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### Title

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### Permalink

<https://escholarship.org/uc/item/05w979zn>

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### Publication Date

2026-01-28

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Building Technologies Department  
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# Strategic Energy Plan

## City of Key West, Florida

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January 2026



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## Acknowledgements

The work described in this study was conducted at Lawrence Berkeley National Laboratory and supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

This report was funded by the U.S. Department of Energy's Energy Technology Innovation Partnership Project (ETIPP). ETIPP is a community-led technical support program for coastal, remote, and island communities to access unique solutions and increase energy resilience. By uniting federal agencies, national laboratories, regional organizations, and community stakeholders, ETIPP provides tailored technical support to help communities achieve affordable reliable solutions to their energy system challenges. This collaborative model leverages the combined expertise and resources of its partners to deliver comprehensive, practical solutions that align with local needs.

The authors would like to acknowledge the valuable guidance and input provided during this report. The authors are grateful to the following list of contributors.

- Alison Higgins, City of Key West
- Sheetal Almas, City of Key West
- Ray Atkinson, City of Key West
- Jake Leech, Southeast Sustainability Directors Network
- Catherine Mercier-Baggett, Southeast Sustainability Directors Network
- Michael Dexter, Southeast Sustainability Directors Network
- Mike Campton, National Laboratory of the Rockies

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## 4 Acronyms and Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEV	battery electric vehicle
BFE	Base Flood Elevation
Btu	British thermal unit
CCMUA	Camden County Municipal Utilities Authority
CVA	climate vulnerability assessment
DC	direct current
DOE	U.S. Department of Energy
EEM	energy efficiency measure
EPA	U.S. Environmental Protection Agency
ESCO	energy services company
ESPC	energy savings performance contract
ETIPP	Energy Technology Innovation Partnership Project
EUI	energy use intensity
EV	electric vehicle
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FKAA	Florida Keys Aqueduct Authority
ft <sup>2</sup>	square feet
HOA	homeowners association
HVAC	heating, ventilation, and air conditioning
IECC	International Energy Conservation Code
IGA	investment grade audit
KEYS	Keys Energy Systems

kW	kilowatt
KWHA	Key West Housing Authority
kWh	kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
LEED	Leadership in Energy and Environmental Design
MaaS	mobility-as-a-service
MW	megawatt
MWh	megawatt-hour
NOAA	National Oceanic and Atmospheric Administration
NLR	National Laboratory of the Rockies
O&M	operations and maintenance
PACE	Property Assessed Clean Energy
PDRRP	Post-Disaster Recovery and Reconstruction Plan
PPA	power purchase agreement
PV	photovoltaic
ROI	return on investment
R-value	thermal resistance
SHGC	solar heat gain coefficient
SPS	secure power supply
SSDN	Southeast Sustainability Directors Network
TOU	time of use
U-value	thermal transmittance

## 5 Executive Summary

This Strategic Energy Plan for the city of Key West, Florida—developed through the U.S. Department of Energy’s Energy Technology Innovation Partnership Project (ETIPP)—outlines a comprehensive strategy to advance the city’s energy vision: to improve energy efficiency and independence using local energy resources to foster long-term resilience. To guide this effort, the plan is structured around four focus areas:

- **Energy efficiency:** Reduce overall energy consumption and utility costs across municipal, residential, and commercial buildings.
- **Local energy generation:** Increase the share of energy produced from local sources to enhance energy independence.
- **Resilience:** Strengthen critical infrastructure and community preparedness for flooding, hurricanes, and other natural weather hazards.
- **Electric transportation:** Support the addition of new electric vehicles (EVs) and develop reliable charging infrastructure to reduce reliance on imported fuels.

ETIPP provides strategic energy planning, technical assistance, and direct funding to U.S. coastal, remote, and island communities to improve energy resilience. Key West was part of ETIPP’s fourth cohort. As a low-lying island community vulnerable to infrastructure damage due to natural weather hazards, Key West seeks to reduce its dependence on external energy and build long-term sustainability. The Strategic Energy Plan identifies specific challenges, sets clear goals, and proposes actionable opportunities with implementation timelines and key stakeholders. A baseline assessment reveals significant energy consumption in both city-owned and residential/commercial buildings, limited local energy generation, and an early-stage EV market with vulnerable charging infrastructure. The proposed solutions emphasize a multifaceted approach, leveraging both established and innovative technologies, while addressing financial, technical, and community engagement challenges.

The baseline assessment provided a snapshot of current energy conditions in Key West, evidencing key challenges and opportunities across the city’s energy priorities. Building on the baseline assessment and extensive input from city staff, local stakeholders, and community partners, a set of targeted opportunities was identified to address Key West’s energy goals. Each was evaluated in terms of its potential benefits, key implementation steps, associated challenges and mitigation strategies, and the city departments and stakeholders best positioned to lead or support progress.

### Energy Efficiency in City Buildings

- **Baseline condition:** The City of Key West owns approximately 100 buildings, with 41% built before 1974. The city spent more than \$3 million on water and electricity during Fiscal Year 2023 (October 1, 2022 to September 30, 2023). High-energy consumers include the Police and Fire Station #1 compound and City Hall, which is highly energy inefficient with an ENERGY STAR score of 30 on a scale of 1–100. The city is pursuing an energy savings performance contract to upgrade major facilities.

- **Summary of opportunities:** Operational improvements can yield major savings in city-owned buildings. These actions strengthen internal capacity and reduce utility costs without requiring major capital for upgrades. Three near- to short-term strategies were identified:
  - Training facility managers on energy-efficient operations and system-specific maintenance
  - Implementing structured preventive maintenance programs to extend equipment life and reduce emergency repairs
  - Promoting low-cost energy management practices using timers, sensors, and employee engagement.

### Energy Efficiency in Residential and Commercial Buildings

- **Baseline condition:** The residential building sector is the largest electricity consumer in the city, averaging more than 10,000 megawatt-hours monthly. Single-family homes, which comprise 95.5% of residential buildings, have a monthly mean energy use intensity of 1.13 kilowatt-hours per square foot (kWh/ft<sup>2</sup>), significantly higher than the Florida state average of 0.72 kWh/ft<sup>2</sup>, indicating substantial potential for efficiency improvements.
- **Summary of opportunities:** Retrofit strategies targeting single-family homes focus on weatherstripping and air sealing, duct sealing, shading devices, raised floors (with and without insulation), appliance upgrades, and impact-resistant, energy-efficient windows. Many of these upgrades are low-cost and can be bundled with home elevation projects to reduce disruption and construction costs. Simulation results of a typical Key West single-family house show combining these measures can reduce annual electricity use by up to 35% in older homes and 20% in newer homes, with annual savings of up to \$880 per household. At the time of writing, rebates from Keys Energy Services (KEYS)<sup>1</sup> and Property Assessed Clean Energy (PACE)<sup>2</sup> financing options were available, but they applied only to certain energy efficiency measures.

### Local Energy Generation

- **Baseline condition:** Solar energy generation remains limited across the city, with 702 solar accounts totaling approximately 3.7 megawatts of installed capacity as of early 2024. Most of this capacity is at U.S. Navy facilities, installed on housing operated by a third-party contractor. Only two city buildings have solar photovoltaic (PV) systems: the Frederick Douglass Community Center (28.2 kilowatts [kW]) and Glynn Archer City Hall (70.6 kW).

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<sup>1</sup> Rebates from KEYS available at <https://www.keysenergy.com/resources/rebate-program>.

<sup>2</sup> Property Assessed Clean Energy: <https://www.pacenation.org/what-is-pace/>.

- **Summary of opportunities:** Although residential solar adoption in Key West is limited, the city has strong solar potential and high electricity rates that make rooftop PV systems an attractive investment. For example, a 6-kW PV system could supply approximately 27% of the annual electricity needs of a typical historic home and up to 37% for a more efficient newer home. With storage,<sup>3</sup> these systems could also provide backup power during grid outages—an increasingly valuable feature in a hurricane-prone region. To expand residential adoption, the plan also illustrates rooftop solar systems with the option of battery-free backup configurations—such as secure power supply inverters or hybrid systems with manual transfer switches—for residents who wish to avoid the cost and complexity of batteries. Although these technologies can provide limited backup power during outages and offer resilience benefits, they come with important constraints, such as limited power output, reliance on solar availability, and incompatibility with existing inverters and electrical infrastructure.

## Resilience

- **Baseline condition:** Key West has developed a Post-Disaster Recovery and Reconstruction Plan and a Climate Vulnerability Assessment. The new Frederick Douglass Community Center serves as a resilience hub, equipped with a rooftop PV system and a generator and designed to withstand hurricanes.
- **Summary of opportunities:** Opportunities to enhance resilience in Key West prioritize the protection of critical infrastructure and continuity of essential services during hurricanes, flooding, and power outages. For water and wastewater systems, solar-plus-storage installations can ensure autonomous operation when the grid goes down, reducing reliance on diesel generators and enhancing public health and safety. Utility infrastructure upgrades—such as replacing aging wooden poles with steel alternatives, elevating substations, and reinforcing vulnerable assets—are essential to minimize storm-related outages and accelerate recovery. In parallel, smart grid technologies and demand response programs can improve system flexibility and reliability by enabling real-time load management and consumer participation. KEYS has already taken important steps in this direction through its deployment of time-of-use pricing and metering infrastructure.

## Electric Transportation

- **Baseline condition:** As of early 2024, only 285 EVs were registered in Key West. Although there are approximately 21 networked EV charging stations, many are in flood-vulnerable repetitive loss areas, highlighting long-term resilience concerns.
- **Summary of opportunities:** A four-part strategy is proposed to advance electric transportation in Key West by addressing both access and infrastructure challenges:

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<sup>3</sup> More information on solar energy and storage basics can be found here: <https://www.energy.gov/eere/solar/solar-integration-solar-energy-and-storage-basics>.

- Support for private charger installations can help expand access in multifamily buildings and workplaces, particularly through KEYS' rebate program and targeted efforts to reduce installation barriers.
- The creation of mobility hubs that integrate EV charging, bike-share, and public transit will promote multimodal travel and reduce reliance on personal vehicles.
- Expanding the public charging network with fast chargers in flood-resilient locations—through partnerships with private property owners and municipal sites—will increase access and convenience, with an emphasis on technical reliability, appropriate deployment, and streamlined permitting.
- Incentive programs could lower the upfront costs of EVs and e-bikes, particularly for income-qualified residents. For e-bikes, careful consideration of local regulations and safety measures should be made before offering any incentives, with managing their safe growth on the island as a key focus. This opportunity is a secondary priority and would require additional studies to assess its effectiveness and guide the allocation of resources.

### **Community Workshops**

Community engagement played a critical role in shaping Key West's energy strategy, with a strong emphasis on in-person dialogue and local input. The first workshop, held in January 2025, brought together city staff across departments and other relevant stakeholders to explore the city's energy goals across the four key areas. Their input helped shape the specific opportunities and implementation strategies assessed throughout the project. The second workshop, held in June 2025 at the Frederick Douglass Community Center, followed an open-house format with informational posters and subject matter experts available for one-on-one conversations. Participants shared feedback directly on the materials, expressing strong interest in expanding access to solar and implementing practical energy efficiency upgrades such as LED lighting, air sealing, and insulation. There was also broad support for public outreach to homeowner associations, improved permitting processes, and education on solar financing and storm resilience.

### **Community Survey**

A citywide survey complemented these in-person events and gathered responses from residents across various housing types and neighborhoods. Respondents reported widespread adoption of basic energy-saving measures and strong interest in further upgrades. Solar energy received broad support, although many noted challenges related to cost, property eligibility, or homeowners association restrictions. On resilience, 70% of respondents said they would "definitely" or "possibly" use a community resilience hub after an emergency and suggested future hub locations based on accessibility and neighborhood needs. Views on electric transportation were mixed, with nearly half of respondents planning to purchase an EV, whereas others raised concerns about cost, charging access, or prioritization. Overall, resilience emerged as the community's highest priority, followed by local energy generation and energy efficiency.

### **Strategic Next Steps**

The baseline assessments, improvement opportunities, and community engagements presented in this report outline several critical actions the City of Key West can take to become more energy efficient and resilient, including enhancing the city's critical infrastructure for resilience, reducing energy use and utility costs of buildings, increasing local energy generation from PV, and improving access to electric transportation infrastructure. It is suggested the city further explore these investment opportunities as the next step to support the city's energy vision. As a follow-up collaboration motivated by the City of Key West, four project ideas were proposed for a potential Deep Dive project under ETIPP.

## 6 Background

The Energy Technology Innovation Partnership Project (ETIPP) provides strategic energy planning, in-depth technical assistance, and direct funding to U.S. coastal, remote, and island communities to improve their energy resilience. ETIPP is funded by the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy. The program is supported by a network of four national laboratories and nine regional partner organizations that provide modeling, analysis, capacity building, education, and regional insight to support communities in developing secure, reliable, and affordable energy systems. The National Laboratory of the Rockies (NLR), Lawrence Berkeley National Laboratory (LBNL), and the Southeast Sustainability Directors Network (SSDN) partnered with Key West, Florida, to provide technical assistance as part of ETIPP's fourth cohort of communities (Figure 1).

Key West is a low-lying island city at the southern tip of Florida, covering 4.27 square miles with an average elevation of 4.7 feet. Surrounded by the Atlantic Ocean and the Gulf of Mexico, the city is highly exposed to flooding risks, including sea level rise, storm surge, tidal flooding, and extreme rainfall. As a geographically isolated community at the end of a 100-mile-long archipelago, Key West residents have developed a strong resilience mindset, shaped by past hurricane events and periods of isolation. To address ongoing energy challenges on the island, the City of Key West applied to participate in the ETIPP program. This report summarizes the project's outcomes, including an overview of existing energy use and conditions on the island, as well as the key opportunities and pathways to help Key West achieve its energy goals.



Figure 1. Location of ETIPP Cohort 4 communities

### 6.1 Laboratories and Regional Partners

Brief introductions to the participating partners are provided next.

**National Laboratory of the Rockies:** NLR is a DOE, Office of Energy Efficiency and Renewable Energy laboratory that focuses on security and reliability. NLR leads energy

systems innovation and integration—enhancing existing technologies and developing new, cutting-edge solutions that unlock economic opportunity and fuel America's global competitiveness. NLR's role was to coordinate the communication efforts of the ETIPP partners and selected communities throughout the entire project time frame.

**Lawrence Berkeley National Laboratory:** LBNL is a DOE Office of Science national laboratory located in Berkeley, California. As a partner on ETIPP, LBNL offered its expertise in energy efficiency, energy reliability, and energy affordability in buildings and urban environments. LBNL was the lead laboratory providing technical support to Key West.

**Southeast Sustainability Directors Network:** SSDN is a collaborative network of local government sustainability professionals dedicated to advancing sustainability initiatives in the Southeastern United States. SSDN is one of two ETIPP Regional Partners for the Gulf Coast Region. ETIPP Regional Partners serve as conduits between communities and the national laboratories and act as advocates for those communities. SSDN provided regional context, connected the national laboratories to local and regional parties, and helped the laboratories communicate with the communities.

## 6.2 Challenges

Key West faces critical resilience challenges, including flooding, sea level rise, weather hazards, and economic vulnerabilities. Its geographic isolation makes the city heavily dependent on the mainland for electricity, water, goods, fuel, and services, leaving it vulnerable to supply disruptions. Monroe County, where Key West is located, is among the most vulnerable counties in the United States to population displacement caused by rising sea levels (Monroe County 2021).

The oldest houses on the island are typically located on higher ground, outside designated flood hazard zones. In contrast, many of the city's residential and commercial buildings built after World War II have floor elevations below the Federal Emergency Management Agency (FEMA) Base Flood Elevation (BFE), ranging from 6 to 13 feet NAVD88 (North American Vertical Datum of 1988). In 2019, FEMA released preliminary Flood Insurance Rate Maps (FEMA n.d.) with updated flood zone boundaries and higher BFEs. The city has challenged FEMA's maps and is awaiting a decision. Once finalized, these maps will affect flood insurance costs and influence design standards citywide. Several coastal neighborhoods—especially along the southern Atlantic shoreline—have faced repeated flooding in recent years, resulting in some of the highest rates of repetitive loss per capita in Florida. Repetitive loss properties are insurable buildings that have had at least two claims of more than \$1,000 paid by the National Flood Insurance Program within 10 years. In 2021, there were 180 repetitive loss buildings in Key West, with 12 of those considered “severe” (City of Key West 2021).

Aside from natural hazard concerns, the city struggles with housing and labor shortages because nearly 50% of residences are used as second or third homes, making affordable housing scarce for workers and further constrained by the island's limited space. The workforce crisis has deepened, with Key West losing almost 2,000 workers during the COVID-19 pandemic (March 2020 to May 2021), further straining the local economy. Sustainability efforts remain limited, with minimal solar power adoption, low recycling participation (only 50% of businesses recycle), and heavy reliance on waste hauling rather than local circular economy solutions. These challenges reduce the city's capacity to maintain and upgrade critical energy infrastructure, making resilience planning even more urgent.

In addition to these challenges, Key West's aging and inefficient building infrastructure presents a major obstacle. Many city-owned buildings are outdated, with 90% in need of energy upgrades and 41% built before Florida's 1974 building code. As a result, the city spends more than \$3 million annually on water and electricity, highlighting the urgent need for efficiency improvements. However, the Resiliency Division is underfunded, with no dedicated funding for energy audits or implementing building upgrades. A recent lighting retrofit at the police station took an entire year, demonstrating the challenges of completing even small-scale energy improvements.

Further compounding these issues, limited resources and funding make infrastructure upgrades difficult. The few local contractors available are already heavily engaged with island-based residential projects, leaving little capacity for municipal or large-scale energy improvements. Hiring workers from the mainland increases costs because of Key West's high cost of living and lack of temporary housing. With limited local resources and high costs, workforce shortages and infrastructure challenges are further strained. Addressing these interconnected challenges will require strategic planning, workforce development, financial investments, and expanded sustainability initiatives to enhance Key West's long-term resilience.

## 7 Key West Energy Vision

Key West’s vision was defined as “Improve energy efficiency and independence using local energy resources to foster long-term resilience.” This vision reflects the city’s commitment to reducing reliance on external energy sources while enhancing sustainability, resiliency, and preparedness for future challenges with a focus on cost-conscious, efficient solutions.

To achieve this, four focus areas were identified for improvement, targeting specific challenges (Table 1 **Error! Reference source not found.**):

- Energy efficiency, to reduce overall energy consumption and costs without compromising comfort or functionality
- Resilience, to strengthen infrastructure and adaptability to natural weather hazards
- Local energy generation, to expand the use of local resources such as solar power, and to foster energy independence
- Electric transportation, to support more sustainable mobility solutions and incremental independence.

This ETIPP Strategic Energy Plan is intended to inform and support the development of the city’s 10-Year Energy Resiliency and Cost Savings Plan, under development as of July 2025. Although the 10-Year Plan will ultimately define specific projects, funding needs, and grant opportunities to enhance resilience, energy, water, and cost savings, this document provides foundational analyses, strategic guidance, and potential opportunities to help shape that process. The vision and goals outlined here are aligned with those of the forthcoming 10-Year Plan, but this document should be understood as a technical and strategic input—not a substitute for the city’s formal planning document.

**Table 1. Key West’s challenges, focus areas, and goals**

Challenges	Focus Areas	Goals
Flooding, sea level rise, weather events, and power outages	Resilience	Strengthen critical infrastructure and community preparedness to ensure reliable services during and after weather hazards
Inefficient buildings	Energy efficiency	Reduce energy consumption and utility costs through building upgrades, efficient technologies, and appropriate access to retrofit programs
Cost of living and affordable housing		
Reliance on mainland resources	Local energy generation	Expand local energy sources, such as solar, to enhance energy independence and ensure reliable power for essential services
	Electric transportation	Promote the use of electric vehicles and support infrastructure to reduce dependence on imported fuels

## 8 Baseline Assessment

The baseline assessment seeks to collect data and understand the current energy and infrastructure conditions in Key West across each of the previously identified focus areas.

### 8.1 Energy Efficiency

This area focuses on investigating the energy efficiency of buildings in Key West, which was split between 1) city-owned buildings and 2) residential and commercial buildings.

#### 8.1.1 City Buildings

The city of Key West owns approximately 100 buildings and structures, ranging in size from a small 64-square-foot (ft<sup>2</sup>) sailing club to the 24,300-ft<sup>2</sup> police station. Among these, 23 buildings hold historic significance, either listed on the National Register of Historic Places or classified as contributing structures. Although the city operates some buildings directly, 53 are not city operated, and 47 of these 53 are leased to various retail businesses, restaurants, and nonprofits. In addition, six buildings are under contract for essential services, including solid waste management, wastewater treatment, and the Keys Overnight Temporary Shelter.

A significant portion of the city's structures predates modern standards: 41% were built before 1974, predating Florida's first statewide minimum building code, whereas another 41% were constructed between 1974 and 2002. Only 18% of the city's buildings were built after 2002, meaning most structures may not fully meet the most recent hurricane-resistant building standards, highlighting the importance of resilience-focused upgrades.

Figure 2 shows the monthly electricity consumption of 34 city-owned buildings in 2023, with the top 15 largest consumers highlighted in different colors. The consumption of the remaining 19 buildings is aggregated and shown in gray. These 34 buildings are registered in the U.S. Environmental Agency's Portfolio Manager,<sup>4</sup> where the city maintains updated information—although the city owns additional buildings not included in this tool. The Roosevelt Police and the Fire Station #1 stand out with the highest consumption, although it should be noted that such consumption serves two separate buildings that are connected to the same energy meter. The Roosevelt Police is a two-story building with a gross floor area of 24,768 ft<sup>2</sup> built in 2002. Fire Station #1 was built in 1997 with 11,489 ft<sup>2</sup> in a single floor and was significantly renovated in 2017. City Hall was built in 1923 and significantly renovated during its conversion from a school into the City Hall in 2016. It has 37,757 ft<sup>2</sup> divided into two floors and is responsible for the second largest consumption. On a scale from 1 to 100, its ENERGY STAR<sup>5</sup> score is 30, indicating it is much less efficient than most similar buildings. Although the building achieved Leadership in Energy and Environmental Design (LEED) Platinum certification<sup>6</sup> under the 2009 rating system, this may no longer reflect current performance expectations. Possible contributing factors to the low ENERGY STAR score include outdated sensors or controls not

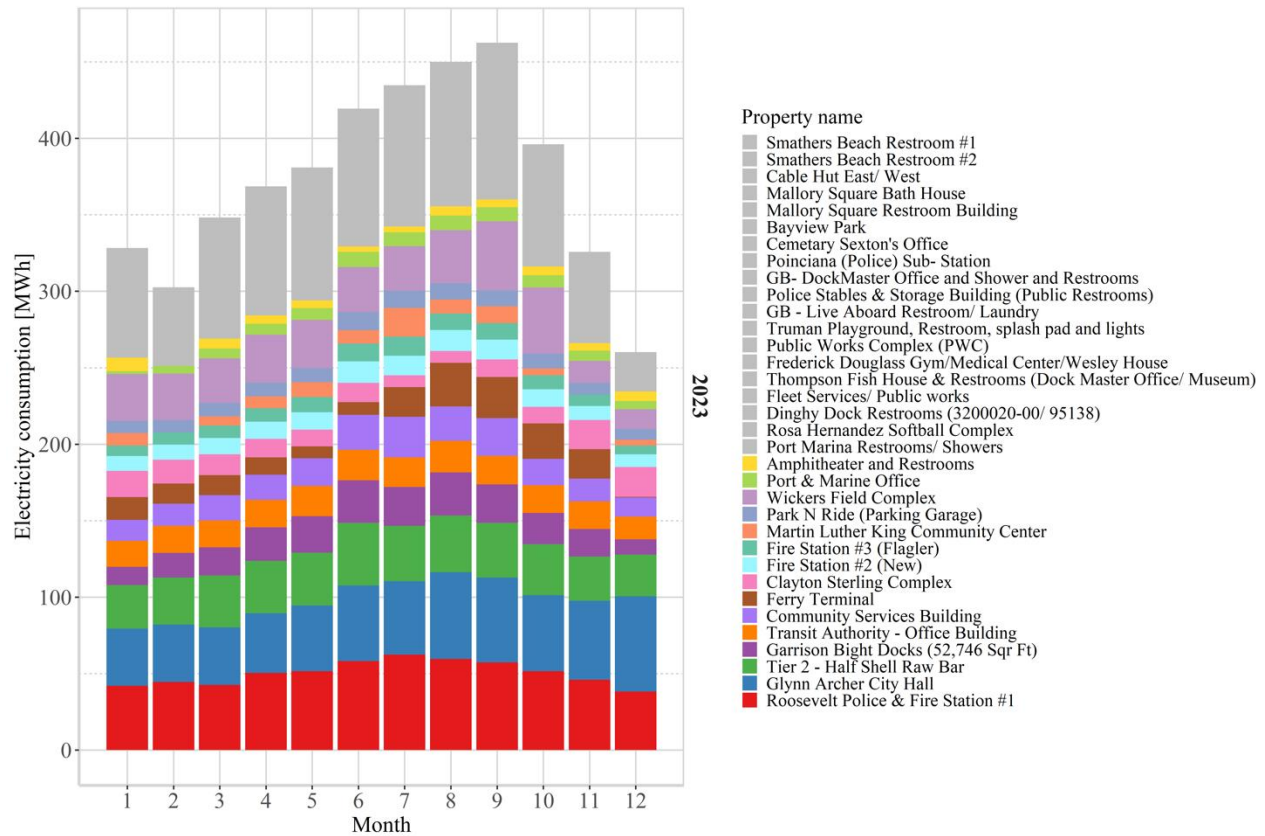
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<sup>4</sup> Portfolio Manager is a resource management tool to benchmark the energy use of buildings. More information can be found at <https://www.energystar.gov/buildings/benchmark>.

<sup>5</sup> <https://www.energystar.gov/buildings/benchmark/understand-metrics/how-score-calculated>.

<sup>6</sup> LEED is a globally recognized green building certification program that rates buildings on sustainability and efficiency. More information can be found at <https://www.usgbc.org/leed>.

being fully used, aging equipment, deferred maintenance, or staff not being fully trained to operate the technologies installed during the renovation.



**Figure 2. Monthly electricity consumption of 34 city-owned buildings in 2023 with the top 15 consumers highlighted in different colors**

*MWh = megawatt-hours*

Besides these top consumers within the city buildings, the monthly electricity consumption from municipal city lighting varied between 48 MWh (around summertime) and 81.7 MWh (around wintertime) from October 2022 to September 2023. Average monthly consumption is 59.5 MWh, which would be in similar magnitude to the main consumer shown in Figure 2. As they burn out, the sodium vapor lights are being upgraded to light-emitting diode (LED) by Keys Energy Systems (KEYS). Although the upgrade comes at no cost to the city, the slow replacement rate means it could take several years to fully transition all streetlights.

The wastewater treatment plant represents another major consumer, with an annual energy cost approaching \$1 million. The Richard A. Heyman Environmental Pollution Control Facility in Key West, operated by Jacobs, treats wastewater to advanced standards and then discharges the effluent to an on-site deep injection well. Recent upgrades totaling more than \$67 million enhanced both system efficiency and reliability (City of Key West n.d.).

The City of Key West staff hopes to use an energy savings performance contract (ESPC)<sup>7</sup> to implement energy efficiency upgrades across its municipal buildings. An ESPC allows the city to partner with an energy services company (ESCO) to identify, implement, and finance energy-saving measures without requiring upfront capital investment. The project is divided into three phases:

- **Phase 1: Investment grade audits (IGAs).** An ESCO will perform detailed audits on high-priority city buildings to assess existing energy usage, identify potential improvements, and estimate cost savings.
- **Phase 2: Implementation.** Based on the IGA findings, the city will select and implement a package of energy efficiency upgrades (such as LED lighting; heating, ventilation, and air conditioning [HVAC] improvements; and efficient appliances) in those buildings.
- **Phase 3: Monitoring.** The ESCO will track and verify the energy savings post-implementation to ensure the expected performance outcomes are met.

Besides structural and retrofitting strategies, the city has significant opportunities to enhance energy efficiency in its buildings through improved operations and maintenance (O&M) practices. Potential actions include training facility managers on energy-efficient operations, implementing proactive maintenance schedules such as regularly sealing duct leaks, launching employee engagement initiatives to encourage turning off unused lights and equipment, and establishing clear policies for managing office appliances and equipment more efficiently.

### 8.1.2 Residential and Commercial Buildings

A large portion of Key West’s housing stock comprises older, single-family homes built with concrete block construction on slab foundations along with some elevated wood-frame structures. The area also includes multifamily residences and mobile homes. Several buildings are listed as historic landmarks or recognized as historically significant.

Housing affordability for service-sector workers remains the most urgent housing challenge in Key West. This population is particularly vulnerable to storm surge impacts, and many chose not to return following past hurricanes. Rising insurance costs are expected to further worsen affordability in the years ahead (City of Key West 2021).

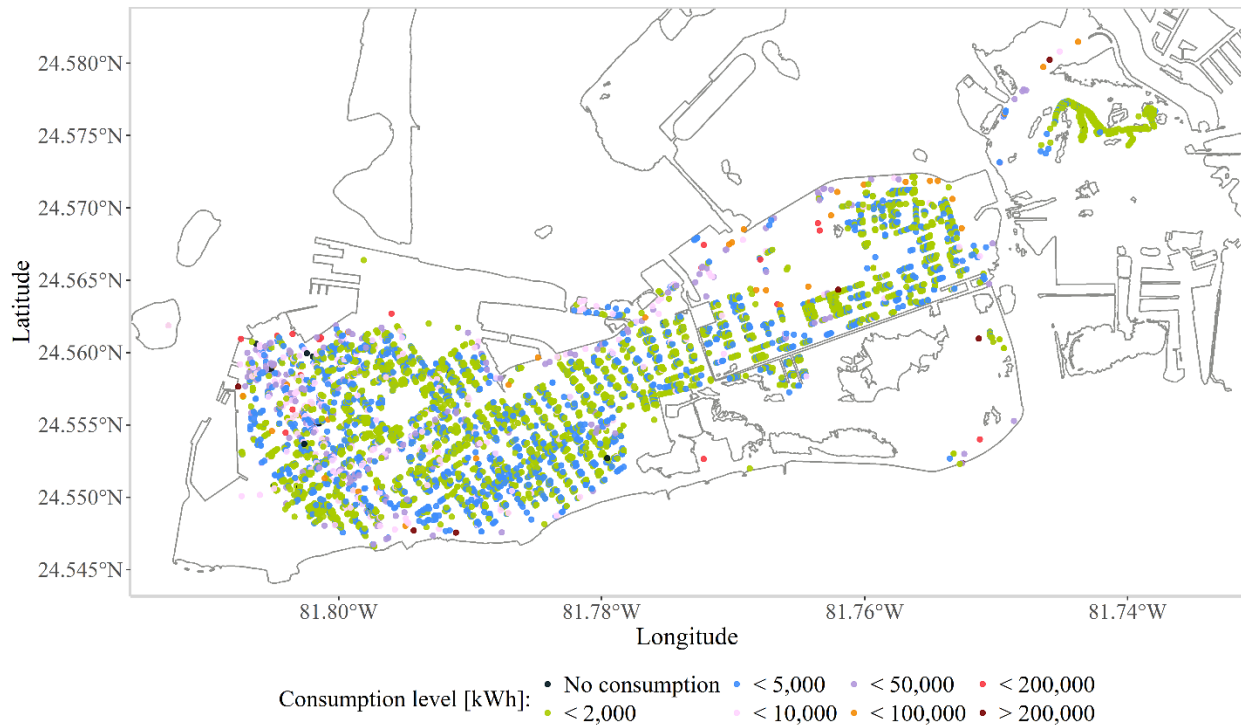
The City of Key West is actively addressing its affordable housing shortage by planning the development of 200–500 new workforce housing units. Efforts include identifying appropriate sites; aligning projects with updated floodplain maps; and partnering with stakeholders such as the Key West Housing Authority (KWHA), private developers, and the county. The city is also exploring code amendments to incentivize accessory dwelling units and assessing the potential for multifamily housing on city-owned land. In addition, it is engaging with military and commercial property owners for future housing opportunities. To preserve existing affordable housing, the city is supporting KWHA’s Physical Needs Assessment plan, facilitating updates to

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<sup>7</sup> Details on federal energy savings performance contracts can be found at <https://www.energy.gov/femp/about-federal-energy-savings-performance-contracts>.

zoning and density regulations, and assisting Habitat for Humanity’s repair program<sup>8</sup> for elderly and financially vulnerable residents (Elisa Levy Consulting and City of Key West 2021).

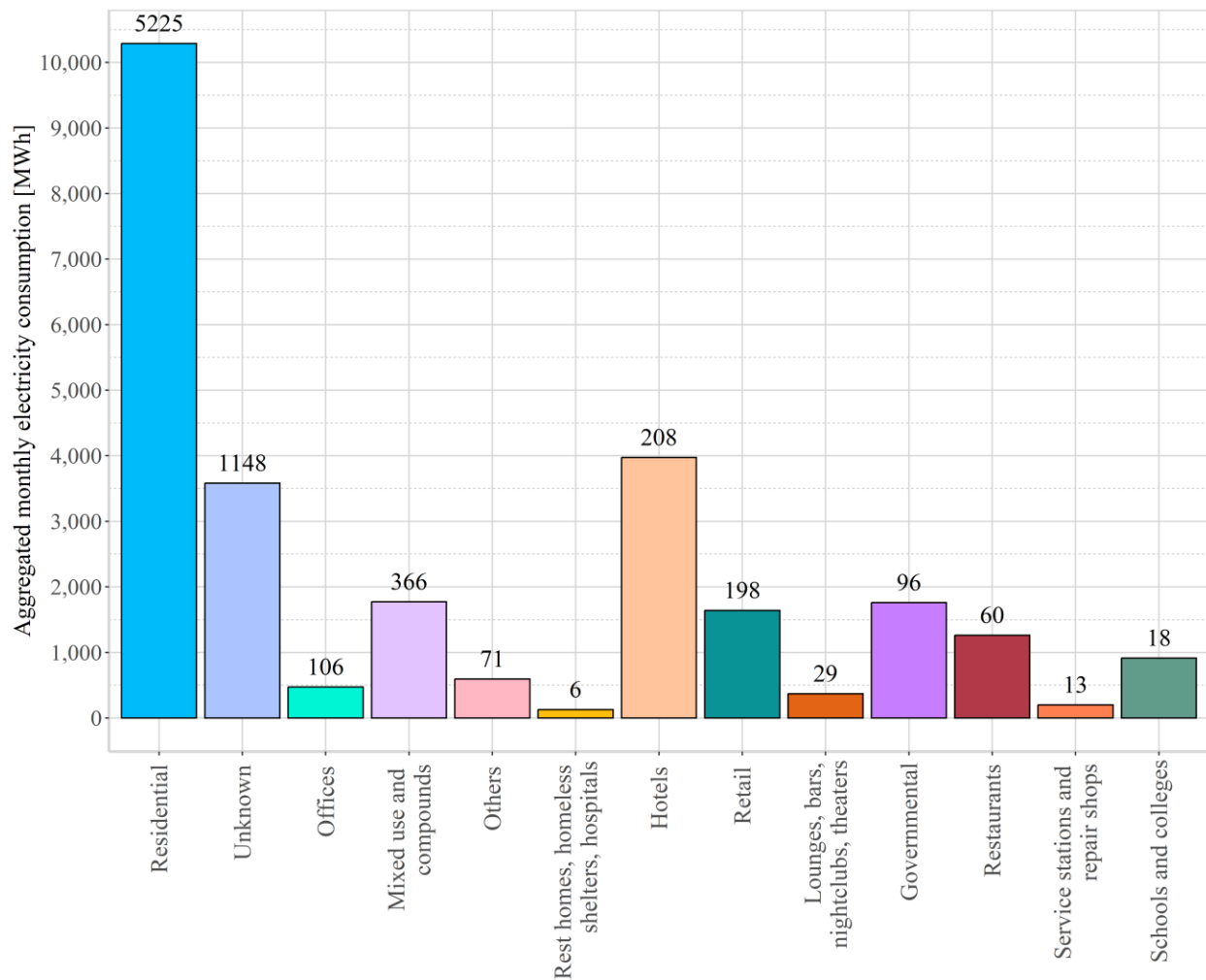
Figure 3 maps the average monthly electricity consumption at various addresses within the city, with values divided between seven consumption levels—buildings averaging less than 2,000 kilowatt-hours (kWh)/month up to those averaging more than 200,000 kWh/month. These results originate from a sample of 7,544 unique addresses whose consumption and specific characteristics were provided by KEYS and Monroe County Property Appraiser Office. It should be noted that often, more than one meter and/or building are located within each address. Consequently, the number of buildings represented herein is larger than 7,544—although the exact quantity could not be determined with the available data.



**Figure 3. Average monthly electricity consumption map**

Figure 4 shows the average monthly electricity consumption from various building types in the city, with the values on top of each bar corresponding to the number of individual buildings included in each category. The residential sector is the largest consumer of electricity in the city, averaging more than 10,000 MWh per month because of the large number of residential buildings. Another important sector is hotels, which account for only about 2.76% of all buildings yet consume approximately 4,000 MWh of electricity each month. In addition, there are 1,148 buildings whose types are uncharacterized in the Monroe County Property Appraisers database; these buildings may either belong to existing categories or represent entirely new classifications.

<sup>8</sup> More about Habitat for Humanity’s repair program can be found here: <https://www.habitat.org/volunteer/near-you/home-preservation>.



**Figure 4. Average total monthly electricity consumption by building type**

Although restaurants in this sample do not represent a top consumer category in terms of aggregate energy use, individual restaurants have the highest median monthly consumption among all building types—slightly more than 12,500 kWh/month (see Figure 5). Monthly electricity consumptions of schools and colleges vary significantly because of the significant variation of building sizes within this same category.

Of the 5,225 residential buildings, 95.5% (4,992) are single-family buildings, which represents a significant portion of the building stock. Consequently, initiatives to improve energy efficiency in these buildings would significantly reduce citywide energy demand while enhancing affordability. To facilitate comparison, Figure 6 presents the distribution of average monthly energy consumption for single-family residential buildings, normalized by their floor area (i.e., energy use intensity). The mean energy consumption of these buildings is 1,742 kWh/month in Key West, with a mean floor area of 1,540 ft<sup>2</sup>. For reference, similar buildings across the state of Florida consume 1,166 kWh/month on average and have around 1,623 ft<sup>2</sup> (U.S. Energy Information Administration 2023). This leads to 1.13 kWh/ft<sup>2</sup> monthly for homes in Key West

compared to 0.72 kWh/ft<sup>2</sup> monthly across Florida—a difference of about 57%—highlighting important potential for improved energy efficiency.

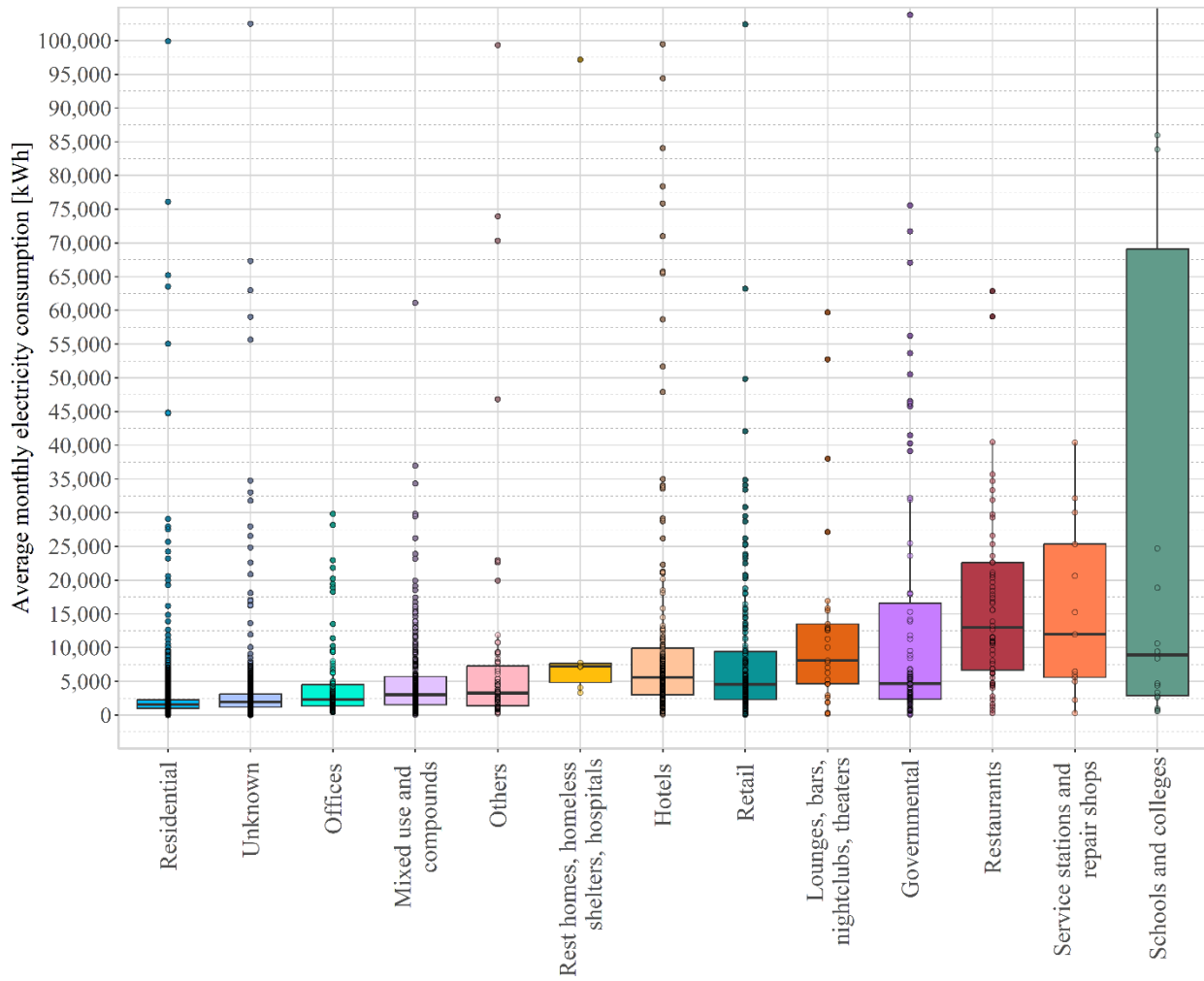
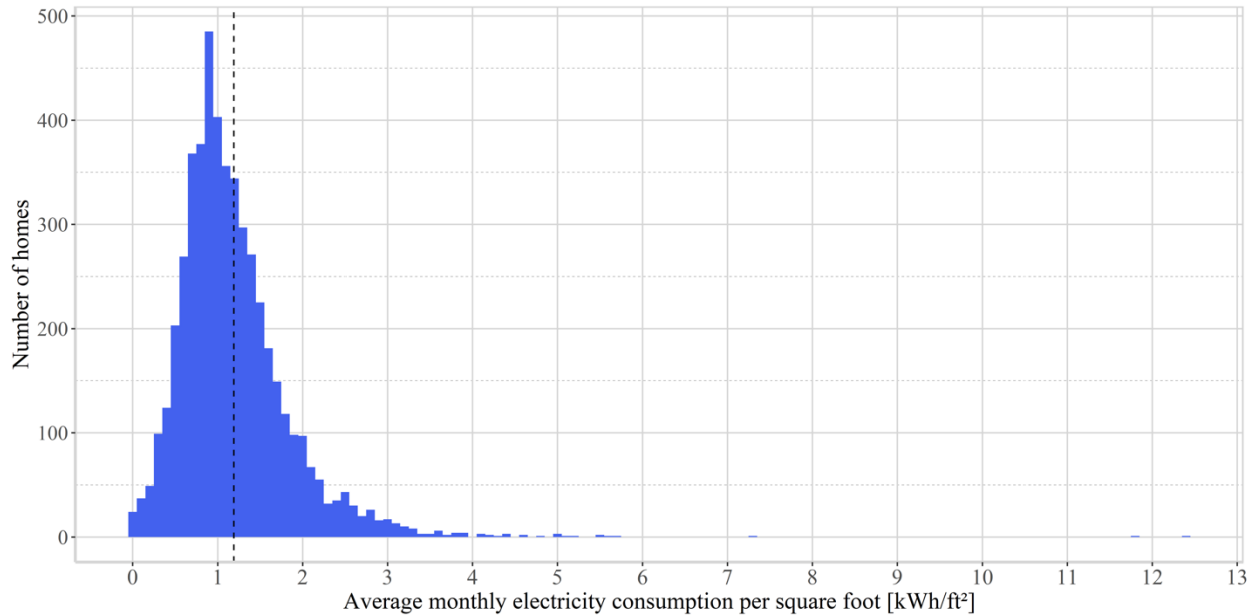


Figure 5. Average individual building’s monthly electricity consumption distribution by building type



**Figure 6. Average monthly energy use intensity distribution for single-family homes**

## 8.2 Resilience

The City of Key West has undertaken a comprehensive effort to understand its challenges and foster resilience throughout the years. In 2021, Key West published its first Post-Disaster Recovery and Reconstruction Plan (PDRRP) (City of Key West 2021), outlining strategies to recover from and mitigate future disasters. The plan addresses vulnerabilities such as aging infrastructure, sea level rise, and flooding, proposing solutions across nine focus areas: procurement, land use and buildings, transportation, infrastructure, funding, economy, environment, communications, and housing. It establishes roles and responsibilities for various city departments and external stakeholders, including a Recovery Task Force and Adaptation Planning Team.

The 2024 Stormwater Master Plan Update for the City of Key West (Mitchell Lee Griffin and Jacobs Engineering Group Inc. 2024) provides a comprehensive strategy to reduce flooding and enhance resilience to sea level rise over the next 30 years. Developed in two phases, the plan uses updated hydrologic and hydraulic models to simulate flood conditions, assess infrastructure needs, and guide the design of future stormwater projects. Key components include evaluating flood-prone areas, incorporating updated sea level rise projections, and designing conceptual projects that integrate gravity-based systems and large-scale pump stations.

The City of Key West conducted a climate vulnerability assessment (CVA) in 2024 to identify current and future flood risks to critical infrastructure, public services, and historic assets in the city, using modeling based on sea level rise, storm surge, tidal flooding, and extreme rainfall. Funded by the Florida Department of Environmental Protection, the CVA complies with Section 380.093 of Florida statutes and supports eligibility for infrastructure funding through the Resilient Florida Grant Program (Florida Department of Environmental Protection n.d.). The CVA evaluates more than 4,700 assets across 11 high-risk areas and considers National Oceanic and Atmospheric Administration (NOAA) 2017 sea level rise projections—specifically the intermediate-low and intermediate-high scenarios—for 2040, 2070, and 2100. It incorporates

geographic information system analysis, stakeholder input, and data from NOAA and FEMA to rank vulnerabilities and inform adaptation strategies. The CVA lays the groundwork for an adaptation plan to increase community resilience through policy, infrastructure, and funding efforts.

After nearly a decade of efforts to secure funding, the new Frederick Douglass Community Center (Figure 7) in Bahama Village was completed in 2025 after just 17 months of construction. Located at 101 Olivia Street behind the historic Frederick Douglass Gym, the \$8 million facility includes classrooms for after-school tutoring, a 2,600-ft<sup>2</sup> event hall, a commercial kitchen, rehearsal and music rooms, and an outdoor courtyard. The center will support a variety of community initiatives, including the Bahama Village Music Program, which offers free music, theater, and vocal instruction to local youth. In addition, the facility is designed to operate as a resilience hub, providing critical support following emergencies such as hurricanes, and during incidents such as power outages or infrastructure failures.

The PDRRP defines resilience hubs as enhanced community facilities that support residents and coordinate resources after disruptions such as hurricanes, pandemics, or infrastructure failures. These hubs are designed to address a range of community needs. Beyond emergency response, they serve as trusted sources of information, foster community connections, and contribute to broader goals such as improving quality of life and revitalizing neighborhoods.

The resilience hub in Bahama Village is already equipped with key features including a 28.2-kilowatt (kW) rooftop solar photovoltaic (PV) system (with an estimated annual savings of \$7,400), a diesel-based generator with 4–6 days of fuel, two shower areas, and a kitchen with food storage and cooking facilities; it is elevated 2.5 ft above flood level and built to withstand 180 mph wind speeds. These features ensure it can remain functional during and after a disaster.

A second phase of the project will further enhance its resilience capabilities. Planned improvements include hardening and repainting the historic Douglass Gym, replacing and repairing the gym floor and substructure, upgrading the generator’s electrical tie-in and backup air conditioning units, and improving communications systems through bidirectional amplifier (BDA), and communication on wheels (COW) technologies. The plan also includes above-ground water collection and on-site freshwater generation to further support long-term emergency operations. City officials and community leaders have acknowledged the facility as a long-term investment in the safety, well-being, and resilience of the neighborhood.



**Figure 7. Frederick Douglass Community Center**

*Photo courtesy of Karen Wilman, Community Redevelopment Agency Manager, City of Key West*

### 8.3 Local Energy Generation

Local solar energy generation in Key West remains limited. At the city level, only two buildings are equipped with solar PV systems. The Frederick Douglass Community Center has a 28.2-kW system (Figure 8, left). Glynn Archer City Hall operates a 70.6-kW array (Figure 8, right), which generated approximately 102 MWh in 2024 and covered 13% of the building's annual energy needs.



**Figure 8. PV panels installed in the Frederick Douglass Community Center (left) and Glynn Archer City Hall (right)**

*Left photo courtesy of Karen Wilman, City of Key West; right photo by TLC Engineers, courtesy of Bender & Associates Architects*

At the broader community scale, 702 solar accounts were registered as of 2024, totaling approximately 3.7 megawatts (MW) of installed capacity. Much of this capacity is located at U.S. Navy facilities, installed on housing operated by a third-party contractor—indicating residential and commercial adoption of solar energy remains relatively low. In 2024, citywide solar energy systems generated an estimated 5,336 MWh. This total reflects only systems equipped with production meters installed before February 2024. KEYS discontinued the requirement for these dedicated production meters, so energy output from systems installed after that date—including 11 new accounts with a combined capacity of 109 kW—is not currently tracked.

### 8.4 Electric Transportation

As of early 2024, there were 285 registered<sup>9</sup> electric vehicles (EVs) in the Key West ZIP Code 33040. Battery electric vehicles (BEVs) comprise the majority with 209 registrations (73.3%), whereas plug-in hybrid electric vehicles account for the remaining 76 vehicles (26.7%).

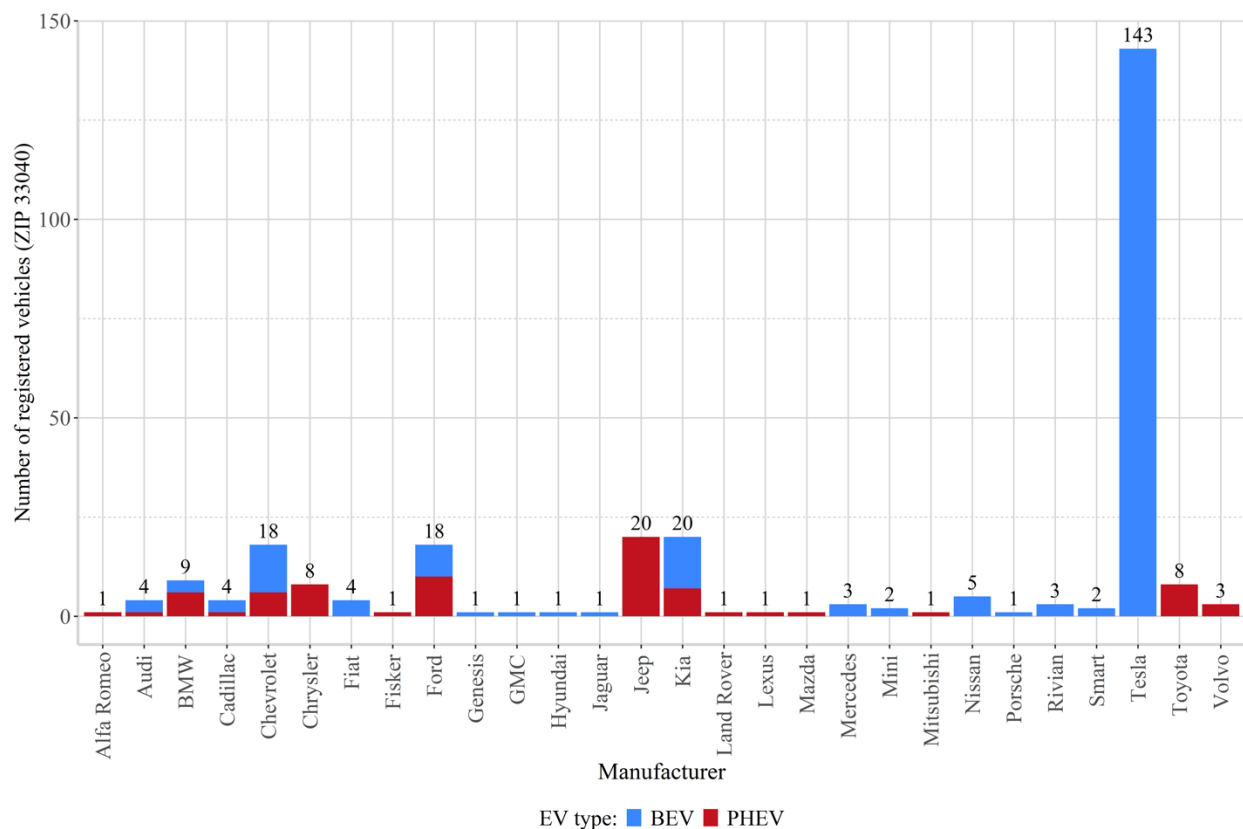
Tesla dominates the local EV market with 143 registered BEVs, representing approximately half of all EVs in the city. Most other brands are represented by only a few vehicles (see Figure 9), indicating the EV market is still in an early growth phase and concentrated among a few automakers.

Given that most EV charging stations are located at hotels, along with Key West's seasonal population and high volume of visitors, the actual number of EVs present on the island is likely

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<sup>9</sup> This number refers only to registered electric automobiles. Other electric modes of transportation, such as e-bikes, are not considered in this count.

higher than the number of local registrations. In addition, although not counted as traditional electric transportation, low-speed vehicles—such as golf carts—are commonly used by tourists.



**Figure 9. Electric vehicles registered in Key West by manufacturer and type**

Key West currently hosts approximately 21 EV charging stations, the majority of which are Level 2.<sup>10</sup> Although this provides a foundational level of infrastructure, many of these stations are located in areas vulnerable to flooding—classified as repetitive loss areas—posing long-term resilience concerns. This highlights the need for strategic siting of future infrastructure to ensure accessibility and reliability during storm events and tidal flooding.

In addition, although the city is not yet part of a federally designated EV fuel corridor,<sup>11</sup> best practice is to provide direct current (DC) fast chargers every 50 miles, with standardized, interoperable plug types. Establishing a more robust, flood-resilient charging network would support broader EV adoption in Key West and strengthen energy and transportation resilience.

<sup>10</sup> A Level 2 EV charging station uses a 240-volt power supply and can typically add 25 miles of range per hour of charging, making it much faster than standard 120-volt (Level 1) home charging but slower than DC fast charging. More information can be found at <https://afdc.energy.gov/fuels/electricity-stations>.

<sup>11</sup> A fuel corridor is a federally designated stretch of highway with alternative fueling infrastructure such as EV charging or hydrogen stations. More information can be found at <https://afdc.energy.gov/laws/11675>.

Beyond physical infrastructure, the city faces additional challenges in supporting electric mobility; these include encouraging residents to install home charging stations, the safe charging of e-bikes and stand-up electric scooters, ensuring consistent maintenance of public chargers, and promoting energy-smart charging behavior—such as charging at night when electricity demand is lower.

## 9 Community Engagement and Outreach

Community engagement was a core component of the ETIPP process in Key West, ensuring project efforts aligned with local priorities and needs. The national labs team and SSDN conducted regular biweekly meetings with the city to review progress, share results, and adapt work based on community input. Broader outreach included two sets of in-person workshops, a virtual public meeting, and a citywide survey—each focused on the plan’s four key areas: energy efficiency, local energy generation, electric transportation, and resilience. These efforts provided valuable avenues for residents and stakeholders to learn and share feedback. Insights from these activities were translated into a list of opportunities to shape the city’s long-term energy strategy, as detailed in the Opportunity Assessment in Section 10.

### 9.1 First In-Person Workshop

The first in-person workshop with the City of Key West (see Figure 10) took place over 2 days, January 30–31, 2025, and comprised four focused meetings—each addressing a key component of the city’s 10-Year Energy Resiliency Plan. The meetings were designed to bring together stakeholders with expertise and responsibilities in various areas of energy and resilience. The first session focused on **energy efficiency and local energy generation** in municipal buildings, whereas the second explored similar opportunities at the community level. The third meeting centered on the development and expansion of **resilience hubs**, and the fourth addressed challenges and opportunities for **electric transportation** in Key West. In total, 26 stakeholders participated in the workshop series, including representatives from city departments, utilities, community organizations, and regional partners.

Throughout the discussions, participants acknowledged the city’s aging building stock and the pressing need to address deferred maintenance, system complexity, and staff turnover, which all affect energy performance. For city facilities such as City Hall and the Police Department headquarters, issues such as underperforming solar arrays, misaligned HVAC systems, and mold concerns highlighted the importance of better system commissioning, ongoing staff training, and a centralized facilities management approach. Participants emphasized that solar readiness, not just deployment, must be integrated early in design and renovation efforts, and staff capacity must be built through standardized tools, manuals, and training platforms.

In the second session, energy affordability, homeownership barriers, and infrastructure readiness emerged as key themes. Although residential buildings in Key West tend to consume more energy than the state average, uptake of distributed solar remains limited and many buildings are ineligible because of structural constraints or insurance limitations. Stakeholders discussed potential improvements to zoning language, permitting processes, and targeted incentives to accelerate efficiency upgrades and prepare more homes for distributed generation<sup>12</sup>.

The third and fourth sessions explored resilience hubs and EV infrastructure. The Frederick Douglass Community Center was highlighted as a flagship resilience hub, with plans for solar, cistern water storage, and emergency communications upgrades. Lessons learned from prior

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<sup>12</sup> Distributed generation refers to producing energy from small, local energy sources, such as rooftop solar or small generators, located close to where the power is used.

projects, including incomplete retrofits and gaps in maintenance funding, reinforced the importance of whole-system planning—especially for facilities serving vulnerable populations during disruptions. New candidate sites for future resilience hubs include public gyms, ferry terminals, and fire stations, and discussions acknowledged the delicate balance between promoting hubs as post-disaster resources while avoiding undermining evacuation priorities. In discussions on EVs, conversations focused on the high cost of EV infrastructure and maintenance in remote areas, the potential of leveraging partnerships with local businesses, and aligning new charger locations with multifamily housing and public parking lots. Overall, the workshops sparked coordinated planning efforts and identified numerous opportunities for cross-departmental collaboration, improved data tracking, and continued outreach.



**Figure 10. First in-person workshop discussing resilience strategies in Key West (left). LBNL, NLR, SSDN, and Key West teams visiting the Frederick Douglass Gym (right).**

*Photo courtesy of Sheetal Almas, City of Key West*

## 9.2 Virtual Workshop

On May 1, 2025, a virtual workshop was held to introduce the Key West community to the 10-Year Energy Resilience and Cost Savings Plan and share progress made through ETIPP. The session familiarized residents with the key focus areas explored throughout the project—energy efficiency, local energy generation, electric transportation, and community resilience—and highlighted specific opportunities identified. To ensure broad community access, the session was recorded and is now available on YouTube<sup>13</sup> for anyone interested in learning more about Key West’s energy transition efforts. As of July 30, 2025 (1 month after upload), the video had 74 views and will remain on the city’s YouTube<sup>14</sup> channel to support ongoing visibility and engagement. This virtual event also served as preparation for the community survey and the second in-person ETIPP workshop, helping align expectations, build awareness, and encourage broader participation.

## 9.3 Second In-Person Workshop

The second in-person workshop was held on June 6 and 7, 2025, at the Frederick Douglass Community Center, with three sessions scheduled to accommodate a range of community availability. Structured as an open-house-style event, the workshop featured a series of

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<sup>13</sup> [https://www.youtube.com/watch?v=ZBXXYrhB\\_P8&t=2s](https://www.youtube.com/watch?v=ZBXXYrhB_P8&t=2s).

<sup>14</sup> <https://www.youtube.com/@CityofKeyWest>.

informational posters presenting the core elements of the project (Figure 11). Each poster focused on one of the four main goals:

- Lowering energy costs and increasing efficiency
- Improving resilience to natural weather hazards
- Expanding the use of local energy generation
- Supporting EV adoption.

Subject matter experts were stationed at each poster to share information, answer questions, and engage in one-on-one discussions with attendees. Participants were encouraged to directly share feedback on the posters, helping ensure community perspectives remain central as the project moves forward. The workshop boards were later displayed in City Hall for a week to extend public access to the materials.



**Figure 11. Second in-person workshop featuring a series of informational posters on electric transportation (left) and resilience (right)**

*Photo by Amanda Krelling, Lawrence Berkeley National Laboratory*

Participants showed the strongest interest in promoting solar and energy efficiency both in the community and on city-owned buildings. In terms of energy efficiency, most respondents expressed curiosity or willingness to learn more about getting a home or business energy audit, with only two indicating no interest. When asked about top priorities to reduce utility costs, most participants selected practical measures such as switching to LED lighting, using motion sensors, improving insulation, and sealing air leaks. Respondents also emphasized the importance of sharing resources with homeowner associations (HOAs) and realtors.

Community feedback on solar generation reflected a range of perspectives, from experienced users to those still unfamiliar with the option. One respondent with solar on their building shared detailed insights, including a calculated 8- to 10-year return on investment with federal tax credits, and emphasized the importance of net metering and state-level advocacy. They also expressed interest in complementary technologies such as battery storage and on-site wind, noting Key West may be windier than other parts of Florida. Others appreciated the ability of their solar systems to power essential equipment such as air conditioning units, although they wished they had batteries for added resilience. Among those who had not yet adopted solar,

respondents cited barriers such as HOA restrictions, living in rental housing, and the misconception that solar is disallowed on buildings in historic areas.<sup>15</sup>

When asked how the city should prioritize its efforts to support solar adoption, participants showed the strongest support for working with third parties to reduce solar costs through co-op programs—such as those run by Solar United Neighbors<sup>16</sup>—followed by strong interest in expanding solar education focused on costs and storm resilience. Streamlining the permitting process and improving access to financing options such as PACE received moderate attention. One participant noted they were not yet ready for solar because of their need for a fireproof roof replacement, which evidences how home readiness can influence adoption.

There was also meaningful support for EVs and resilience hubs. Feedback on electric transportation reflected both interest and concern, particularly around the implementation of mobility hubs. Participants raised questions about potential conflicts with local businesses, the risk of property damage from new mobility users, and the need for better management of bike-share and scooter-share programs to avoid blocking walkways. There were also concerns about where mobility hubs would be located and who their primary users would be, with some questioning whether they would serve tourists, locals, or both. Suggestions included developing a user-friendly Mobility-as-a-Service (MaaS) system<sup>17</sup> with features such as color coding, real-time GPS tracking, and offline access to improve usability and accessibility.

When asked where the next resilience hub should be located, participants offered a range of suggestions based on accessibility and community needs. Key West High School received the most support, followed by the Ferry Terminal. Other suggested sites included the Transit Building on Stock Island and an area near Flagler and Venetian Drive, reflecting interest in placing future hubs in areas that are both familiar and strategically positioned within the community.

## 9.4 Community Survey

To complement the in-person and virtual workshops, a community survey was conducted using Google Forms to gather additional input on local priorities related to energy efficiency, local energy generation, electric transportation, and resilience. A total of 50 complete responses was received. The survey helped capture a broader range of perspectives, including those from renters, homeowners, and individuals living in various neighborhoods across Key West.

Respondents showed a strong level of engagement with energy efficiency practices. Many reported already having taken steps such as installing LED lighting, adjusting their air conditioning thermostat, and upgrading appliances. There was also widespread interest in installing shade structures to reduce cooling needs, insulating attics, weatherstripping, and installing energy-efficient windows. Figure 12 illustrates how many respondents indicated they were very interested in each energy efficiency initiative, with results ranked by number of votes.

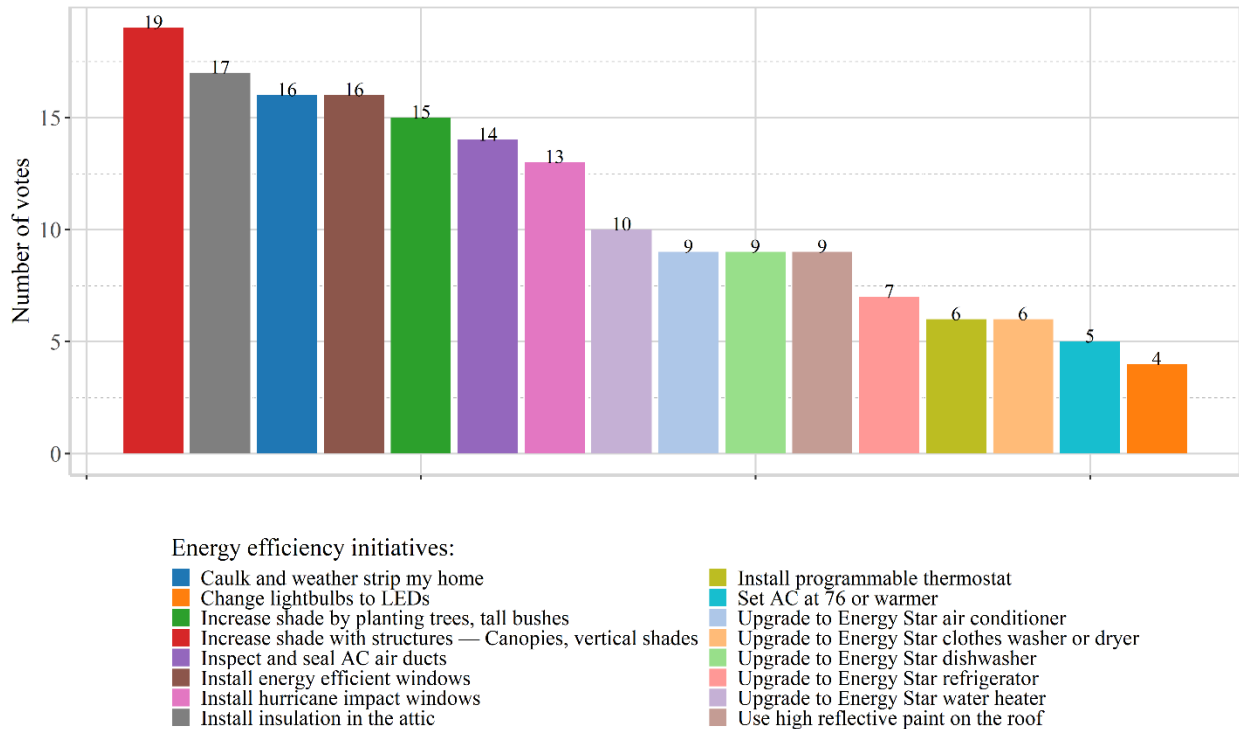
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<sup>15</sup> Solar panels are allowed on historic buildings if they avoid damaging historic features and are minimally visible. More information can be found at <https://www.cityofkeywest-fl.gov/FAQ.aspx?QID=306>.

<sup>16</sup> More information can be found at <https://solarunitedneighbors.org/>.

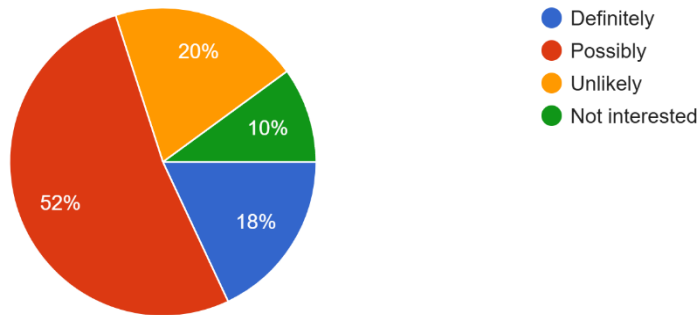
<sup>17</sup> MaaS combines multiple transportation options into a single on-demand platform with unified trip planning and payment, offering a convenient, sustainable alternative to private car use. More information can be found at <https://maas-alliance.eu/homepage/what-is-maas/>.

Community attitudes toward solar energy were generally positive, with many respondents supporting solar adoption for the purpose of reducing energy bills, increasing resilience, and reducing environmental impact. However, concerns about upfront costs, property eligibility (e.g., roof conditions or HOA rules), and the impact on insurance premiums were also mentioned. Some respondents already had solar installed, whereas others were interested but needed more information or financial readiness. Given Key West’s vulnerability to weather hazards and power outages, backup power in homes is a critical need. This was reflected in the survey, where 67% of respondents reported having other forms of backup system installed, such as portable gas generators or propane standby units.



**Figure 12. Number of respondents indicating they are very interested in different energy efficiency initiatives for their homes**

Survey responses revealed strong community interest in improving resilience to storms and weather hazards. Many respondents had already taken steps such as installing hurricane-rated windows or floodproofing, whereas others were curious about how additional upgrades could reduce insurance costs. There was significant support for resilience hubs, with respondents asking about their locations and availability. When asked about their likelihood of going to a community resilience hub after an emergency, 70% of respondents said they would “definitely” or “possibly” use one (Figure 13).



**Figure 13. Community interest in going to resilience hubs following emergencies**

Opinions on electric transportation were mixed. Although some respondents expressed strong support, others raised concerns about range limitations, environmental impacts of battery materials, and the cost of installation. A few preferred smaller electric mobility options, such as e-bikes, over full-size EVs. It’s important to note the survey was available only in English, which likely limited input from many e-bike users with limited English proficiency. Offering future surveys in additional languages could help boost response rates and better capture the perspectives of e-bike riders in Key West. Overall, 46% of respondents reported either owning or planning to purchase an electric car, truck, or van. There was interest in placing chargers in commercial areas. However, 28% of respondents did not support using city funds to install more public EV charging stations, reflecting differing views on how such investments should be prioritized.

When asked which focus area should be prioritized through future efforts in the community, 50% of respondents ranked **resilience** as the highest priority. A total of 24% and 22% selected **local energy generation** and **energy efficiency**, respectively, as their first choice. **Electric transportation** was consistently ranked as the lowest priority among the four focus areas, with 64% of respondents placing it fourth. These results suggest a clear emphasis on strengthening infrastructure and reducing energy use before expanding mobility options. This may also reflect the fact that electric transportation is influenced by a broader set of factors, including enforcement and public perceptions—such as e-bike speeding concerns—which do not apply as strongly to the other focus areas.

## 10 Opportunity Assessment

Based on the baseline assessment, input from key stakeholders and city staff, and feedback from local partners, a set of opportunities aligned with the city’s energy vision and goals was identified to:

- Increase energy efficiency to reduce energy bills—both for city buildings and residential and commercial buildings
- Foster energy resilience and protection against natural weather hazards
- Expand residential solar energy generation
- Promote the adoption of electric transportation—including diverse modes of mobility.

Each opportunity was reviewed by local partners, and the most promising options were assessed with respect to their benefits, related challenges and potential mitigation strategies, key steps for implementation, and potential stakeholders and city departments involved.

### 10.1 Opportunities To Increase Energy Efficiency To Reduce Energy Bills

Opportunities to increase energy efficiency were identified through distinct approaches for city buildings versus residential and commercial properties. For city buildings, the focus was on enhancing O&M practices, whereas for residential and commercial buildings, the emphasis was on implementing retrofit strategies to improve energy performance.

#### 10.1.1 City Buildings

Improving energy efficiency in city-owned buildings represents a practical and impactful way for Key West to lower operating costs. Three key opportunities have been identified with near-term (0–1 year) or short-term (2–5 years) implementation time frames, each offering unique benefits (see Table 2) and requiring tailored steps for execution (see Figure 14).

One key area is the **training and coordination of facility managers**, particularly related to the specific HVAC and electrical systems installed in municipal buildings. Effective training can empower staff to operate and maintain equipment more efficiently, reducing energy waste and unplanned maintenance issues. In addition to building technical skills, this effort involves continuing to improve coordination between Capital Improvement Projects (CIP) and O&M staff. Currently, there is a need to centralize equipment manuals and standardize documentation practices. Developing system-specific training materials, scheduling regular interdepartmental meetings, and creating a shared digital repository for manuals are actionable strategies. Training staff is a near-term priority (within 0–1 year), whereas building and consolidating manuals is expected to occur over the short term (2–5 years). This initiative could result in substantial long-term savings and improved system reliability. However, it requires a concerted effort to inventory existing systems and overcome institutional silos.

**Table 2. Benefits, performance metrics, and key collaborators across opportunities to increase energy efficiency in city buildings**

Opportunity	Benefits	Performance Metrics	Key Collaborators
Training for facility managers	Improves understanding of city-owned systems; enhances communication and long-term planning	Number of staff trained; percentage of buildings with completed system-specific training guides	Community Services Department (Facilities Maintenance), Engineering Department, Information Technology Department, Human Resources
Preventive maintenance	Reduces unplanned outages, extends equipment life, lowers repair and utility costs	Percentage of equipment covered by maintenance schedules, total number of emergency repair incidents, average equipment downtime	Community Services Department (Facilities Maintenance), Engineering Department, Finance Department
Equipment and appliance energy management	Quick implementation, low cost, raises awareness	Number of automated devices installed (timers and sensors), participation in energy awareness campaigns, reduction in energy use	Community Services Department (Facilities Maintenance), Engineering Department, Information Technology Department

**Preventive maintenance** is another high-impact strategy. Many cities have demonstrated a structured maintenance program can prevent equipment failure, extend asset life, and maintain consistent building performance. This involves creating a detailed checklist tailored to each building’s systems—such as HVAC units, electrical panels, lighting, and plumbing fixtures—assigning clear roles and responsibilities, and using scheduling tools to ensure regular upkeep. A successful preventive maintenance program reduces the frequency and cost of emergency repairs<sup>18</sup> and improves the overall efficiency of building operations. Implementation typically falls within a short time frame (2–5 years), depending on the complexity of the systems and the availability of staff. The main challenges include ensuring buy-in from all departments and dedicating the necessary time and oversight to maintain the program consistently.

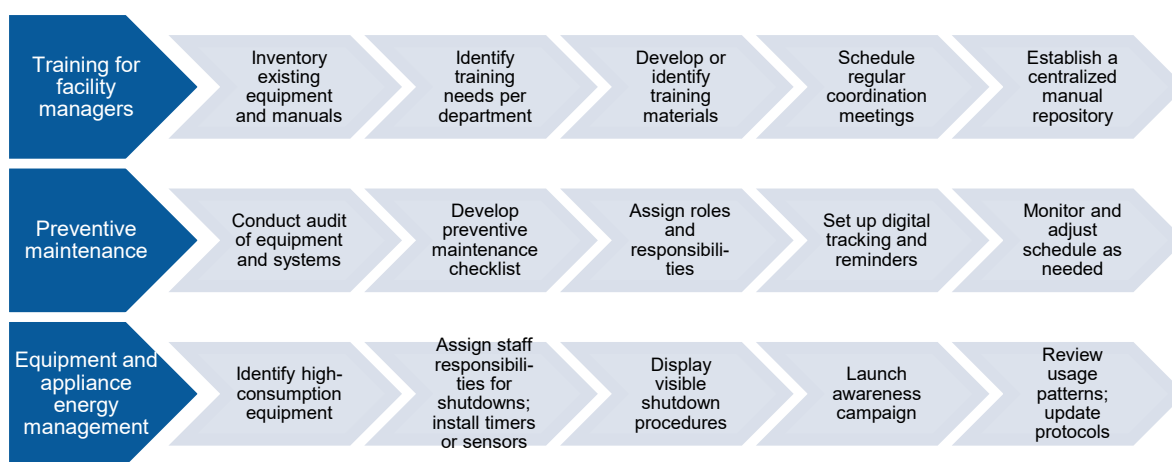
To support the success of a preventive maintenance program, the city uses two platforms to manage facility repairs and upkeep. SeeClickFix allows anyone from the public to submit repair requests,<sup>19</sup> which are directed to the Community Services Department for action. MaintainX is used internally to track and manage work orders, schedule preventive maintenance, and store essential documentation such as O&M manuals, meter data, and system records. Although these tools provide a strong foundation for improving building performance, MaintainX is still being implemented, with only 3 of approximately 100 properties fully entered in the system. Progress has been slowed by limited staffing and the time required to collect and organize

<sup>18</sup> Emergency repairs refer to unplanned, urgent maintenance actions required to fix equipment or building systems that have failed or pose an immediate risk to health, safety, property, or essential operations.

<sup>19</sup> City’s Key West Connect app (powered by SeeClickFix): <https://www.cityofkeywest-fl.gov/760/Key-West-Connect>.

building information. In many cases, equipment manuals and building records are missing or difficult to find because of staff turnover and inconsistent documentation practices. Dedicating resources to complete the full implementation of MaintainX will strengthen the city’s ability to manage its buildings proactively.

A third opportunity involves **managing the energy use of equipment and appliances**. Many energy savings can be achieved by encouraging behavioral changes (such as turning off lights, computers, or HVAC systems when not in use) and supplementing these efforts with automation. Simple solutions such as installing timers, motion sensors, or automatic shut-off systems can help reduce unnecessary energy consumption without requiring constant staff intervention. Although this approach is relatively low-cost and quick to implement (0–1 year), its success depends heavily on employee engagement and ongoing awareness campaigns. Appointing energy champions within departments and tracking usage patterns are practical first steps.



**Figure 14. Overview of main steps to implement opportunities to improve energy efficiency in city buildings**

Each of these opportunities presents advantages as well as limitations. Training and coordination efforts build internal capacity and improve interdepartmental collaboration, although they require time and cultural shifts. Preventive maintenance programs can reduce long-term costs and disruptions but need upfront investment in planning and tools. Equipment management is cost-effective and easy to start but may be limited in scope if not paired with automation or behavior change strategies. Table A-1 in Appendix A summarizes the main challenges linked to each opportunity and potential mitigation strategies.

### 10.1.2 Residential and Commercial Buildings

A set of practical strategies has been identified to improve the energy efficiency of residential and commercial buildings in Key West. These strategies are particularly relevant given the city’s exposure to flooding and the growing momentum around home elevation projects, which present a unique opportunity to incorporate energy upgrades at reduced cost and with greater ease.

**Sealing gaps and cracks around windows, doors, vents, and other openings** in the building envelope is one of the most cost-effective strategies to improve energy efficiency and indoor comfort. By reducing air leaks, this measure helps prevent unwanted heat gain or loss, lowering the burden on HVAC systems and leading to noticeable reductions in energy bills. It

also enhances indoor air quality by minimizing the infiltration of outdoor pollutants, moisture, and allergens.

These improvements are particularly valuable in Key West, where high humidity and frequent use of air conditioning make airtightness essential for maintaining comfort and preventing mold and moisture-related issues. Weatherstripping and sealing can be implemented as part of routine home maintenance or included in broader renovation efforts, such as window replacements or energy retrofits.

Although these measures are relatively simple and low-cost, their impact is magnified when paired with other upgrades. For instance, they complement insulation improvements by ensuring the building envelope functions as an integrated system. In addition, weatherstripping and air sealing are easy to incorporate into home elevation projects when structural access is already available, reducing labor costs and ensuring a more thorough seal. Overall, this strategy offers immediate benefits with minimal disruption, making it an ideal first step for homeowners looking to improve energy performance.

**Sealing and insulating ductwork** further complements these air sealing strategies by addressing another critical source of energy loss in homes. By minimizing air leakage in HVAC ducts, this measure ensures conditioned air is effectively delivered throughout the building, reducing energy waste and improving indoor comfort. Its benefits are particularly pronounced in hot, humid climates such as Key West, where cooling efficiency is essential. Moreover, duct sealing and insulation can be seamlessly integrated into home elevation projects, because HVAC systems are often exposed or rerouted during such work. This creates a cost-effective opportunity to enhance system performance without requiring additional demolition or labor.

**Passive shading strategies**, such as eaves, awnings, pergolas, solar screens, or planting shade trees, offer a simple yet effective way to reduce solar heat gain and lower cooling demand, especially in sun-intense climates such as Key West. These features block direct sunlight from entering windows and walls, helping maintain cooler indoor temperatures, reduce air conditioning use, and improve overall comfort. Mobile shading devices, such as retractable awnings, adjustable louvers, or operable shutters, offer added flexibility by allowing residents to control shading based on time of day or seasonal needs. These adjustable solutions can often be installed with minimal structural changes, making them a practical option for both existing homes and those undergoing renovations. When incorporated into elevation projects, passive shading can be custom-designed to suit the new structure's height and orientation, further enhancing energy performance. Although these strategies are already fairly well adopted in Key West, quantifying their energy and comfort benefits—along with highlighting appropriate design and installation practices—could help raise awareness and encourage even broader implementation.

**Hurricane-resistant and energy-efficient windows** offer a dual benefit for homeowners in Key West: They enhance a building's resilience to weather hazards while significantly improving thermal performance. These windows are designed to withstand high winds and flying debris, reducing the risk of storm damage and improving occupant safety. At the same time, their insulated glazing and tight seals help reduce heat gain, lower cooling loads,<sup>20</sup> and improve

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<sup>20</sup> Cooling loads refer to the amount of heat that must be removed from a space to maintain a desired indoor temperature, typically by air conditioning systems.

indoor comfort. Although the upfront cost is higher compared to standard windows, their value is maximized when installed as part of a larger renovation or home elevation project. In such cases, permitting and construction resources are already in place, making it more cost-effective to integrate these upgrades. Over time, the investment pays off through energy savings, improved durability, and enhanced protection against the region's frequent storms.

**Spray foam or rigid insulation for raised floors** presents a compelling opportunity for homes undergoing elevation. Elevating a home creates a crawl space beneath the floor, which can either be left open to allow air circulation or enclosed and insulated to reduce heat transfer. When the area is left uninsulated, the airflow beneath the raised floor can help dissipate heat, creating a passive cooling effect that reduces indoor temperatures and eases the load on air conditioning systems. However, in some cases, applying spray foam or rigid insulation beneath the floor may be considered. Although this can reduce thermal bridging and improve enclosure tightness, it can also limit beneficial passive cooling—potentially increasing cooling demand. Therefore, the decision to insulate raised floors should carefully weigh climate conditions, airflow potential, and moisture protection needs to ensure the strategy delivers the intended energy performance benefits. For example, in single-family homes in Key West, using raised floors without insulation proved more effective for enhancing energy efficiency than adding insulation (see Section B.1.4.3 for additional details).

**Replacing outdated appliances** with ENERGY STAR certified models is another effective way to reduce energy consumption and improve household performance. Although upfront costs and the logistics of removing old units may present initial barriers, the long-term benefits (including lower utility bills, increased reliability, and better functionality) make this a valuable investment. The most significant energy savings come from upgrading high-consumption appliances such as refrigerators, clothes washers and dryers, dishwashers, room air conditioners, and dehumidifiers. These appliances comprise a substantial portion of household energy use, and in a hot, humid climate such as Key West, improvements in cooling efficiency and moisture control not only reduce energy demand but also improve indoor comfort and lessen the load on HVAC systems.

Together, these strategies not only reduce energy consumption and improve indoor comfort but also align naturally with the scope and goals of home elevation projects. Encouraging residents to bundle energy efficiency upgrades with elevation efforts can lead to cost savings, improved building performance, and enhanced long-term resilience. Table 3 summarizes the benefits and level of intervention of each of these opportunities.

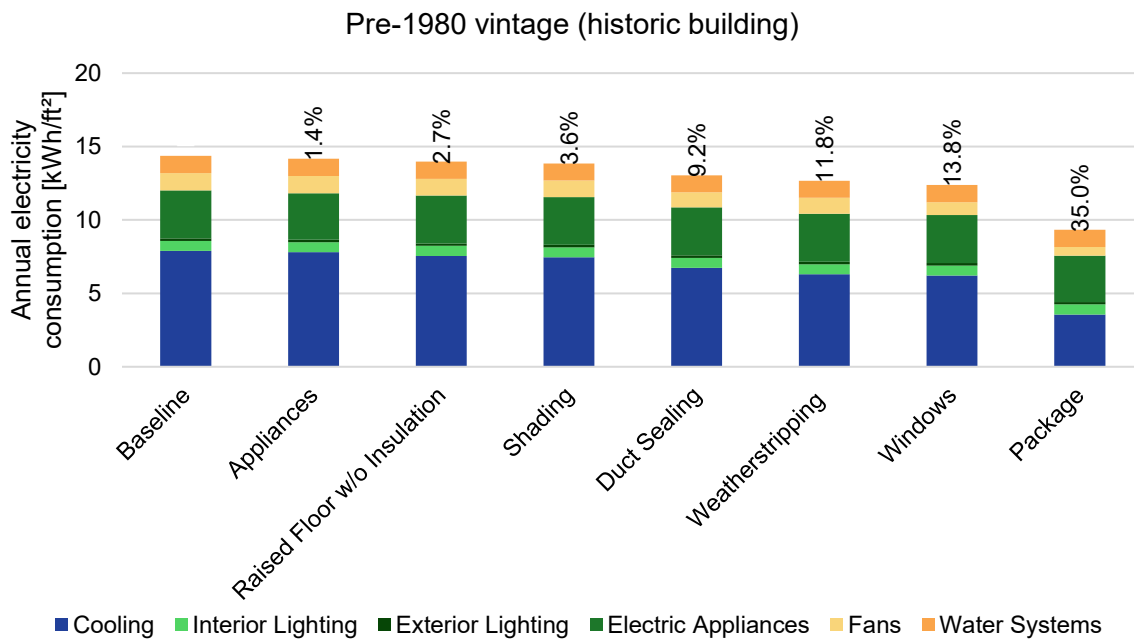
Given the significant impact of single-family residential buildings on communitywide energy use (as shown in the baseline assessment in Section 8.1.2), two building performance simulation models were developed to evaluate the potential energy savings from the energy efficiency measures described previously. In addition, the combination of all measures combined was also explored as a package to assess its energy efficiency potential. These two models reflect representative historic (i.e., pre-1980 vintage) and new homes (2006 vintage) in Key West.

**Table 3. Benefits and level of intervention to increase energy efficiency in residential and commercial buildings**

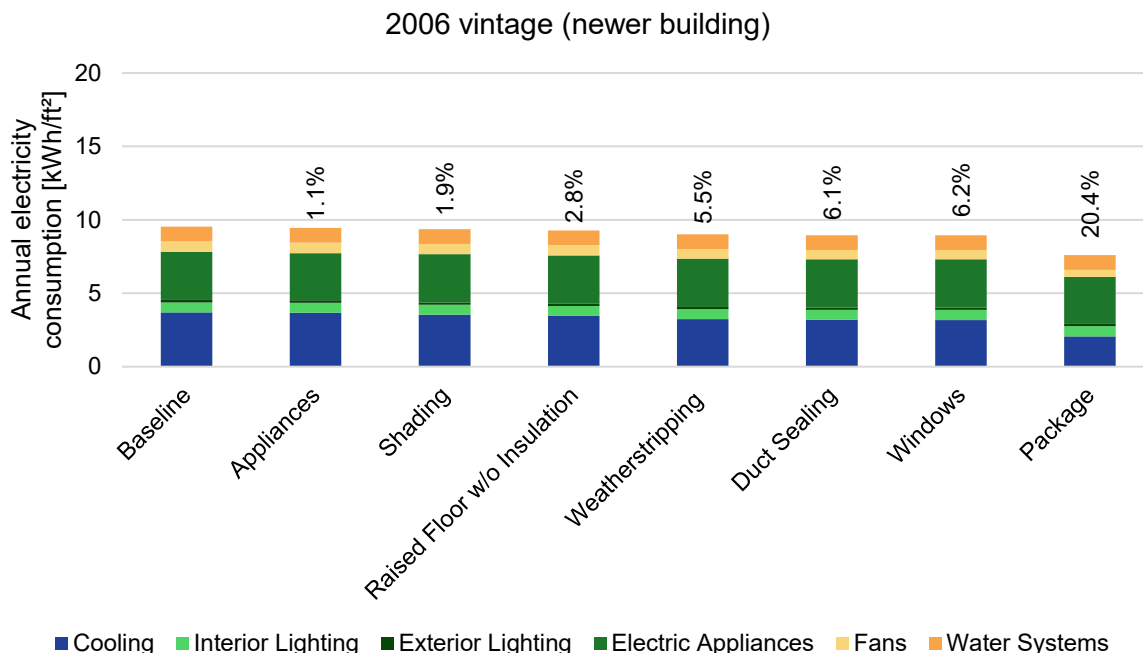
Opportunity	Benefits	Level of Intervention
Weather-stripping and air sealing	Decreases cooling losses, reducing energy bills. Improves indoor air quality by preventing infiltration of dust or pollutants. Limits drafts and temperature fluctuations indoors. Enhances building durability by reducing moisture intrusion.	<b>Low:</b> Typically, a do-it-yourself (DIY) or handyman-level task involving applying weatherstripping around doors/windows and using caulk or spray foam to seal gaps and cracks. Minimal disruption to the home; often done in a few hours.
Duct sealing and insulation	Reduces conditioned air loss, improving efficiency of HVAC systems.	<b>Low:</b> Generally performed by professionals. Requires access to ducts, which may be located in attics, crawlspaces, or behind walls, posing minor to moderate disruption depending on location.
Passive shading strategies (eaves, solar screens, pergolas)	Lowers cooling loads and electricity use during hot months. Reduces indoor heat gain and glare, especially in sun-exposed rooms. Can increase building lifespan by protecting surfaces from UV exposure.	<b>Low to medium:</b> Installation of fixed or retractable exterior shading elements such as awnings, solar screens, or pergolas. May require structural anchoring, mounting to walls or roofs, and appropriate orientation planning. Usually, no interior work needed.
Hurricane-resistant and energy-efficient windows	Minimizes heat gain/loss through windows, reducing HVAC demand. Provides storm protection, improves safety, and can enhance noise insulation.	<b>Medium to high:</b> Requires removal of existing windows and professional installation of new glazing. These windows are often thicker and heavier than standard models, which may not fit into existing openings. Installations can involve modifying wall framing to accommodate deeper window profiles, reinforcing headers for additional weight, and ensuring proper air/water sealing. Moderate interior disruption expected. Best installed during broader renovations or elevation projects.
Raised floors (with or without insulation)	<b>Without insulation:</b> Enhances passive cooling by allowing airflow beneath the home, reducing indoor temperatures and lowering cooling demand. Especially effective in hot, humid climates. <b>With insulation:</b> Reduces heat gain/loss through the floor, improves enclosure tightness, and can help with moisture control in certain conditions.	<b>Medium to high:</b> Both options involve access to the crawlspace or underside of the home. Uninsulated raised floors are simpler to implement, especially during elevation projects, and generally require less material or labor. Insulated floors require specialized spray foam or rigid board installation, along with moisture barriers and proper ventilation. Best implemented during elevation projects to minimize disruption.
Appliance upgrades	Lower energy consumption; increased appliance efficiency.	<b>Low to high:</b> Replacing plug-in appliances (e.g., refrigerators) is straightforward and low-disruption. However, HVAC or water heater upgrades may involve professional installation, system sizing, permit approvals, and potential electrical or plumbing modifications.

A simulation model is a physics-based virtual representation of a building that estimates energy use under various conditions, enabling the analysis of retrofit strategies. Representative building models are examples that typify broader groups of buildings based on specific characteristics, such as the year of construction (i.e., pre-1980 and 2006 vintages used in this analysis). These models allow simulations to reflect the energy behavior of the overall building stock without modeling every individual home. It should be noted, nonetheless, that these representative models do not capture the full variability of individual buildings' conditions and usage patterns; rather, they serve as an initial analysis to provide general guidance for broader energy planning. Appendix B summarizes the simulation process and its main assumptions.

Figure 15 and Figure 16 illustrate changes in annual electricity consumption resulting from applying each measure in the simulation models. The consumption is also categorized by end use, highlighting the dominance of space cooling, which accounts for 56% of total electricity use in pre-1980 homes and 39% in 2006 homes. To facilitate future comparisons with other energy data, the consumption is divided by the building floor area, expressing the annual energy use intensity (EUI).



**Figure 15. Electricity EUI for the pre-1980 vintage single-family home in Key West and energy savings from energy efficiency measure applications (in ascending order)**



**Figure 16. Electricity EUI for the 2006 vintage single-family home in Key West and energy savings potential from energy efficiency measure applications (in ascending order)**

Simulation results show targeted energy efficiency measures can significantly reduce electricity consumption and peak demand, particularly in older homes. Among individual upgrades, weatherstripping and air sealing, duct sealing, and high-performance window installations yielded the highest energy savings—up to 14% for pre-1980 homes and 6% for 2006 homes. Passive shading and raised floors offered modest reductions in cooling loads. When combined as a package, these measures achieved up to 35% annual electricity savings and 27% peak load reduction for older homes and 20% savings with 15% peak reduction for newer homes.

The relatively limited impact of appliance upgrades (1.0%–1.4%) is because of the smaller share of appliance loads in total energy use and the assumption that most existing appliances already meet basic efficiency standards. Similarly, shading strategies produced only 2%–4% savings because the modeled retrofits used small overhangs and vertical fins (each with 20 inches of depth; see Figure B-3 in Appendix B), selected to reflect low-impact interventions that avoid major structural changes. Although practical for retrofitting, this design constraint also limits the potential for reducing solar heat gain, especially in newer homes with already efficient glazing.

Translating these potential savings into residents' energy bills, Table 4 summarizes the annual electricity cost per square foot (\$/ft<sup>2</sup>) in residential buildings across baseline conditions and their retrofitted versions upgraded with energy efficiency measures. A fixed energy rate of \$0.1118 per kWh was considered, reflecting the tariffs effective for residential customers as of June 2025 (Keys Energy Services 2025d). To illustrate what these values represent in actual homes, two examples were used to represent different housing sizes. The first example is a 1,540-ft<sup>2</sup> house, identified as the average housing size in Key West (see Section 8.1.2). The second example corresponds to a larger house used in the modeling analysis (2,405 and 2,381 ft<sup>2</sup> for pre-1980 and 2006 vintages, respectively).

**Table 4. Potential energy savings for residential buildings in Key West through energy efficiency measures**

Vintage	Energy Efficiency Measure	Annual Electricity Cost (\$/ft <sup>2</sup> )	Annual Electricity Cost for 1,540-ft <sup>2</sup> House (\$)	Annual Electricity Cost Saving for 1,540-ft <sup>2</sup> House (\$)	Annual Electricity Cost for Representative House (\$)	Annual Electricity Cost Saving for Representative House (\$)
Pre-1980	Baseline	1.61	2,486.6	-	3,883.3	-
	Appliances	1.58	2,438.6	48.0	3,808.3	75.0
	Raised floor w/o insulation	1.56	2,406.6	80.0	3,758.3	124.9
	Shading	1.55	2,384.2	102.4	3,723.3	159.9
	Duct sealing	1.46	2,245.0	241.6	3,505.9	377.3
	Weatherstripping	1.42	2,181.0	305.6	3,406.0	477.3
	Windows	1.38	2,131.3	355.2	3,328.5	554.8
	Package	1.04	1,606.5	880.1	2,508.9	1,374.4
2006	Baseline	1.07	1,649.7	-	2,550.6	-
	Appliances	1.06	1,625.7	24.0	2,513.5	37.1
	Shading	1.05	1,612.9	36.8	2,493.7	56.9
	Raised floor w/o insulation	1.04	1,596.9	52.8	2,469.0	81.6
	Weatherstripping	1.01	1,553.7	96.0	2,402.2	148.4
	Duct sealing	1.00	1,542.5	107.2	2,384.9	165.8
	Windows	1.00	1,540.9	108.8	2,382.4	168.2
	Package	0.85	1,307.3	342.4	2,021.2	529.4

Across both pre-1980 and 2006 homes, the package of energy efficiency measures yielded the highest annual electricity cost savings—up to \$880 for a 1,540-ft<sup>2</sup> house and \$1,374 for the representative home in pre-1980 buildings. Notably, weatherstripping alone also resulted in considerable savings (up to \$306 and \$477, respectively) and is among the most affordable measures to implement.

KEYS currently offers a [rebate program](#) (Keys Energy Services 2025b) that supports the implementation of some energy efficiency strategies described in this section, specially covering appliance upgrades. By reducing upfront expenses, these incentives make it more feasible for homeowners and businesses to invest in long-term energy savings and comfort improvements. KEYS also offers a Free Home Energy Survey (Keys Energy Services 2025a), where a trained representative visits a home to assess energy use and recommend cost-effective improvements. In addition, the PACE Program in Monroe County (Monroe County 2025) allows property owners to finance energy efficiency, local energy generation, and wind-hardening improvements through a voluntary property tax assessment. The program helps cover upfront costs for upgrades such as solar panels, impact-resistant windows, insulation, and high-efficiency HVAC systems, with repayment spread over time through annual property tax bills.

Participation is voluntary, and financing is available through third-party providers approved by the county.

## 10.2 Opportunities To Foster Energy Resilience and Protection Against Natural Weather Hazards

Three key opportunities were identified to improve resilience<sup>21</sup> in Key West (see Table 5), focused on strengthening the resilience of critical infrastructure including electricity, water, and wastewater systems. These opportunities aim to ensure essential services can withstand and recover from weather events while supporting long-term energy goals. Although the city plays a central role in guiding these efforts, implementation will require coordination with external stakeholders such as Jacobs, Florida Keys Aqueduct Authority (FKAA), KEYS, and regional partners.

**Table 5. Benefits, performance metrics, and key collaborators across opportunities to increase resilience**

Opportunity	Benefits	Performance Metrics	Key Collaborators
Resilient water and wastewater energy systems	Increases water security; operates independently during outages	Hours of autonomous operation during grid outages; percentage of city residents served by facilities with resilient backup power	Utilities Department (wastewater treatment plant contracted to Jacobs), FKAA, Fire Department (emergency management), KEYS, solar contractors
Storm-hardened utility infrastructure	Reduces vulnerability to hurricanes and weather hazards	Amount of infrastructure upgraded per year (e.g., miles of line, percentage of poles); reduction in storm-related service outages	KEYS, Florida Department of Environmental Protection, Fire Department (emergency management), Planning Department, Community Services Department, community stakeholders and property owners
Smart grid and demand response programs	Improves grid reliability; empowers consumer participation	Peak demand reduction (kW) during demand response events, percentage of customers enrolled in demand response or time-of-use programs, customer satisfaction or awareness levels related to smart grid features	KEYS, Florida Municipal Power Agency, local government and regulatory agencies, community and residents, technology and service providers

Key West’s isolation and vulnerability to natural weather hazards create a critical need for **water and wastewater systems** that can operate independently during grid outages. A resilient

<sup>21</sup> Resilience is the ability of a system or community to withstand, adapt to, and recover quickly from disruptions.

solution could involve deploying solar-powered backup systems—paired with battery storage—at drinking water and wastewater treatment facilities. These installations would ensure continuous operation during emergencies, protect public health, and reduce reliance on generators that require fuel transported from the mainland by increasing the use of local energy sources.

A successful example of this approach can be seen at the Camden County Municipal Utilities Authority (CCMUA) in Camden City, New Jersey. To reduce energy costs and enhance resilience, CCMUA installed a 1.8-MW solar panel array at its sewage treatment plant, which now supplies approximately 10% of the facility's electricity needs. Through a 15-year power purchase agreement (PPA) with the contractor, the Authority avoided capital and maintenance costs, paying only for the solar electricity at rates significantly lower than utility prices. This initiative is projected to save \$300,000 in its first year and approximately \$7 million over the agreement's duration (CCMUA 2012). However, it should be noted that, although this PPA model has proven successful in other states, it is currently not permitted under Florida law.

To implement this strategy, the city must first identify the most critical water and wastewater infrastructure and assess the technical feasibility of integrating solar and storage systems. This is followed by securing adequate funding to support implementation. Once funded, the systems would be designed, procured, and installed by qualified contractors. Training staff and conducting routine drills will ensure readiness in case of power disruptions. However, challenges include the high upfront costs of solar and battery systems and the need for strong coordination with agencies such as FCAA. In addition, systems must be carefully sized to support critical loads and designed to withstand coastal weather conditions.

**Reinforcing utility systems against weather hazards** is essential to minimize service interruptions and improve resilience. One of the primary strategies currently used by KEYS is the replacement of traditional wooden poles with steel alternatives, which offer superior resistance to high winds and salt corrosion. Unlike undergrounding, which is often infeasible because of the technical constraints of burying transformers as well as high costs, steel poles present a practical compromise between durability and accessibility.

Implementing this opportunity requires a structured and collaborative approach. KEYS, as the local electric utility, holds primary responsibility for designing and executing infrastructure upgrades, including the replacement of poles, elevation of substations, and reinforcement of anchoring systems. The city plays a critical supporting role by coordinating infrastructure mapping and comprehensive risk assessments to identify and prioritize vulnerable assets. The city can also streamline permitting processes, engage local stakeholders, and align these upgrades with broader resilience and capital improvement plans. Input from permitting agencies and regulatory bodies is essential to ensure compliance with environmental and zoning requirements, and public engagement helps build support and minimize delays.

Notably, the Resilient Florida Program has already identified many critical and at-risk assets through its statewide vulnerability assessment (Florida Department of Environmental Protection 2024). This assessment provides a strong foundation for aligning local hardening efforts with available state-level funding mechanisms.

Despite the clear benefits, several challenges complicate implementation. These include the high capital investment required for storm-hardened materials and the labor-intensive nature of upgrades, particularly in densely built environments. In addition, transformer systems currently in use are not compatible with underground installations, limiting options in certain areas.

Finally, permitting and environmental review processes can introduce significant delays unless proactively managed. Cross-department coordination and phased implementation will be key to scaling these improvements effectively across the city.

To improve energy resilience and efficiency, Key West can invest in **smart grid technology and demand response programs**. These systems enable real-time monitoring of electricity consumption and empower utilities and consumers to shift or reduce loads during peak demand, preventing blackouts and optimizing energy use.

In Key West, KEYS is leading efforts to modernize grid infrastructure, as seen in its Time-of-Use (TOU) Pilot Program (Keys Energy Services 2025c) and investments in advanced metering systems. However, these upgrades face several challenges, including the need for significant infrastructure improvements, technical complexity, and community engagement. To address these challenges, a phased implementation plan could be developed, informed by ongoing analysis of pilot program data. Establishing localized microgrids<sup>22</sup> to serve critical facilities and educating the public on smart grid<sup>23</sup> benefits can further ease adoption. The City of Key West can support these efforts by facilitating permitting, promoting public awareness, and ensuring alignment with local energy and resilience goals.

Figure 17 provides an overview of main steps to implement opportunities to improve resilience in Key West. Table A-3 in the Appendix A summarizes the main challenges linked to each opportunity and potential mitigation strategies.

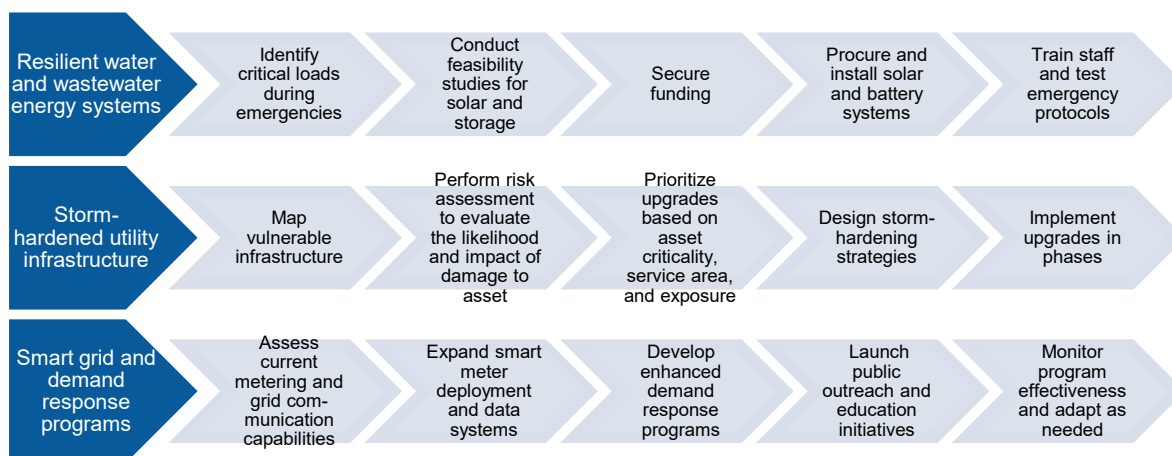


Figure 17. Overview of main steps to implement opportunities to improve resilience

### 10.3 Opportunities to Expand Residential Solar Energy Generation

Expanding residential solar energy generation in Key West presents a significant opportunity to reduce household electricity costs and enhance energy resilience, given the region’s abundant solar resources and the community’s interest in the technology. In line with the City’s goal to

<sup>22</sup> A microgrid is a localized energy system that can operate independently from the main power grid, using its own energy sources—such as solar panels and batteries—to supply electricity during outages or peak demand.

<sup>23</sup> A smart grid is an upgraded electrical system that uses digital technology to monitor, communicate, and manage electricity flow more efficiently and reliably.

harness local resources, rooftop solar photovoltaic (PV) systems are a proven technology, widely adopted across the state, that offer strong financial returns for many residents and reduce dependence on mainland fuel sources. For example, a 6-kW PV system installed on a historic home<sup>24</sup> in Key West could meet approximately 27% of the household's electricity needs without battery storage, depending on the building's condition and energy usage patterns. The same system in a newer, more efficient home<sup>25</sup> could meet approximately 37% of the load (see Appendix C for more details). When paired with battery storage, these systems could provide not only bill savings and demand management benefits but also backup power during grid outages—an increasingly valuable feature in a hurricane-prone region.

Although most residential PV systems are connected to the utility grid, standard grid-tied systems are required to shut down during power outages to prevent backfeeding and ensure safety for utility workers. This limitation reduces the perceived resilience value of solar energy in storm-prone areas such as Key West, where extended outages can occur. Although battery storage systems are typically used to provide backup power, their high cost remains a barrier for many households. Two viable battery-free alternatives were explored in this section to enable limited use of solar power during outages.

One viable option involves using **inverters equipped with a secure power supply (SPS) feature**. These inverters include a dedicated outlet (typically around 1.5 kW) that can be used during outages, powered directly by the solar panels when the sun is shining. This allows residents to plug in small devices or appliances—such as phone chargers, laptops, medical equipment, or fans—without modifying the household electrical system or installing batteries. Although this option does not support full home loads or automated switching, it is simple to implement and provides meaningful resilience benefits at minimal additional cost. It should be noted that the SPS is not an add-on that can be installed on existing inverters; rather, it is a built-in hardware feature available only on certain inverter models. Consequently, this option is best suited for residents who already have PV systems and must replace their inverters, because it offers a cost-effective opportunity to add limited backup functionality without installing a battery. It also presents a practical entry point for new solar adopters who cannot afford a battery system but want access to basic power.

Another alternative is a **hybrid system configured with a manual transfer switch and load isolation**, using a specially selected inverter capable of operating in island mode without batteries. Under normal conditions, the system functions like any grid-tied PV installation: Solar power is used to meet household demand, and any excess is exported to the grid. In the event of an outage, the manual transfer switch can be used to disconnect a critical load panel from the grid, allowing the inverter to power selected essential circuits (such as lighting, refrigeration, or fans) directly from the solar panels. However, this approach presents several technical and operational challenges. It requires a compatible inverter (many standard inverters do not support islanding without a battery) and careful system design to ensure real-time solar generation always exceeds the load, because there is no battery to buffer fluctuations. Power is available only when the sun is shining, and any mismatch between production and demand may cause interruptions. The installation also involves additional electrical work, including load panel

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<sup>24</sup> This historic home refers to the representative building performance simulation model in the pre-1980 vintage (baseline condition). See Section 10.1.2 and Appendix B for more details.

<sup>25</sup> This home refers to the representative building performance simulation model in the 2006 vintage (baseline condition). See Section 10.1.2 and Appendix B for more details.

rewiring and permitting, and relies on manual operation during outages. Limited installer familiarity and public awareness of this configuration may further constrain adoption. As such, this option is best suited for homeowners who already have compatible equipment or who cannot install batteries because of space, permitting, or maintenance constraints and are willing to take on a more hands-on and customized backup solution. Table 6 summarizes the main components needed for this setup. Table A-4 in Appendix A summarizes the main challenges linked to the two alternatives and potential mitigation strategies.

To implement these opportunities, the city can work with solar installers, equipment manufacturers, and utilities to identify technically viable configurations and streamline permitting pathways. Outreach and education will be key, both for contractors and residents, to ensure awareness of equipment options and proper system design. Coordination with KEYS and other stakeholders will also be essential to establish safe operational standards and grid interconnection guidelines.

**Table 6. Main components for battery-free islanding with transfer switch**

Component	Operation Mode	Description
Solar PV panels	Both	Generates DC electricity from sunlight
Hybrid inverter <sup>26</sup> with batteryless islanding	Both	Converts DC to AC; must support grid-tied and off-grid operation without batteries
Main service panel	Both	Distributes power to all household circuits
Critical load panel (subpanel)	Islanded	Contains only essential circuits (such as refrigerator and lights) powered during grid outages
Transfer switch	Islanded	Isolates critical load panel from the grid and connects it to inverter during outage
Alternating current (AC) disconnect	Both	Required for code compliance; allows manual shutdown of PV system
Rapid shutdown devices (if rooftop system)	Both	Required by code in many areas for fire safety
Utility meter (net-metering capable)	Grid-tied	Measures import/export from the grid
Wiring, conduit, breakers, protections	Both	Required electrical infrastructure

## 10.4 Opportunities to Promote the Adoption of Electric Transportation

As EVs become more affordable and accessible, Key West has the opportunity to accelerate their adoption and build a transportation system that is quieter and flexible to meet various user needs. Such flexibility would be reflected by fostering multiple modes of transportation, meaning

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<sup>26</sup> A hybrid inverter is a type of solar inverter that can operate in both grid-tied and off-grid modes and is designed to manage multiple power sources (typically solar panels, the utility grid, and a battery system).

not only electric cars are incentivized but also electric bikes, trikes, and other forms of sustainable transportation. Four key opportunities have been identified to support this transition (see Table 7), which center around fostering EV adoption and reducing infrastructure barriers by:

- Supporting the installation of convenient chargers where people live and work
- Ensuring multiple electric transportation and land use options are integrated to improve access for all users and make the best use of Key West’s limited available land
- Ensuring ample and accessible public chargers for times when private charging is unavailable or impractical
- Making EVs more affordable.

Supporting **private chargers**—especially **at residences and workplaces**—is critical for enabling overnight charging, which helps distribute grid demand and improves user convenience. KEYS already offers an Electric Vehicle Charger Rebate Program (Keys Energy Services 2025b) to encourage the installation of Level 2 chargers by residential and commercial customers. The program provides up to \$400 per charger, a \$350 base rebate for UL-certified<sup>27</sup> Level 2 chargers, and an additional \$50 efficiency rebate for ENERGY STAR certified models. Rebates are available to customers within KEYS’ service territory and are applied as a credit to their electric account. Eligibility includes single-family, multifamily, and commercial properties, with limits on the number of rebates based on property type and number of units. However, several challenges may arise in advancing this or similar efforts, requiring proactive measures such as the following:

- **Space constraints:** Dense urban areas and multifamily dwellings often lack adequate space for chargers. This can be addressed by promoting compact or wall-mounted chargers and encouraging the installation of shared stations in common areas.
- **Electrical upgrades:** Older buildings may require costly upgrades to support charger loads. Offering financial incentives or rebates for electrical panel improvements can help overcome this hurdle.
- **Condo association agreements:** Despite Florida’s right-to-charge laws (Maintenance; Limitation upon Improvement; Display of Flag; Hurricane Shutters and Protection; Display of Religious Decorations 2021), residents may still face administrative resistance. Developing standardized agreements that define responsibilities for installation, maintenance, and insurance can streamline approvals.
- **Utility coordination:** Increased demand from private chargers may stress grid infrastructure. Working closely with utility providers to assess capacity, plan phased installations, and promote TOU rates for off-peak charging can help balance loads. KEYS is already implementing TOU pricing (Keys Energy Services 2025c).

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<sup>27</sup> UL-certified means the product has been tested and meets safety standards set by Underwriters Laboratories, a trusted global safety certification organization.

- **Maintenance and support:** Ensuring chargers remain functional and safe is essential. Strategies include partnering with certified maintenance providers, training property managers and residents on basic upkeep, developing inspection guidelines, and establishing a network of service technicians for timely repairs.
- **Public awareness:** Limited understanding of incentives and legal rights can reduce participation. Outreach campaigns and educational programs can raise awareness, inform property owners about benefits such as property value increases, and encourage broader involvement.
- **Insurance requirements:** Insurance-related uncertainties can delay projects. Creating standardized safety guidelines and offering risk assessments can help minimize liability concerns and support smoother implementation.

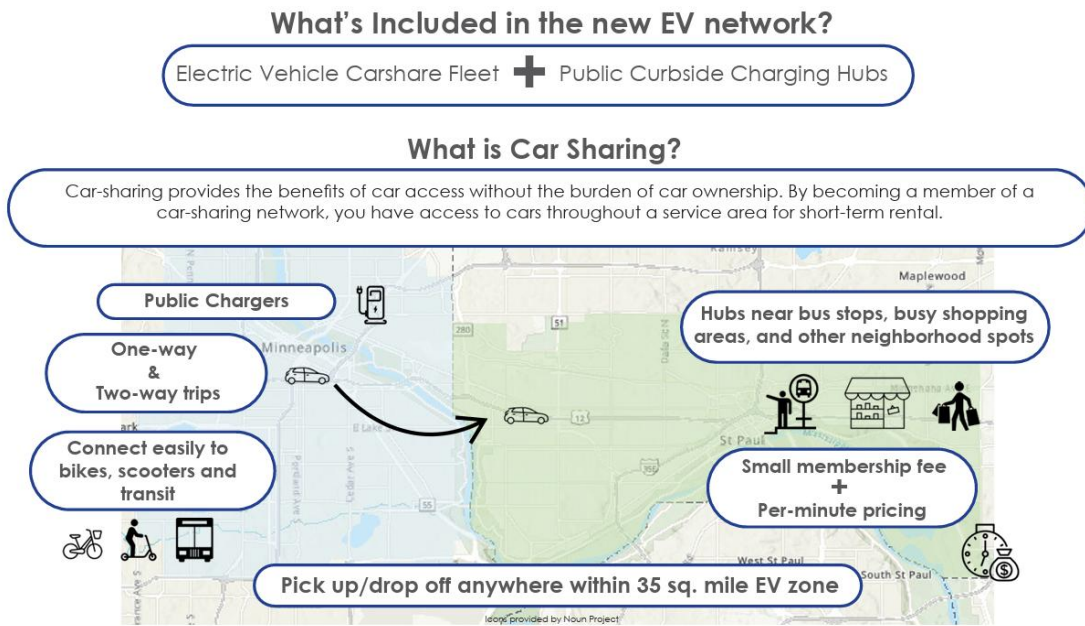
The opportunity to install **mobility hubs** in Key West presents a promising strategy to encourage mixed-use, transit-oriented, and trail-oriented development; enhance multimodal transportation connectivity, accessibility, and convenience; and reduce traffic congestion. Mobility hubs are centralized locations that integrate various transportation modes—such as public transit, bike-sharing, EV charging, and pedestrian access—into a single, convenient space. These hubs support multimodal travel and encourage the use of sustainable transport options, particularly for residents and tourists who may not rely on private vehicles.

However, several challenges must be addressed, including limited space for new infrastructure, funding constraints, and the need for coordination across multiple stakeholders. To overcome these barriers, the city can repurpose underused public parking lots or municipal land, coordinate with private property owners, and seek partnerships with EV companies or private investors. Financially sustainable models, such as pay-per-use or subscription systems, can also support long-term viability. Implementation steps include identifying strategic locations, engaging stakeholders, designing inclusive layouts, and phasing installations based on community needs and usage data.

As an example, the EV Spot Network (City of Saint Paul 2023) is a city-owned initiative jointly managed by the Cities of Saint Paul and Minneapolis, Minnesota (referred to as “Twin Cities”). The network includes 70 curbside charging locations, each equipped with 140 charging heads for Evie Carshare vehicles and 140 for privately owned EVs, enabling convenient access to EV charging across both cities. Complementing this charging network is Evie Carshare, an all-electric, one-way, floating car-share service operated by HOURCAR. With a fleet of 168 EVs, Evie Carshare allows users to pick up a car, drive to their destination, and park within a designated area—avoiding the costs of ownership. According to a recent user survey, 77% of respondents said car-sharing helped them sell or delay purchasing a personal vehicle, and over the past 3 years, Evie Carshare has saved residents more than \$30 million (City of Saint Paul and City of Minneapolis 2025). Figure 18 provides an overview of the EV Spot Network and its deployment across the Twin Cities.

**Table 7. Benefits, performance metrics, and key collaborators across opportunities to promote the adoption of electric transportation**

Opportunity	Benefits	Performance Metrics	Key Collaborators
Accelerate residential and commercial EV charger installations	Reduces reliance on public charging and spreads demand on the grid	Number of chargers installed; percentage of properties with at least one EV charger	Code Enforcement Department, Planning Department, Finance Department, Fire Department, Housing and Community Development Department, KEYS, property owners and landlords, residents and tenants, EV charger manufacturers and suppliers
Install mobility hubs	Improve access to affordable and connected transportation by supporting multimodal travel, mixed-use development, and reducing reliance on single-occupancy vehicles	Number of trips or charging sessions, user savings, number of transportation modes and routes integrated at each hub, number of MaaS applications	Transportation Department, Parking Department, Planning Department, Community Services Department, Florida Department of Transportation (FDOT), KEYS, residents and tenants, EV manufacturers and suppliers, MaaS companies
Public charging network expansion	Increases convenience and visibility of EV infrastructure, supports long-distance travel and daily commuting, reduces range anxiety for drivers without home charging access, and encourages broader EV adoption across diverse communities	Total number of public charging stations installed, geographic coverage, wait times	Parking Department, Transportation Department, Planning Department, FDOT, KEYS, residents and tenants, EV manufacturers and suppliers
Incentive-based approaches to increase EV uptake	Encourages EV adoption by lowering upfront and operational costs	Total count of rebates, vouchers, or tax credits issued; increase in EV adoption attributable to the incentive	Finance Department, Transportation Department, FDOT, KEYS, residents and tenants, EV manufacturers and suppliers



**Figure 18. Overview of the EV Spot Network connecting the Cities of Saint Paul and Minneapolis**

*Illustration by EV Spot Network (City of Saint Paul 2023)*

**Expanding the public EV charging network** by investing in fast-charging stations across public areas is another critical opportunity to accelerate EV adoption in Key West. This initiative enhances the convenience and visibility of EV infrastructure, supporting both daily commuting and long-distance travel. It helps reduce range anxiety and promotes broader access to electric transportation by addressing the needs of residents without access to home charging—particularly those in multifamily or rental housing—as well as tourists and seasonal residents.

However, successful implementation requires overcoming several challenges. Key barriers include grid capacity constraints during peak demand, space limitations in dense or high-traffic areas, and the need for upfront investment. Solutions include integrating solar or battery storage systems, partnering with private property owners to host chargers, and using underused municipal lots. Establishing public-private partnerships and adopting flexible pricing models can also help fund infrastructure and support long-term operations.

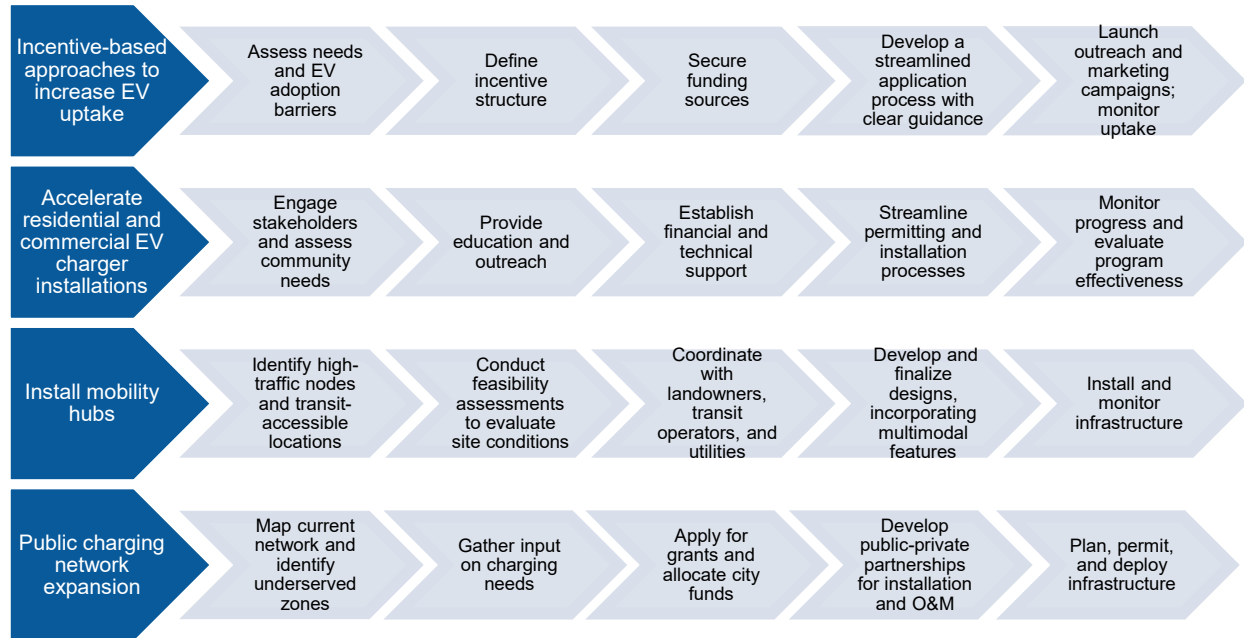
Environmental risks such as flooding and corrosion—especially in coastal areas—can be mitigated by elevating charging platforms and developing contingency plans for severe weather. Addressing community concerns through outreach and transparent planning will be essential to gaining public support, whereas policy alignment (such as zoning overlays and streamlined permitting) will facilitate smoother deployment. Ensuring technical compatibility across vehicle types and maintaining a responsive support network will help sustain reliable service.

Seattle City Light’s Public Charging Network (City of Seattle 2025) in Washington state is an example of a municipally operated program designed to increase EV charging availability, with a focus on serving underserved communities. The utility installs and manages Level 2 curbside and fast chargers in public areas, helping make EV ownership more accessible for residents who lack at-home charging options.

**Incentive-based models** are a foundational approach to increasing EV adoption, particularly by reducing upfront vehicle and charging costs. These models include rebates for EV purchases, discounted electricity rates for charging, and tax credits. Although these programs can significantly boost adoption, they require stable funding sources, well-managed administration, and alignment with utility billing structures. Targeted education campaigns, transparent eligibility criteria, and robust administrative oversight will also be essential to encourage participation and build long-term support for EV infrastructure expansion. This opportunity would need to be carefully analyzed in the context of overall funding allocation priorities, making incentive-based programs a secondary focus. For e-bikes in particular, any incentive program should be preceded by a careful review of local regulations and safety measures, with an emphasis on managing safe growth on the island. Additional studies would help determine the effectiveness of such incentives and guide future resource allocation.

As an example, the City of Tampa’s eBike Voucher Program (City of Tampa 2025) provides upfront discounts ranging from \$500 to \$2,000 to eligible residents for the purchase of a new eBike at participating local bike shops. Voucher amounts are determined based on the applicant’s income, ensuring greater support for those with financial constraints. By offering vouchers rather than post-purchase rebates, the program removes upfront cost barriers and makes eBikes more accessible to low-income individuals and families.

Figure 19 provides an overview of main steps to implement opportunities to improve resilience in Key West. Table A-5 in Appendix A summarizes the main challenges linked to each opportunity and potential mitigation strategies.



**Figure 19. Overview of main steps to implement opportunities to promote the adoption of electric transportation**

# 11 Implementation Timeline and Potential ETIPP Deep Dive Projects

## 11.1 Implementation Timeline

Figure 20 presents an implementation timeline outlining the identified key strategies to enhance energy efficiency, resilience, and electric transportation infrastructure in the community. Actions are categorized into three phases—near-term (0–1 year), short-term (2–5 years), and long-term (5+ years)—based on expected readiness and complexity. Near-term actions are those that the city already has the capacity to implement, such as training for facility managers and improving equipment and appliance energy management. Short-term actions require some maturation time and additional coordination, including the development of systems manuals, preventive maintenance practices, smart grid programs, and support for solar PV without batteries. This phase also prioritizes the expansion of EV infrastructure through mobility hubs, residential and commercial charger installations, and incentive-based programs. Long-term actions will require more extensive planning, funding, and stakeholder engagement, focusing on building resilient water and wastewater energy systems and storm-hardened utility infrastructure to ensure reliable service considering future energy challenges. Further techno-economic evaluations are needed to inform the selection of cost-effective measures, which can be supported through ETIPP’s Deep Dive technical assistance as the follow-up to this strategic energy planning.

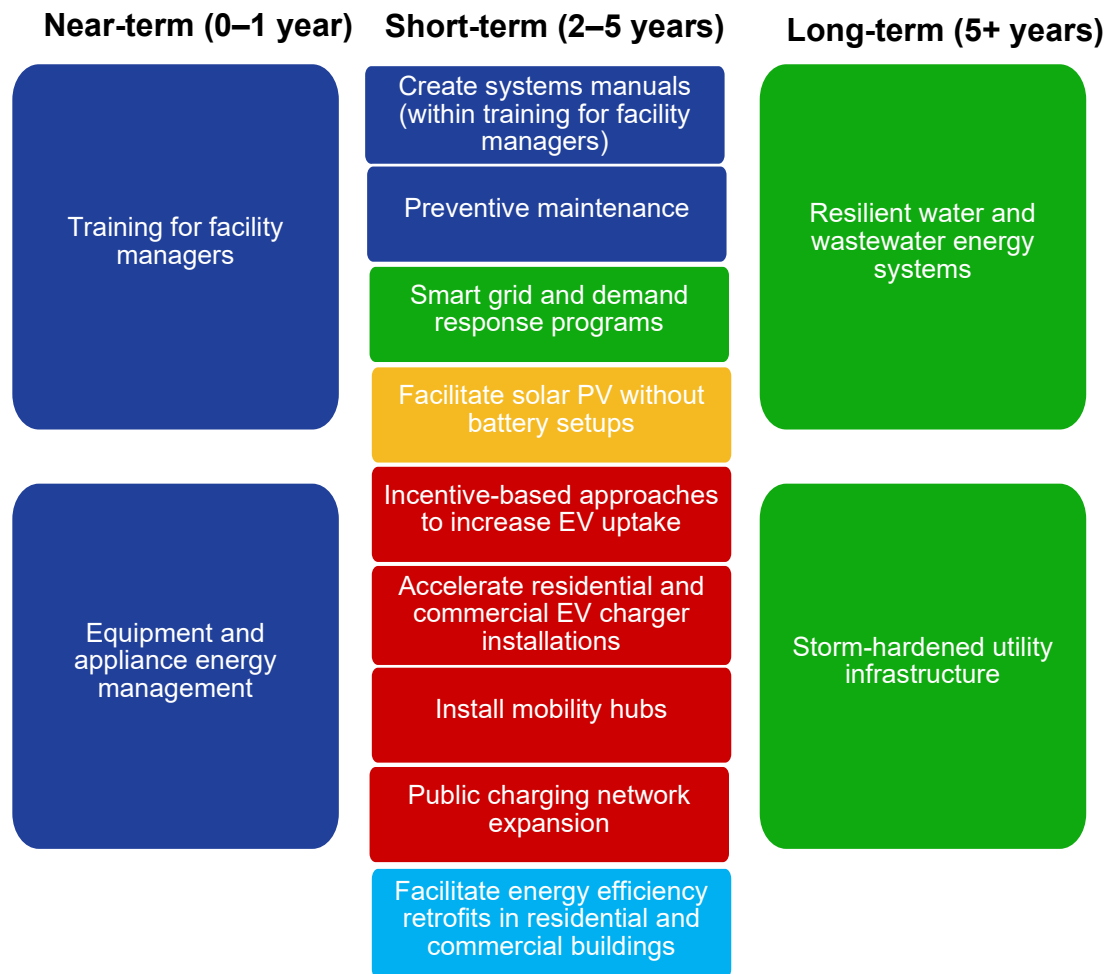


Figure 20. Overview of opportunities and implementation timeline across focus areas: Energy efficiency in city buildings (dark blue) and residential and commercial buildings (light blue); resilience (green); local energy generation (yellow); and electric transportation (red)

## 11.2 Potential ETIPP Deep Dive Projects

Building on the data and insights developed through the Strategic Energy Planning process, four potential projects have been identified for further exploration through the support of ETIPP’s Deep Dive track. These efforts would leverage existing datasets and analytical tools to address key priorities for the City of Key West, including energy efficiency, resilience, local generation, electric transportation, and emergency preparedness. Each potential project is described next, with an illustrative scope of work in Appendix D that combines Project Ideas 1 and 2 to demonstrate the feasibility of a Deep Dive project.

## **Potential Project 1: Energy Efficiency Map for Key West**

This project proposes the creation of a citywide energy efficiency map by developing an urban building energy model of Key West’s building stock. Using the CityBES tool<sup>28</sup> (Figure 21), the project would simulate the impacts of a diverse set of energy efficiency measures—such as envelope insulation, HVAC upgrades, and window coating—across existing buildings in the city. The analysis would provide estimates of implementation costs, energy and utility cost savings, and return on investment (ROI), helping identify the most cost-effective strategies to reduce energy use and improve energy affordability. Much of the necessary building and energy data to support this work were collected during the Strategic Energy Planning process. This potential project would expand the opportunity assessment already performed during energy planning (see Section 10.1.2 and Appendix B) in two fundamental aspects: representing the diversity of existing buildings in Key West (including residential and commercial) instead of a representative single-family home and including implementation costs and ROI beyond potential energy savings. The latter aspect is a pressing concern of the city, because cost estimates of energy efficiency measures are commonly provided at the national or state levels—which can vary significantly from those practiced in Key West because of its isolated location. Federal, state, and city incentives or rebates for the energy efficiency measures will be considered in the techno-economic assessments.

## **Potential Project 2: Resilience Map for Key West**

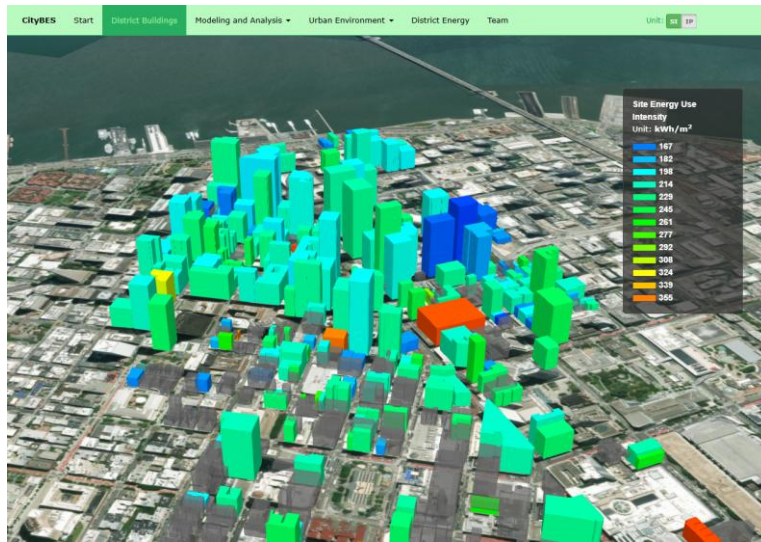
This project will develop a resilience map of Key West using an urban building energy model of the city to simulate how buildings perform under heat stress from weather hazards and electric-grid-related events. Using CityBES, the project would analyze building-level responses to scenarios such as extreme heat, extended power outages, and future climate conditions. The results would highlight the most vulnerable existing buildings, communities, and populations, providing critical insights for resilience planning and emergency response. The foundational data needed for this effort were largely compiled as part of the Strategic Energy Planning process. This potential project is aligned with the city’s goal of enhancing resilience as well as with the community-expressed desire to pursue this path (see results from the community survey in Section 9.4). Outputs from this project could help the city identify priority areas for adaptation investments, inform building codes and land use planning, and support grant applications or funding strategies to enhance community resilience. Outputs may also guide outreach efforts and resource allocation during emergencies.

As an example of similar work previously done by LBNL (relevant to Potential Projects 1 and 2), Lee et al. (2024) demonstrated how CityBES was used to evaluate retrofit strategies for 13 heat-vulnerable multifamily buildings in El Monte, Los Angeles County, California. The analysis assessed both energy savings and indoor thermal conditions under current and future scenarios, including during power outages. A package of passive and low-power measures—such as cool roofs, solar films, air sealing, and ceiling fans—was found to reduce peak electricity demand by 19% and lower annual energy costs by \$183 per unit. The study showed although these retrofits improve thermal resilience, air conditioning remains essential during

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<sup>28</sup> CityBES is a web-based data and computing platform, focusing on energy modeling and analysis of a city’s building stock to support district- or city-scale efficiency programs. More information can be found at <https://citybes.lbl.gov/>.

extreme heat events. This integrated approach provided actionable insights for policymakers to balance energy efficiency, occupant health, and adaptation goals in the community.



**Figure 21. Example of a 3D building energy map generated using CityBES**

*Image from CityBES, Lawrence Berkeley National Laboratory*

### **Potential Project 3: Resilience and Mobility Hub Modeling**

This project focuses on modeling the thermal and energy performance of a resilience and mobility hub in Key West—either an existing facility or a proposed new site—to evaluate its ability to provide essential services during emergencies. Using EnergyPlus,<sup>29</sup> the project would simulate the hub’s performance under scenarios such as heat waves, power outages, and future weather shifts. It would also assess options for solar PV, battery storage for critical infrastructure including the mobility hub, and energy efficiency upgrades. In addition, the simulation framework could be used to test various response protocols, such as shelter-in-place or cooling center activation, helping the city refine emergency plans and improve operational readiness. This potential project is aligned with the community’s goal of enhancing local long-term resilience.

As an example, and relevant to this potential project, a study conducted by LBNL researchers (Sheng et al. 2023) assessed how a community-serving building can maintain critical functions during extreme heat events and power outages. The analysis evaluated various retrofit packages—including HVAC upgrades, envelope improvements, cool roofs, and solar plus storage systems—under both normal and emergency conditions. Results showed integrating passive strategies with on-site energy generation and storage significantly improved thermal safety and reduced energy costs while ensuring backup power availability. This type of integrated modeling approach provides a clear example of how similar methods could be used to support the design and preparedness planning of a resilience hub in Key West.

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<sup>29</sup> EnergyPlus is a tool that captures detailed building physics to support building energy performance assessments

#### **Potential Project 4: Pathways for Electric Transportation for City Residents**

This project explores how various levels of EV adoption in Key West’s residential sector may impact electricity demand, infrastructure, and household costs. Using CityBES and EV charging profiles, the project would model scenarios for single-family and multifamily homes, estimating added EV charging electrical loads and evaluating the implications under KEYS’ existing TOU tariffs. The study would help the city plan for appropriate and efficient EV integration. In addition, the project could explore opportunities to integrate rooftop solar with EV charging—an important goal for the city—to enhance energy resilience and reduce dependence on imported fuels. Potential outputs include load profiles, grid impact assessments, and strategies for residential EV infrastructure deployment. Much of the relevant residential and energy data have already been assembled through the Strategic Energy Planning process.

A relevant example for this potential project is the study by Hong et al. (2025), which used CityBES to simulate electrification scenarios for more than 43,000 homes in Portland, Oregon. Although the primary focus was on building electrification for space and water heating, the modeling approach is directly applicable to evaluating the impacts of residential EV adoption. The study assessed changes in energy consumption, peak electricity demand, and household energy costs under various retrofit scenarios. It found although electrification alone increased peak demand by 9%, combining it with energy efficiency upgrades reduced peak load by 6% and lowered median energy costs by 28%. The analysis also highlighted the value of TOU rates in managing electricity costs and grid impacts. These insights can inform strategies in Key West to model EV charging loads and explore the integration of rooftop solar to enhance resilience and reduce dependence on imported fuels.

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## Appendix A. Challenges and Mitigation Strategies

This appendix includes tables summarizing challenges and mitigation strategies related to the identified opportunities within each focus area:

- Energy efficiency:
  - For city buildings (Table A-1)
  - For residential and commercial buildings (Table A-2)
- Resilience (Table A-3)
- Local energy generation (Table A-4)
- Electric transportation (Table A-5).

**Table A-1. Challenges and mitigation strategies related to identified opportunities to improve energy efficiency in city buildings**

Challenges	Mitigation Strategies
Opportunity: Training for facility managers	
<b>Resource Alignment and Documentation:</b> Compiling equipment manuals and documenting existing building systems across departments requires substantial effort, involving data collection, recordkeeping, and standardization	<b>Centralized Digital Repository:</b> Develop a centralized asset management program (such as MaintainX, as already in use by the city), accessible digital platform for storing building information, equipment manuals, building system documentation, and maintenance records.
	<b>Standardized Templates:</b> Create uniform templates for documenting system specifications, operating procedures for improved efficiency, and maintenance schedules to streamline data collection and ensure consistency.
<b>Communication Gaps:</b> Effective interdepartmental coordination can be challenging, impacting the consistency of operational practices	<b>Regular Coordination Meetings:</b> Establish check-ins between facility managers and key departments (e.g., Operations and Maintenance) to discuss training progress and align on energy efficiency goals.
	<b>Feedback Loops:</b> Implement regular feedback mechanisms to gather insights from facility managers on training content and operational challenges, enabling timely course adjustments
<b>Institutional Knowledge Dependence:</b> Success relies on staff knowledge and their	<b>Mentorship Program:</b> Pair experienced facility managers with less experienced staff to facilitate knowledge transfer and reinforce training concepts

Challenges	Mitigation Strategies
willingness to actively share information and collaborate	Knowledge Sharing Platform: Develop an internal knowledge base or forum where staff can contribute insights, share best practices, and troubleshoot operational issues collectively
<b>Opportunity: Preventive maintenance</b>	
<b>Scheduling and Coordination:</b> Ensuring that maintenance activities are consistently scheduled without disrupting daily operations	Implement a centralized maintenance management software to schedule, track, and coordinate all maintenance activities across departments
	Develop a rolling maintenance schedule that considers building occupancy patterns to minimize disruptions.
<b>Resource Allocation:</b> Allocating sufficient budget and staff time for regular maintenance activities, including inspections and repairs	Establish a dedicated maintenance reserve fund to cover unexpected repairs and preventive maintenance costs.
	Develop staffing plans that allocate specific hours for preventive tasks, ensuring routine maintenance is not deprioritized.
<b>Asset Inventory:</b> Identifying and documenting all critical systems and equipment to establish comprehensive maintenance protocols	Train facility managers as shown in the previous opportunity.
<b>Training and Knowledge Gaps:</b> Ensuring facility managers and maintenance staff are adequately trained in preventive maintenance best practices	Train facility managers as shown in the previous opportunity.
<b>Monitoring and Reporting:</b> Establishing protocols for ongoing monitoring of key performance metrics to detect potential system failures early	Install automated monitoring systems to track equipment performance and alert staff to potential issues (e.g., temperature fluctuations and pressure drops).
	Implement routine performance reporting protocols to assess equipment efficiency and detect patterns that may indicate emerging issues.
	Develop key performance indicators for maintenance performance (e.g., energy consumption history and downtime) and review them during monthly operations meetings.
<b>Supply Chain Delays:</b> Securing timely access to necessary parts and materials for repairs, especially during supply chain disruptions	Develop agreements with multiple suppliers to ensure access to critical parts and materials.
	Maintain an on-site inventory of high-frequency replacement parts to minimize downtime during supply chain disruptions.

Challenges	Mitigation Strategies
<p><b>Communication and Coordination:</b> Facilitating communication between departments to report maintenance needs and schedule repairs promptly</p>	Implement a digital communication platform to streamline reporting of maintenance needs and track task progress in real time.
	Develop maintenance request protocols that standardize how issues are reported, prioritized, and addressed.
<p><b>Opportunity: Equipment and appliance energy management</b></p>	
<p><b>Behavioral Compliance:</b> Ensuring staff consistently adhere to shutdown protocols for nonessential equipment at the end of the day</p>	Assign designated energy champions to monitor compliance and provide reminders.
	Display visible signage near equipment and exits to reinforce shutdown procedures. Use labeled power strips with clear instructions about which devices should be turned off, and which should remain powered.
<p><b>Communication and Awareness:</b> Educating staff on the importance of energy-saving practices without causing disruptions to workflow</p>	Conduct brief, targeted training sessions to explain the impact of energy-saving practices.
	Share periodic updates on energy savings achieved, reinforcing the effectiveness of collective efforts.
<p><b>Resistance to Change:</b> Overcoming habitual practices of leaving equipment on, especially in shared or multiuser workspaces</p>	Involve staff in creating the shutdown policy to foster buy-in and address specific concerns.
<p><b>Equipment Accessibility:</b> Ensuring designated staff can access all areas where equipment must be powered down, especially after hours</p>	Assign after-hours access to designated staff responsible for powering down equipment.
	Implement centralized power strips (when suitable) for easy, single-point shutdown of multiple devices. Devices suitable for power strips are those that are noncritical, operate intermittently, consume standby power, are easily accessible, are low-power, and can be safely powered down without disrupting operations.
<p><b>Appliance Inventory:</b> Identifying all nonessential appliances and maintaining an up-to-date list of devices requiring shutdown</p>	Conduct a comprehensive equipment audit to identify all nonessential appliances (to be aligned with previous two opportunities).
	Maintain a digital inventory that includes appliance locations, usage schedules, and shutdown responsibilities (to be aligned with previous two opportunities).
<p><b>Monitoring and Verification:</b> Tracking equipment usage and confirming devices are powered down or unplugged as required</p>	Use smart plugs or energy monitors to track power usage and confirm compliance.
	Implement periodic spot checks to verify appliances are powered down according to protocol.

Challenges	Mitigation Strategies
<b>Maintenance Considerations:</b> Avoiding potential wear and tear from frequent power cycling of certain appliances or equipment	Develop specific guidelines for safely powering down sensitive equipment to prevent damage (to be aligned with previous two opportunities). Consult with equipment manufacturers on best practices for power cycling without compromising equipment lifespan.

**Table A-2. Challenges and mitigation strategies related to identified opportunities to improve energy efficiency in residential and commercial buildings**

Challenges	Mitigation Strategies
<b>Opportunity: Appliance upgrades (e.g., ENERGY STAR refrigerators, HVAC, water heaters)</b>	
Upfront costs	Provide utility rebates or financing options.
	Promote phased replacements during renovations.
Disposal of old appliances	Establish appliance recycling programs.
<b>Opportunity: Duct sealing and insulation</b>	
Accessing ducts in hard-to-reach areas	Use diagnostic tools (e.g., blower door testing <sup>30</sup> ) to prioritize sealing zones.
	Train local contractors in best practices.
	Schedule work during renovations or HVAC upgrades.
<b>Opportunity: Weatherstripping and air sealing</b>	
Requires periodic maintenance and proper sealing of all air leaks	Offer “do-it-yourself” (DIY) kits with clear instructions.
	Provide homeowner education on seasonal checks.
<b>Opportunity: Passive shading strategies (e.g., eaves, solar screens, pergolas)</b>	
Aesthetic considerations; proper orientation	Use adjustable/mobile shading systems.
	Provide design templates or technical guidance based on building orientation.
<b>Opportunity: Hurricane-resistant and energy-efficient windows</b>	
Higher upfront cost; thicker and heavier than standard windows; may not fit existing wall openings	Combine installation with elevation or renovation projects.
	Provide information on available incentives and potential insurance savings.
<b>Opportunity: Spray foam or rigid insulation for raised floors</b>	

<sup>30</sup> Check relevant information about blower door testing at <https://www.energy.gov/energysaver/blower-door-tests>.

Challenges	Mitigation Strategies
Moisture control, ensuring proper installation	Provide instructional videos and guides on best practices.

**Table A-3. Challenges and mitigation strategies related to identified opportunities to improve resilience in Key West**

Challenges	Mitigation Strategies
<b>Opportunity: Resilient water and wastewater energy systems</b>	
<b>High Initial Costs:</b> Significant capital investment required for solar panels, battery storage, and system integration	Apply for grants and incentives targeting critical infrastructure resilience.
	Phase the implementation to spread costs over multiple fiscal years.
	Prioritize high-impact systems (e.g., essential pumps) for initial deployment.
<b>Space Constraints:</b> Limited available land or rooftop space for sufficient solar panel deployment	Integrate carport solar canopies in parking areas to optimize land use.
<b>Grid Interconnection:</b> Complexity in integrating solar systems with existing grid infrastructure, especially during power outages	Develop a microgrid strategy that allows seamless islanding during grid outages.
	Collaborate with KEYS to define interconnection agreements and standards.
	Conduct grid impact studies to identify potential upgrades or control requirements.
<b>System Maintenance:</b> Regular maintenance and potential repair costs for solar and backup systems, especially after natural weather hazards	Implement modular system designs to facilitate quick replacement of damaged components.
<b>Operational Reliability:</b> Ensuring consistent power supply from solar systems during prolonged cloudy periods or storms	Implement energy management systems to prioritize critical loads during extended outages.
	Size battery storage systems to maintain essential operations for a predefined duration.
	Integrate diversified power sources, such as diesel generators or wind turbines, as secondary backup.
<b>Environmental Considerations:</b> Potential impacts on surrounding areas,	Elevate PV systems and battery units to mitigate flood risks.
	Design battery enclosures to prevent leaks or hazardous material releases during flooding.

Challenges	Mitigation Strategies
especially in flood-prone or environmentally sensitive zones	
<b>Opportunity: Storm-hardened utility infrastructure</b>	
<p><b>Technical Limitations:</b> Transformers cannot be buried, limiting the feasibility of underground systems; steel poles provide greater wind resistance but may still be vulnerable to saltwater corrosion and storm surge impacts</p>	<p>Use corrosion-resistant coatings for steel poles to minimize saltwater damage.</p> <p>Elevate transformers and critical components to protect against storm surge and flooding.</p> <p>Explore hybrid systems combining underground and overhead infrastructure to balance resilience and cost.</p>
<p><b>Maintenance Complexity:</b> Underground systems may be more difficult and expensive to repair after flooding or ground shifts; steel poles require regular inspections and maintenance to prevent rust and structural degradation, especially in a coastal environment</p>	<p>Establish a regular inspection schedule for steel poles, focusing on rust prevention and structural integrity.</p>
<p><b>High Costs:</b> Significant financial investment required for burying power lines, installing steel poles, and reinforcing substations</p>	<p>Pursue state and federal grants to offset infrastructure upgrade costs.</p> <p>Implement phased construction to spread costs over several budget cycles.</p>
<p><b>Space Constraints:</b> Installing additional steel poles or elevated substations may require land acquisition or modifications to existing infrastructure layouts</p>	<p>Optimize existing infrastructure layouts to accommodate new steel poles.</p> <p>Implement compact substation designs that reduce space requirements.</p>
<p><b>Community Disruption:</b> Installing steel poles or burying power lines may require temporary road closures, service interruptions, and coordination with other utilities</p>	<p>Develop a communication plan to inform residents of construction schedules and expected impacts.</p> <p>Coordinate with traffic management to minimize road closures and detours.</p> <p>Schedule construction during low-traffic periods to reduce disruptions.</p>
<b>Opportunity: Smart grid and demand response programs</b>	
<p><b>Infrastructure Upgrades:</b> Upgrading existing grid infrastructure to support smart</p>	<p>Develop phased implementation plans to spread costs and minimize service disruptions.</p> <p>Pursue grants for smart grid infrastructure improvements.</p>

Challenges	Mitigation Strategies
grid technology and communication systems	
<b>Technical Complexity:</b> Integrating diverse energy sources and managing grid stability during peak demand	Use data from the TOU pilot program to assess peak demand patterns and inform grid management strategies.
	Establish microgrids to isolate critical loads during peak demand or outages.
<b>Community Acceptance:</b> Ensuring public awareness and participation in demand response programs	Highlight the TOU pilot program as a step toward grid modernization and invite more participants (Keys Energy Services 2025c).
	Offer educational workshops on how TOU pricing can help residents lower their bills and reduce peak demand stress.

**Table A-4. Challenges and mitigation strategies related to identified opportunities to expand residential solar energy generation in Key West**

Challenges	Mitigation Strategies
Opportunity: Facilitate solar PV without battery setups—Alternative 1: PV system with secure power supply (SPS)	
<b>Limited power capacity:</b> Typically restricted to 1,500–2,000 watts, which may not be sufficient for larger or multiple essential appliances	Educate residents on what devices can be supported (e.g., phones, fans, medical equipment) and how to prioritize usage during outages. Provide preconfigured SPS-compatible appliance kits or checklists.
<b>Daylight-only availability:</b> Power is accessible only when solar generation is active, meaning no power during nighttime or heavy cloud cover	Encourage complementary passive resilience measures (e.g., natural ventilation, insulation) and provide guidance on load scheduling to maximize daytime use.
<b>Outlet-based use only:</b> SPS provides power through a dedicated outlet, not through the home’s wiring or panels, requiring manual plug-in of devices	Promote the use of power strips or portable SPS-compatible emergency kits. The city could partner with local hardware stores to offer discounted SPS extension kits for residents.
<b>Not retrofit-compatible with most inverters:</b> SPS functionality is hardware-specific and cannot be added to existing inverters; requires purchasing a compatible model	Provide targeted outreach to residents with aging inverters, encouraging upgrades to SPS-capable models when appropriate and replacements are already needed.
<b>Low awareness and availability:</b> Many residents and installers are unfamiliar with the feature	Launch an educational campaign in coordination with local installers, utilities, and community groups to demonstrate SPS functionality.

Challenges	Mitigation Strategies
<b>Opportunity: Facilitate solar PV without battery setups—Alternative 2: Transfer switch with load isolation</b>	
<b>Complex system design:</b> Requires selection of compatible inverter (capable of islanding without a battery), careful load sizing, and customized electrical setup	Provide residents and contractors with standardized design templates and vetted equipment lists for battery-free islanding.
<b>Installation complexity:</b> Involves adding a manual transfer switch and a dedicated critical load panel, with rewiring of selected household circuits	Provide installer training in collaboration with local licensing authorities.
<b>No energy buffering:</b> Without a battery, power is vulnerable to interruptions from cloud cover or solar fluctuations (loads must match real-time generation)	Encourage residents to identify and prioritize the use of low-power, essential devices that are less sensitive to brief power interruptions.
<b>Limited installer familiarity:</b> Not all solar contractors are experienced with batteryless islanding systems, which could increase costs or design errors	Support certification or continuing education programs for local contractors focused on battery-free islanding configurations.

**Table A-5. Challenges and mitigation strategies related to identified opportunities to promote the adoption of electric transportation in Key West**

Challenges	Mitigation Strategies
<b>Opportunity: Incentive-based approaches to EV uptake</b>	
<b>Funding and Budget Constraints:</b> Securing sufficient and stable funding without straining local budgets	Explore utility-managed incentive programs where KEYS can recover costs through peak demand management savings. KEYS already provides a rebate for EV chargers (Keys Energy Services 2025b).
<b>Program Design and Administration:</b> Developing effective criteria for incentive eligibility and preventing misuse or fraud	Establish clear eligibility criteria based on income levels, vehicle type, and charger installation location to prevent misuse.
	Conduct regular audits to ensure funds are appropriately allocated and adjust program parameters as needed.
<b>Community Awareness and Outreach:</b> Educating residents and businesses about available incentives and how to apply for them; addressing potential misconceptions about EV costs, maintenance, and charging	Launch targeted educational campaigns highlighting the cost savings and environmental benefits of EVs, focusing on common misconceptions.
	Create informational materials (flyers, website content, workshops) that clearly outline incentive eligibility and application processes.

Challenges	Mitigation Strategies
infrastructure and how e-bikes and scooters are legally defined as electric vehicles	
<b>Energy Resilience:</b> Assessing the impact of increased electricity consumption on the local grid, especially during peak demand periods	Assess existing grid capacity to identify potential stress points and prioritize upgrades in high-demand areas.
	KEYS TOU pilot program also aims to incentivize EV owners to charge during off-peak times (Keys Energy Services 2025c).
<b>Limited Buy-In in Flood-Prone Areas:</b> Risk of EVs and chargers being damaged by flooding; concerns about power outages and grid instability during and after flooding events, impacting EV charging availability	Develop public charging hubs in safer, elevated locations to provide reliable access for residents in flood-prone areas.
	Offer additional incentives to install elevated or flood-resistant EV chargers in high-risk zones.
<b>Insurance and Liability Issues:</b> Higher insurance costs for EVs and charging equipment in areas prone to flooding, with added wind coverage needed for hurricane and storm damage	Educate EV owners about available insurance options and how to mitigate risk, such as installing surge protectors or waterproof equipment.
	Collaborate with local emergency management to establish guidelines for safely relocating EVs and chargers in advance of natural weather hazards.
<b>Opportunity: Accelerate residential and commercial EV charger installations</b>	
<b>Space Constraints:</b> Limited parking space in densely populated areas may restrict charger installation, especially in multifamily dwellings	Promote the use of compact or wall-mounted chargers to minimize space requirements.
	Implement shared charging stations in common areas for multifamily dwellings.
<b>Electrical Upgrades:</b> Older buildings may require costly electrical upgrades to accommodate charger installation	Provide financial incentives or rebates for electrical panel upgrades to accommodate chargers.
<b>Condo Association Agreements:</b> Even with right-to-charge policies in Florida, condominium unit owners may still face resistance from associations or property managers, complicating the installation of EV chargers in designated parking spaces	Develop standardized agreements that outline installation costs, maintenance responsibilities, and insurance requirements.
<b>Utility Coordination:</b> Increased demand from home chargers could strain local grid infrastructure, requiring utility coordination	Work with utility providers to assess grid capacity and plan for phased charger installations.
	Promote the use of TOU rates to incentivize off-peak charging (KEYS is already doing this).
	Partner with certified EV charger maintenance providers to offer service plans for private chargers.

Challenges	Mitigation Strategies
<p><b>Maintenance and Support:</b> Ensuring private chargers are properly maintained to avoid technical issues and ensure safety</p>	Implement training programs for property managers and residents on basic charger maintenance.
	Develop guidelines for routine charger inspections to identify potential safety or operational issues.
	Establish a local network of service technicians to provide timely repairs.
<p><b>Public Awareness:</b> Limited awareness of available incentives and right-to-charge policies could reduce participation</p>	Launch targeted outreach campaigns to inform residents and businesses of available incentives and right-to-charge policies.
	Implement educational programs to inform landlords of potential property value increases from EV charger installations.
<p><b>Insurance Requirements:</b> Potential increases in insurance premiums or gaps in coverage for charger installations, particularly for multifamily or commercial properties</p>	Develop standardized safety guidelines for charger installations to minimize insurance risks.
	Promote risk assessment services to identify potential hazards and recommend mitigation strategies.
<p><b>Opportunity: Install mobility hubs</b></p>	
<p><b>Infrastructure Space Constraints:</b> Identifying suitable, centrally located sites for mobility hubs with sufficient space for various vehicle types</p>	Use underused public parking lots or municipal properties for multimodal charging hubs.
	Develop shared charging zones for multiple vehicle types to reduce footprint.
	Coordinate with commercial property owners to integrate chargers into existing parking areas.
<p><b>Funding and Investment:</b> Securing financing for fast-charging infrastructure and ongoing maintenance across multiple vehicle modes</p>	Partner with private investors or EV companies to co-fund charging station installation and operation.
	Implement pay-per-use or subscription-based charging models to offset operational costs.
	Apply for grants aimed at electric mobility and infrastructure development.
<p><b>Interoperability of Charging Systems:</b> Ensuring compatibility between chargers and diverse modes (e.g., bikes, scooters, cars) to avoid redundant infrastructure</p>	Select universal charging connectors compatible with multiple vehicle types (e.g., scooters, bikes, cars).
	Implement open standards for charging infrastructure to avoid proprietary systems and ensure future compatibility.
	Install elevated charging platforms to reduce flood risks in vulnerable areas.

Challenges	Mitigation Strategies
<p><b>Environmental Vulnerability:</b> Protecting charging equipment from flooding, saltwater corrosion, and storm surge impacts</p>	<p>Develop a storm preparedness plan that includes temporary shutdowns or relocations of charging stations.</p>
	<p>Incorporate solar-powered chargers with battery backups to maintain charging capability during power outages.</p>
<p><b>Demand Fluctuations:</b> Planning for seasonal tourist influxes that may strain charging capacity and create congestion at hubs</p>	<p>Monitor charging station usage data to identify peak periods and adjust operational hours or add temporary chargers.</p>
	<p>Implement dynamic pricing to encourage off-peak charging and manage peak demand periods.</p>
<p><b>Policy and Permitting:</b> Navigating zoning laws, permitting processes, and regulatory requirements for multimodal charging infrastructure</p>	<p>Work with city planning departments to identify zoning overlays or special districts that accommodate multimodal charging.</p>
	<p>Establish design guidelines for multimodal hubs that include safety and accessibility considerations.</p>
<p><b>Public Awareness and Engagement:</b> Educating the public about hub locations, available modes, and incentives for multimodal transportation</p>	<p>Launch targeted marketing campaigns to promote the benefits of multimodal charging hubs.</p>
	<p>Provide informational kiosks or digital displays at hub locations to educate users on how to charge various vehicle types.</p>
	<p>Develop a user-friendly mobile app that shows hub locations, available modes, and real-time charging station availability.</p>
	<p>Offer introductory incentives for first-time users to encourage adoption and collect user feedback.</p>
<p><b>Maintenance and Technical Support:</b> Developing a maintenance plan for chargers serving multiple vehicle types, each with unique charging requirements</p>	<p>Develop service agreements with charging equipment manufacturers for regular inspections and maintenance.</p>
	<p>Implement remote monitoring systems to detect equipment issues and minimize downtime.</p>
	<p>Maintain a stock of spare parts for quick repairs, especially during peak demand periods or tourist seasons.</p>
<p><b>Opportunity: Public charging network expansion</b></p>	
<p><b>Grid Capacity and Peak Demand:</b> Managing increased electricity demand from</p>	<p>Integrate solar or battery storage systems to reduce grid impact and maintain charging availability during outages.</p>

Challenges	Mitigation Strategies
multiple fast-charging stations, especially during peak usage hours	<p>Coordinate with KEYS to assess grid capacity and identify necessary upgrades for EV charging corridors.</p> <p>Develop tiered pricing structures to incentivize off-peak charging and discourage charging during peak hours.</p>
<p><b>Space Constraints and Site Selection:</b> Identifying suitable, centrally located sites for chargers, particularly in areas with limited parking or high tourist density</p>	<p>Identify underused parking lots, municipal properties, or existing gas stations as potential charging locations.</p> <p>Coordinate with private property owners to integrate chargers into existing parking facilities. Offer incentives for businesses to host chargers on their property.</p>
<p><b>Funding and Investment:</b> Securing financial resources for fast-charging infrastructure, including installation, operation, and ongoing maintenance</p>	<p>Develop public-private partnerships with EV manufacturers or charging network operators.</p> <p>Implement pay-per-use charging fees to offset maintenance costs and generate revenue.</p>
<p><b>Environmental Vulnerability:</b> Protecting charging stations from flooding, storm surge, and saltwater corrosion</p>	<p>Install elevated charging platforms to mitigate flood risks in low-lying areas.</p> <p>Develop contingency plans for relocating or temporarily deactivating chargers during storm events.</p>
<p><b>Community Acceptance and Engagement:</b> Addressing potential resistance from residents and businesses over charging station placement and perceived disruptions</p>	<p>Conduct public outreach to educate residents and businesses on the benefits of EV charging infrastructure. Address concerns related to visual impact, noise, and potential traffic disruptions through transparent communication.</p> <p>Implement community feedback mechanisms to adjust charging station locations based on resident input.</p>
<p><b>Policy and Permitting:</b> Navigating zoning laws, building codes, and permitting processes for charging infrastructure in public and private spaces</p>	<p>Work with city planners to streamline permitting processes for EV infrastructure projects.</p> <p>Develop zoning overlays or designated EV charging districts (special planning tools that apply targeted rules to specific areas) to simplify siting and approval processes.</p> <p>Establish clear design guidelines for EV charging stations that consider safety, accessibility, and visual impact.</p>
<p><b>Tourism and Seasonal Demand:</b> Planning for fluctuating demand during tourist season, which may create charging congestion and strain on infrastructure</p>	<p>Expand charging capacity in tourist-heavy areas during peak seasons to prevent congestion.</p> <p>Implement dynamic pricing to manage demand and reduce charging congestion during high-traffic periods.</p>

Challenges	Mitigation Strategies
	Develop digital apps or signage to provide real-time information on charger availability and estimated wait times.
<p><b>Interoperability and Compatibility:</b> Ensuring charging stations are compatible with various EV models and connector types to prevent access issues</p>	<p>Develop partnerships with major EV manufacturers to ensure chargers meet their specifications.</p> <p>Install universal chargers compatible with multiple EV connector types.</p>
<p><b>Maintenance and Technical Support:</b> Ensuring availability of skilled local technicians for timely repairs and maintenance, especially in high-traffic locations</p>	<p>Develop maintenance agreements with charging equipment manufacturers to ensure timely repairs.</p> <p>Implement remote monitoring systems to detect faults and optimize maintenance schedules.</p> <p>Maintain a stock of critical spare parts to expedite repairs during peak demand periods.</p>

## **Appendix B. Analysis of Energy Efficiency Solutions in Residential Buildings**

Key West, with its hot and humid tropical climate, presents both challenges and opportunities for implementing energy efficiency measures (EEMs) in residential buildings. This section evaluates the results of building energy simulations for a typical single-family home to assess the performance of selected EEMs. The measures include energy-efficient electric appliances, raised flooring with added insulation, passive exterior shading, weatherstripping and air sealing, duct sealing, and energy-efficient windows. The study also evaluates the integrated energy savings achieved when these measures are implemented as a package.

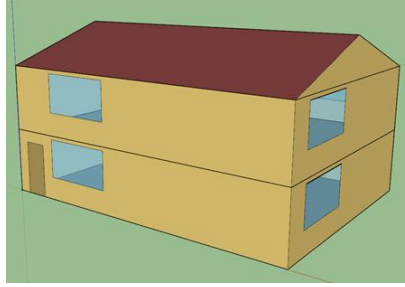
### **B.1 Single-Family Prototype Homes and Energy Benchmarking**

This analysis used the U.S. Department of Energy (DOE) residential prototype energy models for single-family homes representing two vintages: pre-1980 homes (older construction) and 2006 homes (built to meet 2006 residential building standards). Key West's climate is classified as Zone 1A (hot and humid) according to American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards (ASHRAE 2020). Building energy simulations for these baseline energy models were conducted using EnergyPlus version 25.1, a whole-building energy modeling engine that simulates heating, cooling, lighting, ventilation, and other energy flows. EnergyPlus captures detailed building physics—including HVAC systems, control strategies, and interactions with weather—to support building energy performance assessments (DOE 2025a). For energy simulation, Typical Meteorological Year 3 (TMY3) weather data in Key West Airport were used (Wilcox and Marion 2008; DOE 2025c).

#### **B.1.1 Model Description**

The prototype single-family home energy model is a two-story, all-electric building with a conditioned living space on both floors. The home is occupied by three residents, and occupancy profiles and internal loads follow the standard assumptions embedded in the prototype model. Cooling is provided by a heat pump system with a fixed cooling setpoint of 77°F. No space heating system is included, consistent with local design practice. Envelope characteristics reflect the corresponding construction vintage representing pre-1980 and 2006 conditions.

The prototype single-family home energy models are based on DOE residential building prototypes. The pre-1980 model builds on previous research by Lawrence Berkeley National Laboratory (Rosado and Levinson 2019). The 2006 model is derived from DOE's International Energy Conservation Code (IECC) -compliant residential prototype (DOE 2025b). Figure B-1 shows the single-family home energy model 3D view. Table B-1 summarizes key characteristics of the two models for pre-1980 and 2006 conditions.



**Figure B-1. 3D View of prototype single-family home. Note: The colors shown in this figure are not used for actual color considerations in the model; they are used within the modeling tool only to visually distinguish between various surface types.**

**Table B-1. Key single-family home energy model specifications for the pre-1980 and 2006 vintages**

Category	Parameters	Pre-1980	2006
Space	Conditioned living area (ft <sup>2</sup> )	2,405	2,381
	Garage area (ft <sup>2</sup> )	0	400
Envelope efficiency level	Roof assembly R-value <sup>31</sup> (ft <sup>2</sup> ·°F·h/Btu)	9.3	27.7
	Exterior wall assembly R-value (ft <sup>2</sup> ·°F·h/Btu)	5.7	10.7
	Gross window-to-wall ratio <sup>32</sup>	0.15	0.16
	Windows U-value <sup>33</sup> (Btu/ft <sup>2</sup> ·°F·h)	1.2	1.2
	Windows SHGC <sup>34</sup>	0.6	0.34
	Infiltration air change per hour <sup>35</sup>	0.59	0.54
HVAC	Cooling system EER <sup>36</sup> (Btu/W-h)	7.9	12.5

<sup>31</sup> The R-value, also called thermal resistance, describes the level of insulation of building surfaces. In the United States, the notation R-## (e.g., R-30) means “R-value of ##,” where the number is the material’s thermal resistance in ft<sup>2</sup>·°F·h/Btu. The higher the number, the better the insulation resists heat flow. More information on insulation can be found at <https://www.energy.gov/energysaver/insulation>.

<sup>32</sup> Window-to-wall ratio is the proportion of a building façade’s area that is composed of windows.

<sup>33</sup> The U-value, also called thermal transmittance or U-factor, measures how easily heat flows through a material or assembly and is the inverse of the R-value. Lower U-values indicate better insulation performance. For windows, a U-value of 1.2 Btu/ft<sup>2</sup>·°F·h is typical of a single-pane window.

<sup>34</sup> The solar heat gain coefficient (SHGC) is the fraction of solar radiation that passes through a window. Lower SHGC values mean less solar heat is transmitted, indicating greater shading effectiveness. More about energy performance of windows can be found at <https://www.energy.gov/energysaver/energy-performance-ratings-windows-doors-and-skylights>.

<sup>35</sup> Infiltration air changes per hour is the rate at which outdoor air enters and indoor air leaves a building through unintentional leaks. It is expressed as the number of times the entire indoor air volume is replaced in 1 hour.

<sup>36</sup> EER, or energy efficiency ratio, measures a cooling system’s efficiency by dividing its cooling output in Btu/h by its electrical input in watts, with higher values indicating better efficiency.

Category	Parameters	Pre-1980	2006
Lighting	Lighting power density <sup>37</sup> (W/ft <sup>2</sup> )	0.24	0.22
Electric load from appliances	Refrigerator (W)	91	91
	Clothes washer (W)	30	28
	Dishwasher (W)	68	66
	Electric dryer (W)	222	222
	Cooking range (W)	248	248
	Miscellaneous electric load (W)	908	908

### B.1.2 Baseline Simulation Results

The annual energy a home uses for every square foot of cooled (or heated) space (called energy use intensity [EUI]) for the baseline models is 14.4 kWh/ft<sup>2</sup> for the pre-1980 vintage single-family home and 9.6 kWh/ft<sup>2</sup> for the 2006 vintage. Table B-2 and Table B-3 provide the monthly end-use EUI breakdowns for both pre-1980 and 2006 vintages. Cooling energy dominates total use, accounting for 56% in pre-1980 homes and 39% in 2006 homes.

**Table B-2. Pre-1980 single-family prototype home electricity end-use EUI from building energy simulation results**

Month	Interior Lights (kWh/ft <sup>2</sup> )	Exterior Lighs (kWh/ft <sup>2</sup> )	Electric Equipment (kWh/ft <sup>2</sup> )	Fans (kWh/ft <sup>2</sup> )	Cooling (kWh/ft <sup>2</sup> )	Water Systems (kWh/ft <sup>2</sup> )	Total (kWh/ft <sup>2</sup> )
1	0.06	0.01	0.27	0.04	0.25	0.11	0.73
2	0.06	0.01	0.24	0.06	0.35	0.10	0.82
3	0.06	0.01	0.27	0.07	0.49	0.10	1.00
4	0.06	0.01	0.26	0.09	0.60	0.09	1.12
5	0.06	0.01	0.27	0.12	0.77	0.09	1.32
6	0.06	0.01	0.26	0.14	0.96	0.08	1.51
7	0.06	0.01	0.27	0.16	1.04	0.08	1.62
8	0.06	0.01	0.27	0.15	1.02	0.08	1.59
9	0.06	0.01	0.26	0.13	0.90	0.08	1.44
10	0.06	0.01	0.27	0.11	0.76	0.10	1.31
11	0.06	0.01	0.26	0.09	0.59	0.10	1.12

<sup>37</sup> Lighting power density is the amount of electrical power used for lighting per unit of floor area, usually expressed in watts per square foot (W/ft<sup>2</sup>).

Month	Interior Lights (kWh/ft <sup>2</sup> )	Exterior Lighs (kWh/ft <sup>2</sup> )	Electric Equipment (kWh/ft <sup>2</sup> )	Fans (kWh/ft <sup>2</sup> )	Cooling (kWh/ft <sup>2</sup> )	Water Systems (kWh/ft <sup>2</sup> )	Total (kWh/ft <sup>2</sup> )
12	0.06	0.01	0.27	0.06	0.37	0.11	0.87
Annual Sum	0.7	0.1	3.2	1.2	8.1	1.2	14.4

**Table B-3. 2006 vintage single-family prototype home electricity end-use EUI from building energy simulation results**

Month	Interior Lights (kWh/ft <sup>2</sup> )	Exterior Lighs (kWh/ft <sup>2</sup> )	Electric Equipment (kWh/ft <sup>2</sup> )	Fans (kWh/ft <sup>2</sup> )	Cooling (kWh/ft <sup>2</sup> )	Water Systems (kWh/ft <sup>2</sup> )	Total (kWh/ft <sup>2</sup> )
1	0.06	0.01	0.28	0.03	0.09	0.10	0.57
2	0.06	0.01	0.25	0.04	0.15	0.08	0.59
3	0.06	0.01	0.28	0.05	0.21	0.09	0.70
4	0.06	0.01	0.27	0.06	0.28	0.08	0.75
5	0.06	0.01	0.28	0.07	0.36	0.07	0.85
6	0.06	0.01	0.27	0.08	0.46	0.07	0.96
7	0.06	0.01	0.28	0.08	0.50	0.07	1.00
8	0.06	0.01	0.28	0.08	0.49	0.07	0.99
9	0.06	0.01	0.27	0.08	0.45	0.07	0.94
10	0.06	0.01	0.28	0.07	0.36	0.08	0.86
11	0.06	0.01	0.27	0.06	0.27	0.09	0.75
12	0.06	0.01	0.28	0.04	0.15	0.10	0.63
Annual Sum	0.7	0.1	3.3	0.7	3.8	1.0	9.6

### B.1.3 Community Benchmark Comparison

A sample of 4,994 single-family residential buildings was extracted from the dataset of average monthly electricity consumption summarized in Section 8.1.2. These homes vary in size and construction years, ranging from 1870 to 2024. The median annual EUI is 13.5 kWh/ft<sup>2</sup> for homes built before 1980, 11.5 kWh/ft<sup>2</sup> for those built between 1980 and 2005, and 9.9 kWh/ft<sup>2</sup> for homes constructed after 2006. Figure B-2 presents the distribution of EUI values across the residential dataset, categorized by three construction vintages.

The simulation results indicate the annual EUI for the pre-1980 vintage prototype model (14.4 kWh/ft<sup>2</sup>) is approximately 7% higher than the median EUI (13.5 kWh/ft<sup>2</sup>) derived from the measured annual energy consumption dataset. The pre-1980 prototype model assumes no retrofits to the building envelope or energy systems, reflecting the original built condition of

single-family homes from that vintage. In contrast, the measured consumption dataset may include homes that have undergone energy retrofits, leading to reduced energy usage.

For the 2006 vintage, the prototype model EUI (9.6 kWh/ft<sup>2</sup>) is approximately 3% lower than the median measured EUI (9.9 kWh/ft<sup>2</sup>) for homes built after 2006. This discrepancy may be attributed to real-world conditions, such as increased plug loads or lower cooling setpoint temperatures, which are not accounted for in the standardized operating assumptions of the prototype model. The differences between simulated and measured EUIs for both vintages are within 7%, indicating the prototype models serve as a reliable baseline for evaluating community-recommended energy efficiency measures.

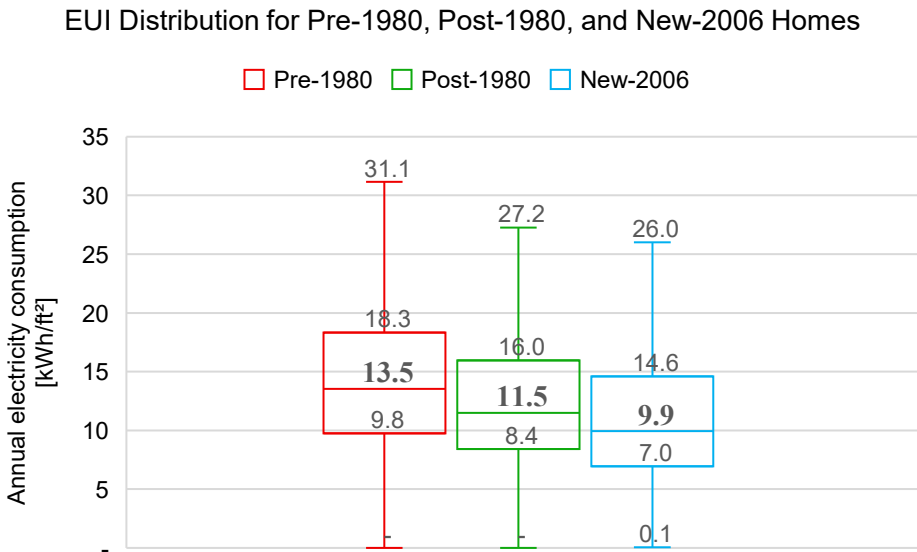


Figure B-2. Distribution of residential EUI by construction vintages of pre-1980, post-1980, and 2006

### B.1.4 Energy Efficiency Measures and Energy Saving Potentials

The study used building energy simulations to evaluate energy saving potential from implementing the EEMs. To manage simulations and conduct parametric analysis efficiently, jEPlus was used. jEPlus is a parametric simulation tool that automates EnergyPlus runs by systematically varying input parameters across multiple simulations. It enables parametric analysis, supporting sensitivity studies and design exploration (Yi Zhang 2025). The selected EEMs were the following:

- Upgrades to energy-efficient electric appliances
- Raised floors with and without insulation
- Passive shading strategies: exterior fixed shading
- Duct sealing
- Weatherstripping and air sealing
- Installation of energy-efficient windows

- Energy efficiency measures package (a combination of all the above).

Details of these measures and their associated energy savings potential from the simulation results for the two prototype vintages are discussed next. Table B-4 presents the simulation results, including the annual EUI for baseline and retrofit conditions of the pre-1980 and 2006 vintage homes, as well as the EUI breakdown by end use of electricity. The table ranks the EEMs by percentage energy savings potential.

Table B-5 summarizes the peak electricity intensity and peak time under baseline conditions and the corresponding reductions achieved through retrofits.

**Table B-4. Electricity EUI by end use for the baseline condition and retrofit conditions with EEMs and energy savings potential for pre-1980 and 2006 vintage single-family prototype home in Key West**

Vintage	Energy Efficiency Measure	Total (kWh/ft <sup>2</sup> )	Total Savings (%)	Electric Appliances (kWh/ft <sup>2</sup> )	Electric Appliances Savings (%)	Cooling (kWh/ft <sup>2</sup> )	Cooling Savings (%)	Fans (kWh)	Fans Savings (%)	Water Systems (kWh/ft <sup>2</sup> )	Interior Lighting (kWh/ft <sup>2</sup> )	Exterior Lighting (kWh/ft <sup>2</sup> )
Pre-1980	Baseline	14.4	-	3.3	-	7.9	-	1.2	-	1.2	0.7	0.2
	Appliances	14.2	1.4	3.2	3.1	7.8	1.1	1.2	1.2	1.2	0.7	0.2
	Raised Floor w/o Insulation	14.0	2.7	3.3	-	7.6	4.3	1.1	4.2	1.2	0.7	0.2
	Shading	13.8	3.6	3.3	-	7.5	5.6	1.1	6.2	1.2	0.7	0.2
	Duct Sealing	13.0	9.2	3.3	-	6.7	14.6	1.0	14.4	1.2	0.7	0.2
	Weatherstripping	12.7	11.8	3.3	-	6.3	20.1	1.1	8.7	1.2	0.7	0.2
	Windows	12.4	13.8	3.3	-	6.2	21.2	0.9	25.8	1.2	0.7	0.2
	Package	9.3	35.0	3.2	3.1	3.6	54.8	0.6	50.5	1.2	0.7	0.2
2006	Baseline	9.6	-	3.3	-	3.7	-	0.7	-	1.0	0.7	0.2
	Appliances	9.4	1.1	3.2	2.5	3.7	0.4	0.7	0.3	1.0	0.7	0.2
	Shading	9.4	1.9	3.3	-	3.5	4.2	0.7	3.4	1.0	0.7	0.2
	Raised Floor w/o Insulation	9.3	2.8	3.3	-	3.5	6.3	0.7	5.2	1.0	0.7	0.2
	Weatherstripping	9.0	5.5	3.3	-	3.2	12.5	0.7	8.2	1.0	0.7	0.2
	Duct Sealing	9.0	6.1	3.3	-	3.2	13.7	0.6	10.7	1.0	0.7	0.2
	Windows	8.9	6.2	3.3	-	3.2	13.9	0.6	11.0	1.0	0.7	0.2
	Package	7.6	20.4	3.2	2.5	2.1	43.9	0.5	34.3	1.0	0.7	0.2

**Table B-5. Peak electricity demand and peak time for the baseline condition and retrofit conditions with EEMs and peak electricity reduction potential for pre-1980 and 2006 vintage single-family prototype home in Key West**

Vintage	Energy Efficiency Measure	Peak Electricity (W/ft <sup>2</sup> )	Peak Timestamp	Reduction (%)
Pre-1980	Baseline	4.5	31-MAY-18:10	-
	Appliances	4.5	13-AUG-18:10	0.1
	Raised Floor w/o Insulation	4.5	31-MAY-18:30	-0.8
	Shading	4.4	13-AUG-18:10	1.2
	Duct Sealing	4.2	14-AUG-16:20	5.5
	Weatherstripping	4.0	13-AUG-18:20	11.7
	Windows	3.9	22-JUL-19:20	12.7
	Package	3.3	18-JUL-18:40	27.1
2006	Baseline	3.2	18-JUL-18:10	-
	Appliances	3.2	18-JUL-18:10	0.5
	Shading	3.2	14-AUG-18:10	1.0
	Raised Floor w/o Insulation	3.2	09-JUN-18:10	0.5
	Weatherstripping	3.0	04-SEP-17:40	6.0
	Duct Sealing	3.0	15-JUN-18:40	4.6
	Windows	3.0	19-AUG-18:40	7.3
	Package	2.7	31-MAY-18:30	14.9

#### *B.1.4.1 Upgrades to Energy-Efficient Electric Appliances*

Replacing older appliances—such as refrigerators, dishwashers, and clothes washers—with ENERGY STAR-rated models reduces electricity consumption associated with appliance use. In this study, electricity usage from other home appliances and plug loads was assumed to remain constant for both pre-1980 and 2006 vintage homes. The reduction in appliance electricity use also contributes to decreased cooling energy demand because of lower internal heat gains. The efficiency levels for these upgraded appliances are based on the IECC 2024 prototype single-family home energy model (DOE 2025b). The resulting electricity savings from appliance upgrades are estimated at 1.3% for pre-1980 homes and 1.1% for 2006 vintage homes.

#### *B.1.4.2 Raised Floor With and Without Insulation*

A raised flooring system for residential homes in Key West, Florida (Climate Zone 1A: hot–humid) can reduce energy consumption primarily by enhancing passive cooling. The raised floor facilitates natural air circulation beneath the home, creating a buffer zone between the hot ground and the building envelope. This airflow cools the underside of the floor, reducing the

temperature differential across the floor assembly and lowering the overall thermal load (Tahir et al. 2010). In cases where the subfloor space is highly ventilated, the underside temperature closely follows the outdoor air temperature, further enhancing convective cooling. In the energy modeling, the baseline condition has a slab-on-grade foundation, whereas the raised floor measure allows air movement beneath the structure and heat transfer from the floor to the exterior air.

**The baseline model assumes a slab-on-grade floor with no floor insulation. According to the IECC requirements for single-family homes in Climate Zone 1A—which includes Key West, Florida—there is no mandatory requirement for slab-on-grade floor insulation under the prescriptive compliance path (Salcido et al. 2024). In the raised floor scenario without added insulation, electricity consumption decreases by about 3%, primarily driven by a 4% reduction in cooling energy use. Note the raised floor interacts with outdoor air temperature and wind, affecting heat transfer through the floor to the interior space. Because cooling demand varies with weather conditions, this can result in either a positive or negative impact on peak electricity consumption compared to the slab-on-grade condition.**

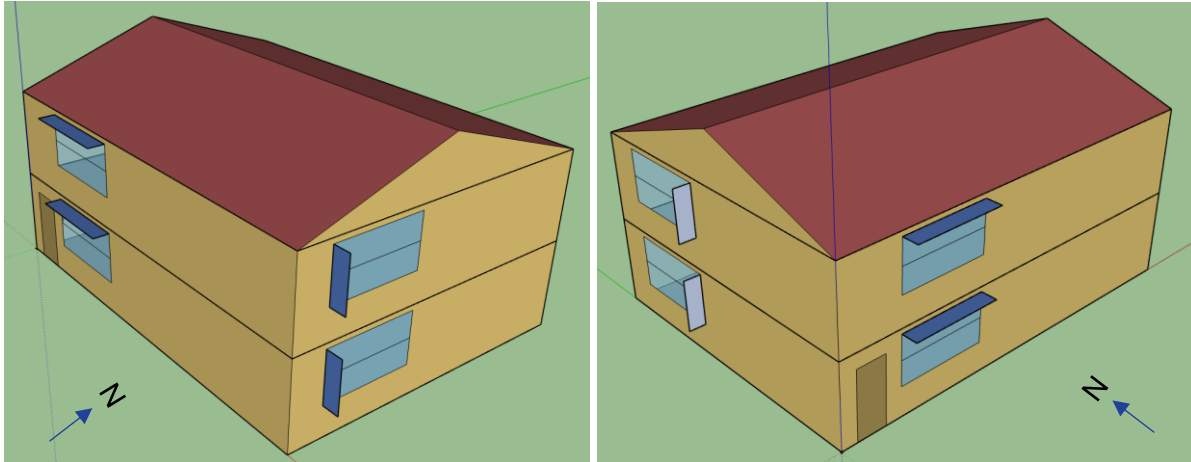
Table B-5 shows a slight increase in peak electricity demand for pre-1980 vintage homes and a slight decrease for 2006 vintage homes, occurring at various times.

In cooling-dominated climates such as Key West, floor insulation is generally less beneficial than in heating-dominated regions, where it helps prevent heat loss (Staszczuk et al. 2017). To evaluate the impact of insulation, the study tested an elevated floor with insulation rated at R-10.7 (ft<sup>2</sup>·°F·h/Btu), equivalent to the exterior wall insulation level by IECC 2024 code (DOE 2025b). Simulation results showed this added insulation had a negative effect, increasing cooling energy consumption by approximately 5%–6%. This is likely because of reduced passive cooling from the floor.

#### ***B.1.4.3 Passive Shading Strategies: Exterior Fixed Shading***

Exterior shading strategies—overhangs and vertical fins—were applied to windows to reduce direct solar heat gain. The external shading overhang and fin elements are specified as follows based on the research on resilient passive cooling strategies (Al-Assaad et al. 2025). Each louver is 20 inches deep. A horizontal overhang is applied to windows on the south façade. On both the east and west façades, vertical fins are placed on the southern edge of each window. No shading devices are applied to the north façade. The length of each louver corresponds to the width (for overhangs) or height (for fins) of the window. Figure B-3 illustrates the application of overhangs and fins in the single-family home prototype model.

These overhangs and fins contribute to electricity savings of approximately 4% for pre-1980 vintage homes and 2% for 2006 vintage homes. The savings are primarily because of reduced cooling demand resulting from decreased solar heat gain. Because the window systems in pre-1980 homes are generally less efficient than those in 2006 homes, the shading measures have a greater impact on energy performance in the older vintage. In addition, the fixed exterior shading devices help reduce peak cooling loads during summer afternoons, contributing to a 1% reduction in peak electricity demand.



**Figure B-3. Overhangs applied to the south façade and vertical fins installed on the south side of windows on the east and west façades**

#### ***B.1.4.4 Duct Sealing***

Sealing the ductwork minimizes air leakage and improves air distribution efficiency. In the baseline condition, duct systems are assumed to lose 10% of air through leaks. The duct sealing measure eliminates this loss by ensuring airtight ducts, allowing all conditioned air to reach the living spaces (Jump et al. 1996). This results in reduced energy consumption for both cooling and fan operation by preventing unnecessary energy loss. The duct sealing measure contributes to electricity savings of approximately 9% for pre-1980 homes and 6% for 2006 vintage homes by reducing losses in cooling and fan energy.

#### ***B.1.4.5 Weatherstripping and Air Sealing***

Reducing air leakage through air-tightness measures—such as sealing cracks and gaps—helps minimize energy losses. In this study, the air leakage rate was reduced to 0.3 air changes per hour, consistent with the requirements for single-family homes in the latest IECC 2024 code (DOE 2025b). This measure contributes to estimated energy savings of approximately 12% for pre-1980 vintage homes and 6% for 2006 vintage homes.

#### ***B.1.4.6 Installation of Energy-Efficient Windows***

Installing energy-efficient windows reduces solar heat gain and improves overall thermal performance. This measure decreases cooling energy consumption by limiting solar heat gain through high-performance glazing, enhancing indoor comfort and reducing reliance on air conditioning. The technical specifications of the windows are based on the IECC 2024 requirements for single-family homes, with a U-value of 0.5 Btu/ft<sup>2</sup>·°F·h and SHGC of 0.218 (DOE 2025b).

Both pre-1980 and 2006 vintage prototype homes were observed to have single-pane windows. Pre-1980 homes typically have poor glazing performance with a high SHGC of 0.60, whereas the 2006 vintage homes exhibit a lower SHGC of 0.33. As a result, the energy savings potential from window replacement is more significant in older homes because of the greater contrast in window performance. Upgrading from inefficient to high-performance windows yields more savings in the older vintage homes.

#### *B.1.4.6 Energy Efficiency Measures Package*

The study evaluates the combined effect of all EEMs implemented as a package. This integrated approach results in an estimated 35% reduction in annual electricity consumption for pre-1980 vintage homes and 20% for 2006 vintage homes. In addition, the package contributes to peak electricity load reductions of 27% for pre-1980 homes and 15% for 2006 homes during the high cooling demand period in the summer season.

## Appendix C. Analysis of Solar Generation Potential in Residential Buildings

This analysis used electricity load profiles generated from the building performance simulation models described in Appendix B, reflecting baseline conditions for pre-1980 and 2006 residential building vintages. The objective was to estimate the potential solar PV generation from rooftop installations on representative homes. A roof area of 600 ft<sup>2</sup> was assumed to be available for PV panels, which corresponds to the building’s south-facing section. The REopt modeling tool<sup>38</sup> was used to evaluate system performance and estimate the share of the building’s electricity demand that could be met by solar under typical operating conditions.

A 6-kW PV system was identified as suitable for both housing vintages, based on the assumed roof area and typical system sizing. At this stage, battery storage was not included in the analysis, because the scope was limited to assessing solar generation potential under normal grid-connected conditions without considering the additional benefits of backup power during outages. Table C-1 provides a summary of the main results.

**Table C-1. Annual electricity profile considering 6-kW PV system in pre-1980 and 2006 residential building vintages**

Vintage	Breakdown of Annual Electricity Use and PV Generation	Electricity (kWh)	Fraction of Electricity Consumption
Pre-1980	Grid Serving Load	25,135	73%
	PV Serving Load	9,338	27%
	PV Exported to Grid	227	-
	PV Total Electricity Produced	9,565	-
	Total Electricity Consumed	34,473	100%
2006	Grid Serving Load	14,370	63%
	PV Serving Load	8,311	37%
	PV Exported to Grid	1,254	-
	PV Total Electricity Produced	9,565	-
	Total Electricity Consumed	22,681	100%

<sup>38</sup> Learn more about REopt at <https://reopt.nrel.gov/tool>.

## **Appendix D. Potential Scope of Work for a Deep Dive Project**

**Project Title:** Energy Efficiency and Resilience Mapping for the City of Key West

**Project Duration:** 12 months (November 2025–October 2026)

### **Project Summary:**

This project proposes the development of a citywide energy efficiency and resilience map for Key West using the CityBES tool to evaluate and identify improvements in the performance of residential, institutional, and commercial buildings. It will simulate the impacts of implementing energy efficiency measures and assess how buildings perform under stress from extreme heat and extended power outages. The analysis will provide building-specific estimates of energy savings, implementation costs, and return on investment while identifying vulnerable structures and populations. The project will build on prior analysis conducted through the ETIPP Strategic Energy Plan, leveraging existing data and expanding the assessment to support implementation. Outputs will support resilience planning, guide adaptation investments, inform local policy, and enhance community preparedness and engagement.

### **Project Goal:**

Develop a citywide energy and resilience map for Key West using an urban building energy model to evaluate the impacts of energy efficiency upgrades and assess building vulnerability under grid-related stressors. The project will inform cost-effective retrofit strategies and resilience investments by simulating energy savings, implementation costs, and risk exposure across the city's diverse building stock.

### **Anticipated Impacts:**

- Mapping of potential energy savings through implementation of cost-effective efficiency measures across building types
- Mapping of financial benefits through locally tailored estimates of upgrade costs, return on investment (ROI), and payback periods
- Risk reduction through identification of buildings and populations vulnerable to extreme heat and power outages
- Increased funding competitiveness through evidence-based applications for grants and resilience investments
- Community resilience enhancement through building-level strategies to reduce energy demand and outage impacts
- Public engagement through accessible mapping and analysis of energy and resilience opportunities.

## D.1 Activities

### D.1.1 Activity 1: Data Collection for Energy and Resilience Modeling

**Description:** This activity will focus on compiling and refining the building-level data necessary to support energy modeling and resilience analysis in CityBES. It includes verifying and supplementing existing datasets from the Strategic Energy Plan to accurately represent the diversity of residential and commercial buildings in Key West. The technical team will guide the city in identifying any data gaps, collecting missing information, and validating inputs such as building geometry, usage, construction characteristics, and HVAC system types. This foundational work will ensure the reliability of simulation results and the effectiveness of the energy and resilience map.

#### Tasks:

1. Review and refine existing building data from the Strategic Energy Plan to ensure suitability for energy and resilience modeling.
2. Identify and fill critical data gaps related to building type, geometry, systems, and construction characteristics.
3. Coordinate with city staff to collect or validate missing information and ensure local accuracy.
4. Prepare, document, and format the final dataset for integration into CityBES.

#### Risks:

- Incomplete or imprecise data may require assumption-based estimates.
- Delays in data collection or delivery may affect the timeline of modeling tasks.

**Output:** CityBES-ready input files for use in simulation and mapping activities.

### D.1.2 Activity 2: Data Collection for Cost Assessment of Energy Efficiency Measures

**Description:** This activity will focus on gathering local cost data for implementing energy efficiency measures in Key West. It aims to supplement national or state-level benchmarks with region-specific information that reflects local labor rates, material availability, and logistical constraints. This effort will ensure cost and ROI estimates produced by the modeling are grounded in real-world conditions and provide actionable insights for city decision making. The analysis will focus on the energy efficiency measures identified during the Strategic Energy Planning process, including those prioritized by the community through the survey conducted.

#### Tasks:

1. Identify key energy efficiency measures to be assessed, based on the Strategic Energy Plan and community priorities.
2. Gather local cost data for labor, materials, and installation through engagement with contractors, vendors, and city departments.
3. Document all cost inputs and estimation methods for integration into ROI analysis.

**Risks:**

- Limited availability of localized cost data may require reliance on estimates or extrapolation from broader datasets.
- Variation in contractor pricing or seasonal fluctuations could affect the accuracy of cost assumptions.
- Difficulty engaging local vendors or obtaining consistent pricing information may delay data collection.
- Differences in scope or installation practices may complicate comparisons across measures.

**Outcome:** Localized cost dataset for key energy efficiency measures relevant to Key West.

**D.1.3 Activity 3: Model Development Under Baseline Conditions**

**Description:** This activity will involve building and calibrating a baseline urban building energy model of Key West using the CityBES platform. The model will reflect current building characteristics, systems, and energy use patterns under typical operating conditions, without any efficiency upgrades. It will serve as the foundation for evaluating the performance and cost-effectiveness of retrofit strategies as well as for identifying resilience vulnerabilities.

**Tasks:**

1. Set up the CityBES model using refined building data, including geometry, construction, and system characteristics.
2. Run baseline simulations to estimate current energy performance of modeled buildings.
3. Calibrate model outputs using utility data previously collected during the Strategic Energy Plan to improve accuracy and reliability.

**Risks:**

- Data limitations could impact the accuracy of the analysis.
- Limitations in CityBES or available input data may restrict the ability to fully represent certain building types or systems.
- Inconsistencies in the utility data may limit the effectiveness of model calibration. Calibration challenges may also arise if energy use patterns have changed since data collection during the Strategic Energy Plan. To mitigate these risks, additional energy use data can be collected, if deemed necessary.

**Outputs:**

- CityBES baseline energy model representing residential and commercial buildings in Key West

- Simulated energy performance results for all modeled buildings under current conditions
- Ready-to-use baseline model for subsequent scenario analysis and retrofit evaluation
- Presentation slides for community feedback.

#### **D.1.4 Activity 4: Model Development Under Energy Efficiency Scenarios**

**Description:** This activity will simulate the energy and economic impacts of implementing selected energy efficiency measures across Key West’s building stock. Using the calibrated baseline model developed in the previous activity, the team will apply upgrade scenarios—such as improved insulation, high-efficiency HVAC systems, and advanced windows—to estimate energy savings, cost reductions, and related performance metrics. Scenarios will be tailored to various building types and characteristics, aligning with priorities identified in the Strategic Energy Plan and community input.

#### **Tasks:**

1. Define energy efficiency upgrade scenarios based on Strategic Energy Plan findings and community priorities.
2. Apply selected upgrade measures to the calibrated baseline model in CityBES across various building types.
3. Simulate energy performance, cost savings, and other relevant metrics for each scenario.
4. Analyze and compare results to identify high-impact strategies by building type or sector.

#### **Risks:**

- Variability in building conditions may lead to inconsistent results across similar building types.
- Data limitations could impact the accuracy of the analysis.
- Uncertainty in cost assumptions could influence ROI and payback estimates.

#### **Outputs:**

- Simulated energy performance and cost savings results for each upgrade scenario
- Comparative analysis of energy efficiency measures across building types and sectors
- ROI and payback period estimates for locally relevant retrofit strategies
- Summary tables and graphics to support decision making and communication of results
- Presentation slides for community feedback.

### D.1.5 Activity 5: Model Development Under Resilience Scenarios

**Description:** This activity will evaluate how buildings in Key West perform under stress conditions such as extreme heat and extended power outages. Using the calibrated baseline model and one selected energy efficiency scenario, simulations will be conducted to assess passive survivability and thermal resilience across residential and commercial buildings. The analysis will identify which buildings are most at risk of overheating or unsafe indoor conditions during grid disruptions.

#### Tasks:

1. Define stress scenarios representing extreme heat and extended power outages based on local conditions.
2. Simulate indoor thermal performance under these scenarios using the calibrated model.
3. Compare resilience outcomes under baseline conditions and after implementation of a selected energy efficiency scenario.
4. Assess passive survivability and identify priority buildings or areas for resilience interventions and emergency planning.

#### Outcomes:

- Building-level map identifying structures at highest risk of overheating during multiday power outages
- Ranked list of priority buildings for resilience interventions based on indoor thermal performance
- Presentation slides for community feedback.

### D.1.6 Activity 6: Final Report and Public Outreach

**Description:** Synthesize findings from all project activities into a clear, comprehensive final report that supports public outreach, community decision making, and next steps.

#### Tasks:

1. Compile all data, analysis, and findings from previous activities.
2. Integrate stakeholder feedback and community preferences.
3. Draft and revise the final report.
4. Present results in a community-facing meeting or summary format.

#### Deliverables:

- Final written report summarizing the process, findings, and options, including potential next steps and funding sources.
- A presentation slide deck.

## D.2 Project Schedule

The project will last 12 months, estimated to start in November 2025 and end in October 2026 (see Table D-1).

**Table D-1. Potential Schedule for the Deep Dive Project**

	2025		2026									
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
<b>Scoping</b>	x											
<b>Technical Assistance</b>												
<b>Activity 1:</b> Data Collection for Energy and Resilience Modeling		x	x									
<b>Activity 2:</b> Data Collection for Cost Assessment of Energy Efficiency Measures		x	x	x								
<b>Activity 3:</b> Model Development Under Baseline Conditions			x	x	x							
<b>Activity 4:</b> Model Development Under Energy Efficiency Scenarios						x	x	x				
<b>Activity 5:</b> Model Development Under Resilience Scenarios									x	x		
<b>Activity 6:</b> Final Report and Public Outreach											x	x

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