

## Climate Change

As we are looking for newer, environmentally friendly and sustainable sources of energies, the integration of renewable wind energy worldwide is limited when using the current technology. No single country has been able to reach an overall yearly balance exceeding 25% share of wind electricity generation in its grid. There are significant technical challenges that need to be surmounted relative to the stability of an electric grid when higher wind penetration rates are sought. Countries that have introduced successful wind energy deployment strategies are slowly reaching these limits. As a result, developing countries with smaller grids and growing electricity needs are far less likely to adopt these technologies.

The intermittent nature of wind represents a difficult challenge to overcome as higher wind power penetration rates have to be matched by adequate levels of flexibility in the management of electric networks. Many different options exist for increasing the wind energy penetration rates into a grid system. Besides optimized power dispatching through HVDC technologies, and the introduction of smart grids with demand-side management features, power storage and restitution technologies represent the only alternative which would enable an exclusive recourse of this clean energy.

Due to lower electricity demands during windy days, several European countries such as Germany and Spain recently resorted to curtail their domestic wind energy production. As a result, significant quantities of green electricity -which could have been used otherwise- were lost to protect the systems stability. Since these countries are likely to double their installed wind power capacities in the near future, to comply with the European Union's environmental objectives for 2020, the occurrence of wind power curtailments will be more frequent. Hence, the possibility of storing excess wind energy production into batteries for powering vehicles in the transport sector for example, is an option that is currently being considered. According to EURELECTRIC, the association regrouping grid operators, existing European electricity infrastructures can be used in most of the countries for charging vehicles. If cars are charged at night even a standard household socket (16 A) would be sufficient. The grid is robust enough to allow a certain number of electric plug-in vehicles (e.g. 10% of market share) to charge simultaneously without any severe impact on the network in off-peak time. Hence, this alternative will contribute to increase the flexibility of electric grids while effectively addressing greenhouse gas emissions issue in the transport sector.

Wind energy is a carbon free energy technology. Addressing technical limits to wind energy deployment worldwide is linked to environmental security in as far as the electricity generation sector is responsible for over 40% of the world overall carbon -essentially CO<sub>2</sub>- emissions (\*).

The introduction of a large infrastructure project such as the Sahara Wind Project feeding into regional electricity markets and the deployment of smart grid technologies will gradually enhance the power dispatching and integration capabilities of renewable energies in existing energy systems. Beyond these short term possibilities, hydrogen as an emission free energy carrier can also be derived through an increased use of wind energy in electricity grids, which in turn, can be applied to the transport sector. Electromobility, namely in the introduction of batteries-fuel cell powered vehicles would substitute low efficiency internal combustion engines burning the limited fossil fuel reserves we dispose of worldwide, by green hydrogen derived from an enhanced access to intermittent renewable energies. Hydrogen is clean, emission less and Fuel cells are far more efficient than internal combustion engines when applied in the transport sector.

With the lowest Well-to-Wheel CO<sub>2</sub>-emissions of Different Propulsion Concepts, hydrogen out of wind power coupled with Fuel Cell is the most environmentally friendly technology available according to the latest IPHE Renewable Hydrogen Report. This option to be demonstrated in the Sahara Wind-Hydrogen Development Project involving Morocco & Mauritania's universities will open new perspectives in the way renewable energies are being harnessed. In extending the green revolution to the automotive industry thereby modernizing it through the introduction of state of the art technologies, climate change mitigation issues could be effectively addressed.

By resorting to such alternatives, a further 23% of global CO<sub>2</sub> emissions derived from the transport sector could be eliminated. This would leave overall carbon emissions at much lower levels than they currently are.

The deployment of green hydrogen technologies would improve the access to intermittent renewable energies quite significantly. For obvious hydrogen infrastructure and deployment issues, the automotive industry has not yet been able to shift significantly into these technologies. Hence, industrial applications remain currently the main users of hydrogen.

(\*) Source: International Energy Agency (IEA) World Energy Outlook 2009