D.T3.5.2 JOINT METHODOLOGY FOR MONITORING RESULTS

Version 01

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Edited by PP4 KSSENA

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ABSTRACT

D.T3.5.2 Joint methodology for monitoring results is a technical document within the activity A.T3.5 Methodology for monitoring results of the Local energy Saving Plans in Municipalities.

In this document we will prepare the methodology that can be used for monitoring results. This methodology is prepared by 5 steps:

1. Decide on system boundaries
2. Choose a baseline year
3. Decide on units of output
4. Gather the energy use data
5. Data analysis

Monitoring results is also known as energy management. Buildings that have developed energy management systems generally achieve far greater savings than those without, because they review and manage energy use across the whole organisation, on a defined basis.

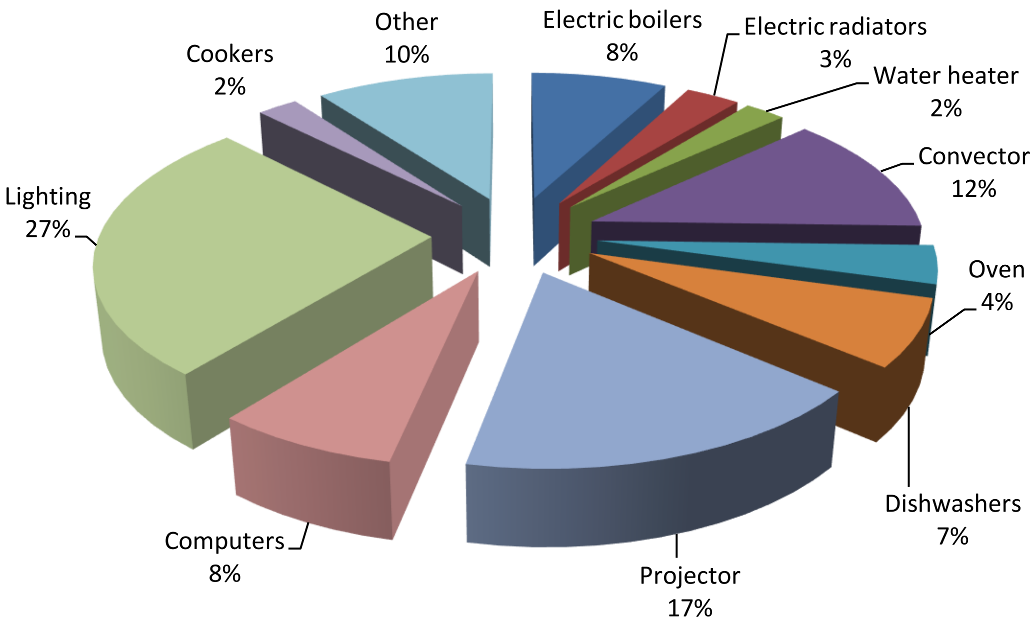
Energy management is the process of monitoring energy consumption, collecting and organizing the data, identifying opportunities to save energy and analysing their impact, taking targeted action towards implementing technological and organizational measures that address these opportunities and monitoring the progress in terms of achieved energy savings.

Energy management is the key aspect of addressing energy usage systematically and enables:

- reduce operating expenditure of the school and increase the amount of funds available for other programs,
- reduce carbon footprint and attributed environmental damage, avoid or reduce carbon associated taxes and duties and promote a sustainable, green eco-friendly image of the organization

1. DECIDE ON SYSTEM BOUNDARIES

The first step we have to take for monitoring results is to define what kind of data we want to include in the process. You can separate consumption on lighting, heating, cooling, office equipment, cooking, etc. in corresponding to the data that is actually available in building. We have to make an inventory of how building is heated and provided with electricity and how much of this energy is obtained from renewable energy sources.



2. CHOOSE A BASELINE YEAR

For any building that we want to demonstrate improvements in energy performance, the energy consumption baseline has to be set. An energy baseline is a reference tool that allows the organization to compare energy performance before and after any measure are implemented on building site or system. The baseline establishes the "before state" by capturing a building or system total energy use prior to making improvements. Without an accurate baseline, the monitoring of results cannot be achieved, and hence corrective actions and improvements cannot be identified or implemented.

To set the baseline year it is recommended to collect the energy consumption for three years or at least for one whole year. It is necessary to verify that no major measures have been implemented on the building system, during the defined period, because such data is not correct (example: replacement of energy carrier for heating). In case that the three years data are not available, it is required to collect the data that extends for at least one year to account for the effects of outdoor temperatures in all seasons.

This kind of data can be easily collected from smart metering systems. When becoming a "Smart school" the investment in smart meters is mandatory.

3. DECIDE ON UNITS OF OUTPUT

Because each building is using a different energy carrier it is recommended to use the energy factors to unify the units of energy consumption, this enable us to compare energy savings.

Energy factors are coefficients for quantify the final energy consumption by different energy carrier.

Energy Carrier	**kg EP**	**kWh**
1 kg heating oil	1.01	11.744
1 kg gasoline	1.051	12.221
1 kg diesel	0.95	11.047
1 litro diesel	0.789	9.169
1 kg Liquid Gas	1.099	12.779
1 litro Liquid Gas	0.56	6.517
1 mc Liquid Gas	2.055	23.897
1 kg Natural Gas	1.126	13.093
1 Smc Natural Gas	0.82	9.535
1 kg solid biomass (humidity 25%)	0.33	3.837
1 kWhe (internal gross consumption)	0.2021	2.5
1 KWhe (final gross consumption)	0.086	1
1 kWht	0.086	1

Table 1: Energy factors from EGSSM plan

When comparing buildings energy savings we have to consider:

- Building categorisation (public building, residential building, etc.)
- Temperature deficit (buildings in different geographical position have different energy consumption due to different outdoor temperature)
- Units (kWh/person; kWh/m^2; etc.)

4. GATHER ENERGY USE DATA

Energy consumption should be collected and divided on areas, as predefined in the first step decide on system boundaries. In the table below, you can see the example of divided energy consumption on different areas.

Category	FINAL ENERGY CONSUMPTION (kWh)													Total
	electricity	Thermal	Fossil fuels				Renewable energies							
			Natural gas	Natural gas liquid	Heating oil	Lignite	Wind	Hydroelectric	Photovoltaic	Biogas	Wood	Solar Thermal	geothermal	
LIGHTING														
SPACE HEATING														
SPACE COOLING														
WATER HEATING														
OFFICE EQUIPMENT														
COOKING														
VENTILATION														
MISCELLANEOUS														
TOTAL														

Category	CO2 EMISSIONS [ton]													Total
	electricity	Thermal	Fossil fuels				Renewable energies							
			Natural gas	Natural gas liquid	Heating oil	Lignite	Wind	Hydroelectric	Photovoltaic	Biogas	Wood	Solar Thermal	geothermal	
LIGHTING														
SPACE HEATING														
SPACE COOLING														
WATER HEATING														
OFFICE EQUIPMENT														
COOKING														
VENTILATION														
MISCELLANEOUS														
TOTAL														

Table 2: final energy consumption and produced CO_2 emissions

The second part of the table above are calculated CO_2 emissions from emission factors based on energy consumption. The calculation of CO2 emissions (produced in case of consumption and avoided in case of energy saving) are very important because CO2 is the main cause of climate change. The emission of CO2 depends on the combustion of the fuel we use but in the case of electricity, since there is no combustion, we calculate the emission factor linked to the production of the electricity we use. When we use renewable energy sources, by convention, the CO2 balance is zero.

Emission factors are coefficients which quantify the emission per unit of activity. CO_2 emissions are calculated for each energy carrier by multiplying final energy consumption by the corresponding emission factors. We have adopted IPCC approach or emission factors for fuel combustion based on the carbon content of each fuel (Table 3) as well as for renewable energy sources (Table 4). (*1.6.1 Energy guardians smart-school management plan*)

Table 3: Emission factors for fossil fuel combustion (*1.6.1 Energy guardians smart-school management plan*)

Energy carriers	tCO_2/MWh
Natural Gas	0.202
Natural Gas Liquid	0.231
Heating Oil	0.267
Lignite	0.364

Table 4: Emission factors for local electricity or thermal production renewable energy sources (*1.6.1 Energy guardians smart-school management plan*)

Energy carriers	tCO_2/MWh
Wind Power	0
Hydroelectric Power	0
Photovoltaics	0
Biogas	0.197
Wood	0,007
Geothermal	0
Solar thermal	0

IPCC emission factor should be reported close to zero if the biofuels/biomass meet sustainability criteria

Table 5: Emission factors for electricity by country involved in the ENERGY@SCHOOL (*1.6.1 Energy guardians smart-school management plan*)

	IPCC tCO2/MWh					
Country	2005	2006	2007	2008	2009	2010
Austria	0.226	0.212	0.202	0.206	0.200	0.204
Germany	0.619	0.621	0.645	0.626	0.609	0.616
Hungary	0.563	0.551	0.606	0.593	0.516	0.539
Italy	0.491	0.494	0.493	0.484	0.453	0.467
Poland	1.262	1.243	1.188	1.123	1.141	1.165
Slovenia	0.536	0.536	0.539	0.561	0.613	0.582

Source: Joint Research Centre of the European Commission. Last update: July 2016

5. DATA ANALYSIS

Data analysis is the process of measuring and determining the actual energy savings after implementation of the energy efficiency measure. Energy savings cannot be directly measured, since they represent an unused energy, therefore savings are usually estimated by comparing the energy use before - baseline and after implementation of the measure (behavioural change is also a measure). This process is necessary in order to evaluate the effectiveness of the implemented measures and make appropriate adjustments and improvements.

When analysing the data we have to also consider about temperature deficit (read more in *D.T3.2.1 Vocational energy guardian training programme*). There are rather complexed ways of how to calculate it, but for basic needs we can calculate the temperature degree day from several different websites, for example: https://www.degreedays.net. This website enables you to choose the nearest weather station and will calculate a number of degree days in that area.

For example the calculation for Slovenj Gradec, Slovenia: the number of degree days in year 2017 was 1940 and in year 2018 was 1746. This shows us, that year 2017 was cooler since there was more degree days than in year 2018. Based on this calculation we can conclude that the energy consumption must be bigger in year 2017.

6. CONCLUSION

There is not a “one size fits all” methodology for monitoring results and for identification of the energy baseline. The methods that are chosen have to be adapted to the needs of the discussed building. Whatever the method used, it sometimes discriminates changes in consumption caused by energy efficiency measures from changes caused by relevant variables (e.g. weather, occupancy, etc.). These factors can cause variations that mask the effects one is trying to detect and quantify. Simple baseline development approaches usually have some degree of inaccuracy that can make them misleading, while rigorous and reliable approaches are sometimes too complexed.

The bottom line is that setting a precise baseline could present the most challenging step when decided to implement the energy management system for monitoring results. However, an inaccurate baseline could forfeit the main benefits of an energy management and could mislead an organization in assessing their energy results and thus in measuring the impact of EE measures and interventions.