

CLEAN ENERGY'S PUBERTY YEARS – BEWILDERING AND IRREVERSIBLE



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"Between the idea
And the reality
Between the motion and the act
Falls the Shadow"

TS Eliot, The Hollow Men, 1925

These are difficult years for the clean energy sector. A few years ago the industry seemed to be entering a golden age of limitless growth and infinite potential, the arrival of a new Aquarian age of progressive environmental business. Barack Obama prophesied that his election as president would herald the moment "when the rise of the oceans would begin to slow, when our climate would begin to heal".

The arrival of the global financial crisis, coinciding with the failed Copenhagen climate talks, put an end to all that. For a while it looked like the sector might escape Armageddon, pivoting from sunlit optimism to industrial planning, co-opting the world's stimulus programmes with talk of green jobs and shovel-ready projects.

Over the past two years, however, the full challenge facing the sector has been revealed. The Wilderhill New Energy Global Innovation Index, or NEX, which tracks 96 clean energy stocks worldwide, has underperformed the S&P 500 by 53 percent since the end of 2010. The sector is dotted with the wreckage of former darlings like Q-Cells SE, Solyndra LLC, Solar Millennium AG and Evergreen Solar Inc. Even leading companies like Vestas Wind Systems A/S, Hoku Corp and Panasonic Corp. are having to lay off staff.

The U.S. wind industry is facing the likely expiry of its Production Tax Credit at the end of this year just as it tries to climb a

wall of cheap unconventional gas. In Europe, feed-in tariffs are being reduced or removed. In every sector there is more manufacturing capacity than there is demand.

Is this the inevitable end of every clean energy boom? Was the whole cleantech thing just a bubble? Are we now back in the new normal?

The answer to all of these is no. What we are seeing is an industry in transition. Six different transitions, in fact, all happening at once. Each one on its own challenging, all together, painful. But six transitions which will see the emergence in due course of a fully mature and competitive clean energy sector.

ECONOMICS

The first transition relates to the economics of clean energy.

In the past, the cost of clean energy was so much higher than fossil alternatives that project developers based investment decisions largely on the generosity of subsidies or support mechanisms available in any location. Now, as a result of dramatic recent reductions in clean energy costs, the industry is shifting towards one where revenue from power sales – and therefore the level of electricity prices and the quality of renewable resources – drive investment.

Latin America is arguably leading the way, with capacity being built in Brazil, Chile and Mexico on the basis either of market electricity prices, or of auctions in which wind has actually out-bid fossil fuel opponents such as gas-fired generation. Among the large projects recently financed in that region without European-style subsidies, Macquarie Mexican

Infrastructure Fund in February tied up \$693 million in debt for its Marena 396-megawatt wind project in Mexico, and in May, Siemens AG landed a contract for turbines for a 115-megawatt wind project north of Santiago in Chile. In March, Mexican industrial conglomerate Grupo Musa said it was developing a \$1.4 billion photovoltaic project in Baja California to reduce – yes, reduce – its power bills.

Spain will be an acid test of the appetite for non-subsidized clean power. Two years ago the Spanish government made retroactive changes to the feed-in tariff regime; now the sector is being threatened with new taxes. However, some developers are bouncing back by announcing huge PV projects made economic – they hope – by tumbling hardware costs and high electricity prices, rather than by subsidies. In May, for instance, German companies Wuerth Solar GmbH & Co. and Gehrlicher Solar AG said they planned to build PV parks of 287 megawatts in Murcia and 250 megawatts in Extremadura respectively. Their plan, contingent on government approval, is for construction to start in 2013-2014.

In solar, we are already at the point where small-scale, residential PV can produce power at a levelized cost below the retail electricity price in several important countries – including Germany, Denmark, Italy, Spain and Australia. This does not mean that it is economic for households to go off-grid and generate all their power from rooftop PV, but the economic case is there for panels to produce at least a proportion of total needs. Geothermal power and waste-to-energy have been fully competitive for some time.

The second transition involves the impact of renewables on the wider power sector. For a long time, wind and solar were so tiny in terms of power contribution that they had a negligible impact on wholesale power prices. Now,

in places as far apart as Germany and Texas, the percentage of renewable generation has reached a point at which it is starting to move prices, changing the returns for conventional as well as for clean energy generators.

In Texas on June 22, wind power output reached 8.4 gigawatts, a new record. Wind was supplying 17.6 percent of the total system load at one point, thanks to high winds. That was far from a U.S. state record: on April 15, wind met 57 percent of Colorado's power needs. In Germany on May 25, solar power generated a massive 22 gigawatts of electricity per hour, enough to meet 50 percent of national electricity demand. Such peaks of renewable supply put extreme downward pressure on spot power prices, because the marginal cost of production from fuel-free technologies is zero. In fact, the Texas wind surge pushed electricity prices in the Texas West Hub below zero for 2.5 hours, something that has also been seen in Denmark and Germany; in the U.K., wind farms in similar situations have been paid to stop generating.

In one sense, this development is good for renewables, as it demonstrates to a skeptical public that investment in clean energy can result in lower, rather than higher, power prices. In another sense, it is not so good, because it begs the question of how countries can maintain a stable power system when intermittent

generation depresses power prices and makes them so volatile.

Policy-makers have a range of tools to deal with the issue, the main one being to bring in incentives to maintain peaking capacity. Generators need to know that it is worth their while building capacity – often in the form of gas generators – which can quickly be switched on when the wind does not blow and the sun does not shine. Other tools include incentives for storage technologies such as batteries and pumped hydro, investment in demand response, and interconnection with neighbouring countries. All of this will require a new, more sophisticated mind-set from regulators. A mistake can create windfall profits or slam the brakes on investment, or both, and it is a high-stakes game, keeping the lights on as old nuclear and coal capacity is retired. It will take a while until regulators everywhere figure out how to play this new game, and in the meantime the clean energy sector has to tread carefully.

Transition three relates to the emergence of a mature supply chain, one which will be dominated by sophisticated industrial players with advanced capabilities in quality assurance, cost engineering and investment planning.

In the early years of the century, as clean energy took off, its technology providers were nimble start-ups, long on

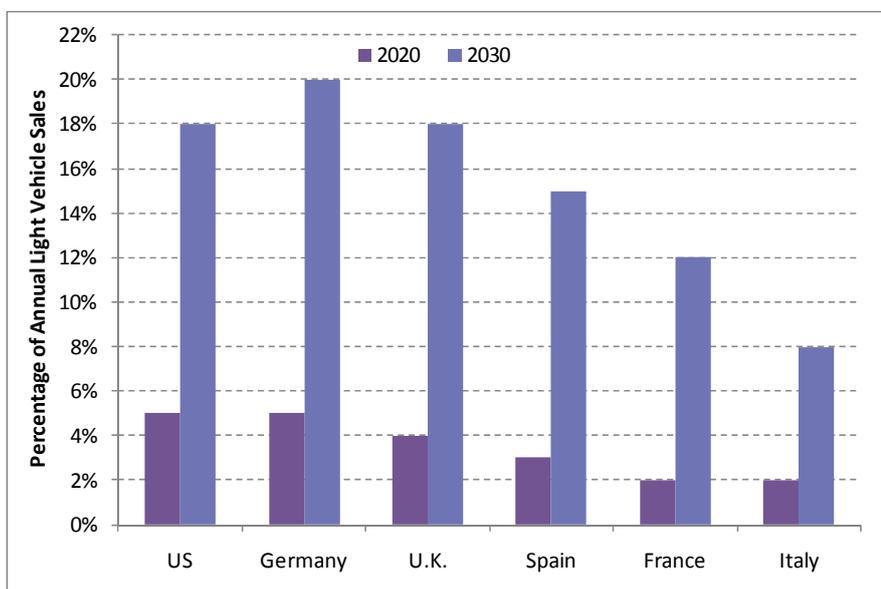
vision and technology, but short on operational skills. During the go-go years, there was enough market demand and enough capital for these companies to survive. No longer. There is a clear trend for major industrials to take the lead in clean energy markets. Any small players who are not on the steepest of learning curves are not going to make it.

ACQUISITIONS

Some of the majors are getting into clean energy by opportunistic acquisition. First movers were General Electric Co., with its 2002 acquisition of Enron Corp's wind business and Siemens, with its take-over of Bonus Energy A/S in 2004. Some component makers too have fallen into larger hands, including gearbox maker Hansen Transmissions International NV, bought by ZF Friedrichshafen AG last summer. However, in wind, acquisitions have not been the preferred route so far. While there has been plenty of talk about possible takeovers of major players like Vestas, Suzlon Energy Ltd. and Gamesa Corp. Technologica SA, there have been no formal offers yet. Enercon GmbH too was on the target list until this year, when its founder announced his intention to place his shares in a foundation. Offshore pioneer Bard Holding GmbH has been looking for some time to find a buyer. Meanwhile engineering giants like Mitsubishi Heavy Industries Ltd. and the Korean shipbuilding players now moving into offshore wind have so far opted to build their own operations, rather than make acquisitions.

In PV, there have been some acquisitions of module-making specialists by industrial groups, including Robert Bosch GmbH's takeover of ErSol Solar Energy AG in 2008 and Total SA's purchase of 60 percent of SunPower Corp. last summer, though neither of those buyers is thought to be particularly enamored with their deals. Meanwhile most of the other PV supply chain manufacturers, from Suntech Power Holdings Co. to Trina Solar Ltd. and SMA Solar Technology AG to Renewable Energy Corp., remain – for the moment – in the hands of investors, rather than large corporate owners. Production of silicon is split between specialists and major players. Suppliers of production equipment have seen some M&A activity, with Meyer Burger Technology AG buying Roth & Rau AG in 2011. Some of the most significant

Electric Vehicles May Be 20% of German Light Vehicle Sales in 2030



Source: Bloomberg New Energy Finance.

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industrial groups entering the solar market have chosen to do so organically, rather than by acquisition – most recently GE with its thin-film announcement last year, and Foxconn Technology Co Ltd, the Taiwanese contract manufacturer plotting its entry into the module business.

In some of the secondary areas of clean energy outside wind and solar, industrial giants have been more prepared to make acquisitions. In solar thermal, Siemens has mopped up niche players such as manufacturer and developer Solel Solar Systems and thermal receiver firm Archimede Solar Energy, while Areva SA absorbed Ausra Inc. In the fledgling area of marine power, as we wrote in this column last month, the likes of Siemens, ABB Ltd, Andritz AG, Rolls-Royce Holdings Plc and Alstom SA have bought into specialist device makers.

In biofuels, enzyme producer Verenum Corp has gradually seen its next-generation biofuel assets acquired by BP Plc. Likewise, DuPont Co. bought enzyme company Danisco A/S last year.

In smart grid in 2011, Toshiba Corp. bought electronic metering leader Landis+Gyr AG, and Schneider Electric SA took over distribution management software provider Telvent GIT SA. Then, Eaton Corp. acquired electrical grid equipment maker Cooper Industries Plc in May this year; more recently, Siemens snapped up Senergy Sistemas de Medicao SA, a smart-metering business previously owned by Brazilian company Nansen SA Instrumentos de Preciso; and ABB purchased wireless communications firm Tropos Networks Inc, in order to gain control of the latter's GridCom mesh networking technology.

Other areas have been slower to consolidate through acquisition, including batteries, where growth in manufacturing capacity has run far ahead of demand, particularly among companies hoping to serve the electric vehicle sector. Start-

ups and relatively small technology players remain prominent, though their difficulties are obvious – as exemplified by the bankruptcies of Valence Technology Inc. and Ener1 Inc. This month saw China's largest auto parts company, Wanxiang Group Corp., sign a non-binding memorandum of understanding for a multi-stage deal that could see it ultimately acquiring 80% of troubled A123 Systems Inc. The deal is subject to all conditions being met for each stage, and Wanxiang exercising all of its options for each stage. However, it can only be a matter of time before the battery sector too is dominated by the big boys.

Whether they grow their clean energy businesses organically or by acquisition, the shift of supply from independent specialists to major industrials will have profound effects. Costs will continue to come down as these companies bring their formidable purchasing and operational skills to bear. These suppliers have real balance-sheet power – they can promise long-term service contracts and stand behind their products with meaningful warranties; they may even be able to extend vendor finance to smaller customers. And major engineering companies have powerful friends – they can draw on webs of alliances and play the lobbying game in a way that start-ups can only dream about. Once the big engineering companies are in the driving seat, the world of clean energy will be a very different place.

ADVANCED TRANSPORTATION

The fourth ongoing clean energy transition relates to advanced transportation. We are still very much in the calm before the storm. The modern pioneers of the electric drive-trains, Toyota Motor Corp. and Tesla Motors Inc., have been followed by the nimbler giants, Mitsubishi Corp., General Motors Co. and Renault-Nissan. But 2013 will see a veritable flood of new electric and plug-in hybrid models from major

manufacturers – Bayerische Motoren Werke AG, Volkswagen AG, Daimler AG, Ford, Fiat SpA, Honda Motor Co. and so on. Every car company is now betting in some way on electric; even Chrysler Group LLC is experimenting with a hybrid Dodge Ram.

Electric vehicle sales are increasing, though from a modest base. Bloomberg New Energy Finance estimates that sales of EVs worldwide in the first half of 2012 were more than 45,000, equivalent to nearly 90 percent of the figure for the whole of 2011. This will not be enough to meet the 320,000 unit target auto manufacturers had aimed for in 2012, but each new model brings an advertising budget, each sale adds to the pressure to grow the charging network. Increased volume means lithium-ion battery prices are falling steeply, and are set to go on dropping. The market appears to have self-sustaining momentum, aided by the same \$100 oil price that is also fuelling interest in natural gas-fuelled vehicles. A tipping point, at some stage, beckons, provided there is no strong reversal of current policy priorities.

In due course the uptake of electric vehicles will have a substantial impact on fuel use and transport patterns, as well as on electricity demand and the architecture of the grid. But for the moment, all this lies beyond the imagination of most road users, and beyond the investment horizon of most companies. The clean energy industry can do little more than wait and hope.

The fifth transition that the sector is navigating relates to biofuels moving from first-generation to next-generation. Bloomberg New Energy Finance forecasts that world biofuel output will increase threefold between now and 2030 – reaching 558 billion litres per year. More importantly, the mix may change completely: in 2010, next-generation feedstock such as cellulosic biomass residues and dedicated energy crops accounted for less than 1 percent

of total biofuel production; by 2030 this could be as high as 60 percent, if technology improves, and costs fall, as much as the industry hopes.

Next-generation biofuels have been attracting the lion's share of venture capital and private equity going into the renewable fuels sector for over five years now. According to our data, first-generation biofuels such as corn ethanol and rapeseed biodiesel attracted \$1.2 billion in 2006, against just \$216 million for next-generation fuels based on converting non-food crops and waste. By 2010, the tables had been turned completely, first-gen attracting \$84 million against next-gen's \$606 million. In 2011, it was a mere \$14 million for first-gen and \$802 million for the next-gen.

Indeed next-gen biofuels has been one of the few areas of clean energy to enjoy a rising tide of money from the recession-battered VC/PE industry. Venture funds have not been funding the likes of algae-based fuels maker Sapphire Energy Inc., which landed \$144 million in the second quarter of this year, out of the goodness of their hearts. They have been doing it because they perceive the potential for substantial industry growth. So have the likes of

Royal Dutch Shell Plc, BP and Exxon Mobil Corp, which have also been heavy investors in the sector. Our analysis, published during the World Economic Forum in Davos this year with the support of Novozymes A/S, shows that using 17.5 percent of agricultural waste in eight regions of the world could supply 50 percent of the world's transport fuels. In a few years, we will be seeing a battle royal for the future of transportation between next-gen biofuels and electrification. But not quite yet.

The sixth and final transition is the one I wrote about in this column in June – the shift from a narrow to a broad geographical base. A few years ago, investing in clean energy meant investing in Europe, Brazil or North America. Then came China and Korea. Now, new Latin American countries are in play, from Chile and Mexico to Nicaragua and Panama, which did so well in the inaugural ClimateScope index we released with the Inter-American Development Bank at Rio+20. Last year, India was the fastest-growing major clean energy market, and its recent black-outs will give manufacturers new incentives to secure their own power. Since the Fukushima nuclear accident,

Japan is back in the clean energy game. With solar power now fully competitive with kerosene and diesel, Africa is waking up, as is the Middle East.

At the beginning of this sixth transition, clean energy was a rich-man's game, restricted to wealthy democracies willing to buy indulgences to assuage the guilt of fossil-fuel reliance. At the end of it, clean energy will be simply another part of the energy mix, available in some form anywhere in the world, economic, ubiquitous, attractive.

This is the real narrative behind the growing pains of today's clean energy industry. The great clean energy squeeze of 2010-2012 does not herald the end of the sector. Just as the disappearance of 497 U.S. car companies between 1903 and 2000 did not herald the end of the automobile. Just as the bursting of the dotcom bubble did not herald the end of the Internet and the collapse of telecoms valuations did not herald the end of the mobile phone industry.

Six transitions. Six painful processes, which together will reveal the mature form of the clean energy industry. Clean energy is dead. Long live clean energy!