

Smart Domo Grid project

Smart Domo Grid is a new-generation integrated home appliances for enhanced energy efficiency and reduced cost of energy consumption. The project aims at integrating 'traditional' electric grids, electronic meters, renewable energy in-house production system (photovoltaic energy), and smart appliances. In particular, energy consumption was measured and managed by the help of an application through Wi-Fi connection embodied in the new models of appliances (namely washing machine, dishwasher and the refrigerator) which is beneficial both for the energy providers and users.



The project has been carried out in collaboration with twenty Italian families. The in-field pilot test started in July, 2014 in the city of Brescia. All the other smart grid components were provided by the companies involved. The energy management Application helps monitoring energy consumption with providing insights on how to minimize the consumption. The smart grid will enable users to actively save energy by scheduling the most convenient time slot for operations of the appliances via the insights of the application. In particular, the insight is exposed by the cost of energy in each time for users based on overloads and multi-tariff system (Provided by the energy provider company according to the estimated production of the photovoltaic system). Therefore, the application is able to identify a point of optimum automatically with cost benefits for users and leveraging consumptions for the energy provider. The final goal would be to avoid overloads of energy consumption leading to enhance the quality of the service offered.

The system will have obviously economic and environmental benefits both for users, energy and appliances providers. It will enable the energy providers to be able to manage overloads to avoid using inefficient resources of energy, enhance the energy quality, minimize energy dispersion where users exceed photovoltaic production, and avoid penalties and unneeded investments. It will enable appliance providers to understand how the market interacts with the possibilities offered by the new technology before the market launch. Moreover, the project has social benefits by stimulating users for more sustainable life style.

Engagement of End Users and Other Stakeholders

End user integration: By a comprehensive process of users' selection, twenty families were selected by the energy provider (A2A) to test the system for one year from the initial sample of 300 families living in the Violino Village (a district of the Italian city of Brescia). For selecting the users, a structured questionnaire has been asked by telephone calls from the sample. Then, users' responses were weighted for prioritization. The prioritization was based on some criteria including possession of photovoltaic panels and internet connection, the modality, intensity and frequency of use of the appliances. Then, from selected 50 families who were invited to a face-to-face meeting, 25 families signed a contract to be involved in the project. The contract includes the availability of users to compile questionnaires, participate in interviews, and possibility of home visits. After the final selection, the family houses were inspected by several pre-test with the aim of setting the proper test environment. In addition, to enhance users' commitment in involvement and energy savings, a game was introduced to users. Also,

users rewarded with an incentive system for the more proactive behavior. After proper adjustments of the electric systems of their houses, smart appliances and the tablet were consigned and a specific training was provided. The families were asked to empirically use the appliances. After the first experience of users, Whirlpool (the appliance provider) conducts **interviews** to collect the first feedbacks.

Finally, after the abovementioned preparation steps, the test of the grid system were organized in three steps; first, on monitoring the appliances; second, A2A tests the overall interaction of the grid, the photovoltaic energy production and simulated grid overload by information provided by the user tablet. Also, users' reactions towards the system's advices were observed and electronically registered. Third, an installed accumulator were added to the system to enhance the overall efficiency of photovoltaic and grid usage by accumulating photovoltaic energy for overloads.

Stakeholder collaboration inside-and-out:

- **Whirlpool** is the international major appliance manufacturer company in the world, producing appliances for Home, Kitchen and Laundry. It has approximately \$20 billion in annual sales, 100,000 employees and 70 manufacturing and technology research centers throughout the world in 2014. The company is serving more than 170 countries with multiple brands. Whirlpool Italia is the Italian branch of the international enterprise which was the appliances provider.
- **Electrical Networks A2A SpA** is today the second Italian electric operator with about 11 thousands Mw of installed capacity. In 2011, the group achieved a turnover of Euro 6.5 billion. The company is active in production, sale and distribution of electricity and gas. Moreover, it produces, distributes and sales heat through district heating networks. Moreover, it deals with the waste management and the integrated water cycle.
- **Politecnico di Milano (POLIMI)** is a scientific-technological university. The university formed a foundation in 2003 to support the university's research projects. The aim of the foundation directed towards innovation and economic, productive and administrative environment development. It develops innovation projects as well as social responsibility projects not only for large corporations, but also for numerous small to medium sized enterprises. The energy department of the university via POLIMI foundation, provides technical support for the smart grid and an innovative prototype of an accumulator. When the innovative accumulator would be industrialized, it would save costs for the adoption of the system by users and energy providers. Moreover, they play a key role in balancing the objectives of the other partners and contribute to the project from the management perspective.
- ***Company for phone interviews:*** this company was engaged by A2A to call families in the district for selection of the most suitable users. They asked families the questionnaire developed by A2A by phone calls.
- ***A2A's newborn innovation department:*** The department was responsible for managing the project on time and efficiently with its commitment and coordination effort.

- **A2A and Whirlpool communication department:** the two departments intensively collaborate to set rules and plans for user involvement and communication. The decisions were jointly made, with the users' communication by A2A along the project.
- **Whirlpool's R&D department:** it develops the smart appliances, the tablet and energy management Application with also responsibility of feedbacks collection.
- **Economic Development Ministry of Italy:** this entity provides the funds to the project.

Following is the summary of the process of the project development with highlighted involved partners, their roles, methodologies and actions (Table 1).

Phase	Time	Role	Method/Action	Explanation
Idea generation	2011	A2A	Project initiator	Start the idea of the project based on a previous project; involve POLIMI; provide grid technology.
		POLIMI	Technical partner	Involve Whirlpool; Provide accumulator and required technologies;
		Whirlpool	Appliance provider	Develop smart appliances
		Economic Development Ministry of Italy	Research announcement for smart grid	Provides the funding.
Development	2013	A2A & POLIMI & Whirlpool	Project setting through multiple meetings	Set objectives and develop appliances and equipment, set requirements for involved users
		A2a and Whirlpool	Communication and user involvement Planning	A2A and Whirlpool plan the communication setting and user involvement program; Set incentives for customers
		A2A	Coordinator; manage and perform user selection	Selection of Violino Village; Development of questionnaire and required criteria; Involve Service Provider for phone calls to users; Prioritize customers, Create events for users for administrative issues (e.g. signing the contracts)
Test	July 2014	A2A; POLIMI; Whirlpool	Preparation phase	Equip customer houses; coordinate pre-test visits and setting; Conduct the 2 nd step of the test.
		A2A	Central role	Coordinate the three step tests; Conducting the 2 nd step of the test
		Whirlpool	Conducting the 1 st step of the test	Collect feedbacks with interviews; Appliance training to users, record feedbacks
		POLIMI	Conducting the 3 rd step of the test	Record and measure result on accumulator tests
		Users	Interviews, visits, meetings, calls.	Their houses equipped, they were trained how to use appliances and tablet, they react to application's insights on energy cost; enable the three steps of the test.

Table 1. Summary of the process with the involved partners