Maryland Department of Labor

Division of Labor and Industry

Building Codes Administration

Report to the Public Service Commission and Legislative Policy Committee

February 1, 2024

Maryland
DEPARTMENT OF LABOR

OFFICE OF THE SECRETARY
1100 N. Eutaw Street 6th Floor
Baltimore, MD 21201
Portia Wu, Secretary

MSAR# 14142

February 1, 2024

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 Section 10 of Chapter 38 of the Laws of 2022 (SB 528)

The legislation assigns seven tasks to the Building Codes Administration of the Maryland Department of Labor, which were first reported on in an interim report to the Legislative Policy Committee in January 2023. The legislation requires a final report on these tasks to the Legislative Policy Committee in accordance with § 2–1257 of the State Government Article.

The final 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,

Portia Wu
Secretary, Department of Labor

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Executive Summary:

The Climate Solutions Now Act of 2022 (CSNA) designated that the Building Codes Administration (BCA) produce an interim report on the findings of seven items on or before January 1, 2023, and a final report on or before December 1, 2023. An extension on the final report was given to February 1, 2024. Those seven items are:

1. 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;
2. Develop recommendations for the fastest and most cost–efficient methods for decarbonizing buildings and other sectors in the State;
3. Assess the availability of technology and equipment that will be needed to construct all–electric buildings in the State;
4. Assess the impact of building electrification on workforce shortages;
5. Develop recommendations regarding efficient cost–effectiveness measures for the electrification of new and existing buildings;
6. 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; and
7. 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 law allows 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 and move toward all-electric codes, providing examples and information in those efforts. The BCA did not hire consultants to provide additional information for the interim or final reports, nor was funding for consultants provided in the bill.

The BCA is a small unit of 3 full-time employees within the Division of Labor and Industry (DLI) at the Maryland Department of Labor that is responsible for adopting State-wide minimum building codes. 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 in Maryland 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 recently, in addition to the building codes, that offers minimum standards to reduce the negative impacts and increase the positive impacts of construction on the natural environment and building occupants.

One of the central goals of the CSNA is the reduction of greenhouse gas emissions, or decarbonization - 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 to achieve it.

The CSNA also addresses electrification. 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, BCA considers any onsite power generation from wind or solar as part of the overall electric grid.

The following report goes further into each of the above seven items. Though the BCA does not have complete authority over each item, the items are in areas where MDL can work collaboratively with other State agencies to assist Maryland in attaining the ambitious goals set in the CSNA. The BCA is already working with other divisions within the Department of Labor and several sibling agencies on applying for federal grants from the U.S. Department of Energy (DOE) related to energy efficiency.

The Department stands ready to work with other State agencies to achieve the items that are attainable in the short term and put the necessary components in place to achieve the long-term goals. One such component would be to hire additional BCA staff who are subject matter experts to enhance the Unit's ability to put the CSNA's goals into action across the State.

In this report, the BCA includes a list of recommendations the Department feels will help lead Maryland towards attaining the goals of the CSNA and the other sustainability goals of the State. The list is in order of most immediate impact. Most of these recommendations can be achieved within existing, or minimal additional resources.

<u>Overview of Recommendations:</u>

1. Seek a summary report from BCA on the status of certain code adoptions of the following 2024 International Codes for adoption with possible amendments by December 31, 2024.
2. Create a system within BCA and with local jurisdictions, as appropriate, to provide a transparent process for limited exemptions or alternatives to full electrification.
3. Create a task force consisting of MDL (BCA and Division of Workforce Development and Adult Learning (DWDAL), Maryland Energy Administration (MEA), Maryland Department of the Environment (MDE), the Chief Sustainability Officer, a representative from the Maryland Building Officials Association (MBOA), Maryland Department of Housing and Community Development (DHCD), and the Maryland chapter of the American Institute of

Architects (AIA) to collaborate on attaining grant funds, sharing resources, and report back to the legislature by December 15, 2024 on recommendations and findings to continue to achieve the goals of the State as related to electrification, decarbonization, and sustainability.

4. Fund two additional positions within the BCA to assist with a transition to an all-electric code and to provide training to the jurisdictions throughout the State that will be tasked with adopting and enforcing the new codes.
5. Phase in the new all-electric codes to initially apply to residential and small commercial projects less than 5,000 square feet, renovation work, and replacement of outdated equipment.
6. 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. BCA does not have access to the information or technical skills to make this determination and would suggest that the Public Service Commission provide guidance on this issue.
7. Provide resources to DWDAL to help develop the skilled and trained workforce contractors and enforcing jurisdictions will need as Maryland continues to modernize the energy codes and they become more complex.
8. Encourage and incentivize the following:
    a. The purchase of hybrid gas/electric vehicles.
    b. The purchase of more fuel-efficient and diesel-powered vehicles.
    c. The installation of high-capacity electric panels in existing homes to accommodate the future purchase of electric vehicles.
    d. The replacement of carbon-based systems with all-electric systems (where feasible) in residential and commercial buildings.
    e. The replacement of carbon-based systems with hybrid or mixed-fuel systems where existing conditions do not readily allow for replacement with all-electric systems.
    f. The construction of all-electric commercial, industrial, and multifamily residential buildings, while allowing exemptions for those that fall under the U.S. Department of Homeland Security's Cybersecurity and Infrastructure Security Agency (DHS CISA) list to be able to use any fuel source deemed appropriate. By aligning with the federal government directive and allowing backup generators of any fuel type, buildings will look to decarbonize while also having a secure backup system.
9. Allow time for continued innovations in technology and construction methods. As technology advances, continue to adopt future codes for larger residential and commercial buildings that encourage all-electric systems while allowing certain necessary exemptions for backup power supply generators.
10. When a commercially available heat pump is available that functions without an emergency backup at temperatures as low as 0 degrees Fahrenheit, remove the exemption for hybrid heat pumps in the next code adoption cycle.

Below are the seven elements required by the CSNA. Each element contains MDL response and/or analysis. Relevant background, additional details, and supporting information is contained in the Appendices section following the final report.

1. *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;*

The BCA recommends the following to advance an all-electric code for the State:

1. During the next building code adoption cycle, require the BCA to consider the following optional Appendices to the 2024 International Energy Conservation Code with possible amendments:
    a. Appendix CB Solar-Ready Zone
    b. Appendix CC Zero Energy Commercial Building Provisions
    c. Appendix CD The 2030 Glide Path
    d. Appendix CG All-Electric Commercial Building Provisions
    e. Appendix CH Electric-Ready Commercial Building Provisions
    f. Appendices listed in the Residential portion are not currently available, but they may be similar to the Commercial ones.

    Note: Appendices must be directly adopted during regulation promulgation in order to be considered an enforceable regulation.
2. Provide for BCA to create a system and work with local jurisdictions, as appropriate, to provide a transparent process for limited exemptions or alternatives to full electrification.
3. Fund two additional positions within the BCA to assist with a transition to an all-electric code and to provide training to the jurisdictions throughout the State that will be tasked with adopting and enforcing the new codes.
4. Phase in any new all-electric codes to initially apply to residential and small commercial projects less than 5,000 square feet, renovation work, and replacement of outdated equipment.
5. 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. BCA does not have access to the information or technical skills to make this determination and it is suggested that the Public Service Commission provide guidance on this issue.

See Appendix A-1 for additional information.

2. Develop recommendations for the fastest and most cost–efficient methods for decarbonizing buildings and other sectors in the State;

1. Encourage and incentivize the following:
    a. The purchase of hybrid gas/electric vehicles.
    b. The purchase of more fuel-efficient and diesel-powered vehicles.
    c. The installation of high-capacity electric panels in existing homes to accommodate the future purchase of electric vehicles.
    d. The replacement of carbon-based systems with all-electric systems (where feasible) in residential and commercial buildings.
    e. The replacement of carbon-based systems with hybrid or mixed-fuel systems where existing conditions do not readily allow for replacement with all-electric systems.
    f. The construction of all-electric commercial, industrial, and multifamily residential buildings, while allowing exemptions for those that fall under the DHS CISA list to be able to use any fuel source they deem appropriate. By aligning with the federal government directive and allowing backup generators of any fuel type, buildings will look to decarbonize while also having a secure backup system.
2. When a commercially available heat pump is available that functions without an emergency backup at temperatures as low as 0 degrees Fahrenheit, remove the exemption for hybrid heat pumps in the next code adoption cycle.
3. Phase in the new all-electric codes to initially apply to residential and small commercial projects less than 5,000 square feet, renovation work, and replacement of outdated equipment.
4. 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. BCA does not have access to the information or technical skills to make this determination and suggests that the Public Service Commission provide guidance.
5. Allow time for continued innovations in technology and construction methods. As technology advances, continue to adopt future codes for larger residential and commercial buildings that encourage all-electric systems while allowing certain necessary exemptions for backup power supply generators.

See Appendix A-2 for additional information.

3. Assess the availability of technology and equipment that will be needed to construct all–electric buildings in the State;

Technology and equipment exist to construct all-electric residential buildings including townhouses and one- and two-family homes. Commercial-side technology and equipment is more difficult to come by at the present time. There are also ongoing supply chain issues, but those delays and wait times are continuing to decrease.

See Appendix A-3 for additional information.

4. Assess the impact of building electrification on workforce shortages;

According to the Climate Pollution Reduction Plan, Maryland's strategies to achieve its emissions goals will result in an annual average of 5,505 new jobs. The plan states that construction and transportation occupations experience most job gains, followed by installation, maintenance, and repair occupations. It is not clear what proportion of these job gains are from building electrification or from other strategies, such as the Maryland Transportation Plan.

Phasing in the transition to building electrification will allow the workforce to adjust to the needs of future technology. Baltimore Gas and Electric (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 there will be a need for land surveyors, land clearing, site work, and construction crews. There will be adjustments and displacement of certain workers in non-electric fuel source related fields, but the amounts are unknown.

The BCA recommends providing resources to DWDAL within MDL to help develop the skilled and trained employees contractors and enforcing jurisdictions will need as Maryland continues to modernize its energy codes and they become more complex.

See Appendix A-4 for additional information.

5. Develop recommendations regarding efficient cost–effectiveness measures for the electrification of new and existing buildings;

The BCA believes these actions will help maximize cost-effectiveness:

1. Phase in the new all-electric codes to initially apply to residential and small commercial projects less than 5,000 square feet, renovation work, and replacement of outdated equipment.
2. 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. BCA does not have access to the information or technical skills to make this determination and suggests that the Public Service Commission provide guidance on this issue.
3. When a commercially available heat pump is available that functions without an emergency backup at temperatures as low as 0 degrees Fahrenheit, remove the exemption for hybrid heat pumps in the next code adoption cycle.
4. Encourage and incentivize the following:
    a. The installation of high-capacity electric panels in existing homes to accommodate the future purchase of electric vehicles.
    b. The replacement of carbon-based systems with all-electric systems (where feasible) in residential and commercial buildings.
    c. The replacement of carbon-based systems with hybrid or mixed-fuel systems where existing conditions do not readily allow for replacement with all-electric systems.
    d. The construction of all-electric commercial, industrial, and multifamily residential

buildings, while allowing exemptions for those that fall under the DHS CISA list to be able to use any fuel source they deem appropriate. By aligning with the federal government directive and allowing backup generators of any fuel type, buildings will look to decarbonize while also having a secure backup system.

5. Allow time for continued innovations in technology and construction methods. As technology advances, continue to adopt future codes for larger residential and commercial buildings that encourage all-electric systems while allowing certain necessary exemptions for backup power supply generators.

See Appendix A-5 for additional information.

6. 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)(2)(i) of this section;

The BCA tried to find data to complete this section and was unable to locate any. It is noteworthy that the General Assembly is exploring the possibility of utility companies compiling this information based on several 2024 proposed bills.

See Appendix A-6 for additional information.

7. 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 BCA currently recommends the following:

1. 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 (an abbreviation of "Pennsylvania, New Jersey and Maryland" after the territories where the utilities first joined together) power grid network.
2. Allow the PJM system to improve and optimize electricity production across the region.
3. Allow buildings to use hybrid systems while technology is given a chance to advance to allow for all-electric systems to be available and fully operational with an electric grid that can handle the required output.

See Appendix A-7 for additional information.

The following Appendices contain relevant background, additional details, and supporting information arranged by element.

Appendices

<u>Appendix A-1: *Develop recommendations for an all–electric building code for the State, including appropriate exemptions*</u>

Introduction

Within Maryland, most of the 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 (US Energy Information Administration, 2016). Maryland uses as much as 40% 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 (US Department of Energy, 2021). In the guidance document explaining the announcement, they note that this will result in an **<u>increase</u>** in carbon dioxide, nitrous oxide, mercury, and sulfur dioxide emissions.

> *"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"* (US Department of Energy, 2021).

Maryland's energy suppliers are part of the PJM system, 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.com). 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, 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. **The following are PJM's three pillars**:

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.

It is along those lines and to meet the goals of Maryland and the CSNA the BCA was charged to investigate seven items that could move Maryland and those goals closer to an all-electric future.

Building codes, like other codes adopted and enforced by DLI, set standards primarily about the health, safety, and welfare of the occupants. These standards tell builders and contractors how to build structures and they are enforced by local 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 merely building safety and items that are enforceable by the code officials. For example, a home with R38 insulation (approximately 11.6 inches in thickness) installed in the ceiling is not safer or more structurally sound than a home with R30 insulation (about 9.3 inches in thickness). However, it would be less expensive for the owner to heat and cool the home. With each successive code cycle, the code has continued to increase the amount of insulation thickness, but it does not make the home safer for the occupants, only more energy efficient to a certain degree. It is with this in mind that our recommendations under the CSNA try to balance the aggressive goals of the law with what is safe and can be achieved with current technology, while allowing for technological advances that are sure to come in the near future.

The current set of building codes that the State uses as its base to create the Model Performance Code and Maryland Building Performance Standards are put out by the International Code Council on a three-year cycle. 2024 is the next round of code updates and adoptions and Maryland will have a chance to potentially advance an all-electric code or at least allow for an option of an all-electric code. The International Energy Conservation Code (IECC) is the main driver for the all-electric code provisions. The IECC has two sections - a commercial section and a residential section - each with different requirements for electrification.

The BCA conducted a sampling of 16 jurisdictions around the State and eight responded. Jurisdictions were asked whether or not they go beyond the current building codes for electrification requirements. Currently, only Montgomery County has adopted amendments in their regulations to prepare their county toward an all-electric code. The BCA also asked if jurisdictions anticipated any challenges to enforcing an all-electric code. Baltimore County and Howard County responded that they are preparing to add pieces of an all-electric code during the upcoming code cycle. The other six jurisdictions said they would need additional manpower and training on an all-electric code.

An all-electric commercial code

Technology for commercial buildings (multifamily, retail, industrial, etc.) may exist, but research indicates this technology may not be at the stage where it’s reliable and readily available. Many of the supporting documents and reports submitted to both the Maryland Legislature during the debate over the CSNA and to the Montgomery County Council during their debate over an all-electric code further suggest that staggering 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.

Concerns have been expressed whether non-residential construction and large multifamily construction all-electric codes may work at this time. Quoting from the National Association for Industrial and Office Parks (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" (Ndou, 2022).

An all-electric residential code

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 and element 3 in this report goes further into that aspect.

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 homes will be adequate 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 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."

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.

Exemptions to an all-electric code

Regarding the consideration of exemptions to an 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) (Laws – Statute Text, 2022). The Biden administration's declaration on December 7, 2022, through the Department of Energy 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 (US Department of Energy, 2021). 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.

National Security: Designated Critical Infrastructure Sectors

The DHS CISA directive identifies 16 critical infrastructure sectors and designates associated federal Sector Risk Management Agencies (SRMAs). In some cases, co-SRMAs are designated where those departments share the roles and responsibilities of the SRMA (Cybersecurity & Infrastructure Security Agency, 2022). 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 SRMA for that sector (Cybersecurity & Infrastructure Security Agency, 2022). The sectors and SRMAs are as follows:

Chemical - Department of Homeland Security (DHS);
Commercial Facilities - DHS;
Communications - DHS;
Critical Manufacturing - DHS;
Dams - CISA;
Defense Industrial Base - Department of Defense;
Emergency Services - DHS;
Energy - Department of Energy;
Financial Services - Department of Treasury;
Food and Agriculture - Department of Agriculture and Department of Health and Human Services (HHS);
Government Facilities - DHS and General Services Administration;
Healthcare and Public Health - HHS;
Information Technology - DHS;
Nuclear Reactors, Materials, and Waste - DHS;

Transportation Systems - DHS and Department of Transportation; and
Water and Wastewater Systems - Environmental Protection Agency.

The BCA spoke with representatives of the CISA and based upon those discussions and other research; the BCA does not see a practical way to write code language that can incorporate the necessary exemptions. First, determining what industries may or may not fall into a particular category is not as simple as it sounds as many companies have multiple product lines that are interconnected, and some may fall under CISA and some may not. Second, determining which companies or facilities would fall under the "critical infrastructure" exemption,[1] which is so broadly defined that a large portion of the buildings in Maryland could make the argument that they are critical and exempt. And third, not all buildings are constructed knowing who the end user is going to be and then sold or leased after completion. Building codes with exemptions for the end user is not possible if the end user is not known. It is for these reasons that the BCA does not believe it is possible to create a code with the required exemptions. The exemptions are vital to national security, 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 available to have an all-electric requirement that can guarantee not to negatively impact national security, critical infrastructure, or life sciences.

Backup power at data centers, industry experts say, is just as critical as standard power, because it needs to be available for major natural disasters and other emergencies. While the industry is scrambling to find clean energy alternatives, most backup power at data centers across the U.S. is provided by fossil fuel sources. Even though there are exemptions and good reasons for those exemptions, they may not always be approved by the agency tasked with the review. Recently, a company working on a data center project in Maryland was denied a waiver request to install diesel generators as the backup power at its planned facility (Kurtz, 2023). Issuing a denial may have a negative effect on the project moving forward or possibly being canceled altogether. Without a set process for approving exemptions, these will be subject to the interpretations of the reviewing agency.

Two jurisdictional examples

Evaluation of two jurisdictions in Maryland that are moving forward with plans for an all-electric code:

1. **Howard County**
   The Howard County Department of Inspections, Licenses and Permits has put together a report to their County Council to respond to Bill No. 5-2023 asking what would be needed to require all-electric buildings. Their recommendations included the following:
   A. Incorporate the 2024 International Energy Conservation Code all-electric appendix into the code for both commercial and residential buildings.

[1] 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.

B. Consider exemptions for certain buildings in meeting the all-electric code requirements.
C. Adopt the 2024 International Green Construction Code (IgCC).
D. Review a net zero standard for County buildings.

Montgomery County

In 2022, Montgomery County signed into law Bill 13-22, the Comprehensive Building Decarbonization Law. This law requires the County to have an all-electric code by 2027. To prepare for this transition, the County introduced several commercial energy code amendments to the 2021 codes that included electrification ready measures, electric vehicle infrastructure requirements and energy storage system measures (for new construction) in the IgCC. They are also proposing to remove all natural gas points from the elective section of the energy code and proposing a change to the performance pathway (modified Appendix G) in the energy code that will align the next three code cycles to result in a net zero energy requirement by the third code cycle.

In addition to Bill 13-22, the Department of Permitting Services is proposing amendments to the adoption of the 2021 IECC residential construction that encourages electrification or electric capable construction.

Appendix A-2: ***Develop recommendations for the fastest and most cost–efficient methods for decarbonizing buildings and other sectors in the State***

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 (such as the gas/electric hybrid Ford Escape, 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, 55% of residential heating is provided by gas or oil (Maryland Public Service Commission, 2021). And the projected growth rate for the residential sector for the next ten years is only 6.43%, so 93.57% of residential users are existing homes (Maryland Public Service Commission, 2021). 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 new and renovated 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 does not yet exist or is not readily available. The goal is elimination of carbon emissions, but progress can be made and carbon emissions can also be *reduced* by a variety of paths other than just moving to all-electric. 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 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" report estimates that the retrofit cost for an average Baltimore-area home to switch from natural gas to all-electric would be $25,017 (Home Innovation Research Labs, 2021). The estimated energy savings for the all-electric house ranges from $77 to $184 per year, so payback time on an electrification project could be over a hundred years.

Improving the energy efficiency of a building, whether it is a home or a commercial/industrial building, has a range of options. Depending on the building, the type of construction, and the age, there may be some "low hanging fruit", but deep improvements may be physically impossible or financially infeasible for some buildings. Traditional single-family homes 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 the 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 fully 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 cannot accommodate the charging system, an individual 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 (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 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"* (Ndou, 2022).

According to the PJM 2021 Annual Report:

"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" (PJM, 2021).

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):

"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" (Ndou, 2022).

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 and some areas within the Baltimore region experienced rolling brown outs in an effort to keep the grid functional (PJM, 2022).

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 in 2021, the International Energy Administration highlighted that “energy systems with heavy dependence on electricity for space heating will be challenged by exceptionally cold temperatures” (Everhart & Molnar, 2021). The cold weather had three main impacts on the Texas power system:

1. The cold weather drove electricity demand much higher than normal.
2. Most of Texas’ electricity demand is met with natural gas. The cold weather caused gas production to stall due to frozen gas wells.
3. Gas generators declared their resources unavailable to the lack of natural gas.

More recently, this past December, the Maine Board of Environmental Protection delayed their vote on an electric vehicle mandate due to a major storm that caused widespread power outages (Catenacci, 2023). The power outages showed that electric vehicles would be rendered useless given their need to use electricity to generate their power. The article goes on to mention that automakers are scaling back their electric vehicle production and that critics of aggressive electric vehicle requirements are pointing out that the current U.S. power grid is not equipped to handle the significant increased demand and load placed on the grid by widespread electric vehicle policy adoption.

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, “Seasonal Residential Space Heating Opportunities and Challenges,” projects that Maryland’s percent change from Spring to Winter “marginal emission rate” would be an astounding 1,118.7% - the third worst in the country behind only North Dakota and South Dakota (Liss & Bonetti, 2022). According to that same report, switching Maryland from gas heat to all-electric would mean an *increase* in greenhouse gas emissions by 529.3% during these coldest winter days (Liss & Bonetti, 2022).

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.”[19] from Washington Gas. The report notes that vulnerable elderly citizens face an acute danger from unreliable heat, noting:

> *“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”* (Washington Gas, 2020).

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 (Clark & Aas, 2021).

Affordability and equity

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**:

> *"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"* (US Department of Energy, 2021).

The Air-Conditioning, Heating & Refrigeration Institute (AHRI) September 10, 2021, letter to the Maryland Department of the Environment regarding Maryland Building Decarbonization Policy Options 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"* (Stewart & Osorto, 2021).

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 (US Department of Energy, 2021).

The AHRI September 10, 2021 letter made several points that are relevant to this section:

- *"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 the 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"* (Stewart & Osorto, 2021).
- *"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 construction code"* (Stewart & Osorto, 2021).
- *"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"* (Stewart & Osorto, 2021).
- *"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 the 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"* (Stewart & Osorto, 2021).
- *"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"* (Stewart & Osorto, 2021).

Older homes may be more difficult

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 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 current Department of Labor building at 1100 N. Eutaw Street, is almost entirely single-pane glass on the exterior, so an energy-efficient exterior upgrade could require an entirely new exterior shell. The cost of this renovation might exceed the value of the building itself. NBI referred to these buildings as "lost cause buildings", and depending upon how strict the BEPS requirements are, the percentage of lost cause buildings can change (*Building Energy Performance Standards*, n.d.).

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 within the report as well as breaking them down in detail:

> *"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, and the introduction of plug-load management, low GWP refrigerants, energy storage, and active demand management, typically 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., car park roof, grounds) availability and orientation"* (Kampschroer, 2022).

Additional good news

There is promising news regarding decarbonization. First, last December, the U.S. Green Building Council released a first-of-its-kind report titled *State of Decarbonization: Progress in U.S. Commercial Buildings 2023.* The report, based on the U.S. commercial real estate sector, examined 30 years of data and found that the U.S. has made progress in decarbonizing commercial real estate, though it has been uneven (US Green Building Council, 2024). The report says that the U.S. has the tools it needs to reduce building-related emissions and there are federal funds available to continue to move forward in the decarbonization process (US Green Building Council, 2024).

<u>Appendix A-3: *Assess the availability of technology and equipment that will be needed to construct all–electric buildings in the State*</u>

Technology exists to build an all-electric home

There are ways to heat a home without carbon-based fuel. A heat pump, for example, uses electricity to transfer heat from a cool space to a warm space. In the heating season, the heat pump creates warm air to put into the house from the cooler outside air. In the cooling season, the heat pump will move the heat from inside the house to the outdoors. 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. 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"* (Liss & Bonetti, 2022).

The only decarbonization measure on the chart with a rating of 11 is an efficient gas appliance condensing furnace. Cold-climate air-source heat pumps (ASHPs) for residential and small commercial projects 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.

Heat pumps still have a downside though, as BGE's letter to the Montgomery County Council (October 26, 2022) notes:

> *"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."*

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 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

Technology for some all-electric non-residential buildings is still in nascent stages, and many of the innovative 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 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 where they could be the only option for new large buildings.

Appendix A-4: *Assess the impact of building electrification on workforce shortages*

History shows that transitions often result in the displacement of workers who already experience systemic barriers in the labor market, while creating new opportunities for other workers. The types of jobs that will be affected by building electrification (both those gained and those lost) are jobs that require specialized training and skills. Intentional efforts will be needed to ensure incumbent workers and populations who experience barriers to employment are prioritized for new training opportunities.

People who install and service heat pumps, build electric substations, or service steam boilers receive years of training to safely perform their jobs. New workers to the field will likely be transitioning from the natural gas and oil sectors, as well as plumbers and pipefitters, and they may 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 found an increase in building construction and building retrofit jobs, but a loss in jobs in the gas utility industry and gas infrastructure (Gloria, 2021). A 2021 study for the city of Los Angeles notes 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) (Jones, 2021).

A 2019 study for the California building decarbonization executive order 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 (Jones & Karpman, 2019). The introduction of the 2019 study summarizes 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. 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"* (Jones & Karpman, 2019).

According to the Climate Pollution Reduction Plan, Maryland's strategies to achieve its emissions goals will result in an annual average of 5,505 more jobs than if these strategies were not implemented (Maryland Department of the Environment, 2023). The Construction and Transportation occupations experience most job gains, followed by Installation, Maintenance, and Repair occupations (Maryland Department of the Environment, 2023). It is not clear what proportion of these job gains are from building electrification or from other strategies, such as the Maryland Transportation Plan. In addition, it's possible that jobs are phased in as the move towards electrification is also phased in. Some workers in the gas trades may also choose to switch over to the electrical field which is a similar type of field.

One sector where Maryland must grow is manufacturing. We lack the manufacturing workforce needed for electrification. Maryland currently imports most of its electricity from neighboring states and only has about 50 jobs in the state for the manufacturing of household appliances (US Bureau of Labor Statistics, 2022). Household appliances like gas stoves, ranges and washers and dryers that will need to be replaced with electric ones in the switch to electrification.

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, 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 of this magnitude will need time for retraining talent.

MDL is working to address the workforce shortage. DWDAL is currently applying for an Energy Auditor Training Grant with several other divisions within the MDL, including the BCA (US Department of Energy, 2023). This program would help train individuals to conduct energy audits, or surveys, on both commercial and residential buildings (US Department of Energy, 2023). If awarded a grant, the timeframe to use the funds is three years - approximately 2025-2028 (US Department of Energy, 2023).

MDL and MEA are also applying for the Training for Residential Energy Contractors (TREC)[35] program that will provide states assistance to develop and implement a state workforce energy program that prepares workers to deliver energy efficiency, electrification, and clean energy improvements (US Department of Energy, 2023).

Appendix A-5: ***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 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 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.

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** (US Department of Energy, 2021):

> *"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"* (US Department of Energy, 2021).

Regulations that assess an additional cost to the carbon ("social cost of carbon") do not lower the cost of the electric home, they merely add an additional cost to the gas home (US Environmental Protection Agency, 2022). This doesn't make the electric home any less expensive. The consumer still bears the extra costs.

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, the Boiler Inspection Unit has 27,711 boilers registered in Maryland as of January 5, 2024. 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. And this is only based on data that we have - only boilers over 200,000 BTU are inspected by the State. There is no database that keeps records of boilers under that size.

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 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. 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.

Appendix A-6: ***Report to the Public Service Commission on the projected annual and peak summer and winter gas and electric loading impacts of electrification***

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 details 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; and
   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 details 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; and
   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 lawnmower, 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. Achieving full decarbonization is difficult in this circumstance as 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. Finally, they need to replace the lawnmower with an electric riding lawn mower.

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.

Additionally, 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.

Now 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 to plan for the impact of the electrification on the grid.

The Search for Data

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 found that it 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.

We were able to speak with a company called Costar, an industry leader in commercial real estate information, analytics and news. Costar has over 35 years in the business and has about 77,000 commercial properties in their database for Maryland. They felt confident that they currently track roughly 85% of the commercial buildings in the State. They can be sorted based on type of building or size. However, there is no information related to utility usage in their database.

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 electricity 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%)"* (Liss & Bonetti, 2022).

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 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 study, "Maryland Building Decarbonization Study," discussed earlier - the future peak winter electricity demand will be between double and triple the current demand (Clark & Aas, 2021). 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. 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.

Appendix A-7: ***Consider recommendations for the inclusion of renewable, low–carbon biofuels, including biodiesel, during the State's transition to an all–electric building code***

The term *biofuels* usually applies to fuels produced from renewable organic material. Most biofuels are used as transportation fuels, but they may also be used for heating and electricity generation. Biodiesel is made from a variety of resources such as oil or animal fats. Biodiesel is a renewable, clean-burning diesel replacement. Sugar and starch crops are converted through fermentation to form a bioalcohol. Ethanol is the most widely used bioalcohol fuel and most vehicles can use a gasoline-ethanol blend containing up to 10 percent ethanol. See the EPA webpage on "Economics of Biofuels".

The 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. The production of biofuels results in greenhouse gas emissions, however, the Environmental Protection Agency's 2010 analysis of the Renewable Fuel Standard projected that several types of biofuels could yield lower lifecycle greenhouse gas emissions than gas over a 30-year timeframe (US Environmental Protection Agency, 2019).

The Biden administration estimates that natural gas is less expensive than electricity. Until they become closer in cost, people will look to use the less expensive option. In addition, there are concerns that equity will also come into play as lower-income communities will not be able to afford the push towards electrification. The same would also apply to biofuels if they are just as expensive as electricity.

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 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. In addition, allowing the PJM system to improve and optimize electricity production across the region will have benefits for all.

END OF REPORT

References

Building Energy Performance Standards. (n.d.). Maryland Department of the Environment; Maryland Department of the Environment. https://mde.maryland.gov/programs/air/ClimateChange/Pages/BEPS.aspx

Catenacci, T. (2023, December 21). *Maine forced to delay vote on EV mandate amid widespread power outages*. Fox News. https://www.foxnews.com/politics/maine-forced-delay-vote-ev-mandate-amid-widespread-power-outages

Clark, T., & Aas, D. (2021). Final Report Maryland Building Decarbonization Study. In *Maryland Department of Energy*. Energy + Environmental Economics. https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/E3%20Maryland%20Building%20Decarbonization%20Study%20-%20Final%20Report.pdf

Cybersecurity & Infrastructure Security Agency. (2022). *Critical Infrastructure Sectors*. Cybersecurity and Infrastructure Security Agency. https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors

Everhart, K., & Molnar, G. (2021, February 18). *Severe power cuts in Texas highlight energy security risks related to extreme weather events*. IEA.org; International Energy Agency. https://www.iea.org/commentaries/severe-power-cuts-in-texas-highlight-energy-security-risks-related-to-extreme-weather-events

Gloria, T. (2021). San Diego Jobs Impact Analysis. In *SanDiego.Gov*. City of San Diego. https://www.sandiego.gov/sites/default/files/sd_jobs_impact_analysis_summary_memo_dec2021_final-2.pdf

Home Innovation Research Labs. (2021). *Cost and Other Implications of Electrification Policies on Residential Construction*. https://www.nahb.org/-/media/NAHB/nahb-community/docs/committees/construction-codes-and-standards-committee/home-innovation-electrification-report-2021.pdf

Jones, B. (2021). Los Angeles Building Decarbonization: Community Concerns, Employment Impacts, Opportunities . In *NRDC.org*. Natural Resources Defense Council. https://www.nrdc.org/sites/default/files/los-angeles-building-decarbonization-jobs-impacts-report-20211208.pdf

Jones, B., & Karpman, J. (2019). California Building Decarbonization: Workforce Needs and Recommendations. In *innovation.luskin.ucla.edu*. University of California Los Angeles. https://innovation.luskin.ucla.edu/wp-content/uploads/2019/11/California_Building_Decarbonization.pdf

Kampschroer, K. (2022). GSA Green Building Advisory Committee Advice Letter: Recommendations for Advancing GHG Reductions in Existing Federal Buildings. In *General Services Administration*. General Services Administration. https://www.gsa.gov/system/files/GBAC%20Decarbonization%20Advice%20Letter%20Final%2011-09-22%282%29.pdf

Kurtz, J. (2023, December 11). *Centers of controversy: Is there enough energy for Md. to meet its tech ambitions?* Maryland Matters. https://www.marylandmatters.org/2023/12/11/centers-of-controversy-is-there-enough-energy-for-md-to-meet-its-tech-ambitions/?emci=670565c9-b3af-ee11-bea1-0022482237da&emdi=391c6728-b8af-ee11-bea1-0022482237da&ceid=266358

Laws - Statute Text. (2022). Mgaleg.maryland.gov; Maryland General Assembly. https://mgaleg.maryland.gov/mgawebsite/Laws/StatuteText?article=gec&section=3-201&enactments=false

Liss, W., & Bonetti, E. (2022). Seasonal Residential Space Heating Opportunities and Challenges. In *GTI Energy*. GTI Energy. https://www.gti.energy/wp-content/uploads/2022/05/21917-Topical-Report-

Seasonal-Space-Heating-Opportunities-and-Challenges-w-Appx_05-2022-v2.pdf

Maryland Department of the Environment. (2023, December 28). *Maryland's Climate Pollution Reduction Plan*. Maryland Department of the Environment; Maryland Department of the Environment. https://mde.maryland.gov/programs/air/ClimateChange/Pages/Maryland%27s-Climate-Pollution-Reduction-Plan.aspx

Maryland Public Service Commission . (2021). *Ten-Year Plan (2021-2030) of Electric Companies in Maryland*. https://www.psc.state.md.us/wp-content/uploads/2021-2030-Ten-Year-Plan.pdf

Ndou, L. (2022, October 31). *Bill 13-22, Buildings – Comprehensive Building Decarbonization*. Montgomery County Government ; Montgomery County Government . https://www.montgomerycountymd.gov/council/Resources/Files/agenda/cm/2022/20221103/20221103_PHED1.pdf

PJM. (2021). *PJM 2021 Annual Report* . Pjm.com; PJM. https://services.pjm.com/annualreport2021/innovation/

PJM. (2022, December 24). *PJM Asks Consumers To Conserve Electricity*. Insidelines.pjm.com; PJM. https://insidelines.pjm.com/pjm-asks-consumers-to-conserve-electricity/

Stewart, M., & Osorto, C. (2021). Maryland Building Decarbonization Policy Options. In *Maryland Department of the Environment* . Air-Conditioning, Heating, & Refrigeration Institute . https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/MWG_Buildings%20Ad%20Hoc%20Group/AHRI.pdf

US Bureau of Labor Statistics. (2022). *Quarterly Census of Employment and Wages: Employment and Wages Data Viewer*. Data.bls.gov; US Bureau of Labor Statistics. https://data.bls.gov/cew/apps/table_maker/v4/table_maker.htm#type=0&year=2022&qtr=A&own=5&ind=3352&supp=0

US Department of Energy. (2021, December 21). *Clean Energy for New Federal Buildings and Major*

Renovations of Federal Buildings. Federal Register; US Department of Energy. https://www.federalregister.gov/documents/2022/12/21/2022-27098/clean-energy-for-new-federal-buildings-and-major-renovations-of-federal-buildings

US Department of Energy. (2023a). *DE-FOA-0003204: BIPARTISAN INFRASTRUCTURE LAW (BIL) 40503: ENERGY AUDITOR TRAINING*. Infrastructure-Exchange.energy.gov; US Department of Energy. https://infrastructure-exchange.energy.gov/Default.aspx#FoaId038dc577-5945-4a71-9190-7b95b61cd629

US Department of Energy. (2023b). State and Community Energy Programs (SCEP) Inflation Reduction Act (IRA) of 2022 State-Based Home Energy Efficiency Contractor Training Grant Program CFDA Number: 81.041 ADMINISTRATIVE AND LEGAL REQUIREMENTS DOCUMENT (ALRD). In *energy.gov*. US Department of Energy. https://www.energy.gov/node/4831194

US Energy Information Administration. (2016). *Maryland - State Energy Profile Analysis - U.S. Energy Information Administration (EIA)*. Eia.gov; US Energy Information Administration. https://www.eia.gov/state/analysis.php?sid=MD

US Environmental Protection Agency. (2019, January 29). *Economics of Biofuels*. Epa.gov; US Environmental Protection Agency. https://www.epa.gov/environmental-economics/economics-biofuels

US Environmental Protection Agency. (2022). Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances. In *epa.gov*. US Environmental Protection Agency. https://www.epa.gov/system/files/documents/2022-11/epa_scghg_report_draft_0.pdf

US Green Building Council . (2024). *State of Decarbonization: Progress in U.S. Commercial Buildings 2023*. Usgbc.org; US Green Building Council. https://build.usgbc.org/state-of-decarbonization-2023

Washington Gas. (2020). Natural Gas and its Contribution to a Low Carbon Future Climate Business Plan for. In *Washington Gas Climate Business Plan*. AltaGas. https://washingtongasdcclimatebusinessplan.com/wp-content/uploads/2020/04/Climate-Business-Plan-

March-16-2020-FOR-WEB.pdf