Firm Power Parity: A Framework for Understanding the Disruptive Threat of Solar + Storage
Electricity from solar photovoltaics and wind turbines has become cost-competitive with traditional power generation in markets all around the world. Hundreds of billions of dollars in private sector investment are flowing into renewables as a result. There is no doubt that technological innovation is moving the world towards a cleaner energy system.

Yet it remains unclear where, and exactly when, it becomes profitable for consumers to switch away from grid-supplied electricity to clean, on-site power generation. At the heart of this financial consideration is the notion of cost parity.

In the case of renewable energy, “grid parity” describes the point of economic indifference between the cost of on-site renewable energy (e.g., rooftop solar) and the cost of conventional supply. At current solar photovoltaic (PV) prices, grid parity (without storage) is now a reality for most residential consumers, regardless of the country in which they live. Given the historically high cost of solar energy, that’s an extraordinary achievement.

But as the renewables industry evolves, so too must the language about cost-competitiveness. The notion of grid parity misses the big question going forward: Where and when will it be profitable for consumers to outright disconnect from the grid?

Given the conceptual limitations of grid parity, we have developed a new framework. We call it firm power parity. Building on the notion of cost equivalence, firm power parity is the moment in time at which on-site renewables deliver the same service at the same cost as conventional electricity supplies. Firm power is available when the wind doesn’t blow, or the sun isn’t shining.

This document provides highlights from the academic working paper that develops our framework and forecasts profitable switching in six major cities around the world. Our number-crunching indicates that despite tremendous advances in technology costs, re-creating high-availability, grid-connected power will not be easy. Cheaper solar + storage will disrupt the electricity supply industry, but it is unlikely that residential consumers will be leading agents of these changes.

See working paper at: http://ssrn.com/abstract=3031992
Recognizing the practical difficulties of grid parity, we developed a new concept. Firm power parity is the point in time when renewable energy technologies provide a similar service at a lower cost than grid supplied electricity.

Our framework is constructed using a 3x3 matrix, which allows for differentiation by three distinct consumer types (residential, commercial, and wholesale) and the three levels of energy services (i.e., PV energy-only, PV energy levelized over a day, and PV energy levelized over a year). The framework provides a more comprehensive outlook on market development than grid parity alone and allows for easy comparison between different regional markets.

We have initially focused our techno-economic modeling on four points within the firm power parity matrix. As access to finance is a key driver for technology uptake, we developed cost of capital scenarios that reflect a range of potential macroeconomic conditions over the next 20 years.

We employed a traffic light system to indicate when parities have been achieved (green), are close to being reached (yellow) and far from being achieved (red). The system provides an easy-to-understand indicator of the profit opportunity for consumers in a given market, at a given time.

Our modeling on solar PV and lithium-ion battery costs was conducted using data from a global literature review and estimates by researchers at Imperial College London. The analysis employs Monte-Carlo Analysis with a large number of simulations (n=1000) to generate central case projections. Full details of our methodological approach can be found in the academic working paper.

Our analysis does not yet account for the value obtained from a variable or time of use (TOU) tariffs, which would likely act to accelerate the date of firm power parity. Furthermore, it does not incorporate the social costs greenhouse gas emissions from grid-supplied electricity. To keep things simple, we fixed the price of electricity in each market, keeping it constant in 2017 real money terms throughout the forecast period.

Below are visual highlights from one of our six case studies. Despite the relatively small amount of annual sunlight, London is currently at a state of residential energy-only parity for consumers with a low cost of capital. Assuming no changes to real electricity prices and no compensation for services provided to the network, it will take at least another decade for households to install solar PV power generation with day-storage profitably.

**Case Study: London over the period 2017-2030**

Full results for London, New York, Munich, Bangalore, Johannesburg, and Santiago can be found in the academic working paper. See working paper at: http://ssrn.com/abstract=3031992
The advent of cheaper battery storage presents a game-changer for one of the world’s largest industries. With storage, consumers can manage a higher proportion of their electricity demand, thereby reducing what they buy from their traditional electricity supplier – or even quit the utility altogether. Mass adoption of a profitable switching opportunity by consumers, and the inevitable response by utilities to raise prices on their remaining customers, has been dubbed “the utility death spiral.” So, does the pairing of cheap solar and storage threaten to kill the electric utility business model?

Our results suggest that while it will become increasingly profitable for consumers to generate and store their own electricity, profitably disconnecting from the grid is more than a decade away in most markets. For consumers who already enjoy reliable transmission and distribution infrastructure, the cost of replicating grid reliability (even on a single-day basis) will remain significant.

There are, however, at least a billion people in the world without access to electricity. By some estimates, another billion are served by unreliable networks prone to frequent blackouts. The development of a “mini-grid” business model countries in countries such as India and Kenya demonstrates that the economics of building new private infrastructure in underserved areas are increasingly favorable. The disruptive potential of solar + storage may be most compelling in markets where the utility business model has already failed.

In summary:

We developed a new version of cost parity in electricity markets that is better suited to the competitive landscape of new and conventional energy technologies today. This concept differentiates the type of parity by the volume of service demanded and the level of service provided. To road-test the concept, we forecast the timing of four points of parity in six cities over the next 25 years.

Our London case study shows that cost of capital will be an important variable in deciding whether home battery storage is competitive in the future. Mass adoption of residential battery storage will require access to cheap financing, as already exists for other types of consumer durables.

The Centre for Climate Finance & Investment undertakes cutting-edge research on how capital markets are responding to global climate change. Building on Imperial College London’s international reputation for multi-disciplinary analysis, the Centre is helping investors and policymakers overcome the lack of clarity about risk and return in clean energy, low-carbon technologies, and green infrastructure. Our mission is to help shape a global energy transformation through the fusion of business, technology and an entrepreneurial mindset.

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