SmartSPIN

Clustering Event

25th April 2023

Luciano De Tommasi

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

Introduction to SmartSPIN

- **Scope of the project**
  - Background
  - SmartSPIN Concept
  - Demonstration sites
  - Stakeholders mapping
- **Overview of the key results**
  - Business model and revenue streams
  - Service definition
  - Performance evaluation methodology
- **Lessons learnt**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 10133744.

Scope of the Project

- *European Priority:* Evaluate and implement measures to remove the barriers to energy efficiency, especially those concerning the split of incentives between the owner and tenant of a building (Energy Efficiency Directive, Article 19.)

- Develop a **business model to implement low cost actions to reduce buildings energy consumption**
  - adopt sensors to improve state estimation capabilities and the M&V process
  - fine tuning the controls of the building systems
  - unifying all the energy efficiency measures to pursue the common goal of **improving energy efficiency when adopting the SmartSPIN business model**

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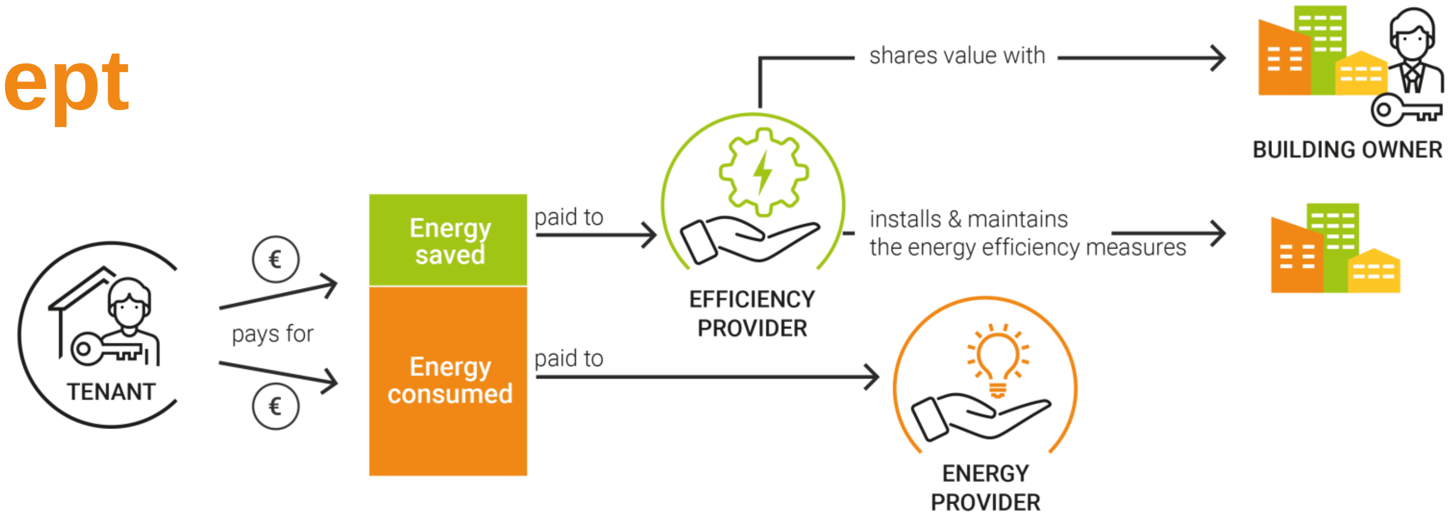
The SmartSPIN concept



Step1: **Bilateral agreement between energy efficiency service provider and tenant**.

- The agreement concerns either services of **optimized energy management** and **equipment performance monitoring** (which do not require upfront investments) or interventions that do not require landlord's permission, such as **replacement of equipment owned by tenant with more energy efficient units**.
- The efficiency provider *monitors* the performance of the building systems *improving their control strategies and sequences*.
- SLA for outcome of system operation (e.g. indoor conditions for the case of a heating system)
- Tenants pay for the energy saved to the efficiency provider
- M&V process estimating the impact of the interventions and quantifies their added value.

Step2: **Agreement between energy efficiency service provider and tenant with building owner's consent**.

- Service providers engage with building's owner to get his consent for installing equipment and performing construction works
- Service providers fund the upfront costs: equipment, construction, operations, monitoring and maintenance
- Tenants pay for the energy saved to the efficiency provider
- Service providers share value with building's owner

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SmartSPIN Demonstration sites – Spain

Plenilunio Mall: 5.3 GWh/year electricity, 171 tenants over 70,684 sq. m, Madrid, Spain

La Gavia Mall: 3.9 GWh/year electricity, 0.6 GWh/year natural gas, 139 tenants over 85,382 sq. m, Madrid, Spain

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SmartSPIN Demonstration sites – Ireland and Greece

30 Herbert Street, Dublin, Ireland: 0.89 GWh/year electricity, 0.91 kWh/year natural gas, Dublin, Ireland

- 7,100 sq. m owned by JLL Ireland (Real Estate Advisors & Professionals)
- 1,809 sq. m covered by landlord which includes the ground floor reception,
- Tenant 1 (Investment Services) = 61.69% (2,714.36 sq. m)
- Tenant 2 (Private Banking and Asset Management) = 18.30% (805.20 sq. m)
- Tenant 3 (Hedge Fund) = 20.01% (880.44 sq. m)

i4G building complex in the Thessaloniki City Centre, Greece: 0.4 GWh/year electricity, Thessaloniki, Greece

- building complex (Incubation for Growth) located 10 km off the city centre of
- two inter-connected buildings of four floors each, hosting 15 tenants in a total operational surface of 1,600 sq. m and 1,800 sq. m respectively

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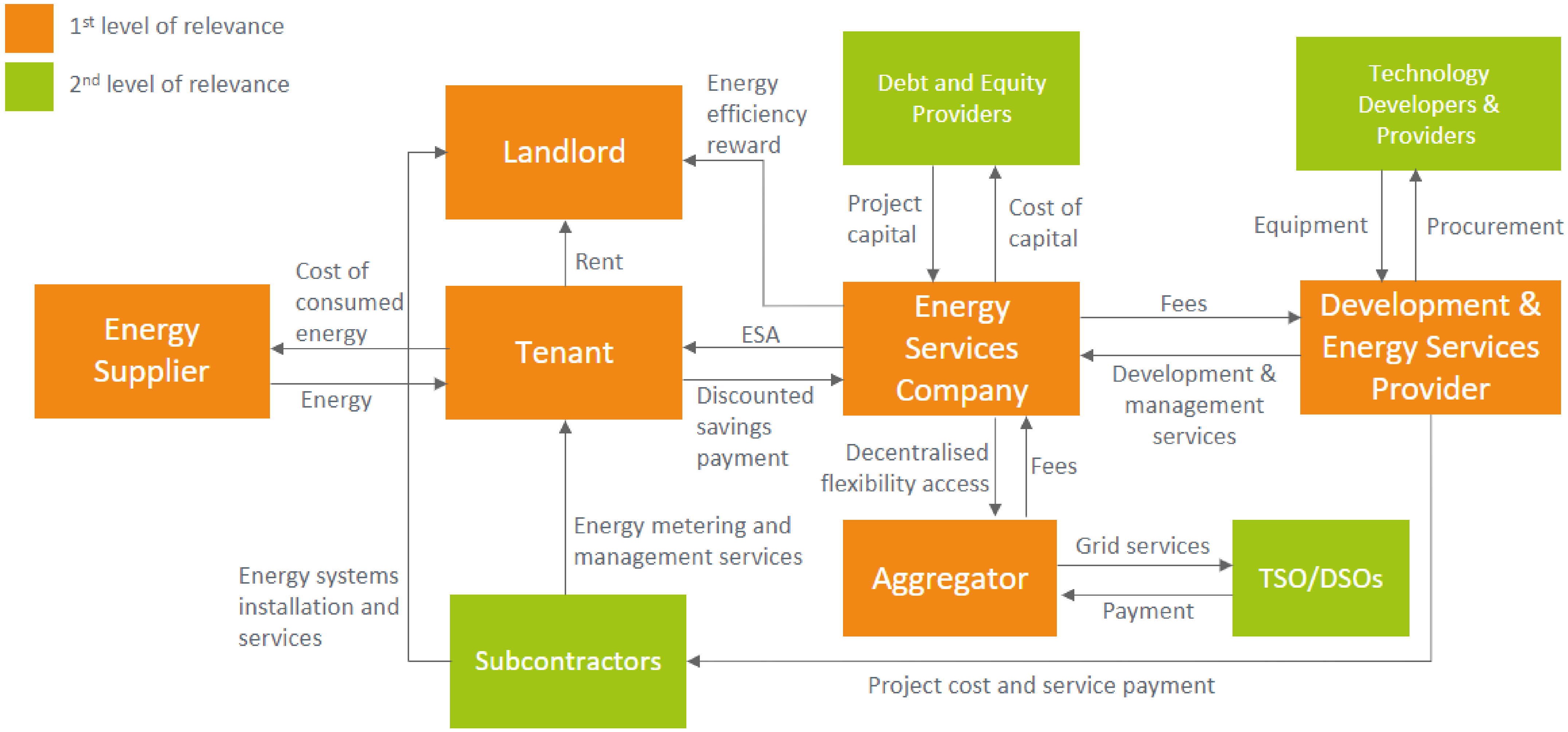
SmartSPIN stakeholders



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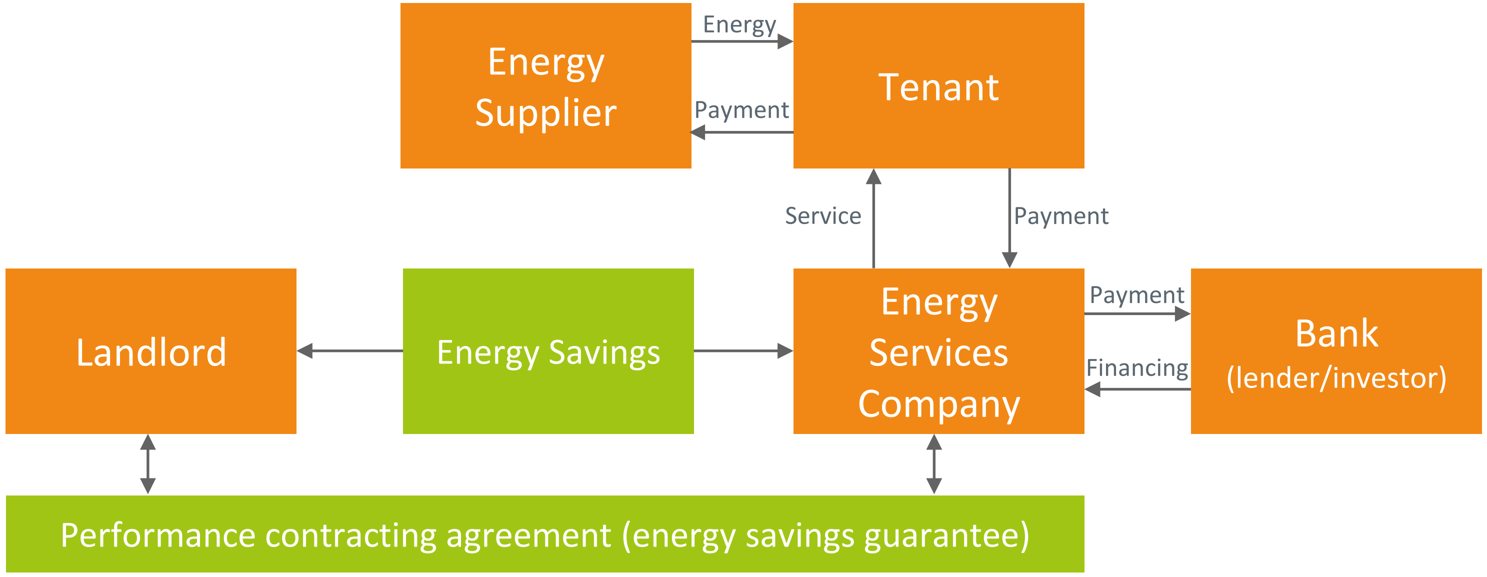
ESCO Business models addressing split incentive – 1

Shared savings business model addressing the split-incentive



- The ESCO is responsible for designing, financing and implementing the project
- The ESCO is responsible to verify the savings during the contract period
- The ESCO gets a fixed portion of the saving over a fixed period *and shares the savings with the landlord*
- The tenant pays the fees for the energy service to the ESCO
- Low risk model for the client

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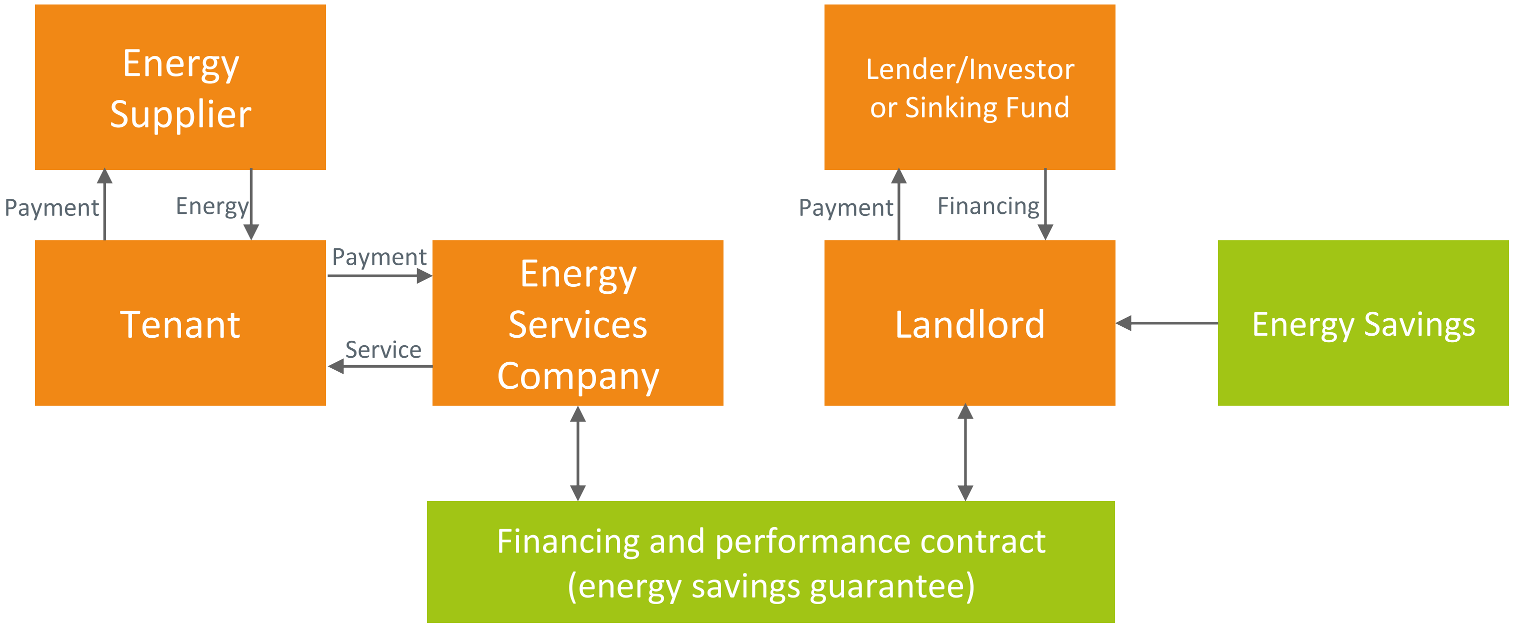
ESCO Business models addressing split incentive – 2

Guaranteed savings business model addressing the split-incentive issue



- The ESCO is responsible for designing and implementing the project but it is not responsible for financing it
- The ESCO guarantees that the savings will be sufficient to pay for the service fees

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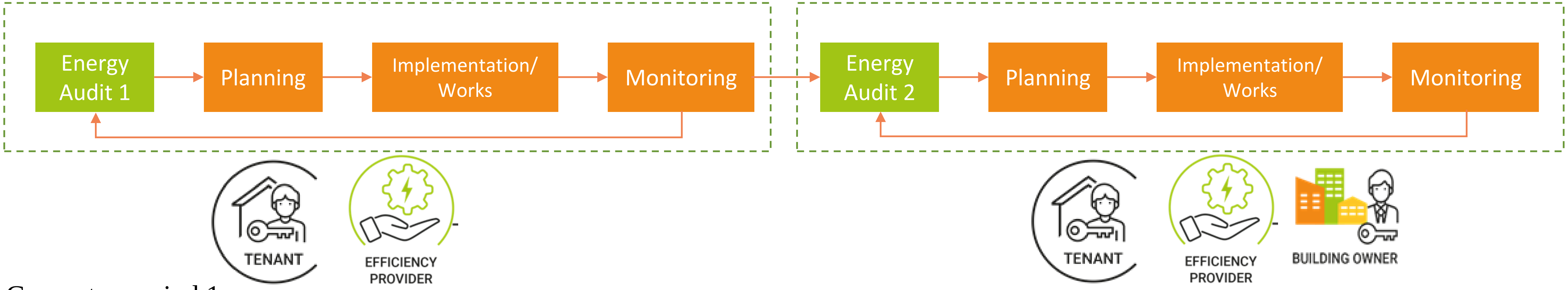
The SmartSPIN Energy Efficiency as a Service Model

Towards a Tripartite Energy Performance Contracting

Guarantee Period 1: optimized energy management & EEMs owned by tenant ***Guarantee Period 2:*** EEMs & upgrades to the building owned by building owner



Guarantee period 1

- The service provides:
  - Optimized energy management and advice to reduce energy consumption.
  - Installation/replacement of energy efficient equipment owned by the tenant (agreed in Energy Audit 1).
- Start / end date of guarantee period 1
- Target energy savings in guarantee period 1
- Penalty for the ESCO if not achieving the target savings
- Service Level Agreement (users' satisfaction / thermal comfort)

Guarantee period 2

- List of approved energy efficiency measures which can be installed in Step 2 (agreed in Energy Audit 2).
- Start / end date of guarantee period 2
- Financing means other than energy savings accumulated in period 1
- End date of ESCO contract
- Target energy savings in period 2
- Penalty for the ESCO if not achieving the target savings
- Service Level Agreement

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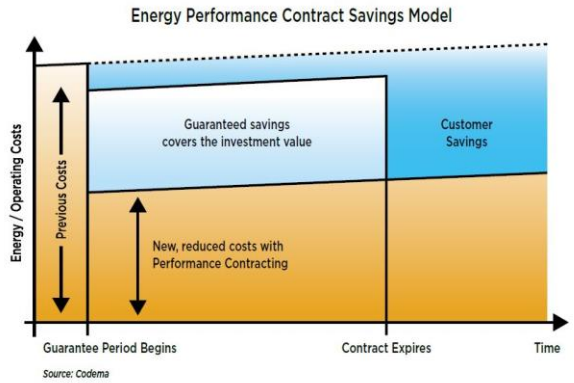
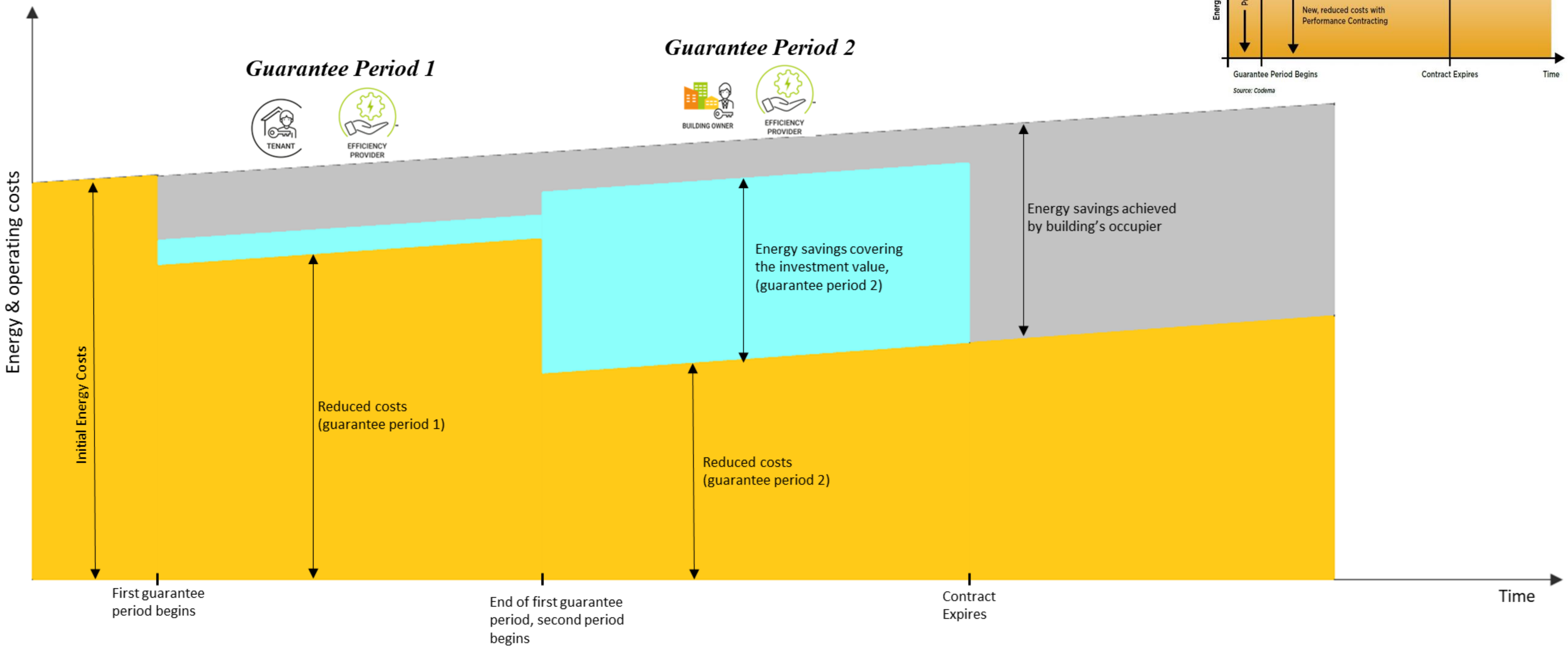
T1.6 – The SmartSPIN energy savings model





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Task 1.6 Cost-effective and rigorous M&V approach

T1.6 will leverage a state-of-the-art M&V methodology developed in T5.3

State-of-the-art M&V seeks the optimal balance between *costs and rigour of M&V for project performances evaluation*

Data collection
use periodic data collection rather than continuous data collection

Baseline
Use extensive metering in the baseline period and make justified assumptions for parameters which cannot be metered

Existing equipment and practices
Use as much as possible existing instrumentation, energy management systems, and energy management behavioural practices

Energy Sector Management Assistance Program. (2017). Assessing and Measuring the Performance of Energy Efficiency Projects. World Bank.

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T1.6 – Impact Analysis Methodology

IPMVP Method	Description	Possible Application in SmartSPIN
A – Partially Measured Retrofit Isolation (measurement of key parameters)	A partial set of measurements of the energy use of the system(s) to which an EEM is applied is used to determine energy savings.	Monitoring of loads where the pre and post retrofit power consumptions are measured whereas the operating hours are agreed upon (e.g. lighting retrofits).
B – Retrofit Isolation (measurement of all parameters)	Field measurements of the energy use of the systems to which the EEMs are applied are used to determine the savings.	To determine the energy consumption of loads which are individually metered such as a variable speed drive on a pump.
C – Utility Bills	Savings are determined by measuring energy use at the utility meter level before and after the application of EEMs. A correction to take into account the weather may be applied to the bills.	To determine the overall effect of a combination of multiple EEMs applied to many systems in a building.
D – Computer Simulation	If there is no pre-retrofit utility data available then calibrated computer simulations may be used for establishing a baseline.	Probably out of the scope of the SmartSPIN approach, but it could be useful when the baseline cannot be measured.

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Task 1.6 Costs of M&V options

1-3%	3-10%	1-5%	3-10%
LOW	HIGH	LOW-MEDIUM	HIGH
Whole facility measurement (utility bill)	Retrofit isolation with measurement of all parameters	Retrofit isolation with measurement of key parameters	Calibrated computer simulations

Energy Sector Management Assistance Program. (2017). *Assessing and Measuring the Performance of Energy Efficiency Projects*. World Bank.

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T1.6 Ranking of ECMs for performance evaluation

Category	ECM performance and operating characteristics	Load	Hours
1	Constant load, constant operating hours	Constant	Constant
2	Constant load, variable operating hours with a fixed pattern	Constant	Variable
3	Constant load, variable operating hours without a fixed pattern (e.g. weather)	Constant	Variable
4	Variable load, constant operating hours	Variable	Constant
5	Variable load, variable operating hours with a fixed pattern	Variable	Variable
6	Variable load, variable operating hours without a fixed pattern (e.g. weather-dependent)	Variable	Variable

The methodology of T1.6 that will be applied across the chosen pilot sites to evaluate the actual primary energy savings achieved (and GHG emissions avoided) should preferably enable to breakdown the ECMs into six categories to evaluate their savings separately then add them up to calculate the total.

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Task 1.6 Degree of uncertainty of measured savings

Modelling uncertainty

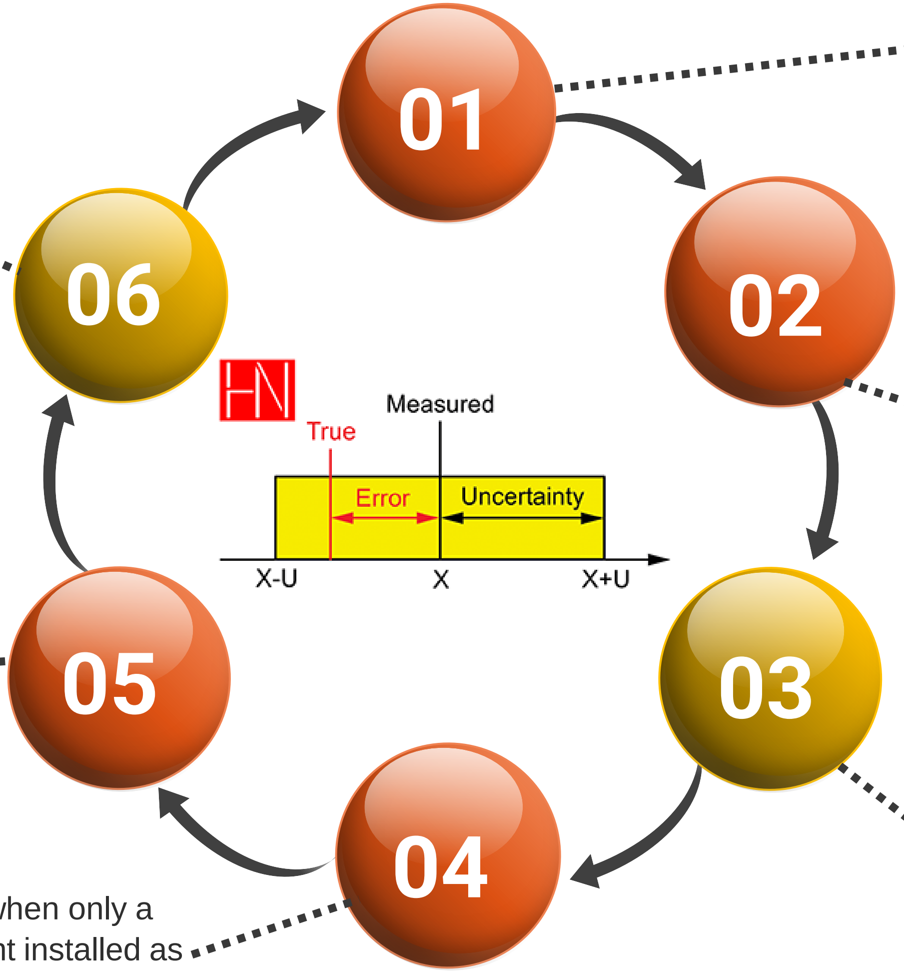
This is the uncertainty due to estimation of savings using engineering or simulation models. The simulation model must account for all variations in energy use using appropriate analysis techniques, including selection of relevant variables and exclusion of the irrelevant ones.

Uncertainty due to use of engineering estimates

The efficiency of an equipment may be estimated using type and age of the equipment as well as engineering knowledge about the equipment.

Sampling uncertainty

Sampling uncertainty occurs when only a sample of appliance/equipment installed as a retrofit is measured and the results are generalized to the entire population.



Metering equipment inaccuracies

Specifications for a meter may indicate that it is accurate within ±5%, meaning that any reading obtained by the meter may be up to 5% off in excess or in defect

Uncertainty due to meter placement

Poor meter selection, placement, or misestimation of independent variables may contribute to unquantifiable errors. For example, the flow rate and temperature in a duct vary between the edge and the centre. Elbows affect flow and heat transfer characteristics for a non-negligible downstream portion of the duct.

Uncalibrated instruments

Calibration is the comparison of the measurements from the instrument to a known value of the measured quantity. Calibration allows to determine how uncertain this measurement is.

Adjustment involves the change of the readings on a measuring device, so it corresponds to the real value of what is being measured

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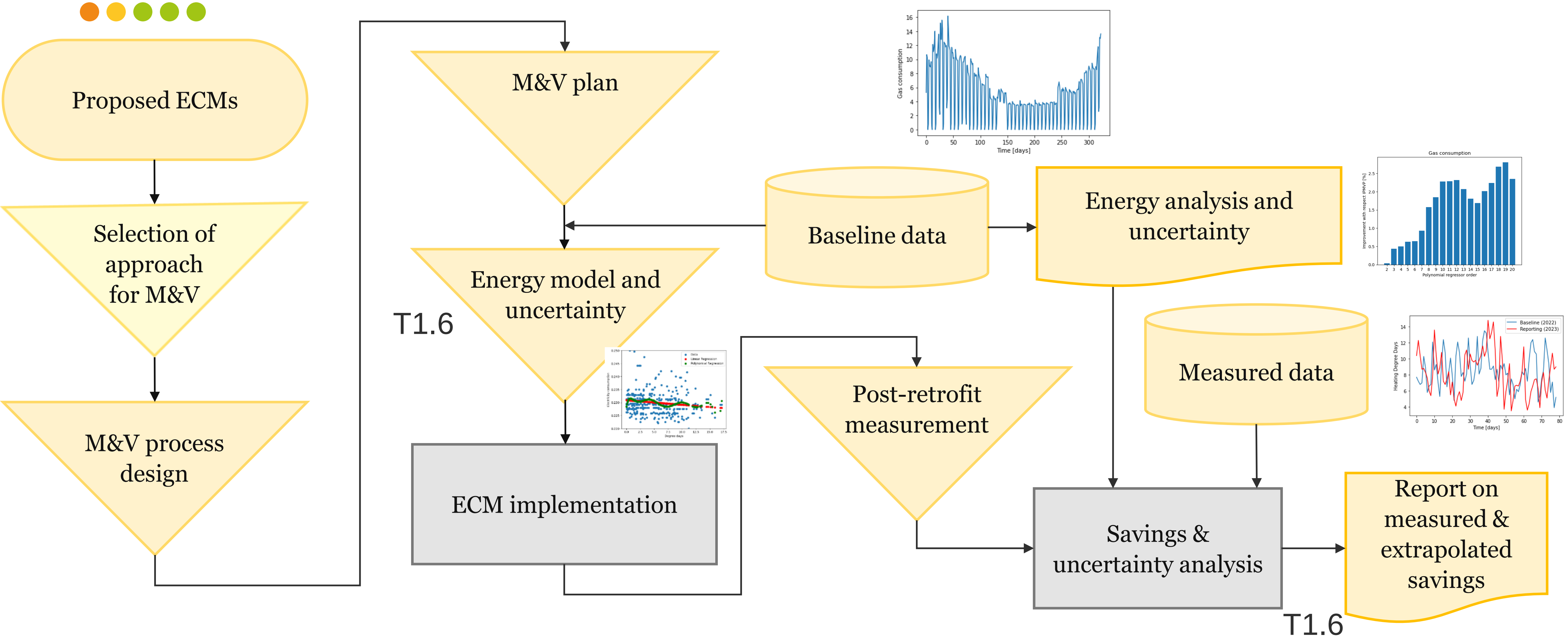
T1.6 Performance evaluation based on M&V outcomes



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T1.6 – Impact Analysis Methodology

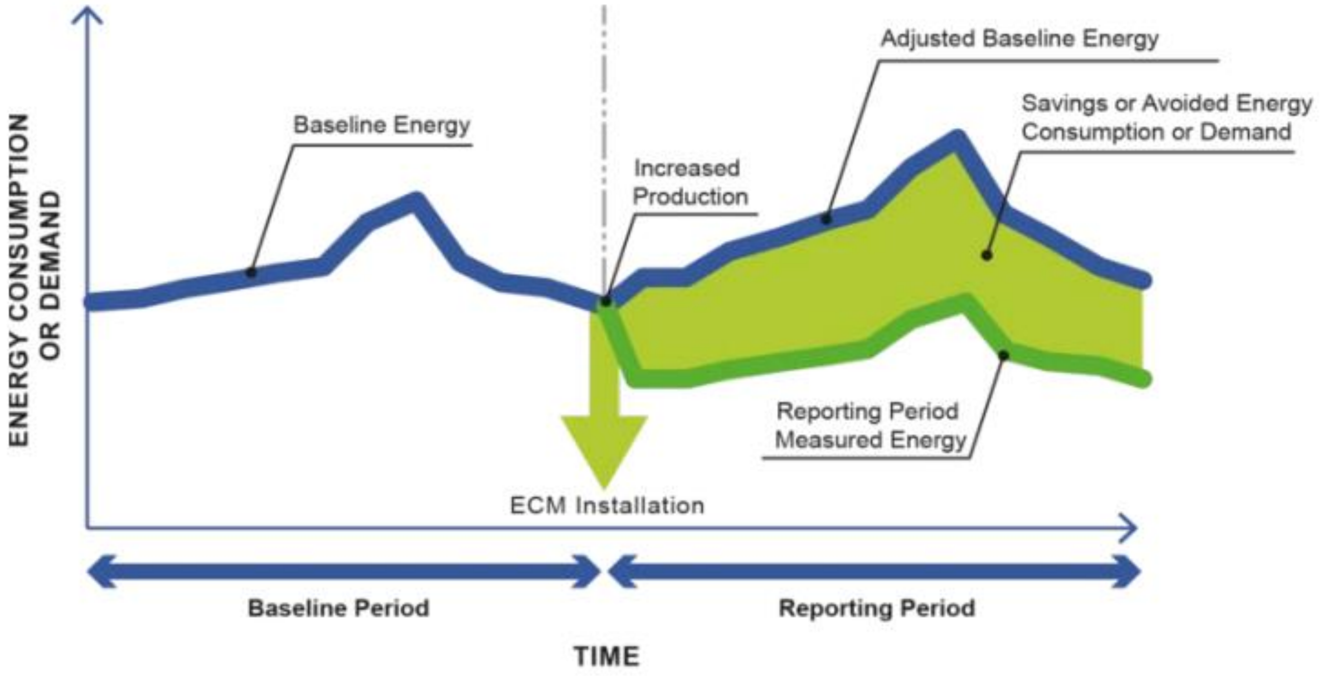

Figure from "Measurement and verification guide", EATON https://www.eaton.com/content/dam/eaton/products/low-voltage-power-distribution-controls-systems/power-energy-meters/pxeva-pxbig/pxeva-measurement-and-verification-guide-br150005en.pdf

T1.6 determines adjustments to be applied to the measured baseline to account for variations of known factors influencing the energy consumption from the baseline period to reporting period.

T1.6 reviewed existing methodologies for **routine** and **non-routine adjustments** and will provide recommendation for the **SmartSPIN M&V process**.

Routine adjustments – account for any energy-governing factors expected to change routinely during the reporting period, including weather conditions, occupancy or production volume

Non-routine adjustments – account for energy-governing factors that are not usually expected to change, such as operation of installed equipment, system design, number of weekly production shifts of a factory and others. These changes need to be monitored throughout the reporting period.

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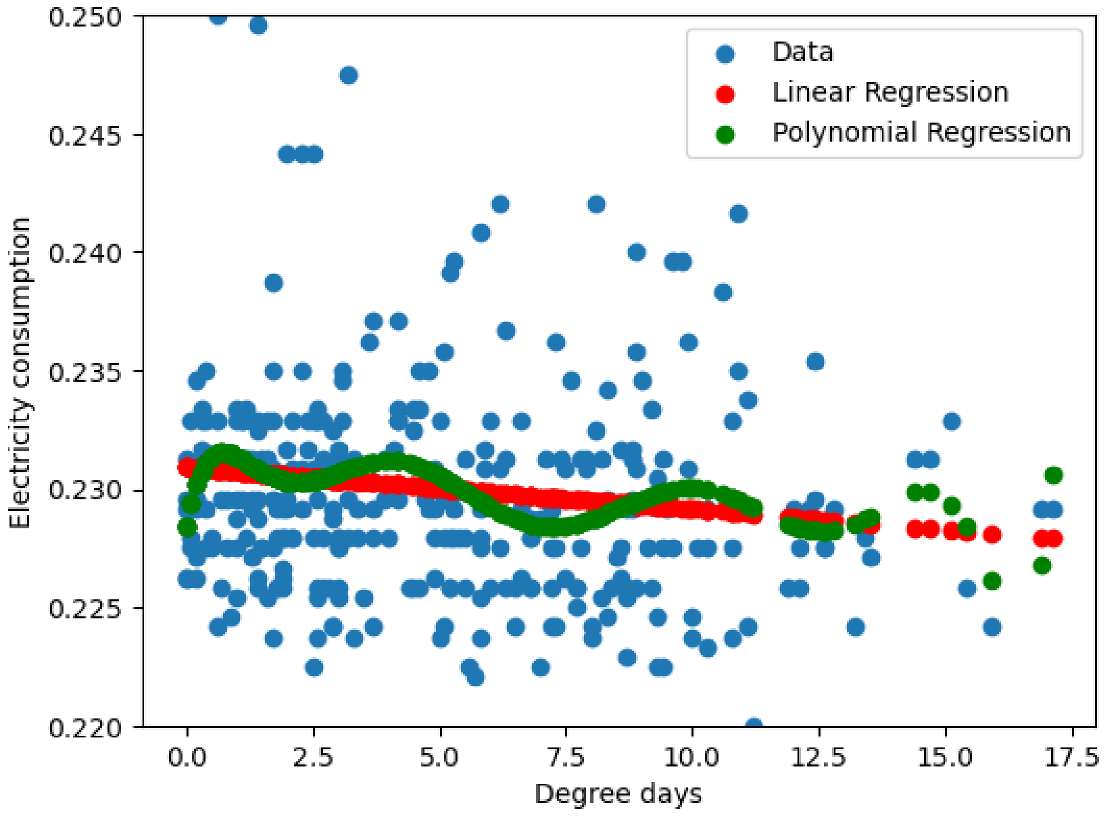
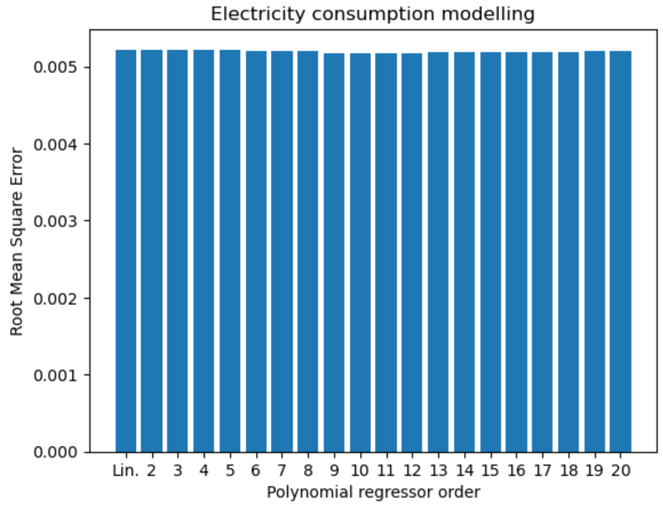
T1.6 Baseline modelling

Outliers were removed

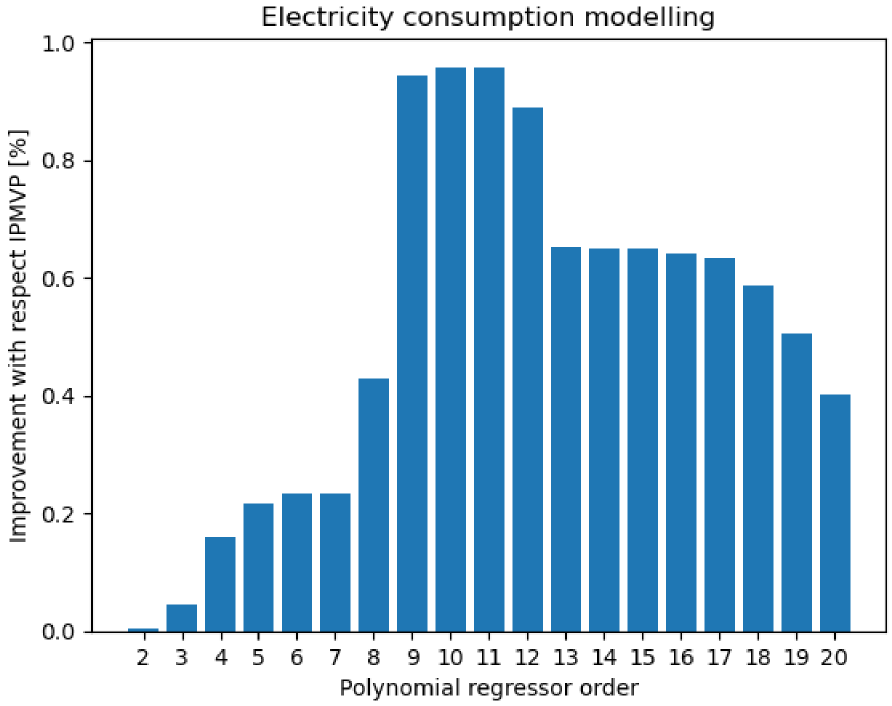


Electricity demand does not depend on heating demand

Polynomial regression: up to ~ **1%** accuracy improvement w.r.t. linear regression (IPMVP)



Regression errors of linear regression (IPMVP) and polynomials (different orders) are similar



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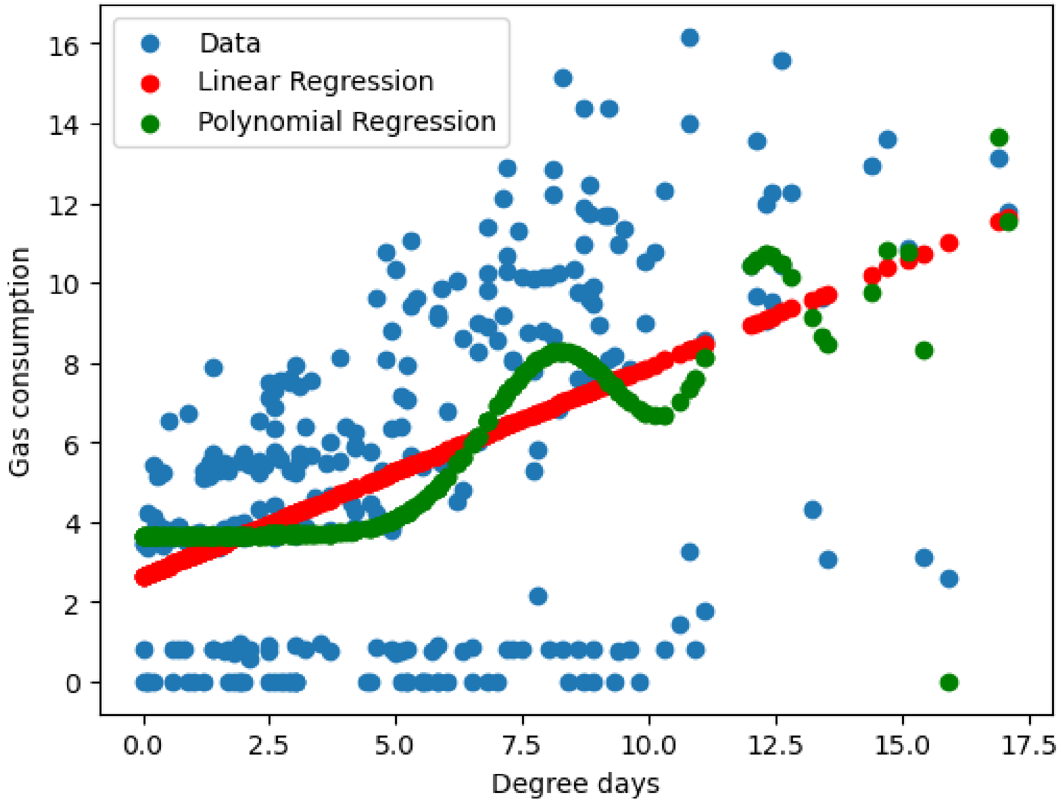
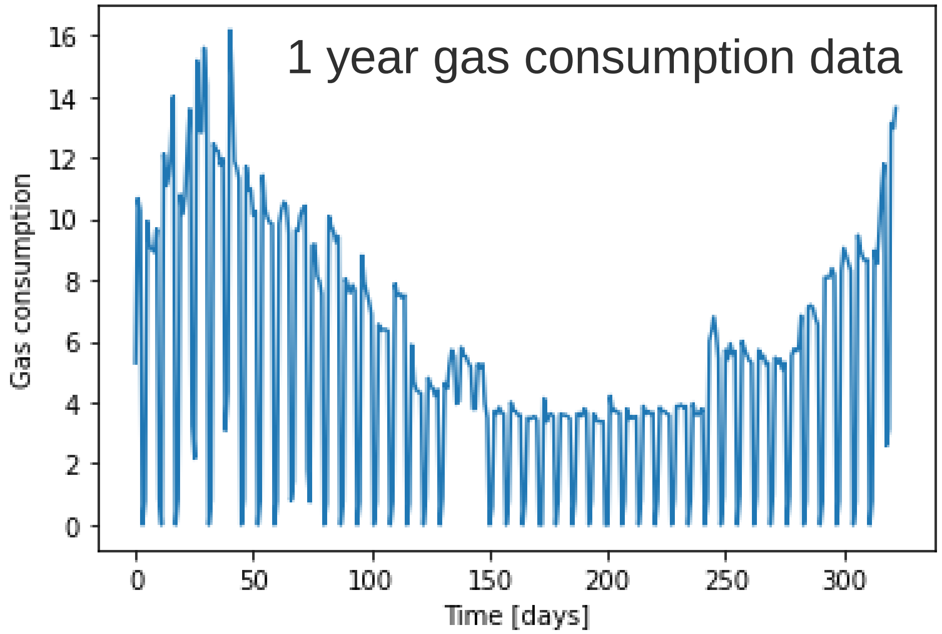
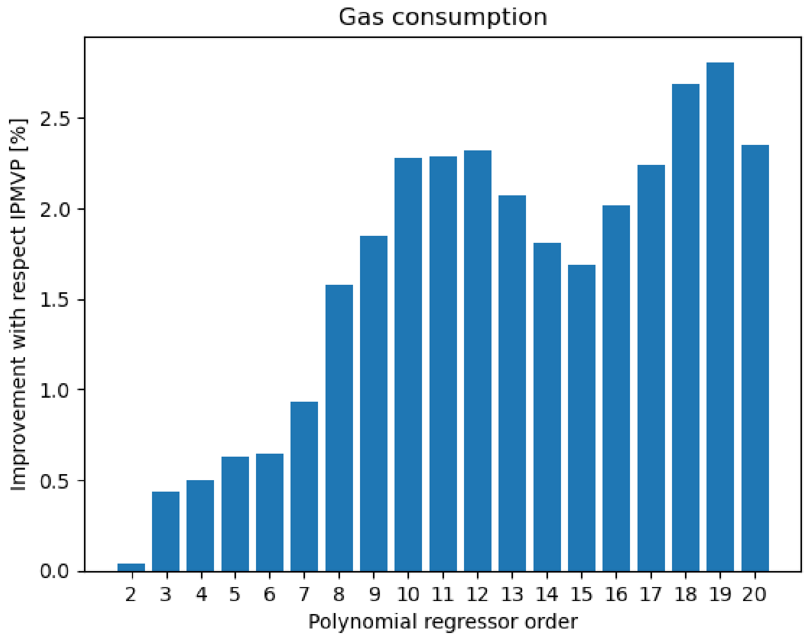
T1.6 Baseline modelling





Polynomial regression: up to **2.5%** accuracy improvement w.r.t. linear regression (IPMVP)



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T1.6 – Impact Analysis Methodology

Routine adjustment accounting for outdoor temperature variations based on degree days

θ_b base temperature for degree days calculation

$\theta_o(t)$ outdoor temperature

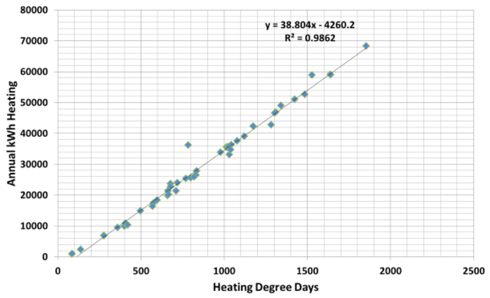
If $[\theta_b - \theta_o(t)] > 0$ $\quad DD = \dfrac{\sum_{t=1}^{24}[\theta_b - \theta_o(t)]}{24}$

Consider the baseline days for DD calculation:

$$\mathrm{d}_{bas} \in \{d_{bas,1}, \ldots d_{bas,N}\}$$

Establish the regression model
(i.e. determine *a* and *b*):

$$E_{heat,bas}(\mathrm{d}_{bas}) \approx a \cdot DD(\mathrm{d}_{bas}) + b$$



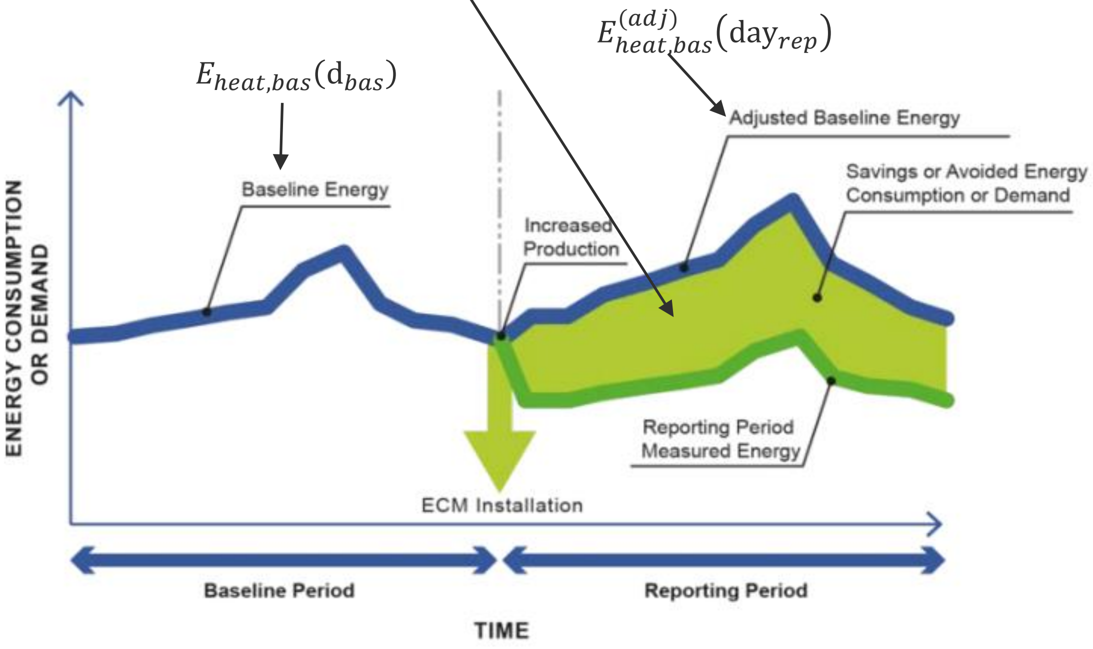
Consider the reporting period days for DD calculation:

$$d_{rep} \in \{d_{rep,1}, \ldots d_{rep,N}\}$$

Evaluate the adjusted baseline: $E_{heat,bas}^{(adj)}(\mathrm{day}_{rep}) = \Theta\left[E_{heat,bas}^{(meas)}(\mathrm{day}_{bas}), DD(\mathrm{d}_{bas}), DD(\mathrm{d}_{rep})\right]$

Estimated energy savings:

$$ES = \sum \left[E_{heat,bas}^{(adj)}(d_{rep}) - E_{meas}(d_{rep})\right]$$



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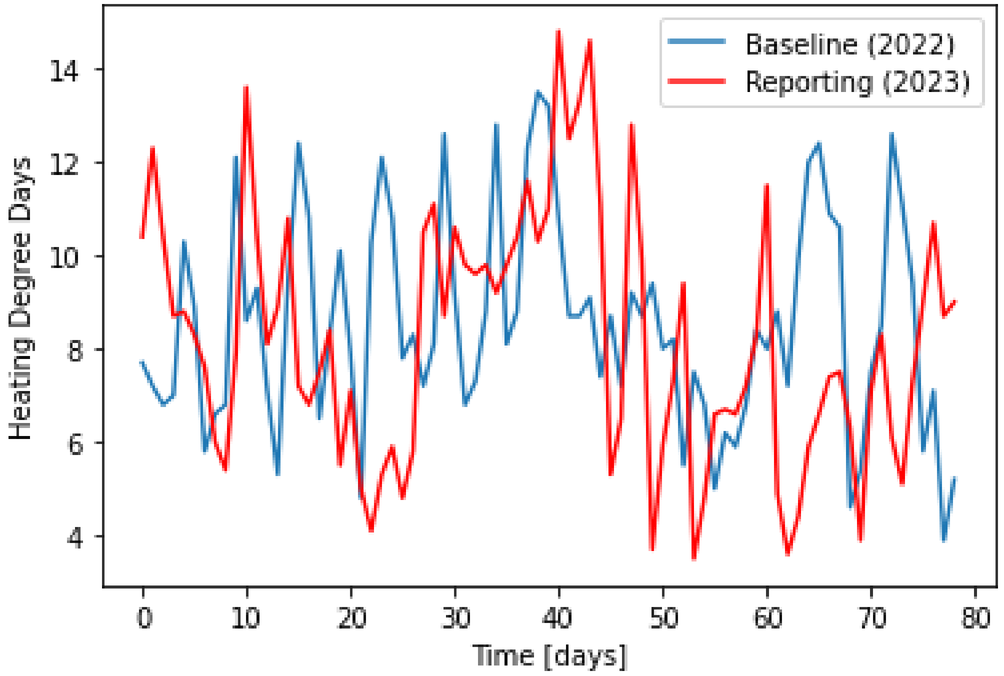
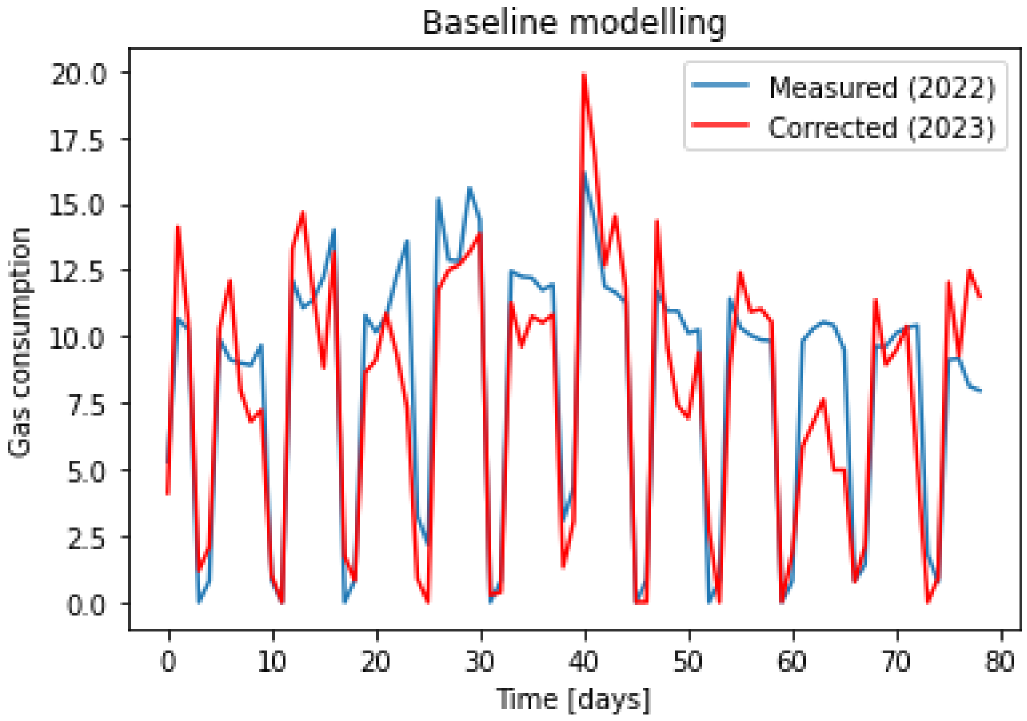
T1.6 – Impact Analysis Methodology

$$y_{bas}(t) = y_{model,bas}^{avg}(t) + noise(t)$$

$$\boldsymbol{y_{bas,corr}(t) = y_{bas}(t) - y_{model,bas}^{avg}(t) + y_{model,rep}^{avg}(t)}$$
$$= y_{model,rep}^{avg}(t) + noise(t)$$



Degree days of year 2022 are rather different on degree days of year 2023



Baseline measured in 2022 needs to be corrected using degree days of 2023 (*hypothetical reporting period*) to evaluate energy savings.

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Lessons learned and key recommendations

- The ***Energy as a Service*** (EaaS) model should cover: Energy Management, Maintenance, Total Guarantee of Equipment, Improvement works, Improvement of energy efficiency
- The SmartSPIN service should comprise: energy management, changing the electricity supplier, equipment/RES installation (e.g. solar PV installations) or replacement and O&M services
- The ***Measurement & Verification*** process should be standardized, ensuring no measurement errors and trusted by stakeholders
- ***Green leases*** should be used to allow engagement of landlords and tenants for improvement of sustainability and energy efficiency in rented commercial buildings.
- Two cases should be considered for service definition: 1. the landlord owns space and equipment and 2. the landlord owns only the space.
- The engagement of both landlord and tenants with an ESCO should be achieved by means of a ***tripartite Energy Performance Contract*** which can deliver *performance guarantee* in the rented scenario (while circumventing the split incentive issue)
- Sub-metering is required for a fair billing of tenants' energy consumption
- The energy tariff for the electricity, gas consumption and water applied to the tenants should be independent of the season, fair and easy to understand.

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Backup

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Scope of Project - 1

Objective 1: To demonstrate the feasibility, effectiveness and advantages of the SmartSPIN innovative business model that combines both energy and non-energy benefits in a smart energy services offering for the commercial rented sector. (WP5, M1-M36)

The energy and non-energy benefits (such as cost savings on maintenance and repair, increased building value in new rental contracts) for different building typologies in different markets around Europe will be determined.

- Testing and validating the SmartSPIN business model in 3 pilot regions (Spain, Greece, Ireland).
- Market testing the contractual templates that the project creates by deploying them in pilot regions and seeking feedback from Advisory Board and key market stakeholders.

Key indicators of success:

- 3 buildings using the data driven algorithms developed by the project.
- 3 contracts signed between ESCO and clients in the commercial rented sector for SES.
- **4.72** GWh/year of primary energy savings resulting in **812** tonnes CO2eq/year saved.
- By the end of the project SmartSPIN triggers further investment in EEMs that require higher capital outlay amounting to sustainable energy investments of €**7.38** M.

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Scope of Project - 2

Objective 2: To address the barriers that prevent the commercial rented sector from engaging in energy services, energy efficiency projects and performance based contracting. (WP2, M1-M12)

This objective will address the understanding of the barriers that are preventing uptake of EEMs and performance based contracting in the commercial rented sector and the design a business model enabling the successful deployment of SES. This objective will be addressed by:

- Undertaking an online survey with key stakeholders including ESCOs, landlords and tenants to gather knowledge on the status of the market and indications of market trends (Task 7.1).
- Conducting focussed interviews with key members of the advisory board to gather detailed information on the barriers and opportunities for lowering them from their different perspectives.
- Reviewing regulations and policies supporting the deployment of SES at European and pilot country level.
- Reviewing any legal or contractual elements that prevent implementation of EEMs and SES.

Key indicators of success:

- Minimum of 60 responses to online surveys from 20 ESCOs, 20 landlords and 20 tenants.
- 10 focussed interviews with members of the Advisory Board and other key stakeholders.
- 2 x best practice guides for key stakeholders: one for ESCOs and a second for landlords and tenants.
- 1 x series of guidelines for policy makers to support roll out of SES.

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Scope of Project - 3

Objective 3: To demonstrate how big data generated from smart equipment can be used to better control energy consumption in buildings and more accurately measure and verify energy savings and flexible energy consumption. (WP4, M1-M36)

Critical to the success of SmartSPIN is the continuous evaluation of the impact of the efficiency interventions, making the relevant data accessible to all parties, and improving the energy efficiency providers' capability to design competitive agreements. A robust M&V approach using data-based algorithms will build trust between the parties and reduce the opportunity for disputes which is particularly relevant for overcoming the split incentive problem. To achieve this SmartSPIN will:

- Propose and demonstrate an automated M&V approach that is tailored to the SmartSPIN model.
- Develop and demonstrate platform-agnostic predictive models and algorithms to quickly diagnose opportunities for improvements of building performance and turn them into a service available to all stakeholders. Use the models to optimize short and medium term energy efficiency and flexibility.
- Deploy these data-driven models in real buildings and verify their effectiveness.

- Key indicators of success:
- 3 buildings using the data driven algorithms developed by the project.
- A series of short and long term (platform-agnostic) prediction algorithms for building operation and control.
- A SmartSPIN Application Programming Interface (API) and web dashboard to allow wider use of the algorithms developed by external stakeholders with other platforms.

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Scope of Project - 4

Objective 4: To develop an innovative business model and new contractual templates that allow the proposed SES to be deployed in the commercial rented sector. (WP3, M1-M18)

The deployment of SES in the commercial rented sector will depend on the availability of tested and trusted contractual models for fairly allocating the energy and non-energy benefits (such as reduced emissions, comfort and productivity improvements, reduced risk of service disruptions) that result from the installation of EEMs. SmartSPIN will address this by:

- Developing a new contractual template governing the relationship between ESCO, landlord and tenant in performance based contracts for energy efficiency and flexibility (T3.5).
- Developing and testing new flexible dynamic electricity tariff structures to provide incentives for customers to embrace implicit demand response (demand side flexibility based on customer response to price signals).
- Deploying the contracts in 3 demonstration regions (Spain, Greece and Ireland).
- Seeking feedback from Advisory Board Members and making appropriate modifications to the contractual templates.

Key indicators of success:

- 3 SES contracts signed by the end of the SmartSPIN project.
- 1 flexible dynamic electricity tariff tested by the end of the project.
- 10 follow up interviews with Advisory Board Members and other key stakeholders.

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Scope of Project - 5

Objective 5: To engage and train key market stakeholders (ESCOs, landlords, tenants, industry bodies, M&V practitioners, smart technology manufacturers) in the deployment of the SmartSPIN business model. (WP6 & WP7, M1-M36)

Unless key stakeholders in the SES value chain are aware of the business model and have the tools to deploy it, SmartSPIN will not gain traction in the commercial rented sector. To ensure the business model is exploited as far as possible within the contract duration and 5 years beyond, SmartSPIN will:

- Develop best practice guides for SES deployment for key stakeholders including ESCOs, landlords and tenants and policy makers.
- Develop a business model toolkit describing the key features of the business model and value proposition.
- Present the key project findings project in accessible formats (infographics, web tools, webinars, workshops).

Key indicators of success:

- Creation of a knowledge hub on the SmartSPIN website.
- 1 best practice guide for ESCOs: 1 best practice guide for landlords/tenants.
- 1 business model developed and 1 value proposition developed.
- 6 exploitation workshops (2 in each of the pilot countries Spain, Greece, Ireland) and 4 webinars.
- 1 final workshop in Brussels for stakeholders including policy makers.
- 350 actors in the SES value chain trained in the use of the SmartSPIN business model.

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Luciano De Tommasi, IERC

Ruchi Agrawal, IERC

Thank you

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