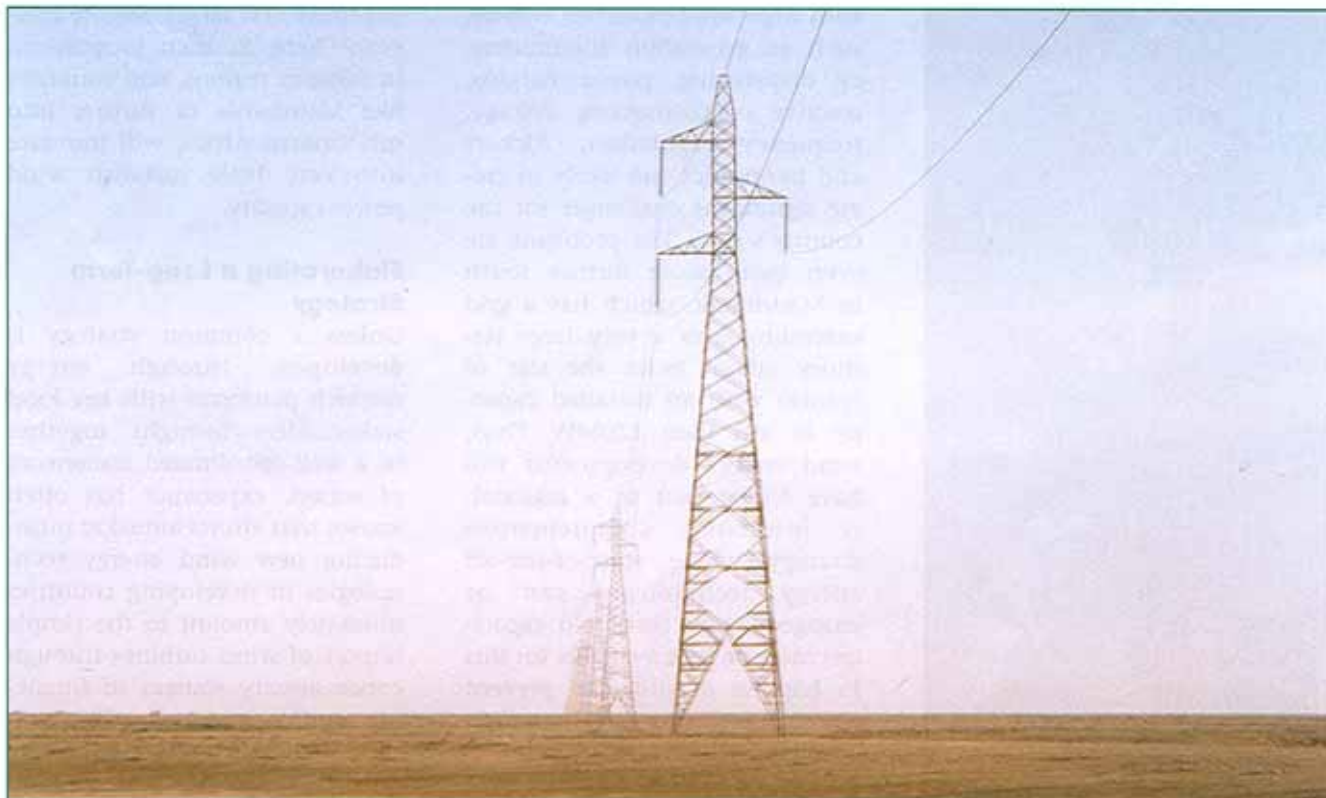


*The wind energy industry was initially encouraged to provide employment in the relatively poor North Sea regions of Germany. In the last 10 years, however, it has emerged as a major business providing most competitive prices of electricity even when operated under marginal European wind conditions. The trade winds that blow along the Atlantic coast from Morocco to Senegal represent the largest and most productive wind potentials available on Earth. Because of the erratic nature of winds, however, wind energy cannot be integrated locally on any significant scale unless far-ranging, more advanced energy technologies are considered. The Sahara Wind Energy Development Project is looking at ways in which these large trade wind resources could be used to benefit both North Africa and Europe.*

*By Khalid Benhamou, Sahara Wind Inc., Morocco*

## Sahara Wind's Integrated Development Approach

Setting the Framework for the Sahara Wind Energy Development Project



Morocco's utility (ONE) 225kV high voltage line 24km north of Tarfaya

The Sahara Wind Project developed by Sahara Wind Inc. serves as the foundation of an ambitious programme that supports a vision

highlighting possibilities for tackling energy scarcity and sustainable development objectives on a regional basis. This programme is

likely to take advantage of the significant breakthroughs expected to happen regarding newer and more advanced energy technolo-



gies, particularly through their association with large sources of renewable energies.

**Limits of a Conventional Wind Energy Development Approach**

Although the Saharan trade winds that extend from Morocco through Senegal represent some of the largest wind energy potentials available on Earth, their erratic nature undermines optimal use and only a marginal proportion of that wind energy can be fed into the region's weak grid infrastructure. With clean energy generation perspectives considerably reduced, industrial integration and economic development cannot take place locally on a significant scale. Thus, a conventional approach to wind energy developments to feed smaller local electricity markets cannot enable a viable wind energy industry to be established, which could have been essential

for tackling the region's economic problems such as those resulting from pressure from Sub-Saharan migrant populations. Indeed, a large renewable energy industry accompanied by many social benefits and job creation could actually improve the region's economics, particularly as it would be based on the sustainable use of one of the world's largest wind energy resources.

**Overall Limited Electric Generation Capacities**

Morocco's grid has approximately 4,500MW of installed electric capacity concentrated mainly in the northern part of the country. Although this grid is among North West Africa's biggest, it is relatively small and, unless precautions are taken, it can hardly cope with any large amounts of wind-generated electricity before encountering grid stability problems. Common issues associated with high wind penetration rates, such as generation intermittency, dispatching, power margins, reactive compensation, voltage, frequency regulation, flickers and harmonics, are likely to create significant challenges for the country's grid. The problems are even more acute further south in Mauritania, which has a grid extending over a very large territory (about twice the size of France) with an installed capacity of less than 120MW. Thus, wind energy developments will have to be part of a regionally integrated, comprehensive strategy where state-of-the-art energy technologies can be engaged. Spare threshold capacities must be kept available for this to happen in order to prevent any grid infrastructure saturation problems.

**Technological Barriers**

No technology currently exists for enabling the significant uptake of wind energy on a reliable basis. Countries that have achieved the highest wind penetration rates,



*Rocky flat terrain in the Sahara desert by Tarfaya*

such as Denmark, do not cover more than 25% of their domestic energy consumptions through wind power and rely on extremely high interconnected 'backup' capabilities. As wind turbine manufacturing represents one of Denmark's main industrial activities, the debate as to whether 25% represents a technical limit or a governmental target is quite irrelevant here, as such proportions in Saharan regions, and countries like Mauritania or further into sub-Saharan Africa, will translate into very little installed wind power capacity.

**Elaborating a Long-Term Strategy**

Unless a common strategy is developed, through energy research platforms with key local stakeholders brought together in a well-coordinated framework of action, experience has often shown that efforts aimed at introducing new wind energy technologies in developing countries ultimately amount to the simple import of wind turbines through concessionary sources of financing and/or export credit packages. Such policies have done very little in terms of local capacity building and industrial integration, even though the technologies appear promising in terms of economic opportunities, as they potentially address energy scarcity issues through the creation



*A 55kW wind turbine in the Sahara desert with the team operating it in 1995*





Aerial picture: Saharan coastline 160km north of Tarfaya

and development of an accessible integrated industrial activity.

### Encouraging Regional Applied Research Projects

Developing a new energy economy will require a global strategy to be introduced and progressively implemented. Any applied research conducted into alternative options for integrating widely available wind/renewable energy resources into grids and other viable energy infrastructure technologies for instance, are likely to be very promising in terms of results as they are of strategic dimension. The introduction of state-of-the-art energy technologies at an early stage, through regional applied research projects, will probably contribute help to identify and establish areas where potential breakthroughs can become significant in the future.

### Reinforcing Existing Scientific and Academic Research Capabilities

North Africa has a qualified pool of university professors, engineers and scientists that could make good use of their research infrastructures. Equipping and networking the region's main research institutions could be considered as a first step towards a successful, gradual introduction of new energy technologies. While this will also prevent any technological gaps from widening in the future, the net-

working of these facilities and their activities are necessary now for supporting and developing a comprehensive approach towards new sustainable energy alternatives.

### Tackling Consequences of Environmental Challenges

It is essential to foster regional collaboration in clean energy technologies for tackling energy access, environment and sustainable development issues. Collaboration between North Africa's scientific communities is very important in providing focus and responsiveness in the development of alternatives to handle economic consequences of high energy dependencies or limited energy access. If combined with environmental challenges, such as land degradation, desertification and demographic pressure, these problems could, in the long run, generate economic distress. Africa's largely agricultural-based societies are indeed threatened by environmental challenges. Building scientific capacities, and developing a vision that can generate a dynamic around fast growing energy and sustainable industries which boasts 20% growth worldwide (located essentially in Europe), could in the long term become an alternative in fixing migrant populations, and contributing to their social integration.

### An Integrated Renewable Energy Economy

Developing a more sustainable and socially acceptable energy industry is what most emerging countries currently seek when facing their rather uncertain energy future. Integrating local capacities is fundamental to that objective, and donor countries are welcome to contribute in making the renewable wind energy economy, initially pioneered by their own small companies, hold these promises, in enabling the very same socio-economical benefits to apply in the developing world. ■

### Biography of the Author

As an engineer, developer and founder of Sahara Wind Inc., Khalid Benhamou installed Morocco's first hybrid wind/diesel system in the Sahara desert. He supported the vision of large integrated wind energy developments in the region with European industry leaders at a time when three-quarters of the world's wind capacity was located in the US State of California.



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