Supply Chain Analysis & Reduction Targets Gridflex Heeten

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History

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1.0	19-03-2018	Merel Segers	Initial version
1.1	26-03-2018	Mark van Eesteren	Review
1.2	28-03-2018	Merel Segers	Quantifying scope 3 emissions
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Inhoud

1 Introduction

ICT Group N.V. (“ICT”) aspires to maintain level 4 of the CO_2-prestatieladder. This report contains the results of one of the two supply chain analysis required to comply with requirement 4.A.1.[1] and 4.B.1.[2] of the CO_2 Prestatieladder.

This report contains the quantitative supply chain analyses of the GridFlex Heeten project, and more specifically, the Energy Management System (EMS) ICT Group developed for this project (chapter 2). CO_2 reduction targets are formulated based on this analysis in chapter 3.

For more information about ICT and the qualitative assessment of ICT’s most material CO_2 emissions, see report ‘CO_2 Scope 3 Chain analyses 2017 ICT Group NV’. For the second supply chain analysis, see report ‘Chain analysis – Loading poles”.

1.1 Topic of this analysis: GridFlex Heeten - Energy Management System (EMS)

With this supply chain analysis, we meet the first part of the requirement as described in Handbook CO2-prestatieladder 3.0:

‘One supply chain analysis needs to be made for one of the two most material emissions, and one other supply chain analysis for one of the six most material emissions.” The ranking of the most material emissions can be found in table 2 in the report ‘CO_2 Scope 3 Chain analyses 2017 ICT Group NV’.

The product/market combination (PMC) ‘Energy’ is ranked first in the materiality table. Therefore, it was decided to make a supply chain analysis of the energy product as used in the GridFlex Heeten project: Energy Management System (EMS).

1.1.1 GridFlex Heeten

With the GridFlex Heeten project a local energy market is developed in which an optimal local energy system is realized by means of pricing mechanisms, incentives and energy flexibility. Energy cooperative ‘Endona’ received an exemption on the Dutch Elektriciteitswet (‘electricity law’) to experiment. Using this exemption, a local energy market will be realized in Heeten in which innovative pricing mechanisms will be tested with local renewable energy sources and energy storage. Consumer flexibility and demand-side management ensures the energy is consumed locally, especially using the combination of storage and photovoltaics. By innovative pricing mechanisms good behaviour is stimulated. This leads to reduced losses and delaying or even making further investments in the grid unnecessary. The achieved savings are shared in a fair way.

ICT is a partner in the project and is responsible for developing the EMS – Energy Management System, enabling the local energy market and behaviour changes in users.

1.1.2 Energy Management System (EMS) for GridFlex Heeten

The EMS is a product of ICT that contributes to the development of efficient, decentralized energy networks.

The hardware of the EMS is linked to the smart meter of households that participate in Gridflex Heeten. Data is send via the EMS to the cloud. A central computer can send signals to the EMS modules at each participating household. Users get access to an app and web portal to gain insights into their energy consumption, production and storage. Through the central computer the energy market is managed, for instance using storage capacity at households to balance the grid or enabling users to buy electricity when prices are low. See figure 1 & 2 for a visualization of the EMS system and app & web portal.

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[1] Eis 4.A.1. ‘*Het bedrijf heeft aantoonbaar inzicht in de meest materiële emissies uit scope 3, en kan uit deze scope 3 emissies tenminste 2 analyses van GHG-genererende (ketens van) activiteiten voorleggen.’* (Handboek CO_2-prestatieladder 3.0)

[2] Eis 4.B.1. ‘*Het bedrijf heeft voor scope 3, op basis van 2 analyses uit 4.A.1., CO_2-reductiedoelstellingen geformuleerd of bedrijf heeft voor scope 3, op basis van 2 materiele GHG-genererende ketens van activiteiten CO_2-reductiedoelstellingen geformuleerd. Er is een bijbehorend plan van aanpak opgesteld inclusief de te nemen maatregelen. Doelstelling zijn uitgedrukt in absolute getallen of percentages ten opzichte van een referentiejaar en binnen een vastgelegde termijn.’* (Handboek CO_2-prestatieladder 3.0)

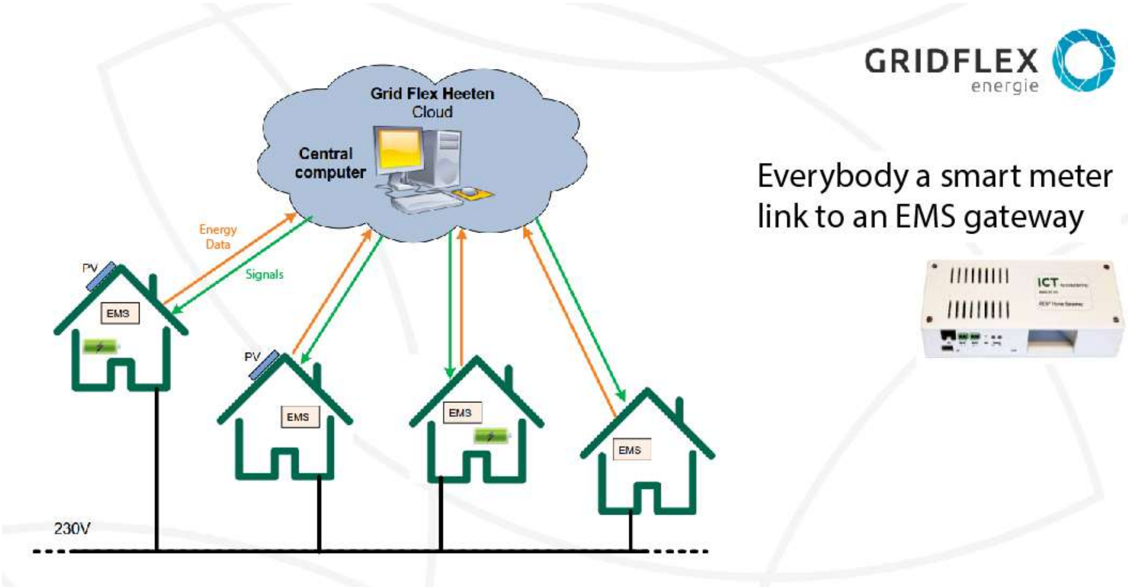

Figure 1: EMS sends energy data to the GridFlex Heeten cloud. A central computer can send signals to the EMS at every household.

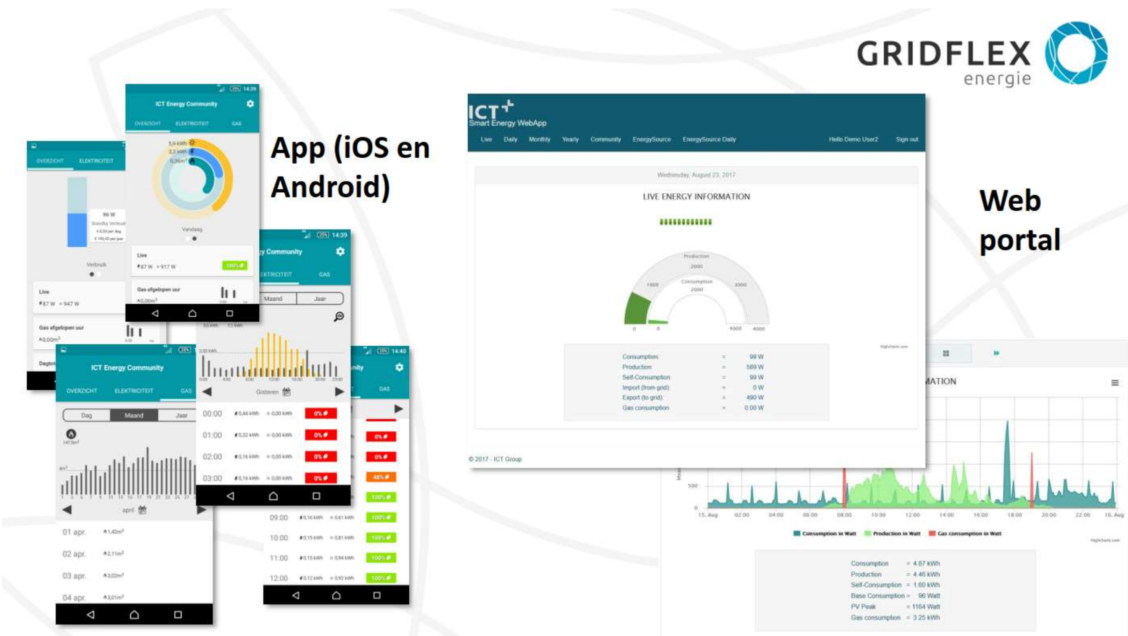

Figure 2: Visualizations of possible app / web portal interfaces.

1.2 Approach Supply Chain Analysis

The approach as described in the SKAO manual 'Handboek CO2-prestatieladder 3.0', requirement 4.A.1. was followed for this supply chain analysis. Data was collected through interviews with Mark van Eesteren – Sustainability Officer ICT Group N.V., Marten van der Laan, senior business consultant smart energy at ICT Group and Victor Reijnders, PhD TU Twente. Additional sources and studies were used to substantiate the supply chain analysis, for references go to the Sources chapter.

1.2.1 Data

The CO_2 impact factors were selected from CO2emissiefactoren.nl and milieudatabase.nl, in accordance with CO_2 Prestatieladder 3.0. Since we could not find all impact factors here, we also used the database Eco-costs 2017 V1.2. This database is made by TU Delft and is calculated using Simapro 8.5.0.0. using LCI database Ecoinvent 3.4.

1.2.2 CO_2 equivalents

Carbon Footprint is expressed in CO_2 equivalents (CO_2e) in all the databases used. This is based on the Global Warming Potential (GWP 100); the extent to which a gas contributes to the greenhouse effect in 100 years' time. For example, methane has a GWP 100 of 28 and Nitrous oxide (N20) a GWP 100 of 265 (IPCC Fifth Assessment Report (AR5), 2014).

1.2.3 Results: CO_2e and energy

The results (paragraph 2.5) are expressed both in CO_2e and in energy (kWh). Gridflex Heeten households use solar energy, which results in low CO_2e emissions in the use phase compared to using the EMS in a conventional setting in which grey electricity is used. This while energy savings are higher in the Gridflex Heeten scenario. By adding energy as a result, the extra benefit of avoiding losses of solar energy by enhancing grid stability in the Gridflex Heeten project can be shown.

2 Supply chain analysis GridFlex Heeten - Energy Management System (EMS)

As indicated in the Handboek 3.0 of the CO_2 Prestatieladder, the supply chain analysis follows the structure as described in chapter 4 of "A Corporate Accounting and Reporting Standard" (WBCSD, 2004).

- Describe the value chain (section 2.1)
- Determine which scope 3 categories are relevant (section 2.2)
- Identify partners along the value chain (section 2.3.)
- Quantify scope 3 emissions (section 2.4.)

2.1 Describe the value chain

"Because the assessment of scope 3 emissions does not require a full life cycle assessment, it is important, for the sake of transparency, to provide a general description of the value chain and the associated GHG sources (WBCSD, 2004)

A simplified version of the supply chain is depicted in figure 3. In every phase of the supply chain energy and materials be added, and emissions to air, soil and water are released. Transport takes place between the phases. For this analysis only CO_2e is considered as an emission, in accordance with the requirements of the CO_2 Prestatieladder (SKAO, 2015).

2.1.1 Setting system boundaries

The system boundaries determine which processes and activities are included in the overall analysis. This to define where to stop tracking energy and material uses of processes: otherwise the analysis would be infinite and the impacts to the environment would be diluted in those of the several processes studied.

This analysis focusses on the EMS and its functioning within the GridFlex Heeten project. The following system boundaries are set:

- For this analysis the full life cycle of the EMS is considered.
- Electricity in the use phase is considered for supporting ICT, such as the cloud service by Microsoft Azure and the central computer.
- The CO_2e emissions of other technologies needed to make GridFlex Heeten function, such as batteries and servers, are outside the scope of this analysis. Batteries can be added to this calculation in a later stage of the project when batteries are selected and integrated into the Gridflex Heeten project. At this moment (May 2018) this is not the case yet.
- Development of the software is included in the scope 1 & 2 emissions of GridFlex Heeten.

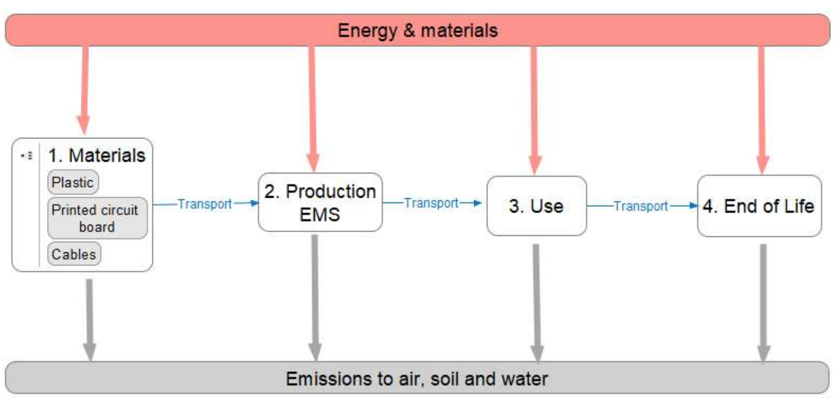

Figure 3: Simplified supply chain of the EMS

2.1.2 Supply chain phases

The following phases are identified:

1. Materials

The hardware of the EMS is made of an injection moulded plastic casing, a printed circuit board (PCB) and the following cables: a power cable, a connection cable to connect the EMS to the smart meter and an internet cable.

The materials are transported from different locations to the production location.

2. Production
The EMS is produced in the Netherlands at ICT Group N.V..

The EMS is transported from ICT Group N.V. to participating households in Heeten.

3. Use
The GridFlex Heeten project is developed to save electricity & materials. But, the system also uses electricity to function. This will be calculated in the Use paragraph of this supply chain analysis.

Electricity use:
- The EMS, the cloud service by Azure and the central computer use electricity.

Electricity savings:
- Behaviour change of households due to increased transparency of their electricity use.
- Balancing the net – avoiding transport & transformer losses due to local renewable electricity use & storage.

Materials savings:
- Balancing the net – avoiding investments in strengthening the net.

4. End of Life
The end of life of the EMS is estimated at 15 years. This is a standard depreciation time for simple electronics. Since it is a new product, the actual lifetime in use has not yet been determined.

2.2 Relevant scope 3 categories

Table 1 shows the relevant scope 3 categories per supply chain phase, in accordance with the GHG Protocol (2011).

Table 1: Relevant scope 3 categories

Supply chain phase	Relevant scope 3 categories
1. Materials	1. Purchased goods and services 4. Upstream transportation and distribution 5. Waste generated in operations
2. Production	1. Purchased goods and services 4. Upstream transportation and distribution 5. Waste generated in operations
3. Use	9. Downstream transportation and distribution 11. Use of sold products
4. End of Life	9. Downstream transportation and distribution 12. End-of-life treatment of sold products

2.3 Identify partners along the value chain

Table 2 lists the partners involved in the supply chain. Below this table the activities is described of the parties mentioned in 3. Use.

Table 2: Partners along the value chain

Supply chain phase	Partners
1. Materials	Suppliers of production facility
2. Production	Production facility
3. Use	Households participating in GridFlex Heeten (Buurkracht), ICT Group, Endona, Enexis, Enpuls, Twente University (see below for more information).
4. End of Life	Waste companies

Buurkracht
Buurkracht is the organization of Heeten households that have joined Gridflex Heeten.

ICT Group N.V.
ICT Group N.V. is responsible for the IT architecture and data retrieval with respect to GridFlex Heeten.

Endona
Endona is the local energy cooperation of Heeten. Endona is the local representative for the realisation of the local energy market.

Enexis
Enexis is the local energy network manager in Heeten and is therefore responsible for the stability and reliability of the local energy network used to transfer energy.

Enpuls
Enpuls is an advisor on realizing local energy ambitions. In the GridFlex Heeten project Enpuls will advise the consortium.

Twente University
Twente University will perform studies regarding innovative market models with flexible price mechanisms. The aim is to investigate which pricing models fit best with a local energy market.

2.4 Quantify scope 3 emissions

The analysis is elaborated in the paragraphs below.

2.4.1 Materials & production of the EMS (Phase 1 & 2)

Appendix A contains the calculation of the CO_2 emissions of the materials & production of the EMS. Ecoinvent database 3.4 was used to determine the emission factors. The electronics in the EMS cause 85% of the CO_2e impact.

Materials & production: 4 kg CO_2e

2.4.2 Use (Phase 3)

Appendix B & C contain the calculation of the CO_2e emissions of the use of the EMS. We chose two different use scenarios, because the EMS can also be applied to other households besides Gridflex Heeten. In this case a different energy mix will be applicable:

- In the scenario 'Convential' the household uses the standard electricity mix of the Netherlands.
- In the scenario 'Gridflex Heeten' the household uses solar energy.

Electricity use:

- The EMS:
  The EMS uses 1.6 Watts. This leads to an annual energy use of 14 kWh yearly and an energy use of 210.2 kWh during the EMS's total lifetime (15 years). In table 3 the CO_2e emissions of the conventional scenario are calculated and in table 4 the emissions of the Gridflex Heeten scenario.

Table 3: The energy use and its corresponding CO_2e emissions of the EMS - conventional scenario

Scenario	**kWh**	**Emission factor kg CO_2e**	**Emision factor**	**Emission kg CO_2e**
Conventional lifetime (15 yrs)	210.2	0.649	Grey electricity	136.4

Table 4: The electricity use and its corresponding CO_2e emissions of the EMS - Gridflex Heeten scenario

Scenario	**kWh**	**Emission factor kg CO_2e**	**Emision factor**	**Emission kg CO_2e**

Gridflex Heeten lifetime (15 yrs)	210.2	0.07	Solar power including production solar panel	14.7

- Cloud service by Microsoft Azure.
  Gridflex Heeten uses approximately 16 kWh a year for storing data of a single household on the Microsoft Azure server. In 2017 44% of the electricity used at Microsoft's servers was renewable (Greenpeace USA, 2017). The other emissions are compensated by unbundled Renewable Energy Certificates and offsets.

  "We achieved carbon neutrality in 2014 and have met our goal of averaging 1.125 power usage effectiveness (PUE) for any new datacentre—exceeding the industry average by more than 30 percent." (Microsoft, 2018).

  Electricity use Microsoft Azure: 0 kg CO_2e annually; 0 kg CO_2e over lifetime EMS. – applicable both scenarios

- The central computer:
  The central computer uses electricity, we assume that the central computer will be used 0.5 day a week for a year. ICT Group N.V. has an energy mix of 60% renewable and 40% grey electricity. Most renewable energy is wind energy. See table 5 for the calculation.

Table 5: Electricity use central computer – applicable both scenarios

Energy mix	Percentage grey / renewable	Hours	Watts	kWh	Emission factor kg CO_2e	Emision factor	Emission kg CO_2e
Annual electricity use – grey	40%	26	200	1.508	0.649	Grey electricity	1.35
Annual electricity use – renewable (mainly wind)	60%	26	200	3.692	0.012	Wind energy including production wind turbine	0.04
Total annual							1.39
Total lifetime (15 yrs)							20.8

Electricity savings:

- Behaviour change of households due to increased transparency of their energy use.
  Multiple sources (Fischer 2008 & Darby 2006) cite energy savings potentials related to transparency in energy use. Qurrent, the Dutch provider of energy manager Qbox, reports average savings of 10% over the lifetime of the energy manager. Savings mainly take place in the first year of using the energy manager. We assume similar energy savings related to the EMS. In table 6 the CO_2e emissions of the conventional scenario are calculated and in table 7 the emissions of the Gridflex Heeten scenario.

Table 6: Behaviour change (lifetime EMS) – Conventional scenario

Scenario	Scenario	kWh	Emission factor kg CO_2e	Emision factor	Emission kg CO_2e
Lifetime energy savings due to energy manager (15 yrs)	10% of 3000 kWh – average energy use Dutch household	300	0.649	Grey electricity	- 194.7

Table 7: Behaviour change (lifetime EMS) – Gridflex Heeten scenario

Scenario	Scenario	kWh	Emission factor kg CO_2e	Emision factor	Emission kg CO_2e
Lifetime energy savings due to energy manager (15 yrs)	10% of 3000 kWh – average energy use Dutch household	300	0.07	Solar power including production solar panel	- 21

- Balancing the net – avoiding transport & transformer losses due to local renewable electricity use & storage.

  Note: This effect can only be reached in the Gridflex Heeten scenario and not in the conventional scenario.

  Electricity losses can be avoided by limiting the transportation distance of electricity. Through stimulating using local renewable electricity when it is generated by means of pricing mechanisms and local battery storage, these losses are minimized.

  In 2016, Enexis had a grid loss of 4.5% in its electricity grids (ACM (2017)). These grid losses are caused by technical causes (electrical resistance) and administrative causes (e.g. vacancy or fraud) (AMC, 2017). Approximately 70% of net losses are due to technical causes (3.2%) and 30% is due to administrative causes (1.3%) (Energeia (2014) & KEMA (2011))

  Annual losses due to technical causes can be reduced by balancing supply and demand. This limits transportation distances and losses due to transforming electricity from low (LS) to medium (MS), high (HS) and ultra-high (UHS) voltage. We assume, substantiated by an interview with Victor Reijnders of TU Twente, that 50% of technical energy losses can be avoided by deploying the EMS in the Gridflex Heeten project. Noting that the real savings can only be known later in the project, when the Gridflex Heeten project is fully operational and has been running for several years. See table 8 for the calculation.

Table 8: energy savings due to avoiding technical energy losses – Gridflex Heeten scenario

	Scenario	kWh	Emission factor kg CO_2e	Emision factor	Emission kg CO_2e
Year 1: Annual energy savings due to avoiding technical energy losses per household	Potential smart grid (50% reduction of energy losses being 1.6% of 3000 kWh[3])	48	0.07	Solar power including production solar panel	- 3.4
Year 2-15: Annual energy savings due to avoiding technical energy losses per household	Potential smart grid (50% reduction of energy losses being 1.6% of 2400 kWh)	38.4	0.07	Solar power including production solar panel	- 2.7
Lifetime energy savings due to avoiding technical energy losses per household					- 41

[3] The scenario is made up as following. In the first year we use 3.000 kWh and in year 2-15 we use 2.400 kWh. This because we consider 10% of energy savings due to the EMS. Savings mainly take place in the first year of using the energy manager.

- Balancing the net – avoiding investments in strengthening the net.

  Note: This effect can only be reached in the Gridflex Heeten scenario and not in the conventional scenario.

  Trends in the current energy transition in the Netherlands will require a large amount of low voltage electricity networks to be reinforced in the coming years. At the GridFlex Heeten project alternatives to reinforcing the net are assessed by experimenting with energy storage and balancing demand & supply. It is expected that this will avoid cable reinforcements and replacing transformers (Groen, 2018). The embedded CO_2e emissions of these products will be avoided. But, because the project just started and its results regarding avoiding strengthening the net are unknown at this moment, this benefit is not considered at this moment for this supply chain analysis. Noting that it is something to consider when monitoring CO_2e emissions of the project in the future.

  Embedded CO_2e due to material savings: Unknown at this moment.

2.4.3 End of Life (Phase 4)

Appendix B contains the calculation of the CO_2e emissions of the End of Life of the EMS. Ecoinvent database 3.4 was used to determine the emission factors.

End of Life: 0.18 kg CO_2e

2.4.4 Transport

Appendix C contains the calculation of the CO_2e emissions of the transport of the EMS. CO_2emissiefactoren.nl was used to determine the emission factors.

End of Life: 0.035 kg CO_2e

2.5 Results

The impact of of the EMS system was analysed using the principles and assumptions described above. Results on CO_2e and energy are listed below.

2.5.1 CO_2e

Table 9 provides a summary of the results for both scenarios. Figure 4 shows that the reduction of CO_2e in the use | energy savings phase is greater than the CO_2e emitted during Materials & Production, Use | EMS, End of Life and Transport for both scenarios.

Table 9: CO_2e savings per EMS conventional scenario

Scenario	**Conventional** **Lifetime EMS (15 years)**	**Gridflex Heeten** **Lifetime EMS (15 years)**
Indicator	**kg CO_2e**	**kg CO_2e**
Materials & Production	4	4
Use | EMS & central computer	157	36
Use | Energy savings	-194.7	-62
End of life	0.18	0.18
Transport	0.035	0.035
Total	**-33.2**	**-22.3**

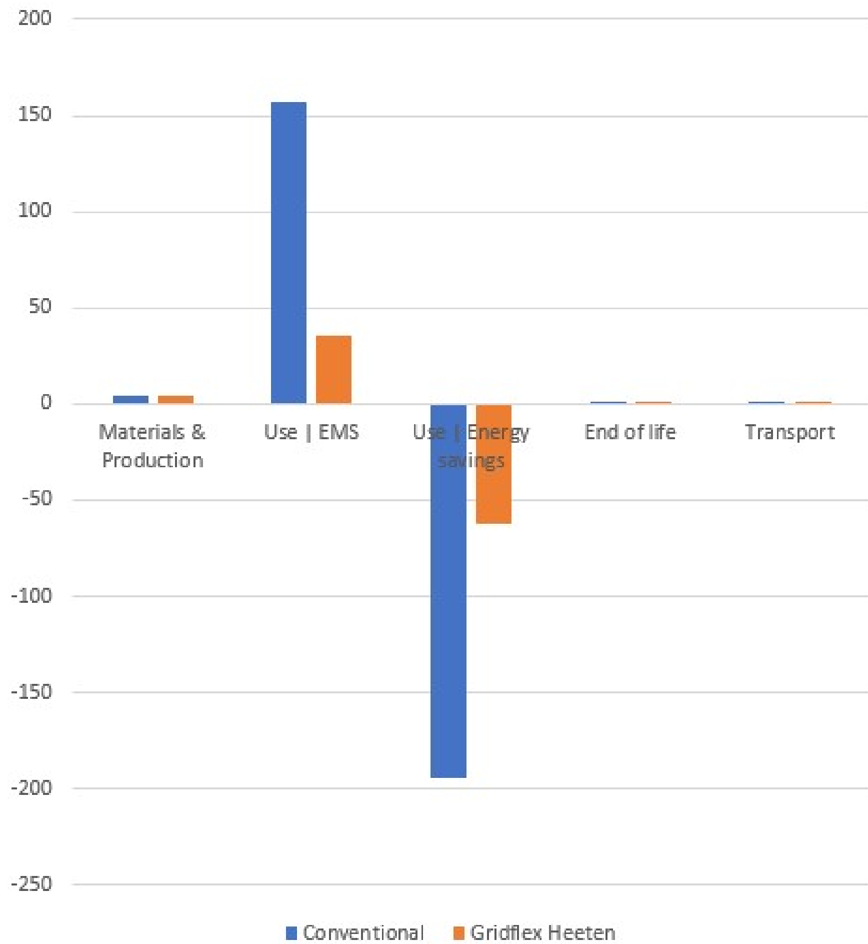

Figure 4: CO_2e EMS

2.5.2 Energy

If we look at energy, the Gridflex Heeten scenario saves more energy than the conventional scenario (table 10). The EMS enables balancing the net when the inflow of solar energy is high, with the benefit of avoiding net losses. The reason that the Gridflex Heeten scenario results in lower CO_2e emissions is because in the Gridflex Heeten scenario solar energy is the source of electricity for households, resulting in lower CO_2e emissions compared to grey electricity of the conventional scenario. This gives a somewhat distorted image, which is the reason why we also report the energy use of both scenario's.

Table 10: Energy use conventional vs Gridflex Heeten

Scenario	**Conventional** **Lifetime EMS (15 years)**	**Gridflex Heeten** **Lifetime EMS (15 years)**
Indicator	**kWh**	**kWh**
Use | EMS & central computer	231	231
Use | Energy savings	-300	- 341
Total	**-531**	**-572**

3 Reduction targets (4.B.1)

The following reduction targets have been set for requirement 4.B.1[4].

3.1 Goals & action plan

We are convinced that the EMS reduces CO_2 in the supply chain. ICT only indirectly influences this CO_2 reduction, since the effects take place among households and supply chain partners. By devising innovative solutions, we can make a greater contribution to a CO_2 reduction. The target of ICT Group N.V. is thereby formulated as a 'inspanningsverpichting' (effort commitment). ICT Group N.V. set the following goals that are challenging and are endorsed by management.

3.1.1 Goals

- In 2018 deploy at least 70 EMS's in the Gridflex Heeten project.
- Monitoring of EMS to test saving scenarios.
- Further development of the EMS.
- Further collaboration in smart grid projects.

3.1.2 Action plan

Our action plan is to deploy more projects with EMS's in future to scale up the EMS product, which is a part of the EnergyNXT platform. As the development of energy projects in which the EMS's will be used is the investigation phase, we expect on a yearly basis to double the number of EMS's installed. This is a careful estimation.

This results in the following action plan:

Table 10: Action plan EMS

When	How many	What
2018	1 project	70 EMS's deployed at Gridflex Heeten
2019	2 projects	140 EMS's – future projects
2020	4 projects	280 EMS's – future projects

The above expectation is on the one hand based on the investments of ICT in the EnergyNXT platform, which is an Internet of Things platform. The development of the EnergyNXT platform is part of the internal innovation program of ICT in which ICT invests 1,5% of the adding value on a yearly basis. For more formation about the EnergyNXT platform, see https://ict.eu/solutions/energynxt/#cases.

On the other hand, ICT is also part of the 'Energiekoplopers Heerhugowaard' project in which 100 households are joining already phase 2 of the project.

3.1.3 Expanding the chain analysis in 2018/2019

In this chain analysis we did not include the potential CO_2 reduction with respect to prevention of grid reinforcements as locally produced electricity is consumed. As explained in paragraph 2.4.2 there is no availability of sufficient data with respect to CO_2 reductions if future grid reinforcements will be prevented by using batteries as storage for electricity. For example, we need data about the number of kilometer cables and transformer cabinets which are not needed. Grid reinforcements are expected following from the energy transition from which it expected that gas will be replaced by electricity and following from the increase in the use of electric vehicles.

We will further investigate if in 2018/2019 we are able to expand the Gridflex Heeten chain analysis in which the potential CO_2 reductions of using the local stored electricity instead of the electricity from the Dutch grid and preventing grid reinforcements will be calculated.

3.2 Reduction

We will deploy at least 70 EMS's for Gridflex Heeten in 2018 and expect to double this amount yearly (table 10). It is unknown of the future projects will be projects like Gridflex Heeten of conventional

[4] Eis 4.B.1: *Het bedrijf heeft voor scope 3, op basis van 2 analyses uit 4.A.1., CO_2-reductiedoelstellingen geformuleerd of bedrijf heeft voor scope 3, op basis van 2 materiele GHG-genererende ketens van activiteiten CO_2-reductiedoelstellingen geformuleerd. Er is een bijbehorend plan van aanpak opgesteld inclusief de te nemen maatregelen. Doelstellingen zijn uitgedrukt in absolute getallen of percentages ten opzichte van een referentiejaar en binnen een vastgelegde termijn. (Handboek CO_2-prestatieladder 3.0)*

(households using solar energy vs household using grey energy). Therefore, calculations are made for both scenarios. CO_2e savings are expected to be:

When	How many	Annual CO2 reduction (kg CO_2e)	Annual CO2 reduction (kg CO_2e)
		Gridflex Heeten scenario	Conventional scenario
2018	70 EMS's	104	Not applicable[5]
2019	140 EMS's	208	259
2020	280 EMS's	415	569

When	How many	Annual CO2 reduction (kg CO_2e)	Annual CO2 reduction (kg CO_2e)
		Gridflex Heeten scenario	Conventional scenario
2018	70 EMS's	104	Not applicable[5]
2019	140 EMS's	208	259
2020	280 EMS's	415	569

This leads to the following reductions during the lifetime of the EMS's (15 years):

- Total reduction over lifetime EMS – Gridflex Heeten scenario: 6.230 kg CO_2e
- Total reduction over lifetime EMS – Conventional scenario: 8.536 kg CO_2e

And the following energy savings (kWh) during the lifetime of the EMS's (15 years):

- Energy savings over lifetime EMS – Gridflex Heeten scenario: 160 MWh
- Energy savings over lifetime EMS – Conventional scenario: 152 MWh

4. Project progress

During 2018 the 70 households of GridFlex Heeten are connected as local energy network. This means that based on the theoretical CO_2 reduction as calculated in previous paragraph a CO_2 reduction of 104 kg CO_2 kg is realised.

The role out of the salt sea battery is delayed. The GridFlex Heeten consortium has decided to put this on a side track and to move on with other parts of the traject. As the batteries are not physically in place the University of Twente has projected the behaviour of batteries based on a simulation as if the batteries were in place. Furthermore, the consortium is looking for another battery supplies.

Another part of the project contains the adjustment of household energy usage to the status of the local network. This by avoiding peaks on the energy network so that the energy network can be used more efficient. This prevents grid reinforcements and aging. For that Enexis introduced a dynamic net work electricity rate and ICT has extended the Gridflex Heeten with the dynamic electricity rate including a 24 hours prediction. Based on this app the GridFlex Heeten households can decide when they want to use energy and unburden the energy network.

[5] Not applicable because it is already known that the 70 EMS's will be used in the Gridflex Heeten Project. That's why the CO_2e savings of 70 times the annual savings in the gridflex Heeten project is used for the first year for both scenarios.

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Appendix A Calculation CO_2e materials & production EMS

Database: Ecoinvent 3.4

Phase 1: Materials					Phase 2: Production		
Part	**Material**	**Weight (kg)**	**Emission factor kg** CO_2e	**emission kg** CO_2e	**Production method**	**Emission factor kg** CO_2e	**emission kg** CO_2e
Casing	ABS	0.00085	3.96	0.003	Injection molding	0.5	0.0004
Printed circuit board		0.01	339.7	3.4	Included in emission factor material		
Power cable		0.1	5	0.5	Included in emission factor material		
Connection cable		0.01	5	0.05	Included in emission factor material		
Internet cable		0.01	5	0.05	Included in emission factor material		
				4			**0.0004**

Table 11: CO_2e materials & production EMS

Appendix B Calculation CO_2e End of Life

Database: Ecoinvent 3.4

Unfortunately, recycling electronics, for instance at Umicore in Belgium, is not included in Ecoinvent.

Material	Weight kilograms	End of life scenario	Emission factor kg CO_2e	CO_2e emission kg CO_2e
ABS	0.13085	Recycling (50%)	1.14	0.07
		Incineration (50%)	1.54	0.10
Printed circuit board	0.01	Recycling	-	Unknown
Power cable	0.1	Recycling	-	Unknown
Connection cable	0.01	Recycling	-	Unknown
Internet cable	0.01	Recycling	-	Unknown
Total				0.18

Table 12: Calculation CO_2e End of Life

Appendix C Calculation CO_2e transport EMS

Database: CO_2emissiefactoren.nl.

Truck> 20 tonnes: 0.110 kg CO_2 / tkm
Delivery van > 2 ton: 1.153 kg CO_2 / tkm
Boat big (10-20 dwkt): 0.015 kg CO_2 / tkm
Truck waste processor average (10-20 ton): 0.259 kg CO_2 / tkm

Transport via company delivery van is not included, since this is included in scope 1 (shaded grey in table).

Phase	Weight Ton	Route	Distance km	Emission factor tkm / kg CO_2e	CO_2e emission kg CO_2
1 → 2 Materials to production	0.0001	Truck Foshan – Guangzhou*	50	0.11	0.001
		Boat Guangzhou – Rotterdam*	18207	0.015	0.027
		Truck Rotterdam – Eindhoven*	120	0.11	0.001
2 → 3 Production to user	0.0001	Delivery van Eindhoven – Heeten	140	1.153	
3 → 4 User to waste processing	0.0001	Heeten – Olen, Belgium (Umicore, WEEE recycling)	210	0.259	0.005
Total					0.035

Table 13: Calculation CO_2e transport EMS

*Production materials EMS in Foshan, China. Transport to harbour in Guangzhou. Transport per boat to Rotterdam. By truck to Eindhoven (production at ICT Group N.V.).