# Ancillary Services: A Huge, Under The Radar Storage Market Opportunity

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In a continuing effort to chart the direction of energy storage markets, this note will lay out the basics around the market for ancillary services: what it is, how big an opportunity we believe it to be, and what players are selling into these markets. We will likely explore this market in greater depth in upcoming briefs, but given the increasing interest from many of our subscribers in storage applications, this note will begin laying out our framework.

## The Market – What is Ancillary Services and Why Should You Care

Ancillary services are those services needed to support reliable transmission from generators of power to purchasers of power. Purchasers of power are groups – typically Independent System Operators (ISO) or utilities – who have a legal obligation to maintain reliable transmission systems. Reliable transmission requires voltage, power and energy to remain within certain acceptable ranges. Therefore, ancillary services include scheduling and dispatching power, frequency regulation / voltage control, load following (boosting or reducing supply to compensate for demand), system protection, and compensation for power losses.

While selling to quasi-public bodies like ISOs or utilities can be a time consuming process, there are a number of reasons why the ancillary market is highly attractive:

### (1) Size

The Cleantech Group estimates the ancillary services market to be **6.5 gigawatts (GW)** in the United States annually, or an estimated **value in the range of $3-$10 billion** depending on power prices and specific ancillary services applications.[1] Globally, we estimate the market to be **33 gigawatts (GW), or a dollar value of between $16 - $45 billion**.[2] While these estimates represent a "ballpark" figure and have a highly variable dollar range, the significant magnitude of the market is indisputable .

### (2) Growth

The market for ancillary services is set to grow on the back of three trends. First, increases in power generation and purchasing require some marginal increase in demand for ancillary services. The reason is simple: new energy supplies of any kind must be transmitted reliably to power purchasers, and ancillary services are a key element of ensuring reliable transmission. While demand for power has declined in the U.S. and Europe due to the global recession, it has continued to grow in emerging markets and is forecasted to rebound in developed markets as well.

1 Source: Cleantech Group research and analysis
2 Source: Cleantech Group research and analysis

Second, increasing supplies of renewable energy represent a significant boost to the ancillary services market. The Cleantech Group estimates that roughly **4MW of ancillary services are required for every 100MW of wind energy** added to the grid.[3] Solar also requires accompanying ancillary services greater than base load generation technology. Despite the recession, Renewable Portfolio Standards (RPS) in many states in the U.S. will guarantee a continuing supply, and greater grid penetration, of renewable sources of energy like wind. The same goes for markets outside the U.S., including Europe and Asia.

Third, a "peaky" demand profile – or demand that spikes at certain points in the day – is also a driver of ancillary services demand, particularly for load following applications. While innovations like demand response, thermal energy storage, time of use pricing, and even "smart" appliances may make headway in addressing this issue, peak demand should be an issue for years to come – particularly in markets with hot climates where afternoon air conditioning strains the grid. PJM – the ISO for Pennsylvania, New Jersey, Maryland and parts of other Mid-Atlantic states – estimates ancillary services address up to 1% of peak power demand. Therefore, "peaky" demand should drive the ancillary services market for years to come.

We expect that the ancillary services market will grow **3.8% CAGR in the U.S. over the next 25 years to reach 16.7GW or $8.8 – $29.4 Billion by 2035**.[4] Internationally, we expect the ancillary services market will grow at a **4.2% CAGR over the next 25 years to reach 91GW by 2035**.[5]

## (3) Dynamics

Though some market participants are challenged by the highly regulated and sometimes bureaucratic nature of the market, there are two factors in particular that make ancillary services attractive. The first is that, in the United States, operators of control areas – usually ISOs or utilities – have a legal obligation to ensure reliable transmission. Just as in any other market, these participants will seek out the lowest cost service that can still meet their needs. But the legal obligation makes this market distinct because ISOs or utilities cannot choose to forgo the market entirely. Therefore, the law creates something of a market "floor" and insulates against general economic trends.

Second, the United States grid has many local operators. While this also creates logistical obstacles in each geography, it reduces the buying power of each operator. Instead of a single national operator using its size and dominance to drive down prices, market participants can choose to target distinct independent service organizations. This allows for a wider range of opportunities as participants fill the distinct market needs of various operators.

While this note focuses on the U.S. market, dynamics in international markets are often similar. Specific legal regulations or obligations to ensure transmission reliability may be different, but it is safe to say that governments do not want to raise the ire of their citizens with an unreliable grid. Therefore, many of the same dynamics hold true in these markets as well.

Finally, it's worth noting that only ~45% of the U.S. market has established a standard interconnection approval process whereby non-generation resources like flywheels have the opportunity to bid and sell

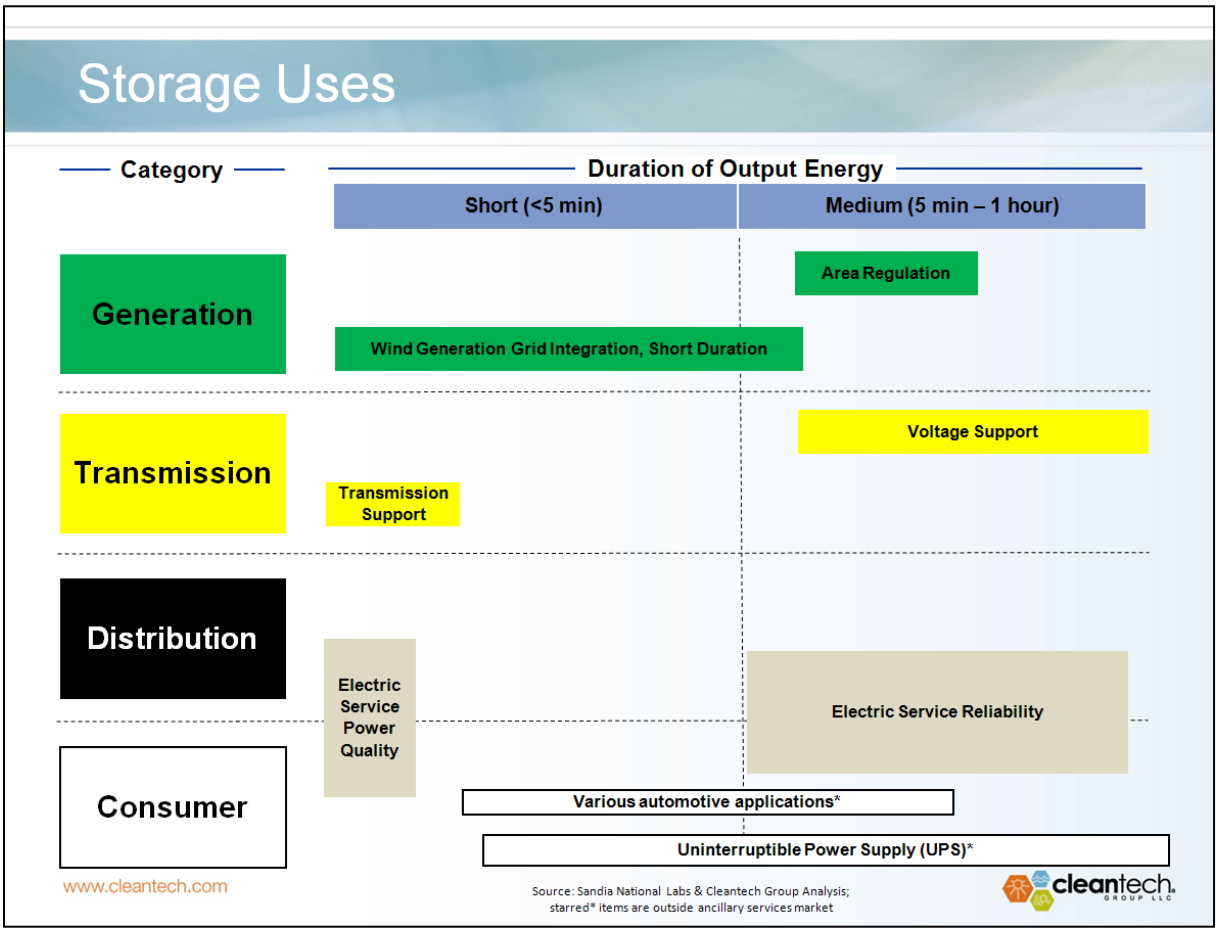
3 Source: Cleantech Group analysis developed from published NYISO figures.
4 Source: Cleantech Group analysis based on IEA renewable energy growth estimates
5 Source: Cleantech Group analysis based on IEA renewable energy growth estimates

into these markets. There is good reason to believe this will ultimately expand to the rest of the U.S. market via regulatory pressure from FERC. At the moment, however, this constraint acts as a "ceiling" on the available market.

## (4) Adjacencies

Finally, many of the solutions developed for the market can address multiple ancillary services with the same product, and even markets outside ancillary services. As one can see from the diagram below, multiple ancillary services require a similar product specification, as do consumer uses outside the core market.

**Table 1: Ancillary Services Market Participants & Adjacencies**




There are a number of real-world examples of companies addressing related markets with the same technology. **Altair Nano**, a lithium ion battery company, has an ancillary services pilot with **PJM** but is also addressing the mass-transit and uninterruptable power supply (UPS) market. **Maxwell** and **EEStor**, supercapacitor companies, are also addressing the UPS and mass-transit markets. In fact, it's hard to find a company operating in the ancillary services market who isn't at least trying to address other markets with the same solution.

## The Solutions: Comparison of Ancillary Services Solutions

| Type | Economics | Pros | Cons | Key Vendors |
|---|---|---|---|---|
| **Flywheels** | **$/kw:** 3360 – 3920<br>**$/kWh:** 1340-1570<br>**Hours** .25<br>**Capital ($/kW):** 3695-4313 | • Meets heavy duty cycle requirements for frequency regulation<br>• Fast discharge and recharge<br>• Significant existing deployments = lower technology and deployment risk<br>• Operates under diverse environmental conditions | • Higher capital cost and cost per kw<br>• Requires significant space – limiting where it can be deployed<br>• Less power than other solutions – narrowing range of potential grid uses | • Beacon Power<br>• Active Power |
| **Lithium Ion** | **$/kw:** 350 – 500<br>**$/kWh:** 400 – 600<br>**Hours** 4<br>**Capital ($/kW):** 1950 – 2900 | • Mature technology – deployed in variety of settings<br>• Investment dollars and attention from major EV and consumer electronics companies ($Bs in R&D)<br>• Good potential for power = multiple grid uses | • Potential for thermal runaway<br>• Challenges in scaling to grid<br>• Hazardous materials<br>• Cyclic requirements may require frequent replacement (and higher cost)<br>• Slower discharge than non-electrochemical options | • A123 Systems<br>• BYD<br>• Ener1<br>• Altairnano |
| **Lead Acid** | **$/kw:** 420 – 660<br>**$/kWh:** 330 – 480<br>**Hours** 4<br>**Capital ($/kW):** 1740 – 2580 | • Mature technology – deployed in variety of settings<br>• No danger of thermal runaway<br>• Good potential for power = multiple grid uses | • Lower energy density than lithium ion<br>• Challenges in scaling to grid<br>• Hazardous materials<br>• Cyclic requirements may require frequent replacement (and higher cost)<br>• Slower discharge than non-electrochemical options | • Xtreme Power<br>• Axion Power |
| **Supercapacitor** | **$/kw:** 250 – 350<br>**$/kWh:** 20,000 – 30,000<br>**Hours** .0027<br>**Capital ($/kW):** 300 – 450 | • Fastest discharge<br>• Very high round-trip efficiency<br>• Can meet cyclic needs of frequency regulation market | • Technology risk – very little grid commercialization to date | • EEStor<br>• Maxwell |

Note: Costs are EPRI estimates as of February, 2009; remainder of table is Cleantech Group Analysis

As depicted in the table above, there are a number of technology solutions that address the ancillary services market. The solutions above include only those technologies most able to meet discharge times requiring one minute or less which have been deployed on the grid: flywheels, supercapacitors, and electrochemical options (lithium-ion and lead-acid).

In addition to differences in rated power and discharge time, each technology has distinct capital and operational costs, and a variety of other advantages and disadvantages. The table should make clear that there is no “silver bullet” solution which addresses all ancillary services market needs at a competitive cost. Indeed, we believe the most effective strategy for both consumers of, and investors in, ancillary services is to carefully consider the specific market needs that a proposed solution addresses, and to evaluate the proposed solution against alternate options that might meet the same need. Pending major technological breakthroughs, this type of case by case analysis appears to be the most viable approach to accurately assessing technology approaches at this time.

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