

The Disruptive Discoveries Journal

Weekly analysis of how disruption in commodities, geopolitics, and macroeconomics converge to create opportunities

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The “New” Great Game – The Race to Win an Electrified Future

In the 19th century, geopolitical tensions were at the fore as Great Britain and Russia jockeyed for position in much of Central Asia with an eye on protecting British interests in India. At risk was control of land and sea routes for trade. Ultimately, other countries including China, Afghanistan, and some in Europe would be drawn in and would set the stage for geopolitical rivalries which still exist today.

This geopolitical chess match became known as The Great Game, a phrase coined by Arthur Conolly, a British intelligence officer in India at the time. Control of land and sea meant not only economic security, but also the ability to project economic and political power far beyond one's borders. The common belief that the sun “never set on the British Empire” was at risk.

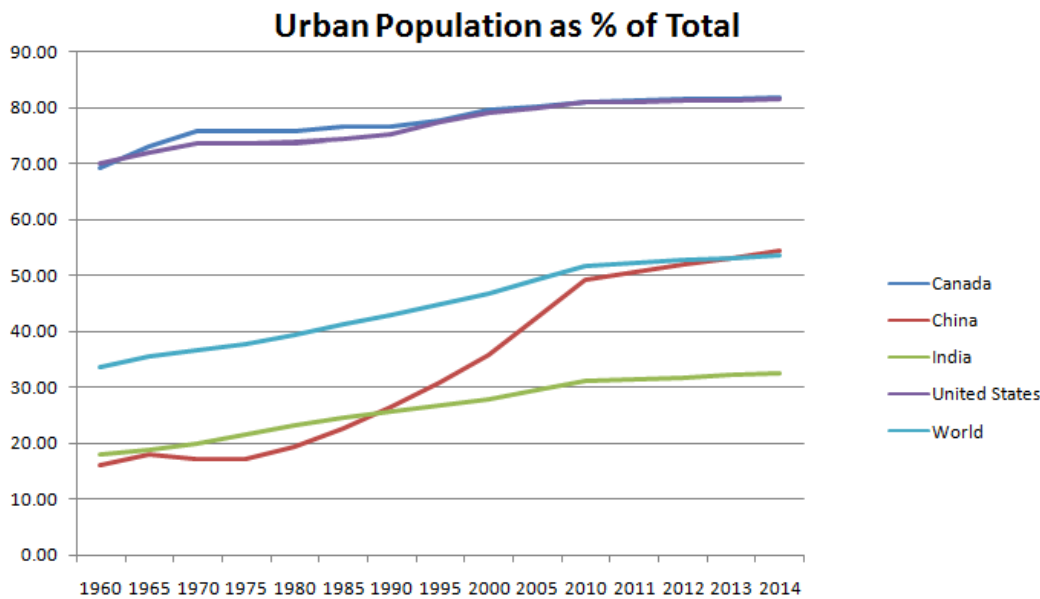
About the same time (late 19th Century) in Germany, a self-taught engineer named Ferdinand Porsche built what is widely believed to be the first electric vehicle. Mr. Porsche wouldn't found his famous automobile company until 1948. He could have hardly realized it at the time, but this invention would be the eventual catalyst for the emergence of a “new” Great Game. However, today it isn't countries that are the main players and it isn't trade routes that are at stake. The new players are companies and what is at stake is energy usage for mobility and continued enhancement quality of life.



Source: Porsche.com

Globalization, Urbanization, and Convergence

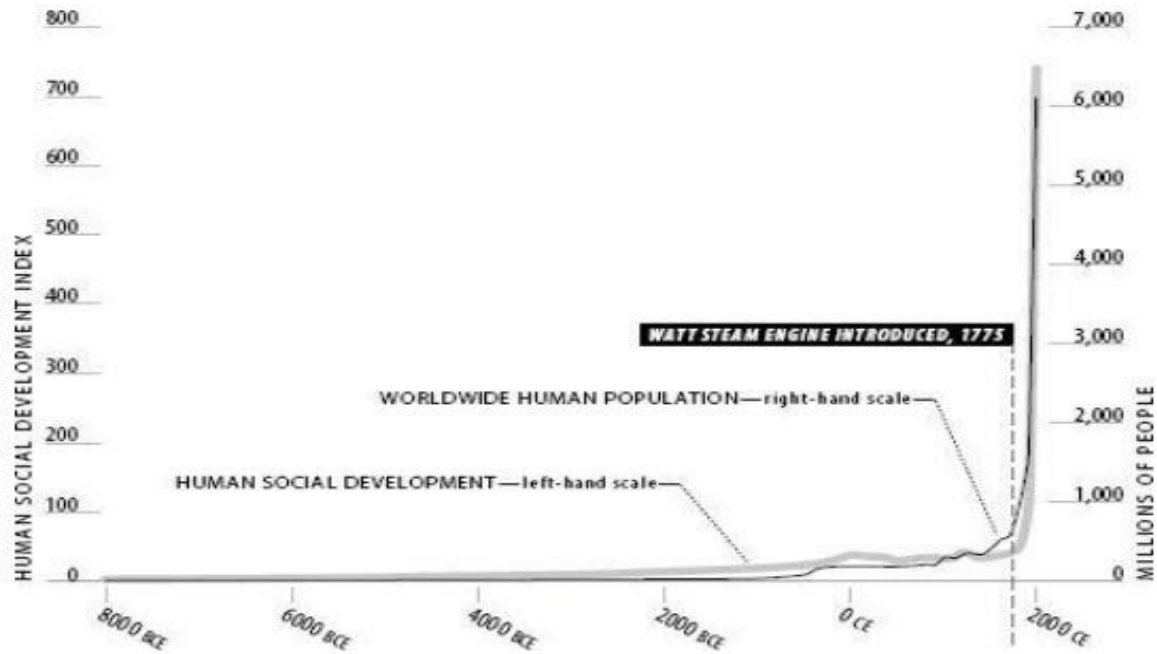
As trade routes have proliferated, trends including globalization, urbanization, and technological progress have combined to enhance the living standards of hundreds of millions of people. This phenomenon, popularized by Nobel laureate Michael Spence is also known as Convergence. The chart below from the World Bank shows this Convergence in action as urbanization in the emerging world over the past 50 years has easily outpaced the urbanization in the West. It is widely believed that a society is fully “urbanized” when the percentage of city dwellers reaches 80%. Obviously countries like China and India still have some catching up to do. There is no guarantee that they will converge any time soon. Threats like the “middle income trap” may delay this, but even coming close dictates increased raw material demands and environmental stresses. This implies that sustainability should be ranked as a driving macro force going forward.



Source: World Bank

While some of the data may be suspect and the bend in the chart is extreme, it demonstrates what can happen to quality of life when macro forces such as technology and demographics converge.

A final way to examine this phenomenon is to ascertain how quickly various technologies are being adopted globally:

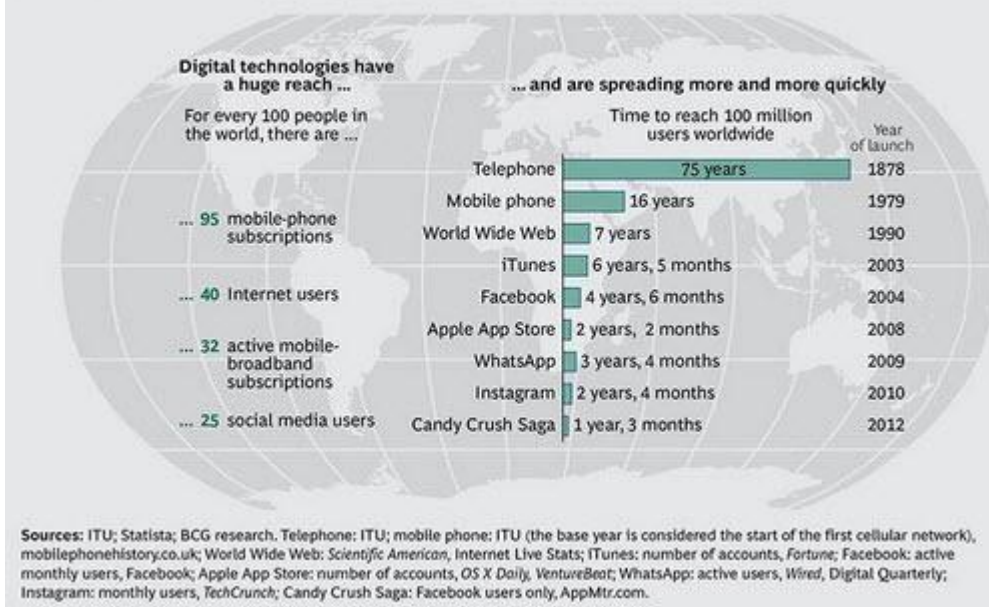


Source: McAfee, Andrew, Brynjolfson, Erik; *The Second Machine Age: Work, Progress, & Prosperity in a Time of Brilliant Technologies*

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EXHIBIT 2 | The Pace of Disruption Has Increased Exponentially



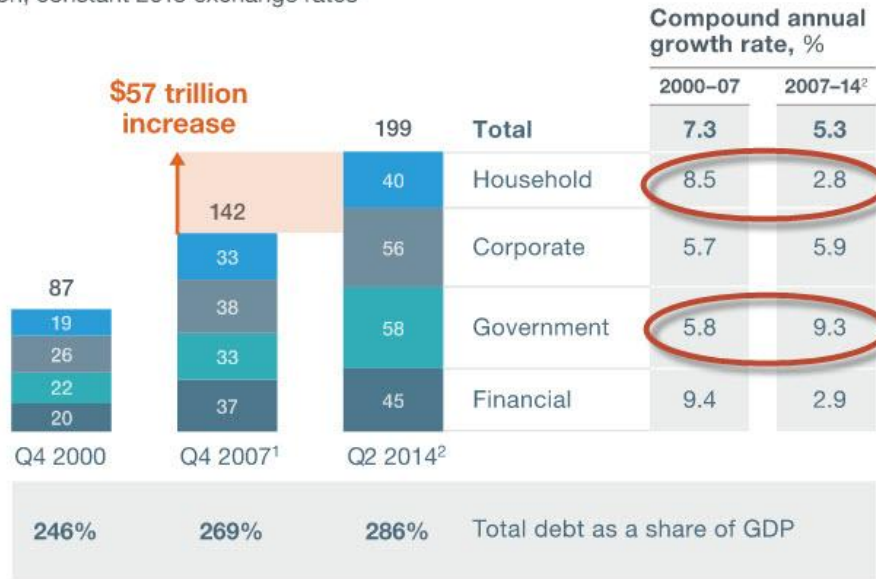
It is obvious that the invention of Candy Crush Saga does not hold the positive benefits for humanity that the invention of the telephone does (it's quite possibly detrimental if you've ever played it), but the pace and ubiquity of technology in a connected world is undeniable. The overall assessment is that it is a force for good. This speed has given the theme of disruptive technologies its prominence in recent years.

Before delving into what the future might look like as the new Great Game unfolds, it makes sense to briefly look at the current macroeconomic backdrop. This can help provide insight into how companies can move forward to gain market share and build out supply chains.

Drowning or Waving?

No commentary on economic growth over the last decades would be complete without an analysis of China, whose economic reforms have lifted hundreds of millions out of poverty and ignited the greatest urban migration in human history. It is now widely believed that China's accession to the World Trade Organization in 2001 was the spark which ignited the commodity super cycle, lasting from roughly 2001 to 2011. During this time, prices of almost all commodities – hard and soft – took off with a relatively brief intermission during the onset of the financial crisis in 2008. The repercussions from the Global Financial Crisis were blunted by central banks that flooded the world with liquidity and debt to re-ignite growth. The results, from McKinsey, are below:

Global stock of debt outstanding,
\$ trillion, constant 2013 exchange rates



Source: McKinsey

As a result of the market's belief in indefinitely higher resource prices, companies all along the mining supply chain, poured billions of dollars into capital expenditures and levered up balance sheets to take advantage.

Many resource prices peaked in 2011 and, as China's economy has begun to slow, this has placed an effective "lid" on commodity prices. The capital poured into mining projects has resulted in write offs and, worse, excess production capacity which must be worked through or written off to renew the commodity cycle. As a result, much of the global economy now suffers from excess supply, muted demand, and a large debt overhang. These all act as an impediment to growth and, when combined, are profoundly deflationary in nature.

If there is a silver lining, it is that there is a difference between "good" and "bad" deflation. It would appear that supply chains can benefit from the "good" deflation of lower raw materials prices. Downward pricing pressure can effectively "deflate" the value of end products such as lithium ion batteries or associated products. While technological advances are also responsible for this cost deflation, lower raw materials prices can tend to filter throughout the value chain.

With respect to energy generation and mobility, this thesis seems to be accurate when one looks at the prices of solar power and of lithium ion batteries, both experiencing dramatic decreases in cost (per watt and per kilowatt hour). Since 2000, lithium ion battery costs per kWh have fallen by a CAGR of 14% per year by some estimates. Technology and lower raw material prices have themselves converged to make a new energy paradigm a reality.

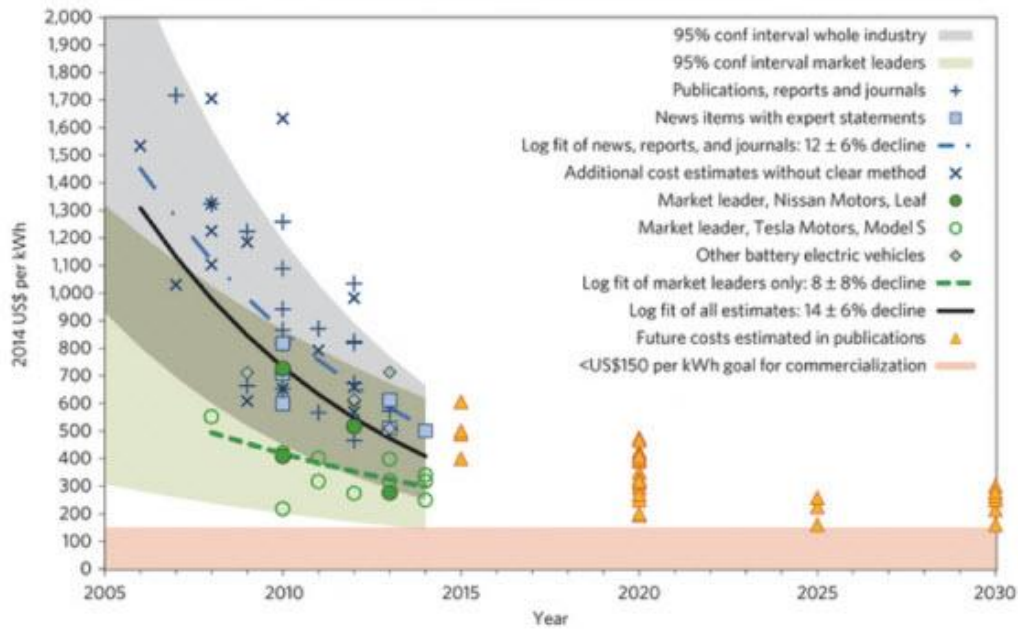
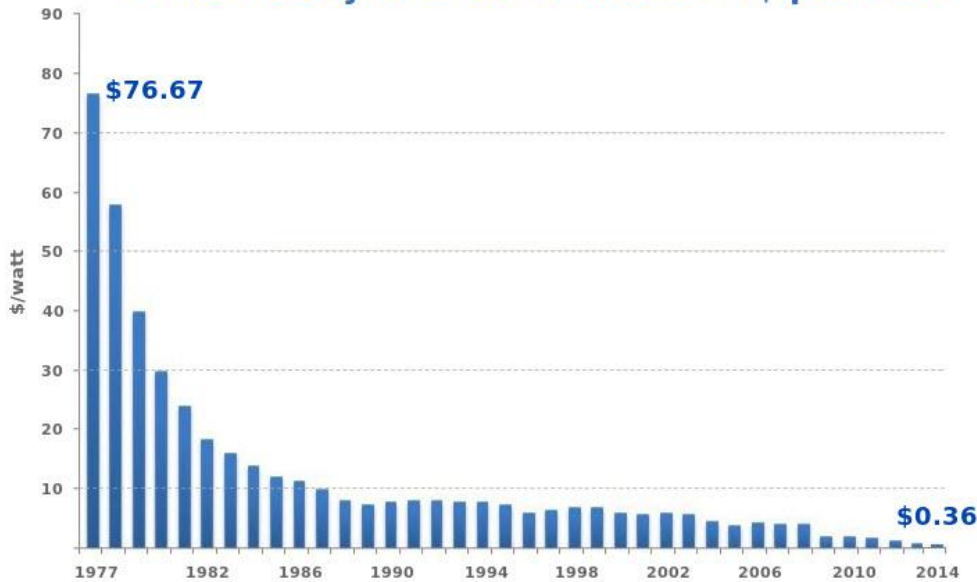


Figure 1: Cost of Li-ion battery packs in BEV. (Source: Nykvist & Nilsson, 2015)

Price history of silicon PV cells in \$ per watt



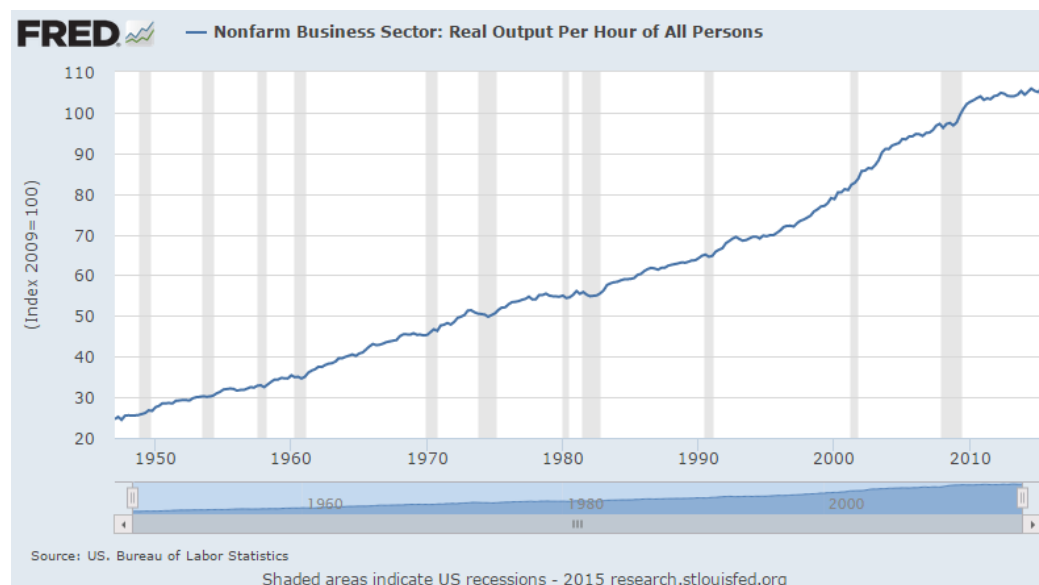
Source: Bloomberg, New Energy Finance & pv.energytrend.com

Given mean reversion in raw materials prices and increased access to cheap technology such as personal electronics, it would appear that our lives are improving at a faster pace. But is this trend set to continue? This is dependent on a number of factors including global financial stability. However, other factors are more difficult to manage. These include demographics and productivity.

Demographic changes can take decades to appear, and can work against a societies' growth rate (think about Japan) just as they can work in favor of it (much of Africa). As global lifestyle convergence continues, there is one engine of growth in particular which should be a priority for policy makers and business leaders regardless of where you reside: productivity.

Why Productivity Matters

Productivity is a measure of efficiency where more output per worker is generated with the same (or fewer) number of inputs. Essentially, as the level of productivity in a society rises, this increases wages without pressuring the overall inflation rate in an economy. The challenge for economies today is continuing to increase productivity against the headwinds of sluggish global growth and excessive debt levels.



Source: St. Louis Federal Reserve

Productivity in the United States (shown above) trends positive, however the worrying issue is that productivity growth appears to have stagnated somewhat since the Great Recession in 2008. Historically, productivity growth has been underpinned by advances in technology. Re-igniting this is crucial to continued increases in living standards and wage increases. While labor productivity has grown at roughly 2.5% per year since 1947, this growth rate has slowed to 0.7% per year since 2010.

Silicon Valley to the Rescue?

So if the need for faster economic growth is clear, where will it originate? This brings us back to the idea of a new Great Game. Again, the players this time are different in that sovereign country ambitions will take a back seat to those companies that can leverage technology most easily. The ability to create value chains and business models that are flexible enough to adapt to rapidly changing and volatile economic environment is a key strategic corporate objective.

There are a number of sectors of the economy that could benefit from productivity boosts. However, as the purpose of this article is to examine how energy is generated and used, we will focus on

vehicle electrification and energy storage as the battery business overall appears to be well placed to serve as a source for growth.

While debatable, companies like Tesla, Apple, Google, and Uber are angling to redefine how humanity views electric mobility going forward. What is amazing is that only one of these companies (Apple) was in existence before 1998 and Apple and Google were not openly involved in the automotive business – another testament to the rapid pace of technological development. Essentially in 17 years, a new crop of competitors in the electric mobility space has emerged to compete with established automotive players such as Ford, General Motors, Daimler, BMW, Volkswagen, and Audi – all of whom have been in existence for decades and are being forced to reexamine their business models. This competition is a huge positive for consumers as competition breeds innovation, efficiency, and choice.

Anyone who has studied the sector agrees that electric vehicles in their many forms (plug ins, hybrids, full EVs) are here to stay. Where people disagree however is on the degree of EV penetration. The collapse in the price of oil has led some industry analysts to downgrade their forecasts of EV market penetration. Forecasts for market penetration of all types of EVs are literally all over the map and we'd prefer to be more cautious. We've seen bullish cases for electric cars comprising about 10% of the global auto fleet by 2020 which would equate to about 10,000,000 cars. Industry analysts we have spoken with think that automobiles with electric drive trains can comprise about 3% of the global auto fleet in the coming years in a bullish case. This would equate to roughly 2,500,000 vehicles up from around 750,000 today. These trends seem aggressive, but the implications for raw material access and supply chains are profound, with each electrified drive train requiring more copper, lithium, graphite, and cobalt than in a traditional internal combustion engine (ICE) car today.

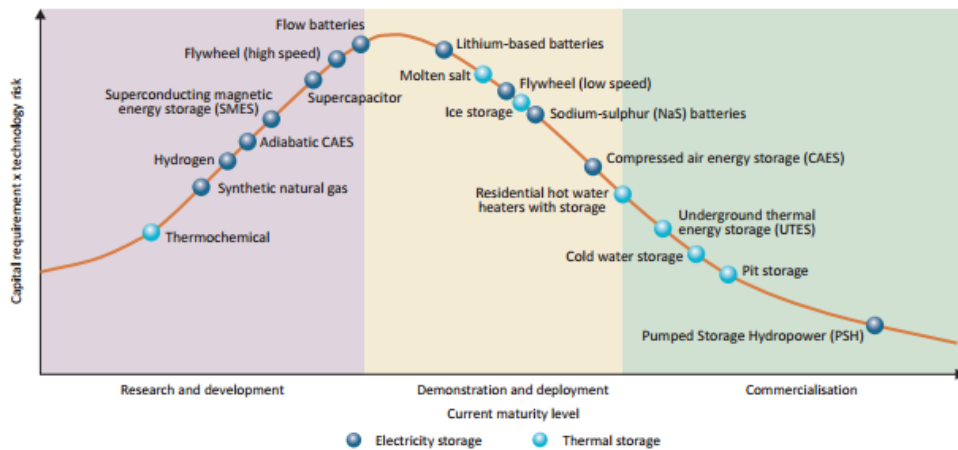
The real challenges for the new automotive players will be integration of their technologies with existing infrastructure. As an example, it was recently confirmed that Apple is working on its own version of an EV. In order to gain market share in the automotive business, these new players are faced with a typical "build or buy" choice. Would it make more sense for Apple with around \$200 billion in cash to build out its own automotive supply chains in the same way it has for its electronic products, or would it be a more impactful strategy to just purchase an automotive company such as BMW?

It may sound farfetched and perhaps a joint venture of sorts is a better starting point. However, it's really not so unlikely if any of these companies new to the automotive business really want to have an impact. Apple is clearly a victim of its own success and needs to find new markets to enter into to continue to generate adequate returns for shareholders.

Lithium Ion as the Winner (for now) and Storage as the Key

A natural outgrowth of increased electric vehicle penetration is energy storage – again centered on the battery. In this sector, the number of players is much larger as utilities, traditionally responsible for the distribution of electricity, will be involved. The key will likely be finding markets where "distributed generation", or the ability to generate, store, and use electricity both on and off the electricity grid, is feasible. Opportunities are arguably boundless as huge swaths of the population in Africa have little or no access to reliable electricity (600 million people according to the World Bank). Additionally, developed markets in the United States and Europe are all experimenting with unique financing structures which can help solar power backed by in-home battery energy storage become ubiquitous.

The chart below from the International Energy Agency provides a useful map of various battery storage technologies and where they are vis-à-vis market commercialization.

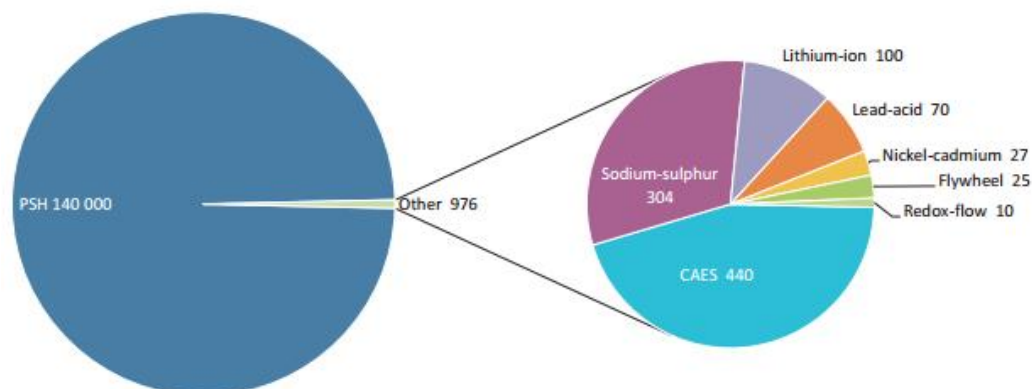


Source: Decourt, B. and R. Debarre (2013), "Electricity storage", *Factbook*, Schlumberger Business Consulting Energy Institute, Paris, France and Paksoy, H. (2013), "Thermal Energy Storage Today" presented at the IEA Energy Storage Technology Roadmap Stakeholder Engagement Workshop, Paris, France, 14 February.

The dominant companies in the lithium ion battery market include Panasonic, LG Chem, Samsung SDI, Sony, and dozens of startups intent on solving the issue of the optimal battery chemistry. Lux Research estimates that the market for EV batteries today is \$5 billion and will grow to \$30 billion by 2020. Given the potential growth rates, it is no surprise that companies like Tesla and LG Chem are promoting their own line of in-home energy storage batteries. Additionally, as established battery producers look to lock up intellectual property that can help enhance battery energy density, we would expect to see a wave of M&A wash over the sector. Alliances are already taking shape with Samsung SDI acting as battery supplier to BMW, VW, and Chrysler; LG Chem supplying General Motors, Renault, Ford and Hyundai; and of course Panasonic (the market leader with a 38% share) supplying Tesla.

Energy storage is believed by many to be the "holy grail". It involves a host of additional players including the utility sector which must maintain and upgrade the electricity grid even as these potential changes continue to unfold. Given the depth of analysis necessary for energy storage, we will publish a second note soon on how utilities will be forced to adapt to the disruptive forces of distributed generation and smart grids. In the mean time, below from the IEA is the current global size of the energy storage market.

Figure 4: Current global installed grid-connected electricity storage capacity (MW)



Source: IEA analysis and EPRI (Electric Power Research Institute) (2010), "Electrical Energy Storage Technology Options", Report, EPRI, Palo Alto, California.

Finally, as companies across the energy value chain jockey for market share, a few caveats are in order. They include myriad battery chemistries, sluggish global growth, low gasoline prices, CAFÉ mileage standards, removal of subsidies, the threat of higher interest rates, and impacts on raw material supply from weather events such as El Niño. These events vary widely their potential for impact but should not be factored in to any analysis.

Despite the many issues we read on the front pages of newspapers, one thing is clear: the world seems to be changing faster than ever before and overall for the better. To be sure, over-levered economies and companies must right their respective balance sheets, as the opportunities for profit in an era of enhanced electrical mobility are clear. In much the same way the United Kingdom and Russia raced to secure geopolitical primacy in the late 19th and early 20th Centuries, many companies like Apple, Google, General Motors, or BMW along the evolving energy supply chains of today are jockeying for position to capture a piece of a growing market and fundamentally reshape how we view mobility and energy use now and in the future.

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