Creative Destruction of the Energy Sector
Technology in Global Energy: A Story of David vs. Goliath

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Creative destruction: the new replacing the outdated via incessant innovations

- **Markets**: Digitalization vastly changes production costs, increases data availability and transparency, thereby changing market efficiency and pricing not only in major energy markets, but potentially down to the neighborhood or more micro levels.

- **Upstream**: Digitalization helps to reduce production bottlenecks, uncover problems quickly and early, lower production costs, and identify/recover even more oil and gas in the ground.

- **Downstream**: Digitalization improves demand-side management, and the ability to collect, process and analyze more data to take advantage of *arbitrage* opportunities.

- **Business models** – creative destruction of sectors:
  - Utilities could (i) become distribution service platform providers for Distributed Energy Resources (DERs), as the New York state is already envisioning; (ii) split old, volatile businesses vs. new, more stable businesses
  - Corporates or homeowners would become energy providers through DERs or whatever excess energy generated
  - Third-party or other service providers provide energy services and/or aggregate DERs
  - Car companies become service and energy providers (e.g. through batteries.)
  - Technology companies could provide energy network optimizing technology or even operate platforms
  - Energy companies that transition to providing services could become asset-light, as they could control how energy is routed and optimized
  - Companies to emerge to provide data or leverage data analytics

Source: Company reports, Citi Research
**Markets:** Technology to differentiate company performance, reduce volatility

**Prices:** Look to stabilize at half the price than before

**Business models:** Shale patch innovators see their stock price rising, while traditional players lagging

**Gas volatility:** besides shale, *massive data availability and modeling* reduce uncertainty and volatility

**Oil volatility** to fall as more data become available – satellite, infrared etc – data analytics firms emerging

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Source: Bloomberg, Citi Research estimates
**Upstream**: production rising with lower costs, labor; next to tackle bottlenecks

**Production**: US oil production from shale plays to rise, possibly with further upside

**Labor**: The return of shale is done without an appreciable increase in labor; “apps” have taken over some processes

**Difficult projects**: Even deepwater cost is falling...

**Bottlenecks**: Going step-by-step along the value-chain, efficiency and tech change to resolve bottlenecks

*Source: BLS, EIA, Company reports, PacWest, Citi Research*
**Downstream**: Data analytics to help integrate renewables, raise plant utilization

To minimize disruptions due to intermittency, energy storage, better forecasting and grid integration are key (ERCOT hourly wind generation in March 2014)

“Duck” curve is problematic but presents opportunity: arbitrage using storage or better grid integration? (net load curve for California from 2012 to 2020)

- California renewable energy curtailment could hit 8-GW is an example of integration bottleneck
- **Solutions as opportunities**
  - Energy storage
  - Better forecasting
  - Good ol’ oil plants as back-up
  - Grid integration

- This is a story of how software transforms a hardware-dominated sector; it is the kind of creative destruction that demands fundamental changes in an entire sector

Source: ERCOT, IEA, CAISO, Citi Research
Utilities are cool again – energy is not just a hardware business anymore

Components needed to support a greater integration of renewable energy and distributed generation into the grid

- **Sensing and Measurements**
  - Visualization tools that enable complete visibility of generation, loads and grid dynamics across the electric system

- **Devices and Integrated Systems**
  - Establish common test procedures and interoperability standards for devices that can provide valuable grid services alone and/or in combination

- **System Operations and Power Flow**
  - Develop advanced real-time control technologies to enhance the reliability and asset utilization of T&D systems

- **Design and Planning Tools**
  - Create grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales

- **Security and Resilience**
  - Develop advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems

- **Institutional Support**
  - Provide tools and data that enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector

Source: DOE
Growth momentum should stall:
- Jet, LPG are only areas of growth
- Gasoline growth could slow on rising fuel efficiency, flattening of per capita car ownership, alternatives/electrification
- Diesel keeps falling on macro shift
- Fuel oil declines on lower teapot refinery demand

Story would repeat across Asia

Appendix: Demand growth in China: a peak could come before mid-2020

*Base case: terminal per capita # cars = 350, fuel efficiency = flat after 2020; Case 1: terminal per capita # cars = 350, fuel efficiency = up 1MPG/yr after 2020
Case 2: terminal per capita # cars = 250, fuel efficiency = flat after 2020
Appendix: Long term fuel substitution could be a tide that’s difficult to turn

The fuel substitution transformation could take 15 to 20 years, due to the replacement of infrastructure, but once the tide turns, it’s difficult to reverse.

Transitions driven by long-term fuel substitution typically follow an “S” curve, which features a rapid transition period once some critical mass has been reached.

A prime example of classic “S”-curve adoption is the diesel-for-gasoline substitution that began in the late 1950s through to the 1970s in trucking sector.

A similar example is the transition of locomotives in rail transport. In the early mid-20th century, higher efficiency and lower requirement for manual labor drove diesel-electric locomotive transition from steam to diesel-electric in merely 20 years.

Source: MacKay, Wards Auto, Westport, Ayres-Ayres-Warr, Citi Research
Appendix A-1

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