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Solar PV+

Insight from Simon Currie

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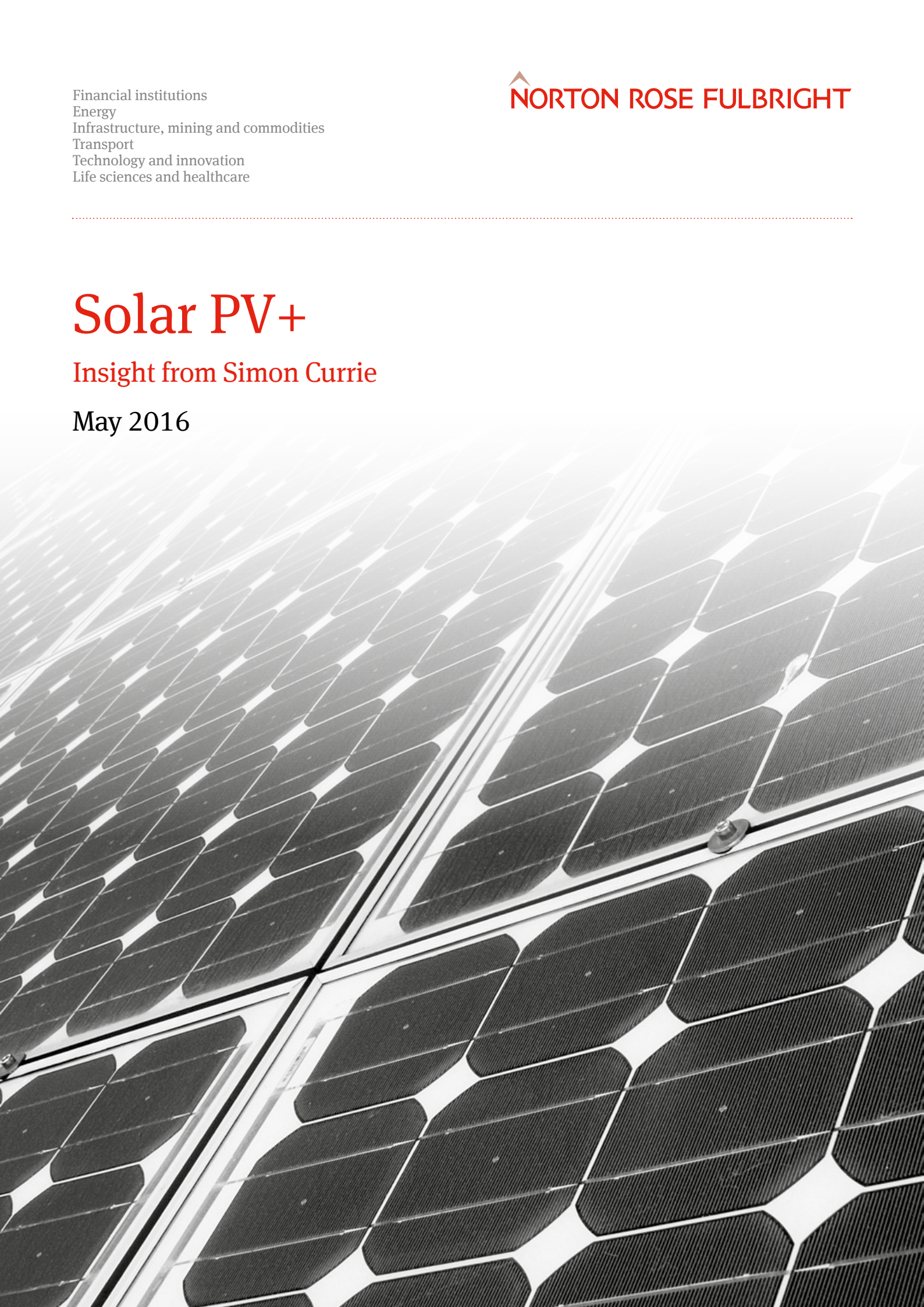

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Introduction

We are standing at the dawn of a new era. Over the last 10 years, the solar PV industry has defied the sceptics and has gone from being a cottage industry to a major disrupter to all traditional energy sources.

Large scale solar PV is now competitive in many different scenarios and markets. The latest pricing signals from the Dubai 800MW tender are stunning - US$0.0299c/kwh was the lowest bid. It was only two (2) years ago when a bid under US$0.10c/kwh was seen as unsustainably low and the market believed there must be hidden subsidies for the equity or debt.

At these levels solar PV isn't just competitive against the very best wind projects but, in many markets, it can now compete against existing coal-fired generation and that is without imposing carbon taxes or caps on emission levels.

So now the question turns from whether solar PV can compete to how we redesign our energy systems to make the most out of this technology and the inevitably high levels of deployment. We know solar PV has the potential to be successfully applied in many more places around the world than wind, hydro and most other renewable energy technologies; however, the sun doesn't shine all day anywhere and, even when it is sunny most of the time, clouds have a habit of creeping across the sky when we least expect them.

Solar PV+

What do we mean by 'Solar PV+'? We view solar PV+ as a system or a solution which delivers more than just AC or DC electricity. We will explore some of the obvious (and less obvious) alternatives to standalone solar PV. Solar PV+ is the idea of utilising solar PV in a number of varying and innovative ways by integrating it with other technologies or deploying solar PV in non-traditional ways (Solar PV+) and this article is intended to offer some 'food for thought' and demonstrate the adaptability of solar PV.

Solar PV + battery storage

Solar PV + battery storage is hardly an innovative solution. Many companies have already come out with products which provide different solutions for industry and remote communities. The potential for combining batteries with solar PV has been picked up by many of the developers. Some developers, such as RES, have started with standalone battery systems in the US and have now started to look at deploying solar PV/battery systems. Companies such as Neoen, Juwi and EDL have built systems designed for remote, off-grid mining sites and major suppliers such as ABB, Siemens and GE all have an integrated offering of products.

Large scale solar PV projects are being developed with associated batteries which have the advantage of allowing solar PV owners to shape generation profile to meet demand, reduce peak network demand and increase voltage control. However, integrating solar PV and storage creates the inevitable regulatory challenges we often see when traditional systems are challenged by new technology. Regulations and (the lack of) market rules create uncertainty, which places additional burden on the early projects. For example, in the US the Federal Energy Regulatory Commission may consider a storage project to be a generator, but at state level they may classify that same project as transmission or distribution. It is regulatory dilemmas like this that we will continue to encounter as we grapple with integrating battery storage into a regulatory regime where network operators have not yet developed the technical standards to address the issues of connecting batteries to the system.

The costs of batteries aren't falling at the same rate as solar PV. However, the overall system costs continue to fall and we believe this is helping to make the battery storage option increasingly viable.

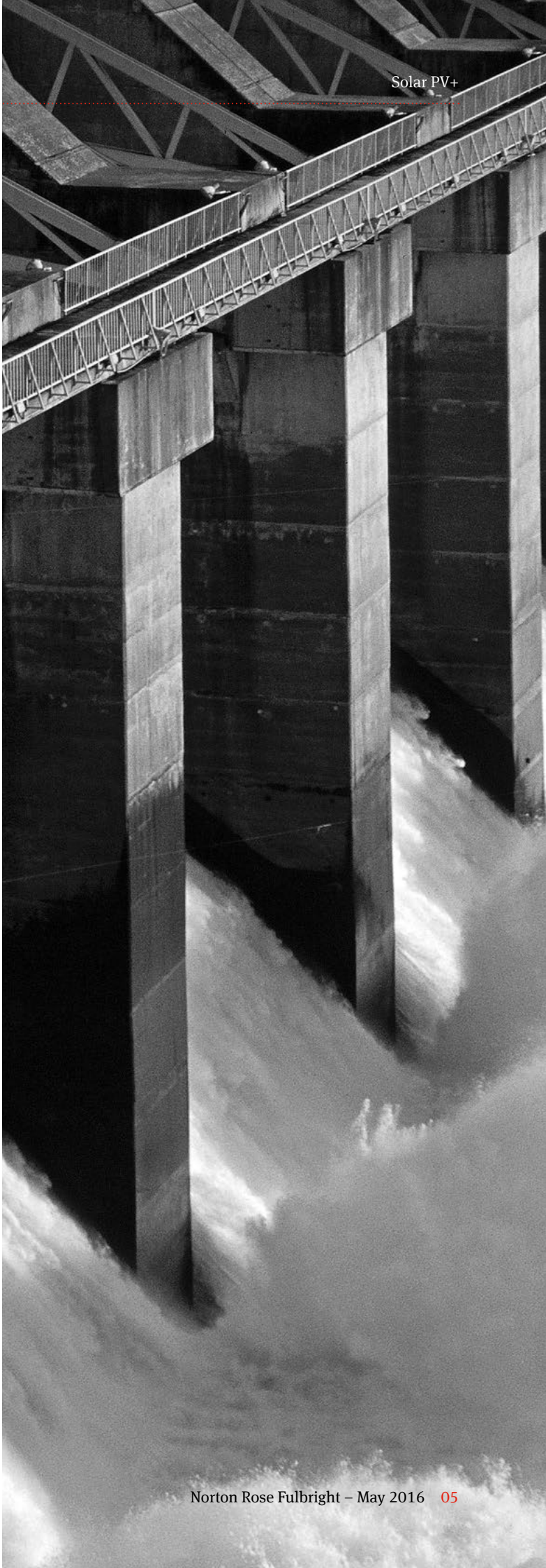
For more information on the regulatory challenges associated with integrating solar PV and storage, please see our recent article 'Energy Storage Projects – A Global Overview' published in Project Finance International.

Solar PV + Hydropower

Hydropower is all about making the most effective use of the available water resources. If you look across the global hydropower fleet you will find a number of projects which are running at low capacity levels because of water shortage or the need to divert water for alternative uses.

In countries like Norway, they have pioneered the combination of wind and hydro power in order to maximise the value of the wind and water resources. The same principles apply to combining solar PV with hydropower projects. This can be done on a physical basis with solar PV being sited close to the Hydroelectric Power Project (HEPP). Alternatively, we are seeing owners of large scale HEPPs starting to develop solar PV projects which are connected to the same grid system or power pool but not located close to the existing HEPP. The owner will then dispatch the HEPP taking into account the production from the solar PV project. This helps save the precious water to meet peak demand system support requirements.

In some markets the impetus is provided by the renewable certificate regime as existing hydropower projects may not be eligible to receive such certificates. This hampers the ability of owners of large scale HEPPs to enter the retail and wholesale markets and compete with other utilities who may, for example, own wind and solar facilities alongside flexible thermal generation.



Solar PV + Water

As you fly into Heathrow airport from the north you come over the Queen Elizabeth II (QE II) reservoir, one of the main sources of drinking water for London. If you look carefully you will see one of the first large scale floating solar PV projects in the UK. This project was financed on a project finance basis as part of a portfolio of projects developed by Lightsource Renewable Energy.

Floating PV is not just about finding areas of land which are effectively sterilised from other development (like a city supply of water) and covering it with solar panels. Floating PV can bring a number of benefits to water sources.

Water reservoirs are faced with a range of challenges. These include the rates of evaporation (which can make a huge difference in sunbelt countries) and the impact of algal bloom and weeds. One of the ways to address these issue has been to invest in relatively expensive covers for reservoirs. However, Floating PV can ameliorate some of these issues. While you may not deploy Floating PV across an entire reservoir or system, it has been shown that Floating PV can improve evaporation rates and should reduce the risk of algae and weed affecting water quality.

There are a number of different technologies. Some of them are floating islands, others work on the basis of tethers and anchors.

It is important that that Floating PV should not be an expensive option. Some of the costs of ground mounted solar can be avoided, such as frames and foundations. This will help offset the added costs of constructing and operating in a new environment. It's not just a cost issue, Floating PV is simply an efficient use of space. The QE II Floating PV project covers only 6% of the reservoir and has no discerned impact on the ecosystem.

Solar PV + Desalination

Desalination is a costly, energy-intensive process that is usually powered by fossil fuel baseload plants. Some countries have already required renewable energy inputs in order to make the desalination process more sustainable. Solar powered water desalination has the potential to dramatically increase access to fresh water in many arid locations and we have seen 'desert projects' in places such as Chile and Saudi Arabia (where Advanced Water Technology commissioned one of the world's first large scale solar powered water desalination plants using 15 MW of solar PV built by Abengoa to provide much of its power needs).

Solar PV generation isn't always aligned to the load requirements of a desalination plant which may require baseload generation, but solar PV will now be one of the cheapest options in many places. When you think about countries like Namibia where there are limited supplies of potable water, a low population and a huge sunny non-arable land mass it seems sensible to look at using solar PV when developing a new desalination plant.

Solar PV + Wind

The regulators and the market have finally woken up. Why do we keep building expensive new grid connections to "nowhere" (our description of a wind farm with a low capacity factor) and not encourage developers to install solar PV next to the wind farm or somewhere along the route of the connection?

It won't be viable everywhere, but in many countries globally the energy yields from solar PV are relatively constant across the country, even if the wind resource is not.

This trend is also being encouraged by offtakers as they would much prefer to buy a block of power rather than just variable wind output. Installing solar PV doesn't magically transform a wind project into a base load generator but it looks a lot better than on a standalone basis. In many locations there is a very low risk of material constraints on output because of the lack of correlation between the wind and solar resources.

In order to properly incentivise developers to look at hybrid solutions, we suggest that grid companies should be encouraged to offer more attractive connection terms for such projects. Grid companies generally benefit from having the grid being used on a more regular basis across each day. In some markets there will be benefits already (such as incentives for generators within a local distribution grid).

Solar PV + CSP

Concentrated Solar Power (CSP) was long seen as a straight alternative to solar PV. If you wanted flexible generation and you have the right levels of sun, heat and weather conditions CSP is a possible option instead of solar PV. Some countries such as South Africa, Morocco, Israel and, in the past, the US and Spain have strongly encouraged the development of large scale CSP projects. Parabolic trough and tower technology is generally recognised as proven, and the LCOE of CSP has fallen. However, costs have not fallen anything like the cost of solar PV, and the cheapest projects in Morocco and South Africa remain materially higher than the latest solar PV costs. In a market like South Australia, where there are very high levels of wind penetration and declining levels of thermal generation, CSP may be a sensible way of providing flexible generation to help balance the system, even at costs above $1/kwh.

The next generation of projects will see solar PV + CSP on an integrated basis. There are already some sites in Spain and the US with solar PV and CSP but many of these grew organically rather than being designed as an integrated project from day one.

One of the drivers for integrated projects is better utilisation of scarce transmission resources in markets like South Africa. In 2016 we will see the Moroccan Agency for Solar Energy (Masen) bring the Noor Midelt project in Morocco to the market. This will require bidders to propose a 400MW solution combining solar PV with CSP which is expected to deliver energy at certain times and achieve the lowest overall tariff.

One of the practical issues with solar PV + CSP is the limited number of CSP developers. Large players include Engie, ACWA, Solar Reserve, Acciona and TSK, but some other competitors have exited the market. This means that you may not get the same levels of competition for an integrated project as you see for a straight solar PV project. However, we believe that integrated solar PV and CSP projects will prove to be one of the winners in a Solar PV+ world. This is because the LCOE of integrated projects will benefit from the falls in solar PV and you are combining traditional steam turbines which are proven heat collection systems with solar PV technology.

Solar PV + Pumped Storage Hydro

Pumped storage hydropower has been one of the principal methods of delivering flexible fast response generation in many developed markets. Generally PSH has involved large scale projects which are capable of providing electricity and system support services for the system as a whole. The water is pumped to the reservoir using electricity at off peak times and then made available when the system needs it the most. Currently well over 90% of the installed storage capacity globally is PSH.

The combination of renewable energy with PSH has taken off in recent years – with large scale projects developed in Spain and the US. One of the most high profile examples is the Kiddston solar PV + PSH being developed by Genex Power in an old gold mine in Australia. The solar PV project is located next to the proposed Kiddston PSH project which will be located in the old mine. Rather than build expensive reservoirs and tunnels in a hill (the conventional way of building large scale PSH), it will reuse the existing shaft of the mine. This concept may be replicable on a global basis and allow us to come up with innovative uses of existing depleted and closed mine sites. In the context of an open cast site it may be feasible to have solar PV suspended above the PSH reservoir rather than located adjacent to the mine. This is likely to increase costs when compared to a simple ground-mounted site but may be a sensible option when available land for solar PV is limited. Solar PV projects have also been successfully developed inside depleted mines or quarries (such as Lark Energy's project in Rutland County, UK). This demonstrates that solar PV can be an efficient tool to rehabilitate existing industrial sites.

Solar PV + Technology

It may sound confusing to talk about combining solar PV with technology. What we mean is how you can take basic solar PV systems and turn them into something which is more system friendly.

We strongly believe that the renewable energy industry needs to move towards self-help rather than being "dumb" and expecting the system to bear the costs of intermittency and the limitations of the resource.

Inverters are getting smarter. We are seeing inverters which can store energy for short periods of time and are responsive to market and system signals. You can't convert solar PV into spinning reserve overnight (or probably ever), but you can legitimately expect solar PV project owners and operators to invest in weather forecasting tools so they can accurately predict their output and reduce system costs.

This concept has been implemented in markets like Kenya where they are extremely concerned about the impact of wind and solar on their fragile grid system.

As solar PV system costs fall we expect that network operators and regulators will encourage greater investment in such technology and it will become a standard requirement in some markets.

Solar PV + Agriculture

It is very simple. Agriculture wouldn't exist without the sun. We now have the ability to integrate energy production into agricultural environments. Hopefully, we can do this without creating a food versus fuel debate like we have seen with biofuels.

Solar greenhouses are already deployed at scale in a number of countries. A new application is designing and installing hurricane resistant greenhouses on islands and in other hurricane struck areas. Akuo Energy has developed several of these projects in the French Caribbean.

Solar PV projects don't need to be developed in a way which sterilises farmland. As costs reduce and efficiencies increase you can incorporate solar PV into farms. In some cases farmers may take the decision to utilise some of their land to "farm" solar energy and ring fence that area. This could be done on a farm by farm basis or a more co-operative basis. In other cases farmers will look to maximise the use of fence lines, driveways, barns and other land.

There are other options we have seen which include elevated solar where farm animals can graze under panels or use them for shading and "zebra stripes" where rows of solar panels sit between crops.

Sustainable agriculture is one of the buzz words for agri-industry. If you are running a diesel generator and driving a diesel tractor this doesn't really seem like a long term sustainable option. We expect to see some producers trumpeting that they are not only organic but that the direct energy used in production is fossil fuel free. One way to achieve this is solar PV and Electric Vehicles (EVs).

Solar PV + EVs

Today you can't make an analysis of the electricity industry without thinking about the potential impact of EVs. Our view as to the potential roll-out of EVs is very similar to how we looked at solar PV a few years ago. It was a niche industry that was only going to appeal to 'greenies' or when it was heavily subsidised. Like many others we got that wrong.

We now believe some of the biggest drivers behind EV penetration will be countries choosing to go fossil fuel free. This has already started in countries like The Netherlands and we are increasingly seeing public transport turn to electricity. Companies such as Tesla and BYD continue roll out new and improved EVs and global orders continue to rise.

We expect that there will be a growing trend towards electric scooters in emerging markets. This isn't just about moving from fossil fuels but is also about environmental quality and noise pollution concerns.

Solar PV + EVs is one of the areas where rooftop solar (at a household, district and commercial level) comes together. Microgrids are being promoted from the grass roots and top down (such as the New York Reforming the Energy Vision). The idea that you charge your neighbours' car while you are at work is no longer a pipe dream. How you get paid for this and whether the laws permit you to do this is another matter. As we move towards a new energy ecosystem, utilities and regulators will need to accept that the current rules need to be adapted to accommodate new technology and meet the expectations of the systems users. A good example is the news that Transgrid (an Australian transmission operator) is investing in automated demand response and exploring how solar PV+ EVs can assist in meeting peak load requirements.

Solar PV + what next?

We are at the beginning of the solar age.

There is a lot of potential for greater efficiencies in the conversion of irradiation into electricity. The improvements in efficiencies have already been very significant but don't yet match what we have seen in other industries like microprocessors.

One of the issues being discussed at an industry level is whether we need to keep converting from DC to AC. There will be obstacles, but as we move towards an electricity system which is fit for the future it is one of the debates we need to have.

There will be costs and failures as we transition away from fossil fuels towards a lower carbon energy system. We won't get the technology or the business model right every time. Regulators will move too slowly and then over-react - as we have seen with solar subsidies in the last decade.

Citibank produced a report in late 2015 titled "Why a low carbon future doesn't need to cost the earth". Solar PV+ will be part of our future and we are certain that it won't cost that much at all.

Contacts

If you would like further information please contact:

Simon Currie
Global Head of Energy
Sydney
+61 2 9330 8236
simon.currie@nortonrosefulbright.com

NORTON ROSE FULBRIGHT

Law around the world
nortonrosefulbright.com