

Spring 2011

EARTHRISE OBSERVATORY

Commentary on energy & environmental technology industry developments

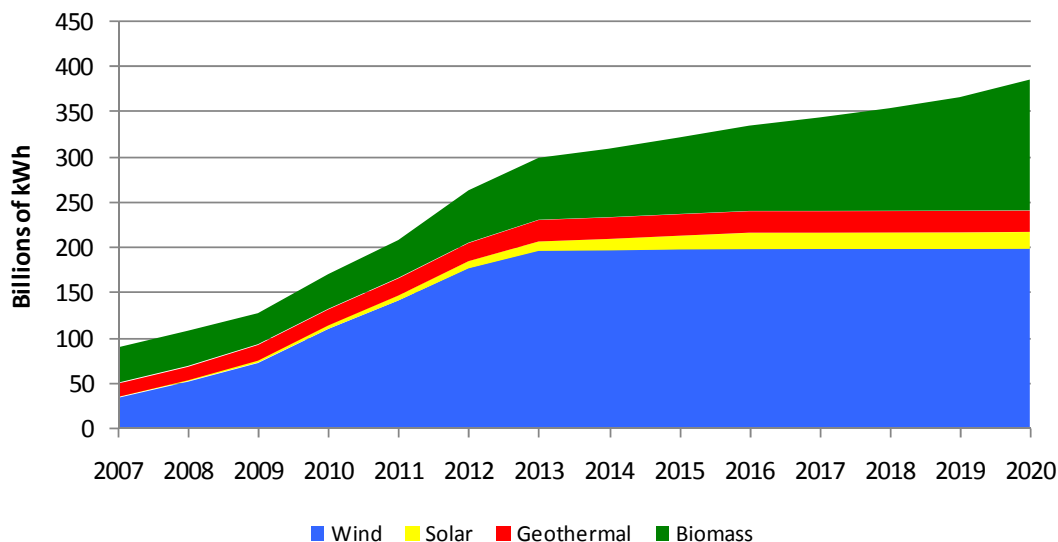


And the Winner is.....Biomass!

As part of our periodic review of the prospects for various renewable energy sources, we came upon some provocative findings in the U.S. Energy Information Administration's *Annual Energy Outlook 2010*. For the United States, the EIA expects wind to provide much of the growth in renewable energy generation over the next few years. However, in the latter half of the decade, the EIA expects the big winner to be not wind, not solar, but biomass. The graph below, which we created from the EIA's underlying data set, shows annual U.S. power generation in billions of kilowatt-hours from four renewable energy sources: biomass, geothermal, solar and wind. Here is the rationale supporting the EIA's conclusions:

- The primary source of growth for renewable energy from 2015 to 2020 should be biomass, in the form of biomass fired co-generation of heat and power for industrial processes, and co-firing of pelletized biomass with coal to displace some of the coal required to fuel existing power plants.
- Growth in wind should be rapid through 2013, but is then expected to fall off sharply as the Federal Production Tax Credit program expires, and state RPS mandates are fulfilled. In fact, by 2013, installed renewable energy generation capacity should be sufficient to meet state RPS requirements through 2030.
- Solar is expected to remain too expensive for utility-scale power generation, but small-scale, distributed PV capacity should continue growing rapidly due to state, federal and utility industry support.
- Growth opportunities for geothermal are restricted by the relatively small number of suitable sites.

U. S. Power Generation from Selected Sources



Source: Energy Information Administration, *Annual Energy Outlook 2010*.

EARTHRISE CAPITAL PORTFOLIO OBSERVER



In our “Earthrise Capital Portfolio Observer,” we hope to provide a deeper understanding of our investments through interviews with a team member of one of our portfolio companies. In this issue, we interview Thomas G. Granville, Chief Executive Officer of Axion Power International. Earthrise Capital Fund owns shares in Axion Power International (AXPW), a developer and manufacturer of a unique lead-carbon battery. The Company is publicly traded; Earthrise Capital Fund made its investment by way of a \$26 million private investment in public equity in December, 2009.



Earthrise: What is unique about Axion's patented PbC battery technology?

Granville: The substitution of a carbon electrode for the lead negative electrode gives our battery its unique characteristics such as: faster discharge, accelerated recharge and much greater charge acceptance-- all critical for the rapidly growing new start-stop vehicle technology.

Earthrise: How much greater is the charge acceptance then that of a conventional lead acid battery?

Granville: Ten to fifteen times greater charge acceptance than lead-acid, with a six to seven times faster rate of charge. It rivals that of nickel metal hydride or lithium-ion batteries, which are new types of, advanced batteries. Axion's durability (cycle life) is also longer than that of advanced lead acid batteries, three to four times longer in some applications.

Earthrise: What is the pricing relative to lead acid batteries and relative to lithium-ion and nickel metal hydride?



Granville: A top of the line advanced lead acid battery sells for \$240-\$260 and Axion's battery will command some premium over that. Axion's battery is about one third the price of a lithium-ion or a nickel metal hydride battery solution.

Earthrise: What is start-stop vehicle technology and how important a trend is it in automotive design?

Granville: Start-stop is the term used for the technology that turns off a car's engine when normally it would be idling. Ford announced recently that all its U.S. vehicles will employ start-stop by 2016. Several manufacturers in Europe already use start-stop technology and all of the “majors” have committed to hybridization (employing stop/start) across their entire fleets.

Earthrise: There are various ways of accomplishing start-stop. Why do you think Axion's battery will be a preferred solution?

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Granville: The advantage with Axion is in cost when compared to other advanced battery technologies. Our PbC batteries are a fraction of their cost. Our advantage when compared to lead-acid batteries is in our performance. Simply put, lead-acid batteries don't allow the stop/start vehicle to operate the way it was designed to operate (i.e., the engine won't shut off as frequently because of the lack of charge in the battery).

Earthrise: Which vehicles do you expect will be the first to use the stop/start technology?

Granville: Initially passenger vehicles, especially the large gas-guzzlers. There will initially be fuel savings of 10 to 15% if advanced battery technologies, or Axion's technology, are used. The next step is regenerative braking and "rolling stop" applications, which could result in fuel savings and CO₂ emission reductions of 25% or more.

Earthrise: How far behind is the U.S. with this new technology rollout?

Granville: The U.S. is not as far behind as people may assume. GM just announced it is introducing a form of mild hybrid technology for greater fuel economy. It currently uses a lithium-ion battery, an expensive solution. We expect that GM and other automakers will want a lower-cost alternative for widespread adoption.

Earthrise: How large is the projected market for start-stop technology for new vehicles?

Granville: The estimate is 12-18 million vehicles a year by 2016 in the U.S. and Europe. That is a several billion dollar annual market for batteries. This is an estimate for micro-hybrid cars only. It is estimated that a large percentage of new auto sales will be micro-hybrid sales by 2016, due to tougher emissions standards in Europe and more stringent fuel economy standards in the U.S. Most automotive manufactures cannot meet the looming change in emissions and mpg standards without hybridization.

Earthrise: How do you distinguish between micro-hybrid and mild hybrid?

Granville: Neither micro-hybrid nor mild-hybrid are full hybrid vehicles with electric drive capability. Micro-hybrid vehicles use stop-start technology but not regenerative braking. They may include other improvements such as low resistance tires. Mild-hybrids include regenerative braking.

Earthrise: What progress are you making on other applications such as large-scale energy storage and hybrid locomotives?

Granville: Both on-site and with our Office of Naval Research program, we continue testing batteries and electronics for our Power Cube. Our PowerCube can be used for back-up power, power smoothing, power quality and other power ancillary services, and is scalable up to 25MW.

In hybrid locomotives, Norfolk Southern (NS) will soon begin to test our batteries at their facilities. We have had a service agreement with NS for more than a year and, as part of that agreement, we have tested their application and our battery management system extensively. We are highly confident it works; the next step is to test it in a field application where the large test strings mimic real world application. Pending final testing, Norfolk Southern plans to use the PbC battery for "yard switchers", as well as over-the-road locomotives.

Earthrise: Do you have an estimate of the market size for the locomotive market?

Granville: No real market size projection is available yet from the railroads. However, several major railroads and locomotive manufacturers are interested. There are about 34,000

locomotives in the U.S. and Europe. A hybrid solution requires about 1500 batteries per locomotive.

Earthrise: Is your manufacturing plant upgrade and installation of your electrode manufacturing equipment almost completed now?

Granville: We have made major strides with our plant upgrade, a few of those photos were presented at our last investor conference (at Jefferies & Co.) and are posted on our website (www.axionpower.com). This month we expect delivery of the Gen. 2 automated electrode production line equipment. As you know, our technology is emerging from development to commercialization and continues to be extensively tested with various potential customers at present.

Earthrise: Thank you, Tom.

Axion Power International News:

Battery orders

New Castle, Pa., March 8, 2011 / PR Newswire/ - Axion Power International, Inc. the developer of advanced lead-carbon (PbC) batteries, has received a series of orders for the production and immediate delivery of flooded lead-acid batteries. The batteries will be branded by the purchaser. Axion anticipates weekly shipments of these batteries in 2011 with a total minimum purchase price of \$3.5 million and a potential maximum purchase of \$8 million....

Thomas Granville, Axion Power CEO, commented, "These battery types have been produced on the manufacturing lines at New Castle for decades. Revenue and margin from the sale of these batteries will begin to be reported in our financial results for the first quarter of 2011."

Earthrise Comment: Axion's main focus remains the commercialization of its PbC battery. In the meantime, the order for lead-acid batteries is a welcome source of revenue today.

The comments expressed in this report reflect the opinion of Earthrise Capital as of the date of publication. The information, including historical data series, estimates and projections, contained herein is believed to be reliable and has been obtained from sources believed to be reliable, but Earthrise Capital makes no representation or warranty, either express or implied, as to the accuracy, completeness or reliability of such information.

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Earthrise Capital Fund is a venture capital fund which invests in resource efficient technologies, including energy efficiency, clean energy, power conversion, energy storage, alternative fuels, and green chemistry.

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