5th Session
The Next big thing: energy internet and the bottom up generation models
Time 9:15 a.m. (duration 1,5 h)

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A sense of energy for communities

Every week the kids and the women from the African village walk to the big city carrying dozens of empty tanks on their shoulders, and come back bearing the same tanks full of litre of gasoline. Gasoline is needed to cook, to light kerosene candles, and not least to make power generators run and make TV sets work. Gasoline is the blood of the community.

The African village had lived centuries with a strict rule: energy independence was the limit to the development of the community. The force of the sun was their light, and the wood they could chop and burn at night was their source for illumination and cooking. Draught Oxen could be fed on the neighbouring availability of fodder.

The global influence introduced new behavioural patterns, bringing new advantages and new burdens. It all started in Europe, precisely in England. The Second Industrial Revolution was represented by a deep change in the relation between communities and energy.

Some researchers see the Revolution as a "need" more than as a "consequence" of industrial innovation. In the nineteenth Century England, there started to be not enough fodder to feed all the horses used for transportation and working. For this reason, the expansion of society had to leverage other kinds of natural resources and machines, than fodder and horses[1]. Not by chance, among the first uses of machines there was the pumping of air into coal mines, allowing miners to work longer and excavate deeper tunnels, therefore increasing coal production.

The invention of machines represented a change in the sense that energy production was "centralized", and therefore separated by the community of users. Increasingly, more and more developed machines started using natural resources coming from far away lands, from other regions to other continents. Increasingly, the power produced by machines could be transported to far away users, or to communities needing it.

The industrial communities lost the "responsibility" of energy production, and only at the end of the twentieth century they started feeling again that energy production has consequences that must be considered.

The task now is to track the hypothesis of a community-based energy production, leveraging renewable technologies. It is not an easy goal, yet we have to be aware of one point: we are not trying to invent something new. It is more of a return to our past, where out local behaviours were limited by the local energy availability, and communities were accountable for the energy they produced.

How realistic is a model of energy self sufficient cities?

Given the available renewable energy technology, is energy independence for communities achievable?

Many speculations have been made, but probably the most direct evidence is what it is currently being achieved close to Abu Dhabi, in the United Arab Emirates. The Masdar Initiative, a government funded program, has started building a city which will host 1,500 businesses and

[1] N.F.R. Crafts, *Exogenous or Endogenous Growth? Industrial Revolution Reconsidered*, The Journal of Economic History, December 1995

50,000 citizens. Thin layers solar modules will be incorporated in the building materials. Public transportation will be electric, will be ordered from you laptop monitor, and will stop in front of your doorstep after a rationalization computation. In general, energy savings compared to a "traditional" city will be around 75%, and the remnant will come from the sun[2].

But this is the case of a city which will be built from scratch, which will leverage the specific climate conditions of the torrid Arabian peninsula. Nevertheless, the project will be able to dig full hands in the large amount of cash provided by the Emirates' oil boom, for as much as 22 billion dollars for the city keys.

What is to be done with centuries old cities? Being way too cutting, one could say that cities like Rome or New York are simply "energy inefficient", like an old car that is polluting too much. Abandoning such metropolis on the grounds of environmental problems may be too radical. Yet, all efforts have to be spend to try "convert" them to new models. Research results are encouraging, although they refer to smaller communities than the largest cities of the world.

In 2005, the US "Institute for Environmental Research and Education" completed a study on the technical, economic and social aspects of taking a community to energy independence. As a model, the study selected the lake island of Vashon-Maury, in the Washington State, hosting 11,000 people, whose households are grid-connected. The results were quite optimistic: the researchers estimated that energy consumption of households could have been reduced by 70% by using existing technologies, investing 35 million dollars, and benefiting for a net present value of savings of 95 million.

Once energy savings are in place, 15 wind turbines could power up the island. Investment would be 40 million, including vanadium batteries to keep energy flowing also when there is no wind. The plan would be backed by the islanders, although citizens living off-island, on the lake coasts, expressed concerns for the visual disturbance caused by wind mills[3].

We may safely assume that experiments such as Masdar for new cities, and Vashon-Maury for old ones, are scalable and adaptable to other towns and communities. A recent study by a Minneapolis think tank[4] stated that at least 50% of the American States could cover their internal energy needs through energy production within their borders, and the vase majority could meet a significant percentage.

On the side of technology, indicators seem to point at a positive outlook: we can do it. But if technology is not a constraint, what is the constraint?

Possible, but expensive: renewable energy revealed

The great challenge to renewables comes from the "big challengers": oil, coal and gas. They still show a set of direct costs that are way lower than renewables: some analysts place them at 4 cents per KWh, compared to the 12 cents per KWh of Wind, that is also very irregular in production; and to the above 50 cents per KWh of solar panels production.

The big challengers also have a significant advantage when compared to renewables: that of sourcing. Coal, Oil and Gas can be routed exactly where it is needed, to fire up power generators in the regions where they are placed, without the need of a complicated, interconnected and expensive high-voltage grids.

This assumption works for both large scale and granular projects. On a large scale, booming economies often find preferable to set up polluting coal fire generation monsters where it is mostly needed, than setting up rows of wind turbines, with all the complicated physical calculations required. On a smaller extent, a portable power generation device produces large quantities of

[2] MIT Technology Review of May 2008, *Building the Zero Emissions City*
[3] IERE, *Pacific Northwest Energy Independent Communities*, July 2005
[4] Farrell, J. & Morris, D., *Energy Self-reliant States – Homegrown renewable Power*, The New Rules Project, November 2008

energy within a reduced time-span, at a scale that is not achievable by alternative devices such as small solar modules. This is the case of the African generators mentioned above.

It is clear than the market alone might be failing in achieving results, because it is not able to correctly give a monetary value to what economists call “externalities”. For example, carbon emissions create global warming, but the damages can only be estimated in general, and it is not directly possible to assign responsibility for the climate damage to specific carbon emitters.

Therefore, fossil energy appears to be economically more viable than renewables, because it does not account for the “external damages” to the environment. Prof. Robert Kennedy Jr. wrote in his blog that “ In fact, there is no such thing as "clean coal." And coal is only "cheap" if one ignores its calamitous externalized costs. In addition to global warming, these include dead forests and sterilized lakes from acid rain, poisoned fisheries in 49 states and children with damaged brains and crippled health from mercury emissions, millions of asthma attacks and lost work days and thousands dead annually from ozone and particulates. Coal's most catastrophic and permanent impacts are from mountaintop removal mining. If the American people could see what I have seen from the air and ground during my many trips to the coalfields of Kentucky and West Virginia: leveled mountains, devastated communities, wrecked economies and ruined lives, there would be a revolution in this country[5]”

How much would coal costs if all this could be taken into account? If the market fails to account for externalities, should States intervene? It is a matter of how interacting with economic dynamics, and is the real key to an actual development of renewables.

Sun comes at a price: who pays for the bill?

Technology is not a limit, yet economics is. It is still very uncertain how the green change should be funded. The lucky United Arab Emirates option is a privilege of few countries in the world. In other countries, different schemes have been tried. Tax advantages, co-payments, contributions: results have been mixed, basing on communities and economies.

The general economic problem is that, given the present market economics, renewable energy communities may end up to pay more for their energy bill, than communities that leverage large and scaled carbon power plants, because the least do not have to pay for externalities.

A solution could be that of creating a tax on the goods that are imported from the communities (i.e. the States) that pollute more. Of course, this would represent a huge imposition in terms of import tariffs, and would advantage those countries that do not impose them.

In order to develop an attracting business environment for those willing to switch to clean energy, some countries have chosen to give fiscal or cash advantages to renewable programs, allowing higher returns to investors, at level that often outperforms that of the “big challengers”.

The US opted for a “tax credit” structure. Yet, in the way the system is projected, tax credits mostly seem to benefit those who have a “passive income”, or are in the higher income bracket. It failed in helping communities, and rural communities above all, in developing renewable energy infrastructures.

Some American policy setters are therefore looking at the “feed-in tariff”, an option that some European States such as Italy and some Laender in Germany are using,. States co-pay for the production of energy, and offer investors a long-term contract for the plants they create. Usually the contracts last 20 years. Results have been promising in lands such as Bavaria, or in some regions in Spain and Italy.

Yet, this solution as well has some backlashes. A correction of the market is also a distortion of the market. A subsidized sun power project in Italy can achieve guaranteed returns for even 13% a year for twenty years. It is working, but with strange movements in the sense of profit distribution. Industry professionals in Southern Italy, nicknamed “developers”, run businesses whose only task is

[5] Robert F. Kennedy Jr., *Coal’s True Cost*, The Huffington Post, November 29, 2007

to find out a viable area to build a renewable plant, ask for a (very) preliminary construction permit, and sell it to actual energy businesses for prices which easily reaches 200,000 euro per MW. In other cases, people have build solar plants and asked for permits, but then connected a gasoline generator to the grid, to receive more contribution. Many have been caught because the "solar" plants were producing energy also at night.

Carlo Stagnaro of the Italian liberal think-tank "Istituto Bruno Leoni" noticed then that in the peninsula the development of renewable projects has been positive, yet if the sector should expand too much, it would translate into an additional burden to the energy bill that Italians have to pay. Sun costs more than coal[6].

Probably, the development of renewable energy production should also not only leverage economic aspects, but also social ones. Renewable energy for communities has to exploit a different set of advantages when compared to carbon-based generation.

The main task could be that of developing a community with a "sense for energy", an element that can also be measured quantitatively. A study considering 11 wind project in five American States found that earning benefits for local communities were six times higher if the ownership of the installation was local, compared to an "absent" ownership[7].

A solution could be that of basing the creation of "community based projects", with some degrees of feed-in payment by governments, but with a deeper involvement of stakeholders. This solution could have different forms: association of apartment owners in a building; farmers in a rural community; workers in a building. The creation of a group would assure that energy project may gain broader funding, could be well sought after, and would avoid scams through the presence of multiple shareholders.

Being aware of the whys and hows energy is produced, through the presence of wind mills or solar panels, fosters efforts for individuals to save energy. Jobs to make the industry run, from installation to maintenance, are created within the community. If local finance is also involved in investing, especially for rural communities, cash benefits advantage the local population.

Shall an energy community be "isolated" or "connected"?

The creation of energy independent communities also lightens up an interesting debate about the creation of "isolated" or "connected" networks.

To achieve a real "energy awareness" by communities, some argue that energy networks should be separated. President Obama called for the creation of a "National Smart Grid" to make energy better transportable within the US, attracting critics by those who argue that hyper-consumption States such as California or New Jersey would not be complied to develop a reliable energy strategy.

The US example is a good one to understand the debate on quantitative grounds. We mentioned that 50% of the American States would be able to achieve energy independence if they leveraged all available renewable resources they have. Yet, at a closer look at the case of the American States, the results could not be as promising as we thought. Most of the States that would achieve energy independence are exactly the less populated ones, and often those where economies are less expanded. The East and the West coasts, the economic tractors of the country, would be in deep energy deficit.

North Dakota would be able to achieve 14,300 percent of its current energy needs if it exploited all its reasonable roof-top solar production and stand-alone wind turbines possibilities. Yet, North Dakota's 640,000 citizens bring the State population density at around 3.5 per square kilometre. Lower energy needs and higher renewable resources create such a promising situation for North Dakota

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[6] Interview by the author, 3/19/2009

[7] Farrell, J. & Morris, D., *Rural Power – Community Scaled Renewable Energy and Rural Economic Development*, August 2008

Let's compare the North Dakota situation with that of a more industrialized State as California. California's population of almost 37 million people, with a density of 90 people per square kilometre, would be able to cover for just 82% of its energy needs, despite the enormous availability of solar opportunities.

Prospects for other industrialized and deeply urbanized States even look more grim: Florida could cover for as few as 44% of its needs, and New Jersey 42%.

It seems therefore that the element of energy interconnection becomes a need, more than a choice. Economic and industrial communities do not only flourish where energy is available: they also develop where there other factors are present, such as access to transportation markets and skilled labour force. Energy can then be transported from one "community" to another one, and communities with an energy surplus serve the others with higher needs.

Interrelated energy networks may also be more efficient: is a community has a peak of energy surplus, it may serve the needs of a community that is living a deficit peak. Or also: a black-out in one portion of the grid may be helped by increasing production in another part.

But this solution does not come at the cost of restructuring energy grids from their basis. Traditional grids are based on a system of "large highways" from concentrated production plants, transporting power to a granular distribution network. Smaller, renewable energy plans, from 0,5 to 10 MW, would call for the building of granular "energy collection" terminals as well. It would be costly, and could have significant environmental impacts where the energy lines would pass.

In any case, community awareness has to be developed. The solution may be that of creating communities whose energy network is connected to the general net, but build on production facilities that leverage all resources available in the territory. A community may start by reducing consumption, then level up to geothermal, then solar, then wind, and then connect to the grid where it could get the energy it needs for the more energy-consuming activities, such as manufacturing or trains. Such an approach can be very successful in promoting the creation of a "social sense" of energy, and in creating a local energy industry, with new jobs and a lively finance market.

Why should an energy sufficient city be more democratic?

Beneath technical and economic challenges, that of building energy conscious communities also raises a set of thoughts towards the political implications of such structures

The benefits of the new frameset are clear: people may become more aware of the economic and ecologic impact of the energy they use. In particular, the plan would be a great fit for transformed urban areas. Thin layers solar panels may guide the transformation of the energy sourcing of big cities: labs in Europe, the US and Japan are working full time on it.

On the other hand, there is an impact of energy interconnection that is strictly political: energy interchange is a form of commerce, and therefore of communication. Two countries or two communities connected by an energy interchange structure will likely make their best to develop good relations, otherwise one would lose its energy, and the other would lose its income. Communities are forced to meet: political isolation is not an option.

If a higher grade of energy independence is needed for the environment, then inter-community relations have to be kept alive by other means. Energy independent countries often show signs of diplomatic isolations, and so could communities do. Of course, this may be a way of preserving traditional cultures; but this will happen at risk of cultural segregation.

African Villages are receiving sun-powered flashlights, so that kids in families will be able to study at night, and become doctors one day. All the kids of different villages meet the following day at the only school of the area. Local sun energy powers the education of kids, to meet and benefit all their communities.