



Sahara Wind-Hydrogen Development Project

Morocco and Mauritania

The trade winds that blow along the Atlantic coast from Morocco to Senegal represent one of the largest, most productive wind potentials available on Earth. The same region currently suffers from a limited, decentralized grid infrastructure in need of stabilization. The Sahara Trade Winds to Hydrogen Project aims to utilize these Saharan winds to produce hydrogen in order to enhance the access and integration of wind electricity in Morocco and Mauritania. The project uses a phased approach, beginning with demonstration projects in academic settings to build capacity and knowledge and later moving on to larger projects in industrial settings.

Coordinated by Morocco's Sahara Wind Inc., this project began in the second half of 2007 and is expected to last three years. The project team is composed of 10 partners from Morocco, 8 from Mauritania, and 4 co-directors from the United States, Germany, Turkey, and France.

Objectives

The erratic nature of the trade winds resource means that wind energy cannot provide a sustainable source to the region's weak infrastructure, prohibiting any conventional approach of a continuous feed into smaller local electricity markets. The

size of Morocco's grid is also relatively small (~5,000 MW) and cannot handle large amounts of wind-generated electricity before encountering grid stability problems, such as generation intermittency and power margins. These problems escalate further south in Mauritania where the grid capacity is less than 120 MW.

Therefore, the most beneficial approach is believed to be the use of wind electrolysis as a means of grid stabilization within integrated applications utilizing electrolysis by-products such as hydrogen for power storage restitution/backup, or as a fuel or feedstock for specific uses in remote locations.

The Sahara Wind-Hydrogen Project has led to a NATO "Science for Peace" SfP-982620 Sahara-Hydrogen contract aiming to accomplish the following goals:

- Use electrolyzers as a stabilizer in weak electricity grids
- Co-develop wind-electrolyzer systems for local conditions
- Map regional wind resource potential
- Build "Green Campus Concepts" with hydrogen storage
- Develop integrated wind electrolysis applications within the region's industries and load centers

Project Overview

What

Sahara Wind-Hydrogen Project

Who

Sahara Wind Inc.

When

Started: 2007

Duration: 3 years

Participants

Lead Country

Morocco

Partner Country

Mauritania, US, Germany, Turkey and France

Renewable Technology

Wind

Renewable H₂ Production

This project will demonstrate hydrogen production from wind electricity along with hydrogen storage used as a feedstock for specific industries and hydrogen shipping via pipeline.

Website

www.saharawind.com

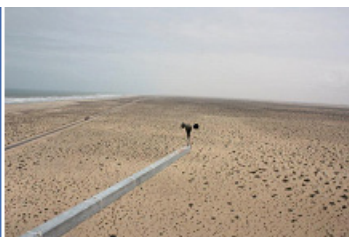
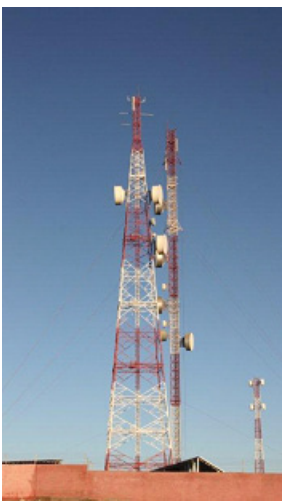
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Trade wind resource assessment using telecom tower infrastructures



Approach

The initial phase of the project is being carried out through applied research programs in academic settings in order to develop local expertise in the technologies. This is being done through the deployment of wind electrolysis systems within “Green Campus Concepts” programs at several universities in Morocco and Mauritania for demonstration and training purposes. The systems use a series of small 5 kW wind turbines that simultaneously provide power to the grid and to a 30 kW pressurized alkaline electrolyzer. The electrolyzer produces hydrogen, which is then stored in cylinders at a pressure of 12 bar and used in a 1.2 kW fuel cell to produce electricity and stabilize the grid at times of low wind speed.

After being initiated at the universities, the technology will gradually be extended to the region’s industries. Current plans are to install demonstration systems followed by larger pilot projects at Morocco’s water and electric utility’s corporate headquarters and main water treatment plant, as well as at the Tarfaya desalination plant. These systems will consist of small wind turbines powering hypochlorite (membrane) electrolyzers. The hydrogen is stored and used in a fuel cell and internal combustion engine generator for back-power, as well as being used as fuel for electro-mobility applications. A similar project using alkaline electrolyzers and wind turbines will be put in place at Mauritania’s iron ore company in the city of Nouadhibou.

Accomplishments

Small wind turbine industrial engineering programs have been established at several universities, enabling development of the technological expertise that will be needed to support the planned and future demonstration projects.

The project has also enabled a wind monitoring infrastructure to be deployed in both Morocco and Mauritania with the help of the project’s industrial partners. Both of the telecom operators in Morocco and Mauritania have made their telecommunication mast tower infrastructures available for this project, enabling a regional wind mapping network to be established. Atmospheric parameters such as pressure, temperature, humidity are being recorded in addition to wind direction and speed on International Measuring Network of Wind Energy Institutes (MEASNET) calibrated instruments at several tower heights. The wind mapping network is expected to facilitate future utilization of the area’s trade wind resources by providing specific information about the quality of the resource over large geographical areas, thus enabling projects involving utilization of hydrogen to be deployed as part of a large-scale, integrated system using high voltage direct current (HVDC), local use of hydrogen, and hydrogen pipelines for export.

Future Plans

The wind and electrolyzer equipment for training and applied research purposes will be put into operation in early November

2010 at the Al Akhawayn University of Morocco and the University of Nouakchott in Mauritania. These systems will be gradually updated to increase their wind generation capacities, with a goal of providing system stabilization of up to 30% of base load.

Other small, wind-turbine test benches are being delivered to the Ecole Nationale Supérieure d’Arts et Métiers (ENSAM) School of Engineering in Meknes, Morocco, and will be installed in late 2010. The technical economic analysis for end-user pilot project applications has already been completed, including technical equipment configurations.

In the future, the project plans to partner with the region’s industries representing the main local energy loads to build an integrated energy system complementary to Sahara Wind’s High Voltage DC Transmission project. This system will use hydrogen storage and hydrogen shipping via pipeline. By enhancing the local ownership of wind resources on a regional basis and supporting industrial use of local mining resources using cleaner more sustainable processes, such a system could potentially serve as a secondary power source to both North Africa and Europe.

Ultimately, project participants would like to see this project enhance the integration of an end-user-driven, comprehensive, sustainable, applied research program. This is likely to lead to the adoption of a holistic, integrated approach to renewable energy technologies in North Africa.

Map showing the locations of two of the university projects (left). Schematic of Sahara Wind wind-hydrogen system (right).

