

LCA-SUPPORTED POLICIES FOR THE ENERGY CONSUMPTION REDUCTION IN THE BUILDING SECTOR: THE ITALIAN ALESSANDRIA PROVINCE CASE STUDY

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ABSTRACT

The aim of the study is to assess the feasibility of reducing to zero the use of fossil resources in a typical northern Italian region (Piedmont), and the Alessandria province was taken as case study. First, the present energetic situation was assessed (base scenario), then an ideal scenario where renewable sources and energy saving were maximized was devised, neglecting the economic aspects. In both cases the analysis focused on five main sectors: residential, private and commercial tertiary, industry and agriculture, while transportation was discarded. Although in the ideal scenario any economic or technological restriction was eliminated, the energetic self-sufficiency based on renewable resources was unattainable. The carbon footprint of some refurbishment strategies to be applied to the tertiary sector in the ideal scenario was assessed via LCA and the CO₂-eq payback time calculated.

INTRODUCTION

In 2012 public administrators, representatives of the private industrial sector and of other commercial categories of the Alessandria province, an area situated in the Piemonte (Piedmont) region of north Italy (Figure 1), gave birth to a panel which, in collaboration with universities and a public research center (RSE), had the commitment to devise a plan for reducing the fossil fuel consumption in the whole provincial area.

In particular, the panel should have answered the following question: discharging any economic aspects of the problem, what could be the energetic situation of the province of Alessandria if all decisions finalized to reduce fossil fuel consumptions and improve sustainable resources would be taken?

Considering the technical feasibility of the project and according to the EU directive “20-20-20” goals, the panel tried to justify every energetic decision, with a particular attention to land usage and carbon emissions. Emissions markers and the simplified LCA were adopted to analyze pros and cons of different scenarios.

In particular, refurbishment strategies in the public tertiary building sector have been examined with the aid of LCA methodology (ISO 14040-14044, 2006) and the environmental payback time estimated. To do that, the building stock of the entire province has been classified according to its construction time and role (public school, hospital, etc.); model buildings have been created and energy saving refurbishment strategies devised. Then, an LCA analysis of these retrofitting interventions has been carried out.

Going beyond the “20-20-20” directive, the ultimate goal would have been to reach the “ideal” situation of zero fossil fuel consumption and energy self-sufficiency. Notwithstanding this “ideal” situation (further strengthened by the removal of any economic and temporal limit), the result of the analysis shows that the absence of fossil fuel consumption is not technically reachable without forcing the idea of environmental sustainability. More realistic objectives have been consequently put forward and a holistic approach toward quasi-self-sufficiency in the energy sector of the Italian province of Alessandria suggested.

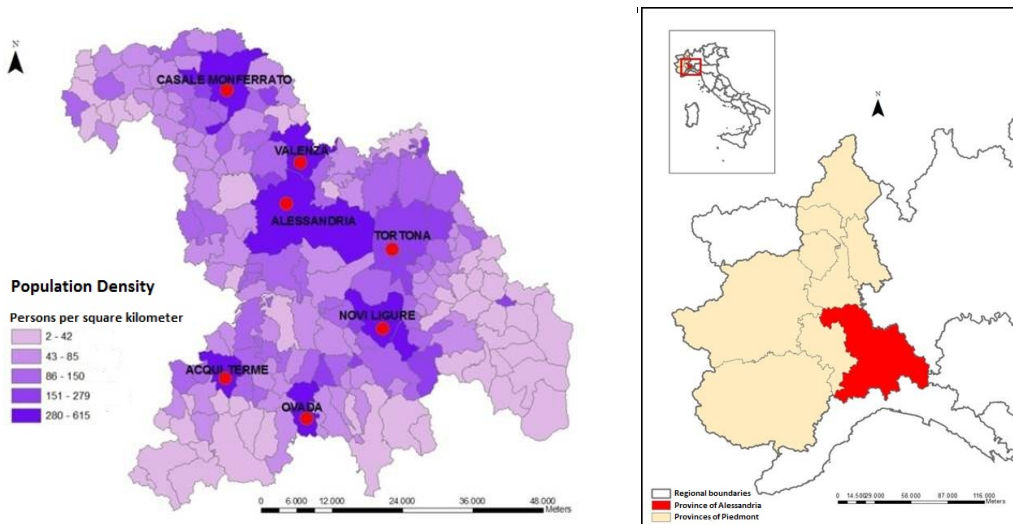


Figure 1. Piedmont region (right) and its location in Italy (inlet); population density distribution in the Piedmont region (left)

METHODS

The base energy consumption scenario of the province was built up starting from local policy directives and regional databases. Data collected were grouped into 5 main sectors: residential, public (or commercial) and private tertiary, industry and agriculture. Transportation was not taken into account considering that is not tightly dependent on local energy policies.

The ideal scenario was devised in accordance with the following assumptions:

- Differentiation between thermal and electrical energy request;
- Application of the maximum energy efficiency potential to each sector;
- Use of renewable energy resources in substitution of fossil fuels whenever applicable.

In the civil sector extensive refurbishment strategies were implemented in the line of quasi zero-energy buildings. To do that, the private and public building stock of the province was classified according to structural characteristics, age, thermal requirement and final use. Proper retrofitting actions were devised for each building class. On the contrary, in the industrial sector only “soft” refurbishments strategies were implemented with the aim of reducing wasted energy and possibly improving process efficiency, but without a drastic redesign of the production process.

LCA analysis of some refurbishment strategies to be applied to representative buildings of the residential and tertiary sector was carried out in order to assess the environmental load due to retrofitting and to calculate the carbon payback time. The system boundaries in the ideal scenario comprise materials used in the retrofitting, use phase of the building (50 years lifetime span) and waste disposal of substituted components, while in the base scenario only the use phase is accounted for.

RESULTS AND DISCUSSION

Energy consumptions of each sector in the two scenarios are reported in Table 1. In the building sector, both residential and tertiary, the potential energy saving ranges between 40 and 60%, while in the industrial sector the target was set to about 10 % reduction, and the outcomes were consistent with this hypothesis. Improvements in the agricultural sector were very low. Energy consumption is converted into CO₂-eq emissions by using proper emission factors (Table 2).

Table 1. Thermal and electrical energy consumption per year of base and ideal scenario subdivided into five main sectors.

Sector	Base Scenario			Ideal Scenario		
	Final Electricity Consumption	Final Heat Consumption	Final Energy Consumption	Final Electricity Consumption	Final Heat Consumption	Final Energy Consumption
	[ktep]	[ktep]	[ktep]	[ktep]	[ktep]	[ktep]
Residential	47,0	224,9	271,9	34,4	130,9	165,3
Public tertiary	13,1	33,4	46,5	12,3	6,1	18,4
Commercial tertiary	38,8	75,1	113,9	34,9	17,8	52,7
Industrial	150,8	310,2	461,0	135,7	279,2	414,9
Agricultural	2,8	57,0	59,8	2,6	51,3	53,9
Total	252,5	700,6	953,1	219,9	485,3	705,2

LCA was performed on representative buildings of tertiary stock, such as schools and municipal offices and the carbon payback time calculated. For nursery, primary, and secondary schools the carbon payback time of refurbishments is about 3 years, while in the case of municipal offices is about 50 months.

Table 2. CO₂-equivalent emissions per year corresponding to energy consumptions in the two scenarios.

Source	Base scenario	Ideal scenario
	Mt CO ₂	Mt CO ₂
Electrical energy	1,31	-
Natural Gas	1,60	0,79
Oil	0,84	0,41
Total	3,75	1,20

CONCLUSIONS

Energy consumptions of an entire province located in the northern Italy have been assessed. An ideal scenario was sketched in order to maximize energy efficiency and renewable resources use with the aim of going beyond the 20-20-20 directive and evaluating the possibility of attaining an energy self-sufficiency relative to the province territory. Although high reductions percentages were attainable, it is not feasible to imagine a self-efficiency in the energy sector without a massive use of biomasses which in turn would involve a dramatic change of the local economy. Refurbishment strategies in the building sector have a payback time in the order of few years while entailing substantial reductions in CO₂ emissions.

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