Can wind and solar fuel Africa's future?

With prices for renewables dropping, many countries in Africa might leap past dirty forms of energy towards a cleaner future.

BY ERICA GIES

At the threshold of the Sahara Desert near Ouarzazate, Morocco, some 500,000 parabolic mirrors run in neat rows across a valley, moving slowly in unison as the Sun sweeps overhead. This US$660-million solar-energy facility opened in February and will soon have company. Morocco has committed to generating 42% of its electricity from renewable sources by 2020.

Across Africa, several nations are moving aggressively to develop their solar and wind capacity. The momentum has some experts wondering whether large parts of the continent can vault into a clean future, bypassing some of the environmentally destructive practices that have plagued the United States, Europe and China, among other places.

"African nations do not have to lock into developing high-carbon old technologies," wrote Kofi Annan, former secretary-general of the United Nations, in a report last year[1]. "We can expand our power generation and achieve universal access to energy by leapfrogging into new technologies that are transforming energy systems across the world."

That's an intoxicating message, not just for Africans but for the entire world, because electricity demand on the continent is exploding. Africa's population is booming faster than anywhere in the world: it is expected to almost quadruple by 2100. More than half of the 1.2 billion people living there today lack electricity, but may get it soon. If much of that power were to come from coal, oil and natural gas, it could kill international efforts to slow the pace of global warming. But a greener path is possible because many African nations are just starting to build up much of their energy infrastructure and have not yet committed to dirtier technology.

Several factors are fuelling the push for renewables in Africa. More

MAINSTREAM RENEWABLE POWER

Jeffreys Bay Wind Farm in South Africa generates enough energy to power 100,000 homes there.

than one-third of the continent's nations get the bulk of their power from hydroelectric plants, and droughts in the past few years have made that supply unreliable. Countries that rely primarily on fossil fuels have been troubled by price volatility and increasing regulations. At the same time, the cost of renewable technology has been dropping dramatically. And researchers are finding that there is more potential solar and wind power on the continent than previously thought — as much as 3,700 times the current total consumption of electricity.

This has all led to a surging interest in green power. Researchers are mapping the best places for renewable-energy projects. Forward-looking companies are investing in solar and wind farms. And governments are teaming up with international-development agencies to make the arena more attractive to private firms.

Yet this may not be enough to propel Africa to a clean, electrified future. Planners need more data to find the best sites for renewable-energy projects. Developers are wary about pouring money into many countries, especially those with a history of corruption and governmental problems. And nations will need tens of billions of dollars to strengthen the energy infrastructure.

Still, green ambitions in Africa are higher now than ever before. Eddie O'Connor, chief executive of developer Mainstream Renewable Power in Dublin, sees great potential for renewable energy in Africa. His company is building solar- and wind-energy facilities there and he calls it "an unparalleled business opportunity for entrepreneurs".

POWER PROBLEMS

Power outages are a common problem in many African nations, but Zambia has suffered more than most in the past year. It endured a string of frequent and long-lasting blackouts that crippled the economy. Pumps could not supply clean water to the capital, Lusaka, and industries had to slash production, leading to massive job lay-offs.

The source of Zambia's energy woes is the worst drought in southern Africa in 35 years. The nation gets nearly 100% of its electricity from hydropower, mostly from three large dams, where water levels have plummeted. Nearby Zimbabwe, South Africa and Botswana have also had to curtail electricity production. And water shortages might get worse. Projections suggest that the warming climate could reduce rainfall in southern Africa even further in the second half of the twenty-first century.

Renewable energy could help to fill the gap, because wind and solar projects can be built much more quickly than hydropower, nuclear or fossil-fuel plants. And green-power installations can be expanded piecemeal as demand increases.

Egypt, Ethiopia, Kenya, Morocco and South Africa are leading the charge to build up renewable power, but one of the biggest barriers is insufficient data. Most existing maps of wind and solar resources in Africa do not contain enough detailed information to allow companies to select sites for projects, says Grace Wu, an energy researcher at the University of California, Berkeley. She co-authored a report[2] on planning renewable-energy zones in 21 African countries, a joint project by the Lawrence Berkeley National Laboratory (LBNL) in California and the International Renewable Energy Agency (IRENA) in Abu Dhabi. The study is the most comprehensive mapping effort so far for most of those countries, says Wu. It weighs the amount of solar and wind energy in the nations, along with factors such as whether power projects would be close to transmission infrastructure and customers, and whether they would cause social or environmental harm. "The IRENA–LBNL study is the only one that has applied a consistent methodology across a large region of Africa," says Wu. High-resolution measurements of wind and solar resources have typically been done by government researchers or companies, which kept tight control of their data. The Berkeley team used a combination of satellite and ground measurements purchased from Vaisala, an environmental monitoring company based in Finland that has since made those data publicly available through IRENA's Global Atlas for Renewable Energy. The team also incorporated geospatial data — the locations of roads, towns, existing power lines and other factors — that could influence decisions about where to put energy projects. "If there's a forest, you don't want to cut it down and put a solar plant there," says co-author Ranjit Deshmukh, also an energy researcher at Berkeley.

The amount of green energy that could be harvested in Africa is absolutely massive, according to another IRENA report[3], which synthesized 6 regional studies and found potential for 300 million megawatts of solar photovoltaic power and more than 250 million megawatts of wind (see 'Power aplenty'). By contrast, the total installed generating capacity — the amount of electricity the entire continent could produce if all power plants were running at full tilt — was just 150,000 megawatts at the end of 2015. Solar and wind power accounted for only 3.6% of that.

"A decade ago, people would have told you there isn't any wind in regions such as East Africa."

The estimate of wind resources came as a surprise, says Oliver Knight, a senior energy specialist for the World Bank's Energy Sector Management Assistance Program in Washington DC. Although people have long been aware of Africa's solar potential, he says, as of about a decade ago, few local decision-makers recognized the strength of the wind. "People would have told you there isn't any wind in regions such as East Africa."

The World Bank is doing its own studies, which will assess wind speeds and solar radiation at least every 10 minutes at selected sites across target countries. It will ask governments to add their own geospatial data, and will combine all the information into a user-friendly format that is freely available and doesn't require advanced technical knowledge, says Knight. "It should be possible for a mid-level civil servant in a developing country to get online and actually start playing with this."

SOUTH AFRICA LEADS

In the semi-arid Karoo region of South Africa, a constellation of bright white wind turbines rises 150 metres above the rolling grassland. Mainstream Renewable Power brought this project online in July, 17 months after starting construction. The 35 turbines add 80 megawatts to South Africa's supply, enough to power about 70,000 homes there.

The Noupoort Wind Farm is just one of about 100 wind and solar projects that South Africa has developed in the past 4 years, as prices fell below that of coal and construction lagged on two new massive coal plants. South Africa is primed to move quickly to expand renewable energy, in part thanks to its investment in data.

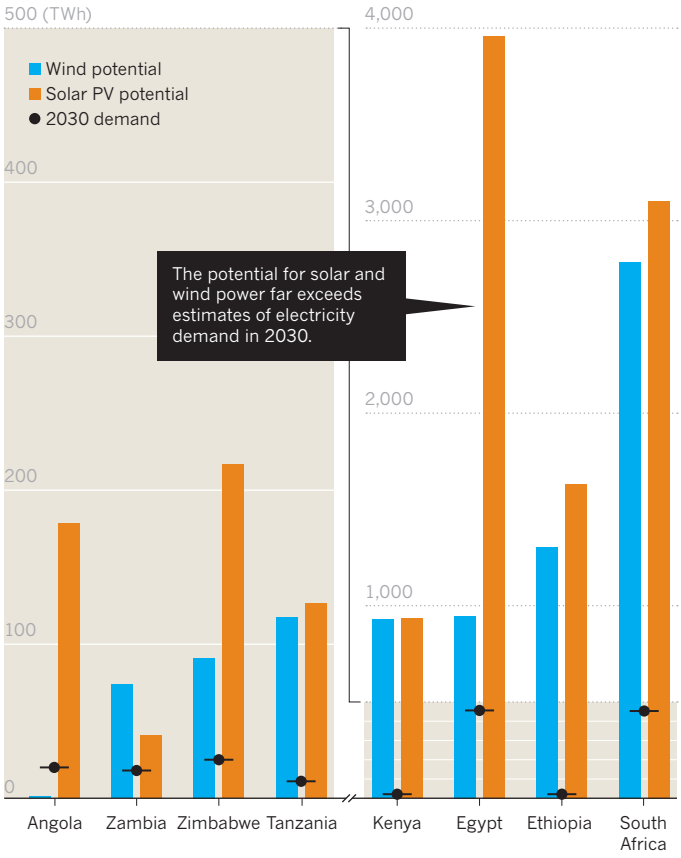
Environmental scientist Lydia Cape works for the Council for Scientific and Industrial Research, a national lab in Stellenbosch. She and her team have created planning maps for large-scale wind and solar development and grid expansion. Starting with data on the energy resources, they assessed possible development sites for many types of socio-economic and environmental impact, including proximity to electricity demand, economic benefits and effects on biodiversity.

The South African government accepted the team's recommendations and designated eight Renewable Energy Development Zones that are close to consumers and to transmission infrastructure — and where power projects will cause the least harm to people and ecosystems. They total "about 80,000 square kilometres, the size of Ireland or Scotland, roughly", says Cape. The areas have been given streamlined environmental authorization for renewable projects and transmission corridors, she says.

But for African nations to go green in a big way, they will need a huge influx of cash. Meeting sub-Saharan Africa's power needs will cost US$40.8 billion a year, equivalent to 6.35% of Africa's gross domestic product, according to the World Bank. Existing public funding falls

POWER APLENTY

Studies of some African nations suggest that they could harvest vast amounts of power from wind turbines and solar photovoltaic (PV) projects.



SOURCE: REF. 3

far short, so attracting private investors is crucial. Yet many investors perceive African countries as risky, in part because agreements there require long and complex negotiations and capital costs are high. "It's a real challenge," says Daniel Kammen, a special envoy for energy for the US Department of State and an energy researcher at the University of California, Berkeley. "Many of these countries have not had the best credit ratings."

Elham Ibrahim, the African Union's commissioner for infrastructure and energy, advises countries to take steps to reassure private investors. Clear legislation supporting renewable energy is key, she says, along with a track record of enforcing commercial laws.

South Africa is setting a good example. In 2011, it established a transparent process for project bidding called the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). The programme has generated private investments of more than $14 billion to develop 6,327 megawatts of wind and solar.

Mainstream Renewable Power has won contracts for six wind farms and two solar photovoltaic plants through REIPPPP. "This programme is purer than the driven snow," says O'Connor. "They publish their results. They give state guarantees. They don't delay you too much." Although the country's main electricity supplier has wavered in its support for renewables, the central government remains committed to the programme, he says. "I would describe the risks in South Africa as far less than the risks in England in investing in renewables."

For countries less immediately attractive to investors, the World Bank Group launched the Scaling Solar project in January 2015. This reduces risk to investors with a suite of guarantees, says Yasser Charafi, principal investment officer for African infrastructure with the International Finance Corporation (IFC) in Dakar, which is part of the World Bank Group. Through the Scaling Solar programme, the IFC offers low-priced loans; the World Bank guarantees that governments will buy the power generated by the projects; and the group's Multilateral Investment Guarantee Agency offers political insurance in case of a war or civil unrest.

Zambia, the first country to have access to Scaling Solar, has won two solar projects that will together provide 73 megawatts. Senegal and Madagascar were next, with agreements to produce 200 and 40 megawatts, respectively. Ethiopia has just joined, and the IFC will give two further countries access to the programme soon; its target is to develop 1,000 megawatts in the first 5 years.

MAKING IT FLOW

That power won't be useful if it can't get to users. One of the big barriers to a clean-energy future in Africa is that the continent lacks robust electricity grids and transmission lines to move large amounts of power within countries and across regions.

But that gap also provides some opportunities. Without a lot of existing infrastructure and entrenched interests, countries there might be able to scale up renewable projects and manage electricity more nimbly than developed nations. That's what happened with the telephone industry: in the absence of much existing land-line infrastructure, African nations rapidly embraced mobile phones.

The future could look very different from today's electricity industry. Experts say that Africa is likely to have a blend of power-delivery options. Some consumers will get electricity from a grid, whereas people in rural areas and urban slums — where it is too remote or too expensive to connect to the grid — might end up with small-scale solar and wind installations and minigrids.

Still, grid-connected power is crucial for many city dwellers and for industrial development, says Ibrahim. And for renewables to become an important component of the energy landscape, the grid will need to be upgraded to handle fluctuations in solar and wind production. African nations can look to countries such as Germany and Denmark, which have pioneered ways to deal with the intermittent nature of renewable energy. One option is generating power with existing dams when solar and wind lag, and cutting hydropower when they are plentiful. Another technique shuttles electricity around the grid: for example, if solar drops off in one place, power generated by wind elsewhere can pick up the slack. A third strategy, called demand response, reduces electricity delivery to multiple customers by imperceptible amounts when demand is peaking.

These cutting-edge approaches require a smart grid and infrastructure that connects smaller grids in different regions so that they can share electricity. Africa has some of these 'regional interconnections', but they are incomplete. Four planned major transmission corridors will need at least 16,500 kilometres of new transmission lines, costing more than $18 billion, says Ibrahim. Likewise, many countries' internal power grids are struggling to keep up.

That's part of what makes working in energy in Africa challenging. Prosper Amuquandoh is an inspector for the Ghana Energy Commission and the chief executive of Smart and Green Energy Group, an energy-management firm in Accra. In Ghana, he says, "there's a lot of generation coming online".

The country plans to trade electricity with its neighbours in a West African Power Pool, Amuquandoh says, but the current grid cannot handle large amounts of intermittent power. Despite the challenges, he brims with enthusiasm when he talks about the future: "The prospects are huge."

With prices of renewables falling, that kind of optimism is spreading across Africa. Electrifying the continent is a moral imperative for everyone, says Charafi. "We cannot just accept in the twenty-first century that hundreds of millions of people are left out." ■

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1. Africa Progress Panel *Power, People, Planet: Seizing Africa's Energy and Climate Opportunities* (Africa Progress Panel, 2015).
2. Wu, G. C., Deshmukh, R., Ndhlukula, K., Radojicic, T. & Reilly, J. *Renewable Energy Zones for the Africa Clean Energy Corridor* (IRENA/LBNL, 2015).
3. Miketa, A. & Saadi, N. *Africa Power Sector: Planning and Prospects for Renewable Energy* (IRENA, 2015).