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Can deployment of renewable energy put downward pressure on natural gas prices?

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Abstract

High and volatile natural gas prices have increasingly led to calls for investments in renewable energy. One line of argument is that deployment of these resources may lead to reductions in the demand for and price of natural gas. Many recent US-based modeling studies have demonstrated that this effect could provide significant consumer savings. In this article we evaluate these studies, and benchmark their findings against economic theory, other modeling results, and a limited empirical literature. We find that many uncertainties remain regarding the absolute magnitude of this effect, and that the reduction in natural gas prices may not represent an increase in aggregate economic wealth. Nonetheless, we conclude that many of the studies of the impact of renewable energy on natural gas prices appear to have represented this effect within reason, given current knowledge. These studies specifically suggest that a 1% reduction in US natural gas demand could lead to long-term average wellhead price reductions of 0.8–2%, and that each megawatt-hour of renewable energy may benefit natural gas consumers to the tune of at least $7.5–20.

Keywords: Renewable energy; Natural gas prices; Risk mitigation

1. Introduction

Renewable energy has historically been supported because of its perceived economic, environmental, economic-development, and national-security benefits. Recently, extreme price volatility in wholesale electricity and natural gas markets has led to discussions about the potential risk mitigation value of renewable resources in the United States and elsewhere. Deepening concerns about the ability of conventional gas production to keep up with demand have also resulted in a growing number of voices calling for resource diversification (see, e.g., Bernstein et al., 2002; Henning et al., 2003; NARUC, 2003; NPC, 2003a).

Renewable energy provides a direct hedge against volatile and escalating gas prices when it reduces the need to purchase variable-price natural gas-fired electricity generation, replacing that generation with fixed-price renewable energy (see, e.g., Bolinger et al., 2003; Awerbuch, 2003). In addition to this *direct* contribution to price stability, by displacing gas-fired generation, renewable energy may also reduce demand for natural gas and thus *indirectly* place downward pressure on gas prices.

Many recent modeling studies of increased renewables deployment in the United States have demonstrated that this "secondary" effect of putting downward pressure on natural gas prices could be significant, with the consumer benefits from reduced gas prices in many cases more than offsetting any increase in electricity costs caused by renewables deployment. As a result, this price effect is increasingly cited as justification for policies promoting renewable energy.[1]

To date, little work has focused on reviewing the reasonableness of this price-suppression effect as it is portrayed in various studies, and research has not attempted to benchmark the modeling results against economic theory. This article is a first attempt to address these two issues. Although we emphasize the impact of renewable energy on natural gas prices, we acknowledge

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[1] These effects may not appear to be present in analyses of carbon reduction policies more generally, however, because such policies are likely to lead to a shift from coal- to gas-fired generation.

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that similar effects would result from greater energy efficiency, as well as increased utilization of other non-gas energy sources whose fuel costs are not highly correlated with the price of natural gas (e.g., coal or nuclear power, but not oil-fired generation). Additionally, while our analysis focuses on the US, similar effects might be expected elsewhere.

The remainder of this article is organized as follows. Section 2 reviews economic theory to explain the principles underlying the price-suppression effect. Section 3 examines many of the modeling studies conducted during the past 5 years that have measured the price-reduction effect, illustrating the potential impacts of renewables deployment on natural gas demand and wellhead prices, as well as on consumer electricity and gas bills. Section 4 calculates the long-term inverse price elasticity of natural gas supply implied by the modeling output of each of the studies, allowing us to assess the consistency of the natural gas price response among the modeling results. Section 5 compares the range of inverse price elasticities from Section 4 with results from other analyses using the Energy Information Administration's (EIA)'s National Energy Modeling System (NEMS) (to test for intra-model consistency) and with other energy models altogether (to test for inter-model consistency). Section 6 compares the inverse price elasticities from Section 4 with the limited empirical economics literature that estimates the historical elasticities for natural gas and other energy commodities (to test for model consistency with the real world). In Section 7 we summarize our key findings.

2. Natural gas supply and demand: a cursory review of economic theory

The subsections below review the economic concepts of supply and demand curves as they relate to natural gas, introduce the inverse price elasticity of natural gas supply, and discuss the nature of the benefit derived from a reduction in natural gas demand and prices.

2.1. Supply and demand curves

It is not clear whether today's inflated natural gas prices represent a short-term imbalance between supply and demand or a longer-term effect that reflects the true marginal cost of production (see, e.g., EMF, 2003; Henning et al., 2003; Holtberg, 2002; NPC, 2003a). In either case, however, economic theory predicts that a reduction in natural gas demand caused by increased deployment of renewable energy will—by causing an inward shift in the aggregate demand curve for natural gas—generally lead to a reduction in the price of natural gas relative to the price that would have been expected under business-as-usual conditions.[2] The magnitude of the price reduction will depend on the amount of demand reduction, with greater displacement of demand for gas leading to greater drops in the price of the commodity.[3] Equally important, the shape of the natural gas supply curve will have a sizable impact on the magnitude of the price reduction.

The shape of the supply curve for natural gas will, in turn, depend on whether one considers short- or long-term effects. One generally assumes upward, steeply sloping supply curves in the short term when supply constraints exist in the form of fixed inputs like labor, machinery, and well capacity (Henning et al., 2003). In the long term, the supply curve will presumably flatten because supply will have time to adjust to higher (or lower) demand expectations, for example, through increased (or decreased) exploration and drilling expenditures (Dahl and Duggan, 1998). Because natural gas is a non-renewable commodity, however, the long-term supply curve must eventually slope upward as the least-expensive resources are exhausted.

The shape of the long-term supply curve is an empirical question and is subject to great uncertainty and debate. Nonetheless, economists generally agree that the long-term supply curve will generally be flatter than the short-term supply curve. This implies that the impact of increased renewable energy deployment on natural gas prices, on a per-MWh basis, will be greater in the short term than in the long term.[4]

In this article, we primarily emphasize the long-term impacts of renewable energy investments in the US as a whole, and thus focus most of our attention on the shape of the long-term supply curve, ignoring gas transportation constraints. We take this approach for two key reasons. First, renewable energy investments are typically long term in nature, so their most enduring effects are likely to occur over the long term. Second, the model results presented in this paper often do not clearly distinguish between short- and long-term effects, but appear to focus on long-term, national-level impacts.

2.2. Measuring the inverse price elasticity of supply

It is convenient to use elasticity measures to estimate the degree to which shifts in natural gas demand affect the

[2]It is worthy of note that natural gas prices may fall over time even with increasing demand if technological progress allows gas to be extracted at lower prices despite the need to extract resources from increasingly less attractive resource areas. Our argument here is simply that a reduction in natural gas demand is expected, *all else being equal*, to result in lower natural gas prices than would be seen under a higher-demand scenario.

[3]We would not generally expect any particular threshold of demand reduction to be required to lower the price of gas (unless the supply curve was flat over some of its range). Instead, greater quantities of gas savings should result in higher levels of price reduction. The impact on prices, however, need not be linear over the full range of demand reductions; it will, instead, depend on the exact—as yet unknown—shape of the supply curve in the region in which it intersects the demand curve.

[4]Note that the long-term *demand* curve is also expected to be flatter than the short-term *demand* curve (EMF, 2003). This too will moderate the long-term impacts of renewable energy investments on natural gas prices.