



# **GN3 Study of Environmental Impact Inventory of Greenhouse Gas Emissions and Removals - ASNET-AM**

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# 1. Introduction

## 1.1. Background

Being a member of GEANT Green team since 2015, Academic Scientific Research Computer Network of Armenia (ASNET-AM) is focused on energy consumption minimisation of both networking and computational facilities. The ISO 14064 standard is recognised for calculating and reporting the green audits

## 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 information can be used for comparison with other NRENS, and for use by other NRENS for GHG assessments the following years.

The intended user of this report are the NRENS, GEANT and the Green GEANT team. Data from this report and its comparison with previous years may be disseminated to relevant stakeholders in the area of analysis of environmental impact of IT infrastructure and the use of ICT solutions for environmental friendly purposes.

## 1.3. ASNET-AM: Purpose and Profile

The main aim of ASNET-AM is to provide state-of-the-art networking, computing and data solutions to the Academic, Scientific, Research, Educational, Cultural and other organisations of Armenia and beyond, which are preliminary engaged in scientific and educational activity. Nowadays the network interconnects about 60 scientific, research, educational, cultural and other organisations located in 5 cities of Armenia, integrating them to GEANT. Besides providing networking and computing facilities to the beneficiaries, the main activities of ASNET-AM include scientific investigations in ICT; distributed computing infrastructures; scientific computations; database development and processing; participation and support of scientific, educational, technical, cultural and other programs and projects; and IT training and education. ASNET-AM is a member of several international organisations, such as GEANT, RIPE and CEENET.

## 1.4. Green ASNET-AM Activities

ASNET-AM has recently been involved in several green activities towards the minimization of energy consumption both for the networking and computational facilities. The Green policy has been adopted in 2015. The scientific investigations include the study and provide state-of-the-art services to user communities based on well known methods and techniques, such as the dynamic voltage frequency scaling and memory ballooning.

## 2. Inventory Design and Development

### 2.1. Organizational and Operational Boundaries

The Institute for Informatics and Automation Problems of the National Academy of Sciences (IIAP) of the Republic of Armenia (NAS RA) is responsible for administration and the development of ASNET-AM since 1998 by decision of the Presidium of NAS RA. The offices of ASNET-AM located in Yerevan in the presidium of NAS RA (Marshal Baghramian ave. 24 ) and IIAP (Paruyr Sevak 1), the Backbone Network and core services of the computational facilities incurred as a part of the staff's work. It should be noted that only the energy consumption of the network is included in this report.

### 2.2. Responsible Party

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### 2.3. Reporting Period Covered

The period covered by this inventory is the year from Jan 2015 to Dec 2015, both inclusive.

### 2.4. Base Years

The first GHG inventory for ASNET-AM, covering the year Jan 2015 to Dec 2015 serves as historical base year as well as base year for this inventory.

## 2.5. Base Year Changes and Recalculations

This is the first GHG inventory for ASNET-AM, covering the year Jan 2015 to Dec 2015 serves as a historical base year as well as base year for this inventory.

## 2.6. Compliance Statement

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

## 2.7. Verification Statement

This report was submitted by ASNET-AM NOC team to assure that the report is in accordance with ISO 14064. This resulted in a positive evaluation statement on 03 of March 2016.

## 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)
- Perfluorocarbons (PFCs)
- Sulphur Hexafluoride (SF<sub>6</sub>)

When GHG emissions are calculated, the impact of each GHG is transformed to a CO<sub>2</sub> equivalent. This is done by multiplying the emissions of a GHG by a factor that represents the effect of the GHG on climate change. These effects are based on the IPCC GWP100 factors. The effect of CO<sub>2</sub> is 1, since by definition effect of CO<sub>2</sub> is 1 CO<sub>2</sub>-eq.

### 3.2. Data used for calculating GHG emissions

As a starting point we have decided to compute GHG emission for ASNET-AM network using simple measurement devices (such as UPSs), vendor's data sheets and bills. The network administrator of the ASNET-AM network has data on the devices (routers, switches ) operating in the network. We have used special UPS devices to calculate the average energy consumption of each device type in the network. Moreover we have compared the collected information with the theoretical averages provided by the vendors.

The reference values for the price of the electricity and CO<sub>2</sub> emission per 1 kWh of power were taken from the local authorities and international organisations, as an example the amount of CO<sub>2</sub> emission per 1 kWh of electricity power in Armenia which was calculated in the referenced paper.

### 3.3. Impact of uncertainties on the accuracy of the data

ASNET-AM started to measure and report on GHG emission in 2016, it takes the most basic approach to measure the power consumption of all network devices. This method has been carried out after an agreement between all ASNET-AM staff and members, to give an accurate indication of the level of GHG emission. This report has been created in accordance with ISO14064-1.





## 4. Scope 1: Direct GHG Emissions

Direct (Scope 1) GHG emissions are defined as emissions caused by the combustion of fuels or direct emissions of GHGs. These emissions are characterized as Scope 1 according to ISO 14064. The section also includes information regarding GHG removals, possible exclusions and direct CO<sub>2</sub> emissions from the combustion of biomass.

### 4.1. GHG Removals

ASNET-AM 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

ASNET-AM 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 0.0 tons CO<sub>2</sub>-eq.

## 5. Scope 2: Indirect GHG Emissions

This section covers the methodology used to quantify energy-indirect GHG emissions within ASNET-AM. 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 ASNET-AM network.

### 5.1. Quantification Methodologies

In this inventory, only recurrent emissions are considered. Indirect emissions are calculated from activities in three main categories:

The office:

ASNET-AM Headquarter Offices are located in capital Yerevan in the presidium of NAS RA (Marshal Baghramian ave. 24 ) and IIAP (Paruyr Sevak 1). The resource consumption of the office is estimated from the overall power and gas usage from office's equipment and heating (lighting, air conditioning, computers (not included in the network), heating etc.).

Backbone Network:

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

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

For the network equipment, energy consumption values comes either from existing documentation or from real time measurements.

Data centers:

This section regards energy consumption and emissions from Data centres that are caused from the storage equipment as well as supporting infrastructure such as cooling, ups, etc.

Energy consumption data for all the types of equipment is based either on real time measurements (in cases that it is possible) or in their typical energy consumption, as detailed in the manufacturer's datasheets. The total amount of kWhs is converted into tons of CO<sub>2</sub>-eq based on how many kgr of CO<sub>2</sub>-eq correspond to 1 kWh for the NREN's country in the specific year and on the PUE factor.

### 5.2. Reasons for selection of Inventory Sectors

Only recurrent emissions are considered. The embedded energy and consequent GHG emissions from building and production of facilities and equipment are not included.

The emissions are calculated from activities in one main area which are the Network facilities.

## 5.3 The Office

### 5.3.1 Facilities

The two office facilities of ASNET-AM are located in Yerevan, Armenia the electricity and heating costs used by the offices are accounted from the proportional amount of resources used for building services (electricity and heating)

### 5.3.2 Exclusions

The cost of the network devices operating in the office have been calculated in the backbone, thus excluded from the office costs.

### 5.3.3 Measurement Method

All GHG emissions are indirect as a result of the consumption of electricity power (lighting, cooling, etc.). For heating purposes the Natural Gas is used. The values have been calculated according to the proportion of the office are and whole building, because the bills comes for whole building.

### 5.3.4 GHG Emissions of the ASNET-AM Offices

The emissions caused by the ASNET-AM's Offices are 4.21 tons of CO<sub>2</sub>-eq (based on 0.128 kg CO<sub>2</sub>-eq per KWh of Electricity, 0.021 kg CO<sub>2</sub>-eq per m<sup>3</sup> of Natural Gas)

The calculation estimates that 4.21 tons of CO<sub>2</sub>-eq are caused by 32,600.00 KWh of Electricity, 1,900.00 m<sup>3</sup> of Natural Gas.

In detail, the distribution among Offices is as follows:

- Office "ASNET-AM PoP1": 2.04 tons of CO<sub>2</sub>-eq caused by 15,800.00 KWh of Electricity, 833.33 m<sup>3</sup> of Natural Gas
- Office "ASNET-AM PoP2": 2.17 tons of CO<sub>2</sub>-eq caused by 16,800.00 KWh of Electricity, 1,066.67 m<sup>3</sup> of Natural Gas

## 5.4 Backbone Network

The ASNET-AM backbone consists of network communication nodes in 4 cities of Armenia which are interconnected by fiber-optics and wireless links. The main PoPs located in the Presidium of the National Academy of Sciences and in the Institute for Informatics and Automation Problems.

### 5.4.1 Facilities

The only POP facility accounted for is the electricity used for by the POPs .

### 5.4.2 Exclusions

Network and server equipment not owned by ASNET-AM is excluded from this report.

### 5.4.3 Measurement Method

ASNET-AM's network is consists of several types of switches, routers and radio modems.

The energy consumption mainly are calculated by the energy meters. However if it was not possible to measure by the energy meter we have take a average energy consumption from device specification mentioned in the vendor's guide.

PUE can't be calculated but it is assumed that is value 2.

Almost all the devices have small size so there are not special networking rooms and separate cooling is not needed.

### 5.4.4 GHG Emissions of the ASNET-AM Network

The calculation estimates that 63.63 KWh are attributed to ASNET-AM's network.

This corresponds to 8.14 tons CO<sub>2</sub>-eq (based on 0.128 kg CO<sub>2</sub>-eq per KWh).

## 5.5 Data Centers

This section concerns the energy consumption and emissions from Data Centers that are produced only from the storages. Energy consumption data for each Data center (IT and supportive infrastructure) is based on typical energy consumption of the hosted equipment, as detailed in the manufacturer's data sheets.

### 5.5.1 Facilities

The data centre facilities are located in the PoP1.

### 5.5.2 Exclusions

No exclusions are applied.

### 5.5.3 Measurement Method

All GHG emissions are indirect as a result of the consumption of electricity power, lighting and cooling.

### 5.5.4 GHG Emissions of the ASNET-AM Datacenters

The calculation estimates that 8,760.00 KWh are attributed to ASNET-AM's Data Centers (0.45 tons of CO<sub>2</sub>-eq caused by 1,752.00 KWh at the Data Center 1, 1.79 tons of CO<sub>2</sub>-eq caused by 7,008.00 KWh at the Data Center 2).

This corresponds to 2.24 tons of CO<sub>2</sub>-eq (based on 0.128 kg CO<sub>2</sub>-eq per KWh)

## 5.6. Total CO<sub>2</sub>-eq under Scope2

The emissions under Scope2 are 14.60 tons of CO<sub>2</sub>-eq.

## 6. Scope 3: Other indirect GHG Emissions

### 6.1 Transport

The calculation estimates that 0.30 tons of CO<sub>2</sub>-eq are emitted due to personnel commuting.

The calculation estimates that 2.43 tons of CO<sub>2</sub>-eq are emitted due to personnel flights.

#### 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 ASNET-AM: commuting to and from work, and travel “on mission” as part of one's duties to the ASNET-AM.

#### 6.1.2 Exclusions

There are no exclusions from either category of transport.

#### 6.1.3 Measurement Method

For transport associated with commuting to and from work, all employed staff answered a questionnaire regarding how they reach office based on the area where each employee lives. The approximate distance for each staff member's daily journey is taken from <http://maps.google.com/> and categorized by walk/cycle, train, metro, bus, motorbike, taxi, car.

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

### 6.2. Total CO<sub>2</sub>-eq under Scope3



The emissions under Scope3 are 2.73 tons of CO<sub>2</sub>-eq.

# 7 Summary of GHG Emissions

The emission of GHG's caused by ASNET-AM calculated within this report is as follows:

- The emissions under scope/tier 1 are 0.00 tons of CO<sub>2</sub>-eq.
- The emissions under scope/tier 2 are 14.60 tons of CO<sub>2</sub>-eq.
- The emissions under scope/tier 3 are 2.73 tons of CO<sub>2</sub>-eq.
- The final figure for GHG emissions by ASNET-AM the year 2015 is 17.33 tons of CO<sub>2</sub>-eq.

Item	Energy Source	Energy Consumption	CO <sub>2</sub> Factor	PUE Factor	Total (Tons CO <sub>2</sub> -eq)
<b>Scope 1 - Direct Emissions</b>					
Office					0.0
<b>Scope 2 - Indirect Emissions</b>					
<b>1. Offices</b>					<b>4.21</b>
<b>1.1 Office 1 "ASNET-AM PoP1"</b>					<b>2.04</b>
Office 1 - Electricity	Electricity	15,800.00 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh		2.02
Office 1 - Natural Gas	Natural Gas	833.33 m <sup>3</sup>	0.021 Kgr CO <sub>2</sub> -eq per gas m <sup>3</sup>		0.02
<b>1.2 Office 2 "ASNET-AM PoP2"</b>					<b>2.17</b>
Office 2 - Electricity	Electricity	16,800.00 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh		2.15
Office 2 - Natural Gas	Natural Gas	1,066.67 m <sup>3</sup>	0.021 Kgr CO <sub>2</sub> -eq per gas m <sup>3</sup>		0.02
<b>2. Backbone</b>					<b>8.14</b>

Access	Electricity	36,914.64 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh		4.73
Core	Electricity	26,718.00 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh		3.42
<b>3. Data Centers</b>					<b>2.24</b>
Data Center 1	Electricity	1,752.00 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh	2.0	0.45
Data Center 2	Electricity	7,008.00 KWh	0.128 Kgr CO <sub>2</sub> -eq per KWh	2.0	1.79
<b>Scope 3 - Other Indirect Emissions</b>					
<b>Transport</b>					<b>2.73</b>
<b>Commuting</b>					<b>0.30</b>
Bus	Distance	4,400.00 Km			0.10
Car	Distance	4,400.00 Km			0.20
<b>On Mission</b>					<b>2.43</b>
<b>Total CO<sub>2</sub>-eq</b>					<b>17.33</b>