RENEWABLE ENERGY SOURCES: ENVIRONMENTAL AND SOCIAL ISSUES

International Colloquium of SC C3
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by Antonio Negri, SC Chairman, and Francisco Parada, Portuguese Member

Introduction

Renewable Energy Sources (RES) are expected to play a growing role in the electricity generation worldwide in the next future. According to IEA "World Energy Outlook 2009" the generation from RES will increase by a factor 3.5 - 4 from 2005 to 2030, allowing an incremental generation of about 10,000 TWh/year, if we want to stabilize GHG concentration at a level of 450 ppm CO_2 equivalent, a level deemed necessary to avoid drastic climate change.

A carbon-free future will be based on RES, but power generation won't be without environmental and social impacts. Moreover, future Electric Systems shall be modified and adapted to manage a significant percentage of RES generated power, with its inherent fluctuating character.

CIGRE Study Committee C3, together with Portuguese CIGRE National Committee, organized a Colloquium in the city of Porto, on September 23, 2009 [1], to discuss the RES development perspectives and role in Electric Power Systems in the light of Sustainable Development principles, and the relevant environmental/social impacts (positive or negative), that can act either as constraints or stimulus to RES penetration.

The Colloquium was opened by Oscar Ribeiro, Secretary of Portuguese CIGRE National Committee, followed by an introduction from João do Nascimento Baptista, Director General of ELECPOR, the Portuguese Association of Electric Power Sector Utilities, who emphasized the importance of RES in the future energy scenarios, recalling the ambitious goals set up by European Union.

[1] All the presentations are available in the SC C3 website, www.cigre-c3.org, at the section "Publications/Other documents"

Antonio Negri, Chairman of the CIGRE Study Committee C3, briefly recalled the mission and current activities of the SC, in the frame of the new CIGRE Strategic Plan, which includes the environmental issues as one of the main driving forces of the Power System evolution.

After the introductory speeches, the Colloquium focused on the more important renewable sources, namely Biomass, Hydro, Wind and Solar.

Renewable Energy is often associated with small-scale plants and, therefore, with the so-called "Distributed (or Dispersed) Generation". But what is exactly "dispersed generation"? and is it more "environmentally friendly" than "bulk" (conventional) generation?
Thomas Smolka (Germany), Convener of the Working Group C3.05, active inside the SC C3, presented some of the answers the group is currently working on. Dispersed Generation can be defined as : (1) today not centrally dispatched, (2) today not centrally planned, (3) connected to the distribution network (MV, LV), (4) smaller than 50 MW, (5) based on co-generation units (heat and electricity), renewable energies or other conventional sources. The analysis of environmental costs/benefits, based on the LCA (Life Cycle Assessment) methodology, should go beyond the well-known component level (i.e. Environmental Impacts of different Technologies), to encompass the whole system, thus taking into account factors like:

- Operation of DG with other DG units in distribution networks influenced by centralized power plants
- System aspects -not included on component level view- e.g.
    - Impacts of co-generated Heat
    - Impacts of reduced/increased power losses
    - Which scenario of DG in power grids leads to minimized emissions?

Biomass is projected to give a substantial contribution to the energy consumption, both with the production of liquid fuels for transport and the power generation in stationary plants.
Ricardo Furtado (Brazil) gave the audience a deep insight of the Brazilian situation, where, in the last three years, more than 200 biomass fired plants (for more than 8,000 MWe) has been auctioned. These power plants are fueled with "bagasse", i.e. the residue of ethanol production, which is foreseen to pass from the present 25 to more than 60 billion liters in ten years.
The main environmental issues of biomass exploitation in a such big scale can be summarized as follows: Food competition, Land use on expansion areas, Energy Balance, Air Emissions, Solid wastes and Liquid effluents, Water consumption.
Brazilian industry and Environmental Authorities are operating to manage each of these issues. A careful planning, both at federal and local level, together with dedicated studies and satellite monitoring, ensure the compatibility with Food competition and Land use. Bagasse and straw, both co-products of sugarcane production, can be used for energetic purposes, thus reducing fossil fuel consumption and related air emissions. The "vinasse" (high BOD effluent) produced in sugarcane processing is destined for the crop field in substitution for chemical fertilizers, while other liquid effluents can be easily treated before released on the environment. Water availability remains one of the main environmental constraints for new plants licensing, particularly in the Southeast Region.

Again talking about Biomass, the opportunities and challenges of the energy use of wastes, and especially the Municipal Solid Wastes (MSW), have been thoroughly discussed by **Stefanie Hellweg** (Switzerland).
Stefanie emphasized the waste shall be considered a resources, because an integrated use of the wastes could substitute fossil energy, allow recovering materials and minimize the dissipation of toxic materials in the environment. A sustainable wastes management policy should be based on: (1)Avoidance, (2)Reuse, (3)Material Recycling, (4)Thermal Recycling and finally (5)Disposal.

The Thermal Recycling allows the production of electricity and heat: there are around 450 wastes incineration plants in Europe and other some 80 are foreseen in the next future, however there is still a large potential unexploited: the incineration (with energy recovery) of the presently land filled wastes could add some 65 TWh electricity generation in Europe.
Thermal recycling, though an effective solution, is not always the best option, under a sustainability point of view: for each waste material, the optimal treatment should be identified, comparing all options with a comprehensive assessments, based on the well-known Life Cycle Assessment (LCA) methodology. Often it could be seen that: material recycling is better than co-processing in industrial processes, which in turn is better than waste incineration, which has been always proven to be preferable to sanitary landfills.
In case of waste incineration, energy production is a fundamental by-product. In order to maximize the overall efficiency, it is is important to include also the heat co-generation, provided that heat demand is present.

Hydro-power with some 2900 TWh per year contributes to around 16% of the world electricity generation; moreover, the economically feasible potential is estimated twice the present production.
Glen Singleton (Canada) presented very interesting highlights about hydro development issues.

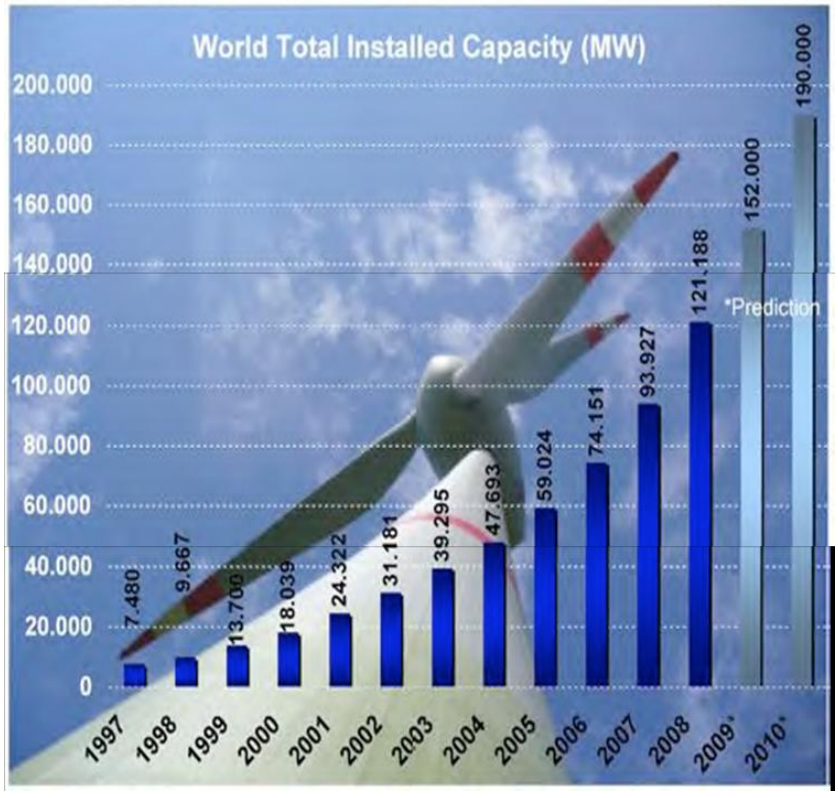
Large Hydro-power plants

The “top five” of hydro power production are China (170 GW installed capacity, 585 TWh/y production), Canada (89 GW, 370 TWh/y), Brazil (69 GW, 364 TWh/y) USA (80 GW, 250 TWh/y) and Russia (45 GW, 160 TWh/y).
Most of energy comes from “large dams”, i.e. those who features the following characteristics: more than 15 meters high (or 10m with crest >500m), more than 1 million m^3 storage capacity and more than 2000 m^3/sec spilling capacity. Very often these dams show unusual design and/or foundation problems. Small and microhydro accounts for some 70 GW, over a total capacity of about 960 GW.
There are very different and conflicting ways to see (large) hydro power: the “backbone” of a sustainable energy system, on one side, the harm to sustainability, security of supply and environment, on the other.
Environmental drawbacks of dam are related to: Ecosystem Destruction, Fish Blockage and Wildlife Losses, Large-Scale Flooding Due to Dam Failures, Sedimentation and Salinity, Herbicide and Other Toxic Contamination, Evaporative Losses, Nutrient Flow Retardation and Release of greenhouse gasses. Social drawbacks are due to: Human Displacement, Flooding of Cultural Sites, Social disruption, Cost overruns, Socioeconomic centralization.

On the other side hydro power could feature relevant advantages in comparison with other generation technologies, namely: Energy source is renewable, Can contribute to fresh water storage. Improve grid stability and flexibility, Guarantee low pollution and can be low for GHG, is based on proven technology, is generally affordable.
Probably the most technically sounded way to view the whole question is to concentrate on how to mitigate the negative impacts and enhance the positive aspects. The main mitigation strategies have been described by Glen, comprising: Mitigation and compensation commitments during licensing, Permanent fish and wildlife compensation programs, Comprehensive water use plans negotiated with government and public, Ongoing operational controls and monitoring.

Wind energy showed -in these recent years- the highest increasing rate, among the renewable sources and even more promising perspectives are opened to off-shore installations.
António Sá da Costa (Portugal) focused his speech on the social acceptance of wind energy. After recalling the growing share of worldwide electricity production from wind, he emphasized the difficulty in making energy-related issues understandable for the "common citizen" and stressed the need of adopting a language that could be understood by them.
He summarized the positive aspects of renewable, and wind in particular, that can have the greatest impact on the public perception as follows:

- RES are a very effective tool to fight against Climate Change,
- RES will allow to pursue a sustainable way of development
- the wind sector has now become a global job generator, with more than 440'000 jobs created worldwide
- the wind sector represented in 2008 a turnover of € 40 billion, thus being a powerful stimulus for the global economy
- the municipalities and local communities could benefit from installed wind farms, getting a share of the generated energy income.



Trend of wind power installed capacity

The crucial issue of integrating different RES has been tackled by **Gonzalo Piernavieja** (Canary Islands, Spain), who gave the audience a powerful and fascinating vision about "El Hierro – Corona del Viento[2]" project, aimed to ensure sustainability, environmental preservation and independence on (imported) fossil sources for the Canary Islands.

A panoramic view of El Hierro Island

The "El Hierro Project", was designed for the El Hierro Island, (278 km^2 and 10,500 inhabitants), to exploit the local huge wind potential and abrupt topography, combining wind generation and hydro pumped storage, together with solar thermal collectors and dispersed photovoltaic systems. The main energy plant data are as follows:

Wind Farm	11.5 MW
Hydroelectric Substation	11.3 MW
Pumping Station	6 MW
Upper Reservoir	556,000 m^3
Lower Reservoir	150,000 m^3
New Diesel systems	0 (zero)
Renewable energy penetration	80%
Total investment cost	56 M€

The RES system yearly avoids the release into atmosphere of: 740 t of SO_2, 2700 t of NOx, 130,000 t of CO_2, 47 t of VOC and the consumption of over 40,000 t of fuel oil.

Hervé Laffaye (France) discussed the issues related to the network development, as an indispensable tool to support effective and massive RES penetration.
On a local scale, intermittence, typical of the solar and wind energy, rises the issue of local energy back-up: HV network is a good candidate. In order to integrate RES on a bigger scale, new assets have to be built in network free areas and, therefore, existing network has to be reinforced. In both

[2] Wind Crown

cases the support from Political and NGOs may be important; however TSOs need to find and to apply new technologies, like HVDC, underground cables, high temperature low sag conductors…
DC technologies are likely to be chosen, thus raising some questions, like Power control & protection schemes, DC breakers to be developed and so on…
There will be no efficient grid without standardisation, which, in turn, makes urgent for TSO the need of a unified R&D, in support of European Research programmes.
At the same time, new environmental impacts are to be studied:

– Underwater impacts of cables during works and operation (soil, marine mammals, benthic fauna…),
– DC current effects (EMF, Corona and Ions production)
– Satellite view integration (for continent-wide grids)

Finally, analyzing the network planning issues, Hervé emphasized the need to integrate the various national views into a broader picture; as an example he proposed the important role devoted by European Union to ENTSO-E, to provide a Ten Years Network Plan at continent level.
A Network Development Plan shall take into account the proper RES penetration goals, which means, on one side, that consistent generation (timing and sitting) scenarios have to be built and agreed by stakeholders before grid planning, and, on the other one, that TSOs shall be given the right incentives and regulatory framework to speed up the necessary connections.

Communication and Stakeholders consultation and engagement are crucial issues for the development and operation of Power Systems, as disc used by **Hector Pearson** (United Kingdom), Convener of Working Group C3.04, who presented some results of the WG activity on the topic.
Energy related projects are facing diffused opposition, or –at least- a difficult acceptance, as show in the table here below:

Public attitudes towards hypothetical developments proposed in their community

	Strongly oppose	Somewhat oppose	Somewhat support	Strongly support	Net opposition
Waste Collection/landfill site	80	6	3	9	-73
Power plant or utility	77	6	5	8	-70
Quarry	75	7	5	7	-70
Office	53	7	9	27	-24
Retail park	54	7	9	27	-24
Supermarket	50	7	10	31	-16
New road project	36	8	15	36	7
School	10	8	15	61	54

Source: K Barker, Review of Lanc use Planning, Interim Report – Analysis, UK 2003

Stakeholders engagement may be required by law and investors or governments may seek it; moreover, in many countries, citizens have rights to influence projects and, in general, different subjects (e.g. local politicians, press / radio / TV / newspapers…) can have the power to influence projects.

According to a more "pro-active" vision, good corporate governance in companies may require engagement and the responsibilities of Sustainable Development strengthen the need to engage with stakeholders.
The WG conducted a worldwide survey, via an on-line questionnaire dedicated to power sector utilities, about communication and stakeholder's engagement policies and practices. According to the results obtained, utilities undertake consultation mainly in the frame of formal Environmental Statement and EIA or when required by the law, especially for very large projects; less common is consultation about developing policies and mall projects. Legal obligation, on one side, and company reputation, values and ethical issues, on the other one, are the main reasons to start a consultation process. The main "positive effects" expected are as follows:

- Good Stakeholder Relation
- Reputation
- Customer Focus and Loyalty
- Build Trust
- Secure Licence to Operate
- Less Opposition, Gain Public Acceptance

The WG will prepare a benchmarking of communication and stakeholders engagement policies and practices; some preliminary issues are summarized here below:

Key principles	Suggestions
Understand your stakeholders	'Asking' has to come before 'deciding'
Start early in the process	Do not use consultation in order to justify the project
Create an open process	Do not mix up "selling" and "asking"
Use a mix of methods – be flexible	Integrate consultation and involvement in project decision-making
Have feed-in and feedback loops in place	Manage the expectations of all stakeholders - clearly state aspects stakeholders are able to contribute to or influence, and the aspects of the project that are fixed
Enable constructive debate	May need to build the capacity of stakeholders
Monitor and Evaluate	Do not forget 'voiceless'

Another very useful insight into the social aspects of energy systems development has been given by **Mirian Regini Nuti** (Brazil), who discussed the issue of social development programs in Hydro Power development.
Energy is an important social development factor. It seems obvious to remember the economic importance of supply tariffs, the potential of job creation of energy sector and the social impact of having a fair access to electricity. It must also keep in mind that in the environmental licensing process for new installations there are actions negotiated between entrepreneur, regulatory institutions and affected groups, with noticeable economic and social impact. Last but not least, "social responsibility" programs launched by utilities are to be mentioned, i.e. corporative initiatives assuming partnership with social groups to promote better conditions of life, culture and education, involving corporate marketing and social, healthy and safety policies.

Mirian discussed some of the most important energy development projects in Brazil, with special attention devoted to Hydro power plants (HPP), analyzing in some detail their social impacts.
Social programs aimed to support a sustainable development can be found in every stage (HPP planning, construction and operation) and scale (local, regional or national). Utilities social programs can be seen, in developing countries, as a complement to the State presence regarding social, health and infrastructure, thus mitigation and compensation are strictly related with public policies and can have a significant impact on project costs. A final emphasis has been put on the monitoring phase, which needs to be better developed in order to show clearly the benefits of such programs.

The closing keynote speech has been given by **Francisco Saraiva** (Portugal), who presented a comprehensive discussion, from a TSO point of view about our energy future.
He emphasized the need of a new energy paradigm, based on Energy Efficiency, Endogenous and Renewable Energy Sources and other Low-Carbon technologies.
The role of electricity in this scenario can be summarized as follows:

- Demand side: Less electricity where possible (savings), More electricity where needed (high efficiency processes, new uses)
- Supply side: Use of **low-carbon** power generation and new technologies in electricity supply

RES show a great potential, however a critical issue to be solved is their intermittency with the consequent non-dispatching character. Storage could help solving this problem, decoupling the load (consumption) and the generation (renewable power) diagrams and reducing the risk of loss of renewable resources. Wind-Hydro integration and PHEV (Plug-in Hybrid Vehicle) will be effective solutions in the short-medium term.

A reinforced and smart grid can ensure multiple benefits, namely:

- New uses of the electric grid (operation and "consumer side" applications)
- More distributed generation can be integrated with the grid
- Mass-scale renewable integration
- Consumer incentive for efficiency.

Francisco concluded with the following remark: "*more sustainable energy … more electricity (in the global energy mix) … more renewable energy (increased operational flexibility) …more grid*", that could be assumed as the ultimate lesson from this Colloquium.