Another California First: Country’s First Energy Storage Law

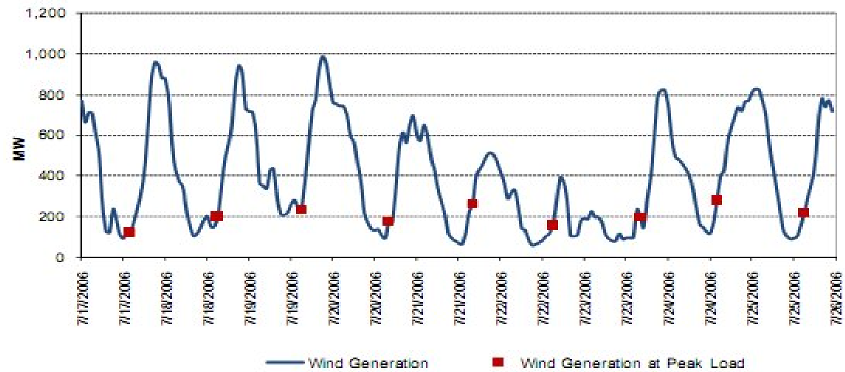
More intermittent renewables require more storage, but do we need a law for something this obvious?

Coming weeks before the 2 November election, a bill supported by California’s Attorney General, **Edmund G. Brown**, directs the **California Public Utilities Commission** (CPUC) to establish targets for utility adoption of cost-effective **energy storage** technologies. The **California Energy Storage Alliance**, not an unbiased trade group, hailed the country’s first energy storage law claiming that it would boost the energy storage industry and create up to 10,000 manufacturing jobs. It is not entirely clear what this bill will accomplish since everyone recognizes the importance of energy storage.

Needless to say, the integration of large amounts of intermittent renewable resources requires equally large amounts of energy storage and/or back-up generation. In September 2010, the **California Air Resources Board** (CARB), the agency responsible for implementing the state’s climate bill, adopted a new standard that requires the state to get 33% of its electricity from renewables by 2020.

A lot of wind capacity, but hardly any when you really need it

Wind production during CA’s most recent heat wave in July 2006, in MW



Source: *Integration of renewable resources*, CAISO, 31 Aug 2010

The fate of California’s 33% **renewable portfolio standard** (RPS), the state’s climate bill, **Assembly Bill 32**, and the state’s governorship, is to be decided in early November. Stay tuned. ■

Apples And Oranges: Don’t Compare Levelized Cost Of Renewables

Joskow points out what may not be so obvious

Cars are often compared based on how many miles per gallon, or liters per kilometer, they get. Alternative supply-side resources are typically compared based on their **levelized costs**, in cents/kWh. Even though an imperfect metric, it allows a simplistic way to compare. But is it an appropriate measure when comparing intermittent renewables?

In a recently published paper, MIT Professor **Paul Joskow** points out that the levelized metric “is inappropriate for comparing intermittent generating technologies like wind and solar with dispatchable generating technologies like nuclear, gas combined cycle, and coal” – perhaps not so obvious until one examines the reasons.

According to Joskow, the levelized comparison “fails to take into account differences in the production profiles of intermittent and dispatchable generating technologies and the associated large variations in the market value of the electricity they supply.” Levelized cost comparisons, he points out, *overvalue* intermittent generating technologies compared to dispatchable base load, they also overvalue **wind** – which typically blows during off-peak hours – compared to **solar** – which tends to have a much better correlation with peak demand.

How to compare apples to oranges
An illustrative case where levelized costs of intermittent and base-load technologies are roughly equal

	Base Load	Intermittent
Construction + Fixed O&M Cost (levelized/MW/year)	$300,000/MW/Year	$150,000/MW/Year
Operating Cost (levelized/MWh)	20.0¢/KWh	0¢/KWh
Capacity Factor	90%	30%
MWh/MW/year	7884	2628
Levelized cost/MWh	$58.1/MWh	$57.1/MWh

Source: P. Joskow, MIT, full paper available from http://econ-www.mit.edu/files/5989

To illustrate his point, Joskow examines a simplistic power system with 3,000 hours of *peak* and 5,760 hours of *off-peak* and assumes a competitive wholesale market with $90 and $35/MWh prices, respectively, as shown in the accompanying table. In this example, the levelized costs of the two technologies are approximately the same, roughly $58/MWh, so they appear to be competitive – but are they? Intuitively we know that the answer is no.

When the intermittent power is generated determines its value
Alternative scenarios with corresponding profit and loss

	Dispatchable MWh supply	Intermittent MWh supply	Intermittent MWh supply	Intermittent MWh supply
		Case 1	Case 2	Case 3
Peak MWh	3000	0	50	2628
Off-peak MWh	4844	2628	2578	0
Revenues $/MW/year	463,760	105,120	107,620	236,520
Costs $/MW/year	457,680	150,000	150,000	150,000
Profit $/MW/year	6,080	--44,800	-42,380	86,520

Source: P. Joskow, MIT, full paper available from http://econ-www.mit.edu/files/5989

As illustrated in the second column of the second table, an incremental 1 MW investment in the dispatchable technology earns enough revenue to cover its costs plus a small *profit*. The intermittent technology, despite the fact that it enjoys a zero marginal generation cost – since renewable energy is free – generates a *loss* of $44,800 under case 1, column 3 of table, where it has been assumed that *all* generation takes place during *off-peak hours*. This would correspond to wind generation profile in places like Texas and California where wind mostly blows during off peak hours.

The point of the example is that despite having roughly the same levelized costs, the economic value of the electricity supplied by a unit of dispatchable generation is over 4 times that of intermittent wind. No wonder renewable generators require subsidies or a mandatory target.

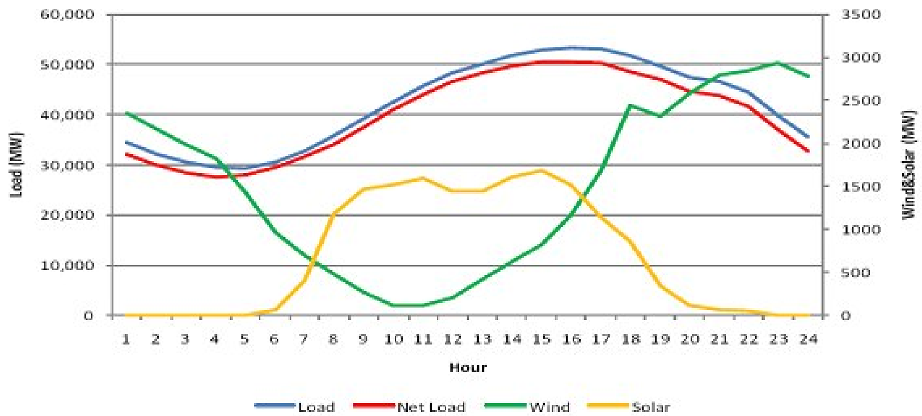
A second example is provided in column 4 where the intermittent generator is assumed to run for 50 hours during the *peak* and 2578 hours during the *off-peak* period, increasing revenues, but still ending with a loss of $42,380.

Finally, Joskow examines a case where *all* the output of the intermittent technology, say a solar plant, is assumed to occur during *on-peak hours* as illustrated in column 5, resulting in a $86,520 profit.

"The key message from these examples is that when the electricity is produced by an intermittent generating technology, the level of output and the value of the electricity at the times when the output is produced are key variables that should be taken into account," according to Joskow.

Here is why solar is preferred to wind

Simulated load and generation on a typical summer day for 25 July 2010 in CA, in MW



Source: *Integration of renewable resources*, CAISO, 31 Aug 2010

This explains the growing interest in **concentrated solar power** (CSP) by summer peaking utilities in sunny regions of the southwest. CSP plants generate most of their energy during peak demand hours, where it has a premium value (see accompanying chart for California). Adding a few hours of **thermal storage**, will allow CSP plants to extend their operation into late afternoon hours when peak demand often occurs, further boosting their economic value. ■

Congressional Inaction On Climate *Not* Good News For Embattled US Coal

The immediate beneficiary of uncertainty on carbon legislation is natural gas

The US Congress has been unable and unwilling to pass a comprehensive energy and climate bill – even less likely after the mid-term November elections. Ironically, that is *not* good news for coal. As much as a fifth of the existing US coal-fired generation could close within a decade while few *new* conventional coal plants are expected to be built. And that is without any *explicit* price on carbon or a cap-and-trade scheme, according to **Wood Mackenzie**, a consultancy. Others who follow developments in the US coal business generally concur.

Tightening regulations by the US **Environmental Protections Agency** (EPA) on **NOx, SOx, mercury**, **fly ash** as well as **water** use for cooling are likely to make many aging and inefficient coal-fired plants un-economic even without a **carbon price**. In the last few months, a number of large coal-burning US utilities including **Xcel Energy** with plants in Colorado, **Exelon** based in Chicago and Charlotte-based **Duke Energy**, have announced their intention to retire or sell their coal-fired plants or convert them to natural gas. Wood Mackenzie reckons US demand for natural gas for power generation may rise by as much as 20% by 2030. The current glut of non-conventional gas and historically low prices are consistent with such an outcome.

In documents filed with the state utility commission, **Duke Energy** stated it might close 7 coal-fired plants within five years, in part because it expects the EPA to strengthen the clean air laws. Duke figures it would be cheaper to shut them down rather than retrofit them to meet more stringent regulations. As proposed, Duke's coal use in its generation mix would fall from 42% today to 29% by 2030 while the company will need an additional 6,000 MW of capacity.

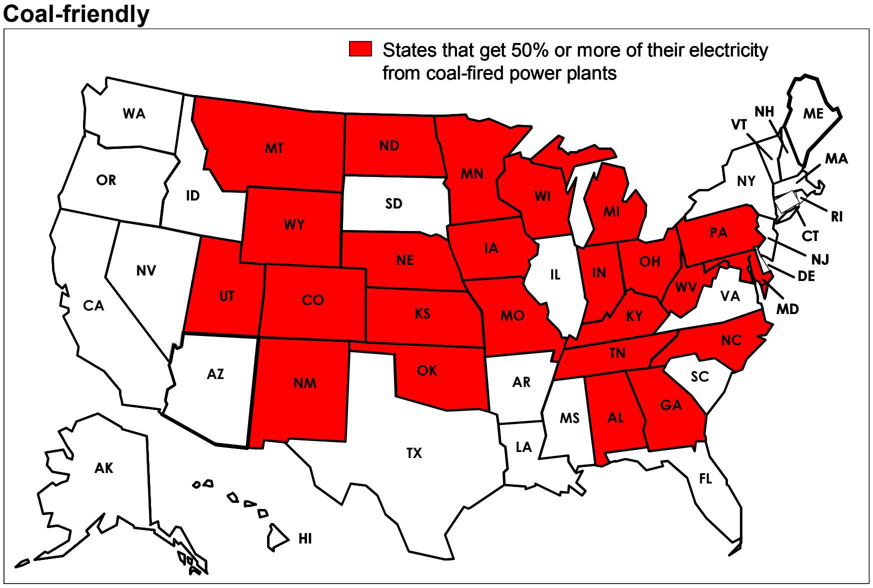
Under current regulations, US power plants and other major stationary sources that emit 25,000 tons or more of CO_2 a year will be come under new EPA rules (see box). For any such facilities to be refurbished and for any new ones built, they would have to install **best available technologies** (BAT). EPA estimates that 10,000 sources responsible for roughly 85% of all US **greenhouse gas emissions** would be affected under this rule.

> **Will EPA act on Clean Air Act?**
>
> The US **Environmental Protection Agency** (EPA) has issued details of its compliance proposals on some 40 rules affecting coal-fired plants under the **Clean Air Act**. These proposals are expected to result in significant compliance costs, especially for older, less efficient and more polluting coal-fired US plants, many built 40-60 years ago but still operating.
>
> EPA's own costs estimate puts a price tag exceeding $1 billion for each of at least 8 proposed rules including:
>
> - New **ozone standards** at $19-90 billion annually;
> - New **NOx ambient air quality standard**, $3.6 billion in 2020; and
> - New **SOx standard**, $1.5 billion in 2020
>
> Not surprisingly, the US coal-lobby and their sympathetic supporters in the US Congress are concerned about the pace at which EPA is issuing regulatory proposals under the Clean Air Act. Writing to EPA Administrator **Lisa P. Jackson**, 2 Texas Republican members of the House of Representatives, **Joe Barton** and **Michael Burgess**, said they were "concerned about the billions of dollars in new costs, as well as the workability of a number of the proposed new rules."
>
> With their expected new majority in the House following the November election, EPA and the White House may have to delay, or shelve, some of the proposed regulations. ■

When Congress passed the original **Clean Air Act** in 1970, it was assumed that many of the then existing coal plants would be reaching the end of their useful lives by the end of the century – few suspected that so many would still be operating. These plants have been granted *routine maintenance* exemptions from the Act up until now, but there is a heated debate about their fate going forward. The environmental community says they should comply with the new regulations or be retired. It is not entirely clear which point of view will prevail as EPA has vacillated on the matter with mixed signals coming from the White House under the Bush and Obama administrations, intense pressure from the powerful coal-lobby and their sympathizers in the US Congress.

Under the **Obama White House**, the EPA has gained more bargaining power and appears poised to exercise its mandate under the Clean Air Act. Skeptics , however, think that this is mere posturing as the EPA, and the White House, are simply trying to pressure Congress to pass a comprehensive climate bill, an uphill battle with the expected Republican gains in mid-term elections.

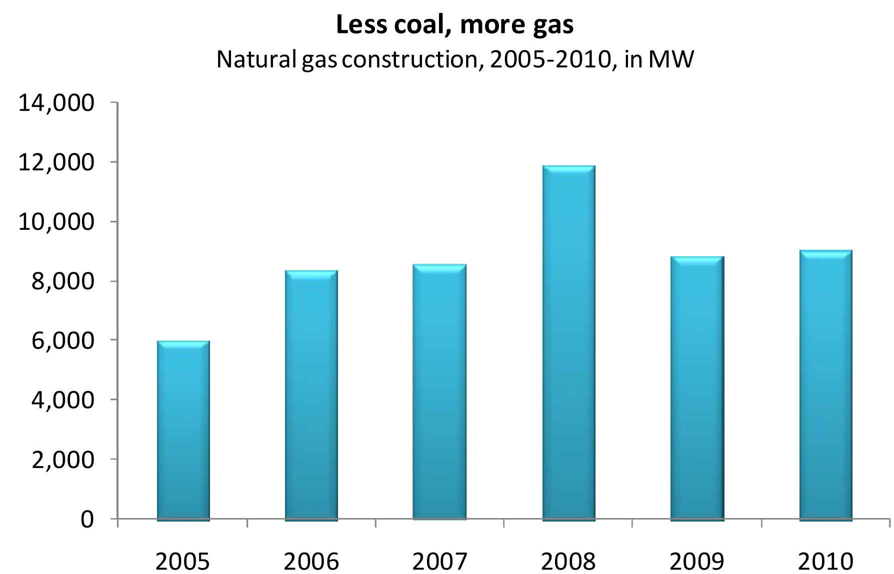
Coal-friendly



Source: US Department of Energy

US Energy **Secretary Steven Chu**, who once famously called coal his "worst nightmare," has learned to be more diplomatic, especially when speaking before pro-coal audiences. He now talks mostly on safer subjects such as **carbon capture and sequestration** (CCS), coal's most likely salvation. Appearing in Charleston, West Virginia, he pointed out that **greenhouse gas emissions** (GHG) have increased by 40% since the start of the industrial revolution and said the White House has allocated \$3.4 billion to clean coal technologies that will help keep coal relevant.

In the US, as in other coal-dependent countries like **Australia**, the fate of coal is closely intertwined with the politics of coal-dominated states, mostly in the Midwest and in the South (see map). In Charleston, Dr. Chu was joined by Senator **Jay Rockefeller**, a Democrat, who has proposed legislation to block the EPA to introduce regulations that would curb GHG emissions.



Source: Power, Sept 2010, based on data from Industrial Info Resources

But even Senator Rockefeller, who represents coal-friendly WV, concedes that it is *only a matter of time* before GHG emissions will have to be curtailed. He told the audience that he was in favor of preserving jobs for coal miners and considered the EPA regulations, set to take effect early next year, as "harmful." But he confessed to the unsympathetic audience that he was *not* one of those who believed that global warming was a myth, urging those who espouse such views to quit "burying their heads in the sand," not easy to do in WV.

He surprised many of his constituents by admitting, "I agree with the science of climate change," adding, "GHG emissions are not healthy for the earth." The problem "will not go away if we ignore the issue," warning that, "There will be some additional regulations within a couple years."

Secretary Chu, however, stayed on safer ground, pointing to the 10 MW experimental CCS project undertaken by **American Electric Power** (AEP) at its **Mountaineer plant** in WV with \$334 million federal funding. If successful, AEP plans to try a 200 MW project in Oklahoma. And *if* that works, to be followed by commercial scale SSC projects, perhaps as early as 2015 – a timeline considered optimistic by most observers.

In the mean time, **natural gas**, along with renewable resources, are gaining ground (see accompanying chart). Aside from carbon uncertainty and tightening EPA regulations, natural gas is currently plentiful and cheap, thanks to major discoveries of **non-conventional gas**. The US nuclear renaissance, appears to be going nowhere, while progress on the commercialization of CCS technology is years, if not decades, away. Ironically, natural gas benefits from the growth of **intermittent renewable technologies** since there is more need for thermal back-up and peaking generation.

While nobody sees natural gas as a long-term solution – it is finite and emits significant amounts of GHGs – most view it as a convenient bridge until there are more renewables, more nuclear, commercially feasible CCS, or perhaps something else. ■

Is There Money In Carbon Storage?

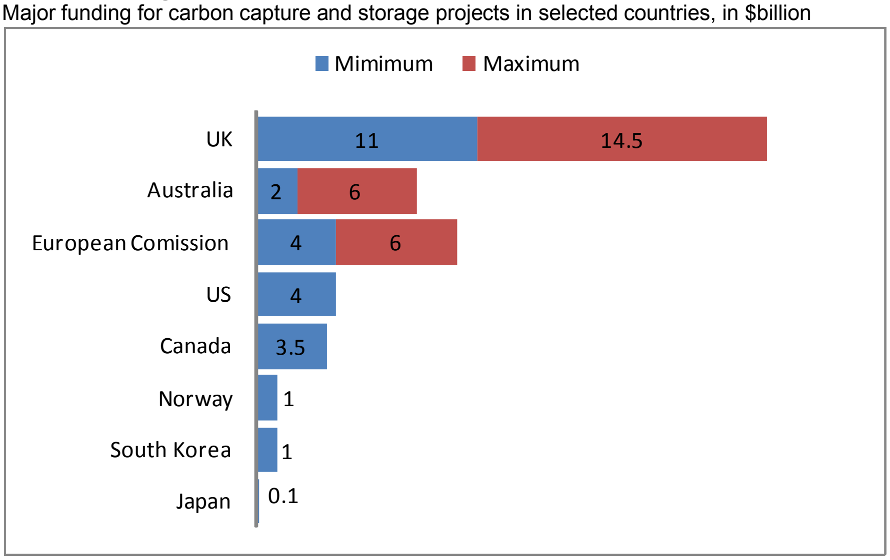
Norway's Statoil believes there is

Since 1996, **Statoil**, the Norwegian state-owned company, has been quietly pumping some 13 million tonnes of CO2 in a North Sea gas field from its **Sleipner offshore platform**, where it is expected to remain for a long time. CO2, of course, is a by-product of natural gas production. Most of the time, it is vented into the atmosphere, but not in this case.

Now the company is thinking of making a business out of its reservoir, extensive pipeline infrastructure and storage expertise. "We want to build a business at Statoil as a CO2 storage provider," **Kristofer Hetland**, a Statoil executive was quoted in **Financial Times** (3 Sept 2010). It could turn out to be a lucrative business if a global price is placed on carbon emissions. Millions of tons of the stuff needs to be captured and stored somewhere – why not in depleted oil and gas reservoirs under the North Sea, courtesy of Statoil?

Who's working on CCS?

Major funding for carbon capture and storage projects in selected countries, in $billion



Source: Financial Times, 3 Sept 2010 based on data from governments & EC

Governments and energy companies around the world are spending billions on developing a commercial scale **carbon capture and storage** (CCS) technology with the focus on capturing carbon from power generation combustion process, particularly in coal-fired plants. Others are looking at similar technologies for oil refineries and other industrial processes with significant carbon emissions, as well as emissions from natural gas fired plants, which emit roughly has as much as coal-fired units per unit of generated electricity.

In a few small-scale experiments in **Germany** and in the **Netherlands** where smallish quantities of captured CO2 were proposed to be injected in underground reservoirs, the locals have objected due to safety concerns. Like nuclear waste repositories, nobody wants to live near a carbon storage dump. And despite Statoil's excellent experience to date in the North Sea, there are concerns about accidents in offshore platforms, with images of BP's recent accident in the Gulf of Mexico still fresh in memory.

But if the CCS technology evolves to the point where it is commercially feasible, a big if, then the know-how and the infrastructure of companies such as Statoil will become handy, and potentially handsomely profitable.■