USER GUIDE FOR THE ACEEE LOCAL ENERGY EFFICIENCY POLICY CALCULATOR (LEEP-C), VERSION 1.0 BETA

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By naming individuals and organizations above we do not mean to imply endorsement of the research product; instead our intention is to acknowledge their contributions and to thank them.

ABOUT THE AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY (ACEEE)

ACEEE is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting economic prosperity, energy security, and environmental protection. For more information, see www.aceee.org. ACEEE fulfills its mission by:

- Conducting in-depth technical and policy assessments
- Advising policymakers and program managers
- Working collaboratively with businesses, public interest groups, and other organizations
- Organizing conferences and workshops
- Publishing books, conference proceedings, and reports
- Educating consumers and businesses

Projects are carried out by staff and selected energy efficiency experts from universities, national laboratories, and the private sector. Collaboration is key to ACEEE's success. We collaborate on projects and initiatives with dozens of organizations including federal and state agencies, utilities, research institutions, businesses, and public interest groups.

Support for our work comes from a broad range of foundations, governmental organizations, research institutes, utilities, and corporations.

ABSTRACT

The ACEEE Local Energy Efficiency Policy Calculator, or LEEP-C (pronounced "leap see"), is intended for use by local policymakers and stakeholders interested in advancing the adoption of energy efficiency in their communities. Currently the tool is capable of analyzing the impacts of a total of seven different policy types from two economic sectors—existing public buildings and existing residential buildings. Based on existing research on the costs and savings from specific policies and user inputs regarding local energy and economic characteristics and level of investment, LEEP-C is able to calculate estimated impacts of specific policy choices on energy savings, cost savings, pollution, jobs, and other outcomes over a time period set by the user. Additionally, the tool allows users to interactively explore the absolute and relative impact of different policies. Finally, the tool allows for the weighting of different policy options based on user inputs regarding community priorities to find those policies that best fit with community goals. While the tool is primarily designed to analyze local policy options, it is also applicable to some issues of interest to state, regional, and national policymakers and stakeholders.

Users can:

- Explore the potential impacts of policy choices based on current economic and demographic conditions in their community;
- Customize the inputs for specific policies to match the likely level of investment that is possible in their community;
- Discover the policies that best help them meet their community goals; and
- Explore the impact of the policies in different communities and under different economic conditions.

Resulting costs and benefits are available on an annualized basis and are presented as absolute values and in relation to costs for:

- Policy costs
- Energy savings, for electricity and natural gas
- Energy cost savings
- Greenhouse gas emissions
- Criteria pollutant emissions
- Net jobs

The LEEP-C tool and related resources are available for free at aceee.org/portal/local-policy/calculator.

INTRODUCTION

Goals and Uses

The ACEEE Local Energy Efficiency Policy Calculator, or LEEP-C (pronounced "leap see"), is intended for use by local policymakers and stakeholders interested in advancing the adoption of energy efficiency in their communities. Currently the tool is capable of analyzing the impacts of a total of seven different policy types from two economic sectors—existing public buildings and existing residential buildings. Based on existing research on the costs and savings from specific policies and user inputs regarding local energy and economic characteristics and level of investment, LEEP-C is able to calculate estimated impacts of specific policy choices on energy savings, cost savings, pollution, jobs, and other outcomes over a time period set by the user. Additionally, the tool allows users to interactively explore the absolute and relative impact of different policies. Finally, the tool allows for the weighting of different policy options based on user inputs regarding community priorities to find those policies that best fit with community goals. While the tool is primarily designed to analyze local policy options, it is also applicable to some issues of interest to state, regional, and national policymakers and stakeholders.

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- Explore the impact of the policies in different communities and under different economic conditions.

The policies able to be customized and analyzed with the tool include:

1. Public Buildings Comprehensive Retrofit
2. Public Buildings Retrocommissioning
3. Public Buildings Benchmarking and Disclosure
4. Home Performance with ENERGY STAR
5. Residential Energy Use Disclosure
6. Residential Upgrade Requirements (RECOs)
7. Assistance to Multifamily Affordable Housing

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- Energy savings, for electricity and natural gas
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- Greenhouse gas emissions
- Criteria pollutant emissions
- Net jobs

LEEP-C builds upon ACEEE's decades of experience in national, state, and local policy analysis; technology and program assessments; and economic impact analysis. These ACEEE projects include but are not limited to the State Clean Energy Resource Project (SCERP), the Dynamic Energy Efficiency Policy Evaluation Routine (or DEEPER Modeling System), and the Stimulus Jobs Calculator. Our goal with this tool is to package some of these methodologies and associated data for use by the broader public. We hope the tool will provide greater understanding of the broad economic, environmental, and community development opportunities available from energy efficiency policies and will allow for better integration of energy efficiency resources into public policy and planning processes.

Please note that LEEP-C is intended as a planning and decision support tool and is designed to give first-cut estimates of impacts. *It is not an economic model or financial tool, but a "reconnaissance assistant.*" While we have made every effort to apply the best available data and analysis methodologies, actual results from the implementation of policies will vary. This tool should not be used as a substitution for gathering locally appropriate data, seeking out estimates of costs and benefits from potential project implementers, or developing detailed policy-specific analyses.

The LEEP-C tool and related resources are available for free at aceee.org/portal/local-policy/calculator.

We are interested in your input on how LEEP-C can be improved to better meet your needs. Please send suggestions to Eric Mackres at emackres@aceee.org.

Energy Efficiency Policies

For the purposes of this tool, energy efficiency "policies" are defined as systematic, multi-year efforts to increase the level of adoption of energy efficiency technologies and practices. Some of the policies included in LEEP-C would more commonly be described as *programs*, but are considered policies for our purposes because they are analyzed as implemented over an extended period of time and are intended to contribute to specific policy aims. Others may look like energy efficiency *projects*; however, these are actually policies because they put in place a systematic approach through which to evaluate and pursue many projects over an extended period of time.

The question of *who* puts in place or implements a policy is not included as a variable in the LEEP-C analysis. Costs and benefits from implementation are calculated for the scale of analysis as set by the user, but it is possible that the policies could be *implemented* at a different scale from the scale of analysis (e.g., policies are implemented by the state government, but analysis is set to determine the impacts on a single county in that state). In general, costs and benefits at the scale of analysis would be similar whether implemented at that scale or another; the major difference would be to whom costs accrue and how. However, there can be advantages to implementing a policy over larger geographies such as economies of scale, lower administrative costs, and greater market consistency.

It is important to recognize that choices among the policies included are not mutually exclusive. Many of them are even complementary to each other. However, LEEP-C evaluates the impact of the policies without accounting for any interaction effects between them. These interactions could be synergistic in some cases, when policies "a" and "b" reinforce each other. This is similar to the interactions at the project-level where, for example, residential building shell improvements could decrease the size required for a new furnace or boiler to replace obsolete equipment, decreasing its cost and increasing its cost-effectiveness. This also shows that savings can be *path-dependent,* with cost-effectiveness and savings varying with the sequence in which measures are undertaken. We do not attempt to include these interactions in this screening tool. More sophisticated modeling potential analyses, such as ACEEE's SCERP studies, do account for these interaction effects.

While the results presented on this spreadsheet give information on which policies may have the greatest impact on the community if implemented successfully, the results do not provide a framework through which to think about which policies are most appropriate to the politics, experience, resources, and capacities, among other variables, in a particular community. With that caveat in mind, this section attempts to provide a few thoughts to help integrate these considerations into policy selection.

It may be helpful to think of the policies included in LEEP-C as fitting into categories differentiated by the level of political effort and investment that they require:

1. **Energy information policies** (*Public Building Benchmarking and Disclosure* and *Residential Labeling and Disclosure*)—These are relatively low-cost policies because the actions they require are only marginal costs on top of the much larger costs associated with planned building improvements or real estate transactions. While they do require changes to practices for specific actors (notably building operators and realtors, and building owners to a lesser degree), these are also marginal. The greater level of information on energy use available thanks to these polices can increase adoption of energy efficiency.
2. **Incentives for energy improvements and resulting encouragement of energy performance businesses** (*Home Performance with ENERGY STAR* and *Assistance to Affordable Housing*)—These policies provide financial incentives and technical assistance to building owners willing to make energy efficiency improvements. In addition to improving energy efficiency, these policies if implemented correctly can also help to foster a community of businesses, such as trained contractors, focused on improving energy performance. The upfront costs from financial incentives and the level of effort required to successfully administer these program can be high. As a result, partnership with energy utilities, state governments, or other existing service providers is often desirable.
3. **Energy improvement requirements** (*Public Building Retrofit*, *Public Building Retrocommissioning*, and *Residential Upgrade Requirements*)—Any form of energy performance improvement requirement, whether directed at public or private buildings, will lead to greatly decreased public costs for program administration with enforcement being the only remaining related function. However, this type of policy will considerably increase the upfront costs to building owners as a whole. While the number of buildings making improvements (and total resulting energy savings) would go up, depending on how the policy is designed the average cost per household making energy improvements may go down because many participants would only be doing the bare minimum for compliance.

It is possible to view the first two of these three categories of policies as foundational to the subsequent policy. For example, information policies can increase demand for incentives for energy improvement and successful incentive programs can create greater acceptance for minimum energy performance. Of course, it makes sense to also think about policy strategies for specific sectors as well because, for example, the actions of building managers in the public sector are unlikely to impact the actions of homeowners. However, it may be more appropriate to simply think of these policy types within a sector as working together in numerous ways and in any combination to create an ecosystem conducive to greater energy efficiency. If one takes that view, the specific policies that are adopted and the order in which they are implemented become questions of less importance. What is more important is that any one or more policies that make sense for a community are adopted and that they are used as starting points to develop momentum for continual improvement in energy efficiency.

INSTRUCTIONS

Getting Started

Learning how to use LEEP-C can take a decent amount of time. Users are encouraged to set aside several hours to get the most out of the tool. Users will need to learn how the tool functions, collect and enter data about their community, customize policies, consider resulting impacts, and make adjustments to variables. With this in mind, users who are quick learners can get a considerable amount of valuable information from LEEP-C in an hour or two. Other users may choose to use LEEP-C in the course of a community planning process; in this case the users may come back to the tool between or during meetings over the course of months.

When the LEEP-C Excel document is first opened, the user may be prompted with one or more "Security Warning" notices from Microsoft Excel. If prompted with "Macros have been disabled" or some similar message, the user should select to "enable content." If prompted with the question "Do you want to make this file a trusted document?", select yes. Some versions of Microsoft Excel are not compatible with macros. Users will likely receive a prompt when opening the file if the version is not compatible. The only limitation on the functionality of LEEP-C without macros is to the "Attractiveness Based on Community Priorities" chart on the Results page. All other aspects of LEEP-C function without macros.

Throughout the tool, cells that can be edited by users are indicated by **bold dark green text** in cells with a light green background. All other cells should not be edited, as they present outputs based on user inputs or are simply descriptive. When the file is first opened many of the editable cells are already populated with default values. Once these values are changed by the user there is no automatic way to reset the values back to their defaults. However, each value with a default also has that default value written in the cell next to it in the format ***(default is __)***. These cells can be used for reference if the user wants to manually return values to their defaults.

When a value is changed by a user the change is automatically reflected throughout every sheet in the tool, with the one exception of the attractiveness index on the Results sheet. When users want to save their work they need only save the file using the usual Excel Save or Save As functions.

Checklist of User Inputs

To make the most out of LEEP-C, users will need to gather some data about energy use in their community. However, the number of required inputs is small and the information needed for most of them is readily available. The numerous optional inputs allow users to better customize the results to their community, but default values are pre-programmed into LEEP-C for each of these inputs.

Required:

- Population of your community—*available from U.S. Census American FactFinder*
- Years over which policies will be implemented—*determined by user*
- Years over which policy impacts will be evaluated—*determined by user*
- Total square footage of public buildings in community (or estimate, if not available)—*may be available from the building management department of local government*
- Number of occupied residential units in community, disaggregated by building type (single-family, multi-family, mobile home)—*available from U.S. Census American FactFinder*

Optional:

- A ZIP code in your community—*any ZIP code in the community will work, available from USPS*
- Total annual energy consumption by sector in your community—*may be available from the local energy utility(ies) or local government*
- Annual energy use growth rate by sector in your community—*may be available from the local energy utility(ies) or local government*
- A prioritization of energy-related community priorities—*determined by community stakeholders or user*
- Financing terms of energy efficiency investments—*based on the average cost of capital to be made available for the policies*
- Specific policy design variable preferences—*determined by local policymakers and stakeholders*

Navigation

The LEEP-C tool is contained in an Excel workbook-based file. It consists of six spreadsheets that can be navigated by the user through using the tabs at the bottom left of the application screen. Users are encouraged to maximize the window in which they have the tool open. Many of the sheets in the tool are both very tall and wide. Users with lower resolution monitors may have to scroll left and right to see the entirety of certain sheets. The six spreadsheets are:

- "***1. Intro"***—this sheet contains general background information on the goal including a brief description of its uses, development credits, and a link to the user guide.
- ***"2. Local Conditions"***—Users input information about the location, size, and priorities of their community as well as information about their planning timeline and financing environment. This information is used calculate inputs for the analysis in the next sheets.
- ***"3a. Options—Pub Buildings"***—This sheet requires user inputs regarding the general size and energy consumption characteristics of public buildings in the community being analyzed, or allows for users to select default values. It also contains general descriptions of the polices to be analyzed; allows for user customization of the policy design; and provides outputs of annual cost and energy savings, policy costs, and jobs calculations for each policy. The policies included on this sheet are:
    1. Public Building Comprehensive Retrofit
    2. Public Building Retrocommissioning
    3. Public Building Benchmarking and Disclosure
- ***"3b. Options—Res Buildings"***—This sheet contains identical functionality to Sheet 3a but is designed for user inputs regarding general residential building characteristics and customization of policy variables. The policies included on this sheet are:
    4. Home Performance with ENERGY STAR
    5. Energy Use Disclosure
    6. Upgrade Requirements (RECOs)
    7. Assistance to Multifamily Affordable Housing
- ***"4. Results"***—This sheet displays the outputs of the analysis of the variables entered in the previous sheets in multiple formats. It includes two tables:
    - Total Impacts of Policies—this displays the impacts of all seven policies in absolute units (e.g., electricity savings of 2,000,000 kWh) for financial costs and savings, energy savings, jobs, and pollutants
    - Relative Impacts of Policies—this displays the impacts of all policies in relative units (e.g., electric savings of 15 kWh per dollar invested)

  And two figures:
    - Comparison of Policy Performance—displays a radar chart of 13 metrics by which the performance of each policy is measured. This allows for the visual comparison of the relative merits of each policy.
    - Attractiveness Based on Community Priorities—displays a modified bar chart on which each policy is plotted on an index or relative attractiveness. The index is calibrated based on the user inputs of community priorities from "2. Local Conditions."
- ***"5. Cash Flow"***—This sheet displays year-by-year details of cash flow and other costs and benefits for each policy. Summaries of each of these data points are provided on sheet 4; however, this sheet lets users see more detail about when costs and benefits accrue.

The next sections of the document will describe each spreadsheet of the tool and the use of its component sections and fields.

"2. Local Conditions" Spreadsheet

Green values can be adjusted by user			
Required User Inputs			
Community characteristics			
Use national averages?	**No**		
If "No," enter ZIP Code in area	84180	*Used to automatically calculate energy prices and emissions rates*	
State	UT		
Community Population	2,607,573	*Used to scale local job impact estimates to the size of the community*	
Community Priorities			
How important are each of these issues to your community?			
(choose a value from 0 to 10 for each, with 10 meaning extremely important and zero meaning not important at all. 5 is the default.)			
Issue	**Importance**		
	At Present	*In 10 years*	
Total impact			
Create and retain jobs	10	10	
Reduce Energy Bills	0	0	
Save Energy	0	0	
Reduce Greenhouse Gas emissions	0	0	
Reduce Criteria pollutants	0	0	
Keep upfront public costs low	0	0	
Keep upfront private costs low	0	0	
Relative impact			
Jobs per dollar	0	0	
Energy bill savings per dollar	0	0	
Energy saved per dollar	0	0	
Criteria Pollutant reduction per dollar	0	0	
Greenhouse Gas reduction per dollar	0	0	
Minimize frequency of maintenance	0	0	
How important is the present?	5	(must be greater than zero)	
How important is the future?	5	(must be greater than zero)	
Policy and Financial conditions			

Community Characteristics

In this section the user provides inputs that are used to calculate local scaling factors for energy costs, energy related pollution, and job impacts. The first two fields in this section (***Use national averages?*** and ***If no, enter ZIP Code***) allow the user to select national averages or to enter a ZIP code in the area to be analyzed. Based on the response to this question the associated ***State*** will be displayed. Using the input, the appropriate state average retail prices are calculated for electricity and natural gas plus the emissions rates of all major air pollutants associated with electricity generation are calculated for the eGRID emissions subregion in which the ZIP code is located. If the ZIP code field is left blank or a ZIP code for which data is not available is entered, then an error of "#N/A" will be displayed in the State field. If this error is received the user must choose a different ZIP code or choose to use national average numbers. The third field (***Community Population***) is used to estimate the purchase diversity ratio, or the amount of spending from the community that stays in the community, which is a variable used to calculate job creation impacts.

Note: It is fine if the geography and population to be analyzed spans more than one ZIP code. ZIP codes are requested in this section simply because it provides a more geographically precise location than selecting a state. This is important for our calculations because there is often more than one emissions region in a state.

Tip: basic information about your community's characteristics can be obtained through the American FactFinder Web site of the U.S. Census Bureau (Census 2011). This is a good place to start if you have limited data on your community. The data points relevant for inputs into LEEP-C include population and housing units by number of units in structure. Use the most recent data available.

Community Priorities

In this section the user is given a list of thirteen specific ***Issues*** and requested to choose a value for each indicating its ***Importance*** on a scale of 0 to 10, with 10 being extremely important and 0 meaning the issue is not important at all. The default value for each issue is a 5. Users are also asked to distinguish between the importance of the issue to the community at present and in 10 years. Finally users are asked to weight how important the present and future are (the value entered for these two fields must be greater than zero). The purpose of entering these preferences is to allow for the automatic weighting of policies based on the selected preferences after the quantitative analysis of policy impacts. In a sense this allows the raw results to be filtered through the values of the users to provide results that are more relevant to the users. Preferences from individuals or interest groups can, of course be entered, but we strongly suggest that for LEEP-C to be of most value to the community that the importance values entered in this section be based on consensus preferences resulting from a community engagement process. Admittedly the issues integrated in LEEP-C are limited and may not capture all the energy-related values prioritized by communities, but hopefully it covers the majority of them. Based on user feedback, additional issues may be included to future versions of the tool.

The issues listed are split into two general categories: Total Impact and Relative Impact. ***Total Impact*** issues describe those whose impact is measured by the absolute contribution of a policy toward addressing that issue (e.g., electricity savings of 2,000,000 kWh). ***Relative Impact*** issues are those that are measured by impact relative to another value, most often for our purposes impact per dollar spent (e.g., electric savings of 15 kWh per dollar invested). It is important to keep these distinctions in mind when entering values for each. Also, a user can choose to weight policies based on Total or Relative impact only by setting the values to all issues in the other category to zero. A zero value for any issue will result in related impacts being ignored in automatic weighting calculations.

Note: the relevance of the output from the values entered will be greater if the user allows for more variation between responses to specific issues. For example, if every issue is important to the community in some form and it is tempting to give each one a score of 9 or 10, it is better to take time to think through their relative importance in order to allow for greater differentiation through scores ranging from, for example, 5 to 10.

Policy and Financial Conditions

Users are requested to select the starting and ending year of the ***Policy Implementation Period***, the maximum period of time over which all policies to be evaluated will be in place. Depending on the characteristics of the specific policy this selection can stretch the same level of investment over different periods of time or increase investment by replicating an annual level of investment over all years in the period. The implementation period of some policies can be further customized in spreadsheets 3a and 3b, but they cannot be adjusted beyond the maximum bounds set in spreadsheet 2. After the starting and ending years have been entered the Total Implementation Period is displayed in years. The years selected as the starting and ending years are counted inclusively (e.g., a starting year of 2015 and ending year of 2020 results in a total implementation period of six years).

Next, users are able to customize the ***Impact Analysis Period***, the timeframe over which impacts resulting from the policies are summed to determine the program results. The starting year is automatically set to the same year of the starting year of the implementation period, but the ending year of the analysis period can be customized by the user. In most cases, setting the Analysis Period as at least twice the length of the implementation period is recommended because energy savings benefits (and, in some cases, costs) continue for many years after implementation ends. Depending on the policy, these benefits can continue to accrue for between 7 to 20 years after implementation finishes. As a result, setting the ending year of the analysis period for 20 years after the ending year for the implementation period will capture all direct benefits from the policy. After the starting and ending years have been entered the Total Analysis Period is displayed in years. The years selected as the starting and ending years are counted inclusively.

Any years starting with 2010 can be selected for both the implementation period and analysis period. However, the tool is designed to function best between the years of 2010 and 2035, because energy price projections have been included for those years. Calculations of energy bill savings in any subsequent year use the prices from 2035, and therefore do not reflect projected price fluctuations. Additionally, it is important to note that the format of the spreadsheet in which the total impacts are calculated (5. Cash Flow) is designed to accommodate a maximum of 30 years. As a result the Total Analysis Period is restricted to no more than 30 years, because any results after 30 years will not be accounted for. Calculations beyond 30 years into the future are not encouraged, because, by their nature, long-term savings projections become decreasingly reliable the further into the future they try to capture. There are at least two problems with very long-term projections. First, there is increasing uncertainty about the underlying parameters (for example, demographic trends such as number of people per household, economic trends such as energy costs, and technology trends such as efficiency and adoption). Second, at almost any discount rate, the marginal increase in the present value of policy implementation far in the future is very small, and should not be a major decision factor.

Wherever dollar values are presented in the tool they are in constant, or real, 2008 U.S. dollars. Users are able to customize the real ***Social Discount Rate***, the value by which costs and benefits in future years are marked down (adjusted for inflation) in order to account for opportunity costs. LEEP-C uses a default real discount rate of 3%, which can be adjusted by users. Determining a social discount rate is an art and science in its own right, with a wide range of approaches used. For a good introduction to the issues surrounding social discounting see Zhuang et al. (2007).

Project Financing

LEEP-C allows users to adjust three variables related to how policies and their associated investments are financed. ***Percent Down*** is the portion of the total investment that is paid for "out-of-pocket." ***Interest Rate*** is the annualized cost of money in real dollars. ***Loan Period*** is the number of years over which the borrowed funds and interest are paid back. Finally, the Capital Recovery Factor, the calculation of annual payments based on the interest rate and loan period, is automatically determined.

For simplicity, all policies and associated investments are assumed to be financed under the same terms in LEEP-C. However, this assumption is not likely to reflect reality, because for example, public investments are often able to be financed at a lower interest rate than those made by households. Also, some policies would be eligible for certain funds and financing, while others would not be. Users should estimate the average terms for all financing that is likely to be used.

Local Characteristics Based on User Inputs

The remainder of this sheet displays values determined based on information entered previously by the user. *None of these values can be adjusted by the user.* This section provides previews of some of the variables that will be used to calculate impacts in the next sheets. ***Energy Cost in [State] in [Starting Year]*** displays the projected average retail prices in the state selected by the user (or national averages if selected) for the year selected as the starting year for the implementation and analysis periods. Retail prices for residential, commercial, and industrial customers are displayed for both electricity and natural gas. These prices are just a snapshot for one year; however, when policy impacts are calculated projected changes in prices from year to year are accounted for.

The next section, ***Emissions Rates (Non-Baseload Output)***, displays the U.S. Environmental Protection Agency (EPA) eGRID emissions subregions for electricity-related emissions based on the user-entered ZIP code (or "U.S." if the user elected to use national averages) and the associated rates of emission per unit of electricity use for six electricity-related pollutants: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_X), ozone season NO_X, and sulfur dioxide (SO_2). "Non-baseload" rates mean that they are they are the emissions associated with a marginal unit of electricity use (or avoided use), not the average for all electricity generation in that region. This section also calculates and displays the totaled emissions rates for all greenhouse gases for which data is available (CO_2, CH_4, N_2O) in units of carbon dioxide-equivalents (CO_2e). The remainder of the pollutant types included are criteria air contaminants, or criteria pollutants, as defined by the EPA. These emission rates will be used to calculate impacts of the energy efficiency policies on greenhouse gas and criteria pollutant emissions. These emission rates, most recently updated by EPA with 2007 data, are used for all years in the impact analysis period and are not adjusted based on projected changes in future years. This means, for example, that that if a state has implemented a clean energy standard requiring some fraction of all electricity services by some deadline to be provided by renewable energy or energy efficiency over the coming years, that policy direction will not be reflected in the emissions results of LEEP-C.

The final section displays the ***Jobs Calculation Multipliers***. These values are used to calculate the number of net jobs resulting from our policies based on the level of investment that is contributed or removed from a particular economic sector. More information on the methodology used to calculate energy prices, emissions, and employment impacts can be found in Appendix B.

"3a. Options—Pub Buildings" Spreadsheet

Green values and green outlined boxes can be adjusted by user				
EXISTING PUBLIC BUILDINGS				
Sector Characteristics				
Include Sector?	**Yes**			
Total public building square footage	**38,000,000**			
Annual energy consumption				
Use default calculation based on average per square foot?	**Yes**			
If no, enter annual energy consumption in green boxes		*Calculations based on average per sq ft*		
- Electricity consumption (kWh)	-	*600,400,000*		
- Natural Gas consumption (therms)	-	*14,060,000*		
Estimated public building energy costs in 2012 ($)	$ 51,971,000			
Annual Energy Use Growth Rate	**0.80%**	(default 0.80%)		
Policy Characteristics				
1 PUBLIC BUILDINGS COMPREHENSIVE RETROFIT				
Policy Description: Many public buildings have not had a major renovation in decades. A comprehensive energy assessment, or audit, can determine a building's current level of performance and may identify both small adjustments in operations and technology as well as capital investments that would greatly reduce operating costs, while improving comfort and overall performance. Choosing to implement a variety of these recommended cost-effective, whole-building performance improvements would constitute a comprehensive retrofit. Often building certification systems—such as ENERGY STAR Certification and LEED—are used by governments to designate a desired level of energy performance.				
Include Policy?	**Yes**			
Policy Design Variables			**Average Annual Impacts**	
Portion of all buildings to be retrofitted	**25%**		*In an Implementation Year*	
Building Energy Savings Goal	**23%**	(default is 23%)	Total Policy costs (w/o finance)	$ 14,626,800
Years over which retrofits occur	**2**	(default is 2)		
			In the Analysis Period	
			Total Policy costs (w/ finance)	$ 1,950,240
			Electric savings (kWh)	31,776,900
			Natural Gas savings (therms)	744,140
			Gross energy cost savings	$ 2,800,200
2 PUBLIC BUILDINGS RETROCOMMISSIONING				
Policy Description: Retrocommissioning, or "RCx," provides existing buildings with a "tune-up" to improve the functioning of their systems and energy performance. Detecting and fixing deficiencies in a building's operation can be done extremely cost-effectively and often result in great energy savings. Governments can adopt policies and practices to ensure that their buildings undergo retrocommissioning at regular intervals to ensure that buildings continue to perform at a high level of efficiency.				

This sheet and the next are where the user enters data on the characteristics of a particular sector in their community, learns about the policies being evaluated for the sector, and customizes the design of the policies to be evaluated.

Sector Characteristics

This sheet evaluates three energy efficiency policy approaches that can be applied to existing public buildings. All values entered on this sheet will apply to these policies only. Near the top of the sheet is a section for user inputs related to Sector Characteristics. First, the user is allowed to include or exclude this entire sector from the analysis with their Yes/No response to the question ***Include Sector?*** If the user is excluding the sector, the rest of the sheet can be skipped. The user is requested to enter the ***Total Public Building Square Footage*** of public buildings in their community. This will provide a baseline from which energy use and potential energy savings can be calculated. Next, the user can select how they would like to calculate ***Annual Energy Consumption*** for the square footage identified. If "Yes" is selected from the dropdown menu, energy consumption is calculated based on national averages of electricity and natural gas use per square foot in commercial buildings. If the user has actual data on public building energy consumption from a utility bill analysis or other source, "No" can be selected and the user is able to directly input their data on total annual electricity and natural gas consumption into the green boxes. Based on these user inputs the ***Estimated Energy Cost*** for the Starting Year of the policy implementation period is displayed. The consumption and cost figures present "business as usual" expectations prior to the implementation of any policies. Finally, the user can customize the ***Annual Energy Use Growth Rate***, the rate at which energy use in the buildings in question is estimated to increase without intervention.

Tip: The best source of data on public buildings in your community is likely the building management department of your local government. They may know the total square footage of public buildings. They may also know information on annual energy consumption for the whole building portfolio. However, it is also likely that determining energy consumption would require collecting energy bills from many departments and analyzing them. Users should use their judgment to decide how to collect the best information possible in the time they have available. If the user is in a position to influence the building management department of the local government, this is a great opportunity to encourage them to begin using ENERGY STAR Portfolio Manager, if they are not already, to track the energy use in their buildings. Using this free, industry standard tool and the information it provides has a strong record of enabling energy efficiency improvements in public buildings.

Policy Characteristics

Once the sector-wide inputs have been established, the *design of the specific policies* can be adjusted if desired. All of the remaining inputs on this page are optional, as defaults based on experience with these policies in other places have already been entered (detail on how these defaults were derived is available in Appendix B). However, users are encouraged to adjust any of the policy variables, within reason, so that they better match the situation in their local community. In general, defaults are set to reflect the typical experiences with each policy; however, these values do vary based on local context and policy design. On the bottom half of the sheet three items of information are presented for each policy: first is a short ***Policy Description*** (more details on and related resources for each policy are included in Appendix A of this document); below the description on the left is an option to exclude the policy from analysis through selecting "No" in response to ***Include Policy?*** as well as the major ***Policy Design Variables*** that can be adjusted by the user; and on the right are the ***Average Annual Impacts***—costs and savings—resulting from the policy design.

The first policy listed is ***Public Buildings Comprehensive Retrofit*** or customized building improvements to improve energy efficiency. For this policy users can adjust the percentage of buildings to be retrofitted, the targeted level of energy savings per building retrofitted, and the years over which all the retrofits occur. These same policy variables can be adjusted for the second policy, ***Public Buildings Retrocommissioning***, essentially a "tune-up" for buildings. The *portion of buildings* to be retrofitted or retrocommissioned is the most important variable to be adjusted by the user as this is primarily determined by the policy mandate in a particular community. The *energy savings goal* for each policy is set to a default percentage based on the average energy savings historically achieved from the policy. However, these savings do vary based on a variety of variables. If you would like to see the impacts of higher or lower savings levels you can adjust them between 0-30% for the retrofit policy and between 0-20% for the retrocommissioning policy. Finally, the *years over which the policy occurs* can be adjusted to fit the actual timetable in the community for implementing the projects related to the policy. These years can be adjusted as the user sees fit;

however, if the number of years is greater than the Total Implementation Period as set on "2. Local Conditions" then only the investments resulting from the policy within the Total Implementation Period will be analyzed.

The third policy analyzed for this sector is ***Public Buildings Benchmarking and Disclosure***. This policy requires detailed information on energy performance of public buildings to be kept and made public. The availability of this information has been shown to increase the adoption of energy efficiency measures. Users can customize the portion of buildings to be benchmarked, years over which initial benchmarking occurs and the rate at which benchmarking results in audits to investigate the energy improvements appropriate for the buildings. Defaults are provided for each variable. Although each of the variables can vary, the first two are likely to vary based on policy design while the third will vary mostly based on implementation.

For each of these three policies ***Average Annual Impacts*** are displayed to the right of the user inputs. These outputs include averages for a typical implementation year (policy costs without financing) and for the Impact Analysis Period as a whole (total policy costs with financing, annual electricity and natural gas savings, and energy bill cost savings). These numbers are automatically recalculated whenever changes are made to any variables that impact the policy. They are primarily intended to provide directional indications of the impact of a particular user adjustment. Of particular note is that the Implementation Year and Analysis Period average costs and benefits are from different timeframes and comparisons should not be made between the categories to estimate cost-effectiveness. More detailed and comprehensive outputs are provided in the subsequent tabs.

Details on the methodology and data behind the calculations of costs and benefits of each policy are available in Appendix B of this document.

"3b. Options—Res Buildings" Spreadsheet

Green values and green outlined boxes can be adjusted by user

EXISTING RESIDENTIAL BUILDINGS

Sector Characteristics

Include Sector?	**No**					
Total Occupied Residential units	**136,328**					
percent single-family	**61.0%**	(default 69%)				
percent multi-family	**38.0%**	(default 25%)				
- multi-family w/ household incomes below $35,000	***10.0%***					
percent mobile home	**1.6%**	(default 6%)				
Annual Residential Energy consumption						
Use U.S. averages?	**Yes**	*Calculations from U.S. averages*				
If no, enter total annual energy consumption in green boxes			*Total*	*Single-family*	*Multi-family*	*Mobile homes*
- Elec consumption (kWh)	-		*1,461,566,000*	*1,063,906,000*	*371,725,000*	*25,935,000*
- Natural Gas consumption (therms)	-		*57,461,000*	*40,589,000*	*16,493,000*	*379,000*
Estimated residential energy costs in 2012 ($)	$ 172,166,000					
Annual Energy Use Growth Rate	**0.80%**	(default 0.80%)				

Policy Characteristics

4 Home Performance with ENERGY STAR (single-family only)

Policy Description: Home Performance with Energy Star (HPwES) is a nation-wide program that promotes a comprehensive, whole-house approach to improving home energy efficiency. The program encourages homeowners to make home energy improvements based on an individualized energy assessment. Energy Star is nationally sponsored by the U.S. Environmental Protection Agency and the Department of Energy, however it is state and local sponsors who manage the HPwES programs and recruit home improvement contractors who are qualified to perform comprehensive home energy improvements and energy assessments. Upon completion of the home improvements, contractors assess the home's performance to document that promised energy savings were achieved and improvements were properly installed. Typical energy efficiency improvements include: sealing air leaks and adding insulation, improving heating and cooling systems, sealing ductwork, and upgrading lighting and appliances.

Include Policy? **Yes**

Policy Design Variables			**Average Annual Impacts**	
			In an Implementation Year	
Annual single-family participation rate	**1.00%**	(default 1%)		
Annual number of participating homes	830		Total Policy costs (w/o finance)	$ 3,480,000
			- Program Administration	$ 418,000
Building Energy Savings Goal	**22%**	(default 22%)	- Incentives to Participants	$ 551,000
Financial Incentive to Participants (% of measure costs)	**18%**	(default 18%)	- Participant costs	$ 2,511,000
Administration Costs (% of total policy costs)	**12%**	(default 12%)		
			In the Analysis Period	
			Total Policy costs (w/ finance)	$ 3,480,000
			Electric savings (kWh)	18,965,000
			Natural Gas savings (therms)	758,600
			Gross energy cost savings ($)	$ 2,303,000

5 ENERGY USE DISCLOSURE (single-family only)

Policy Description: A Building Rating and Disclosure policy works by requiring that information on the energy efficiency of a building be made available to buyers and renters through a standardized energy assessment. A home energy assessment evaluates an existing home to determine energy

Sector Characteristics

This sheet evaluates four policies that can be applied to existing residential buildings. All values entered on this sheet will apply to these policies only. First, the user is allowed to include or exclude this entire sector from the analysis with their Yes/No response to the question ***Include Sector?*** If the user is excluding the sector, the rest of the sheet can be skipped. Three major Sector Characteristics are requested from the user. The user must enter an estimate of ***Total Occupied Residential Units*** in the community as well as estimates of the percentage of units that are single-family, multi-family, multifamily affordable only, and mobile homes. The default percentages are based on national data from the 2009 Residential Energy Consumption Survey (EIA 2009). Next, in a similar manner to the previous sheet, users are required to choose how they would like to calculate ***Annual Residential Energy Consumption*** for these homes. If users select "Yes," calculations will be made based on national average per unit electricity and natural gas consumption for each housing type. If "No" is selected, users must manually enter estimates of total electricity and natural gas consumption for all housing units. While use of the national average consumption data is an option, we discourage it. Consumption varies considerably based on building stock, region of the country, common fuels used, and climate. Any local data you have will likely more accurately reflect the consumption characteristics in your community. Based on these selections and/or inputs, estimated annual energy costs for the residential sector are displayed for the Starting Year of the Implementation Period. Finally, users are able to adjust the ***Annual Energy Use Growth Rate*** for the sector.

Policy Characteristics

The bottom portion of this sheet is designed in a manner very similar to sheet 3a. Likewise, making adjustments to ***Include Sector?*** and the default ***Policy Design Variables*** is optional, but can be done in order to better match the policy design to local characteristics (detail on how the defaults were derived is available in Appendix B).

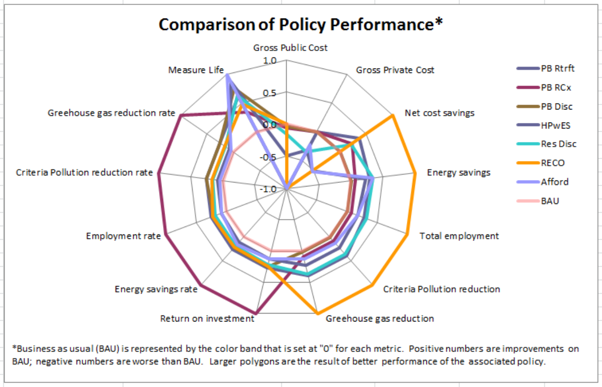
The first residential policy is ***Home Performance with ENERGY STAR***, a comprehensive, whole-house approach to energy improvements primarily focused on single-family homes. The user can adjust the annual rate participation in the program, the energy savings goal per home participating, the level of financial incentives provided to the participant, and the level of program administration costs relative to spending on energy improvements. For the ***Energy Use Disclosure*** policy for single-family buildings, adjustments can be made to the rate at which events triggering the policy (e.g., sale, rental, or finance of the property) occur, the level of compliance with policy, and the level of incentives given to households choosing to make energy improvements in their home after disclosure.

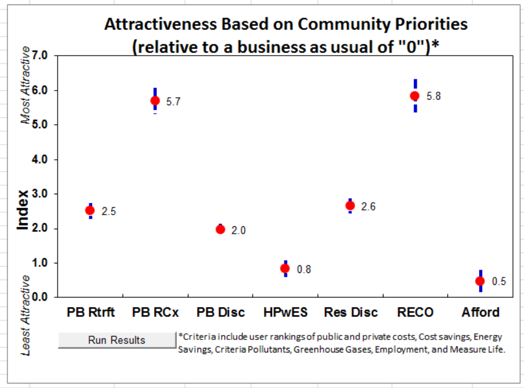
For ***Upgrade Requirements (RECOs)***, a policy of required home energy improvements at particular trigger points, the user can select if multi-family units are included in the policy and customize the trigger rate, average spending per unit, and average energy savings for each unit improved for single-family and multi-family units. The final residential policy is ***Assistance to Multifamily Affordable Housing*** in making energy efficiency improvements at time of renovation. Assistance is financial and through technical expertise. The user can customize the frequency of rehabilitations for the housing stock, the portion of the buildings with central air conditioning, and the rate of participation in the program.

The ***Annual Average Impacts*** displayed for each policy include the same outputs are found for the public buildings polices—electric and natural gas savings, energy bill savings, and policy cost for both implementation years and the analysis period—plus a few others. The total number of housing units covered and/or participating in each policy is displayed. In addition to displaying the total annual policy costs, these costs are broken out further to provide more detail on how much is paid by the public and how much by the property owner. Policy costs are separated into up to three categories: program administration; incentives to participants; and participant costs. The first two costs categories accrue to the public and the third to the property owner. Of particular note is that the Implementation Year and Analysis Period average costs and benefits are from different timeframes and comparisons should not be made between the categories to estimate cost-effectiveness. More detailed and comprehensive outputs are provided in the subsequent tabs.

"4. Results" Spreadsheet

Total impacts over the period of 2012 to 2026 of policies implemented from 2012 to 2026





Absolute Impacts	Gross costs	Net Cost Savings		Net Present Value	Energy savings			Net Jobs	Criteria Pollution svgs		GHG svgs
Public Buildings		*Public*	*Households*		*Electricity (kWh)*	*NG (therms)*	*Total (MMBtu)*	*Avg Jobs/yr*	*lbs NOx*	*lbs SOx*	*lbs CO2e*
1. Public Building Retrofit (PB Rtrft)	$ 29,253,600	$ 12,749,000	$ -	$ 5,828,100	476,653,000	11,162,130	2,742,600	19.70	890,720	360,350	612,676,400
2. Public Building Retrocommissioning (PB RCx)	$ 1,715,800	$ 7,641,400	$ -	$ 6,751,400	108,920,500	2,550,670	626,700	4.63	203,540	82,340	140,003,400
3. Public Building Benchmarking and Disclosure (PB Disc)	$ 988,000	$ 377,200	$ -	$ 147,500	15,993,600	302,060	84,800	0.58	29,890	12,090	20,557,700
Existing Residential Buildings											
4. Home Performance with ENERGY STAR (HPwES)	$ 52,200,000	$ (14,535,000)	$ (3,113,800)	$ (16,564,500)	284,472,800	11,379,340	2,108,600	12	531,600	215,100	365,653,400
5. Labeling and Disclosure (Res Disc)	$ 44,895,000	$ (4,590,000)	$ 11,845,600	$ 2,911,900	438,930,200	16,293,270	3,127,000	22	820,200	331,800	564,188,600
6. Upgrade Requirement (RECO)	$ 115,125,000	$ -	$ 34,290,400	$ 20,647,000	1,214,370,100	51,243,990	9,267,800	70	2,269,300	918,100	1,560,917,300
7. Assistance to Affordable Housing (Afford)	$ 55,230,000	$ (29,430,000)	$ 11,410,600	$ (17,017,900)	155,597,500	26,879,230	3,218,800	12	290,800	117,600	200,000,700

Relative Impacts	NPV Benefit-Cost	Leverage	Measure Life	Energy Savings rate			Jobs rate	Criteria Pollution svgs rate		GHG svgs rate	Attractiveness
Public Buildings	*$ benefits / $ costs*	*% public costs*	*years*	*Elec (kWh/$)*	*NG (therms/$)*	*All (MMBtu/$)*	*jobs/yr/mil$*	*lbs NOx / $*	*lbs SOx / $*	*lbs CO2e / $*	*Mean*

This spreadsheet summarizes the total impacts during the Analysis Period resulting from the policies implemented during the Implementation Period. The timeframe of these two periods are displayed at the top of the sheet as the title, ***Impacts over the period of [Analysis Period] of policies implemented from [Implementation Period]***. The sheet displays the policy impact data in three ways: tables with the numeric values for several absolute and relative policy performance metrics; a radar diagram that graphically represents performance of each policy against 13 metrics; and a chart that displays each policy on an "index of attractiveness" to the community. All values on this sheet are calculated based on user inputs as entered on sheets 2, 3a, and 3b.

Presentations of Policy Impacts

The policy performance metrics presented in the ***Absolute Impacts* table** for each policy include totals for gross policy cost, net cost savings (to the public and households), net present value of the policy, energy savings (electricity, natural gas, and total), average net jobs per year (technically in units of "job person-years"), criteria pollution reductions (pounds of NOx and SOx), and greenhouse gas reductions in pounds of carbon dioxide equivalent. These metrics provide the user with information on progress toward increasing or decreasing the total amount of these goods or "bads" in their community. The ***Relative Impacts* table** provides information on the level of impact relative to another variable, in most cases per dollar invested. Many of these numbers can give the user information on relative cost-effectiveness of the policies. The table includes return on investment (ROI), the percent of costs that are borne by the public, the number of years over which energy savings will last (or "measure life"), the amount of energy savings per dollar invested (for electricity, natural gas, and total), the number of jobs per year created per million dollars invested, the reduction in criteria pollutants per dollar (for NOx and SOx), greenhouse gas savings per dollar, and finally an "attractiveness" score (to be discussed in more detail below). Values in these tables can be converted into other units outside of the tool as desired by the user. Many reference guides for such conversions are available on the Internet. For example, one good resource for converting greenhouse gas impacts into different units or equivalencies more understandable to the average person is the EPA Greenhouse Gas Equivalencies Calculator (EPA 2011a).

The ***Comparison of Policy Performance* radar diagram** visually compares thirteen of the metrics from the tables. Each policy is represented by a different color polygon. Each metric is represented as a radial string on the web (or, if you prefer, a different spoke on the wheel). For each metric the policy with the highest impact is given a score of "1" and the rest of the policies are scored in the range of 0 to 1 relative to it (for the two upfront cost metrics this is reversed and the highest value is set as "-1," because for our purposes higher costs represent poorer policy performance). Note that the "0" value is not at the center of the web, but rather halfway between the center and the edge of the diagram. This scoring process is repeated for each metric and plotted on the diagram. Additionally there is a polygon labeled "BAU," for business as usual, which is scored with a "0" for every metric. Policies with higher relative performance for a number of metrics will result in a larger polygon. The larger the polygon is the better the overall performance of the policy in regard to all metrics. Only the points on the radial strings have meaning; the points between strings do not. The metrics from the Absolute Impacts table are grouped on the right-hand side while those from the Relative Metrics table are on the left-hand side. As a result those policies with greatest *total* impact will have a large portion of their polygon on the right-hand side and those that have a large impact *per dollar* will have a large portion of their polygon on the left-hand side. This diagram allows users to quickly see the comparative performance of policies based on all metrics. Additionally, this diagram can be used as a reference to quickly see the impact of a change in user inputs on the comparative policy performance.

The final presentation of the summary impacts on this sheet is the ***Attractiveness Based on Community Priorities*** **chart**. This chart presents the performance of the policies weighted against the issues of importance as inputted by the user. Through use of a probabilistic linear vector analysis, or Monte Carlo simulation, the Community Priorities as inputted by the user on the "2. Local Conditions" sheet are used to create standardized weightings for each metric and the policy impacts listed in the Impacts tables are used to create standardized scores for each metric for each policy. These values are then multiplied to develop a mean score for each policy on an index of relative attractiveness, represented by a red dot. The chart also presents 95% confidence intervals for each policies score on the index. The shorter the length of the dashed blue lines, the greater the certainty of the index score. The higher the score on this index, the more appropriate that policy is for achieving the user-defined issues of importance. While mean numeric values are provided for each policy, these values represent the qualitative inputs of users when ranking the issues of importance to them. These values are on a linear scale, meaning that a score for one policy double that of another translates into that policy being twice as attractive for meeting the community's priorities. Changes in user inputs will change the scores of the policies. Because the calculations for this chart are made through a Visual Basic Macro, the user must select the "Run Results" button every time they wish to update the scores on the index to reflect the changes caused by other inputs. The calculation for this chart is the only one that must be run manually in LEEP-C; all other calculations are automatically updated. The scores from this chart provide one tool to select and prioritize policies for implementation in the community being analyzed.

Users are encouraged to make adjustments to their inputs on previous sheets to explore the impacts that different policy designs, analysis periods, discount rates, financing terms, community priorities, and other variables have on the results. Making a series of adjustments like this can allow the user to see what conditions would be required to result in desired outcomes and to better understand the advantages and disadvantages of particular choices or conditions.

"5. Cash Flow" Spreadsheet

	Year		**1**	**2**	**3**	**4**	**5**	**6**	**7**
			2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
	Discount Rate	3.00%	1	0.9709	0.9426	0.9151	0.8885	0.8626	0.8375
EXISTING PUBLIC BUILDINGS									
1. Public Building Comprehensive Retrofit									
	COSTS								
	Policy Total		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Loan amount		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Out-of-pocket		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Payments on principal		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Payments on interest		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	NPV costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	BENEFITS								
	Elec savings (kWh)		0	0	0	0	0	0	0
	Natural Gas savings (therms)		0	0	0	0	0	0	0
	Elec bill savings		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	NG bill savings		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	NPV benefits		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Net Jobs		0.00	0.00	0.00	0.00	0.00	0.00	0.00
	NET IMPACTS								
	Annual Nominal Savings		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Net Present Value		$ -	$ -	$ -	$ -	$ -	$ -	$ -
2. Public Building Retrocommissioning									
	COSTS								
	Policy Total		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Loan amount		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Out-of-pocket		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Payments on principal		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Payments on interest		$ -	$ -	$ -	$ -	$ -	$ -	$ -
	NPV costs		$ -	$ -	$ -	$ -	$ -	$ -	$ -

In a way, this sheet provides a "behind the scenes" look at the calculations made to determine the impacts of the policies. The outputs from this sheet are also summarized on sheet 4. However, the purpose of this sheet is to provide year-by-year details of cash flow and other costs and benefits. All values on this sheet are calculated from input on sheets 2, 3a, and 3b.

Across the top of the sheet are thirty ***Years***, beginning with the *Starting Year* as selected in sheet 2, displayed in both calendar year and counted from the *Starting Year* as year "1." All data in the column below a year is associated with that year. The next line below the two rows of year information includes the ***Discount Rate*** (as set on sheet 2) and the calculated discount multiplier for each year displayed under the appropriate year. These values are used to calculate net present value. Listed along the left-hand side of the sheet in the first column are the same sectors (Existing Public Buildings and Existing Residential Buildings) and their respective policies as found on the other sheets. In the second column are sets of rows describing costs, benefits, and net impacts. The identical line items are replicated for each of the seven policies. The ***Costs*** lines displayed are total annual policy cost, amount of the loan taken to finance the policy costs, amount of the policy costs paid without financing (or "out-of-pocket"), payments on loan principal in that year, and payments on loan interest in that year. The ***Benefits*** lines are electricity savings in kilowatt-hours, natural gas savings in therms, electric bill savings in dollars, natural gas savings in dollars, and net jobs resulting from the policy in that year. Finally, the ***Net Impacts*** lines are annual net cost savings (or expenditures) in constant 2008 dollars and the net present value of those cost savings in that year. As you move to the right you see the associated value for each line item in the year represented by the respective column. These cells are populated based on the values set in the previous sheets.

On the far right side of the sheet, beyond the column for year 30, are four columns that present two versions of the totals and averages for each line item on the sheet. The first two columns, labeled ***Analysis Period***, display the sum and mean respectively for the values in that row from the years included in the *Analysis Period* as set on sheet 2. These values are used to derive many of the values include on the Results sheet. Finally, the next two columns, labeled ***Entire Sheet (years not = "0")***, display the sum and mean for that row for every year on the sheet where the value isn't zero. Although the values in these columns are not used elsewhere in the tool, they provide a quick way to check the values in the previous two columns. Also, the *Total* column can be referenced to see the total impacts of a policy over the thirty year-period, even if the Analysis Period is set for a fewer number of years. The *Average* column provides averages for every year in which there is some activity in that row and ignores the cells with a value of zero. As a result it can display values such as average annual loan payments for all borrowers during the length of the loans.

This sheet lets users see more detail about when costs and benefits accrue. This information may be important if the user is under temporal constraints. Some examples of such constraints include: if the policies under consideration must be completed within a particular annual budget or if the user would like to see net cost savings within a set time period after the start of the policy. *Users can adjust the various timeframe, financing, or policy parameters to better match the annualized outcomes to their goals or constraints.*

EXAMPLE SCENARIOS

While the detailed walk-through of the calculator's features in the previous section should bring users up to speed on the technical aspects of using the tool, this section provides a few specific examples of how the tool can be used to provide answers to specific questions that an energy efficiency stakeholder may have. These three scenarios use the tool over different timeframes, in different communities, to answer different questions, and to address different goals. While each scenario uses real places and some real data, they are hypothetical and not meant to represent real goals or situations in that place. Also, each scenario is a planning exercise; the actual costs and savings may vary based on the conditions on the ground not captured in LEEP-C.

Budget and Time Constrained

The mayor of Omaha, Nebraska is interested in pursuing energy efficiency and has been able to carve out a small budget ($50,000) for pursuing related policies and projects. However, the city council is skeptical; as a result the mayor wants to see significant direct public cost savings by the time of the next election in four years. Within the constraints of the limited budget and timeline, how can Omaha maximize public cost savings while demonstrating the long-term value of energy efficiency?

After collecting basic information on Omaha (a ZIP code, population, housing units, estimate of public building square footage), this information is entered along with community priorities (values of "10" for "Reduce Energy Bills" and "Keep upfront public costs low" and values of "0" for all others), a Policy Implementation Period of 2012-2013, an Impact Analysis Period of 2012-2015, and no Policy Financing (100% "Percent Down") on the Local Characteristics tab and the Sector Characteristics sections of the two Options tabs.

On the Results tab, the cost savings are negative for most policies because of the low energy costs in Nebraska, short Impact Analysis Period, and the lack of financed and amortized costs. Public Building Retrocommissioning is the only policy with positive public net cost savings: about $9,900 for a public building portfolio of 200,000 square feet with all Policy Design Variables set at their defaults. The total costs for the policy are only $4,500. If we adjust these defaults to be more ambitious (implementing retrocommissioning on all of the buildings over one year instead of in 25% of buildings over two years), the result is public net cost savings of $79,000 and total policy costs of $36,000 in 2012-2015. Omaha can make their funds go even further through financing their retrocommissioning investments. Financing at the default settings (20% down, 6% interest rate, and 10-year loan term) increases public cost savings to $88,000 and reduces policy costs to $27,000 for the 2012-2015 period.

In each of these scenarios the city has some of the $50,000 left over that can be invested in other cost effective energy efficiency measures or policies that may take longer to achieve net cost savings. Assuming the city chooses the ambitious approach to retrocommissioning with financing, there is $23,000 of the budget left. One option for the use of these funds would be to study and advocate for the implementation of a Residential Energy Conservation Ordinance (RECO). Assuming the entire remaining $23,000 was used to successfully adopt a RECO starting in 2013, the $50,000 investment would create net public savings of $65,000 over 2012-2015 (a 130% return on investment). Also, the small investment in getting the RECO started would create an additional $8.2 million in net household savings over the 2013 to 2022 time period at no additional cost to the city.

Outcome Goal

The City Council of Tampa, Florida has set a goal of decreasing greenhouse gas (GHG) emissions a much as possible cost-effectively by 2030. The city's department of environment has been tasked with defining "cost-effective" and establishing the strategies that will be used to meet the goal. What energy efficiency policies will contribute the greatest reductions in greenhouse gas emissions by 2030 cost-effectively?

The local values collected for Tampa from the American FactFinder and an estimated public building area of 300,000 square feet are entered on tabs 2, 3a, and 3b. The Policy Implementation Period and Impact Analysis Period are both set at 2012-2030. Initially, all other variables in LEEP-C are left at their defaults. The Results tab shows positive net present value (NPV) for each policy and resulting GHG emissions savings ranging from 200,000 to 2.2 billion pounds of CO2 equivalent. The three policies with the greatest total GHG savings are Residential Upgrade Requirement (RECO), Residential Labeling and Disclosure, and Home Performance with ENERGY STAR.

However, to get at the question of cost-effectiveness we will need to look at other data. If the department would like to define cost-effectiveness as greater cost savings than costs over the Analysis Period the "NPV Benefit-Cost" field on the Results tab provides one version of this information. Any policy with a value greater than 1 in this field is cost effective: the higher the number the more cost-effective the policy. Under these conditions all the policies are cost-effective. An alternative and unconventional way to look at cost-effectiveness would be to consider which policies produced the greatest GHG savings per dollar invested. This value is presented in the "GHG svgs rate" field on the Results tab. The three policies with the highest GHG savings per dollar are Public Building Retrocommissioning, Public Building Benchmarking and Disclosure, and Public Building Retrofit. While this method does not measure benefits in dollars, it does directly establish a relationship between dollar costs with the stated goal of the program.

With these three pieces of data (total GHG savings, NPV benefit cost, and GHG savings per dollar spent) the department can formulate its recommended strategies in several ways. One option would be to establish a cost-effectiveness screen which removes from consideration any policies with an NPV benefit-cost ratio less than one. The policy design and financing variables could even be adjusted to maximize GHG savings while still keeping the policies cost-effective. Next, the department could rank the remaining policies (in this case all of them) based on total GHG savings, the GHG savings rate, or a combination of the two. This ranking can be done through the Community Priorities settings on tab 2. If both GHG savings metrics are to be included and weighted equally, both "Reduce Greenhouse Gas Emissions" and "Greenhouse Gas reductions per dollar" should be set to "10" and all other potential priorities set to "0." If one metric is to be given half the weight of the other, it can be given a value number half that of the other metric. Rankings based on these weightings can be determined by running the results on the Attractiveness Based on Community Priorities chart on the Results tab. The resulting rankings could be a proposed order in to which pursue policies were until no more funds remained or the GHG reduction objectives were met. With equal weighting between the two GHG metrics, the top three most attractive policies are Upgrade Requirement (RECO), Public Building Retrocommissioning, and Residential Labeling and Disclosure. If the GHG per dollar metric is weighted more heavily the public buildings policies receive better rankings. If the Total GHG metric is weighted more heavily the residential policies receive better rankings.

Sector Focus

The state of Utah is exploring energy efficiency options for the 38 million square feet of public buildings it owns. Along with its interest in energy cost savings, the state is hoping to maximize the number of jobs created through its investments to provide an example of the positive economic development impacts energy efficiency can have for the state. How can Utah best maximize job creation through energy efficiency in its public buildings while still reducing the state's energy costs over the next fifteen years?

Once the Utah- and scenario-specific values are entered on tabs 2 and 3a, including setting both the Implementation and Analysis Periods to 2012-2026, the user can consider the job creation and cost saving impacts of the policies on the Results tab. For this analysis the user can exclude the residential sector polices by selecting "No" in response to the "Include Sector?" field at the top of tab 3b.

With all other fields left at their default, the three public buildings policies all have positive net cost savings, net present value, and net jobs impacts. The benefits from each of these policies can be increased by adjusting the policy design defaults to increase the percentage of buildings participating and the speed at which they do. Public Building Retrofit has, by far, the largest job impact averaging 19.7 jobs per year over the analysis period. The next closest policy is Public Building Retrocommissioning, which averages 4.6 jobs per year. The retrofit policy also has the highest net cost savings at nearly $13 million. However, it has a slightly lower NPV than Public Building Retrocommissioning ($5.8 million compared to $6.8 million) because of its higher overall costs. As long as the slightly lower NPV is an acceptable tradeoff for the much larger number of jobs, Retrofit is probably the most appropriate policy for the stated goals.

OPTIONS FOR FUTURE DEVELOPMENT

LEEP-C in its current form, like nearly all planning tools and models, has many limitations. Several of these limitations have already been discussed in this text. ACEEE aims to improve existing functions and develop additional functionality for the tool over the course of 2012. While there are many possible areas of improvement, our next efforts will likely be focused in a few priority areas to help improve functionality including:

- *New sectors and policies*—Currently LEEP-C only includes policies related to existing public buildings and existing residential buildings. Obvious additional sectors and related policies to add to LEEP-C include transportation, existing commercial buildings, industry, and new buildings for the commercial, residential and public sectors. There are a wide variety of policy options for these sectors. For transportation, these could include those focused on encouraging the adoption of alternative fuel or high efficiency vehicles as well as policies related to the intersection of land use and transportation including compact development, parking requirements, and complete streets. For existing commercial buildings, various information-related, retrofit, and retrocommissioning policies could be added. For new buildings, green building incentives and requirements, building codes, and local code options could be included as new policies.
- *Regional and localized end-use datasets*—LEEP-C allows the user to enter their own information about baseline energy consumption for a sector, if they have it, or use national averages to calculate an approximate baseline. However, baseline consumption varies greatly depending climate, geography, and other factors. Currently, user-entered ZIP codes are only used to calculate state average fuel prices and emissions rates by eGRID subregion, and are not used to calculate baseline consumption defaults. For the next version of LEEP-C we intend to include baseline consumption data from each Census Division of the country to allow users to select default values that more closely approximate energy use in their region.
- *Improved subsector detail*—Particularly for the public and commercial buildings sectors, the current analysis of savings for an average building, as included in LEEP-C, has limited value because of the large variety of building types (e.g., office, school, lodging, retail, etc.) within the

sectors. We hope to add functionality to allow users to better customize the mix of building types in their communities.

- *Additional fuels*—The current version of LEEP-C only analyzes the impact of efficiency measures on electricity and natural gas consumption and related costs. However, other fuels can be heavily implemented by energy efficiency. In the building sectors, fuel oil remains an important heating fuel in some regions, particularly in the Northeast. Additionally, as we add transportation policies to the tool, impacts on gasoline and diesel will need to be added.
- *New community issues and related metrics*—The current list of issues of which users are able to rank the importance is extensive, but far from comprehensive. We will consider adding new issues and related metrics to the next version of LEEP-C. Potential new values and metrics may include impacts on peak energy demand; local investment/industries; net cost of living, net economic output, avoided infrastructure costs, water savings, and various cost-effectiveness tests.
- *Non-electricity-related emissions*—As we add new fuels and metrics it will become more important to include pollutant emissions beyond those associated with electricity, to which LEEP-C is currently limited. We will add these to allow for a more comprehensive picture of the environmental benefits from efficiency.

There are many other areas of potential improvements; however, many of these would require considerable redesign of the tools calculation structures or more advanced programming and therefore may not be included in our next development round. Some of these areas are:

- *Better data visualization and interface*—The current LEEP-C design and interface are limited by its Excel platform and a limited use of Visual Basic macros. In a future version of LEEP-C it could be moved to a Web-based platform to allow for better and more varied visualizations of impacts, as well as allow users to save their settings, report their results to help with improving the tool, and generate summary reports.
- *User-customized policies*—Users of LEEP-C are currently limited to the policies and related data pre-programmed into the tool by the developers. However, these policies certainly do not include all of the policies that could be of interest to a community. A future version of the tool could allow for user-defined "custom policies." To create a custom policy, users would need to enter data on costs, benefits, when they accrue, and to whom. Although using this feature would require research on the part of the user, it could make the tool more appropriate to their needs. Additionally, users could submit the data and sources used to create their custom policies to allow for it to be included in a future version of the tool and made available to other users.
- *User-customized policy portfolios*—As previously discussed, LEEP-C does not account for interaction effects among policies. Future improvements may attempt to address this shortcoming. With or without interaction effects considered, the tool could be expanded to allow users to calculate total impacts from a user-selected portfolio of the available policies. This could be useful for users who are using the tool to explore how much various combinations of policies will contribute toward achieving a goal (energy savings, greenhouse gas reduction, etc.).
- *More detailed actor-based costs and benefits*—LEEP-C is able to calculate simplified costs and benefits to the public sector and households. However, there are many other actors and entities that can benefit from energy efficiency investments including businesses, utilities, and taxpayers. A more detailed treatment of the different categories of actors will allow for calculations of investment paybacks from multiple perspectives, allow for customization of detailed and differentiated financing terms by actor, and allow for the tool to calculate results for a variety of commonly used energy efficiency cost-benefit tests.
- *Expanded treatment of uncertainty*—The number of variables and related forecasts and assumptions necessary to develop a tool like LEEP-C means that the results have uncertainty associated with them. A future version of the tool could better describe and depict the level of uncertainty and, as a result, risk associated with outputs. Perhaps even more importantly the tool could put the risk associated with energy efficiency policies in the context of other common policy, investment, economic, and environmental risks.

Users are encouraged to submit comments about the tool and suggestions for its improvement. This feedback will be considered in the development of the next version of the tool over the course of 2012.

CONCLUSIONS

LEEP-C can be used by local policymakers and stakeholders interested in advancing the adoption of energy efficiency in their communities to analyze the impacts of policy choices. Currently the tool can analyze a total of seven different policy types from two economic sectors—existing public buildings and existing residential buildings— and calculate estimated impacts of specific policy choices on energy savings, cost savings, pollution, jobs, and other outcomes over a time period set by the user.

We are interested in your input on how LEEP-C can be improved to better meet your needs. Please send suggestions to Eric Mackres at emackres@aceee.org.

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APPENDIX A: POLICIES INCLUDED

Public Buildings Comprehensive Retrofit

Policy Description: Many public buildings have not had a major renovation in decades. A comprehensive energy assessment, or audit, can determine a building's current level of performance and may identify both small adjustments in operations and technology as well as capital investments that would greatly reduce operating costs, while improving comfort and overall performance. Choosing to implement a variety of these recommended cost-effective, whole-building performance improvements would constitute a comprehensive retrofit. Often building certification systems—such as ENERGY STAR Certification and LEED—are used by governments to designate a desired level of energy performance.

Performance: A 2005 ACEEE report determined the average energy savings from a comprehensive retrofit for commercial buildings to be around 23% with costs averaging around $2.50 per square foot. Costs and savings for more public buildings would likely be similar to those of commercial buildings.

Who Has Implemented:

- Durham County, NC: Major renovations to non-school public buildings must achieve a minimum of LEED certified or comparable performance criteria. All other construction or renovation must use energy-efficient and green buildings practices to the maximum extent possible.
- City of Los Angeles, CA: Passed in 2008, this policy requires that all city-owned buildings built before 1978 or larger than 7,500 square feet be retrofitted to meet the requirements of LEED for Existing Buildings Silver certification or higher.

Public Buildings Retrocommissioning

Policy Description: Retrocommissioning, or "RCx," provides existing buildings with a "tune-up" to improve the functioning of their systems and energy performance. Detecting and fixing deficiencies in a building's operation can be done extremely cost-effectively and often result in great energy savings. Governments can adopt policies and practices to ensure that their buildings undergo retrocommissioning at regular intervals to ensure that buildings continue to perform at a high level of efficiency.

Performance: A 2009 study from the Lawrence Berkeley National Laboratory reviewed a sample of 163 commercial building retrocommissioning projects and found that half of projects saved between 9 and 31% of energy use and the median energy savings of all projects was 16%. Costs most commonly ranged from $0.15 to $0.62 per square foot with a median of $0.30. The median payback was just over one year.

Who Has Implemented:

- Arlington County, VA: Building Energy Report Cards for the major county buildings provide detail on the energy management and capital improvements made to each building, including retrocommissioning.
- State of Minnesota: Public Buildings Enhanced Energy Efficiency Program (PBEEEP) provides technical assistance and financing to local governments for retrocommissioning and other energy efficiency measures.

Public Building Benchmarking and Disclosure

Policy Description: The past few years have seen a surge of governments, both state and local, requiring regular benchmarking of energy performance in their own buildings through tool such as ENERGY STAR Portfolio Manager which allow for tracking of energy consumption over time and for comparisons of performance to other similar buildings around the country. Many of these policies also require that the performance information be disclosed to the public through the internet or other method to improve transparency. Benchmarking allows for better management of building operations and maintenance and allows building departments to more effectively consider energy efficiency when making their capital investment plans.

Performance: Benchmarking can directly improve energy-related operations and maintenance in public buildings. Additionally, it frequently catalyzes investments in energy efficiency measures that would not have taken place otherwise. A California Energy Commission report estimated that the average commercial building participating in benchmarking would save 0.13 kWh and 0.002 therms per square foot annually. This translates to annual savings of 0.95% for electric and 0.77% for natural gas. Savings for public buildings may even be higher than in commercial buildings if policies also directly encourage or require energy investments in specific energy saving technologies, retrocommissioning, or comprehensive retrofits.

Who Has Implemented:

- Seattle, WA: Requires benchmarking and annual reporting to the city of energy performance of all public and non-residential buildings greater than 10,000 square feet and multifamily residential buildings of four or more units. It complements a Washington State law that requires disclosure to prospective buyers, lessees, or lenders.
- Washington, DC: The Clean and Affordable Energy Act of 2008 requires annual disclosure of benchmarking results for all public buildings and private buildings greater than 50,000 square feet. Disclosures are to be made public on an internet database.

Home Performance with ENERGY STAR

Policy Description: Home Performance with Energy Star (HPwES) is a nation-wide program that promotes a comprehensive, whole-house approach to improving home energy efficiency. The program encourages homeowners to make home energy improvements based on an individualized energy assessment. Energy Star is nationally sponsored by the U.S. Environmental Protection Agency and the Department of Energy, however it is state and local sponsors who manage the HPwES programs and recruit home improvement contractors who are qualified to perform comprehensive home energy improvements and energy assessments. Upon completion of the home improvements, contractors assess the home's performance to document that promised energy savings were achieved and improvements were properly installed. Typical energy efficiency improvements include: sealing air leaks and adding insulation, improving heating and cooling systems, sealing ductwork, and upgrading lighting and appliances.

Performance: Through Home Performance with Energy Star, more than 75,000 homes have been accessed and improved as of 2011. These homeowners are benefiting from an average savings of 20 percent or more on energy bills. Some programs have seen much higher average savings. For example Austin Energy's Program has achieved an average of 28% energy savings. Other benefits include improved indoor air quality and more consistent temperatures throughout the home with fewer drafts. Increasing numbers of utilities and state energy offices are implementing Home Performance with Energy Star as an important component of their residential energy efficiency portfolio.

Who Has Implemented:

- Austin Energy (Austin, TX): Austin Energy provides up to $1,575 in rebates, loan options, and energy and water savings calculators to assist customers in understanding energy savings associated with Home Performance with Energy Star. Austin Energy also provides training to participating contractors, cooperative advertisement, and public recognition awards.
- NYSERDA, New York: Most homeowners are eligible for free or reduced cost home assessments by contractors certified by the Building Performance Institute (BPI). Low-cost financing is made available to consumers and new participating contractors.

Residential Energy Use Disclosure

Policy Description: A Building Rating and Disclosure policy works by requiring that information on the energy efficiency of a building be made available to buyers and renters through a standardized energy assessment. A home energy assessment evaluates an existing home to determine energy efficiency: where energy is being lost and the cost-effective improvements that can be implemented to enhance occupant comfort, make the home more durable, and lower utility costs. This mechanism aims to raise consumer awareness about energy performance and incentivize sellers to upgrade the energy performance of their buildings in order to boost their value and sell or rent building more easily to an informed public. As it is a foundational policy, governments can use rating and disclosure to build awareness of building energy performance and costs, improve participation in existing efficiency programs, or expand the local market for building performance professionals. The policies can be implemented in a variety of ways. Implementing agencies have established different mechanisms to "trigger" rating and disclosure and have used different rating systems.

Performance: Rating and disclosure policies have direct impacts on the level of actionable information available to building and home owners. Additionally, they have indirect, but tangible impacts on adoption of energy efficiency improvements. A California Energy Commission study estimates that the average annual energy savings for a home covered by a rating and disclosure policy would be 543 kWh and 31 therms. In percentage term, this translates to annual savings of 6.0% for electricity and 6.8% for natural gas.

Who Has Implemented:

- Austin Energy (Austin, TX): Single-family residential units ten years or older require an energy audit at the time of sale.
- Maine- Building Energy Efficiency and Carbon Performance Ratings: Disclosure of energy performance to prospective residential renters is required.
- New York- Truth in Heating: The seller of a residential structure must provide purchaser a complete set of heating and/ or cooling bills upon request of the purchaser.

Residential Upgrade Requirement (RECOs)

Policy Description: Residential energy upgrade requirements, or residential energy conservation ordinances (RECOs), establish prescriptive- or performance-based energy efficiency improvements that homeowners or residential building owners must implement at a "trigger point," such as sale or rental of a unit. These energy efficiency measures are often low-hanging energy improvements, with a quick payback period. The majority of housing stock in the United States was built prior to current energy building standards. Local governments have established upgrade requirements to reduce the energy demand of these older homes and ensure that all existing homes meet a minimum level of efficiency. Usually these requirements have cost caps, to prevent the cost from being burdensome to homeowners.

Performance: Our review of five of the existing or proposed RECO policies in the U.S. shows costs ranging from $650 to $1,300 per home and resulting energy savings ranging from 5-20 percent and averaging around 13 percent.

Who Has Implemented:

- Burlington Electric (Burlington, VT): Time of Sale Energy Efficiency Ordinance requires the installation of a minimum level of energy efficiency measures when rental properties in which tenants pay the electric bill are sold. Total costs must not exceed 3% of the sale price or $1,300 per rental unit whichever is less.
- San Francisco, CA: Residential Energy Conservation Ordinance (RECO) requires residential property owners to provide certain energy and water conservation measures for their buildings prior to the sale of property or performing major improvements. Owner costs are capped at 1% of sales price.

Assistance to Multifamily Affordable Housing

Policy Description: This policy combines technical assistance and financial incentives for improvements to the building shell and heating, ventilation, and air conditioning (HVAC) systems in multifamily buildings. It includes tune-ups to buildings with central air conditioning and major improvements at the time of a building's renovation. For this analysis affordable units are defined as those whose tenants make an annual household income of less than $35,000. Multifamily buildings, affordable housing, and rental units are several of the more difficult building types to reach with energy efficiency policies. However, these buildings also have large energy savings potential and the cost savings resulting from improved efficiency can have a large positive impact on the budgets of low-income households.

Performance: A California Energy Commission study estimated this policy could achieve average annual savings of 271 kWh and 72 therms or greater per unit, equivalent to annual savings of 6.2% for electric and 24.1% for natural gas. Energy Savers in Chicago, a program targeting affordable multifamily buildings but with a different program design, has achieved an average per unit energy savings of 30%.

Who Has Implemented:

- Energy Savers (Chicago, IL): Combining step-by-step assistance to building owners, energy assessments, financial guidance, and performance monitoring this program has facilitated energy improvements in 5,000 residential units.
- NYSERDA Energy $mart Multifamily Performance Program: This program assists building owners and managers in developing an individualized energy improvement plan for their buildings, connects them with technical experts and provides incentives for specific improvements.

APPENDIX B: ANALYSIS METHODOLOGY AND DATA SOURCES

Energy Prices

Projected prices of electricity and natural gas for the years 2010 through 2035 by state are derived from datasets available from the Energy Information Administration (EIA). All prices are presented in 2008 dollars for comparability in real terms across years.

Electricity

Actual average electricity prices for 2010 for each state were obtained from Tables 5.6.B of the March 2011 edition of EIA Electric Power Monthly (EIA 2011a). These prices were converted into 2008 dollars. Price projections at the state level are not available from EIA data; however, they can be estimated from cost of generation projections available through 2035 for each electricity generation region. Based on the state-by-state 2010 actual sector prices, cost of generation projections by sector by Electricity Market Module (EMM) Regions from the reference case of the EIA Annual Energy Outlook 2010 (Supplemental Tables 72-85) were used to extrapolate state price projections from 2011 to 2035 for the residential, commercial and industrial sectors (EIA 2010). The formula used to calculate the state projections for each year is as follows:

> *(2010 state sector price – 2010 EMM cost of generation) + EMM cost of generation in year for which price projection is being calculated*

This formula bases state level retail price projections on changes in generation costs and assumes that all other components of the price remain the same from year to year.

Natural Gas

Average retail natural gas prices by sector for 2010 for each state were obtained from Tables 18-20 of EIA Natural Gas Monthly for March 2011 (EIA 2011b). These prices were converted into 2008 dollars. Retail price projections for each sector through 2035 by census region are available from the EIA Annual Energy Outlook 2010 (Supplemental Tables 11-20) (EIA 2010). Using the 2010 state prices as the starting point, estimated prices in each state by sector were calculated for the years 2011 through 2035 through using the regional price projections to determine a growth rate from year to year. The formula used to calculate the sector projections in each state for each year is as follows:

> *Previous year state sector price * (Census region projected price for current year / Census region projected price for previous year)*

Emissions

LEEP-C is able to calculate emissions reductions associated with reduced energy consumption. Currently this tool calculates only electricity-related emissions, not those associated with natural gas or other fuel savings. Additionally, LEEP-C uses emissions rates that remain static over time and does not attempt to project changes in emission intensity from year to year.

All emissions data is based on 2007 Annual Non-Baseload Output Emissions Rates from EPA eGRID2010 Version 1.1 (EPA 2011b). In eGRID the emission rates (in the form of lbs/MWh or lbs/GWh) are available for each eGRID subregion for each of six electricity-related pollutants: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), nitrogen oxides (NO_X), ozone Season NO_X, and sulfur dioxide (SO_2). Based on the ZIP code entered by the user, the emission rates from the eGRID region associated with that geography are applied to all electricity savings resulting from the policies.

When emission of individual greenhouse gas pollutants (CO_2, CH_4, and N_2O) are combined into one number in the tool, conversions are made into units of carbon dioxide equivalents (CO_2e) through the use of global warming potential coefficients as described in EPA (2005).

Employment

The net employment impacts calculated for LEEP-C are based on input-output modeling. This methodology is based on a simplified version of the **D**ynamic **E**nergy **E**fficiency **P**olicy **E**valuation **R**outine—or DEEPER Modeling System—a 15-sector quasi-dynamic input-output model of the U.S. economy developed by ACEEE. (For a short introduction to DEEPER see ACEEE 2011; or a more detailed description of the model in the context of a policy study see Appendix B of Laitner 2011.) The methodology used in LEEP-C is a four sector model consisting of construction, energy utilities, financial, and the average for the community as a whole. National average multipliers for job creation (the number of jobs resulting from $1 million of investment) for each of these sectors in 2007 was obtained from the Minnesota IMPLAN Group (IMPLAN 2009). These national values are then scaled based on the community population size provided by the user. This scaling allows for a more accurate estimation of the net job impacts (i.e., including those jobs lost and gained) that result in the community itself as distinct from job impacts in general, including those outside the community. The job outputs in LEEP-C are presented in “job person-years,” a unit equivalent of a full-time job for one person for one year.

Policy Costs and Energy Savings

LEEP-C uses data from a variety of sources to calculate the costs and resulting energy savings from the specific policies included. The data sources and calculation methodologies are described for each policy in the following sections.

Public Buildings Comprehensive Retrofit

For this policy a cost curve was constructed based on research summarizing the performance of comprehensive retrofit projects around the U.S. Notably, it is based on data regarding average, high-end and low-end costs and energy savings from a review of projects as reported in Mendelsohn and Amann 2005. The cost curve is then derived from these points through the use of the Long-Term Industrial Energy Forecast model, or LIEF (for a brief introduction to LIEF see the appendix to Laitner 2009). The high-end and low-end energy saving values are also used to set the range of possible user adjustments to the *Building Energy Savings Goal* on sheet 3a, while the average energy savings is used as the default.

Annual policy costs for each year in which retrofits occur—as displayed in the *Annual Policy Costs* field on sheet 3a—is derived from the equation:

> *(Total Public Building Square footage * Portion of Buildings to be retrofitted * cost per square foot at Building Energy Savings Goal) / Years over which retrofits occur*

Energy savings (both electricity and natural gas) for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—are derived from the equation:

> *[Number of Years in which retrofits occurred within the period of the Measure Life prior to and including the current year * Total annual consumption of fuel in Starting Year * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period) * Building Energy Savings Goal * Portion of Buildings to Retrofitted] / Years over which Retrofits occur*

Public Buildings Retrocommissioning

Data on the typical distribution of costs per square foot and percent energy savings for retrocommissioning projects were collected from Amann and Nadel 2003 and Mills 2009. The LIEF model was then applied to the values from these two sources to develop a cost curve. The high-end and low-end energy savings values from Amann and Nadel 2003 were also used to set the range of possible user adjustments to the *Building Energy Savings Goal* on sheet 3a, while the average energy savings is used as the default.

Annual policy costs for each year in which retrocommissioning occurs—as displayed in the *Annual Policy Costs* field on sheet 3a—is derived from the equation:

> *(Total Public Building Square footage * Portion of Buildings to be retrocommissioned * cost per square foot at Building Energy Savings Goal) / Years over which retrocommissioning occurs*

Energy savings (both electricity and natural gas) for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—are derived from the equation:

> *[Number of Years in which retrocommissioning occurs within the period of the Measure Life prior to and including the current year * Total annual consumption of fuel in Starting Year * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period) * Building Energy Savings Goal * Portion of Buildings to retrocommissioned] / Years over which retrocommissioning occurs*

Public Building Benchmarking and Disclosure

Data on the costs and benefits of this policy are derived from the Strategy Assumptions for Commercial Building Benchmarking as defined on pages 64-66 of the California Energy Commission report *Options for Energy Efficiency in Existing Buildings* (CEC 2005). Values for annual energy savings per square foot for both electricity and natural gas as well as costs per square foot for administration and to program participants are borrowed from this report. Energy savings in kWh and therms were converted to percent savings using data on energy intensity in an average California commercial building from the *California Commercial End Use Survey* (Itron 2006). The CEC 2005 report is also the source of the default value for the portion of benchmarked buildings resulting in an audit and the life of measures resulting from the policy.

Annual policy costs, consisting of both costs to participants and program administration cost as displayed on sheet 3a, are calculated using the equation:

> *[(Total Public Building Square footage * Portion of Buildings adopting benchmarking and disclosure * portion of benchmarked buildings resulting in an audit * participant costs per square foot) / Years over which initial benchmarking occurs] + [(Total Public Building Square footage * Portion of Buildings adopting benchmarking and disclosure * portion of benchmarked buildings resulting in an audit * program administration costs per square foot) / Years over which initial benchmarking occurs]*

Energy savings for each fuel (both electricity and natural gas) is calculated for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—using the equation:

> *[Number of Years in which initial benchmarking occurs within the period of the Measure Life prior to and including the current year * Total annual consumption of fuel in Starting Year * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period) * Portion of Buildings adopting benchmarking and disclosure * portion of benchmarked buildings resulting in an audit * annual percent fuel saving per square foot * baseline average energy use per square foot] / Years over which initial benchmarking occurs*

Home Performance with ENERGY STAR

Data on costs and benefits of this policy are based on a review of existing Home Performance with ENERGY STAR (HPwES) programs in the U.S. drawing on existing research including Belzer et al. 2007, Hoffmeyer 2010, and Plympton et al. 2010. The LIEF model was then applied to this data to develop a cost curve. The default annual participation rate and default financial incentives to participants are based on the results of the Austin Energy HPwES program. The building energy savings goal is based on HPwES literature which notes that a participant in the program "typically saves…20% or more on energy bills" (ENERGY STAR 2011). Default administration costs are based on average administration costs for utility energy efficiency program portfolios (Friedrich et al. 2009).

Annual policy costs, consisting of both costs to participants and program administration cost as displayed on sheet 3a, are calculated using the equation:

> *[Total residential units * percent single-family * annual participation rate * percent administration costs * cost per home at Building Energy Savings Goal] + [Total residential units * percent single-family * annual participation rate * percent financial incentives to participants * cost per home at Building Energy Savings Goal * (1 – percent administration costs)] + [Total residential units * percent single-family * annual participation rate * (1 – percent financial incentives to participants) * cost per home at Building Energy Savings Goal * (1 – percent administration costs)]*

Energy savings for each fuel (both electricity and natural gas) is calculated for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—using the equation:

> *Number of Years in which policy is in place within the period of the Measure Life prior to and including the current year * Total annual residential consumption of fuel in Starting Year * National average single-family energy consumption as a percentage of national average residential energy consumption * percent single-family * annual participation rate * Building Energy Savings Goal * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period)*

Residential Energy Use Disclosure

Data on the costs and benefits of this policy are derived from the Strategy Assumptions for Time-of-Sale Information Disclosure as defined on pages 52-55 of *Options for Energy Efficiency in Existing Buildings* (CEC 2005). Values for annual energy savings per home for electricity and natural gas, as well as cost per home for administration and costs to the participant were borrowed from the report. Energy savings in kWh and therms were converted to percent savings using data on residential energy use in an average single-family California home from the Residential Energy Consumption Survey (EIA 2005). The report is also the source for the default annual transaction rate, default compliance level, default incentive rate, and measure life.

Annual policy costs, consisting of program administration costs, costs to participants, and incentives paid to participants as displayed on sheet 3b, are calculated using the equation:

> *[Total residential units * percent single-family * Annual transaction rate * compliance rate * Administration costs per home] + [Total residential units * percent single-family * Annual transaction rate * compliance level * participant costs per home * Incentives to participants as percent of participant costs] + [(Total residential units * percent single-family * Annual transaction rate * compliance rate * participant costs per home) – total incentives to participants]*

Energy savings for each fuel (both electricity and natural gas) is calculated for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—using the equation:

> *Number of Years in which policy is in place within the period of the Measure Life prior to and including the current year * Total residential units * percent single-family * Annual transaction rate * compliance level * annual percent fuel saving per home * baseline average energy use per home * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period)*

Upgrade Requirements (RECOs)

Data on the costs and benefits of this policy are based on an ACEEE review for this project of the data associated of five existing or proposed RECOs: San Francisco, CA (EarthFuture 2011); Berkeley, CA (Haines and Mackres 2011; LaPierre 2011); Burlington, VT (Burlington Electric 2011); Boulder, CO (Reiss 2007); and the State of Nevada (Geller, Mitchell, and Schlegel 2005). The averages and ranges of costs and saving are based on these programs.

Annual policy costs, consisting of program administration costs and costs to participants as displayed on sheet 3b, are calculated using the following equation when single-family and multifamily are both included in the policy:

> *(Single-family trigger rate * total residential units * percent single-family * average improvement spending per single-family home) + (Multi-family trigger rate * total residential units * percent multi-family * average improvement spending per multi-family home) + Program administration*

Energy savings (both electricity and natural gas) is calculated for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—using the following equation when single-family and multifamily are both included in the policy:

> *Number of Years in which policy is in place within the period of the Measure Life prior to and including the current year * { [Total annual residential consumption of fuel in Starting Year * (Single-family trigger events / Total residential units) * National average single-family energy consumption as a percentage of national average residential energy consumption * Average single-family percent energy savings from improvements] + [Total annual residential consumption of fuel in Starting Year * (Multi-family trigger events / Total residential units) * National average multi-family energy consumption as a percentage of national average residential energy consumption * Average single-family percent energy savings from improvements] } * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period)*

Assistance to Multifamily Affordable Housing

Data on the costs and benefits of this policy are derived from the Strategy Assumptions for Assistance to Affordable Housing as defined on pages 62-64 of *Options for Energy Efficiency in Existing Buildings* (CEC 2005). Values for annual energy savings per home for electricity and natural gas, as well as cost per home for administration, costs to the participant, and incentives to participants were borrowed from the report. Energy savings in kWh and therms were converted to percent savings using data on residential energy use in an average U.S. multifamily home and average California home from the Residential Energy Consumption Survey (EIA 2005). The report is also the source for the default frequency of rehabilitation, default participation rate, and measure life. The default portion of buildings with central air conditioning is based on national data from the 2005 Residential Energy Consumption Survey (EIA 2005).

Annual policy costs, consisting of program administration costs, costs to participants, and incentives paid to participants as displayed on sheet 3b, are calculated using the equation:

> *[Number of housing units in targeted market * Participation rate * Administration costs per unit] + [Number of housing units in targeted market * Participation rate * Incentives to participant per unit] + [Number of housing units in targeted market * Participation rate * Participant costs per unit]*

Energy savings for each fuel (both electricity and natural gas) is calculated for a particular year—as displayed in the *Electric Savings* and *Natural Gas Savings* rows on sheet 5—using the equation:

> *Number of Years in which policy is in place within the period of the Measure Life prior to and including the current year * Annual number of housing units participating * annual percent fuel saving per home * baseline average energy use per home * ((1 + Annual Energy Use Growth Rate) ^ Year number in Analysis Period)*