Morocco & COP 22

Managing Climate Change

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Pressure rises to keep up momentum in Marrakesh

Progress on agreements to cut greenhouse gases has raised the stakes for summit, writes *Pilita Clark*

Between the rancorous US presidential election campaign, growing divisions over the UK's Brexit vote and the protracted turmoil in Syria, the closing months of 2016 have hardly been a showcase for calm co-operation.

The first two weeks of October, however, were marked by a rare high point of unity on a problem that global leaders have long struggled to resolve: climate change.

In the space of 11 days, governments around the world agreed to take three separate steps to tackle the rise of greenhouse gas emissions, a moment with little parallel in more than 20 years of fraught efforts to combat global warming.

First, so many countries rushed to ratify or join the Paris climate accord adopted last December that on October 5 the two thresholds needed for the agreement to enter into force were met: approval by 55 countries accounting for 55 per cent of global emissions. It took more than seven years for the agreement's predecessor, the 1997 Kyoto protocol climate treaty, to come into effect. The architects of the Paris accord had expected a wait of at least another year.

Then, on October 6, governments struck the first global climate deal for aviation, a fast-growing source of emissions long deemed too hard to include in UN accords such as Paris and Kyoto.

Finally, in the early hours of October 15 in the Rwandan capital of Kigali, another global deal was sealed — to phase out hydrofluorocarbons, or HFCs.

Global warming: Patricia Espinosa calls for urgent action — Reuters/Youssef Boudlal

These planet-warming chemicals are used in millions of air conditioners and refrigerators and it is estimated that the Kigali agreement could help avoid as much as 0.5C of future global warming.

As hundreds of delegates descend on the Moroccan city of Marrakesh this week for the latest UN climate change talks, it is hard to think of another period when so much international action occurred in such a short time.

Patricia Espinosa, the veteran Mexican diplomat recently appointed the UN's top climate official, has seen nothing like it before. "I have spent a good part of my career in multilateral affairs and I can tell you it is really unprecedented," she says.

Behind the bout of diplomatic activity, however, large questions remain about whether it is going to be possible to meet the Paris agreement's central aim of avoiding dangerous global warming.

Some of the answers will come at the two-week Marrakesh meeting on November 7-18.

It was expected to be a quiet affair but has been galvanised by the Paris agreement coming into force sooner that expected, a step that means every country ratifying the pact is now legally bound by its terms.

That has thrown the spotlight on the climate action plans that countries have volunteered under the accord, known in UN jargon as "nationally determined contributions".

Countries are not legally obliged to meet any emissions targets in their plans but they do have to update them every five years so that, ultimately, global temperature rises are kept "well below" 2C compared to pre-industrial revolution levels, and 1.5C if possible.

Many decisions still have to be made

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Inside

Energy curbs pose a future mortal threat to oil majors

Hydrocarbon demand Leading suppliers consider their role, writes *Andrew Ward*

All pumped up: oil and gas producers are bracing themselves for an eventual fall in demand
Spencer Platt/Getty Images

For decades, energy analysts argued over when the world would reach "peak oil" — a tipping point after which reserves of hydrocarbons would go into inexorable decline.

Today, it looks like that was the wrong question to ask. The new debate swirling around the energy industry is when the world's demand for oil and gas will peak.

As uptake of renewable energy accelerates in tandem with political efforts to tackle climate change, it seems increasingly likely that demand for fossil fuels will enter permanent decline long before supplies do.

Projections issued last month by the World Energy Council, a network of industry leaders and policymakers, estimated that demand would peak in 2030 at between 94m and 103m barrels a day if uptake of low-carbon technologies continues to expand rapidly. This compares with 86m bo/d in 2014

Some think decline could set in even sooner — and this is not just the view of the many critics of the oil industry who are willing it to happen. Simon Henry, chief financial officer of Royal Dutch Shell, Europe's biggest oil major, said this month that "peak demand" could be reached as early as 2021.

"We've long been of the opinion that demand will peak before supply," he told investors on a conference call after the company's third-quarter results. "And that peak may be somewhere between 5 and 15 years hence, and it will be driven by efficiency and substitution."

By "efficiency and substitution", Mr Henry meant the development of more efficient internal combustion engines that consume less fuel, and the gradual replacement of petroleum with alternative fuels and electricity in the transport system.

These are precisely the sorts of development that policymakers are trying to bring about with incentives for investment in clean energy and limits on carbon emissions. To have even a 50 per cent chance of keeping global temperature rises to within 2C of pre-industrial levels — the limit targeted by international climate policies — scientists have estimated that one-third of known oil reserves and half of gas reserves must be left in the ground. This might be good for the planet, but it poses an existential threat to oil and gas companies.

Fitch, the credit rating agency, last month warned that the industry faced a "resoundingly negative" threat from a potential "leap forward" in battery technology that "could transform the viability of electric vehicles (EVs)".

"Assessing the chances of a rapid decline in oil demand due to EV growth is key to understanding the oil sector's prospects," Fitch said. "A market with structurally falling demand will be a lot more risky for all oil companies, with long periods of low prices and investment uncertainty."

Companies are coming under pressure to be more open about these risks — and to spell out their strategies for responding. ExxonMobil, for example, is under investigation by New York's attorney-general for allegedly concealing from shareholders what it knew about climate change as early as the 1980s.

Some investors are already fleeing the sector. The Rockefeller Brothers Fund, the family foundation built on the riches of John D Rockefeller's Standard Oil, is in the process of divesting fossil fuel holdings and shifting money to clean energy.

For oil executives, how to respond to these threats represents the biggest long-term strategic problem facing their companies. Several are beginning to diversify beyond hydrocarbons by investing in green technology.

By far the most radical steps so far have been taken by Dong Energy, the Danish group built on North Sea oil and gas, which is now the world's largest offshore wind farm operator. Among the supermajors, Total of France has gone furthest with a combined $2.5bn of investments in SunPower, a US solar company, and Saft, a French battery developer.

Total was among 10 large oil companies that last week launched a $1bn joint fund to develop low-carbon technologies. Others included Shell, BP and Saudi Aramco, the Saudi Arabian state-owned producer.

The investment, co-ordinated by a group called the Oil and Gas Climate Initiative, reflects growing acceptance within the industry that a long-term shift away from hydrocarbons is unavoidable. However, there remains wide divergence in views on the pace and extent of the decline.

Amin Nasser, chief executive of Saudi Aramco, told a conference in October that, although fossil fuels would gradually lose market share, the transition would be slow and overall demand for oil and gas would continue rising. This reflects a view — shared with ExxonMobil and Chevron, the two biggest US producers — that uptake of electric vehicles will be outpaced by growth in petrol-fuelled transportation in countries such as China and India.

> Scientists estimate one-third of known oil reserves and half of gas reserves must be left in the ground

Fossil fuels currently meet about 80 per cent of total world energy demand and Mr Nasser forecast the figure would still be as high as 75 per cent of a bigger market in 2040.

Even if Shell's more pessimistic outlook for oil proves correct, Mr Henry said the group would adapt by accelerating its shift to natural gas and biofuels. Shell and other majors are betting that gas will be a "bridging fuel" between the hydrocarbon and renewable era, because it emits half as much carbon as coal when burnt to generate electricity. "Even if oil demand declines, its replacements will be in products that we are very well placed to supply," Mr Henry said.

Calls mount for a global carbon price but progress is slow

Emissions trading

Adoption of the Paris climate accord could spur more action to limit fossil fuel use, says *Pilita Clark*

It was one of the most curious moments in the run-up to the UN talks that sealed the landmark Paris climate change agreement last December.

The chief executives of six large European oil companies, including BP and Royal Dutch Shell, declared that they hoped the negotiations would lead to "widespread carbon pricing in all countries". In other words, they would be happy if it cost more to burn the fossil fuels on which their revenues depend.

Given the political difficulties governments have faced when trying to introduce carbon pricing in a single country, let alone the entire world, the companies' call was a safe one to make.

Economists have championed a global carbon price for decades, arguing that making it more expensive to buy petrol or electricity generated from coal is the most cost-effective way to cut the world's use of fossil fuels and the planet-warming carbon dioxide they produce.

But governments have been slow to respond. So far, around only 40 countries and 20 or so cities, states and regions have put a price on carbon, World Bank data show.

Most have used either a tax or a cap-and-trade scheme such as the EU's 11-year-old emissions trading system, the world's largest carbon market.

These schemes set a progressively shrinking cap on emissions and then distribute or auction allowances — each equal to a tonne of carbon — to factories and other polluters. Companies without enough allowances to cover their emissions can buy from other firms in a market that sets a price on carbon pollution.

The jurisdictions with carbon pricing in place account for only 13 per cent of global emissions at the moment. However, that figure could jump to more than 20 per cent following China's pledge to start rolling out a national emissions trading scheme in 2017.

The precise details of Beijing's plans are still murky but one little-noticed section of the Paris agreement offers carbon pricing proponents hope of further action.

Article 6 of the agreement gives a green light for countries to act a little like the factories covered by the EU's carbon market, and trade emissions allowances with each other to help reach their targets. It says governments can use "internationally transferred mitigation outcomes" under a new UN mechanism, details of which are still to be decided.

"Basically, what that says is governments can transfer emissions reductions between themselves," says Jeff Swartz, international policy director at the International Emissions Trading Association. "This could open the opportunities for carbon pricing beyond anything we've ever seen before."

Much has to be decided in future UN talks before anything goes ahead, not least making sure accounting rules are in place to ensure emissions cuts are counted in only one country, not two.

Reaching agreement on such provisions could be tricky. Countries such as Bolivia have long opposed carbon markets outright, claiming they "commodify" the environment. Others argue it would be hard to devise rules ensuring international allowances are generated by legitimate measures or projects that actually cause overall emissions to fall.

Storing up trouble: coal being readied for use at a US power station

But climate negotiators and private sector groups have already begun informal discussions about Article 6.

"It's somewhat early days and I think people are getting their heads around the issues," says Elliot Diringer of the Center for Climate and Energy Solutions research group in the US.

Article 6 sends a clear message to countries that they are entitled to use international emissions trading to meet the climate plans they submit under the Paris agreement, Mr Diringer says. "There's strong interest among many parties in doing that."

Establishing clear ground rules for such transactions could help spur the growth and linkage of carbon trading systems, he adds.

Whether this could lead to an international price on carbon, however, is unclear. "I do think there is significant potential there in terms of facilitating the carbon market which perhaps some day will lead to a seamless system with a global carbon price. But I think that's pretty far down the road," says Mr Diringer. "I don't see any of this leading very quickly toward a global carbon price."

Meanwhile, existing carbon trading schemes reveal the challenges of making such measures work.

The share of global emissions covered by carbon pricing systems has increased threefold over the past decade. But the EU scheme is suffering from such an oversupply of allowances that carbon prices have been as low as €4 a tonne this year, not nearly enough to drive a sweeping shift away from fossil fuels.

At the same time, countries such as Australia have backed away from plans for a carbon tax while Kazakhstan this year temporarily suspended its emissions trading system, citing a need to improve reporting and verification. Still, Canada's centre-left government announced a plan last month requiring all jurisdictions to have a price on carbon emissions by 2018, starting at C$10 a tonne.

If China ends up delivering a workable national emissions trading system, it would probably create the largest carbon market ever seen. But whether there will ever be a global price on carbon that curbs climate change is still very far from clear.

Giant sunshades and carbon capture mooted

Emergency measures
Schemes to control global temperatures remain unproven and risky, says *Clive Cookson*

As human activities raise levels of the greenhouse gas carbon dioxide in the atmosphere, researchers are thinking up ways of counteracting its warming effects through methods known collectively as geoengineering.

Although many theoretical studies and small-scale experiments have been carried out, scientists and the wider public are wary of going ahead with geoengineering — defined as deliberate large-scale intervention in the Earth's natural systems to counteract climate change. As investigations by authorities such as the US National Academy of Sciences and Britain's Royal Society have found, the risk of action in the short term is still too great.

But they advocate wide-ranging research to lay the foundations for geoengineering in case it is needed to fight a global emergency in the more distant future. This could be required if international efforts to hold down carbon dioxide emissions fail or the climate turns out to be more sensitive than expected to rising CO2 levels.

Though many different geoengineering techniques have been proposed, they fall broadly into two main categories. One is based on the removal of excess CO2 from the atmosphere. The other depends on reflecting more of the sun's energy back into space.

The second category, solar radiation management, is riskier but could be implemented more quickly in an emergency. Several futuristic schemes have been proposed that include the building of giant sunshades in Earth orbit. But the two most realistic ideas are to inject aerosols of tiny reflective particles into the upper atmosphere — mimicking the cooling effect of a large volcanic eruption — and to increase reflective cloud cover over the oceans.

Blue sky thinking: conceptual illustration of orbiting mirrors aimed at reducing global temperatures
Getty Images/ Visuals Unlimited

The downsides of solar radiation management are the unpredictability and possible side-effects of the proposed techniques, and the fact that they would temporarily mask the problem without tackling its cause. "In the absence of carbon dioxide reductions [such techniques] would need to be sustained indefinitely and at increasingly large scales to offset warming, with severe negative consequences if they were to be terminated," according to the National Academy of Sciences.

CO2 removal, the first category of potential geoengineering solutions, is generally less drastic than solar radiation management and addresses the main cause of climate change at source. However there are still many doubts about its practicality and impact.

"Many CO2 removal techniques have been proposed," says Phil Williamson of the University of East Anglia, author of a recent analysis of the field in the journal Nature. "Whether any of them could work at the scale needed to deliver the goal of the Paris agreement — limiting the increase in global average temperature above pre-industrial levels to well below 2C — remains to be seen.

"Large-scale CO2 removal, by whichever means, will have knock-on effects for ecosystems and biodiversity," he warns. "There could be benefits but damage seems more likely."

> Futuristic schemes proposed include the building of giant sunshades in orbit

Challenges to be tackled using this broad technique include how fast CO2 can be removed and where it can be stored, preferably permanently and certainly for many thousands of years.

Carbon capture and storage (CCS) technology is being developed for power stations — extracting CO2 from smokestack emissions, compressing and liquefying it, and pumping it into suitable rock strata deep underground. Such programmes, however, do not provide any net removal of CO2 that has already been accumulated in Earth's atmosphere from energy previously generated from fossil fuels.

Growing biomass crops and burning them in power plants deploying CCS technology does sequester CO2. However, the crops needed to make a significant impact on climate in this scenario would cover more than 500m hectares, which is half the land area of the US, says Mr Williamson: "This would in turn accelerate the loss of forests and natural grassland, with impacts for wildlife whilst also having implications for food security."

Extracting CO2 directly from the air rather than from power station emissions is another possibility. The difficulty is that, though human activities have raised its concentration in the air to 400 parts per million, CO2 is still too dilute to be captured easily by chemical traps.

However, there was good news this year about the prospects for disposing permanently of CO2, regardless of how it is captured. An experiment by an international team in Iceland found that CO2 pumped underground into volcanic basalt rock was almost completely converted into solid carbonate minerals within two years — a far faster process than anyone had predicted. Scientists had feared that mineralisation would take hundreds or thousands of years.

Because basalt strata are widely distributed worldwide, carbon mineralisation could be a preferable alternative to pumping CO2 into underground reservoirs from which it might leak. "We need to deal with rising carbon emissions," says Juerg Matter of Southampton University, senior author of the study published in the journal Science. "This is the ultimate permanent storage — turn them back to stone."

Before geoengineering goes ahead on a significant scale, practitioners are calling for an international code of conduct and governance. Oxford university's Oxford Geoengineering Programme has set out key principles for attempts to shape the global climate: geoengineering should be regulated as a public good, with public participation in decision making; research projects and their results should be published openly; and impacts should be assessed independently.

Venue blazes solar power trail

Role models The host of the global talks has emerged as a pioneer in renewables and funding, says *Siona Jenkins*

Rays of hope: the Noor 1 solar power plant in central Morocco — Fadel Senna/AFP/Getty Images

Until this year the Moroccan town of Ouarzazate was best known for its ancient-looking kasbah façades, used as an exotic backdrop in many Hollywood movies. But now it has a very 21st century landmark: the world's largest concentrated solar power (CSP) plant.

With 500,000 parabolic mirrors, the plant — Noor 1 — has a generating capacity of 160 megawatts — equivalent to that of a conventional single gas turbine power station. It is the first of three CSP plants at the site that will eventually be capable of generating more than 500MW at peak output.

Noor is the most high-profile component of Morocco's ambitious push for renewable energy, which will be showcased when the country hosts COP 22 in Marrakesh. The government has committed to an unconditional 17 per cent reduction in greenhouse emissions by 2030 compared with business as usual, and has adopted a multi-pronged plan combining renewable energy development and improved energy efficiency.

Energy independence has been the main impetus for the programme. Morocco lacks significant fossil fuel supplies of its own. However, electricity demand is growing at 5-6 per cent a year as the country pushes its long-term programme to wean its economy off a dependence on agriculture towards industry.

In 2009, the state set an ambitious target to produce 42 per cent of its electricity from renewable sources by 2020 — a goal that officials say they are on track to meet. This was then extended last year at the COP21 summit in Paris, when King Mohammed VI announced a new goal of 52 per cent by 2030.

The country has received plaudits for both the scale and success of its programme. Michael Taylor, a senior energy analyst at the International Renewable Energy Agency, says Morocco has been helped by factors including strong institutions, funding from bilateral and multilateral agencies and ample supplies of wind and sun. "It's kind of a confluence of influences that have allowed them to step up early and, of course, they're reaping the benefits of those renewables now, earlier than others," he says.

Moroccan officials say they can offer lessons for other countries looking to increase their use of renewables.

"It's not just about money. It's much more a matter of capacity building, technology transfer and the right policies," says Said Mouline, director-general of the Moroccan Agency for Energy Efficiency (AMEE). "We have a sustainable environment approach for all sectors. It's in our constitution and there is will at the highest level of the state."

> 'We have a low price in renewables, we have industrial integration, and we have job creation'

Over the past seven years this has translated into 54 action plans covering all economic sectors. They go beyond installing renewables to cover agriculture, land use, forestry, waste, and industrial policies. As well as establishing a nascent renewables industry, subsidies on fossil fuels have been phased out and energy efficiency encouraged. "We have a low price in renewables, we have industrial integration, and we have job creation," says Mr Mouline.

The Noor project has caught the attention of energy analysts around the world. The plant uses mirrors that reflect sunlight to heat liquid, which can power a turbine. Unlike onshore wind and solar photovoltaic schemes, CSP plants can store energy in superheated liquid that can be used later to drive turbines. This makes it one of "the key technologies for unlocking those very high levels of renewable power generation," says Mr Taylor.

But it is the project's funding model has been singled out as one of Morocco's key achievements. "They've been a game changer," says Anne Lapierre, partner for energy and projects with law firm Norton Rose Fulbright. She was involved in advising Masen, the government agency behind the venture, on the tendering process, which gave it tight control over all aspects of the programme and allowed it to keep costs down.

Masen was able to use funds borrowed by the government from multilateral agencies and banks and then lend the money on to the project company. "It was the first IPP [independent power producer] where the bidders were meant to bid fully-financed. So the winning bidder was accessing the financing, which is a total disruption," Ms Lapierre says.

Through Masen, the government also became a minority shareholder in all the project structures. "We had to simplify things as much as possible. The most complicated things can be realised if they are simplified," Mustapha Bakkoury, head of Masen, told the FT ahead of Noor 1's launch earlier this year.

After a restructuring last year, Masen is now responsible for the development of all Morocco's renewables. It also has the capacity to invest abroad.

Other countries, particularly in sub-Saharan Africa, have shown an interest in the country's approach and Ms Lapierre believes the Noor funding and development model could work as a template for future renewable projects.

Modern Marrakesh

The city is an alluring combination of easy-going charm and edgy exoticism

When American writer and long-time Morocco resident Paul Bowles visited Marrakesh in 1961, he discovered a town painted with a "wash made of the pink earth on which it rests", filled with dusty expanses and palm gardens.

Today the pink walls remain but "*la ville rose*" has morphed from a dusty backwater into Morocco's second-biggest city. Set against the spectacular backdrop of the Atlas Mountains, it has managed to retain an easy-going charm and edgy exoticism that make it a magnet for visitors from around the world.

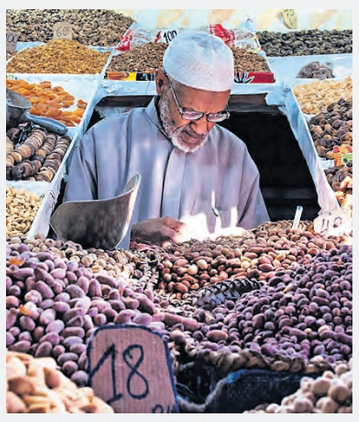
The city is roughly divided into three parts: the walled medina — home to labyrinthine souqs, hidden mansions and historic sites; a substantial French-built new town, known as Guéliz; and the Palmeraie, an 8km-long palm-filled oasis at the city's northern edge. Shopping, nightlife and restaurants are concentrated in the medina and Guéliz. Resort hotels are located in the Palmeraie.

COP 22 has given the authorities an excuse for a spruce-up. New highways have been built, infrastructure upgraded, solar-powered street lights installed and pink walls re-rendered.

The conference is being held at a 30-hectare site adjacent to Bab Ighli, on the town's southern edge. Delegates will have access to electric cars and minibuses to ferry them back and forth from key points in the town.

Those looking for a break from the proceedings are spoilt for choice. Wandering the streets of the medina is one of the joys of Marrakesh, and a well-enforced ban on unofficial guides means aggressive touts who used to harass tourists have gone.

The city may not have as many historic sites as some others in Morocco, but a number of them are clustered inside the old city walls not far from the conference site. Highlights include the ornately decorated Saadian tombs, which date back to the 16th century; the ruined Badi palace, with a spectacular 90m pool and sunken gardens; and the



A stall in the souk of the medina

alleyways of the Mellah, the historic Jewish quarter. A little further away is the Ben Youssef Medersa, a religious school established in the 14th century which has echoes of Spain's Alhambra.

The medina's spiritual — if not physical — centre is Djemaa el-Fna. A vast, chaotic square filled with market stalls, Berber hawkers, snake charmers, musicians playing exotic instruments and the aroma of grilled meat, it is an anarchic emblem of the city that cannot be missed.

Passages off the north side of the square lead into Marrakesh's colourful souqs. Morocco nurtures its handicrafts — there is even a ministry devoted to artisanship — and their range and quality is on exuberant show in the souq's winding alleys and colourful stalls. Bargaining is expected and is part of the fun.

The city's tradition of artisanship has attracted Moroccan and European designers, who have also made their mark — most famously Yves St Laurent, who bought the park of Jardin Majorelle in Guéliz to stop it being sold to a hotel developer.

Food in Marrakesh is as varied as the offerings in the souk. Many of the city's *riads* (old mansions or houses that have been turned into boutique hotels) offer Moroccan or European-Moroccan fusion dishes to non-residents if they call ahead.

The fashion crowd's long love affair with Marrakesh has also helped foster a lively, atmospheric nightlife.

Finally, there is the age-old Marakshi pleasure of sipping sweet mint tea on a rooftop under the stars. While the dusty expanses of 50 years ago have disappeared, some things in the pink city remain unchanged.

Siona Jenkins

African path to avoid fossil fuel dependency

Energy supply

Technology advances can help developing countries to leapfrog the west, reports *Andrew Ward*

Charging ahead: a man using solar panels to power devices — Sia Kambou/AFP/Getty Images

Africa is not an obvious continent to prioritise in the race to replace fossil fuels with renewable power. The 49 countries of sub-Saharan Africa take a year to emit the amount of carbon belched out by the US in less than two months.

Yet, this lack of carbon intensity — annual per capita CO2 emissions from sub-Saharan Africa average 0.8 metric tonnes compared with 16.4 metric tonnes from the US — also represents an opportunity for the continent.

Whereas more developed regions of the world face the challenge of overhauling deeply entrenched energy systems based on fossil fuels, Africa's relative lack of development gives it a chance to build new kinds of infrastructure from scratch.

Advocates for renewable power say Africa can become a global champion of clean energy by harnessing the continent's plentiful solar, wind and geothermal resources. "Similar to the way mobile phones leapfrogged over landlines in Africa, the same can happen with electricity," says Kate DeAngelis, policy analyst for Friends of the Earth, the environmental group.

There are early signs that just such a revolution could be taking root. Between 2010 and 2013, installed solar capacity across sub-Saharan Africa rose sevenfold from 40 megawatts to 280MW, according to the International Energy Agency.

However, even that elevated number was equivalent to just one small conventional power station, and, for most Africans, electricity of any kind remains elusive.

Only 43 per cent of people on the continent have access to reliable power, leaving 635m people without, according to the IEA.

This energy deficit represents one of the biggest obstacles to economic development across the continent — a fact that has been attracting increased attention from policymakers and activists. While previous international aid efforts have focused on areas such as health, hunger and education, there is growing recognition that wider provision of electricity is essential to driving down poverty.

Barack Obama, during his time as US president, has led the way by launching his Power Africa initiative in 2013. This campaign aims to add 30,000MW of generating capacity by 2030, equivalent to almost a third of sub-Saharan Africa's existing supply, at a cost of $7bn.

However, three years into the scheme, only 374MW of new capacity is up and running. Further projects are due soon but the slow progress demonstrates the difficulty of fulfilling Mr Obama's promise to bring "light where currently there is darkness".

Ms DeAngelis says Power Africa and its partners should focus more on small-scale renewables schemes for rural communities, rather than large centralised power stations and distribution grids. "Power Africa needs to stop approaching energy the way the US has for the past 100 years," she adds.

This view is echoed by Thomas Duveau, head of business development for Mobisol, a German company which has installed solar power systems in 60,000 households in Tanzania and Rwanda. "We put a solar panel on the roof, a battery in the house and a set of electrical appliances to run off the power," explains Mr Duveau.

> Sub-Saharan Africa takes a year to emit the amount of carbon belched out by the US in less than two months

Technology such as Mobisol's transforms living standards by allowing people to refrigerate food, watch television and charge mobile phones. But another key health gain is that it also eliminates the unhealthy pollution and fire risk from smoky paraffin lamps.

Local "distributed" electricity systems such as household solar panels provide a faster and more affordable way to electrify Africa than the centralised power networks typical in the developed world, according to Mr Duveau. "Fifty to 70 per cent of rural areas in Africa will never see the grid," he says.

Despite initiatives such as Power Africa, far more investment is needed if the local successes of Mobisol and other pioneers like it are to become more widespread. According to the World Economic Forum, it would take an extra $55bn per year until 2030 to lift the continent out of energy poverty.

Ms DeAngelis says the little commercial investment which has been made has tended to focus on traditional power infrastructure for urban areas — benefiting relatively wealthy consumers with grid connections and industrial users.

"Banks are risk averse and often avoid financing unfamiliar projects," she says. "Mini and off-grid projects unfortunately tend to fall into this category. It can therefore be difficult for distributed renewal projects to get off the ground."

However, there are signs that this could be changing. Mobisol last month announced that Investec Investment Management was taking a "significant shareholding" in the company, adding to existing backers including Deutsche Bank and the EU's European Development Fund.

Mr Duveau reckons that, with a big push from local governments and international donors and investors, Africa could close its energy gap with the rest of the world much faster than most people imagine. "I think we can do it in 10 years," he says.

UN climate chief takes softly, softly approach

Diplomacy
Mexico's Patricia Espinosa must build on the legacy of her predecessor, writes *Pilita Clark*

What is it about Spanish-speaking women in their fifties and climate change?

For the past six years, the UN's top climate official has been the feisty Costa Rican, Christiana Figueres, a driving force behind the successful adoption of the Paris agreement last December.

When she decided to leave after her term ended in July, the UN chose to replace her with Patricia Espinosa, a former foreign minister of Mexico and an altogether different type of diplomat.

Ms Espinosa has had a foreign service career spanning 35 years and was living in Berlin as Mexico's ambassador to Germany when the news came through that she had been selected to replace Ms Figueres.

"I was very happy," she says, but there was no wild celebration to mark the news, just a quiet night with her daughter and husband, a businessman. "We had a nice dinner," she says, conceding some champagne had been involved.

Her appointment meant a shift from Berlin to Bonn, home of the UN's climate secretariat, and a busy work agenda now that the Paris agreement has reached the threshold for coming into force much earlier than expected.

The secretariat has been partly shaped by the last international climate treaty, the 1997 Kyoto protocol, which required only a relatively small group of wealthy countries to cut emissions.

Now all countries are obliged to deliver some sort of climate plan under the Paris accord, which Ms Espinosa says will entail changes for the way the secretariat operates.

"Yes absolutely, we need to make some adjustments," she says. There will be a lot more focus on supporting "action on the ground", she adds, though the basic structure of the organisation will remain in tact.

Ms Espinosa is an experienced diplomat but she has a lower public profile than Ms Figueres, who took on the job shortly after the disastrous failure of the 2009 climate summit in Copenhagen.

Handover: Patricia Espinosa (left) and predecessor Christiana Figueres — AFP/Getty

When Ms Figueres was asked at her first press conference if she thought a global climate deal was possible, she replied abruptly: "Not in my lifetime."

It is hard to imagine Patricia Espinosa delivering such a blunt assessment.

"She's very calm, very under control," says Laurence Tubiana, France's envoy to the COP 21 meeting that delivered the Paris accord and a veteran of climate negotiations. "She's not an outspoken campaigner."

> The Paris agreement has reached the threshold for coming into force much earlier than expected

That is likely to stand her in good stead now that the Paris agreement has been sealed, says Ms Tubiana, because there needs to be a firm focus on ensuring it is properly implemented.

Ms Espinosa has spent relatively little time in UN climate negotiations, though the experience she has had was important. Mexico hosted the first UN talks after the failure of Copenhagen and Ms Espinosa, then foreign minister, chaired the two-week talks that were held in Cancún in 2010.

Against tradition, she held negotiations on Sundays, speeding up the often tardy process, and gavelled down protests from Bolivia that threatened to derail the final agreement. "I also took a lot of care in providing in Cancún a good atmosphere so that people were also personally feeling comfortable," she says.

She is familiar with the inner workings of the UN, having spent time close to the organisation at various points of her career, including a stint in Mexico's mission to the UN in Geneva, where she worked on economic issues.

She says her work as a Mexican diplomat on multilateral agreements covering issues such as drug trafficking has given her a good understanding of how to operate in complex negotiations.

That experience could be important when it comes to helping steer climate talks starting in Marrakesh this week.

The Paris agreement says decisions on a raft of rules governing its implementation should be taken by a body known by the unwieldy name of the Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement (or CMA).

However, the agreement was not expected to enter into force as quickly as it did. So, although the CMA will meet in Marrakesh, it cannot make decisions without excluding dozens of countries that have yet to ratify the deal.

It is therefore expected that this governing body will meet but then be suspended until at least 2018, leaving countries to bicker over rules but take no concrete decisions to finalise them.

Ms Espinosa is not fazed by the prospect of such an outcome.

"The holding of the first CMA will mark really this very unprecedented progress towards this low carbon transition at the global level," she says. "That in itself will be in my view a very significant moment."

Pressure rises to maintain momentum in Marrakesh

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about the rules guiding exactly what is in these updated plans. The first batch, made ahead of the COP21 meeting in Paris, would still put the world on course for at least 2.9C of warming this century, the UN said last week.

Collectively, these plans amount to a hotchpotch of pledges, from building wind farms to planting trees, with an array of different targets for bringing down emissions.

The US, for instance, has proposed an emissions cut of up to 28 per cent on 2005 levels by 2025, while the EU is planning a 40 per cent cut from 1990 levels by 2030. China has no goal for an outright cut at all, but instead says its emissions will peak by 2030.

The Paris accord stipulates that a new governing body for the agreement should decide "at its first session" on rules for common timeframes in climate plans and other measures making it easier to compare each country's actions. That includes more common standards for reporting greenhouse gas emissions in a timely and accurate fashion, for instance.

The EU, the US and other developed countries have generally submitted emissions data to the UN for at least the year 2013. But some of China's latest figures date back to 2005 while those of other countries are from the 1990s.

Poorer countries also want to see more transparent reporting of the financing commitments wealthier nations have pledged to deliver to help tackle global warming.

Because the agreement is coming into force unexpectedly early, its new governing body can technically hold its first session in Marrakesh. But dozens of countries have yet to formally ratify the deal, meaning they cannot take part in the early shaping of any decisions.

As a result, it is expected the new body will convene and then be suspended, leaving time for more countries to join.

At a minimum, many governments want the Marrakesh meeting to set a deadline of 2018 for agreeing on the "rule book" needed for the Paris accord.

That still makes the meeting important for investors, says Zoe Knight, managing director for climate change at HSBC.

"More clarity on how the aims set out in country plans will be measured and monitored allows a more effective climate risk assessment," she says.

More than 600 companies have already said they expect to change their strategy as a result of the Paris agreement's adoption, says Paul Simpson, chief executive of the Carbon Disclosure Project, a non-profit body that compiles company environmental data for hundreds of investors. Some plan to adopt an internal carbon price; others say they will use more renewable energy. But corporations will still be watching closely to see how countries implement the agreement's rules, as will climate scientists.

Commuters add to carbon emissions

Temperatures have already risen nearly 1C since the industrial revolution, following a fossil-fuelled boom in carbon dioxide emissions, and some scientists think the goal of limiting the rise to 2C will be hard to meet, let alone 1.5C.

Average global CO2 levels in the atmosphere reached 400 parts per million in 2015 and surged to new records this year on the back of a powerful El Niño weather system that is likely to make 2016 the warmest year on record.

Experts at Oxford university held a conference in September to consider the Paris agreement's 1.5C goal. Some attendees had sobering views.

"The very first year at 1.5C could be in about 10 years time if we happen to get an extra warm year on top of the long-term warming trend, like we had with the recent El Niño event," said Professor Richard Betts, head of climate impacts at the Met Office Hadley Centre in the UK. The prospect of hitting this threshold so soon illustrates the challenges of meeting the Paris deal's targets.

The good news is that there has been "remarkable" progress in the growth of renewable energy alternatives to fossil fuels, says Andrew Steer, chief executive of the World Resources Institute research group in the US.

The International Energy Agency recently reported a record-breaking number of installations of wind and solar power last year that has led to renewables overtaking coal to become the world's largest source of installed power capacity.

"We've got a lot to be enthusiastic about," Mr Steer says. But there is no room for complacency, he adds. "We are still a long, long way off from getting to where we need to get to."

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