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TRANSACTIONS

2022 Q3

ELECTRIC VEHICLES Problem or Opportunity

According to the Environmental Protection Agency (EPA), 27% of the total U.S. greenhouse gas emissions are attributable to the transportation sector. Significantly reducing these emissions can be achieved through electrifying cars and decarbonizing power supply. Therefore, electric vehicles are a key focus of plans to help solve climate change. Since 2010, over 2.5 million plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV) have been sold nationwide. In just the last year, BEV sales increased by 85% in 2021 and PHEC sales more than doubled (138% growth).

Projections for the number of electric vehicles are difficult to determine since the technology is in the early stages of the adoption lifecycle. However, projections range from 10 million to 30 million electric vehicles on the road by 2030. A survey of eight major corporations found that respondents plan to purchase over 375,000 zero-emission vehicles over the next five years. Additionally, President Biden has set a goal of bringing the nation's emissions down to net zero by 2050. The average light-duty vehicle operating in the U.S. is 12 years old, and vehicle lives range from 15-20 years, indicating an aging national fleet of internal combustion engine (ICE) vehicles that are primed for replacement. Finally, Ford, GM, Subaru, Mercedes-Benz, and Volvo plan to phase out sales of new ICE vehicles by 2035, at which point more than half of the vehicles being sold in the U.S. will be BEVs.

Is the oncoming growth in PHEV and BEV a problem for electric utilities or an opportunity? These new loads might add to peak demand on the grid which could mean increased distribution infrastructure capacity and additional peaking generation and transmission investments. This could be a problem for utilities. However, others see the opportunity associated with increased energy sales and revenues.

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***Table 1.* CHARACTERISTICS OF CHARGING OPTIONS FOR ELECTRIC VEHICLES**

Charging Level	Voltage	Connector	Rectifier	Power Delivery	Time to Charge 60kWh*
Level 1	120 volt AC	SAE J1772	On-Board	1 to 1.4 kW	30-40 hours
Level 2	240 volt AC	SAE J1772	On-Board	3.9 to 19.2 kW	2.5-4.5 hours
Level 3	DC Fast Charger	CCS, CHAdeMo, Tesla	External	24 to 300 kW	30-40 minutes

** Most BEVs have battery capacities of 10 kWh to 20 kWh. Exceptions include the Tesla Model S, which has 90 kWh capacity, and the Ford F-150 Lightning with a battery option of 131 kWh capacity.*

What can utilities do to ensure this transformation in how America drives represents an opportunity that minimizes the problem?

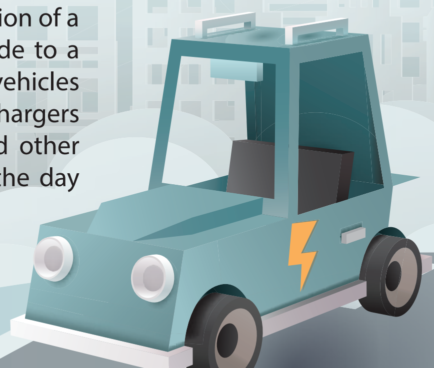
DEFINING THE PROBLEM

The average American household has 1.81 vehicles. As the number of all vehicles in a utility service area increases and as the share of those vehicles that are electric increases, the likelihood of a household having two electric vehicles in the garage increases, which has the potential to stress the existing electric infrastructure, specifically the service transformer and feeders. To fully define the potential threat for electric stress on the system, it is necessary to understand the charging options for the vehicles and some of the human factors involved in charging decisions and habits. Recent research out of California (currently home to over 40% of all U.S. electric vehicles) and from EPRI on behalf of the Salt River Project provide some information helpful to defining the problem.

There are essentially three basic charging methods available today: **Level 1**, **Level 2**, and **DC Fast chargers**. Level 1 chargers will generally require 10 or more hours to fully charge a nearly depleted battery and could represent a 30%-40% increase in peak demand for a home with a peak of 3.5-4.5 kW. Level 2 chargers will charge a battery in 2-4 hours and can represent an increase to demand of over 250%. Furthermore, installation of a Level 2 charger may require the homeowner to upgrade to a 400-amp panel. DC Fast Chargers (Level 3) can charge vehicles up to 80% charge in as little as 30 minutes. These fast chargers are normally installed at shopping centers, hotels, and other commercial centers and tend to be used throughout the day thus providing less coincidence with system peaks.[1]

Another variable to consider is the state of charge (SOC) of the battery at the time the vehicle is plugged in. A battery that is near empty (5% SOC) will take longer and require more energy to charge than a battery at 80% SOC. Therefore, not all Level 1 chargers will operate all evening to produce a fully charged vehicle battery since some vehicles will have a 50% or 80% SOC at the time they are connected to the charger. The Salt River study found that 70% of the charge events occurred with the battery at SOC of 40% or higher.[2] Range anxiety for the vehicles seems to be a partial if not leading reason for this fact. Owners fear running out the battery away from a charger. As evidence of this, the Salt River study tracked 100,000 trips that totaled only 915,000 miles, or 8.6 miles per trip while most BEVs now have ranges of 150 miles or more per charge. Furthermore, 99% of the trips were less than 65 miles, easily obtainable on a single charge. Increasing the number of public charging stations to ease range anxiety has been identified as a key infrastructure improvement necessary to encourage faster BEV adoption.

Along with the type of charger and the SOC, the timing of when cars are plugged in and drawing from the charger is important for electric system planning. Many of us assume that BEV owners plug in their vehicle every night and charge to 100% SOC. However, a California study, *Distribution Grid Impacts of Electric Vehicles*, found otherwise.[3] ***They found most EV drivers charged their vehicles between 4 p.m. or 5 p.m. and midnight but that another group of drivers started charging at midnight due to automatic charging timer delays.*** Such delays are often the default factory setting. The typical charging time was 2 to 4 hours. The study used this data to develop an aggregated load curve of 1,000 BEVs. The curve had a peak demand of 1.5 MW plus or minus 30%, rising sharply at 7 p.m., peaking at midnight, and having minimal charging between 6 a.m. and 6 p.m.



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If a distribution feeder serves 1,000 homes and each home has 1.85 vehicles, then a BEV penetration of 10% would represent 185 vehicles requiring electric charging. Assuming a diversified peak demand without electric vehicles for the feeder at 3,000 kW, then 185 electric vehicles could add 9%-12% to the peak load. At 20% penetration for electric vehicles, the potential demand increase from BEV approaches 20% to 25%.

FINDING THE OPPORTUNITIES

Electric vehicle adoption represents a great opportunity for increased energy sales and revenues for electric utilities, helping to ease fixed cost recovery for all customers. That is, if the electric vehicles do not increase peak demands. It therefore becomes important for electric utilities to take an active role in managing the charging of electric vehicles. A prudent utility will begin to explore such opportunities even if there are not many electric vehicles on its system today.

One option is the use of time-of-use (TOU) rates. TOU rates provide a price signal to the customer to encourage charging during off-peak periods. Difficulties in TOU rate design can abound though, including whether to implement the rate for all residences, whether to submeter just the charger or subject all consumption to the rate, and how to structure the rate to appropriately incentivize the behavior in the utility's best interests. Several independent analyses show an on-peak price to off-peak price ratio of at least 3-to-1 is necessary to begin to "move the needle" in any meaningful way on customer consumption patterns.

Another option for utilities to influence driver behavior is demand-side management of the vehicle charging. This represents firm utility control of the load and requires utility incentives. This strategy can be implemented through a number of methods.

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A common method is control over a Level 1 or Level 2 charger (programs often target Level 2). Similar to an AC control program, the utility can control the charger to be inactive during likely peak events. Sometimes, the program has an opt-out option for customers. This type of control requires communication infrastructure and the ability to communicate with the charger. Options include providing a "free" programmable charger, intelligent breakers in the disconnect panel, or even communicating directly with the vehicle through Wi-Fi.

Other opportunities for utilities to manage BEV demand risks are evolving. Electric vehicles may not have significant impact on most electric infrastructure systems today, but the change is not too far into the future. Therefore, ***utilities should be preparing for control of charging through rate design, load management, and other approaches to maximize the opportunities afforded by adoption of electric vehicles while minimizing the potential problems.*** ■

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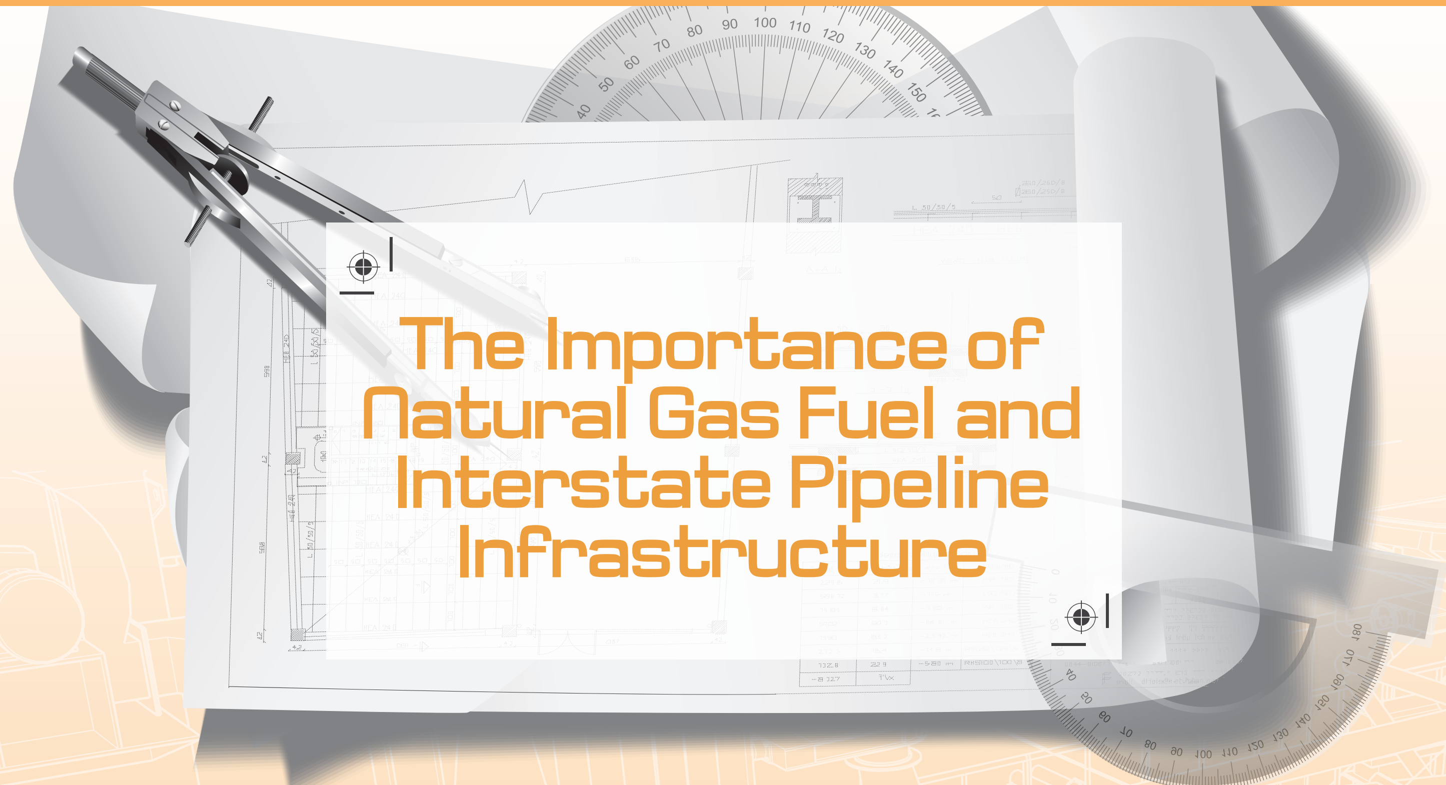
References

[1] The load factor on a DC Fast Charger is often 10% or less.

[2] The study tracked the SOC of a set of 100 BEVs over an 18 month period.

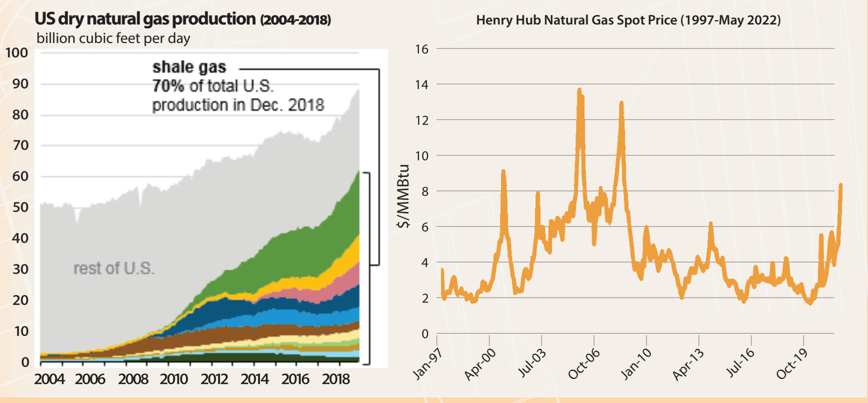
[3] The Study logged data from 233 unique EVs consisting of the 6 most popular vehicles over the course of a year. They recorded 52,146 separate charging events and 2.99 million miles traveled.



The Importance of Natural Gas Fuel and Interstate Pipeline Infrastructure

The electric and natural gas industries are intertwined, and several recent events including natural gas pipeline review changes contemplated by the Federal Energy Regulatory Commission (FERC), a rapid increase in natural gas commodity prices, and extreme winter weather events have brought a focus to the relationship between those industries. In the last 15 years, the intersection between the electric and natural gas industries has expanded and intensified. Natural gas has grown significantly as an electric generation fuel source in that time, both as a replacement for retiring coal and as flexible generation, balancing growing intermittent resources like wind and solar. The prominence of natural gas-fueled generation has been propelled by the shale gas revolution, which significantly increased domestic natural gas production, resulting in sustained low prices for several years (see ***Figure 1***) and a redefinition of how the natural gas pipeline network was utilized and expanded. Higher and higher intermittent generation penetration and the uncertainty / variability of electric output from these sources make quick-starting natural gas generation a critical reliability component on the grid.

Figure 1. **US SHALE GAS PRODUCTION & PRICES**[1]



Although other technologies, such as renewables and batteries, continue to proliferate, new technologies may emerge, and environmental policy continues to evolve, natural gas-fired electric generation will remain critical to maintaining reliable electric service for the foreseeable future. Indeed, the U.S. Energy Information Administration (EIA) projects that natural gas resources will remain relatively constant as approximately one-third of the generation capacity mix through 2050, with some regions likely at a higher percentage.

Natural gas power plants provide several valuable attributes to the electric grid that help maintain its reliability. One of those attributes is flexibility, meaning the ability to vary output rapidly (including stopping and starting) as needed. Natural gas power plants, across the relevant technologies (e.g., combustion turbine, engines, combined cycles) and especially newer plants, are typically highly flexible. From peaking plants that can be started very rapidly as needed, to other natural gas plants that can vary their output quickly, natural gas power plants can respond to the dynamic needs of the electric grid. For example, in the California Independent System Operator (CAISO) footprint, natural gas has been significant as a complement to increased output from solar resources (see ***Figure 2***). The flexibility of natural gas power plants has been utilized to ramp down generation during the midday solar production period and then quickly ramp back up in the evening as solar output diminishes while load requirements are high.

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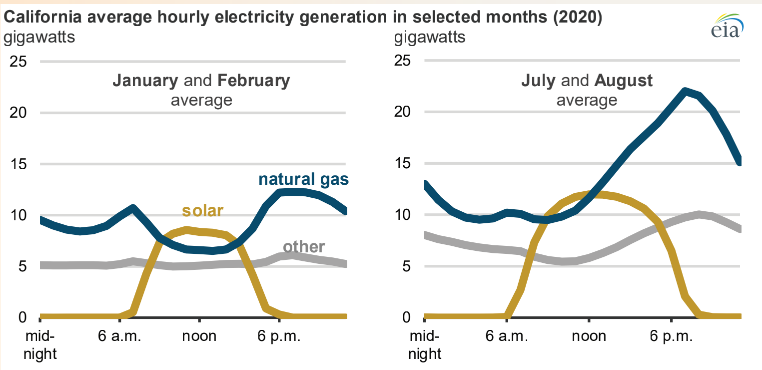
***Figure 2.* HOURLY NATURAL GAS OUTPUT IN CALIFORNIA**[2]



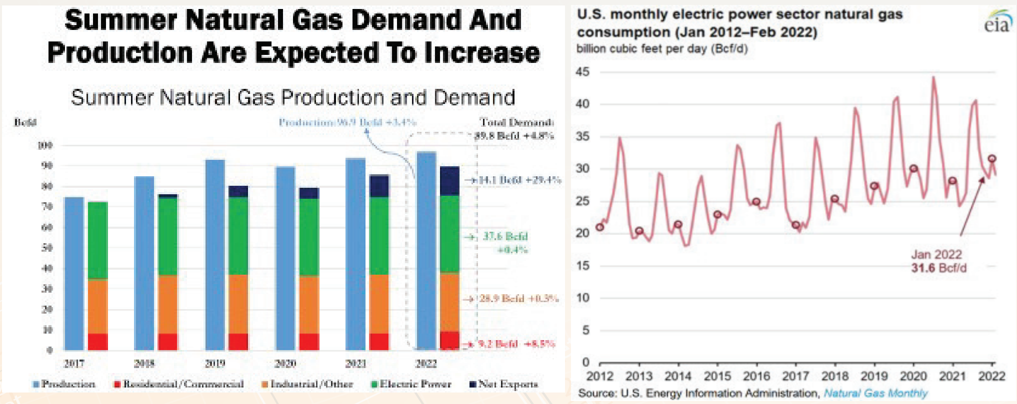
Given their prevalence and critical role that natural gas power plants play in providing reliable generation to the grid, the price of fuel for these plants can significantly impact the price of electricity ultimately paid by consumers. There is a strong, well-established connection between wholesale natural gas and power prices. In the FERC-regulated organized markets, the relationship between natural gas prices and wholesale electric prices is particularly evident. Because natural gas power plants are often on the margin, they frequently set the price in structured wholesale electricity markets, where the cleared offer price of the marginal unit sets the overall market price.

Since the effective deregulation of natural gas commodity prices in the 1990s, natural gas prices have been the product of supply and demand market factors. This can leave electric utilities and their customers exposed to significantly increased costs for essential natural gas fuel when supply constraints and / or other factors lead to higher natural gas prices, as has been the case in 2022. The recent increase in natural gas prices has been attributed to reduced exploration due to the COVID pandemic and environmental policy, fallout of the February 2021 arctic weather event, increased difficulty financing exploration, and increased liquefied natural gas (LNG) export activity, among other factors.

Indeed, over the past seven years, the amount of LNG exports from the U.S. has consistently risen and is expected to continue to rise. This trend has only been accelerated and intensified due to the war in Ukraine, and domestic users of natural gas are increasingly competing with global users. As demand increases, new supply is often tracked using rig count as an indicator of exploration and development. Although the number of rigs has been steadily increasing since a sharp slump that occurred in 2020, it has still not returned to 2019 levels. The importance of natural gas to reliable and affordable electric service highlights the need to ensure an adequate and reliable natural gas supply chain, including sufficient natural gas transportation infrastructure.

As the lead regulator with authority to approve new interstate natural gas pipeline facilities, FERC plays a significant role in ensuring adequate infrastructure exists to meet demand for natural gas, including that for electricity generation. In the past few years, FERC has been undertaking an overhaul of its processes for reviewing new pipeline applications, with potentially significant implications for natural gas supply and price reliability. The ongoing need for natural gas supply will continue to place demands on transportation infrastructure. ***Figure 3*** shows that summer 2022 demand is expected to surpass recent history (driven by electric generation and exports), after January 2022 recorded the highest ever use of natural gas for electric generation.

***Figure 3.* GROWING NATURAL GAS DEMAND**[3,4]



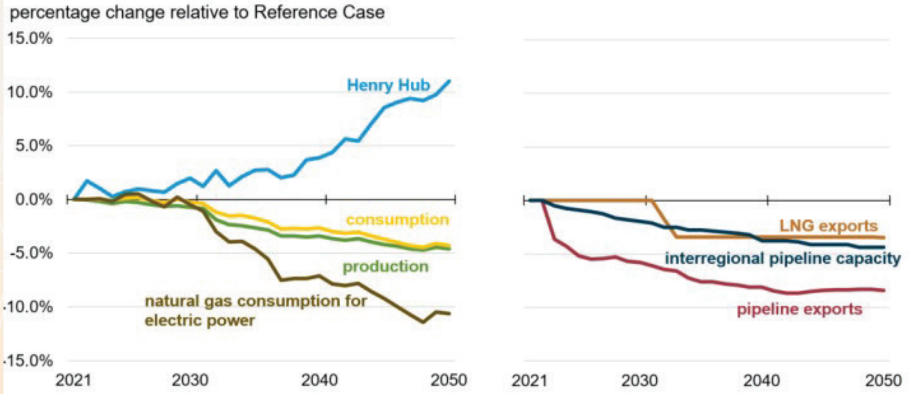
A reliable and affordable supply of natural gas depends on adequate transportation infrastructure. NERC has asserted that "additional pipeline infrastructure is needed to reliably serve load."[5] FERC is reporting 13,353 MMcf/d of major pipeline projects pending as of June 1, 2022.[6]

EIA highlighted the affordability concerns associated with inadequate gas pipeline capacity by specifically studying a scenario assuming no interstate pipeline expansion as a part of its 2022 Annual Energy Outlook (AEO). As compared to its 'Reference Case,' EIA noted several changes in the no pipeline addition case by mid-century including approximately 2 Tcf less gas production and 11% higher wholesale natural gas prices (see ***Figure 4***).[7]

A reliable and affordable supply of natural gas depends on adequate transportation infrastructure

Figure 4. **EIA NO PIPELINE EXPANSION MODELING**

Figure 1. Percentage change between the Reference case and the No Interstate Pipeline Builds case, AEO2022



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022* (AEO2022)
Note: The percentage change represents the No Interstate Pipeline Builds case minus the Reference case.

Natural gas is and will continue to be an important driver of electric reliability and cost. The nexus between the electric and natural gas industries has intensified and will continue to be critical for the foreseeable future. The availability of adequate natural gas supply and the infrastructure to deliver it will impact the electric sector, including public power, as U.S. policy develops and changes. As an element of that policy, regulatory review of necessary energy investment should harmonize legally robust decisions with concrete approval conditions and streamlined processes. Otherwise, the reliability and affordability of the mutually dependent natural gas and electric systems will be harmed. ***The table below*** repeats the key points of this article and to read the full article please visit the American Public Power Association website **HERE**. ■

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SUMMARY OF KEY POINTS

01 Natural gas has grown as an electric generation fuel and will continue to play several important roles in the electric system for the foreseeable future.

02 The natural gas and electric systems are interdependent, and the adequacy of each industry impacts the other.

03 Natural gas prices are an important driver of electricity affordability.

04 Regulatory processes should meet statutory requirements while maximizing efficiency and certainty. Cost and reliability may be exacerbated by poor infrastructure review processes.

05 Necessary infrastructure can address constraints on natural gas supply. Without adequate natural gas supply and the pipeline infrastructure to transport it, natural gas, power, and home heating customers are likely to experience elevated energy prices.

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