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Leveling the Playing Field for Natural Gas in Transportation

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Leveling the Playing Field for Natural Gas in Transportation

Petroleum has long dominated the U.S. transportation sector, but growing concerns about U.S. energy security and the environmental effects of oil have increased pressures to find alternative energy sources. Newly available domestic supplies of cheap natural gas provide a potential alternative to oil. Natural gas is cleaner than oil and technological developments have driven down the costs of extraction leading to an unprecedented difference between the price of oil and natural gas, making natural gas an increasingly attractive and practical alternative. A shift toward natural gas as a fuel for cars and trucks in the transportation sector could mitigate the environmental consequences of our energy use and increase U.S. energy security.

In a new discussion paper for The Hamilton Project, Christopher R. Knittel of the Massachusetts Institute of Technology offers a set of policy proposals designed to help the United States make the transition toward increased use of natural gas in transportation (see Box 1: Natural Gas in Transportation). The paper proposes that policymakers provide support for natural gas infrastructure through regulation and that incentives for natural gas use be aligned with its environmental and energy security benefits. With his recommendations, Knittel seeks to remove obstacles to the use of natural gas in transportation and allow the United States to realize the benefits of energy diversification and cleaner energy.

The Challenge

With recent drops in U.S. natural gas prices and increases in gasoline prices, natural gas vehicles and fuels can offer consumers savings over conventional gasoline vehicles. Although natural gas vehicles are more expensive than gasoline vehicles, consumers save on fuel at current prices, creating a net private benefit for a variety of vehicles (see Table 1, Panel A). However, these numbers omit one clear disadvantage of natural gas—the lack of refueling infrastructure. Consumers are reluctant to buy natural gas vehicles without a network of fueling stations, and companies are reluctant to invest in fueling stations until consumers have purchased cars. This chicken-and-egg problem forces consumers to remain in the status quo, even though they and society would benefit from a shift toward natural gas vehicles.

Even if natural gas fueling infrastructure were built, natural gas would still likely be underutilized because many of its benefits over other fuel sources are not reflected in market prices. Today the prices of fuel sources and vehicles reflect the private costs of production and distribution—the price consumers pay at the pump—but do not take into account the wider costs imposed on society. Gasoline, for example, creates pollution that contributes to global warming and endangers human health. U.S. dependence on oil also exposes the economy to downturns caused by fluctuations in oil prices, and it compromises U.S. foreign policy.

Natural gas reduces these costs, relative to gasoline, and provides a benefit to society (see Table 1, Panel B). For example, because

BOX 1.

Natural Gas in Transportation

Natural gas can serve as a replacement for petroleum in three forms:

Methanol. Natural gas can be converted to methanol, a chemical that is similar to ethanol. Like ethanol, methanol can be mixed with gasoline in a range of proportions and burned in car engines, with a slight vehicle modification.

Compressed Natural Gas (CNG). Light- and medium-duty vehicles can use existing engine technologies to burn compressed natural gas—natural gas stored at high pressures. CNG is less energy-dense than gasoline, so CNG vehicles travel shorter distances between refueling than conventional cars. For example, the Honda Civic GX, a CNG version of the Civic sedan, has a capacity equivalent to 8 gallons of gasoline compared to 13 gallons for the conventional model. Although none are offered in the U.S. right now, bi-fuel vehicles, capable of burning either CNG or gasoline, are available in other countries.

Liquefied Natural Gas (LNG). Medium- and heavy-duty vehicles are also able to use LNG—natural gas stored at very low temperatures. LNG requires bulky tanks, but is more energy-dense than CNG, and so LNG vehicles can travel farther before refueling than CNG vehicles. Long-term LNG storage, however, is expensive, and so LNG is most practical for heavy-duty vehicles that refuel often, such as long-haul trucks.

TABLE 1.

Lifetime Private and External Benefits of Switching from a Conventional Gasoline Vehicle to a Natural Gas Vehicle (Dollars)

	Pickup truck (15-MPG)	Sedan (30-MPG)	Heavy-duty truck (5-MPG)	Heavy-duty truck (7-MPG)
A. Private Benefits				
Savings on fuel	$15,171	$7,586	$186,828	$133,449
Extra cost of natural gas car	-$11,000	-$5,500	-$70,000	-$70,000
Total private benefits	**$4,171**	**$2,086**	**$116,828**	**$63,449**
B. External Benefits				
Reduction in external costs				
From lower carbon emissions	$1,093	$546	$8,768	$6,263
From fewer local pollutants	$1,661	$831	$32,586	$23,276
From lower macroeconomic externalities	$1,694	$847	$18,466	$13,190
Total external benefits	**$4,448**	**$2,224**	**$59,820**	**$42,729**
Total social benefit	**$8,620**	**$4,310**	**$176,648**	**$106,177**

natural gas vehicles emit fewer local pollutants, switching from a gasoline pickup truck to a CNG pickup truck can have a benefit of more than $1,600 in reduced health costs over the lifetime of the car. However, because these external benefits are not included in the prices that consumers use to make decisions, natural gas tends to be under-consumed compared to petroleum.

Ethanol and electricity, two other alternatives to petroleum, face similar obstacles to natural gas in transportation. Policymakers have taken steps to encourage the use of these energy alternatives in vehicles by providing tax preferences and other incentives. Knittel points out that while these policies help level the playing field for ethanol, electricity, and petroleum, they distort the playing field between these alternatives and natural gas.

A New Approach

To address the challenges faced by natural gas and to help the U.S. realize the benefits outlined above, Knittel proposes a series of steps that policymakers could implement to support the development of natural gas fueling infrastructure and to encourage the increased use of natural gas vehicles and fuels. This approach addresses both the consumer and the infrastructure sides of the chicken-and-egg problem, and provides incentives that would put natural gas on a more level playing field with other vehicle fuels.

Developing Natural Gas Refueling Infrastructure

Step 1: Encourage home refueling by pricing natural gas for CNG vehicles at efficient rates.

As with electric vehicles, one advantage of CNG vehicles is the ability to refuel at home. However, natural gas utility companies often charge high unit rates for natural gas delivered to homes in order to recoup the cost of building pipelines to individual residences. Consumers must pay a high markup on each unit of natural gas delivered to their homes, which eliminates the price advantage that natural gas has over gasoline.

Knittel proposes that state utility commissions, which approve the rates set by local distribution companies, lower the price of natural gas used in CNG vehicles to the cost of production and distribution. This rate structure is similar to the preferential rates for electricity used in electric vehicles and would encourage greater use of natural gas in CNG vehicles.

Step 2: Encourage natural gas local distribution companies to offer CNG stations.

Natural gas local distribution companies are well situated to build natural gas refueling stations on-site and open their use to the public. However, these companies have little incentive to provide refueling to retail customers if regulators do not allow them to re-coup the cost of their investment. Knittel proposes that state

utility commissions allow distribution companies to build retail stations and to include building costs in their rate base.

Step 3: Establish an industry consortium to investigate and coordinate on LNG refueling infrastructure.

The potential market for heavy-duty LNG trucks is more concentrated than the CNG market, so coordination between vehicle manufacturers, vehicle consumers, and fuel providers may be easier for LNG vehicles. The market is also more geographically concentrated than many others, because long-haul truck travel is generally confined to interstate highways. For these reasons, Knittel proposes that the U.S. Department of Energy establish an industry consortium to investigate the possibility of creating "Blue Corridors" of LNG fueling stations along popular interstate routes.

Encouraging Use of Natural Gas Vehicles and Fuels

Step 4: Include methanol in the Renewable Fuel Standard.

The Energy Independence and Security Act (EISA), passed by Congress in 2007, established the second phase of the Renewable Fuel Standard (RFS), a federal mandate that certain amounts of bio-fuels be sold each year. Bio-fuels are classified into three categories, based on their lifecycle emissions and what they are made from, and each category has its own quota. The RFS is designed to increase the use of ethanol, a domestically produced renewable fuel.

Although methanol—made from natural gas—is not a renewable fuel, it has many of the same energy security benefits as ethanol. The reduction in greenhouse gas emissions from natural gas is similar to the reduction from the use of ethanol, and indeed may even be larger. Knittel argues that including methanol in the quota for the RFS is therefore consistent with the goals of the policy, and proposes that Congress move to add methanol to the RFS.

Step 5: Mandate a significant share of vehicles manufactured to be able to burn gasoline, ethanol, and methanol.

Knittel recommends that Congress require all vehicles be able to burn gasoline, ethanol, and methanol. Ethanol and methanol can be mixed with gasoline and burned in conventional engines, but vehicles require some modifications to burn either fuel in large proportions. Some bi-flex-fuel cars, which are able to use up to 85 percent ethanol, already exist. A tri-flex-fuel car would cost about $200 more to manufacture than a conventional vehicle. On the other hand, Knittel estimates that the external benefits of switching to a vehicle that burns 85 percent methanol are over $300 for a sedan and over $600 for a pick-up truck.

Knittel suggests phasing-in the flex-fuel requirement so that 50 percent of new automobiles in 2016 are able to run on up to 50 percent of both ethanol and methanol, 80 percent of new vehicles by 2018, and 95 percent in 2020.

Roadmap

Incentivizing Natural Gas Refueling Infrastructure

- Step 1: FERC would issue guidance encouraging state utility commissions to require that each unit of natural gas used to refuel compressed natural gas (CNG) vehicles at home is priced at the cost of distribution and production.
- Step 2: FERC would encourage state utility commissions to allow natural gas local distribution companies to offer natural gas refueling stations and allow the costs of building the station to be included in the utility's rate base.
- Step 3: The U.S. Department of Energy would create a consortium to investigate and coordinate liquefied natural gas (LNG) refueling stations, creating "Blue Corridors" through major interstate trucking routes.

Encouraging the Use of Natural Gas Vehicles

- Step 4: In order to make methanol more competitive with other alternative fuels, Congress would amend the Energy Independence and Security Act of 2007 to include methanol from natural gas in the Renewable Fuel Standard.
- Step 5: Congressional action would also be taken to mandate that a significant share of vehicles manufactured be able to burn gasoline, ethanol, and methanol.
- Step 6: Congress would be encouraged to provide the same subsidies to CNG sedans as are provided for electric vehicles, and medium-duty CNG vehicles should receive even larger tax credits.
- Step 7: The U.S. EPA and the California Air Resources Board would take the lead in investigating ways to streamline the retrofitting certification process for gasoline vehicle conversion to CNG.

This small investment on the vehicle side would increase the likelihood that firms would offer methanol fuels, and help overcome the reluctance of consumers and firms to make the initial investments in methanol. This flexibility of the vehicles would also have a large option value for the U.S. economy. Such a fuel standard would ensure that consumers can choose between gasoline and natural gas as their relative prices continue to change. This standard would also reduce the impact of disruptions to worldwide petroleum markets, thereby enhancing U.S. energy security.

Learn More About This Proposal

This policy brief is based on The Hamilton Project discussion paper, Leveling the Playing Field for Natural Gas in Transportation, which was authored by

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Additional Hamilton Project Proposals

Modernizing Bonding Requirements for Natural Gas Producers

LUCAS DAVIS

Existing legislation requires natural gas producers to post a bond prior to drilling, to help ensure that funds are available for clean-up when accidents occur, and to motivate producers to work hard to avoid environmental damages. For drilling done on federal lands, current minimum bond amounts were last set in 1960. Today, they provide inadequate protection because they have not been updated for inflation and because hydraulic fracturing and other technological advances in drilling raise new environmental concerns. This proposal would increase federal minimum bond amounts to account for inflation and the risks associated with fracking, and encourage states to adopt similar minimum bond amounts for drilling on private lands. In addition, the proposal would eliminate provisions that currently allow companies to meet their bonding requirements by posting a single "blanket" bond.

A Strategy for U.S. Natural Gas Exports

MICHAEL LEVI

Increased natural gas production in the United States has caused domestic natural gas prices to plummet in recent years. Ample domestic production capacity and higher natural gas prices in foreign natural gas markets place the United States in an ideal position to export natural gas overseas. Indeed, several applications to export natural gas are awaiting review at the Department of Energy. This paper proposes a framework for regulators to use in order to evaluate if applications to export natural gas are in the public interest. The paper then utilizes its proposed framework to conclude that the benefits to the United States of natural gas exports would outweigh the costs, suggesting that the federal government should approve applications for exports. The paper also offers broader policy recommendations aimed at using U.S. natural gas export policy to advance the nation's foreign policy and trade goals.

Step 6: Provide subsidies for natural gas vehicles commensurate with the reduction in external costs associated with their use.

In this step, Knittel recommends that CNG sedans be given the same level of federal income tax credits as electric vehicles, and that medium-duty CNG pickup trucks should be allotted an even larger incentive. He notes that electric vehicles and CNG vehicles have similar benefits in terms of greenhouse gas emissions and reduced exposure to macroeconomic shocks, but electric vehicles qualify for a $7,500 tax credit, while CNG vehicles have only a $4,000 subsidy. He argues that vehicles and fuels should receive subsidies that reflect their benefit to society. Subsidies that are designed under this principle will lead to efficient use of alternative vehicles and fuels because the prices that consumers use to make their decisions will then reflect the effects of their choices on society.

Step 7: Streamline the retrofitting certification process for gasoline vehicle conversion to CNG.

Because new vehicles comprise roughly 8 percent of the vehicle stock in any given year, retrofitting existing cars is an important avenue for increasing natural gas use in transportation. The U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (CARB) have certification programs for CNG conversions.

Many have complained, though, that the certification process is unduly expensive for manufacturers of conversion kits. As a final step, Knittel proposes that the EPA and CARB find ways to streamline the certification process.

Conclusion

Natural gas provides an alternative to oil that has fewer negative effects on the environment and on human health. The recent boom in North American shale gas creates the potential for low natural gas prices and increased domestic supply, creating both private cost savings and U.S. energy security benefits. Even a modest increase in the use of natural gas in transportation could provide large benefits. Knittel projects that if natural gas became 10 percent of the transportation market, the U.S. would see over $25 billion in private benefits and over $7 billion in external benefits. Realizing these benefits, though, will require action on the part of policymakers to help natural gas overcome challenges to its increased use.

Questions and Concerns

1. How do natural gas cars compare to electric and hybrid electric cars?

In total, the reduction in external costs for a hybrid sedan is about $1,300, compared to $2,200 for a CNG sedan. The reduction in carbon-related costs for hybrid cars is about 14 percent higher than the reduction in carbon-related costs for a similar natural gas vehicle. However, the hybrid still suffers from macroeconomic external costs (exposure to oil-price shocks) and emits more local pollutants than natural gas.

The reduction in external costs for electric cars varies widely by region, depending on the type of fuel used to generate electricity in that region. On average, electric cars reduce carbon-related external costs by about $700, compared to about $550 for CNG vehicles, but, in some places, electric vehicles actually emit more carbon than CNG vehicles. The reductions in local pollution and macroeconomic externalities are comparable for CNG vehicles and electric vehicles. Electric vehicles cost about $10,000 more than CNG vehicles, though, and so their total benefit (private and external) is less than the total benefit of CNG vehicles.

2. How much natural gas is used in the transportation sector?

In 2011, less than 3 percent of energy consumption in the transportation sector came from natural gas. Almost 93 percent of energy consumption was petroleum-based, and the rest came from renewable sources. The overwhelming proportion of oil underscores the importance of diversifying energy sources and provides room for the promotion of natural gas use.

3. How do local environmental effects of hydraulic fracturing affect the cost-benefit calculation for natural gas cars?

The boom in domestic shale gas has been driven by breakthroughs in hydraulic fracturing, or "fracking"—a drilling technique that extracts natural gas from shale formations. As fracking has become more widely used, concerns have grown over possible environmental damage. The cost-benefit calculations presented in the paper do not account for potential local environmental costs, and there is still much uncertainty over the extent of these effects. Moving forward, it will be essential for policymakers to study these impacts closely and to incorporate them into policies relating to natural gas.

In a new Hamilton Project discussion paper, "Modernizing Bonding Requirements for Natural Gas Producers," Lucas Davis puts forward a proposal to enhance and expand a market-based approach to promoting environmental stewardship—federal and state bonding requirements. He argues that improved bonding will incentivize producers to take proper precautions while drilling.

Highlights

Christopher R. Knittel of MIT puts forward policies to support the development of natural gas fueling infrastructure and to encourage the use of natural gas fuels and vehicles. These measures take advantage of the opportunity offered by the shale gas revolution to substitute natural gas for petroleum, increasing U.S. energy security and reducing the environmental and health costs of our energy choices.

The Proposal

A. Support the development of natural gas fueling infrastructure

- Step 1: Encourage home refueling by pricing natural gas for CNG vehicles at efficient rates.
- Step 2: Encourage natural gas local distribution companies to offer CNG stations.
- Step 3: Establish an industry consortium to investigate and coordinate on LNG refueling stations.

B. Encourage the use of natural gas fuels and vehicles

- Step 4: Include methanol in the Renewable Fuel Standard.
- Step 5: Mandate a significant share of vehicles manufactured to be able to burn gasoline, ethanol, and methanol.
- Step 6: Provide subsidies for natural gas vehicles commensurate with the reduction in external costs associated with their use.
- Step 7: Streamline the retrofitting certification process for gasoline vehicle conversion to CNG.

Benefits

These proposals will help overcome obstacles in establishing a critical mass of natural gas fueling stations and generating the initial demand necessary to sustain these stations. The creation of this network of stations allows consumers to realize the cost savings promised by cheap natural gas. An overall shift to natural gas will also benefit society, because natural gas emits fewer greenhouse gases and local pollutants than petroleum. Finally, these proposals will reduce U.S. dependence on oil, increase U.S. energy security, and diversify our energy sources.

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BROOKINGS