METHODOLOGY FOR THE DEVELOPMENT AND EVALUATION OF THE IMPACT OF PUBLIC INVESTMENT PLANS

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Author	Orlandi Lorenzo, Antinucci Marcello, De Nigris Silvio
Organization	Ecuba – Province of Torino

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Short Description
This document defines and describes the methodology for developing Action Plans for Public Investments and for the evaluation of the impact of public investment plans.

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Author	Orlandi Lorenzo - orlandi@ecuba.it, Antinucci Marcello - antinucci@ecuba.it, De Nigris Silvio - silvio.denigris@provincia.torino.it

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Summary

1. REPORT A: METHODOLOGY FOR DEVELOPING PUBLIC INVESTMENT PLANS IN RESPONSE TO THE REQUISITE MENTIONED IN ARTICLE 5 OF THE 2012/27/UE DIRECTIVE REGARDING MUNICIPALITIES

1.1 ANALYSIS OF THE CONTEXT

Article 4 of the 2012/27/UE European Directive dictates that the Member States must create a strategy for unfreezing investments in energy requalification for private and public buildings. Article 5 of the same directive requires the public sector to hold an exemplary role regarding this strategy, which is put into effect by obligating the buildings of the central government to enforce energy requalification in 3% of the total building property (greater than 500 m2), with the aim of bringing energy performance back to the legal values dictated by the 2010/31/EU European Directive, which has reinstated the 2009/91/CE Directive.

Article 5 suggests a possible voluntary extension of this objective to the member states for public buildings of the administrative offices in the periphery as well, such as, for example, those of the Municipality. It also indicates as a criterion that priority should be given to the buildings which have the poorest energy performance. It lastly suggests that the Public Administration, at a local level, should develop **Investment Plans for energy efficiency in public buildings,** which will allow for:

- Setting goals and specific actions for energy conservation and energy efficiency;
- Adopting an energy management system which includes energy audits;
- Appealing to the companies providing energy services (ESCo) and the energy output contracts (EPC) in order to finance the renovations.

The "SEAP ALPS" project aims to develop and share a methodology for the development of these plans at the municipal level. It will address the following aspects:

1. The definition of a set of indexes useful for categorizing the municipality-owned public structures based on their energy performance and total consumption;
2. Drafting a guide on how to calculate the proposed indexes, how to recover the data and to keep the monitoring system updated;
3. Definition of a methodology for specifying intervention priorities in accordance with the requisites mentioned in the 2012/27/UE Directive, and the timeframes in which these interventions must be planned;
4. Ways in which it will be possible to assess necessary economic resources for their implementation and to identify the parameters for discovering the best ways to guarantee financing, drawing from public and private resources according to the size and type of the investments.

1.1.1 Experiences in Investment Plans and the management of groups of buildings

The first experiences in this field date back to the Anglo-Saxon "Monitoring and Targeting" methodologies first developed in the industrial sector in the 1970's and were then transferred to the residential sector in the following decades. This methodology, defined and analysed here, consists of:

- organizing a system for monitoring consumption on a regular periodic basis (typically from a few months to a year for buildings);

- making the observed consumption comparable in different periods comparable through opportune corrections aimed at eliminating the effect of climactic variations, changes in types of use and heated surfaces;
- setting a reasonable savings goal, making interventions to be completed by the subsequent period which can be either investments in technology or management methods, and verifying whether or not the goal has been reached by the end of the period.

In the 1980s some real estate agencies that managed groups of buildings sought to obtain a descriptive understanding of the energy quality in the buildings they managed through a series of indexes. In some cases, for example, they compared the consumption of heating (registered in containers of fuel), expressed in Kilowatt hours, to the unit of used surface. The results are represented in histograms in which the buildings are presented starting with those with greater specific consumption and become progressively lower. This elaboration is shown in chart 1 which is, however, relative to a hypothetical group of buildings (see the following table) consisting of public buildings owned/managed by a small/middle-sized municipality (about 25,000 to 30,000 inhabitants).

Building name	**Annual consumption of methane gas (kWh_t)**	**Floor area (m2)**	**kWh/m2**
Library	147.591	1.032	143
Theatre	362.612	5.220	69
Sports Hall	701.057	5.787	121
Elementary School A	717.153	4.483	160
Nursery School	300.233	1.596	188
Town Hall	261.689	3.704	71
Covered Market	50.932	499	102
Kindergarten A	167.101	903	185
Offices	69.614	714	98
Elementary School B	265.271	1.768	150
Elementary School C	344.378	2.595	133
Middle School	819.606	13.096	63
Kindergarten B	159.162	1.453	110
Auditorium	130.648	1.195	68
TOTAL	**4.497.047**	**44.763**	**119 *(average)***

Table I: examples of consumption and floor area data in a hypothetical set of municipal buildings

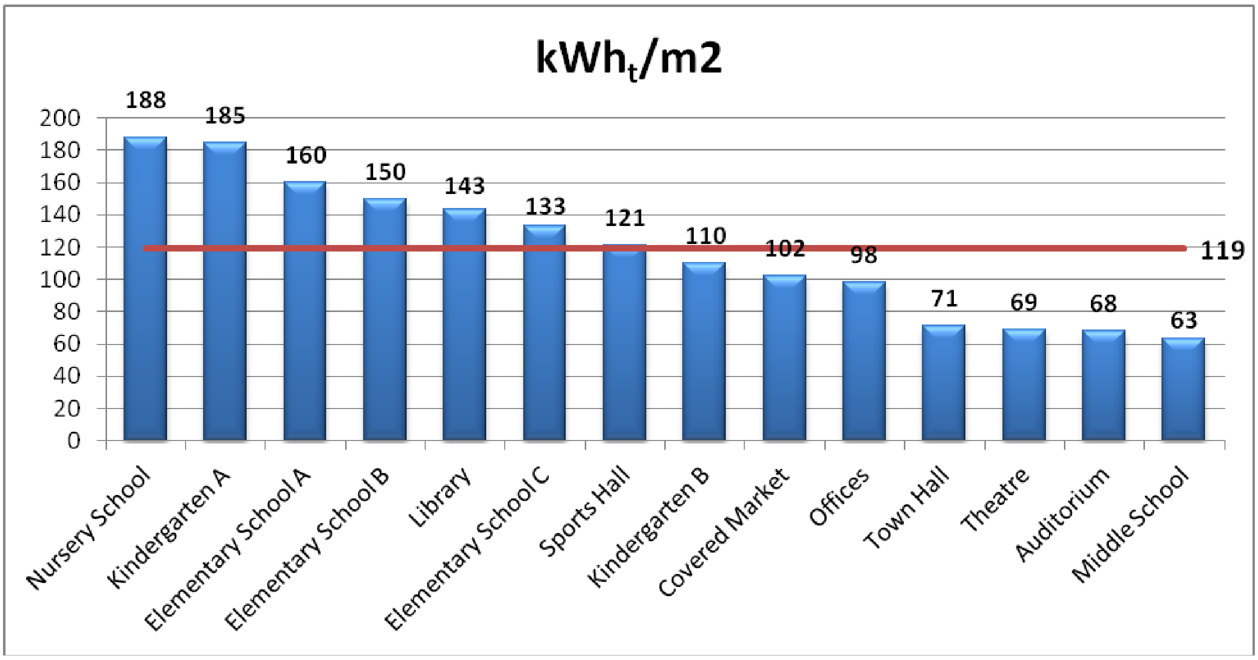


Chart 1: classification of the buildings according to their kWh/m2 consumption index

A horizontal line through the chart highlights the average consumption of the entire group of buildings and allows the expert in energy management (EGE), therefore, to concentrate his/her attention on the buildings which are of a specific consumption above the average. From this collection of buildings some will be chosen for energy audits. In the chart shown above, the buildings which require priority intervention are those above the red line, and therefore: nursery school, kindergarten A, elementary school A, elementary school B, library, elementary school C, sports hall.

The development of Action Plans for Sustainable Energy in Municipalities adherent to the Pact of Mayors has produced the necessity to adopt methods for evaluating the performances of groups of buildings which consist mainly of schools, offices and recreational/sports complexes. In collections of this type the methodology based on the consumption index of heating per unit of surface area reveals itself to be, however, too incomplete: the schools, in fact, tend to have both thermal and electric consumption levels systematically lower than the offices, despite the fact that their surface area and building quality are the same. Moreover, the sports complexes have specific consumption rates which are much greater than the average (high percentage of domestic water, limited surface area, presence of pools, external illumination of playing fields, etc.).

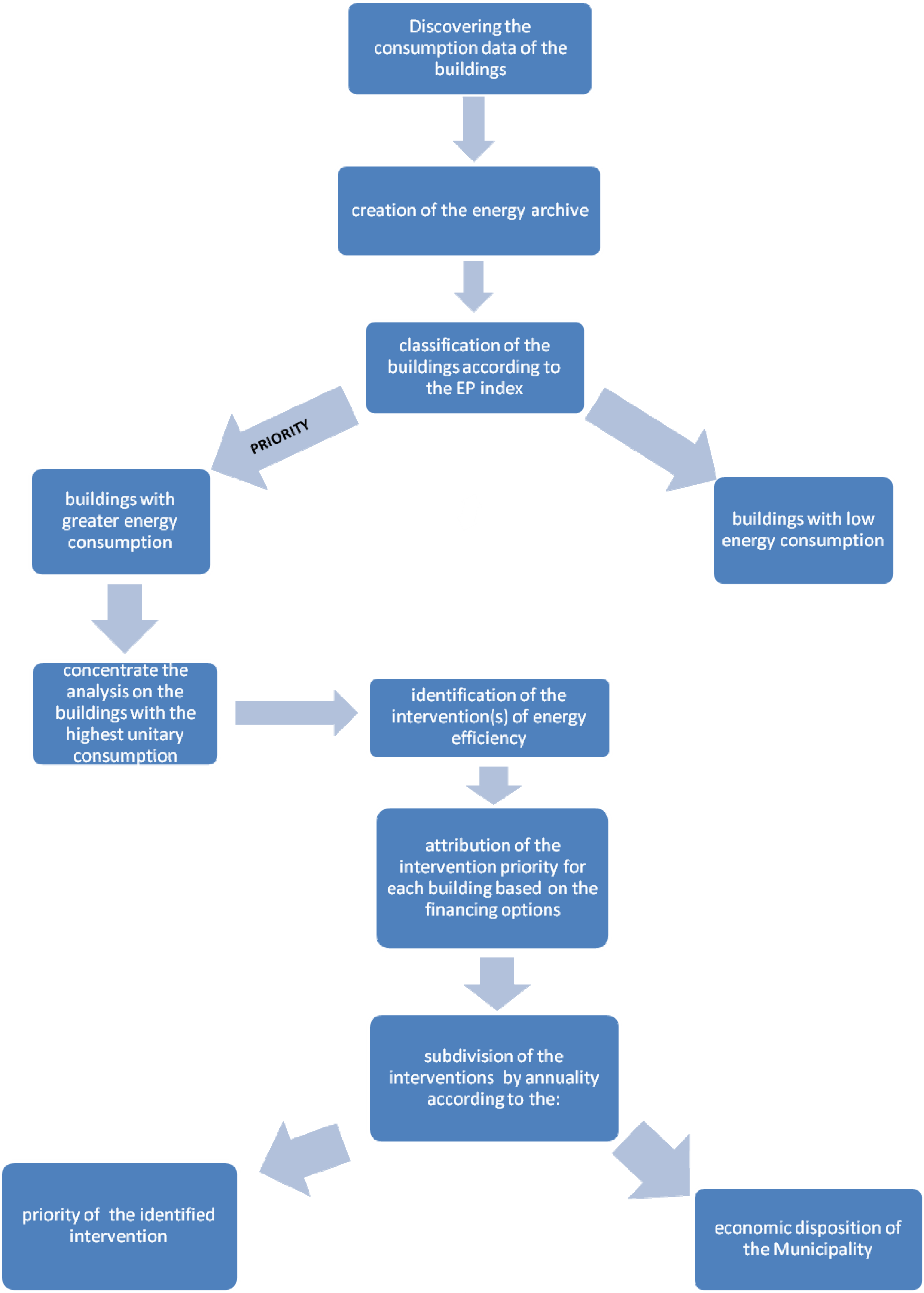
Another difficulty which is often encountered is the lack of precise data from the Municipalities on the heated surface area (used surface), since they only have the gross surface area at their disposition.

1.2 DEFINITION OF THE DECISION-MAKING PROCESS

The decision-making process will be employed in the following phases:

1) discovery of informative (name, address, etc.) and thermal/electric consumption data relative to the public buildings run by the Municipality;
2) the creation of an IT energy archive of the buildings on an Excel file by inserting previously acquired data;

3) the classification of the buildings according to an energy performance (EP) index based on unitary-energetic consumption. It will be considered a priority to act on the less efficient buildings which have a higher unitary energy conservation level (equal to the type of intervention);
4) concentration of the analysis on the buildings which have greater absolute consumption, giving less priority to those which show lower consumption;
5) identifying the various possible energy efficiency interventions by grouping them according to type;
6) attributing an intervention priority to every building while keeping in consideration the possible financing options;
7) distributing the interventions into different annuities based on the priorities identified and economic availability, assigning a description to each intervention including the relative indexes of energy performance and type of financing chosen.


Discovering the consumption data of the buildings
creation of the energy archive
classification of the buildings according to the EP index
PRIORITY
buildings with greater energy consumption
buildings with low energy consumption
concentrate the analysis on the buildings with the highest unitary consumption
identification of the intervention(s) of energy efficiency
attribution of the intervention priority for each building based on the financing options
subdivision of the interventions by annuality according to the:
priority of the identified intervention
economic disposition of the Municipality

1.3 METHODS OF APPLICATION

1.3.1 Choosing the indexes

Based on the process described above, it is necessary to consider a more complex set of indexes relative to energy performance:

- consumption of fuel per volume unit for public and assimilated offices ((kWh_t/m3);
- consumption of fuel per volume unit for schools, excluding gymnasiums (if separable);
- consumption of fuel per number of users (co-owners, in the case of sports companies which manage the complex) for the sports complexes, and for the scholastic gyms which have a separate count(kWh_t/number of users or students);
- electricity consumption per unit of surface area of offices (kWh_e/m2);
- electricity consumption per unit of surface area of schools;
- electricity consumption per number of users (co-owners, in the case of sports companies which manage the complex) for the sports complexes, and for the scholastic gyms which have a separate count (kWh_t/number of users or students);

Regarding the problem of the lack of availability of useful surface area it could be possible to introduce a transformation coefficient from the gross external surface to the net surface of the walls. This coefficient will be equal to 0.81 for the calculation of the walls (0.9 squared), in the same way that one performs an appraisal. In the case of volumes it will be equal to 0.729 (0.9 cubed).

The use of volume for the schools and offices (for the calculation of the EP of the non-residential buildings) should consider the buildings higher than the standard building, as often occurs with schools and town halls inside historical buildings. The electricity consumption, on the other hand, is not normally influenced by the height of buildings.

As for the calculation of the emissions, the values will be set in CO_2 and not in CO_2eq., making use of IPPC[1] conversion factors.

It must be remembered that the conversion factors from energetic units (thermal kWh values relative to various combustibles and electric kWh values) are defined by the guidelines which are based on the physical dimensions for thermal kWh values. As for the electrical kWh values, they derive from a national mix of electric energy production/importation which has conventionally been unavailable data when producing the guidelines, in order to avoid counting, among the environmental benefits thanks to the action of the Municipality, also the eventual improvement of the electric mix (except in decentralized plants under 10 MW_e) on which the municipality has no control.

1.3.2 Calculating the indexes

The SEAP ALPS guide explains how to calculate the proposed indexes, how to obtain data and how to maintain the monitoring system updated:

- Criteria for reading fuel and electricity meters;
- Criteria for using bills to obtain periodic consumption levels;
- Criteria for the calculation of floor spaces;
- Necessary corrections for comparing consumption to standard conditions (baseline);
- Coefficients for transforming units of measurement;
- Ways to elaborate data and its presentation in tables and charts.

[1] The Intergovernmental Panel on Climate Change (IPPC) is a scientific forum founded in 1988 by two sections of the United Nations, the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP) with the aim of studying global warming.

The criteria for the reading of meters will contain practical advice on how using the buttons on the digital meters, and instructions for how to access the online service offered by the distributors for the sequential reading of the monthly meters (above 50 kW), which will allow the obtainment of consumption data in brief intervals, and identifying possible wastes (for example nocturnal consumption or weekend consumption).
The criteria for the reading of bills will indicate how to distinguish actual consumption from presumed consumption. These will be performed by the distributors when it is impossible to obtain answers from digital meters at the moment in which information is requested; how to get information for preventing lump balances which falsify the periodical bookkeeping; how to verify the presence of reactive energy or energy penalty in order to extract the greatest contractual power.
In the case of floor area, the previously-mentioned correction will be proposed, equal to the coefficient 0.9 for each linear direction, but will include warnings for its application (for example smaller dimensions), and in cases in which caution is necessary (historical buildings or buildings with thick walls, buildings with very large spaces), as examples.
In order to bring these to the baseline, the corrections of the data periodically obtained must consider, for heating, the climactic variations (using degree days), the variations (proportional) of the heated volume, variations in the hours of use (weighing with a factor between 0.1 and 0.2 of the proportional quota of variation of hours compared to the baseline hours, in consideration of the thermal inertia of the building, which produces limited changes in the internal temperature for periods lasting up to several hours) and the eventual changes in use (heated areas at temperatures different from standards for complying to the needs of the users).
The conversion coefficients will be recovered by the guidelines of the JRC.
For the elaboration of data it is advised to use a standard periodicity for the publication of the data in an online database, in order to favour viewing for everyone involved, and a standardized electronic sheet for an automatic elaboration of the corrections (and automatic conversions into tCO_2) before publication. The charts will include the histogram of the indexes of the group of buildings, the time graph of the indexes for each building, with the indication of the expected goals (target) and the real gap relative to these. An important added instrument of analysis is the “energy signature”, defined in the UNI-EN regulation 15603. This method requires the acquisition of consumption data (on at least a weekly basis) in periods characterized by sufficiently diversified external temperatures, in order to obtain a consumption chart per unit of time based on the delta T between the internal and external value, with care to subtract the average consumption of household water (obtainable through summer measures). If the data allows for the obtainment of a line with a good coefficient of regression, the slope will express the coefficient of the heat loss in the building in kW/K. This method is of great use when comparing the coefficient before and after an intervention of thermal isolation in the building. A lowering of the line parallel to the slope indicates an improvement in the efficiency of the installation.

1.3.3 Choosing the priority of the interventions

The buildings with a high intervention priority of energy efficiency will be identified according to the following model/chart:

- Diagram with kWh/m^2 versus absolute kWh for each building

As an example one may take a hypothetical group of buildings consisting of buildings belonging to or at least the responsibility of a Municipality; this group of buildings represents our database on which the values of energy consumption will be measured.

This example refers to a model of a group of buildings[2] in a small/medium-sized municipality (circa 25.000-30.000 inhabitants) and one assumes that the annual consumption of heating expressed in kWh is the following:

Name of building	Annual consumption of methane gas (kWh_t)	Floor area (in m2)	Volume of the buildings (in mc)	kWh/m2	kWh/m3
Library	147.591	1.032	3.199	143	46,1
Theatre	362.612	5.220	21.404	69	16,9
Sports Hall	701.057	5.787	34.720	121	20,2
Elementary school A	717.153	4.483	15.689	160	45,7
Nursery School	300.233	1.596	4.949	188	60,7
Town Hall	261.689	3.704	11.483	71	22,8
Covered Market	50.932	499	1.546	102	32,9
Kindergarten A	167.101	903	2.798	185	59,7
Offices	69.614	714	2.212	98	31,5
Elementary School B	265.271	1.768	6.187	150	42,9
Elementary School C	344.378	2.595	9.081	133	38,0
Middle School	819.606	13.096	45.837	63	17,9
Kindergarten B	159.162	1.453	4.505	110	35,3
Auditorium	130.648	1.195	5.935	68	22,0
TOTAL	**4.497.047**	**44.763**	**166.346**	**119 *(average)***	**34,3 *(average)***

Table 1: example of a small/medium group of buildings (circa 25.000-30.000 inhabitants).

Example diagram with absolute kWh values of a single building versus kWh/ m^2

In this graph every building which takes part in the group of buildings is represented by:

- on the x axis the relationship between unitary thermal consumption of the building and the relative floor area;
- on the y axis the unitary thermal value of a single building in kWh.

Thanks to the elaboration in the upper-right of the graph (AA: high-high), the buildings which have a greater unitary consumption and a greater consumption compared to the floor surface unit will be

[2] This is the same example in table 1 with the addition of the column for the volume of the buildings and the relative index of energy performance in kWh/m3.

seen, highlighting therefore the buildings which have greater intervention priority/energy efficiency. The buildings, therefore, which have specific and absolute consumption levels above the average are: elementary school A and sports hall.

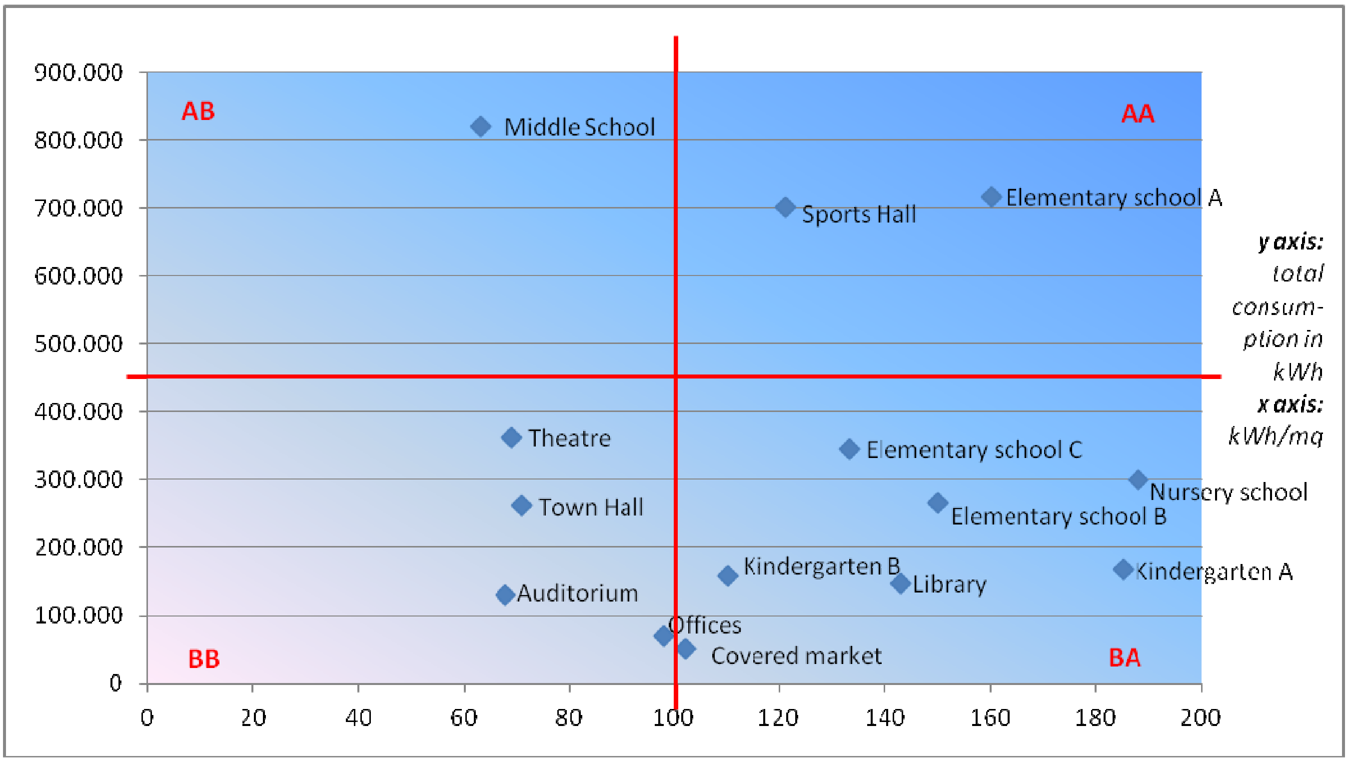


Chart 2: diagram with absolute consumption of the buildings in kWh compared to the relative energy performance indexes in kWh/m²

This graph represents the first filter, a first step towards analysing the group of buildings and highlighting the buildings which consume the most energy; it will be possible, later, to move to a deeper understanding of these by dividing them by category (so, in addition, we will also consider the different types of buildings and the intensity of utilization of the single building).

1.3.4 Data collection sheet arranged by building

The data of every building will be stored on a specific sheet, on which it will be necessary to fill out both the specifics useful for the identification of the building (the registry information of the building) as well as those relative to the machinery and thermal electric consumption.
In particular it will be required to fill out the following fields relative to:

- name of the building;
- address;
- municipality the building is part of;
- ID code of the building;[3]

[3] The identification of the buildings is not always simple and unambiguous, especially in the case of the buildings with walls typical of historical centers. For this reason a code is required which will identify the building and its relative thermal and electric consumption in an unambiguous way; this is a code which the municipal administrations are usually already using.

- use (school, office, warehouse, sports complex, for tourism/culture, or other use[4]);
- year of construction;
- surface area in m2;
- volume in m3;
- possible extra maintenance or renovations;
- profiles of use;
- possible pre-existing machinery for renewable energies;
- possible notes.

Also, as for the heating of the building:

- fuel used;
- I.D. of the thermal machinery;
- year of the boiler;
- brand;
- useful energy in kW;
- performance in %;
- annual thermal consumption (in m^3, lt., or kWh) with the year of reference;
- annual expenses in €.

Finally, as for the supplying of electric energy:

- point of Delivery code;[5]
- annual electricity consumption (in kWh) with the year of reference;
- annual expenses in €.

Example of a SUMMARY SHEET FOR THE REGISTRY/ENERGY DATA OF THE BUILDING

Section 01 – GENERAL INFORMATION:				
NAME	……………………………………………………………		ID CODE	……………………………
MUNICIPALITY	……………………………………………………………		PROVINCE	……………………………
Street/Ave/etc.	……………………………………………………………		BUILDING NUMBER	……………………………
USED FOR	……………………………………………………………		YEAR OF CONSTRUCTION	……………………………
Heated SURFACE AREA (m^2)	Gross ☐ Net ☐ ……………………………		Heated VOLUME (m^3)	Gross ☐ Net ☐ …………………………………
POSSIBLE EXTRA MAINTENANCE OR RENOVATION	YEAR:	……………………	INTERVENTION:	…………………………………

[4] The "other" category is formed by unused buildings beyond those which do not belong in the types already indicated.

[5] The Point of Delivery code is an alphanumeric code consisting of 14 or 15 numbers used to identify the pick up or delivery points of the electric network. It is used both by producers as well as by consumers of electric energy and is generally indicated on the bill.

Section 02 –PROFILE OF USE:			
WEEKLY			
AREA(S)	**DAY**	**FROM (:00)**	**TO (:00)**
…………………………	…………………………	…………………………	…………………………
…………………………	…………………………	…………………………	…………………………
…………………………	…………………………	…………………………	…………………………
ANNUAL			
AREA(S)	**MONTH**	**FROM**	**TO**
…………………………	…………………………	…………………………	…………………………
…………………………	…………………………	…………………………	…………………………
…………………………	…………………………	…………………………	…………………………

Section 03 – THERMAL:			
FUEL USED	Methane Gas ☐		
	Diesel Fuel ☐		
	Liquefied Petroleum Gas ☐		
	District Heating Network ☐		
	Electric Power Source (electric heaters, air conditioners, climbing panels) ☐		
MACHINERY I.D.	……………………………	BOILER YEAR	……………………………
BRAND	……………………………	USEFUL ENERGY(in kW)	……………………………
OUTPUT (in %)	……………………………		
ANNUAL CONSUMPTION	m^3 ……………………………	lt. ……………………………	kWh …………………………
ANNUAL EXPENSES	€ ……………………………….	YEAR OF REFERENCE /DAY	……………./…………….
POSSIBLE NOTES	……………………………………………………………………………………………………		

Section 04 – ELECTRIC:			
P.O.D. Code	………………………………………………………		
ANNUAL CONSUMPTION	kWh ……………………………………………		
ANNUAL EXPENSES	€ ………………………………………	YEAR OF REFERENCE /DAY	……………/……………
POSSIBLE NOTES	………		

Section 05 – POSSIBLE MACHINERY FOR RENEWABLE ENERGY ALREADY IN USE:		
TYPE	**INSTALLED POWER or ANNUAL ENERGY PRODUCTION (in kWh_t/kWh_e)**	**YEAR OF REFERENCE**
SOLAR PHOTOVOLTAIC	…………………………………………….	……………………………
THERMAL SOLAR	…………………………………………….	……………………………
BIOMASS BOILER	…………………………………………….	……………………………
GEOTHERMAL	…………………………………………….	……………………………
COGENERATION	…………………………………………….	……………………………
NOTES ……		

1.3.5 Inspection Process

The survey will consist of a visit lasting roughly a half an hour during which the technician in charge, equipped with a camera, will make an analysis of the situation of the building by noting and photographing the geometric, physical and machinery-related characteristics of the structure under investigation.
The walls will be measured in addition to the windows and other useful distances for identifying the most ideal interventions of energy efficiency, and all criticism will be noted concerning the energy performance of the structure, in addition to the registration of all the useful elements for filling out the building sheet such as: reading of the meters, possible presence and functioning of renewable energy installations, etc.
For the thermal machinery the data can be retrieved from the boiler booklet.

1.3.6 Identification of the interventions

The search for interventions of energy efficiency, based on investments, will be developed in the following phases:

- interventions which deal will the casing of the building (thermal isolation of the opaque walls; changing of the fixtures and windows; isolation of covering and bases on unheated basements, areas on stilts, etc.);

- reduction of the infiltrations and ventilation, for example, due to entry doors;
- interventions on the structure at a generational, distributional, emission-related or regulatory level;
- controlled mechanical ventilation and the recovery of heat from the expelled air, preheating of the renewed air even geothermally, day and night *free cooling*;
- application of renewable sources: solar thermal for ACS, solar photovoltaic, geothermal heat pumps, small wind turbines, biomass boilers and micro-networks of district heating;
- mini e micro-cogeneration.

For each intervention the costs will be calculated according to the budget (that is finding the economic cost of the intervention and multiplying it by a specific cost value obtained based on estimates and previously performed projects).
The economic benefits, however, will be estimated in a simplified way starting with standard percentages of improvement and efficiency, applied on the “baseline” energy consumption for the entire building; in other cases the savings percentage on a unit of itself will be used (for example the coefficient U of the transmission of heat through m2 of wall), and will be multiplied by the climactic factors (degree day and hour-day). For each type of intervention proposed, a screening of the opportunities will be done, based on the methodology of the Life-Cycle-Cost (LCC)[6] which will be the determining element for the priority of the intervention.
An improvement of the energy management and maintenance of the building must be included in the interventions. This will allow for a progressive reduction of waste and maintaining a level of good quality in the structure (monitoring and targeting) through a Plan – Do – Check – Act process (PDCA)[7].

1.3.7 Financing the interventions

Once the interventions which have a minor LCC have been selected, pre-feasibility studies will be conducted which will allow for a deeper understanding of both the level of planning from the outset as well as the economic-financial evaluations, developing therefore a potential investment plan and evaluating it from the point of view of an external investor (that is, guaranteeing a profit).When the economic/financial conditions of the plan have been considered satisfactory for a potential investor, “market research” will be undertaken presenting to a number of operators the summary of the project (made public) in order to verify the potential interest. Once positive interest is attained, an

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[6] The Life-cycle cost (LCC) refers to the total cost of ownership over the life of an asset. Also commonly referred to as "cradle to grave" or "womb to tomb" costs. Costs considered include the financial cost which is relatively simple to calculate and also the environmental and social costs which are more difficult to quantify and assign numerical values. Typical areas of expenditure which are included in calculating the whole-life cost include: planning, design, construction and acquisition, operations, maintenance, renewal and rehabilitation, depreciation and cost of finance and replacement or disposal.

[7] The Deming Cycle (PDCA cycle : plan–do–check–act) is a model studied for the continuous improvement of quality in a long-range point of view. It is necessary for promoting a quality culture which is aimed at the continuous improvement of the processes and optimal use of the resources. This instrument starts with the assumption that in order to reach maximum quality it is necessary to have a constant interaction between research, planning, testing ,production and sales. In order to improve the quality and satisfy the client, the four phases must constantly rotate, keeping quality as a principal criterion. The logical sequence of the 4 points is the following:

- P – Plan: planning
- D – Do: execution of the program, initially in circumscribed contexts;
- C – Check: testing and checking, study and collection of results and comparisons;
- A - Act: action for making the process definitive and/or improving it.

energy service announcement for a group of buildings or an energy performance contract for a single building will be made.
The discount rate, to calculate the Life-Cycle-Cost, will be the local discount rate (for each country) according to the local energy procurement.

1.3.8 The elaboration of the multi-year plan for interventions regarding energy requalification

For every pre-determined financial solution for the year in question, a choice must be made which considers the priorities of the intervention as well as:

- if it resorts to balanced financing: of the maximum total available;
- if it resorts to the mortgage: of the maximum trust it is possible to obtain, of the duration and worth of the mortgage payment compared to saving;
- if it appeals to FTT: the shorter-term interventions with a simple return.

In order to foresee the possible damages deriving from this, the greatest amount of priority must be given to the type of interventions that are necessary and not deferrable due to the oldness of the components and which would allow for the avoidance of the risk of a possible interruption of the service.
Another possible criterion involves the aggregation of the interventions into the same building in order to optimize the costs aimed at limiting the inconveniences during the long construction period.

1.4 THE OPERATING PROCEDURE FOR THE MUNICIPALITIES

The principal steps for performing the methodologies previously described are:

1. the acquisition and archiving of energy consumption data;
2. inspection of the buildings;
3. registering the data of the buildings on an appropriate sheet;
4. analysis of the data on the sheet for identifying the intervention priorities;
5. including the interventions in a multi-year plan according to their priorities or other local factors;
6. calculation of the impact indicators (see specific methodology);
7. approval of the plan;
8. carrying out of the plan with possible presentation to the public and the public's possible participation.

1.5 TESTING THE METHODOLOGY

The experimentation will be started on a pilot Municipality which will adhere to the Pact of the Mayors and which will satisfy the following requisites: medium dimensions, with an important and variegated heritage, with a system for monitoring the already operating energy consumption. Through technical meetings with the pilot Municipality the suitability of the data collection will verified and the Public Investment Plan will be elaborated, then shared with the technical and political branches of the Municipality. The plan will be presented to the technical and branches of the Municipality and then at an event open to the citizens' participation. A local information/training event will be organized for sharing experimented methodologies with other Municipalities in the territory. The experimentation may also include the preparation of the technical contract for the starting of the Plan with FTT.

1.5.1 Revision of the methodology

Following a comparison with partners, in light of the results of the analysis of the impact made on the Municipality, a revision of the methodology will be made.

2. REPORT B: METHODOLOGY FOR THE EVALUATION OF THE IMPACT OF PUBLIC INVESTMENT PLANS IN REPSPONSE TO THE REQUISITE MENTIONED IN ARTICLE 5 OF THE 2012/27/UE DIRECTIVE REGARDING MUNICIPALITIES

2.1 GOAL

The set of indexes is aimed at evaluating the impact of the fulfilment of an investment plan in the territory in question from a social-economic and environmental point of view.
The evaluation of the impact should regard both local and global environmental repercussions, as well as the employment and turnover effects for the global economy. The aim is to assess the repercussions of the application of the requisite from article 5 of the European Directive 2012/27/UE locally.

2.2 DEFINITION OF A SET OF INDEXES

The **impact evaluation** of the public Investment Plans, which is relative to the energy efficiency of the buildings that are part of the group of buildings in a Municipality, requires the definition of a set of indexes which deal with:

- Energy impact (reduction of energy consumption in primary energy);
- Climate change impact (reduction of the emissions of CO_2 in tons);
- Improvement of the local energy system (percentage of improvement of energy efficiency of the entire group of buildings);
- Impact on the global economy (global value of foreseen investments);
- General and local employment impact (calculated based on the employment tables of FTE – Full Time Equivalent – for each technology and activity).

The **energy impacts** will be derived from the indicators selected in the methodology relative to the development of the plans (see Report A), transforming the thermal and electric kWh in the equivalent tons of petrol, which will represent the measurement units that will allow for the unification of the energy impact for each type of fuel and electric energy. One will have therefore, a quota of energy conservation expressed in teps and a resulting percentage of energy saved both on the total of energy consumption for the Municipality as well as a total savings on the Municipalities of the territory.
<u>Energy Indexes:</u> conserved energy expressed in teps.

The calculation of **greenhouse gas emissions**, expressed in tons of carbon dioxide, will be equally used by the indexes for the quantification of benefits in the development phase of the plans, as described in Report A, for the bookkeeping required by PAES, and the IPCC conversion factors will be used.
One will obtain a quota of reduction of greenhouse gas emissions in the atmosphere expressed in tCO_2 and a consequent percentage of emission reductions both to energy consumption of the Municipality in question as well as the total of those traceable to the entire territory
<u>Environmental Indexes:</u> reduction of the tCO_2.emissions; % total emissions of the Municipality and on the total emissions in the territory.

As for the coefficients of transformation in tCO_2 from electric kWh, as these are different according to each country in question, one will receive the following conversion table (tCO_2/MWh_e) aimed at the European Countries interested in the project

Country	**Standard emission factor (tCO_2/MWh_e)**
Austria	0,209
Germany	0,624
France	0,084
Italy	0,483
Slovenia	0,557
EU-27	**0,460**

Table 2: National and European emission factors for the consumption of electric energy

The conversion table for the most common types of fuel will be shown as well. In this case the equivalent for all Countries:

Type	**Standard emission factor (tCO_2/MWh_t)**
Motor fuel	0,249
Diesel Fuel	0,267
Combustible Oil	0,279
Natural Gas	0,202
Thermal Solar Energy	0
Geothermal Energy	0

Table 3: Standard emission factors for CO_2 (from IPCC, 2006) for the most common types of fuel

The percentage of **improvement of energy efficiency in the group of buildings** in the Municipality requires the adding of all consumption from all the properties owned or being used by the Municipality, transforming the raw data into teps, and comparing it with consumption down line of the interventions of energy investment. In this case, however, attention must be placed on improvements in energy performance retraceable to better management or a more correct behaviour by the users. These improvements are not important for the evaluation of the Investment Plan, moreover they are often excluded from the calculation for being seen as factors which perturb the pure evaluation of the economic feasibility of the intervention. They are, on the other hand, pertinent for a global evaluation of the energy impact of the municipality's energy system.
At the end of the calculation operations, a percentage will be obtained relative to the decrease in energy consumption for the entire group of buildings due to the energy efficiency interventions in relation to the previous situation, comparing the situation before and after with the same climactic situations, of volume used and hours of use.
<u>Indicators of Energy Efficiency:</u> saved energy in teps; % of energy saved compared to the total consumption of the Municipality in question and % compared to the total consumption of the territory.
The global economic impact is supplied in a simplified way from the total sum of the investments necessary for energy efficiency, regardless of the origin of the supply of the size of the workforce.

In order to obtain the **local impact** (regional) on the other hand it would be necessary for a complex operation of evaluation on the added value which is made locally compared to the merchandise that enters from the outside (input-output method). Although there is a great deal of writing on these calculations, their accuracy is limited due to the quantity of factors which can change the evaluation (for example profit margins or decentralized productions with the tags of other countries). A rough estimate can be supplied by evaluating only the added value for the installation and maintenance, overshadowing that relative to the materials.
We will proceed, therefore, to estimate the total necessary investments for various energy efficiency interventions and estimate the economic benefits which regard the Municipality in question.
In this case a useful indicator of global economic evaluation is that which refers to the total of € spent for installation and maintenance per inhabitant, considering that the municipal buildings are real estate to be used by the citizens and it is therefore opportune to consider the demographic variable.
<u>Index of global economic impact:</u> total € spent for installing and maintenance / inhabitants of the municipality.
If it is not possible to distinguish the expenses for installation and maintenance, it may be possible to recur to the total invested.
In reference to the example, in which 1,750.278 € was figured to be the total of the necessary investments for the various interventions of energy efficiency and considering that 30,000 units is the population of the municipality, the value of the index results to be 58,3 € invested/inhabitant.

Finally the **employment impact** is obtained through calculations which multiply the value of the investment made[8], divided by the principal types of activities, by opportune coefficients, which supply the number of employed persons, expressed in FTE (Full Time Equivalent) per unit of value of the investment for that determined type of activity; these coefficients can be found in writing, and may be different from country to country. Also in this case there are ample margins of uncertainty, and it is opportune to keep the production of goods separate from their installation or demolition in preparation for the new installation.
For Italy, for example, one may use the estimation of the employment impacts the methodology and the coefficients indicated in the Cresme report on ENEA data from July 2010 "*Analisi sull'impatto socio-economico delle detrazioni fiscali del 55% per la riqualificazione energetica del patrimonio edilizio esistente*". (The analysis of the social-economic impact of the fiscal deductions of 55% for the energy requalification of the existing building heritage)
Using for an example of group of buildings the same sample that was analysed in table 2, the other basic elements of the estimation are:

- <u>Estimation</u> of the investment in energy requalification of the buildings in the group: 1.750.278 €, determined from table 5, column **A**;
- Effect of the demolition workforce: from 18% (installation thermal solar devices) to 79,2% (installation thermal devices) determined from table 5, column **B**;
- Effect of the installation workforce: from 18% (fixtures) to 55% (opaque vertical structures), determined in table 5, column **C**;
- Turnover per employee hired (€ x 1,000), see table 5, column **D**;

[8] It would be more correct to use the added value produced locally by the investment (that is in the territory subject to the research) as a basic data in order to exclude the employment impact outside the territory itself. Since the calculation of the added value is very complex and can easily produce huge errors, it is more opportune to use the total value of the investment.

- Effect of the demolition on the total costs of installation with **I.D.** and the following percentage values:
  - vertical opaque structures: 7,9%;
  - horizontal opaque structures: 25%;
  - fixtures: 7,4%;
  - solar thermal: 0;
  - thermal installations: 5,2%;
  - combined interventions: 7,2%;
- average gross cost (including payroll costs) for the workers employed for demolition 35.280 €/year;
- average gross cost (including payroll costs) per the installation workers: 41.280 €/year.

	TOTAL INVESTMENT (€)	Effect on demolition workforce (%)	Effect on installation workforce (%)	Turnover per GENERATED employee (€x1.000)
	(A)	(B)	(C)	(D)
Opaque vertical structures	33.095	79,0	55,0	135,0
Opaque horizontal structures	106.386	79,0	48,0	188,2
Fixtures	479.124	72,8	18,0	160,0
Thermal Solar	124.889	18,0	27,0	95,0
Thermal Installation	369.205	79,2	27,0	587,8
Combined interventions	637.579	69,6	26,0	296,6
Total	**1.750.278**			

Table 4: estimation of the employment generated by the investments (divided into types of energy efficiency interventions); basic elements for the estimation.

	DEMOLITION WORKFORCE	INSTALLATION WORKFORCE	GENERATED WORKERS	TOTAL WORKERS
	((A)*(B)*I.D.%)/ 35.280	(A)*(C)/41.280	(A)/(D)	
Opaque vertical structures	0,06	0,44	0,25	0,74
Opaque horizontal structures	0,60	1,24	0,57	2,40
Fixtures	0,73	2,09	2,99	5,82
Thermal Solar	0	0,82	1,31	2,13
Thermal Installation	0,43	2,42	0,63	3,48
Combined interventions	0,91	8,99	2,15	12,05
Total	**2,73**	**15,99**	**7,90**	**26,61**

Table 5: estimation of the employment generated by investments; development of the estimation (see the formulas in the second line).

By using the basic elements of estimation previously indicated it will be possible to obtain the following employment values for each different type of energy efficiency intervention:

- demolition workforce: this value is taken from the product of A,B and I.D. compared to the average gross cost (including payroll costs) for the workers employed in the demolition (35.280 €/year);

- installation workforce: the value obtained from the product of A and C compared to the average gross cost (including payroll costs) for the installation workers (41.280 €/year);
- general workforce: the value obtained from the relationship between A and D;
- total workforce: the sum of the three previous values.

The methodology of this calculation also foresees the estimation of the amount of workers employed, that is, those involved in the production of goods necessary for the undertaking of the intervention who are added to the workers involved in demolition and installation. Due to the difficulty of evaluating which part of the employment is a benefit to the territory and which is external,[9] we have preferred to omit this quota of workers from the estimation of the employment impact.
This methodology of calculation indicated is useable by every other partner of the project through the identification of the relative national values. Regarding the gross salary for installers and for demolition staff, other countries have provided their data, shown in the following table. Other data (for example: the percentage of investment due to demolition for the various categories of works) are the same for all countries and are taken from Italian sources (see above: columns B, C, D and I.D.):

Country	average gross salary for installers	average gross salary for demolition staff
Austria	33.600 €/year	27.515 €/year
Germany	36.550 €/year	32.200 €/year
France	39.960 €/year	40.369€/year
Italy	41.280 €/year	35.280 €/year
Slovenia	15.515 €/year	12.793 €/year

Table 6 : average gross salary for installers and for demolition staff

The index which is obtained by estimating the previous table 4 and 5, hypothesizing a distribution of the investments on different types of activity indicated in the two tables, is therefore the following:
<u>Index of employment impact:</u> € invested per worker (estimation total investments/total new workers). In the example chosen this value is 65.775 € invested per worker, or 15,2 F.T.E. per millions of €.

2.2.1 Operating procedure for verifying the impact

- acquire the necessary data for calculation;
- insert them in a calculation sheet;
- obtain the results of the indexes;
- analyse the results obtained by inserting them in an impact report.

The evaluation of the impact of the results of the Public Investment Plan will be compared with all the partners in the project in order to operate a comparison between the efficiency of the above-

[9] Consider also the recent debates on the origins of photovoltaic modules (in a great degree from the far East) which has influenced the judgment of benefits generated on the employment of Italian workers from the public incentives to photovoltaic power.

mentioned plans, using the impact indexes previously defined. The complete evaluations will be included in a report.