Horizon 2020 – enerSHIFT project

List of buildings performance-monitoring indicators

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IRE Liguria

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Infrastrutture Recupero Energia Agenzia Regionale Ligure I.R.E. S.p.A.
Sede Legale Via Peschiera 16, 16122 Genova
info@ireliguria.it irespa@legalmail.it www. ireliguria.it
Capitale Sociale € 372.972,00 Codice fiscale e Partita IVA 02264880994
Registro Imprese Genova R.E.A. n. 473022
Soggetta alla direzione ed al coordinamento di FI.L.S.E. S.p.A.

DIVISIONE ENERGIA
Via XX Settembre 41, 16121 Genova
tel +39 0105488730 fax +39 0105700490
energia@ireliguria.it

This report outlines a set of key performance indicators (KPIs) to be used by the SHOs for monitoring the performance of buildings over time as well as for evaluating the impact of investments.The indicators will be calculated according the data collected in task 2.3 “Consolidated aggregated baseline” (state of art – ante interventions) and then used in the coming years as valuable tool to monitor building performance (post interventions).

The three following aspects have been taken into account in the KPIs definition:

1. energy consumption and efficiency
2. value of the investment
3. maintenance costs

1. Energy consumption and efficiency

IRE has identified two indicators to compare energy consumption before and after energy efficiency interventions at the whole building level. In order to do so, the following main parameters have been taken into account:

- **Ante retrofit period**: parameters and items related to the state before any energy efficiency intervention;
- **Post retrofit period**: parameters and items after energy efficiency interventions
- **Routine adjustments**: for changes in parameters that might reasonably occur throughout the post-retrofit period and for which a relationship with energy use/demand can be identified. These changes are often seasonal or cyclical, e.g. **weather (through the Degree Days DD) or occupancy variations (through the building occupiers number).**

Indicator 1. In case of not centrally operated Domestic Hot Water (DHW) – with heating centrally operated

Energy efficiency indicator (EEI) = [kWh/ year]

$$= \text{Heating Energy consumption}_{\text{ante retrofit period}} / \text{DD}_{\text{ante retrofit period}} \times \text{DD}_{\text{post retrofit period}}$$

Indicator 2. In case of centrally operated DHW (together with central heating)

Energy efficiency indicator (EEI) = [kWh/ year]

$$= \text{Heating Energy consumption}_{\text{ante retrofit period}} / \text{DD}_{\text{ante retrofit period}} \times \text{DD}_{\text{post retrofit period}} + \text{DHW Energy consumption}_{\text{ante retrofit period}} / \text{Occupiers n°}_{\text{ante retrofit period}} \times \text{Occupiers n°}_{\text{post retrofit period}}$$

The methodology adopted by IRE also finds validation in “Option C- Whole facility” (comparable in our case to the “building level”) of the International Performance Monitoring & Verification Protocol (IPMVP) approach, whose specific aim **is to measure and verify the effective energy saving** related to energy efficiency, water efficiency and renewable energy projects.

2. Value of Investment

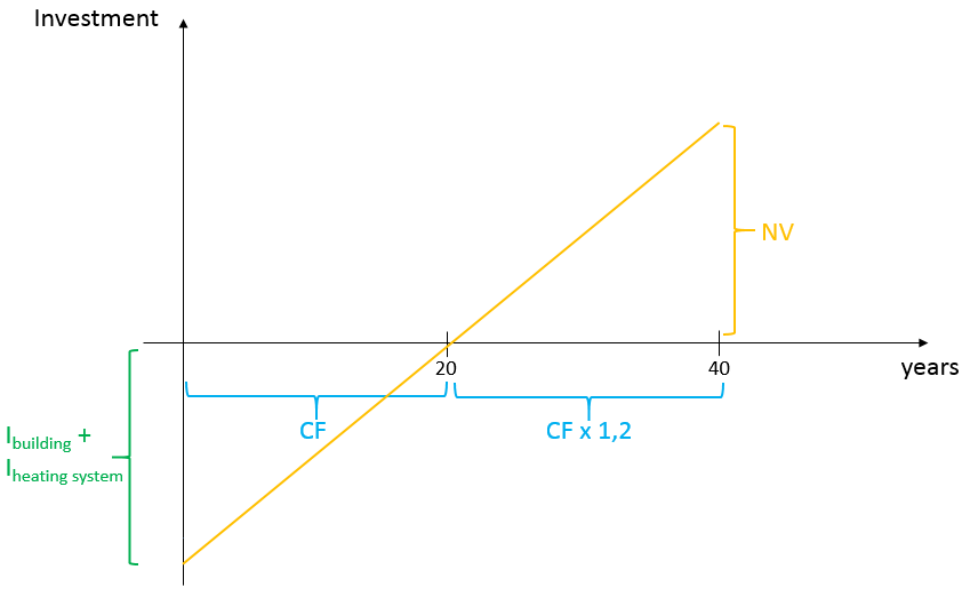
To evaluate the global investment in economic terms, the indicator that has been identified is the Net Value (NV) parameter. The NV allows to assess the economic and energy benefit of interventions.

NV has been defined in order to take into account the different life expectancy of the various components involved in an energy efficiency intervention at building level, e.g. the heating system replacement (life expectancy of about 20 years) and interventions on building envelope (wall insulation: life expectancy of about 40 years).

Net Value (NV) = [€]

= Cash Flow X 20_{years} + Cash Flow X 20_{years} X 1,2* - (Investment $_{Building}$ + 2X Investment $_{Heating\ system}$)

* the factor 1,2 represents the increase in the heating system performance due to the new replacement after 20 years.



Net value scheme – best conditions

As shown in the table above, the NV allows to evaluate the profit of the investment:

- at ante intervention stage, NV has to be calculated using project level data: if the NV results equal to zero it means that the CF doesn’t generate any earnings against the initial

investment; in the best conditions the NV would be equal to the initial investment, however to be considered acceptable it has to be at least a positive value;

- after interventions, NV will be re-calculated using real investment costs and the real cash flows.

The comparison between the two NVs (before and after interventions) will make it possible to assess whether the expected economic advantage is still consistent in real conditions.

3. Maintenance costs

In order to compare the ordinary maintenance costs in the pre-retrofit period with the costs related to the post-retrofit period, the following indicator has been identified, calculating the ordinary maintenance cost (€) in relation to the heating plant size (kW).

Maintenance cost indicator (MCI) = [€/kWh]

= Ordinary maintenance costs $_{\text{ante retrofit period}}$ / boiler size $_{\text{ante retrofit period}}$

In general, the maintenance cost is strictly connected to the boiler size but is also influenced by the state of the heating plant in particular in terms of age, state of conservation and site accessibility. After the interventions, the values are likely to decrease especially in those cases where the conditions of age and state of conservation were worst.

Conclusions

The following table summarizes the KPIs identified at this stage for the different aspects as described above:

LIST OF BUILDINGS PERFORMANCE-MONITORING INDICATORS			
Component			**Description**
Energy efficiency	EEI – Energy efficiency indicator (in case of not centrally operated DHW)	[kWh/ year]	**= Heating Energy consumption $_{\text{ante retrofit period}}$ / DD $_{\text{ante retrofit period}}$ X DD $_{\text{post retrofit period}}$**
	EEI – Energy efficiency indicator (in case of centrally operated DHW)	[kWh/ year]	**= Heating Energy consumption $_{\text{ante retrofit period}}$ / DD $_{\text{ante retrofit period}}$ X DD $_{\text{post retrofit period}}$ + DHW Energy consumption $_{\text{ante retrofit period}}$ / Occupiers n° $_{\text{ante retrofit period}}$ X Occupiers n° $_{\text{post retrofit period}}$**
Investment impact	NT – Net Value	[€]	**= Cash Flow X 20_{years} + Cash Flow X 20_{years} X 1,2 – ($\text{Investment}_{\text{Building}}$ + 2X $\text{Investment}_{\text{Heating system}}$)**

Maintenance costs	MCI- Maintenance cost	[€/kW]	**= Ordinary maintenance costs** $_{\text{ante retrofit period}}$ **/ boiler size** $_{\text{ante retrofit period}}$

If needed, further considerations on these issues could be developed in the future before the tender.