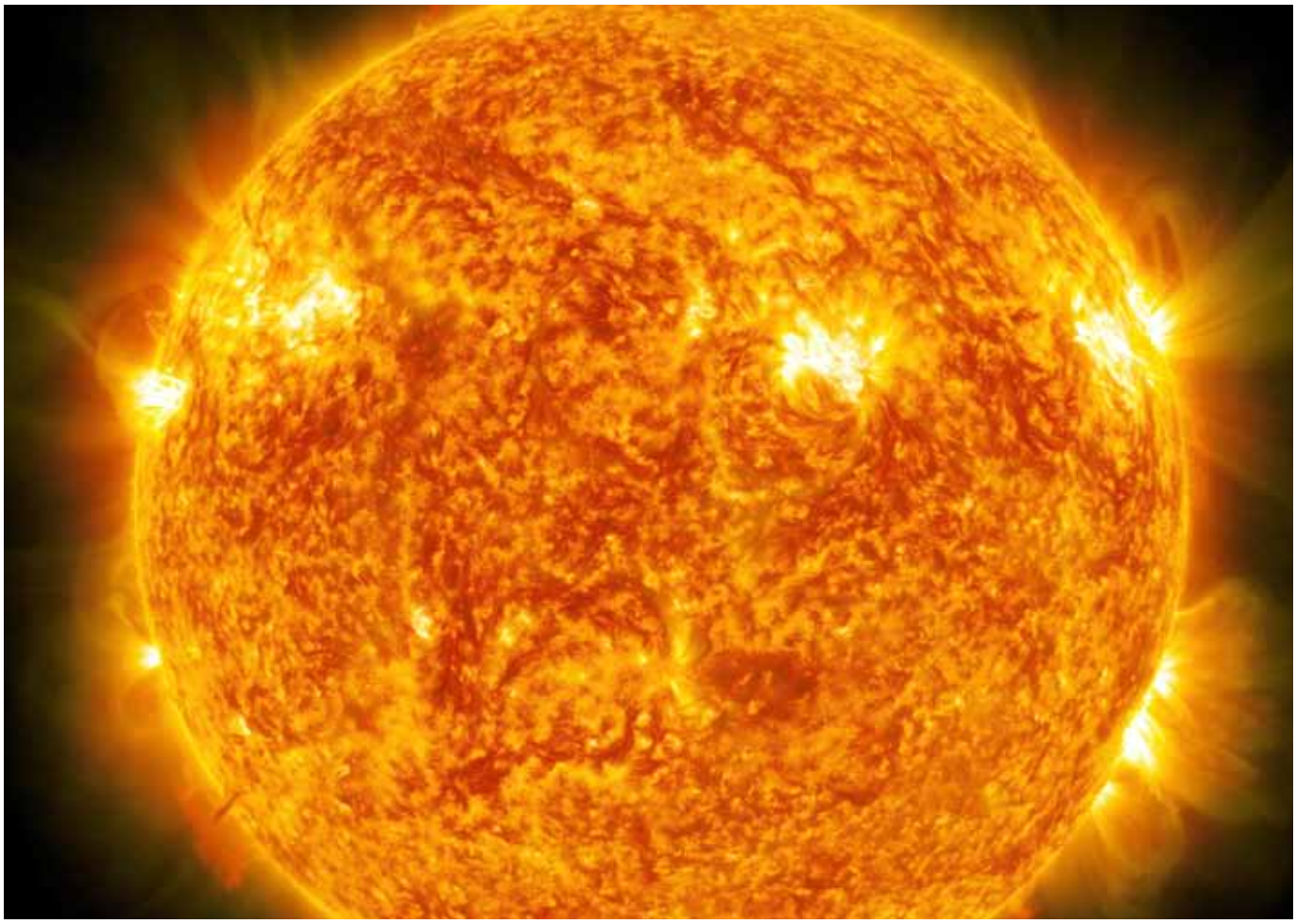
A new energy paradigm readies for take-off



Hot ticket: the sun supplies the Earth with $1.5x10^{22}$ joules of energy every day

THIS year, if all goes to plan, Bertrand Piccard and Andre Borschberg will be the first pilots to circumnavigate the world in a solar-powered plane. Solar Impulse 2 will be the only aeroplane of perpetual endurance, able to fly day and night without a drop of fuel, thanks to its thin-film solar cells, clean energy motors and super-efficient batteries. The plane's engine does not power down and then turn off when the sun goes down.

Of course, the plane is not commercially viable. Everything has been built with lightness in mind. The gangly aircraft has wings wider than a Boeing 747 jumbo jet, but is still lighter than the average family car. There's only one seat, so the plane will stop at various points during its five-month world tour, set to begin by March, to change pilots. In fact, the only thing preventing a non-stop flight is the crew who need to restock on supplies, rest, and drop off waste every few days.

Still, billed as an exploration to change the world and help improve the quality of life on our planet, the around-the-world-flight is designed to show that clean energy air travel is a possibility.

It also illustrates many of the shifts under way today – thanks to improving technology and rising efficiency – that are making energy cleaner, more plentiful, easier to distribute, cheaper to store and capable of being used more intelligently, whatever the oil price.

The mainstream media has tended to focus on the effects of crashing oil prices on the shift towards low-carbon energy. But the story may not be so much what falling oil prices mean for clean energy, than what the prospects of clean energy mean for the oil price, argues Michael Liebreich, chairman of the advisory board at Bloomberg New Energy Finance.

The International Energy Agency (IEA) estimates the world will need to find $23 trillion over the next 20 years to fund continued fossil-fuel extraction, but the prospect of much cheaper solar power and storage capability may put investors off, Edward Lucas, an energy specialist at *The Economist* wrote recently.

And demand for fossil fuels, particularly oil and coal, could be curbed if global leaders agree on a path to cut carbon emissions late this year at a climate change meeting in Paris. Gas, being the cleanest-burning fossil fuel, should benefit at coal's expense, in any managed transition to low-carbon energy systems. But the ultimate goal is zero-carbon systems, otherwise the planet will be cooked by global warming, predict climate scientists.

Even based on present climate-change policies, demand for fossil fuels in the world's two biggest energy consumers will take a hit. A recent bilateral agreement unveiled between the US and China to slash emissions could see the two countries' oil demand reduced by more than 15 billion barrels of oil over the next 15 years, reckons Lord Browne, former chief executive of BP and now a board member of UK shale explorer Cuadrilla Resources.

"That represents a huge potential destruction of value,

and is a major long-term risk to any oil producer," he said. Browne – who as a partner in private equity group Riverstone Holdings, co-heads one of the world's largest renewable energy funds – advocates that energy companies should seek to diversify their businesses into low-carbon technologies, as falling prices for wind, solar and other renewables, make green energy an increasingly attractive business proposition.

Yet most of the international oil companies appear to be taking little notice – save, perhaps, for the likes of Norwegian national oil company Statoil and French major Total. Both have been singled out as potential candidates to make a managed retreat from the oil and gas business. If they did, it would mark an unprecedented step for the industry, and they would be following in the footsteps of European utility E.ON, which recently announced it will spin off its fossil fuel assets into a legacy company to focus on its core future-oriented renewables business.

"Combined with international efforts to curb climate change, calls for universal access, and a growing demand for energy security, I believe it is no longer a matter of whether but of when a systematic switch to renewable energy takes place – and how well we manage the transition," Adnan Amin, director general of the International Renewable Energy Agency (Irena), said in the Abu Dhabi-based non-government organisation's 2014 report *Rethinking Energy*.

While progress has been made across the spectrum of energy use, it is electric power that has driven much of the present transformation.

The expansion in solar, which made up almost half of clean energy investment in 2014 at nearly $150 billion, its highest share ever, continues to surprise as costs plummet. The IEA expects the cost of solar panels to halve in the next 20 years. By 2050, it predicts that solar will be the largest provider of global electricity – fuelling 27% (solar photovoltaic and thermal) of supply. The usually conservative Paris-based agency has consistently underestimated the growth of renewables in the past.

Big banks like Citigroup, UBS, and Deutsche Bank are forecasting that unsubsidised solar will become the cheapest form of new power generation by 2020.

Transformation

Indeed, the power sector is changing so quickly that policy makers are finding it hard to keep up. Solar photovoltaic costs alone fell by two-thirds between the end of 2009 and 2013 – a speed of change comparable to that seen in the IT revolution. In Denmark, wind recently became the cheapest energy source of all, beating coal. In Germany, almost half of all renewable-power generation is owned by households and farmers, marking a profound shift in control.

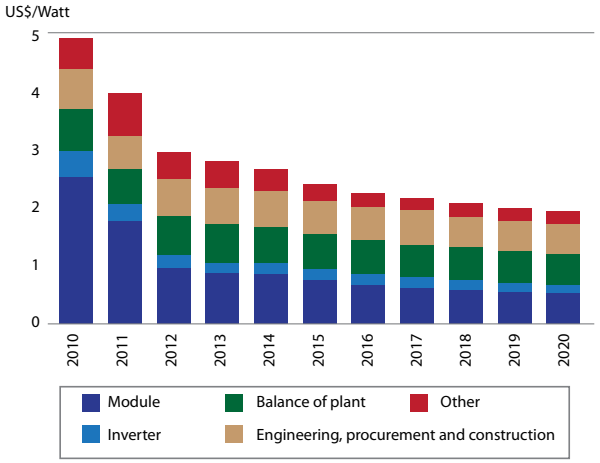
Elsewhere, renewables are showing real commercial promise in places as diverse as India, Chile, the United Arab Emirates, Hawaii and parts of Africa, where the climate is favourable, costs are low and other sources of power expensive. As subsidies fall renewables capacity is rising. There is good reason to expect renewable energy will continue its exponential growth. Innovation is driving advances and cutting costs in technologies at such a rapid pace that it's hard to imagine what the next few decades will bring.

And it's not just first-generation renewable energy, there are other potential technologies, such as fusion electricity, micro-nuclear power, space-based solar, subsea tidal turbines, as well as fuel cells and hydrogen vehicles, that could meet surging demand for energy in a low-carbon manner.

A breakthrough in fusion power, which could yield limitless amounts of carbon-free electricity, would be revolutionary as it would be the only non-fossil fuel able to provide baseload power.

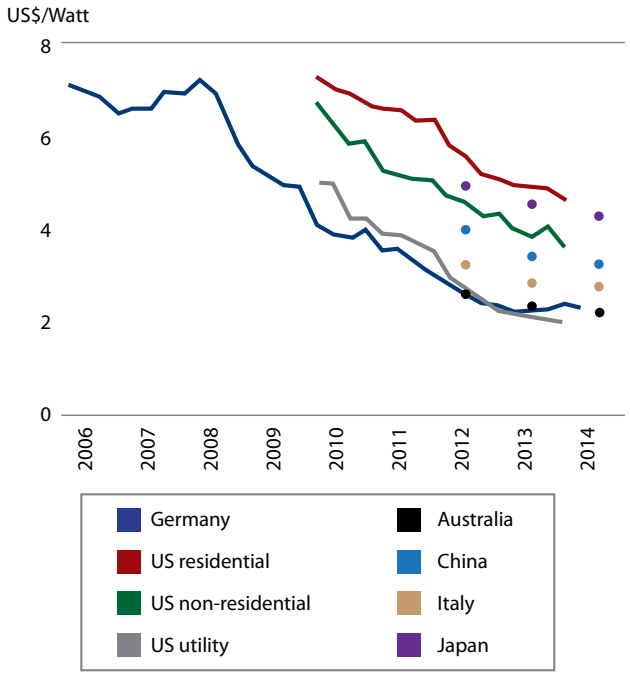
Even the idea of aeroplanes powered by small fusion reactors has been mooted as a possibility within a decade or so. It might sound far-fetched. But 10 years ago, the notion of a solar-powered plane circumnavigating the world was almost inconceivable. **DE**

Figure 1: Projected solar PV system deployment costs



Source: IRENA

Figure 2: Solar PV system costs by country



Source: IRENA, Costing Alliance