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CES Technical Expectations for 2021 and Beyond

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The new year and the future will bring good things to the energy industry, the environment, and the economy. Specifically, new technologies for generating and storing energy from wind and solar will keep improving, there will be a decline of fossil fuel generation, and we will see electrification of the transportation, and residential and commercial heating sectors, as well as cleaner water and air. All of this will come at a lower cost to consumers thanks to the miracle of new technologies and increasing economic activity in developing these technologies and energy dependent sectors.

- We will see the start of development of planned offshore wind projects and the development of many additional projects in the Northeastern US and California coasts. The new turbines will have higher efficiency and size, while still having a lower production cost than the older turbines.
- We will see new onshore wind projects, as well, and the repowering of existing older projects. New turbines with higher efficiency and a larger size and lower production cost than the older turbines will also become available.
- As the cost of solar generation keeps going down and the technology improves (such as higher efficiency panels, multi-axes solar tracking, and bi-facial panels), there will be an increase in new utility-scale projects and small-scale residential and commercial rooftop projects.
- Demand-side participation will become more prevalent. There will be optimized control of heating and cooling and the adoption of more efficient lighting and appliances for residential and commercial use.
- An increase in electric vehicles (cars and buses) will lead to their participation in the electric power market, allowing for the integration of EV batteries as system-wide storage and charging options.

- Smart distribution systems will enable the integration of distributed renewables and electric vehicles and link consumers with power markets for active participation where they can see market prices and respond to the price signals.
- Inter-regional coordination to accommodate more renewables at lower cost will increase economic activities in the energy sector. This will require the use of new, updated software technologies to allow market participants to easily and efficiently participate in these new regional markets.
- The construction and planning of new transmission projects to interconnect offshore wind and renewables-rich areas (such as the southern US for solar energy and Texas and Midwestern states for wind power) to demand centers will accelerate. Such projects will also be needed to interconnect regional utilities and markets to improve economic exchange and reduce the impact of the intermittency of renewables.
- New technologies will be developed to optimize the operation of the existing transmission grid and increase the utilization of existing assets without degrading the reliability and resiliency of the transmission and generation systems.
- Cybersecurity for utilities will become even more important as more automation and data collection is needed to operate the transmission and distribution systems. The control of these systems must be protected against failure as well as malware and piracy of data.
- Software algorithms and technologies to forecast weather and the output of wind and solar generation more accurately will improve. Tools to optimize the operation of the power grid with these intermittent and uncertain resources combined with existing thermal generation and storage will also become available to maintain high reliability at a lower cost.
- The status of nuclear power plants remains a wild card, and depending on national and regional economic and environmental policies, we might see life extension for some of these plants as well as possible development of new technologies that are inherently safe.

As the generation mix gets dominated by renewables with marginal production cost close to zero, the locational marginal prices and the structure of these markets will evolve and regulators and policy makers need to help in improving these markets to meet the new challenges.

The power markets are evolving and the market development will vary by region; ERCOT is energy only, while all others in the US have both energy and capacity markets, with different portions of total market value coming from each market in different regions. Depending on the new policies, we will see a shift in the importance between these two markets and stabilize somewhere between or in one of the following two options.

- Energy only markets, with no capacity pricing, and the hourly energy price could be determined by the value of power to consumers combined with the cost of storing energy. This market design must allow for high volatility and caps (or no caps) of energy prices. When there is excess renewable energy the prices will be very low, and when there is little renewable generation the energy prices will go very high, determined and limited only by demand-side value for power. This allows storage technologies to come in to arbitrage the prices and balance the market, raising the prices during high renewable generation hours to the expected value during

shortages (minus cost of storage) and lowering the prices during high renewable generation hours and setting the prices close to the cost of energy.

- Capacity-only markets, where the energy prices become very low and somewhat irrelevant, and the capacity market prices could become the dominant component and be driven by the capital cost of new projects and long-term energy contracts. This market design isolates the consumer from price volatility and diminishes their ability to respond to prices, thereby reducing the potential to optimize the short-term operation of the market and grid. The capacity markets will be more granular to capture the true capacity of renewable resources and storage (seasonal or monthly and correlation to load).

Also, on the negative side, there might be power plant closures, which means layoffs and reduced tax revenue for small communities, but that will be more than offset with new jobs and tax revenue created by these renewable projects. The difficulty is that these are different groups, so public policy needs to address this issue to help minimize the impact on the communities losing jobs.

Finally, the industry needs to start building recyclable blades, batteries and solar panels. This should help in reducing the impact on the environment once these projects are repowered or retired.