DELAWARE'S
Climate Action Plan





Delaware's Climate Action Plan was prepared by the
Delaware Department of Natural Resources and Environmental Control

November 2021

Recommended Citation:
Delaware Department of Natural Resources and Environmental Control, *Delaware's Climate Action Plan*, by Jennifer de Mooy, Margaret Pletta, and Ian Yue (Dover, DE, November 2021).

Photo credit: Eric Crossan

Authors and Acknowledgements

Delaware's Climate Action Plan was coordinated by staff from the Delaware Department of Natural Resources and Environmental Control (DNREC) and informed by the input of residents, businesses and organizations from around the state.

The lead authors and editors of this report are:

Jennifer de Mooy, Principal Planner
Margaret Pletta, Planner IV
Ian Yue, Planner IV

from the DNREC Division of Climate, Coastal and Energy.

Additional written contributions were provided by other members of the Climate Action Plan team, consisting of:

DNREC Division of Air Quality
Valerie Gray, Planning Section Administrator
Ajo Rabemiarisoa, Environmental Engineer II
Christian Wisniewski, Environmental Engineer II

DNREC Division of Climate, Coastal and Energy
Dayna Cobb, Division Director
Kimberly Cole, Coastal Programs Section Administrator
Jim Lee, Community Relations Officer
Susan Love, Climate and Sustainability Programs Section Administrator
Thomas Noyes, Principal Planner
Nicole Rodi, Planner III
Dr. Robert Scarborough, Program Manager II
Brett Swan, Planner II
Robert Underwood, Energy Policies and Programs Section Administrator

Final editing was provided by Joy Drohan, Eco-Write, LLC.
Document design and layout provided by Noodlebox Design, LLC

The Climate Action Plan team would like to acknowledge the technical contributions of ICF for its greenhouse gas emissions modeling and the stakeholder engagement expertise of Kim Lundgren Associates, Inc.; Planning Communities, LLC; and Hamel Environmental Consulting for their assistance in climate change communications and outreach. The team would also like to thank the economic sector technical experts, state agency staff and hundreds of Delaware residents who provided feedback and ideas to the design of this plan.

This project was partially funded using federal funds under award NA18NOS4190144 from the Delaware Coastal Management Program and the Office for Coastal Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions and recommendations in this plan are those of the state of Delaware and do not necessarily reflect the views of the NOAA Office for Coastal Management, National Oceanic and Atmospheric Administration or the U.S. Department of Commerce.

Funding for this project was also provided through Delaware's participation in the Regional Greenhouse Gas Initiative.

Message from Governor Carney

When I took the oath of office to become Delaware's 74th Governor, I pledged not only to uphold our Constitution, but to 'respect the right of future generations to share the rich historic and natural heritage' of our state. That includes recognizing the threat that climate change poses to Delaware – the lowest-lying state in the nation – and taking action to protect our natural environment and prepare our state for the future.

The past decade was the hottest on record in Delaware. Sea levels are rising at an accelerated pace. Heavy rainfall and severe storms are becoming more frequent. These changes --and the resulting impacts including infrastructure damage and heat-related illnesses--will continue to worsen in the coming decades if we don't act now Because climate change is caused by human activities, we alone can solve the climate challenge. It is our responsibility to ourselves, to our most vulnerable communities and to future generations to take the threat of climate change seriously and act now.

Delaware's Climate Action Plan highlights practical and common-sense strategies we can take to maximize our state's resilience to climate change impacts and minimize planet-warming greenhouse emissions.

This plan lays out a pathway for the state to meet the goal I set during my first year as Governor to reduce greenhouse gas emissions by at least 26% by 2025. It also identifies actions our state can take to reduce emissions beyond 2025. By putting this state-wide plan into action, Delaware will play a leading role in meeting ambitious and achievable climate goals, while also creating economic opportunities and improving environmental health.

In addition to reducing emissions, we must be prepared for the impacts of climate change. State agencies play an essential role in maintaining our exceptional quality of life, from economic growth to human and environmental health to hazard response. This plan recognizes the important role of state agencies by highlighting strategies they can take to maximize our resiliency to climate impacts. Implementing these strategies now can ensure that state funding mechanisms, regulations, management plans and state facilities are prepared to meet the changing and challenging effects of global climate change.

In the coming months, I will be working directly with state agencies to move forward on these actions, but state agency action alone cannot get us where we need to go. I encourage every business owner, non-profit agency, local government and resident to help us achieve our climate goals by learning about the effects of climate change, preparing your home and business and reducing your emissions.

We can and should embrace the change to a cleaner energy future. Investments in solar, wind and other renewable sources will create good new jobs for Delaware families, and position our state to lead on environmental protection.

The Climate Action Plan was strengthened by public input and we'll need your help to see our goals through. Together, we can implement and support the actions outlined in the plan and ensure a safe, healthy, and economically vibrant Delaware for ourselves and for future generations.

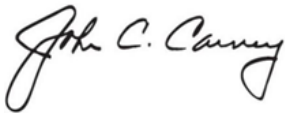


Table of Contents

Tables

Figures

Boxes

Acronyms and Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
degrees C	degrees Celsius
degrees F	degrees Fahrenheit
DNREC	(Delaware) Department of Natural Resources and Environmental Control
FY	fiscal year
IECC	International Energy Conservation Code
LULUCF	land-use, land-use change and forestry
MT CO_2e	metric tons of carbon dioxide equivalent
U.S.	United States (of America)

This page intentionally left blank.

Executive Summary

Climate change is affecting Delaware and will continue to influence our state going forward. From increased temperatures and rising sea levels to heavy precipitation and flooding, our residents are experiencing the impacts of climate change in their daily lives. Acting on climate change is necessary to protect the people, places and resources we love in the First State.

For more than a decade, Delaware has taken steps to address the causes and consequences of climate change. But we need to do more. The state will benefit from a strategic, streamlined plan for the decades ahead, which is why we created Delaware's Climate Action Plan.

Delaware's Climate Action Plan will guide state efforts to:

- **Minimize greenhouse gas emissions**, which drive the climate change we see today, and
- **Maximize resilience to climate change impacts.**

Implementing the strategies in this plan will help Delaware meet its greenhouse gas emissions goals and better prepare for climate change impacts. Taking these actions can also build economic opportunities and improve public health.

Climate Change in Delaware

Modern research has shown that the climate is changing more rapidly than it has in the past, and it is extremely likely that human activities are the major driver of that change. In particular, the burning of coal, natural gas and oil for energy and heat has raised atmospheric carbon dioxide to record levels. Carbon dioxide is a "greenhouse gas," a type of gas with the ability to trap heat around the Earth. Increased emissions of carbon dioxide — in addition to other greenhouse gases released from human activities, such as methane, nitrous oxide and fluorinated gases — are correlated with temperature increases and other changes in our Earth and climate.

The impacts of climate change look different depending on where you are in the world. In Delaware, the most prominent climate change impacts are sea level rise, increased temperatures and changes in precipitation patterns (including extreme weather and flooding). Delaware is already feeling these effects, which are projected to worsen in the future.

Sea Level Rise. Delaware has already experienced over 1 foot of sea level rise at the Lewes tide gauge since 1900. By midcentury, sea levels are projected to rise another 9 to 23 inches and, by 2100, up to an additional 5 feet. This will result in both the permanent inundation of low-lying land and an increase in high-tide flooding. Inundation and flooding affect the integrity and usability of infrastructure, including roads, wastewater systems and electricity transmission systems. Sea level rise can also increase the salt content of ground water and surface water, making them unusable for human consumption and irrigation. Additionally, sea level rise could disrupt natural habitat for important species and reduce the availability of parkland for outdoor recreation.

Increased Temperatures. Average temperatures in Delaware have increased approximately 2 degrees F since 1895, and temperatures are projected to continue increasing. Compared to the period of 1981 to 2010, Delaware's average temperatures could be 2.5 to 4.5 degrees F warmer by midcentury and 3.5 to 8 degrees F warmer by 2100. Additionally, the number of days above 95 degrees F in Delaware is projected to increase from an average of 5 to more than 10 days per year over the next two decades. Increased temperatures and high heat events can impact human health, elevating the risk of heat exhaustion and heat stroke, various respiratory issues and diseases such as West Nile virus and Lyme disease. Higher temperatures also affect both natural resources and agriculture by shifting growing seasons, increasing plant and crop susceptibility to pests and invasive species, and triggering biological stress for wildlife and domesticated animals. High temperatures also put infrastructure at higher risk, due to heat damage and potential overloading of the electrical grid.

Changes in Precipitation Patterns. Annual average precipitation in the state is projected to increase by 10% by 2100. The number of very wet days — periods with 2 inches or more of rainfall in 24 hours — is also projected to increase. Such impacts can result in more flooding events, which are further amplified by sea level rise. These impacts affect human health due to potential increased mold production, exposure to more waterborne diseases and contamination, and risk of septic failure. Changes in precipitation, including more intense rainstorms, can also affect the quality of water resources, agricultural crop yields and natural habitat for wildlife. Additionally, infrastructure can be impacted due to increased pressure on water control structures and a greater potential for erosion of banks, pavements and structural supports.

Climate Action in Delaware

Climate action means preparing people, property and economies for climate change. By taking climate action, we acknowledge that climate change impacts can negatively affect Delawareans and recognize the benefits of proactively addressing those impacts. Maximizing resilience and adapting to climate change impacts now better prepares us for extreme and unexpected events, including avoiding property damage and loss, direct and indirect business interruptions, and human deaths and injuries. Minimizing emissions now links us to a worldwide effort to avoid some of the most highly damaging climate change impacts, while also allowing us to reap health benefits and spur innovation for low-carbon technology development.

Recognizing the importance of proactive action, the state created Delaware's Climate Action Plan for three primary purposes:

- **To help meet a commitment the state has already made:** In 2017, Governor John Carney committed Delaware to reducing greenhouse gas emissions by 26% to 28% from 2005 levels by 2025. Delaware's Climate Action Plan provides information on our state's emissions reduction progress and lays out strategies for meeting or exceeding our goal.
- **To set a course for the decades ahead:** Delaware's Climate Action Plan looks at past and present work and uses this work as the launching point for continued climate action.
- **To integrate actions for *both* minimizing greenhouse gas emissions *and* maximizing resilience to climate change impacts:** A climate action plan that specifically focuses on just reducing emissions *or* enhancing resilience misses out on the opportunity to link these action types to create a stronger, more effective

strategy. Delaware's comprehensive response to climate change requires both minimizing emissions and maximizing resilience, as these actions are inherently interrelated.

Developing the Plan

Climate action can be most effective when it expands and builds upon existing policies, programs and initiatives. As such, developing this plan first involved accounting for the state's past and present actions to minimize emissions and maximize resilience; then, it required determining strategic areas for continued action. Staff from Delaware's Department of Natural Resources and Environmental Control (DNREC) led these plan development efforts.

Delaware's past and present actions to minimize emissions have focused on the areas of clean and renewable energy, energy efficiency, transportation and reducing "high global warming potential" greenhouse gases. Examples include:

- **Delaware's Renewable Energy Portfolio Standards Act:** A 2005 law, updated in 2021, requiring the state's utilities to get an increasing percentage of electricity from renewable sources
- **Regional Greenhouse Gas Initiative:** An 11-state carbon dioxide cap-and-trade program for carbon dioxide emissions from power generation facilities
- **Code for Energy Conservation:** Statewide building codes, updated in 2020, that aim to improve energy efficiency and cost savings
- **Renewable Energy and Energy Efficiency Incentive Programs:** Including DNREC programs such as the Green Energy Program and Energy Efficiency Investment Fund that provide incentives to deploy renewable energy and reduce energy use
- **DNREC's Clean Transportation Incentive Program:** Individual and business rebates to offset the cost of purchasing zero-emission vehicles and related charging infrastructure
- **DNREC's "Cool Switch" Low Impact Refrigerant Program:** Incentives to switch from hydrofluorocarbon refrigerants to those with more limited climate change impacts

Delaware's past and present actions to maximize resilience and adapt to climate change have focused on the areas of policy, planning and regulations; capacity-building for state and local governments; and developing research, data and tools. Examples include:

- **Sea Level Rise Planning:** A 5-year effort, started in 2009, that provided a vulnerability assessment, recommendations for adapting to climate change impacts, and planning scenarios for the state
- **Climate Framework for Delaware:** A 2014 report that outlined state agency actions to adapt to climate change; a related output was a flood avoidance guide for state assets
- **Technical Assistance and Funding:** Initiatives such as the Resilient Community Partnership, Coastal Training Program, Strategic Opportunity Fund for Adaptation, and Sustainable Communities Planning Grant that support local or state government climate action
- **Delaware Climate Change Impact Assessment:** A 2014 report that provided an overview of climate change impacts in Delaware, along with projections for heat and precipitation to the year 2100
- **Coastal Inundation Maps:** Developed

by the Delaware Geological Survey in 2017 to inform infrastructure, facility, land-use and capital spending planning for sea level rise

To determine areas for continued climate action, DNREC identified where greater knowledge was needed to inform next steps.

In terms of minimizing emissions, DNREC identified the need for a comprehensive model of state greenhouse gas emissions. To address this need, DNREC contracted with ICF, a consulting firm with extensive experience in conducting technical analyses to support climate planning. ICF modeled projections of Delaware's greenhouse gas emissions over the next three decades, with and without further action to reduce emissions. Modeling indicated that, with no further action, Delaware's net emissions would decline by 25% from 2005 levels, falling just short of the state's goal of 26% to 28% emissions reduction by 2025. Furthermore, emissions would start rising again around 2032. However, if Delaware were to implement the suite of 20 emissions reduction actions modeled by ICF, Delaware's net emissions would decline by 31% by 2025, achieving and exceeding the state's 2025 goal and setting the state up for further reductions going forward. Additional reductions beyond this are also possible because these 20 actions are not the only actions Delaware could implement.

In terms of maximizing resilience, DNREC identified the need to better understand what climate action state agencies have pursued over the last few years. To address this need, DNREC interviewed staff from 10 state agencies to review the status of previously identified, agency-driven climate change resilience actions. These interviews served as a baseline for identifying climate change adaptation actions that these agencies would like to implement over the next 5 years.

Finally, to complement the above efforts, DNREC also engaged an array of public and technical stakeholders to gather ideas and input for the Climate Action Plan.

DNREC hosted two rounds of public workshops. The purpose of the first round, held in March 2020, was to brainstorm ideas for climate action. Input gathered informed the emissions reduction strategies ICF modeled in its technical analysis as well as the questions DNREC asked during its state agency interviews. The second round, held in September and October 2020, focused on reviewing strategies being considered for the Climate Action Plan. Input gathered helped DNREC gauge public support for actions for near- and long-term implementation.

DNREC paired these public workshops with two rounds of technical expert input. The first round, a "technical advisory workshop" held in March 2020, sought stakeholder feedback on the viability of possible actions that could help Delaware meet its 2025 emissions reduction goal. Input gathered informed the emissions reduction strategies ICF modeled in its technical analysis. DNREC followed this up with sector-specific "technical expert conversations" in September 2020 to review the results of ICF's technical analysis and to generate input on opportunities and barriers for implementing the modeled strategies.

Strategies to Minimize Greenhouse Gas Emissions

Based on the results of the greenhouse gas emissions modeling analysis and stakeholder input, DNREC identified four overarching "action categories" for minimizing emissions:

1. **Clean and renewable energy** expansion, which has the greatest potential to reduce emissions in the long term
2. **Energy efficiency** measures, which

can be put in place relatively quickly and implemented through existing programs

3. **Transportation** sector transitions to zero-emission vehicles and more efficient transportation systems
4. **"High global warming potential" greenhouse gas** emissions reductions and management of greenhouse gases other than carbon dioxide

Below is the list of emissions reduction strategies, by action category, that Delaware can implement to meet its climate goals. Actions linked to each strategy are outlined in Chapter 3 of the Climate Action Plan.

Clean and Renewable Energy. Increasing the amount of renewable and clean energy that runs our electrical grid and powers our homes and businesses has the greatest potential to reduce emissions in the long term. Shifting away from fossil fuels to produce electricity also accelerates the impact of other actions, such as the transition to zero-emission vehicles. These strategies also provide co-benefits, including job creation and economic development in clean energy technologies and improved air quality with related health benefits, particularly for communities near power generation facilities. Strategies Delaware can implement:

- Strengthen Delaware's Renewable Energy Portfolio Standards
- Increase the number of on-site renewable energy systems in residential and commercial buildings
- Increase the number of on-site renewable energy systems in industrial buildings
- Ensure that Delaware is prepared for offshore wind energy opportunities
- Address equity challenges in access to renewable energy
- Increase commitment to renewable energy in state agency operations

Energy Efficiency. Using less energy in our homes, offices and manufacturing centers through energy efficiency measures is an effective way to reduce greenhouse gas emissions. Energy efficiency measures can be particularly useful for reducing emissions in the near term, given they can be put in place quickly and implemented through existing programs. These strategies also provide co-benefits, including job development and training in energy efficiency technologies, cost savings to consumers and homeowners, and improved air quality. Strategies Delaware can implement:

- Strengthen building energy codes
- Expand energy efficiency programs for residential and commercial buildings
- Expand energy efficiency opportunities for low- and moderate-income residents and small businesses
- Improve industrial energy efficiency
- Support the long-term transition to building electrification

Transportation. Transportation is currently the largest in-state source of greenhouse gas emissions. Delaware can reduce emissions in the transportation sector by shifting to low-carbon technologies, improving fuel efficiency and increasing opportunities for transportation choice, such as walking and biking. These strategies also provide co-benefits, including economic and job opportunities in low-carbon transportation technologies and vehicle sales, cost savings to drivers, and improved air quality, particularly in urban areas with high traffic congestion. Strategies Delaware can implement:

- Strengthen consumer adoption of electric vehicles to achieve a goal of 17,000 electric vehicle sales per year in Delaware by 2030
- Capitalize on the transition to zero-emission vehicles to stimulate innovation and provide jobs

- Expand charging infrastructure for electric and plug-in hybrid electric vehicles
- Improve accessibility of low-carbon transportation options for all Delawareans
- Ensure electric and plug-in hybrid electric vehicles contribute to grid stability
- Reduce vehicle miles traveled by 10% by 2030
- Improve the efficiency of freight delivery
- Partner with other states to implement market-based mechanisms to reduce greenhouse gas emissions from transportation
- Promote increased vehicle fuel efficiency
- Lead by example in state government operations to reduce transportation emissions

High Global Warming Potential Greenhouse Gases. Each type of greenhouse gas has a different ability to trap heat in the atmosphere. "High global warming potential" greenhouse gases trap heat in the atmosphere more effectively than carbon dioxide; even small emissions of these gases can have a large warming effect. In Delaware, the focus is on two such gases: hydrofluorocarbons and methane. Strategies to reduce emissions include transitioning to the use of lower global warming potential gases or capturing, diverting and reducing leakage of gases. These strategies also provide co-benefits, including improved air quality and potential gains in energy efficiency. Strategies Delaware can implement:

- Reduce emissions from hydrofluorocarbons
- Reduce methane emissions through expanded methane capture
- Reduce methane leakage from natural gas transmission and distribution pipelines
- Increase renewable natural gas production and incentivize markets for its use as a fuel
- Reduce methane emissions by diverting waste from landfills through increased recycling and waste diversion

Offsetting Carbon Emissions. Delaware's forests, croplands, wetlands and urban greenspaces can play an important role in responding to climate change. The plants and soils in these "natural and working lands" have the ability to absorb (or sequester) carbon dioxide from the atmosphere. This provides a cost-effective, temporary or long-term carbon storage solution. Capitalizing on natural carbon storage can help offset a portion of emissions released by human activities. Strategies Delaware can implement:

- Support best management practices on agricultural lands that provide greenhouse gas emissions co-benefits
- Support conservation and restoration of forest lands
- Support local communities' enhancement of urban greenspaces
- Improve methods for measuring and tracking carbon sequestration

Strategies to Maximize Resilience to Climate Change Impacts

Based on input gathered from state agency interviews and stakeholder input, DNREC identified seven overarching "action categories" for state agency action to maximize resilience and adapt to climate change impacts:

1. **Updated or new state regulations** that address protection and conservation of vulnerable and impacted resources
2. **Support for communities and stakeholders** in the form of trainings, resources and technical assistance

3. **Management plans** for natural resources, emergency response, state facilities and agency equipment
4. **Facility design and operation** that accounts for future climate conditions
5. **Research and monitoring** that studies the impacts of climate change and methods of adapting
6. **Outreach and education** on climate change impacts and adapting to climate change
7. **Agency support** that provides the resources to implement resilience actions

Below is the list of strategies, by action category, that state agencies can take to best prepare Delaware for climate change impacts. Specific actions linked to each strategy are outlined in Chapter 3 of the Climate Action Plan.

Updated or New State Regulations. Many state regulations and procedures were written and enacted prior to the current understanding of climate change and its impacts. These strategies focus on the periodic review, updating and possible creation of new regulations under current and future climate conditions. Strategies Delaware can implement:

- Update regulations to reduce risk to properties from climate change
- Update regulatory processes to allow for greater inclusion of climate change impacts in permit decisions
- Develop a comprehensive regulatory strategy to conserve and restore ecosystem services under future climate conditions

Support for Communities and Stakeholders. Many of Delaware's municipalities depend on state agencies and other organizations for planning and implementation support. These strategies address how the state can support the transfer of knowledge and effective resilience action implementation to sub-state entities. Strategies Delaware can implement:

- Increase grant opportunities for climate change adaptation projects, and prioritize the funding of projects that incorporate climate change impacts in project design and implementation
- Assist local governments, homeowners, industries and utilities in increasing their resilience to climate change
- Support programs and initiatives that help frontline communities adapt to climate change
- Provide training, tools and technical assistance on climate change impacts and accompanying resilience actions

Management Plans. State agencies use various planning documents to manage natural resources, emergency response, state facilities and agency equipment. These strategies look at incorporating future climate conditions and resilience action opportunities into planning documents for effective management and use of resources. Strategies Delaware can implement:

- Incorporate climate change impact and adaptation considerations into strategic plans
- Update emergency response and hazard reduction plans to incorporate future climate projections
- Update or create management plans to incorporate future climate projections

Facility Design and Operation. State-owned facilities are already being impacted by climate change and will continue to be affected as the rate of change increases. These strategies look to improve the resilience of state-owned facilities to climate change

impacts and to reduce future management costs. Strategies Delaware can implement:

- Update facility construction guides and standards to increase resilience to climate change impacts
- Prepare state facilities and equipment for climate change impacts

Research and Monitoring. While national and international research can support local and regional decisions, Delaware-specific research may provide increased clarity on the most effective solutions to issues the state is facing. These strategies look at research and monitoring of climate change impacts within state agencies and a continued push towards climate change solution-making. Strategies Delaware can implement:

- Continue and expand research on climate change impacts in Delaware
- Increase the number of resilience pilot projects and demonstration sites in Delaware

Outreach and Education. The more that individuals get involved in the conversation about climate change — and start taking climate action — the healthier Delaware's communities and economy can become. These strategies outline how the state can incorporate climate change information and resilience actions into outreach activities for stakeholders. Strategies Delaware can implement:

- Develop targeted communication tools and messages about climate change
- Increase the availability of climate change educational programming
- Provide outreach to businesses to help them understand and build resilience to climate change impacts

Agency Support. Support from agency and state leadership will be necessary to implement many of the actions in the Climate Action Plan. These strategies address how Delaware can be a leader in resilience by providing resources, conducting employee trainings and promoting cooperative efforts between all levels of government. Strategies Delaware can implement:

- Increase the capacity of all state agencies to build resilience to climate change
- Improve information sharing across state agencies to support regulatory and policy decisions
- Act as climate change adaptation leaders

Next Steps

Delaware's Climate Action Plan outlines strategies for addressing climate change that can be implemented through a variety of actions over time, as resources, data and partnerships develop. It is intended to be a living document. As our collective understanding of climate impacts, emissions reduction strategies and resilience and adaptation measures grows, actions to advance strategies can evolve and change.

Implementing Delaware's Climate Action Plan requires setting guiding principles for climate action, outlining a framework for moving from planning to action, and defining equitable climate action.

How climate action is implemented can be just as critical as what is implemented. Three principles should be applied when implementing Delaware's Climate Action Plan:

Principle No. 1: Ensure Climate Action is Ambitious yet Adaptable. The Intergovernmental Panel on Climate Change asserts that swift and concerted climate

action is necessary to avoid the most damaging climate change impacts. Ambitious climate action must be taken now. However, strategies must also remain adaptable enough so they can be adjusted over time.

Principle No. 2: Ensure Climate Action Accounts for All Costs and Benefits. Decision making on climate action should consider the full costs and benefits (including co-benefits) of taking such action and assess the opportunity costs and the cost-effectiveness of alternative action options.

Principle No. 3: Ensure Climate Action is Engaged, Empowering and Equitable. Engaging early and often with key stakeholders and community members is critical — as is empowering local governments to take climate action. Additionally, careful attention must be paid to inequities in climate action design, as actions could potentially favor some people over others. It would be particularly problematic if climate action inadvertently compounds inequities or further hinders communities already facing adverse environmental, social or economic conditions.

Many of the strategies outlined in this plan focus on steps that can be taken specifically by state agencies. Cooperation across state agencies and leadership within those agencies — coupled with stakeholder partnerships — will help facilitate and motivate the transition from climate planning to climate action. This can be assisted by a framework for accountability and transparency:

Accountability. Statewide emissions reduction targets and climate change impact planning scenarios can help drive accountability for taking climate action in Delaware. By establishing mid- and long-term greenhouse gas emissions reduction targets in statute or executive order, the state can set a common goal and expectation for statewide planning and future operations.

Climate planning scenarios are also needed for preparing our infrastructure and communities for climate change impacts. The state should, on a regular schedule, formulate, update and disseminate a standard set of planning scenarios that provides state-specific climate change impact projections for sea level rise, precipitation, and temperature. Mechanisms should also be put in place to ensure that state agencies use these scenarios consistently in their respective planning processes.

Transparency. Tracking and reporting are necessary to evaluate progress on emissions reduction and resilience actions. To evaluate progress over time, a suite of key metrics to track climate action should be identified. These metrics should be monitored and reported on a consistent timeline.

Finally, for climate action to benefit all Delawareans, the state must dedicate efforts to both understand and address the needs of residents — particularly those who may be disproportionally impacted by climate change or climate action. This can be accomplished by:

Understanding Vulnerable Communities. It is vitally important to improve our understanding of, and contact with, communities that may be most immediately affected by climate change impacts or climate action. Authentic community engagement is necessary to leverage local knowledge of impacts and to better understand the obstacles and issues these communities face.

Partnering with Communities to Build Equity. Collaborations and partnerships with communities can help build equity into climate action. Early and continued engagement is essential, as residents can speak first-hand to community-specific climatic and economic impacts. It should be noted that productive partnerships with communities are only

Taking proactive climate action can help preserve Delaware's unique places for future generations. Photo credit: DNREC

possible if trust is established. This trust can be built over time, in part, by openly working with communities to evaluate whether climate actions have the intended effects once implemented.

Proactive climate action can save lives, reduce costs and preserve Delaware's unique places for future generations. Delaware's long history of climate action, established partnerships, and technical knowledge position the state well to address climate change. By engaging Delaware's governments, businesses and residents in coordinated climate action; guiding action to be ambitious yet adaptable; and ensuring climate action is engaged, empowering and equitable, we can realize a future where the First State is a leader in climate action.

Chapter 1: Introduction


Climate change is affecting Delaware and will continue to influence our state going forward. From increased temperatures and rising sea levels to heavy precipitation and flooding, our residents are experiencing the impacts of climate change in their daily lives. Acting on climate change is necessary to protect the people, places and resources we love in the First State.

For more than a decade, Delaware has taken steps to address the causes and consequences of climate change. But we need to do more. The state will benefit from a strategic, streamlined plan for the decades ahead, which is why we created Delaware's Climate Action Plan.

Delaware's Climate Action Plan will guide state efforts to:

- **Minimize greenhouse gas emissions**, which drive the climate change we see today, and
- **Maximize resilience to climate change impacts.**

Implementing the strategies in this plan will help Delaware meet its greenhouse gas emissions goals and better prepare for climate change impacts. Taking these actions can also build economic opportunities and improve public health.

1.1 What is Climate Action?

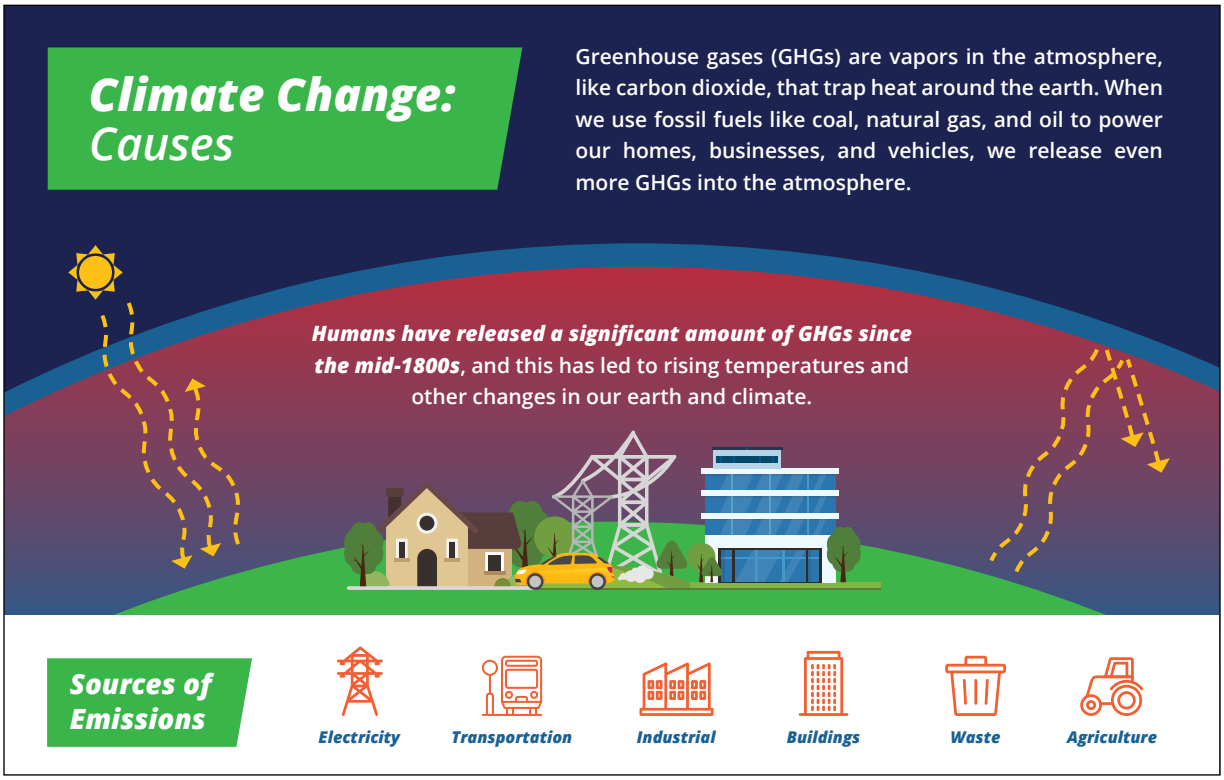
Climate action means preparing people, property and economies for climate change. For Delaware, this means anticipating and readying the state for climate change impacts such as sea level rise and increased temperatures. It also means ensuring the state does its part to reduce the greenhouse gas emissions that drive the climate change we see today.

1.1.1 Climate Change Basics

Earth's climate has changed naturally throughout its history due to various influences such as volcanic eruptions, levels of carbon dioxide in the atmosphere, variations in Earth's orbit and changes in the intensity of solar radiation.[1] However, modern research has shown that the climate is changing more rapidly than it has in the past — and it is "unequivocal" that human activities are the major driver of that change.[2]

Human activities — particularly the burning of coal, natural gas and oil for energy and heat —have raised global atmospheric carbon dioxide to record levels.[3] Over the last 150 years, carbon dioxide levels increased from 280 parts per million to 410 parts per million. While carbon dioxide occurs naturally in the atmosphere, atmospheric levels never reached above 300 parts per million at any point in the last 800,000 years. Additionally,

Figure 1: An illustrated depiction of the causes of climate change Source: DNREC



the yearly rate at which carbon dioxide levels are currently rising in our atmosphere is about 100 times faster than previous natural increases.[4]

All of this affects our climate because carbon dioxide is a "greenhouse gas," a type of gas with the ability to trap heat around the Earth. Increased emissions of carbon dioxide — in addition to other greenhouse gases released from human activities, such as methane, nitrous oxide and fluorinated gases[5] — are correlated with average global temperatures increases of about 2 degrees F since 1880.[6] This temperature change may not seem significant, but small changes in temperature can have large impacts. For example, at the end of the last ice age, when the northeast U.S. was covered by thousands of feet of ice, average global temperatures were only 5 to 9 degrees F cooler than they are today.[7]

Because the Earth is a complex system, the impacts of climate change look different depending on where you are in the world. Still, all of the known impacts — temperature increases, heat waves, more frequent and longer droughts, changes in growing seasons and precipitation patterns, more extreme weather and sea level rise, among others — can directly or indirectly affect ways of life, traditions, jobs, public health and economies.

1.1.2 Why Climate Action Matters

By taking climate action, we acknowledge that climate change impacts are serious and can negatively affect us. It also means we recognize that proactive actions yield significant benefits.

By maximizing resilience and adapting to climate change impacts now, we are better prepared for extreme and unexpected events. According to a 2019 report by the National Institute of Building Sciences, proactive actions to reduce the impacts of natural hazards — such as improving building codes, enhancing infrastructure

and leveraging federal pre-disaster grants — offer between $4 and $11 in benefits per dollar invested in these actions.[8] Benefits include reductions in property repair costs; direct and indirect business interruptions; community and emergency service disruptions; and human deaths, injuries and disorders.[9] As such, taking proactive actions not only avoids losses to assets but also losses to human well-being.

Additionally, by minimizing emissions now, we contribute to a worldwide effort to reduce the severity of rapid climate change. According to the Intergovernmental Panel on Climate Change, we must quickly reduce global greenhouse gas emissions to avoid some of the most highly damaging climate change impacts.[10] Reducing greenhouse gas emissions also provides benefits beyond avoiding climate change impacts. For example, switching to lower carbon transportation, such as zero-emission cars and buses, reduces emissions of greenhouse gases and chemicals and particles known to be harmful to human health. Moving towards this transportation model also helps spur innovation for developing low-carbon technologies.[11]

Increasing the use of renewable energy sources reduces the amount of harmful greenhouse gas emissions in our atmosphere. Photo credit: Adobe Stock

Taking climate action additionally allows us to collaborate with others in ways that can benefit our state economy. For example, Delaware's participation in the Regional Greenhouse Gas Initiative, a collaboration of Northeast and Mid-Atlantic states,[12] not only reduces greenhouse gas emissions in the power sector, but also provides the state funds to invest in energy efficiency, renewable energy, consumer benefit programs and other low-carbon initiatives.[13] Additionally, Delaware's participation in the U.S. Climate Alliance, a coalition of 25 governors committed to reducing greenhouse gas emissions, gives Delaware access to resources and networks for developing a low-carbon energy economy. The benefits of such an economy cannot be understated: Since 2005, Alliance states have outpaced non-Alliance states in both emissions reductions and total and per capita economic output.[14]

Given the realities of climate change, strategic climate action is necessary to continue protecting Delaware's people, property and economies. Such actions must be coordinated so that they both minimize emissions and maximize resilience. While there is no single pathway to do this, nor will decisions be easy, furthering climate action signals that we take the First State's future seriously and are ready to act in the best interest of our current and future residents.

Box 1. Do Delaware Residents Support Climate Action?

Since 2009, the state has commissioned a statistically representative survey every 5 years to understand public attitudes surrounding climate change.[15] This survey was most recently carried out in November and December 2019, with the participation of over 1,100 Delaware residents. Outcomes from this study were enlightening: Not only do a majority of Delawareans believe that climate change will personally harm them (56%) but also a large portion of our population believes climate change will harm future generations (77%). In addition, more than three-fourths of Delawareans are convinced that climate change is happening (77%), and seven in ten residents say the state should take immediate action to reduce the impacts of climate change (70%). The state views these results as a clear indication to keep moving on climate action.

1.1.3 Roadmap of Delaware's Climate Action Plan

The remainder of this chapter looks at the impacts of climate change on Delaware and how the state defines climate action in the context of this plan. Chapter 2: Developing the Plan describes the process the state followed to put the plan together. Chapter 3: Climate Action Plan outlines specific strategies and actions Delaware can take to minimize greenhouse gas emissions and maximize resilience to climate change impacts. Finally, Chapter 4: Next Steps illustrates how the state can move from planning to action, including achieving equitable climate action.

Delaware's Climate Action Plan references numerous topics and concepts, some of which may be unfamiliar to the reader. To enhance readability, a glossary with definitions for technical terms used throughout the document is included after Chapter 4.

Figure 2: Summary of climate change management strategies supported by Delawareans Source: DNREC

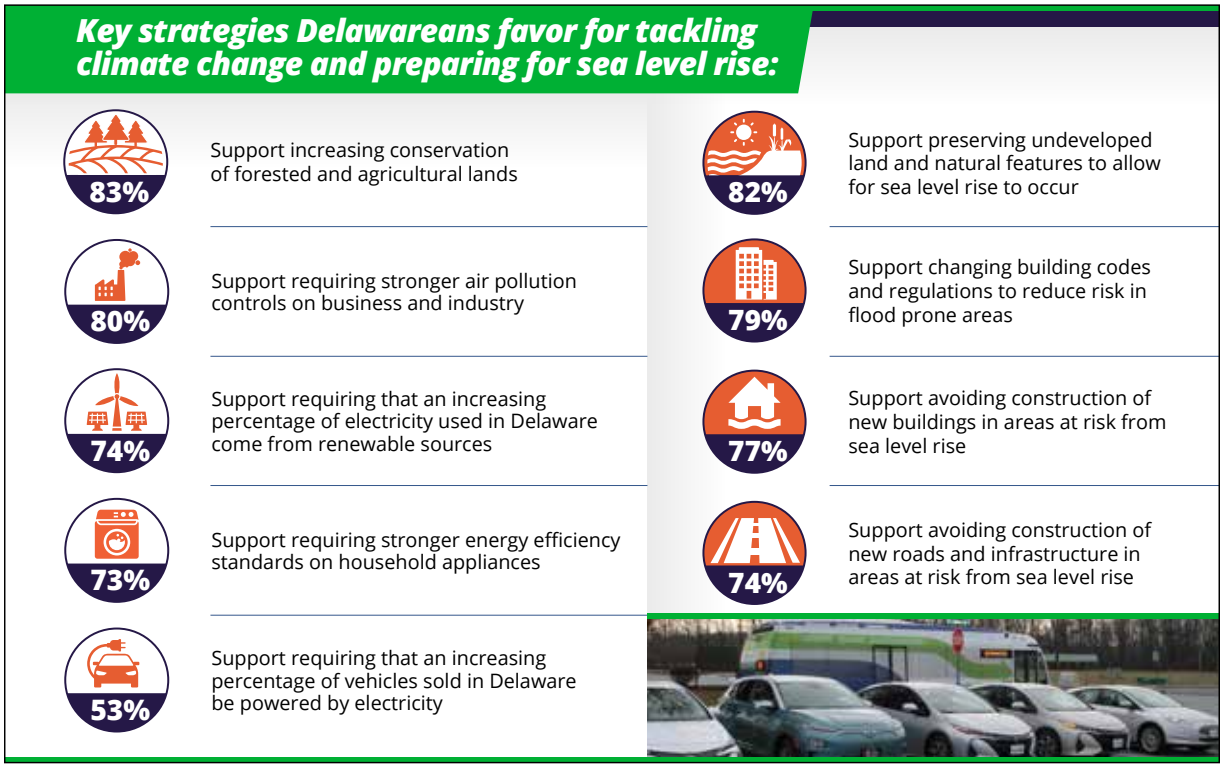
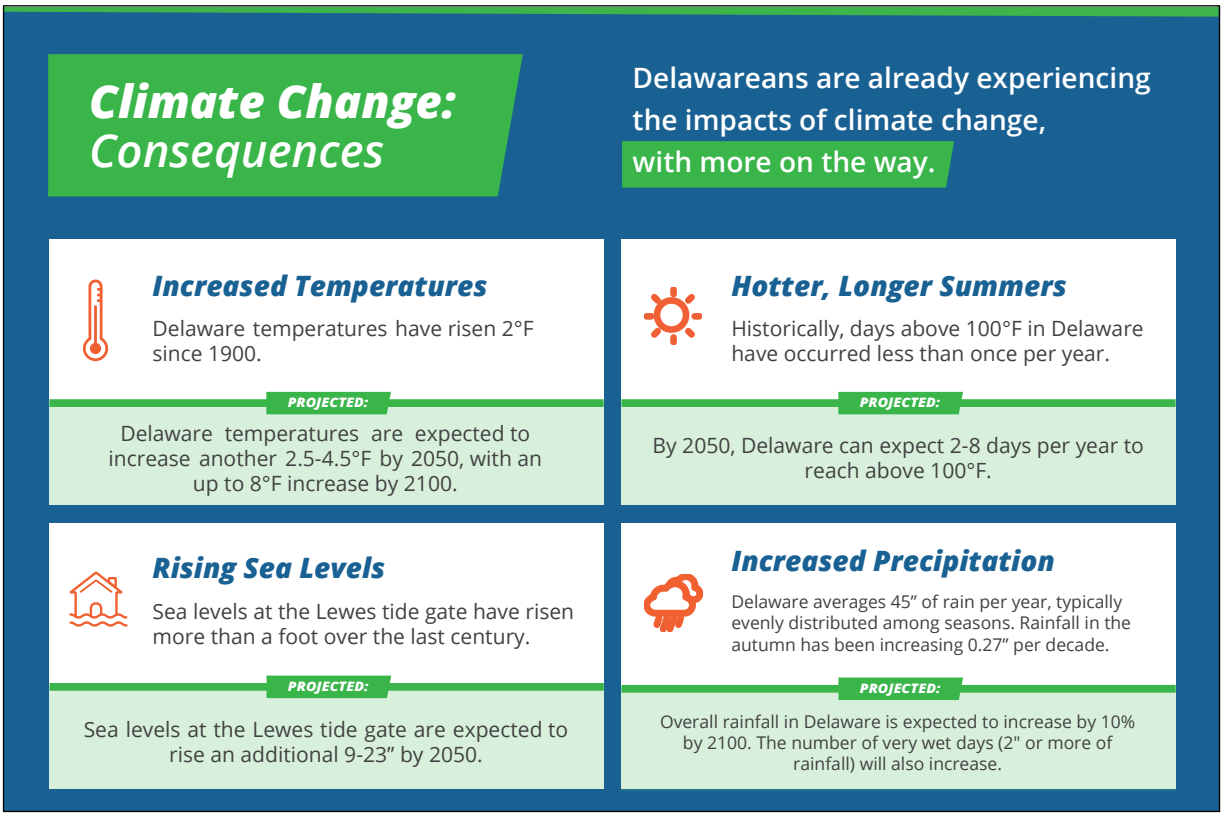


Figure 3: A summary of the current and projected impacts of climate change in Delaware Source: DNREC



1.2 Climate Change Impacts on Delaware

Climate change is here and now. Delaware is already feeling the effects of climate change, and many of these effects are projected to worsen over the next few decades.

In Delaware, the most prominent impacts of climate change are sea level rise, increased temperatures and changes in precipitation patterns (including extreme weather events and flooding). Below, we summarize how each of these impacts affects the state and the potential costs of such impacts. Unless otherwise indicated, all the information below comes from the Delaware Climate Change Impact Assessment,[16] Delaware's Sea Level Rise Vulnerability Assessment,[17] and the Recommendation of Sea-Level Rise Planning Scenarios for Delaware Technical Report.[18] More information on climate change impacts to Delaware can be found in these reports.

1.2.1 Delaware's Vulnerability to Sea Level Rise

Delaware lies in a sea level rise "hotspot," where sea levels are rising faster than elsewhere in the world due to a combination of both sinking land and climate change.[19] The state has already experienced over 1 foot of sea level rise at the Lewes tide gauge since 1900. By midcentury, sea levels are projected to rise another 9 to 23 inches and, by 2100, up to an additional 5 feet. This will result in both the permanent inundation of low-lying land and an increase in high-tide flooding. For instance, a 2020 National Oceanic and Atmospheric Administration study projects that Lewes could face 50 to 135 high-tide flood events per year by 2050; Reedy Point, just southeast of Delaware City, could face 25 to 100 events per year. Typical high-tide flood events in the year 2000 numbered just 4 days and 1 day per year in Lewes and Reedy Point, respectively.[20] Sea level rise can impact

Saltwater intrusion from sea level rise threatens Delaware's farms and agricultural industry. Photo credit: Adobe Stock

agriculture, water resources, infrastructure, natural resources and human health.

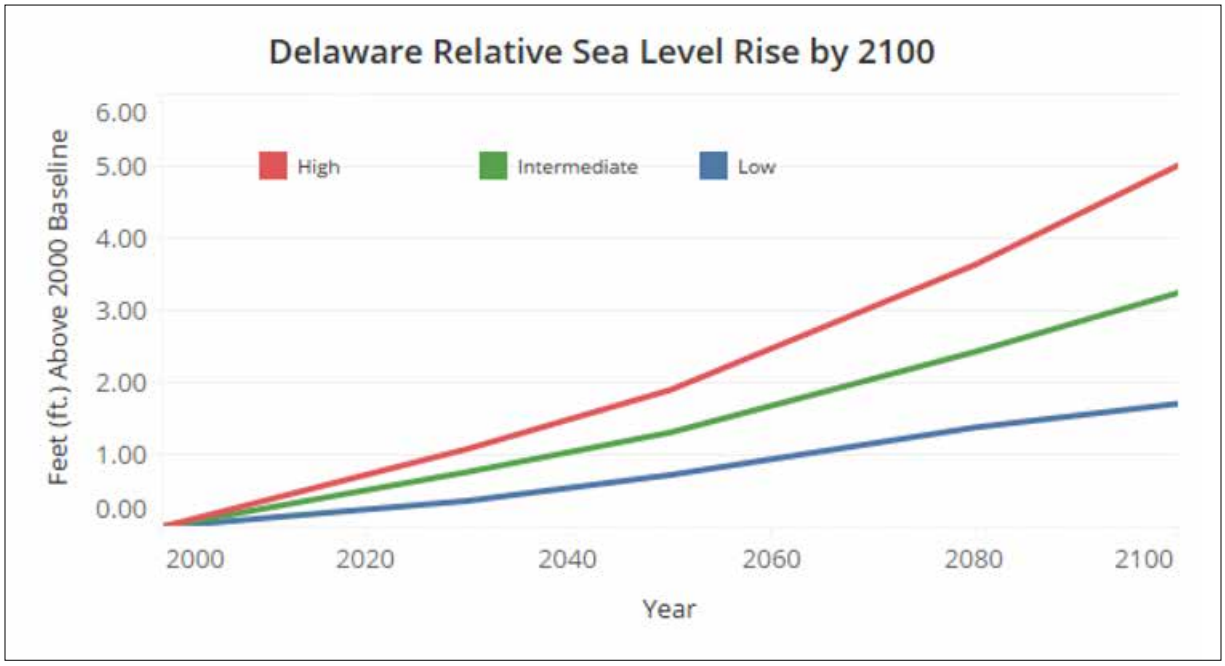
Agriculture. As sea levels rise, the saltwater boundary in groundwater moves inland. If irrigation wells are near this boundary, the groundwater will not be usable for irrigation. Such a scenario decreases crop yields and raises farmers' costs to access usable water. Additionally, if saltwater floods onto agricultural fields, even temporarily, the health of the soil and its ability to support crops could be undermined by increased salt content.

Water Resources. Most of Delaware's drinking water comes from groundwater supplies. All public and domestic drinking water south of the Chesapeake and Delaware Canal is from groundwater resources. North of the canal, 30% of drinking water is from groundwater sources, with the rest from four surface water sources. If the salt content of groundwater increases due to sea level rise, groundwater could become unusable for consumption. Sea level rise could also affect Delaware's freshwater rivers and streams, which provide drinking water and habitat for recreational and commercial fish species. Sea level rise will cause saltwater to extend farther upstream, reducing the availability of freshwater for human consumption. A change in salinity can also cause changes in vegetation and habitat suitability for a variety of species, including American shad and striped bass, which rely on freshwater rivers for spawning.

Infrastructure. A 5-foot rise in sea levels could inundate 5% of the state's roads and bridges and 6% of evacuation routes. This could affect both the ability of people to travel safely across the state and the provision of essential goods and emergency services. Sea level rise impacts to infrastructure can be particularly problematic when combined with heavy rainstorm events, making access to roads and evacuation routes even more difficult when they are needed most. The state's wastewater infrastructure could also be impacted. Many wastewater treatment facilities are located along waterways, and sea level rise could increase the risk of these facilities flooding. Additionally, storm sewers

Figure 4: Sea level rise scenarios for Delaware in feet per decade above the baseline sea level in 2000

Credit: 2017 Sea Level Rise Planning Scenarios for Delaware, converted from meters to feet



can be overloaded, resulting in backups and overflows; this is particularly problematic for areas of the state with combined sewer systems. The state's electricity transmission system is also at risk from sea level rise. Numerous electrical sub-stations and transmission lines are located in areas at risk to sea level rise. Over time, these facilities can be damaged by flooding and become inaccessible during storm events, increasing the risk of lengthy power outages during storm events.

Natural Resources. Delaware's tidal wetlands provide numerous benefits, including habitat for commercially important species, sediment and pollutant removal and protection from storm surges and flooding. Projections show that with just 1.5 feet of sea level rise, 97% of tidal wetlands could be inundated. If these wetlands are unable to increase their elevation or migrate landward — processes made difficult with rapid sea level rise and structures built upland of wetland areas. Wildlife areas, forests and state parks are also at risk from sea level rise. Projections show that 37% to 44% of Delaware's protected lands could be inundated by sea level rise of 1.5 to 5 feet respectively, which could disrupt natural habitats and the availability of parkland for outdoor recreation.

Human Health. In addition to the direct human health impacts associated with drinking water quality and failing infrastructure highlighted above, areas that experience frequent flooding may strain the emotional well-being of residents due to the continual need to evacuate from hazardous conditions, replace lost or damaged belongings, and repair or adapt homes. If residents eventually decide to leave their homes, they may lose a sense of community and connection with neighbors and friends. Additionally, relocation may prove stressful if residents have difficulty finding alternative places to live that are affordable and accessible to jobs, schools and other amenities.

Extreme temperatures can cause roadways to buckle and crack. Photo credit: Adobe Stock

1.2.2 Delaware's Vulnerability to Increased Temperatures

Climate change is heating up Delaware. Average temperatures in Delaware have increased approximately 2 degrees F since 1895. In fact, the years 2010 to 2019 marked Delaware's hottest decade in recorded history.[21] Temperatures are also projected to continue increasing. Average temperatures in Delaware are projected to be 2.5 to 4.5 degrees F warmer by midcentury compared to the period of 1981 to 2010. Average temperatures in Delaware are projected to be 3.5 to 8 degrees F warmer by 2100 compared to the same base period of 1981 to 2010. In addition to average temperatures rising, extreme temperature events are also projected to become more frequent. The number of days above 95 degrees F in Delaware is projected to increase from an average of 5 days per year over the period of 1981 to 2010 to more than 10 days per year over the period of 2020 to 2039. These temperature changes could impact agriculture, water resources, infrastructure, natural resources and human health.

Agriculture. Higher temperatures and extreme heat mean that agricultural producers could see reductions in harvest yields and may need to irrigate more. Longer growing seasons can also increase incidents of pests and weeds. Additionally, higher temperatures and extreme heat could affect both the outdoor working conditions for farmers and the health of livestock and poultry. All these changes could impact farmers' bottom lines by reducing profitability.

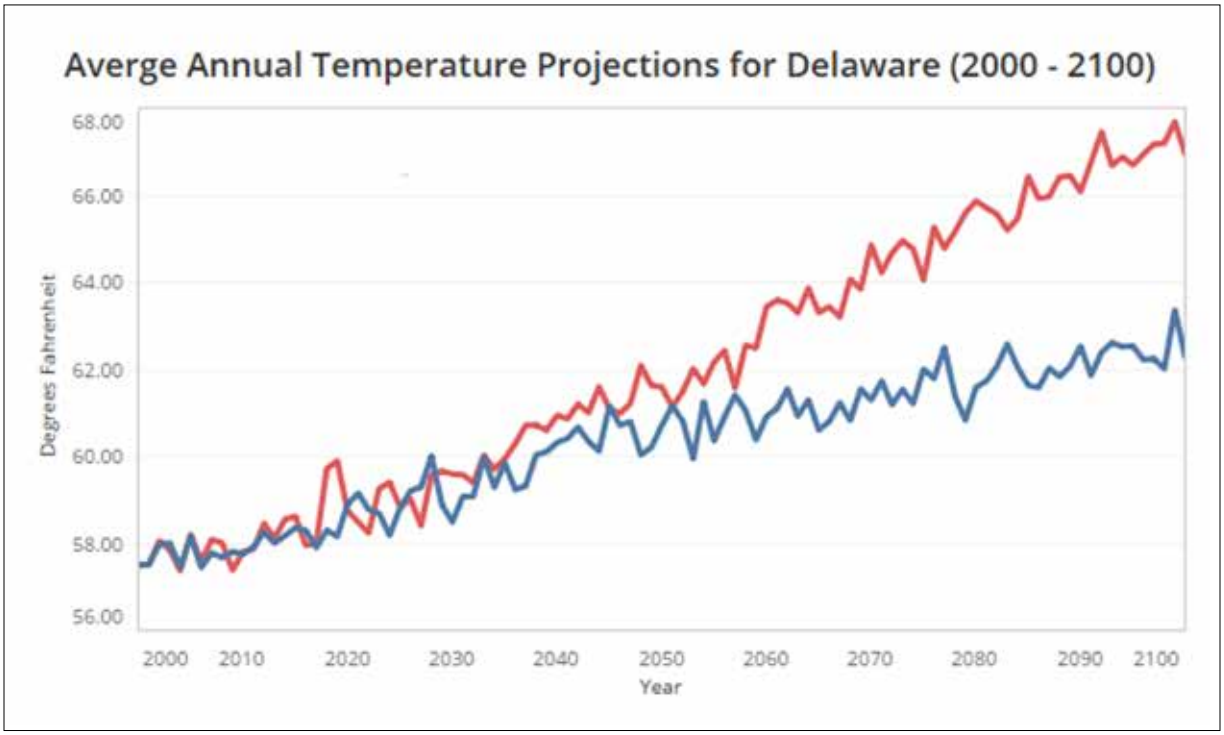
Water Resources. Higher temperatures increase evaporation of water from soil and can increase the demand for water use, which could affect drinking water supplies, particularly in New Castle County. Drinking water in New Castle County comes predominantly from surface water, which could become limited during periods of both lower precipitation and higher temperatures.

Infrastructure. Delaware has already faced incidents of roads buckling due to high heat on major roadways; as temperatures increase, these incidents could become more common, leading to more dangerous driving conditions and increased costs for both road and vehicle maintenance. Increased temperatures also increase demand for electricity, which could cause the electrical grid to become overloaded. This could cause power outages.

Natural Resources. Higher temperatures can cause biological stress for both plants and animals, which has cascading effects. When native species are stressed, they are more vulnerable to pests, diseases, competition from invasive species and poor growth and reproduction. This could affect food availability up the food chain. Additionally, higher temperatures can affect hibernation and life cycles for important species such as bats, which provide both pollination and insect control.

Figure 5: Average temperature projections for high emission scenarios (in red) and low emission scenarios (in blue) in degrees Fahrenheit by decade

Credit: 2014 Delaware Climate Change Impact Assessment



Human Health. Increased temperatures directly impact human health by elevating the risk of heat exhaustion and heat stroke. Populations particularly at risk from high heat include children, the elderly, people who work outside,[22] people with underlying health conditions and people with limited access to cooling. High temperatures, in combination with sunlight and air pollutants, can worsen air quality by increasing ground-level ozone conditions, aggravating respiratory issues.[23] Additionally, high temperatures affect the body's ability to recoup from illness, particularly if temperatures at night do not cool down enough for the body to recover.[24,25] Increased temperatures can also indirectly impact human health. Milder winters can contribute to increasing mosquito and tick populations that can carry diseases such as West Nile virus and Lyme disease. When temperatures reach below freezing, insect populations decrease; with milder winters, more insects can survive until spring.

1.2.3 Delaware's Vulnerability to Changes in Precipitation Patterns

Historically, Delaware is a wet state, with an average of 45 inches of precipitation annually. With climate change, annual average precipitation is projected to increase by 10% by 2100. The number of very wet days — periods with 2 inches or more of rainfall in 24 hours — is also projected to increase. These changes to precipitation patterns in Delaware could result in more flooding events, which are further amplified by sea level rise. All this could impact agriculture, water resources, infrastructure, natural resources and human health.

Agriculture. During the growing season, heavy precipitation events elevate financial risks for farmers, including crop damage, crop disease pressure, damage to farm facilities and delays in crop plantings and harvests. For instance, in 2018, Delaware requested an emergency declaration from the U.S.

The combination of higher temperatures and increased precipitation can lead to increased mold production in buildings and negative impacts to human health.
Photo credit: Adobe Stock

Department of Agriculture after heavy rains destroyed several high-dollar crops and threatened the yield of many others.[26] Heavy precipitation can also erode soil and cause soil nutrient losses, both of which impact crop yields. Additionally, heavy precipitation can increase areas of standing water, elevating the risk of increased mosquito breeding and livestock bites. Insect bites stress animals, reducing their overall fitness, and can leave them susceptible to disease and other pests. These impacts have the potential to affect farmers' profits as well as the regional food supply.

Water Resources. Heavy precipitation can erode soil and wash excess nutrients and pollution into water bodies. Increases in sediments, nutrients and pollution reduce water quality and can result in rapid algae growth and fish kills. Reduced water quality also increases the cost of treating drinking water because additional steps are needed to ensure its safety for consumption.

Infrastructure. Many of Delaware's dams, levees and other water control structures are integrated into roadways and bridges. Heavy precipitation can trigger cascading and potentially damaging effects, such as water spilling over or breaching these structures. Additionally, heavy precipitation increases the volume and velocity of storm-water runoff, which can erode banks and pavement; undermine structural supports; and weaken roads, bridges and culverts. These impacts affect human safety and increase the costs for structural repair and rebuilding — and these impacts could be made worse when combined with sea level rise.

Natural Resources. In combination with sea level rise, heavy precipitation and flooding can escalate dune and beach erosion. This could, in turn, increase the vulnerability of habitat and property upland of dunes and beaches. Additionally, many of the state's coastal wetlands are managed by a series of dikes to control water levels for mosquito management, wildlife habitat and fisheries support. Heavy precipitation and flooding could cause water to spill over or damage dikes. This could change habitat structure, such as water depth and salinity, which in turn impacts wildlife dependent on these areas for habitat.

Human Health. When combined with higher temperatures, greater precipitation can raise overall moisture levels, which can increase mold production. Mold is known to aggravate allergic reactions and respiratory conditions. Increased precipitation and flooding can expand human exposure to waterborne diseases and contamination, particularly in

areas with compromised air, soil or water quality. Numerous areas of the state are already facing septic failures due to persistent flooding and ground saturation, particularly after heavy rainstorms; septic failures could increase with more incidents of heavy precipitation and flooding.

1.2.4 Costs of Climate Change Impacts

Climate change impacts could be costly for the state, especially as Delaware deals with evolving weather patterns, which can increase the frequency and intensity of storms. Hurricane Sandy provides a historical example. During this storm, the dune system along the Atlantic Ocean breached, allowing flood waters and sediments to wash onto State Route 1 near the Indian River Inlet. This incident damaged the roadway and required its closure for several days. Cleanup and repair included pumping more than half a million cubic yards of sand from the inlet onto the beach to construct a new dune at a cost of $19.3 million.[27] Also, while the new Indian River Inlet Bridge was not damaged, areas next to the bridge were heavily eroded.[28] In response, the Delaware Department of Transportation constructed a sheet pile seawall to maintain the integrity of the bridge at an added cost of $1.4 million.[29] While Sandy was not, historically, a "normal" storm event for Delaware, future events of large magnitude are projected to become more frequent with climate change.

At the time of this plan's publication, the Delaware Department of Natural Resources and Environmental Control (DNREC) is working with consultants to complete an economic study on the costs of climate change impacts to the state in the areas of natural resources, transportation, human health, agriculture and public safety. While study results are forthcoming, there is a general understanding of state resources that may be at risk (Box 2).

Box 2. What's at Risk to Climate Change in Delaware?

Nearly $1.5 billion in tax-assessed property is located within areas that are projected to be inundated by 5 feet of sea level rise.[30,31]

Climate change has the potential to disrupt Delaware's agricultural industry. According to a 2010 University of Delaware study, the state's agricultural economy is worth $8 billion per year.[32]

Climate change could affect the vitality of the state's coastal communities, which play a large role in driving tourism in Delaware. According to a 2018 assessment by the Delaware Tourism Office, tourism's contribution to the state's gross domestic product is $3.5 billion, with the industry generating over $545 million in annual tax revenue. The tourism industry is the fourth largest private employer in the state, accounting for over 44,000 jobs.[33]

It's worth noting that direct damage costs are not the only financial risk the state faces. A 2020 report by a sub-committee of the U.S. Commodity Futures Trading Commission indicates that climate change will impact financial systems at both county-wide and state scales. The financial costs of these impacts could be borne by both individual and institutional investors if proactive actions are not taken. Given feedbacks inherent in the financial system, climate-related losses to individuals can impact the larger system. For example, if rising sea levels and extreme weather cause losses to homeowners, property values can diminish, and mortgage portfolios bear greater risk. If such losses are repetitive, insurance claims could rise, insurance companies could pay more and insurance becomes either more expensive or unavailable.[34]

Additionally, financial ratings firms are increasingly looking at whether jurisdictions are vulnerable to climate change and whether they are taking actions to address those vulnerabilities.[35] For instance, for the past 2 years DNREC has worked with the Delaware Department of Finance to provide information about the state's climate strategies to the bond ratings agencies. Delaware's strategic efforts to address the causes and consequences of climate change have helped support Delaware's triple-A bond rating. This in turn ensures savings for Delaware taxpayers.

1.3 Why Do We Need Delaware's Climate Action Plan?

Earlier in this chapter we discussed the importance of climate action and how climate action can benefit Delaware. We also discussed the impacts climate change is having, and could continue to have, on the state. But where does Delaware's Climate Action Plan fit in? And why does the state need a plan?

Delaware's Climate Action Plan helps the state meet a commitment it has already made. In June 2017, Delaware joined the U.S. Climate Alliance, a coalition of U.S. states and territories that aims to reduce greenhouse gas emissions.[36] Upon joining, Governor John Carney committed Delaware to reducing its greenhouse gas emissions by 26% to 28% by 2025 compared to 2005 levels. This is the same pledge the U.S. made when it joined the Paris Agreement under the United Nations Framework Convention for Climate Change. Based on data from Delaware's Greenhouse Gas Emissions Inventory for 2016, state efforts have resulted in an emissions reduction of 18.3% from 2005 to 2016.[37] Given that we have not yet met our goal, Delaware's Climate Action Plan provides further information on Delaware's emissions reduction progress and lays out strategies to ensure we can meet or exceed our goal.

Delaware's Climate Action Plan sets a course for the decades ahead. Delaware has carried out climate action for years, both reducing emissions and increasing resilience. While these actions have been pursued with purpose, they have not, until now, been placed in the context of a strategic plan. Delaware's Climate Action Plan takes account of our past and present work and uses this work as the launching point for future climate action.

Delaware's Climate Action Plan integrates actions for *both* minimizing greenhouse gas emissions *and* maximizing resilience to climate change impacts. A climate action plan that specifically focuses on just reducing emissions *or* enhancing resilience misses out on the opportunity to link these action types to create a stronger, more effective strategy. Delaware's comprehensive response to climate change requires both minimizing emissions and maximizing resilience, as these actions are inherently interrelated.

In concluding this section, it is important to clarify what Delaware's Climate Action Plan does and does not do. First, this plan does not create new mandates or requirements. So, while the plan looks to enhance state decision making — and can help inform executive or legislative action — it is not prescriptive in scope. Secondly, this plan focuses on climate action from a statewide perspective. While strategies in the plan may support local communities, community-level planning must complement this plan because land-use decisions are made at the county or local levels. Finally, the strategies outlined in this plan are meant to guide state action and to be flexible over time. Not all strategies can be implemented at once; rather, they can be put in place as resources, data and partnerships evolve. Additionally, actions to advance these strategies may change over time for a variety of reasons, including an increased understanding

Route 1 at the Indian River Inlet was impassable after Superstorm Sandy due to major dune erosion. Extreme weather events, along with more costly storm damage, are projected to become more frequent as a result of climate change.
Photo credit: DNREC

of climate impacts, technology advancements and stakeholder and community input.

It was important that the state consider equity in the strategies proposed in this plan because climate change impacts are not felt equally across communities. Climate change not only creates new risks but can also exacerbate existing vulnerabilities. Many climate change impacts — including rising temperatures in urban areas, more polluted air and an increased frequency of extreme weather events — disproportionately affect people and communities already facing economic and social challenges.[38] These communities may already have lower capacity to prepare for and cope with these impacts.[39] For example, people struggling to pay an electric bill may find it even more difficult to do so if there is an increase in the number of high heat days. Additionally, climate solutions, if not carefully considered or implemented, could disproportionally affect communities that are already vulnerable or disadvantaged if new policies or programs do not consider existing inequalities.[40] The state worked to incorporate principles of equity into both strategies presented in this plan and the proposed steps for moving from planning to action.

This page intentionally left blank.

Chapter 2: Developing the Plan

The process of putting together Delaware's Climate Action Plan consisted of three steps:

1. **Accounting for past and present climate action**, including the state's existing policies, programs and initiatives
2. **Identifying gaps in climate action** to clarify the steps needed to continue addressing climate change in the state
3. **Building knowledge to inform continued climate action** in such a way that further action can be pursued strategically

DNREC staff were tasked with carrying out the three above steps. This chapter provides a summary of how DNREC went about accomplishing this task.

2.1 Accounting for Past and Present Climate Action

Climate action can be most effective when it expands and builds upon policies, programs and initiatives that have already been established or taken place. As such, it is necessary to first inventory past work. This section provides an overview of past and present state action to minimize greenhouse gas emissions and maximize resilience to climate change impacts.

2.1.1 Past and Present Climate Action to Minimize Greenhouse Gas Emissions

Over the last two decades, Delaware has invested in programs and policies that reduce greenhouse gas emissions. This includes efforts to use energy more efficiently, expand renewable energy, reduce emissions from cars and trucks, and replace industrial refrigerants. Table 1 summarizes examples of some of these initiatives.

Transitioning to renewable energy sources, like wind, can create new jobs. Photo credit: Adobe Stock

Table 1. Delaware Initiatives to Minimize Greenhouse Gas Emissions

	Consumer and Business Incentives	Policy and Regulations
Clean and Renewable Energy	DNREC's Green Energy Program[41] provides grants to offset the cost of solar panels, solar water heating, wind and geothermal renewable energy technologies.	The Delaware Renewable Energy Portfolio Standards Act,[42] passed in 2005 and updated in 2021, requires Delaware's utilities to get an increasing percentage of their electricity from renewable sources. By 2035, 40% of the utilities' electricity must be from renewable sources.
Energy Efficiency	Delaware's Weatherization Assistance Program[43] provides no-cost home energy efficiency upgrades to low- and moderate-income Delawareans who rent or own a home. DNREC's Energy Efficiency Investment Fund[44] provides grants and low-interest loans to help commercial and industrial customers replace aging, inefficient equipment and systems with energy-efficient alternatives. DNREC also has an Energy Efficiency Industrial[45] program that helps large-scale energy users make their operations more energy-efficient through innovative upgrades.	DNREC is required to review and update the statewide code for energy conservation every 3 years. In 2020, DNREC amended the Code for Energy Conservation[46] by adopting the 2018 International Energy Conservation Code (IECC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 2016 Energy Standard for Buildings Except Low Rise Residential Buildings. In 2017, DNREC issued Evaluation, Measurement and Verification[47] regulations that set forth procedures and standards for defining and measuring electricity and natural gas savings from energy efficiency programs provided by Delaware's utilities.
Transportation	DNREC's Clean Transportation Incentive Program[48] offers rebates to businesses and individuals to offset the up-front cost of purchasing an electric or plug-in hybrid electric vehicle. Rebates for vehicle charging stations are also available. Delaware participates in the National Clean Diesel Campaign[49] through Diesel Emission Reduction Act[50] funding. This U.S. Environmental Protection Agency program funds grants and rebates for technologies that reduce harmful emissions from diesel engines. Delaware received $9.6 million from the Volkswagen Environmental Mitigation Trust.[51] These funds are being used to replace high-emitting diesel engines and install electric vehicle charging stations.	DNREC's Low Emission Vehicle Program[52] regulations hold to the more stringent California tailpipe emissions standard to reduce smog-forming emissions and greenhouse gases, beginning with 2014 model year vehicles. As a result of this program, new cars will emit 75% less smog-forming pollution in 2025 than the average new car sold in 2015.[53] Delaware's Office of Management and Budget Fleet Services section has committed to transitioning 20% of its light-duty vehicle fleet to electric by 2025.[54] This will result in an emissions reduction of 1,300 metric tons of carbon dioxide equivalent by 2025.
High Global Warming Potential Greenhouse Gases	DNREC's newly launched "Cool Switch" Low Impact Refrigerant Program[55] provides financial incentives to commercial and industrial users to replace hydrofluorocarbon refrigerants with refrigerants that have less climate change impacts.	In March 2021, DNREC issued regulations requiring the phase down of specific hydrofluorocarbons used in air conditioning/refrigeration equipment, aerosols and foam.[56] The regulations go into effect in September 2021.

The 2-megawatt wind turbine on University of Delaware's Lewes campus generates more than enough electricity to power its six buildings throughout the year.
Photo credit: DNREC

Delaware has also reduced greenhouse gas emissions through interstate collaboration. One such collaboration is the Regional Greenhouse Gas Initiative, a multistate carbon dioxide cap-and-trade program consisting of 11 Northeast and Mid-Atlantic states. This program sets a regional cap on carbon dioxide emissions from the power sector.[57] Since the program's inception in 2008, emissions from electricity generation in the state have decreased by 45%.[58] Electricity generators that emit carbon pollution must purchase credits in an auction platform; proceeds from the auction are returned to states, which invest the funds into programs that further reduce greenhouse gas emissions. Many of the "Consumer and Business Incentives" mentioned in Table 1 are partially or fully funded by proceeds from the Regional Greenhouse Gas Initiative. This program also helps fund the Delaware Sustainable Energy Utility, known as Energize Delaware, a statewide organization that offers incentive and loan programs to residents, nonprofits and commercial entities to enhance energy efficiency and renewable energy opportunities in the state.

Additionally, Delaware participates in the Transportation and Climate Initiative, a multistate collaborative of Northeast and Mid-Atlantic states seeking to reduce emissions in the transportation sector.[59] The states in the Transportation and Climate Initiative have worked to evaluate transportation emissions in the region, develop strategies to encourage zero-emission vehicles and alternative fuels, and enhance freight efficiency. The Transportation and Climate Initiative states are now engaged in a multiyear effort to develop a market-based program that would cap regional emissions from transportation fuel combustion. Emissions allowances would be auctioned, and auction proceeds would be returned to states to invest in programs that further reduce greenhouse gas emissions. Delaware is at the table in the development of this program to evaluate its implications for Delaware.

Finally, Delaware has made strides to track greenhouse gas emissions in the state. Since 2008, DNREC has overseen the state's Greenhouse Gas Inventory, which presents data and analyses on six greenhouse gases.[60] DNREC's Division of Air Quality prepares the annual inventory to characterize the state's historical greenhouse gas emissions, providing information on activities that contribute to greenhouse gas emissions.

2.1.2 Past and Present Climate Action to Maximize Resilience to Climate Change Impacts

Delaware has invested more than a decade's worth of work in maximizing resilience and adapting to climate change impacts through statewide planning efforts; policy development and regulations; capacity-building for state and local governments; and the development of research, data and tools. Table 2 summarizes examples of some of these initiatives.

Table 2. Delaware Initiatives to Maximize Resilience to Climate Change Impacts

Policy, Planning and Regulations	Starting in 2009, DNREC carried out a 5-year sea level rise planning[61] initiative to assess the impacts of sea level rise on the state. Outputs of this effort included a vulnerability assessment, recommendations for adapting to climate change impacts, an interim implementation plan and, in 2017, updated sea level rise planning scenarios for the state.[62] In 2013, then-Governor Jack Markell signed Executive Order 41: Preparing Delaware for Emerging Climate Impacts and Seizing Economic Opportunities from Reducing Emissions. As part of the Executive Order, the state developed the 2014 Climate Framework for Delaware,[63] a summary of efforts that state agencies identified as ways they could better help maximize Delaware's resilience to climate change. Other outputs from this effort included a guide for state agencies[64] to avoid and minimize flood risk to state assets and the Flood Risk Adaptation Map,[65] a tool for state flood risk planning that combines current flood modeling with sea level rise projections to depict areas in Delaware vulnerable to flooding, now and in the future. In 2016, DNREC released a Climate Action in Delaware report,[66] outlining progress made on efforts included in the Climate Framework. In 2017, Governor John Carney signed into law amendments to Delaware's Coastal Zone Act.[67] A newly created permit under the amended act requires prospective businesses to develop a Sea Level Rise and Coastal Storms Plan as part of the permitting process. This is the first time such a requirement was codified in Delaware law. A number of state agencies have outlined plans and policies that address how they will account for climate change impacts in their programs and operations. Such documents include: Delaware Division of Historical and Cultural Affairs Strategic Plan FY15/FY19 (Department of State, 2013)[68] Delaware Wetland Management Plan (DNREC, 2015)[69] Delaware Wildlife Action Plan (DNREC, 2015)[70] Strategic Implementation Plan for Climate Change, Sustainability & Resilience for Transportation (Department of Transportation, 2017)[71] State of Delaware All-Hazard Mitigation Plan (Department of Safety and Homeland Security, Delaware Emergency Management Agency, 2018)[72] Delaware Statewide Forest Strategy (Department of Agriculture, Delaware Forest Service, 2020)[73]
Capacity-Building for State and Local Governments	In 2015, DNREC launched its Resilient Community Partnership[74] program to provide technical assistance and potential funding to plan for and reduce the impacts of coastal hazards related to flooding from sea level rise, coastal storms and climate change through the development of planning strategies at the local level. Recipients of assistance through this program include the Town of Slaughter Beach, the City of New Castle and various Atlantic beach communities. In 2016, DNREC led the establishment of the Resilient and Sustainable Communities League,[75] a collaborative network of state, nonprofit and academic partners that provides information, technical assistance and networking opportunities to state, local and county governments, citizen groups, the private sector and nonprofit organizations to advance the goals of resilience and sustainability in Delaware. DNREC continues to provide strategic direction and funding to this effort.

	In 2016 and 2018, DNREC provided funding through its Strategic Opportunity Fund for Adaptation program to assist state agencies in adapting to climate change, particularly focusing on efforts that agencies outlined in the Climate Framework for Delaware. Some example projects include on-the-ground restoration projects, asset vulnerability assessments, climate change impact modeling and health tracking databases. State agencies that have used program funds include the Delaware State Housing Authority, Department of Agriculture, Department of Health and Social Services, DNREC, Department of Safety and Homeland Security (including the Delaware State Police and the Delaware Emergency Management Agency), Department of State (Division of Historic and Cultural Affairs), Department of Transportation and the Office of Management and Budget. In 2017, DNREC provided funding through its Sustainable Communities Planning Grant program to assist local governments with developing sustainability plans that reduce greenhouse gas emissions and increase readiness for climate change impacts. Recipients of funding through this program include Wilmington, Newark, Frederica, Milton and Fenwick Island. DNREC offers an ongoing Coastal Training Program[76] that provides technical assistance and training for coastal resource planners and managers on critical issues. Past trainings have addressed climate change and community resilience, wetlands restoration, project planning and evaluation and science communication techniques.
Research, Data and Tools	In 2011, the Delaware Geological Survey and the Delaware Environmental Observing System, with support from DNREC, developed the Delaware Coastal Flood Monitoring System,[77] a web-based tool and alert system designed to provide emergency managers, planners and the Delaware public with information on the extent, timing and severity of upcoming coastal flood conditions. In 2014, DNREC released the Delaware Climate Change Impact Assessment,[78] which provided an overview of climate change impacts in Delaware, including projections for heat and precipitation to the year 2100. The assessment looked at what those projections mean for Delaware's public health, water resources, agriculture, infrastructure and ecosystems. In 2016, the University of Delaware's Institute for Public Administration, with support from DNREC, developed the Delaware Database for Funding Resilient Communities, a searchable web database of relevant financial assistance programs that can be used by communities to support climate change resilience projects.[79] In 2017, the Delaware Geological Survey, with support from DNREC, developed a series of coastal inundation maps[80] for the state. These maps, in coordination with the updated sea level rise planning scenarios for the state, were created to inform long-range planning for the state's infrastructure, facilities, land management, land use and capital spending. In 2018, the University of Delaware Center for Environmental Monitoring, with support from DNREC, established the Delaware Climate Information Center,[81] an online clearinghouse of data, reports, tools, funding opportunities and events aimed at providing easy access to relevant and useful information for assessing impacts and preparing for climate change in Delaware. DNREC has helped fund climate-related research for numerous graduate students over the years. Supported research has looked at, among other things, groundwater movement and storage, greenhouse gas exchanges between land and atmosphere, and the landward migration of wetlands. DNREC also leads a variety of multiyear monitoring efforts[82] to better understand short- and long-term climate change impacts; these monitoring activities include examining the timing of plant life cycles, measuring water levels and wetland surface heights, and taking surveys of aquatic animals. Delaware actively participates in the Mid-Atlantic Coastal Acidification Network,[83] which seeks to better coordinate, support and lead coastal and ocean acidification research and monitoring. Staff from DNREC sit on the Network's Steering Committee, Science Workgroup and Outreach Workgroup.

2.2 Identifying Gaps in Climate Action

The next step in the state's climate action planning process was to identify gaps in existing climate action. This was done through a qualitative "gaps analysis," a process that compares "where we are at" to "where we want to be." A gap was defined as any element that was missing but essential to getting to "where we want to be." Carrying out a gaps analysis was critical to helping the state prioritize areas for new or expanded efforts in climate action. This section summarizes findings from the gaps analysis.

2.2.1 Gaps in Climate Action to Minimize Greenhouse Gas Emissions

As mentioned earlier, Delaware has committed to reducing greenhouse gas emissions by 26% to 28% from 2005 levels by 2025. However, DNREC found in its gaps analysis that the state had not previously quantified the actions necessary to ensure Delaware meets this goal. Additionally, Delaware does not yet have emissions reduction goals beyond 2025. As such, DNREC determined that a gap in the state's climate action is a strategic and feasible pathway to meet its 2025 goal, along with a framework for further emissions reductions beyond 2025.

To fill this gap, DNREC identified the need for a new analysis to assess where the state's greenhouse gas emissions are projected to come from in the decades ahead and which sectors have the greatest potential for reducing emissions. This analysis would help the state understand the impact of its emissions reduction practices, both currently and into the future.

2.2.2 Gaps in Climate Action to Maximize Resilience to Climate Change Impacts

As noted in Table 2, in 2013 state agencies identified actions they could take to adapt to climate change and increase Delaware's resilience. These actions were published in the 2014 Climate Framework for Delaware.[84] Additionally, as part of Delaware's statewide sea level rise planning effort, the Delaware Sea Level Rise Advisory Committee approved and published a list of recommendations for adapting to sea level rise in the state.[85]

This rain garden at University of Delaware helps maximize resilience by reducing stormwater runoff from the pavement. Photo credit: University of Delaware Sea Grant

In 2016, DNREC produced a Climate Action in Delaware report to provide an update on the actions and goals outlined in the Climate Framework, including state agency accomplishments in resilience work.[86] However, DNREC found in the gaps analysis, that since this report, no comprehensive effort had been carried out to assess progress on the actions outlined in the Climate Framework and the sea level rise recommendations report. As such, DNREC determined that a gap in the state's climate action is an understanding of how state agencies have pursued climate action over the last few years and where actions may still be needed.

To fill this gap, DNREC identified a need to reconnect with all the state agencies involved in the Climate Framework and sea level rise planning processes. DNREC noted that by holding interviews with state agency staff, it could identify actions already taken and determine current priorities within state agencies. This information could, in turn, inform where the greatest attention and effort may be needed to enhance Delaware's resilience to climate change impacts.

2.3 Building Knowledge to Inform Continued Climate Action

To make decisions about continued climate action, the state needed to solicit new information to fill the identified gaps and inform next steps. This section summarizes the state's process for building knowledge to inform what climate action to take going forward.

2.3.1 Review of Other State Plans

One of the first steps the state took in developing Delaware's Climate Action Plan was to understand how other U.S. states implemented their climate action planning processes. This mainly took the form of reviewing other states' climate action and energy plans and reaching out to staff in those states for informal conversations. There was a particular focus on:

- whether (and how) states integrated actions to minimize emissions and maximize resilience into a single document;
- whether (and how) climate action plans built on existing plans or documents;
- how goals (e.g., emissions reduction, resilience) were determined and set;
- whether, to what degree and at what intervals plans (or goals) were updated; and
- how progress towards goals laid out in a plan was tracked and reported.

DNREC also found it informative to learn how states that were not on track to meet their goals pivoted to ensure that meaningful progress was still being made.

In addition to the broader considerations noted above, DNREC also focused attention on specific elements in other states' plans regarding minimizing greenhouse gas emissions and maximizing resilience to climate change impacts.

In terms of minimizing emissions, DNREC paid special attention to who prepared the plan (i.e., state staff vs. consultants, which state agencies were involved) and on which sectors the plans focused (e.g., sector-specific vs. economy-wide). DNREC also consulted representatives from Connecticut, Pennsylvania and various municipalities in other states to understand the process for working with consultants to provide technical support for climate action planning, including what goes into the contracting process, what services to seek and what skill sets (or areas of expertise) would be valuable to look for in a consultant.

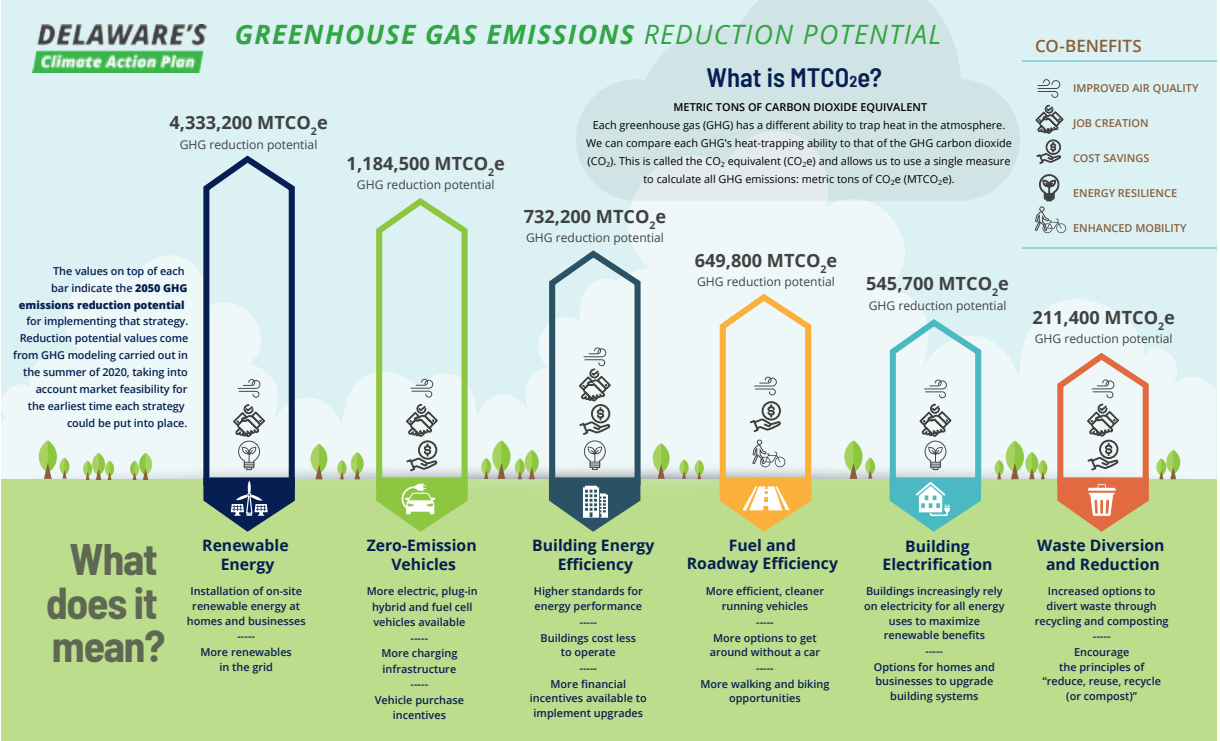
In terms of maximizing resilience, DNREC reviewed other states' plans with an eye for identifying actions to adapt to climate change that could be implemented in Delaware. This review not only involved noting specific actions but also observing the types of actions that other states incorporated in their plans. Such actions were included as part of DNREC's interviews with Delaware state agencies, being provided to agency staff as example actions to consider for implementation.

2.3.2 Technical Analysis for Assessing Greenhouse Gas Emissions in Delaware

DNREC began working in early 2020 with a team from ICF — a consulting firm with extensive experience in conducting technical analyses to support climate planning — to analyze what Delaware's greenhouse

Figure 6: The benefits and co-benefits of reducing greenhouse gas emissions based on modeling completed by ICF in 2020

Source: DNREC



gas emissions could look like over the next three decades. DNREC commissioned ICF to look at two emissions scenarios in its analysis:

- Scenario 1: Delaware takes no new actions to minimize emissions (i.e., business-as-usual)
- Scenario 2: Delaware implements new and expanded strategies to minimize emissions

Carrying out this analysis required taking a number of steps. First, greenhouse gas emissions sources associated with different economic sectors were identified by the DNREC team to be included in the analysis. Next, technical experts from the identified sectors were consulted to gauge the type of greenhouse gas emissions reduction actions they felt were feasible for Delaware (see 2.3.4 *Stakeholder Engagement* for more details on this process). Feedback received from the stakeholders was used to select emissions reduction actions to model for Scenario 2. Finally, DNREC coordinated with ICF to establish modeling assumptions and identify existing data sets that could be used for the analysis.

Given limitations in time and resources, DNREC selected only 20 greenhouse gas emissions actions to model for Scenario 2. The selection criteria included looking at each action's greenhouse gas emissions reduction potential, action feasibility in Delaware and the ease with which an action could be modeled. DNREC also worked with ICF to determine a subset of the 20 modeled actions to analyze for high-level costs and benefits. Further details on the methodology of the technical analysis can be found in the Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis Report.[87]

Based on the results of the greenhouse gas emissions modeling analysis, DNREC identified four overarching "action categories" for minimizing emissions:

1. **Clean and renewable energy** expansion, which has the greatest potential to reduce emissions in the long term
2. **Energy efficiency** measures, which can be put in place relatively quickly and implemented through existing programs
3. **Transportation** sector transitions to zero-emission vehicles and more efficient transportation systems
4. **"High global warming potential" greenhouse gas** emissions reductions and management of greenhouse gases other than carbon dioxide

Strategies and actions developed for these four action categories are described in *3.1 Plan to Minimize Greenhouse Gas Emissions*. That section also addresses strategies and actions to "offset" emissions, which were not modeled in detail in ICF's analysis.

2.3.3 Interviews with Delaware State Agency Staff

Data collection to support actions for maximizing resilience to climate change impacts focused on interviewing staff at 10 of Delaware's state agencies (Box 3). From April to July 2020, DNREC hosted interviews with state agency staff to review the status of actions their agencies previously identified in either the Climate Framework for Delaware[88] or the recommendations report from the state's sea level rise planning effort.[89] The interviews also aimed at determining climate change adaptation actions that these agencies would like to implement over the next 5 years.

Box 3. State Agencies Interviewed on Maximizing Resilience to Climate Change Impacts

- Delaware State Housing Authority
- Department of Agriculture
- Department of Education
- Department of Health and Social Services
- Department of Insurance
- Department of Natural Resources and Environmental Control
- Department of Safety and Homeland Security
- Department of State
- Department of Transportation
- Office of Management and Budget

Based on input gathered from the state agency interviews, DNREC identified seven overarching "action categories" for maximizing resilience:

1. **Updated or new state regulations** that address protection and conservation of vulnerable and impacted resources
2. **Support for communities and stakeholders** in the form of trainings, resources and technical assistance
3. **Management plan**s for natural resources, emergency response, state facilities and agency equipment
4. **Facility design and operation** that accounts for future climate conditions
5. **Research and monitoring** that studies the impacts of climate change and methods of adapting
6. **Outreach and education** on climate change impacts and adapting to climate change
7. **Agency support** that provides the resources to implement resilience actions

Public participation and stakeholder engagement are key to implementing climate action. Photo credit: DNREC

Strategies and types of actions developed for these seven action categories are described in *3.2 Plan to Maximize Resilience to Climate Change Impacts*.

2.3.4 Stakeholder Engagement

DNREC was committed to engaging stakeholders in the development of this plan. In addition to the state agency staff interviews, stakeholder engagement was primarily carried out through facilitated workshops and discussions with both members of the Delaware public and economic sector representatives.

DNREC hosted two rounds of public workshops. The first round of workshops was held in-person from March 3 to 5, 2020, with the same workshop held in each of the three Delaware counties. These workshops aimed to both educate the Delaware public about climate change impacts in the state and engage participants in brainstorming ideas for climate action. The workshops focused specifically on transportation, energy and resilience. Input gathered from these public workshops gave the state an initial understanding of the climate change solutions Delawareans support. This input further informed the emissions reduction strategies that ICF modeled in its technical analysis, as well as the questions that DNREC asked during its state agency interviews. More information about these workshops can be found in the March 2020 public workshop summary report.[90]

Another round of public workshops was held from September 15 to October 1, 2020. This round consisted of four unique workshops held fully online. The first workshop, offered as two separate sessions, focused on strategies to minimize greenhouse gas emissions and covered high-level results from the ICF analysis. Input gathered from these two sessions provided DNREC with an understanding of which emissions reduction strategies Delawareans would like to see implemented first and whether there is an appetite among the public to set a long-term emissions reduction target.

The next three workshops focused on strategies to maximize resilience and adapt to climate change impacts, with each workshop dedicated to a specific climate change impact:

Information gathered at public workshops helped shape Delaware's Climate Action Plan. Photo credit: DNREC

sea level rise, increased temperatures or heavy precipitation and flooding. The purpose of these workshops was to highlight how the seven action categories identified by state agencies intersected with climate change impacts in Delaware. Input gathered from these workshop sessions informed DNREC about which strategies had high public support for near- and long-term implementation.

More information about all four workshops can be found in the two Fall 2020 public workshop summary reports.[91,92]

For each round of public workshops, DNREC also hosted an interactive online survey on the Climate Action Plan website (declimateplan.org) that incorporated the same general topics as those covered at the workshops during the corresponding round. The purpose of these surveys was to solicit feedback from those unable to attend a workshop. Each survey opened prior to the first workshop of each round and stayed open for at least 1 month. The results from each survey, including how the results compared to the feedback received at the public workshops, are included in the appendix of the associated public workshop summary report.

Members of the public were also able to submit written input on Delaware's Climate Action Plan from February 1, 2020, through October 16, 2020. Submission options included U.S. mail to the DNREC Division of Climate, Coastal and Energy; in-person or email delivery of written content to a DNREC Division of Climate, Coastal and Energy staff member; emailed input to declimateplan@delaware.gov; and, starting March 1, 2020, written input via the "Submit a Comment" form on the Climate Action Plan website (declimateplan.org). All comments received between February 1 and October 16, 2020, were logged, read and forwarded to relevant members of the DNREC Climate Action Plan team for consideration. The full record of written public input submissions is available at de.gov/climateplan.

DNREC also hosted two rounds of engagement activities for technical experts. Invitees

Technical experts provide input on actions that could be implemented to reduce greenhouse gas emissions at a Technical Advisory Workshop. Photo credit: DNREC

included agencies and businesses that could be considerably impacted by greenhouse gas emissions reduction strategies or those that may have a notable role in helping to reduce greenhouse gas emissions in the state. The engagement focused on five economic sectors: buildings (encompassing both commercial and residential), electric power, industrial processes, transportation and waste.

For the first round of technical expert engagement, DNREC held a half-day "technical advisory workshop" in-person on March 4, 2020. The purpose of this workshop was to solicit input on the types of actions that could be implemented for Delaware to reach its 2025 emissions reduction target. Workshop participants were asked to assess the viability of certain emissions reduction strategies, methods for strategy implementation and examples of best practices for sector-specific emissions reductions. Input gathered from this workshop informed which emissions reduction strategies ICF modeled in its technical analysis. More information about this workshop can be found in the March 2020 technical advisory workshop summary report.[93]

For the second round of technical expert engagement, DNREC carried out virtual, sector-specific technical expert conversations with representatives from each of the five sectors. These conversations were held from September 9 to 22, 2020. The purpose of these conversations was to review the results of ICF's technical analysis and to generate input on opportunities and barriers for implementing the modeled strategies. Input gathered from these conversations helped shape which strategies and actions were included in Delaware's Climate Action Plan, including how such actions were discussed.

As noted previously, while Delaware's Climate Action Plan indicates the types of climate action the state should take, it does not dictate all the details of how those actions will (or should) be implemented. The plan itself also does not create new mandates or requirements. As such, how the plan is carried out will require further engagement with stakeholders that is concerted, thoughtful, intentional and inclusive.

DNREC looks forward to further conversations with Delaware residents, communities and organizations to determine how the climate actions laid out in this plan can be designed, collaborated on and implemented in a way that works to provide equitable benefits and opportunities for all Delawareans.

Chapter 3: Climate Action Plan




Delaware's Climate Action Plan addresses both the causes and consequences of climate change. This chapter lays out specific strategies and actions for these two important components:

- **Minimizing greenhouse gas emissions actions** are described in Chapter 3.1
- **Maximizing resilience to climate change impacts** actions are described in Chapter 3.2

Delaware is committed to ensuring that climate action is engaged, empowering and equitable. Implementing the strategies in this plan will take leadership and coordination – between state agencies and local governments, communities and residents, businesses and industries. By working together, we can realize a future where the First State is a leader in climate action.

Throughout the process of developing Delaware's Climate Action Plan, the state used technical analysis and stakeholder engagement to identify strategies that can be implemented to meet our 2025 goal and set a course for long-term emissions reductions. Many of these strategies are already supported through existing programs and policies. However, scaling up climate action will new and expanded policies and programs as well.

3.1 Plan to Minimize Greenhouse Gas Emissions

Minimizing greenhouse gas emissions is one of the key components of Delaware's Climate Action Plan. This means taking action to reduce the greenhouse gas emissions that drive the climate change we see today. Many of these actions have additional benefits: providing job growth and economic opportunities in clean energy technology; reducing air pollutants and improving environmental conditions; and helping residents, businesses and communities across the state have access to clean and reliable energy.

Throughout the process of developing Delaware's Climate Action Plan, the state used technical analysis and stakeholder engagement to identify strategies that can be implemented to meet our 2025 goal and set a course for long-term emissions reductions. Many of these strategies are already supported through existing programs and policies. However, scaling up climate action will require new and expanded policies and programs, as well.

This section discusses progress to date on minimizing greenhouse gas emissions and presents a summary of Delaware's emissions

reduction goals. This section also provides a summary of results from ICF's technical analysis. Finally, this section outlines strategies and actions that Delaware can implement within the next 5 years. Some of these actions may require additional technical analysis to ensure successful implementation.

3.1.1 Progress in Delaware to Minimize Greenhouse Gas Emissions

Delaware's Climate Action Plan lays out steps for continued climate action, while recognizing that the state has already made important progress in reducing greenhouse gas emissions over the past two decades. Table 1 in *2.1.1 Past and Present Climate Action to Minimize Greenhouse Gas Emissions* includes a list of existing state programs and initiatives that contribute to reducing greenhouse gas emissions.

As previously mentioned, in 2017, Governor John Carney committed to reducing Delaware's greenhouse gas emissions by 26% to 28% from 2005 levels by 2025 by joining a coalition of states in the U.S. Climate Alliance.[94] This target — identical to the goal the U.S. made upon joining the Paris Agreement under the United Nations Framework Convention for Climate Change — affirms Delaware's recognition that state-level action is important to addressing climate change. Based on data from Delaware's Greenhouse Gas Inventory for 2016, state efforts have resulted in an emissions reduction of 18.3% from 2005 to 2016.[95] Given that Delaware has not yet met its emissions reduction goal, this plan looks to identify actions the state can take to ensure that we meet or exceed it.

Box 4. Delaware's Greenhouse Gas Inventory

Delaware has systems in place to track greenhouse gas emissions. DNREC's Division of Air Quality prepares an annual Greenhouse Gas Inventory to characterize Delaware's historical and projected greenhouse gas emissions and inform policy option development. Six greenhouse gases are included in the inventory: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

The inventory provides information on the activities that produced emissions as well as background information on the methods used to estimate the emissions. Emissions are tracked in seven sector areas: electric power, transportation, industry, residential (buildings), commercial (buildings), agriculture and waste.[96]

3.1.2 Greenhouse Gas Emissions Reduction Goals

Meeting Delaware's 2025 greenhouse gas emissions reduction goal is an important step. However, the state also recognizes the need to strengthen our commitment to reducing emissions beyond 2025.

The Intergovernmental Panel on Climate Change indicates that worldwide greenhouse gas emissions must reach net zero by 2050 to stop Earth's warming beyond 1.5 degrees C (1.7 degrees F) and to avoid the worst consequences of climate change.[97] In line with this reality, many countries, 16 U.S. states and hundreds of local governments have adopted targets to reduce emissions by at least 80% by 2050.[98]

ICF's modeling analysis shows that implementing practical climate actions can lead Delaware towards greenhouse gas emissions

reductions of more than 40% below 2005 levels by 2035 (see *3.1.3 Overview of Greenhouse Gas Emissions Technical Analysis* for details). However, this estimate is based on the 20 actions that were selected for the modeling analysis. If we take additional steps beyond these modeled actions, Delaware can realize similar emissions reductions to those targeted by surrounding states (Box 4). In this spirit, the strategies in Delaware's Climate Action Plan lay out options for the state to achieve ambitious emissions reductions in the short, mid- and long terms.

Box 5. Greenhouse Gas Emissions Reduction Goals of Neighboring States[99]

- **Pennsylvania:** Long-term goal of 80% below 2005 levels by 2050 (enacted in 2019 by executive action)
- **New Jersey:** Long-term goal of 80% below 2006 levels by 2050 (enacted in 2007 by executive action)
- **Maryland:** Mid-term goal of 40% below 2006 levels by 2030 (enacted 2016 by statute)
- **Virginia:** Mid-term goal of net-zero emissions by 2045 (enacted 2020 by statute)

3.1.3 Overview of Greenhouse Gas Emissions Technical Analysis

Early in 2020, DNREC began working with a team from ICF, a consulting firm with extensive experience conducting technical analyses to support climate planning. Their task was to model Delaware's greenhouse gas emissions, and potential reductions, over the next three decades. As described in Chapter 2: Developing the Plan, this involved looking at two modeling scenarios:

- Scenario 1: Delaware takes no new actions to minimize emissions
- Scenario 2: Delaware implements new and expanded strategies to minimize emissions

The methodology and results of this analysis are presented in the *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis Report*.[100] A brief summary of the analysis and key findings is included below.

As a first step, the ICF team conducted a modeling exercise to develop a "business-as-usual" scenario (described above as Scenario 1). The business-as-usual scenario assumes that no additional actions will be taken in the future to reduce emissions beyond state and federal policies and programs already in place. As such, the business-as-usual scenario serves as a baseline for additional emissions reductions that can be achieved through new or expanded actions. The business-as-usual model provides a comprehensive look at Delaware's greenhouse gas emissions going back to 2005 and projecting through 2050.

The results of the business-as-usual analysis project net greenhouse gas emissions in Delaware to **decline by 25% in 2025** from 2005 levels, falling just short of the state's 2025 greenhouse gas emissions reduction goal of 26% to 28%. The analysis also shows us that without additional emissions reduction actions, emissions are projected to start rising again around 2032. The projected rise in emissions is mostly due to population growth and increased economic activity. Because emissions are projected to rise in the 2030s and beyond, Delaware's net emissions reduction in 2050 is projected to be just 19.6% from 2005 levels.

The second step in the technical analysis was to assess potential greenhouse gas emissions reductions from new actions that could be implemented in the state (described above as Scenario 2). DNREC and ICF selected 20

emissions reduction actions for this analysis, based on public and technical expert feedback, data availability and modeling feasibility. The suite of actions modeled represents a wide variety of possibilities across many sectors and, where possible, focuses on actions that have the highest emissions reduction potential. Not every potential action could be modeled due to budget limitations and time constraints.

Results of the analysis indicate that if all 20 actions were fully implemented, Delaware's net greenhouse gas emissions would **decline by 31% in 2025** from 2005 levels. This would meet and exceed Delaware's 2025 emissions reduction goal. Additionally, the analysis projects Delaware could achieve a reduction of 41% in 2035 from 2005 levels if all 20 strategies were fully implemented.

The analysis revealed three important takeaways:

1. Decarbonizing the electrical grid has the greatest emissions reduction potential in the mid- and long terms and accelerates the emissions reduction potential of other actions.
2. Energy efficiency actions provide effective and low-cost strategies to meet Delaware's short-term goal and remain important for emissions reduction in the long term.
3. Electrification of the transportation and building sectors is an important transition that can lead to significant greenhouse gas emissions reductions over time. Achieving the greatest potential emissions reductions from these actions depends on decarbonizing the electrical grid.

Box 6. Key Terms in Greenhouse Gas Emissions Reduction

Decarbonization: Long-term strategies to reduce carbon dioxide emissions by phasing out the use of carbon-emitting processes and technologies. This is primarily accomplished by eliminating the combustion of fossil fuels as an energy source, with the end goal of a carbon-free global economy.

Electrification: The process of replacing technologies that use fossil fuels as an energy source with technologies that use electricity instead. Electrification holds to the expectation that electricity is generated using a clean or renewable energy.

Energy Efficiency: Practices in which older or less energy-efficient appliances, vehicles, building materials and other technologies are replaced with newer, more efficient designs that require less energy. By reducing energy demand, efficiency improvements can both reduce greenhouse gas emissions and realize cost savings in the short-term. Energy efficiency can also be driven by, and carried out in tandem with, electrification.

Table 3 summarizes the greenhouse gas emissions reduction actions that were modeled in this analysis. It should be noted that some of the modeled actions are combined in the table for ease of reading. Table 3 also shows the annual greenhouse gas emissions reduction potential achieved in each of these action categories in the years 2025 and 2050. To put the table values into perspective:

- Greenhouse gas emissions in 2005 are established as a baseline for current and future greenhouse gas emissions reduction targets.

- In 2005, Delaware's greenhouse gas emissions were 22,800,000 metric tons of carbon dioxide equivalent (MT CO_2e).
- Delaware's goal for 2025 is to reduce annual emissions to approximately 16,500,000 MT CO_2e, a reduction of 28% (and a difference of about 6,300,000 MT CO_2e) compared to 2005.

Box 7. What is MT CO_2e?

Each greenhouse gas has a different ability to trap heat in the atmosphere. We can compare each greenhouse gas's heat-trapping ability to that of carbon dioxide (CO_2). This is called the carbon dioxide equivalent (CO_2e), and it allows us to use a single measure to calculate all greenhouse gas emissions: metric tons of carbon dioxide equivalent (MT CO_2e).

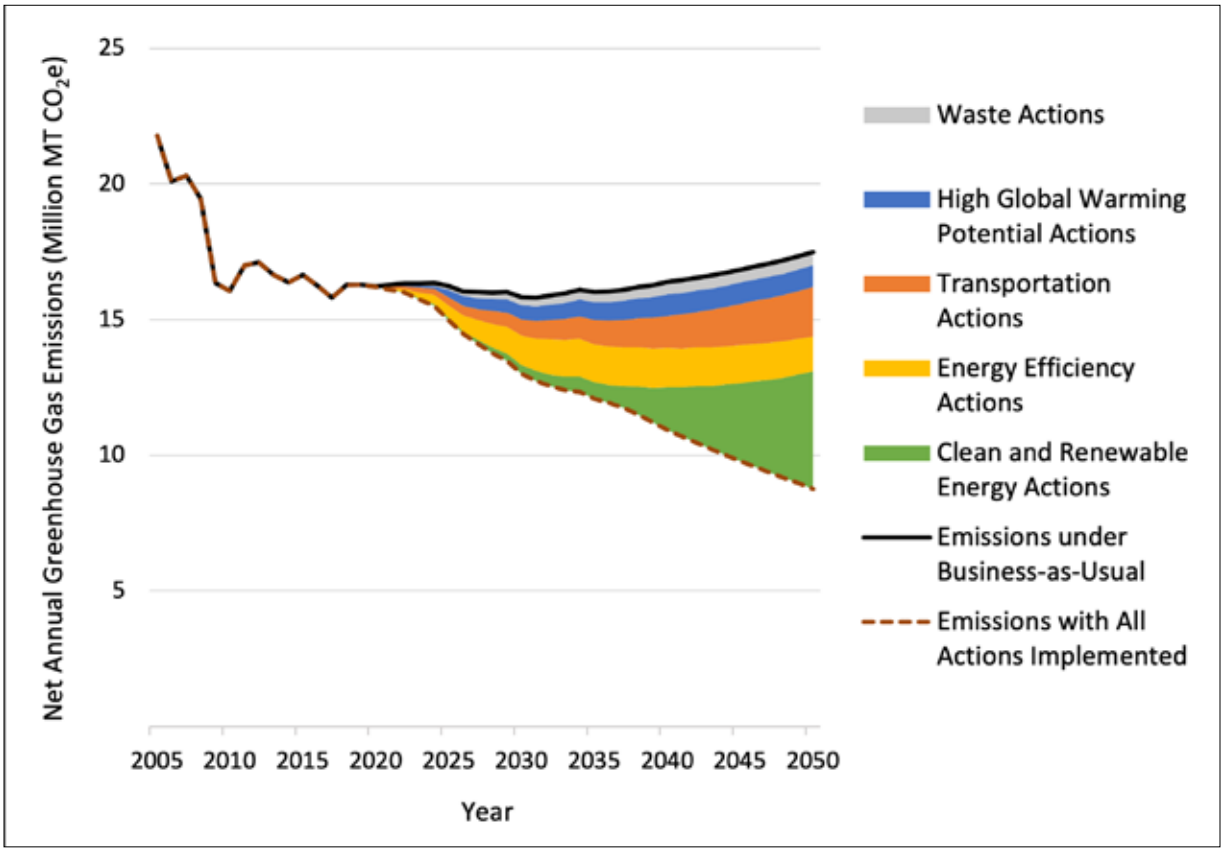
Table 3. Summary of Actions Modeled in ICF's Greenhouse Gas Emissions Technical Analysis

Action Categories	Modeled Actions	Estimated Annual Emissions Reductions Compared to the Business-as-Usual Scenario All amounts in metric tons of carbon dioxide equivalent (MT CO_2e)	
		2025	2050
Clean and Renewable Energy	• Expanded Renewable Energy Portfolio Standards • Expanded renewable energy on site in residential, commercial and industrial buildings	**68,200**	**4,333,000**
Energy Efficiency	• Expanded building energy codes • Expanded energy efficiency programs for residential, commercial and industrial buildings • Building electrification	**479,000**	**1,278,000**
Transportation	• Consumer electric vehicle adoption incentives • Fuel-efficient vehicles • Light-duty vehicle travel demand management and land-use strategies • Vehicle manufacturer regulations • Expanded freight best practices and regulatory actions • State fleet electrification • Low carbon fuel standard	**290,000**	**1,834,000**
High Global Warming Potential Gases	• Reducing high global warming potential emissions in the commercial and industrial sectors • Expanded methane capture • Methane emission reduction from utility gas lines • Waste diversion and reduction	**421,000**	**1,288,000**

Figure 7 depicts the greenhouse gas emissions reductions highlighted in Table 3, illustrating that reducing emissions will require a range of strategies across all action categories. This figure also highlights one of the key takeaway messages from the analysis: that decarbonizing the electrical grid and shifting to renewable energy sources will lead to significant long-term emissions reductions. It should be noted that Figure 7 is derived from the Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis Report. In that report, "waste" and "high global warming potential" actions are separated out. In this document, both action types are combined under the single action category "High Global Warming Potential Gases."

Figure 7: Projected Delaware greenhouse gas emissions reduction in million metric tons of carbon dioxide equivalent by action category

Source: 2020 Technical Greenhouse Gas Mitigation Analysis Report



The actions selected for this modeling analysis were meant to inform the strategies to include in the following section, *3.1.4 Greenhouse Gas Emissions Reduction Strategies and Actions*. However, Section 3.1.4 also includes strategies and actions that were not modeled in the technical analysis but have the ability to provide additional emissions reductions for the state.

3.1.4 Greenhouse Gas Emissions Reduction Strategies and Actions

This section presents a set of strategies and actions for reducing Delaware's greenhouse gas emissions to achieve both the state's 2025 goal and set a course for continued reductions beyond 2025. The strategies are presented in four "action categories": Renewable Energy, Energy Efficiency, Transportation and High Global Warming Potential Greenhouse

Gases. In addition, a fifth section presents strategies and actions for offsetting greenhouse gas emissions through the implementation of best management practices in the Natural and Working Lands sector.

3.1.4.1 Clean and Renewable Energy

Increasing the amount of renewable and clean energy that runs our electrical grid and powers our homes and businesses has the greatest potential to reduce greenhouse gas emissions in the long term. Shifting away from carbon-intensive energy sources to produce electricity — referred to as decarbonizing the electrical grid — also accelerates the impact of other emissions reduction actions, such as the transition to zero-emission vehicles. The strategies presented here also include expanding on-site renewable energy systems, such as solar panels for homes and commercial buildings, as well as increasing renewable energy systems for industrial facilities and creating opportunities for community solar development. These strategies also provide co-benefits: Investment in clean energy strategies and technologies creates job and economic development opportunities. Implementation of these strategies will also improve air quality, leading to health benefits, particularly for communities near power generation facilities.

Strategies and actions Delaware can implement:

Strategy: Strengthen Delaware's Renewable Energy Portfolio Standards. Delaware currently has a statute that requires the state's electric utilities to get an increasing percentage of their electricity from renewable sources. This requirement is part of the state's Renewable Energy Portfolio Standards.[101] Actions included in this strategy seek to achieve an increasing amount of renewable energy to "decarbonize" the electrical grid, accommodate new technologies and ensure adequate transmission infrastructure.

- **Action:** Fully implement Delaware's existing Renewable Energy Portfolio Standards to achieve 40% renewable electricity from the electrical grid by 2035.
- **Action:** Take legislative action to amend Delaware's Renewable Energy Portfolio Standards to:
  - Add requirements to maximize the use of renewable energy and other carbon-free strategies from in-state sources, while continuing to secure necessary out-of-state renewable energy resources.
  - Consider incorporating an energy storage component to integrate renewable energy into the grid.
- **Action:** Initiate comprehensive studies to determine strategies for achieving 100% renewable and carbon-free electricity from the electrical grid by 2050.
  - Conduct planning to assess how to integrate utility-scale and distributed renewable energy.
  - Conduct planning to assess integrating offshore wind from projects in neighboring states into Delaware's grid.
  - Assess needs and opportunities for resilience benefits through microgrids and other advanced grid technologies.
  - Integrate other carbon-free technologies into the grid to complement renewable energy.
  - Assess opportunities for renewable natural gas (biogas), low-carbon gases or other new clean energy technologies to meet energy needs and contribute to decarbonizing the grid.

- **Action:** Ensure adequate transmission infrastructure is in place to accommodate the growing use of renewable energy through coordination with the Public Service Commission,[102] utilities and the regional transmission organization PJM Interconnection.[103]

Strategy: Increase the number of on-site renewable energy systems in residential and commercial buildings. Delaware has existing incentive programs that help homeowners and business install renewable energy systems such as solar panels, solar water heating and geothermal systems.[104] This strategy builds on existing programs and considers opportunities for new technologies and applications for renewable energy use at residential and commercial sites.

- **Action:** Conduct a market analysis to determine the needs for expanding the current state incentive programs to achieve on-site renewable energy goals of 25% of residential homes and 15% of commercial spaces having renewable energy systems by 2050.
- **Action:** Conduct analyses to ensure efficient implementation of renewable energy programs.
  - Conduct a gap analysis to project funding needs to promote distributed solar energy for residential, commercial and industrial users.
  - Conduct an analysis to determine the optimal balance between utility-scale and distributed energy and how to use emerging microgrid and storage technologies to integrate distributed energy into the grid in a way that supports and promotes grid stability.
- **Action:** Assess opportunities for solar panels/fields in areas other than rooftops, including landfills, carports and other applications.

Strategy: Increase the number of on-site renewable energy systems in industrial buildings. Industrial sites can provide an ideal opportunity for deployment of renewable energy systems, yet few industrial facilities in Delaware incorporate solar or wind energy on site. This strategy provides additional opportunities for industries to integrate renewable energy systems in their facilities, including energy storage and grid integration.

- **Action:** Expand existing state incentive programs to achieve an on-site renewable energy goal of 15% of industrial sites having renewable energy systems by 2050.

Strategy: Ensure that Delaware is prepared for offshore wind energy opportunities. Offshore wind development in the Mid-Atlantic and off the coast of Delaware is intensifying as there is an increased demand for renewable energy. Delaware is working to understand the effects of this rapidly growing industry to electricity transmission and distribution — and to minimize its impacts to other ocean uses and marine life.

- **Action:** Engage with other East Coast states and PJM Interconnection to adapt the transmission grid to accommodate offshore wind energy.[105]
- **Action:** Engage and coordinate with neighboring states on offshore wind energy policy.
- **Action:** Investigate potential pathways for procurement of offshore wind energy. This should include potential mechanisms for environmental data collection and monitoring.
- **Action:** Ensure sustainable offshore wind energy planning, construction, operation and decommissioning by incorporating data and information to support effective decision making in the Mid-Atlantic Ocean Data Portal.[106]

- **Action:** Identify and promote economic development opportunities presented by offshore wind energy development.
- **Action:** Identify industries in Delaware that could serve the growing offshore wind energy supply chain and prepare Delaware's workforce for emerging opportunities.

Strategy: Address equity challenges in access to renewable energy. Low-income households spend a higher percentage of their total income on energy costs than higher income households. They also face numerous barriers in accessing clean and renewable energy programs that could reduce this high cost burden. This strategy seeks to expand opportunities to provide renewable energy to low- and moderate-income residents and communities, while ensuring energy affordability.

- **Action:** Collaborate with the Public Service Commission and other stakeholders to consider a graduated rate structure (e.g., a lower rate for electricity for income-qualified ratepayers).[107]
- **Action:** Expand opportunities to provide solar systems to low- and moderate-income residents and communities through efforts including community solar projects and targeted incentive programs.

Strategy: Increase commitment to renewable energy in state agency operations. The state of Delaware currently purchases Renewable Energy Credits and Solar Renewable Energy Credits to equal 50% of the state government's electricity usage.[108] Implementation of this strategy would demonstrate state agency leadership by increasing the state's commitment to transition to 100% renewable energy for its operations.

- **Action:** Increase state electricity procurement from 50% to 100% renewable by 2025.

3.1.4.2 Energy Efficiency

Using less energy in our homes, offices and manufacturing centers through energy efficiency measures is an effective and proven way to reduce greenhouse gas emissions. Energy efficiency strategies are especially effective in reducing emissions in the near term because they can be put in place relatively quickly and implemented through existing programs. The strategies presented here also include strengthening building energy codes and preparing for a transition to increasing electrification of residential and commercial buildings. These strategies also provide co-benefits: Installation of energy-efficient technologies creates jobs while also helping consumers save money. Additionally, reduced energy use can result in improved air quality near power generation facilities.

Strategies and actions Delaware can implement:

Strategy: Strengthen building energy codes. Delaware has a statewide code for energy conservation detailing minimum standards that must be met by local governments. The statewide building energy code standard was updated in 2020 and reflects the highest standards currently available.[109] To achieve the full energy efficiency benefits of this code, this strategy outlines actions that increase code compliance and provide training for construction trades and local building officials. It also highlights opportunities for net-zero energy buildings and local government stretch codes.

- **Action:** Establish in-state training infrastructure for code inspectors, contractors and building designers, including certification training, continuing

Ensuring homes are well-insulated makes homes more comfortable while also reducing energy use. Photo credit: Adobe Stock

education and code transition assistance during code adoption cycles.

- **Action:** Establish statewide energy code compliance improvement goals of 10% annual improvement above current baseline.
  - Conduct an energy code compliance benchmarking field study to determine a baseline of Delaware's current code compliance rates, followed by code compliance studies on a biannual basis to track improvements.
- **Action:** Fully implement existing code requiring residential new construction to be net-zero energy-capable by 2025 — and for commercial new construction to meet the same requirements by 2030.
  - Update 16 Del. Laws, c. 76, §7602(c) to include reporting and enforcement mechanisms, clarify the existing definition of net-zero energy home/building and establish an incentive program to promote the construction of net-zero energy homes and commercial buildings.[110]
- **Action:** Provide technical support for municipalities to adopt more stringent local stretch codes with the development of policy tool kits and training resources.
- Provide technical support for the International Energy Conservation Code (IECC)[111] or American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 189.1[112] to be adopted by municipalities as strengthening appendices to the IECC and ASHRAE 90.1.[113]

Strategy: Expand energy efficiency programs for residential and commercial buildings. Supporting energy efficiency improvements in homes and businesses is one of the most cost-effective strategies for reducing greenhouse gas emissions. These actions provide cost savings to building owners by reducing energy use, and offer job development opportunities in energy efficiency technologies, installation and maintenance.

- **Action:** Build on existing incentive programs to reduce energy consumption by 0.7% annually by 2022 and by 1.5% annually from 2023 forward.[114]
  - Continue implementation of Energy Efficiency Advisory Council goals to expand cost-effective energy efficiency programs. Create new cost sharing programs that expand

programs across utilities (shared savings).[115]

- **Action:** Expand weatherization programs to reach more homes and buildings for retrofits, accomplishing increased efficiency.
- **Action:** Work with state agencies and educational institutions to promote worker training in energy efficiency technologies, installation and maintenance.
- **Action:** Assess feasibility and benefits of adoption of legislation to institute stronger appliance energy efficiency standards.
- **Action:** Develop a "cool roof" program to promote the use of vegetation or reflective materials that absorb less heat or reflect more sunlight than standard roofs.

Strategy: Expand energy efficiency opportunities for low- and moderate-income residents and small businesses. Energy efficiency is one of the most direct ways to help reduce energy bills for homeowners, renters and small businesses — and reducing energy use means reducing greenhouse gas emissions. Delaware offers a range of incentive programs, such as the Weatherization Assistance Program, to support households and businesses with the greatest economic need.[116] Continued investment and coordination with partners can help expand these opportunities to more Delawareans.

- **Action:** Strengthen programs to increase energy efficiency in affordable and multifamily housing.
  - Support statewide energy efficiency programs, working with the Delaware State Housing Authority[117] and the Delaware Sustainable Energy Utility,[118] among others.
  - Partner with local agencies and nonprofit organizations to provide energy efficiency through existing low-income programs, including Habitat for Humanity, New Castle County Lead Remediation,[119] Milford Housing and Development,[120] and Good Neighbors,[121] among others.
- **Action:** Partner with other agencies to provide energy education for clients of the Weatherization Assistance Program.
  - Refer homeowners and renters to energy efficiency education programs that deliver a complete picture to the low-income client about energy efficiency and behavioral changes.
- **Action:** Expand existing energy efficiency programs to better support minority-, women- and veteran-owned businesses.

Strategy: Improve industrial energy efficiency. Delaware's industrial sector is a significant part of the state's economy and is also a major energy consumer. Reducing energy use through efficiency measures in industrial facilities provides cost savings to these businesses and helps drive down greenhouse gas emissions.

- **Action:** Build on existing incentive programs to reduce energy consumption in the industrial sector by 0.7% annually by 2022 and by 1.5% annually from 2023 forward.
- **Action:** Maintain existing funding from the Public Utility Tax[122] to support the Energy Efficiency Investment Fund.[123]
- **Action:** Expand energy efficiency incentive programs to target the ten highest energy users in Delaware.
- **Action:** Provide additional outreach and education on energy efficiency to industrial facilities to assist in identifying opportunities to reach independent corporate goals.

Strategy: Support the long-term transition to building electrification. Over several decades, reducing the use of fossil fuels for heating and cooking in buildings can provide significant reduction in greenhouse gas emissions. This can be accomplished by retrofitting existing buildings and requiring electrification in new construction, coupled with decarbonizing the electrical grid. This strategy requires long-term action, as the replacement of building heating systems occurs over decades. Planning for this transition now can help set a path for long-term benefits in greenhouse gas emissions reduction.

- **Action:** Conduct an analysis of opportunities and barriers for the transition to building electrification.
- **Action:** Research the adoption of EV-ready building code requirements from the International Green Construction Code as strengthening amendments to adoption of future IECC code and ASHRAE standard versions.[124]

3.1.4.3 Transportation

Transportation is currently the largest in-state source of greenhouse gas emissions; light-duty passenger vehicles are responsible for 61% of these emissions. Emissions from vehicles also contain harmful air pollutants such as carbon monoxide, nitrous oxides and particulate matter, which disproportionately affect communities near highways and industrial centers. The strategies presented here seek to reduce emissions from vehicles by promoting the technology shift to zero-emission vehicles and expanding the availability of vehicle charging infrastructure. Strategies to reduce emissions also focus on improved fuel efficiency and actions that increase opportunity for transportation choice, such as walking and biking. These strategies also provide co-benefits: Installation of vehicle charging infrastructure and innovation in low-carbon transportation technology creates jobs and economic development opportunities. Also, driving fuel-efficient and zero-emission vehicles saves consumers and businesses money. Additionally, transitioning to zero- and lower-emission vehicles improves air quality, leading to health benefits, particularly in urban areas with high traffic congestion.

Strategies and actions Delaware can implement:

Strategy: Strengthen consumer adoption of electric vehicles to achieve a goal of 17,000 electric vehicle sales per year in Delaware by 2030. Transitioning to zero-emissions vehicles, especially electric vehicles, represents a significant opportunity for steep reductions in transportation emissions especially when coupled with a decarbonizing electrical grid. Every auto manufacturer is bringing new electric models to the market, including sport utility vehicles, pick-up trucks and semi-trucks. Costs for these vehicles, once out of reach for most consumers, is now coming down rapidly because of improved battery technology. Supporting this technology transition, through consumer incentives and education, can help set a path for long-term greenhouse gas emissions reductions.

- **Action:** Continue offering electric and plug-in hybrid electric vehicle rebates through Delaware's Clean Transportation Incentive Program to encourage the purchase or lease of these types of vehicles.[125] Modify incentive levels over time to respond to market trends and emerging technologies.
- **Action:** Adopt California's Zero Emissions Vehicle portion[126] of the

A fully electric DART bus passes a fully electric passenger vehicle parked near a solar canopy at the Delaware Technical Community College Terry Campus in Dover. Photo credit: DNREC

Advanced Clean Cars Program[127] to require light-duty vehicle manufacturers to make available specific quantities of zero-emission vehicles for sale in Delaware.

- **Action:** Develop audience-specific marketing campaigns and education to highlight the benefits of electric vehicles, particularly for dealerships, businesses, local governments and low-income communities.
- **Action:** Assess opportunities for indirect incentives for electric vehicle drivers, such as discounted parking rates and registration fees.

Strategy: Capitalize on the transition to zero-emission vehicles to stimulate innovation and provide jobs. The transition to zero-emission vehicles represents a potential economic opportunity for the state. Clean and renewable energy jobs, including those associated with zero-emission vehicles, are a fast-growing employment segment and provide comparably higher wages. Zero-emission vehicles also represent an economic opportunity for small businesses focused on battery and hydrogen research or deployment of innovative technologies.

- **Action:** Partner with technical and vocational schools to provide zero-emission vehicle maintenance and repair training programs inclusive of light-, medium- and heavy-duty vehicles.
- **Action:** Review existing state economic development funding to ensure that small businesses conducting research and manufacturing for batteries, hydrogen, charging and other components are eligible for funding.

Strategy: Expand charging infrastructure for electric and plug-in hybrid electric vehicles. Lack of charging stations is a frequently cited barrier to ownership of electric vehicles. This strategy seeks to increase the availability of convenient and affordable vehicle charging stations in both public and private locations. It also addresses the need for charging station siting and use guidance.

- **Action:** Set payment standards and interoperability standards for public vehicle charging stations (i.e., Open Charge Point Protocol, Open Smart Charging Protocol).[128]
- **Action:** Create guidance and model ordinances for local governments to streamline permitting and

installation of vehicle charging stations in residential and commercial buildings, public parking facilities and rights-of-way.
- **Action:** Continue offering vehicle charging station rebates through Delaware's Clean Transportation Incentive Program to defray initial costs of installing stations. Modify incentive levels over time to respond to market trends and emerging technologies.[129]

Strategy: Improve accessibility of low-carbon transportation options for all Delawareans. About 6% of households in Delaware do not have access to a vehicle, and driving a vehicle is the most expensive mode of transportation when compared to car-sharing, transit, biking or walking. This strategy recognizes the need to broaden the range and accessibility of affordable low-carbon transportation options for Delawareans.

- **Action:** Expand Delaware's Clean Transportation Incentive Program to include incentives for used electric and plug-in hybrid electric vehicles and/or increased rebate amounts for low- and moderate-income car buyers.[130]
- **Action:** Support access to zero-emission vehicle mobility for populations with limited access to personal vehicles (including low-income households, students and seniors), through local car-sharing programs and strategic deployment of charging stations.
- **Action:** Partner with state agencies to develop charging station accessibility requirements to meet compliance with the Americans with Disability Act.[131]
- **Action:** Maintain and augment state programs that reduce the cost of public transit travel for low-income individuals, such as the Get a Job/Get a Ride Program recently relaunched by DART First State.[132]
- **Action:** Facilitate installation of charging stations for electric and plug-in hybrid electric vehicles in multifamily dwelling units through partnership with electric utility providers and pilot projects.
- **Action:** Establish working groups to develop action plans to address barriers to low-carbon transportation in rural and low-income communities in Delaware.

Strategy: Ensure electric and plug-in hybrid electric vehicles contribute to grid stability. Electric and plug-in hybrid electric vehicles pose challenges and benefits to grid stability. This strategy seeks to plan for and adapt to this transition by using new technologies and smart incentives to encourage off-peak charging.

- **Action:** Require utilities to offer programs for drivers of electric and plug-in hybrid electric vehicles, including advanced active charging management practices and time-of-use rates to encourage vehicle charging in off-peak hours.
- **Action:** Partner with universities and colleges to expand the deployment of vehicle-to-grid technology.
- **Action:** Incentivize solar-powered charging stations by developing a joint incentive program between Delaware's Clean Transportation Incentive Program[133] and the Green Energy Fund.[134]

Strategy: Reduce vehicle miles traveled by 10% by 2030. Annual vehicle miles traveled in the U.S. has tripled since the 1970s. While fuel efficiency has improved during that time, one of the most direct ways to reduce greenhouse gas emissions from transportation sources is to drive less. This strategy builds on existing

This 'Vehicle to Grid' electric bus for the Warehouse in Wilmington will use stored energy from the bus battery to support the regional power grid while also providing opportunities for teens to engage with clean energy and clean transportation technologies. Photo credit: DNREC

efforts to promote a variety of actions that would lead to a reduction in vehicle miles traveled by providing more opportunities to live close to work and school, offer nonmotorized ways to commute and recreate, and promote more efficient transportation systems. This strategy also provides additional benefits of cost savings to consumers through reduced fuel use and vehicle maintenance and health benefits due to reduced air pollution.

- **Action:** Accelerate and enhance existing efforts to create "Complete Communities," which promote healthy lifestyles, economic growth and sustainability through integrated approaches to transportation, land use and community design.[135]
- **Action:** Build on existing incentives and partnerships for businesses to encourage employees to use alternative modes of transportation (including telecommuting) for commuting to/from work.
- **Action:** Partner with counties and municipalities to evaluate methods to incorporate the greenhouse gas emissions consequences of land-use decisions into comprehensive development plans and master plans.
- **Action:** Help to improve the Project Prioritization Criteria for the state's Capital Transportation Program to incorporate greenhouse gas emissions and develop a standard method for quantifying emissions impacts.[136]
- **Action:** Designate funding and incentives to expand broadband internet access to help facilitate telecommuting (and other benefits) in areas that lack adequate broadband coverage.
- **Action:** Conduct research to determine whether increased use of ride-share services such as Uber and Lyft will affect vehicle miles traveled, congestion and emissions.

Strategy: Improve the efficiency of freight delivery. Moving goods from producers to markets to consumers relies on medium- and heavy-duty vehicles such as delivery vans and semi-trucks. Emissions from these vehicles represent 26% of the greenhouse gas emissions from the transportation sector. Emissions reductions from heavy-duty vehicles can have a significant air quality and health benefit for communities surrounding industrial sites, ports and major transportation corridors. This strategy seeks to reduce emissions from the medium- and heavy-duty vehicles we rely on for freight delivery.

- **Action:** Build on existing programs, such as the U.S. Environmental Protection Agency's SmartWay program, and develop incentives to support freight businesses in adopting best practices for route optimization, last-mile solutions and mode switching.[137]
- **Action:** Improve marketing of existing and underused incentive programs for fuel switching, such as Delaware's Clean Transportation Incentive Program,[138] the Volkswagen Environmental Mitigation Trust[139] and the Diesel Emissions Reduction Act,[140]

Level 2 electric vehicle charging stations provide easy and convenient charging at downtown destinations and workplaces. Photo credit: DNREC

to accelerate the transition of medium- and heavy-duty vehicles to emission-free technology.

Strategy: Partner with other states to implement market-based mechanisms to reduce greenhouse gas emissions from transportation. Delaware is part of a regionally interconnected transportation system. Regionally coordinated actions to reduce emissions and improve efficiency in the transportation system can multiply the effectiveness of state-level actions. These strategies build on existing efforts to reduce emissions and coordinate with surrounding states.

- **Action:** Assess the feasibility of adopting a Low Carbon Fuel Standard in Delaware to drive innovation and further carbon reductions from the fuels supply chain.
- **Action:** Continue to assess the feasibility of adopting the Transportation and Climate Initiative cap-and-invest policy,[141] a mechanism that sets a decreasing cap for on-road transportation emissions while also generating revenues that can be invested in additional low-carbon transportation programs.
- **Action:** Assess the potential implications of a mileage-based user fee on greenhouse gas emissions in the state.

Strategy: Promote increased vehicle fuel efficiency. Improving fuel efficiency for gasoline-powered vehicles is also an important strategy for reducing emissions. Delaware has adopted[142] the California Low Emission Vehicle standards,[143] which are stricter than the federal standard for vehicle emissions. This strategy seeks to ensure that conventional vehicles sold in Delaware use the best technology available and provide consumers with the most fuel-efficient options.

- **Action:** Support federal legislation and regulations that require more stringent nationwide standards for vehicle emissions and technology.
- **Action:** Adopt the proposed California Advanced Clean Cars II Program addressing technology and emission standards for light-duty vehicles for model years 2026 to 2035.[144]
- **Action:** Adopt the California Advanced Clean Trucks Program addressing technology and emission standards for medium- and heavy-duty vehicles for model years 2024 to 2035.[145]

Strategy: Lead by example in state government operations to reduce transportation emissions. The state of Delaware is committed to making the transition to lower-emission vehicles in the state's fleet. Transitioning to electric vehicles for state government business contributes to emissions reductions and saves money in fuel and maintenance costs. This strategy seeks to achieve an increasing proportion of electric vehicles in the state fleet and provide options for employees to reduce vehicle miles traveled in personal vehicles.

- **Action:** Convert 20% of state-owned light-duty vehicles to electric by 2025 and install adequate charging stations to support these vehicles.[146]
- **Action:** Encourage increased telecommuting options for state employees, including training for managers, updated telecommute policies and investments in technology.

3.1.4.4 High Global Warming Potential Greenhouse Gases

Carbon dioxide represents the largest percentage of greenhouse gas emissions, but other types of greenhouse gases also contribute to climate change. Each greenhouse gas has a different ability to trap heat in the atmosphere. "High global warming potential" greenhouse gases trap heat in the atmosphere more effectively than carbon dioxide, meaning that even small emissions of these gases can have a large warming effect. In Delaware, the focus is on two of these gases: hydrofluorocarbons and methane. Hydrofluorocarbons include products used as refrigerants. Methane is a product of landfill decomposition, wastewater treatment and certain agricultural practices. Methane is also the primary component of natural gas, and leaks in natural gas pipelines and equipment contribute to emissions. State strategies to reduce emissions include transitioning to the use of lower global warming potential gases or capturing, diverting and reducing leakage of gases. These strategies also provide co-benefits, including improved air quality and potential improvements in safety and energy efficiency.

Strategies and actions Delaware can implement:

Strategy: Reduce emissions from hydrofluorocarbons. Hydrofluorocarbons are potent greenhouse gases with a global warming potential that can be hundreds to thousands of times greater than carbon dioxide. This strategy promotes the transition to safer alternative substances through both voluntary and regulatory actions.

- **Action:** Adopt and implement state regulations, including *7 DE Admin. Code 1151*, to establish a phase-down schedule for end use–specific hydrofluorocarbons.[147]
- **Action:** Develop and implement incentive programs, in addition to the Cool Switch Low Impact Refrigerant Program, to accelerate the transition from the use of hydrofluorocarbons by alleviating the up-front costs of new equipment using alternative refrigerants.[148]
- **Action:** Develop and implement a statewide Refrigerant Management Program, including requirements for technician certification, refrigerant recovery and equipment recycling, management of refrigerant leaks and reclamation, equipment disposal and recordkeeping.

Strategy: Reduce methane emissions through expanded methane capture. Methane is estimated to have a global warming potential that is 28 to 36 times more potent than carbon dioxide. It is also a precursor to the formation of ozone, another greenhouse gas and air pollutant. This strategy promotes the safe reuse of captured methane, which reduces emissions of this high global warming potential gas.

- **Action:** Assess strategies for improving collection efficiencies of

Landfills produce methane, a high global warming potential greenhouse gas. Methane can be captured from landfills and used as a fuel source, reducing emissions into the atmosphere. Photo credit: DNREC

sources of methane (e.g., landfill gas, wastewater treatment). Also assess strategies for improving refinement of captured gas for increased use in applications such as energy generation projects and production of renewable natural gas as a vehicle fuel source.

Strategy: Reduce methane leakage from natural gas transmission and distribution pipelines. Utilities are currently required to conduct regular leakage surveys of natural gas transmission and distribution pipelines to identify and repair leaks. Because methane is a potent greenhouse gas, additional measures should be considered to address emissions.

- **Action:** Encourage utilities to become partner programs of the U.S. Environmental Protection Agency's Natural Gas STAR Program to implement methane-reducing technologies and document voluntary emissions reduction activities for natural gas transmission and distribution pipelines.[149]

Strategy: Increase renewable natural gas production and incentivize markets for its use as a fuel. Methane is a major component of natural gas and can be used as a fuel source. Capturing methane from landfills and other sources provides "renewable natural gas" that can replace other types of fossil fuels for powering vehicles and equipment.

- **Action:** Assess opportunities to convert captured landfill gas into renewable natural gas to be used as fuel for heavy-duty vehicles, power generation and industrial processes, among other applications.
  - As part of this action, an effort should be undertaken to ensure adequate emissions control technology for renewable natural gas-fired engines, as the exhaust may contain higher levels of air toxics emissions, such as formaldehyde.
- **Action:** Assess opportunities to support anaerobic digestion projects to process organic and agricultural

Forests, croplands and wetlands can absorb carbon dioxide from the atmosphere and act as a carbon sink.
Photo credit: DNREC

waste into a usable renewable natural gas product.

- **Action:** Encourage the use of renewable natural gas as a fuel for trash collection trucks by working with landfill operators to offer lower disposal rates for trash trucks that are fueled by renewable natural gas.
- **Action:** Develop and incentivize projects for renewable natural gas fueling stations for vehicles to generate demand for new heavy-duty vehicles that use renewable natural gas as a fuel source.

Strategy: Reduce methane emissions by diverting waste from landfills through increased recycling and waste diversion. Delaware has existing programs to support the recycling of plastics and paper and the composting of organic waste.[150] Scaling up these efforts to decrease the amount of waste going to landfills conserves resources and improves air quality. This strategy includes a variety of actions to turn waste products into usable resources and make recycling more efficient.

- **Action:** Improve the waste stream characterization methodology to calculate recycling rates and identify components of the waste stream for downstream specialty compost manufacture.
- **Action:** Develop education and outreach programs, and implement a disposal system, to efficiently separate waste types prior to collection and to develop a pay-as-you-throw variable rate system for trash collection and disposal.

3.1.5 Offsetting Greenhouse Gas Emissions in Natural and Working Lands

Reducing or eliminating emissions from the combustion of fossil fuels and the release of high global warming potential greenhouse gases is the primary focus of this section of Delaware's Climate Action Plan. However, protecting the "natural services" provided by Delaware's forests, croplands, wetlands and urban greenspaces is another important strategy for responding to the climate change we see today.

The plants and soils contained within these "natural and working lands" have the ability to absorb (or sequester) carbon dioxide from the atmosphere, acting as a "carbon sink." This provides temporary or long-term carbon storage that is also cost-effective. Capitalizing on this natural carbon storage can help offset a small portion of the greenhouse gases released in the atmosphere by human activities.

There are two general approaches to maximizing the benefit of natural and working lands for carbon sequestration and storage: conservation and enhancement. Conservation strategies focus on protecting carbon that is already stored in natural and working lands by preventing land-use changes. This defensive approach prevents the release of stored carbon. Enhancement strategies seek to increase the carbon sequestration and storage of natural and working lands through management and restoration actions.

Delaware has a wide range of programs and policies that support land conservation, habitat restoration and best management practices for agriculture and forestry. Many of these existing programs and policies support carbon sequestration and storage. For example, agricultural cost-share programs offer an incentive for land management practices that promote healthy soils, which increases their capacity for carbon storage. Projects that improve water quality, such as forested buffers along streams, can also achieve the added benefit of increasing carbon sequestration and storage. In addition, many land management practices can increase resilience to climate change impacts. For example, increasing carbon content in soil can improve its capacity to retain moisture during periods of drought.

Delaware is well positioned to incorporate natural and working lands carbon sequestration and storage actions into its climate strategy. Of Delaware's approximate 1.25 million acres, 359,000 are forest land and 39,000 are cropland. Thanks in part to permanent funding mechanisms for the state's land protection programs, approximately one-third of our forests and croplands are permanently protected. However, significant losses occur annually, primarily because of development activities. Annually, an average of 3,900 acres of Delaware's forest land is converted to other uses, primarily residential and commercial development.[151]

3.1.5.1 Quantifying Carbon Benefits

While the role of carbon sequestration and storage in some natural and working lands is known to be important, it can also be difficult to measure with certainty, leading to challenges with quantifying the carbon benefit of these lands. Effectively quantifying the carbon benefits of natural and working lands is important for several reasons. First, it helps us understand the carbon sequestration and storage benefits of existing land protection and management actions. Secondly, it allows us to compare the relative benefits of different management actions. Thirdly, it can aid in prioritizing opportunities for management actions and help track actions to maximize the carbon sequestration and storage benefits of natural and working lands.

Some carbon estimation methods exist for forests and agricultural lands and are currently used in Delaware's Annual Greenhouse Gas Inventory.[152] The inventory identifies the land-use sector (referred to as land-use, land-use change and forestry or "LULUCF") as a carbon sink for greenhouse gas emissions in Delaware. Carbon emissions and sequestration in the land-use sector are calculated

Best management practices to reduce nutrient runoff, such as planting cover crops like the clover and vetch shown here, also provide the co-benefit of storing carbon.
Photo credit: Dr. Jarrod Miller, University of Delaware

as the annual change in carbon storage among different carbon "pools" of Delaware's forest lands and croplands, as well as through harvested wood products. For instance, the state's Greenhouse Gas Inventory estimated that the land-use sector offset roughly 4.6% of Delaware's gross greenhouse gas emissions in 2016.[153] However, the tools and methods for estimating the carbon sequestration potential from some ecosystems, such as tidal and nontidal wetlands, are still in the early stages of development. Use of remote sensing technology and other methods to assess land use continue to improve accounting for the carbon sink potential of natural and working lands.

3.1.5.2 Strategies and Actions for Sequestering Carbon

A policy report by the University of Delaware Cooperative Extension builds on efforts by DNREC staff to summarize best management practices that contribute to maintaining and increasing carbon sequestration and storage on agricultural lands, forest lands, urban greenspaces and wetlands.[154] The report also identifies programs that support these climate benefits and meet other environmental goals, including for water quality, soil health and wildlife habitat protection. The strategies presented below are derived from this report and are aligned with existing state goals and commitments implemented by DNREC and the Delaware Department of Agriculture, including the Delaware Forest Service.

Strategies and actions Delaware can implement:

Strategy: Support best management practices on agricultural lands that provide greenhouse gas emissions co-benefits. The agriculture sector is considered a source of greenhouse gas emissions in Delaware; however, many agricultural management practices that are implemented for environmental benefits can also reduce or offset emissions. This strategy includes current goals that align with Delaware's commitments under the Chesapeake Bay Watershed Implementation Plan.[155] This includes increasing the adoption of best management practices that are supported through technical assistance and cost-share programs. Many of these practices also contribute to improved soil health and crop productivity.

- **Action:** Increase statewide implementation of winter cover crops with a goal of reaching 224,000 acres annually by 2025 through continued state funding for cost-share programs and partnership with conservation districts.[156]
- **Action:** Increase use of grassed buffers from just over 9,000 acres statewide in 2018 to slightly more than 13,000 acres by 2025 through

implementation of Delaware's Watershed Implementation Plan, as part of the Chesapeake Bay Program.

- **Action:** Increase use of forest buffers adjacent to croplands by 171 acres with a goal of reaching a total of 1,000 acres by 2025 in the Inland Bays and Chesapeake watersheds.
- **Action:** Increase tree planting in agricultural lands with a goal of 671 acres of trees planted by 2025.

Strategy: Support conservation and restoration of forest lands. Forest lands are considered a net sink for greenhouse gases in Delaware through their ability to absorb carbon dioxide from the atmosphere (sequestration) and for long-term carbon storage in the wood, leaves and roots of the trees. This strategy includes current goals that align with the Delaware Statewide Forest Strategy.[157] Conserving forest lands provides many additional benefits, including protection of water quality and supply, supporting wildlife habitat and providing recreational opportunities.

- **Action:** Permanently protect 2,500 acres of forest areas by 2028 and 1,000 acres of headwater forests by 2025, through conservation easements or fee acquisition.

Strategy: Support local communities' enhancement of urban greenspaces. Urban greenspaces are developed areas where trees and other vegetation provide environmental benefits to the community, while also absorbing carbon dioxide from the atmosphere (sequestration). Trees in urban settings also shade buildings and paved areas, reducing the heat island effect and lowering the energy costs for cooling and heating homes and businesses. This strategy includes current goals that align with Delaware's commitments under the Chesapeake Bay Watershed Implementation Plan[158] and the Delaware Statewide Forest Strategy.[159]

Planting trees and restoring our forest lands, which take carbon dioxide from the atmosphere, helps reduce greenhouse gas pollution. Photo credit: DNREC

- **Action:** Increase urban tree planting throughout the state by 371 acres by 2025.
- **Action:** Establish 5 miles of urban riparian buffers along impaired waterways and isolated wetlands by 2025.
- **Action:** Plan and implement Governor Carney's Tree for Every Delawarean Initiative through coordination with state and local governments, homeowner associations and nonprofit partners.

Strategy: Improve methods for measuring and tracking carbon sequestration. Improved tracking of annual carbon

sequestration enables us to reliably account for the carbon sinks in our natural and working lands. Having an accurate estimate for these carbon sinks will help establish natural and working lands as an effective method for achieving net greenhouse gas emissions reductions.

- **Action:** Use new coastal wetlands carbon mapping, conducted by Duke University, in current research and management planning efforts.[160]
- **Action:** Assess opportunities to use new forest carbon accounting, conducted by University of Maryland.[161]

3.2 Plan to Maximize Resilience to Climate Change Impacts

Maximizing resilience to climate change impacts is one of the key components of Delaware's Climate Action Plan. Resilience is defined as the ability to "bounce back" after hazardous events, rather than merely reacting to impacts.[162] This principle is also applicable to preparing for long-term climate change impacts, such as sea level rise, increased temperatures and changes in precipitation patterns.

Climate change impacts are location specific. During the development of this plan, the decision was made to focus on state agency actions to increase resilience and adapt to climate change. State agencies serve as a resource to local governments and communities, enabling these agencies to assist in addressing climate change impacts that are relevant to a community's location and circumstances.

DNREC identified seven overarching "action categories" for state agencies to increase Delaware's resilience and adapt to climate change impacts (Box 8). Interviews with state agency staff, along with public input, were used to develop the action categories, along with corresponding strategies and actions. The action categories are presented in this section in descending order of public support (i.e., the highest-supported action category is presented first), as identified by public workshop feedback, online survey responses and written public input submissions. For greater details on the methodology used to determine these action categories, see Chapter 2: Developing the Plan.

While the strategies and actions presented in this section are targeted to state agencies, many may directly or indirectly support the efforts of local communities or other groups. Additionally, the strategies and actions laid out in this section are not prescriptive in nature; they are meant to guide state agency action and to be flexible over time.

Box 8. Action Categories for Maximizing Resilience to Climate Change Impacts

- **Updated or new state regulations** that address protection and conservation of vulnerable and impacted resources
- **Support for communities and stakeholders** in the form of trainings, resources and technical assistance
- **Management plans** for natural resources, emergency response, state facilities and agency equipment
- **Facility design and operation** that accounts for future climate conditions
- **Research and monitoring** that studies the impacts of climate change and methods of adapting
- **Outreach and education** on climate change impacts and adapting to climate change
- **Agency support** that provides the resources to implement resilience actions

3.2.1 Progress in Delaware to Maximize Resilience to Climate Change Impacts

State agencies have been building resilience and adapting to climate change for more than a decade, and great strides have been made to prepare the state for climate change impacts. Two documents that guided state progress were the 2013 sea level rise recommendations report[163] and the 2014 Climate Framework for Delaware.[164] For more details on these documents, see *Chapter 2: Developing the Plan*. Across the two documents, 210 actions were identified, and as of July 2020, 27 were completed and 131 were ongoing. Full details on agency resilience actions and their status can be found in the Delaware Climate Resilience Actions Summary 2013-2020.[165] The strategies and types of actions presented below build on this previous state agency work.

3.2.2 Updated or New State Regulations

State agencies are tasked with upholding regulations and policies that protect Delaware's residents and resources. However, many regulations and procedures were written and enacted prior to the current scientific understanding of climate change and its impacts. To ensure that agencies protect and manage state resources appropriately — under both current and future climate conditions — periodic review of, updates to, and possible creation of regulations and policies are needed. This strategy aims to protect the safety and well-being of the state's residents, businesses, resources and economy.

Strategies and types of actions Delaware state agencies can implement:

Strategy: Update regulations to reduce risk to properties from climate change. One of the most efficient and effective ways to reduce risk is to avoid building in high hazard areas. The potential risks to a property can change over time for various reasons, but climate change is known to increase property risk. A thorough review and update of regulations to incorporate future climate conditions is crucial to reducing potential risks to property and human life.

- **Action:** Periodically update the regulations for the Beach Preservation Act, incorporating current best science and management practices to account for rising sea levels and storm surge.[166,167]
- **Action:** Evaluate and update Tax Ditch Regulations to account for the impacts of increased flooding and drainage issues related to sea level rise and changing precipitation patterns.[168]
- **Action:** Identify opportunities to fully implement the Dam Safety Program regulations to address changing precipitation patterns.[169]
- **Action:** Update state hazardous substance cleanup regulations to require the use of the most current climate change information in remediation decisions.[170]

Strategy: Update regulatory processes to allow for greater inclusion of climate change impacts in permit decisions. Regulations are enforced following specific policies that define permit requirements. Many current permit requirements are based on historical climate conditions and hazards. Updating permit requirements to account for

current climate change impacts can protect those who live and work close to permitted activities and increase the financial stability of permitted entities.

- **Action:** Incorporate the requirement of a Sea Level Rise and Coastal Storms Plan into the Coastal Zone Act permitting process to outline steps to address future changes in climate.[171]
- **Action:** Update the Coastal Zone Act Conversion Permit regulations to use the most current, state-developed sea level rise planning scenarios in a company's required Sea Level Rise and Coastal Storms Plan.[172]
- **Action:** Require the involvement of enforcement officers, when creating or updating regulations that address climate change, to ensure enforceability.
- **Action:** Incorporate updates of state enforceable policies that include climate change into the Delaware Federal Consistency Program.[173]
- **Action:** Update the Accidental Release Prevention Regulation[174] to require owners or operators of stationary sources of regulated substances to include climate change impacts in their Risk Management Plans.[175]

Strategy: Develop a comprehensive regulatory strategy to conserve and restore ecosystem services under future climate conditions. Delaware has approximately 13 different habitat types that each provide ecosystem services.[176] An ecosystem service is "any positive benefit that wildlife or ecosystems provide to people."[177] Multiple stakeholders manage many of Delaware's habitats. A holistic regulatory approach should be taken to conserve these areas to reduce future financial impacts to landowners and safeguard the benefits that wildlife or ecosystems provide to people.

- **Action:** Continue efforts to protect freshwater wetlands to conserve their flood storage and infiltration abilities under future climate conditions.
- **Action:** Update the Delaware Wetlands Act jurisdictional mapping procedures to allow for site-specific evaluation to compensate for sea level rise.[178]
- **Action:** Update the wetlands and subaqueous lands permitting process to require permit applicants to account for sea level rise projections before being issued a final permit.
- **Action:** Designate shoreline zones for resilience actions that could include rolling easements or transfer of development rights.

3.2.3 Support for Communities and Stakeholders

There are 57 incorporated municipalities in Delaware, all of which will be impacted by climate change. Many of these municipalities depend on state agencies and other organizations for planning and implementation support. State agencies can provide up-to-date tools, training and technical support to communities, practitioners and land stewards on enhancing resilience.

Strategies and types of actions Delaware state agencies can implement:

Strategy: Increase grant opportunities for climate change adaptation projects, and prioritize the funding of projects that incorporate climate change impacts in project design and implementation. A recent study completed by the University of

Prioritizing the remediation of hazardous waste sites that are susceptible to sea level rise, flooding and other climate impacts can reduce the dispersal of contaminates into waterways and soils. Photo credit: DNREC

Delaware's Joseph R. Biden, Jr. School of Public Policy and Administration found that the most significant barrier to communities preparing for climate change is having the monetary resources and technical capacity to implement actions.[179] While many of Delaware's municipalities have taken the first step and updated their comprehensive management plans to account for climate change impacts, due to a lack of resources, only a few have implemented actions. State agencies can help by prioritizing resilience project implementation grants to communities.

- **Action:** Incorporate a funding criterion into state-sponsored grant and loan programs that requires applicants to consider projected climate conditions as part of project proposals.
- **Action:** Prioritize state and federally funded hazardous waste investigation and remediation resources towards areas susceptible to sea level rise, flooding and other climate change impacts.
- **Action:** Develop a community assistance program to help municipalities put lands into conservation easements to retain ecosystem services.
- **Action:** Create a grant program for individuals and communities to update their water and wastewater infrastructure for projected climate change impacts.
- **Action:** Prioritize communities with effective drainage and floodplain management practices to receive state funding.

Strategy: Assist local governments, homeowners, industries and utilities in increasing their resilience to climate change. In Delaware, land-use decisions are made at the county and municipal level. These decisions dictate how and where homeowners, industries and utilities can build or maintain structures. The state can assist local governments, and their stakeholders, in making sustainable and fiscally sound land-use and development decisions.

- **Action:** Develop a climate resilience playbook for local governments that would include model ordinance language for key resilience strategies.
- **Action:** Provide technical support to local governments to create community development master plans, with the goal of every jurisdiction having a master plan.
- **Action:** Assist communities to practice executing their emergency response plans.
- **Action:** Assist local governments in developing strategies to protect wastewater treatment facilities from flooding.
- **Action:** Provide technical assistance to industrial and port facilities to incorporate climate change impacts into investment and continuity of business plans.

Strategy: Support programs and initiatives that help frontline communities adapt to climate change. Frontline communities experience the first, and often worst, impacts of climate change. Many frontline communities are also often low-income, minority neighborhoods that are already disproportionally exposed to and negatively impacted by hazardous pollution and industrial practices.[180] To equitably adapt to climate change in Delaware, resources and programs need to be identified and directed into these communities.

- **Action:** Provide annual training to frontline community advisory groups on climate change impacts and resilience actions.
- **Action:** Host climate change engagement workshops with frontline communities to identify specific needs and opportunities to increase resilience.
- **Action:** Create a resilience grant program for frontline communities.

Strategy: Provide training, tools and technical assistance on climate change impacts and accompanying resilience actions. There are various opportunities available for the state to support local decision making on climate change resilience. The state should continue expanding its efforts to provide resilience support and technical assistance to local governments and public stakeholders.

- **Action:** Assist health department staff and community health providers with preparing for climate change impacts.
- **Action:** Provide a forum for communities to share lessons learned from successful and unsuccessful resilience actions.
- **Action:** Update the Delaware Flood Mapping Tool to include sea level rise projections.[181]
- **Action:** Continue to improve and expand real-time data collection of coastal flooding conditions.
- **Action:** Encourage the insurance industry to develop new technologies, practices and business models that are responsive to both climate change risks and opportunities.

3.2.4 Management Plans

State agencies use various planning documents to manage natural resources, emergency response, state facilities and agency equipment. Effective management and resource use will require state agencies to incorporate future climate conditions and opportunities for resilience into planning documents now.

Emergency response plans will require updates to consider the impacts and incorporate actions to deal with climate change impacts, like flooding from extreme weather events. Photo credit: Army National Guard

Strategies and types of actions Delaware state agencies can implement:

Strategy: Incorporate climate change impacts and adaptation considerations into strategic plans. Strategic plans are an essential tool to outline the mission, vision and long-term goals of an organization — including actions and resources needed to reach these goals. State agency strategic plans should be updated to ensure all activities outlined in the plan support statewide resilience.

- **Action:** Incorporate climate change impacts into agency strategic plans.
- **Action:** Incorporate actions from the Climate Action Plan into the next update of the Delaware Strategies for State Policies and Spending in 2025.[182]

Strategy: Update emergency response and hazard reduction plans to incorporate future climate projections. It is projected that the frequency of extreme weather events will increase over the coming century. These events can bring widespread damage and destruction to property and natural resources, adversely impacting human safety in turn. How the state prepares for and responds to these events is vital to reducing risk. Plans are updated periodically and should include actions that incorporate projected climate change impacts.

- **Action:** Maintain, and update when necessary, the Natural Disaster and Forest Health Response Plan for forest pests and natural disasters.[183]
- **Action:** Complete a full update of the Energy Assurance Plan to incorporate climate change.[184]
- **Action:** Update emergency response standard operating procedures for future climate conditions.
- **Action:** Include actions from the Climate Action Plan into the next update of the state's All-Hazard Mitigation Plan scheduled for 2023.[185]
- **Action:** Continue to routinely evaluate evacuation routes to identify any necessary routing updates due to sea level rise.

Strategy: Update or create management plans to incorporate future climate projections. State agencies manage and maintain various natural and human-made assets, including property, equipment, buildings and other infrastructure. Long-term management decisions should be outlined now to avoid fiscal decisions that may be unsound in the long-run. Agencies may need to perform cost-benefit and cost-effectiveness analyses for asset management decisions that incorporate climate change impact projections into their calculations.

- **Action:** Create long-term infrastructure management plans that include options to protect, retreat or abandon structures under future climate conditions.
- **Action:** Create sediment management and channel maintenance plans that outline sediment sources, and identify projects where the sediment dredged for channel maintenance can be reused for shoreline projects to offset climate change impacts.
- **Action:** Create an irrigation management program that works with producers to manage water sources under future climate conditions.
- **Action:** Incorporate projected climate change impacts into the hazardous substances investigation process.
- **Action:** Develop a statewide managed retreat plan and update it periodically.

3.2.5 Facility Design and Operation

State-owned facilities are already impacted by climate change and will continue to be affected as the climate continues to change. The Delaware Office of Management and Budget manages and maintains more than 100 facilities, 165 acres of property and over 900 vehicles statewide.[186] These totals do not include additional land and facilities owned by other state agencies, making the total area owned and maintained even higher. Actions to improve resilience and adapt state-owned facilities to prepare for climate change are necessary to reduce future management costs.

Intense storms, which are increasing in frequency due to climate change, can overwhelm municipal sewer systems causing flooding and degrading water quality.
Photo credit: Adobe Stock

Strategies and types of actions Delaware state agencies can implement:

Strategy: Update facility construction guides and standards to increase resilience to climate change impacts. State agency facility construction is guided by the International Building Code and Delaware Building Code. While there have been great strides in updating codes to make buildings more energy-efficient and resilient, there is still room for improvement. The state should review current codes and create new mandates that require all new state facilities to incorporate greenhouse gas–minimizing designs and strict resilience standards.

- **Action:** Support periodic updates to state-building design practices, policies and codes to incorporate the latest science on climate change and climate change impacts.
- **Action:** Update facility construction guidelines to incorporate resilient materials and best practices to prepare for future climate conditions.
- **Action:** Review and implement recommendations from the Avoiding and Minimizing Risk of Flood Damage to State Assets: A Guide for Delaware State Agencies document.[187]

Strategy: Prepare state facilities and equipment for climate change impacts.
To sustain facilities and complete daily work tasks, agencies possess and maintain an array of equipment. The state should prepare all facilities and equipment for climate change impacts to sustain cost-effective maintenance and use of these assets for the future.

- **Action:** Assess public health facilities to identify the most vulnerable sites to climate change impacts and the state's response capacity.
- **Action:** Update and maintain heating, ventilation and air conditioning systems in state-owned buildings for proper functioning under future climate conditions.
- **Action:** Coordinate across agencies to identify potential future access issues to properties, due to climate change impacts, to guide current facility management decisions.
- **Action:** Install appropriate infrastructure and resources at key areas in state natural and recreational areas where visitors may be at risk to high heat and extreme weather conditions.
- **Action:** Incorporate flooding considerations from sea level rise into the siting of state facilities.

3.2.6 Research and Monitoring

While national and international research can support local and regional decisions, Delaware-specific research may provide increased clarity on the most effective solutions to issues the state is facing. State agencies already collect data across all sectors, but not every agency conducts climate change research. For effective decision making, research and monitoring of climate change impacts in Delaware and possible solutions must continue and expand across all agencies.

Strategies and types of actions Delaware state agencies can implement:

Strategy: Continue and expand research on climate change impacts in Delaware.
Climate change will impact natural resources, infrastructure and human health. Research on each of these sectors is necessary to prepare for and adapt to climate change impacts. The more extensive the body of knowledge on local climate change impacts, the better a decision can be made regarding protection, conservation or restoration of resources.

- **Action:** Monitor groundwater resources to track saltwater intrusion from sea level rise.
- **Action:** Conduct cultural resource vulnerability assessments for climate change impacts.
- **Action:** Examine the socioeconomic impacts of climate change on local communities and identify opportunities to provide climate change adaptation assistance.
- **Action:** Identify transportation infrastructure at risk from flash flooding and opportunities available to

Living shorelines, like this one at the Blackbird Creek Reserve in Townsend, can increase resiliency to sea level rise caused by climate change. Photo credit: DNREC

reduce flash flooding frequency.

- **Action:** Conduct health impact assessments to evaluate the public health consequences of climate change.

Strategy: Increase the number of resilience pilot projects and demonstration sites in Delaware. Climate change affects all sectors in the state, creating opportunities for innovative solutions and ideas about how the state can best prepare for and adapt to climate change. However, some actions will work better than others. To determine which methods work best, they must be tested before large-scale implementation. State agencies should install pilot projects and demonstration sites to monitor their function and evaluate their long-term sustainability and cost.

- **Action:** Foster pilot projects that demonstrate the effectiveness of best management practices to manage agricultural lands affected by climate change.
- **Action:** Install demonstration sites on state properties to validate and showcase resilience best management practices for natural resources and infrastructure.
- **Action:** Support pilot projects that explore energy storage, microgrids and other technologies for grid resilience.
- **Action:** Remove blockages on rivers to support upriver fish migration, compensating for downriver salinity changes due to climate change.
- **Action:** Research living shoreline best practices to support shoreline management and protection from climate change impacts.

3.2.7 Outreach and Education

State agencies can support Delaware residents and visitors in their efforts to increase resilience. A key ingredient to agency support is outreach and education on both climate change impacts and opportunities to build resilience. Outreach and education can empower individuals to engage in community decisions and proactively prepare for climate change. The more individuals get involved in climate action, the healthier Delaware's communities and economy become. Thus, state agencies should incorporate climate change information and resilience actions into their stakeholder outreach activities.

Increasing outreach and education opportunities can lead to a better understanding of the causes and consequences of climate change. Credit: Scott Figurski, DNREC

Strategies and types of actions Delaware state agencies can implement:

Strategy: Develop targeted communication tools and messages about climate change. Climate change will impact everyone in the state, and communication should be designed with that reality in mind (e.g., accounting for differences in language and educational level). Still, the climate change impacts felt by a specific individual or community may vary. Such variation must be incorporated into state decision making on resources and messaging to ensure that the right information gets to the right people.

- **Action:** Develop a comprehensive outreach strategy to educate all stakeholders about climate change.
- **Action:** Promote targeted education on the health impacts of climate change to vulnerable populations.
- **Action:** Partner across agencies to identify community-specific impacts of climate change and develop targeted outreach to those impacted communities.
- **Action:** Provide outreach and education to local governments on opportunities to reduce risks from climate change in their communities via updates and changes to local land-use ordinances.
- **Action:** Incorporate sea level rise information into homeownership counseling and other housing-related communications.

Strategy: Increase the availability of climate change educational programming. Climate change science is complicated, and to understand it requires continual exposure and education. Educational opportunities on the subject must be made increasingly available for everyone. Learning the science of climate change and its impacts can help individuals feel more confident to engage in climate change conversations and take actions to reduce their risk. Greater public engagement around climate change and preparing for risks would increase statewide resilience.

- **Action:** Require a climate change science curriculum for all students in grades 6 to 12.
- **Action:** Incorporate climate change-related topics into public health education, such as climate change impacts on human health and preparedness strategies.
- **Action:** Incorporate climate change education into agency exhibits and programming.
- **Action:** Identify possible funding sources to provide scholarships for students to attend educational programming about climate change outside of the classroom.
- **Action:** Update the Department of Insurance's Flood Insurance web page to include information about climate change and sea level rise risks.

Strategy: Provide outreach to businesses to help them understand and adapt to climate change impacts. Both large corporate companies and small local businesses are integral to the state's economy and character. Preparing businesses to be more resilient to climate change will reduce disruptions to service and negative impacts on the economy.

- **Action:** Provide resources and education to businesses about climate change impacts and incentive programs related to maximizing resilience and minimizing emissions.
- **Action:** Promote economic growth and development in appropriate areas not adversely impacted by climate change.
- **Action:** Educate and assist businesses and industries to build resilience to climate change.
- **Action:** Encourage the Delaware Prosperity Partnership to use the Climate Action Plan as part of its business development decision making process.[188]

3.2.8 Agency Support

To implement many of the Climate Action Plan's strategies and actions, support from agency and state leadership will be necessary. Support can be in various forms, including providing additional resources, conducting employee training or promoting cooperative efforts between all government levels. With strong leadership and sufficient support, Delaware can be a resilience leader.

Strategies and types of actions Delaware state agencies can implement:

Outreach to businesses can help them to better prepare for climate change impacts. Photo credit: DNREC

Strategy: Increase the capacity of all state agencies to build resilience to climate change. Many resilience actions will require additional resources to implement. Resources can include, but are not limited to, increased training for state agency personnel, hiring additional staff, increased cross-agency coordination and contracting consultants. Enhancing agency capacities now could reduce future costs associated with a more reactive approach to adapting to climate change.

- **Action:** Provide annual training opportunities for state agency staff to learn about the impacts of climate change and resilience.
- **Action:** Explore opportunities to leverage funds from grant programs to help agencies choose energy-efficient options when updating facilities.
- **Action:** Update agency Continuity of Operations Plans to incorporate future impacts of climate change.
- **Action:** Continue to participate on the state's Insurance Coverage Determination Committee, established

The annual conference hosted by the Resilient and Sustainable Communities League (RASCL) provides an important venue for information sharing and networking. Photo credit: DNREC

under Chapter 65 of the Delaware Insurance Code to ensure that the state's property and casualty insurance coverage adequately protects the state's assets in view of climate change.[189]

- **Action:** Continue to improve interactions among federal, state and local emergency service planners and providers to promote regional and statewide response and recovery capacity in light of projected climate change impacts.

Strategy: Improve information sharing across state agencies to support regulatory and policy decisions. Data are needed to make fiscally sound and effective decisions. There are currently methods and tools in place to promote data exchange. However, improved data sharing and collection between agencies are needed.

- **Action:** Continue developing and enhancing electronic reporting procedures for laboratories to quickly identify emerging health impacts due to climate change.
- **Action:** Create a standardized data collection, tracking and storage methodology to make data-based management decisions related to climate change.

Strategy: Act as climate change adaptation leaders. Delaware has a history of close cooperation between agencies and with federal organizations. This history of collaboration needs to be continued and built upon. Through agency actions, Delaware can provide valuable information to other states in the region to help build regional and national resilience.

- **Action:** Strengthen coordination and management across agencies to identify new and creative ways to address climate change impacts.
- **Action:** Promote participation in energy efficiency programs offered by federal agencies and others.
- **Action:** Continue participation in the National Association of Insurance Commissioners Climate Risk and Resilience Working Group.[190]
- **Action:** Participate in national committees to gain and transfer knowledge on the current and projected impacts of climate change.

Chapter 4: Next Steps




Throughout plan development, DNREC heard from hundreds of Delawareans about why they care about climate change, how it affects them and what climate action they would like to see the state take going forward. Residents voiced concerns about the cost of climate change, both in relation to the cost of inaction (e.g., storm damage, impacts on human health) and the cost of taking action (e.g., shoreline restoration and road construction becoming increasingly expensive). Residents also expressed a strong desire that no one be left behind by climate action, particularly those communities already facing economic and social challenges.

Delaware's Climate Action Plan accounts for these concerns, alongside data and information from greenhouse gas emissions modeling and state agency interviews. The plan outlines strategies for addressing climate change that can be implemented through a variety of actions over time, as resources, data and partnerships develop. It is intended to be a living document. As our collective understanding of climate impacts, emissions reduction strategies and resilience and adaptation measures grows, actions to advance strategies can evolve and change.

This chapter lays out next steps for implementing Delaware's Climate Action Plan. This includes setting guiding principles for climate action, outlining a framework for moving from planning to action, and defining equitable climate action.

4.1 Guiding Principles for Climate Action

How climate action is implemented can be just as critical as what is implemented. Three principles should be applied when implementing Delaware's Climate Action Plan:

Principle No. 1: Ensure climate action is ambitious yet adaptable. The Intergovernmental Panel on Climate Change asserts that swift and concerted climate action must be taken to minimize greenhouse gas emissions and avoid the most damaging climate change impacts.[191] This plan recognizes the need for ambitious action now to reduce future climate risks. At the same time, strategies for action must remain adaptable enough to accommodate changes in climatic and economic conditions.

Principle No. 2: Ensure climate action accounts for all costs and benefits. Climate action has costs but is a worthwhile investment. Large-scale economic modeling has shown that shifting to a low-carbon economy provides considerable, net positive benefits to society.[192] This is especially true when the costs of climate change damage and the savings gained from energy efficiency are included.[193] Still, Delaware's decision making on climate action must consider the full costs and benefits of taking climate action in the state, including co-benefits (e.g., reduced respiratory impacts from decreased vehicle

The City of Wilmington is incorporating resiliency strategies and green space into redevelopment plans for the east bank of the Christina River. Photo credit: Adobe Stock

emissions, lower flood insurance premiums from implemented coastal management strategies). Assessing opportunity costs and the cost-effectiveness of alternative action options is also critical.

Principle No. 3: Ensure climate action is engaged, empowering and equitable. Climate action cannot be implemented without the support of Delaware's residents, businesses and communities. Ensuring everyone is at the table throughout the implementation process is vital to the success of the plan. Facilitating this approach will require engaging early and often with key stakeholders and community members. It also requires empowering local governments to take climate action at the local level. While state-level action is essential, actions at the local level can be tailored to a community's specific needs.

Additionally, to ensure climate action benefits all Delawareans, careful attention must be paid to inequities in climate action design, as actions could potentially favor some people over others. It would be particularly problematic if climate action inadvertently compounds inequities or further hinders communities already facing adverse environmental, social or economic conditions. Additional details on addressing equity in plan implementation are noted in *4.3 Achieving Equitable Climate Action*.

4.2 Moving from Planning to Action

Delaware's Climate Action Plan serves as a guide for the strategies Delaware can put into place to minimize greenhouse gas emissions and maximize resilience. As highlighted above, implementation of the strategies in this plan is intended to occur over the course of years and must be flexible over time.

The strategies outlined in the plan will require resources, technical capability, data and partnerships to move forward. Implementation of these strategies will also require the participation of a variety of players, including state agencies, the state legislature, nonprofit partners, businesses and residents. In some cases, strategies can be accomplished by one entity; in most other cases, implementation of strategies will require coordinated efforts.

Many of the strategies outlined in this plan focus on steps that can be taken specifically by state agencies. Cooperation across state agencies and leadership within those agencies — coupled with stakeholder partnerships

— will help facilitate and motivate the transition from climate planning to climate action. This can be assisted by a framework for accountability and transparency.

4.2.1 Accountability for Taking Climate Action

Statewide emissions reduction targets and climate change impact planning scenarios can help drive accountability for taking climate action in Delaware.

By establishing mid- and long-term greenhouse gas emissions reduction targets in statute or executive order, the state can set a common goal and expectation for statewide planning and future operations. Delaware would benefit from setting these goals soon so that appropriate strategies and actions can be identified to implement the Climate Action Plan. As discussed in 3.1 Plan to Minimize Greenhouse Gas Emissions, many U.S. states have set greenhouse gas emissions reduction targets of 80% by 2050. These targets are ambitious but achievable.

Complementary to emission reduction targets are planning scenarios that can be used to prepare our infrastructure and communities for climate change impacts. The state should, on a regular schedule, formulate, update and disseminate a standard set of planning scenarios that provides state-specific climate change impact projections for sea level rise, precipitation, and temperature. Mechanisms should also be put in place to ensure that state agencies use these scenarios consistently in their respective planning processes.

4.2.2 Transparency in Tracking Climate Action

Tracking and reporting are necessary to evaluate progress on emissions reduction and resilience actions. Tracking and reporting mechanisms can also help identify areas where climate actions can be made more efficient or effective.

To evaluate progress over time, a suite of key metrics to track climate action should be identified. These metrics should be monitored and reported on a consistent timeline. A data dashboard highlighting these tracking metrics would be an appropriate tool for providing easy access to information and facilitating transparency.

4.3 Achieving Equitable Climate Action

For climate action to benefit all Delawareans, the needs of residents — particularly those who may be disproportionally impacted by climate change or climate action — must be better understood, then addressed through engagement and partnership.

4.3.1 Understanding Vulnerable Communities

It is vitally important to improve our understanding of, and contact with, communities that may be most immediately affected by climate change impacts or climate action. This can begin by analyzing environmental, census and other geographic data to identify those communities most at risk, while also engaging residents on the ground. Authentic community engagement is necessary to leverage local knowledge of impacts and to better understand the obstacles and issues these communities face.

It is also important to gain an understanding of how climate action, such as transitioning to low-carbon energy, could impact existing jobs or alter job opportunities. Knowledge of potential job gains and losses resulting from climate action can help guide where state resources are most needed to ensure that certain populations are not left behind. The state can initiate this knowledge-building process through a commissioned job impacts study, in which businesses, labor groups and communities are all consulted.

Finally, climate change-related engagement

with communities most at risk to climate change impacts and those most immediately affected by climate action should increase and improve. Targeted outreach can help disseminate climate change information and provide communities with a way to provide the state with input and insight for decision making.

4.3.2 Partnering with Communities to Build Equity

Collaborations and partnerships with communities can help build equity into climate action. Early and continued engagement — especially when considering new or updated programs or policies — is essential, as residents can speak first-hand to community-specific climatic and economic impacts. Particular attention should be paid to communities that may be disproportionately impacted by climate change or climate action.

It should be noted that productive partnerships with communities are only possible if trust is established. This trust can be built over time, in part, by openly working with communities to evaluate whether climate actions have the intended effects once implemented.[194] Such a process, if held to, can ensure that action is carried out in a way that provides benefits to both communities and the state as a whole.

4.4 Conclusion

Climate change is already affecting our state, and its effects are projected to worsen in the coming years. Proactive climate action can save lives, reduce costs and preserve Delaware's unique places for future generations. Delaware's long history of climate action, established partnerships, and technical knowledge position the state well to address climate change, both now and into the future.

Delaware's Climate Action Plan is a guide for how the state can minimize the greenhouse gas emissions that drive the climate change we see today and maximize resilience to climate change impacts. The strategies outlined in the plan are meant to guide state action and to be flexible over time. Not all strategies can be implemented at once; rather, they can be put in place as resources, data and partnerships evolve.

By engaging Delaware's governments, businesses and residents in coordinated climate action; guiding action to be ambitious yet adaptable; and ensuring climate action is engaged, empowering and equitable, we can realize a future where the First State is a leader in climate action.

Glossary of Terms

Accretion: As it relates to wetlands, accretion is the vertical growth of wetland surface elevation. Accretion occurs through two processes: (1) when sediments are deposited onto wetlands during periods of flooding, and (2) when wetland roots and decomposing plant material accumulate on top of one another.[195]

Adaptation: The process of adjusting to new or changing climate conditions, both to reduce (or avoid) negative impacts to valuable assets and to take advantage of emerging opportunities.[196]

Alternative fuel: A fuel derived from sources other than petroleum. Most are produced domestically, reducing dependence on imported oil; some are derived from renewable sources. Often, alternative fuels produce less pollution than gasoline or diesel.[197]

Anaerobic digestion: The natural process by which microorganisms break down organic material in closed spaces where there is no air (or oxygen). Anaerobic digestion can occur in a built system, known as a digester, to produce renewable natural gas.[198] *Also see: Renewable natural gas*

Behavioral emergency preparedness: The ability to provide mental health, substance abuse and stress management services to disaster survivors and responders.[199]

Best management practices: Practical methods for preventing and reducing the type of pollution that is carried by precipitation and runoff (such as fertilizers, eroded sediments, livestock and septic waste, and spilled oil and chemicals). A major goal of these practices is to improve water quality. Many of these practices include land management techniques for the agriculture and forestry sectors.[200,201] *Also see: Cover crop*

Biogas: See Renewable natural gas

Biological stress: A condition in which a physical, environmental or social pressure affects a living organism's function or behavior. Biological stress may affect an organism's ability to grow, reproduce or survive.[202]

"Business-as-usual" scenario: As it relates to the ICF analysis, the "business-as-usual" scenario is the model of Delaware's greenhouse gas emissions that assumes no additional actions will be taken to reduce emissions beyond existing federal and state policies and programs. *Also see: Greenhouse gas emissions*

Bond rating: The evaluation of a bond issuer's financial strength, as measured by its ability to pay back a bond's principal and interest in a timely fashion. Ratings are typically letter grades. Bond issuers can include government jurisdictions, such as states and municipalities.[203]

Building codes: Sets of regulations that govern the design, construction, alteration and maintenance of structures. These codes specify the minimum requirements to adequately safeguard the health, safety and welfare of building occupants.[204] *Also see: Energy conservation codes, EV-ready building codes, Stretch codes*

Building energy codes: See Energy conservation codes

Cap-and-invest: A market-based approach aimed at both reducing greenhouse gas emissions and growing the economy. A jurisdiction (such as a state or country) that implements cap-and-invest would set a total greenhouse gas emissions limit (or cap) for either a specific industry or the whole economy. That limit would decrease over time, reducing the amount of pollution from emissions. For an entity to release emissions, it would have to buy "emissions allowances" through an auction. Auction proceeds are returned to the jurisdiction to invest in programs that further reduce emissions.[205] *Also see: Greenhouse gas emissions*

Carbon accounting: The process by which an organization measures its greenhouse gas emissions (primarily carbon dioxide). Organizations use carbon accounting both to measure their impacts on climate change and to set goals to limit or reduce emissions. Also known as carbon inventorying or greenhouse gas inventorying.[206] *Also see: Carbon dioxide, Greenhouse gas emissions*

Carbon dioxide: Carbon dioxide (CO_2) is a heat-trapping greenhouse gas. Carbon dioxide is released into the atmosphere through human activities, such as deforestation and the burning fossil fuels, as well as through natural processes, such as respiration and volcanic eruptions.[207] *Also see: Greenhouse gases, greenhouse gas emissions*

Carbon sequestration and storage: The process by which plants remove carbon dioxide from the atmosphere and convert it to another form of carbon, such as plant tissues, roots and leaves. Through this process, carbon is taken from the atmosphere and stored in the plants themselves or in soils.[208] *Also see: Carbon dioxide, Carbon sink, Natural and working lands*

Carbon sink: Natural features — such as oceans, plants and soils — that serve as "reservoirs" for storing carbon. These reservoirs increase as more carbon is accumulated over time.[209] *Also see: Carbon dioxide, Carbon sequestration and storage*

Clean energy: Low- or zero-carbon energy derived from sources other than wind and solar. This includes electricity produced from nuclear or hydroelectric plants and energy sources, such as renewable natural gas. *Also see: Renewable energy, Renewable natural gas*

Climate: The long-term regional or global average of temperature, humidity and rainfall patterns over seasons, years or decades.[210] *Also see: Weather*

Climate action: Action taken to prepare people, property and economies for climate change. For Delaware, this means anticipating and readying the state for climate change impacts such as sea level rise, increasing temperatures and changes in precipitation patterns. It also means ensuring the state does its part to reduce the greenhouse gas emissions that drive the rapid climate change we see today. *Also see: Climate change, Climate change impact, Greenhouse gases, Greenhouse gas emissions, Rapid climate change*

Climate change: A long-term change in the average weather patterns that have come to define Earth's local, regional and global climates.[211] *Also see: Climate, Rapid climate change, Weather*

Climate change impact: An observed or projected effect of climate change that is already affecting, or could affect, people, property and economies. Climate change impacts include, but are not limited to, temperature increases, heat waves, more frequent and longer droughts, changes in growing seasons and precipitation patterns, more extreme weather and sea level rise. In Delaware, the most prominent climate change impacts are sea level rise, increased temperatures and changes in precipitation patterns (including extreme weather events and flooding). *Also see: Climate change, Rapid climate change*

Coastal acidification: The change in chemistry of coastal waters due to freshwater inputs and excess nutrient runoff from land. Pollution and fertilizers are a common cause of excess nutrients entering coastal waters. Excess nutrients can cause water to become more acidic. Increases in water acidity impact ecosystems and wildlife, particularly when coastal acidification is combined with ocean acidification.[212] *Also see: Ocean acidification*

Combined sewer system: Sewers that are designed to collect rainwater runoff, domestic sewage and industrial wastewater in the same pipe. During periods of heavy precipitation, the wastewater volume in a combined sewer system can exceed the capacity of the system. This causes the system to discharge excess, untreated wastewater directly to nearby streams, rivers or other water bodies. During situations where the systems are unable to effectively discharge the excess wastewater, the sewer system may back up.[213]

Community solar: A solar energy development model in which multiple participants share, invest in and benefit from a single solar energy system (often a larger, off-site development). Individuals either own or lease a portion of the system and reap the benefits (such as cost savings) from the solar energy generated by the portion they own or lease. Community solar arrangements allow people to benefit from solar energy without having to install their own solar energy systems.[214] *Also see: Renewable energy*

Conservation easements: A voluntary, legal agreement that permanently limits uses of the land to protect its conservation value.[215]

Cooling station: A location, typically in an air-conditioned or cooled building, that has been designated as a site to provide respite and safety to people during extreme heat events.[216]

Cover crop: A plant that is primarily used to slow soil erosion, improve soil health, enhance water availability, smother weeds and control pest and diseases on crop fields. Cover crops have also been shown to increase crop yields, add organic matter to soil, improve crop diversity on farms and attract pollinators. Planting cover crops in winter is considered a best management practice to improve water quality, as the plants take up remaining fertilizers in the soil; this prevents fertilizers from being carried by runoff into waterways and polluting the water.[217] *Also see: Best management practices*

Decarbonization (of the electrical grid): Long-term strategies to reduce carbon dioxide emissions by phasing out the use of carbon-emitting processes and technologies. This is primarily done by eliminating the combustion of fossil fuels as an energy source, with the end goal of a carbon-free global economy.[218] *Also see: Carbon dioxide, Electrification, Greenhouse gas emissions*

Distributed renewable energy: Distributed energy describes situations in which electricity is generated from sources at or near the point of use instead of through a centralized generation source, such as power plants. As such, distributed renewable energy is the use of renewable sources, such as wind and solar, to establish distributed energy systems.[219] *Also see: Grid stability, Renewable energy*

Ecosystem services: Any positive benefit that wildlife or ecosystems provide to people.[220]

Electric vehicle: A type of zero-emission vehicle that has a battery instead of a gasoline tank and an electric motor instead of an internal combustion engine. Also known as an all-electric vehicle or battery-electric vehicle. For the purposes of Delaware's Climate Action Plan, an electric vehicle differs from a plug-in hybrid electric vehicle.[221] *Also see: Plug-in hybrid electric vehicle, Zero-emission vehicle*

Electrification: The process of replacing technologies that use fossil fuels as an energy source with technologies that use electricity instead. Electrification holds to the expectation that electricity is generated using a clean or renewable energy.[222] *Also see: Clean energy, Decarbonization, Greenhouse gas emissions, Renewable energy*

Emissions: The release of fine solid particles, liquid droplets or gases into the air. For the purposes of Delaware's Climate Action Plan, emissions primarily refer to greenhouse gas emissions. *Also see: Greenhouse gas emissions*

Energy conservation codes: Standards that set minimum efficiency requirements for new and renovated buildings to reduce energy use and emissions over the life of the building. Energy codes are a subset of building codes, which establish baseline requirements and govern building construction. Also known as building energy codes.[223] *Also see: Building codes, EV-ready building codes, Greenhouse gas emissions, Stretch codes*

Energy efficiency: Practices in which older or less energy-efficient appliances, vehicles, building materials and other technologies are replaced with newer, more efficient designs that require less energy. By reducing energy demand, efficiency improvements can both reduce greenhouse gas emissions and realize cost savings in the short-term. Energy efficiency can also be driven by, and carried out in tandem with, electrification.[224] *Also see: Electrification; Evaluation, measurement and verification codes; Greenhouse gas emissions*

Energy storage: Battery technology that allows electricity to be stored in devices. Such devices can, ideally, manage the amount of power required to meet electricity demand when it is needed most. Energy storage is an important component to renewable energy systems.[225] *Also see: Grid stability, Renewable energy*

Epidemiology: The method used to find the causes of health outcomes and diseases in populations. Using epidemiology, health experts can study the patterns and risk factors of different health events in relation to specific communities. Epidemiology can be also applied to control health problems.[226]

Equity: Just and fair inclusion in a society where all can participate, prosper and reach their full potential.[227]

EV-ready building codes: Building codes that have electric and plug-in hybrid electric charging infrastructure requirements for new construction projects. Such requirements include specifying electrical capacity and electrical wiring set-ups to make future installation of vehicle charging stations possible. States and municipalities often develop EV-ready building codes to accommodate local vehicle market trends and to meet location-specific climate goals.[228] *Also see: Building codes, Electric vehicle, Energy conservation codes, Plug-in hybrid electric vehicle, Stretch codes, Zero-emission vehicle*

Evaluation, measurement and verification regulations: The requirements, procedures and standards by which energy efficiency programs and projects are measured to see whether they are saving energy and money as they were designed to do. These codes assess whether programs are working and help determine energy-saving strategies to pursue in the future.[229] *Also see: Energy efficiency*

Fish kill: An incident in which there is a notable die-off of fish in a body of water. Many fish kills result from low concentrations of dissolved oxygen in the water.[230]

Forested buffers: The areas next to streams and rivers where trees, shrubs and other plants grow. Forested buffers provide a variety of benefits such as preventing pollution from entering waterways, stabilizing stream banks, providing food and habitat to wildlife, and keeping streams cool during hot weather.[231]

Freight efficiency: Implementing strategies that improve efficiency in freight operations. Efficiency can be measured in terms of lowered emissions, reduced maintenance and cost savings in operations, among other metrics. Examples include, but are not limited to, route optimization, mode switching and use of fuel-efficient vehicles. *Also see: Mode switching, Route optimization*

Frontline community: Communities that experience the first, and often worst, impacts of climate change.[232]

Greenhouse gases: Gases in the atmosphere that have the ability to trap heat. Common greenhouse gases include carbon dioxide, methane, nitrous oxide, ozone, certain fluorinated gases (such as hydrofluorocarbons and chlorofluorocarbons) and water vapor. Greenhouse gases in the atmosphere form what can be thought of as a "heat-trapping blanket" around the Earth. *Also see: Carbon dioxide, Greenhouse gas emissions, Hydrofluorocarbons, Methane*

Greenhouse gas emissions: The release of greenhouse gases into the atmosphere as a result of human activities, particularly the burning of coal, natural gas and oil for energy and heat. *Also see: Emissions, Greenhouse gases*

Grid stability: Reliability, consistency and balance in the generation and use of power in the electrical grid. Stability must consider the integration of individual- and utility-scale renewable energy in the grid and an increasing need to power electronic devices, such as electric and plug-in hybrid electric vehicles. Strategies that can help achieve grid stability include distributed energy, microgrids, battery storage, time-of-use rates, off-peak charging and vehicle-to-grid technology.[233] *Also see: Battery storage technology, Distributed renewable energy, Electric vehicle, Microgrid, Off-peak charging, Plug-in hybrid electric vehicle, Renewable energy, Time-of-use rates, Vehicle-to-grid technology*

Ground-level ozone: Ozone is a gas composed of three atoms of oxygen (O_3). Ozone occurs both in the Earth's upper atmosphere and at ground level. Ground-level ozone is a harmful air pollutant because it causes breathing issues and is a primary ingredient of "smog." Most ground-level ozone is created when pollutants emitted by cars, power plants, industrial boilers, refineries and chemical plants chemically react in the presence of sunlight.[234]

Hazard reduction: Any sustainable action that reduces or eliminates long-term risk to people and property from future disaster events. Also known as hazard mitigation.[235] *Also see: Sustainability*

Heat island effect: Scenarios in which urban areas experience higher temperatures than outlying areas. Structures such as buildings, roads and other infrastructure absorb and re-emit the sun's heat more than natural landscapes, such as forests and water bodies. As such, urban areas, where these structures are highly concentrated and greenery is limited, become "islands" of higher temperatures relative to outlying areas.[236]

High global warming potential: Greenhouse gases warm the Earth by absorbing energy and slowing the rate at which energy escapes into space. Different greenhouse gases have different warming effects based on their ability to absorb energy and how long they stay in the atmosphere. The "global warming potential" measurement was developed to compare the warming effect of a specific greenhouse gas to that of carbon dioxide. Gases with high global warming potential trap substantially more heat than carbon dioxide — sometimes thousands or tens of thousands of times more. Hydrofluorocarbons and methane are examples of high global warming potential gases.[237] *Also see: Carbon dioxide, Greenhouse gases, Hydrofluorocarbons*

High-tide flooding: Scenarios in which tidal waters, in the absence of storm surge or rainfall, temporarily rise above a level that results in standing water on low-lying roads or seawater entering stormwater systems. Also known as nuisance flooding or sunny-day flooding.[238]

Hydrofluorocarbons: Hydrofluorocarbons are greenhouse gases with global warming potentials that can be hundreds to thousands of times more than that of carbon dioxide. Hydrofluorocarbons are commonly used in refrigerants, fire extinguishing systems and air conditioning building insulation.[239] *Also see: Carbon dioxide, Greenhouse gases, High global warming potential*

Hydrogen fuel cell vehicle: A type of zero-emission vehicle that is powered by hydrogen and emits only water vapor and warm air. This type of vehicle uses a propulsion system similar to that of an electric vehicle, where energy stored as hydrogen is converted to electricity by a fuel cell. For the purposes of Delaware's Climate Action Plan, a hydrogen fuel cell vehicle differs from an electric vehicle.[240] *Also see: Electric vehicle, Zero-emission vehicle*

Interoperability standards: As it relates to electric and plug-in hybrid electric vehicles, interoperability standards are specifications that allow different vehicles, vehicle charging stations and charging station networks to interact with one another. This includes allowing vehicles to use different chargers, chargers to interact with one other (and with their associated charging management systems), and charging service providers to process payments between different charging networks.[241] *Also see: Electric vehicle, Plug-in hybrid electric vehicle, Zero-emission vehicle*

Invasive species: Plants, animals or other organisms that are nonnative (or alien) to a specific ecosystem and whose introduction causes (or is likely to cause) harm.[242]

Living shoreline: A structure made up of natural or nature-based materials that is used to stabilize or control erosion along a shoreline. Materials commonly used in living shorelines include native plants and shellfish, oyster shells and biodegradable coconut-fiber logs.[243]

Low carbon fuel standard: A regulatory program modeled after (or similar to) the California Low Carbon Fuel Standard. The California Standard is a regulatory program designed to decrease the carbon emissions per unit energy produced (also called the "carbon intensity") of the fuels used within the state. The California Standard is also designed to provide an increasing range of low-carbon fuels to reduce petroleum dependency and achieve air quality benefits.[244] *Also see: Carbon dioxide, Greenhouse gas emissions*

Managed retreat plan: A plan for the voluntary movement and transition of people and ecosystems away from vulnerable coastal areas.[245]

Methane: Methane (CH_4) is a greenhouse gas that is a primary component of natural gas. It is the second most emitted greenhouse gas after carbon dioxide and is about 25 times more potent than carbon dioxide in trapping heat in the atmosphere. Human activities that can result in methane emissions include landfills, oil and natural gas systems and wastewater treatment plants.[246] *Also see: Anaerobic digestion, Greenhouse gases, Greenhouse gas emissions, High global warming potential, Methane capture, Renewable natural gas*

Methane capture: Technologies, such as those in anaerobic digestion systems, that restrict the release of methane into the atmosphere. The methane captured can be used for energy or flared.[247] *Also see: Anaerobic digestion, Methane, Renewable natural gas*

Microgrid: A local energy grid that can disconnect from the traditional (or main) electrical grid and operate on its own.[248] *Also see: Grid stability*

Migration (of wetlands): The natural process by which wetlands gradually shift inland with sea level rise onto formerly dry land.[249] *Also see: Wetland*

Mileage-based user fee: A distance-based fee levied on a vehicle driver for use of a roadway system. Under this fee structure, a user driving on a certain roadway system would pay a per-mile rate multiplied by the number of miles driven. Also known as a vehicle-miles traveled fee.[250]

Mode switching: The partial or complete shift of freight operations from truck to rail. *Also see: Freight efficiency*

Natural and working lands: Landscapes — including forests, grasslands, croplands, wetlands and urban greenspaces — that sequester carbon and provide significant and cost-effective opportunities to reduce or offset greenhouse gas emissions.[251] *Also see: Carbon sequestration and storage, Greenhouse gas emissions*

Net-zero emissions: As it relates to greenhouse gas emissions, net-zero emissions is achieved when greenhouse gas emissions from human activities are balanced out by removing greenhouse gases from the atmosphere, a process known as carbon removal. Carbon removal can be carried out via carbon sequestration and storage as well as through the use of carbon removal technology.[252,253] *Also see: Carbon sequestration and storage, Greenhouse gas emissions*

Net-zero energy building/home: Buildings and homes that combine energy efficiency and renewable energy generation to consume only as much energy as can be produced on site through renewable resources over a specified time period. Also known as a zero energy building. *Also see: Energy efficiency, Renewable energy*

Noxious weed: Any plant designated by federal, state or local government officials as injurious to public health, agriculture, recreation, wildlife or property. Once a weed is classified as noxious, authorities can implement quarantines and take other actions to contain or destroy the weed and limit its spread.[254]

Ocean acidification: The change in chemistry of ocean waters due to an increased uptake of carbon dioxide from the atmosphere. Due to the increased concentration of carbon dioxide in the atmosphere, oceans are absorbing more carbon dioxide. This results in ocean waters becoming more acidic. Increases in water acidity impact ecosystems and wildlife, particularly when ocean acidification is combined with coastal acidification.[255] *Also see: Coastal acidification, Rapid climate change*

Off-peak charging: Charging an electric or plug-in hybrid electric vehicle at times when the local energy demand (and cost) on the electrical grid is low. *Also see: Electric vehicle, Grid stability, Plug-in hybrid electric vehicle, Time-of-use rates*

Offshore wind energy: Electricity produced by offshore wind turbines that connect to the electrical grid on land through a series of cable systems buried under the sea floor. Electricity powered by offshore wind energy is routed through "coastal load centers" that prioritize where the electricity should go and distribute power to the electrical grid.[256] *Also see: Renewable energy*

Plug-in hybrid electric vehicle: A type of zero-emission vehicle that is a combination of a gasoline vehicle and an electric vehicle; as such, it has a battery, an electric motor, a gasoline tank and an internal combustion engine. For the purposes of Delaware's Climate Action Plan, a plug-in hybrid electric vehicle differs from an electric vehicle.[257] *Also see: Electric vehicle, Zero-emission vehicle*

Public utility tax: As it relates to Delaware, a public utility tax is a tax imposed on firms that provide steam, gas, electric, telephone, telegraph or cable television services within the state. With the exception of cable television services, receipts from sales to residential users are exempt from this tax. A separate license tax is based on gross receipts of businesses that produce steam, gas or electricity.[258]

Rapid climate change: A nontechnical, colloquial term used to describe the rapid changes in Earth's climate observed over the last 75 to 150 years. Modern research has shown that human activities, particularly the emission of greenhouse gases from the burning of fossil fuels, are "extremely likely" to be the major driver of these changes.[259] *Also see: Climate, Climate change, Climate change impact, Greenhouse gases, Greenhouse gas emissions*

Regional transmission organization: An independent, membership-based, nonprofit organization that operates a bulk electric power system in a specific part of North America. The purpose of a regional transmission organization is to ensure reliability and optimize supply and demand bids for wholesale electric power. Eight regional transmission organizations serve the United States, and as of 2009, these U.S.-serving organizations managed 60% of the power supplied to entities that provide electricity to end-use customers. Delaware's electrical grid falls under the purview of the regional transmission organization PJM Interconnection.[260]

Remediation: The removal of pollution or contaminants from groundwater, surface water or soil to protect human health and help restore environmental conditions.[261]

Renewable energy: Energy derived from resources that are naturally replenishing and virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy sources include biomass, hydropower, geothermal, solar and wind.[262] *Also see: Clean energy, Distributed renewable energy, Offshore wind energy, Renewable energy credits, Renewable portfolio standards, Solar renewable energy credits, Utility-scale renewable energy*

Renewable energy credits: A way to track the generation, delivery and purchase of renewable energy in the electrical grid. Each renewable energy credit represents 1 megawatt-hour (a measure of electricity generated) that was produced and delivered to the electrical grid by a renewable resource, such as wind or solar; when 1 megawatt-hour of electricity is generated, a credit is generated as well. Each credit can be kept by the generating entity or sold to someone else. The owner of a renewable energy credit can claim the property rights to the environmental, social and other non-power attributes of the renewable energy generated with that credit. As such, renewable energy credits represent a "currency" of sorts for the renewable energy market.[263,264] *Also see: Solar renewable energy credits*

Renewable energy portfolio standards: A regulatory mandate to increase the production of energy from renewable sources (such as wind, solar and biomass) as an alternative to fossil fuel and nuclear electric generation.[265] Delaware's Renewable Energy Portfolio Standards require the state's electric utilities to get an increasing percentage of their electricity from renewable sources.[266] Also known as renewable electricity standards or simply as renewable portfolio standards. *Also see: Renewable energy*

Renewable natural gas: An energy product, primarily consisting of methane, that is produced by the decomposition of organic matter and then processed to purity standards. Renewable natural gas is often captured at landfills, wastewater treatment plants and agricultural facilities and can replace other types of fossil fuels. Also known as biogas.[267] *Also see: Anaerobic digestion, Methane, Methane capture*

Resilience: The ability to "bounce back" after hazardous events rather than merely reacting to impacts.[268]

Rolling easement: A planning and development approach to low-lying coastal lands that is based on the premise that land must eventually give way to rising sea levels. Rolling easements use land-use and legal tools to allow wetlands and beaches to migrate inland as people remove buildings, roads and other structures from land that becomes submerged from sea level rise.[269] *Also see: Sea level rise, Wetland migration*

Route optimization: The process of determining transportation routes for both time- and cost-effectiveness.[270] This does not necessarily mean finding the shortest route by distance. Route optimization can help manage transportation costs, reduce greenhouse gas emissions and move goods more efficiently.[271] *Also see: Freight efficiency, Greenhouse gas emissions*

Sea level rise: An increase in the average level of the ocean surface, caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers on land and the expansion of seawater as it warms.[272] Delaware lies in a sea level rise "hotspot," where sea levels are rising faster than elsewhere in the world due to a combination of both sinking land and climate change.[273] *Also see: Climate change impacts, Greenhouse gases, Rapid climate change, Rolling easement*

Sequestration: See Carbon sequestration and storage

Solar renewable energy credits: A form of renewable energy credits generated by solar energy photovoltaic systems. *Also see: Renewable energy credits*

Stretch codes: A building energy conservation code, or compliance pathway, that is more aggressive than a base energy code. Stretch codes are often locally mandated and are compared to the base code enforced at a higher jurisdictional level (such as the state level). However, stretch codes can either be voluntary or mandatory. The main purpose of stretch codes is to help buildings achieve greater energy savings and implement advanced building practices. Also known as reach codes.[274,275] *Also see: Building codes, Energy conservation codes, EV-ready building codes*

Subaqueous lands: Land located below the limits of low tide and thus always underwater.[276]

Sustainability: The creation and maintenance of conditions under which humans and nature can exist in productive harmony to support both present and future generations.[277]

Tax ditch: A governmental subdivision of the state, formed by a legal process to oversee the drainage of a specific watershed area. A tax ditch organization is made up of all landowners of the watershed area. Tax ditches were created for and designed to move normal water flows off agricultural lands to keep them productive.[278]

Telecommuting: A situation in which someone works for an organization from their home and communicates with the main office and customers primarily by phone or email.[279]

Time-of-use rates: An electricity pricing structure in which rates vary according to the time of day, season and/or day of the week (weekday or weekend/holiday). Higher rates are charged during the peak demand hours and lower rates during off-peak (low) demand hours. This rate structure incentivizes people to shift energy use from peak hours to off-peak hours.[280] *Also see: Grid stability, Off-peak charging*

Toxicology: The scientific study of the negative effects that chemicals have on living organisms.[281]

Transfer of development rights: A market-based tool that allows communities to focus development in designated growth areas away from natural landscapes, drinking water sources and farmland. Also known as transfer of development credits.[282]

Travel demand management: The implementation of strategies and policies aimed at using transportation resources more efficiently and reducing the need for travel by single-occupancy vehicles.[283] *Also see: Vehicle miles traveled*

Utility-scale renewable energy: Large renewable energy projects, usually defined as those that are 10 megawatts or larger. Such projects can often benefit from state and local policies and programs that help to address and overcome potential barriers to implementation.[284] *Also see: Renewable energy*

Vector: Living organisms that can transmit infectious diseases between humans or from animals to humans.[285] *Also see: Vector-borne disease*

Vector-borne disease: A disease that results from an infection transmitted to humans and other animals by blood-feeding organisms, such as mosquitoes, ticks and fleas.19 *Also see: Vector*

Vehicle miles traveled: A measure of the amount of travel for all vehicles in a geographic region over a given period of time. Vehicle miles traveled is calculated as the sum of the number of miles traveled by each vehicle. *Also see: Travel demand management*

Vehicle-to-grid technology: The technical capability that allows electricity to flow from zero-emission vehicles to the electrical grid.[286] *Also see: Grid stability, Zero-emission vehicle*

Waterborne disease: A disease caused by microorganisms, biotoxins or toxic contaminants in water that leads to illnesses such as cholera, schistosomiasis and other gastrointestinal problems. Outbreaks of waterborne diseases often occur after heavy precipitation events.[287]

Weather: Atmospheric conditions that occur locally over short periods of time, from minutes to hours or days. Familiar examples include rain, snow, clouds, winds, floods and thunderstorms.[288] *Also see: Climate*

Weatherization: A range of practices aimed at weatherproofing and installing energy-efficient measures in a building or home to improve the structure's envelope, heating and cooling systems, electrical system and electricity and fuel consumption.[289] Weatherization programs can include home energy audits, air sealing, insulation, moisture control and ventilation.[290] *Also see: Energy efficiency*

Wetland: An area where the frequent and prolonged presence of water at or near the soil surface drives and supports a system of plants and animals that are adapted for wet soil conditions. Swamps, marshes and bogs are well-recognized types of wetlands.[291] *Also see: Wetland migration*

Zero-emission vehicle: A vehicle that has the potential to produce no tailpipe emissions. It can still have a conventional internal combustion engine, but it must also be able to operate without using it. Examples include electric, plug-in hybrid electric and hydrogen fuel cell vehicles.[292] *Also see: Electric vehicle, Hydrogen fuel cell vehicle, Plug-in hybrid electric vehicle*

References

1 "What Causes the Earth's Climate to Change?," *British Geological Survey*, accessed November 10, 2020, https://www.bgs.ac.uk/discovering-geology/climate-change/what-causes-the-earths-climate-to-change.

2 "Scientific Consensus: Earth's Climate is Warming," *National Aeronautics and Space Administration, Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/scientific-consensus.

3 "The Causes of Climate Change," *National Aeronautics and Space Administration, Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/causes.

4 Rebecca Lindsey, "Climate Change: Atmospheric Carbon Dioxide," *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Climate.gov*, last modified August 14, 2020, https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide.

5 "Overview of Greenhouse Gases," *U.S. Environmental Protection Agency*, last modified September 8, 2020, https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

6 "World of Change: Global Temperatures," *National Aeronautics and Space Administration, Earth Observing System Project Science Office*, accessed November 10, 2020, https://earthobservatory.nasa.gov/world-of-change/global-temperatures.

7 "The Effects of Climate Change," *National Aeronautics and Space Administration*, *Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/effects.

8 Multihazard Mitigation Council, *Natural Hazard Mitigation Saves: 2019 Report* (Washington, DC: National Institute of Building Sciences, December 2019), 4, https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mitigation_saves_2019/mitigationsaves2019report.pdf.

9 Multihazard Mitigation Council, *Mitigation Saves*, 32.

10 "Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments," *Intergovernmental Panel on Climate Change*, last modified October 8, 2018, https://www.ipcc.ch/2018/10/08/ summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments.

11 "Electric Vehicle Report: The Road to Clean Air," *American Lung Association*, accessed November 10, 2020, https://www.lung.org/clean-air/electric-vehicle-report.

12 "Homepage," *Regional Greenhouse Gas Initiative*, accessed November 10, 2020, https://www.rggi.org.

13 "Regional Greenhouse Gas Initiative," *Delaware Department of Natural Resources and Environmental Control, Division of Air Quality*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/air/greenhouse-gas.

14 "U.S. Climate Alliance Annual Report," *U.S. Climate Alliance*, accessed November 10, 2020, http://www.usclimatealliance.org/annual-report.

15 "Climate Change and Sea Level Rise Perceptions," *Delaware Department of Natural Resources and Environmental Control Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/coastal-programs/planning-training/adapting-to-sea-level-rise/climate-change-perceptions.

16 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Delaware Climate Change Impact Assessment*, by Jennifer de Mooy, Morgan Ellis, Daniel J. Leathers, Katherine Hayhoe, Anne Stoner, and Rodica Gelca (Dover, DE, February 2014), http://www.dnrec.delaware.gov/energy/ Documents/Climate%20Change%202013-2014/DCCIA%20interior_full_dated.pdf.

17 Delaware Department of Natural Resources and Environmental Control, Delaware Coastal Programs, *Preparing for Tomorrow's High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware* (Dover, DE, July 2012), http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/AssesmentForWeb.pdf.

18 Delaware Sea-Level Rise Technical Committee, *Recommendation of Sea-Level Rise Planning Scenarios for Delaware* (Newark, DE: University of Delaware, Delaware Geological Survey, November 2017), https:// www.dgs.udel.edu/sites/default/files/projects-docs/Delaware%20SLR%20Technical%20Report%202017.pdf.

19 Asbury H. Sallenger, Jr., Kara S. Doran and Peter A. Howd, "Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America," *Nature Climate Change* 2 (2012): 884-888, https://dx.doi.org/10.1038/nclimate1597, https://www.cityofboston.gov/Images_Documents/Hotspot%20of%20accelerated%20sea-level%20rise%20-%20USGS%206-25-12_tcm3-33215.pdf.

20 U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services, *2019 State of U.S. High Tide Flooding with a 2020 Outlook*, NOAA Technical Report NOS CO-OPS 092 (Silver Spring, MD, July 2020), 15, https://tidesandcurrents.noaa.gov/publications/Techrpt_092_2019_State_of_US_High_Tide_Flooding_with_a_2020_Outlook_30June2020.pdf.

21 "Climate at a Glance: Statewide Time Series," *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Centers for Environmental Information*, last modified November 2020, https://www.ncdc.noaa.gov/cag/statewide/ time-series/7/tavg/ann/8/1895-2020?base_prd=true&begbaseyear=1901&endbaseyear=2000&trend=true&trend_base=10&begtrendyear=1895&endtrendyear=2020.

22 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Delaware Climate-Ready Workforce Pilot Project: Summary Report*, by Four Twenty Seven and MDB, Inc. (Dover, DE, June 30, 2017), 5, http://www.dnrec.delaware.gov/energy/Documents/Climate/Climate-Ready%20Workforce%20Pilot-Summary%20Report%20FINAL.pdf.

23 "Air Pollution," *U.S. Centers for Disease Control and Prevention, National Center for Environmental Health*, last modified December 21, 2020, https://www.cdc.gov/climateandhealth/effects/air_pollution.htm.

24 U.S. Global Change Research Program, "Temperature-Related Death and Illness" in *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (Washington, DC, April 2016), 46, https://dx.doi.org/10.7930/J0R49NQX.

25 U.S. Environmental Protection Agency and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, *Climate Change and Extreme Heat: What You Can Do to Prepare*, EPA 430-R-16-061 (Washington, DC, October 2016), 5, https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf.

26 Delaware Department of Agriculture, "Delaware Requests Emergency Declaration from USDA for Crop Damage Due to Recent Storms," News release, June 22, 2018, https://news.delaware.gov/2018/06/22/delaware-requests-emergency-declaration-usda-crop-damage-due-recent-storms.

27 U.S. Army Corps of Engineers, North Atlantic Division, "Officials Commend Army Corps' Efforts to Restore Delaware Coastline," News release, June 22, 2018, https://www.nad.usace.army.mil/Media/News-Releases/Article/483893/officials-commend-army-corps-efforts-to-restore-delaware-coastline.

28 Kim Geiger, "Sandy Smashed Road to Old Delaware Bridge, Spares New One," *Los Angeles Times*, October 30, 2012, https://www.latimes.com/nation/la-xpm-2012-oct-30-la-na-nn-hurricane-sandy-delaware-bridge-20121030-story.html.

29 Jim Pappas, "Severe Storm Impacts on Infrastructure in a Low Lying State" (presentation, Committee on Transportation System Security and Resilience Annual Meeting, San Diego, CA, July 11, 2018), https://ctssr.transportation.org/wp-content/uploads/sites/54/2018/08/delaware718.lgp_.pdf.

30 DNREC, *Sea Level Rise Vulnerability Assessment*, 67.

31 Delaware Sea-Level Rise Technical Committee, *Sea-Level Rise Planning Scenarios*, 15.

32 Titus O. Awokuse, Thomas W. Ilvento, and Zachary Johnston, *The Impact of Agriculture on Delaware's Economy* (Newark, DE: University of Delaware, College of Agriculture & Natural Resources, Department of Food & Resource Economics, December 2010), 16, https://cdn.canr.udel.edu/wp-content/uploads/2014/04/AgInDeEconB.pdf.

33 "The Value of Tourism in Delaware," *Delaware Tourism Office*, accessed November 10, 2020. https://www.visitdelaware.com/industry/tourism-statistics.

34 Pierpaolo Grippa, Jochen Schmittmann and Felix Suntheim, "Climate Change and Financial Risk: Central Banks and Financial Regulators are Starting to Factor in Climate Change," *Finance & Development* 56, no. 4 (2019): 26-29, https://www.imf.org/external/pubs/ft/fandd/2019/12/climate-change-central-banks-and-financial-risk-grippa.htm.

35 Alex Brown, "Climate Change Could Make Borrowing Costlier for States and Cities," *Stateline* (blog), *The Pew Charitable Trusts*, October 1, 2019, https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2019/ 10/01/climate-change-could-make-borrowing-costlier-for-states-and-cities.

36 Delaware Office of the Governor, "Delaware Joins U.S. Climate Alliance to Uphold Goals of Paris Agreement," News release, June 5, 2017, https://news.delaware.gov/2017/06/05/delaware-joins-u-s-climate-alliance-to-uphold-goals-of-paris-agreement.

37 Delaware Department of Natural Resources and Environmental Control, Division of Air Quality, *Delaware's 2016 Greenhouse Gas Emissions Inventory* (Dover, DE, June 2019), 3, http://www.dnrec.delaware.gov/Air/Documents/2016-de-ghg-inventory.pdf.

38 Tiffany Ganthier, "Equitable Adaptation Legal & Policy Toolkit: Introduction," *Georgetown University, Georgetown Law, Georgetown Climate Center*, accessed November 10, 2020, https://www.georgetownclimate.org/adaptation/toolkits/equitable-adaptation-toolkit/introduction.html.

39 U.S. Global Change Research Program, "Summary Findings" in *Fourth National Climate Assessment*, *Volume II: Impacts, Risks, and Adaptation in the United States* (Washington, DC: U.S. Government Publishing Office, November 2018, rev. February 2020), 25, https://dx.doi.org/10.7930/NCA4.2018, https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.

40 U.S. Global Change Research Program, "Overview" in *Fourth National Climate Assessment*, *Volume II: Impacts, Risks, and Adaptation in the United States* (Washington, DC: U.S. Government Publishing Office, November 2018, rev. February 2020), 36, https://dx.doi.org/10.7930/NCA4.2018, https://nca2018.globalchange.gov/downloads/NCA4_2018_FullReport.pdf.

41 "Renewable Energy Assistance," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/renewable/assistance.

42 "Renewable Energy Portfolio Standards," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed February 18, 2021, https://dnrec.alpha.delaware.gov/climate-coastal-energy/renewable/portfolio-standards.

43 "Weatherization Assistance Program," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/sustainable-communities/weatherization.

44 "Energy Efficiency Investment Fund," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/energy-efficiency-investment-fund.

45 "E2I: Energy Efficiency Industrial," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/industrial.

46 "Building Energy Codes," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/building-energy-codes.

47 "Evaluation, Measurement and Verification," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/evaluation-measurement-verification.

48 "Clean Fuel and Transportation Initiatives," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/evaluation-measurement-verification.

49 "Reducing Diesel Emissions," *Delaware Department of Natural Resources and Environmental Control, Division of Air Quality*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/air/mobile-sources/diesel-emissions.

50 "Diesel Emissions Reduction Act (DERA) Funding," *U.S. Environmental Protection Agency, Office of Transportation and Air Quality*, last modified November 4, 2020, https://www.epa.gov/dera.

51 "VW Mitigation Plan," *Delaware Department of Natural Resources and Environmental Control, Division of Air Quality*, accessed February 15, 2021, https://dnrec.alpha.delaware.gov/air/mobile-sources/vw-mitigation-plan.

52 "Clean Vehicles and Fuels," *Delaware Department of Natural Resources and Environmental Control, Division of Air Quality*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/air/mobile-sources/clean-vehicles-fuels.

53 "Delaware Low Emission Vehicle Program," 7 *DE Admin. Code* 1140 (May 11, 2019), https://regulations.delaware.gov/AdminCode/title7/1000/1100/1140.shtml.

54 "State and Local Policy Database: Fleets," *American Council for an Energy-Efficient Economy*, last modified October 2020, accessed November 10, 2020, https://database.aceee.org/state/fleets.

55 "Cool Switch Low Impact Refrigerant Program," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/cool-switch.

56 "Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses," 7 *DE Admin. Cod*e 1151 (March 11, 2021), https://regulations.delaware.gov/AdminCode/title7/1000/1100/1151.shtml.

57 "Homepage," *Regional Greenhouse Gas Initiative*, accessed November 10, 2020.

58 "Regional Greenhouse Gas Initiative," *DNREC*, accessed November 10, 2020.

59 "About Us," *Transportation and Climate Initiative*, accessed November 10, 2020, https://www.transportationandclimate.org/content/about-us.

60 "Regional Greenhouse Gas Initiative," *DNREC*, accessed November 10, 2020.

61 "Adapting to Sea Level Rise," *Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/coastal-programs/planning-training/Adapting-to-sea-level-rise.

62 Delaware Sea-Level Rise Technical Committee, *Sea-Level Rise Planning Scenarios*.

63 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Climate Framework for Delaware: Executive Order 41 Summary of Recommendations*, by Delaware Cabinet Committee on Climate and Resilience (Dover, DE, December 31, 2014), http://www.dnrec.delaware.gov/energy/Documents/ The%20Climate%20Framework%20for%20Delaware%20PDF.pdf.

64 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Avoiding and Minimizing Risk of Flood Damage to State Assets: A Guide for Delaware State Agencies*, by Delaware Flood Avoidance Workgroup (Dover, DE, March 2016), http://www.dnrec.delaware.gov/energy/Documents/DE%20Flood%20Avoidance%20Guide%20For%20State%20agencies.pdf.

65 "Flood Risk and Avoidance," Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/climate-change/flood-risk-avoidance.

66 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Climate Action in Delaware: 2016 Progress Report*, by Jennifer de Mooy, Morgan Ellis, Caren Fitzgerald, Susan Love, and Kerri Yandrich (Dover, DE, December 2016), http://www.dnrec.delaware.gov/energy/Documents/2016%20Climate%20Action%20Progress%20Report/Climate%20Action%20in%20Delaware%202016%20Progress%20Report.pdf.

67 *Coastal Zone Act*, 7 *Del. Laws*, c. 70, https://delcode.delaware.gov/title7/c070/index.shtml.

68 Delaware Department of State, Division of Historical and Cultural Affairs, *Delaware Division of Historical and Cultural Affairs Strategic Plan: FY15/FY19* (Dover, DE, January 1, 2014), https://history.delaware.gov/wp-content/uploads/sites/179/2019/01/strategicPlanFY15.pdf.

69 Delaware Department of Natural Resources and Environmental Control and Delaware Department of Agriculture, Delaware Forest Service, *2015 Delaware Wetland Management Plan* (Dover, DE, 2015), http://www.dnrec.delaware.gov/Admin/DelawareWetlands/Documents/2015%20Delaware%20Wetlands%20Management%20Plan.pdf.

70 "Delaware Wildlife Action Plan," Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/fish-wildlife/conservation/wildlife-action-plan.

71 Delaware Department of Transportation, *Strategic Implementation Plan for Climate Change, Sustainability & Resilience for Transportation* (Dover, DE, July 2017), https://deldot.gov/Publications/reports/SIP/pdfs/SIP_FINAL_2017-07-28.pdf.

72 Delaware Department of Safety and Homeland Security, Delaware Emergency Management Agency, *State of Delaware All-Hazard Mitigation Plan* (Smyrna, DE, August 2018), https://dema.delaware.gov/contentFolder/pdfs/HazardMitigationPlan.pdf.

73 Delaware Department of Agriculture, Delaware Forest Service, *Delaware Statewide Forest Strategy* (Dover, DE, October 2020), https://agriculture.delaware.gov/wp-content/uploads/sites/108/2020/08/2020-Delaware-Forest-Strategy_reduced-draft.pdf.

74 "Resilient Communities," Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/coastal-programs/planning-training/resilient-communities.

75 "Homepage," Delaware Resilient and Sustainable Communities League, accessed November 10, 2020, https://www.derascl.org.

76 "Coastal Training Program," Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/coastal-programs/planning-training/coastal-training.

77 "Homepage," University of Delaware, Delaware Geological Survey and Delaware Environmental Observing System, Delaware Coastal Flood Monitoring System, accessed November 10, 2020, http://coastal-flood.udel.edu.

78 "Understanding Climate Change," Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/climate-change.

79 "Delaware Database for Funding Resilient Communities," University of Delaware, Joseph R. Biden, Jr. School of Public Policy and Administration, accessed November 10, 2020, https://www.bidenschool.udel.edu/research-public-service/ddfrc.

80 "Coastal Inundation Maps for Delaware," University of Delaware, Delaware Geological Survey, accessed November 10, 2020, https://www.dgs.udel.edu/projects/coastal-inundation-maps-delaware.

81 "Homepage," University of Delaware, Center for Environmental Monitoring and Analysis, Delaware Climate Information Center, accessed November 10, 2020, https://www.declimateinfo.org.

82 "Coastal Monitoring," Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/coastal-programs/coastal-science/coastal-monitoring.

83 "Homepage," Mid-Atlantic Coastal Acidification Network, accessed November 10, 2020, https://midacan.org.

84 DNREC, *Climate Framework for Delaware*.

85 Delaware Department of Natural Resources and Environmental Control, Delaware Coastal Programs, *Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise in Delaware* (Dover, DE, September 2013), http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/FinalAdaptationPlanasPublished.pdf.

86 DNREC, *Climate Action in Delaware: 2016 Progress Report*.

87 ICF, *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis* (Fairfax, VA, August 31, 2020), https://de.gov/climateplan.

88 DNREC, *Climate Framework for Delaware*.

89 DNREC, *Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise*.

90 Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, *Delaware's Climate Action Plan Public Workshop Summary: Round 1: March 2020*, by Kim Lundgren Associates, Inc. (Dover, DE, June 2020), https://de.gov/climateplan.

91 Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, *Delaware's Climate Action Plan Public Workshop Summary: Round 2: Fall 2020, Workshop No. 1*, by Planning Communities, LLC (Dover, DE, December 2020), https://de.gov/climateplan.

92 Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, *Delaware's Climate Action Plan Public Workshop Summary: Round 2: Fall 2020, Workshop Nos. 2, 3 and 4* (Dover, DE, December 2020), https://de.gov/climateplan.

93 Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, *Delaware's Climate Action Plan Technical Advisory Workshop Summary: Round 1: March 2020*, by Kim Lundgren Associates, Inc. (Dover, DE, June 2020), https://de.gov/climateplan.

94 Delaware Office of the Governor, "Delaware Joins U.S. Climate Alliance to Uphold Goals of Paris Agreement."

95 DNREC, *Delaware's 2016 Greenhouse Gas Emissions Inventory*, 3.

96 "Regional Greenhouse Gas Initiative," *DNREC*, accessed November 10, 2020.

97 "Summary for Policymakers," *IPCC*, last modified October 8, 2018.

98 Cody Sullivan, "National Climate Assessment: States and Cities are Already Reducing Carbon Emissions to Save Lives and Dollars," *National Oceanic and Atmospheric Administration, Climate.gov*, last modified February 5, 2019, https://www.climate.gov/news-features/featured-images/national-climate-assessment-states-and-cities-are-already-reducing.

99 "U.S. State Greenhouse Gas Emissions Targets," *Center for Climate and Energy Solutions*, last modified September 2020, https://www.c2es.org/document/greenhouse-gas-emissions-targets.

100 ICF, *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis*.

101 "Renewable Energy Portfolio Standards," *DNREC*, accessed February 18, 2021.

102 "About the Public Service Commission," *Delaware Public Service Commission*, accessed November 10, 2020, https://depsc.delaware.gov/public-service-commission.

103 "Who We Are," *PJM Interconnection*, accessed November 10, 2020, https://www.pjm.com/about-pjm/who-we-are.aspx.

104 "Renewable Energy Assistance," *DNREC*, accessed November 10, 2020.

105 "Who We Are," *PJM Interconnection*, accessed November 10, 2020.

106 "About the Portal," *Mid-Atlantic Ocean Data Portal*, accessed November 10, 2020, https://portal.midatlanticocean.org/about-us.

107 "About the Public Service Commission," *Delaware Public Service Commission*.

108 Delaware Office of Management and Budget, Division of Facilities Management, "Award Notice, Contract No. OMB19326-ELECT_SUPPLY, Statewide Competitive Supply of Electricity," by Megan Garrett (notice of award, Dover, DE, June 17, 2019), http://bidcondocs.delaware.gov/OMB/OMB_19326-ELECT_SUPPLY_an.pdf.

109 "Building Energy Codes," *DNREC*, accessed November 10, 2020.

110 *County or Municipal Building, Plumbing, Electrical and Other Codes*, 16 *Del. Laws*, c. 76, https://delcode.delaware.gov/title16/c076/index.shtml.

111 "Overview of the International Energy Conservation Code (IECC)," *International Code Council*, accessed December 17, 2020, https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/iecc.

112 "2018 International Green Construction Code Powered by Standard 189.1-2017: A Comprehensive Solution for High-Performance Buildings," *American Society of Heating, Refrigerating and Air-Conditioning Engineers*, accessed December 17, 2020, https://www.ashrae.org/technical-resources/bookstore/standard-189-1.

113 "Standard 90.1-2019 – Energy Standard for Buildings Except Low-Rise Residential Buildings," *American Society of Heating, Refrigerating and Air-Conditioning Engineers*, accessed December 17, 2020, https://www.ashrae.org/technical-resources/bookstore/standard-90-1.

114 "Energy Efficiency Investment Fund," *DNREC*, accessed November 10, 2020.

115 "The Delaware Energy Efficiency Advisory Council," *Delaware Department of Natural Resources and Environmental Control Division of Climate, Coastal and Energy*, accessed November 18, 2020, https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/energy-efficiency-advisory-council.

116 "Weatherization Assistance Program," *DNREC*, accessed November 10, 2020.

117 "About DSHA," *Delaware State Housing Authority*, accessed December 17, 2020, http://www.destatehousing.com/DirectorsOffice/aboutAgency.php.

118 "What Energize Delaware is All About," *Delaware Sustainable Energy Utility*, accessed December 17, 2020, https://www.energizedelaware.org/about-us.

119 "Lead Program," *New Castle County Delaware*, accessed December 17, 2020, https://www.nccde.org/1982/Lead-Program.

120 "About MHDC," *Milford Housing Development Corporation*, accessed December 17, 2020, http://milfordhousing.com/about.

121 "Who We Are," *Good Neighbors, Inc.*, accessed December 17, 2020, https://www.goodneighborshomerepair.org/about-us.html.

122 Delaware Department of Finance, Division of Revenue, *State of Delaware Tax Preference Report: 2019 Edition* (Dover, DE, 2019), 4-1, https://financefiles.delaware.gov/docs/p_util.pdf.

123 "Energy Efficiency Investment Fund," *DNREC*, accessed November 10, 2020.

124 "Overview of the International Green Construction Code," *International Code Council*, accessed December 17, 2020, https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/igcc.

125 "Clean Fuel and Transportation Initiatives," *DNREC*, accessed November 10, 2020.

126 "Zero-Emission Vehicle Program," *California Environmental Protection Agency, California Air Resources Board*, accessed December 17, 2020, https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program.

127 "Advanced Clean Cars Program," *California Environmental Protection Agency, California Air Resources Board*, accessed December 17, 2020, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program.

128 "The Importance of Open Protocols," *Open Charge Alliance*, accessed December 17, 2020, https://www.openchargealliance.org/protocols.

129 "Clean Fuel and Transportation Initiatives," *DNREC*, accessed November 10, 2020.

130 "Clean Fuel and Transportation Initiatives," *DNREC*, accessed November 10, 2020.

131 U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office, *ADA Requirements for Workplace Charging Installation: Guidance in Complying with Americans with Disabilities Act Requirements*, DOE/GO-102014-4563 (Washington, DC, November 2014), https://afdc.energy.gov/files/u/publication/WPCC_complyingwithADArequirements_1114.pdf.

132 "Get a Job, Get a Ride (GaJ/GaR)," *RideShare Delaware*, accessed November 18, 2020, https://ridesharedelaware.org/get-a-job-get-a-ride.

133 "Clean Fuel and Transportation Initiatives," *DNREC*, accessed November 10, 2020.

134 "Renewable Energy Assistance," *DNREC*, accessed November 10, 2020.

135 "Complete Communities Toolbox," *University of Delaware, Joseph R. Biden, Jr. School of Public Policy and Administration*, accessed November 10, 2020, https://www.completecommunitiesde.org.

136 "Capital Transportation Program," *Delaware Department of Transportation*, accessed December 17, 2020, https://deldot.gov/Publications/reports/CTP/index.shtml.

137 "Learn About SmartWay," *U.S. Environmental Protection Agency, SmartWay Transport Partnership*, last modified December 19, 2017, https://www.epa.gov/smartway/learn-about-smartway.

138 "Clean Fuel and Transportation Initiatives," *DNREC*, accessed November 10, 2020.

139 "VW Mitigation Plan," *DNREC*, accessed December 17, 2020.

140 "Diesel Emissions Reduction Act (DERA) Funding," *U.S. EPA*, last modified November 4, 2020.

141 "Fact Sheet: Cap-and-Invest as a Tool to Reduce Pollution," *Transportation and Climate Initiative*, accessed November 10, 2020, https://www.transportationandclimate.org/fact-sheet-cap-and-invest-tool-reduce-pollution.

142 "Delaware Low Emission Vehicle Program," 7 *DE Admin. Code* 1140 (May 11, 2019).

143 "Low Carbon Fuel Standard," *California Environmental Protection Agency, California Air Resources Board*, accessed November 10, 2020, https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard.

144 "Advanced Clean Cars II Meetings & Workshops," *California Environmental Protection Agency, California Air Resources Board*, accessed December 17, 2020, https://ww2.arb.ca.gov/advanced-clean-cars-ii-meetings-workshops.

145 "Advanced Clean Trucks," *California Environmental Protection Agency, California Air Resources Board*, accessed December 17, 2020, https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks.

146 "State and Local Policy Database: Fleets," *ACEEE*, last modified October 2020, accessed November 10, 2020.

147 "Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses," 7 DE Admin. Code 1151.

148 "Cool Switch Low Impact Refrigerant Program," *DNREC*, accessed November 10, 2020.

149 "Natural Gas STAR Program," *U.S. Environmental Protection Agency, Natural Gas Star Program*, last modified August 25, 2020, https://www.epa.gov/natural-gas-star-program/natural-gas-star-program.

150 "Delaware Recycles," *Delaware Department of Natural Resources and Environmental Control, Division of Waste and Hazardous Substances,* accessed November 18, 2020, https://dnrec.alpha.delaware.gov/waste-hazardous/recycling.

151 Delaware Department of Agriculture, Delaware Forest Service, *Delaware Forest Resource Assessment* (Dover, DE, October 2020), https://delawaretrees.com/del_forest_resource_assessment_2020r.pdf.

152 "Regional Greenhouse Gas Initiative," *DNREC*, accessed November 10, 2020.

153 Delaware Department of Natural Resources and Environmental Control, Division of Air Quality, *Delaware's 2017 Greenhouse Gas Emissions Inventory* (Dover, DE, June 2020), 18, http://www.dnrec.delaware.gov/Air/Documents/2017-DE-GHG-Inventory.pdf.

154 Jennifer Volk, *Delaware's Natural and Working Lands: A Policy Report for the Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy* (Dover, DE: University of Delaware, College of Agriculture and Natural Resources, Cooperative Extension, 2020), https://de.gov/climateplan.

155 Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship, *Delaware's Phase III Chesapeake Bay Watershed Implementation Plan*, by Delaware's Chesapeake Bay WIP Steering Committee (Dover, DE, August 2019), http://www.dnrec.delaware.gov/swc/district/Documents/ CB%20WIP/DE%20Phase%20III%20WIP%2008232019%20with%20appendices.pdf.

156 "Conservation Districts," *Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship*, accessed December 17, 2020, https://dnrec.alpha.delaware.gov/watershed-stewardship/conservation/districts.

157 DDA, Delaware Forest Service, *Delaware Statewide Forest Strategy*.

158 DNREC, *Delaware's Phase III Chesapeake Bay WIP*, by Delaware's Chesapeake Bay WIP Steering Committee.

159 DDA, Delaware Forest Service, *Delaware Statewide Forest Strategy*.

160 "Carbon Sequestration and Resiliency in Coastal Habitats," *Duke University, Nicholas Institute for Environmental Policy Solutions*, accessed November 18, 2020, https://nicholasinstitute.duke.edu/project/carbon-sequestration-and-resiliency-coastal-habitats.

161 Sara Gavin, "Forests of the Future: Researchers Map Maryland Forests' Potential to Store Carbon, Reduce Greenhouse Gas Emissions," *Maryland Today* (blog), *University of Maryland, Office of Strategic Communications*, April 18, 2019, https://today.umd.edu/articles/forests-future-78955b5c-5689-4c5c-8a36-ebab635a70b8.

162 "What is Resilience?," *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service*, last modified November 5, 2020, https://oceanservice.noaa.gov/facts/resilience.html.

163 DNREC, *Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise*.

164 DNREC, *Climate Framework for Delaware*.

165 Delaware Department of Natural Resources and Environmental Control, Division of Climate, Coastal and Energy, *Delaware Climate Resilience Actions Summary 2013-2020* (Dover, DE, 2021), https://de.gov/climateplan.

166 "Regulation Governing Beach Protection and the Use of Beaches," 7 *DE Admin. Code* 5102 (April 11, 2017), https://regulations.delaware.gov/AdminCode/title7/5000/5102.shtml.

167 *Beach Preservation*, 7 *Del. Laws*, c. 68, https://delcode.delaware.gov/title7/c068/index.shtml.

168 *Drainage of Lands and Management of Waters; Tax Ditches*, 7 *Del. Laws*, c. 41, https://delcode.delaware.gov/title7/c041/sc01/index.shtml.

169 "Delaware Dam Safety Regulations," 7 *DE Admin. Code* 5103 (December 11, 2009), https://regulations.delaware.gov/AdminCode/title7/5000/5103.shtml.

170 "Regulations Governing Hazardous Substance Cleanup," 7 *DE Admin. Code* 1375 (March 11, 2019), https://regulations.delaware.gov/AdminCode/title7/1000/1300/1375.shtml.

171 *Coastal Zone Act*, 7 *Del. Laws*, c. 70, https://delcode.delaware.gov/title7/c070/index.shtml.

172 "Regulations Governing Delaware's Coastal Zone," 7 *DE Admin. Code* 101 (September 11, 2009), https://regulations.delaware.gov/AdminCode/title7/100/101.shtml.

173 "Delaware Coastal Management Program Federal Consistency Policies and Procedures," 7 *DE Admin. Code* 2201 (November 11, 2018), https://regulations.delaware.gov/AdminCode/title7/2000/2201.shtml.

174 "Accidental Release Prevention Regulation," 7 *DE Admin. Code* 1201 (March 11, 2006), https://regulations.delaware.gov/AdminCode/title7/1000/1200/1201.shtml.

175 "Risk Management Plans (RMPs)," *Delaware Department of Natural Resources and Environmental Control, Division of Waste and Hazardous Substances*, accessed December 17, 2020, http://www.dnrec.delaware.gov/dwhs/EPR/Pages/RiskManagementPlans.aspx.

176 Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, "Chapter 2: Delaware's Wildlife Habitats" in *The Delaware Wildlife Action Plan 2015-2025* (Dover, DE, 2015), 38-174, http://www.dnrec.delaware.gov/fw/dwap/Documents/2015%20Submitted%20Documents/Chapter%202%20-%20reduced.pdf.

177 "Ecosystem Services," *National Wildlife Foundation*, accessed October 28, 2020, https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Ecosystem-Services.

178 *Wetlands*, 7 *Del. Laws*, c. 66, https://delcode.delaware.gov/title7/c066/index.shtml.

179 Philip Barnes and Kohei Akiba, *Delaware's Climate Change Programming: Evaluating Its Effectiveness and Impact on Local Resiliency* (Newark, DE: University of Delaware, Joseph R. Biden, Jr. School of Public Policy and Administration, August 2020), 25, https://udspace.udel.edu/bitstream/handle/19716/27749/ClimateChangeProgramming_2020.pdf.

180 Ganthier, "Equitable Adaptation Legal & Policy Toolkit: Introduction," accessed November 10, 2020.

181 Delaware Department of Natural Resources and Environmental Control, *Delaware Flood Planning Tool* (map), 2019, Scale not given, "FirstMap 2019," accessed October 28, 2020, https://maps.dnrec.delaware.gov/floodplanning/default.html.

182 Delaware Office of State Planning Coordination, *Delaware 2020 Strategies for State Policies and Funding* (Dover, DE, July 2020), https://stateplanning.delaware.gov/strategies/documents/2020-state-strategies.pdf.

183 DDA, Delaware Forest Service, *Delaware Statewide Forest Strategy*, 17.

184 Delaware Department of Natural Resources and Environmental Control, Division of Energy and Climate, *Energy Assurance Plan*, by Energy Planning Consultants, Inc., and The Olson Group, Ltd. (Dover, DE, February 2, 2011), http://www.dnrec.delaware.gov/energy/Documents/Delaware%20Energy%20Assurance%20Plan.pdf.

185 DSHS, DEMA, *State of Delaware All-Hazard Mitigation Plan*.

186 "Building Maintenance, Custodial and Grounds," *Delaware Office of Management and Budget, Division of Facilities Management*, accessed October 28, 2020, https://dfm.delaware.gov/maint/index.shtml.

187 DNREC, *Avoiding and Minimizing Risk of Flood Damage to State Assets*.

188 "Delaware's State Economic Development Agency," *Delaware Prosperity Partnership*, accessed December 17, 2020, https://www.choosedelaware.com/state-economic-development-agency.

189 *Insurance for the Protection of the State*, 18 *Del. Laws*, c. 65, https://delcode.delaware.gov/title18/c065/sc01/index.shtml.

190 "Climate Risk and Resilience Working Group," *National Association of Insurance Commissioners*, accessed November 10, 2020, https://content.naic.org/cmte_c_climate.htm.

191 "Summary for Policymakers," *IPCC*, last modified October 8, 2018.

192 Helen Mountford, Jan Corfee-Morlot, Molly McGregor, Ferzina Banaji, Amar Bhattacharya, Jessica Brand, Sarah Colenbrander, Ed Davey, Laëtitia de Villepin, Faustine Delasalle, Annabel Farr, Leonardo Garrido, Ipek Gençsü, Saira George, Catlyne Haddaoui, Leah Lazer, Nathaniel Mason, Jeremy Oppenheim, Rachel Spiegel, Lord Nicholas Stern, and Michael Westphal, "Report Summary" in *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times* (Washington, DC: The Global Commission on the Economy and Climate, 2018), https://newclimateeconomy.report/2018/executive-summary.

193 Michael I. Westphal, Dora Fazekas, and Leonardo Garrido, "Insider: 7 Things to Know About the Economic Analysis of the New Climate Economy 2018 Report," *Insights* (blog), *World Resources Institute*, January 30, 2019, https://www.wri.org/blog/2019/01/insider-7-things-know-about-economic-analysis-new-climate-economy-2018-report.

194 Lisa Anne Hamilton, "Equitable Adaptation Legal & Policy Toolkit: Governance & Budgeting," *Georgetown University, Georgetown Law, Georgetown Climate Center*, accessed November 10, 2020, https://www.georgetownclimate.org/adaptation/toolkits/equitable-adaptation-toolkit/governance-budgeting.html.

195 Peddrick Weis, "Salt Marsh Accretion" in *Encyclopedia of Estuaries*, Encyclopedia of Earth Sciences, ed. Michael J. Kennish (Dordrecht: Springer, 2016), https://doi.org/10.1007/978-94-017-8801-4_28.

196 "Glossary," *U.S. Climate Resilience Toolkit*, accessed November 10, 2020, https://toolkit.climate.gov/content/glossary.

197 "Alternative Fuels," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*, accessed November 10, 2020, https://www.fueleconomy.gov/feg/current.shtml.

198 "Basic Information About Anaerobic Digestion (AD)," *U.S. Environmental Protection Agency*, last modified July 27, 2020, https://www.epa.gov/anaerobic-digestion/basic-information-about-anaerobic-digestion-ad.

199 "Disaster Behavioral Health," *U.S. Department of Health and Human Services, Office of the Assistant Secretary for Preparedness and Response*, last modified September 8, 2020, https://www.phe.gov/Preparedness/planning/abc/Pages/disaster-behavioral.aspx.

200 "What are BMPs?," *North Carolina Forest Service*, last modified March 6, 2017, accessed November 10, 2020, https://ncforestservice.gov/water_quality/what_are_bmps.htm.

201 "Basic Information About Nonpoint Source (NPS) Pollution," *U.S. Environmental Protection Agency*, last modified October 7, 2020, https://www.epa.gov/nps/basic-information-about-nonpoint-source-nps-pollution.

202 David E. Alexander, "Ecological Stress" in *Environmental Geology*, Encyclopedia of Earth Science (Dordrecht: Springer, 1999), https://doi.org/10.1007/1-4020-4494-1_94.

203 "Bond Rating," *Investopedia*, last modified March 25, 2020, https://www.investopedia.com/terms/b/bondrating.asp.

204 "Seismic Building Codes," *U.S. Department of Homeland Security, Federal Emergency Management Agency*, last modified October 13, 2020, https://www.fema.gov/emergency-managers/risk-management/earthquake/seismic-building-codes.

205 "Fact Sheet: Cap-and-Invest as a Tool to Reduce Pollution," *TCI*, accessed November 10, 2020.

206 "Carbon Accounting 101," *Environmental Defense Fund, Supply Chain Solutions Center*, accessed November 10, 2020, https://supplychain.edf.org/resources/carbon-accounting.

207 "Carbon Dioxide," *National Aeronautics and Space Administration, Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/vital-signs/carbon-dioxide.

208 Jennifer Volk, *Delaware's Natural and Working Lands*.

209 Jennifer Volk, *Delaware's Natural and Working Lands*.

210 "Overview: Weather, Global Warming and Climate Change," *National Aeronautics and Space Administration, Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/resources/global-warming-vs-climate-change.

211 "Overview: Weather, Global Warming and Climate Change," *NASA*, accessed November 10, 2020.

212 "Our Changing Ocean," *U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Ocean Acidification Program*, accessed November 10, 2020, https://oceanacidification.noaa.gov/OurChangingOcean.aspx.

213 "What are Combined Sewer Overflows (CSOs)?," *U.S. Environmental Protection Agency, Region 1*, last modified April 10, 2017, https://www3.epa.gov/region1/eco/uep/cso.html.

214 "Community and Shared Solar," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*, accessed November 10, 2020, https://www.energy.gov/eere/solar/community-and-shared-solar.

215 "What is a Conservation Easement?," *National Conservation Easement Database*, accessed October 29, 2020, https://www.conservationeasement.us/what-is-a-conservation-easement.

216 U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Environmental Health, Division of Environmental Hazards and Health Effects, *The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation*, by Stasia Widerynski, Paul Schramm, Kathryn Conlon, Rebecca Noe, Elena Grossman, Michelle Hawkins, Seema Nayak, Matthew Roach, and Asante Shipp Hilts, Climate and Health Technical Report CS280845-A (Atlanta, August 2017), 4, https://www.cdc.gov/climateandhealth/docs/UseOfCoolingCenters.pdf.

217 Andy Clark, "Cover Crops," *Sustainable Agriculture Research and Education*, accessed November 10, 2020, https://www.sare.org/resources/cover-crops.

218 ICF, *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis*, 6.

219 "Distributed Generation of Electricity and Its Environmental Impacts," *U.S. Environmental Protection Agency*, last modified March 13, 2018, https://www.epa.gov/energy/distributed-generation-electricity-and-its-environmental-impacts.

220 "Ecosystem Services," *National Wildlife Foundation*, accessed October 28, 2020.

221 "Explaining Electric & Plug-In Hybrid Electric Vehicles," *U.S. Environmental Protection Agency*, last modified October 29, 2020, https://www.epa.gov/greenvehicles/explaining-electric-plug-hybrid-electric-vehicles.

222 ICF, *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis*, 6.

223 "Why Building Energy Codes?," *U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy*, last modified November 21, 2016, https://www.energycodes.gov/about/why-building-energy-codes.

224 ICF, *Delaware Climate Action Plan Supporting Technical Greenhouse Gas Mitigation Analysis*, 6.

225 "Energy Storage," *U.S. Department of Energy, Office of Electricity*, accessed November 10, 2020, https://www.energy.gov/oe/energy-storage.

226 "What is Epidemiology?," *U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Deputy Director for Public Health Science and Surveillance, Center for Surveillance, Epidemiology, and Laboratory Services, Division of Scientific Education and Professional Development*, last modified June 17, 2016, https://www.cdc.gov/careerpaths/k12teacherroadmap/epidemiology.html.

227 "The Equity Manifesto," *PolicyLink*, accessed November 2, 2020, https://www.policylink.org/about-us/equity-manifesto.

228 Matt Fromer, "Cracking the Code on EV-Ready Building Codes," *Southwest Energy Efficiency Project*, last modified October 23, 2018, https://www.swenergy.org/cracking-the-code-on-ev-ready-building-codes.

229 "Evaluation, Measurement and Verification," *DNREC*, accessed November 10, 2020.

230 "Water Q&A: What Causes Fish Kills?," *U.S. Department of the Interior, U.S. Geological Survey*, accessed November 10, 2020, https://www.usgs.gov/special-topic/water-science-school/science/water-qa-what-causes-fish-kills?qt-science_center_objects=0#qt-science_center_objects.

231 "Forest Buffers," *Chesapeake Bay Program*, accessed November 10, 2020, https://www.chesapeakebay.net/issues/forest_buffers.

232 Ganthier, "Equitable Adaptation Legal & Policy Toolkit: Introduction," accessed November 10, 2020.

233 U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, National Renewable Energy Laboratory, "Grid Coordination Opens Road for Electric Vehicle Flexibility: Unlocking the Value of Electric Mobility Technologies to Drive Efficiency and Reliability Across the Power System," News release, August 3, 2020, https://www.nrel.gov/news/features/2020/grid-coordination-opens-road-for-electric-vehicle-flexibility.html.

234 "Ground-Level Ozone Basics," *U.S. Environmental Protection Agency*, last modified September 10, 2020, https://www.epa.gov/ground-level-ozone-pollution/ground-level-ozone-basics.

235 "Hazard Mitigation Assistance Grants," *U.S. Department of Homeland Security, Federal Emergency Management Agency*, last modified September 30, 2020, https://www.fema.gov/grants/mitigation.

236 "Heat Island Effect," *U.S. Environmental Protection Agency, Heat Island Reduction Program*, last modified December 9, 2020, https://www.epa.gov/heatislands.

237 "Understanding Global Warming Potentials," *U.S. Environmental Protection Agency, Climate Change Division*, last modified September 9, 2020, https://www.epa.gov/ghgemissions/understanding-global-warming-potentials.

238 "High-Tide Flooding," *U.S. Climate Toolkit*, last modified July 1, 2020, https://toolkit.climate.gov/topics/coastal-flood-risk/shallow-coastal-flooding-nuisance-flooding.

239 "Reducing Hydrofluorocarbon (HFC) Use and Emissions in the Federal Sector through SNAP," *U.S. Environmental Protection Agency*, last modified April 8, 2020, https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap.

240 "Fuel Cell Electric Vehicles," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office*, accessed November 10, 2020, https://afdc.energy.gov/vehicles/fuel_cell.html.

241 M.J. Bradley & Associates, LLC, *Electric Vehicle Charging Interoperability*, MJB&A Issue Brief (Concord, MA, May 13, 2019), 1, https://mjbradley.com/sites/default/files/MJB%26A%20Interoperability%20Issue%20Brief%20May%202019.pdf.

242 "National Invasive Species Information Center (NISIC)," *U.S. Department of Agriculture, National Agriculture Laboratory*, accessed October 30, 2020, https://www.invasivespeciesinfo.gov.

243 "About Living Shorelines," *Delaware Living Shorelines Committee*, accessed October 30, 2020, https://www.delawarelivingshorelines.org/what-is-a-living-shoreline.

244 "Low Carbon Fuel Standard," *CalEPA, CARB*, accessed November 10, 2020.

245 Katie Spidalieri and Annie Bennett, "Managed Retreat Toolkit: Introduction," *Georgetown University, Georgetown Law, Georgetown Climate Center*, accessed November 10, 2020, https://www.georgetownclimate.org/adaptation/toolkits/managed-retreat-toolkit/introduction.html.

246 "Importance of Methane," *U.S. Environmental Protection Agency*, last modified October 22, 2020, https://www.epa.gov/gmi/importance-methane.

247 Library of Congress, Congressional Research Service, *Methane Capture: Options for Greenhouse Gas Emission Reduction*, by Kelsi Bracmort, Jonathan L. Ramseur, James E. McCarthy, Peter Folger, and Donald J. Marples, CRS Report for Congress 7-5700 R40813 (Washington, DC, January 7, 2011), Summary par. 2, https://fas.org/sgp/crs/misc/R40813.pdf.

248 Allison Lantero, "How Microgrids Work," *U.S. Department of Energy*, last modified June 17, 2014, https://www.energy.gov/articles/how-microgrids-work.

249 "Make Way for Marshes," *Northeast Regional Ocean Council*, accessed November 10, 2020, https://www.northeastoceancouncil.org/committees/coastal-hazards-resilience/resilient-shorelines/make-way-for-marshes.

250 "Vehicle-Miles Traveled (VMT) Fees," *U.S. Department of Transportation, Federal Highway Administration, Center for Innovative Finance Support*, accessed November 10, 2020, https://www.fhwa.dot.gov/ipd/tolling_and_pricing/defined/vmt.aspx.

251 Jennifer Volk, *Delaware's Natural and Working Lands*.

252 Kelly Levin and Chantal Davis, "What Does 'Net-Zero' Mean? 6 Common Questions, Answered," *Insights* (blog), *World Resources Institute*, September 17, 2020, https://www.wri.org/blog/2019/09/what-does-net-zero-emissions-mean-6-common-questions-answered.

253 World Resources Institute, *Explainer: What is Carbon Removal?*, September 7, 2018, YouTube, 0:48, https://www.youtube.com/watch?v=zhPFrAI4Ino.

254 Public Awareness Committee, *Do You Have a Weed, Noxious Weed, Invasive Weed or "Superweed"?: Simple Distinctions Make All the Difference*, WSSA Fact Sheet (Westminster, CO: Weed Science Society of America, January 2016), par. 4, https://wssa.net/wp-content/uploads/WSSA-Weed-Science-Definitions.pdf.

255 "Our Changing Ocean," *NOAA*, accessed November 10, 2020.

256 Liz Hartman, "Top 10 Things You Didn't Know About Offshore Wind Energy," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*, last modified October 8, 2020, https://www.energy.gov/eere/wind/articles/top-10-things-you-didn-t-know-about-offshore-wind-energy.

257 "Explaining Electric & Plug-In Hybrid Electric Vehicles," *U.S. EPA*, last modified October 29, 2020.

258 Delaware Department of Finance, Division of Revenue, *State of Delaware Tax Preference Report: 2019 Edition*.

259 "Scientific Consensus: Earth's Climate is Warming," *NASA*, accessed November 10, 2020.

260 "About 60% of the U.S. electric power supply is managed by RTOs," *Today in Energy* (blog), *U.S. Department of Energy, Energy Information Administration*, April 4, 2011, https://www.eia.gov/todayinenergy/detail.php?id=790.

261 U.S. Department of Labor, Bureau of Labor Statistics, *Careers in Environmental Remediation*, by James Hamilton, Green Jobs Report 8 (Washington, DC, September 2012), 1, https://www.bls.gov/green/environmental_remediation/remediation.pdf.

262 "Renewable Energy Explained," *U.S. Department of Energy, Energy Information Administration*, last modified June 22, 2020, https://www.eia.gov/energyexplained/renewable-sources.

263 "Renewable Energy Certificates (RECs)," *U.S. Environmental Protection Agency*, last modified May 13, 2019, https://www.epa.gov/greenpower/renewable-energy-certificates-recs.

264 U.S. Environmental Protection Agency, *RECs: Making Green Power Possible*, uploaded March 27, 2015, YouTube, 1:18, https://www.youtube.com/watch?v=_12VYXms6-c.

265 "Renewable Portfolio Standards," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, National Renewable Energy Laboratory*, accessed November 10, 2020, https://www.nrel.gov/state-local-tribal/basics-portfolio-standards.html.

266 "Renewable Energy Portfolio Standards," *DNREC*, accessed February 18, 2021.

267 "Renewable Natural Gas Production," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office*, accessed November 10, 2020, https://afdc.energy.gov/fuels/natural_gas_renewable.html.

268 "What is Resilience?," *NOAA*, last modified November 5, 2020.

269 U.S. Environmental Protection Agency, Climate Ready Estuaries Program, Rolling Easements, by James G. Titus, EPA 430-R-11-001 (Washington, DC, June 2011), iii, https://www.epa.gov/sites/production/files/documents/rollingeasementsprimer.pdf.

270 D. L. T. Bale, C. Ugwu, and E. O. Nwachukwu, "Route Optimization Techniques: An Overview," *International Journal of Scientific & Engineering Research* 7, no. 11 (2016): 1367-1372, https://www.ijser.org/researchpaper/ROUTE-OPTIMIZATION-TECHNIQUES-AN-OVERVIEW.pdf.

271 U.S. Environmental Protection Agency, SmartWay Transport Partnership, *Route & Network Optimization for Shippers: A Glance at Clean Freight Strategies*, EPA 420-F-19-016 (Ann Arbor, March 2019), iii, https://www.epa.gov/sites/production/files/2019-07/documents/420f19016.pdf.

272 "Sea Level," *National Aeronautics and Space Administration, Jet Propulsion Laboratory*, accessed November 10, 2020, https://climate.nasa.gov/vital-signs/sea-level.

273 Sallenger, Jr., et al., "Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America."

274 "Stretch Codes," *New Buildings Institute*, accessed November 10, 2020, https://newbuildings.org/code_policy/utility-programs-stretch-codes/stretch-codes.

275 "Stretch Code Development," *Rhode Island Office of Energy Resources*, accessed November 10, 2020, http://www.energy.ri.gov/policies-programs/lead-by-example/case-studies/stretch-code-development.php.

276 *Subaqueous Lands*, 7 *Del. Laws*, c.72, § 7202, https://delcode.delaware.gov/title7/c072/index.shtml.

277 "Learn About Sustainability," *U.S. Environmental Protection Agency*, last modified November 18, 2020, https://www.epa.gov/sustainability/learn-about-sustainability.

278 "Tax Ditch Program," *Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship*, accessed November 10, 2020, https://dnrec.alpha.delaware.gov/watershed-stewardship/drainage/tax-ditches.

279 "Telecommuting," *Cambridge University Press, Cambridge Dictionary*, accessed November 10, 2020, https://dictionary.cambridge.org/dictionary/english/telecommuting.

280 "What are TOU Rates?," *California Public Utilities Commission*, accessed November 10, 2020, https://www.cpuc.ca.gov/general.aspx?id=12194.

281 "Toxicology Curriculum for Communities Trainer's Manual: Module 1 - Lecture Notes," *U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry*, last modified September 1, 2015, https://www.atsdr.cdc.gov/training/toxmanual/modules/1/lecturenotes.html.

282 Paul D. Gottlieb, "What is a Transfer of Development Rights (TDR) Program," *Rutgers University, New Jersey Agricultural Experiment Station Rutgers*, accessed November 2, 2020, https://njaes.rutgers.edu/highlands/transfer-development-rights.php.

283 "Travel Demand Management," *European Union Smart Cities Information System*, accessed November 10, 2020, https://smartcities-infosystem.eu/ict/travel-demand-management.

284 "Renewable Energy: Utility-Scale Policies and Programs," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*, accessed November 10, 2020, https://www.energy.gov/eere/slsc/renewable-energy-utility-scale-policies-and-programs.

285 "Vector-Borne Diseases," *World Health Organization*, last modified March 2, 2020, https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases.

286 "V2G Home," *University of Delaware, College of Earth, Ocean & Environment*, accessed November 10, 2020, http://www1.udel.edu/V2G.

287 "Waterborne Diseases," *U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Environmental Health Sciences*, accessed November 10, 2020, https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/waterborne_diseases/index.cfm.

288 "Overview: Weather, Global Warming and Climate Change," *NASA*, accessed November 10, 2020.

289 "Definition of 'Weatherization' for Single-Family Residential Units," *Connecticut Department of Energy and Environmental Protection, Bureau of Energy and Technology Policy*, accessed November 10, 2020, https://portal.ct.gov/DEEP/Energy/Weatherization/Weatherization-Definition-in-CT.

290 "Weatherize," *U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy*, accessed November 10, 2020, https://www.energy.gov/energysaver/weatherize.

291 "How Wetlands are Defined and Identified Under CWA Section 404," *U.S. Environmental Protection Agency*, last modified April 15, 2019, https://www.epa.gov/cwa-404/how-wetlands-are-defined-and-identified-under-cwa-section-404.

292 "Zero-Emission Vehicles Help Fight Climate Change," *Transport Canada*, last modified January 31, 2020, https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles.

Photo credit: Adobe Stock

DELAWARE'S
Climate Action Plan

de.gov/climateplan