



Capital questions

Why the future of renewables depends on the costs of capital and other questions around renewable energy

Gerard Reid, founding partner of Alexa Capital, and Jochen Kreusel, head of ABB Smart Grids Industry Sector Initiative, discuss renewables and new business models in the energy sector in an interview with ABB Review.

1 Annual renewables capacity addition by technology (2001 – 2014)

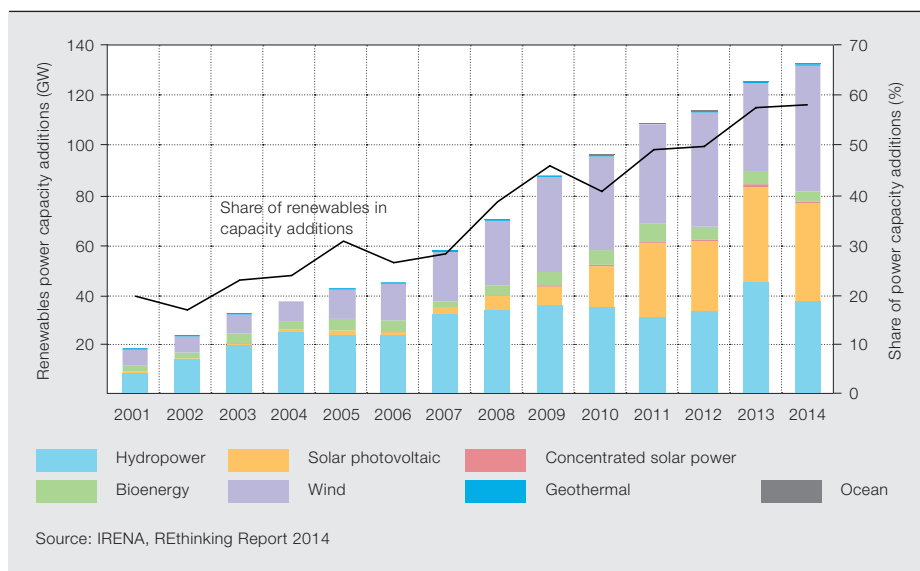


ABB Review (AR): The renewables transformation is advancing at dizzying speeds → 1. What are the drivers of this development?

Gerard Reid (GR): We really wouldn't be seeing renewables rolled out across the world without a government mandate. Particularly in Europe this has been the major driver → 2.

There are two other important factors. One of them is cost. We've seen very rapid reductions in costs, especially in solar but also in wind. Renewables are rapidly becoming too cheap to ignore → 3.

The other factor is strategic advances in technology. And I don't mean just the renewable technologies themselves, but how they are integrated into the system. Ten years ago most people in Germany would have said that it would be impossible to integrate 10 percent of renewables – today they are at 30 percent. In my own country, Ireland, it's 25 percent.

Those drivers are going to remain, but their balance will shift. I think we will be seeing a move away from the importance of the government mandate and toward costs and technology.

Jochen Kreusel (JK): And both technology and the cost of that technology is where industry is flexing its muscles. Electricity demand is growing rapidly and CO₂ emissions have to be reduced. These two countertrends can really only be addressed by technology – front-end renewable technology per se and the associated technology that supports it. In-depth knowledge of renewable power generation technologies and experience installing these around the world are required to serve the renewable energy industry. This comprehensive approach will become ever more significant as the renewable business continues its rapid evolution.

AR: Where is the government mandate coming from? Environmental concerns?

GR: Yes. If you take the case of Europe, there would never have been such a massive build-out of renewables without a green movement that pushed in terms of legislation on pollution and emissions.

AR: With the new technology becoming so affordable, do we still need continued government support in Europe?

GR: Yes. The power markets as we know them are broken. No generation of any type can be built without some form of

very clear regulation in place. The reason is that, in Europe, you are not going to get your capital expenditure back, except maybe in the United Kingdom.

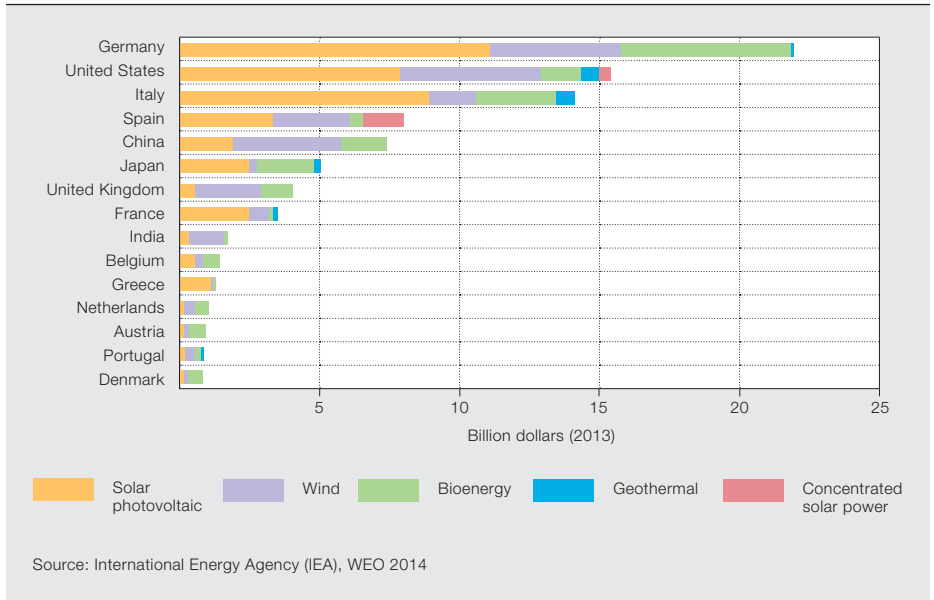
We really wouldn't be seeing renewables rolled out across the world without a government mandate. Particularly in Europe this has been the major driver.

Without that return, there is going to be no investment in power generation. This is why renewables – and energy in general – will need a support or market mechanism.

From the power-market perspective, there is a new phenomenon that renewables have brought about, namely that they have zero marginal costs. They don't have fuel costs and the running costs are very low. A gas- or a coal-powered station needs fuel for every kWh generated and needs a lot of people to make sure that the power station just keeps working. With renewables you have the exact opposite. If a utility has a whole range of power generation assets available, when it has to decide what it's going to take as part of its generation mix, it's likely to use the renewables preferentially – based on the variable costs. As we keep putting more renewables on

Government mandates, cost and strategic technology advances are driving the advancement of renewables.

2 Renewables power subsidies by source in the top 15 subsidy-supplying countries



the grid, eventually what will happen is that the wholesale price of power will tend toward zero.

That can be seen in particular in Germany. The German power prices are at 30 to 35 euros/MWh (about \$33 to \$39/MWh). Nobody will build conventional generation at those prices because they can't recover the variable cost, let alone the investment cost. And that's the big opportunity that renewables have brought to the market.

JK: ABB sees a large part of the renewable cost equation and the power markets issue being addressed by products that make the integration of large amounts of renewable power into the grid cost-effective and straightforward. I'm thinking here about automation and control systems for flexible power generation, HVDC, FACTS and a whole host of other enabling technologies on one side and a market design giving flexibility and dispatchability at an adequate price on the other.

AR: You say the variable costs are going toward zero, but what about the fixed costs?

GR: In terms of CAPEX, people might say the costs of solar are \$1 million/MW and say the figure for gas is about the same, and so assume they are at parity. But that's not true because what you really have to look at is the CAPEX per MWh. If a gas generator is going to run 60 per-

cent of the time and a solar park is going to run 15 percent of the time, the CAPEX cost per unit generated is going to be four times higher for the solar park. If we want to get renewables onto the system, we have to get the cost of capital down. Capital costs are going to be determinant in getting renewables onto the grid.

This can have different implications across regions. For example, the cost of capital in India is almost twice as high as in Germany. However, as India has nearly twice as much sun, the cost of electricity production is more or less the same in both countries.

We've never had this scenario with conventional generation because we recovered CAPEX through the power price, and the power price was determined by the marginal cost. So if fuel costs went up, they went up for everybody, and so the power price went up.

With renewables, we don't live in that world anymore. Based on the low marginal costs of renewables, a utility or power producer can offer consumers a power purchase agreement with a set price for the next 20 years. No utility would do this with gas or coal. However, with competition in the market, a consumer can switch suppliers quickly, and thus sign only short-term contracts. This does not align to renewables as investors need the security of power prices to recover the capital costs. This requires a fundamental change in the way we look at power markets.

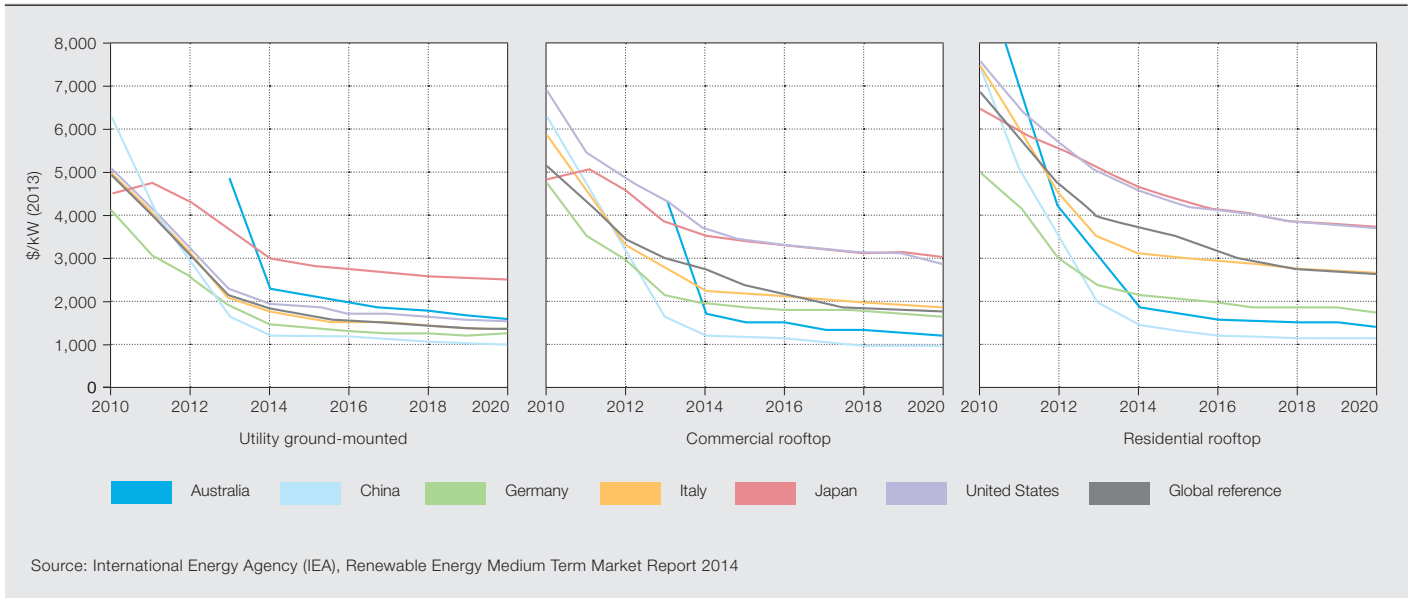
AR: How must the power market be reformed to support this different way of looking at things?

GR: I think that the best way to do it is to allow the power price to determine everything. Rather than 15-minute pricing we will need one-minute prices. If you price on a minute basis you get a lot of volatility in the power price, but that would mean power suppliers can recover their cost through that volatility.

JK: In my opinion, this approach may indeed help to give incentives for demand response or other dispatchable types of generation, but I do not see how this will help the renewables. The reason behind the current market mechanism in which the power price is determined by the marginal cost is that it delivers the lowest operational cost to run a given group of power plants. The task of particularly spot markets is to determine the optimal load dispatch. This task is becoming obsolete in a system with zero marginal cost. Therefore, short-term markets will not be an adequate tool anymore. We already see different market approaches in other fixed-cost dominated markets, such as telecommunications. We see flat rates and incentives to sign longer-term contracts – admittedly two rather than 20 years. In this case, competition is indeed strongly determined by the cost of capital.

GR: Another approach to the market is that you give a regulated return to the owners of renewable assets, which in

3 Historical and projected typical solar PV investment costs at the beginning of the year



some cases is happening already. But one way or the other, radical changes are required. Recent attempts at reforming the market have just been about tinkering. We need far more radical restructuring.

AR: We have talked about solar. What about other renewables?

GR: For me, solar is a revolution and wind is not – it's an evolution. We've had wind for the last 50 years and it has got steadily better and better and it's very clear that it is and will remain part of our energy system. In Ireland we're producing electricity below the wholesale power price, so it is a game changer.

The biggest problem we have with wind is that it is not easy to predict. Even in a country like Germany where power traders are trying to predict it on a daily basis, they rarely get it right. Solar is much easier to predict. In addition, what makes solar so attractive is its flexibility. You can put it in your calculator, you can put it on your roof, you can build a big plant, and it's quick to install. It doesn't have the same visual or spatial impact as a wind turbine, and its installation doesn't face the same level of opposition. We've never had a technology like solar where you can do something so locally, cheaply, quickly and effectively.

Other renewables such as biomass, geothermal and wave are all evolutionary technologies. Please don't get me wrong, they're all great, but they're not revolu-

tionary in the same way as solar. Ten years ago the global market for solar was 1 GW. This year it's projected to be at least 50 GW. Looking at the cost roadmaps of companies in the future, I see cost reductions of another 40 percent over the next five years. Meanwhile, for wind I only see a cost reduction potential of maybe 5 percent a year, but not 10 percent.

AR: So lower costs in solar mean it will continue to lead in terms of growth in renewables. What effects do you foresee for other renewables?

GR: There is only so much feed-in tariff money to go around and the majority of it is going into solar. Solar was able to add 7 GW of new capacity every year in Germany for three years in a row. Wind wasn't able to match that. I think wind has a huge role to play in generation, but I also think solar is competing against offshore wind at the level of investment capital. Why? The costs of offshore wind haven't come down. On the contrary, they've gone the opposite way.

JK: I do agree that solar power has revolutionized the power generation landscape, bringing new opportunities, but also challenges especially to the power distribution system. However, I think we should not undermine the huge potential wind power still has to offer. Wind power has become the least-cost option for new power generation capacity in many countries and new markets in Asia, Africa and Latin America have continued to

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emerge during the last year. In addition, if we take for instance the findings of the IEA World Energy Outlook 2014, we can expect the global installed wind power capacity to triple by 2040. Therefore, I believe that further interesting developments in this field will continue.

AR: Who is or should be putting up the money for new renewables capacity? Will the traditional incumbents defend their market dominance and take the lead, or will new investors move in and gradually take over the market?

GR: Let's look at the telecoms space. We actually still have all the old incumbents: British Telecom, Deutsche Telekom, etc. Some of them have merged, some have changed their names, but they're still there. But we also have a whole pile of new companies that came into being. The problem the incumbents have is that after 100 years of doing the same thing, they may face a challenge in adapting to the sudden revolution.

JK: If you look at the telecoms companies as you say, the old ones are still there, but much of the money in value-added telecommunication-based services is being made by new players. The incumbents are still providers of the commoditized infrastructure, but the money is being made by the users of that infrastructure, or in one prominent case, by a device manufacturer. Do you expect there to be a similar development in the power market?

GR: I think it's a good analogy. Another analogy that I see is the automobile industry, which is going through big changes as it electrifies and is thus bringing itself closer to the utilities. One of the main reasons for this is that the costs of batteries is going down. Looking at automobile manufacturers, I ask myself, what they will be in 10 years' time. I think some of them will be service companies. Some might use the automobile as a platform, but will be providing energy services and a whole range of other services into them. This is why I think that the players they should be watching out for are the likes of Apple and Google. After what these companies

have done to the telecoms space, they are now looking at the automobile and electricity space and seeing it's also all about data. They can say, "We are already in the data space and we are already in the home. Let's go and run the electric vehicle, install the solar panel and connect them all together."

So in the future it's not just going to be about the power market but the power market will be interconnected with these other spaces in a convergence of two if not three industries.

AR: So if the photovoltaic panel and the battery of the future are going to be commodities, where is the added value in the renewables market?

GR: I agree that the solar panel is going to be a commodity. I do question though, whether the battery is going to be a commodity. There's a huge complexity around the battery, and there is real intellectual property in it. In addition, with all second-life batteries being dumped into the stationary power market, the entire storage scenario is going to change.

JK: I don't think that second-life batteries are going to have a big impact on power markets as long as battery prices continue to come down at the present rate, making new batteries with higher performance cheaper than used ones. I think grid-side

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battery storage will use purpose-manufactured rather than pre-owned batteries.

GR: We will probably not see second-life batteries used for critical applications such as the primary reserve market, but I am convinced we will see them being used in our homes and our businesses. The key advantage for the battery manufacturers is they get to delay the recycling of the batteries and they can generate more money using them. And as it now stands today second-life batteries are half the price of new batteries.



Gerard Reid is a founding partner of Alexa Capital, which delivers corporate advisory, financing and asset management solutions across the energy, energy infrastructure and energy technology sectors.

He has spent the last decade working in equity research, fund management and corporate finance with a focus on energy and in particular the revolution he calls the Digital Energy Revolution. He is also an author, energy blogger (www.energyandcarbon.com) and monthly columnist for Biz Energy Today, the German energy industry publication.

He has also recently been appointed to the World Economic Forum's Global Agenda Council on the Future of Electricity. Prior to founding Alexa Capital, Gerard Reid was managing director and head of European Cleantech Research at Jefferies & Co.

AR: Won't the technology differentiation flatten out at some point as the technology approaches an optimum, driving batteries into the commodity corner?

GR: Yes. But let's look at the TV business. I think there are now three global TV manufacturers. At some point they got so big that nobody else could compete and enter the market. I think the same is going to happen in batteries and that's to some extent how manufacturers can protect themselves against commoditization a little bit. In contrast, in photovoltaic panels there are about 40 manufacturers around the world all competing with more or less the same product – and that's leading to commoditization.

The real value is in managing the complexity and integrating it into something the customer wants. The differentiation is in the software and the service.

JK: Talking about commoditization with respect to your example of the TV industry, consolidation could actually de-commoditize that industry. This could similarly happen to the photovoltaic panel manufacturers.

GR: We may eventually see consolidation in the solar market as we have seen in TVs but I don't think this will happen until the global growth for solar slows, and I think we are probably five to 10 years away from seeing peak annual installations for solar.

AR: The newcomer companies are best known for their ability to redefine the market with disruptive technologies. Can you say something about disruptive technologies in the energy sector?

GR: Let's not talk just about disruptive technologies but about disruptive technologies and business models. If we look at the so-called disruptive businesses that are out there, what they really are is a mixture of technology and business model.

If your customers have a battery in their car, you can aggregate those batteries and use them to trade in the power market. The idea might sound crazy, but it makes sense from the battery manufacturer's or automobile maker's point of view. He wants to make sure that the charging of that battery is controlled. He wants to control the charging by giving you a ser-

vice package. So he could say, "Here is a flat rate for your battery, you can plug it in wherever you want and it will cost you, say, \$35 per month." He has all the data about you: He knows where you are. He realizes you're in the airport and are going to be in France for two days. So he takes that battery, aggregates it across a country, and participates in the power market. That is a revolution. And manufacturers and consumers will sign up to this agreement because it is in their interest.

You are thus going to get customers signing up for long-term purchase agreements. Many of us do not want to go out and buy a \$500 smartphone but accept those costs when they are hidden in our mobile phone bills.

JK: Revolutions typically start as evolutions and at some point gather their own momentum. The last real revolution we had in the energy sector, in my opinion, was the introduction of electricity. I believe back then people did not foresee or imagine how quickly it would catch on or how ubiquitous it would become – with maybe the exception of a very few visionary people.

GR: I agree, but looking elsewhere in the energy sector, looking at oil and gas, we are also seeing a huge revolution in terms of what's happening with shale gas. Who would have predicted that the United States would be the biggest oil and gas producer in the world? This has not happened in the energy world for a long time.

Based on the low marginal costs of renewables, a utility or power producer can offer consumers a power purchase agreement with a set price for the next 20 years.

AR: We have talked about the importance of batteries in mobility, but looking at e-mobility in the context of renewable energy, what trends do you foresee?

I don't think that second-life batteries are going to have a big impact on power markets as long as battery prices continue to come down at the present rate.

JK: One trend that is already shaping up is that more and more players are becoming active in the e-mobility renewable energy chain. This brings its own challenges, so we have to be sure we have the right products available and that we can make it easy and safe – for both the customer and the grid itself – to swiftly adapt and bring in new products and practices. In other words, increased flexibility will be a major trend.

GR: My view is that everything is going to go electric and everything is going to go digital. The consumers are also beginning to change their behavior. Young consumers don't need to own the latest top-of-the-range car. They are quite happy to actually just rent a car. And this means they can rent the best car for the job rather than having a one-size-fits-all car.

I've heard that some car manufacturers make twice as much money on a car that they put out to car sharing. That's impressive in terms of margins – but of course it doesn't help them in terms of volumes as they're going to make fewer cars overall. But it's very clear that they're moving from thinking in terms of ownership models to service models. This is a very courageous strategy, but in a revolution you need to be brave. You cannot predict the future but you can try to shape it.

AR: As new service models come online, larger and larger amounts of data will need to be collected and exchanged. Placing a device online also means making it potentially vulnerable to cyber attacks. If you hack into a home or building automation system, you can essentially

control the house or factory. How are we going to mitigate these aspects?

GR: The electricity company is going to need to know what I'm doing in the home. Of course there are privacy issues coming out of this. But look at the amount of data Google collects, and yet most people simply don't care.

Cyber security is not an enormous issue yet, but it's going to become one. The power world has not needed a lot of software until now, but this is changing. So there is a threat not just for utilities and customers but also for hardware producers. However, I don't think the move toward digitalization is going to stop, but obviously security is going to become a much bigger challenge.

AR: We have talked a lot about the market situation and services, but at the beginning of this interview you also mentioned that technological advances for system integration are a main factor in enabling the further deployment of renewables. How do you see the impact of such technologies on the development of the future power grid?

GR: I think there is a tradeoff of sorts between the grid and storage. With more and more batteries on the distribution-level grid, the grid itself will be relieved of peak situations – peak referring both to load and feed-in. Storage is thus emerging as an alternative to transmission. To return to our telecoms analogy: The fixed-line telecom network – although still important – is no longer the ubiquitous backbone it once was.

JK: I think there is an important difference, namely that the mobile networks have in part replaced the functionality of fixed lines in a one-on-one manner. In the power grid, there is the challenge of providing electricity in regions with strong seasonal variations. For example, winter in the northern hemisphere. Batteries can shift the load within the day, but you cannot shift loads over months in an economical manner using batteries.

I see only two ways to deal with that. One is to not go beyond, say, 50 percent renewables. The other is to connect regions with transmission. Areas with the best wind and solar resources are often situated in remote locations. Tapping into

these resources will require efficient ways to transport a large amount of power to the consumption centers. Power transmission interconnections need to be enhanced to facilitate optimum utilization of renewables and balancing of loads.

GR: Fair enough. Nevertheless, I see the main need for investment in the distribution grid. We are blind in the distribution grid. And this is where most of the changes are going to take place.

I also think we're going to see flexibilization on the demand side. The utilities are going to use cost-driven models to sell electricity to consumers. I know this is already happening with commercial customers, or in the home sector if you are using electric storage heaters. You give the customer the opportunity to buy at the cheapest price.

AR: Thank you, gentlemen, for this very interesting and valuable discussion. ABB Review runs regular articles on renewables technologies, so it is good to extend our scope and hear about the business model and capital investment implications too. Even just driving around you can see how dramatically the major renewable businesses – both solar and wind – are surging and how important they are becoming. We are all aware too, of course, of the climate-driven necessity for change. It is obvious that, as direct government supports ebbs, the contribution of the private sector will become ever more important and that flexibility and nimbleness will become key attributes.

It has become apparent, too, just how important the balance between capital costs and marginal costs is, and the implications this has for the directions of future technology development.

At the moment, ABB supports customers along the complete power value chain to plan, generate, connect, transmit, monitor and control power from renewable installations as well as to maintain and optimize their systems, and it is clear from our discussion that all these areas of technology are critical to the future of renewable energy.

This interview was conducted by Andreas Moglestue, chief editor of ABB Review. Please direct inquiries to Norma Guentert, communications manager for ABB Smart Grids and Wind Power Industry Sector Initiatives: norma.guentert@ch.abb.com