Capturing the sun

The economics of solar investment

Building a better working world

Despite the environmental benefits, economic factors are the most important drivers of growing solar investment.

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Executive summary

Solar photovoltaic (PV) energy is widely recognized as a crucial component in addressing our worldwide need for secure, affordable and renewable energy.

With many countries reliant on costly energy imports and unsustainable fossil fuels, investment in renewables is now double that of coal and gas combined.[1] Solar PV global capacity continues to rise exponentially and has made staggering progress in the last two decades. In recent years, investment in renewables has often outperformed traditional energy stocks, and this is set to continue – with PV, alongside onshore wind, set to "win the cost race" and become our cheapest energy option by 2020.[2]

Despite these trends, many investors still view PV as a niche investment shaped by ecological rather than financial criteria. In reality, economic and environmental factors are rapidly creating a new set of mainstream investment opportunities in renewable energy. Solar investment is advancing quickly, with more PV capacity installed between 2010 and 2014 than in the previous 40 years. A record US$329b was invested in global renewable energy in 2015, up from US$62b in 2004. Moreover, solar assets accounted for 49% (or US$161b) of 2015's total.[3]

The growth of solar investment seems certain to continue. Bloomberg New Energy Finance (BNEF) forecasts that renewables will account for around 65% of an estimated US$12.2t investment in all forms of energy generation between now and 2040. Over the same period, PV is expected to jump from 2% of installed global generation capacity to around 26% – more than any other source. Deutsche Bank expects PV electricity to achieve "grid parity" (when alternative energy sources can generate power at a levelized cost of electricity (LCOE) less than or equal to the price of the existing electricity grid) in up to 80% of global markets within two years.

This paper highlights the economic factors catapulting solar to the forefront of the global energy revolution. Solar investments share many features of other real assets, and boast a number of unique characteristics that make them especially attractive to capital providers. Of course, these assets are not without risks, illustrated by the underperformance of some companies and the occasionally uneven retreat of subsidies. However, these challenges have been exaggerated and solar looks poised to become one of the major investment themes of the next 10 to 20 years.

Many institutions and major investors are still only dabbling in this market, with solar assets typically representing less than 1% of total allocations. It is time for investors to revisit their attitudes to PV, engage with solar companies and other stakeholders, develop their understanding, and see solar as a distinct and growing element of mainstream asset allocation.

1 Martinot, E. *Renewables 2006 global status report. REN21 Renewable Energy Policy Network*. 2016.

2 Bloomberg New Energy Finance, *Global Trends in Renewable Energy Investment*. 2016

3 Bloomberg New Energy Finance, *Global Trends in Renewable Energy Investment*. 2016

What about the economics?

Despite the environmental benefits, economic factors are the most important drivers of growing solar investment.

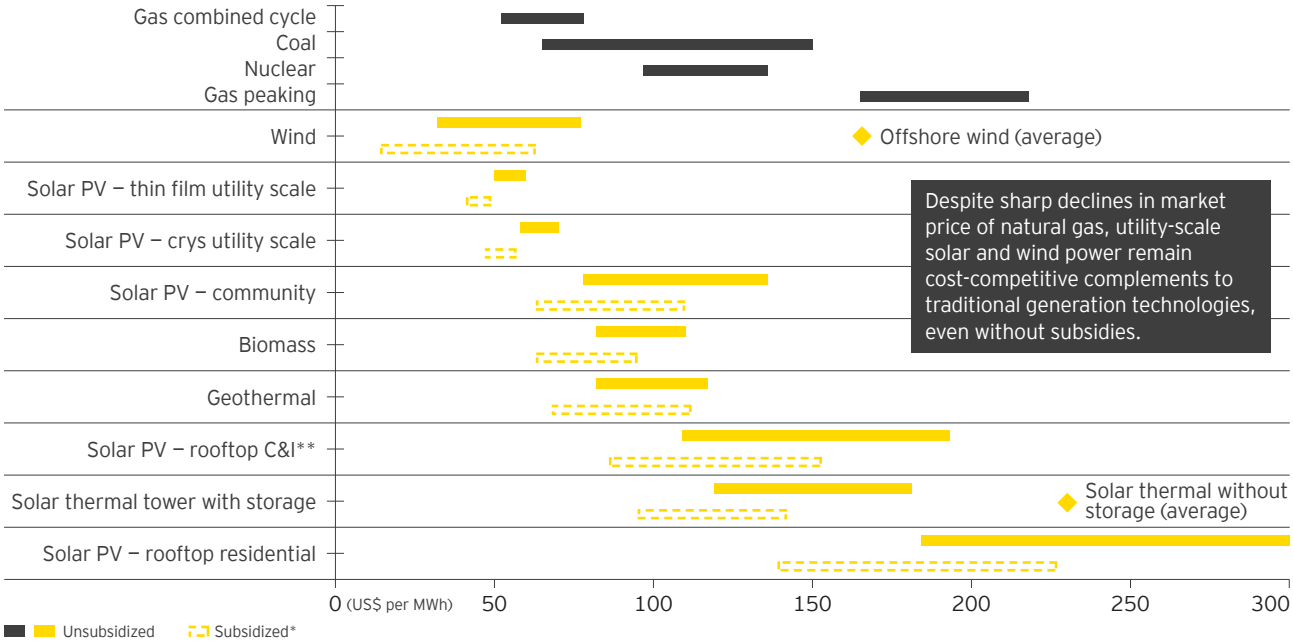
In particular, utility scale PV (the large-scale use of PV solar panels to generate electricity) is fast becoming one of the most cost-effective sources of energy in a growing range of markets.

Solar generation costs have undergone a stunning decline over the past decade, fuelled by an explosion in PV cell output. Driven by Chinese manufacturing, global cell production increased from 50MW in 2004 to 55GW in 2015 – more than a 500-fold increase. As a result, average solar PV system costs have plummeted by 82% in the last six years alone.

In some markets, average levelized costs[4] of solar applications are already low enough to compete with conventional energy on an unsubsidized basis. Solar and onshore wind are rapidly reaching grid parity with conventional fuels (see Figure 1). Australia, Morocco, Chile, Brazil and India are just some of the countries now delivering record low unsubsidized solar tariffs that outcompete their fossil fuel equivalents. State projects supporting grid parity are also emerging in the UK, Italy, China and some US states. In June 2016, Dubai agreed to a bid for 200MW of solar at 2.99 US cents, the lowest figure ever recorded globally.

This continuing slide in costs means that solar is entering a new investment era. Instead of chasing preferential subsidies, developers and investors can now evaluate these assets on a standalone, purely commercial basis.

Figure 1: Levelized cost of energy range by technology (US$ per MWh)

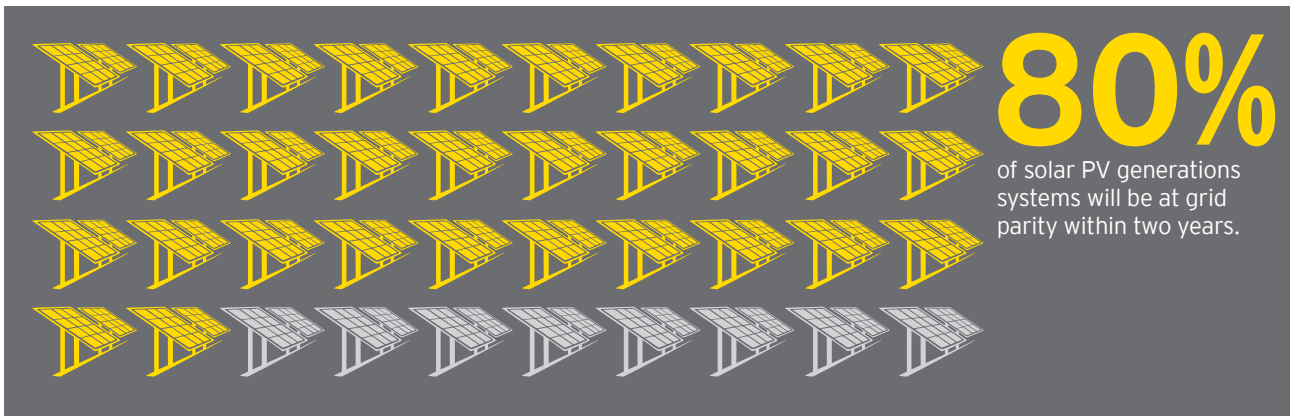


* This assumes US$23 per MWh wind PTC (production tax credit) and 30% solar ITC (investment tax credit), given an eligibility window through to end of 2016. More detailed subsidy assumptions and alternative scenarios provided in Lazard's levelized cost of energy analysis – version 9.0

** Cost and installation

Source: EY analysis of Lazard data

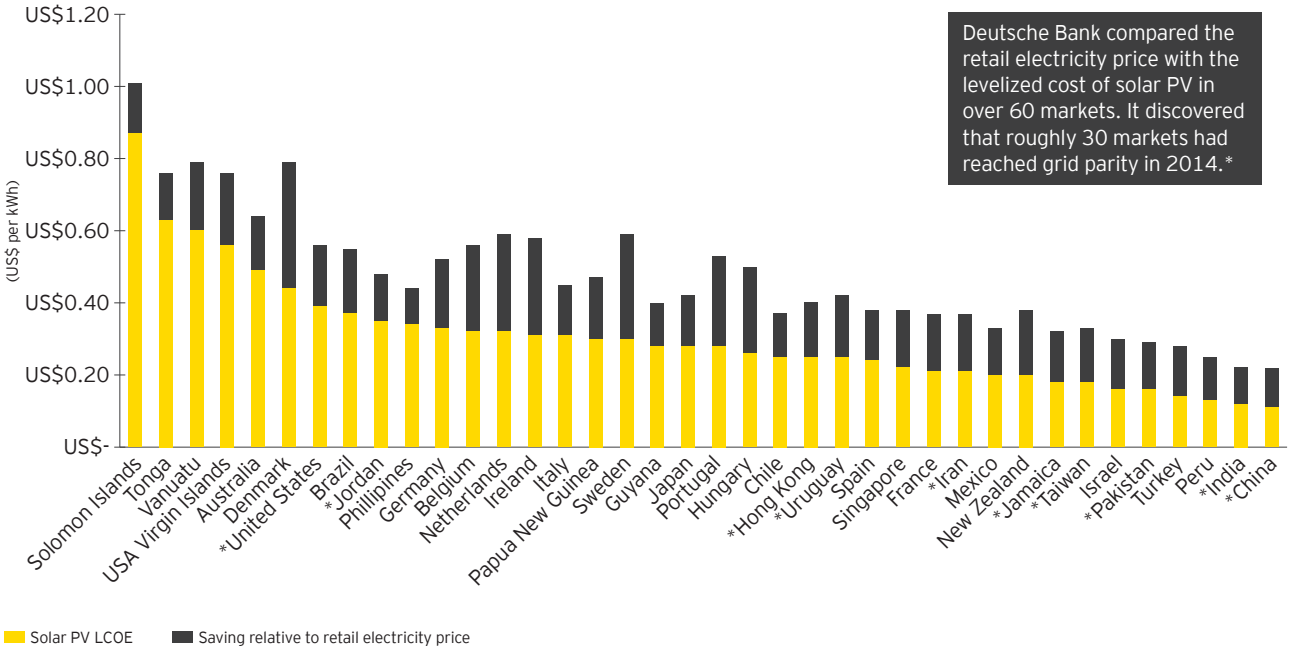
4 LCOE is the present value of costs per unit of electricity of building and operating a generating plant over an assumed financial life and duty cycle. It typically includes capital costs, fuel costs, fixed and variable operations and maintenance costs, financing costs, and sometimes an assumed utilization rate for each plant type.



Going forward, rising grid-based electricity prices and the likelihood of further reductions in solar PV module costs mean that many analysts expect solar to be able to outcompete conventional energy sources in most markets within a decade. A 2015 report by Deutsche Bank predicts that solar PV generation systems will be at grid parity in up to 80% of the global market within two years (see Figure 2).

Technological developments are close to creating a tipping point in the energy industry, with off-grid PV solutions set to revolutionize the utility industry, enabling residential and business consumers to install their own systems. Alongside this, utility scale installations are growing to 100MW, 800MW and further. There is no limit to the size except land area required, meaning that they will soon be comparable to conventional generation plants. Finally, the PV industry to set to go through further consolidation and changes in future – there remains a glut of panel supply, the finances of many companies are under strain, with tender prices and feed in tariff regimes decreasing, margins are getting smaller and economies of scale are increasingly important. In terms of opportunities, some markets are maturing and new ones are appearing often in different forms.

Figure 2: Average levelized cost of solar relative to retail electricity price by country



Source: Deutsche Bank, *Solar grid parity in a low oil price era,* 2015
*Against the highest local rates
Solar PV LCOE: levelized costs of solar photo voltaic energy

Why should you invest in solar assets?

The rapidly increasing cost-competitiveness of solar energy is creating attractive opportunities for capital providers interested in infrastructure investment.

Alongside this cost-competitiveness solar technology has four characteristics which sets it apart from other renewable and traditional energy assets.

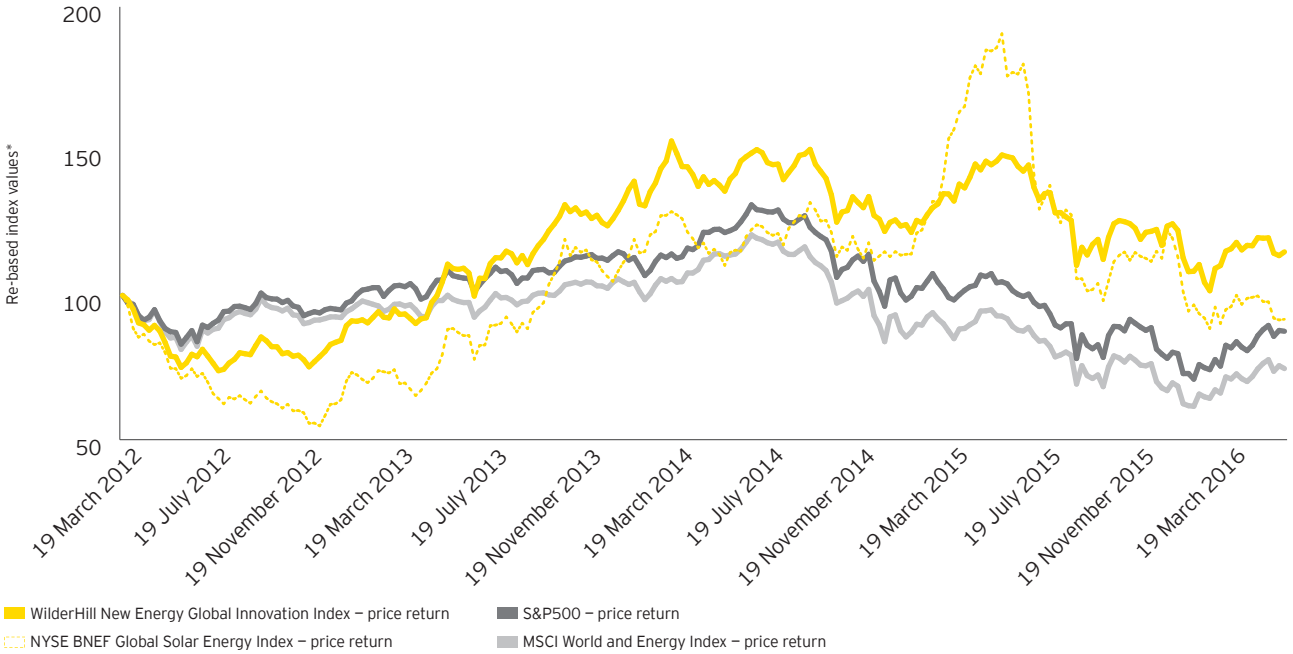
Similar to other renewables, solar investments are typically backed by real assets. These offer predictable, long-term, inflation-linked revenues supported by power purchase agreements. A large scale PV or onshore wind project will usually have an economic life of 20 years and a productive life of 25-35 years, with potential for repowering. Current investors include pension funds who are looking for different asset classes which can provide stable and reliable returns, companies looking at going 100% renewable and individual consumers interested in switching to green sources and installing own home systems.

Reasons to invest in solar can be categorised into the following: operational, scalability and financial:

Operational:
Solar investments have a number of unique operational characteristics, resulting in both risk and cost benefits for investors:

- Lower resource risk, since the predictability of solar irradiation is typically higher than wind speeds or rainfall. This allows for more confident output forecasts.
- Lower technology risk, since most solar systems are electronic not mechanical, with few moving parts and limited reliance on component inputs.

Figure 3: Performance of renewable and solar indices versus energy index and S&P 500, March 2012 to May 2016



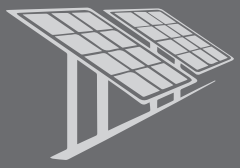
*Re-based 19 March 2016 index values to 100 for all indices

Source: Capiq

Unique characteristics for solar investments

Lower resource risk

Correspondingly lower operating and maintenance cost



Lower technology risk

Shorter construction lead times

- Correspondingly lower operating and maintenance costs, often bolstered by comparatively easy access to solar installations.
- Shorter construction lead times, given that many solar installations can be deployed in months compared to years for comparable scale wind projects.

Scalability:
The unique scalability of solar is another attractive investment feature, both in terms of the asset itself, but also the potential levels of investment and profit.

Solar assets can be sited on ground or rooftop, at utility, commercial or residential scale. That means they can be located near to where energy is required, reducing the costs of transmission and distribution infrastructure maintenance. Planning restrictions are often less onerous than for other renewables, since solar installations are often added to existing infrastructure. These factors create a wide range of "off-grid" investment opportunities, such as the commercial use of solar to power factories, offices or datacenters.

Solar has significant scope for technological improvements. This is in addition to the further reductions in PV module costs already predicted by analysts.

- Continuing investment in R&D by PV manufacturers will result in enhancements to the efficiency, durability and flexibility of PV technology.
- The natural variability of solar output is stimulating the development of 'smart' infrastructure such as microgrids and intelligent energy management systems. Innovations like these are creating new investment opportunities. A recent EY paper suggested that microgrids could allow commercial users in twenty countries to achieve total annual energy savings of US$64b-US$171b by 2020.[5]
- Developments in battery technology, and lithium ion (LI) batteries in particular, could give an additional boost to solar PV capacity growth. Technology companies' investments in R&D and large-scale manufacturing is widely expected to drive LI costs down a PV-like curve over the next five years.

The significant volume of capital already flowing into solar investments provides the most compelling evidence that solar is no longer just a niche market. Recent years have seen around US$750b of investment, creating more than 200GW of solar capacity. A growing number of pension funds, sovereign wealth funds, local authorities and insurers are getting comfortable with solar assets. Investment managers are setting up their own infrastructure funds and even investing directly in specific projects. In the UK alone, the first quarter of 2016 has seen solar installations acquired by a Danish pension fund, a German insurer and a global investment manager.

The march towards grid parity and the investment features we have outlined are galvanizing ever-increasing investment. BNEF forecasts US$3.7t of investment in solar energy alone between 2015 and 2040, with the resulting capacity of around 3,500GW – equivalent to as much as 35% of all new global generation capacity during the period – split evenly between utility-scale and small-scale installations.

Financial:
Historic performance data shows that these characteristics can deliver attractive returns, with key renewable and solar indices outperforming broader market and traditional energy stocks over the past four years (see Figure 3). Meanwhile, recent research suggests that solar investments have the potential to generate average annual expected returns on investment of between 6.6% and 10.1% over the next 35 years, depending on the scenario, ranging from transformation (ambitious climate change mitigation action) to fragmentation (limited climate action).[6]

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5 EY, *Will Microgrids be utility killers or saviors.* 2015

6 Mercer LLC, *Investing in a time of climate change.* 2015

What are the key entry points?

The activities of the solar industry span research, manufacturing, construction, installation and maintenance.

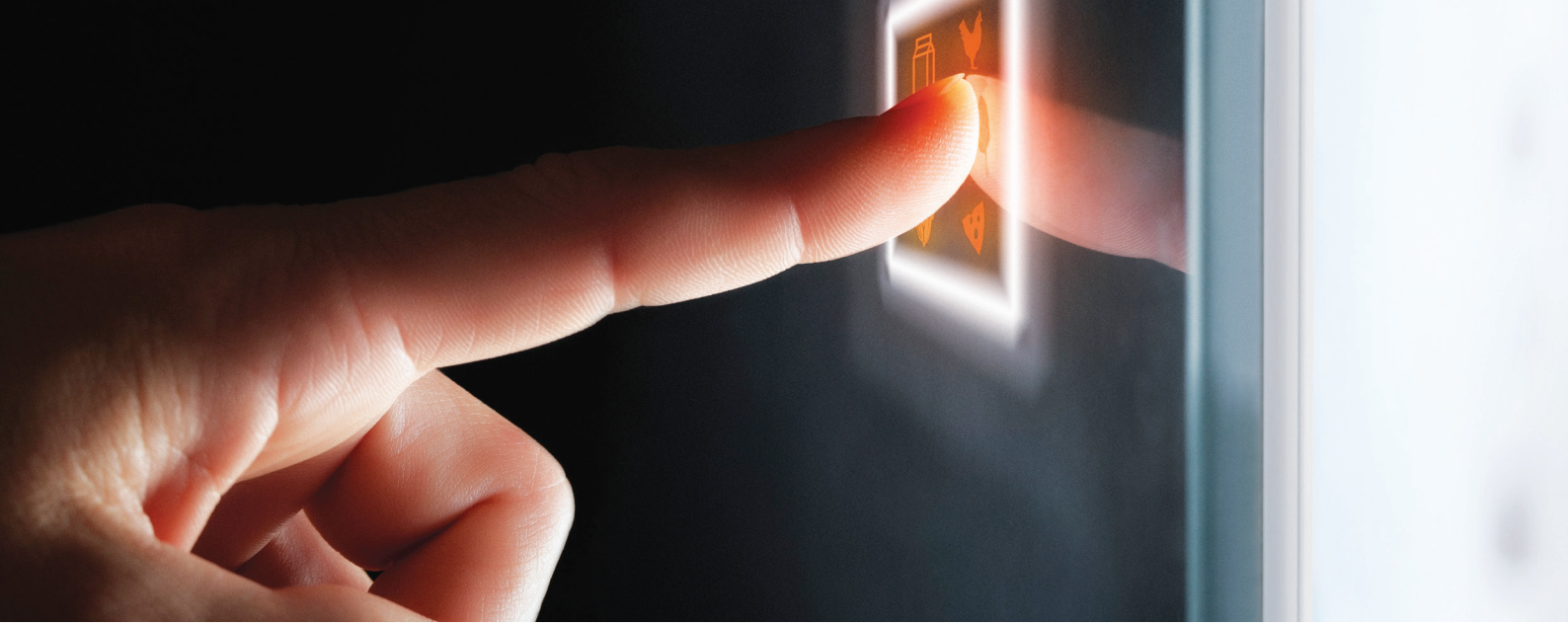
Technological advances in solar generation, storage and smart infrastructure should give venture capital and private equity investors some attractive opportunities in the development stages of the value chain.
The most important entry points are:

Secondary finance for operational assets
Once operational, solar installations can be refinanced using senior debt backed by future revenues. Secured debt is the solar investment vehicle of choice for many institutions. It offers a low risk yield profile and, even if not very liquid, is relatively easy to market. The availability of secured senior debt should increase as utilities, many of which have arguably been slow to adapt to renewable energy, embrace alternatives to traditional balance sheet funding and look to raise funds or finance M&A by offloading operational assets.

Initial project finance for construction
As demand for senior debt backed by solar assets grows, yields are coming under pressure. In response major investors, including certain sovereign and pension funds, are opting to provide initial project finance at the development or construction phase of a project. This offers a higher risk-return profile and, in the case of equity investment, greater scope for capital gains.

Subordinated debt
Labelled and unlabelled "green bonds" are an alternative entry point for fixed income investors, and an increasingly popular funding option for corporates, municipalities, governments and commercial lenders. A record US$41.8b of labelled bonds was issued during 2015, with 46% dedicated to renewable energy investments. The unlabelled green bond market is larger, at about US$500b, but offers weaker environmental safeguards. Despite the growing use of green bonds for corporate and project financing, both categories could face growing scrutiny as investors look for differentiation beyond their "green" credentials.

Common equity
Institutions looking for higher returns can invest in the listed stock of utilities shifting towards solar assets, or energy companies competing with utilities in solar markets. There is no escaping the fact that incumbent utilities, and the challenger businesses now competing with them, hold a large proportion of the world's power assets. As these players build the solar elements of their portfolios, their common equity offers upside exposure to global solar adoption.



"Yieldcos"

An alternative to conventional equities, yieldcos are companies that own specific operating assets and use their predicable cash flows to pay investors an attractive dividend. Yieldcos are typically listed subsidiaries of larger energy producers. Following an initial bubble, in recent years many yieldcos have suffered from excessive investor expectations or the financial weakness of parent companies. The next 12-18 months could see growing calls to restructure existing vehicles. The yieldco model is likely to survive, although unlisted vehicles may be preferred in future.

Asset-backed securities (ABS)

Securitisation is giving major institutions the chance to invest in smaller-scale solar projects, which are becoming an increasingly important part of the global energy mix. Companies that install and lease rooftop solar PV assets to private individuals are packaging up revenue streams from long-term contracts to issue bonds or notes. Residential solar ABS has been successfully issued in markets including the US, China and Kenya. Greater standardisation of contracts could also hasten the securitisation of mid-scale commercial and industrial solar assets.

It is important to note that solar investment opportunities span high growth and developed markets, providing a wide range of macro-economic exposure. The ten most attractive countries for solar investment as ranked in the May 2016 edition of EY's quarterly Renewable Energy Country Attractiveness Index (RECAI) give an illustration of the diversity of solar investment markets (see Figure 4).

China, the world's leading solar market, is aiming to install 100GW of new generation by 2020, tripling its current capacity. India is also targeting 100GW of new capacity – a near twenty-fold increase – while Chile, Brazil, Mexico and South Africa are launching large-scale projects backed by a mixture of private and public investment. In the first three months of 2016, solar accounted for 64% of all new electricity that came online in the USA.[7]

Nor are these investment opportunities restricted to "sunny" or high growth markets. Non-sunny markets, such as Germany (the world's leading solar market until 2014, second to China in 2016), can be grown to have significant installed solar capacity. Australia and the US are seeing an explosion in rooftop solar investment. In addition, increasingly aggressive carbon reduction targets in Europe and North America suggest that investment opportunities will continue to multiply in these markets.

Figure 4: EY RECAI solar indices rankings, May 2016

RECAI attractiveness ranking, May 2016	Solar photovoltaics	Concentrated solar power
1	United States	United States
2	India	South Africa
3	China	Chile
4	Australia	India
5	Brazil	Egypt
6	Mexico	Morocco
7	Chile	China
8	Egypt	Australia
9	France	Jordan
10	South Africa	Brazil

Source: EY RECAI, May 2016

What challenges do investors face?

Despite the stunning growth of recent years, solar investment still represents less than 1% of most institutional investors' asset allocations.

This is hardly surprising. Historic labels such as 'green' or 'alternative' have left many investors unsure how renewable assets should fit into their wider strategies. The restructuring of solar energy yieldcos has raised questions in the minds of some, whilst the rapid advance of solar technology has taken many observers by surprise.

Investors are one of many groups trying to get up to speed with these developments. As they seek to familiarise themselves with solar investment, newcomers need to understand a few potential obstacles to successful investment. For example:

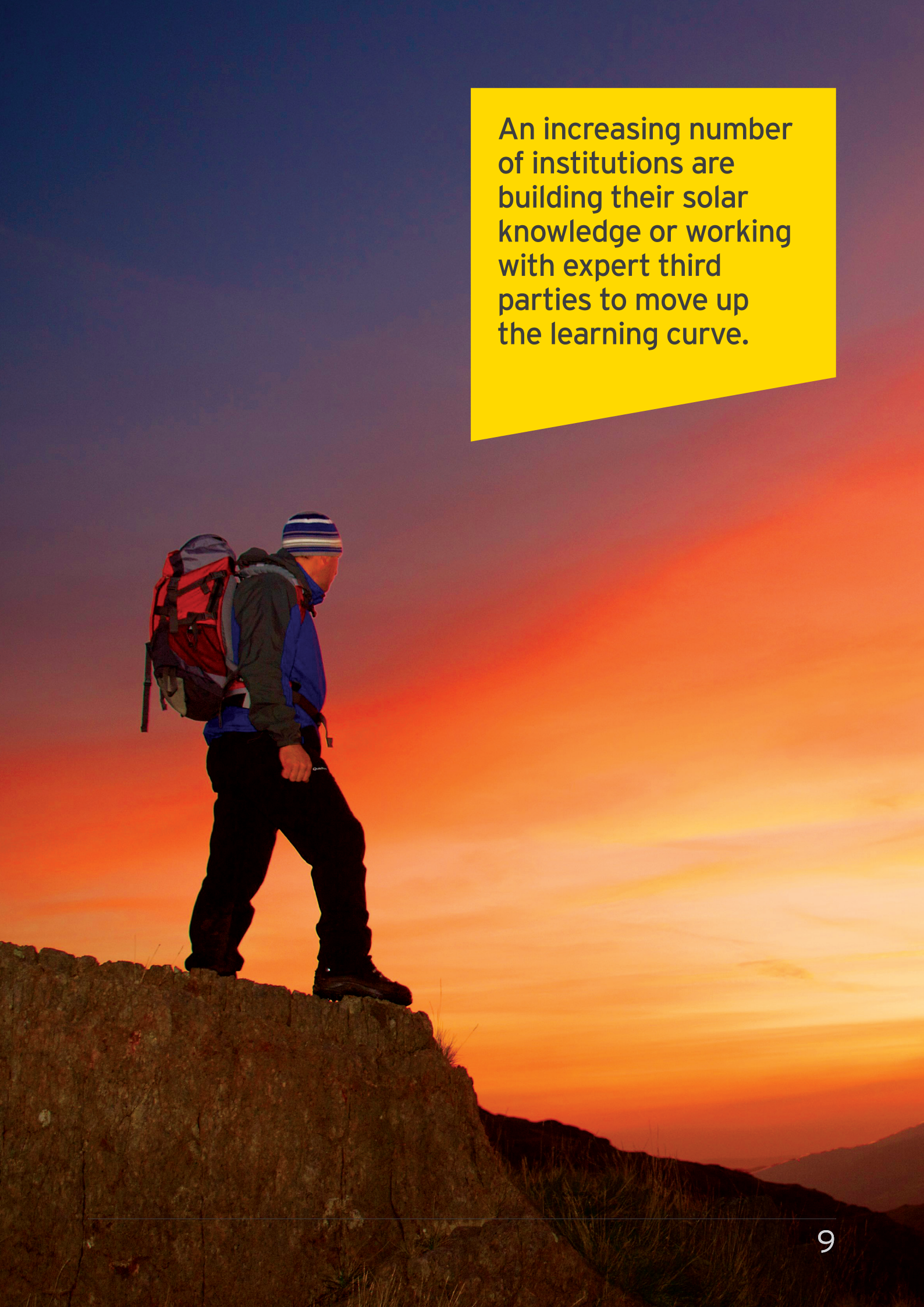
Policy risk
In the past, solar and other renewable energy technologies relied heavily on policy-driven price subsidies or favourable regulation to compete with conventional energy sources. More recently, unexpectedly strong demand for subsidised investments and the rapid decline in solar PV costs have led to unpredictable or sudden policy reversals, such as the UK's 2015 decision to end rooftop subsidies a year earlier than planned. These shifts have dampened investor confidence and created boom-bust deployment cycles in some markets. However, policy risks are declining as solar power reaches grid parity in many markets. Although the review and reduction of solar subsidies will continue to create near-term hiccups, the increasing ability of solar investments to generate sustainable, unsubsidized returns is a highly positive indicator for the future.

Output variability
As already discussed, the natural variations of solar output contrast with the more constant "base load" of conventional energy sources and renewables like biomass or geothermal. As the scale of solar deployment increases, this variability has the potential to create balancing issues for transmission networks. The good news is that technological advances have the potential to address solar variability. Battery-based and other forms of storage are helping to decouple supply and demand, and other forms of 'smart infrastructure' are enhancing grid resilience. Storage costs are expected to fall rapidly over the next five years. The combination of scalable generation and scalable storage is widely expected to supercharge demand for solar capacity.

Sector knowledge
The technology and economics of solar power can appear complex to non-specialist investors, few of which typically have in-house sector expertise. Local variations in regulations and market structures can also be a source of confusion. These factors, together with the growing choice of investment options, can make it hard for institutions to identify the most suitable opportunities. However, these are common challenges for energy investors. An increasing number of institutions are building their solar knowledge or working with expert third parties to move up the learning curve.

Track record
Although the rapid deployment of solar has produced significant volumes of performance data, in practice much of this is fragmented, proprietary and hard to access. Fortunately, investors have increasing opportunities to work collaboratively with project developers and asset operators to gather and collate the data they require to compare projected and actual performance. The ability to generate more reliable long-term forecasts will help investors to make decisions across a range of vehicles and entry points.

The good news is that experienced investors should be able to address or mitigate most of these challenges. Few are unique to solar investing, and many will naturally resolve themselves as solar assets move into the mainstream and more institutions build their understanding and experience of the sector.



An increasing number of institutions are building their solar knowledge or working with expert third parties to move up the learning curve.

Is now the time to invest?

Solar PV is a rapidly growing asset, with plummeting costs and constantly improving technology.

This, alongside the minimal operational requirements (compared to traditional energy sources), vast potential for scale and proven financial returns make it one of the most attractive assets for investors in the short, medium and especially long terms. In addition, the added benefit is the environmental argument, one which is quickly growing in importance for regulators and investors, particularly millennials (due to inherit US$30t in the coming decades), alike.

For these reasons, groups as diverse as pension funds, sovereign wealth funds, national green banks, mutual fund investors and crowdfunding investors are increasingly interested in solar, with investors finding themselves competing for the best deals.

At the same time, companies seeking capital for solar assets need to ensure they are doing all they can to package those assets in ways that meet the needs of investors. That includes making a greater effort to engage with potential investors and educate them about the solar industry.

Overcoming misconceptions that solar assets are immature, specialised or particularly complex is a key challenge. The unique potential of solar to deliver stable long-term cash flows, comparatively low risk profiles and scalability across a worldwide range of markets – even in the least sunny regions – shows that investors need to consider solar investments as a mainstream asset class in their own right.

Today, solar investments represent a drop in the ocean of global asset allocations. Fast forward to 2040, and solar power is estimated to represent almost a third of installed global generating capacity.[8] It seems obvious that a significant ramping up is required to reflect this weighting in energy portfolios, demonstrating that investors failing to engage with the solar market are overlooking attractive opportunities. Even oil and gas companies are moving towards renewables, with the largest global IPO in the first half of 2016 being a renewable energy company. DONG Energy, originally Danish Oil and Gas, now has 75% of its capital going into renewables.[9]

There is a vital need for investors – especially large institutions able to provide the lowest costs of capital – to recognize that an energy sector in transformation is also an energy sector in need of capital. A willingness to understand the unique and highly promising solar investment market could offer some equally unique long-term returns.

> "I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that."
>
> **Thomas Edison, 1931**

8 Bloomberg New Energy Finance, *New Energy Outlook*. 2015

9 Crooks, E., Stacey, K. "Big Oil: From black to green", *The Financial Times,* 28 June 2016

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