Second Level - **Methodology and performance assessment for public and historic buildings**

Starting from the analysis of the municipal building database (see the "red" columns of the Governee database template), for each building the following activities may be performed:

- identify priorities (need of extraordinary maintenance for specific building components, buildings with highest consumption in absolute values or per cube meter)
- identify opportunities (financial support, incentives, roof surface availability for installation of solar panels, etc.)
- keep in mind that improvements of building components should come before improvements of the heating system
- calculate (or estimate) "quantities" to be renovated for building components and heating system (square meters of roof, windows, power of boilers, number of radiators, etc.)
- calculate (or estimate) "quantities" for renewable energy (power that could be installed for photovoltaic generation, square meters available for thermal solar panels, etc.)
- evaluate costs, by multiplying the previously identified "quantities" with the public works department prices for each action
- calculate (or estimate) energy savings or energy generation
- evaluate pay-back time and/or other economic parameters
- evaluate monitoring indicators (see "Monitoring system and financial evaluation framework to assess and evaluate energy efficiency programs related to public heating" - WP 3.3.5 ex 3.3.7) for each building/measure (if available or needed according to the Municipal criteria and indicators of the planned monitoring).

Do not remove costly measures only because of a high payback time, since the Action Plan may consider group/groups of municipal buildings to be renovated, where a short payback time of a certain action may compensate a long payback time of another action.

The previous activities require the performance of "detailed" energy audits on all buildings or on a sample of them. If the sample is sufficiently representative of the whole buildings stock, results obtained by the "detailed" audits may be extended to the other buildings; usually, the extension comes from the application of savings and costs in a parametric way (cost per cube meter, % saving per cube meter).

A first discussion among municipal departments is needed at this stage of the work, so that potential measures proposed by the energy audit (energy/environment department) are verified with the public works department.

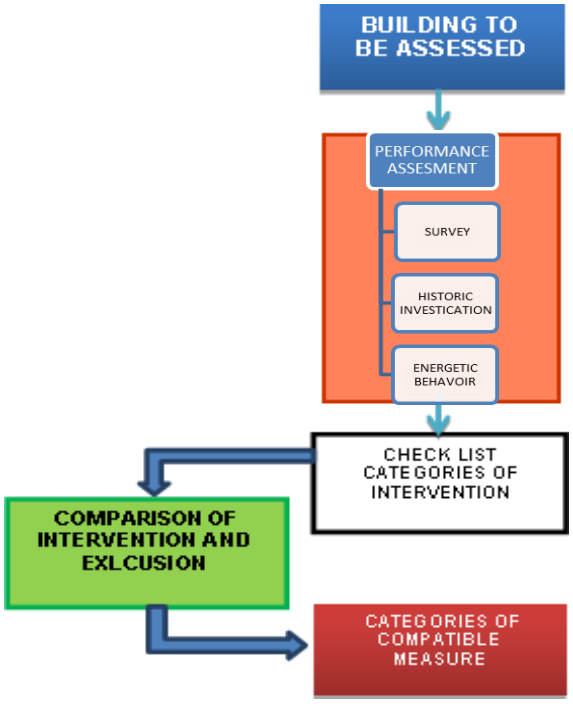
	Interventions	**Purpose**
Plant	Interventions on the plants to increase the efficiency of the components and to balance the distribution of heat in all room.	*Minimize the primary energy supplied to the building to ensure the required comfort.*
Building	Interventions on the building to limit thermal dispersion, typically insulating and adopting high insulation windows that protect both summer and winter, and that simultaneously increase the comfort.	*Minimize the energy requested in the building, to ensure the required comfort.*
Management	Maintain undamaged the plant efficiency, improve the operating conditions and eliminate all forms of waste.	*Optimize the use of energy, ensuring the required comfort.*
Energy sources	Even partial use of other forms of energy such as solar thermal, heat pumps, biomass, etc.	*Replace all or part of the primary energy source with a free renewable source, independent of fossil-fuel and not taxed.*

MEASURES FOR EE & RES
Horizontal elements on the ground
Reconstruction of the floor with the creation of an aerated ground floor loose stone foundation (if not already present) and the application of a thermal insulation
Construction of trenches of aeration / ventilation
Realization of aerated cavity wall below the floor (floating floor)
Opaque vertical elements
Thermal plaster
External insulation finishing system
Using thermo-reflective materials
Horizontal and/or inclined elements
Introduction of a layer of thermal insulation or thermo-acoustic in the floor
Introduction of the layer of thermal insulation in the roof slab
Creating cavity wall for the natural ventilation of the roof
Introduction of materials (sheathing, insulation materials) heat-reflective in the roof
Introduction waterproofing membranes and / or vapour barriers in the roof
Internal insulation of walls
Transparent elements
Replacement of window frames with a modify of material or type of frame
Replacing the glass with just any partial amendment of the frame
application of external films filtering solar radiation
maintenance existing fixtures
Renewable technologies
Introduction of a system for the production of electricity by the photovoltaic system integrated with groundwater heat pumps
Introduction of a system for the production of electricity by photovoltaic arranged in small outdoor appurtenant areas
Plant of heating and production of hot water with the use of solar thermal panels
Production of energy through horizontal geothermal systems
Production of energy through vertical geothermal systems
Construction of plant for the production of wind energy (mini-wind)
Realization of plant for the production of hydraulic energy (mini-hydraulic)
Use of biomass for energy
Biofuels

CHP (CHP: Combined Heat and Power Production) using RES
Control and management Systems
Using automation to control indoor environment (lighting, weather conditions)
Replacing existing lamps with energy saving light bulbs or LED
Improvement of contribution of natural light through systems conduction of sunlight such as the solar chimney or systems with fiber optics
Introduction of special items to improve thermal efficiency through passive technologies (wall trumpets, solar greenhouse, chimneys collection)
Use of materials at the phase transition to produce heating and passive cooling
Heating
GAS HIGH EFFICIENCY BOILERS
HEAT PUMPS
EE heat distribution systems
EE control systems

SPECIFICATIONS FOR HISTORIC BUILDINGS

In the case of refurbishment of historic buildings, whether undergoing ordinary or extraordinary maintenance, the possibility of introducing elements of energy efficiency should always be assessed.
In order to achieve the refurbishment of historic buildings it is primarily necessary to carry out a performance analysis.
Unlike other types of buildings, historic buildings require an analysis that takes into account environmental aspects (which may cause damage to buildings of historical value) in addition to those typically performed to evaluate the performance of the energy behaviour.
The first phase of the performance assessment is oriented to acquire the set of elements useful to the knowledge of the building, the microclimate conditions and the resulting dynamics of degradation of the materials which are part of the building shell and of the goods contained therein. The second part of the analysis will detect the thermal performance of the building (shell / plants / consumption).
These analysis may be used for several purposes:
1. to classify buildings according to their historical value
2. to categorize the buildings for inclusion in the database of municipal public buildings
3. to identify measures for energy retrofit of buildings
4. to plan interventions upon the public property within a Municipal Strategic Plan
5. to monitor the state of conservation and energy efficiency of public buildings on the base also of operating costs
6. to have a clear picture of public property so to prepare Energy Performance Contracts with ESCos (for the management and the energy efficiency retrofit of the public buildings).
The following diagram summarizes the steps to achieve the performance assessment. The analysis will allow to consciously choose which solutions may be implemented.



PERFORMANCE ASSESSMENT (knowing the building)	SURVEY	Morphology	Planivolumetric compactness and S/V Orientation/Shading
		Type of building (category)	
	HISTORIC INVESTIGATION	Materials	
		Stratigraphy of building envelope	
		Invetigations of microclimatic conditions	
		state of preservation of the building	
	ENERGETIC BEHAVIOUR	Existing plant system	
		Thermal Transmittance	
		Thermal lag	
		Potential for explotation and optimizazion of natural resources	

Compatibility of the intervention on historic building

Starting from the considerations regarding interventions to improve performance energetic building envelope, below we suggest an evaluation schedule for the categories of intervention relating to each component of the building, showing the eligibility of any action with respect to the requirements of protection legislation.

Legend	
•	Very limited
••	Limited
•••	Acceptable
••••	High

CATEGORIES OF INTERVENTION for the energy saving	**FEASIBILITY ON HISTORIC BUILDING**	
Horizontal elements on the ground		
Reconstruction of the floor with the creation of a ground floor loose stone foundation aerated (if not already present) and the introduction of layer of thermal insulation	Assess compliance with the requirements of the building	••
Construction of trenches of aeration / ventilation	Assess compliance with the constraints of the building	•••
Realization of aerated cavity wall below the floor (floating floor)	Assess compliance with the characteristics of the element	•••
Opaque vertical elements		
Thermal plaster	Particular attention to the use of specific materials	••
External insulation finishing system	Assess compliance with the constraints and morphology of the building	•
Using thermo-reflective materials	Assess in relation to constraints and morphology	••
Interior wall insulation without paintings	Assess compliance with the requirements of the building and constraints of the element	••
Horizontal and/or inclined elements		
Introduction of a layer of thermal insulation or thermo-acoustic in the floor	Assess compliance with the requirements of the building	•••
Introduction of the layer of thermal insulation in the roof slab	Assess compliance with the requirements of the building and constraints of the element	•••
Creating cavity wall for the natural ventilation of the roof	Assess compliance with the requirements of the building and constraints of the element	•••
Introduction of materials (sheathing, insulation materials) heat-reflective in the roof	Assess compliance constraints and characteristics of the building	••••
Introduction waterproofing membranes and / or vapour barriers in the roof	Assess compliance constraints and characteristics of the building	••••
Transparent elements		
Replacement of window frames with a modify of material or type of frame	Only if the window frames do not have to be maintained	••••
Replacing the glass with just any partial amendment of the frame	Respect to the constraints of existing windows	••••

Maintenance of existing fixtures with improving the energy performance of the original wooden frames	Respect to the constraints of existing windows	••••
Films filtering solar radiation	Evaluate on the base of possible restraints	•••
Control and management Systems		
Using automation to control indoor environment (lighting, weather conditions) and control of pollutant emissions (CO 2 , u.r.)		••••
Replacing existing lamps with energy saving light bulbs or LED		••••
Improvement of contribution of natural light through systems conduction of sunlight such as the solar chimney or systems with optical fibre	Evaluate characteristics of the building	•
Introduction of special items to improve thermal efficiency through passive technologies (wall trumpets, solar greenhouse, chimneys collection)	Rarely feasible's historical buildings	•
Use of materials at the phase transition to produce heating and passive cooling	Shortly feasible in relation to the constraints of a historic building	••