Medium-term outlook for US power: 2015 = deepest de-carbonization ever

Contents

In 2015, the US could set new national records: for annual renewable build; for coal retirements; and for gas burn from the power sector. Meanwhile, electricity-related emissions could fall to their lowest levels since 1994. This Research Note examines our short-term forecasts for US power.

- **Renewable build** will total 18.3GW in 2015 – 9.1GW from solar (an all-time high); 8.9GW from wind (third-most ever). Both technologies are in the midst of a temporary build rush, as developers race to capture important federal tax incentives that are set to step down or expire by 2017. California will account for over half of the solar build in 2015; ERCOT will absorb over one third of the new wind.
- The Mercury and Air Toxics Standard (MATS) take effect on 16 April 2015, hastening a wave of **coal retirements** among generators whose economics are otherwise challenged by the effects of old age and cheap gas. In all, expect 23GW to stop burning coal this year, with another 30GW falling offline before decade-end. PJM and the Southeast will be hardest hit.
- Natural gas-fired generators are poised to back-fill lost generation from retiring coal; and even more importantly, plummeting gas prices have enabled efficient, combined-cycle gas turbines to undercut marginal costs of coal in many parts of the country. Coal-to-gas switch calculus is complex, but we believe these two factors (lost coal capacity and a relative improvement in gas-fired economics) will lead to the most **gas burn** from the power sector ever – more even than witnessed in 2012 ('the year of no winter', when Henry Hub sank below $3/MMBtu).

Figure 1: US power mix

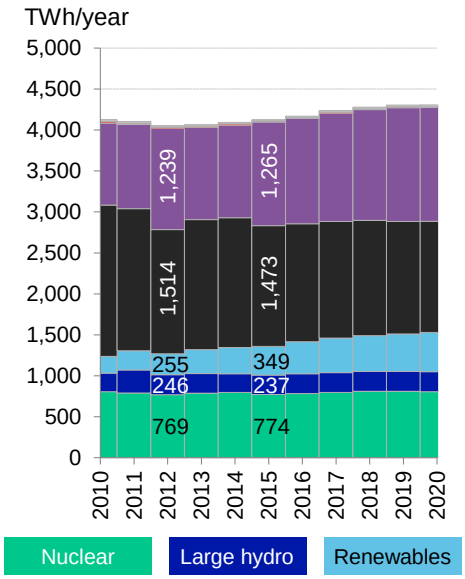


Figure 2: New build and retirements

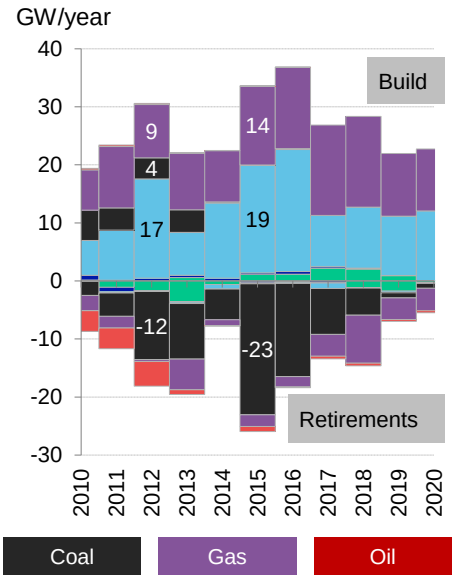
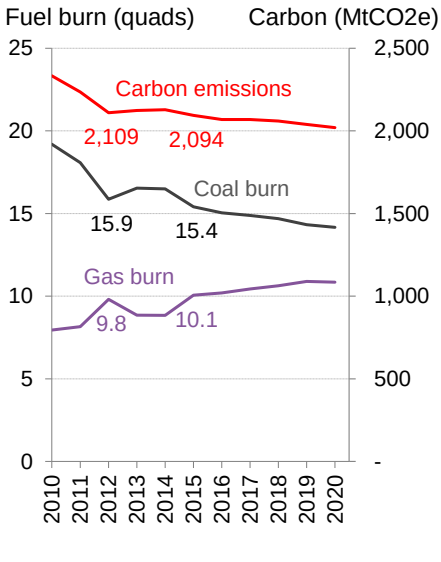


Figure 3: Fuel burn and CO2 emissions



Nuclear | Large hydro | Renewables | Coal | Gas | Oil

Click here to view these same graphs on a US regional basis – and to access other detailed outputs behind this analysis

Source: Bloomberg New Energy Finance, EIA 923, EIA 860, Bloomberg Terminal

- Only 8% of the nation's power-sector **carbon emissions** are actually 'covered' by cap-and-trade; meaning only 8% carry a price tag. But the industry should take notice of emissions levels in light of the Clean Power Plan, which is (mis)-understood to call for a '30% carbon cut from 2005 levels by 2030'. Our estimate puts 2015 emissions at 2,094MtCO2 – 16% below 2005 levels, and roughly 350Mt away from our 2030 'goal'. On an *emissions rate* basis (t/MWh), 2015 will be the cleanest year in over 60 years for which we have historical data.

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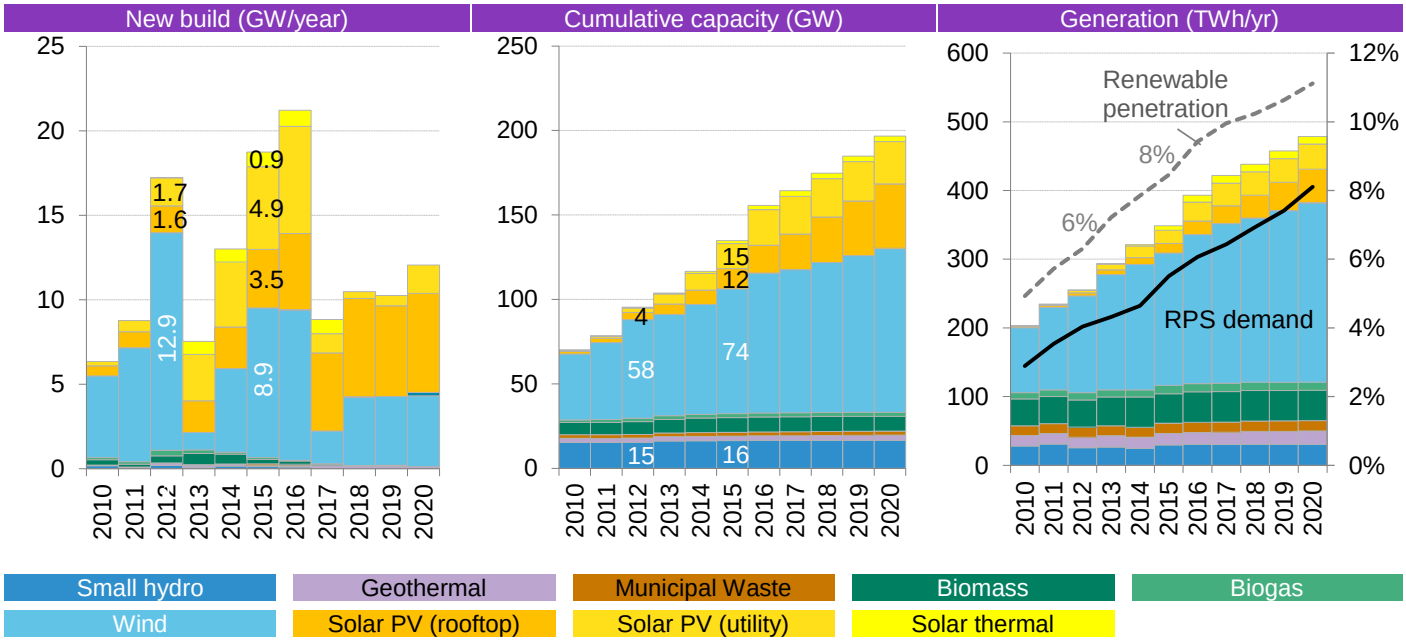
- This Research Note is more sensationalist than we typically write. While it is true that US power will break several records in 2015, it is important to keep these changes in a broader context. Figure 1 tells a relatively sobering story: that at a high level, even when multiple records are broken, the generation mix from one year to the next looks roughly similar. There is plenty of inertia in a +1,000GW, +4,000TWh/year system such as the US power grid. Change comes slowly, even in the most transformative times.

1. RENEWABLES: TEMPORARY BOOM

Installed renewable capacity grows every year. As such, every year breaks a record for total renewable energy capacity and generation (Figure 4) – but 2015 is shaping up to be an exceptional year for new installations as well.

Figure 4: Renewable build, cumulative capacity and generation – historic and according to BNEF base case forecast



Source: Bloomberg New Energy Finance build and generation forecasts; historical build and generation from EIA Form 860 and Form 923.
Click here for underlying data

- In total, we expect 18.5GW of **renewable build** in 2015. This would eclipse the previous record of 17.1GW observed in 2012. While the 2012 record was met largely as a result of record wind build ahead of policy expirations, this year will see a nearly even mix of wind and solar. Next year (2016) could be a repeat of this one, as projects in wind and solar rush to meet completion dates in line with expiring tax credits.
- **Utility-scale solar** installations are expected to reach an all-time high of 4.9GW this year, thanks to the completion of a handful of mega-projects (+100MW) in California[1], and bolstered by a wave 'baby ground mounts' in the 1-10MW range. (This 1-10MW range is where we think the sector's most promising future lies.) Saturation[2] in California and the pending step-down of the federal

1 For example, Mount Signal I PV is a two-phased project totalling 266MW in Imperial Valley, California which came online in May 2014 and was acquired by TerraForm (the yieldco of SunEdison) shortly thereafter.

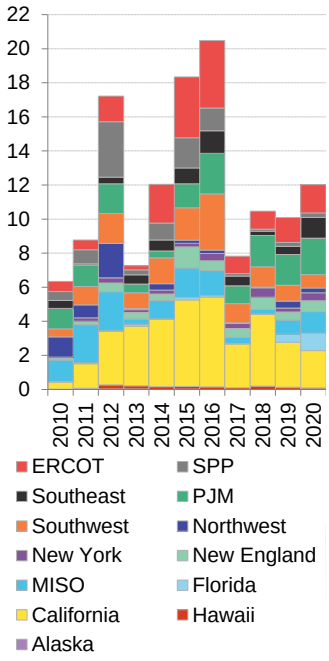
2 California is approaching saturation points for utility-scale solar on two fronts: firstly, its existing RPS targets for 2020 are largely met, eliminating the need for incremental build beyond the existing pipeline; and secondly, a surplus of installed solar capacity is already causing mid-day prices to sag, due to a phenomena known as the 'merit order effect'.

Investment Tax Credit (ITC) from 30% to 10% will temporarily cripple the utility-scale solar business beyond 2016. The next two years will be utility-scale solar's time in the sun.

- **Rooftop solar** is also on the rise, thanks to module cost declines and innovations in financing and ownership. We expect the US will finish with a record 1.9GW of residential solar installations in 2015, and another record of 1.6GW on non-residential roof-space. Rooftop solar will prove more resilient to the step-down of the ITC than utility-scale build, because of favourable economics (rooftop solar competes against retail electricity prices; utility-scale against wholesale prices) and broader geographic diversity (less dependence on California).
- Technically, the Production Tax Credit (PTC) for **wind** was extended for just two weeks last December, but in practice, safe-harboured projects have until the end of 2017 to capture the important federal incentive without facing additional IRS scrutiny. Further extensions beyond the effective end-date in 2017 are viewed as unlikely with the current US Congress.

  As such, developers are racing to bring projects online ahead of 2017 to qualify for the programme. As part of this wave, we expect nearly 9GW of new wind projects to be commissioned in 2015, with a similar number pending for 2016. This is almost double the capacity additions in 2014 (when 4.9GW came online), but is overshadowed by the incredible rush of projects in 2012 – ahead of the previous expiration of the PTC.
- **RPS requirements** jolt upward by 43TWh in 2015 – by far the steepest annual increase in renewable energy credit (REC) demand in history and in the projected future (Figure 4). States with the largest annual increase in RPS demand from 2014-15 are as follows: Oklahoma's voluntary 15% RPS goal kicks into gear in 2015; California's RPS marches steadily forward; and North Carolina, Oregon, Michigan, Colorado and Wisconsin take step-function leaps.

Figure 5: Renewable build by region (GW/year)



Source: Bloomberg New Energy Finance

Click here for underlying data

Regional build (Figure 5)

- At the end of 2014, **California** housed near half of all installed solar capacity in the US; that ratio will carry forward into 2015. Part of the reason we think that California took on so much utility-scale solar capacity relates to the way in which utilities valued the time-of-day production of a typical solar array. California's investor-owned utilities (IOUs) may have over-valued the 'on-peak' aspect of solar generation during requests for proposals (RFPs) to meet their RPS demand.
- **Texas** is in the midst of its second wave of wind build – with 9GW expected to come online between 2014 and 2016. The first occurred from 2007-09, when Texas installed nearly 7GW. Most of the renewable capacity added in ERCOT in 2015 will be located in the Panhandle, where resources are especially strong, and where the last leg of the Competitive Renewable Energy Zone (CREZ) transmission lines were recently completed.

2. COAL RETIREMENTS: BEGINNING OF THE END

The US coal fleet is entering an unprecedented period of retirements, as the industry faces a three-pronged assault from low gas prices, an aging fleet, and stringent environmental compliance.

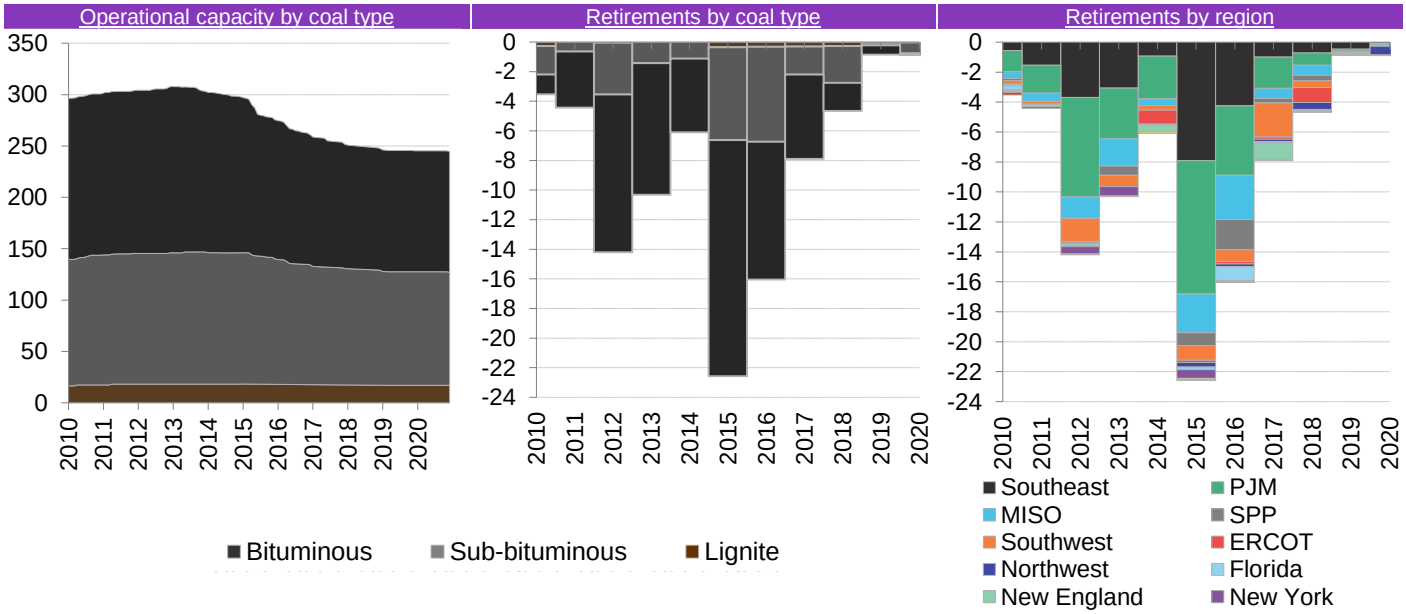
- **Old age:** numerous units are today approaching 50+ years of operation.
- **Cheap gas:** sub-$4/MMBtu Henry Hub gas will hit coal units twice – first, by reducing wholesale power prices; and second, by bringing combine-cycle gas turbines (CCGTs) into the base-load power mix, encroaching on sales of coal-fired electricity.
- **Environmental regulations:** standards laid out by the US Environmental Protection Agency (EPA) will force generators to decide whether to invest in expensive environmental controls.

2015 will be particularly noteworthy, as the first date for compliance with EPA's Mercury and Air Toxics Standard (MATS) arrives on 16 April 2015. MATS serves as an artificial deadline for the retirement of units whose economics were already challenged. Overall, we expect 23GW of coal to retire in 2015 alone, in what marks the largest wave of coal retirements in US history. Over 50GW are expected to retire by 2020.

The coal units now slated to come offline accounted for over 270TWh/year from 2013-14 – roughly 7% of US generation. While we do anticipate higher capacity factors at the remaining coal units, the result should be a fundamental reduction in coal's share of the US power mix.

The impact of coal retirements will be particularly strong in the regions east of the Mississippi: nearly 70% of retiring capacity is located in the Southeast and PJM power regions (Figure 6).

Figure 6: Coal capacity, retirements, and generation, according to BNEF forecasts, 2010-20 (GW)



Source: Bloomberg New Energy Finance, EIA Form 860, company filings and interviews.

Click here for underlying data

3. FUEL BURN: 'STRUCTURAL' GAS GROWTH

In 2012, natural gas burn in the power sector reached a record high of 25Bcfd, driven by a perfect combination of low gas prices and high summer load. Now, 2015 is shaping up to be a major year for gas generation as well. Year-to-date, natural gas burn in 2015 is 1Bcfd above 2012 levels. With 23GW of coal unit retirements, 14GW of gas build, and Henry Hub forward curves predicting gas prices below $3.00/MMBtu, 2015 looks likely to overtake – or at least match – 2012 in terms of gas burn (Figure 7).

Figure 7: US power sector gas and coal burn forecasts, 2005-20

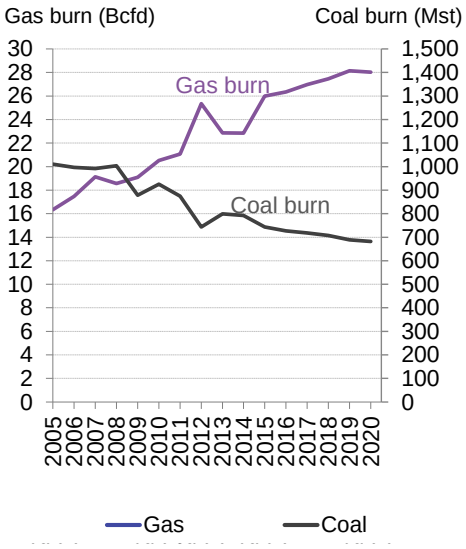


Figure 8: Gas burn by region, 2005-20 (Quads)

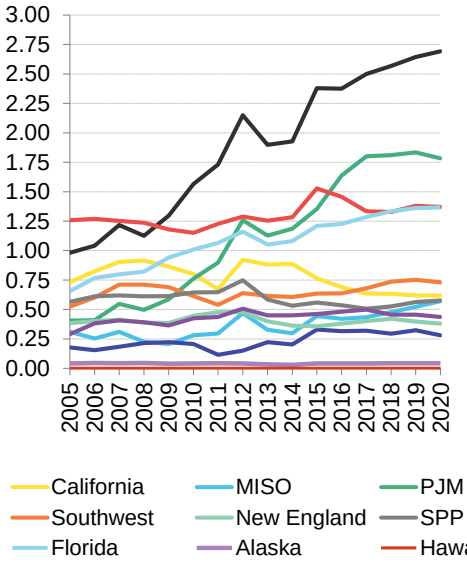
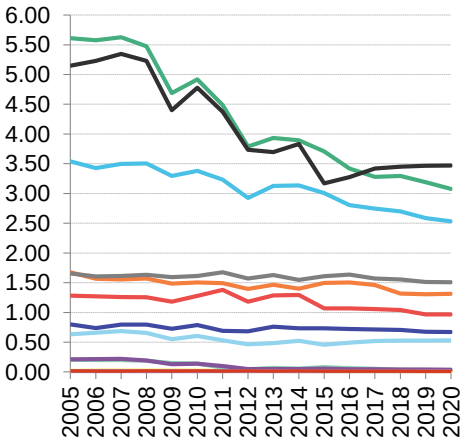


Figure 9: Coal burn by region, 2005-20 (Quads)



Source: Bloomberg New Energy Finance, EIA 923, Bloomberg Terminal

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Structural fuel switching: evolution of the plant stack

In addition to the relative price of fuel, the available plant stack has an impact on coal and gas generation: in order to switch off coal generators in favor of gas (when prices signal such a choice), there must be sufficient capacity of gas and coal available for generation. As explained in Section 2, a wave of coal retirements will reduce this potential going forward – especially in the Southeast and PJM, where nearly 70% of coal unit retirements will occur. Meanwhile, gas capacity is set to grow, with over 56GW of net gas capacity additions expected online between 2015-20.

Operational fuel switching: relative economics of gas versus coal

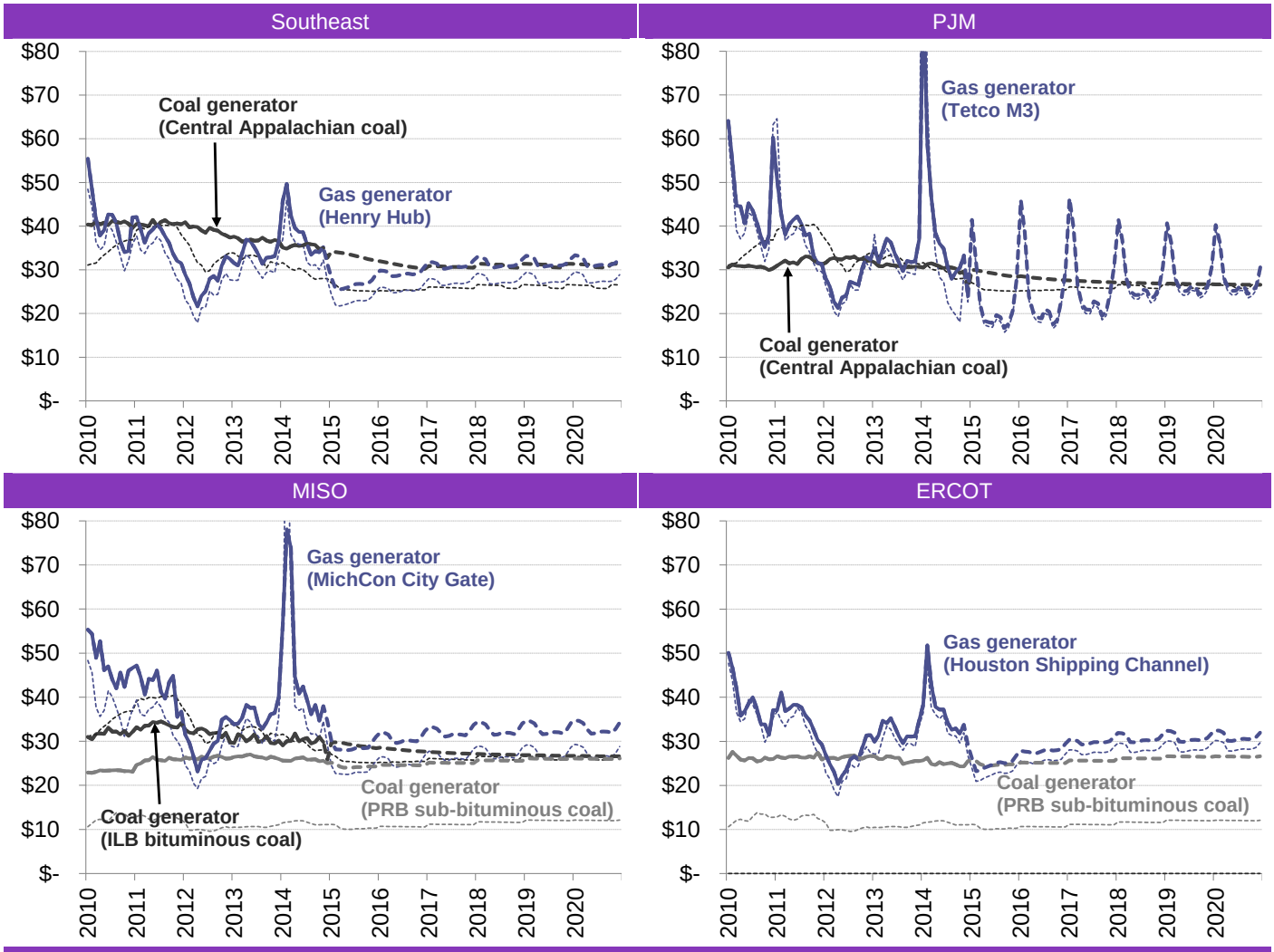
On an operational basis, gas burn is governed by the hour-by-hour competition between the nation's 450GW of gas turbines and its 300GW of coal. Since fuel price is the most significant component of operating costs for both gas and coal units, the relative price of each fuel in a dollar per megawatt-hour ($/MWh) basis has a significant impact on the relative generation from gas versus coal.

- **Coal prices** have come down since 2011, especially for Central Appalachian coal, which is consumed by most power plants in PJM (the unregulated market which spans the mid-Atlantic and Midwest) and the Southeast.
- However, **natural gas** prices are also low this year – with forward curves suggesting that prices this summer will be near 2012 levels (or even below, in the case of PJM).

As a result, competition between the average gas and coal generator will be intense across the US. Figure 10 shows the average short run marginal costs for fossil generators in the four US region with the highest levels of natural gas burn for electricity. When the costs for gas generators (purple) fall below those of coal (black/grey), there is an opportunity for switching to gas.

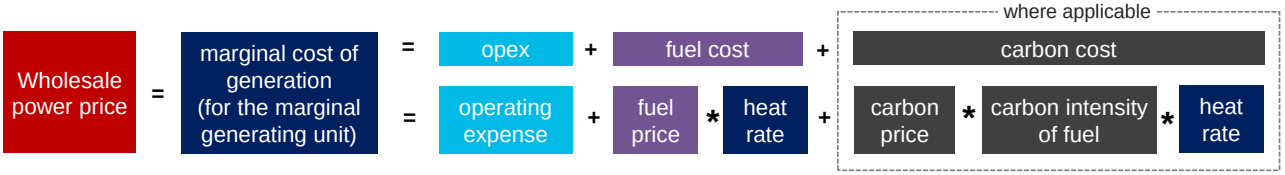
For the rest of the decade, natural gas economics look very strong relative to coal in the Southeast and PJM – although in ERCOT and MISO, where generators can take advantage of cheaper coal from the Powder River Basin (PRB), coal generation has a slight edge past 2015.

Figure 10: Short run marginal costs of generation by fuel and region, 2010-20 (all-in $/MWh; real 2014USD)



Click here for our database of US power and fuel prices

Source: Bloomberg New Energy Finance, EIA 923; Bloomberg Terminal Fair Value Curves. Notes: All lines represent marginal costs of generation, based on various fuel prices. Dotted lines track fuel hub prices; solid lines track average all-in costs, including transport from hub to plant. Marginal costs in Figure 10 are calculated using the following formula:



Where fuel and carbon prices are tied to the market-traded forward curves; heat rate assumptions for coal-fired generators and natural gas combined cycle turbines are 10MMBtu/MWh and 7MMBtu/MWh, respectively; opex costs are assumed to be $4.50/MWh for coal and $3.50/MWh for gas; carbon intensity is 0.10tCO2/MMBtu for coal and 0.05t/MMBtu for gas. Dotted lines represent fuel prices, solid lines represent the all-in average short run marginal cost of generation. PRB is Powder River Basin coal, ILB is Illinois Basin coal.

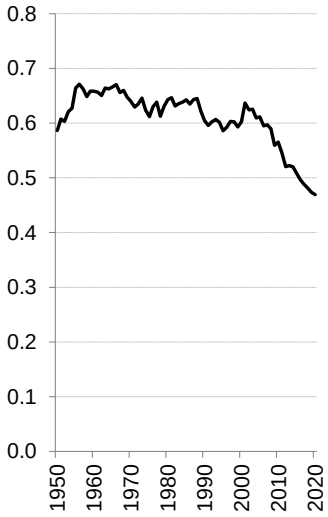
4. CARBON EMISSIONS: FURTHER TO FALL

Rising renewable penetration and coal-to-gas switching culminates in lower carbon emissions. Only load growth can prevent 2015 from posting the lowest electricity-related emissions in over two decades. So long as we do not see extreme summer heat waves[3], US power sector emissions are poised to drop 35Mt (2%) below last year's levels.

This would not be the steepest single-year drop: emissions recently fell 126Mt between 2011 and 2012, but the 2012 decline was more cyclical in nature – driven by inherently temporary, weather-related declines in natural gas prices and electricity load. (Emissions rebounded the following two years.) In contrast, the reduction in 2015's carbon footprint from the power sector is a more 'structural' phenomenon – driven by permanent factors like more renewable capacity and less coal.

Ultimately, to put carbon emissions in proper context, we must take a longer view. The relevant milestone for US power-sector emissions is 2030: the final deadline to comply with the Clean Power Plan. Figure 12 demonstrates how 2015 emissions stack up relative to the trajectories required in order to comply with the Clean Power Plan, according to EPA modelling. And just for fun (or because the Clean Power Plan itself does not target emissions; it targets 'adjusted' *emissions rates*), Figure 11 maps estimated *emissions rates* from 1950-2015, showing that megawatt-hour for megawatt-hour, 2015 is poised to be the US power sector's cleanest year on record.

Figure 11: US fleet-wide emissions rates, 1950-2020 (tCO2e/MWh)



Source: Bloomberg New Energy Finance, EIA Notes: Calculations for pre-2000 emissions rates are rough approximations, based on the energy generated from different resources. We assumed a flat emissions factor for coal, gas, oil, etc.
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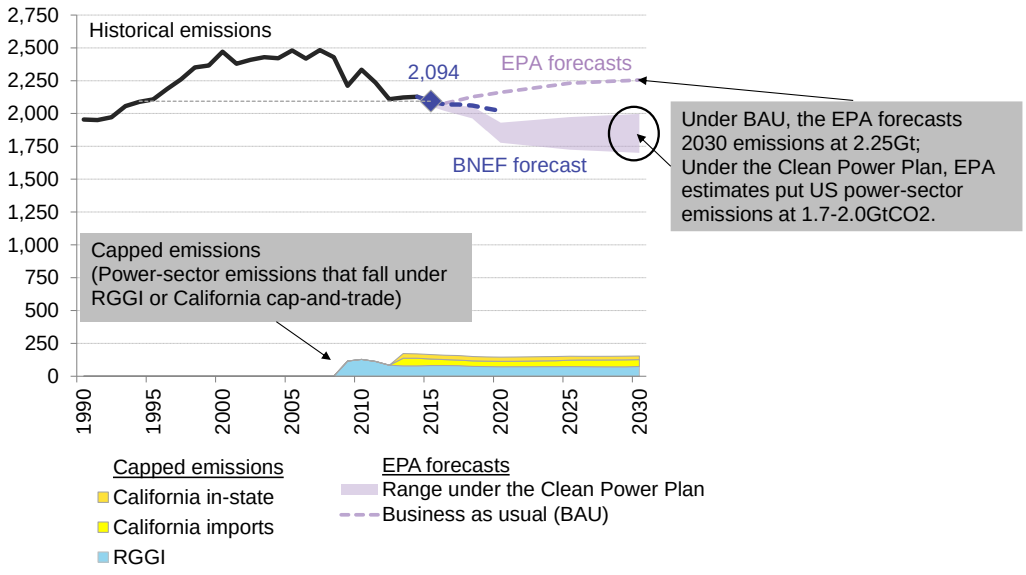
Figure 12: US power-sector emissions under various forecasts (MtCO2)



Source: Bloomberg New Energy Finance, EIA 923, EPA modelling, RGGI, CARB
Click here for underlying data

3 Hot summers lead to increased use of air conditioners – major drivers of electric load. Increased electricity demand in turn leads to more fuel, and more carbon emissions.

Appendices

5. FURTHER READING

This Research Note draws extensively from other analyses; it updates themes laid out in our previous comprehensive survey of the US electricity sector; and it sets the stage for a longer, more detailed view of US power out to 2045 (currently in our research pipeline). In the meantime, Table 1 recommends previous publications for further reading.

Table 1: Selected publications for further reading

Title	Publication Date
US Power	
US power in transition: gasify, oversize, de-carbonize	26 September 2014
US power and fuel prices (2005-35)	Updated monthly
Renewables	
H1 2015 US Solar Outlook	16 January 2015
H1 2015 US Wind Outlook	Coming in April 2015
H1 2015 US SREC Outlook	9 January 2015
H1 2015 US REC Outlook: California	Coming in April 2015
H1 2015 US REC Outlook: PJM	Coming in April 2015
H1 2015 US REC Outlook: New England	Coming in April 2015
Fossil generation	
Wave goodbye to 17% of US coal capacity	16 March 2015
Q1 2015 North American Gas Outlook	25 Feb 2015
H1 2015 North American Long-Term Gas Outlook	16 Jan 2015
Carbon and the Clean Power Plan	
RGGI Deep Dive: fuel switching fades away	18 March 2015
H1 2015 California Carbon Deep Dive	Coming in April 2015
Who's afraid of the EPA Clean Power Plan?	5 November 2014
Rate-based trading under the Clean Power Plan	3 November 2014
Finance and Economics	
H1 2015 AMER LCOE Update	13 March 2015
H2 2014 US PPA Market Outlook	15 December 2014

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