will be responsible for inserting/updating/validating country- and report-specific data, such as the reporting period covered, the preferable metric for distance values, the base years, the responsible person and contributors to the report, the emission factors for the specific year and documentation files. “Documentation files” serves as a “storage area” allocated to each NREN for uploading files used for the realisation of the report (e.g. energy consumption bills, reports extracted from energy consumption monitoring tools, etc.).
Figure 3.2: Data entry for energy usage at a facility headquarters

In addition to the introductory forms with report-specific data, specific web forms will be available for providing input data to each category of GHG emissions of each NREN (indirect and direct emissions). For the indirect emissions, specific sub-pages will be available for the office area, including: the networking infrastructure, the data centres and the transportation sector.

Indirect emissions in the office area originate from electricity usage for the office itself (electricity is used for lighting, air conditioning and ventilation, desktop/laptop computers, coffee machines, displays, beamers, etc.) and electricity for building services. Outside the offices, energy is spent on lifts, lighting and security. Specific fields will be available for reporting electricity usage in each area.

Direct energy consumption, as well as emissions in office areas, may derive either from a smart meter installed in an NREN’s premises or from an overview of the service costs for the NREN’s premises (a file with the power utility operator bills or similar statements may be uploaded for verification). The NREN must add the number of units used per bill for the corresponding year to arrive at the annual amount. Then the total amount will be automatically converted to tonnes CO$_2$-eq, based on how many kg CO$_2$-eq correspond to 1 KWh for the NREN’s country in a specific year. The procedure is similar for all energy sources.

Energy consumption of the networking infrastructure includes energy consumption in all the PoPs, where network equipment, owned by the NREN, is located. This equipment may consist of:

- Optical network equipment consisting of optical amplifiers, (de)multiplex devices, wavelength switches, optical controllers and DWDM equipment.
Activities

- IP network equipment, consisting of routers.
- Layer2 network equipment, consisting of switches.

In case the total energy consumption in the PoP, including the networking and the supportive infrastructure, is available (through an energy consumption monitoring infrastructure or the energy bills from the utility operator), the corresponding value may be declared and no further calculations need to be done. Otherwise, the NREN must state all of its PoPs and list the network equipment in each PoP, accompanied with the corresponding energy consumption. In the latter case, energy consumption values may result either from real-time monitoring of energy consumption of the device (e.g. in case of existence of a smart power outlet or in case of collection of such data via SNMP), or from the device specifications in the manufacturer's datasheets.

In the data centres, energy consumption and emissions derive from storage, computing and networking equipment, as well as the supportive infrastructure. Energy consumption data for each data centre (IT and supportive infrastructure) may be based on real-time measurements (in case that monitoring infrastructure is available) or on typical energy consumption of the hosted equipment, as detailed in the manufacturer's datasheets. Within both the network PoPs and the datacentres, it is important to provide information for the Power Usage Efficiency (PUE) metric in order to be able to estimate the total energy consumption, given the value of the estimated IT equipment consumption.

It will also be important to agree on a final set of metrics to be supported by the audit tool, reflecting both the data type as well as specific qualities of each NREN. The results from the tool will also need to be disseminated to relevant groups in international organisations and standards bodies.

In all areas, additional output is necessary for the extraction of meaningful statistics, such as: total network traffic (incoming and outgoing) served by the NREN’s network, minimum and maximum values of the real-time energy consumption, number of racks in a DC, etc. Since the online audit tool is going to constitute an international database with energy consumption data from NRENs, the extraction of useful statistics by the online tool is crucial. The full definition of meaningful metrics should be supported by the ECO 2 Meter tool, taking into account the type of the collected data and the peculiarities of each NREN. Such metrics will be defined based on the use of the audit tool during user testing, mid-April 2014. The results will also be disseminated to relevant groups in international organisations and standardisation forums.

One example in the latter category, is the GHG emissions result from personnel’s daily transportation and from travel as part of their duties at the NREN. In order to gather information relating to transport associated with commuting to and from work, all employed staff could answer an online questionnaire regarding how they reach the office, based on where they live. The approximate distance for each staff member's daily journey may be taken from Google Maps, while the form of transportation may include car, motorbike, subway, bus, tram, etc. Daily kilometres travelled are multiplied by the number working days to get the annual figure and then the CO$_2$-eq is automatically calculated by the tool.
In addition to the audit tool functionalities mentioned above, further features will be also provided, such as the automatic creation of the final reports based on the input provided (these reports can be used for verification by an external body, which is a requirement for an official ISO 14064-compliant report), the automatic estimation of data based on predefined values (e.g. CO₂ emission factors per country, tonnes of emissions per passenger-mile in international flights), the provision of advanced statistics with useful (longitudinal) comparisons, based on a diverse set of criteria (e.g. geographical area, energy consumption per sector of the NREN’s infrastructure, GHG emissions per number of PoPs) and the comparisons among the NRENs. Based on the GN3plus Report to Reviewers (Periodic Report) and the available data per annual report, a procedure has to be defined for realising audits based on ISO 14064 (or any other relevant standard). This is especially crucial for new NREN members of the Environmental Team in order to proceed to verification of their base report and will take place by end-2014.

### 3.1.3 Current Status and Next Steps

A demo version of the audit tool was completed in the first quarter of 2014, while the final version was released at the beginning of the second quarter of 2014. The actual process followed includes:

1. The release of the complete version for internal testing from GRNET at the end of February 2014.
2. The realisation of a set of tests from GRNET for acceptance purposes.
3. The release of the complete version of the audit tool for testing to all the GN3plus Environmental Team members by mid-March 2014, for a period of two weeks.

4. The release of the final version of the tool – incorporating updates based on the comments received from the team members, will be completed by mid-April 2014. Documentation files and user guides will also be prepared and disseminated within the team in parallel with the release of the different versions of the tool. Several training sessions on how to use the tool are also planned, which include the 2014 GÉANT Environment Team meeting, TERENA 2014, and a larger dissemination event planned for Q3 2014, and targeted at a large audience of interested users.

Upon successful realisation of the tool, existing data will be incorporated, while all the new GHG-emission reports of the NRENs participating in GN3plus NA3, T3 will join and participate in the preparation of annual GHG emission reports. It should be noted that the initial results extracted from the available data may facilitate the GÉANT community’s definition of a unified sustainability policy for all the NRENs, and provide generic guidelines for the reduction of its energy consumption footprint.

3.2 **Comparison of Results from GHG Audits**

For the first time, the GN3plus Environmental Team has chosen to present its approach to GHG emissions auditing in a forum based on industry and academic researchers working the energy challenges and roles of mechanics as a means for seeking solutions, involving multiple disciplines in technology, science and management. [ISECM].

Five NRENs agreed to share the results of their GHG audits. Some, such as AMRES, are only just beginning to chart their progress while others, like SURFnet, have had years of results to draw on. At present, each NREN has provided a commentary about the year-on-year changes in their figures and indicated the rationale behind these changes. In Year 2 of the project, the team will hold a critical discussion about the performance of each NREN and summarise lessons learnt and indicate if any actions can be taken to improve their own set of results. The team will also be able to draw comparisons using the online audit tool.

3.2.1.1 **Comparison of Audit Results: GRNET**

The CO₂ footprint of the GRNET network is fluctuating quite a bit, which is mostly due to a CO₂-factor of 1.021 kg/kWh used in the 2010 report, and a factor of 1.13 kg/kWh in 2011–12. (Note, the 2012–13 report from the power utility operator is pending). This means that with the same amount of energy consumption, the footprint changes ‘automatically’. Commentary on the analysis will take into account such variations, to attempt to normalise the data being presented. While these figures are fine for reporting on the carbon footprint, the ultimate goal is to use the actual energy consumption and compare those figures to determine whether any measures taken had any impact.
### Activities

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Table 3.1: GRNET GHG Audit result comparison

Energy consumption in the GRNET data centres follows an increasing trend, which is mainly due to the expansion of the computational and storage equipment hosted within the data centres. In 2012, GRNET extended its computational infrastructure with processing, storage and networking equipment, aiming to permit the provision of advanced cloud computing services and to enhance the scalability and reliability of such services.

Currently, the new phase of the GRNET network (GRNET-4) is under deployment, and GRNET has submitted a request for the initial end date of 30 July 2014 to be extended to 31 December 2015. GRNET-4 network is going to be based on three service layers: the optical service layer, the carrier service layer and the IP service layer.

In 2013–14, the existing cloud computing infrastructure is going to be extended, while an HPC infrastructure and an energy efficient (green) data centre is going to be installed, aiming at a low PUE through the exploitation of green technologies and renewable energy sources. Therefore, changes in the energy consumption of the various parts of the networking and computational infrastructure are expected.

In most cases, energy consumption will increase due to the installation of new equipment, while in other cases (e.g. core and access network), energy consumption will be similar or less than it was prior to the installation.

#### 3.2.1.2 Comparison of Audit Results: SURFnet

SURFnet started reporting on its carbon footprint in 2010. Since then, most of the work has been focused on improving the carbon footprint report and trying to make sense of the numbers: i.e. What does ‘x’ amount of CO$_2$-emissions mean and what can be done about it?

In 2010, SURFnet began calculating the emissions of its network, since this would be the largest source of CO$_2$-emissions, and added some easy-to-gather figures for the office as well as services. Transportation (e.g. commuting) and network operations were not yet included. For the 2011 report, both services and a complete set of transport figures were included. External consultants delivered the first two reports, and the latter two reports have been carried out by SURFnet employees.
Comparison of emissions: 2010 to 2013

Below is a comparison of SURFnet’s carbon emissions, network and services during the last four years of reporting. Note that a number of fields are labelled NA, meaning that these figures were not included in those reports. For this, and other reasons explained below, it is not possible to compare the totals. Although it is difficult to compare, it is valuable to learn from these numbers and how they change over the years.

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<tbody>
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<td><strong>Scope 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office – Heating</td>
<td>50</td>
<td>52</td>
<td>54</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Scope 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office – Electricity</td>
<td>94</td>
<td>84</td>
<td>69</td>
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</tr>
<tr>
<td>Network Excluded in the Office</td>
<td>-4</td>
<td>-4</td>
<td>-3</td>
<td>TBD</td>
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<tr>
<td>Office – Cooling</td>
<td>0.12</td>
<td>0.07</td>
<td>0</td>
<td>TBD</td>
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<tr>
<td>Office – Service</td>
<td>52</td>
<td>40</td>
<td>34</td>
<td>TBD</td>
</tr>
<tr>
<td>Network</td>
<td>967</td>
<td>733</td>
<td>867</td>
<td>TBD</td>
</tr>
<tr>
<td>Services</td>
<td>NA</td>
<td>252</td>
<td>221</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Scope 3</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Transport – Commuting (Trains)</td>
<td>NA</td>
<td>47</td>
<td>46</td>
<td>TBD</td>
</tr>
<tr>
<td>Transport – Commuting (…)</td>
<td>NA</td>
<td>12</td>
<td>12</td>
<td>TBD</td>
</tr>
<tr>
<td>Transport – On Mission (Trains)</td>
<td>NA</td>
<td>15</td>
<td>14</td>
<td>TBD</td>
</tr>
<tr>
<td>Transport – On Mission (…)</td>
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<td>2</td>
<td>TBD</td>
</tr>
<tr>
<td>Transport – On Mission (Fight)</td>
<td>93</td>
<td>129</td>
<td>153</td>
<td>TBD</td>
</tr>
<tr>
<td>Network Operations (Outsourced)</td>
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<td>NA</td>
<td>NA</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Totals (Not Comparable)</strong></td>
<td>1253</td>
<td>1362</td>
<td>1469</td>
<td>TBD</td>
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</tbody>
</table>

Note: 2013 emissions were not available at time of publication; expected mid-2014.
Table 3.2: Carbon emissions of SURFnet’s network and services (note Scope and categories are based on ISO demarcation)

Understanding the Numbers

On Calculating CO₂ Emissions

Most CO₂-emissions are calculated by multiplying the amount of energy used or kilometres travelled, with a nationwide average value that may change each year. Since most of the footprint is based on electricity use (i.e. network and services), the footprint of the Dutch energy mix has a high impact on the outcome of the reports. The CO₂-factor used for the 2010 report was 364 g/kWh, in 2011 it was 332 g/kWh, in 2012, it was 300 g/kWh,
and in 2013, 321 g/kWh. This means that with the same amount of energy consumption, the footprint ‘automatically changes’. While this is fine for reporting on a carbon footprint, the actual energy consumption should be used for comparison and to determine whether any measures taken had any impact. In the table below, the energy consumption of a number of items is listed to illustrate the difference. Most happen to follow the trend also shown in the CO\textsubscript{2}-emissions table, with the notable exception of the services. They remained roughly the same, but show a significant difference in CO\textsubscript{2}-emissions.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Scope 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office – electricity</td>
<td>$2.6 \times 10^5$</td>
<td>251986</td>
<td>229918</td>
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</tr>
<tr>
<td>Network excluded in the Office</td>
<td>$-1.1 \times 10^4$</td>
<td>-11826</td>
<td>-10494</td>
<td>TBD</td>
</tr>
<tr>
<td>Office – service</td>
<td>$1.4 \times 10^5$</td>
<td>119480</td>
<td>113494</td>
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</tr>
<tr>
<td>Network</td>
<td>$2.7 \times 10^6$</td>
<td>2208576</td>
<td>2890493</td>
<td>TBD</td>
</tr>
<tr>
<td>Services</td>
<td>NA</td>
<td>759362</td>
<td>737281</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Note: 2013 emissions were not available at time of publication; expected mid-2014.

Table 3.3: SURFnet power usage

Another example could be the use of truly renewable energy (not imported hydro-based certificates), which could reduce the footprint of certain elements to zero, as it is then allowed to set the GHG multiplying factor to zero. SURFnet is currently investigating how to do this, since (as implied above) not all green energy sources are as climate friendly as they claim.

**The Network Footprint**

The SURFnet network is by far the largest part of its footprint. SURFnet has been struggling to make the network footprint as accurate as possible. The reason for this is that the equipment is spread over the country in almost 300 locations, and none of these locations are owned by SURFnet or are exclusively used by SURFnet. This means that setting up continuous (real-time) distance measurements are practically impossible, and even undertaking measurements on site takes time and effort to set up. SURFnet has studied the possibility of installing extra equipment, but it was not worth the effort from a financial or environmental perspective.

In 2013, SURFnet installed a software-based measurement approach, which should replace the annual onsite measurements by measuring continuously and thus more accurately. While this approach is still largely based on assumptions (mostly caused by equipment not able to report on their energy usage), this software solution is connected to the asset management database, which allows for an accurate day-to-day status of equipment active in the network.

The footprint of SURFnet’s network has fluctuated quite a bit. In 2011, SURFnet cleaned up old network equipment. Combined with more accurately recorded usage measurements and the drop in CO\textsubscript{2}-factor of the Dutch energy mix, this resulted in the lower network footprint. In 2012 and 2013, SURFnet was mid-transition to a new network, with new equipment located next to old equipment, which resulted in a clear increase in network footprint. This was a necessary property of SURFnet’s innovative network, but it makes it more difficult to compare changes in footprint over the years. There has been approximately 11% increase in the total CO\textsubscript{2} emissions 25%
of this is account for all the extra travel required attending the TERENA Networking Conference in Iceland as a precursor to host the event in Maastricht in 2013. The remaining 75% of this increase is caused by adding the network higher bandwidth capacity equipment to the network and support additional resilience needs for SURFnet clients.

This fluctuation is also enhanced by the PUE-factor. All equipment measurements are multiplied with the local PUE-factor, the power usage efficiency of the data centre. If the PUE is unknown, SURFnet takes a conservative number of PUE=2 (most data centres will likely be closer to 1.5 or less than 2). SURFnet asked the managers of housing locations for their PUE, most of them not professional commercial locations, but unfortunately only a few a few knew their PUE. Clearly, this has a large impact on the calculation of the footprint of the network (a 1.5 PUE average translates into a 25% footprint reduction) and shows how sensitive CO₂-reporting is to assumptions.

Finally, research on the SURFnet network shows that it is already quite energy efficient in terms of its design. This is because the energy needs of current network equipment is not influenced by its load, meaning that the energy efficiency of the network is directly proportional to the number of devices active in the network. The research shows that impact of network traffic, in that sense, is quite minimal.

On Absolute Figures

At present, SURFnet only reports its absolute consumption figures, which makes year-to-year comparisons difficult. Fortunately, when comparing changes in network topology or adding new services, it is possible to decouple energy consumption from environmental impact through the use of renewable energy. As continuous increase in ICT use is likely, it is clearly necessary to transition to a green energy mix. This is not an easy switch, however, with the possibility of extra costs involved, as well as because of shared responsibility, as SURFnet is usually not the owner of housing locations.

This also reinforces the need to suggest a set of metrics that is applicable to all NRENs (such as energy/bit, energy/PoP, energy/number of cores in data centers, etc.) Establishing a fair and useful set of metrics, however, will take some time, and is earmarked for delivery in Y2 of the project. In the meanwhile, another way to improve understanding of annual carbon figures is to complement absolute figures with relative figures. For example, one could introduce an energy-per-bit metric for their network, or add extra granularity to the services footprint by measuring per service. This is something SURFnet is currently investigating.
### Emissions in Tonnes CO$_2$-eq

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Scope 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office – Electricity</td>
<td>94</td>
<td>84</td>
<td>69</td>
<td>TBD</td>
</tr>
<tr>
<td>Office – Service</td>
<td>52</td>
<td>40</td>
<td>34</td>
<td>TBD</td>
</tr>
<tr>
<td>Network</td>
<td>967</td>
<td>733</td>
<td>867</td>
<td>TBD</td>
</tr>
<tr>
<td>Services</td>
<td>NA</td>
<td>252</td>
<td>221</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Scope 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport – On Mission (flight)</td>
<td>93</td>
<td>129</td>
<td>153</td>
<td>TBD</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1326</td>
<td>1362</td>
<td>1469</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Note: 2013 emissions were not available at time of publication; expected mid-2014.

Table 3.4: SURFnet GHG Audit result comparison

#### 3.2.1.3 Comparison of Audit Results: HEAnet

HEAnet’s GHG Audit comparison shows some major fluctuations. First, the office emission figure dips in 2010, due to the switch to a different energy provider, Airtricity. While office power consumption remained fairly similar to the year before, Airtricity was generating most of its power from wind generation, so it had a relatively low CO$_2$ emission conversion factor of 140 g/KWs, compared to the 538 g/Kwh hour it had been with ESB, the previous electricity supplier. This figure has since risen to 450 g/Kwh again in 2011, as business and household demand for power supplied by Airtricity has risen and they had to source power from the Electricity Grid.

<table>
<thead>
<tr>
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</thead>
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<td>32</td>
<td>101</td>
<td>90</td>
<td>96</td>
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<td>35</td>
<td>39</td>
<td>40</td>
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<td>Data centre</td>
<td>540</td>
<td>909</td>
<td>891</td>
<td>1061</td>
<td>1034</td>
</tr>
<tr>
<td>Backbone</td>
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</tr>
<tr>
<td>Network</td>
<td>697</td>
<td>763</td>
<td>715</td>
<td>764</td>
<td>766</td>
</tr>
<tr>
<td>Schools</td>
<td>363</td>
<td>467</td>
<td>429</td>
<td>489</td>
<td>465</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1766</td>
<td>2211</td>
<td>2171</td>
<td>2443</td>
<td>2401</td>
</tr>
</tbody>
</table>

Table 3.5: HEAnet GHG emission figure comparison table

The figure for transportation has remained relatively similar, even though there has been a 10% increase in staff numbers. The data centre CO$_2$ emissions increased dramatically in 2010, when many new, virtualised servers were introduced in the network as a result of customer demand.
In 2013, one of the data centre providers has recorded that changes have been made to the quality of its infrastructure and reduced the PUE factor from 1.93 to 1.8. Approximately 70% of the total energy consumption occurs at the larger data centres where most of the managed network services equipment is located. This data centre provides co-hosting for some users, which is why the figure has fallen in 2013, even though the trend is actually rising.

In 2010, the Schools 100 Mbit/s High-Speed Programme was launched, which offered 100 Mb broadband connectivity to schools. This initiative required a major network update, which included the installation of 14 MX480 routers to support this new network, running both 10 Mb and 100 Mb networks in parallel. In 2012, a directive was sent out to these schools to turn off their local broadband routers, hence the reduction in emissions by about 6%. This is reflected in 2013 figures, even though the number of schools on the more energy-demanding 100 MB network had increased by 30%. While CO₂ emissions figures have risen by 35% in this five-year period, the actual data traffic on the HEAnet network has increased by a multiple of three.

3.2.1.4 Comparison of Audit Results: NIIF

Despite all the efforts exerted to improve energy efficiency, the total GHG emissions of NIIF in 2013 was about 2.5 times higher than that of 2009 (the Base Year). This is explained by the fact that were major changes to the NIIF network providing new internet connectivity to several new clients. The increase shown was triggered by several factors, including:

- Schoolnet of Hungary became part of the NIIF infrastructure as of 1 January 2013. Previously the Schoolnet system was independently operated by another organisation, thus its emissions were not calculated into the NIIF Base Year GHG report. Schoolnet serves ~4800 endpoints throughout Hungary, with CPE owned and operated by NIIF.

- In order to offer satisfactory services for Schoolnet users, as well as a new cloud and storage services for the academic institutes, several new servers and a large storage capacity had to be installed.

- In 2011 NIIF put four new supercomputers into operation and suspended the use of an outdated one. Although the new supercomputers have improved the energy efficiency of the HPC service by tenfold, the total consumption has still increased, since the total computing capacity became ~80 times greater than before.

- As a consequence of the increasing volume of responsibilities and infrastructure, the number of employees (and office space) of the NIIF Institute almost doubled from 2009 to 2013.

Although the above factors all contributed to the higher level of GHG emissions, there were a number of factors that helped to reduce emissions:

- Several outdated, inefficient devices have been replaced with new, more energy-efficient ones.
- Server virtualisation has become a widely used technology, allowing for consolidation and more efficient use of HW resources.
- The amount of business travelling has slightly decreased.
3.2.1.5 Comparison of Audit Results: AMRES

AMRES completed its first GHG audit in Q3 2013, covering the period July 2012 to June 2013. This timeframe was the most pragmatic at the start of the project to build AMRES’s relevant competencies. The outcome and data collected will be realigned to ensure compatibility with reports from other NRENs.

AMRES’s resultant CO_2 emission figure is 612 tonnes CO_2-eq. Powering its backbone network generated 182 tonnes of CO_2-eq emission, while its data centre requirements to support the AMRES services generated 213 tonnes CO_2-eq. The CO_2 emission from AMRES’s office was equivalent to the emission from the whole network, at about 186 tonnes of CO_2-eq. AMRES was required to use the following figures in its audit.

- Average CO_2-eq caused by 1 KWh of electricity in the Serbia is 724g CO_2-eq in 2010.
- Average CO_2-eq caused by the equivalent of 1KWh of Natural h 0.18404 kg CO_2-eq per KWh).
- Communal heating plant.

Approximately 5 tonnes of CO_2-eq were produced by this heating system, which would have been approximately 25 tonnes if provided by electricity.

3.3 Environmental Policy

An environmental policy is usually concerned with the management of actions in order to conserve resources, reduce waste and generally minimise the impact of any man-made changes on the environment. According to Eco-Management and Audit Scheme (EMAS), “An environmental policy is top management's declaration of its environmental commitment. It is a set of basic principles, which guide the organisation when defining objectives and targets for improving environmental performance. It is also a key tool for telling employees, customers, environmental interest groups, etc. what the organisation's environmental priorities are. The organisation must then act according to these principles.” [EMAS]

Even in the NREN sector, whose members are developing networks and supporting services to meet end-user needs, there is a strong indication that environmental issues have a low priority in most of the partner institutions. One of the emerging initiatives from the GN3plus Environmental Team is to dramatically increase the number of NRENs with an environmental policy in GN3plus, including the solicitation to DANTE and TERENA to design their own environmental policies.

GÉANT is actively in the process of preparing its own environmental policy, at the time this document is being prepared, and this is expected to be ready by M15 of GN3plus.

According to EMAS, the following points are essential to a good environmental policy:

- It is clearly and concisely written.
- It is credible and realistic, and does not make promises the organisation cannot keep.
- It motivates. The employees are pleased, not surprised or alarmed by its statements and aims.
- It addresses top priorities for being an efficient environmental performer
- It gives a clear direction and can be achieved through objectives and targets.
3.3.1 Environmental Policy Template

The GN3plus Environmental Team has now produced an environmental policy template, as well as links to previously published NREN policies. One of the team’s goals, in addition to providing this template, is to have a large part of the NREN constituency adopt an environmental sustainability policy. The team has now set a goal to have 20 NRENs develop their own environmental policies by the end of the GN3plus project in April 2015.

Key parts of this template include background details/objectives and a number of statements that reflect how strategic principles of the new environmental policy will be applied within the NREN.

Included in the Environmental Policy template are examples of how the statements can be put into effect. This new template is available for download, with instructions for its use [POLICYTEMPLATE].

A public page will be released by the end of April 2014.

3.3.2 Migrating the Environmental Policy into a Working Strategy

Translating an environmental policy into operational activities requires long-term strategic thinking from the NREN Management team, as well as an organisation following a strategic plan that maps out their activities for a number of years and is endorsed by their stakeholders. HEAnet realised that environmental sustainability has sufficient importance that it should be reflected in its company strategy. In order to facilitate this initiative, sections of a strategy document that mirror the areas of focus have been identified in HEAnet’s Environmental Policy, [HEANETPOLICY], with actions being identified for in-house Initiatives, National Promotion and Outreach Initiatives and International Research Commitments.

This approach is very action-oriented. All the key statements in an NREN's environmental policy that reflect strategic principles, correspond to day-to-day activities that promote sustainability in all three focus area: in-house, national, and international activities.

3.4 Test Case Activities

There are a number of test cases that have been undertaken to add to the resources available, including:

- An e-waste Policy for NRENs.
- A Green ICT Maturity Model for Higher Education.
- Deciding to Transport Bits or Energy
- Virtualising CPE and NREN Energy Savings.
- Steps Taken to Enhance an Asset Database to Ease the Generation of an NREN’s Greenhouse Gas Report.
- Power Saving Utilising Power over Ethernet (PoE).
- Improving Energy Efficiency in Greek Schools with IPv6-enabled Smart Meters.
Activities

- GRNET Videoconferencing Services.

Summaries have been provided to provide an overview of the investigations, with references provided for more information. In the year ahead, the GN3plus Environmental Team will review the value of such test cases and present some of the findings as GN3plus Showcase / webinars and invite feedback from a larger audience.

3.4.1 An e-waste Policy for NRENs

Short Task Description

The disposal of electrical and electronic devices, e-waste, is of growing environmental and social concern. Especially in developed countries, e-waste has seen rapid growth, and can already be responsible of more than 10% of total municipal waste. Because such devices are complex products, composed of many different and often rare materials, proper recycling is difficult, and most of the e-waste ends up on landfills and in incinerators. Incineration is of great social concern because it often happens in developing countries with little concern for health.

From an environmental and social perspective, it is clearly important to think about proper and responsible disposal of electrical and electronic devices. However, this e-waste is also strongly linked to information security, and making sure that no sensitive or private information falls into the wrong hands. Finally, careless disposal can lead to damaged reputations, for example, when ICT equipment clearly marked with logos of an organisation ends up on illegal landfills in developing countries.

Purpose and Contribution Towards GN3plus Environmental Team Goals

One of the challenges of the GN3plus Environmental Team is to ‘promote good practices of equipment usage and reduction of waste in support offices, data centres and network-deployment locations’. Clearly, consideration of e-waste is relevant to this challenge. In 2013, SURFnet made its first steps towards an e-waste policy, which has just been finalised in early-2014. SURFnet would like to share this policy as an example and a source of inspiration for other NRENs and Higher Education and research organisations. The policy has therefore been translated into English as part of this team’s work.

Further steps will be taken in the second year of GN3plus to see how such policies can be promoted amongst NRENs, and the team hopes to support the development of more e-waste policies. This will include clear policy suggestions and approaches to handle this type of waste with illustrative case examples. Extra categories or more precise guidelines will be provided, based on feedback from different NRENs, their clients and also third-party waste recycling companies.

3.4.2 A Green ICT Maturity Model for Higher Education

Short Task Description

A Green ICT maturity model allows organisations to carry out a self-scan on their performance of using ICT in an environmentally responsible manner. The maturity model in question is designed to be lightweight, and allows higher education institutions to scan themselves in a quick, inexpensive and independent manner. The purpose
of the model is to provide an indicator of an institution’s development of green ICT, and it enables organisations to launch an internal dialogue, to gain agreement on the status quo, and to define actions for improvement.

The focus of the model is on energy and material efficiency. It currently consists of 21 attributes that can be scored with a maturity-level grading, illustrating progress from non-existent to leading-edge performer. Each attribute has a short explanation as well as a description for the ‘ideal situation’; i.e. a situation that deserves the highest maturity score. These attributes are divided in three domains:

- Green ICT within the organisation.
- Greening of ICT.
  - Is the organisation using technologies that are considered the most environmental sustainable at that particular time, produced with recyclable materials that are easy to replenish and using the minimal amount of energy to power this equipment?
  - Has the organisation optimised its support process to minimise resources required to adequately support the solution?
- Greening of operations with ICT.

A fourth domain is forthcoming and concerns the ‘Greening of primary processes with ICT’.

**Purpose and Contribution Towards GN3plus Environmental Team Goals**

As part of its efforts to move towards greener ICT provision, SURFnet has combined the development of a Dutch green ICT maturity model, together with advice from a number of experts of Green ICT in Higher Education. In recognition of the larger relevance of such a model, the maturity model has been translated to English in the hope that it helps the international higher education community to further increase sustainability with the support of ICT solutions.

As part of the GN3plus Environmental Team’s work, SURFnet wants to promote the use of the maturity model internationally in HE institutions, as well as NRENs, to ‘actively demonstrate the advantages of IT technology, to allow clients to help reduce their environmental impact’ (as formulated as a team challenge) [SURFNETMATMOD]. The Team anticipates that refining the ICT Maturity model could lead to an online questionnaire (possibly as an extension to the online audit tool), with the appropriate visualisations. Indications based on the model, in addition to results from the audits and the statistics, must be combined towards the preparation of NREN-based guidelines for improving energy efficiency and adopting best practices.

### 3.4.3 Deciding to Transport Bits or Energy

**Short Task Description**

What is more energy efficient: transporting bits or transporting energy? Should NRENs make use of a distant data centre powered by renewable energy and transport the bits via an energy efficient optical network, or should they power a nearby data centre with renewable energy imported from far away? Obviously, there are many factors determining the outcome of this question, such as how often the data network is used to transport data in order to complete a computational task, but the key takeaway is that this trade-off affects cloud computing and the assumption that is widely advertised that cloud computing is always greener than local solutions.
Activities

Purpose and Contribution Towards GN3plus Environmental Team Goals

Building on previous work, the University of Amsterdam is using real data from the SURFnet network to generate a case study on this trade-off and offer the NREN community some insight as a contribution towards the challenge of the GN3plus Environmental Team to "promote good practices of equipment usage and reduction of waste in support offices, data centres and network-deployment". A categorisation of cloud computing services based on computational/storage or network intensity will be considered in the next part of this study that will include a cost comparison between transporting bits compared to the cost per energy unit.

3.4.4 Virtualising CPE and NREN Energy Savings

Short Task Description

The main benefit of virtual Customer Premises Equipment (CPE) is the cost reduction of extraneous equipment at the border between the NREN and the client. This is possible where this equipment is needed to provide a logical demarcation, but not a physical conversion, and can be accomplished by the virtualisation-enabled possibility of having several customers to consume virtualised instances on the same physical equipment. The fact that this physical equipment is not only concentrated, but also co-located, allows for several secondary, but relevant, benefits on operational expenses. This allows for reducing space, power and cooling needed for physical equipment, and therefore the cost and environmental impact of the same.

Purpose and Contribution Towards GN3plus Environmental Team Goals

As less equipment should now be deployed when setting up connectivity to a number of users, what energy savings can be achieved? The test case will attempt to answer questions similar to the following: How many end clients have to be setup logically on a physical router to actually achieve energy savings, as new physical routers will be larger and consume more power than the previously dispersed single CPE-per-client model? Are there different models of virtual CPE that offer greater reductions in energy usage? What lessons can be learnt and how can these experiences be shared with the GÉANT community? Are there equivalent approaches that might offer the potential to reduce energy consumption in this part of the network? Can manufacturers be stimulated to offer new logical switching and routing solutions that enable the GÉANT community reduce its carbon footprint at the initial point of connectivity to NREN clients?

3.4.5 Steps Taken to Enhance an Asset Database (to facilitate the generation of an NREN’s Greenhouse Gas Report)

Short Task Description

Mature NRENs have deployed many hardware assets at their PoPs, data centres and client sites, and at collocation facilities that provide interconnection to their own network providers. Descriptions of these assets are stored in an asset database repository. For larger NRENs, such a database could hold records of tens of thousands of assets. Techniques to enhance the information stored in the database, enable easier search and report collecting and facilitate analysis for environmental sustainability are evaluated. The Asset Database solution is usually unique to each NREN and can be highly integrated into an NREN’s financial accounting
structure. The objective is to structure the database in a way that facilitates easy searching for information required for the eCO₂Meter tool.

Purpose and Contribution Towards GN3plus Environmental Team Goals

As more equipment is added to the NREN networks, due to requests for additional client connectivity or to meet new service requests, it becomes more difficult to collect energy usage figures for analysis of new energy-saving initiatives to employ or measuring the expected energy usage. Extra attributes can be added to the database record for each asset that can reduce this burden. This can also facilitate better deterministic measurements rather than using estimates from datasheets or suppliers. Scripts extracting this information are reviewed to determine the practicality of more automated data collection.

3.4.6 Impact of Malicious Traffic on Electrical Power Consumption in ICT rooms

Short Task Description

This test case describes research results in the field of monitoring power supplies and energy consumption in ICT data centres. Two ways of power consumption monitoring are being explored at present: monitoring Uninterruptible Power Supply (UPS) and by monitoring specialised Power Distribution Units (PDU).

The aim of this test case is to collect information on power consumption in the University of Belgrade Computer Centre (RCUB), an ICT centre using already available equipment that is often present in ICT rooms. Results of the measurements are taken on both type of devices, UPS and PDU, compared, and then the main conclusions are presented. The GN3plus Environmental team is analysing the measurement accuracy and usability of this approach to electric power consumption measurement, the impact of the amount of network traffic on power consumption and the prediction of electrical power consumption behaviour, based on network traffic throughput. Using collected information, the impact of undesirable traffic on electrical power consumption is also calculated.

The first part of the study describes the testing environment and different variables that were collected from network equipment during the experiment. The second part of the work describes the correlation between collected results and the prediction of power consumption in ICT rooms. An experiment was performed on the production equipment located in the RCUB.

Purpose and Contribution Towards GN3plus Environmental Team Goals

Monitoring electricity and calculating the Power Usage Effectiveness (PUE) is an area where the GN3plus Environmental Team has had much experience. A custom NMS Network Monitoring System has been implemented, based on the control of overall energy consumption, identifying the reasons for abnormal consumption.

3.4.7 Power Saving Utilising Power over Ethernet (PoE)

Short Task Description

Power over Ethernet (PoE) itself was designed in order to improve power supply chain efficiency, improve safety and reduce cabling of Direct Current (DC) powered, low-consumption, Ethernet-connected devices. PoE replaces
less-effective adapters with one “central” Power Supply Unit (PSU) with better performance and reduced cabling, as power distribution shares the same wiring with Ethernet data. A typical example of PoE-powered devices are IP phones, their power consumption is low, but they are deployed in very large numbers, and excluding shared workplaces, their operation is necessary only during work hours. Furthermore, wireless access points are deployed in smaller quantities, but these are also becoming more power hungry with increasing bandwidth.

The pilot version of currently developed ‘PowMon’ software enables an administrator to manage energy savings for the selected devices. The database includes list of managed devices, their groups, ports of connection, list of schedules and affiliation of devices to partial groups and schedule. The software periodically checks the status of ports and sets the wanted state, according to a schedule. The software also supports creation of statistics and counts saved energy based on allocated power.

**Purpose and Contribution Towards Team Goals**

This work promotes the good practice of reducing wasted power by a very simple arrangement with minimal extra effort and expenses. The savings achieved on a single device are not large, but the numbers of deployed devices are, resulting in significant savings. Furthermore, PoE uses open database software. Ideally both the database and GUI are operated over virtual machines.

Further steps will be taken in 2015 to finish the implementation and supply example power-saving schedules [CESNET].

### 3.4.8 Improving Energy Efficiency in Greek Schools with IPv6-enabled Smart Meters

**Short Description**

The Greek IPv6 pilot in schools aims to demonstrate that IPv6 could become the leveraging technology for enhancing existing services or providing new services to end users. In the context of GEN6, this pilot investigates the benefits of establishing an advanced metering infrastructure over IPv4 and IPv6, and provides insights about the benefits of building IPv6 services. This initial case study describes work in progress regarding the implementation of the Greek pilot within the framework of the GEN6 project (number 261584) [GEN6 [GEN6_REQS] that is co-funded by the European Commission under the ICT Policy Support Programme (PSP) as part of the Competitiveness and Innovation framework Programme (CIP).

The Greek IPv6 schools pilot has been supported by the following public authorities, research organisations and commercial companies: the Computer Technology Institute & Press “Diophantus” (CTI Diophantus), the Greek Research & Technology Network [GR&TN] and the Intelen Group [INTELEN]. This pilot has been conducted as a response to recent statistics that indicate great potential for energy-saving Greek public infrastructures. Initial results from the pilot suggest a reduction of carbon footprint of more than 30% (detailed results are available in [GEN6SCH]). Through the implementation of the Greek IPv6 pilot, the deployed infrastructure will be extended, and many problems related with the use of IPv4 for access to the smart energy meters will be overcome. This extension will provide a signal to European stakeholders that IPv6 technology can be a green enabler.

**Purpose and Contribution Towards GN3plus Environmental Team Goals**

This case study is of great relevance to the activities of the Green GÉANT Team [GREENGÉANT] and the efforts of the Green GÉANT team members for the dissemination and the adoption of ‘green’ best practices from the
NRENs. The technology applied in the case study and the conclusions that will be extracted from the final results may constitute a guide for the replication of the case study to a wider scale in the research and academic community in Europe.

### 3.4.9 GRNET Videoconferencing Services

#### Short Description

The ePresence service [EPRESENCE](#) offered to the Greek research and academic community allows its members to organise and conduct high-quality, interactive videoconferencing. The supported video quality in the virtual conference rooms can be up to High Definition (720p/30fps). ePresence supports the dynamic adaptation of the real-time video quality according to the end-user network connection, its terminal capabilities and the end user's preferences. Furthermore, the service illustrates a simplified approach to organising and participating in secure videoconferencing meeting rooms. This service is available for conducting special-purpose videoconferences, and it is freely available to those with a justified need for secure, high-quality videoconferences.

Between November 2011 and February 2014, more than 9000 videoconferences have been conducted, while about 5300 end users participated in these conferences. About half of these videoconferencing sessions were meetings that, until the offering of the ePresence service as a secure and legitimate alternative for participation, required participants' physical presence onsite. The moderate estimated savings for all the organisations that deployed ePresence as an alternative to physical presence for participation is about EUR15 million. The reduction in CO$_2$ emissions from avoiding travel is also important, but an accurate estimation of this saving is still pending.

A web videoconferencing service, e-conf, is also currently under development. This service will facilitate every user in the GRNET community to establish and participate in videoconferencing sessions on demand, anytime, without requiring previous reservation. In order to cope with the requirements imposed by the use of the service from many concurrent users, the e-conf videoconferencing servers will be deployed in the cloud computing infrastructure as virtual machine instances. Based on this service, end users will be able to create ad-hoc videoconferencing rooms by using cloud resources and communicate with each other via their browsers.

#### Purpose and Contribution Towards GN3plus Environmental Team Goals

This service is expected to cover all users' everyday videoconferencing needs. Since it will be freely accessible to all of the GRNET user community, it will raise a significant request rate for videoconferences. It will be deployed in the cloud and one of its main design objectives is to be able cope with the demand, using as little energy as possible.

Furthermore, this service will also lead to reductions in CO$_2$ emissions from avoiding travel.

### 3.5 Dissemination Activities

Here is a short overview of the dissemination activities currently being pursued by the GN3plus Environmental Team.

#### Special Green ICT and Sustainability Workshop for NRENs
This workshop is currently being organised in collaboration with TF-MSP. It will take place on 16 and 17 September 2014, in Budapest, where HUNGARNET will host.
Activities

Presentations and Special Meetings

- TNC2013: BoF: A Shared Environmental Sustainability Policy for NRENs [TNC2013].
- GN3plus Symposium October 2013: NRENs and (environmental) sustainability.
- ETSI Workshop on Environmental Impact Assessment and Energy Efficiency [ETSIWS].
- TF-MSP meeting February 2014: NRENs and (environmental) sustainability [TF-MSP].
- Montenegro Informacione Tehnologije – IT 2014 conference [MONTENEGRO-CONF].

Submitted Abstracts

- Internet2 Global Summit April 2014: NRENs, Sustainability and Green ICT: What we can do with the higher education community (accepted) [I2GLOBAL].
- TNC2014: Improving NREN’s environmental impact – online GHG audit tool (not accepted, resubmitted as poster).
- TNC2014: Shared Environmental Policy for NRENs (submitted for lightning talk).
- TNC2014: BoF: NREN climate change preparedness (accepted) [TNC2014].
- ECM2014: NRENs and GHG Reporting: creating a collaborative environment (accepted) [ECM2014].
- ECM2014: The GÉANT Green Team: practical application of the role of ICT in sustainability efforts (accepted).

3.5.1.1 Local Dissemination Initiatives

Since 2013, HEANet started to investigate some outreach activity with its university and higher education institute users, and quickly found that many of them (35%) were actively involved in the programme called “Green Campus”, run by An Taisce, the National Trust for Ireland [GREENCAMPUS]. The relationship between HEANet and the Green Campus programme has grown stronger over the past year, and HEANet will seek Green Campus recognition status in 2014–15. HEANet is also planning a number of joint workshops for both groups’ mutual clients. This program is the pilot program for the eco-University campus program [ECOUNIVERSITY].

Six institutions in Ireland have achieved full certification and been awarded a Green Campus Flag. One of these clients, University College Cork, is now registered as an ISO50001 campus, and has made savings of over EUR1 million because of initiatives taken by students and staff.

The Green Campus initiative is based on the success of the Green Schools and International Eco-Schools programmes. It has been piloted and amended for implementation in post-secondary and tertiary-level educational institutions. The Green Campus programme encourages a partnership approach to environmental management in third-level institutions, and aims to ensure that members of a campus community can engage in a meaningful way to enhance sustainability on their campus. This is an enhancement of traditional environmental management systems, which tend to be management driven. The Green Campus programme identifies the campus as a community, and places significant importance on the inclusion of all sectors of the campus community in its environmental management and enhancement.
It must be noted that the Green Campus programme does not reward specific environmental projects or implementation of a new technology. Instead, it rewards long-term commitment to continuous improvement from the campus community in question. In order for a campus to qualify for the Green Campus award, a committee representative of the campus community must be formed. This committee must then register its intent to implement the Green Campus programme with the Environmental Education Unit at An Taisce. Committees must be registered for a minimum of one academic year and have successfully implemented all seven steps of the programme before applying for the award.

The seven steps of the programme are:

1. Establishing a Green Campus committee incorporating student and staff representatives.
2. Undertaking an environmental review.
3. Implementing an action plan.
4. Monitoring and evaluating actions carried out.
5. Linking the programme to learning on campus.
6. Informing and involving the campus and wider community.

The full Green Campus Certification process is illustrated in Figure 3.2.
Figure 3.2: Green Campus Certification Process
Activities

These seven steps focus on areas such as:

- Litter and waste prevention.
- Reduction / management.
- Energy conservation/reduction.
- Water.
- Travel.
- Biodiversity.
- Procurement and environmental risk.

The Environmental Education Unit within the An Taisce organisation is the national operator in Ireland for all international environmental education programmes of the Foundation for Environmental Education (FEE), (see [FEE]). The An Taisce group has welcomed HEAnet’s involvement as it views IT as one of the most important enablers for success. The group now has access to a source of technical knowledge that is independent of local campuses and can provide visibility and advice that will be readily accepted by all parties.

FEE is a non-governmental, non-profit organisation promoting sustainable development through environmental education. Established in 1981, FEE was originally a European initiative, primarily active in environmental education through internal meetings, external seminars and conferences, and in a number of publications. Today FEE operates globally and is mainly active through its five environmental education programmes: Blue Flag, Eco-Schools, Young Reporters for the Environment, Learning about Forests, and Green Key. As this is an international programme, which is being readily accepted by NRENs’ users, any support given to such a programme can be amplified by introducing more competitiveness between organisations that are part of FEE.

FEE is now starting to investigate opportunities to work with some of the other NRENs that are part of the GN3plus Environmental Team, and contacts will be established in some of these countries to investigate what opportunities are available to work towards the common goal of more sustainable campuses in the education arena. The International Programme Co-ordinator has met with HEAnet several times and has sent several memos to their partners in all 28 member states, suggesting that they engage with their local NREN in promoting the eco-University Program. A contact list for all the local FEE representatives in each country is now provided [FEECONTACTS] and a copy available on the team’s intranet site.
4 Future Activities

During Year 2 of this Task, the GN3plus Environmental Team plans to continue with its work researching opportunities for NRENs to reduce energy usage or de-materialise work practices to make the work environment more environmentally sustainable. Use of the environment policy template will be actively encouraged, and several GÉANT Showcases / webinars are planned for Q2 of Year 2 (2015), promoting the environmental template, GN3plus Environmental Team activities, how to progress towards an environmental strategy and using the GHG Online Audit Tool.

Build Competency and Expertise

![Diagram showing the process of building environmental competence]

- Generate Environmental Policy
- Determine Items to Monitor
- Identify Improvement Opportunities
- Carry out GHG Audit

Develop Environmental Strategy

![Diagram showing the process of developing environmental strategies]

- Review Progress
- Integrate as Normal Work Activities
- Set a Series of KPI Metrics to Achieve
- Enhance Procurement Guidelines

Promote and Disseminate Sustainability Expertise

![Diagram showing the process of promoting sustainability]

- Monitor Sustainability Competencies
- Develop Best Practice Guides
- Assess Sustainability Maturity
- Benchmark Against Others

Figure 4.1: Environmental skill building, strategy development and best practice dissemination

Each NREN based in the Environmental Group will have an Environmental Policy by July 2014, and will also identify how they are progressing towards a full environmental strategy definition within their organisation by the end of 2014. The team will evaluate if some of this material should be produced as videos for distribution to support ongoing training needs. The team goal is to have 20 NRENs with completed environmental policy by the end of this GN3plus project.
Members of the GN3plus Environmental Team will engage with other experts who practice environmental sustainability at a special BoF on "Climate Change preparedness with a focus on NRENs" This session is planned for the TERENA Networking conference in Dublin in May 2014. Some of the team members will then test their Business Continuity plans to see if they can match with some of the scenarios being examined. They will then pilot any suggested solutions or changes in their plans and report back to the team and also produce a ‘Best Campus Practice’-style document. The present test cases will be concluded and new test cases will also be identified, researched and completed.

Topics are expected to include the following:

- Presentation of Energy Efficiency Tactics used by CYNET members.
- Demonstration of Importance of VCs and Working from Home.
- Market Survey of Power Efficiency Equipment.
- Implementation of a Green Data Centre in NIIF (lessons learnt).
- Shared Campus Multimedia Facilities.
- Power Savings Advantages of Using Optical Networking equipment.
- Advantages of Green Information Modelling and Automated Provisioning solutions.
- Modifications to NREN Business Continuity plans (which encompass climate change planning).

Other test cases / Best Campus Practice-style documents may be added to this list as the year progresses, based on feedback from workshops, webinars, conferences and training events.

There will also be an update of this report at the end of Y2 in the form of Deliverable D3.6 (DN3.3.2) Environmental Impact Report 2015, (and the corresponding Milestone MS37 (MN3.3.2).
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## Glossary

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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>BoF</td>
<td>Birds of a Feather (discussion group based on shared interests, usually conference based)</td>
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<td>CO₂</td>
<td>Carbon dioxide</td>
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<td>CPE</td>
<td>Customer Premises Equipment</td>
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<td>DC</td>
<td>Direct Current</td>
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<td>DWDM</td>
<td>Dense Wavelength Division Multiplexing</td>
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<td>EMAS</td>
<td>Eco-Management and Audit Scheme</td>
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<tr>
<td>e-waste</td>
<td>Electronic waste (discarded electronic equipment)</td>
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<td>FEE</td>
<td>Foundation for Environmental Education</td>
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<td>GeSI</td>
<td>Global e-Sustainability Initiative</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>GN3</td>
<td>(GÉANT Network 3), a project part-funded from the EC's Seventh Framework Programme under Grant Agreement No.238875</td>
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<tr>
<td>GN3plus</td>
<td>(GÉANT Network 3 plus), a project part-funded from the EC's Seventh Framework Programme under Grant Agreement No.605243</td>
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<tr>
<td>HPC</td>
<td>High Performance Computing</td>
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<td>HW</td>
<td>Hardware</td>
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<td>ICT</td>
<td>Information and Communications Technology</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>IPv6</td>
<td>Version 6 of the Internet Protocol (StB IETF)</td>
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<td>ISECM</td>
<td>International Symposium on Energy Challenges and Mechanics</td>
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<tr>
<td>kg</td>
<td>Kilogramme</td>
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<td>kWh</td>
<td>Kilowatt hour</td>
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<td>NA</td>
<td>Networking Activity</td>
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<td>NIIFI</td>
<td>National Information Infrastructure Development Institute</td>
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<td>NREN</td>
<td>National Research and Education Network</td>
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<td>PDU</td>
<td>Power Distribution Units</td>
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<td>PoE</td>
<td>Power over Ethernet</td>
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<td>PoP</td>
<td>Point of Presence</td>
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<td>PSP</td>
<td>Policy Support Programme</td>
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<td>PSU</td>
<td>Power Supply Unit</td>
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<td>PUE</td>
<td>Power Usage Efficiency</td>
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<td>RCUB</td>
<td>University of Belgrade Computer Centre</td>
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<td>SNMP</td>
<td>Simple Network Management Protocol</td>
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<td>Task</td>
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<td>TF-MSP</td>
<td>Task Force on Management of Service Portfolios</td>
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<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
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