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Benefit Cost Analysis Report

# Summary

The Jacksonville Port Authority (JAXPORT) seeks Federal support through the Port Infrastructure Development Program (PIDP) to develop the **JAXPORT *EXemplifying Potential to Reduce Emissions with Sustainable Solutions* (EXPRESS)** Project. The JAXPORT EXPRESS Benefit Cost Analysis (BCA) evaluates the cost savings, emissions reductions, safety benefits, and throughput / efficiency improvements of executing and operating the JAXPORT EXPRESS Project (Project).

When complete, the Project will achieve immediate and substantial reductions of greenhouse gas and criteria air pollutant emissions, and increase cargo capacity, efficiency, safety, reliability, and throughput for international and domestic trade across multiple terminals at the Port of Jacksonville, in partnership with SSA Jacksonville LLC (SSA) and Crowley Logistics Inc. (Crowley). The Project will achieve these elements through purchase and deployment of the following equipment and execution of the following elements:

Table 1. JAXPORT EXPRESS Project Elements, Lead, and Function

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Component | Component | Quantity | Lead | Function |
| Proposed Zero- and Low-Emission Equipment | Hybrid RTG | 6 | SSA | Hybrid CHE |
| Tier-4 Top Picks | 6 | SSA | Low-Emission CHE |
| 18,000+-lb Forklift | 5 | SSA | ZE CHE |
| 150+ kW EVSE | 5 | SSA | Infrastructure |
| Make-Ready Stub-Outs | 5 | SSA | Infrastructure |
| Reefer Rack Plugs | 160 | Crowley | Infrastructure |
| Yard Tractor | 10 | Crowley | ZE CHE |
| 10,000-lb Forklift | 10 | Crowley | ZE CHE |
| 36,000-lb Forklift | 1 | Crowley | ZE CHE |
| 150+ kW EVSE | 10 | Crowley | Infrastructure |
| Planning and Development | Port and Maritime Electrification Plan | 1 | JAXPORT | Electrification Planning |
| Workforce Development | 1 | All | Workforce |
| Technology / Knowledge Transfer | 1 | All | Industry Engagement |

The BCA considers deployment of the capital components of the Project at two terminals: SSA’s Blount Island Jacksonville Container Terminal (JCT) and Crowley’s Talleyrand Marine Terminal (TMT). Combined, these two terminals move more than 587,000 twenty-foot-equivalent units (TEU) and 3,134,898 tons of cargo on an annual basis. The BCA quantifies costs and benefits from each of the capital elements of the Project, above. Additional benefits are provided through the planning and development elements, but these are considered qualitatively rather than quantitatively. The BCA considers four primary equipment deployment components that enable substantial fuel consumption and emissions reductions: 1) installation of electrified racks/stacks for refrigerated containers (reefer racks) to increase cargo throughput and reduce diesel and energy demand; 2) procurement of six hybrid-electric rubber-tired gantry (RTG) cranes to increase cargo capacity and reduce fuel consumption; 3) procurement of 16 battery-electric forklifts, 10 battery-electric yard tractors, and seven Tier 4 diesel top picks to reduce emissions and reliance on fossil fuels; and 4) installation of 15 high-power direct current (DC) fast charging stations and additional make-ready stub-outs supporting zero-emission (ZE) cargo handling equipment (CHE). Completion and adherence to the recommendations / outcomes of the Port and Maritime Electrification Plan will result in substantial additional future emissions reductions and fossil fuel consumption offsets. However, these elements cannot yet be quantified within a reasonable level of certainty, and therefore are not considered quantitatively in the BCA.

The Project will require capital investment, but will also generate significant local and regional benefits in terms of long term cost savings, improved terminal efficiency and cargo throughput, greenhouse gas emissions reduction, and pollutant emissions reduction, including associated savings. Based on anticipated benefits for each of these categories, we expect that the Project will generate a **net present value (NPV) of $99.7 million** at a 7% discount rate, along with an exceptionally strong **benefit to cost ratio of 3.313**.

Table : Summary of Costs, Benefits, and Net Present Value, and Benefit Cost Ratio

| **Cost or Benefit Category** | **Total Value (7% Discount)** |
| --- | --- |
| Net Capital Cost Savings | $(23,451,124) |
| Net Operations and Maintenance Cost Savings | $89,250,865 |
| NOX Emissions Reduction | $12,162,675 |
| PM2.5 Emissions Reduction | $12,162,675 |
| SOX Emissions Reduction | $(192,643) |
| CO2 Emissions Reduction (3% discount rate) | $11,037,147 |
| Safety Improvements | $50,784,046 |
| **Total Benefits of Project** | **$142,816,448** |
| Total Capital Costs | $43,110,078 |
| **NET PRESENT VALUE** | **$99,706,370** |
| **BENEFIT COST RATIO** | **3.313** |

# Benefit Cost Analysis

## Base Case

* The Project team, in not implementing the Project, would not procure, complete, install, or operate any of the activities proposed under this application for the JAXPORT EXPRESS Project. Specifically, the Base Case scenario would not include deployment of RTGs, or the other low- and zero-emission equipment proposed, nor the planning or other study elements of the Project.
* The Base Case scenario would, however, include select equipment upgrades over time, which would be completed consistent with typical equipment replacement timeframes, according to currently-planned schedules. To this end, the Base Case will include the following updates:
  + Top Picks, replacements, 2 per year (20 total), years 2026 through 2035
  + Top Picks, new, 2 in year 2030
  + Forklifts, 18,000 lb, replacements, 1 per year (5 total), years 2027 to 2031
  + Forklifts, 10,000 lb, replacements, 1 per year (10 total), years 2026 to 2035
  + Forklifts, 36,000 lb, replacements, 1 per year (10 total), years 2026 to 2035
  + Yard Tractor, replacement, 1 per year (10 total), years 2026 to 2035
  + Reefer Stack Upgrades, 20 per year (160 total), years 2026 to 2033

No other updates or advancements would be made under the Base Case scenario.

## JAXPORT EXPRESS Project Case

The Project Case assumes that the Project Team completes the proposed JAXPORT EXPRESS Project as described in the attached narrative. Key project elements include the following:

Table : Summary of Proposed Project Equipment and Other Elements

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Component** | **Partner** | **Design Status** | **Quantity** | **Unit Cost[[1]](#footnote-1)** | **Total Cost[[2]](#footnote-2)** |
| Grant Administration | JAXPORT | N/A | N/A | $150,000 | $150,000 |
| PMEP | JAXPORT | 30% | 1 | $1,000,000 | $1,000,000 |
| Hybrid RTG | SSA | 90% | 6 | $3,000,000 | $23,400,000 |
| Tier-4 Top Pick | SSA | 90% | 6 | $780,000 | $5,148,000 |
| 18,000-lb Forklift | SSA | 90% | 5 | $308,000 | $1,694,000 |
| 150+-kW EVSE | SSA | 30% | 5 | $100,000 | $550,000 |
| Make-Ready Stub-Outs | SSA | 10% | 5 | $38,000.00 | $209,000 |
| Reefer Stack Upgrade | Crowley | 90% | 160 | -- | $7,700,000 |
| Yard Tractor | Crowley | 90% | 5 | $400,000 | $4,400,000 |
| 10,000-lb Forklift | Crowley | 90% | 10 | $65,000 | $715,000 |
| 36,000-lb Forklift | Crowley | 90% | 1 | $500,000 | $550,000 |
| Tier-4 Top Pick | Crowley | 90% | 1 | $700,000 | $770,000 |
| 150+-kW EVSE | Crowley | 30% | 10 | $50,000 | $550,000 |
| Workforce Development | All | N/A | N/A | $100,000 | $100,000 |
| Tech / Knowledge Transfer | All | N/A | N/A | $100,000 | $100,000 |

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| Figure . Example Top Pick Stack Cycle |

Note that the Project includes a key change in operations. Hybrid rubber-tired gantry cranes (RTGs) are costly yet substantially more effective, efficient, reliable, and safe in handling cargo as relevant to the Project’s operation. Specifically, the proposed hybrid-electric RTG rows will improve yard utilization by increasing terminal density, improve the speed and efficiency of cargo throughput by more than 40%, and substantially reduce terminal emissions associated with managing container stacks with only top picks. The proposed RTG stacks will be configured as a 5-high, 7+-wide stack with a dedicated truck lane within the span of the hybrid RTGs. The transition to RTG stacks will enable the terminal to fit 144 TEU ground slots per acre as opposed to 119 TEU when serviced by top picks while also reducing average cycle times—the amount of time to grab a container in a stack—to 50 seconds, down from 65 seconds when operated by a top pick. Moreover, when attempting to reach a container at the bottom-middle of a stack, an RTG is expected to take just four moves over 200 seconds to cycle the pile as compared to a top pick taking 20 moves over 1,300 seconds for the same objective. As a result, the Project will result in a notable increase in efficiency across the Jacksonville Container Terminal. Additionally, the Project will substantially improve site operations related to the handling of cargo and integration with truck-level drayage, improving circulation, reducing wait times, and reducing distance driven by vehicles as port containers are hauled to and from the site. These improvements will result in considerable efficiency gains, which are tracked in the BCA, including as relevant to reduced fuel consumption and associated emissions.

Existing reefers transiting the Crowley’s Talleyrand Marine Terminal are operated using two centralized gensets (each serving 30 plugs), plus individual generator units for the remaining reefers. These would be replaced under the project, with utility connected electrical connections.

Other equipment replacement would be in kind for existing, ageing, and polluting equipment with new Tier 4 diesel equipment (top picks) and zero-emission battery electric versions of existing equipment (yard tractors and forklifts).

All other elements of the Project included in the BCA are discussed in the Project narrative associated with this grant application. Please refer to that document for additional details, which are consistent with Table 2, above.

The Project would also result in key safety benefits. These would accrue as a result of fewer on-dock work hours and terminal densification, resulting in fewer dock-related safety events, as well as reduced on-dock traffic and improved efficiency / routing / circulation, which is expected to further reduce potential for accidents (see parameters discussion below).

## Key Parameters and Assumptions

The analysis incorporates various assumptions and key parameters relevant to the overall results. Key parameters are summarized in the following table, along with applicable sources. For additional detail, please refer to the BCA model, which is attached to this application as an excel file.

Table : Summary of Key Parameters and Assumptions

| **Parameter** | **Value** | **Notes; Source** |
| --- | --- | --- |
| Replacement ratio: RTG: Top Pick | 1:2.5 | Anticipated project operational characteristics, planned based on typical RTG efficiencies in comparison to top picks, as relevant to the Project operations |
| Contingency percent for baseline scenario | 19.2% | A contingency that is consistent with the project contingency for equipment purchases and construction is also included in the baseline |
| Shifts per day on each piece of equipment | 2 | Typical / anticipated operations |
| Fuel Costs: Diesel Cost, PADD1C region | $3.15/gallon | EIA Fuel Cost Data for the PADD1C region |
| PADD1C Region taxes applied | $0.343/gallon | Regional tax levies |
| Estimated non-road diesel cost | $2.772/gallon | Calculated from above |
| Charging Efficiency Factor | 1.11 | Consistent with 90% efficiency / 10% loss |
| Electricity Cost | $0.097499 / kWh | Based on actual kWh costs at JAXPORT: 172806 kwh @ $16,848.42 |
| Project reduced on-dock traffic estimated reduction in incident occurrence | 6.8% | Conservative estimate based on anticipated operations which will reduce on-dock equipment and vehicle movement, resulting in fewer on-dock safety incidents |
| Existing equipment model years | Top Picks: 1993 to 2003  Reefer generators: 2003  Forklift, 10,000 lb and 18,000 lb: 2008  Forklift, 36,000 lb: 2004  Yard Tractors: 2010 | Chosen based on available equipment data / information for existing equipment |
| Model years for proposed Project equipment | 2023 to 2025 | Based on project characteristics / implementation schedule |
| Model years for Base Case equipment | 2025 to 2035 | Based on anticipated implementation schedule |
| Air Emissions Costs/Savings (2023)  NOx  PM2.5  SO2  CO2 | $16,000/MT  $744,700/MT  $43,100/MT  $49/MT | BCA Guidance Documentation, note these update each year |
| Discount Rate | 7% | BCA Guidance |
| Discount Rate for GHG | 3% | BCA Guidance |
| Emission Factors | Varies based on equipment type and model year | Conservatively based on California CHE emissions data available through the California Air Resources Board’s EMFAC database. |
| Discount Rate | 7% | BCA Guidance |
| Project construction period considered in model | 2023 to 2025 | Assumption based on anticipated schedule |
| Project operation period considered in model | Through 2043 | Assumption based on anticipated equipment lifetime |

## Methods

The Project Team has completed a benefit cost model for the base case and the Project case, both described previously. Note that, for reviewer convenience, we have separated results from the two scenarios on the summary page of the BCA. The remaining discussion in this document focuses on results of the full BCA, which considers the Project case in comparison to the base case. Please refer to the Narrative for additional details. The full model is attached and was completed in full compliance with BCA guidance provided by DOT. Briefly, the analysis considers the costs and benefits of the fully implemented JAXPORT EXPRESS Project less the benefits and costs of the base case scenario. Costs included all project capital costs, accrued according to the anticipated procurement and construction schedules. The base case scenario would not include implementation of any Project specific elements.

Briefly, the BCA considers the following elements:

* **Capital Costs** for all proposed equipment, and implementation/execution costs of the grant.
* **Operational Costs** for all proposed equipment and its operation, including labor, fuel, electricity; for the Project case, grant administration, workforce development, and technology transfer were all included under operational costs. These elements would not be included in the base case scenario, and therefore were not considered therein.
* **Changes in Fuel Consumption**, for all proposed equipment and operations. The project shifts select equipment from diesel fuel to electricity, and replaces other old, polluting diesel equipment with higher efficiency diesel equipment. Costs and benefits in this category consider both reductions in diesel fuel consumption and increases in electricity consumption. Note that reduced fuel consumption from improved efficiency is incorporated into the model under operational costs, resulting in lower fuel costs in the OPEX category.
* **Changes in Emissions**, for all proposed equipment and associated operations, including NOX, PM2.5, SOX, and CO2. These resulted from reduced fuel consumption per above. Grid related emissions from power consumption were also included.
* **Labor** reduced for certain on-dock workers as a result of the transition from top picks to RTGs, resulting in operational savings.
* **Safety** was improved due to both fewer on-dock workers (see above), as well as improved terminal circulation and efficiency. Safety metrics and costs were calculated based on BCA guidance.
* **All Capital Costs** were assembled based on preliminary quotes and other sources, as documented in the full grant application for the JAXPORT EXPRESS Project.

## Project Impact

Output from the BCA indicates, consistent with prior analyses completed by the Project Team, that the project would result in a substantive net benefit in comparison to the base case scenario. Specifically, as shown in Table 5, the project would result in the following benefits:

Table : Net Benefits of the Project

| **Cost or Benefit Category** | **Amount and Units** | **Total Savings  (7% Discount)** |
| --- | --- | --- |
| Reduced Diesel Consumption | 12,332,455 gallons/project lifetime | $18,098,364 |
| Reduced Electricity Consumption | (126,694,347) kWh/project lifetime (increase due to use of electric equipment) | $(6,565,734) |
| NOX Emissions Reduction | 1,339 tons/project lifetime | $12,162,675 |
| PM2.5 Emissions Reduction | 6 tons/project lifetime | $3,225,483 |
| SOX Emissions Reduction\* | (9) tons/project lifetime | $(192,643) |
| CO2 Emissions Reduction | 254,034 metric tons/project lifetime | $11,037,147  (Discounted at 3% per guidelines) |
| Safety Reduced Cost of Claims | $50,784,046 non-discounted | $25,880,201 |
| Labor Cost Reduction | $105,808,205 non-discounted | $53,592,987 |
| Total Operational Cost Reduction | Note: includes labor and fuel consumption per above | $89,250,865 |

\* SOX increased due to high SOX burden in regional grid electricity mix.

Reduced diesel consumption was calculated based on anticipated consumption rates of new / proposed equipment, in comparison to existing consumption of existing equipment, as projected under future operational scenarios under the base case. Note that equipment replacements under the base case were also considered for emissions reduction, but were not considered for changes in fuel consumption as anticipated future equipment was assumed to not result in a substantial increase in fuel efficiency in comparison to existing equipment proposed under the base case only. Increases in electricity consumption were estimated based on typical electric consumption per project duty cycles using the proposed equipment, per manufacturer specifications.

Labor cost reductions were based on reduced labor requirements for operating the proposed hybrid-electric RTGs as compared to continued operation of top picks under the base case scenario. Safety cost related benefits were calculated based on actual data aggregated from terminal operators, with values assigned to safety incidents based on BCA guidance provided by DOT. Note that key elements of terminal operator safety data are highly confidential and therefore have been aggregated and sanitized in the BCA calculations.

In total, the Project is expected to reduce emissions by 1,339 tons of NOX, 6 tons of PM2.5, and 254,035 metric tons of CO2 emissions. The project will also result in a net increase of 9 tons of SOX emissions, due to the relatively high SO2 burdens of the regional grid electricity mix supplied by JEA, the local electric utility. Collectively, these emissions reduction benefits will support $26.2 million in emissions reduction benefits (discounted at 7% or 3% for CO2), based on the air emissions savings valuations provided in the BCA guidance documentation.

Table : Summary of All Net Benefits and Costs

| **Cost or Benefit Category** | **Total Value (7% Discount)** |
| --- | --- |
| Net Capital Cost Savings | $(23,451,124) |
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| **BENEFIT COST RATIO** | **3.313** |

Based on these numbers and on total costs for deploying and operating the Project, final results of the BCA show an exceptionally strong **net present value (NPV) of $99.7 million**. This NPV will be equivalent to a benefit cost ratio (**BCR**) **of 3.313** Therefore, Project implementation will provide exceptional return on DOT’s investment. For additional information on the BCA, please refer to the associated spreadsheet file.

1. Unit Costs are based upon actual quotes received from vendors since January 2022. [↑](#footnote-ref-1)
2. Costs for equipment and infrastructure components include cost contingencies of 10%-30%. [↑](#footnote-ref-2)