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Managing the Transition

Proactive Solutions for Stranded Gas Asset Risk in California

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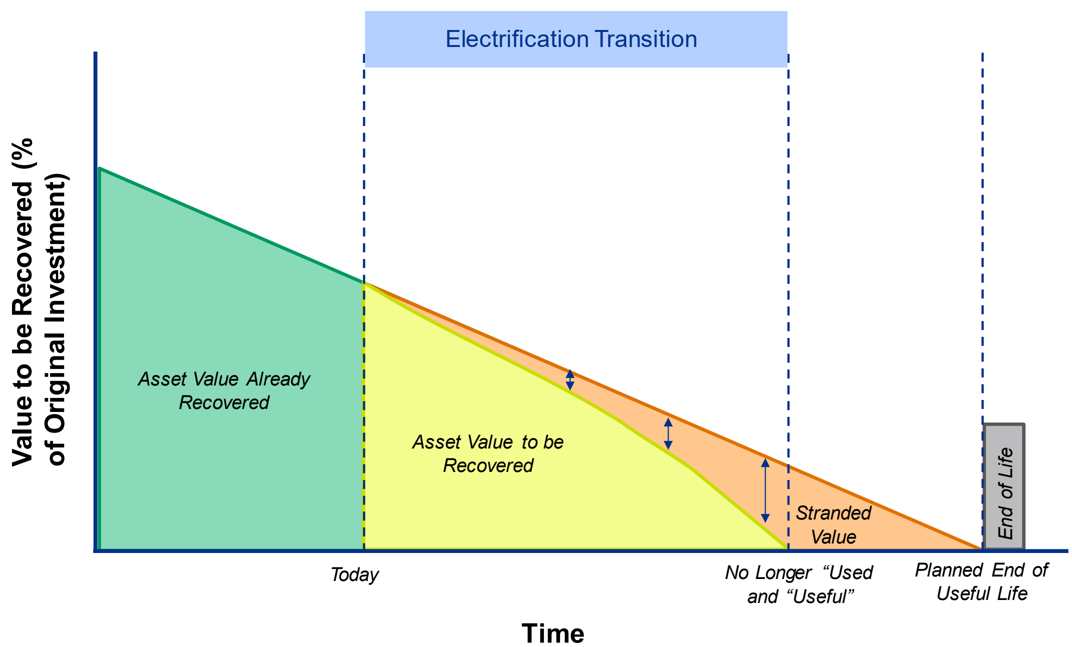
Executive Summary

California has established goals and regulatory strategies for reducing climate pollution from its energy sector, including recently adopted commitments to decarbonize the buildings sector. As evidenced by new state energy policy plans and commitments from local governments and utilities, building electrification – or converting energy end uses in buildings from fossil fuels to cleaner electricity – is a core strategy to achieve California's greenhouse gas emissions reduction targets.

Reducing gas use in buildings could also lead to a reduction in the gas customer base and a diminished need for the state's gas infrastructure. Aside from the emissions benefits from reduced gas consumption, there are several financial implications to the reduction, including the risk that some gas assets will no longer be "used and useful". "Used and useful" is a principle that is used to determine when a utility can recover an investment from their customers through rates. In California, when an asset no longer meets the standard of "used and useful," the utility no longer recovers the costs from its customers or earns the associated rate of return. With increased building electrification, the state's legacy gas investments may no longer meet the "used and useful" standard potentially causing substantial investment value to be "stranded."

Figure ES-1
Overview of Stranded Asset Value for Investments



If not addressed proactively, "stranded" gas assets can complicate the effort to transition the state away from excessive reliance on gas and its incompatibility with California climate goals. At the core of these complications are potential reductions in overall utility investment, rate increases for remaining gas customers, which could unduly burden lower-income and other vulnerable communities and threaten equitable access to energy and the notion of equitable distribution of responsibility and burden amongst a variety of potentially competing stakeholders including current vs. future ratepayers, utility shareholders vs. ratepayers, high income vs. low income customers, and gas vs. electric utility ratepayers.

Before analyzing pathways for addressing potential "stranded" gas assets in California, this paper develops a framework for evaluating the range of data necessary to identify the magnitude of risk for gas investments. For example, data on the value and recovery timelines for each gas asset, as well as the specific locations of investments, in relation to expected timelines and geographies for electrification should be developed. Evaluating this data within the framework presented will inform an understanding of the effectiveness of the strategies available and allow the state to frame more effective solutions and a better management of risk.

This paper develops a framework for evaluating the range of data necessary to examine the magnitude and impact of stranded assets and what solutions are available to manage that risk.

Through a review of past examples where the state of California was faced with and responded to events involving stranded assets, this paper evaluates the mechanics of specific solutions, both in narrative and graphical form, in the context of electrification. This analysis does not recommend a particular solution be pursued, but rather discusses the pros and cons of each. Specifically, this analysis evaluates:

1. **Strategic targeting of electrification:** Setting of criteria for targeting marketing, education, outreach, incentives, and pilots to ensure a more coordinated rollout of electrification that effectively reduces the magnitude of stranded asset risk
2. **Developing pathways to pay for early retirement:** Establishing creative financing mechanisms like securitization, accelerated depreciation, changes to return on equity, and disallowance of recovery to encourage the cessation of use of an asset before the end of its planned life.
3. **Alternative uses of existing assets**: Continuing to utilize the existing gas infrastructure with lower carbon fuels, particularly biomethane and hydrogen, as an alternative to traditional fossil gas.

Building electrification may also accelerate the time horizon for the decommissioning of the state's gas assets. End of life expenditures (i.e. depressurization or removal) normally occur after the gas asset has reached the end of its useful life. As a result, California may need to plan now for this decommissioning. Ratepayer costs should also be reconsidered given the shifts from gas to electric customers. This paper discusses a few options for handling these decommissioning costs, including new distribution system charges, creating a line-item on customers' bills, and establishing a trust fund.

For future near-term gas infrastructure investments, California should establish a decision-making framework that provides for continued operations and safety, ensures an effective transition, and maintains investor confidence. A first step is developing a "bright line" for determining when investments are more at risk of being stranded and identify potential stakeholders in apportioning that risk. Clear mandates for electrification would provide regulatory certainty and a transition timeline for utilities.

If California is able to collect, synthesize, and overlay the needed data effectively, a framework can be envisioned in which the various solutions are optimally deployed for individual assets in different geographies, and on different timelines to drive cost-effectiveness in support of California's policy goals compared to the status quo.

At this stage, California is early on in its understanding of the scope, magnitude, and timeline of the stranded assets issue and importantly its solutions. It is therefore important for the state to develop an effective forum, likely through the CPUC or legislature, and use a framework such as that proposed here for systematically evaluating and understanding the different drivers, leverage points, and pathways for managing the transition away from gas.

Introduction

California is in position to leverage its early work in decarbonizing the power sector to help decarbonize other sectors of our economy.

California has taken an important step to help combat the well-established and dangerous impacts of climate change[1] in adopting aggressive greenhouse gas emissions reduction and clean energy goals, including returning to 1990 levels by 2020[2] and 40% below 1990 levels by 2030[3], 80% reductions from 1990 levels by 2050[4], and carbon neutrality by 2045[5].

With the state's parallel push for renewable energy and decarbonization of the electricity sector – 50% renewable energy by 2025, 60% renewable energy by 2030, and 100% zero-carbon[6] electricity by 2045[7] – and its progress towards those goals (34% retail electricity sales in 2018 came from renewable energy)[8], California is in position to leverage its early work in decarbonizing the power sector to help decarbonize other sectors of its economy. This paper concentrates on the implication of decarbonizing one of the largest end uses of energy - buildings - and discusses some of the key financial and regulatory implications of reducing GHG emissions on California's gas infrastructure.

As alluded to, a core part of meeting the state's critical emission reduction goals will be addressing GHG emissions from the industrial, commercial, and residential sectors. Collectively, in 2016, these sectors (excluding electricity use) were responsible for over 151.75 MMTCO2e or about 35% of total GHGs in California (23% - Industrial, 7% - Residential, 5% - Commercial) with gas combustion in buildings contributing 80% of the residential sector emissions and 50% of the commercial sector emissions. Under a business as usual scenario, emissions from gas combustion in the residential and commercial sector would, by themselves, exceed the level of emissions associated with California's 2045 goal.

As a result of this, California now needs to develop new solutions for driving decarbonization and fuel switching in the built environment, with a primary focus on residential and commercial buildings. Doing so will not only cut climate pollution in California, it can also catalyze solutions and technologies that can be put into effect in other jurisdictions in the Unites States and beyond. To this end, building electrification has been identified as a clear, cost-effective solution for deep decarbonization of the building sector and utilization of renewable energy in California.[9,10,11] Building electrification is the process through which energy end uses such as heating and cooling appliances in buildings that are commonly directly powered by fossil fuels (e.g. gas, fuel oil, propane, etc.) are powered by electricity instead[12]. With growing levels of renewable energy online and opportunities to align usage with smart electricity rates, high electrification technologies can be strategically installed and operated to capitalize on clean energy availability and drive reductions in GHG emissions from buildings. As identified above, this will be critical for enabling the state to achieve its critically important climate goals.

[1] IPCC. (2018). Global Warming of 1.5 ºC.
[2] State of California. (2006, September 27). Assembly Bill No. 32, California Global Warming Solutions Act of 2006.
[3] State of California. (2016, September 08). Senate Bill No. 32, California Global Warming Solutions of 2006: emissions limit
[4] State of California - California Gov. Arnold Schwarzenegger. (2005). Executive Order S-3-05.
[5] State of California - Executive Department. (2018, September 10). Executive Order B-55-18 To Achieve Carbon Neutrality.
[6] "Zero-carbon" sources include nuclear power, which is not renewable
[7] State of California. (2018, September 10). Senate Bill No. 100 - California Renewables Portfolio Standard Program: emissions of greenhouse gases.
[8] California Energy Commission. (2019). Tracking Progress - Renewable Energy.
[9] E3. (2018). Deep Decarbonization in a High Renewables Future.
[10] Deason, J., Wei, M., Leventis, G., Smith, S., & Schwartz, L. (2018). Electrification of buildings and industry in the United States - Drivers, barriers, prospects, and policy approaches. Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory.
[11] California Energy Commission. (2019). Final 2018 Integrated Energy Policy Report Update - Volume II.
[12] Deason, J., Wei, M., Leventis, G., Smith, S., & Schwartz, L. (2018). Electrification of buildings and industry in the United States - Drivers, barriers, prospects, and policy approaches. Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory.

Generally, there are three ways to promote end-use electrification: fuel switching and fuel substitution in buildings that are already constructed, and installing electric appliances and services in new construction. While the first two approaches for existing construction are similar, they have important distinctions.

- Fuel-switching measures involve shifting from an energy source that is not utility-supplied/interconnected (i.e. fuel oil, propane, wood, etc.) to a utility-supplied/interconnected energy source (i.e. electricity).
- Fuel-substitution involves substituting one utility-supplied/interconnected energy source (that is, electricity and gas) for another.[13] It should be noted that fuel substitution technically can also include substituting gas for other less carbon intensive fuels other than electricity, such as biomethane (also referred to as renewable natural gas) or hydrogen fuels.

For parties supporting electrification as a policy goal, it is commonly believed that more needs to be done to foster new development and uptake of new electricity end uses and to encourage interconnections to promote fuel switching to electricity - but that is not the focus of this paper. Rather, this paper focuses on the implications of fuel substitution from utility regulated gas to electricity to promote building decarbonization.

Local governments and some utilities have also recognized building electrification as a critical component of California's energy progress.

As a specific policy step towards building electrification and fuel substitution, California recently passed targeted pieces of legislation specific to building electrification in Senate Bill (SB) 1477 and SB 3232. SB 1477 establishes and allocates $50 million to two statewide initiatives that work to advance the state's market for low-emission space and water heating equipment and develop incentives for deployment of zero emission technologies in buildings.[14] SB 3232 requires the California Public Utilities Commission (CPUC) to assess the potential for the state to reduce GHG emissions from the state's residential and commercial building stock by at least 40% below 1990 levels by January 1, 2030.[15, 16]

Building on this, in their most recent Integrated Energy Policy Report (IEPR) – which is a principal document for guiding and determining policy directions for the state – the California Energy Commission highlighted the critical importance of decarbonizing buildings and documented policy pathways and opportunities for electrification as a "highly salient strategy to reduce or eliminate GHG emissions from buildings." Continuing, the IEPR report highlighted "a growing consensus that building electrification is the most viable and predictable path to zero-emission buildings…due to the availability of off-the-shelf, highly efficient electric technologies and the continued reduction of emission intensities in the electricity sector."[17]

At the same time as this state level action to cut emissions from buildings, some local governments and utilities have also started their own efforts to promote building electrification as a necessary component of California's energy progress. At the municipal level, the need to meet local emissions reductions commitments has caused cities like Los Angeles and San Francisco to propose major electrification initiatives for existing buildings.[18] At the utility level, Southern California Edison, Sacramento Municipal Utility District and Los Angeles Department of Water and Power have done the same.[19,20,21]
Further, groups like the Building Decarbonization Coalition (BDC) – a coalition of utilities, NGOs, manufacturers, and local and state governments – have developed ambitious roadmaps and

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[13] Energy Commission. (2017). Framework for Establishing the Senate Bill 350 Energy Efficiency Savings DoublingTargets.
[14] State of California. (2018, September 13). Senate Bill No. 1477 Low-emissions buildings and sources of heat energy.
[15] State of California. (2018, September 13). Assembly Bill No. 3232 Zero-emissions buildings and sources of heat energy.
[16] California Energy Commission. (2019). Final 2018 Integrated Energy Policy Report Update - Volume II.
[17] C40 Cities. (2018). 19 Global Cities Commit Make New Buildings "Net Zero Carbon" by 2030.
[18] Southern California Edison. (2017.). The Clean Power and Electrification Pathway - Realizing California's Environmental Goals.
[19] Sacramento Municipal Utility District. (2018). SMUD and D.R. Horton agree to build all-electric homes.
[20] City of Los Angeles. (2018). Motion: 18-0002-S7.
[21] California Energy Commission. (2019). Final 2018 Integrated Energy Policy Report Update - Volume II.

reports to help guide state energy policy and develop new pathways for California to decarbonize its buildings. The BDC Roadmap, for example illustrates the targets to increase the share of sales of high efficiency electric heat pumps for space and water heating to 50% by 2025 and 100% by 2030 as a pathway to achieving 40% carbon reductions in the building sector by 2030 and 100% by 2045.[22]

Building electrification in California still has significant challenges that must be overcome to meet full deployment potential and to provide the complete range of environmental, economic, and health benefits possible to the state. Among these challenges are capital costs and associated financing, building codes and technical specifications, market development, and customer acceptance and demand.[23, 24] Despite this, the recently enacted legislation, IEPR findings, and local commitments have established a valuable decarbonization pathway where California's buildings will be significantly reducing their demand for gas over time. The reduction in the demand for gas could, by extension, mean a significant reduction in both the need for, and the utilization of, the state's extensive gas infrastructure.

Depending on the time frame for the transition away from heavy reliance on gas, there are potentially significant implications facing utilities that experience a declining customer base and demand for their product.

Depending on the time frame for the transition away from heavy reliance on gas, there are potentially significant implications facing utilities that experience a declining customer base and demand for their product. First, the already committed investments and the ongoing costs of operation and maintenance of the gas system are now spread over a smaller customer base – potentially causing the gas rates for remaining customers to increase, particularly in the short term. Further, depending on the amount of customer fuel substitution and how quickly it occurs, there is a risk that certain infrastructure investments will no longer be considered "used and useful" (defined and discussed further below), causing some investment value to become "stranded." As a result, potentially significant financial and political risks may materialize for utilities and ratepayers if the issue is not managed proactively.

At the same time, because the state has obligations to the gas utilities, both its customers and its shareholders – the move to electrification and the risk of causing stranded assets means the state must address important issues across an array of policy and legal considerations.

- Since state law recognizes energy as a basic necessity, and requires that all residents of the state should be able to afford essential electricity supplies,[25] state approved electrification strategies must address the affordability of energy – especially for the remaining customers on the gas system who are not able to transition to electricity (high capital costs, technological limitations, etc.).
- Since California has to ensure that all utility customers are given affordable, clean and reliable service, the state must work to ensure that vulnerable customers which cannot readily perform fuel-substitution are not left behind.
- Since California grants utilities monopoly power while expecting utility investments to be made, the state has an obligation to the utility's shareholders who may be at risk by downsizing the gas system. Under the current agreement, shareholders expect to get an opportunity for a return on their investment (with the ability to earn profit) in exchange for provision of goods and services and the effective operation of those goods and services that would not be invested in otherwise. This regulatory compact is jeopardized if recovery cannot occur because the state ex-post investment changes policy.[26]

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[22] Deason, J., Wei, M., Leventis, G., Smith, S., & Schwartz, L. (2018). Electrification of buildings and industry in the United States - Drivers, barriers, prospects, and policy approaches. Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory.
[23] California Public Utilities Code. (n.d.). PUC § 382.
[24] Regulatory Assistance Project. (2016). Electricity Regulation in the US: A Guide.
[25] California Public Utilities Code. (n.d.). PUC § 382.
[26] Regulatory Assistance Project. (2016). Electricity Regulation in the US: A Guide.

The competing tensions involved in a strategy where California electrifies a large number of buildings and shifts customers towards the electricity system, resulting in a shift away from reliance on the gas system, highlights a critical juncture for the state. California will need to proactively design solutions to help ensure the state is successful in driving decarbonization while still managing the impact on gas assets to ensure a cost effective, equitable, and politically viable transition for all stakeholders.

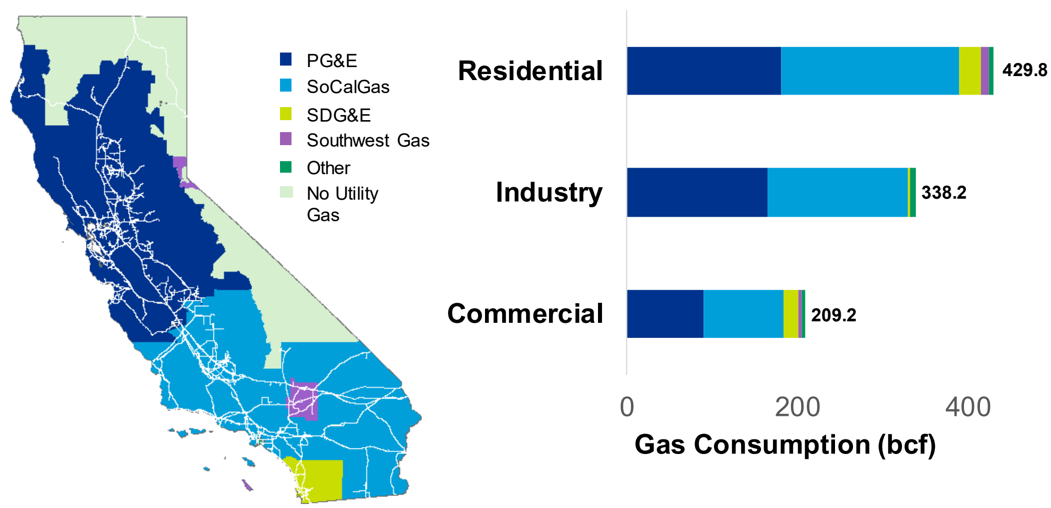
This paper will explore the issue of stranded assets in California and their potential implications for stakeholders, the energy system, and the environment. In addition it will discuss potential pathways for managing risk for both existing and future investments, and identify key unknowns California needs to address in order to respond effectively to the issue of stranded assets. In doing so, this paper will propose specific recommendations for initiating a process to proactively respond to stranded asset concerns that, if left unaddressed, may undermine the larger movement toward building electrification and expanded decarbonization. This paper, while concentrating on California, may also provide guidance and a framework for other jurisdictions that are considering the financial and regulatory implications of decarbonizing buildings.

Overview of California Gas System

Collectively, in 2017 California's 10.5 million residential customers, almost 396,000 commercial customers, and 32,000 industrial customers consumed over 977 billion cubic feet of gas. 96% of those customers were served by one of four companies – Southern California Gas Company (SoCalGas), Pacific Gas and Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southwest Gas Corporation (Southwest Gas) with the remainder of customers served by one of several municipal gas utilities (Long Beach Gas, Palo Alto Municipal, City of Vernon, and City of Susanville). SoCalGas is by far the largest provider with 51% of all customers (5.5 million residential, 177,000 commercial, and 16,647 industrial) and over 467 bcf of gas served (93 bcf commercial, 165 bcf industrial, and 208 bcf residential) in 2017. PG&E is the second largest provider with 37% of customers and 434 bcf of gas served (89.9 bcf commercial, 164.1 bcf industrial, and 180.7 bcf residential) (Figure 1).[27, 28]

California's investment in the gas pipeline system is also long-standing and robust. For example, in 2017 the investor owned gas utilities revenue requirement for gas distribution, transmission, and storage infrastructure was over $6.2 billion dollars – PG&E $3.1 billion, SoCalGas $2.6 billion dollars, SDG&E $397 million dollars.

Figure 1
Service Territory and 2017 Consumption for California Gas Providers



[27] California Energy Commission. (2019). CECGIS - California Natural Gas Pipelines.
[28] California Energy Commission. (2019). California Energy Consumption Database.
[29] California Public Utilities Commission Energy Division.(2018). California Electric and Gas Utility Cost Report.

The Basics: Financing Assets

Under normal circumstances, a gas utility will deliver energy to its customers through a system of physical infrastructure (assets) which require high upfront costs to build, and ongoing costs to operate and maintain. The utility incurs significant debt up-front to place the asset into the system, and then the utility recovers these up-front costs from its customers over time and earns profit over the life of the asset. In order for a California utility to recover costs from its customers, the utility must demonstrate to the CPUC before construction that the asset will be "used and useful" and will remain so for the life of the project. If the CPUC concurs that the new asset will be "used and useful", it will grant the utility a permit to construct or a certificate of public convenience and necessity and allow the utility to recover from its customers the costs of the new asset. This recovery will include the one-time construction related and installation costs, the physical cost of the asset itself, and ongoing expenditures operations and maintenance.

A brief overview of the "used and useful" standard is provided below. Following this is a discussion as to what happens when an asset is no longer used and useful, or when it has been stranded.

Utilities need to demonstrate that an asset is both providing physical service (used) and that without the asset, costs would be higher or the quality of service would be lower (useful).

"Used and useful"

"Used and useful" is a utility regulation principle that is used to determine when a utility can recover an investment from their customers through rates. According to this principle, before recovery can occur in rates, utilities need to demonstrate that an asset is both providing physical service (used)[30,31] and that without the asset, costs would be higher or the quality of service would be lower - that is to say service is actually needed by ratepayers (useful). When either of these components is not met, an asset is no longer considered "used and useful", and would be excluded from a utility's rate base meaning the utility could no longer recover the costs of the asset from its customers or earn the associated rate of return. Generally in California, in the case where the asset no longer qualifies as "used and useful," the remaining book value cannot be recovered from ratepayers, and as a result must be absorbed by the utility shareholders.[32] Before an asset is removed from rate base, the state will need to make a finding that the asset in question no longer meets the "used and useful" standard.

The "used and useful" test was developed over time through a series of court decisions[33] starting initially with the "fair value doctrine" established in Smyth v. Ames, 171 U.S. 361 (1898). This doctrine had two key balancing ideas that laid the groundwork for later "used and useful" language: 1) companies were entitled to collect rates that represented the fair value of the property being used by it for the convenience of the public; and 2) the public was entitled to demand that no more value be extracted from the property than the services rendered by it are reasonably worth.[34]

What followed this fair value doctrine was the prudent investment standard first suggested in *Southwestern Bell Tel. Co. v. Public Svc. Comm'n, 262 U.S. 276 (1923)* and built upon in *Denver Union Stock Yard Co. v. United States, 304 U.S. 470 (1938)* and finally culminating in F*ederal Power Commission v. Hope Natural Gas Co., 320 U.S. 591 (1944)*. When taken together, these cases created a prudent investment standard that suggested regulators should consider economic relevance in

[30] Lesser, J. A. (2002). The Used and Useful Test: Implications for A Restructured Electric Industry. Energy LawJournal, 23:349.
[31] Regulatory Assistance Project. (2016). Electricity Regulation in the US: A Guide.
[32] California Public Utilities Commission Policy & Planning Division. (2017). Utility General Rate Case - A Manual for Regulatory Analysts.
[33] A thorough overview of the used and useful doctrine can be seen in Lesser 2002 and Hoecker 1987
[34] Lesser, J. A. (2002). The Used and Useful Test: Implications for a Restructured Electric Industry. Energy Law Journal

the determination of fairness and ensure that all investments included in the rate base are both necessary and prudent. Specifically, in Denver Union, it was determined that "property not used or useful in rendering the services of the public utility need not be included in rate base" (emphasis added).[35]

Although the Hope decision principally dealt with utility rate of return (discussed further below), it established a focus on "just and reasonable" rates based on an end result. This end result doctrine would become critical in future "used and useful" determinations, particularly with regards to investments in gas infrastructure and nuclear power plants. In the end, cases following the Hope decision affirmed that even prudent costs could not be included in rate base, unless a benefit from such expenditures inures to the benefit of present ratepayers.[36]

Two critical cases for the application of the "used and useful" principle followed the Hope cases. First, *Jersey Central Power & Light Company v. Federal Energy Regulatory Commission 589 F.2d 142* (3rd Cir. 1979) which, among other key determinations, found that the "used and useful" doctrines was "one of several permissible tools of ratemaking", though it need not be, and is not, employed in every instance.[37,38] The second case was *Duquesne Light Co. v. Barasch, 488 U.S. 299 (1989)* which upheld a Pennsylvania statute that required investments to be "used and useful" saying that "to the extent that utilities' investments turn out to be bad ones (such as plants that are cancelled and so never used and useful to the public), the utilities suffer because the investments have no fair value and so justify no return." Essentially, these cases find that "used and useful" laws are constitutional even when they exclude costs that were prudent and reasonable when the investment was made.[39] More than anything, both of these cases highlight the crucial factor of context for application of the "used and useful" determination.

In California, the CPUC has defined "used and useful" as property "actually in use and providing service".[40] The CPUC has stated "the general rule of ratemaking has been that a utility is not allowed to recover the costs of plant (asset) which is not used and useful"[41] However, a number of exceptions to these rules have also been established by past proceedings.

For example, "during a period of dramatic and unanticipated change", the CPUC has stated "[…] the ratepayer should participate in the increased risk confronting the utility" – even if the "used and useful" test would otherwise apply.[42] Projects abandoned in the decade following the oil embargo of 1973 exemplify this uncertainty exception to the "used and useful" principle.[43] Additionally, the CPUC has allowed utilities to rate base assets when "there was something left from the abandonment that was of value to ratepayers".[44] One example of this includes assets deemed Plant Held for Future Use (PHFU), which are assets maintained in rate base for use at a later time.[45]

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[35] Denver Union Stock Yard Co. v. United States, 304 (U.S. 470 1938)
[36] Hoecker, J. J. (1987). "Used and Useful": Autopsy of Ratemaking Policy. Energy Law Journal, 8:303.
[37] Hoecker, J. J. (1987). "Used and Useful": Autopsy of Ratemaking Policy. Energy Law Journal, 8:303.
[38] Lesser, J. A. (2002). The Used and Useful Test: Implications for a Restructured Electric Industry. Energy Law Journal
[39] Lesser, J. A. (2002). The Used and Useful Test: Implications for a Restructured Electric Industry. Energy Law Journal
[40] In the Matter of the Application of Southern California Gas Company and Pacific Lighting Gas Supply Company for authority to include in rate base as plant held for future use the costs associated with the Liquefied Natural Gas Project, D.84-09-089 (Sep 6, 1984).
[41] Application of Pacific Gas and Electric Company for authority, among other things, to increase its rates and charges for electric and gas service, D.89-12-057 (Dec 20, 1989).
[42] Application of Pacific Gas and Electric Company for authority among other things to increase its rates and charges for electric and gas service, D.84-05-100 (May 16, 1984).
[43] Application of Pacific Gas and Electric Company for authority, among other things, to increase its rates and charges for electric and gas service, D.89-12-057 (Dec 20, 1989).
[44] In the Matter of the Application of Southern California Gas Company for authority to increase rates charged by it for gas service, D.92-49-7 (Dec 5, 1980).
[45] In the Matter of the Application of Southern California Gas Company and Pacific Lighting Gas Supply Company for authority to include in rate base as plant held for future use the costs associated with the Liquefied Natural Gas Project, D.84-09-089 (Sep 6, 1984).

Finally, in more recent decisions, the CPUC has broken from the interpretation that "shareholders earn a return only on plant that is used and useful",[46] by authorizing a reduced rate of return on abandoned assets (e.g. D.96-01-011 and D.11-05-018).[47,48]

An overview of key CPUC decisions related to stranded assets can be seen in Table 1 below, and a more detailed look at the key issues, CPUC decision points, and arguments for the case studies can be seen in Appendix 1. Inclusion of these case studies is intended to demonstrate California's history with stranded assets and highlight nuances and themes across historical examples from utilities, stakeholders, and the CPUC in order to provide context for the possible fate of gas assets today in an electrified future. Other states will have their own set of case law on "used and useful" and how to handle stranded assets, but this table may serve as a guide.

Table 1
Overview of CPUC Decisions Related to Stranded Assets

DECISION	UTILITY -- ASSET (S)	STRANDED VALUE
D.92497 (12/5/1980)	SCG - Coal Gasification Plant	$9.7 million
D.83-08-031 (8/3/1983)	Pacific Telephone and Telegraph Company- Digital "Customer Premesis Equipment"	$19–95.7 million (Estimated)
D.84-05-100 (5/16/1984)	PG&E - Various Plants	$60.8 million (preconstruction costs)
D.84-09-089 (9/6/1984)	SCG & PG&E -Liquefied Natural Gas Project	$133.7 million
D.85-08-046 (8/21/1985)	PG&E - Humboldt Bay power plant Unit 3	$88 million
D.85-12-108 (12/20/1985)	SDG&E - Encina 1 and South Bay 3 power plants	--
D.89-12-057 (12/20/1989)	PG&E - Various	$3.97 million
D.92-08-036 (8/11/1992) **D.95-12-063** (1/10/1996)	SCE/SDG&E - San Onofre Nuclear Generating Station Unit 1	$460 million
D.92-12-057 (12/16/1992)	PG&E - Geothermal Plant (Geyser 15) and Steam Payments	$5.03 million and $30.2 million
D.96-01-011 (1/10/1996)	SCE/SDG&E - San Onofre Nuclear Generating Station Units 2 & 3	$3.461 billion
D.11-05-018 (5/5/2011)	PG&E - SmartMeters	$341 million

In sum, based on past examples and case law, in the absence of a firm rule delineated in California statute, the test for recovery by utilities for "used and useful" investments has largely developed into a guideline for the CPUC – a guideline that affords a great deal of flexibility to the agency. This flexibility is compared to California's well established standard requiring utilities to only charge rates that are "just

[46] Application of Pacific Gas and Electric Company for Authority among Other Things to Increase Rates and Charges for Electric and Gas Service, D.92-12-057 (Dec 16, 1992).
[47] In the Matter of the Application of Southern California Edison Company (U 338-E) for Authority to Increase Its Authorized Level of Base Rate Revenue under the Electric Revenue Adjustment Mechanism for Service Rendered Beginning January 1, 1995, D.96-01-011 (Jan 10, 1996).
[48] Application of Pacific Gas and Electric Company for Authority, Among Other Things, to Increase Rates and Charges for Electric and Gas Service Effective on January 1, 2011, D.11-05-018 (May 13, 2011).

and reasonable" as enshrined in Public Utilities Code §451.[49] Under §451, the CPUC establishes that utilities may recover funds in rates, generally in the form of requests for a decree of a Certificate of Public Convenience and Necessity, to help build large infrastructure projects where the utility can earn a rate of return.

Return on Investment in the Gas System

Under the general regulatory compact for utilities in California, the CPUC grants the utility protections from competition for the sale and distribution of gas to customers in its defined service territory. In return, the company is placed under an obligation to serve and is committed to supplying the full quantities demanded by those customers at a price calculated to cover all operating costs plus a "reasonable" return on the capital invested in the enterprise.[50]

While the Supreme Court has not explicitly affirmed the notion of a regulatory compact[51], it has developed a strong history of case law affirming that utilities operating to provide service and support in the public interest are entitled to fair and reasonable rates with the most notable standards rising out of two Supreme Court cases: *Bluefield Water Works & Improvement Co. vs Public Service Commission of West Virginia (1923) 262 U.S. 679* and *Federal Power Commission vs. Hope Natural Gas Co. (1944) 320 U.S. 591.*

The *Bluefield* decision states that a public utility should be provided an opportunity to earn a return necessary for it to provide utility service. In Bluefield, the Court stated: "The return should be reasonably sufficient to assure confidence in the financial soundness of the utility, and should be adequate, under efficient and economical management, to maintain and support its credit and enable it to raise money necessary for the proper discharge of its public duties."[52]

A utility should be able to offer returns to investors comparable to those achieved on alternative investments of comparable risk.

The *Hope* decision reinforces and expounds upon the Bluefield decision insofar that it emphasizes such returns should be commensurate with returns available on alternate investments of comparable risks. This idea is based on the basic principle in finance that rational investors will only invest in a particular investment opportunity if the expected return on that opportunity is equal to the return investors expect to receive on alternative investments of comparable risk.

As a result of *Bluefield* and *Hope*, two standards have emerged related to utility return on investments in the gas system. First, returns should be adequate to enable a utility to attract investors to finance the replacement and expansion of a utility's facilities to fulfill its public utility service obligation. Second, to attract capital, a utility should be able to offer returns to investors comparable to those achieved on alternative investments of comparable risk.[53]

To add clarity to the return on investment question in California, the CPUC adopted and utilized what is known as the **prudent manager test**. Under this standard, to receive a return on investment, a utility must prove that it acted reasonably, and prudently operated and managed its system. Such a showing must be demonstrated by the utility's actions, practices, methods, and decisions showing reasonable judgment in light of what it knew or should have known at the time, and that those actions are in the interest of achieving safety, reliability and reasonable cost.[54] The prudent manager test is designed so that utility operates in the best interest of its customer and not the shareholder; if the utility acts in a

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[49] California Public Utilities Code. (n.d.). PUC § 451.
[50] Lesser, J., & Giacchino, L. (2007). Fundamentals of Energy Regulation.
[51] Regulatory Assistance Project. (2016). Electricity Regulation in the US: A Guide.
[52] Bluefield Water Works & Improvement Co. vs Public Service Commission of West Virginia, 262 (U.S. 679 1923).
[53] California Public Utilities Commission. (2017). An Introduction to Utility Cost of Capital.
[54] D.87-06-021 summarized in D.18-07-025

prudent manner, then customers receive the benefit and will pay the costs if there are unanticipated expenditures. The prudent manager test does not demand perfect knowledge nor the benefit of hindsight, but rather reasonable actions given the information available at the time. However, if the utility operates imprudently, perhaps favoring shareholder interests, then shareholders will face the costs for unforeseen circumstances.

To the extent that California has modified the return on investment requirements at the CPUC, the question under the prudent manager test asks whether, and to what extent, gas utilities that purport to be entitled to recovery at the CPUC acted prudently in their behavior. Under the prudent manager test, the utility cannot always predict new policy directions or specific legislation. If the state seeks a new policy direction (decarbonize buildings through electrification) resulting in the gas utilities potentially being forced to retire assets prematurely, the utilities may still be able to recover the value of those assets if it acted prudently. Meaning, the state cannot "cancel" the remaining recovery costs owed to shareholders as long as the utility acted in a prudent manner.

On the flip side, utilities not meeting the prudent manager test will be confronted with a different fate and may be faced with lack of recourse to recover for prior investments in infrastructure, thus resulting in stranded assets. The timing of the utility's actions vis-à-vis state law being enacted will be a critical threshold for consideration if the continued investment into the asset is prudent and therefore just and reasonable. The establishment of a clear policy signal creates a "bright line" for future investments to be judged against the prudent manager test. The vintage of the investment, those that occurred before or after the bright line, may result in different rate recovery treatment. If after the establishment of the "bright line" the gas utility continues major investments without considering this new policy direction, then there may be new shareholder exposure for acting imprudently.

As a result of the prudent manager test in California dictating utility return on investment, the evolving policy landscape in the energy sector creates market uncertainty which will force investors to demand higher return on equity to make investments in infrastructure – including investments to operate and maintain current infrastructure – less risky. Investors will look at both new state law requiring changes in investment behavior, and the associated investment responses from the utility, from the lens of riskiness. If the state deviates from the "used and useful" and the "prudent manager" standards, it will increase regulatory uncertainty and increase the perception of riskiness associated with new investments. Investors will demand a higher rate of return on future investment, increasing costs to all customers, to overcome the riskiness associated with this uncertainty.

How Does a Gas System Asset become Stranded?

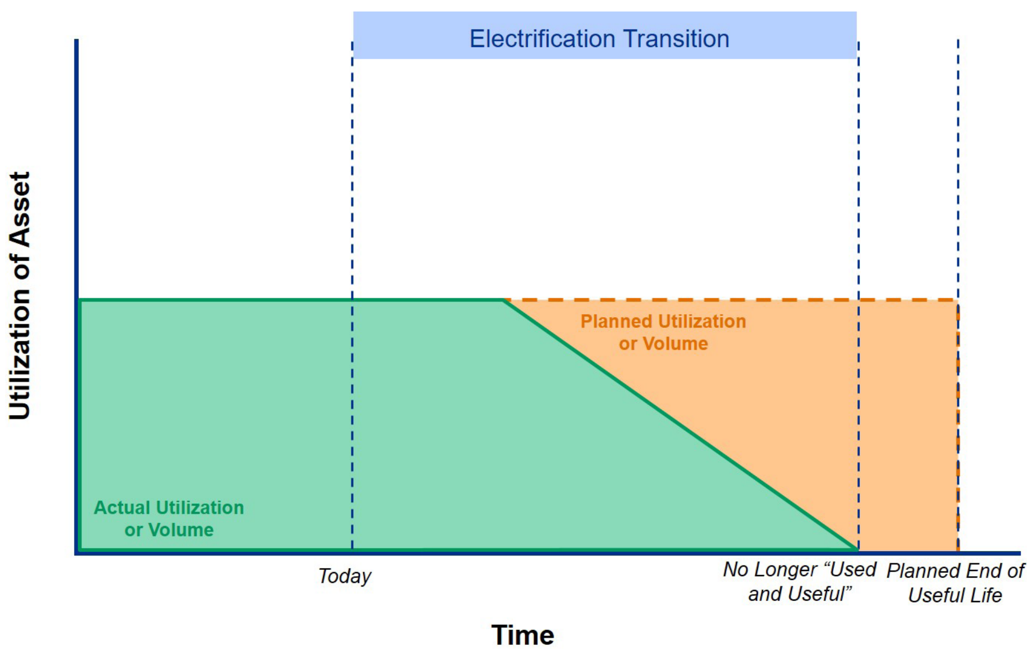
When a prudent investment is made, it is deemed to be "just and reasonable" and therefore eligible for rate recovery. To ensure affordability and full utilization of the asset, the recovery generally is amortized throughout its expected "useful life." The asset costs are allocated to all customers on a pro-rata basis, and are generally recovered on a volumetric basis. As the number of customers change, the volumetric charge is adjusted so that the utility only recovers the value of the asset (including associated potential profit). If there is a significant increase in the number of customers, the cost per customer declines as long as there is available gas capacity with the asset. If there is a significant decline in the number of customers, the remaining customers' rate will increase as long as the asset meets the "used and useful" definitions.

In the case of gas infrastructure, particularly on the distribution side for residential and commercial customers, the state approved these assets expecting that they would be needed and would meet the "used and useful" standard throughout their useful lifespan. However, with the policy goal to decarbonize buildings by decreasing gas demand and increasing building electrification, the number of customers demanding gas will decrease, which in turn will reduce the usefulness or the need for the assets. If the state is successful in its electrification efforts and no more throughput, for example, is needed to be delivered through a given gas line, that line is no longer "used and useful" even if it technically still had the potential for useful life. It is at this point that the asset could be considered "stranded." This paper conceptually illustrates the issue of stranded assets and their solutions more to demonstrate the mechanics of considering stranded assets and their solutions rather than represent any specific asset or case in practice. The expectation is that the specific values for capital costs and asset profiles will need to be addressed for individual assets as part of a coordinated strategy in the future (more below).

In Figure 2, the planned utilization or volume demand (usefulness) of a specific asset or set of assets in the gas system is expressed over the span of its/their intended life. For most gas system assets under normal conditions, the volume or utilization remains the same over time as the investment was made to perform a particular service (i.e. serve the gas demand of a particular community). This is represented by the orange section. If however that community decides to shift away from gas system dependency by going all-electric, either over time or all at once, then the volume demand or utilization for that asset declines. Eventually, utilization reaches a threshold level where it is no longer appropriate from an economic or operational perspective[55] to keep the asset in rate base (i.e. the asset is no longer "used and useful").

As customers electrify, there is a gap between the planned recovery value of an asset and the value that can be recovered from remaining customers.

Figure 2
Overview of "Used and Useful"



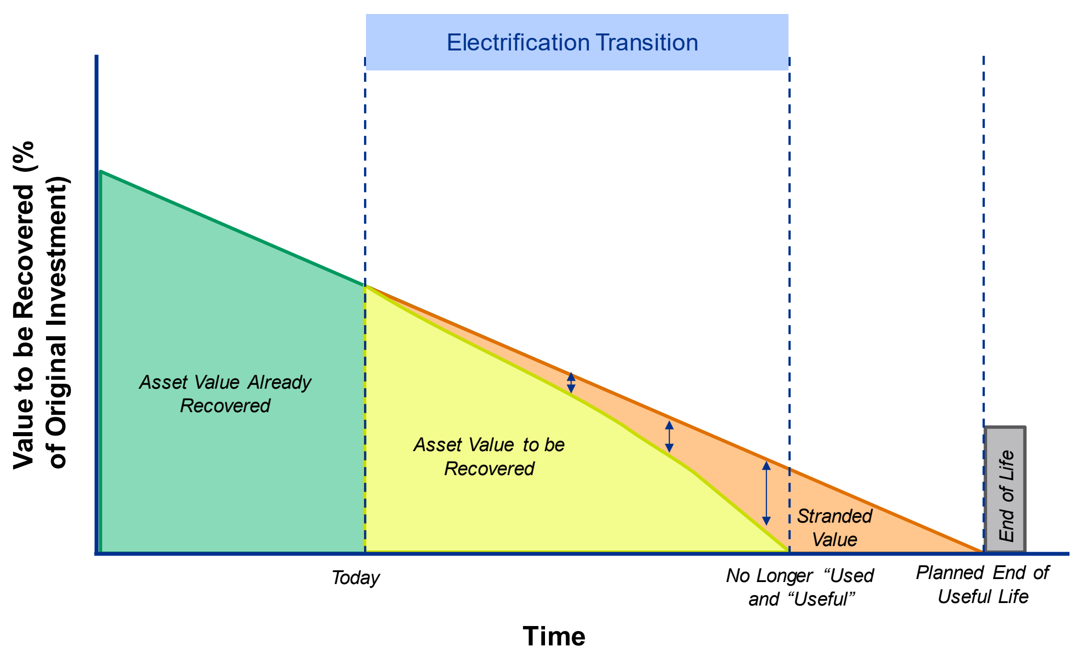
Following this, Figure 3 shows the undepreciated costs or unrecovered value of an asset over time. Since electric and gas investments are so capital intensive, the costs of the investment are spread out and recovered over the entire expected useful life of the asset. In its simplest form, the unrecovered value starts at 100% of original investment and declines over time as more of the initial investment value is recovered in rates and the asset depreciates year over year. At the end of its useful life, the unrecovered

[55] It should be noted that gas systems require both a minimum and a maximum allowable operational pressure, and the graphs presented in Figure 2 and other places are meant to be illustrative. Operational and safety constraints will not be a smooth decline to zero.

value should be zero since the asset is paid off and there is no more remaining book value.

Under the baseline conditions, all of the initial investment value was supposed to be recovered from all of the volume and ratepayers the investment was planned for. However, as customers leave the system in an electrification scenario, less utilization/volume is available for recovery and there starts to be a gap (blue arrows) between the planned recovery value and the value that can be recovered from remaining ratepayers. This gap as well as the remaining book value of the asset when it is no longer "used and useful" are known as "stranded value" (orange area) which is unable to be recovered in traditional rate base. The area between when the asset no longer being "used and useful" and the planned end of useful life represents the value that is truly stranded with no customer base to recover from, and the remaining orange area that was planned for but not fully utilized is the cost shift onto the remaining customers. For illustration purposes, Figure 3 shows all of the gap as stranded value, but in reality at least in the short term, the gas system is robust enough that losing a few customers will not impact the system appreciably. At some point, however, the gap becomes large enough that it needs to be addressed by raising rates for remaining customers or through a different recovery pathway.

Figure 3
Overview of Stranded Asset Value for Investments



Key Areas for Evaluation

While there are many unknowns associated with stranded assets in California, this report highlights five critical areas that California will need to address in order to effect a just and cost-effective transition towards a carbon-free energy system without impeding state goals:

1. Valuation of existing assets (including vintage of asset, remaining book value and potential magnitude of stranded asset risk)
2. Timeline and strategy for electrification
3. Threshold for "Used and Useful"
4. Equitable distribution of financial risks associated with the asset
5. Appropriate mix of solutions

Understanding these different drivers and leverage points will open pathways forward and suggest what solution sets are available for California. While forward this report is looking at the not yet realized issue of stranded assets, ratepayers and the state as a whole will benefit from as long of a planning horizon as possible to spread out costs, so it is prudent to start exploring these issues as soon as possible. This will likely need to be done through a specific CPUC or legislative pathway as discussed further below. These and other unknowns are summarized in Table 2 and discussed in further detail below.

Table 2
Overview of Key Data Needs for Stranded Assets

KEY UNKNOWN	DESCRIPTION	SOURCE
Investment value of the gas system	Total investment value in the gas system by specific assets, asset classes and geography to determine the overall magnitude of value	Utilities, CPUC
Recovery timelines and depreciation schedules for the gas system	Timelines for recovery of investment in gas system assets to determine how much value has been recovered and what value still needs to be recovered	Utilities, CPUC
Timeline and geography for electrification	Compiled data detailing how quickly electrification is happening in different areas of the state to determine the actual risk of stranded assets and which geographies may need more focused solutions	Utilities, CCAs, municipal governments, NGOs, 3rd party installers or contractors
Strategy for targeting of electrification	Set of criteria for targeting marketing, education, and outreach, incentives, and pilots to ensure a more coordinated rollout of electrification that effectively addresses stranded asset risk	CPUC, State Legislature with input from stakeholders
Threshold for "Used and Useful"	Determination for threshold levels of demand or use for gas assets that determines when an asset is legally considered "used and useful" and allowed to be recovered in ratebase.	CPUC with input from stakeholders
Timeline and magnitude of stranded asset risk	The specific magnitude and timeline for stranded value in California's gas system that needs to be addressed with solutions depending on the interaction of the above unknowns.	Utilities, CPUC
Equitable distribution of stranded asset burden	Strategy and balancing of costs and responsibilities for stranded assets depending on timeline, geography, customer class, and asset type	CPUC, State Legislature with input from stakeholders
Appropriate mix of solutions for stranded assets	Mix of financing and alternative solutions for mitigating stranded asset risk and impact depending on stranded value risk, asset class, geography, etc.	CPUC, State Legislature with input from stakeholders

Valuation of Existing Assets

First and foremost there needs to be a better understanding of the actual magnitude of remaining investment value for both individual assets and the system as a whole, as well as the associated recovery timelines for the system overall and for individual assets/geographies. These parameters correspond to the overall size or value of the investment (square from Figure 2 and or triangle from Figure 3), how much has been recovered so far (green triangle - Figure 3), how much value still needs to be recovered from ratepayers (yellow triangle - Figure 3), and how far into the future the planned end of life is.

Understanding these issues will frame what solutions are on the table for specific assets and geographies while focusing the development of more effective solutions and a better management of risk. For example, some asset types or geographies may not be at risk of becoming stranded because most of their value has already been recovered in which case the state interventions become working to find alternatives to future investment rather than financing stranded value as discussed below. Similarly, this analysis could identify areas that all other things equal should be less prioritized for electrification in the near term as they have high risk of stranded value, and these areas then become targets for targeted leak reduction work in the gas system and to the extent feasible a limited deployment of alternative fuels (discussed below).

There needs to be additional transparency and coordination around infrastructure and investment to improve development of solutions.

To address any of these issues, however, there needs to be additional transparency and coordination around the data for infrastructure and investment values and locations and their associated recovery timelines. For the most part, this information is only well understood by the gas utilities themselves, and even then, not within a coordinated risk management structure that intersects with electrification efforts. Further, the spatial distribution of these assets, values, and timelines is not well understood outside of the utilities making it difficult to integrate those considerations into strategic electrification.

The ability for the state to proactively prioritize actions and investment to reduce overall risk of stranded assets down the line requires this more coordinated and transparent understanding of the portfolio of gas infrastructure that could be impacted by electrification. As a result of the lack of data, it will likely be necessary for the CPUC or state legislature to direct the collection, sharing, and analysis of this needed data and to gather stakeholder feedback on which solutions are in play based on different asset characteristics.

Timeline and Strategy for Electrification

Second, the timeline for electrification and its rollout both overall and overlaid with specific investments and geographies will be critical to understand. The timing for electrification, particularly as it intersects with the asset recovery timelines from above, will principally help determine what value or what assets are more at risk of being stranded and how quickly this is becoming an issue for different assets and the system as a whole (the shape and slope of the decline in Figure 2 and Figure 3. Depending on how fast and how linear the transition is, the state could see dramatically different scenarios for potential stranded value. If the state is wildly successful on electrification and the transition occurs in a rapid fashion, there may be more assets and value on the line. On the other hand, it is also possible that the transition is more gradual or back loaded in time and the issue of stranded assets is less critical. The most recent IEPR[56] provided some of the initial information needed for this analysis, but there are still several unknowns the state has yet to coordinate.

[56] California Energy Commission. (2019). Final 2018 Integrated Energy Policy Report Update - Volume II.

Efforts here will necessarily need to synthesize ongoing pilots and electrification efforts – particularly those coordinated in specific areas or communities – with the value and recovery timelines of specific gas assets. For example, if the CPUC elected to focus the state's electrification strategy on low-income or disadvantaged communities, then it may be worthwhile to select a location and situation specific stranded assets recovery strategy to complement that choice. However, if the state were to focus on the vintage of the asset, that may suggest a different set of strategies. States may want to consider linking and coordinating its building electrification targeting with how it handles stranded assets. This strategic electrification solution is discussed in more detail below.

Threshold for "Used and Useful"

Federal and California precedent for "used and useful" have left a fair measure of flexibility and authority to the CPUC for the specific determination of "used and useful." The demand threshold where an asset is no longer considered "used and useful" (x axis and dashed lines in Figure 2 and Figure 3) needs to be established and litigated in the CPUC and include a determination for the utility's obligation to serve customers in the discussion of stranded assets. Among other things, key considerations will need to include interaction with other elements of the utilities' general rate case, distribution costs, pipeline safety, and technological limitations. As discussed above, the utility will need to determine as the operator of the system what the minimum allowable operating pressure is for each segment of the line. There may also be a minimum number of customers or demand below which it does not make technical or economic sense to continue to serve customers. Since there is flexibility given in code, the CPUC may need to reconsider the "used and useful" definition for the decarbonization context.

Equitable Distribution of Financial Risks

A mix of solutions applied for different assets, geographies, and customer classes will likely need to be developed to balance diverse stakeholder perspectives effectively.

As discussed in more detail below, there are critical tensions between different customer classifications that need to be considered in working to manage the risk and impact of stranded value during this transition. Importantly, key questions will need to be addressed regarding the balance between future and current customers, electric and gas customers, high income and low income customers, just to name a few. In the near term, it is highly possible that wealthier customers are more likely to be able to afford to disconnect from the gas system and to electrify its buildings, leaving the remaining customers with a lower ability to pay to pick up the remaining costs. As customers leave the system, the state may want to consider how the cost of the "exit" should be addressed and accommodated for, and on what time horizon.

Appropriate Mix of Solutions

Given the complex nature of stranded assets and the California energy landscape, it is likely that no one solution will be appropriate for all situations and for all stakeholders. Some solutions will make sense for specific circumstances (asset classes, geographies, and/or levels of risk or stranded value) and most likely a suite of them will be needed for the entire transition to be most efficient.

A mix of solutions applied for different assets, geographies, and customer classes will likely need to be developed to balance regulatory certainty, rate shock, investor concerns etc. As more clarity is developed, there will need to be systematic discussions and balancing of stakeholder perspectives to develop a solution set to manage stranded assets that effectively. Providing a set of policy guidance in advance will help implement the best mixture of financial solutions. As indicated above, perhaps in conjunction with an assessment of the value of gas assets, California may want to consider initiating an investigatory process to help establish the policy priority of these issues.

Implications of Stranded Assets in the California Gas System

Stranded assets in the California Gas System have significant potential implications for state policy goals, ratepayers, utilities, the electric grid, and the environment. Some of the key impacts are discussed below.

State Policy Goals – Mismanaging stranded assets can hurt the economy, stymie investment, decrease safety, create rate increases for customers, and exacerbate equity issues in the energy sector. Accordingly, stranded assets can hinder momentum towards achieving state policy goals such as on greenhouse gas emissions reductions, reduction in gas demand, and deployment of end-use electrifications. If maintaining a dwindling gas utility infrastructure becomes too expensive for remaining customers, California's decarbonization progress may suffer.

There is a real political and human health risk for people not being able to afford basic energy services, particularly if support programs are not in place to ease the transition.

Equity – With gas system operation and maintenance costs spread out across a smaller customer base, there is a significant risk that certain customer groups, particularly those low income customer groups, will be left footing the bill for an oversized gas system that other parties have now departed. Such groups may be stuck with rising gas rates (departing customers and recovery costs) and an inability to electrify (high capital costs, etc.). Further, there are also concerns over intergenerational equity as future ratepayers could be saddled with the costs of investments in the gas system that are no longer used and useful and they receive no benefit from.

Customer Rates and Rate Shock – It is possible that a transition away from full utilization of existing gas infrastructure may increase costs experienced by existing gas ratepayers. Further, a political and human health risk exists that people may not be able to afford basic energy services, particularly if the cost increases do not happen gradually and/or support programs are not in place to ease the transition. As a result, it will be critical for the state to proactively manage costs and create opportunities for all utility customers to access affordable, clean and reliable service.

Utility Financial Health – Significant stranding of value and/or an uncoordinated and not deliberate transition in investments and business models can cause significant impact to the financial viability of utilities. At the highest level, there is a significant risk to the state's economy and health if the investor owned utilities fail because of this transition and interruptions or other serious disruptions to the provision of energy services occur.

Shareholder Value – Significant stranded investments may, and likely will, directly impact the return on investment for shareholders which can further decrease company viability and result in limited new or continued investment in the future as discussed below.

Investor Confidence in Gas Infrastructure – The prospect of asset stranding in the future has the potential to stymie investment now – depending on whether investors perceive this risk to be material, and whether they are adequately compensated for the risks they bear. While new investment in gas infrastructure will need to be tempered by a bright line approach aligned with decarbonization timelines (discussed below), as a result of the handling of current investments, investors in gas companies may be less inclined to loan capital for safety and maintenance, leakage reduction, and other short term investments in the gas infrastructure needed to maintain energy reliability, and support California's transition and decarbonization.[57] Additional capital will be required to overcome this risk perception.

Maintenance and Safety of Current Infrastructure – The transition away from utilizing gas infrastructure and towards electrification could increase the riskiness of future recovery by utilities with gas assets, which creates an operator incentive to defer maintenance as long as possible. Since many of California's gas utility problems have been trying to take a more risk-based and pro-active approach, the transition to stranded assets and encouraging more deferred maintenance may unintentionally create new safety concerns.

Risk of Path Dependent Investments – Fuel substitution to non-fossil fuels, while using the same infrastructure to deliver that fuel (e.g. delivering biomethane or hydrogen through existing gas lines) may be a strategy for specific end uses and as a transition measure coupled with targeted leak improvements (discussed below), but those investments, once made, may be difficult to pivot from, thus creating a path-dependency for the system as a whole.

[57] Aqua Consultants; frontier economics. (2016). Future Regulation of the UK Gas Grid - Impacts and institutional implications of UK gas grid future scenarios – a report for the CCC.

Who is Responsible for Stranded Assets?

A key consideration in the determination of which approach to use in response to the possibility of stranded assets is the issue of equitable distribution of responsibility and burden. It is important to determine which parties should be responsible for what specific burdens and risks caused by the transition and potential early retirement of the gas assets. To address this issue, a few key tensions are worth highlighting.

Current vs. Future Customers – One key tension exists between current and future customers. Depending on how solutions for stranded assets are structured, future consumers could be penalized by being required to contribute to the return of capital on a proportion of assets from which they do not derive benefits. This concern over intergenerational equity will be one of the key drivers for balancing proposed solutions.

Shareholders vs. Ratepayers – Another key tension exists between whether utility shareholders or ratepayers should be held responsible for the remaining costs associated with legacy investments. This tension is especially prevalent in the circumstance where investments are originally made in the public interest and shifts in state policy – even those supported by a majority of Californians and driven by the critical need to address climate change – are responsible for asset stranding. The extent to which costs and risks of stranded assets are a shared responsibility for shareholders and ratepayers will influence the outcome of matters concerning costs and the level of ambition for new investments by the utility, including investments in electrification, new renewables, and efficiency. The ability to finance new investments in California, and the perceived riskiness of those investments, will be a critical consideration for managing stranded asset risk.

It will be crucial for the state to help vulnerable customers participate in electrification or at the very least not be unfairly burdened.

High Income vs. Low-Income Customers – With high up front capital costs associated with some electrification strategies, some investments will likely be implemented by higher income communities and customers.[58] As a result, with a dwindling customer base in the gas system, large scale electrification may leave some lower income customers vulnerable to rising gas rates and no avenue to escape. As a result, a tension based on income and personal resources available to perform fuel substitution may increase over time, necessitating changes and expansions to public purpose programs to help vulnerable customers.

Gas vs. Electric Customers – If a gas customer goes all electric and leaves the system, the policy question remains of whether that customer is responsible for some portion of the remaining gas costs since the investments were in part made with the expectation of serving them. Just like an electric customer who departs the system for distributed generation, it is possible that gas customers who elect to electrify may need to pay an "exit fee". This creates the potential of a cross payment between gas and electric customers to leave non participating customers indifferent. Similarly, if the state pursues a pathway to mitigate the risk of stranded assets through something like securitization or accelerated depreciation as discussed below, those fees can and must be recovered from electric customers or gas customers.

[58] Efforts have been made to better target electrification opportunities for low-income communities. Most notably is the California Public Utilities Commission. (2018, December). R. 15-03-010 Order Instituting Rulemaking to Identify Disadvantaged Communities in the San Joaquin Valley and Analyze Economically Feasible Options to Increase Access to Affordable Energy in those Disadvantaged Communities and Southern California and Southern California Edison's Advice Letter 3951-E (2019, February) Proposal for a HPWH Demand Response Pilot in Disadvantaged Communities. The low income issue is also in scope of the Building Decarbonization Rulemaking, R.19-01-011.

If electrification is targeted more explicitly to drive benefits or minimize costs, risks of stranded value can be more effectively managed.

Combined Gas and Electric Utilities vs. Gas Only Utilities – It is likely that the issue of stranded assets and indeed the response to the risk will be substantially different for gas only utilities compared to combined utilities. In a combined utility like Pacific Gas & Electric Company (PG&E) or San Diego Gas & Electric Company (SDG&E), the issue of how to approach stranded assets may be different than the approach used by Southern California Gas Company (SoCalGas) or Southwestern Gas Company (Southwest Gas). California will need to consider if customers can cross subsidize each other within a company and across companies to mollify the effects of stranded assets.

Core vs. Non-Core Customers – Gas customers in California are split into two buckets: core customers and non-core customers. Core customers are residential and small commercial customers whereas large consumers like electric generation and industry are referred to as non-core customers. Even though core customers make up the vast majority of California's customer base they only accounted for about 1/3 of gas delivered in 2012.[59] However, much of the electrification efforts have been focused on core customers since industrial applications are more heterogeneous and require more precise controls of variables like heat and quality and are therefore likely to require more time and cost to switch.[60] If core customers begin to depart the gas system en masse, non-core customers could be faced with rapidly growing gas rates and no real immediate relief, creating a tension that could affect the desire to pursue electrification initiatives.

[59] California Public Utilities Commission. (2018). Natural Gas and California.
[60] Deason, J., Wei, M., Leventis, G., Smith, S., & Schwartz, L. (2018). Electrification of buildings and industry in the United States - Drivers, barriers, prospects, and policy approaches. Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory.

Pathways for Mitigating Risk and Impact of Stranded Assets in the California Gas System

Due to the numerous tensions and implications associated with stranding new and existing assets in California, it is critical for the state to proactively evaluate, manage and mitigate the risks associated with stranded assets in the California gas system. Through this effort, it may be necessary for California to develop smoother revenue paths for utilities and more stable pricing outcomes for consumers.

Four main pathways are presented and explored in more detail individually below:

1. Strategic targeting of electrification
2. Developing pathways to pay for early retirement
3. Decommissioning
4. Alternative uses of existing assets

The discussion and diagrams that follow are provided to illustrate the mechanics and considerations of various solutions rather than provide any prescriptive outcomes. There are several critical unknowns that would need to be addressed in order to compare solutions more deterministically including the asset values and recovery timelines, projected timelines and geographies for electrification, and demand thresholds for "used and useful" as identified above. With additional data on these and other issues, a more comprehensive economic analysis can and should be conducted to advise strategy development in California.

Strategic Targeting of Electrification Efforts

Perhaps the first opportunity for proactively managing the risk of stranded assets from building electrification is to strategically plan and target electrification efforts in the state. Given the relative nascence of electrification in California, the current approach has been to encourage any and all electrification as a vehicle for creating new markets and momentum in the sector. While necessary in the short term, as the state approaches higher levels of electrification a more deliberate approach to electrification efforts may be needed to take stranded assets risk and/or mitigation strategies into account. In doing so, the state could direct both the electric and gas utilities to coordinate neighborhood electrification and optimize for the best "bang for the buck" to minimize the impacts of stranded assets. This coordination could be prioritized in several ways, such as the vintage of the gas infrastructure, the average cost to electrify by neighborhood, and the reduction in local air pollution.

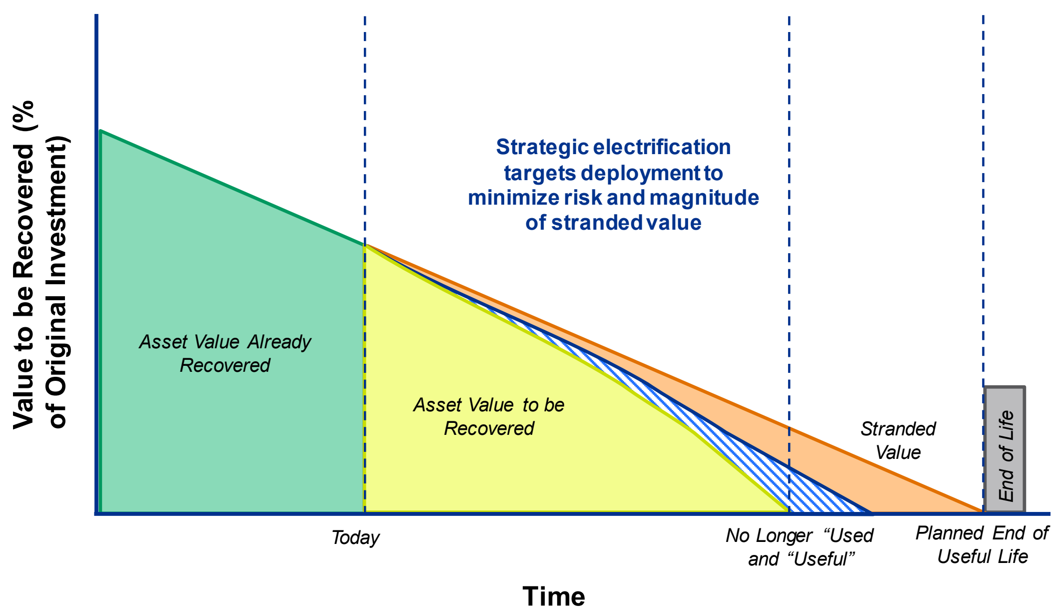
By way of example, if electrification occurs on a house-by-house basis, both gas pipelines and electricity lines in a neighborhood will be maintained and benefits from electrification could take longer to manifest. The state could therefore miss critical opportunities for market and grid transformation. There may be better bang for the buck to push to electrify entire blocks or subdivisions, both from a marketing perspective and from deployment of grid infrastructure. If however, electrification is targeted more explicitly to drive grid and customer benefits or minimize customer and grid costs, risks of stranded assets can be more effectively managed.

To this end, the state could develop a set of criteria for targeting marketing, education, and outreach, incentives, and pilots to ensure a more coordinated rollout of electrification that helps to lessen the impact of potential stranded assets while driving additional value for consumers and the state. These criteria will need to balance various stakeholder concerns, but some ideas on where to focus efforts include areas where:

- Gas assets are the most costly to maintain (benefits of decommissioning the lines are high)
- Gas assets require a substantial new investment which can be deferred if demand on the line is reduced due to electrification (avoids future investment)
- Gas assets are the oldest or closest to their end of useful life (least impact at stake for stranding)
- Gas assets are least valuable (magnitude of stranded asset risk)
- Decommissioning costs are likely to be lower (end of life costs)
- Throughput/number of customers is small (easiest to drive down demand for the asset)
- Throughput/number of customers is large (most GHG benefit)
- Large scale electrification efforts are planned or underway
- Gas assets that are the most leaky (methane reduction benefit)
- High concentration of a particular type of customer or sector (balancing core vs. non-core risk and actually driving decommissioning)
- High concentration of customers vulnerable to being left behind in the transition or at risk of holding the bag in the end (equity)

Many of these approaches will have tradeoffs or implications for the risks of stranded assets. Some of them will be mutually exclusive, but in reality, the state will likely end up needing to adopt a mix of criteria. Regardless, the point remains that the state can more strategically approach electrification and influence the magnitude and risk of stranded assets. In the stranded assets diagram, depending on how this strategy is implemented, the magnitude and timeline for stranded asset risks will be changed (Figure 4). This reduction or change is highlighted in the figure with the blue hashed area.

Figure 4
Strategic Targeting of Electrification Efforts



To be successful in a program that targets infrastructure replacement to minimize the risk of stranded assets, there needs to be transparency and trust in both investment and infrastructure data, as well as a coordinated criteria selection and prioritization process. At present however, while a centralized management of asset deployment is something that California has endeavored to execute with some of its Distributed Energy Resource (DER) deployments in prior CPUC proceedings, the necessary level of transparency does not yet exist. Further, it is unclear where the legislative pathway for this strategic deployment lies, but it is possible that funding from SB 1477 or ratepayer funding designed from the CPUC in its building Decarbonization efforts (R.19-01-011) could be utilized to develop a more cohesive framework.

Developing Pathways to Pay for Early Retirement

If gas assets are deemed no longer "used and useful" before the end of their planned life, creative financing strategies will need to be developed and deployed. These financing strategies are necessary in order to minimize and mitigate the economic and political risks from potential stranded assets. These strategies will vary in how they allocate and balance costs and risks to a variety of different groups (i.e. ratepayers vs. shareholders and the future vs. the present as discussed above).

Although there may be a variety of pathways to mitigate the risk of stranded assets associated with declining utilization of gas, a few key options – securitization, accelerated depreciation, changes to return on equity, and disallowance of recovery – are explored in detail below. This paper focuses on those options which have received the most treatment in the literature or because there is a history of employing them in California.

Securitization

Securitization is attractive because it minimizes shareholder exposure and it also results in lower costs to ratepayers

Securitization is the issuance of ratepayer backed bonds to recover stranded costs. California has employed securitization in a variety of applications, most notably during the deregulation of electric markets in the late 1990s. The choice to deregulate the electric industry had the direct consequence of rendering many electric utility assets uneconomic to operate due to decreases in revenues.

In theory, the valuation of ratepayer backed bonds should be related to the remaining value of the existing asset, such that ratepayers will save money in recovery when compared to traditional recovery via customer rates. When the bond is issued, the utility no longer earns a rate of return on the asset, and the primary customer savings comes from the difference between the authorized cost of capital and the interest rate attached to the bond. Given the relatively large spread between the authorized Return on Equity compared to the prevailing cost of debt, these savings could be significant. Securitization requires legislative action to authorize utilities to charge ratepayers a fee (often referred to as a transition property) to recover the costs associated with their stranded assets. The legislature then creates a special entity, sometimes referred to as a bankruptcy-remote entity[61] or a Special Purpose Vehicle (SPV) that issues ratepayer bonds and sells them to investors using the proceeds to buy out the stranded assets and move them out of rate base. Because the ratepayer backed bonds are more secure, the bonds require less interest (even compared to other forms of debt). The SPV then collects the authorized fees from ratepayers in order to pay back the bond investors.[62,63]

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[61] A bankruptcy remote entity is formed to protect assets from being administered as property of a bankruptcy estate. Bankruptcy remote entities are intended to separate the credit quality of assets upon which financing is based from the credit and bankruptcy risks of the entities involved in the financing. Essentially a legal firewall between the finances of a specific set of assets and the utility itself to reduce the risk of lost value due to bankruptcy.

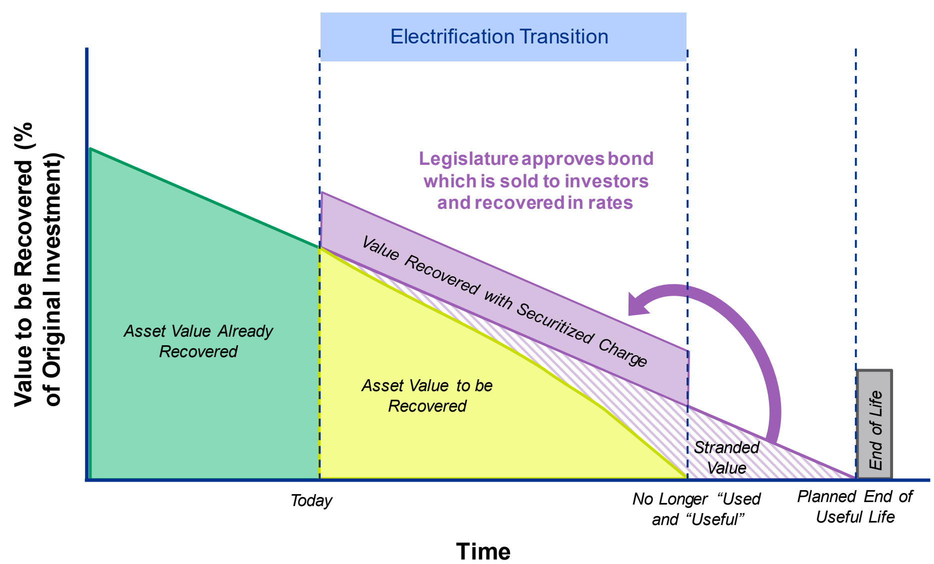
[62] Blake, K. (2003). Rate Reduction Bonds - A diversifying asset class.

[63] California Public Utilities Commission. (2012). Trends in Utility Infrastructure Financing.

Securitization provides upfront recovery of capital for the utilities and potentially allows them to refinance and make new investments better aligned with public policy objectives benefits for both the utility and its customers.[64] In addition, this type of financing preserves utility credit and lessens the pressure to issue additional equity.[65] The assets are however removed from rate base which disallows utilities from receiving a rate of return on the asset. Thus shareholders will no longer earn a profit on the asset, but they will not absorb remaining costs either. Securitization is attractive because it minimizes shareholder exposure and it also results in lower costs to ratepayers because they are only paying for the debt cost – which is lower because of the lower interest rates on securitized debt – rather than debt cost and rate of return.[66] Further, securitization can be applied equitably across all ratepayers in the state rather than needing to be targeted to a specific subset (i.e. gas ratepayers). This can potentially help alleviate some of the concerns over risk and burden sharing outlined above. California has had past experience with utility securitization for all three of its utilities. For example, in 1997[67] the CPUC allowed SCE, SDG&E, and PG&E to recover $7.3 billion in transition costs authorized by AB 1890 as part of the transition from deregulation.[68]

In the stranded assets diagram, securitization essentially spreads out the stranded value over the new "used and useful" life (Figure 5). The value of the area requires a determination of the remaining value, number of customers and vintage of the investment. Since the ratepayer backed bond has been securitized, the value of the purple area is less than the book value of the original orange area and ratepayers are saving money over time even if there is a near term rate increase. The Commission will need to establish timelines for securitization and a bright line for what value is included in that package, but for illustrative purposes securitization in Figure 5 is shown covering the full stranded value gap. In reality the securitization timeline is likely to be set at some point in the future, so the value recovered (purple area) would be smaller and shifted forward. It should be noted that the solid purple area should in theory be less than the stranded asset value, since the revenues yielded from securitization have ratepayer savings from avoided future payments of utility profits.

Figure 5
Recovery of Stranded Value through Securitization



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[64] Rocky Mountain Institute. (2018). Navigating Utility Business Model Reform.
[65] Morgan Lewis. (2010). New Uses for Utility Securitization Bonds in the Absence of Traditional Rate Recovery.
[66] California Public Utilities Commission. (2012). Trends in Utility Infrastructure Financing.
[67] See D.97-09- 057, D.97-09-56, and D.97-09-055
[68] California Public Utilities Commission. (2012). Trends in Utility Infrastructure Financing.

Accelerated Depreciation

Accelerated depreciation is a way to minimize investor and ratepayer risk and large rate shocks in the future by paying off an asset and removing it from rate base in advance of its intended end of life. Traditionally, the value of the asset is depreciated over its expected useful life to maximize ratepayer value and minimize rate impacts. Accelerating depreciation acknowledges that the end of useful life will be sooner, and result in a rate increase for customers in the short term but shortens the rate obligation associated with the asset.

Accelerated depreciation can better manage cost recovery risks by bringing forward recovery where appropriate.

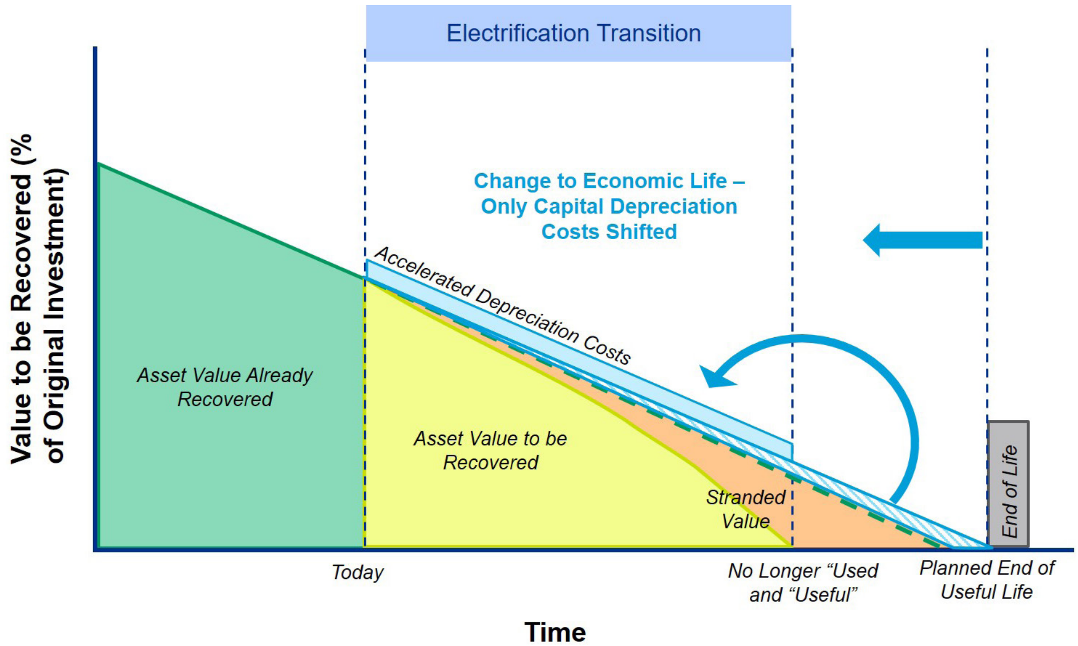
In the case of accelerated depreciation, regulators can approve, and require, changes to the depreciation schedules of capital investments or assets allowing utilities to pay off depreciation expenses earlier than initially planned. Accelerated depreciation can better manage cost recovery risks by addressing the back-loading of depreciation under current models and approaches, bringing forward recovery where appropriate, or allowing scope for the deferral of the return of capital across multiple regulatory periods, such as general rate cases. Shareholders continue to earn profit during the accelerated period, and ratepayers may save some money in the long run in exchange for higher rates in the near term.

Accelerated depreciation can effectively limit the magnitude and duration of the stranded value. However, since capital depreciation costs only represent a portion of the delivery cost of gas, particularly compared to the operations and maintenance costs, the strategy is not likely to address the full stranded value. Using accelerated depreciation could however be paired with other strategies to more effectively manage the full risk. Accelerating the depreciation of the asset is only paid for by the remaining active customers; customers who have departed the system do not pay the costs and do not experience the rate increases associated with this ratemaking adjustment.

In the diagram (Figure 6), accelerated depreciation shifts the end of economic life earlier and the value shifted will includes the depreciation costs. As a result, the blue area is less than the orange area because it only addresses depreciation costs and not the full stranded value.

This option helps address the issue of intergenerational equity between current and future gas ratepayers. If current ratepayers are expected to use the infrastructure more intensively than future ratepayers are likely to, current customers should pay relatively more than future customers. Since current ratepayers are also making the decision to shift away from the gas asset, they in theory have more direct responsibility than future ratepayers. Accelerated depreciation contributes towards intergenerational equity because it avoids future ratepayers bearing an undue proportion of costs for services which they do not or did not derive benefits from, and instead provides for the recovery of the costs of assets from their beneficiaries.

Figure 6
Accelerated Depreciation



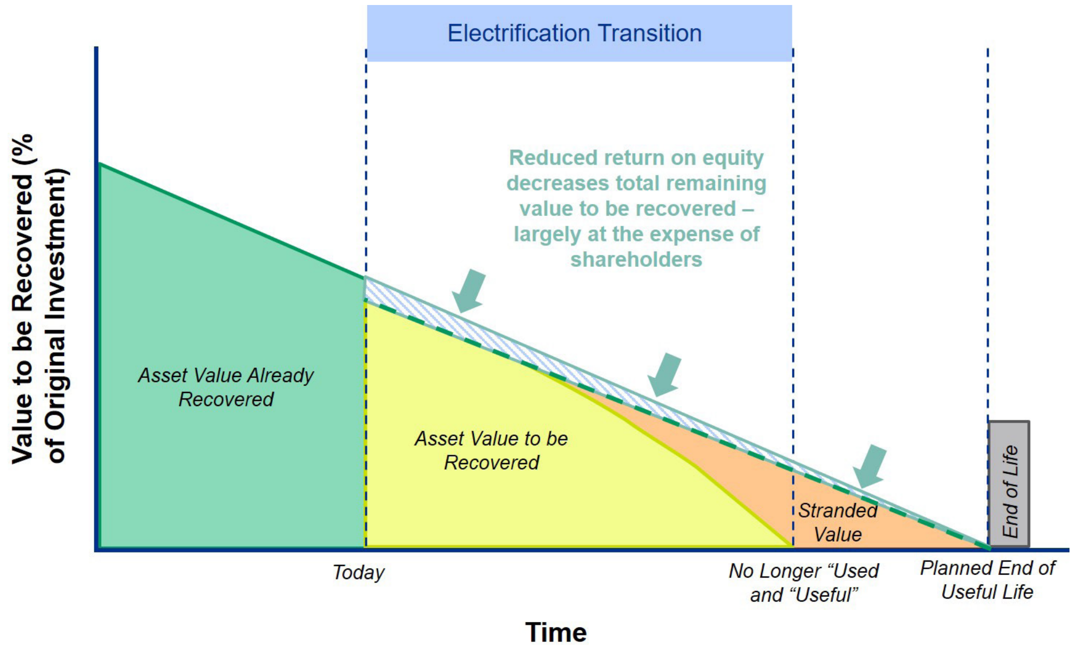
Changes to Return on Equity

Another possible avenue is changing the return on equity allowed for a specific asset. This reduces the total potential stranded value by reducing the overall remaining value for this asset. In California, the CPUC generally does not impose a reduction in return on equity for concerns of increasing perceived investment risk. However, reductions in return on equity do occur as a coordinated piece of a larger solution set, often through settlement agreements.[69] For example, this strategy has been employed previously by the CPUC in the San Onofre Nuclear Generating Station (SONGS) proceedings, where return on equity was reduced by 10% as part of a settlement resulting from the facility's premature unexpected shutdown. As demonstrated in accepting the SONGS settlement agreement, the CPUC would be willing to accept a reduction in the return on equity as part of a settlement package, most likely because the utility has agreed to the reduction. Investor confidence can be maintained that the settlement is a better option compared to the other possibilities and the reduction in the return on equity reduces other regulatory uncertainty.

In the diagram, lowering the return on equity shifts the slope of the recovery triangle for the remaining asset life and reduces overall stranded value (Figure 7). As indicated above, since building decarbonization is a new policy area, it is unlikely that the CPUC would impose a reduction on the return on equity on the utility to ameliorate stranded assets. However, the CPUC could re-consider reconsider the return on equity prospectively. The CPUC routinely reviews the electric and gas utilities in separate "cost of capital" proceedings and this may be an appropriate forum to discuss stranded asset risks. The state could prospectively lower the gas utility's overall return on equity to make future investments in gas look less attractive than present trends. Currently, the authorized return on equity for (all gas utility) SoCalGas is lower than Southern California Edison (all electric) and this trend may continue.

[69] Investors tend to look upon settlement agreements differently and the same concerns of investment risk do not apply.

Figure 7
Reduced Return on Equity



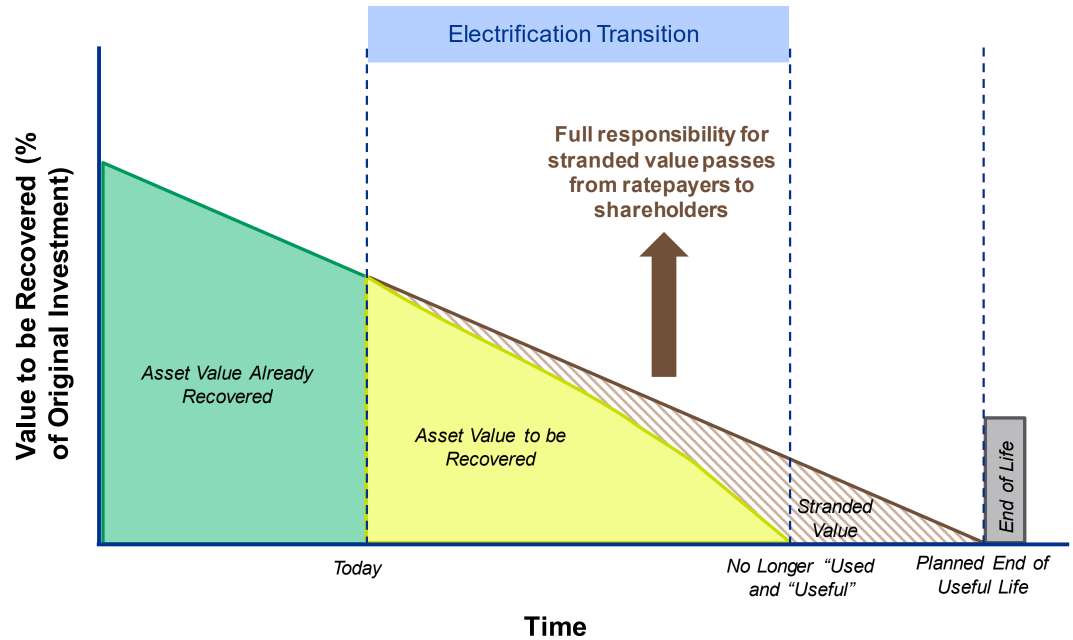
Disallowance of Recovery

On an extreme end of the spectrum, the CPUC could prohibit gas utilities from continuing to recover all or part of the stranded assets from ratepayers. The result would be holding the gas utilities and their shareholders responsible for all remaining costs of the gas assets, including both the foregone revenue and the write-offs.

Recovery disallowance typically occurs in instances when the utility has acted imprudently. As discussed above, the prudent manager test is a critical for consideration of disallowance. For example, if the utility had caused the asset to become stranded because it acted in a way to benefit shareholders and render the line unable to meet the "used and useful" standard.

For the purposes of building electrification, the state has made a policy choice exogenous to the utility's actions. Therefore, given the ratemaking background outlined above, total disallowance of all stranded assets is highly unlikely to be a viable strategy. At the time many of the investments in the gas infrastructure were made, the state had not established its low carbon policy goals, so the financial risks from these imposed transitions were not understood or indeed even present. Seeking no recovery of these stranded assets could be seen as a changing of the goal posts, causing a reduction in investor confidence going forward. In the diagram, a recovery disallowance strategy essentially transfers the burden of paying for the stranded asset values from ratepayers to companies and their shareholders (Figure 8). The orange area from Figure 3 is now shareholder responsibility.

Figure 8
Disallowance of Recovery



While disallowance is not likely to be a viable approach for existing assets, a variation of this strategy could be employed for future investments in the form of a mandate for departure from gas investment after a certain date. It could be argued that after a certain period of time that is mutually agreed upon and based on the state's public policy goals, the gas utility shareholders should have sufficient information on risks available and future investments would no longer be prudent. The CPUC may want to create a "bright line" (or stakeholders may argue that the legislature created one already with the passage of SB 1477). This "bright line" designation creates a threshold, after which any future investment could be put at risk since there is now new information available to the utility that should influence its decision making. This cut off of investments would most likely not include those needed for safety or to maintain the system reliably but would be limited to expansion of new service connections.

Other Mechanisms

There are a number of other financial mechanisms that this paper could consider for remedying with the financial consequences of stranded assets including[70]:

- State takeover of the assets and write-off of the investment
- Offers of alternative revenues streams to soften the impact
- Alternative depreciation models (i.e. Sum of Years Digits, Double Declining Balance)
- Compulsory rates for network access
- Direct payments from government entities paying utilities to close or retire assets

Many of these strategies will have more difficulty overcoming political and consumer acceptance barriers. While they are theoretically possible, they may not be immediately viable in the present California context. Other states may consider these options as viable and may want to consider them using the framework provided in this paper.

[70] Rocky Mountain Institute. (2018). Managing the Coal Capital Transition.

Ilustrative Comparison of Mechanisms

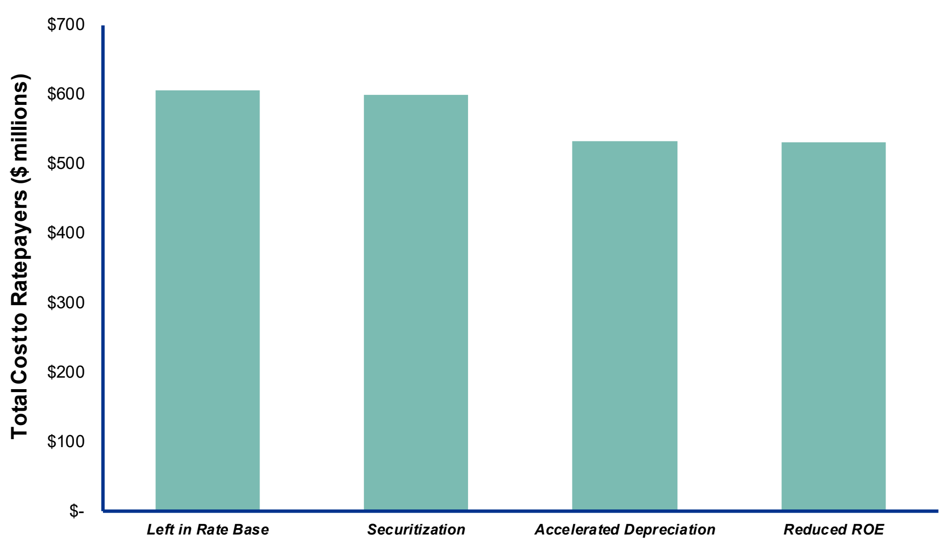
As explored above, applying the three main mechanisms (securitization, accelerated depreciation, and reduced return on equity) for financing the early retirement of assets, allows stakeholders to assess key tradeoffs in overall costs to ratepayers as well as the rate impact in individual years (some approaches may lead to more rate shock than others).

While the absolute savings to ratepayers and actual rate impacts will be wholly contingent on key assumptions like the accelerated depreciation schedule, the new Return on Equity (ROE), and the specific bond characteristics, it is important for stakeholders to be able to transparently discuss these parameters to find the most cost effective and equitable solution – or mix of solutions more likely – for the issue of stranded assets. To that end, an illustrative comparison of costs to ratepayers for a hypothetical asset with the following characteristics was developed below (Figure 9):

- **Valuation:** $1 billion
- **Planned useful life:** 40 years
- **Actual useful life:** 25 years (stranded 15 years early)
- **Current age:** 10 years
- **Depreciation type:** Straight line
- **Debt to equity split:** 50-50 debt/equity funded
- **Rate of return (debt):** 5.77%[71]
- **Rate of return (equity):** 10.10%[72]
- **Rate of return (aggregate):** 7.94%
- **Depreciation costs proportion of total value:** 20%
- **Decommissioning Costs:** $100 million

In addition to just the pure cost comparisons, other factors like equity and other risks as discussed above should also be leveraged for comparing solutions.

Figure 9
Illustrative Comparison of Financing Mechanisms for Stranded Assets



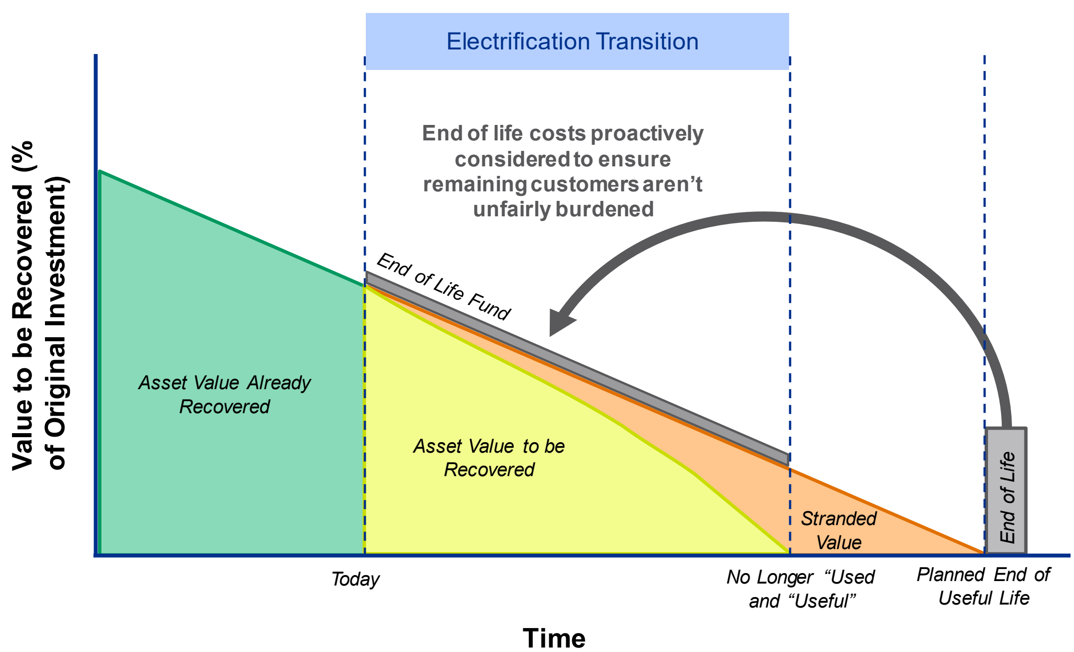
[71] Application of Southern California Edison Company (U338E) for Authority to Establish Its Authorized Cost of Capital for Utility Operations for 2013 and to Reset the Annual Cost of Capital Adjustment Mechanism., D.12-12-034.
[72] Application of Southern California Edison Company (U338E) for Authority to Establish Its Authorized Cost of Capital for Utility Operations for 2013 and to Reset the Annual Cost of Capital Adjustment Mechanism., D.12-12-034.

Paying for Decommissioning

Regardless of the strategy or mix of strategies utilized to mitigate and manage the risks of stranded assets, it will be critical to proactively be planning for the end of life costs for those gas assets that are not going to be replaced or retrofitted for continued operation after their useful life. This includes, for example, the costs to decommission, depressurize, seal, and cap those assets remaining in ground, and potentially the costs of removing assets entirely. The cost to decommission a system becomes more relevant to plan for now with electrification, since the customer base is shifting from gas customers to electric customers. Separate from the cost of the existing value of the system is the cost to the remaining customers to decommission the system. It may be prudent to cost-share decommissioning costs with electric customers or some other source of funds rather than requiring the remaining gas customers to fully decommission the assets once they reach the end of its useful life.

In the diagram, these decommissioning costs occur after useful life, but will likely need to be spread out through the useful life in order to minimize ratepayer and system risks (Figure 10). For example, a fund or line item could be established to help spread the costs of decommissioning over a longer time period and more customers. This strategy should happen in a targeted manner in coordination with the prioritization efforts described above. Planning for decommissioning costs should be a consideration when selecting strategies on stranded assets, since the timeline may impact rate increases and the overall affordability concerns.

Figure 10
Planning for Decomissioning Costs



Mostly, as observed in the past, decommissioning costs will need to be collected from ratepayers in California. Accordingly there are a few key action steps, and associated options, for the state to pursue.

First, the magnitude of decommissioning costs needs to be estimated in accordance with whatever policy change will result in the retirement of existing assets. With these estimates, one option the state could pursue is to allow the decommissioning costs for the gas infrastructure to be embedded "behind the scenes" of a customer's bill by including the costs as part of distribution system costs. A second option is to create a specific non-bypassable line item on customers' bills for the gas decommissioning costs akin to what has been done previously with the Nuclear Decommissioning Charge [73,74] and the Department of Water Resources Bond Charge.[75,76] Another related opportunity could be the establishment of a trust fund – funded by rates and grown over time through managed wealth. Since it is being accelerated and compounded by the need to mitigate climate change impacts through state policy, non-gas utility ratepayer funds (or tax funds in general) may be appropriate.

Alternative Uses of Existing Assets

Another approach to avoiding the creation of stranded assets that is being explored – mostly by the owners of gas assets themselves – is continuing to utilize the existing gas infrastructure with new lower carbon fuels, particularly biomethane and hydrogen, as an alternative to traditional fossil gas. The state would need to deem these fuels as central to its building decarbonization strategy.

At the highest level, utilizing alternative fuels like hydrogen and biomethane within the existing gas system can reduce or otherwise eliminate the risk of stranded assets by providing additional "useful life" – albeit with a different intended fuel and at substantial additional cost. By example, investing in needed upgrades to support hydrogen or biomethane potentially extends the actual useful life back out to the original economic life (the new investments could also extend useful life further). However, since it takes potentially significant investment, this strategy increases the total amount of value that needs to be recovered. For illustrative purposes, the solution is shown to cover the whole gap from Figure 3, but how much of the value and its interaction with electrification and other solutions will need to be determined.

While the dynamics of biomethane and hydrogen in the stranded assets diagram are similar, their opportunities and challenges should be viewed separately. The California IEPR identified that biomethane applications for decarbonizing buildings are likely to be constrained by limitations on fuel availability, cost, and ongoing methane leakage concerns.[77] Given this, however, there may still be some viable applications for biomethane as a short term transition fuel to minimize stranded asset risk. Deployment of biomethane may also address certain equity issues, such as when customers are unable able to electrify because of building configuration, cost, etc. Biomethane may allow customers who will have trouble electrifying in the short term (i.e. renters who may be faced with a split incentive challenge if their landlord does not want to or cannot electrify) to still reduce the GHG impacts from their building energy use while policy and programs are being developed to provide a longer term solution. Biomethane may also be an important strategy for when electrification is not practical, such as industrial applications where heat is required and electrification is not practical.

For hydrogen, there is potential for it to fill a longer term role in the electricity system, particularly with regards to season to season storage of renewables. For example, instead of curtailing excess renewable generation, that energy could produce hydrogen which can be deployed in a later

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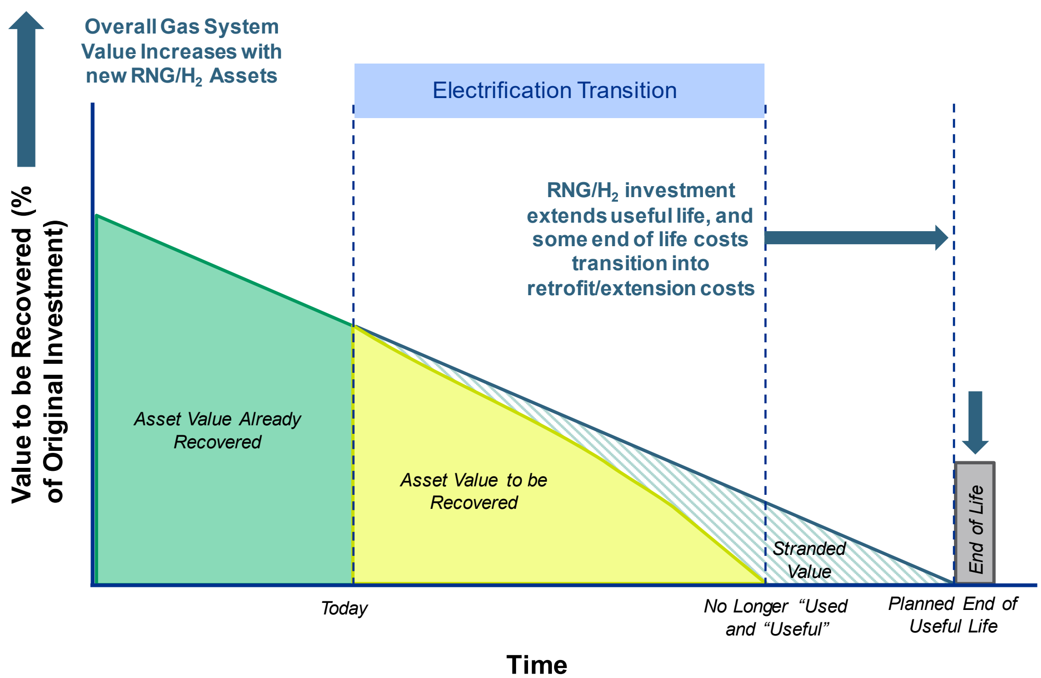
[73] California Public Utilities Code. (n.d.). PUC § 8325.
[74] California Public Utilities Code. (n.d.). PUC § 8326.
[75] California Public Utilities Code. (n.d.). PUC § 360.5.
[76] California Water Code. (n.d.). WAT § 80200.
[77] California Energy Commission. (2019). Final 2018 Integrated Energy Policy Report Update - Volume II.

season when less renewable energy is available. In California, with the expanded need for turbine generation technology to match the "ramp" of solar generation, hydrogen could be used as a substitute fuel for traditional gas that still allows for this ramping product to be available. Given present high costs and concerns with regards to safety and injection thresholds, combustion and other characteristics (maximum allowable operating pressures, corrosiveness, burn rate, heat quality, injection needs, etc.), and appliance compatibility, deployment of hydrogen is likely to be developed over time. Consideration of hydrogen from a stranded assets perspective should be for longer term assets, but should not impede other cost-effective solutions, like electrification in the meantime.[78,79,80] Like biomethane, hydrogen is a potential option for addressing GHG emissions from hard to electrify applications like industrial processes if the combustion and other characteristics can be aligned safely.

Regardless of fuel, to the extent that this "alternative uses" strategy is deployed for specific geographies or end uses, it will be critical to target those areas of the gas system with deliberate leak reduction retrofits both for safety (particularly with hydrogen) and to mitigate the impact of short term climate pollutants (particularly for biomethane). Further, as identified, a critical piece for both fuels is determining how much this strategy can be modular and utilized for specific applications, like industry, and as a short term decarbonization option rather than a more path dependent "all or nothing" solution.

As demonstrated in Figure 11, additional analysis is needed to ascertain whether or not this is a viable strategy. A brief overview and description of some of the logistical challenges and opportunities for both biomethane and hydrogen is provided in Annex 2.

Figure 11
Finding Alternative Uses for Gas Assets



[78] de Santoli, L., Paiolo, R., & Lo Basso, G. (2017). An overview on safety issues related to hydrogen and methane blend applications in domestic and industrial use. Energy Procedia.
[79] International Energy Agency. (2015). Technology Roadmap: Hydrogen and Fuel Cells.
[80] NREL. (2013). Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues.

What about new investments?

To this point, the solutions discussed in this paper have primarily focused on how to manage the asset risk for existing investments and infrastructure, but to drive an effective transition the state also needs to proactively address planned and future investments. It is clear that some level of continued investment will be required to maintain the integrity of the existing system and provide critical safety and operations retrofits to meet the declining, but continued demand for gas. However, what level of investment is required and what level is prudent given the rapidly evolving risk of stranding those assets. It is also clear that the state will need to establish a clear investment evaluation framework to provide for continued operations and safety, an effective transition, and investor confidence.

It is clear that some level of continued investment will be required to meet the declining, but continued demand for gas without jeopardizing public health and the grid.

A first step towards this is establishing clear and actionable criteria or a "bright line" for determining when investments are more at risk of being stranded and for determining which stakeholders, particularly which ratepayers are responsible for specific costs and for how long. For example, one bright line may be set to determine that departing gas customers are responsible for paying for their share of gas infrastructure investment costs up until a certain point in time and then that burden can no longer be allocated to them. This could be akin to the Competitive Transition Charge that was utilized to pay for stranded assets that resulted from California's deregulation of the power sector.

In the same vein as a bright line approach, clear mandates and targets for the transition away from gas can provide investment certainty and a transition timeline for utilities and other actors. Such mandates could take the form of electrification requirements or targets similar to the California Title 24 requirements for solar that require all new homes to be equipped with solar generation. It is unknown whether requiring all-electric new developments will help to drive down the current stranded assets issues as it will likely be for infill development, but it can at least not make the issue worse. Restrictions on certain types of technology creates a ratcheting down of recoverable value for gas investments over time while effectively creating a codified understanding of investment risk for investors.

One approach to new investments that has been pursued in the Federal context is tying recovery for new gas infrastructure to climate policy – such that no recovery can be obtained after a date certain unless certain characteristics exist. In stakeholder filings at the Federal Energy Regulatory Commission (FERC) for Certification of New Gas Facilities[81], EDF highlights the need for more robust evidence for the proposed economic useful lives of gas assets, particularly those in excess of 35 years. This documentation should include, among other things, an assessment of whether alternative energy resources are likely to offer a viable competitive substitute for gas over the proposed economic life of the pipeline.

This approach aligns with the idea of directly tying economic/useful life of gas infrastructure to California's policy and market initiatives (i.e. aligning gas investment timelines with the timelines of state climate and renewable energy goals). In furtherance of this approach, California could require similar documentation and justification since there are pipelines in the state owned by non-utilities that will need to seek Federal remedies in response to state policy actions. For each state, a declaration of a "bright line" that is tied to its policy objectives will be critical for appropriately allocating costs for future investments onto the appropriate mixture of customers. The framework provided throughout this paper could be useful to help determine the appropriate outcome for customer equity, shareholder certainty, and other key considerations.

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[81] Docket No. PL18-1-000

Investment Evaluation Framework and Next Steps

The above discussion highlights the need to develop a methodology for both dealing with existing gas investments and future investments strategically by taking into account data discussed throughout this report like investment value, recovery timelines, depreciation schedules, and their interactions in time and space with expected electrification for both individual assets and the system as a whole. If California is able to collect, synthesize, and overlay the needed data effectively, a framework can be envisioned in which different solutions for stranded assets are evaluated and deployed for different assets in different geographies, and on different timelines (i.e. assets that have little expected risk of stranded value) to drive cost-effectiveness in support of California's policy goals compared to the status quo. The criterion for this decision making will of course need to be established and balanced by policymakers, but it allows for more effective consideration of potential risk and burden as well as equity across different groups of stakeholders.

While this report focused on California, stranded assets is likely to be an issue faced by other states as well, particularly those pursuing ambitious climate goals. The mix of available mechanisms to address the issue are likely to be similar across different geographies, but pieces like the definition and handling of "used and useful", the availability of gas investment data, the pace and targeting of electrification, and past regulatory precedents for utility assets are likely to vary for each state. California may be a model for developing a more strategic conversation and framework for addressing stranded assets resulting from decarbonization. To that end, an effective next step for supporting future work on this issue would be to conduct a more comparative study that looks at the needed data streams and context across states.

Conclusion

A proactive and coordinated strategy will need to be developed to ensure a cost effective, equitable, and politically viable transition for all stakeholders.

This paper seeks to play a convening role and ensure that individual stakeholders and the state as a whole recognize the value of early, proactive, and coordinated discussions around the issue of stranded assets in the gas system as California undergoes the critical large scale transition away from fossil fuels in order to meet climate goals.

At this stage, the scope, magnitude, and timeline of the stranded assets issue and importantly its solutions are still developing for stakeholders in California's energy landscape. It is therefore important for California to develop an effective forum and utilize a transparent framework for systematically evaluating and responding to the issue of stranded assets to allow for long planning horizons to improve cost effectiveness over time. Accordingly, a principle recommendation from this paper is the need to develop a more strategic consideration of the transition issue for the gas industry. Initially, this is most likely going to need to happen through a specific CPUC proceeding and/or focused legislative effort.

California has made prudent investments into its gas infrastructure over the last 100 years. However, if California is to be successful in achieving its necessary and ambitious decarbonization goals, a proactive and coordinated strategy will need to be developed to ensure a cost effective, equitable, and politically viable transition away from gas infrastructure for all stakeholders. Such financial solutions need to be transparent to investors, the rate changes need to remain affordable to customers, and the state needs to have confidence that this is a smooth transition.

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Appendix 1: CPUC Case Studies for Stranded Assets

Table 3

CPUC Decisions Relevant to "Used and Useful" and Treatment of Stranded Assets

DECISION	UTILITY – ASSET(S)	STRANDED VALUE – RATIONALE	COST RECOVERY	RATE BASE	TIME FRAME	DECISION FACTORS
D.92497 (12/5/1980)	SCG - Coal Gasification Plant	$9.7 million - Unable to secure loan and cwlear lease; project never came into operation	SoCal recovers $8.315 million of prudently incurred expenses exclusive of AFUDC; overall, ratepayers pay 74.22% and shareholders pay 25.78% of all stranded costs	No rate base treatment	4 Years	Commission encouraged undertaking the project, costs were prudent, energy shortage placed high priority on new fuel sources
D.83-08-031 (8/3/1983)	Pacific Telephone and Telegraph Company- Digital "Customer Premesis Equipment"	$19–95.7 million (Estimated) - Technology improvements and migration/marketing strategy employed by the utility	Recovery of stranded value not resulting from migration strategy; no recovery of stranded value due to migration strategy	Removal of $19M from rate base, overall increase in annual revenue allowance of $45M	—	Commission considered technology trends in the years prior, impact on retirement timelines for equipment groups, merits and shortfalls of the group accounting approach, and the utilities own migration/marketing strategy
D.84-05-100 (5/16/1984)	SCG & PG&E -Liquefied Natural Gas Project	$133.7 million - Carrying the costs of the project became an intolerable burden	Abandoning the project (recover a percentage of the costs in rates over 4 years) or placing the cost of the site in rate base as Plant Held for Future Use for a maximum of 3 years	No rate base treatment if project was abandoned	4 Years	The Liquefied Natural Gas Project was developed during a period of great uncertainty regarding the availability of energy resources in the US after the 1973 oil embargo.
D.85-08-046 (8/21/1985)	PG&E - Humboldt Bay power plant Unit 3	$88 million - The Nuclear Regulatory Commission (NRC) made modifications to plant's operating license that prevented it from operating	PG&E recovers $54 million of prudently incurred expenses exclusive of AFUDC	No rate base treatment	4 years	The ratepayer is responsible for the plant's direct cost even though the plant retired prematurely. The shareholder should recover the investment but should not receive a return on the remaining undepreciated plant.
D.85-12-108 (12/20/1985)	SDG&E - Encina 1 and South Bay 3 power plants	The utility could obtain energy costs savings if both plants were put in 'storage'	Encina 1: the undepreciated balance would be amortized over five years with no return earned. South Bay 3: Remain in rate base as Plant Held for Future Use	Encina 1: removed from rate base; South Bay 3: remain in base rate	5 Years (Encina 1)	The Commission considered 2 things when deciding to keep South Bay 3: 1. 'the uncertain reliability inherent in SDG&E's resource plan' and 2. South Bay 3 was 'the most economical of the stored plants'
D.89-12-057 (12/20/1989)	PG&E - Various	$3.97 million - Varies	No cost recovery	n/a	n/a	PG&E has not demonstrated that abandonment was the product of a period of great uncertainty
D.92-08-036 (8/11/1992) D.95-12-063 (1/10/1996)	SCE/ SDG&E - San Onofre Nuclear Generating Station Unit 1	$460 million - Outages & low capacity factor leading to high costs	Recovery of all unamortized investment	—	4 Years	Utilities permitted to generate a low rate of return to reflect the time and risk of recovery Risk of recovering stranded assets reduced through "non-bypassable charge on distribution customers"
D.92-12-057 (12/16/1992)	PG&E - Geothermal Plant (Geyser 15) and Steam Payments	$5.03 million (Steam payments) $30.2 million (Undepreciated plant) - Issues with quality and quantity of steam procurement	Recovery of unamortized investment; no recovery for steam payments	$30.2 undepreciated asset removed from rate base	4 Years	Unit will never operate again and so cannot be considered useful; no precedent for group accounting argument
D.96-01-011 (1/10/1996)	SCE/SDG&E - San Onofre Nuclear Generating Station Units 2 & 3	$3,461 million - Shut down for low-level radioactive leak; never reopened	Recovery of all unamortized investment	—	8 Years	Consistent with precedent set in SONGS 1, above
D.11-05-018 (5/5/2011)	PG&E - Smart-Meters	$341 million - Replacing electromechanical meters with SmartMeters at encouragement of CPUC	Recovery of all unamortized investment	—	6 Years	Reduction in equity rate reflects reduced regulatory risk; Equity rate above debt rate reflects incentive to make investments with public benefits

Appendix 2: Overview of Biomethane and Hydrogen

Biomethane

Biomethane, also known as renewable natural gas, is a substitute for traditional gas produced from organic resources including manure, food waste, landll gas, wastewater treatment sludge, forest residues, agricultural residues, and the organic fraction of municipal solid waste (MSW). There are a variety of pathways for producing biomethane depending on the organic resources being utilized. These pathways primarily include capturing naturally occurring methane from the breakdown of waste in landfills, anaerobic digestion of organic material, and gasification.[82] Once it has been processed to utility standards, biomethane can be directly injected into existing gas infrastructure where it can be stored or otherwise used in power generation, transportation, industry, or in residential and commercial buildings.[83]

California has taken steps to create a regulatory environment for both exploring and utilizing biomethane as a transition alternative to traditional gas. Most significantly, SB 1383 passed in 2016 required state agencies to "consider and, as appropriate, adopt policies and incentives to significantly increase the sustainable production and use of renewable gas, including biomethane and biogas."[84]

Towards this objective the state has conducted several feasibility studies - including a 2018 study on carrier pipeline access for biomethane pursuant to SB 840[85] and a study by the California Air Resources Board on the feasibility of biomethane as a substitute.[86] The CPUC has also established Rulemaking (R.) 13-02-008, to consider and adopt biomethane standards and requirements, pipeline open access rules, and related enforcement provisions. In 2018, California passed two additional pieces of legislation related to biomethane: 1) SB 1440[87] which requires the CPUC and CARB to consider adopting specific biomethane procurement targets if it is cost effective and directly resulting in environmental benefits; and 2) SB 3187[88] which requires the CPUC to open a proceeding to consider funding biomethane interconnection infrastructure through a gas corporation's utility rates.

While some studies have shown low cost pathways for biomethane,[89] substantial challenges remain. Among the challenges are the commercial scalability and financial viability of biomethane facilities and supporting infrastructure, and the cost of these facilities compared to the cost of stranded assets. For example, there are high costs for ensuring gas meets stringent specifications for injection and transport.[90] Similarly, pipeline interconnections costs for feeder pipelines from biomethane sourced gas are also a commercial barrier.

Critically, there is also the issue of feedstock availability – both in the near-term and the long-term under maximum utilization rates. At least one recent study estimated that California's technical potential for biomethane supply could be up to 82 bcf per year with only half of that feedstock possible at a

[82] Jaffe, A. M. (2016). The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute.
[83] Parker, N., Williams, R., Dominguez-Faus, R., & Scheitrum, D., (2017). Renewable natural gas in California: An assessment of the technical and economic potential. Energy Policy.
[84] State of California. (2016). Senate Bill No. 1383 Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills.
[85] California Council on Science and Technology. (2018). Biomethane in California: Common Carrier Pipelines: Assessing Heating Value and Maximum Siloxane Specifications.
[86] Jaffe, A. M. (2016). The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute.
[87] State of California. (2018, September 23). Senate Bill No. 1440 Energy: biomethane: biomethane procurement.
[88] State of California. (2018, September 20). Assembly Bill No. 3187 Biomethane: gas corporations: rates: interconnection.
[89] Navigant. (2018). Analysis of the Role of Gas for a Low-Carbon California Future.
[90] Jaffe, A. M. (2016). The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute.

relatively inexpensive price point.[91,92] An NREL analysis of total US biogas availability topped out at a total potential of 420 bcf/year.[93] Both of these estimates, however, are small compared to the over 977 bcf utilized in California buildings in 2017 (429 bcf for residential alone), so biomethane is likely not going to be a viable system wide solution. This conclusion was also supported in the California IEPR's assessment of the potential supply of biomethane based on a review of available literature that found that 60 – 100 MMBtu could be supplied using existing production methods (100 – 340 MMBtu). At these levels the IEPR and the E3 study on long term GHG reduction scenarios both conclude that potential supply of biomethane is insufficient to meet the state's gas demand from buildings and industry.

Hydrogen

Hydrogen as a fuel source in buildings is relatively new, but it has a technical potential to support the future of the energy sector because of its flexibility, high potential capacity, long discharge duration capable of bridging seasonal mismatches in supply and demand, and the ability to connect low carbon energy with end use applications that are otherwise difficult to decarbonize like transport, industry, and buildings.[94] There are several options for manufacturing hydrogen, but in general the two main ways for producing it are steam methane reforming (SMR) which utilizes heat and pressure in a steam reformer to convert gas and water into hydrogen, carbon monoxide, and CO2 and electrolysis which utilizes electricity to split water into hydrogen and oxygen.[95]

If powered by zero carbon energy and/or fossil fuels coupled with carbon capture and utilization, these processes can enable hydrogen to be produced via carbon free methods capable of augmenting and replacing gas. This hypothetical zero carbon hydrogen could be utilized in three main ways with varying roles for existing gas infrastructure vs. new infrastructure. First, hydrogen can be blended into the existing gas pipeline network without major adaptations to infrastructure or appliances if the blend contains relatively low percentages of hydrogen. These ranges vary significantly study to study. An NREL study found that if implemented with relatively low concentrations, less than 5%–15% hydrogen by volume, hydrogen blending appears to be viable without significantly increasing risks associated with utilization of the gas blend in end-use devices (such as household appliances), overall public safety, or the durability and integrity of the existing gas pipeline network.[96] Other studies have found upwards of 30% blending as viable for current gas networks.[97] Hydrogen can also be converted directly to methane through methanation or injected into pure hydrogen networks if appliances are converted, leakage control is improved, and pipelines are retrofitted or replaced with noncorrosive and non-permeable materials.[98]

Although this paper does not offer a technical examination of the different mechanisms for hydrogen deployment, of those presented, it appears that a blending strategy is the most likely near term option for addressing the stranded assets issue related to gas use in buildings. In support of this, hydrogen blending is currently being piloted on a relatively large scale in Europe with projects like the GRHYD project in France[99] and the H21 Leeds CityGate project in the UK.[100] In California, outside of some

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[91] While some of this feedstock would be relatively inexpensive – the least expensive quarter can be produced below $9/mmBtu ($9.5/GJ) and the middle half can be produced between $9/mmBtu ($9.5/GJ) – some of it would be very difficult and expensive to procure – 50% of the resource rapidly increases from $20/mmBtu ($21/GJ) to over $80/mmBtu ($84/GJ).
[92] Parker, N., Williams, R., Dominguez-Faus, R., & Scheitrum, D. (2017). Renewable natural gas in California: An assessment of the technical and economic potential. Energy Policy.
[93] NREL. (2013). Biogas Potential in the US.
[94] International Energy Agency. (2015). Technology Roadmap: Hydrogen and Fuel Cells.
[95] International Energy Agency. (2015). Technology Roadmap: Hydrogen and Fuel Cells.
[96] NREL. (2013). Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues.
[97] de Santoli, L., Paiolo, R., & Lo Basso, G. (2017). An overview on safety issues related to hydrogen and methane blend applications in domestic and industrial use. Energy Procedia.
[98] Hydrogen Council. (2017). Hydrogen scaling up - A sustainable pathway for the global energy transition.
[99] Engie. (2018, March). Hydrogen: At the heart of the energy transition. Pour La Science.
[100] H21 Leeds City Gate Team. (2016). h21.

deployments of hydrogen fueling stations in the transportation sector, the state has not yet pursued hydrogen deployment on a major scale.

Despite its potential, there are still significant concerns for hydrogen to overcome, particularly with regards to safety, leakage, and material durability.[101,102,103] Further, addressing key questions for hydrogen uses like how its combustion and other characteristics (maximum allowable operating pressures, corrosiveness, burn rate, heat quality, injection needs, etc.) and how end use appliances need to be adapted to function with hydrogen blending will be critical.

Also, capital costs for the required infrastructure to support both hydrogen production (electrolyzers, reformers, etc.) and its integration into the distribution grid (pipelines, storage, appliances, etc.) remain an unknown and potentially very significant barrier for hydrogen to overcome. Further, regulatory authorities may be hesitant to invest in long-lived path dependent infrastructure necessitated by hydrogen as a solution for the existing stranded infrastructure problem.

[101] de Santoli, L., Paiolo, R., & Lo Basso, G. (2017). An overview on safety issues related to hydrogen and methane blend applications in domestic and industrial use. Energy Procedia.
[102] International Energy Agency. (2015). Technology Roadmap: Hydrogen and Fuel Cells.
[103] NREL. (2013). Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues