THE FUTURE OF BUILDINGS

New York's Carbon Neutral Buildings Roadmap

Executive Summary

DECEMBER 2022

NEW YORK STATE

NEW YORK STATE | NYSERDA

Our Vision

New York is a global climate leader building a healthier future with thriving communities; homes and businesses powered by clean energy; and economic opportunities accessible to all New Yorkers.

Our Mission

Advance clean energy innovation and investments to combat climate change, improving the health, resiliency, and prosperity of New Yorkers and delivering benefits equitably to all.

Our Promise

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Introduction

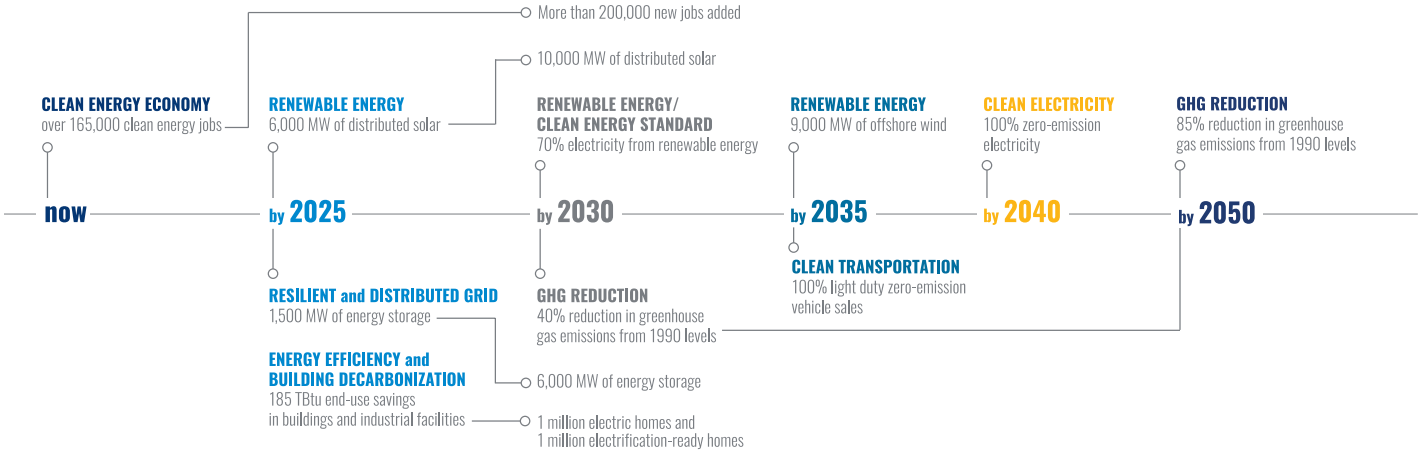
Equitable access to high-quality, clean and resilient spaces where we live, work, and play is fundamental to a healthy and sustainable society, and represents the **Future of Buildings** in New York State.

Direct emissions from buildings today account for roughly one-third of greenhouse gas emissions in New York State, driven predominantly by fossil fuel-based space and hot water heating.[1] When adding the emissions attributable to generating the electricity used in buildings, that figure rises to over 40%. Decarbonizing buildings at scale will be essential to meet the State's mandate to reduce its economywide greenhouse gas emissions 85% by 2050, while providing a once-in-a-lifetime opportunity to make our buildings and spaces safer, healthier, and more comfortable, affordable, and resilient.

Over the next three decades, existing buildings will inherently require new heating and cooling systems, roofs and insulation, domestic hot water systems, and other potential efficiency and weatherization upgrades as current equipment, systems and materials reach their end of useful life. Rather than just replacing like-for-like, these milestones are key opportunities to invest in better equipment, materials, and measures to transform and modernize our aging building stock in ways that improve the experiences of the people that live and interact within them, while significantly reducing overall energy consumption and eliminating greenhouse gas emissions. For new buildings, technologies are available and ready today to design and build spaces that are clean, healthy, and affordable.

Built upon years of rigorous analysis, programmatic development, and stakeholder outreach and feedback, the first report in a new series, NYSERDA's **Future of Buildings,** is the *Carbon Neutral Buildings Roadmap* (the "Roadmap"), which lays out a guiding framework and general solution set for the critical work that must be undertaken to modernize New York State's building stock while reducing, and in most cases eliminating, their use of fossil fuels. The *Roadmap* provides a long-term vision of the built environment in 2050, including recommendations on key policies, potential focus areas for technology advancement and programmatic needs, while also highlighting the near-term actions that are technologically ready, economically viable, and are being adopted in the market today.

CLIMATE ACT TARGETS AND TIMING



New York State's clean energy goals are defined by the Climate Leadership and Community Protection Act (Climate Act). The law calls for 85% reduction in greenhouse gas (GHG) emissions by 2050, and a 40% reduction in emissions by 2030. In addition, the Climate Act includes targets for clean electricity, renewable energy, energy efficiency, and grid resilience. See Figure 1.1 on page 14 of the full *Roadmap*.

The *Roadmap* emphasizes the need to reduce the cost of decarbonization measures. It also lays out a number of critical activities that the State and private industry must undertake to achieve the cost reduction, including workforce development; expansive outreach for consumer education; and awareness to build market demand for an equitable clean energy transition. The recommendations in the *Roadmap* will require partnerships with other State agencies and authorities as well as local governments, academic institutions, the real estate industry, and a broad array of other organizations.

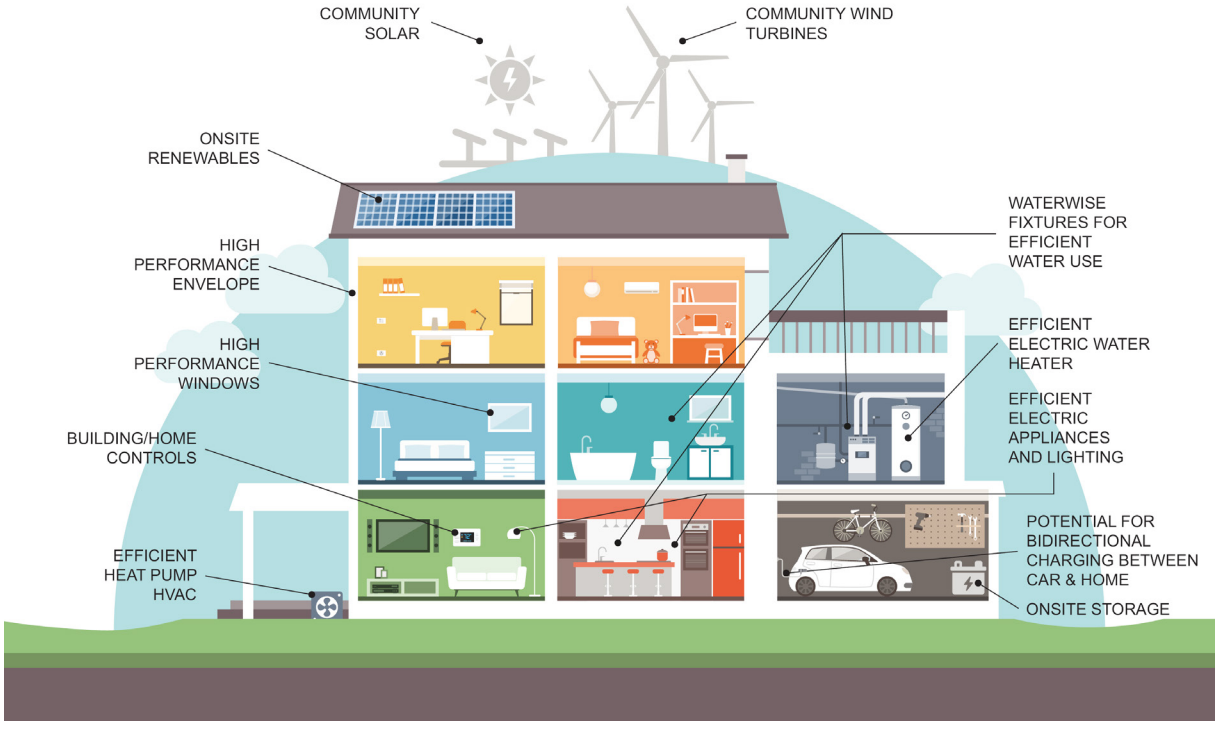
The *Carbon Neutral Buildings Roadmap* will be supplemented by a second report in NYSERDA's **Future of Buildings** series, the *Building Electrification Roadmap*. The draft report, which will be released in early 2023, focuses specifically on strategies and actions to scale heat pump adoption paired with thermal efficiency—between now and 2030—at a pace required to meet the State's 2050 climate goals.

Lastly, NYSERDA's **Future of Buildings** series will include the release of the *Two Million Climate Friendly Homes Draft Action Plan* in early 2023. This Action Plan will utilize the broad findings of the *Roadmap* and the modeled scenarios from the *Building Electrification Roadmap*. It will operationalize a path to achieving efficiently electrifying at least 1 million New York homes and making another 1 million homes electrification-ready by 2030.

What is a Carbon Neutral Building?

The *Roadmap* defines a carbon neutral building as a highly energy efficient building whose design, construction, and operations do not contribute to emissions of carbon and other greenhouse gases (GHG) that contribute to climate change.

A CARBON NEUTRAL SINGLE-FAMILY HOME



This carbon neutral home is highly energy efficient (with particular focus on building envelope efficiency and water efficiency to reduce thermal loads) has all-electric appliances and equipment, a high performance envelope, onsite renewable energy generation and battery storage, and is grid integrated. See Figure 2.1 on page 22 of the full *Roadmap*.

Specific attributes that characterize a carbon neutral building include:

- **Maximizes energy efficiency** potential, especially for thermal (heating, cooling and domestic hot water) needs.
- **Has no on-site fossil fuel combustion** for building operations, however, does allow for emergency generators and process loads to continue to be fossil fuel-based.
- **Produces or procures zero-emission electricity**[2] for its electric needs.
- **Is designed with energy use flexibility,** or the ability to reduce or shift electricity demand when needed to support and respond to electric grid conditions (e.g. via distributed energy resources, such as solar and battery or thermal storage, or flexible equipment such as programmable hot water heaters and other appliances).

Carbon neutral buildings also include features that enhance the resiliency of the building, better protecting occupants and critical building systems and components. Improved health, safety, comfort, and productivity are also important outcomes of a carbon neutral building. These buildings should also reduce embodied carbon in building materials and construction activities, and utilize a reduced volume of low Global Warming Potential (GWP) refrigerants when and where available.

This *Roadmap* focuses on four priority building types—single-family residential, multifamily residential (low and mid-rise), office (low and mid-rise), and higher education (dorms and classrooms). Future research needs may include additional building types including tall buildings, schools, hospitals, hospitality, and retail facilities. Other cross-cutting issues should be addressed, as well as an increased focus on how to reduce and manage embodied carbon in building materials and the GWP associated with the use and leakage of refrigerants. Accordingly, the *Roadmap* may be updated periodically, or additional information on building decarbonization published as needed. NYSERDA is already working hard to find solutions that were not the primary focus of the *Roadmap* through initiatives including the Buildings of Excellence, Carbon Neutral Communities for Economic Development, Clean Green Schools, the Empire Buildings Challenge, and the recent release of the Empire Building Playbook for very tall commercial buildings.

Kathleen Grimm School for Leadership and Sustainability at Sandy Ground. New York, NY. *Photo Courtesy of SOM*

Current Opportunities and Market Development Needs

The clearest current path to a carbon neutral built environment in New York State is through a focus on efficiency first, followed by the electrification of the highly efficient building, and coupled with the State's ongoing decarbonization of the electric grid.

For the most difficult building-related systems to decarbonize (e.g. industrial processes, existing district steam systems like the one in New York City), low-carbon fuels could play a role in the future. But there is significant uncertainty regarding availability and cost of supply, as well as how a potentially limited supply should be prioritized across buildings and other sectors economywide.

Modernizing and decarbonizing our buildings creates a diverse set of benefits. Traditional energy-related work in buildings has focused on energy efficiency and the resulting simple payback of initial project capital costs from lower utility bills. However, clean and resilient buildings generate a number of benefits far beyond the traditional energy efficiency and simple payback paradigm. This more comprehensive set of benefits (health, comfort, productivity, safety, and resiliency) are frequently what home and building owners and occupants cite as the primary drivers for building, modernizing, renovating, and operating clean and resilient buildings.

- **Reducing energy consumption and emissions:** New York's transition to carbon-neutral buildings will result in significant reductions in overall emissions and energy consumption from the State's building stock and can also reduce operating costs and utility bills for New Yorkers under various scenarios.

- **Improved health and living/working environment:** The reduction or elimination of onsite fossil fuel combustion, improved filtered ventilation, and mitigation of pest infestation through weatherization measures improve indoor air quality. Furthermore, reducing onsite fossil fuel combustion also improves neighborhood outdoor air quality. Additional air quality benefits are driven by electric efficiency (e.g. such as more efficient cooling) and load flexibility measures, which can reduce usage of fossil fuel-burning power plants. In fact, pollution from fuel combustion in residential and commercial buildings in New York led to an estimated 1,940 premature deaths and totaled $1.7 billion in health impacts in 2017.[3]

- **Better comfort, productivity, and cognitive outcomes:** Improved indoor air quality, increased thermal comfort, lower noise levels from window replacement and other envelope improvements, improved mechanical systems, better indoor lighting, and access to daylight create more comfortable environments allowing for increased productivity and cognitive outcomes. In fact, one study showed workers in green, well-ventilated offices recorded a 101% increase in cognitive scores (brain function).[4]

- **Increased safety:** Switching to all-electric space heating, water heating, and other appliances reduces the risk of carbon monoxide poisoning and gas leaks. The use of induction stove tops also reduces the risk of burns and kitchen fires.

- **Improved resiliency:** High performance envelope measures offer resiliency benefits such as an extended ability of a building to maintain comfortable and safe temperatures during power outages. Onsite solar, energy storage, and load flexibility control solutions, especially if broadly deployed in regions and neighborhoods, can provide protection against brownouts, blackouts, and utility shutoffs.

- **Maximizing usage of building space:** Some modern, all-electric buildings will end up using less space dedicated to heating and other equipment than the current solutions deployed in

the typical mid-rise multifamily buildings, freeing up space for other uses. For example, mounting air source heat pumps (ASHPs) high on walls can free up space currently occupied by radiators and window-mounted air conditioners.

There are a growing number of use cases where building decarbonization is economically viable today based solely on the resulting energy and maintenance savings. For example, new construction projects; adaptive reuse in many instances; and the conversion of certain existing buildings that currently heat with oil, propane, or electric resistance systems.

There are numerous decarbonization solutions in the market for a number of building types that can be implemented today and provide straightforward economic returns, meet performance needs, and are reliable. These solutions include and prioritize various energy and water efficiency measures, as well as efficient electric heating and cooling equipment (e.g. cold-climate air source heat pumps, ground and water source heat pumps).

Some advanced developers and design teams with more high performance building experience report that they are able to deliver carbon neutral new construction projects at or near initial construction cost parity with business-as-usual fossil fuel projects, while also benefiting from the improved health, comfort, safety, resiliency, and productivity that these homes and buildings provide. In many other cases, however, it is the full value (including these co-benefits) of the homes or buildings over their respective lifetimes that tip decision makers toward proceeding with carbon neutral projects.

Retrofits of existing buildings are usually more costly and complex than new construction, which is not a situation unique to energy-related projects. These higher retrofit costs can be caused by the age and diversity of building stock, and the variety in existing baseline conditions found in New York such as the type of existing heating and distribution system, size of electric service/panel or distribution lines, extent of occupant disruption, and environmental remediation needed for both weatherization and electrification.

Notwithstanding these higher retrofit costs, conversions of many existing buildings from oil and propane-based heating fuels or electric resistance heating systems to efficient heat pumps can also provide market-acceptable returns through lower operating costs based on energy bill savings.

Attributes of a Carbon Neutral Building

These attributes focus upon the building, the impact of that building on the electric grid, and the value of infrastructure as an investment. A carbon neutral building in New York should focus on the following attributes:

Maximizes **energy efficiency,** especially to reduce thermal needs.

No fossil fuel combustion for building services or other appliances onsite (all-electric end uses).*

Produces or procures **zero-emission electricity** consistent with the Climate Act.

Designed with flexible loads and real-time control strategies and/or storage that can respond to grid conditions.

Features **resiliency measures** that protect buildings and occupants.

Designed and operated with the **health, wellness, comfort, and productivity** of occupants as a priority.

* It should be noted that a building can achieve carbon neutrality using low-carbon fuels like renewable natural gas or hydrogen, but that those fuels are projected to be in very limited supply and utilized primarily for harder sectors of the economy to electrify. See **Chapter 6: Limits to Electrification** for discussion of the approaches to hard-to-electrify building types and sectors.

See **Chapter 8: The Economics, Benefits, and Challenges for Carbon Neutral Buildings** for a more complete discussion of costs and benefits of carbon neutral design, construction, and renovation.

However, at current gas and electric commodity price levels, more work is needed to reduce the incremental cost of electrification projects over business-as-usual natural gas heating system replacements in order for natural gas-to-heat-pump conversions, in many circumstances, to meet traditional simple payback tests for energy efficiency (which only include projected energy bill savings over a certain period as the benefit, measured against the initial installation cost).

The *Roadmap* recommends tackling this issue of economics from two directions:

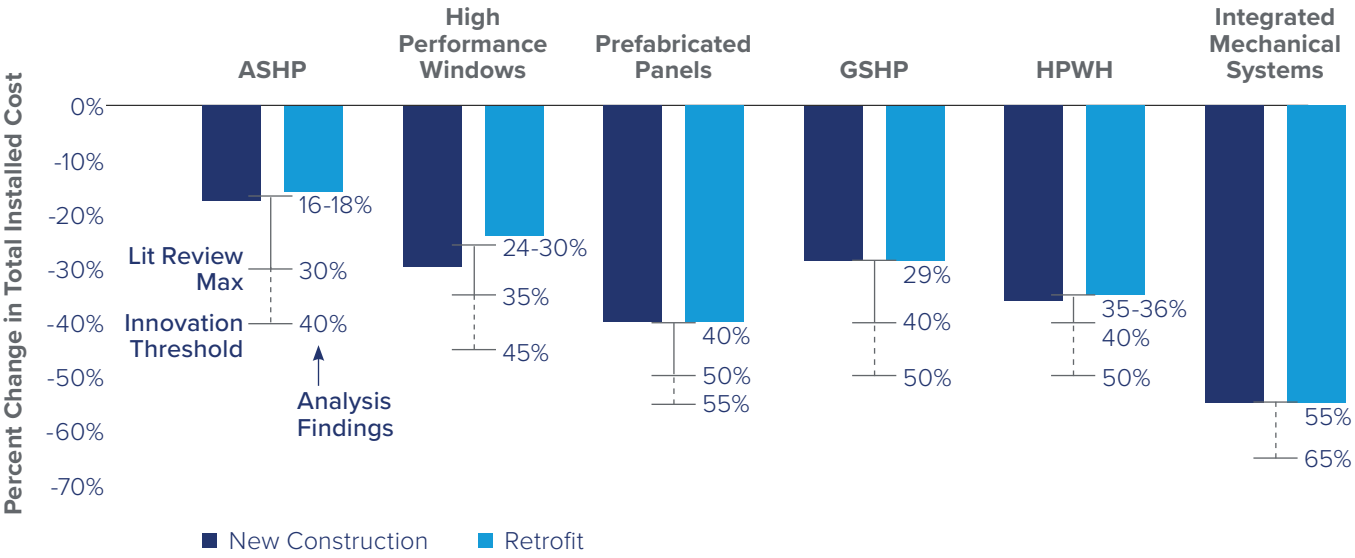
1. Costs can also be decreased by increasing demand through consumer awareness, technological innovation, workforce development, integrated design processes, expansion of incentives, and low-cost financing mechanisms.

2. The second approach is to better understand, quantify, and potentially monetize the individual and societal co-benefits of health, safety, productivity, comfort, resiliency, and GHG reductions described above. Many building owners, developers and design teams who are already successfully building and renovating carbon neutral homes and buildings rely on business models that value these co-benefits. In rental properties, for instance, these factors can help drive faster initial lease-up rates, lower resident turnover, and potentially higher rental rates, which combine with more predictable operating costs to produce higher net operating income.

For example, NYSERDA and the NYS Department of Health are currently undertaking a healthy homes pilot, focused on proving out the health benefits—primarily reduction in respiratory ailments—from complete home interventions including weatherization and electrification in certain circumstances, with the aim of leveraging Medicaid as a co-funding source for these improvements.

As noted above, New York State has work to do to lower the upfront incremental cost of electrification

COST COMPRESSION POTENTIAL BY 2040 FOR KEY DECARBONIZATION TECHNOLOGIES



Based on analysis findings, capital costs for nearly all technologies are anticipated to drop by at least 30% by 2040 as the market scales. Innovation could further decrease costs for a total capital cost reduction between 40-65%, depending on the technology.

The most significant drop is likely in Integrated Mechanical Systems (unitized, combined HVAC and water heating systems)—these are only applicable to residential typologies and are not yet commercially available in the U.S. Maximum found in literature is based on highest values cited from both academic/industry review and interviews with manufacturers. Not all literature or interviews were New York specific. Innovation threshold is based either on identified threshold for widespread adoption in literature or discussion with NYSERDA stakeholders on "moonshot" goals. See Figure 8.12 on page 114 of the full *Roadmap*.

projects in existing buildings over business-as-usual equipment replacements, in particular for buildings heating with gas. In the meantime, the *Roadmap* recognizes that managing the costs of electrification in existing buildings warrants planning and a phased approach, especially to support affordability and benefits for low- and moderate-income (LMI) households and disadvantaged communities.

Ongoing electrification initiatives are targeting market opportunities that have stronger economic returns, notably high performance new construction, adaptive reuse, and retrofit of homes and buildings currently heating with oil, propane, or electric resistance systems. These initial phases of clean heating and resiliency work will help develop market capacity, which in turn will help reduce the upfront costs of decarbonization for other parts of the market. Looking to 2030, the *Building Electrification Roadmap* is exploring what level of expansion of public financial incentives would motivate rapid increases in the market share of efficient electrification in existing homes and businesses.

The technologies needed to decarbonize New York's buildings are largely available today. However, innovation in equipment performance and design, as well as cost compression across a range of technologies, is needed to scale up adoption.

Reaching our carbon neutrality goal in the most cost-effective manner is dependent on innovation—bringing new technology into the forefront, adapting existing technologies to New York and national markets, and innovating on business and financial models. The *Roadmap* examined solutions from around the world to identify and prioritize a set of key technology development needs that are focused on improving performance, reducing cost, and filling gaps, in particular for existing buildings and residents of underserved and marginalized communities. NYSERDA should focus on removing the barriers that prevent the import and adaptation to the U.S. market of a number of clean building technologies that are already being adopted in Europe and Asia but are not currently available in New York or the U.S. Areas of opportunity include:

- Heat pumps, integrated mechanical systems, geothermal system wellfield drilling, windows and prefabricated panels (integrated wall/roof assemblies), are likely to reduce in cost due to improved manufacturing, scale and/or experience with solutions.
- Integrated mechanical systems (40% expected cost reduction by 2025, 55 % by 2030), and batteries (20% cost reduction expected by 2025, 38% by 2030) are the fastest advancing key technologies with the shortest projected cost reduction timeframes.
- Critical consideration for ongoing research and development and innovation are:
  - low global warming potential refrigerants; and
  - software and hardware systems, communication standards and protocols, and a more robust and modernized market to advance the use of building-to-grid interactivity and communications.

Critical Cross-Cutting Issues

Modernizing and decarbonizing New York's building stock is a transformative opportunity to touch upon all aspects of the economy and society that interact with our built environment and to "build it better" than we have in the past, including addressing historical inequities.

This applies not only to buildings themselves, but more importantly, to the residents that live, work, and play within them and the workers that design, build, operate and maintain them.

Addressing affordability for, and prioritizing investments toward, historically underserved and marginalized communities is essential to an equitable buildings transition and a resilient economy and society.

Direct government actions and support should prioritize equitable access to clean, resilient, and high-quality living, work, and recreation spaces for communities on the front lines of the climate crisis and historically marginalized and underserved communities, including LMI families. New York State recognizes that certain communities have borne a disproportionate negative impact from the injustices and burdens of our current fossil-fuel based economy. Not surprisingly, these residents and communities are also often the ones at greatest risk from climate change impacts, and are the same communities that lack the resources to proactively make the investments needed to modernize and decarbonize buildings.

The Climate Act requires at least 35%, with a target of 40%, of the benefits of New York's clean energy investments to go to disadvantaged communities (DACs).[5] The *Roadmap's* recommended actions target the higher 40% threshold, built on the guiding principles of "do no harm," accessibility, transparency, and accountability. Specifically, the *Roadmap* recommends first-order prioritization of direct investments and programming as well as holistic support (e.g. education, workforce training, community outreach and engagement) for residents in DACs over the long-term not only to unlock access to cleaner, resilient, healthier, and more comfortable spaces, but also to provide entrepreneurial opportunities and build inclusive clean energy communities as the State transitions to a carbon neutral economy.

Affordability, of both the up-front costs to retrofit homes and businesses and the ongoing operating costs (e.g. utility bills) of all-electric systems, continues to pose a challenge for residents of historically marginalized and underserved communities. There is an imperative to avoid increasing basic living costs for vulnerable New Yorkers and where possible, identify direct opportunities to lower their utility bills consistent with the State's goal of reducing energy cost burdens to no more than 6% of pre-tax income for these households. NYSERDA has numerous efforts underway to better understand the LMI market and to test and scale-up high potential strategies for accelerating LMI electrification.

NYSERDA's Empower initiative pays for 100% of the cost of weatherization services for low-income customers, reducing their energy bills and providing healthier and more comfortable living conditions. In addition, the development of municipal-scale community thermal energy networks in DACs, which would operate in conjunction with highly efficient ground/water source heat pumps, could be a mechanism that may contribute to lower utility bills, help expand affordable access to air conditioning, and benefits in those communities. The *Two Million Climate-Friendly Homes Action Plan* will detail other specific programs and initiatives that are intended to scale LMI uptake of clean energy solutions.

Workforce education, training and diversification is pivotal to modernizing and decarbonizing buildings at scale, and provides another important opportunity to deliver benefits from the State's clean energy transition to frontline environmental justice communities.

The transition to carbon-neutral buildings will necessitate significant new workforce needs, providing pivotal opportunities to incorporate diverse and new workers in high-wage jobs in the clean energy economy while supporting the transition of workers affected by the shift away from fossil fuels. The *Roadmap* finds there is a skilled labor shortage today, including HVAC installers and geothermal drillers, while there is a growing demand for labor in the fields of energy conservation, electrification, low-carbon fuels, distributed solar installation and building-grid integration, among others. To build a skilled labor force at scale, local capacity building, as well as education and training are key and can be accelerated by leveraging supply chain and marketplace partners. Efforts should prioritize access, education, training, and hiring of residents of DACs that are historically underserved and marginalized. Collaboration across various levels of government and key agencies, and with labor groups and other external stakeholders and community groups is also crucial.

Ultimately, this work isn't just about upgrading buildings for better energy performance and zeroing out carbon emissions. The work is also about building a more resilient society and an economic engine within the State of New York that will put New Yorkers in the lead, offering new high-paying jobs and entrepreneurial opportunities, and delivering cleaner air and healthier, more comfortable and resilient homes, workplaces, schools, and institutions.

Beach Green Dunes
Photo Source: The Bluestone Organization

Impact on the Electric Grid

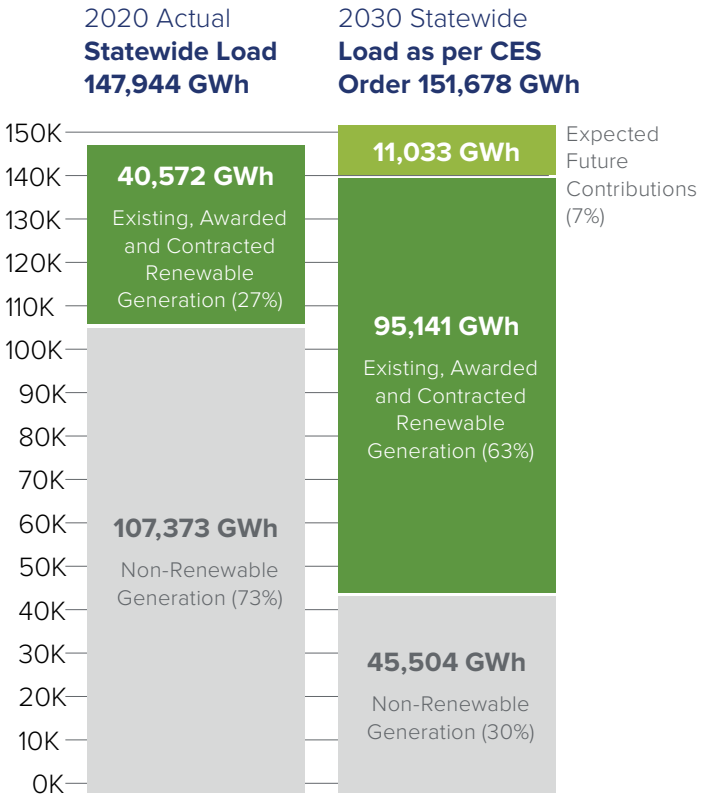
How New York decarbonizes its building stock matters. By emphasizing energy efficiency and load flexibility; supporting the adoption of as large a percentage of ground or water source heat pumps as practical; and continuing to support an increased deployment of onsite distributed energy resources like solar photovoltaics (PV), the State can materially reduce the impact on its electric grid from electrifying buildings.

The electrification of heating at scale, even if done efficiently, will turn New York State into a winter peaking electric system, but this is not projected to occur until the mid-2030s. However, the amount by which the new winter peak will exceed the current summer peak can be mitigated by the solutions the market adopts, and remains to be determined. Accordingly, how buildings are decarbonized and the degree of efficiency and load flexibility adopted will have significant implications for how much investment is needed across the State's electric system to build out peak capacity—from new clean electric generation resources, to transmission, to distribution. These grid-level investment needs directly impact how much consumers pay for electricity and so New York's path to a carbon neutral built environment needs to be planned carefully.

Measures that target thermal efficiency, including building envelope improvements, energy recovery, and water efficiency, are key actions that can be taken now to reduce consumers' energy bills, and are an important element of the statewide decarbonization strategy. Focusing on these measures, as well as other improvements that target thermal loads, is critical to the effective performance of heat pumps, helping reduce energy consumption, improve comfort, and lower operating costs/utility bills. These measures also reduce peak electricity requirements, the primary driver of electric grid build-out needs. By reducing buildings' electric loads across the board, these measures will also help protect grid reliability both in the summer and the winter. Already, for all-electric new construction that is governed by the strictest energy codes, the incremental impact on grid load is much lower than most existing buildings due to best-in-class envelope performance, energy recovery, as well as the overall energy and water efficiency of building systems.

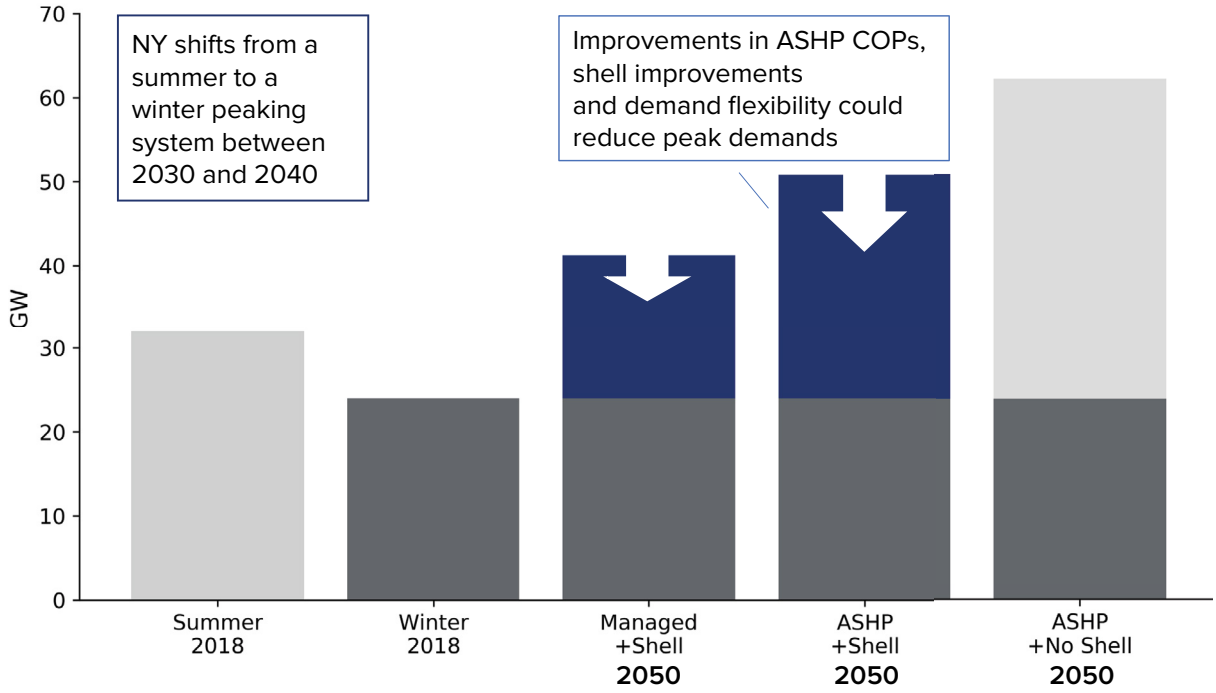
Flexible loads, building-to-grid interactivity, and distributed energy resources (DERs) can further reduce the impact of electrification on the electric grid by helping to shift and manage peak loads. Reducing the impact of electrification (of buildings and vehicles) on

PROGRESS TO DATE TOWARDS MEETING THE 70% BY 2030 RENEWABLE ENERGY GOAL



See Figure 5.2 on page 61 of full *Roadmap*.

SCENARIO 2050 PEAK DEMANDS COMPARED TO 2018 WINTER AND SUMMER VALUES



The chart presents two scenarios for residential space heating transformation presented to the Climate Action Council in June 2020. In both cases, most homes in New York shift from natural gas and fuel oil heating systems to heat pumps, but with different adoption trajectories. Similar transitions occur for other key residential and commercial heating equipment, including domestic hot water, cooking, and clothes drying. See Figure 5.4 on page 63 of the full *Roadmap*.

the electric grid will require minimizing the increase of peak demand and addressing local grid constraints. Load flexibility allows buildings to shift a portion of their energy demand from periods of peak electric grid demand to times of lower demand. Wide use of load flexibility reduces the need for, and costs of, building a larger grid, and helps to manage real-time energy prices. Load flexibility can be accomplished through energy storage (batteries and/or thermal storage systems), enhanced building systems controls, and grid interactivity—meaning the ability of a building to respond directly to price signals from the grid operator or utilities to shift electric loads in real time. Finally, the more that buildings adopt solar and other distributed energy resources, particularly in combination with battery storage, the less the State will need to invest to build out new emission-free central electric generation facilities.

Expanding the deployment of ground source heat pumps and community thermal energy networks can also help mitigate peak load impacts on the grid and resulting operating costs. Ground or water source heat pumps can be at least twice as efficient as air source heat pumps, meaning that they require half as much electricity to generate an equivalent unit of heat. Ground source heat pumps currently cost more than air source heat pumps for the upfront cost of installation. However, given the longer useful life of various components of ground source heat pumps and ongoing operational savings, these systems are more cost competitive with air source heat pumps when using a life cycle cost analysis. Community thermal energy networks can potentially be even more efficient than stand-alone ground source heat pumps, depending on the mix of thermal sources and sinks that are part of the system or network. They also provide a meaningful business opportunity and the creation of good-paying jobs for natural gas utilities and the labor force that currently works on natural gas power plants and pipelines. Given the recent passage of the Utility Thermal Energy Network and Jobs Act,[6] New York State is now intensively exploring how to design and deploy these thermal energy networks at scale.

Policies to Align the Building Transition With New York State Climate Law Requirements

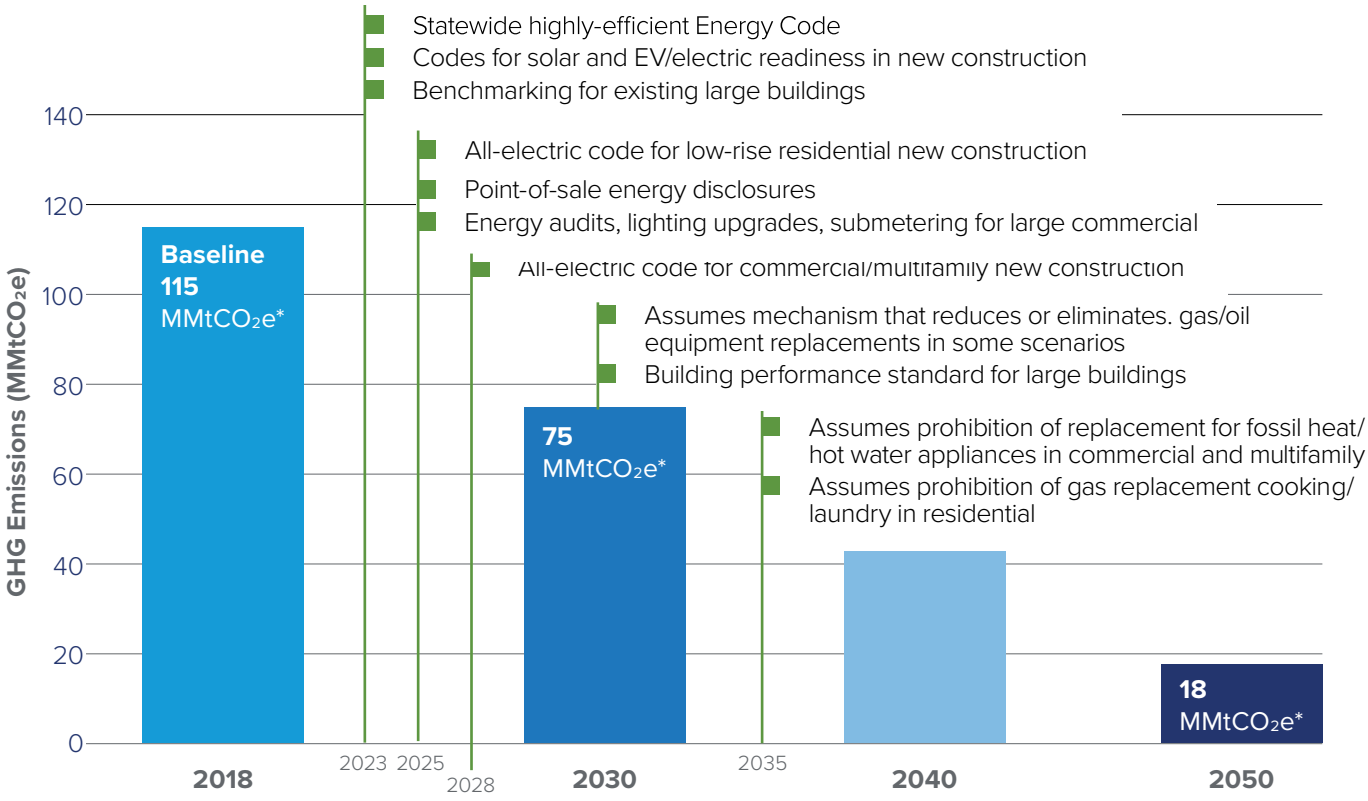
Policies and mandates that provide clear regulatory signals will be required to move the market and spur the retrofit of buildings at the pace needed to meet the Climate Act's stated timeline.

While market development work is critical to move early adopters and make progress on the cost issue, the policies highlighted below are critical to accelerating the modernization and decarbonization of buildings across New York State.

Highly Efficient State Energy Code and New Construction Requirements

Maximized energy efficiency stringency in codes will reduce energy waste in new and existing buildings.[7] These codes and standards may also incorporate

TIMELINE FOR KEY BUILDING POLICY PHASE-IN



See Figure 9.3 on page 124 of the full *Roadmap*.

(and at a certain point may require) all-electric, low-carbon solutions, and should also facilitate onsite solar, readiness for batteries and advanced electric equipment like heat pumps and induction ranges, readiness for electric cars, and the capability for major energy consuming appliances, batteries, and cars to run and charge in coordination with the electric grid.

Starting in 2025 for single-family homes and low-rise apartments, and by 2028 for multifamily and commercial buildings, the State codes are evaluating a requirement for all electric equipment for space conditioning, hot water, and cooking in all new construction and adaptive reuse projects.

Replacement of Space Heating and Hot Water Equipment Using Efficient and All-Electric Technologies

To address the majority of emissions from existing buildings, the large majority of which will still be here in 2050, New York may need to consider enactment of emissions-based standards that prohibit replacing fossil-burning space conditioning, water heating, cooking and drying equipment with like-kind new equipment after dates, potentially similar to the following:

- 2030 for space conditioning and domestic hot water in single-family homes; and
- 2035 for cooking and dryers in single-family homes, and for all space conditioning, water heating, cooking, and drying equipment in multifamily and commercial buildings.

By targeting replacements at end of life, costs are contained by leveraging the natural investment points in the lifecycle of a building or piece of equipment. By setting the threshold dates for this transition far enough in advance, the market will be able to ramp up in time to meet the increased demand.

Consider Implementation of Statewide Building Benchmarking Requirements, Leading to Future Adoption of an Efficiency-Based Building Performance Standard for Large Buildings

Building benchmarking and disclosure requirements—already proven effective in driving efficiency in markets like New York City—would require owners of large properties to annually report overall energy use, GHG emissions, and water usage, with specific disclosure requirements at point-of-sale and lease, in addition to conducting regular energy audits.[8] Benchmarking requirements should be enacted as soon as possible, and will provide data that will

Clean and Resilient Design in Practice

Brooklyn, NY

The solar-powered R-951 Residence in Brooklyn is the first Passive House-certified and net-zero-capable building in New York City. The three apartments have 4 kW of grid-tied generation from rooftop solar, an energy recovery ventilation system, triple-glazed tilt-and-turn windows and doors, a high performing building envelope, and a 1,200-gallon rainwater harvesting system. There is an outlet for daytime backup power during a utility outage. The high performance envelope improves passive survivability, and the rainwater harvesting can be used as a non-potable water source.[9]

Photo source: https://g-omediastudios.kinja.com/inside-the-green-design-principles-behind-a-passive-hou-1793346743

inform the compliance standards for a statewide building performance standard—an energy efficiency performance metric applicable to buildings larger than 25,000 square feet. The building performance standard should be enacted now, but become effective at 2030 in order to establish market signals for individual property owners and managers regarding how much more efficient their respective buildings will need to become to meet upcoming compliance thresholds. Any such standard would need to include safeguards for the continued affordability of multifamily properties in DACs.

Lighting upgrade requirements for commercial spaces in large buildings, and a submetering requirement for commercial tenants, would mirror what is already in place in New York City under Local Law 88, give commercial tenants ongoing feedback on energy consumption habits, and start to address the "split incentive" issue.

Supporting Policy Strategies are Needed to Help Drive the Scale and Certainty Needed to Transform the Market

New York State should develop innovative public/private funding mechanisms to leverage private capital and provide building owners with sources of low-cost financing. The State should also increase incentives to help spur early adopters to begin scaling the market, with a focus on LMI households and DACs. It will also be critical for the State to provide further policy support for workforce development; consumer education and awareness; and additional targeted research, development, and demonstration projects. New York should also lead by example with its government-owned-and-operated building stock and procurement practices.

Qualify Resiliency as a Critical Benefit Resulting from a Carbon Neutral Building

The types of efficiency measures that are foundational to the effective electrification of buildings also have a variety of resiliency co-benefits that center on the ability to potentially shelter in place and protect buildings from freeze damage for a longer duration during utility outages and extreme cold or heat events. Other aspects include:

- Distributed energy resource (DERs)/storage that provide load flexibility can also provide backup power for a limited duration during a power outage or for critical life/safety systems.
- Physical resiliency measures continue to be important to mitigate a range of risks for buildings beyond power outage issues—e.g. elevating mechanicals, siting of new construction in light of flooding risks, stormwater management practices, natural ventilation, and cooling opportunities.
- Extreme heat, and issues like the urban heat island effect, will continue to be health challenges in the near term while longer-term electrification efforts across LMI, residential, and multifamily buildings should provide more access to cooling.

Ongoing work is occurring to identify opportunities to design and integrate other measures that protect and adapt buildings.

EcoVillage. *Photo Source:* **GO Logic**

Passive Survivability in Practice

Belfast, ME

The EcoVillage in Belfast, ME, is a passive house community that boasts R-45 wall insulation and R-80 ceiling insulation, heat-recovery ventilation, is PV ready, and faces south. When an ice storm led to a power outage that lasted five days, only 8 to 10 degrees of internal temperature were lost. Residents pay $300 in annual heating costs, and the homes' design results in a 90% reduction in energy use for space heating compared to the average house.[10]

Photo source: **http://www.gologic.us/portfolio_page/belfast-cohousing-and-ecovillage/**

Putting the *Roadmap* in Context and the Work Ahead

In summary, the Carbon Neutral Buildings Roadmap is designed to support both the long-term policy objectives of New York State and the requirements of the Climate Act. It is a cornerstone piece of achieving a carbon neutral economy in New York State by 2050.

Importantly, the *Roadmap* is a plan for New Yorkers developed with New Yorkers. Over 1,000 individuals with ranging points of view gave input into the document's development. Experts from around the world also provided insights included in the Roadmap.

The need to modernize and decarbonize our buildings is anticipated to drive significant market activity, technology innovation, and policy and regulatory changes over the next 30 years.

Along with its two forthcoming companion **Future of Buildings** reports (the *Building Electrification Roadmap* and the *Two Million Climate-Friendly Homes Action Plan),* this ***Roadmap*** outlines current market gaps to developing carbon neutral buildings and best-in-class approaches that will be necessary to address those gaps between now and 2030, including what is needed to catalyze heat pump adoption at scale over that period, with an emphasis on the residential sector. The **Future of Buildings** series also identifies the foundational work and investments needed to trigger market forces over the next five to seven years that will accelerate progress in the period from 2030 to 2050. The **Future of Buildings** reports anticipate the development of a zero-emission electric grid by 2040 and value a building stock whose aggregated attributes reduce the cost of building and operating the future grid while enhancing its reliability, value, and the health of its users.

The New York State Climate Action Council's Draft Scoping Plan considered the recommendations of the Council's seven advisory panels—including the Energy Efficiency and Housing Advisory Panel—along with the Climate Justice Working Group and Just Transition Working Group, which will help guide the State in achieving its statutory obligations under the Climate Act to significantly reduce greenhouse gas emissions, increase renewable energy development, ensure climate justice, and advance the Climate Act's goal of carbon neutrality economy-wide by 2050.

The preliminary findings from this *Roadmap* helped inform the Energy Efficiency and Housing Advisory Panel as they developed their recommendations. The recommendations from the sector-focused advisory panels, along with feedback from the Climate Justice Working Group, were integrated into statewide emissions reduction scenarios and a cost-benefit assessment of the scenarios accounting for emissions reductions and health benefits. The Draft Scoping Plan, along with extensive public comments thereon, is currently under consideration by the Climate Action Council as it advances its responsibilities to finalize a Scoping Plan by January 1, 2023 that achieves New York's ambitious climate goals and provides a clear signal to the entire State community of the policy, market, community, and workforce needs to meet those goals.

Endnotes

1 New York State Climate Action Council Draft Scoping Plan, Chapter 4 (2021) https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

2 The *Roadmap* assumes achievement of the Clean Energy Standard as set forth in the Climate Leadership and Community Protection Act (Climate Act), which requires at least 70% of the State's electricity to be generated from renewable resources by 2030, and 100% of its electricity to be generated from emissions-free resources by 2040.

3 New York City Department of Health and Mental Hygiene. 2021. "A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy." https://www1.nyc.gov/assets/doh/downloads/pdf/eode/eode-air-quality-impact.pdf.

4 Harvard University. "The impact of green buildings on cognitive function." https://green.harvard.edu/tools-resources/research-highlight/impact-green-buildings-cognitive-function.

5 NYSERDA defines low-income households as those that are income-eligible for NYS HEAP (Heating Energy Assistance Program) benefits-- households with incomes at or below 60% of state median income (SMI). Similarly, moderate-income households are defined as those with incomes above the HEAP threshold, but less than 80% of the greater of state median income and area median income for the household's geographic area. https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/Program-Evaluation/2017ContractorReports/LMI-Market-Characterization---Full-Report.pdf.

6 The Climate Leadership and Community Protection Act directs the Climate Justice Working Group (CJWG) to establish specific criteria for disadvantaged communities. Draft criteria were issued for public comment in March 2022. Until the criteria are finalized, NYS has identified interim criteria for disadvantaged communities, which includes communities (1) located within census block groups that meet the HUD 50% area median income (AMI) threshold that are also located within the DEC Potential Environmental Justice Area; or (2) are located within NYS Opportunity Zones. https://climate.ny.gov/Our-Climate-Act/Disadvantaged-Communities-Criteria.

7 The New York State legislature passed the Utility Thermal Energy Network and Jobs Act during the 2022 legislative session. This Act (1) directs the NYS Public Service Commission (PSC) to initiate a proceeding to develop a regulatory structure for utility thermal energy networks, (2) permits utilities to own, operate and manage thermal energy networks, as well as acquire and supply thermal energy with PSC oversight, and (3) applies prevailing wage requirements and certain apprenticeship agreements intended to help natural gas pipeline workers and other trades transition to clean energy jobs. https://www.governor.ny.gov/news/governor-hochul-announces-progress-toward-implementing-utility-thermal-energy-network-and-jobs.

8 On July 5, 2022, Governor Hochul signed the Advanced Building Codes, Appliance and Equipment Efficiency Standards Act of 2022 requiring New York State Energy Conservation Construction Code to be updated to achieve energy efficiency and greenhouse gas emission reductions in support of the Climate Act. Additionally, this legislation authorizes NYSERDA, in consultation with the New York State Department of State, to adopt efficiency standards for appliances and equipment that reduce energy usage. https://www.governor.ny.gov/news/governor-hochul-signs-legislative-package-spur-energy-efficiency-consumer-savings-and#:~:text=The%20Advanced%20Building%20Codes%2C%20Appliance,along%20with%20expanded%20appliance%20standards.

9 As part of the Draft Scoping Plan, The Energy Efficiency & Housing Advisory Panel has recommended that sellers of single-family homes be required to provide energy performance characterizations, or ratings like the Home Energy Rating System (HERS) or Energy Star at point of sale, by 2027. These ratings can work in parallel with other standards for health and well-being that also help drive low-carbon outcomes. https://climate.ny.gov/Our-Climate-Act/Draft-Scoping-Plan.

10 Balfe, John, Moses Riley, and Carolyn Sarno-Goldthwaite. 2019. Resilient & Efficient Communities: Strategies for Success. Northeast Energy Efficiency Partnership, https://neep.org/sites/default/files/Resilient%20and%20Efficient%20Communities%20Slide%20Deck%209.30.19_0.pdf.

Clean energy can power New York while protecting the environment. The New York State Energy Research and Development Authority, known as NYSERDA, promotes energy efficiency and the use of renewable energy sources. These efforts are key to developing a less polluting and more reliable and affordable energy system for all New Yorkers. Collectively, NYSERDA's efforts aim to reduce greenhouse gas emissions, accelerate economic growth, and reduce customer energy bills.

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