In no other place in the world is wind energy used for so many different purposes as between Morocco and Mauritania – all within an intricately inter-related system including scientists, academia, government agencies, industrial companies and NATO – that ultimately could benefit the lives of millions of people.

The winds that blow along the Atlantic coast from Morocco to Senegal represent one of the largest wind potentials available on Earth. However, due to the erratic nature of winds, steady electricity is difficult to integrate on any significant scale unless local mechanisms are developed to improve capturing wind energy.

THE SAHARA WIND PROJECT

CONNECTING WIND AND WATER

Writer: Khalid Benhamou
Photographer: Natercia Caneira

Khalid Benhamou is Managing Director of Sahara Wind Inc. To view more details on the project and contact information, visit: www.saharawind.com.

Anemometer in desert region of Tarfaya, Morocco.

From idea to project:

1993 – Initial wind measurements installed (Sahara trade wind region)

1994 – Report on Sahara trade wind energy potential to King Hassan II of Morocco

1994–1997 – Wind-Diesel-Hybrid test site with small grids and variable loads

1997–1999 – EU discussions (Commission and Parliament) on importing electricity from Saharan Atlantic trade winds to Europe

2002 – Sahara Wind Inc. presents the Sahara Wind Project at the European Parliament

2003–2005 – Joint "Morocco Sahara Wind Phase I / Tarfaya On-Grid Electricity in a Liberalized Market"; Public-Private Partnership (PPP) with Moroccan Ministry of Energy to supply Euro-Mediterranean markets with a base of 5,000 MW.

2012 – Regional projects and integrative processes: UNIDO, IPHE, IEA, USA-Morocco S&T agreement, NATO SfP-982620, capacity building industry-academia partnerships in Morocco and Mauritania.

Both based in Rabat, Morocco,
Sahara Wind Inc. and the **International Institute for Water and Sanitation (ONEP-IEA)** work together to harness the tremendous wind potential coming off the Atlantic ocean. The ingenuous system they devised functions as follows:

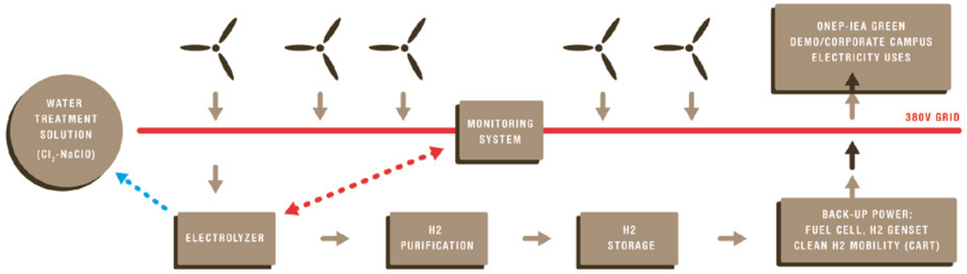
Combining Wind Energy and Electrolyzer Technologies

When winds blow as strong as they do in many parts of the African continent, such as Egypt, and particularly in the Sahara/Sahel region, the power generated by turbines remains nonetheless intermittent – winds are never steady. Electrolyzer technologies can enhance access to such intermittent sources of renewable energy in weaker grid infrastructures by stabilizing variable electricity levels. Electrolysis also produces chlorine, an indispensable element for the treatment and purification of potable water. The Sahara Wind Clean Hydrogen and Water Project aims to solve both energy access and water treatment solutions.

The site selected for the introductory phase of the Sahara Wind Project is located in Morocco's main water treatment facility and headquarters of the National Potable Water Office (ONEP). Coupling electrolyzers with wind turbines to produce chlorine also generates hydrogen which has multiple functions as a feedstock and energy carrier. Hydrogen can be considered a renewable energy storage medium and used as backup when fed through a fuel cell or even as a clean fuel in sustainable mobility applications.

The system devised therefore creates electricity grid stabilization and attains energy efficiency objectives while recuperating hydrogen. Future plans are to partner with these industries which represent the main local energy loads to build an integrated energy system complementary to Sahara Wind's High Voltage DC Transmission Project. Labeled within the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)'s list of world hydrogen projects, this project will ultimately use hydrogen storage and hydrogen shipping via pipelines as well by enhancing local ownership of trade winds on a regional basis to support more sustainable industrial processing of mining resources, this system could become a secondary power source to both North Africa and Europe.

Labeled within the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)'s list of world hydrogen projects, this project will ultimately use hydrogen storage and hydrogen shipping via pipelines as well.



Bouregreg water treatment station of ONEP in Rabat, Morocco.

Hydrogen can be considered a renewable energy storage medium and used as backup when fed through a fuel cell or even as a clean fuel in clean mobility applications.

Integrating Wind Energy and Water Treatment Technologies

A Green Corporate Campus is being developed within Morocco's Water and Electric Utilities headquarters to highlight the importance of integrative industrial processes when accessing renewable energies. The nearby location of the ONEP-IEA training programs within Africa's second largest water treatment station provides an operational environment that is most advantageous to finding innovative technological solutions to today's energy challenges.

Small wind turbines are to feed power into the administrative headquarters on site and the energy proceeds are then to be applied to the water treatment station nearby. To maximize output, a dual approach is being considered to test technologies in an industrial setting while demonstrating the multiple uses of green hydrogen in storing and using renewable energies within a green building concept. Combining wind turbines and hydrogen in a green urban setting addresses the lack of energy efficiency and sustainability currently impeding hydrogen technologies.

Finding the most adequate processes for the intermittent production, filtration and pressurized storage of hydrogen represent the major challenges that need to be addressed.

Hydrogen is stored in pressurized tanks and used as a fuel for electricity generation through fuel cells for power backup (emergency power), peak power shedding and in hydrogen eco-mobility applications (eco-karts). Carrying out smart grid applications with hydrogen storage as an eco-mobility solution is important to initiate and demonstrate within Morocco's water utility headquarters. Fuel cell vehicles built by regional engineering schools with local automobile manufacturers create complementary solutions for clean mobility and represent one the most environmentally friendly technologies available.

Trade winds coming off the Atlantic Ocean

Finding the most adequate processes for the intermittent production, filtration and pressurized storage of hydrogen represent the major challenges that need to be addressed.

How this system is self-sustainable

Chlorine/hypochlorite production supports the ONEP-IEA sanitation demonstrator pilot plant. All components connect to the local power distribution grid of the water treatment station and the adjacent administrative headquarter complex. A signal from the small wind turbine is sent into the electrolyzer power setting to stabilize the wind mini-grid system as if it were running in a stand-alone renewable energy setting.

The system enables the wind, electrolyzer, and hydrogen components to operate independently. The flexibility and reliability of the entire system are reinforced, as a critical failure of any single component will not impact the functioning of others. End-users will benefit from the functionality of individual components as well as from the entire system that could be replicated to any industrial setting.

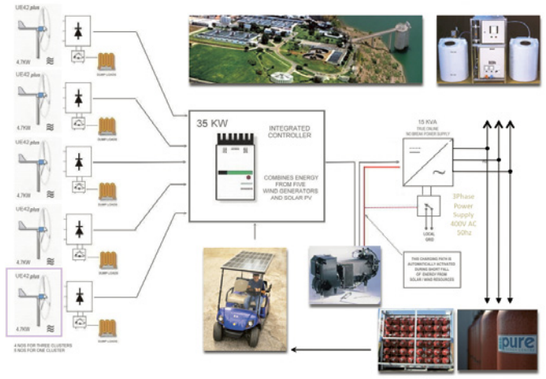


Diagram of ONEP-IEA green corporate center located at ONEP's Bouregreg water station.

Tarfaya - Pilot Project

In order to supply the local water processing plant and the surrounding Saharan region with integrated water treatment solutions, a pilot project in the windy region of Tarfaya is currently being evaluated.

TARFAYA WIND-ELECTROLYSIS:

A large pilot project in Tarfaya aims to support chlorine needs in the Saharan trade wind region. The Tarfaya pilot project will be designed with a capacity optimized for remote applications on an industrial scale. Building upon experience drawn from the first system installed at the ONEP - IEA pilot plant, this larger project will use hydrogen in grid support back-up systems as well as clean mobility and chemical feedstock applications.

WIND RESOURCE ASSESSMENT:

The production and integration of other electrolysis by-products such as oxygen, chlorine and caustic soda within local industries will rely on wind measurements carried out through the Sahara Trade Winds to Hydrogen: Applied Research for Sustainable Energy Systems network of project partners in Morocco and Mauritania. The wind assessment relies on ongoing academic-industry partnerships with telecom operators and energy users. The availability of mast tower infrastructures of the telecom operators enables accurate wind measurements.

EQUIPMENT SELECTION AND DESIGN:

The selection of equipment emanates from partner universities which have industrial engineering programs on small wind turbine component designs, integration and maintenance, electrolyzer planning, configuration and site design with hydrogen storage and fuel cell systems. Overall project costs and risks associated with technology deployment are likely to be reduced as future design and maintenance issues will benefit from experiences of previously deployed systems.

Desalination plant on the Saharan coastline, Tarfaya, 2010.

Once training and expertise are available, renewable energy access can be addressed in a much broader synergetic context.

Green Campus Connections

The concept of the 'Green Corporate Campus' is to promote the development of local and international training and sensitization activities of ONEP-IEA. Along with Morocco's engineering universities, this platform could be introduced within Morocco-UNIDO's automotive industry program.

This will be complementary to the long-term regional collaborative applied research framework that has been established between educational institutions in Morocco and Mauritania. The Sahara Trade Winds to Hydrogen: Applied Research for Sustainable Energy Systems Program involves 18 institutions from six different countries. This end-user driven applied research project is focused on facilitating integrated access to wind energy through industrial synergies. The project is carried out in partnership with local industries, public utilities and the universities of Morocco and Mauritania.

Project partners from the NATO Mediterranean Dialogue countries are the École Nationale Supérieure d'Arts et Métiers (ENSAM) and Al-Akhawayn University in Morocco, and the University of Nouakchott in Mauritania. The NATO country project partners are the USA (State Department, Bureau of Oceans and International Environmental and Scientific Affairs-OES), France (Commisariat à l'Énergie Atomique et aux Energies Alternatives), Germany (NRW) and Turkey (UNIDO-ICHET). First presented at the USA-Morocco Science & Technology Agreement signing ceremony in 2006, the project opened regional perspectives on integrated renewable energy applications such as green campuses, smart grids, green mobility and synergetic industrial processes.

Co-developing wind-electrolysis technologies enables university campuses fed by small wind turbines to stabilize their power grids with electrolyzers and to become living laboratories of renewable energy integration through hydrogen storage. An industrial engineering program for building small wind turbines enables

Fostering regional (south/south) collaboration in clean energy technologies to tackle energy access challenges is a critical issue.

engineering students to better address the operation and maintenance of these systems. In seeking stand-alone power supply solutions, telecom operators agreed to provide their mast infrastructures network for wind measurements. An exhaustive network of telecom masts towers is now available in Morocco and Mauritania for a regional assessment of trade wind resources.

To match the needs of local industries, a new training curriculum is being devised at the University of Nouakchott, Mauritania. In Morocco, the Al-Akhawayn University's Master of Science in Sustainable Energy Management program received a first-year record enrolment. Fuel-cell vehicle prototypes co-developed at

Ecole Mohammedia d'Ingénieurs – Morocco's largest engineering school – in partnership with local automotive industries, will be tested utilizing an on-campus green-hydrogen filling station.

A more comprehensive approach for access to and potential applications of Saharan trade winds will enable a more effective tackling of current regional social, economic, and political challenges. The processing of mineral resources, while utilizing the region's wind potential could for instance provide enhanced sustainability. When applied to phosphates – a critical element to world food security – or iron-ore processing, resource efficiencies may be seen in a different light. Once training and expertise are available, renewable energy access can be addressed in a much broader synergetic context. Besides enhancing local ownership of resources, this approach is complementary to renewable energy developments occurring elsewhere in Europe. This enables a leveraging of both social and technological benefits derived from green energies.

Connecting with Europe and the Mediterranean

Given wind energy's indisputable importance to the economies of both North Africa and Europe in the near future, efforts have been mobilized to meet the former's education, training and capacity building needs. The Sahara Wind Project's phased implementation and initial capacity of 400-500 MW provides a market-based, locally integrated economic development rationale justifying the transfer of wind technologies into developing countries.

Considering that Morocco is 97 percent dependent on imported fossil fuels and Mauritania has tremendous difficulties to access electricity, problems related to energy scarcity, higher costs of energy and limited access to water, combined with environmental degradation, desertification and demographic pressure, could in the long term, generate great economic distress. The building of scientific capacities that can generate a constructive dynamic grouped around a booming sustainable energy industry could provide economic alternatives and curb migration, thus contributing to social integration. Fostering regional (south/south) collaboration in clean energy technologies to tackle energy access challenges is a critical issue. Beyond addressing Morocco and Mauritania's immediate needs, supporting the region's transition from a fossil fuel system to one driven by renewables is a strategic priority for long-term security and stability in Saharan, Mediterranean and European countries.

The Sahara Wind Project is involved in focus groups established in the relevant ministries to assess the training and education needs required by Morocco's Solar and Wind Energy plans for 2 gigawatts each by 2020. Within this context, applied research and development are key aspects to consider, particularly when ownership of a technology or process is sought.

NATO supports the Sahara Wind Project

The NATO Science for Peace and Security (SPS) Program is a policy tool that enhances regional cooperation through scientific projects and dialogues between NATO and its partners. Science has the unique ability to provide solutions to security challenges as well as foster collaboration even between disparate nations and regions. The SPS program consists of NATO-funded activities, as well as nationally funded SPS activities.

For more information on the NATO SPS program, visit: www.nato.int/science

WINDMADE

COMMERCIALIZING RENEWABLE ENERGY PRODUCTS

Writer: Sijbren de Jong

Sijbren de Jong is Energy Editor at *Revolve Magazine* and Research Fellow for Energy Security & Climate Change at the Leuven Center for Global Governance Studies, Belgium.

Revolve talks to Angelika Pullen, Director of Communications at WindMade, about the launch of the label and the future of renewable products and cities.

On November 18, 2011, several large global enterprises including Motorola Mobility, Deutsche Bank, Bloomberg, Method and BD (Becton, Dickinson and Co.), announced their commitment to source at least one quarter of their energy needs from wind turbines. The announcement emanates from these companies' commitment to become certified under the recently launched WindMade consumer label.

WindMade is a non-profit organization supported by Vestas Wind Systems, the Global Wind Energy Council (GWEC), WWF, the UN Global Compact, the LEGO Group and Bloomberg. The label represents the world's first global consumer label for companies and products that use windpower to produce their products and to power their operations. Companies can communicate in a transparent way the share of wind power and other renewable sources they use as part of the overall power demand of their operations.

"The ultimate goal is to create a kind of 'consumer pull effect' which will drive demand for wind power operations worldwide and boost investments that enable the renewable energy market to grow – and not limited to those markets where wind power has already taken off," says Angelika Pullen.

The WindMade 'company and organization label' enables enterprises, once authorized, to use the label for their corporate communications such as print, online, TV and radio advertising, reports, press releases, stationary, signage on buildings and retail facilities.

In a world where consumers are becoming increasingly sensitive to sustainability and companies that support it – according to a recent survey[1], 90 percent of consumers worldwide wish to see more renewable energy and 79 percent have a more positive perception of brands produced with renewable energy – the marketing potential is obvious and it should thus come as no surprise that companies are eager to jump on the renewable bandwagon.

Currently, a second standard is in the making which would allow individual products to bear WindMade certification. Pullen states that: "Obviously global product markets are where the real progress can be made. Leading consumer brands carry the potential to give WindMade the required level of visibility." The WindMade product label will be introduced in 2012.

Pullen believes WindMade can also do much more: "One could think of making 'events' WindMade certified for example. Also, there are cities in the north of Germany and Denmark which generate a vast share of their electricity from wind power and one could envision the creation of a WindMade standard for cities. After all, if we are to make a real impact, we ought to adopt a visionary perspective."

With the signing on of giants Deutsche Bank, Motorola, PricewaterhouseCoopers, Bloomberg and Lego, this visionary perspective seems to have begun paying off and the WindMade standard could quite possibly be en route to becoming a trusted logo on consumer brands.

Whether one day we will live in WindMade cities, consuming WindMade products remains to be seen. However, it is a telltale sign that sustainability is moving out of the traditional 'do-gooder sector' and into the realm of industry where its business potential is firmly embraced. Ultimately, such a development can only be strongly supported.

1. **Global Consumer Wind Study 2011**
Commissioned by Vestas and carried out by TNS Gallup in 26 markets among 31.000 consumers and 31 leading global brands, the survey showed that 50 percent of consumers worldwide would be willing to pay extra for products based on renewable energy. Sixty-five percent of respondents would prefer to purchase brands produced through wind energy and the survey indicated that consumers in general want more information about the extent to which renewable energy is used in the production of brands, for instance through labeling. www.businessgreen.com.