Annex 49

Low Exergy Systems for High-Performance Buildings and Communities

B3.3 Collection of Best Practice Examples for New and Retrofit forms of Technology for Community Supply Structures

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☐ **DISCUSSION PAPER**

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Project name: Parma 2020

Location	*The city of Parma and its neighbouring.*
Type of project	*Local energy planning with the purpose of reaching 2020 European goals*
Duration	*One year*
Expected results	*Local mandatory regulations for energy efficient design and retrofit of residential and commercial buildings, low energy and low exergy technologies application, energy efficiency measures for end-users.*
Further improvements	*Identification of potential emission reduction and economic advantages from distributed energy resources exploitation*

Project description

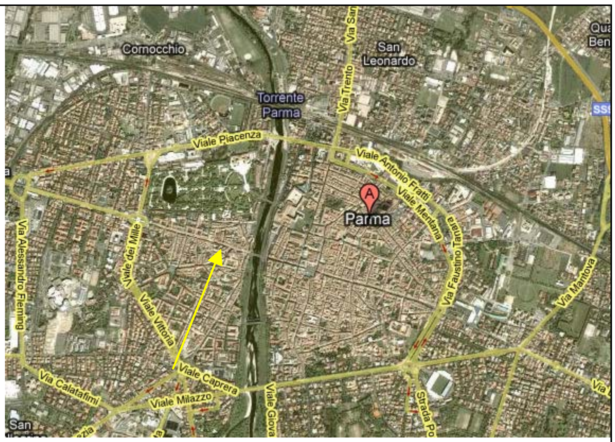
General description

The city of Parma is located in Northern Italy, in the Emilia-Romagna region, with approximately 178.000 people living and a balanced presence of tertiary, industrial and agricultural sector, a mild climate and a notable historical buildings stock and cultural heritage. Because of these characteristics, Parma represents a typical city of the Pianura Padana.

Parma during last years has undergone many initiatives related to energy efficiency measures for its community, with two energy plans (the last date back to 2006), local regulations for mobility, and the current project of a local mandatory buildings energy regulation with advanced quality certification tools and incentives for low energy and renewable energy technologies implementation.

The project starts with a detailed energy use analysis for residential, tertiary, industrial and agricultural sector. The consumption of electricity, fuels for heating and water were given by the local utility and implemented in a GIS, in addition to thermal plants data. This tool allows to easily localized energy consumptions and to match with buildings features, location, type of activity in a comprehensive database. This database will be first used by the local administration in a campaign for thermal plants efficiency control and certification.

After that energy efficiency improvements, renewable energy potential and emission reductions strategies will be assessed to find a realistic path to reach 2020 European goals, introducing mandatory regulatory issues on local energy planning. The end of the project will be an assessment on the futuristic hypothesis of transforming Parma in a 100% renewable city by the year 2050 adopting as a benchmark today best available technologies.



To that end, low energy and low exergy technologies will be proposed.

Available data

Consumption for heating

Electricity consumption

Water consumption

District heating data

Buildings' features and location

Buildings' destination and location

Time resolution of data

Fuels: yearly, monthly

Electricity: yearly, monthly, hourly (only for a limited number of cases, that will be analysed as representative)

District heating: yearly, monthly

Approach

Yearly energy use data for each building and activity will be split into monthly values, using statistical correlation given by the utility. After that, thermal energy demand will be disaggregated into three main categories, heating, domestic hot water and cooking. Than electric energy consumption will be subdivided into categories related to the different activities (using statistical data collected in other similar case studies), thus allowing us to compute possible efficiency improvements by the use of low energy appliances.

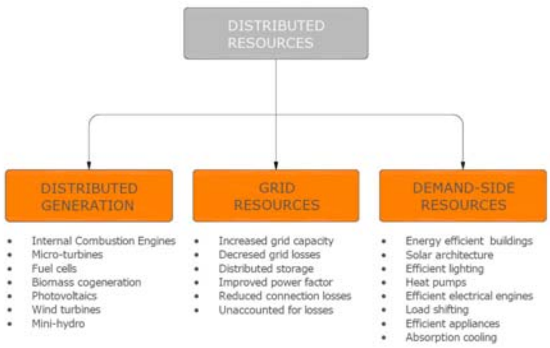
In particular the approach adopted in calculation will be bottom-up engineering oriented, in order to suggest practical and readily available solutions for the customer (the end-user has to be aware of the possible economic advantages of energy saving strategies, and how to implement them).

Three scenarios will be evaluated for Parma: business as usual, 2020 European goals (the path for reaching renewable energy integration, primary energy consumption reduction and carbon emission reduction goals) and Best Practice (best available technologies adoption). Than an assessment on how to transform Parma in a 100% renewable energy city by the year 2050 will be conducted. To that end, also low exergy technologies will be proposed.

Some simulations will be made after selecting hourly data (load profiles) of electric power demand for particular categories of end-user (and projecting this evaluation to others with similar features), and considering thermal energy time distribution to investigate distributed generation potential with combined production of electricity, heating and cooling power. This simulation will require apposite software tools, that are under development by ENEA (Italian Energy and Environmental Agency).

Distributed generation

The possibilities given by the optimization of community energy supply systems have to be thought first in terms of distributed energy resources potential, focusing the attention on different kinds of action. We could subdivide our interventions into three main categories, which are not merely related to different technologies implementation but also to exergy losses, in the energy supply chain, assessment and dynamic energy demand evaluation.
Energy demand is variable in time and space and dependent on different destinations.
In this context, distributed multi-generation could be the new paradigm to be followed and energy districts are the ideal test bed. Distributed multi-generation could be defined as the efficient combined generation, distribution and storage of energy vectors to serve different energy demand within an energy district. All sectors (residential, commercial, transportation, manufacture, agriculture) can be simultaneously present in a community. Distributed multi-generation systems should be implemented in order to improve exergy efficiency, energy efficiency and to reduce emissions.



Public administration decisions and cities role

Local sustainable energy initiatives shall exploit the potential of distributed resources and provide local economic development. Cities are energy intensive nodes and so they are essential partners in the process; achieving the targets set by national government will be largely reliant on these actions: city authorities can have great influence over energy use patterns within their boundaries. In particular they can contribute through:

- Building regulation;
- Urban layout;
- Efficient mobility;
- Standards and codes;
- Air quality control.

The path towards 2020 European Goals will involve the reduction of dependence from fossil fuels, the improvement of renewable energy sources production and the improvement of efficiency in the end-use.

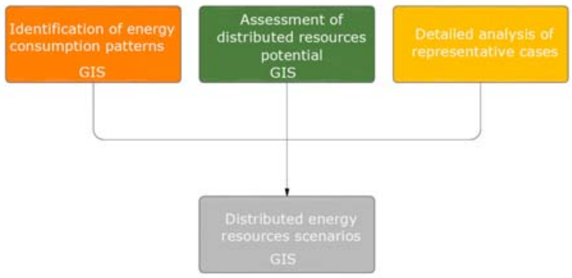
Referring to the action plan for the city of Parma, a bottom up engineering-oriented approach will be followed taking into account the assessment of environmental and economic benefits given by the adoption of:

- Thermal and electric generation efficient technologies;
- Energy efficient electric appliances;
- Energy efficient lighting technologies;
- Mobility good practices;
- Buildings construction and retrofit good practices.

The minimization of exergy losses will be considered ad a criterion in the implementation of the previous actions.

The plan of Parma, from the present to the future

In order to efficiently support the transition towards a distributed multi-generation paradigm, it has to be investigated the interaction between customers and the grid for selling and buying both electrical and thermal energy.
For this reason, energy consumption data (natural gas and electricity) were mapped in a GIS to visualize energy use pattern and identify land-use constraints that can prevent distributed multi-generation technologies adoption.
Firstly, monthly energy loads will be analyzed. Then, monthly energy demand will be split into five main categories: electricity only end-use (appliances, lighting, etc.), refrigeration and building cooling, water heating, building space heating and natural gas only end-use (cooking, etc.). After that, some representative cases of possible energy districts will be identified; these will be studied in detail also for determining their hourly load profiles for electricity (from utility data) and thermal energy (simulated heating and cooling demand of buildings).
Then, also complementary use for the different energy demands were analyzed in order to improve energy generation.
Primary energy and emissions reduction due to the adoption of efficient and low exergy systems will be assessed based on energy costs, technology costs and performances.
What should be founded is a set of technologies aimed to minimize annual costs for matching energy demand for the community of Parma.



In order to find out these results, useful models for defining energy and power demands, sector by sector, will be implemented, also based on GIS.
The study will analyse the present situation and the evolution for the future, i.e. with a step of 5 or 10 years till 2050, taking into account also the variation of the energy systems performances.
The methodology can be used to develop both realistic scenarios and sensitivity analyses (e.g., using different technology adoption rates).

Analysis of electric energy and natural gas demand

Here we represent graphically how energy service customers are distributed within a city and their main characteristics. We can observe that the most of them are aggregated and located near the city centre, and so they are predominantly residential and commercial. If we analyze the cumulative frequency curves of electricity and natural gas yearly demand we can seen how the predominant part of the customers are small ones (residential and small commercial sector) and only a part of the whole is characterized by a large energy consumption. The total yearly electric energy consumption of the city (except for three large industrial customers that buy electricity directly from the national grid and account for one third of the total electricity consumption) is 2021 GWh and the total number of individual customers is 122276. The total yearly natural gas consumption of the city is 467 milion m^3 and the total number of individual customers is 86599. The monthly distribution of electricity and natural gas consumption are strictly related to the specific energy sector of customers and so, if we want to identify complementary energy demand in time and space we have to match first energy sector and available statistics on a spatial base. In order to perform consequently a detailed analysis with one hour resolution data, it is necessary to identify some representative cases. In this way it is possible to analyze complementary demands and identify where distributed multi-generation can be efficiently applied with given land-use and buildings features constraints. In our opinion, low exergy technologies adoption could be boosted by introducing this paradigm at the community level.