Renewables Grid Initiative

Summary Report of the RGI Workshop on:

Transmission Technologies and Technical Developments: Cable vs. Overhead – AC vs. DC – Innovations

Today it is broadly accepted that the share of renewable energy sources in the European power grid is going to increase substantially and will reach very high percentages in the future production mix. Grid expansion is inevitable to allow for this "renewable revolution"!

But grid expansion is often controversial. Transmission System Operators (TSOs) need to accommodate not only for the 2020 targets but also to prepare for the more challenging full de-carbonisation of the power sector by 2050. The NGO community is still not united with respect to supporting or opposing grid expansion, and in which way.

A number of technical, environmental and health questions need to be addressed and clarified to improve a shared understanding among and across TSOs and NGOs. A better understanding will help RGI members and interested stakeholders, in general, to communicate issues regarding grid expansion and become more transparent and effective when dealing with political uncertainties and public opposition.

Due to the variety and complexity of the subjects two workshops[1] will be organised. The first one covered the technical aspects and took place on 8 September 2010 at the headquarters of TenneT in Arnhem, the Netherlands.

The participants of the workshop covered a broad stakeholder spectrum, including TSOs, NGOs, policy makers, industry, academia and engineering consultancies.

The workshop consisted of four sections. In all sections, participants contributed to discussions actively through their experience and expertise.

- The first section revolved around grid planning in terms of a European power grid. Speakers from the European Commission, ENTSO-E and Imperial College London contributed to this section.
- The second topic focused on the technical aspects of transmission technologies; the choice between AC vs DC, and Overhead vs Underground. This section was lead by speakers from TenneT, ABB and KEMA.
- The third section demonstrated national legislation approaches for grid infrastructure projects. The Dutch Ministry of Economic Affairs and Deutsche Umwelthilfe provided their insights on this section.
- The fourth section consisted of transmission project case studies. TU Delft, Transpower and 50Hertz presented the issues TSOs face when developing such projects.

[1] The second workshop will cover the environmental and health aspects. The host of the second workshop is the Royal Society for the Protection of Birds (RSPB) and the exact date will be defined at a later stage. Participants are strongly invited to participate to both events as they depend on each other. The results of the workshops will feed in a stakeholder conference which will take place at the end of October in Brussels.

First Section: Grid Planning for a European Power Grid

A clear consensus among the workshop's participants was reached regarding the need for a common voice between TSOs and NGOs in grid expansion issues. Moreover, all stakeholders involved (TSOs, industry, NGOs, governments, policy makers) need to work together towards achieving the grid expansion required for a decarbonised EU power sector penetrated by large shares of renewable power, in a cost effective and efficient manner.

The role of this strengthend grid is to access EU's diverse renewable energy sources and provide high levels of asset utilisation. Essentially, the decarbonisation of EU's power sector faces more cost and acceptability challenges than technical ones. As demonstrated by the European Climate Foundation Roadmap 2050 study, large available transmission capacities between European regions can:

- diversify generation from renewable energy sources
- reduce demand volatility
- use demand response to reduce additional transmission, back-up and balancing capacity (as the degree of dispersity and renewables sharing is increased, so is the ability for demand response)
- reduce grid and generation investment costs

The flexibility value of renewable energy sources needs to be addressed and grid expansion should serve the purpose of adding value to the market. Improvements need to be made to take advantage of this flexibility and earn revenue streams both in supply and demand.

NGOs need to use the key messages from the ECF Roadmap 2050 study as a tool towards public acceptance obstacles TSOs face. When dealing with public acceptance, the overall focus should be on policy makers and not on NIMBY behaviours. Additonally, media awareness needs to be raised in order to demonstrate the different interests between TSOs and utilities.

Second Section: Technical Aspects of Transmission

Today's transmission network does not require active control and additional compensation components. Moreover, its high reliability and low repair time constitute a network that does not provide immense challenges to the TSOs. The downside lies on its high visual pollution and footprint. However, the required capabilities of the transmission technologies need to change. This change is driven by the current network requirements:

- two-way flows
- central and local generation
- increase in volatility
- greater distance between supply and demand
- more capacity needed
- less space available

Currently, the available transmission technologies that can satisfy this change in network requirements are HVDC (LCC 3000MW, VSC 800MW), HVAC underground cables and GIL. Each technology has a number of desirable capabilities but also shortcomings that still prohibit their wide deployment.

HVDC exhibit high levels of controllability and do not require synchronization. It also has lower tower cost, lower losses for long distances and narrower right-of-way. On the contrary, HVDC requires active converter stations, lacks effective fault managing and reliable circuit breakers, and needs higher power ratings (for VSC). The role of DC circuit breakers is crucial as they prevent the system from shutting down.

HVAC underground cables can be buried overcoming any permitting obstacles but are at a disadvantage due to the lack of technology improvements (little experience exist for extra high voltages >380kV), high costs and long repair times. Additionally, AC cables exhibit approximately 20-30 times more reactive power than an overhead line and require additional resistance to maintain system flow stability.

GIL has high capacity and does not require any form of compensation. On the downside, it uses a green-house gas (SF6) whose potential leakage can prove to be 23,000 times more harmful than CO_2. The need to monitor the line for leakage is of great significance.

When comparing transmission options, the system perspective needs to be taken into account first, followed by the cable one.

The need for standardising these technologies is of utmost importance. Standardisation is driven by system functionalities and requirements. An attractive option for the future grid architecture is VSC HVDC. However, there is still uncertainty on the choice of the appropriate voltage level, cable insulation, DC circuit breakers and costs. Manufacturers and TSOs need to collaborate and assist the Commission in setting these standards in the next couple of years.

Third Section: National Grid Planning Procedures

The Dutch legislation includes grid infrastructure planning and permitting procedures that demonstrate fast streamlined decisions. All decisions are taken at the same time and citizens, local authorities and the TSO are engaged from the beginning of this process. The TSO provides the technical specification of the possible options but the political responsibility to weigh these options lies with the ministry. If the government can show that it has followed a thorough and detailed process, local objections can be over-come through some form of compensation. The government decides and forces the local community to accept the type of compensation based on a 'damage guide' developed by TenneT and the outcomes emerging from negotiations with the local community.

The German planning procedures are similar to the Dutch ones with one fundamental difference separa-ting them. It is not clearly defined who bears the responsibility of the final decision and it is passed on.

NGOs can play a vital role in grid planning procedures by improving acceptance and facilitating changes in the legal framework. This can be achieved through shortening the information gap between policy makers and TSOs, providing effective information, and increasing the level of knowledge of the public.

Fourth Section: Project Cases

Experience through R&D on transmission technologies has shown some concrete differences between AC cables and overhead lines. In particular, AC cables exhibit:

- 20 times larger capacitance per unit length
- 24 times larger reactive power
- 5 times smaller series inductance
- 10 times smaller surge impedance

These parameters result to a much greater level of shunt compensation and lower resonance frequencies. The purpose of R&D activities in the field of transmission technologies is to examine how they behave within the system when they are 'out' and how the outage time could be minimised.

Transmission line projects in Germany have showed two major obstacles when developing such projects. Firstly, the large amount of paperwork and involved parties for permitting purposes are delaying the development of a project. Moreover, increased media attention and local resistance are further putting the realisation of a project at risk. Secondly and specifically for underground cables, should a fault occur, the lack of ease to access the cable results in prolonged periods (up to 12 months) of operating the system without the n-1 criterion. This essentially places the stability of the system at great risk.

Concluding remarks

RGI's role in this process of grid expansion can be seen as an expert body that can provide useful input to policy makers in a number of areas, including:

- regulatory frameworks needed to attract investors for grid infrastructure projects with desirable return on investment
- harmonisation of rules and cost allocation models across Europe for multi-country projects (how to deal with revenue streams when countries have different feed-in-tariffs, time schemes)
- how to predict the usage of transmission lines to estimate revenues

This type of input can be very useful to the European Commission when developing legislative instruments such as the upcoming Infrastructure package by DG Energy. The communication of this package will be published by November 2010 and the new instrument replacing TEN-E will be published by mid-2011. The Infrastructure package will also aim at covering areas not included in detail in TEN-E such as offshore wind and planning/permitting procedures.

From the Commission's perspective, it would be useful if ahead of the Infrastructure package, a common understanding on the criteria that should classify a grid infrastructure project as of "European interest" and the time horizon for such projects. Additionally, a concrete definition of the Super/Smart Grid concept needs to be addressed.

Two factors currently weigh unfavourably towards accelerating grid expansion at EU level; the tight discussions for the next EU budget, and the additional measures that aim at complementing the 3rd Energy package, which was supposed to solve grid infrastructure incentives through unbundling.

RGI can assist in developing a grid communication strategy based on the fact that the future generation mix will have a large share of renewables but will still remain relatively unknown. There is a clear need to package renewables and their associated grid technologies in a different narrative and develop best practices on technical and regulatory issues.

RGI will continue developing the background paper on transmission technologies and begin building up additional documents on:

- definition of the Super/Smart Grid concept
- key R&D areas related to transmission technologies
- priority list of transmission corridors
- public acceptance
- recent transmission projects and the issues faced

All RGI members and workshop's participants are welcome to contribute to these working documents that RGI intends to develop.