GrowSmarter
Transforming cities for a smart, sustainable Europe

SMART CITY MARKET INTRODUCTION

DELIVERABLE 6.4.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 646456. The sole responsibility for the content of this document lies with the author and in no way reflects the views of the European Union.

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1. Executive Summary

The goals of this document are the following:

- Goal 1. To define the key elements that can guarantee the possibility of replication and scalability of the different measures within the Lighthouse cities but also in other cities within the European Union (EU-28).
- Goal 2. To determine the role of the public authorities in enhancing the replicability and scalability of the measures.
- Goal 3. To improve the assessments undertaken in Deliverable 6.3, regarding the sustainability of the measures from a financial point of view and from an economic point of view.
- Goal 4. To give recommendations to industrial partners on how to improve the business models, especially when the measures are not sustainable from a financial point of view.

The main results obtained are:

WORK PACKAGE 2

For **residential buildings**, two elements determine the sustainability of the measures: size and weather. The measures implemented in large buildings in cold weather countries (Germany and Sweden, as compared to Spain) are sustainable thanks to the reduction of energy bills (in the case of Cologne) or the mix of a reduction of energy bills and CO_2 reduction (in the case of Stockholm). However, if one of these elements is missing, the financial sustainability is not achieved. In the case of Barcelona, the residential buildings showed an interesting reduction in energy bills. However, this reduction has to be completed with public funds.

For **tertiary buildings**, financial results vary from building to building, when the analysis focuses on public buildings. Some of them are sustainable (the library in Barcelona or Slakthusomradet in Stockholm), while others are not. The reason why some are not sustainable from the financial point of view seems to be due to a need to improve the structure of incomes, either because the incomes designed are lower than what the project needs or because the building does not seem to generate enough energy savings. In the case of private buildings, financial sustainability is reached when the building is used in an intensive way (like the hotel or sports center, but not for the education center).

Finally, within the low-energy district solutions, the **energy management systems** (solutions 3 & 4), when analyzed separately from the rest of the solutions (1), are seen in some cases as unsustainable from a financial point of view, due to the rank of the measure, with not enough users testing the systems. On the other hand, in Barcelona these solutions do seem to perform well, demonstrating the achievement of both financial and economic sustainability.

WORK PACKAGE 3

Regarding the **smart street lighting solutions** (solution 5), when there is revenue related to the measure (Cellnex Smart tower in Barcelona or IBM sensors in Stockholm), the financial sustainability is almost reached or totally reached. In the other measures, the lack of revenues makes them unsustainable. When technical data is available, the measures that are unsustainable from the financial side are sustainable from an economic point of view.

Regarding the **waste management measures** (solutions 6 & 7), both are financially and also economically sustainable. However, it is important to note that the implementation needs to be adapted to the specific characteristics of each city.

For the **big data management solutions** (solution 8), all the measures are economically sustainable. However, some of them are not financially sustainable. The reason is that, due to strategic decisions, the partner has followed an open source approach.

WORK PACKAGE 4

On the **mobility** side (solutions 9 to 12), a first conclusion is that almost all the measures that have defined revenues are on the right path to financial sustainability. This is the case of the **micro-distribution** measure in Barcelona or the **car charging stations** in Stockholm. For the measures without revenues, the ones with technical data seem to be economically sustainable, although the CO_2 emission savings do not justify the amount given by the EU grant. This is the case of **charging stations in lamp posts** in Cologne (measure 5.1, analyzed in the Solution 11 section) or the **travel demand management system** implemented in Stockholm. Finally, in the case of the **car sharing system** implemented in Cologne, the economic sustainability is almost reached (although the grant is too big compared to the CO_2 emission savings), while the financial sustainability is far from being reached, looking at the private side of the partnership (Cambio). This is due to a need to improve the location of the mobility stations and to foster the use of electric cars over conventional ones.

Finally, regarding the **Consolidation Construction Center** (solution 2), the measure is not sustainable from the financial side or the economic side. The revenues are far from filling the gap with the costs, and the positive externalities are unknown.

What can be highlighted from these results is that **when the revenues are correctly structured, the financial sustainability** of the measures seems to be reached. This proves the importance of improving the business models, as has been carried out in this document.

In terms of **replicability and scalability**, although the factors that determine the capacity to increase the presence of the measures are very different from solution to solution, some key elements can be observed among all of them. First, that the **public sector is crucial** to enhance the measures' success, because of the legal instruments that this sector can use to improve the implementation of these measures (i.e., by determining part of the energy price, by allowing a more flexible use of private data or by giving priority to the measures in public space), but also thanks to its engagement in the use of the measures. Second, **user engagement** or citizens' engagement is crucial to success in the deployment of these measures on a greater scale. Without user confidence, it will be very difficult to implement these solutions. And, finally, **the need to invest in** building, deploying or improving existing **infrastructures**. All the measures need some kind of a preexisting infrastructure. Although the ways in which they interact with that infrastructure will be different, nonetheless, investment, and the associated economic costs are a main driver in all the measures.

A final conclusion of the document is the impact in terms of jobs created. Based on the input-output tables methodology (see section 3, Evaluation Methodology), the number of jobs created as a result of the investment in the measures evaluated here is 320 FTE Jobs.

2. Introduction

This report aims to provide the private and the public sector with elements to enhance the measures implemented during the GrowSmarter project. Therefore, this document centers on two main questions: how the measures are performing from a financial and economic point of view, and what elements can help these measures to be replicated and scale up in other European cities?

The first question was already answered in document 6.3 (financial and economic validation). However, for some measures, the data linked to the validations was not complete, despite the fact that, in some cases, the measures were not evaluated due to a lack of data. Therefore, in this document, all the measures implemented have their own financial and economic validation, and, when possible, they have been improved with respect to the previous validation in document 6.3. In addition to the assessment, for each measure that needs it, the document includes recommendations on how to improve the business model.

The second question is answered for the first time in this document. In that respect, most of the answers have been given at the solution level. Thus, for each solution, this document points out which elements may be crucial when it comes to replicating the measures in other cities (or other areas of the city where they have already been implemented). This document also tries to determine how the measures can be scaled up, including the elements for their replicability that can be also crucial for scalability. Finally, this document points to what the role of the public authorities should be in enhancing the replicability and scalability of the measures.

The insights regarding the replication and scalability of the measures have been possible thanks to several meetings with the industrial partners implementing the measures, the work package coordinators, the Lighthouse cities coordinators and the representatives from the follower cities. First at the measure level, and then at the solution level, IESE has had several meetings with the partners in the interest of determining the key elements for success in those topics.

The insights presented in this document may be useful for the technical stakeholders of the GrowSmarter project but also for the general public, private companies, public officers and for European citizens wishing to learn more about the GrowSmarter project's scope and the potential and benefits of the solutions implemented.

This document is of relevance for the business development directors from the industrial partners, but also for public authorities (at the local, regional, national and European levels) looking to increase the market of solutions that can aid in the mitigation of climate change.

3. Evaluation Methodology

Deliverable 6.1. contains an extended version of the evaluation methodology. However, some of the methodology is detailed in the following sections.

In Deliverable D6.2, IESE grouped several measures (identified as technical measures by KTH) into a single business model. This merging of measures was carried out together with the industrial partner (IP), giving the result of 48 measures from the business model point of view. In this document, the measures are analyzed as in Deliverable 6.2.

3.1. Data Collected

For the baseline and the financial and economic analysis, **an Excel spreadsheet was sent to each partner**. The spreadsheet contains all the information needed to calculate the proposed indicators of economic and financial performance. To illustrate the data collected, here is the **template of the Excel spreadsheet**:

DIRECT COSTS (report according to Currency on spreadsheet "metadata")	year1	year2	year3	year4	year5
Investment costs					
Personnel costs					
Energy costs					
Maintanence costs					
Other expenses					
Taxes					
REVENUES					
Payments by users					
Savings					
EU grant					
Public financing by municipality					
Other public contribution					
Private financing					
Jobs involved FTE*					
*Full Time Equivalent					

Definitions

Investment costs are classified by:

- Initial investment: includes the capital costs of all the fixed assets (e.g., land, buildings, plant and machinery, equipment, etc.) and non-fixed assets (e.g., start up and technical costs such as design/planning, project management and technical assistance, construction supervision, publicity, etc.). Where appropriate, changes in net working capital should also be included. Information must be taken from the technical feasibility studies. Cost breakdown over the years should be consistent with the physical realizations envisaged and the time frame for implementation. Where relevant, the initial investment shall also include environmental and/or climate change mitigating costs during the construction.
- Replacement costs: includes costs occurring during the reference period to replace short-life machinery and/or equipment (e.g., engineering plants, filters and instruments, vehicles, furniture, office and IT equipment, etc.).

Personnel costs: labor costs for the employer; includes wages and salaries, tax-rolls, social benefits, insurance and other expenses in kind.

Energy costs: fuel, energy, and other energy process consumables (taxes included). If possible, separated by type of energy (electricity, fuel, gas, etc.).
https://aiguasol.coop/wp-content/uploads/2018/12/Residential_Retrofits.pdf

Maintenance costs: materials needed for maintenance and repair of assets different from initial investment and replacement costs.

Other expenses: services purchased from third parties, rent of buildings or sheds, rental of machinery; general management and administration; insurance costs; quality control; waste disposal costs.

Taxes: emission charges (including environmental taxes, if applicable), local taxes (property, etc.), non-refundable taxes.

Payments by users: cash in-flows directly paid by users for the goods or services provided by the operation, such as charges borne directly by users for the use of infrastructures, sale or rent of land or buildings, or payments for services. Excluding VAT or other refundable taxes.

Savings: energy or other savings in economic terms for solutions financed by savings.

EU grant: includes the amount of EU contribution used for the deployment and operation of the project.

Public financing by municipality: transfers or subsidies from local public budgets.

Other public contribution: transfers or subsidies from other public budgets, for example, regional or state governments.

Private financing: includes project promoter's contribution (loans or equity), if any, and or private contribution under a public-private partnership, (equity and loans) if any.

Source of Financial Data

Financial Data was provided by the IP. They were asked to send the economic data five times: February 2017, September 2017, February 2018, September 2018, February 2019 and May 2019.

However, some of the measures have not been included in this document. The reason is that these measures are simulations and, therefore, do not have a business model behind them. More specifically, the measures not included in the document are: Barcelona District-Heating Rings (WP3 – M6.2), Barcelona Smart Local Thermal District (WP3 – M6.3), Barcelona Smart Traffic Signals (WP4 – M10.1), Stockholm Smart Traffic Lights (WP4 – M 10.4) and Barcelona Smart Taxi Rank System (WP4 – M12.6).

3.2. Explanation of the Financial and Economic Validation

Financial validation consists in determining whether a measure is sustainable by analyzing only the financial data generated by the measure and without considering a grant or a subsidy from the public sector (such as the EU grant for being part of the GrowSmarter project). These financial data are the group of costs and revenues linked to the measures, considering the period of time related to the amortization period of the assets used to implement the measure.

Energy savings that can be transformed into bill reductions or cost reductions are included in the calculations of the financial validation.

Economic validation consists in determining whether a measure is sustainable from a social point of view, including the public grants or subsidies and observing whether the monetization of the energy savings or other positive externalities generated by the measure are sufficient to compensate the economic support from the public sector.

Therefore, the following assessments look first at the financial validation and then at the economic validation. However, the financial validation is also undertaken without accounting for the EU grant. Optimal financial sustainability will occur when a measure does not need the EU grant in order to be implemented. If the EU grant is needed for the financial sustainability, then the monetization of the energy savings or other positive externalities will determine whether support from a public administration (i.e., EU) grant is worth it or not, and therefore the measure can be considered economically sustainable.

3.2.1. Financial Sustainability

Methodology

A measure will be considered financially sustainable if the **financial net present value** is positive, meaning that the revenues are higher than the cost, during the lifetime of the asset.

The **financial net present value** on an investment is defined as the sum that results when the expected investment and operating costs of the project (discounted) are deducted from the discounted value of the expected revenues:

$$\text{FNPV(C)} = \sum_{t=0}^{n} a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \ldots + \frac{S_n}{(1+i)^n}$$

where:
S_t is the balance of cash flow at time t, a_t is the financial discount factor chosen for discounting at time t, and
i is the financial discount rate

However, as previously commented, some business models do not yet envisage revenues related to the use of the measures. Therefore, in these cases, the financial net present value cannot be calculated.

Therefore, to solve this problem, the financial evaluation will take the following steps:

- Step 1. Calculation of the **total cost of the measure**, considering the investment cost and the operational cost for the lifetime of the assets (including Inflation).
- Step 2. Calculation of the **hypothetical revenues** needed to reach a positive financial net present value.

The following formula explains how the hypothetical revenues have been calculated:

$$R_t = (1+i)^t \times \frac{IC}{T} + OC_t \times (1+r)^t$$

Where,
R_i are the hypothetical revenues per year t
i is the discount rate
IC are the investment costs
OC_t are the operational costs of the measures per year t
r is the average inflation rate
T is the number of years equal to the lifetime of the assets.

- Step 3. **Financial evaluation** by comparing the hypothetical revenues with the existing revenues reported:
  - The measure seems **sustainable from the financial** point of view if the existing revenues are higher than the hypothetical revenues (and the costs).
  - The measure seems **unsustainable from the financial** point of view, if the existing revenues are lower than the hypothetical revenues (and the costs).
  - If there are no **existing revenues**, the hypothetical revenues will help to implement a price per use of the measure in the future.

About the Data Used in the Financial Evaluation

Investment costs. Investment costs will be those reported by the IP.

Operational costs reported. The rest of the costs reported by the IP will be considered operational costs.

Operational costs non-reported. As proposed in Deliverable 6.1, the IP reported operational costs for a limited number of years for the implementation of the measure (normally around five years). To calculate operational costs for the rest of the lifetime of the asset, an annual average of the already reported operational costs will be used. These costs will be considered constant during the lifetime of the project plus inflation.

Inflation. For all the calculations, the inflation used will be the average inflation for the last 18 years (2000-2017) per country (Sweden, Germany and Spain), based on data provided by EUROSTAT, as shown in the following table.

Average Inflation rate for the Period 2000-2017

Germany	1,5
Spain	2,2
Sweden	1,5

Source:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tec00118&plugin=1

Lifetime of the assets. The number of years for which forecasts are provided should correspond to the project's time horizon (or reference period). The choice of time horizon affects the appraisal results. In practice, it is therefore helpful to refer to a standard benchmark, differentiated by sector and based on internationally accepted practice. We propose the use of the European Commission reference periods, which are:

European Commission's reference periods by sector

Sector	Reference period (years)
Railways	30
Roads	25-30
Ports and airports	25
Urban transport	25-30
Water supply/sanitation	30
Waste management	25-30
Energy	15-25
Broadband	15-20
Research and Innovation	15-25
Business infrastructure	10-15
Other sectors	10-15

Source: ANNEX I to Commission Delegated Regulation (EU) No 480/2014.

These values should be considered as including the implementation period. In the case of unusually long construction periods, longer values can be adopted.

However, some assets used in the measures do not have a reference from the Commission. Therefore, in these cases, the lifetime of the assets considered has been the following, based on discussions with the IPs:

- Cars used for car sharing: 4 years
- Charging stations: 10 years
- Software: 5 years

When the reference periods are a range of years, the last year will be the one used.

Discount rate. For all the calculations, the discount rates used will be the national bonds rates for 5, 10 or 20 years, per country (Sweden, Germany and Spain), based on data provided by the World Government Bonds and as shown in the following table.

National bonds rate

	20 years	10 years	5 years
Germany	0,795	0,426	-0,169
Spain	2,193	1,587	0,549
Sweden	1,327	0,656	0,117

Source: World Government Bonds. 2018.

Public grants. During the financial analysis, public grants will be considered as revenues only if the customers are public authorities. If the customers are private users, public grants are not included in the calculations.

Savings. Energy savings will only be used in the financial analysis if they represent a reduction in energy bills. If not, they will be used in the economic analysis. Data related to energy savings was sometimes provided directly by the IP, already converted into euros. However, this was only very occasionally the case. For most of the measures, the energy savings data was collected from D5.3, if the data was available.

3.2.2. Economic Sustainability

Methodology

The economic evaluation will take the following steps:

- Step 4. **Observation of the size of the public grant.** Including the public grant with the existing revenues and comparing it with the hypothetical revenues.
  - If the existing revenues and the public grant are higher than the hypothetical revenues, then the public grant can be lower.
- Step 5. **Monetization of the positive externalities**, if data from D5.3 is available.
- Step 6. Verifying whether the public grant is equal to or lower than the monetization of the positive externalities.
- Step 7. **Economic evaluation**:
  - The measure seems **sustainable from the economic** point of view and **the size of the public grant is adequate** if the existing revenues and the public grant are higher than the cost, and the public grant is equal to or lower than the monetization of the positive externalities.
  - The measure seems **sustainable from the economic** point of view and **the size of the public grant can be lower** if the existing revenues and the public grant are higher than the cost, and the public grant is higher than the monetization of the positive externalities.
  - The measure seems **unsustainable from the economic** point of view if the existing revenues and the public grant are lower than the cost, and the public grant is lower than the monetization of the positive externalities. However, an increase in the existing revenues or/and the public grant will make the measure sustainable from the economic point of view.
  - The measure seems **unsustainable from the economic** point of view if the existing revenues and the public grant are lower than the cost, and the public grant is higher than the monetization of the positive externalities. However, an increase in the existing revenues will make the measure sustainable from the economic point of view.

About the Data Used in the Economic Evaluation

In addition to the data used in the financial evaluation, two other variables are used in the economic evaluation: public grants and positive externalities.

Public grants. In the context of the economic analysis, public grants are the ones reported by the IP, if the customers are not public authorities. Otherwise, this information will have been used in the financial evaluation.

Positive externalities. The positive externalities are the energy savings monetized, not including a reduction of energy bills or other positive externalities generated by the measures (such as CO_2 reduction thanks to a reduction of congestion). Data related to energy savings was sometimes delivered directly by the IP, already converted into euros. However, this was only very occasionally the case. For most of the measures, the energy savings were collected from D5.3, if the data was available.

Other positive externalities were also collected from D5.3.

When data related to positive externalities was not available, the rest of the information regarding the measure (such as information about the dimension of the measure, sqm used, number of devices implemented or others) was used to make hypothetical calculations, allowing for a potential economic assessment. If the rest of the information was insufficient for hypothetical calculations, insights from external reports were used as potential positive externalities for the measures.

The following table summarizes the positive externalities considered in this document:

Positive impacts and externalities	Brief explanation	KPI to euros	Academic references
Reduction in CO_2 emissions	Social cost of carbon by 2020: price that should pay off for all social negative externalities	€ 60 per ton of CO_2	Stern, Nicholas and Stiglitz, Joseph E. (2017) Report of the high-level commission on carbon prices. World Bank, Washington D.C.. OECD (2018), "Effective Carbon Rates 2018: Pricing Carbon Emissions Through Taxes and Emissions Trading", OECD Publishing, Paris. https://doi.org/10.1787/9789264305304-en
Electricity savings	KW/h of electricity saved by implementing the measure	Germany: 0,3048 EUR per KWh // Spain: 0,2296 EUR per KWh // Sweden 0,1936 per KWh (2017 prices)	Eurostat, 2018
Gas savings	Giga Joule (GJ) of gas saved by implementing the measure	Germany: 16,98 EUR per GJ // Spain: 18,52 EUR per GJ // Sweden 33,6762 per GJ (2017 prices)	Eurostat, 2018
Noise reduction	Perceived benefit of noise reduction	€ 25 per house-hold per decibel per year.	Traffic noise reduction in Europe Health effects, social costs and technical and policy options to reduce road and rail traffic noise. Delft, August 2007. Authors: L.C. (Eelco) den Boer A. (Arno) Schroten // Navrud, Ståle. (2019). The State-Of-The-Arton Economic Valuation of Noise. Final Report to European Commission DG Environment April 14th 2002
Travel time savings	Value of reducing the time spent in travelling	50% of median hourly wage (local travel); 70% (intercity travel)	US Department of Transportation. The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations Revision 2 (2016 Update)

3.2.3. Input-Output Methodology

Input-output (IO) analysis is the name given to the analytical framework for industry interrelations developed by Wassily Leontief, recognized with the 1973 Nobel Prize in Economic Sciences. This framework has been cemented as an important tool for economic analysis and decision-making in the short term, which is used in many countries around the globe.

The model is based on input-output matrices constructed from observed economic data for a specific geographic region (metropolitan area, state, country, etc.). The matrices depict the activity of a group of industries that both produce goods (outputs) and consume goods from other industries (inputs) in the process of producing each industry's own output (Miller & Blair, 2009), allowing for an inter-sectorial assessment of the economy. From the IO matrix, we can calculate the final demand multipliers in terms of output (sales), value added (VA, comparable to the gross domestic product) and employment (number of jobs).[1] These multipliers express the linkage degree between industries and make it possible to quantify the total effect that a specific industry has over the economy. As such, it has been commonly used to quantify the economic impact of an increase in the final demand of a given industry.

The multipliers capture two effects of a change in the economic activity: direct and indirect effects. The idea behind this is that an initial increase in the final demand of a given industry will multiply the demand of that industry (direct effect) as well as the linked industries (indirect effect). For example, the initial investment in electric car sharing will affect the final demand of the automobile industry, increasing its sales; at the same time, it will increase the car manufacturing industry, which will lead to increased production in metallurgic industries, which results in more production in mining.

In this section, we estimate **the expected** macroeconomic impact of the investment in every measure covered in the study. We construct the national output, VA, and employment multipliers following the methodology established in the *Eurostat Manual of Supply, Use and Input-Output Tables* (Eurostat, 2008).[2] This way, we can approximate the potential impact of the investment in every measure on the national economy in terms of output, value added and jobs generated in the short term.

Finally, it is important to note that the IO methodology includes some assumptions that may limit the final interpretation of the results. Additionally, the use of national macroeconomic data makes the results inaccurate if used for a deeper understanding of the impact on the regional economy (such as at the state or city level). In spite of these constraints, the methodology can be used as a good approximation at the national level, although we recommend the reader interpret the results with caution.

References
Eurostat. (2008). Eurostat Manual of Supply, Use and Input-Output Tables: Methodologies and Working papers.
Miller, R. E., & Blair, P. D. (2009). *Input-Output Analysis: Foundations and Extensions*. New York: Cambridge University Press.

3.2.4. Internal Rate of Return

The internal rate of return (IRR) is used as a tool for assessing to accept or reject investment projects. It is meant to be used as an indicator of financial sustainability and to rank competing projects in investment decision making.

Basically, the higher the IRR, the more interesting it is to invest into the project.

[1] The final demand records the sales by each sector to final markets for their production.
[2] The estimates were carried out using the *iotables* package on R, developed by Eurostat following the manual's procedures.

3.2.5. Summary of the Assessments

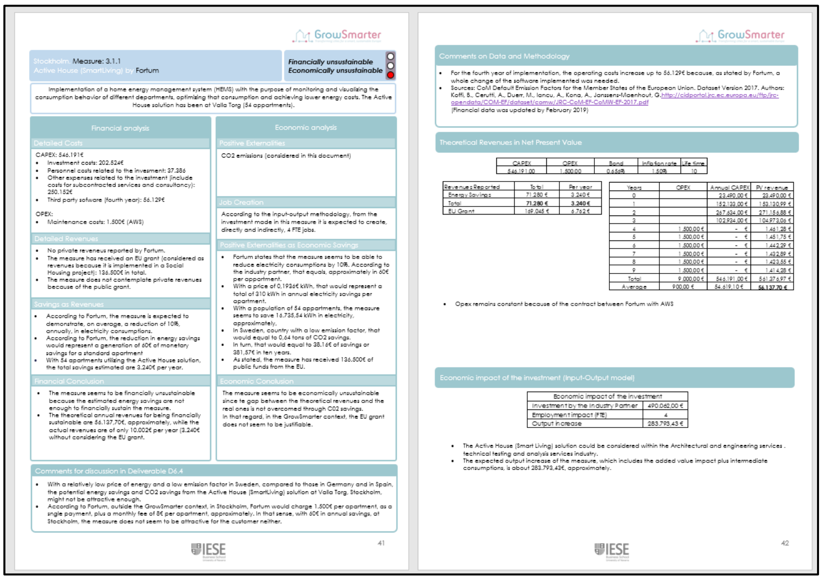
The following table provides a summary of the financial and economic assessments:

Existing Revenues > Hypothetical Revenues	Existing Revenues < Hypothetical Revenues
SUSTAINABLE	**UNSUSTAINABLE**

	Existing Revenues + Externalities > Hypothetical Revenues	Existing Revenues + Externalities < Hypothetical Revenues
Public Grant < Positive Externalities	SUSTAINABLE	UNSUSTAINABLE Public Grant or Revenues should be higher
Public Grant > Positive Externalities	SUSTAINABLE But Public Grant could be lower	UNSUSTAINABLE Public Grant should be lower and Revenues should be higher

3.3. Explanation of the Validation Documents

In the following section, we present the main document, explaining the assessment that has been made for each measure. The document is shown in the following picture and it contains the following sections:



- **Name of the measure**, partner responsible for the implementation and number of technical measures related to the measure.
- **Traffic light symbol** indicating if it is financially sustainable and economically sustainable, where:
    - **Red light** means that the measure is not sustainable from a financial point of view or from an economic point of view.
    - **Orange light** means that the measure is not sustainable from one point of view (financial or economic), but it is sustainable the other (financial or economic).
    - **Green light** means that the measure is sustainable from both a financial point of view and an economic point of view.
- **Brief description** of the measure.
- **Financial analysis**, where the main information regarding the financial analysis is shown.
    - **Detailed costs**, where the main costs are listed.
    - **Detailed revenues**, where the main revenues are listed.
    - **Savings as revenues**, where the energy savings or similar savings that represent a direct reduction of the expenditures related to the measure are explained.
    - **Financial conclusion**, where the financial evaluation is shown, as explained previously.
- **Economic analysis**, where the main information regarding the economic analysis is shown.
    - **Positive externalities**, where the positive externalities considered in each measure are listed.
    - **Job creation**, where the full-time equivalent (FTE) jobs required to implement and exploit the measure are detailed.
    - **Positive externalities as economic savings**, where the savings in CO_2 emissions or other positive externalities are presented, monetized in euros, if possible, and otherwise based on external reports.
    - **Economic conclusion,** where the economic evaluation is shown, as explained previously.
- **Comments for discussion in Deliverable 6.4**, as an introduction to a more detailed proposition of improvements, which will be presented in D6.4.
- **Comments on data and methodology** are presented, with the explanations regarding the different formulas or specific bibliography that was used for the financial and economic evaluations. Some comments related to the quality of the data and the last date of submission are included.
- **Theoretical revenues in net present value**, where the tables used for the hypothetical revenues are shown.
- **Economic impact of the investment**, using the Input-Output model, as explained previously.

4. Financial and Economic Results

Before stating our conclusions, we would like to remind readers that our evaluation has taken into account the standard amortization period for each of the industries to which each measure is related.

4.1. Work Package 2. Low-Energy Districts

Measure Name	Measure number	WP	City	CAPEX	Annual CAPEX	OPEX (average)	Revenues	Employment Impact	Output Increase	Financially Sustainable	Economically sustainable	Business Model	Internal Rate of Return (IRR)
Refurbishment of Private Residential Buildings (Canyelles, Ter 31, Lope de Vega)	1.0; 1.1.10.1; 1.1.10.2 (3.1.3)	2	Barcelona	€ 848.614,00	€ 33.944,59	€ 721,00	€ 6.089,00	6,51	€ 623.820,12	No	No	B2C ESCO	-10,99
Refurbishment of a Private Residential Building (Melon District)	1.0; 1.1.10.1: 1.1.10.2	2	Barcelona	Confidential	Confidential	Confidential	Confidential	1,23	€ 117.906,91	Yes	Yes	B2C	10,32
Refurbishment of a Private Tertiary Building (CEM Claror Cartagena)	1.0; 1.1.10.1: 1.1.10.2	2	Barcelona	Confidential	Confidential	Confidential	Confidential	5,03	€ 481.344,53	Yes	Yes	B2B ESCO	6,54
Refurbishment of a Private Tertiary Building (Escola Sert)	1.0; 1.1.9; 1.1.10.1; 1.1.10.2; 1.1.11	2	Barcelona	Confidential	Confidential	Confidential	Confidential	1,91	182,719,56	No	No	B2B ESCO	-3,41
Refurbishment of a Private Tertiary Building (Hotel H10)	1.0; 1.1.9; 1.1.10.1; 1.1.10.2	2	Barcelona	Confidential	Confidential	Confidential	Confidential	4,32	€ 413.479,73	Yes	Yes	B2B ESCO	10,37
Refurbishment of a Public Tertiary Building: Ca l'Alier	1.0; 1.1; 1.1.6; 1.1.9; 1.1.10.1; 1.1.10.2; 6.3	2	Barcelona	€ 10.268.189,00	€ 410.727,56	€ 33.886,00	€ 610.152,00	80	€ 9.755.036,25	Yes	Yes	Public-Private Partnership (PPP)	2,79
Refurbishment of a Public Tertiary Building: Biblioteca Les Corts	1.0; 1.1; 1.1.6; 1.1.9; 1.1.10.1; 1.1.10.2	2	Barcelona	€ 8.345.300,00	€ 333.812,00	€ 27.753,00	€ 408.683,00	65	€ 7.927.958,63	Yes	Yes	Public-Private Partnership (PPP)	1,04
Refurbishment of a Public Residential Building – Passeig Santa Coloma (Big Blue)	1.0; 1.1.10.1	2	Barcelona	€ 1.884.321,00	€ 75.372,82	€ 1.000,00	€ 104.094,00	15	€ 1.784.836,24	Yes	Yes	Public-Private Partnership (PPP)	2,57
Energy-Efficient Refurbishment of a Public Residential Building – Stegerwaldsiedlung	1.1	2	Cologne	€ 10.031.897,00	€ 401.275,89	€ 101.564,37	€ 593.817,00	74	€ 9.982.398,26	Yes	Yes	B2B/ B2B2C	1,64
Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 6)	1.1 (1.1.1; 1.1.2; 1.1.3; 1.1.4; 1.1.5; 1.1.9)	2	Stockholm	€ 712.965,00	€ 28.518,58	€ -	€ 33.366,00	3,83	€ 424.384,21	Yes	Yes	B2B	1,25
Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 7)	1.1 (1.1.1; 1.1.2; 1.1.3; 1.1.4; 1.1.5; 1.1.9)	2	Stockholm	€ 741.344,00	€ 29.653,77	€ -	€ 33.953,00	4,04	€ 443.922,72	Yes	Yes	B2B	1,07
Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 8)	1.1 (1.1.1; 1.1.2; 1.1.4; 1.1.5; 1.1.9)	2	Stockholm	€ 588.065,00	€ 23.522,61	€ -	€ 25.593,00	3,07	€ 344.353,05	Yes	Yes	B2B	2,89
Implementation of Energy-Efficient solutions in a Private Residential Condominium	1.1.6; 3.1; 4.1	2	Stockholm	€ 174.812,34	€ 6.992,49	€ 9.808,75	€ 10.137,00	1	€ 100.624,86	No	Yes	B2C	-16,41
Refurbishment of a Public Tertiary Building – Slakthusomradet	1	2	Stockholm	€ 645.655,84	€ 25.826,23	€ -	€ 220,00	5	€ 436.885,61	No	Yes	Public-Private Partnership (PPP)	-1,17
Refurbishment of a Public Tertiary Building – Kylhuset	1	2	Stockholm	€ 446.489,65	€ 17.859,59	€ -	€ 14.991,00	2,18	€ 257.384,07	Yes	Yes	Public-Private Partnership (PPP)	1,29
Construction Consolidation Center	2.1	2	Stockholm	€ 85.000,00	€ 4.250,00	€ 225.000,00	€ 68.333,00	0,61	€ 57.515,59	No	Yes	B2B	Negative Cash Flow
Virtual Energy Advisor	3.1.3	2	Barcelona	€ 183.219,00	€ 12.214,60	€ 3.000,00	€ 33.965,00	1,43	€ 116.150,14	Yes	Yes	B2C	13,73
Home Energy Management System	3.1.3	2	Barcelona	€ 182.220,00	€ 36.444,00	€ 564.400,00		1	€ 163.856,00	No	No	B2C	Negative Cash Flow
Home Energy Management System: SmartHome	3.1 / 5.3 (WP3)	2	Cologne	€ 124.549,00	€ 124.549,40	€ 1.500,00		1	€ 78.074,20	No	No	B2C	Negative Cash Flow
Active House (SmartLiving)	3.1.1	2	Stockholm	€ 546.191,00	€ 54.619,00	€ 1.500,00	€ 3.240,00	4,19	€ 316.297,57	No	No	B2C	-41,26
Resource Advisor: A Visualization Platform to Assess the Impact of Retrofitting	4.2.1	2	Barcelona	€ 20.300,00	€ 4.060,00	€ -	€ 12.000,00	1	€ 14.638,90	Yes	Yes	B2B	58
Smart energy and Self-Sufficient Block	4.2.1	2	Barcelona	€ 141.027,90	€ 5.641,12	€ 1.005,40	€ 8.936,00	0,66	€ 126.815,53	Yes	Yes	B2C	3,94
Neighborhood Management System	4.1	2	Cologne	€ 64.627,33	€ 12.925,47	€ -	€ 13.132,00	4	€ 409.854,64	No	No	B2C	-23,32

The measures included in Work Package 2 have been implemented in residential and tertiary buildings. However, their viability as a project seems to depend, among different factors, not only on the type of building, which conditions consumption behaviors and therefore potential generation of energy savings, but also on the ownership: that is, whether the ownership is public or private and, therefore, who pays the implementation costs and who receives the benefits. As such, a decision was made to distinguish between public and private buildings, on the one hand, and between residential and tertiary buildings, on the other.

With respect to public residential buildings three retrofitting projects have been analyzed, one for each city. In the analysis, all three projects seem to be financially sustainable, mostly due to a reduction in the cost of energy through energy bills. All the projects were carried out in large residential complexes or in big buildings, generating potential scale advantages. Because public funds have been considered as revenues, as all the buildings are associated with public housing, in all cases revenues seem to be sufficient to financially support the projects. However, if public funds were not considered as revenues, in the case of Barcelona, the energy savings do not seem to justify the investment, and would require public funding in the form of subventions, in order to reach a break-even. In contrast, in Cologne and Stockholm, energy savings are very attractive, but there is a discrepancy between who does the investing and who receives most of the benefits. Additionally, whereas in Cologne rents have marginally increased, in Stockholm rents have only increased because of the standard retrofitting works but not for the energy efficiency measures, limiting the potential revenue generation after the energy-efficient retrofitting. Considering this circumstance as a limitation of the revenue structure, public funding seems to be necessary in all public residential retrofitting projects. Finally, since all projects are able to generate positive externalities, with savings in CO_2 emissions, better comfort or positive impacts on health, in the context of GrowSmarter, the energy efficiency interventions carried out in public residential buildings can be considered as economically sustainable.

With respect to public tertiary buildings, four projects have been analyzed. Two of these projects took place in Barcelona and the other two in Stockholm. The projects in Barcelona are considered financially sustainable. The refurbishment of an old industrial site to house a library in Barcelona is considered financially sustainable given the assumption that the purpose of the project is not to generate financial revenues but to supply a public service and to increase citizens' quality of life. An in-depth accounting analysis of the project has not been carried out, since it was not possible to consider additional operational revenues for a public library, apart from the potential energy savings. In addition, IESE aimed to analyze the financial sustainability of the project in more detail by comparing it with standard refurbishment projects in order to differentiate between energy efficiency measures and structural ones. However, due to a lack of available information, this was not possible. The same problem was found in the other project in Barcelona, also on a former industrial site, where structural and energy efficiency measures were implemented together in the same building. In that case, it was developed through a public-private partnership (PPP) and can be considered financially and economically sustainable.

The other two projects took place in Stockholm. The first one is a former industrial building rebuilt to become a restaurant and event venue, which was completely refurbished with structural and energy efficiency measures. The second is an office building, in which active and passive energy efficiency measures were implemented. According to the municipality, the retrofitting of the former industrial building has a long-term payback period. Because the building was not used for many years, it required many structural interventions and did not have any heating or ventilation systems. However, if only energy efficiency measures are considered, the project is almost financially sustainable, when accounting public funds as revenues.

With respect to private residential buildings, the refurbishment projects for residential buildings in Barcelona do not seem to be financially sustainable if only energy savings are considered in the analysis. According to industry partners, implementing passive energy efficiency measures, with high investment costs, in mild climates do not seem to be attractive enough to generate sufficient energy savings. Furthermore, the business models for comprehensive retrofitting projects, seem to focus on gains in comfort for residents. Taking that into consideration, refurbishing a building with energy-efficiency measures in Barcelona could be attractive for an investor only if those potential gains in comfort could be estimated and accounted into a financial analysis. In that sense, the challenge is to monetize the gains in comfort while, at the same time, finding methods to minimize non-payment risks, for example, via public administration support, among other financing sources.

In Barcelona, the private residential examples presented in this document are not financially sustainable as business models in the context of GrowSmarter. The exception is the Melon District, also in Barcelona, which is sustainable due to its larger scale and because the scope of the project, without the implementation of passive energy efficiency measures, has been minor compared to the other residential buildings in Barcelona. In addition, it is not a common residential building, as it is a student housing building. Industry partners also point out the importance of combining passive with active energy efficiency measures like photovoltaics in order to obtain better energy performance, which, in turn, would translate into more financial savings and shorter periods in terms of returns on the investment.

In the case of Stockholm, the private residential retrofitting project seems to be financially unsustainable. This could be explained by the relatively low energy price, especially if compared with the other two lighthouse cities. This case, a private condominium, is a smaller-scale project, again, when compared with other GrowSmarter interventions. In this project, several different new techniques were implemented, which, after five years, have a lower investment cost due to a decreasing cost of the technology, among other factors. Testing new techniques is more expensive in the beginning. For this project, the negative financial gap seems to be almost neutralized through savings in CO2 emissions, making the project economically sustainable. Furthermore, the project would have been financially sustainable if it were not for the costs of the batteries installed, which significantly increased the project's implementation costs.

With respect to private tertiary buildings, upon compiling the main results for the three private tertiary buildings in Barcelona, implementing energy-efficiency measures in retrofitting projects for tertiary buildings seems to be financially sustainable. The aspect that should be taken into account for the replicability of energy performance contracting regarding tertiary buildings operated by private entities, as is the case of the Sports Center in Barcelona, is the duration of concessions. For example, the administrative concessions that are made between the administration and the concessionaire organization for the management and operation of the private tertiary equipment. The administrative concessions should take into account the private investment in energy efficiency, whether with regard to contract duration or financial support or other measures. This factor might be very important when considering replicating these measures elsewhere and if it is done through a concession.

GrowSmarter projects seem to prove the importance of active measures in bringing financial sustainability to an energy-efficient retrofitting project. In other words, the financial performance of measures such as photovoltaics, efficient HVAC systems and LED lighting systems, is greater than other, generally passive, measures and, therefore, their implementation could be more of a priority for future rehabilitation projects.

As an important remark, when it comes to carrying out a financial and economic analysis of energy retrofitting projects for residential and tertiary buildings, other factors such as the increase in comfort or an expected increase in the value of the properties should be taken into account in a more in-depth analysis. Due to a lack of data, it has yet not been possible to carry out a financial and economic analysis with that level of detail for the GrowSmarter projects related to energy retrofitting.

Finally, the solutions related to energy management systems have been implemented along with other measures in residential and tertiary buildings. When analyzed separately, the results obtained show a lack of financial sustainability for two cases: one in Cologne and the other in Stockholm. Two possible explanations for this were identified. First, the low price of energy, especially in Stockholm; and, second, the limited number of users, in that case, especially affecting Cologne's measure, leading to an increase in the average cost per user and missing out on potential scale advantages. In addition, accounting for the CO2 savings, the solution seems to fail in terms of economic sustainability in both cases. In the case of Barcelona, our results for the resource advisor show a high potential for achieving energy savings and, therefore, attractive returns on investment. The virtual energy advisor also seems to be a highly attractive measure, having achieved and reported direct positive results in that sense, although the business model is completely different, since the local partner has subsidized it. With regard to the solution related to local energy generation, in Barcelona, it has achieved positive results, as it is financially and economically sustainable.

4.2. Work Package 3. Integrated Infrastructures

Measure Name	Measure	WP	City	CAPEX	Annual CAPEX	OPEX (average)	Revenues	Employment Impact	Output Increase	Financially Sustainable	Economically sustainable	Business Model	Internal Rate of Return (IRR)
Smart LED Street Lighting	5.1.1, 5.1.2, 5.1.3	3	Stockholm	€ 1.889.247,00	€ 94.462,00	€ 20.679,00	€ 5.026,00	7,9	€ 1.215.891,03	No	No	B2B	Negative Cash Flow
Smart Connected City Environment	5.2	3	Stockholm	€ 249.033,00	€ 12.452,00	€ 12.452,00	€ 93.120,00	1,5	€ 148.588,76	Yes	Yes	B2B	32%
Smart Multifunctional Tower	5.2	3	Barcelona	€ 317.440,00	€ 21.163,00	€ 29.617,00	€ 43.328,00	1,6	€ 205.787,46	No	Yes	B2B or B2C	-5%
Smart Meter Information and Actuators	5.3	3	Barcelona	€ 438.529,00	€ 29.235,00	€ 107.772,00	€ 94.653,00	2,2	€ 284.286,07	No	Yes	B2B	Negative Cash Flow
Open District Heating Using Waste Heat	6.1	3	Stockholm	€ 712.037,00	€ 35.602,00	€ 136.549,00	€ 212.474,00	1,4	€ 302.318,09	Yes	Yes	B2B	9%
Automated Waste Collection	7.1, 7.2, 7.3	3	Stockholm	€ 467.302,00	€ 31.153,00	€ 56.308,00	€ 93.673,00	1,6	€ 378.752,94	Yes	Yes	B2B	2%
Big Consolidated Open Data Platform	8.1	3	Barcelona	€ 363.438,00	€ 24.229,00	€ -	€ -	3,4	€ 231.318,84	No	Yes	B2B - Open Source	No Revenues
Urban Cockpit	8.1, 8.2	3	Cologne	€ 212.444,00	€ 14.163,00	€ -	€ 78.000,00	1,4	€ 157.316,02	Yes	Yes	B2B	36%
Big Consolidated Open Data Platform	8.1	3	Stockholm	€ 329.838,00	€ 21.989,00	€ 11.288,00	€ 40.195,00	1,6	€ 196.573,47	Yes	Yes	B2B	4%

One of the main conclusions of Work Package 3 is that a majority of measures are financially and/or economically sustainable. It is important to remark that these results are based on strategic decisions on the part of the implementors. For example, in software-related solutions, one could decide to freely open the code. Therefore, it is advisable to take these conclusions for what they are: contingent on strategic decisions made by the partners involved.

On the other hand, there are several measures that are close to being financially sustainable. This could mean two things: first, that after including more information about formal and direct revenues the measure will be financially sustainable and, second, that after taking into account the economic, environmental or other types of savings arising from Work Package 3, some of the measures could also be economically sustainable.

Regarding the specific details of each measure:

- Measures 5.X: Some of the measures report financially viable numbers while others do not. However, as we have said before, some measures do not show financial viability.

- Measures 6.X: These measures provide an interesting case for Public-Private partnerships for retrofitting existing infrastructure thanks to private-generated heat to feed district heating systems. In addition, the measure is financially sustainable and will become one of the best cases of the project. However, the measure is highly dependent on existing infrastructure (mainly a district heating system and private heat producers like supermarkets or data centers), which will make it harder to replicate in many cities around Europe.

- Measures 7.X: These measures are financially sustainable. The measures seem to be financially sustainable. However, as in the previous measures (6.X) the deployment of this kind of infrastructure is highly dependent on the idiosyncrasy of each city (regarding deployed infrastructure, city structure, public-sector operations for waste recovery, existence of treatment plants, etc.).

- Measures 8.X: big data, open data and data platforms in general are some of the most promising areas in technology applied to urban development and management. However, promises for better decision-making are straightforward and easy to foresee. Like in previous measures, these come with potential challenges like operations management, organizational culture or decision-making biases that may hamper or foster the benefits of the measures. Therefore, it is advisable to pay special attention to the operations, strategy and management perspectives of the measures beyond technology.

4.3. Work Package 4. Sustainable Mobility Solutions

Measure Name	Measure	WP	City	CAPEX	Annual CAPEX	OPEX (average)	Revenues	Employment Impact	Output Increase	Financially Sustainable	Economically sustainable	Business Model	Internal Rate of Return (IRR)
Delivery room for sustainable deliveries	9.1	4	Stockholm	€ 139.000,00	€ 6.950,00	€ 24.644,05	NO REVENUES	1,6	€ 85.204,22	No	No	B2B & B2C	No Revenues
Micro distribution of freight	9.2	4	Barcelona	€ 74.517,43	€ 14.903,49	€ 289.729,43	€ 267.747,08	1,7	€ 57.862,64			B2B	Negative Cash Flow
Travel demand Management & Smart guiding	10.3 & 11.5	4	Stockholm	€ 41.400,00	€ 8.280,00	NO OPEX	NO REVENUES	0,2	€ 20.655,00	No	No	B2B or PPP	No Revenues
Traffic signals synchronized	10.5	4	Stockholm	€ 3.154,14	€ 630,83	€ 10.093,81	NO REVENUES	0,02	€ 1.573,64	No	No	B2B or B2C or PPP	No Revenues
Electrical Charging and Street Lighting	5.2	4	Cologne	€ 18.281,00	€ 1.828,10	€ 4.808,23	NO REVENUES	0,1	€ 14.220,95	No	No	PPP & B2C	No Revenues
Developing Charging Infrastructure	11.1	4	Cologne	€ 140.745,13	€ 14.074,51	€ 40.558,66	€ 40.519,77	0,4	€ 109.486,90	No	No	B2B or B2C or PPP	Negative Cash Flow
Developing Charging Infrastructure	11.1	4	Stockholm	€ 52.960,00	€ 5.296,00	€ 9.615,12	€ 11.666,67	0,2	€ 31.292,53	No	No	PPP & B2B	-38%
V2G Charging Stations and EV fleet	11.1 & 11.2	4	Barcelona	€ 123.819,14	€ 24.763,83	€ 1.529,85	€ 11.043,13	0,7	€ 78.023,89	No	No	B2B or B2C	-25%
Renewable fuels for heavy-duty vehicles	11.4	4	Stockholm	€ 2.395.359,25	€ 159.690,62	€ 74.064,46	NO REVENUES	4,8	€ 1.017.026,42	No	No	PPP or B2B to B2C	No Revenues
Electric car sharing pool	12.1	4	Stockholm	€ 12.917,65	€ 2.583,53	€ 17.086,69	NO REVENUES	0,1	€ 8.859,98	No	No	B2C	No Revenues
Electrical and cargo bike pool	12.2	4	Stockholm	€ 7.881,95	€ 1.576,39	€ 4.601,06	NO REVENUES	0,02	€ 6.140,76	No	No	B2B & PPP	No Revenues
Mobility station	12.3	4	Cologne	-	-	€ 28.288,46	€ 11.297,33	-	-	No	No	B2C & PPP	Negative Cash Flow
Electrical and conventional car sharing	12.4	4	Cologne	Cambio: € 547.200,00 KVB: € 160.648,00	Cambio: € 109.440,00 KVB: € 53.549,33	Cambio: € 289.599,20 KVB: NO OPEX	Cambio: € 289.597,60 KVB: € 40.162,00	4	€ 549.377,53	No	No	B2C & PPP	Cambio: Negative Cash Flow KVB: NO OPEX Reported

Our analysis shows that, based on the available data, most of the sustainable mobility solutions analyzed are on the right path to achieve financial and economic sustainability. That is, every year their revenues were closer to the necessary threshold to make them financially viable, suggesting that either the business or the market (or both) had adapted, creating a better context for these measures to thrive. However, so far none of the cases can be considered as successful, given that they are not explicitly viable. Moreover, half of the measures did not report any revenues, impairing the financial conclusions.

Furthermore, the vast majority of the WP4-related measures do not capture any type of financial savings for their future balance sheets, stressing the importance of public funding for the projects' existence. In other words, the industry partners have no financial gains from their investment, so the public authorities will have to offer them financial incentives in order for the measure to be executed. Those measures are part of the group that are financially unsustainable but expected to be economically sustainable, i.e., the positive externalities are large enough to cover the financial losses.

Looking at the measures that are already operational, they have shown a significant reduction of CO_2 emissions and expect to reduce even more as the business grows. However, at this point, no case has been able to reduce enough CO_2 emissions to justify the amount received through the EU grant. Nonetheless, we should keep in mind that only the data being collected to quantify the economic impact is the reduction in CO_2 emissions. The measures in Work Package 4 generate other positive externalities, such as travel time savings due to congestion reduction and noise reduction, as well as a positive impact for the country's economy in general.

Summarizing:

1. The measures for which revenues were analyzed are on the right path toward financially and economically sustainability, suggesting that either the business or the market (or both) adapted, creating a better context for these measures to thrive.

2. The measures that are not financially sustainable are expected to be economically sustainable as a result of their reduction of CO_2 emissions.
   i. However, the savings only from CO_2 emissions do not yet justify the amount awarded by the EU grant.

3. The economic evaluation could be improved if other positive externalities were measured and collected.

4. Half of the measures show a lack of revenues; therefore, their business model needs to be improved.

5. Replicability and Scalability Overview

5.1. Work Package 2. Low-Energy Districts

For WP2, we find that there are certain factors that seem to affect most of the measures when trying to replicate them or scale up them. The **climate** seems to be one of these factors. In that sense, it seems that, with temperate weather conditions, the potential for reaching energy savings could be more difficult than with more extreme conditions. Another factor is the **price of energy**, since it directly affects how the energy savings are translated into financial savings. With lower prices, the cost of opportunity of implementing energy-efficiency measures is higher, hindering its financial attractiveness. A third factor to highlight is the increase in **comfort**. Especially in those locations with more temperate climates, the main selling point of implementing these solutions is not the potential for generating energy savings but an increase in comfort. In turn, this could even affect how users and residents change their consumption habits, either increasing or reducing consumption according to their preferences. A fourth factor is a potential increase in the **value of the properties**. In this regard, we assume a potential increase in the value of a property after implementing the solutions from this Work Package. In turn, this would help to increase the attractiveness of investing in refurbishing a building in keeping with energy-efficiency criteria. A fifth factor is the **type of building**. How a building is used, seems to have a large influence on the potential energy savings generation. For example, in Barcelona, tertiary purposed buildings do seem to be able to generate more energy savings than residential ones. In contrast, the projects being carried out in bigger residential buildings in the three Lighthouse cities do seem to have generated important energy savings, which, among other factors, seem to benefit from scale advantages. In that sense, the **scalability degree of a measure acts as an additional condition for replication**. Another factor that could condition the way in which a measure is replicated, as well as its level of scalability, is **user engagement**. Fostering awareness among citizens of the environmental and **economic benefits** (positive externalities) of the solutions is crucial in order to implement them in more locations. Finally, we should mention the importance of the public sector for ensuring, in some cases, the financial sustainability of the solutions, and therefore their replication. The higher investment cost and the need for adequate regulatory frameworks require public institutions to be actively involved in the deployment of these energy-efficiency solutions.

5.2. Work Package 3. Integrated Infrastructures

For WP 3, four elements seem to be crucial to guarantee the replicability of the measures. The first one is **legal issues**. While, from the technical point of view, there are no major problems in replicating the solutions in different contexts and environments, legal barriers do arise as the main challenge to overcome in terms of replicability, especially for solution 8. The legal issues, although solved in all the measures implemented in GrowSmarter, are related to European legislation on privacy. While it is not a problem per se, when replicating the different solutions one should be cautious and informed about privacy in different legal environments.

The second element involves **infrastructure needs**. Although the solutions in WP3 vary in terms of needs for pre-existing infrastructure, all of them require the deployment of infrastructure to some extent. However, WP3 includes two different types of infrastructure needs: for measures 5 to 7, the need is for physical infrastructure (pipelines, electrical networks, sorting facilities, etc.); whereas, for the measures included in solution 8, the need is for cloud infrastructure.

The third element is the **multiplicity of administrations involved**. Many of the solutions need to interact with different administrations or administrative departments, whether it is for getting permits and licenses or for getting access to data. In many cases, this interaction is not as easy as it should be, which creates frictions in terms of replicability, especially when approaching a new city for potential deployment of the solution. Therefore, one of the main options for overcoming this particular challenge is the creation of unique internal actors (inside the public sector) to deal with these frictions by leveraging their internal knowledge of the organization and personal contacts.

The final element is **strategic alliances**. For some of the measures, additional gains can be achieved by creating strategic alliances with other organizations. For example, outside organizations can benefit from existing data or deployed infrastructure by extracting value through infrastructure, sharing or complementing their own. However, these alliances are not always easy to create and manage.

In terms of scalability, two elements should be considered: **planning ahead** and **user engagement**. Many of the solutions would benefit from planning the interactions they will need to face during different phases of the deployment and operation of the measure. In some cases, this plan should be related to establishing early contacts in order to explain the benefits of the solution to potential users or public administrators, while in others the early interaction should be focused on gaining trust from key stakeholders. Regarding user engagement, one of the main challenges identified in WP3 solutions is how to foster use by different users. In the case of physical infrastructure (Solutions 5 to 7), the deployment phase may create disturbances for future users, or the operations may be perceived as inefficient or costly (even if they are not). On the other hand, for solution 8, the deployment of new technological platforms can help organizations to make better decisions through data-driven insights. However, organizations tend to have existing routines and procedures that may be hard to overcome. Change and adaptation to new ways of doing can be slow. Therefore, it is advisable to foresee these challenges and try to accommodate the organization as soon as possible to avoid user resistance once the solution is deployed.

5.3. Work Package 4. Sustainable Mobility Solutions

Looking at the big picture of Work Package 4, it is clear that there is no “one size fits all” solution. The city’s urban mobility planning will vary depending on its type of geography and urban planning, in addition to factors such as differences in legislation. For instance, in some cities it will be more attractive to encourage the use of bicycles given the layout of the urban geography. Yet, in other cities it makes more sense to invest in alternative ownership mobility models (sharing economy) powered with clean energy. Therefore, a central planner should define what the goals for the city’s mobility are in the near future in order to begin a systemic change to create a better context for sustainable mobility measures.

With regard to WP4 measurements, we find that certain elements are recurrent across the different smart solutions, when we talk about how to replicate and/or scale them up. In this conclusion we will highlight three points that seem to be of greatest importance when the objective is scalability and replicability.
The first point is **where the measure is being implemented**. This is a fundamental issue for smart solution 9, smart solution 11 and for the mobility stations from smart solution 12.
We see that the measures should be implemented in areas of easy access both for users of a service – such as the mobility stations in Cologne or the delivery room in Stockholm – and for suppliers, in the case of the Urban Consolidation Center in Barcelona that needs to receive packages from a truck before making the last-mile distribution by cargo-bike.
In addition, the location needs to be strategically designed so that the service is in **areas that maximize the use of the target market.** Strategic location also includes implementing the measure in areas where your service has an advantage over a competitor, such as the Micro Distribution of Freight measure that makes deliveries by tricycle in areas where motor vehicles are restricted.
It is important to point out that the public authorities can be of great help in locating a site. The public sector can either make strategic public spaces available at a reasonable price for measures such as mobility stations to be implemented, or it can take actions such as restricting motor vehicles in certain areas of the city to foster the alternative transportation market.

The second point is the **high investment costs.** Measures that require the purchase of expensive vehicles in relation to business returns – such as electric cars from car-sharing stations in Cologne or cargo-tricycles for micro distribution of freight in Barcelona – experience financial issues whenever they have to renew their fleet of vehicles. Therefore, to replicate and scale up measures that are subject to such expenses, it would be important to have financial instruments to amortize them over time.
The costly investment also appears as a difficulty in measures that require adjustments to the infrastructure of the city for their implementation. This is the case of the Smart Traffic Signal measure in Stockholm, where new traffic lights would need to be installed in order for the software to work, or the Smart Taxi Stand measure in Barcelona, which requires work on the street asphalt to install the sensors.

These last measures exemplify the third and final point that we would like to highlight: **technological failures**. While software development was successful in the mobile application "Travel demand management & Smart guiding to alternative fuel and fast charging in Stockholm", which can be replicated without too many difficulties, hardware-dependent measures have not had the same fortune. In the case of the Smart Traffic Signal, there was a failure in the interaction between the software and the traffic lights. In the case of the Smart Taxi Stand, the sensors did not last long enough, generating maintenance costs that make the project unfeasible.

6. Financial and Economic Validation

6.1. Work Package 2. Low-Energy Districts

Solution 1. Low-Energy Districts

Barcelona. Measures 1.0; 1.1.10.1; 1.1.10.2 (3.1.3)
Refurbishment of Private Residential Buildings (Canyelles, Ter 31, Lope de Vega) by Naturgy

Financially unsustainable
Economically unsustainable

This solution consists of implementing passive and active energy-efficiency measures in three residential buildings in the city of Barcelona with the purpose of reducing energy costs and making the buildings more environmentally sustainable.

Financial Analysis

Detailed Costs

CAPEX: €848,614
OPEX: €721

Detailed Revenues

Private financing: €174,088 (that is €6,964 per year on average)

Savings as Revenues (per dwelling)

Canyelles (56 dwellings):
Savings in electricity: 427kWh (€50.3 or €0.9 per dwelling)
Savings in gas: 83,299kWh (€3,698.48 or 67€ per dwelling)
Lope de Vega (5 dwellings):
Savings in electricity: 4,782kWh (€563.32 or €112.65 per dwelling)
Ter 31 (6 dwellings):
Savings in electricity: 6,118kWh (€720.7 or €120 per dwelling)
Total savings: €5,032 per year (€6,089 including taxes, and €152,218 in 25 years).

Financial Conclusion

The measure seems to be financially unsustainable since the real revenues (€13,052) do not meet the theoretical net present value revenues for reaching a break-even (€45,300.02).

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure is able to generate 6.51 FTE jobs.

Positive Externalities as Economic Savings

Savings in CO_2 emissions:
Canyelles: 0.370
Lope de Vega: 1.58 tones
Ter 31: 2.02 tones
Total: 3.97 tones per year (€238.2).
- €5,955 in 25 years

The Project has received a grant from the EU (€29,362)

Economic Conclusion

The measure seems to be economically unsustainable. However, we have only accounted savings in CO_2 emissions, and other positive impacts should be considered in a more in-depth analysis.

The EU Grant does not seem to be justifiable, since the positive externalities in CO_2 emissions are marginal.

Comments on Data and Methodology

Financial was updated in December 2019. Energy savings information was updated in December, 2019
The generation of energy savings can con only be achieved if consumption behaviors remain the same as before the renovation of the buildings. If users (residents) did change their consumption habits (likely to happen, since the cost of achieving better comfort levels is lower than it was before), by consuming more energy, it would be more difficult to account energy savings for this solution. However, if that were the case, that would not mean that the measures were less effective.
Emission factors: Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report "FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES"
https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
848.614,78	720,96	2,193%	2,20%	25

Revenues Reported	Total	Per year
Private Financing	174.088 €	6.964 €
Energy Savings	152.218 €	6.089 €
Total	326.306 €	**13.052 €**
EU Grant	734.059 €	29.362 €

Internal Rate of Return (IRR): -10.99%

Years	OPEX	Annual CAPEX	PV revenue
0	720,96 €	33.944,59 €	34.665,56 €
1	736,83 €	33.944,59 €	35.410,01 €
2	753,04 €	33.944,59 €	36.170,79 €
3	769,60 €	33.944,59 €	36.948,25 €
4	786,53 €	33.944,59 €	37.742,76 €
5	803,84 €	33.944,59 €	38.554,69 €
6	821,52 €	33.944,59 €	39.384,43 €
7	839,60 €	33.944,59 €	40.232,36 €
8	858,07 €	33.944,59 €	41.098,89 €
9	876,94 €	33.944,59 €	41.984,42 €
10	896,24 €	33.944,59 €	42.889,37 €
11	915,95 €	33.944,59 €	43.814,16 €
12	936,10 €	33.944,59 €	44.759,23 €
13	956,70 €	33.944,59 €	45.725,03 €
14	977,75 €	33.944,59 €	46.712,00 €
15	999,26 €	33.944,59 €	47.720,62 €
16	1.021,24 €	33.944,59 €	48.751,35 €
17	1.043,71 €	33.944,59 €	49.804,69 €
18	1.066,67 €	33.944,59 €	50.881,13 €
19	1.090,14 €	33.944,59 €	51.981,17 €
20	1.114,12 €	33.944,59 €	53.105,34 €
21	1.138,63 €	33.944,59 €	54.254,15 €
22	1.163,68 €	33.944,59 €	55.428,16 €
23	1.189,28 €	33.944,59 €	56.627,92 €
24	1.215,44 €	33.944,59 €	57.853,98 €
Total	12.649,66 €	848.614,78 €	1.132.500,47 €
Average	947,67 €	33.944,59 €	**45.300,02 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	848.614,78 €
Employment impact (FTE)	6,51
Output increase	623.820,12 €

- The investment costs of this project have been categorized within the “Architectural and engineering services; technical testing and analysis services” industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €623,820.12 approximately.

Improving the Business Model

Revenue structure: the measure could increase its revenues by including all the free-riders who benefit from the positive indirect impact of the solution. In addition, the benefits in comfort should be considered when deciding what final users should pay for the energy-efficiency measures.

The model could consider replicating only those measures that seem to be the most effective in terms of energy savings generation potential. For example, focusing only on active measures if they are the only financially sustainable ones (photovoltaics).

Emission factors: Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report “FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES” https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Barcelona. Measures 1.0; 1.1.10.1: 1.1.10.2 Refurbishment of a Private Residential Building (Melon District) by Naturgy

Financially sustainable
Economically sustainable

The scope of the refurbishment in Melon District was totally different compared to the other residential buildings. In that case, only one active measure and no passive measures were carried out in the building. This active measure consisted of the substitution of the electric heaters used for the heating demand by a connection to the nearest district heating network. The connection allows Melon District to reduce its primary energy consumption through the substitution of the use of electricity by waste heat from the DH to supply the building's heating demand.

Financial Analysis

Detailed Costs

CAPEX: €160,394.87
OPEX: €42.20

Detailed Revenues

Private financing: €45,000 (that is €1,800 per year on average)

Savings as Revenues

Baseline consumptions: 2194106 kWh
Post-retrofitting consumptions: 1930164 kWh
Energy savings per year: 263942 kWh Savings by removing electric heaters and providing heat through district heating:
- Savings (€) = (Heat provided by district heating for heating) * (72.26 - 25.82)
Savings (€) = 410,497 * (72.26-25.82) = € 19,063
- Savings by eliminating part of the independent air conditioning equipment and providing that cold with the district cooling:
- Savings (€) = (Reduced cold demand with independent equipment) * (72.26/3 - 43.76)
Savings (€) = (401,364 - 260,887) * (72,26 / 3 - 43,76) = -2,764
- Savings by eliminating ACS boilers and providing that heat with district heating:
Savings (€) = (Heat provided by district heating for ACS) * ((Natural gas price in € / MWhPCS) / 0.8 - 25.82)
- Savings (€) = 439,602 * (40 - 25,82) = €6,234
Total savings = 19,063 -2,764 + 6,234 = €22,533 per year.

Financial Conclusion

The project seems to be financially sustainable, since the real revenues are greater than the theoretical net present value revenues for reaching a break-even (€8,467.91).

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure is able to generate 1.23 FTE jobs.

Positive Externalities as Economic Savings

Baseline: emissions of CO2 / year: 689 tons per year.
Post-retrofitting emissions of CO2 / year: 399 tons per year.
Savings in CO2 emissions: 290 tons per year
Savings in euros: 17,400 euros per year. (435,000 in 25 years).

Economic Conclusion

The project seems to be economically sustainable.

The measure does not seem to need public funds in order to be financially sustainable. However, the public grant is lower than the positive externalities and should help to incentivize scaling up and replicating the implementation of active energy-efficiency measures in similar buildings.

Comments on Data and Methodology

Financial data has been updated as of March 2019. Energy savings data has been updated in late December, 2019 (KTH's D5.4).
Energy prices according to Naturgy, June 2019.
Emission factors: Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report "FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES"
https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Theoretical Revenues in Net Present Value

Revenues Reported	Total	Per year
Private Financing	45.000 €	1.800 €
Energy Savings	453.616 €	18.145 €
Total	498.616 €	**19.945 €**
EU Grant	84.507 €	3.380 €

Internal Rate of Return (IRR): 10.32%

CAPEX	OPEX	Bond	Inflation rate	Life time
160.394,87	42,20	2,193%	2,20%	25

Years	OPEX	Annual CAPEX	PV revenue
0	42,20 €	6.415,79 €	6.457,99 €
1	43,13 €	6.415,79 €	6.598,70 €
2	44,08 €	6.415,79 €	6.742,48 €
3	45,05 €	6.415,79 €	6.889,42 €
4	46,04 €	6.415,79 €	7.039,59 €
5	47,05 €	6.415,79 €	7.193,04 €
6	48,09 €	6.415,79 €	7.349,86 €
7	49,14 €	6.415,79 €	7.510,12 €
8	50,22 €	6.415,79 €	7.673,89 €
9	51,33 €	6.415,79 €	7.841,26 €
10	52,46 €	6.415,79 €	8.012,30 €
11	53,61 €	6.415,79 €	8.187,08 €
12	54,79 €	6.415,79 €	8.365,70 €
13	56,00 €	6.415,79 €	8.548,24 €
14	57,23 €	6.415,79 €	8.734,78 €
15	58,49 €	6.415,79 €	8.925,41 €
16	59,78 €	6.415,79 €	9.120,22 €
17	61,09 €	6.415,79 €	9.319,30 €
18	62,44 €	6.415,79 €	9.522,75 €
19	63,81 €	6.415,79 €	9.730,66 €
20	65,21 €	6.415,79 €	9.943,13 €
21	66,65 €	6.415,79 €	10.160,26 €
22	68,11 €	6.415,79 €	10.382,15 €
23	69,61 €	6.415,79 €	10.608,91 €
24	71,14 €	6.415,79 €	10.840,64 €
Total	740,42 €	160.394,87 €	211.697,87 €
Average	55,47 €	6.415,79 €	**8.467,91 €**

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	
Employment impact (FTE)	1,23
Output increase	117.906,91 €

- The investment costs of this project have been categorized within the “Architectural and engineering services; technical testing and analysis services” industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €117,906.91 approximately.

Improving the Business Model

Cost structure: the cost of implementing this active energy-efficiency measure should go down in the future since the cost of the technology is expected to fall, while, in addition, potential scale advantages could be achieved if it is implemented in more places.

Barcelona. Measures 1.0; 1.1.9; 1.1.10.1; 1.1.10.2; 1.1.11
Refurbishment of a Private Tertiary Building (CEM Claror Cartagena) by Naturgy

Financially sustainable
Economically sustainable

The refurbishment carried out at CEM Claror was focused, on the one hand, on the reduction of the energy demand of the swimming pool area and, on the other, on the improvement of the energy efficiency of the lighting system as well as the heating and cooling production systems.

Financial Analysis

Detailed Costs

CAPEX: €654,797.87
OPEX: €22,642.20

Detailed Revenues

Private financing: €502,533 (that is €20,101 per year on average)

Savings as Revenues

- Savings in Electricity 122,000 kWh per year (€11,224)
- Savings in Gas: 538,000 kWh per year (€21,520)
- Total savings: €32,744

Financial Conclusion

The measure seems to be financially sustainable, since the real revenues are greater than the theoretical net present value revenues for reaching a break-even (€32,493.97).

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure is able to generate 5.03 FTE jobs.

Positive Externalities as Economic Savings

The measure is able to generate savings in CO_2 emissions.

Savings due to gas energy demand: 121 tons
Savings due to electric energy demand: 41 tons
Total: 162 tons. That would equal to €9,720 per year (€243,000 in 25 years)

The measure has received an EU grant of €502,533 in total (€20,101.32 per year on average).

Economic Conclusion

The measure is economically sustainable, as it can stand on its own financially, and it generates positive externalities. In that sense, the EU Grant is not needed, although it should help to incentivize scaling-up and replicating the implementation of active and passive energy-efficiency measures in other similar buildings.

Comments on Data and Methodology

Financial information updated in December 2019. Energy savings information updated in December 2019.
The prices for energy were provided by Naturgy and have been used for assessing the energy savings of the project.

Emission factors: Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report "FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES"
https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Theoretical Revenues in Net Present Value

Revenues Reported	Total	Per year
Private Financing	502.533 €	20.101 €
Energy Savings	818.600 €	32.744 €
Total	1.321.133 €	**52.845 €**
EU Grant	228.807 €	9.152 €

Internal Rate of Return (IRR): 6.54%

CAPEX	OPEX	Bond	Inflation rate	Life time
654.797,87	22.642,20	2,193%	2,20%	25

Years	OPEX	Annual CAPEX	PV revenue
0	22.642,20 €	26.191,91 €	48.834,11 €
1	23.140,33 €	26.191,91 €	49.410,05 €
2	23.649,42 €	26.191,91 €	49.998,59 €
3	24.169,70 €	26.191,91 €	50.600,00 €
4	24.701,44 €	26.191,91 €	51.214,56 €
5	25.244,87 €	26.191,91 €	51.842,57 €
6	25.800,25 €	26.191,91 €	52.484,32 €
7	26.367,86 €	26.191,91 €	53.140,10 €
8	26.947,95 €	26.191,91 €	53.810,23 €
9	27.540,81 €	26.191,91 €	54.495,03 €
10	28.146,71 €	26.191,91 €	55.194,81 €
11	28.765,93 €	26.191,91 €	55.909,90 €
12	29.398,78 €	26.191,91 €	56.640,64 €
13	30.045,56 €	26.191,91 €	57.387,36 €
14	30.706,56 €	26.191,91 €	58.150,44 €
15	31.382,10 €	26.191,91 €	58.930,21 €
16	32.072,51 €	26.191,91 €	59.727,05 €
17	32.778,11 €	26.191,91 €	60.541,32 €
18	33.499,22 €	26.191,91 €	61.373,43 €
19	34.236,21 €	26.191,91 €	62.223,74 €
20	34.989,40 €	26.191,91 €	63.092,67 €
21	35.759,17 €	26.191,91 €	63.980,62 €
22	36.545,87 €	26.191,91 €	64.888,01 €
23	37.349,88 €	26.191,91 €	65.815,27 €
24	38.171,58 €	26.191,91 €	66.762,82 €
Total	397.268,37 €	654.797,87 €	1.426.447,86 €
Average	29.762,10 €	26.191,91 €	**57.057,91 €**

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	
Employment impact (FTE)	5,03
Output increase	481.344,53 €

- The investment costs of this project have been categorized within the "Architectural and engineering services; technical testing and analysis services" industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €481,344.53 approximately.

Barcelona. Measures 1.0; 1.1.10.1; 1.1.10.2
Refurbishment of a Private Tertiary Building (Escola Sert) by Naturgy

Financially unsustainable
Economically unsustainable

The project consists in implementing a building integrated photovoltaic system and a BMS.

Financial Analysis

Detailed Costs

CAPEX: €248,562.87
OPEX: €1,172.40

Detailed Revenues

Private financing: €118,790 (that is €11,879 per year on average)

Savings as Revenues

Savings as Revenues per year

- On-site electricity production: 13,060kWh/yr
  - Energy Savings: €1,083.98
- Savings in gas consumption (16.50 MWh PCS): €627.18

Financial Conclusion

The measure seems to be financially unsustainable, since real revenues are lower than the theoretical net present value revenues for reaching a break-even (€28,942).

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure has generated 1.91 FTE jobs.

Positive Externalities as Economic Savings

According to KTH's D5.4, the measure seems to achieve savings of 4,66 tons of CO_2 emissions per year.
That would equal to €279.6 per year (€2,796 in 10 years)

The project has received an EU grant of €68,247

Economic Conclusion

The measure is most likely unsustainable considering the negative financial results. The EU grant does not seem to be justifiable in order to internalize positive externalities.

Comments on Data and Methodology

Financial Data received in December 2019. Energy prices according to Naturgy, December 2019.

Energy savings data updated in December 2019.

Energy savings could be even better if it were not for an apparent change in consumption behavior.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
248.562,87	1.172,40	2,19%	2,20%	10

Years	OPEX	Annual CAPEX	PV revenue
0	1.172,40 €	9.942,51 €	11.114,91 €
1	1.198,19 €	9.942,51 €	11.333,03 €
2	1.224,55 €	9.942,51 €	11.555,94 €
3	1.251,49 €	9.942,51 €	11.783,72 €
4	1.279,03 €	9.942,51 €	12.016,50 €
5	1.307,16 €	9.942,51 €	12.254,39 €
6	1.335,92 €	9.942,51 €	12.497,49 €
7	1.365,31 €	9.942,51 €	12.745,92 €
8	1.395,35 €	9.942,51 €	12.999,79 €
9	1.426,05 €	9.942,51 €	13.259,23 €
10	1.457,42 €	9.942,51 €	13.524,36 €
Total	14.412,88 €	109.367,66 €	135.085,30 €
Average	1.310,26 €	9.942,51 €	**12.280,48 €**

Revenues Reported	Total	Per year
Private Financing	118.790 €	11.879 €
Energy Savings	79.353 €	7.935 €
Total	198.143 €	**19.814 €**
EU Grant	68.248 €	2.730 €

Internal Rate of Return (IRR): -3.41%

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	
Employment impact (FTE)	1,91
Output increase	182.719,56 €

- The investment costs of this project have been categorized within the “Architectural and engineering services; technical testing and analysis services” industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €182,719.56 approximately.

Improving the Business Model

Due to the tertiary use of this building, consumption behaviors do not seem to be improved as much as could be necessary to achieve the energy savings that would make the solution financially sustainable. The model could be attractive in that sense if energy prices increased or if the cost of implementing energy-efficiency solutions decreased.

Barcelona. Measures 1.0; 1.1.9; 1.1.10.1; 1.1.10.2
Refurbishment of a Private Tertiary Building (Hotel H10) by Naturgy

Financially sustainable (expected)
Economically sustainable

This building was completely renovated in order to convert it from a residential apartment block into a hotel. Thus, the retrofit has included not only active and passive energy-efficiency measures, but also other improvements for adapting the building to the new use.

Financial Analysis

Detailed Costs

CAPEX: €562,477.87
OPEX: €1,487.00

Detailed Revenues

Private financing: €277,212 (that is €1,487 per year on average)

Savings as Revenues

Savings in electricity: 250,861kWh
Savings in euros: €18,312.85 per year.

Financial Conclusion

The project seems to be financially sustainable, since the real revenues are greater than the theoretical net present value revenues for reaching a break-even (€31,035.67).

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure has generated 4.32 FTE jobs.

Positive Externalities as Economic Savings

Savings in CO_2 emissions due to electric energy demand (t/year): 90 tons.
That would equal to €5,400 per year (€135,000 in 25 years)

The project has received an EU grant of €192,318

Economic Conclusion

The project seems to be economically sustainable.

The EU grant does not seem to be necessary in order to sustain the project economically. However, the positive externalities in the form of CO_2 savings are lower than the EU grant.

Comments on Data and Methodology

Financial and technical data was updated in December 2019. Energy savings are based on energy consumption data validated by KTH (D5.4). Energy prices according to Naturgy.

Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report "FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES FUENTES DE ENERGÍA FINAL CONSUMIDAS EN EL SECTOR DE EDIFICIOS EN ESPAÑA".
https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
562.477,87	1.487,00	2,19%	2,20%	25

Revenues Reported	Total	Per year
Private Financing	277.212 €	11.088 €
Energy Savings	2.187.184 €	65.201 €
Total	2.464.396 €	**76.290 €**
EU Grant	192.318 €	7.693 €

Years	OPEX	Annual CAPEX	PV revenue
0	1.487,00 €	22.499,11 €	23.986,11 €
1	1.519,71 €	22.499,11 €	24.479,62 €
2	1.553,15 €	22.499,11 €	24.983,95 €
3	1.587,32 €	22.499,11 €	25.499,34 €
4	1.622,24 €	22.499,11 €	26.026,02 €
5	1.657,93 €	22.499,11 €	26.564,25 €
6	1.694,40 €	22.499,11 €	27.114,29 €
7	1.731,68 €	22.499,11 €	27.676,38 €
8	1.769,78 €	22.499,11 €	28.250,80 €
9	1.808,71 €	22.499,11 €	28.837,82 €
10	1.848,50 €	22.499,11 €	29.437,70 €
11	1.889,17 €	22.499,11 €	30.050,74 €
12	1.930,73 €	22.499,11 €	30.677,22 €
13	1.973,21 €	22.499,11 €	31.317,44 €
14	2.016,62 €	22.499,11 €	31.971,69 €
15	2.060,98 €	22.499,11 €	32.640,29 €
16	2.106,32 €	22.499,11 €	33.323,55 €
17	2.152,66 €	22.499,11 €	34.021,80 €
18	2.200,02 €	22.499,11 €	34.735,35 €
19	2.248,42 €	22.499,11 €	35.464,55 €
20	2.297,89 €	22.499,11 €	36.209,73 €
21	2.348,44 €	22.499,11 €	36.971,26 €
22	2.400,11 €	22.499,11 €	37.749,48 €
23	2.452,91 €	22.499,11 €	38.544,77 €
24	2.506,87 €	22.499,11 €	39.357,50 €
Total	26.090,14 €	562.477,87 €	775.891,69 €
Average	1.954,59 €	22.499,11 €	**31.035,67 €**

Internal Rate of Return (IRR): 10.37%

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	
Employment impact (FTE)	4,32
Output increase	413.479,73 €

- The investment costs of this project have been categorized within the “Architectural and engineering services; technical testing and analysis services” industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €413,479.73 approximately.

Barcelona. Measures: 1.0; 1.1; 1.1.6; 1.1.9; 1.1.10.1; 1.1.10.2; 6.3
Refurbishment of a Public Tertiary Building: Ca l'Alier by Barcelona Municipality and IREC

Financially sustainable
Economically sustainable

Objective: rehabilitation and comprehensive refurbishment of an old factory, using energy-efficiency criteria in order to reduce the environmental impact. In addition, the renovation of Ca l'Alier is a Public-Private partnership to establish a center for developing, ideating, creating and promoting start-ups or new ideas related to Smart Cities.

Financial Analysis

Detailed Costs

The costs of the measure are structured as follows:

CAPEX: €10,268,189 (all taxes included).

- Investment costs: €6,622,972
- Personnel costs: €3,645,218

OPEX:

- Maintenance costs: €33,886 per year (€847,161 over 25 years)

Detailed Revenues

- Rent: CISCO made a single payment in advance, contributing to the initial investment and covering the rent for 15 years, €3,540,703
- Maintenance: CISCO covers 41% of the building's maintenance costs, €347,336
- Public funds
    - Municipality: €6,727,486
- Other contributions: €600,000

Savings as Revenues

- Energy savings: data on real financial savings through lower energy bills is not available for this analysis.
- Comparing current consumption with the results in the BEST table, the building seems to show 251,520 kWh per year in energy savings.
- The estimated energy savings are of €57,850 per year.

Financial Conclusion

- Hypothetical annual average revenues needed to reach a positive financial net present value would be €573,310.64.
- The expected annual revenues, including energy savings (€610,152) are greater than the hypothetical revenues for reaching a financial break even.
- The measure seems to be financially sustainable.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions

Job Creation

According to BIMSA, the project has employed 1,465 people (119,982 hours), although not FTE.
According to the input-output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 80 FTE jobs.

Positive Externalities as Economic Savings

- With an estimated 251,520 kWh of annual energy savings, the retrofitting project of Ca l'Alier could save 98.6 tons of CO_2 per year.
- The savings in CO_2 equal €5,915.75 per year.
- In 25 years, that would be a total of €147,893.76, assuming that the SCC remains the same.

Economic Conclusion

- The measure seems to be economically sustainable as it is financially sustainable and it is able to generate positive externalities.

Comments on Data and Methodology (continued)

The connection with the Districlima system seems to help to achieve the nZEB consideration of the building. However, the emissions resulting from Districlima should also be included in a more detailed analysis. This refurbishment project has been carried out on an old industrial site. It would be of interest to compare it with other refurbishment projects that have not implemented energy-efficient solutions. A comparison of operating revenues from energy savings for standard versus energy-efficient refurbishments, also calculating the average investment costs for both types of refurbishments, would be useful in preparing a more detailed cost-benefit analysis of refurbishing an old industrial site. CISCO has advanced the rent for 15 years. We have assumed the same rent for the last 10 years in a 25 year amortization period. We have applied the methodology for the maintenance costs.

Energy savings: Electricity and gas prices according to Eurostat (October, 2018). Average prices in Spain, period 2015-2017.
kWh to CO_2: Oficina Catalana del Canvi Climàtic; *Nota informativa sobre la metodología de estimación del mix eléctrico* (February 2018). Financial information updated in January 2019.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
10.268.189,00	33.886,00	2,193%	2,20%	25

Revenues Reported	Total	Per year
Municipality	6.727.486 €	269.099 €
Rent (25 years)	5.901.172 €	236.047 €
CISCO pays €3.540.703 for 15 years		
Maintenance (25 years)	578.893 €	23.156 €
CISCO pays €347.336 for 15 years		
Schneider Electric	600.000 €	24.000 €
Energy Savings	1.446.250 €	57.850 €
Total	15.253.801 €	**610.152 €**

Internal Rate of Return (IRR): 2.79%

Years	OPEX	Annual CAPEX	PV revenue
0	33.886,00 €	410.727,56 €	444.613,56 €
1	34.631,49 €	410.727,56 €	453.623,14 €
2	35.393,38 €	410.727,56 €	462.830,24 €
3	36.172,04 €	410.727,56 €	472.239,21 €
4	36.967,82 €	410.727,56 €	481.854,46 €
5	37.781,12 €	410.727,56 €	491.680,53 €
6	38.612,30 €	410.727,56 €	501.722,03 €
7	39.461,77 €	410.727,56 €	511.983,69 €
8	40.329,93 €	410.727,56 €	522.470,34 €
9	41.217,19 €	410.727,56 €	533.186,91 €
10	42.123,97 €	410.727,56 €	544.138,44 €
11	43.050,69 €	410.727,56 €	555.330,09 €
12	43.997,81 €	410.727,56 €	566.767,13 €
13	44.965,76 €	410.727,56 €	578.454,92 €
14	45.955,01 €	410.727,56 €	590.398,98 €
15	46.966,02 €	410.727,56 €	602.604,92 €
16	47.999,27 €	410.727,56 €	615.078,48 €
17	49.055,25 €	410.727,56 €	627.825,54 €
18	50.134,47 €	410.727,56 €	640.852,10 €
19	51.237,43 €	410.727,56 €	654.164,27 €
20	52.364,65 €	410.727,56 €	667.768,33 €
21	53.516,67 €	410.727,56 €	681.670,67 €
22	54.694,04 €	410.727,56 €	695.877,85 €
23	55.897,31 €	410.727,56 €	710.396,53 €
24	57.127,05 €	410.727,56 €	725.233,56 €
Total	594.546,29 €	10.268.189,00 €	14.332.765,93 €
Average	44.541,54 €	410.727,56 €	**573.310,64 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	10.268.189,00 €
Employment impact (FTE)	80
Output increase	9.755.036,25 €

- Retrofitting a former industrial site to house an innovation hub should be considered within the construction industry. However, part of the investment could be considered within the electricity, gas, steam and air conditioning industry, and yet another part within the repair and installation services of machinery and equipment industry. Without disaggregated investment data, this differentiation into separate industries is not possible.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €9,755,036.25.

Barcelona. Measures: 1.0; 1.1; 1.1.6; 1.1.9; 1.1.10.1; 1.1.10.2
Refurbishment of a Public Tertiary Building: Biblioteca Les Corts by Barcelona Municipality and IREC

Financially sustainable
Economically sustainable

This refurbishment project of a public library has been carried out using energy-efficient solutions in order to achieve important sustainability savings and reduce the environmental footprint of the building as much as possible. It is a complete retrofitting of a former factory for use as a public building.

Financial Analysis

Detailed Costs

CAPEX: €8,345,300 (all taxes included)

- Investment costs: €4,339,125
- Personnel costs: €1,528,555
- Other expenses: €725,106
- Taxes: €1,752,513

OPEX

- Maintenance costs: €27,753 per year.

Detailed Revenues

Through BIMSA, a public-owned agency for public infrastructure, the municipality has covered all the investment cost, and maintenance and energy costs for the project.

Savings as Revenues

- Energy savings: real financial savings due to lower energy bills are yet not possible to estimate.
- Using the estimations in the BEST table for Biblioteca Les Corts, the building would be able to provide approximately 325,526.5 kWh per year in energy savings.
- In monetary terms, the estimated energy savings would be €74,871 per year.

Financial Conclusion

- The project seems to be financially sustainable thanks to the public funds from the municipality covering the entire cost of the investment and thanks to the potential energy savings.
- Validating the financial sustainability of retrofitting an old industrial site for use as a public library is not the aim of this document. However, it would be worthwhile to compare the cost of a standard retrofitting project with the cost of applying additional energy-efficiency measures.
- Qualitative analysis: if this were not a public project, the average theoretical annual revenues the measure would need in order to reach a break-even would be €466,161.59. The building is far from demonstrating that amount of energy savings. In that case, a different revenue structure would most likely apply.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions

Job Creation

According to BIMSA (municipality), the project has employed 718 people, although not FTE.

According to the input-output methodology, from the investment made in this project, it is expected to create, directly and indirectly, 65 FTE jobs.

Positive Externalities as Economic Savings

- With an estimated 325,526.5 kWh of annual energy savings, and with an emission factor of 392 grams of CO_2 per kWh, the retrofitting project of the library could save 127.6 tons of per year (using the emissions factor for electricity).
- The savings in CO_2 would be translated into €7,656.38 per year.
- In 25 years, that would be a total of €191,409.58, assuming that the SCC remains the same.

Economic Conclusion

- As it is presented, the project seems to be economically sustainable, since it seems to be financially sustainable and it generates positive externalities.

Comments on Data and Methodology

Energy Savings: Electricity and gas prices according to Eurostat (October, 2018). Average prices in Spain, period 2015-2017.
kWh to CO_2: Oficina Catalana del Canvi Climàtic; *Nota informativa sobre la metodología de estimación del mix eléctrico* (February 2018). Financial information updated in January 2019.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
8.345.300,00	27.753,00	2,193%	2,20%	25

Revenues Reported	Total	Per year
Municipity	8.345.300 €	333.812 €
Energy Savings	1.871.777 €	74.871 €
Total	10.217.077 €	**408.683 €**
EU Grant (not received)	1 EUR per kWh of energy savings	

Internal Rate of Return (IRR): 1.04%

Years	OPEX	Annual CAPEX	PV revenue
0	27.753,00 €	333.812,00 €	361.565,00 €
1	28.363,57 €	333.812,00 €	368.887,40 €
2	28.987,56 €	333.812,00 €	376.370,33 €
3	29.625,29 €	333.812,00 €	384.017,33 €
4	30.277,05 €	333.812,00 €	391.831,98 €
5	30.943,14 €	333.812,00 €	399.817,97 €
6	31.623,89 €	333.812,00 €	407.979,05 €
7	32.319,62 €	333.812,00 €	416.319,06 €
8	33.030,65 €	333.812,00 €	424.841,92 €
9	33.757,32 €	333.812,00 €	433.551,65 €
10	34.499,98 €	333.812,00 €	442.452,34 €
11	35.258,98 €	333.812,00 €	451.548,18 €
12	36.034,68 €	333.812,00 €	460.843,46 €
13	36.827,44 €	333.812,00 €	470.342,53 €
14	37.637,65 €	333.812,00 €	480.049,88 €
15	38.465,68 €	333.812,00 €	489.970,07 €
16	39.311,92 €	333.812,00 €	500.107,77 €
17	40.176,78 €	333.812,00 €	510.467,74 €
18	41.060,67 €	333.812,00 €	521.054,87 €
19	41.964,01 €	333.812,00 €	531.874,13 €
20	42.887,22 €	333.812,00 €	542.930,62 €
21	43.830,73 €	333.812,00 €	554.229,54 €
22	44.795,01 €	333.812,00 €	565.776,19 €
23	45.780,50 €	333.812,00 €	577.576,03 €
24	46.787,67 €	333.812,00 €	589.634,59 €
Total	486.939,83 €	8.345.300,00 €	11.654.039,65 €
Average	36.480,00 €	333.812,00 €	**466.161,59 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	8.345.000,00 €
Employment impact (FTE)	65
Output increase	7.927.958,63 €

- Retrofitting a former industrial site to house a library should be considered within the construction industry. However, part of the investment could be considered within the electricity, gas, steam and air conditioning industry, and yet another part within the repair and installation services of machinery and equipment industry. Without disaggregated investment data, this differentiation into separate industries is not possible.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €7,927,958.63.

Barcelona. Measures: 1.0; 1.1.10.1
Refurbishment of a Public Residential Building – Passeig Santa Coloma (Big Blue) by Barcelona City Council and IREC

Financially sustainable
Economically sustainable

The municipality simultaneously implements the required structural renovation of a municipality-owned social housing building (Passeig Santa Coloma) and the energy retrofitting of that building (renovating a building using passive energy-efficiency measures) to increase both the security and the overall energy efficiency of the building. This leads to increased comfort inside the building and generates monetary savings for the residents (social housing).

Financial Analysis

Detailed Costs

CAPEX: €1,884,321 (all taxes included)

- Investment costs: €1,123,089
- Personnel costs related to investment: €761,232

OPEX:

- Maintenance costs: €1,000 per year

Detailed Revenues

Total revenues

- Payments by users (private): no rent increases considered
- Public funding (municipality): €1,889,321(including maintenance costs for the first four years)

Savings as Revenues

- According to IREC, the energy efficiency measures saved 168,236 kWh of gas per year.
- The estimated energy savings are €11,061 per year, approximately (€276,523.46 in 25 years), assuming the price of energy remains constant.
- Tenants capitalize the energy savings.

Financial Conclusion

Considering the public funds as a revenue plus the expected energy savings, the project seems to be financially sustainable. The public sector assumes all costs of investment.

However, from the investor's point of view, the measure does not seem to be financially sustainable as it is presented. In that sense, the investor, the municipality, does not capture the direct benefits of the project – i.e., energy savings in the monthly bill. In addition, there is no increase in the rent for the tenants.

The energy savings are noticeably inferior to the theoretical annual revenues that, on average, the project should have in a 25-year period. In that case, the theoretical revenues are €99,985.80, which represent €88,925 more than the expected annual energy savings of €11,061.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions

Job Creation

According to IREC, the project has employed 30 people (FTE).

From a theoretical perspective, using the Input-Output methodology, for the investment required in the refurbishment of this public residential building, the estimated employment impact of the measure is 15 jobs (FTE).

Positive Externalities as Economic Savings

- The building should be able to demonstrate energy savings through the implementation of active and passive energy-efficient measures.
- With an estimated 168,236 kWh of annual energy savings, and with an emission factor of 252 grams of CO_2 per kWh, the retrofitting project of Passeig Santa Coloma could save 42.4 tons of CO_2 to the atmosphere, per year.
- In monetary terms, considering €60 per ton as the Social Cost of Carbon (SCC), the savings in CO_2 would be translated as approximately €2,544 per year.
- In 25 years, that would be a total of €63,593.21 assuming that the SCC remains constant.

Economic Conclusion

Accounting for the CO_2 savings (€2,544), the positive externalities are far below the public investment. If public investment where not considered part of the revenues but as a grant, the project would not seem to be economically sustainable if only CO_2 savings are considered as positive externalities.

Comments on Data and Methodology

Financial and economic information updated in June 2019.

Emission factors: Proposed CO_2 factors have been obtained from the latest applicable CO_2 factors published by the Ministry of Energy of Spain. Source: report "FACTORES DE EMISIÓN DE CO_2 y COEFICIENTES DE PASO A ENERGÍA PRIMARIA DE DIFERENTES"
https://energia.gob.es/desarrollo/EficienciaEnergetica/RITE/Reconocidos/Reconocidos/Otros%20documentos/Factores_emision_CO2.pdf

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
1.884.320,57	1.000,00	2,193%	2,20%	25

Revenues Reported	Total	Per year
Municipality (BIMSA)	1.889.321 €	75.573 €
Energy Savings	713.026 €	28.521 €
Total	2.602.347 €	**104.094 €**
EU Grant (not received)	1 EUR per kWh of energy savings	

Internal Rate of Return (IRR): 2.57%

Years	OPEX	Annual CAPEX	PV revenue
0	1.000,00 €	75.372,82 €	76.372,82 €
1	1.022,00 €	75.372,82 €	78.025,82 €
2	1.044,48 €	75.372,82 €	79.715,06 €
3	1.067,46 €	75.372,82 €	81.441,35 €
4	1.090,95 €	75.372,82 €	83.205,49 €
5	1.114,95 €	75.372,82 €	85.008,32 €
6	1.139,48 €	75.372,82 €	86.850,68 €
7	1.164,54 €	75.372,82 €	88.733,45 €
8	1.190,16 €	75.372,82 €	90.657,50 €
9	1.216,35 €	75.372,82 €	92.623,75 €
10	1.243,11 €	75.372,82 €	94.633,11 €
11	1.270,46 €	75.372,82 €	96.686,54 €
12	1.298,41 €	75.372,82 €	98.784,99 €
13	1.326,97 €	75.372,82 €	100.929,47 €
14	1.356,17 €	75.372,82 €	103.120,97 €
15	1.386,00 €	75.372,82 €	105.360,53 €
16	1.416,49 €	75.372,82 €	107.649,21 €
17	1.447,66 €	75.372,82 €	109.988,07 €
18	1.479,50 €	75.372,82 €	112.378,22 €
19	1.512,05 €	75.372,82 €	114.820,78 €
20	1.545,32 €	75.372,82 €	117.316,91 €
21	1.579,32 €	75.372,82 €	119.867,78 €
22	1.614,06 €	75.372,82 €	122.474,59 €
23	1.649,57 €	75.372,82 €	125.138,56 €
24	1.685,86 €	75.372,82 €	127.860,96 €
Total	17.545,48 €	1.884.320,57 €	2.499.644,92 €
Average	1.314,45 €	75.372,82 €	**99.985,80 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	1.884.320,57 €
Employment impact (FTE)	15
Output increase	1.784.836,24 €

- The investment costs defined as "building works" have been categorized within the construction and construction works industry.
- The investment costs defined as "monitoring installation" have been categorized within the repair and installation services of machinery and equipment industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €1,784,836.24.

Cologne. Measure: 1.1
Energy-Efficient Refurbishment of a Public Residential Building – Stegerwaldsiedlung by DEWOG

Financially sustainable
Economically sustainable

This building refurbishment project consists of implementing passive energy-efficiency measures in 16 residential buildings with the aim of reducing energy costs and reducing the harmful impact on the environment.

Financial Analysis

Detailed Costs

Dewog has provided data for the investment costs, which include the personnel costs related to investment.
CAPEX (DEWOG): €10,031,897 (all taxes included)

- Investment costs: €8,430,166
- Taxes related to investment: €1,601,731

OPEX (RheinEnergie): €101,564.37 per year

Detailed Revenues

According to the industry partner, rent increases are limited by political restrictions. However, rents have been marginally increased after modernizing the buildings (phase 3 buildings not included):
€114,670/year for phase 1 buildings
€290,883.36 for phase 2 buildings

Savings as Revenues

Real energy savings (data provided by RheinEnergie): Comparing energy consumption of gas and electricity from 2018 to figures from 2015.

- Electricity savings: (data received for all buildings): increase in consumption in 35,606 kWh but achieving energy savings through PV generated electricity: €53,272.34
- District heating: increase in consumption is 2,716,275 kWh. (€124,948.65)
- Gas savings: 4,002,516 kWh (€259,939.40 in savings).

Financial Conclusion

The actual energy savings seem to be greater than the estimated savings from the BEST tables.
The measure seems to be financially sustainable, since the theoretical annual average revenues that the project should have, €552,560.58, are lower than the real revenues, €593.817, obtained by increasing rents and through energy savings.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

In the GrowSmarter context, considering the investment required for this energy-efficient refurbishment project, the expected employment impact of the measure is 74 FTE jobs according to the Input-Output methodology.

Positive Externalities as Economic Savings

- According to the industry partner, compared to 2015, in 2018 the estimated amount of CO_2 savings achieved thanks to the Growsmarter related solutions for this project are 775.16 tons per year. That would equal to €46,509.43

  The project has received an EU grant of €468,230 accounted as a subvention.

Economic Conclusion

The project is considered as economically sustainable because it seems financially feasible, and it seems to generate positive externalities in the form of CO_2 savings.

The EU grant seems to be unnecessary both to financially sustain the project and to internalize positive externalities.

Comments on Data and Methodology

The measure seems to achieve great energy savings through reducing gas consumption. However, since the supply is ensured through the district heating connection, the emissions derived from the district heating should be accounted for in this measure. Data in that regard has not been available for this analysis. Financial data has been updated in April 2019. Energy savings information has been updated by Rheinenergie in October 2019.
Energy prices updated by Rheinenergie in July 2019:
Energy price for the heat pumps: 4.653 ct per kWh; VAT: 19%; Electricity prices: 22 ct/kWh net (26.36 ct per kWh gross). Gas price: €18.04 per JG.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
10.031.897,23	101.564,37	0,795%	1,50%	25

Revenues Reported	Total	Per year
Rent increases (construction phase 1)	2.866.740 €	114.670 €
Rent increases (construction phase 2)	7.272.084 €	290.883,36 €
Energy Savings	4.706.594 €	188.264 €
Total	14.845.418 €	**593.817 €**

Years	OPEX	Annual CAPEX	PV revenue
0	101.564,37 €	401.275,89 €	502.840,26 €
1	103.087,84 €	401.275,89 €	506.740,78 €
2	104.634,15 €	401.275,89 €	510.671,64 €
3	106.203,67 €	401.275,89 €	514.633,06 €
4	107.796,72 €	401.275,89 €	518.625,29 €
5	109.413,67 €	401.275,89 €	522.648,56 €
6	111.054,88 €	401.275,89 €	526.703,12 €
7	112.720,70 €	401.275,89 €	530.789,21 €
8	114.411,51 €	401.275,89 €	534.907,07 €
9	116.127,68 €	401.275,89 €	539.056,96 €
10	117.869,60 €	401.275,89 €	543.239,13 €
11	119.637,64 €	401.275,89 €	547.453,82 €
12	121.432,21 €	401.275,89 €	551.701,28 €
13	123.253,69 €	401.275,89 €	555.981,79 €
14	125.102,49 €	401.275,89 €	560.295,58 €
15	126.979,03 €	401.275,89 €	564.642,93 €
16	128.883,72 €	401.275,89 €	569.024,09 €
17	130.816,97 €	401.275,89 €	573.439,32 €
18	132.779,23 €	401.275,89 €	577.888,90 €
19	134.770,92 €	401.275,89 €	582.373,09 €
20	136.792,48 €	401.275,89 €	586.892,16 €
21	138.844,37 €	401.275,89 €	591.446,38 €
22	140.927,03 €	401.275,89 €	596.036,02 €
23	143.040,94 €	401.275,89 €	600.661,37 €
24	145.186,55 €	401.275,89 €	605.322,69 €
Total	1.694.310,81 €	10.031.897,23 €	13.814.014,49 €
Average	122.133,28 €	401.275,89 €	**552.560,58 €**

Internal Rate of Return (IRR): 1.64%

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	10.031.897,23 €
Employment impact (FTE)	74
Output increase	9.982.398,26 €

- The investment costs for the “isolation and windows” have been categorized within the construction and construction works industry.
- The investment costs for “energy-efficient elevators” have been categorized within the repair and installation services of machinery and equipment industry.
- The investment costs for “heating and smart efficient lighting (LED)” have been categorized within the electricity, gas, steam and air conditioning industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €9,982,398.26 approximately.

Improving the Business Model

Rent increases are lower than the theoretical revenues for reaching a break-even. However, the business model seems to be sustainable overall, since energy savings are significantly important. However, from a financial point of view, the revenue structure could take into account who pays the cost of the solution and who benefits from it: that is, tenants capitalize the energy savings, while the cost of the solution is paid by the owner, who receives less (from rent increases) than what he/she pays. In that regard, the cost structure could be adjusted to this circumstance in order to improve. In addition, free-riders who benefit from the solution (the city and the Federal Republic of Germany) could contribute to the implementation of the solution, since positive externalities (in CO_2 savings) are important as well.

Stockholm. Measure: 1.1 (1.1.1; 1.1.2; 1.1.3; 1.1.4; 1.1.5; 1.1.9)
Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 6) by Skanska

Financially sustainable
Economically sustainable

The project consists of implementing a series of energy-efficiency measures and a home energy management system

Financial Analysis

Detailed Costs

- CAPEX: €712,965
  - Investment costs: €447,263
  - Personnel costs related to investment: €132,273
  - Taxes: €133,428

Detailed Revenues

The project has been funded by Skanska and it has received an EU grant of €317,952 (accounted as a revenue).

Savings as Revenues

The following savings are based on incomplete and preliminary measurements:

Energy savings: €33,366 per year.

Financial Conclusion

The project is financially sustainable, since real revenues (€33,366 + an average EU grant of €12,718 per year) are greater than the minimum theoretical revenues for reaching a financial break-even (€33,557.59).

Without the EU grant, the project would be almost financially sustainable (since theoretical revenues would only be €191.68 greater than the real ones).

In addition, a real increase in the value of the property should be considered, as highlighted in the financial evaluation for the whole Valla Torg project.

In addition, a real increase of the value of the property should be considered.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

In the GrowSmarter context, considering the investment required for this refurbishment project with energy-efficiency measures, the expected employment impact of the measure is 4 jobs (FTE) according to the Input-Output methodology.

Positive Externalities as Economic Savings

The following savings are based on incomplete and preliminary measurements:

- Savings in CO_2 from building 6: 48 tons or €2,898 per year.

Economic Conclusion

The project is economically sustainable as it is financially sustainable and, in addition, internalizes positive externalities in the form of CO_2 savings.

The EU grant does not seem to be necessary for this particular building.

Comments on Data and Methodology

Financial information received and updated in June 2019.
Energy savings were presented by Skanska to IESE in monetary figures.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
712.964,60	0,00	1,327%	1,50%	25

Revenues Reported	Total	Per year
Payments by users	0 €	0 €
Energy Savings	834.148 €	33.366 €
Total	**834.148 €**	**33.366 €**
EU Grant	317.952 €	12.718 €

Internal Rate of Return (IRR): 1.25%

Years	OPEX	Annual CAPEX	PV revenue
0	- €	28.518,58 €	28.518,58 €
1	- €	28.518,58 €	28.897,03 €
2	- €	28.518,58 €	29.280,49 €
3	- €	28.518,58 €	29.669,04 €
4	- €	28.518,58 €	30.062,75 €
5	- €	28.518,58 €	30.461,68 €
6	- €	28.518,58 €	30.865,91 €
7	- €	28.518,58 €	31.275,50 €
8	- €	28.518,58 €	31.690,52 €
9	- €	28.518,58 €	32.111,06 €
10	- €	28.518,58 €	32.537,17 €
11	- €	28.518,58 €	32.968,94 €
12	- €	28.518,58 €	33.406,44 €
13	- €	28.518,58 €	33.849,74 €
14	- €	28.518,58 €	34.298,93 €
15	- €	28.518,58 €	34.754,07 €
16	- €	28.518,58 €	35.215,26 €
17	- €	28.518,58 €	35.682,57 €
18	- €	28.518,58 €	36.156,08 €
19	- €	28.518,58 €	36.635,87 €
20	- €	28.518,58 €	37.122,02 €
21	- €	28.518,58 €	37.614,63 €
22	- €	28.518,58 €	38.113,78 €
23	- €	28.518,58 €	38.619,55 €
24	- €	28.518,58 €	39.132,03 €
Total	- €	712.964,60 €	838.939,64 €
Average	0,00 €	28.518,58 €	**33.557,59 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	712.964,60 €
Employment impact (FTE)	3,83
Output increase	424.384,21 €

- The investment costs for measure 1.1.1 have been categorized within the construction and construction works industry.
- The investment costs measures 1.1.2, 1.1.3 and 1.1.4, have been categorized within the repair and installation services of machinery and equipment industry.
- The investment costs for measures 1.1.5 and 1.1.9 have been categorized within the electricity, gas, steam and air conditioning industry.

The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €424,384.21 approximately.

Stockholm. Measure: 1.1 (1.1.1; 1.1.2; 1.1.3; 1.1.4; 1.1.5; 1.1.9)
Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 7) by Skanska

Financially sustainable
Economically sustainable

The project consists of implementing a series of energy-efficiency measures and a home energy management system to decrease the overall consumption levels of a residential building at Valla Torg and capture savings for the people living there.

Financial Analysis

Detailed Costs

- CAPEX: €741,344
  - Investment costs: €462,199
  - Personnel costs related to investment: €140,641
  - Taxes: €1138,504

Detailed Revenues

The project has been funded by Skanska and it has received an EU grant of €357,760 (accounted as a revenue).

Savings as Revenues

The following savings are based on incomplete and preliminary measurements (data validated by KTH (D.5.4):

Energy savings: €33,953 per year.

Financial Conclusion

The project is financially sustainable, since real revenues (€33,953 + an average EU grant of €14,310 per year) are greater than the minimum theoretical revenues for reaching a financial break-even (€34,893.35).

Without the EU grant, the project would be almost financially sustainable (since theoretical revenues would be €940.81 greater than the real ones).

In addition, a real increase in the value of the property should be considered.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

In the GrowSmarter context, considering the investment required for this refurbishment project with energy-efficiency measures, the expected employment impact of the measure is 4 jobs (FTE) according to the Input-Output methodology.

Positive Externalities as Economic Savings

The following savings are based on incomplete and preliminary measurements (data validated by KTH (D.5.4):

Savings in CO_2 from building 6: 37.6 tones or €2,256 per year (€56,400 in 25 years).

Economic Conclusion

The project is economically sustainable as it is financially sustainable and, in addition, internalizes positive externalities in the form of CO_2 savings.

The EU grant does not seem to be necessary. However, it should help to internalize positive externalities and to ensure the financial sustainability of the project for building 7. Nonetheless, the EU grant could be significantly reduced to only €940.81 in order to internalize positive externalities in the form of CO_2 savings.

Comments on Data and Methodology

Financial information received and updated in June 2019.
Energy savings were presented by Skanska to IESE in monetary figures.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
741.344,15	0,00	1,327%	1,50%	25

Revenues Reported	Total	Per year
Payments by users	0 €	0 €
Energy Savings	848.813 €	33.953 €
Total	**848.813 €**	**33.953 €**
EU Grant	357.760 €	14.310 €

Internal Rate of Return (IRR): 1.07%

Years	OPEX	Annual CAPEX	PV revenue
0	- €	29.653,77 €	29.653,77 €
1	- €	29.653,77 €	30.047,27 €
2	- €	29.653,77 €	30.446,00 €
3	- €	29.653,77 €	30.850,02 €
4	- €	29.653,77 €	31.259,40 €
5	- €	29.653,77 €	31.674,21 €
6	- €	29.653,77 €	32.094,53 €
7	- €	29.653,77 €	32.520,42 €
8	- €	29.653,77 €	32.951,97 €
9	- €	29.653,77 €	33.389,24 €
10	- €	29.653,77 €	33.832,31 €
11	- €	29.653,77 €	34.281,27 €
12	- €	29.653,77 €	34.736,18 €
13	- €	29.653,77 €	35.197,13 €
14	- €	29.653,77 €	35.664,20 €
15	- €	29.653,77 €	36.137,46 €
16	- €	29.653,77 €	36.617,00 €
17	- €	29.653,77 €	37.102,91 €
18	- €	29.653,77 €	37.595,27 €
19	- €	29.653,77 €	38.094,16 €
20	- €	29.653,77 €	38.599,67 €
21	- €	29.653,77 €	39.111,88 €
22	- €	29.653,77 €	39.630,90 €
23	- €	29.653,77 €	40.156,80 €
24	- €	29.653,77 €	40.689,68 €
Total	- €	741.344,15 €	872.333,63 €
Average	0,00 €	29.653,77 €	**34.893,35 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	741.344,15 €
Employment impact (FTE)	4,04
Output increase	443.922,72 €

- The investment costs for measure 1.1.1 have been categorized within the construction and construction works industry.
- The investment costs for measures 1.1.2, 1.1.3 and 1.1.4, have been categorized within the repair and installation services of machinery and equipment industry.
- The investment costs for measures 1.1.5 and 1.1.9 have been categorized within the electricity, gas, steam and air conditioning industry.

The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €443,922.72 approximately.

Stockholm. Measure: 1.1 (1.1.1; 1.1.2; 1.1.4; 1.1.5; 1.1.9) Energy-Efficient Refurbishment Project of a Public Residential Building (Hus 8) by Skanska

Financially sustainable
Economically sustainable

The project consists of implementing a series of energy-efficiency measures and a home energy management system to decrease the overall consumption levels of a residential building at Valla Torg and capture savings for the people living there.

Financial Analysis

Detailed Costs

- CAPEX: €588,065
  - Investment costs: €371,677
  - Personnel costs related to investment: €106,261
  - Taxes: €110,127

Detailed Revenues

The project has been funded by Skanska and it has received an EU grant of €255,296 (accounted as a revenue).

Savings as Revenues

The following savings are based on incomplete and preliminary measurements:

Energy savings: €25,593 per year (€639,813 over 25 years)

Financial Conclusion

The project is financially sustainable, since real revenues (€25,593 + an average EU grant of €10,212 per year) are greater than the minimum theoretical revenues for reaching a financial break-even (€27,678.86).

Without the EU grant, the project would be almost financially sustainable (since theoretical revenues would only be €2,086.33 greater than the real ones).

In addition, a real increase in the value of the property should be considered, as highlighted in the financial evaluation for the whole Valla Torg project.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

In the GrowSmarter context, considering the investment required for this refurbishment project with energy-efficiency measures, the expected employment impact of the measure is 3 jobs (FTE) according to the Input-Output methodology.

Positive Externalities as Economic Savings

The following savings are based on incomplete and preliminary measurements:

Savings in CO_2 from building 6: 32.2 tons or €1,932 per year (€48,300 in 25 years).

Economic Conclusion

The project is economically sustainable as it is financially sustainable and, in addition, internalizes positive externalities in the form of CO_2 savings.

The EU grant does not seem to be necessary. However, it should help to internalize positive externalities and to ensure the financial sustainability of the project for building 7. Nonetheless, the EU grant could be significantly reduced to only €2,086.33 in order to internalize positive externalities in the form of CO_2 savings.

Comments on Data and Methodology

Financial information received and updated in June 2019.
Energy savings were presented by Skanska to IESE in monetary figures.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
588.065,22	0,00	1,327%	1,50%	25

Revenues Reported	Total	Per year
Payments by users	0 €	0 €
Energy Savings	639.813 €	25.593 €
Total	**639.813 €**	**25.593 €**
EU Grant	255.296 €	10.212 €

Internal Rate of Return (IRR): 2.89%

Years	OPEX	Annual CAPEX	PV revenue
0	- €	23.522,61 €	23.522,61 €
1	- €	23.522,61 €	23.834,75 €
2	- €	23.522,61 €	24.151,04 €
3	- €	23.522,61 €	24.471,53 €
4	- €	23.522,61 €	24.796,26 €
5	- €	23.522,61 €	25.125,31 €
6	- €	23.522,61 €	25.458,72 €
7	- €	23.522,61 €	25.796,56 €
8	- €	23.522,61 €	26.138,88 €
9	- €	23.522,61 €	26.485,74 €
10	- €	23.522,61 €	26.837,21 €
11	- €	23.522,61 €	27.193,34 €
12	- €	23.522,61 €	27.554,19 €
13	- €	23.522,61 €	27.919,84 €
14	- €	23.522,61 €	28.290,33 €
15	- €	23.522,61 €	28.665,75 €
16	- €	23.522,61 €	29.046,14 €
17	- €	23.522,61 €	29.431,58 €
18	- €	23.522,61 €	29.822,14 €
19	- €	23.522,61 €	30.217,88 €
20	- €	23.522,61 €	30.618,87 €
21	- €	23.522,61 €	31.025,18 €
22	- €	23.522,61 €	31.436,89 €
23	- €	23.522,61 €	31.854,06 €
24	- €	23.522,61 €	32.276,76 €
Total	- €	588.065,22 €	691.971,57 €
Average	0,00 €	23.522,61 €	**27.678,86 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	588.065,22 €
Employment impact (FTE)	3,07
Output increase	344.353,05 €

- The investment costs for measure 1.1.1 have been categorized within the construction and construction works industry.
- The investment costs for measures 1.1.2 and 1.1.4, have been categorized within the repair and installation services of machinery and equipment industry.
- The investment costs for measures 1.1.5 and 1.1.9 have been categorized within the electricity, gas, steam and air conditioning industry.

The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €344,353.05 approximately.

Stockholm. Measures: 1.1.6; 3.1; 4.1 Implementation of Energy-Efficient solutions in a Private Residential Condominium (Brf Årstakrönet) by L&T

Financially unsustainable
Almost economically sustainable

The project consists of implementing a series of energy-efficiency measures and a home energy management system to decrease the overall consumption levels of a private residential condominium, in order to make it more environmentally sustainable.

Financial Analysis

Detailed Costs

CAPEX: €174,812

- Investment costs: €75,340.70
- Personnel costs related to investment: €78,053.80
- Taxes: €21,418

OPEX: €9,808.75

- Personnel costs: €8,808.75
- Maintenance costs: €209
- License fee: €730

Detailed Revenues

Private financing: €7,826 in total (average of €522 per year).

Savings as Revenues

Energy savings: according to the industry partner, the energy savings derived from the different energy-efficient measures implemented are approximately €9,615. In 15 years, that would equal €144,232.
Savings through the district heating: 61,409 kWh.
Savings in electricity consumption: 22,000 kWh, approx.
Savings in water: 349,000 kWh, approx.

Financial Conclusion

The implementation of measures 1.1.6, 3.1 and 4.1 in the condominium does not seem to be financially sustainable.

- Hypothetical annual average revenues to reach a positive financial net present value would be €17,607.91.
- With €10,137.23 of actual average revenues, the reported annual revenues, including energy savings, are lower than the hypothetical revenues.
- The negative gap is approximately €7,471.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions

Job Creation

- According to the industry partner, the project at the condominium has created 6 jobs FTE approximately.
- According to the Input-Output methodology, the investment is expected to create 1 FTE job.

Positive Externalities as Economic Savings

The projects seems to generate 432,409 kWh in energy savings.
That would equal 16.43 tons in CO_2 savings.

- In monetary terms, considering €60 per ton as the Social Cost of Carbon (SCC), the savings in CO_2 would be translated as €5,711.46 per year, approximately.
- In 25 years, that would give a total of €142,787, assuming that the SCC remains constant.
- No EU grant was reported by the industry partner.

Economic Conclusion

The project seems to be almost economically sustainable, since the gap between real revenues and theoretical revenues is reduced to approximately €1,760.
In that regard, it would be recommendable to encourage the public sector to partially fund the project in order to overcome the gap and to internalize positive externalities in the form of CO_2 savings.

Comments on Data and Methodology

Swedish krona (SEK) to euros (€): https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-sek.en.html# (Average exchange rate from February 18, 2014 to February 19, 2019.) (Financial information received in February 2019.)

- Sources: CoM Default Emission Factors for the Member States of the European Union. Dataset Version 2017. Authors: Koffi, B., Cerutti, A., Duerr, M., Iancu, A., Kona, A., Janssens-Maenhout, G.http://cidportal.jrc.ec.europa.eu/ftp/jrc-opendata/COM-EF/dataset/comw/JRC-CoM-EF-CoMW-EF-2017.pdf

(Financial data was updated in February 2019.)

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
174.812,34	9.808,90	1,327%	1,50%	15

Revenues Reported	Total	Per year
Private Financing	7.826 €	522 €
Energy Savings	144.232 €	9.615 €
Total	152.058 €	**10.137 €**

Internal Rate of Return (IRR): -16.41%

Years	OPEX	Annual CAPEX	PV revenue
0	9.808,90 €	6.992,49 €	16.801,39 €
1	9.956,03 €	6.992,49 €	16.910,93 €
2	10.105,37 €	6.992,49 €	17.021,73 €
3	10.256,95 €	6.992,49 €	17.133,80 €
4	10.410,81 €	6.992,49 €	17.247,17 €
5	10.566,97 €	6.992,49 €	17.361,85 €
6	10.725,48 €	6.992,49 €	17.477,85 €
7	10.886,36 €	6.992,49 €	17.595,20 €
8	11.049,65 €	6.992,49 €	17.713,90 €
9	11.215,40 €	6.992,49 €	17.833,99 €
10	11.383,63 €	6.992,49 €	17.955,48 €
11	11.554,38 €	6.992,49 €	18.078,38 €
12	11.727,70 €	6.992,49 €	18.202,71 €
13	11.903,61 €	6.992,49 €	18.328,50 €
14	12.082,17 €	6.992,49 €	18.455,76 €
Total	163.633,42 €	104.887,40 €	264.118,65 €
Average	10.908,89 €	6.992,49 €	**17.607,91 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	174.812,34 €
Employment impact (FTE)	1
Output increase	100.624,86 €

- The investment costs accounted as "energy study, temperature sensors, energy saving center, thermographic control, tightness check" have been categorized within the architectural and engineering services; technical testing and analysis services industry.
- The investment costs accounted as "adaptive control system for heating" have been categorized within the architectural and engineering services; technical testing and analysis services industry.
- The investment costs accounted as "PV" have been categorized within the architectural and engineering services; technical testing and analysis services industry.
- The investment costs accounted as "water saving equipment" have been categorized within the repair and installation services of machinery and equipment.
- The investment costs accounted as "EnergyHUB" and "smart ventilation control" have been categorized within the computer programming, consultancy and related services and Information services industry.
- The investment costs accounted as "batteries" have been categorized within the electrical equipment industry.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €100,624.86.

Stockholm. Measure: 1
Refurbishment of a Public Tertiary Building – Slakthusomradet by Municipality of Stockholm and L&T

Almost Financially Sustainable
Almost Economically sustainable

Refurbishment project for an office building incorporating energy-efficient measures. The project includes measures implemented by L&T: the Energy Quality Control (1.1.7), the Energy Saving Center (3.1.1), and the Energy Hub (4.1). The investment reported here only relates to the implementation of energy-efficient measures.

Financial Analysis

Detailed Costs

CAPEX: €645,656

- Investment costs: €550,945; 85.33%
- Personnel costs related to investment: €59,518; 9.22%
- Other expenses related to investment: €35,193; 5.45%

Detailed Revenues

The revenues of the measure are structured as follows:

- Payments by users: €127,888
- Public funds (considered as revenue):
  - EU grant: €137,180

Savings as Revenues

- According to the industry partner, the implementation of active and passive energy-efficient measures seem to have a direct positive impact in the final energy consumption and therefore in the energy bills.
- According to KTH, the energy savings achieved in one year (2017-2018) have been of 271,000 kWh.
- According to the industry partner, the energy savings represent €16,590 in one year.

Financial Conclusion

- The estimated theoretical annual revenues that the project should have, on average, considering a 25-year period, are approximately €30,389.52.
- From the investor's point of view, the project seems to be financially unsustainable, since the real annual revenues of €21,706, achieved thanks to energy savings (€16,590) and through the average annual payment from users (€5,116) are €8,684 lower than the theoretical revenues for reaching a break-even point.
- However, considering public funds as revenues (€5,487 per year), the project is almost financially sustainable, reducing the financial gap between operational revenues and the theoretical ones to €3,197.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

- However, other positive externalities should be taken into account, including the expected implicit increase in the value of the property, values that have not been considered in the analysis due to lack of data.

Job Creation

According to the input-output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 5 FTE jobs.

Positive Externalities as Economic Savings

- According to the available technical data, the building is now emitting less CO_2 emissions, with a 59% reduction, approximately. That is a reduction of 26 tons of CO_2.
- The savings in CO_2 equal €1,581 per year.
- In 25 years, that would be a total of €39,537, approximately, assuming that the SCC remains the same.
- EU grant: €137,180. With €39,537 in positive externalities, the EU grant seems to be too big.

Economic Conclusion

Without considering public funds as revenues:

- Adding CO_2 emissions to the revenues, the financial gap between the average theoretical revenues and real revenues is reduced to €7,100 approximately.
- The measure seems to be economically unsustainable because the gap between the theoretical revenues and the real ones is not overcome by the positive externalities accounted for in this analysis.
- Assuming an EU grant equal to the positive externalities, the gap would be reduced to €5,500 approximately.

Considering public funds as revenues (Stockholm's case): the project is almost economically sustainable, reducing the financial negative gap to only €1,616, approximately.

Comments on Data and Methodology

- Since public funds are considered as revenues, because the client is the public sector, the measure seems to be almost financially sustainable and therefore economically sustainable, as it seems to generate positive externalities and no negative ones. However, from the investor's point of view, it seems to be unsustainable, since the project depends on public funds.
- Energy savings and CO_2 savings: *Appendix 3_Environmental impact_Slakthus 8.pdf; GrowSmarter's* ProjectPlace; Fortum, KTH. (Financial information updated in February 2019.)

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
645.655,84	0,00	1,327%	1,50%	25

Revenues Reported	Total	Per year
Payments by users	127.888 €	5.116 €
Energy Savings	364.980 €	16.590 €
Total	**492.868 €**	**21.706 €**
EU Grant	137.180 €	5.487 €

Years	OPEX	Annual CAPEX	PV revenue
0	- €	25.826,23 €	25.826,23 €
1	- €	25.826,23 €	26.168,95 €
2	- €	25.826,23 €	26.516,21 €
3	- €	25.826,23 €	26.868,08 €
4	- €	25.826,23 €	27.224,62 €
5	- €	25.826,23 €	27.585,89 €
6	- €	25.826,23 €	27.951,95 €
7	- €	25.826,23 €	28.322,88 €
8	- €	25.826,23 €	28.698,72 €
9	- €	25.826,23 €	29.079,55 €
10	- €	25.826,23 €	29.465,44 €
11	- €	25.826,23 €	29.856,45 €
12	- €	25.826,23 €	30.252,64 €
13	- €	25.826,23 €	30.654,09 €
14	- €	25.826,23 €	31.060,87 €
15	- €	25.826,23 €	31.473,05 €
16	- €	25.826,23 €	31.890,70 €
17	- €	25.826,23 €	32.313,89 €
18	- €	25.826,23 €	32.742,69 €
19	- €	25.826,23 €	33.177,19 €
20	- €	25.826,23 €	33.617,45 €
21	- €	25.826,23 €	34.063,55 €
22	- €	25.826,23 €	34.515,58 €
23	- €	25.826,23 €	34.973,60 €
24	- €	25.826,23 €	35.437,70 €
Total	- €	645.655,84 €	759.737,98 €
Average	0,00 €	25.826,23 €	**30.389,52 €**

Internal Rate of Return (IRR): -1.17%

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	645.655,84 €
Employment impact (FTE)	5
Output increase	436.885,61 €

- The implementation of energy-efficient measures at Slakthusomradet might be considered within the construction Industry. However, part of the investment could be considered within the architectural and engineering services, and yet another part within the repair and installation services of machinery and equipment industry or in the electricity, gas, steam and air conditioning industry, because of the installation of photovoltaics and other equipment. However, without disaggregated investment data, it is impossible to make that differentiation, although it is possible to provide an estimation of the expected output.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €436,885.61.

GrowSmarter
Transforming cities for a smart, sustainable Europe

Stockholm. Measure: 1
Refurbishment of a Public Tertiary Building – Kylhuset by Municipality of Stockholm and L&T

Financially sustainable
Economically sustainable

Refurbishment project for an office building incorporating energy-efficient measures. The project includes measures implemented by L&T: the Energy Saving Centre (3.1.1), and the Energy Hub (4.1). The investment reported here only relates to the implementation of energy-efficient measures.

Financial Analysis

Detailed Costs

CAPEX: €446,89.65 (all taxes included)

Detailed Revenues

- Increase in rents related to heating and cooling innovations: according to the industry partner, no rent increases have been charged to tenants.
- Public funds (considered as revenue):
  - EU grant of €169,045 (€6,762 per year on average).

Savings as Revenues

- Compared to 2016, in 2018 the A building saved according to the most recent appendix 1: 356,140 kWh – 243,036 kWh =113,104 kWh in heat (DH) consumption. That would represent €6,892.09 in financial savings (before taxes).
- Compared to 2016, in 2018 the A building saved 15,000 kWh in electricity consumption. That would represent €1,502.64 in financial savings (before taxes).
- In addition, it is estimated to save 12,000 kWh per year, approximately, through PV cells. That would be €3,598 in energy savings per year.

The total energy savings from 2016 to 2018 for the A building, have been €14,991 a year, approximately, including taxes.

Financial Conclusion

Considering public funds as revenues, the measure seems to be financially sustainable.

The theoretical annual revenues that the project should have on average for reaching a break-even (€21,015.23) are lower than the actual revenues (€21,753).

Economic Analysis

Positive Externalities

Reduction in CO_2 savings.

Job Creation

In the GrowSmarter context, with the amount of investment required for the implementation of energy-efficient measures at Kylhuset, the expected employment impact of the project is 2.18 people employed (FTE), according to the Input-Output methodology.

Positive Externalities as Economic Savings

- According to the available technical data (2016-2019), the building is now emitting less CO_2 emissions:
  - Heat: 10,521 kg of CO_2 savings
  - Electricity: 944 kg of CO2 savings
  - Solar electricity: 395 kg of CO2 savings

  That would be a total of 11.86 tons of CO_2 per year
- Taking this numbers, that would represent €711.6 per year in positive externalities.
- In 25 years, the estimated CO_2 savings would represent a total of €17,790, approximately, assuming that the SCC remains the same.
- The project has received an EU grant of €169,045.

Economic Conclusion

The project seems to be economically sustainable, since the positive externalities seem to be enough in order to reach a break-even:

Energy Savings + EU grant + Positive externalities = €21,284
Theoretical NP value revenues for reaching a break-even = €21,015.23

Comments on Data and Methodology

This project can be considered as financially unsustainable as it is presented now. However, it could be argued that the value of the property could increase because of the implementation of energy-efficient measures. In addition, other positive externalities, aside from the reduction in CO_2 emissions, could be considered.
The project has not contemplated an increase in rents derived from the implementation of energy-efficient measures. This would be an option to consider for the revenue structure of the project, in order to financially sustain it and therefore be able to replicate it in other places.

Comments on Data and Methodology (continuation)

Energy savings and CO_2 savings: *Appendix 03_Environmental impact_Kylhuset_ver1.pdf; GrowSmarter's* ProjectPlace; Fortum, KTH. (Financial information updated in February 2019 and in September 2019.)
Swedish krona (SEK) to euros (€):
https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-sek.en.html# (Average exchange rate from February 18, 2014 to February 19, 2019.)

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
446.489,65	0,00	1,327%	1,50%	25

Internal Rate of Return (IRR): 1.29%

Revenues Reported	Total	Per year
Payments by users	not reported	not reported
Energy Savings	329.802 €	14.991 €
Total	**329.802 €**	**14.991 €**
EU Grant	169.045 €	6.762 €

Years	OPEX	Annual CAPEX	PV revenue
0	- €	17.859,59 €	17.859,59 €
1	- €	17.859,59 €	18.096,58 €
2	- €	17.859,59 €	18.336,72 €
3	- €	17.859,59 €	18.580,05 €
4	- €	17.859,59 €	18.826,61 €
5	- €	17.859,59 €	19.076,44 €
6	- €	17.859,59 €	19.329,58 €
7	- €	17.859,59 €	19.586,09 €
8	- €	17.859,59 €	19.845,99 €
9	- €	17.859,59 €	20.109,35 €
10	- €	17.859,59 €	20.376,20 €
11	- €	17.859,59 €	20.646,59 €
12	- €	17.859,59 €	20.920,57 €
13	- €	17.859,59 €	21.198,19 €
14	- €	17.859,59 €	21.479,49 €
15	- €	17.859,59 €	21.764,52 €
16	- €	17.859,59 €	22.053,34 €
17	- €	17.859,59 €	22.345,99 €
18	- €	17.859,59 €	22.642,52 €
19	- €	17.859,59 €	22.942,98 €
20	- €	17.859,59 €	23.247,44 €
21	- €	17.859,59 €	23.555,93 €
22	- €	17.859,59 €	23.868,52 €
23	- €	17.859,59 €	24.185,25 €
24	- €	17.859,59 €	24.506,19 €
Total	- €	446.489,65 €	525.380,74 €
Average	0,00 €	17.859,59 €	**21.015,23 €**

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	446.489,65 €
Employment impact (FTE)	2,18
Output increase	257.384,07 €

- The investment costs accounted for "roof insulation" have been categorized within the construction and construction works industry.
- The investment costs accounted as "photovoltaics" have been categorized within the repair and installation services of machinery and equipment industry.
- The investment costs accounted as the "air handling unit" have been categorized within the electricity, gas, steam and air conditioning industry.
- The investment costs accounted as "project manager and consultants" have been categorized within the legal and accounting services, services of head offices and management consultancy services industries.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is approximately €257,384.04

Stockholm. Construction Consolidation Center by CARRIER
Measure: 2.1

Financially unsustainable. Economically sustainable (Expected).

The Construction Consolidation Centre (CCC) is a logistical set-up to improve the conditions for construction projects such as new developments or refurbishments. By planning the material flow and steering inbound deliveries to the CCC, it is possible to increase the efficiency of the building process.

Financial Analysis

Detailed Costs

The CCC CAPEX is equal to €85,000.

CCC average OPEX is €225,000, of which:
- 62% are maintenance costs.
- 9% are other expenses.
- 27% are personnel costs.
- 2% are energy costs.

Detailed Revenues

CCC's reported payment by user is €315,000.

Savings as Revenues

No financial savings related to CO_2 savings

Financial Conclusion

With the actual revenues reported (€68,333/year as an average), the measure is unsustainable from the financial point of view. The reason is that these actual revenues are far from the average theoretical revenues necessary to pay back the CAPEX and the Opex during the lifetime of the asset, i.e., €233,972 a year.

Economic Analysis

Positive Externalities

- The added proposition of the CCC is an overall reduction in the number of deliveries to the construction site, hence, a reduction of congestion and CO_2 emissions.

Job Creation

Until this moment, partners reported the creation of 1 full-time equivalent (FTE) job.

According to the input-output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.1 FTE jobs.

Positive Externalities as Economic Savings

With the data provided in with the D5.4 it is not possible to make an economic analysis.

However, there are potential positive externalities: external reports related to implementation of the CCC point out that these infrastructures generate the following improvements:
- a reduction in freight traffic to site by up to 70%
- increased productivity of site labor by 30 minutes per day leading to a 6% productivity gain
- a waste reduction of 7%-15% from reduced damage and shrinkage through loss of material.

Economic Conclusion

As there is no technical data related to positive externalities, an economic validation is not possible. However, taking a look at the gap (€165,639) between the average actual revenues (€68,333) and the theoretical average revenues (€233,972), it can be observed that only if the CO_2 reductions were 2,761 tons would the measure be sustainable from an economic point of view. If that were the case, a grant from the public sector, equivalent to this gap, would make sense.

Improvement of the Business Model

Similar CCCs have been used in other places where huge infrastructures were built, such as the enlargement of Heathrow airport. Hence, the financial sustainability of this measure might be related to public works for the implementation of important infrastructures. That is, the solution could be sustainable including more actors or coupling the consolidation centre with major public infrastructure projects

Comments on Data and Methodology

Benefits of CCCs: Information related to the benefits of CCCs can be found in the report "Using Construction Consolidation Centers to reduce construction waste & carbon emissions" by Wrap (2011). www.wrap.org.uk/sites/files/wrap/CCC%20combined.pdf.
Last data received: 4Q2018

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
85.000,00 €	225.000,00 €	0,01327	0,015	20

Years	OPEX	Annual CAPEX	PV revenue	Revenues reported
1	228.375,00 €	4.250,00 €	229.690,55 €	- €
2	231.800,63 €	4.250,00 €	230.132,50 €	60.000,00 €
3	235.277,63 €	4.250,00 €	230.575,87 €	145.000,00 €
4	238.806,80 €	4.250,00 €	231.020,67 €	
5	242.388,90 €	4.250,00 €	231.466,90 €	
6	246.024,73 €	4.250,00 €	231.914,59 €	
7	249.715,11 €	4.250,00 €	232.363,73 €	
8	253.460,83 €	4.250,00 €	232.814,35 €	
9	257.262,74 €	4.250,00 €	233.266,45 €	
10	261.121,69 €	4.250,00 €	233.720,04 €	
11	265.038,51 €	4.250,00 €	234.175,15 €	
12	269.014,09 €	4.250,00 €	234.631,78 €	
13	273.049,30 €	4.250,00 €	235.089,94 €	
14	277.145,04 €	4.250,00 €	235.549,65 €	
15	281.302,21 €	4.250,00 €	236.010,91 €	
16	285.521,75 €	4.250,00 €	236.473,75 €	
17	289.804,57 €	4.250,00 €	236.938,17 €	
18	294.151,64 €	4.250,00 €	237.404,19 €	
19	298.563,92 €	4.250,00 €	237.871,82 €	
20	303.042,38 €	4.250,00 €	238.341,08 €	
Total	5.280.867,47 €	85.000,00 €	4.679.452,10 €	
Average	264.043,37 €	4.250,00 €	233.972,61 €	68.333,33 €

Internal Rate of Return (IRR): 81.89%

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partner	85.000,00 €
Employment impact (FTE)	1 (0,61)
Output increase	57.515,59 €

Following the Input-Output model, this measure's investment generates an expected increase of €57,515.59 to Germany's economy (through a multiplier effect).

Solution 3. Smart Energy-Saving Tenants

Barcelona. Measure: 3.1.3
Virtual Energy Advisor by the Municipality of Barcelona and IREC

Financially sustainable
Economically sustainable

The Virtual Energy Advisor aims to reduce household electricity consumption by influencing consumer behavior, showing electricity consumption data obtained from smart meters and giving tips on how to reduce consumption.

Financial Analysis

Detailed Costs

CAPEX (all taxes included):
Investment costs:

- Software integration costs: €21,659
- Hardware (metering equipment): €73,300
- User's management and hardware installation: €88,260

OPEX:

- Software and hardware maintenance: €3,000 per year

Detailed Revenues

The measure has been subsidized by the local energy agency in Barcelona.

Savings as Revenues

Energy savings: 293 kWh per household annually
That would equal €67 per household.
Total energy savings for 504 households: €33,965 per year.

Financial Conclusion

Overall, the measure seems to be financially sustainable, since the average annual revenues (€33,965) are greater than the theoretical ones for reaching a financial break-even (€17,281.60).

However, the municipality, as an investor, does not capitalize the benefits of the implementation, and its aim is to raise environmental awareness among citizens, offering the tool for free to early adopters.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure is able to create, directly and indirectly, 1.43 FTE jobs.

Positive Externalities as Economic Savings

Savings in CO_2 through energy savings: 0.11486 tons of CO_2 per household/year.
With 504 households, that would equal to 57.89 tons of CO_2.

- 57.89 tons of CO_2 would equal €3,473 per year (€52,099 with the same €60 SCC throughout the 15-year period).

The project is entirely subsidized by the municipality, which assumes the user management costs and the integration costs. In that sense:

- Public funds from the municipality are greater than the positive externalities.

Economic Conclusion

The measure seems to be economically sustainable. The measure does not need public funding in order to justify its economic sustainability. Positive externalities, and therefore, economic benefits, only represent a minor part of the total revenues;

Energy savings (financial revenues) + CO_2 savings (economic revenues) = €33,965 per year.

Comments on Data and Methodology

Financial data has been updated in May 2019.
Energy savings reported by IREC in May 2019. Technical validation by KTH is still pending.
Emission factor: 392 g of CO_2 per kWh (electricity).

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
183.219,00	3.000,00	2,193%	2,20%	15

Revenues Reported	Total	Per year
Energy Savings	509.468 €	33.965 €
Total	509.468 €	**33.965 €**
Public funds (Agència energia de Barcelona)	Subsidizes the CAPEX and the OPEX	

Internal Rate of Return (IRR): 13.73%

Years	OPEX	Annual CAPEX	PV revenue
0	3.000,00 €	12.214,60 €	15.214,60 €
1	3.066,00 €	12.214,60 €	15.482,67 €
2	3.133,45 €	12.214,60 €	15.756,62 €
3	3.202,39 €	12.214,60 €	16.036,57 €
4	3.272,84 €	12.214,60 €	16.322,65 €
5	3.344,84 €	12.214,60 €	16.615,00 €
6	3.418,43 €	12.214,60 €	16.913,76 €
7	3.493,63 €	12.214,60 €	17.219,07 €
8	3.570,49 €	12.214,60 €	17.531,07 €
9	3.649,05 €	12.214,60 €	17.849,91 €
10	3.729,32 €	12.214,60 €	18.175,73 €
11	3.811,37 €	12.214,60 €	18.508,69 €
12	3.895,22 €	12.214,60 €	18.848,96 €
13	3.980,91 €	12.214,60 €	19.196,67 €
14	4.068,50 €	12.214,60 €	19.552,01 €
Total	52.636,45 €	183.219,00 €	259.223,99 €
Average	3.509,10 €	12.214,60 €	**17.281,60 €**

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	183.219,00 €
Employment impact (FTE)	1,43
Output increase	116.150,14 €

- The investment costs accounted as “integration of the platform” and “user’s management” have been considered within the computer programming, consultancy and related services and Information services industry.
- The investment costs accounted as “metering equipment” have been considered within the repair and installation services of machinery and equipment industry.
- The expected output increase of the measure, which includes the added value impact plus intermediate consumptions, is about €116,150.14, approximately.

Improving the Business Model

The model does not need to be improved, although the average costs of implementation (metering equipment) could be reduced in the future.

- Revenue structure: the solution is entirely subsidized by the public sector and does not charge a cost to households (who capitalize the entire financial benefits of the solution). It would be recommendable to charge part of the measure to households, such as the implementation of the metering system. However, residents would not accept that, if financial benefits are lower than the cost of implementation.
- Cost structure: taking advantage of scale economies would help to replicate the solution in other places and, in turn, it could help to reduce the average costs of implementation. In addition, the cost of the metering system could be reduced, as technology matures over the years.
- Furthermore, the measure could be easily scaled up without the metering equipment, since the visualization tool could serve to enhance consumption behaviors on its own. In turn, the cost of implementation would decrease dramatically. In addition, the technical difficulties associated with the installation of the equipment would be avoided as well, helping, in turn, to reduce the implementation costs even more.

Barcelona. Measure: 3.1.3
Home Energy Management System by Naturgy

Financially sustainable
Economically sustainable

The Virtual Energy Advisor aims to reduce household electricity consumption by influencing consumer behavior, showing electricity consumption data obtained from smart meters and giving tips on how to reduce consumption.

Financial Analysis

Detailed Costs

CAPEX (all taxes included):
Investment costs:

- Investment costs: €125,750
- Personnel costs related to investment: €56,470

OPEX: (€56,400 in average – 5 year period)

- Maintenance: €72,000 (5 years)
- Operating costs: €210,000 (5 years)

Taxes: €338,470

Detailed Revenues

No revenues contemplated for this measure.
The equipment was given for free to users.

Savings as Revenues

See comments in *Data and Methodology* box

Financial Conclusion

Overall, the measure seems to be financially unsustainable, since the systems are offered for free and the energy savings are yet not estimated. The theoretical ones for reaching a financial break-even (€69,100.35)

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

According to the Input-Output methodology, the measure is able to create, directly and indirectly, 1 FTE job.

Positive Externalities as Economic Savings

See comments in the *Data and Methodology* Box

Economic Conclusion

With the information available so far, it is yet no possible to draw an economic analysis for this measure.

Considering the results obtained with similar measures within this project (Home Energy Management systems) it is expected, for these measure, to generate positive externalities in the form of savings in CO_2 emissions.

Comments on Data and Methodology

Financial data has been updated in December 2019.
Regarding evaluation, Naturgy highlights that the same dwellings that have HEMS installed are the same dwellings that have participated in other Measures of GrowSmarter. This means that a comparison between the consumption pre-implementation and post implementation of the dwellings to evaluate the impact of HEMS does not have much sense because different Measures influence the reduction of the energy consumption. For that reason, the evaluation of this Measure will be based more on surveys, which allow to evaluate the customer experience about the devices, functionalities and usability of HEMS.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
182.220,00	56.400,00	2,193%	2,20%	5

The system has been offered for free.

Energy savings expected but yet not available.

Years	OPEX	PV OPEX	Annual CAPEX	PV revenue
0	56.400,00 €	56.400,00 €	36.444,00 €	92.844,00 €
1	57.640,80 €	56.403,86 €	36.444,00 €	93.647,08 €
2	58.908,90 €	56.407,73 €	36.444,00 €	94.467,69 €
3	60.204,89 €	56.411,59 €	36.444,00 €	95.306,21 €
4	61.529,40 €	56.415,45 €	36.444,00 €	96.163,03 €
Total	294.683,99 €	282.038,64 €	182.220,00 €	472.428,00 €
Average	58.936,80 €	56.407,73 €	36.444,00 €	**94.485,60 €**

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	182.220,00 €
Employment impact (FTE)	1
Output increase	163.856,42 €

- The expected output increase of the measure, which includes the added value impact plus intermediate consumptions, is about €163,856,42 approximately.

Cologne. Measure: 3.1 / 5.3 (WP3)
Home Energy Management System: SmartHome by RheinEnergie (hardware) + AGT (software).

Financially unsustainable
Economically unsustainable

Implementation of a home energy management system (HEMS) with the purpose of monitoring and visualizing the consumption behavior of different departments, optimizing that consumption and achieving lower energy costs.

Financial Analysis

Detailed Costs

Total CAPEX: €124,549

Related to Hardware (RheinEnergie)
CAPEX: €26,549

- Investment costs: €15,000€ (Hardware €582 + costs of installation = €1,000 per participant).
- Personnel costs: €10,740
- Taxes: €809

Related to Software (AGT):
CAPEX: (discussed during the GrowSmarter workshop between IESE and Cologne's industry partners)

- Invemstent costs related to software: €98,000

OPEX:

- AWS: €1,500 approximately

Detailed Revenues

The HEMS solution is offered for free, although only five participants have agreed to implement the solution in their homes.

Savings as Revenues

- Energy Savings: RheinEnergie estimates at 48.59 kWh per square meter the energy savings derived from the heating circuit system.
- Energy Savings: RheinEnergie estimates up to 8% in energy savings.
- Energy Savings: RheinEnergie estimates at €55 annually the potential energy savings per user (with five participants in total, which would represent a total of €275 per year).
- AGT: During the official IESE – GrowSmarter's industry partners meeting at Cologne, AGT, estimated at 4% the potential energy savings generated through the implementation of their software.

Financial Conclusion

- The measure seems to be financially unsustainable.
- The average theoretical annual revenues required for being financially sustainable are €10,357.39, while the actual revenues are €275 per year (energy bills).

Economic Analysis

Positive Externalities

Savings in CO_2 emissions

Job Creation

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 1 FTE job.

Positive Externalities as Economic Savings

- Savings of CO_2: With an emission factor of 0.435 kg of CO_2 per kWh, the estimated annual savings in tons of CO_2 emissions are approximately 5.92 tons of CO_2.
- The estimated annual savings of CO_2 emissions are of €355. In 15 years, that would be a total of €5,326.
- Measure 3.1 (Home Energy Management System by RheinEnergie) has received €18,000 from the EU grant.

Economic Conclusion

- The measure does not seem to be economically sustainable just considering the reduction in C02 emissions.
- The public grant (€18,000) does not seem to justify the economic savings (€5,326 in 15 years, assuming the same Social Cost of Carbon during the entire period and assuming that the population is always of five apartments).

Comments on Data and Methodology

Savings as revenues:

- RheinEnergie admits that the potential savings may sometimes be overestimated, especially if they are determined by the energy provider or the manufacturer of the solution, but that an 8% in energy savings can be achieved if thermostats have, so far, been regulated only manually.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
124.549,40	1.500,00	0,795%	1,50%	15

Years	OPEX	Annual CAPEX	PV revenue
0	1.500,00 €	8.303,29 €	9.803,29 €
1	1.522,50 €	8.303,29 €	9.879,80 €
2	1.545,34 €	8.303,29 €	9.956,90 €
3	1.568,52 €	8.303,29 €	10.034,60 €
4	1.592,05 €	8.303,29 €	10.112,91 €
5	1.615,93 €	8.303,29 €	10.191,84 €
6	1.640,16 €	8.303,29 €	10.271,38 €
7	1.664,77 €	8.303,29 €	10.351,54 €
8	1.689,74 €	8.303,29 €	10.432,33 €
9	1.715,08 €	8.303,29 €	10.513,75 €
10	1.740,81 €	8.303,29 €	10.595,81 €
11	1.766,92 €	8.303,29 €	10.678,51 €
12	1.793,43 €	8.303,29 €	10.761,86 €
13	1.820,33 €	8.303,29 €	10.845,85 €
14	1.847,63 €	8.303,29 €	10.930,51 €
Total	25.023,21 €	124.549,40 €	155.360,87 €
Average	1.668,21 €	8.303,29 €	**10.357,39 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	124.549,40 €
Employment impact (FTE)	1
Output increase	78.074,20 €

- The hardware part of this solution is considered within the electrical equipment industry. The software part of this solution (measure 5.3) is considered within the computer programming and information services industry.
- The estimated output increase of the measure, which includes the added value impact plus intermediate consumptions, is approximately €78,074.20.

Improving the Business Model

- With a population of only five apartments, the measure does not seem to maximize its potential in terms of economies of scale.
- Considering the theoretical revenues of €10,357.39 and the estimated €55 per year of annual energy savings per apartment, the measure seems to need a minimum critical mass of 189 users in order to be financially sustainable through energy savings.

Stockholm. Measure: 3.1.1
Active House (SmartLiving) by Fortum

Financially unsustainable
Economically unsustainable

Implementation of a home energy management system (HEMS) with the purpose of monitoring and visualizing the consumption behavior of different departments, optimizing that consumption and achieving lower energy costs. The Active House solution has been implemented at Valla Torg (54 apartments).

Financial analysis

Detailed Costs

CAPEX: €546,191

- Investment costs: €202,524
- Personnel costs related to the invesment: €37,386
- Other expenses related to the investment (including costs for subcontracted services and consultancy): €250,152
- Third-party software (fourth year): €56,129

OPEX:

- Maintenance costs: €1,500 (AWS)

Detailed Revenues

- No private revenues reported by Fortum.
- The measure has received an EU grant (considered as revenues because it is implemented in a social housing project): €136,500 in total.
- The measure does not contemplate private revenues because of the public grant.

Savings as Revenues

- According to Fortum, the measure is expected to demonstrate, on average, a reduction of 10%, annually, in electricity consumptions.
- According to Fortum, the reduction in energy savings would represent a generation of €60 of monetary savings for a standard apartment
- With 54 apartments utilizing the Active House solution, the total savings estimated are €3,240 per year.

Financial Conclusion

- The measure seems to be financially unsustainable, because the estimated energy savings are not enough to financially sustain the measure.
- The theoretical annual revenues for being financially sustainable are €56,137.70, approximately, while the actual revenues are of only €10,002 per year (€3,240 without considering the EU grant.

Economic analysis

Positive Externalities

CO_2 emissions (considered in this document)

Job Creation

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 4 FTE jobs.

Positive Externalities as Economic Savings

- Fortum states that the measure seems to be able to reduce electricity consumptions by 10%. According to the industry partner, that equals approximately €60 per apartment.
- With a price of €0.1936 kWh, that would represent a total of 310 kWh in annual electricity savings per apartment.
- With a population of 54 apartments, the measure seems to save 16,735.54 kWh in electricity, approximately,
- In Sweden, country with a low emission factor, that would equal 0.64 tons of CO_2 savings.
- In turn, that would equal €38.16 in savings, or €381.57 in 10 years.
- As stated, the measure has received €136,500 of public funds from the EU.

Economic Conclusion

The measure seems to be economically unsustainable since the gap between the theoretical revenues and the real revenues is not overcome through C02 savings.
In that regard, in the GrowSmarter context, the EU grant does not seem to be justifiable.

Comments on Data and Methodology

- With a relatively low price of energy and a low emission factor in Sweden, compared to those in Germany and in Spain, the potential energy savings and CO_2 savings from the Active House (SmartLiving) solution at Valla Torg, Stockholm, might not be attractive enough.
- According to Fortum, outside the GrowSmarter context, in Stockholm, Fortum would charge €1,500 per apartment, as a single payment, plus a monthly fee of €8 per apartment, approximately. In that sense, with €60 in annual savings, in Stockholm, the measure does not seem to be attractive for the customer either.

Comments on Data and Methodology (continued)

- For the fourth year of implementation, the operating costs increased to €56,129 because, as stated by Fortum, the software needed to be changed entirely.
- Sources: CoM Default Emission Factors for the Member States of the European Union. Dataset Version 2017. Authors: Koffi, B., Cerutti, A., Duerr, M., Iancu, A., Kona, A., Janssens-Maenhout, G.http://cidportal.jrc.ec.europa.eu/ftp/jrc-opendata/COM-EF/dataset/comw/JRC-CoM-EF-CoMW-EF-2017.pdf
  (Financial data was updated in February 2019.)

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
546.191,00	1.500,00	0,656%	1,50%	10

Revenues Reported	Total	Per year
Energy Savings	71.280 €	3.240 €
Total	**71.280 €**	**3.240 €**
EU Grant	169.045 €	6.762 €

Internal Rate of Return (IRR): -41.26%

Years	OPEX	Annual CAPEX	PV revenue
0		23.490,00 €	23.490,00 €
1		152.133,00 €	153.130,99 €
2		267.634,00 €	271.156,88 €
3		102.934,00 €	104.973,06 €
4	1.500,00 €	- €	1.461,28 €
5	1.500,00 €	- €	1.451,75 €
6	1.500,00 €	- €	1.442,29 €
7	1.500,00 €	- €	1.432,89 €
8	1.500,00 €	- €	1.423,55 €
9	1.500,00 €	- €	1.414,28 €
Total	9.000,00 €	546.191,00 €	561.376,97 €
Average	900,00 €	54.619,10 €	**56.137,70 €**

* Opex remains constant because of the contract between Fortum and AWS.

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	546.191,00 €
Employment impact (FTE)	4,19
Output increase	316.297,57 €

- The Active House (Smart Living) solution could be considered within the architectural and engineering services, technical testing and analysis services industry.
- The expected output increase of the measure, which includes the added value impact plus intermediate consumptions, is approximately €316,297.57.

Barcelona. Measure: 4.2.1
Resource Advisor: A Visualization Platform to Assess the Impact of Energy Retrofitting Measures by Schneider Electric

Financially sustainable
Economically sustainable (expected)

This measure, consisting of a data visualization software for energy performances in buildings, is suitable to monitor and evaluate energy-saving measures in buildings. The aim of the measure is to make use of a tool (a software platform) developed by Schneider Electric that allows for monitoring the key performance indicators (KPIs) to evaluate the impact of energy retrofitting work in several GS Barcelona buildings, detect deviations from the expected values, and make sure that the savings are achieved over time. The goal of the platform was not to identify potential additional savings, though it could be used for this purpose as well.

Financial Analysis

Detailed Costs

CAPEX: €20,300 (divided over three years)
According to the industry partner, all investment costs are related to personnel costs. No software costs have been reported due to prior amortization.

Detailed Revenues

- No operational revenues reported by the industry partner for deploying the solution in GrowSmarter.

EU grant: €3,710 (with a three-year implementation, equal to €1,237 per year on average)

- Outside GrowSmarter:

Potential revenues: €20,700 divided over three years (of the implementation)
€12,000 the first year; €7,500 the second year; €7,500 the third year.
· Energy savings for this measure, if used to identify potential energy savings, could amount to 12,000€/yr even with a conservative savings projection (5%).

Savings as Revenues

According to the industry partner, the measure should be able to reduce energy consumption by optimizing consumption behaviors (see section Comments on Data and Methodology)

Financial Conclusion

Hypothetical revenues to reach a positive financial net present value: €4,104.82 per year.
The measure seems to be financially sustainable as it seems to generate enough energy savings.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions, centralized data management tool.

Job Creation

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0 (0.22) FTE jobs.
According to the industry partner, the measure required 0.3 FTE jobs.

Positive Externalities as Economic Savings

D5.4 does not provide data related to CO_2 savings.
As mentioned before, the measure has received a public grant of €3,710.

Economic Conclusion

The measure seems to be economically sustainable as it seems to be financially sustainable as well.
It has not been possible to undertake a detailed economic assessment for this measure, since positive externalities have not been calculated.

Comments on Data and Methodology

The EU grant has been considered as revenues because, in some cases, the client is a public institution. In addition, the public grant seems to substitute operational revenues from users, as the industry partner has provided what would be the estimated revenues from users.
Similar solutions (see the Virtual Energy Advisor) show clear advantages of having monitoring tools. In addition, the Resource Advisor could help to manage consumptions, since a digital platform can reduce the time spent on monitoring and evaluating as well as on fixing, adjusting and optimizing the benefits and efficiency levels of other energy-efficiency measures.
The direct impact of the Resource Advisor in terms of energy savings could vary from one building to another. Academic literature does not agree on a percentage in that sense, and it tends to offer different ranges of potential energy savings. According to Darby (2006), the average potential energy savings could go from 5% to15%. This is consistent with the findings of measure 3.1 by IREC.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
20.300,00	0,00	0,549%	2,20%	5

Revenues: EU grant: €3,710 in 3 years (€1,237 annually)
Estimated energy savings: 5% (Estimated in €12,000 for the GrowSmarter project)

Years	OPEX	Annual CAPEX	PV revenue
0	- €	4.060,00 €	4.060,00 €
1	- €	4.060,00 €	4.082,29 €
2	- €	4.060,00 €	4.104,70 €
3	- €	4.060,00 €	4.127,24 €
4	- €	4.060,00 €	4.149,89 €
Total	- €	20.300,00 €	20.524,12 €
Average	0,00 €	4.060,00 €	**4.104,82 €**

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	23.000,00 €
Employment impact (FTE)	1
Output increase	14.638,90 €

- The Resource Advisor could be considered within the computer programming, consultancy and related services and information services industry.
- The expected output increase of the measure, which includes the added value impact plus intermediate consumptions, is about €14,638.90, approximately.

Improving the Business Model

- Costs structure: the business model could show strength judging by the evolution of the implementation costs, especially those derived from storing data on the servers. The cost structure may be improved in the short term.
- Revenue streams: the industry partner has noticed that it could be better, for both the company and the final customer, to distribute the initial investment costs in monthly payments throughout the amortization period. That could erase some initial barriers, facilitating the entry to new competitors while increasing the attractiveness of the solution for the customer.
- Standardization: the solution uses the EPC protocol, but the industry partner points out the lack of standardization in upper layers. A lack of regulation in that sense introduces uncertainty and inefficiencies when trying to take advantage of the solution. Public institutions, according to Schneider, should draw improved and adequate regulatory frameworks for the energy management industry in terms of standards and protocols to be used.
- User engagement: in general, the final consumer seems to ignore the real benefits of the measure. Therefore, it could be argued that some kind of pedagogy, from the industry partner (and public administrations), is needed. For instance, focusing on the potential economic savings that a BEMS is able to provide. Furthermore, according to the company, Schneider Electric is not a well-known company as a brand among final consumers, something necessary for entering into competition against the final distributors of energy in the provision of this type of solutions to the final consumer. Additionally, the industry partner should try to get feedback from the customer and try to learn from that. In that regard, Schneider is aware that people need flexibility, and to design user-friendly policies in that sense would be positive for them.
- Moreover, it might be advisable for the public sector to promote actions to publicize that measure, with the aim of fulfilling the 2020 environmental targets.

Barcelona. Measure: 4.2.1
Smart energy and Self-Sufficient Block by Naturgy / IREC

Financially sustainable
Economically sustainable

Implementation of photovoltaics in two residential buildings (Sibelius 3 and Valldonzelles) helping to minimize consumption of fossil fuels and electricity. The local renewable energy production is mainly dependent on weather conditions. Also, a BEMS system installed, has the capacity of planning an optimal supply/demand of energy and ensuring a system balance in real time.

Financial Analysis

Detailed Costs

CAPEX: €141,027.90

OPEX: €1,005.40

Detailed Revenues

Private Financing: €1,159.20 (Sibelius 3) + €6,980.60 (Valldonzelles) = €6,980.60

Savings as Revenues

Energy savings: €1,987 per year, approximately, including taxes.

Financial Conclusion

From the energy company's point of view, the measure is financially sustainable since the net present value revenues are higher than the theoretical ones for reaching a break even. However, from the consumer's point of view, the energy savings achieved are lower than the price they are paying for.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions, centralized data management tool.

Job Creation

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.66 FTE jobs.

Positive Externalities as Economic Savings

- Savings of CO_2: the estimated annual savings in tons of CO_2 emissions are approximately 2.735 tons of CO_2.
- The estimated annual savings of CO_2 emissions are of €164.1 per year. In 25 years, that would be a total of €4,102.5.
- The solution has received an EU Grant which represents, approximately, 70% of the investment cost (€98.719) and it seems to not be necessary in order to sustain the economic feasibility of the solution.

Economic Conclusion

The measure is economically sustainable since it demonstrates its financial sustainability plus it generates positive externalities in the form of CO_2 savings.

Comments on Data and Methodology

Financial and technical data has been updated in late December 2019.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Bond	Inflation rate	Life time
141.027,90	1.005,40	2,193%	2,20%	10

Revenues Reported	Total	Per year
Private Financing	69.806 €	6.981 €
Energy Savings	19.877 €	1.988 €
Total	89.683 €	**8.968 €**

Years	OPEX	Annual CAPEX	PV revenue
0	1.005,40 €	5.641,12 €	6.646,52 €
1	1.027,52 €	5.641,12 €	6.770,29 €
2	1.050,12 €	5.641,12 €	6.896,79 €
3	1.073,23 €	5.641,12 €	7.026,05 €
4	1.096,84 €	5.641,12 €	7.158,15 €
5	1.120,97 €	5.641,12 €	7.293,14 €
6	1.145,63 €	5.641,12 €	7.431,09 €
7	1.170,83 €	5.641,12 €	7.572,07 €
8	1.196,59 €	5.641,12 €	7.716,13 €
9	1.222,92 €	5.641,12 €	7.863,36 €
10	1.249,82 €	5.641,12 €	8.013,81 €
Average	1.123,62 €	5.641,12 €	**7.307,94 €**

Internal Rate of Return (IRR): 3.94%

Economic Impact of the Investment (Input-Output Model)

Economic impact of the investment	
Investment by the Industry Partner	141.027,90 €
Employment impact (FTE)	0,66
Output increase	126.815,53 €

- The added value impact plus intermediate consumptions, is about €126,027.90 approximately.

Cologne. Measure: 4.1
Neighborhood Management System - Siedlungsmanagement
By Rheinenergie

Financially unsustainable
Economically unsustainable

The solution consists of a virtual power plant (intelligent management system) that connects local photovoltaic production, heat pumps and batteries. The system optimizes energy and heat consumption by connecting internal energy producers (photovoltaic, heat pumps, and battery storage) and external ones (district heat). The project leads to a partly self-sufficient energy supply, which results in less pressure on energy grids, lower carbon emissions, and better air quality.

Financial Analysis

Detailed Costs

CAPEX:
(Siedlungsmanagement):
€741,060

- Cost per apartment: €1,077.12 (688 apartments)
- Simulation (considering only 60 apartments): €64,627.33

CAPEX (other):

- PV: €859,639.35
- Batteries: €1,334,276.61
- Heat Pumps: €698,263.14
- Optical fiber: €37,595.15

Detailed Revenues

License fee: €25,000 (€2,180 for 60 apartments)

Savings as Revenues

RheinEnergie carried out a simulation of the Siedlungsmanagement for early evaluation. The simulation was based on real data in a building with 60 dwellings.
The simulation has shown that the following can be achieved by using the software:

- Energy cost savings (17%): €3,257 / year

If the system were optimized for self-sufficiency, there were no savings, and the costs would increase by 2,472.00 € / year.

- Additionally (equipment on the building):
  Income from PV € 1,576.33 / year.
  Income from Heat € 4,446.98 / year.

Financial Conclusion (Siedlungsmanagement)

- Hypothetical annual average revenues to reach a positive financial net present value would be of €13,132.62 per year
- The measure seems to be financially unsustainable as real revenues do not match the hypothetical net present revenues for reaching a break even.

Economic Analysis

Positive Externalities

Reduction in CO_2 emissions.

Job Creation

- According to the Input-Output methodology, the investment is expected to create 4 FTE jobs.

Positive Externalities as Economic Savings

With an expected increase in the efficiency levels of the systems and therefore, an expected generation of energy savings, the software should be able to consolidate a reduction in CO_2 emissions where implemented.
With the data available in D5.4, so far, it is yet not possible to assess the economic savings derived from a reduction in CO2 emissions for this measure.

The measure has high potential in that regard, and it could be of interest, for public institutions, to foster the implementation of energy management systems in order to internalize positive externalities.

Economic Conclusion (Siedlungsmanagement)

The solutions shows high potential in terms of internalizing positive externalities. However, with the data available, it is not possible to draw an economic analysis for this measure.

Improving the Business Model

The business model for the management system is not sustainable. The investment costs and license costs per year are much higher than the potential financial benefits for the customers, which are of approximately €3,257 in total for the 60 apartments (2018). From the industry partner's side, with only 688 dwellings as customers, it is much needed to increase revenues in order to reach a financial break-even. That could be achieved by increasing the license fee or by increase the total number of customers.

Theoretical Revenues in Net Present Value (Siedlungsmanagement)

CAPEX (simulation)	OPEX	Life time	Bond	Inflation rate
64.627,33	0,00	5	0,795%	1,50%

Revenues for the industry partner: Simulation (Siedlungsmanagement) (1 building, 60 apartments)	Total	Per year
License fee for the software	10.900 €	**2.180 €**
Revenues for the customer		
Energy Savings	16.285 €	3.257 €
No savings if system is optmized	-12.360 €	-2.472 €

Years	OPEX	Annual CAPEX	PV revenue
0	- €	12.925,47 €	12.925,47 €
1	- €	12.925,47 €	13.028,22 €
2	- €	12.925,47 €	13.131,80 €
3	- €	12.925,47 €	13.236,20 €
4	- €	12.925,47 €	13.341,42 €
Total	- €	64.627,33 €	65.663,11 €
Average	0,00 €	21.542,44 €	**13.132,62 €**

Internal Rate of Return (IRR): -23.32%

Economic Impact of the Investment (Input-Output model)

Economic impact of the investment	
Investment by the Industry Partner	741.060,52 €
Employment impact (FTE)	4
Output increase	409.854,64 €

- The investment costs accounted as “Support of the project management, connection of the systems, development of the Siedlungsmanagement-software”, have been categorized within the computer programming, consultancy and related services; information services industries.
- The expected output increase of the project, which includes the added value impact plus intermediate consumptions, is €409,854.64 approximately.

6.2. Work Package 3. Integrated Infrastructures

Solution 5. Smart Street Lighting

Stockholm. Measures: 5.1.1; 5.1.2; 5.1.3
Smart LED Street Lighting by Stockholmshem and IBM

Financially not sustainable
Economically not sustainable

This measure deploys sensor-controlled LED lighting for pedestrian and bicycle paths to enable the lights to provide base lighting to provide a feeling of security at all times and increase the level of lighting when someone approaches.

Financial Analysis

Detailed Costs

For this measure, CAPEX is €179,478 with the following proportion:

- Lamppost and sensor costs represent 44.25% (€79,424)
- Personnel costs represent 13.27% (€23,826)
- Other expenses represent 38.76% (€70,252)

The remaining costs are related to energy usage.

Detailed Revenues

No revenues have been reported.

Savings as Revenues

Thanks to the savings in energy (and associated bills) from LED technology, the measure provides an initial revenue of €477.

Financial Conclusion

As of now, there is not enough financial information reported for revenues, especially for savings derived from reduced consumption. Therefore, the measure is not financially sustainable right now.

Economic Analysis

Positive Externalities

The deployment of LED technology will increase the savings provided by the measure. However, at this moment we cannot analyze the economic impact due to unavailability of data. Once we receive the reports about financial and environmental savings, they will be added to the calculations.

Job Creation

These kinds of measures, where deployment of infrastructure is a must, can offer many job opportunities, especially during the implementation phase. However, the partner has not provided this information.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.791 FTE jobs.

Positive Externalities as Economic Savings

The new lampposts will save around 1,175 grams of CO_2 each, which means that, since the measure has deployed 50 lampposts, the current savings (in euros) are €3.5 (1,175g/lamppost * 50 lampposts * €60/tons CO_2).

Economic Conclusion

As mentioned before, there is not enough information to draw economic conclusions.

Comments on Data and Methodology

For more information about the potential of LED lighting see “Prospects for LED lighting” (Pimputkar, Speck, DenBaars and Nakamura; Nature Photonics, 2009) or Grow, Robert T., “Energy Efficient Streetlights - Potentials for Reducing Greater Washington's Carbon Footprint,” March, 2008 or “Energy Efficient Streetlights -- Potentials for Reducing Greater Washington’s Carbon Footprint” - (American Chamber of Commerce Executives (ACCE) Ford Fellowship in Regionalism and Sustainable Development, 2008).

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
179.478 €	1.674 €	20	1,33%	1,50%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	1.699 €	8.974 €	10.770 €	477 €
2	1.725 €	8.974 €	10.893 €	
3	1.750 €	8.974 €	11.019 €	
4	1.777 €	8.974 €	11.145 €	
5	1.803 €	8.974 €	11.274 €	
6	1.830 €	8.974 €	11.404 €	
7	1.858 €	8.974 €	11.536 €	
8	1.886 €	8.974 €	11.669 €	
9	1.914 €	8.974 €	11.804 €	
10	1.943 €	8.974 €	11.941 €	
11	1.972 €	8.974 €	12.080 €	
12	2.001 €	8.974 €	12.221 €	
13	2.031 €	8.974 €	12.363 €	
14	2.062 €	8.974 €	12.507 €	
15	2.093 €	8.974 €	12.653 €	
16	2.124 €	8.974 €	12.801 €	
17	2.156 €	8.974 €	12.951 €	
18	2.188 €	8.974 €	13.103 €	
19	2.221 €	8.974 €	13.257 €	
20	2.255 €	8.974 €	13.413 €	
Total	39.290 €	179.478 €	240.806 €	
Average	1.964 €	8.974 €	12.040 €	

Internal Rate of Return (IRR) cannot be calculated due to a negative cash flow.

Input-Output Model

Economic impact of the investment	
Investment by industry partner	179.478,00 €
Output increase (Output impact - investment)	106.048,35 €
Employment impact	0,791

Improving the Business Model

Drawing on the information we have right now, the measure seems to be financially unsustainable. However, this situation may be caused by the fact that we do not have enough information on the financial and economic savings that the measure is providing. For example, it may be the case that by switching to LED technology we will observe a decline in maintenance costs. However, we have not received this information.

GrowSmarter
Transforming cities for a smart, sustainable Europe

Stockholm . Measure: 5.2

Smart Connected City Environment by IBM

Financially sustainable.
Economically sustainable.

Deployment of sensors to collect and analyze data about vehicle flow and emissions.

Financial Analysis

Detailed Costs

- CAPEX accounts for a total of €24,156
- More than 80% of the cost (€14,779) is related to maintenance and other expenses. The other costs are due to investment and personnel costs.

Detailed Revenues

No private revenues reported by the partner. However, it can be assumed that the EU grant (average: €62,000 per year) could be used as a proxy for a fee payment outside the project.

Savings as Revenues

The partners report savings of €9,033 per year thanks to better decision making. See "Positive Externalities as Economic Savings".

Financial Conclusion

The measure seems to be financially sustainable.

The theoretical annual revenues for being financially sustainable are €3,721, while the expected savings are €9,033.

Economic Analysis

Positive Externalities

Besides the financial plausibility of the measure, one could also take into account potential positive externalities that could derive in more revenues: for example, if we take into account potential innovation and increases in productivity due to better connection to the Internet and benefits associated with deployment of IoT infrastructure facilitated by this measure.

Job Creation

These kind of measures, where deployment of infrastructure is a must, can offer many job opportunities, especially during the implementation phase. According to our models, the measure will produce 0.119 FTE and the partner reports 2 FTE.

Positive Externalities as Economic Savings

By leveraging data and more informed decisions, real estate owners and service providers can make better decisions. For pedestrian/cyclists, a three-day measurement including analytics and report costs €111,555. These savings are calculated for four quarters (winter, spring, summer and autumn). For traffic, the cost is €12,125 for short measurements, and there is a need for a minimum of four measurements per year.

Economic Conclusion

As for the revenue streams, although there are no direct payments or fees, due to optimized decision-making we can expect societal benefits through savings in time and space with an average benefit of €9,033. We are waiting for more information regarding economic savings.

Comments on Data and Methodology

Regarding "savings as revenues", we are waiting for more information and clarifications from the partner. However, the measure has potential to bring enough benefits to become economically sustainable.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
249.033 €	25.705 €	20	1,33%	1,50%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	26.091 €	12.452 €	38.366 €	93.120 €
2	26.482 €	12.452 €	38.577 €	
3	26.879 €	12.452 €	38.791 €	
4	27.282 €	12.452 €	39.007 €	
5	27.692 €	12.452 €	39.225 €	
6	28.107 €	12.452 €	39.446 €	
7	28.529 €	12.452 €	39.669 €	
8	28.956 €	12.452 €	39.895 €	
9	29.391 €	12.452 €	40.123 €	
10	29.832 €	12.452 €	40.353 €	
11	30.279 €	12.452 €	40.587 €	
12	30.733 €	12.452 €	40.822 €	
13	31.194 €	12.452 €	41.061 €	
14	31.662 €	12.452 €	41.302 €	
15	32.137 €	12.452 €	41.545 €	
16	32.619 €	12.452 €	41.792 €	
17	33.109 €	12.452 €	42.041 €	
18	33.605 €	12.452 €	42.293 €	
19	34.109 €	12.452 €	42.548 €	
20	34.621 €	12.452 €	42.805 €	
Total	**603.310 €**	**249.033 €**	**810.247 €**	
Average	**30.165 €**	**12.452 €**	**40.512 €**	

Internal Rate of Return (IRR): 32%

Input-Output Model

Economic impact of the investment	
Investment by industry partner	249.033,00 €
Output increase (Output impact - investment)	148.588,76 €
Employment impact	1,471

Following the Input-Output model, this measure's investment generates an expected increase of €148,588.76 to Sweden's economy.

Improving the Business Model

Deployment is not a goal per se. Technology solutions like this one may enable better decision-making and faster responses from the public sector. Therefore, we need to take into account other KPIs beyond technological variables to understand the effective usage of the measure and how it has impacted operations in the city.

Barcelona . Measure: 5.2
Smart Multifunctional Tower by Cellnex

Financially - Economically sustainable (Expected)

Solution to save energy and rationalize the use of public space by the integration of lighting, environmental sensors and communications devices in a single lighting pole.

Financial Analysis

Detailed Costs

Total CAPEX for this measure is €317,440 distributed between investment and personnel costs. Costs are distributed among several categories:

Personnel costs represent 42.21% of total costs (€119,500)
Investment costs represent 29.55% of total costs (€154,015)
Other expenses represent 22.40% of total costs (€29,050)

Detailed Revenues

- Payment by users: 29.17% (€177,570)
- EU grant: 26.94% (€163,975)
- Other public contribution (city assets): 27.30% (€166,193)
- Private financing: 16.60% (€101,025)

Savings as Revenues

There are no financial savings associated with this measure. All the revenues are direct payments from users and, potentially, public funding.

Financial Conclusion

As for the financial evaluation, the measure is almost financially sustainable. Proof is that the measure has an average yearly hypothetical revenue of €50,072 and an average yearly revenue of €43,328.

Economic Analysis

Positive Externalities

In addition to the financial plausibility of the measure, one could also take into account potential positive externalities that could derive in more revenues: for example, if we take into account potential innovation and increases in productivity due to a better connection to the Internet and benefits associated with deployment of IoT infrastructure facilitated by this measure.

Therefore, we should also include these potential economic benefits in the evaluation of the measure.

Job Creation

These kinds of measures, where deployment of infrastructure is a must, can offer many job opportunities, especially during the implementation phase. Our results show 1.5 FTE generated.

Positive Externalities as Economic Savings

As mentioned before, this is an enabling measure with potential impact beyond the direct use of the infrastructure. In that sense, potential savings in better management of the infrastructure or more productivity could arise during the evaluation phase.

Economic Conclusion

The measure seems to have enough potential, both from the financial and the economic point of view, thanks to direct provision of services through the infrastructure and through potential positive externalities.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
317.440 €	24.775 €	15	2,19%	2,20%
Years	**OPEX**	**Annual CAPEX**	**PV Revenue**	**Revenues**
1	25.320 €	21.163 €	46.403 €	43.328 €
2	25.877 €	21.163 €	46.879 €	
3	26.446 €	21.163 €	47.366 €	
4	27.028 €	21.163 €	47.863 €	
5	27.623 €	21.163 €	48.371 €	
6	28.231 €	21.163 €	48.890 €	
7	28.852 €	21.163 €	49.420 €	
8	29.486 €	21.163 €	49.962 €	
9	30.135 €	21.163 €	50.516 €	
10	30.798 €	21.163 €	51.081 €	
11	31.476 €	21.163 €	51.660 €	
12	32.168 €	21.163 €	52.251 €	
13	32.876 €	21.163 €	52.854 €	
14	33.599 €	21.163 €	53.471 €	
15	34.338 €	21.163 €	54.102 €	
Total	**444.253 €**	**317.440 €**	**751.088 €**	
Average	**29.617 €**	**21.163 €**	**50.073 €**	

Input-Output Model

Economic impact of the investment	
Investment by industry partner	317.440,00 €
Output increase (Output impact - investment)	205.787,46 €
Employment impact	1,566

Following the Input-Output model, this measure's investment generates an increase of €205,787.46 to Spain's economy.

Improving the Business Model

This is an enabling measure, which means that it is hard to evaluate by itself. The potential benefits are derived from other operations carried out over the deployed infrastructure (like detailed information, better decision-making or better connection).

For this measure, outside organizations can benefit from existing data or deployed infrastructure by extracting value through infrastructure sharing, or by complementing their own infrastructure. However, these alliances are not always easy to create and manage.

Internal Rate of Return (IRR): -5%

Barcelona . Measure: 5.3
Smart Meter Information and Actuators by ENDESA

Almost Financially Sustainable
Economically -

The creation of a "data hub", called a Multiservice Concentrator (MSC), which will serve as a data node collecting and managing city data. The data will be used to integrate and optimize several utilities, to obtain increased efficiency in infrastructures and to create new smart grid services.

Financial Analysis

Detailed Costs

The total CAPEX for this measure is €438,529

Overall years:

- Personnel costs: €190,823
- Investment costs: €190,000
- Other expenses: €57,706

Detailed Revenues

Forecasted revenues are distributed between savings (€9,000,000) and private financing (€200,779).

Savings as Revenues

The savings are associated with better maintenance and reduced intervention time in case of emergency. This allows for avoiding and foreseeing potential risks that could have a serious impact on the infrastructure. As for now, the measure has provided €4,500 in savings.

Financial Conclusion

As for the financial evaluation, the measure seems to be almost sustainable. The partner reports revenues of €4,500 saved per year, a public contribution of €63,107 in the form of an EU grant and €27,046 in private financing (amounting to a total of €94,653), while the PV revenue for the first year is €120,036.

Economic Analysis

Positive Externalities

Besides the financial positive impact measured by savings in reduced intervention time and problems avoided, the measure has the potential to generate bigger impacts for society.

Job Creation

This measure requires the installation of smart meters and sensors during the implementation phase, which means that jobs related to hardware deployment will be needed. Furthermore, maintenance and software engineers are needed to maintain the service. According to our estimations, the measure has created 2.1 FTE.

Positive Externalities as Economic Savings

This measure provides expectations for better decision-making and faster information. Both may deliver economic savings in terms of reduced risks, fewer errors and less time required for information gathering.
However, we are waiting for more information and clarifications from the partner.

Economic Conclusion

While the measure seems financially viable, with more data regarding avoided problems and risk mitigation, this measure could complement its feasibility with economic impacts derived from better decision-making and other positive externalities.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
438.529 €	90.153 €	15	2,19%	2,20%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	92.137 €	29.235 €	120.036 €	94.653 €
2	94.164 €	29.235 €	120.697 €	
3	96.235 €	29.235 €	121.373 €	
4	98.352 €	29.235 €	122.063 €	
5	100.516 €	29.235 €	122.769 €	
6	102.727 €	29.235 €	123.489 €	
7	104.987 €	29.235 €	124.226 €	
8	107.297 €	29.235 €	124.978 €	
9	109.658 €	29.235 €	125.747 €	
10	112.070 €	29.235 €	126.533 €	
11	114.536 €	29.235 €	127.335 €	
12	117.056 €	29.235 €	128.155 €	
13	119.631 €	29.235 €	128.993 €	
14	122.263 €	29.235 €	129.850 €	
15	124.952 €	29.235 €	130.724 €	
Total	**1.616.581 €**	**438.529 €**	**1.876.969 €**	
Average	107.772 €	29.235 €	125.131 €	

Internal Rate of Return (IRR) cannot be calculated due to negative cash flow.

Input-Output Model

Economic impact of the investment	
Investment by industry partner	438.529,00 €
Output increase (Output impact - investment)	284.286,07 €
Employment impact	2,163

Improving the Business Model

The measure has great potential to reduce intervention times in case of any problem. However, the benefits follow a power law distribution in terms of problem severity (i.e., there is a low probability of a big accident, but the effects of this accident would be extreme). In these situations, it is hard to measure the potential benefits and value created, since the occurrence of the problems that the measure is intended to avoid are not common.

Solution 6. Waste-Heat Recovery

GrowSmarter
Transforming cities for a smart, sustainable Europe

Stockholm. Measures: 6.1
Open District Heating Using Waste Heat by Fortum.

Almost Financially sustainable
Economically sustainable

Waste heat will be recovered from data centers (installation of heat recovery equipment in order to recover heat from the cooling process of a datacenter for the district heating/cooling system) and fridges and freezers in supermarkets (installation of heat recovery equipment in order to recover heat from the cooling process of a supermarket for the district heating/cooling system).

Financial Analysis

Detailed Costs

- CAPEX is €712,037, mainly concentrated in investment costs due to infrastructure deployment.
- The majority of the costs are concentrated in investment (mainly equipment, like heat pumps and infrastructure, like pipes). This field accounts for almost €670,000.

Detailed Revenues

On the revenue side, the financial model is based on different savings (heat production avoided) or direct revenues, like district heating sales or monthly connection fees to the District Heating network. Direct payment by users amounted to €22,262 in 2017 and €44,525 in 2018.

Savings as Revenues

The measure provides savings through avoided costs associated with energy production. More specifically, the partner reports annual savings of almost €90,000 with a prognosis of delivering more than €130,000 in savings and earnings for 2019 and more than €192,000 in the following years (see "Comments on Data and Methodology").

Financial Conclusion

As for the financial evaluation, the measure seems to be almost feasible right now. However, we should wait for more financial information and the economic savings derived from the measure. If the forecasted savings become real, the measure will be financially feasible.

Economic Analysis

Positive Externalities

The measure will avoid energy production through heat recovery. Therefore, we should expect savings in CO_2 emissions (depending on the energy production mix).

Job Creation

The infrastructure deployment requires many jobs during the implementation phase. In addition, the infrastructure needs specific and regular maintenance to keep offering its services. According to our model, the measure has produced 1.44 FTE.

Positive Externalities as Economic Savings

According to the information in Deliverable 5.4, the measure has provided savings of CO_2 accounting for 70 tons in 2017 (which translates into €4,680) and 208 in 2018 (which translates into €12,480).

Economic Conclusion

According to the available data, this measure's positive externalities (€12,480 in 2018) plus the savings through avoided costs (€88,893 in 2018) are not far from the needed average revenue (€159,472).

In addition, if we add direct revenues (€44,525 in 2018), the measure will be sustainable.

Comments on Data and Methodology

Information for 2019 and 2020 are forecasts done by the partner.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
712.037 €	116.357 €	20	1,33%	1,50%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	118.103 €	35.602 €	152.630 €	52.954 €
2	119.874 €	35.602 €	153.308 €	133.417 €
3	121.672 €	35.602 €	153.992 €	181.416 €
4	123.498 €	35.602 €	154.684 €	212.474 €
5	125.350 €	35.602 €	155.382 €	
6	127.230 €	35.602 €	156.087 €	
7	129.139 €	35.602 €	156.799 €	
8	131.076 €	35.602 €	157.518 €	
9	133.042 €	35.602 €	158.244 €	
10	135.038 €	35.602 €	158.978 €	
11	137.063 €	35.602 €	159.719 €	
12	139.119 €	35.602 €	160.468 €	
13	141.206 €	35.602 €	161.224 €	
14	143.324 €	35.602 €	161.988 €	
15	145.474 €	35.602 €	162.759 €	
16	147.656 €	35.602 €	163.539 €	
17	149.871 €	35.602 €	164.326 €	
18	152.119 €	35.602 €	165.122 €	
19	154.401 €	35.602 €	165.926 €	
20	156.717 €	35.602 €	166.738 €	
Total	**2.730.971 €**	**712.037 €**	**3.189.430 €**	
Average	**136.549 €**	**35.602 €**	**159.472 €**	

Internal Rate of Return (IRR): 9%

Input-Output Model

Economic impact of the investment	
Investment by industry partner	712.037,00 €
Output increase (Output impact - investment)	302.318,09 €
Employment impact	1,442

Following the Input-Output model, this measure's investment generates an expected increase of €302,318.09 to Sweden's economy.

Improving the Business Model

While the scalability of the measure is highly dependent on existing infrastructure (the district heating system and heat sources like supermarkets or data centers), it has a potential scalability and replicability in situations with suitable conditions. In addition, it provides an interesting case for public-private partnerships in energy provision.

Solution 7. Smart Waste Collection

Stockholm . Measures: 7.1; 7.2 and 7.3
Automated Waste Collection by ENVAC

Financially sustainable
Economically sustainable

Residents separate their waste into separate color-coded bags. The system will be able to identify the amount and type of waste thrown away by individual users.

Financial Analysis

Detailed Costs

CAPEX is €467,302, mainly concentrated in investment costs due to infrastructure deployment.

The main investment costs are for containers, exhausters, control systems, pipes, and waste inlets. As for the energy costs, they include costs for running exhausters (waste collection), compressors (system operation), and control equipment.

Detailed Revenues

The main revenue is direct payment by customers and a public contribution which, on average, accounts for €93,673 per year (see methodology).

Savings as Revenues

The measure provides savings through avoided costs in operations associated with waste collection through pipes instead of traditional methods relying on trucks.

Financial Conclusion

With the available information, the measure seems to be financially sustainable. The partner reports revenues of €93,673 per year (on average) with a PV revenue of €81,534 for the first year.

Economic Analysis

Positive Externalities

The added value of the measure is to improve quality of life limiting the use of inner and/or outer surfaces for waste bins and containers, reducing environmental impact, waste collection traffic (by 90% with an accompanying reduction in CO_2 emissions, noise and pollution), and emissions compared to the conventional bin collection using rear-loading trucks. Furthermore, processing collected food waste as biogas will greatly reduce GHG emissions from the waste.

- All these potential positive externalities can provide economic positive externalities.

Job Creation

Implementing the measure will have an impact in job creation, not just during the deployment phase but also during the operation phase. While the truck-drivers' jobs will disappear, more highly skilled jobs will be necessary: for example, engineers to manage the collection system and specialized maintenance workers will be needed for the infrastructure. According to our model, it has created 1.62 FTE.

Positive Externalities as Economic Savings

The traffic for collecting waste can be reduced by 90%, and space can be cleared in neighborhoods as there is no longer a need for storing garbage in many different places in the area. All waste is transported underground in pipelines to a collecting station located in a residential area with easy access for collection vehicles, generating economic savings.

Economic Conclusion

According to the savings reported by the partner in deliverable 5.4 (a reduction of traffic by 90%), the measure will provide a saving of €2.70 (see "Comments on Data and Methodology").

Comments on Data and Methodology

Calculations assuming 900 g CO_2/km based on "Too Big to Ignore – Truck CO_2 Emissions in 2030" (Transport Environment, 2015) and 50 km of truck handling saved per year. Regarding the revenues, users pay an average of €75,755 per year, although the public sector contributed €52,548 in 2017 and 2018 from the EU grant.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
467.302 €	49.882 €	15	1,33%	1,50%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	50.630 €	31.153 €	81.534 €	93.673 €
2	51.390 €	31.153 €	82.038 €	
3	52.161 €	31.153 €	82.548 €	
4	52.943 €	31.153 €	83.064 €	
5	53.737 €	31.153 €	83.585 €	
6	54.543 €	31.153 €	84.113 €	
7	55.361 €	31.153 €	84.646 €	
8	56.192 €	31.153 €	85.186 €	
9	57.035 €	31.153 €	85.732 €	
10	57.890 €	31.153 €	86.284 €	
11	58.758 €	31.153 €	86.842 €	
12	59.640 €	31.153 €	87.407 €	
13	60.534 €	31.153 €	87.978 €	
14	61.442 €	31.153 €	88.555 €	
15	62.364 €	31.153 €	89.140 €	
Total	**844.620 €**	**467.302 €**	**1.278.651 €**	
Average	**56.308 €**	**31.153 €**	**85.243 €**	

Internal Rate of Return (IRR): 2%

Input-Output Model

Economic impact of the investment	
Investment by industry partner	467.302,00 €
Output increase (Output impact - investment)	378.752,94 €
Employment impact	1,621

Following the Input-Output model, this measure's investment generates an expected increase of €378,752.94 to Sweden's economy.

Improving the Business Model

OPEX can be reduced when the product goes from the current state of prototype to a more fine-tuned serial-produced version. One key factor in the reduction of OPEX is to change technology for the automatic operation of the hatch on each inlet. Today, the measure uses pneumatic pressure, which causes an idle energy of 10,796 kWh per year for 300 apartments. With a rather straightforward design upgrade, the partner's estimate is that they can reduce the idle energy by 90% or 9800 kWh per year. By changing from pneumatic to electric drives, the pneumatic compressor only needs to operate for two hours instead of 24 hours per day. In addition, the energy consumption for electric drives of this small size can be disregarded.

This would also be beneficial for the CO_2 emissions caused by the system.

Solution 8. Big-Data Management

Barcelona . Measures: 8.1
Big Consolidated Open Data Platform by BSC

Financially not sustainable
Economically sustainable (Expected)

Data and information platform that can be used for city planning, traffic and energy management, or environmental monitoring.

Financial Analysis

Detailed Costs

For this measure, the CAPEX amounts to €340,146.

As is typical in software development projects, the majority of costs (up to 90%) are related to personnel costs.

Detailed Revenues

As of now, the only revenue is the EU grant. The rationale is that the measure intends to be an open-source platform. However, at any moment there is the option to charge a usage fee or license (per user or per institution).

Savings as Revenues

The measure provides savings through avoided costs associated with the time it takes to collect, process, analyze and visualize data.

Financial Conclusion

As for the financial evaluation, the measure seems to be unsustainable. The main reason is that we do not have access to information related to (potential) payments by users or financial savings related to the use of the platform (see Economic Analysis). However, this sustainability will be reached with an annual revenue higher than €28,940.

Economic Analysis

Positive Externalities

The platform can generate potential economic impacts through better decision-making, more informed decisions, reduced risk and increased productivity through automatization of procedures for data retrieving, merging, analysis and visualization.

Through the characterization of a typical procedure to be carried out with this measure, we concluded that the savings –in time and, therefore, euros- will be around €19.000 per user. Therefore, with two users the measure will be economically sustainable.

Job Creation

This measure is related to software, which is not particularly intensive in terms of job creation compared to hard infrastructure. According to our method, it has created 3.42 FTE.

Positive Externalities as Economic Savings

This measure provides expectations for better decision-making and faster information. Both may deliver economic savings in terms of reduced risks, fewer errors and less time on information gathering.

Economic Conclusion

With more data regarding avoided problems and risk mitigation, this measure could complement its feasibility with economic impacts derived from better decision-making and other positive externalities.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
363.438 €	0 €	15	2,19%	2,20%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	0 €	24.229 €	24.761 €	0 €
2	0 €	24.229 €	25.304 €	
3	0 €	24.229 €	25.858 €	
4	0 €	24.229 €	26.426 €	
5	0 €	24.229 €	27.005 €	
6	0 €	24.229 €	27.597 €	
7	0 €	24.229 €	28.202 €	
8	0 €	24.229 €	28.821 €	
9	0 €	24.229 €	29.453 €	
10	0 €	24.229 €	30.099 €	
11	0 €	24.229 €	30.759 €	
12	0 €	24.229 €	31.434 €	
13	0 €	24.229 €	32.123 €	
14	0 €	24.229 €	32.827 €	
15	0 €	24.229 €	33.547 €	
Total	0 €	363.438 €	434.215 €	
Average	0 €	24.229 €	28.948 €	

Internal Rate of Return (IRR): no revenues reported (open source business model).

Input-Output Model

Economic impact of the investment	
Investment by industry partner	363.438,00 €
Output increase (Output impact - investment)	231.318,84 €
Employment impact	3,420

Following the Input-Output model, this measure's investment generates an increase of €231,318.84 to Spain's economy.

Improving the Business Model

Although the partner has not reported any revenues or savings, we do believe there is a great potential for financial and economic benefits. Beyond the financial savings derived from reduced intervention times (through better data-relationship discoveries or other types of tasks), we could explore the possibility of deploying potential revenue streams like training, consultancy or maintenance services.

Cologne . Measures: 8.1 and 8.2
Urban Cockpit by Ui! and Cologne City Council.

Financially sustainable
Economically sustainable

Fast and easy overview of the current situation in your city in terms of traffic, energy, environment and the impact of smart measures concerning the 20/20/20 climate protection objectives. Consolidating, aggregating and using existing and new sensor data from infrastructure, traffic and users lays a new foundation for innovation to support a new generation of management, control and policies.

Financial Analysis

Detailed Costs

CAPEX Ui! €212,444 All their CAPEX is related to personnel costs for software development.	CAPEX Cologne City Council €72,000 (personnel costs) The maintenance costs for year 1-5 = Azure Cloud; year 6 to 10 Azure Cloud (5* €32,400 = €162,000) and the license costs for Urban Pulse and 2 Cockpits (5* €78,800 = €394,000 - 19% Taxes €74,860 = €319,140).

Detailed Revenues

For periods of less than three years, the UrbanPulse license will be €59,000/year. The Cockpit license for less than two years will be €9,900/year. Therefore, we assume €78,800 per year and per city.

According to the partner, for years 6 to n, Cologne will not be the only customer. More specifically, the partner expects to deploy their platform in three more cities.

Savings as Revenues

Depending on the data integrated in this type of urban platform, there are a lot of different possible savings as revenues. For example, savings in the area of parking space monitoring.

Financial Conclusion

With the information available, hypothetical average annual revenue to reach a positive financial net present value would be €15,098 per year. Therefore, from the Ui! point of view, the measure is financially sustainable.

However, from the city point of view, this is an enabling measure. This means that, although we can foresee potential benefits arising from opening data to citizens and companies in the city, those are hard to capture and evaluate. In that sense, the better the real-time data on the pulse, the better services can be created using this data.

Economic Analysis

Positive Externalities

Regarding the economic impact of the measure, it can be analyzed through data collection on decision-making processes, analysis and visualization.

In addition, potential positive impacts could derive from better information for decision-making and reduced risk.

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Job Creation

While the job impact is not as high as in other measures, it enables existing work to be carried out in a faster and more efficient way, thus freeing up time (and ultimately money) for other purposes. Job creation for this measure is 1.43 according to our model.

Positive Externalities as Economic Savings

This measure provides expectations for better decision-making and faster information. Both may deliver economic savings in terms of reduced risks, fewer errors and less time on information gathering.

Economic Conclusion

With better and more fine-grained data regarding problems avoided and risk mitigation, this measure could complement its feasibility with economic impacts derived from better decision-making and other positive externalities. As the open urban data platform is an enabling measure, its economic feasibility depends on the data given from the partners in the various measures. For example, by using real-time data from mobility stations, it would be possible to compare the offers of each station station prior to starting a trip to a city and to plan the trip more economically or environmentally consciously. This could increase the utilization of the mobility station and reduce individual traffic.

Theoretical Revenues in Net Present Value

Ui!				
CAPEX	OPEX	Lifetime	Bond	Inflation Rate
212.444 €	0 €	15	0,80%	1,50%
Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	0 €	14.163 €	14.275 €	78.800 €
2	0 €	14.163 €	14.389 €	
3	0 €	14.163 €	14.503 €	
4	0 €	14.163 €	14.619 €	
5	0 €	14.163 €	14.735 €	
6	0 €	14.163 €	14.852 €	
7	0 €	14.163 €	14.970 €	
8	0 €	14.163 €	15.089 €	
9	0 €	14.163 €	15.209 €	
10	0 €	14.163 €	15.330 €	
11	0 €	14.163 €	15.452 €	
12	0 €	14.163 €	15.575 €	
13	0 €	14.163 €	15.699 €	
14	0 €	14.163 €	15.823 €	
15	0 €	14.163 €	15.949 €	
Total	0 €	212.444 €	226.469 €	
Average	0 €	14.163 €	15.098 €	

Cologne City Council				
CAPEX	OPEX	Lifetime	Bond	Inflation Rate
72.000 €	44.400 €	15	0,80%	1,50%
Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	45.066 €	4.800 €	49.549 €	0 €
2	45.742 €	4.800 €	49.900 €	
3	46.428 €	4.800 €	50.254 €	
4	47.125 €	4.800 €	50.610 €	
5	47.831 €	4.800 €	50.968 €	
6	48.549 €	4.800 €	51.330 €	
7	49.277 €	4.800 €	51.694 €	
8	50.016 €	4.800 €	52.060 €	
9	50.767 €	4.800 €	52.429 €	
10	51.528 €	4.800 €	52.801 €	
11	52.301 €	4.800 €	53.175 €	
12	53.085 €	4.800 €	53.552 €	
13	53.882 €	4.800 €	53.931 €	
14	54.690 €	4.800 €	54.314 €	
15	55.510 €	4.800 €	54.699 €	
Total	751.797 €	72.000 €	781.264 €	
Average	50.120 €	4.800 €	52.084 €	

Internal Rate of Return (IRR): 36%

Input-Output Model

Economic impact of the investment	
Investment by industry partner	284.444,00 €
Output increase (Output impact - investment)	157.316,02 €
Employment impact	1,433

Following the Input-Output model, this measure's investment generates an increase of €157,316.02 to Germany's economy.

GrowSmarter
Transforming cities for a smart, sustainable Europe

Stockholm . Measures: 8.1
Big Consolidated Open Data Platform by IBM

Financially Sustainable
Economically Sustainable

By consolidating, aggregating and using existing mobile phone data, the platform will lay a new foundation for innovation to support a new generation of management, control and policies.

Financial Analysis

Detailed Costs

CAPEX for the measure is €329,838

As in many software development related projects, the majority of costs are personnel costs.

Cost of sensors, including any installation cost, is covered by another measure and not included in the cost for this measure.

Detailed Revenues

The partner reports benefits of €40,195 per year. The benefits will also increase in conjunction with an increase of users.

Savings as Revenues

Depending on the data integrated in this type of urban platform, there are a lot of possible different savings as revenues. For example, savings in the area of parking space monitoring.

Financial Conclusion

As seen in the financial evaluation, while the costs will slow down and the benefits will increase over time, this measure will eventually become more sustainable. The main reason is that we do not have access to information related to (potential) payments by users or financial savings related to the use of the platform (see Economic Analysis). However, this sustainability is already reached with an annual revenue higher than €34,612.

Economic Analysis

Positive Externalities

The benefits will be a better understanding of the area's flow of people and vehicles. This information can be used for decisions on how to use the sensors, big data, analytics and cloud technology going forward on a larger scale.

Job Creation

While the job impact is not as high as in other measures, it enables existing work to be carried out in a faster and more efficient way, thus freeing up time (and ultimately money) for other purposes. According to our model, it has created 1.63 FTE.

Positive Externalities as Economic Savings

Data can be retrieved from different sources. Some data can be accessed without adding new sensors. One example is weather data that can be accessed through the cloud platform. The project has installed new sensors for Wi-Fi and detection of vehicles.

Economic Conclusion

In the savings, the following items are included:

- Rubber line measurements for vehicles in three places, estimated at €9,445/year.
- Time saving for visitors to the area with a total value of €14,167/year. This is estimated from saving 10 minutes for 100 individuals 30 times per year. A value of €28/hour is used.
- Manual measurements for number of visitors to the area, including people flow and bicyclists measurements. Estimated at €9,445/year.
- Emission data from the area for the traffic analysts – estimated at a value of €9,445/year.

Theoretical Revenues in Net Present Value

CAPEX	OPEX	Lifetime	Bond	Inflation Rate
329.838 €	10.000 €	15	1,33%	1,50%

Years	OPEX	Annual CAPEX	PV Revenue	Revenues
1	10.150 €	21.989 €	32.298 €	40.195 €
2	10.302 €	21.989 €	32.611 €	
3	10.457 €	21.989 €	32.928 €	
4	10.614 €	21.989 €	33.248 €	
5	10.773 €	21.989 €	33.573 €	
6	10.934 €	21.989 €	33.902 €	
7	11.098 €	21.989 €	34.235 €	
8	11.265 €	21.989 €	34.572 €	
9	11.434 €	21.989 €	34.914 €	
10	11.605 €	21.989 €	35.260 €	
11	11.779 €	21.989 €	35.610 €	
12	11.956 €	21.989 €	35.965 €	
13	12.136 €	21.989 €	36.324 €	
14	12.318 €	21.989 €	36.688 €	
15	12.502 €	21.989 €	37.056 €	
Total	169.324 €	329.838 €	519.184 €	
Average	11.288 €	21.989 €	34.612 €	

Internal Rate of Return (IRR): 4%

Input-Output Model

Economic impact of the investment	
Investment by industry partner	329.838,00 €
Output increase (Output impact - investment)	196.573,47 €
Employment impact	1,630

Following the Input-Output model, this measure's investment generates an increase of €196,573.47 to Sweden's economy.

6.3. Work Package 4. Sustainable Mobility Solutions

Solution 9. Sustainable Delivery

Stockholm . Measures: 9.1
Delivery room for sustainable deliveries by Stockholmshem & Carrier

Financially Unsustainable
Economically Unsustainable

A delivery room installed in a communal area of a residential building, providing 24h accessibility to all tenants. All packages are delivered by Move-By-Bike, a bike and e-bike transport company.

Financial Analysis

Detailed Costs

CAPEX is equal to €139,000.00

OPEX is equal to €21,000.00, of which:
- 95% are maintenance costs.
- 5% are other expenses.

Detailed Revenues

As far as can be seen from the implementation and evaluation phase, the measure was not able to meet the minimum revenues.

Savings as Revenues

No financial savings are expected, as the savings that the delivery room and the cargo bicycles for the "last-mile" distribution might generate will not be captured by the industry partners.

Financial Conclusion

With the information available, the hypothetical average annual revenue to reach a positive financial net present value would be €29,385.42 per year.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Carrier reported the creation of 0.5 full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 1.6 FTE jobs.

Positive Externalities as Economic Savings

According to the report D5.4 from KTH, this measure presented no significant CO2 reduction.
Therefore, there is no positive externalities' monetary impact for the city of Stockholm.

Data related to traffic or noise reduction was not collected for further analysis.

Economic Conclusion

Even without information about revenues, it is clear that the measure needs more users to become feasible. However, making the service available for free to tenants may increase the use of the measure but not necessarily pay the implementation costs.

New ways to improve the business model will be developed in the "How to improve BM" frame and in the "replicability and scalability"section.

Comments on Data and Methodology

- The figures presented in this deliverable only describe the Carrier's costs.
- Most of the investment corresponds to preparation and pre-study effects of the measure before actually implementing it.

Last data received: 1Q2019

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
139.000,00 €	21.000,00 €	0,01327	0,015	20
Years	OPEX	Annual CAPEX	PV revenue	
1	21.315,00 €	6.950,00 €	28.078,08 €	
2	21.634,73 €	6.950,00 €	28.207,45 €	
3	21.959,25 €	6.950,00 €	28.338,11 €	
4	22.288,63 €	6.950,00 €	28.470,10 €	
5	22.622,96 €	6.950,00 €	28.603,42 €	
6	22.962,31 €	6.950,00 €	28.738,09 €	
7	23.306,74 €	6.950,00 €	28.874,13 €	
8	23.656,34 €	6.950,00 €	29.011,56 €	
9	24.011,19 €	6.950,00 €	29.150,39 €	
10	24.371,36 €	6.950,00 €	29.290,64 €	
11	24.736,93 €	6.950,00 €	29.432,34 €	
12	25.107,98 €	6.950,00 €	29.575,49 €	
13	25.484,60 €	6.950,00 €	29.720,12 €	
14	25.866,87 €	6.950,00 €	29.866,24 €	
15	26.254,87 €	6.950,00 €	30.013,88 €	
16	26.648,70 €	6.950,00 €	30.163,06 €	
17	27.048,43 €	6.950,00 €	30.313,79 €	
18	27.454,15 €	6.950,00 €	30.466,09 €	
19	27.865,97 €	6.950,00 €	30.619,99 €	
20	28.283,96 €	6.950,00 €	30.775,50 €	
Total	492.880,96 €	139.000,00 €	587.708,45 €	
Average	24.644,05 €	6.950,00 €	29.385,42 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	139.000,00 €
Output increase (Output impact - Investment)	85.204,22 €
Employment impact	1,6

Following the Input-Output model, this measure's investment generates an increase of €85,204.22 to Sweden's economy.

How to improve BM

- This measure faced a demographic issue in the area where the delivery room was implemented. The user profile of this measure should be young, because they are the group that most buys online and looks for new ways to receive deliveries. However, the residential area where the measure was implemented is composed of a majority of inhabitants of generations older than the target consumer. Therefore, implementing the delivery rooms in areas with a younger population could improve the figures for this measure.

- A potential way to improve the business model would be to integrate this service with the national post office. This would increase the reliability of the service, all stores would be able to use the service, it would have fewer bureaucratic issues in scaling up, and the number of customers would increase. This suggestion is further discussed in section 7.3.

Barcelona . Measure: 9.2

Micro distribution of freight by VANAPEDAL & CENIT

Financially Sustainable
Economically Sustainable

The company Vanapedal created an urban consolidation center (UCC), which is a last-mile distribution service. The UCC receives packages brought by the carriers and delivers them to their final destination using electric tricycles.

Financial Analysis

Detailed Costs

CAPEX is equal to €74,517.43

OPEX is equal to €289,729.85, from which:

- 6% are general supply costs.
- 75% are personnel costs.
- 19% are other expenses.

Detailed Revenues

Average yearly payments by users are about 91% of total revenue.

Average yearly public funding is about 9% of total revenue.

(The industry partner does not want to share the absolute value of the revenues).

Savings as Revenues

No financial savings are expected, as the savings that the UCC might generate from the last-mile distribution will not be captured by Vanapedal.

Financial Conclusion

Hypothetical annual average revenue to reach a positive financial net present value would be €314,464.29 per year.

The reported revenues are lower than the hypothetical revenues, especially when public subsidies are not taken into account.

Moreover, at the end of 2018, VANAPEDAL got a new client, an important e-commerce company, which increased their amount of deliveries by 154%. In following years, this new client will increase their revenues, which is likely to make them financially sustainable.

Economic Analysis

Positive Externalities

The potential positive externalities are:

- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

VANAPEDAL reported the creation of 16.7 full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 1.7 FTE jobs.

Positive Externalities as Economic Savings

According to CENIT, this measure reduced 231,258.59 kg of CO_2 emissions in 22 months. This can be translated as a positive externality of €13,875.50, or €7,568.45 a year, on average, for the city of Barcelona.

Data related to traffic or noise reduction was not collected for further analysis.

Economic Conclusion

According to the available data, this measure's positive externalities (€7,568.45) are lower than the gap between the needed and real average revenues (€46,717.21) as well as the public funding.

As mentioned before, the deal with the new important client will not only increase their revenues but also their impact in terms of positive externalities, which is likely to make them economically sustainable.

Comments on Data and Methodology

VANAPEDAL provided their tax reports from 2015, 2016 and 2017 for the financial analysis.

Last data received: 4Q2018.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
74.517,43	289.729,85	0,55%	2,20%	5

Years	OPEX	Annual CAPEX	PV revenue	Real Revenue
0	289.729,85 €	14.903,49 €	304.633,34 €	262920,07
1	296.103,91 €	14.903,49 €	309.469,70 €	286966,03
2	302.618,20 €	14.903,49 €	314.384,53 €	253355,14
3	309.275,80 €	14.903,49 €	319.379,12 €	
4	316.079,86 €	14.903,49 €	324.454,76 €	
Total	1.513.807,62 €	74.517,43 €	1.572.321,45 €	
Average	302.761,52 €	14.903,49 €	314.464,29 €	267747,08

Internal Rate of Return (IRR) cannot be calculated due to negative cash flows.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	74.517,43 €
Output increase (Output impact - Investment)	57.862,64 €
Employment impact	1,7

Following the Input-Output model, this measure's investment generates an expected increase of €57,862.64 to Spain's economy.

How to improve the Business Model

- The success of this measure is due to the restrictions on motor vehicles in certain areas of the city. With more areas with such restrictions, the partner will have more customers and more packages to distribute by cargo-bikes ensuring the sustainability of the business.
- One cost issue with this business model is that every five years, on average, it is necessary to buy new cargo tricycles. This equipment makes up one of the highest costs in relation to the modest cash flow volume that a small business such VANAPEDAL has. In other words, in the year when cargo bikes have to be replaced, it generates high deficits for the partner. Today, at least in Barcelona, there is no market for leasing this type of asset. Such a financial instrument would avoid the payment of VAT on the sale, which is paid by the leasing entity and would allow for deducting up to triple the tax amortization from the corporation taxes, thereby helping to maintain the financial health of the business in the long run.

Stockholm . Measures: 10.3 & 11.5
Travel demand Management & Smart guiding to alternative fuel stations and fast charging by KTH

Financially - Economically sustainable (Expected)

An integrated multi-modal phone application promoting sustainable travel choices, improving travel behavior and updating information on price and location of alternative fuel stations.

Financial Analysis

Detailed Costs

CAPEX is equal to €41,400.00.

The measure is not sold to the market yet, therefore no OPEX was reported. According to KTH, operational costs will only exist when a company or city hall hires the service. However, it will be a single and low cost per new contract.

Detailed Revenues

At this development stage, the product has not been yet sold on the commercial market, therefore, there is not have enough data for further conclusions.

Savings as Revenues

No financial savings are expected, as the savings that the phone application might capture from reducing traffic congestion and promoting green fuels will not be captured by KTH.

Financial Conclusion

With the information available, hypothetical average annual revenue to reach a positive financial net present value would be €8,309.11 per year.

Economic Analysis

Positive Externalities

The potential positive externalities are:

- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Based on the industry partners' personnel costs information, this measure creates 0.07 FTE jobs during years 3 and 5, and 0.14 FTE jobs during year 4.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.2 FTE jobs.

Positive Externalities as Economic Savings

The measure is operating on a limited basis at the test site, and in a municipality outside Stockholm, and no data related to CO_2 emissions has been collected yet.

Data related to traffic or noise reduction was not collected for further analysis.

Economic Conclusion

In the event that this measure has no revenue, it could still be economically sustainable if it reduces 138.5 tons of CO_2 per year. That CO_2 amount would cover the (€8,309.11) in hypothetical revenues.

According to *American Public Transportation Association*, the use by a solo commuter, switching his/her commute from a private vehicle, can reduce CO_2 emissions by more than two tons in a year. Therefore, if this measure causes about 64 users to switch their commuting behavior, it could reach a reduction of 138.5 tons of CO_2 per year.

Comments on Data and Methodology

All the costs reported are personnel costs because, according to the partner, any other cost that might exist is marginal and insignificant.
Reference from *American Public Transportation Association*:
https://www.apta.com/resources/reportsandpublications/Documents/greenhouse_brochure.pdf
Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
41.400,00 €	- €	0,00117	0,015	5
Years	OPEX	Annual CAPEX	PV revenue	
1	- €	8.280,00 €	8.289,69 €	
2	- €	8.280,00 €	8.299,39 €	
3	- €	8.280,00 €	8.309,10 €	
4	- €	8.280,00 €	8.318,82 €	
5	- €	8.280,00 €	8.328,55 €	
Total	- €	41.400,00 €	41.545,54 €	
Average	- €	8.280,00 €	8.309,11 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	41.400,00 €
Output increase (Output impact - Investment)	20.655,00 €
Employment impact	0,2

Following the Input-Output model, this measure's investment generates an increase of €549,377.53 to Sweden's economy.

How to improve the Business Model

- Partner must attract users who are willing to change how they commute. These users are usually young workers.
- Therefore, they could consider investing in marketing strategies to attract such users.
- A possible solution is to have a free version with advertisements for people to get to know the service and a paid version without advertisements.
- The paid version can be sold to companies and municipalities, who would offer it to their employees for use. Moreover, the company could create an incentive for the app to be used regularly as an award for employees who emit less C02 per km during the period of a month or a quarter.
- Partnerships with car-sharing and bike-sharing companies can be beneficial for the business. Such partnerships would create more added value to the app, attracting more users, which in turn, might increase the car and bike shared services.

Stockholm . Measure: 10.5
Traffic signals synchronized to prioritize certain vehicles' movement of goods by Carrier & Stockholm city hall

Financially unsustainable
Economically -

Traffic signals will be reprogrammed and synchronized to prioritize the movement of goods distribution vehicles to minimize starts and stops.

Financial Analysis

Detailed Costs

CAPEX is equal to €3,154.14, which corresponds to personnel costs to reprogram and synchronize the traffic signals.

OPEX is equal to €9,795.50, of which:
- 100% are maintenance costs.

Detailed Revenues

As it is a measure of public infrastructure modernization, this measure does not expect revenues.

Savings as Revenues

Financial savings are expected, as the savings on delivery time and fuel consumption that the traffic signals system might generate will be captured by the carrier. However, for data collection complications, it is not yet possible to state the magnitude of such savings.

Financial Conclusion

With the information available, hypothetical average annual revenue to reach a positive financial net present value would be €10,702.20 per year.

In case the financial savings information was available, it would be feasible to evaluate the operational cost reduction for Carrier, that would also reduce the hypothetical average annual revenue estimation.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

According to partners, this measure created on average 0.1 full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.02 FTE jobs.

Positive Externalities as Economic Savings

According to the report D5.4 from KTH, this measure presented an unsatisfactory data collection. Therefore, we will not be able to estimate the positive externalities' monetary impact for the city of Stockholm.

This measure's average yearly public funding is €10,846.88, entirely from an EU grant.

Economic Conclusion

With the information available, it is not feasible say whether this measure is economically sustainable.

However, if we consider the public financing as a correct representation of the positive externalities value, then this measure would be economically sustainable. The EU grant (€10,846.88) is greater than the hypothetical average annual revenues (€10,702.20).

Comments on Data and Methodology

Partners have not yet confirmed the validity of the data.

Last data received: 1Q2018.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
3.154,14 €	9.795,50 €	0,00117	0,015	5
Years	OPEX	Annual CAPEX	PV revenue	
0	9.795,50 €	630,83 €	10.426,33 €	
1	9.942,43 €	630,83 €	10.562,38 €	
2	10.091,57 €	630,83 €	10.700,30 €	
3	10.242,94 €	630,83 €	10.840,12 €	
4	10.396,59 €	630,83 €	10.981,86 €	
Total	50.469,03 €	3.154,14 €	53.510,99 €	
Average	10.093,81 €	630,83 €	10.702,20 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	3.154,14 €
Output increase (Output impact - Investment)	1.573,64 €
Employment impact	0,02

Following the Input-Output model, this measure's investment generates an increase of €1,573.64 to Sweden's economy.

Improving the Business model

- Low annual revenues needed looking at the cost side, since they might be rather easily compensated by the financial savings.

Solution 11. Alternative Fuel-Driven Vehicles for Decarbonizing and Better Air Quality

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Cologne. Measures: 5.2
Electrical Charging and Street Lighting by RheinEnergie.

Financially unsustainable
Almost economically sustainable

By combining electrical charging with street lighting poles, the aim is to make urban areas ubiquitously connected and to enable a shared sensing infrastructure in open street spaces.

Financial Analysis

Detailed Costs

CAPEX is equal to €18,281.00

OPEX is equal to €6,133.28, from which:
- 71% are energy costs.
- 24% are maintenance costs.
- 5% are taxes.

Detailed Revenues

Given the relatively low costs for RheinEnergie to install and operate the charging infrastructure on their lampposts, the partner decided not to charge payments for the service or the energy used.

Savings as Revenues

No financial savings are expected, as the savings that the charging stations might generate for EV drivers will not be captured by RheinEnergie.

Financial Conclusion

The hypothetical annual average revenue to reach a positive financial net present value would be €6,460.36.

This measure is not financially sustainable but, in practice, it was never planned to be. RheinEnergie is the owner of the lighting poles, the grid and the electricity producers. Their cost to provide this measure's service is very low. According to the partner, the benefits of installing and managing a payment system would not compensate for the associated costs. Therefore, they decided to offer the service for free and include the cost in the marketing budget.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Noise reduction.

Job Creation

Partner has not reported the creation of full-time equivalent (FTE) jobs.
According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.1 FTE jobs.

Positive Externalities as Economic Savings

RheinEnergie estimates that, in 2018, this measure saved 1,343 kg of CO_2 emissions. Moreover, the partner expects an annual growth rate of 52% of electric vehicles in Cologne for the first five years. By then, this measure will be saving 8,822 kg of CO_2 every year.
This can be translated as a positive externality of €80.60 for the city of Cologne in 2018 and €529.30 after the EV's increase.
Therefore, if we consider the latter CO_2 savings for the 10-year lifespan of this measure, we would have a positive externality of €5,293.00.

Data related to noise reduction was not collected for further analysis.

The partner estimates that €22,000.00 of the EU grant was spent over the entire duration of the project, which means, on average, €4,400.00 a year.

Economic Conclusion

According to the available data, this measure's positive externalities (€529.30) are lower than the needed average revenue (€6,460.36) as well as the EU grant (€4,400.00).

As mentioned before, RheinEnergie will have better figures after an important increase of electric vehicles in Cologne. However, the measure cannot be considered economically sustainable even at that point with the current business model.

Comments on Data and Methodology

RheinEnergie estimates that the stations' usage will increase 52% for the five following years. All projections are made with RheinEnergie's estimative data.

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
18.281,00 €	6.133,28 €	0,01064	0,015	10
Years	OPEX	Annual CAPEX	PV revenue	
0	2.546,45 €	1.828,10 €	4.374,55 €	
1	2.599,60 €	1.828,10 €	4.419,78 €	
2	3.023,19 €	1.828,10 €	4.827,08 €	
3	3.667,05 €	1.828,10 €	5.439,52 €	
4	4.645,71 €	1.828,10 €	6.360,30 €	
5	6.133,28 €	1.828,10 €	7.744,60 €	
6	6.225,28 €	1.828,10 €	7.790,21 €	
7	6.318,66 €	1.828,10 €	7.836,14 €	
8	6.413,44 €	1.828,10 €	7.882,40 €	
9	6.509,64 €	1.828,10 €	7.928,99 €	
Total	48.082,32 €	18.281,00 €	64.603,55 €	
Average	4.808,23 €	1.828,10 €	6.460,36 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	18.281,00 €
Output increase (Output impact - Investment)	14.220,95 €
Employment impact	0,1

Following the Input-Output model, this measure's investment generates an expected increase of €14,220.95 to Germany's economy.

Improving the Business Model

- The business model of this measure is designed to support the charging network infrastructure for electric vehicles without aiming at a direct profit, so RheinEnergie does not intend to charge for the service. This low-cost infrastructure support should, to some extent, foster the electric vehicle market by increasing the demand for paid charging stations offered by RheinEnergie at various points in the city.

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Cologne. Measures: 11.1
Developing Charging Infrastructure by RheinEnergie

Financially unsustainable
Economically unsustainable

Ten public charging stations for EV have been implemented in six GrowSmarter "mobility stations".

Financial Analysis

Detailed Costs

CAPEX is equal to €140,745.13

Average yearly OPEX is equal to €40,558.66, of which:
- 75% are energy costs.
- 21% are maintenance costs.
- 4% are taxes.

Detailed Revenues

For the years of the GrowSmarter project, RheinEnergie did not charge for the service or energy.

In the near future, payments by users are estimated to be 36.4% higher than energy costs. For instance, the average yearly revenue is € 40,519.77. This margin is enough to cover the yearly fixed costs from taxes and maintenance (€10,167.45) in the long term.

Savings as Revenues

No financial savings are expected, as the savings that the charging stations might generate for EV drivers will not be captured by RheinEnergie.

Financial Conclusion

Given the expected annual growth rate of 52% of electric vehicles in Cologne for the first five years:
- Hypothetical annual average revenue to reach a positive financial net present value would be €52,997.65 per year.
- Looking at their average yearly payment by user, it is €12,477.88 less than the needed revenue.
- The actual revenue seems to be moving in the right direction. Payments by user would need to increase by less than 1% in the sixth year for the revenue to exceed the operational cost.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Noise reduction.

Job Creation

Partner has not reported the creation of full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.4 FTE jobs.

Positive Externalities as Economic Savings

RheinEnergie estimates that, in 2018, this measure saved 4,051 kg of CO_2 emissions and after the five-year increase of electric vehicles it will save 32,865 kg of CO_2 every year. This can be translated as a positive externality of €243.00 for the city of Cologne in 2018 and €1,972.00 after the EV's increase.
Therefore, if we consider the latter CO_2 savings for the 10-year lifespan of this measure, we would have a positive externality of €19,720.00.

Data related to traffic or noise reduction was not collected for further analysis.

The partner estimates that €156,300.00 of the EU grant was spent over the entire duration of the project, which means, on average, €31,260.00 a year.

Economic Conclusion

According to the available data, this measure's positive externalities (€1,972.00) are lower than the gap between the needed and real average revenues (€12,477.88) as well as the EU grant (€31,260.00).

As mentioned before, RheinEnergie will have better figures after an important increase of electric vehicles in Cologne. However, the measure cannot be considered economically sustainable even at that point with the current business model.

Comments on Data and Methodology

This measure started operating in 2018, and RheinEnergie estimates that the stations' usage will increase 52% for the next five following years. All projections are made with RheinEnergie's estimative data.

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate
140.745,13	54.438,46	0,01064	0,015
Years	OPEX	Annual CAPEX	PV revenue
0	15.665,92 €	14.074,51 €	29.740,44 €
1	18.321,76 €	14.074,51 €	32.353,13 €
2	22.651,15 €	14.074,51 €	36.552,33 €
3	29.231,83 €	14.074,51 €	42.846,83 €
4	39.234,46 €	14.074,51 €	52.291,28 €
5	54.438,46 €	14.074,51 €	66.471,91 €
6	55.255,04 €	14.074,51 €	66.852,55 €
7	56.083,86 €	14.074,51 €	67.235,83 €
8	56.925,12 €	14.074,51 €	67.621,77 €
9	57.779,00 €	14.074,51 €	68.010,40 €
Total	405.586,61 €	140.745,13 €	529.976,49 €
Average	40.558,66 €	14.074,51 €	52.997,65 €

Internal Rate of Return (IRR) cannot be calculated because of negative cash flow.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	140.745,13 €
Output increase (Output impact - Investment)	109.486,90 €
Employment impact	0,4

Following the Input-Output model, this measure's investment generates an expected increase of €109,486.90 to Germany's economy.

Improving the Business Model

- Like the other measures related to charging stations, location is fundamental. The stations should be located in areas in the path of people who have sufficient purchasing power to afford an electric car. Ideally, the stations should be located close to the home or work of these individuals, as this is where they leave the vehicle parked for a long period of time.

Stockholm . Measures: 11.1
Developing Charging Infrastructure by Fortum

Almost financially sustainable.
Economically sustainable (Expected)

One fast-charging station and three normal charging stations implemented in the city of Stockholm.

Financial analysis

Detailed Costs

CAPEX is equal to €52,960.00 €.

OPEX is equal to €9,880.00, of which:
- 61% are energy costs.
- 29% are personnel costs.
- 10% are maintenance costs.

Detailed Revenues

Average yearly payment for the chargers is €11,666.67.

Savings as Revenues

No financial savings are expected, as the savings that the charging stations might generate for EV drivers will not be captured by Fortum.

Financial Conclusion

With the information available, the hypothetical average annual revenue to reach a positive financial net present value would be €14,963.31 per year.

The reported revenues from payments by users are lower than the hypothetical revenues by €3,296.64 a year.

Economic analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Noise reduction.

Job Creation

Fortum reported the creation of 0.18 full-time equivalent (FTE) jobs during the installation of the chargers, but it is reduced to 0.01 FTE jobs for the following years.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.2 FTE jobs.

Positive Externalities as Economic Savings

According to the report D5.4 from KTH, this measure could not be validated due to missing information in the evaluation
report. Therefore, we will not be able to estimate the measure's monetary impact for the city of Stockholm.

Average yearly public funding is €16,193.33, entirely from an EU grant.

However, looking at charging infrastructure measures 5.2 and 11.1 in Cologne as a benchmark, we see that they generate €529.30 and €1,972.00, respectively, from CO_2 savings.

Economic Conclusion

As mentioned before, the information available is not have enough to draw strong economic conclusions.

Comments on Data and Methodology

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
52.960,00 €	9.880,00 €	0,00656	0,015	10
Years	OPEX	Annual CAPEX	PV revenue	Real Revenue
1	11.900,00 €	5.296,00 €	17.230,74 €	9.000,00 €
2	5.700,00 €	5.296,00 €	11.065,71 €	11.000,00 €
3	6.200,00 €	5.296,00 €	11.600,91 €	15.000,00 €
4	9.880,00 €	5.296,00 €	15.316,34 €	40.000,00 €
5	10.028,20 €	5.296,00 €	15.434,85 €	
6	10.178,62 €	5.296,00 €	15.554,28 €	
7	10.331,30 €	5.296,00 €	15.674,65 €	
8	10.486,27 €	5.296,00 €	15.795,97 €	
9	10.643,57 €	5.296,00 €	15.918,23 €	
10	10.803,22 €	5.296,00 €	16.041,45 €	
Total	96.151,18 €	52.960,00 €	149.633,14 €	75.000,00 €
Average	9.615,12 €	5.296,00 €	14.963,31 €	18.750,00 €

Internal Rate of Return (IRR): -38%

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	52.960,00 €
Output increase (Output impact - Investment)	31.292,53 €
Employment impact	0,2

Following the Input-Output model, this measure's investment generates an increase of €31,292.53 to Sweden's economy.

Improving the Business Model

- Like the other measures related to charging stations, location is fundamental. The stations should be located in areas in the path of people who have sufficient purchasing power to afford an electric car. Ideally, the stations should be located close to the home or work of these individuals, as this is where they leave the vehicle parked for a long period of time.

Barcelona . Measures: 11.1 & 11.2
V2G Charging Stations and EV fleet by NISSAN & IREC

Financially -
Economically -

NISSAN and IREC implemented a car fleet along with green electricity chargers with bi-directional technology, allowing a vehicle to grid (V2G) capability, in addition to an energy storage and photovoltaic system.

Financial Analysis

Detailed Costs

CAPEX is equal to €123,819.14

Average yearly OPEX is equal to €1.464.00, of which:
- 97% are maintenance costs.
- 3% are taxes.

Detailed Revenues

Since NISSAN is the user of their own measure, no payments by users are reported.

Savings as Revenues

The yearly financial savings for NISSAN for using their EVs plus charging stations instead of conventional vehicles is €11,043.13.

Financial Conclusion

With the information available, the hypothetical average annual revenue to reach a positive financial net present value would be € 26,439.53 per year.

As mentioned before, so far, NISSAN is the customer for their own measure. Therefore, all we can say is that they have a yearly financial savings of €11,043.13 by using the V2G system instead of a conventional car fleet.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Noise reduction.

Job Creation

NISSAN reported the creation of 0.22 full-time equivalent (FTE) jobs during the installation of the chargers.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 0.7 FTE jobs.

Positive Externalities as Economic Savings

NISSAN estimates that, in 2019, this measure will save 3,073.47 kg of CO_2 emissions.
This can be translated as a positive externality of €184.41 for the city of Barcelona.

Data related to noise reduction was not collected for further analysis.

The public funding is €80,579.00, entirely from an EU grant.

Economic Conclusion

According to the available data, this measure's positive externalities (€184.41) are lower than the gap between the needed and real average revenues (€26,439.53) as well as the EU grant (€80,579.00).

Comments on Data and Methodology

Last data received: 2Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
123.819,14 €	1.464,00 €	0,00549	0,022	5

Years	OPEX	Annual CAPEX	PV revenue
0	1.464,00 €	24.763,83 €	26.227,83 €
1	1.496,21 €	24.763,83 €	26.387,82 €
2	1.529,12 €	24.763,83 €	26.548,95 €
3	1.562,77 €	24.763,83 €	26.711,24 €
4	1.597,15 €	24.763,83 €	26.874,69 €
Total	7.649,24 €	139.000,00 €	587.708,45 €
Average	1.529,85 €	24.763,83 €	26.550,10 €

Internal Rate of Return (IRR): -25%

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	123.819,14 €
Output increase (Output impact - Investment)	78.023,89 €
Employment impact	0,7

Following the Input-Output model, this measure's investment generates an increase of € 78,023.89 to Spain's economy.

Improving the Business Model

- NISSAN's plan is to market the system for use in homes, buildings or any other context that uses an electric grid and where it makes sense to park cars in the vicinity.
- NISSAN intends to sell its EVs along with the V2G chargers to urban customers who understand that most charging will take place at home, whereas the use of rapid-charging infrastructure will be more sporadic, i.e., casual, extraordinary use in public places.

Stockholm. Measures: 11.4
Renewable fuels for heavy-duty vehicles by Stockholm City Hall.

Financially -
Economically -

A fueling station with alternative fuels – Diesel EN 590, Bensin EN 228, HVO 100, ED95, AdBlue and CNG/CBG – for heavy vehicles.

Financial Analysis

Detailed Costs

CAPEX is equal to €2,395,359.25

OPEX is equal to €65,612.01, of which:
- 38% are land rental.
- 35% are energy costs.
- 17.5% are maintenance costs.
- 9.5% are other operational costs.

Detailed Revenues

This data is captured by a third party outside the project and, therefore, we cannot access it.

Savings as Revenues

No financial savings are expected, as the savings that the alternative fueling stations might capture from promoting green fuels will not be captured by Stockholm City Hall.

Financial Conclusion

With the information available, hypothetical average annual revenue to reach a positive financial net present value would be €231,844.91 per year.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.

Job Creation

Partner has not reported the creation of full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 4.8 FTE jobs.

Positive Externalities as Economic Savings

According to the report D5.4 from KTH, there are no figures related to the CO2 emission reduction due to this measure. Therefore, we will not be able to estimate the positive externalities' monetary impact for the city of Stockholm.

Economic Conclusion

As mentioned before, there is not enough data to draw strong conclusions

Comments on Data and Methodology

- The figures presented in this deliverable portray only one alternative fueling station, even though we had financial data for two different ones. The reason for that choice is that the second station is not constructed yet.
- It is also important to note that, according to the partner, the reported data describes a rather positive scenario.
- The lifespan of the asset is equal to 15 years, because within the investment cost the lifetime of the assets varies between 10 and 20 years.

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Station1				
Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
2.395.359,25 €	65.612,01 €	0,0075	0,015	15
Years	OPEX	Annual CAPEX	PV revenue	
1	66.596,19 €	159.690,62 €	226.988,74 €	
2	67.595,14 €	159.690,62 €	229.690,10 €	
3	68.609,06 €	159.690,62 €	231.919,74 €	
4	69.638,20 €	159.690,62 €	234.173,70 €	
5	70.682,77 €	159.690,62 €	236.452,29 €	
6	71.743,02 €	159.690,62 €	238.755,80 €	
7	72.819,16 €	159.690,62 €	241.084,54 €	
8	73.911,45 €	159.690,62 €	243.438,82 €	
9	75.020,12 €	159.690,62 €	245.818,95 €	
10	76.145,42 €	159.690,62 €	248.225,24 €	
11	77.287,60 €	159.690,62 €	250.658,02 €	
12	78.446,92 €	159.690,62 €	253.117,61 €	
13	79.623,62 €	159.690,62 €	255.604,35 €	
14	80.817,97 €	159.690,62 €	258.118,56 €	
15	82.030,24 €	159.690,62 €	260.660,58 €	
Total	1.110.966,89 €	798.453,08 €	1.159.224,56 €	
Average	74.064,46 €	159.690,62 €	231.844,91 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Following the Input-Output model, this measure's investment generates an increase of €1,017,026.42 to Sweden's economy.

Economic impact of the investment	
Investment by the Industry Partners	2.395.359,25 €
Output increase (Output impact - Investment)	1.017.026,42 €
Employment impact	4,8

Solution 12. Smart Mobility Solutions

How to Improve the Business Model

Stockholm . Measures: 12.1
Electric car sharing pool by Stockholmshem

Financially -
Economically -

Implement an electric car sharing pool station, with two vehicles, to serve a variety of users and functions.

Financial Analysis

Detailed Costs

CAPEX is equal to €12,917.65

OPEX is equal to €16,581.72 yearly. This value represents a monthly payment of €500 per vehicle to MoveAbout, the car sharing supplier, plus a monthly loss of revenue for 2 parking spaces.

Detailed Revenues

The revenues related to the measure go to MoveAbout. That is, data is captured by a third party outside the project and, therefore, we cannot access it.

Savings as Revenues

No financial savings are expected, as the savings that Stockholmshem might generate for the users who will not buy and maintain a car will not be captured by the partner.

Financial Conclusion

With the information available, the hypothetical average annual revenue to reach a positive financial net present value would be €19,629.74 per year.

Looking at MoveAbout's pricing system and assuming that an average customer uses a shared car either three times a week for roughly five hours each time or 10 hours spread over a week, this car sharing pool station would need to have almost 40 different users. That is not realistic, given that there are only two cars in this station.
However, this result does not convey the actual financial situation of the measure, as MoveAbout's pricing system is designed for their business within all of Sweden.

Economic Analysis

Positive Externalities

The potential positive externalities are:

- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Partner has not reported the creation of full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create 0.1 FTE jobs.

Positive Externalities as Economic Savings

Stockholmshem estimates that, from February 2018 to March 2019, this measure saved 8,336 kg of CO_2 emissions.
This can be translated as a positive externality of €500.16 for the city of Stockholm.

Data related to traffic or noise reduction was not collected for further analysis.

Economic Conclusion

As we do not have data on the current revenues of this measure, we cannot draw economic conclusions.

Comments on Data and Methodology

The figures presented in this deliverable portray only one electric car sharing station. Moreover, there are two stations installed but only one is operating, so we consider only half of the total costs of the stations' installation.

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
12.917,65 €	16.581,72	0,00117	0,015	5
Years	OPEX	Annual CAPEX	PV revenue	
0	16.581,72 €	2.583,53 €	19.165,25 €	
1	16.830,44 €	2.583,53 €	19.394,31 €	
2	17.082,90 €	2.583,53 €	19.626,53 €	
3	17.339,14 €	2.583,53 €	19.861,96 €	
4	17.599,23 €	2.583,53 €	20.100,64 €	
Total	85.433,44 €	12.917,65 €	98.148,68 €	
Average	17.086,69 €	2.583,53 €	19.629,74 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	12.917,65 €
Output increase (Output impact - Investment)	8.859,98 €
Employment impact	0,1

Following the Input-Output model, this measure's investment generates an increase of €8,859.98 to Sweden's economy.

Stockholm . Measures: 12.2
Electrical and cargo bike pool by Stockholmshem

Financially -
Economically -

Two electric cargo bikes in the pool at Valla Torg. They are available for tenants living in the buildings that are part of the Grow Smarter project.

Financial Analysis

Detailed Costs

CAPEX is equal to €7,881.95

OPEX is equal to €4,465.08 yearly. This value represents a monthly payment of €372,09 for both bikes to Cykelpoolen, the private company that conducts the electric cargo bike pool.

Detailed Revenues

The revenues related to the measure go to Cykelpoolen. That is, data is captured by a third party outside the project and, therefore, we cannot access it.

Savings as Revenues

No financial savings are expected, as the savings that Stockholmshem might generate for the users who will not buy and maintain a car will not be captured by the partner.

Financial Conclusion

With the information available, the hypothetical average annual revenue to reach a positive financial net present value would be €6,166.55 per year.

Economic Analysis

Positive Externalities

The potential positive externalities are:

- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Partner has not reported the creation of full-time equivalent (FTE) jobs.

According to the Input-Output methodology, from the investment made in this measure it is expected to create 0.02 FTE jobs.

Positive Externalities as Economic Savings

Stockholmshem estimates that, from February 2018 to March 2019, this measure saved 33 kg of CO_2 emissions. This can be translated as a positive externality of €1.98 for the city of Stockholm.

Data related to traffic or noise reduction was not collected for further analysis.

Economic Conclusion

As we do not have data on the current revenues of this measure, we cannot draw economic conclusions.

Comments on Data and Methodology

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

Investment Costs	Operating Costs	Bond	Inflation rate	Life time asset
7.881,95 €	4.465,08	0,00117	0,015	5
Years	OPEX	Annual CAPEX	PV revenue	
0	4.465,08 €	1.576,39 €	6.041,47 €	
1	4.532,06 €	1.576,39 €	6.103,15 €	
2	4.600,04 €	1.576,39 €	6.165,68 €	
3	4.669,04 €	1.576,39 €	6.229,08 €	
4	4.739,07 €	1.576,39 €	6.293,35 €	
Total	23.005,28 €	7.881,95 €	30.832,73 €	
Average	4.601,06 €	1.576,39 €	6.166,55 €	

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	7.881,95 €
Output increase (Output impact - Investment)	6.140,76 €
Employment impact	0,02

Following the Input-Output model, this measure's investment generates an increase of €6,140.76 to Sweden's economy.

Cologne . Measure: 12.3
Mobility station by Ampido (+ RheinEnergie, Cambio & KVB).

Financially unsustainable. Economically sustainable (Expected).

Measure 12.3 comprises measures 12.4 along with 11.1 plus the service provided by Ampido. Therefore, this fact sheet focus on Ampido. For more information on the rest of the measure, check the others previously mentioned.
Ampido is an app that lets users look for a parking spot and book it in advance. This service is offered in mobility station's parking spaces.

Financial Analysis

Detailed Costs

Ampido's CAPEX is equal to €0, since the app software was developed before the GrowSmarter project.

Ampido's average OPEX is €28,288.46, of which:
- 62% are personnel costs.
- 21% are maintenance costs.
- 17% are other expenses.

Detailed Revenues

Ampido's average yearly payment by user is €11,297.33.

Savings as Revenues

No financial savings are expected, as the savings that Ampido might generate for the users who will not drive around looking for a parking place will not be captured by the partner.

Financial Conclusion

Ampido's needed average revenue to reach financial sustainability is €28,288.46 a year.
Looking at their average payment by user, it is €16,991.13 less than the needed revenue. Hence, the profits of this measure came from the EU grant.
However, it seems that, every year, payments by users are getting closer to the needed revenue, suggesting that business and market adaptations took place during the span of the project.

Economic Analysis

Positive Externalities

The potential positive externalities are:
- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Up to this moment, partners reported the creation of an average of 0.3 full-time equivalent (FTE) jobs. However, they plan to make a cut in personnel costs, reducing the jobs to 0.1 FTE.

Positive Externalities as Economic Savings

According to Ampido, this measure reduced 108.83 kg of CO_2 emissions from 2017 until mid-2018, with 106.38 kg in 2018 alone. If we take the monthly average of last year's CO_2 savings for the five-year lifespan of this measure, we would have a positive externality of €11.

Data related to traffic or noise reduction was not collected for further analysis.

Ampido's average yearly public funding is €20,416.67, entirely from an EU grant.

Economic Conclusion

According to the available data, this measure's positive externalities (€11) are lower than the gap between needed and real average revenue (€16,991.13) as well as the EU grant (€20,416.67).

Although, each year Ampido has had better figures, the potential for positive externalities is quite low. It will not make the measure economically sustainable if the financially viability is not reached.

Comments on Data and Methodology

Ampido reported detailed data for every year of their measure, which was enough to cover the whole lifespan of their assets. Therefore, no assumptions were made in realizing the financial analysis.
In measures 12.3 and 12.4, the figures of the services offered in the mobilty hubs were made available separately. Therefore, what it is possible to analyze are these services individually. In order to analyze the added value of the mobility stations as a single measure, it would be necessary to have data from the industrial partners before and after the construction of the stations, taking into account several factors in a before and after analysis, such as location, user profile, market size, etc.
Last data received: 4Q2018.

Theoretical Revenues in Net Present Value

Investment Costs	Opearting Costs	Life time asset	Bond	Inflation rate
- €	-	6	0	0,015

Years	OPEX	Annual CAPEX	Needed revenue	Real Revenue
0	27.000,00 €	- €	27.000,00 €	- €
1	35.470,00 €	- €	35.470,00 €	1.329,00 €
2	35.520,76 €	- €	35.520,76 €	11.455,00 €
3	32.380,00 €	- €	32.380,00 €	16.000,00 €
4	27.080,00 €	- €	27.080,00 €	18.000,00 €
5	12.280,00 €	- €	12.280,00 €	21.000,00 €
Total	169.730,76 €	- €	169.730,76 €	67.784,00 €
Average	28.288,46 €	- €	28.288,46 €	11.297,33 €

Internal Rate of Return (IRR) cannot be calculated because of negative cash flow.

Input-Output Model

Since the partner stated that there was no investment, it will not be possible to use the Input-Output model to estimate this measure's expected impact on employment or Germany's output.

Improving the Business Model

Ampido has been providing its service since before the GrowSmarter project. Therefore, the insights coming from their experience inside and outside of the project is discussed in the scalability and replicability section.

Cologne. Measure: 12.4
Electrical and conventional car sharing by Cambio & KVB.

Financially unsustainable. Economically sustainable (Expected).

Implement (e)car sharing as well as (e)bike sharing to serve a variety of users and functions. The measure is partly integrated with Measure 12.3 as part of Cologne's multi-modal mobility service, with charging infrastructure delivered by Measure 11.1.

Financial Analysis

Detailed Costs

Cambio's CAPEX is equal to €547,200.00.
Cambio's average OPEX is €305,409.20, of which:

- 35% are maintenance costs.
- 26% are other expenses.
- 23% are personnel costs.
- 14% are energy costs.
- 2% are taxes.

KVB's CAPEX is equal to €160,648.00 €.

KVB is owned by the city council and their operational cost is part of the city's budget. Thus, they do not report any OPEX.

Detailed Revenues

Cambio's average yearly payment by user is €289,597.60.

KVB does not receive any payment by users.
KVB's yearly average public funding is €40.162,00 to cover the CAPEX, from which:

- 70% is an EU grant.
- 30% is municipality financing.

Savings as Revenues

No financial savings are expected, as the savings that Cambio and KVB might generate for the users who will not buy and maintain a car will not be captured by the partners.

Financial Conclusion

KVB has all their cost covered by public funds, having no losses or gains.

Cambio's needed average revenue to reach financial sustainability is €399,039.20 a year.
Looking at their average payment by user, it is €109,441.60 less than the needed revenue. Hence, the profits of this measure came from the EU grant.
However, it seems that, every year, payments by users are getting closer to the needed revenue, suggesting that business and market adaptations happened during the time of the project.

Economic Analysis

Positive Externalities

The potential positive externalities are:

- CO_2 emission reduction.
- Travel time savings due to congestion reduction.
- Noise reduction.

Job Creation

Up to this moment, partners reported the creation of 3.5 full-time equivalent (FTE) jobs. However, they plan to cut personnel costs, reducing the jobs to 2.64 FTE.

According to the Input-Output methodology, from the investment made in this measure it is expected to create, directly and indirectly, 4 FTE jobs.

Positive Externalities as Economic Savings

According to Cambio, this measure reduced 370,869.00 kg of CO_2 emissions in the last three years, with 117,436.00 kg only in the last year. This can be translated as a positive externality of €22,252.14 for the city of Cologne in the last three years and €7,046.16 only last year.
Therefore, if we consider last year's CO_2 savings for the five-year lifespan of this measure, we would have a positive externality of €35,230.80.

Data related to traffic or noise reduction was not collected for further analysis.

Cambio's average yearly public funding is €128,990.80, entirely from an EU grant.

Economic Conclusion

According to the available data, this measure's positive externalities (€7,046.16) are lower than the gap between the needed and real average revenues (€109,441.60) as well as the EU grant (€128,990.80).
As mentioned before, for each year that has passed Cambio has shown better figures. This is especially true for the increase in users. Therefore, in coming years we can expect not only an increase in revenues but also in the positive externalities' impact. This is likely to make these stations economically and financially sustainable.

Comments on Data and Methodology

Cambio and KVB reported detailed data for every year of their measure, which was enough to cover the whole lifespan of their assets. Therefore, no assumptions were made in order to realize the financial analysis.

Last data received: 1Q2019.

Theoretical Revenues in Net Present Value

CAMBIO'S Costs and Revenues

Investment Costs	Operating Costs	Life time asset	Bond	Inflation rate
547.200,00	-	5	0	0,015
Years	OPEX	Annual CAPEX	Needed revenue	Real Revenue
0	63.445,00 €	109.440,00 €	172.885,00 €	45.000,00 €
1	306.774,00 €	109.440,00 €	416.214,00 €	273.301,00 €
2	351.625,00 €	109.440,00 €	461.065,00 €	335.352,00 €
3	365.060,00 €	109.440,00 €	474.500,00 €	368.887,00 €
4	361.092,00 €	109.440,00 €	470.532,00 €	425.448,00 €
Total	1.447.996,00 €	547.200,00 €	1.995.196,00 €	1.447.988,00 €
Average	289.599,20 €	109.440,00 €	399.039,20 €	289.597,60 €

Internal Rate of Return (IRR) cannot be calculated because of negative cash flow.

KVB's Costs and Revenues

Investment Costs	Operating	Life time asset	Bond	Inflation rate
160.648,00 €	-	3	0	0,015
Years	OPEX	Annual CAPEX	Needed revenue	Real Revenue
0	-	53.549,33 €	53.549,33 €	107.817,00 €
1	-	53.549,33 €	53.549,33 €	28.767,00 €
2	-	53.549,33 €	53.549,33 €	28.767,00 €
Total	- €	160.648,00 €	160.648,00 €	165.351,00 €
Average	-	53.549,33 €	53.549,33 €	55.117,00 €

Internal Rate of Return (IRR) cannot be calculated because no revenues were reported.

Input-Output Model

Economic impact of the investment	
Investment by the Industry Partners	712.551,00 €
Output increase (Output impact - Investment)	549.377,53 €
Employment impact	4,0

Following the Input-Output model, this measure's investment generates an expected increase of €549,377.53 to Germany's economy.

How to Improve the Business Model

According to Cambio, there are a few important issues related to losses in the GrowSmarter stations:

- First, some of them seem to be located in places that do not favor their use. They are either hidden or not within an optimal distance from the train station exits. Consequently, their average time usage is less than half of the other Cambio stations. So a major improvement would be to reallocate underutilized stations or invest in marketing strategies to entice people to use them.
- Second, in order to generate a better environmental impact, 30% of their fleet consists of electric cars, whereas the German Car Sharing Association speaks of a currently feasible 5% of the fleet in order to economically integrate e-mobility into car sharing. We must keep in mind that an electric car costs 55% more than a conventional car. One possible solution would be for the government to subsidize or reduce taxes levied on the purchase of an electric car.
- Finally, capacity utilization averages 36% per day for conventional vehicles and only 21% for electric cars (e.g. acceptance problems). For this issue, it is possible that, over time, people will have more knowledge about electric cars, relying more on their performance, and will use them more. In fact, according to Cambio, in 2019 the usage of electric cars has been increasing more than expected.
  Moreover, depending on the cost, it would also be worth considering investing in advertising that generates status for the driver in choosing an electric car.

6. Methodology Regarding Scalability and Replicability

6.1. Definitions

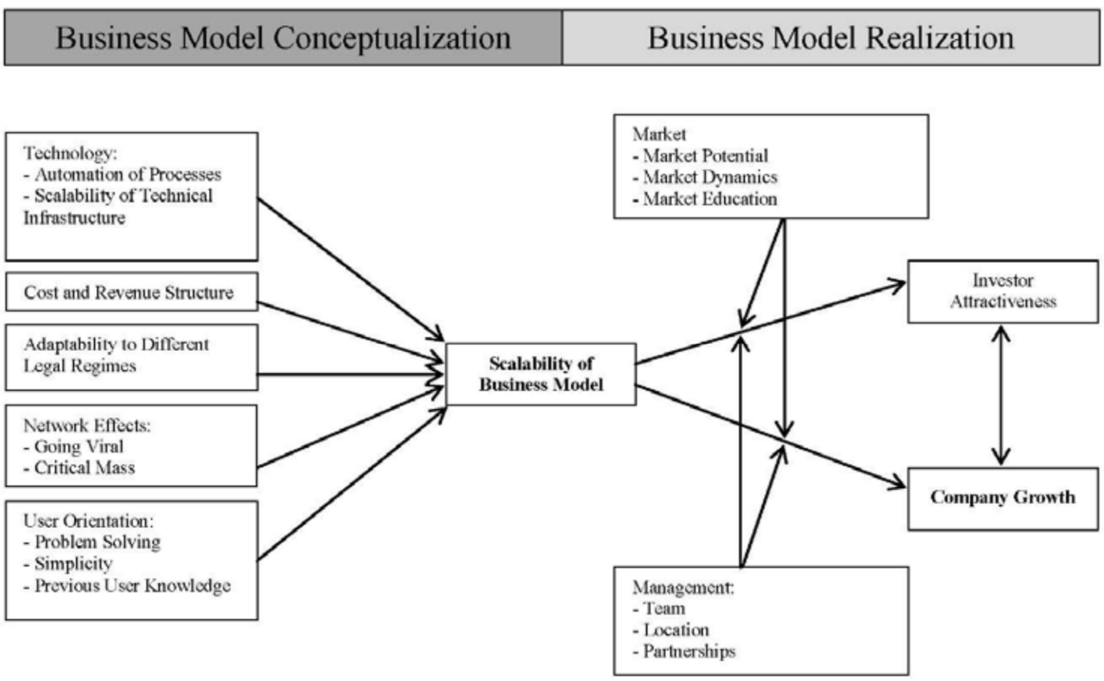
Prior to explaining the methodology regarding the scalability and replicability of a project, it is useful to understand the concepts.

SCALABILITY

Although the literature on business models is widespread both in academia and practitioner's fields, the concept of scalability is not properly addressed. Therefore, the analysis of scalability in the GrowSmarter project is one of the firsts attempts toward a multi-sector, multi-company and multi-location assessment of scalability, which allows us to advance in the business model knowledge stream with empirical data. However, drawing on the scarce literature on the scalability of business models, we can point out a preliminary definition for scalability.

For example, in Stampfl et al. (2013), the authors refer to scalable business models as the ability to increase revenues faster than the corresponding cost base (Hallowell, 2001) or, in other words, the concept of increased returns to production (like economies of scale) and adoption (like network effects) (Björkdahl & Holmén, 2013). Moreover, scalability is cited as one of the main characteristics of business models that determines their success (Amit & Zott, 2001; Bouwman & MacInnes, 2006; Rappa, 2004).

As a summary of the factors that lead to business model scalability, we will rely on the following diagram presented in Stampfl et al. (2013):



Source: Stampfl et al. (2013).

As can be seen from the diagram, the identified causes of business model scalability can be operationalized through five different factors (Chrisman, Hofer, & Boulton, 1988): (a) technology, (b) cost and revenue structure, (c) adaptability to different legal regimes, (d) network effects and (e) user orientation. Although we have taken into account the majority of the factors in our scalability analysis, the adaptability to different legal regimes has been moved to the next study construct: replicability.

REPLICABILITY

Although the concept of scalability – the ability of a measure to change its scale in order to meet growing volumes of demand without incurring in surpassing costs – is closely linked to replicability, they are not the same. We will refer to replicability as the property of a measure or solution that allows it to be replicated at another location or time (May et al. 2015). Therefore, it is similar to scalability but adding the fact that some extra factors need to be taken into account. On the one hand, we need to take into account the potential different legal regimes in which the measure or solution is expected to be deployed. On the other hand, there are other factors related to scalability like acceptance or involvement of end users, regulators, local authorities or complementary stakeholders (May, Morch, Verboven, & Rouco, 2015). Summarizing, we could define replicability as the ability of a measure/solution to be deployed in a different city without major disruptions in its business model (beyond specific or small changes to fit into the new environment).

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6.2. Methodology

To reach the goal of understanding the key elements in guaranteeing the scalability and replicability of the measures, IESE has done a qualitative study based on several interviews with the partners. These interviews have been individual, one by one with the partners, or in groups, at the solution level. In the workshops done during the General Assembly in Porto (November 2017), the scalability and replicability of the measures was addressed by IESE to the partners for the first time. Afterwards, several meetings in the Lighthouse cities (January 2019), along with more workshops at the General Assembly in Barcelona (November 2018), and a set of interviews during March, April and May 2019 have helped to define the key elements for the scalability and replicability of the measures.

Regarding these meetings, and especially the ones held during 2019, IESE's team did a literature review on the topics to clarify the definition of the concepts (see section 6.1) and also to help the interviewers to focus on the main subjects to discuss during the meetings. The result of this work can be seen in the following pages. First, we show a group of questions that IESE's researchers used during the meetings, and second, a table of key concepts that might help the researchers to summarize the insights obtained during the meetings.

Questions Prepared for the Meetings

1- Present the goals of the meeting: scalability & replicability (to get their output, but not to give
2- Learnings: what have you learned since the beginning of the project? Or what have been the most important learnings that you've got during this period?...)
    1- What is not working? What are the problems?? (i.e. What elements of the CANVAS are not working?) (This could be very useful for us because if we found companies that are already implementing the BM, we would identify general barriers of it...legal...).
    2- What are the adjustments that you have been doing during this period?
    3- What are the strengths of your model? What have been the elements of your model that are making your business successful or that could/would make it potentially successful?
    4- Have you had any changes of the services provided? Any diversification of your revenues streams?
    5- How much expansion have you had in these last years of the project? In terms of assets/services offered/products provided. Have you initiated an international expansion of your business model? (not asking about the solution – technology, project...- but the BM specifically?)
        a. If no expansion: why not?
        b. If no expansion... Are you collaborating with others to deliver your solution? (We are asking about technology transfer, property rights... BARRIERS for replication....)
        c. What have you learned that could be replicated by the following cities, (from your business model)?
        d. If yes, was it worth it? What have you learned? (scale and scope)
        e. From a business model perspective, how functional your business model is in the current scale and scope of business?
    6- Barriers: what are the barriers that you have found?
        a. Legislation Barriers
        b. Immaturity of the market
        c. Immaturity of the technology
        d. Investment (technology is too expensive, construction costs...)
    7- Public sector:
        a. How the public sector has affected your business?
            i. How do you evaluate the role of the public sector for your business
                - Pros and cons
3- What role would you like to play when thinking about replicating this measure somewhere else in Europe (follower cities...)?
    - Industry partner could answer this question conditioned by the barriers they have found, or they think that they will find. (Property rights, legislation, geographic limitations and so on)

Table of Key Concepts

	Factors	Improvements	Replicate	Scale
		Write comments and highlight the importance of each factor in each category		
Internal Factors (CANVAS)	Value Proposition			
	Customer Segments			
	Customer Relationships			
	Channels			
	Revenue Streams			
	Key Partners			
	Key Activities			
	Key Resources			
	Cost Structure			
External Factors	(Role of) Public Sector / Legislation			
	Technology			
	Market			
	Intellectual Property			
	Others			

7. Key Elements for Scalability and Replicability

7.1. Work Package 2. Low-Energy Districts.

Solution 1. Low-Energy Districts

Replicability

Solution 1 is highly replicable considering the wide sample of buildings needing to be refurbished (in Europe, there are approximately 110 million households that need to be refurbished). However, there are different factors that seem to condition the ability to carry out energy-efficiency projects in a specific location. Below, we have listed the ones we consider to be the most important.

- Price of energy: gas and electricity prices do directly condition the necessity of implementing energy-efficient measures, at least from the financial point of view. In places where electricity is cheaper, the need to generate financial savings due to lower energy consumptions can be difficult to achieve and, therefore, less interesting for the owner. By comparing the three Lighthouse cities according to Eurostat, we see that, in Stockholm, electricity prices are lower than in Barcelona and Cologne. Therefore, to generate energy savings through electricity efficiency measures would be more difficult in Stockholm than in the other two cities. On the other hand, gas prices in Sweden are greater than in Spain and Germany. In that sense, if we only consider energy prices, it would be recommendable to implement gas-efficiency measures rather than electricity-efficiency measures in Stockholm, whereas the case would be the opposite in Barcelona and Cologne.

Average Energy Prices (2015-2018)		
Eurostat	Electricity (EUR per KWh)	Gas (EUR per gigajoule)
Germany	0.298933	18.04
Spain	0.226333	19.22
Sweden	0.189367	3.215.383.333
Variable tariff according to energy providers	Electricity (EUR per KWh)	Gas (EUR per gigajoule)
Germany	0.2636	No applies (measure 1)
Spain	Tertiary buildings: €0.08566535 per kWh Residential buildings: €0.1174 per kWh	Tertiary buildings: €0.033623 per kWh Residential buildings: €0.0444 per kWh
Sweden	No data (energy savings already submitted to IESE in monetary units by the municipality in measure 1.1)	

This table shows an approximation of the energy prices for the three Lighthouse cities. The Eurostat methodology is based on real invoiced prices paid by end-users, and therefore includes the variable and non-variable tariffs of the invoices.

Since energy savings are reflected only on the variable proportion of the final invoice, the Eurostat prices shown in the table on the left are not the best possible approximation. In that sense, we have asked energy industry partners and energy providers to send IESE the real prices that apply for the GrowSmarter project.

According to the energy prices submitted by the energy providers, variable tariffs seem to differ from the Eurostat aggregate prices. In Spain, the fixed term represents a significant part of the final energy bill, hindering potential incentives of achieving financial energy savings.

- Climatology: in more temperate weather conditions, the potential of achieving significant energy savings, enough to pay back the investment, does not seem to be possible, at least for residential buildings as in the case of Barcelona. In contrast, in Cologne and Stockholm, with lower annual average temperatures, generating enough energy savings seems to be easier. In turn, that would facilitate replicating solution 1 in these two cities, compared to Barcelona. For tertiary buildings, it is not possible to extract definitive conclusions in that regard, since the sample of GrowSmarter buildings does not include a tertiary building in Cologne. Moreover, the typology of tertiary buildings is not comparable between Barcelona and Stockholm.

Average temperatures (Daily mean in ˚C)														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Source
Cologne (1981-2010)	2.6	2.9	6.3	9.7	14.0	16.6	18.8	18.1	14.5	10.6	6.3	3.3	10.3	Deutscher Wetterdienst
Barcelona (1987-2010)	11.8	12.4	14.2	15.8	19.3	22.9	25.7	26.1	23.0	19.5	14.9	12.3	18.2	Generalitat de Catalunya - Agència Estatal de Meteorologia
Stockholm (1981-2010)	-1.6	-1.7	1.2	6.0	11.7	15.7	18.8	17.6	12.7	7.7	3.0	-0.3	7.6	Météo Climat and SMHI

- Increase in comfort: according to industry partners, comfort seems to be one of the main drivers in order to replicate the implementation of active and passive energy-efficiency measures in residential buildings in Barcelona, since energy savings do not seem to be enough for this type of buildings.

  For tertiary buildings, an increase in comfort is also expected for users utilizing the services in these buildings in Barcelona. However, in this case, comfort is not the main driver for replication, because the potential generation of energy savings is attractive enough.

  On the other hand, in Cologne, it seems that energy savings, by themselves, do justify the investment. However, an increase in comfort for residents of the building is also expected. Therefore, that would be an additional argument in order to justify the replicability of solution 1 in the German city.

  For the public housing project in Stockholm, energy savings do seem to be enough to pay back the investment in a 25-year period. However, gains in comfort are also expected, as it would be easier to reach and maintain comfort temperatures. However, for both tertiary buildings, the energy savings generated by the implementation of solution 1 do not seem to be enough, relying on other measures (District Heating) and potential increases in comfort, among other factors (increase in value of the property), to justify the investment.

- Value of the property: a potential increase in the value of the property due to the retrofitting works and the energy-efficiency measures implemented could pay off a significant part of the investment, making the solution more interesting from the owner's point of view and, therefore, more replicable. A study by the University of Aalborg highlights that, in Denmark, the average increase in the value of a property after an integral retrofitting projects is about 20%.[3]

[3] Christensen, F. K. (2011). *When Property Value Changes During Urban Development: Model and Factors*. Institut for Samfundsudvikling og Planlægning, Aalborg Universitet.

- Type of building: the purpose or utilization of the building seems to condition the potential generation of energy savings, determining, in some cases, the financial sustainability of the projects. Furthermore, how users are going to change their consumption behaviors after retrofitting a building has to be taken into account when estimating the savings in energy.

  - In Barcelona: in the Spanish city, residential buildings do not seem to generate enough energy savings in order to pay back the investment costs in less than 25 years. For instance, in Barcelona, a standard energy-retrofitting project of €15,000 per dwelling has an average payback period of 40 years. Therefore, in order to replicate solution 1 in Barcelona (and in similar urban environments), it would be recommendable to focus the purpose of the energy retrofitting project on an increase in comfort and in the value of the property, rather than on achieving significant energy savings.

    On the other hand, half of tertiary projects in Barcelona seem to achieve enough energy savings in order pay back the investment in less than 25 years. The exception seems to be the library, a public tertiary building. Furthermore, smaller scale tertiary projects, like the educational center (showing consumption behaviors similar to an office), do not seem to generate enough energy savings in order to pay back the investment. However, this conclusion is only true for GrowSmarter, as the sample is limited to few buildings.

    With regard to the tertiary buildings, in terms of energy savings, investing in energy retrofitting projects for tertiary buildings seems to be more attractive than for residential buildings, according to the GrowSmarter results. Nonetheless, the type of tertiary utilization and the scale of the building seem to highly condition the amount of energy savings that could be achieved after finishing the implementation of active and passive energy-efficiency measures.

  - In Cologne: the situation in Barcelona does not apply to Cologne, where the residential complex of buildings does seem to achieve enough energy savings after the construction and retrofitting works. Different factors could explain this conclusion, as the project could benefit from important scale advantages, since it is a bigger project, but also due to the climate conditions, as explained above.

  - In Stockholm: regarding residential buildings, the context is similar to the one in Cologne, with a large refurbishment of a residential complex able to generate important energy savings. On the other hand, in relation to the tertiary buildings, the situation is the opposite of Barcelona. Both office buildings cannot generate enough energy savings after implementing solution 1. However, the tertiary use is very different from the buildings in Barcelona. Therefore, it is not possible to compare the tertiary buildings of Stockholm with those of Barcelona.

- Scope economies: the proliferation of standard refurbishment projects, which initially do not consider implementing advanced energy-efficiency measures, seems to be a great opportunity to introduce the measures in solution 1. Taking advantage of the need to refurbish buildings could be a great opportunity to implement this type of active and passive energy-efficiency measures. In that sense, the investment costs for implementing solution 1 would be lower than if it had to be implemented after a standard rehabilitation.

- Legislation: adequate regulatory frameworks are crucial for replicating solution 1. The implementation of active and passive energy measures with favorable regulations would considerably decrease the costs of implementation. First, because with favorable regulations, such as the standardization of procedures and technologies, the development and manufacturing costs of the technologies and other elements implemented could be lower. Second, because in this case, favorable legislation can be translated into fiscal incentives. And, third, because the utilization of energy-efficiency measures, especially the active ones, can be much more efficient. In that sense, recent legislative changes in Spain permit the sale of the surplus from self-generated energy to other buildings in the same local network. In other words, a new regulatory framework in Spain means that, automatically, the installation of local energy production solutions, such as solar panels, is much more attractive without the need for disruptive technological changes.

  In the case of Sweden, the legislation regarding social housing is not comparable to legislation in Spain and Germany. Public housing companies have to compete under the same conditions as private companies with the same targets in terms of profits, and they do not receive any special benefit for being publicly owned. In that regard, the legislation allows municipality-owned companies to promote and increase the provision of housing in the city for everyone, not only for low-income and vulnerable people. Such specific legislation in Sweden could affect the criteria considered for retrofitting buildings with energy-efficiency measures, as the importance of generating economic savings could be even more important. In contrast, public-owned housing companies in Spain are generally thought to provide housing solutions for vulnerable segments of the population. Similarly to Spain, in Germany, public authorities also run specific programs for social housing, directly promoting and funding projects, and even encouraging private companies through more favorable taxes and levies, to include social housing units to their respective projects.

- Public sector: the public administration, and how it is involved in deploying or helping to enhance the implementation of energy-efficiency measures, is a factor to consider when analyzing the potential for replicating solution 1 in other places. As mentioned, public institutions could take a leading role in legislating in favor of integral refurbishment projects for residential and tertiary purposed buildings. Therefore, political support for environmental policies and retrofitting projects of the housing stock, among other policies, has to be considered a conditioning factor for replicating solution 1. The following section describes in more detail the role of the public sector in replicating the implementation of energy-efficiency measures.

- Finance: Due to the high investment costs, having enough funding and being able to ensure periodic payments determines, to a certain extent, the possibility of replicating the solution. How to fund this kind of projects is a challenge – even more so when a neighborhood community cannot afford the investment. In addition, it is important to differentiate between the stakeholder(s) paying for the investment and who is capitalizing the benefits. For instance, in residential communities with a high percentage of rents, the party making the investment, i.e., the owner, can pass on the cost to tenants, who directly benefit from the positive impact in comfort and capture the energy savings.

  Designing adequate revenue streams for each project is a clear factor for replicating the solution. For instance, in public housing projects, it could be counterproductive or impossible to increase rents or charge the investment to owners. That could potentially favor gentrification and negatively affect social stratification.

  With regard to the different energy-efficiency solutions, from a point of view of generating financial energy savings, the usefulness of complementing passive measures with active ones seems to be proven. By themselves, passive measures, although effective in many cases, do not usually pay off the investment that they require, at least in the case of Barcelona, where energy savings are not enough to compensate the entire investment in residential buildings. Nonetheless, if passive measures are complemented with active ones, the payback period can be dramatically reduced, to the point that it would be of interest to a private investor (less than 15 years). This will depend on each context, but it highlights the capacity of active measures to generate more financial savings than the passive ones in Barcelona.

- User engagement: involving final users in the implementation of the measures in solution 1 has become one of the most difficult tasks throughout the GrowSmarter project. When it comes to replicating the solution in other buildings or other cities, having the acceptance and collaboration of the owners, tenants, residents and users of a building can dramatically enhance the replicability level of a retrofitting project – especially in terms of improving the know-how. Receiving constant feedback from users and other stakeholders should improve the quality of the information relied on when making decisions. Although this may delay the decision-making process, in can help to avoid making incorrect decisions. Therefore, having good communication channels between investors, construction companies and final users could be a key factor in reducing information asymmetries. In addition, users have to be aware of the benefits of the project, and they should know how to utilize the measures that are being implemented. In order to do so, it would be recommendable to involve public administrations, understanding them to be credible and impartial institutions.

- Verification of results: the degree of replication will be highly dependent on accurate submetering activities to validate the results before and after the project. If empiric experiences do not justify the presence of financial and economic benefits, it will be more difficult to replicate the implementation of energy-efficiency measures in other buildings in the future.

Scalability

The existence of scale advantages for energy retrofitting projects could be understood as an additional factor for replication. Moreover, some of the previous factors for replication could also apply for scaling-up a retrofitting project with pro energy-efficiency measures.

- User engagement: for residential buildings, before starting up a retrofitting project, it seems to be highly recommendable for all the owners of the various units to agree previously on the need to carry out an integral reform. If there are owners who do not want to be a part of the integral retrofitting project, that could compromise the financial viability of the project as well its effectiveness, making it harder to take full advantage of potential scale benefits.

- Legislation: designing coercive legal mechanisms to force free riders (owners who do not want to pay their part of the investment) could help to solve the problem. For some communities, it may be the case that some owners do not have the means to cover their share of the investment. In that case, the community should be able to cover those costs. Nonetheless, the public sector, in the interest of promoting the energy rehabilitation of residential buildings but also with the aim of reducing social stratification, could assume the part of the investment that could not be paid by those owners.

Some legislative changes mentioned in the replicability section also apply when analyzing the potential for scalability. In that sense, the possibility of commercializing the surplus of self-produced energy on the local electricity network should help to achieve scale advantages, making retrofitted buildings less dependent on regular sources of energy and able to consume electricity produced locally by other buildings. The more buildings contribute to the local electricity network, the lower the dependence on other sources of energy will be.

- Size of a building: in terms of construction work, the presence of scale benefits seems to be less significant, as current margins in the construction sector are already very tight. However, it is worth noting the existence of potential scale advantages at a building level through the single allocation of materials or the use of scaffolding when having to work on certain elements of the façade.

  In larger buildings, the potential generation of energy savings could be greater, as some energy efficiency measures can be more efficient if deployed on a larger scale. In addition, especially in the energy-retrofitting sector, which is highly technologically advanced, the marginal cost of an energy-efficiency solution could decrease as it is being implemented in more places or on a larger scale. In turn, that would translate into lower average costs of implementation for larger buildings. Therefore, such scale advantages should help to replicate solution 1 in larger buildings.

Role of the Public Sector

- Finance: Solution 1 has been implemented in residential and tertiary purposed buildings. Some of the residential refurbishment projects took place in public housing buildings, where residents do not have enough financial resources to afford the investment. When it comes to people with an unfavorable economic situation living in a building in a poor state of conservation, needing to be refurbished, public administrations have to assume a leading role in financing most of the investment without aiming to charge any cost of the project to the final user. In these cases, due to the user profile, public administrations not only have to fund the investment; they must also take on a role as managers of the project. In turn, that implies additional managing costs for the public sector.

  If the public sector does not cover part of the investment, it could be considered a free-rider, since it benefits indirectly. Improving the energy performance of buildings helps countries to meet the environmental targets determined by supranational institutions. Nevertheless, it is in the matter of taxes where public administrations benefit the most.

  On the other hand, for those private residential buildings where tenants can afford part or the entire cost of the investment, the public sector could still be involved in helping to finance the project. In that sense, tax incentives such as tax reductions are an incentive element for replicating solution 1. In addition, there may be cases of owners who are capable of paying the cost of the reform and implementation of energy-efficiency measures, but who need a bank loan. In this context, the public sector could design low-interest loan programs for those owners who cannot access the necessary credit for paying the investment costs.

  In relation to the financing of tertiary buildings, the public sector can be actively involved in an energy-retrofitting project to enhance the potential for replicability in three ways. First, by paying the entire investment costs. This would apply in cases where the economic benefits are expected to be greater than the financial costs, but also in publicly owned tertiary buildings, as is the case of the library in Barcelona. Second, through Public-Private partnerships, where, for instance, the municipality makes a deal with a private investor to rent out the building during the amortization time of the investment, as is the case with the public tertiary building in Barcelona. Third, by contributing, through public loans, subventions and fiscal incentives, to the rehabilitation of tertiary private buildings in order to foster energy retrofitting projects and internalize the positive externalities.

- User engagement: the public sector also needs to make the neighborhood or the community aware of the benefits of the energy-efficiency measures implemented. In that regard, in the GrowSmarter context, the stakeholders involved in deploying solution 1 have been struggling to engage with final users. For this reason, public administrations, especially municipalities, can take on the role of intermediaries between private stakeholders and residents, acting as credible and impartial agents.

- Legislation: public institutions have to lead the changes in legislation to foster the implementation of the measures included in solution 1. Making changes in regulations, which need to meet the present needs and demands of the market and the environment, while also anticipating the needs and demands of the future, is a challenge – especially in a technologically advanced sector like the rehabilitation of buildings with energy-efficiency criteria. This adds additional difficulties when legislating due to the unpredictability of some of the future technical advances. In order to draw up efficient regulatory frameworks, it could be advisable to involve all the stakeholders, including municipalities and the energy retrofitting sector, as well as the rest of the parties that participate in designing and implementing active and passive energy efficiency measures.

  For instance, in Spain, a recent legislative change that is expected to help the replication of solution 1 is the possibility of selling the surplus of self-produced electricity. Retrofitting projects that implement active measures, especially photovoltaics, will directly benefit from this change.

Solution 2. Smart Buildings Logistics

Construction Consolidation Center

Replicability

- Size: similar CCCs have been used in other places, but they have been linked to huge infrastructures, such as the enlargement of Heathrow airport. This can be a crucial element when it comes to replicating the measure. Another element might be an exceptional increase of the building sector in a particular city during a specific period. However, both options should be supported by a restriction of trucks inside cities. Together, the CCC could have options to be replicated.

Scalability

- Dimension: the scalability depends on the dimension of the work related to the CCCs. These are crucial to benefiting from the economic scale of the measure. In that sense, the more works are linked to it, the bigger the option to scale up the measure will be.

Role of the Public Sector

- Strategic view: the public sector can push to build huge infrastructures, related to large-scale events or strategic needs of the city.
- Legislation: together with this drive, the legal restriction of using a certain type of truck inside the city will also enhance the measure. A more radical option would be for the city authority to make it mandatory to always have a CCC related to existing construction. This would force the companies working in the city to create a CCC around their work sites.

Solution 3. Smart Energy-Saving Tenants

Replicability

- Price of energy: as a crucial factor for determining the potential economic savings in the energy invoices. Gas and electricity prices do directly condition the necessity of implementing energy-efficiency measures, at least from the financial point of view. In places where electricity is cheaper, the necessity to generate financial savings due to lower energy consumptions can be difficult to achieve and, therefore, less interesting for the owner. By comparing the three Lighthouse cities, we see that, in Stockholm, electricity prices are lower than in Barcelona and Cologne. Therefore, to generate energy savings through electricity efficiency measures would be more difficult in Stockholm than in the other two cities. On the other hand, gas prices in Sweden are greater than in Spain and Germany. In that sense, if we only consider energy prices, it would be recommendable to implement gas-efficiency measures rather than electricity-efficiency measures in Stockholm, whereas the case would be the opposite in Barcelona and Cologne.

- Legislation: it would be recommendable to have the same kind of legislation in Europe in order to help to replicate the solution throughout the region. Although there have been improvements in that regard, like the general data protection law, there are significant differences between countries. It would be recommendable to define clear legislation about how to use data and homogenize it for all countries at the European level.

- Proliferation of integral retrofitting projects with energy-efficiency measures: since solution 3 is being implemented together with other energy-efficiency measures, its replication also depends on the proliferation of integral retrofitting projects. In turn, those projects could incorporate a home-energy-management system as an additional measure that would complement and maximize the efficiency of the active and passive energy-efficiency measures.

- Climatology: climatology can affect the attractiveness for replication of solution 3. This solution depends highly on the deployment of smart meters, and it monitors the energy-efficiency levels of a dwelling after implementing active and passive energy efficiency measures. For this reason, because we consider the weather conditions as a factor for replicating solution 1, we must do the same for solution 3.

- Scale: this solution, because it is mostly based on deploying sensors and software, seems to show clear scale advantages, since the more is replicated the lower average unitary costs of implementation are. We consider this factor as one of the most important when thinking about the replication of software-based solutions. In that sense, scalability is a crucial factor for replication.

- Maturity of the market:

    - Technology: a decrease in the price of the technology implemented can be expected, as is already happening with prices for storing data or the average prices of smart meters. If so, it would be easier to replicate the solution.

   - Competition: the software to be used is proprietary, and so each competitor has to develop their own or pay for a license. The cost of developing a specific software for energy management could be of significance, adding difficulties for new competitors.

   - Critical mass: the solution requires a minimum number of users in order to reach break-even. The more dwellings implementing the solution for a single provider, the easier it will be for the same provider to replicate it in other places. We consider this factor as one of the main drivers for making this solution financially feasible. In other words, the more mature the market is, the easier it will be to scale up the solution and, therefore, to replicate it, as described before.

- High investment costs: the cost of developing the system and implementing smart meters is high, adding difficulties for replicating the measure by new competitors. However, the cost of operating it does not seem to be important once enough users have adopted it.

- User engagement: according to GrowSmarter's industry partners, having better user engagement is a key element that facilitates replicating the solution. Ask users for feedback, taking surveys and generally involving users in the decision-making process during the implementation of the solutions seems to be an appropriate recommendation. Furthermore, it is important to educate users about the benefits of the solution and to teach them how to use energy management systems in order to maximize the full potential of the system in terms of energy savings.

Scalability

The measure is highly scalable as its main entry barriers are the cost of developing the software and the deployment of smart meters. Scaling up the solution becomes the main driver for ensuring its financial sustainability, as the marginal cost of implementing the software in new dwellings is reduced. However, due to the fixed costs of developing the software, plus the operational costs (storage costs and continuous deployment of smart meters), the solution needs a considerable number of users willing to adopt it in order to reduce the average cost. In addition, scaling up the solution would be helpful in improving its potential benefits, since the more information is being monitored, the better the quality of the information will be for understanding how to improve consumption behaviors.

Some of the factors that could explain the potential for replicating this solution might also condition the potential for scaling it up. In that regard, the proliferation of integral retrofitting projects is crucial for scaling up the solution in all the units in a building. Furthermore, the legislative factor also seems to affect the scalability level of the solution, since adequate regulatory frameworks affecting smart metering and data utilization could help to harness data on a larger scale, even by third parties, who could even use anonymized data to replicate their own solutions.

Role of the Public Sector

- Finance: the public sector as a key actor for replicating the solution, providing funding for those economically sustainable refurbishment projects that struggle to become financially sustainable.

- Legislation: to standardize the protocols and contracts through legislative changes. Furthermore, appropriate regulatory frameworks incentivizing the implementation of smart management systems could be recommendable, as the deployment of the solution is still in its early stages.

- User engagement: as already stated, it is crucial to involve final users in the implementation of smart management systems, since they are the ones making use of the solution. With better user engagement, users can maximize the benefits. In that sense, public administrations should actively insist on the positive aspects of the solution, engaging in informative campaigns, and incentivize final users to install smart management systems in dwellings.

Solution 4. Smart Local Electricity Management

The implementation of smart local electricity management systems, or management systems at a building level, within the GrowSmarter project, has been a challenge from different perspectives. In the case of Barcelona, the solution has been led by Schneider Electric, and there are some takeaways that can be highlighted from its implementation. One of the main strengths of the model is its value proposition, which did not need to be adapted; it was aligned with customer needs without requiring any change or significant adaptation. However, from the business model point of view, the project has been less widespread than was expected.

The implementation of Virtual Power Plants, Building-Energy-Management Systems and Visualization Tools is, in many cases, combined with other energy-efficiency measures (as is the case with the GrowSmarter project). For this reason, the replicability of solution 4 can be highly conditioned by the replication of other smart-efficiency solutions related to WP2.

Replicability

Price of energy: the higher the price of energy, the greater the potential generation of economic savings through reduced energy invoices will be. Because these systems focus on improving consumption behaviors, showing tenants their consumption patterns and letting them know, through smart monitoring, what kind of energy they have been consuming, the solution is highly attractive and therefore more replicable, when potential economic savings are greater. In that sense, in places where energy is not cheap, energy-savings-focused solutions are more attractive and, therefore, better to replicate.

In the case of the Virtual Power Plant in Cologne, the implementation of the measure should improve energy consumption, helping end users to decide whether to get their energy from local self-produced sources (PV cells) or to get it directly from the regular electricity network. In that sense, with better consumption, the solution's ability to generate economic savings is greater.

In Stockholm, the price of electricity is not as high as in the other two Lighthouse cities. However, by optimizing the PV cells installed on the rooftops thanks to the software, the solution is able to maximize energy savings, helping to ensure the financial sustainability of implementing PVs. Therefore, solution 4 becomes crucial in order to replicate this kind of active energy-efficiency solutions in Stockholm.

In Barcelona, the price of electricity is similar to Cologne. In that sense, given current electricity prices, the solution seems to be more attractive for tertiary buildings, since this type of building in Barcelona seems to generate enough energy savings to pay back the investment in less than 25 years. On the other hand, solution 4 could also be attractive for residential buildings, and therefore more replicable, because it provides information on energy consumption behaviors. With that information, users can improve their consumptions and adapt them to their preferences, which in turn, would translate into better comfort.

- Legislation: regulatory frameworks differ from one country to another. To replicate the measure in other places around Europe, it would be recommendable to have the same kind of legislation in order to avoid uncertainties for the private investor. The recently approved general data protection law in Europe could be considered as a step forward in that sense. However, there are countries, like Germany, where the legislation seems to be even more restrictive compared with Spain. Because the solution relies highly on the use of private data, in places where restrictive regulations limit how private operators can collect and make use of that data, the implementation of smart management systems in buildings will most likely be hard to replicate. In addition, the lack of a specific regulation for energy management systems (for example, standardizing the protocols to be used), could limit the potential for replication of this solution. Moreover, legislation affects multiple aspects of solution 4, in addition to the use of private data and the level of standardization for developing and implementing it.

- Proliferation of integral retrofitting projects with energy-efficiency measures: solution 4 complements the implementation of other energy-efficiency measures, contained within solution 1. In that sense, solution 4 takes on increased meaning when it is needed to monitor, through smart meters and visualization tools, the impact of other energy-efficiency measures.

- Public sector: public institutions are crucial in drawing up adequate regulatory frameworks for fostering the implementation of smart management systems and virtual power plants. In that sense, the political will to promote them will affect their potential for replication. Designing favorable regulations, sensitive to the demands of the different stakeholders involved, seems to be highly beneficial. However, GrowSmarter shows that there is still a long way to go, and it exemplifies the need to continue unifying the policies among the different European countries.

- Climatology: the potential generation of energy savings is highly related to the weather conditions of the place. It seems that, for residential buildings in more temperate climates, energy-efficient solutions are less attractive if only energy savings are considered. However, in these climates, these solutions can be replicated in tertiary buildings, since they usually have more intensive consumption behaviors.

- Maturity of the market and competition: in a market economy, it is easier to replicate a business model when the market is free, with as few barriers to entry as possible. Also, replicating a solution should be easier in a mature market, both in terms of technology and consumers. However, the energy-retrofitting sector is yet not mature, since it is still in its early stages. Although smart management systems are not widespread across the enormous sample of buildings in Europe, increasing energy prices and environmental challenges seem to predict a growing need for such solutions.
    - Technology: a decrease in the price of the technology needed for deploying solution 4 can be expected, helping to replicate it in the future in more places. For instance, data storage on servers is becoming cheaper.

In addition, from the technological point of view, taking advantage of the data collected is crucial in order to keep replicating the solution in more buildings. As more data is being collected, the amount of information available to optimize the solution is greater.

- Competition: the solution is easy to copy and does not have significant restrictions in that regard, apart from the intellectual property rights of each of the management systems. Each time a new competitor enters the market, it has to purchase a license fee from a software provider or develop its own management software.

- Critical mass: the implementation of solution 4 requires a minimum number of users in order to become financially feasible. For example, we found that, in Cologne, the Virtual Power Plant has not been widely implemented, hindering the opportunities to take advantage of scale economies. In that case, the unitary cost, although subsidized, is too high, exceeding the potential economic benefits of the energy savings.

- High initial investment costs: the solution requires a significant amount of investment in order to carry it out. Most of it is explained by the costs of developing or purchasing the specific software from a subcontractor. The former (developing) is the case in Barcelona and Stockholm, and the latter (purchasing) is the case of Cologne.

- User engagement: establishing good communication channels with end users seems to be one of the most important aspects to make a smart management system successful. In that regard, it is important to ensure that the end users are aware of the benefits of the system and that they also know how to use it in order to make the most of its advantages.

Scalability

The solution shows clear scale advantages if implemented in more places. The marginal costs of implementing an energy management software do not increase. However, it is necessary to extend the metering equipment, where necessary, since the solution is being replicated in more buildings.

In order to scale up the solution, it would help to transition from ad-hoc integrated systems to general ones. That, in turn, would help to replicate the solution, since many energy management systems have to be implemented in buildings with very specific characteristics.

- Legislation: standardization of technologies and protocols should help to improve the scalability of the solution. Furthermore, tax reduction programs and other fiscal incentives through new and favorable regulatory frameworks could help to scale up this solution into entire city blocks.

- User engagement: in order to implement this solution at a neighborhood level, it is necessary to reach awareness among citizens about the benefits of the solutions and integral refurbishment projects involving energy-efficiency measures.

- Network economies: if energy management systems were being replicated in more buildings, the implementation of solution 4 could take advantage of scale economies. The more buildings are equipped with energy management systems, the better and greater will be the amount of information available for analysis. In addition, if these systems are implemented at a neighborhood scale, it would be possible to establish local energy networks more efficiently, with the ability to produce energy through local power stations (PV cells).

Role of the Public Sector

- Finance: as smart management systems are being implemented along with other energy-efficiency measures, the replicability of solution 4 seems to be highly dependent on public funds. For this reason, establishing economic incentives, such as better taxation or subvention programs, seems to be an appropriate option since it could help to encourage the implementation of the solution in more places.

- User engagement: public administrations are responsible for launching informative campaigns regarding the benefits of solution 4. In addition to this pedagogical role towards end-users, the public sector, in many cases, can act as an intermediary between the provider of the solution and the user.

- Legislation: municipal, national and supranational institutions can directly condition the replicability and scalability of this solution, because those institutions define how to collect and how to manage private data. We have seen differences between who owns the smart meters for collecting the necessary information related to energy consumptions – differences that translate into information asymmetries and inefficiencies that might hinder the opportunities for maximizing the benefits of the measures in this solution.

7.2. Work Package 3. Integrated Infrastructures.

Solution 5. Smart Street Lighting

Replicability

- **Legal issues:** while from the technical point of view there is no major problem for replicating the solution in different contexts and environments, legal barriers do arise as the main challenge to be overcome in terms of replicability. Since each local context has its own legal framework, solution providers need to adapt to the specificities of each potential replication site.

- **Multiplicity of administrations involved:** in some cases, the measures included in solution 5 are deployed in phases or in specific areas of a city. Depending on the local context, the partner needs to ask for permits and legal validations from administrations, like neighborhood or district councils, which have their own specific requirements. As in the previous case, this multiplicity of administrations slows down the deployment and complicates the replicability of the measure.

- **Technological change:** some of the measures involved in solution 5 have deployed sensors. However, after five years of project, there are alternative technologies that provide the same – or even better – service at a lower price. Therefore, some sensors deployed are not replicable anymore, due to a loss in competitive advantage and financial/economic returns. However, the deployment of these sensors has been useful in assessing the importance of information for managing infrastructures.

- **Strategic alliances:** for some of the measures, additional gains can be achieved by creating strategic alliances with other organizations. For example, outside organizations can benefit from existing data or deployed infrastructure by extracting value through infrastructure sharing, or by complementing their own infrastructure. However, these alliances are not always easy to create and manage.

Scalability

- **Legal and administrative permits:** some of the measures need to be deployed in public space, which means that companies need to deal with different public departments and, potentially, with different administrations. Therefore, the company deploying the solution needs to interact with several decision makers with different requirements and procedures. These administrative tasks slow down the deployment and scalability of some of the measures.

Role of the Public Sector

- **Innovative public procurement:** according to the partners, a significant change in the design of public licenses would facilitate the implementation of these types of measures. More specifically, the procurement process has to be shifted away from the classic model based on price towards another model in which the expected and desired value plays a central role.

- **Process facilitator:** one potential solution to challenges like administrative permits or the multiplicity of administrations involved could be introducing a unique point of contact with the administration, creating teams of public employees devoted to accelerating, or coordinating actions across public departments.

Solution 6. Waste-Heat Recovery

Replicability

- **Infrastructure needs:** one of the main needs when it comes to replicating the measure in different contexts and cities is the need for an existing district heating infrastructure. The measure aims to recover waste heat; thus, it needs an existing district heating system to feed it. In that sense, the measure is highly dependent on the existing infrastructure.

- **Heating needs:** this solution is aimed to recover waste heat. Therefore, it needs a source of waste heat in order to be replicated. The sources can be different from the ones implemented in Stockholm, like industries that produce waste heat or even data centers inside companies, organizations or universities.

- **Energy production mix:** one of the main drivers of profitability for the measure is the existing energy production mix. For example, if the solution is deployed in a fully sustainable city that feeds the district heating system with renewable energies, the solution will not add much to the overall sustainability of the city.

- **Technological standardization:** as for right now, the partner reports that they have developed a standardized technological connection to the district heating system. This means that, as long as the first replicability challenge is solved (infrastructure needs), there will be no major problems to connect the waste heat recovery system to the main pipeline.

Scalability

- **Invest from the beginning:** one of the most interesting features of the measure is that it can deliver great outcomes if it is deployed at the same time as the infrastructure that will produce the waste heat. For example, if instead of a traditional cooling system for data centers one deploys this solution, the recovered waste heat will pay off the investment in just 5 years.

- **Big waste heat producers:** on the other hand, a challenge for scalability can be the existence –or lack – of infrastructure producing waste heat. As for now, the solution has been deployed in supermarkets and data centers. However, the absolute number of supermarkets or data centers in a city is finite. Therefore, the measure is as scalable as the waste heat producers in a given city.

Role of the Public Sector

- **Infrastructure needs:** as explained in the replicability section, the measure aims to recover waste heat, and therefore it needs an existing district heating system to feed it. Usually, the infrastructure is deployed and owned by the public sector. Consequently, if the public sector deploys this type of infrastructure, the solution can be implemented as a complementary asset of the project.

Solution 7. Smart Waste Collection

Replicability

- **Infrastructure:** the added value of the measure is to improve quality of life by limiting the use of indoor and/or outdoor surfaces for waste bins and containers, reducing environmental impact and waste collection traffic. However, to fully deploy the benefits of this type of technology, the city where one would want to replicate the measure needs to have a sorting facility to deal with the different types of waste bags delivered through the pipe system.

- **GDPR:** the General Data Protection Regulation of the EU has had a significant impact on the operations of the measure. Since one of the main benefits of the measure is providing users with analytics derived from waste disposal at different aggregation levels, the partner in charge of the measure needed to adapt their solution to the new GDPR. The main adaptation to the new legislation has been showing the information at the building level and using IDs instead of real names. However, now that the solution has been adapted, it can be replicated in any other European city without major disruptions to its operations or business model. This is only critical if you need individual feedback/statistics.

Scalability

- **Sorting facility:** although the existence of a sorting facility would be beneficial for the measure, it is not critical. The reason is that waste sorting can be done in other ways (separate inlets/containers or manual sorting). In the specific deployment for GrowSmarter, the initial idea was to sort the bags at the collection station, locally, in the area. However, it failed due to space limitations.

- **Recycling system:** beyond the need for a sorting facility, there is also the need for the existence of a recycling system. According to the information we have, this will help to get even better outcomes, since the recycling system will take care of all types of wastes generated in the deployed areas. However, the partner has indicated that (large) cities may start sorting at the source without a recycling system, with the purpose of improving users' awareness and behavior.

- **End-user engagement:** Although the system is prepared to work efficiently – it can handle four waste bags per minute, some of the users do not have the same opinion. The system to open the bin where users deposit their waste bags has several steps and uses more technology than is expected by the users. Since some of them are elderly people, the measure is suffering small resistance by the end users. However, according to the partner's experience in previous deployments, users will learn as they go along. In other words, it is only a matter of time.

Role of the Public Sector

- **Innovative public procurement:** Due to permits for deployment and operating the infrastructure, the process is slow and, sometimes, involves more than one public sector department. Therefore, as in previous measures, the solution will be highly benefited with a significant change in the design of public procurement, with faster procedures for innovative and advanced infrastructures.

Solution 8. Big-Data Management

One of the main takeaways from the implemented measures is that technology is not the biggest challenge; humans are. They are the biggest challenge in the sense that the majority of barriers identified in this solution are related to usage, skills or organizational routines that need to be updated to new technologies.

Replicability

- **Data and privacy:** all the measures included in this solution comply with the European legislation regarding data privacy and security. Since European legislation regarding these issues is one of the most protective in the world, privacy issues are not a challenge for the replicability of this type of measure.

- **Managerial commitment to open data:** one of the main challenges for the deployment of these types of measures is managerial or public commitment to open data initiatives. Although the platforms in solution 8 can be deployed in a fully closed format, some of the measures are intended to be used (at least partially) as open data platforms. However, to do so there is a need for a managerial and public commitment to uploading useful, updated and clean data onto the platform. Otherwise, the platform will not be perceived as useful by potential users.

- **Expanding through replicability:** many of the measures included in this solution will benefit from replicability in different cities. Since platforms are replicated through cloud infrastructures and built over existing complements, the fact that some cities can add knowledge and new complements will benefits all the other cities using the platform.

- **Network externalities:** platforms need data to be valuable. The more data they have, the more interesting they become for potential internal and external users. At the same time, the more potential users there are, the higher the incentives are to add more data to the platform. This two-sided challenge is based on network externalities that need to be activated to generate, exploit and capture the full potential of the platform.

Scalability

- **Cloud infrastructure:** since all measures can be deployed in cloud infrastructure, scalability (also replicability) is straightforward from the technological point of view. The only increase in costs is associated with paying for extra storage and processing power to the cloud provider.

- **Incremental approach:** following the knowledge acquired during the project, the scalability of this solution is highly accelerated through education based on use cases. Therefore, starting the deployment of the solution with a quick-win approach and an effective communication policy will increase the likelihood of success in terms of scalability.

- **Fostering usage:** one of the main challenges with platforms is how to foster usage among different users. Many organizations have routines and procedures that are not adapted to new technologies and, therefore, need an adaptation and accommodation stage to be fully accepted by the users.

Role of the Public Sector

- **Improving skills:** one of the challenges with the implementation of this type of measures is a lack of skills and technological knowledge on the part of the users, not just from the operating or using point of view, but also from the value point of view. The more people know about the potential of new technologies and platforms, the more they will be able to think about the positive impact those technologies and platforms can have or the value they can generate.

- **Gain trust:** according to different partners, platforms can generate trust through focusing on existing problems that can be solved through their implementation. In addition, showing potential users how they can benefit from the platform, mainly through specific use cases, will also help to build trust.

7.3. Work Package 4. Sustainable Mobility Solutions.

Solution 9. Sustainable Delivery

Delivery Room

Replicability

- Customer Segment: when it comes to replicating the delivery rooms from Measure 9.1, defining their location is crucial. First, the rooms should be located near the potential users of the service, who are mostly young people since they are the ones who shop online and are more open to using new delivery services. Second, the delivery rooms will have a greater impact in areas where there is a lack of delivery services and collection points.

Scalability

- Key partners: one of the challenges of Measure 9.1 is that some stores do not accept or want to use the delivery room system. They claim that they will have less control over tracking their packages and that they could be harmed by someone else's fault. Thus, to scale up the delivery rooms from Measure 9.1, the business partner should make sure that shops agree to using the delivery system.

- Customer relationship: another challenge associated with measure 9.1 is the lack of confidence in the security of the delivery rooms. In theory, once a person has access to the room, he or she is able to remove any of the packages. Although the delivery rooms have security cameras, users are still not willing to use the service for valuable goods. Therefore, to increase the number of users it is necessary to develop ways for the package to be secure until the recipient collects it.

Role of the Public Sector

- As mentioned before, a major point for the success of the delivery rooms is their location. Therefore, the public authorities can either provide a space in a public building or other facilities to implement these delivery rooms in strategic areas, or identify private building in those areas that could implement delivery rooms for the region and then facilitate their implementation.

- The public authorities can play a very large role by using the national postal service to provide the delivery room service. If the national postal service developed the delivery rooms, the service would be integrated into a much larger delivery system, which could increase the amount of packages delivered by cargo bikes to the rooms and enhance the reliability of the service. Additionally, all shops would have to accept delivering through this service, since it would be part of the national mailing system. Moreover, the public authorities would have all the incentives to promote usage and finance the delivery rooms.

Micro-distribution of Freight

Replicability

- Cost structure: one of the financial difficulties of starting a micro-distribution of freight business with cargo bikes is the high price of the vehicles in relation to the low cash-flow volume of a small last-mile distribution business. Thus, financial institutions could act in a way that would help to kick off and scale up micro-distribution businesses with leases and/or rents for cargo bikes.

- Diversify income sources: VANAPEDAL takes advantage of the infrastructure and knowledge it has to preserve its tricycles, in order to diversify its sources of income. The UCC (Urban Consolidation Center) also works as a repair service for bicycles and tricycles, either electric or conventional. Diversifying the type of service is something that VANAPEDAL has already done, which can serve as an example for companies that want to replicate the business in other cities.

Scalability

- Key resources: in order to scale measure 9.2 it would be necessary to implement new UCCs (Urban Consolidation Centers). Such centers should be strategically located where it is possible for vans and pathways to have easy access to leave the packages at the UCC and, at the same time, they should be close to areas where delivery by bicycle is advantageous.

- Take advantage of new market opportunities: in the example of VANAPEDAL, it is observed that e-commerce increasingly requires a large volume of deliveries of often small or medium-sized packages that can be easily transported on a cargo tricycle. As e-commerce has grown, the last-mile distribution business has great potential to take advantage of this new form of consumption.

Role of the Public Sector

- An action that the public authorities can take to foment measures related to cargo-bike distribution, such as Measures 9.1 and 9.2, is the restriction of motor vehicles in certain areas of the city. Such restriction gives both measures a potential market, in which delivery companies that use vans and/or trucks cannot compete.

- Public authorities can help a micro-distribution business by providing tax incentives for providers of such services. The size of the financial support can range from a tax exemption on part of the company's cash flow to the full availability of the UCC structure in a strategic location for business success. The latter is the case of the collaboration between Barcelona City Council and VANAPEDAL.

Solution 10. Smart Traffic Management

Replicability

- Customer Segment: in order to replicate an app like the one in Measure 10.3 & 11.5, one has to think of a strategy for how to reach the target market. The potential users of this app are mostly young people open to testing out new ways of commuting. One way to enter the market would be to sell the service directly to companies that would make the app freely available to their employees.

- Technology: the software developed for Measure 10.4, which would inform the driver of the right speed to be able to hit green lights, does not work with every type of traffic signal. The information provided by the software is only reliable for time-based traffic lights, because their predictability is much higher than that of other traffic light control systems, such as coordinated control and adaptive control. Therefore, this measure's success in a European city depends on the type of traffic light control the city employs.

Scalability

- Cost structure: like with most apps/software, the highest investment is needed for development. This means that scaling up will not add high operational costs to the business. Therefore, efforts at scaling up should be maximized, since the cost-benefit ratio can be very advantageous.

- Key partners: looking at Measure 10.3 & 11.5, partnerships with car sharing and bike sharing companies can be beneficial for the business. Such partnerships would create more added value for the app, attracting more users, which, in turn, might increase the car and bike sharing services.

Role of the Public Sector

The public sector should be part of the measures involving traffic signals on two different levels. First, they could finance part or all of the investments in infrastructure that might need to be made for the software to work properly. Traffic signals are not only part of public infrastructure, they are also too expensive for a company to buy them on a large scale.

Second, the public authorities must take part on the operational side, since they are able to control and ensure the proper function of the traffic lights, since they are part of the city's mobility planning.

The public authorities should have a vested interest in facilitating these measures, since they would improve traffic flow and decrease congestion.

Solution 11. Alternative Fuel-Driven Vehicles for Decarbonizing and Better Air Quality

Renewable Fuels for Heavy-Duty Vehicles

Replicability and Scalability

The charging stations in this solution are part of an infrastructure for both electric and alternative fuel driven vehicles. Therefore, the partners in these measures invest in them as the increase in infrastructure and a growing number of vehicles have appeared to demand their products.

For Measure 11.4, scalability and replicability meet at some point. Following the logic that alternative fuel-demanding vehicles will only exist if there is an infrastructure to supply the market, in the case of renewable fuel-powered haulage trucks (the consumer in measure 11.4), the scale of the infrastructure needs to be at the European level. A truck that crosses countries in Europe for delivery will need to refuel in different countries and regions across the continent. Therefore, for the renewable fuel heavy-duty vehicle market to work, it is necessary to scale up and replicate this measure across Europe, rather than on the scale of a single city.

Another point that should be taken into account when thinking about replicability and scalability is the location. It may be that the city council already has urban development plans for an area that do not mesh with a big charging station and the infrastructure required for trucks to circulate around the area. Therefore, the public authority has to be on board with the plan of where to place the charging station, especially in the case of serving heavy vehicles, since they take up more physical space.

Role of the Public Sector

With regard to renewable fuel stations for heavy goods vehicles, there is a willingness on the part of private fuel distribution companies to invest in these stations. This seems like a reasonable investment, given that companies working with trucks want to buy cleaner-fuel vehicles because they will use cheaper fuel. Although it is a bit more expensive to buy cleaner vehicles, reducing the cost of operation would make up for this difference.

Therefore, the role of the public authorities to help scale up and replicate this measure is not to create incentives to generate investments but rather to provide public space where these stations can be best utilized, in addition to smoothing over the bureaucracy involved in the implementation of the stations.

Another action that the public authorities can take is to pass legislation for trucks that limits their CO_2 emissions. It would be similar to the existing legislation for cars, but accounting for the proper measurements that would apply to a truck. This could help to accelerate the transition toward cleaner fuels, as it would put some pressure on the market.

Electric Charging Stations

Replicability

When it comes to planning a city's charging infrastructure, it is crucial for the plan to be in line with city's long-term strategy. For instance, the charging stations have to be placed in locations that are designed for circulation and parking cars. If not, there will either be an increase in the number of cars in areas that cannot handle this new quantity of vehicles or, more likely, a disuse of the stations because they are not located in practical areas for the user. Moreover, it is important to start implementing the charging stations in places where the target users can use them most easily: i.e., in residential areas where people can afford electric cars and/or along their commuting path to work.

Another point to be considered for the implementation of the charging stations infrastructure involves the legislative issues. Depending on the city, the regulations differ on where and how public space can be used for charging stations. For instance, in Cologne, RheinEnergie does not have any problems when it comes to installing the charging spots on lampposts located in public space, since they are the owner of those assets. Additionally, the city of Cologne is gradually offering more strategic public spaces for the implementation of new charging stations.

Lastly, in terms of the replicability of the electric charging stations, it should be pointed out that a partnership among the charging stations provider, the local energy supplier and the electric grid owner is essential. These are the three agents needed to provide the service. Depending on the city, the same company might offer one, two or all three elements of the chain (as in the case of RheinEnergie in Cologne).

Scalability

First of all, Scaling up the charging stations is mainly profitable because it will expand the charging infrastructure for electric cars, creating a better context for car users to substitute conventional vehicles with electric ones.

Secondly, in order to promote and facilitate the scalability, some technological standards should be applied. Every electric vehicle manufacturer (and thus every charging station provider) should comply not only at the city level but also at the European level, and ideally on a global level. In other words, every car should have the same type of power outlet, which would be compatible with a universal type of power plug/connector. This norm would give electric car owners the assurance that they can commute anywhere, knowing that it will be possible to charge the vehicle regardless of the make, thereby stimulating an increase in EV users.

Role of the Public Sector

The public sector, in this case, has two important roles. The first is as an enabler and facilitator of the partnerships between the charging station operator, the electricity grid operator and the electricity distribution company. In other words, the public authority will act as a central planner, regulating these partnerships as efficiently as possible.

The second function of the public sector, together with the operator of the charging stations, is to find strategic public spaces for the implementation of the measure, so that it is compatible with the city's urban planning.

Solution 12. Smart Mobility Solutions

Car-Sharing/Mobility Stations

Replicability

- Customer relationship: mobility station usage seems to be optimized in residential areas, as well as in areas connected with public transport stations. Additionally, the car-sharing stations need to be located in prominent places to facilitate user access.

Scalability

- Value propositions: creating some stations that are connected to central public transport stations even if they are not financially viable, in order to foment public transport usage and increase CO_2 savings.
- Cost structure: one of the financial difficulties of increasing the number of stations with electric cars is the high price of such vehicles. However, after the initial expensive cost, an electric car is less costly to keep running than a conventional car. Thus, financial institutions could act in a way that would help to scale up electric car sharing with leases and/or loans designed specifically for that business.

Role of the Public Sector

- Given the financial peculiarities of purchasing electric cars mentioned above, public authorities could consider a tax incentive program for the purchase of electric cars.
- As the mobility stations' location is a crucial factor for success, the public authorities should work to make the most strategically located public spaces available at a fair price for the implementation of these stations.
- The government can foster the use of car sharing by investing and promoting public transport, either by lowering the price or by increasing the quality of the service. Car sharing services like the ones in Cologne and Stockholm are designed to be part of the city's transportation system, so the greater the use of public transportation, the greater the use of car sharing.
- Additionally, another possible investment from the public sector in the city's transportation system would be the partial funding of stations that are connected with other means of transportation but not financially viable, as mentioned previously.

Smart Taxi Stands

Replicability

- Cost structure and value proposition: installing the sensors from measure 12.6 is expensive, since a certain level of work is required on the asphalt where the taxi stations are located. This high cost does not seem to be justified by the low utilization of the information provided by the sensors regarding both taxi drivers and taxi users. Therefore, this measure does not seem to be worth replicating in other cities.

Scalability

- Technology: scaling measure 12.6 does not seem to be financially viable. The maintenance costs of the sensors are high and constant, because it is necessary to change the batteries very often. Using these sensors in stations with higher taxi turnover would mean the sensors would have to work even more, wearing out the batteries even more quickly and decreasing their lifespan. The increase in the maintenance costs would not compensate for the planned gain for this measure.

Role of the Public Sector

An idea to attract users to measure 12.6 would be to offer those who take a taxi from a station, instead of anywhere else on the street, a discount on the ride, thus increasing the use of taxi stations and consequently the usefulness of measure 12.6. However, it would be necessary to assess whether the possible traffic improvement would offset the additional cost to the public sector.

8. Conclusions

The goal of this document was fourfold. First of all, we aimed to define key elements for the replication and scalability of measures implemented in the GrowSmarter project. Second, to determine the role of public authorities in fostering and enhancing the adoption of measures. Third, to improve the financial and economic evaluation of the measures. And, finally, to give recommendations to industrial partners and other stakeholders for improving their business models by leveraging the knowledge generated by the project.

As for the first goal, defining the key elements for the replication and scalability of measures, we have found several key issues to take into account. For example, we have concluded that when it comes to improving the sustainability of residential buildings, two elements determine the financial viability of the measures: size and weather. The measures implemented in large buildings in cold weather countries (Germany and Sweden, as compared to Spain) are sustainable due to the reduction of energy bills (in the case of Cologne) or the mix of a reduction of energy bills and CO_2 reduction (in the case of Stockholm). However, if one of those elements is missing, the financial sustainability is not achieved. On the other hand, for tertiary buildings, financial results vary from building to building. Some of them are sustainable (the library in Barcelona or Slakthusomradet in Stockholm), while others are not. The reason why some are not sustainable from the financial point of view seems to be due to a need to improve the structure of incomes, either because the incomes designed are lower than what the project needs or because the building does not seem to generate enough energy savings. In addition, if we look at private buildings, financial sustainability is reached when the building is used in an intensive way. Furthermore, for smart street lighting and waste management measures, there is economic sustainability for all of them. However, it is important to note in this regard that these types of measures rely on preexisting and complementary infrastructures in cities (for example, with recycling centers). The projects involving big data platform solutions show positive financial and economic results. While there are some challenges to overcome, summarized in following paragraphs, the benefits derived from more digital and data-intensive procedures, both inside and outside the public sector, can bring tangible outcomes that surpass the implementation costs. On the mobility side, almost all the measures that have defined revenues are on the right path for their financial sustainability. What can be highlighted from these results is that when the revenues are correctly structured, the financial sustainability of the measures seems to be reached. This proves the importance of improving the business models and the importance of enhancing the collaboration between the private and public sectors to promote the success of the measures (for example, when it comes to legal instruments that the public sector can use to improve the implementation of these measures).

Our second goal, determining the role of the public authorities in fostering and enhancing the adoption of sustainable measures, there are several challenges common to all the solutions and measures implemented. For example, in energy-saving measures, public institutions could take a leading role in legislating in favor of integral refurbishment projects for residential and tertiary purposed buildings. Another example for energy-saving measures could be the possibility of commercializing the surplus of self-produced energy to the local electricity network, which should help to achieve scale advantages, being less dependent on regular sources of energy, and being able to consume electricity produced locally by other buildings. The more buildings contribute to the local electricity network, the lower the dependence on other sources of energy would be. Moreover, another recommendation for the public sector is to actively embrace innovative public procurement. According to the partners, a significant change in the design of public licenses would facilitate the implementation of these types of measures. More specifically, the procurement process needs to shift away from the classic model based on price towards another model where the expected and desired value plays a central role.

As for big data platforms, it is important to note the need for improved skills and to foster trust within the public sector. One of the challenges with the implementation of this type of measure is the lack of skills and technological knowledge of the users – not just from the operating point of view, but also from the value point of view. The more people know about the potential of new technologies and platforms, the more they will be able to think about the positive impact they can have or the value they can generate. In that sense, raising public awareness about the practical and specific benefits is crucial. Therefore, identifying and sharing business cases, quick wins and collaborations between organizational departments is crucial to foster the acceptance and adoption of this type of technological measures. As for mobility solutions, public authorities can help micro-distribution businesses by providing tax incentives for the providers of such services, facilitating the installation of charging stations/mobility stations in key locations to increase their usage, or being an enabler and facilitator of partnerships not just between public and private organizations but also between private stakeholders (like grid operators, energy distributors and mobility companies).

In terms of our third goal, to improve the financial and economic evaluation of the measures, we have collected and analyzed data for 12 solutions and their corresponding measures. The data collected relates to two main areas: financial and economic information. As for the financial information, we collected data on the cost structure and the revenues/savings. On the other side, economic data is comprised of savings in emissions, time, or any other positive externality translated into monetary values. By doing this, we can differentiate between measures that are financially sustainable and measures that produce enough positive externalities to be subsidized. The specific results can be found in the corresponding chapter of this document, but it is important to highlight some key findings. First of all, when it comes to carrying out a financial and economic analysis of energy retrofitting projects for residential and tertiary buildings, other factors such as an increase in comfort or an expected increase in the value of the value of the properties should be taken into account in a more in-depth analysis. In other words, the financial performance of measures such as photovoltaics is greater than other, generally passive, measures and, therefore, their implementation could be more of a priority for future rehabilitation projects. For mobility measures, they have shown a significant reduction of CO_2 emissions and expect to reduce even more as the business grows. Finally, for integrated infrastructure, a majority of measures are financially and/or economically sustainable. It is important to remark that these results are affected by the strategic decisions made by the implementers. For example, in software-related solutions, one might decide to freely open the code. Therefore, it is advisable to take these conclusions for what they are: contingent on strategic decisions made by the partners involved.

Finally, the document has given recommendations to industrial partners and other stakeholders for improving their business models by leveraging knowledge generated by the project. One of the main areas of improvement across the measures implemented for the project is user engagement. For example, in order to replicate the energy-efficiency solutions in other buildings or cities, it is important to have the acceptance and collaboration of the owners, tenants, residents and users of a building. Although this may seem obvious, keeping this in mind from the beginning can dramatically enhance the replicability level of a retrofitting project – especially in terms of improving the Know-How, because receiving constant feedback from users and other stakeholders should improve the quality of the information used when making decisions. Similarly, one of the main challenges with big data platforms is how to foster usage by different users. Many organizations have routines and procedures that are not adapted to new technologies and, therefore, need an adaptation and accommodation stage to be fully accepted by users. In that vein, platforms can generate trust by focusing on existing problems that can be solved through the technology's implementation. In addition, showing potential users how they can benefit from the platform, mainly through specific uses cases, also helps to build trust among them. Another example of changes in the business model during the project timeline involves the micro distribution of freight by taking advantage of new market opportunities. In this measure, it is observed that e-commerce increasingly requires a large volume of deliveries and often small or medium-sized packages that can be easily loaded onto a cargo tricycle. As e-commerce has grown, the last mile distribution business has great potential to take advantage of this new form of consumption.

As concluding remarks, we want to pinpoint the importance of evaluation in Smart City projects. Although the methodology may vary between projects, we have provided a common evaluation method for solutions in three main sectors: energy efficiency, integrated infrastructures and mobility. By doing so, we help to advance existing knowledge through a cross-sectional comparison of measures and solutions, providing specific numbers and data for better decision making and, finally, recommendations for public and private stakeholders based on the information that is generated. This has been one of the main attempts to evaluate Smart City solutions by taking into account the business models, financial data and economic information. We believe that the conjunction of these three aspects can help us understand the challenges ahead and provide solutions for faster, better and more efficient implementation to achieve European sustainability goals and, ultimately, increase the livability of our cities and the quality of life of European citizens.

GrowSmarter
Transforming cities for a smart, sustainable Europe

GrowSmarter project partners

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 646456. The sole responsibility for the content of this document lies with the author and in no way reflects the views of the European Union.