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#RSCEU
Welcome to the July 2018 issue

This month in the magazine we focus on the spectacular growth of battery storage and microgrids, which have emerged as key enablers of the clean energy revolution.

As Michael Levitin reports from San Francisco, a raft of new legislation in California, combined with a sharp drop in the costs of solar and wind power in recent years, is leading to an explosion in storage capacity in the Golden State.

And California is not alone, with New York setting even bigger targets for battery storage than California, and developments across the country from Massachusetts to Hawaii.

The amount of storage capacity in the US is estimated at 1.5 gigawatt hours, almost double 2016 levels. This is expected to accelerate, with Tesla’s new Gigafactory in Nevada forecast to generate enough batteries to drive down costs by 30%.

Mike Scott reports from London on how growth in the offshore wind industry is driving battery storage developments in Europe and in the US, while Brian Donaghy in Adelaide writes about how a change in government in South Australia is not expected to derail that state’s ambitious clean energy transition based on renewables and battery storage.

Mike Scott also looks at how microgrids are beginning to revolutionize energy systems around the world, providing cheap, reliable power in markets as disparate as remote island communities to neighbourhoods in Brooklyn. According to Navigant Research, more than $100bn will be spent on microgrids over the next decade.

He also looks at India, where the spread of microgrids is critical to fulfilling the government’s commitment to bring power to the 200 million people living without electricity.

Plenty of poolside reading to keep you busy until next month’s issue on sustainable urban transport.

Enjoy your summer.

Terry Slavin
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#SRCEU
Why California’s dreaming about battery storage

Michael Levitin reports on how a raft of new legislation, combined with lower costs, is leading to an explosion in storage capacity in the Golden State

In the race to lower emissions and cut energy costs to consumers, battery storage has emerged as a leading clean energy solution in US states where solar, wind and other renewables are generating an ever-greater percentage of electricity. Recent aggressive policies in California have driven the battery market, and other states are following suit as the utility industry seizes on a decrease in costs and a growth in legislation to monetize storage technology.

Up until a few years ago, batteries were considered too expensive and untested to be used in a utility setting. But in the same way that costs for solar and wind power have dropped sharply over the past decade, lithium ion and other battery storage technologies have fallen dramatically in price, leading to a boom in their production and use. At the same time, the quality and performance of batteries has increased.

Analysts predict that Tesla’s new Gigafactory in Nevada will make enough lithium ion batteries to further drive down costs by 30%. The International Renewable Energy Agency (IRENA) estimates global battery storage could grow from 1.5 gigawatts (GW) today to 250GW by 2030. And by 2020, batteries are forecast to be a $14bn market – seven times their value in 2015.

‘Compared with eight or 10 years ago, storage is much more in the toolkit of the electrical system’
California is the leader in the energy storage revolution. Escondido, 30 miles north of San Diego, is home to America’s biggest operating battery storage system, a collection of battery packs totalling 30MW, powerful enough to charge 20,000 homes for four hours. The facility, built by AES Energy Storage for San Diego Gas & Electric, is the latest example of the way grid-scale batteries are transforming the state’s energy utility landscape.

Planned developments are even more ambitious. In June, the San Diego utility won approval from the CPUC for five new energy storage projects totalling 83.5MW. This month, publicly traded utility PG&E, which provides electricity to 5.2 million California homes, applied to build the world’s biggest battery using Tesla’s Powerpack energy system.

The lithium ion battery, at 182.5MW, would surpass the sprawling 100MW system it built last year in South Australia, the reigning world big battery champion. While the new system will have capacity to produce 730MWh of energy, it could be expanded to 1.1GWh (See South Australia’s clean energy transition powers on).

Then there is San Francisco-based developer Recurrent Energy’s plan to build 350MW of solar power, with up to 350MW of battery storage capacity, over 2,500 acres of public lands at the base of the Mule Mountains in southern California’s Riverside County, which has been submitted for federal approval.

To understand how battery technology has progressed so quickly, it’s necessary to look at the legislative model favouring energy storage in California, where the volume of renewables flooding the grid has made storage capacity more urgent.

The Golden State, which has more than 4.2GW of solar capacity, has pioneered various models to incorporate clean energy into the grid. To create more demand, it has accelerated a policy framework that is pushing down costs.

Compared with eight or 10 years ago, “storage is much more in the toolkit of the electrical system”, said Alex Morris, director of policy and regulatory affairs at the industry trade group California Energy Storage Alliance.

30 SECOND READ

- Batteries used to be thought too expensive to use in a utility setting. But lithium ion and other storage technologies have dropped in price, while quality has increased, leading to a boom in use. It is estimated that global battery storage could grow from 1.5GW today to 250GW by 2030.
- In the US, where renewable sources are taking a larger share of the energy market, batteries add reliability to the grid, providing power when the sun isn’t shining or the wind blowing.
- California has been legislating aggressively to favour energy storage, setting ambitious targets and playing a lead role as a developer. It is home to the America’s largest lithium ion battery, which can charge 20,000 homes for four hours.
- With the world on track to produce half its energy from renewables by 2050, storage will play a key role. Greater monetization, so companies can depend upon a revenue stream, alongside legislation on the Californian model, will unlock the industry's full potential.

’S B 1347 is a really prudent planning step to keep the state moving in the direction of a high renewable future’
As renewable sources take over a larger share of the nation’s energy market, the need for storage will continue to grow.

A big advantage is it allows utilities “to absorb the extra solar at the right time and discharge it at a later time, so you can be less reliant on traditional power resources”, says Morris.

California’s first battery storage law, AB 2514, came into effect in 2010 and established a mandate of 1,325 megawatts (MW) of installed battery capacity by 2020 among the state’s three investor-owned utilities (Pacific Gas & Electric, Southern California Edison and San Diego Gas & Electric). Prior to the law, which the California Public Utilities Commission (CPUC) formally adopted in 2013, battery storage was barely on the map, said Thomas Baker, partner and managing director of the Boston Consulting Group, which studies developments in the renewable energy sector.

In 2016, the law AB 2868 added an additional 500MW to that target. And last year, the bill SB 700 called on the CPUC to establish an Energy Storage Initiative whereby utilities were directed to use battery storage to help disadvantaged and lower-income communities better manage their energy supplies. In a further effort to make battery storage more affordable, the state’s Self-Generation Incentive Program (SGIP) provided funds for lower-income customers to install battery systems at homes, churches, community centres and elsewhere.

The Climate Group released a case study last year showing how California’s legislation blazed the path for battery storage nationally. Earlier this year, the Federal Energy Regulatory Commission issued orders 841 and 845, which affirmed California’s lead role as a developer in the battery market and suggested that other states pursue its model.

A new bill working its way through the California legislature, SB 1347, seeks to further drive the storage industry, with an emphasis on renewables integration and flexibility. The measure has a provision mandating that battery storage be made more cost-effective, while calling for an additional 2,000MW in installed capacity in the state by 2024. “SB 1347 is a really prudent planning step to keep the state moving in the direction of a high renewable future, only [applying] storage where it makes good sense,” said Morris.
“It keeps industry focused on bringing the most competitive pricing to California, which is in the best interest of ratepayers. A lot of people will respond, costs will continue to come down, and we’re simultaneously feeding this into our grid to deal with current challenges concerning renewables integration,” he added. “The bill is signalling that California is taking this very seriously.”

The state generated 17% of its power from solar and wind sources in 2016 and added 95MW of new storage capacity last year, almost half the total added across the US. Some hotels, for example, are installing solar panels with battery storage so they can charge power during the day, when the grid has cheap and excess flow, then discharge it in the evenings when guest demand is high.

Other examples abound. In southern California, ENGIE Storage is providing the San Diego County Water Authority with a $2m battery system to store its solar power, saving the authority $100,000 in annual energy costs. Two other projects – Advanced Microgrid Solutions’ new 500 kilowatt (kW) battery system for the Long Beach Water Department, which stores 3 megawatt hours (MWh) of power daily and saves $150,000 in annual energy costs; and Doosan GridTech’s 20MW lithium ion battery energy storage system built for the Los Angeles Department of Water and Power, will further impact the battery storage space market.

Meanwhile, batteries employed in the state’s Imperial Irrigation District have provided frequency balancing to a previously unstable electric system. And Canadian company AltaGas has rehabilitated a gas-powered plant in the Los Angeles basin that now uses battery storage to provide power to residents.

Outlook
Like the industry itself, the uses and applications for battery storage are growing. To date, about 400MWh of storage nationally is used for frequency regulation, to keep the grid stable. Another application involves shifting energy to provide for times of peak demand on the grid. But probably the two biggest applications are known as renewables collocation – placing batteries where renewables are installed – and grid investment deferral, which improves grid management while enabling utilities to defer making bigger investment upgrades to their grid.
As renewable sources take over a larger share of the nation’s energy market, the need for storage will continue to grow. Batteries are particularly helpful in places that swing from high to low demand, like spots with lots of sun or wind, because they add flexibility and reliability to the grid. And unlike building a giant power plant, battery storage projects can be completed in as little as four to six months. Daniel Finn-Foley, an analyst with GTM Research who spoke recently with the Desert Sun, said: “We’re going to see a lot more solar companies baking in the potential, if not the outright installation, of storage into their systems. If you’re looking ahead three, four, five years out, it’s going to be increasingly a story about storage’s ability to enhance large, utility-scale solar.”

John Jung, the CEO of Greensmith Energy, an energy storage integrator based in Emeryville, California, that represents around 20% of the US storage market, says the industry is still in its infancy. “We think combining energy storage with wind and solar is going to be a massive driving trend for the adoption of energy storage around the world,” he said. “The key to unlocking the industry’s full potential will be investing in a software controls platform that can optimize all of the grid’s existing assets.”

Right now, what’s needed is greater monetization so that companies and utilities can count on a revenue stream when they install more storage. “Battery storage provides capacity and flexibility, and in a world where there are more renewables, capacity is increasingly important,” said Baker. “That’s the biggest challenge: to create the economic incentives to help monetize the value that storage provides.”

The question for many, therefore, is what policies and legislation can be enacted soon, on the model of California and New York (see Storage catches on from Hawaii to New York) to catapult battery storage into the mainstream. According to Bloomberg New Energy Finance, thanks to the rapid development of battery storage technology, the world is on track to produce half its electricity from renewables by 2050.

“All signs indicate storage is going to play a big role in the future,” said Morris. “Storage is coming soon to a grid near you.”
In the US, where renewables account for an ever-increasing share of the energy market, the capability of storing the power produced is emerging as a leading clean energy industry. While California is blazing a trail on battery storage, (see Why California’s dreaming about battery storage) it is not the only state where the technology is taking off. Around the country, bids for renewable power projects that include battery storage systems have become cheaper and more common. According to Thomas Baker, partner and managing director of the Boston Consulting Group, there is a total of about 1.5 gigawatt hours (GWh) of battery storage across the US, almost double the 800 megawatt hours (MWh) in 2016. Market projections are for national storage capacity to balloon to 11-12GW by 2022. As of last year, according to Greentech Media, 21 US states had more than 20MW of storage capacity completed or in production, and 10 states had more than 100MW.

Baker said the decline in cost for battery technology is helping drive the trend. “Based on what we’ve come to expect in costs, storage will be economic, and once there’s an economic driver you’re going to see an explosion of storage,” he said. The other key factor is legislation. More than 140 policies and regulations are now in place nationwide encouraging growth in the storage sector.

The northeast is another hot spot: New York’s aggressive Reforming the Energy Vision (REV) programme is disrupting that state’s utility industry by providing incentives and implementing a broad mandate to create opportunities for battery storage and microgrids. New York set even bigger targets than California when Governor Andrew Cuomo announced early this year a new state storage target of 1,500MW by 2025. That coincides with New York’s plans to solicit bids for 800MW of offshore wind power. Cuomo also directed the state-sponsored NY Green Bank to invest $200m to further drive down the costs of energy storage.

As a result, New York expects to see some 30,000 jobs created in the storage industry in the coming years. According to Strategen Consulting, battery storage could reduce the Empire State’s greenhouse gas emissions by 75% and help it achieve its climate targets of 50% renewables by 2030 and 80% by 2050. Right now, said Baker, there still isn’t a clear way
for utilities to capture the value they’re creating from battery storage, but current policy may change that. “As part of the New York REV process, they have a philosophy that we need to balance renewable energy with the grid and create market mechanisms to reward the types of services that battery storage is providing to the grid.”

Massachusetts has implemented procurement targets of 200MWh in battery storage by 2020. Meanwhile, PJM Energy Market, the independent service operator that manages grid reliability across New Jersey, Pennsylvania, Maryland, Delaware and other states, has established an auction that creates a market for frequency regulation in battery storage. By offering credits to utilities that adopt a variety of battery storage applications, PJM sent a price signal that helps to create an incentive for new battery installations. “PJM demonstrated a very clear market for battery storage,” said Baker.

Elsewhere, Xcel Energy, the largest utility in Colorado, said it’s seeing greater battery use from its suppliers. Tucson Electric Power last year agreed to build a solar and battery storage project, and Florida Power & Light this year added battery storage to a solar plant. Hawaii is moving to incorporate massive battery storage into its energy system. And though it currently has no legislation favouring battery storage, Texas is so flush with utility-scale wind power that analysts consider it a “sleeper state” to watch.

New York Governor Andrew Cuomo set a state storage target of 1,500MW by 2025.
How energy storage is unlocking the full power of offshore wind

The cost of offshore wind power has fallen at a dizzying rate in the past few years. The same is true of energy storage. Now there are plans to put the two together, to boost the flexibility and economic viability of offshore wind still further. A few years ago, the offshore wind industry was warning that it would struggle to meet its target for reducing costs to below £100 per megawatt hour (MWh) by 2020. Offshore costs are higher because of the difficulty of installing, maintaining and decommissioning turbines in the challenging marine environment.

However, thanks to concerted efforts to cut costs and apply the lessons of earlier rounds of offshore wind installations, the 2020 target was met in the 2015/16 round of capacity auctions and in 2017, two new projects won contracts to deliver power at £57.50/MWh. This was cheaper than new gas-fired power stations and significantly lower than the £97.50 “strike” price for the Hinkley Point nuclear power station.

The same trend can be seen in the battery storage sector, where costs have fallen by 80% since 2010, according to Bloomberg New Energy Finance. The International Renewable Energy Agency predicts they could fall a further 66% by 2030, stimulating a 17-fold increase in the market. Battery storage is increasingly being combined with solar and onshore wind projects, so it was only a matter of time before it started to be applied to offshore wind as well.

Danish group Orsted has been exploring the possibility of combining offshore wind farms and battery storage. It added storage to its Burbo Bank scheme in the UK to stabilize the wind farm’s delivery frequency to the grid in what was believed to be the first use of storage and offshore wind.

And its 800MW Bay State Wind proposal for a wind farm off the coast of Massachusetts in New England included 55MW/110MWH of storage “to help the region in overcoming winter reliability challenges by delivering energy when it is needed most and help to reduce winter peak energy prices and price volatility”.

Bay State Wind, whose bid was ultimately unsuccessful, said the storage would cut winter power prices by around $158m by enhancing grid stability.
Deepwater Wind, which is developing the 400MW Revolution Wind project 15 miles off the Rhode Island coast, said in April that it could supply 200MW of power to utilities in the neighbouring state of Connecticut with an optional energy storage component. This would make Revolution Wind capable of delivering clean energy during peak hours of demand on the regional electric grid – even when the wind isn’t blowing, the company said.

The recently renamed Equinor, formerly Norway’s state-owned energy company Statoil, added a 1MW/1.3MWh battery storage system, called Batwind, to its Hywind floating wind farm off the coast of Scotland.

“The variability of renewable energy can to a certain extent be managed by the grid. But to make renewable energy more competitive and integrate even more renewables to the grid, we will need to find new, smart solutions for energy storage to provide firm power,” says Sebastian Bringsvaerd, development manager for Hywind and Batwind.

“While there are many energy storage products and solutions in the market, the battery software solutions are less developed. We want to teach the battery when to hold back and store electricity, and when to send power to the grid, thus increasing the value of the power,” said Bringsvaerd.

“Such projects allow variable renewable energy projects to react flexibly to changes in demand, and eventually may allow renewables to generate baseload power.”

He pointed out that it could be especially effective for getting more power from offshore wind, which is more consistent and stronger than onshore, but produces energy at times of low demand, such as overnight.

Mike Scott
South Australia’s clean energy transition powers on

Home to the world’s biggest battery, the state is a renewable energy powerhouse – something that looks unlikely to change under the new government, reports Brian Donaghy in Adelaide

The state of South Australia is something of a poster child for the clean energy transition. It sourced 48% of its power from wind and solar energy in 2017, one of the largest clean energy penetrations in the world, and is within a whisper of hitting its 2025 target of 50% renewables, with the help of large-scale battery storage, including the world’s largest lithium ion battery.

The contrast to what is happening at the federal level is stark, according to Climate Action Tracker. Although Australia committed to a 26–28% cut in greenhouse gas emissions by 2030 compared with a 2005 baseline in the Paris Agreement, Climate Action Tracker said the government in Canberra was not doing anything to change course, continuing to rely on coal for energy and downplaying renewable energy.

Fears that South Australia might do a U-turn on the transition rose in March after the Labor government of Jay Weatherill was unseated in state elections. The new Liberal premier, Steven Marshall, told reporters that a plan to install batteries in 50,000 homes, creating the world’s biggest virtual power plant, “is not part of our agenda”.

Other signals from the new government, however, have been more reassuring.
“The transition is under way, and the transition will continue,” the new energy minister, Dan van Holst Pellekaan, told the Australian Energy Storage Conference in Adelaide in May, assuring his listeners that the Liberal government would mean more batteries, not less.

“South Australia will lead and show the world how a sensible transition can be done,” he said.

Professor John Spoehr, who is pro vice-chancellor overseeing research impact at Flinders University in Adelaide, believes the momentum surrounding renewables in South Australia is now unstoppable.

Spoehr, who is also director of the Australian Industrial Transformation Institute, said the state will remain a global renewables showcase.

“Battery storage has added much-needed stability to the system ... South Australia is now well-positioned to be one of the world’s leading test beds for renewable energy technologies,” said Spoehr.

“We can derive both a price reduction dividend and an industry development dividend from rapid adoption of renewables.”

South Australia’s only coal-fired power station closed in Port Augusta in May 2016. Four months later a powerful storm took down powerlines, blacking out most of the state.

In the face of fierce criticism from the federal government, the state declared it would spend up to A$500m to reclaim control of South Australia’s energy supply. It would install the world’s biggest battery, set up its own diesel generator back-up station and give the green light to a 150 megawatt (MW) solar thermal power station near Port Augusta.

Tesla won the tender to provide the 100MW battery, and the government then announced that it would provide 5 kilowatt (kW) solar panels and 13.5 kilowatt hours (kWh) of Tesla Powerwall batteries for up to 50,000 homes, with the first 1,100 installed free in Housing Trust homes (equivalent to social housing).

Van Holst Pellekaan has not ruled out continuing with Labor’s 50,000 target, but said this would depend on the success of the initial stages and the provision of private finance.
Meanwhile AGL Energy is continuing to extend Australia’s largest existing virtual power plant (VPP), aiming to connect 1,000 homes in Adelaide by the end of the year.

The company has offered participating households the opportunity to upgrade their battery systems to the latest technology from Tesla, SolarEdge and LG Chem. An AGL spokesperson said the response has been “overwhelmingly positive”.

The spokesman added that the total capacity will depend on the mix of hardware that makes up the final 1,000 batteries but the energy storage system output would be rated at a peak 5MW with a minimum of 10 megawatt hours (MWh) of storage capacity.

He added that the results of the trial would be shared with the Australian Renewable Energy Agency (Arena) and the industry.

“We expect VPPs comprising a range of distributed energy resources will become common across the National Electricity Market [the grid that covers eastern and southern Australian states] in the future,” the AGL spokesman said.

Tesla’s giant lithium ion battery, instigated by the previous Weatherill government, has been officially operating since 1 December last year and has already proved itself. When the Loy Yang power station in the neighbouring state of Victoria suddenly went off line less than a month after it was commissioned, the battery delivered 100MW into the national electricity grid in 140 milliseconds.

Once mocked by conservatives in Canberra, Australia’s capital, as too small, and about as much use as a big banana, no one is sneering at the battery any more.

It responds so quickly to a surge in demand that it beats traditional generators to the punch when prices start rising. The game of holding back supply until prices reach astronomical levels doesn’t really work.

The battery is owned and operated by the French company Neoen, at its Hornsdale wind farm, 200 km north of Adelaide. The state government has the right to some 30% of the power if required for grid stability.

But Tesla’s big battery is far from the only one in town.
On the Yorke Peninsula, an A$30m 30MW/8MWh battery is expected to be fully operational next month. Built by South Australia’s power network provider ElectraNet, and operated by AGL, the battery will help ensure grid stability, but it will also keep the lights on during an outage in its own area.

Meanwhile, GFG Alliance, an integrated mining, metals and energy group run by British billionaire Sanjeev Gupta, is planning to use a combination of solar, pumped hydro and energy storage to power its Whyalla steelworks, which it recently rescued from closure.

GFG, which took a majority stake in Zen Energy last year, has also struck eight-year deals to provide power to five other major South Australian mining companies, promising to cut their bills by 50%. Its new lithium ion battery, to be built near Port Augusta at the top of the peninsula, is expected to be a 120MW/140MWh facility.

Some 30km north of Port Augusta, US-based SolarReserve is pressing ahead with the Aurora solar thermal power plant, which was given the nod by the Weatherill government in August last year.

It will be Australia’s largest solar thermal plant, generating more than 500 gigawatt hours (GWh) of baseload power annually. Its molten salt storage is said to have a 40-year life, and will have the capacity to pump out a full load for up to eight hours.

Aurora received a major boost recently from one of Australia’s biggest mining companies, the Adelaide-based OZ Minerals. OZ and SolarReserve are to share the operational costs of 35km of a new transmission line to run, via the solar thermal plant, to OZ Minerals’ Prominent Hill and Carrapateena mines in the state’s north.

Just south of Port Augusta, Sundrop Farms is using solar power to grow tomatoes in greenhouses on degraded land. Its concentrated solar tower also powers a thermal desalination plant so that seawater can be used for irrigation. Sundrop now grows 15m kilograms of tomatoes a year.

Port Augusta’s mayor, Sam Johnson, says: “The closure of the coal-fired power station was a A$168m blow to the local economy, but it also brought to fruition the need to change, and market forces have come together to make it happen.”

Little wonder Professor Spoehr believes the energy transition is unstoppable.
How microgrids are bringing green power to the people

Microgrids could give millions of people access to power, while also transforming national grids globally. Mike Scott reports on the new technology offering cheap, reliable, low-carbon energy

Type the word “microgrids” into a search engine and two stories sit next to each other. The first, from MIT Technology Review, is headlined How Solar-Based Microgrids Could Bring Power to Millions, and highlights the potential of microgrids to provide power to 1.5 billion people, many of them in remote areas in the developing world; the second, in Scientific American, proclaims A Microgrid Grows in Brooklyn.

The latter article outlines how a start-up company called LO3 Energy is helping owners of solar panels in a New York community sell surplus energy to their neighbours who want to use more green energy, rather than having to sell it (at cost) to the local utility.

The juxtaposition of the two stories is a neat illustration of how this nascent technology could provide the solution to a host of challenges in both the developed world and across emerging markets.

“The world is becoming more and more electric,” says Matthieu Mounier, head of the microgrid business at Schneider Electric. “In places such as Africa and South East Asia, microgrids can help provide access to energy to people with no power, while in developed countries, electricity will be a bigger part of the energy mix thanks to the growth in the number of electric vehicles.”
“At the same time, we are completely changing the way we produce that electricity. It will be a lot more distributed and decentralized, and it will be provided by renewable energy, which is the cheapest, fastest way to provide power now.”

However, because much of the electricity will be from renewable sources – mainly wind and solar photovoltaic – it will be more intermittent. The rapid development of energy storage will help to integrate these energy sources into the existing power network. The costs of energy storage are falling rapidly as technology advances and capacity increases, but storage alone will not be enough to enable the fully decarbonized energy system that we need to meet our climate change targets.

“The microgrid is one of the key technologies to enable the integration of these renewable sources and to provide cheap, reliable, low-carbon electricity,” Mounier says. It has the additional benefit of making grids more resilient – a factor much on the minds of the power industry, regulators and policymakers in the wake of recent high-profile disasters such as hurricanes Harvey, Irma and Maria in the US, as well as hugely damaging typhoons in Asia such as Haiyan, which devastated large parts of the Philippines in 2013.

The potential of the market is huge: Navigant Research says that more than $100bn will be spent on microgrids over the next decade, up from next to nothing today. Already the sector is attracting investors such as private equity giant The Carlyle Group, which has allocated an initial $500m.

In their simplest form, microgrids have been around for decades in the form of isolated communities producing their own electricity using generators, and facilities keeping back-up power in case the grid goes down. But the future microgrid is likely to contain renewable energy assets, some kind of energy storage and possibly diesel gensets to supplement the clean energy capacity. Unless they are isolated “islanded” grids, they will also use “smart” features such as fast switching between grid and storage, and controlling the generation mix according to the balance of supply and demand on the network.

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In their simplest form, microgrids have been around for decades in the form of isolated communities producing their own electricity using generators, and industrial facilities and essential infrastructure having their own back-up power in case the grid goes down. But the future microgrid is likely to contain renewable energy assets, some kind of energy storage and possibly diesel gensets to supplement the clean energy capacity. Unless they are isolated “islanded” grids, they will also use “smart” features such as fast switching between grid and storage, and controlling the generation mix according to the balance of supply and demand on the network.
advanced analytics and the ability to feed power into and withdraw power from the grid network. Blockchain technology, which is an integral part of LO3’s Brooklyn microgrid, may be used to keep track of and verify what power is being produced and consumed and by whom.

While the potential is huge, the market is still in its infancy, with many companies experimenting with how best to integrate different assets into microgrids and the microgrids themselves into larger networks.

One such project is being carried out in Oxford, England, by UK firm Moixa. The company has equipped 89 homes, many of which have solar panels on their roofs, with its smart batteries. Using a software platform that integrates different energy sources and storage devices, the company can “change the flow of energy into or out of the batteries to deliver savings”, says Ed Gunn, operations director.

“The value of the microgrid to the consumer is that it reduces the requirement to buy energy from a mainstream supplier, which leads to lower bills,” he adds. “Customers can look at our apps and see what energy they are consuming and where it’s coming from. They can see where their peaks and troughs in supply and demand are and adapt their consumption patterns accordingly.”

At the same time, microgrids that are connected to the distribution network can enable distribution network operators (DNOs) or distribution system operators (DSOs) to balance their grids by feeding power into the network or taking it out to be stored in batteries as the network requires.

Another Moixa pilot scheme, in Barnsley, links 40 home batteries. The company says this will demonstrate how virtual power plants can relieve pressures on the electricity network and enable more homes to install solar panels without having to upgrade the local network. The project is expected to halve residents’ energy bills and save millions in the costs of running the UK’s power network. In total, Moxia is delivering 10 projects this year ranging from peer-to-community, electric vehicle smart charging and smart storage management.

One key driver for growth will be the increased focus in years to come on decarbonizing the heat and transport sectors, Gunn asserts. “The demands
that electric vehicles will place on local grids will be a massive challenge for DNOs to manage. Putting them in a microgrid is one way to head that off,” he adds.

The entry of deep-pocketed investors such as Carlyle is important because, although microgrids have very low operating costs once they are up and running, they require significant upfront investment, Mounier says. Schneider Electric is developing a microgrid-as-a-service model that removes the need for upfront investment from the customer, but Mounier says in developed markets there will be a mix of investor-owned microgrids, those owned by developers and those owned by end users. In emerging markets, however, he thinks new utilities will spring up that will own and operate microgrid assets.

The growth of the microgrid market will change the nature of national grids, he adds. “There is still a need for a national-level power network. It provides stability and strength to microgrids. But as an increasing number of microgrids become connected to the grid, it is changing the grid itself. In future, there will not be a national grid as we know it – it will be more of a grid of grids and the network operator will be in charge of ensuring consistency between them.”

Microgrids have the potential to answer many of the questions that the power sector will face in coming years, including how to incorporate more renewable energy into the system, how to shift energy demand from peak times, how to integrate electric vehicles into the system and how to store energy, both electrical and heat/cooling. However, the technology is ahead of regulators, legislation will be needed to make it easier for utilities to get involved.

There is understandable reluctance to embrace microgrids on the part of utilities, given that they will reduce the market for the power that they provide, but as Israeli and Danish researchers point out in a recent article in Renewable and Sustainable Energy Reviews: “Utilities are coming around to the view that they may be well positioned, if allowed by regulators, to provide microgrid services to their existing customers since they have extensive knowledge, distribution infrastructure already in place, and franchise rights from local authorities.”

Mike Scott is a former Financial Times journalist who is now a freelance writer specialising in business and sustainability. He has written for The Guardian, the Daily Telegraph, The Times, Forbes, Fortune and Bloomberg.
Overcoming barriers to minigrids key to India’s solar mission

Microgrids are seen as a crucial instrument to provide electricity to millions of people in India who currently lack access to power, says Atul Mudaliar, India programme manager at the Climate Group. “Currently, there are about 200 million people who don’t have access to grid electricity.”

Prime Minister Narendra Modi who was elected in 2014, promised to provide access to electricity to all of the 18,000-plus villages without power and in April this year announced the target had been reached. But the definition of electrification is that at least 10% of houses and public places such as schools and health centres in the village have power, Mudaliar explains. “Just because a village has been electrified, it doesn’t mean that all houses are connected and can get access to the power that they need,” he says.

Microgrids, also known as minigrids in India, are a key part of the campaign to bring power to people living in rural areas, millions of whom lack access to electricity. The government announced an ambition to install about 10,000 minigrids – so-called because they have an element of infrastructure attached to them rather than just being single devices such as solar lamps – with an aggregate capacity of 500 megawatts (MW) by 2022. “Although there is no accurate count of projects installed in the country, the Clean Energy Access Network estimates that more than 14,000 systems have been installed”, says Mudaliar.

There are a number of barriers to India achieving full electrification, including the fact that rural customers are not a priority for the nation’s utilities because they are heavily subsidized and different states have different policies.

In addition, microgrids are only allowed to operate where the grid has not yet reached, meaning that as villages get grid access, even if it is only partial, their opportunities are limited. And because the minigrids are operated by private companies, their costs are higher than the subsidized power provided through the grid by the large utilities and distribution companies.

Finally, there is suspicion from the distribution companies, which are already losing customers to rooftop solar schemes in the big cities and fear the challenge of dealing with
thousands of microgrids if they were to be brought under the regulatory purview and integrated with the grid. “There is a lot of pushback from the distribution companies not to have rooftop solar connected to the grid. They are creating hurdles,” Mudaliar says.

However, at the same time, the distribution companies are losing a great deal of money because of technical and “commercial” losses (or theft of power) and they are under pressure from both the central government and the states to make the grid more resilient. Proponents of decentralized renewable energy are highlighting the potential for microgrids to help reduce losses by giving control of the supply to local people.

“There are moves to see if minigrids can be connected to the grid and operators can start to act as agents for the network,” Mudaliar adds. “A couple of states have introduced regulation, including Uttar Pradesh, which introduced rules in 2016.”

Minigrid operators have a number of options in this situation – they can work in parallel to the grid, connect their assets to the grid, making them eligible for feed-in tariffs, or sell their assets to the distribution companies.

Many of the companies involved in the sector are social entrepreneurs, often backed by philanthropic institutions, that are focused on increasing access to electricity because providing power to people opens up economic development in remote areas and helps people stay in their communities rather than move to the city to find work. While the social entrepreneur model has been very successful in the initial stages of the minigrid rollout, the sector needs to become more commercial if it is to scale up, says Mudaliar.

“We are working very closely with the finance companies to see what their level of understanding is of these products and what they need to be comfortable funding them. For funding to increase, it’s important that business models move to focus more on making a profit,” he adds.

This should be entirely feasible. “These are essentially infrastructure assets with returns over 10-15 years,” he concludes.

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