



*Energy Efficiency Improvement Program (PMEE)
for public buildings owned by the municipality of Agnone*

**WP4 activities:
Task 4.4 - Energy Plan
Executive Summary Report D 4.4**

October 2014

RAGGRUPPAMENTO TEMPORANEO DI IMPRESE



**IZI METODI, ANALISI
E VALUTAZIONI ECONOMICHE**

Technical support service of Molise Region



Consorzio Zero Energy Building
PROJECTS, CONSULTING, TRAINING & SERVICES



The project is co-funded by the European Union, Instrument for Pre-Accession Assistance



Introduction

ALTERENERGY (*Energy Sustainability for Adriatic Small Communities*) is a Strategic Project funded within the cross-border Cooperation Programme IPA-Adriatic 2007-2013.

Launched in September 2011, with a 12,5 Mln Euro total budget and with a duration of 4 years (completion of work in August 2015), ALTERENERGY aims to promote Energy sustainability through the ever- wider use of renewable energy sources and through the diffusion of interventions to increase efficiency and energy saving, thereby seeking to contribute to the achievement of the Europe 2020 objectives.

In particular, this Strategic Project promotes **sustainability within small Adriatic communities** (having a population of less than 10.000 inhabitants) through an integrated approach for the efficient use of energy and its production from renewable sources.

The specific aim of the project is to develop replicable management models of sustainable energy resources within small Adriatic municipalities, thus improving their ability to plan and manage integrated actions of energy saving and production from renewable sources.

In this context, the **region Molise**(Partner of the Strategic Project ALTERENERGY¹)has identified **Agnone** as the community where to conduct the experimental activities of the Project(Memorandum of Understanding between Region and Municipality signed on 17/12/2013).

By public tender, region Molise has designated a Temporary Firms Association (formed by IZI spa, EdilNEZ consortium, CRESME Consulting Srl, AFORIS Srl) to provide all the necessary technical support to accomplish its tasks for the Alterenergy Project.

One of these task is the development of an “*Energy Efficiency Improvement Program*” (in Italian PMEE) for public buildings to be tested in Agnone municipality. The task was performed with the support Planergy™, a web application specifically designed to monitor public real estate from the energy consumption point of view.

The performed activities are fully consistent with those included in the SEAP issued by Agnonemunicipality on May 2013 which are organized into the following three phases.

1. **Energy Assessment:** after a site survey in each public building, collection and analysis of data related to energy consumption and structure performance (ref.WP4 activities - Task 4.3);

¹ ALTERENERGY relies on a partnership of 18 organizations, regions, ministries and energy agencies belonging to all the countries of the Adriatic area: Italy (7 Adriatic Regions- Puglia, Abruzzo, Emilia Romagna, Friuli Venezia Giulia, Marche, Molise, Veneto), Albania, Bosnia Herzegovina, Croatia, Greece, Montenegro, Serbia and Slovenia.

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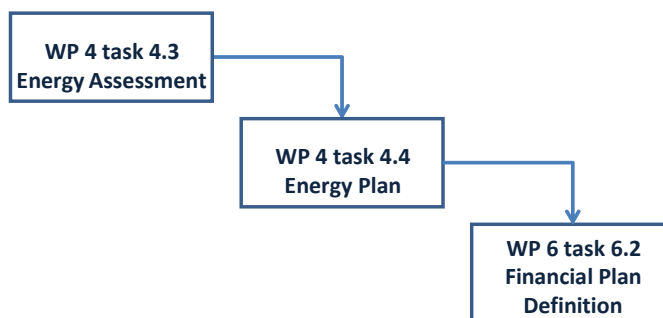
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2. **Energy plan:** after a technical desk analysis and a quantitative / qualitative assessment of results achieved in the first phase, identification of candidate Energy Efficiency Improvement² measures (such as technical interventions on building envelope or systems), estimation of their expected cost-benefit ratios, selection of the package of applicable technical solutions which maximizes the expected revenues at the entire real estate stock level i.e. PMEE(ref. WP4 activities -Task 4.4);
3. **Definition of a convenient Financial Plan** which can support PMEE procedures according to a building Monitoring and Verification approach(ref. WP6 activities -Task 6.2)



This document is an executive summary of **Report D 4.4** concerning Energy Plan activities (phase II), carried out on 8 properties of Agnone municipality.

²In Italian: “Misure di Efficienza Energetica” MEE

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Results outline

The energy plan has been developed for a set of 8 properties owned by Agnone municipality on the basis of the information framework obtained from the Energy Assessment (please refer to Report D 4.3). The results are summarized in the following table.

Code	Property	Main Use	USE				ENERGY CONSUMPTION		
			Total available area (in & out) (m ²)	Available Int. Area (m ²)	Used int. area (m ²)	Usage rate (%) (3)	Primary Energy (kWhp) (mean 2011-13)	Energy Perf. Index kWhp/m ² (mean 2011-14)	CO ₂ emission (kg CO ₂) (mean 2011-2014)
1	Town Hall	Office	1.818	1.490	1.490	81,5%	166.258	112	70.707
2	Palazzo San Francesco	Culture	2.940	1.823	1.570	81,5%	95.297	61	37.605
3	Palazzo dei Filippini		643	459	0	0,0%	3.845	0	2.097
4	Palazzo Bonanni	Office	1.738	1.532	485	72,2%	50.294	104	22.950
5	Palazzo Nuova Pretura	Office	1.350	1.350	1.350	46,3%	84.289	62	30.776
6	Scuola elementare Capoluogo Marinelli	Education	2.020	1.500	1.500	96,3%	245.876	164	85.911
7	Scuola Materna	Education	908	608	608	83,3%	85.238	140	33.498
8	Asilo nido Ape Maia	Education	470	220	220	83,3%	10.818	49	3.323

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The identification of the Energy Efficiency Improvement measures has been achieved in three steps:

1. Construction of a catalogue of solutions feasible for our analysed building set.
2. Estimate of the costs of proposed measures and of their expected effects on each building.
3. Selection of those measures which are successfully applicable for the analysed properties through an evaluation in terms of their cost benefit ratio.

The catalogue of possible measures to improve Energy Efficiency

For the purposes of the evaluation and selection of measures to improve energy efficiency, below are cited the solutions found and belonging to the following three categories:

- solutions to improve building envelope;
- solutions to improve technological systems;
- incentives for energy efficiency.

1.1 Interventions to improve building envelope performance

	Energy Efficiency Measure on building envelope	Cost (material + mounting) €/m ²	Cost considered for the estimation €/m ²	Achievable Energy savings	Savings considered in the estimation
Thermal insulation of Perimeter walls					
INV1	- External coat	75-100	85	20 - 25%	20%
INV2	- Internal insulation	40-70	60	15 - 25%	15%
Roof Thermal insulation					
INV3	Insulated Soffit	40-70	55	15 - 20%	15%
INV4	Insulated top surface	75-100	85	25 - 30%	25%
Thermal Insulation of floor on the ground					
INV5	Thermal Insulation of floor on the ground	20-50	35	10%	7%
INV6	Replacement of windows and doors	350-550	400	10%	7%

Energy Efficiency measures: Costs and savings table

1.2 Interventions for improvement of technological systems

	Energy Efficiency Measure on building systems	Notes	Technical life
IMP1	Replacement of heat generators with condensation generators	Modular condensation generators with digital thermo regulation	>= 15 years
IMP2	Replacement of electrical water heaters with electric heat pumps	Air-to-water heat pump with storage tank at wall, plastic material with high thermal insulation	15 years
IMP3	Installation of solar thermal collectors for hot water facility	Flat plate solar collectors, storage ranging from 200 to 300 litres, natural circulation, high efficiency rate.	15 years
IMP4	Installation of photovoltaic system P<20 kW	Photovoltaic modules, 60 polycrystalline high efficiency silicon cells, Nominal power 240 kW.	20 years
IMP5	Replacing fluorescent lamps with LED	LED lamps (Light Emitting Diode)	50.000 hours
IMP6	Replacing incandescent bulbs with LED		50.000 hours
IMP7	Replacing halogen lamps with LED		50.000 hours

Financial instruments and incentive tools

In this report the following accessible incentive tools have been considered for energy efficiency improvement interventions:

- Energy Efficiency Thermal Incentive (in Italy named “Conto termico”);
- Net metering for photovoltaic systems;
- Energy Saving Certificates (or white certificates).

For the buildings set under analysis only the “Conto termico” incentive has found fruitful applications. Its characteristics are summarized in the following table.

Summarizing framework of Energy Efficiency Thermal Incentive (“Conto Termico” in Italy)

Solutions	TYPE OF INTERVENTION	CONDITIONS FOR PUBLIC ADMINISTRATION
INV	Improvement of the building envelope (e.g. insulation of walls and roofs, replacement of windows and doors, solar screen installation)	Access mode: <ul style="list-style-type: none"> • <u>direct</u>, after execution of the interventions • incentive booking, funding approval, start of intervention within 60 days from approval. Incentive: 40% of sustained costs with limitations on building surface entity and overall cost. Duration: 5 years Technical requirements: guaranteed minimum value of heat transmittance (for building envelope); guaranteed minimum values for thermal efficiency (for systems).
IMP1	Installation in replacing of condensing boilers	
IMP3	Replacement of heating systems with heat pumps nominal inferior thermal power $P \leq 500$ kW installation of solar cooling systems, solar thermal collectors	Access mode: <ul style="list-style-type: none"> • <u>direct</u>, after execution of the interventions • incentive booking, funding approval, start of intervention within 60 days from approval. Incentive: for heat pumps incentive rates are dependent on system technology and on expected thermal energy production level; for solar cooling and/or heating systems incentive rates depend on radiation surface. Duration: 2 years system replacements up to 35 kW; 5 years in all other cases. Technical requirements: guaranteed minimum values of yield and performance
IMP2	replacement of electric water heaters with heat pump water heaters	
	Replacement of heating systems with heat pumps nominal inferior thermal power $500 \text{ kW} \leq P \leq 1000 \text{ kW}$	Access mode: booking and registration of intervention conditioned on funding availability. Incentive, duration and minimum technical requirements: as above



Evaluation criteria to assess Energy Efficiency interventions

Based on building characteristics (e.g. volumes, dimensions, envelope surfaces, usage, energy flows behaviour) and on measured energy consumption (period 2011-2013), a building model has been developed and the potential impact of each improvement measure listed in the catalogue has been analysed and evaluated. Interventions not compatible with existing zoning ordinances have been discarded.

Adopted performance indicators

Each standard type of intervention has been evaluated according to the following two performance indicators :

1. **payback time** T_r defined as the number of years an Energy efficiency intervention provides a return on investment;

$$T_r = \frac{C_{inv} - I_{tot}}{R_e}$$

where

C_{inv} denotes the total investment amount;

I_{tot} the total obtainable incentive amount;

R_e the annual expected energy saving rate.

2. **CO₂ emissions abatement cost indicator** which is defined as the ratio between the initial investment cost C_{inv} [Euro] and the avoided emissions of CO₂ t saved during the entire investment period (related to the equipment technical life).

The selected interventions package

The package of selected interventions to be implemented on the analysed building stock is reported in the following table.

	BUILDING	TYPE SOLUTION	INVESTMENT	ESTIMATED TECHNICAL LIFE	ESTIMATED ANNUAL ENERGY SAVINGS		ANNUAL COST SAVINGS	INCENTIVE			BENEFICI AMBIENTALI	
					EE	GAS		€ / year	n° years	€ tot	Tons of CO2 NOT EMITTED INTO THE ATMOSPHERE (in technical life)	Cost/benefit ratio
					kwh	mc		€ / year				
1	municipio- verdi	INV4	34.080	30	-	1.255	1.117	2.726	5	13.632	102	201
2	municipio- verdi	INV5	12.950	30	-	439	391	1.036	5	5.180	36	218
3	municipio - tamburri	INV4	24.000	30	-	666	593	1.680	5	8.400	54	289
4	municipio - tamburri	INV5	8.050	30	-	233	207	564	5	1.000	25	277
5	municipio	IMP5	5.809	11	2.117	-	635	-	-	-	16	360
6	municipio	IMP6	642	11	2.201	-	660	-	-	-	17	38
7	Pal. San Francesco	IMP1	18.330	20	-	792	705	1.466	5	7.330	43	257
8	Pal. San Francesco	IMP5	3.429	12	963	-	289	-	-	-	18	192
9	Pal. San Francesco	IMP6	3.269	12	6.401	-	1.920	-	-	-	118	28
10	Pal. San Francesco	IMP 7	1.522	12	486	-	146	-	-	-	9	169
11	Pal. Bonanni	IMP6	911	11	-	1.593	1.418	-	-	-	27	34
12	Nuova pretura	INV4	54.400	30	-	1.280	1.139	4.352	5	21.760	104	315
13	Nuova pretura	INV5	17.500	30	-	448	399	1.400	5	7.000	36	289
14	Nuova pretura	IMP1	11.532	20	-	544	484	931	5	4.655	29	234
15	Nuova pretura	IMP5	9.478	17	3.221	-	966	-	-	-	84	112
16	Nuova pretura	IMP6	578	17	742	-	222	-	-	-	19	30
17	Scuola elementare	INV1	104.300	30	-	3.965	3.529	8.344	5	41.720	232	269
18	Scuola elementare	INV4	48.000	30	-	3.965	3.529	3.840	5	19.200	305	94
19	Scuola elementare	INV5	17.920	30	-	1.388	1.235	1.434	5	7.168	103	104
20	Scuola elementare	IMP1	28.164	20	-	1.979	1.761	2.253	5	11.265	107	158
21	Scuola elementare	IMP3	4.596	15	-	813	723	1.127	2	2.254	33	71
22	Scuola elementare	IMP5	12.497	11	4.487	-	1.346	-	-	-	76	164
23	Scuola elementare	IMP6	239	11	4.487	-	1.346	-	-	-	2	156
24	Scuola elementare	IMP4	6.400	20	4.487	-	1.346	-	-	-	169	38
25	Asilo nido	IMP1	2.282	20	-	191	170	183	5	915	10	132
26	Asilo nido	IMP5	1.971	15	840	-	252	-	-	-	19	101
27	Asilo nido	IMP4	1.971	20	1.266	-	380	-	-	-	18	112
28	Scuola materna	INV1	32.340	30	-	1.151	1.024	2.587	5	12.936	93	208
29	Scuola materna	INV4	52.000	30	-	1.151	1.024	4.160	5	20.800	93	334
30	Scuola materna	IMP3	1.701	20	-	242	215	392	2	784	13	70
31	Scuola materna	IMP5	7.976	15	3.685	-	1.106	-	-	-	85	94
32	Scuola materna	IMP4	5.400	20	4.270	-	1.281	-	-	-	132	41
TOTALI GENERALI			534.236	21	39.652	22.095	31.560	185.999	79	185.999	2229	156

The selected investment package shows the feasibility of an investment plan where **32 energy efficiency measures** are applied on eight buildings for a total investment of **€ 534.236**. The initiative should generate:

- An expected annual savings of **€ 31.560 per year**;
- A total incentive of **€ 185.999 (distributed in 5 years)**.

Pay Back Time: about 11 years.

During the technical life of the interventions package, the avoided carbon dioxide emissions in the atmosphere amount to **2.229 t** for an expected CO₂ abatement cost equal to **156 €/Ton**.