MOBISTYLE
MOtivating end-users Behavioral change by combined ICT based modular Information on energy use, indoor environment, health and lifeSTYLE

Contract No.: 723032

Report: Two documented 'energy workshops'

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Content

1. Introduction summary

The overall aim of MOBISTYLE is to raise consumer awareness and motivate behavioral change by providing attractive personalized combined knowledge services on energy use, indoor environment, health and lifestyle, by ICT-based solutions. Providing more understandable information on energy, health and lifestyle will motivate end-users to change their behavior towards optimized energy use and provide confidence in choosing the right thing. It will offer consumers more and lasting incentives than only information on energy use.

The aim of the report is to document the execution of Energy Workshop conducted with partners and to deliver a list of ideas for energy reduction for MOBISTYLE purposes. Primarily, the objective of the Whirlpool EMEA Energy Workshop process is to find out energy saving opportunities at every level of the plant/site (machines, lines, utilities, specific areas, buildings, full site) concerning every energy media (electric energy, natural gas, hot water, steam etc.) used in the scoped site. The report presented in MOBISTYLE D2.4 is divided in four main sections:

1. Describing the Energy Workshop Process as it has been designed for Whirlpool EMEA internal usage;
2. Describing the adaptation of the process to MOBISTYLE needs;
3. Documenting the actual physical workshop and its outcomes for the Slovenian demonstration case (University of Ljubljana, Ljubljana);
4. Documenting the actual physical workshop and its outcomes for the Italian demonstration case (Hotel L'Orologio, Turin).

2. Energy Workshop Generalities

The Energy Workshop is a Whirlpool EMEA proprietary process, developed in 2010 by Energy Environment, Health and Safety department, that aims to generate energy consumption reduction ideas in a cross functional and data-based way.

The main objective of the Energy workshop is to find out energy saving opportunities at every level of the plant/site (machines, lines, utilities, specific areas, buildings, full site) concerning every energy media (electric energy, natural gas, hot water, steam etc.) used in the scoped site.

Objectives of the Energy Workshop are:

1. To generate ideas in a cross-functional process through a data-based Catalyst Session involving internal and external subject matter experts;
2. To provide a structural way to monitor energy efficiency improvement.

The workshop is structured in four different but sequential phases where Each one has a specific scope to help scheduling the workshop with time and space. As presented in Figure 1, these phases are:

- Phase I: Kick-off;
- Phase II: Data gathering and prework;
- Phase III: Catalyst session;
- Phase IV: Disposition and implementation of ideas.

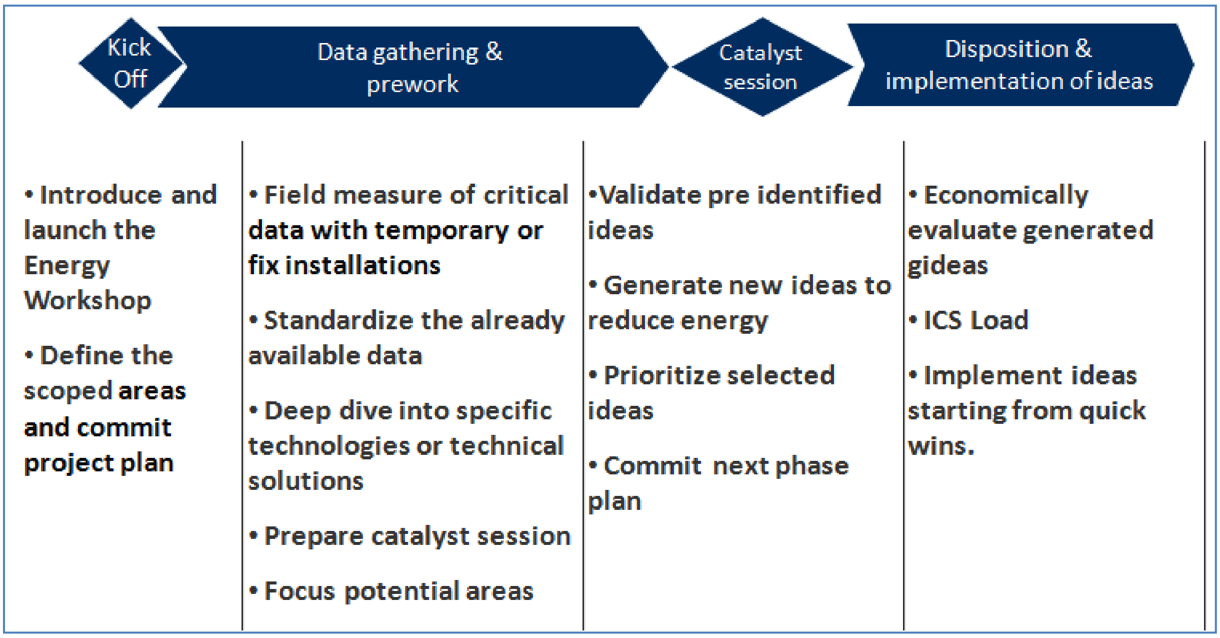
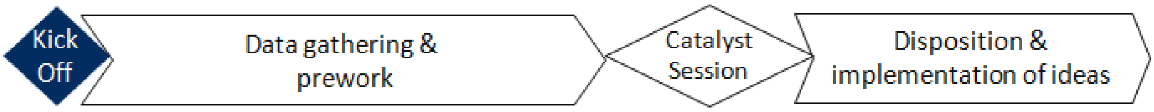


Figure 1: Overall schema of Energy Workshop.

2.1 Phase I: Kick-off



Kick Off is a cross-functional meeting that introduces and launches the Energy Workshop. Scope of the Kick Off is to identify, through the analysis of overall consumption data and preliminary energy breakdown, the areas that will be investigated during the Energy Workshop, define the 'To do List' (a list of measures and data to be collected to prepare the Catalyst Session) and commit the involved resources. Typically, the kick off requires 2 – 3 days.

The tools used in this phase are concerning the site data collection check list as presented in Figure 2.

Figure 2: Site Data Collection.

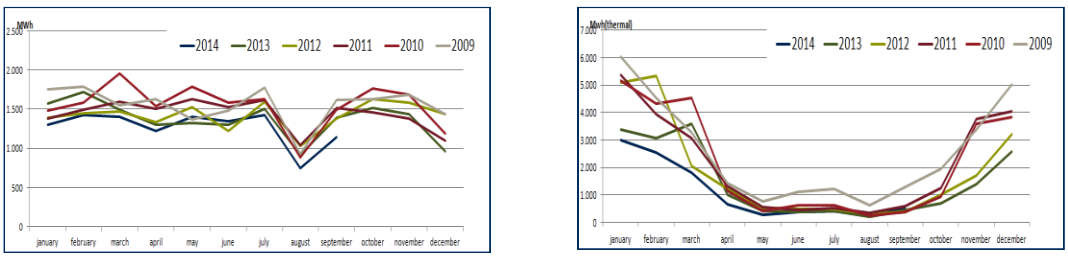


Figure 3: Typical energy consumption vs. time graphs.

The Energy Distribution Matrix (EDM) is a tool used during the kick off to assess the different levels of energy consumption inside the factory, and the possibility to measure local consumption.

The factory is divided into 'Energetic homogeneous areas': clearly identifiable and well-defined areas with a specific type of energy consumption (i.e.: compressors station, painting department, an assembly line, lighting, etc.).

For each of these areas, two values are inserted into the matrix. The first value is referred to the energy consumption and could be measured (if dedicated meters are available) or estimated based on plate values and spot measures. The second value refers to the data availability, that means the presence of dedicated counter for each area and the type.

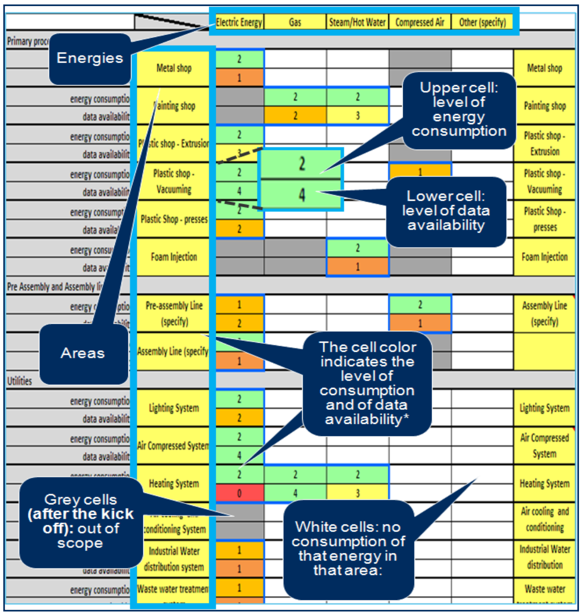
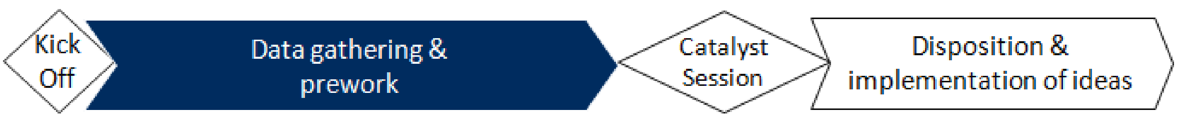


Figure 4: Energy Distribution Matrix.

Cell emptu: no conpsumption of the specific energy	
1 = there is a consumption of the given energy, but it's not relevant	**1**
2 = there is a relevant consumption of the given energy	**2**
0 = no consumption data is measured (no presence of any energy meter)	**0**
1 = presence of an energy meter, but consumption data are not collected/recorded	**1**
2 = presence of an energy meter, consumption data periodically manually collected	**2**
3 = presence of an energy meter, consumption data automatically recorded (local data logger)	**3**
4 = presence of an energy meter, consumption data automatically recorded and stored in a digital data base	**4**

Figure 5: Heat Map legend for Energy Distribution Matrix.

2.2 Phase II: Data Gathering and Pre-work

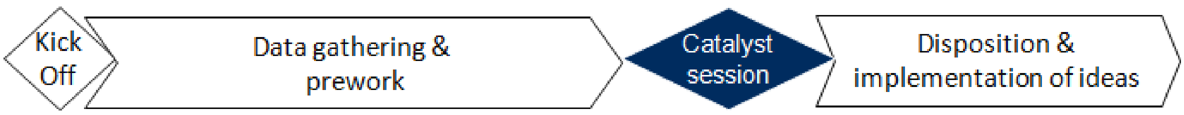


During the Data gathering and pre-work phase, data are collected according to the 'To do list' committed during the kick off. The data could be both measurements of the consumption (with fix meters or temporary instruments), historical data and specific information such as layouts, census of equipment, etc.

Once the data have been collected, they are analyzed and the support documentation for the Catalyst session is prepared. This phase could last between two to four weeks, according to the data availability and to the measurement campaigns planned.

Figure 6: Example of collection of data prepared for Catalyst session.

2.3 Phase III: Catalyst session



The Catalyst Session is the core of the Energy Workshop process. It is a cross functional brainstorming, and its main objectives are to generate new energy efficiency ideas, validate the already existing ones and share best practices. The result is an 'Idea List', containing all the identified ideas, prioritized according to a preliminary evaluation of benefits and constraints.

Figure 7: Site visit and classroom.

The Catalyst session must be conducted at the site for all participants to get a look to the facilities (e.g. power generator, equipment and machines, distribution system, boilers, compressors, heating ventilation and air-conditioning system etc.).

The idea generation phase is facilitated by a central expert and is based on critical review of all the data gathered and analyzed at previous stage. The approach is brainstorming (i.e. no filter, no criticism at idea generation stage) to guarantee both big number and big variety of idea.

All gathered ideas will be then evaluated and prioritized using Prioritization Matrix having potential savings ('High' and 'Low') on Y axis ordinates and constraints (costs, time to be implemented, impact on production, legal constraints, resources availability and all aspects that can impact on the implementation of the idea) on X axis.

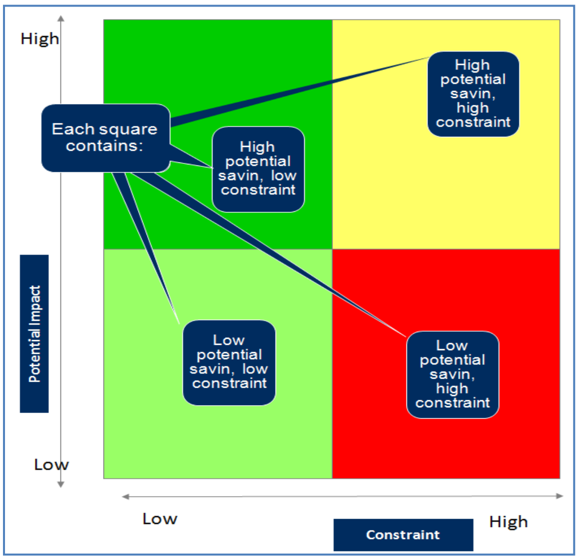
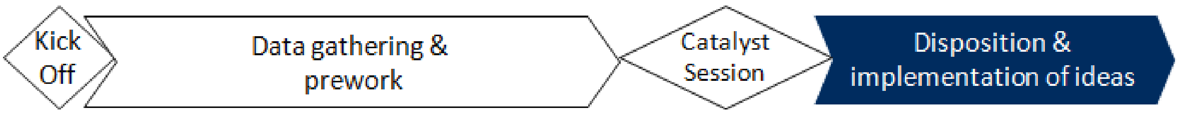


Figure 8: Prioritization Matrix.

2.4 Phase IV: Disposition and implementation



The last phase of the Energy Workshop is the Disposition and Implementation of ideas. During this phase, the economical saving of each idea is evaluated, and business cases are developed.

Ideas are inserted in Initiatives Control System (ICS), Whirlpool database to track all the cost reduction opportunities, and implemented starting from quick wins.

3. Process adaptation to MOBISTYLE project needs

The Whirlpool Energy Workshop process has been developed and tailored for internal usage, characterized by production intense entities, clear identification of roles, availability of resources to implement ideas, focus on economical savings, and as such not directly transferrable for the MOBISTYLE project purposes. However, the number and types of adaptation have been quickly identified and applied:

1) Shortening of Training phase

The training phase has been shortened and delivered during General Assembly meeting held in Amsterdam on 13th of February 2017. The training, condensed in 2.5 hours lecture, was conducted by Whirlpool SME, Sergio Simioni and it introduced the workshop scope and methodology to use case owners. The content of the workshop was the standard energy workshop exactly as described in Chapter 2 of this document.

2) Virtualization of Kick-off:

The kick-off meetings have been done in a virtual way, just by mail exchange. These minor adaptations were possible due to the high commitment and high skills available in the project consortium team.

3) Reduction of Requested variety of participants:

While in a large company the involvement of different functions (i.e. Industrial Engineering, Maintenance, Procurement, Production, etc.) are vital to ensure that the generated idea has high degree of feasibility and, more important, a distributed ownership, in MOBISTYLE project use case this seems not to be an issue. The involved entities are small and quite simple from organizational point of view; the main focus is to identify behavioral related energy reduction ideas (area of occupant behavior in buildings). Moreover, in the use cases their own staff own most of the knowledge needed to implement the Energy Workshop

4) Virtualization of some phases:

While for internal use the commitment of the people can be achieved only by a physical involvement to ensure full attention and dedication to the workshop (sometime perceived as a derailed in day-to-day activities), the level of commitment of MOBISTYLE use cases is very high. A lot of activities can be conducted using mail exchange, also because in the use case realities are not present specific equipment such as production lines that require dedicated in place activities.

5) Insertion of special focus to people behavior in idea generation:

During Idea generation phase, a special focus to people behavior (both in the facilitator approach and in the classification of items) is used to make sure a proper feeding of ideas to T2.6 and T2.7.

4. First physical energy workshop in Slovenia: Ljubljana University (LU)

4.1 Kick-off

The kick-off has been conducted alongside the GA meeting held in Amsterdam on February 13-14th 2017. During the informal kick-off meeting, some important decisions were made to optimize the effectiveness of the workshop such as determining the pre-work to be done by university alone and sharing the data framework used to gather energy related data.

4.2 Data Gathering and pre-work

The data gathered by LU has been sent very well before the workshop date (during April 2017) and has been review by WHR expert and formatted using a PowerPoint presentation file in order to facilitate the catalyst session.

The energy related data has been grouped into:

1. Energy spending;
2. Energy Distribution matrix;
3. Best Practices;
4. Time based energy distribution (Calendar, historical consumption, energy consumption profiles);
5. Space based energy distribution (Energy distribution matrix).

The overall quality of the data, both in terms of veracity and validity, thanks also to the presence of a SCADA system which is monitoring and controlling the overall building, has been judged positively by WHR expert allowing a flawless and productive catalyst session, that has been arranged for June 13th and 14th 2017.

4.3 Catalyst session

4.3.1 Ljubljana University Buildings Site Visit

The workshop was conducted by Sergio Simioni assisted by Pierluigi Petrali from Whirlpool EMEA and was hosted and attended by Simon Pikovnik and Jure Vetršek from LU.

Figure 9: Workshop attendants at University of Ljubljana, Slovenia.

The workshop started with a detailed site visit of the building which consists of three main blocks, hosting classrooms of several dimensions, offices, laboratories, meeting rooms, halls, janitorial rooms etc.

Figure 10: Aerial view of Ljubljana Technical University.

The visit started with the inspection of technical facilities such as HVAC, Air and water treatment, which are the main energy sources of consumption. The avaliability of pre-analysed data allowed the team to use the visit as a way to confirm or to explore more in detail some technical aspects of the facilities.

Figure 11: Technical room in the basement (left) and Air treatment detail (right).

The team then moved on the rooftop, where big evaporating towers are installed.

Figure 12: Inspection of the evaporation towers at the rooftop.

Once finshed the technical side (on the energy production / transformation side) a broad view of main energy utilization point was made: rooms (for HVAC and Energy), labs and offices. A particular attention was dedicated to chemistry laboartories which are also involving very peculiar human interactions.

Figure 13: Examination of the chemistry lab.

4.3.2 Review of Gathered data

The next phase of the workshop consisted in reviewing the data gathered by LU. Since the number of attendants was under 10 people and the data was both very clear and not questionable, the team decided to mix the idea generation phase after each main topic.

The initial view is the overall cost of energy, here split in Electrical energy and Gas consumption.

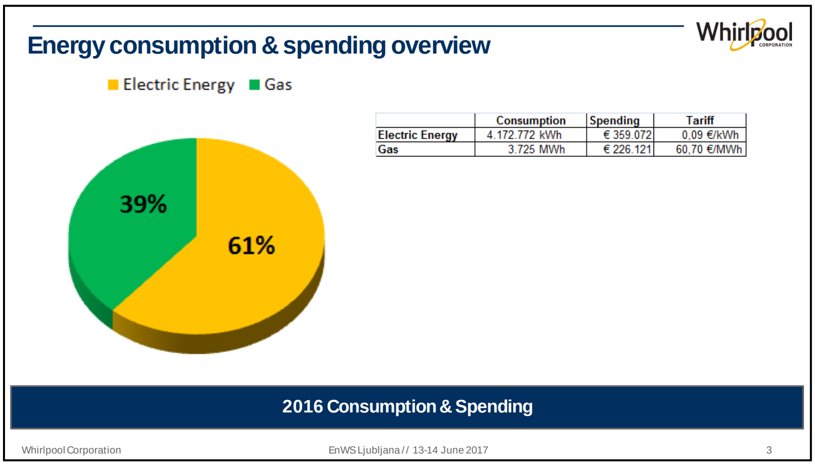


Figure 14: Total energy consumption.

The second and most important data source is the Energy Distribution Matrix from where Air cooling and heating systems are two focus points which impact energy savings to highest degree. These two topics account for more than 20% of total energy consumption for, respectively, electrical energy and gas.

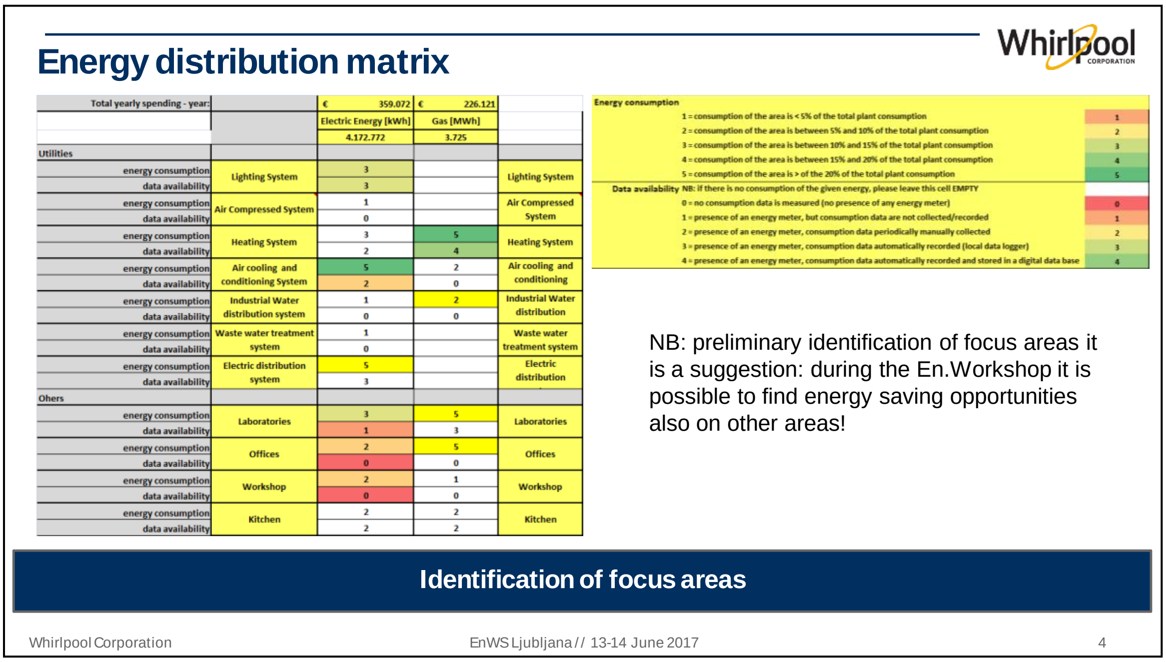


Figure 15: Energy Distribution Matrix (EDM) for LU.

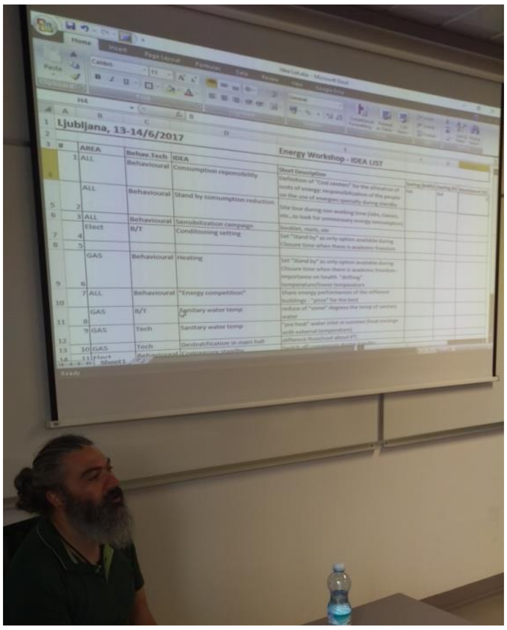


Figure 16: WHR expert leading discussion on EDM.

The next phase was cross-checking the pre-defined list of best practices. From one side, a very positive outcome is that many of them were already implemented (as said a SCADA system for the building allows for an easy automation of some functions); from other side, it turned out that some areas (e.g. compressed air) present very encouraging area of improvement.

Best practices

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Measurement Systems	1.1	Meters for electricity @ (main) trafo station level	1	
	1.2	Meters for electricty @ dept/equipment level	0,5	buildings, equipment that is common
	1.3	Meters for Gas @ production level (ovens, boilers)	0	there is a meter for heating, labs and kitchen separately
	1.4	Meters for thermal energies	1	For each building. We calculate the thermal energy from pumps estimated flow and dT for example AHUs
	1.5	Meters for compressed air @ factory level	na	Low consumption.
	1.6	Meters for water	1	
	1.7	Sofware for energy consumption monitoring	0	
Standby Consumption	2.1	Management of switch off durign non working time	0,5	Schedules on SCADA
	2.2	Macro switch for lines	na	
Lighting system	3.1	Lights: High efficiency lights production area	0,5	
	3.2	Lhights: efficiency lights external	0,5	
	3.3	Lights: management system (timers,sensors) for production area	1	
	3.4	Lights: management system (timers,sensors) for offices	1	
	3.5	**Lights: management system (timers,sensors) for warehouses***	na	
	3.6	**Removal of all lights in "useless" points (e.g. Behind machines, racks..)***	0	
	3.7	**zone-switches (not one single switch) for lights in bigger halls***	0,5	
	3.8	**Ceilings/walls painted with white to reduce lighting needs***	1	
HVAC	4.1	Management of heating (by thermostats/sensors)	1	
	4.2	Management of conditioning (by thermostats/sensors)	1	
	4.3	Partitioning of not heated areas	0,5	
	4.4	Spot heating for small areas inside not-heated ones	0,5	
	4.5	**Insulation of thermal energy distribution piping/valves/manifolds***	1	
	4.6	**Proportional burner for boilers instead of stages burner***	1	
	4.7	**Destratification on higher (< 6m) halls***	na	
Compressed Air	5.1	One compressors with inverter	0	
	5.2	Yearly losses identification campaing with instrument	0	
	5.3	Compressed air distribution Partitioning	0	
	5.4	**Compressors management software***	0	
	5.5	**Automatic valves to cut off compressed air when line is not working***	0	
	5.6	**Boosters for machines needing C.A .at higher pressure than main system***	0	
	5.7	**Local compressors for specific users to allow shut off of the main system***	0	
VSD	6.1	Inverter on main water distribution pumps	1	
	6.2	**Inverter on water wells pumps***		
	6.3	Inverter on air extractors	0,5	
Heat Recovery	7.1	Heat Recovery on compressors: oil/water exchangers	na	
	7.2	heat recovery reuse of hot air (eg: from compressors, chillers, ovens)	0	heat form chiller goes to water tower
	7.3	Heat Revovery on ovens (exhaust to degreasing bath)	na	
Other processes	8.1	**Insulation on injection moulding barrels***	na	
	8.2	**Presence of High efficiency IE 4 electric motors (7,5 kW < power < 75 kW)***	0,5	
Awarness	9.1	Data-based energy map of the factory	0	
	9.2	Energy saving training & communication	0	
	9.3	Defined Energy Strategy with energy consumption reduction targets	0	

1	Implemented
0,5	Partially implemented
0	not implemented
NA	not applicable

Implementation score (implemented/ applicable): 46%

Whirlpool Corporation EnWS Ljubljana // 13-14 June 2017 5

Figure 17: Best practices cross-check.

The team then started to look at time-based energy data: one of the most important factors to be considered is to understand when the building is active/in use (e.g. when students are there) and when it is passive (e.g. when students are in holidays or during weekend). To generate ideas, it is important to address the right user family (e.g. students, professor, technicians etc.) who have different roles according to calendar. Management/optimization of consumption during non-working time is an area where people behavior could have a relevant impact.

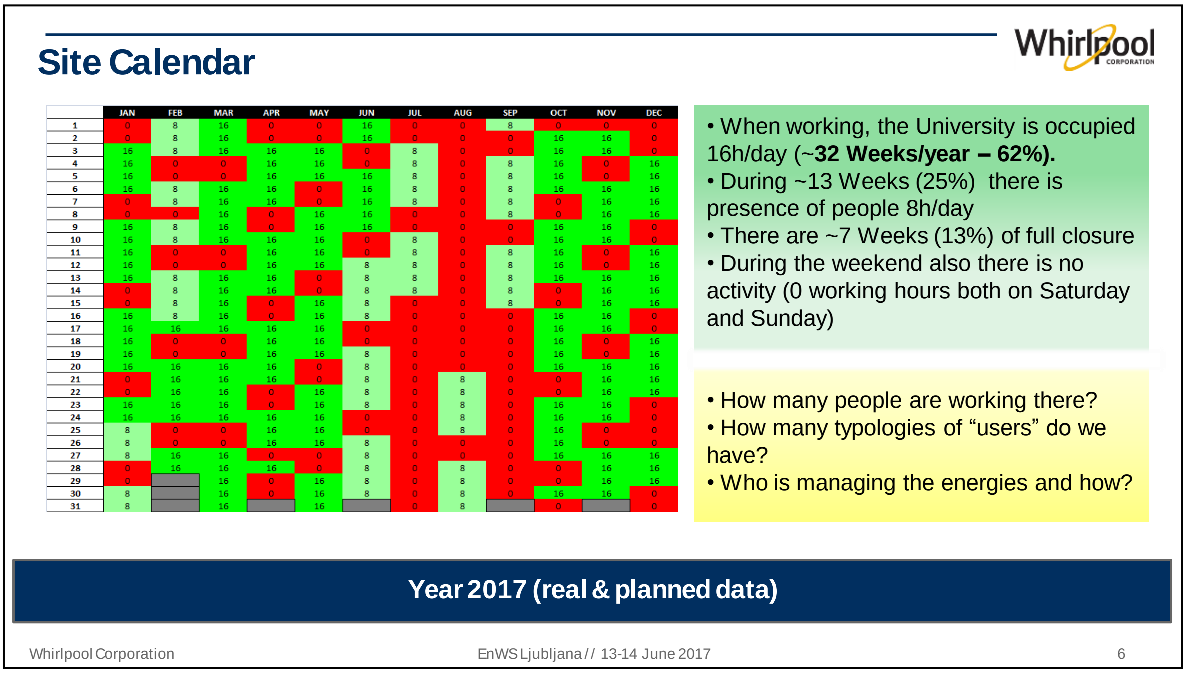

Figure 18: LU yearly calendar occupancy.

When crossing calendar data with energy consumption some interesting question arose: suspicious peaks can provide some hints of unexpected behavior or unmanaged external conditions.

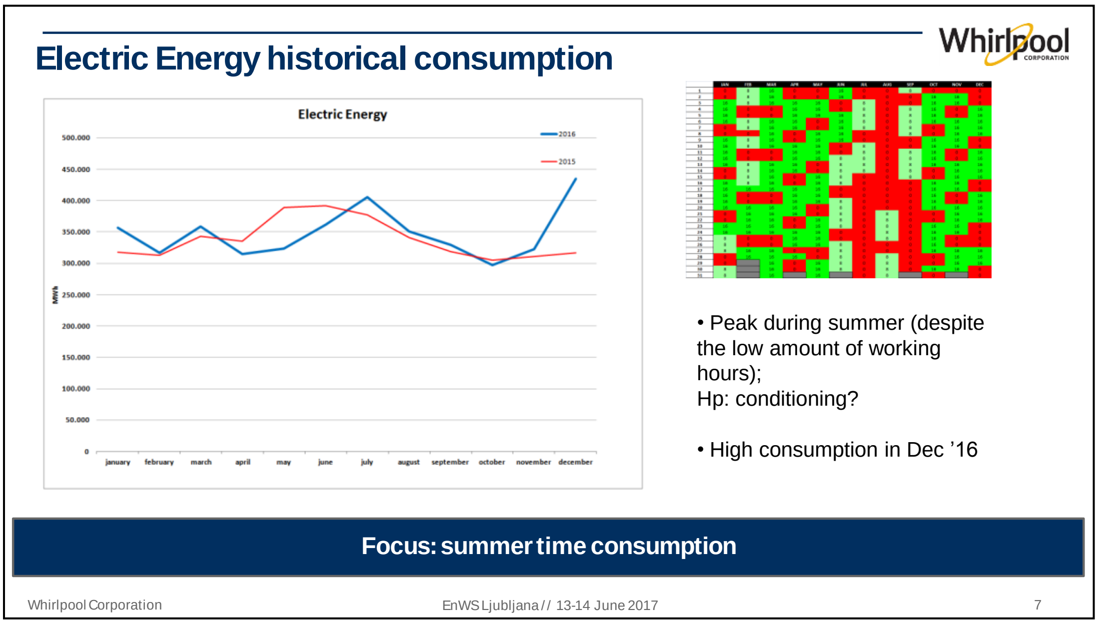

Figure 19: Summer time consumption peak – estimated that due to air conditioning.

This peak is of a particular attention since July and August are the two months with less working hours: influencing the behavior of few present occupants during this period could provide a lot of benefits.

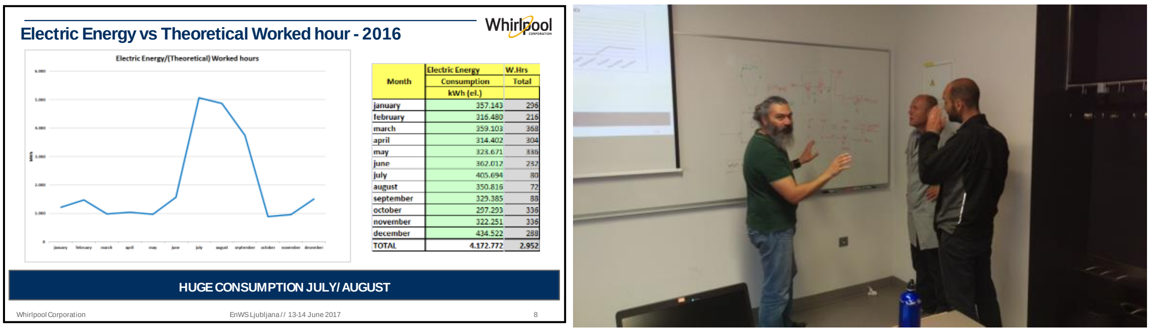

Figure 20: Peak of Energy during workhours in the summer.

Another very powerful way of analyzing energy data based on time is to evaluate the consumption against the baseline (like the basal metabolic rate): in principle during non-productive days (i.e. days with no lessons, no research activities etc.) the building should stay at a very low level compared with productive days.

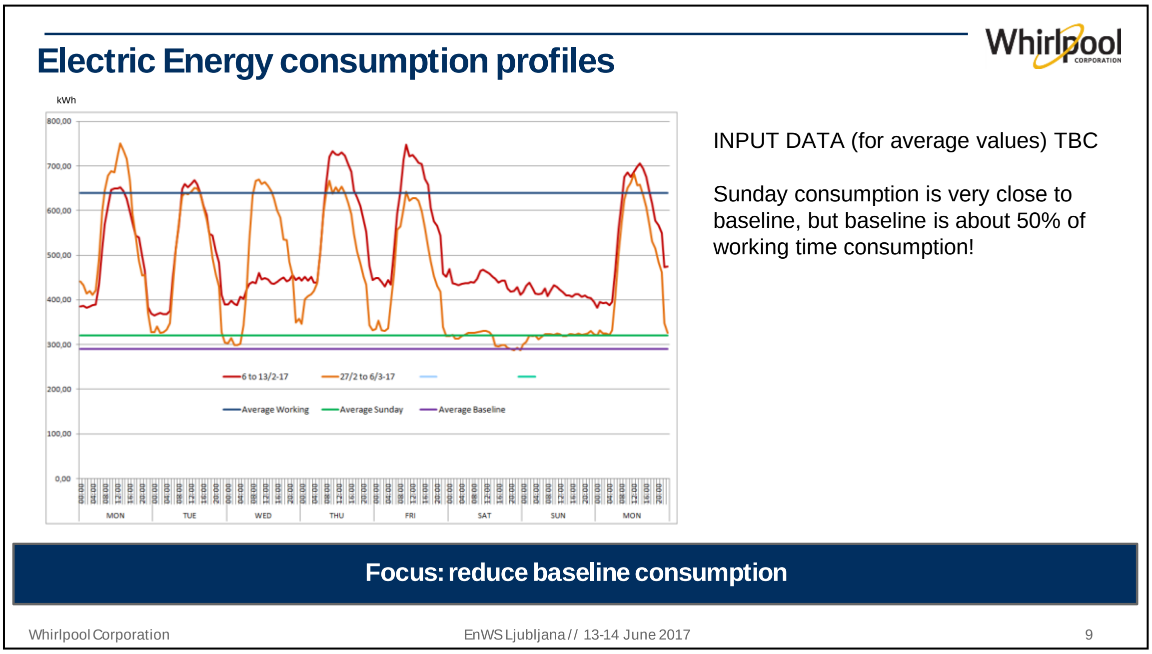

Figure 21: Working days vs. Sundays consumption

The discussion with LU was related to a big difference between working days and non-working days where the baseline is pretty high, accounting for 50% of total consumption. The focus of the investigation was therefore on how to reduce this basal consumption rate to a lower level.

Figure 22: The team discussed over basal consumption and how to reduce Sunday's consumption.

The Carpet plot did not provide great hints, apart a positive event in 1st week of March. Based on the understanding on what happened then lead to a repeatable understanding for similar time periods.

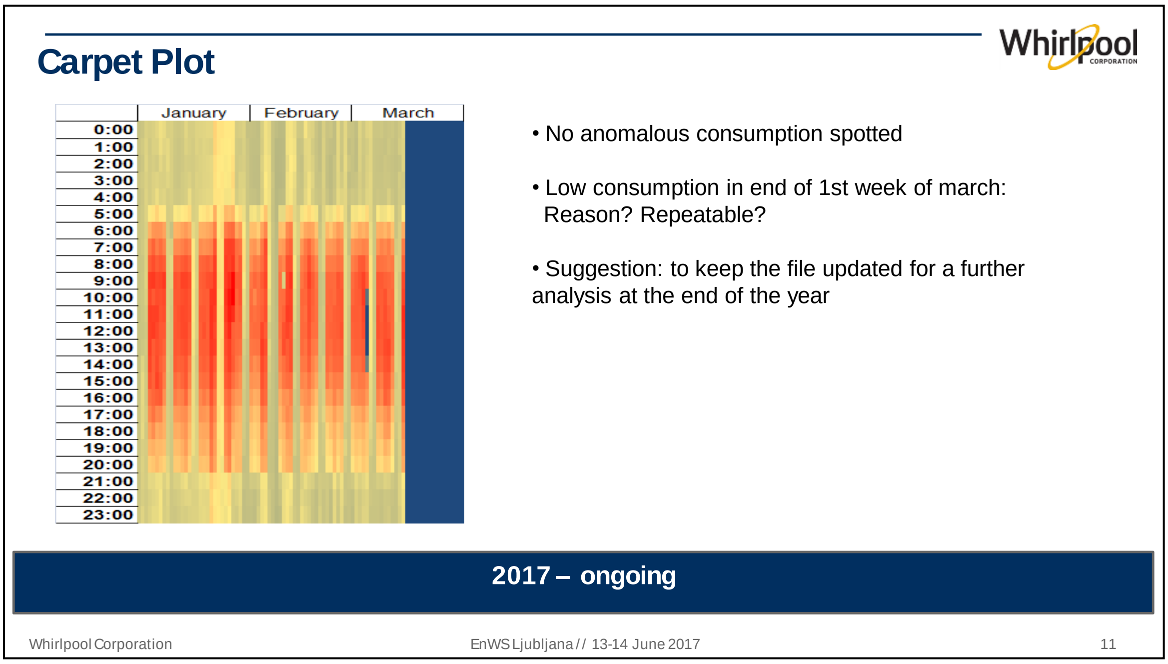

Figure 23: Carpet plot example for LU.

The distribution of thermal energy and gas consumption showed a well-known and common behavior as seen on Figure 24 and Figure 25. From Figure 25 it can be inspected that more careful investigation and attention should be brought to the month of May 2016.

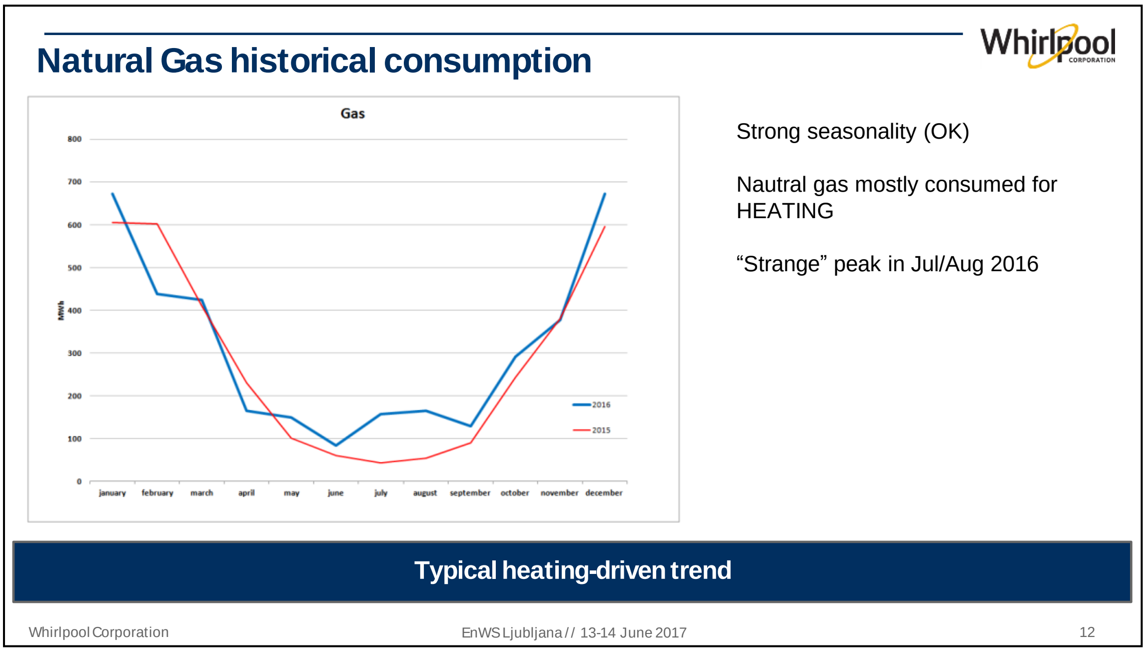

Figure 24: Gas consumption chart over 2016.

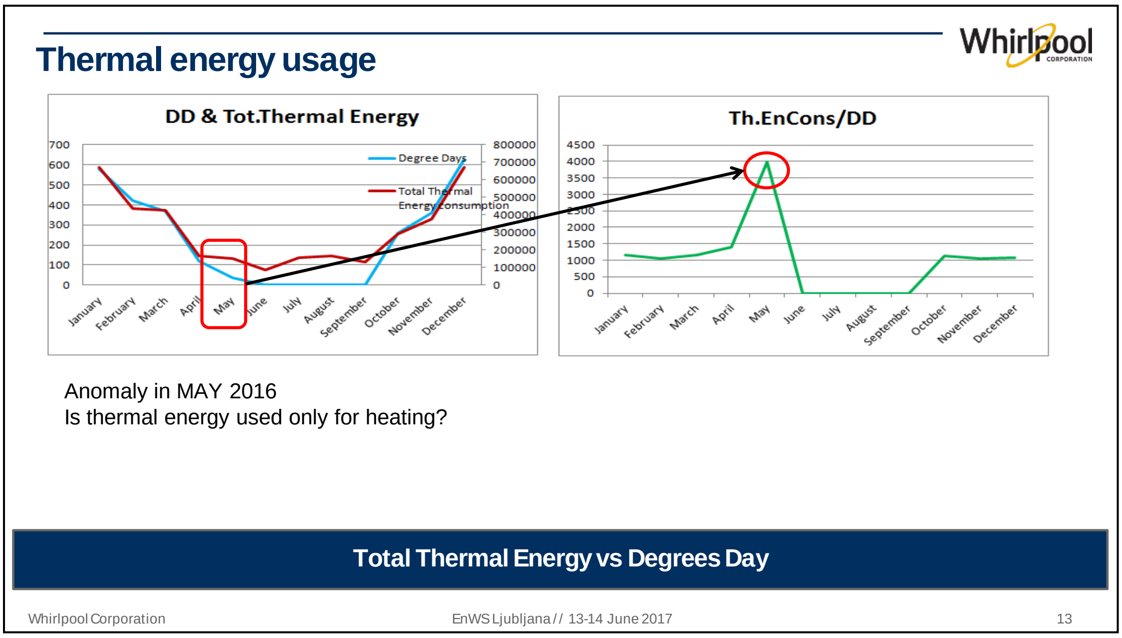

Figure 25: Thermal energy usage for 2016 with a detection of the anomaly for month May.

The anomaly seems to be due to the need of heating up cold air from air conditioning to reasonable temperatures during transition months.

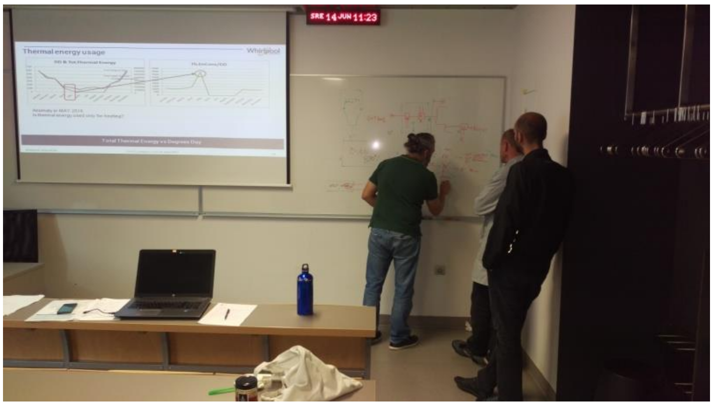

Figure 26: Deeper investigation to analyze the reasons for May peak consumption.

Other data reviewed the energy and resources distribution layout for all the buildings as seen on Figure 27 and 28.

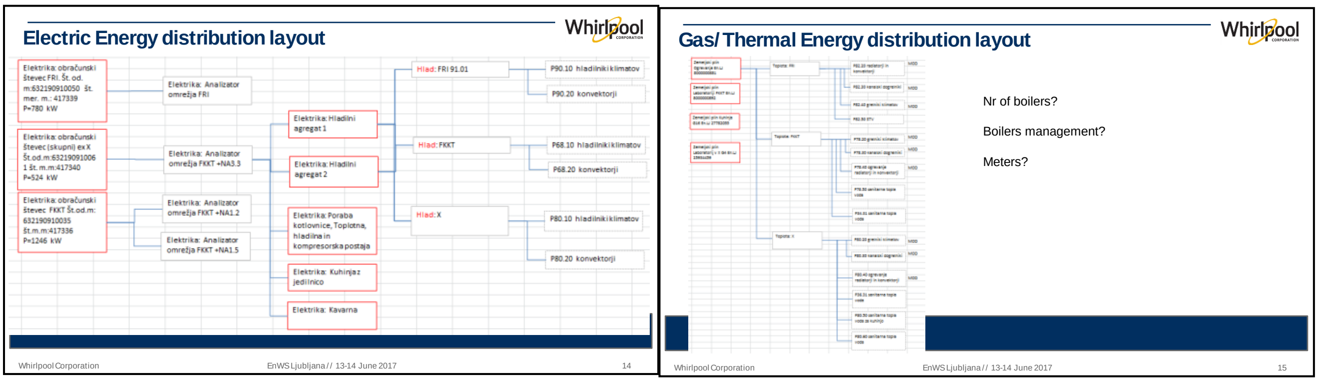

Figure 27: Electric energy distribution layout (left) and Gas and thermal energy distribution (right).

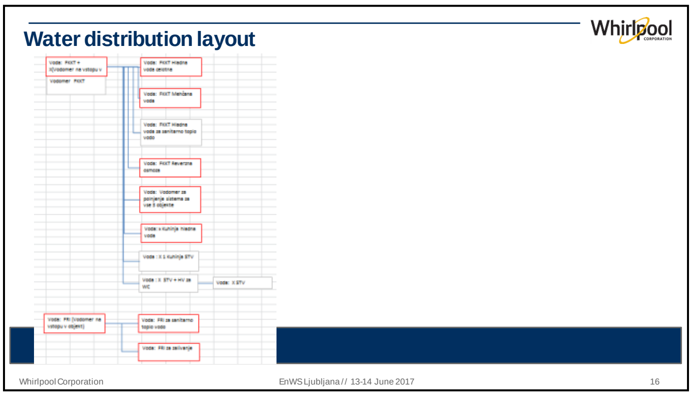

Figure 28: Water distribution layout.

4.4 Outcomes of the Ljubljana Workshop

All the ideas coming out during the workshop have been gathered and provided as a further tool to be used by LU.

#	AREA	Behav.Tech	IDEA	Short Description	Saving [kWh]	Saving [€]	Investment [€]
1	ALL	Behavioural	Consumption reponsibility	Definition of "Cost centers" for the allocation of costs of energy: responsibilization of the people on the use of energies specially during standby	NA	NA	0
2	ALL	Behavioural	Stand by consumption reduction	Site tour during non working time (labs, classes, etc…to look for unnecessary energy consumption)			
3	ALL	Behavioural	Sensibilization campaign	booklet, mails, APPS, Stickers etc			
4	Elect	B/T	Conditioning setting	Set "Stand by" as only option available during Closure time when there is academic freedom			
5	GAS	Behavioural	Heating	Set "Stand by" as only option available during Closure time when there is academic freedom - Importance on health "drifting" temperature/lower temperature			
6	ALL	Behavioural	"Energy competition"	Share energy performances of the different buildings - "prize" for the best - Sinergy with Anthropologic team			
7	GAS	B/T	Sanitary water temp	reduce of "some" degrees the temp of sanitary water			
8	GAS	Tech	Sanitary water temp	"pre heat" water inlet in summer (heat excange with external temperature) (thermal solar panels?)			
9	GAS	Tech	Destratification in main hall	differece floor/roof about 8°C			
10	Elect	Behavioural	Compressor standby	Switch off compressor during standby			
11	ALL	Behavioural	ramp up time reduction	Reduce ramp-up time for heating/conditioning			
12	All	B/T	Energy mapping	periodical report of energy consumption/(kpi): matrix, update carpet plot, etc			
13	GAS	B/T	Post heating for cooling	Central post heating instead of local post heating (saving rather than local regulation)			
14	*GAS*	*Tech*	*Dehumidification*	*Heat recovery instead of gas*			

Table 1: Overall list of ideas emerged at ESW 1 for LU.

This was followed by extraction of the list of only behavioral ideas that, opportunely generalized, can be used to feed MOBISTYLE application content:

Consumption reponsibility	Definition of "Cost centers" for the allocation of costs of energy: responsibilization of the people on the use of energies specially during standby
Stand by consumption reduction	Site tour during non working time (labs, classes, etc…to look for unnecessary energy consumption)
Sensibilization campaign	booklet, mails, APPS, Stickers etc
Conditioning setting	Set "Stand by" as only option available during Closure time when there is academic freedom
Heating	Set "Stand by" as only option available during Closure time when there is academic freedom - Importance on health "drifting" temperature/lower temperature
"Energy competition"	Share energy performances of the different buildings - "prize" for the best - Sinergy with Anthropologic team
Sanitary water temp	reduce of "some" degrees the temp of sanitary water
Compressor standby	Switch off compressor during standby
ramp up time reduction	Reduce ramp-up time for heating/conditioning
Energy mapping	periodical report of energy consumption/(kpi): matrix, update carpet plot, etc
Post heating for cooling	Central post heating instead of local post heating (saving rather than local regulation)

5. Second physical workshop in Italy: Residence L'Orologio Turin (ROT)

5.1 Kick-off

As for Ljubljana case, a formal kick-off was elaborated through the commitment of the involved people from Politecnico of Turin and hotel ownership was already achieved through personal contacts and e-mail.

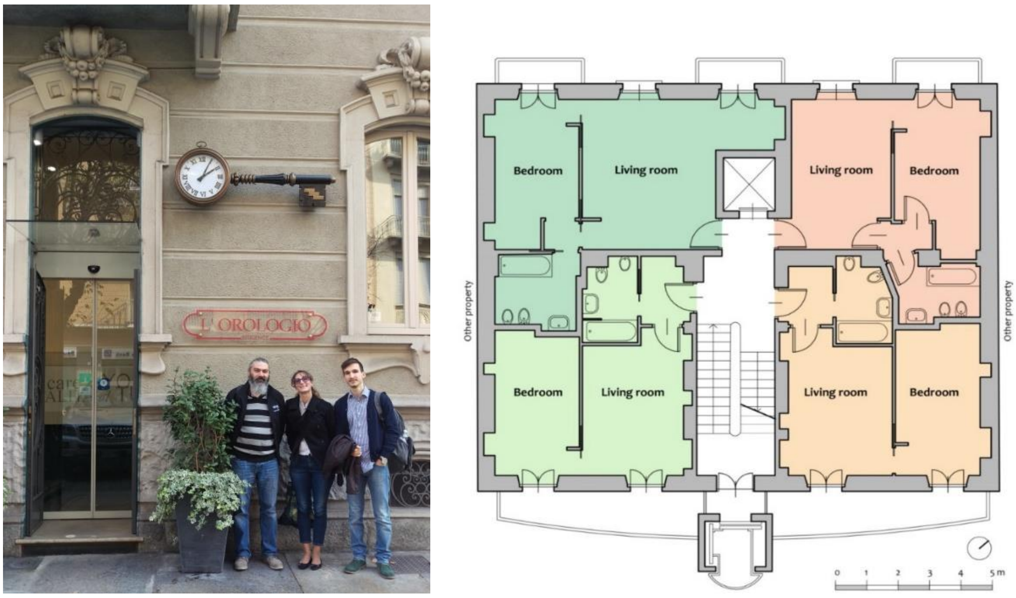

Figure 29: View of Hotel L'Orologio in Turin, Italy.

5.2 Data Gathering and pre-work

The data gathered has been based on a previous study conducted by Politecnico of Turin (V. Fabi et V. Barthelmes) and send in anticipation to workshop leader. Despite the report referring to year 2014, the data has been considered significant since the most important factor of energy consumption was not changed through the last three years.

Figure 30: Interior of residence.

5.3 Catalyst session

The catalyst session took place in Turin on 17th October 2017 with the participation of Sergio Simioni and Pierluigi Petrali from Whirlpool EMEA; Valentina Fabi and Riccardo Sanna from Politecnico Turin; Stefania Talaia and Gianluca Dho from Residence l=L'Orologio.

5.3.1 Residence L'Orologio Building Site Visit

Residence L'Orologio, based in Corso Alcide De Gasperi 41, Turin, is a family owned hotel consisting in 20 rooms distributed on 6 floors for a total of 78 bed availability. It provides a total surface of 1.138 m^2 of which 874 are dedicated to guest rooms. It also comprises a gym, a kitchen for the staff and a children playroom.

Architectural description of the renovated apartments.

Residence L'Orologio presents a very traditional structure with load bearing masonry walls. During the first refurbishment of the building, 10 years ago, no further insulation was added because the thermal transmittance of these elements was high enough according to the national minimum requirements in effect at that time. Nonetheless, the walls transmittance (U_{wall},hotel = 1,12 W/m^2K) is far below the limit U-value currently in force in Piedmont (U_{wall},standard = 0,33 W/m^2K). On the contrary, all the windows were replaced with the most efficient window type solution in 2005: windows with double-pane and wooden frame (U_{window},hotel = 2,5 W/m^2K). Again, the thermal performance of windows are below the current standards expectations (U_{window},standard = 2,00 W/m^2K).

HVAC

Dealing with plants, the building is now heated by 2 condensing boilers powered by natural gas (rated output 84 kW), also used for Domestic Hot Water (DHW) production. The DHW loop also includes an accumulation tank of 300 litres, where water is maintained at the temperature of 46°C. A chiller (cooling capacity 97 kW) is installed for the cooling system. Two-pipes fan coil units, placed in the false ceiling, are the terminals of the heating and cooling system. At present, the building does not have a mechanical ventilation system (except for exhaust air systems in bathrooms and kitchens) and it does not use any on-site renewable energy source.

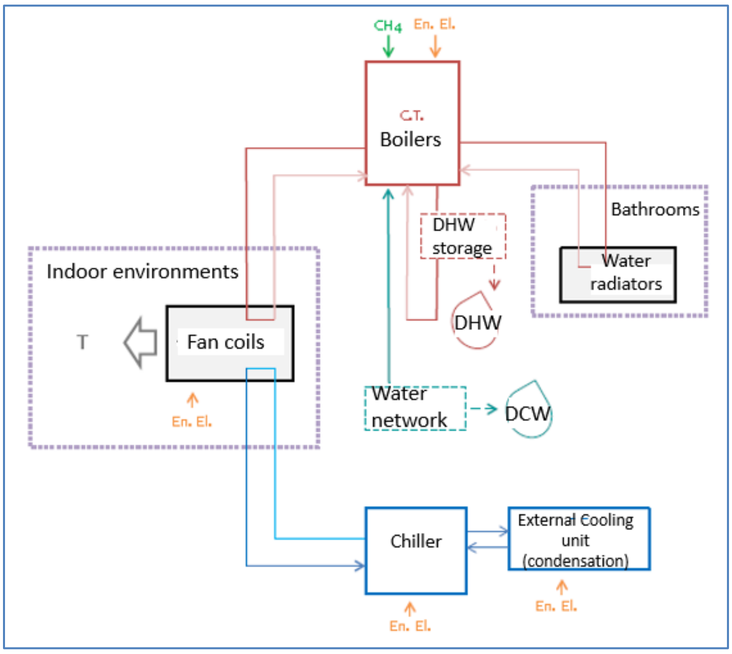

Figure 31: HVAC block layout.

Figure 32: Heating system details.

5.3.2 Review of gathered data

Also, for this case, the team decided to dedicate the Idea generation phase after each data presentation. The very first dataset looked at has been the energy distribution matrix as presented in Figure 33.

Total yearly spending - year:		€ -	€ -
		Electric Energy [kWh]	Gas [m3]
		91.600	0
Primary processes			
Utilities			
energy consumption	Lighting System	3	1
data availability		0	0
energy consumption	Heating System	2	5
data availability		0	0
energy consumption	Air cooling and conditioning System	5	1
data availability		0	0
energy consumption	Apartments electrical appliances and lift	5	1
data availability		0	0
Functional zones			
energy consumption	Underground floor (Laundry, Gym, plant room)	4	2
data availability		0	0
energy consumption	Common areas	3	1
data availability		0	0
energy consumption	Reception	1	2
data availability		0	0
energy consumption	Living apartments	5	5
data availability		0	0

Figure 33: Energy Distribution matrix for RLO.

The EDM reveals no unexpected results, most of the consumption is due to apartments and currently there is not a direct measurement system to gather living data from each apartment. The look at best practices confirmed that, apart the partitioning of areas, all the others are already covered.

Hotel L'Orologio	Valentina Fabi
2017	16.03.2017
	Comments
Management of switch off durign non working time	Yes
Macro switch for lines	Yes
Lights: High efficiency lights production area	Yes
Lhights: efficiency lights external	Yes
Ceilings/walls painted with white to reduce lighting needs*	Yes
Management of heating (by thermostats/sensors)	Yes
Management of conditioning (by thermostats/sensors)	Yes
Partitioning of not heated areas	No

Figure 34: Best Practices at RLO.

However, opportunities that deserve further investigation have been shared with the RLO owner and technicians: many of them, once implemented, could help in addressing both saving opportunities and also user behavior.

Meters for electricity @ floor level
Meters for electricty @ guest room level
Meters for Gas @ (other users beside boilers?)
Meters for thermal energies @ guest room level
Meters for water @ guest room level
Sofware for energy consumption monitoring
Lights: management system (timers,sensors) common areas
Lights: management system (timers,sensors) external areas
Lights: management system (timers,sensors) for guest rooms
Spot heating for small areas inside not-heated ones
Insulation of thermal energy distribution piping/valves/manifolds*
Heat Recovery opportunities
Free cooling
Energy saving training on staff
Energy saving campaing (stickers, leaflet) for guests
Defined Energy Strategy with energy consumption reduction targets

Figure 35: Further common best practices evaluation.

The host time distribution (in % of room booked and in total number of days*person) is the base to then evaluate the consumption of related energy: the seasonality seems to have a low peak during summer, since typical customers are long term commuters who book the room for work reason for period of weeks to months. In any case the variability is high (e.g. January 2013 had ca 850 days*person compared to January 2014 ca 450 days*person).

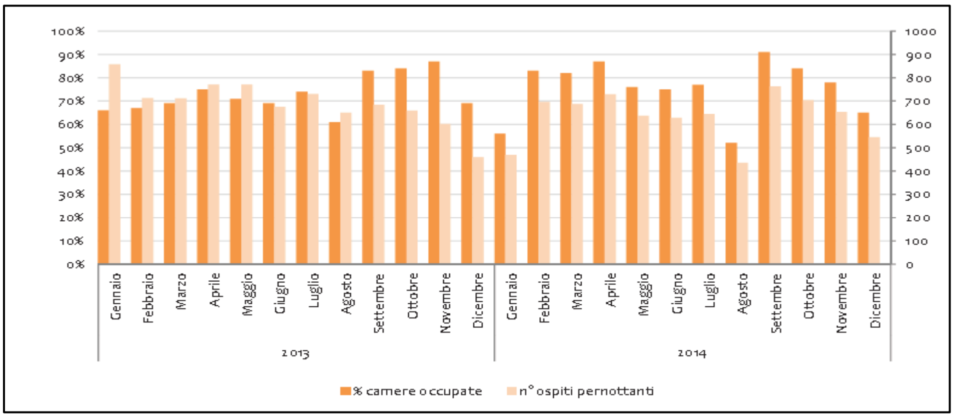

Figure 36: Distribution of monthly room occupancy rate in 2013 and 2014.

The annual electrical energy profile for the two years show a similar behavior (Figure 37), with a peak on summer period clearly attributable to air conditioning, and thus a strong input for MOBISTYLE objectives. According to RLO customers habits are very demanding and scarcely influence-able on room temperature during summer period. As example, there has been reported the case of a customer that due to satisfaction with the indoor temperatures bought on his own expenses a further portable air conditioner installed in the room.

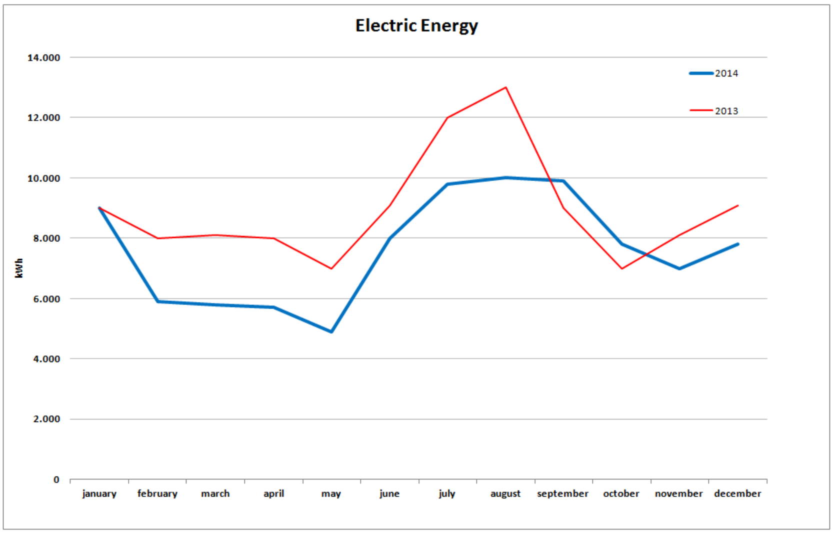

Figure 37: Electrical Energy consumption chart.

Gas consumption chart at Figure 38 shows the typical "cup-shape" profile due to the strong impact of heating during winter months; it is also visible a base load due to the production of domestic hot water.

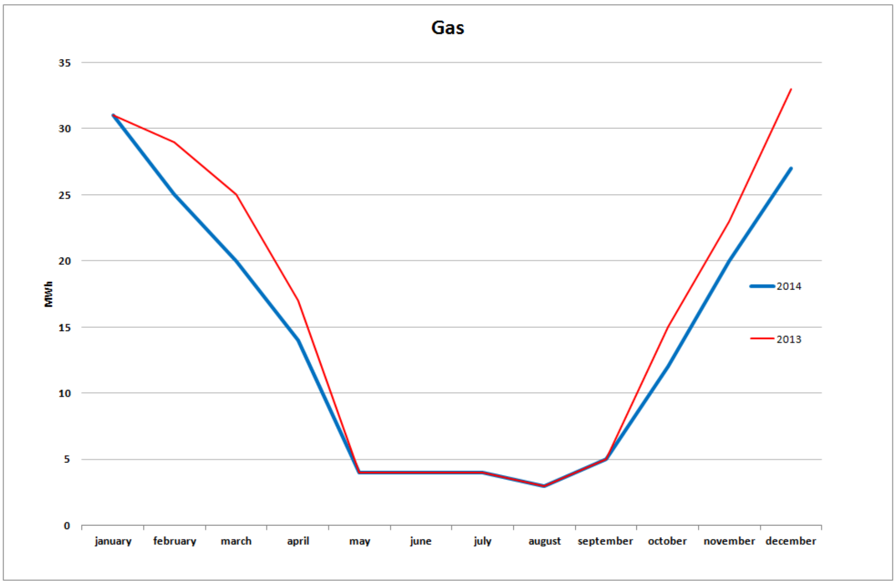

Figure 38: gas consumption chart

When comparing the total thermal energy to the external temperature (Figure 39), two peaks emerge in spring and autumn, suggesting that also in that period a kind of education/user awareness raising is needed.

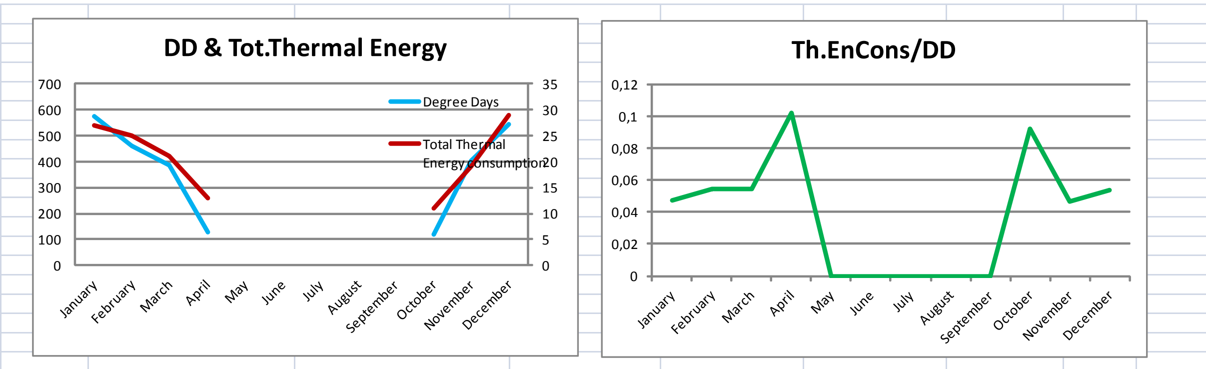

Figure 39: Relationship between thermal consumption and outside temperature.

5.4 Outcomes of Residence workshop

The main focus has been kept on behavior related ideas.

#	AREA	Behav/Tech	IDEA	Short Description
1	Metering	T	Meters for Guestrooms	Insall dedicated meters for each guest room (3/4 metes per floor)
2	Heating	T/B	Set-back @ Nightime	during nightime (midnight?) set the temperature in ALL ROOMS (= Also occupied) at 16°/17°-2 (as it is for unoccupied rooms)
3	ALL	B	Prize for best energy savers	(it is necessary to have metering for each guestroom): prize/offers (eg: discounts, giftcards, etc) for the long stay guests whose consume below a given baseline
4	Communication	B	Information	create a brochure/leaflet to distribte to guests with information on benefits of energy savings (es: sleep at a lower temperature is good for health)
5	Communication	B	Information	"Hint of the day" on screen in common areas or inside the rooms (jpg)
6	Heating	T	Sanitary water temp	reduce of "some" degrees the temp of sanitary water; and/or plan temperature scheduling
7	Electricty	T	Lift at "0 consumption"	Technology by Thyssenkrup with energy recovery (to be investigated)