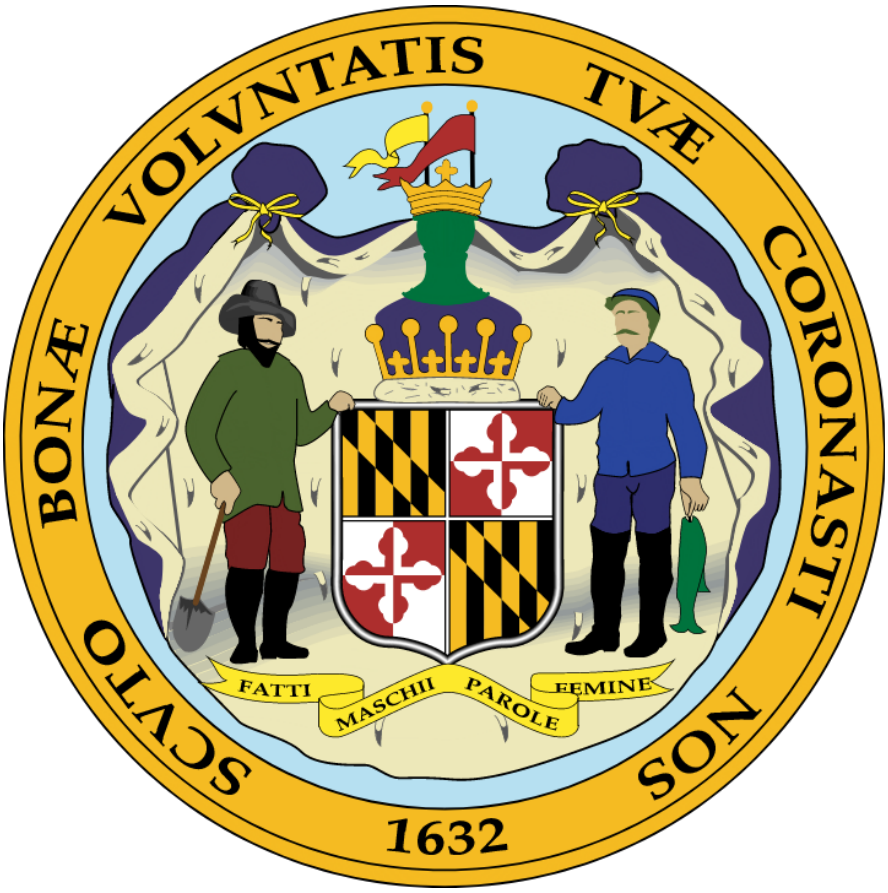
Maryland Department of Labor

Division of Labor and Industry

Building Codes Administration



Report to the Public Service Commission and Legislative Policy Committee

January 1, 2023

Maryland
DEPARTMENT OF LABOR

DIVISION OF LABOR & INDUSTRY
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MSAR# 14142

January 1, 2023

The Honorable Bill Ferguson
Maryland Senate, President
100 State Circle, H-107
Annapolis, Maryland 21401

The Honorable Adrienne A. Jones
Maryland House of Delegates, Speaker
100 State Circle, H-101
Annapolis, Maryland 21401

Dear President Ferguson and Speaker Jones:

We are pleased to provide this report on the Climate Solutions Now Act (CSNA) as required by the passage of S.B. 528 (Ch. 38) 2022.

The legislation assigns seven tasks to the Building Codes Administration of the Maryland Department of Labor, requires a report to the Public Service Commission, and an interim report to the Legislative Policy Committee in accordance with § 2–1257 of the State Government Article.

The interim report is attached for your review and consideration. Should you have questions or comments regarding the report, please contact Andrew Fulginiti, Director of Legislative Affairs, at Andrew.Fulginiti@maryland.gov or (443) 401-5129.

Sincerely,

Matthew Helminiak
Commissioner of Labor & Industry

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Introduction:

One of the central goals of the Climate Solutions Now Act (CSNA) of 2022 is “decarbonization”, which is the process of reducing carbon dioxide emissions, with the eventual goal of eliminating them. Carbon emissions occur throughout our daily lives, both directly when we do something like drive a gas-powered car or cook on a gas stove, and indirectly when we use an electric car that is charged by plugging into a power grid that uses carbon-based fuel to generate some of the electricity. Decarbonization’s end goal is the removal of all carbon dioxide emissions from the entire system, and the CSNA sets aggressive goals for when we want to achieve it. Technology advances over the last few years have provided some solutions, and technology will continue to progress as more attention is paid to decarbonization. Coordinating the pieces of the decarbonization puzzle requires information, and the CSNA assigned these information gathering requests to various state agencies.

The CSNA designates several tasks to the Building Codes Administration (BCA) and asks for an interim report on the findings on or before January 1, 2023, and a final report on or before December 1, 2023. The law allows for the BCA to hire consultants to conduct studies for this report. There have been multiple studies already conducted by Maryland state agencies and outside companies. Other states and the Federal Government are also trying to decarbonize, providing examples and information as well. The BCA did not hire consultants to provide additional information for the interim report.

The BCA is a small unit within the Division of Labor and Industry (DLI) at the Maryland Department of Labor that is responsible for adopting building codes at the State level. Most of the building codes that are adopted by Maryland are based upon a suite of codes written by the International Code Council (ICC). ICC produces dozens of different codes, but the main codes that govern building construction are the International Building Code (IBC), the International Residential Code (IRC) and the International Energy Efficiency Code (IECC). The International Green Construction Code (IGCC) was added later on as an additional code that sets standards for construction and usage of non-residential buildings that go above and beyond the standard set of codes. These codes contain elements that govern the way buildings are constructed, what equipment can be used in the building, and what energy efficiency measures are required.

Building codes, like other codes adopted and enforced by the DLI, are primarily about safety. They set standards for buildings so that the residents, tenants and owners can be sure that the building is safe to use. These standards tell builders and contractors how to build the building, and they are enforced by code officials who inspect the building as it is being built. As time progressed, additional elements were added to the building codes so they now go beyond only building safety. For example, a home with R38 insulation in the ceiling isn’t really any “safer” than a home with R30 insulation, however, it would be less expensive for the owner to heat and cool the home. It is with this in mind that our recommendations under the CSNA of 2022 try to balance the aggressive goals of the law with what’s safe and can be achieved with current technology, while allowing for technological advances that are sure to come in the near future.

(i) develop recommendations for an all–electric building code for the State, including appropriate exemptions for particular industries, including life sciences, as defined in § 3–201 of the Economic Development Article, local conditions, and sectors deemed critical infrastructure vital to the interest of national security as identified by the U.S. Department of Homeland Security's Cybersecurity and Infrastructure Security Agency;

Electrification of the built environment seeks to remove on-site carbon emissions by switching buildings to all-electric appliances and heating. The energy to power the electric systems in a building will require a corresponding increase in power sourced from the grid. For the discussion in this report, we consider any onsite power generation from wind or solar as part of the overall electric grid.

Within Maryland, most of our electricity comes from natural-gas fired generation (48%), followed closely by nuclear (37%). We also derive power from coal-fired power plants (11%) and petroleum-fired power plants (<1%). A small percentage comes from hydroelectric (<1%) and non-hydroelectric renewables (3%). Maryland uses more energy than it produces, so we also draw electricity from the interstate power grid. According to the US Energy Information Administration,[1] Maryland uses as much as 60% more energy than it generates, so any additional electricity demand from buildings that use all-electric systems will either have to come from increased in-state generation or be imported from other states.

Because the electric grid itself relies in large part on carbon-based fuel, increasing demand for electricity from the power grid is not carbon neutral. The Biden administration issued a declaration on December 7, 2022 through the US Department of Energy that orders all new and refurbished federal buildings to become fully electrified by 2025. In the guidance document explaining the announcement, they note that this will result in an **increase** in carbon dioxide, nitrous oxide, mercury and sulfur dioxide emissions. (See page 116)[2]

> *"DOE's analyses indicate that the proposed regulation would save a significant amount of site energy; however, switching from gas loads burned on-site to electric loads produced off-site, at national average level emission rates, would result in an increase of CO2, N2O, Hg, and SO2 emissions with a decrease in NOX and CH4 emissions."*

Maryland's energy suppliers are part of the PJM system[3] (an abbreviation of "Pennsylvania, New Jersey and Maryland" after the territories where the utilities first joined together), the regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of 13 states and the District of Columbia. PJM is focused on grid reliability, and also planning for the future transformation of the grid into a less carbon-reliant system. In early 2021, PJM, as the neutral, independent operator of the nation's largest grid, developed a five-year strategic plan guided by their core purpose to preserve reliability in ways that are efficient and cost-effective, harnessing the power of competitive markets to achieve these

[1] https://www.eia.gov/state/analysis.php?sid=MD
[2] https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf
[3] https://www.pjm.com/

objectives while planning for and facilitating a cleaner and more sustainable future.
The three pillars of the strategic plan are working towards many of the same goals of the CSNA. PJM's pillars are:

1. FACILITATING DECARBONIZATION.
PJM helps to facilitate a reliable and cost-effective energy transition. PJM serves as a trusted, unbiased analytics provider to inform policy decisions. PJM works to drive consensus for market-based, regional solutions.

2. PLANNING THE GRID OF THE FUTURE
PJM holds a unique role as the operator and administrator of the largest grid in the U.S. PJM is facilitating an efficient transition to the grid of the future.

3. FOSTERING INNOVATION
PJM creates an environment to foster grid innovation.

An all-electric residential code:
The New Buildings Institute (NBI) has developed a "Building Decarbonization Code"[4] that can be overlaid on top of the 2021 IECC and result in an ell-electric IECC. This can be used as a starting point for an all-electric code in Maryland.

Transitioning to an all-electric building code means reducing the use of on-site sources of carbon emissions. In a residential home that could mean carbon-based fuel used for space heating, water heating, cooking, and clothes drying. An all electric home would not have a gas stove or a wood-burning fireplace, for example. Technology exists to build an all-electric home. An electric heat pump, for example, extracts heat energy from the outside air and concentrates it to heat the home. It's possible to take 40 degree outside air and concentrate the heat energy from that 40 degree air to make 80 degree air to heat the home. The heat energy in the air decreases as the air temperature falls, so making 80 degree air out of 10 degree air uses more electricity. Therefore, as the outside temperature falls, the electricity demand from heat pumps increases. When the outside temperatures are very low, this could mean the cost to heat a home increases significantly.

When considering an all-electric residential code it is important to consider any drawbacks, particularly drawbacks that may be regionally specific to the state. For example, the Montgomery County Council debated in the summer of 2022 whether they should adopt an all-electric code for Montgomery County. The Maryland Building Industry Association (MBIA) submitted a letter to the Montgomery County Council which detailed some of these regional specific concerns. The letter stated:

> *"It is also important to note that given the ongoing supply chain issues the industry continues to face, most heat pumps and in some cases water heaters have increasingly long lead times for large projects. There is doubt that the electrical systems that could be put in place to meet the heating requirements for home's will be inadequate to the task in Maryland's climate. Heat pumps become less efficient in cold weather and cannot meet the temperature requirements of individual residents once the temperature drops below a certain threshold. Since the bill makes no provision for creating a backup heating*

[4] https://newbuildings.org/resource/building-decarbonization-code/

system, consumers will be stuck with an apparatus that does not function properly when most needed and have no opportunity to install their own gas backups because building codes will prevent it. Backup power and emergency generators need to function on natural gas to provide an unlimited emergency power resource for occupants, food preservation, heating, cooling and safety, especially for the sick, handicapped and elderly. Emergency generators should be exempt from the natural gas ban."

BGE's letter to the Montgomery County Council (October 26, 2022):

"Consistent with DEP's testimony, BGE agrees heat pump technology allows for heat transfer and operation down to 0 degrees Fahrenheit. However, DEP agreed with BGE's testimony of the inefficiency of heat pumps below 32 degrees Fahrenheit stating this applies to "builder grade" heat pumps. The majority of heat pumps installed by builders will be "builder grade" and will require auxiliary heat with either natural gas or resistive heating. All agree resistive heating is undesirable and expensive. Providing the option of natural gas is currently more economical and reliable."

In testimony to the Montgomery County Council, GTI energy submitted a study entitled "Seasonal Residential Space Heating Opportunities and Challenges"[5]. The study contended that

"*The Maryland Buildings Study and BGE study found that there are multiple pathways to decarbonize buildings, but that electrification has an important role to play, especially in new construction. These studies both pointed to cost benefits in leveraging additional building space heating solutions that can lessen impacts on the electric grid, such as hybrid heat pump systems."*

The cost of electricity has risen in recent months, and the cost of petroleum-based fuels can fluctuate. There may be times when oil or gas is a significant savings, and in a time of higher gas costs, electric heat may be lower priced. A multiple or hybrid fueled system offers the ability for the consumer to choose which is the most cost-effective way to heat their home. It also can help alleviate pressure on the supply/demand pricing during times of shortage, thus keeping cost pressures down.

All-electric code for larger buildings?

Technology for all-electric larger buildings (multifamily, commercial and industrial) may exist, but research indicates it may not be at the stage where it's reliable and readily available. A large number of the supporting documents and reports submitted to both the Maryland Legislature during the debate over the CSNA of 2022 and to the Montgomery County Council during their debate over an all-electric code further suggest that bifurcating the application of an all-electric code may be a more effective immediate approach. This would ensure a more efficient and less burdensome application for both the residential and commercial industries.

[5] https://www.gti.energy/residential-space-heating/

Concerns have been expressed whether non-residential construction and large multifamily construction all-electric codes may work at this time. Quoting from the NAIOP Maryland Chapter's letter to the Montgomery County Council (July 29, 2022):

> *"Decoupling from national building codes and writing a local all-electric construction code raises concerns that design teams will be forced to use unproven technologies or meet costly, untested code requirements..Electric Heat Pump Systems Do Not Necessarily Scale Up Well for Large Buildings – While it is less challenging to electrify new construction than existing buildings, even in new construction current electric heat pump and heat pump hot water technologies are often better suited to smaller residential and commercial buildings. For larger buildings, system designs become complicated by limitations on refrigerant line length, roof and basement space available for equipment. For some applications such as water heating, there are limited all-electric equipment options in the market that can meet the energy efficiency, health and comfort needs of large multi-family buildings. While there has been some advancement in development of residential cold climate heat pumps, improvement is needed for commercial equipment. Declines in both operating and capital costs of commercial equipment are necessary to close the feasibility gap between small and large buildings. ➢ Recommendation: Montgomery County should focus first on small buildings and uses that have low space and water heating needs."*

Exemptions to an all-electric code:

Regarding the consideration of exemptions to the all-electric code, the CSNA also required the BCA to include appropriate exemptions for particular industries, including life sciences, as defined in §3–201 of the Economic Development Article, local conditions, and sectors deemed critical infrastructure vital to the interest of national security as identified by the U.S. Department of Homeland Security's Cybersecurity and Infrastructure Security Agency (DHS CISA). The Biden administration issued a declaration on December 7, 2022 through the Department of Energy that orders all new or refurbished federal buildings to eliminate the use of natural gas and become fully electrified beginning in 2025. The order, however, includes many exemptions, including allowing for the use of non-emergency backup generators that use on-site fossil fuels (see page 18).[6] Note that the Biden administration's recent proposal to phase out the onsite use of fossil fuels in federal buildings also allows for some national security exemptions (see page 26).

National security: Designated Critical Infrastructure Sectors and Sector-Specific Agencies

The CISA directive[7] identifies 16 critical infrastructure sectors and designates associated Federal SSAs. In some cases co-SSAs are designated where those departments share the roles and responsibilities of the SSA. The Secretary of Homeland Security shall periodically evaluate the need for and approve changes to critical infrastructure sectors and shall consult with the Assistant to the President for Homeland Security and Counterterrorism before changing a critical infrastructure sector or a designated SSA for that sector. The sectors and SSAs are as follows:

Chemical:

[6] https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf
[7] https://www.cisa.gov/critical-infrastructure-sectors

Commercial Facilities:
Communications:
Critical Manufacturing:
Dams:
Defense Industrial Base:
Emergency Services:
Energy:
Financial Services:
Food and Agriculture:
Government Facilities:
Healthcare and Public Health:
Information Technology:
Nuclear Reactors, Materials, and Waste:
Transportation Systems:
Water and Wastewater Systems:

Important CISA directive definitions
For purposes of the CISA directive:
The term "critical infrastructure" has the meaning provided in section 1016(e) of the USA Patriot Act of 2001 (42 U.S.C. 5195c(e)), namely systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems and assets would have a debilitating impact on security, national economic security, national public health or safety, or any combination of those matters.

The term "national essential functions" means that subset of Government functions that are necessary to lead and sustain the Nation during a catastrophic emergency.

The term "primary mission essential functions" means those Government functions that must be performed in order to support or implement the performance of the national essential functions before, during, and in the aftermath of an emergency.

The term "resilience" means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.

The terms "secure" and "security" refer to reducing the risk to critical infrastructure by physical means or defense cyber measures to intrusions, attacks, or the effects of natural or manmade disasters.

The BCA spoke with representatives of the DHS CISA and the BCA, based upon those discussions and other research, does not see a practical way to write code language that can incorporate the necessary exemptions. First, what industries may or may not fall into a particular category is not as simple as it sounds - many companies have multiple product lines that are interconnected, and some may fall under CISA and some may not. Second, what companies or facilities would fall under the “critical infrastructure” exemption is so broadly defined that a large portion of the buildings in Maryland could make the argument that they are critical. And third, not all buildings are constructed knowing who the end user is going to be. A commercial building may be built without a known end-user and then sold or leased after completion. A code with exemptions for the end user is not possible if the end user is not known. It is for these reasons

that the BCA doesn't believe it is possible to create a code with the required exemptions. The exemptions are vital to the security of the homeland, so if it's impractical to write in the exemptions, national security precludes the blanket extension of an all electric code to commercial and industrial construction at this time. The new technology is not widely enough available to have an all-electric requirement that can guarantee not to negatively impact national security, critical infrastructure or life sciences.

Conclusions:

Transitioning to an all-electric future should start with new construction single family residential buildings; the technology exists, is available, and can be deployed during the construction process. It would not be safe to require non-residential, industrial and commercial buildings to move to all-electric unless the technology is available to provide the needed heat and power solutions. This will also allow time for the electric grid to increase supply so it can guarantee the needed electricity to the buildings. Phasing in the use of all-electric codes allows time for the grid to increase capacity and modernize to a cleaner power supply. PJM continues to improve and advance towards decarbonized power generation.[8]

Recommendations:

- Use the NBI Building Decarbonization Code overlay with the 2021 IECC and apply to single-family residential new construction at this time. The code should allow exceptions for backup generators with a non-electric fuel source and exceptions for hybrid heat pumps that operate primarily on electricity but have systems that use non-electric fuel sources when temperatures fall below where readily available heat pumps begin to fail.
- If cold climate residential heat pump technology advances and provides a commercially available heat pump that functions without emergency backup at temperatures as low as 0 degrees Fahrenheit, remove the exemption for hybrid heat pumps in the next code cycle.
- Encourage and incentivize, but do not require, builders of commercial, industrial, and multifamily residential buildings to construct all-electric buildings, but allow any tenant or occupant that falls under the DHS CISA list to be able to use any fuel source they deem appropriate. Aligning with the Federal government directive, allow backup generators of any fuel type so buildings that choose to decarbonize have a secure backup in case of power outages or reduced supplies.

[8] https://energycentral.com/c/um/ferc-approves-pjm-queue-reform

(ii) develop recommendations for the fastest and most cost–efficient methods for decarbonizing buildings and other sectors in the State

The first section of this report dealt with new construction. Maryland is a mature state with a low new construction growth rate, therefore most of the decarbonization needs to happen within existing buildings and other sectors within the State. There have been technological improvements that make the promise of electrification something that looks more and more possible. There have also been technological improvements in equipment that uses carbon-based fuel more efficiently (think gas/electric hybrid Toyota Prius, for example) and moves us closer to decarbonization.

The scope and scale of the challenge of decarbonizing the existing buildings and other sectors in the State is, to put it mildly, enormous. According to the Public Service Commission (PSC) November 2021 Ten Year Plan,[9] 56% of residential heating is provided by gas or oil (page 9). And the projected growth rate for the residential sector for the next ten years is only 6.43% (page 5), so 93.57% of residential users are existing homes. Decarbonizing buildings means transitioning them to "all electric" and removing any systems or devices that produce carbon emissions. That would mean the elimination of gas cooking, gas or wood fireplaces, gas or oil heat, or any other device that uses any fuel source that produces onsite carbon emissions.

Phasing in decarbonization will allow the power grid to add the needed additional capacity to provide energy to the transforming buildings. The existing power grid does not yet support total decarbonization; many existing buildings will require extensive and expensive modifications; and in some cases the technology doesn't yet exist or is not readily available. The goal is elimination of carbon emissions, but progress can be made and carbon emission can also be *reduced* by a variety of paths other than just moving all-electric. Yes, some existing buildings can transition to electric-fueled systems from carbon-based systems. Energy not used in the first place is energy that doesn't need to be generated, so an energy efficiency improvement to an existing building reduces carbon emissions. And finally, even if a building doesn't move to all-electric, replacing a carbon-based system with a more efficient hybrid (typically an electric heat pump with a natural gas or propane backup) system can dramatically reduce carbon emissions and move us closer to total decarbonization.

Challenges of decarbonization:

Replacing a gas or oil heat system with an all electric heating system might not be a simple like-for-like replacement of the furnace. Some types of gas or oil heating systems such as the traditional radiator and piping system would require installing ductwork to move conditioned air from the furnace to the rooms. If the gas or oil house already has ductwork, the ductwork might

[9] https://www.psc.state.md.us/wp-content/uploads/2021-2030-Ten-Year-Plan.pdf

still need to be modified. Forced air gas and oil heat is normally a higher temperature air than a heat pump, so ducts might need to be resized. Both of these are expensive propositions for an existing home. Research for this report has found various estimates for the cost to electrify a building. The Home Innovation Research Lab "Cost Impact of Electrification Strategies on Residential Construction"[10] report estimates that the retrofit cost for an average Baltimore-area home to switch from natural gas to all electric would be $25,017 (page 17). The estimated energy savings for the all-electric house ranges from $77 to $184 per year. (page 24), so payback time on an electrification project could be over a hundred years.

Improving the energy efficiency of a building, whether it's a home or a commercial/industrial building, has a range of options. Depending on the building, its type of construction, and its age, there may be some "low hanging fruit", but deep improvements may be physically impossible or financially infeasible for some buildings. A traditional single family home with an attic can usually have additional insulation installed in the attic at a reasonable cost. An "A-frame" house or a flat-roof row home might not have an accessible attic space, so an easy opportunity to increase the insulation wouldn't exist. Replacing windows with more efficient windows could help, but costs for window replacement vary depending on the standardization of the window size, the type of window, and availability of product.

Decarbonizing the transportation sector has a similar range of options. There are multiple obstacles to full adoption of all-electric vehicles. Despite increasing demand for EV's, there is not yet sufficient vehicle supply to switch all vehicles to full electric. The power grid does not have enough electric capacity at this time. Many homes don't have enough wiring or capacity at the junction box. And many neighborhoods don't have wiring capacity to push enough electricity through to the buildings. The goal is to reduce and eventually decarbonize entirely, but making progress to that goal can involve some non-electric choices. If a house can't accommodate the charging system, the homeowner can still reduce carbon emissions by buying a more efficient hybrid engine or a fuel-efficient gas engine. Allowing the transition to electric cars to happen more gradually will allow the grid and built environment to modernize to support the required increased electricity.

The power grid:

The existing power grid cannot provide enough electricity to accommodate all-electric buildings at this time, nor can it accommodate all electric vehicles. It is estimated that the additional electricity demanded by these two changes would more than double, and perhaps triple, the electricity generation demands from Maryland. BGE said in their letter to the Montgomery County Council[11] (October 26, 2022)

> *"Concerns about costs multiply significantly when one looks at the impacts on energy costs. As BGE's Ervin McDaniel III told the Committee, BGE projects that it will need to build or expand 250 substations and roughly double its feeder*

[10] https://www.nahb.org/-/media/NAHB/nahb-community/docs/committees/construction-codes-and-standards-committee/home-innovation-electrification-report-2021.pdf

[11] https://www.montgomerycountymd.gov/council/Resources/Files/agenda/cm/2022/20221103/20221103_PHED1.pdf

system to support building and transportation electrification in its service territory, with investments likely to exceed $50B. Beyond the financial impacts of the needed investments, the increase in infrastructure will require additional real estate for substations and the use of the public rights of way for the installation of infrastructure. The associated construction activity associated with this work will have a significant impact on traffic, the communities we serve and the county's roadways. An integrated energy system reduces the overall costs by $8B - $12B and minimize construction activity."

Maryland is part of the PJM regional transmission organization, which is working towards some of the same goals of the CSNA. According to the PJM 2021 Annual report: [12]

"As state and federal policymakers respond to increasing consumer preferences for decarbonized generation resources, our generation interconnection queue has followed suit. More than 95% of the generation resources lining up in the PJM interconnection queue are solar, wind, storage or a hybrid combination of variable renewables. Beyond traditional industry practices, which shore up capacity to meet the needs of the grid, resource flexibility is also growing in importance. As more variable resources come onto the system, the role of balancing power systems becomes ever more critical."

BGE's letter to the Montgomery County Council (October 26, 2022) discusses their concerns regarding the power grid's ability to handle the increased demand of electrification for both buildings and electric vehicles:

"...the move to rely fully and exclusively on electric power for buildings will take place simultaneously with efforts to transition the transportation sector to fully electric vehicles. BGE believes significant planning and investment will be needed to meet these dual and simultaneous transitions, which rely on the same distribution infrastructure. An all-electric residential development may present what seems to be only incremental demands on the system, but the demands may look far more daunting when they include powering the development's passenger vehicles, service vehicles, schools and school buses."

Washington Gas expressed similar concerns in their letter to the Montgomery County Council: (July 26, 2022)[13]

"During the 2022 Maryland General Assembly Legislative Session, State legislators heavily debated the issue of climate change in the 2022 CSNA. One key point that came up was the question of if the power grid could manage the increased energy needs of an all-electric energy system. The electric utility companies were concerned about grid reliability and the significant infrastructure investments needed to bolster the grid distribution system. We at Washington Gas share those concerns for our current customers."

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[12] https://services.pjm.com/annualreport2021/innovation/

[13] https://www.montgomerycountymd.gov/council/Resources/Files/agenda/cm/2022/20221103/20221103_PHED1.pdf

BGE, also warned in its testimony:

> *"According to modeling of the BGE territory, residential gas customers can expect to pay $10,000 or more per household for heating costs and retrofits. In aggregate, this shift will cost our residential and commercial gas customers no less than $2.8 billion. These projections do not include the electric infrastructure costs described above to ready the system for load growth.""*

Troubles in extreme cold weather

During extreme cold weather, especially when the cold weather conditions are present in multiple areas connected to the same power grid, the power grid may not be able to supply enough electricity to meet the demand. This was seen in the Maryland region during the recent Christmas 2022 cold snap. When temperatures dropped into the single digits, heat pumps required more energy to generate heat, many heat pumps were not able to produce heat and relied on emergency heat functions. The regional conditions caused the PJM system to ask consumers to conserve electricity[14] and some areas within the Baltimore region experienced rolling brown outs in an effort to keep the grid functional.

This was not a singular, isolated incident - other areas experienced similar issues during extreme cold. Following the past extreme cold weather events that left many homes and businesses without power across Texas last year, the International Energy Administration[15] highlighted that "energy systems with heavy dependence on electricity for space heating will be challenged by exceptionally cold temperatures."

The additional power demand during a cold weather event could increase carbon emissions by a greater percentage than the daily balance in the system. As demand spikes, the additional supply often comes from less emission-friendly sources. The GTI energy study referenced earlier (report number 21917 - Seasonal Residential Space Heating Opportunities and Challenges, page 19) projects that Maryland's percent change from Spring to Winter "marginal emission rate" would be as astounding 1,118.7% - the third worst in the country behind only North Dakota and South Dakota. According to that same report, page 27, switching Maryland from gas heat to all electric would mean an *increase* in greenhouse gas emissions by 529.3% during these coldest winter days.

Cold weather vulnerability: an interesting point is made in the appendix of the 2020 "Natural Gas and its Contribution to a Low Carbon Future - Climate Business Plan for Washington, D.C."[16] from Washington Gas. The report notes on page 36 that vulnerable elderly citizens face an acute danger from unreliable heat, noting

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[14] https://insidelines.pjm.com/pjm-asks-consumers-to-conserve-electricity/ https://www.pjm.com/-/media/about-pjm/newsroom/2022-releases/20221223-news-release-w1-statement-call-for-conservation.ashx

[15] https://www.iea.org/commentaries/severe-power-cuts-in-texas-highlight-energy-security-risks-related-to-extreme-weather-events.

[16] https://washingtongasdcclimatebusinessplan.com/wp-content/uploads/2020/04/Climate-Business-Plan-March-16-2020-FOR-WEB.pdf

"Older adults are particularly affected by energy poverty and cold weather, according to the National Institute of Health (NIH). For an older person, a body temperature of 95 degrees F or lower can cause many health problems…Even mildly cool homes with temperatures from 60 to 65 degrees can trigger hypothermia in older people. The Centers for Disease Control (CDC) found; "cold-related deaths are more prevalent than heat related.""

Mixed fuel scenarios:

The Maryland Commission on Climate Change's E3 report (published October 2021) analyzed several pathways to meet the State's climate goals to decarbonization, and determined that a fuel neutral approach provided for a more reliable and resilient energy system. In a recent study in Massachusetts (February 2022)[17], consulting firm E3 stated

"a coordinated gas and electric decarbonization strategy, utilizing a diverse set of technologies and strategies, is likely to be better able to manage the costs and feasibility risks of decarbonization than scenarios that rely more heavily on single technologies or strategies."[18]

"In the two reports, E3 analyzed various scenarios that will lead to robust, and similar decarbonization goals as Montgomery County, it is clear that energy diversity is essential when considering affordability, reliability, and resiliency."

Affordability and equity:

In the Montgomery Climate Action Plan, published in 2021,[19] the County put equity and social justice at the forefront of all climate solutions that will be considered. Natural gas usage remains more affordable than electricity. Studies have shown that in Maryland, natural gas is less costly for customers as compared to electrification. As stated earlier, the cost of electricity and gas has fluctuated in recent years. Removing the option for a homeowner to choose a cheaper fuel hurts those who can least afford the more expensive fuel choice.

In the guidance document for the Biden administration's December 7, 2022 order for federal buildings to move away from on-site fossil fuel use, they note the increase in cost for electricity when compared to the cost of fossil fuels. They estimate that electricity is **4.3 times more expensive than natural gas** (see below from page 82)[20]:

"There are increases in energy costs across the board, this is because despite the increases in equipment efficiency and overall site energy savings the difference between the cost of fossil fuels (primarily natural gas) and purchased electricity at a national level are too high for the improvements to overcome. The EIA AEO 2021 energy outlook rate projections indicate that per the same amount

[17] https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/E3%20Maryland%20Building%20Decarbonization%20Study%20-%20Final%20Report.pdf

[18] https://thefutureofgas.com/content/downloads/2.15.22%20%20DRAFT%20Independent%20Consultant%20Technical%20Report%20-%20Part%20I%20(Decarbonization%20Pathways).pdf

[19] https://www.montgomerycountymd.gov/green/Resources/Files/climate/climate-action-plan.pdf

[20] https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf

of site energy consumed, electricity is about 4.3x more expensive than natural gas, this number gradually reduces over time per this projection down to 3.2x by the year 2050."

The Air-Conditioning, Heating & Refrigeration Institute (ARHI) September 10, 2021 letter to the Maryland Department of the Environment regarding Maryland Building Decarbonization Policy Options[21] states

"Maryland should address equity with any building decarbonization policy. Raising the price of electricity during peak hours will unevenly impact different customer classes due to differences in the ability to either reduce the volume of their energy consumption or shift its occurrence in time. Utility burden is not evenly shared across society. Low-income communities and small businesses face utility burdens that far exceed national averages.
Prior to the adoption of electrification and decarbonization policies, Maryland should establish measurable goals regarding equity; ensure that programs address or do not exacerbate the housing shortage; and create a stable, long-term public fund to support and subsidize advanced efficiency measures. Over 50 percent of Maryland households will have a negative cost impact when switching fuel technologies. AHRI agrees that additional funding can be used to ensure low- and moderate-income households can procure new and more efficient equipment via incentive funding. Limiting the funding to only electric equipment, however, is likely to limit the carbon reduction available to Maryland. Replacing existing equipment with newer more efficient equipment of the same fuel type is a cost-effective way to reduce emissions."

Integrated / Mixed-fuel equipment eases the transition

As discussed earlier, The Biden administration issued a declaration on December 7, 2022 through the Department of Energy that orders all new or refurbished federal buildings to eliminate the use of natural gas and become fully electrified beginning in 2025. The order, however, includes many exemptions, including allowing for the use of non-emergency backup generators that use on-site fossil fuels (see page 18).[22]

The GTI energy project number 21917 "Seasonal Residential Space Heating Opportunities and Challenges" report on page 5 says

"There are multiple viable paths to decarbonization" "Pathways that rely on an integrated energy system carry a lower overall cost and level of challenge relative to those that rely primarily on electrification or renewable gases." "Gas infrastructure serves as an existing, low-cost source of capacity that reduces the amount of electric generation, transmission and distribution capacity that will need to be added over the coming decades." "An integrated approach that leverages the advantages of both electric and gas infrastructure can help to

[21] https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/AHRI.pdf
[22] https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf

reduce both total energy system and consumer costs, while also reducing challenges associated with large-scale electric infrastructure additions and customer retrofits, while still achieving decarbonization across all sectors."

Continuing on page 6

"All scenarios that achieve net-zero require significant investments in electric generation and delivery infrastructure, but those costs can be mitigated via an integrated approach." "Relying on a dual energy approach reduces the overall scale of infrastructure additions required to achieve net-zero goals. As a result, pathways that rely on an integrated energy system are lower cost than all-electric or all-renewable gas based pathways." "Consumers are central to the transformations required to achieve net-zero and achieving the scale of adoption envisioned here will require developing solutions that are affordable and work for all customers, equitably. All-electric solutions can lead to higher retrofit costs for existing buildings, particularly older buildings, relative to alternatives…Lower income customers are expected to face higher energy burdens, particularly in the Limited Gas scenario, so identifying strategies to mitigate those impacts will be critical to achieving a just transition to net-zero."

The GTI report looks specifically at Baltimore on page 15

"79% of homes within BGE's service territory currently have central air conditioning… However, many homes, particularly those within the City of Baltimore, are older (just 36% were built after 1980) and are less likely to have either a central air conditioner or a high efficiency building envelope."

Continuing the analysis of Baltimore on page 36,

"All scenarios see increasing costs associated with heating buildings in BGE's service territory. These higher costs stem in part from the higher equipment costs discussed above, as well as the impacts from decarbonized energy supply, which put upward pressure on both electric and gas rates. An integrated approach to decarbonizing building heating can reduce those rate impacts by reducing electric system infrastructure requirements and by reducing reliance on costly renewable fuels."

They discuss equity concerns on page 39:

"Absent policy interventions, decarbonization scenarios could have deleterious impacts on equity, particularly because in all scenarios the cost of heating homes in BGE's service territory increases…All else equal, customers with higher incomes will be better able to incur those costs, while lower-income customer or renters will not…Energy burden for residential customers is going to increase under any future scenario."

The Air-Conditioning, Heating & Refrigeration Institute (ARHI) September 10, 2021 letter to the Maryland Department of the Environment [23] regarding Maryland Building Decarbonization Policy Options made several points that are relevant to this section

[23] https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/AHRI.pdf

- *"Electrification with fuel backup is the most cost-effective and low-risk option for promoting decarbonization. Based on data presented during Building Ad Hoc Committee meetings, and data developed during U.S. Department of Energy rulemakings, 73-percent of homes in Maryland currently use gas, propane, or oil furnaces, a mere 20-percent of which would experience a net savings if switched to a heat pump at this time, and over 50-percent of all Maryland households would have a negative cost impact if required to switch fuel technologies."*
- *"Targeting code updates to occur after this 2025 transition would allow time to go through the same design and testing cycle and result in a higher likelihood of product availability for Maryland's goal of building decarbonization. AHRI recommends Maryland review a gradual transition to any all-electric*
- *"Building retrofit requirements are much more complicated than new construction codes. For example, switching from a gas furnace to an electric heat pump, even in a major renovation, could require substantial modification to a building including duct sizing, electric panel upgrades, and modifying room size, among other issues. As such, Maryland's building codes should take an incremental approach that initially focuses on new construction only."*
- *"AHRI believes it is important for Maryland to understand the scope of its installed base of heating equipment and ensure that fuel switching is cost effective, feasible on the electric grid, and maintains consumer choice. Maryland should preserve multiple fuel options and let Marylander's choose lowest cost and lowest carbon energy system. Moving the thermal load from gas to electric will result in a significant increase in electric peak in winter. Load increases on the grid may limit energy reliability and availability in Maryland, as we've seen other parts of the country experience widespread electricity outages due to extreme weather events such as ice storms, heat waves, and hurricanes."*
- *"A minority of Marylanders will save money by switching from a furnace to a heat pump. Cost burdens from this switch are also likely to disproportionately affect low-income households."*

Older homes may be more difficult:

According to the "Modeling the Economic Impact of a Local Gas Moratorium in the Baltimore Metropolitan Area"[24] study from the American Gas Association (AGA), a gas moratorium would affect more than 666,000 homes and 28,000 commercial structures in the Baltimore area. Older homes do not have the wiring capacity to handle an all-electric heating system or the additional electric needs of vehicle charging. Homes built before 1960 would likely need new wiring and a high-voltage service panel. There are at least 300,000 such older homes in the Baltimore area alone.

Some houses cannot be electrified at a reasonable cost - particularly in older homes that lack central air ductwork, lack sufficient wiring to handle the increased electrical demand, and are not

[24] https://www.aga.org/research/reports/implications-of-policy-driven-residential-electrification/grounded-in-reality-the-implications-of-electrification/

readily able to improve their energy efficiency. Many older homes do not have the wiring capacity to handle an all-electric heating system or the additional electric needs of vehicle charging. Homes built before 1960 would likely need new wiring and a higher-voltage service panel. There are at least 300,000 such older homes in the Baltimore area alone.

If the cost to upgrade the building is past a certain percentage of its value, it might not make economic sense to do the upgrades. Discussions of "Building Energy Performance Standards" (BEPS) with representatives of the New Buildings Institute (NBI) and the BCA brought up the fact that a certain percentage of buildings can't comply with the requirements. There can be multiple reasons why a building might not be able to meet the requirements of a BEPS program. One example would be that the design and construction of the existing building might not be able to be upgraded at a cost that is reasonable. A brick row home in Baltimore City has an air space between the brick exterior and the interior surface of the wall, but the brick allows water to seep through during a rain event, so the air space allows the moisture to dry. If the cavity were filled with insulation, it could create a mold and mildew hazard. Another example: the Department of Labor building at 1100 N. Eutaw Street (which the Board of Public Works approved a lease for the Department of Labor on December 21, 2022 to move out of), for example, has almost entirely single-pane glass on the exterior, so an energy-efficient exterior upgrade could require an entirely new exterior shell, the cost of which might exceed the value of the building itself. NBI referred to these buildings as "lost cause buildings", and depending upon how strict the BEPS[25] requirements are, the percentage of lost cause buildings can change.

Federal Government Building Decarbonization Measures

The US General Services Administration (GSA) is also working towards decarbonization of the large stock of buildings it owns and operates. They have a Green Building Advisory Committee that most recently released a report in November, 2022. They list some possible steps that can be taken to move towards decarbonization. The GSA has set aggressive timelines much like the CSNA does, and they estimate the energy savings from these steps on page 9. Each of these is broken down in further detail starting on page 23 of the report [26]:

"The next step of the prioritization process is to use the three screening factors to determine which general decarbonization measures should be targeted for each building. These measures include retro-commissioning, energy efficiency retrofits, deep energy retrofits, electrification, and on-site renewable energy. Estimated energy savings ranges are included in the description below:

- *Retro-commissioning – Low-cost/no-cost measures resulting from re-tuning and repair of building systems and equipment, typically resulting in 10-15% energy savings.*
- *Energy Efficiency Retrofits – Replacement and upgrading of HVAC equipment, lighting, and controls, typically resulting in 20-30+% energy savings.*
- *Deep Retrofits – Repair, replacement, and enhancement of the building envelope (e.g., roof, walls, windows) combined with the integrated retrofit of HVAC, lighting, controls,*

[25] https://mde.maryland.gov/programs/air/ClimateChange/Pages/BEPS.aspx
[26] https://www.gsa.gov/cdnstatic/GBAC%20Decarbonization%20Advice%20Letter%20Final%2011-09-22.pdf

and the introduction of plug-load management, low GWP refrigerants, energy storage, and active demand management, typical resulting in 40-50+% energy savings.

- *Electrification – Complete or partial replacement of fossil fuel heating (space heating, service hot water, and cooking) with electric alternatives (e.g., heat pumps, heat recovery chillers), typically resulting in 50-100% reduction in fossil fuel energy use.*
- *On-site Renewables – Addition of solar PV, battery electric storage and other distributed energy resources (e.g., EV charging, renewable CHP) with energy savings dependent on building space and site (e.g., carpark roof, grounds) availability and orientation.*

Conclusions:

Allowing decarbonization to happen gradually will allow technology to overcome some difficulties associated with moving away from carbon-based heat, cooking and energy systems in existing buildings. Technological advances will continue and will enable more opportunities for decarbonization, but there may be some buildings where decarbonization is not possible or practical. Focus needs to be on improving the energy usage of all systems, both carbon and decarbonized, while allowing time for technology and the power grid to modernize.
Electric-based systems should be encouraged where possible and practical. Hybrid or mixed-fuel systems should be encouraged during the transition to allow safe operation of buildings and provide heat in winter when an all-electric power grid would be at peak demand, thus reducing pressure on the power grid.

Recommendations:

- Encourage and incentivize the purchase of more fuel-efficient gas and diesel powered vehicles.
- Encourage and incentivize the purchase of hybrid gas/electric vehicles
- Encourage and incentivize the installation of high-capacity electric panels in existing homes to accommodate future purchase of electric vehicles
- Where all-electric systems are feasible in residential and commercial buildings, encourage and incentivize replacement of carbon-based systems with all-electric systems.
- When existing conditions do not readily allow for replacement with all-electric systems, encourage and incentivize replacement of carbon-based systems with hybrid or mixed-fuel systems.

(iii) assess the availability of technology and equipment that will be needed to construct all–electric buildings in the State;

Technology exists to build an all-electric home:

As stated earlier, there are ways to heat a home without carbon-based fuel. A heat pump, for example, extracts heat energy from the outside air and concentrates it to heat the home. It's possible to take 40 degree outside air and concentrate the heat energy from that 40 degree air to make 80 degree air to heat the home. The heat energy in the air decreases as the air temperature falls, so making 80 degree air out of 10 degree air uses more electricity. As the temperature falls, the electricity demand increases because the heat pump has to work harder to extract and concentrate the heat energy from the colder air. There is a point at which a heat pump can no longer generate enough heat. A heat pump can have an electric resistance "emergency" backup (essentially heating the air with the same technology as a toaster). Some other heat pumps have gas or oil backups (referred to as hybrid or mixed-fuel systems). Without a backup heat option, the heat pump fails to heat the home at low temperatures.

The GTI energy study referenced earlier in this report, entitled "Seasonal Residential Space Heating Opportunities and Challenges", states that "...The International Energy Agency (IEA) has established a Technology Readiness Level (TRL) scale for decarbonization measures. A technology with a TRL of 11 is ready to scale, options lower than that may need research, development, and commercialization support. Portfolios of decarbonization options that rely on lower TRL measures carry additional risk." The only decarbonization measure on the chart with a rating of 11 is an efficient gas appliance condensing furnace. Cold-climate ASHP's for residential and small commercial are close at a rating of 10. This illustrates that there is much room for growth and development of these technologies to be able to adequately support aggressive decarbonization efforts.

The need for a reliable back-up heat and power supply is especially important for our most vulnerable citizens that have more difficulty handling temperature extremes. The Maryland Building Industry Association's letter to the Montgomery County Council dated July 24, 2022 [27] says…

> *".Backup power and emergency generators need to function on natural gas to provide an unlimited emergency power resource for occupants, food preservation, heating, cooling and safety, especially for the sick, handicapped and elderly. Emergency generators should be exempt from the natural gas ban."*

Challenges for non-residential buildings:

[27] https://www.montgomerycountymd.gov/council/Resources/Files/agenda/cm/2022/20221103/20221103_PHED1.pdf

Technology for some all-electric non-residential buildings may exist, but many of the cutting edge technologies are not yet widely available enough to make them mandatory. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) publishes a monthly journal[28] that often discusses the new technologies and their availability (the BCA is a member and subscriber). Two of the 2022 issues detail some emerging technologies that may provide an all-electric solution for large buildings, but the technology is still in its infancy and products are not widely available enough that they could be the only option available for new large buildings.

Quoting from the NAIOP Maryland Chapter's letter to the Montgomery County Council (July 29, 2022):[29]

> *"Decoupling from national building codes and writing a local all-electric construction code raises concerns that design teams will be forced to use unproven technologies or meet costly, untested code requirements..Electric Heat Pump Systems Do Not Necessarily Scale Up Well for Large Buildings – While it is less challenging to electrify new construction than existing buildings, even in new construction current electric heat pump and heat pump hot water technologies are often better suited to smaller residential and commercial buildings. For larger buildings, system designs become complicated by limitations on refrigerant line length, roof and basement space available for equipment. For some applications such as water heating, there are limited all-electric equipment options in the market that can meet the energy efficiency, health and comfort needs of large multi-family buildings. While there has been some advancement in development of residential cold climate heat pumps, improvement is needed for commercial equipment. Declines in both operating and capital costs of commercial equipment are necessary to close the feasibility gap between small and large buildings. ➢ Recommendation: Montgomery County should focus first on small buildings and uses that have low space and water heating needs."*

Conclusion:

Technology exists and is available for all-electric single family homes. The heat pump technology has improved and functions in colder weather, but there are still points where a heat pump fails and relies on either electric-resistance or carbon-based backup heat.
Though technology for electric systems in larger buildings is coming to market and is available for some scenarios, it is not yet at the point where it is widely enough available, suitable for every building need, and can be safely required.

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[28] https://ashrae.org/technical-resources/ashrae-journal (notably the October 2021 and November 2022 issues)

[29] https://www.montgomerycountymd.gov/council/Resources/Files/agenda/cm/2022/20221103/20221103_PHED1.pdf

(iv) assess the impact of building electrification on workforce shortages;

History shows that any transition results in displacement of some workers and the creation of new opportunities for others. The types of jobs that will be affected by building electrification (both those gained and those lost) are not jobs that require only a week or two of training. People who install and service heat pumps, build electric substations, or service steam boilers receive years of training in order to safely perform their jobs. Workers will need years of retraining to transition from one field to the other.

There have been several studies in California analyzing the job impacts of their move towards reducing greenhouse gas emissions. A 2021 study for San Diego[30] noted an increase in building construction and building retrofit jobs, but a loss in jobs in the gas utility industry and gas infrastructure. A 2021 study for the city of Los Angeles[31] notes on page 12 that "off-the-shelf economic models do not work well for building decarbonization" and predicts increases in construction jobs and a loss in utility jobs, with estimates that range from a few thousand additional jobs at the low end to over 20,000 new jobs at the high end (note that the study uses a "job years" metric that can be converted into full-time-equivalent jobs).

A 2019 study for the California building decarbonization executive order[32] estimates a net gain of jobs in California of between 64,232 and 104,060, with the bulk of the new jobs in building retrofits, manufacturing, electricity generation/transmission/distribution, and renewable energy construction, with job losses in new construction and gas distribution. The introduction of the 2019 study summaries the challenge well:

> *"Building electrification will impact several employment sectors. Most obvious is growing the work performed in the process of electrifying more than 14 million homes and more than 8 billion square feet of commercial building space in California; construction jobs associated with efficiency improvements, building modifications, and equipment installations. In addition, there may be jobs in the manufacturing of electrical equipment and appliances needed for installation.*
>
> *There is also work required to ensure that the electricity system can support new demand loads driven by building electrification, which may require new renewable energy and grid infrastructure. Utility jobs to support increased electricity sales represent another area of job growth.*

[30] https://www.sandiego.gov/sites/default/files/sd_jobs_impact_analysis_summary_memo_dec2021_final-2.pdf
[31] https://www.nrdc.org/sites/default/files/los-angeles-building-decarbonization-jobs-impacts-report-20211208.pdf
[32] https://innovation.luskin.ucla.edu/california-building-decarbonization/

In addition to the increased demand for workers in these areas, there will be a reduced need for workers in other areas. All-electric new construction of buildings eliminates the need for plumbers and pipefitters to extend gas lines and connections; and reduced gas sales could cut the number of utility workers needed to provide gas service to customers, depending on the pattern of reductions. This study assesses all of these impacts.

To guide workforce planning and engagement, this study discusses the distribution of the positive and negative employment effects by market segment and by industry. It provides recommendations for engaging skilled and trained workers in the transition to clean energy generation and electric buildings. Suggestions to minimize and mitigate potential job losses from decreased natural gas consumption are also presented."

The GTI energy study referenced earlier "Seasonal Residential Space Heating Opportunities and Challenges" report on page 41 discusses the workforce impact.

"The large amount of infrastructure added to each scenario will require an expanded energy workforce, creating economic opportunity and job creation across scenarios. In particular, the central role of electrification across all decarbonization cases will require skilled labor to decarbonize and expand the state's electricity system and support customer installations and retrofits. Along the same lines, an expanded building performance industry will be needed to achieve the scale and depth of building electrification and energy efficiency retrofits envisioned in all scenarios. Other sectors of the economy, especially those associated with the production and delivery of fuels, are more likely to see workforce declines. For example, in the Limited Gas scenario, the gas workforce may need to be reskilled over time though, importantly, even in that case the transition occurs over a multi-decade period."

Phasing in the transition to building electrification will allow the workforce to adjust to the needs of future technology. BGE estimates they will need to at least double the capacity of the existing power grid, which will require at least 240 new substations to be built. This means land surveyors, land clearing and site work, and construction crews. The increased demand for these and other trades will more than make up for the reductions in the industries that are phased out. There will be adjustments and displacement of workers, but the amounts are unknown. The BCA does not have the ability to forecast specific workforce demands into the future. Any transition will need time for retraining of talent.

(v) develop recommendations regarding efficient cost–effectiveness measures for the electrification of new and existing buildings;

An all-electric *new* home may be more expensive to build, but technological advances are bringing the cost increases down. Electrifying an *existing* building will be an expensive proposition. It will likely increase the cost to live and work in the buildings, as electric systems are often more expensive to operate than carbon-sourced systems. Previous sections of this report, notably section 2, have already covered much of this topic, and the data is not clear regarding whether a cost-effective electrification is even possible for some buildings.

Equity concerns:

We must consider the impacts on the affordability of energy for the most vulnerable customers and members of the community. Equity and social justice will be compromised if electrification results in higher costs to people who cannot afford them. We must ensure that a decarbonized future does not leave anyone behind. There are various studies that have tried to analyze the cost differences between a gas-heated home and an electric-heated home. The cost of the equipment and the cost of the fuel factor into these estimates. Natural gas usage remains more affordable than electricity. Studies have shown that in Maryland, natural gas is less costly for customers as compared to electrification.[33]

Repeating the information quoted earlier in this report from the guidance document for the Biden administration's December 7, 2022 order for federal buildings to move away from on-site fossil fuel use, they note the increase in cost for electricity when compared to the cost of fossil fuels. They estimate that electricity is **4.3 times more expensive than natural gas** (see below from page 82)[34]:

> *"There are increases in energy costs across the board, this is because despite the increases in equipment efficiency and overall site energy savings the difference between the cost of fossil fuels (primarily natural gas) and purchased electricity at a national level are too high for the improvements to overcome. The EIA AEO 2021 energy outlook rate projections indicate that per the same amount of site energy consumed, electricity is about 4.3x more expensive than natural gas, this number gradually reduces over time per this projection down to 3.2x by the year 2050."*

[33] https://www.montgomerycountymd.gov/green/Resources/Files/climate/climate-action-plan.pdf
[34] https://www.energy.gov/sites/default/files/2022-12/doe-clean-energy-snopr.pdf

Regulations that assess an additional cost to the carbon ("social cost of carbon") don't lower the cost of the electric home, they merely add an additional cost to the gas home. This doesn't make the electric home any less expensive. The consumer still bears the extra costs.[35]

Scale of the challenge:

Within the Division of Labor & Industry, the Safety Inspections unit has jurisdiction over boiler inspections for the state of Maryland. To give an idea of the magnitude of the challenge for one piece of the complex puzzle, the Boiler inspections unit has 27,687 boilers registered in Maryland as of November, 2022. Most of these boilers were installed after 1950, but there are thousands that are older than 1950. The oldest registered boiler still in use was built in 1900 and is heating a school in Laurel. In an all-electric future, every one of these boilers that uses a carbon-based fuel will need to either be replaced with an electric water boiler, or a new HVAC heating system will need to be installed in the building.

According to the "Modeling the Economic Impact of a Local Gas Moratorium in the Baltimore Metropolitan Area" study from the American Gas Association (AGA)[36], a gas moratorium would affect more than 666,000 homes and 28,000 commercial structures in the Baltimore area. Older homes do not have the wiring capacity to handle an all-electric heating system or the additional electric needs of vehicle charging. Homes built before 1960 would likely need new wiring and a high-voltage service panel. There are at least 300,000 such older homes in the Baltimore area alone.

Conclusions:

Replacement of carbon-based systems will be expensive, both in terms of the installation costs of the new systems and the ongoing costs associated with their operation. Vulnerable populations, especially those who live in older homes, will be hardest hit and can least afford these costly upgrades.

Some houses just simply cannot be electrified at a cost that's reasonable - particularly in older homes that lack central air ductwork, lack sufficient wiring to handle the increased electrical demand, and are not readily able to improve their energy efficiency. Some older homes do not have the wiring capacity to handle an all-electric heating system or the additional electric needs of vehicle charging. If the cost to upgrade the house is past a certain percentage of the value of the home, it may not make economic sense to do the upgrades. In those cases, there are still improvements that can be made even if "all-electric" can't be achieved.

Recommendations:

- Focus on electrification of new single-family homes. The technology exists and is readily available.
- Allow time for innovations in technology and construction methods. As the technology advances, adopt future codes for larger residential buildings and commercial buildings that encourage all-electric systems, with allowances for specific industries and uses and

[35] https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf
[36] https://www.aga.org/research/reports/implications-of-policy-driven-residential-electrification/

for necessary backup power supply generators.

- For existing homes and buildings, encourage and incentivize installation of electric systems with allowances for hybrid systems where appropriate.
- Do not require existing buildings to fully electrify before the power grid and power generation systems are in place to accommodate the increased power demand. A reliable and resilient system using multiple fuel sources needs to be in place unless and until it is safe and reliable to move to all-electric.

(vi) on or before January 1, 2023, report to the Public Service Commission on the projected annual and peak summer and winter gas and electric loading impacts of electrification, categorized by building type and size, in sufficient detail for gas and electric public service companies to develop the plans required under subsection (c)(1)(i) of this section;

In order to project the electric loading impacts in sufficient detail, the following data points are needed:

1) A database of all buildings in Maryland that contains accurate detail about:
    a) The size of every building
    b) The building type and current use
    c) The energy use per month for each type of energy source (i.e. electricity usage, non-electric heat fuel use, non-electric power or other use)
    d) The projected date of replacement of every non-electric system
    e) The type of system that will replace every non-electric system
    f) The projected energy use of the all-electric replacement systems, broken down by month
2) A database of all vehicles used in Maryland that contains accurate detail about:
    a) The fuel type used by the vehicle itself (gas/diesel/hybrid/electric/etc.)
    b) The fuel type used by any equipment attached to the vehicle
    c) The amount of fuel used broken down by vehicle, and by month
    d) If current vehicle is non-electric, the energy use estimate of an electric vehicle that would replace each vehicle, broken down by month
    e) The projected date of replacement of every non-electric vehicle

An Example Scenario

Consider the case of one single-family house with two adults and two teenagers that also have their driver's licenses. Their 2,400 square foot house was built in 1982 with R30 insulation in the ceiling and R13 insulation in the walls. It has air conditioning and uses propane for the water heater, the two furnaces, the clothes dryer and the oven. The home also has a wood pellet stove in the basement. And the family owns a gas grill with a propane tank, a gas riding lawn mower, and has a wood-burning fire pit in the backyard. The family owns a 2015 Ford F-150 that one adult uses for work, a 2019 Honda Civic the other adult uses to commute to work, and a 2014 Toyota Sienna that the teenagers use. In order to fully decarbonize, the family needs to replace both furnaces with heat pumps, replace the gas water heater with an electric water heater, replace the gas dryer with an electric dryer, and replace the oven with an electric oven. They need to remove the pellet stove entirely. They also need to discontinue use and dispose of their gas grill and wood fire pit. They need to replace the lawnmower with an electric riding lawn mower.

In order to project the electric loading impacts, the data has to exist for the current energy use of each and every device mentioned in the example, the projected energy use of each and every device that replaces them, and an estimate of when every device will be replaced. The home is going to add insulation to the attic at some point and replace the windows with more energy efficient windows, so the energy usage is going to change before and after these energy improvements. The exterior walls cannot be upgraded from the R13 insulation without removing the drywall. And the roof is going to be replaced with a new roof, but the current roof is dark gray and they are going to choose a lighter brown color shingle for the new roof, so there is less solar gain from the new shingle color. Less solar gain means better energy efficiency in the summer, but worse energy efficiency in the winter.

And that's only for the house. Consider the vehicles. The total fuel consumption for each existing vehicle needs to be known, broken down by month. The data needs to be predicted for what all-electric vehicle will replace each non-electric vehicle, when it will be purchased, and then what the electricity usage of the replacement vehicle will be, also broken down by month. The by month usage needs to be known in order to plan for the impact of the electrification on the grid.

The Search for Data

In order to complete this section, this level of detail needs to be known for every building in Maryland, along with every vehicle in Maryland. The BCA tried to find data to complete this section and the data does not exist.

For the breakdown of buildings in Maryland categorized by type and size, we talked to several counties to see if the data exists at the county level and were told it does not. We talked to the State Department of Assessments and Taxation and they said their database does not contain this information in enough detail to be responsive. We spoke with electric utilities and they do not have the data on building type and size.

For the electricity and non-electric fuel use of each building, some of the data does exist. Energy companies know the usage of their product at each building. But in the case of the example house in the above scenario, though the electricity use is known by the electric utility, the home also uses a separate propane supplier that delivers to the house and buys their wood pellets from the hardware store. The utility that provides the electric does not have the data for the other fuels used at the home. Those data points would also need to be known and matched up to each building.

The MVA does have data for each vehicle that is registered in Maryland, but the fuel usage broken down by month does not exist.

The Future Estimates

This section requires the projection of the timeline for electrification of every building and every vehicle, the future electricity demand of each building once it's electrified, broken down by month, and the future electricity demand of every vehicle, broken down by month. This data

does not exist. But there are estimates that can predict trends. Testimony to the Montgomery County Council predicted that the overall demand for electricity under an all-electric scenario will result in at least double, and perhaps triple, the peak winter demand. The electric grid in Maryland is typically a peak summer system. Transitioning to electric vehicles will increase the demand throughout the year. But converting building heat from carbon-based fuel sources to electric-based systems will add to the winter demand.

As stated in the GTI energy study referenced prior:

> *"A key consideration with electric space heating is the non-linear increase in electricity consumption as temperatures decrease. The issue becomes acute when cold temperatures descend over a region for days or weeks." And on page B-3 "Across the 48 states, the projected future winter peak for residential electricity would be 175% of the future summer peak. Winter peaks would occur in 45 of the 48 states (94%)." (page B-1)*

The BCA reached out to the utilities to see if they have data that would be responsive to this section and they are working on estimates for the future scenarios. BGE was able to provide the BCA with some "directional only" estimates, meaning that the numbers themselves are estimates and trends can be seen when looking at the overall direction of the changes. Notably, their estimates show the overall electricity load will flip from a summer-peak to a winter-peak scenario. The two driving factors are the building electrification and the transition to electric vehicles. Building electrification has a greater impact in the winter scenario because buildings that were heated by natural gas or oil are now being heated by electric systems. Electric vehicles add to the load estimates throughout the calendar year, the only variable is the extent to which electric vehicles are adopted - the sooner there are a large percentage of electric vehicles, the sooner the increase in electricity demand. These estimates align with the estimates from the E3 studies discussed earlier - the future peak winter electricity demand will be between double and triple the current demand. There is not, however, data in sufficient detail to satisfy the full requirements of this section.

As other states also move towards decarbonization, the electricity demand in winter will strain the entire regional grid. As seen in the 2022 Christmas cold weather event, Maryland is a small state and cold weather that hits Maryland will also likely hit other states in the PJM region that rely on the same power grid. As a net importer of energy, Maryland should not assume that the regional grid will have the excess capacity to make up for shortfalls in Maryland's power generation capacity.

(vii) consider recommendations for the inclusion of renewable, low–carbon biofuels, including biodiesel, during the State's transition to an all–electric building code including an analysis of the impact on electric and gas rates, market availability, and environmental impact.

The term *biofuels* usually applies to liquid fuels and blending components produced from biomass materials called *feedstocks*. Most biofuels are used as transportation fuels, but they may also be used for heating and electricity generation. Biodiesel is made from an increasingly diverse mix of resources such as recycled cooking oil, soybean oil and animal fats. Biodiesel is a renewable, clean-burning diesel replacement. Ethanol is a renewable fuel that can be made from various plant materials, collectively known as "biomass." Renewable Natural Gas (RNG) can provide benefits in terms of fuel security, economic revenues or savings, local air quality and greenhouse gas emission reduction. Other biofuels include renewable heating oil, renewable jet fuel (sustainable aviation fuel, alternative jet fuel, biojet), renewable naphtha, and renewable gasoline. See EPA webpage[37].

Production and use of biofuels is considered by the U.S. government to have fewer or lower negative effects on the environment compared to fossil-fuel derived fuels. There are also potential national economic and security benefits when biofuel use reduces the need to import petroleum fuels.

The data does not show that biofuels are necessarily cleaner than existing alternatives. According to one study by the Manomet Center for Conservation Studies for the Massachusetts Department of Environmental Conservation, burning wood to produce electricity produces 46 per cent more emissions, kilowatt-hour-for-kilowatt-hour, than burning coal[38]. Studies about the cost of biofuel are also mixed. They show biofuel could result in higher costs, or lower costs.[39] [40] [41] [42]

Conclusions:

A "renewable" carbon-based fuel still produces carbon dioxide. The building codes should reduce energy use where possible and ensure the building is safe to use.

As the rest of this report shows, the coming changes to the built environment are going to dramatically increase the demand for electricity. The increased demand on the electric grid of an all-electric code will put a strain on the grid and the changes contemplated elsewhere in this report will double or triple the demand for electricity in Maryland. The focus needs to be on

[37] https://www.epa.gov/lmop/renewable-natural-gas
[38] https://www.invw.org/2014/04/23/biomass-fuel-worse-for-cl-1432/
[39] https://physicsworld.com/a/biomass-energy-green-or-dirty/
[40] https://viterbigradadmission.usc.edu/2018/03/are-biofuels-really-environmentally-friendly/
[41] https://www.conserve-energy-future.com/advantages-and-disadvantages-of-biofuels.php
[42] https://www.viaspace.com/biomass_versus_alternatives.php#

increasing the total electricity generation capacity of the Maryland system. Biofuels should be part of an “all options on the table” mindset that allows technology and science to advance, but does not favor one carbon based fuel over another and distort the function of the PJM power grid network.

Recommendations:

We do not recommend mandating or incentivizing biofuels at the expense of any other fuel that can be shown to produce electricity in a comparably clean manner. Allow the PJM system to improve and optimize electricity production across the region.

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END OF REPORT