

# **NYSERDA Product Development Impact Evaluation**

*Final Report*

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## Executive summary

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This report presents the results of an impact evaluation that assessed Innovation and Research product development projects from multiple technical areas for a sample of 166 products developed as part of projects with completion dates between Q1 2016 and Q4 2020<sup>1</sup>. The population evaluated in this impact evaluation does not represent the entire scope of activity within NYSERDA's portfolio of Innovation and Research investments. Product development projects are a specific type of project (for example, compared to a feasibility study or a product demonstration project) that were competitively selected through at least 40 distinct solicitations categorized into the technical focus areas Building Innovations, Clean Transportation Innovation, Grid Modernization, and Renewables Optimization. This evaluation seeks to assess the energy and non-energy impacts of project investments to overcome barriers to organizations developing innovative clean energy products and technologies.

This impact evaluation is the first of its kind by NYSERDA, insofar as it seeks to assess the impacts of NYSERDA's support to project partners to develop early-stage products developed with investment from NYSERDA. As a working definition, an early-stage product is a service, software, or hardware device that has not yet completed a demonstration and is not yet widely adopted in its market. Evaluation of product development is unique for several reasons, including:

- **Time to market:** It takes time for new products to gain traction in their markets and result in measurable impacts. Some products in this evaluation period may already have been adopted by the market and gained full commercialization reflected through sales. Other products are still in development and expect future commercialization – the impacts of those products are prospective and cannot be verified.
- **Pivot of product development to adapt to new market needs:** As products are moved along development stages through NYSERDA projects, the work reveals performance or commercialization barriers that cause participants to shift course: either they discontinue development or they pivot to a new form, or even a successor product that better serves the function or the market.
- **Product diversity:** NYSERDA's Innovation and Research portfolio intentionally and strategically funds a wide variety of products through different stages in their development. This planned diversity in Innovation and Research's investment portfolio poses challenges to evaluators because the variety of product innovations requires a variety of methodologies, and innovative methodologies, to evaluate effectively.

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<sup>1</sup> This evaluation included funding portfolios such as System Benefits Charge (SBC), System Benefits Charge – Technology and Market Development (SBC4), Clean Air Interstate Rule (CAIR), Clean Energy Fund (CEF) and New York State Statutory Research and Development Funds (NYRD).

This evaluation also included a process evaluation through an online survey of developers to assess their experience partnering with NYSERDA and to identify opportunities for improvement in the way NYSERDA's Innovation and Research team engages with product developers.

## **Approach**

Project data and documentation provided by NYSERDA were used to characterize the sample of 166 projects. The evaluation team conducted a one-time 25-minute online survey of product developer firms that received investment from NYSERDA between January 2016 and June 2020. A total of 109 developers completed surveys that assess the energy, economic, and non-energy impacts realized from products that have been commercialized; impacts anticipated from products that have yet to commercialize; feedback on satisfaction with the process of partnering with NYSERDA; and other questions to gain insight into the experiences and barriers faced by developers of clean energy innovations.

The evaluation team interviewed project managers in NYSERDA's Innovation and Research (I&R) team to identify products with known disruptive technological potential and/or high energy impact potential. A subset of 18 survey respondents for whom the developer company has reported sales, and whom the NYSERDA Innovation and Research team also identified as having disruptive potential, were evaluated to assess and characterize the energy, non-energy, and economic benefits achieved by these products.

In most cases, validated energy savings and cost data from end users or other third-party sources were not available as inputs to this study. As such, this evaluation reports modeled estimates of energy and cost savings by leveraging the most reliable data the evaluation team was able to obtain from project data and documentation provided by NYSERDA, survey responses and follow-up interviewing with developers, and literature review of studies of product impacts conducted by third parties and customers of the products assessed, rather than by collecting billing data or conducting onsite visits to validate energy savings or validated ROIs to NYSERDA (ratepayers) or developers.

Table ES-1 shows a summary of the scope and data collection methods used in this evaluation.

**Table ES-1. Evaluation scope and data collection methods applied to product subsets**

	Product set	Count	Scope of study	Data sources
<b>Products population summary</b>	All	161	Characterize projects and products, funding, timing, responses to prior NYSERDA data collection	Project data Metrics survey NYSERDA project manager interviews
<b>Funding opportunity process improvement</b>	Developer survey respondents	109	Assess overall rates of commercialization, satisfaction, barriers and catalysts, opportunities	Developer survey
<b>Market characterization</b>	Subset with disruptive or high impact potential	57	Characterize markets and disruptive potential of products that already or are expected to create, scale, or disrupt a market	Developer survey, NYSERDA project manager interviews
<b>Impact evaluation</b>	Subset with sales	18	Estimate energy savings/generation, economic, and non-energy impacts through verification data and/or customer interviews	Developer In-Depth Interviews
<b>Preliminary findings memos</b>	Subset with customer interviews or verification data	3	Detailed success stories, indirect impacts and market characterization	Customer interviews/ Verification data

## Results

This evaluation yielded several key findings and recommendations.

**Finding 1: NYSERDA invested \$109M in product development projects that were completed between January 2016 and June 2020. This investment resulted in 38 successfully commercialized products that reported sales. This subset of 38 products received \$13.79 million of the total funding.** However, sales are not the only or even the best indicator of product development progress, since the theory of change is different among projects.

**Recommendation 1:** The evaluation team does not have a recommendation directly related to this finding.

**NYSERDA Response to Recommendation:** N/A



**Finding 2: The total annual energy savings for 18 selected commercialized products is 1.36 million MMBtu based on sales through 2021.** This energy savings translates to 165,462 MTCO<sub>2e</sub> of greenhouse gas reduction. Further, this 1.36 million MMBtu/year is comprised of electric savings of 289,710 MWh/year inventoried across seven products and 373,211 MMBtu/year from two projects that saved transportation fuel (gasoline and diesel). Within NYS, the total annual energy savings is estimated to be 77,484 MMBtu, which translates to of 9,927 MTCO<sub>2e</sub> of reduced greenhouse gas.

**Table ES-2. Annual electric savings, transportation fuel savings, and greenhouse gas reductions of selected products by technical focus area (n=18)**

Technical focus area <sup>a</sup>	Estimated electric savings (MWh/yr)	% of total	Estimated fuel savings (MMBtu/yr)	% of total	GHG Reduction <sup>2, 3</sup> (MTCO <sub>2e</sub> )	% of total
<b>Clean Transportation Innovation</b>	5,498	2%	373,211 <sup>4</sup>	100%	155,679	55%
<b>Building Innovations</b>	284,211	98%	0	-	124,244	44%
<b>Renewables Optimization</b>	0	-	0	-	824	0%
<b>Total</b>	289,710	100%	373,211	100%	280,747	100%

<sup>a</sup> The technical focus area Grid Modernization is not shown on this table because there were insufficient product data to assess GHG impact for this area.

**Recommendation 2:** Given the scale of impacts uncovered through this evaluation, future evaluations should continue to assess energy impact value from these projects.

**NYSERDA Response to Recommendation:** Pending. The NYSERDA Evaluation and Innovation and Research teams will consider future studies to evaluate the energy impacts from product development investments.

**Finding 3: Many developers identified that NYSERDA’s strengths come through both its engaged NYSERDA project managers and through the connectivity between NYSERDA funding opportunities.** For instance, NYSERDA is helpful with making connections within industry – establishing partnerships, acquiring customers, and collaborating at conferences and

<sup>2</sup> Projected Emission Factors for New York State Grid Electricity, NYSERDA Report #22-18. August 2022. <https://www.nyserdera.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-18-Projected-Emission-Factors-for-New-York-Grid-Electricity.pdf>

<sup>3</sup> Fossil and Biogenic Fuel Greenhouse Gas Emission Factors, NYSERDA Report # 22-23. Revised May 2023. <https://www.nyserdera.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-23-Fossil-and-Biogenic-Fuel-Greenhouse-Gas-Emission-Factors.pdf>

<sup>4</sup> Fossil fuel consumption estimations for the evaluated projects could not be verified through end-user data.

with industry groups. Similarly, NYSERDA experts, through the Entrepreneurs-in-Residence and other expertise, provided critical assistance to help product development.

**Recommendation 3: NYSERDA should continue to build on these strengths to enable more product developers to make the necessary connections with NYSERDA offerings that can promote collaboration and provide technical expertise.** To enable a clearer funding path for continued project development, many developers cited an opportunity for NYSERDA to provide funding in phase-gates or through flexible contracting means to support continued successful research and development (R&D) efforts or pivot to more beneficial activities. Similarly, developers recommended that NYSERDA establish company Master Services Agreements to take a portion of the re-application burden out of subsequent funding opportunities. Finally, strong NYSERDA project manager support has helped developers to make key decisions and refine their approach as their R&D activities evolve, particularly in early stages of development.

**NYSERDA Response to Recommendation:** Implemented. The NYSERDA Innovation and Research team already follows this recommendation and will continue to do so.

**Finding 4: NYSERDA incentivizes development of a wide variety of products, and product designs frequently change over the course of their development. In addition, it can be challenging for evaluators to obtain product information from product developer firms. Given these factors, evaluators face difficulties obtaining data needed to evaluate energy impacts of NYSERDA's product development support.** Specifically, different products employ different technologies, access different markets, yield different benefits, and are developed by different firms; relatedly, obtaining usable documentation on competitor products and unit energy benefits to conduct impact evaluation across these products can be difficult for the evaluator to compile and analyze. In addition, since products oftentimes change during development - even if these details are documented during the product development project - product information may not be applicable by the time the product's impact is evaluated several years after project completion. Further, NYSERDA requires product developer firms to submit annual metrics collection surveys, and due to time constraints faced by some firms, some firms do not respond to the evaluator's data collection requests, further limiting the data the evaluator can collect.

**Recommendation 4a: Define a process that enables Innovation and Research staff to establish and record key details about the product as will be needed to evaluate the product's impacts.** This data could be collected from the developer by the NYSERDA project manager or a contractor and distilled into a brief summary for more robust impact estimation and

future evaluation. The necessary information could be collected as part of developer submissions, or a deliverable submitted by the product developer during the project. Furthermore, the Salesforce project records for these projects could be used to document the following information, included but not limited to:

1. Describe the disruptive potential of the product and the market it will disrupt.
2. Define a unit of sale of the product NYSERDA is funding for development.
3. Define the product, if any, that the incentivized product would displace or replace in the market, i.e. the competitor product, that would serve as the performance baseline for comparison of energy or other benefits.
4. Describe the specific benefits of the product in terms of energy, economic, waste, health, comfort and other impacts, estimating quantities of benefits where possible. The existing “Project Benefits” field in Salesforce could be used to address this need.

**NYSERDA Response to Recommendation:** Pending. NYSERDA Innovation and Research management adopts the recommendation, in so far as it can be added to the process of data collection through the project at the appropriate time to generate most valuable and consistent responses. Feedback will be collected at an appropriate time in the project timeline.

**Recommendation 4b: Instead of interviewing Innovation and Research staff, NYSERDA should use a survey instrument adapted from the interview guide developed for this evaluation to better capture project manager knowledge of the products’ relative impacts, disruptive potential, project successes, development progress and trajectory, anomalies in the sales data, and openness to being contacted to facilitate the evaluation.** This survey could be sent to Innovation and Research project managers prior to in-depth file review activity or indirect impact methodology development to improve the efficiency and completeness of data collection.

**NYSERDA Response to Recommendation:** Pending. The outcome of more robust information (itemized in the recommendation) at project close may be more effectively collected directly from the developer through a data collection form. The requirement for completion of this form would be transparently communicated to project partners at the outset of project agreement.

**Recommendation 4c: NYSERDA should consider requiring product developer firms to commit to supporting NYSERDA in evaluating their products, by way of an attestation signed at the time the NYSERDA investment is approved.** NYSERDA already requires proposers to sign attestations when initiating a project, and an additional attestation committing the product developer to respond to an evaluator’s survey outreach and interview attempts at a later date could increase the evaluator’s chances of obtaining a response from the firm.

**NYSERDA Response to Recommendation:** Pending. NYSERDA product development contractors already agree as part of contracting that they will support evaluation efforts. However, Innovation and Research could clarify and expand on guidance to the product developer firms in their terms and conditions to clarify the support they will be asked to provide later and what they will be asked report and could reinforce these requirements as part of project kickoff and closeout meetings.

# 1 Introduction

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This evaluation assesses the impacts of Innovation and Research product development projects funded through the portfolios such as System Benefits Charge (SBC), System Benefits Charge – Technology and Market Development (SBC4), Clean Air Interstate Rule (CAIR), Clean Energy Fund (CEF) and New York State Statutory Research and Development Funds (NYRD). Projects selected for the study had purchase order close dates between Q1 2016 and Q4 2020. Project start dates varied, with some initiated as early as 2000. The impact evaluation team, led by DNV with partner APPRISE, opted not to evaluate projects that were not awarded NYSERDA funds in this study, but future evaluations may find such an opportunity.

This impact evaluation is the first study of its kind by NYSERDA, insofar as it seeks to assess impacts of NYSERDA’s support to project partners to develop early-stage products prior to demonstration of these products and prior to widespread market adoption.

## 1.1 Program description

NYSERDA’s Innovation and Research portfolio aims to advance the development of innovative, reliable, affordable, efficient, clean energy technologies, and to increase their market acceptance and adoption.

NYSERDA’s Product Development projects aim to support the development of commercially viable products, primarily generating benefits through the sale and use of the products, and sometimes through affecting transformative change in markets resulting from the introduction of disruptive technologies.

Projects were selected through at least 40 distinct solicitations. The projects are categorized into the following technical focus areas specific to the technological progress they promote. Technical focus areas were established over time in support of New York State’s climate equity and decarbonization goals.

- **Building Innovations**<sup>5</sup> supports new technology to lower building emissions and energy that will decarbonize the building stock in NY.
- **Clean Transportation Innovation**<sup>6</sup> enhances public transit, zero-emission vehicles, and smart mobility to increase use of electric vehicles and low-carbon transportation options.

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<sup>5</sup> <https://www.nyserdan.y.gov/All-Programs/Innovation-at-NYSERDA/Focus-Areas/Advanced-Buildings>

<sup>6</sup> <https://www.nyserdan.y.gov/All-Programs/Innovation-at-NYSERDA/Focus-Areas/Clean-Transportation>

- **Grid Modernization**<sup>7</sup> invests in high-performing grid, future-proofing the grid, grid flexibility, and the grid resilience needed to achieve New York State’s Climate Act goals for a 70% renewable grid in 2030 and a GHG-free electric grid in 2040.
- **Renewables Optimization**<sup>8</sup> targets at least six gigawatts of energy storage by 2030 through hydrogen, electrical, mechanical, chemical, and thermal-electric storage technology and product development.

## 1.2 Evaluation objectives and methods

A primary goal of this evaluation was to assess the energy and non-energy impacts of project investments funded by NYSERDA to overcome barriers to organizations developing innovative clean energy products and technologies. Table 1-1 summarizes the objectives of the evaluation, as well as data sources used to meet those objectives. All impacts of the research and development projects are defined as “indirect” because development was supported by NYSERDA, rather than direct equipment purchases or contractor installations provided by a program.

**Table 1-1. Study objectives, research questions, and methods**

Impact evaluation question	Research objective	Data sources and evaluation methods
Identify disruptive products	Identify whether products have already or are expected to create, scale, or disrupt a market	Project tracking data and project file reviews, NYSERDA Project Manager Interviews, Developer survey, Developer interviews
Validate energy savings	Annualized first-year electric (kWh), natural gas (MMBtu), and other energy savings	Developer survey, Developer interviews
Estimate economic benefits	Total energy bill cost savings (\$) associated with the NYSERDA funding for these projects	Developer survey, Developer interviews
	Benefits to the Contractor company that developed the product, including ROI, sales and revenue generated (\$), and jobs created <sup>9</sup>	Developer survey
	ROI for NYSERDA (ratepayer funds) investing in product development projects (i.e., the ratio of monetized benefits from all product development projects divided by NYSERDA’s direct investment in dollars) <sup>10</sup>	Developer interviews
	Economic benefits (including but not limited to revenue and/or cost savings) to market actors affected by the product other than the contractor, including benefits to	Developer survey, Developer interviews

<sup>7</sup> <https://www.nyserdera.ny.gov/All-Programs/Innovation-at-NYSERDA/Focus-Areas/Grid-Modernization>

<sup>8</sup> <https://www.nyserdera.ny.gov/All-Programs/Innovation-at-NYSERDA/Focus-Areas/Energy-Storage>

<sup>9</sup> The evaluation attempted to collect information sufficient to calculate an ROI benefit to the Contractor company and NYSERDA investments, but limitations to the data collected yielded only a portion of the benefits and costs to Contractors and NYSERDA. Therefore, the evaluation reports a portion of the economic impacts but do not report a robust ROI.

<sup>10</sup> See footnote 5.

Impact evaluation question	Research objective	Data sources and evaluation methods
	low-to-moderate income households and disadvantaged communities <sup>11</sup>	
Estimate non-energy, noneconomic benefits	Evaluate whether products have significant non-energy, non-economic benefits to users (e.g., air quality, time saved, improved usability)	Developer survey, Developer interviews
Identify barriers and catalysts to product development	Understand the degree to which product development teams consider NYSERDA to be an important contributor in their decision to undertake and complete a product development project	Developer survey
	Counts, NYSERDA investment amounts (\$) and private investment amounts (\$) <sup>12</sup> of NYSERDA-funded product development projects that were also supported by one of NYSERDA's Technology to Market programs	Project tracking data and project file reviews
	Understand what types of NYSERDA solicitations and approaches were associated with successful commercialization of products and/or high product sales	Project tracking data and project file reviews, Developer survey
	Identify other factors either leading to or hindering commercialization and/or sales, and their relative strength	Developer survey
	Identify barriers and catalysts to the replication of developed products by nonparticipant companies	Developer survey
Process Improvement	Identify process improvements and recommendations for improving NYSERDA Innovation and Research funding opportunities based on feedback from participating developers	Developer survey
Characterize projects, products, sales, developers, and markets	Types of developer companies funded through these projects	Project tracking data and project file reviews, NYSERDA Project Manager Interviews
	Technology types and end-use customer sectors of products developed as part of these projects (Data collection includes secondary research)	Project tracking data and project file reviews, NYSERDA Project Manager Interviews
	Types and locations of customers who purchased products developed as part of these projects, including breakdown of which customers were low-to-moderate-income and/or located in disadvantaged communities	
	For products with disruptive potential and/or high unit energy or non-energy benefits, characterize the potential and stock of the market for the product (Data inconclusive)	Developer survey

<sup>11</sup> The developer survey and developer surveys explicitly asked developers whether benefits were realized that impacted low-to-moderate income households and disadvantaged communities. While these benefits were reported, sufficient data was not obtained that could discern the distinct economic benefit to these groups, therefore, these benefits are not reported.

<sup>12</sup> Private investment amount data is considered proprietary in many cases and could not be collected by the evaluation.

## 2 Results

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The results of this evaluation first summarize the characteristics of the full project population, then review the status of product development progress for products whose developers shared that information. Next, the results detail energy, non-energy and economic impacts for a set of products selected for their high impact and/or market disruption potential. Next the section summarizes feedback from product developer partners relating to process satisfaction and opportunities for program improvement and barriers to product development, and participation in NYSERDA's Technology-to-Market programs. Lastly, key findings and recommendations drawn from the results of the evaluation are highlighted at the end of this section.

### 2.1 Product population summary

Table 2-1 characterizes the full population of projects that ended between 2016 and 2020 through product investment and commercialization (sales) reported by product developer partners by technical focus area over the period of evaluation. The \$109 million invested in this population of projects, 13% of total NYSERDA funds resulted in sales. Sales as a measure of commercialization was reported for 23% of the 166 projects. Figure 2-1 further illustrates the proportion of projects in each technical focus area that contribute to the 166 executed projects, and within those groups, the proportion that resulted in sales.

In terms of NYSERDA investments, the largest investment was in Renewables Optimization (74% of total NYSERDA funds supported 35% of projects) and higher relative award/loan value (\$1.385 million average award). Projects categorized in this technical focus area for the evaluated period also had the lowest sales rate (about 6% of overall funds resulted in sales for this focus technical area). The Grid Modernization technical focus area was awarded the lowest overall funding amount within the evaluated set of projects (4% of projects) and led to sales for 2% of overall I&R funding, with all sales resulting from a single project. The Building Innovations technical focus area produced sales for 4% of overall funding, and Clean Transportation Innovation projects resulted in some form of reported sales for 4% of overall funding.



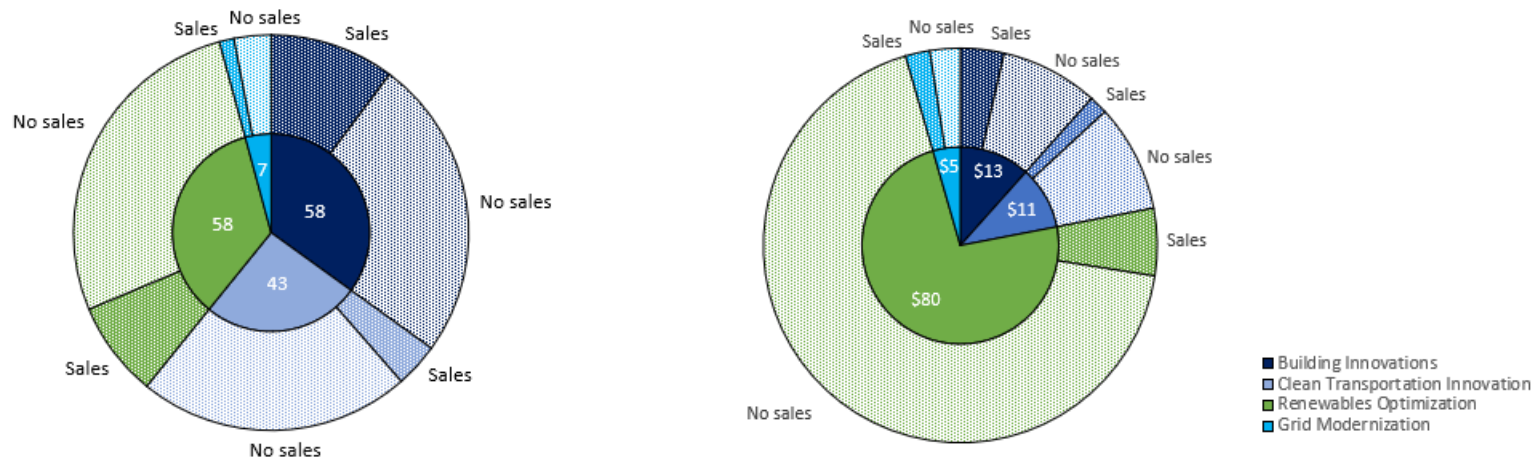
**Table 2-1. Population characterization: Product investment and reported sales by technical focus area (n=166 projects)**

Technical focus area	Count of projects			% of projects overall	% of technical focus area projects		Total NYSERDA funding (\$1,000)			Avg/project (\$1,000)	% of NYSERDA funding	% of technical focus area funding	
	Total	Sales	No sales		Sales	No sales	Total	Sales	No sales			Sales	No sales
<b>Building Innovation</b>	58	17	41	35%	10%	25%	\$12,685	\$3,920	\$8,765	\$219	12%	4%	8%
<b>Clean Transport. Innovation</b>	43	6	37	26%	4%	22%	\$11,303	\$1,665	\$9,638	\$263	10%	2%	9%
<b>Renewable Opt.</b>	58	13	45	35%	8%	27%	\$80,318	\$6,020	\$74,298	\$1,385	74%	6%	68%
<b>Grid Mod.</b>	7	2	5	4%	1%	3%	\$4,900	\$2,190	\$2,710	\$700	4%	2%	2%
<b>Total</b>	<b>166</b>	<b>38</b>	<b>128</b>	<b>100%</b>	<b>23%</b>	<b>77%</b>	<b>\$109,205</b>	<b>\$13,795</b>	<b>\$95,410</b>	<b>\$658</b>	<b>100%</b>	<b>12%<sup>13</sup></b>	<b>88%</b>

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<sup>13</sup> Total percent of funding for sales and no sales does not match the sum of program area proportions due to rounding error.

**Figure 2-1. Project population by technical focus area: total, proportions with and without sales. NYSERDA funding by technical focus area: total proportion with sales, and proportion without sales (\$million).**



The population summary shows NYSERDA investments and sales as an indicator of commercialization for which data was available for all projects in the population. However, sales are not the only or even the best indicator of product development progress, since the theory of change is different between products. Different pathways to commercial and technology readiness are appropriate for different products to overcome their specific barriers, and progress along these paths often takes time. Further, some Innovation and Research projects have indirect impacts through increasing awareness of novel technologies among participants and other stakeholder groups. Increased awareness may ultimately lead to additional engagements with NYSERDA or product replications by the same or additional organizations.

## **2.2 Developer survey respondent self-reports of product status**

Seeking to represent the development pathways of the products in the evaluated population, a survey of 109 developers self-reported product development status in the categories of development completed, ongoing, or abandoned. The survey asked developers to confirm sales reported in the metrics survey. For completed and ongoing development reports, the survey then asked whether developers planned to commercialize. Figure 2-2 represents the development outcomes and continued efforts by developer companies toward commercialization of products for 109 respondents. Within this group, nearly half (48%) of products' development was completed (53 products). Another 30 products (28%) have abandoned development, while another 24% continue development (26 products). Within the set of products that have completed development, 35 product developers confirmed sales previously reported in the NYSERDA metrics survey, and eight products still have plans to commercialize.

**Figure 2-2. Product development status for all products with developer survey responses (n=109)**

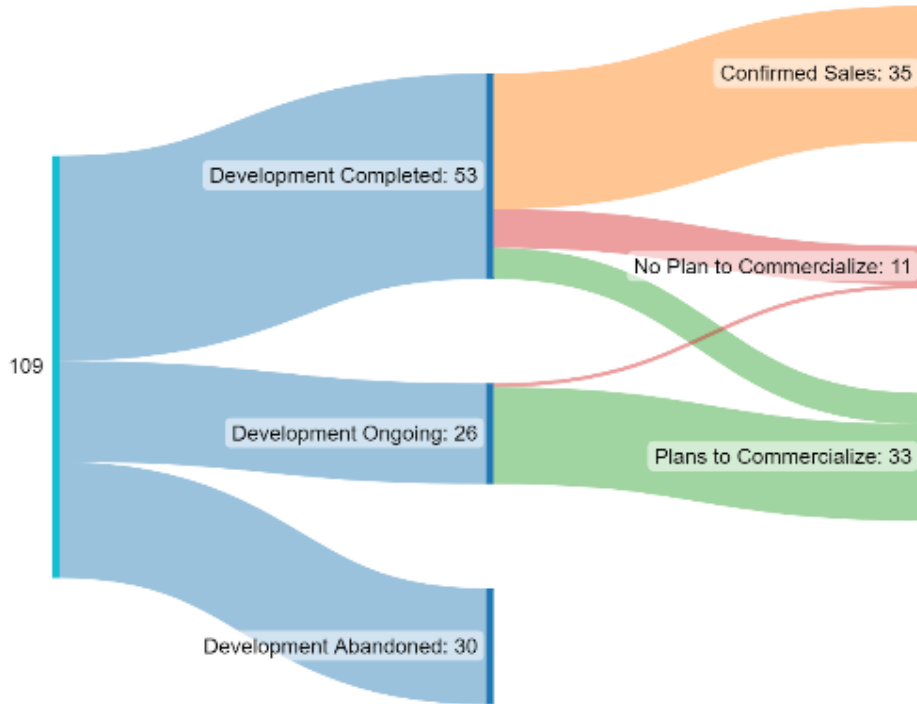


Table 2-2 shows this same set of product status information by technical focus area. Technical focus area product status mirrors that of the overall group for the most part, with more than half of project development completed. The exception is Renewables Optimization, with a slightly lower 37% product completion rate (14 out of 38 products) within this pool of developer survey respondents.

**Table 2-2. Product development status by technical focus area (n=109)**

Technical focus area	Complete	Ongoing	Abandoned	Total	Products with estimated indirect impacts <sup>14</sup>
Building Innovations	20	8	10	38	8
Clean Transportation Innovation	15	6	6	27	3
Grid Modernization	4	0	2	6	1
Renewables Optimization	14	12	12	38	6
Totals	53	26	30	109	18

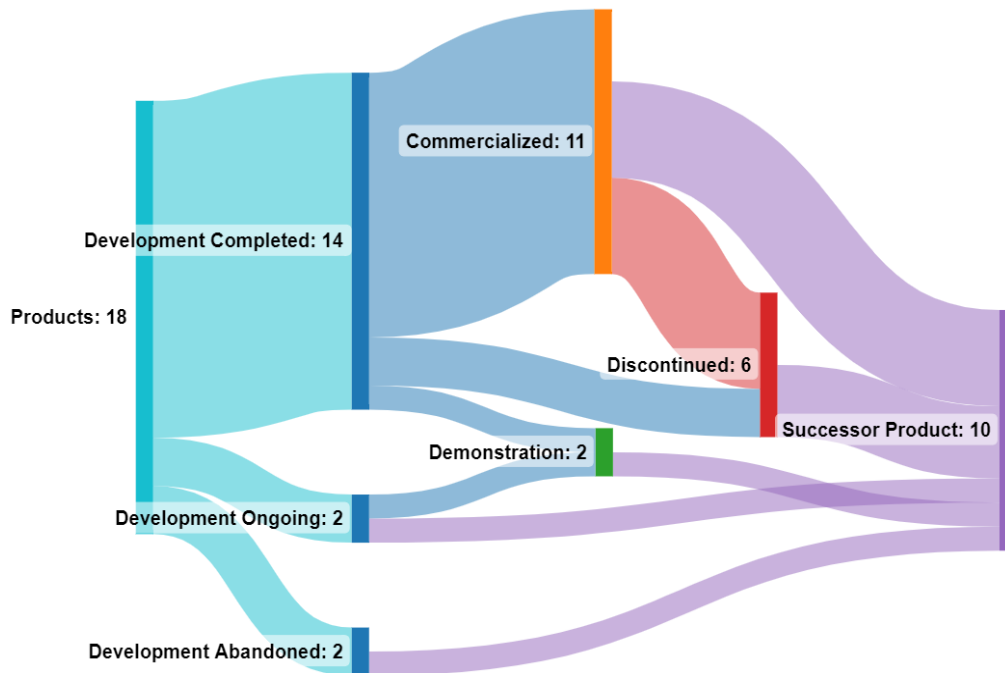
<sup>14</sup> Indirect impacts were evaluated for 18 products or 19 projects in the overall population.

### 2.3 Estimated indirect impact results

This section presents the indirect impacts of Innovation and Research funding to market disruption potential, energy, economic, and non-energy/non-economic impacts for a selection of *18 products that reported sales* (through the metrics and developer surveys) *and were also noted as having high disruptive potential and/or high impact potential in NYSERDA project manager interviews.*

Product development and commercialization take time, and several of these products are still in development or testing. As such, the estimated impacts herein are considered the lower bound of impacts for the 18 products insofar as more products are expected to complete development and reach sales that affect the market. This storyline of product development, demonstration, and commercialization is depicted in Figure 2-3. Of the 18 products shown at the start of the flow, 10 ultimately resulted in one or more successor products<sup>15</sup> that are either in development or commercialized themselves.

**Figure 2-3. Product development status for products with estimated indirect impacts (n=18)**



<sup>15</sup> Successor Product: Next generation product planned for or in commercialization. The evaluation team calculated impacts for some successor products, where they were known, and those impacts are available in product-specific documents but are not catalogued in the estimations for program activity related to funded products.

Fourteen of the 18 products were reported to have completed development, two are ongoing, and another two were abandoned after some sales. Of the 14 products with completed development, 11 products were fully commercialized by 2022, and six were discontinued after completion. While not readily apparent from the figure, seven products (representing 15% of the cumulative sales data asserted in this impact evaluation) continue to sell to the market in the state incentivized by NYSERDA, thus indirect impacts will grow and continue to benefit the market. Two of the projects led to demonstration of the technology.

As outlined in Section 3.2, the determination of impacts for products in the development stage is difficult for a number of reasons, notably that funding directly impacts product development. All other impacts are indirect. The variety of product end-uses and impact categories dictate that product-specific impact results cannot be meaningfully expanded to estimate the impacts of the full population of products. Finally, limitations to collection from developers, and especially from end-users who could verify their experience or a basis for measurement of impacts, mean that these estimations are “verified” for only three of the 18 products. As described elsewhere, end-user contact information was largely unavailable because developers were either unable (due to privacy agreements or unavailability of data) or unwilling to provide customer contact information. As a result, the impacts are largely self-reported by developers, and do not represent a statistically significant verified result for the larger population within the evaluation scope. Because of this and other limitations, the findings from this evaluation should not be considered representative of the overall portfolio of Innovation and Research investments, nor should it be considered representative of the overall portfolio of Innovation and Research product development investments in particular.

### **2.3.1 Estimated indirect energy impacts**

The total annual energy savings for commercialized products<sup>16</sup> within the selected product set is estimated to be 1.36 million MMBtu, based on sales through 2021.<sup>17</sup> This energy savings translates to 165,462 MTCO<sub>2</sub>e of greenhouse gas reduction. The contribution of impacts between electric savings and transportation fuel savings are shown in Figure 2-4. Further, this 1.36 million MMBtu/year in indirect energy impacts translates to electric savings of 289,710 MWh/year inventoried across seven products and 373,211 MMBtu/year from two projects that saved

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<sup>16</sup> From the 11 commercialized products described in Section 2.3.1, energy savings resulted from eight products. Seven products resulted in electric savings, and two products resulted in fuel savings (one included in the electric savings product count).

<sup>17</sup> Product installation sometimes occurred later.

transportation fuel (gasoline and diesel). This transportation result comes primarily from a work zone safety project that avoided a large number of automobile accidents and thus saved fuel consumption during idle time on a high-traffic interstate.

Within NYS, the total electric savings is estimated to be 77,484 MMBtu/year, with a decrease of 9,927 MTCO<sub>2</sub>e of greenhouse gas.

**Figure 2-4. Total energy savings (MMBtu) through 2022 for selected products (n=18)**

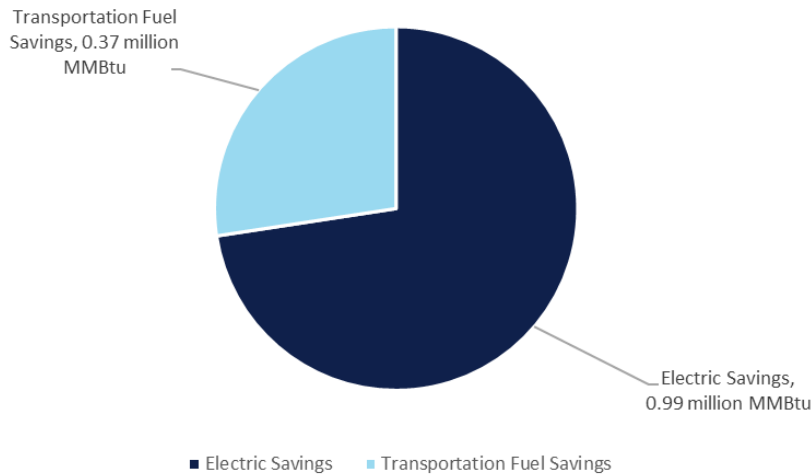


Table 2-3 breaks out the evaluated total annual electric energy savings and transportation fuel savings by NYSERDA funding portfolio.

**Table 2-3. Total annual electric and transportation fuel savings by NYSERDA funding portfolio**

Funding portfolio	Electricity savings, gross annual (MWh)	Gasoline savings, gross annual (MMBtu)	Diesel savings, gross annual (MMBtu)	Total MMBtu	Total TBtu
SBC	5,676	0	0	19,367	0.02
SBC4	284,024	0	0	969,129	0.97
CAIR	0	0	0	0	0.00
CEF	0	0	0	0	0.00
NYRD	11	209,649	163,562	373,247	0.37
<b>TOTAL</b>	<b>289,710</b>	<b>209,649</b>	<b>163,562</b>	<b>1,361,743</b>	<b>1.36</b>

### 2.3.2 Energy savings and GHG reduction by technical focus area

The distribution of indirect impacts by technical focus area are shown for energy, economic benefits to end-users, and other impacts in the tables below. Table 2-4 shows the electric energy savings, fuel savings, and related greenhouse gas reductions by technical focus area for the selected products. Table 2-5 shows electric energy savings, fuel savings, and related greenhouse

gas reductions by focus area within the jurisdiction of New York State. Electric savings come exclusively from the Clean Transportation Innovation and Building Innovations technical focus areas, while a large fuel savings logically follows from the decarbonization of transportation. Additional, but less quantifiable, energy impacts to those shown here result from products that provide new infrastructure, improved functionality, or stability for additional renewable capacity to electricity distribution systems.

**Table 2-4. Annual electric savings, transportation fuel savings, and greenhouse gas reductions of selected products by technical focus area (n=18)**

Technical focus area <sup>a</sup>	Estimated electric savings (MWh/yr)	% of total	Estimated fuel savings (MMBtu/yr)	% of total	GHG Reduction <sup>18,19</sup> (MTCO <sub>2</sub> e)	% of total
<b>Clean Transportation Innovation</b>	5,498	2%	373,211 <sup>20</sup>	100%	155,679	55%
<b>Building Innovations</b>	284,211	98%	0	-	124,244	44%
<b>Renewables Optimization</b>	0	-	0	-	824	0%
<b>Total</b>	289,710	100%	373,211	100%	280,747	100%

<sup>a</sup> The technical focus area Grid Modernization is not shown in this table because there were insufficient product data to assess GHG impact for this area.

**Table 2-5. Annual electric savings, transportation fuel savings, and greenhouse gas reductions of selected products by technical focus area in New York State (n=18)**

Technical focus area <sup>b</sup>	Estimated electric savings (MWh/yr)	% of total	Estimated fuel savings (MMBtu/yr)	% of total	GHG reduction (MTCO <sub>2</sub> e)	% of total
<b>Clean Transportation Innovation</b>	1,037	5%	0	-	453	5%
<b>Building Innovations</b>	21,671	95%	0	-	9,474	95%
<b>Total</b>	22,708	100%	0	-	9,927	100%

<sup>b</sup> The technical focus areas Renewables Optimization and Grid Modernization are not shown in this table because there were insufficient product data to assess electric and fuel impacts for these areas.

<sup>18</sup> Projected Emission Factors for New York State Grid Electricity, NYSERDA Report #22-18. August 2022. <https://www.nysERDA.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-18-Projected-Emission-Factors-for-New-York-Grid-Electricity.pdf>

<sup>19</sup> Fossil and Biogenic Fuel Greenhouse Gas Emission Factors, NYSERDA Report # 22-23. Revised May 2023. <https://www.nysERDA.ny.gov/-/media/Project/Nyserda/Files/Publications/Energy-Analysis/22-23-Fossil-and-Biogenic-Fuel-Greenhouse-Gas-Emission-Factors.pdf>

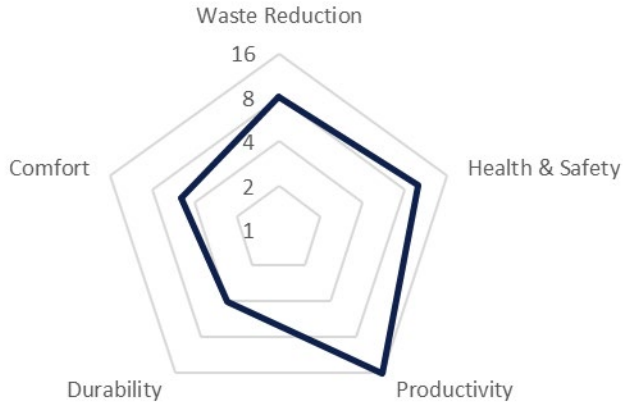
<sup>20</sup> Fossil fuel consumption estimations for the evaluated projects could not be verified through end-user data.



### 2.3.3 Non-energy impacts

Instances of non-energy impacts demonstrated by products in the selected set are shown qualitatively in Figure 2-5. Impacts were inventoried quantitatively in many cases on a product level by more refined impact categories. Productivity and health/safety impacts occurred most frequently among the selected product set.

**Figure 2-5. Overall instances of qualitative impacts by category for evaluated products (n=18)**



The productivity improvements include reduction in radar interference (for aircraft that must navigate over or around wind turbines), increased generator drivetrain efficiency, more versatile applications of commercial lighting technology, better optimized energy storage integration and electricity delivery, building load control and curtailment, improved EV charging user experience and adoption, avoided material defects, and high purity hydrogen generation. Health and safety impacts include improved safety, hazard reduction, improved air traffic safety, improved health, and avoided accidents. The mechanisms for these improvements vary from improved lighting, reduced contamination by hazardous or infectious material, prevention of vandalism and theft, and tools or information that improves end-user's capability to navigate around hazards. The five products with waste reduction bridged material savings in plastics, ceramic material, e-waste, and grid-scale energy storage batteries (through both recyclable replacement technology and longer lifespans). One product seeks to displace an estimated 900,000 MMT/year in plastic packaging with a compostable material.

### 2.3.4 Economic impacts

The evaluation conducted a cost-benefit analysis using information obtained through desk review of project files and interviews with developer companies, but in most cases validated cost data from end users or other third-party sources were not available. As such, the benefits for this

evaluation should not be used to represent a validated ROI to NYSERDA (ratepayers) or developers. However, this evaluation did develop modeled estimates of economic benefits using desk review of project files and interviews with developers.

The economic impact to date (end of year 2022) for commercialized products is estimated through the ratio of modeled end-user benefits to the total that NYSERDA invested. Eighteen successful products are estimated to have returned a minimum of \$66.5 million in economic impacts from a \$7.23 million NYSERDA investment. Thus, gross consumer benefits are estimated to be at least 9.2 times the NYSERDA investment for the subset of products. Estimated economic benefits to end-users are limited to fuel/electric bill savings, O&M costs, avoided replacements, construction, and accident avoidance. Some of these products achieved benefits to consumers that we could not quantify that would have increased this ratio. For instance, the developer survey responses indicated that many companies benefited from jobs increases due to NYSERDA funding, but this cumulative effect could not be reliably quantified. Some of the more disruptive products achieved benefits to producers through larger-scale changes in supply and demand. Further, some had impacts on secondary or related markets outside the direct product market and may have achieved added benefits in those markets. The investment value is limited to NYSERDA funding; other funding sources, including company investments and end-user investments in the product are not included.<sup>21</sup>

The full evaluated population of products received \$109.2 million in NYSERDA investment. Estimated consumer benefits for the subset of products result in 61% of the total NYSERDA investment for the full population of projects. This estimate represents a *lower bound* of the impact of the population of products' commercialization, because more products have sales than those investigated in detail, products in this pool will continue to have sales, and more products will commercialize in the evaluated population. The full economic impact cannot be estimated without knowledge of these additional factors.

The contribution of different impact types to the economic benefits that could be monetized are shown in Table 2-6. Further instances of qualified impacts are summed in the table, demonstrating opportunities for further economic impact that could not be inventoried with the

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<sup>21</sup> Economic benefit estimates only consider NYSERDA investment and consumer benefits that the evaluation team could quantitatively estimate, that occurred in NYS and that impacted NYSERDA, the product development firm, and its customers. There may have been costs and benefits experienced by other organizations in the market that have not been accounted for.

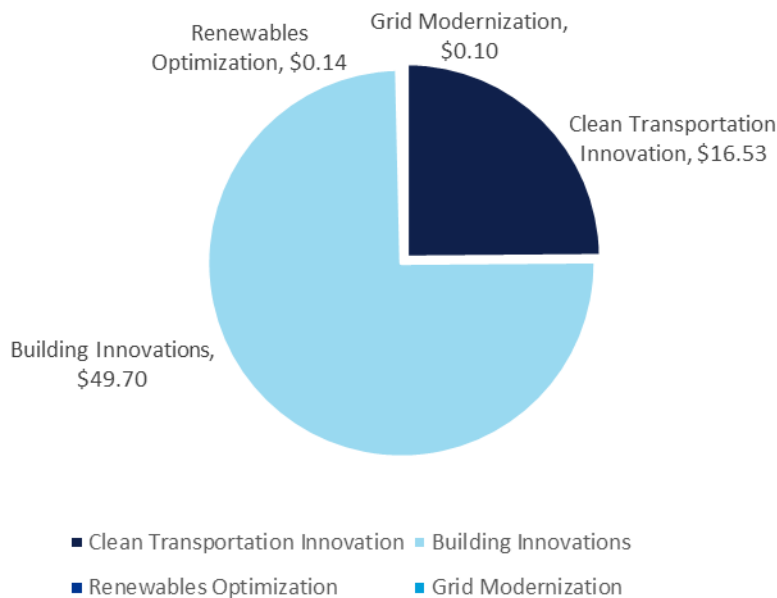
collected data. By far the highest contribution of economic impacts comes from avoided energy bill cost, followed by avoided construction cost.

**Table 2-6. Total annual economic impacts per impact category (n=18)**

Economic impact categories	Total economic impact for end-users (\$1,000/yr)	Additional qualified impacts (Instances)
Avoided energy bill cost	\$59,083	0
Reduction in levelized cost of energy	\$0	1
Demand charges reduction	\$0	1
Avoided replacement cost	\$2,996	1
Reduced O&M cost/opex cost	\$55	1
Reduced capex cost	\$223	0
Reduction in product cost/system cost	\$6	1
Avoided manufacturing cost (including labor)	\$0	2
Avoided electric utility infrastructure cost/construction cost	\$4,101	1
<b>Total</b>	<b>\$66,465</b>	<b>8</b>

Figure 2-6 shows annual economic impacts to end-users. These impacts are highest for Buildings Innovation technical focus area projects, closely followed by Clean Transportation Innovation projects.

**Figure 2-6. Total annual end-user economic benefits of selected products by technical focus area (million \$) (n=18).**



## 2.4 Developer feedback: Satisfaction and recommendations

The developer survey asked developers about their satisfaction with their participation, focusing on the grant application process, technical assistance, communications on and after grant status, and overall for the solicitation they participated in. Table 2-7 shows the satisfaction results.

Overall, developers reported high satisfaction across all technical focus areas. The team analyzed whether higher project funding or projects with more commercial success resulted in higher satisfaction scores, but neither variable was correlated with higher satisfaction. Satisfaction was reported by developers on a scale of 1 to 5, with 1 representing Very Dissatisfied and 5 representing Very Satisfied.

**Table 2-7. Innovation and Research initiative satisfaction**

Technical focus area	Grant application process (n=103)	Technical assistance (n=86)	Communication on grant status (n=101)	Communication after grant award (n=101)	Overall (n=104)
Building Innovations	4.0	4.0	4.0	3.9	4.0
Clean Transportation Innovation	3.9	4.0	4.3	4.3	4.4
Grid Modernization	4.3	4.2	4.7	4.8	4.3
Renewables Optimization	4.2	3.6	4.1	4.2	4.2
Total	4.0	3.9	4.2	4.2	4.2

Though satisfaction scores were high, developers highlighted several opportunities to improve participant satisfaction, including:

- **Streamline decision-making** with simpler application documents, quicker turnaround time for application review and from notice of award to contract so that contracting doesn't stall projects. Several developers identified that contracting slowed down their fast-moving research and development progress and that faster contracting could help them produce results faster. Suggestions included a Master Services Agreement<sup>22</sup> approach for companies with multiple funding opportunities, to avoid repeat vetting of companies, rather, focus reviews on project suitability for the solicitation's goals.
- **Provide more flexibility in funding across the stages of product development.** Developers cited changing needs as they progressed through research and development and sought more flexibility in funding and participation requirements such that they remain relevant as

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<sup>22</sup> Master Services Agreements are contracts that establish the foundational scope of relationships between parties, including terms and conditions, which enable more efficient vetting and contracting for future engagements.

research evolves. Stage-gate funding was cited as a useful example for early-stage projects to achieve milestones and seamlessly proceed to later stage funding, as appropriate. Developers asked for more NYSERDA willingness to modify contracts of design flexibility into the contract. For example, if partners or subcontractors change through the development process, or if research learnings necessitate project pivots, the contract could be flexible to that change. One mechanism for this flexibility would be a focus on outcomes rather than process.

- **Better communication after grant awards and about additional funding opportunities.** While some project managers received kudos for their knowledge and attentive leadership, many developers indicated they would have liked more engagement and support from the NYSERDA project manager and were unaware of other funding opportunities. Recommendations included a handbook or guidebook about what funding is available, what is upcoming, and how to go out and get it, and more personalized attention for appropriate opportunities, rather than generic emails that can be overlooked. Similarly, more communication related to specific tasks and milestone completion documentation needs, and more follow-up after project completion would help with overcoming barriers to development.
- **Provide more market intelligence and expertise to support developers.** This support was highly appreciated where provided and was highlighted as area where more could be done.
- **Foster collaboration within New York and throughout the industry.** Beyond funding, this was the key area where NYSERDA is understood to have extensive networks and could assist developers in making connections.

## 2.5 Developer feedback: Barriers to product development

The developer survey asked about the primary barriers to successful product development. Key barriers included:

- **Insufficient funding.** This was the most common barrier identified by developers that inhibited progress. Many of the companies funded through these grants are small and rely on NYSERDA and other agencies to support their early-stage research.
- **Lack of market opportunity and/or customer interest.** Many developers struggled to gain market traction, citing high costs, lack of customers or customer interest, and challenges breaking into difficult and risk averse industries. Where this problem occurs for a viable, beneficial product but the market is risk averse, NYSERDA could help with demonstrations and promotions of the valuable product as the state imprimatur.
- **Difficulty finding partnerships.** Developers faced challenges finding the right partners for their research and commercialization efforts. Additional networking and collaboration support could help match promising research with business needs.
- **Technical and technology limitations.** Some products could not overcome technical performance hurdles necessary to achieve commercial success. This is an expected outcome of R&D investments and shows that NYSERDA is funding products across a wide variety of industries and applications.

## 2.6 Developer feedback: Participation in NYSERDA Technology-to-Market programs

The developer survey investigated the extent to which developers are connecting with the available NYSERDA pathways to funding research and development efforts. The results are shown in Table 2-8. Forty-four percent (44%) of responding product developers indicated that they have participated in one of NYSERDA’s Technology-to-Market programs, either for different stages of the same product or for different products, with 82 total instances of additional program participation. The largest proportion of responding developers, 32%, had participated in the Entrepreneurs-in-Residence program to benefit from “expert mentors at no cost.” Another 13% (11 respondents) had been part of Clean Energy Incubators, which “provide early-stage climate tech companies with access to essential resources that catalyze company growth.” Manufacturing Corps Hardware Scale-ups were joined by another seven developers in the pool. These cohorts help “hardware-focused climate tech startup companies scale up manufacturing, grow teams, and develop supply chain relationships.” Another 38 developers were involved in “other” NYSERDA programs identified through open responses, including a wide variety of PONs and other funding opportunities, including other technical focus areas.

**Table 2-8. Developer participation in additional NYSERDA programs**

<b>NYSERDA Program</b>	<b>Product developer participation</b>
Entrepreneurs-in-Residence	26
Clean Energy Incubators	11
Manufacturing Corps (M-Corps) Hardware Scale-Up	7
Other	38
<b>Total</b>	<b>82</b>

## 2.7 Findings and recommendations

The results of this evaluation yield several key findings and recommendations to inform NYSERDA’s work.

### 2.7.1 Finding 1

**NYSERDA invested \$109M in product development projects that were completed between January 2016 and June 2020. This investment resulted in 38 successfully commercialized products that reported sales. This subset of 38 products received \$13.79 million of the total funding.** However, sales are not the only or even the best indicator of product development progress, since the theory of change is different among projects.

**Recommendation 1:** The evaluation team does not have a recommendation directly related to this finding.

**NYSERDA Response to Recommendation:** N/A

### 2.7.2 Finding 2

**The total annual energy savings for 18 selected commercialized products is 1.36 million MMBtu based on sales through 2021.** This energy savings translates to 165,462 MTCO<sub>2e</sub> of greenhouse gas reduction. Further, this 1.36 million MMBtu/year in indirect impacts is comprised of electric savings of 289,710 MWh/year inventoried across seven products and 373,211 MMBtu/year from two projects that saved transportation fuel (gasoline and diesel). Within NYS the total annual energy savings is estimated to be 77,484 MMBtu, which translates to 9,927 MTCO<sub>2e</sub> of reduced greenhouse gas.

**Recommendation 2:** Given the scale of impacts uncovered through this evaluation, future evaluations should continue to assess energy impact value from these projects.

**NYSERDA Response to Recommendation:** Pending. The NYSERDA Evaluation and Innovation and Research teams will consider future studies to evaluate the energy impacts from product development investments.

### 2.7.3 Finding 3

**Many developers identified that NYSERDA's strengths come through both its engaged NYSERDA project managers and through the connectivity between NYSERDA funding opportunities.** For instance, NYSERDA is helpful with making connections within industry – establishing partnerships, acquiring customers, and collaborating at conferences and with industry groups. Similarly, NYSERDA experts, through the Entrepreneurs-in-Residence and other expertise, provided critical assistance to help product development.

**Recommendation 3: NYSERDA should continue to build on these strengths to enable more product developers to make the necessary connections with NYSERDA offerings that then help promote collaboration, provide technical expertise, etc.** To enable a clearer funding path for continued project development, many developers cited an opportunity for NYSERDA to provide funding in phase-gates or through flexible contracting means to support continued successful research and development (R&D) efforts or pivot to more beneficial activities. Similarly, developers recommended that NYSERDA establish company Master Services Agreements to take a portion of the re-application burden out of subsequent funding

opportunities. Finally, strong NYSERDA project manager support has helped developers make key decisions and refine their approach as their R&D activities evolve, particularly in the early stages of development.

**NYSERDA Response to Recommendation:** Implemented. The NYSERDA Innovation and Research team already follows this recommendation and will continue to do so.

#### **2.7.4 Finding 4**

**NYSERDA incentivizes development of a wide variety of products, and product designs frequently change over the course of their development. In addition, it can be challenging for evaluators to obtain product information from product developer firms. Given these factors, evaluators face difficulties obtaining data needed to evaluate energy impacts of NYSERDA’s product development support.** Specifically, different products employ different technologies, access different markets, yield different benefits, and are developed by different firms; relatedly, obtaining usable documentation on competitor products and unit energy benefits to conduct impact evaluation across these products can be difficult for the evaluator to compile and analyze. In addition, since products oftentimes change during development - even if these details are documented during the product development project – product information may not be applicable by the time the product’s impact is evaluated several years after project completion. Further, NYSERDA requires product developer firms to submit annual metrics collection surveys, and due to time constraints faced by some firms, some firms do not respond to the evaluator’s data collection requests, further limiting the data the evaluator can collect.

**Recommendation 4a: Define a process that enables Innovation and Research staff to establish and record key details about the product as will be needed to evaluate the product’s impacts.** This data could be collected from the developer by the NYSERDA project manager or a contractor and distilled into a brief summary for more robust impact estimation and future evaluation. The necessary information could be collected as part of developer submissions, or a deliverable submitted by the product developer during the project. Furthermore, the Salesforce project records for these projects could be used to document the following information, included but not limited to:

1. Describe the disruptive potential of the product and the market it will disrupt.
2. Define a unit of sale of the product NYSERDA is funding for development.
3. Define the product, if any, that the incentivized product would displace or replace in the market, i.e. the competitor product, that would serve as the performance baseline for comparison of energy or other benefits.



4. Describe the specific benefits of the product in terms of energy, economic, waste, health, comfort and other impacts, estimating quantities of benefits where possible. The existing “Project Benefits” field in Salesforce could be used to address this need.

**NYSERDA Response to Recommendation:** Pending. NYSERDA Innovation and Research management adopts the recommendation, insofar as it can be added to the process of data collection through the project at the appropriate time to generate most valuable and consistent responses. Feedback will be collected at an appropriate time in the project timeline.

**Recommendation 4b: Instead of interviewing Innovation and Research staff, NYSERDA should use a survey instrument adapted from the interview guide developed for this evaluation to better capture project manager knowledge of the products’ relative impacts, disruptive potential, project successes, development progress and trajectory, anomalies in the sales data, and openness to being contacted to facilitate the evaluation.** This survey could be sent to Innovation and Research project managers prior to in-depth file review activity or indirect impact methodology development to improve the efficiency and completeness of data collection.

**NYSERDA Response to Recommendation:** Pending. The outcome of more robust information (itemized in the recommendation) at project close may be more effectively collected directly from the developer through a data collection form. The requirement for completion of this form would be transparently communicated to project partners at the outset of project agreement.

**Recommendation 4c: NYSERDA should consider requiring product developer firms to commit to supporting NYSERDA in evaluating their products, by way of an attestation signed at the time the NYSERDA investment is approved.** NYSERDA already requires proposers to sign attestations when initiating a project and an additional attestation committing the product developer to respond to an evaluator’s survey outreach and interview attempts at a later date could increase the evaluator’s chances of obtaining a response from the firm.

**NYSERDA Response to Recommendation:** Pending. NYSERDA product development contractors already agree as part of contracting that they will support evaluation efforts. However, Innovation and Research could clarify and expand on guidance to the product developer firms in their terms and conditions to clarify the support they will be asked to provide later and what they will be asked to report, and could reinforce these requirements as part of project kickoff and closeout meetings.

### 3 Methods

This impact evaluation employed several investigative techniques to understand the breadth of product development, market disruption, and energy and non-energy impacts achieved by the projects NYSERDA funded.

#### 3.1 Evaluation methods overview

Table 3-1 outlines the evaluation methods used for this study, summarizing the scope product set and data sources used in each area of evaluation.

**Table 3-1. Evaluation scope and data collection methods applied to product subsets**

	Product set	Count	Scope of study	Data sources
<b>Products population summary</b>	All	161	Characterize projects and products, funding, timing, responses to prior NYSERDA data collection	Project data Metrics survey NYSERDA project manager interviews
<b>Funding opportunity process Improvement</b>	Developer survey respondents	109	Assess overall rates of commercialization, satisfaction, barriers and catalysts, opportunities	Developer survey
<b>Market characterization</b>	Subset with disruptive or high impact potential	57	Characterize markets and disruptive potential of products that already or are expected to create, scale, or disrupt a market	Developer survey, NYSERDA project manager interviews
<b>Impact evaluation</b>	Subset with sales	18	Estimate energy savings/generation, economic, and non-energy impacts through verification data and/or customer interviews	Developer in-depth interviews
<b>Preliminary Findings Memos</b>	Subset with customer interviews or verification data	3	Detailed success stories, indirect impacts and market characterization	Customer interviews/ Verification data

#### 3.2 Challenges

This impact evaluation is the first of its kind by NYSERDA. Some challenges to achieving the research objectives of this evaluation included:

- **Product diversity:** A wide variety of projects incentivized by Innovation and Research are intended to advance a diverse set of products through different stages in their development.

The subset of evaluated product impacts cannot be expanded to the population of projects evaluated due to their uniqueness. Whereas many NYSERDA market development programs incentivize adoption of similar technologies across a large population of end users, NYSERDA's investments in product developer companies fund development of a wide variety of products that achieve dramatically different impacts from one another. Therefore, the impacts of specific products that the evaluator was able to estimate through this study cannot be used to extrapolate the impacts of other products in this population for which the evaluation team was unable to evaluate impacts.

- **Product developers who are in the research or startup stage:** As products are moved along development stages through NYSERDA projects, the work reveals performance or commercialization barriers that cause participants to shift course: either they discontinue development or they pivot to a new form, or even a successor product that better serves the function or the market.
- **Time to market:** It takes time for new products to gain traction in their markets and result in measurable impacts. Some products in this evaluation period may already have been adopted by the market and gained full commercialization reflected through sales. Other products are still in development and expect future commercialization - impacts of those products are prospective and cannot be verified.
- **Solicitation volume:** Many solicitations over the evaluation time period had different objectives and mechanisms. The relative effectiveness of these mechanisms is difficult to judge due to low volumes of projects awarded under each solicitation.

### 3.3 Data collection

Figure 3-1 outlines the data collection activities and completion rates for this evaluation. The data collection plan evolved over the evaluation to overcome gaps in project documentation and obstacles in data collection to tell the complete story of product evolution and impacts of funding. The plan relied heavily on self-reported information provided by developers to estimate impacts. The original plan also relied on verification of data by end-users of products; however, this information was largely unavailable (three completes). Innovation and Research staff were interviewed to obtain insights on products and helped improve interview response rates with product development firms by emailing these firms to prompt them to respond to the evaluator's interview requests.

**Figure 3-1. Data collection activities for the Product Development Impact Evaluation**



Details on each data collection activity are detailed below.

- **File reviews** – The evaluation team reviewed all project files and other artifacts available for projects within the population and created data capture forms to reflect project information, project descriptions, statements of work, progress reports and final reports, where available, had information on the nature of products and sometimes included intended benefits. For projects with sales, evaluators searched for **secondary data sources** including developer websites, evidence of product marketing, and other publicly available reports, including prior NYSERDA company or product case studies. Once these reviews were complete, evaluators reviewed the list of projects with their NYSERDA project managers to understand which products had high impact potential and/or high market disruption potential.
- A **developer survey** administered online through email recruitment included all project developer contacts, the same contacts who reply to an annual NYSERDA metrics survey to collect sales and other data. One hundred and nine (109) of the 161 projects (66%) responded to the survey. This response rate is lower than the 85% response rate of NYSERDA metrics surveys. The survey collected data on major study objectives, including commercialization success or intent, development progress, market barriers and catalysts, and recommendations for improvement of the project application, award, and management process.
- In-depth analysis of indirect impacts was completed for a subset of 18 products that NYSERDA project managers reported as having high disruptive and/or impact potential, and sales were reported in the metrics survey. The team **solicited purchaser lists** from and requested **developer in-depth interviews** for this subset of projects. In preparation for data collection, the team developed indirect impact evaluation method memos for each product, estimated quantitative and qualitative impacts where possible, and established a detailed understanding of the product development lifecycle and ultimate status of the product.

### 3.4 Impact estimation methods

The impact evaluation team worked with NYSERDA staff to identify the companies for which to conduct detailed market and impact characterizations. NYSERDA staff identified companies from the set of 18 that had sales and/or were deemed to have disruptive potential. Disruptive potential was identified through the initial developer survey conducted in 2022 and through interviews with NYSERDA project managers.

A wide variety of products and markets supported by Innovation and Research funding. The team determined that separate market characterization strategies and indirect impact estimation methodologies were required for each product. This necessitated the development of custom interview guides for each product.

The team developed indirect impact memoranda to document the expected qualitative and quantitative impacts of the 18 products selected for impact estimation. The memoranda included calculation methods for quantitative impacts, outlining known and unknown parameters for those calculations, and listing potential sources for those parameters.

The team also developed market potential memoranda to characterize the market and potential benefits for each product estimated to have high disruptive potential. When drafting the strategy memoranda, the team conducted secondary research to assess what publicly available data could be used to characterize each relevant market and to identify what knowledge gaps could be filled by developers and end-users in follow-up interviews. The strategy memoranda also identified which barriers from the 2022 Clean Energy Fund Compiled Investment Plans were addressed by NYSERDA's support for the relevant product.

The team completed detailed follow-up interviews with 11 of the 18 products' developers. The developer interviews identified products that had since been abandoned by the developer and companies that had gone out of business. The interviews also identified which products had informed other products that were still being commercialized or pursued by the companies. Finally, the interviews discussed the practical and technical limits to product market applicability.

During interviews, the team asked developers to provide contact information for end-users. Very few developers were able or willing to provide end-use contacts. Some products had not yet been commercialized, others had non-disclosure agreements associated with their use, and others had developers with no visibility to the end-user. The team managed to talk to end-users of two products and got an independent analysis for another product.

The impact estimates developed by the evaluation team were based on best available data, including publicly available third-party studies, responses from the developers during the in-depth interviews, and documents provided by the developers after the interview. As such, some of the key parameters used for estimating energy and economic benefits were drawn from developer companies themselves rather than from third-party sources. Future studies could obtain stronger modeled estimates using parameter values obtained from end-users or other third parties.