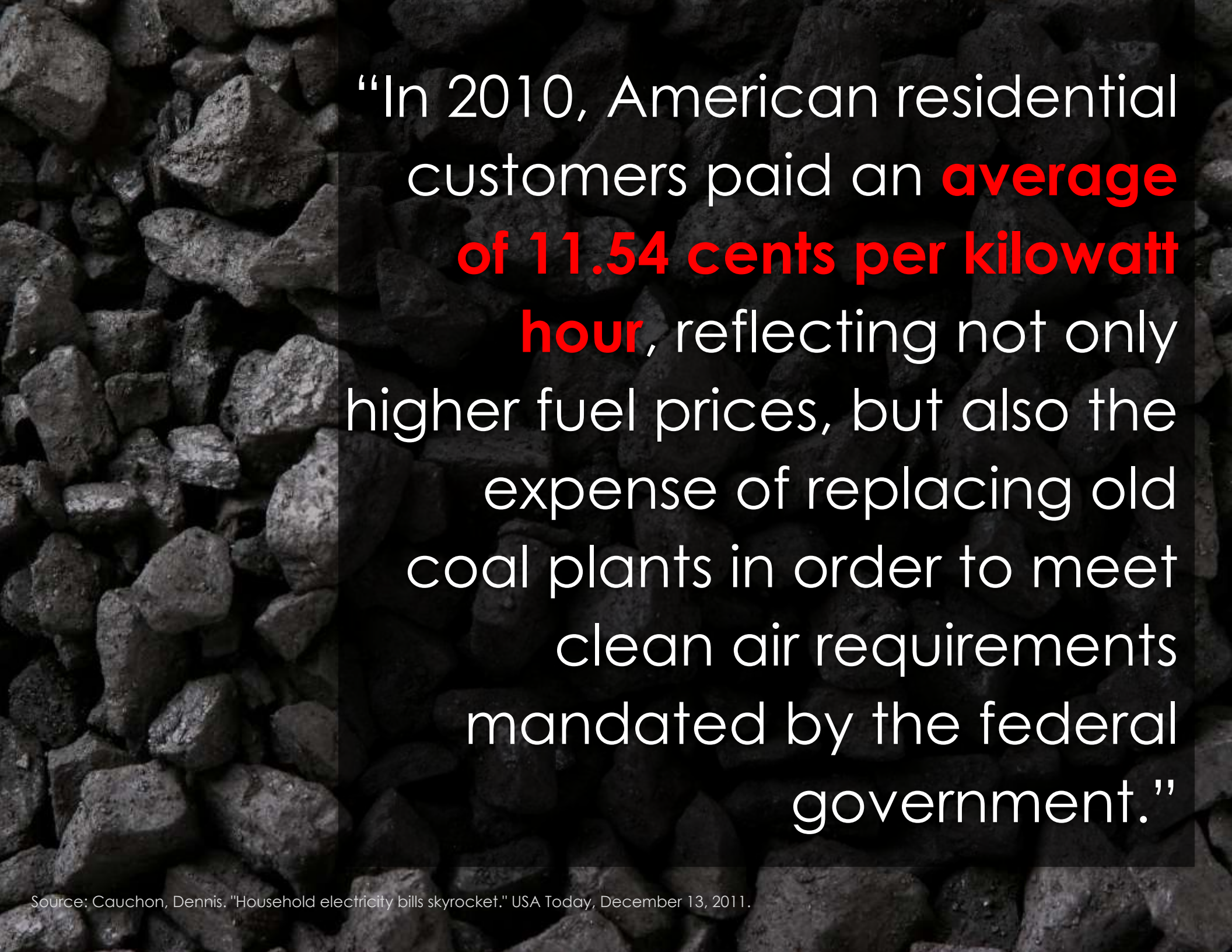


Coal:

Development Costs (vs. Natural Gas & Renewables)

Zpryme Smart Grid Insights Presents a Special Report Series (Part 2 of 3):



“In 2010, American residential customers paid an **average of 11.54 cents per kilowatt hour**, reflecting not only higher fuel prices, but also the expense of replacing old coal plants in order to meet clean air requirements mandated by the federal government.”

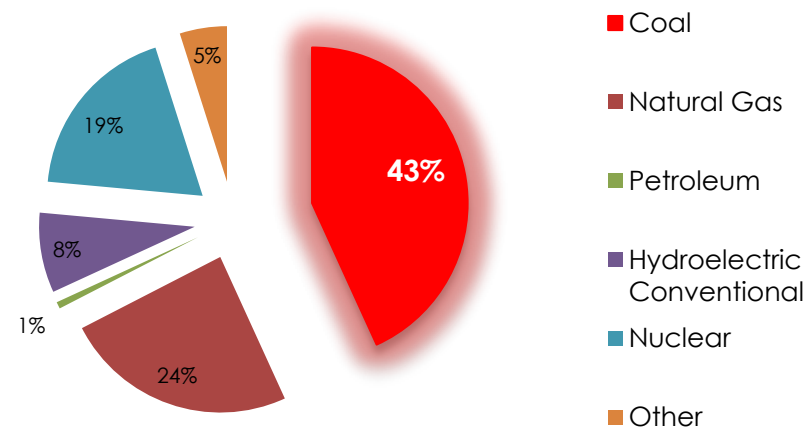
Coal: Generating Capacity & Projections in the US

Coal currently makes up about 40% of the world's power supply. This is projected to grow by an additional 60% by 2030 – mostly by developing countries. Coal also is responsible for 40% of CO2 emissions related to energy.¹ According to a 2008 report, between 1975 and 2005, 448 coal-fired plants were built in the US² and a system of transmission has developed around these plants. However, a new report by Nordhaus et al published in the *American Economic Review* cites coal-fired energy plants are responsible for more than a quarter of the damage caused by pollution.³

A New York Times article also cited that the rise in emissions recently is driven for the most part by coal.⁴ The EPA plans to release additional regulations for coal-fired plants to control emissions. These aging coal plants will be subject to additional regulation causing many to shut down or to upgrade. Thus, although coal currently leads power supply both nationally and internationally, this will likely shift over the course of the next few decades due to rising costs associated with its production.

Natural gas, nuclear and renewable energy sources make up smaller pieces of the current energy mix, see Figure 1:

Figure1: US Net Generation by Energy Source
Source: EIA | August 2010 - August 2011



Natural Gas

The EIA predicted strong growth in shale gas in their 2011 Energy Outlook report released in November. Recent increases in shale gas production has led to an increase in natural gas production in US to record levels; 3.852 trillion cubic feet the week ending November 18. More than 20 shale basins have been identified in the US and these could lead to additional growth in production.⁵ These new basins are predicted to add \$118 billion to the US economy and create 870,000 jobs over the next four years. This will also benefit the manufacturing industry, particularly the steel industry, as shale gas will make up \$1.9 trillion in capital expenditures according to a December 6 report by IHS Global Insight.⁶ It is also

¹ iea.org/ciab/Post-2012_GHG_Red_Statement.pdf

² eia.gov/cneaf/electricity/page/capacity/capacity.html

³ aeaweb.org/articles.php?doi=10.1257/aer.101.5.1649

⁴ nytimes.com/2011/12/05/science/earth/record-jump-in-emissions-in-2010-study-finds.html?_r=1

⁵ www.zpryme.com | www.smartgridresearch.org

⁵ hydrocarbonprocessing.com/Article/2943911/Latest-News/Shale-gas-gives-rise-to-era-of-energy-independence.html

⁶ industryweek.com/articles/u-s-manufacturers-gear-up-for-shale-gas-boom-26150.aspx

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expected that US energy costs could be reduced by 10%.⁷ However, hydraulic fracturing extraction of shale gas has led to recent controversy surrounding health and environmental impacts of “hydrofracking” and may lead to increased regulations and costs on this process. The EPA is currently looking into applying regulations based on air pollutants released from the “hydrofracking” process.⁸ An EPA report released on December 8 indicates that “hydrofracking” in Wyoming has led to water contamination in the town of Pavillion. This report has caused further complications to “hydrofracking” in New York State, where the state Department of Environmental Conservation is creating rules and regulations for this process, to be released January 11, 2012.⁹

Zwim, Chief executive of the Energy Unit at Siemens predicts that “about half of this year’s 13,000 megawatts of new power plants are being fueled with natural gas” and by 2016 “roughly 30,000 megawatts of new gas-fired power plants will be under development or under construction, all potential customers for Siemens’s gas turbines.”¹⁰

Renewable energy

IEA launched the first in depth renewable energy technology study on December 1, 2011. The study will include a focus on separating annual operational costs from initial investment costs in these technologies.¹¹

⁷ businessweek.com/news/2011-12-06/shale-gas-drilling-to-add-870-000-jobs-by-2015-report-says.html

⁸ upi.com/Top_News/US/2011/12/06/EPA-critical-of-Pa-shale-gas-policy/UPI-75781323203592/?spt=hs&or=tn

⁹ nydailynews.com/new-york/hydrofacking-push-york-derailed-contaminated-water-wyoming-article-1.989828

¹⁰ <http://online.wsj.com/article/BT-CO-20111116-713367.html>

¹¹ iea.org/files/Solar_Energy_Perspectives.pdf

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Renewable energy forms include wind (onshore and off), solar, hydro, biomass, geothermal and biofuel. Some of these technologies are more advanced than others, particularly solar PV.¹² In 2010, the learning rate for solar PV was 19.3%.¹³ One of the strengths of PV systems is that they are “lower in cost per energy than fuel-only cost of fossil fired generators and power plants.”¹⁴ Learning to capture solar energy more efficiently will lead to increased fuel-parity as the amount of sunlight that hits Earth in a 90 minute time span contains enough energy to potentially meet global energy needs for one year.¹⁵ However the large initial investments in infrastructure necessary for new forms of renewable energy paired with the high costs of connecting them to existing energy grids may discourage investors in the present period. Tax credits have been a major driver of growth in the renewable energy industry; for example the wind industry grew by 300% under the current system of tax credits.¹⁶ Tax credits for investments in renewables are winding down; therefore development projects in this industry in 2012 and beyond will need to rely on other investments.

The EIA’s Annual Energy Outlook 2011 uses levelized costs to evaluate the true costs of various energy sources. These levelized costs use the present value of the total costs of building and operating a generating plant over its projected life, adjusting for inflation. These numbers include the overnight capital cost, fuel cost, variable operating and maintenance costs, financing costs and an assumed rate of inflation. Figure 2, below, illustrates the

¹² iea.org/files/Solar_Energy_Perspectives.pdf

¹³ iea.org/files/Solar_Energy_Perspectives.pdf

¹⁴ http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5771714

¹⁵ iea.org/LatestInformation.asp

¹⁶ http://nawindpower.com/e107_plugins/content/content.php?content.9015

various costs (in 2009 dollars) for coal, gas, nuclear, wind, solar, geothermal, biomass and hydro power sources for plants coming on line in 2016.¹⁷

Figure 2. US Average Levelized Costs for Plants entering Service in 2016¹⁸
Source: EIA | April 2011

Plant Type	Levelized Cost (2009 \$/megawatt hour)
Conventional Coal	\$95.10
Advanced Coal	\$109.7
Advanced Coal with CCS	\$136.50
Natural Gas-Fired:	
Conventional Combined Cycle	\$65.1
Advanced Combined Cycle	\$62.2
Advanced CC with CCS	\$88.4
Conventional Combustion Turbine	\$123.0
Advanced Combustion Turbine	\$102.1
Conventional Combined Cycle	\$65.10
Advanced Combined Cycle with CCS	\$88.40
Conventional Combustion Turbine	\$123.00
Advanced Nuclear	\$114.00
Wind	\$96.10
Wind - Offshore	\$243.70
Solar OV	\$211.00
Solar Thermal	\$312.20
Geothermal	\$99.80
Biomass	\$112.60
Hydro	\$90.50

These estimates do not take into consideration outside incentives, such as subsidies or taxes that may be imposed. However, we can see that the cost of producing energy with a conventional coal-fired generator is \$95.10

per megawatt hour, \$30 higher than producing energy with a natural gas-fired conventional combined cycle, and more than an advanced natural gas-fired combined cycle with carbon capture and sequestration (CCS) technology employed. Wind (onshore) is only slightly higher cost of \$96.10 per megawatt hour and Hydro is only \$90.50 per megawatts hour.

Coal: Bottom Line

Historically, the cost of coal has been heavily subsidized. Most recently, the tax exemptions both coal and natural gas receive in Pennsylvania have come into the light.¹⁹ Tax exemptions and other such subsidies have artificially held the price of coal lower than other energy sources. However, the environmental and health effects of coal and natural gas are also gaining more attention and may be subject to more regulation. These regulations and the potential removal of the subsidies in the future could significantly raise the cost of coal and natural gas compared to renewables. However, for the time being per the EIA, NERC and Exxon Mobile reports, natural gas seems to be the lowest cost energy source investment as costs associated with coal are rising and natural gas capacity is expanding.

¹⁷ eia.gov/forecasts/aeo/electricity_generation.cfm

¹⁸ Costs are expressed in terms of net AC power available to the grid for the installed capacity.

4 www.zpryme.com | www.smartgridresearch.org

¹⁹ <http://stateimpact.npr.org/pennsylvania/2011/12/06/pennfuture-report-claims-pa-has-shelled-out-2-9-billion-to-oil-coal-and-gas-companies/>

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