Renewable Chicago Project

Final Report

August 2018

ELEVATE ENERGY
Smarter energy use for all

Spire Solar/National Renewable Energy Laboratory

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Project Overview

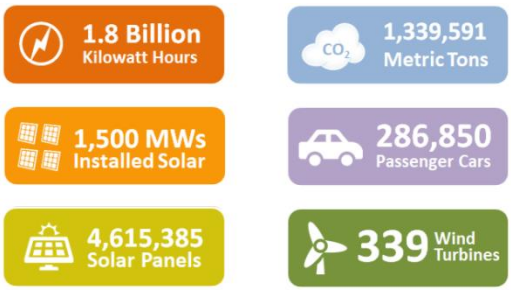
The Renewable Chicago Project was launched in July of 2017, led by the Mayor's Office and facilitated by Elevate Energy. This project set out to engage internal and external stakeholders to inform the development of renewable energy deployment strategies that meet the Mayor's commitment to power the City's more than 900 buildings with renewable energy by 2025.

A working group was established that includes members of the Mayor's Office, the Department of Fleet and Facility Management (2FM), sister agencies, as well as community and industry leaders. Through a series of facilitated work sessions, the working group addressed issues critical to the development of a robust renewables deployment strategy that not only meets the requirements of the Mayor's commitment, but also considers the complexities of carbon accounting, energy management, non-energy benefits and leveraging deployment to help overcome community and industry barriers.

As the renewables industry launches in Illinois in 2018 with the passage of the Future Energy Jobs Act, the opportunities for Chicago are tremendous, with more than $10 billion in renewables investment anticipated across the state over the next twelve years. How the City approaches this emerging industry and how it implements their renewable deployment strategy can have a profound impact on City agencies, communities, and the renewables industry.

Executive Summary

The City of Chicago's 900+ buildings use more than 1.8 billion kilowatt-hours (kWh's) of electricity annually. The goal of ensuring the City's entire electricity load comes from renewable energy is significant and complex. Well-established frameworks for measuring renewable energy usage, like the Environmental Protection Agency's Green Power Partnership and others, use Renewable Energy Certificates (RECs) as the basis for measuring environmental attributes that move cities towards these goals.



Metrics equivalent to the City's electricity load

While RECs provide a clear mechanism for acquiring and measuring the environmental attributes of renewable energy, a REC-based approach presents challenges when trying to meet the goals and priorities of internal and external stakeholders. Renewable energy generation produces two distinct and tradeable commodities, electricity, measured in kilowatt-hours, and environmental attributes, measured in RECs. Generators commonly sell these different commodities to different parties. To meet renewable energy goals through common carbon accounting practices, securing RECs is all that is required, which can be counter-intuitive. For example, energy intensive buildings that offset their load with out-of-state wind RECs provide qualified renewable credits, while efficient buildings with installed solar that sell their RECs to make the project more affordable do not. In addition, many of the goals and priorities set by internal and external stakeholders simply cannot be achieved through REC purchases alone, like reducing onsite energy use, lowering energy costs, creating local jobs, etc.

These objectives, discussed below, will come more commonly from energy efficiency upgrades and onsite renewable generation.

The aim of the working group is to identify renewable energy barriers and goals, prioritize them, to quantify their impact on energy costs, and determine which priorities can be positively impacted by various deployment methods and strategies. Following is a subset of the priorities identified and assessed.

- Meets environmental compliance goals
- Reduces onsite electricity consumption
- Reduces energy costs
- Creates new generation
- Creates new generation within Illinois
- Reduces onsite demand charges
- Stabilizes energy costs
- Supports low- and moderate-income workforce
- Provides training opportunities

Onsite Generation Analysis

Elevate Energy conducted an analysis of the City's portfolio of buildings to assess onsite generation potential. Various onsite and REC-based deployment strategies were modeled to measure the impact on energy costs and stakeholder priorities. The analysis provides insight into how an overall portfolio strategy can combine multiple deployment methods to achieve environmental compliance, costs savings, and meet stakeholder priorities. The onsite generation analysis, summarized in Table 1, looked at a sample of 13 properties representing common property types in the City's portfolio that have onsite generation potential. The electrical load of this sample of buildings represents about 50 million kilowatt hours per year or 3% of the full portfolio load. Our analysis shows that 24% of the electricity load of these 13 buildings can be offset by onsite renewable generation.

	Solar Capacity kW DC	Annual Production (kWhs)	Annual Usage (kWhs)	Annual Load Reduction
15th District Police Station	153	188,092	1,365,518	14%
Altgeld Gardens	2000	2,458,720	11,558,629	21%
CTA Heavy Rail Facility	1900	2,335,784	4,765,424	49%
Englewood Senior Center	53	65,156	238,482	27%
Fire Engine Company 96	21	25,817	77,405	33%
Martin Luther King Jr. Center	205	252,019	814,120	31%
Parking Lot No. 49	340	417,982	18,809	2222%
Richard M. Daley Library	53	65,156	234,809	28%
Roseland Neighborhood Health Center	24	29,505	232,200	13%
South Water Purification Plant	142	2,458,720	20,127,269	12%
Taft High School	600	737,617	3,455,244	21%
Warren Park Fieldhouse	534	656,478	921,226	71%
Wright College	2000	2,458,720	6,195,095	40%
Total	**8,025**	**12,149,764**	**50,004,230**	**24%**
Average	**617 kW**	**934,597**	**3,846,479**	**24%**

Table 1: Onsite Generation Summary

Importantly, it should be noted that the 24% onsite generation potential found for this sample is not likely to represent the potential for the entire portfolio of 900+ buildings. This is because the property types selected for this sample were selected because of their onsite generation potential. Many property types across the portfolio are more likely to have structural issues, roofs that are not suitable for solar or are, generally, less likely to be good candidates for solar. As such, we anticipate the percentage of onsite generation potential for the full portfolio of 900+ buildings to be measurably less than 24%. We have used 10% as a point of comparison in our

analysis to illustrate the impact on energy costs and meeting stakeholder priorities when the onsite generation target is changed. Our analysis shows that the greater the onsite generation deployed within the portfolio, the greater the ability to reduce costs and meet stakeholder priorities.

Analyzing Deployment Strategies

Analysis was conducted on each site modeling various deployment methodologies, including bundled onsite generation (retaining RECs) and unbundled onsite generation (selling RECs), as well as REC-based procurements, including national versus Illinois RECs and RECs from new versus existing generation. REC procurement methods were analyzed[1] for this sample of sites, showing that a REC-only approach will increase energy costs from approximately 2% to 9%, while meeting only the priority of environmental compliance. Bundled supply (electricity supply sold with RECs) can increase electricity supply costs by as much as 13%.

	Current Supply Rate	Bundled Supply Rate	National Existing RECs	National new RECs	Illinois Existing RECs	Illinois New RECs
Current Annual Usage (kWh)	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230
Current Supply Rate	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)
20 Year LCOE Rate After Deployment	($0.0550)	($0.0620)	($0.0560)	($0.0570)	($0.0575)	($0.0600)
Projected Cost Increase/Decrease Against Supply Rate	▼ 0.00% Cost Savings	▲-12.73% Cost Increase	▲-1.82% Cost Increase	▲-3.64% Cost Increase	▲-4.55% Cost Increase	▲-9.09% Cost Increase
Environmental Compliance	No	Yes	Yes	Yes	Yes	Yes
Reduces Onsite Usage	No	No	No	No	No	No
Reduce Energy Costs	No	No	No	No	No	No
Creates New Generation	No	No	No	Yes	No	Yes
Within Illinois	No	No	No	No	Yes	Yes
Reduce Onsite Demand Charges	No	No	No	No	No	No
Stablize Energy Costs	No	No	No	No	No	No
Supports LMI Workforce	No	No	No	No	No	No
Can Provide Training Opportunities	No	No	No	No	No	No

Table 2: REC Procurement Analysis

Additional analysis was conducted to measure the cost impacts of unbundled onsite generation, where solar is built on City properties and RECs sold to support installation costs. Using the onsite generation target of 24% of assessed load from our sample of sites, analysis shows that energy costs would decrease between 13% and 30% (with this sample set), meeting most stakeholder priorities, but not meeting the City's renewable compliance criteria. These outcomes were then compared to a combined strategy, where RECs were "swapped," e.g. RECs were sold at a high value for onsite generation and offsite RECs purchased at a lower value to offset the building's entire load. This approach allowed for energy savings as high as 28% across the sample portfolio, meeting all of the stakeholder priorities and compliance requirements at least some of the time. This recommended approach can be called REC swapping or REC arbitrage. While the process has a longer development timeline, the long-term benefits across the portfolio are clear and significant. It's important to

[1] *Analysis compares the current average supply rate to the Levelized Cost of Energy (LCOE), based on the 20-year Net Present Value of the aggregated generation systems over 20-year power generation measured in kilowatt hours. Analysis assumes the portfolio load of 50 million kWhs for the sample of 13 sites and the average site capacity and load for that sample.*

note that there are an exponential combination of deployment methods that can go into any strategy. The summary below provides just several scenarios, representing the greatest potential costs and the greatest potential savings, assuming 24% of the portfolio load is offset by onsite generation. More detailed analysis is found later in this report.

			REC-Only		*Onsite Generation (Unbundled)*		*REC Swapping*	
	Current Supply Rate	**Bundled Supply Rate**	**National RECs / Existing Systems**	**Illinois RECs / New Systems**	**Onsite DG Unbundled Gen Mkt RECs**	**Onsite DG Unbundled ILSFA RECs**	**Existing National RECs + ILSFA DG**	**New IL RECs + ILSFA DG**
Current Annual Usage (kWh)	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230
Load offset	100% RECs	100% RECs	100% RECs	100% RECs	24% Onsite	24% Onsite	100% RECs 24% Onsite	100% RECs 24% Onsite
Current Supply Rate	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)
20 Year LCOE Rate after deployment	($0.0550)	($0.0620)	($0.0560)	($0.0600)	($0.0442)	($0.0330)	($0.0340)	($0.0380)
Projected Cost Increase/Decrease against supply rate	▼ 0.00% Cost Savings	▲-12.73% Cost Increase	▲-1.82% Cost Increase	▲-9.09% Cost Increase	▼ 13.18% Cost Savings	▼ 30.04% Cost Savings	▼ 28.22% Cost Savings	▼ 20.95% Cost Savings
Environmental Compliance	No	Yes	Yes	Yes	No	No	Yes	Yes
Reduces Onsite Usage	No	No	No	No	Yes	Yes	Yes	Yes
Reduce energy costs	No	No	No	No	Yes	Yes	Yes	Yes
Creates New Generation	No	No	No	Yes	Yes	Yes	Yes	Yes
Within Illinois	No	No	No	Yes	Yes	Yes	Yes	Yes
Reduce onsite demand charges	No	No	No	No	Yes	Yes	Yes	Yes
Stablize energy costs	No	No	No	No	Yes	Yes	Yes	Yes
Supports LMI Workforce	No	No	No	No	No	Yes	Yes	Yes
Can provide training opportunities	No	No	No	No	No	Yes	Yes	Yes

Table 3: Financial Analysis of Deployment Methods Using 24% Onsite Generation Potential.

Summary Recommendations

The summary results of this analysis are represented in the four recommendations below. These recommendations provide high level guidance on how to combine deployment methodologies to build a comprehensive strategy. Details are discussed throughout this report.

REC Swapping	Use REC swapping as an overall strategy where the long term deployment plan includes a realistic percentage of unbundled onsite generation. RECs are sold for onsite generation projects at a high value and less expensive RECs are purchased to offset the entire load and meet the 100% commitment. Selling high value RECs creates enough savings to pay for all compliance REC purchases, allowing higher cost Illinois and new generation RECs to be included while still saving money on long-term energy costs.
Prioritize Illinois Solar for All Program RECs	ILSFA provides the greatest savings for unbundled, onsite generation. This savings can be used to offset the expense of compliance and allows portfolio managers to maximize stakeholder priorities and still save money. Be realistic with allocations for ILSFA, as the blocks are fairly small annually. Our analysis included no more than 2% ILSFA across the portfolio as a long term strategy.
Maximize Stakeholder Priorities	Maximizing the use of ILSFA and Illinois/new generation RECs will ensure stakeholder priorities are met as often as possible. Instead of trying to simply maximize energy cost reduction across the portfolio, ensure a minimum level of cost reduction (say 1% to 3%) while maximizing priorities through a balanced portfolio strategy.

Maximize Unbundled Onsite Generation	Do a thorough assessment of your portfolio to maximize unbundled onsite generation. This provides the greatest amount of onsite energy reductions, new Illinois generation and provides significant cost savings to fund the broader strategy.

Table 4: Summary of Final Recommendation

Considerations

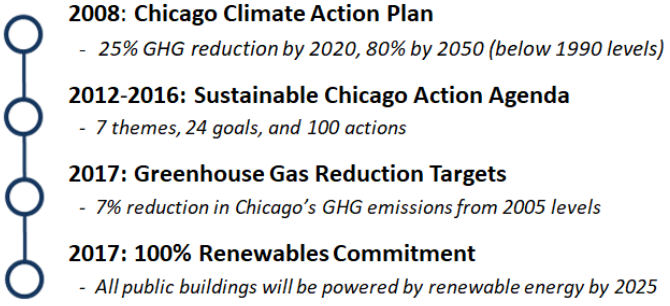
Additional considerations should be included in the strategy development process, including the following:

1	Onsite generation on vacant parcels is less attractive because, with no load at that site, generated power is sold at a lessor rate directly to the utility, minimizing savings.
2	Power Purchase Agreements at sites with no load will also yield less value for developers and less savings for the City as off-taker.
3	Hosting and subscribing to community solar provides greater benefits on vacant sites or sites with no loads than distributed generation because of the combination of lease payments and energy savings.
4	While installation costs for parking canopies have decreased significantly in the past five years, payback and returns are minimal. However, hosting community solar with these systems can provide a greater value with no upfront costs.
5	Distributed generation with General Market (Adjustable Block Program) RECs has a better payback with smaller systems when no tax benefits can be realized.
6	Subscribing to offsite community solar has no limitations in terms of share of portfolio load. Even a 10% subscriber savings can be significant across a large share of the portfolio load.

A number of deliverables were developed to support this analysis and to support the City and sister agencies in their development of renewable deployment strategies. These deliverables include a Site and Portfolio Planner that portfolio managers can use to assess and quantify various deployment strategies, financial models for 13 City sites, a template for assessing other specific sites for onsite generation, permitting and business process research data, and technical assistance for City and sister agency planners for analyzing their portfolios and building their strategies.

Chicago's Sustainability Strategy

The City of Chicago is a leader of innovative environmental initiatives and sustainability is a key focus of Chicago policy. From the Chicago Climate Action Plan's broad leadership to the City's targeted energy efficiency investments, Chicago is integrating sustainability in the places residents work, live, learn, and play while preparing for a resilient future.



"I want Chicago to be the greenest city in the world, and I am committed to fostering opportunities for Chicagoans to make sustainability a part of their lives and their experience in the city." — Mayor Emanuel

Working Group

Participants

The Project Team was led by the Mayor's Office and co-chaired by Commissioner David Reynolds from the Department of Fleet and Facility Management for the City of Chicago and Anne Evens, CEO of Elevate Energy. Processes and analysis were facilitated by Elevate Energy, engaging more than 40 individuals from 25 internal and external stakeholder agencies and organizations.

Comm. David Reynolds
Co-Chair

Anne Evens
Co-Chair

Chris Wheat
Project Sponsor

Robert Skipwith
Project Sponsor

Margaret Hansbrough
Project Lead

Amanda La Brier
Project Lead

Vito Greco
Project Manager/Analyst

Internal Stakeholders	External Stakeholders
• Chicago Public Schools • Chicago Department of Buildings • Chicago Housing Authority • Chicago City Colleges • Department of Planning and Development • Department of Fleet and Facility Management • Chicago Park District • Chicago Transit Authority • Chicago Infrastructure Trust • Public Building Commission	• AECOM • Borrego Solar (ISEA) • Chicago Urban League • Citizens Utility Board • ComEd • Elevate Energy • Enterprise Community Partners • Environmental Law and Policy Center • Faith in Place • Illinois Sierra Club • Illinois Solar Energy Association • Institute for Cultural Affairs • International Brotherhood of Electrical Workers, Local 134 • Little Village Environmental Justice Organization • SunRun (ISEA)
Project Partners	
• SolSmart administered by The Solar Foundation • National Renewable Energy Laboratory	• Zach Greene • Zoe Ripecky • Elizabeth Doris • Jason Coughlin • Kate Anderson • Daniel Studer • Emma Elgqvist • Kathleen Krahr

Table 5: Working Group Participant Organizations

Working Group Objectives

The objectives of the working group were to establish a process that engaged stakeholders in a conversation about deploying renewable energy to offset the electrical load of the City's more than 900 public buildings. The working group provided insight and analysis to help inform the development of deployment strategies for the City and sister agencies to:

- Better understand Chicago's public buildings and how they use energy,
- Better understand the various renewable deployment strategies that might be undertaken and analyze them both qualitatively and quantitatively,
- Define the needs and barriers faced by internal and external stakeholders as the market emerges,
- Engage stakeholders within the City, sister agencies, the industry, and communities to understand how to most effectively leverage deployment strategies to meet stakeholder needs,
- Develop key metrics that measure the effectiveness of individual deployment strategies against an agreed set of criteria, and
- Provide recommendations to ensure deployment strategies best meet the Mayor's commitment and stakeholder needs to the greatest extent possible.

Process

The Renewable Chicago Project established a process that engaged internal and external stakeholders through a series of work sessions over an eight month period. These sessions were facilitated to convene a wider working group on overall strategy and objectives, then to convene smaller, targeted groups to address specific issues, analysis, and deliverables.

- Working Group Kick-off ..... *Full Working Group*
- Community & Industry Barriers Work Session ..... *Industry and Community Group*
- Asset Mapping Work Session ..... *Industry and Community Group*
- Renewables Strategy Work Session ..... *City and Sister Agencies Group*
- Critical Facilities Work Session ..... *City and Sister Agencies Group*
- Permitting & Business Processes Research ..... *Industry Respondents*
- Final Working Group ..... *Full Working Group*

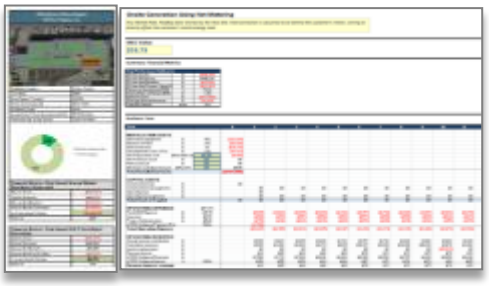
The working group launched the Renewable Chicago process in July of 2017 with a first meeting of internal and external stakeholders. The launch provided an overview of the working group process and goals, then began the process of identifying deployment strategies and the primary barriers communities and the solar industry face in growing the emerging renewables market in the region. The deployment strategies and barriers identified were used to inform subsequent work sessions to identify solutions and to begin the analytical process. The working group established the timeline, milestones, and deliverables for the project.

Deliverables

The Renewable Chicago Project carefully considered stakeholder input and methods of engagement that would most effectively get at answers to critical questions about how the City of Chicago will develop a renewable deployment strategy across its portfolio of buildings. Each work session was aimed at providing input for specific deliverables. Below is a list of the primary deliverables and tools produced through this effort:

Community and Industry Barriers and Solutions Summary

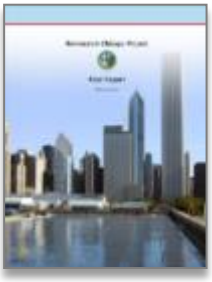
Permitting Research Report



Financial Models (for each of 13 sites)

Financial Model Template

Site and Portfolio Planner



Final Report

Community and Industry Barriers

Barriers and Needs

While the Future Energy Jobs Act will catalyze the renewables industry in Illinois by leveraging an anticipated $10 billion in investment over the next twelve years, various segments of the industry and our communities may face barriers in effectively accessing resources, realizing benefits, or deploying renewables. Two work sessions were conducted with industry and community stakeholders to identify potential barriers and to better understand how the City's deployment strategy can be leveraged to help overcome those barriers. Stakeholders first identified barriers and needs and then prioritized them. The working group identified seven critical barriers facing communities and six facing the solar industry.

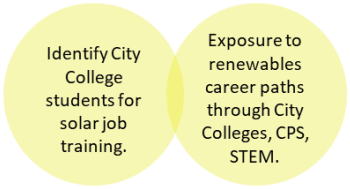
- What are the potential barriers facing the industry and our communities in deploying and accessing renewable energy?
- How can the City affect these barriers through their deployment strategy?
- What specific solutions can be integrated into the City's deployment strategy?
- Which solutions are actionable?
- Which solutions should be prioritized?

Solutions

The working group then worked to identify specific solutions for each barrier that could potentially be integrated into the City's renewable deployment strategy. Some solutions can be integrated directly into specific renewable deployment procurements. Others could affect these barriers and needs more indirectly; i.e. through other City of Chicago initiatives, processes, or resources. For example, Workforce Development is seen as a potential barrier as renewables are deployed in the region, particularly in creating equitable workforce development opportunities. Seven specific solutions were identified to overcome this barrier. Of the seven identified solutions, five were assessed as opportunities that could be directly impacted by the City's renewable deployment strategy. For example, the City could directly impact this barrier by leveraging IL Solar for All programs where low- and moderate-income workforce development is required to be part of every installation or they could work with City Colleges to facilitate onsite training and build the requirement into contracts.

Workforce Development Solutions

Solutions Directly Impacted by City of Chicago Solar Deployment

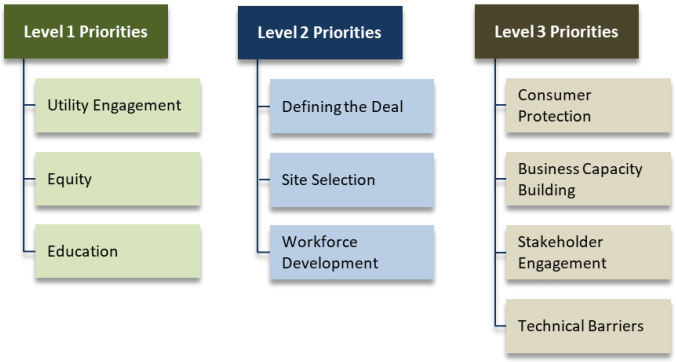


Solutions Not Directly Impacted by City of Chicago Solar Deployment

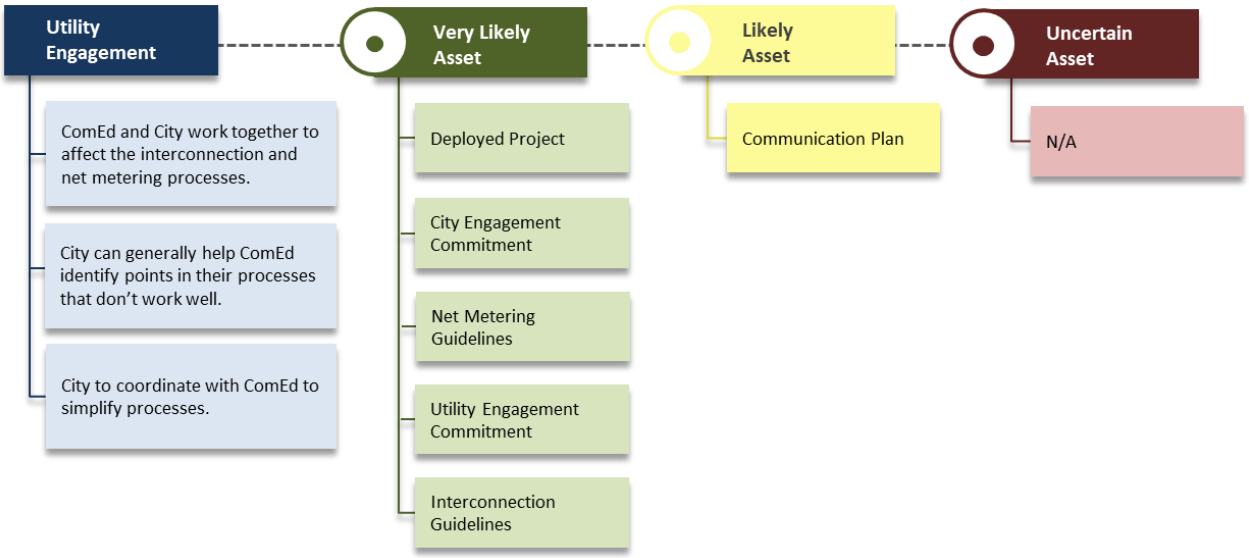
Some of the solutions identified are thought to only indirectly impact this barrier, such as educating City Colleges students on renewables career paths and training opportunities. A full list of barriers and solutions can be found in Appendix 4.

Prioritization

In the final stage of the community and industry work session, stakeholders collaborated on a final prioritized list of barriers common to both segments. This is summarized below. Each barrier included a prioritized list of solutions that, ideally, could be directly impacted by the City of Chicago's renewable deployment strategy. Assets were then considered for each solution, assessing whether clear assets could be identified or if gaps exist that could make that solution less likely to be effective. The result is a final set of prioritized barriers that include specific, actionable solutions.



Some priority categories are difficult to directly leverage through specific deployment strategies. For example, utility engagement is the highest-priority barrier identified. Solutions include ComEd and the City working together to inform and affect the interconnection and net metering processes and, generally, to provide guidance on streamlining those processes. While the assets suggest this is achievable, it cannot be affected directly though deployment or procurement. Instead, the City and ComEd will need to commit to an ongoing process related to, but outside of, specific deployments to affect communication and changes to the process.



Similarly, education is a critical barrier, where a number of specific solutions were recommended that can facilitate a wider and direct education of stakeholders across City staff and Chicagoans in general. But, these efforts are not likely to be part of a deployment strategy or done through individual procurements.

Affecting equity and workforce development, two of the top four priorities, can directly be integrated into deployment strategies and individual procurements, as indicated by the solutions identified. This is most easily done by leveraging IL Solar for All programs where these requirements are mandated. However, these priorities can also be embedded into any contract or procurement. Since equity and workforce development were top

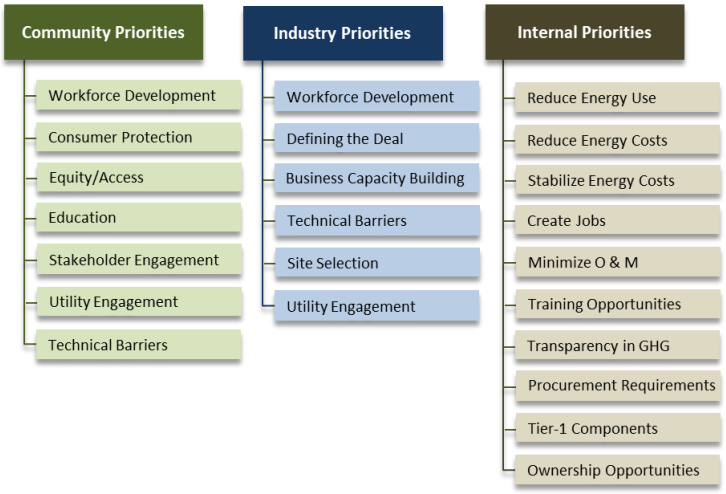
priorities and because they are seen as directly being impacted by deployment methods, they have been included as key metrics for evaluating deployment strategies and are part of the measured output of the Site Planner and Portfolio Planner tool developed through the project. A full list of barriers, solutions, and assets can be found in Appendix 5.

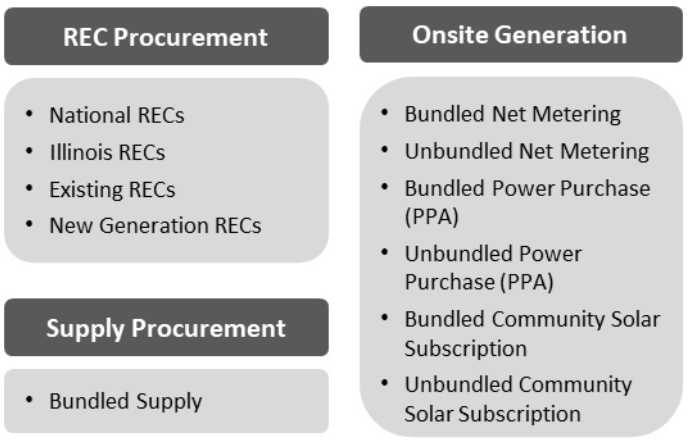
Meeting Stakeholder Priorities

There are many issues important to internal and external stakeholders. As indicated in the full list of barriers, solutions, and assets, community and industry stakeholders have very specific ideas of how to overcome many of these barriers. The working group aimed to categorize each solution in a way that identified those that were more actionable and could be affected by specific deployment requirements or methods. In a subsequent section, we will present a rubric that was developed to quantify how nine top priorities are met through each of the deployment methods analyzed. Clearly, not all of these priorities can be included in this kind of analysis, nor can they be addressed in each deployment. However, the priorities and solutions identified provide the City's energy and procurement managers with practical ideas on which priorities to address and how to address them.

Renewables Strategy Work Session

An internal work session was convened by the project team and sister agencies to identify a framework for developing deployment strategies for each agency. The first step in developing this framework was to establish the internal deployment priorities. Internal priorities identified were focused primarily on the deployment method's impact on energy use and cost. All internal priorities identified can be directly impacted by deployment strategies and measured specifically.





This session then identified deployment methods for achieving the requirement of 100% renewables by 2025, including onsite generation, bundled supply and environmental attribute procurement through Renewable Energy Certificates (RECs).

Finally, this session developed a framework for analyzing site-specific and portfolio wide deployment strategies that would provide detailed financial metrics and measure each deployment method against priorities established by stakeholders.

Onsite Generation Analysis	• Select a sample of common property types to model for individual onsite generation projects and as a portfolio of projects, assessing each deployment method identified. • Develop a financial template for onsite generation analysis that provides detailed pro forma and financial metrics for all identified onsite deployment methods.
Site Planning Tool	• Develop a Site Planner Tool that will allow users to assess individual sites for all onsite and REC-based deployment methods and compare Levelized Cost of Energy (LCOE) for current and long-term energy prices.
Portfolio Planning Tool	• Develop a Portfolio Planner Tool that will allow users to assess a portfolio of properties using any combination of onsite and REC-based deployment methods, comparing Levelized Cost of Energy (LCOE) for current and long-term energy prices.
Deployment Priority Rubric	• Develop a rubric that provides guidance on whether each identified deployment method meets key stakeholder priorities; embed this rubric into tools to quantify results.

Table 6: Deployment Strategy Framework

Deployment Priority Rubric

A rubric was developed to assess each deployment method qualitatively against the top priorities for internal and external stakeholders. This rubric was also incorporated into the Site and Portfolio Planner Tools to measure deployment methods and strategies against key priorities quantitatively. With seventeen priorities and 55 distinct solutions identified, it was not practical to include every priority in a rubric or tool, more so because many of the priorities could not be directly impacted or measured by deployment methods.

The final rubric consists of nine specific priorities, including the primary priority of meeting environmental compliance. Each priority is measured against all fifteen deployment methods identified, including REC-based procurement, bundled supply, and bundled and unbundled onsite generation. The rubric uses a simple yes/no criterion for meeting each priority. A deployment method was not assessed a "yes" in meeting a priority unless it was clear that it could be met in all instances. For example, "Supports Low and Moderate Income (LMI) Workforce" was only indicated "yes" when Illinois Solar for All (ILSFA) deployment methods were used. That is because ILSFA mandates LMI workforce development in all instances. It is possible that this priority could be a requirement of any City procurement for onsite generation, but not in all instances. Other priorities were clearer. For example, buying Illinois or new RECs are distinct deployment methods that meet specific stakeholder priorities, so those priorities are indicated as "yes" when those deployment methods are used.

	Environmental Compliance	Reduces Onsite Electricity Consumption	Reduce Energy Costs	Creates New Generation	Creates Generation in Illinois	Reduce Onsite Demand Charges	Stablize Energy Costs	Supports LMI Workforce	Can Provide Training Opportunities
REC Purchases in Voluntary Market									
REC Purchase - New Renewable Generation: Illinois	Yes	No	No	Yes	Yes	No	No	No	No
REC Purchase - New Renewable Generation: Outside Illinois	Yes	No	No	Yes	No	No	No	No	No
REC Purchase - Existing Renewable Generation: Illinois	Yes	No	No	No	No	No	No	No	No
REC Purchase - Existing Renewable Generation: Outside Illinois	Yes	No	No	No	No	No	No	No	No
Bundled Supply Purchases									
Community Solar Subscription - Bundled	Yes	No	No	Unsure	Yes	No	No	No	No
RES Electric Supply - Bundled	Yes	No	No	No	No	No	No	No	No
Onsite Generation Bundled									
Onsite Generation - Bundled	Yes	Yes	No	Yes	Yes	Yes	No	No	No
Onsite PPA - Bundled	Yes	Yes	No	Yes	Yes	Yes	No	No	No
Community Solar Host - Bundled	Yes	No	No	Yes	Yes	No	No	No	No
Onsite Generation Unbundled									
Onsite DG - ILSFA Non-profit/Public Facility	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Onsite DG - General Market	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Onsite PPA - ILSFA Non-profit/Public Facility	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Onsite PPA - General Market	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Onsite Community Solar Host/Anchor - ILSFA	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Onsite Community Solar Host/Anchor - General Market	No	Yes	Yes	Yes	Yes	No	Yes	No	No

Table 7: Deployment – Priority Rubric

RECs and Carbon Accounting

Renewable Energy Certificates (RECs)

Renewable energy generation produces two distinct and tradeable commodities, electricity, in the form of kilowatt-hours (kWhs), and environmental attributes, in the form of Renewable Energy Certificates (RECs). Generators commonly sell these different commodities to different parties. Renewable Energy Certificates (RECs), also known as Renewable Energy Credits or Green Tags, are market-based instruments that represent the property rights to the environmental, social, and other non-power attributes of renewable electricity generation.

RECs are issued when one megawatt-hour (MWh) of electricity is generated and delivered to the electricity grid from an eligible renewable energy resource. Since the physical electricity we receive through the utility grid cannot distinguish the origin of the electrons delivered, RECs play an important role in accounting, tracking, and assigning ownership to renewable electricity generation.

Compliance and Voluntary REC Markets

The REC market in the U.S. is driven both by policy (Compliance Market) and consumer demand (Voluntary Market). In some states, legislative mandates, such as Renewable Portfolio Standards (RPS), require electricity service providers to procure a minimum portion of their electricity supply from renewable generation sources. Utilities use RECs to demonstrate their compliance with these requirements. In the Voluntary Market, consumers choose to purchase green power over and above any policy requirements to reduce the environmental impact of their energy use.

Both compliance and voluntary markets can exist in the same geography. In Illinois, for example, our RPS requires that our supply source 25% of eligible retail electricity sales from renewable energy by 2025. Utilities are required to purchase environmental attributes through REC contracts to demonstrate their compliance. These RECs create a significant compliance market in the state and will leverage an anticipated $10 billion in renewable investment over the next 12 years through the Adjustable Block Program created by FEJA.

Municipalities, businesses, and other entities that choose to source their electricity from renewable generation need to go to the voluntary market to acquire RECs and quantify the environmental attributes. These environmental attributes are over and above the 25% renewable supply mandated by the Illinois RPS. Renewable electricity generators are able to sell RECs produced through their system's power production through either the compliance or voluntary market. The voluntary market, generally, produces RECs at a lower value because they are governed by supply and demand. Due to the generous compliance market in Illinois, it will be difficult to obtain voluntary RECs from new generation during the compliance period because generators will opt for the higher payments and fixed prices available through those programs. Voluntary RECs in Illinois during this period will likely be made available from 1) existing generation from systems energized prior to the compliance period, 2) new generation from systems that did not qualify because available REC blocks were over-subscribed, or 3) new generation on City-owned properties.

100% Renewables Goals for the City of Chicago

For the City of Chicago to meet its goal of 100% renewable energy for its 900+ buildings by 2025, RECs are all that is required. These RECs cannot be obtained from compliance market programs (e.g., those mandated from the Future Energy Jobs Act or FEJA) because those RECs are required to be owned and retired by Illinois utilities (or by the Illinois Power Agency in the case of ILSFA). To meet the City's goals, RECs must come from the voluntary market, which can be generated from renewable energy systems in Illinois or in most states nationally.

The challenge, as stated above, will be the smaller number of RECs available in the competitive Illinois voluntary market and the likely increased value of those RECs because of high demand and short supply—especially new generation, Illinois RECs. In addition, purchasing RECs to comply with the City of Chicago's goals will increase energy costs, regardless of their origin, because they represent a cost outlay with no accompanying reduction in on-site electricity usage. As such, complementing a REC-based strategy with onsite generation may provide greater flexibility and the opportunity to hedge or even lower energy costs over time.

Onsite Generation Analysis

The Rationale for Onsite Solar Generation

REC procurement provides a clear mechanism for acquiring and measuring the environmental attributes of renewable energy and moving the City closer to its 2025 goal. REC procurement also represents a fairly straightforward process that can be completed quickly and with little technical capacity. However, a REC-only procurement strategy will increase energy costs and will not address many of the additional identified goals and priorities of internal and external stakeholders.

To meet their commitment, the City will need to accumulate the environmental attributes of a significant amount of renewable generation, about 1.8 million RECs annually based on 2016 consumption. These RECs can be purchased 1) separately from the electricity of offsite systems, 2) "bundled" with the electricity from offsite systems, or 3) bundled with the electricity from onsite generation, e.g., building a system on City property and *not* selling the RECs that come as a result. The challenge with this latter method is that the value proposition for most facility managers is that the electricity and RECs produced from renewable energy represent a compelling reduction in energy costs only when RECs are sold. This reduces the cost of installation, energy use, and energy costs. However, to gain the environmental benefits required to meet the 100% renewable commitment, RECs need to be retained and retired (i.e., not sold), thereby turning potential savings in energy costs from onsite generation into a cost increase.

Another method would allow the City to sell the RECs from their onsite system at a high value and purchase RECs from remote generation at a lower cost. For example, if a site uses 100,000 kWh's of electricity per year and can produce about 50,000 kWh's per year from solar, the facility manager could sell 50 onsite RECs for $100 each and buy 100 remote RECs for $2 each. This technique, called REC swapping or REC arbitrage, would allow facility managers to meet the environmental requirement while also reducing onsite energy use and costs. This method also creates the opportunity to meet other stakeholder priorities.

Assessing Buildings

Onsite generation can be an important part of the City's overall deployment strategy. As such, the Renewable Chicago Project has undertaken a process to assess buildings within the City's portfolio to better understand its potential. More than 400 sites from the Department of Fleet and Facility Management portfolio were reviewed and categorized, as well as sites from each sister agency portfolio. The goal of this assessment was to better understand the potential for onsite generation across the most common City of Chicago property types. Thirteen sites were selected as sample properties because these property types are the most common across the portfolio and more likely to support onsite generation. A case study was developed for each that includes an onsite solar system design, power generation projections, energy usage and a cost-benefit analysis for a number of deployment methodologies. The analysis also includes a Levelized Cost of Energy (LCOE) based on a 20-year Net Present Value (NPV) supply rate to allow us to compare all future costs to current supply rates. The output from these analyses is used to measure the value of site specific deployment methods, as well as for portfolio-wide strategy development.

A qualitative review was first conducted to provide guidance to each agency on the onsite potential for various building types in their portfolios. Buildings were categorized and a high-level assessment was conducted which included looking at average available roof or parcel size, common property usage and condition, average age, and general category suitability for solar. For example, ward yards and maintenance parking facilities are commonly used for large vehicle storage and are not suitable for solar canopies. Structures on this type of site tend to not support the additional weight of solar. As such, this category of property does not represent a likely candidate for onsite generation. While police stations, fire stations and libraries, which make up a significant share of the portfolio, each have characteristics that suggest these are good candidates for moderately-sized, onsite generation systems.

This qualitative assessment provides recommendations for categories that have excellent potential for onsite generation, possible potential or little potential. Sixteen categories of buildings were deemed good candidates and should be considered for onsite generation, representing more than 400 buildings across the portfolio. Another seven categories were deemed possible for onsite generation, while only five categories are not recommended for further analysis. A detailed list and descriptions for each category can be found in Appendix 6.

Excellent Onsite Potential
Chicago Housing Authority
Chicago Public Schools
Chicago Transit Authority
City Colleges
Community Centers
Fire Facilities
Fire Stations
Health Clinics
Libraries
Operations Facilities
Parking Lots
Police Station/Facilities
Pumping Stations
Senior Centers
Vacant Parcels
Other Property Types

Possible Onsite Potential
Auto Pounds
Chicago Park District
Garages
Office Buildings
Permit Centers
Ward Yards
Warehouses

Little Onsite Potential
Communications Towers
Fuel Stations
Maintenance Garages
Outdoor Facilities
Vacant Buildings

Table 8: Onsite Generation Likelihood for City Portfolio Property Type

Structural Integrity and Long-Term Operations and Maintenance

Our analytical process did not take into account structural integrity or roof condition of individual building sites, nor did it account for current land or property value or long-term property use planning. These are important processes to undertake during an assessment of onsite generation potential for individual sites. The purpose of this analysis, however, is to provide an assessment of deployment potential for various building types and compare projected financial metrics across various deployment strategies. This analysis aims to help planners build a portfolio-wide strategy that realistically incorporates onsite generation and measures the viability of a number of deployment options.

Assumptions for Onsite Generation Analysis

Thirteen sites were selected for further analysis of onsite generation potential, including one site from each of eight Department of Fleet and Facility Management property categories and one site from each of the five sister agency portfolios. These thirteen sites vary in age, size, and solar capacity. They were selected as representative sites for the selected categories that have onsite potential. Sites for sister agency properties were selected for analysis based mostly on their inclusion in the Cook County Community Solar project analysis. This allowed the project team to leverage the site assessment and analysis used for that project to gain efficiencies and assess more properties in this work.

System Design

Each site was assessed for potential solar capacity using the Helioscope design tool and PVWatts. These tools allow for a full system design that takes into account orientation, seasonality, shading, and component options. A system was optimized for each site using consistent components, including 300 watt panels, smart-string inverters, and fixed racking based on the needs of the particular site. Final designs for each site include overall system capacity in kW DC and projected seasonal power output assumptions. In general, our designs and capacity assumptions tended towards conservative estimates of power production potential.

Financial Model Assumptions and Metrics

Excel-based financial models were created for each site. The models developed for this analysis include a number of inputs derived from industry averages that can be found in the individual models. A summary of key assumptions is listed here:

- 25-year system life
- 20-year Levelized Cost of Energy (LCOE)
- Renewable Energy Certificate (REC) Values based on the Illinois Power Agency Long Term Renewables Resource Procurement Plan approved by the Illinois Commerce Commission on February 27, 2018
- Smart Inverter Rebate of $250 per kW
- Installation costs based on National Renewable Energy Laboratory pricing study and projected for 2019 based on an annual 4% decrease in cost: https://www.nrel.gov/docs/fy17osti/68925.pdf
- 14% capacity factor
- 0.50% derate
- 2.78% annual energy cost increase
- NPV discount rate of 8.0%
- No tax benefits

The model creates individual pro forma for each of eight different onsite deployment methods:

- Owned Distributed Generation: General Market
- Owned Distributed Generation: IL Solar for All
- Power Purchase Agreement (PPA): General Market
- Power Purchase Agreement (PPA): IL Solar for All
- Vacant site ground-mount exporting - Owned
- Vacant site ground-mount exporting - PPA
- Community Solar Host and Anchor: General Market
- Community Solar Host and Anchor: IL Solar for All

Key metrics for each installation are used for comparison, including 25-year costs, 25-year revenues, 25-year net revenues, 25-year Net Present Value (NPV), Internal Rate of Return (IRR), and Return on Investment (ROI). Other metrics include average annual energy savings and percent of annual electricity use offset by onsite generation. 20-year Levelized Cost of Energy is used to compare each method's output to current supply rates.

Current Supply Rates and Levelized Cost of Energy (LCOE) Assumptions

Comparing onsite generation value to current supply rates or to current market-based REC values is done using a Levelized Cost of Energy (LCOE) for onsite generation. Our calculations for lifetime onsite generation value assume a 20-year Net Present Value (NPV) over a 20-year power production projection in kilowatt-hours. This provides a consistent basis for measuring the kilowatt-hour rate of current supply, current market REC values and the present value of onsite generation over a 20 year system life. 20-year NPV is the common metric used in the industry, even though systems can produce energy for 25 or even 30 years.

$$\frac{NPV = \sum \{After\text{-}Tax\ Cash\ Flow\ /\ (1+r)^{t}\} - Initial\ Investment}{System\ Generated\ Kilowatt\text{-}Hours \times 20\ Years} = Levelized\ Cost\ of\ Energy\ (LCOE)\ per\ kWh$$

Onsite Generation Value of Thirteen Sites

Onsite Solar Capacity

Below is a summary of the onsite solar potential for each of the thirteen sites analyzed. The average system size was found to be 617 kW DC across this sample, producing an average of 24% of the cumulative electricity load across this group of properties. While this capacity analysis does not represent the projected onsite solar potential for the entire portfolio of 900+ buildings, it does suggest that the potential is significant and can have an impact on portfolio-wide strategies and energy costs.

	Solar Capacity kW DC	Annual Production (kWhs)	Annual Usage (kWhs)	Annual Load Reduction
15th District Police Station	153	188,092	1,365,518	14%
Altgeld Gardens	2000	2,458,720	11,558,629	21%
CTA Heavy Rail Facility	1900	2,335,784	4,765,424	49%
Englewood Senior Center	53	65,156	238,482	27%
Fire Engine Company 96	21	25,817	77,405	33%
Martin Luther King Jr. Center	205	252,019	814,120	31%
Parking Lot No. 49	340	417,982	18,809	2222%
Richard M. Daley Library	53	65,156	234,809	28%
Roseland Neighborhood Health Center	24	29,505	232,200	13%
South Water Purification Plant	142	2,458,720	20,127,269	12%
Taft High School	600	737,617	3,455,244	21%
Warren Park Fieldhouse	534	656,478	921,226	71%
Wright College	2000	2,458,720	6,195,095	40%
Total	**8,025**	**12,149,764**	**50,004,230**	**24%**
Average	**617 kW**	**934,597**	**3,846,479**	**24%**

Table 9: Onsite Generation Analysis Summary

Importantly, it should be noted that the 24% onsite generation potential found for this sample is not likely to represent the potential for the entire portfolio of 900+ buildings. This is because the property types selected for this sample were intentionally chosen to be more likely to support onsite generation. Many property types across the portfolio are more likely to have structural issues or roofs that are not suitable for solar, and are, generally, less likely to be good candidates for onsite generation. As such we anticipate the percentage of onsite generation potential for the full portfolio of 900+ buildings to be measurably less than 24%. We have used 10% as a point of comparison in our analysis to illustrate the impact on energy costs and meeting stakeholder priorities when this target changes. Our analysis shows that the greater the onsite potential, the greater the ability to reduce costs and meet stakeholder priorities.

Onsite Generation Unbundled Financial Metrics

Next, onsite generation financial metrics were evaluated for each of eight unbundled deployment methods: distributed generation of City-owned systems, distributed generation PPA, ground-mounted systems both owned and PPA on City-owned vacant sites, and community solar host/anchor subscribe. Each deployment method was evaluated using both general market (Adjustable Block Program) RECs and ILSFA RECs. All of these scenarios evaluate unbundled projects or projects where the RECs are sold to support installation costs. The results provide an indication of the value of various unbundled deployment methods over the life of the system, indicating that system ownership provides the greatest value and ILSFA provides significantly more value than the general market program.

		Gen Mkt DG		ILSFA DG		Gen Mkt PPA	
	2017 Annual Electricity Expense	Average Annual Savings	Payback In Years	Average Annual Savings	Payback In Years	Average Annual Savings	Payback In Years
15th District Police Station	$102,063	$11,305	9.5	$17,384	0.9	$4,440	0.0
Altgeld Gardens	$1,109,628	$159,393	9.1	$235,552	0.9	$57,549	0.0
CTA Heavy Rail Facility	$457,481	$132,888	13.4	$205,239	5.2	$82,751	0.0
Englewood Senior Center	$20,360	$5,308	6.8	$7,563	0.8	$1,512	0.0
Fire Engine Company 96	$5,993	$2,279	5.4	$3,286	0.8	$266	0.0
Martin Luther King Jr. Center	$82,417	$23,237	7.3	$31,138	0.9	$8,474	0.0
Parking Lot No. 49	$1,568	($8,844)	25.0	$535	20.0	$3,975*	0.0
Richard M. Daley Library	$20,686	$5,526	6.5	$7,781	0.8	$1,555	0.0
Roseland Neighborhood Health Center	$19,566	$2,492	5.6	$3,643	0.8	$675	0.0
South Water Purification Plant	$1,306,141	$107,172	12.1	$183,331	0.9	$46,781	0.0
Taft High School	$331,703	$58,271	8.2	$81,119	0.9	$21,823	0.0
Warren Park Fieldhouse	$88,438	$34,268	14.1	$54,603	5.8	$20,176	0.0
Wright College	$576,144	$177,847	8.8	$254,006	0.9	$72,637	0.0
Average	**$317,092**	**$54,703**	**10.1**	**$83,475**	**3.1**	**$26,553**	**0.0**

* Max system size of 15 kW based on load

Table 10a and 10b: Onsite Generation Metrics for Various Deployment Methods

		ILSFA PPA		Community Solar Host and Anchor: Gen Mkt.		Community Solar Host and Anchor: ILSFA	
	2017 Annual Electricity Expense	Average Annual Savings	Payback In Years	Average Annual Savings	Payback In Years	Average Annual Savings	Payback In Years
15th District Police Station	$102,063	$9,769	0.0	$6,984	0.0	$8,610	0.0
Altgeld Gardens	$1,109,628	$140,097	0.0	$92,101	0.0	$114,550	0.0
CTA Heavy Rail Facility	$457,481	$135,274	0.0	$87,242	0.0	$108,188	0.0
Englewood Senior Center	$20,360	$4,157	0.0	$2,433	0.0	$3,018	0.0
Fire Engine Company 96	$5,993	$1,678	0.0	$877	0.0	$1,193	0.0
Martin Luther King Jr. Center	$82,417	$17,556	0.0	$9,820	0.0	$12,692	0.0
Parking Lot No. 49	$1,568	$1,142*	0.0	$15,714	0.0	$19,617	0.0
Richard M. Daley Library	$20,686	$4,277	0.0	$2,433	0.0	$3,017	0.0
Roseland Neighborhood Health Center	$19,566	$1,856	0.0	$1,100	0.0	$1,361	0.0
South Water Purification Plant	$1,306,141	$110,794	0.0	$89,350	0.0	$107,671	0.0
Taft High School	$331,703	$46,163	0.0	$27,630	0.0	$34,365	0.0
Warren Park Fieldhouse	$88,438	$38,019	0.0	$24,520	0.0	$30,406	0.0
Wright College	$576,144	$147,501	0.0	$88,071	0.0	$104,474	0.0
Average	**$317,092**	**$54,762**	**0.0**	**$34,483**	**0.0**	**$42,243**	**0.0**

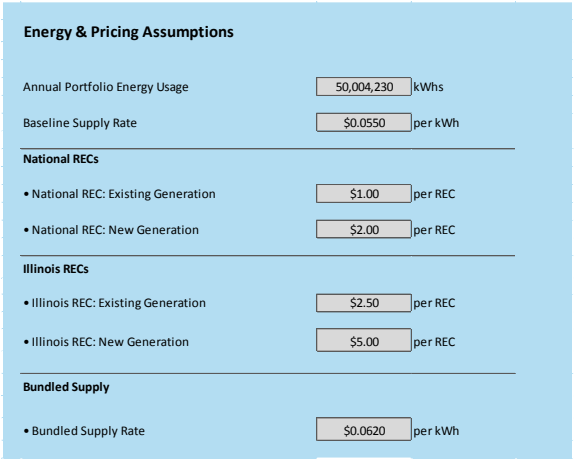
* Max system size of 15 kW based on load

Table 10a and 10b: Onsite Generation Metrics for Various Deployment Methods

Unbundled onsite generation can provide significant energy savings and can meet a number of stakeholder priorities. However, deployed alone, these methods do not meet the goals of environmental compliance because RECs are sold. These methods only become relevant and viable with a combined approach using REC swapping, i.e., together with the purchase of RECs in the voluntary market.

REC Procurement Financial Metrics

Procuring RECs to meet the City's 100% Commitment will represent a net increase in costs from the current supply rate for all buildings because onsite usage and expenses remain unchanged. To measure the impact to energy costs, we can assess the average REC value in the voluntary market and add these costs to the current supply rate. In this analysis, we looked at various REC types, national versus Illinois RECs and new versus existing RECs. Average costs for each were determined for this analysis based on current market prices and entered as inputs into the Site and Portfolio Planner Tool developed for this purpose[2].



For this analysis, the full electricity load of the thirteen sample sites (50,004,230 kWh per year) was measured using an average supply rate of $.0550 per kilowatt-hour. Average REC values were entered based on current market values as indicated in the snapshot. These values can be adjusted as needed to measure the impact on energy costs. Site load and solar capacity was based on the average site for that sample. In addition to the LCOE for each REC type and the current supply rate, each stakeholder priority is assessed as to whether or not the specific method or REC type meets that goal.

[2] *Average national REC prices have reached as low as $0.40, but have been increasing to over $1.00 in Q1 and Q2 of 2018. SRECTrade, Energy Sage, Status and Trends in the US Voluntary Green Power Market – NREL E; O'Shaughnessy 2017.*

	Current Supply Rate	Bundled Supply Rate	National Existing RECs	National new RECs	Illinois Existing RECs	Illinois New RECs
Current Annual Usage (kWh)	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230
Current Supply Rate	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)
20 Year LCOE Rate After Deployment	($0.0550)	($0.0620)	($0.0560)	($0.0570)	($0.0575)	($0.0600)
Projected Cost Increase/Decrease Against Supply Rate	▼ 0.00% Cost Savings	▲-12.73% Cost Increase	▲-1.82% Cost Increase	▲-3.64% Cost Increase	▲-4.55% Cost Increase	▲-9.09% Cost Increase
Environmental Compliance	No	Yes	Yes	Yes	Yes	Yes
Reduces Onsite Usage	No	No	No	No	No	No
Reduce Energy Costs	No	No	No	No	No	No
Creates New Generation	No	No	No	Yes	No	Yes
Within Illinois	No	No	No	No	Yes	Yes
Reduce Onsite Demand Charges	No	No	No	No	No	No
Stablize Energy Costs	No	No	No	No	No	No
Supports LMI Workforce	No	No	No	No	No	No
Can Provide Training Opportunities	No	No	No	No	No	No

Table 11: Levelized Cost of Energy Projections for REC-based Strategies

The results show that the average for national, existing system RECs (the least expensive available RECs) will increase energy costs by 1.82% against the current supply rate. When other RECs are procured to address stakeholder priorities, the overall energy costs increase further to as high as a 12.73% against current average supply rate. New Illinois RECs (RECs that meet two key stakeholder priorities) will increase energy costs by 9%. As expected, this shows that accounting for stakeholders priorities can be done only if additional costs are incurred in a REC-only based strategy.

Financial Impacts of REC Swapping

With an understanding that REC procurement alone will present ongoing energy cost increases and unbundled onsite generation provides significant cost savings, our next analysis looked at combining methods across the same portfolio of properties to measure the impact on long-term energy costs. To do this, the Site and Portfolio Planner Tools were used similarly, allowing for the full load to be offset with REC purchases allocated across any or all of the REC purchase methods and, additionally, allowing for a portion of the load to be offset using onsite generation. In our analysis of the 13 sites, we used both the 24% onsite load reduction projected in our system designs as well as a 10% onsite load reduction assumption representing a more conservative value for the City's portfolio.

Since the combination of methods is exponential, we did not look at every possible combination. Instead we looked at several combinations representing the least and most expensive options for each category. For example, national existing RECs are the least expensive option and Illinois new generation RECs the most expensive. Onsite generation with unbundled ILSFA RECs provide the greatest savings over general market program RECs.

	24% Onsite Generation					10% Onsite Generation				
	Current Supply Rate	Existing National RECs + ILSFA DG	Existing National RECs + ILSFA PPA	New IL RECs + Gen Mkt DG	New IL RECs + Gen Mkt PPA	Current Supply Rate	Existing National RECs + ILSFA DG	Existing National RECs + ILSFA PPA	New IL RECs + Gen Mkt DG	New IL RECs + Gen Mkt PPA
Current Annual Usage (kWh)	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230	50,004,230
Current Supply Rate	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)	($0.0550)
20 Year LCOE Rate After Deployment	($0.0550)	($0.0393)	($0.0465)	($0.0523)	($0.0562)	($0.0550)	($0.0488)	($0.0519)	($0.0567)	($0.0584)
Projected Cost Increase/Decrease Against Supply Rate	▼ 0.00% Cost Savings	▼ 28.22% Cost Savings	▼ 16.44% Cost Savings	▼ 4.09% Cost Savings	▲ -0.79% Cost Increase	▼ 0.00% Cost Savings	▼ 10.70% Cost Savings	▼ 5.79% Cost Savings	▲ -3.60% Cost Increase	▲ -5.63% Cost Increase
Environmental Compliance	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Reduces Onsite Usage	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Reduce Energy Costs	No	Yes	Yes	Yes	No	No	Yes	Yes	No	No
Creates New Generation	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Within Illinois	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Reduce Onsite Demand Charges	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Stablize Energy Costs	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Supports LMI Workforce	No	Yes	Yes	No	No	No	Yes	Yes	No	No
Can Provide Training Opportunities	No	Yes	Yes	No	No	No	Yes	Yes	No	No

Table 12: Levelized Cost of Energy Projections for REC Swapping Strategies

The potential of onsite generation offsetting 24% of the analyzed load is markedly different than offsetting 10% of the load. The larger load offers a greater amount of overall savings to offset the expense of REC purchases. With greater savings there is more of an opportunity to purchase RECs that address stakeholder priorities and still save money. This analysis shows that the ability to combine methods with REC swapping can provide enough savings from unbundled onsite generation (selling RECs) to more than compensate for the additional cost of REC purchases. The analysis also shows that leveraging ILSFA unbundled RECs provides the greatest cost savings and should be considered whenever possible. General market PPA projects, assumed to be an important part of the strategy, do not provide enough savings unless combined with other strategies.

Building a Renewables Deployment Strategy

Developing a renewable deployment strategy, however, is not as simple as combining one or two methods. Instead, a sound strategy will require a more complex combination of deployment options that is likely to change over time. The Site and Portfolio Planner Tool allow users to adjust the share of any specific deployment method in any combination to see the effect on overall energy costs from a given strategy. Strategies can be looked at for a single year or for multiple years by increasing the overall load targeted. A final Deployment Strategy for the City of Chicago or any of the sister agencies should include multiple onsite generation methods as a percent of offset across the portfolio that is aggressive, but realistically achievable. It should also combine REC purchases in a way that balances cost and stakeholder priorities. The goal can be to maximize meeting stakeholder priorities while remaining cost-positive.

Annual Portfolio Planner

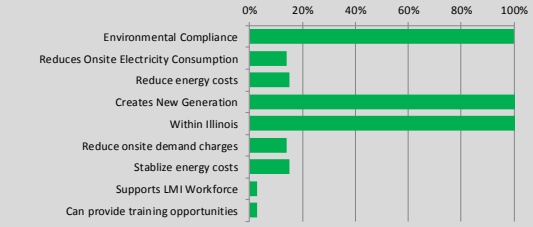
Energy & Pricing Assumptions

Annual Portfolio Energy Usage	1,800,000,000	kWhs
Baseline Supply Rate	$0.0550	per kWh
National RECs		
• National REC: Existing Generation	$1.00	per REC
• National REC: New Generation	$2.00	per REC
Illinois RECs		
• Illinois REC: Existing Generation	$2.50	per REC
• Illinois REC: New Generation	$5.00	per REC
Bundled Supply		
• Bundled Supply Rate	$0.0620	per kWh

Annual Renewables Portfolio Costs/Savings

Current Annual Baseline Supply Costs	($99,000,000)
Total Annual Renewables Cost	$2,052,427
LCOE (RECs, Onsite & Supply)	($0.0539)
Change in Annual Baseline Supply Cost	▼ 2.07% Cost Reduction

Benefits Rubric: Frequency of Meeting Priority



Onsite Generation

	%	kWh	LCOE	Costs/Revenue
1-Vacant Land - Own	0%	0	($0.0137)	$0
2-Vacant Land - PPA	0%	0	$0.0053	$0
3-Rooftop Owned (General Market RECs)	6%	108,000,000	$0.0302	$3,261,884
4-Rooftop PPA (General Market RECs)	6%	108,000,000	$0.0190	$2,053,866
5-Rooftop Owned (ILSFA Market RECs)	1%	18,000,000	$0.0688	$1,239,131
6-Rooftop PPA (ILSFA Market RECs)	1%	18,000,000	$0.0418	$753,084
7-Community Solar Host & Anchor(Gen Mkt RECs)	0%	0	$0.0720	$0
8-Community Solar Host & Anchor(ILSFA RECs)	1%	18,000,000	$0.0882	$1,586,755
9-Bundled Rooftop (Retain RECs)	0%	0	($0.0054)	$0
TOTAL COST FOR ONSITE GENERATION	**15%**	**270,000,000**		**$8,894,721**

Community Solar Offsite Subscription

	%	kWh	LCOE	Costs/Revenue
1-General Market Community Solar	2%	36,000,000	$0.0190	$684,622
2-IL Solar For All Community Solar	1%	18,000,000	$0.0418	$753,084
		54,000,000		**$1,437,706**

REC Purchases

	%	kWh	LCOE (REC only)	Cost (REC only)
National RECs				
• National REC: Existing Generation	10%	180,000,000	($0.0010)	($180,000)
• National REC: New Generation	0%	0	($0.0020)	$0
	10%	**180,000,000**		**($180,000)**
Illinois RECs				
• Illinois REC: Existing Generation	0%	0	($0.0025)	$0
• Illinois REC: New Generation	90%	1,620,000,000	($0.0050)	($8,100,000)
	90%	**1,620,000,000**		**($8,100,000)**
Bundled Supply				
• Bundled Supply	0%	0	($0.0070)	$0
	0%	**0**		**$0**
TOTAL COST FOR REC PURCHASES	100%	**2,070,000,000**		**($8,280,000)**

For example, the above strategy analyzes the full City load for one year. It assumes that onsite generation can account for 15% of that load. Due to the small block of available ILSFA RECs on an annual basis, this deployment strategy only includes 1% for ILSFA owned systems and 1% for ILSFA PPAs. The remaining unbundled onsite generation comes from general market and community solar projects. The savings from this onsite generation allows 90% of the RECs purchased to be new generation, Illinois RECs, which maximizes stakeholder priorities and still saves more than 2% in overall energy costs. The available quantity of new, Illinois RECs available during any given period is uncertain and not likely to represent a significant percentage of the overall portfolio load. But, for planning purposes, building a strategy in this way sets an aggressive target and ensures that savings can be achieved with the most expensive RECs built into the plan.

These findings suggest that there are a number of approaches and combinations that can go into a deployment strategy that can meet a good number of stakeholder priorities and still save money on long-term energy costs. Once a strategy is developed, then a long-term procurement and development plan should follow, i.e., how to plan for an onsite procurement process, onsite development and installation, and long-term REC procurement. Following are the primary recommendations that are the outcome of this analysis.

Portfolio Strategy Recommendations

REC Swapping	Use REC swapping as an overall strategy where the long term deployment plan includes a realistic percentage of unbundled onsite generation. RECs are sold for onsite generation projects at a high value and less expensive RECs are purchased to offset the entire load and meet the 100% commitment. Selling high value RECs creates enough savings to pay for all compliance REC purchases and allows higher cost Illinois and new generation RECs to be included while still saving money on long-term energy costs.
Prioritize ILSFA	ILSFA provides the greatest savings for unbundled, onsite generation. This significant savings can be used to offset the expense of compliance and allows portfolio managers to maximize stakeholder priorities and still save money. Be realistic with allocations for ILSFA, as the blocks are fairly small annually. Our analysis included no more than 2% ILSFA across the portfolio as a long term strategy.
Maximize Stakeholder Priorities	Maximizing the use of ILSFA and Illinois/new generation RECs will ensure stakeholder priorities are met as often as possible. Instead of trying to simply maximize energy cost reduction across the portfolio, ensure a minimum level of cost reduction (say 1% to 3%) while maximizing priorities through a balanced portfolio strategy.
Maximize Unbundled Onsite Generation	Do a thorough assessment of your portfolio to maximize unbundled onsite generation. This provides the greatest amount of onsite energy reductions, new Illinois generation and provides significant cost savings to fund the broader strategy.

Considerations

Additional considerations should be included in the strategy development process, including the following:

1	Onsite generation on vacant parcels is less attractive because, with no load at that site, generated power is sold at a lessor rate directly to the utility, minimizing savings.
2	Power Purchase Agreements at sites with no load will also yield less value for developers and less savings for the City as off-taker.
3	Hosting and subscribing to community solar provides greater benefits on vacant sites or sites with no loads than distributed generation because of the combination of lease payments and energy savings.
4	While installation costs for parking canopies have decreased significantly in the past five years, payback and returns are minimal. However, hosting community solar with these systems can provide a greater value with no upfront costs.
5	Distributed generation with General Market (Adjustable Block Program) RECs has a better payback with smaller systems when no tax benefits can be realized.
6	Subscribing to offsite community solar has no limitations in terms of share of portfolio load. Even a 10% subscriber savings can be significant across a large share of the portfolio load.

Site-Specific Onsite Generation Analysis

Analyzing a specific site for onsite generation will provide helpful details for site-specific procurement and help plan for how to include onsite generation in your overall portfolio deployment strategy. To begin, it may be helpful to use the Financial Model Template for a given site. The data required for a summary analysis are 1) projected solar system size (in kW DC), 2) annual electricity load (in kWh's annually), and 3) the Net Metering Class based on your annual usage. The electricity load can typically be found on your monthly electricity bill for that site. Look for total kilowatt hours for a consecutive twelve month period and use this total for this field. Additionally, understanding which Net Metering class the specific site falls under is important. A simple approach is to use NM3 for loads of less than 100 kW capacity and NM5 for loads greater than 100 kW capacity. The formulas in the tool will calculate approximate net metering credits based on these established tariffs.

To determine the projected solar system size, utilizing tools like Helioscope, Aurora, SAM and other solar assessment tools will allow for relatively precise projections. These tools take into account system orientation, shading and seasonal weather patterns. However, estimating rooftop and parcels for solar capacity can be approximated with simple formulas. For example, measuring the total square footage of a rooftop or parcel and assuming an average useable space of 70% of that square footage is a good, conservative approximation of available, useable space. Approximating the panel size and efficiency will then allow for a total system size. For example, current panels average 17.5 s.f. in size and produce an average of 300 to 325 watts. A simple formula is built into the Financial Model Template to help approximate system size when formal designs are not available.

Entering these inputs into the Financial Model Template provides a detailed pro forma for each of the eight unbundled, onsite generation deployment methods, summarizing key financial metrics to allow users to compare results. A number of additional inputs can be adjusted or default values can be used to generate reliable, approximate pro forma.

Using the Site Planner Tool

These same inputs can be entered into the Site Planner Tool for similar analysis, but includes the ability to compare the energy costs for a number of bundled and unbundled deployment methods. The Offsite REC-Only Savings sections provides a comparison of the current supply rate to the aggregated rate of current supply and REC procurement costs combined. The Onsite and Offsite REC Swap Savings provides a comparison of current supply rate to the aggregated rate of current supply, REC procurement costs and unbundled onsite generation costs. Both are indicated as a total LCOE rate, as well as a percent cost savings/cost increase against the current rate.

The Onsite Generation Annual Load Offset indictaes the percent of annual load offset by onsite generation for the proposed system at this site. The Benefits Rubric provides a simple Yes/No indication of whether each of the stakeholder priorities are being met with this deployment scenario.

Site Details:

Building Address:
441 N. Waller Ave.

Building Name:
Fire Engine Company 96

Annual Energy Usage:
77,405

Onsite Solar Capacity (kW DC)
21

Current Baseline Supply Rate (Per kWh)
$0.0526

Baseline Price Assumptions:

National RECs	Per MWh
• National REC: Existing Generation	$1.00
• National REC: New Generation	$2.00
Illinois RECs	Per MWh
• Illinois REC: Existing Generation	$2.50
• Illinois REC: New Generation	$5.00
Bundled Supply	Per kWh
• Bundled Supply/ Community Solar Rate	$0.0620
• Additional LCOE for Bundled Supply	$0.0094

Onsite and Offsite REC Swap Costs

Deployment Type:	kWh:	LCOE	Total Cost
Onsite Generation	33%	$0.0469	$1,210
REC Offset	100%	($0.0050)	($387)
Total Arbitrage Cost:			**$823**
Total Arbitrage LCOE (kWh):			**$0.0106**

Select REC Type:

Illinois REC: New Generation

REC Value:	Additional LCOE
$5.00	($0.0050)

Select Onsite Generation Type:

3-Rooftop Owned (General Market RECs)

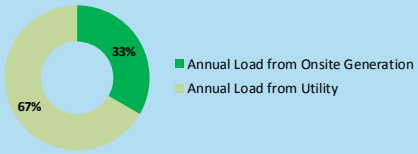
LCOE
$0.0469

Onsite and Offsite REC Swap Savings

Base Supply Rate LCOE:	($0.0526)
Arbitrage LCOE:	($0.0420)
Projected Energy Costs	**▼ 20.22%** **Cost Reduction**

Onsite Generation Annual Load Offset

	Percent Load	kWh
Annual Load from Onsite Generation	33%	25,817
Annual Load from Utility	67%	51,588
Annual Load Total	**100%**	**77,405**



Offsite REC Only Savings

Base Supply Rate LCOE:	($0.0526)
REC Only LCOE:	($0.0576)
Projected Energy Costs	**▲-9.51%** **Cost Increase**

Benefits Rubric

Yes	Environmental Compliance: Contributes to 100% renewable buildings
Yes	Reduces Onsite Electricity Consumption
Yes	Reduce energy costs
Yes	Creates New Generation
Yes	Within Illinois
Yes	Reduce onsite demand charges
Yes	Stabilize energy costs
No	Supports LMI Workforce
No	Can provide training opportunities

Using the Site Planner Tool to Analyze Sites

Enter Site Details	Building specific details that represent onsite solar potential, as well as onsite annual electricity usage. Enter the appropriate Net Metering Class. A simple approach is to select NM3 for annual loads with a capacity of under 100 kW and NM5 for loads above 100 kW.
Enter Baseline Price Details	Default values for current REC price averages and bundled supply rate. Can be adjusted based on changing rates or to see the impact of potential future changes.
Select the REC type	RECs in this analysis include: • National REC: Existing Generation • National REC: New Generation • Illinois REC: Existing Generation • Illinois REC: New Generation • Bundled Supply Rate
Select Onsite Generation type	Onsite Deployment strategies include: 1-Vacant Land - Owned 2-Vacant Land - PPA 3-Rooftop Owned (General Market RECs) 4-Rooftop PPA (General Market RECs) 5-Rooftop Owned (ILSFA Market RECs) 6-Rooftop PPA (ILSFA Market RECs) 7-Community Solar Host & Anchor (Gen Mkt RECs) 8-Community Solar Host & Anchor (ILSFA RECs) 9-Bundled Rooftop (Retain RECs) No Onsite Generation
Adjust REC and Onsite Generation types	REC and Onsite Generation types can be changed to see the impact of various strategies on overall energy costs or to change the impact of the Benefits Rubric.

Developing an Onsite Generation Target Percentage

Developing an onsite generation target percentage is the starting point for building a portfolio wide deployment strategy. As the analysis shows, the greater the percentage of onsite generation across the portfolio, the greater the savings, and the more opportunity to maximize stakeholder priorities. Projecting this percentage may not be an exact science without comprehensive site analysis and some solar design. However, approximations can be made to allow for a reasonable overall target. This can be done by estimating solar capacity for common property types and projecting across that category of buildings in the portfolio. As indicated by our analysis of 13 sample sites with high onsite generation potential, 24% is a high target percentage. By building financial models for individual sites that represent building types in your portfolio, a target can be approximated. By filtering this target through other site condition criteria, like approximate roof age, structural limitations of certain property types, etc., this target can be refined to a more realistic proportion of the overall portfolio load. Another approach is to build overall strategies with multiple onsite generation targets to see the impact on costs; i.e. 10%, 12% and 14%, for example. A conservative, realistic target percentage is a better starting point than an aggressive target that must be revisited over time.

Building a Deployment Strategy Using the Portfolio Planner Tool

The Portfolio Planner Tool allows users to analyze a portfolio based on the aggregate electricity load for the targeted set of buildings. The two primary data inputs required are annual aggregated electricity load in kilowatt hours and a target onsite generation percentage. The aggregate annual load is entered into the Portfolio Planner as a single value, for example, the 50,004,230 kilowatt hours for the electricity load of the 13 sites assessed in our analysis. The onsite generation percentage target is then allocated as shares across the eight unbundled onsite generation methodologies, as well as the additional method of bundled onsite generation. If the onsite generation target is 10%, for example, the total percentage across all nine categories should total 10%. The user can then enter values for REC-based purchases across the portfolio load. Allocations across the four REC-based methodologies, as well as the additional bundled supply methodology, must equal 100%. The user can adjust these allocations to balance overall cost and stakeholder priorities. But, the total must always be 100%.

Each deployment method displays the designated share of load as total kilowatt hours, LCOE and total annual costs. These costs are totaled across all deployment methods and summarized in the Annual Renewables Portfolio Costs/Savings section. The final metric displays the Current Annual Baseline Supply Cost and the Total Annual Renewables Cost, then indicates the aggregated LCOE as a cost per kilowatt hour and as a percent cost savings or increase. The Benefits Rubric in the Portfolio Planner provides individual percentages for each stakeholder priority that indicates how often each priority is being met. This metric is based on the number of kilowatt hours from various deployment methods that meets reach priority and aggregates that over the portfolio. Adjusting allocations across methodologies will change these outcomes.

Enter Portfolio Usage and Supply Rate	Portfolio Usage represents the total annual load for the entire portfolio in kilowatt hours. For example, the 13 sites analyzed represent a total load of 50,004,230 kWh's annually. The base rate average is $0.055 per kWh.
Enter Pricing Assumptions	Default values for current REC price averages and bundled supply rate. Can be adjusted based on changing rates or to see the impact of potential future changes.
Enter Site Details in the Inputs Tab	The site specific details are important because the pro forma produced for each method determines the LCOE values in the Portfolio Planner. Use a represntative solar capacity and electricity load for properties in the portfolio. Other inputs can remain as default values or be adjusted based on that average property type.
Assign % to Onsite Generation Deployment Strategies	The total across all onsite deployment strategies should equal the anticipated load offset for onsite generation across the portfolio. This is based on the percent of kilowatt hours of onsite generation divided by the total annual kilowatt hour load. For example, the 13 sites analyzed have a 24% load offset.
Assign % to REC Purchase Strategies	Percentages can be assigned to each REC Purchase strategy. The total percentage must equal 100% across the five REC deployment strategies.
Adjust REC and Onsite Generation percentages	REC and Onsite Generation percentages can be changed to see the impact of various strategies on the overall cost of energy or on the impact to the Benefits Rubric.

Annual Portfolio Planner

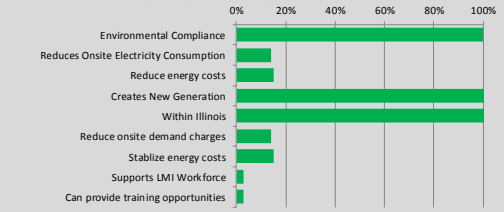
Energy & Pricing Assumptions

Annual Portfolio Energy Usage	50,004,230	kWhs
Baseline Supply Rate	$0.0550	per kWh
National RECs		
• National REC: Existing Generation	$1.00	per REC
• National REC: New Generation	$2.00	per REC
Illinois RECs		
• Illinois REC: Existing Generation	$2.50	per REC
• Illinois REC: New Generation	$5.00	per REC
Bundled Supply		
• Bundled Supply Rate	$0.0620	per kWh

Annual Renewables Portfolio Costs/Savings

Current Annual Baseline Supply Costs	($2,750,233)
Total Annual Renewables Cost	$106,466
LCOE (RECs, Onsite & Supply)	($0.0529)
Change in Annual Baseline Supply Cost	▼ 3.87% Cost Reduction

Benefits Rubric: Frequency of Meeting Priority



Onsite Generation

	%	kWh	LCOE	Costs/Revenue
1-Vacant Land - Own	0%	0	($0.0137)	$0
2-Vacant Land - PPA	0%	0	$0.0053	$0
3-Rooftop Owned (General Market RECs)	6%	3,000,254	$0.0302	$90,616
4-Rooftop PPA (General Market RECs)	6%	3,000,254	$0.0190	$57,057
5-Rooftop Owned (ILSFA Market RECs)	1%	500,042	$0.0688	$34,423
6-Rooftop PPA (ILSFA Market RECs)	1%	500,042	$0.0418	$20,921
7-Community Solar Host & Anchor(Gen Mkt RECs)	0%	0	$0.0720	$0
8-Community Solar Host & Anchor(ILSFA RECs)	1%	500,042	$0.0882	$44,080
9-Bundled Rooftop (Retain RECs)	0%	0	($0.0054)	$0
TOTAL COST FOR ONSITE GENERATION	**15%**	**7,500,635**		**$247,096**

Community Solar Offsite Subscription

	%	kWh	LCOE	Costs/Revenue
1-General Market Community Solar	5%	2,500,212	$0.0190	$47,547
2-IL Solar For All Community Solar	2%	1,000,085	$0.0418	$41,842
		3,500,296		**$89,389**

REC Purchases

	%	kWh	LCOE (REC only)	Cost (REC only)
National RECs				
• National REC: Existing Generation	10%	5,000,423	($0.0010)	($5,000)
• National REC: New Generation	0%	0	($0.0020)	$0
	10%	**5,000,423**		**($5,000)**
Illinois RECs				
• Illinois REC: Existing Generation	0%	0	($0.0025)	$0
• Illinois REC: New Generation	90%	45,003,807	($0.0050)	($225,019)
	90%	**45,003,807**		**($225,019)**
Bundled Supply				
• Bundled Supply	0%	0	($0.0070)	$0
	0%	**0**		**$0**
TOTAL COST FOR REC PURCHASES	100%	**57,504,865**		**($230,019)**

Conclusion

Developing strategies that meet the Mayor's commitment to offset 100% of the electricity load for 900+ City of Chicago buildings is not only possible, but can be done in a way that ensures the energy used by the City is reduced, is cleaner and is procured in a way that benefits our communities and the emerging local solar industry. Portfolio managers across City agencies can develop comprehensive deployment strategies that include a variety of methodologies, balancing cost with internal and external stakeholder priorities, including cost reduction, energy reduction, local development and job creation.

While the task of meeting the Mayor's commitment is complex and new skills will need to be learned, the stakeholders that have been a part of this working group hold a unique set of skills and experiences that have informed this process and can help guide the development of deployment strategies moving forward. The analysis and tools developed as part of the Renewables Chicago project can serve as a guide to the processes and considerations that are part of building these strategies.

This report and the accompanying tools represent the work of many individuals within the City of Chicago and sister agencies, as well as 25 organizations representing our communities and the solar industry. The cumulative impact of deploying these strategies promises long term benefits to our communities, our economy and our environment.

Resources

Illinois Power Agency: *Long Term Renewable Resources Procurement Plan.*
https://www2.illinois.gov/sites/ipa/Documents/2018ProcurementPlan/LTRRPP-Filed-Long-Term-Renewable-Resources-Procurement-Plan.pdf

Illinois Power Agency: *Revised REC Pricing, June 4th, 2018.*
https://www2.illinois.gov/sites/ipa/Documents/2018ProcurementPlan/ComplianceFilingMemorandum.pdf

State of Illinois Adjustable Block Program:
http://illinoisabp.com

State of Illinois: *Future Energy Jobs Act*
http://ilga.gov/legislation/99/SB/PDF/09900SB2814enr.pdf

U.S. Environmental Protection Agency's Green Power Partnership: *Renewable Energy Certificates (REC) Arbitrage.*
https://www.epa.gov/sites/production/files/2017-09/documents/gpp-rec-arbitrage.pdf

U.S. Environmental Protection Agency's Green Power Partnership: *RECs: Making Green Power Possible.*
https://www.youtube.com/watch?v=_12VYXms6-c

U.S. Environmental Protection Agency's Green Power Partnership: *Guide to Making Claims About Your Solar Power Use.*
https://www.epa.gov/greenpower/guide-making-claims-about-your-solar-power-use

Carbon Offset Research and Education (CORE): *Renewable Energy Certificates (RECs) and Carbon Offsets.*
http://www.co2offsetresearch.org/consumer/RECs.html

World Resource Institute: *Bottom Line On Renewable Energy Certificates.*
http://wriorg.s3.amazonaws.com/s3fs-public/pdf/bottom_line_renewable_energy_certs.pdf

GTM Research: *No, Cities Are Not Actually Leading on Climate.*
https://www.greentechmedia.com/articles/read/hard-truths-about-city-failures-with-clean-energy

National Renewable Energy Laboratory: REopt: Renewable Energy Integration & Optimization
https://reopt.nrel.gov/

National Renewable Energy Laboratory: Data and Tools
https://www.nrel.gov/research/data-tools.html

PJM: *Environmental Information Service.*
https://pjm-eis.com/

SRECTrade:
http://www.srectrade.com/

SolSmart:
https://www.solsmart.org/

The Solar Foundation:
https://www.thesolarfoundation.org/

Appendices

Appendix 1: Solar Plus Storage and Critical Facilities

Solar and storage has been considered as a viable option for achieving various levels of resiliency for some time. Generating energy onsite and having the ability to use that energy on demand can send less energy to the grid, use less energy from the grid, and provide a safeguard against outages for critical loads. Increasingly, however, solar plus storage is being used to strengthen the value proposition of solar. This is achieved through the management of peak load and peak demand or through other ancillary services that have a long-term positive impact on energy costs.

The Renewable Chicago project team met with the Mayor's team, AECOM, and the Chicago Office of Emergency Management and Communications (OEMC) to strategize on the potential use of solar and storage. The meeting established a basis for analysis and research to better understand the use and potential for solar and storage to meet resilience needs and also improve the financial viability of solar.

Defining Resiliency

The definition of resiliency is difficult and used in various ways. In the context of municipal emergency power, the most critical facilities are commonly defined by code or statute. For example, NAPFA 70, The National Electrical Code, requires that emergency power systems include an automatic transfer switch that transfers the load within 10 seconds of loss of normal power, standby systems must transfer within 60 seconds, and critical operations power systems must operate continuously. To meet these and the critical load requirements for essential City of Chicago facilities, solar and storage becomes difficult or very costly compared to traditional diesel and natural gas generator systems that serve automated switching technology. These systems, informally referred to by this group as Level One Resiliency, will continue to be required for long-term resiliency planning for critical facilities within the City's portfolio, e.g., police, fire, and OEMC critical facilities.

The session established a potential for a Level Two Resiliency and considered this to include health centers, senior centers, community centers and other facilities that provide critical services or could be used as cooling centers, for example. The rationale for considering a Level Two facility was to find facilities that could 1) use solar and storage as a means to reduce costs through peak load and peak demand management compared to solar alone and 2) benefit from the resiliency secondarily.

Analyzing Level Two Facilities

Several properties within the sample of thirteen properties were selected as candidates for solar and storage analysis. The first step in the analysis was to model these facilities for solar and storage using peak shaving as a means for ensuring economic viability; that is, using the battery as a means to reduce energy use from the grid during those times when energy is most expensive or peak demand is the highest. Sites included the MLK Jr. Center, Roseland Neighborhood Health Center, Englewood Senior Center, and Altgeld Gardens.

Our initial analysis showed that all but one property could not be made financially viable with solar and storage. Elevate Energy used both the NREL ReOPT Lite tool and the GELI tool. The results were the same with both systems. For all sites except Altgeld, the savings when storage was introduced did not cover the additional costs. It was determined that peak demand charges are generally low in Illinois, averaging about $7.00 per kW. In most

instances, the breakeven for most facilities happens when demand charges are $12-$15 or higher. There are expectations, however, with facilities that have very large or very inconsistent loads.

Solar and Storage at Altgeld Gardens

Altgeld Gardens has characteristics that are more optimal for solar and storage with a very high load and peak demand as a master-metered residential complex. An analysis was facilitated by Elevate Energy and conducted by the Northwestern University Microgrid Team in 2017 and the data used here to illustrate this concept. In this analysis, using the HOMER and DER-CAM platforms, outputs suggest an optimized system that includes a 5,000 kW solar array, 4,000 kWh flow battery storage system as well as microgrid PMS for power management and islanding.

Solar Output Assumptions:

- Hours of operation: 4,375 hrs/yr (HOMER output)
- Power output: 8,595,028 kWh/yr (HOMER output)
- Sellback rate for excess solar energy: 2.7cents/kWh
- Solar panel footprint: depending on the technology, typical 4.8 MW solar system would occupy anywhere between 241,024 sq. ft. to 321,365 sq. ft. (22,400 m^2 to 29,866 m^2), roughly the size of four football fields

Storage Output Assumptions:

- Annual battery throughput: 41,012 kWh/yr (HOMER output)
- Storage footprint: depending on the technology, typical 1MW/4MWh flow battery would occupy 2,889 sq. ft. (268 m^2) without service access, roughly the size of a tennis court
- Including Microgrid

The Levelized Cost of Energy (LCOE) for "solar only" in this model was projected to be $.030/kWh. This yields energy savings of $495,592/year and demand savings of roughly $5,567/year or a total projected savings of $501,159/year. The Levelized Cost of Energy (LCOE) for solar plus storage in this model was projected to be $.029 cents/kWh. This yields an annual energy savings of $508,401/year as well as ancillary service benefits that bring the total projected savings to $692,415/year.

SOLAR + STORAGE (4.8 MW + 4000kWh)				
	With Ancillary services		**Without Ancillary Services**	
SREC	With SREC	Without SREC	With SREC	Without SREC
Project Payback	2.8 years	8.2 years	3 years	12 years
IRR (20 year)	23.9%	8.4%	21.7%	5.6%
NPV	$11.89M	$1.67M	$9.98M	-$0.24M
CAPEX	$14.27M	$14.27M	$14.27M	$14.27M

The result of this analysis shows that by introducing storage at this site and for this load profile, the overall energy savings is greater and provides significant resilience benefits. These include greater cost savings, backup power for critical loads, microgrid and islanding for greater resiliency during outages, and greater overall grid stability.

Recommendations for Solar and Storage

Due to limitations from consistent annual interval data for most sites in our sample, only a limited set of properties could be analyzed. It is recommended that the City of Chicago prioritize the economic benefits of solar plus storage, identifying candidate properties based on their load profiles, i.e., significantly large and inconsistent (spikey) loads. Examples would be water facilities, CTA maintenance facilities, or other facilities that operate for longer periods and with large loads. These sites can be analyzed using ReOPT, GELI, or HOMER to determine where solar and storage can optimize the renewable system and accelerate savings. Then critical loads can be determined to benefit from the availability of backup power when needed.

Appendix 2: Solar Permitting and City Business Processes

Overview and Methodology

The Renewable Chicago Project conducted analysis of the current solar permitting process along with other associated business processes related to the renewables industry. This research sought to better understand the effectiveness of these processes and the potential for creating further efficiencies ahead of the anticipated rapid market growth in the region. An online survey was published in October and November of 2017, inviting more than 200 industry professionals representing solar developers and installer/contractors currently working in or preparing to work in Illinois.

28 industry professionals responded and 21 completed the survey between October 23 and November 3. This represents a response rate of about 10%. While the sample size is too small to provide statistical significance, it does represent a significant segment of the solar industry in Illinois and provides very specific insight into a number of important and actionable items that support processes important to them.

Key Findings: Permitting Processes

Findings:

- The Standard Plan Review for solar is poorly rated, while the Easy Permit Process is highly rated.
- Local organizations have significantly higher opinions of the permitting processes than regional or national organizations.

Recommendations:

- Simplify, streamline, and standardize, do it over-the-counter and online.
- Concurrent department review is recommended to save time.
- Allow better access to knowledgeable permitting and zoning officials.

"Chicago is not the first city to have solar installed in its limits, it does not need to treat (for example) a small residential garage roof install as if it were a large commercial installation. Make permitting simple and faster. It affects everyone's bottom line."

Key Findings: Other Processes

Findings:

- Other City permitting processes are rated much higher than solar permitting.
- Inspections are inefficient; inspectors need to be more knowledgeable.
- Emerging issues include storage, rooftop wind, ground-mount in residential areas, and taxes for solar.

Recommendations:

- 13.44kW threshold needs to be higher; consider the LTRRP threshold of 25 kW.
- Solar ordinances should be adopted.

"Solar ordinances (zoning policies laying out ground rules for solar) can increase permitting efficiency by volumes. Additionally, a solar ordinance should make solar permitted by right or by special review in various zoning districts to avoid complicated and vague permitting processes."

Key Findings: Solar Organizations

Findings:

- Key organizational distinctions include developer vs. installer and geographic scope. All responses are filtered by these categories.
- Local installers and developers are more positive about all permitting and business processes.
- Residential solar is more common among state and local organizations; national organizations are less likely to serve residential customers.
- Local organizations are more diverse.

"Find money for Minority Owned Businesses to participate!"

Recommendations:

- Local organizations should be supported to ensure diversity and service to residential households.

Key Findings: Tools and Resources

"[Create an] online permit process similar to electrical done by electrical contractors"

"An online permit process is best"

"[Create a] one-stop, online application process"

Findings:

- Solar Express is highly regarded by local and state organizations.
- Solar permitting should have an online application form.

Recommendations:

- Create a one-step, online application process for solar.
- Make permitting an online process.
- Work with ComEd to create a grid stability and insolation map.

Full details, data and analysis can be found in the Permitting and Business Processes Survey Results Report.

Appendix 3: April 9, 2017: Mayor Emanuel Announces City Buildings to Be Powered By 100 Percent Renewable Energy By 2025

OFFICE OF THE MAYOR
CITY OF CHICAGO

FOR IMMEDIATE RELEASE
April 9, 2017

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MAYOR EMANUEL ANNOUNCES CITY BUILDINGS TO BE POWERED BY 100 PERCENT RENEWABLE ENERGY BY 2025

Chicago Public Schools, Chicago Housing Authority, Chicago Park District, and City Colleges of Chicago all join Mayor's commitment

Mayor Rahm Emanuel, Chicago Public Schools (CPS) CEO Forest Claypool, Chicago Park District CEO Mike Kelly, Chicago Housing Authority (CHA) Eugene Jones, Jr., Fleet and Facility Management Commissioner David Reynolds, and City Colleges of Chicago (CCC) leadership today announced their commitment to move their buildings' electricity use to 100 percent renewable energy by 2025. When implemented, Chicago will be the largest major city in the country to have a 100 percent renewable energy supply for its public buildings.

"As the Trump administration pulls back on building a clean energy economy, Chicago is doubling down," Mayor Emanuel said. "By committing the energy used to power our public buildings to wind and solar energy, we are sending a clear signal that we remain committed to building a 21st century economy here in Chicago."

Collectively the City, CPS, the Park District, CHA, & CCC used nearly 1.8 billion kilowatt hours of electricity in 2016, amounting to eight percent of all electricity use in Chicago; it is the equivalent to powering approximately 295,000 Chicago homes. The electricity used by these agencies is the same amount of energy created by over 300 wind turbines in one year. The commitment will be met through a combination of acquiring renewable energy credits, utility-supplied renewable energy via Illinois' Renewable Portfolio Standard, and on-site generation. Initial purchases will begin in 2018 and 2019.

"Today's action is a historic step forward in establishing Chicago as a clean energy leader," said Jack Darin, Illinois Sierra Club President. "By moving boldly to repower its public buildings with renewable energy like wind and solar, Chicago is leading by example at a time when local leadership is more important than ever. While President Trump and his administration would reverse America's progress on climate change and clean energy, Mayor Emanuel is ensuring that Chicago will move forward, and that its residents will benefit from the good jobs and cleaner air that come from renewable energy projects. We look forward to working with the Mayor, community leaders, and the people of Chicago to achieve this bold goal on the path to eventually powering all of Chicago with 100% clean energy."

121 NORTH LASALLE STREET, ROOM 507, CHICAGO, ILLINOIS 60602

Mayor Emanuel announced Chicago's new commitment on the rooftop of Shedd Aquarium, which has installed over 900 solar panels in an effort to reduce their energy use by 50 percent by 2020. As a member of Mayor Emanuel's Retrofit Chicago Energy Challenge, Shedd Aquarium has also retrofitted nearly 1,000 of its own light bulbs to LED and installed a 60,000 pound, one-megawatt battery on their own property.

The City and its sister agencies have already made significant strides to green their energy supply. In 2013, the City eliminated coal from the over 1 billion kilowatt hours in electricity it buys on an annual basis. A dozen CPS schools have had solar arrays installed since 2009, while the Park District and City Colleges currently procure large portions of their energy use from renewable sources.

Earlier this week, the U.S. Environmental Protection Agency announced the City of Chicago earned a 2017 ENERGY STAR Partner of the Year Award. It is given annually to honor organizations that have made outstanding contributions to protecting the environment through energy efficiency.

Last week, the Mayor announced that the Smart Lighting Project will start on the South and West Sides this summer. Once approved by City Council, the Chicago Smart Lighting Project will replace 270,000 of Chicago's light fixtures and add a management system that will give the city a state-of-the-art smart lighting grid.

Today's announcement builds on the strong environmental track record built since 2011. In January, Mayor Emanuel announced that Chicago has reduced its carbon emissions by seven percent from 2010 to 2015. The reduction in greenhouse gases came at the same time Chicago saw a 25,000 person increase in its population and 12 percent growth in the region's economy and jobs within the city. The emissions reduction, equivalent to shutting down a coal power plant for eight months, compares to a one percent increase in nationwide emissions from 2009 to 2014.

###

Appendix 4: Community and Industry Barriers and Solutions

Workforce Development

Direct Impact	Use city projects as on-the-job training opportunities
Direct Impact	Leverage LAA and CHA facilitates training/Section 3 for solar job training
Direct Impact	Direct job training to City College students
Direct Impact	Engage ILSFA programs that require job training
Direct Impact	Place a preference, requirement, or premium on local hiring with City contracts or RFPs
Indirect Impact	City Colleges identify students from specific low-income communities to target for job training
Indirect Impact	Education or exposure to renewables career paths through City Colleges, CPS, STEM

Consumer Protections

Direct Impact	Use City contracts and RFPs as a means for adding specific consumer protection requirements
Direct Impact	Procurement requirements that include consumer protections
Direct Impact	Preference for companies that meet requirements for being fair and transparent with retail customers
Direct Impact	Facilitating group buys/solarize campaigns with consumer protection requirements
Direct Impact	Look into “Sun-rights” as an option to protect solar investments
Indirect Impact	Education campaigns to prevent consumer protection abuses
Indirect Impact	Marrying existing consumer protection education with what is to come in regards to solar
Indirect Impact	Equip BACP to work with CUB, others to ramp up consumer protection resources
Indirect Impact	Leverage opportunities for input on consumer protections for Illinois Power Agency programs

Equity/Access

Direct Impact	Leverage ILSFA for deployment on public buildings to ensure low-income participation
Direct Impact	Prioritize brownfield land, low-income projects at higher SREC values
Direct Impact	City serves as anchor for low-income or equity-based community solar projects
Direct Impact	Procure community solar projects on City land and require subscribers from that community, low-income participation, etc.
Direct Impact	Prioritize deployment on City properties in the most disadvantaged communities
Direct Impact	Prioritizing tax-delinquent or land bank properties as install sites, will more likely mean development in areas of greatest need
Direct Impact	Subscription guarantee or “backup subscription” for community solar projects that are low-income or have an equity component
Direct Impact	Group buys with projects that have an equity component
Direct Impact	Partner on RFPs with equity-based community groups or WBE/MBE
Indirect Impact	City to better understand the role of development and displacement

Education

Indirect Impact	Partner with organizations on early education of ILSFA opportunities
Indirect Impact	Mechanisms to monitor and evaluate effects of solar development in low- to moderate-income neighborhoods
Indirect Impact	Educate consumers on the purchase process for solar
Indirect Impact	Educate consumers on how to engage the city during the solar deployment process
Indirect Impact	Share materials developed internally within the City/sister agencies and share externally

Stakeholder Engagement

Indirect Impact	Educate communities on those sites within their borders that are solar-ready
Indirect Impact	Develop opportunities for feedback with the public, solar developers, utility, and City

Utility Engagement

Direct Impact	ComEd and City work together to affect the interconnection and net metering processes
Direct Impact	City can partner with utility on workforce development in solar industry
Indirect Impact	City can generally help ComEd identify points in their processes that don't work well

Technical Barriers

Direct Impact	City could pilot innovative technologies

Industry Barriers and Solutions

Workforce Development

Direct Impact	Use city projects as on-the-job training opportunities
Direct Impact	City Colleges to integrate energy efficiency and electrical training into renewables training
Direct Impact	RFPs for City projects that require workforce training
Direct Impact	Programs being developed by IBEW and Colleges to make certification credentials transferable

Defining the Deal

Direct Impact	City and sister agencies can clearly state parameters of the deal as requirements for doing business with the City
Direct Impact	City can prioritize local workers and locally trained workers for any City project
Direct Impact	RFPs that require local installers or local component procurement

Business Capacity Building

Indirect Impact	Cross-train solar businesses for energy efficiency, electrical, or trades

Site Selection

Direct Impact	Make a public list of the City's solar-ready buildings
Direct Impact	City land, brownfields, and land bank properties can be used as sites for PPAs to offset City load and to help developer site selection
Direct Impact	Publically categorize parcels that are City-owned, City-leasable, brownfields, or other lots available for development
Direct Impact	Mapping website of City properties suitable for solar, brownfields, land bank, etc.
Direct Impact	Provide simple "how-to" guidance on how to engage City on potential land acquisitions for solar developments
Direct Impact	Revise zoning laws to allow for ground mount solar in residential neighborhoods
Direct Impact	Coordination with utility to ID the prime and priority areas for interconnection

Technical Barriers

Direct Impact	City can facilitate storage and emerging technologies by piloting
Direct Impact	City can facilitate storage and emerging technologies by easy permitting requirements

Utility Engagement

Indirect Impact	City to coordinate with ComEd to simplify processes

Appendix 5: Priority Barriers, Solutions, and Assets

Utility Engagement	Very Likely Asset	Likely Asset	Uncertain Asset
● ComEd and City work together to affect the interconnection and net metering processes ● City can generally help ComEd identify points in their processes that don't work well ● City to coordinate with ComEd to simplify processes	● Deployed Projects ● City Engagement Commitment ● Net Metering Guidelines ● Utility Engagement Commitment ● Interconnection Guidelines	● Communication Plan	

Equity/Access	Very Likely Asset	Likely Asset	Uncertain Asset
● Leverage ILSFA for public buildings to ensure low-income participation ● City serves as anchor for low-income or equity-based community solar projects ● Procure community solar projects on City land and require subscribers from that community, low-income participation, etc. ● Subscription guarantee or "backup subscription" for community solar projects that are low-income or have an equity component ● Prioritize brownfield land, low-income projects at higher SREC values ● Prioritize deployment on City properties in the most disadvantaged communities	● City Deployment Commitment ● ILSFA ● Willing Communities ● Suitable Brownfield Land ● City RFPs ● City Procurement Process	● Suitable Sites ● Willing Subscribers	● Willing Investors ● Willing Solar Developers

Education	Very Likely Asset	Likely Asset	Uncertain Asset
● Partner with organizations on early education of ILSFA opportunities ● Mechanisms to monitor and evaluate effects of solar development in and around low- to moderate-income neighborhoods ● Educate consumers on the purchase process for solar ● Educate consumers on how to engage the City during the solar deployment process ● Share materials developed internally within the City/sister agencies and share externally	● Education Content ● Agreed Metrics ● Community Education Partners ● Education Materials	● City Resource Commitment ● Data ● Defined City Processes ● Sister Agency Resource Commitment	

Workforce Development	Very Likely Asset	Likely Asset	Uncertain Asset
● Use city projects as on-the-job training opportunities ● Leverage LAA and CHA facilitates training/Section 3 for solar job training ● Direct job training to City College students ● City Colleges to integrate energy efficiency and electrical training into renewables training ● Programs being developed by IBEW and Colleges to make certification credentials transferable	● City Deployment ● Trainees ● Willing Developers ● Energy Efficiency and Electrical Trainers ● IBEW	● Training Organizations ● Trainers ● Training Resources ● Energy Efficiency and Electrical Curriculum ● Colleges	● Clear Regulatory Framework ● IBEW and College Policy

Defining the Deal	Very Likely Asset	Likely Asset	Uncertain Asset
● City and sister agencies can clearly state parameters of the deal as requirements for doing business with the City ● City can prioritize local workers and locally trained workers for any City project ● RFPs that require local installers or local component procurement	● City Deployment ● RFP ● Local Installers	● City Procurement Process ● Willing Developers ● Local Supply Chain	

Site Selection	Very Likely Asset	Likely Asset	Uncertain Asset
● Make a public list of the City's solar-ready buildings ● City land, brownfields, and land bank properties used as sites for PPAs to offset City load and to help developer site selection ● Publically categorize parcels that are City-owned, City-leasable, brownfields, other lots available for development ● Mapping website of City properties suitable for solar, brownfields, land bank, etc.	● City Resource Commitment ● Willing Developers ● City Sites	● Building Data ● Willing Investors ● Technology	

Consumer Protections	Very Likely Asset	Likely Asset	Uncertain Asset
● Use City contracts and RFPs as a means for adding specific consumer protection requirements ● Procurement requirements that include consumer protections ● Preference for companies that meet certain requirements for being fair and transparent with retail customers ● Facilitating group buys/solarize with consumer protection requirements	● Clear Regulatory Framework ● City Deployment ● Willing Developers	● ILSFA ● City RFPs ● Willing Investors	● City Procurement Process

Appendix 6: Summary of Property Categories Assessed for Solar Suitability

Facility Type	Number of Sites	Average Age (years)	Average Sq. Footage	% Owned	% Occupied	Suitable for Solar	Selected to be Modeled
Auto Pounds	4	No data	922,600	100%	100%	Possible	No
While solar canopies are a possibility for auto pounds, the higher cost of canopies compared to roof or ground mount systems, along with potential security concerns, make this a less likely category for onsite generation.							
Chicago Housing Authority	1,000	50 years	Unknown	100%	91%	Yes	✓ Yes
The CHA operates more than 20,000 units of housing across multiple property sites and hundreds of buildings. There is a great opportunity for onsite solar generation, although more complicated because of the varying size and property types in the portfolio. There may also be a tremendous opportunity for onsite generation using ILSFA program RECs.							
Chicago Park District	754	64 years	Unknown	12%	99%	Yes	✓ Yes
With 214 fieldhouses, as well as many parking lots and other facilities, the Chicago park District presents a good opportunity for significant onsite generation. Many of the buildings and sites are unique and will present a challenge in determining an onsite percentage target. But, the percentage should be significant and can provide the basis for measureable cost savings through unbundled onsite generation.							
Chicago Public Schools	700	74 years	Unknown	Unknown	Unknown	Yes	✓ Yes
Chicago Public School buildings represent a tremendous opportunity for onsite solar. Roofs are commonly large and flat with minimal obstructions. One challenge will be the various age and conditions of the roofs on these buildings. However, onsite generation can be deployed to align with capital plans for roof repairs and replacements. Rooftop solar systems alone could represent nearly 100 MW.							
Chicago Transit Authority	238	Unknown	Unknown	76%	100%	Yes	✓ Yes
The CTA operates 129 rail stations, 64 electrical substations, and more than 30 garage, maintenance, office, and general facilities that have a clear potential for onsite generation. A number of sites represent an opportunity for large onsite systems with significant potential load reduction.							
City Colleges	33	39 years	134,720	100%	100%	Yes	✓ Yes
While the City Colleges portfolio is small, the seven campuses represent multiple buildings with a great potential for onsite solar generation. These roofs are large, flat, and many are in good structural condition for solar.							
Communications Towers	3	66 years	3,133	100%	100%	Not Likely	No
The towers themselves have no onsite generation capacity. The land surrounding towers does potentially have suitability for ground mount solar, but the parcel sizes are typically quite small and promise no economies of scale.							
Community Centers	8	40 years	22,598	63%	100%	Yes	✓ Yes
These buildings are moderately sized structures typically with flat, unobstructed roofs. These buildings would support onsite solar and should be considered when assessing sites for onsite generation. While the number of properties is fairly small and the building stock similar to many other categories, there is value in assessing this category.							
Fire Facilities	10	67 years	20,446	100%	100%	Yes	No
Fire facilities represent buildings that house supporting services and equipment for the Chicago Fire Department other than fire stations. While the number of facilities is small, this category represents a good stock of moderately sized buildings with typically flat roofs and should be considered for onsite generation.							

Facility Type	Number of Sites	Average Age (years)	Average Sq. Footage	% Owned	% Occupied	Suitable for Solar	Selected to be Modeled
Fire Stations	94	65 years	10,270	100%	100%	Yes	✓ Yes
Fire stations represent the largest single category of buildings in the City's portfolio. While these buildings are typically fairly small, they are well suited for solar. Most of the newer buildings have green roof features, which may limit onsite generation. But, it is believed that sections of the roof were designed specifically for the addition of solar.							
Fuel Stations	10	No data	58,880	100%	100%	Not Likely	No
These properties are mostly used for large vehicle parking, which is not conducive to solar. There are portions set aside for standard car parking, which could work for solar canopies, but at a higher cost. The building structures present on these properties tend to be less inherently suitable structurally for onsite generation or less likely to be well-maintained.							
Garages	25	39 years	40,609	92%	100%	Possible	No
Some indoor parking structures have good flat roofs and represent significant individual opportunities for onsite solar installations. Some are very old or have bow-truss roofs or other designs that make solar installation more costly or impossible. Some outdoor lots are for large vehicles and are not conducive to onsite generation. As such, the opportunity is mixed.							
Health Clinics	15	62 years	19,127	60%	100%	Yes	✓ Yes
While the buildings in this category are typically older, they commonly have simple, moderately sized, flat roofs which can be well suited for solar. In addition, there is a compelling case for health clinics as a category for solar and storage for resiliency purposes if the electricity profiles have moderate to high demand charges.							
Libraries	77	67 years	23,311	71%	100%	Yes	✓ Yes
Libraries represent the second largest category of buildings in the City's portfolio after fire stations. While library buildings tend to be older, they commonly have good flat roofs conducive to solar. The newer libraries have green roof features that may limit solar installation, but it is believed that these roofs were designed to accommodate the addition of solar.							
Maintenance Garages	12	33 years	56,174	100%	100%	Not Likely	No
Maintenance garage structures commonly have roof designs that are not inherently suitable for solar installation, e.g., bow-truss or other types with less structural weight capacity. These structures also seem to be less well-maintained than other property types. As such, this category is less likely to be suited for onsite generation.							
Office Buildings	20	64 years	113,774	65%	100%	Possible	No
This category represents a fairly diverse stock of buildings. Most tend to have small useable roof space. Sites should be assessed individually for onsite suitability. For most of these structures, however, the systems are likely to be small and economies of scale not realized, especially those in denser areas surrounded by taller buildings.							
Operations Facilities	6	41 years	67,706	100%	100%	Yes	No
While there are a small number of buildings in this category, the roof sizes are large overall and may be suited for large arrays. While these sites are likely to be suitable for solar installation, individual sites and roof conditions need to be assessed, especially considering the rooftop equipment present on many.							
Outdoor Facilities	6	No data	37,046	83%	100%	Not Likely	No
This small category of sites includes properties used mostly as parking for large vehicles. These sites are not conducive to solar canopies because of layout, paving, and vehicle use. There are not many existing structures and those that exist are not well suited for solar.							

Facility Type	Number of Sites	Average Age (years)	Average Sq. Footage	% Owned	% Occupied	Suitable for Solar	Selected to be Modeled
Parking Lots	25	No data	28,160	92%	100%	Yes	✓ Yes
While the cost for solar canopy installation is higher than roof or ground mounted systems, costs have decreased significantly in recent years. Besides public parking lots, parking facilities exist on most properties across the portfolio. Solar canopies can be financially viable and represent a highly visible deployment option for the City.							
Permit Centers	6	No data	12,782	50%	100%	Possible	No
This category is very small, with just six properties. The structures are small as well. While solar would likely work for these buildings, the system sizes would be small and would see no economies of scale. Individual sites can be analyzed for solar potential.							
Police Station/Facilities	29	31 years	49,375	97%	100%	Yes	✓ Yes
Police stations and facilities represent a varied stock of buildings. The newest buildings have green roof features that will limit solar capacity, but may be designed for retrofit solar installation. Older buildings may have varied roof conditions and sizes, but could be good for moderately sized systems. Like fire stations, the size of the category and the additional benefits of creating more resilient structures is a good rationale for assessing this category.							
Pumping Stations	15	81 years	44,979	100%	100%	Yes	✓ Yes
Pumping stations represent a moderately sized building category, with 15 sites/buildings. These buildings tend to be much older, but have large flat roofs and significant structural foundations to support large solar arrays. In addition, these sites typically have large electrical loads and may benefit not only from energy production/reduction, but from potential reduction in demand charges.							
Senior Centers	12	23 years	14,855	50%	100%	Yes	✓ Yes
This category represents only 12 buildings of varying age and size. Most of the buildings are new with green roof features, which may limit solar. However, a number of sites may offer simple, flat roofs good for solar installation. In addition, there is a compelling case for solar and storage for resiliency in this category.							
Vacant Properties	34	89 years	10,738	100%	3%	Possible	No
This category represents parcels and structures that are not currently occupied. Buildings may not have structured O&M plans, which is not conducive to operating solar systems. However, there are several significant vacant land parcels, which represent great opportunities for large solar arrays if the long term land use is in alignment.							
Ward Yards	31	54 years	6,564	97%	97%	Possible	No
Ward yards are typically used for equipment or vehicle storage. The yards themselves are not conducive to solar panels because of the type of paving and large vehicle use. However, some of the structures are large with large flat roofs that could work well for solar. Properties in this category should be assessed individually for potential onsite generation.							
Warehouses	9	91 years	257,235	78%	100%	Possible	No
Warehouses represent a small set of large buildings. Most of these structures are fairly old, averaging 91 years across the category. While the buildings have very large flat roofs, many seem to have numerous equipment obstructions. Some of these structures may represent a good opportunity for onsite generation.							
Other Properties	34	73 years	75,536	79%	100%	Yes	No
This category represents a number of separate building categories and, hence, has varied building stock and characteristics. Buildings include museums, training facilities, salt storage, and more. There are a number of clear opportunities for onsite solar in this set. These sites should be assessed on a case by case basis for solar suitability.							

Appendix 7: FEJA Workforce Development Programs[3]

Over 120,000 Illinoisans are already working in the clean energy sector as of 2016. However, as a result of the Future Energy Jobs Act (FEJA) which requires at least 4,300 megawatts of new solar and wind power - enough electricity to power millions of homes - to be built in Illinois by 2030, thousands of more jobs will be created.

FEJA authorized a total of $30 million to develop and establish three clean energy-related job training programs for Illinois citizens over the next 12 years in order to support the additional workforce needed to reach these goals. FEJA requires these programs to be implemented by ComEd through their Workforce Development Implementation Plan. The $30M will be allocated in three $10 million increments which will be paid in the delivery years of 2017, 2021, and 2025, spread across 3 different programs as further detailed below. These workforce development programs offer job and skill set training in the electric and solar industry, resulting in potential job placement in the clean energy, electrical, or construction sector.

The goals of the job training programs are to (1) establish a pool of trained installers who will be able to work on the distributed generation and community solar projects that FEJA seeks to develop; (2) assist in the development of a workforce with the skills to perform solar installations in the electric industry, including but not limited to installations enabled by FEJA; (3) fund job training through community-based, diversity-focused organizations that strive to provide participants with economic or career-related opportunities within, but not limited to, to the electric industry. Many of these training programs are expected to begin in 2018 and 2019 in a variety of locations across the State, so that all residents in Illinois, including low-income households, returning citizens, foster care alumni, and environmental justice community residents, have an opportunity to access.

Solar Training Pipeline ($3M each delivery year)

The Solar Training Pipeline is designed to establish a pool of trained solar installers from economically disadvantaged and environmental justice communities, alumni of the Illinois foster care system, and returning citizens with a job placement goal of 2,000 individuals by 2029. The pipeline will feed into solar projects approved under the Illinois Solar for All program, but trainees might not exclusively work on Illinois Solar for All projects. Training providers were selected through a competitive bidding process administered by the Chicago Community Trust, with preference given to women- and minority-led providers. In December 2017, the following four training providers were awarded:

Elevate Energy (Chicago and Marion/Carbondale)

- Elevate Energy will partner with Millennium Solar Electric to deliver solar installer training to underserved communities on the south and west sides of Chicago. This program will entail four trainings with 25 students each (1 per year over 4 years) starting in May 2018, with each training running for 10 weeks.
- Elevate Energy will partner with Lutheran Social Services of Illinois and GRID Alternatives for employment skills and solar installer training for returning citizens, foster care alumni, and veterans in the Marion/Carbondale region – three training classes of up to 12 students starting in April 2018
- Elevate Energy will manage a contractor accelerator program, working to develop minority/woman/disadvantaged/veteran owned businesses to be solar contractors– three trainings of 5-10 students, which will include a series of bi-monthly contractor development workshops

[3] *Illinois Solar Energy Foundation*

Illinois Central College (ICC) - Peoria

- Illinois Central College will establish two 10-week trainings per year with 15 participants per training beginning in March 2018
- This program includes 4 weeks of job-readiness training with Tri-County Urban League and Heaven's View Community Development Corporation, plus 5 weeks of solar training.
- Technical training also includes ten NABCEP knowledge objectives to assist with preparation for NABCEP Associate Certificate Exam
- Participants earn $10/hour during the technical training portion and receive assistance with job placement, including with HVAC and existing rooftop solar companies until FEJA solar projects become shovel ready
- Program is designed to help ex-offenders, former foster children, and residents of Peoria's low-income areas, but is also open to all 18-year olds with a high school diploma or equivalent who live within ICC's 11-county boundaries - application form is available online

OAI, Inc. (Chicago)

- OAI plans to train 160 participants from low-income minority, current and former foster care, women and veteran, and environmental justice communities over 4 years
- OAI will establish eight cycles of twenty students (8-10 weeks each) - 2 classes in 2018 starting in May, plus 3 classes/year in 2019-2021
- Training includes power skills, career guidance, technical solar training basics, MREA site PV solar site assessor, basic carpentry, OSHA, and forklift operations, totaling 252 hours
- Training prepares students to take NABCEP Associate Exam and MREA PV Solar Site Assessment Certificate Exam

Safer Foundation

- Safer Foundation will manage recruitment of all participants for Millennium Solar Electric training cohorts, with assistance from Little Village Environmental Justice Organization and Faith in Place

Solar Craft Apprenticeship Program ($3M each delivery year)

Administered by the International Brotherhood of Electrical Workers Local 134 in Chicago (IBEW 134), this program seeks to provide apprenticeship participants with the foundational knowledge necessary for a career within the solar industry and provide diverse low-income, minority, or economically disadvantaged populations with additional craft apprenticeship opportunities. The program will also encourage participants to achieve National American Board of Certified Energy Practitioners (NABCEP) installer, associate, and/or sales certifications. Under the Solar Craft Apprenticeship Program, IBEW Local 134 will:

1. Implement solar training into existing apprenticeship programs at 17 other IBEW sites across state by September 2018
2. Implement solar training at 6 Illinois community colleges in the following locations:
    - Olive Harvey College (north of Pullman neighborhood in Chicago) - Fall 2018
    - College of Lake County (Grayslake or Waukegan) - Fall 2018/Spring 2019
    - Rock Valley Community College (Rockford) - Spring 2019
    - Lincoln Land Community College (Springfield) - Spring 2019
    - Southwestern Community College (Metroeast) - Fall 2019
    - John Logan Community College (near Carbondale/Marion) - Fall 2019

3. Implement a high school solar curriculum at six Illinois high schools in underserved neighborhoods throughout the State in order to create entry into a pre-apprenticeship program to be developed in partnership with IBEW Locals. Two Chicago area high schools have been selected to begin in September 2018 and will serve as templates for future high school programs:
    - Benito Juarez Community Academy (Pilsen neighborhood)
    - Prosser Career Academy (Belmont Cragin neighborhood)
        - Fifteen students per school will be accepted into Local 134 pre-apprenticeship program starting in June 2019
        - The pre-apprenticeship program consists of 6-12 months of field training with contractor (paid), which includes school for six of the Saturdays.

Multicultural Jobs Program ($4M each delivery year)

This program funds six community-based, diversity-focused organizations in the Chicago area to provide participants development, economic, or career-related opportunities. It offers the widest array of training, including in the technology sector and solar sales and marketing, in addition to offering existing business owners training for expansion. It targets individuals from diverse and/or underserved backgrounds.

In November 2017, the multicultural training grants were awarded to the following 6 organizations:

- Chicago Urban League
- Hispanic American Construction Industry Association
- National Latino Education Institute
- ASPIRA, Inc. of Illinois
- Chatham Business Association Small Business Development, Inc.
- Austin Peoples Action Center