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Analytical Brief

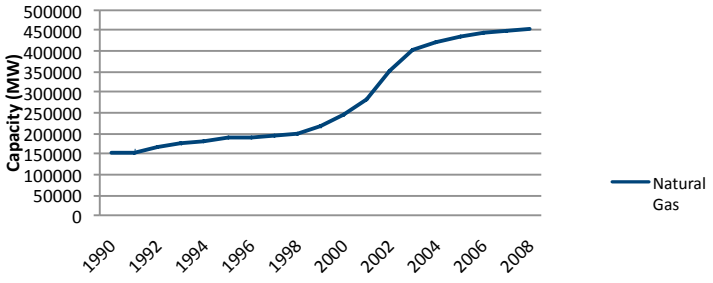
Natural Gas: An Unconventional Story

This analytical brief explores the remarkable episode of growth that occurred in natural gas-based electricity development in the U.S. between 1990 and 2008. This boom was the product of a complex convergence of factors, including electricity restructuring, relatively low gas prices, technological innovation and a host of other interacting factors. Together, these factors drove a rush of capital investment that significantly altered the capital stock of the U.S. electricity industry. Understanding this history is critical to better understanding the competitive landscape facing renewable energy technologies today.

Compound interests

Natural gas experienced a boom in the late 1990s in the wake of deregulation in the electric sector in the U.S. (Figure 1). This restructuring created significant opportunities for new gas development for electricity generation, many of which were attributable to the convergence of technological developments and the intrinsic characteristics of natural gas.

Figure 1: U.S. Natural Gas-fired Electricity Capacity



Source: EIA, *E3 Analytics 2010*

A number of factors drove this development. First, environmental permits were significantly easier to obtain for natural gas plants than for coal or nuclear plants. Siting was less fraught with legal and environmental challenges, and projects could therefore be built more rapidly, and closer to load centers. In addition, the installed cost of new natural gas power plants was significantly lower per unit of installed capacity than that of other generation options.

On the technological front, the prospects for natural gas-based electricity generation expanded rapidly with the advent of the combined cycle gas turbine, which became something of a "disruptive innovation" in the otherwise mature electricity industry. Combined cycle gas turbines were derived from the design of a jet engine, and led to the commercialization of a highly modular turbine unit that could be mass produced and scaled to suit a variety of sizes and applications.

Added to this, gas prices themselves were low, making the generation of competitively priced electricity possible (see Figure 2). In fact, most new gas generation began undercuting the price of existing electricity

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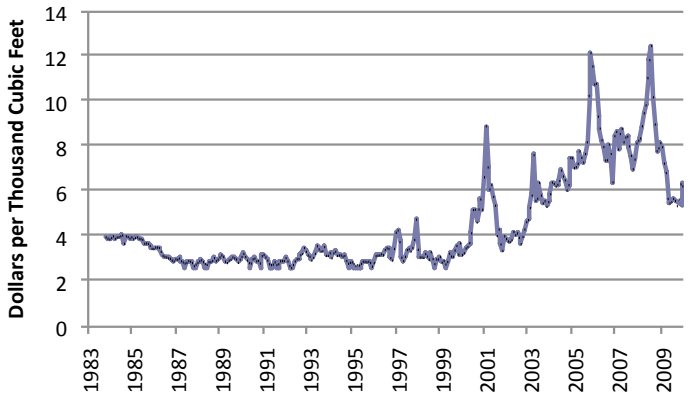
Figure 2:
U.S. Average Natural Gas City Gate Price 1983-2009



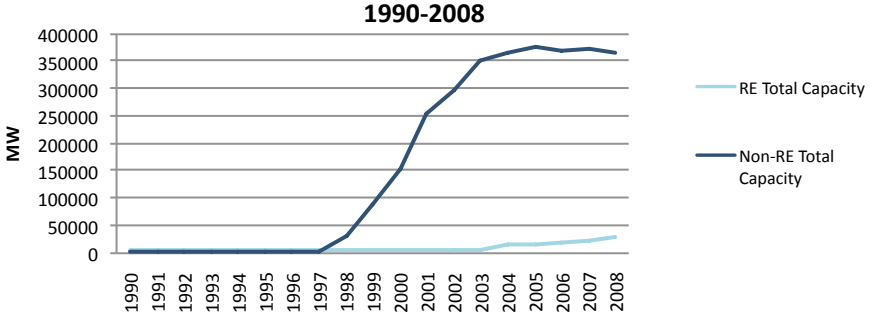
Source: EIA, *E3Analytics 2010*

generation, making them an attractive option to meet new load growth.

All of this occurred against the backdrop of electricity deregulation, and the accompanying trend toward greater direct price competition between utilities. This increased competition created growing demand for new, low cost electricity options, and led to rapid growth in private electricity generation activity (see Figure 3).

Yet another feature of natural gas that facilitated this rapid growth is that gas-based generators could ramp their supply up and down quickly and relatively efficiently, providing valuable ancillary services for capacity-constrained electricity markets. This made natural gas a valuable addition to the overall electricity supply infrastructure, and enabled utilities to dispatch new gas generators to serve peak demand.

Figure 3: U.S. Independent Power Producer Capacity 1990-2008



Source: EIA, E3 Analytics 2010

Finally, previous legislation under the 1992 Energy Policy Act in the U.S. removed a number of restrictions on independent power producers, making it easier for a new class of investors to capitalize on the opportunities opened up by the restructuring of the electricity sector. The majority of this capacity was in new natural gas-fired plants, which started at roughly 5 % of total U.S. independent power producer (IPP)capacity in 1990, rising to over 50% today (see Figure 4).

Taken together, these significant shifts within the U.S. electricity industry made gas-fired power plants the technology of choice for new electrical capacity in the U.S. **This powerful set of circumstances enabled natural gas plants to be built much more quickly, cheaply, and run more profitably than other generation options at the time.**

The rest, as they say, is history.

Filling Up

Much of the new rush in investment in new electrical capacity between 1990 and 2008 was also in response to a prior period of relatively low investment in new electricity generation. This under-investment created pressures in certain markets, and helped generate a rush of

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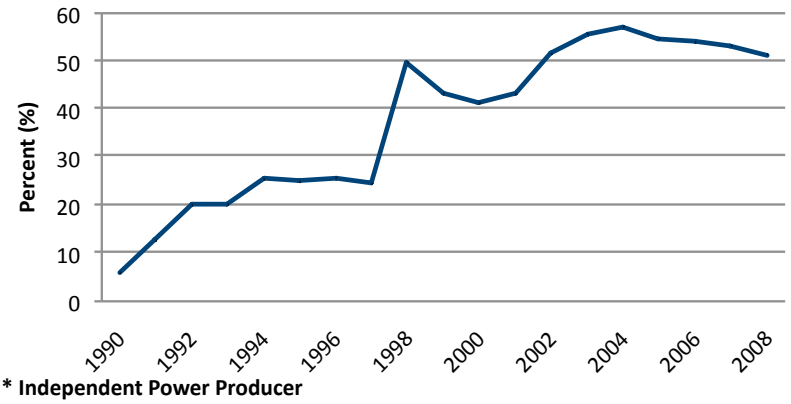
Figure 4: Natural Gas Share of Total U.S. IPP* Capacity



* Independent Power Producer
Source: EIA, *E3 Analytics 2010*

investment, while helping to quell fears of a future shortfall. Combined with relatively low natural gas prices (hovering between $2-4 per thousand cubic feet from 1983-1997,) these changes in the electricity market created a boom in energy development opportunities.

As shown in Figure 5, this led to an episode characterized by rapid growth in capacity (MW) that significantly outstripped the rate of growth in actual generation (MWh). The result was that a significant share of natural gas capacity in the U.S. went unused (or at least under-used), having been built largely to capitalize on new opportunities and on the expectation of capitalizing on increasingly lucrative electricity markets. As a result, many of these plants ended up serving primarily peak demand, operating less than 5% of the time.

Carrying Capacity

Natural gas capacity grew from 152 GW of installed capacity in 1990 to over 454 GW of capacity in 2008, representing an average compound annual growth rate (CAGR) of 7.9%. This reflects a growth in its share of total U.S. electricity capacity from 20% in 1990 to over 41% in 2008 (see Figure 5).

As a result, natural gas represents over two fifths of total U.S. electrical capacity (more than any other source), and yet it only generates roughly one fifth of its actual electricity.

Compare this to coal.

Over this period coal capacity remained virtually stagnant, increasing from 330 GW in 1990 to 337 MW in 2008. As a result of the dramatic increase in natural gas capacity, coal's share of total U.S. electrical capacity shrank from 42% to roughly 30%, although it still represents just under 50% of total U.S. electricity generation.

Booms and... busts?

Although there was arguably no bust in natural gas development per se (leaving the story of Enron and the California electricity crisis aside for the moment), a combination of price spikes in October 2005, and again in July 2008 where city gate natural gas prices went over $12 per thousand cubic feet, have made some regulators leery of depending too heavily on gas (see Figure 2).

With the prospect of increasing natural gas for use in the transportation sector, demand could increase significantly in the years ahead, tightening the market again and leading to further upward pressure on prices. Indeed, price volatility has remained one of the defining features of natural gas, being notoriously susceptible to the influence of speculation, as well as rapid changes in weather, both of which can have significant impacts on overall gas demand.

The road ahead

As of early 2010 and in the

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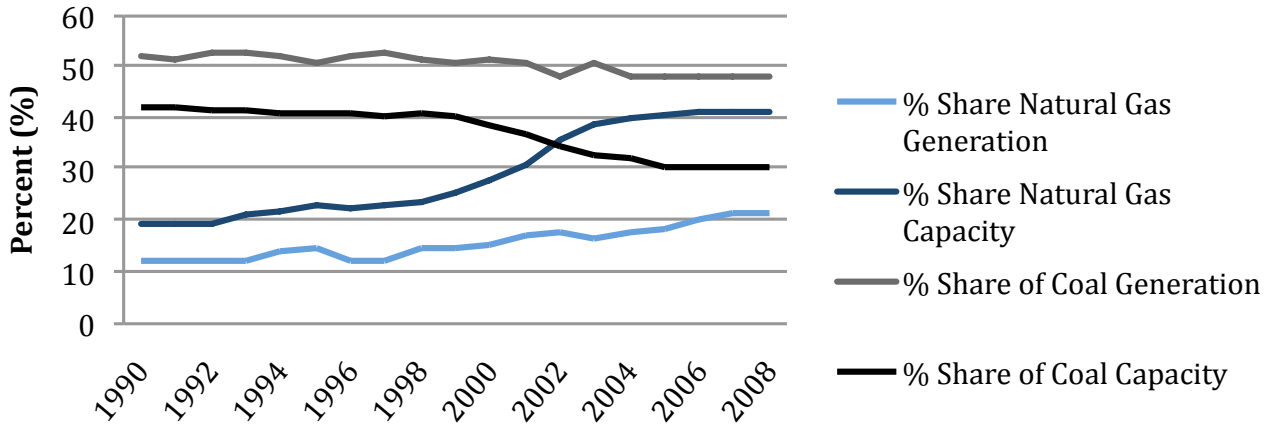
Figure 5: U.S. Natural Gas and Coal % Share of Total Electrical Capacity and Generation



Source: EIA, *E3 Analytics 2010*

wake of the financial crisis, natural gas remains competitively priced, and a new expansion of relatively inexpensive shale gas is likely to keep U.S. gas prices relatively low for the near future.

As a result, many utilities in the U.S. have begun dispatching natural gas generating units before coal units, marking a significant sea change in North American electricity markets. This suggests that some of the "over-capacity" in U.S. natural gas-fired infrastructure may start being used more fully in the months and years ahead.

The implementation of restrictions on carbon emissions could further drive this transition, reviving dormant gas capacity to displace aging (and increasingly costly) coal-fired capacity. These changes are likely to produce environmental benefits in the near-term, as GHG-intensive coal takes a back seat to natural gas, which emits roughly half the CO2 per unit of output. However, one of the immediate challenges low-priced gas creates for renewable energy markets is that it redefines the pricing landscape, and the cost of marginal electricity supply, which risks undermining the pricing rationale for adopting renewable energy technologies. This is likely to fuel investor uncertainty over the near-term competitiveness of new renewable energy technologies, arguably at the time when stability and market certainty is needed most.

Ultimately, regulators are beginning to recognize the value of the long-term price stability introduced by renewable energy sources, due to their independence from volatile fuel prices. Combined with the prospects of future uncertainty of carbon-based generation options, rapidly decreasing cost curves, and the growing emphasis on green jobs and clean energy development, renewable energy technologies are well positioned to experience a boom of their own, as investors recognize their critical role within current and future electricity markets.

The rapid expansion of natural gas capacity developed in the past 15 years can indeed provide the much-touted "bridge" to a cleaner energy future – the challenge for regulators and investors alike is not to forget where that bridge is ultimately leading us, and not to forget that the energy system awaiting us on the other side may look markedly different from the one used to build it.

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