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Climate Action Planning Guidelines
Working Group

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Abstract: This *Guideline* provides a roadmap for an agency to develop a climate action plan or participate in a coordinated regional climate action planning process that helps guide an agency's climate goals.

Keywords: climate action plan, greenhouse gas emission inventory/reporting, resilience, climate equity, sustainability return on investment, community climate plan, continuous improvement

Summary: The Climate Action Planning guideline is a practical tool for transit agencies to develop, implement or improve their climate change goals. It provides a comprehensive roadmap and a proactive approach, that relies on collaboration, inclusion, equity, target setting and tracking, as primary keys to success in every aspect of climate planning. The tool is framed with the Plan-Do-Check-Act methodology, an effective approach for developing a CAP that integrates an iterative process to ensure continuous improvement. The guide also outlines current best practices on how transportation agencies are planning and reporting on climate change risks and opportunities.

Scope and purpose: This document provides a Plan-Do-Check-Act methodology for the development of an agency climate planning process.

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Participants

The American Public Transportation Association greatly appreciates the contributions of the Climate Action Planning Guidelines working group, which provided the primary effort in the drafting of this document.

At the time this standard was completed, the working group included the following members:

Aliesa Adelman, Wendel, *Chair*
Robert Borowski, Capital Metropolitan Transportation Authority, *Vice Chair*

Aliesa Adelman, *Wendel*
Rob Borowski, *Capital Metropolitan Transportation Authority*
Andrew Brennan, *Massachusetts Bay Transportation Authority*
Rebecca Collins, *Jacksonville Transportation Authority*
Claudia Glen, *Washington Metropolitan Area Transit Authority*
Janet Gonzalez, *HDR*
Rachel Healy, *Washington Metropolitan Area Transit Authority*
Christina Jaworski, *Santa Clara Valley Transportation Authority*
Matt Krupp, *Washington Metropolitan Area Transit Authority*
Cris Liban, *Los Angeles Metropolitan Transportation Authority*
Elizabeth Lovinggood, *Washington Metropolitan Area Transit Authority*
Miranda Mair, *HDR*
Deborah Matherly, *WSP*
Amy Shatzkin, *Sound Transit*
Jane Sullivan, *Champaign-Urbana Mass Transit District*
Marcella Thompson, *HDR*
Heather Unger, *WSP*

Project Team:
Art Guzzetti, *American Public Transportation Association*
Christina Jung, *American Public Transportation Association*

Climate Action Planning Guidelines

Executive Summary

Our world is experiencing unprecedented changes and challenges related to equity, climate change and public health. Transit Agencies are mindful of the need to restore our systems to be even safer, stronger, cleaner and more equitable than before. Transit infrastructure and systems need to change and be prepared to not only to return to normal but to bounce forward. Climate change threatens that ability,[1] it affects infrastructure, alters operations, and ultimately hinders public trust in transit.

Climate change planning is an ongoing, participative, and iterative process. It is cross-cutting, and its most effective when it becomes second nature throughout the agency. A successful Climate Action Plan (CAP) impacts every part of the organization, and its implementation needs to be wholly embraced throughout it.

The CAP guideline is a practical tool for transit agencies to develop, implement or improve their climate change goals. It provides a comprehensive roadmap and a proactive approach, that relies on collaboration, inclusion, equity, target setting and tracking, as primary keys to success in every aspect of climate planning. The tool is framed with the Plan-Do-Check-Act methodology, an effective approach for developing a CAP that integrates an iterative process to ensure continuous improvement. The guide also outlines current best practices on how transportation agencies are planning and reporting on climate change risks and opportunities.

This document is divided in sections designed to stand alone while complementing each other. This framework allows each transit agency to tailor the process to meet their specific climate change planning needs. Each section includes information on planning; engaging stakeholders; developing visions, goals and strategies; and monitoring the process.
Given the uncertainty around climate change impacts, efforts to reduce GHG provide tangible benefits, also, programs that reduce resource consumption generally provide significant financial benefits. GHG emission reduction strategies focus on mitigating internal GHG emissions and supporting GHG reduction within the region the agency serves.

The need to mitigate for climate change is ongoing, and some strategies might require policy changes and coordination efforts that take time. The four-phase process laid out in the document, provides an effective roadmap to develop and implement a CAP and ensure its long-term success by including implementation strategies as well as monitoring and improvement techniques.

[1] U.S. Department of Transportation (DOT), "Climate Change Adaptation Guide for Transportation Systems Management, Operations, and Maintenance," 2015, https://ops.fhwa.dot.gov/publications/fhwahop15026/fhwahop15026.pdf

While decreasing GHG emissions may help reduce the severity of events related to climate change, no one can predict exactly whether the mitigation measures will be enough. Transit agencies, therefore, will need to adapt to the uncertainty of a changing climate and build more resilient systems that avoid, minimize and mitigate risk.

To ensure broader implementation of resilience practices throughout the transit industry, the guide includes a resilience component. Transit agencies will find key recommendations from the Transit Cooperative Research Program (TCRP) Guide and lessons from case studies of transit agencies around the country. Including resilience planning into the CAP will inform decision-making and direct investment to improvements that will make the greatest impact, quantify the direct and indirect impacts associated with each threat, and ultimately minimize risk.

As transit agencies we are on the front lines of climate change on three fronts. We are leading the way to a greener, more sustainable future, we are minimizing risks from extreme weather by adapting our systems to become more resilient, and we are embracing collaboration, inclusion and equity as primary keys to success in every aspect of climate change planning. With a straightforward roadmap for planning and a flexible approach for adoption and implementation, the Climate Action Planning Guidelines support transit agencies in their efforts to plan and build a sustainable and resilient transit systems, which in turn enables equitable, connected and economically vibrant cities and regions.

1. Introduction

As we navigate the challenges of encouraging passengers to return to safe transit options amid the hazards of a pandemic, we are mindful of the need to restore our systems to be even safer, stronger, cleaner and more equitable than before. We must defuse myths: Transit was not a "major disseminator" in New York City's COVID-19 outbreak as noted in media. We must make use of tools and resources, such as APTA's "Developing a Pandemic Virus Service Restoration Checklist," to ensure the safety and build the confidence of employees and customers. Educating and enforcing safe practices for employees and customers, such as touchless access and egress, wearing masks, and frequently washing hands will reinforce our social contract and rebuild trust.

As many businesses and individuals rethink and revamp their work patterns, transit systems will have to be nimbly adjusting to the new normal. Establishing or maintaining climate change mitigation, transit system resilience and equity as priorities or key organizing frameworks can help ensure that "survival mode" strategies are not myopic. Initiatives to reimagine services are underway. Persuasively advocating for principles of equity, resilience and sustainability, in the midst of urgent decisions to reimagine and rebalance adequate levels of service, may uncover opportunities and synergies, and forestall shortsighted decisions that would incur long-term adverse consequences.

1.1 Overview

As transit agencies, our communities expect us to provide reliable, sustainable service to everyone who needs it or wants it, especially including the most vulnerable, who have limited or no options for transportation. A climate action plan provides a road map to addressing these interrelated challenges. A comprehensive Climate Action Plan mitigates future damage to the climate by reducing greenhouse gases while simultaneously working to build the agency's resilience to the impacts from climate change that are already occurring and increasing in frequency and intensity.

Sections 2, 3 and 4 in this guide have been designed to essentially stand alone, while still complementing one another. Each section therefore includes information on planning; engaging stakeholders; developing visions, goals and strategies; and monitoring the process. All follow the "Plan-Do-Check-Act" general framework for developing a Climate Action Plan, described in detail in Section 2, but sections 3 and 4 slightly modify the steps and terminology, as they specifically apply to developing and implementing greenhouse gas mitigation plans (in Section 3) and developing and implementing system-wide resilience practices (in Section 4). Each section includes several case study "snapshots" of effective practices identified in transit agencies throughout the country. Section 5, the conclusion and call to action, provides a very brief synopsis of this "living document," as well as a compilation of the resources and references identified throughout the document.

1.2 Quick start

1. **I don't have a Climate Action Plan. What do I do?**

Begin by reviewing the Plan-Do-Check-Act steps in Section 2. Section 3 provides detailed steps and resources for evaluating greenhouse gas (GHG) emissions and alternatives to develop a GHG mitigation plan. Section 4 provides steps and resources to help agencies become more resilient to extreme weather and other adversity. In combination, you're reducing harmful emissions to slow down or mitigate future climate change impacts (Section 3) while fending off the near-term impacts that are already hitting us (Section 4).

2. I already have a Climate Action Plan. What's new and different in this guidance?

If you already have a Climate Action Plan developed under the previous guidance, you'll probably want to review sections 2 and 3 (details on the Plan-Do-Check-Act process and developing GHG reduction elements of the CAP plan) to find updated resources and examples to help you update your plan. Section 4 focuses on building resilience into the CAP plan and throughout the transit system, which was not included in previous guidance.

3. Why would a transit agency want to develop a Climate Action Plan?

- Many people are becoming more aware of transit's potential contributions to a healthier; greener; and more sustainable, equitable and reliable transportation future.
- Most people understand the value of walking or biking more and driving less, and some may need or seek a safe transit alternative for the "trunk" portion of their longer trips.
- Many people are increasingly aware of the dangers of greenhouse gases that are increasing the volatility of climate change impacts. They want to reduce their own driving, and they want the bus they are riding or observing to be clean, not spewing diesel fumes into their neighborhood.
- Most people are more aware than ever of the central, vital role transit plays in promoting community equity—providing transportation to essential employees for hospitals, medical and educational facilities, manufacturing and distribution plants, and retail and service industries; providing community connections to services, education and recreation; and more.
- Most people are also more aware than ever of the disproportionate adverse impacts that are faced by people in poverty and underserved communities, particularly Black and Indigenous communities. They are more susceptible to impacts from climate change and extreme weather (flooding, heat, and more), to adverse health impacts from pollution (due to siting of pollution sources including transportation), from limited access to health facilities (particularly in inner-city and rural areas), and from healthy-food deserts.
- Most people are also aware of how disruptions to transit service can disrupt the community and economy, and thus are aware of the importance of transit system resilience to climate or other events.

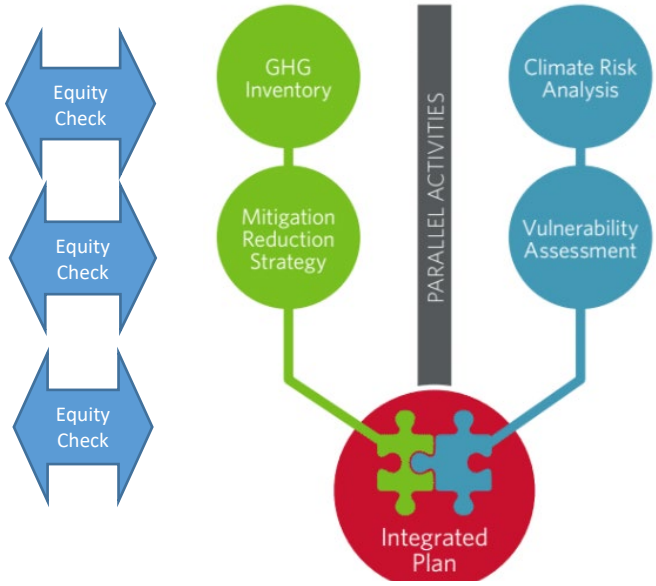
A climate action plan (CAP) will not address all these challenges, but it will help agencies begin or continue to address many of these issues, consistent with the priorities and capabilities of the region.

For example, non-diesel buses deployed in underserved neighborhoods reduce "hotspots" of harmful emissions and pollution, while increasing connectivity and opportunity to access employment, education and healthcare. Such neighborhoods frequently experience higher incidence of asthma, COPD and other health issues; clean buses can also help make the case for other clean fleets in a "virtuous cycle. "Likewise, resilience-minded bus operators and supervisors who track and report flooding and other routine disruptions help dispatchers and service planners provide customers with more reliable service. Some transit agencies also work with city agencies to develop solutions to neighborhood problems like recurrent flooding, or coordinate with residents to design a better route.

Transit can be a community and regional leader in mainstreaming clean energy and resilience, providing healthier and more sustainable transportation alternatives for everyone. The CAP guidance provides suggestions on developing stakeholder alliances and making the business case for proactive, forward-thinking investments and modest changes to operating procedures to save money and preserve service in the future for the whole community.

1.3 Climate Action Plan framework

FIGURE 1
Climate Action Plan Framework



The Climate Action Plan guidelines focus on GHG emissions, GHG mitigation, climate risk analysis and overall resilience, to provide an integrated approach that includes mitigation and adaptation strategies for transit agencies, as depicted in **Figure 1**. The impacts and proposed actions and solutions will have equity impacts, positive and negative. Throughout the planning processes, transit agencies are encouraged to actively engage with stakeholders, especially including innovative, comprehensive and inclusive outreach to typically underserved and marginalized populations, to consider the alternatives for implementation within the framework of equity. Examples are provided throughout the guidance.

The guidance is organized as follows:

- Section 2 describes the overall planning framework of Plan-Do-Check-Act. It includes details on each step, with pertinent examples from Climate Action Plans. It describes the key steps and importance of each phase in the iterative process of improvement.
- Section 3 addresses climate change plan mitigation, focusing on actions to reduce GHGs, from modifying light fixtures to converting to a non-diesel fleet.
- Section 4 addresses resilience, from modifying procurement practices and operating plans to working with regional stakeholders on broader resilience initiatives.

Each section includes examples; case studies; resources and suggestions on engaging stakeholders; establishing vision, goals, objectives, strategies and performance metrics; carrying out plans; and monitoring performance. Section 2 provides a comprehensive grounding in the Plan-Do-Check-Act process, but those who know the process well may want to skim that section and then delve into sections 3 and 4 as desired. Related APTA guides and standards and a full list of resources are included in Section 5, “Conclusion and call to action.”

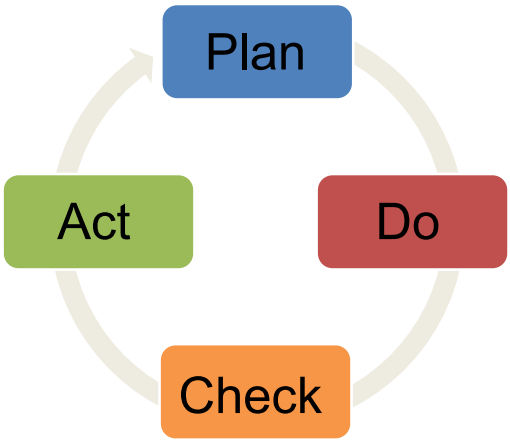
2. Planning process

A Climate Action Plan (CAP) helps a transit agency achieve two separate but interrelated goals: reducing greenhouse gas (GHG) emissions to mitigate the impacts of climate change and improving climate resilience. Like many other planning processes within a transit agency, developing a CAP should be an objective and inclusive process that prioritizes efforts that make the greatest impact.

With that in mind, there are many proactive actions, or strategies, for emissions reductions and increased resilience that can be identified through the planning process. A well-defined planning process, guided by the established vision and goals of the agency, is key to clarifying the scope of the effort, the expected outcomes, and the implementation efforts that would be most efficient and effective for all stakeholders involved.

Fortunately, existing tools can help provide a framework for developing a CAP, whether it is the first for an agency or an update to an existing plan. For example, the familiar Plan-Do-Check-Act methodology defined in the ISO 14001 standard (**Figure 2**) provides an effective approach to develop a clear vision for the CAP, from development through implementation and continuous improvement. The Plan-Do-Check-Act process itself has been used across a wide scope of planning efforts and is flexible enough to work on both small and large scales.

FIGURE 2
Plan-Do-Check-Act Cycle



Plan. CAP development begins with identifying internal and external partners, establishing a vision, and identifying key data and information. CAP planning defines targets and goals, and designs the framework required to achieve them. Strategies and actions that are identified in the planning phase to produce the greatest impact for the lowest amount of investment (or the shortest payback period) are ideal candidates for the start of the implementation phase of any CAP.

Do. Implementation of the plan should be based on a clearly identified schedule, with committed resources (people and financial) that are allocated support for implementation of the plan. At this stage, a comprehensive business case can be developed to ensure these resources are adequate for the planned targets. The implementation schedule should define milestones based on potential phasing of strategies. Actions should directly support progress toward measurable goals that will be periodically evaluated and reassessed.

Check. The Check process begins with reviewing initial considerations of how the agency intends to define milestones and to monitor performance over time, as defined in the Plan step. The milestones should be closely coordinated with the agency capital improvement program and available funding for operations and

maintenance. A monitoring program should be established to track an agency's progress on meeting the vision and goals of the CAP. It is important that the monitoring plan be based on meaningful performance metrics for which the agency can collect the necessary data.

Act. It is also important to make sure the agency dedicates the necessary resources and establishes procedures to act upon the findings from data collected during the monitoring program. Auditing the monitored data helps to identify lessons learned, which in turn should drive steps toward reevaluation and revision of the plan as necessary. Continuous improvement and evolution is a key component of any CAP.

The remainder of this section and the next sections of this document will provide a more thorough description of this process as it relates to developing plans for mitigation of greenhouse gas emissions and also opportunities to build institutional resilience within a transit agency, supporting larger city-wide or regional goals.

2.1 Plan: Build the foundation

2.1.1 Partnerships

Questions to consider:

- Whom do you need to engage? Could you build an organizational chart for stakeholder groups?
- Who is managing the planning process?
- What are the dynamics between stakeholder groups?
- Is there communication between stakeholders?
- What criteria will you use for the selection of stakeholders?
- What size of working groups, steering committees, review panel or information-gathering efforts are appropriate for your organization?
- How will you define different levels of stakeholders? How will you plan to engage them at different points in the process?

Partnerships are critical to any planning process, bringing together the perspective of diverse stakeholders and building organizational alignment. This is especially true when developing a CAP, which affects a wide variety of operational and organizational aspects. It's important to identify both internal and external partners. Involving the right internal stakeholders is important for developing goals and identifying specific actions to implement the CAP, while the participation of external stakeholders can uncover synergies with related community objectives.

Transit agencies will likely find that there is some overlap with stakeholders for the GHG mitigation and resilience components of the CAP. For example, both require the input and support of operations. For the GHG mitigation component, operations will assist with gathering emissions inventory data and prioritizing mitigation strategies. For the resilience component, operations will provide valuable insight to vulnerable assets. In other cases, the GHG mitigation and resilience components may require support from entirely different stakeholders. For example, the resilience component may require more coordination with external stakeholders, such as local emergency management agencies and other critical infrastructure operators.

FIGURE 3
Climate Action Planning Stakeholders

These are the stakeholders identified in **Figure 3**:

- **Key process leaders:** Primarily made up of internal partners who shape and develop the CAP. This may include agency divisions such as Finance, board members, Insurance/Legal, Operations, etc.
- **Partners to implement:** External organizations with whom an agency works closely to guide the vision of the plan or execute external strategies or actions in support of reaching the CAP goals. This may include nongovernmental organizations (NGOs), local utility providers, school districts, etc.
- **Highly affected:** Local community members who will be most impacted by actions developed in the CAP. This could include any neighborhood groups that are sensitive to climate threats, disadvantaged ridership groups, or other entities that may wish to influence CAP development through public comment.
- **Everyone affected:** The broader population served by the transit agency.

2.1.2 Vision

Questions to consider:

- How is this part of the agency strategic plan or vision statement?
- How will the agency gather input from each group of stakeholders?
- Would it be beneficial to map the stakeholder groups?
- Should the agency conduct a materiality assessment to identify highest priorities/most sensitive issues for each group?
- What are the drivers for action? Definitions of success?
- How will the agency pull all that information together and sort it/chart it/map it to help build consensus behind clearly defined goals?

Establish goals that work toward the vision of success and desired outcomes. Keep guiding objectives at the forefront of communication to ensure consistency throughout the entire planning process.

2.1.3 Target-setting

Questions to consider:

- Which metrics will be tracked for each target?
- How much data is available for any of these metrics?
- What controls does the agency have to work toward these targets?
- Are there any outside influences that may impact progress toward targets?
- How will success be defined for each target?

Setting targets is an effective way of communicating overarching goals and desired outcomes. Targets should provide clear, measurable objectives that are easily understood by internal and external stakeholders. There are a number of factors for an agency to consider when establishing CAP targets:

- **Internal or external:** Targets can be set internally or externally. An agency may set a goal internally to reduce emissions by a certain percentage, or a city may set a city-wide emissions reduction goal of a certain percentage that agencies strive toward. When selecting targets, the agency should be mindful of what factors are within its control and what will rely on outside support.
- **Absolute or intensity-based target:** Understanding the type of the target is crucial to informing strategies for achieving the target. An example of an absolute target could be a reduction of greenhouse gases overall (e.g., 30 percent by 2030). An example of an intensity-based target could be a reduction of emissions per economic unit (e.g., bus trips, miles traveled).
- **Alignment with science-based targets and/or other community or regional goals:** Whichever is selected, targets should be evaluated in the context of science-based targets. Science-based targets account for the concept of a global carbon budget, and tie in with relevant climate research to strengthen the case that the targets will directly contribute to the mitigation of global warming.

2.1.4 Baseline development

Questions to consider:

- Which metrics have current and/or historical data?
- What parameters will be affected by actions outlined in the plan?
- How does the agency plan to identify methodologies for calculating impacts and establish current values?
- What is a realistic amount of data to collect?
- What would give the clearest picture of the agency's current status of emissions?

The selection of base year (against which reductions are to be measured) and target year (by when reductions are to be achieved) varies by state, as do the levels of targeted reduction.

2.1.5 Communication strategies

Questions to consider:

- How many stakeholders were identified?
- What methods of communication are most effective for each stakeholder group?
- What level of input will each stakeholder group have in each stage of the planning process?

- How will you keep the guiding vision for the plan present in the agency's communications?
- What strategies can be used to inform stakeholders and/or solicit input?

One of the largest challenges with collecting stakeholder input during the planning process is ensuring clear and effective communication. Depending on the scale of the stakeholder involvement, there may be benefit to creating committees, working groups or other structures to guide the flow of information. Working with affected communities can be an opportunity to not only gather input, but also provide context for the climate action planning process, discuss driving factors and educate stakeholders about the vision for the resulting CAP.

2.1.6 Build leadership and partnerships

As stakeholders are identified and integrated into the planning process, be mindful of opportunities for leadership and/or partnership. Find synergies with other interested partners. Existing programs could supplement/support the agency's strategies, and engaged communities can provide helpful feedback and perspective while also feeling included in the process.

2.1.7 Develop goals, strategies and actions

2.1.7.1 Analyze metrics

Questions to consider:

- How many metrics will need analysis?
- What staffing and/or financial resources are required?
- Which metrics are the best indicators or highest priorities?

Analyze the baseline metrics collected, and compare against the goals and objectives developed earlier to help find strategies for improvements that will produce the greatest return on investment for the stakeholders involved. What stood out as an easy project (low risk, high reward)? Sort options into "possible" versus "not possible" versus "possible at a later time." Are there any actions/studies that would help identify more options/strategies? Explore those at this time. Gather additional feedback from stakeholders.

2.1.7.2 Options and strategies evaluation process

Step 1: Define criteria

The first step is to consider how the agency will screen, evaluate and prioritize strategies. Based on the agency's strategic plan and other relevant policies, it is important to define the evaluation criteria. For the screening stage, the agency may not have sufficient information for detailed evaluation, so the criteria have to be flexible enough to respond to available information. **Table 1** lists some key criteria to consider, divided into primary and secondary criteria. The primary criteria are weighted more heavily in the screening phase.

TABLE 1
Examples of Evaluation Criteria and Considerations

Evaluation Criteria	Considerations
Primary	
GHG emissions reduction benefit	• GHG per vehicle mile, revenue mile or passenger mile
Technical feasibility	• Certainty of technical advances • Technology readiness • Ease of implementation
Costs: first and life cycle	• Upfront and life cycle capital costs • Long-term O&M costs
Secondary	
Co-benefits	• Cost savings • Reduced energy demand • Reduced criteria pollutant emissions • Public relations • Land use multiplier • Travel choices • Long-term O&M savings
Risks: adaptation and cost	• Climate resilience/adaptation • Certainty of cost estimates
Customer satisfaction (and other key agency criteria)	• Passenger crowding • Passenger comfort (temperature) • Passenger safety and security

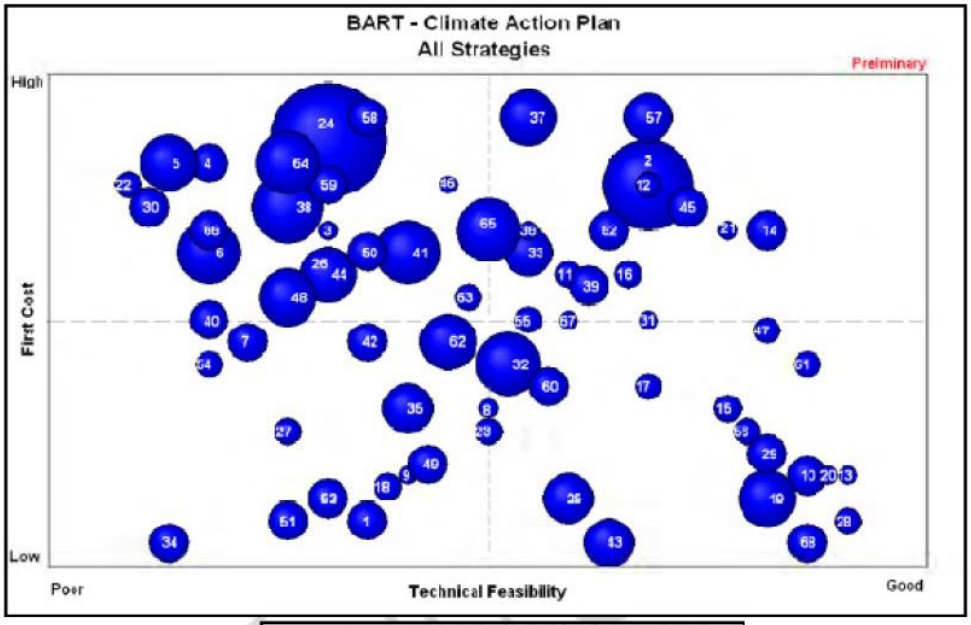
Step 2: Identify potential strategies

The next step is to assemble a master list of potential GHG reduction strategies, in line with the agency's vision, goals and objectives. Departments within the agency may already be considering or implementing cost- or energy-savings strategies. By working with the internal agency working group, consider existing agency initiatives through the lens of GHG emissions reduction. Reach deep within the agency to collect a broad list of potential strategies to reduce emissions. For many agencies, it may be best to frame the effort around identifying cost-savings or energy-reduction measures. It is helpful to learn from other transit agencies or sectors. As possible, identify the potential strategy, along with any available cost-benefit information.

Step 3: Screen strategies

The next step is to assess all the potential GHG emissions reduction strategies using the evaluation criteria. The purpose of this task is to screen down to the most promising strategies. The agency will want to consider, and advance, those "easy win" actions that are both low-cost and technically feasible, even if they do not produce major emissions reductions. One way that many CAPs approach this is to assign timelines to strategies and supporting actions, such as those that can be done in the short term (easy win), those that can be done in a medium timeframe and those that may be longer term (e.g., 10 years or more). In addition, it is important to identify strategically important strategies and supporting actions that need further technical development, funding, stakeholder and/or political support but also could have significant GHG reduction benefits and other co-benefits. A visual representation of rankings developed in this step may prove useful, as in the example shown in **Figure 4**.

FIGURE 4
A Visual Way to Evaluate Strategies



Source: BART

It is also important to consider that there can be strategies and supporting actions that are necessary to allow other strategies to be undertaken. For example, regulations can impose barriers to action. Working to change such regulations could be part of a CAP. These types of strategies can be considered "capacity-building" rather than "direct" actions that result in displaced community emissions or a reduction in direct emissions from agency operations.

Step 4: Detailed strategy development

Once the agency has selected the most promising strategies, it is helpful to develop and refine these strategies in more detail to better understand their technical feasibility, costs and benefits, including the set of supporting actions that may be needed to implement a strategy. This has to be developed within the agency's existing budget limitations. There can be some benefit to identifying specific strategies that can use designated funding from other budget areas that can't otherwise be applied to general operations within a transit agency.

The agency will want to estimate its projected emissions reduction due to implementation of the recommended strategies. It will also be helpful to identify the potential costs. This applies to internal emissions reduction strategies, as well as community emissions displacement strategies. The horizon year is a central consideration that will affect the life-cycle assessment of the benefits and costs of these strategies.

Step 5: Identify recommended strategies and implementation program

Based on the additional development and analysis of the screened strategies, select the top priority strategies that will support the plan's targets and goals. For operating strategies, look for opportunities for a demonstration program to better understand implementation issues and quantify potential benefits. For capital improvements, consider how individual strategies can be phased within the context of the agency's overall capital investment program. The recommendations should consider short-term strategies that are feasible and can be advanced for funding and implementation right away, as well as medium- and long-term investments that are strategically important but need further research and development and/or political or stakeholder support.

As another phasing example, consider the agency's fleet replacement schedule, or scheduled upgrade of the vehicle washing facility. How can GHG emissions reductions be considered within the implementation cycle for each of the investments? The analysis needs to take the capital improvement plan schedule into consideration as the agency evaluates technical feasibility, phasing and costs.

The strategies and implementation program could be incorporated into an agency's APTA Sustainability Commitment action items and stretch goals. These strategies could also be incorporated into actions to address significant environmental aspects, compliance obligations, or risks and opportunities (clause 6.1.4, ISO 14001) for an agency's ISO 14001 Environmental Management System.

2.2 Do: Implement the plan

2.2.1 Business case

Questions to consider:

- What are the drivers for the agency's goals?
- What financial or personnel resources are available?
- Are there timing and cost considerations?
- Does the agency have internal or external champions for these projects?
- Does the agency have a specific budget for CAP strategies?
- Are CAP strategies tied into strategic planning efforts?
- How can the agency align projects with internal TAM or energy management initiatives?

Understanding of partnerships among stakeholders informs the analysis for the business case to support any strategy: cost-benefit analysis through the lens of each relevant party, life-cycle cost and the impact on metrics as defined in the baseline exercise (and also the measurement structure—more to come in the "Monitoring and improvement" section), ROI and payback structures—not only existing avenues, but potentially developing new programs that will serve the needs of the planning organization. If supported through the city government, creative solutions could become codified to support the goals and objectives of the administration.

In many cases, it can be best to lead implementation with the "easy wins" that have low investment costs and quick payback periods. For electric power, consider emerging state-level requirements for utilities to transition toward greener power supplies (renewable portfolio standards); performance contracting agreements with private energy services companies that could be used to identify, fund and implement energy efficiency measures; and power purchase agreements in which a private green-power provider obtains the tax benefits of green-power investments and provides long-term power at a stable price to the public transit agency. Phasing of strategies can also be effective—for example, working on one or two larger strategies while simultaneously building momentum using small projects with easy wins.

2.2.2 Agency policies

Questions to consider:

- Are there any current policies that would hinder progress toward a CAP goal?
- Would policy updates streamline resource allocation?
- Who has the authority to create new policies and guidance?
- What is the timetable for policy or guidance updates?

Create necessary policies and guidance to integrate CAP principles into agency behavior. It is important that leadership approve of the draft CAP document before the agency begins circulating the document and assigning tasks. The adoption of the CAP provides the necessary authority and support to create the policies and provide the guidance needed to implement the plan. It is also important that the proper guidance is provided across the organization to ensure proper integration of the CAP into the everyday work of agency departments. Ideally, these policy changes should be identified during the strategic planning phase so they can be presented as part of the draft plan, but it may be that some of these needed changes become evident only as the agency conducts its internal review and preparatory action for adoption.

2.3 Check: Monitoring assessments

Reference previously determined metrics for success. Ensure that consistent measurement methodology is applied. Seek the best information and concisely deliver it to key stakeholders. Observe lessons learned through experimentation with pilot initiatives and use performance measurements that continue to evolve as the process is refined.

The following approaches offer a systematic way to ensure that the agency benefits from this crucial step. This is comparable to Monitoring, Measurement, Analysis, and Evaluation (clause 9.1); Internal Audit (clause 9.2); and Management Review (clause 9.3) of the ISO 14001 standard.

2.3.1 Milestone audits and performance assessments

Routine, systematic assessments of accomplishments and progress toward established milestone objectives and targets provide essential input on the effectiveness of program performance. Organizations employ a combination of leading and lagging indicators to assess tactical accomplishments, as well as overall management effectiveness in minimizing negative impacts.

2.3.2 Lessons learned and after-action reviews

Building on the outputs of audits and performance assessments, lessons learned and after-action reviews provide valuable information about both positive and negative performance. Frequently, these activities yield insights into internal best management practices and successful operating models that can be further leveraged across the enterprise.

2.3.3 Internal and external reporting

Internal reporting of sustainability successes and performance stimulates accountability, promotes healthy competition among peer organizations and feeds program momentum. Best-in-class reporting processes emphasize transparency, timely data capture and dissemination to internal organizations, and the use of technology tools to ensure efficient and accurate information exchange.

With growing stakeholder scrutiny of agency performance in fulfilling legal and regulatory mandates or self-determined objectives, organizations should consider complementing internal reporting with formal external reports and outreach communications. Agencies may wish to consider joining The Climate Registry or another reporting system to assist with this reporting effort. Participation in such a registry can provide

technical assistance, facilitate benchmarking, and demonstrate transparency and accountability. Participating in such a visible, respected and rigorous reporting body can also lend immense credibility to the effort through independent validation and verification, while also creating incentives for the agency to continue making progress. Agencies engaging in these bodies are also encouraged to actively seek to inform their practices about unique attributes of transit that deserve recognition in reporting and verification practices.

This has the potential to be a capacity-building strategy for other agency actions. For example, The Climate Registry's recently adopted Performance Metrics for Transit Agencies recognize that carbon intensity is an appropriate measurement technique for transit agencies to use and provides a standardized method for doing so. This in turn can help position agencies to use such metrics to demonstrate their emissions-reduction benefits in the context of climate action planning.

2.4 Act: Continuous improvement

Climate action planning is an iterative process, and knowledge gained through developing the first plan or strategy will inform plan changes and new strategies that follow. Tracking progress using clearly defined, objectively measurable metrics will result in a number of actions rising to the top to improve the plan and enhance its effectiveness going forward.

2.4.1 Management review

While many organizations collect performance data, those that excel translate these inputs into discrete actions to build institutional capability, to instill corrective and preventive actions, and to promote continual improvement. The value of this activity is not simply in the individual management review, typically conducted annually, but instead in management's engagement and the institution's commitment to create a culture of excellence using these reviews as a starting point.

2.4.2 CAP recalibration

By leveraging past successes and overcoming performance deficiencies through periodic review and recalibration of climate action planning and strategic goals, organizations can more effectively promote and integrate climate action to ensure ongoing mission value.

2.4.3 Corrective actions

As with any EMS or other Plan-Do-Check-Act management systems, monitoring performance and taking corrective action is an essential step to seize opportunities for improvement and to ensure that the agency meets its adopted goals. Corrective actions can be small adjustments to targets, new prioritization of strategies, incorporating new data or metrics, or initiating a new plan phase or component.

2.5 Conclusion

- Development of a Climate Action Plan can be tailored to meet the needs of a specific transit agency. The Plan-Do-Check-Act cycle promotes continuous improvement through an iterative process, which allows agencies to craft their plan in stages and solicit valuable input from stakeholders. By identifying strategies and prioritizing them wisely, agencies implement their plan and move toward achieving their targets and goals. Once the CAP actions begin to gain momentum, regular assessments check milestone progress and ensure that activities are performing well. If inefficiencies are found, it's important to thoughtfully review the lessons learned and act to correct or recalibrate the CAP as necessary.

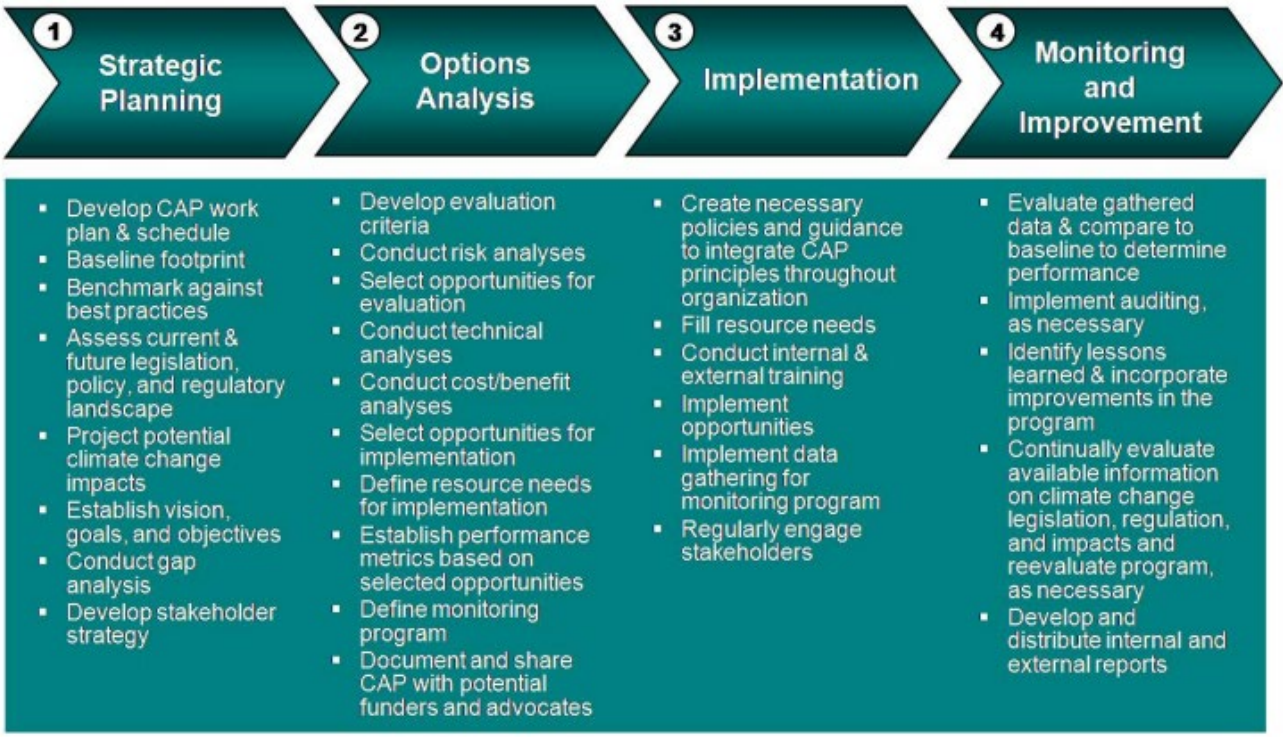
3. Mitigation: Planning to reduce and displace Greenhouse gases

3.1 Introduction

A CAP outlines how a transit agency plans to mitigate its internal GHG emissions, as well as support GHG reduction within the region the agency serves (GHG displacement). Climate change mitigation refers to actions that reduce a transit agency's GHG emissions. Internal climate change mitigation can range from simple steps such as converting office lighting from fluorescent to light-emitting diodes (LED) to more substantial actions such as purchasing 100 percent renewable and GHG-free electricity or converting the transit fleet to electric vehicles. External climate change mitigation requires coordination with external partners and may consist of establishing a new bus rapid transit (BRT) line that substantially reduces travel by single-occupancy vehicles. The cost and resources required to implement mitigation options will vary significantly. Agencies will need to evaluate the costs, benefits and feasibility of each option when determining which mitigation actions are appropriate.

This section outlines a four-phase process to develop and implement a CAP, as shown in **Figure 5**. The first two, strategic planning and options analysis, will result in developing a CAP. The second two, implementation and monitoring and improvement, will ensure that the CAP achieves long-term success.

FIGURE 5
The Four Phases of Climate Action Planning



Each phase will require a different level of effort to complete. Some agencies may be just starting out by preparing their first GHG inventory, while others have more advanced programs to address GHG emissions. It is important to set realistic expectations and tailor the process to the agency. The following sections describe each phase in detail.

3.2 Strategic planning

The first phase in determining how a transit agency plans to mitigate its internal GHG emissions and support GHG reduction within the region is to develop a strategic plan. Strategic planning provides the framework that informs each of the subsequent phases of the climate action mitigation process. This process involves a series of steps, including establishing a vision, preparing a baseline GHG inventory, engaging stakeholders, and setting goals and targets. Establish a vision

The strategic planning phase begins with establishing a vision to provide overall direction and guidance. The vision for the CAP should paint a picture of where the agency wants to be. Fundamentally, the vision for mitigation will include a reduction in an agency's GHG emissions. Given limited resources, competing priorities and varying levels of political support, it is important that the vision for mitigation be realistic about the level of reductions that can be achieved within a reasonable timeframe. Such a realistic vision will help to ensure that the scope and scale of mitigation is attainable. It is also important that the vision for mitigation align with the agency's mission, vision and core values. Such alignment will provide a strong basis for the agency to support the development and implementation of a mitigation plan.

The vision of the SFMTA Sustainability and Climate Action Program[2] is to ensure that the work of the agency improves the quality of life and environment in San Francisco and the region by reducing transportation-related greenhouse gas emissions, reducing resource consumption, planning for more environmentally friendly mobility options and conducting critical adaptation planning initiatives to improve the resilience of San Francisco's multimodal transportation system. The program is guided by a comprehensive network of agency and citywide plans, policies, and initiatives that provide a strong foundation for near-term mitigation actions and long-range adaptation planning.

3.2.1 Develop a baseline GHG inventory

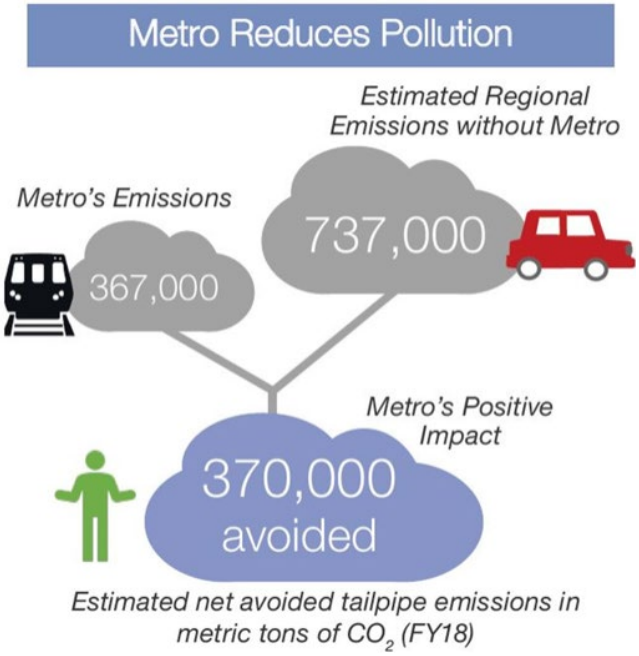
After establishing a vision, the next step is to develop a baseline GHG inventory that serves as a reference point for setting goals and measuring progress. A GHG inventory provides information on the amount and source of GHGs generated and displaced by an agency in a given year. A transit agency generates GHGs through fuel (e.g., diesel, gasoline, natural gas) and electricity consumption. Importantly, transit agencies also displace (reduce) emissions in two ways:

1. Avoided emissions from displaced trips that would have been made using private automobiles
2. Avoided emissions when transit enables denser land-use patterns that promote shorter trips, walking and cycling, and reduced car use and ownership

Regional avoided emissions far outweigh generated emissions. **Figure 6** shows that the Washington Metropolitan Area Transit Authority (WMATA) avoided twice as many emissions as it generated during Fiscal Year 2018.

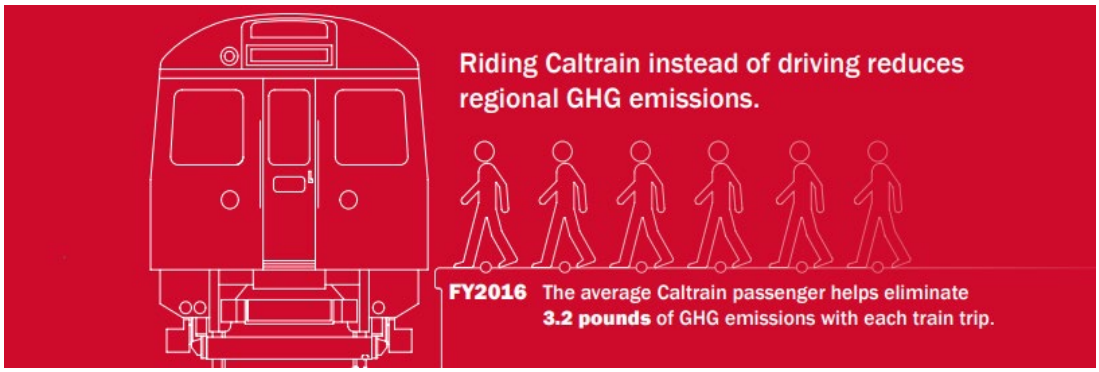
[2] San Francisco Municipal Transportation Agency, "Our Vision for Sustainability and Climate Action." https://www.sfmta.com/about-us/sustainability-and-climate-action/vision-sustainability-and-climate-action

FIGURE 6
Avoided Emissions at WMATA



As shown in **Figure 7**, Caltrain calculated the amount of avoided emissions per passenger in its 2016 GHG Inventory.

FIGURE 7
Avoided Emissions per Passenger at Caltrain



A basic GHG inventory consists of collecting data on major sources of fuel and electricity consumption and applying emissions factors to calculate the estimated GHG emissions in metric tons of CO_2 equivalent ($MTCO_2e$) from these sources. Refer to the APTA recommended practice "Quantifying Greenhouse Gas Emissions from Transit" (2018) for a more detailed discussion on how to prepare a GHG inventory. A GHG inventory is invaluable in identifying areas where limited resources can be leveraged to yield the most effective emissions reductions.

The determination of the base year for the GHG inventory may be externally driven by local, regional or state policies, or it could be internally driven by agency commitments to sustainability, such as the year the agency became a signatory of the APTA Sustainability Commitment. The level of detail in the GHG inventory will

be influenced by data availability, staffing, and organizational priorities. The data collection and analyses can take a significant amount of time and resources to extract, review and convert to GHG using the most appropriate methodology and emissions factors. As a result, GHG inventories and baselines can range from basic to comprehensive in terms of the types of emissions evaluated and the number of facilities included. By documenting the assumptions and limitations of the methodology used, an agency can properly set expectations and provide a strong foundation for continuous improvement in future updates of the GHG inventory. The APTA Sustainability Committee developed a GHG Inventory template to help transit agencies quantify GHG emissions (see References).

3.2.2 Identify and engage stakeholders

Taking the time early in the mitigation planning process to identify stakeholders to provide direction, focus and support for the mitigation plan will help to ensure that the plan is inclusive and accurately reflects the priorities of the agency and the community. The types of stakeholders will vary depending on the scope and scale of the mitigation plan, but they should represent interests from both inside and outside the transit agency. Communication and outreach on a regular basis with stakeholders are critical to maintaining the integrity of the engagement process and establishing a sense of ownership among stakeholders for the outcome of the planning process.

Internal stakeholders typically include employees from the main departments that will be affected by the plan's recommendations and should encompass all levels of the organization, including executives, midlevel managers and frontline staff. An internal team can be formed to guide development of the mitigation plan, or existing committees, groups and communications channels can be leveraged to facilitate participation. Key internal stakeholders generally include operations, facilities, finance, sustainability and engineering.

Key external stakeholders will vary based on the CAP objectives but may include local government, nonprofits, community groups, utilities, advocacy groups (e.g., electric vehicle advocacy), elected officials and riders/customers.

3.2.2.1 RTD stakeholder engagement

As of 2019, RTD had 26 battery electric vehicles (BEVs) in service. During the agency's first BEV deployment, RTD learned the importance of both internal and external stakeholder engagement:

- Internally, some things fell through the cracks because everyone wasn't at the table. For example, the agency did not have a full understanding of the infrastructure needs and the time it would take to implement upgrades. RTD formed an Internal Fleet Electrification Task Force before the second BEV deployment to discuss challenges and solutions for the current fleet and best practices and next steps for future deployments. The task force brings together representatives from several departments: operations, planning, engineering, facilities, asset management, IT, safety and communications. This variety of perspectives ensures that the agency is considering all aspects of each challenge and opportunity.
- RTD also engaged external stakeholders including BEV advocacy groups, its local utility and the public utilities commission (PUC). The agency became part of the PUC electric vehicle working group and became a party to the rate case so it would have a seat at the table to represent the interests of transit.

It may be helpful to develop a stakeholder engagement plan that identifies all internal and external stakeholders, their role in the CAP development and/or implementation, and their expectations. An example is shown in **Table 2**.

TABLE 2
Stakeholder Engagement Matrix Template

Stakeholder	Role	Key Concerns	Type of Engagement
Finance	Provides funding, determines payback	Ensures the project fits into the agency budget, determines if lending terms are favorable	Member of CAP working group

Special attention should be given to engaging the advocacy stakeholders so the process allows for constructive conversation and debate. It is important early in the process for the lead agency to frame the scope and scale of the planning process and to secure agreement on those parameters from its stakeholders, so all stakeholders are working toward a shared vision with an agreed-upon process for developing the plan based on majority or consensus decision-making. This will ensure that a balanced plan is developed, without allowing the plan development process to be controlled by a single stakeholder. It is recommended that advocacy stakeholders have an understanding of the role of transit as a regional emissions reduction strategy and represent a geographic area that is equal to or larger than the geographic scope of the transit agency.

3.2.3 Determine goals and set targets

The final step in the strategic planning phase is for the agency to set a GHG reduction goal and target. The GHG reduction goal and target should be aspirational and guide agency strategies. Setting a clear and attainable goal and target should motivate immediate actions, influence long-range plans, and be measurable to promote accountability that can be used to monitor the effectiveness of the mitigation plan.

Depending on the policy environment or context, the GHG reduction goal and target may be externally mandated or internally driven. For example, a number of states, regions and cities have adopted GHG reduction goals and targets that trickle down to the agency level through implementing policies and programs. In these cases, it is important for the agency to consider transportation-specific goals and targets if available when setting a goal and targets that support external mandates and policies. **Table 3** includes examples of state and local targets.

TABLE 3
Examples of State and Regional Targets

California Entity	Targets	Source
State	• 2000 levels by 2010 • 1990 levels by 2020 (15% reduction expected under a business as usual scenario) • 80% below 1990 by 2050	Executive Order S-3-05, AB 32, SB 375
Region/sector: California Air Resources Board GHG Reduction Goal for the Metropolitan Transportation Commission (Bay Area)	• 7% reduction in per capita GHG emissions from cars and light trucks by 2020 (relative to 2005 levels) • 15% reduction in per capita GHG emissions from cars and light trucks by 2035 (relative to 2005)	Climate Initiatives Program: Evaluation Summary Report
County: San Mateo County	• 17% below baseline emissions (2005) by 2020	San Mateo County Energy Efficiency Climate Action Plan

The Center for Climate and Energy Solutions maintains interactive web maps that identify state GHG emissions reduction goals and other climate policies (see References).

If there is no externally mandated goal or target, then the agency will need to identify its own GHG emissions reduction goal or target. Establishing the goal or target necessitates internal and external research. A helpful place to start is by examining the agency's own GHG inventory and forecasting the change in GHG emissions based on various scenarios. It may also be helpful to include an assessment of peer agencies' targets. However, it is incumbent on the agency to determine what are and aren't appropriate goals targets for the agency and region.

In general, the GHG reduction goal and target can be expressed as either an absolute target (reduction in the total quantity of GHGs being emitted) or an intensity target (reduction in GHG emissions per unit such as passenger miles, vehicle miles or vehicle hours; see **Table 4**). While absolute GHG reduction targets show an agency's contribution to reducing agency-controlled GHG emissions, it does not account for the fact that transit can displace direct and indirect GHG emissions by taking vehicles off the road. As such, absolute emissions reduction targets can penalize growth in transit services or impose additional costs or regulatory burden upon transit. APTA encourages transit agencies to include displaced emissions in the agency GHG inventory to provide a more complete picture of transit's net contribution to GHG reductions. Information on estimating displaced emissions is included in the APTA recommended practice "Quantifying Greenhouse Gas Emissions from Transit."

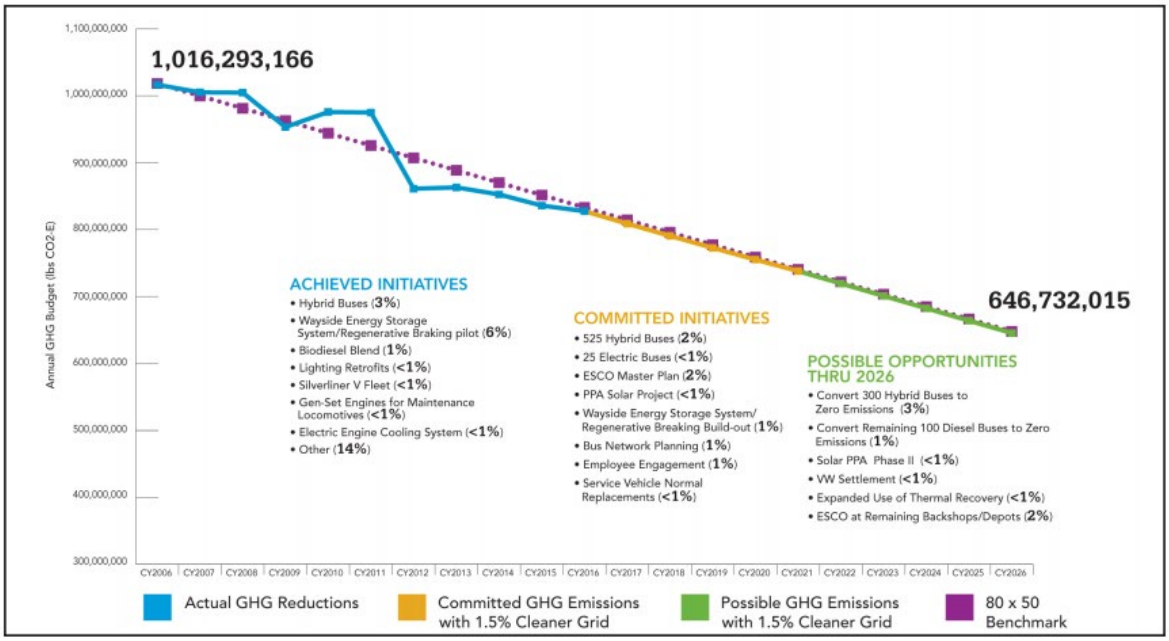
Two good resources for GHG reduction goal-setting are the "Mitigation Goal Standard" from the Greenhouse Gas Protocol and the organization Science Based Targets (see References).

Table 4 presents some of the considerations to take into account when using different performance metrics.

TABLE 4
Examples of Performance Metrics

Metric	Considerations
Absolute	
Direct emissions generated ("debit")	Consistent with climate science; does not measure displaced emissions
Direct emissions displaced ("credit")	Measures net impact when combined with direct emissions generated
Intensity	
GHG per passenger mile	Measures emissions reductions due to mode shift and technology; could adjust for passenger vehicle fleet and speeds
GHG per revenue vehicle hour	Captures efforts to reduce deadheading and roadway congestion
GHG per revenue vehicle mile	Reflects efficiency of operations or route structures
Science-Based Target	
The world's scientists and governments agree that it is essential to limit the increase in global average temperature to below 2 °C and, better yet, below 1.5 °C. To accomplish this ambitious goal, each agency should consider setting a science-based target to align with global emissions budgets created by climate models. There are multiple methodologies that can be used to set a science-based target. For methodological information, see the Science Based Target manual in the References section at the end of this document.	
80 × 50 Emissions Reduction Target	
Several states and cities, including New York City, Boston, Philadelphia, Chicago, San Francisco, Portland, Minneapolis, New York State, California, Colorado, Connecticut, Florida, Massachusetts and Michigan, as well as the European Union, have pledged to reduce GHG emissions 80 percent by 2050. These "80 by 50" pledges differ in the baseline years selected. SEPTA is tracking agency GHG emissions reductions against this target (see **Figure 8**).	

FIGURE 8
80 × 50 Framework



Another important aspect of setting goals and targets is to select specific short-, mid- and long-range timeframes for achieving the goals and targets. This allows progress to be monitored, provides accountability, and ensures continuous improvement.

Work done by SFMTA provides an example of the way in which one agency has approached setting goals and targets. SFMTA's goals and targets are based on the goals and targets adopted by the Board of Supervisors in San Francisco in 2008. In the 2017 San Francisco Transportation Sector Climate Action Strategy, the city announced a new mode shift goal, which is to "Shift 80 percent of all trips to environmentally sustainable modes by 2030." In the spring of 2018, the mayor announced an ambitious goal of eliminating citywide greenhouse gas emissions by 2050. Together, these goals guide the SFMTA climate action efforts and initiatives to reduce the impact of the transportation sector on the environment and quality of life in San Francisco.

Example GHG reduction goal: LA Metro is committed to reducing our GHG emissions by 79 percent relative to 2017 levels by 2030 and 100 percent (i.e., zero emissions) by 2050.

3.3 Options analysis

This section provides guidance for identifying and evaluating various GHG emissions reduction strategies that a transit agency could implement, developing an implementation plan, and preparing the CAP.

3.3.1 Evaluate options/strategies

The process begins with the identification and evaluation of different options/strategies to reduce GHG emissions. This can be achieved using the four-step process shown in **Figure 9**.

FIGURE 9
Steps for Identifying Strategies

3.3.1.1 Step 1: Define criteria

The first step is to consider how the agency will screen, evaluate and prioritize strategies. This involves defining appropriate evaluation criteria—how will the agency determine if an option/strategy is feasible? Evaluation criteria can be developed based on an agency's strategic plan; sustainability goals; or other relevant goals, objectives or policies. **Table 5** lists some key criteria to consider, divided into primary criteria (generally most important) and secondary criteria (generally less important). It may be useful to develop two types of evaluation criteria—one set for use during an initial screening of the options/strategies that requires less detailed information and another set for use during a more comprehensive evaluation of the options/strategies.

TABLE 5
Example Evaluation Criteria and Considerations

Evaluation Criteria	Considerations
Primary	
GHG emissions reduction benefit	• GHG reduced per vehicle mile, revenue mile or passenger mile per year
Technical feasibility	• Certainty of technical advances • Technology readiness • Ease of implementation
Costs: first and life cycle	• Upfront and life cycle capital costs • Long-term O&M costs • Cost per GHG reduced ($/ton CO_2) • Cost savings
Timeframe	• Short-term or long-term
Secondary	
Co-benefits	• Reduced energy demand • Reduced criteria pollutant emissions • Public relations • Land use multiplier • Travel choices
Risks: adaptation and cost	• Climate resilience/adaptation • Certainty of cost estimates
Customer satisfaction (and other key agency criteria)	• Passenger crowding • Passenger comfort (temperature) • Passenger safety and security

3.3.1.2 Step 2: Identify potential strategies

The next step is to assemble a master list of potential GHG reduction strategies, in line with agency and community goals and objectives. Departments within the agency may already be considering or implementing cost- or energy-savings strategies. By working with an internal stakeholder group (Section 3.2.3), consider existing agency initiatives through the lens of GHG emissions reduction. Reach deep within the agency to

collect a broad list of potential strategies to reduce emissions. For many agencies, it may be best to frame the effort around identifying cost-savings or energy-reduction measures. If possible, also seek to develop potential strategies that align with community GHG reduction goals. Where feasible, identify the potential strategy, along with any available cost-benefit information.

Table 6 provides a matrix of potential strategies to reduce GHG emissions based on TCRP Synthesis 84: "Current Practices in Greenhouse Gas Emissions Savings from Transit" (2010). Although the publication is a decade old, the strategies remain relevant today. Strategies identified as internal generally only affect the transit agency's own operations and can be undertaken with little or no external collaboration. Strategies identified as external involve changes to transit service, land use or policies and would require partnerships with other stakeholders. It may also be helpful to evaluate if the proposed mitigation strategy would align with other agency objectives, such as EMS aspects, the Global Reporting Initiative (GRI) indicators, other APTA guidance, or the UN Sustainable Development Goals.

TABLE 6
Example GHG Emissions Reduction Strategies

Type of Strategy	Strategy
Internal	
Vehicle emissions reduction strategies	• Convert fleet to low-carbon hybrid or alternative fuel vehicles (e.g., battery electric, renewable fuel sources, hydrogen) • Install a wayside power energy storage system • Educate fleet drivers on fuel-efficient driving techniques • Implement anti-idling policies/technologies • Implement/improve vehicle maintenance programs (e.g., ensure bus tires are properly inflated) • Retrofit vehicles with more efficient technology
Strategies to reduce emissions from construction and maintenance	• Require all new construction to meet LEED- or ENVISION-certified standards • Reduce emissions embodied in construction materials (e.g., use recycled materials during construction, source local/regional materials) • Reduce emissions from construction and maintenance equipment (e.g., use Tier 4 emissions construction equipment) • Commit to zero-waste construction practices
Other energy-efficiency and renewable energy measures	• Purchase renewable energy through electric provider • Install solar panels on agency property • Enter into a Power Purchase Agreement (PPA) to procure renewable energy • Upgrade to more efficient lighting/HVAC systems • Improve/start recycling and composting programs • Address behavioral efficiency opportunities through staff education • Provide incentives for employees to use active modes of transportation (walk, bike, transit or carpool)
External	
Expanding transit service	• Increasing the geographic coverage of routes • Increasing service frequencies • Extending operating hours • Adding new (or partnering with) transportation modes

TABLE 6
Example GHG Emissions Reduction Strategies

Type of Strategy	Strategy
Increasing vehicle passenger loads consistent with new and emerging guidelines on social distancing and safety	• Improve access to transit • Improve the comfort and safety of transit • Improve the speed and reliability of service • Provide information about and incentives to use transit • Investigate partnerships with colleges, universities and large employers • Optimize transit routes
Strategies to mitigate congestion	• Partner with state or local agencies to improve existing transit capacity in key travel corridors • Improve transit service through intelligent transportation system strategies • Provide incentives to use transit
Strategies to promote compact development and equity	• Develop an equitable transit-oriented development (TOD) policy • Require TOD development on property owned by the transit agency • Participate in local and regional planning to promote TOD • Partner with local jurisdictions to support transit connectivity through improved pedestrian and cycling infrastructure

Source: Many of the strategies are taken/adapted from Chapter 4 of TCRP Synthesis 84: Current Practices in Greenhouse Gas Emissions Savings from Transit (2010).

TriMet example: TriMet commissioned a study to evaluate the cost and GHG reduction impact of five bus fueling options:

1. Biodiesel (diesel made from plants or animal fats mixed with regular diesel)
2. Renewable diesel (diesel made from plants or animal fats only)
3. Renewable natural gas (natural gas sourced from naturally occurring breakdown of organic matter such as from wastewater treatment plans and landfills)
4. Battery electric
5. Hydrogen fuel cell (hydrogen can be sourced from natural gas or electrolysis)

TriMet established two key evaluation criteria to determine the best option:

1. Reduction in GHG emissions
2. Costs (including vehicle purchase, infrastructure, O&M and renewable energy credits)

Table 7 presents the estimated GHG emissions associated with each fuel type, and **Figure 10** presents the anticipated capital and operational costs.

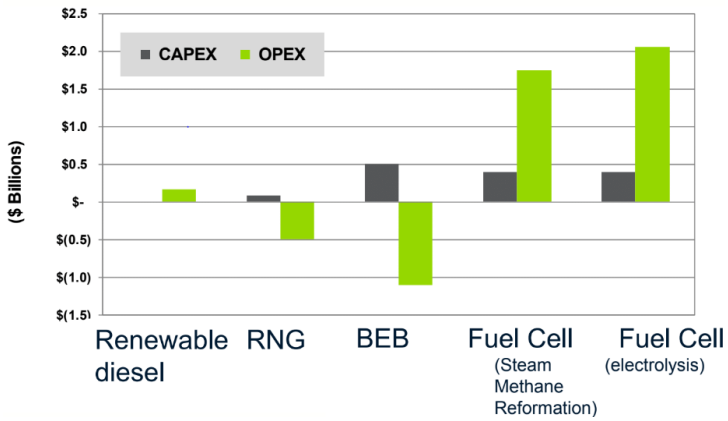
> **NOTE:** The estimated emissions reduction and associated costs were developed specifically for the Portland area and may differ substantially in other parts of the country.

TABLE 7
TriMet Fuel GHG Emissions Comparison

Fuel Type	GHG Reduction Relative to Diesel Fleet
Biodiesel or renewable diesel	5–49 percent
Renewable natural gas	65 percent
Battery electric	56 percent
Hydrogen fuel cell	6–65 percent

Source: Navigant Research, 2019

FIGURE 10
Cumulative Cost from 2020 Through 2040 per Fuel Type



The GHG emissions vary for battery electric and hydrogen fuel cell vehicles based on the process used to produce hydrogen and the electricity generation mix. Based on the analysis, battery electric is the most promising option in the long run because of the reduction in O&M costs. However, it should be noted that the GHG emissions reductions from renewable diesel can also be substantial at no additional capital cost (though renewable diesel still emits criteria air pollutants).

3.3.1.3 Step 3: Evaluate strategies

The next step is to assess each potential GHG emissions reduction strategy using the evaluation criteria developed in step 1. The purpose of this task is to identify the most promising strategies. Transit agencies may find it useful to conduct an initial screening of the potential options/strategies to narrow down the list before conducting a more comprehensive evaluation. A matrix similar to the example in **Table 8** could help the agency screen options/strategies.

TABLE 8
Example Scoring Matrix

Scoring Criteria	Criteria Description	Rating Description		
		High (5 points)	Medium (3 points)	Low (1 point)
GHG emissions reduction benefit	Amount of GHG emissions reductions anticipated	Strategy will result in a direct, quantifiable reduction in GHG emissions	Some GHG emissions reduction may occur, but it cannot be quantified	GHG reduction is very indirect, unlikely to occur or unknown

TABLE 8
Example Scoring Matrix

Scoring Criteria	Criteria Description	Rating Description		
		High (5 points)	Medium (3 points)	Low (1 point)
Technical feasibility	Technical feasibility of the option/strategy	Strategy/option has examples of successful implementation that can be applied to the agency and/or there is a clearly detailed implementation plan in place	Some examples exist for generation implementation, but there are some uncertainties	Vague or nonexistent understanding of how the strategy can be implemented by the agency
Costs: first and life-cycle	Upfront and O&M costs	Low up-front and O&M costs	Mid-range up-front and/or O&M costs	High up-front and/or O&M costs
Timeframe	Implementation timeframe	Short-term (less than one year)	Medium-term (one to five years)	Long-term (more than five years)
Co-benefits	Other benefits achieved, such as reduced energy demand or criteria pollutant emissions	Strategy/option would result in multiple co-benefits	Strategy/option would result in one or two co-benefits	No co-benefits anticipated
Risks: adaptation and cost	Impact on agency resilience and level of cost certainty	Strategy/option would improve agency resilience; cost estimate certainty is high	Strategy/option would slightly improve agency resilience; cost estimate certainty is medium	Strategy/option would not improve agency resilience; cost estimate certainty is low
Customer satisfaction	Level of customer support	Significant increase in customer satisfaction anticipated	Some increase in customer satisfaction anticipated	No increase in customer satisfaction anticipated

Source: Adapted from Cleaner, Greener Communities: Capital Region Sustainability Plan

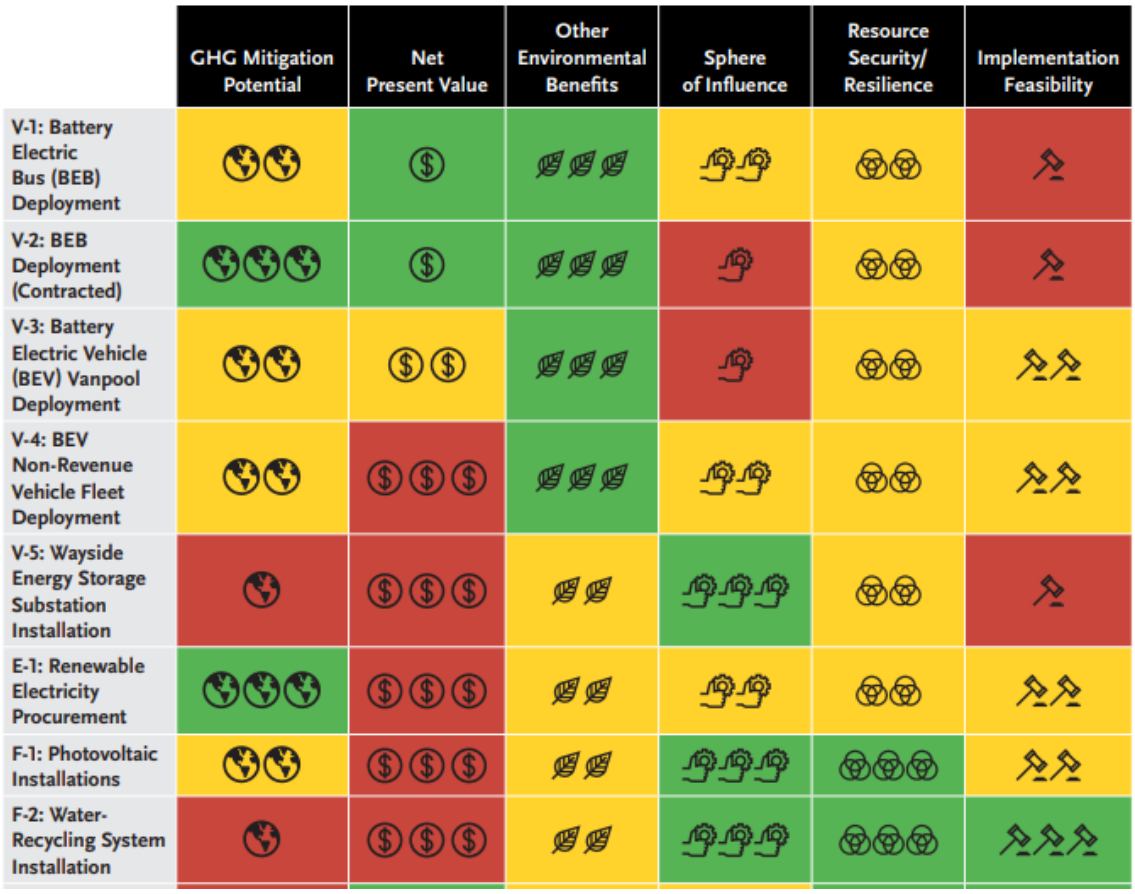
It can be helpful to use visual tools to illustrate how the strategies perform against the evaluation criteria (see **Figure 8** and **Figure 11**).

LA Metro feasibility and co-benefits matrix: LA Metro conducted a qualitative assessment of various mitigation measures. In addition to evaluating cost and GHG mitigation potential, LA Metro used the following qualitative criteria to evaluate the feasibility and co-benefits of each measure:

- **Sphere of influence:** Reflects Metro's ability to directly or indirectly influence a measure's implementation and execution.
- **Implementation feasibility:** Captures the ease of enacting a measure given Metro's resource allocation, availability of funds, financing policy and impact to operations or conflicting priorities.
- **Resource security:** Gauges benefits from changes in resource consumption that reduce Metro's reliance on purchasing energy and water resources.
- **Other environmental benefits:** Considers air and water pollution and other non-GHG environmental impacts (e.g., solid waste generation, toxic releases, land use).

An excerpt of the results of this assessment are seen in **Figure 11**. Color coding is used to indicate high (green), medium (yellow) and low (red) benefits for each evaluation criterion. Symbols increase in number if the outcome is more desirable (except in the case of costs, where more symbols reflect an undesirable outcome—i.e., increased costs).

FIGURE 11
Feasibility and Co-Benefits Matrix



The agency will want to consider and advance "quick wins" that are both low-cost and technically feasible, even if they do not produce major emissions reductions. In addition, it is important to identify strategies and supporting actions that need further technical development, funding, stakeholder and/or political support but that could have significant GHG reduction benefits and other co-benefits. In some cases, additional action may be necessary before a GHG reduction strategy can be advanced. For example, regulations can provide barriers to action. Working to change such regulations could be part of a CAP. These types of strategies can be considered "capacity-building" rather than "direct" actions that result in displaced community emissions or a reduction in direct emissions from agency operations.

Once the agency has selected the most promising strategies, it is helpful to develop and refine these strategies in more detail to better understand their technical feasibility, the stakeholders needed for implementation, and costs and benefits, including the set of supporting actions that may be needed to implement a strategy. This has to be developed within the agency's existing budget limitations. The agency will want to estimate its projected emissions reduction due to implementation of the recommended strategies. It will also be helpful to identify the potential costs. This applies to internal emissions reduction strategies, as well as community emissions displacement strategies.

The horizon year is a central consideration that will affect the life-cycle assessment of the benefits and costs of these strategies. The Sustainability Return on Investment (S+ROI) Calculator is a useful tool to help transit

agencies quantify the costs and benefits (including GHG emissions reduction) of sustainability actions (see box below).

Tools for a Sustainable Transit Agency

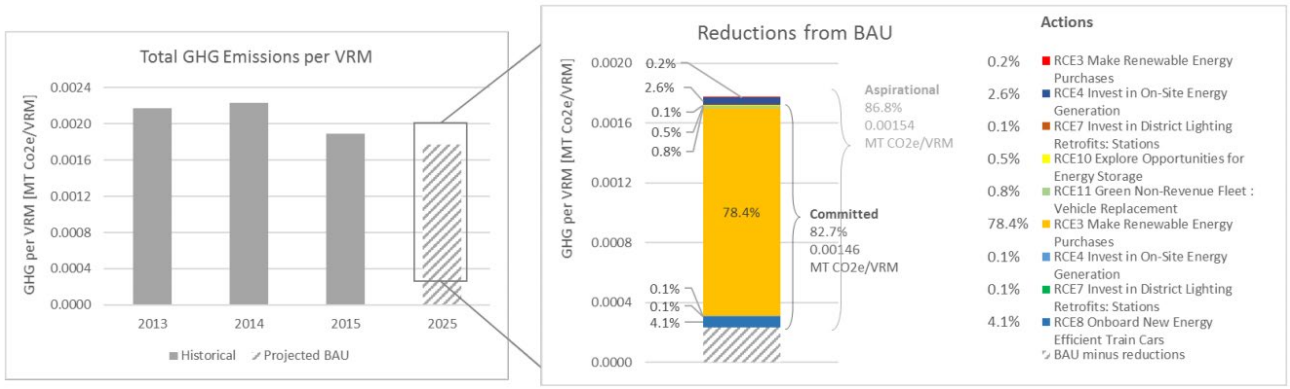
The Sustainability Return on Investment (S+ROI) Calculator is a tool developed as part of **Transit Cooperative Research Project (TCRP) 197: Tools for a Sustainable Transit Agency** (see References) to assist transit agencies in calculating the sustainability and ROI of projects. The tool includes an internal cost-benefit estimator and an external benefits estimator. The internal estimator calculates a transit agency's total cost of ownership (TCO) for a proposed project, as well as the environmental savings (e.g., GHG emissions, energy, water). The external estimator calculates regional benefits from transit projects that increase transit ridership.

3.3.1.4 Step 4: Identify recommended strategies

Based on the additional development and analysis conducted in step 3, the agency should select and prioritize strategies that will support the plan's targets and goals. For operating strategies, look for opportunities for a demonstration program to better understand implementation issues and quantify potential benefits. For capital improvements, consider how individual strategies can be phased within the context of the agency's overall capital investment program. The recommendations should consider short-term strategies that are feasible and can be advanced for funding and implementation right away, as well as medium- and long-term investments that are strategically important but need further research and development and/or political or stakeholder support.

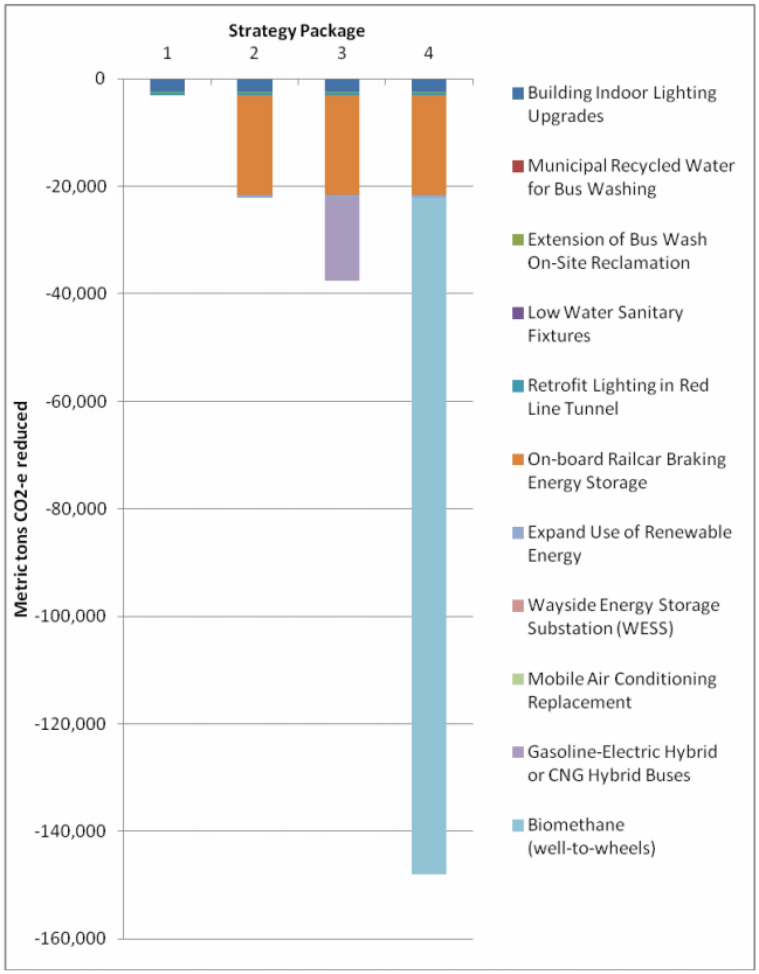
Figure 12 and **Figure 13** illustrate BART's planned actions and the corresponding GHG emissions reduction expected from each.

FIGURE 12
BART's Expected Emissions Reductions



District GHG emissions per VRM historical (left) and projected 2025 BAU scenario reductions (right). Actions repeat where there are both committed and aspirational impacts of the same activity. See bart.gov/sites/default/files/docs/BART_SustainabilityActionPlan_Final.pdf.

FIGURE 13
GHG Emissions Reduced in 2020 by Strategy Packages



3.3.2 Develop implementation plan

Once the agency has prioritized potential strategies/options, an implementation plan should be developed to answer the following questions:

- Who will lead the initiative?
- Which departments will be involved?
- What is the cost for each initiative?
- What is the source of funding to cover those costs?
- When will the initiative be completed?
- How will the agency track progress?

The milestones established for the CAP should be based on the implementation plan. The planning process should provide some initial consideration of how the agency intends to define milestones and monitor performance over time. The implementation schedule should define milestones based on potential phasing of strategies. The milestones should be closely coordinated with the agency capital improvement program and available funding for operations and maintenance.

The implementation plan should be developed to complement the agency's short- and long-term plans where feasible. For example, consider the agency's fleet replacement schedule, or scheduled upgrade of the vehicle washing facility. How can GHG emissions reductions be considered within the implementation cycle for each of the investments? The analysis needs to take the capital improvement plan schedule into consideration as the agency evaluates technical feasibility, phasing and costs. An example implementation plan template is provided in **Table 9**.

TABLE 9
Example Implementation Plan Template

Strategy/ Option	Related Initiatives	Cost	Funding Source	GHG Reduction Anticipated	Implementation Timeframe	Performance Measures	Task Leader

Example: Understanding an agency's procurement schedule

It is critical to be familiar with the agency's procurement cycles. The procurement process for significant purchases or contracts can be lengthy and complex. If an agency misses this window, it could be several years before it has another opportunity to ensure that climate mitigation is considered in the procurement. For example: A fuel contract may expire at the end of the year, but the RFP for a new contract will be developed and issued months in advance. The new contract may lock the agency into a decision for several more years.

Identifying funding for the implementation of the recommended strategies from the CAP can be difficult. Often transit agencies are hesitant to use scarce existing capital and operating resources to fund climate change mitigation and adaptation strategies. Therefore, it may be helpful to identify funding opportunities that are specific to climate change mitigation and are not eligible to be used for regular transit capital or operations. These funding opportunities can come from environmental programs at traditional transit funding sources (e.g., the FTA or state DOTs) or from "nontraditional" funding sources (e.g., federal and state environmental and energy agencies or private foundations) that have an interest in addressing climate change. However, funding for transit investments and operations is challenging even in the best of times. Alternatively, there may be existing agency interests or goals that are consistent with climate action but were never identified as such. In such cases, the CAP could add additional support of these actions. Agencies engaged in climate action planning have used new funding opportunities to achieve such low-hanging fruit by pursuing strategies in a variety of areas.

In many cases, it can be best to lead implementation with the "easy wins" that have low investment costs and quick payback periods. For electric power, consider emerging state-level requirements for utilities to transition toward greener power.

A monitoring program should be established to track the agency's progress on meeting the vision and goals of the CAP. It is important that the monitoring plan be based on meaningful performance measures for which the agency can collect the necessary data. **Table 10** provides a list of example performance measures. It is also important to make sure the agency dedicates the necessary resources and establishes procedures to implement

the monitoring program. This involves identifying the appropriate staff to coordinate the monitoring program and establishing the processes and procedures for collecting the necessary data.

TABLE 10
Example Performance Measures

Strategy/Option	Performance Measures
Convert 80 percent of bus fleet to electric vehicles	• Percentage/number of electric buses in service • Total GHG emissions reduced (MT CO_2) per vehicle mile traveled (VMT) • GHG emissions reduced (MT CO_2) per dollar invested • Number of drivers trained on efficient operation of electric buses
Upgrade 100 percent of building lighting to LED	• Percentage/number of lights replaced • Total GHG emissions reduced • GHG emissions reduced (MT CO_2) per dollar invested
Purchase 50 percent renewable electricity	• Percent of electricity that is GHG-free • GHG emissions reduced (MT CO_2) per kilowatt hour (kWh)

3.3.3 Prepare the CAP

Once the implementation plan is developed, a formal CAP should be prepared and communicated with internal and external stakeholders. As with rolling out any planning process, the first step in implementing a CAP is to develop the document that will capture decisions made during the strategic planning and options analysis stages and then direct work throughout the organization in support of those decisions. It is important to start with a draft document in order to continue soliciting feedback from the stakeholders identified at the beginning of the process. Having representative and engaged stakeholders throughout the organization and within the community is fundamental to the success of implementing a CAP. While having buy-in from a diverse set of stakeholders is important, it is also essential that support for implementing the CAP extend to the highest levels of agency leadership. Ideally, the CAP should be adopted by the transit agency board or comparable authority.

The box below includes some links to transit agency CAPs and related plans. Note that in some cases the plans focus on energy action or sustainability but still include the elements of a CAP.

Example Climate Action Plans

LA Metro:
https://media.metro.net/projects_studies/sustainability/images/Climate_Action_Plan.pdf

San Francisco Municipal Transit Agency:
https://www.sfmta.com/sites/default/files/reports-and-documents/2017/12/cap_draft_full_document-final1.pdf#page=28

WMATA Energy Action Plan:
https://www.wmata.com/initiatives/sustainability/upload/WMATA-Energy-Action-Plan-Final-4_18.pdf

SEPTA Energy Action Plan:
http://www.septa.org/sustain/2018-energy-action-plan.pdf

BART Sustainability Action Plan:
https://www.bart.gov/sites/default/files/docs/BART_SustainabilityActionPlan_Final.pdf

3.4 Implementation

With an adopted and supported CAP document in hand, it is time to move on to implementation. The CAP is intended to help an organization make wise decisions and prioritize projects and programs to mitigate climate change. A transit organization's main purpose is to provide mobility, and the very nature of transit is to provide a sustainable mobility choice. However, the degree to which transit reduces agency and regional GHG emissions will depend on decisions made by the agency.

Prior to implementation, an organization must understand the political will to implement the CAP by providing resources in a timely manner. By getting the "lay of the land," the organization can frame the discussion of the CAP's benefits and request the appropriate resources. Implementing the CAP will be challenging. In many cases, it will require altering the fundamental ways business is conducted at an organization, and change is hard.

While each organization will have its own formal processes in place through which it must implement a program or product, the following steps will help provide an organization with tools to reduce the uncertainty that comes with change in order to successfully implement a CAP.

3.4.1 Create necessary policies and guidance

The CAP will impact every part of the organization, and to be successfully implemented it needs to be wholly embraced throughout the organization. It is important that leadership approve of the draft CAP document before the agency begins circulating the document and assigning tasks. The adoption of the CAP provides the necessary authority and support to create the policies and provide the guidance needed to implement the CAP. Nonetheless, the organization's leadership must "officially" empower a group or individual within the organization to support CAP implementation—developing policies, coordinating stakeholder outreach and providing technical support. These roles can be split among several groups and individuals; however, in all cases, the individuals must be allowed to implement processes that will alter the organization's current decision-making framework.

The CAP must become integrated into the core business processes in the organization and considered a key factor in decision-making through the development and enforcement of organization-wide policies and procedures. This means identifying the processes inside the agency that guide decision making for functions that directly relate to GHG reduction strategies. This may include management processes within procurement,

capital planning and asset management. Integrating consideration for GHG emissions into existing processes is far more effective than creating stand-alone initiatives that fall outside established programs.

These processes should direct staff to answer two vital questions:

1. Is the proposed project or program the best choice (i.e., alternatives analysis)?
2. Once the project or program is approved, how does it minimize climate impacts and contribute to resilience?

Organizational policies to answer these questions will require both a modification in decision-making processes to include CAP considerations (e.g., will the purchase increase GHGs?) and a prescriptive set of CAP-related guidelines (e.g., requiring a project to use the most efficient lighting technology).

Adopting third-party standards like LEED, ENVISION, ISO 14001 and/or EMS as organizational policy may provide a path to help simplify and address certain CAP goals. Many cities and transit agencies have adopted a LEED standard for new construction. In order to get sufficient points to qualify, the standards will require the project to use specific technologies that are designed to minimize negative environmental and GHG impacts. For projects without clear third-party standards, like revenue buses, an organization should consider adopting specific design guidelines that represent the organization's goals. These design guidelines will provide clear direction for future bus procurement decisions.

If it is not possible for an organization to create new design guidelines, it can outline specific performance standards and require the use of specific analytical tools (e.g., life-cycle cost analysis) in procurement documents that represent the organization's CAP goals. This approach will put the CAP-related analysis burden on the proposing companies.

Decisions on what to buy will be based not on cost alone but also the CAP impact. This will require changes to procurement processes where additional variables may need to be included in the evaluation of a product. Tools like life-cycle analysis or a sustainable ROI, while incredibly useful in helping to choose the best product for the organization, may be challenging to implement without clear guidance. Staff will need to work together to identify capacity and gaps to perform different CAP-related tasks and analysis.

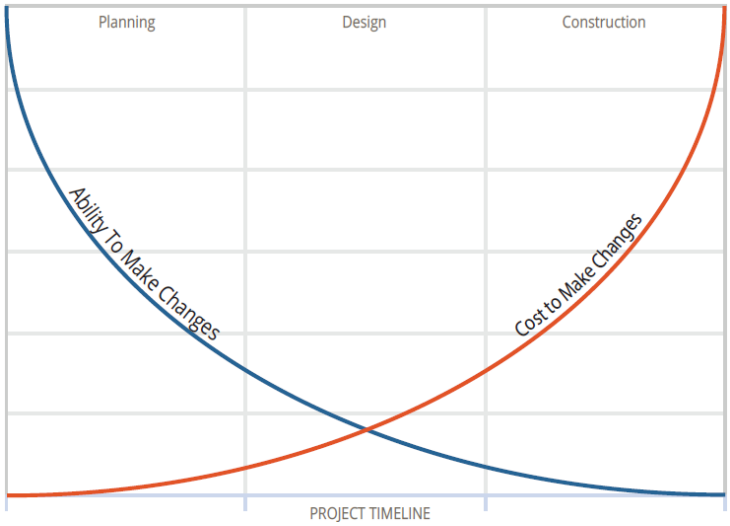
3.4.2 Fill resource needs

The adoption of the CAP may mean that additional responsibilities related to implementation or monitoring may be charged to specific agency departments, necessitating additional resources (i.e., staff, tools and funding) where possible. It is critical to fill identified resource needs in order to not fall behind on the plan's implementation schedule. As with policy changes, the need for restructuring or additional hiring should ideally be identified when the initiatives for implementation are agreed on and accounted for as part of the life-cycle cost analysis within the CAP. This will indicate what funding is needed, not only for implementation, but also for monitoring, and should help the agency determine whether it has the resources in house to fully implement the plan or if it needs to bring on additional resources.

Fiscal constraints may limit the ability of an organization to secure additional resources. In many cases CAP projects may provide a positive ROI. Demonstrating this positive ROI to stakeholders may help support gathering additional resources. For situations where the ROI is undetermined, staff may use a risk-based approach when undertaking new projects to help determine the impacts. Staff must communicate the need to ensure that the best investment for the organization requires this additional analysis. The costs are much lower to adjust in the planning and design phases of a project than once a project is under construction.

As shown in **Figure 14**, it is much less expensive to make changes to projects in the planning phase than in construction.

FIGURE 14
Costs over a Project Timeline



Courtesy of Envision V3

If direct agency funds still are unavailable after presenting the ROI and risk-based approaches, consider applying for federal, state, local or foundation grants.

3.4.3 Conduct training

Even if hiring or restructuring aren't necessary, successfully implementing the CAP will often require additional training for internal and external stakeholders. Agencies should identify the skills that will be needed to implement the strategies identified in the CAP, as well as to monitor the performance of those strategies. Once the teams have been assembled, agencies should do an assessment of the skills still needed and in which its staff can be trained. This step may identify some skill gaps that will need to be filled through additional hiring or restructuring.

3.4.4 Implement opportunities

In order to generate momentum in support of the plan, agencies should begin to implement the promising strategies identified during the options analysis. As noted, they may want to start out with some "quick wins"—strategies with relatively low risk and with low barriers to implementation—in order to build team morale and to resolve any issues that may occur as a result of staff taking on new roles or structures. Starting with "quick wins" could also help bolster the credibility of the plan and the agency as a whole.

Resource efficiency projects are common quick wins because they generally result in both GHG emissions reductions and cost savings. Reducing the fuel consumption in revenue vehicles or non-vehicles or reducing a building's energy use often will provide immediate cost benefits as well as significant GHG emissions reductions. A great first step is simply swapping out old technology lighting with LED lights.

3.4.4.1 Case study: WMATA

In 2017, in partnership with the DC Sustainable Energy Utility (DCSEU), Metro replaced outdated inefficient lighting at Shepherd Parkway Bus Facility with LED lighting, saving approximately $75,000 annually in energy costs. Additional lighting improvements completed at Metrorail stations are expected to reduce energy

costs by $60,000 annually while dramatically improving lighting quality and safety for passengers. In addition, Metro has accelerated the station chiller replacement program. Improving chiller efficiency helps maintain ambient temperatures within stations and improves passenger comfort levels, particularly during the humid summer months. The new units feature variable frequency drives and frictionless magnetic bearings, allowing the chiller unit to operate oil free. The new chillers save an estimated $15,000 in annual energy costs per station.

Building initial trust by achieving "easy wins" will help pave the way to address more complex challenges. Each organization and agency will have different opportunities to support their community in the CAP. Some agencies that are tied to local government can influence local land use development, and road design while others can focus on facility efficiency.

In addition to the work above, the opening of the Metrorail station at NoMa-Gallaudet U in 2004, Metro's first "infill" station in Washington, D.C., created the conditions that enabled the creation of a new neighborhood. Metro worked with the D.C. government to change the land use designations for the area and encouraged investment from the federal government. The area was catalyzed by the development of D.C. government offices and the construction of the new Bureau of Alcohol, Tobacco, Firearms and Explosives headquarters. Over the past 15 years, NoMa has changed from an industrial warehouse district to a mixed-use, walkable neighborhood. Now over 10,000 people live and 24,000 people work within the station area, with more development in the pipeline. According to the "NoMa-Gallaudet U Metro Station: Success Built on Transit Report" (2015), the impact of the development in the region will result in "$1 billion in total cumulative revenue to the District." By creating the conditions to form a new neighborhood, the NoMa-Gallaudet U Metrorail station helped reduce the pressure to develop on agricultural and car-dependent parts of the region. See **Figure 15**.

FIGURE 15
Development of NoMa Neighborhood

An aerial photo of the NoMa neighborhood in northeast Washington, D.C. The M logo on the right picture represents the new station entrances to the Metrorail Red line added in 2004.

3.4.5 Collect data

As the organization begins to implement strategies, it will need to have resources for data gathering and analysis in place. For this reason, it is important to understand up front what data are available, where there are data gaps, what is the required level of effort to collect it, and potential data-gathering improvement actions. As data is collected and analyzed, agencies should engage in the evaluation process and share the results with the appropriate teams of stakeholders.

3.4.6 Regularly engage stakeholders

While moving through the implementation steps above, organizations should maintain engagement with their internal and external stakeholders. This will help to bolster the sense of ownership and commitment felt by stakeholders. In particular, this is the time to leverage stakeholders' support for implementation, including potential funding, coordination and supportive policy/legislative changes external to the agency.

Language choices may vary with different stakeholder groups. An organization should be aware of the political constraints and opportunities when using different terms related to the CAP. As noted earlier, many CAP actions provide a positive ROI. If a community objects to using funds for "climate" or "environmental" items, these actions can often be reframed with terms like "efficiency" and "conservation of resources." Projects and actions that do not have a positive ROI may be framed in terms around resilience and the ability to recover from disasters. The CAP, like all good, responsible planning and project development, is not based on politics but the necessity to use the public's resources wisely.

3.5 Monitoring and improvement

Monitoring performance and taking corrective action is an essential step to identify opportunities for improvement and to ensure that the agency meets its goals. The following approaches offer a systematic way to ensure that the agency benefits from this crucial step.

3.5.1 Performance assessment

The mitigation plan should be reviewed periodically (at least annually) to evaluate progress toward GHG reduction goals. This assessment can be incorporated into an agency's existing EMS program. Corrective actions should be taken if the agency is falling behind.

3.5.2 Internal and external reporting

Reporting elements of a CAP can serve as a method of monitoring and improvement. There are numerous benefits of reporting as well as various methods of reporting.

Benefits of reporting:

- stimulates accountability
- promotes healthy competition among peer organizations
- feeds program momentum
- emphasizes transparency
- encourages timely data capture and dissemination
- uses technology tools to ensure efficient and accurate information exchange
- responsive to stakeholder scrutiny
- fulfills legal and regulatory mandates or self- determined objectives
- provides opportunity for outreach and communications

Reporting methods:

- monthly facility reports
- fuel use by division
- reports/complaints of idling
- APTA Sustainability Commitment
- annual energy/sustainability reports
- website updates
- board presentations

- The Climate Registry
- CDP (formerly the Climate Disclosure Project)
- Official Social Media Outlets

Becoming a signatory of the APTA Sustainability Commitment is a great way to demonstrate progress and get recognition for agency GHG emissions reduction efforts and achievements.

3.5.2.1 The Climate Registry

Organizations such as The Climate Registry maintain inventories of GHG emissions based on standardized protocols. Participation in such a registry can provide technical assistance, facilitate benchmarking, and demonstrate transparency and accountability. It can also lend immense credibility to the effort through independent validation and verification, while also creating incentives for the agency to continue making progress. Should an agency decide to register its emissions with The Climate Registry, APTA strongly encourages the inclusion of avoided emissions from displaced trips.

3.5.3 Management review

Organizations may choose to use a management review process to contribute to monitoring and improvement. The value of this activity is in top management's engagement and the institution's commitment to climate action planning. Top management feedback allows organizations to more effectively promote and integrate climate action planning and ensure continual improvement. The information below is based on the ISO 14001:2015 Standard.

Example structure of a management review:

- status of actions from previous management reviews
- updates on any major changes
- the extent to which CAP goals and targets have been achieved
- information on the organization's performance as it relates to climate action planning
- adequacy of resources
- relevant communications from interested parties
- opportunities for improvement

Outputs of the management review may include:

- conclusions on the continuing suitability, adequacy and effectiveness of the CAP
- decisions related to continual improvement opportunities
- actions when CAP goals and targets have not been achieved
- opportunities to improve integration of the CAP with other business processes
- any implications for the strategic direction of the organization

The management review should be high-level, typically on an annual basis. Organizations may consider incorporating the CAP management review into regularly scheduled management activities, such as board meetings.

It would be valuable for the results of internal or third-party performance assessments (Section 3.5.1) and internal or external reports (Section 3.5.2) to be presented in the management review, if those monitoring tools are used.

3.6 Conclusion

The mitigation component of a CAP provides the roadmap for how a transit agency can lower GHG emissions. With each agency doing its part to reduce agency GHG emissions and displace regional emissions, the transit community can collectively make a positive contribution toward sustaining the planet. Given the uncertainty around climate change impacts, the efforts to reduce GHG provide additional tangible benefits. A robust CAP planning process will create vital human connections between internal stakeholders and external organizations to tackle the complex challenges that lie ahead. Additionally, CAP programs that reduce resource consumption generally provide significant financial benefits.

Some CAP programs will be easier to implement than others. While converting to LED lights provides a quick win with clear GHG and economic benefits, other actions and policies may require years to implement. Do not be discouraged. The need to mitigate for climate change is ongoing. Build allies through stakeholder engagement and continually review programs while looking for opportunities to improve.

Reducing GHG emissions may help reduce the severity and uncertainty coming with climate change. However, no one can predict exactly whether the mitigation measures will be enough. Transit agencies, therefore, will need to adapt to the uncertainty of a changing climate and build more resilient systems, which is the topic for the next section.

4. Resilience

4.1 Introduction

Extreme weather events and other natural disasters threaten the operations and capital assets of transit systems across the country. Billions of dollars of transit assets—buses, trains, trolleys, tracks, stations, subsystems and more—have been destroyed by climate-related disasters in the past decades. As a result, millions of passengers have been deprived of reliable transit service for short or long periods of time. Transit agencies have been fighting back against this unnecessary waste of agency resources and taxpayer dollars, and their customers' loss of service, by taking steps to become more resilient.

> "The ability to prepare and plan for, absorb, respond, recover from, and more successfully adapt to adverse events… enhanced resilience allows better anticipation of disasters and better planning to reduce disaster losses – rather than waiting for an event to occur and paying for it afterward."
>
> —National Academies of Sciences

A resilient transit system avoids, minimizes and mitigates risk. It is a system that can absorb the impacts of disaster, recover quickly and return rapidly to providing the services that customers rely on to get to their work and meet their other travel needs. Many lessons have been and are still being learned, in the wake of multiple weather-related, disastrous events—wildfires, exceptional heat, blizzards, major floods—in many areas throughout the country, as well as recurrent hurricanes.

TCRP Web-Only Document 70, "Improving the Resilience of Transit Systems Threatened by Natural Disasters," was published in December 2017 (hereafter referred to as the "TCRP Guide"). The study included case studies of 17 transit agencies; the study team worked with a panel including APTA, FTA and transit agency representatives. The study team worked with APTA throughout the project on a mechanism for incorporating resilience into APTA standards and practices, to ensure broader implementation of resilience practices throughout the transit industry.

This section is the first iteration of this resilience-integration process. It summarizes key findings from the full TCRP Guide. Transit agencies are encouraged to refer to the full TCRP Guide for greater detail and context.

The TCRP Database includes extensive worksheets and tools, some developed for the project and some garnered from transit agencies that have piloted and tested procedures and techniques.

Throughout this section, direct quotes from the TCRP Guide are in italics, with longer quotes indented. A key finding from the guide is that resilience has a lot in common with safety culture and asset management implementation: It is cross-cutting, and most effective when it becomes second nature throughout the agency—part of everyday practices and thinking as well as long-range planning. This section summarizes how to get an agency to that state.

The five remaining sub-sections can be taken stepwise by agencies beginning the process, or agencies can focus on those areas where the most attention is needed.

4.2 Strategic planning

4.2.1 Partnerships

Partnerships are a key piece of the strategic planning process for resilience, especially in situations when the solutions may lay outside an agency's control. Developing a plan to better prepare agencies for the increasing impacts of extreme weather events requires integrating strategies that engage transit agencies, intra-agency stakeholders and external stakeholders. While transit agencies do not usually take the lead in the planning effort, they are a critical partner in providing essential services to the community while also being reliant on many partners such as utilities, fuel suppliers and communication providers. These interdependencies create vital links that need to be recognized and leveraged during the planning phase. Partners may include local municipalities, MPOs, other transit agencies, universities, utilities, internet infrastructure services, business partners or key suppliers.

As any impacts to horizontal infrastructure will most likely result in a disruption to an agency's normal operation, entities involved in the operation and maintenance should also be considered as important partners. For example, state governments, state departments of transportation, MPOs and others may already have hazard mitigation plans in place, and may be placing a greater emphasis on resilience.

FIGURE 16
Transit Agency Stakeholders

The steps outlined in the TCRP Guide Chapter 3, "Reinforce Your Agency's Regional Interdependencies," can serve as a guide to ensuring transit agencies' needs and value are represented in planning efforts. Questions to lead the initial conversations when evaluating potential partners may include the following:

- Who has an interest in transit system resilience?
- Who has knowledge, expertise and resources to bring to the discussion?
- Who can influence decisions regarding transit resilience?
- Who is demonstrating or could demonstrate resilience leadership?

4.2.1.1 Case study: City of Austin partnering to reduce greenhouse gases

In 2014, the City of Austin set an ambitious goal of achieving net-zero community-wide greenhouse gases by 2050. The first Austin Community Climate Plan in 2015, was the roadmap that was put in place—the result of an extensive community collaboration.

Capital Metro joined the City and other regional agencies and community partners to identify key strategies and develop metrics to measure the impact. The effort coincided with Capital Metro's Connections 2025 system re-design, Project Connect regional high capacity transit plan, and fleet and infrastructure electrification powered by Austin Energy's Green Choice renewable energy—all of which became key strategies in the Community Climate Plan.

Since the Plan's adoption progress has been made toward achieving the goals and by 2019 Austin marked a decrease in greenhouse gas emissions. During that same time, Capital Metro achieved a steady increase in ridership for 16 consecutive months, through early 2020. Construction began on the new North Operations Electric Bus Depot in 2019, with an electric-ready capacity for over 180 buses.

In 2020 Austin launched a Plan update process with community based-advisory groups to focus on: Transportation Electrification, Natural Systems, Sustainable Buildings, Transportation and Land Use, and Consumption of Goods.

The new planning process also has an increased focus on equity. The planning team recognized that that climate solutions have the potential to improve the quality of life of all Austinites, but climate change impacts do not affect everyone equally. The new effort makes it *a priority to engage with a racially and economically diverse set of people about the challenges, barriers, and opportunities facing historically underrepresented groups — specifically, people of color — in conversations around energy, transportation, food, and access to nature.* A specific outcome is the launching of the Climate Ambassadors program, to create connections with people in the community that may not normally be engaged in an effort like this.

Capital Metro continues to provide leadership and planning resources for the Community Climate Plan. The first twelve electric buses are being integrated into the fleet for service in 2020 and the electric bus depot will be ready for operation. Zero emissions buses will be the first choice for all future fleet expansions-battery electric powered by Austin Energy Green Choice renewable energy. Capital Metro has joined with Austin Transportation Department, Bikeshare of Austin, and others to expand the current bike share system and launch an e-bike fleet that will be integrated with transit. Additional strategies such as adopting ENVISION for sustainability guidance, expanding solar lighting installation at public and administrative facilities, and expanding energy assessment programs will further support Austin and Capital Metro's climate goals.

4.2.1.2 Case study: Georgetown Climate Center

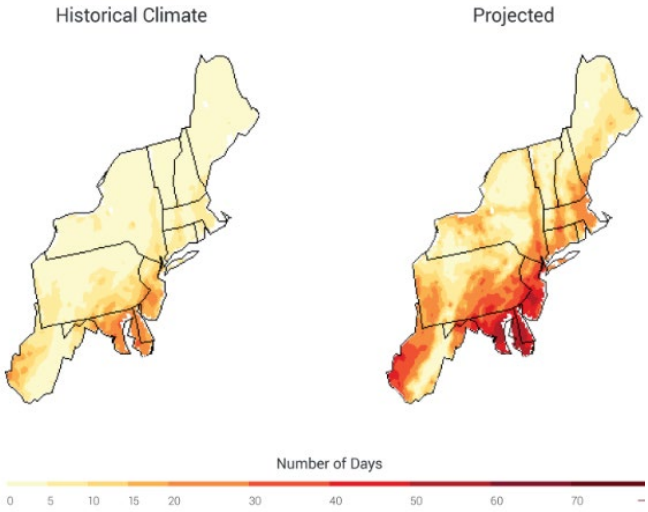
In 2017 the Georgetown Climate Center released a case in regional collaboration, Lessons in Regional Resilience. The report highlights six case studies and explores climate collaboratives from around the United States that are bringing together local governments and stakeholders to address the impacts of climate change. The report includes lessons and case studies to assist regional collaboratives and includes the history and impetus for creation of each collaborative, how the collaboratives are structuring themselves and establishing decision making methods, what funding sources are being tapped, and the roles and initiatives each collaborative is pursuing. The report recognizes the challenges in regional collaboration and the benefits that arise from maximizing efficiencies in the process and organizational structure.

4.2.1.3 Regional specifics

A one-size-fits-all approach is not feasible in resilience planning, as climate impacts, local governance structures, funding and strategies are specific to each region. Agencies can find more information on regional climate impacts, natural disaster projections, as well as funding and evacuation support emergencies in FHWA's Climate Change and Extreme Weather Vulnerability Assessment Framework, FTA's Emergency Relief Manual, and the U.S. Global Change Research Project.

FIGURE 17

Northeast Regional Heat Map—Projected Increases in the Number of Days over 90 °F



U.S. Global Change Research Project

4.2.1.4 Case study: Valley Metro strategies for heat resilience

Valley Metro developed strategies for heat resilience in response to changes in climate and in support of sustainable goals for community health and wellness. Increases in the frequency of extreme heat events can have detrimental impacts on both infrastructure and patrons. Design solutions were developed in collaboration with partners such as the Sustainable Cities Network and Arizona State University and implemented at critical locations within the Valley Metro service region.

Design strategies included using a light station color scheme with high-albedo materials, paving materials with solar reflectance index of at least 29, open grid pavement system for non-walking surfaces, extensive shading with links to amenities and waiting areas, and increased vegetation.

As referenced in the TCRP Guide, as agencies start engaging with partners, they will be able to "work toward developing and implementing strategies that address identified gaps and weaknesses across agency and jurisdictional lines." Working with municipal partners who are in the process of developing climate action and resilience plans will improve a region's readiness, response and restoration in a severe weather event and lessen the impacts to vulnerable assets and populations.

4.2.2 Understand agency context

Enhancing organizational and operational resilience is most impactful when strategies and policies are interwoven into existing policies and programs that provide the foundation for day-to-day decision making. This requires a broad understanding of an agency's governance structure. The following can help embed resilience within an agency's core mission:

- **Accountability at all levels.** Defining board- and executive-level responsibilities puts resilience as a top agency priority, while establishing goals for middle management drives progress on specific initiatives. Further, including a connection to resilience in performance evaluations provides a meaningful incentive to prioritizing effort and investment. Together, these approaches play an important role in empowering change and inspiring action.
- **Integrated planning.** Ideally resilience will become part of existing agency planning processes, including both long-range system planning and annual planning. This avoids common pitfalls associated with creating independent plans that can inadvertently create confusion and competing messages within an agency. Additional opportunities to integrate resilience into department-specific plans, such as safety, security and asset management, provide opportunities to define function-specific strategies.
- **Valuing resilience.** Resilience is a holistic concept that encompasses operational reliability, capacity to recover from acute shocks and long-term stressors, and ability thrive through changes in society and the natural environment. Often conventional approaches to evaluating the financial return on investment for specific capital projects or agency programs do not place value on these aspects of resilience. Therefore, it is critically important to engage an agency's finance department on how resilience can be integrated into capital programming and other financial decision-making processes.

KEY QUESTIONS

Do organizational silos exist that impact system-wide decision making?
Consider establishing a cross-functional Resilience Working Group to break down these barriers and enable strategic decision-making.

What existing programs, people, projects and procedures can be leveraged to enhance organizational resilience while achieving other priorities and goals?
Look for potential synergies with areas such as risk management, asset management and system planning.

Are there creative ways to bring new money and resources to the table?
Federal agencies, municipalities, and nongovernmental organizations are all making strategic investments to improve resilience of critical infrastructure, including transit, particularly in communities representing underserved or vulnerable populations. Even public-private partnerships to improve resilience can provide mutual benefits to communities and local economies.

Articulate a resilience vision and goals

People often have different ideas about what resilience entails. If the agency does not already have a definition for resilience, it may want to spend some time to develop one, or at least look at existing definitions to find one that resonates. The TCRP Guide provides a National Academy of Sciences definition as a foundation but also includes many examples from transit agencies that might fit better with the culture of the agency.

The agency likely already has a vision statement. If that vision does not already embody resilience, the agency may want to explore how to amend that vision to include resilience aspects and goals. Or it may want to establish a stand-alone resilience vision.

The agency likely already has many goals, but how many of these goals relate to resilience? Table 2.2 from the TCRP Guide provides example goals. Three examples are shown in **Table 11**.

TABLE 11
Examples of Resilience Goals

Vision Component	Example Goal
Preparedness	Implement operations changes and asset investments to reduce or eliminate weather-related service delays and disruptions (within five years).
Protection	Minimize damage by taking protective action (larger-scale fleet decarbonization or smaller scale equipment relocation or preemptive curtailment of service to improve safety and avoid equipment damage).
Rapid recovery	Restore safe service as quickly as is safely possible: safe for staff, passengers, equipment and facilities. (Establish and train for exceptional standard operating procedures within one year; implement additional protocols as preparedness, protection and adaptation projects and procedures are brought on board.)

Also as described in Table 2.2 from the TCRP Guide, (adapted from Askdan, 2016), good goals are SMART: Specific, Measurable, Acceptable, Realistic and Time-bound (also flexible, suitable, and understandable)

4.2.3 Identify opportunities and barriers to improving resilience

Agencies commonly ask themselves the same question when first developing a resilience strategy: Where should we start? Fortunately, there are several proven strategic planning tools to bring focus and prioritize action. The TCRP Guide features many such tools. The Resilience Lens Tool outlines a strategy of appointed or self-selected champions with sample questions for incorporating resilience throughout the domains of the organization: Purchasing, O&M and more. Another example is the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. This structured planning technique identifies internal strengths and weaknesses and external opportunities and threats.

SWOT analysis can be applied to evaluating resilience across an entire agency, single department, or specific project or initiative. A SWOT analysis provides value at each level. When completed to inform development of a resilience strategy at the agency level, key themes will emerge identifying existing programs that can be leveraged or improved, as well as external considerations impacting the agency's resilience. A SWOT analysis for a specific project or program will identify more granular details, supporting the development of a tactical plan and specific actions. In both cases, the result is an insightful matrix that can be used to guide next steps.

4.2.4 Start to make a business case for resilience

Start with the ordinary requirements of the agency's operations, and consider the impacts of disaster or even substantial disruption on achieving those requirements. This creates the frame for discussing the business necessity of resilience. Even to those closest to the agency, quantifying the direct and indirect impact of a disaster or significant service disruption can be challenging. Monetizing risk is complicated by uncertainty, in terms of severity of impact and probability of occurrence.

Building a business case for resilience can be approached by both estimating the benefits of a more resilient system and the direct and indirect cost of service disruption.

The financial impacts are often limited to those directly affecting the agency, despite the fact that the ripple effect throughout the community can quickly overshadow this figure. Limiting the business case analysis to the operational boundaries of the agency overlooks the fact that transit is critical infrastructure to the communities it serves and is directly linked to the health of the local economy. The more comprehensive understanding of costs and impacts, the stronger the business case for pursuing investment from other public and private sector funding sources, including the following:

- cap and trade
- green bonds
- West Coast Infrastructure Exchange
- Intermountain Infrastructure Exchange

4.2.4.1 Case study: MTA

According to the Climate Bonds Initiative, the New York Metropolitan Transport Authority issued its first Climate Bonds Certified bond in 2016. MTA had over $11 billion of eligible assets to issue against as part of its 2010–14 Capital Plan. The proceeds from bond sales will be allocated for capital investments in MTA's electrified rail assets and supporting infrastructure.

4.3 Options analysis

The purpose of an options analysis is to identify the threats that may impact the agency's infrastructure and operations, assess vulnerability of the system, and prioritize mitigation and adaptation strategies to improve operating resilience. The objective of this process is to inform decision-making and direct investment to improvements that will make the greatest impact. This requires an objective approach that is grounded with data to quantify the direct and indirect impacts associated with each threat.

Preferred options to improve resilience should be integrated into existing programs, projects and procedures to institutionalize the strategies and ease the burden of change management. An options analysis is generally completed using a four-step approach: threat and hazard identification; risk assessment; resilience opportunity analysis; and prioritization and implementation.

4.3.1 Threat and hazard identification

Threats and hazards take many forms and are generally defined as any circumstance or event with the potential to cause significant disruption through loss of or damage to an asset. Start by reviewing threats and hazards already experienced by the agency; this retrospective review can provide context for operational impacts. Next, inventory threats and hazards that have impacted other organizations regionally or transit agencies nationally.

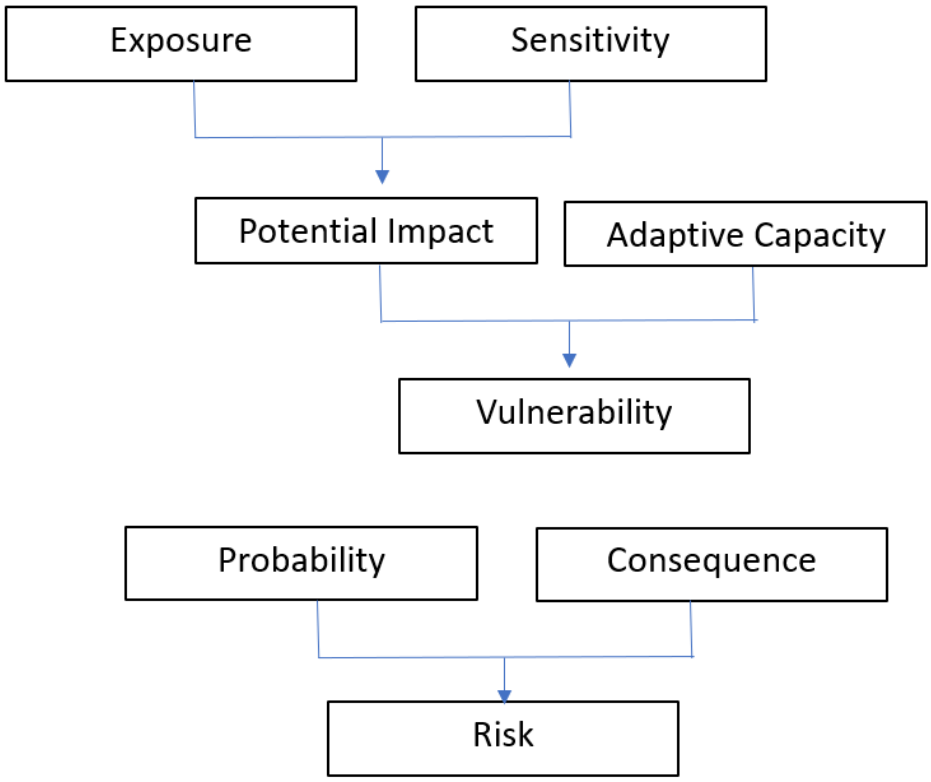
Natural hazards include storm-related (flood, wind) or seismic disasters. Human-made threats originate from human activity and include accidental or intentional events such as spills, acts of terrorism or cybersecurity incidents. This document focuses on natural hazards associated with climate change; however, the agency should define the types of threats included in the scope of the options analysis.

Focus on what the agency can control. Threats and hazards are unpredictable and cannot be controlled. However, the agency can identify vulnerabilities associated with each threat and implement strategies to proactively minimize risk and enhance recovery from unplanned service disruptions.

Wherever possible, obtain relevant data to support the evaluation of each threat. For example, data on projected impacts of climate change should be acquired from local universities, the National Oceanic and Atmospheric Administration or the Environmental Protection Agency, preferably in collaboration with local or regional organizations (e.g., the MPO or RPO) to share costs and build partnerships and actions around common threats and goals. Data should include both historical information and anticipated future conditions to provide a holistic view of potential threats.

4.4 Conduct risk assessment

With a complete view of threats and hazards, the next step is to understand the likelihood and magnitude of impacts to the Agency. First, it is important to understand what transit infrastructure may be impacted by the threat. Develop an inventory of transit infrastructure and assets that may be impacted by the threats and hazards identified. This should include vehicles, facilities, stations and fixed guideways, as well as the support systems (such as maintenance facilities, administrative facilities) necessary to operate services. This inventory can be developed using existing asset management programs and identifying each of the considerations in the flowchart below as part of the planning process.



Risk = Impact × Probability. Relative risk includes consideration for both potential impact of the threat or hazard and the likelihood of occurrence.

Second, determine the most likely and worst-case scenarios for each threat to complete a scenario analysis. This will help the Agency understand and quantify the difference between planning for events with the highest probability of occurring and mitigating risks associated with catastrophic events. For example, what is the relative impact of increased frequency and intensity of heavy precipitation events for both the low- and high-end projections? And what is the difference in approach and level of investment to mitigate these risks?

Performing a resilience self-assessment may take many forms. Below are a few pieces of information that should be included.

a. Prioritize assets and services
   i. Asset inventory
   ii. Criticality factors
      - Direct damages (damages to agency). This may include consideration for the relative criticality of each asset. For example, is the asset critical for vulnerable populations? Is there redundancy for the route? What is the cost associated with repairs and insurance fees?
      - Indirect damages (impact to local economy, community)
   iii. Assess vulnerability
      - Risk = Probability × Severity / Consequence

b. Select and prioritize implementation strategies
    i. Initial screening
        - Does the strategy contribute to achieving one or more goals?
            - Is the strategy within the authority of the agency to implement?
            - Is the strategy technically feasible?
            - Is the strategy politically feasible?
            - Is the strategy acceptable to the public and customers?
        - Further prioritize based on impact and ease of implementation (decision matrix)

4.4.1 Example: emerging promising practice

The State of Massachusetts developed its combined "State Hazard Mitigation and Climate Adaptation Program" in 2018. This plan identifies hazards of all types across the state, as well as plans to address climate change, addressing FEMA Mitigation Plan requirements together with State Climate Adaptation mandates. Adverse climate change and other risks to concentrations of people in poverty, elderly, minority, with disabilities, and with combinations of risk factors for disadvantage are identified in sections describing hazards.

4.5 Implementation: Move forward

4.5.1 Explore the shared sense of need

The assessments of threats, risks, and assets and criticalities in the previous step has likely generated conversations and concerns about system vulnerabilities across business units and functions, and an understanding of the potential magnitude of impact from different hazards and threats. In order to embrace change, people need to have a shared understanding of the real need for change: why it's important, what difference it will make, how they may be affected and how their contributions will count. Articulating this shared sense of need can be a good foundation for building a resilience vision and goals, or for explicitly incorporating resilience into the broader agency vision and goals.

The shared sense of need may emerge from different sources. For example, direct disaster experience may have a meager upside as a catalyst for change. Others' hardships may also provide impetus. A leader or champion who develops a sound and compelling business case for resilience may bring others "into the fold."

Other paths to resilience include sustainability and environmental programs and asset management. In many cases, agencies that embrace resilience have found that multiple initiatives—sustainability, asset management and leadership, for example—have converged to include a focus on resilience. Some recognize it as an effective emphasis area or tool to foster collaboration and communication toward a common goal, much like safety, asset management, and sustainability.

4.5.2 Aspirational suggestions for across-the-board resilience progress

In some cases, the agency may need to commit long-term investments to become more resilient. However, in many cases, it can become more resilient through small changes in everyday activities. Start with what the people in the agency already knows and can put into action.

Operations and maintenance personnel, both line and supervisors, are the eyes and ears for emerging and recurring problems. They will be the front line for advance actions to prevent bigger problems.

Asset managers and procurement personnel are on the lookout for the best deals when considering full life-cycle costs, including risks from changing weather conditions (such as higher heat and more rain, wind, ice and/or snow) and what that will mean for equipment. They avoid the short-term, false economy of a cheap replacement part or fix that will cost more in labor and breakdowns over the long haul.

Systems planners are looking for recurring patterns of required route diversions for flooding and other mishaps for potential fixes. Moving the route? Working with the city to fix the underlying stormwater drainage problem? They are also on the alert for evolving needs for passengers, such as shelters to partially protect waiting passengers from excessive heat or excessive cold.

Capital planners and engineers are looking at a range of long-term outlooks for natural events and taking at least some of those "worst-case" forecasts into consideration in their plans. They are pushing back on the urge to "value engineer" to minimum standards and, instead, looking at best-value solutions. They know that most engineering standards are lagging the risks of natural events and consequences by years or decades.

Senior leaders, including general managers and executive staff, supported by the elected or appointed advisory governing body, are encouraging staff at all levels to share information and to collaborate on resilience initiatives. They know that resilience is a key success factor for virtually every aspect of system operations and customer-focused service, including safety, sustainability and asset management.

4.5.3 Select and prioritize implementation strategies; develop detailed action plans

The next step, as in any strategic plan, is to select and prioritize strategies and develop detailed action plans. Threats are rarely or never clearly defined as to time, place and severity, but your risk and asset assessments should give you a clear understanding of trends and possibilities. Note that the state, region, Department of Transportation, and/or transit agency likely has a Hazard Mitigation Plan in place, addressing FEMA requirements. Continue those connections as the agency develops its action plans.

Consider the hazards again in light of the agency vision and goals: extreme heat; wildfires; tornadoes; flooding from rainfall, snowmelt, rising rivers or all of the above, possibly exacerbated by wildfires; blizzards, hailstorms or ice storms; earthquakes; tsunamis; volcanos; landslides; avalanches; hurricanes; storm surges; sea level rise/land subsidence; as well as human-caused threats such as bombs, active shooters and vehicle accidents. Considering the agency's hazards, assets, and vision and goals, consider a few scenarios while planning implementation strategies, especially if the agency faces substantial uncertainty about future trends.

Some agencies adopt a "no- or low-regrets" strategy for at least some investment and operating decisions: These strategies can offer immediate benefits, as well as lay the foundation for future changes. No-regrets options provide benefits for a wide range of future uncertainty, even in the absence of climate change risks or other risks. Low-regrets options may incur an additional cost to offset climate change risks, but these costs are small in comparison to the benefits of avoiding future costs.

Transit agency examples:

- Operations plans, such as establishing "standard operating procedures" for non-standard events, including MOUs to move vehicles out of harm's way (e.g., to higher ground) if threatened.
- Operations alerts and GIS tracking, where operators and supervisors report flooding or other routine disruptions so they can be tracked/avoided, aiding service planning.
- Capital procurement, such as ordering buses with white tops that better reflect heat (for hot climate areas).

If an agency is considering a major investment, such as locating and designing a new maintenance facility or station, or developing a new BRT or light rail line, it may want to enhance its strategy choices with scenario planning. Particularly for infrastructure projects, planners, designers and engineers can use the ADAP to assess existing and future assets' sensitivity to projected climate trends.

As the agency continues to identify strategies and tactics for moving forward, it should develop a timeline for continual check-ins where each of the following items are addressed.

1. Evaluate resource availability
2. Establish tasks to complete the chosen strategies/actions
3. Develop schedule to complete the actions
4. Assign responsibility within the agency
    a. Lead change/mobilize commitment to support implementation
    b. Leadership decisions: Full commitment? Phased approach? Pilot?
    c. What areas of business at the agency may affect and/or be affected by proposed changes?
    d. What is the nature of the effects?
    e. Who at the agency will be most impacted by the proposed changes?
    f. Who will and won't be on board with the proposed changes and why?

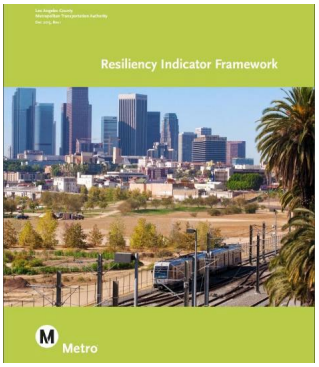
4.6 Monitoring and improvement

As discussed in Section 3, monitoring performance and taking corrective action is an essential step to identifying opportunities for improvement and to ensure that the agency meets its goals. The approach for monitoring and improving for resilience is consistent with the steps in Section 3.5 and the process below:

1. Monitor progress
    a. Choose performance measures and metrics
    b. Process and input metrics
    c. Output metrics
    d. Outcome metrics
    e. Desirable characteristics of resilience metrics:
        i. Relevant, easily related to objective being measured
        ii. Acceptable to agency personnel and other stakeholders
        iii. Measurable, using available data or easy to collect/calculate
        iv. Accurate
        v. Sensitive enough to detect trends, change over time
        vi. Appropriate and specific enough
    f. Track data
        i. Identify internal and external data sources
    g. Evaluate success
        i. Process/input evaluation
            - Has leadership demonstrated active and visible commitment to resilience adoption?
            - What progress has been made on implementing each item in strategy action plans?
            - Do personnel have adequate resources to advance implementation?
            - Should priorities be changed to address certain implementation steps over others?
        ii. Impact evaluation
            - Have policies, procedures and other supportive processes been changed to reflect resilience considerations?
            - Are infrastructure and other critical systems being made more resilient?
            - Are a greater number of personnel being trained in emergency management procedures?
            - Has transit resilience improved (after event plus qualitative concurrent measures)?

4.6.1 Case study: LA Metro Resiliency Indicator Framework

In 2015, LA Metro developed resilience indicators for transit programs to help address climate change. The framework is intended to help prioritize and evaluate climate adaptation implementation priorities to ensure infrastructure resilience and maintain a state of good repair.



The framework is intended to help prioritize and evaluate climate adaptation implementation priorities to ensure infrastructure resilience and maintain a good state of repair. A proposed weighting system was applied to each factor analyzed and can be used as a template for agencies undergoing a resileiency and risk evaluation.

5. Call to action/conclusion

Climate adaptation is an ongoing, participative, iterative process. As expressed in Section 2, we plan, we do, we check, we act and we repeat, Climate is changing, and impacts are increasing. As transit agencies we are on the front lines on three fronts. We are leading the way to a greener, more sustainable future, with our roadmap to greenhouse gas emissions reduction spelled out in Section 3. We are often bearing the brunt of climate impacts, affecting our infrastructure, our buses, trains and other vehicles, our service routes, and most importantly, our people—our employees and our customers. So while we are working to mitigate climate change, we must at the same time become more resilient agencies and systems, as laid out in Section 4. Finally, collaboration, inclusion and equity are primary keys to success in every aspect of climate adaptation, as summarized in each section and laid out more completely in the source documents.

Climate adaptation is a rapidly evolving field, with rapid changes in technology, engineering, climate science, and operational and organizational practices. We invite you to become part of the conversation and change process. Please share your challenges and successes, and please stay in touch so we can share bold new ideas and terrific incremental tweaks and successes. We are all in this together.

Related APTA standards

APTA SUDS CC-RP-001-09, Rev. 1, "Quantifying Greenhouse Gas Emissions from Transit"

References

AccountAbility, the United Nations Environment Programme and Stakeholder Research Associates, "The Stakeholder Engagement Manual, Volume 2: The Practitioner's Handbook on Stakeholder Engagement," October 2005. https://www.ccednet-rcdec.ca/sites/ccednet-rcdec.ca/files/the_stakeholder_engagement_manual_-_volume_2.pdf

American Public Transportation Association, APTA Sustainability Committee, GHG Inventory template. https://www.apta.com/wp-content/uploads/Standards_Documents/APTA-SUDS-CC-RP-001-09_Rev-1.pdf

Center for Climate and Energy Solutions, State Climate Policy Maps. https://www.c2es.org/content/state-climate-policy/

City of Austin, "Austin Community Climate Plan." http://austintexas.gov/page/austin-community-climate-plan

Federal Highway Administration, "Climate Change and Extreme Weather Vulnerability Assessment Framework," December 2012. https://www.fhwa.dot.gov/environment/sustainability/resilience/publications/vulnerability_assessment_framework/index.cfm

Federal Highway Administration, "Costing Asset Protection: An All-Hazards Guide for Transportation (CAPTA)," January 2013. https://www.fhwa.dot.gov/security/emergencymgmt/profcapacitybldg/captool_users_guide.cfm

Federal Highway Administration, "INVEST Infrastructure Voluntary Evaluation Sustainability Tool." https://www.sustainablehighways.org/

Greenhouse Gas Protocol, "Mitigation Goal Standard." https://ghgprotocol.org/sites/default/files/standards/Mitigation_Goal_Standard.pdf

LA Metro, "Metro Climate Action and Adaptation Plan," 2019. https://media.metro.net/projects_studies/sustainability/images/Climate_Action_Plan.pdf

Science Based Targets website (https://sciencebasedtargets.org) and manual (https://sciencebasedtargets.org/wp-content/uploads/2017/04/SBTi-manual.pdf)

Transit Cooperative Research Program, Sustainability Return on Investment (S+ROI) Calculator, TCRP 197, "Tools for a Sustainable Transit Agency," 2018. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_197.zip

Transit Cooperative Research Program, TCRP Document 70. http://www.trb.org/Publications/Blurbs/177007.aspx

Climate and Resilience Database. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/

Articulating a Resilience Vision Worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e507e245671148d3052370/

Identifying Internal and External Operational Interdependencies Worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e5099ebcb51748add1a996/

Initial Identification of Stakeholders Worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e504ae84c83648b2cf2c48/

U.S. Global Change Research Program, Regional Climate Information & Modeling, US Global Change Research Project. https://www.globalchange.gov/about

Resilience Lens Tool. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e5031750fef948974ad16b/

Resilience Strategy planning worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e5091b2f2cc048b375123c/

Agency Context: Resilience Planning Questionnaire. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e5041218c8df48b96efd5a/

SWOT Analysis Planning Guide. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e50553ec379848d0b659c9/

Making a Business Case for Resilience Worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e506d3c270e2496d3ac843/

Articulating a Resilience Vision Worksheet. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58e507e245671148d3052370/

Adapting to Climate Change Through Asset Management Planning. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58ee8dd1eaa3bf4c7b73c21c/

Addressing Transportation Agency Challenges in Improving Climate Resilience: Two Tools from FHWA. http://vtc.rutgers.edu/tcrp/tcrp-database/#resources/resilient-transit-tools-and-resources-details/58efa2f6c2ecb10c1e5b2360/

Abbreviations and acronyms

ADAP	Adaptation Decision-Making Assessment Process
BAU	business as usual
BEV	battery electric vehicle
BRT	bus rapid transit
CAP	Climate Action Plan
DCSEU	DC Sustainable Energy Utility
DOT	Department of Transportation
EMS	environmental management system
FEMA	Federal Emergency Management Agency
FTA	Federal Transit Administration
FHWA	Federal Highway Administration
GHG	greenhouse gas

GIS	geographic information system
GRI	Global Reporting Initiative
HVAC	heating, ventilation and air conditioning
IT	information technology
kWh	kilowatt hour
LEED	Leadership in Energy and Environmental Design
LED	light-emitting diodes
MOU	memorandum of understanding
MPO	metropolitan planning organization
MT	metric tons
MTCO2e	metric tons of carbon dioxide equivalent
NATSA	North American Transportation Services Association
NGO	nongovernmental organization
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PUC	public utilities commission
RFP	request for proposal
ROI	return on investment
RPO	rural planning organization
RTD	Regional Transportation District (Denver)
SEPTA	Southeastern Pennsylvania Transportation Authority
SFMTA	San Francisco Municipal Transportation Agency
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAM	transit asset management
TCO	total cost of ownership
TOD	transit-oriented development
VRM	vehicle revenue mile
WMATA	Washington Metropolitan Area Transit Authority

Summary of document changes

- Section 2 which introduces the Plan-Do-Check-Act methodology is a new addition to the previous version
- Section 3 addressing the climate change plan mitigation has been updated to reflect more current industry and regulatory trends
- Section 4 on Resilience is a new addition to the previous version

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