

**NYSERDA TRANSPORTATION PROGRAM  
CASE STUDY:**

**Public Transit Research and Development Funding for  
Alstom Transportation**

*Final*

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# 1. Executive Summary

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This case study presents the results of a recent evaluation of a subway-railcar gearbox development project that was funded by NYSERDA. From 2002 to 2006, the NYSERDA Transportation Program provided funding and support to Alstom Transportation to assist them in developing a subway-railcar gearbox to adapt its European propulsion system for use in North American railcars. The evaluation objectives for the Alstom Alternating Current (AC) Gearbox were the following:

1. Investigate the commercialization of this gearbox both within and beyond New York.
2. Estimate energy savings from the gearbox.
3. Identify strategies for NYSERDA to replicate the successes of this project in future public transportation research.

ERS conducted five interviews with NYSERDA, Alstom, and New York City Transit Authority (NYCT) staff to assess these objectives, along with secondary research into the product's design and applications. The results of this research are summarized in the following subsections and detailed throughout this report.

## **Commercialization**

Alstom successfully leveraged the research that was performed for this project into a contract win to deliver, along with contract partner Kawasaki, 1,662 R160 subway railcars to the NYCT from 2005 to 2010. Additional commercialization outside of New York State has not occurred, but the NYCT contract win was a tremendous success for Alstom.

## **Energy and Economic Impacts**

The ERS team anticipated that the gearbox would also provide energy savings, but research concluded that regardless of the Alstom gearbox the NYCT would have awarded a contract to Alstom or another manufacturer to deliver railcars featuring an AC propulsion system. The Alstom gearbox was not materially different from gearboxes available on the market at the time, resulting in little to no energy savings. However, this project did provide direct and indirect economic development to New York State. The research funding from NYSERDA directly funded in-state research, design, and engineering of the gearbox; as an indirect effect, after winning the NYCT contract, Alstom employed over eight hundred staff, who produced two railcars per day equipped with this gearbox.

## **Strategies for Future Research**

The Alstom AC Gearbox project was a success for the NYSERDA Transportation Program due to its incorporation as an important component of Alstom's bid for the R160 train and its role in increasing the New York State content of railcar design, engineering, and manufacturing. In order to replicate this success, NYSERDA should proactively engage New York State transit authorities to better understand what these agencies need in terms of short- and long-term system and efficiency improvements. These procurement offices are often bound by least-cost procurement rules and thus are unable to fund a wide array of research and development (R&D) activities. This presents an opportunity for NYSERDA to align its project funding with the strategic interests of the state's transit agencies to support the development of a series of technologies with beneficial applications in the sector.

## 2. Project Background

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In 2013, New York State's transportation sector consumed more than 1,032 trillion Btu of energy, or 43% of the total energy consumed in the state. Approximately 92% of transportation energy consumption came from petroleum products. As a result of its reliance on the combustion of petroleum products, New York's transportation sector was responsible for 75 million metric tons of CO<sub>2</sub>-equivalent emissions in 2013, or 42% of all fuel-borne greenhouse gas emissions in the state.<sup>1</sup>

Within this context, the NYSERDA Transportation Program has identified several objectives:

- To reduce and diversify the energy consumed by the transportation sector
- To minimize greenhouse gas emissions
- To create economic development opportunities in New York State<sup>2</sup>

The current NYSERDA Transportation Program builds on decades of research conducted with state and federal funding. Beginning in 2016 with the transition to NYSERDA's Clean Energy Fund (CEF), the program adopted three focus areas: electric vehicles, public transportation, and mobility management. The project described in this case study – Alstom Transportation's AC Gearbox – aligns with the public transportation focus area.

### 2.1 Project Identification and Funding

Alstom Transportation is a large French multinational company operating in rail transit markets for passenger transportation, signaling/controls, high-speed trains, and manufacturing of metro, urban, and suburban railcars. At the time of the NYSERDA project, Alstom had developed an alternating current (AC) propulsion system for use on commuter rail vehicles, but the system could not be implemented without a gearbox to adapt the system to North American railcars.

While there was an existing gearbox on the market that Alstom had used in prior railcars at the time of the project, Alstom was explicitly interested in designing and developing its own gearbox within New York to increase its U.S. presence and to establish a competitive advantage for future New York and U.S.-based railcar contract bids. Senior engineers and officials within Alstom had existing relationships with NYSERDA personnel, and initial conversations between the two organizations leveraged these relationships to set up the framework for the project. Alstom initially pursued internal funding but was not successful in moving the project forward with internal management until they identified NYSERDA as a funding partner.

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<sup>1</sup> NYSERDA. Patterns and Trends – New York State Energy Profiles: 1999–2013. October 2015. Available at: <http://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Patterns-and-Trends>.

<sup>2</sup> NYSERDA. Transportation Program: Product Development, Product Demonstration, and Product Deployment, Program Theory and Logic Model Report. August 2015.

From 2000 to 2006, NYSERDA provided a total of \$500,000 in funding to Alstom for research, design, and prototype testing of the gearbox. The NYSERDA funding was segmented into three distinct project phases:

1. Develop and analyze a gearbox design that is compatible with the NYCT subway requirements.
2. Assemble and test a prototype gearbox in a laboratory setting.
3. Field-test commercial-scale gearboxes on active NYCT railcars for 1 year.

Following the NYSERDA funding, Alstom incorporated the gearbox into its successful bid to deliver more than one thousand R160 railcars in a large multiyear contract with the NYCT. The gearbox is shown for reference in Exhibit 1.

**Exhibit 1. Alstom AC Gearbox Design**

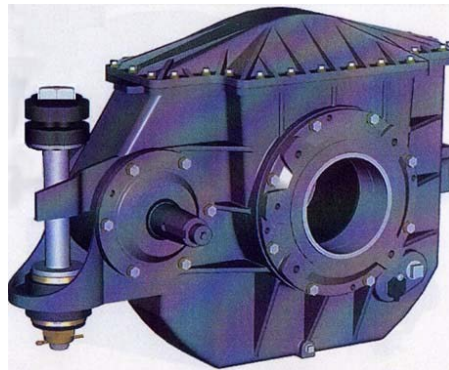


Exhibit 2 provides additional detail on the focus of this case study. In particular, the primary intent is to understand the market impacts of the project, including commercialization to-date and the potential for future benefits with this technology and similar applications in the public-transit sector.<sup>3</sup>

**Exhibit 2. Evaluation Scope**

Evaluation Question	Data Sources and Analytic Methods
1. To what extent was this product commercialized after NYSERDA's funding? How many railcars are using the technology in the NYCT and in cities beyond NYC?	<ul style="list-style-type: none"> <li>• Review of the information provided by Alstom to NYSERDA as part of NYSERDA's standard follow-on reporting requirements</li> <li>• Internet research to investigate the NYCT railcar inventories and contracts, and AC propulsion systems implemented throughout U.S. subway systems</li> <li>• Interviews with Alstom and the NYCT</li> </ul>
2. What were the energy impacts from this project? What fossil fuel and/or emissions reductions were achieved?	<ul style="list-style-type: none"> <li>• Interviews with Alstom and NYSERDA</li> <li>• Review of the information provided by Alstom to NYSERDA as part of NYSERDA's standard follow-on reporting requirements</li> </ul>
3. What additional benefits did NYSERDA's intervention contribute to the success of the Alstom project?	<ul style="list-style-type: none"> <li>• Review of the information provided by Alstom to NYSERDA as part of NYSERDA's standard follow-on reporting requirements</li> <li>• Interviews with NYSERDA, Alstom, and the NYCT</li> </ul>

<sup>3</sup> This case study is part of a suite of six case studies with an overall purpose of the following: (1) highlight important transportation research and development accomplishments in New York State; (2) understand the role that the Transportation Program played in achieving those outcomes; and (3) inform the Transportation Program strategy by identifying effective approaches that NYSERDA can build on and the remaining market barriers to address.

The following sections of this report discuss the evaluation questions, methods, and findings in detail. Section 2 summarizes the results of the case study analysis for each of the three evaluation questions listed in Exhibit 2. Section 3 then examines the strategic implications of those findings, including effective approaches that NYSERDA can build on to increase its benefit to New York public transit activities.

## 3. Project Outcomes

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The following three sections discuss each of the three evaluation questions in detail. First, Section 3.1 highlights the commercialization of the Alstom gearbox product after NYSERDA's funding. Next, Section 3.2 discusses the energy impacts of the gearbox project. Finally, Section 3.3 describes the benefits of NYSERDA's intervention in contributing to the success of the project.

### 3.1 Commercialization of Alstom AC Gearbox

A central focus of this case study was the extent to which the gearbox funded by NYSERDA was commercialized, both within New York City and in additional subway systems throughout the country. Based on interviews with NYSERDA project managers and Alstom staff who were familiar with the project, a review of NYSERDA's project files, and supplemental research into the NYCT railcar inventories, the ERS team found that Alstom incorporated the gearbox into its successful bid to deliver R160 railcars to the NYCT. This contract was awarded to Alstom in 2002 with initial delivery in 2005 for NYCT testing. The contract, including several options exercised by the NYCT, had a total value greater than \$2 billion and resulted in Alstom delivering, in conjunction with Kawasaki, a total of 1,662 R160 railcars. This contract win is a great success for Alstom, and all interviewees indicated that the gearbox developed with NYSERDA was an important component of Alstom's winning contract bid by increasing the content of the railcar design and manufacturing completed in New York State.

While the gearbox has been successfully commercialized for the NYCT, further commercialization in additional subway systems outside of New York City has not yet occurred. Interviews with Alstom and corresponding research revealed that Alstom has submitted unsuccessful bids for subway railcars in major U.S. cities using the gearbox designed with NYSERDA. Alstom does have other business lines, including contracts to provide passenger transport railcars and to provide controls and signaling services. At the time of the ERS team interview Alstom was working to prepare a bid for the next major NYCT procurement, the R211 railcar, using the gearbox.

### 3.2 Energy Impacts of Alstom AC Gearbox

AC propulsion systems enable a variety of energy efficiency opportunities and reduced operations and maintenance costs relative to direct current (DC) propulsion, making AC propulsion an attractive strategy for reducing operating costs and carbon emissions. Additionally, AC propulsion provides increased opportunities for efficiency in system operation due to its superior integration with regenerative braking capabilities.

The ERS team expected to identify energy impacts from the Alstom gearbox under the assumption that without this gearbox Alstom would need to leverage DC propulsion systems rather than AC systems in its railcars. However, interviews with NYSERDA and Alstom project managers revealed that the driver of this project was not AC vs. DC propulsion as initially perceived, but rather this project was initiated for Alstom to design and build its AC gearbox in-house – in New York – to better compete for the R160 and other future railcar contracts.

All interviewees indicated that the NYCT had already been purchasing railcars featuring AC propulsion, and that even without the Alstom gearbox the R160 contract would likely have been awarded to Alstom or another manufacturer using an existing gearbox available on the market at the time. Alstom previously used an AC gearbox from another manufacturer in their contracts with the NYCT and would likely have used the same gearbox or another existing product without this project. The Alstom project manager indicated that these incumbent gearboxes were often found to leak and require additional maintenance, and this was another driver for Alstom's decision to build its gearbox in-house. However, the project manager was not aware of any differences in energy efficiency between the two designs, and thus, the ERS team concluded that there were no appreciable, direct energy impacts associated with the gearbox project.

Neither NYSERDA nor Alstom quantified energy impacts during the project, as the drivers were to enable Alstom to be more competitive for the R160 contract by increasing the content of its railcar design, engineering, and manufacturing that is completed in New York State, with any resulting energy and emissions reductions being a secondary benefit of the project.

### 3.3 Benefits of NYSERDA Support

Interviews with Alstom's gearbox project manager, NYSERDA project managers, and the NYCT confirmed that NYSERDA offered both financial and nonfinancial support to Alstom. The key nonfinancial benefits provided by NYSERDA were based on NYSERDA's existing relationships and reputations within New York and, specifically, the public transit sector:

- **Connecting Alstom with New York City transit organizations** – The gearbox project was important in helping Alstom establish and strengthen relationships with key players throughout the New York City transit industry. These benefits were in large part due to the efforts of the NYSERDA project manager, who devoted significant time to nurturing relationships with the Metropolitan Transportation Authority (MTA) and NYCT, including enrolling in courses to become certified to walk New York City subway tracks with NYCT maintenance crews.
- **Assisting Alstom in securing manufacturing partners to increase economic impact within New York State** – NYSERDA's connections were helpful to Alstom in securing manufacturing partners for the gearbox. Specifically, design work was performed by Alstom in New York and the gearbox was manufactured for Alstom by Renold Ajax in Westfield, NY.

The relationships developed between NYSERDA and the MTA during and after this project led to additional research funding for transportation-related projects. While these were primarily funded under the Clean Power Technology Innovation (CPTI) program, they included several regenerative braking projects to research the feasibility and cost-effectiveness of wayside energy storage using batteries and flywheels. These projects will be evaluated as part of the ongoing CPTI evaluation. The retirement of the NYSERDA project manager for the Alstom project diminished some of these relationships, but NYSERDA retains connections with the MTA and NYCT.

### 3.4 Overall Results

Overall, the Alstom gearbox project was successful in assisting Alstom to win a multiyear contract to deliver R160 railcars to the NYCT. Developing the gearbox in-house provided Alstom a competitive advantage; without it, Alstom would have had to purchase an equivalent (and faulty, per Alstom's



engineering assessment) gearbox from a competitor. The total value of this contract, including several options exercised by the NYCT, was greater than \$2 billion for 1,662 railcars; Alstom delivered 1,002 R160 railcars over the duration of the contract and their partner Kawasaki delivered 660 R160 railcars, most of which also used the Alstom gearbox developed in this project.

The Alstom contract to deliver R160 cars had a direct economic development impact for New York State. The gearbox was designed, engineered, and manufactured within the state. This was a significant shift for Alstom, which historically performed its design work in France, requiring U.S.-based fabricators to translate plans and schematics from metric scale for construction. This hurdle was avoided and additional engineering jobs were created throughout the research effort for the gearbox. In addition, to design and engineering jobs the R160 contract brought significant manufacturing jobs to Alstom’s plant in Hornell, NY. At the height of production Alstom was producing two railcars per day, employing eight hundred workers in two shifts.

While Alstom has not won a railcar contract outside of the NYCT that includes the gearbox, the company is planning to bid on the NYCT’s upcoming procurement for the R211 railcar using the AC gearbox developed during this project.<sup>4</sup>

The progress achieved for each of the evaluation questions is summarized in Exhibit 3.

**Exhibit 3. Alstom Gearbox Evaluation Questions Results Summary**

Progress Achieved	Gaps in Achievement
Evaluation Question 1: To what extent was the Alstom Gearbox commercialized both within the NYCT and in urban subway systems throughout the United States?	
<ul style="list-style-type: none"> <li>Alstom won the NYCT contract to deliver more than 1,000 R160 cars using the gearbox that was developed with NYSERDA funding.</li> <li>Beyond New York, Alstom has not won additional contracts to deliver railcars using the gearbox technology.</li> </ul>	<ul style="list-style-type: none"> <li>The gearbox is only applicable for passenger subway/metro applications. Alstom has bid on, but not won, any subway contracts in other U.S. cities.</li> </ul>
Evaluation Question 2: What were the energy impacts from this project? What fossil fuel and/or emissions reductions were achieved?	
<ul style="list-style-type: none"> <li>There were no direct energy impacts from the Alstom Gearbox project. The NYCT had already been purchasing AC propulsion railcars. Without the Alstom gearbox, the R160 project would likely still have been awarded to Alstom or another manufacturer using the incumbent gearbox on the market.</li> <li>The project was about economic development – increasing New York State content of subway cars and enabling Alstom to better compete in subway car manufacturing.</li> </ul>	<ul style="list-style-type: none"> <li>Direct energy efficiency improvements via gearbox design are small to negligible as the gearbox does not differ appreciably from previous gearbox designs. However, there are future energy savings opportunities achievable using AC propulsion, such as harnessing energy from regenerative braking.</li> </ul>

<sup>4</sup> The ERS team did not identify any information indicating that the gearboxes used by other railcar suppliers are better than Alstom’s or even that the gearbox itself was a deciding factor in Alstom’s not winning contracts in other jurisdictions.

Progress Achieved	Gaps in Achievement
Evaluation Question 3: What benefits – beyond financial – did NYSERDA contribute to the project?	
<ul style="list-style-type: none"> <li>• Relationships/connections – NYSERDA's existing relationships helped Alstom connect with suppliers and manufacturers for gearbox components.</li> <li>• New York State economic development – Engineering jobs to design the gearbox and related components</li> <li>• Local (New York State) manufacturing – Alstom employed eight hundred workers in two shifts throughout the NYCT contract, producing two NYCT subway cars per day.</li> </ul>	<ul style="list-style-type: none"> <li>• The project was valuable in establishing relationships with the MTA and its related companies, leading to additional project work for NYSERDA's transportation and CPTI programs. Some of these connections have diminished with the retirement of the NYSERDA project manager who led this project.</li> </ul>

## 4. Strategic Implications

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The ERS team’s review of the Alstom gearbox project identified strategies that NYSERDA can adopt to recruit additional projects that would strengthen the public transit sector both within and beyond New York State. The core strategy for NYSERDA to consider is to proactively engage public sector procurement offices, including state agencies, transit authorities, and municipalities.

### 4.1 Engage Procurement Offices

Most public sector procurement offices in New York State and throughout the country leverage least-cost procurement strategies, where agencies must accept the lowest qualifying bid for procurement contracts. Under such restrictions, it is difficult for procurement offices to effectively foster innovation and R&D. The NYSERDA Transportation Program provides a potentially great resource for procurement offices, supporting early-stage research that can be commercialized in the public transit sector and more broadly throughout the program’s focus areas.

In order to maximize this impact, NYSERDA should focus on building relationships with procurement offices. Understanding agency priorities and aligning NYSERDA research objectives with those priorities will best leverage the program for the greatest impact. Some organizations are already proactive; for example, the NYCT Innovation and Technology Office works cross-functionally across the NYCT to put together annual lists of department and program needs across the organization. These needs identify the strategic areas of opportunity throughout the NYCT, identifying specific project focus areas as well. These needs are communicated broadly to entities such as NYSERDA as an initial step toward collaboration. Exhibit 4 summarizes the NYCT’s 2016 strategic needs.

**Exhibit 4. NYCT 2016 Public Transit Needs for NYSERDA Program Considerations**

Strategic Objectives	Needs	Project Focal Points
Lower life-cycle costs of operational equipment	Efficient rail equipment	<ul style="list-style-type: none"> <li>• Vehicle light-weighting</li> <li>• Vehicle HVAC/lighting efficiency</li> </ul>
	Efficient bus/non-revenue fleet	<ul style="list-style-type: none"> <li>• EE propulsion</li> <li>• Fuel procurement</li> <li>• EV charging</li> </ul>
	Improved energy harvesting	<ul style="list-style-type: none"> <li>• Regenerative braking</li> <li>• Hybrid propulsion systems</li> <li>• Solar/wind energy harvesting</li> </ul>
	Improved metering/measuring capability	<ul style="list-style-type: none"> <li>• Integrated EMS</li> <li>• Analysis to support decision-making</li> </ul>
	Cost-effective compliance with regulatory requirements	<ul style="list-style-type: none"> <li>• Lower-emissions bus equipment</li> </ul>
Lower life-cycle costs of operating facilities	Reduce facility energy costs	<ul style="list-style-type: none"> <li>• Lighting, HVAC, energy management</li> </ul>
	Facility energy harvesting	<ul style="list-style-type: none"> <li>• Solar/wind energy harvesting</li> </ul>
	Enhance energy data collection/analysis	<ul style="list-style-type: none"> <li>• Data collection to support energy decision-making</li> </ul>
	Increased collaborations in MTA communities	<ul style="list-style-type: none"> <li>• Community energy collaborations with third parties</li> </ul>

Strategic Objectives	Needs	Project Focal Points
Accelerate adoption of value-added technology	Increase introduction rate of new technologies, processes, and procedures to enhance energy saving	<ul style="list-style-type: none"> <li>• Inter-agency collaborations</li> <li>• “Proof of concept” approach for new technologies</li> <li>• Stakeholder collaboration and outreach</li> </ul>

The NYCT strategic needs outline a spectrum of energy efficiency and R&D project opportunities that NYSERDA is already using to assess project funding decisions. While the NYCT is a large player in the New York State public transit arena, NYSERDA can expand its reach upstate by engaging the state’s other major public transit agencies, which are shown in Exhibit 5.

**Exhibit 5. New York State Public Transit Agencies**

Public Transit Agency	Service Territory
Metropolitan Transit Authority (MTA)	New York City and surrounding areas (NYCT, LIRR, Metro-North)
Capital District Transit Authority (CDTA)	Albany metro area
Niagara Frontier Transit Authority (NFTA)	Buffalo metro area
Regional Transit Service (RTS)	Rochester metro area
Central New York Regional Transit Authority (Centro)	Syracuse metro area

## 4.2 Leverage Statewide Knowledge for Project Identification & Recruitment

By engaging with procurement offices throughout New York State, NYSERDA will have greater insight into the kinds of research and technologies most likely to have scalable impacts. This knowledge can be used proactively through outreach to universities, key private sector companies, and past project participants to share agency interests and solicit projects. This knowledge can also be used reactively to work with prospective applicants by tailoring their research to increase the potential for commercialization in the public transportation sector. NYSERDA already performs these functions, but the additional insight into procurement processes and needs can increase its influence and impact in funding successful projects from the academic and private sectors.

## 4.3 Conclusions

The Alstom AC gearbox project was a success for the public transit sector of the NYSERDA Transportation Program; the project created economic development for the state in the form of engineering and manufacturing jobs and helped Alstom win the R160 railcar contract with the NYCT, leveraging increased New York State content of its railcar bid. This project is a strong example of how NYSERDA can effectively work as an intermediary between the private sector and public procurement offices. To repeat this success more broadly in the public sector, NYSERDA should proactively engage New York State procurement offices and transit authorities in New York and other states, strengthening existing relationships and fostering new contacts to better understand the agencies’ needs. NYSERDA should continue to fund multiple products and technologies for the public transit sector, incorporating procurement office needs as a component of its process in making funding-related decisions.

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