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# **Inventory of Greenhouse Gas (GHG) Emissions and Removals**

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Authors: Maja Bandjur  
Milan Kuželka  
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## Related Documents

Document Name	Filename	Version	Date
Green GEANT Plan			
ISO 14064-1			2006
ISO 14064-2			2006
ISO 14064-3			2006

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# 1 Introduction

## 1.1 Background

Academic Network of Serbia (AMRES) joined the Green GÉANT Team in 2013. AMRES has just started to build their experience and competencies with Green process and practices. This project will help to provide us guidance and promote sharing experience with other NRENs which should establish a solid foundation for further development of environmental awareness and some services in Serbian Research & Education community.

There are many measures used in calculating and reporting for green audits. In order to establish metrics which can be validated, and which can be replicated at different times and in different organisations, it is important to adhere to recognised standards. In this instance, the ISO standard is the set of documents under ISO 14064. These documents are used to guide the form and content of the inventory process.

## 1.2 Scope

The primary goal of this assessment is to account for the Green House Gas (GHG) emission according to the ISO 14064:2006 part 1 standard. This means that

- Scope 1 (direct emissions),
- Scope 2 (indirect emissions related to bought energy), and
- Scope 3 emissions (e.g. emissions related to the production of bought products, travel, and waste) are all included in this assessment.

## 1.3 AMRES purpose and profile

Academic Network of Serbia (AMRES) is the National Research and Education Network of the republic of Serbia, offering modern information-communication services and Internet connection to its users. AMRES provides significant scientific, research and educational resources and acts as the carrier and catalyst for the Information Society development in Serbia. It's considered to be one of the most advanced networks in our country, with more than 170 connected institutions and more than 150.000 active users.

AMRES provides national, regional and local networking services by means of an infrastructure which spans the country. This comprises over 2200 km of dark fibre optic transmission medium, together with switching and routing equipment.

One of the tasks it has committed resources to is GN3-NA3-Task 3 part of the GN3Plus program, the main objective of which is to conduct a green audit of the GÉANT network. AMRES audited its own network as part of this project.

Above all, AMRES has set the internal goal to raise awareness of IT staff to save consumption of electricity and try to decrease GHG emissions by making the policy for future use.

# 2 Inventory design and development

## 2.1 Organisational boundaries

AMRES and its network services comprise several separate facilities, some owned and controlled by the AMRES organisation, others equipment collocated to AMRES service

centres or AMRES institutions. The GHG emissions of AMRES are consolidated into four categories: a. office, b. data centre c. backbone and d. transportation.

Each one is measured in a controlled and documented manner. In this way, AMRES accounts for all GHG emissions and removals from facilities over which it has financial and operational control.

The operational boundaries of AMRES include

- two offices located in Belgrade (Kumanovska 7 and Bulevar kralja Aleksandra 90),
- the Backbone Network,
- one Data Centre and
- transportation incurred as a part of the staff's work.

## **2.2 Responsible party**

The inventory is carried out by:

Maja Bandjur

Email: maja.bandjur@rcub.bg.ac.rs

Phone: +381 11 303 12 58

## **2.3 Reporting period covered**

The period covered by this inventory is the year from July 2012 to June 2013, both inclusive.

## **2.4 Historical base year selected and the base year GHG inventory**

This is the first GHG inventory for AMRES.

# **3 Calculating GHG emissions**

## **3.1 Greenhouse gasses and CO<sub>2</sub>-eq definition**

The greenhouse gasses (GHGs) are:

- Carbon dioxide (CO<sub>2</sub>)
- Methane (CH<sub>4</sub>)
- Nitrous Oxide (N<sub>2</sub>O)
- Hydrofluorocarbons (HFCs)
- Petrofluorocarbons (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.

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. Specifically, energy consumption in AMRES premises is calculated based on the power utility operator bills. For the network equipment, energy consumption values are estimated from the manufacturer's datasheets while total energy consumption in data centre is recorded based on AMRES network monitoring tool.

Based on the “2013-Climate-Registry-Default-Emissions-Factors.pdf” published by <http://www.theclimateregistry.org/>. This applies for the total energy demand in the Serbia the average CO<sub>2</sub>-eq caused by 1 KWh of electricity in the Serbia is **724g CO<sub>2</sub>-eq** in 2010.

Equivalent data figures for 2011 and 2012 are not yet available, therefore data being analysed is calculated using the 2010 figure.

## **4 Scope 1: Direct GHG Emissions**

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

AMRES does not own any car or other form of motorised transport or any source of direct emission of the GHGs listed. So the value for direct CO<sub>2</sub> emission is 0 tons.

### **4.1 GHG removals**

AMRES is not responsible for any GHG removals.

### **4.2 Exclusions**

There are no exclusions.

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

AMRES 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 **0** tons.

## **5 Scope2: Indirect GHG Emissions**

This section covers the methodology used to quantify energy-indirect GHG emissions, by sector, within AMRES 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 AMRES offices, the AMRES data centre and the AMRES backbone network.

### **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. AMRES does not produce any GHGs by direct emission. Indirect emissions are calculated from activities in four main areas:

#### **The office:**

is a leased premises at Kumanovska 7, Belgrade and Bulevar kralja Aleksandra 90, Belgrade where all staff are employed. Indirect emissions in this 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.
- Electricity for building services. Outside the office energy is spent in lifts, lighting and security

#### **Backbone Network:**

The network (or backbone) includes all the PoPs where network equipment, owned by AMRES, is located. This equipment consists of:

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

#### **Data centres:**

AMRES owns one data centre where computer and storage equipment is installed.

## **5.2 Reasons for selection of inventory sectors**

The four sectors were selected so as to facilitate the allocation of the inventory task to all members of the Environment Working Group, in a fair and sensible manner. The sectors chosen are distinct (with no overlap between them) and comprehensive (no omissions from the GHG profile of the organisation). Within each sector, consistent and reproducible methods of quantifying GHG emissions are described below.

## **5.3 The Office**

Direct emissions were derived from an overview of the service costs for the AMRES premises (appended file “AMRES-Office-and-DataCenter.xlsx”).

The calculation available in appended file “AMRES-Office-and-DataCenter.xlsx” estimates that 249800.6 KWh are attributed to AMRES for electricity (232259.6 KWh for Kumanovska 7 and 17541 KWh for Bulevar kralja Aleksandra 90).

This corresponds to **180.81tons CO2-eq** (based on 724 g CO2-eq per KWh).

### **5.3.1 Facilities**

The only office facility accounted for is the offices in Belgrade (Bulevar kralja Aleksandra 90 and Kumanovska 7) the electricity used by the office is accounted for as well as the proportional amount of electricity used for building services inside and outside the office (lifts, security, lighting).

### **5.3.2 Exclusion**

No exclusions are applied.

### **5.3.3 Measurement method**

All GHG emissions are indirect as result the consumption of electricity power, lighting, heating and cooling. Electricity is supplied by the public corporation EDB (Electrical Distribution Belgrade). The monthly electricity bills (provided by EDB) are used for the reporting period (July 2012-June2013).

The Unit reported by the EDB is the kilowatt hour: 1 unit = 1 kWh.

The AMRES Data Centre is located in the same building where are offices in Kumanovska7, therefore the power consumption of Office2 obtained by subtracting yearly power



consumption provided by company bills and Total power consumption in Data Centre (IT Equipment Power plus Power consumption of cooling devices in DC).

Detailed calculations can be found in the appended file “AMRES-Offices-and-DataCenter.xlsx”

The AMRES office (Bulevar kralja Aleksandra 90) is located in a multi-tenant building with a central heating and cooling system powered by natural gas.

Based on the annual bill submitted by the company that provides the heating energy, it is estimated that 25244.5KWh are attributed to AMRES.

This corresponds to **4.6 tons CO<sub>2</sub>-eq** (based on 0.18404 kg CO<sub>2</sub>-eq per KWh)

## **5.4 Backbone network**

The AMRES backbone presents a number of links between AMRES PoPs. The backbone infrastructure relates to intercity links which connect the AMRES service centres in Belgrade, Novi Sad, Kragujevac and Nis.

All other institutions are connected to the one of the 4 AMRES service centres.

Optical technology is used for data transfer via dark fibre optical infrastructure (2200 km dark fibre links). Gigabit Ethernet technology (1000BASE-X) is used in AMRES, and transport of signals is done over Single Mode and Multi Mode fibres.

### **5.4.1 Facilities**

The AMRES IP network topology includes established L2/L3 Ethernet links for the interconnection of AMRES institutions. The AMRES network topology is shown in Figure 1. The AMRES network can be divided into core and access network parts. The access network consists of dark fibre pairs between the point of presence (PoP) of AMRES in each major city in Serbia and the PoP of the connected university or research institute. Around 172 clients are connected to the AMRES network.



Figure 1 AMRES Network Topology

#### 5.4.2 Exclusions

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

#### 5.4.3 Measurement Method

AMRES's network is illustrated by IP/Ethernet network equipment. The IP/Ethernet network consists of 3 routers and 56 switches from different vendors.

Energy consumption data for all types of equipment is based either on actual power measurement of the devices (in cases that it was possible to measure power consumption) or in their typical energy consumption working mode, as detailed in the manufacturer's datasheets. PUE can't be calculated but it is assumed that is value 2.

Almost all ITC equipment are located in small rooms that are not designed as computer room and do not have adequate cooling.

Detailed calculations are can be found in the appended file "AMRES - Backbone Network.xlsx".

#### 5.4.4 GHG emission of the AMRES network

The calculation available in appended file “AMRES - Backbone Network.xlsx” estimates that 125353.85 KWh are attributed to AMRES. This corresponds to **181.51 tons CO<sub>2</sub>-eq** (based on 0,724 kg CO<sub>2</sub>-eq per KWh and a PUE=2).

### 5.5 Data centres

#### 5.5.1 Facilities

AMRES owns one data centre, as stated earlier, where computational and storage equipment is installed and where is also one AMRES’s PoP. The data centre is currently equipped with 5 racks hosting servers and storage equipment and 4 racks with telecom equipment

#### 5.5.2 Exclusions

No exclusions are applied.

#### 5.5.3 Measurement method

Power consumption of devices in the data centre is measured by NetIIS monitoring tool (<http://netiis.rcub.bg.ac.rs>) based on SNMP protocol and by external script which is made and implemented for this purpose. The bash script collects and summarizes data of power consumption of all PDUs and UPSs installed in the DC. In order to calculate the total power consumption it was needed to find SNMP MIB base and appropriate OIDs for UPSs and PDUs. By using this information, it was possible to obtain the result of IT equipment power consumption in DC. The total facility power consumption for reporting period is obtained through monthly bills.

Actual power consumption of cooling system in the DC was unavailable, due to SNMP unavailability on the device, The manufacturer-provided information about maximum power usage value was used to calculate the overall figure. Two indicative screenshots from energy consumption in data centre on a daily and a weekly basis are provided in Figures 2 and 3.

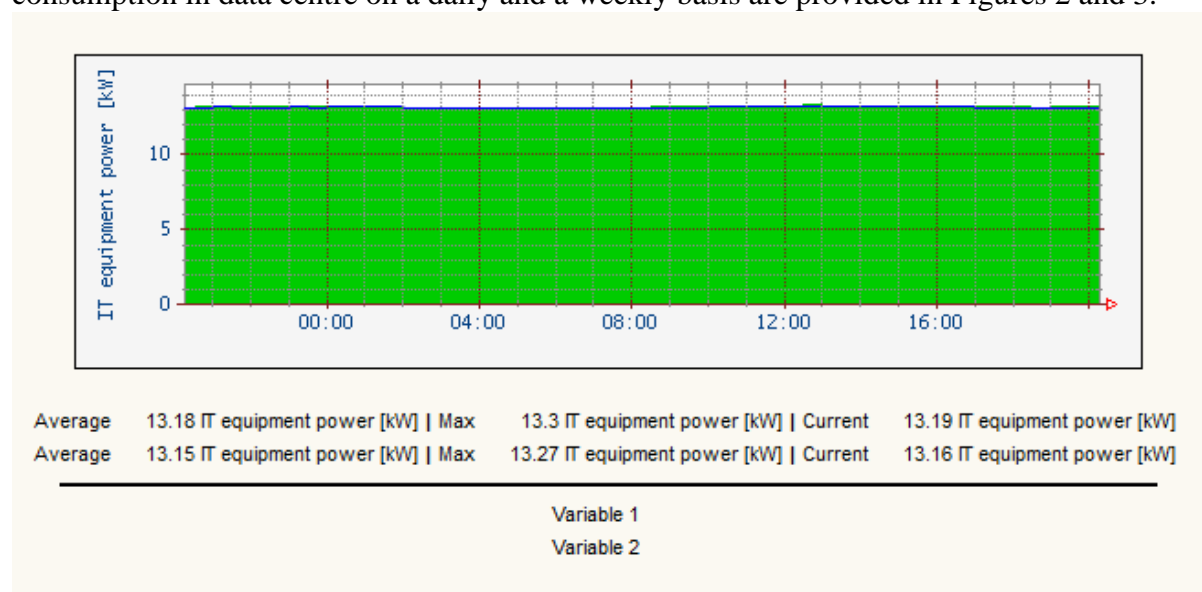


Figure 2 Energy consumption on daily basis

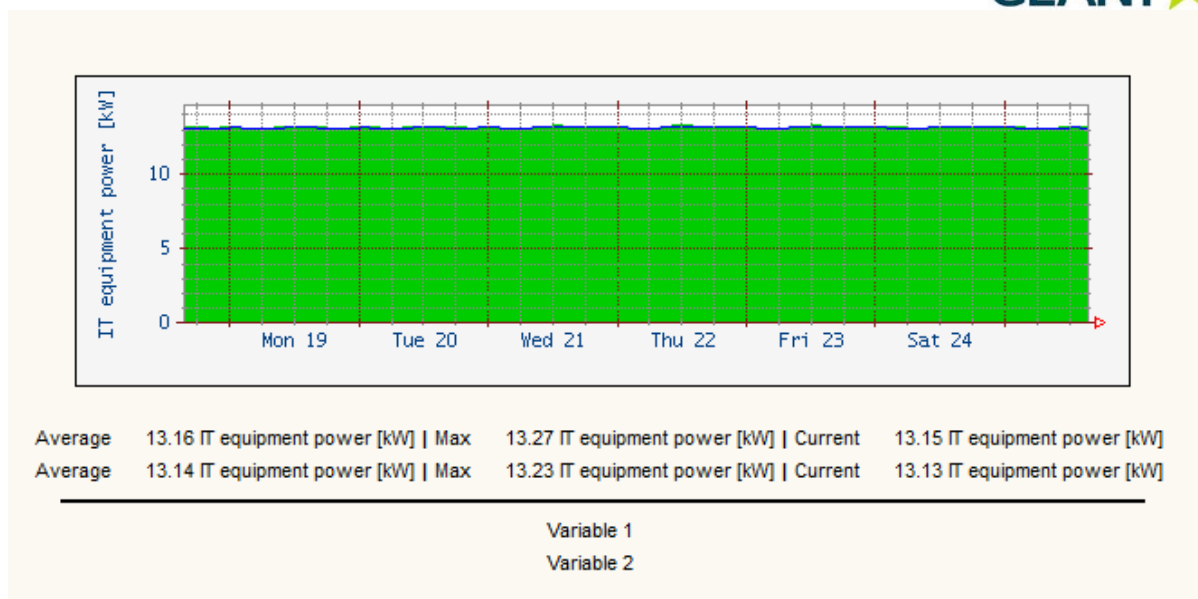


Figure 3 Energy consumption on weekly basis

#### 5.5.4 GHG emission of the AMRES Data Centre

The calculation available in the appended file “AMRES –Offices-and-DataCentre.xlsx” estimates that 293.810,4 KWh is consumed in the AMRES data centre.

This corresponds to **212.72 tons** CO<sub>2</sub>-eq (based on 0,724kg CO<sub>2</sub>-eq per KWh).

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

The emissions under Scope2 are **579.73 tons** CO<sub>2</sub>.

## 6 Scope 3: Other indirect GHG emissions

### 6.1 Transport

#### 6.1.1 Scope of transport

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

#### 6.1.2 Exclusions

There are no exclusions from either category of transport.

#### 6.1.3 Measurement method

GHG emissions for transportation result from flights for business purposes and from AMRES personnel’s daily transportation. For transport associated with commuting to and from work, all employed staff filled personnel information (“Travel GHG Estimations AMRES, Final.xls”) regarding how they reach office based on the address where each employee lives. The approximate distance for each staff member’s daily journey is taken from <http://www.planplus.rs/> and categorized by walk/cycle, train, bus, tram, motorbike, taxi or car.

It is assumed that each employee completes a round-trip on the days they commute to the office. We assumed 220 working days per year. Daily kilometres per category are calculated and are multiplied by 220 days to get the annual figure.

The corresponding emissions derive from:

Cars: from <http://www.carbonfootprint.com/calculator.aspx> according to the type of the car and the travelled distance

Buses/Trams: from <http://www.carbonfootprint.com/calculator.aspx> according to the travelled distance

The calculation available in appended file “AMRES -Travel GHG Estimations.xls” estimates that **24.9 tons CO<sub>2</sub>-eq** are emitted due to personnel commuting.

In the case of transport used while on mission a log is kept of all flights taken by staff for travel to and from meetings, conferences etc. All information are taken from internal PMO which keeps records of all approved travels. The approximate emission of each flight is calculated from <http://www.carbonfootprint.com/calculator.aspx>

The calculation available in appended file “Travel GHG Estimations AMRES, Final.xls” estimates that **6.86 tons CO<sub>2</sub>-eq** are emitted due to personnel flights.

## 7 Summary of GHG Emissions

The conversion factors are taken from:

<http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf>

[http://www.carbontrust.com/media/18223/ctl153\\_conversion\\_factors.pdf](http://www.carbontrust.com/media/18223/ctl153_conversion_factors.pdf)

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

- The emissions under scope/tier 1 are 0 ton CO<sub>2</sub>-eq.
- The emissions under scope/tier 2 are 579.73 ton CO<sub>2</sub>-eq.
- The emissions under scope/tier 3 are 31.76 ton CO<sub>2</sub>-eq.
- The final figure for GHG emissions by AMRES in the year July 2012 to June 2013 both inclusive is **611.49 tons** of CO<sub>2</sub> equivalent.

The results from all sectors are shown in Table 1.

## AMRES GHG AUDIT JULY 2012 – JUNE 2013

Item	Energy source	Energy consumption(KWh)	CO2 Factor kg CO2-eq per KWh	PUE	Total (tons CO2-eq)
<b>Scope1-Direct Emissions</b>					
					<b>0.00</b>
<b>Scope2-Indirect Emissions</b>					
<b>1. Offices</b>					
Office 1	Electricity	17541	0.724		12.70
Office 2	Electricity	232259.6	0.724		168.16
Office 1 - Heating	Natural gas	25244.5	0.18404		4.65
<b>2. Data Centre</b>					
Data Centre BUCC-AMRES PoP	Electricity	293810.4	0.724	2.5	212.72
<b>3. Backbone Network</b>					
Routers&Switches	Electricity	125353.848	0.724	2	181.51
<b>Scope3-Other Indirect Emissions</b>					
<b>Transport</b>					
Commuting					24.90
Private Cars					
Bus					
On missions					6.68
Flights					
Bus					
<b>TOTAL CO2-eq</b>					<b>611.49</b>

Table 1 Summary of GHG Emissions by AMRES