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New drivers of sustainable development in developing countries / Unlocking the energy saving potential in Albania's residential sector

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Abstract

In - and due to - the current economic and social condition, new innovation processes are happening in developing countries, 'proving that scarcity of means can stimulate technical inventiveness.' (Galiano, 2014). This is what occurs when cities and the existing demanding conditions are considered strategic and potential resources for their occupants. Albania, one of the fastest-growing countries in Europe before the global financial crisis, is making every effort to attain a competitive market economy and reach EU membership. Despite demonstrating significant economic growth in the last decade, the country's development is constrained by an insecure power supply and obsolete energy infrastructure. One of the main challenges in ensuring a reliable and sustainable power sector is represented by electricity, whose production is completely dependent on hydropower generation. Notwithstanding the value and the benefits of using a renewable energy source, the national hydroelectric power generation brings inconstant production levels due to the weather and hydrological conditions of the area. In addition, the high level of distribution losses forces the country to resort to considerable imports in order to meet the growing national demand, with consequent negative effects on Albania's economy. Both these issues do not allow the energy sector to have a self-generation capacity and to be financially self-sustaining, together with distorted electricity prices, low collection rates and high arrears. As it absorbs over half of all Albania's electricity supply (Eurostat, 2015a), with an increase in consumption by 50% between 2003 and 2014 (Eurostat energy data, n.d.) and a floor area of over 40 million m2 (INSTAT Census 2011), the residential sector represents a huge opportunity to reduce energy misuse and address energy deficits. In this context, the National Energy Efficiency Action Plan (NEEAP) sets an energy saving target of 9% of the average final consumption by 2018. However, the complex Albanian regulatory framework, which does not provide government incentives to EE investments, and the lack of knowledge of the market potential prevent the development of a serious EE program. In addition, the sector is characterised by a lack of specific expertise, therefore a lack of knowledge of available technologies and benefits of application. Within this framework, a study conducted by researchers from the Polytechnic University of Tirana, Aalborg University in Denmark, Gridkraft LLC in Seattle and the American Council for an Energy-Efficient Economy (ACEEE) in Washington, published in 2015 and based on a sample of 70 residential units in Tirana, investigated the real share of electricity attributable to the different residential uses and the factors affecting each type of electricity consumption. Many countries in Europe offer examples of how to sustainably meet household energy needs, and how to address the most critical areas of energy use. Here, the knowledge of the context and a realistic attitude are the instruments needed to face the demanding conditions by exploring the existing potential of places with a new inventiveness. This innovative approach inspires original design and planning solutions, able to address higher-order problems and trigger innovation processes.

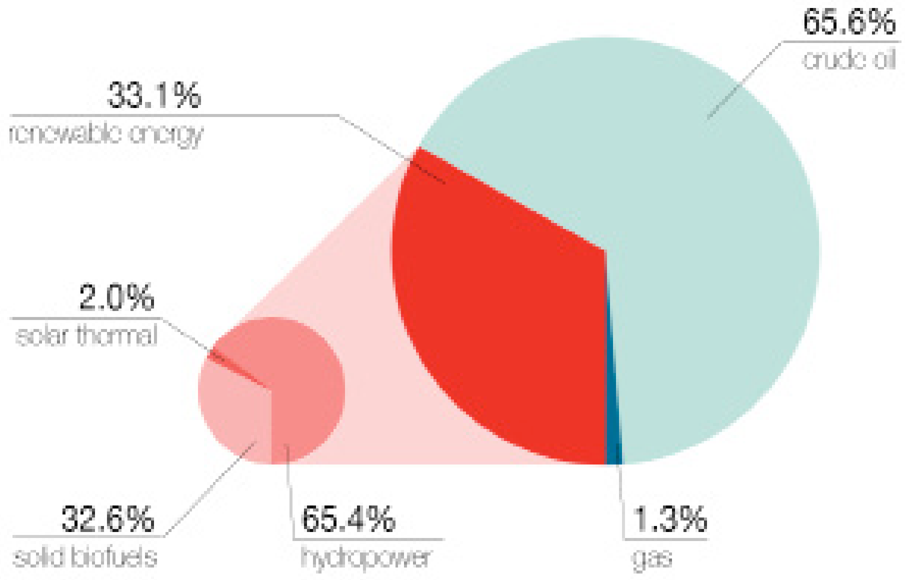

Fig1 / Primary production of energy by resource (2014)
source / Eurostat energy data, elaborated by the author

How can the knowledge of these realities innovate the way we look at Albania's energy issues? What do these experiences mean for Albania and for developing countries in general? And what could be the impacts on urban and local policies? Starting from these examples, the challenges facing Albania's energy sector are not only the limit to its socio-economic growth, but conceal a huge potential. They reveal to be the occasion to address the demanding economic and climatic conditions through innovative design solutions, which will become new drivers of sustainable development for Albania.

Introduction

Albania is experiencing a transition phase into a competitive market economy. Yet the country's development is constrained by an insecure power supply and mounting contingent liabilities, for which the energy sector is not able to be financially self-sustaining. Within this framework, electricity represents the toughest issue. The total dependence on hydropower generation and its vulnerability to weather patterns leads to a lack of self-generation capacity and financial self-sufficiency. This, together with the high level of distribution losses, which requires significant power imports, is adding financial stress to the sector and the economy. Being the main responsible factor for the national electricity misuse, the residential is at the same time one of the most problematic sectors in Albania's energy consumption and one of the areas with the highest potential in achieving a sustainable energy use in the country since it conceals a huge untapped energy saving potential. This issue is strictly related to the NNEAP, which has defined a series of energy saving strategies targeting the household energy consumption in order to reach the environmental goals set by Albania for 2020.
However, the challenges facing the national energy and economic sectors share their starting point with the experiences offered by some European countries. In these realities the demanding conditions have become chances to define innovative design solutions able to take advantage of the existing resources and trigger processes of sustainable development.
Therefore, a focused action aimed at optimising Albania's use of energy, especially in those areas characterised by massive and irrational consumption, could incite unexpected innovation processes.

Albania's energy sector

In 2014, Albania's total production of energy was about 2.0 Mtoe (million tons of oil equivalent), of which 65.6% was crude oil, 1.3% was natural gas, 33.1% was renewable energy. Solid fuels and nuclear energy amounted to 0%.
In particular, in the renewable energy sector, hydropower represented 65.4%, solid biofuels were 32.6%, solar thermal accounted for 2.0%, while geothermal and wind power were 0% (Eurostat energy data, n.d.).
Given the national significant role in the oil sector, and despite a negligible gas market due to the minimal gas supply, Albania's economic challenges are currently greatly affected by electricity, the production of

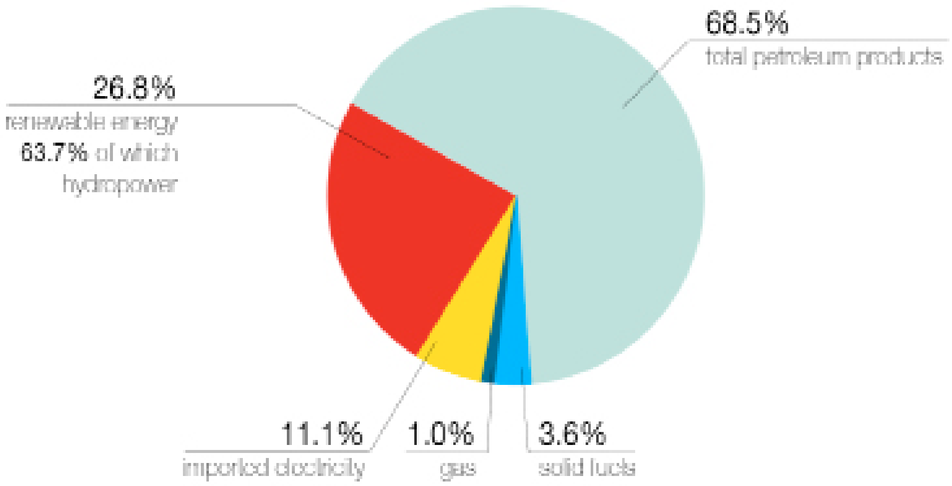

Fig2 / Gross inland energy consumption by fuel type (2014)
source / Eurostat energy data, elaborated by the author

which is totally based on hydropower.
In spite of being a renewable energy source, which forbids fossil fuels and could enable Albania to produce its own energy without being reliant on international fuel sources, hydroelectric power is subject to the weather and hydrological conditions of the country, which result in neither a constant nor a reliable production. This limit, along with the high level of distribution losses, distorted electricity prices, low-collection rates and high arrears, requires significant imports in order to meet the growing national demand, adding financial stress to the economy.
For all these reasons, the energy sector is not able to be self-sustaining in terms of electricity production, and consequently to be financially self-sustaining. One of the factors that negatively contributes to this issue is represented by the structure of the electricity market, which is dominated by state-owned companies both on the wholesale and the retail level, as well as for the transmission system.
Within this framework, the new Power Sector Law, adopted in 2015, addresses the liberalization of the electricity market, treatment of public service obligations, unbundling of the transmission system operation, powers of the national regulatory authority, supply of electricity and customer protection (Energy Community Secretariat, 2015).
Taking into account the country's final energy consumption, the leading sectors are represented by transport and residential, which respectively reached 44.2% and 27.3% in 2013, while the main leading sector in the electricity consumption is residential, which accounts for 55,1%, followed by industry and services, which represent 19,8% and 18,7% (Eurostat, 2015a).

Historic development and future trends in energy use / the dynamics involved

A critical analysis of the characteristics of the country's energy production and consumption allows the making of useful observations on how the use of energy is evolving over the years.
The absence of price regulation conditions, along with the too expensive alternative energy sources, has led people to use electricity, the overconsumption of which has led to high levels of non-technical losses and a reduced security of supply.
Although the improvements in energy intensity , started from 2000 (Knoema World Data Atlas, n.d.), should be a positive sign, this dynamic is actually a result of the collapse of heavy industries, to the leading amount of hydropower production and the growth of financial resources coming from abroad, firstly those linked to Albanian emigrants. In fact, considering the total final energy consumption, the trend shows a continuous increase (Eurostat energy data, n.d.), which suggests the urgent need to define energy-saving strategies and to prevent energy consumption from increasing proportionally towards economic growth.
Moreover, the challenges brought by the process of transition, especially the heavy price increases, could decrease the poverty level of low-income and vulnerable families, which perhaps cannot afford utility energy services.

Electricity	2013	2014
Electricity production [GWh]	6,957	4,726
Net imports [GWh]	2,322	3,356
Net exports [GWh]	1,425	288
Gross electricity consumption [GWh]	7,986	7,815
Losses in transmission [%]	2.3%	2.1%
Losses in distribution [%]	45.0%	37.8%
Final consumption of electricity [GWh]	4,530	5,011

Fig3 / Electricity (2013-2014)
source / Energy Community Secretariat (ECS), 2015, elaborated by the author

	total	solid fossil fuels	gas	crude oil & petroleum prod.	renewable energies
Final energy consumption	1,875	67	6	1,103	699 *
Industry	258	63	6	83	106
Transport	828	0	0	828	0
Commercial and public services	166	4	0	33	129
Residential	513	0	0	80	433
Agriculture / Forestry	60	0	0	50	10
Fishing	29	0	0	29	0
Others	21	0	0	0	21

* 486 ktoe of hydropower

Fig4 / Final energy consumption by sector (ktoe) (2013)
source / Energy balance sheets - 2013 data, elaborated by the author

	electricity
Total consumption	686 *
Industry	136
Transport	0
Commercial and public services	128
Residential	378
Agriculture / Forestry	14
Fishing	0
Others	30

* 486 ktoe from hydropower
200 ktoe from imports

Fig5 / Electricity consumption by sector (ktoe) (2013)
source / Energy balance sheets - 2013 data, elaborated by the author

1 / Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as the ratio between the total primary energy supply (TPES) and the gross domestic product (GDP).

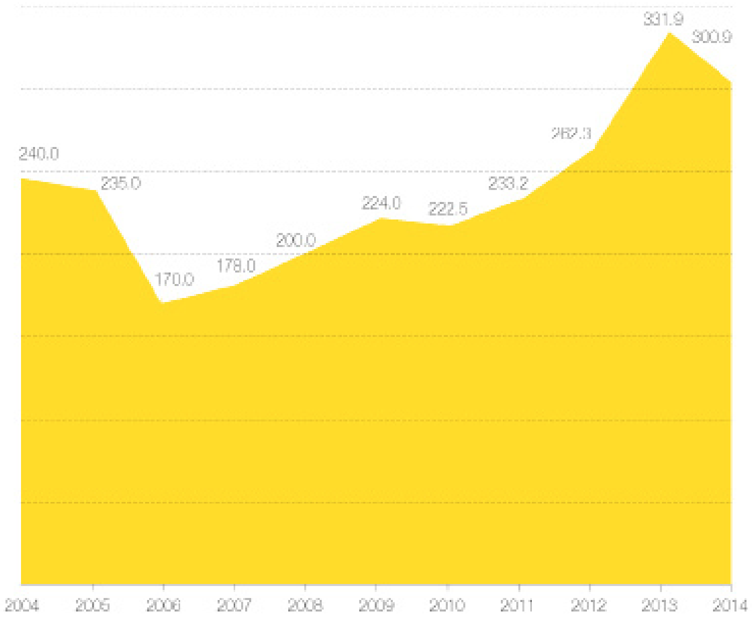

Fig6 / Electricity consumption by households (ktoe) (2004-2014)
source / Eurostat energy data, elaborated by the author

Key objectives for 2020

In the frame of EU integration process, the country has set a series of environmental targets for 2020:

- reduce greenhouse gas emissions of 20%;
- increase the share of renewable energy sources in energy consumption by about 38%;
- improve energy efficiency (EE) by 9% until 2018, 31% of which should be achieved in transport, 25% in industry, 22% in households, 19% in services and 3% in agriculture, according to the National Energy Efficiency Action Plan (NEEAP). The goal is to reach 10% until 2020.

In order to reach these goals, the NEEAP has defined these main quantitative and qualitative measures addressed at various aspects of residential energy use:

- thermal insulation of buildings, to reduce the energy demand for space heating and air conditioning as well;
- introduction of central and district heating schemes, which will contribute to provide space heating and domestic hot water (DHW), especially in new apartments of multi-storey buildings:
- introduction of LPG, to reduce the quantity of electricity used for space heating and cooking;
- introduction of solar systems for DHW production, in the place of electricity;
- use of energy-efficient lamps in order to decrease the amount of electricity employed in lighting (NEEAP, 2010).

Household energy consumption / how Albania became addicted to electricity

As demonstrated by the data mentioned above, residential is one of the leading sectors in the country's energy consumption. At the same time, electricity is the main energy source used by households, and the trend shows an annual growth. In addition to it, residential energy services are covered by fuel wood (for heating purposes and DHW), LPG (for cooking), and partially by solar and diesel.
The current energy situation can be better understood by looking at Albanian history in terms of energy. In the second half of the 19th century, the communist government (1945 – 1990), aiming at the complete independence of the Albanian economy from the foreign countries, started to exploit the national hydropower potential. At the same time, at the beginning of 1950, the government organized schemes to use fuel wood for heating purposes, also because of the big forest areas present in the country. For these reasons as well as undeveloped infrastructures for using other energy resources, including renewable energies, the amount of fuel wood used in Albania was very high until fairly recently, 1992.
This tendency started to change from 1992, when the share of fuel wood used for heating and DHW began to decrease in rural areas, due to the substitution of wood with electricity. In addition to this, there are two other dynamics explaining the decreasing trend. On the one hand, woods are protected as part of natural protected areas, and on the other hand, the demand for industrial use is very big, ensuring a good income to rural households. Therefore, although the potential for energy use is high, wood

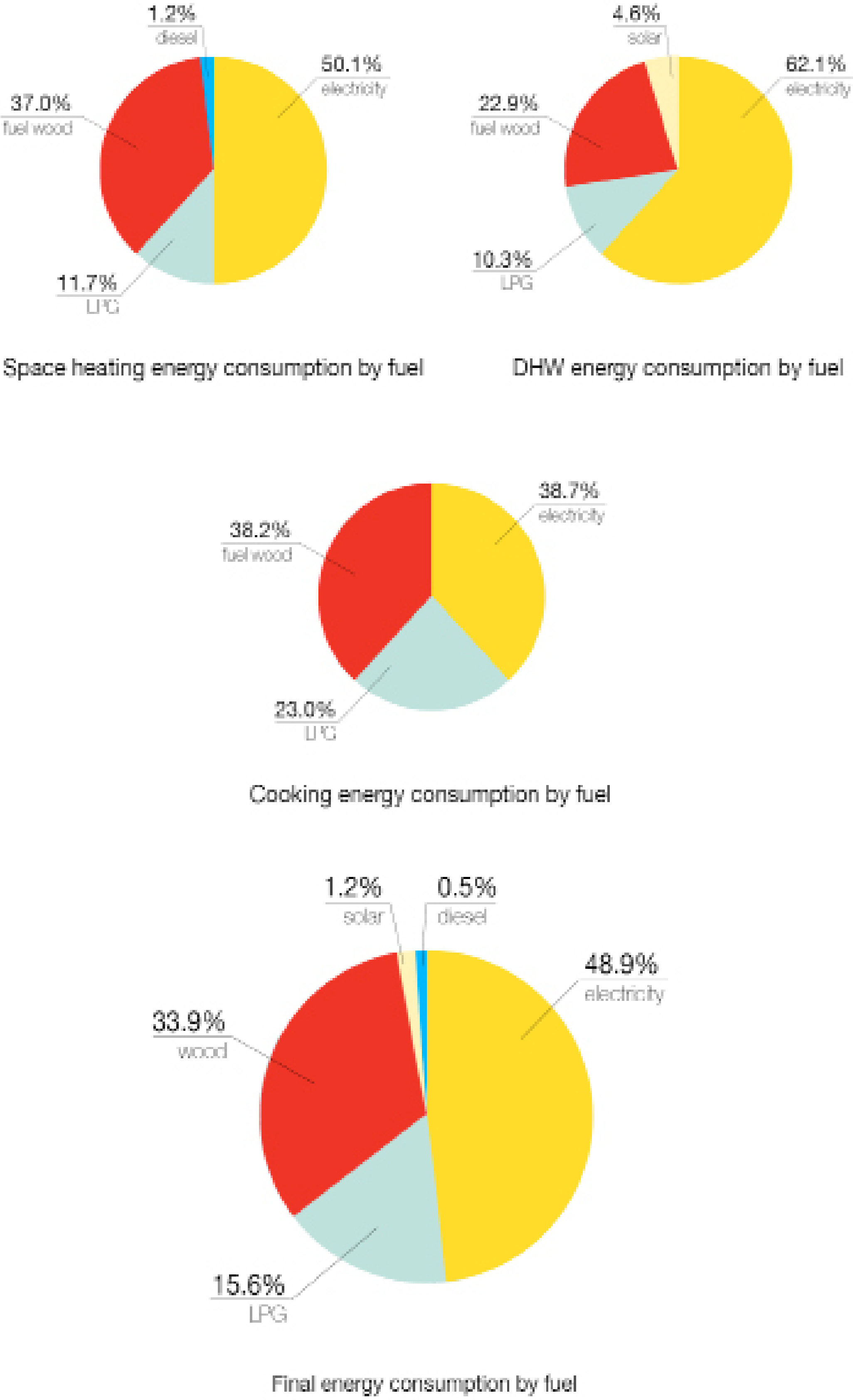

Fig7 / Final energy consumption in households by fuel and by use (2013)
source / INDC Technical Background Document: Albania vers25.08.2015, elaborated by the author

is used for purposes other than the production of energy.
The same decreasing process applies to the share of hydropower. Since the demand for energy is increasing, while the national hydropower production capacities have remained the same since 1986, the amount of domestic electricity production is decreasing with a consequent growth in imports (Cela and Himzo, 2009).

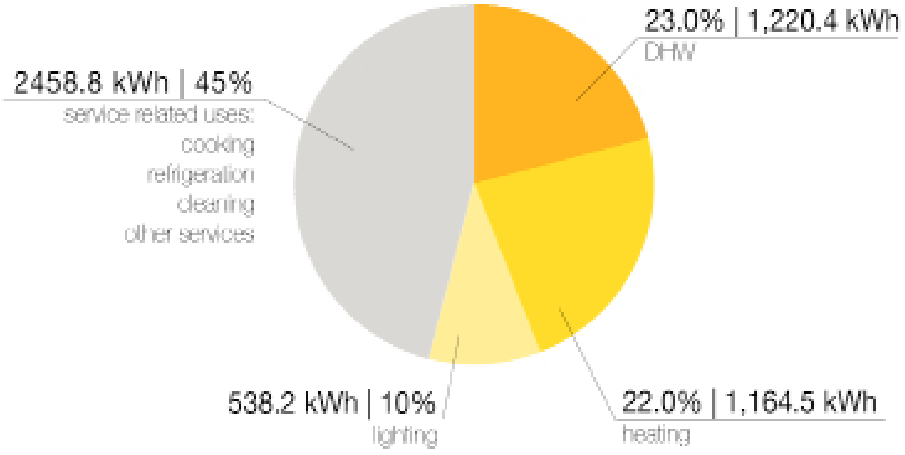

Fig8 / Breakdown of annual average electricity consumption for single household (2012)
source / Evaluation of the heating share of household electricity consumption using statistical analysis: a case study of Tirana, Albania, elaborated by the author

Household electricity consumption/ a study revealing the real share of electricity attributable to the different uses

A study conducted by researchers from the Polytechnic University of Tirana, Aalborg University in Denmark, Gridkraft LLC in Seattle and the American Council for an Energy-Efficient Economy (ACEEE) in Washington, published in 2015, aimed at investigating household electricity consumption, producing interesting results (Bidaj et al., 2015).
The research underlines further elements affecting the increasing electricity consumption, such as the high rate of rural-to-urban migration and high system losses which amounted to 41% of the total electricity production in 2012. Only 18-20% of these are due to technical problems, while the majority - nontechnical losses – are linked to non-payment, theft, etc. (Bidaj et al., 2015).
The importance and urgency of the problem is demonstrated by two factors: the distorted electricity prices, which are higher than in other regional countries, and the frequent electricity shortages and supply disruptions.
In order to investigate this issue, the study takes into consideration a sample of 70 residential units chosen from different zones of Tirana, during a two-year time period: 2011 - 2012. All the units have an average number of dwellers of 3.4, were built between 1980 and 2010, lacks insulation and have single-pane glass windows.
The research analyses the monthly electricity consumption of the several case studies, and, in particular, the three major uses of electricity: space heating, DHW, lighting and appliances.
The results show that:
- The average annual electricity consumption of a residential unit in Tirana during 2012 is 5,382 kWh. The data reveal an increase of 6.86% compared to 2011, due to the rising incomes and changing climatic conditions which cause an increase for the cooling demand.
- The share of electricity attributable to heating amounts to 21.63% of total electricity consumption, that is 1,164 kWh;
- Electricity used for the production of DHW is the main variable in household electricity consumption since it depends on the outside temperature and human behaviour. It is 22.7% of a household's total electricity consumption, therefore it is comparable to the amount of electricity used for heating.
An attentive analysis of the obtained results suggests consequent energy saving strategies, recalling the measures predicted by the NEEAP: thermal insulation of buildings and introduction of household-scale heat pumps, combined with solar thermal systems for the production of DHW. In fact, Albania's solar energy potential is excellent since the country has among the highest number of sunshine hours per year in Europe, an average of 2,500.
Therefore, three of the most critical issues in household energy consumption, such as building insulation, space heating and DHW needs, are at once the most potential areas to improve the country's development. These factors represent

Tirana (Albania)

HDD	1815
CDD	467
Average summer temperature	23.3 °C
Average winter temperature	7.7 °C
Average annual sunshine hours	2526

Rome (Italy)

HDD	1253
CDD	786
Average summer temperature	22.8 °C
Average winter temperature	7.0 °C
Average annual sunshine hours	2516

Fig9 / Climate data for Tirana and Rome
source / Ecofys VII and ClimateData.eu, elaborated by the author

the limits and the tools to achieve a sustainable energy use in Albania.

The share of electricity used to meet the service-related uses, amounting to 45% of the total electricity consumption, could be reduced through the legislation and implementation of legal framework for labelling of electric appliances according to efficiency classes based on European standards (Classes A-B). An appliances-labelling scheme has already been introduced in Albania but it must be improved and strengthened by regular inspections and reporting by the State Inspectorate. At the same time, this EE measure should be followed by the introduction of minimum standards for electric appliances. The prescriptions of the EuP-Directives for electric appliances should be stepwise transferred to the legal framework in Albania.

Unlocking the residential energy saving potential: a housing prototype as a prospective instrument for – and in comparison with – the typical Albanian house

From all the observations considered above, we can state that the residential sector - because of the challenges which affect it - actually represents a precious opportunity, since it conceals a huge untapped energy saving potential. Every strategy able to use household energy limits as a resource becomes a new driver of sustainable development for Albania.

In order to test this approach to the country's energy issue, innovative for a context like Albania but already widespread in most European developed countries, and starting from the possible EE strategies mentioned above, we will take into consideration a housing prototype as a potential instrument to trigger energy saving processes. The first step consists in finding a context with weather conditions similar to those of Albania. Although the country has a high number of climatic regions, its climate can be classified as hot-summer Mediterranean (Csa zone according to the Köppen climate classification), as most Mediterranean countries, especially the cities of Central and Southern Italy. Taking into account other weather parameters, the most comparable city to the Albanian capital results to be Rome, Italy.

RhOME for denCity

The Italian project RhOME for denCity is the winner of the 2014 Solar Decathlon Europe, an international competition in which universities from all over the world meet to design, build and operate an energy-efficient and cost-effective home, thanks to the use of solar energy and equipment with all the technologies useful for maximising efficiency.

The project was designed by a multidisciplinary team of the Università degli Studi Roma Tre and was awarded the first prize for social housing by Cecodhas Housing Europe. In addition to this, RhOME for denCity is the starting point of the research program Building at Positive Energy for the Urban Regeneration of Informal Settlement, which is focused on the development of sustainable housing prototypes able to trigger processes of urban regeneration.

energy data

RhOME for denCity
single residential unit

heating energy demand:	6 kWh/m^2y
cooling energy demand:	12 kWh/m^2y
DHW energy demand:	5 kWh/m^2y
lighting & appliances energy demand:	40 kWh/m^2y
overall energy demand:	63 kWh/m^2y
average annual electricity consumption	16 kWh/m^2y
photovoltaic system production:	97 kWh/m^2y

Rome shares the problem of informal housing and illegal settlements with Albania (UN, 2009). Within this framework, RhOME for denCity tries to redensify and requalify a quarter characterised by high fragmentation, where the basic services and the hierarchy of spaces are missing, by improving low-energy city living through passive solar design and urban connectivity.
The research project is 'an opportunity to deal with the current global challenges starting from local scale solutions (RhOME for denCity, 2014). This approach presents an innovative change of attitude which is emerging in the field of architecture, where few architects have started to face the demanding local conditions by exploring the existing potential of places with a new inventiveness (Lepik, 2010). RhOME for denCity is designed to produce more energy than it consumes, up to partially supporting the area where it will be built.
The project develops within four storeys and is composed by eight apartments with different sizes arranged around a central column for services. The volume consists of a wooden envelope with movable screens, loggias, balconies and thick walls in order to take advantage of thermal inertia properties, reaching extremely low-transmittance values. In this way, the house optimises heat gains in winter and minimises those in summer, achieves the highest quality of natural light, creates comfort conditions without energy waste and better integrates photovoltaic and thermodynamic plants for the uptake of solar power.
Each residential unit is provided with:
- a heat pump of 20.4 kW with an energy efficiency ratio (EER) of 4 for cooling demand;
- a photovoltaic plant of 5 kW peak power for the electrical demand;
- a pellet boiler of 30 kW for heating demand.
The CO_2 emissions are decreased by 23.5 tons per year if compared to a plant conventionally used in a residential building.
The structure is made with frame-wall technology (Platform Frame), which is a dry construction system, efficient from the

Fig10 / Energy data of a residential unit of RhOME for denCity and a typical Albania's residential unit source / technical data sheet RhOME for denCity, " The Typology of the Residential Building Stock in Albania and the Modelling of its Low-Carbon Transformation, Evaluation of the heating share of household electricity consumption using statistical analysis: a case study of Tirana, Albania, Renewable energy scenarios for Albania", elaborated by the author

point of view of energy. It is lightweight, fast to assemble, reduces costs and the need for specialised workers. The building construction is characterised by the reuse of local building materials, reducing the environmental impact of the intervention and producing new skills and job opportunities. In this way, the waste of one phase becomes a resource for another.

The flexible design allows the volume to grow and adapt according to the changing needs. The first phase consists in the construction of the main part of the complex, then the resulting materials are placed inside a shed within the lot. When the residents have the financial resources, the process continues through the construction of new expansions. This allows to reach the lot's maximum saturation.

The innovation is to think about future transformations in the design phase, in order to prevent illogical expansions. The return on investment is calculated in 5 years with a cash flow higher than 350,000 € after the 15th year (Battista et al. 2015). If we compare the energy data of a single unit of RhOME to the ones representing the energy consumption of a typical Albanian household located in Tirana (climate zone B), the huge energy saving potential of the project RhOME for denCity becomes clear.

The data regarding the energy consumption of the Albanian household acquires higher importance if we consider that people heat and cool only part of their dwellings and for only part of the day.

2 / The aim of the paper in this phase is just to propose a tool, therefore, for all specific information please refer to the references.

In particular, about only the 60% of the dwelling area is heated in the climate zone B, and households using electricity heat for 10 hours per day. The calculations take into consideration that if the entire dwelling area during the whole day is heated, final energy consumption would be at least double (Support for Low-Emission Development in South Eastern Europe (SLED), 2016).

Conclusions

The ongoing development process and Albania's potential growth still coexist with the backwardness and unawareness which characterise some aspects of the country. However, many countries in the world are offering examples of what occurs when the cities and the existing demanding conditions are considered strategic and potential resources for their occupants, 'proving that scarcity of means can stimulate technical inventiveness' (Galiano, 2014). These are examples of how looking at the context with a realistic attitude and awareness of the problems and of the potential enables looking at challenges as opportunities and developing innovative design solutions able to take advantage of the existing resources. The housing prototype RhOME for denCity is designed for a context with almost the same starting conditions and problems of Albania - informal settlements and urban fragmentation - and which aims at the same objectives -reducing energy misuse and sustainably meeting household energy needs by using the existing local resources.

The high-performance wooden envelope of the prototype, which optimises winter heat gains and minimises those in summer by taking advantage of thermal inertia properties, represents a possible solution to the Albania's issue of the poor thermal insulation of buildings. In this way, the energy demand for space heating and air conditioning could be reduced, also by using one of the biggest country's resources which is wood.

Being equipped with a household-scale heat pump, RhOME for denCity addresses Albania's electricity misuse to provide household space heating and cooling. As regards the DHW production, the Italian housing prototype is characterised by a photovoltaic plant, offering an effective alternative to the typical Albanian use of electricity. Furthermore, the introduction of solar systems could allow the country to take advantage of its excellent solar energy potential. RhOME for denCity achieves the highest quality of natural light combined with a high-performance artificial lighting system, which is linked to the Albanian aim of reducing the share of electricity for lighting. In addition to this, CO_2 emissions are cut by 23.5 tons per year.

All the design strategies mentioned above follow the measures defined by the Albania's NEEAP in order to reach the environmental targets set for 2020, which are fundamental in the frame of the EU integration process. Taking into account the country's social issues, the Italian housing prototype is thought as an instrument for the urban regeneration of informal settlements, a problem which deeply affects Albania. Through the reuse of local building materials, the environmental impact of the intervention is reduced, while new skills and job opportunities are produced.

RhOME for denCity is designed in order to grow and adapt according to the changing needs. In this way, it addresses the tendency for Albanian people to build their homes by taking into account future expansions and often self-constructed additions, depreciating real estate values. The flexible design of the prototype could seriously consider this specific aspect of the Albanian culture and, in addition to this, it could take advantage of it: homes harmonically developed over time acquire value and become a shortcut to equity and wealth. As it happened for the Chilean Social Housing program of the architectural team Elemental, this demonstrates that 'realism can greatly improve policy: self-construction was ignored in government policy but instrumentalised by designers' (Cook and Boyer, 2010). The result is not only a project, but the generation of a process of local sustainable development.

The data considered above show that 'Albania's energy challenges can be viewed as opportunities to respond to the country's changing economic and climatic conditions with smart choices that provide Albanians with reliable and sustainable energy services' (Bidaj et al., 2015).

A higher level of energy efficiency will positively affect the country's development firstly on a building level, by improving the energy performance of buildings, along with air quality and thermal comfort, cutting energy costs for private households and increasing real estate value.

On a national level, a more sustainable energy use will contribute to the implementation of the NEEAP and will raise energy security, also bringing significant benefits to the country's economy such as higher competitiveness, poverty alleviation and social inclusion.

Taking into account the urban and local policies, these experiences are opportunities to face the current global challenges, starting from local scale solutions moving towards addressing higher-order problems and trigger innovation processes.

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