The future of photonics

To celebrate the tenth anniversary of the launch of *Nature Photonics*, we asked eight sets of experts (in the fields of photovoltaics, X-ray science, imaging, terahertz technology, quantum optics, plasmonics, organic optoelectronics and optical communications) to write a set of short, easy-to-read, opinion articles on how their fields are likely to evolve over the next ten years. On the following pages, you can read their thoughts on the trends, challenges and possible achievements for a variety of important areas of photonics. These are complemented by a graphical representation of the Nobel Prizes related to photonics that have been awarded since our launch. We hope you find the section to be illuminating, informative and thought provoking.

A new era for solar

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The field of photovoltaics has grown tremendously over the past decade and in 2015 solar cell deployments accounted for 20% of the expansion of global electricity capacity.

In December 2006, when *Nature Photonics* published its inaugural issue online, the world had installed ~7 GW of photovoltaic (PV) electric power capacity[1]. Ten years later by the end of 2016, total PV installations are expected to reach ~300 GW (ref. 2), a factor of 40 increase. This past decade marked the beginning of the global clean-energy revolution, with both wind and PV starting to impact global electricity production, as shown in Fig. 1. During this period, the rate of deployment and price of solar energy have both changed dramatically. The deployment rate of PV has increased by a factor of 25, to ~50 GW per year, representing ~20% of global electricity capacity added in 2015 (Fig. 2c). Furthermore, the global average module price has dropped from US\$4 W^{-1} in 2006 to US\$0.40 W^{-1} in 2016[3,4]; and system prices dropped from US\$7–10 W^{-1} to US\$2–4 W^{-1} during the same period[4].

The 1954 breakthrough invention of the silicon p–n junction has evolved from an expensive curiosity to the heart of a major industry that supplies significant electricity. For example, it can be estimated from ref. 5 that solar provided 13–14% of California's electricity during 2016.

However, it is important to remember that the global electricity system was built over the course of a century and, given its massive scale, could take decades to change. Both the scale of the challenge and the recent rate of change are illustrated in Fig. 2. Figure 2a shows that solar accounted for only ~1% of electricity generated in 2015. Figure 2b, which plots the commonly quoted electricity capacity, shows a solar slice that is 2.5 times wider than that in Fig. 2a, illustrating that (because solar plants operate only when the Sun is shining) a megawatt solar plant delivers only ~40% as much electricity as the average megawatt conventional plant. In contrast, nuclear plants usually run day and night, so deliver more electricity (Fig. 2a) for their rated power (Fig. 2b). Figure 2c shows that PV accounted for ~20% of new electricity capacity added in 2015, demonstrating that the role of PV in annual additions (~20%) is much greater than its current contribution to electricity generation (~1%).

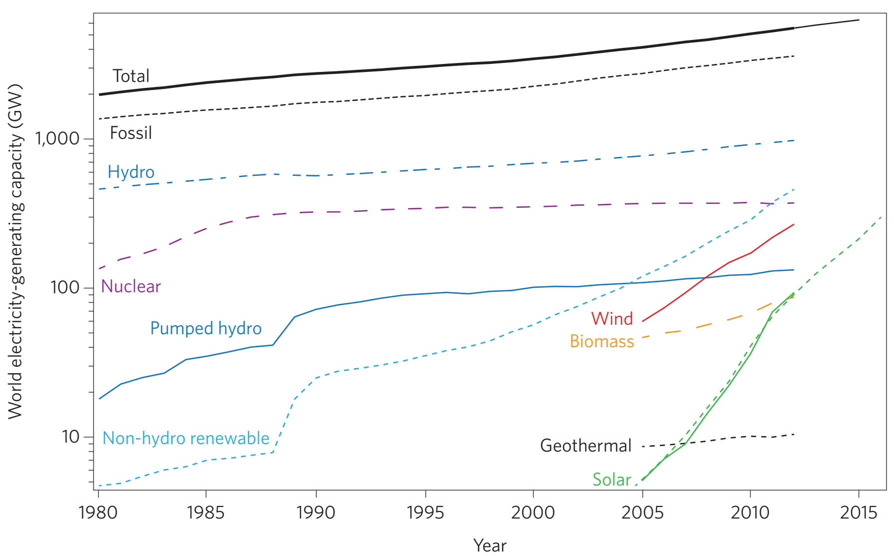

Figure 1 | World electricity-generating capacity by energy source. Data before 2012 are from ref. 12. More recent data (2012 onwards) are from ref. 13 (for 'Total', thinner black line) and from ref. 1 (for 'Solar'; dashed green line, which shows good agreement with data from ref. 12 up to 2012).