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The Business Council for Sustainable Energy®

SUSTAINABLE ENERGY in America 2013 Factbook

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EXECUTIVE SUMMARY

A revolution is transforming how Americans produce, consume, and even think about energy. Traditional sources are in decline, while natural gas, renewables and energy efficiency are on the rise. These changes, which show no sign of abating, have far-reaching implications for US economic and national security interests. They are increasing the diversity of the country's energy mix, improving its energy security, and rapidly shrinking its 'carbon footprint' – a major positive development for addressing climate change.

Behind this revolution is a slew of new energy innovations, technologies, and applications. These include: newly applied techniques for extracting natural gas from shale rock formations; lower-cost and higher-efficiency photovoltaic panels for converting sunlight to electrons; highly efficient, natural gas end-use applications; vehicles fuelled by electricity and natural gas; and 'smart meters' that allow consumers to monitor, modulate, and cut electricity consumption.

This Factbook – researched and produced by Bloomberg New Energy Finance and commissioned by the Business Council for Sustainable Energy – offers a fresh look at the state of US energy along with the roles these new technologies and innovations now play. Its goal is to offer simple, easy-to-understand benchmarks on the contributions these new energy technologies are making today. It also provides information on finance and investment trends in clean energy resources.

What's unique about this Factbook

- First, the report is **quantitative and objective**, intended to arm policy-makers, journalists, and industry professionals with up-to-date, accurate market intelligence.
- Second, the report looks at **clean energy broadly defined**. The Factbook takes the pulse of the wide range of clean energy industries represented by the Council, including natural gas, renewable energy sources (including solar, wind, hydropower, geothermal, and biomass – but excluding liquid biofuels), distributed power, and energy efficiency.
- Third, the report **fills important data gaps**. For example, data sources and economic models of the US energy industry often fail to capture the full contribution of sectors such as distributed generation. This Factbook seeks to quantify accurately some sectors that are currently small but growing rapidly.

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The US energy sector is undergoing dramatic change

- Total energy use fell 6.1% between 2007 and 2012, driven largely by advances in energy efficiency.
- Use of natural gas and renewable energy has increased, while other major energy sources such as coal and oil have experienced significant declines. Natural gas provided the US with 27% of its total energy supply in 2012, and renewables (including hydropower) supplied 9.3%.
- In the electricity sector, lower- and zero-carbon power sources are growing. Natural gas-fired power plants provided 31% of US electricity in 2012, up from just 22% in 2007. Renewable energy generation has meanwhile grown from 8.3% to 12.1% over that period. These technologies, which include wind, solar, geothermal and hydropower, represented the largest single source of new capacity growth in 2012, with more than 17GW added.

Factbook highlights

- *The need for reliability will increasingly be met by the advantages of flexibility.* Ensuring ongoing reliability will become an even tougher challenge for electricity market operators and regulators, given the diminished role for coal and the increased presence of variable resources (ie, intermittent renewables). Yet other changes afoot – including reduced electricity demand through energy efficiency; the introduction of smart grid technologies for improved grid management; and the growing role for dispatchable resources such as natural gas plants, hydropower, and demand response – can help the electricity industry meet this challenge. Still, most market structures do not yet fully recognize the benefits of some of the technologies offering increased flexibility, such as energy storage.
- *The shift in the US energy sector is not just about technologies and fuels, but also about markets.* The country's power sector – long skewed towards large, centralized systems such as coal plants – is beginning to open up to a wide range of small, distributed power generators, including combined heat and power (CHP) generators (mainly fuelled with natural gas), and fuel cells, and small-scale renewables. In addition, electricity market structures are evolving: over the past decade, 40 states have passed policies that enable profits to be decoupled from the amount of energy (electricity, natural gas, or both) that private utilities sell, in order to encourage economical investment in improved efficiency.
- *Estimated total new investment in US clean energy was $44.2bn in 2012.* This amount, which includes investments in most renewable and energy efficiency technologies but excludes natural gas, is well above the $10.4bn figure from 2004, when Bloomberg New Energy Finance first started tracking these investments. However, it marks a 32% decline from 2011, largely due to uncertainty over the fate of certain federal incentives that support financing for renewables.
- *Total US installed capacity of natural gas (442GW) plus renewables (187GW) is now at 629GW (58% of the total power generating mix) – up from 605GW (56%) in 2011 and 548GW (54%) in 2007.* Between 2008 and 2012, the US nearly doubled its renewables capacity from 44GW to 86GW (excluding hydropower, which itself is the single largest source of renewable power, at 101GW as of 2012). Recent years have also seen rapid growth in digital energy controls (eg, smart grid deployments and demand response controls), and energy efficiency (eg, building retrofits). Some sectors have seen relatively low deployment thus far but have the potential to

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have a major impact: these include fuel cells, storage technologies other than pumped hydropower, and carbon capture and storage (CCS).

- *Natural gas is in the midst of a remarkable boom.* The emergence of new technologies has enabled the commercially viable extraction of unconventional natural gas resources including shale – a domestic, abundant, low-cost fuel (a mild winter in 2011-12 pushed prices down even further). Utility investments into natural gas infrastructure – such as pipelines, compressors, and meters – totalled $17bn in 2011.

- *Low natural gas prices can both complement and conflict with other energy sources.* For wind power in particular, cheaper gas has made it difficult to compete economically, though the one-year extension of the Production Tax Credit in 2013 has strengthened the business case for wind in the short term. Yet gas generators, which are inherently flexible technologies that can be easily ramped up and down to meet demand, are natural counterparts for variable resources such as wind and solar. Other options, such as combined heat and power (CHP), and fuel cell installations, which draw on natural gas for fuel, have become more competitive as natural gas prices decline.

- *The levelized costs of electricity for renewable technologies have plummeted.* For example, the cost of electricity generated by cost-competitive large solar power plants has fallen from $0.31 per kilowatt-hour in 2009 to $0.14 per kilowatt-hour in 2012, according to Bloomberg New Energy Finance's global benchmarking analysis based on already financed projects from around the world. (These figures exclude the effect of tax credits and other incentives, which would bring those costs down even lower.) Over the same period, the cost of power from a benchmark large wind farm has fallen from $0.09 in 2009 to $0.08 per kilowatt-hour.

- *Energy efficiency is making its mark on the grid and on buildings.* Since 1980, energy intensity of commercial buildings has decreased by over 40%, propelled by increasingly sophisticated approaches to financing for energy efficiency retrofits, as well as by standards, such as those that apply to heating and cooling units and to thermal performance (ie, insulation). Overall, US utility budgets for energy efficiency reached $7bn in 2011 (the latest available date for which data exists). Demand response capacity, which typically involves the curtailment of electricity consumption at times of peak usage, has grown by more than 250% between 2006 and 2011, allowing major power consumers such as manufacturers to cut their energy costs and utilities to scale back production from some of the costliest power plants. Some 46m smart meters have been deployed in the US, while spending on smart grid roll-outs hit $4.3bn in 2012, up from $1.3bn in 2008.

- *Policy is potent.* Though the levelized costs of electricity of many renewable generation technologies have fallen drastically, most of these technologies still rely on incentives to compete. State-level mandates have been important drivers for renewable growth in the US, though in the case of most states, quotas for the next several years have already been satisfied. Policy measures have also helped further the cause of energy efficiency: Energy Star-certified commercial building floor space has increased by 139% from 2008 to 2012, and the stringency of building air conditioning efficiency standards has increased by up to 34% since 2005. Public funding for research and large-scale projects has also been a major driver of CCS activity. There are, however, some clean energy technologies which are ready (or on the brink of being ready) to operate in the marketplace without any incentives or policy directives at all.

- *Evolution of the transport sector mirrors that of power.* The country's ground transport sector is undergoing its own transition prompted by advances in technology and new fuel economy

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requirements. Corporate average fuel economy (CAFE) standards calling for the efficiency of US light-duty vehicles are scheduled to nearly double by 2025 compared with the 2011 average. Hybrids, plug-in electrics, and natural gas vehicles are growing in prominence; sales for the first two reached 488,000 vehicles in 2012 (3.25% of US passenger vehicle sales), and natural gas use in the transport sector (particularly among buses and light trucks) increased by 26% over 2008-11. In addition, a number of major automakers are aiming for commercial roll-out of fuel-cell electric vehicles by 2015. These developments, along with a growing role for biofuels, have driven gasoline consumption down 5.7% from its 2007 peak. These advanced vehicles largely still rely on incentives to be economical.

- *One winner from all of these developments is US air quality.* Reduced air pollution and emissions of greenhouse gases are a welcome consequence of the changes underway in the country's energy mix. The reductions in coal generation, ascendancy of gas, influx of renewables, expansion of CHP and other distributed power forms, adoption of demand-side efficiency technologies, rise of dispatchable demand response, and deployment of advanced vehicles are all contributing to the decline in carbon emissions from the energy sector (including transport), which peaked in 2007 at 6.02Gt and have dropped by 12% since. They are now at their lowest level since 1994.

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1.1. Hydropower

Policy

The primary federal incentive for hydropower is the 30% ITC, which was extended for one more year as part of the 1 January 2013 tax package (projects must begin construction by the end of 2013). Developers can also choose to take an $11/MWh PTC in lieu of the ITC. On the state level, most RPS programs allow 'small hydropower' to qualify (the qualifying size of a project varies by state).

Deployment

Hydropower represents the second-largest largest source of non-fossil-fuel generation in the US, behind nuclear (7% of generation, with nuclear at 19%). Recent development has been limited – 19MW was commissioned in 2012 – compared with the cumulative installed capacity base of 79GW, or 101GW including the contribution from pumped storage projects (Figure 1).

Development in recent years has been predominantly small-scale (<100MW). Yet there is some activity to pursue large-scale build: Alaska is in the process of permitting the 600MW Susitna-Watana project, projected to come online by 2023, and the US DOE has released a report showing there are several projects larger than 100MW at existing non-powered dams and is currently in the midst of an assessment of large-scale greenfield projects across the US. In addition, Pennsylvania utility PPL is nearing completion of a $434m project to add another 125MW to its 108MW Holtwood hydropower plant.

Unlike other clean energy sectors, there is no 'one-stop shop' for annual installed hydropower capacity data. The incremental capacity figures in Figure 1 are sourced from the Federal Energy Regulatory Commission (FERC), which only provides figures from 2009. Additionally, FERC data does not include hydropower projects developed by the federal government (eg, the Army Corp of Engineers). Thus, Figure 1 may understate actual annual installed hydropower capacity.

Though recent installation numbers have been low, developers have received licenses or exemptions from FERC for 730MW of new capacity since 2009, potentially foreshadowing an upswing of new development (Figure 2). (Exempted projects do not require renewed applications to FERC to continue operating, as opposed to licenses, which have terms of 30-50 years. All hydropower projects, both licensed and exempted, require environmental reviews, public participation, and agency consultation before licenses or exemptions are permitted to proceed.)

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Figure 1: US hydropower project build, 2008-12

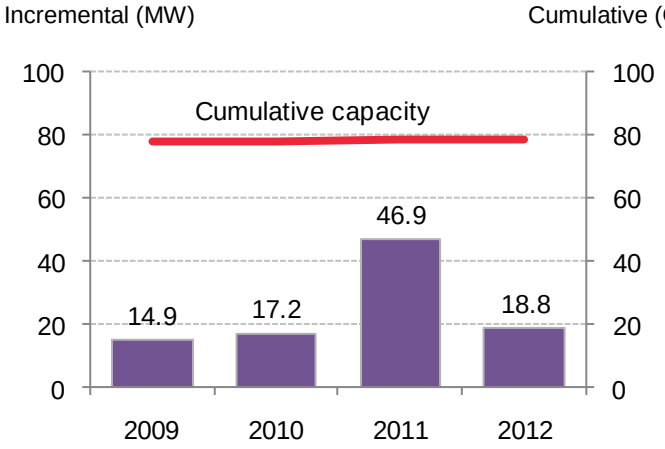


Figure 2: US new hydropower capacity licensed or exempted by FERC, 2010-12 (MW)

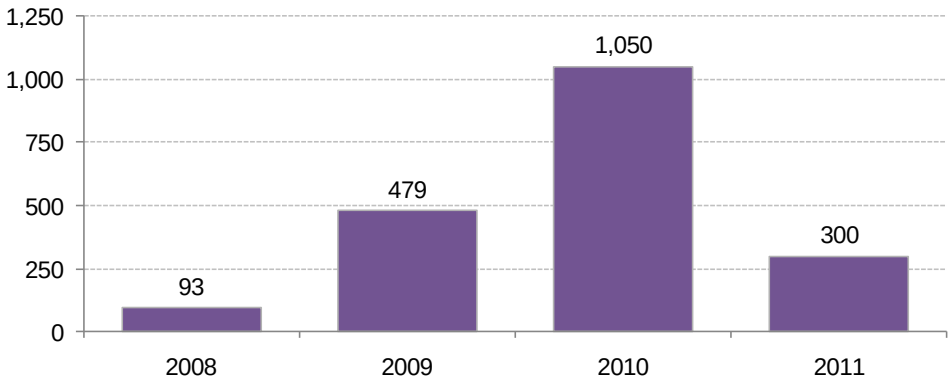
Source: Bloomberg New Energy Finance, EIA, FERC Note: Data on cumulative capacity is from the EIA; incremental capacity from FERC.

Financing

US hydropower asset finance flow has been slow compared with that for other renewable energy sectors with an estimated $1.9bn provided from 2008-11. The bulk of this is attributed to American Municipal Power, which began construction on several plants totalling 300MW of new capacity on the Ohio River in 2009-11. It estimated a total cost of $1.7bn for these new installations, implying a weighted capex of about $5.7m/MW

The relatively low volume of financing has been a function of limited development (aside from the project mentioned above) rather than a scarcity of capital. Project financiers report that financing is typically available at a reasonable cost for good hydropower projects with a credit-worthy offtaker.

Figure 3: Annual asset finance for US hydropower projects, 2008-2011 ($m)



Source: Bloomberg New Energy Finance Note: 2012 data is not available.

Economics

Project economics for hydropower plants are heavily dependent on site-specific factors, including the availability and constancy of water resources and the cost of site preparation and material procurement. Five US hydropower projects disclosed total construction costs in 2008-12, with costs ranging from $3m/MW to $6.34m/MW and an average capex of $4.57m/MW.

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Market dynamics

In the world of small hydropower, the largest asset owner is Brookfield Renewable Energy Partners. As of end-2011, the company had 103 US projects in 11 states totalling 1,966MW of capacity (plus other large and small hydropower assets in Canada and Brazil). Hydro Green Energy and Free Flow Power are other examples of independent power producers targeting this sector. While IPPs are the principal players behind small hydropower, the development of large hydropower plants is generally a utility- or state-led effort. The projects tend to be rate-based, owing to the massive capital expenditure involved – ie, the 600MW Alaska project is under the direction of the Alaska Energy Authority and will require an estimated capex of $5.2bn.

Hydropower, including run-of-river projects, is a dispatchable asset, capable of providing much-needed flexibility to the grid. Yet most electricity market structures do not fully monetize the flexibility-related benefits – including the ability to help the grid absorb variable energy resources – offered by hydropower and by pumped storage.

1.2. Energy storage

Policy

FERC Order 755 has been an important policy development for the energy storage sector. The order requires independent system operators (ISOs) to compensate frequency regulation resources for the actual quality and quantity of regulation provided. It could boost annual revenues of energy storage assets providing regulation by a factor of 2-3, depending on how each ISO implements the new rules.

California's energy storage policies also merit attention. The state has consistently advanced a progressive set of policies and incentives. Table 1 details the structure and status of the three most important storage policies in California.

Table 1: California storage policies

Policy	Timeline	Status	Structure	Notes
AB 2514	2010-21	Signed into law, implementation underway	Establishes energy storage procurement targets for investor-owned utilities in 2015 and 2020 and for publicly owned utilities in 2016 and 2021	The CPUC decides upon IOU procurement targets by 1 October 2013 The publicly owned utility's local governing board decides on its procurement targets – if any are determined to be appropriate – by 1 October 2014
Self- Generation Incentive Program (SGIP)	2001-14	Active	Provides $2/W incentive to small behind-the-meter storage assets 50% of incentive upfront, 50% is performance based over five years	$83m annual IOU budget from the rate base was approved, about 10% of which is reserved for storage
Permanent load shifting (PLS)	2006-14	Active	Provides $0.25-1/W incentive to end-users Funded from the rate base	$32m annual IOU budget IOUs are being directed to standardize programs state-wide for PLS technologies (which shift load from times of peak power to off-peak times)

Source: Bloomberg New Energy Finance

The US American Recovery and Reinvestment Act provided $185m for energy storage demonstration projects. The total cost of these 16 projects amounts to $585m (with the remaining $400m coming from the private sector). Additionally, since its inception in 2009, the Advanced Research Projects Agency-Energy (ARPA-E) has invested $85m in fundamental research in energy storage.

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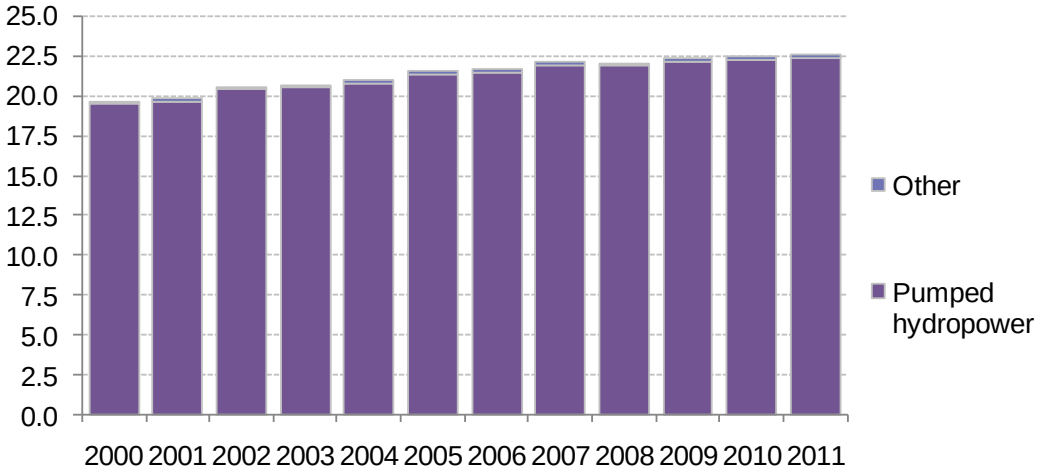
Deployment

Pumped hydropower makes up almost the entirety of the US energy storage market, with 22.3GW of installed capacity (99% of existing total storage capacity). It also comprises the bulk of new capacity: net summer capacity for pumped hydro has increased by 2.9GW since 2000. Overall, the energy storage market in the US has increased 15% since 2000 (Figure 6).

Figure 4: Cumulative energy storage capacity, 2000-11 (GW)



Source: Bloomberg New Energy Finance, EIA Note: Pumped hydropower capacity is net summer capacity.

Non-hydropower storage technologies comprise a much smaller share of the market. Total installed capacity of these technologies (including batteries, flywheels, and compressed air) has grown from 136MW to 289MW over the past decade. The stimulus funding towards the end of 2009 helped promote the growth of new storage technologies, but since then, many of the projects that received support are still waiting to be commissioned, and the number of newly announced projects remains low (Figure 5).

There are four major obstacles to the adoption of storage:

- *Market structure:* industry players find fault with the failure of markets to properly compensate the benefits provided by storage, including the ability for technologies to ramp up rapidly or to absorb energy in periods of excess output from intermittent resources
- *High cost:* with the exception of lithium-ion batteries, there have not been significant cost reductions in commercially available energy storage technologies.
- *Unclear application value:* a significant number of utilities and other potential storage buyers have now started one or two projects looking at storage. It will take time for their assessment of the true financial value of storage to be complete and be used to inform further, larger-scale purchases.
- *Worsened economics:* although frequency regulation does have a clear value proposition, the economics have deteriorated significantly in the past year in the US due to low-cost natural gas.

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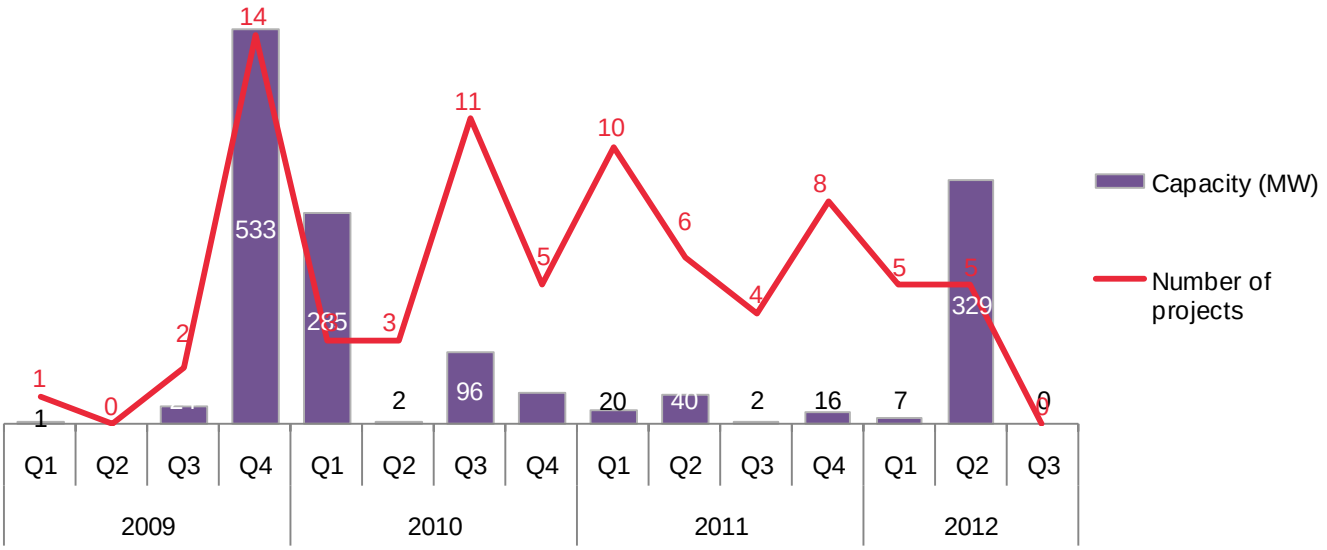
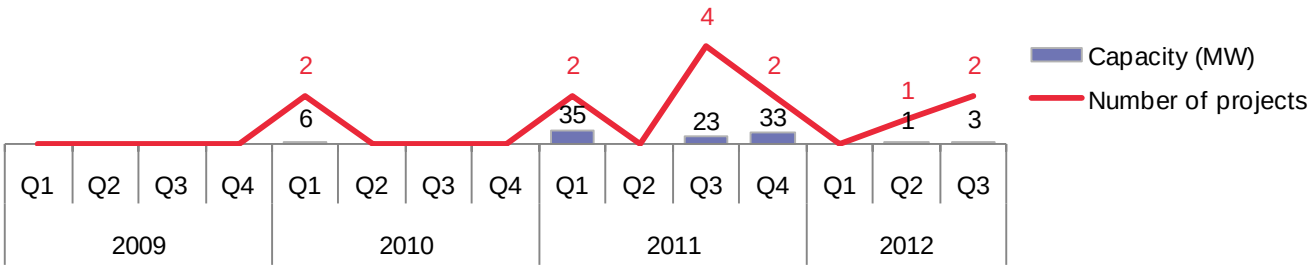
Figure 5: Announced non-hydropower energy storage projects in the US (MW and number of projects)



Source: Bloomberg New Energy Finance

Figure 6: Commissioned non-hydropower energy storage projects in the US (MW and number of projects)



Source: Bloomberg New Energy Finance

Economics

The cost of storage technologies remains a significant barrier to further adoption. Compared to the most widely used storage technology – pumped hydropower – most new technologies are significantly more expensive both on a capex and capex per cycle basis. In the past couple of years, however, the costs of new storage technologies have declined. In particular, the lithium-ion battery sector has advanced along its learning curve due to increased electric vehicle production.

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Figure 7: Capex – capital costs of select storage technologies ($/kW)

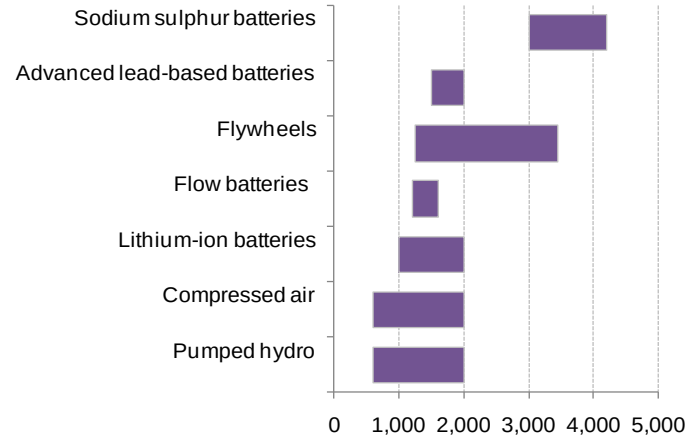
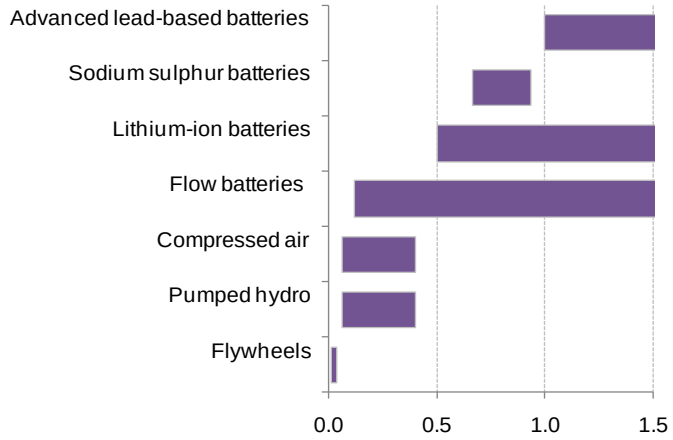


Figure 8: Capex – capex per cycle costs of select storage technologies ($/kW/cycle)



Source: Bloomberg New Energy Finance

A full assessment of storage economics requires a detailed look at potential revenue as well as costs. There are three main applications at the generation level: arbitrage, frequency regulation and system capacity. Across all US ISOs, down to individual pricing zones, none of the three applications currently makes economic sense. The cost of storage systems is far higher than the potential revenue gained.

Yet a turning point is on the horizon. The introduction of FERC Order 755, along with the continuing decline in technology costs and a rise in natural gas prices, could turn frequency regulation into a profitable market segment in a number of ISOs in the near future. For storage assets focused on long duration, high premiums for demand response have strengthened their economics. These premiums can comprise energy and capacity market payments, and even payments from utility-administered programs in some cases. But these may take a long time to become economical.

Other applications, including transmission and distribution applications and renewable integration, still require significant regulatory changes for the financial benefit of storage to be recognized.

Market dynamics

Developer interest in pumped storage technology has risen in recent years: FERC received 110 preliminary permit applications over 2008-11, compared to just 16 the previous four years. Over 50 projects totalling 44GW in capacity have received preliminary permits, though not all will be built.

Among non-hydropower technologies, compressed air energy storage is the leader in terms of installed capacity (Figure 9). However, there is just one commissioned compressed air project in the US with another six in the pipeline, four of which are unlikely to be commissioned soon. The technology that has seen the most progress has been lithium-ion batteries, where US companies such as A123 Systems have pioneered technology improvements (though not without risk, as demonstrated by A123's bankruptcy in 2012).

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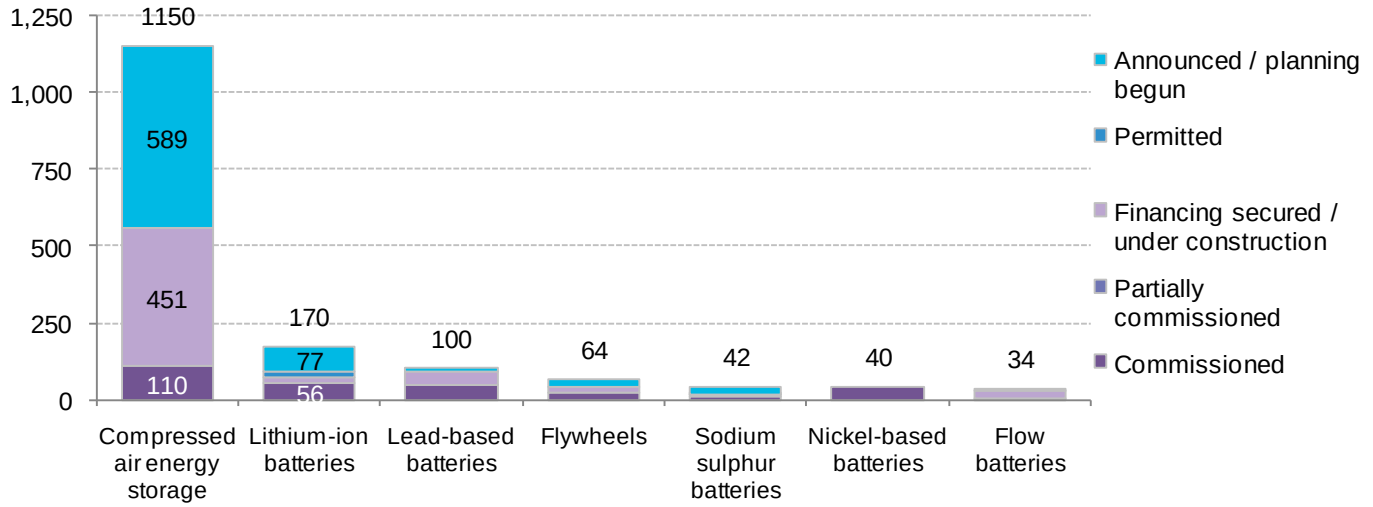
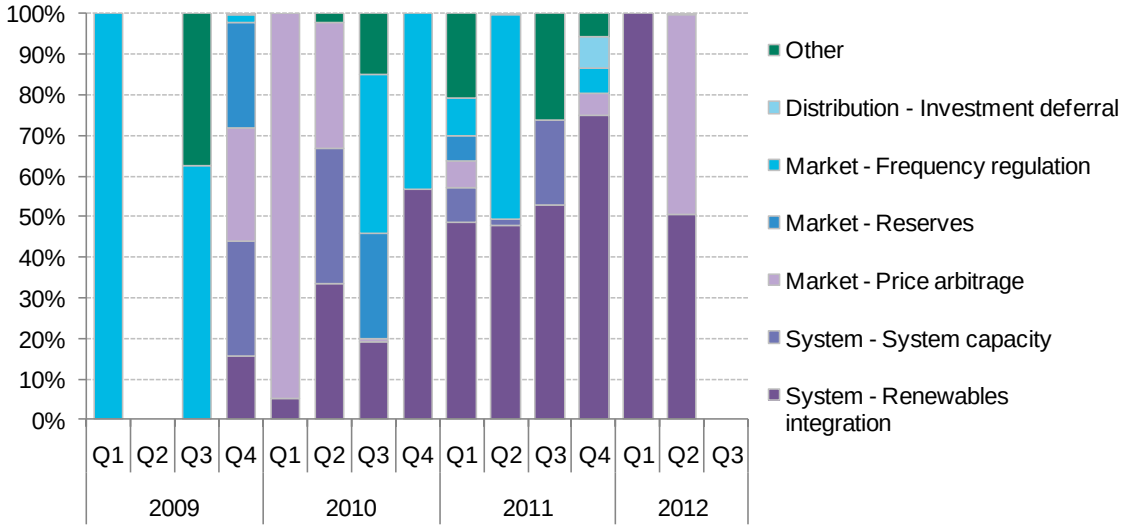
Figure 9: Non-hydropower energy storage projects in the US by technology (MW)



Source: Bloomberg New Energy Finance Note: Pumped storage is not included in this chart as it would dwarf all other technologies.

In terms of *application mix*, in recent years, the storage sector has increased its focus on renewable energy integration (Figure 10). At least 11 pumped storage projects have received preliminary permits in California, which has one of the most ambitious RPS programs in the country. Other commercial storage projects using technologies such as batteries are starting to appear to help integrate large-scale wind and solar on islands. However, most of these are still demonstration projects.

Figure 10: Non-hydropower application mix of announced energy storage technologies in the US (% by MW)



Source: Bloomberg New Energy Finance Note: Empty columns represent quarters where there were no new projects announced.

Two companies have led the battery market so far: A123 Systems and Xtreme Power. The former has been particularly dominant in the frequency regulation segment through its partnership with AES Energy Storage; Xtreme, however, has been recognized as a leading system integrator specializing in renewable integration.

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