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SmartSPIN

Smart energy services to solve the **SP**lit **IN**centive problem in the commercial rented sector

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D6.5 – INFOGRAPHICS, FACTSHEETS & TOOLS FOR THE BUSINESS MODEL TOOLKIT

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Work package	**WP6 – Business model definition and development of SmartSPIN toolkit**		
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Dissemination level	PU		

Version and amendments history

Version	Date (MM/DD/YYYY)	Created/Amended by	Changes
0.1	17/05/2024	IERC	Deliverable structure with initial content
0.2	27/05/2024	IERC	Added appendix
0.3	14/06/2024	IERC	Contents added in sections 2.1 and 2.3 (comments by EGEN). Updated section 2.2. Updated table of figures.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101033744.

0.4	20/06/2024	IERC	Revised sections 1.2, 1.3, 1.4, 1.5, 1.6 (updated figures and text).
0.5	21/06/2024	IERC	Expanded Executive Summary and Conclusions. Minor changes applied to section 3.2.
1.0	02/07/2024	IERC	Comments from quality review addressed. Appendix revised. Final review and submossion

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	Opportunity	Investment (€)	Energy Savings (kWh)	Energy Cost Savings (€)	Payback (Years)	Carbon Savings (Tonnes CO2)	Opportunity Benefit		
							Landlord Only	Tenant Only	Both
Engineering	Complete LED Transition*	48000	51,659	€9,432.91	5.09	17.86			•
	AHU and air quality control of fresh air system	€210,000.00	68,107	€20,700.00	10.14	39.25			•
	Smart Controls for local TRV and AC units	€32,000.00	43,134	€3,600.00	8.89	8.75		•	
	BMS Upgrade with energy metering	€70,000.00	159,650	€21,201.84	3.30	43.65			•
	Solar PV	€119,456.00	34,200	€11,970.00	9.98	11.82			•
	Bi-Directional Car Charging	To be fully assessed							•
	Demand Response	To be fully assessed							•
	Battery Storage	To be fully assessed							•
	Total Engineering	**€479,456.00**	**356,750**	**€66,904.76**	**7.17**	**105.64**			
Fabric	Hybrid/Passive Ventilation	€99,745.00	58,398	€8,278.41	12.05	16.73		•	
	Improve Building Fabric and Air Infiltration Performance	€801,100.00	261,743	€31,098.89	25.76	66.24			•
	Upgrade Building Glazing	€1,200,000.00	67,305	€7,996.86	150.06	17.03			•
	Total Fabric	**€2,100,845.00**	**387,446**	**€47,374.16**	**44.35**	**100.00**			
	Green Building Certification and Green Guidance	Certification Costs							•
Overall Total		**€2,580,301.00**	**744,196**	**€114,278.91**	**22.58**	**205.64**			

Table 1: Energy efficiency measures applicable to the SmartSPIN pilot building in Dublin...................... 13

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List of Abbreviations

ABBREVIATIONS	Description
SES	Smart Energy Services
ESCO	Energy Service Company (energy efficiency provider)
KPIs	Key Performance Indicators

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EXECUTIVE SUMMARY

SmartSPIN is a project funded by the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 101033744. The project aims at developing a new business model to improve the energy efficiency and foster flexibility in energy consumption in the commercial rented sector. The SmartSPIN consortium has designed and is demonstrating, implementing, and testing smart energy solutions in three European pilot sites in Ireland, Spain and Greece.

The deliverable presents a set of infographics, factsheets & tools that supports the business model toolkit aiming at deploying a Smart Energy Service (SES) to the commercial rented sector that improves energy efficiency thereby mitigating climate change effects.

The purpose of the infographics is to illustrate in an effective and direct manner the different variants of the SmartSPIN business model, distinguishing the cases where the building owner is performing the investment in energy efficiency measures (either using their own sinking fund or liaising with a bank or lender) or where the ESCO is responsible for the funding of such measures. Another infographic highlights the rebound effect of the energy consumers, which consists in an increase of their energy consumption after the installation of energy efficiency measures. This effect needs to be brought to the attention of the ESCO, as it may reduce the actual energy savings if not addressed properly. Other infographics represent the multi-period implementation approach of the energy efficiency measures (i.e., no-cost and low-cost measures are implemented in the first period, without necessarily involve the building owner, whereas medium and high-cost measures are implemented in the second period with the consent and support of the building owner) and the demand response service which can be implemented using the SmartSPIN flexible tariff template.

Moreover, the report presents factsheets which summarize the energy savings (potential or already achieved), the revenue streams for the ESCO and the building owner, the cost and the benefits of the SmartSPIN service, the expected reduction of the energy bill for the tenants, at the three demonstration sites in Ireland, Spain and Greece. These factsheets depict the expected agreements between the parties which will be reached at the end of the project, considering the information available at the time of writing this deliverable.

Finally, the report presents the tools that SmartSPIN has developed and is currently validating. These include the contractual and tariff templates, the interactive web-application, the early building and performance diagnostics web-dashboard, the measurement and verification app, the visualization dashboard and the gamification app. In addition, in the appendix a tool to evaluate the Net Present Value (NPV) of an energy efficiency project for the building owner, the tenants and the ESCO is discussed. This tool enables to determine the effect of different contractual durations and percentage of energy savings shared by the building owner with the tenants on the NPVs and therefore to facilitate the achievement of optimal contractual agreements between the parties.

INTRODUCTION

The scope of this deliverable is to provide insights about the SmartSPIN business model for the deployment of the SmartSPIN Smart Energy Service (SES) to the commercial rented sectors in Ireland, Spain, and Greece, improving energy efficiency and unlocking flexibility in energy consumption through deployment of energy efficiency measures and a flexible dynamic energy tariff thus mitigating climate change. The SmartSPIN business model was constructed using the Osterwald's Business Model canvas, investigating multiple bilateral and multilateral options for a performance-based contractual agreement between landlord, tenants, and energy efficiency provider (ESCO). This deliverable includes a separate description for each of the infographics, factsheet and tools.

1. INFOGRAPHICS

1.1 FIRST INFOGRAPHIC

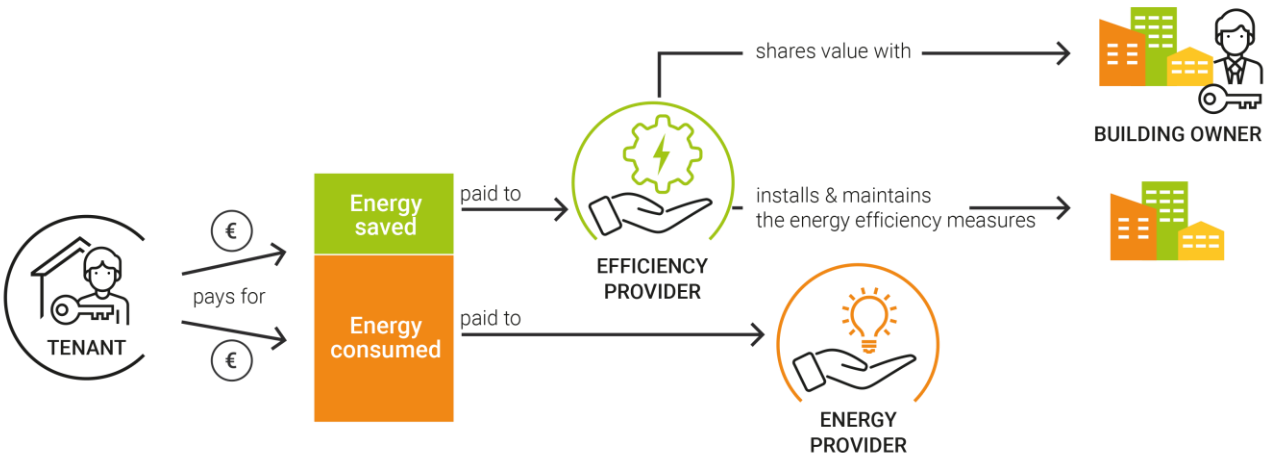

Figure 1: SmartSPIN concept and interaction between actors of the commercial rented sector

The first SmartSPIN infographic is included in Figure 1 and represents the concept that enables to overcome the split incentive issue in the commercial rented sector. The infographic shows that after the deployment of the SmartSPIN service, the tenant (who will enjoy reduced energy bills due to the energy efficiency measures installed by the efficiency provider) will pay a service fee to the efficiency provider that is proportional to the energy saved by the tenant. The energy efficiency provider will share part of the value of the energy savings with the building owner, who will be therefore incentivised in investing in energy efficiency measures and in contracting with the energy efficiency provider.

1.2 SECOND AND THIRD INFOGRAPHICS

The second infographic is illustrated in Figure 2. The infographic depicts a tri-partite energy performance contractual agreement between tenant, building owner and the energy service company (energy efficiency provider). In this specific set-up, the building owner is responsible for the financing of the energy efficiency upgrades via own funding (which could be sinking fund of their rented building).

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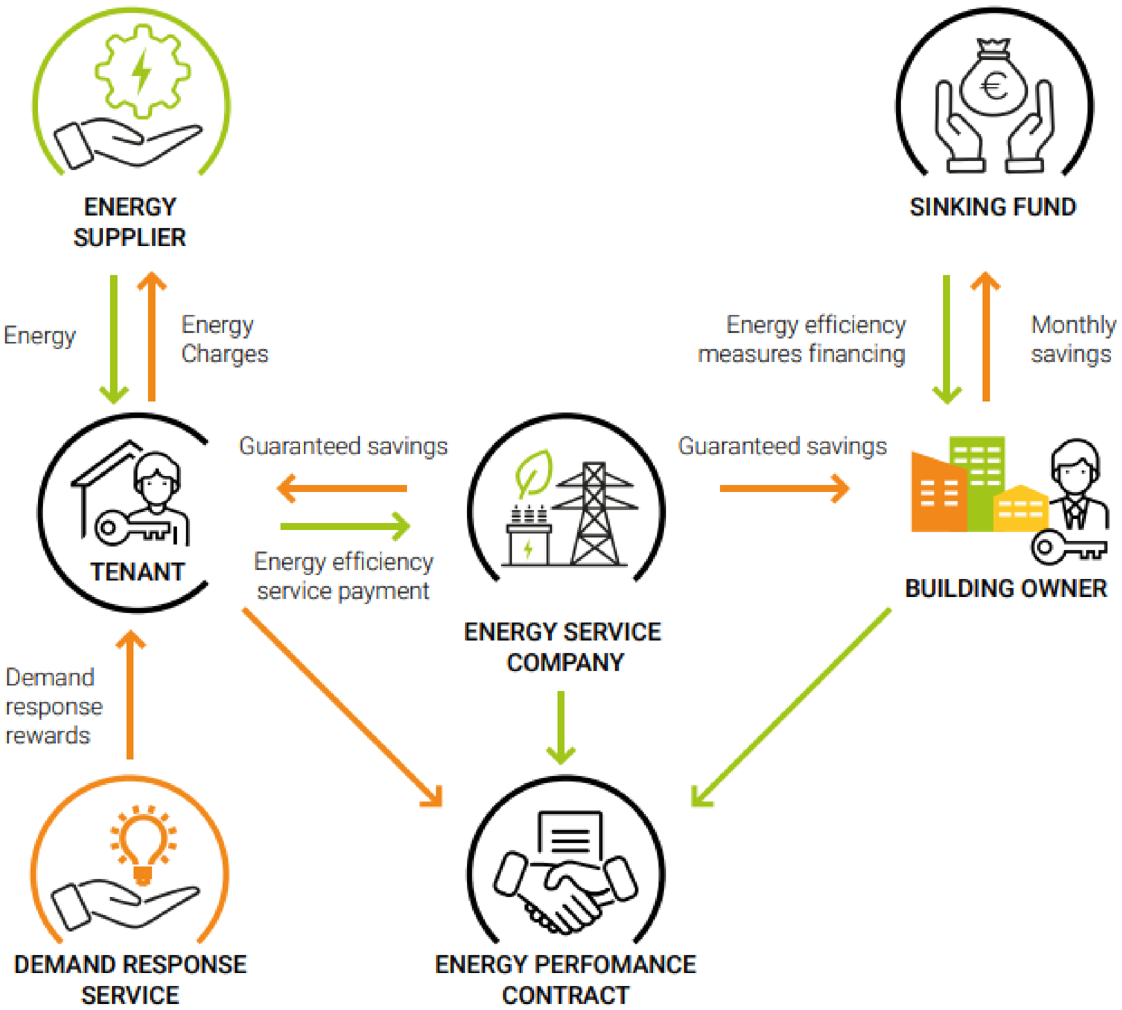

Figure 2: SmartSPIN Business Model (Sinking Fund).

The building owner then attributes back to their own fund or sinking fund the remuneration from the monthly guaranteed energy savings to payback the investment. The energy service company receives a monthly remuneration from the tenants, paid from the energy cost savings achieved by them. Indeed, the tenants also pay the energy supplier company based on their actual energy consumption. Their monthly energy bill will be reduced because of the implementation of the energy efficiency upgrades.

Moreover, the energy supplier could potentially provide a flexible tariff contract incentivizing the shift of energy consumption of energy consumers toward non-peak hours, which will in turn allow the trading of customers' flexibility to the market. In this way, the available flexibility in energy consumption by tenants may be unlocked, thus leading to a further reduction of the operational energy costs for the tenants.

At the end of the contract, either the tenant or the building owner can choose to purchase the equipment paying its residual value to the ESCO, extend the contract, or (less commonly) return the

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equipment. Furthermore, the third infographic in Fig. 3 highlights the rebound effect, which consists in an increase of the energy consumption because the energy consumers do not assume fully energy efficient behaviors as they are conscious of the fact that energy efficiency measures have been installed, and therefore expect their energy consumption to be lower. Such a rebound effect needs to be considered by the ESCO when setting up a performance contract. Some energy consumers tend to use even more energy when the economic benefits (i.e., a tangible reduction of their energy bills) of an energy efficient project do not accrue to them. This may be the case for the tenants, when the ESCO and the building owner do not share energy savings with them. Hence, the rebound effect that applies to the tenants' energy consumption should be considered when determining the optimal split of energy savings between the landlord and tenants, to avoid a situation where the energy savings are significantly lowered by an increased consumption by the tenants. More information about this issue is included in the Appendix.

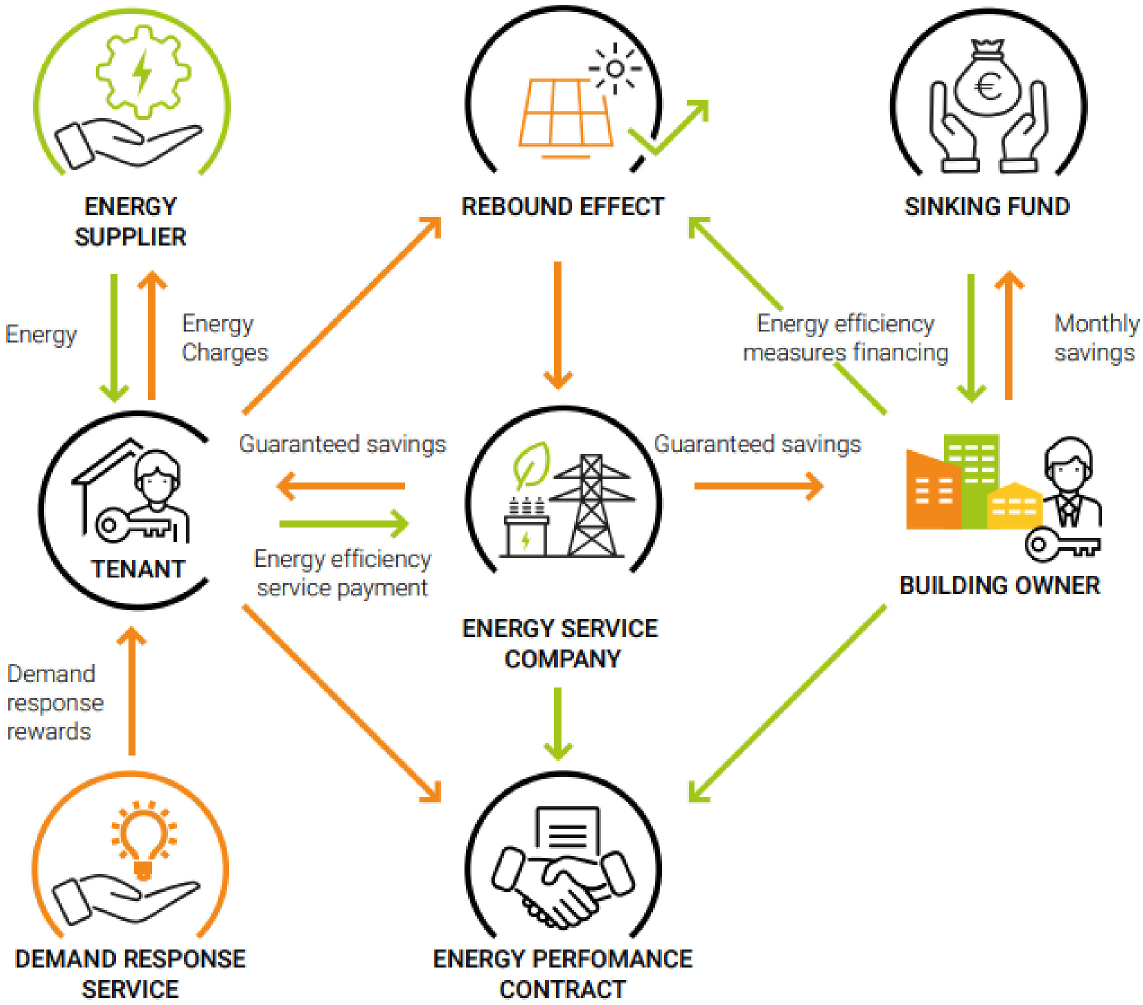

Figure 3: SmartSPIN business model including rebound effect for energy consumption

1.3 FOURTH INFOGRAPHIC

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The fourth infographic is depicted in **Error! Reference source not found.**4. This infographic represents the case where the funding source can be a different entity like a bank or lender. In this case, the energy efficiency upgrade measures are funded by the building owner through a bank loan, and consequently the building owner is responsible for the loan repayment.

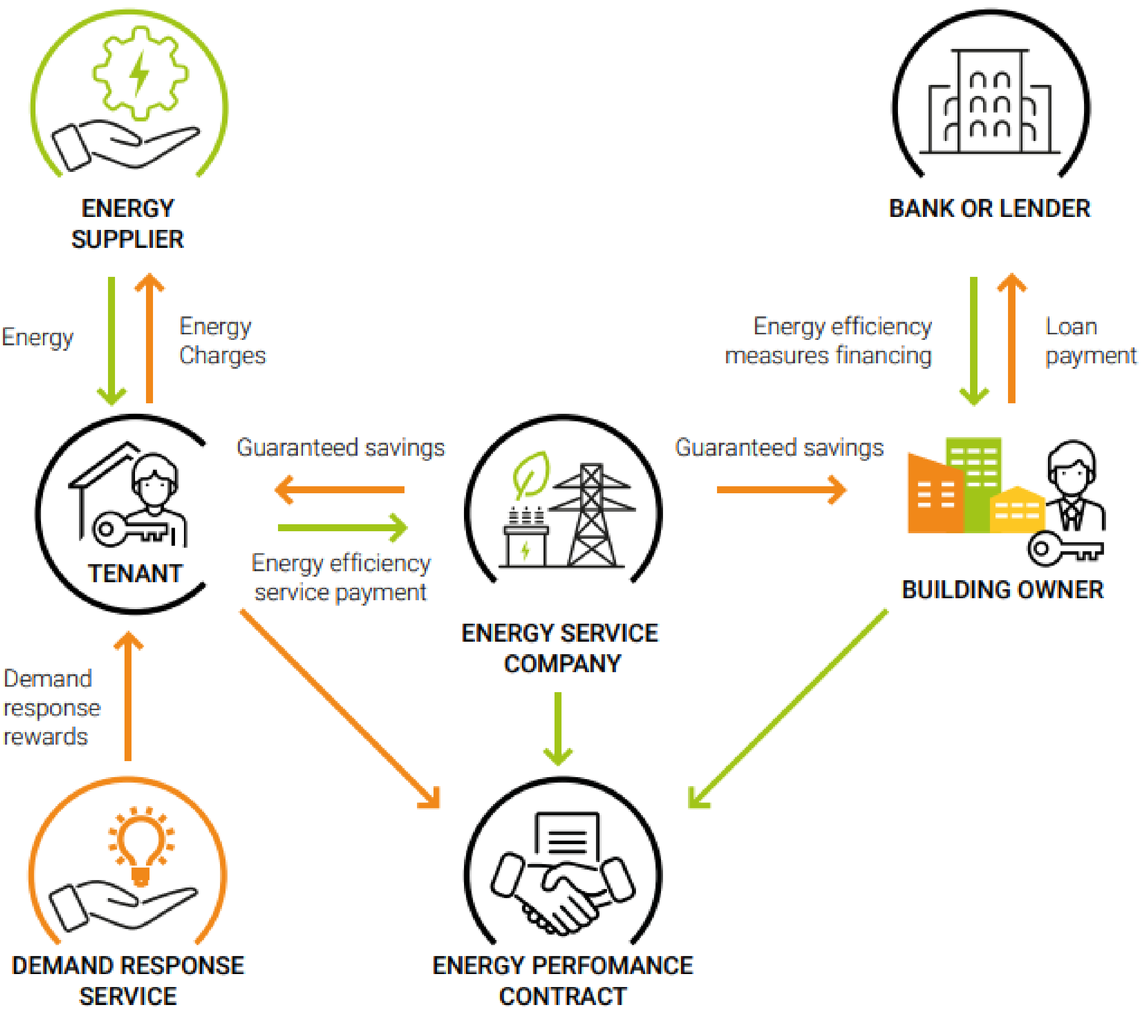

Figure 4: SmartSPIN Business Model (Building owner liaising with Bank or Lender)

1.4 FIFTH INFOGRAPHIC

The fifth infographic (Figure 5) shows the case where the ESCO acts as the project financer via a bank loan and shares the energy savings with the building owner according to an agreed percentage. In this case, since the ESCO provides the funding required for implementing the energy efficiency measures, the contractual agreement will normally not include a guarantee for a minimum amount of energy savings. This model is known as the shared savings model, because the parties will share the savings according to agreed percentages.

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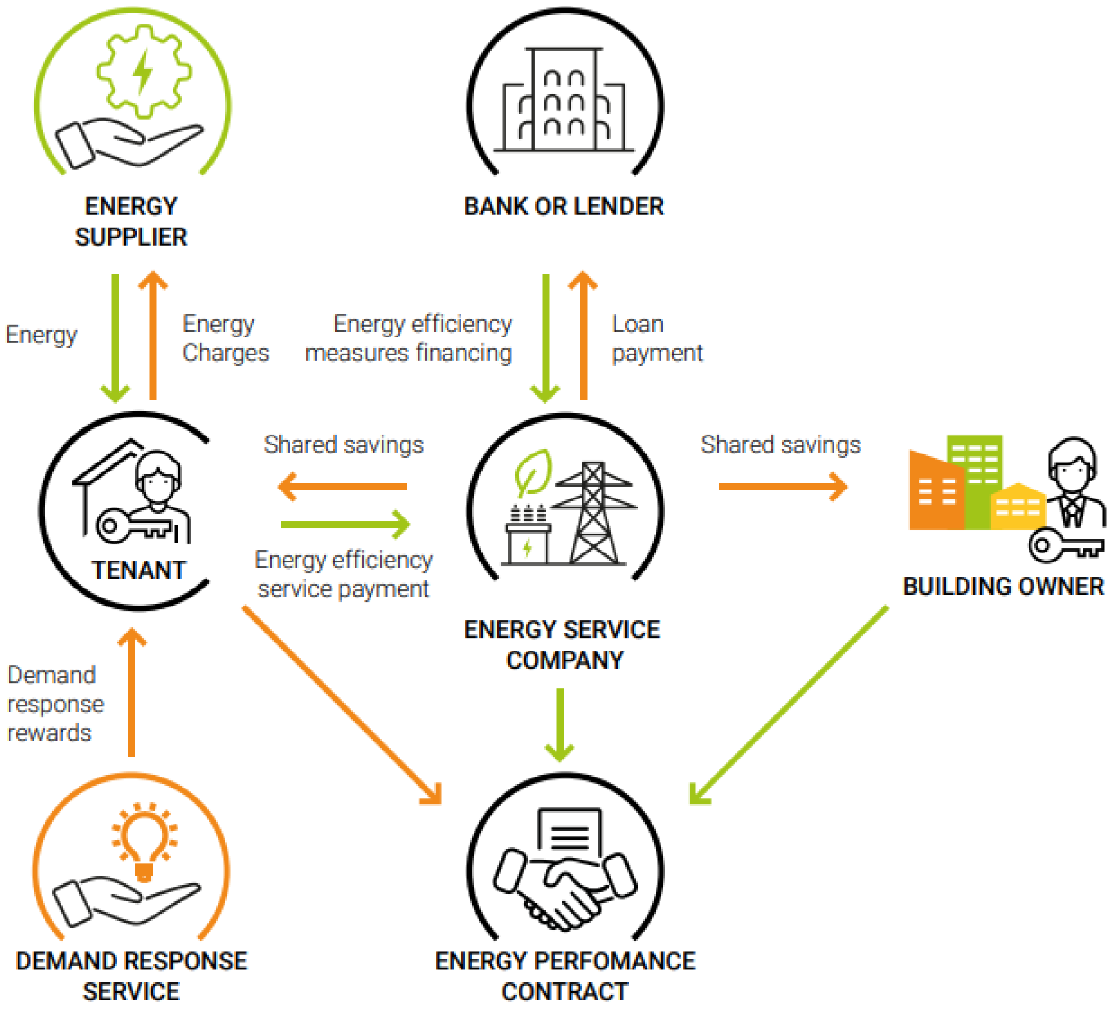

Figure 5: SmartSPIN Business Model (Energy Service Company liaising with Bank or Lender)

1.5 SIXTH INFOGRAPHIC

The sixth infographic is depicted in Figure 6. It shows that the parties (tenant, building owner and energy efficiency provider) may decide to deploy energy efficiency measures in multiple time periods. In case of two implementation periods, the energy efficiency measures can be deployed in the following manner:

- During the first implementation period (called guarantee period-1, using the language of energy performance contracting), no cost or low-cost measures (which may not require permission from the building owner) are installed. The first implementation period aims to demonstrate how the service works and to build the trust of the client in the ESCO, while a decision to install medium/high-cost measures is taken by the building owner.
- During the second implementation period, medium and/or high-cost measures (which require permission and often an investment from the building owner) are installed. The second implementation period aims to obtain high energy savings while reducing the performance risk for the building owner.

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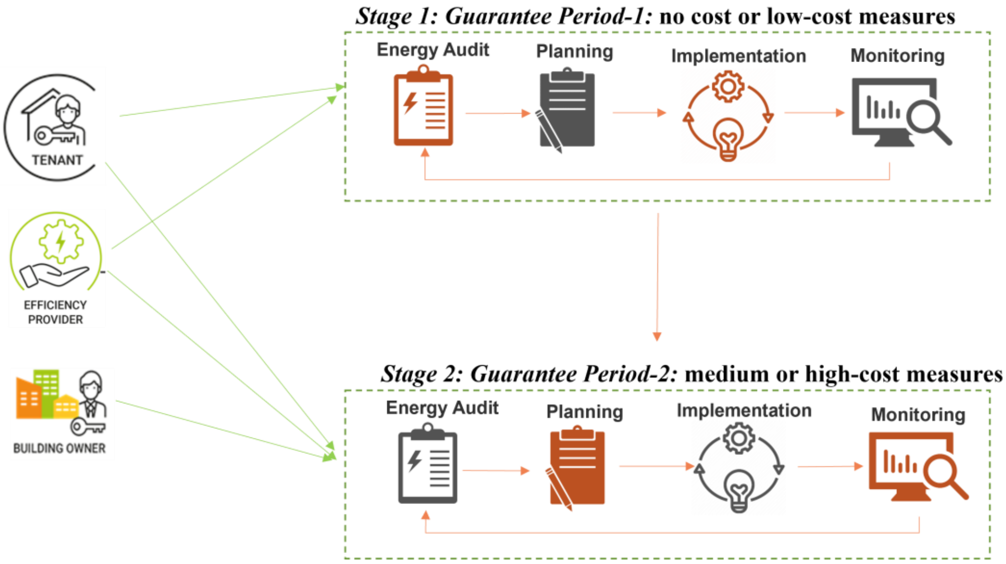

Figure 6: Multi-stage implementation of SmartSPIN Smart Energy Service

A variant of the scenario shown in the infographic considers the installation of medium cost measures in period 1 and high-cost measures in period 2.

1.6 SEVENTH INFOGRAPHIC

The seventh infographic is included in Figure 7. It represents how an implicit demand response service is deployed using the flexible tariff template that SmartSPIN has developed in Work Package 3. The flexible tariff incentivizes flexible energy consumption (i.e. load shifting from peak hours to non-peak hours) by means of a discounted tariff that rewards the energy consumers who can sufficiently reduce their consumption during the peak hours.

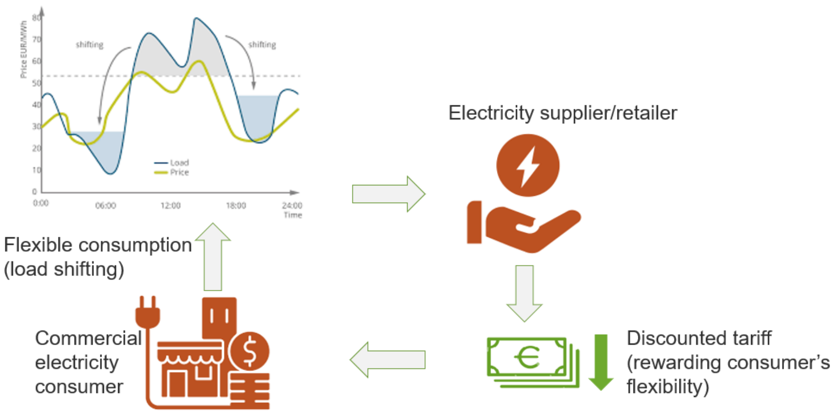

Figure 7: Implicit demand response service based on SmartSPIN Flexible Tariff

2. FACTSHEETS

2.1 IRELAND

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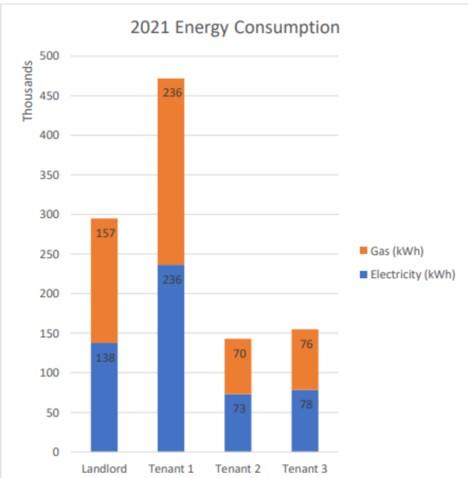
The pilot site in Ireland is a building located at 30 Herbert St. in Dublin which has six floors with a classical façade constructed in reconstituted stone precast concrete panels (Figure 8). The total lettable floor area of the building is ~4,400 m^2 (47,349 sq. ft) with the total floor area covering approximately 7,100 m^2 and includes approximately fifty car parking spaces. The building was originally built in 1996 and underwent a refurbishment in 2014 after a long period of being unoccupied. New tenants moved into the building in 2015 after the refurbishment works. The landlord occupies 1,809 m^2 (29.14% of the total floor area). Tenant 1 (an investment service company) occupies 2,714.36 m^2 (43.72% of the total floor area), whereas tenant 2 (a private banking and asset management company) and tenant 3 (hedge fund) occupy respectively 805.20 m^2 (12.97% of the total floor area) and 880.44 m^2 (14.18% of the total floor area).

Figure 8: Office building in 30 Herbert Street in Dublin

The baseline energy consumption and CO_2 emissions for the building in 2021 are shown in Fig. 9.



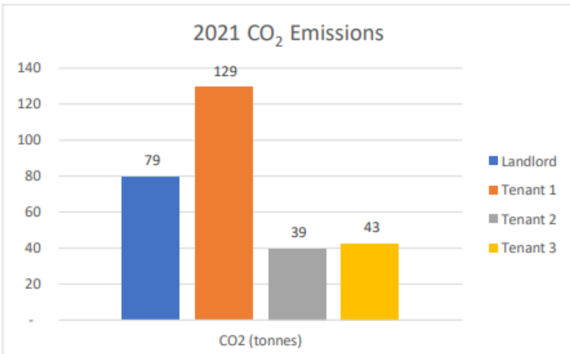


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Figure 9: Baseline energy consumption and carbon emissions for the building in 30 Herbert Street in Dublin

Lawler Sustainability has identified several opportunities for improving the energy efficiency of the building. Applicable measures that have been identified are summarised in the table 1. These measures are currently being reviewed and the list could be updated any time after the submission of this report.

	Opportunity	Investment (€)	Energy Savings (kWh)	Energy Cost Savings (€)	Payback (Years)	Carbon Savings (Tonnes CO2)	Opportunity Benefit		
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Fabric	**Total Fabric**	**€2,100,845.00**	**387,446**	**€47,374.16**	**44.35**	**100.00**			
	Green Building Certification and Green Guidance	Certification Costs							•
Overall Total		**€2,580,301.00**	**744,196**	**€114,278.91**	**22.58**	**205.64**			

Table 1: Energy efficiency measures applicable to the SmartSPIN pilot building in Dublin

At the time of writing this deliverable, the BMS upgrade with energy metering is the only measure that has been approved for implementation. The installation of BMS will start shortly. The BMS upgrade will deliver benefits to both landlord and tenants in 30 Herbert Street, Dublin with estimated total energy cost savings of about 21,000 €/year and CO_2 reduction of 43.65 tCO_2/year. The project will also cover the harmonisation of competing heating/cooling systems in tenancies with landlord systems. Such system harmonisation aims to ensure that radiators, mechanical fresh air systems and tenant air-conditioning systems all act in a coordinated way. It will also deploy energy submetering and environmental sensing in tenancies to allow better coordinated energy management and visibility of the internal comfort conditions of tenancies.

The current BMS control system is depicted in Figure 10. All the tenanted floors have their own Air Handling Unit (AHU) supplying tempered air to the floor space. Moreover, on each floor there are Mitsubishi Electric City Multi Air Conditioning units which are used to maintain comfort levels. The distribution boards on each floor feed the Mitsubishi equipment for that floor and its associated AHU. The control points for the AHU's connect back to the existing BMS, whereas the Mitsubishi units are not connected with this system. Each AHU has an LPHW coil which is fed from a constant temperature circuit in the boiler house. The boiler house has two boilers and three circuits: a constant temperature circuit, a variable temperature circuit, and a DHW system for toilets. The variable temperature circuit is weather compensated and has mixing valves which are two zone valves on each floor for background heat. Wireless sensors will be installed, which will communicate via an internal radio network (LoRaWAN) with the BMS.

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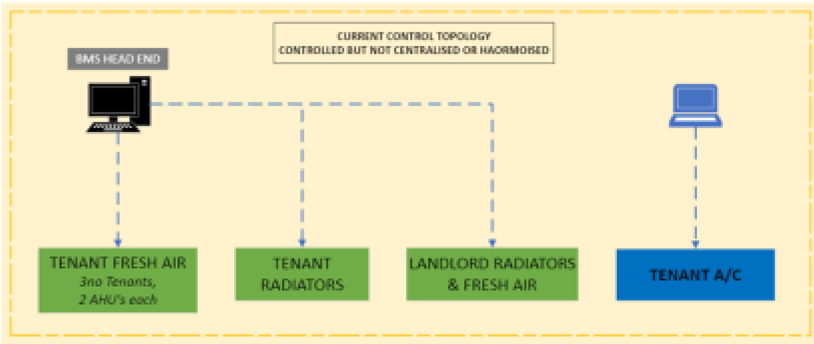

Figure 10: Existing BMS control system in 30 Herbert Street building

The upgraded system is illustrated in Figure 11. It can be noted that tenants' energy consumption and comfort will be monitored through the installation of electrical and heat meters, occupancy controls, air quality sensors and wastewater monitoring system. This information will provide the energy efficiency provider with the information that will enable to quantify the energy and non-energy benefits for the tenants in 30 Herbert Street, Dublin. Moreover, the connection of the Mitsubishi Electric City Multi Air Conditioning units to the BMS will allow to operate the AHU systems, radiators and air conditioning in a more coordinated manner reducing energy consumption.

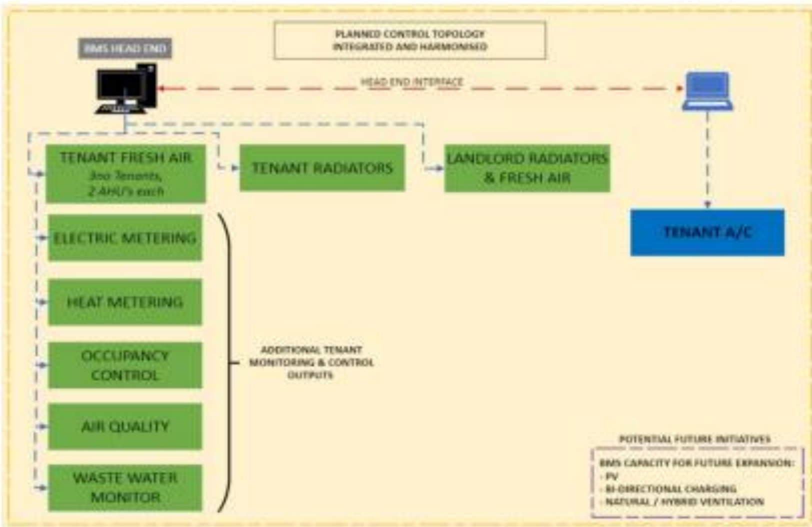

Figure 11: Upgraded BMS control system in 30 Herbert Street building

The agreements between landlord and energy efficiency provider (Lawler Sustainability) for the first two years following the completion of the upgrade project are illustrated in Figure 12. It The energy efficiency provider will monitor the system, measure the energy savings, and optimise the system if necessary. The building owner will pay a monitoring and optimisation fee to the energy efficiency provider. This fee is performance based and it will be about €1,000/month if the contractual guaranteed energy savings are met and will be lowered to €500/month in case the energy savings are not met. During the first two years after the installation of the BMS upgrade there will be no payment from tenants to energy efficiency provider as it was previously illustrated in the business model in Figure 2. The reason is that the decision to invest in the BMS upgrade project was taken by the landlord mainly because the existing equipment is at its end of the life. Moreover, the building owner will reap energy savings because the upgrade will increase energy efficiency of the building

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owner too. The building owner sees the business case in harmonising tenant and landlord different systems and the upgrade project will contribute to improve the relationships with the four parties by promoting their common sustainability agenda. The participation and interest in the BMS upgrade project from senior management within building owner, their management agent and all tenants also support this view. SmartSPIN has generated awareness in the building owner and their management agent regarding the proposed business model and how it can help to overcome the split incentive issue. In particular it has been made clear that the tenants may support the investment in energy efficiency by the building owner through the payment of a service fee to the energy efficiency provider, whose value is eventually shared (in part) with the building owner. However, given the fact that the business model proposed by SmartSPIN is new and has never been deployed on the market in Ireland, it has been decided to begin with a 2 years monitoring & optimisation project that will allow to measure and verify the energy savings accrued by the tenants along with other non-energy benefits (such as improved indoor comfort). Following this initial assessment of the energy efficiency gains for the tenants, the building owner in 30 Herbert Street may decide to request the tenants to pay a service charge for their improved energy efficiency. Moreover, the building owner may decide to deploy the SmartSPIN business model in other buildings they own. On the other hand, the energy efficiency provider prefers that the building owner establishes an agreement directly with the tenants, because the building owner has a stronger balance sheet and a revenue stream coming from the tenants.

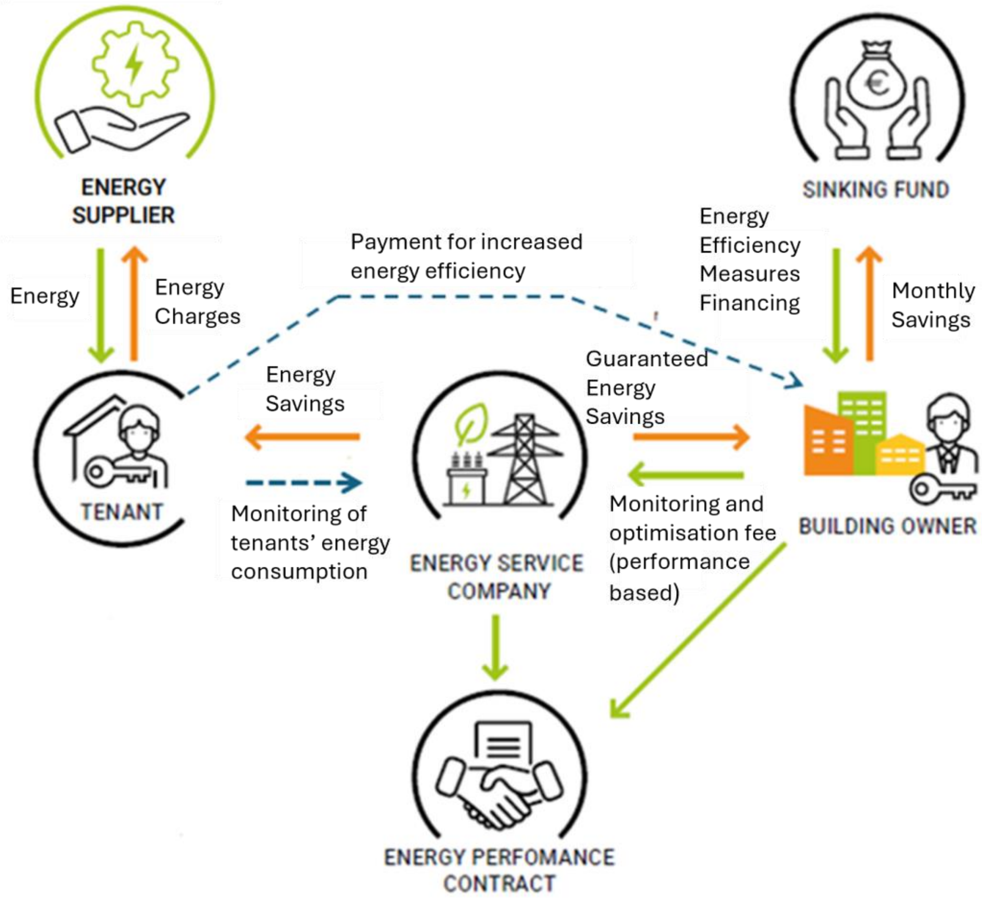

Figure 12: Agreements between landlord and energy efficiency provider for the building Dublin

In conclusion, SmartSPIN provided a smart energy service to the owner of the building at 30 Herbert Street, fulfilling both the technical and financial requirements of the desired building upgrade project.

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The deployment of the SmartSPIN smart energy service is creating transparency about the avoided cost within tenancies through improvements in the energy consumption metering and system monitoring, and this will eventually allow the building owner to recover a significant part of his investment.

2.2 SPAIN

2.2.1 La Gavia pilot site



Figure 13: La Gavia shopping centre in Madrid

La Gavia shopping centre is located in the booming Ensanche de Vallecas district, 11 kilometers from Madrid city centre. The mall extends over 85,382 mq and has 139 tenancies. La Gavia's energy consumption is 3.28 GWh/year of electricity and 0.6 GWh/year of natural gas. SmartSPIN solved the split incentive issue at La Gavia shopping centre through its innovative business model, which enabled to determine the appropriate agreements between landlord, tenants and energy efficiency provider. SmartSPIN determined €2.87M investments in energy efficiency measures, which delivered final energy savings of 1.17 GWh/year (1.11 GWh/year electricity savings and 0.06 GWh/year natural gas savings). After the implementation of the SmartSPIN service, tenants of La Gavia pay a reduced energy bill (on average €428/month) compared to the baseline bill (on average €629/month). Tenants also pay an average monthly fee of €181 to energy efficiency provider, that brings their total monthly expenditure for energy to €609. The energy efficiency provider pays on average €121/month to the landlord for each tenant, thereby providing a revenue stream to the landlord that is a key factor which determines the decision to invest in energy efficiency measures. Considering that La Gavia has 139 tenants, SmartSPIN determined a monthly profit of €8,403/month for the energy efficiency provider and €16,807/month for the landlord. The proposed agreements between parties at La Gavia shopping centre are illustrated in Figure 13.

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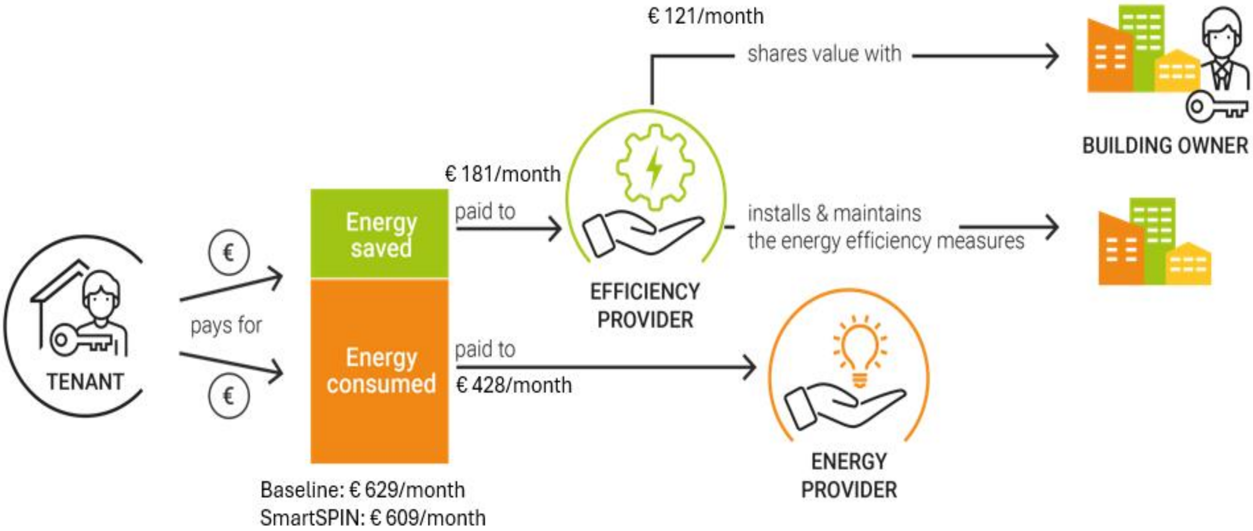

Figure 14: La Gavia average agreements between tenants, building owner and energy efficiency provider.

2.2.2 Plenilunio pilot site

Figure 15: Plenilunio shopping centre in Madrid.

Plenilunio is a premium shopping centre located at 11 kilometres east of Madrid attracting a large and growing population with significant purchasing power. The shopping centre extends over 70,684m^2 and has 171 tenancies. Plenilunio's energy consumption is 4.38GWh/year of electricity and 0.81GWh/year of natural gas. SmartSPIN solved the split incentive issue at Plenilunio shopping centre through its innovative business model, which enabled to determine the appropriate agreements between landlord, tenants and energy efficiency provider. SmartSPIN

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determined €3.84M investments in energy efficiency measures, which delivered final energy savings of 1.5GWh/year (1.42 GWh/year electricity savings and 0.081GWh/year natural gas savings).

After the implementation of the SmartSPIN service, tenants of Plenilunio pay a reduced energy bill (on average €487/month) compared to the baseline bill (on average €685/month). Tenants also pay an average monthly fee of €178/month to the energy efficiency provider, that brings their total monthly expenditure for energy to €665. The energy efficiency provider pays on average €119/month to the landlord for each tenant, thereby providing a revenue stream to the landlord that is a key factor which determines the decision to invest in energy efficiency measures. Considering that Plenilunio has 171 tenants, SmartSPIN determined a monthly profit of €10,139 for the energy efficiency provider and €20,279 for the landlord respectively. Agreements between parties at Plenilunio shopping centre are illustrated in Fig. 15.

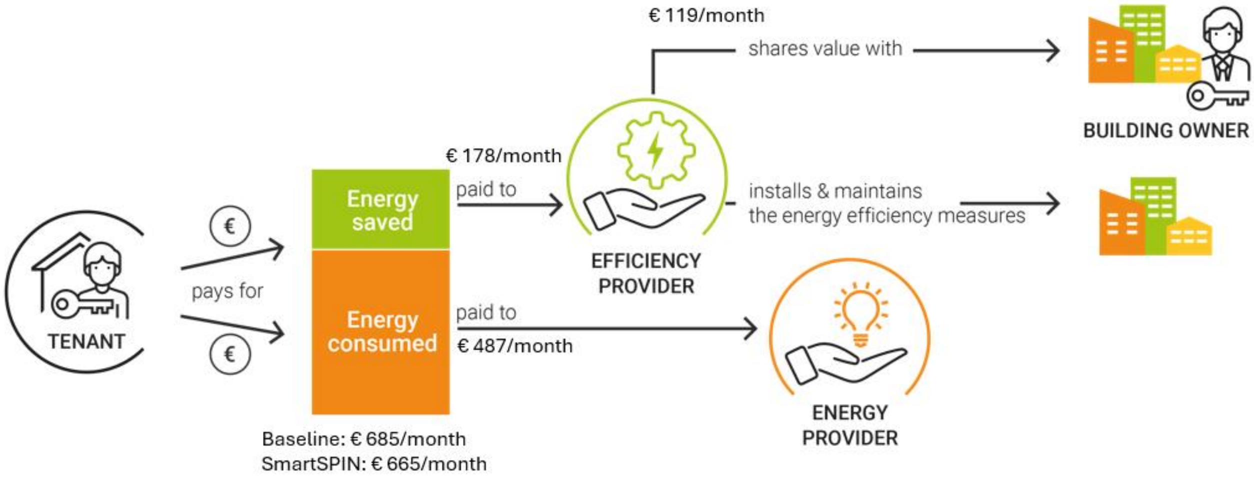

Figure 16: Plenilunio average agreements between tenants, building owner and energy efficiency provider.

2.3 GREECE

The pilot site in Greece is a large office building complex located 10 kilometres off the city centre of Thessaloniki, the second largest city of Greece. The complex is named i4G (Incubation for Growth) and comprises two inter-connected buildings of four floors each, hosting 15 tenants in a total operational surface of 1,600m^2 and 1,800m^2 respectively. The tenants are mainly start-up companies as well as mature and well-known technology and innovation companies.

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Figure 17: i4G building complex in the Thessaloniki City Centre, Greece.

The baseline electricity consumption of the I4G buildings is 0.40GWh/year; natural gas is not used in the buildings. SmartSPIN has deployed smart equipment in the I4G buildings enabling tangible energy efficiency gains. Furthermore, the method for energy costs sharing between tenants which consisted in the owner to share the energy costs with the tenants based on the rented area (i.e., considering the square meters of each office) has been upgraded by means of submetering, thereby allowing the tenants to pay for their actual consumption. This upgrade enables a fairer and accurate sharing of energy costs.

SmartSPIN solved the split incentive issue at the i4G office building complex through its innovative business model, which enabled to determine the appropriate agreements between landlord, tenants and energy efficiency provider. SmartSPIN determined €0.17M investments in energy efficiency measures, which delivered energy savings of 0.24GWh/year (0.07GWh/year determined by smart equipment and controls and 0.17 GWh/year determined by local renewable energy production).
After the implementation of the SmartSPIN service, tenants of i4G office building complex pay a reduced energy bill (on average €212/month) compared to the baseline bill (on average €530/month). Tenants also pay an average monthly fee of €286/month to the energy efficiency provider, that brings their total monthly expenditure for energy to €498. The energy efficiency provider pays on average €191/month to the landlord for each tenant, thereby providing a revenue stream to the landlord that is a key factor which determines the decision to invest in energy efficiency measures.

Considering that the i4G office building complex has 15 tenants, SmartSPIN determined a monthly profit of €1,430 for the energy efficiency provider and €2,861 for the landlord respectively. Agreements between parties at i4G office building complex in Thessaloniki, Greece, are illustrated in Fig. 18.

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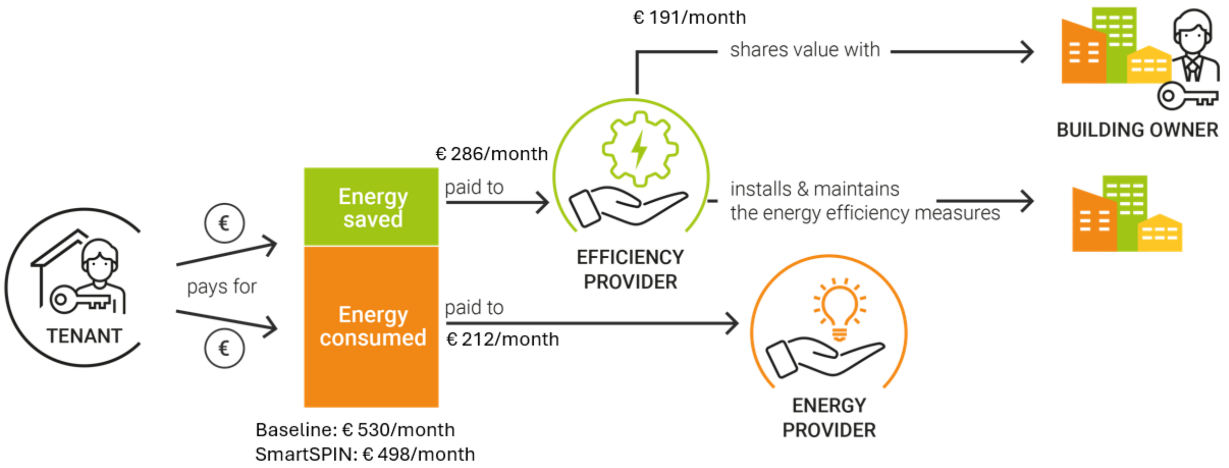

Figure 18: I4G average agreements between tenants, building owner and energy efficiency provider.

3. TOOLS

SmartSPIN project has developed a suit of tools to support the implementation of SmartSPIN business model. This suit of tools includes (i) SmartSPIN contractual and tariff template, (ii) SmartSPIN interactive webapp showing the potential for energy management in EPC commercial buildings, (iii) Early building performance diagnostics web-dashboard, (iv) SmartSPIN Measurement & Verification App, (v) SmartSPIN visualization dashboard and (vi) SmartSPIN gamification app

3.1 SMARTSPIN CONTRACTUAL AND TARIFF TEMPLATES

SmartSPIN has defined a contractual model to optimise the building energy services between ESCO, landlord and tenant. This contract addresses the needs and obligations of all parties involved in the commercial rented sector and can be freely used as a basis for drafting a contract involving more than two parties. The contract template would preferably be a tri-partite model including Landlord/Tenant/ESCO. The template was designed so that it accommodates this possibility. The performance guarantee of savings by the ESCO is an essential keystone and marketing tool for the overall process as it ensures that the client gets a financial return from the project. Flexible tariff template links the system marginal price, (SMP) i.e., electricity market hourly clearing price to the electricity price paid by the customer. The flexible tariff template attempts to compare 15-minute consumption data for clients with the SMP for every hour of every day using data provided by the authorised DSO. D3.5 Contractual and Tariff Templates describes SmartSPIN contractual tariff template and flexible tariff template developed by the project.

3.2 SMARTSPIN INTERACTIVE WEB-APP

The stakeholders interested in an EPC in a commercial rented building can use the SmartSPIN Interactive Webapp to obtain useful information about energy cost savings potential, revenue streams from implicit demand response strategies (peak-shaving and load-shifting) as well as explicit demand response programs, smart readiness of a building as measured by the Smart Readiness Indicator (SRI). The App presents the most suitable "target" market across Europe for the SmartSPIN

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split-incentives business model based on Energy Performance Contracts (EPC). The web-app focuses on different typologies of commercial buildings and facilities, summarizing their potential for EPC under different boundary conditions such as climate, demand response market maturity, and dynamic electricity tariffs.

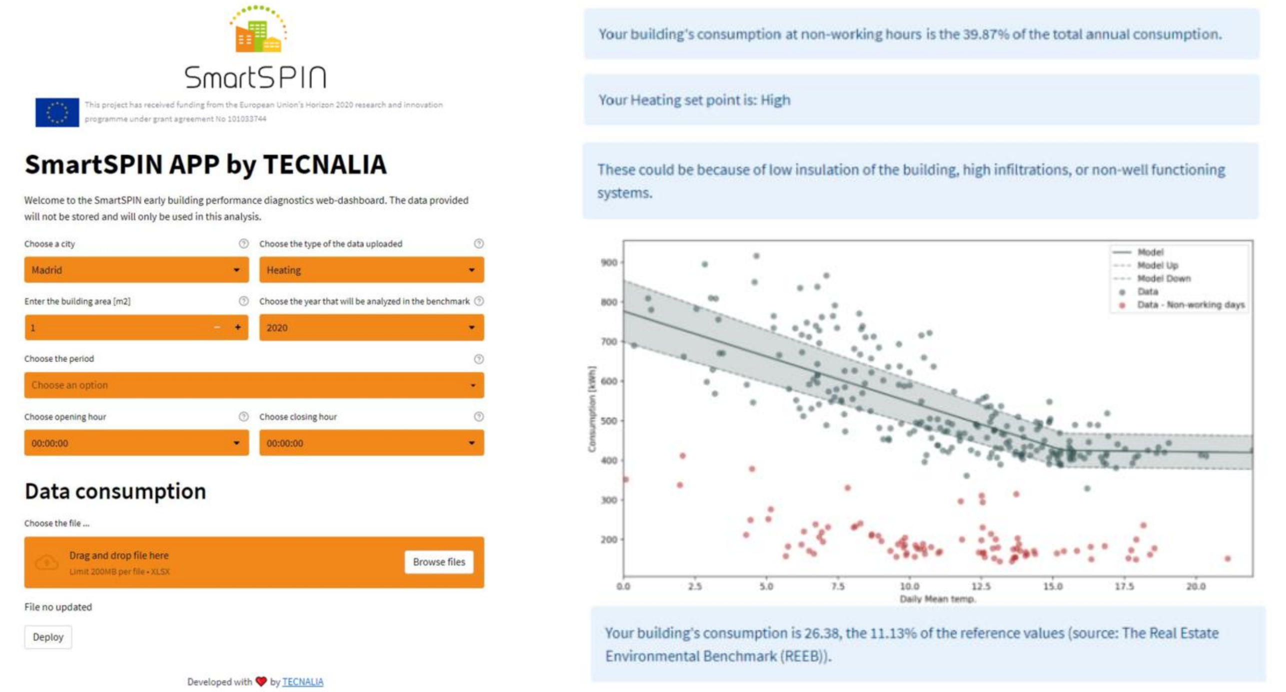

Figure 19: SmartSPIN Interactive Web-App.

3.3 SMARTSPIN EARLY BUILDING PERFORMANCE DIAGNOSTICS WEB-DASHBOARD

The early building performance diagnostics web-dashboard is a data-driven energy diagnostics algorithm to identify the most significant energy & cost streams in buildings using a minimal dataset of information. It considers general information about the building such as location (i.e., climate), characteristics (i.e., size), usage (opening hours, schedules, etc.), and general HVAC characteristics, as well as overall facility energy consumption. In line with the overall SmartSPIN concept, the diagnostic will comprise not only overall energy use, but also deliver granular data for its integration with energy tariffs in real practice (i.e., this implies that energy use is divided by energy carrier, and that electricity use is divided by billing schedules). The early building diagnostic results in the calculation of key performance metrics that allow automatic identifying energy saving measures when cross-referenced against current building performance databases.

3.4 SMARTSPIN MEASUREMENT AND VERIFICATION APP

The measurement and verification (M&V) application of SmartSPIN is built upon the recommendations and best practices defined by existing M&V protocols such as the International Performance Measurement and Verification Protocol (IPMVP), ASHRAE Guideline 14, Uniform Methods Project (UMP). The M&V tool enables: 1. to train data-driven energy baselining models and calibrate them against pre-intervention data; and 2. to facilitate the use of sub-metering data and information on technical systems in the M&V process. The data-driven models incorporated into the M&V tool enable to assess demand-response and control optimisation measures. The M&V tool enables to perform a seamless update of baseline-models and assessment of the impact of energy

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saving measures, along with supporting the identification of non-routine adjustments to models. The tool works in synergy with the algorithms for early building diagnostics and prognostics for operation and control and facilitates their verification and fine-tuning.

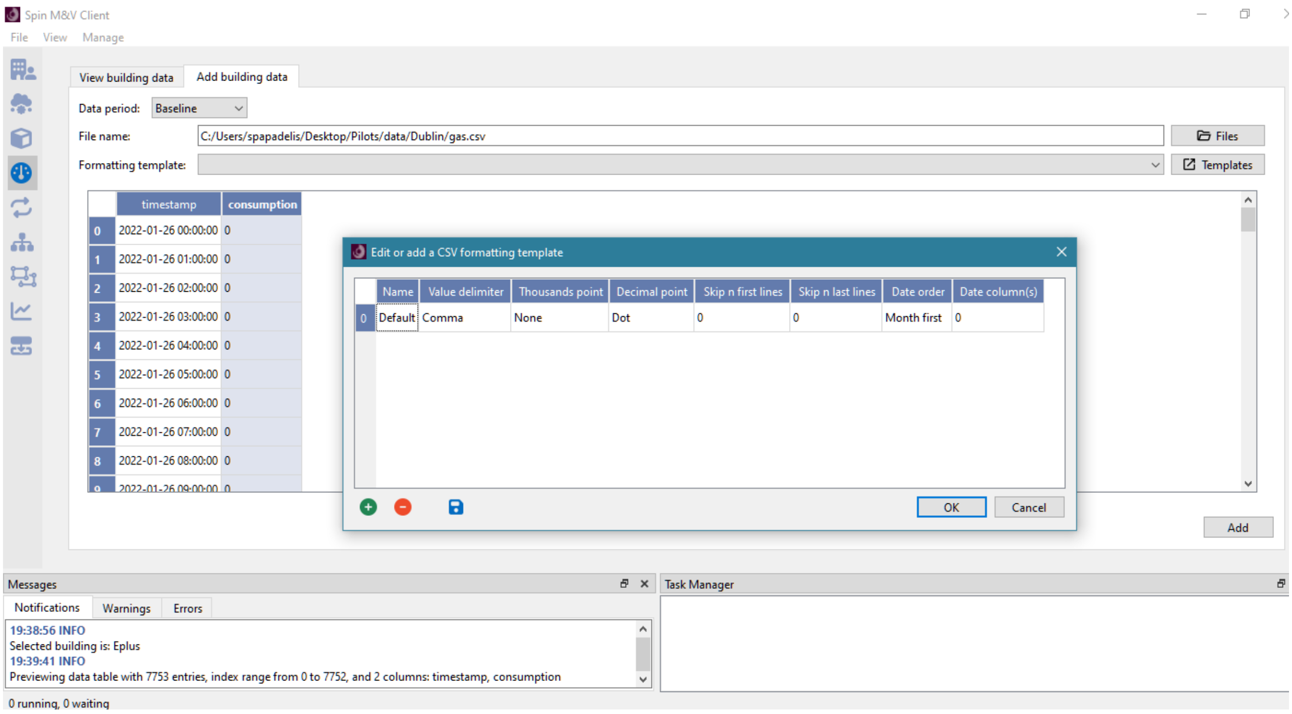

Figure 20: SmartSPIN Measurement and Verification Tool.

3.5 SMARTSPIN VISUALISATION DASHBOARD

Building on the current SMARKIA platform, SmartSPIN is developing a visualisation dashboard that allows the visualisation and presentation of the results generated by the data-driven algorithms developed in WP4 (Data analytics for energy management). A detailed presentation and assessment of the visualisation dashboard will be presented in the forthcoming deliverable D4.5. The visualisation dashboard is used in the WP5 for the demonstration and validation of the SmartSPIN service at the project pilot buildings and will deliver personalised information and results for the different stakeholders involved, such as buildings occupants, building or operation & maintenance manager, ESCO, building owner.

3.6 SMARTSPIN GAMIFICATION APP

SMARKIA is developing a smartphone app that will enable to engage tenants to take actions that will further reduce building energy consumption and to reward them when they assume energy efficient behaviours. The app enables to compare the performance of tenants within the same building using the principles of gamification. Moreover, it can be used to play a competitive game that will stimulate the interest for the implementation of energy saving opportunities. The app is an innovative tool that can help to maximise energy savings by encouraging tenants to take more energy efficient behaviours and could potentially determine increased revenue streams for landlords and tenants from energy efficiency.

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CONCLUSIONS

The SmartSPIN project presents an innovative business model designed to revolutionize the deployment of a Smart Energy Service (SES) designed for the commercial rented sector that enhances energy efficiency and (if applicable to the considered building) flexibility in energy consumption, ultimately aiming to reduce carbon emissions and combat climate change.

This deliverable has presented the infographics, factsheets and tools that support the dissemination of the SmartSPIN business model toolkit across the commercial rented sector in Ireland, Spain and Greece and the uptake of the SmartSPIN service by interested ESCOs.

Seven infographics have been presented in section 1. These illustrate the variants of the SmartSPIN business model with respect to the actor funding the measures (i.e., the building owner performs the investment or ESCO invests, in the former case a sinking fund or bank load can be used, energy savings are guaranteed by the ESCO or shared), the deployment of the measures which can be performed in different time periods (implementing first no-cost and low-cost measures liaising only with the tenants, and after that, deploying more powerful medium and high-cost measures with the approval of the building owner), and the demand response service based on load shifting described in the SmartSPIN flexible tariff template. The infographics show the flexibility of the SmartSPIN business model and its adaptability to a broad range of use cases, facilitating the engagement with the stakeholders that are interested in the exploitation of the SmartSPIN business model toolkit.

The factsheets in section 2 highlight the expected revenue streams for the ESCO and the building owner, the cost and the benefits of the SmartSPIN service, the expected reduction of the energy bill for the tenants, at the three demonstration sites in Ireland, Spain and Greece. They have been developed using the data available at the time of writing this report and will be validated after the completion of the on-going T5.5 Validation of SmartSPIN service. The factsheets show that SmartSPIN has a large potential to solve the split incentive issue in commercial rented properties once that the stakeholders have engaged with the ESCO. This process may require intermediate steps (like in Ireland) where the installed measures are tuned to achieve their best performances, and the energy savings are assessed and presented to the building owner and the tenants. This way the ESCOs (SmartSPIN partners) will be able to build the trust which is necessary to get the performance contracts signed and the service operational in buildings in Ireland, Spain and Greece.

The SmartSPIN tools summarised in section 3 show that the project has developed practical tools to support the service implementation by ESCOs, in synergy with facility management companies, building owners and tenants. These tools are part of the SmartSPIN business model toolkit. Their development has been completed (contractual and tariff templated, interactive web application, early building performance diagnostics web-dashboard) or will be completed shortly (measurement and verification app, visualisation dashboard, gamification app). All the tools will be validated as part of T5.5.

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APPENDIX – TOOL FOR THE EVALUATION OF ECONOMIC KEY PERFORMANCE INDICATORS

A tool to evaluate economic key performance indicators of an energy efficiency project for landlord, tenants and the energy efficiency provider has been implemented in a Jupyter notebook. The KPIs that are evaluated by the tool are the Net Present Value (NPV) for the building owner, renters and ESCO.

The net present value (NPV) is an economic key performance indicator that measures the value generated by an asset (e.g., an energy efficiency measure) which generates cash flow (i.e., energy cost savings) by adding up the present value of all the future cash flows that the asset will generate. The present value of a cash flow depends on the interval of time between now and the actual cash flows because a discount rate applies.

The tool considers the following factors when evaluating the NPVs:

1. Contract duration (a longer contract duration increases the value for the energy efficiency provider and reduces it for the landlord, because the ESCO takes part of the energy savings)
2. Aging of energy efficiency equipment (aging reduces effectiveness of energy efficiency measures over time and therefore energy savings will be also reduced).
3. Increase in the energy prices over time (forecast).
4. The amount of energy savings that the energy efficiency provider guarantees to the landlord.
5. The amount of energy savings that are shared with the tenants (which relates to the service fee that is paid by the tenants to the ESCO). The tool models the rebound effect which determines an increase in energy consumption for the tenants, when the energy savings shared with them are low.

The revenues for the ESCO, renters and building owner are respectively given in equations (1), (2) and (3), whereas the NPVs for ESCO, renters and owner are provided in (4), (5) and (6).

- I_C is the capital cost of the energy efficiency measures;
- $R(t)$ are the predicted energy savings;
- G is the guaranteed energy savings threshold agreed with the ESCO;
- β is the fraction of energy savings exceeding the guaranteed savings threshold G that is shared with the ESCO's clients;
- n is the contract duration.
- N is the duration of the installed energy efficiency measures.
- θ is the fraction of savings taken by the landlord, whereas $1-\theta$ is taken by the tenants (renters).
- $I_{OM}(t)$ are the operation and maintenance costs
- r_E , r_O, r_R are the expected rates of return for ESCOs, building owner and renters.

The investment in energy efficiency measures at $t = 0$ can be performed either by the ESCO or by the building owner. If the building owner invests then $\gamma = 1$, whereas if the ESCO invests $\gamma = 0$ (these investments are negative cash flows at $t = 0$ for the calculation of NPVs). Scenarios with $0 < \gamma < 1$ (landlord and ESCO share the initial capital costs of the measures) are under investigation.

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The duration of the contract *n* appears in (4) and shows that NPV_E increases when the contract duration increases because the ESCO takes more energy savings.

$$R_E = \begin{cases} 0, \quad t = 0 \\ R(t) - G - \max[0, \beta(R(t) - G)], \quad t = 1, \dots n \\ 0, \quad t = n+1, \dots . N \end{cases} \tag{1}$$

$$R_R = \begin{cases} 0, \quad t = 0 \\ (1-\theta)(G + \max[0, \beta(R(t) - G)]), \quad t = 1, \dots n \\ (1-\theta)R(t), \qquad t = n+1, \dots N \end{cases} \tag{2}$$

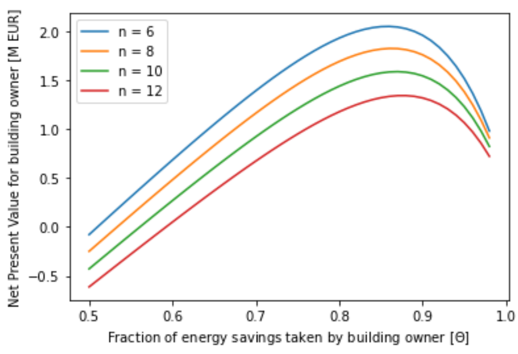
$$R_O = \begin{cases} 0, \quad t = 0 \\ \theta(G + \max[0, \beta(R(t) - G)]), \quad t = 1, \dots n \\ \theta R(t), \quad t = n+1, \dots . N \end{cases} \tag{3}$$

$$NPV_E = (\gamma - 1)I_C + \sum_{t=1}^{n} \frac{R(t) - G - max[0, \beta(R(t) - G)] - I_{OM}(t)}{(1+r_E)^t} \tag{4}$$

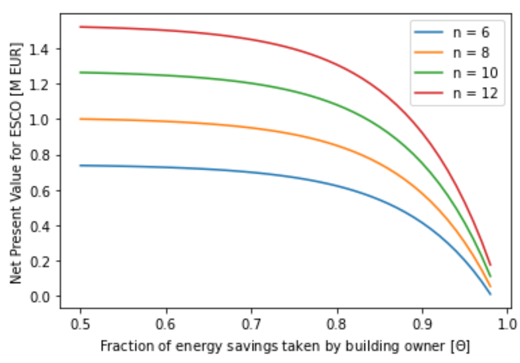
$$NPV_O = -\gamma I_C + \sum_{t=1}^{n} \frac{\theta(G + max[0, \beta(R(t) - G)])}{(1+r_O)^t} + \sum_{t=n+1}^{N} \frac{\theta R(t) - I_{OM}(t)}{(1+r_O)^t} \tag{5}$$

$$NPV_R = \sum_{t=1}^{n} \frac{(1-\theta)(G + \max[0, \beta(R(t) - G)])}{(1+r_R)^t} + \sum_{t=n+1}^{N} \frac{(1-\theta)R(t)}{(1+r_R)^t} \tag{6}$$

The tool provides a method for evaluating and comparing different choices in relation to 1. Installation of different energy efficiency measures (choice of energy efficiency measures affects I_C in 4 and 5); 2. investment choices (e.g., landlord or ESCO performs the capital investment, i.e. γ parameter in 4 and 5); 3. agreements about energy savings division between the parties that affect the Net Present Value of the project for each party (landlord, tenants, and ESCO, i.e., parameters G, β, θ in 1-6). The most appropriate contract duration *n* is the one which maximises NPV_O while guaranteeing $NPV_E \geq NPV_{E,min}$ (the value for the ESCO is greater or equal to the minimum desired value). NPV_O is maximised when both the share of the initial investment in energy efficiency measures γ for the building owner and the contract duration *n* are minimised. However, if the ESCO bears partially or totally the cost of the investment I_C, the contract duration will have to be chosen sufficiently long to ensure that the ESCO achieves the targeted profit.



(a)



(b)

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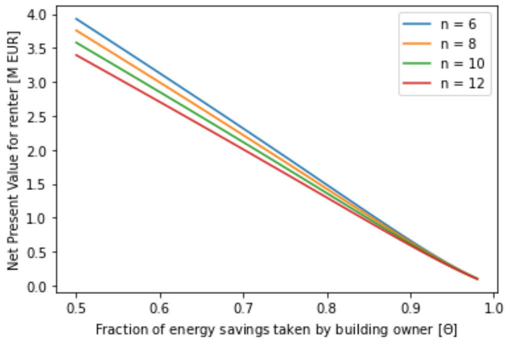
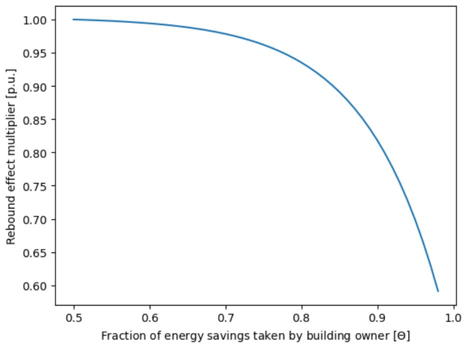


(c)



(d)

Figure 21: Example of output from economic KPIs evaluation tool (ESCO investing).

An example of the output of the tool is shown in Figure 13 and refers to the shopping centre Plenilunio in Spain. We consider the following parameters: $I_C = 3.84$ M€; $G = 250\ \text{k€/year}$; β=0.2; n = 6,8,10,12; N = 25; θ ranging from 0.5 to 1; $I_{OM}(t) = \left(\frac{1}{1.025}\right) I_C e^{\left(-\frac{\sigma_H^2 t}{2}+\sigma_H \varepsilon_H \sqrt{t}\right)}$ where $\sigma_H = 0.25$ and ε_H=0.01; $\gamma = 1$ (the initial investment is performed by the landlord); $r_O = r_R = 0.031$; $r_E = 0.06$.

Fig. 13a shows NPV_O as a function of θ and for different contract durations. Increasing the amount of savings taken by the landlord determines in the first part of the curves an increment of their NPV up to a point (corresponding to $\theta \cong 0.87$) when the renters will begin to consume more energy because they are not sufficiently rewarded with part of the value of energy savings (rebound effect). The NPV curves corresponding to longer contract duration are lower because the ESCO will take a more energy savings with a longer contract duration. Fig. 13b shows NPV_E versus the θ parameter. Increasing the amount of savings taken by the landlord will determine and increased consumption by the renters (rebound effect) that in turn determines lower energy savings $R(t)$ and therefore a lower NPV for the ESCO. The ESCO may increase their NPV by increasing the contract duration (moving to curves that are higher for longer contract durations). Fig. 13c shows that NPV_R decreases as θ increases and it is zero when $\theta = 1$ (the landlord takes all the energy savings sharing nothing with the renters). Fig. 13d shows the rebound effect function that multiplies the potential energy savings achievable to give the actual energy savings $R(t)$. The curve shows that the energy savings are maximised when $\theta = 0.5$, whereas they are reduced to about 60% when $\theta = 1$ (the landlord takes all the energy savings).

The tool can be used to validate the contractual agreements between the actors (building owners, tenants and ESCO) that want to implement the Smart Energy Service by SmartSPIN using state of the art models that enable to evaluate the cost of the service for renters (service fee to be paid to ESCO) and their energy consuming behaviour, a long term prediction of energy savings which takes into account degradation, investment choices and contract duration

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