

LISTED INFRASTRUCTURE

DISRUPTIVE TECHNOLOGY CREATES GROWTH OPPORTUNITIES

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- Disruptive technologies are an area of significant market interest given shorter cycles and increasing velocity of transformative innovations
- Infrastructure assets are well positioned to grow and adapt to such innovation through higher utilization of their assets
- History suggests infrastructure assets have been key enablers of technological innovation which has generated hundreds of billions of dollars of growth capex opportunities
- Global listed infrastructure provides a unique opportunity to participate in a number of significant potential innovations; we provide examples for midstream, communications, and utility sectors



The concept of disruptive technologies is an area of increasing focus of corporate executives and market participants trying to identify how to profit on the next great innovation. This is no wonder given the prevalence of paradigm shifting technologies witnessed the past two decades alone. The great rise of online retailing, smart phones and social media are just a few of the examples that have caused monumental shifts in how we live our lives, interact with one another and how businesses interact with us.

Advances have been made across many sectors; creating winners and losers and incentivizing hundreds of billions of dollars of capital investment. Innovation is a constant in the Information Age and advances in technological sophistication fosters even more innovation.

With these thoughts in mind, we set out to understand what impact such innovation has had in the past and might have in the future for infrastructure assets. We also consider the most near term innovation, battery storage, and its impact on listed infrastructure companies.

WHAT DOES THIS MEAN FOR INFRASTRUCTURE COMPANIES?

The phrase “disruptive technology” imbues a negative connotation despite the positive innovation that typically belies it. Perhaps this harkens back to human nature and a fear of the unknown or maybe it’s simply because change is seen as a threat to those benefitting the most from the way things are today.

While it’s not as simple as the adage “out with the old and in with the new”, it is true that technological innovation will continue to forge ahead and challenge the status quo. Such simple logic most certainly registers as risk in the eyes of companies operating in competitive environments, especially those that have found great success with “the old”. As such, there must be consideration given to what lies ahead, as challenging as that may be, in order to maintain a competitive edge amidst evolving technologies, business practices and societal behavior.

For companies engaged in the ownership of infrastructure assets the concept of a “disruptive technology” seems almost foreign. We define infrastructure as “the structures and systems which are the real assets and organizational facilities that provide society with the essential resources to function.” With very high barriers to entry and near inelastic demand which supports long, stable cash flow streams, it’s hard to envision what disruptive force could pose a risk to infrastructure assets. Assets like roads or pipelines do not come to mind when thinking about technological breakthroughs.

Likewise, envisioning alternative technologies that would signal infrastructure assets’ obsolescence is far-fetched in the short-to-medium term. This is not to imply there is no feasible disruptive technology that will impact infrastructure assets. The competitive threat of such technologies is mitigated by infrastructure’s necessity.

The most likely way infrastructure assets will be impacted by disruptive technology is the manner in which those assets are utilized and how they may need to be expanded or altered to accommodate innovation.

For example, the rise of the United States as a producer of commodities such as natural gas and oil has led to a substantial need for new infrastructure. Newfound pockets of oil and gas supply heralded the potential for the “energy renaissance”. However, it was the significant innovation in drilling technology and techniques that ultimately enabled the U.S. to access these resources. The effect, as we’ve now seen through dramatic volatility in oil prices and the response from OPEC, has very much proven disruptive to the global energy complex.

The good news, for infrastructure asset owners engaged in owning midstream pipelines, is that capital investment opportunities have been created in order to service the rapidly changing needs of energy producers. Newfound production areas are needed to provide takeaway capacity in the form of pipelines and processing facilities. Existing networks need also to be altered to reroute domestic supply and enhance capacity. These organic growth opportunities have been significant, totaling more than \$150 billion in the 10 years ended 2014.

The opportunity afforded to midstream companies highlights a significant advantage held by infrastructure companies owning assets that are difficult and often uneconomic to replicate. It essentially provides them an incumbent advantage. New technologies foster the need to adapt existing networks of infrastructure assets and infrastructure companies are in the most economic position to capitalize on these changes.

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WHAT DISRUPTIVE TECHNOLOGIES COULD IMPACT INFRASTRUCTURE ASSETS IN THE YEARS AHEAD?

Profound technological advances at various stages of research and even in early stages of adoption are prevalent across the major infrastructure sectors. We can only speculate which technologies will truly alter the market, yet one thing we know for certain is that innovation will continue to flourish and some percentage of today’s nascent technologies will ultimately prove to be game-changers.

Given the critical role that infrastructure plays and with a reach that touches numerous industries, these technologies will surely have some impact on listed infrastructure companies. Below we list new technologies which we believe to be the most relevant in the intermediate term, each of which has the potential to positively influence capital investment in the listed infrastructure space.

Sector	Disruptive Forces/Technologies	Potential Impact
Communications	<p>Spectral efficiency/New wireless technology (i.e. 5G)</p> <p>Proliferation of small cells/ competing technologies</p> <p>Internet of Things</p>	<p>History has proven spectral efficiency increases end-user demand which has driven significant investment by wireless carriers who are forced to spend on tower capacity to satisfy consumer demands</p> <p>Efficiency of cell towers over large areas is unlikely to be challenged near term but in dense areas, tower owners have been participating in small cell applications as a complement to their core business</p> <p>Implies the constantly connected nature of everyday items which will enhance functionality through technology will provide pricing power to owners of data networks and assets servicing them while requiring increased investment to improve speed and reliability</p>
Midstream	<p>Continued drilling efficiencies</p> <p>Seismology technology</p>	<p>While this has largely taken place, future enhancements will continue to drive down production costs thereby sustaining midstream growth opportunities even amidst depressed commodity markets</p> <p>Increasingly sophisticated methods of identifying underground commodity deposits could pull-forward demand for midstream offtake capacity as E&P cycle times compress and become more cost effective</p>
Transports	<p>Drone vehicles/ships</p> <p>Technologies enabling safe and reliable high-speed travel</p>	<p>Nascent technologies today but will ultimately enable higher fluidity of transportation networks which will require capital investment and support higher throughput</p> <p>Technologies such as high-speed magnetic rail and supersonic flight would create greater throughput on transportation networks, potentially creating additional demand while reducing costs</p>
Utilities	<p>Battery storage</p> <p>Renewables and distributed generation</p>	<p>Significant impact on the electric grid and power markets which could be negative for commodity sensitive power producers but a growth opportunity for traditionally regulated utilities</p> <p>Ongoing evolution in renewables and distributed generation will change the way traditional electric grids are utilized which will likely require modernization via growth enhancing capex</p>

Communication Infrastructure: Disruptive Technology Case Study

Over the years the communications sector has been exposed to disruptive technologies which many have speculated would have negative consequences for owners of communication infrastructure assets. Terrestrial based networks were expected to displace satellite capacity while new technologies such as microcells and wifi-offload would signal the demise of the cell tower. It's true that this sector has seen tremendous technological changes. They have altered communications networks as the Information Age has given rise to "big

data" and sent network traffic surging. Nonetheless, technological improvements have made the use of tower and satellite assets even greater as their efficiency in covering large geographic areas has made them cornerstones in evolving network architectures which themselves are becoming more sophisticated. Network engineers have not shunned time-tested infrastructure assets, but continued to embrace and adapt them to evolving technologies to maximize performance.

OPPORTUNITY OR THREAT: WHAT CAN WE LEARN FROM HISTORY?

It is unlikely that all of the potential disruptive technologies we've listed will come to fruition in the near future. But these disruptive forces are not implausible and, in fact, many are the result of existing technologies already being designed, tested, and in some cases even being implemented.

To best understand what impact disruptive technologies may have, we do not necessarily need to predict the future. Rather, we can revisit the impact disruptive technologies have had on the infrastructure space in the past. Fortunately, the listed infrastructure space has exhibited tremendous growth as a result of technological innovation.

In the example of advanced drilling techniques we previously covered, midstream companies were quickly able to ramp up development of new pipeline capacity and shift flows from inbound to outbound in areas once seen as end-user markets. This shift has generated more than \$150 billion in growth capital investment which continues today.

A similar narrative has transpired in the communications space where tower companies have enjoyed the benefits of multiple waves of

technological innovation. Advances in both wireless technology (e.g. – 3G to 4G) and wireless devices (e.g. – smartphones) have dramatically driven end-user data demand. This has incited heavy capital investment on behalf of wireless carriers seeking to provide customers with the best possible service.

Cell towers remain one of the key assets in facilitating the roll-out of such carrier upgrades resulting in strong cash flow growth for owners of tower assets. Jim Taiclet, CEO of American Tower, the world's leading provider of wireless infrastructure, recently noted that more than \$135 billion has been spent by wireless carriers since 2010 in the U.S. alone to upgrade their networks.

This growth opportunity is playing out around the globe and remains a highly visible one as other markets are following the same trajectory witnessed in the U.S. as smart phone penetration climbs higher and equipment costs decline. In the meantime, technological advances in the field of wireless technology continue to change consumer behavior in ways that will support a continuous carrier upgrade cycle to the benefit of tower owners.

**Jim Taiclet, CEO of American Tower
Q1 2015 Earnings Call, April 30, 2015**

"...With more than 400 million connected devices in the U.S. today generating ever-higher usage, wireless carriers have invested more than \$135 billion in wireless CapEx since 2010, or around \$30 billion a year, and are expected to invest another \$30 billion or more in 2015."

"...Moreover, while incremental spectrum and technology improvements have helped to alleviate a portion of the strain on carriers' networks, most of the solution lies in adding physical equipment, such as base station electronics, antennas and connecting cables, largely deployed on macro towers."

THE POWER OF INNOVATION - BATTERY STORAGE WILL ALTER THE UTILITY LANDSCAPE

Perhaps the most impactful of the list we've compiled on potentially disruptive technologies is battery storage. The concept is simple: Adapt existing technology used in everyday batteries, make them industrial scale, and plug them into the electric grid. The benefits are numerous as it relates to the use and reliability of the electric grid. Batteries can help alleviate issues caused by periods of grid overload, become an inexpensive way to meet peak demand, improve overall grid reliability, complement the use of renewables, scale to adapt various deployments, etc.

Given the significant number of benefits, the concept isn't a new one. But a lack of technological sophistication and an ominous cost curve have been the most significant hurdles to implementing battery storage solutions.

Ted Craver, CEO of Edison International Q2 2015 Earnings Call, June 30, 2015

*The goal of the Distribution Resources Plan is to facilitate the integration of distributed energy resources... [t]hese resources include distributed renewable generation, such as rooftop and ground-mount solar; electric vehicle charging; energy storage; energy efficiency; demand response. California views these resources as enablers in achieving its low-carbon objectives over the next several decades. At the expected adoption rate for these distributed resources, the electric grid will require **substantial investment in modernization and upgrades.***

From the Tesla Energy Online Press Kit

"...Tesla is amplifying its efforts to accelerate the move away from fossil fuels to a sustainable energy future with Tesla batteries, enabling homes, business, and utilities to store sustainable and renewable energy to manage power demand, provide backup power and increase grid resilience."

"Tesla is already working with utilities and other renewable power partners around the world to deploy storage on the grid to improve resiliency and cleanliness of the grid as a whole."

Technological advances in the world of battery storage have surprised many, driven by factors that at the time seemed unrelated. At center stage has entered Elon Musk and his much heralded Tesla Motors which has been producing battery-powered cars to compete with the internal combustion engine. The innovative battery technology at Tesla Motors led to the 2015 announcement of the formation of Tesla Energy.

The entrance of Tesla is seen by many as a watershed moment. It may catalyze the implementation of battery storage technology on a grand scale, perhaps making it the greatest improvement in the utility space since nuclear fission paved the way for clean, low-variable-cost baseload power production.

The research group at Barclays recently published a report entitled "The Battery Revolution: The stationary energy storage opportunity" in which the authors estimate global energy from battery usage could grow by 50% or more per annum through 2025. There will be winners and losers along the way, with providers of battery storage being at risk of failing to become either cost or product leaders.

Downstream impacts will likely be positive for utilities able to earn a regulated return on capital earmarked towards the technology. In contrast, others who profit on power price volatility may see profits squeezed in a more even-keel pricing environment.

Growing interest in the space is driving costs down and end-users, notably utilities, are beginning to take notice. Southern Company, one of the largest U.S. regulated utilities, recently announced a partnership with Telsa to begin testing their battery solutions and begin to understand how best to utilize such a technology.

Other utilities such as Edison International and AES Corporation have also been wanting to use this technology. While these companies are clearly trying to stay ahead of the curve and will likely become some of the early adopters, more are likely to follow, providing additional momentum for battery storage and ultimately making widespread adoption a commercial reality.

Battery storage may well be the next \$100 billion+ investment opportunity in the infrastructure space. Utilities are a significant component of the listed infrastructure universe, collectively accounting for roughly half of the total \$3.2 trillion in equity market cap. With a significant portion of the overall utility sector being regulated, which are typically able to earn a fair return on their investments, we believe the investment in battery storage will be a significant positive in the coming decades for the sector, and by extension, the global listed infrastructure space at large.

CONCLUSION

Disruptive technologies remain an area of interest as ongoing innovation challenges the status quo. The threat of such innovation is typically greatest to business models where the risk of failing to adapt can signal a rapid decline. For listed infrastructure companies, which own critical assets that are difficult to replicate and are often a key enabler of new technology, we believe technological innovation is likely to spur increased utilization and new growth opportunities for years to come. This has been a lesson from history as hundreds of billions of dollars have been spent to accommodate various “disruptive technologies” which have helped drive substantial growth in the infrastructure space. We believe these trends will continue into the future. As we look forward, new and exciting technologies will have positive effects on global listed infrastructure companies.

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