TEAM FIRST FUEL

RECHARGE ELECTRI-CITY

FEBRUARY 18, 2014

EXECUTIVE SUMMARY

Electri-City has set a 10-year, 20% energy reduction goal for a portfolio of 150 public buildings based on a 2011 baseline. This goal presents numerous challenges, including distribution of responsibilities among various city agencies, managing energy data from a wide variety of building types, identifying and prioritizing projects, securing stable long-term financing, and incentivizing energy-efficient behavior from building occupants, facility managers, and citizens.

While significant, these challenges are addressable if Electri-City adopts a comprehensive approach to implementation and establishes a positive, enduring program identity. Dozens of U.S. cities have launched "Solarize" campaigns to promote solar energy in their communities. These programs are touted for stimulating local economic activity and advancing energy independence. Energy efficiency should generate the same level of enthusiasm. We therefore call our approach "**ReCharge Electri-City**." The ReCharge plan consists of four primary strategies:

1. **Assigning clear roles and responsibilities** to city agencies to capitalize on their expertise.
2. **Establishing energy data infrastructure** by submetering, benchmarking, and monitoring the city's portfolio of buildings and using this information to prioritize energy conservation measures, beginning with the lowest-cost, highest-impact projects.
3. **Securing long-term financing** for the program by establishing a revolving loan fund fed by multiple sources, including city special project funds, federal Qualified Energy Conservation Bonds, utility energy efficiency and demand response incentives, and an innovative "crowdfunding" mechanism.
4. **Empowering public employees and citizens** to invest in the program's success by establishing payroll deferred "ReCharge Accounts" that encourage energy-saving behavior among employees, as well as an annual "People Powered Project" supported by the City at large.

This strategy yields a combination of benefits. It minimizes interagency conflicts by clarifying roles. It overcomes the city's energy data problem by establishing real-time interval data from each building. It frees the city from relying on annual funding allocations by establishing an independently managed revolving loan fund. It encourages the buildings' occupants—i.e., public employees—to buy into the idea of energy efficiency by targeting them as funders for the city's energy management program. And it limits costs by prioritizing low- and no-cost energy conservation measures before moving on to deep retrofit projects.

Table 1 describes our proposed energy conservation measures and their expected impact. The ReCharge plan is designed to help Electri-City achieve its energy reduction goal, and we believe it can assist other U.S. cities in achieving similar results.

Energy Conservation Measure	Start Date	Simple Payback	Funding Allocation	Energy Savings From Baseline
Operations, Maintenance & Retro-commissioning	Year 1	< 2 years	$0.8 million	11.0%
Lighting Retrofits	Year 2	8 years	$3.9 million	4.3%
HVAC Upgrades	Year 4	< 7 years	$2.1 million	3.9%
Other	--		$1.3 million	2.4%
TOTAL	--		$8.1 million	21.5%

Table 1. ReCharge Energy Conservation Plan Overview

PROPOSAL ASSUMPTIONS

In the United States, there are approximately 200 mid-sized cities, which are defined as cities with populations between 100,000 and 300,000 within a Metropolitan Statistical Area of 1 million persons or more (Fulton, 2003). As this case study does not identify a specific city as its subject, we have created a generic mid-size city ('Electri-City') with certain assumptions regarding climate, building stock, energy use profiles, and budget.

Our research focused on mid-sized cities within the relatively temperate climates that occupy the majority of the nation's land area—ASHRAE Climate Zones 3, 4, and 5 (see Appendix A, Figure 5). Cities in less temperate climate zones would require some modifications of the proposed energy conservation measures to account for increased level of heating or cooling; however, these cities can nonetheless follow the same general implementation strategy.

In order to estimate the annual energy consumption and cost for the city's 150 public buildings, we made assumptions about building types and sizes. Most mid-size cities in the U.S. have not yet performed benchmarking of their public buildings, though several larger ones, including New York City, Boston, Seattle, Philadelphia, have. We adopted the building type distribution for the city of Boston as our model (Building Energy Reporting and Disclosure Ordinance, 2012). Boston is larger than Electri-City, yet we can assume that the proportional distribution of building types should be similar in a mid-sized city, with one important modification—the exclusion of school buildings. Schools make up a disproportionately large percentage of floor area in Boston (over 70%), yet many cities do not include schools among municipal buildings as each school district manages them separately. We have therefore excluded them from our analysis. Figure 1 shows the building distribution by floor area for Electri-City.

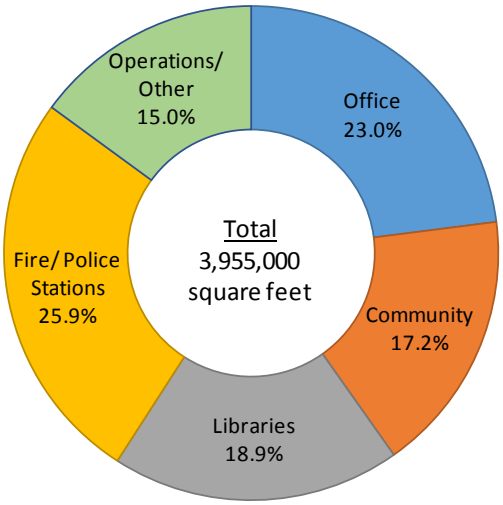


Figure 1. Building distribution in Electri-City.

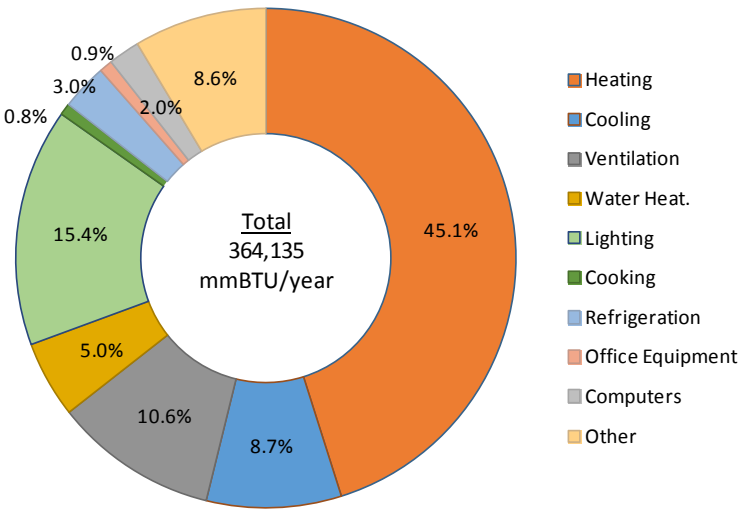


Figure 2. Average city energy consumption by end use.

Our calculation of the average square footage per building was based on the federal *Commercial Buildings Energy Consumption Survey (CBECS)* database value of 22,600 square feet for an average local government-owned building (with 25 of the 150 buildings assumed to be twice as large) (U.S. Energy Information Administation, 2003). This results in a total of just under 4 million square feet of space for Electri-City's 150-building portfolio.

With these assumed building characteristics, we then estimated the city's overall energy consumption using CBECS data for national annual energy use intensities (EUIs). These vary between 45 and 118 kBTU per square foot, depending on building type.[1] This was further divided into end uses such as heating, lighting, or equipment for finer-grained energy savings estimates (illustrated in Figure 2; more detailed tables in Appendix B).

Finally, given these assumptions, we projected an annual utilities budget for the 150-building portfolio. For simplicity, we focused solely on electricity and natural gas as fuel sources, though other cities may use other fuels such as district steam or fuel oil. Based on average U.S. rates for commercial buildings at the end of 2013—$8.43/thousand cubic feet for natural gas, 10.12 cents/kWh for electricity (U.S. Energy Information Administration, 2014)—we estimated an annual electricity cost of $6.6 million and an annual natural gas cost of $1.1 million for the portfolio.

APPROACH OVERVIEW

Under these assumptions, we designed a plan that enables Electri-City to meet and exceed its 20% energy reduction goal in 10 years. In order to accommodate financing and debt service, the ReCharge plan encompasses 15 years of activity linked to the four key strategies outlined in the Executive Summary.

1. In defining agency **roles and responsibilities**, we have focused on promoting collaboration between Electri-City's Energy Management, Facilities, Budget and Management, Treasury, and Human Resources functions, as well as the Mayor.

2. To **collect and manage energy data**, we recommend submetering each facility at the building level so that energy managers can identify projects and establish a database of building-level energy profiles through ENERGY STAR's Portfolio Manager. This data is then used to prioritize low- and no-cost energy conservation measures (ECMs) before moving to more capital-intensive projects.

3. For the bulk of the **program financing**, the city's special projects fund is an ideal source. Should these funds not be available, we suggest issuing a $10 million 15-year bond, ideally a Qualified Energy Conservation Bond bundled with other City infrastructure bonds, to cover equipment upgrades and other efficiency services at minimal capital cost to the City. The special project funding and/or proceeds of this bond sale would be budgeted separately into a **revolving loan fund** in which projects would pay for themselves through reduced utility expenditures and cover the cost of debt service over the 15-year term. Demand response and utility energy efficiency incentives would also flow into this fund.

4. In order to **empower staff and citizens** to pursue energy efficient behaviors, we suggest a two-pronged crowdfunding strategy. First, the City should establish optional "ReCharge Accounts" that enable employees to defer a small portion of their wages (1% suggested) and receive it as a "holiday bonus" lump sum in December. Throughout the year, these deferred wages would flow

[1] An annual energy estimate was performed using average EUIs by building types from the City of Boston 2012 benchmarking as well. While Boston's EUIs differed from CBECS 2003 national averages, the total energy consumption for the city ended up within 4% of the CBECS EUI-based total. More details provided in Appendix B.

into the revolving loan fund. Second, the City should establish an annual "People Powered Project" that citizens can fund through a Kickstarter-like platform. Every donation would receive an energy efficiency "perk," such as a smart power strip or set of LED light bulbs furnished by the local utility. These efforts will require direct marketing to employees and citizens, which is why the "ReCharge" branding is so important to the plan's success.

The following sections describe each of these strategies in greater detail.

1. Roles and Responsibilities for City Agencies

Successfully managing a long-term energy efficiency program will require collaboration between several city agencies:

→ **The City Mayor** will be the public face of the program and should be responsible for introducing the ReCharge plan and updating citizens on its progress and that of other high-profile projects.

→ The office of **Budget and Management** (OBM) should be responsible for managing the revolving loan fund. If the city does not already have a Capital Improvement Advisory Committee, the Mayor should be encouraged to create one to be housed within OBM to provide special oversight for this program and to oversee the allotment of funds to various projects through a new revolving loan fund. This model has been successfully implemented in the City of Chicago (City of Chicago, 2013) and is similar to statewide efficiency efforts managed by Massachusetts' Division of Capital Asset Management and Maintenance through its Advanced Energy Program (MA Division of Capital Asset Management and Maintenance, 2012).

→ The six-person **Energy Management** team will be responsible for energy data management, project identification and prioritization, as well as proposals to the revolving loan fund committee at OBM.

→ **Facilities** will be tasked with overseeing project implementation, carrying out demand response load reduction plans, and ensuring regular operation and maintenance of public buildings.

→ **Treasury** should manage collection of funds for the revolving loan fund. In particular, it will be heavily involved in the issuance of bonds to create the seed money for the fund, and will manage ReCharge Account payroll deferrals and channel them to the fund.

→ Finally, **Human Resources** is a key ambassador for ReCharge Electri-City, communicating the value of the ReCharge program and ReCharge Account benefits to public employees, and managing payroll deferrals and any questions that arise.

2. Energy Data Management

After assigning roles and responsibilities, the next step toward achieving 20% savings for Electri-City buildings is implementing real-time data collection at the building level. This process will help identify energy usage problems throughout the city's portfolio of buildings and verify the impact of any energy savings measures. This data management system should include both metering hardware and energy data management software.

2.1. Submetering Hardware

Electri-City's wide range of building energy meter configurations does not currently provide an adequate level of energy use data for the City's portfolio of buildings. Electri-City must install submetering hardware to provide **real-time energy use data** from each building to establish an

energy baseline and measure performance over time and enable **demand response payments**. Appendix A provides a comparison of the three main types of electricity submetering devices the City should consider (Submetering of Building Energy and Water Usage, 2011).

To reduce submetering hardware costs, Electri-City should negotiate with its local utility, citing the meters' energy efficiency and demand response benefits (see Section 4.4 "Utility Funding"). In order to measure the City's energy savings and use them to comply with local regulations, utilities must meter loads in real time. As a result, many of them offer financial incentives for participation in demand response and energy efficiency programs. These funds could cover the cost of submetering hardware and facilitate additional demand response incentive payments. (See Figure 7 in Appendix A for an illustration of demand response program management.)

While end-use-level submeters (e.g., per outlet, device, or employee) provide the finest-grained control of energy data within buildings and high resolution to discover energy efficiency issues, they are by far the most costly and labor-intensive option. Whole-building metering is the lowest cost feasible option and can be useful in identifying energy use anomalies at the building level, giving facilities managers insights into the buildings most in need of attention (Metering Best Practices: A Guide to Achieving Utility Resource Efficiency, 2011). Building-level metering is recommended, and it is a significant upgrade from the City's current energy data infrastructure.

2.2. Energy Data Management Software

Once building-level metering is in place for all facilities, Electri-City can use this data to assess the performance of its buildings in relation to one another and to similar facilities across the country. EnergyStar's **Portfolio Manager** (PM) is a robust and free-of-charge tool that is also the system of record for many cities and states that mandate energy benchmarking in commercial buildings.[2] PM can also analyze ongoing monthly electricity meter readings and tailor its analysis to a variety of municipal facilities types, including healthcare facilities, prisons, dormitories, and other public service buildings.

Electri-City's Energy Management staff should collect and enter basic building data—including square footage, operating hours, and general plug load data—into PM. Next, the Energy Management staff should begin to enter metered utility data for all facilities at monthly intervals to monitor performance. To reduce time spent on manual data entry, several utilities around the country offer free, automated data exchange with PM.[3] If this is unavailable, third-party companies have developed automated benchmarking services that obtain meter readings from the local utility and automatically upload it to PM. These services do come at a cost and therefore must be evaluated by the Energy Management staff for potential return on investment.[4]

3. Project Prioritization and Planning

Once the initial year of data collection concludes, Portfolio Manager will assign an EnergyStar score to each facility, comparing its performance to similar facilities in the federal CBECS

[2] Three states (California, Washington, Massachusetts) and at least five cities (New York City, Seattle, Philadelphia, Austin and Washington, DC) require energy use benchmarking for all commercial buildings above a minimum size.
[3] These include the Pacific Gas & Electric Company (PG&E) and the San Diego Electric & Gas Company in California, or Puget Sound Energy, Seattle City Light and Seattle Steam in Washington.
[4] These include Ecova, EnergySolve, ei3, Noesis, among others; a full listing of automated benchmarking providers is available on the EnergyStar website.

database normalized for size, occupancy, and climate, and provide metrics such as the site and source energy use intensity (EUI), energy cost intensity, and greenhouse gas emissions. These metrics should be used to prioritize the implementation of energy-reducing measures among all city-operated buildings. Buildings with the largest EUIs and floor areas — i.e., buildings with the greatest overall energy consumption — should get first priority, as these typically have the largest amount of energy savings to be captured.

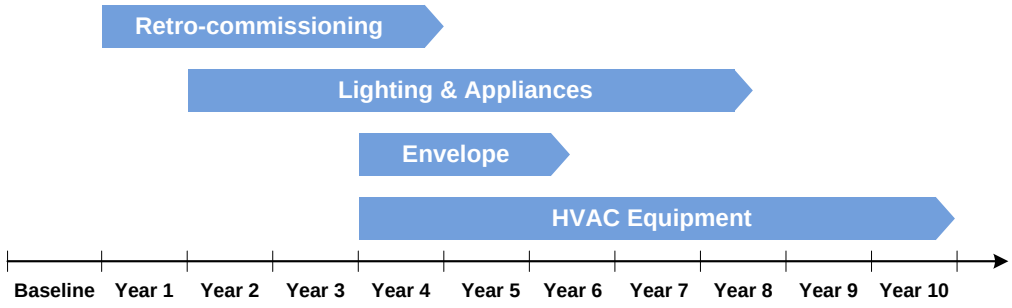


Figure 3. ECM Implementation Timeline

For maximum cost-effectiveness, the City should begin with low-cost or no-cost measures through Operations and Maintenance improvements and retro-comissioning, and use the resulting savings to finance measures requiring higher initial capital investments or having longer payback periods. In essence, we recommend a staged approach to implementing energy efficiency measures that is in line with the U.S. EPA's best practice recommendations for promoting energy efficiency in public buildings (U.S. Environmental Protection Agency, 2011). The basic sequence is illustrated in Figure 3.

3.1. Revolving Loan Fund Management Software

Given the variety of projects Electri-City must finance and their range of savings and payback periods, the City should also adopt fund management software that provides visibility into project costs and realized efficiency savings. The **Green Revolving Investment Tracking System (GRITS)** is designed specifically for organizations using the revolving loan fund structure. It tracks project costs, resource-use reductions, energy prices, expected savings, and ongoing cash flows for the City's revolving loan fund. (See Appendix A for screenshots of the GRITS tool.) Created by the Sustainable Endowments Institute (SEI) for colleges and universities participating in SEI's Billion Dollar Green Challenge, GRITS will soon be available for purchase by municipalities at an annual cost of between $2,500-$10,000 (Blank, 2014).

3.2. Implementation of Energy Conservation Measures

The heart of the ReCharge plan is a 10-year implementation plan for energy conservation measures. The measures recommended below have been assessed with regards to investment and savings based mostly on assumptions and results from Pacific Northwest National Laboratory's publications on building retrofits (Liu, 2011; Thornton, 2009; Wang, 2011) and EnergyStar's Building Upgrade Manual (U.S. EPA, 2008). These were adapted to fit Electri-City's mid-size city characteristics; key assumptions are described below.

For maximum cost-effectiveness, the first year of the program should be spent exclusively on implementing low-cost, high-impact measures. If not already in place, the City should adopt a

city-wide **EnergyStar-compliant appliance purchasing** program. This policy can generate at least 0.65% savings on total electricity use over 10 years.

Next, we propose a multi-year investment in **retro-commissioning (RCx)** to optimize existing building systems by focusing on low-cost operations and maintenance (O&M) measures, such as equipment controls and scheduling and improvement of maintenance procedures. Retro-commissioning should also be used as a tool for employee training: commissioning agents should be selected to combine building inspections with **education in energy-saving strategies and preventive maintenance protocols** aimed at the building managers to prevent large problems from occurring unexpectedly in the facilities they are responsible for monitoring. Retro-commissioning is typically very cost-effective: 60% of the city's public buildings, starting with the largest facilities with the highest EUI, could be retro-commissioned by a building energy services provider for $780,000 with annual savings between 10-20% of total energy and a simple payback of less than two years.

Next, we recommend focusing on **interior and exterior lighting improvements**. Overall, lighting upgrades represent the bulk of the expenditures from the revolving loan fund at approximately $3.9 million worth of projects over 8 years, including:

→ Retrofitting 80% of its buildings' interior lighting using a combination of high-efficiency linear fluorescent, EnergyStar-qualified CFLs, or LED bulbs;
→ Installation of daylight sensors in well-lit perimeter areas and occupancy sensors in non-continuously occupied spaces such as conference rooms, restrooms, storage and copy rooms, and private offices;
→ Upgrading exterior lights for 60% of the City's buildings to metal halide lamps with photocell daylight sensors and timers to partially dim parking lot lights during night hours (e.g., midnight to 5 a.m.) should save up to 12% on lighting energy; and
→ Negotiating bulk bulb purchasing discounts of roughly 20% of the installed cost.

In aggregate, these upgrades can generate up to 40% savings on lighting electricity use (assuming current lighting fixtures are primarily incandescent or lower-efficiency fluorescents and no sensors are installed).

Building **envelope improvements**, while more costly, can reduce heating and cooling requirements and should therefore be addressed before moving on to space conditioning system upgrades. These measures can include the application of solar-control window films, a reflective cool roof coating, exterior shades for cooling-dominated climates, or highly insulating (Hi-R) window panels to the exterior of existing windows (with minimal disruption to occupants, since full window replacements are not needed)[5] for heating-dominated climates. Savings will vary depending on the current condition of buildings.

In year 4 of the program, Electri-City should begin to address **heating, ventilation, and air conditioning (HVAC)** systems. The equipment and installation costs for HVAC retrofits can be considerable: The City could easily spend much more than the $10 million revolving loan fund allocation on upgrading HVAC systems for just a handful of buildings. To address the potentially prohibitive capital costs, we propose starting with operational optimization, then

[5] See the U.S. GSA pilot study results on Hi-R panels for more details (U.S. General Services Administration, 2013).

moving to lower-cost upgrades, and, finally, replacing the major units that come close to the end of their useful operating life with higher-efficiency units.

Before replacing major equipment, the City should use the retro-commissioning process to optimize controls and scheduling protocols to save energy in operations. One strategy is **pre-cooling** the buildings before occupied hours to take advantage of higher efficiencies of the HVAC systems operating in more favorable weather conditions such as early morning, and potentially lowering energy demand during afternoon peak hours. Moreover, installing **economizers** on air-handling units takes advantage of cooling with outdoor air when possible, saving around 10% of the electricity used for cooling and paying for themselves within 7 years.

Finally, existing **equipment nearing its end-of-life** should be replaced with the most efficient models that can be justified through life-cycle cost analysis. Assuming a uniform age distribution of equipment, with 30% of square footage served by chillers (25-year useful life) and 50% by either boilers or gas furnaces (20-year useful life) (Westphaelen & Koszalinski, 1999), the City would have to replace 1 chiller and 3 boilers or furnaces per year. Upgrades from 76%-efficient boilers or furnaces to 90%-efficient condensing boilers or furnaces with condensing heat exchangers, and to new, more efficient chillers, would lead to 14% savings on natural gas and around 7% on electricity used for cooling. Since this is done at the end of equipment life, the cost of this measure is assumed to be just the *incremental* difference between a standard-efficiency replacement and a high-efficiency model; the resulting payback is 6-7 years.

Through this comprehensive 10-year plan, we estimate that the City will reduce its overall energy consumption by 21.5%.

4. Program Financing

To finance energy efficiency projects over the 10-year project period, we recommend that Electri-City create a **revolving loan fund** by targeting four sources:

→ **City funding** from the Special Projects fund;
→ **Federal funding** through Qualified Energy Conservation Bonds;
→ **Utility funding** from demand response and energy efficiency program funds; and
→ **Crowdfunding** from city employees and residents through a "ReCharge" fund-raising program.

This multi-source strategy shields the city from some of the risks associated with relying on a single funding entity. Furthermore ReCharge's crowdfunding approach will link key behavioral incentives for building occupants—i.e., public employees—to operate in an energy-efficient manner at the workplace.

4.1. The Revolving Loan Fund Structure

Revolving funds offer a unique self-sustaining model for project finance. They invest in energy efficiency projects that reduce energy consumption and then reinvest the money saved on energy costs to be used in future projects. They are called "revolving funds" because as money is distributed to specific projects, they are then repaid to the fund through an internal account transfer from savings achieved in the institution's utilities budget. Establishing this revolving fund ensures that the City will always have a source of financing for efficiency projects, thereby

building in a system for supporting ongoing savings (See Figure 4 for an illustration of cash flows).

We recommend establishing a **$10 million loan fund** and have modeled the projected savings and payback process necessary to achieve the City's 20% energy savings goal. As an illustration, Figure 9 in Appendix B shows the annual energy cost savings resulting from energy conservation measures, the utility savings, and the portion of those savings returned to the revolving fund.

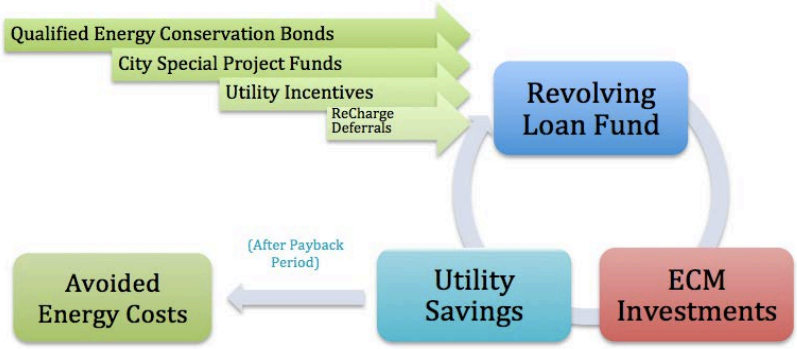


Figure 4 Revolving Loan Fund Cash Flows

4.2. City Funding

Electri-City's energy management office should first apply for the city's special projects funds, worth 2% of the city budget, to seed the revolving loan fund. We believe that ReCharge's self-sustaining structure, combined with its long-term implementation plan will provide a convincing case for raising the required $10 million in funding through this mechanism. However, should these funds not be available, we have also considered several alternatives.

4.3. Federal Funding

In addition to city sources, Electri-City should consider the U.S. federal government's **Qualified Energy Conservation Bonds (QECBs)** program, which offers low-cost financing with net issuance costs of around 0.338% to 1.5% for projects that reduce energy consumption in publicly owned buildings by at least 20% (Energy Programs Consortium, 2013). Issuers can choose to issue taxable bonds with a corresponding tax credit to the holders of the bonds, or more often, issuers elect to receive a direct cash payment from the U.S. Treasury Department and then pay a taxable coupon to the investor and repay principal at the end of the term.

In 2009, Congress allocated $3.2 billion in QECB funding to states and local governments for energy conservation projects, of which more than $2.2 billion in QECBs remained unused as of December 2013. 40 states have more than $10 million left to allocate (Energy Programs Consortium, 2013). Of the 163 bonds issued to date, municipal governments have received the majority. For example, the City of Waterbury, Connecticut, issued $4.7 million of general obligation QECBs in 2010 to make heating and air-conditioning improvements and replace windows in public buildings (Energy Programs Consortium, 2013). These bonds were bundled with other municipal bonds to reduce administration costs and attract investors. We believe that Electri-City would have a strong case to raise $10 million through QECBs.

4.4. Utility Funding

Utilities are often required by state regulators to deliver a certain percentage of kilowatt-hour or capacity reductions each year. For example, at least 25 states have adopted long-term Energy Efficiency Resource Standards (Downs & Molina, 2013). As a result of these standards and other Integrated Resource Planning requirements, many electric power utilities are investing in energy

efficiency and demand response programs. Some of them do so by collecting a small surcharge on electric power (and sometimes natural gas) retail sales. These state clean energy funds generate approximately $500 million per year (Milford & Muro, 2012), making them a significant source of funding for energy projects. Estimates project electric and gas efficiency program spending to double from 2010 levels to $9.5 billion by 2025 (Fuller, 2011). Given this significant source of funds, Electri-City should negotiate with its utility to cover not only the cost of **submetering** its buildings, but also to receive a small incentive of $0.01/kilowatt-hour saved from equipment and lighting improvements, resulting in over $450,000 in revenue for the ReCharge revolving loan fund over the 8 years after metering equipment is installed and projects begin to be implemented.

In addition, utilities and grid operators often negotiate voluntary load reduction, or demand response, programs with large consumers to reduce their need to purchase power during costly peak times. In some markets, such as ISO-New England, PJM, and other large energy markets, cities can work with Curtailment Services Providers (CSPs) to design peak demand management plans. Although these CSPs split incentive payments with their customers, potentially reducing revenue, they can also shield the City from risk of being charged non-performance fees if it cannot deliver on its required peak demand reduction.

Electri-City should therefore explore working with a Curtailment Services Provider to generate demand response revenue and energy/capacity charge savings and limit its risk of non-performance fees. If this is not an option, the City's energy managers should negotiate directly with the utility to create a peak demand management contract. Even at a time when capacity prices have fallen significantly, we conservatively estimate that this process could generate at least $300,000 for the City over the course of the ReCharge revolving loan fund.

4.5. Empower Staff Through Crowdfunding

In addition to these sources, crowdfunding is an increasingly popular way to finance community-based projects. In 2012 alone, millions of donors used platforms like Kickstarter and Indiegogo to raise more than $2.7 billion for more than one million campaigns (Massolution, 2013). Crowdfunding encourages community engagement, which is essential to the success of the ReCharge plan. We therefore recommend a two-pronged crowdfunding strategy: First, the City should enable crowdfunding through payroll deferrals into designated "ReCharge Accounts." Second, the City should designate an annual "People-Powered Project" for the broader urban community to support. Direct employee investment will encourage more energy efficient behaviors among building occupants, and crowdfunding offers a low-cost way for the city to raise additional capital.

Donation through payroll deferral is an increasingly common employee benefit. More than a third of U.S. employers offer benefits promoting charitable giving (Fegley, 2013), including the U.S. federal government. In 2012, its Combined Federal Campaign raised over $258 million for charity with 36% of federal employees participating (U.S. Office of Personnel Management, 2013). Many other employers offer "holiday layaway" plans that deduct a portion of the employee's paycheck throughout the year to be delivered in December to cover holiday expenses.[6] These payroll deferral services are delivered at minimal expense, as they are already part of existing payroll processing infrastructure.

[6] Richard Thaler and Cass Sunstein reference these "Christmas Clubs" in their influential public policy book, *Nudge*.

We therefore propose that the City offer public employees the ability to defer a portion of their paychecks to a "**ReCharge Account**." (One percent would be the suggested deferral.) All funds deferred would be used to supplement the revolving loan fund and would be returned to the employee at the end of the year, similar to a holiday layaway plan.[7] This simple, low-cost form of crowdfunding will not only raise money for the City's efficiency fund but also awareness among employees. As every new employee would be introduced to the effort during his or her orientation and open enrollment period, this approach may in fact be more valuable for its ability to educate the City's workforce than it is to raise funds. Yet, if it proves popular with employees, it could enable even more ambitious projects to move forward. Mid-sized cities covered in our research have average total payrolls in excess of $185 million (excluding school staff). With even a modest 5% employee participation rate at 1% of the employees' salaries, we estimate this program could raise approximately $100,000 during its first year.

Beyond employees, we also recommend the City tap into an even large pool of potential funders: its citizens. The City should designate and promote a "**People-Powered Project**" to be funded through a Kickstarter-like civic crowdfunding platform (e.g. Neighbor.ly) that is open to any interested citizen. We recommend that the City focus on public facilities that already have strong communities supporting them, like public theaters and libraries, and emphasize more capital-intensive building improvements such as HVAC equipment. In addition, the city should work with its local utility to ensure that donors get energy-saving "perks" for donations, including LED light bulbs, programmable thermostats, and smart power strips. The funds raised through this program would supplement the revolving loan fund and help stimulate community discussion of the ReCharge plan throughout the City.

By providing a low-cost, high-visibility source of capital, crowdfunding can enable the City to try new, groundbreaking projects. For example, in the longer term, as hardware costs fall, the City could also use the People Powered Project to fund end-use level metering so that City employees will have a clear understanding of their own energy use within public buildings. This could help to facilitate contests among departments within the same building, or across the City.

CONCLUSION

Electri-City has set an ambitious goal to reduce its energy consumption by 20% in 10 years. In order to achieve this goal, the City must focus on four key strategies:

1. Assigning clear roles and responsibilities among agencies.
2. Establishing energy data metering and management infrastructure.
3. Creating self-sustaining revolving loan fund prioritizing low- and no-cost ECMs.
4. Empowering staff and citizens to invest in energy efficiency.

These strategies will activate City agencies to embrace new responsibilities, solve the City's energy data concerns, establish secure long-term financing, and empower citizens to take part in the push for energy efficiency through a long-term campaign to ReCharge Electri-City.

[7] We considered offering employees a return on their 'investment' but recognize there are restrictions on such investment vehicles. For example, Solar Mosaic offers consumer investments in solar energy projects, but only California residents and accredited investors may participate due to Securities and Exchange Commission regulations. By simply returning the deferred capital, our plan avoids these restrictions.

REFERENCES

Blank, S. (2014, January 24). GRITS Tool for Municipalities. (J. Sokol, Interviewer)
Building Energy Reporting and Disclosure Ordinance. (2012). From City of Boston: http://www.cityofboston.gov/images_documents/BERDODisclosureFinal_tcm3-38229.xls

City of Chicago. (2013, January 1). *City of Chicago 2013-2017 Capital Improvement Program.* Retrieved February 17, 2014, from http://www.cityofchicago.org/content/dam/city/depts/obm/supp_info/CIP_Archive/2013-17CIP.pdf

Downs, A., & Molina, M. (2013, July 1). *State Energy Efficiency Resource Standards (EERS).* Retrieved February 17, 2014, from American Council on an Energy-Efficient Economy: http://www.aceee.org/files/pdf/policy-brief/eers-07-2013.pdf

Energy Programs Consortium. (2013, December 1). *Qualified Energy Conservation Bonds Memo - December 2013.* Retrieved February 17, 2014, from EnergyPrograms.org: http://www.energyprograms.org/wp-content/uploads/2013/12/QECB_memo_12-13-13.pdf

Fegley, S. (2013). *2013 Employee Benefits.* Society for Human Resource Management. Alexandria: Society for Human Resource Management.

Fuller, M. (2011). *Driving Demand for Home Energy Improvements: Motivating residential customers to invest in comprehensive upgrades that eliminate energy waste, avoid high utility bills, and spur the economy.* Lawrence Berkeley National Laboratory. Berkeley: Lawrence Berkeley National Laboratory.

Fulton, W. (2003). *The Mid-size City: Exploring Its Unique Place in Urban Policy* . Solimar Organization. Rochester: City of Rochester, NY.

GP Sullivan, WD Hunt, R Pugh, WF Sandusky, TM Koehler, and BK Boyd. (2011). *Metering Best Practices: A Guide to Achieving Utility Resource Efficiency.* U.S. Department of Energy.

J.P. Holdren. (2011). *Submetering of Building Energy and Water Usage.* Executive Office of the President of the US.

Liu, G., Liu, B., Wang, W., Zhang, J., & Athalye, R. (2011). *Advanced Energy Retrofit Guides: Office Buildings.* Pacific Northwest National Laboratory, U.S. Department of Energy.

MA Division of Capital Asset Management and Maintenance. (2012, January 1). *What is the Accelerated Energy Program (AEP)?* Retrieved February 17, 2014, from Mass.gov: http://www.mass.gov/anf/property-mgmt-and-construction/facilities-mgmt-and-maintenance/energy-and-sustainability/accelerated-energy-program/

Massolution. (2013, April 8). *Crowdfunding Market Grows 81% in 2012*. Retrieved Feb 17, 2014, from PR Newswire: http://www.prnewswire.com/news-releases/crowdfunding-market-

grows-81-in-2012-crowdfunding-platforms-raise-27-billion-and-fund-more-than-one-million-campaigns-finds-research-firm-massolution-201911701.html

Milford, L., & Muro, M. (2012). *Leveraging State Clean Energy Funds for Economic Development.* Brookings-Rockefeller Project on State and Metropolitan Innovation. Washington DC: Brookings Institution.

Thornton, B., Wang, W., Lane, M., Rosenberg, M., & Liu, B. (2009). *Technical Support Document: 50% Energy Savings Design Technology Packages for Medium Office Buildings.* Pacific Northwest National Laboratory.

U.S. Energy Information Administation. (2003). *2003 CBECS Survey Data*. From Commercial Buildings Energy Consumption Survey (CBECS): http://www.eia.gov/consumption/commercial/data/2003/

U.S. Energy Information Administration. (2014). *Electric Power Monthly*. From http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a

U.S. Environmental Protection Agency. (2011, January 1). *Energy Efficiency in Local Government Operations.* Retrieved Februrary 17, 2014, from EPA.gov: http://www.epa.gov/statelocalclimate/documents/pdf/ee_municipal_operations.pdf

U.S. Environmental Protection Agency. (2008). *EnergyStar Building Upgrade Manual.* Retrieved from http://www.energystar.gov/buildings/sites/default/uploads/tools/EPA_BUM_Full.pdf?f169-6af0

U.S. General Services Administration. (2013, October). *High R Value Windows*. Retrieved from Green Proving Ground: http://www.gsa.gov/portal/content/180891

U.S. Office of Personnel Management. (2013, August 28). *Memorandum for Heads of Executive Departments and Agencies.* Retrieved February 17, 2014, from CHCOC.gov: http://chcoc.gov/transmittals/TransmittalDetails.aspx?TransmittalID=5785

Wang, W., Huang, Y., Katipamula, S., & Brambley, M. (2011). *Energy Savings and Economics of Advanced Control Strategies for Packaged Air-Conditioning Units with Gas Heat.* Pacific Northwest National Laboratory.

Westphaelen, D., & Koszalinski, S. (1999, October). *Energy Consumption Characteristics of Commercial Building HVAC Systems.* From U.S. Department of Energy, Building Technologies Office: http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/hvac_volume2_final_report.pdf

APPENDIX A: SUPPLEMENTARY FIGURES

Figure 5. ASHRAE Climate Zones in the United States. (Source: http://tboake.com/carbon-aia/images/climate_zones.jpg)

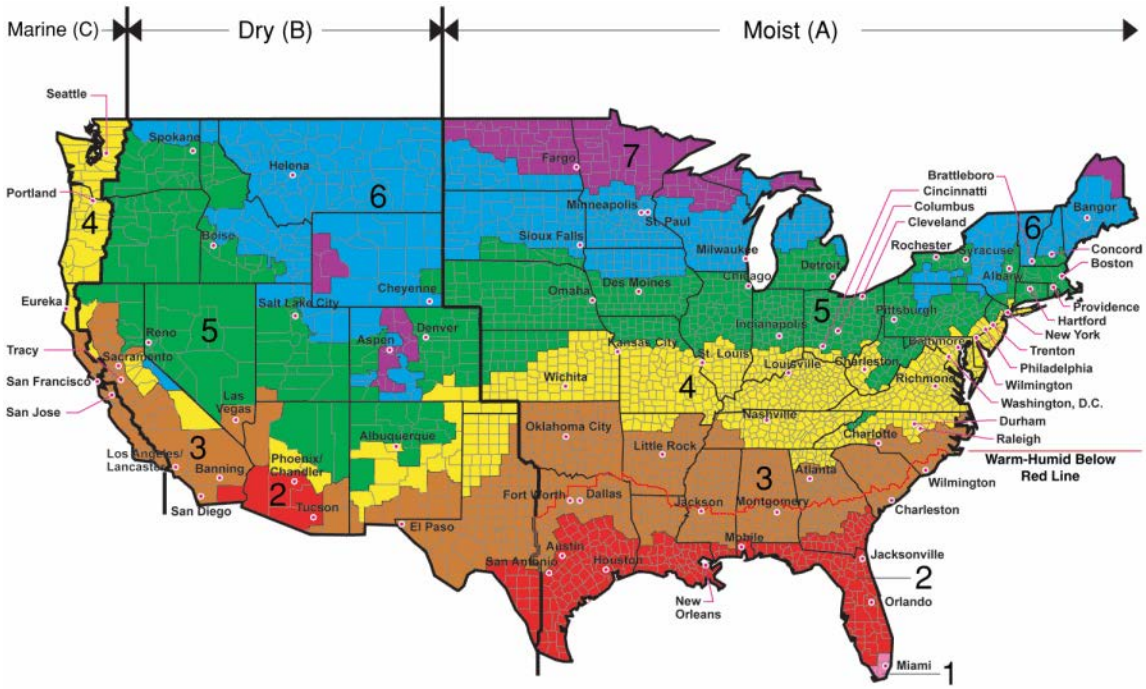
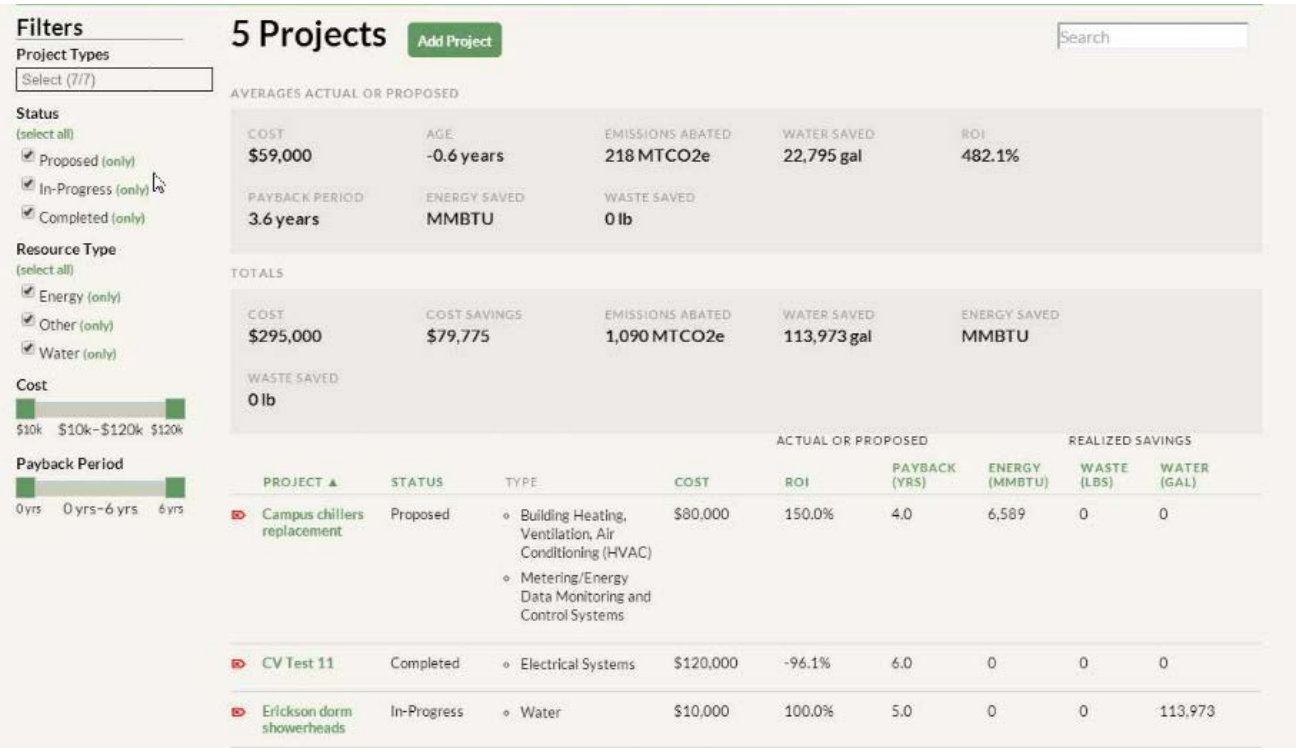


Figure 6. Selected screenshots of GRITS tool for revolving fund management.



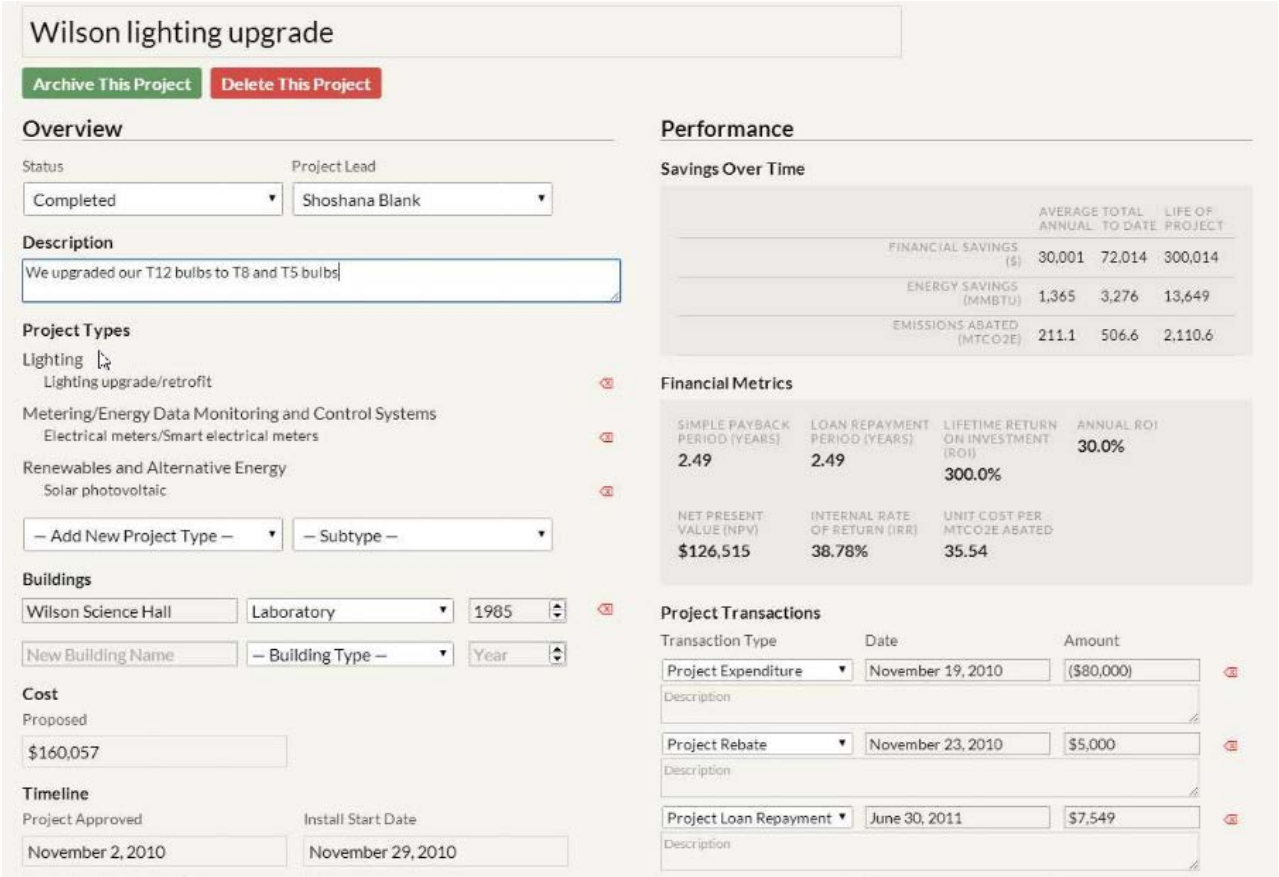


Figure 7. Coordination between energy efficiency measures and demand response, enabled by energy data management systems

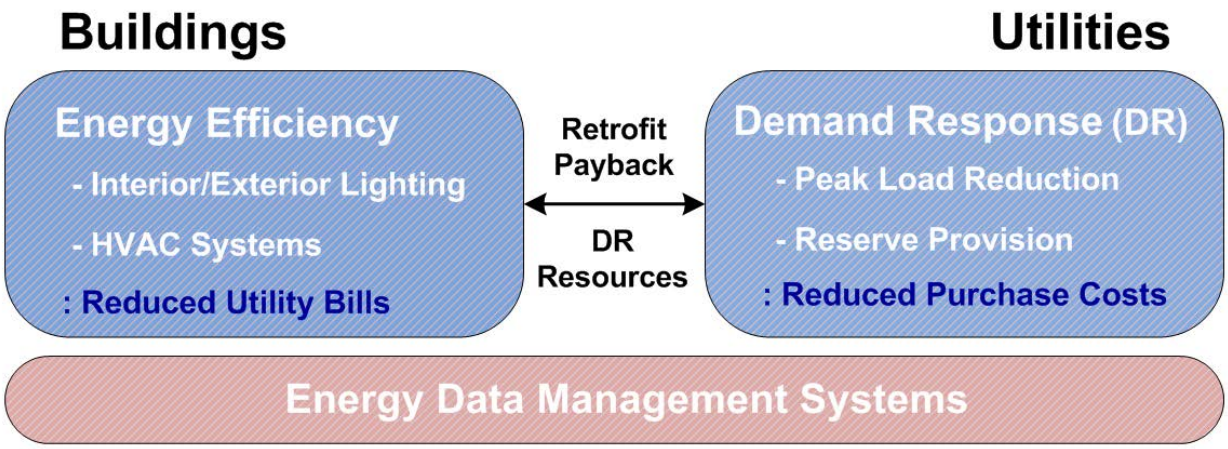


Table 2. Types of Electrical Submeters - Example Comparisons

Specifications	Submeter Type		
	Electromechanical/Solid State		Electronic Non-socket
	Feed-Through	Current Transformer	
Installation			
Cost	$1,000	$2,000-$5000 (over 320 Amp)	$700
Time	2-3 Hours	6-8 Hours	1 Hour
Location	Utility Room	Utility Room	Anywhere
Space	2 SF	11.7 SF	0.25 SF
Features			
Digital Readouts	Optional	Optional	Standard
Multiple Load Monitoring	No	No	Yes
Specific Circuit Monitoring	No	No	Yes
Enhancements	Timed Metering, Software Monitoring, Net-Metering Capability		

APPENDIX B: ENERGY AND FINANCING MODEL

Table 1. Estimated Electri-City energy consumption by end-use and annual energy costs (Sources: CBECS 2003, US EIA Electricity and Natural Gas Monthly Data, City of Boston).

			ENERGY	CBECS EUI	Electric	Gas	Total Cost, $	
Building Type	% of SF	SF	mmBTU	kBTU/SF	mmBTU	mmBTU	Electric	Gas
Office	23.0%	908,989	84,445	92.9	51,654	32,792	1,533,163	267,333
Community	17.2%	681,181	63,963	93.9	39,125	24,838	1,161,293	202,491
Libraries	18.9%	747,509	70,191	93.9	42,935	27,256	1,274,370	222,208
Fire/Police Stations	25.9%	1,025,967	118,807	115.8	72,672	46,135	2,157,027	376,114
Operations/Other	15.0%	591,354	26,729	45.2	16,350	10,379	485,288	84,618
TOTAL	**1**	**3,955,000**	**364,135**	**89.8**	**222,735**	**141,400**	**6,611,140**	**1,152,765**
							SUM OF BOTH: $	**7,763,906**

Total energy by End-use based on CBECS EUI, mmBTU

Heating	Cooling	Ventilation	Water Heat.	Lighting	Cooking	Refrigeration	Office Equipme	Computers	Other
29,815	8,090	4,727	1,818	20,998	273	2,636	2,363	5,545	8,181
33,855	6,539	10,831	681	4,768	545	1,499	-	-	4,428
37,151	7,176	11,885	748	5,233	598	1,645	-	-	4,859
51,196	9,131	9,747	14,364	16,928	1,334	2,975	616	1,539	10,875
11,413	769	1,183	355	7,747	-	2,070	118	296	2,839
163,430	**31,705**	**38,372**	**17,965**	**55,674**	**2,749**	**10,824**	**3,097**	**7,379**	**31,181**

Figure 8. Projected energy and cost savings.

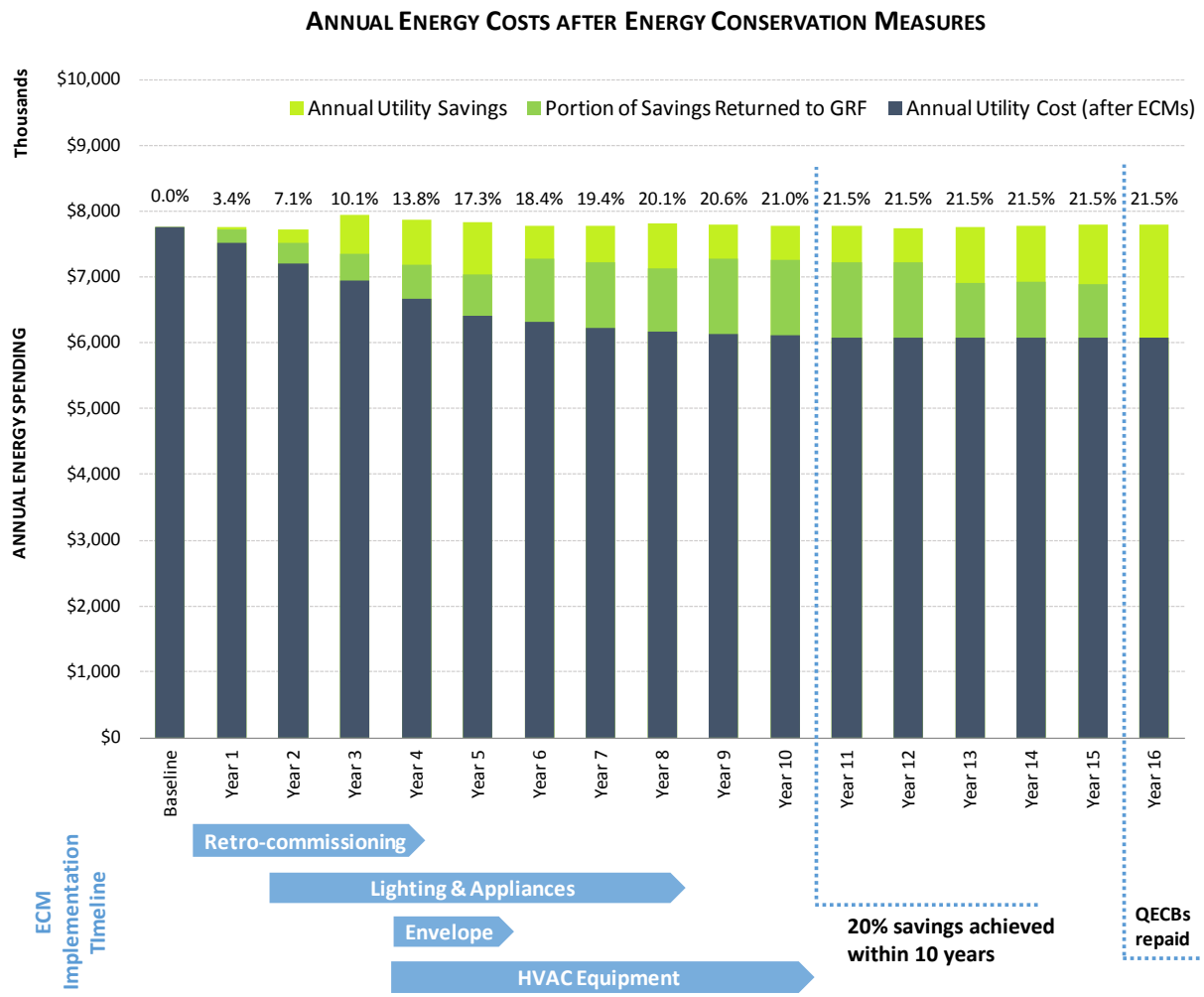


Table 4. Details of Revolving fund model and cash flows from energy conservation measures.

			2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
			Baseline	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
		Revolving Fund Balance	$ 10,000,000	$ 9,847,500	$ 9,131,413	$ 8,447,474	$ 7,504,506	$ 6,736,571	$ 7,018,783	$ 7,481,382	$ 8,067,411	$ 9,064,146	$ 10,076,814	$ 11,095,332
Cost/SF		**Expenditures from Fund, Total**	**$ -**	**$ (355,900)**	**$ (1,071,350)**	**$ (1,149,942)**	**$ (1,526,077)**	**$ (1,454,887)**	**$ (756,788)**	**$ (619,832)**	**$ (468,751)**	**$ (229,078)**	**$ (229,078)**	**$ (229,078)**
or /bldg		GRITS tool	$ -	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)	$ (2,500)
		Submeters	$ -	$ (150,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)	$ (1,000)
$ 0.30	**1**	RCx/O&M Measures	$ -	$ (203,400)	$ (169,500)	$ (135,600)	$ (135,600)	$ (135,600)	$ -	$ -	$ -	$ -	$ -	$ -
$ 1.01	**2**	Interior Lighting retrofit	$ -	$ -	$ (684,780)	$ (570,650)	$ (456,520)	$ (456,520)	$ (456,520)	$ (319,564)	$ (239,673)	$ -	$ -	$ -
$ 0.32	**3**	Exterior Lighting retrofit	$ -	$ -	$ (213,570)	$ (177,975)	$ (142,380)	$ (71,190)	$ (71,190)	$ (71,190)	$ -	$ -	$ -	$ -
$ -	**4**	EnergyStar Purchasing Policy	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 0.22	**5**	Install Economizers	$ -	$ -	$ -	$ (262,217)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	6a	*Hot Climate: Cool roof, win films*	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 80,357	**6b**	Cold Climate: Add Hi-R windows	$ -	$ -	$ -	$ -	$ (562,499)	$ (562,499)		$ -	$ -	$ -	$ -	$ -
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ 225,578	**7**	Upgrade boilers, chillers, furnaces	$ -	$ -	$ -	$ -	$ (225,578)	$ (225,578)	$ (225,578)	$ (225,578)	$ (225,578)	$ (225,578)	$ (225,578)	$ (225,578)
	8	Savings from Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		Revenues Into Fund, Total	**$ -**	**$ 203,400**	**$ 355,263**	**$ 466,002**	**$ 583,109**	**$ 686,951**	**$ 1,038,999**	**$ 1,082,431**	**$ 1,054,780**	**$ 1,225,812**	**$ 1,241,745**	**$ 1,247,596**
		Utility incentives	$ -	$ -	$ 11,266	$ 23,876	$ 33,503	$ 42,022	$ 50,246	$ 56,865	$ 61,835	$ 64,263	$ 66,678	$ 69,081
		Demand respose pay from utility	$ -		$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
		Utility Cost Savings RETURNED to fund	$ -	$ -	$ 30,846	$ 32,876	$ 34,814	$ 36,671	$ 433,861	$ 435,613	$ 437,348	$ 439,058	$ 459,495	$ 461,189
	1	RCx/O&M Measures	$ -	$ 203,400	$ 169,500	$ 135,600	$ 135,600	$ 135,600	$ -	$ -	$ -	$ -	$ -	$ -
	2	Interior Lighting retrofit	$ -	$ -	$ 87,676	$ 159,055	$ 213,556	$ 265,798	$ 315,888	$ 319,564	$ 239,673	$ 376,020	$ 376,020	$ 376,020
	3	Exterior Lighting retrofit	$ -	$ -	$ 25,974	$ 47,120	$ 63,266	$ 71,004	$ 71,190	$ 71,190	$ 85,728	$ 85,728	$ 85,728	$ 85,728
	4	EnergyStar Purchasing Policy	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	5	Install Economizers	$ -	$ -	$ -	$ 37,474	$ 37,474	$ 37,474	$ 37,474	$ 37,474	$ 37,474	$ 37,373	$ -	$ -
	6a	Hot Climate: Cool roof, win films	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	6b	Cold Climate: Add Hi-R windows	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	7	Upgrade boilers, chillers, furnaces	$ -	$ -	$ -	$ -	$ 34,897	$ 68,382	$ 100,341	$ 131,724	$ 162,722	$ 193,371	$ 223,823	$ 225,578
	8	Savings from Demand Response	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
		TOTAL UTILITY SAVINGS PER YEAR	$ -	$ 241,256	$ 553,770	$ 818,747	$ 1,081,210	$ 1,325,296	$ 1,442,127	$ 1,542,086	$ 1,600,432	$ 1,632,791	$ 1,664,944	$ 1,696,920
		PART OF SAVINGS RETURNED TO FUND	$ -	$ 203,400	$ 313,997	$ 412,126	$ 519,607	$ 614,930	$ 958,753	$ 995,566	$ 962,945	$ 1,131,550	$ 1,145,067	$ 1,148,515
		UTLITIES PAID + RETURNED TO GRF	$ 7,763,906	$ 7,726,050	$ 7,524,133	$ 7,357,284	$ 7,202,302	$ 7,053,539	$ 7,280,532	$ 7,217,385	$ 7,126,418	$ 7,262,665	$ 7,244,029	$ 7,215,501

	Energy Savings											
	Total Energy Consumption (mmBTU)	364135	351584	338196	327277	314419	302330	296567	291414	288925	287310	285704	284107
	Electric	222735	216244	206722	198809	191654	185016	181779	179098	177344	176458	175577	174700
	Gas	141400	135340	131473	128468	122765	117315	114788	112316	111581	110852	110127	109407
	Total Energy Cost ($)	$ 7,763,906	$ 7,522,650	$ 7,210,136	$ 6,945,159	$ 6,682,695	$ 6,438,610	$ 6,321,779	$ 6,221,819	$ 6,163,474	$ 6,131,115	$ 6,098,962	$ 6,066,986
	Electric	$ 6,611,141	$ 6,417,962	$ 6,136,471	$ 5,897,373	$ 5,682,839	$ 5,484,935	$ 5,389,105	$ 5,309,553	$ 5,257,285	$ 5,231,002	$ 5,204,873	$ 5,178,838
	Gas	$ 1,152,765	$ 1,104,689	$ 1,073,665	$ 1,047,786	$ 999,856	$ 953,674	$ 932,674	$ 912,266	$ 906,189	$ 900,113	$ 894,089	$ 888,148

Energy Savings (%)	0.0%	3.4%	7.1%	10.1%	13.7%	17.0%	18.6%	20.0%	20.7%	21.1%	21.5%	22.0%
Electric	0.0%	2.9%	7.2%	10.7%	14.0%	16.9%	18.4%	19.6%	20.4%	20.8%	21.2%	21.6%
Gas	0.0%	4.3%	7.0%	9.1%	13.2%	17.0%	18.8%	20.6%	21.1%	21.6%	22.1%	22.6%
Cost Savings ($)	0	$ 241,256	$ 553,770	$ 818,747	$ 1,081,210	$ 1,325,296	$ 1,442,127	$ 1,542,086	$ 1,600,432	$ 1,632,791	$ 1,664,944	$ 1,696,920
Electric	0	$ 193,179	$ 474,670	$ 713,767	$ 928,302	$ 1,126,205	$ 1,222,036	$ 1,301,588	$ 1,353,856	$ 1,380,139	$ 1,406,268	$ 1,432,303
Gas	0	$ 48,076	$ 79,100	$ 104,979	$ 152,909	$ 199,091	$ 220,091	$ 240,499	$ 246,576	$ 252,652	$ 258,676	$ 264,617
Cost Savings ($)	$ -	$ 241,256	$ 795,025	$ 1,613,772	$ 2,694,983	$ 4,020,279	$ 5,462,405	$ 7,004,492	$ 8,604,924	$ 10,237,714	$ 11,902,658	$ 13,599,578

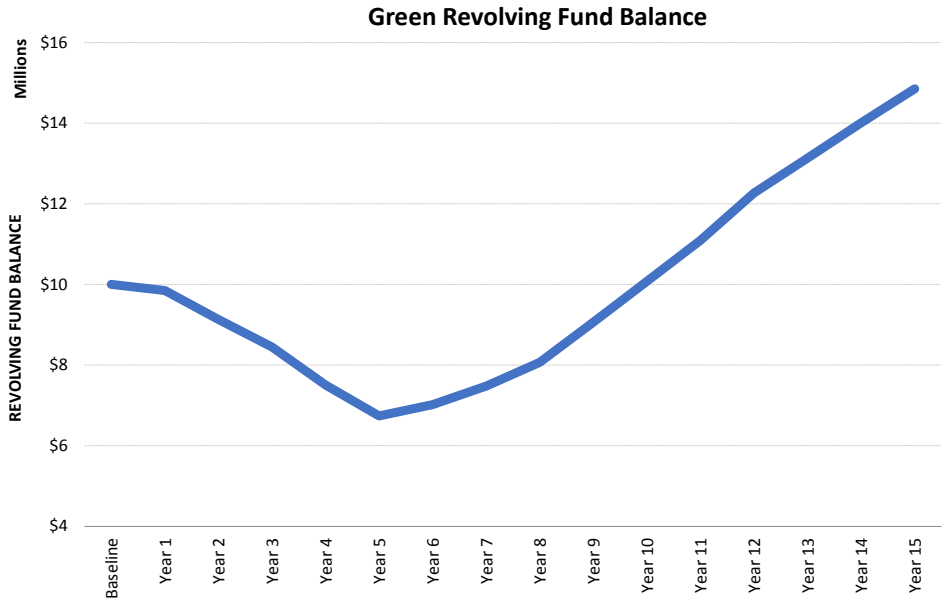



Figure 9. Predicted Green Revolving Fund balance over 15 years.