When it comes to renewable energy, a common argument used is that technologies are often dependent on subsidies to be economically viable. Well, in some scenarios they are. However, the elephant in the room is that fossil fuels also have a long history of relying on subsidies. And they still do, heavily...

Cost calculation conundrums

Which energy technology really is the most economical, cost-effective solution for the long term? And how do renewable technologies really stack up when compared to coal, gas and nuclear on cost?
Gail Rajgor kicks off a new Renewable Energy Focus series by asking whether it is even possible to compare technologies on a truly like-for-like basis. And if so, what do we need to bear in mind?
Introduction

Renewable energy technologies have certainly come into the limelight in the last decade or so, and so too has the debate surrounding them, especially on cost. The skeptics remain large in number, and in some cases for good reason. While hydropower, onshore wind power – and to some extent parts of the solar PV sector – have proven themselves technologically (and economically) in some countries, there is still some way to go for other technologies. Even though their promise and potential look good.

Meantime, the oil, gas and coal sectors remain strong. So called “clean coal” technology is being pushed hard by policy makers.

Energy giants like Shell are pumping millions into exploring new supplies of gas in areas previously deemed inaccessible, although this has already courted much controversy due to the potential environmental impacts of hydraulic fracturing, the process required to extract shale gas.

Increased safety requirements post-Fukushima, could plunge the sector into the role of economic energy underdog.

And finally, let’s not forget developments in smart grid technology, which are spurring a new era of micro-generation. Such fundamental changes to infrastructure will have a critical role to play in giving back some power and control to the consumer – as well as meeting burgeoning energy needs. Many see developments in smart grid (not to mention energy storage) as essential to the adoption of renewable energy sources.

Which source should we choose?

When it comes to energy, debates continue to be heated as to which solution (or mix of technologies) is right, when weighed up against the potential costs – be they social, environmental or economic.

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As for the oil sector, well, it has certainly suffered in the wake of spill disasters like Moncado, but demand is such that business is still booming [editor’s note: the focus of this first series of articles is electricity generation, therefore none of the articles will look at oil in any detail].

And of course, there’s nuclear power too. The incident in Japan has brought the social and environment-related costs of nuclear back into the limelight once again, alongside the hard core financial burdens that will also come to the fore. Construction costs for nuclear power stations are already recognised to be huge, but the need for safe final disposal of nuclear waste is now recognised as vital if the sector stands any chance of a serious rebirth.

The costs associated with that, expected to be borne by the industry, as well as the costs needed to meet other social costs? And how should wider system costs like the need for new transmission lines be shared?

Similarly, subsidies and other public finance and market support systems available (both direct and indirect) come into play when determining cost, although often the latter can be hard to define clearly.

When it comes to renewable energy, a common argument is that they are too often dependent on subsidies to be viable. Well, in some scenarios they are. However, the elephant in the room is that fossil fuels also have a long history of relying on subsidies. And they still do, heavily: “Fossil fuel subsidies have been driven by the rebound in international energy prices... they totalled US$409 billion in 2010, about US$110 billion up on 2009,” the International Energy Agency’s World Energy Outlook 2011 noted.

So even though it’s widely accepted that fossil fuels are subsidised (and will continue to be so), the renewable energy industry is castigated on a daily basis... for the subsidies it receives. And it’s often conveniently forgotten that these subsidies and incentives lead to scale up, which ultimately brings down the cost of the technology.

Rapid advancements in renewable energy technology are taking place almost on a daily basis across the board, and countries like China are making a major impact in some industries – onshore wind and solar PV are two major examples. And though some in the U.S. solar industry continue to be uncomfortable with Chinese involvement in PV, this is driving some costs down significantly.

Of course, there is another side to the innovation coin: Ongoing deployment (and with that experience) tends to highlight previously unanticipated problems. This leads in the short term to a rising cost curve that needs to be halted for the continued viability off that technology.

Offshore wind would come into this camp, as despite the better wind regime out at sea, it becomes much more challenging to get the larger, offshore wind turbines in place, as well as manage their operation and maintenance.

And of course, fluctuating commodity prices (i.e. steel) and fuel costs (which affect coal, gas and biomass – being dependent on feed stocks) means the debate is almost always in a state of constant flux.

Variable assumptions – getting to grips with the metrics

A major challenge is deciding just how we are going to actually measure the cost of the energy generated.

Different variables and metrics can be used – and whether a technology is more economic or cost effective than

Feature article
another can often depend on your point of view; timescale parameters; environmental agenda; and social imperatives.

Even excluding wider system costs; environmental impact and social costs (which may be harder to quantify) does little to alleviate the problem of a lack of a “default” way of measuring energy costs across the board. While basic installed costs can be compared on a fairly firm like-for-like basis (although some markets are more transparent than others), generation costs are highly specific and determined by a multitude of factors. These include:

- The local regulatory regime/arrangements in domestic electricity markets, and the pricing support systems in place;
- general fuel costs, which for some sectors, like coal or biomass, are highly volatile.

Similarly, location impacts the cost calculations for some technologies.

Calculating the real generation costs of a wind farm is heavily dependent on the wind speeds at its location, while for PV projects, a key factor affecting output and efficiency is the available solar resource.

Indeed, all technologies have distinguishing factors which need to be accommodated. Critically, opinion on which criteria should be included when assessing true costs varies widely.

All of this means any energy decisions based on cost must be considered carefully, looking at a cross section of reference material, and leaves all energy sectors open to a barrage of possible misinformation about costs and the need for qualifying statements.

Examples of problematic reports and responses

By way of example are two recent UK reports from influential think tank Policy Exchange, and Civitas. Firstly Policy Exchange: In its paper, The Full Cost to Households of Renewable Energy According to the European Wind Energy Association (EWEA), LCOE calculations do not usually take into consideration the risks associated with some cost components, like volatility of fuel and carbon emission costs. If this were the case, it maintains, electricity generation from gas power plants would cost around €48/MWh (up from €36/MWh without taking into account any risk); for coal-fired generation the cost increases from €51/MWh to €72/MWh; for nuclear power, the demonstrated high capital costs which are incurred because of the long construction period result in a levelised cost of around €100/MWh (risk factor of 2%); finally wind power comes in at €60/MWh (onshore) and €90/MWh offshore (mainly due to the high capital cost). (See http://www.ewea.org/index.php?id=1643).

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Policies, which is an analysis of the UK Government’s annual energy policy statement, the organisation labels offshore wind as “hugely expensive” – estimating the full impact of renewable energy subsidies on an average household by 2020 (through bills, tax and costs of products and services) to be £400 per year.

But according to RenewableUK, the renewable trade body, the pricing model used “fails to account for the reforms to the electricity market being brought in [in 2012], or the 10% cut to support for wind power implemented as part of the Renewables Obligation Banding Review”.

Despite saying its costings remain “robust” because the design of the EMR is at a very early stage, Policy Exchange does confirm it ignored the Department for Energy and Climate Change (DECC)’s cost projections for the future under the new EMR policy, instead using a combination of the Feed-in Tariff (FiT) cost estimate from the 2011 annual energy policy statement, and the Renewables Obligation (RO) figure from the 2010 statement.

Meantime, the Civitas study (Electricity costs: the folly of wind power) by economist Ruth Lea, claims that both onshore and offshore wind power are the most expensive forms of electricity generation.

RenewableUK says the report was based on a range of assumptions, particularly the need to build a new fleet of rapid-response gas power stations (known as open-cycle gas turbines, or OCGT) to back up wind generation on a MW-for-MW basis. But Dr Gordon Edge, RenewableUK’s director of policy explained, “dedicated OCGT plants are not required to provide back-up for wind. Instead, wind can be integrated into our existing electricity system to act as a fuel saver, enabling us to harness the weather when it’s available. Some additional investment is required, but credible analysis puts the cost at one-sixth of [the report’s] inflated claims, even with wind providing two-thirds of our power.”

The key point Edge and RenewableUK would argue is that if you look beneath the headline findings, both these recent reports are to an extent based on outdated and inaccurate information. And this shows just how complicated and contested the matter of cost comparison is. Any direct comparison of generation cost (particularly at a global scale) is always somewhat limited in nature, and no single method of analysis can ever give a truly holistic picture.

Renewable energy cost examples and the importance of risk

To take its place in the world as a mainstream energy source and to silence critics, the Holy Grail for any renewable energy technology is to achieve (perceived) grid parity with its traditional gas, coal and nuclear counterparts.

This is basically when it produces power at a levelised energy cost (LEC) that is equal to or less than the price of purchasing power from the grid.

Onshore wind is often cited as the renewable energy technology closest to doing this, with solar PV some way behind it, although it is important to note that under some scenarios – and in some locations – both are claimed to have already attained that goal.

The levelised cost of electricity (LCOE), another term for LEC, is “an important metric to compare the generation technologies”, says the European Wind Energy Association. It is defined as the actualised kWh cost over the complete lifetime of the project, taking into account the present value of all the cost components. So to determine LEC a full economic assessment of projects is required factoring in:

- Capital costs (including planning, site work and initial investment);
- Operation and maintenance (O&M) cost;
- Fuel cost;
- Cost of capital and return on investment;
- And, notes EWEA, any CO2 emissions cost, as given by the European Trading System for CO2 (ETS) for example.

“The levelised cost of energy has therefore to take into account the different cost components which correspond to the different technologies,” says EWEA.

The issue of risk is an important one that is often not included in calculations. Take windpower for example: according to EWEA, “the main advantage of wind energy is that no fuel is needed in the electricity generation and no carbon emissions are involved. In order to form a fair basis of comparison of the levelised cost of electricity from various sources, this difference has to be taken into account and treated accordingly”. And the same can of course be said for solar PV.

Meantime, EWEA continues, LCOE calculations do not usually take into consideration the possible risks associated with some cost components, for example, volatility of fuel and carbon emission costs. “Differentiating the cost components and treating them separately helps in the identification of the associated risks. Therefore, using
different discount rates that account for these risks, the calculation of the levelised cost is performed, resulting in a fair basis of comparison between generation technologies,” it argues.

When this is done, the cost of conventional technologies (gas and coal) as well as nuclear is increased”, it concludes.

EWEA concedes that when looking at LCOE costs, gas comes out the clear winner in just about every analysis you see. For electricity generation from gas power plants, the cost would be around €36/MWh (without taking into account any risk), it says. Including the risk, however, the cost jumps to €46/MWh, increasing by 29%.

For coal-fired generation the cost with risk included increases from €51/MWh to €72/MWh – by 40%. “The impact of taking into account the risk associated with the volatility of fuel system costs, such as long distance transmission lines and grid connections required for new plant, balancing and reserve costs, or externalities such as decommissioning costs or health related damage.”

PV-related cost metrics

Similarly, caution is always advised when looking at general LEC/LCOE comparisons (including EWEA’s figures) because there is no single LEC/ LCOE calculation assessment tool or standard which all apply equally: “Unfortunately, the LCOE method is deceptively straightforward and there is a lack of clarity of reporting assumptions, justifications and degree of completeness in LCOE calculations, which produces widely varying and contradictory results,” stress the authors (Branker, Pathak, Pearce) of a recent paper, A review of Solar Photovoltaic & Sustainable Energy reviews 15, which looks at the North American market.

Its review found that the LCOE results vary by more than a factor of four, and many do not fully cover assumptions. In fact, the lowest estimated LCOE for PV it found from its review of studies going back to 2004 was $0.122/kWh with the highest coming in at $0.86/kWh, clearly illustrating the problem.

“Different levels of cost inclusion and sweeping assumptions across different technologies result in different costs estimated for even the same location,” it says. “In addition, the trend of eliminating avoidable costs for consumers and folding them into customer charges can mask the real cost of conventional technologies... it is clear that better reporting of LCOE assumptions and justification is required.”

A key recommendation for reporting LCOE for solar PV for example, is the inclusion of assumptions and specifications which make each calculation unique, including:

- The solar PV technology and degradation rate (i.e. type of technology and related factors – such as % degradation rate per year etc);
- Scale, size and cost of the PV project, including cost breakdown;
- Indication of solar resource: capacity factor, solar installation, geographic location, and shading losses;
- Lifetime of the project and term of financing (these are not necessarily equal, it stresses);
- Financial terms: financing (interest rate, term, equity/debt ratio, cost of capital), discount rate;
- Additional terms: inflation, incentives, credits, taxes, depreciation, carbon credits etc (although it says these need not be in the analysis, but it should be clearly stated

Indeed, all technologies have distinguishing factors which need to be accommodated. Critically, opinion on which criteria should be included when assessing true costs varies widely.

and CO₂ is expected to be higher in a more CO₂ intensive power generation technology such as coal.”

For nuclear power, the demonstrated high capital costs which are incurred because of the long construction period result in a high levelised cost of around €100/MWh. “The effect of the volatility of fuel cost has a small impact on the LCOE of nuclear because the fuel cost is expected to be rather constant. Additionally, nuclear power is not subject to CO₂ emissions,” EWEA adds. “Therefore the increase taking into account the risk is in the order of 2%.”

Onshore wind, it continues, already appears competitive with coal and nuclear power, coming in at around €60/MWh. Offshore wind energy, as a more expensive technology, has a levelised cost of electricity around €90/MWh, mainly due to the high capital cost (http://www.ewea.org/index.php?id=1643). It is worth noting here, that LCOE costs do not include wider LCOE assumptions and comparison is being increasingly recognised. Moreover, there are some stand-out studies which enable a reasonably good picture for comparison to be made. In the next part of this series, some hard and fast figures will be analysed, looking at the most up to date installed and generation costs figures available across the energy technologies.

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