

Matter Number 16-00681, In the Matter of the Clean Energy Fund  
Investment Plan

Clean Energy Fund:  
**Building Innovations Chapter**

Portfolio: Innovation & Research

**Submitted by:**

**The New York State Energy Research and Development Authority**

Revised May 7, 2021

Clean Energy Fund Investment Plan: Building Innovations Chapter		
Revision Date	Description of Changes	Revision on Page(s)
August 1, 2016	Original Issue	Original Issue
April 19, 2019	<p>As part of the Annual Investment Plan &amp; Performance Report (IPPR) process, NYSERDA has updated budget and benefit values to align with actuals for past years and adjusted budget and benefit forecasts for future years, as appropriate, based on experience to date. Budget and benefit tables have been moved to Appendix B of this chapter and output/outcome tables have been moved to Appendix C of this chapter. Updated rounding convention has been applied to budget and benefit tables.</p> <p>Output indicator targets have been updated in Appendix C.</p> <p>The method for managing program awards/ contracts has been revised resulting in a change to the reporting of committed budgets and benefits. These changes are reflected in 2016-2018 actuals and forward looking plans found in Appendix B.</p> <p>Updated Milestones</p>	Multiple
May 15, 2020	<p>As part of the Annual Investment Plan &amp; Performance Report (IPPR) process, NYSERDA has updated budget and benefit values to align with actuals for past years and adjusted budget and benefit forecasts for future years, as appropriate, based on experience to date.</p> <p>Revised plan to increase funding for building electrification activities as part of the NY Clean Heat Market Development Plan.</p>	Multiple Appendix B, C
June 5, 2020	Plan was recently updated and is being refiled here as part of the Annual Investment Plan & Performance Report (IPPR) process in which all plans are collectively filed. No changes to plan documents.	None
May 7, 2021	<p>As part of the Annual Investment Plan &amp; Performance Report (IPPR) process, NYSERDA has updated budget and benefit values to align with actuals for past years and adjusted budget and benefit forecasts for future years, as appropriate, based on experience to date.</p> <p>The chapter has been updated to provide a bridge between committed and acquired planning. Committed budget and benefits summaries have been added to plan text, while Appendix B has been updated to reflect expenditure &amp; acquired benefits plans.</p>	Appendix B  9, Appendix B

# NextGen HVAC

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## 1.1.1 Theory of Change

The NextGen HVAC initiative focuses on heating, cooling, and ventilation (HVAC) in buildings. The initiative will focus primarily on commercialization of advanced building technologies, technology validation to drive market impact, and fostering strategic partnerships between market participants, manufacturers, and the innovation community. As the majority of GHG emissions from HVAC are associated with fossil fuel use for heating buildings, the initiative will have a primary focus on space heating, with an additional focus on space cooling and HVAC load reductions in buildings. Improvements in these focus areas will be accomplished through technology development and the integration of HVAC systems with advanced controls.

The goal of the initiative is to develop, demonstrate, commercialize, and de-risk solutions that can deliver better performance and cost reductions.

NYSERDA will work with commercial/residential property owners to define technical needs and performance specifications, engage the industry and innovation community to deliver/tailor products to meet NY building needs, support cost-shared demonstrations of innovative solutions in New York, and leverage opportunities to grow the green economy in New York through Industry and University partnerships, investor community engagements, and international partnerships.

Of the \$15M initially allocated to this initiative, 27 product development/demonstration projects have been initiated, totaling \$15.1M in commitments. The goals and timeline for energy efficiency and GHG reductions have been elevated and accelerated, creating additional opportunities for innovation. The activities under NextGen HVAC will be coordinated with the other identified building electrification initiatives. Program investments and activities will be informed via engagement with stakeholders and subject matter experts.

<b>Technology Opportunities and Market Barriers Addressed</b>	<ul style="list-style-type: none"><li>• <b>HVAC distribution systems have high distribution losses.</b> Most buildings are heated and cooled using a central HVAC plant and a distribution system to transfer the thermal energy throughout the building. The current distribution methodology introduces large thermal losses up to 26%, affecting overall system performance. In certain densely packed building layouts, such as a campus, building complex, or city block, clean thermal energy districts can improve thermal distribution and balance loads across the district by utilizing advanced controls to implement smart metering and system optimization.</li><li>• <b>Improvements to cold climate heat pumps (CCHPs).</b> Mini-split heat pumps are being installed more commonly in NYC and Westchester County. However, current mini-split systems may not be a cost-effective option in traditional single-family homes. An effective air-to-water heat pump is needed for converting existing hydronic baseboard heated homes away from fossil fuels because existing products cannot produce the required hot water temperature. Potential innovations include design and material improvements to help scale the technology for small- to medium-commercial buildings and typical single-family homes.</li><li>• <b>Energy consumption for air conditioning is dominated by the use of compressors.</b> The electricity need by compressors can represent more than</li></ul>
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	<p>80% of total energy consumed by a conventional air conditioning system. A paradigm shift in air conditioning energy efficiency appears achievable if compressorless cooling approaches can be developed.</p> <ul style="list-style-type: none"> <li>• <b>There is a need for integration of renewable generation, thermal storage, and advanced controls.</b> The integration of thermal storage solutions with conventional and renewable heating and cooling systems can significantly improve total system efficiency and economics. The combination of thermal storage with advanced controls can significantly improve total system resiliency, flexibility, efficiency, and economics. The ability of thermal storage to respond to external signals is expected to optimize the use of renewable generation and clean heating and cooling technologies, enable participation in demand response programs, and both heating and cooling peak loads.</li> <li>• <b>The coupling of space conditioning and ventilation limits cooling efficiency improvements.</b> As building envelopes have improved, the sensible cooling requirement has decreased. However, latent cooling requirements, which are largely driven by ventilation needs, have not changed. Lack of solutions for decoupling of the sensible and latent cooling requirements limits opportunities to improve air conditioning efficiency.</li> <li>• <b>Packaged HVAC and domestic hot water systems are needed to enable deep energy retrofits.</b> The low-rise multifamily residential accounts for roughly 529,000 units in NYS. An integrated solution would provide advantages to building owners to accelerate adoption. Currently HVAC, DHW, and electrical systems are sourced and installed by different subcontractors, each adding their own labor costs and material markups. An integrated solution would streamline these steps, leading to competitive pricing over current solutions. This approach would be more cost-effective regarding installation and first cost. In the long term, benefits include reduced utility, operating, and maintenance costs.</li> <li>• <b>Electrifying space heating for existing building is difficult due to existing building envelopes (BEs).</b> Electrifying buildings' heating could require an additional 63,000 GWh of production a year and produce a winter peak 2x the maximum summer peak. Without reductions in the thermal building loads, most buildings will require significant electrical service upgrades to provide heating. Labor is often a large cost component of envelope retrofits (up to 75%). Cost compression due to novel materials, advanced manufacturing, innovative installation techniques, and integrated systems will increase the adoption of building envelope upgrades.</li> <li>• <b>Low GWP Refrigerant Use, Monitoring, &amp; Leak Detection.</b> Heat pumps are an important strategy for the electrification of buildings because they avoid the emissions from the combustion of fossil fuels to provide space heating. However, common heat pump refrigerants have global warming potentials over 1,000x greater than CO<sub>2</sub>. Annual leakage rates from this equipment are on the order of 3 to 4%. Loss of refrigerant charge negatively impacts performance and increases electricity usage. A 40% undercharged heat pump would reduce the relative COP significantly—45% in heating mode and 24% in cooling mode. Development of hardware is needed to ensure detection of refrigerant losses at the earliest stage and support the adoption of low GWP refrigerants.</li> <li>• <b>Innovative HVAC Products Commercially Available Outside of NYS.</b> Many global manufacturers have HVAC products or features not yet available in NYS. There are also areas with climate similar to NYS, such as northern parts of Europe and Asia, that have local companies with products not yet available in NYS. Some of these unique products or features may be advantageous to the NYS market and buildings within the state would benefit from their introduction. An HVAC manufacturer may have limited access to the NYS market due to local equipment or electrical standards, appliance certification, local building codes,</li> </ul>
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	familiarity with the NYS market, and a lack of local partners, distributors, or installers. These barriers can be addressed by late-stage product development, market development, and field demonstrations to demonstrate the benefits for buildings in NYS.
<b>Testable Hypotheses</b>	<ul style="list-style-type: none"> <li>• If large influential building owners and management companies are involved in program development, then it is more likely that they will participate as demonstration sites and will ultimately accelerate adoption of new innovations.</li> <li>• If building operators are provided with innovations that improve the controllability of HVAC systems, they will then capture unrealized economic value through energy savings, GHG reductions and demand management and/or participation in demand response programs.</li> <li>• If innovations can enable increased performance with a compelling value proposition from heating and cooling equipment (including thermal distribution systems, integration of renewables and thermal storage), then homeowners, building owners, and building management firms will adopt this equipment to reduce their energy costs.</li> </ul>
<b>Activities</b>	<ul style="list-style-type: none"> <li>• <b>Determine Technology Performance and Cost Needs.</b> Seek market intelligence on the specific performance and cost thresholds for various technologies that are likely to drive adoption. Once these targets are well understood, focused competitive “innovation challenges” solicitations will be released targeting these thresholds. The solicitations will look to support technology development, technology validation, and tech to market activities.</li> <li>• <b>HVAC Technology Development.</b> Solicitations will empower the innovation community to develop solutions that will provide the desired performance. Multiple innovators may be sought to address a specific technology barrier, increasing the likelihood of a viable/investable solution. Where appropriate, utility involvement will be included.</li> <li>• <b>Technology Validation Effort.</b> Demonstration/validation efforts to test the developed, and other available, innovations in the intended relevant operational environment. For this tactic, NYSERDA will directly engage large real estate management organizations and other key stakeholders to serve as test beds.</li> <li>• <b>Tech to Market Support.</b> Tech to market support will be provided to technology developers to help drive the commercialization of new innovations. This support will be tailored specifically to help early-stage companies navigate the typical channels to market for buildings technologies; for instance, introductions through planned and structured events with key decision makers (HVAC contractors, architecture and engineering firms, energy service companies, consultants, and building owners/operators).</li> </ul>

1.1.2 Target Market Characterization

<b>Target Market Segment(s)</b>	<ul style="list-style-type: none"> <li>• While the end use target market segment is all building types, this initiative will target HVAC and building envelope innovators and manufacturers of technologies that have applications across multiple building types.</li> <li>• Market participants: <ul style="list-style-type: none"> <li>○ Building-systems-related startups and entrepreneurs</li> <li>○ Large original equipment manufacturers (OEMs) with a corporate strategic interest in HVAC technologies and HVAC product manufacturers</li> <li>○ Universities with known research activities in HVAC technologies, material science and manufacturing and contract research organizations</li> <li>○ Professional Design Societies</li> </ul> </li> </ul>
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	<ul style="list-style-type: none"> <li>○ National laboratories</li> <li>○ Commercial building developers and owners</li> <li>○ New York Independent System Operator (NYISO) and Utilities</li> <li>○ Established HVAC vendors</li> <li>○ Established HVAC contractors</li> <li>○ Energy service companies (ESCOs)/energy consultants</li> <li>○ System designers</li> <li>○ Housing authorities</li> <li>○ Builder and trade associations</li> </ul>
<b>Stakeholder/Market Engagement</b>	<ul style="list-style-type: none"> <li>● NYSERDA intends to leverage its relationship with established HVAC consortiums and associations that provide a broad range of targeted economic development assistance to small, medium, and large manufacturers and suppliers of thermal and environmental control equipment.</li> <li>● NYSERDA will engage and partner with building owner and manager associations, real estate boards, and other building related associations.</li> <li>● NYSERDA has initiated customer engagement with key stakeholders (including large property managers, architectural engineering firms, building science practitioners, and technology developers).</li> <li>● To assist in achieving engagement by various stakeholders, dedicated outreach activities will be initiated to promote program participation.</li> </ul>
<b>Relationship to Utility Programs and REV Initiatives</b>	<ul style="list-style-type: none"> <li>● Focusing on development of NextGen HVAC equipment will create the opportunity to improve reliability and potentially delay or avoid the need for utility distribution system upgrades. Similarly, improved controls and capabilities will enable consumers to manage HVAC systems in response to price signals and participate in a transactive energy market envisioned under REV.</li> <li>● To fully realize the benefits of these advances, NYSERDA will engage with the utilities to understand where innovative space conditioning solutions (peak demand reduction) could provide added value to the distribution system and what performance requirements are necessary.</li> <li>● Utilities could also serve as pilot and demonstration partners to accelerate the time to market of new HVAC technologies. NYSERDA will help to engage utilities as appropriate to help establish these connections.</li> <li>● NYSERDA will partner with utilities to demonstrate the opportunities of aggregation and control of dispersed flexible HVAC systems as an alternative to more expensive distribution system upgrades</li> <li>● Utilities are not supporting end-use buildings research and development. However, utilities are providing a range of incentives for commercially available energy efficient equipment in the target markets, which potentially could be informed by the results of the activities undertaken in this initiative.</li> </ul>

**Key Implementation Milestones**

<b>Key Milestones</b>	<p><u>Milestone 1 (2017) - Complete</u></p> <ul style="list-style-type: none"> <li>● Issue RFI, evaluate and establish technology challenge areas and targets.</li> </ul> <p><u>Milestone 2 (2017) - Complete</u></p> <ul style="list-style-type: none"> <li>● Issue 1<sup>st</sup> Technology Challenge.</li> </ul> <p><u>Milestone 3 (2018-2019) - Complete</u></p> <ul style="list-style-type: none"> <li>● Contract projects from 1<sup>st</sup> Technology Challenge.</li> </ul> <p><u>Milestone 4 (2018) - Complete</u></p>
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	<ul style="list-style-type: none"> <li>Review portfolio of activities, solicit market input, and reassess technology challenges areas and targets.</li> </ul> <p><u>Milestone 5 (2018) - Complete</u></p> <ul style="list-style-type: none"> <li>Issue 2<sup>nd</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 6 (2018-2019) - Complete</u></p> <ul style="list-style-type: none"> <li>Contract projects from 2<sup>nd</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 7 (2018) - Complete</u></p> <ul style="list-style-type: none"> <li>Review portfolio of activities, benefits to date, solicit market input, and reassess technology challenges areas and targets.</li> </ul> <p><u>Milestone 8 (2018) - Complete</u></p> <ul style="list-style-type: none"> <li>Issue 3<sup>rd</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 9 (2018-2020)</u></p> <ul style="list-style-type: none"> <li>Contract projects from 3<sup>rd</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 10 (2019) - Complete</u></p> <ul style="list-style-type: none"> <li>Issue 4<sup>th</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 11 (2021)</u></p> <ul style="list-style-type: none"> <li>Issue awards following release of 4<sup>th</sup> Innovation Challenge</li> </ul> <p><u>Milestone 12 (2022)</u></p> <ul style="list-style-type: none"> <li>Issue awards following release of 5<sup>th</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 13 (2022)</u></p> <ul style="list-style-type: none"> <li>Issue awards following release of 6<sup>th</sup> Innovation Challenge.</li> </ul> <p><u>Milestone 14 (2023)</u></p> <ul style="list-style-type: none"> <li>Issue awards following release of 7<sup>th</sup> Innovation Challenge.</li> </ul>
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1.1.3 Fuel Neutrality

<b>Fuel Neutrality</b>	<ul style="list-style-type: none"> <li>Thirty-six percent (67M tons) of the State’s GHG emissions are associated with the heating, cooling, and ventilation in buildings.</li> <li>Of the total GHG emissions associated with HVAC in buildings, 67% is associated with fossil fuel use, only 33% is associated with electricity use, however systems are often integrated.</li> <li>Investing in the development of controls and other technologies for building electrification can reduce fossil fuel consumption of installed equipment for the remainder of their service life, providing emissions and economic benefits.</li> </ul>
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1.1.4 Performance Monitoring and Evaluation Plans

<b>Performance Monitoring &amp; Evaluation Plan</b>	<p>NYSERDA’s approach to monitoring and assessing the effectiveness of the initiative and overall market development is described below.</p>
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	<p>Where appropriate, evaluation efforts for this initiative may be combined with other NYSERDA evaluation studies to optimize resources where technologies, market actors, strategy or geographical regions overlap. While serving to reduce and mitigate potentially duplicative evaluation efforts, this approach will also reduce uncertainty in evaluation findings where discrete, initiative-level assessments are otherwise difficult to discern due to such overlaps.</p> <p><b><u>Test-Measure-Adjust Strategy</u></b></p> <ul style="list-style-type: none"> <li>• Standard metrics: # of projects, leveraged funds, technical/business progress measured via technology readiness level (TRLs) and commercial readiness levels (CRLs).</li> <li>• On a 6 to 8-month interval NYSERDA staff and project participants will reassess the TRLs and CRLs for each project in the portfolio to gauge project progress.</li> <li>• NYSERDA will conduct staged peer reviews of projects at key points. Examples – technical impasse, pivot point, critical milestone.</li> <li>• NYSERDA will assess the portfolio of projects annually with regard to goals, metrics, outputs and outcomes.</li> </ul> <p><b><u>NextGen HVAC Strategy M&amp;V</u></b></p> <ul style="list-style-type: none"> <li>• Technology performance will be measured and verified as part of this strategy. Innovations are first measured under ideal conditions in laboratory settings as a baseline before conducting field demonstrations to measure and verify the performance in a real-world setting.</li> </ul> <p><b><u>Market Evaluation</u></b></p> <ul style="list-style-type: none"> <li>• Market evaluation draws on the theory of change outlined in the logic model and will longitudinal measurement of key indicators of success, such as leveraged funds, products developed and demonstrated, increased revenue, and ultimately replication through increased awareness and technology adoption.</li> <li>• Sources of data include program data, public and commercially available data, and primary data collection through surveys of key market actors.</li> <li>• Focusing on the selected proposals, NYSERDA will gather and document relevant baseline indicator values from known values such as internal, public, and commercially available data (AHRI, LL84, LL87, LL97, NYS building code, etc.).</li> <li>• Baseline values and their associated change over time may be assessed using cost and performance data from project proposals and final project reports. These values will be specific to the technologies funded under this initiative, and will be vetted by the solicitation scoring committee, including NYSERDA staff for accuracy.</li> <li>• Case studies and historical tracing methods may be used to assess broad outcomes and indicators as listed under Appendix 3 after a critical mass of program-initiated activity has been completed. These methods will measure and substantiate the initiative’s role in areas such as commercialized products, investments, and replications.</li> </ul> <p><b><u>Impact Evaluation/Field Verification</u></b></p> <ul style="list-style-type: none"> <li>• A broad product development and demonstration project impact evaluation is planned and will include projects from this area, and other applicable Innovation and Research initiatives, to examine benefits of product development and demonstration projects including, but not</li> </ul>
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	limited to, technology readiness, commercialization readiness, rate of and success factors associated with replication, and benefits of replication projects. Though methods and objectives will differ from a traditional M&V study, cost and energy savings will be quantified as part of this study.
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1.1.5 Budgets

The commitment budget for all activities included in this investment plan is as follows:

Funding Commitments		----- Commitments Plan -----						
Budget	Plan Total	Previously Committed	2020	2021	2022	2023	2024	2025
Incentives and Services	-	-	-	-	-	-	-	-
Implementation	2,261,254	457,336	303,919	300,000	300,000	300,000	300,000	300,000
Research and Technology Studies	27,738,746	8,284,660	3,880,517	7,000,000	5,000,000	2,000,000	1,000,000	573,569
Tools, Training and Replication	-	-	-	-	-	-	-	-
Business Support	-	-	-	-	-	-	-	-
<b>Total</b>	<b>30,000,000</b>	<b>8,741,995</b>	<b>4,184,436</b>	<b>7,300,000</b>	<b>5,300,000</b>	<b>2,300,000</b>	<b>1,300,000</b>	<b>873,569</b>

An annual expenditure budget for all activities included in this investment plan is shown in Appendix B alongside expected acquired benefits. Budgets do not include Administration, Evaluation, or Cost Recovery Fee; these elements are addressed in the Budget Accounting and Benefits chapter filing. The budget as presented in the Budget Accounting and Benefits Chapter will serve as the basis for any subsequent reallocation request. The additional level of detail presented within Appendix B is intended for informational purposes only.

1.1.6 Progress and Performance Metrics

The anticipated commitment benefits totals for the initiative with respect to CEF Order target metrics is as follows:

Benefit Commitments		Indirect Benefit (2016-2030)	
Direct Benefit (2016-2025)	Plan Total		Plan Total
Energy Efficiency MWh Annual	-	Energy Efficiency MWh Annual	-
Energy Efficiency MMBtu Annual	-	Energy Efficiency MMBtu Annual	-
Renewable Energy MWh Annual	-	Renewable Energy MWh Annual	-
CO2e Emission Reduction (metric tons) Lifetime	-	CO2e Emission Reduction (metric tons) Lifetime	-
Participant Bill Savings Lifetime	-		
Leveraged Funds	151,899,636		

Benefits summarized in Appendix B represent the plan for acquiring impacts through completed projects or activities.

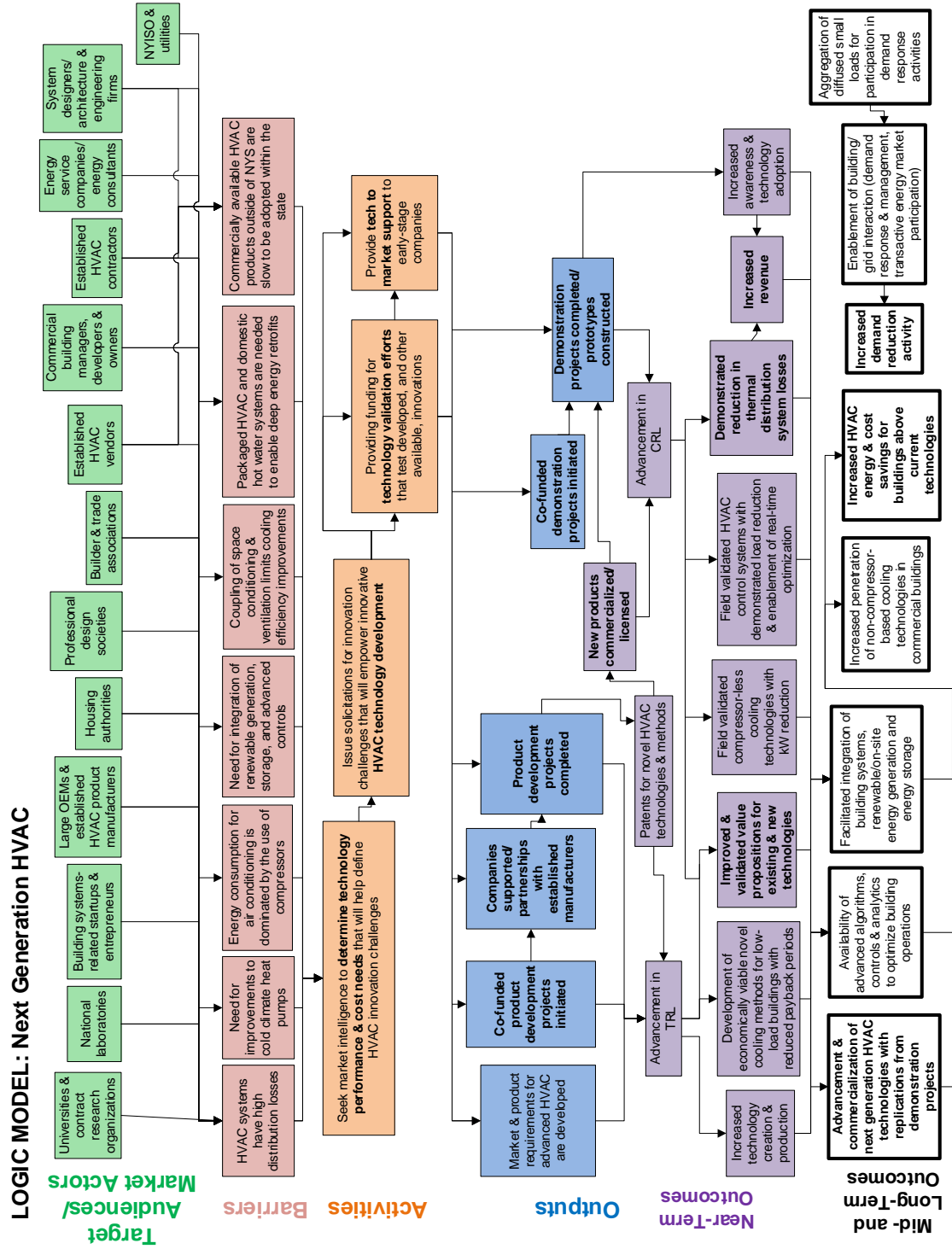
Benefits shown in Appendix B, listed as direct, are direct, near term benefits associated with this initiative’s projects. These benefits will be quantified and reported on a quarterly basis and will be validated through later evaluation.

Appendix C provides program Activity/Output indicators representing measurable, quantifiable direct results of activities undertaken in the initiative. Outputs are a key way of regularly tracking progress, especially in the early stages of an initiative, before broader market changes are

measurable. Outcome indicators can encompass near-term through longer-term changes in market conditions expected to result from the activities/outputs of an intervention. Outcome indicators will have a baseline value and progress will be measured periodically through Market Evaluation.

**Verified Gross Savings Specification** – not applicable.

# Appendix A – Logic Model



# Appendix B | Initiative Budget and Benefits Summary

## NextGen HVAC

		Benefits Acquisition Plan														
	Plan Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>Direct Benefit</b>																
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leveraged Funds	151,899,636	-	-	44,289	560,660	598,895	1,800,000	3,100,000	6,200,000	12,500,000	25,000,000	48,000,000	54,095,792	-	-	-
<b>Indirect Benefit</b>																
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Energy Usage</b>																
Direct Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Participants</b>																
Participants	63	-	-	-	2	8	10	20	15	5	3	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>63</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>2</b>	<b>8</b>	<b>10</b>	<b>20</b>	<b>15</b>	<b>5</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
		Budget Expenditures Plan														
	Plan Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Incentives and Services	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Implementation	2,261,254	-	71,573	241,311	190,599	257,772	300,000	300,000	300,000	300,000	300,000	-	-	-	-	-
Research and Technology Studies	27,738,746	-	46,359	171,456	1,382,580	1,044,432	2,325,000	4,746,894	4,103,151	5,000,000	3,000,000	3,000,000	2,000,000	918,875	-	-
Tools, Training and Replication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>30,000,000</b>	<b>-</b>	<b>117,932</b>	<b>412,766</b>	<b>1,573,179</b>	<b>1,302,203</b>	<b>2,625,000</b>	<b>5,046,894</b>	<b>4,403,151</b>	<b>5,300,000</b>	<b>3,300,000</b>	<b>3,000,000</b>	<b>2,000,000</b>	<b>918,875</b>	<b>-</b>	<b>-</b>

**Table Notes:**  
 \* With the May 2021 IPPR filing of all investment plans, each Appendix B table that accompanies an investment plan was transitioned from yearly commitment-based budget and benefit plans to plans that forecast expenditures and acquired benefits.  
 a. Participants are awardees of NYSERDA contracts to develop or demonstrate NextGen HVAC technologies under this initiative

## Appendix C | Initiative Outputs and Outcomes Summary

### NextGen HVAC

	Indicators	Baseline (Before/Current)	2019 (cumulative)	2022 (cumulative)	2025 (cumulative)
			Target	Target	Target
Outputs	Number of product development projects initiated	0	15	30	30
	Number of product development projects completed	0	6	17	30
	Number of demonstration projects	0	6	20	20
	Number of companies supported or other partnerships (Joint Development, Joint Venture) with established manufacturers	0	20	40	45
Outcomes	Number of products commercialized	0	4	6	10
	Revenue to companies commercializing products (millions)	0	\$3.0	\$18	\$40
	Number of replications from demonstration projects	0	30	60	85

#### Table notes

a. A 0 (zero) as the baseline value denotes that NYSERDA will not count any activities, outputs, and outcomes supported with prior resources (e.g., pre CEF) towards the achievement of the stated goals in this table

b. Here, replications are defined as known incidences where the innovation was deployed without NYSERDA involvement.