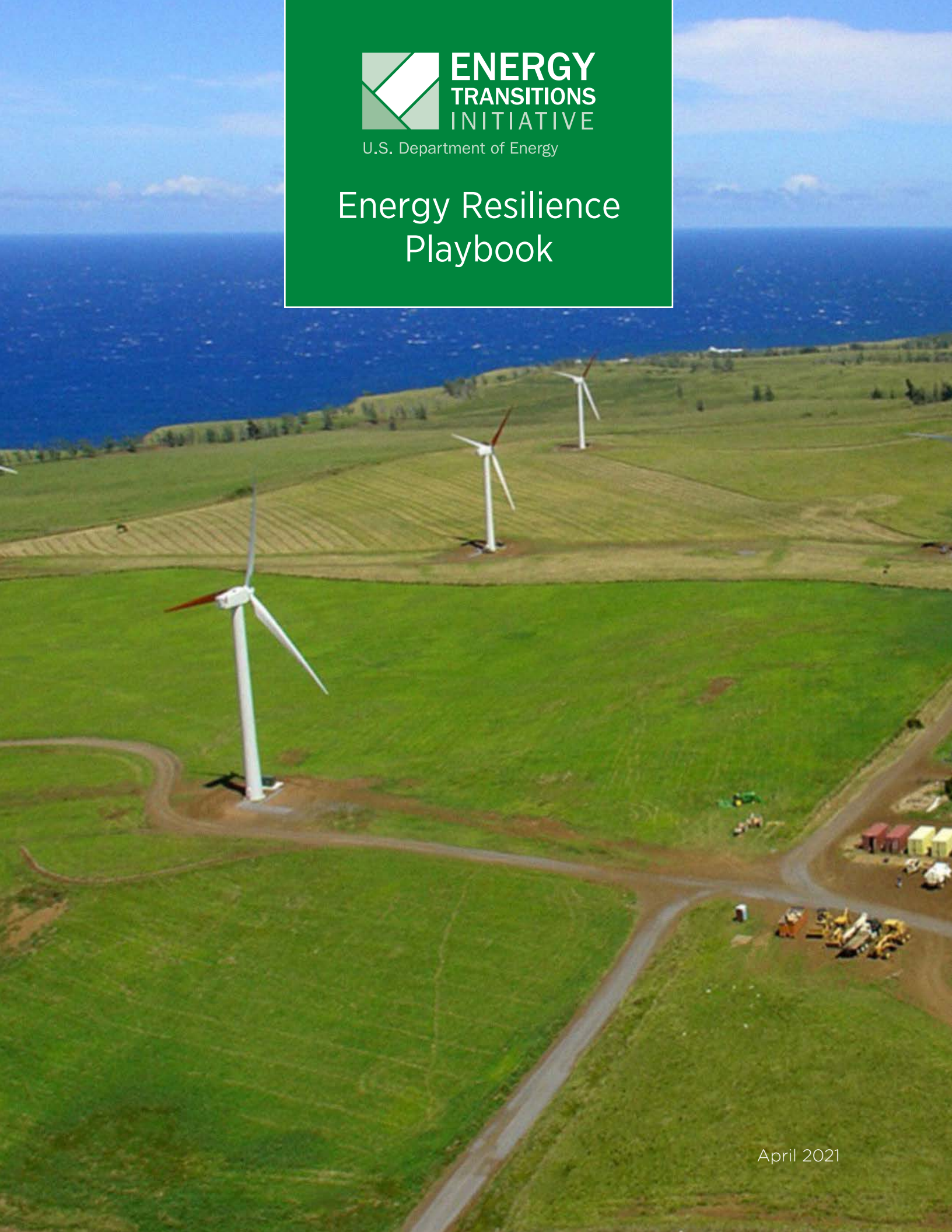
ENERGY TRANSITIONS INITIATIVE

U.S. Department of Energy

Energy Resilience Playbook



April 2021

Contents

Introduction **5**

Convene & Commit **0–1**

0.1 Compile a List of Energy-Related Risks and Resilience Opportunities **0–1**

0.2 Identify Key Decision Makers and Resources **0–2**

0.3 Convene Decision Makers for Initial Discussions **0–2**

0.4 Identify a Community Energy Champion **0–2**

0.5 Document Your Commitment to an Energy Transition **0–2**

0.6 Tools and Resources **0–3**

Worksheets and Templates 0–3

Case Study 0–3

Resources 0–5

Engage & Envision **1–1**

1.1 Develop a Governing Framework **1–1**

1.1.1 Develop a Charter 1–1

1.1.2 Consider a Stakeholder Advisory Board 1–1

1.1.3 Appoint Communications Leads 1–1

1.2 Draft a Vision Statement **1–2**

1.3 Set a Transition Timeline **1–2**

1.4 Engage Community Stakeholders **1–2**

1.4.1 Identify and Map Stakeholders 1–2

1.4.2 Refine and Finalize the Vision Statement 1–3

1.4.3 Initiate a Communications Plan 1–3

1.5 Tools and Resources **1–3**

Worksheets and Templates 1–3

Case Studies 1–4

Resources 1–7

Assess & Plan **2–1**

2.1 Detail the Current Energy Landscape **2–1**

2.1.1 Establish an Energy Baseline 2–1

2.1.2 Catalog Current Energy Activities and Institutional Relationships, Including Public-Private Partnerships 2–1

2.1.3 Conduct Energy Resource Assessments, Including Demand-Side Resources 2–2

2.1.4 Integrate Resilience into Energy Planning 2–2

2.2 Compare the Current Landscape with the Vision Statement To Reveal Pathways **2–3**

2.2.1 Wedge Analysis 2–3

2.2.2 Strengths-Weaknesses-Opportunities-Threats Analysis 2–3

2.2.3 Critical Path Analysis 2–4

2.2.5 Energy Systems Modeling and Analysis 2–4

2.3 Develop Action Plans **2–4**
2.3.1 Draft an Integrated Resource and Resilience Plan 2–5
2.3.2 Complete Other Energy Sector Planning Components as Needed 2–5
2.3.3 Develop a Strategic Communications Plan 2–5
2.4 Identify Policy, Market, Societal, and Operational Barriers and Opportunities **2–6**
2.5 Tools and Resources **2–7**
Worksheets and Templates 2–7
Case Studies 2–7
Resources 2–13

Prepare & De-Risk **3–1**
3.1 Involve Stakeholders in Policy and Operational Reform Efforts **3–1**
3.2 Identify the Human, Technical, and Financial Resources Needed To Complete Near-Term Projects **3–1**
3.2.1 Establish a Project Team 3–1
3.2.2 Select at Least One Quick-Win Project in the Initial Round of Projects 3–2
3.2.3 Define Roles and Responsibilities for Government Entities Executing Near-Term Projects 3–3
3.3 Set a Budget and Analyze Risks **3–3**
3.3.1 Analyze Project Risk 3–4
3.3.2 Common Types of Risk 3–4
3.3.3 Consider Project Resilience 3–6
3.4 Identify Financing Options for Near-Term Projects **3–7**
3.4.1 Sources of Funding and Capital 3–7
3.4.2 Finance Structures 3–7
3.5 Develop Performance, Measurement, and Reporting Plans **3–9**
3.6 Tools and Resources **3–10**
Worksheets and Templates 3–10
Case Studies 3–10
Resources 3–18

Execute & Manage **4–1**
4.1 Implement Schedules, Performance, Measurement, and Reporting Plans **4–1**
4.1.1 Identify All Project Permits 4–1
4.1.2 Set a Realistic Project Schedule 4–2
4.1.3 Performance Plans 4–3
4.1.4 Using Metrics To Track Progress 4–3
4.1.5 Project Reporting 4–3
4.2 Mitigate Adverse Environmental and Social Impacts **4–4**
4.3 Maintain Transparency in Project and Vendor Selection Processes **4–5**
4.4 Develop a Project Closeout Process; Implement When Appropriate **4–5**

4.5 Engage Stakeholders To Keep Project Successes Visible **4–5**
4.6 Tools and Resources **4–5**
Worksheets and Templates 4–5
Case Studies 4–6
Resources 4–8
Operate & Maintain **5–1**
5.1 Monitor and Verify System and Program Performance **5–1**
5.2 Conduct End-of-Warranty Assessments **5–2**
5.3 Monitor Equipment Condition and Perform Predictive Maintenance **5–2**
5.4 Tools and Resources **5–2**
Case Study 5–3
Resources 5–5
Improve & Iterate **6–1**
6.1 Conduct Closeout Interviews with Project Partners and Stakeholders **6–1**
6.2 Collect Lessons Learned and Identify Skills Development Opportunities **6–1**
6.2.1. Lessons Learned Key Features 6–2
6.3 Report Results of Review to Management, Project Partners, and the Public **6–2**
6.4 Accelerate the Energy Transition **6–2**
6.5 Tools and Resources **6–4**
Worksheets and Templates 6–4
Case Study 6–4
Resources 6–6

Navigating an Energy Transition? Use the **Energy Resilience Playbook** To Chart Your Course

To overcome energy and infrastructure challenges and reduce the associated risks, many communities are seeking guidance and insight to transition to clean, resilient energy.

The Energy Resilience Playbook is one of several resources the U.S. Department of Energy's Energy Transitions Initiative (ETI) developed to facilitate and expedite energy transitions by sharing experiences and insights from communities that are actively working toward a cleaner, more resilient energy future.

A play-by-play guide to transitioning to clean, resilient energy, the Playbook outlines the seven basic steps of an energy transition with recommended actions, case study briefs, and relevant resources.

How To Use the Playbook

Transitioning to a clean, resilient energy future is an iterative process, and there are many possible pathways to success. The Playbook provides a flexible framework that includes:

- Overviews of the seven basic phases of an energy transition—highlighting recommended actions, experiential insights, and links to relevant resources for each
- Downloadable PDFs detailing the recommended actions of each phase
- Worksheets, templates, and instructive case studies—to assist communities with planning and implementing any phase.

Enter the Playbook at any point in the process and chart a course that addresses your community's unique energy resilience needs and advances your vision and goals.

ETI thanks our fellow experts at the Rocky Mountain Institute who collaborated on this project, as well as resilience practitioners from all over the world who gave their input and insights.

Convene & Commit

Convene decision makers and commit to an energy transition

Phase 0

Transitioning to a cleaner, more resilient energy system will require leadership and commitment from various parts of the community.

To begin, a group of community leaders—such as utility managers and local officials—expresses their commitment to the public and to potential investors. With an expression of commitment, the challenge then becomes selecting a path, rather than whether the transition is possible.

Phase 0 describes how to:

- ☐ 0.1 Compile a list of energy-related risks and resilience opportunities
- ☐ 0.2 Identify key decision makers and resources
- ☐ 0.3 Convene decision makers for initial discussions
- ☐ 0.4 Identify a community energy champion
- ☐ 0.5 Document your commitment to an energy transition

0.1 Compile a List of Energy-Related Risks and Resilience Opportunities

There are likely many compelling reasons to transition to a cleaner, more resilient energy system. Identifying these reasons will facilitate initial conversations and inspire community leaders to become involved.

Resilience opportunities will evolve over time—and as more stakeholders join the conversation. In this phase, clearly articulating the risks can move decision makers to embrace such opportunities. Use data to build your case.

Example Risk and Opportunity Assessment Table (illustrative, not comprehensive)

Energy-Related Risks	Key Data Points	Resilience Opportunities	Key Data Points
Residential energy costs are high and volatile		Enhance customer participation in markets	
CO_2 emissions impact health, environment, and tourism		Clean, utility-scale solar energy development	
Increasing frequency and intensity of disasters causes outages		Develop community microgrid	
Reliance on imported fossil fuel leads to energy insecurity; funnels money out of the community		Develop indigenous energy resources; keep energy dollars local	

0.2 Identify Key Decision Makers and Resources

The entire community stands to benefit from energy resilience, and success hinges on the input and participation of multiple stakeholders. In later phases, you will engage stakeholders with diverse interests, concerns, values, and perspectives—individuals, nonprofits, businesses, utilities, and more. At this stage, however, your stakeholder list should focus on decision makers and resources with the expertise, influence, and resources to launch the transition.

As your initial stakeholder list grows to include all parties active in the local energy market—from developers and consultants to international organizations—new partners, teams, and resources with potential to help implement the transition will emerge. With broader participation comes more expertise, resources, and capacity, all of which facilitate success.

Sample Stakeholder Matrix

Name	Role in Transition	Impact on Transition	Interest in Transition	Engagement Required

Illustrative only. The downloadable worksheet on page 0–3 can be adapted to suit your community's needs.

0.3 Convene Decision Makers for Initial Discussions

After identifying which energy opportunities to pursue and which stakeholders will be involved at the outset, it is time to start the dialogue about leading the transition. It can be beneficial to have a credible, objective third party—one that does not stand to gain financially or politically—convene and facilitate meetings because its representatives may be perceived as neutral experts.

These early conversations should yield support from key stakeholders to begin Phase 1, including those willing to demonstrate their leadership in the transition. These discussions can also begin to identify aspects of the vision that will take shape in Phase 1.

0.4 Identify a Community Energy Champion

It is difficult to overstate the pivotal role a trusted, widely respected community leader can play in building credibility and trust, generating interest, and inspiring action—all of which are essential to a successful energy transition. Identifying and engaging an influential local champion early to advocate for the transition can be a game changer when it comes to securing stakeholder and community buy-in.

0.5 Document Your Commitment to an Energy Transition

Because an energy transition is a significant undertaking, it may be beneficial for key stakeholders to demonstrate their commitment to the effort in a written document, such as a memorandum of understanding or partnership agreement.

This document formalizes the community's overarching, time-bound clean energy goal. It can also define the terms of the agreement, including the level of commitment necessary to undertake the transition, the scope of the effort, and expectations about roles, responsibilities, and broader participation in the effort.

0.6 Tools and Resources

Worksheets and Templates

Stakeholder Matrix
Identify key stakeholders

Risk and Opportunity Assessment Table
Map risks to opportunities

Memorandum of Understanding
Establish an agreement to formalize partnership terms

Case Study

U.S. Virgin Islands Signs Memorandum of Understanding To Launch Energy Transition Pilot

In February 2010, the U.S. Virgin Islands (USVI) committed to reduce the territory's dependence on fossil fuel by 60% by 2025. More than 25 government leaders, energy office officials, and utility company executives convened at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. Governor John P. de Jongh Jr. signed a memorandum of understanding (MOU) formalizing the territory's commitment to an energy transition.

More than 25 USVI government leaders, energy office officials, and utility company executives convened for an MOU signing committing the territory to an energy transition in 2010. *Photo by Adam Warren, NREL*

> "Forming a public-private partnership among stakeholders with diverse interests, capabilities, and perspectives is foundational to achieving audacious clean energy goals."
>
> —Adam Warren, Director of NREL Integrated Applications Center

What common energy transition challenge or need did the project solve or address?

To launch a successful energy transition, a group of community leaders must come together and formally express their commitment to the project or initiative. Because energy sector stakeholders range from providers to government to end users and represent a wide range of interests, many parties needed to have roles and be represented to support a more resilient sector.

Why is this a common challenge for communities pursuing resilient energy transitions?

The formal involvement and support of key decision makers from across the community lends credibility needed to garner critical support from project sponsors and partners, potential investors, and the public.

How did the community address this challenge or need?

After establishing the USVI's clean energy goal in late 2009, Governor de Jongh set out to charter and empower an effective team to lead the Energy Development in Island Nations (EDIN)-USVI pilot project. The project partners and stakeholders he assembled had different priorities and agendas, but each had expertise, resources, capacities, and capabilities that were essential to advancing the territory's goal.

What key decisions were integral to this project?

- The governor's office appointed the Virgin Islands Energy Office (VIEO) director and the Virgin Islands Water and Power Authority (WAPA) chief executive officer to co-lead the project with support from a steering committee.
- The USVI leadership team scheduled a meeting with federal partners and sponsors at NREL—an objective technical resource, sponsoring partner, and project facilitator.
- The USVI governor, project co-leads, and other community leaders met at NREL to formalize the EDIN-USVI partnership by signing an MOU with the U.S. Department of Energy (DOE), the U.S. Department of the Interior (DOI), and NREL; consider elements of the territory's vision; and identify next steps.
- Basil Ottley of DOI, a former USVI senator, agreed to serve as the project's local energy champion.
- Key USVI decision makers, along with representatives of DOE, DOI, and NREL, formed a steering committee tasked with engaging stakeholders and developing and implementing a plan for achieving the USVI's 60% goal.

Who decided on this course of action and why?

The governor's office appointed top executives from the VIEO and WAPA to jointly lead the project with support from a steering committee made up of federal partners and key decision makers within USVI's government.

The governor, co-leads, and other USVI decision makers selected the local energy champion because of his deep roots and strong connections in the territory; lack of ties to any political administration; and keen understanding of the community's concerns, needs, and values.

DOE and NREL brought to the table unbiased technical expertise that USVI decision makers considered essential to ensuring that proposed technical solutions best used USVI's resources while meeting the community's goals.

What key takeaways or lessons learned might benefit other communities?

- Establish a diverse leadership team that shares a common commitment.
- Identify a community energy champion with the influence, charisma, and insight needed to garner community buy-in.
- Form a public-private partnership to achieve aspirational goals.
- Commit to an energy transition in writing.

Assembling a strong local leadership team to convene with federal partners and formalize a commitment to transition to clean energy provided a solid foundation of technical expertise, credibility, funding support, and local leadership. The USVI leveraged those combined assets to engage other partners, investors, and local stakeholders in advancing the USVI's energy transition.

Resources

Compile a List of Energy-Related Risks and Resilience Opportunities

Climate Extremes Communications Guidebook—A resource developed by the International Council for Local Environmental Initiatives to help local governments communicate about weather and climate extremes in the context of climate change.

Country Risk Assessment—An activity from NREL and USAID's Resilient Energy Platform to guide communities in assessing risks to the power sector by linking and scoring vulnerabilities and threats.

Developing Vulnerability Statements and Assigning Vulnerability Severity Scores—The Resilient Energy Platform's step-by-step guide to identifying vulnerabilities the power sector may face from possible threats, forming vulnerability statements, and assigning severity scores.

Guide to Resilience Solutions—Part of a larger Power Sector Planning Guidebook to help policy makers, system operators, and other energy-sector stakeholders complete key steps of a power sector resilience planning process, this section describes numerous resilience solutions that combine technological diversity, redundancy, decentralization, transparency, collaboration, flexibility, and foresight considerations.

Identify Resilience Solutions—The Resilient Energy Platform's step-by-step guide to identifying potential solutions for enhancing power sector resilience based on identified threats, vulnerabilities, and risks.

Island Energy Snapshots—Designed to capture the energy landscape of islands in the Caribbean, the Pacific, and surrounding areas at a glance, these DOE Energy Transitions Initiative fact sheets highlight key data on each island's electricity sector, clean energy policy environment, energy efficiency and renewable energy projects and resource potential, and opportunities for clean energy transformation.

Mini-Grids and Climate Resilience—An overview of socioeconomic, environmental, and resilience benefits mini-grid systems can provide for remote communities, as well as climate risks posed to mini-grids and measures to increase their resilience.

Renewable Energy to Support Energy Security—A Resilient Energy Platform fact sheet that describes some of the key sectors where energy security is vital, provides an overview of some example categories of energy security threats, and explores opportunities for renewable energy to support energy security.

Strengths/Assets and Vulnerabilities—A guide for identifying institutional strengths and vulnerabilities in the context of climate change. Geared toward campuses, the process is applicable and scalable to jurisdictions of various sizes.

Understanding Power System Threats and Impacts—A "quick read" from the Resilient Energy Platform describing how natural, technological, and human-caused threats can impact the power sector, and how power sector vulnerability assessments can be used to understand potential impacts to various sectors and develop climate resilience action plans.

Valuing Resilience in Electricity Systems—An NREL report outlining the steps involved in quantifying, valuing, and monetizing energy resilience to give utilities and system operators methods to consider resilience benefits of different system designs.

Engage & Envision

Engage stakeholders and establish an energy vision

Phase 1

The goals of Phase 1 are to identify the attributes of your community's future energy system and establish your transition team.

In other words, Phase 1 will establish the benefits and drivers—such as affordability and resilience—needed to motivate stakeholders and lay the groundwork for project planning, development, and execution in Phases 2, 3, and 4.

To accomplish this, the leadership team will structure the transition's governing body, engage community stakeholders, and develop a vision that reflects the shared understanding of the community. In Phase 2, the vision will frame analysis to determine specific pathways to realize this future state.

Phase 1 describes how to:

- ☐ 1.1 Develop a governing framework
- ☐ 1.2 Draft a vision statement
- ☐ 1.3 Set a transition timeline
- ☐ 1.4 Engage community stakeholders

1.1 Develop a Governing Framework

The Phase 1 leadership team is responsible for convening stakeholders from around the community and gathering their input for the vision. A team comprising three to six energy sector leaders with representation from government, utilities, the private sector, and community representation should be structured and empowered to make the necessary decisions to execute the vision.

1.1.1 Develop a Charter

A charter may help the leadership team guide the transition efficiently and minimize misunderstandings. The charter should establish the team's organizational structure or governing framework and its operational guidelines; set expectations for interactions, roles, and responsibilities; and describe how the team will make decisions. It should also define the process for finding new members and replacing outgoing ones.

1.1.2 Consider a Stakeholder Advisory Board

A stakeholder advisory board can serve a coordinating role for many members of the community with similar interests. During Phase 1, the chair of the advisory board can sit on the leadership team and channel input from the business community and the public.

The stakeholder advisory board can continue to operate in later phases as well, with rotating membership to ensure that different stakeholder groups provide input to the process. Because of its constituencies, the stakeholder advisory board can also be a stabilizing force when there is a change in government administration or utility management.

1.1.3 Appoint Communications Leads

Transparency is critical to garnering and maintaining community buy-in and support for the energy transition. Appoint one or two communications leads who will coordinate and speak with the media, develop high-level key messages, and create and disseminate outreach and educational materials.

1.2 Draft a Vision Statement

Recruit the communications lead(s) to draft a vision statement that describes defining characteristics of the future energy system and reflects the input the decision makers provided during Phase 0. A vision is aspirational; it describes the desired future state of the community, including the beneficial impacts of the energy transition. The focus now should be qualitative; quantitative elements come later, in Phase 2.

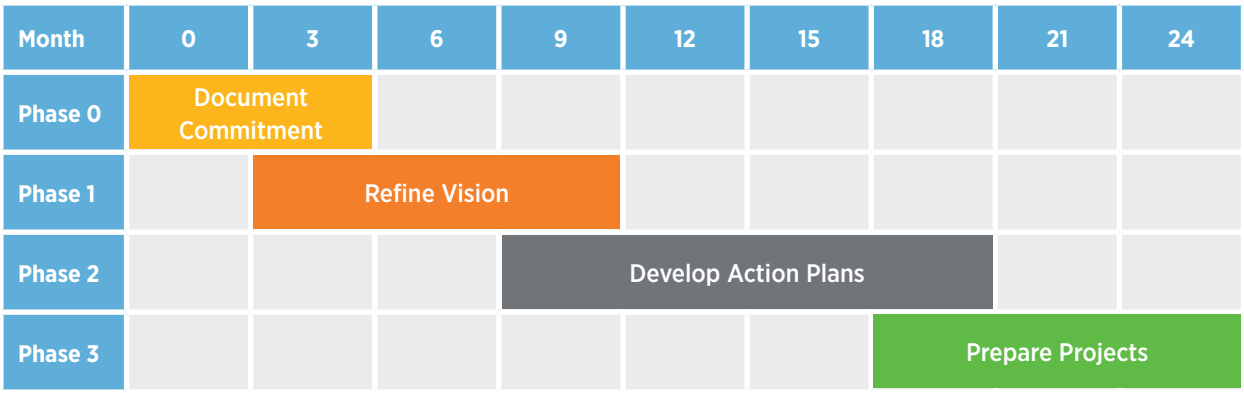
Sample Vision Statement

A resilient energy system that prioritizes local renewable resources over imported fossil fuels to deliver affordable, reliable energy and support an equitable clean energy economy.

1.3 Set a Transition Timeline

The leadership team should develop a general timeline for Phases 2 and 3 to help stakeholders manage their participation and expectations. The timeline should be realistic but reaffirm the commitment to make a concerted effort to realize the vision and transition to a resilient energy system.

Illustrative Timeline



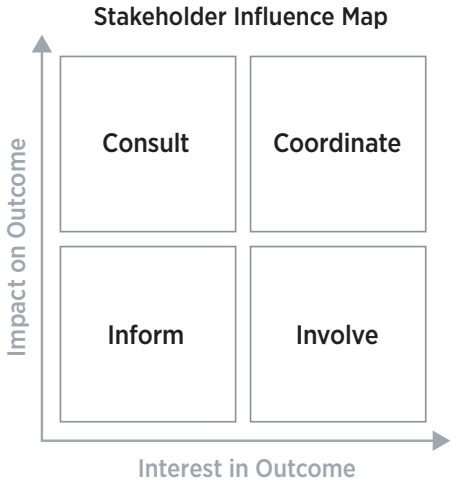
1.4 Engage Community Stakeholders

With a draft vision and a timeline, it is time to engage a broader set of stakeholders to generate buy-in and support for the vision.

1.4.1 Identify and Map Stakeholders

The leadership team should build on the stakeholder list from Phase 0 to develop a more complete roster during Phase 1. This process should help clarify the level and type of engagement stakeholders require based on their impact on and interest in the outcome under consideration.

A simple matrix can map stakeholders to appropriate type of engagement, such as:



- **Inform.** Keep the stakeholder apprised of developments and progress.
- **Involve.** Invite the stakeholder to participate in certain activities, such as meetings or outreach that touch on the stakeholder's interest in the outcome.
- **Consult.** Regularly and actively seek support for and feedback on how best to achieve upcoming goals.
- **Coordinate.** Establish an ongoing relationship regarding all aspects of the transition, ranging from day-to-day operations to timing significant milestones.

The Stakeholder Influence Map can enable the leadership team to evaluate the stakeholder "landscape" more easily within the entire community, individual sectors, or for specific issues.

1.4.2 Refine and Finalize the Vision Statement

Project success or failure may hinge on whether the various interests of stakeholders align with the vision. Therefore, it is recommended to solicit and incorporate input from a diverse group of community stakeholders—including those who may oppose the project.

Achieving consensus on a vision is a challenging but worthwhile endeavor. Consider engaging a professional facilitator to lead a vision-setting exercise. Ultimately, the community must take ownership of the transition, so it is important that stakeholders recognize their fundamental role in shaping and realizing the vision.

1.4.3 Initiate a Communications Plan

In conjunction with establishing the vision, the leadership team should initiate a strategic communications plan to keep the community informed of progress toward realizing the vision. Clear, transparent, consistent communications about the transition help prevent misunderstandings, build momentum toward a successful outcome, and even maintain morale among participants by recognizing their contributions.

The communications plan can begin with early milestones such as finalizing the vision statement, defining key audiences, surveying the communications landscape, assessing risks and opportunities, and establishing key messages. In later stages, the communications team can establish communications goals and develop strategies and tactics for achieving them.

1.5 Tools and Resources

Worksheets and Templates

Stakeholder Influence Map
Categorize engagement by interests and impact

Transition Timeline
Set time frames for Phases 1–3

Case Studies

Hawaii Develops Framework for Achieving Its Bold Clean Energy Vision

Launched in 2008, the Hawaii Clean Energy Initiative (HCEI) adopted the most aggressive energy transition vision in the United States, targeting 70% clean energy by 2030. In Phase 1, HCEI established a governing framework, engaging diverse stakeholders and setting up focused working groups. This structure helped set clear expectations, define roles and responsibilities, and enable stakeholders representing various sectors and interests to participate.

One boat, many paddles—More than 100 community members and national experts formed working groups that pulled together in pursuit of Hawaii's visionary clean energy goal. *Photo from iStock 4695470003*

> "We need every Hawaii citizen to be personally energy aware and feel responsible for contributing in some way to solving our energy problems. Many of the best contributions are low or no cost, involving changes in behavior and attitudes."
>
> —Ray Starling, Program Director, Hawaii Energy

What common energy transition challenge or need did the project solve or address?

HCEI needed to establish an inclusive, multi-sectoral governing body to map out a strategy for achieving 70% clean energy by 2030.

Why is this a common challenge for communities pursuing resilient energy transitions?

A primary barrier to advancing an energy transition is lack of community buy-in. Engaging a diverse set of stakeholders from the outset is foundational to success.

How did the community address this challenge or need?

The HCEI leadership team engaged a diverse set of stakeholders to establish a steering committee and four working groups charged with assessing pathways to 70% in four energy sectors.

What key decisions were integral to this project?

- An HCEI steering committee was formed to coordinate interactions between the four working groups and to ensure that they formulated a comprehensive strategy.
- The working groups were composed of a variety of stakeholders, including federal and local governments, not-for-profit organizations, private sector companies, trade associations, and academic organizations.
- The working groups assumed responsibility for assessing pathways in four energy sectors: electricity (generation and delivery), end-use efficiency, transportation, and fuels.

Who decided on this course of action and why?

The Hawaii Department of Business, Economic Development, and Tourism, with the input from the U.S. Department of Energy (DOE), established HCEI's original governing framework.

What key takeaways or lessons learned might benefit other communities?

- Engage a variety of stakeholders from federal and local government agencies, nonprofit organizations, businesses, trade associations, and academic institutions.
- Identify key sectors of the energy economy and engage stakeholders in each sector.
- Organize stakeholders into working groups representing the various sectors and diverse perspectives.
- Task working groups with developing strategic pathways to sector goals.
- Form a steering committee to coordinate interactions among the working groups.

HCEI's process is a useful example for others to follow because it engaged a wide variety of key stakeholders from the beginning. Involving the public in the planning and decision-making process by establishing focused working groups laid the foundation to make informed decisions about the path to success. With multifaceted analysis, HCEI provided the necessary information to help increase the state's economic and energy security, demonstrate innovations, and develop the workforce of the future.

U.S. Virgin Islands Prioritizes Inclusiveness To Ensure Community Ownership of Clean Energy Vision

During a June 2010 workshop, the U.S. Virgin Islands' (USVI) leadership team and steering committee engaged a group of public and private stakeholders with varying levels of technical expertise, perspectives, and agendas to refine the territory's clean energy vision, discuss pathways for achieving it, and secure community buy-in.

More than 60 USVI stakeholders participated in establishing the territory's vision and formed working groups to advance it. *Photo from Aldeth Lewin,* Virgin Islands Daily News

What common energy transition challenge or need did the project solve or address?

With inclusiveness and transparency as guiding principles, the USVI sought to engage a diverse yet balanced and effective group of community stakeholders in an inaugural workshop to establish working groups and a community-driven vision.

Why is this a common challenge for communities pursuing resilient energy transitions?

Bringing together people with disparate perspectives and agendas—social, political, and economic—to shape a common vision is always an uphill climb. However, inclusiveness allows for civil discourse that is critical to long-term success.

How did the community address this challenge or need?

Steering committee members invited 100 public and private stakeholders to attend the workshop, participate in a vision-setting exercise, and form working groups focused on five strategic areas.

What key decisions were integral to this project?

- The leadership team elected to involve detractors in the early planning stages.
- To encourage open dialogue, the team opted to close discussion to the media.
- To demonstrate transparency, the team held a press conference immediately following the meeting to communicate highlights.

Who decided on this course of action and why?

The USVI leadership team recognized that facilitating open dialogue would help stakeholders understand the project opportunities and barriers from the leadership team's perspective while giving the leadership team insight into the barriers and opportunities from the community's perspective.

What key takeaways or lessons learned might benefit other communities?

- Engage a diverse set of stakeholders—including potential opponents.
- Tap steering committee member communications staffs to help get the right people in the room.
- Rely on the community energy champion to rally support and participation.
- Close the workshop to the media to foster open discussion, but hold a press conference afterward.
- Embrace inclusivity and transparency from the outset to secure critical community buy-in.

By engaging a diverse set of public and private stakeholders in Phase 1, the USVI leadership team established transparency and inclusiveness as guiding principles. This gave project proponents a chance to understand and assess barriers to project success, address opposing views, assuage objections through reasoned arguments backed by hard data, achieve consensus on the clean energy vision, and secure community ownership.

Resources

Draft a Vision Statement

Dialogue and Deliberation Resource Center—Collections of articles, guides, techniques, and infographics on organizing ongoing conversations to facilitate a shared understanding of change.

Guide to Community Energy Strategic Planning—A step-by-step approach to developing a Community Energy Strategic Plan. Step 3 offers valuable tools, tips, and examples for developing a focused energy vision; Steps 1 and 2 are also highly applicable to Phase 1.

Engage Community Stakeholders

Climate Extremes Communications Guidebook—Guidance for local governments on communicating about weather and climate extremes in the context of climate change.

Energy Literacy: Essential Principles for Energy Education—An interdisciplinary approach to teaching and learning about energy, focusing on areas of energy understanding that are essential for all citizens "K-Gray."

Engaging Stakeholders—Guidance on engaging internal and external stakeholders in energy resilience planning. Geared toward institutions, the process and strategies are applicable and scalable to jurisdictions of various sizes.

Low-Emission Development Strategies: Technical, Institutional and Policy Lessons—An Organisation for Economic Co-Operation and Development and International Energy Association guide examining the technical, institutional, and policy challenges associated with preparing national climate change strategies; Step 4.2 offers institutional insights and lessons related to Phase 1.

Assess & Plan

Assess opportunities and develop a road map

Phase 2

In Phase 2, the leadership team will coordinate analysis of various pathways to achieving the energy vision established in Phase 1. Depending on the vision, the solution sets may go beyond electricity to include transportation energy use, water use, and land use planning.

The purpose of this analysis is to provide the community with viable options and flexibility. The energy transition cannot be accomplished all at once, and it is typically iterative rather than linear.

Circumstances inevitably develop that will change what constitutes the best next step in the transition. At the end of Phase 2, the community will have assessed possible solutions and refined a few practical pathways to realizing the vision laid out in Phase 1.

Phase 2 describes how to:

- ☐ 2.1 Detail the current energy landscape
- ☐ 2.2 Compare the current landscape with the vision statement to reveal pathways
- ☐ 2.3 Develop action plans
- ☐ 2.4 Identify policy, market, societal, and operational barriers and opportunities

2.1 Detail the Current Energy Landscape

To ascertain which changes are required to realize the vision, the leadership team must establish an accurate description of the current energy landscape. This survey of the energy landscape relies on technical experts to collect and analyze the best available data. It includes a baseline of supply and demand, the state of energy infrastructure, current energy activities and relationships, and energy resource assessments.

2.1.1 Establish an Energy Baseline

Establishing an energy baseline involves collecting information on energy consumption—by sector and time of year—and energy production, including fuel sources and heat rates. The baseline also includes information about line losses, remaining useful life of assets, common end-use behaviors, and peak loads. Compiling and analyzing this data explains energy system production levels and costs. It can be time-consuming depending on how much information exists.

2.1.2 Catalog Current Energy Activities and Institutional Relationships, Including Public-Private Partnerships

Using the stakeholder analysis from Phases 0 and 1, the leadership team or working groups should catalog current energy activities and institutional relationships, including:

- Incentive programs, policies, and regulations
- Bilateral or multilateral development partners
- Agencies responsible for permitting new energy projects, including building energy efficiency equipment.

The catalog will help shape opportunity pathways and inform how new programs and policies are defined.

2.1.3 Conduct Energy Resource Assessments, Including Demand-Side Resources

Resource assessments estimate the technical and economic potential of various energy resources, including demand-side energy efficiency. These studies can help shape opportunity pathways by highlighting the relative importance of energy sources and determining where the most promising initial site-specific analysis could take place. For example, a resource assessment will provide data needed to estimate how much wind energy could be incorporated into a given pathway.

2.1.4 Integrate Resilience into Energy Planning

When assessing opportunity pathways for the energy sector, resilience is a key consideration. Although resilience is often thought of in terms of physical shocks to the system, such as from hurricanes or other natural disasters, it can also refer to economic and social shocks, such as those brought by the COVID-19 pandemic.

Overall, resilience refers to the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions.

Incorporating resilience into energy planning in Phase 2 brings this important topic to the center and allows for investigation of options that balance resilience with other top stakeholder priorities. For example, a community might want to explore opportunities to increase energy system resilience while also lowering electricity costs, becoming more sustainable, and maintaining reliable electricity delivery to residents.

When assessing potential pathways for their impacts on system resilience, communities can consider several factors, including:

- **Diversity of generation type**—integrating multiple resource types into the grid means some may be able to continue operating even with a failure of one specific type (e.g., physical damage to the generation resource or inability to get the necessary fuel).
- **Diversity of generation location**—siting generation resources in various locations reduces the risk of all of them failing due to an external shock, in contrast to the centralized structure of most electricity systems today.
- **Amount of local resources**—using local resources avoids the need to import resources such as fuel to generate electricity, thereby increasing resilience because there is no need to receive, transport, and store resources from somewhere else following an external shock.
- **Modularity and adaptability**—planning an electricity system to be flexible to changing conditions (e.g., with generation resources that can both serve the grid and operate as stand-alone microgrids for a portion of the load) adds resilience by fostering adaptability.

As a first step in transitioning to a more resilient energy system, communities should focus on critical facilities—hospitals and other healthcare centers, schools, telecommunications, water treatment, and other places people would gather during a disaster.

Focusing first on critical facilities allows communities to gain experience with implementing and operating distributed energy resources (DERs). Optimally deployed DERs benefit the grid during normal operations and provide resilience to keep critical infrastructure powered during an extended outage.

Because many critical facilities are government-owned, they present a prime opportunity for governments and utilities to collaborate on energy transitions.

2.2 Compare the Current Landscape with the Vision Statement To Reveal Pathways

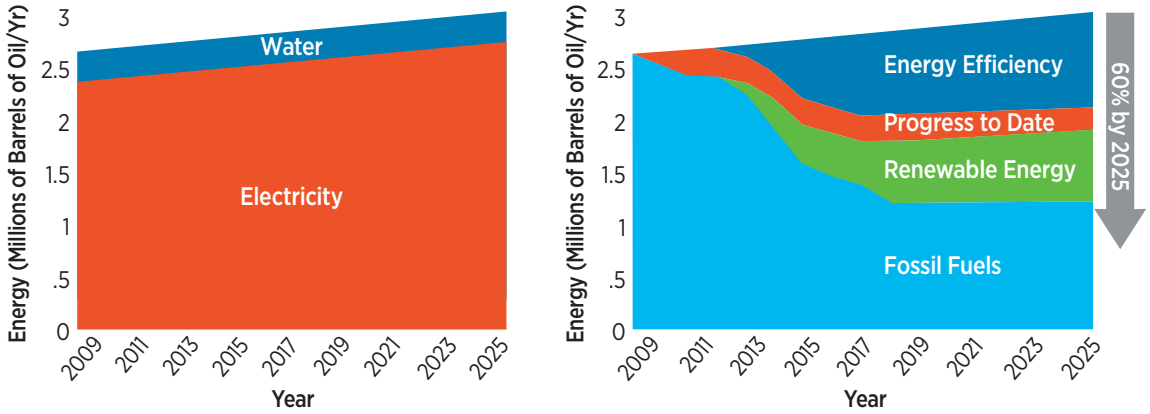
With an accurate profile of the current energy landscape, the community can measure and quantify the changes required to realize the vision. This quantification informs overarching numerical targets—such as a 70% reduction in fossil fuel use or 100% renewable electricity—bringing the Phase 1 vision into sharper focus.

A comparison to the baseline also allows the community to identify specific, practical opportunity pathways to realize the vision. For example, if the vision calls for fuel diversity, a comparison with the baseline can point to different mixes of fuel conversion, new renewable generation, and efficiency measures that would eliminate dependency on any one fuel.

2.2.1 Wedge Analysis

A wedge analysis breaks down the total amount of change needed or expected from "business as usual" into the sectors or activities that will drive that change. When shown as a graph similar to the figure below, the different components of change look like wedges. The wedge analysis describes how change will be achieved and helps the leadership team communicate pathways to stakeholders.

Business As Usual Versus 60% By 2025



2.2.2 Strengths-Weaknesses-Opportunities-Threats Analysis

A Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis can help the team explore factors that will impact success or failure in meeting objectives. Typically, the SWOT is compiled into a 2×2 matrix, with strengths and weaknesses describing the characteristics of the people involved and resources at hand, and opportunities and threats describing the external or environmental factors.

Beyond simply thinking through these factors, completing a SWOT analysis makes it easier to pair strengths with opportunities and weaknesses with threats to evaluate the relative merits of pathways from the current energy landscape to the desired energy landscape. The SWOT can also provide the leadership team with a framework for collecting and compiling input from stakeholders.

SWOT Matrix

Strengths	Weaknesses
Opportunities	**Threats**

2.2.3 Critical Path Analysis

Another analytical tool that may help you evaluate pathways from the current energy landscape to the future one is critical path analysis. Although a formal critical path analysis connects all tasks in an individual project by sequence and duration, you can apply the basic framework in Phase 2 to specify the changes and activities that must occur along a given pathway to realize the vision.

For example, to reduce building energy use, an energy audit must be performed. And before that can happen, a building owner must want an audit and a trained auditor must be available. Finally, capable installers and energy-saving equipment must be available. These activities take time, and some must be done in a specific sequence to meet the objective of reducing building energy use.

2.2.5 Energy Systems Modeling and Analysis

For those tasked with reimagining energy systems and economies, the options have never been greater. At the same time, the decisions that guide energy transitions and influence their outcomes are ever more weighty and complex. Charting the best course to achieve energy goals requires accurate, reliable data and rigorous modeling and analysis.

Two types of modeling inform energy planning:

- **Capacity expansion** modeling simulates and optimizes generation and transmission capacity investments given assumptions about future electricity demand, fuel prices, technology cost and performance, and policy and regulation.
- **Economic dispatch**, or production cost modeling, takes a given generation and transmission system and determines the lowest-cost way to operate it while maintaining reliability under uncertainty and other types of constraints (e.g., emissions).

Modeling and analysis of energy systems with high shares of renewable energy or other variable generation, as well as storage, electric vehicles, demand-side energy efficiency programs, and other transition pathways, can help answer questions such as:

- What should your generation resource portfolio be in the future?
- How much of various types of generation should be built to meet demand?
- What operational costs/savings can be anticipated for one set of resources versus another?
- Will new transmission capacity be needed?
- How does the optimal system change with constraints on emissions, or with local economic development goals?
- How can the system be optimized to deliver reliable power at the lowest cost under specified environmental constraints?
- What are the costs, rate impacts, and social implications of alternative power sector policies or regulations?

2.3 Develop Action Plans

No single planning strategy fits all energy transition visions, but all articulate pathways from the baseline to the future energy landscape should be described in the vision statement. Plans that include energy sector elements link the vision established in Phase 1 to the projects selected in Phase 3 and inform decisions about near-term investments in human or financial capital.

Engaging stakeholders can facilitate comprehensive planning, as various stakeholders may take ownership of plans or aspects of plans.

2.3.1 Draft an Integrated Resource and Resilience Plan

The key to assessing opportunity pathways is the integrated resource and resilience plan (IRRP) for the electricity system. The IRRP's purpose is to specify a portfolio of supply and demand resources that balances risks with anticipated costs and benefits, including environmental and social considerations, of transitioning to a more resilient energy system. It also guides near-term investments. An IRRP is typically developed by the utility with public input.

IRRPs compare anticipated electricity system needs, costs, and risks in future energy scenarios by changing assumptions about costs, benefits, and risks during the next 15–20 years. The government's role is to approve the assumptions, data quality, and conclusions following thorough review.

The IRRP process involves extensive public participation, data collection, and analysis. IRRPs consider all critical components of supply and demand. Some examples include:

- Market segments (e.g., residential, commercial, industrial) and size
- Fuel costs and reliability of supply
- Supply generation and delivery options
- Maintenance and capital investment schedule
- Demand-side energy efficiency
- Legal or regulatory requirements
- Environmental and social objectives.

Although the planning horizon for IRRPs is typically 15–20 years, utilities often update them every 2–3 years to account for changing circumstances.

2.3.2 Complete Other Energy Sector Planning Components as Needed

Like integrated resource and resilience planning, other aspects of energy sector planning can help the leadership team estimate the benefits and costs of other courses of action. For transportation, elements related to energy include fueling infrastructure, public transportation, and fleet purchase policies. Land use policies impact siting of new generation assets, and water use plans influence the relative merits of generation technologies.

A resilient energy system reflects holistic strategies that integrate all planning components related to the energy sector into assessments of energy opportunity pathways in Phase 2.

2.3.3 Develop a Strategic Communications Plan

A communications plan is a critical component of strategic energy planning. Its purpose is to garner the community buy-in and support needed for your plan to succeed. Communicating early, openly, and often is a key to getting the community on board. One of the biggest risks energy projects face is lack of community support; prioritizing transparency establishes credibility and trust.

Strategic communications planning identifies barriers to stakeholder support and develops strategies to overcome them. It also identifies opportunities and finds ways to leverage those. The process starts with a dialogue. The communications leads appointed in Phase 1 should meet with stakeholders; hear from a variety of voices and perspectives; and develop communications goals, strategies, tactics, that address community concerns, goals, and values.

This inclusive process supports the strategic energy plan that the community must own and carry forward. It also creates a road map to keep the communications effort on track. Finally, it ensures everyone responsible for communicating about transition goals, issues, and progress is speaking in a unified voice and sharing clear, consistent messages.

Once the plan is in place, you need a team that can execute it and is committed to working collaboratively on the ongoing effort.

2.4 Identify Policy, Market, Societal, and Operational Barriers and Opportunities

After assessing pathways to realizing the vision, the leadership team should identify specific barriers and enablers along those pathways. Barriers include policy, market, societal, and operational challenges that would prevent or inhibit progress along a particular pathway, such as:

- Initial capital costs
- Unclear or cumbersome permitting requirements
- Utility rate structures
- Lack of consumer awareness
- Public opposition
- Inadequate credit or project repayment history
- Misaligned electricity production incentives
- Overlapping governmental responsibilities over energy
- Access to land
- Lack of necessary skills in the workforce.

Enablers, by contrast, facilitate progress along a particular pathway and can include:

- Grants and other funding and financing mechanisms
- Political commitment
- Transparent planning and resource allocation decisions
- Support from community leaders
- Public interest
- Experience with public-private partnerships
- Well-trained construction and/or utility workforce
- Capital investments that have been recouped and are ready for replacement
- Specialized university training courses and expertise
- Advanced utility metering and billing infrastructure.

It is impossible to accurately describe barriers and enablers to realizing the vision without knowing what changes need to be made.

With possible pathways in mind, the leadership team can assess barriers for their impact on a successful transition and devote resources to addressing them as necessary. Specifying barriers and enablers is the final step in assessing the relative costs and benefits, and risks between pathways. The community is ready to begin allocating resources in Phase 3.

Workers install a 10-kilowatt wind turbine at the St. Croix Reformed Church and Kindshill School in St. Croix, U.S. Virgin Islands. *Photo from Don Buchanan, Virgin Islands Energy Office, NREL 20418*

The optimal mix of policy and operational changes will depend on local conditions. Although it is extremely helpful to examine the pathways other jurisdictions take to achieve their visions, your energy transition pathways and solutions must be tailored to local challenges, goals, values, and institutions to be most effective.

Stakeholders will have valuable input on how to minimize barriers and leverage enablers to arrive at the right mix of policy and operational changes.

2.5 Tools and Resources

Worksheets and Templates

Strengths-Weaknesses-Opportunities-Threats Matrix
Evaluate the relative merits of pathways based on factors that impact success

Integrated Resource and Resilience Plan Objectives
Identify integrated resource and resilience plan objectives and their impacts

Case Studies

Saint Lucia's Inclusive Integrated Resource Planning Process Fosters Stakeholder Buy-In

In 2016, the Government of Saint Lucia and St. Lucia Electricity Services Limited (LUCELEC) led an integrated resource planning (IRP) process as part of developing a National Energy Transition Strategy (NETS). This process, the first of its type undertaken in Saint Lucia, led to a successful assessment of Saint Lucia's opportunity pathways.

What common energy transition challenge or need did the project solve or address?

After aligning stakeholders around a vision, communities need to maintain an inclusive and open process that gives key stakeholders a voice in strategic decisions while maintaining confidentiality and building trust.

Why is this a common challenge for communities pursuing resilient energy transitions?

Coordinating and managing a multistakeholder NETS process over a several months or years is a complex undertaking. It requires maintaining confidentiality while gathering stakeholder input, timing the release of sensitive information and conclusions, and striking a balance between addressing stakeholder priorities and maintaining an appropriate scope.

How did the community address this challenge or need?

Ministerial and utility executives jointly led an IRP process as part of developing a NETS. This core NETS team solicited stakeholder input throughout the process, starting with a public consultation.

What key decisions were integral to this project?

- The core team conducted a public consultation early in the process to share information about the NETS and invite questions and comments.
- Based on the input gathered, the team identified stakeholders' primary goals and objectives for the NETS and agreed upon the questions to be answered by the IRP.

- The team sought input from project developers to allow private-sector interests and industry-specific information to be incorporated into the IRP analysis; they also shared the completed analysis with developers to ensure it adequately and accurately captured their input.
- Although the core NETS team included questions about electric vehicles (EVs) in their analysis based on stakeholder input, they opted to focus on other priority areas while creating the potential to revisit EV strategies as their work progressed and technology costs changed.

Who decided on this course of action and why?

The government and the utility adopted and led the IRP process to ensure ongoing stakeholder engagement and maintain community buy-in.

What key takeaways or lessons learned might benefit other communities?

- Engage both the government and the utility throughout the process to ensure their respective priorities and concerns are integrated into the IRP analysis.
- Obtain public stakeholder input early and often to aid the NETS team in designing and shaping the process to appropriately address the priorities of community members.
- Maintain a degree of confidentiality while the core NETS team gathers relevant information to both build trust within the team and protect sensitive information and conclusions until the appropriate time in the process.
- Invite input from the wider group of stakeholders only when the core team is confident the data they have gathered—and the conclusions drawn from it—are accurate and understood.
- Consider a wide array of opportunities as part of the NETS process, but focus the completed IRP on specific projects that can be completed in the near term to ensure a smooth transition from planning to project implementation.

Saint Lucia's collaborative NETS process, which was guided by a third-party facilitator, addressed the fundamental need to maintain an open process and foster stakeholder input in energy planning to ensure a comprehensive analysis that accurately addresses community priorities.

Project Ownership: A Key Consideration in Assessing Opportunity Pathways

To meet goals related to identifying least-cost investments for Saint Lucia's electricity distribution system and ensuring reliable service, several stakeholders wanted to analyze whether new generation assets should be owned by LUCELEC, a third party, or both.

Among the considerations that supported utility ownership were:

- Internal capacity to operate the new project (given appropriate training)
- Maturity of the technologies identified for utility ownership (solar, wind, and energy efficiency programs)
- Ability to finance the project using low-cost utility capital
- Potential for training and capacity development once the new project is online.

Tailored Approach Boosts Accuracy of Electricity Demand Forecasting in Saint Vincent and the Grenadines

In 2017, the Government of Saint Vincent and the Grenadines (SVG) and St. Vincent Electricity Services Limited (VINLEC) led an integrated resource planning process as part of developing a National Energy Transition Strategy. This process led to a successful assessment of SVG's opportunity pathways and laid a strong foundation for project implementation.

Saint Vincent and the Grenadines anticipated increased tourism with the completion of its new airport would significantly impact electricity demand growth. *Photo from Fidel Neverson*

What common energy transition challenge or need did the project solve or address?

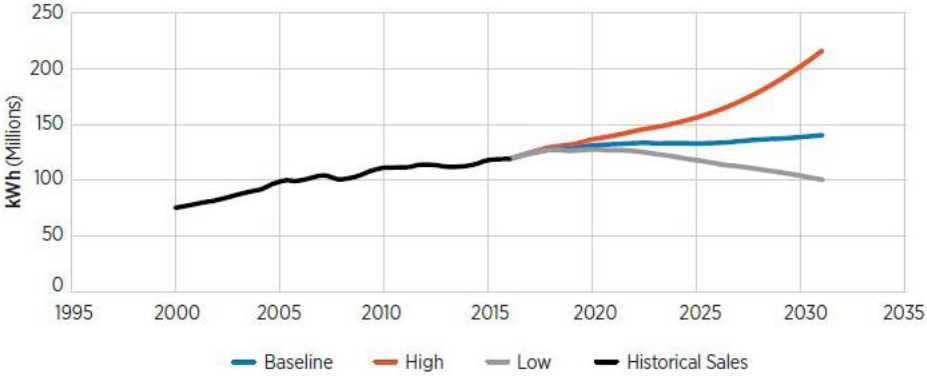
SVG needed to conduct an accurate electricity demand forecast that accounted for anticipated growth stemming from a new airport and the diverse demand profiles of five islands.

Why is this a common challenge for communities pursuing resilient energy transitions?

Communities served by multiple islanded grids face unique challenges in accurately forecasting electricity demand. These challenges are exacerbated when there is significant uncertainty around impacts of planned infrastructure projects.

How did the community address this challenge or need?

SVG adopted a hybrid demand forecasting methodology that combined top-down and bottom-up analysis. The hybrid approach enabled SVG to create a baseline demand forecast along with low and high forecasts to account for uncertainties in both GDP/population trends and tourism-driven growth.



SVG projected electricity demand growth in baseline, high-, and low-growth scenarios.

What key decisions were integral to this project?

- Given the potential impact of the airport, SVG's demand forecast combined top-down and bottom-up analysis in a hybrid approach.
- To determine demand growth from existing conditions, a top-down, econometric model linked GDP and population growth to energy demand growth on each of the five islands.
- A second, bottom-up model added demand from each island's anticipated projects stemming from the airport opening. (A key shortcoming of the bottom-up approach was the 5-year planning horizon of most commercial projects—and the variability that typically exists between the development schedule and project completion).
- Changes in tourism rates were not included in the model, because electricity demand and tourism have not been linked in a predictable way historically.

Who decided on this course of action and why?

The Government of SVG and VINLEC benefited from objective and independent technical support from Rocky Mountain institute, which developed and proposed the hybrid demand forecasting solution.

What key takeaways or lessons learned might benefit other communities?

- Apply an iterative demand forecast process that incorporates both historical trends and the potential impacts of near-term commercial projects to increase accuracy.
- Tailor demand forecasting methodology to your community's unique circumstances to boost accuracy, increase stakeholder confidence, strengthen strategic planning, and clear the way for project implementation.

The integrated resource planning process led by SVG and VINLEC addressed a common challenge of performing an accurate electricity demand forecast when assessing opportunity pathways by tailoring the methodology to SVG's unique circumstances. In addition, the strong results of SVG's demand forecast allowed for properly sizing microgrid projects for the Grenadines with high stakeholder confidence, which set SVG up well for project implementation.

Inclusive Energy Planning Process in the Turks and Caicos Islands Brings Resilience to the Forefront

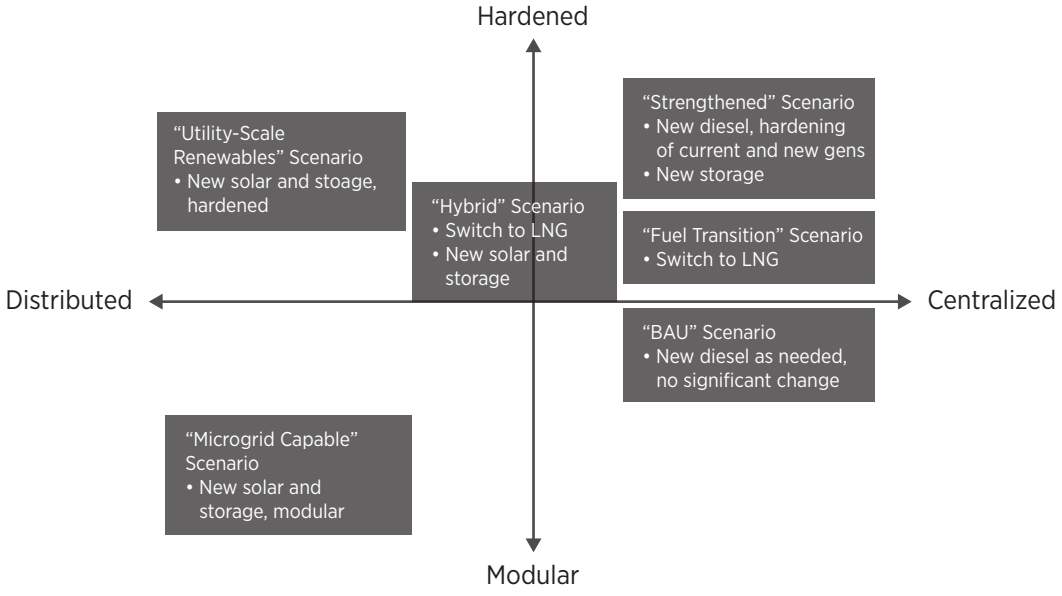
After experiencing widespread electricity outages following hurricanes Irma and Maria in 2017, utility and government stakeholders in the Turks and Caicos Islands (TCI) completed an energy planning process with a focus on resilience. The result is the TCI Resilient National Energy Transition Strategy (R-NETS), which builds upon integrated resource planning to include other stakeholders and incorporate resilience as a core concept.

Government and utility stakeholders kick off Resilient National Energy Transition Strategy development for the Turks and Caicos Islands. *Photo from FortisTCI*

What common energy transition challenge or need did the R-NETS solve or address?

The R-NETS addressed the challenges of identifying energy planning priorities and designing analysis to answer questions and reveal optimal pathways to resilience.

Summary of Six R-Nets Scenarios



Summary of scenarios assessed as part of TCI's R-NETS

Why is this a common challenge for communities pursuing resilient energy transitions?

Expanding the scope of energy planning to include crucial resilience considerations adds complexity because it requires balancing other energy sector priorities that may seem in conflict with the goal to increase resilience.

How did the community address this challenge or need?

The local electricity utility, FortisTCI, and the Government of the Turks and Caicos Islands came together to complete an R-NETS. Rigorous analysis of modeled scenarios helped inform decisions about which of two pathways to pursue.

What key decisions were integral to this project?

TCI assessed scenarios varied in two main dimensions: centralized versus distributed electricity generation resources and modular/flexible versus hardened/consistent resource operation. In the "utility-scale renewables" scenario, new distributed resources would operate consistently in one way (feeding electricity into the grid). In the "microgrid-capable" scenario, new distributed resources would operate more flexibly, feeding electricity into the grid at certain times and separating to form microgrids as needed.

Key steps and decisions in the R-NETS process included:

- Aligning on the top priorities for the TCI's future electricity system, including least-cost, reliability, resilience, and environmental stewardship
- Determining how to define a set of energy system scenarios to test various options and see how they performed against these priorities.

Who decided on this course of action and why?

FortisTCI and the Government of the Turks and Caicos Islands developed the R-NETS collaboratively, with both sets of stakeholders involved deeply throughout the process and the public engaged at various points as well.

What key takeaways or lessons learned might benefit other communities?

- Consider resilience from the very start of an energy planning process.
- Recognize the value of having multiple stakeholders work together on energy planning.
- Modeling and analysis can identify options for increasing resilience while also addressing other priorities.
- Take the opportunity to explore not just different generation types, but also different ways of operating the electricity system.

The inclusive R-NETS enabled the TCI to answer key questions about which pathways to pursue while assessing how the different options might increase resilience while addressing other priorities, rather than requiring a trade-off. TCI's inclusive R-NETS process, which placed resilience at the center of energy planning analysis, may be useful for other communities in Phase 2.

Resources

Communities transitioning to clean, resilient energy may find these resources useful in Phase 2:

Detail the Current Energy Landscape

Energy Resilience Assessment Methodology—The National Renewable Energy Laboratory's (NREL's) replicable methodology for assessing energy risks and developing prioritized solutions to increase site resilience begins with assessing baseline resilience.

EPA Energy Resources for State and Local Governments: State, Local, and Tribal Inventory Tools—U.S. Environmental Protection Agency tools for completing emissions inventories.

International Council for Local Environmental Initiatives Toolkit— Tools for completing an emissions inventory.

Resilience Assessment & Data Explorer (RADE)—A scenario modeling tool to assess site risks associated with potential resilience-related shortcomings of energy, water, transportation, and communication systems.

Strengths/Assets and Vulnerabilities—A guide for identifying institutional strengths and vulnerabilities in the context of climate change. Geared toward campuses, the process is applicable and scalable jurisdictions of various sizes.

Compare the Current Energy Landscape with the Vision Statement To Reveal Pathways

Cost of Renewable Energy Spreadsheet Tool (CREST)—An economic cash flow model designed to assess project economics under various policy support structures.

The Energy Justice Workbook—A scorecard-based approach to advancing equity-centered energy policy, including guideposts for incorporating energy justice into their emerging energy policy frameworks.

Engage Energy Modeling Tool—The DOE Energy Transitions Initiative's no-cost, publicly available capacity expansion and economic dispatch modeling tool for cross-sectoral energy system planning and simulation.

Guide Brief: Resilience Gaps—Identifying and Prioritizing Closure of Resilience Gaps—National Institute of Standards and Technology guidance to assist planning teams in identifying resilience gaps and prioritizing actions based on performance goals.

NREL Transportation & Mobility Research Center Data and Tools—NREL's arsenal of integrated modeling and analysis tools are designed to overcome technical barriers and accelerate the development of advanced transportation technologies and systems.

Renewable Energy Data Explorer—A user-friendly geospatial analysis tool for visualizing and analyzing renewable energy potential; can be customized for different scenarios to support decision-making.

ReOPT: Renewable Energy Integration and Optimization—NREL's techno-economic decision support platform for identifying the optimal mix of renewable energy, conventional generation, and energy storage technologies to meet cost savings, resilience, and energy performance goals.

Resilience Solution Prioritization—A step-by-step guide to prioritizing power sector resilience solutions by impact and effectiveness from NREL and USAID's Resilient Energy Platform.

RETScreen website—Decision support tools for evaluating distributed energy project feasibility and performance.

Technical Resilience Navigator—Federal Energy Management Program tool for identifying energy and water resilience gaps and developing and prioritizing solutions that reduce risk.

Develop Action Plans

Best Practices Guide: Integrated Resource Planning for Electricity—USAID analytical framework and methods for executing integrated resource planning in different economic, political, and geographic settings.

Bridging Climate Change Resilience and Mitigation in the Electricity Sector Through Renewable Energy and Energy Efficiency—Energy efficiency and renewable energy technical solutions bridge action across climate change mitigation and resilience by reducing greenhouse gas emissions and supporting electric power sector adaptation to increasing climate risk.

Clean Energy Strategies—A collection of NREL resources to support state, local, and tribal governments seeking background information, implementation considerations, and best practices for developing policy strategies and clean energy action plans to advance clean energy goals.

Developing the Saint Lucia Energy Roadmap—A Rocky Mountain Institute report describing the process for and results of a collaborative effort between the Government of Saint Lucia and the national electric utility to develop a comprehensive long-term plan for renewable energy investment, setting the stage for the National Energy Transition Strategy.

Guide to Community Energy Strategic Planning—The DOE Office of Energy Efficiency and Renewable Energy's step-by-step approach to developing a Community Energy Strategic Plan.

Integrated Resource and Resilience Plans—Collaborative effort between Caribbean Centre for Renewable Energy and Energy Efficiency and CARICOM Member States to review and recommend available resources for development, including conventional power plants as well as renewable energy sources.

Plan Integration for Resilience Scorecard Guidebook—A method for addressing inconsistencies across various planning documents, such as transportation, hazard mitigation, comprehensive land use, and economic development, by spatially evaluating existing plan documents and vulnerabilities to inform more integrated resilience planning approaches.

Power Sector Resilience: Flexible Adaptation Pathways—An approach for optimizing planning in the face of uncertainty by creating resilience plans that allow decision makers to monitor and adjust to changing conditions.

State and Local Planning for Energy Platform—A DOE-developed tool that integrates dozens of distinct sources of energy efficiency, renewable energy, and sustainable transportation data and analyses into an easy-to-access online platform designed to enable more data-driven state and local energy planning.

State and Local Solution Center: Develop Plans and Programs—Tools, tips, and resources for crafting a robust strategic energy plan using the Energy Efficiency Leadership Framework, which synthesizes stakeholder feedback and public-sector leadership best practices.

Identify Policy, Market, Societal, and Operational Barriers and Opportunities

Critical Facilities: Where Government and Utility Services Redefine Resilience—Article from October 2019 *CEIndustry Journal*, a publication of the Caribbean Electricity Services Corporation.

Evaluating Policies in Support of the Deployment of Renewable Power—Policy brief summarizing common criteria and indicators policy makers can use to evaluate renewable energy deployment policies, focusing on five commonly assessed criteria.

Guide to Risk Assessments—A section of NREL and USAID's Resilient Energy Platform describing the steps involved in assessing, scoring, and evaluating risks as well as identifying levels of risk acceptance.

Prepare & De-Risk

Select projects with input from stakeholders

Phase 3

3.1 Involve Stakeholders in Policy and Operational Reform Efforts

At the end of the opportunity road map process in Phase 2, a Strengths-Weaknesses-Opportunities-Threats analysis identified potential near-term projects on the path to realizing your community's vision. When selecting which ones to pursue, the leadership team and working groups will need to consult subject matter experts as well as stakeholders who may be affected by project implementation.

Many of these stakeholders will have participated in Phase 2 and, based on the priorities they identified then, will likely have input about which projects to pursue first. Without limiting this input, consultations with stakeholders should identify actions that address specific problems with practicable solutions that can be accomplished within a reasonable time frame and defined budget.

Once near-term projects are identified, team members must be ready and willing to explain why they were selected and others were not. This transparency can help maintain stakeholder interest in supporting the overall effort.

Phase 3 describes how to:

- ☐ 3.1 Involve stakeholders in policy and operational reform efforts
- ☐ 3.2 Identify the human, technical, and financial resources needed to complete near-term projects
- ☐ 3.3 Set a budget and analyze risks
- ☐ 3.4 Identify financing options for near-term projects
- ☐ 3.5 Develop performance, measurement, and reporting plans

3.2 Identify the Human, Technical, and Financial Resources Needed To Complete Near-Term Projects

Near-term projects can focus on a variety of actions, such as overhauling policies, designing utility-led programs for ratepayers, assessing renewable resources, identifying funding and financing options, conducting feasibility studies, updating the electricity grid, addressing threats to critical loads, filling gaps in resilience, and developing a workforce to increase capacity.

While considering stakeholder input, the team should prioritize projects that will accomplish specific objectives, can leverage or build upon the strengths of project implementers, are central to realizing the vision, and create value for those impacted by the project.

Project selection must balance the level of effort with the expected benefit, taking into account resources and team strengths. Poor decisions can divert resources from more beneficial efforts, erode the confidence of the project team, and dampen momentum among external stakeholders.

3.2.1 Establish a Project Team

Having identified where project priorities align with the Phase 2 road map, stakeholder interests, and the Phase 1 vision, assemble a team that can complete the project. Project teams will vary in size, but each team must have someone to fill the following roles and responsibilities (even if one person has more than one role):

- **Project lead:** The person who ultimately bears responsibility for the success or failure of the project, the project lead oversees plans, budget, and schedules; delegates responsibilities; and closes out the project.

- **Champion:** The person who initially proposed the project or obtained approval for it, the project champion will seek out additional resources as needed to ensure project success and can positively impact decision makers. Although not necessarily a chief executive or agency head, the champion is typically in a senior supervisory role for the initiative.
- **Subject matter expert(s):** People with experience and expertise relevant to the process, policy, technology, or service that is the focus of the project.
- **Project execution staff:** The people responsible for carrying out the actions set out in the project plan, staff members may be in charge of data collection, reporting, construction, and equipment management.

3.2.2 Select at Least One Quick-Win Project in the Initial Round of Projects

Among the near-term actions identified in Phase 2, it is important to select at least one "quick-win" project that will produce a demonstrable benefit in a short time frame. Quick wins are important to build morale among project teams, demonstrate success to potential investors, and maintain community support for medium- and long-term projects.

Quick-win projects generally have some or all of the following features:

- Low financial cost
- Deliverable in less than a year
- Established ability to act according to law and institutional authority
- High likelihood of energy cost savings, threat mitigation, and/or community investment
- High-visibility locations, such as a large public building, airport, school, or church
- Prominent project partners, such as well-respected politicians, businesspeople, and community leaders.

Examples of quick-win projects in the Caribbean include:

- **Solar water heating (SWH):** SWH can save electricity costs and interior square footage with a minimal capital outlay.
- **Streamlined interconnection policies and procedures:** A streamlined, well-documented process will support and encourage the development of a thriving solar distributed generation industry.
- **Distributed generation:** A modest distributed generation installation (e.g., wind or solar) can serve as a pilot project and learning opportunity.
- **Workforce development program**: Educational or utility training resources can be adapted to train workers in energy retrofitting, building energy management, solar photovoltaic (PV) installation, and other technical skills, building local capacity to implement medium- and long-term projects.
- **Energy operations and maintenance (O&M):** Organizing a group of public and private stakeholders in energy system O&M best practices can save money from day one while creating lead-by-example opportunities.

3.2.3 Define Roles and Responsibilities for Government Entities Executing Near-Term Projects

Project teams do not operate in a vacuum. It is important to manage expectations and ensure the adequate participation of everyone involved in a project, both directly and indirectly. One useful analytical tool to aid in this process is a responsibility assignment matrix—Responsible-Accountable-Consulted-Informed (RACI) matrix.

A RACI analysis describes who is responsible for doing work (R), who is accountable for work being completed (A), who must be consulted during the course of work (C), and who must be informed of the progress being made (I).

Responsibility Assignment Matrix

PROJECT: Issue RFP*		DEPARTMENT: Public Utility			UPDATED: Jan. 20XX		
Step/ Action	Description	Project Lead	Subject Matter Expert	Utility Leadership	Energy Ministry	Public Works Ministry	Governor
1	Define project size and eligible technology	R	C	A	C/I	I	I
2	Draft RFP	A	C	I	I		
3	Publish RFP			R	A	I	C

* Request for proposals

Completing a RACI matrix like the example above can guide decision making and communications through each step of the project, helping the right people contribute to a project in a timely fashion on path to project success.

3.3 Set a Budget and Analyze Risks

With projects selected and teams identified, setting budgets become the priority. The budget establishes project costs, described in hours dedicated and dollars spent, adjusted for project risks. Along with consulting subject matter experts and project participants, the project lead should and look at costs for similar projects—even in other jurisdictions. Experience may save the team from repeating mistakes and missing opportunities

Project costs typically include:

- Staff time
- Project management
- Communications/stakeholder outreach and education
- Travel and meetings
- Data collection and reporting
- Materials procurement
- Information technology license fees
- Insurance
- Site acquisition and preparation
- Capital expenses, training, and specialized equipment
- Consultant services.

As often as possible, base these cost estimates on experience and information from suppliers. Contingency costs are typically expressed as a percentage of total cost and should be included to allow for impacts from risk.

U.S. Virgin Islands School Retrofits Deliver Solid Return on Investment, Validating Ongoing Investments in Energy Efficiency

The Energy Development in Islands Nations (EDIN)-U.S. Virgin Islands (USVI) project provides an example of how achieving significant success early in an energy transition builds support and momentum.

As an EDIN project partner, the USVI was able to tap into a broad spectrum of technical assistance and project development support from the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL).

That support included identifying optimal energy efficiency and renewable energy solutions and a road map for achieving the territory's goal of reducing fossil fuel use 60% by 2025. NREL's initial USVI resource assessments identified energy efficiency measures as "low-hanging fruit"—projects with potential to achieve the greatest energy savings for the least cost.

In October 2011, the USVI achieved one of its most visible and impactful successes toward the 60% goal with the completion of building energy efficiency upgrades in 11 schools. The energy services company that performed the retrofits guaranteed the USVI government an annual cost savings of $1.2 million, and the results exceeded expectations.

Ongoing monitoring by the Virgin Islands Energy Office showed the retrofits saved $1.3 million in energy costs the first year and $1.7 million the next, which helped offset operational costs for the Department of Education. To build on this success, the USVI government authorized $35 million in funding in 2013 to install lighting and water retrofits in 34 more schools and other Department of Education facilities.

Energy efficiency measures offer significant savings with minimal up-front cost and therefore present a prime opportunity to build momentum early in an energy transition. By exceeding cost-savings projections and providing a highly visible example of progress, the school retrofits built credibility for the EDIN-USVI project.

This early win also validated ongoing government investments in energy efficiency by yielding strong returns over the first 2 years. This, in turn, helped build momentum for the EDIN-USVI project by motivating stakeholders and inspiring the community to become engaged in the effort.

3.3.1 Analyze Project Risk

Effectively mitigating risk begins with an analysis of a project's known risks and response options, which include changes to the schedule, budget, and staffing. Phases 1 and 2 will have laid the foundation for determining risk.

The goal in Phase 3 is to articulate root causes of specific risks and assign each a probability value—low, medium, or high. Analyzing and addressing a project's risks can be critical to its "bankability" and attracting the right vendors.

Identified risks can be entered into a matrix that plots the severity of impact and likelihood of occurrence to visually represent which ones justify advance planning. Also, risks can be entered into a "risk register" that can be updated for the life of the project.

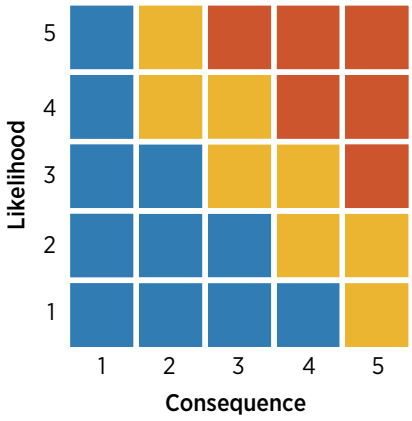
3.3.2 Common Types of Risk

Project risks can be dealt with in several ways. One is changing the project plan to avoid risks. Another is changing the project structure to transfer risks to the party that can most effectively bear them. Certain kinds of risk may require addressing the root cause before it arises. This is known as mitigation or contingency planning and can be critical to shaping bankable agreements.

Risk Reporting Matrix

Likelihood

Level	Likelihood	Probability
1	Not Likely	~10%
2	Low Likelihood	~30%
3	Likely	~50%
4	Highly Likely	~70%
5	Near Certainty	~90%



Consequences

Level	Technical Performance	Schedule	Cost
1	Minimal or no impact	Minimal or no impact	Minimal or no impact
2	Minor reduction in performance	< 1 month schedule slip	< 1% cost increase
3	Moderate reduction in performance	1-2 months schedule slip	< 1-4% cost increase
4	Significant degradation in performance	3-5 months schedule slip	< 5-9% cost increase
5	Severe degradation in performance; will not meet key technical thresholds	≥ 6 months schedule slip	≥ 10% cost increase

Source: DOD, Risk Management Guide for DOD Acquisition

Common types of risk and approaches to addressing them are described below.

Technology risk: This risk arises from the main technology's failure to meet output specifications despite proper design, manufacturing, and installation. Root causes can be addressed as follows:

- Complete assessments to match the technology to the project location and needs.
- Rely on previously demonstrated or commercial technologies.
- Train the workforce in the proper use and maintenance of the technology.
- Identify alternative technologies that may be used in a contingency plan.

Once a technology has been chosen, adequate warranties from a vendor that can honor them addresses this risk.

Legal risk: Legal risk stems primarily from changes in law, or the application of law, that would negatively impact the project. Through the collaborative efforts of diverse stakeholders in Phases 1 and 2, many legal risks will be mitigated. Contract provisions, such as indemnity, conditions present, and warranties can also address legal risk.

Performance risk: Many performance risks can be controlled by drafting suitable project specifications and selecting of capable, experienced vendors. The latter depends in part on transparency in the selection process. In negotiations with vendors, risk can be addressed through adequate warranties and liquidated damages provisions as well as construction bonding requirements.

Other performance risks have operational barriers as root causes, such as interconnection and dispatch requirements. In some instances, changing these root causes becomes a project in itself, but relationship management and facilitated meetings can address them independently.

Even with the best project partners, unexpected equipment delivery delays or labor shortages can arise, so be sure to account for performance risks in the budget.

Payment risk: Payment risk is addressed through a combination of creditworthy customers and suppliers, credit enhancements, firm obligations to pay for performance, and credit insurance, as appropriate.

Cooperation problems: For specific projects, cooperation problems can be reduced by setting up joint trainings between the project team and the implementing government agencies. These trainings or other facilitated meetings can help establish realistic expectations to avoid serious disagreements that would impact project schedule or budgets. An independent alternative dispute resolution or mediation agency may be appropriate as a last resort.

3.3.3 Consider Project Resilience

In preparing specific projects, resilience is an important consideration to ensure the project is not under- or overdesigned and is built to withstand potential external shocks. A prime example of this for many islands is solar PV projects.

At a system level, solar PV can increase community resilience by using a local resource rather than imported fuels for generating power in strategic locations to serve crucial loads during an extended grid outage. However, if the solar PV is not designed and installed to proper standards, the project may not be resilient to an external shock.

This was demonstrated during the 2017 Atlantic hurricane season, when some solar PV systems survived the hurricane impacts and others suffered severe damage, leaving them unable to continue operating after the storms.

RMI and regional partners investigated successful and failed solar PV installations after hurricanes Irma and Maria, summarizing the best practices in a series of reports titled *Solar Under Storm*. Solar PV systems that survived Category 5 hurricane winds had the following common characteristics:

- Appropriate use of or reliance on ballast and mechanical attachments
- Sufficient structural connection strength
- Through-bolted module retention or four top-down clips per module
- Structural calculations on record
- Owner's engineer with QA/QC program
- Vibration-resistant module bolted connections.

Incorporating Category 5 resilient considerations in solar PV projects will result in an average increase of approximately 5 percent in engineering, procurement, and construction cost compared to the current industry standard (Category 3 or 4 rated solar PV installations). When considering lifetime project costs, the additional risk mitigation costs may be money well spent for those exposed to hurricanes, typhoons, and other high-wind events.

Other technologies may require other considerations in the design and installation phases to prepare for the potential impacts of an external shock and incorporate resilience as needed.

3.4 Identify Financing Options for Near-Term Projects

Many potential financing sources, including private debt and equity and public international or multilateral funds, are available to energy infrastructure projects. Financing solutions and partners will vary by project size, technology, partners, and other project- and location-specific factors. The sources and options described below can be combined or adapted to suit the needs of a particular project.

3.4.1 Sources of Funding and Capital

Organization for Economic Co-Operation and Development (OECD): Under the Sector Understanding on Export Credits for Renewable Energy, Climate Change Mitigation, and Water Projects, OECD countries have agreed that public trade finance support for renewable energy and energy efficiency projects will have interest rates at least 1.2% above 10-year OECD country debt and a maximum term of 18 years. This support often depends on a certain percentage of project value or project partner ownership originating in the OECD country providing the support.

Multilateral development banks and finance institutions: These international public institutions, which include the Caribbean Development Bank and the Global Environment Facility, often have climate change mitigation or adaptation programs that could support renewable energy generation or energy efficiency projects. Unlike bilateral public support, there are not typically any domestic content requirements, but other requirements do often impact the type of project, project design, and/or repayment.

Private financial institutions: Although international public financial participation in a deal can lower interest rates, private foreign direct investment is by far the largest source of possible funds. The latter is based on the creditworthiness of project partners, not their home jurisdiction or other predefined eligibility requirements, such as additionality.

Private capital markets: For large projects or a portfolio of projects—typically more than $10 million U.S. dollars (USD)—private capital markets may be willing to participate in the financing structure. Institutional investors, such as pension funds, are beginning to show an appetite for long-term clean energy infrastructure bonds.

Domestic policy support: Although likely not sufficient to finance a project, domestic policies can lower the overall financing cost of capital and infrastructure projects. These types of policies include modified tax treatment, such as investment incentives or accelerated depreciation; government backstops, such as loan loss reserves or other interest rate buy-downs; and dispatch incentives, such as feed-in tariffs or loading orders.

Repurposing public funds: For smaller projects, public funds may be eligible for repurposing to support a project, such as relying on educational resources for the bulk of a workforce development program. Additionally, energy use reduction equipment could receive priority treatment in the commitment of facilities maintenance funds.

Refining legislative authority: Some public finance support structures can be built through amendments to the legislative authority of existing institutions. This approach can sometimes take longer but can also be very effective as part of a package to implement the Phase 1 vision.

3.4.2 Finance Structures

The simplest finance structure is a private financial institution making an unsecured loan directly to a consumer. More complex financing structures are justified when banks perceive undue risk, whether due to consumer credit history or technology, or where consumers perceive high transactions costs, such as identifying reliable service providers or products.

Public financial participation in projects can serve as credit enhancement to reduce these transaction costs for private financial institutions and consumers as well as eliminate the financial and administrative resources needed for direct public funding. Some credit enhancements are described on the next page.

Avoiding Excessive Solar Curtailment on Kauai

Because island grids are small, the impact of adding variable generation—either at the sub-transmission or the distribution level—can have a negative impact on the central generating plants and the quality of power delivered to customers.

In anticipation of these challenges, the Kauai Island Utility Cooperative (KIUC) reached out to DOE and NREL in 2010 for more information on ways to overcome integration challenges and for potential solutions. One of KIUC's primary concerns about meeting its commitment to generate at least 50% of its electricity using renewable energy by 2023 was coordination with its under-frequency load-shedding schemes.

Analysis indicating high penetration of variable renewable generation would not compromise grid stability or power quality helped de-risk the installation of this 1.2-MW PV array on Kauai. *Photo by Jamie L. Keller, NREL 21774*

To address these concerns, the DOE and NREL team performed an economic and technical analysis examining how to model PV inverters in the electricity grid and modeling an initial base case of electricity production and use on Kauai. Different types of PV inverter models were analyzed to ensure the stability of the electrical system during disturbances.

Additionally, the team conducted power system modeling and simulations to accurately plan for overall grid quality. At the time of the study, KIUC only had about 7% renewable energy installed on its system. Because so much diesel power was used, the study reviewed potential renewable-diesel hybrid electrical power systems to supply required loads. Because these types of systems may include fossil fuel generators along with renewable energy, the components have to be combined with storage devices, inverters, and charge controllers to meet load demands. However, adding variable generation such as PV can create potential high ramping rates on the diesel generators.

Given this additional challenge, the team analyzed electrical power system models to better understand the impacts of high penetrations of PV on the power system, finding that the planned projects by KIUC had a balanced mix of renewable energy and would have a low impact on the generation system.

Following the studies, KIUC installed a 1.2- MW solar PV system on one of its electrical distribution feeders demonstrating high penetration levels of solar. The preliminary results from monitoring the circuit indicated overall power quality was not compromised, helping Kauai supersede its goal and achieve 56% renewable electricity generation by 2019.

Loss reserve (partial sovereign guarantee): A loss reserve uses a pool of public resources to reduce repayment risk on loans made by private lenders in support of projects imbued with a public purpose. In exchange for active participation of private lenders at lower interest rates, the reserve will disburse funds on nonperforming debt in a given portfolio, up to the amount of the reserve.

This approach improves the credit evaluation of loans that are negatively impacted by a lack of borrower credit history or technology performance. Loss reserves can partially wrap a portfolio of loans or a bond series, depending on project needs.

Loss reserves, compared to direct subsidies, consume fewer public administrative resources and rely on the ability of private lenders to minimize transaction costs. Property Assessed Clean Energy programs, in which consumers repay loans for distributed generation or energy efficiency retrofits through their property tax bill, typically include a loss reserve.

Sovereign guarantee (full wrap): In contrast to loan loss reserves, which partially wrap a portfolio of smaller projects, this form of contingent explicit liability is capped at the amount of the total project. Sovereign guarantees are sometimes sought for large infrastructure projects when lenders or vendors perceive disproportionate legal, foreign exchange, or political risks.

Utility-led energy services and on-bill repayment: Increasingly, electric utilities are offering nontraditional services, such as distributed generation or efficiency retrofit financing. Because utilities often have access to lower-cost capital than individual consumers do, this structure can allow the utility to broaden its energy business while lowering transaction costs—in part because the consumers repay through their utility bills.

3.5 Develop Performance, Measurement, and Reporting Plans

With an idea about the project focus and financing structure, the project team can begin to shape performance and reporting plans. Regular communication throughout the project term increases the chances of success by identifying potential problems in time to develop effective solutions. To ensure value in this communication, the project team should determine the actions and metrics it requires vendors and others to prioritize.

Performance plans are often organized around milestones, or key actions that need to take place in sequence to successfully proceed toward project completion. Performance plans should include schedules, anticipated approval pathways, and risk and change management strategies, particularly for longer projects.

Milestones depend on project type and project participants, but can include:

- Equipment delivery and acceptance from procurement schedules
- Percentage of workers trained
- Number of installations, such as homes retrofitted or solar water heaters installed
- Attaining financing or completing RFP awards
- Passing key risks into new project stages, such as obtaining all permits and beginning construction
- Communications for performance recognition, such as dollars raised or spent.

Reporting plans should provide a uniform, simplified way to gather the key information the project team and other stakeholders need to track progress. Report information, the timing of reports, and the report approval process should be consistent and reflect who needs what information when. The specific information required varies based on project size and type but should generally include:

- Project name, any identifying number, date of submission, and period covered by report
- Status summary
- Performance and milestone updates
- Progress toward reaching metrics
- Issues that have arisen or have a reasonable likelihood of arising and mitigation strategies
- Budget status and expenditures.

3.6 Tools and Resources

Worksheets and Templates

Responsible-Accountable-Consulted-Informed Matrix
Manage expectations and define roles of project participants

Risk Register Matrix
Plot the severity of impact and likelihood of identified project risks

Sponsor Coordination Matrix
Organize projects and funding sources

Request for Proposals (RFP) Template
Develop an RFP for a grid-tied renewable energy system

Commercial Power Purchase Agreement (PPA) Template
Develop a PPA for grid-tied solar PV system

Case Studies

Ten Microgrids at Puerto Rico Schools Provide Resilience Following an Aggregated Project Preparation Process

In 2019, two years after hurricanes Irma and Maria devastated Puerto Rico and left millions without power, Rocky Mountain Institute (RMI), Save the Children, and Kinesis Foundation installed renewable microgrids in 10 schools in central Puerto Rico. The project provided 400 faculty members and 3,600 students with access to clean, resilient power that supported communities during the earthquakes of early 2020.

What common energy transition challenge or need did the project solve or address?

Like all energy infrastructure projects, microgrid projects must be prepared and de-risked prior to installation. Aggregating projects offers economy of scale but also creates challenges associated with preparing individual projects at multiple sites.

Why is this a common challenge for communities pursuing resilient energy transitions?

Bundling clean energy infrastructure projects exacerbates typical energy project preparation challenges, particularly in remote locations where the organizations that benefit most from these solutions lack the technical resources to execute them.

Teacher training delivered by the project team created an opportunity for students to learn about their school's microgrid system as part of their classroom curriculum. *Photo from RMI*

> "The impact of the blackout on the education in Puerto Rico is an unprecedented case in the history of the United States. Thirteen million collective hours of education were lost in Puerto Rico due to Hurricane Maria; there is a very important relationship between the continuity of education and the access to electrical power."
>
> —Luis Soto, Save the Children's Puerto Rico Director

How did the community address this challenge or need?

A request for proposals (RFP) was prepared seeking an engineering, procurement, and construction (EPC) firm to install the solar and battery systems and provide long-term operations and maintenance (with pre-established funding). Including structural information on the buildings, desired capacity, and other location-specific technical specifications identified through the project preparation process in the RFP enabled bidders to respond with certainty and competitive pricing.

What key decisions were integral to this project?

- Identifying and prioritizing schools to include and getting buy-in from local stakeholders
- Understanding critical needs at each school to determine minimum system size
- Evaluating existing infrastructure at each site to determine the optimal locations and sizes of solar PV systems and battery energy storage as well as basic system design

Who decided on this course of action and why?

The project required collaboration among several stakeholders, including the Puerto Rico Department of Education, nonprofits, EPC contractors, the school population, and families from affected communities.

This project leveraged key strengths of the various stakeholders, from the initiative and financial support of Save the Children to the project management and technical expertise of RMI to the support of government institutions and the participation of the community.

What key takeaways or lessons learned might benefit other communities?

Thorough project preparation was pivotal to various positive outcomes that impacted the overall success of the project:

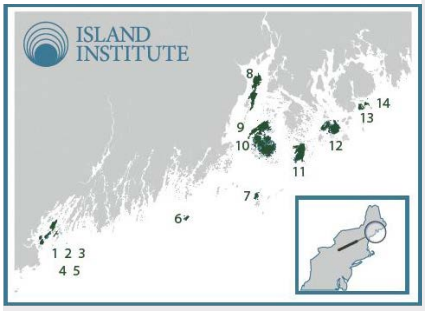
- Including allocations in the project budget for infrastructure improvements enabled the inclusion of roof waterproofing and energy efficiency retrofits such as LED lighting.
- Prioritizing stakeholder engagement was key to successful operation of the microgrids and the incorporation of climate change and renewable energy education into classroom curriculum. The project team delivered training for teachers and administrators on system installation as well curriculum support for teachers.
- Installing sufficient battery and solar capacity to power the critical loads of the school libraries, administrative offices, kitchens, refrigerators, and water pumps indefinitely in the event of an outage enabled the schools to directly support community resilience.

Solar panels on the roof of one of 10 Puerto Rico schools where solar and storage microgrids were installed to power critical loads. *Photo from RMI*

The Puerto Rico school microgrid project demonstrated how linking preparation with implementation can drive success. Focusing on key project preparation steps while aggregating smaller projects across multiple locations may be an effective approach for other communities in Phase 3 of an energy transition.

Maine Islands Achieve Quick Win Through Vendor Coordination, Community Engagement

On 15 Maine islands, citizen groups seeking to reduce vulnerability to energy supply disruptions and improve the resilience of their year-round communities began looking toward new energy technologies as potential solutions. These grassroots energy transition leaders sought support from the Island Institute, a local nonprofit dedicated to sustaining Maine's island and remote coastal communities through strong economies, education and leadership, and shared solutions.



Between 2012 and 2017, more than 380 island homes on 14 Maine Islands participated in Weatherization Weeks, saving $126,400 annually.

What common energy transition challenge or need did the weatherization project solve or address?

Several Maine coastal islands faced barriers to executing a "quick win" energy efficiency project, including limited supply chain, high transportation costs, and skewed public perceptions of the costs and benefits of energy efficiency retrofits.

Why is this a common challenge for communities pursuing resilient energy transitions?

Remote and islanded communities typically face significant cost barriers related to their geographic isolation, including lack of economies of scale. Stakeholders are often skeptical about energy projects because they lack knowledge and experience.

How did the communities address this challenge or need?

Working collaboratively with the Island Institute, several islands decided to launch a collective purchasing project called "Weatherization Weeks." The Island Institute led coordination within and among the communities through outreach to vendors and consumers as well as community engagement.

What key decisions were integral to this project?

Project leaders prioritized addressing two major project barriers: stakeholder misperceptions and the high transportation costs associated with cost of delivering retrofit services to their communities.

Who decided on this course of action and why?

The decision to prioritize stakeholder engagement created an opportunity to share an accurate, empirically-based assessment of energy retrofit benefits with community members. It also raised the visibility of the Island Institute's innovative solution to the transportation cost barrier—banding together to increase economies of scale.

Lining up eight houses a week reduced transportation costs more than 80% and enabled homeowners to take advantage of incentives offered by Efficiency Maine to work with certified contractors who would not normally serve those communities.

What key takeaways or lessons learned might benefit other communities?

- Focus on executing a quick-win project to build momentum for island energy transitions by increasing local interest and engagement in clean energy solutions.
- Hold initial informational meetings to help community members understand project benefits while enabling project leaders to identify barriers to success.
- Engage stakeholders early to help pave the way for developing and executing locally relevant outreach strategies deployed by local volunteers.
- Combine energy audits and initial retrofit work to lower costs and increase efficiency.
- Pursue bulk purchasing to create efficiencies of scale that reduce the delivered cost of energy retrofit materials.

By combining energy audits and initial retrofit work, the inaugural Weatherization Weeks project saved homeowners an average of $350 per year in energy costs. As word of the benefits spread, many communities hosted subsequent Weatherization Weeks. Collectively, the retrofits have resulted in more than $2.3 million in savings for homeowners.

These initiatives have also increased local interest and engagement in clean energy solutions for public buildings and community-owned renewable energy, demonstrating the potential of a quick-win project to build momentum for island energy transitions.

Focused, Streamlined Team Effort Lays Groundwork for a Quick Win in Turks and Caicos

In 2016, the utility in the Turks and Caicos Islands (TCI), FortisTCI, partnered with experts from the Islands Energy Program at Rocky Mountain Institute (RMI) to issue an RFP for an engineering, procurement, and construction (EPC) company to construct and install a 1-megawatt solar PV system across five sites.

FortisTCI and RMI sign a memorandum of agreement to jointly develop and commercialize the first utility-scale solar project across five islands in the Turks and Caicos Islands. *Photo from FortisTCI*

What common energy transition challenge or need did the project solve or address?

The TCI utility needed to identify and implement a project that made economic and technical sense, was good for its customers, and ensured the company was on track to deliver against its renewable energy goals for 2025.

Why is this a common challenge for communities pursuing resilient energy transitions?

Completing a project efficiently at a competitive cost is a common challenge for energy projects because there are many moving parts and multiple players.

How did the community address this challenge or need?

To keep pace with its aggressive timeline, FortisTCI adopted a collaborative approach to project preparation that fostered swift and decisive in-parallel actions aimed at compressing some of the most important early steps in the process.

What key decisions were integral to this project?

Adopting a well-thought-out and strategic approach to project preparation allowed FortisTCI to jump-start the integration of renewable energy and gain momentum while planning for medium- and long-term energy transition goals.

Who decided on this course of action and why?

Identifying viable sites, evaluating interconnection points, conducting technical studies, and implementing the procurement process were key tasks the project team undertook to inform higher-level decisions FortisTCI needed to make to create a strong foundation for a successful renewable energy project.

The project team's focused, synchronous action led to a smooth procurement process and identification of an experienced EPC contractor to complete the project efficiently and cost-effectively.

What key takeaways or lessons learned might benefit other communities?

- Assemble a strong, integrated project team with diverse skills, experience, and expertise to accelerate all aspects of project preparation.
- Streamline project preparation through focused, synchronous teamwork.
- Work in parallel to evaluate project sites, verify renewable energy generation capacity, issue requests for proposals, and complete other key project preparation tasks.

This project, the first of this type undertaken in the TCI, supported FortisTCI's goal to integrate renewable energy levels identified in the company's integrated resource plan, which also identified an optimum energy mix based on the principle of reliable, least-cost energy.

Creative Financing Options Pave Way for Solar Water Heating in Barbados

A rooftop solar water heating program in Barbados met with success thanks to effective financial incentives and government support. *Photo from iStock 6923507*

To achieve the strategic goal of offsetting high fossil fuel costs Barbados sought to use its abundant solar resources to power solar water heaters (SWHs) across the island. The island successfully overcame market barriers to widespread implementation of SWHs thanks to local high-level government champions, financial incentives, and a locally sensitive marketing strategy that won consumer acceptance.

> "It was very important that successive governments were consistent in their support. … Governments need the fortitude to commit to [financial and regulatory support] for the long term."
>
> —Leonard Nurse, Barbados Special Envoy for the Environment

What common energy transition challenge or need did the project solve or address?

Lack of access to start-up capital and low consumer awareness and confidence in solar technology posed barriers to deploying a solar water heating program in Barbados.

Why is this a common challenge for communities pursuing resilient energy transitions?

Because of their size and geographic isolation, remote and island communities often face significant project financing and funding challenges. These barriers can be exacerbated by high up-front costs, historically inconsistent financial incentives, and stakeholder skepticism.

How did the community address this challenge or need?

In lieu of bank financing, the Barbados Institute of Management and Productivity provided a loan. To incentivize public participation in the program, credit unions and distributors allowed consumers to spread unit costs over 3 years.

What key decisions were integral to this project?

- The government introduced measures to support the industry, such as mandating SWHs for all new government housing developments.
- Credit unions and distributors offered financial support. Matching the credit term to the 3-year payback time of the SWH units meant that some consumers spent less money than if they had continued heating their water with gas.
- Consumer acceptance was also key to SWH industry growth in Barbados. Once consumers saw that the technology was sized for their households and worked well, their confidence grew.

What key takeaways or lessons learned might benefit other communities?

- Local finance partners can establish channels of funding for pioneering companies that are struggling to access credit.
- Financial incentives, such as tax credits, can spur adoption of new technology.
- A stable regulatory framework can provide confidence for investors and consumers.
- Consumer credit schemes from manufacturers, distributors, or installers can lower up-front costs to consumers.
- Developing an effective product and ensuring that the size of the SWH is appropriate for each household is crucial for maintaining sufficient water temperature. This was key to boosting consumer confidence and buy-in in Barbados.

Today, the SWHs designed in Barbados are sold throughout the Caribbean, and Barbados is recognized as a leader in the SWH field.

Although challenges may vary by location, Barbados offers an example of why energy champions, financial incentives, and consumer confidence and acceptance are key to ensuring widespread adoption of a renewable energy technology to help offset high energy costs.

Greensburg Implements High-Efficiency Building Codes to Achieve Long-Term Energy Savings

In 2007 a massive tornado struck Greensburg, Kansas, killing 11 people and damaging or destroying more than 90% of structures, most vehicles, and the electricity infrastructure. City and community leaders and residents committed to rebuilding the town as a model sustainable community.

Greensburg rebuilt its K-12 school to LEED Platinum standards. *Photo from Joah Bussert, Greensburg GreenTown, NREL 19952*

What common energy transition challenge or need did the project solve or address?

As one pathway to rebuilding sustainably, the City of Greensburg sought to formalize green building codes. However, it faced concerns about how residents, business owners, and builders would respond to perceived higher building costs and how city staff would learn the new codes and program requirements.

Why is this a common challenge for communities pursuing resilient energy transitions?

Project leaders implementing policy reforms often face resistance from community stakeholders who are wary of mandates and resistant to change.

How did the community address this challenge or need?

City leaders relied on credible, objective technical experts to analyze and summarize the rapidly changing field of green building codes and green building programs for city leaders and present several options for consideration.

> "The technical assistance provided by DOE and NREL staff assures that Greensburg's city and county governments, businesses, and other buildings will continue to save large sums of money for a long time to come."
>
> —Daniel Wallach, Executive Director and Founder, Greensburg Greentown

What key decisions were integral to this project?

After many discussions, the City of Greensburg:

- Approved a voluntary Greensburg Green Building Program that included partnering with the Kansas Building Industry Association to offer training, discount some services, and support public awareness about green building while giving builders a chance to understand green building techniques gradually
- Opted to encourage or incentivize architects and builders to use ASHRAE's Advanced Energy Design Guides
- Adopted the International Energy Conservation Code as the basic energy code because it applied to the residential and commercial sectors and had reasonably achievable energy requirements.

Who decided on this course of action and why?

By seeking unbiased, third-party expertise on rebuilding with energy efficiency, Greensburg was able to explore numerous building energy code options, educate its leaders and residents on those options, and gain stakeholder support for voluntary programs that led to the completion of numerous new and renovated buildings that meet or exceed the city's energy goals.

What key takeaways or lessons learned might benefit other communities?

- Determine gaps and opportunities by comparing current local codes with the latest international standards.
- Educate key stakeholders, including city and business leaders and residents, about the benefits of the proposed changes and why updated codes should be used to meet the community's goals.
- Explore partnerships with reputable building organizations to leverage their expertise and resources.
- Demonstrate success with highly visible public buildings that can serve as living laboratories for incorporating energy efficiency and renewable energy into building designs.

By seeking unbiased, third-party expertise on rebuilding with energy efficiency, Greensburg was able to explore numerous building energy code options, educate its leaders and residents on those options, and implement programs that led to the completion of numerous new and renovated buildings that meet or exceed the city's energy goals.

Resources

Involve Stakeholders in Policy and Operational Reform Efforts

Climate Information for Electric Utilities—Interactive National Oceanic and Atmospheric Administration website focused on identifying, developing, and implementing strategies to increase power system resilience to events that can cause large-area, long-duration outages by helping utilities recognize their potential exposure to climate-related hazards.

Community Resilience Planning Guide for Buildings and Infrastructure Systems: A Playbook—National Institute of Standards and Technology's (NIST's) six-step process for resilience planning, from team formation through plan development, implementation, and maintenance.

Guide Brief: Forming a Collaborative Planning Team and Engaging the Community—Information communities can use to accomplish the first step of the NIST Community Resilience Planning Guide, with best practices and lessons learned from the Federal Emergency Management Agency's Building Resilience with Diverse Communities Program. Also includes resources to assist community leaders in forming collaborative planning teams and engaging the community at large.

Promoting Resilience in the Energy Sector—An Asia-Pacific Economic Cooperation (APEC) report about a 3-day capacity-building workshop on the methodology for evaluating and addressing climate change risks to the power sector in the APEC region.

Identify the Human, Technical, and Financial Resources Needed To Complete Near-Term Projects

Key Principles for Effective Strategic Workforce Planning—A U.S. General Accounting Office report describing the key principles of strategic workforce planning, including illustrative examples.

Template: Forming a Collaborative Planning Team—Template tables from NIST providing examples of planning team members and their roles from local government, business and service professionals, and volunteer organizations.

Set a Budget and Analyze Risks

Building Blocks to Support Cybersecurity in the Power Sector—NREL and USAID recorded webinar presenting a cybersecurity framework and building blocks focused on technical, policy, planning, and regulatory considerations across advanced power system technologies.

Guidelines for Climate Proofing Investment in the Energy Sector—An Asian Development Bank report providing guidance for project teams as they integrate climate change adaptation and risk management into each step of project processing, design, and implementation.

Integrating Variable Renewable Energy into the Grid: Key Issues and Emerging Solutions—A recorded webinar from the Clean Energy Solution Center addressing challenges of integrating significant quantities of variable renewable energy into the grid and highlighting emerging solutions policy makers and grid operators have implemented to integrate wind and solar.

Microgrid-Ready Solar PV: Planning for Resiliency—An NREL fact sheet on microgrids and up-front considerations that can be added to solar project procurement or requests for proposals to help ensure PV systems are built for future microgrid connection.

Solar Under Storm—An RMI report consisting of a two-part guidebook for designing resilient PV systems (ground-mounted and rooftop) and policy-making best practices for improving PV system survivability to intense wind-loading events.

Identify Financing Options for Near-Term Projects

Climate and Disaster Resilience Financing in Small Island Developing States—A report highlighting the latest trends in concessional financing available for climate- and disaster- resilient development in small island developing states.

Financing Energy Improvements on Utility Bills: Market Updates and Key Program Design Considerations for Policymakers and Administrators—A DOE guide to on-bill energy efficiency financing programs offering actionable insights about key program design considerations.

Funding & Financing for Energy Projects—Information about energy project funding and financing opportunities for state, local, and tribal governments.

Green Banks—An NREL resource for state, local, and tribal governments seeking low-cost capital for clean energy projects at favorable rates and terms.

State-Based Financing Tools to Support Distributed and Community Wind Projects—A guide to specific financing assistance and tools states can provide to support smaller-scale wind projects in the future. Many of the tools are applicable to a broad range of renewable energy technologies.

Develop Performance, Measurement, and Reporting Plans

Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities—A Federal Energy Management Program (FEMP) guide containing project development checklists relevant to U.S. utility-scale projects that could provide a basis for tailored project development checklists in other jurisdictions.

The Energy Data Management Guide—A step-by-step approach to establishing a robust and sustainable energy data management program.

Measurement and Verification Operational Guide: Renewable and Cogeneration Applications—A guide to the International Performance Measurement and Verification Protocol, including practical tips, tools, and scenario examples to assist with decision making, planning, measuring, analyzing, and reporting outcomes of energy projects.

M&V Guidelines: Measurement and Verification for Performance-Based Contracts— FEMP procedures and guidelines for quantifying the savings resulting from energy-efficient equipment, water conservation, improved operation and maintenance, renewable energy, and cogeneration projects installed under performance-based contracts.

Execute & Manage

Execute projects and ensure quality control

Phase 4

After selecting a project and designing its components to capitalize on available human and financial resources, the project team can shift to execution—implementing plans, coordinating partners, and keeping the public informed.

Phase 4 describes how to:

- ☐ 4.1 Implement schedules, performance, measurement, and reporting plans
- ☐ 4.2 Mitigate adverse environmental and social impacts
- ☐ 4.3 Maintain transparency in project and vendor selection processes
- ☐ 4.4 Develop a project closeout process; implement when appropriate
- ☐ 4.5 Engage stakeholders to keep project successes visible

4.1 Implement Schedules, Performance, Measurement, and Reporting Plans

4.1.1 Identify All Project Permits

Applying for and receiving project permits are critical components of successful energy projects and are typically central to setting realistic schedules and performance plans.

An experienced project permitting partner can help minimize unforeseen costs and delays, but all project partners need to set realistic expectations regarding the permitting process. Making a comprehensive list of needed permits and their requirements is a good first step. Once the team knows what permits are needed, planning for applications and collecting the relevant data in advance will avoid resubmissions and rework.

If relevant government agencies are streamlining their permitting processes, providing accurate information on the permitting experience will help them reduce any inefficiencies.

Example Project Permits Questionnaire

- What permits or authorizations are required from the local utility or regulating body?
- If leasing the site, what permits or authorizations are required from the site owner?
- What permits or authorizations are required from local jurisdictions or agencies?
- What permits or authorizations are required from central government agencies?
- What information does each permit or authorization require to be processed?
- Is that information free, or will costs be incurred?
- What are the permitting costs, and when must they be covered to meet the project schedule?
- Who will pay the direct costs or the costs of any work required to achieve approvals, authorizations, or permits?
- Could the timing of permits and authorizations significantly impact project costs or economics? Could that put the project in jeopardy?
- Is litigation of permitting issues expected or probable?
- Will delays in permitting impact financing?
- What if the project is not built? Are any parties in the process expecting reimbursement of some, or all, incurred costs?

Adapted from *Developing Renewable Energy Projects Larger than 10 MWs at Federal Facilities* (Federal Energy Management Program 2013).

4.1.2 Set a Realistic Project Schedule

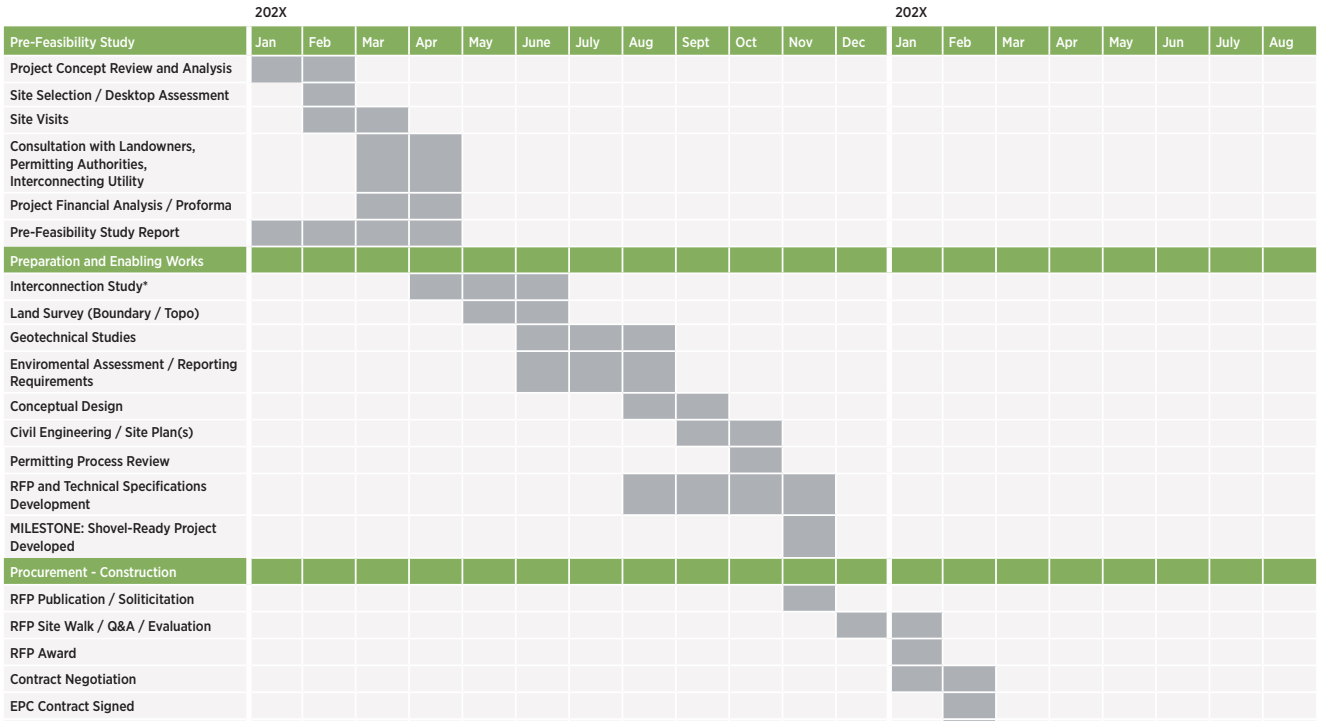
Setting and keeping a realistic schedule is fundamental to project success, in part because it requires the project team to imagine what success looks like and articulate the time and effort required for each step along the way.

When setting a schedule, it is important to include "slack time" for when resources are unavailable, and time for regular meetings, which are an integral yet time-consuming part of project execution. If schedules change, document the changes and file correspondence explaining why the schedule required adjustment and obtaining sign-off on the changes from affected parties.

Several tools, including a Gantt chart and Critical Path Analysis, can aid in setting and monitoring schedules. Templates for these charts are sometimes included with or available for spreadsheet software. Free online tools offer similar functionalities.

Regardless of whether the project team employs a formal method, an arrow diagram may help the project team visualize what resources will be required and in what order to achieve project milestones.

Sample Utility Scale Solar Project Milestone Gantt Chart



A sample schedule for the major milestones in an energy project, from initial concept to final commissioning. This example is based on a typical schedule for a utility-scale solar photovoltaic project and can be used as a starting point for other energy projects. While some steps can and should be completed in parallel, focusing on prefeasibility assessments unlocks the preparation and enabling work that supports successful procurement and project implementation.

Adhering to a schedule requires coordinating with management and other governmental entities involved in, but not responsible for, project success. For example, permitting construction can involve nonenergy agencies, yet their review is necessary to stay on schedule.

The Responsible-Accountable-Consulted-Informed (RACI) diagrams (Phase 3) can be useful in determining which other agencies will participate in project development; in addition, working project schedules into performance plans can help ensure that this coordination proceeds effectively. If the team faces a challenge it is unable to overcome after a good-faith effort, a project champion (if identified in Phase 3) can often help troubleshoot.

4.1.3 Performance Plans

Success will depend on many factors, including the performance of the project team. The initial steps in project execution can involve requests for proposals, technology evaluation, or data collection. But the first and most important step is a phone call or an email from the project lead. Setting expectations for team members helps ensure they all understand their roles and their contributions to the project's success.

A performance plan clearly outlines roles and responsibilities for team members and can identify the training and resources they need to achieve the expected results. It can also link responsibilities to the project schedule to ensure individual team members understand when they need to complete certain tasks to deliver the results on time.

Performance plans also help the project team appreciate the value of their teammates and allow for recognition of individual and team performance.

4.1.4 Using Metrics To Track Progress

Although some responsibilities are task-oriented, focusing on outcomes will ensure that processes achieve desired results. Metrics do not need to count numbers but can track results critical to project success. Outcomes that may be useful to track are:

- Finalizing equipment specifications
- Timely issue of permits
- Close of negotiation with vendors and/or finance partners
- Timely delivery of equipment
- Trainings completed
- Testing and accepting equipment
- Issuance of purchase orders
- Timely reporting with appropriate data
- Equipment in use
- Public engagement activities.

4.1.5 Project Reporting

Beyond ensuring that the project is on track to succeed, project progress reporting is one of the most important tools to communicate progress throughout government and to partners and the public. Building on the planning in Phase 3, simple processes to collect and present progress data clearly and uniformly can document successes and help maintain support for the project.

Although data requirements, reporting frequency, and responsibility for compiling reports will vary by project type, risk, and partner expectations, all ensure that project status is summarized effectively. Because the reporting process involves collecting information from project staff for management and other stakeholders, team leads or project managers are likely in the best position to compile and finalize reports.

Common status reporting periods occur quarterly or semiannually. It is important to note that larger projects often have more comprehensive annual reporting requirements. RACI diagrams can help identify the appropriate audience for reports and, in turn, the appropriate information to include in them, such as:

- Summary of activities since the last report
- Budget status and rate of expenditure (burn rate)
- Milestone and metric status
- Any upcoming challenges for management awareness.

Engage and Educate Stakeholders Early and Often

As part of the Energy Development in Island Nations initiative launched in early 2010, the U.S. Virgin Islands (USVI) began working with the U.S. Department of Energy and the National Renewable Energy Laboratory to develop a strategy for reducing the territory's 100% reliance on fossil fuels 60% by 2025.

Based on preliminary modeling and analysis, the Virgin Islands Water and Power Authority identified waste-to-energy (WTE) as a significant opportunity because municipal solid waste was an abundant renewable resource—in fact, landfills were nearing capacity and were in violation of U.S. Environmental Protection Agency standards.

As such, the USVI identified WTE as a key pathway to its 60% goal, representing 8%–12% of the envisioned 2025 energy mix. But the proposed project ultimately failed, offering a valuable lesson on the importance of proactively addressing a common barrier: lack of stakeholder buy-in.

While the project team did not attempt to keep the project a secret, they did not put much thought or effort into communicating the risks and benefits to stakeholders. Rumors spread about the environmental impacts and costs of the project, and an official announcement about a signed WTE agreement caused an immediate public outcry.

Stakeholders had legitimate concerns about the legal, financial, and environmental ramifications of various aspects of the deal. Faced with intense community opposition, the senate in 2010 rejected a land lease that was a linchpin of the original plan.

In response, the developer modified the plan, eliminating the use of petroleum coke and proposing a single plant on St. Croix. The project partners held events to educate the public on their extensive pollution control measures and released a well-researched technical report on WTE presenting the hard data needed to address concerns.

But public opposition had reached critical levels, and the senate voted down a second proposed land lease agreement, effectively killing the project.

The project team failed to anticipate and address stakeholder concerns about WTE and underestimated the power of public opinion. As a result, the team missed the small window of opportunity early in the project preparation phase to address concerns proactively through a carefully managed stakeholder outreach, education, and engagement strategy.

Key Takeaways

- Consult with key stakeholders about issues and barriers early in the planning stages.
- "Get out in front of the story," responding directly to concerns with hard data and key messaging that is substantively responsive to concerns.
- Educate and inform key stakeholders about proposed technologies and project specifics early and often.
- A transparent approach to information management is a key to successfully developing stakeholder buy-in and winning the public's trust.

4.2 Mitigate Adverse Environmental and Social Impacts

Although, generally, energy efficiency and small to midsize renewable energy projects will not require significant environmental mitigation, even small construction projects can have adverse impacts on neighboring communities. Thus, it is important to take steps to mitigate such impacts.

Waste management; noise and vibration; land and water use; and biological, cultural, and coastal zone management are some of the key considerations when evaluating the potential environmental and social impacts of a project. For example, appropriate siting can mitigate potential impacts from wind projects, such as glare from solar panels or noise and light pollution.

4.3 Maintain Transparency in Project and Vendor Selection Processes

Transparency in Phase 4 demonstrates deliberate and thoughtful decision-making, which mitigates a variety of project risks, facilitates stakeholder support, and ultimately improves the chances of project success.

Transparency can be maintained by articulating a few key components of a successful project and communicating those expectations to project partners and potential vendors. Articulating components of success and their relative importance can help set expectations for the project team and outside stakeholders, paving the way for public recognition of successful projects.

4.4 Develop a Project Closeout Process; Implement When Appropriate

Some projects, such as facility construction, may benefit from a project closeout process. During closeout, the project lead accepts final delivery of the work, so this may be when warranties begin and insurance needs transfer from the contractor to facility owner. It is also another opportunity to ensure that facility operators have received the necessary training to operate and maintain project assets.

Typically, closeout involves calculating and documenting all costs and expenses, and includes written statements confirming that the work is being accepted and equipment has been tested and meets specifications. This documentation is often required to release final payments and provides the opportunity to compare the planned budget to actual expenditures.

Along with financial information, other project documentation—such as plans, correspondence, relevant meeting notes, schedules, deliverables, scope changes, and status reports—should be collected and archived. This documentation can provide a key record of project decision-making, not only for future projects or project reviews, but also warranty claims. It also allows for knowledge transfer from the project team to equipment owners or operators.

Closeout can involve the reassignment of project resources, including team staff time, and performance reviews for staff and contractors. Devoting time to staff transitions can give project team members confidence about their next position, helping ensure that they remain through closeout and minimizing disruptions to staff availability at the close of a project.

4.5 Engage Stakeholders To Keep Project Successes Visible

Continued public support is important to individual projects and to the overall vision. Major project milestones, such as permit applications and beginning of construction, provide opportunities to communicate progress to the public and solicit feedback from key stakeholders, such as project neighbors or consumers.

Events such as groundbreakings and ribbon cuttings can raise the profile of projects and give partners and stakeholders opportunities to interact. Although not directly related to project success, a communications plan that emphasizes highlighting the value of projects and demonstrating the community's capacity to realize its energy vision is a powerful catalyst.

4.6 Tools and Resources

Worksheets and Templates

Gantt Chart
Set a schedule for completing major project milestones

Periodic Report
Document project expenditures, milestones, and scope changes

Case Studies

U.S. Virgin Islands Clears the Way for Unprecedented Levels of Solar Energy

In 2010, the U.S. Virgin Islands (USVI) identified larger and distributed solar resource development as a pathway to achieving its clean energy vision. Thanks to an excellent solar resource and policies in Phase 3 that paved the way for an early win, the territory succeeded in installing the largest airport solar system in the Caribbean, paving the way for additional solar development.

The USVI prioritized stakeholder outreach and education to amplify the success of its energy transition and build community support. *Photo from Don Buchanan, Virgin Islands Energy Office, NREL 20152*

> I don't know of another area or jurisdiction anywhere that has that significant of a portion of their peak demand in a renewable resource such as solar, so this is not only a significant event for the territory but for solar energy everywhere."
>
> —Hugo Hodge Jr., WAPA Executive Director

What common energy transition challenge or need did the project solve or address?

To secure financing and attract quality developers, the USVI needed to demonstrate the technical and economic viability of integrating 10 MW of distributed solar into the grid and mitigate project risks.

Why is this a common challenge for communities pursuing resilient energy transitions?

Utilities and developers are key partners and stakeholders in clean energy projects, but they need to balance community clean energy goals with their operational and economic priorities, including return on investment, long-term profitability, and reliable service delivery.

How did the community address this challenge or need?

The Virgin Islands Water and Power Authority (WAPA) tapped into the analysis and project development expertise of the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) for project development and decision support on resource assessment, optimal siting, policy changes, and grid integration.

What key decisions were integral to this project?

- On June 4, 2012, WAPA signed six power purchase agreements (PPAs) for a combined 18 MW of solar energy.
- The agreements committed three companies to investing a total of $65 million to install 18 MW of solar in the USVI—9 MW on St. Thomas and 9 MW on St. Croix.

Who decided on this course of action and why?

WAPA signed PPAs to purchase renewably generated power at an average cost of approximately $0.18/ kWh over the 25-year term of the projects—significantly less than the utility's cost to produce the same amount of diesel-generated power at its plants. Solid project preparation and de-risking efforts in Phase 3 paid off, building a strong case for technological and economic viability of the project.

Tapping into the technical expertise and renewable energy project development experience of DOE and NREL, WAPA was able to break down common project development barriers by:

- Helping identify optimal sites for solar PV systems
- Identifying policy and regulatory changes that would address current barriers, such as uncertainty, around interconnection procedures and agreements
- Updating the USVI's solar resource assessment to more accurately gauge the potential impact of solar energy in the territory
- Modeling the WAPA grid and developing a strategy to avoid grid integration issues by distributing PV systems geographically
- Analyzing financial and resource data—including one-minute data from a 451-kilowatt-hour (kWh) solar PV system installed at the St. Thomas airport—to model the effects of high-penetration renewable energy on the existing WAPA generation system and grid.

What key takeaways or lessons learned might benefit other communities?

To de-risk renewable energy projects, leverage the technical and analytical support of objective, credible experts to:

- Identify optimal sites for siting new renewable energy generation
- Ensure the accuracy of resource assessments in gauging the potential impact of various resources on the energy system
- Identify and implement policy and regulatory changes that can address project barriers
- Model the impacts of increased variable renewable energy generation on the grid.

These PPAs represented a groundbreaking shift in the territory's energy economy—and set a new standard for community renewable penetration. The USVI's successful execution of these solar projects provides a model for other islands to follow by showcasing the technical and economic viability of renewable energy on islands.

Resources

Implement Schedules, Performance, Measurement, and Reporting Plans

Environmental, Health, and Safety Guidelines Website—Current versions of the World Bank Group Environmental, Health, and Safety Guidelines. Applicable to all sectors, the guidelines contain performance levels and measures that are normally acceptable to the World Bank Group and are generally considered to be achievable in new facilities at reasonable costs by existing technology.

GAO Schedule Assessment Guide—A consistent methodology for developing, managing, and evaluating capital program cost estimates that includes the concept of scheduling the necessary work to a timeline.

Life Cycle Asset Management: Quality Assurance—A DOE guide to developing and implementing quality assurance programs for energy projects.

Quality Assurance Framework for Mini-Grids—An NREL technical report that describes a quality assurance framework comprising defined quality assurance measures that can be applied to the mini-grid market sector.

Quality Assurance Framework Implementation Guide for Isolated Community Power Systems—An NREL technical report that defines a range of service levels that ensure safe, quality, and affordable delivery of basic grid-parity service; provides an accountability framework that can be used to determine whether an agreed-upon service level is delivered.

Quality Assurance Guide for Project Management—Information to assist DOE federal project directors and their integrated project teams to plan, develop, and implement a project-specific quality assurance program that satisfies quality assurance requirements throughout the critical decision process.

Mitigate Adverse Environmental and Social Impacts

Environmental Impacts of Renewable Electricity Generation Technologies: A Life Cycle Perspective—An NREL presentation that covers sustainability analysis, life cycle assessment, and environmental impact studies on topics such as greenhouse gas emissions, water use, and land use.

A Guidebook on Equitable Clean Energy Program Design for Local Governments and Partners—A guide to resources local governments and partners can use to advance social equity in clean energy program design and implementation in their communities, including an inventory of best practice programs and four in-depth case studies.

Life Cycle Assessment Harmonization—Results from NREL's review, analysis, and harmonization of published life cycle assessment estimates for multiple energy generation technologies, including wind, solar, biopower, geothermal, hydropower, and ocean energy.

Fostering Equity in Local Clean Energy Policy—Lessons from the American Council for an Energy-Efficient Economy's 2019 City Clean Energy Scorecard, which uses five dimensions to evaluate how cities and local utilities are creating, promoting, and supporting socially equitable clean energy strategies.

Greenlining: Energy Equity—Resources to help ensure energy policies that build a clean energy future center and prioritize communities of color, opening doors for historically redlined communities.

Sudden Influxes of Resource Wealth to the Economy: Avoiding 'Dutch Disease'—A World Bank policy brief that takes a systematic look at "Dutch Disease" (a macroeconomic phenomenon in which a sudden increase of resource wealth from an extractive sector undermines other areas of the economy) and summarizes policies aimed at preventing or mitigating its harmful long-term economic effects.

Maintain Transparency in Project and Vendor Selection Processes

Asia-Pacific Economic Corporation Government Procurement Experts Group Non-Binding Principles on Government Procurement: Accountability and Due Process—A set of elements established to promote transparency in government procurement, including illustrative examples.

OECD Principles for Integrity in Public Procurement—A set of principles that serve as a policy instrument for enhancing transparency and integrity throughout the public procurement cycle.

Standard Contracts and Securitization Resources—An NREL collection of real-world renewable energy contracts, including requests for proposals.

Vietnam Solar Competitive Bidding Strategy and Framework—World Bank Group strategy document developed to support the Government of Vietnam's goal to scale up solar generation sustainably and affordably by shifting from feed-in tariffs to a competitive bidding mechanism.

Develop a Project Closeout Process; Implement When Appropriate

Best Practices in Project Management Closeout—DOE Office of Science project closeout process overview.

Capital Construction Project Closeout Checklist—A real-world example of the various components of a large project closeout from the National Science Foundation.

Project Closeout: Guidance for Final Evaluation of Building America Communities—An NREL technical report that presents Building America Communities project closeout guidelines, which are applicable to most energy projects.

Engage Stakeholders to Keep Project Successes Visible

NIST Guide Brief: Short-Term Implementation Tasks—Suggestions from the National Institute of Standards and Technology on short-term activities and solutions to support continued engagement in community resilience planning until longer-term solutions are implemented.

Operate & Maintain

Operate and maintain energy systems, assets, and programs

Phase 5

The operations and maintenance (O&M) phase of an energy transition is when the benefits of most energy projects will be realized.

O&M allows full use of project assets and supports resilience by minimizing impact from disruptions and outages. Because the equipment significantly impacts O&M budget requirements, project owners should work closely with vendors and manufacturers to shape O&M budgets, schedules, and employee training.

Phase 5 describes how to:

- ☐ 5.1 Monitor and verify system and program performance
- ☐ 5.2 Conduct end-of-warranty assessments
- ☐ 5.3 Monitor equipment condition and perform predictive maintenance

An O&M strategy must describe—in clear terms and with metrics—the normal use of equipment and any larger system that incorporates that equipment as well as expected performance from normal use.

The strategy should also describe personnel activities, including training requirements and responsibilities for maintaining and repairing equipment, not only to meet key performance indicators but also to enable the exchange of O&M information between operational and managerial staff. The responsible, accountable, consulted, informed (RACI) diagrams referenced in Phase 3 can also be useful for O&M strategies.

O&M involves record keeping to document equipment conditions and any remedial action anticipated/needed/taken. As such, a comprehensive O&M strategy can be an integral part of compliance with applicable environmental or other regulations relevant to the performance and operation of the equipment—and is sometimes required by law.

Beyond regulatory reporting requirements, consistent information collection facilitates component replacement or planned outage requests, warranty claims, and documentation of renewable energy project success. It is also critical to energy efficiency projects, such as energy savings performance contracts (ESPCs), to demonstrate energy savings.

5.1 Monitor and Verify System and Program Performance

Monitoring and verification (M&V) documents energy use reductions resulting from technology installations and behavior changes. Calculating the energy savings attributable to energy efficiency programs can be complex and should be tailored to meet data requirements for project monitoring needs.

At a program level, M&V provides the experiential data needed to shape future programs and understand the role of energy efficiency in load and revenue forecasting. For utilities that incorporate energy efficiency services into their business models, efficiency monitoring and verification (EM&V) can provide the data needed for sales and marketing. The needs of the program administrator will shape the approach to gathering the appropriate data.

For ESPCs, structuring the project so the energy services company (ESC) is paid for service and equipment delivery from avoided cost savings resulting from energy efficiency upgrades is critical to project success.

An ESPC relies on establishing an accurate baseline of energy use to calculate the cost savings resulting from the ESC's services. Savings are calculated based on a mix of stipulated savings for weather or equipment replacements and post-installation measurements at the component, system, or meter level.

5.2 Conduct End-of-Warranty Assessments

As equipment warranties expire, a project owner should conduct an end-of-warranty assessment to determine whether any corrective action is needed from the supplier. Given the importance of the end-of-warranty assessment, the owner should ensure that staff and contractors are trained and capable of collecting and analyzing the appropriate information.

Typical Components Identified in the End-of-Warranty Assessment

Foundation	Cables	Blade bearing	Roads
Tower structure	Bedplate	Generator	Substation equipment
Blades	Gearbox	Generator slip ring	Transformers
Converter	Pitch systems	Yaw system	

Source: DOE 2011

5.3 Monitor Equipment Condition and Perform Predictive Maintenance

For infrastructure and other critical equipment, condition monitoring and predictive maintenance may offer better protection for these large investments than other approaches to O&M. Condition monitoring sensors can collect information on performance indicators and analyze discrepancies from specifications to facilitate maintenance before service disruptions or other failures occur.

For the wind industry, a major component of post-warranty operations expenditures is unscheduled maintenance, indicating that honoring a maintenance schedule and using condition monitoring can help reduce costs. (Industrial control systems, such as linking to a supervisory control and data acquisition system, may also be appropriate, depending on the equipment and its role in the energy system.)

5.4 Tools and Resources

Case Study

Monitoring and Evaluation of Bermuda's First Battery Highlights Savings and Informs Next Energy Transition Steps

In 2019, Bermuda's electric utility, BELCO, installed a 10 MW-/5.5-MWh battery energy storage system. The system's main use is providing reserve capacity to the Bermuda electricity grid, resulting in cost savings driven by direct fuel savings as well as maintenance cost savings. BELCO now maintains the battery while gathering data about its performance and monitoring its operation.

Ongoing monitoring of battery energy storage system performance helps Bermuda chart its course to a clean, resilient energy future. *Photo from BELCO*

> "The BESS continues to be a success story for BELCO. The simple use-case of offsetting mechanical spinning reserve has allowed the operational staff to become familiar with the opportunities energy storage technology can offer as well as allowing internal maintenance staff to gain experience in maintaining these systems. We are looking forward to developing use-cases for future energy storage projects."
>
> —Stephanie Simons, Senior Engineer, Bermuda Electric Light Company

What common challenge or need did the project address?

Bermuda's utility, BELCO, needed to both ensure its first battery energy storage system (BESS) performed optimally and demonstrate the value of the project by monitoring and verifying cost savings and emissions reductions.

Why is this a common challenge for communities pursuing energy transitions?

When communities implement energy projects and leave them to operate without monitoring and verification while focusing resources elsewhere, they risk leaving potential savings unrealized and missing insights that could inform future projects.

How did the community address this challenge or need?

BELCO dedicated resources to monitoring the performance of its battery system, not only to ensure it was operating as expected but also to document its impacts on the electricity system and inform future projects and steps in Bermuda's energy transition.

What key decisions were integral to this project?

Key steps and decisions in the process included:

- Determining what metrics and information to collect on the ongoing performance of the battery
- Ensuring resources are dedicated to continually monitoring the battery's performance and documenting its impact on the utility's technical and financial operation.

Who decided on this course of action and why?

The leadership team at BELCO decided to continually monitor system performance to collect metrics that demonstrate system value, gather data to inform future projects in Bermuda, and share information that can benefit other communities considering battery energy storage projects.

What key takeaways or lessons learned might benefit other communities?

Operating the BESS as a spinning reserve asset enables BELCO to avoid turning on additional diesel generators to provide system reserves while keeping the units that are running near their optimal performance settings.

Documenting the system's operation has highlighted significant benefits for BELCO and Bermuda, including:

- Realizing approximately $2.7 million in energy cost savings
- Offsetting 15,000 barrels of fossil fuel use
- Avoiding more than 5,500 tonnes of CO_2e emissions.

Dedicating resources to monitor and evaluate system performance enabled BELCO to quantify the value of its first battery storage project while collecting insights to inform future projects. As Bermuda continues its clean energy transition, future battery projects may provide different values or meet different needs.

By completing this first battery project and carefully monitoring its performance, BELCO is gaining key experience with energy storage that helps pave the way for future projects in Bermuda. Bermuda's experience may prove useful to other communities as they implement Phase 5.

Resources

Monitor and Verify System and Program Performance

Energy Efficiency Program Impact Evaluation Guide—DOE guide to common terminology, structures, and approaches used for determining energy and demand savings, avoided emissions, and other nonenergy benefits of energy efficiency programs.

Reviewing Measurement & Verification Plans for Federal ESPC Projects—A DOE framework for implementing uniform and consistent reviews of M&V plans for federal ESPC projects.

Monitor Equipment Condition and Perform Predictive Maintenance

Building Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency—DOE O&M guidance for energy managers, including information and suggested actions for achieving savings and benefits from building energy system upgrades.

Installation, Operation, and Maintenance Strategies to Reduce the Cost of Offshore Wind Energy—A National Renewable Energy Laboratory (NREL) technical report that provides a basis for evaluating cost-saving installation, operation, and maintenance strategies and technologies.

The Maryland System Development Life Cycle—Maryland Department of Information Technology framework for reducing project failure, including an example of how to develop an O&M policy for an organization.

Planning and Reporting for Operations & Maintenance in Federal Energy Saving Performance Contracts—ESPC project development guidelines for allocating O&M and repair and replacement (R&R) responsibilities and establishing O&M reporting requirements. The goal is to minimize disagreements over O&M and R&R, and to help ensure savings persist during performance period.

PV System Operations and Maintenance Fundamentals—Practical guidelines for solar photovoltaic (PV) system maintenance and options for inspection practices for grounded PV systems.

A comprehensive O&M strategy should include plans regarding the monitoring and maintenance of equipment, personnel activities, and compliance and reporting requirements. *Photo by Joe Verrengia, NREL 16996*

Improve & Iterate

Improve processes, reassess opportunities, and repeat phases

Phase 6

Shortly after a program ends or a project closes out, collecting insights from team members and stakeholders can provide critical information for improving the next project.

By incorporating the learning that comes from project development and execution into subsequent projects, the team will accelerate progress toward the Phase 1 vision and help ensure that the progress made to date will contribute to lasting change.

After completing a few projects, communities can use the information project teams collect in Phase 6 to reassess opportunity pathways from Phase 2 under new conditions and ensure that the next round of Phase 3 project selections accelerate the energy transition.

Phase 6 describes how to:

- ☐ 6.1 Conduct closeout interviews with project partners and stakeholders
- ☐ 6.2 Collect lessons learned and identify skills development opportunities
- ☐ 6.3 Report results of review to management, project partners, and the public
- ☐ 6.4 Accelerate the energy transition

6.1 Conduct Closeout Interviews with Project Partners and Stakeholders

The project team, project partners such as vendors, and other stakeholders such as customers and neighbors, all have unique perspectives on the conduct and outcomes of a project.

The project lead should solicit specific feedback on the accuracy of schedule and budget estimates, the process of changing schedules or budgets, team member performance, risk identification and management, and project communications from those involved with the project.

Stakeholders whose input was considered in Phases 1–4 should also be consulted, and a project review can identify to what extent the project met their expectations.

Closeout interviews should ask respondents to identify lessons learned or areas for improvement, as well as rate their overall satisfaction with the project.

6.2 Collect Lessons Learned and Identify Skills Development Opportunities

Regardless of success or failure, the experience gained from each project can highlight opportunities to improve the next project. For example, the project team may have identified a way to streamline the permitting process, facilitate communications between project partners, select the most suitable vendor, or even improve project documentation processes.

Through closeout interviews, project teams should identify lessons learned from their experiences. By articulating these lessons, teams can leverage the experiences from one project to improve project planning, preparation, and execution in the next iteration of Phases 4 and 5. This process can also help them balance maintaining consistency of approach with tailoring processes to meet their unique needs.

Over the course of a project, project teams usually develop existing skills and gain new ones. By keeping track of these developments, they can inform the project identification process in the next iteration of Phase 3.

6.2.1. Lessons Learned Key Features

- Provide basic information on who, what, where, and why.
  - The [technology/program/policy] project completed by [who] in [where] represents/demonstrates successful implementation of [Phase #].
- Identify the common challenge for the lessons learned.
  - When undertaking this type of project, one will need to address [common challenge in Phase #].
- Explain why this is a common challenge, with as much specificity as possible.
  - This common challenge arises because it involves [technology risk/financing risk/social risk/changing status quo]. This results from [add detail on challenge that relates to solution].
- Discuss replicable actions (i.e., the how).
  - [Who] addressed [common challenge] in completing the project by [how].
- If appropriate, provide history of reaching the decision point to provide context for course of action taken.
  - [Who] chose this project because [it lowers costs, etc.].
- Highlight reasoning behind decision (i.e., the why).
  - [Who] chose this solution because [why].
  - Indicate alternatives that may suit different circumstances.
- Conclude, emphasizing replicable actions, decisions, or paths to success.
  - This [solution] addressed [common challenge] by [resolving tech/social conflict, etc.], and may be useful for others as they [implement Phase #].

6.3 Report Results of Review to Management, Project Partners, and the Public

The project review process will generate useful information that can help save time and resources in the next project, so it is important to communicate the results. As the final step in any project, share the lessons learned, skills developed, and other information with other project teams, senior leadership, project partners, and stakeholders.

Beyond demonstrating that the project review was worth the effort, sharing this information is important if policy changes or other larger issues need to be addressed for future projects. It also demonstrates to project participants, partners, and stakeholders that their input was valued and was put to good use, not only to complete the project but to benefit others.

6.4 Accelerate the Energy Transition

Insights gained from all phases should be documented in Phase 6, not just to inform the next individual project opportunity, but also to accelerate the community's clean energy transition.

After committing to a transition (Phase 0), setting a vision (Phase 1), identifying pathways and near-term projects (Phase 2), preparing initial projects (Phase 3), implementing those projects (Phase 4), maintaining and monitoring their operation (Phase 5), and documenting lessons learned (Phase 6), communities can move more quickly to scale their transitions more broadly, rather than moving forward one project at a time.

Advancing multiple efforts at once will require dedicated resources, both people and funding. Having a clear long-term plan with commitment from key stakeholders can ensure that the necessary resources are

Updates to Generator Interconnection Minimum Technical Requirements in Puerto Rico

After identifying a significant opportunity to develop renewable energy resources, Puerto Rico revised its interconnection procedures. These procedures govern how generating facilities, including renewable resources, are incorporated into the electric grid and address minimum technical requirements (MTRs).

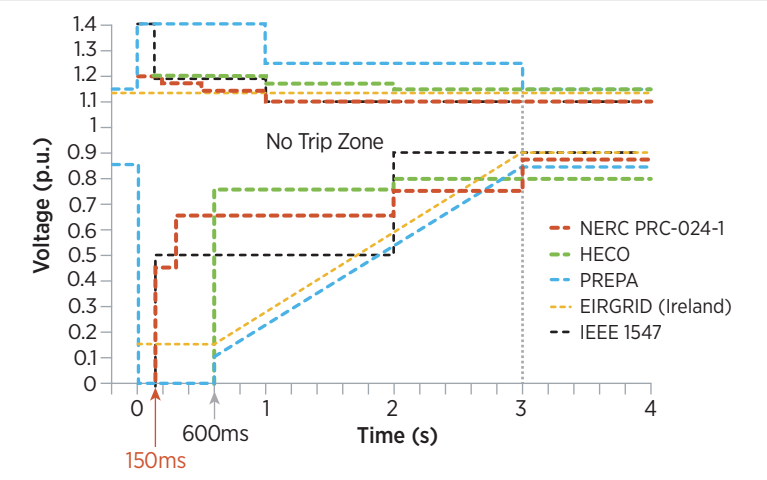
Because many MTRs were written to address relatively large fossil fuel-fired power plants, they often present barriers to the development of renewable and distributed energy projects.

At Puerto Rico's request, the U.S. Department of Energy and the National Renewable Energy Laboratory (NREL) compared the applicable MTRs in Puerto Rico to the generally accepted utility practices in the United States and Europe, as well as the technical aspects of wind and solar photovoltaic projects. Improvements were recommend in several categories, including:

- Voltage fault ride-through
- Voltage regulation system, reactive power, and power factor requirements
- Short-circuit radio influences
- Frequency ride-through and response
- Ramp rate control
- Power quality.

Staff from the Puerto Rico Electric Power Authority (PREPA) participated in the review and ultimately incorporated some recommendations into revised MTRs in August 2012. Utility engineers presented technical rationale for not modifying other requirements.

By seeking out and considering the results from the analysis, Puerto Rico was able to address some of the barriers to high renewable penetration and provide project developers and other stakeholders with clear guidance on the MTRs and the rationale behind them.



As part of its analysis, NREL developed this comparison between low-voltage ride-through requirements and high-voltage ride-through requirements for PREPA, North American Electric Reliability Corporation, and other islands systems such as the Hawaiian Electric Company and EirGrid while also incorporating Institute of Electrical and Electronics Engineers Standard 1547 clearing times. *Figure by NREL*

allocated, and building in clear targets in the more near term (for example, five years) can create helpful focus and certainty in the clean energy market.

Some examples of opportunities to accelerate a successful clean energy transition include:

- Aggregating multiple sites together to achieve a more significant scale, such as combining energy efficiency retrofits with solar photovoltaic (PV) installations at government buildings
- Siting solar PV and energy storage at multiple critical infrastructure locations
- Implementing a community solar approach to create opportunities for increased participation
- Increasing electric mobility, focusing on government, taxi, and utility fleets for immediate beneficial impact.

By continually iterating through the phases of the Playbook, without needing to fully complete one project before moving to the next, communities can keep advancing toward their vision while demonstrating global leadership in clean energy transition.

6.5 Tools and Resources

Worksheets and Templates

Project Skills Register

Collect lessons learned and identify skills development opportunities

Project Closeout Form

Use this CDC form as a guide to close out energy projects

Case Study

Integrated Distribution Planning Helps Hawaii Chart the Course for Ongoing Growth in Distributed Generation

A home in Oahu's Kaupuni Village, the first net-zero community in Hawaii. *Photo by Adam Warren, NREL 34717*

In 2015, Hawaii became the first U.S. state to establish a renewable portfolio standard (RPS) target of 100% by 2045. Having set its sights higher, the state faces near-term challenges to meeting its goals, including an interim RPS target of 30% by 2020 and 40% by 2030. To address these challenges, Hawaii is applying lessons learned in the first iteration of its energy transition.

A few years after the Hawaii Clean Energy Initiative's launch, the pace of solar energy adoption surpassed the technical understanding needed to integrate distributed energy resources (DERs) into the existing grid infrastructure and incorporate new technical solutions, such as advanced inverters. Under this dynamic, the interconnection process became a bottleneck for DER adoption and caused significant frustration for customers and DER providers.

What common energy transition challenge or need did the project solve or address?

Market mechanisms (net metering, standard interconnection agreements, feed-in tariffs) designed to encourage distributed generation (DG) growth in Hawaii outpaced initial expectations. As a result, friction arose between customers eager to install solar photovoltaic (PV) systems and utilities concerned about reliable electricity delivery and profitability.

Why is this a common challenge for communities pursuing resilient energy transitions?

When policy changes spur market growth that outpaces the technology and regulatory progress, utilities must confront technological and financial risks associated with striking a balance between integrating increasing levels of renewable generation and maintaining system reliability and bottom line growth.

What key decisions were integral to this project?

- Facing disagreement among energy stakeholders about whether the feed-in tariff program would continue to be part of Hawaii's energy transition, the Public Utilities Commission (PUC) decided to phase out net metering.
- As an interim solution, the PUC adopted a "self-supply" nonexport option that featured a battery/inverter/PV solution the market was not quite ready to supply.
- This, along with an interconnection backlog, contributed to a marked decline in DER adoption beginning in 2013.

How did the community address this challenge or need?

To plan for DER growth and anticipate future limitations of its six islanded grids, Hawaii adopted a two-pronged approach informed by modeling and analysis, including:

- An evolutionary model that included functional and market objectives deemed best suited to support each stage of distribution system evolution, followed by a summary of the key planning, operations, and market functions required to support DER growth as the state progressed toward its 2045 goal
- Hosting capacity studies to quantify the technical limits of each island and circuit to integrate additional distributed solar based on current infrastructure.

Who decided on this course of action and why?

State energy planners proposed the use of a conceptual model for the evolution of distribution systems. Transition partners Hawaii Natural Energy Institute and More Than Smart adapted the model to Hawaii's unique market structure, operational characteristics, and utility specifications, and established appropriate functional objectives.

The PUC mandated the hosting capacity studies to provide a transparent, quantitative basis for understanding current and projected grid limitations.

What key takeaways or lessons learned might benefit other communities?

- In rapidly changing energy markets, analysis and planning are key to striking the delicate balance required to address the competing priorities of various stakeholders in advance of deployment decisions.

- By anticipating functional requirements of the system caused by increasing amounts of DERs, utility investments in planning, operations, and markets can be staged and phased more economically.
- The next growth phase of DER systems will require a more systematic transition to "Smart DER" systems because each island is nearing limitations to add more rooftop PV without advanced capabilities during peak solar hours.

Through the modeling and analysis performed as part of Hawaii's effort to improve processes, regulators, utilities, and other stakeholders are applying lessons learned to address the common challenge of maintaining system reliability and utility health as DG increases with the evolution of the energy transition.

As Hawaii looks ahead to a new growth phase of more advanced DER technologies and increasing the levels of variable renewables, the lessons from this recent experience and best practices from other jurisdictions can be incorporated in future planning efforts.

As other communities seek to strike a balance between maintaining project momentum and ensuring system reliability through process improvements, Hawaii's data-driven approach to process improvements may prove useful.

Resources

Communities transitioning to clean, resilient energy may find these resources useful in Phase 6:

Conduct Closeout Interviews with Project Partners and Stakeholders

Cornell University Project Manager's Desk Guide—A guidebook developed for project managers at Cornell that provides helpful project management templates, including a project closeout checklist.

Project Closeout: Guidance for Final Evaluation of Building America Communities—An NREL guide to the project closeout process based on a real-world example of a comprehensive closeout review of a large project.

Collect Lessons Learned and Identify Skills Development Opportunities

City of Nashua Hazard Mitigation Plan Update 2019—An overview of the planning process and public participation efforts conducted as part of Nashua, New Hampshire's, five-year Hazard Mitigation Plan review that serves as a model for involving community stakeholders and neighboring communities in monitoring plan implementation and collecting lessons learned.

Federal Crowdsourcing and Citizen Science Toolkit—U.S. General Services Administration toolkit comprising five basic steps for planning, designing, and carrying out a crowdsourcing or citizen science project to engage the public in research and data collection and collaboratively access information that might otherwise be out of reach.

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments—A detailed, easy-to-understand process to help local, regional, and state government decision-makers prepare for climate change with climate risk assessment, resilience and adaptation planning, and project implementation and management. Chapter 12 offers guidance on regularly measuring progress, reviewing, and updating plans, and sharing lessons learned.

Solar Under Storm: Select Best Practices for Resilient Ground-Mount PV Systems with Hurricane Exposure—Summary of RMI's recent field observations and expert analysis of solar PV system failures in the wake of Hurricanes Irma and Maria in the Caribbean, including actionable recommendations for increasing resilience of PV installations with hurricane exposure.

Report Results of Review to Management, Project Partners, and the Public

Boulder County Collaborative: CDBG Disaster Recovery—An information hub formed in response to devastating floods to coordinate regional project and program implementation throughout the disaster recovery process; offers one example of continuous reporting on program updates, public hearings, resources, and successes.

Climate Adaptation Knowledge Exchange—A platform for increasing awareness of adaptation opportunities and engaging the broader community to develop the field of adaptation, including climate change adaptation case studies, tools, and resources along with a calendar of conferences and trainings, job and funding opportunities, and a directory of field practitioners and organizations.

Accelerate the Transition

The CARILEC Renewable Energy Community—A community of energy professionals and utility engineers implementing renewable energy and energy efficiency projects on islands for a more sustainable future (login required).

ENERGY TRANSITIONS INITIATIVE

U.S. Department of Energy

The U.S. Department of Energy's Energy Transitions Initiative advances the development of clean, resilient energy systems through partnerships, tools, and resources that empower communities to realize ambitious energy visions.

Cover photo from the Hawaiian Electric Light Company

DOE/GO-102021-5551 • April 2021