



D3.3 – Technical and Financial indicators for SRTs



This project has received funding from the European LIFE Programme for Research and Innovation under grant agreement no 101077169. Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Project Acronym: easySRI

Project Full Title: Improving and demonstrating the potential of SRI

Grant Agreement: 101077169

Project Duration: 36 months (01/11/2022 – 31/10/2025)

DELIVERABLE D3.3

Technical and Financial indicators for SRTs

Work Package: WP3 – Development of the implementation framework of easySRI

Task: T3.3 – Technical and Financial indicators for SRTs

Document Status: Final

File Name: easySRI_D3.3_Technical and Financial indicators for SRTs

Due Date: 31.01.2024

Submission Date: 13.03.2024

Lead Beneficiary: Frederick University (FREDU)

Dissemination Level

Public ☒

Confidential, only for members of the Consortium (including the Commission Services) ☐

Authors List

Leading Author				
First Name		Last Name	Beneficiary	Contact e-mail
Pavlos		Papadopoulos	FREDU	res.pap@frederick.ac.cy
Co-Author(s)				
#	First Name	Last Name	Beneficiary	Contact e-mail
1	Byron	Ioannou	FREDU	b.ioannou@frederick.ac.cy
2	Evi	Demetriou	FREDU	res.de@frederick.ac.cy
3	Fatemeh	Asgharzadeh	DEMO	fatemeh@demobv.nl
4	Samaneh	Rezvani	DEMO	samaneh@demobv.nl
5	Giuseppe	Mastandrea	E@W	giuseppe.mastandrea@energyatwork.it
6	Cosimo	Liuzzi	E@W	cosimo.liuzzi@energyatwork.it
7	Reshma	Penjerla	E@W	reshma.penjerla@energyatwork.it

Reviewers List

Reviewers			
First Name	Last Name	Beneficiary	Contact e-mail
Paul	Waide	WSEE	paul@waide-europe.eu
Susanne	Geissler	SERA	s.geissler@sera.global

Version History

v	Author	Date	Brief Description
0.1	Pavlos Papadopoulos, FREDU	28/11/2023	First version of ToC ready for internal discussion
0.2	Pavlos Papadopoulos, FREDU	26/01/2024	First draft with material in all sections
0.3	Pavlos Papadopoulos, FREDU	16/02/2024	Updated draft based on partners feedback
0.4	Pavlos Papadopoulos, FREDU	26/02/2024	Document ready for review

0.6	Paul Weide, WSEE Susanne Geissler, SERA	10/03/2024	Review and quality checks
0.8	Pavlos Papadopoulos, FREDU	13/03/2024	Updated after review
0.9	Panagiota Chatzipanagiotidou, CERTH	13/03/2024	Semi-final content check
1.0	Paraskevas Koukaras, CERTH	13/03/2024	Final quality check. Ready for submission

Legal Disclaimer

This project has received funding from the European LIFE Programme for Research and Innovation under grant agreement no 101077169. Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Copyright

© Frederick University - Copies of this publication – also of extracts thereof – may only be made with reference to the publisher.

Executive Summary

Deliverable D3.3 aims to assess simplified technical and financial indicators for the purpose of establishing an SRT Catalogue including the relevant information, thus enhancing user-friendliness. The objective is to connect SRI improvements with product installations, developing financial indicators based on whole Life Cycle Costing (LCC). These indicators are crucial in evaluating the financial aspects of energy upgrades, focusing on the Rate of Return for smart readiness improvements. They also facilitate efficient use of information from SRI reports and Energy Performance Certificates during audits, contributing to a comprehensive SRI scheme evaluation.

The report begins by outlining the theoretical background used, which involves the calculation of impact of building automation on energy performance using a factor-based approach followed by the Life Cycle Cost analysis evaluating economic performance in annual cost expressed in terms of Internal Rate of Return. The methodology of this report encompasses several key chapters, starting with extensive market research regarding the availability of relevant devices proceeded by energy efficiency calculations where the impact of multiple factors is assessed. Finally, to ensure a collaborative approach that utilizes insights from different angles, feedback from project partners is included followed by the establishment of the SRT Catalogue which will provide a structured inventory that serves as a foundational reference for future phases.

In the results section, the project outcomes are presented, starting with an exploration of different market requirements, followed by the financial analysis and profitability of investments. In this final section, a comparative analysis of alternative markets is also included contributing to a comprehensive understanding of market dynamics.

Table of Contents

1	Introduction	9
1.1	Scope and objectives of the deliverable	9
1.2	Structure of the deliverable	10
1.3	Relation to Other Tasks and Deliverables	10
2	Theoretical Background	10
2.1	Definition of Factor Based Methodology	10
2.2	Definition of Life Cycle Cost Analysis	13
3	Methodology.....	16
3.1	Market analysis.....	16
3.2	Energy efficiency calculations: data normalization and interpretation into monetary values.....	16
3.3	Establishment of device catalogue	17
4	Results.....	19
4.1	Market requirements.....	19
4.2	Financial Analysis.....	20
4.3	Comparative analysis of alternative markets.....	22
5	Conclusions	31
6	References	32
	ANNEX A: Automation System Templates	33

List of Figures

Figure 2-1 Energy demand and supply model [3]	11
Figure 2-2 Calculation methods for BACS influence on system energy efficiency. Adapted from ISO 52120-1:2022 [2]	12
Figure 2-3 Calculation sequence of BAC efficiency factor method	13
Figure 2-4 LCC elements	14
Figure 3-1. Methodology workflow for energy savings and LCC analysis calculation	17

List of Tables

Table 1-1. Case study building zones	9
Table 3-1 Simplified SRT Catalogue format.....	17
Table 3-2 Extended SRT Catalogue format	17
Table 3-3 Automation System Economic Performance Evaluation Template	18
Table 4-1. Practical examples of the calculation process 1.....	20
Table 4-2 Practical examples of the calculation process 2.....	21
Table 4-3 Practical examples of the calculation process 3.....	21
Table 4-4 Automation purchase cost comparison	22
Table 4-5 Automation purchase cost comparison (continued).....	23
Table 4-6 Automation installation cost comparison	24
Table 4-7 Automation installation cost comparison (continued)	25
Table 4-8 Automation O&M cost comparison	26
Table 4-9 Automation O&M cost comparison (continued).....	27
Table 4-10 Simplified SRT Catalogue.....	28
Table 4-11 Simplified SRT Catalogue (continued)	29

List of Acronyms and Abbreviations

Term	Description
BACS	Building Automation and Control Systems
BEMS	Building Energy Management Systems
DHW	Domestic Hot Water
EnSPs	Energy Saving
EPIA	Energy Performance Improvement Action
ETC	Engineering Tool Software
EV	Electric Vehicle
$f_{BAC,aux}$	Auxiliary BAC factor
$f_{BAC,c}$	Cooling BAC factor
$f_{BAC,DHW}$	Domestic Hot Water BAC factor
$f_{BAC,el}$	Electricity BAC factor
$f_{BAC,h}$	Heating BAC factor
IRR	Internal Rate of Return
I/O	Input/Output
KPI	Key Performance Indicator
LCC	Life Cycle Costing
MARR	Minimum Attractive Rate of Return
NPV	Net Present Value
PV	Present Value
SRI	Smart Readiness Indicator
TBM	Technical Building Management
VFD	Variable Frequency Drive

1 Introduction

1.1 Scope and objectives of the deliverable

The purpose of the deliverable D3.3 is to define simplified technical and financial indicators which will serve as a basis for constructing an SRT Catalogue of products aimed at enhancing the Smart Readiness Indicator (SRI). The goal of this objective is to improve user-friendliness and understanding by establishing practical connections between SRI improvements and product installations. Therefore, project partners will collaboratively develop financial indicators based on the well-established concept of whole Life Cycle Costing (LCC) [1]. This approach facilitates the interpretation of individual elements of buildings' energy performance and smartness into normalized monetary values [2].

These indicators will play a crucial role in assessing the financial aspects of buildings energy upgrade measures, specifically by examining the Rate of Return associated with smart readiness improvements. Furthermore, they will enable the efficient use of information from both Smart Readiness Indicator reports and Energy Performance Certificates during audit processes. This contribution enhances the overall evaluation of the SRI scheme ensuring a thorough assessment.

It is important to note that at this stage that the analysis in Task 3.3 focuses exclusively on assessing the energy savings derived from higher functionalities that align with the SRI's energy efficiency criteria. The exploration of the most cost-effective methods for incorporating additional smart service functionalities, including but not limited to Electric Vehicle (EV) charging, energy flexibility, and outcomes related to comfort, health, and convenience are not considered.

Furthermore, in the case of the building to be studied in this phase of the deliverable, it will be a single home residential building of 120 m² in Cyprus. All automations will be referred to the building zones of Table 1-1.

Table 1-1. Case study building zones

Zones	Rooms	Area [m ²]
Living Zone	Living room	30
Sleeping Zone	Master bedroom	20
	Additional bedroom 1	10
	Additional bedroom 2	10
Service Zone	Kitchen	20
	Utility	5
Bathroom Zone	Main bathroom	8
	Second bathroom	4
Outdoor Spaces	Balcony	5
Common Areas	Hallways and corridors	5
	Entryways	3
	Sum	120

1.2 Structure of the deliverable

The report is structured into five chapters. Each chapter serves a specific purpose which contributes to the overall understanding of the technical and financial indicators of SRTs. A brief summary of the chapters is described below:

- **Chapter 1:** serves as an introduction to the deliverable, providing a comprehensive overview that includes the scope, objectives, and the structure of the document. It also establishes the relationship between the current deliverable and the other associated tasks or outputs within the broader context.
- **Chapter 2:** presents the Theoretical Background providing a clear understanding of the Factor-Based methodology (used to determine the savings from SRTs as a function of the SRI functionality they provide) and Life Cycle Cost Analysis. This chapter lays the foundation for the subsequent analysis by ensuring a clear understanding of the theoretical concepts.
- **Chapter 3:** covers the methodology for market analysis, the energy efficiency calculations involving data normalization and interpretation to monetary values, the analysis of feedback from project partners, and the systematic establishment of a device catalogue.
- **Chapter 4:** presents the empirical findings and outcomes derived from the applied methodologies, including the findings related to market requirements, financial analysis outcomes and a comparative analysis of alternative markets.
- **Chapter 5:** offers a summary of the entire document highlighting any significant observations or challenges that emerged during the process.

1.3 Relation to Other Tasks and Deliverables

D3.3 represents the first proposal incorporating the correlation between technical characteristics of smart devices and their economic feasibility. The outcomes from this report complement all other WP3 tasks, namely Task 3.1: SRI assessment methods, service catalogues, impact scores and weighting, Task 3.2: Linking energy efficiency with SRI, and Task 3.4: easySRI implementation pathways for EU Member States.

Furthermore, the analysis conducted in this report will provide valuable information for the work conducted in WP4, particularly contributing to the derivation of easySRI tools aimed at supporting financial analysis. Finally, the financial results it produces can facilitate the market uptake of easySRI and the roll-out of smart ready technologies described in WP6.

The present document captures the collaborative knowledge produced by the T3.3 partners – each contributing with his unique expertise – in order to define the technical and financial indicators for SRTs. Also, any additional outputs of this task will be reported via D3.4 - easySRI Implementation pathways.

2 Theoretical Background

2.1 Definition of Factor Based Methodology

Building Automation and Control Systems (BACS) can provide effective control functions (called BAC functions) for any building energy system, for example, heating, ventilating, cooling, hot water, and lighting appliances, that lead to improved operational and energy efficiencies. Complex and integrated energy savings functions and routines can be configured based on the actual use of a building, depending on real user needs, to avoid unnecessary energy use and CO₂ emissions [3].

Technical Building Management (TBM) functions as part of the building management system (BMS) provide information about operation, maintenance, services, and management of buildings, especially for energy management, e.g., measurement, recording trending, and diagnostic alert capabilities that diagnose unnecessary

use. Energy management provides requirements for documentation, controlling, monitoring, optimization, determination and to support corrective action and preventive action to improve the energy performance of buildings [3].

BAC functions are referred to as control function, I/O processing, optimization, management and operator functions. They are listed in the BAC function list for a specification of work [3]. These functions are based on the energy demand and supply model represented in Figure 2-1.

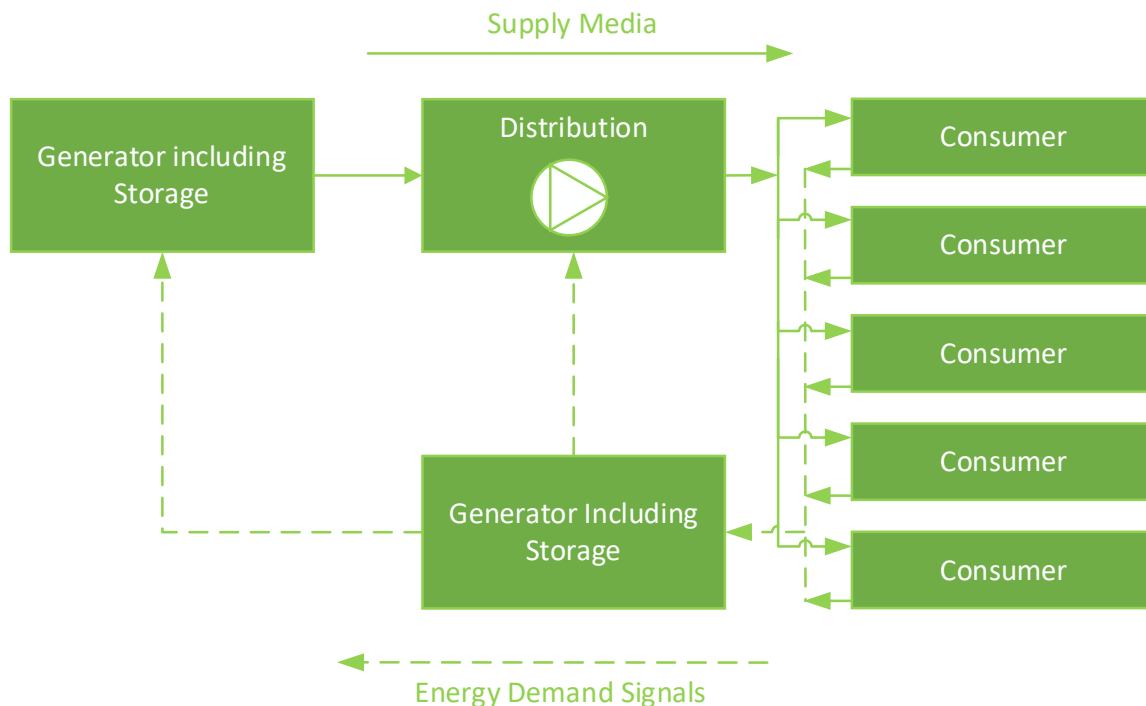


Figure 2-1 Energy demand and supply model [3]

The BAC factor methodology set out in this section has been established within the EPB EN ISO 52120-1:2021 standard to allow a simple calculation of the impact of building automation, control, and management functions on the building energy performance [3]. The factor-based method considers delivered energy as an input and applies BACS efficiency factors, to result in BACS adjustments to delivered energy as outputs. This approach is represented in Figure 2-2. This same standard, or more accurately its immediate predecessors EN15232, was used as the core of the functionalities defined in the SRI Methodology A and B (see details in D3.1), so there is a strong alignment between these functionalities and those applied in the SRI, which means that the BACS factor methodology presented here is directly applicable within the SRI and hence easySRI tools.

Four different BAC efficiency classes (A, B, C, D) of functions are defined both for non-residential and residential buildings.

- Class D corresponds to non-energy efficient BAC. Buildings with such systems should be retrofitted. New buildings are unlikely to be built with such systems.
- Class C corresponds to standard BAC.
- Class B corresponds to advanced BAC and some specific TBM functions.
- Class A corresponds to high-energy performance BAC and TBM functions.

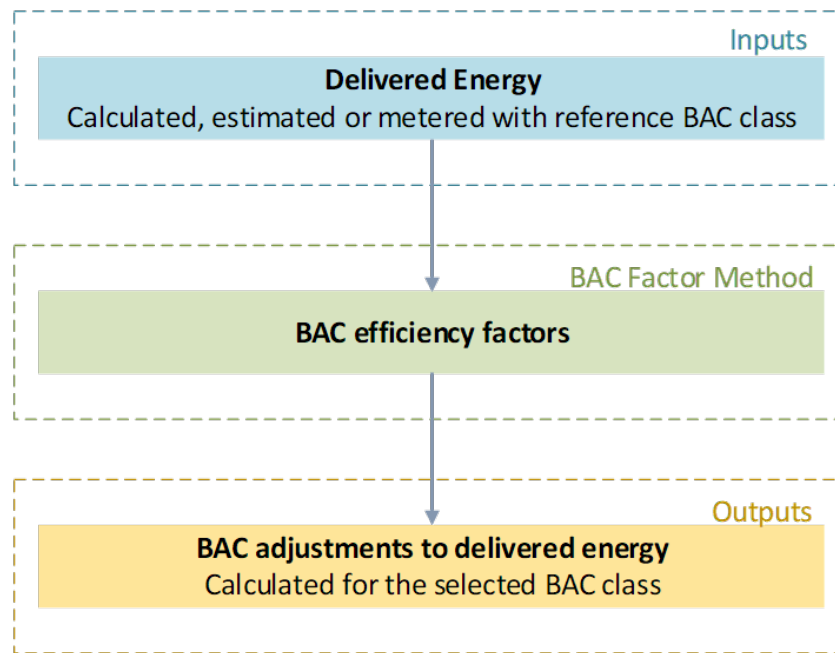


Figure 2-2 Calculation methods for BACS influence on system energy efficiency. Adapted from ISO 52120-1:2022 [2]

The BAC factor method provides a preliminary assessment of how BAC and TBM functions influence the thermal and electric energy demand of a building, categorized into efficiency classes A, B, C, and D. This method is particularly suitable for the initial design phase of a building's automation class and whether it is expected or predefined. No specific details about control and automation functions are necessary at this early stage.

This procedure is designed for a yearly calculation period and yearly calculation time interval. The factors that are related to the annual energy use of a building include:

- Energy needs for heating and cooling, internal temperatures, and sensible and latent heat loads, calculated according to ISO 52016-1 [11].
- Thermal and auxiliary energy input to the space heating system, calculated according to the EN 15316 series [12].
- Thermal and auxiliary energy input to the cooling system, calculated according to EN 16798-9 [13].
- Thermal energy input to the domestic hot water system, calculated according to the EN 15316 series.
- Electric energy input to the lighting system, calculated according to EN 15193-1 [14].
- Electric energy input to the ventilation system, calculated according to EN 16798-5 [15].

In principle, the energy consumption of the building can be computed using various dedicated calculation algorithms, such as EPB standards within Europe, ISO standards outside Europe, or any applicable national or regional codes. Regardless of the chosen calculation method, it will consider the unique characteristics of the building, its designated purpose, and the specific climatic conditions of its location. Consequently, BAC factors remain unaffected by these particulars, such as climatic parameters.

The BAC efficiency factors were derived through transient pre-calculations for various building types, as outlined in ISO 52003-1. Each building type is characterized by distinct user profiles reflecting occupancy and internal heat gains from people and equipment. The BAC efficiency classes (A, B, C, and D) are distinguished by varying levels of control accuracy and quality. The influence of diverse climate conditions on BAC factors was considered negligible, as climatic effects primarily impact energy input data derived from preliminary energy performance calculations.

Finally, four sets of BAC efficiency factors $f_{BAC,H}$, $f_{BAC,C}$, $f_{BAC,DHW}$, $f_{BAC,el}$, and $f_{BAC,aux}$ were extracted from the results of the energy performance calculations. They are available for the assessment of:

- Thermal energy for space heating and cooling ($f_{BAC,H}$, $f_{BAC,C}$)

- Thermal energy for domestic hot water generation ($f_{BAC,DHW}$)
- Electric energy for ventilation, lighting, and auxiliary devices ($f_{BAC,el}$, $f_{BAC,aux}$).

The energy input to the building energy systems (energy use) accounts for building energy demand, total thermal losses of the systems as well as auxiliary energy required to operate the systems.

The BAC efficiency factors were used as illustrated in the following formula to calculate the BAC assessed energy inputs to the systems:

$$Q_{i,tot,BAC} = (Q_{i,nd,B} + Q_{i,ls}) \cdot \frac{f_{BAC,i}}{f_{BAC,i,ref}} \quad (2.1)$$

$$W_{i,aux,BAC} = W_{i,aux} \cdot \frac{f_{BAC,el}}{f_{BAC,el,ref}} \quad (2.2)$$

Equation (2.1) presents the total energy of domain i (i.e. heating, cooling, DHW, ventilation, dynamic envelope, electricity, lighting, EV, monitoring, and control) based on the BACS efficiency class whereas equation (2.2) presents the electrical auxiliary for domain i based on the BACS efficiency class.

Figure 2-3 shows the whole calculation sequence of the BAC efficiency factor method. Normally class C which corresponds to an average building automation and control system is set as a reference case. For this reference case, the annual energy use of the building energy system is computed, either in a detailed or simplified manner using an appropriate calculation method or is measured. Subsequently, the BAC factors facilitate a straightforward evaluation of the energy performance for a building employing a different building automation and control system than the one defined in the reference case. Since the relevant efficiency factors are compared, the building's energy performance is relative to the reference case.

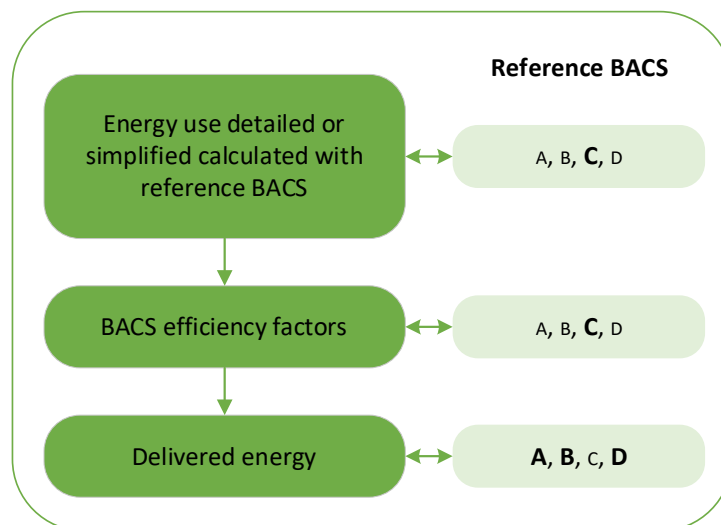


Figure 2-3 Calculation sequence of BAC efficiency factor method

2.2 Definition of Life Cycle Cost Analysis

Life Cycle Cost (LCC) involves the expenses associated with a building or a construction component throughout its life cycle, while meeting both technical specifications (i.e., the type and level of technical features required by the client, users, and/or regulations) and functional requirements (i.e., type and level of functionality outlined by the client, users, and/or regulations) [4].

The purpose of Life-Cycle costing should be to quantify the LCC for input into a decision-making or evaluation process and should usually include inputs from other evaluations (e.g. environmental assessment, design assessment, safety assessment, functionality assessment and regulatory compliance assessment). The quantification should be to the level of detail that is required for key project stages. The scope of costs included/excluded from an LCC analysis should be defined and agreed with the client at the outset [5].

An economic and financial evaluation of an Energy Saving Project (EnSP) or Energy Performance Improvement Action (EPIA) involves three elements [6]:

- The identification and estimation of costs related to the investment (financial approach).
- The identification and estimation of all the benefits to be obtained from the investment (economic approach).
- A comparison of the expensed costs with the energy savings benefits and non-energy benefits to determine the appropriateness of the investment (evaluation and analysis).

The main objectives of implementing the economic and financial evaluation for an EnSP can be categorized as follows [6]:

- Collect and calculate the related costs and cash flows of equipment and installations.
- Assess and calculate both direct and indirect costs, e.g. working capital, general and start-up expenses, manufacturing costs.
- Calculate the price of an energy utility as a function of the location: it is assumed that the EnSP is working under the expected utility prices (e.g. fuel and electricity prices) applicable to the location of the EnSP during the project evaluation period, and under the present condition of utility prices, including inflation, especially regarded energy based on the location.

When appraising the potential costs involved in an EnSP, it is important to specify the type of cost, including fixed, variable, and total costs. The total investment of any project is therefore the sum of the fixed and variable costs [6]. An overview of the LCC elements is presented in Figure 2-4.

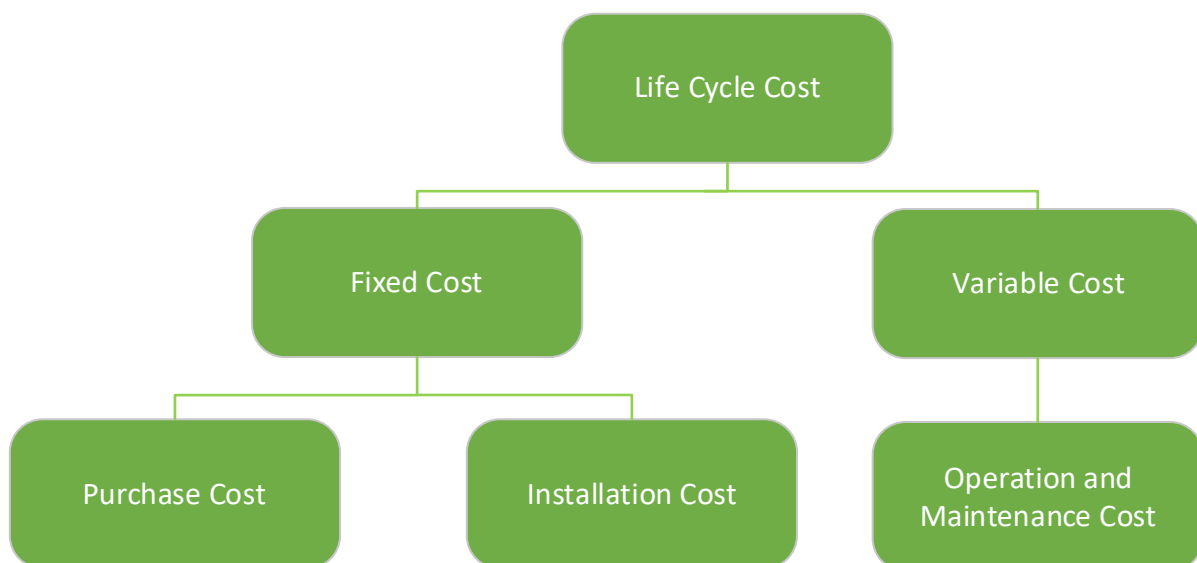


Figure 2-4 LCC elements

From an economic perspective, it is assumed that a project is undertaken if the total benefits exceed the cost. For EnSPs, cost benefit analysis needs to consider the concept of time value of money, i.e. the cash inflow and outflows cannot be simply added or subtracted. This analysis is used to prioritize identified EPIAs [6].

The economic indicators that will be used in this study for the evaluation of an EnSP are:

- Present Value (PV).
- Net Present Value (NPV).
- Internal Rate of Return (IRR).

The following conventions are used to arrive at the cash flows.

- At any given point in time ($t = 0, 1, 2... n$), there can exist both revenue (positive) cash inflows, R_t , and cash outflows, C_t .
- The net cash flow, A_t , is defined by:

$$A_t = R_t - C_t \quad (2.3)$$

where

R_t is the cash inflow over time;
 C_t is the cash outflow (at the beginning of and during the project; this can include an initial investment).

Present Value

Present Value (PV) is an indicator that may not be used alone to justify the EnSP and may be used in conjunction with other indicators. The concept of present value, PV, as a measure of investment worth can be generalized as shown by the equation below [6]:

$$PV = \sum_{t=1}^n A_t(P|F, i, t) \quad (2.4)$$

where

A_t is the net cash flow;
 $(P|F, i, t)$ is the present value factor and is read “to find P given F at $i\%$ for n years”;
 i is the interest rate, in %;
 P is the amount of money at the beginning of the n th year;
 F is the future amount of money at the end of the n th year;
 t is time;
 n is the lifetime of the system, in years.

Net Present Value

Net Present Value (NPV) determines the current value of the discounted net cash flows from an investment based on the organization's required rate of return. It considers the equipment life, risk of the investment and when the energy savings will be delivered. NPV formula can be expressed as below [5]:

$$NPV = \sum_{t=0}^n \frac{R_t - C_t}{(1 + r)^t} \quad (2.5)$$

where

R_t is the cash inflow over time;
 C_t is the cash outflow (at the beginning of and during the project; this can include an initial investment);
 r is the discount rate, in %;
 t is time;
 n is the lifetime of the system, in years.

Internal Rate of Return

Internal Rate of Return (IRR) follows the same reasoning as NPV. The main difference is that, rather than choosing a discount rate which is based on the risk of the project, this method relies on an iterative solution to determine which discount rate will cause the NPV of the project to equal zero. IRR is calculated by trial and error by varying the discount rate in the NPV formula until the NPV is equal to zero [6]. The minimum attractive rate of return (MARR) is the lowest internal rate of return an organization would consider to be a good investment. The MARR is a statement that an organization is confident that it can achieve at least that rate of return.

- If $IRR > MARR$, the EnSP is attractive.
- If $IRR < MARR$, the EnSP is not attractive.
- If the IRR is very close or equal to the value of MARR, then it is often helpful to evaluate the EnSP using another indicator.

3 Methodology

3.1 Market analysis

The technical and financial indicators reported in this document were established by extensive market research. This research involved identifying as many devices/equipment as possible assigned to various BAC(SRI) functionality levels of a given smart service. In some cases, the same equipment may be assigned to more than one BAC(SRI) functionality level. Once the devices have been identified, they are priced according to the relevant market prices in each of the Member States involved in the analysis. Regarding the pricing of the devices, the rules of life-cycle cost analysis were applied followed by the definition of three indicators: the costs of purchase, installation, and maintenance and operation on an annual basis. Based on the partners involved in the task, data from the countries of Cyprus, Italy, and the Netherlands were obtained.

3.2 Energy efficiency calculations: data normalization and interpretation into monetary values

To determine the impact of the control level, an analysis was performed for each possible level upgrade by examining the building inputs given by the partners.

Each SRI service is categorized with a functionality level ranging from 0 to 4 (see D3.1). Level 0 represents the minimum level of control, while higher levels indicate gradual improvements in system control leading to increased automation functionality. Correspondingly, each control level is associated with a reflective BACS efficiency class, according to ISO 52120-1:2022 [3], graded from A to D, with A being the highest efficiency class. It is notable that an increase in the control level doesn't always correlate with an improvement in the BACS efficiency class. There are also cases where an increase in control level by one class results in an increase in efficiency by two classes. Consequently, the transition from a control level to a BAC efficiency class is not always straightforward, thus affecting the potential energy savings from control level upgrades.

Each BAC efficiency class can be expressed as a factor. The coefficients for each class vary depending on the building type (i.e., residential, or non-residential) and on the building function (apartment building, office, hotel, etc.). The efficiency classes range from lowest to highest coefficient value. The specific factors for building types and functions are outlined in ISO 52120-1:2022 [3].

The energy savings resulting from the upgrade of BACS equipment can be determined by dividing the factor of the improved BACS efficiency class by the factor of the reference class which is assigned according to the BAC efficiency of present devices/equipment in the examined building.

To calculate energy savings and express them in monetary values, it is necessary to assign the initial consumption data of the building unit to each area related to the equipment to be installed. These values concern the active area of each domain, the energy costs, and the energy consumption of the given area.

In this report, the average lifetime of automation systems is presumed to be 10 years. Due to limitations in obtaining precise data for each individual automation system, an averaged value of 10 years has been adopted for analytical purposes. This approach allows for a standardized assessment across the systems under consideration, facilitating comparative analysis and decision-making processes. Furthermore, external costs associated with CO₂ emissions have not been factored into the analysis.

For all the calculations in this study, inflation-adjusted currency values were used. All rates are based on data from past experience, market interest rates or rates of return at a regional or national level. The discount rate could be adjusted for risk, but it was no more than seven percentage points higher than the long-term average rate of interest on ten-year government bonds of the appropriate governments(s). The use of a MARR (Minimum Attractive Rate of Return) that is equal to the discount rate was considered. The MARR was chosen based on measured rates of return on investments of comparable organizations [6].

An overview of the methodology approach used to determine the energy efficiency calculations and LCC analysis is presented in Figure 3-1.

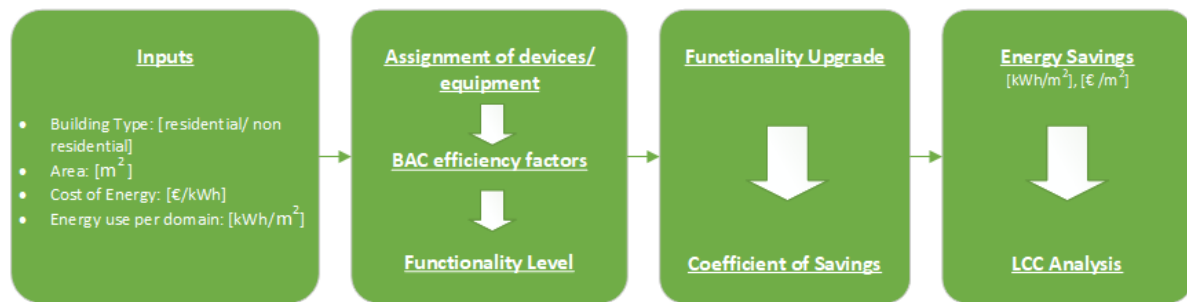


Figure 3-1. Methodology workflow for energy savings and LCC analysis calculation

3.3 Establishment of device catalogue

For the purpose of both reading practicality and future integration of the SRT catalogue into computational tools, it was decided to structure the catalogue based on the following characteristics: Smart Device, Domain Code, and functionality level. For each individual case examined, extra inputs were added regarding the purchase, installation, and operation and management costs of each device. The proposed SRT catalogue formats are presented in Table 3-1 and Table 3-2, respectively.

Table 3-1 Simplified SRT Catalogue format

Smart Device	Code	Functionality Level

Table 3-2 Extended SRT Catalogue format

Smart Device	Accessories	Purchase Cost (€)	Installation Cost (€)	O&M Cost (€)

The proposed automation classification template, presented in Table 3-3 provides a structured and systematic framework for evaluating systems. This formalized template is designed to efficiently capture the essential details related to system specifics, building information, and overall economic performance. By adopting a concise yet comprehensive approach, it streamlines the analysis process, facilitating informed decision-making and strategic planning within the domain of automated systems.

Table 3-3 Automation System Economic Performance Evaluation Template

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain					
Code					
System Details					
Automation system name					
Brief description					
Datasheet hyperlink					
Functionality level	Level 1 ☐	Level 2 ☐	Level 3 ☐	Level 4 ☐	
Functionality upgrade	Domain Code:	Level upgrade:			
Building Information					
Building type					
Climatic zone					
Country					
Total useful floor area					
Equipment information					
Average cost			Average installation cost		
Annual O&M cost					
Discount rate					
Financial Performance					
IRR Year 1		IRR Year 5		IRR Year 10	
NPV Year 1		NPV Year 5		NPV Year 10	
Recommendations					
Overall financial feasibility					

4 Results

4.1 Market requirements

In the pursuit of defining and implementing automation functionalities across different levels, a comprehensive market research initiative was conducted. The focus was primarily on renowned European companies like Siemens and Schneider, and insights were gathered from industry professionals to assess the costs associated with purchasing, installing, and operating automation systems, tailored to specific building requirements.

This research effort aimed to provide unbiased insights into the feasibility and economic implications of automation deployment. By consulting industry experts and engaging with representatives from leading companies, a nuanced understanding of the market landscape was obtained, transcending mere product endorsements.

The findings of this research could serve as a valuable resource for stakeholders seeking to optimize their automation strategies. Continuous monitoring of industry trends and technological advancements will be essential to remain competitive and capitalize on emerging opportunities in the realm of building automation.

4.2 Financial Analysis

The tables shown in Table 4-1 to Table 4-3 present practical examples of the calculation process applied as described in the methodology set out in Chapter 3.2.

Table 4-1 shows some of the automations used in a residential building of 120 m² in Cyprus. For these automations, the functionality levels are indicated along with the BAC factors to which they correspond as per the EN ISO 52120 guidelines. Furthermore, for each device, the average installation and maintenance costs as well as the total number of automations in the building are indicated. Table 4-2 shows the coefficients of savings for each transition to a higher functionality level. Table 4-3 shows the cash flows and the economic feasibility of the indicated thermostat (see Table 4.1) for the case of the residential building in Cyprus. In terms of cash flows, the study was carried out for a period of 10 years during which the financial metrics NPV and IRR in the first and fifth year are reported in parallel.

These examples are meant to provide a clear illustration of the process. When necessary, the detailed calculations are being updated as part of the activities of T3.3 – Technical and Financial indicators for SRTs. A comprehensive set of templates for evaluating the financial performance of an Automation System in the context of a residential building in Cyprus is presented in Annex A.

Table 4-1. Practical examples of the calculation process 1

Heating			Functionality Level					Avg. Device Cost (€)	No. of Devices	Avg. installation cost (€)	Avg. O&M Cost (€)	Avg. Total Cost (€)
BAC Reference Class		BAC Upgraded Class	0	1	2	3	4					
Code	Smart Ready Service	Automation	D	D	C	B	A					
H-1a	Emission control	RDS110 Smart Room Thermostat	1.1	1.1	1	0.88	0.81	356	5	1500	200	3280
		RDF600KN Flush mount KNX room thermostat	1.1	1.1	1	0.88	0.81	190	5	500	200	1450
		UP258D51 Presence Detector	1.1	1.1	1	0.88	0.81	500	5	1550	200	4050
			D	C	B	A	A					
H-1d	Control of distribution pumps in networks	G120P-3/35B Variable Speed Drive	1.1	1	0.88	0.81	0.81	1850	1	1100	367	2950
		RMU710B-1 Universal controller	1.1	1	0.88	0.81	0.81	2930	1	1000	242	3930

Table 4-2 Practical examples of the calculation process 2

Coefficients of Savings									
0>1	0>2	0>3	0>4	1>2	1>3	1>4	2>3	2>4	3>4
1.00	0.91	0.80	0.74	0.91	0.80	0.74	0.88	0.81	0.92
1.00	0.91	0.80	0.74	0.91	0.80	0.74	0.88	0.81	0.92
1.00	0.91	0.80	0.74	0.91	0.80	0.74	0.88	0.81	0.92
0.91	0.80	0.74	0.74	0.88	0.81	0.81	0.92	0.92	1.00
0.91	0.80	0.74	0.74	0.88	0.81	0.81	0.92	0.92	1.00

Table 4-3 Practical examples of the calculation process 3

RDF600KN Flush mount KNX room thermostat					
Year	Energy Savings	O&M Cost	Revenue	Domains	H-1a, C-1a
Investment	-1450		-1450	Discount Rate	3%
1	403.20	200.00	203.20	IRR Year 1	-86.0%
2	415.30	206.00	209.30	IRR Year 5	-9.0%
3	427.75	212.18	215.57	IRR Year 10	9.2%
4	440.59	218.55	222.04	NPV Year 1	-(€1,252.72)
5	453.81	225.10	228.70	NPV Year 5	-(€463.59)
6	467.42	231.85	235.56	NPV Year 10	€522.82
7	481.44	238.81	242.63		
8	495.89	245.97	249.91		
9	510.76	253.35	257.41		
10	526.08	260.95	265.13		

4.3 Comparative analysis of alternative markets

For an overall understanding of alternative market trends, a comparative analysis is essential. It enables the identification of emerging trends and patterns, highlighting similarities and differences. This type of analysis is critical in revealing the complex dynamics and drivers of different markets, providing valuable insights. In addition, benchmarking performance against different markets provides an objective measure of project success and helps identify areas for improvement. Validating the findings with consistent patterns across markets increases the reliability of the study, thereby strengthening the credibility of the results. Finally, this comparative strategy ensures a holistic perspective, considering a wide range of contexts, and contributing to the development of a thorough SRT Catalogue. The findings of that analysis as well as the simplified SRT catalogue are presented in the tables below.

Table 4-4 Automation purchase cost comparison

Main automation	Accessories	Purchase Cost – Cyprus (€)	Purchase Cost – Netherlands (€)	Purchase Cost – Italy (€)
WFW636.D110 Electronic impeller type hot water meter, M-bus radio communication, S-mode, WTT662-BA1100 Network node.	N/A	100	132	135
UP258D51 Presence Detector WIDE multi with temperature, humidity, and CO2 measurement, IR remote control.	S 255/11 IR remote control	518	540	698
RLM162 Air duct temperature controller.	QAP22 Cable temperature sensor	2463	3081	3877
	QBM2030-1U Differential pressure sensor			
	S 290/11 Door/window contact			
	UP 258D12 Presence Detector			
	SSP81 Electromotoric actuator			
	GDB181.1E/BA VAV compact controller BACnet			
	AST20 Handheld tool for VAV compact controllers			
N543D51 Solar protection actuator, 8xAC230V, 6A, with end position detection.	N/A	600	624	803
EcoStruxure Panel Server – universal wireless, concentrator Modbus gateway 110-277 VAC/DC, iEM3155 energy meter -63A- Modbus.	Schneider Electric A9MEM3155 Picture iEM3155 energy meter - 63 A - Modbus	2070	2295	2895

Table 4-5 Automation purchase cost comparison (continued)

Main automation	Accessories	Purchase Cost – Cyprus (€)	Purchase Cost – Netherlands (€)	Purchase Cost – Italy (€)
RDF600KN Flush mount KNX room thermostat	N/A	190	223	327
	N/A			
RDS110 Smart Room Thermostat	N/A	356	438	612
	N/A			
RVL482 Heating controller for boiler temperature control for modulating or 2-stage burners with DHW heating	QAD22 Strap-on temperature sensor	2674	2882.5	3411
	QAE2120.010 Immersion temperature sensor			
	QAP21.2 Cable temperature sensor for high-temperature applications			
	QAC22 Outside sensor			
	QLS60 Solar sensor			
	AP 257/51 Weather station			
RMU710B-1 Universal controller	BAU200 Universal digital indicator	5472	6249	7268
	RMZ792 Bus operator unit			
	RMZ785 Universal module (8UI)			
	OCI700.1 Service tool for KNX / LPB			
	OZW772.16 Web server for 16 Synco devices			
	GDB181.1E/BA VAV compact controller BACnet			
	SSA31.04 Electromotoric actuator			
UH50-A74-00 Ultrasonic heat meter, RS-485(MS/TP) BACnet module, WZU5-2815 pair of temperature sensors	WZM-F270 Spacer DN 50	2615	2529	3484
	WZU-RF Radio module			
	WZU5-2815 Pair of temperature sensors Pt500			
G120P-3/35B Variable Speed Drive, G120P-IP55-PAN-EXT, G120P-AIRSHEET-FSA, G120P-IOP-2-BT Intelligent operator panel	G120P-IP55-PAN-EXT Operator Panel Extension cable	1572	1650	1687
	G120P-AIRSHEET-FSA G120P air guide sheet			
	G120P-IOP-2-BT G120P intelligent operator panel IOP-2-BT			

Table 4-6 Automation installation cost comparison

Main automation	Accessories	Installation Cost – Cyprus (€)	Installation Cost – Netherlands (€)	Installation Cost – Italy (€)
RDF600KN Flush mount KNX room thermostat	N/A	100	180	104
	N/A			
RDS110 Smart Room Thermostat	N/A	300	540	312
	N/A			
RVL482 Heating controller for boiler temperature control for modulating or 2-stage burners with DHW heating	QAD22 Strap-on temperature sensor	2050	3690	2132
	QAE2120.010 Immersion temperature sensor			
	QAP21.2 Cable temperature sensor for high-temperature applications			
	QAC22 Outside sensor			
	QLS60 Solar sensor			
	AP 257/51 Weather station			
RMU710B-1 Universal controller	BAU200 Universal digital indicator	1624	2923	2625
	RMZ792 Bus operator unit			
	RMZ785 Universal module (8UI)			
	OCI700.1 Service tool for KNX / LPB			
	OZW772.16 Web server for 16 Synco devices			
	GDB181.1E/BA VAV compact controller BACnet			
	SSA31.04 Electromotoric actuator			
UH50-A74-00 Ultrasonic heat meter, RS-485(MS/TP) BACnet module, WZU5-2815 pair of temperature sensors	WZM-F270 Spacer DN 50	2000	3600	2080
	WZU-RF Radio module			
	WZU5-2815 Pair of temperature sensors Pt500			
G120P-3/35B Variable Speed Drive, G120P-IP55-PAN-EXT, G120P-AIRSHEET-FSA, G120P-IOP-2-BT Intelligent operator panel	G120P-IP55-PAN-EXT Operator Panel Extension cable	1100	1980	1144
	G120P-AIRSHEET-FSA G120P air guide sheet			
	G120P-IOP-2-BT G120P intelligent operator panel IOP-2-BT			

Table 4-7 Automation installation cost comparison (continued)

Main automation	Accessories	Installation Cost – Cyprus (€)	Installation Cost – Netherlands (€)	Installation Cost – Italy (€)
WFW636.D110 Electronic impeller type hot water meter, M-bus radio communication, S-mode, WTT662-BA1100 Network node.	N/A	93	167	97
UP258D51 Presence Detector WIDE multi with temperature, humidity, and CO2 measurement, IR remote control.	S 255/11 IR remote control	300	540	312
RLM162 Air duct temperature controller.	QAP22 Cable temperature sensor	1730	3114	1800
	QBM2030-1U Differential pressure sensor			
	S 290/11 Door/window contact			
	UP 258D12 Presence Detector			
	SSP81 Electromotoric actuator			
	GDB181.1E/BA VAV compact controller BACnet			
	AST20 Handheld tool for VAV compact controllers			
N543D51 Solar protection actuator, 8xAC230V, 6A, with end position detection.	N/A	300	540	312
EcoStruxure Panel Server – universal wireless, concentrator Modbus gateway 110-277 VAC/DC, iEM3155 energy meter -63A-Modbus.	Schneider Electric A9MEM3155 Picture iEM3155 energy meter - 63 A - Modbus	1300	2340	1352

Table 4-8 Automation O&M cost comparison

Main automation	Accessories	O&M Cost – Cyprus (€)	O&M Cost – Netherlands (€)	O&M Cost – Italy (€)
RDF600KN Flush mount KNX room thermostat	N/A	200	360	208
	N/A			
RDS110 Smart Room Thermostat	N/A	200	360	208
	N/A			
RVL482 Heating controller for boiler temperature control for modulating or 2-stage burners with DHW heating	QAD22 Strap-on temperature sensor	350	630	364
	QAE2120.010 Immersion temperature sensor			
	QAP21.2 Cable temperature sensor for high-temperature applications			
	QAC22 Outside sensor			
	QLS60 Solar sensor			
	AP 257/51 Weather station			
RMU710B-1 Universal controller	BAU200 Universal digital indicator	800	1440	832
	RMZ792 Bus operator unit			
	RMZ785 Universal module (8UI)			
	OCI700.1 Service tool for KNX / LPB			
	OZW772.16 Web server for 16 Synco devices			
	GDB181.1E/BA VAV compact controller BACnet			
	SSA31.04 Electromotoric actuator			
UH50-A74-00 Ultrasonic heat meter, RS-485(MS/TP) BACnet module, WZU5-2815 pair of temperature sensors	WZM-F270 Spacer DN 50	670	1206	697
	WZU-RF Radio module			
	WZU5-2815 Pair of temperature sensors Pt500			
G120P-3/35B Variable Speed Drive, G120P-IP55-PAN-EXT, G120P-AIRSHEET-FSA, G120P-IOP-2-BT Intelligent operator panel	G120P-IP55-PAN-EXT Operator Panel Extension cable	370	666	385
	G120P-AIRSHEET-FSA G120P air guide sheet			
	G120P-IOP-2-BT G120P intelligent operator panel IOP-2-BT			

Table 4-9 Automation O&M cost comparison (continued)¹

Main automation	Accessories	O&M Cost – Cyprus (€)	O&M Cost – Netherlands (€)	O&M Cost – Italy (€)
WFW636.D110 Electronic impeller type hot water meter, M-bus radio communication, S-mode, WTT662-BA1100 Network node.	N/A	31	56	32
UP258D51 Presence Detector WIDE multi with temperature, humidity, and CO2 measurement, IR remote control.	S 255/11 IR remote control	300	540	312
RLM162 Air duct temperature controller.	QAP22 Cable temperature sensor	100	180	104
	QBM2030-1U Differential pressure sensor			
	S 290/11 Door/window contact			
	UP 258D12 Presence Detector			
	SSP81 Electromotoric actuator			
	GDB181.1E/BA VAV compact controller BACnet			
	AST20 Handheld tool for VAV compact controllers			
N543D51 Solar protection actuator, 8xAC230V, 6A, with end position detection.	N/A	50	90	52
EcoStruxure Panel Server – universal wireless, concentrator Modbus gateway 110-277 VAC/DC, iEM3155 energy meter -63A-Modbus.	Schneider Electric A9MEM3155 Picture iEM3155 energy meter - 63 A - Modbus	100	180	104

¹ The values for O&M and installation costs obtained for the countries of Netherlands and Italy are an averaged solution between the cost-of-living index and some indicative values received from the partners. By the end of T3.3 - Technical and Financial indicators for SRTs in M18, it will be attempted to retrieve more accurate results from the relevant representatives of Siemens.

Table 4-10 Simplified SRT Catalogue

Smart Device	Code	Functionality Level
RDF600KN Flush mount KNX room thermostat	H-1a	Level 3
	C-1a	Level 3
RDS110 Smart Room Thermostat	H-1a	Level 4
	C-1a	Level 4
RVL482 Heating controller for boiler temperature control for modulating or 2-stage burners with DHW heating	H-1c	Level 2
	H-2a	Level 2
	H-2b	Level 2
	DHW-1a	Level 3
	DHW-1b	Level 3
	DHW-1d	Level 3
RMU710B-1 Universal controller	H-1d	Level 2
	H-2d	Level 4
	C-1c	Level 2
	C-2a	Level 2
	C-2b	Level 4
	DHW-2b	Level 4
	V-1a	Level 4
	V-1c	Level 3
	V-2c	Level 2
	V-2d	Level 3
UH50-A74-00 Ultrasonic heat meter, RS-485(MS/TP) BACnet module, WZU5-2815 pair of temperature sensors	H-3	Level 4
	C-3	Level 4
	DHW-3	Level 4
WFW636.D110 Electronic impeller type hot water meter, M-bus radio communication, S-mode, WTT662-BA1100 Network node	DHW-3	Level 2

Table 4-11 Simplified SRT Catalogue (continued)

Smart Device	Code	Functionality Level
G120P-3/35B Variable Speed Drive, G120P-IP55-PAN-EXT, G120P-AIRSHEET-FSA, G120P-IOP-2-BT Intelligent operator panel	H-3	Level 4
	C-3	Level 4
	DHW-3	Level 4
UP258D51 Presence Detector WIDE multi with temperature, humidity, and CO2 measurement, IR remote control	H-1a	Level 3
	C-1a	Level 3
	L-1a	Level 4
	L-2	Level 4
	V-6	Level 1
RLM162 Air duct temperature controller	V-1a	Level 2
N543D51 Solar protection actuator, 8xAC230V, 6A, with end position detection	DE-1	Level 3
	DE-2	Level 3
	E-2	Level 4
EcoStruxure Panel Server – universal wireless, concentrator Modbus gateway 110-277 VAC/DC, iEM3155 energy meter -63A- Modbus	E-4	Level 3
	E-8	Level 1
	E-11	Level 4
	E-12	Level 2
	E-2	Level 4

Price variations on automation products, such as those offered by Siemens, across European countries within the Single Market can be influenced by several factors. While the Single Market aims to create a unified economic area, certain factors can still contribute to price disparities. Some of these factors may include the following:

- **Distribution Costs:** The cost of distributing products can vary from one country to another. Factors such as transportation, logistics, and warehousing costs can impact the final price of automation products. Some countries may have more efficient distribution networks, leading to lower overall costs.
- **Regulatory Compliance:** Different countries within the European Union may have distinct regulatory requirements and standards. Ensuring compliance with local regulations can involve additional testing, certification, and administrative processes, which may contribute to variations in prices.
- **Taxation:** Varied tax structures, including value-added tax (VAT) rates, can significantly impact the final price of products. Countries may have different tax policies, and companies often need to adjust their prices to accommodate these variations.
- **Local Demand and Competition:** The level of demand for automation products in a specific country and the competitive landscape can influence pricing. Higher demand or increased competition may lead to more competitive pricing strategies.
- **Bulk Procurement:** Leveraging economies of scale through large-scale purchasing within a country can lead to lower prices per unit of automation products. This strategy allows buyers to negotiate discounts or favourable terms with suppliers, contributing to overall cost reduction.

While the Single Market facilitates the free movement of goods, these factors, among others, can still result in variations in prices for automation products across European countries. Additionally, market dynamics and the strategies of individual companies play a significant role in determining product pricing within the Single Market.

5 Conclusions

This report employs a comprehensive methodology, incorporating theoretical foundations, market research, and energy efficiency calculations. Collaborative feedback from project partners contributed to a well-rounded approach. The report also addresses the successful derivation of a cost optimization methodology based on energy savings attributed to higher levels of control functionality aligned with many of the SRI's functionality levels. This methodology can be applied in the easySRI Wizard Tool in WP4, as discussed in previous chapters, outlining its potential applications and limitations. Furthermore, the SRT Catalogue, a structured inventory, serves as a foundational reference. Results highlight market requirements, financial analysis, and profitability assessments, providing insights into smart readiness evaluations and implementations. Some of the observations and challenges that emerged during the process are presented below:

- Regarding the feasibility of calculations according to the BAC factor method, a significant standardization gap was observed for some smart services, such that for these services it was not possible to calculate the energy savings using ISO 52120-1. The codes of the domains that are pre-defined in the Commission's smart services catalogue v4.5 for which there are gaps or weak overlaps in the definition of smart services with regard to energy savings are as followed: DE-2, DE-4, E-2, E-11, E-12, EV-15, EV-16, EV-17, MC-3, MC-4, MC-9, MC-13, MC-25, MC-28, MC-29, MC-30. More information on the standards and their coverage of smart services can be found in D3.1.
- For the case of the residential building of 120 m² in Cyprus that was studied, the findings showed that within the Lighting domain, exclusive use of motion and daylight harvesting sensors for respective services led to impractical solutions. This result is mainly due to the fact that these automations were applied to the case of the single home building under consideration, where the economic feasibility is questionable and is largely influenced by the area covered by the automations (e.g. outdoor spaces, special spaces, zones, etc.). Furthermore, another reason that could explain this finding could be that these sensors mainly serve safety and security purposes for which no corresponding BAC factors for energy savings is provided by ISO 52120-1 nor its predecessors. Feasible solutions appeared when these sensors also provided measurements for temperature and Indoor Air Quality (IAQ), resulting in a combined domain contribution.
- A recurrent challenge in financial assessment was the unknown average life time of each automation system. Additionally, systems comprising multiple accessories with separate life cycles and potential replacement needs introduced extra costs and uncertainty into the financial evaluation.

Finally, despite the uncertainties inherent in Life Cycle Cost (LCC) analysis and the challenges posed by the evolving nature of sustainable building practices, this approach remains valuable for decision-making in building planning and renovation. While uncertainties arise from dynamic factors like energy prices and technology advancements, and the novelty of sustainable practices adds complexity, advanced statistical techniques and collaboration can mitigate these challenges. LCC provides crucial insights into long-term cost implications, guiding investments in energy-efficient technologies and environmentally friendly materials. Moving forward, addressing these challenges requires continued research, standardization efforts, and interdisciplinary collaboration to optimize resource allocation and promote sustainable development in the built environment.

6 References

- [1]. Dodd, Nicholas & Donatello, Shane & Cordella, Mauro. (2021). Level(s) indicator 6.1: Life cycle costs User manual: Introductory briefing, instructions and guidance (Publication version 1.1).
- [2]. CINEA, "Grant Agreement-101077169-LIFE21-CET-SMARTREADY-easySRI", 2022.
- [3]. ISO 52120-1:2021 (en), Energy performance of buildings – Contribution of building automation, controls and building management – Part 1: General framework and procedures.
- [4]. CYS EN 15643:2021, Sustainability of construction works – Framework for assessment of buildings and civil engineering works.
- [5]. ISO 15686-5:2017, Buildings and constructed assets, Service life planning, Part 5: Life – cycle costing.
- [6]. ISO/TS 50044:2019, Energy saving projects (EnSPs), Guidelines for economic and financial evaluation.
- [7]. https://energy.ec.europa.eu/publications/ecodesign-preparatory-study-building-automation-and-control-systems-bacs_en
- [8]. <https://eubac.org/publications/>
- [9]. https://eubac.org/wp-content/uploads/2021/03/EPBD_impacts_from_building_automation_controls.pdf
- [10]. https://eubac.org/wp-content/uploads/2021/03/Executive_Summary_-_EPBD_impacts_from_building_automation_controls.pdf
- [11]. ISO 52016-1, Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures
- [12]. EN 15316 (all parts), Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies
- [13]. EN 16798-9, Energy performance of buildings –Ventilation for buildings – Part 9: Calculation methods for energy requirements of cooling systems (Modules M4-1, M4-4, M4-9) – General
- [14]. EN 15193-1, Energy performance of buildings - Energy requirements for lighting - Part 1: specifications, Module M9
- [15]. EN 16798-5-2, Energy performance of buildings - Ventilation for buildings - Part 5-2: Calculation methods for energy requirements of ventilation systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) - Method 2: Distribution and generation

ANNEX A: Automation System Templates

Automation System Economic Performance Evaluation Template						
SRI Classification (Domain, code)						
Application domain	Heating, Cooling					
Code	H-1a, C-1a					
System Details						
Automation system name	RDF600KN Flush mount KNX room thermostat.					
Brief description	<p>The Siemens RDF600KN series semi-flush-mount room thermostats offer advanced climate control with KNX bus communications in both S-mode and LTE mode. Featuring a backlit display, 2P/PI/P control, and versatile outputs for on/off or 3-position control and 3-speed or 1-speed fan, they provide seamless integration into Synco, Designo, and other third-party systems. User settings are retained even during power loss, and RDF600KN/S models include additional control buttons for KNX actuators in S-mode.</p>					
Datasheet hyperlink	https://hit.sbt.siemens.com					
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☐		
Functionality upgrade	H-1a	Level 2 → Level 3				
	C-1a	Level 2 → Level 3				
Building Information						
Building type	Residential					
Climatic zone	South Europe					
Country	Cyprus					
Total useful floor area	120 m ²					
Equipment information						
Average cost	950 €		Average installation cost	500 €		
Annual O&M cost	200 €					
Discount rate	3%					
Financial Performance						
IRR Year 1	-86.0 %	IRR Year 5	-9.0 %	IRR Year 10	+9.2 %	
NPV Year 1	-1058.5 €	NPV Year 5	+507.3 €	NPV Year 10	+2464.6 €	
Recommendations						
Overall financial feasibility	Economically viable					

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain		Heating, Cooling			
Code		H-1a, C-1a			
System Details					
Automation system name		RDS110 Smart Room Thermostat.			
Brief description		<p>The thermostat allows direct temperature and mode selection, features energy-optimized operation with a green leaf button, and provides air quality indication. It includes temperature setting limits for public spaces, screen lock protection, and manual switchover. With precise control using a self-learning algorithm, it offers humidity control, presence detection, and multifunctional inputs. The device also supports remote firmware upgrades.</p>			
Datasheet hyperlink		https://hit.sbt.siemens.com			
Functionality level		Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒
Functionality upgrade		H-1a	Level 2 → Level 4		
		C-1a	Level 2 → Level 4		
Building Information					
Building type		Residential			
Climatic zone		South Europe			
Country		Cyprus			
Total useful floor area		120 m ²			
Equipment information					
Average cost		1780 €	Average installation cost		1500 €
Annual O&M cost		200 €			
Discount rate		3%			
Financial Performance					
IRR Year 1	-86.6 %	IRR Year 5	-10.8 %	IRR Year 10	+8.2 %
NPV Year 1	-2660.1 €	NPV Year 5	-180.9 €	NPV Year 10	+2918.1 €
Recommendations					
Overall financial feasibility		Economically viable			

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Heating, Domestic Hot Water				
Code	H-1c, H-2a, H-2b, DHW-1a, DHW-1b, DHW-1d				
System Details					
Automation system name	RVL482 Heating controller for boiler temperature control for modulating or 2-stage burners with d.h.w heating.				
Brief description	<p>The multifunctional heating controller by Siemens is designed for residential and non-residential buildings, supporting various heating systems and control scenarios. Operating at AC 230 V, it offers weather-compensated flow temperature control, demand-compensated boiler temperature control, and versatile heating modes. With optimization and protective functions, remote control, and communication features, it provides efficient and flexible heating management.</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☐	
Functionality upgrade	H-1c	Level 1 → Level 2			
	H-2a	Level 1 → Level 2			
	H-2b	Level 0 → Level 2			
	DHW-1a	Level 1 → Level 3			
	DHW-1b	Level 1 → Level 3			
	DHW-1d	Level 1 → Level 3			
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average cost	2674 €		Average installation cost	2050 €	
Annual O&M cost	350 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-86.1 %	IRR Year 5	-9.1 %	IRR Year 10	+9.1 %
NPV Year 1	-3745.4 €	NPV Year 5	+169.2 €	NPV Year 10	+5062.4 €
Recommendations					
Overall financial feasibility	Economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Heating, Cooling, Domestic Hot Water, Ventilation				
Code	H-1d, H-2d, C-1c, C-2a, C-2b, DHW-2b, V-1a, V-1c, V-2c, V-2d				
System Details					
Automation system name	RMU710B-1 Universal controller.				
Brief description	<p>Siemens universal controllers with a yearly time switch are versatile for basic to complex ventilation, air conditioning, and cold-water plants. They offer preprogrammed options, modular expansion, KNX bus connectivity, and control variables like temperature, humidity, pressure, airflow, and indoor air quality. Featuring a 7-day program, automatic seasonal changeover, and various operating modes, these controllers enable efficient and adaptable control for diverse applications.</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒	
Functionality upgrade	H-1d	Level 1 → Level 2			
	H-2d	Level 1 → Level 4			
	C-1c	Level 1 → Level 2			
	C-2a	Level 1 → Level 2			
	C-2b	Level 1 → Level 4			
	DHW-2b	Level 1 → Level 4			
	V-1a	Level 1 → Level 4			
	V-1c	Level 1 → Level 3			
	V-2c	Level 1 → Level 2			
V-2d	Level 1 → Level 3				
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average cost	5472 €		Average installation cost	2524 €	
Annual O&M cost	800 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-89.5 %	IRR Year 5	-16.5 %	IRR Year 10	+3.4 %
NPV Year 1	-6402.2 €	NPV Year 5	-27.1 €	NPV Year 10	+7941.9 €
Recommendations					
Overall financial feasibility	Economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain		Heating, Cooling, Domestic Hot Water			
Code		H-3, C-3, DHW-3			
System Details					
Automation system name		UH50-A74-00 Ultrasonic heat meter, RS-485(MS/TP) BACnet module, WZU5-2815 pair of temperature sensors.			
Brief description		<p>The UH50 series by Siemens serves as a heat and cooling energy meter, measuring energy consumption in district heating systems and blocks of flats. Comprising a flow measuring section and processor unit, it allows separate reading of heat or cooling energy consumption on-site or remotely. The processor unit accommodates various sensors, power supply, and communication modules, making it versatile for different applications, including hydronic systems.</p>			
Datasheet hyperlink		https://hit.sbt.siemens.com			
Functionality level		Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒
Functionality upgrade		H-3	Level 2 → Level 4		
		C-3	Level 2 → Level 4		
		DHW-3	Level 1 → Level 4		
Building Information					
Building type		Residential			
Climatic zone		South Europe			
Country		Cyprus			
Total useful floor area		120 m ²			
Equipment information					
Average cost		2615 €	Average installation cost		2000 €
Annual O&M cost		670 €			
Discount rate		3%			
Financial Performance					
IRR Year 1	-98.3 %	IRR Year 5	-48.5 %	IRR Year 10	-21.6 %
NPV Year 1	-3887.5 €	NPV Year 5	-977.5 €	NPV Year 10	+2660.1 €
Recommendations					
Overall financial feasibility		Not economically viable			

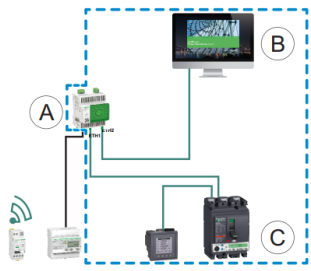
Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Heating, Cooling				
Code	H-1d, C-1d, C-2a				
System Details					
Automation system name	G120P-3/35B Variable Speed Drive, G120P-IP55-PAN-EXT, G120P-AIRSHEET-FSA, G120P-IOP-2-BT Intelligent operator panel.				
Brief description	<p>The Variable Frequency Drive (VFD) facilitates demand-controlled speed control for supply and discharge fans in air conditioning systems, optimizing energy efficiency by adjusting fan speeds based on actual demand. Additionally, it supports demand-controlled speed control for circulating pumps in HVAC systems. The VFD is also applicable for pressure boost and control of pump fill levels, providing versatility for various applications in heating, ventilation, and air conditioning systems where variable speed control is essential for efficient and adaptive operation.</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☐	
Functionality upgrade	H-1d	Level 1 → Level 3			
	C-1d	Level 1 → Level 3			
	C-2a	Level 1 → Level 2			
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average cost	1572 €	Average installation cost			1100 €
Annual O&M cost	370 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-81.3 %	IRR Year 5	-0.5 %	IRR Year 10	+16.0 %
NPV Year 1	-1828.5 €	NPV Year 5	+1545.5 €	NPV Year 10	+5762.9 €
Recommendations					
Overall financial feasibility	Economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Domestic Hot Water				
Code	DHW-3				
System Details					
Automation system name	WFW636.D110 Electronic impeller type hot water meter, M-bus radio communication, S-mode, WTT662-BA1100 Network node.				
Brief description	<p>The meters feature a flow element and an LCD display totalizer, with a 360° rotatable fitting. Made of brass, the flow measuring section includes a sieve for larger dirt particles, ensuring accurate and long-term stable measurements. The system detects incorrect flow direction and transmits volume data via RF to a processing system, powered by a long-life battery lasting up to 10 years with a 1-year reserve capacity</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☐	Level 4 ☐	
Functionality upgrade	DHW-3 Level 1 → Level 2				
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average cost	100 €		Average installation cost	93 €	
Annual O&M cost	31 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-91.2 %	IRR Year 5	-20.6 %	IRR Year 10	+0.2 %
NPV Year 1	-146.4 €	NPV Year 5	+40.1 €	NPV Year 10	+273.1 €
Recommendations					
Overall financial feasibility	Not economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Heating, Cooling, Lighting, Ventilation				
Code	H-1a, C-1a, L-1a, L-2, V-6				
System Details					
Automation system name	UP258D51 Presence Detector WIDE multi with temperature, humidity, and CO2 measurement, IR remote control				
Brief description	<p>The ceiling-mounted passive infrared detector offers a 360° horizontal motion detection area, covering up to 64 m² to 400 m² based on mounting or room height. It features a 7-level presence detection range adjustment, brightness and temperature measurement, and an integrated IR receiver for remote control. Additionally, it includes an integrated bus coupler, enabling bus connection via a bus terminal and electronic operation with bus voltage.</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒	
Functionality upgrade	H-1a	Level 2 → Level 3			
	C-1a	Level 2 → Level 3			
	L-1a	Level 1 → Level 4			
	L-2	Level 1 → Level 4			
	V-6	Level 0 → Level 1			
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average cost	2340 €		Average installation cost		1500 €
Annual O&M cost	500 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-87.2 %	IRR Year 5	-11.4 %	IRR Year 10	+7.3 %
NPV Year 1	-3255.3 €	NPV Year 5	-76.7 €	NPV Year 10	+3896.7 €
Recommendations					
Overall financial feasibility	Economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Ventilation				
Code	V-1a, V-1c, V-2d				
System Details					
Automation system name	RLM162 Air duct temperature controller				
Brief description	<p>The RLM162 is a compact electronic temperature controller with an integrated duct-mounted sensor, designed for easy installation onto HVAC plants. It offers modulating temperature control with 1 or 2 DC 0-10 V output signals. Suitable for various applications, including restaurants, classrooms, and air handling units, it controls heating/cooling valves, air dampers, and more. Additional features include an auxiliary digital output, outside sensor compensation, remote setting unit connection, selectable P or PI control, and various operating modes for versatile HVAC control.</p>				
Datasheet hyperlink	https://hit.sbt.siemens.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒	
Functionality upgrade	V-1a	Level 1 → Level 2			
	V-1c	Level 1 → Level 3			
	V-2d	Level 1 → Level 4			
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average device cost	2463 €		Average device installation cost	4730 €	
Annual O&M cost	100 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-99.1 %	IRR Year 5	-54.9 %	IRR Year 10	-27.2 %
NPV Year 1	-7029.9 €	NPV Year 5	-6377.5 €	NPV Year 10	-5561.9 €
Recommendations					
Overall financial feasibility	Not economically viable				

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain		Dynamic Envelope			
Code		DE-1, DE-2			
System Details					
Automation system name		N543D51 Solar protection actuator, 8xAC230V, 6A, with end position detection			
Brief description		Solar protection actuators control shutters, awnings, and ventilation flaps with up to AC 230 V. Featuring end position detection through current sensing, LED displays for direction and active overrides, and maintenance-free terminals, they ensure efficient installation. Configurable through ETS, these actuators offer extensive control, override functions, and status messages. Safety functions include overrides for wind, rain, frost, and obstructions.			
Datasheet hyperlink		https://hit.sbt.siemens.com			
Functionality level		Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☐
Functionality upgrade		DE-1	Level 1 → Level 3		
		DE-2	Level 0 → Level 3		
Building Information					
Building type		Residential			
Climatic zone		South Europe			
Country		Cyprus			
Total useful floor area		120 m ²			
Equipment information					
Average device cost		600 €	Average device installation cost		300 €
Annual O&M cost		50 €			
Discount rate		3%			
Financial Performance					
IRR Year 1	-96.1 %	IRR Year 5	-36.4 %	IRR Year 10	-12.1 %
NPV Year 1	-817.5 €	NPV Year 5	-487.3 €	NPV Year 10	-74.6 €
Recommendations					
Overall financial feasibility		Not economically viable			

Automation System Economic Performance Evaluation Template					
SRI Classification (Domain, code)					
Application domain	Electricity				
Code	E-2, E-4, E-8, E-11, E-12				
System Details					
Automation system name	EcoStruxure Panel Server – universal wireless, concentrator Modbus gateway 110-277 VAC/DC, iEM3155 energy meter -63A- Modbus				
Brief description	EcoStruxure Panel Server is a gateway, providing connection of wired or unwired smart IoT devices to edge control software or cloud application. Combined with the iEM 3155 which provides: measurement of active and reactive energy, multi tariffs (up to 4), MID/MIR compliance to many meters, pulse outputs, and communication via Modbus, LonWorks, M-Bus or BACnet protocols.				
Datasheet hyperlink	https://www.se.com				
Functionality level	Level 1 ☒	Level 2 ☒	Level 3 ☒	Level 4 ☒	
Functionality upgrade	E-2	Level 1 → Level 4			
	E-4	Level 0 → Level 3			
	E-8	Level 0 → Level 1			
	E-11	Level 0 → Level 4			
	E-12	Level 1 → Level 2			
Building Information					
Building type	Residential				
Climatic zone	South Europe				
Country	Cyprus				
Total useful floor area	120 m ²				
Equipment information					
Average device cost	1890 €	Average device installation cost			1000 €
Annual O&M cost	100 €				
Discount rate	3%				
Financial Performance					
IRR Year 1	-94.0 %	IRR Year 5	-28.6 %	IRR Year 10	-6.0 %
NPV Year 1	-2624.4 €	NPV Year 5	-1561.8 €	NPV Year 10	-233.7 €
Recommendations					
Overall financial feasibility	Not economically viable				

Improving and demonstrating the potential



<https://www.easysri.eu/en/>



<https://www.linkedin.com/company/easysri>



https://twitter.com/sri_easy



<https://www.youtube.com/@easysri2022>



This project has received funding from the European LIFE Programme for Research and Innovation under grant agreement no 101077169. Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.