WP 3.3.7

MONITORING SYSTEM AND FINANCIAL EVALUATION FRAMEWORK

1 Preface

The activity 3.3.7 "*Monitoring system and financial evaluation framework to assess and evaluate energy efficiency programs related to public heating*" is a preparatory phase for work plan 4.5 "*Ex-post analysis: joint monitoring and evaluation of pilots*" (historic buildings in Quedlinburg and Bologna).

The proposed general approach is suitable for all kind of energy efficiency programs related to public heating and will be used in the Strategic Toolkit.
The tool can be used by the Public Authorities (PA) to establish a priority about energy efficiency measures and to make better use of economic resources.
The document contains information that can be used to evaluate the Local Action Plans.

2 Monitoring system in historic buildings

Defining a uniform monitoring system to assess and evaluate energy efficiency actions in public buildings, especially historic ones, is a very ambitious task. In fact no methodology is available in the literature.
Historical buildings from different eras and with various building standards can be badly compared. In addition the buildings can be partly reconstructed, being unequally used, or having a different use respect to the original one. It is very difficult and extensive to detect the existing energetic status as well as to evaluate other aspects like environmental impact, cost effectiveness, etc.
In the next paragraphs two main monitoring systems are described:

- Italian Energy Signature;
- GovernEE monitoring system.

3 Italian Energy Signature

Italian Energy Signature (in Italian “Firma Energetica”[1]) could be implemented as energy consumption monitoring and design tool. Developed by the Engineers Catello Soccavo and Stefano Saroglia, it is an innovative extrapolation method for the rapid calibration of heating and cooling energy consumption in new and existing buildings, included the

[1] URL: http://www.firmaenergetica.it

historical ones. Heating and cooling energy use is correlated to climatic data over a suitable period.

From 1999 to 2001 the Logistics Section of the State of the Canton Ticino (Switzerland) has carried out a campaign of measurements on some central heating systems of buildings of its housing stock. In this way it was possible to determine with great precision the power (expressed in kW) of new power stations. With this method it was possible to reduce considerably the power of heating, with a significant benefit in terms of efficiency and performance, with benefits of the state coffers and the environment.

The innovation started in order to understand whether and how the great experience on the housing stock of the Canton Ticino could be successfully transposed in the Italian construction context and improved in advantage of greater transparency and understanding by citizens (and not only by technicians of the heating sector).

The improvement of buildings efficiency is experiencing a period of intense activity: replacement of windows, insulation of attic locals vs roof, installation of more efficient heat generator, development of control system, etc.

But how to choose between different solutions, results and costs? How to verify the accuracy of the thermal calculations of designers (operation not always easy because of the extreme variety and complexity of regulatory and legislative references involved)?

The Italian Energy Signature is based on fuel consumption, while in Switzerland the method refers to the power generators and thermal energy expressed in kWh/month.

In this way the Italian Energy Signature is immediately comprehensible to the citizen, not only for technicians, because the graphical representation of consumption (eg. m^3 gas/day) is a function of an external parameter (external temperature). The application of the method has also highlighted that the current UNI lead to excessive overestimation of the power demand of buildings.

Going to the figure 1, the points correlate natural gas consumption with the external temperature of the site of the building: the line represents the evolution of consumption for heating and domestic hot water, with reference to external temperatures (daily average data) and is the result of the linear interpolation of the data collected from the monitoring.

The method was successfully used both in the planning stage (from the results calculated according to UNITS 11300) and in the monitoring of the building-plant system.

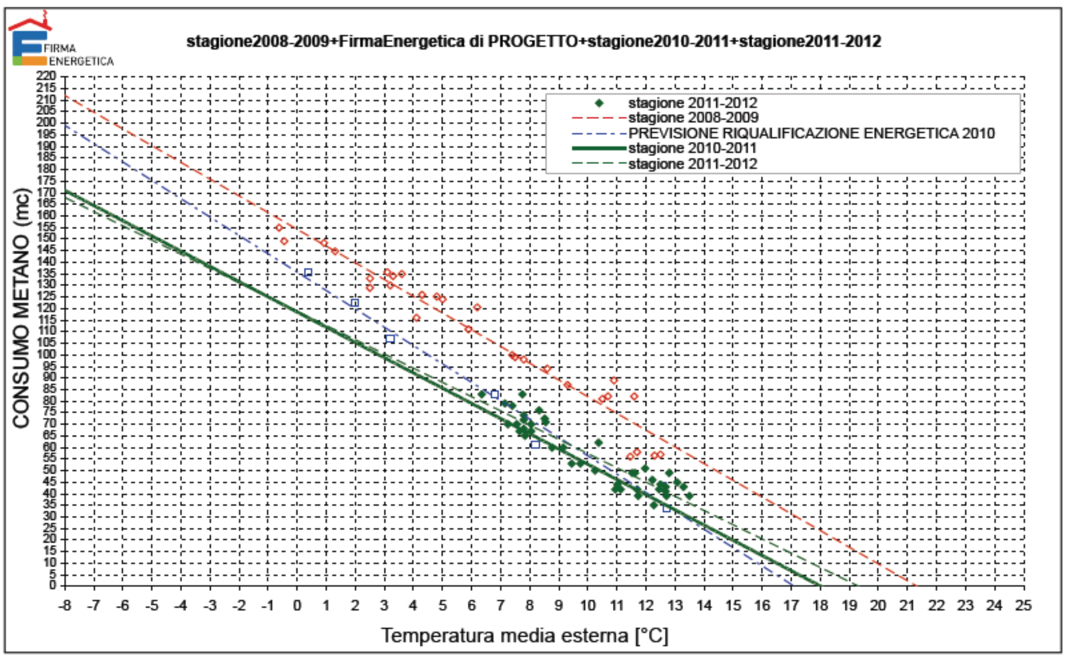

Fig. 1 – An example with "Italian Energy Signature" method by "Firma Energetica" group.

In addition, the Italian Energy Signature can be effectively used in the rapid control of energy performance certificates (the Italian Attestato di Conformità Energetica – ACE), thus:

- designers to see recognized the added value of their work;

- the end users could have a range of information essential to understand the real behaviour of the building – plant system and to take appropriate corrections in case of anomalies.

The tool is user friendly: the designer works to protect the citizen. Public offices can perform simple controls, fast and effective, on thermal projects, and they could be able to monitor (cheaply) the behaviour of their buildings stock to undertake energy saving strategies more profitable in terms of time, efficiency and return on investment.

The aim is to transfer the excellent results obtained with the method for residential buildings on the existing public/historical ones.

CETA proposes to test the Italian Energy Signature tool on two case studies (Quedlinburg and Bologna).

4 GovernEE monitoring system

In the GovernEE framework we are trying to introduce a kind of monitoring system.

The methodology is based on carrying out energy audit of building and comparing the reduction of heat consumption (kWh/m² year and kWh/m^3 year) or GHG following energy efficiency measures. Then the result is compared with several indicators, for example with the cost of the action.

This tack has some limitations relating to:

- preservation of cultural and historic identity;
- conservation of historical elements;
- respect of legal obligations;
- use of traditional materials and technique.

In existing and/or historical buildings there is much less flexibility in the design and layout of energy efficiency measures. For this reason it may be difficult to compare the goodness of energy efficiency measures in different buildings.

Also the energy analysis performed on existing buildings, particularly on historical ones, is often based on inaccurate data (lack of information on building components and systems). For this reason the analysis is often not realistic.

We took into account different criteria and indicators to define energy and environmental performance of buildings aiming at monitoring energy efficiency trends and policy measures in public heating. The parameters included within the system cover sustainable building issues: environment, social and economic sectors.

The monitoring system is then supported by an excel file (see the attached example): each criteria is described through indicators and for each indicator value score and weight are assigned.

In order to assign a value to the indicators, Likert scale has been introduced:

SCORE	DESCRIPTION
-2	**Much worse**: relevant negative deviation from the status quo
-1	**Worse**: negative deviation from the status quo
0	**Benchmark**: respect to the status quo
+1	**Better**: compliance with the PA (public authority) aims
+2	**Much better**: better than the PA aims

In particular, the score:

- "**-2**" means that the performance is significantly below the standard and current practice;
- "**-1**" means that the performance is below the standard and current practice;
- "**0**" represents the standard of comparison (benchmark) which could be for example the current construction practice in accordance with laws (European, national, local) or regulations in force and therefore represents the minimum acceptable performance

defined by laws or regulations (for example, the Covenant of Mayors), or if there are no reference regulation is the current accepted practice;

- "**+1**" represents an improved performance compared with existing regulations and practice;
- "**+2**" represents a considerably advanced performance compared to the current best practice.

For each criteria and each indicator (sub-criteria) a weight is assigned expressed as a percentage and chosen by the PA.

The final value is the weighted average of the considered indicators.

The following list describes some indicators and for some of them a rating scale is proposed as example:

- **Environmental context (cityscape)**
  - ✓ Integration into the surrounding cityscape
  - ✓ Potential environmental impact of development
  - ✓ Saving protected section of the historic building
  - ✓ Cultural heritage compliance
- **Energy efficiency**
  - ✓ Primary Energy Savings (PES) for heating
  - ✓ Energy Balance (EnB)
  - ✓ Tonnes of Oil Equivalent (TOE)
  - ✓ Renewable Energy Sources (RES)
- **Environmental loading**
  - ✓ Greenhouse Gas emission (GHG)
  - ✓ CO_2 avoided emissions
  - ✓ SOx/NOx avoided emissions

- **Technical aspects**
  - ✓ Adoption of Best Available Technologies (BAT)
  - ✓ Space requirements/availability
  - ✓ Employment of not high qualified worker/technician
  - ✓ Systematic maintenance
- **Economic aspect**
  - ✓ Net Present Value (NPV)
  - ✓ Internal Rate of Return (IRR)
  - ✓ Payback Period (PP)
  - ✓ Cost-Benefit Analysis (CBA)
  - ✓ Management costs

The list is not exhaustive and the identified criteria and indicators could be implemented or deleted (assigning a 0% weight) by the PA for the definition of the Strategic Toolkit or for other uses.

4.1 Environmental context (cityscape)

The production, distribution and use of energy create environmental impacts: gaseous emissions from the burning of fossil fuels pollute the atmosphere; large hydropower dams cause silting; both the coal and nuclear fuel cycles emit some radiation and generate waste; wind turbines can spoil pristine countryside; gathering firewood can lead to deforestation and desertification. For the comparison of different projects, the one with the lower environmental impact should be chosen.

4.1.1 Integration into the surrounding cityscape

Human projects and energy activities have economic, social and environmental impacts and may result in cityscape degradation. Urban area is in itself an important resource to protect.

For the comparison of different projects, the one with the higher integration performance in the surrounding cityscape should be chosen.

This indicator is qualitative and its value will be fixed from time to time by the PA in accordance with the planning rules.

4.1.2 Potential environmental impact of development

All projects require resources to be made. However, it is also true that the depletion of resources does not necessarily imply unsustainable development. If an energy source is not renewable, any use of it is irreversible. But this does not mean it should never be used.

For the comparison of different projects, the one with the lower environmental impact should be chosen.

This indicator is qualitative and its value will be fixed from time to time by the PA in accordance with the planning rules.

4.1.3 Saving protected section of the historic building

The impact of the projects on historic buildings and their contexts is important to assess. The project have to comply with the instructions of the Cultural Heritage Protection Office in order to preserve the historical, cultural and anthropological value of the building.

Some projects which ensure a high level of energy efficiency, at the same time can also cause serious damage to the building heritage. Qualitative assessment should be done, in order to analyse case-by-case the cultural and historical value of the building and its surroundings. The choice should be made considering that the final condition of the building and its surroundings should be guaranteed by the project.

Score = (Number of architectural elements protected by the project) / (Number of total architectural elements of the building).

The benchmark is equivalent to a protection percentage of 75%.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**
Score	**-2**	**-1**	**0**	**+1**	**+2**
Saving protected section of the historic building	**≤ 0,50**	**≤ 0,60**	**= 0,75**	**≥ 1,00**	**≥ 1,20**

Please refer to the following table in order to decide how to choose.

If	**It means that**
Indicator ≤ 0,50	the intervention causes the loss of many valuable parts, reducing the peculiarity of the building and of the environment
Indicator ≤ 0,60	the intervention causes the loss of some valuable parts
Indicator = 0,75	the project preserves the fundamental part of the building/environment, as planned
Indicator ≥ 1,00	the achieved objectives of preservation are higher than the one minimum fixed
Indicator ≥ 1,20	total integration of the project, increase of the conservation status, protection together with the landscape and the surrounding environment

For the comparison of different projects, the one with the higher preservation of building heritage or with the higher respect of the instructions of the Cultural Heritage Protection Office should be chosen.

4.1.4 Cultural heritage compliance

Assessing the compliance of the project respect to the cultural value of the building is very important.

The Cultural Heritage Protection Office provides the requirements that the project have to follow for each building or urban environment, such as the use of local materials or local architectural materials, in order to preserve the distinctiveness of the historic building.

Qualitative assessment should be done, in order to compare the Cultural Heritage Protection Office requirements and the ones observed by the project.

In order to assess the indicator through the score scale, the PA gives a percentage value to the minimum requirements to follow – considering the Cultural Heritage Protection Office requirements – and compares them to the ones fulfilled by the project.

The use of local materials and techniques is important for the replacement of damaged parts with new ones, in order to assess the compliance to the original element and to ensure the maintenance of the distinctiveness of the building.

Score = (Number of the restored architectural elements or replaced elements assessed as similar to the original) / (Number of total of the restored architectural elements or replaced elements)

The benchmark is equivalent to a protection percentage of 75%.

Project improvement	Much	Worse	Benchmark	Better	Much

	worse				better
Score	**-2**	**-1**	**0**	**+1**	**+2**
Cultural heritage compliance	**≤ 0,50**	**≤ 0,60**	**= 0,75**	**≥ 1,00**	**≥ 1,20**

Please refer to the following table in order to decide how to choose.

If	It means that
Indicator ≤ 0,50	significant deterioration of the cultural heritage peculiarities occurred
Indicator ≤ 0,60	a decrease of the compliance to the cultural heritage occurred
Indicator = 0,75	the essential compliance, fixed by the project, of the building/environment is maintained
Indicator ≥ 1,00	an increase of the compliance of the project to the cultural heritage occurred
Indicator ≥ 1,20	total compliance of the project, increase of the compliance with relation to the environment and the urban context occurred

For the comparison of different projects, the one with the higher compliance to the cultural context of the project should be chosen.

4.2 Energy efficiency

4.2.1 Primary energy savings (PES) for heating

The European Union has a primary energy savings target by 20% by 2020. The indicator is a measure of energy performance of buildings and is calculated as a percentage of primary energy reduction after the energy efficiency intervention.

The following table proposes a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
Primary Energy Savings (PES)	< 10%	≥ 10%	≥ 20%	≥ 50%	≥ 80%

For the comparison of different projects, the one with the greater primary energy reduction should be chosen.

4.2.2 Tonnes of Oil Equivalent (TOE)

As heating indicator the unit consumption (Tonnes of Oil Equivalent, TOE) per surface (m^2) or volume (m^3) at standard climate is considered.

In order to compare in a meaningful way the energy efficiency performance of the projects, indicators are based on a common definitions of energy consumption. Therefore electricity is converted into Tonnes of Oil Equivalent (TOE) according to the IEA[2] methodology:

- 0.26 toe/ MWh for nuclear;
- 0.086 toe/MWh (3.6 GJ) for hydro, wind and electricity consumption;
- 0.86 toe/MW for geothermal;
- biomass is included in energy consumption figures;
- non-energy uses are excluded from final energy consumption.

The following table proposes a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
Tonnes of Oil Equivalent (TOE)	< 10%	≥ 10%	≥ 20%	≥ 50%	≥ 80%

[2] URL: http://www.iea.org/methodology.html

For the comparison of different projects, the one with the lower TOE production or greater percentage reduction should be chosen.

4.2.3 Renewable Energy Sources (RES)

The promotion of energy, and in particular of electricity from renewable sources of energy (wind energy, small hydro, photovoltaic, solar air heating, biomass heating, solar hot water heating, passive solar heating, ground-source heat pumps), is a high priority for sustainable development for several reasons, including the security and diversification of energy supply and environmental protection.

In according with the European Union targets by 2020, the 20% of gross final energy consumption should be produced by renewable sources.

The indicator is calculated as a percentage of energy produced from renewable sources compared to the energy demand.

The following table proposes a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
Renewable Energy Sources (RES)	< 10%	≥ 10%	≥ 20%	≥ 50%	≥ 80%

For the comparison of different projects, the one with the higher Renewable Energy percentage should be chosen.

4.3 Environmental loading

4.3.1 CO_2 avoided emissions

The EPBD/2002 defines that "*the energy performance of a building shall be expressed in a transparent manner and may include a CO_2 emission indicator*". A numeric indicator of carbon dioxide emissions from fuel combustion is calculated by multiplying the energy use for each fuel type by an associated CO_2 emission coefficient.

Wherever possible, CO_2 emission should be measured directly at the source of energy use. More commonly, however, measured data are incomplete or unavailable. In the absence of measured data, the emission is calculated by multiplying some known data, such as coal production or natural gas throughput, by an associated emission factor derived from a small sample from a relevant emission source or through laboratory experiments.

In according to *Building Regulation 2000* (and following changes) the CO_2 emission factors for the main fuels are given below:

- Natural gas = 0,200 kg CO_2/kWh;
- LPG = 0,225 kg CO_2/kWh;
- Biogas = 0,025 kg CO_2/kWh;
- Oil = 0,270 kg CO_2/kWh;
- Biomass = 0,000 kg CO_2/kWh.

The following is proposed a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
CO_2 avoided emissions	< 10%	≥ 10%	≥ 20%	≥ 50%	≥ 80%

For the comparison of different projects, the one with the higher environmental balance percentage, which means with the higher CO_2 saving potential should be chosen.

4.3.2 Greenhouse Gas Emission (GHG)

Developed Countries are the largest emitters of CO_2 from energy combustion. In the last two decades the EU managed to stabilise its emissions and to use energy sources with lower CO_2 emission factors (e.g. gas, renewables, nuclear). The Kyoto Protocol covers a basket of six greenhouse gases produced by human activities: carbon dioxide (CO_2), methane (GH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Greenhouse gas emissions are central to the debate on whether humankind is changing the climate for the worse. The European Union has a Greenhouse Gas Emission reduction target of 20% by 2020.

This indicator takes into account not only CO_2 emissions but also methane (GH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Projects which require large amounts of fossil fuels or consume too much energy would not be considered sustainable.

The following table proposes a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
Greenhouse Gas Emission (GHG)	< 10%	≥ 10%	≥ 20%	≥ 40%	≥ 60%

For the comparison of different projects, the one with the higher GHG saving potential should be chosen.

4.3.3 SO_2 and NO_2 pollution

By increasing energy efficiency air pollutant emissions from fossil fuels power generating stations are reduced. Carbon dioxide (CO_2), Sulfur Oxides (SO_x) and Nitrogen Oxides (NO_x) are the main key air pollutants.

Sulfur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) are two very common contaminants, especially in areas where outdoor air pollution has particularly high values[34], for this reason these two indicators are used in the analysis.

Weekly average values are expressed in parts-per-million (ppm), in according with the EPBD.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**
Score	**-2**	**-1**	**0**	**+1**	**+2**
SO_2 emissions[3]	**< 10 ppm**	**< 4 ppm**	**< 2,5 ppm**	**< 0,4 ppm**	**< 0,1 ppm**
NO_2 emissions[4]	**< 30 ppm**	**< 20 ppm**	**< 10 ppm**	**< 5 ppm**	**< 2 ppm**

Please refer to the following table in order to decide how to choose.

If	**It means that**
Indicators SO_2<10ppm NO_2<30ppm	High number of complaints. No ventilation system. High risk of harmful gases presence.
Indicators SO_2<4ppm NO_2<20ppm	Significant number of complaints. No sufficient ventilation system. significant risk of harmful gases presence.

[3] The limits have been developed from the Fifth Framework Programme of the EU funded project: "Preventive Conservation Strategies for Protection of Organic Objects in Museums, Archives and Historic Buildings".

[4] The limits have been developed from the Fifth Framework Programme of the EU funded project: "Preventive Conservation Strategies for Protection of Organic Objects in Museums, Archives and Historic Buildings".

Indicators SO_2<2,5ppm NO_2<10ppm	Acceptable complaints. Sufficient ventilation system. Low risk of harmful gases presence.
Indicators SO_2<0,4ppm NO_2<5ppm	Contained complaints. Adequate ventilation system. Sporadic presence of harmful gases.
Indicators SO_2<0,1ppm NO_2<2ppm	No complaints. Good air circulation and ventilation systems. No leaks or possible formation of harmful gases.

For the comparison of different projects, the one with the lower SO_2 and NO_2 pollution should be chosen.

4.4 Technical aspects

To asses a project we should consider if the chosen technology complies with the most modern standards, through the control of certificates or usage tests which testify the effective functionality.

It is also important to asses the project impact on the historic building in terms of space requirements and if it requires high qualified workers for its installation and maintenance.

With regard to the last, moreover, the minimum frequency of the maintenance should be considered.

4.4.1 Adoption of Best Available Technologies (BAT)

The use of BAT-Best Available Technologies is an important aspect that must be taken into account to assess a project. However, it is important to consider not only the costs, but also the actual effectiveness of suggested technologies.

The energy efficiency certificates, and their certification body (for energy efficiency indicators see paragraph 4.2), and test certificates should be considered to assess the efficiency of the suggested technologies. The latest new technology might be valuable, but might have no best practice to check. In this case, for example, the PA might assess two possibilities: a) the PA should discard it because of a lack of reliable data or b) should become itself the test sample(if this involves to a cost cut).

This indicator is qualitative and its value will be fixed from time to time by technician of the PA.

The PA should assign percentage scores to chosen characteristics in order to evaluate the BAT (year of production, number of energy certificates, the number of best practice, test certificates, prizes, environmental conservation) and compare this with the minimum required by the PA, which will be the 100%.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**
Score	**-2**	**-1**	**0**	**+1**	**+2**
Adoption of BAT	**≤ 0,60**	**≤ 0,80**	**= 1,00**	**≥ 1,10**	**≥ 1,30**

Please refer to the following table in order to decide how to choose.

If	**It means that**
Indicator ≤ 0,60	Out-of-data, unknown, not certified technology
Indicator ≤ 0,80	Valuable, but out-of-data technology. There are better technology on the market
Indicator = 1,00	Technology in line with the requests of the PA
Indicator ≥ 1,10	More efficient that the ones required by PA
Indicator ≥ 1,30	The best certified technology on the market

For the comparison of different projects, the one with the best available technology should be chosen.

4.4.2 Space requirements/availability

The space requirements of the project should be compared with the available one in the building: for example, nothing could be installed on the walls of a building with frescoes, in order to not damage them.

In order to assess this indicator, the percentage ratio between the space requirements for the new project and the available space (or space of the whole building) should be considered. Otherwise, the percentage ratio between the space requirements for the new project and the space requirements of the old one that will be replaced (for example, pipes and systems) should be considered.

For the comparison of different projects, the one with the less space requirements should be chosen.

This indicator is qualitative and its value will be fixed from time to time by the PA in accordance with the planning rules and regulations.

4.4.3 Employment of not high qualified worker/technician

A project which requires for its implementation a high number of high qualified workers will be more expensive. At the same time, if a technician is required for the daily working of a heating system, then the PA have to bear the high cost and to solve organisation problems.

In order to assess this indicator, a percentage ratio should be chosen and then compared with the other indicators. Indeed, if a heating system installation needs many high qualified worker, but the system will run only with the supervision of the building users, then the PA should assess it positively, even though the initial cost is high.

Percentage score = (Number of high qualified workers or technicians) / (Number of not qualified workers)

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	**-2**	**-1**	**0**	**+1**	**+2**
Employment of not high qualified worker/technician	**≥ 30%**	**≥ 15%**	**< 15%**	**≤ 10%**	**= 0%**

For the comparison of different projects, the one with the less number of high qualified worker or technician should be chosen.

4.4.4 Systematic maintenance

A project that requires frequent maintenance implies higher cost for the PA, as well as entails uncomfortableness to the users of the building. Furthermore, the energy efficiency aims would be no achievable because of malfunction.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	**-2**	**-1**	**0**	**+1**	**+2**
Systematic maintenance	**≥ 3 per year**	**= 2 per year**	**= 1 per year**	**= 1 every 2 years**	**= 0** maintenance after several years

For the comparison of different projects, the one with the less required maintenance should be chosen

4.5 Economic aspect

The economic issue takes in consideration the investment costs, amortization, ordinary and extraordinary costs, fuel price, any income, etc. Some main economic indicators have been described.

Three indicators are suggested and supplied with tables and annexes for the calculation: the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Payback Period (PP). The PA could take in consideration other indicators, for example: Modified Internal Rate of Return (MIRR), Cost-Benefit Analysis (CBA) or Management costs.

In order to calculate the NPV, IRR and the PP please refer to the file WP3.3.7_Annex4.5.xls.

4.5.1 Net Present Value (NPV)

In finance the Net Present Value (NPV) of a time series of cash flow is a valuation methodology defined as the sum of the Present Values (PVs) of the individual cash flows of the same entity.

NPV is a standard method for using the time value of money to appraise long-term projects and it is an indicator of how much value a project adds.

The following table proposes a rating scale of the indicator[5].

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	n.a.	-1	0	+1	n.a.
Net Present Value	n.a.	< 0	= 0	> 0	n.a.

[5] Because of the NPV discriminates respect to 0, there are only 3 feedbacks available: equal to zero, greater than zero, and lower than zero. Therefore we decided to consider a reduced scale considering only 3 rates: -1, 0, +1.

For the comparison of different projects, the one with the higher NPV should be chosen. Please refer to the following table in order to decide how to choose.

If	It means that	Then
NPV > 0	the investment would add value to the PA	the project may be accepted
NPV < 0	the investment would subtract value from the PA	the project should be rejected
NPV = 0	the investment would neither gain nor lose value for the PA	we should be indifferent in the decision whether to accept or reject the project. This project adds no monetary value. Decision should be based on other criteria, e.g. strategic positioning or other factors not explicitly included in the calculation.

4.5.2 Internal Rate of Return (IRR)

Internal Rate of Return (IRR) calculates the rate of return of a project while disregarding the absolute amount of money to be gained. It measures and compares the profitability of investments. In more specific terms, the IRR of an investment is the discount rate at which the NPV of costs (negative cash flows) of the investment equals the NPV of the benefits (positive cash flows) of the investment.

The following table proposes a rating scale of the indicator.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**
Score	**-2**	**-1**	**0**	**+1**	**+2**
Internal rate of return	**More than 1 point < cost of capital**	**1 point < cost of capital**	**= cost of capital**	**1 point > cost of capital**	**More than 1 point > cost of capital**

For the comparison of different projects, the one with the higher IRR should be chosen.

4.5.3 Payback Period (PP)

The Payback Period (PP) measures the time required for the cash inflows to equal the original outlay. It measures risk, not return. It is easy to apply and easy to understand but is considered an analysis with serious limitations (for example the time value of money is not taken into account), therefore it is better to assess also other indicators.

The following table proposes a rating scale of the indicator.

Project improvement	Much worse	Worse	Benchmark	Better	Much better
Score	-2	-1	0	+1	+2
Payback Period (PP)	> 20 years	≤ 20 years	≤ 10 years	≤ 6 years	≤ 3 years

For the comparison of different projects, the one with the lower PP should be chosen.

5 CONCLUSION

Undoubtedly, poor data drastically limits the applicability of the indicators and therefore the scope and relevance of country energy efficiency assessments. There is an urgent need to establish, at the international level, the minimum basic data requirements that would allow relevant country evaluations and comparisons between countries in terms of energy efficiency, particularly in view of international debate on CO_2/GHG effects.

The project partners are expected to adjust default weights, benchmarks and emission values throughout the system.

6 Attachment

Instructions: modify, if necessary, the weights; put the score in the equivalent cell (for each indicator put only one score); read the final score and its evaluation in red cells.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**	**Weight**
Value	<<	<	=	>	>>	
Score	**-2 [a]**	**-1 [b]**	**0 [c]**	**1 [d]**	**2 [e]**	
Score x weight	a x w	b x w	c x w	d x w	e x w	**w**
Environmental context						**10%**
Integration into the surrounding cityscape					2	*20%*
Potential environmental impact of development				1		*20%*
Saving protected section of the historic building				1		*30%*
Cultural heritage compliance					2	*30%*
Energy efficiency						**30%**
Primary energy savings (PES) for heating				1		*40%*
Tonnes of Oil Equivalent (TOE)				1		*20%*
Renewable energy sources (%)			0			*40%*
Environmental loading						**15%**
CO_2 avoided emissions				1		*40%*
Greenhouse Gas Emission (GHG)				1		*40%*
SO_2 and NO_2 pollution		-1				*20%*
Technical aspects						**20%**
Adoption of Best Available Technologies (BAT)				1		*30%*
Space requirements/availability			0			*25%*
Employment of not high qualified worker/technician		-1				*20%*
Systematic maintenance				1		*25%*
Economic aspect						**25%**
Net Present Value (NPV)		-1				*30%*
Internal Rate of Return (IRR)		-1				*30%*
Payback Period (PP)	-2					*40%*
TOTAL	**$A=\sum a_i w_i$**	**$B=\sum b_i w_i$**	**$C=\sum c_i w_i$**	**$D=\sum d_i w_i$**	**$E=\sum e_i w_i$**	A+B+C+D+E
	-0,200	**-0,220**	**0,000**	**0,460**	**0,100**	**0,140**
						Benchmark