General standards to define a *Green City* in China

Paolo Vincenzo Genovese[1]

According to this investigation, *eco-cities* are almost impossible to be realized, for several reasons. The concept of *eco-city* concerns mainly with "greenwashing". In our view, the main issue for designing a sustainable city is to focus on the policies for planning and management at "district level". Human Settlements are usually considered sustainable, almost in equilibrium with the existing environment, when their size corresponds from 3.000 to 5.000 inhabitants. In China such number of inhabitants corresponds to the size of an average residential compound.

Keywords: green city, eco-city, waste, heating, energy saving, Urbanization in China.

A key topic that we need to discuss concerning sustainability, especially related to Asian context, is defining characters, parameters and standards for *green cities*. According to our investigation, we maintain that *eco-cities* are almost impossible to be realized for many reasons. In our view, the concept of *eco-city* cannot be discussed seriously and it concerns mainly with "greenwashing". So, regarding this issue we disagree with most of the literature about the green and sustainable city; our position does not avoid the responsibility to generate concept and standards to help the existing city to become more acceptable and, in this sense, it is very realistic. We dislike any dream and any lie; we simply would like to point out the enormous difficulties to plan a *green city*. Solutions and strategies that could help the administration to realize good standards exist; also solutions that reduce energy and resources consumption and that, at the same time, reconvert the existing cities in a more "human-friendly" environment. At first it is important to stress what a city, as an organism, cannot inclusively become:
- aggregation of people in equilibrium with the existing environment;

1. Paolo Vincenzo Genovese: Professor of Architecture, Tianjin University (P.R. China); email: pavic.genovese@hotmail.com.

- energy/resources-low-consumption organism;
- human-scale settlement;
- system based on close-cycle concept;
- zero-emission system.

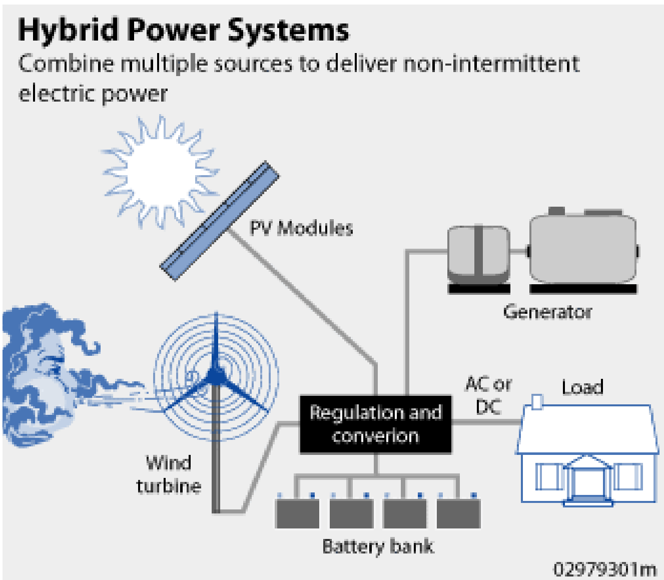
In fact, a city can not be too many things all together: its size and a large number of inhabitants definitely can generate several problems. The concept of modern city itself is basically in contradiction with the idea of sustainability. However, cities exist: we all make use of them and should have the chance to inhabit them as better as possible. Cities often need to be reconverted, "restored", following sustainability standards. Many urban planners misunderstand the idea of *green cities*: they are not cities full of green but cities respecting principles of sustainability. In our view, the main character to generate a sustainable city is determined by focusing on policies for planning and management at "district level". According to what we experience, the maximum size for a human settlement to be considered as sustainable, or to be almost in equilibrium with the existing environment, is 3.000 to 5.000 inhabitants. In China this number of people corresponds to the size of an average residential compound; the recent development presents residential districts planned by different building typologies. Some of them are high-rise high-density buildings, others are low-density buildings, "town-house" or even "single-villa" compounds. These two cases presents very reasonable standards concerning the concept of sustainability applied in the contemporary cities. So, if we want to discuss about sustainability in China, we have to consider, in theory, a combined system of several sustainable districts. Those districts could actually be sustainable using strategies based on the idea to coordinate different districts together, each one based on a different sustainable strategy. We know exactly that a system is much more complex that the sum of the parts, but in this case the system is so complex that we have to divide the contents in several small parts and then try to solve them one by one. A very useful concept is to consider the district as a "Energy neutral" and "CO_2 neutral"[2] system. But this is not enough. We would

2. Krikke, Hensen, Blocken, Willems 2011; In: http://www.bwk.tue.nl/bps/hensen/team/past/master/Krikke_2011.pdf.

like to introduce more parameters in order to generate more severe and high standard eco-cities. In short, the following criteria are the one that should be considered as key issues to determine eco-standards[3]:

A) Energy neutral

This is a trend concept. We do not believe that a city, as we intend it now, could be energy neutral. The reason is that the consumption is generally too high, the dispersions are too extreme and it is very difficult to manage a large number of people with various behaviors. Energy neutral means a kind of balance between the possibility of production of energy and the real consumption of it. We consider that we have to react to create a complex system where different technologies of production of energies can be combined together to determine a "energy neutral" city. In this sense a very interesting solution could be a hybrid system, mixing together different technologies to maximize the reduction of non-renewable energies. This is a basic concept: the way to realize it could have different solutions. The diagram shows the combination between three different system to produce energy[4]:



3. *Ibidem.*

4. Source Wikipedia, word «Photovoltaic system», in: http://en.wikipedia.org/wiki/Solar_photovoltaic_monitoring.

Many of these proposals could be created in order to generate a more efficient system of energy production.

B) CO_2 neutral

This issue is strictly related to the previous one, but with some additional problems. In fact, the pollution of CO_2 does not depend exclusively by the local consumption since it is a global problem. The residential district itself should avoid the production of CO_2 in order not to contribute in increasing the level of pollution. This issue concerns also with the problem of the Zero-Emission Building and of the Zero-Emission District. In this line one significant case comes from Denmark: «the district heating in Aarhus covers 95% of the total need for heating in the city. And by 2015, 100% of the heat production will be based on carbon-neutral biofuel and waste. As for wind power, the Aarhus area has the world's highest concentration of wind power companies which generate no less than 87% of the combined turnover in Denmark's wind power industry».[5] Here, a large part of the strategy in the energy production comes from the wind[6], but this is combined also with the biofuel and waste recycle. According to the European Energy Portal, the following diagram contains the results of emission of CO_2 in the European countries related with the standards of Kyoto protocol[7]:

EU MEMBER STATE	2003	2004	2005	2006	2007	2008	KYOTO TARGET 2012	% UNDER KYOTO TARGET
ESTONIA	21.2	21.2	20.7	19.2	22.0	20.3	40	49.25 %
LATVIA	10.7	10.7	10.9	11.7	12.1	11.9	23.3	48.93 %
LITHUANIA	16.7	21.1	22.6	22.8	24.7	24.3	44.1	44.90 %
ROMANIA	-	160.1	153.7	153.9	152.3	145.9	259.9	43.86 %
BULGARIA	-	68.9	69.8	71.5	75.7	73.5	127.3	42.26 %
HUNGARY	83.3	79.5	80.5	78.8	75.9	73.1	114.9	36.38 %
POLAND	382.5	396.7	399	399.3	398.9	395.6	551.7	28.29 %
SLOVAKIA	51.1	49.5	48.7	49.0	47.0	48.8	67.2	27.38 %
CZECH REPUBLIC	147.5	147.1	145.6	149.1	150.8	141.4	180.6	21.71 %
SWEDEN	70.9	69.7	67	66.9	65.4	64.0	75.2	14.89 %
GREECE	137.2	137.6	139.2	128.1	131.9	126.9	139.6	9.10 %
UNITED KINGDOM	658	660.4	657.4	647.9	636.7	628.2	678.3	7.39 %
FRANCE	560.9	556.1	553.4	541.7	531.1	527.0	564	6.56 %
BELGIUM	147.6	147.6	143.8	136.6	131.3	133.3	135.9	1.91 %
GERMANY	1024.4	1025	1001.5	980.0	956.1	958.1	972.9	1.52 %
FINLAND	85.4	81.2	69.3	79.9	78.3	70.1	71.1	1.41 %
								% ABOVE KYOTO TARGET
PORTUGAL	83.7	84.6	85.5	84.7	81.8	78.4	77.4	1.29 %
NETHERLANDS	215.4	218.4	212.1	208.5	207.5	206.9	200.4	3.24 %
IRELAND	68.4	68.6	69.9	69.7	69.2	67.4	63	6.98 %
ITALY	577.3	580.5	582.2	563.0	552.8	541.5	485.7	11.49 %
SLOVENIA	19.7	19.9	20.3	20.5	20.7	21.3	18.6	14.52 %
DENMARK	73.6	68.2	63.9	71.0	66.6	63.8	54.8	16.42 %
SPAIN	407.4	425.2	440.6	433.0	442.3	405.7	331.6	22.35 %
AUSTRIA	92.5	91.2	93.3	91.6	88.0	86.6	68.7	26.06 %
LUXEMBOURG	11.3	12.8	12.7	13.3	12.9	12.5	9.1	37.36 %
MALTA	3.1	3.2	3.4	2.9	3.0	3.0	NO TARGET	
CYPRUS	9.2	9.9	9.9	9.9	10.1	10.2	NO TARGET	

5.In:http://www.aarhus.dk/da/sitecore/content/Subsites/CityOfAarhus/Home/The-international-perspective/Large-development-projects/Aarhus-CO2neutral-in-2030.aspx.

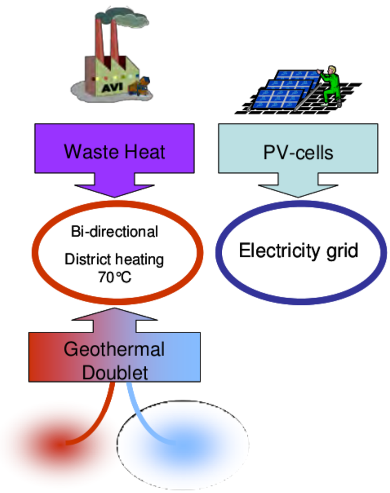
6. In: http://www.aarhus.dk/da/sitecore/content/Subsites/aarhuswindenergy/Home.aspx.

7. Source European Energy Portal, in: http://www.energy.eu/#domestic.

We should not stress more detailed information on it because our discussion is intended to be widely general. What we would like to introduce is the possibility to use the natural resources and the recycling resources to generate a 100% self-sufficient city. The simple combination between wind, biofuel and waste recycle permit to structure a city 100% self-sufficient in terms of energy and zero-emission of greenhouse gas. However many other strategies could be included and combined in this kind of policies.

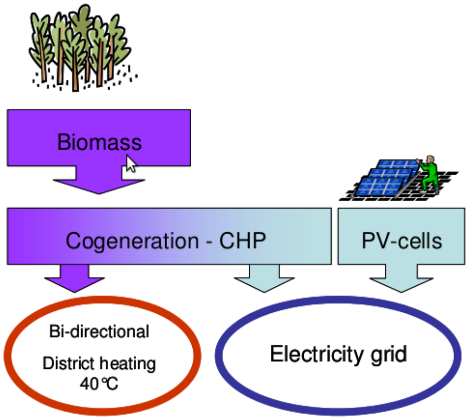
C) Waste heat: district heating with biomass or geothermal;
C1) Waste heat and geothermal (GeoHub): Waste heat source: Industry, electric power plant or geothermal doublet.

Thermal power plants will decrease the electricity generation efficiency. However, when the individual furnace (powered by natural gas) is removed will save the primary energy consumption of the district.



C2) Waste heat and biomass (BioHubs). Waste heat source: Mostly incineration plants.

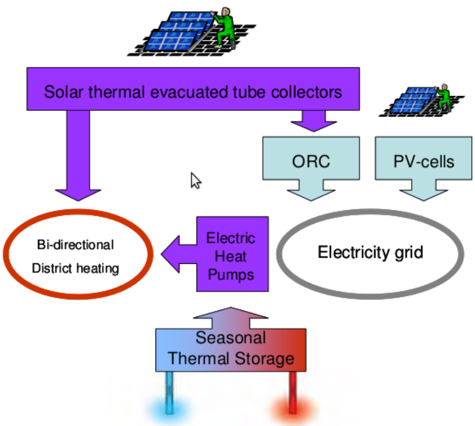
Biomass will be the primary source of the incineration plants. The heat flow out of the incineration plants has a relatively low temperature from 40°C to 50°C. Unlike high temperature waste heat, low temperature waste heat will not lead to a decrease of the electricity generation efficiency.



D) Solar Thermal;

D1) High temperature thermal energy storage.

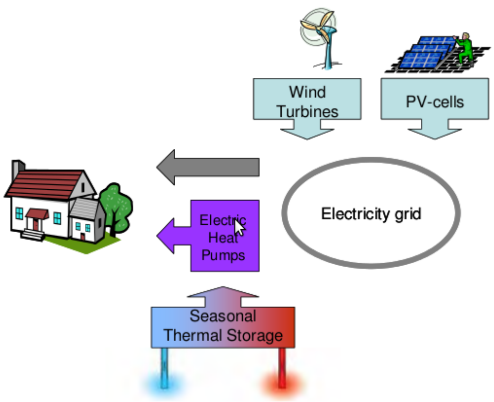
Solar thermal heat evacuated tube collectors combined with a bi-directional district heating network. The thermal energy is stored in shallow geothermal doublets at a high temperature (60°C). During the winter period the thermal energy is distributed with a temperature of 40°C to 50°C.



D2) Low temperature thermal energy storage

These evacuated tube solar thermal collectors can be combined with a bi-directional district heating network. An Organic Rankine Cycle (ORC) converts the thermal energy in electric energy. The low temperature waste heat can be stored. During the winter period, the ORC can function as a heat pump with a low temperature (40°C to 50°C) district heating network.

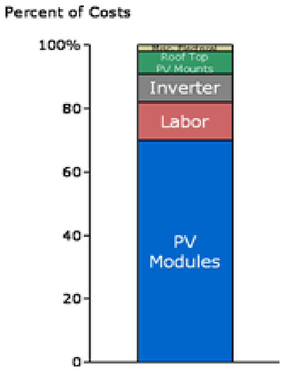
E) Solar Electric;
Solar and/or wind energy is converted to electricity with PV-panels or wind turbines. The electricity is used to power individual vertical ground heat exchangers. The energy balance of the ground is guaranteed by cooling during the summer period.



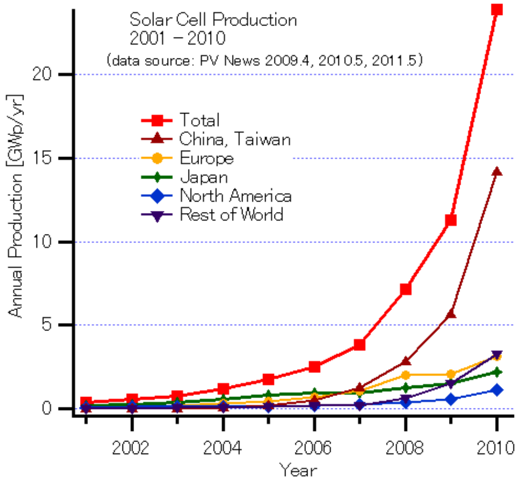
We should mention the importance of solar panels system too. As reported by the literature, the simple cost of a PV-panel could be totally covered in 2 years, or a little more, with Northen European radiation and only in 18 months with the Mediterranean area aone, a slim-film cell in North Europe in a year and in South Europe in 6 months. In addition, many governments, like UK and Italy, fund part of the costs to install a PV panel and this policy definitely let the solution of the photo-cells extremely interesting. This cost is largely arguable because this parameters are calculated on the market-price of the products. A more accurate research could demonstrate that the effective costs of this technologies should be much higher than what we have described just now.[8] This means that all the costs covering all what we just mentioned should last much longer. The costs for PV systems vary depending on what kind of rebates and other financial incentives are available, whether the building is under construction, whether PV panels are integrated into the roof or mounted on top of an existing roof, the size of the

8. Cfr. Plan B 4.0: Mobilizing to Save Civilization, pdf version in: http://www.earth-policy.org/books/pb4.

system, the price of the components and numerous other factors. The breakout costs will be similar to the following scheme:



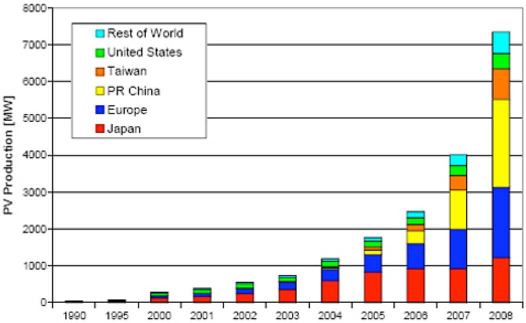
The following scheme means that most of the costs concerning the production of PV modules, gradually, will significantly reduce. It integrates different systems at the same time, like wind and PV panels. About the production of PV cells this diagram shows that China is again a leader in this tendency[9]:



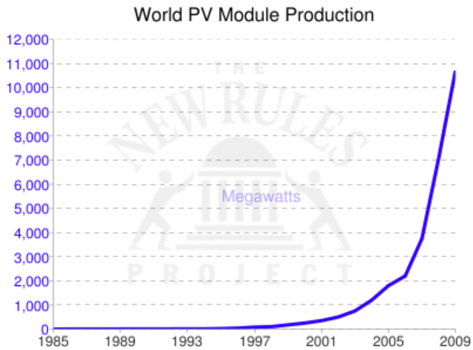
And according to other sources[10]:

9. Source PV NEWS, Greentech Media, quote in: http://en.wikipedia.org/wiki/File:SolarCellProduction-E.PNG.

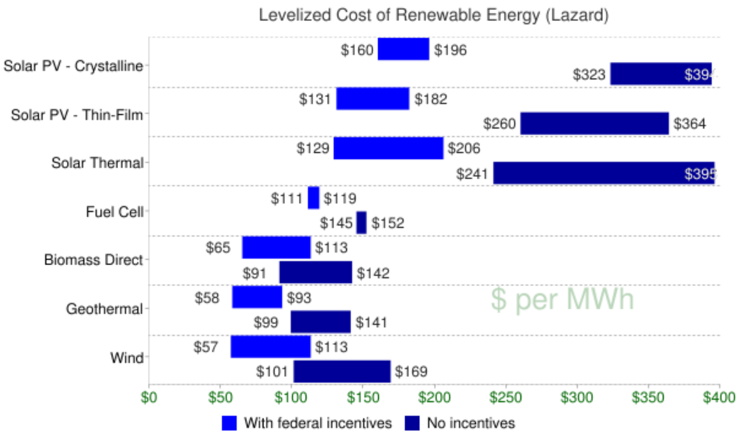
10. Chris Nelder, The Renewable Energy Challenge, Will the U.S. Choose the Path to Profit, or the Freeway to Failure?, September 25th, 2009, In: http://www.greenchipstocks.com/articles/renewable-energy-challenge/514.



In terms of global production, the tendency to use the PV panels is radically increasing in terms of production.[11]



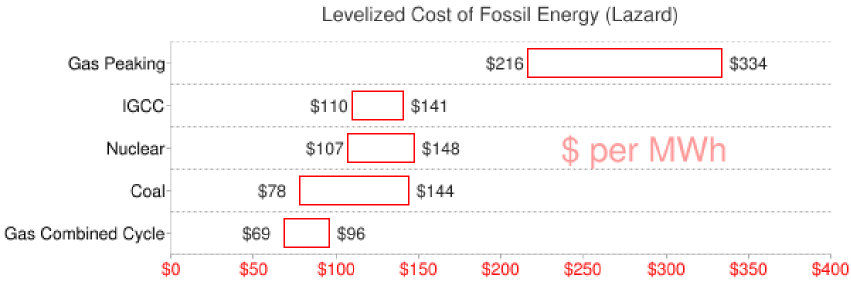
Other sources quote that in USA[12]:



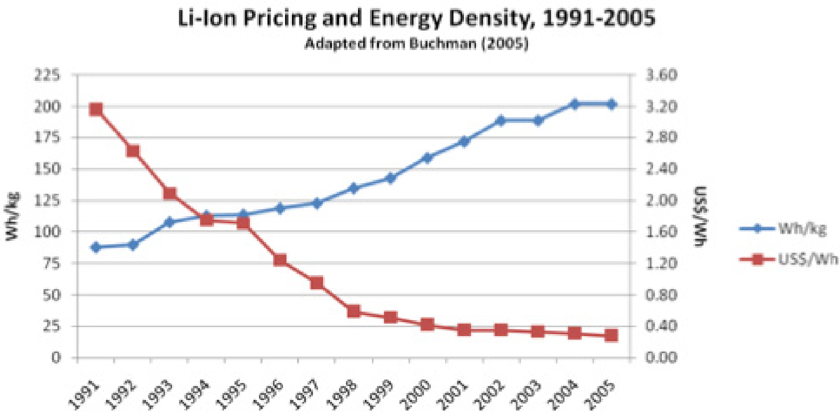
11. Source John Farrell, Graphics from the report: Democratizing the Electricity System, 20/9/2011. In: http://energyselfreliantstates.org/content/graphics-report-democratizing-electricity-system.

12. Source Energy Self-Reliant States, Graphics from the report: Democratizing the Electricity System, in: http://energyselfreliantstates.org/content/graphics-report-democratizing-electricity-system.

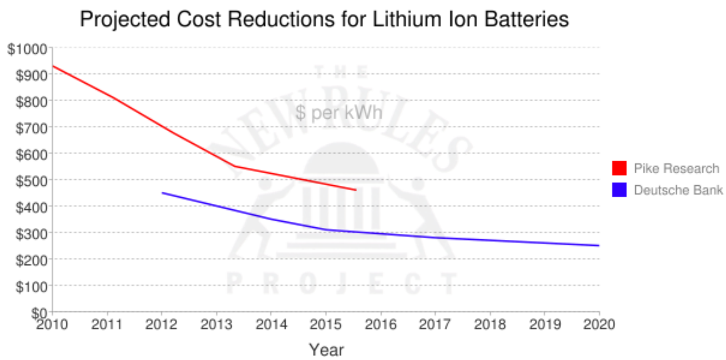
and[13]



A factor which is very significant in any kind of analysis is the storage of energy. As for the market comparison, the cost of battery is going to decease, but increasing capacity and quality.[14]

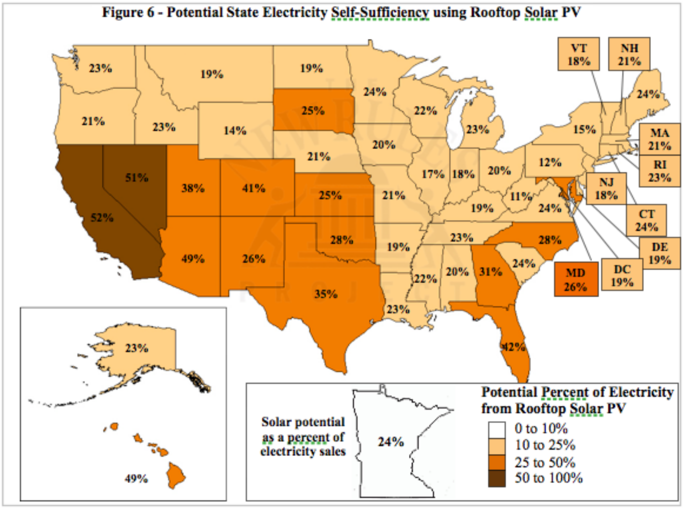


and

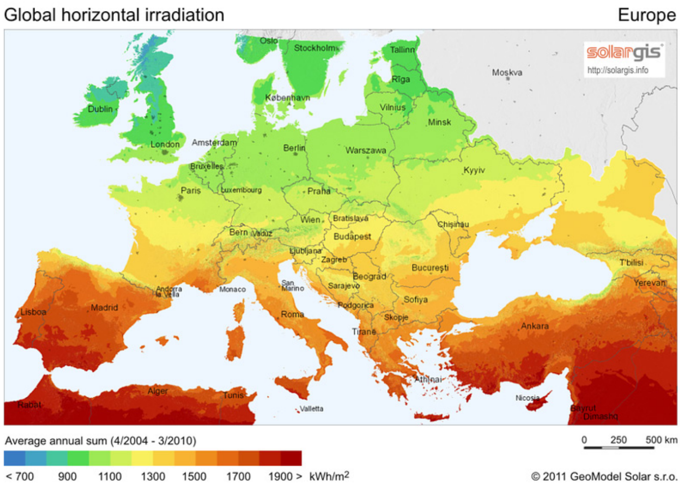


13. *Ibidem.*
14. *Ibidem.*

A very important issue to consider is the cost of the production of the energy made by PV panels. This depends on the “planting” area. In some areas, like South Europe and South USA they are extremely convenient. The map of State Potential Rooftop PV in USA is very clear on this topic[15]:

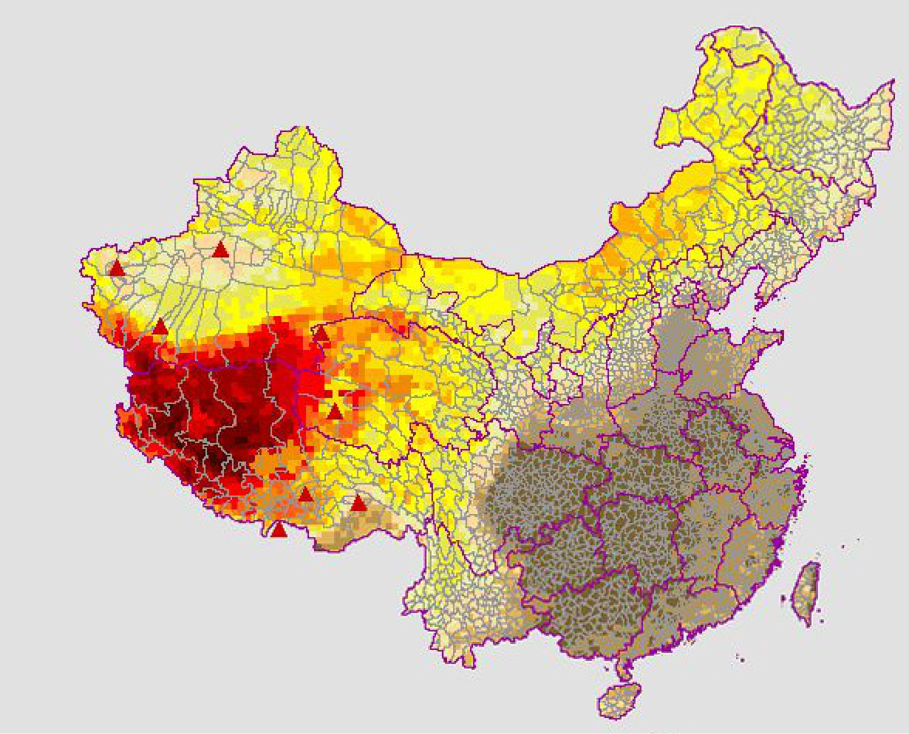


and a simple look to the map of insulation in Europe could easily show the potentiality of this system.



15. *Ibidem*.

And for China[16]:



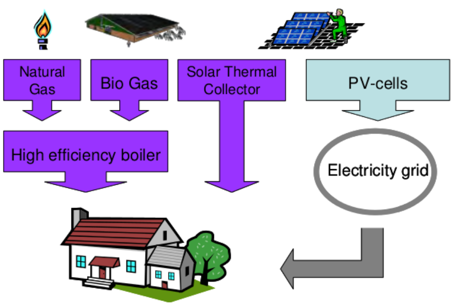
In agreement with Lester Brown: «Solar photovoltaic (PV) cell manufacturers produced a record 10,700 megawatts of PV cells globally in 2009 – an impressive 51% increase from the year before. While growth in 2009 slowed from the remarkable 89% expansion in 2008, it continued the rapid rise of an industry that first reached 1,000 megawatts of production in 2004. By the end of 2009, nearly 23,000 megawatts of PV had been installed worldwide, enough to power 4.6 million U.S. homes».[16] Moreover in the same paper we read that: «China produced 3,800 megawatts of PV in 2009, leading all countries for the second straight year. Together China and third place Taiwan accounted for 49% of all PV manufacturing, a share that should keep climbing as companies there grow larger and more quickly than competitors based

16. Source GENI, Global Energy Network Institute. In: http://www.geni.org/globalenergy/library/renewable-energy-resources/world/asia/solar-asia/solar-china.shtml.

in countries where operating costs are higher. Rounding out the top five producers in 2009 there were Japan in second place, Germany in fourth, and the United States in fifth (see data). These traditional industry leaders have lost significant market share with the recent ascent of China and Taiwan. Indeed, Japan, which dominated the global market in 2004, today controls just the 14% (...) While China now manufactures more than a third of the world's PV cells, most Chinese consumers cannot yet afford the technology. Ninety-five percent of its production is exported, much of it bounds for Germany, the world leader in using PV. Germany installed a record 3,800 megawatts of PV in 2009, more than half the 7,200 megawatts added worldwide. This brought Germany's overall PV generating capacity to 9,800 megawatts, nearly three times as much as the next closest country, Spain. Already in the first half of 2010, Germany added another 3,800 megawatts».[17] For the diffusion of this system, still too expensive for mostly of the private, it is necessary to have some incentives: «This powerful incentive to invest in renewables has now been adopted by some 50 countries, including Ecuador, Israel, Japan, Kenya, Pakistan, Thailand, and most of the European Union».[18] The scenario is very complex[19] and in the economy of our study we only need to point out the main trends to be used for a eco-district project.

F) Conventional Heating;

The conventional heating is based on a traditional system of climatization. The key issue that we need to mention is not the technology to produce heating itself, but basically the resources. As we can see in this scheme:

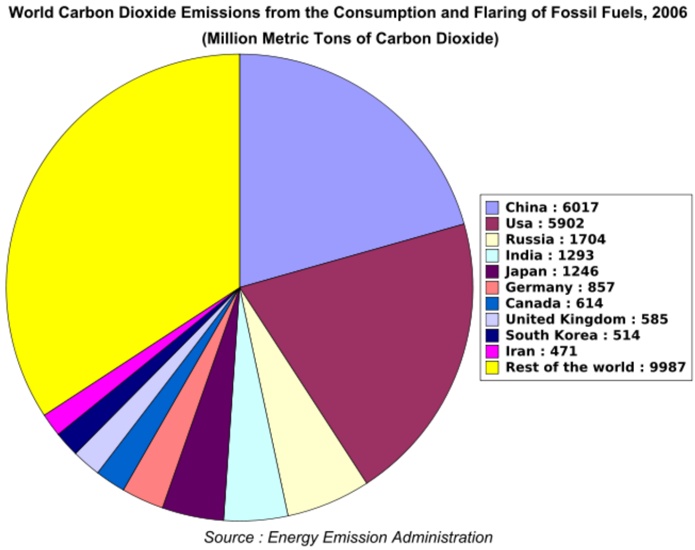


17. *Ibidem*.

18. *Ibidem*.

19. For more information Alex Pasternack, *China's Suntech Will Build Solar Panels in U.S.*, May 13, 2009. In: http://www.treehugger.com/renewable-energy/chinas-suntech-will-build-solar-panels-in-us.html.

The main point is not how we heat and cool the house, but by which resources. The conventional heating is based on a traditional system of climatization, and now the problem is to find some energy resources which avoid the non-renewable resources, like petroleum and natural gas. The discussion should be based to generate a system of heating and climatization able to reduce the CO_2 emission. In line with our investigation, China produce more CO_2 emission than any other country.



«The Government of China had to implement diverse policies to overcome such barriers to renewable energy development as: (a) the high cost of developing renewable energy; (b) the difficulty of connecting renewable energy to the grid; (c) institutional impediments; (d) the lack of international investment; (e) a weak legal and regulatory framework; and (f) an uncertain level of future demand and thus of prices for renewable energy».[20]

So the problem could be divided in two parts: on one side we need to avoid the use of the non-renewable resources, and on the second

20. Source Berkman Center's Cooperation Project, Alternative Energy/Paper, in: http://cyber.law.harvard.edu/commonsbasedresearch/Alternative_Energy/Paper#China.

side we need to generate a kind of system for heating that radically reduce the emission of CO_2. In the scheme that we have mentioned, two energy resources are not suitable (the natural gas, for instance). For the bio-gas the discussion is different. First at all it is a renewable resources: «produced by the biological breakdown of organic matter in the absence of oxygen. Organic waste such as dead plant and animal material, animal dung, kitchen waste can be converted into a gaseous fuel called biogas. It originates from biogenic material and is a type of biofuel».[21] We do not come inside the problem of the specific technology but we have to mention that bio-gas has several weakness that need to be considered. To produce bio-gas it is necessary to combine animal sewage and plants (25%-75%). To feed a production factory of energy 1Mw, 300 ha of land are needed and detracted from the production of food for animals and humans. This is a large problem quoted also by Lester Brown.[22] One of the main problem nowadays is the lack of agriculture production. The increasing demand of energy corresponds to an intensive use of the land for agriculture which is converted in energy and not in food. In addition, it exists an additional problem. The production of vegetable for energy is not destined to humans. In order to maximize the production there is a large use of pesticide and fertilizer that heavily pollute the soil and the ground water.[23] All those problems have to be considered in a strategy for sustainable cities.

Back to architecture, if we need to discuss the traditional technologies to heat then we have to radically re-think the logic applied to housing and reduce or even avoid all the resources that bring any inconvenient. The web reports many interesting diagrams describing energy consumption. In 2008, 41% of all the energy consumed in the United States went for powering homes and commercial buildings.[24] In Europe, in 2009, there were different quantities of energy consump-

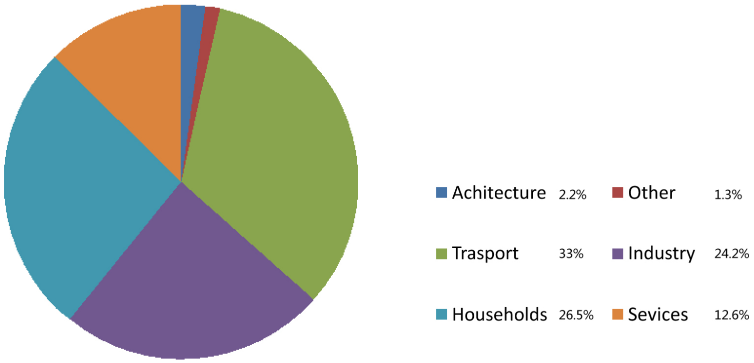
21. Sources Wikipedia, word «Biogas», in: http://en.wikipedia.org/wiki/Bio_ga.

22. Lester Brown, Plan B 4.0: Mobilizing to Save Civilization, pdf version in: http://www.earth-policy.org/books/pb4 Especially Chapt. 2.

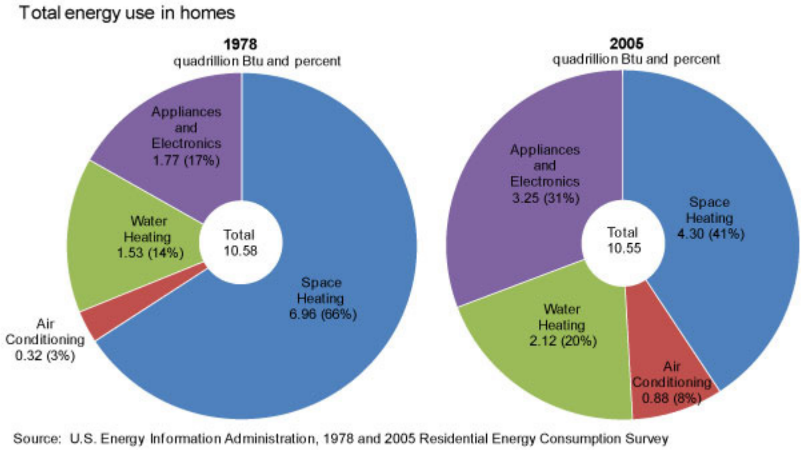
23. Source wikipedia, word «Biogas», in: http://it.wikipedia.org/wiki/Biogas#Svantaggi_del_biogas.

24. Source The National Academies, What you need to know about energy → How we use energy → Home and Work. In: http://needtoknow.nas.edu/energy/energy-use/home-work.php.

tion[25]:



In recent years the quantity of consumed energy has been hugely reduced. According to the U.S. Energy Information Administration this is the reduction in US between 1978 and 2006[26]:



Actually this is not the real trend that we need to follow and the big question is how to change the logic for housing in terms of zero-emission buildings.

25. Source European Commission, in: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy Diagram redraw by Paolo Vincenzo Genovese.

26. Source U.S. Energy Information Administration, Share of energy used by appliances and consumer electronics increases in U.S. Homes, in: http://205.254.135.7/consumption/residential/reports/electronics.cfm.

G) Hydrogen power;

The production of Hydrogen become in recent years very popular. We are not going to discuss the feasibility or convenience of this system but only argue some advantages and disadvantages. One of the main problem that is often mentioned about the "hydrogen economy" is the production and the storage: «Hydrogen has been produced and used for industrial purposes for over one hundred years. Of the world's total hydrogen production of approximately 45 mill. tons, over 90% comes from fossil raw materials. The largest producers of hydrogen are the fertiliser and petroleum industries».[27] In detail: «Currently, global hydrogen production is 48% from natural gas, 30% from petroleum, and 18% from coal; water electrolysis accounts for only 4%».[28]

The topic of the hydrogen power is really wide and basically is technical. It is interesting to point out some character of this natural resource:

Environmentally friendly: Water will be the only product of hydrogen combustion.

Safety: The relatively easy method of using hydrogen as fuel, mixing hydrogen and oxygen together, reduces the risk of having many large-scale accidents in the production of power.

Easy production: Hydrogen is found in great abundance in the universe, allowing it to be produced easily.

Storage: Hydrogen would be difficult to store in liquid form because it requires an immense amount of pressure in order for it to be in its liquid, rather than gas, form.

Flammability: Hydrogen is highly flammable, which may pose a problem to its widespread use in the present time.

Hydrogen may be just one part of a whole suitable energy alternatives. Anyone of the possible solution will require investing heavily in new infrastructure. In order to replace fossil fuels used in passenger cars by 2040 it will be required annually 150 million tons of hydrogen. Here's what it would take to reach that goal with any technology[29]:

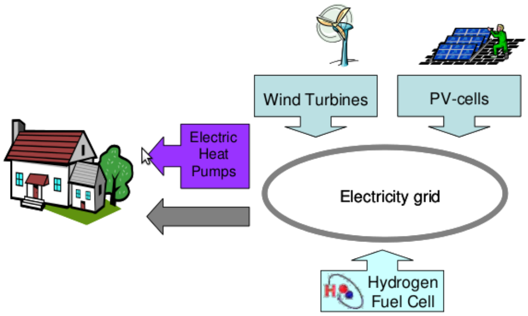
27. Hydrogen - Status and possibilities. In: http://www.interstatetraveler.us/Reference-Bibliography/Bellona-HydrogenReport.html.

28. *Ibidem*.

29. In: http://www.popularmechanics.com/science/energy/next-generation/4199381.

	Natural gas	Nuclear	Solar	Wind	Biomass	Coal
	Gas station-size facilities using steam reformation	Very High Temperature Reactors providing heat for electrolysis or for thermochemical cycles	Photovoltaic systems providing electricity for electrolysis with 10% efficiency	Turbines producing electricity for electrolysis, assuming they operate at 30% capacity	Gasification plants using steam reformation	FutureGen plants using coal gasification then steam reformation
Raw Materials Required	15.9 million cu. ft. of natural gas — only a fraction of current U.S. annual consumption	240,000 tons of unenriched uranium, five times today's global production	2500 kilowatt-hours of sun per square meter per year, found in the Southwestern states of the Sun Belt	7 meters per second average wind speed, typically found in many parts of the country	1.5 billion tons of dry biomass (initially byproducts such as peanut shells, then concentrated crops)	1 billion tons of coal — which would require doubling current U.S. domestic production
Infrastructure	777,000 facilities; though a more likely scenario would include a mix of larger central production plants	2000 600-megawatt next-generation nuclear power plants; only 103 nuclear power plants operate in the States today	113 million 40-kilowatt systems, covering 50% of more than 300 million acres — an area three size the size of Nevada	1 million 2-megawatt wind turbines, covering 5% of 120 million acres, or an area larger than California	3300 gasification plants, and up to 113.4 million acres — or 11% of U.S. farmland — dedicated to growing the biomass	1000 275-megawatt plants; only 12 sites were proposed for a DOE demonstration plant — not all met the requirements
Total Cost	$1 trillion	$840 billion	$22 trillion	$3 trillion	$565 billion	$500 billion
Price Per GGE (Gallon of Gas Equivalent)	$3.00	$2.50	$9.50	$3.00	$1.90	$1
O2 Emissions measured in tons	300 million	0	0	0	600 million*	600 million**
*Zero net emissions because crops pull CO2 from the air. **90% will be captured and stored underground.						
Time Frame	There are four fueling stations that now produce hydrogen from natural gas.	The first Very High Temperature Reactor in the U.S. will be built at Idaho National Laboratory in 2021.	Honda built an experimental solar-powered hydrogen refueling station at its lab in California in 2001.	A 100-kilowatt turbine is now being built at the National Renewable Energy Lab in Colorado.	Government funded bio-mass research will be transferred to private industry in 2015.	By 2012, the first FutureGen demonstration plant should be running at 50% capacity

The above diagram explains all the investments that in the US should be done to replace the fossil fuels. It is only a prevision, but it shows the complexity of their new strategy. In a simple scheme, we can say that the hydrogen source is not independent but needs to be considered inside a larger system of electricity production, following the scheme below:



Conclusion for the Eco-standards

As we previously pointed our, a combined system of different technologies should be regularly integrated in the project of eco-districts. This is the main point in our vision. Every project of eco-districts or eco-cities should be based on a multiple approach for energy production. This strategy needs to be calculated case-by-case in line with the local climate conditions and resources. A simple analysis of the costs of the production of energy could be very useful to generate a precise strategy in the district (or city) planning. If we analyze the costs of electricity by different sources, we could find a good strategy to combine it. This means the different energy provisions have to be combined considering their costs. Wikipedia estimates that costs for energy[30] could be summarized in:

Technology	Cost range (£/MWh)
Onshore wind	80–110
New nuclear	80–105
Natural gas turbines with CO2 capture	60–130
Biomass	60–120
Natural gas turbine, no CO2 capture	55–110
Tidal power	155–390
Offshore wind	150–210
Solar farms	125–180
Coal with CO2 capture	100–155

30. UK energy costs for different generation technologies in pounds per megawatt hour (2010). Source Wikipedia, word «Cost of electricity by source», in: http://en.wikipedia.org/wiki/Cost_of_electricity_by_source.

Another diagram reports further data:

Estimated Levelized Cost of New Generation Resources, 2016.

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2009 $/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	65.3	3.9	24.3	1.2	94.8
Advanced Coal	85	74.6	7.9	25.7	1.2	109.4
Advanced Coal with CCS	85	92.7	9.2	33.1	1.2	136.2
Natural Gas-fired						
Conventional Combined Cycle	87	17.5	1.9	45.6	1.2	66.1
Advanced Combined Cycle	87	17.9	1.9	42.1	1.2	63.1
Advanced CC with CCS	87	34.6	3.9	49.6	1.2	89.3
Conventional Combustion Turbine	30	45.8	3.7	71.5	3.5	124.5
Advanced Combustion Turbine	30	31.6	5.5	62.9	3.5	103.5
Advanced Nuclear	90	90.1	11.1	11.7	1.0	113.9
Wind	34	83.9	9.6	0.0	3.5	97.0
Wind – Offshore	34	209.3	28.1	0.0	5.9	243.2
Solar PV[1]	25	194.6	12.1	0.0	4.0	210.7
Solar Thermal	18	259.4	46.6	0.0	5.8	311.8
Geothermal	92	79.3	11.9	9.5	1.0	101.7
Biomass	83	55.3	13.7	42.3	1.3	112.5
Hydro	52	74.5	3.8	6.3	1.9	86.4

[1] Costs are expressed in terms of net AC power available to the grid for the installed capacity.

Source: Energy Information Administration, Annual Energy Outlook 2011, December 2010, DOE/EIA-0383(2010)

We maintain that the costs of those energy resources appear largely incomplete. The reason comes from the evidence that in the calculation of the Nuclear energy resources some external costs could significantly increase the basic costs – as shown in these diagrams – that previously were note included. For example, the costs report do not include the additional expenses coming from disasters, accidents or dumping. The problem is particularly evident in the case of Nuclear power but it is extremely important in almost every sources of power. The dumping machinery and the simple energetic costs of the production of all the technical system to generate energy often do not count in the calculation. This idea is also quoted by Lester Brown in *Plan B 4.0*.[31] As reported by the analysis of the price, the cost of the petroleum from the ground to the petroleum station should be 80 cents for a liter, in USA in 2009. This price includes: the cost of the petroleum research, extraction and petroleum refining. Then the distribution at petroleum stations. But this costs do not consider some additional costs, like the climate change directly derivated by the CO_2 emissions, the state's financing to the oil company, the increasing of the costs for the oil's war in the Middle-East and the sanitary costs for the pulmonary disease caused by the pollution[32], such as many others. As stated by an evaluation of the Center for Technologies Assessment, all those costs should be evaluated around 3 US Dollars for each liters consumed in the United States; 3 dollars plus 80 cents means almost 4 dollars for each liters, which is more than 4 times the original costs. In our opinion this "factor 4" for the costs should be added in every evaluation for all the products (such as PV panel, wind turbine and so on) included in the previous diagram. Then we can easily understand that the reality is much more dramatic than any initial prevision.

In other words: «the calculation does not include wider system costs associated with each type of power plant, such as long distance connections to grids, balancing and reserve costs, and does not include externalities such as health damage by coal power plants, decommissioning costs of nuclear power plant. These type of items can be explicitly added if necessary. It has little relation to actual price of power, and is widely used to assist policy makers and others to guide discussions and decision making».[33]All this discussion should be considered within the geopolitics of energy. In fact, in most of the European countries, for example, only Denmark is self sufficient in terms of energy.[34]

31. Brown 2009, Lester Brown in *Plan B 4.0: Mobilizing to Save Civilization,* pdf version in: http://www.earth-policy.org/books/pb4.

32. *Ibidem.*

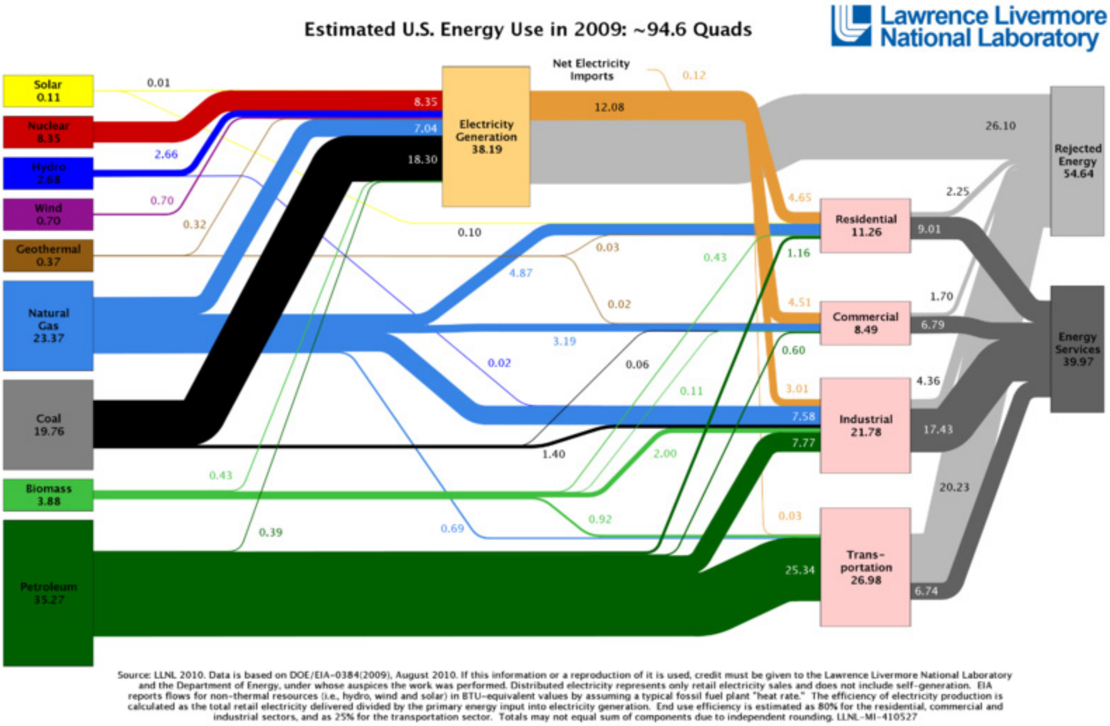
33. Source Wikipedia, word «Cost of electricity by source», in: http://en.wikipedia.org/wiki/Cost_of_electricity_by_source.

34. Source European Energy Portal, in: http://www.energy.eu/#domestic.

	EU Member State	Gross Energy consumption	Net imports	Energy Dependency
1	Cyprus	2.6	3	100%
2	Malta	0.9	0.9	100%
3	Luxembourg	4.7	4.7	98.9%
4	Ireland	4.7	14.2	90.9%
5	Italy	186.1	164.6	86.8%
6	Portugal	25.3	21.6	83.1%
7	Spain	143.9	123.8	81.4%
8	Belgium	60.4	53.5	77.9%
9	Austria	34.1	24.9	72.9%
10	Greece	31.5	24.9	71.9%
11	Latvia	4.6	3.2	65.7%
12	Lithuania	8.4	5.5	64%
13	Slovakia	18.8	12	64%
14	Hungary	27.8	17.3	62.5%
15	Germany	349	215.5	61.3%
16	Finland	37.8	20.9	54.6%
17	EU27	1825.2	1010.1	53.8%
18	Slovenia	7.3	3.8	52.1%
19	France	273.1	141.7	51.4%
20	Bulgaria	20.5	9.5	46.2%
21	Netherlands	80.5	37.2	38%
22	Sweden	50.8	19.8	37.4%
23	Estonia	5.4	1.9	33.5%
24	Romania	40.9	11.9	29.1%
25	Czech Republic	46.2	12.9	28%
26	United Kingdom	229.5	49.3	21.3%
27	Poland	98.3	19.6	19.9%
28	Denmark	20.9	-8.1	-36.8

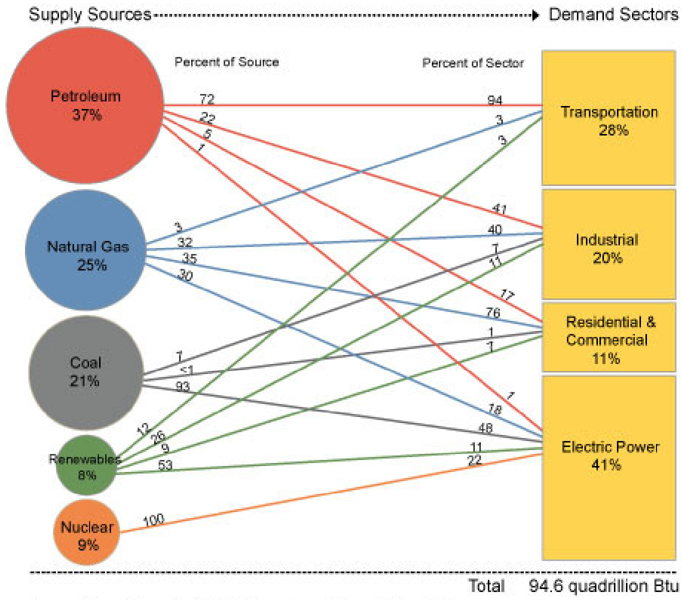
Only considering the situation of European Union, we can easily understand the dimension of the problem. As stated in the diagram and in the available references, most of the European countries are depending from the external sources for their energy needs. So we got a sense that the problem of energy is extremely complex and many factors should be involved in order to be able to conceive a sustainable planning methodology. The following diagram presents how networks and energy systems could be interrelated[35]:

35. Source Wikipedia, Lawrence Livermore National Laboratory, Energy flow charts show the relative size of primary energy resources and end uses in the United States, with fuels compared on a common energy unit basis, 2009, in: https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2009/LLNL_US_Energy_Flow_2009.png.



The different available sources and the real usage are strongly linked: this demonstrates how complex should be a complete reassessment of the system[36]: «What we want strongly emphasize is the necessity to include in every project of urban planning and district planning a precise strategy of energy production. A project of urban planning should consider as normal strategy, an integrated system of production of energy, not only in order to be self-sufficient and reduce the consumption, but also to produce more than it need, and then insert the extra-production inside the electric net in order to help the global needs».

36. Source U.S. Energy Information Administration (Department of Energy), U.S. Primary Energy Consumption by Source and Sector, 2009. In: http://www.eia.gov/energyexplained/images/charts/primary_consumption09-large.jpg.



Source: Energy Information Administration, *Annual Energy Review 2009*

Our proposal

After our inquiry, we realized that the problem of sustainable districts is a small part of a larger problem. It is not possible to solve in one research the conflicts raised by the important global issues involved. Anyway, we were able to point out some parameters which we consider fundamental for designing contemporary sustainable districts in China. We noticed that some of the parameters already mentioned were not sufficient and many other factors had to be considered. In our view research have to respect the character of usability: if a theory is too complex then it drives out of control. The following diagram collects the key parameters that we consider necessary in any project concerning eco-districts. This diagram is based on the surveys that we have done in several eco-districts in Europe and also on a comparative analysis of the key data collected in the present paper. We know that the problem of the eco-distrcts is extremely complex and this few parameters do not satisfy the complexity of eco-living standards. But in our opinion these are the key issues to ensure, at least, a suitable and pragmatic approach for every urban planning project that propose eco-life standards.

CLASSIFICATION RANGE OF ECODISTRICT			
Nb	Designation		Quantity Range
1	Population (Person)		
2	Land (Km²)		
3	Land Per Person (L/P m²)		
4	Water (%)	Outdoor water permeable	
		Use Liter/day/pers.	
		Water Saving	
		Rainwater collection using	
		Recycle	
		None Recycle	
5	Energy(kwh)	Solar	
		Wind	
		Photovoltaic	
		Heating	
		H2	
		Green house	
		Burn recycling	
6	Land Green		
7	Green space (m²/p)	Public Green space	
		Low-rise	
		Medium-rise	
		High-rise	
8	Public trees covering proportion		
9	Species (Various) of planting (100m²)		
10	Duration For recycling Planting (years)		
11	Public area natural lighting		
12	Green Roof (%)		
13	Sky/garden (greenhouse in the building)		
14	Recycling Energy (kwh)		
15	CO2 Emission		
16	Biogas		
17	Parking		
18	Distance between bloc/building		
19	Road		
20	Noise (db)	Daytime	
		Night	
		Air sound insulation of floor	
		Sound pressure level of floor	
		Insulation of door/windows	
21	Natural Ventillation	kitchen	
22	(per room total areas)	Others Rooms	
23	Waste	Collection	
		Recyclable	
		Per / Day (kg)	
24	Using the old building materials		
25	Energy saving of the main body of the building QH:		
26	Annual cooling consumption QC:		
27	Using of the local building materials		
28	Summer emission heat in the building (GJ/m²)		
29	HCFC using control (%)		
30	Air quality standard		
31	Walking distance To public transport (m)		
32	Public transportation	Within 1000 meters	
		Within 1000 meters (Each 30 minutes transport)	
		Within 400 meters (Each 15 minutes transport)	

The original diagram was prepared for a specific study of the city of Tianjin, China, that we can not report in this study because this is a general proposal for the Green standard for the Cinese cities.

Bibliography

Brown 2009
Lester Brown, *Plan B 4.0: Mobilizing to Save Civilization,* W W Norton& Company, 2009
pdf version in: http://www.earth-policy.org/books/pb4.

Krikke, Hensen, Blocken, Willems 2011
T. Krikke, J.L.M. Hensen, B.J.E. Blocken, E.M.M. Willems, *Assessment tools for sustainable district development*, Eindhoven University of Technology, Department of Architecture, Building and Planning Unit Building Physics and Systems, in cooperation with: Cauberg-Huygen Raadgevende Ingenieurs BV, June 2011

Sitography

http://www.bwk.tue.nl/bps/hensen/team/past/master/Krikke_2011.pdf

https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2009/LLNL_US_Energy_Flow_2009.png

http://www.eia.gov/energyexplained/images/charts/primary_consumption09-large.jpg

http://en.wikipedia.org/wiki/Solar_photovoltaic_monitoring

http://www.aarhus.dk/da/sitecore/content/Subsites/CityOfAarhus/Home/The-international-perspective/Large-development-projects/Aarhus-CO2neutral-in-2030.aspx

http://www.aarhus.dk/da/sitecore/content/Subsites/aarhuswindenergy/Home.aspx

http://www.energy.eu/#domestic

http://www.earth-policy.org/books/pb4

http://en.wikipedia.org/wiki/File:SolarCellProduction-E.PNG

http://www.greenchipstocks.com/articles/renewable-energy-challenge/514 http://energyselfreliantstates.org/content/graphics-report-democratizing-electricity-system

http://energyselfreliantstates.org/content/graphics-report-democratizing-electricity-system
http://www.geni.org/globalenergy/library/renewable-energy-resources/world/asia/solar-asia/solar-china.shtml

http://www.treehugger.com/renewable-energy/chinas-suntech-will-build-solar-panels-in-us.html

http://cyber.law.harvard.edu/commonsbasedresearch/Alternative_Energy/Paper#China

http://www.earth-policy.org/books/pb4 Especially Chapt. 2

http://it.wikipedia.org/wiki/Biogas#Svantaggi_del_biogas

http://it.wikipedia.org/wiki/Biogas#Svantaggi_del_biogas

http://needtoknow.nas.edu/energy/energy-use/home-work.php

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Consumption_of_energy Diagram redraw by Paolo Vincenzo Genovese

http://205.254.135.7/consumption/residential/reports/electronics.cfm

http://www.interstatetraveler.us/Reference-Bibliography/Bellona-Hydrogen-Report.html

http://www.popularmechanics.com/science/energy/next-generation/4199381

http://en.wikipedia.org/wiki/Cost_of_electricity_by_source

http://www.earth-policy.org/books/pb4

http://en.wikipedia.org/wiki/Cost_of_electricity_by_source

https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2009/LLNL_US_Energy_Flow_2009.png

http://www.eia.gov/energyexplained/images/charts/primary_consumption09-large.jpg