Smart Cities as a Tool to Tackle Global Challenges

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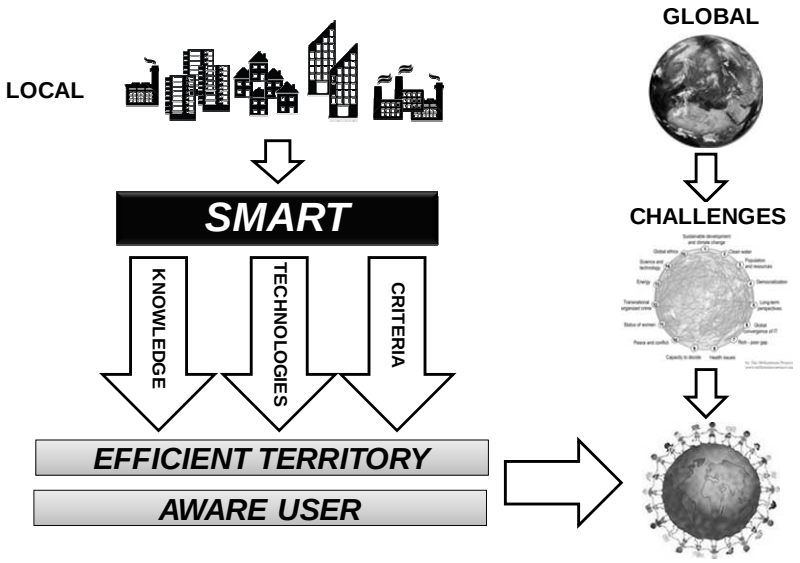
1 ABSTRACT

We live in a planet with limited resources and our way of life is based on resources consumption. This consumption generates externalities as a result of urban metabolism. One of the main resources we always need is energy; we need it for obtaining raw materials, for processing them, for commuting every day, for communicating, for watertreatment, or for our own cellular metabolism; and as our society is becoming more technified we are getting more energy dependent. We must reduce energy consumption and increase efficiency, we have started this race and the actions we undertook had good results but there is more we can do to go forward in this field.

Cities are complex systems, connected and dependent. Cities are the main consumers of resources, and it makes them play an important role as a drivers to change. To make smart cities we need real time data. Technology and knowledge must arrive to final user and the user needs criteria for decision making to make that possible. In the last decade there have been great advances in technologies, in sensor's development, ways and speed for data communication, and tools and applications to visualize data. The challenge now is integrating all of this in order to make the cities smart.



Urbanization, the demographic transition from rural to urban, is associated with shifts from an agriculture-based economy to mass industry, technology, and service. For the first time ever, the majority of the world's population lives in a city, and this proportion continues to grow. One hundred years ago, 2 out of every 10 people lived in an urban area. By 1990, less than 40% of the global population lived in a city, but as of 2010, more than half of all people live in an urban area. By 2030, 6 out of every 10 people will live in a city, and by 2050, this proportion will increase to 7 out of 10 people. Currently, around half of all urban dwellers live in cities with between 100 000 - 500 000 people, and fewer than 10% of urban dwellers live in megacities (defined by UN HABITAT as a city with a population of more than 10 million).[1]

Cities also consume 75% of global energy production, generate more than 70% of the total wastes and are directly responsible for more than 80% of global GHG emissions.[2] So doing cities more efficient, less energy and resources demandant and reducing their ecological footprint is one of the key factors to tackel global

[1] Hugo Ahlenius, UNEP/GRID-Arenda. UNEP 2009. Trends in urban and rural populations, less developed regions, 1960-2030 (estimates and projections)
[2] Ash C, Jasny BR, Roberts L, Stone R, Sugden A (2008) Reimagining cities - Introduction. Science 319(5864): 739-739.

ISBN: 978-3-9503110-6-8 (CD-ROM); ISBN: 978-3-9503110-7-5 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI

challenges. Cities should also contribute to energy generation. One of the main problems is that European cities have old dwellings that they ussually don't acomplish the actual standards. Building brand new efficient urban districts is relativelly easy to acomplish nowadays, but what do we do with the already existing city?

2 SMART CITY BARCELONA

Barcelona is working to be a smart city. The city and metropolitan area are working to get more knowledge and data of the current situation of territory and its potential for being more efficient. New technologies such as satellite data or parameterization are being used to get more information. And the relevance of citizen's role towards a smart city is being more recognized, so the administration is working to provide them with more data and tools to make good decisions.

2.1 Generation of local and renewable enenrgy

Metropolitan area of Barcelona is energy dependent as the main part of urban systems. However there is a part of the needed electrical energy generation that is being produced in the territory. In 2012, about 41% of electrical energy demand could be covered with the energy generated in the metropolitan area. Energy generation in big energy plants, with a combined cycle power of 2.591 MW, cover about 30% of electrical consumption while an important number of small energy plants distributed around the territory contribute in 8% to selfproduction.

If we analyse the electricity consumption in the 36 municipalities that conform the Metropolitan Area we can observe that the ones with highest urban density have less electricity consumption. For example Santa Coloma de Gramenet has a density of 17.147 inhab/km² and the average electricity consumtion per inhabitat is 983 kWh in the other extrem we find La Palma de Cervelló with a urban density of 547,8 inhab/km² and the avergae electricity consumptions is 2.062 kWh/inhab. You can find similar relations with water consumption and CO_2 generation.

URBAN MORFOLOGY AND ENVIRONMENTAL BEHAVIOR IN BARCELONA

	Low density Begues	Medium density Sant Feliu	High density L'Hospitalet
inh	6.520	43.671	257.057
Inh/km²	131	3.703	20.488
m/inh	12,25	1,58	0,92
kWh/year	1.909	1.214	1.095
l/inh/day	137	97	93
tn CO_2/inh	0,73	1,42	0,99
Kg/inh/day	1,87	1,00	1,03
/1000 inh	508	411	316

Urban areas need to use energy in a wiser and smarter way. Dense and compact cities in mild weathers facilitate to implement an efficient public transportation and also they make more easy to implement sustainable mobility (pedestrian and bikes). Barcelona has a mediterranean climate so mainly the energy demand comes from domestic sector. To achieve better energy behavears we will have to work with the existing dwellings but also we will need to use the renewal energy potentials that we have in our area.

How to solve energy supply is an essential and strategical issue that the city and metropolitan area has to deal with, and the selection of the sources will define the degree of fossil fuel dependency or selfsuficiency. Renewable energy production is a suitable way to decrease fossil fuel dependency while increasing selfsufiicciency degree, and makes the city more environmentally friendly and resilient. Barcelona and its metropolitan area are working on how to increase renewable energy generation but furthermore the city is

making an effort to use as own resources some that for a long time has been forgotten and unused, being only some of the urban metabolism outputs.

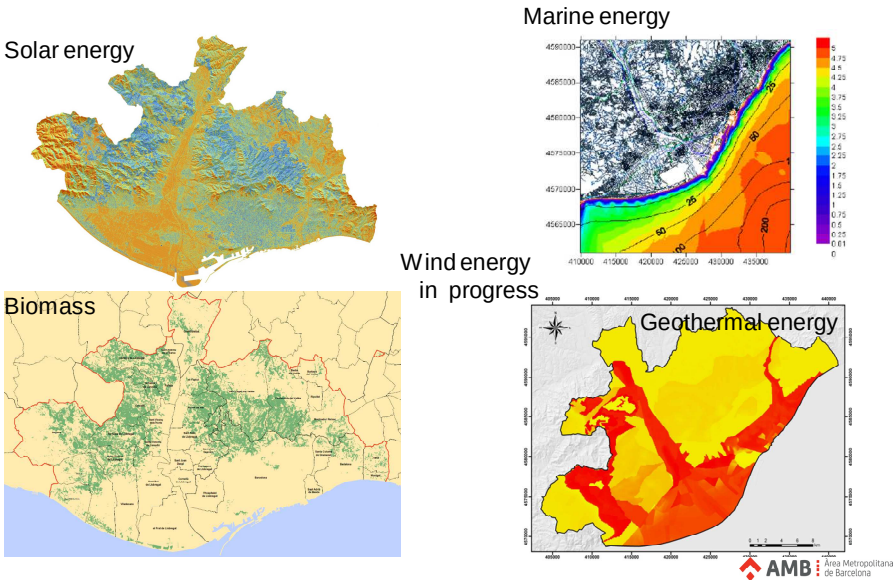
The first infrastructure integrated in the energy system was the incineration plant of domestic waste. A part from the electriciy production, residual heat is now integrated in a district heating and cooling system of more than 13 km of pipe extension supplying 68 buildings (2011). With a heating capacity of 44,6 MW and cooling capacity of 69,2 MW this DHC system, consolidated but with a long way for extension planned, improve energy efficiency and reduce fossil energy consumption in the urban transfomation of 22@ District and Forum area.

The second DHC system of the city combines several systems that make it particularly efficient: on the one hand, the use of residual cold gasification process that takes place in the Port, I+D project completely new, and on the other hand, the use of biomass that comes from municipal parks and gardens.

Regarding to renewable energies, Sustainability Metropolitan Plan has started the study of renewable energy potentials in its territory. Lidar technology was used to create a 3D model so solar radiation could be calculated in detail to create a solar radiation map. Downscaling the results it would be possible to estimate the energy potential of each roof. It will be a tool created with the knowledge of local data, advanced technologies and directed to a specific result. The solar potential could be translated into how many or which type of sollar panels could be installed or how much would be the necessary investment for it, giving criteria to citizens to decide if they want to contribute to energy generation and also to public administrations to priorize some investments to make one step forward towards smart city.

Wind energy was also in study to know the metropolitan potential. From a simplified 3D model it is expected to get generation potential at different height levels. Other renewables as getothermal energy, forest biomass energy or marine energy were studied also with the same vision of identifying and measuring metropolitan renewable energy potentials.

POTENTIAL IN RENEWABLES. MAPPING LOCAL RESOURCES



3 SMART CITY CHALLENGES

Sustainable development and climate change is one of the main global challenges facing humanity. According to the main role cities play in that sense, working to be climate neutral is one of the main aims in the agenda of the global cities.

Climate neutrality can be approached by different scales in city context, from metropolitan to citizen behavior passing through the whole city, districts, buildings or households. District level is probably the one that can have the most impact. The European Project CLUE (Climate Neutral Urban Districts in Europe) is working to define some solutions at this scale.

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The consideration of new districts or existing urban tissues is one of the things that need to be discerned when working towards climate neutrality. Most of the good practices are new developments, but the very real challenge is how existing urban tissues can be transformed to be more climate friendly.

There is one more challenge to consider which is density factor. Urban density can be a parameter that allows cities to be more efficient in many senses, but also a conditioning for the quality of life of their inhabitants. Furthermore, and again, there are many good practices around for planning ecodistricts of low urban densities but the real challenge is how can be built a dense ecodistrict, or a dense climate neutral district.

In the last decades there has been several ecodistricts or green neigborhoods developed all over. When you analize some of these new ecodistricts like Bo01 in Malmö, Kronsberg in Hannover, BedZed in London, or many others you realize that usually they have low densities compared to many other realities or dense and compact cities. As we have seen the world will increase it's population and many of this popoulation is going to be located in cities. New constructions could be more efficient but we will have to consider compacity, density and compact areas as a main goal, which is the equilibrium related to the energy balance of a compact and dense city?

Hong Kong is extremly dense city 56.200 inhab/km². How we can improve all the existing dwellings. In those extremly high skycrapers? how do we implement solar panels or other type of renewals?

Working with passive mesures, reducing demands by increasing building standards, using high efficiency technologies, implementing renewals, using sinergies like waste to energy and with an important behavioral change. Maybe those are only some of the issues to work with. Cities are already using several of this strategies. Changing business as usal way of developing cities is also important.

4 CONCLUSION

One of the main ways to face planet challenges is to focus on cities, so working towards smart cities. In this path is necessary to have and use knowledge, technologies and criteria to make the right decisions to go forward it.

Knowing the potential of renewables in the metropolitan area of Barcelona is only a first step. We can not solve the energy problem of cities only with technology, we also need knowledge, social compromise and to change the economic model based in fossil fuel consumption. Citizens need information, what is their energy consumption? Which elements of their houses or of their style of live is contributing more to climate change? If they've got information and tools to act over the mechanisms they could react and change their behaviors.

Energy is for sure one of the challenges that we have ahead. We have limited resources of fossil fuels and uranium. Energy consumption and population keeps growing although cars, electrodomestics, computers, diveces are getting more efficient. We have a very technified society that demands more energy. Ericsson has calculated that by 2019 there will be more than 9.3 billion of mobile subscriptions,[3] that is more than the estimated population that United Nations reports are estimating for that year.

How cities challenge global issues related to energy and climate change will be determinant for the future of our plannet. Working with climate neutral urban districts will be necessary, but also dealing with adaptation to climate change will be crucial, making more reasilient cities.

We, humans are the only specie that is capable to observe their habitat from outside, we can get information, data from the space, we can mesure how GHG are changing, how the ocean is warming or acidifying, so we don't have excuses to search, to act and to tackle global challenges.

[3] Ericsson Mobility Report November 2013.