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Utilizing the Local Energy Action Framework (LEAF) to Prioritize Decarbonization Projects

February 2023

Authors & Acknowledgments

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Acknowledgements

The authors are grateful to the following people and institutions for providing thoughtful insight and feedback on this tool: City of Alexandria, VA; City of Ann Arbor, MI; City of Atlanta, GA; City of Boise, ID; City of Cincinnati, OH; and County of Miami-Dade, FL.

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Executive Summary

While local governments across the United States have announced 100% renewable energy or carbon-neutrality goals for their operations, understanding what these goals entail and how they should prioritize various projects remains a challenge. While many energy models have been developed for utility resource planning, these frameworks are costly and more technical than most cities and counties need.

To bridge this gap, RMI has co-developed the Local Energy Action Framework (LEAF) with six US local governments, including Alexandria, VA; Ann Arbor, MI; Atlanta, GA; Boise, ID; Cincinnati, OH; and Miami-Dade County, FL. **LEAF is a step-by-step process that helps local governments prioritize facility types and energy actions by leveraging an integrated, holistic, and intuitive energy and decarbonization model**.

This slide deck provides an overview of LEAF and details on the following four key takeaways from the pilot cities and counties:

1. Local governments should prioritize energy efficiency improvements in facilities with the highest electricity demand. For most cities and counties, these will include water and wastewater facilities and airports.
2. Electrification can provide a majority of the potential CO_2 emissions reductions achievable from local investments. Meanwhile, heating and fleet electrification each may increase total facility loads by 5%–17% in cooler climate zones.
    - Electrifying existing fossil fuel appliances in buildings, especially heating, will likely add significant electricity demand in winter and increase load peaks in the early morning.
3. To move toward 24×7 clean electricity, local governments should leverage flexible loads and batteries to shift demand to hours of the day with lower electricity usage and/or greater renewable energy availability.
4. Local governments should purchase off-site renewable energy, especially non-solar resources, to fill the remaining gaps and achieve their 100% targets.

For more information about **how to utilize LEAF to prioritize projects for federal funding opportunities**, watch the webinar recording here.

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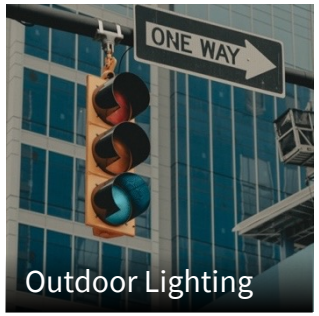
LEAF is a holistic planning framework that helps local governments prioritize decarbonization efforts for municipal operations.

*A holistic framework can help local governments **identify the biggest opportunities and gaps** by addressing the two questions below:*

Which ***facility types*** should be prioritized?

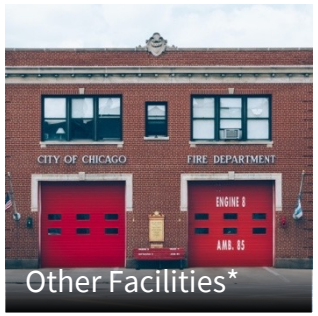

Water & Wastewater


Municipal Airports



Outdoor Lighting


Office Buildings



Other Facilities*


Electrification


Energy Efficiency

Which ***energy actions*** should be prioritized?


Demand Flexibility

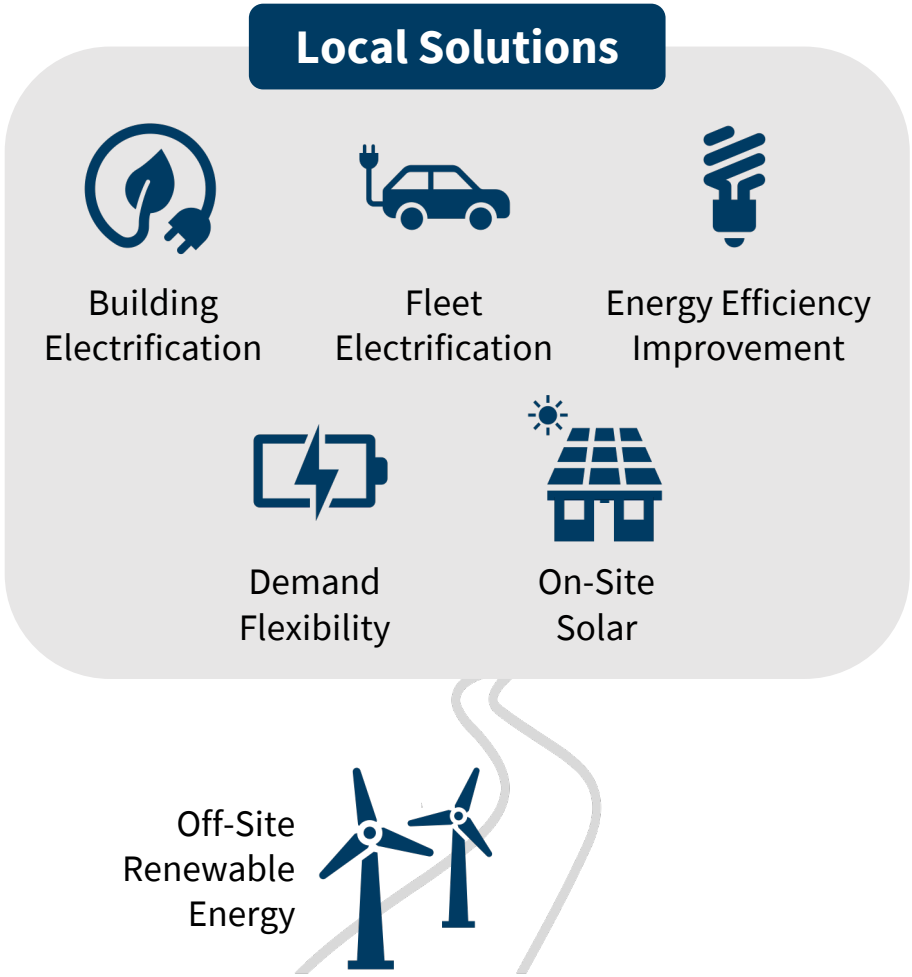
On-Site Solar


Off-Site Renewables

LEAF then **analyzes the collective impacts of these strategies holistically**, allowing local governments to better align overall electricity supply and demand to support a high-renewable grid and minimize both costs and price volatility.

***Note**: Other facilities include police and fire stations, museums, libraries, parks, recreation centers, and warehouses, etc.

A core principle of LEAF is to maximize “local” actions and projects before moving to off-site solutions.



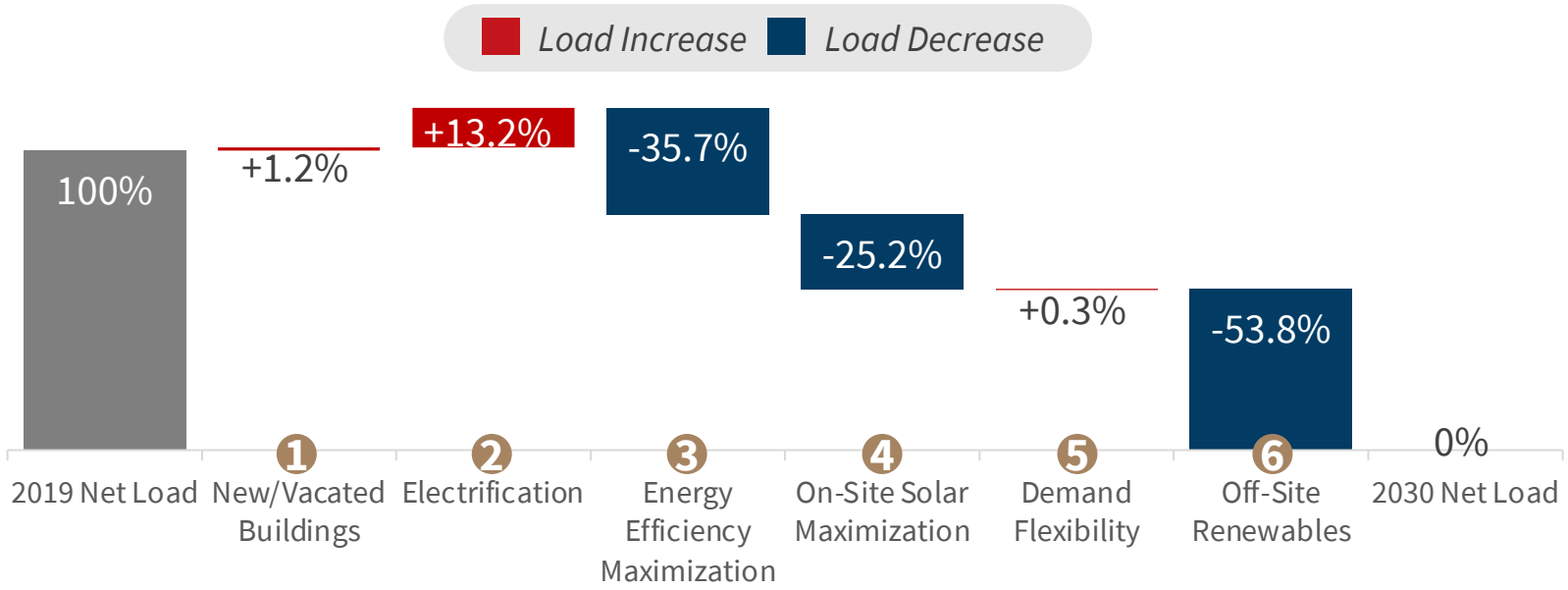
Maximizing local resource utilization can provide **more monetized benefits** and **lower energy costs** by…

- Minimizing transmission & distribution (T&D) losses and the need for more T&D investment
- Increasing the flexibility of local electricity systems
- Creating local clean energy jobs
- Reducing local greenhouse gas emissions and improving local air quality
- Providing local public health benefits

LEAF is based on a quantitative analysis that evaluates the impact of energy actions on municipal loads.

- For US local governments, the potential load increase from electrification and new building development can usually be offset by maximizing energy efficiency upgrades.
- However, on-site solar potential is generally insufficient to achieve 100% clean electricity, meaning that local governments will need to leverage off-site resources to meet their targets.

Impact of Energy Actions on Municipal Load: Example of Alexandria, VA

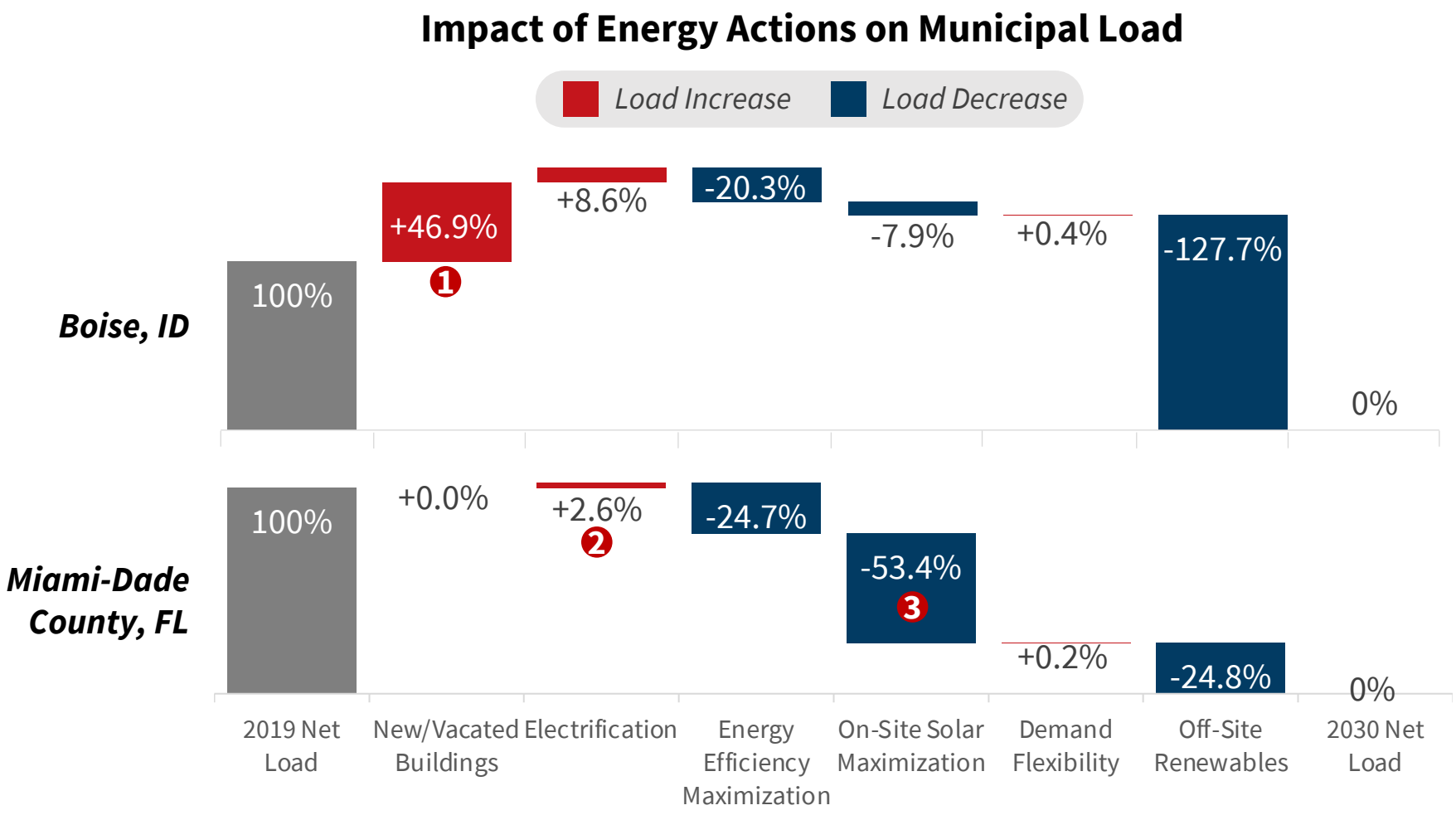


Notes:

1. **New/Vacated Buildings**: Constructing new buildings and/or vacating or demolishing existing ones
2. **Electrification**: Electrifying heating in buildings and procuring electric vehicles
3. **Energy Efficiency Maximization**: The maximum potential for energy efficiency upgrades in municipal facilities
4. **On-Site Solar Maximization**: The maximum potential for installing rooftop solar at municipal facilities
5. **Demand Flexibility**: Shifting load to non-peak hours or when more renewable energy is available
6. **Off-Site Renewables**: Procuring renewable energy through off-site sources, such as power purchase agreements; could include wind or solar

Source: LEAF Analysis

The impacts of each strategy are affected by local development plans and regional differences (e.g., weather patterns)



Highlights:

1. The City of Boise is planning to build a new water facility and an airport terminal, which will significantly increase the city's annual electricity usage.
2. Miami-Dade County's 2030 electrification plan only includes vehicle fleets since most of their buildings had already been electrified by 2019 and there is little need for heating due to the hot climate.
3. Miami-Dade County has excellent on-site solar potential across more than 1,000 office buildings with sufficient rooftop space to host solar PV projects.

Source: LEAF Analysis

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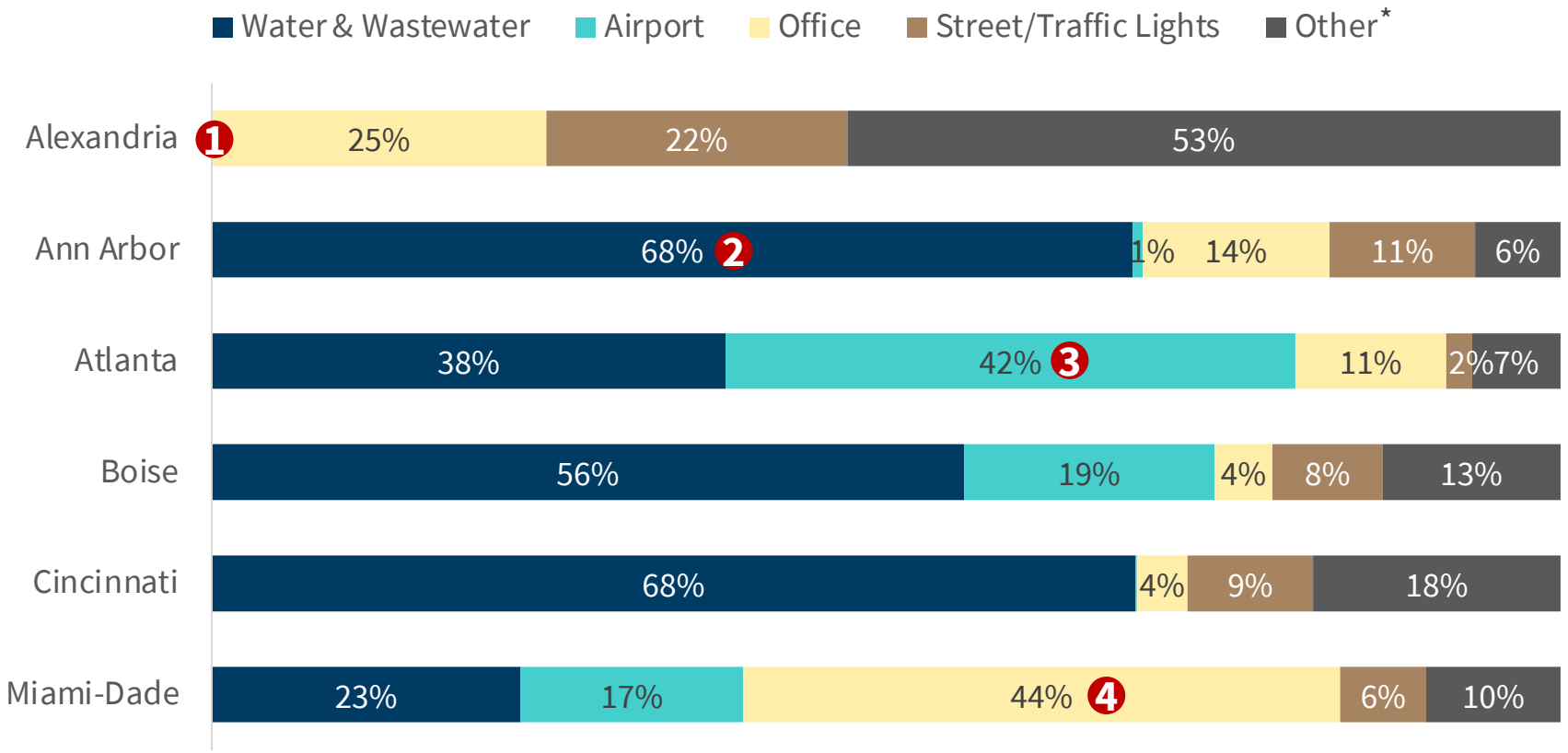
Local governments should prioritize energy efficiency improvements in facilities with the highest electricity demand.

Water/wastewater facilities and airports are often some of the largest electricity users and have large energy efficiency potential.

2019 End-Use Load Profile for Municipal Operations



Highlights:

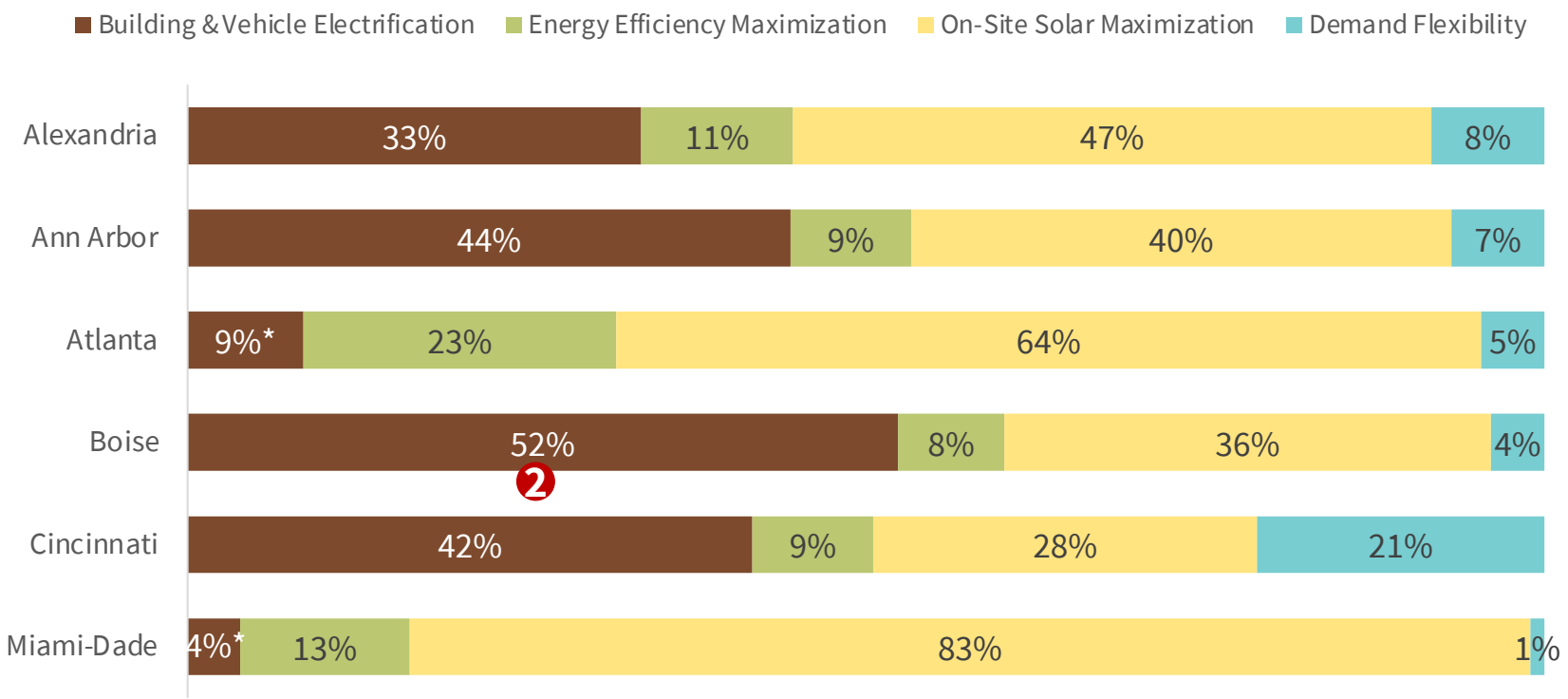
1. The water and wastewater facilities in Alexandria are not operated by the city government.
2. If Ann Arbor maximizes energy efficiency in its water and wastewater treatment plants, the city's total municipal load would be lowered by 10%.
3. The City of Atlanta owns and operates one of the largest airports in the United Stated, the Hartsfield-Jackson Atlanta International Airport.
4. Miami-Dade County has more than 1,000 office buildings with significant energy savings potential.

Source: LEAF Analysis | ***Note**: Other facilities may include police and fire stations, parks, recreation centers, and warehouses, etc.

Electrification can significantly decrease carbon emissions, especially in cleaner electric grids.

Impact of Energy Actions on CO_2 Emissions as a Percentage of Total Reduction Potential 1

(Excluding off-site renewable procurement)



Source: LEAF Analysis | ***Note**: The City of Atlanta and Miami-Dade County do not have heating electrification plans.

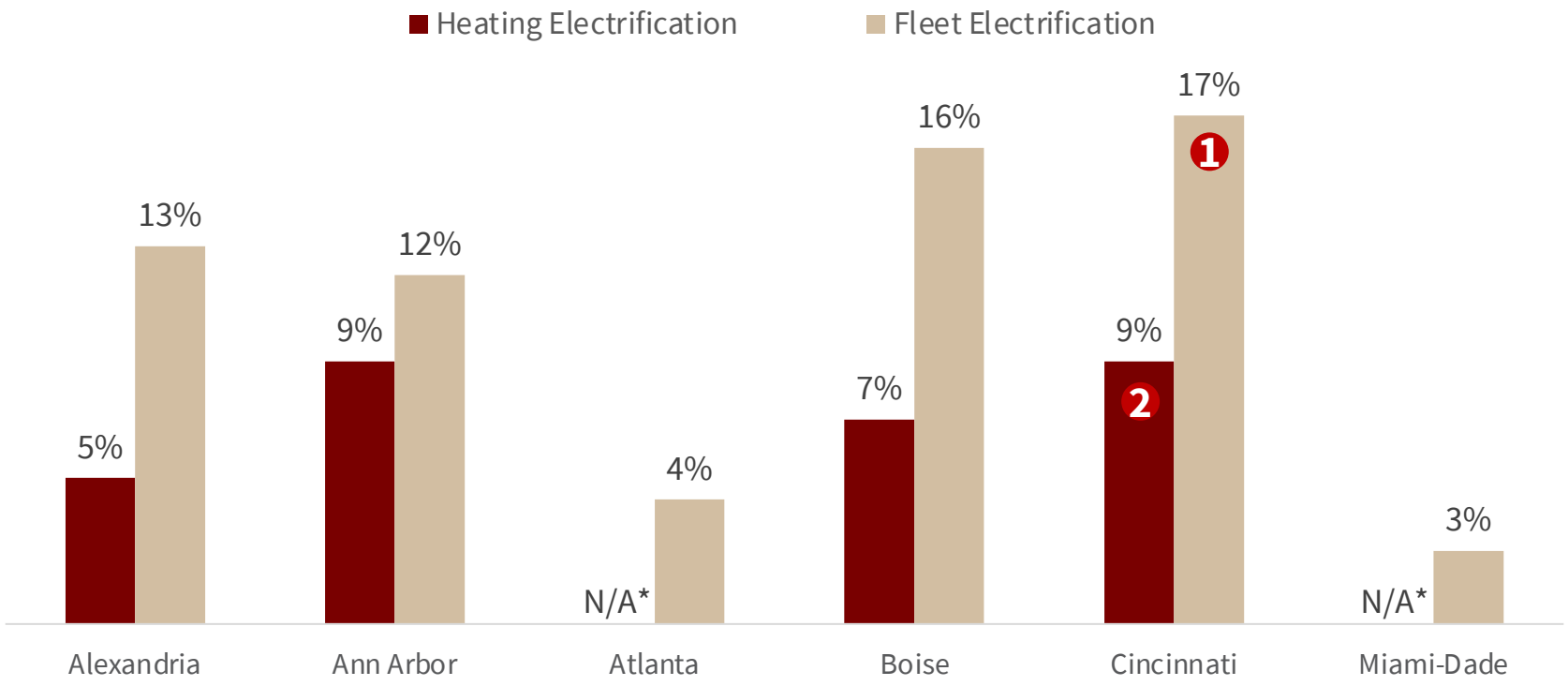
Highlights:

1. The total CO_2 emissions reduction potential depends on how clean the grid is and will be in the future. Local governments should collaborate with local utilities to ensure the grid is decarbonizing in line with their needs and timeline.
2. Under the current emissions scenario, electrification could account for up to 52% of the total carbon emissions reductions resulting from all planned local decarbonization efforts by 2030 (excluding off-site renewable procurement).

Meanwhile, fleet and heating electrification each may increase municipal facility loads by 5%–17% in cooler climate zones.

Load Increase from Heating and Fleet Electrification as a Percentage of the 2019 Total Facility Load

(Excluding water and wastewater facilities)



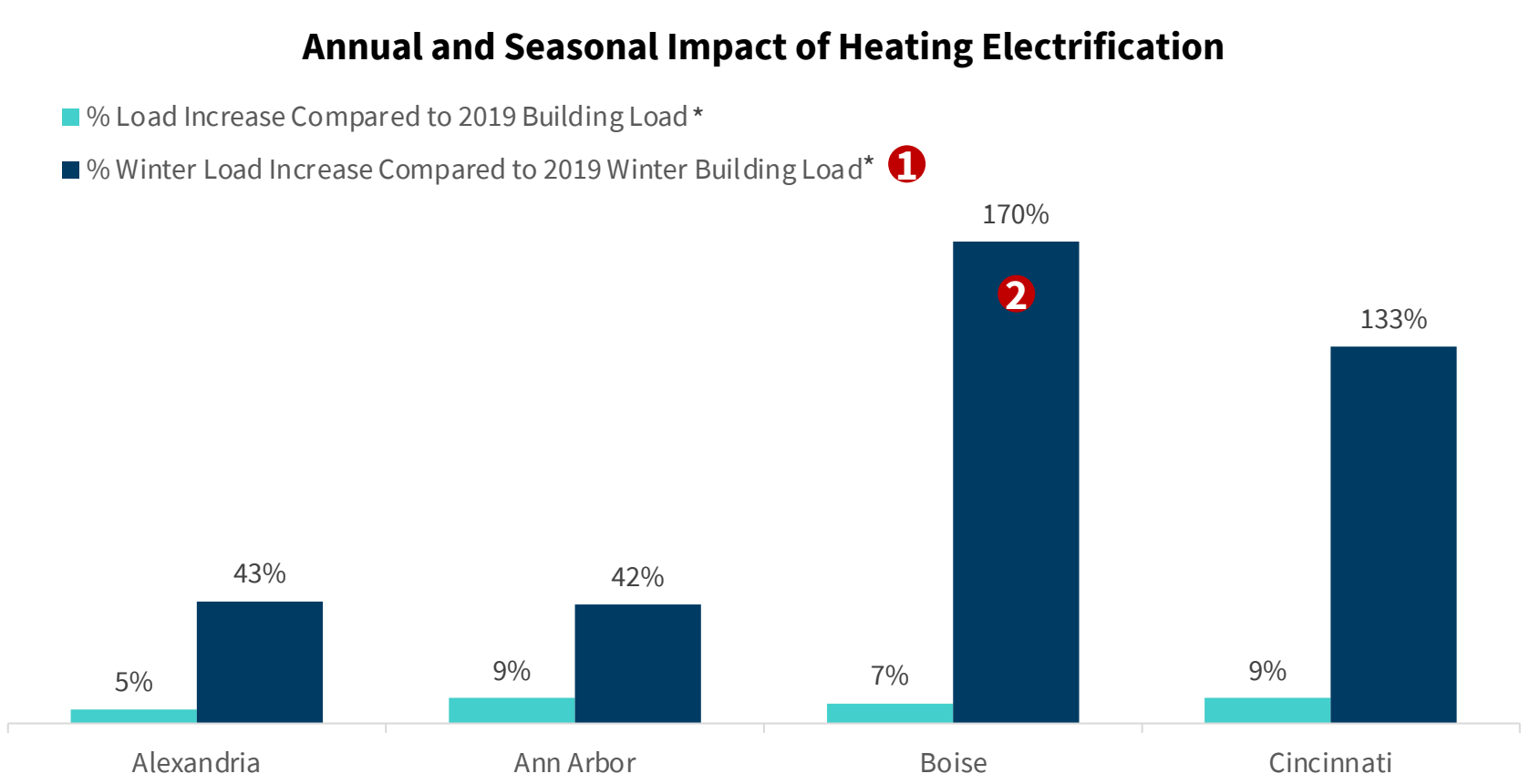
Highlights:

1. Electrifying vehicle fleets will increase the total facility load (excluding water facilities) by up to 17% annually.
2. Electrifying heating in buildings will increase the total facility load (excluding water facilities) by up to 9% annually.

Source: LEAF Analysis | ***Note**: The City of Atlanta and Miami-Dade County do not have heating electrification plans.

Electrifying heating will likely add significant electricity demand in winter and increase the load peaks in the early morning.

It is important to electrify heating with efficient technologies (i.e., heat pumps) to minimize the winter electric load growth.

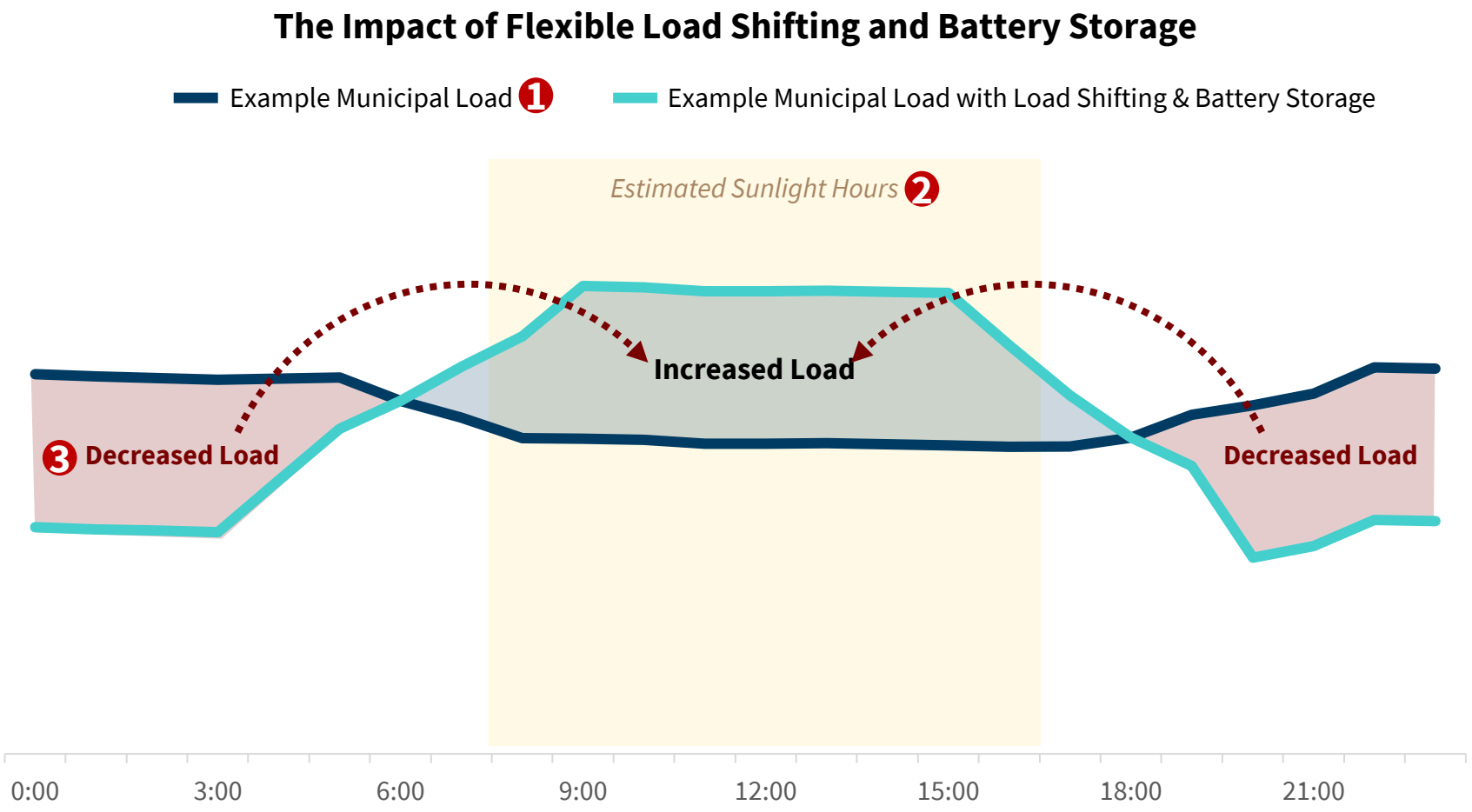


Highlights

1. The significant increase in winter load is due to the electrification of heating systems.
2. When the winter load increases by over 100% compared to 2019 winter building load, it means that the heating electrification is expected to consume more electricity than the municipal buildings currently use. The impact tends to be higher for cities and counties in a cold climate zone, and those that have more large office spaces.

Source: LEAF Analysis | ***Note**: The building load shown here excludes water and wastewater facility load.

To move toward 24×7 clean electricity,* local governments should leverage flexible loads and batteries to shift load to hours with lower electricity demand and/or more renewable generation.



Highlights

1. Across all six local governments in the LEAF analysis, 60%–80% of their electricity consumption occurs between 5 p.m. and 8 a.m.
2. Although solar is prominent in municipal renewable energy portfolios, solar generation usually does not cover large overnight loads from streetlights and water facilities. Local governments may want to shift the operating hours of some flexible loads from night to daytime to better align electricity use with solar generation.
3. Flexible loads may include water facilities, electric vehicle charging, etc.

Source: LEAF Analysis | ***Note**: 24x7 clean electricity has pros and cons. But for most entities, planning now to better align demand and renewable energy supply will provide an opportunity to reduce volatility and costs in the long term.

Flexible electric vehicle (EV) charging hours can help local governments use more renewable energy and reduce carbon emissions.[1]

Climate Impact of Shifting EV Charging to Hours with More Renewables Generation

Example of a Local Government with ***Solar*** as the Only Renewable Energy Resource

Charging Most EVs Overnight

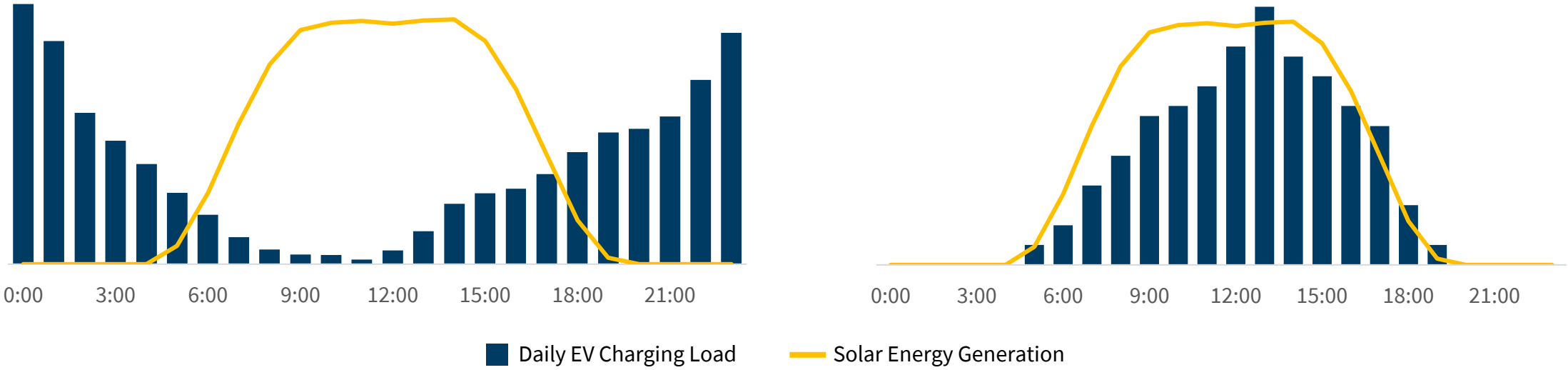
Total Daily Emissions: **11,391** kg CO_2 [2]

Load Shifting

Charging Most EVs In the Daytime

Total Daily Emissions: **7,236** kg CO_2 [2]

36% lower than overnight charging



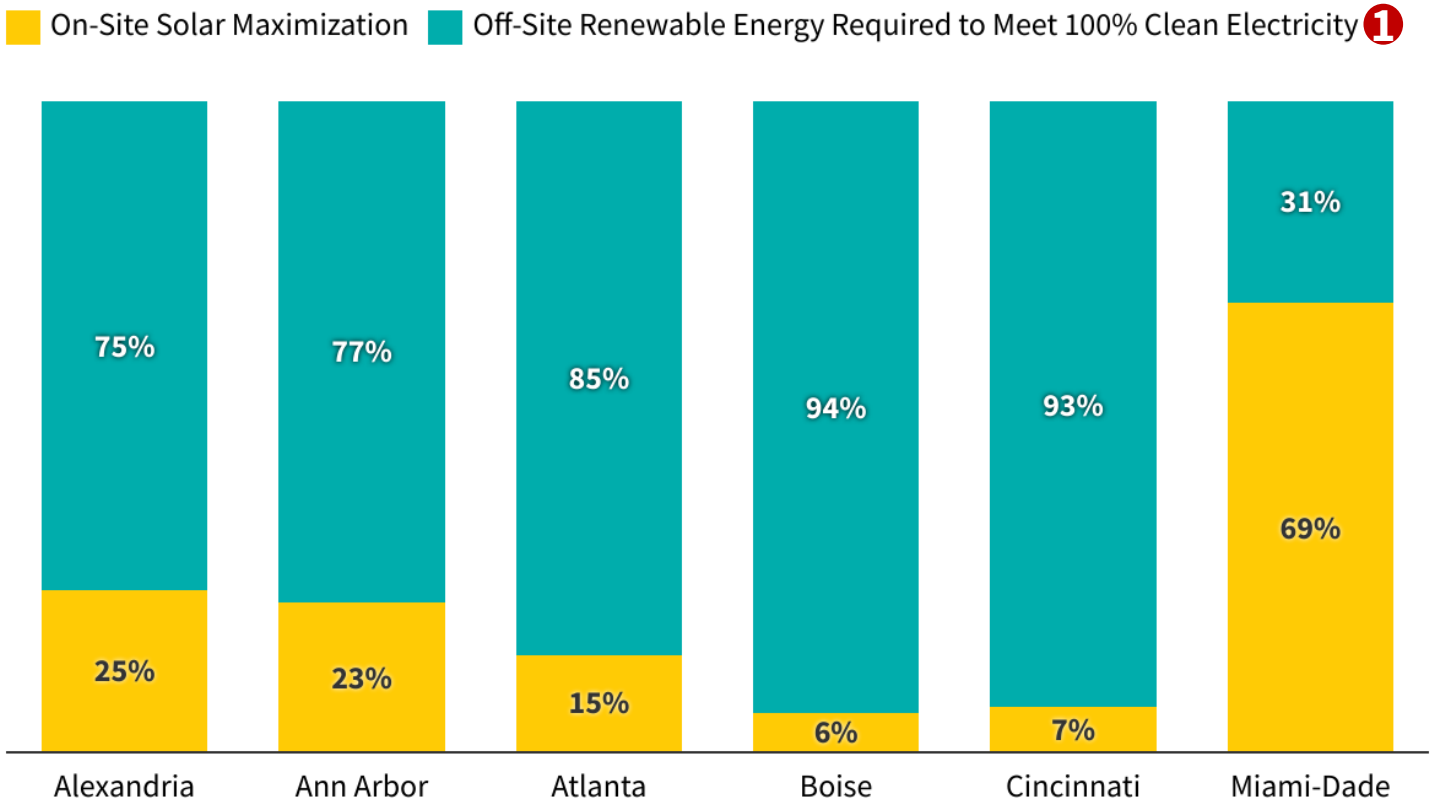
Source: LEAF Analysis

Notes: [1] Local governments may also want to consider their peak loads and structure their EV charging plans to minimize demand charges.
[2] The estimated emissions in this example are based on NREL's 2021 long-run marginal emission rates (LRMER) of Ohio.

To achieve 100% clean electricity goals, local governments will have to procure off-site renewable energy, especially non-solar resources, to fill the gap.

Most local governments do not have enough roof space or local land to deploy enough on-site solar to power all municipal operations.

2030 Municipal 100% Clean Electricity Portfolios



Highlight

1. Cities and counties will need to purchase off-site renewable energy, especially non-solar resources including wind, geothermal energy, etc., to meet 100% clean electricity goals.

Local governments can utilize a variety of procurement methods, such as physical power purchase agreements (PPAs) and virtual PPAs, etc., to purchase off-site renewable energy.

For more information about how local governments can procure renewable energy, check out the Procurement Guidance co-developed by RMI and WRI.

Source: LEAF Analysis

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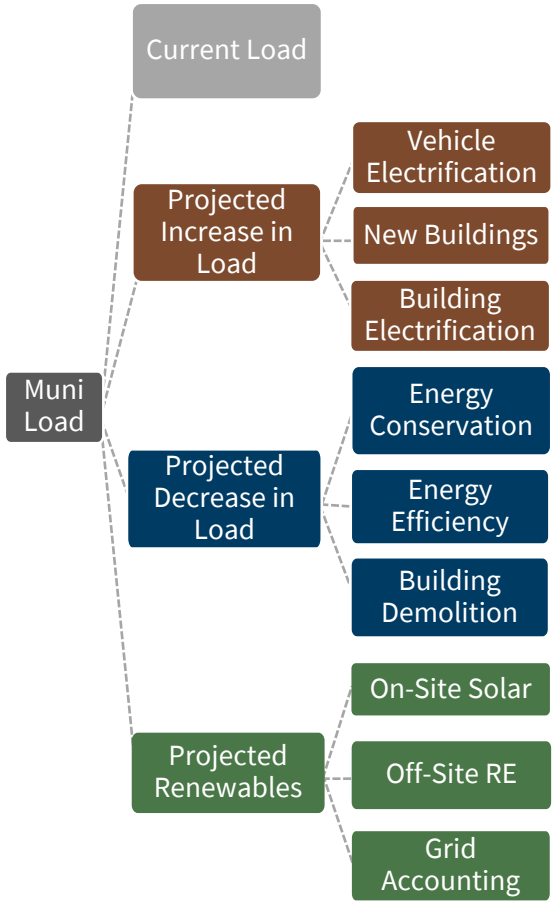
LEAF Analysis Methodology

LEAF is built upon an Excel-based model co-developed by RMI and six US local governments, including Alexandria, VA; Ann Arbor, MI; Atlanta, GA; Boise, ID; Cincinnati, OH; and Miami-Dade County, FL. Here are the key steps in the LEAF model analysis:

1. **Data Collection** – Collecting hourly load data for each municipal facility type, including office buildings, water and wastewater treatment plants, municipal airports, streetlights, and traffic lights, etc., in the benchmark year.
2. **Load Projection** – Estimating future load profiles in the target year based on current hourly loads and projected changes in electricity demands due to building development/vacancy/demolition, electrification, energy efficiency improvements, on-site solar deployment, and off-site renewable energy procurement. This is also called a business-as-usual scenario.
3. **Strategy Design** – Adding one or more advanced energy actions (e.g., additional electrification projects, energy efficiency maximization, on-site solar maximization, and demand flexibility measures, etc.) that are currently not in municipal plans to the load projection analysis. This is also called a what-if scenario.
4. **Impact Assessment** – Analyzing the collective impacts of energy actions on annual municipal load, daily load curves, and carbon emissions in the business-as-usual scenario versus the what-if scenario.
5. **Insight Summary** – Comparing similarities and differences in the impact assessment across the six local governments and summarizing key takeaways on how other US cities and counties can utilize LEAF to prioritize decarbonization projects.

LEAF Analysis Methodology (Continued)

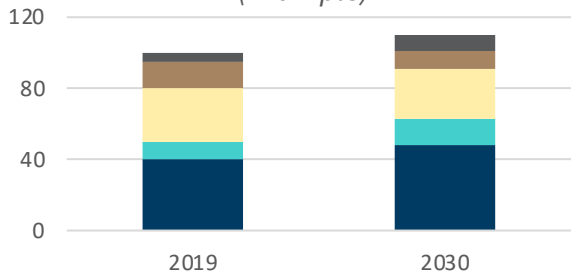
Step 1: Data Collection



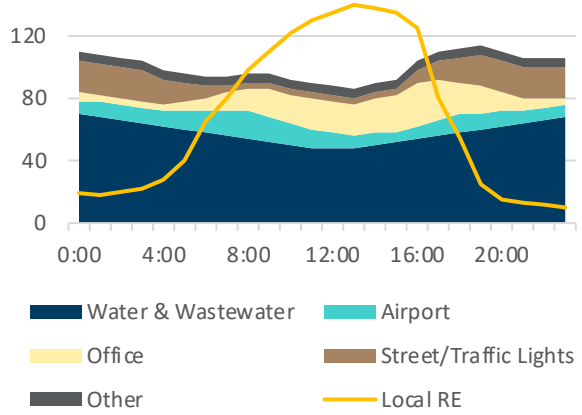
Step 2: Load Projection

Business-as-Usual Scenario

Annual Load *(Example)*



Hourly Load and Local Renewable Energy (RE) Profile *(Example)*



Step 3: Strategy Design

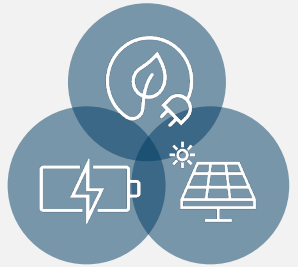
What-If Scenario

- Implementing More Electrification Projects
- Maximizing Energy Efficiency Upgrades
- Maximizing On-Site Solar Deployment
- Utilizing Demand Flexibility Measures
- Procuring More Off-Site Renewables

Step 4: Impact Assessment

- Impact on Annual Load
- Impact on Daily Load Curves
- Impact on Carbon Emissions

Step 5: Insight Summary



- Improving energy efficiency in facilities with the largest load
- Unlocking more climate benefits of electrification by decarbonizing electric grids and using efficient heat pumps
- Leveraging flexible loads and batteries to achieve 24x7 clean electricity
- Procuring off-site renewable energy, especially non-solar resources, to fill the gap

Thank You

For more information about LEAF, please contact:

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