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Abundant low-cost natural gas and deep GHG emissions reductions for the United States

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HIGHLIGHTS

- Abundant gas makes it harder to achieve stringent reductions under carbon-pricing.
- Un*antic*ipated policy combined with lower gas prices exacerbates this difference.
- The gas-price effect on the carbon tax is secondary to that of policy anticipation.

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ABSTRACT

This paper analyzes the implications of the natural gas revolution on the US' ability to achieve deep GHG emissions reductions of 80% below 2005 levels by 2050. It uses a hybrid energy-economy model to test how prevailing low US natural gas prices influence the magnitude of the required carbon price needed to achieve this target. While the paper finds in general that lower gas prices resulting from plentiful gas necessitate a higher carbon price to achieve this target, informing firms and consumers in advance about the magnitude of the future carbon price can lower the necessary level.

1. Introduction

This paper explores how the recent natural gas revolution affects the US' ability to achieve deep emissions reductions of 80% below 2005 levels by 2050. Technological breakthroughs in the extraction of shale and other unconventional natural gas sources, such as tight gas and coalbed methane, have substantially increased the estimated low-cost supply of natural gas in the United States.[1] Since combustion of natural gas is less-emissions intensive per unit energy than coal and conventional crude oil, substitution from these sources to natural gas can potentially serve as a climate change mitigation tool. However, lower cost gas may make it more difficult to achieve the stringent climate target described above by stalling investments in zero Greenhouse Gas (GHG) technologies like nuclear and renewables, and later by requiring expensive retrofits of gas-utilizing technologies into lower-emitting alternatives. We evaluate these claims using a hybrid energy-economy model. The paper finds that while abundant gas makes it slightly harder to achieve the target, this adverse effect can be limited if the policy chosen to achieve the target, such as a rising carbon[2] charge, is deemed credible and announced well in advance. Lacking a credible and well announced policy, however, affects agents' investment decision criteria, and makes this stringent climate target harder to achieve irrespective of the gas price.

This credibility may be lacking in the prevailing policy environment. Although many developed countries have long-term reduction targets,[3] few back these claims with firm and effective policies. The aggregate impact of US climate policy that has been

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[1] The EIA estimates the US gas resource to be 2133 trillion cubic feet (tcf) in 2013, which is 85 times the annual US consumption for that year. US gas prices have thus decreased, with the EIA's wellhead price estimate dropping to $2.66 per trillion cubic feet in 2012- their lowest level since 1999. Consequently, natural gas consumption in the United States has increased rapidly- from 22 tcf to 24 tcf between 2005 and 2013.

[2] Throughout this paper, carbon, as in the context of a carbon charge used here, is shorthand for CO_2.

[3] For the US this corresponds to an 80% reduction below 2005 levels by 2050.

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pursued at the municipal, state, and regional levels, or via regulatory institutions such as the Environmental Protection Agency (EPA), is unlikely to be sufficient to yield the required deep emissions cuts nationally. For instance, the International Energy Agency, in their World Energy Outlook forecasts 2040 CO_2 emissions for the US at 18% below current emissions in their 2014 New Policies Scenario.[4]

Given this lack of credibility, it is unclear how actors making investment decisions today incorporate climate policy in their decision making. Firms may factor in an internal carbon price, yet there appears to be little academic literature estimating what level of carbon price they consider likely.[5] Indeed, emitters may doubt government commitment to climate policy targets, either because they gauge the political will to be lacking, or because they view these targets to be impossible to achieve at reasonable societal cost. Consequently, they may implicitly assume a zero or very low carbon charge.

Given these uncertainties, the model used in this paper explores the implications of two different assumptions to agent decision-making and how knowledge about future policy paths, interacting with changes to the level of the gas price, might influence investments. The first explores a case where a credible stringent policy is announced well in advance of its introduction, which agents readily incorporate in their current decision making. The second explores a case where governments make vague claims to act stringently on climate at a later date, but they do not announce an explicit binding policy to achieve their stated target. Consequently, firms and households do not seriously consider the target in making their current investment decisions. Policymakers, at some future time, then decide to earnestly pursue the stringent target, and introduce a previously unannounced policy that surprises investors. The concern with the second case is that investments made prior to the introduction of the policy might be inconsistent with its goal of deep emissions reductions, making the US energy system more fossil fuel committed and the target harder (costlier) to achieve. Given the prevailing US gas boom, this paper seeks to discern how current investments making that system increasingly “gas-committed” will make a future stringent climate policy more difficult and costly to achieve.

A number of papers in recent years have explored the implications of abundant natural gas on emissions, both for the US and globally in the absence of substantive climate policy. Work from the 26th Energy Modelling Forum (Huntington, 2013), an inter-model comparison project focusing on the implications of abundant gas on the US, found abundant gas to modestly change 2050 emissions- ranging from a −3% to 3%- under prevailing climate policies, with most of the models in the study reporting higher emissions with greater gas use. Similarly, Newell and Raimi (2014) found that the combined effect of abundant gas only slightly alters economy wide GHG emissions. Whether this change in emissions is an increase or decrease depends on modelling assumptions about methane leakage. Shearer et al. (2014), find cumulative emissions for the US between 2013 and 2055 to be slightly lower under scenarios of high gas supply, versus their low gas supply scenarios. At the global level, McJeon et al. (2014) show that increased natural gas use do not discernibly reduce the trajectory of global GHG emissions, finding that greater gas use changes CO_2 emissions by between −2% to 11%, relative to conditions with lower gas use.

Papers that explore the interaction of abundant gas and stringent policy include Brown et al. (2010), who find lower cost natural gas to slightly lower the economic cost of reducing US emissions to 83% below 2005 levels by 2050, and Jacoby et al (2011), who find the cost for the US to meet an emissions reduction target 50% below 2005 levels by 2050 is higher in scenarios with plentiful low-cost natural gas compared to those without.[6] Both of these papers, however, explored the effects in the context of the policy being introduced early enough to prevent the economy from becoming overly gas-dominant.

Hilaire et al. (2015) use a global integrated assessment model to explore how scenarios with varying gas availability interacts with three policy scenarios consistent with the 2 °C target: i) an optimal climate policy introduced immediately, ii) an optimal climate policy with a delay, and iii) a delayed climate policy which shifts from a moderate carbon price to a high carbon price by 2030. They find all abundant gas scenarios result in larger cumulative GHG emissions in 2050, and that this leads to greater global mitigation costs in the abundant gas world relative to a world using less gas. Although they examine how delays in switching to a low-carbon path, combined with varying use of gas in the interim, affects emissions and mitigation costs, they do not vary firms expectations about the future policy alongside the gas price.

A number of papers using findings from the AMPERE study (see Riahi et al., 2015 for an overview), a cross model comparison project examining the consequences of scenarios with different global emission levels in 2030, also explore the implications of near-term fossil fuel investments on the ability of the global energy system to later reach stringent targets consistent with limiting global warming to 2 °C. They do so at within the context of the implications of weak near-term (pre-2030) policies, stemming from countries' Copenhagen commitments. As part of that effort, work by Bertram et al (2015) explore how weak near-term policy may generate a long-term global emissions commitment, what they refer to as carbon lock-in, and the policy implications of this lock-in post-2030 as the system later tries to achieve the necessary reductions to limit global warming. They find a substantial carbon lock-in stemming from greater coal use in electricity under weak near-term targets, and that this commitment results in substantial premature coal retirements between 2030 and 2050, and higher required carbon prices by 2050. Johnson et al. (2015) quantify the magnitude of these premature coal retirements stemming from weak near-term policies, and explore scenarios by which these retirements might be reduced. While not explicitly focusing on the role of increased natural gas supply on driving this emissions commitment, these papers do vary the expectations of the future policy to explore how a policy shock may affect the ease of later achieving targets.

Finally, recent work by Bistline (2015) assesses the implications for the US electricity system by using a two stage stochastic programming model to forecast utility investment decisions under various uncertainties. While modelling investment decisions for

[4] The New Policies Scenario models broad commitments have been announced by countries, including national pledges to reduce GHGs.

[5] A survey by the Carbon Disclosure Project, a UK based NGO, which found these implicit carbon prices to range between $6-$60/tonne (CDA, 2013). Even the high end of this range is low relative to those carbon prices necessary to reach stringent targets. Furthermore, these values apply to the context of large emitters. It is unclear if smaller or medium size emitters, whose individual emissions might be low but whose combined emissions might be quite large, make the same internal calculations. Likewise, Bistline (2015) search 14 Western utility integrated resource plans and find that 8 of the 14 utilities consider a no-policy scenario by 2025 to be a serious possibility. In their range of possible carbon policies; only 36% of the utilities explored extend their range high enough to include the expected 2025 tax value consistent with the proposed Waxman-Markey bill.

[6] Specifically, they note: *“The cost of the policy under current expectation, calculated as above as the net present value of the reduction in welfare over the period of 2010–2050, is about $3.3 trillion (a 3.1% reduction in 2050), whereas if the shale resource were not economic that cost would be $3.0 trillion (a 2.8% reduction in 2050). The slightly lower cost in the no-shale scenario is due to the lower emissions in the corresponding no policy reference, and therefore the lower effort required to meet the 50% target.” Pg 16.*