Residential Energy Use and GHG Emissions Impact of Compact Land Use Types
LURE Tool
Summary for Policy Makers
July 2014

Overview

A Land Use and Residential Energy (LURE) Tool is now available to assist local governments with estimating the residential energy use and greenhouse gas emissions associated with future development based on planned land use scenarios.

Recommended Tool Users: Local policy makers such as elected officials and professional planners

Appropriate planning phase for use of tool: General Plan Updates and Climate Action Plans

How does this research relate to local governments and their choices?

This spreadsheet modeling tool allows local governments to quickly compare various land use scenarios accommodating new growth in residential housing to identify which scenario would result in the lowest GHG emissions.

Background

California's local governments are critical partners in meeting the State's ambitious GHG targets. Land use decisions are made by local governments and have broad implications for GHG emissions. In particular, land use patterns and associated housing types influence residential energy use—a significant source of GHG emissions in California. Nearly 15 percent of California's GHG emissions are related to heating and cooling residential buildings, which are partly a function of house size and orientation, and are therefore strongly tied to land use planning decisions. Prior to this study, a few academic studies examined national data sets of residential energy use as a function of urban form and found that residents living in high density urban centers emit 20 to 50 percent fewer GHG emissions than residents of low density suburbs. The implications of future land use decisions on energy use may be particularly significant in California, given that much of California's anticipated growth over the next several decades is anticipated to occur in inland climate zones with more extreme temperatures where more energy is needed to cool and heat homes.

Until now, however, no tools were available to assist local governments in evaluating the residential energy use and subsequent GHG emission impacts from land use decisions made during General Plan updating and Climate Action planning processes. Valuable tools such as CalEEMod, iPLACE3S, and the Subdivision Energy Analysis Tool (SEAT) are mainly useful at a later stage of the development process, when specific projects are being proposed and highly detailed information pertaining to the projects' characteristics is available. General plans and climate action plans are typically not detailed enough for local governments to use these tools to evaluate the land use policies contained in these plans. By the time that information is available, basic decisions about the location, density, and form of residential growth in the municipality have long since been made. In addition, Rapid Fire and Urban Footprint use pre-defined Land Development Categories that do not correspond to the land use categories and density classes typical of general planning processes, limiting their use during this stage. This project conducted research and created a tool that begins to fill this gap.

The objectives of this research project were to 1) investigate the relationship between land use planning factors and residential energy use in California's various climate zones; and 2) develop a spreadsheet

modeling tool that presents residential energy use and greenhouse gas emissions as a function of land use development types.

Function of the Tool

The LURE Tool is a user-friendly, Excel-based spreadsheet tool that allows users to estimate the GHG emissions impacts due to energy use associated with new residential development land use decisions.

The calculator estimates residential energy use and associated GHG emissions of future planned development based on the amount of housing anticipated in each of the eight land use types.

1. Rural or Very Low Density
2. Low Density Suburban
3. Mid Density Detached
4. High Density Detached
5. Townhomes
6. Low-Rise Apartments/Townhomes
7. Mid-Rise Apartments
8. High-Rise Apartments

The LURE calculator is meant as a screening tool to inform choices between alternatives; it allows planners to make basic distinctions between the energy and GHG intensity of different land use alternatives.

Local government planners can directly compare up to three growth scenarios, and the calculator produces cumulative GHG emissions estimates out to 2035, a relatively long horizon that was selected to recognize the long-lasting nature of major land use decisions.

Users select the land use types (categorized by dwelling units/acre) and number of dwelling units under consideration and the tool calculates the residential energy use and GHG emissions associated with these land use decisions.

The tool's options include calculating:

- Future residential energy use—Users can decide to calculate this based on either 1) past energy use trends in California, or 2) on future updates expected to the building energy codes (Title 24, Part 6).
- Future GHG emissions—Users can decide to calculate this based on 1) the average GHG intensity of a given utility's current energy portfolio, 2) the average GHG intensity that assumes the utility will meet the state's 2020 Renewable Portfolio Standard, or 3) the current GHG intensity of the electricity source most likely to be avoided.
- Total GHG emissions of scenarios—Users can compare up to three residential growth scenarios using any baseline year selected by the user from 2012 through 2035.
- The impacts of common mitigation measures—Users can choose to calculate the benefits of mitigation measures on energy use and GHG emissions, including the benefits of exceeding Title 24 energy efficiency standards, requiring high-efficiency lighting in buildings, and generating renewable energy on site.

How can the tool be used by local governments?

Local governments can use the LURE tool to quickly compare GHG emissions due to residential energy use of different new residential development alternatives as part of the general planning or climate action planning process. In addition, local governments can use the LURE tool to quantify the energy

and GHG reduction benefits of three common mitigation measures, which may also be used to quantify Climate Action Plan efforts.

Before getting started, a local government should have some idea of the total number of planned dwelling units (or total acreage of planned residential development) in each of eight land use types for each scenario that will be examined. The LURE Tool will estimate GHG emissions from residential energy use to 2035 for up to three scenarios of planned future growth. It is possible to customize information about the typical size of dwelling units in a community, and additional information about GHG mitigation measures in the municipality. A user simply fills in information into the tool as instructed and makes selections from pull-down bars. It should only take a few minutes to enter in very simple information and the tool provides immediate results.

How to Interpret the Tool Results
The example below demonstrates how the LURE tool can be used to compare results for three residential growth scenarios.

> **Fresno Residential Growth Scenarios Example**
> For Fresno, assuming that 20,000 dwelling units are needed every five years between 2015 and 2035, a total of 80,000 new residential housing units will be needed to accommodate future growth.
>
> *Other Assumptions for All Three Scenarios*
>
> - Future residential energy use will comply with updates to the Energy Code (Title 24, Part 6)
> - GHG emissions will be based on marginal electricity source avoided
> - GHG intensity of electricity will decrease as the utilities meet the 33% Renewable Portfolio Standard.
>
> Scenario 1 – If more than half of the housing (50,000 units) is zoned rural low density and suburban and the remaining housing (30,000 units) is split equally between high density detached, townhomes, and low-rise apartments, the associated GHG emissions between 2015 and 2035 would total over 6 MMTCO$_2$e (million metric tonne of carbon dioxide-equivalent) as a result of the low density residential development.
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> Scenario 2 – If the majority of housing (60,000 units) are split equally between high density detached, townhomes, and low rise apartments and the remaining housing (20,000 units) is split equally between mid-rise apartments and high-rise apartments, the GHG emissions associated with this future growth scenario would be on the order of 4.6 MMTCO$_2$e.
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> Scenario 3 – If all new development was split equally between mid-rise apartments and high-rise apartments, the associated GHG emissions between 2015 and 2035 would be closer to 2.4 MMTCO$_2$e.
>
> Per dwelling unit, GHG emissions range from 39 metric tons to 77 metric tons. Per capita, GHG emissions range between 18 metric tons for the high density development scenario and 25 metric tonnes for the low density scenario.
>
> If all three growth scenarios added a mitigation measure to exceed the Energy Code (Title 24, Part 6) by 15 percent, total GHG emissions would be reduced between 0.7 MMT CO2e for the low density development scenario and 0.5 MMT CO$_2$e for the high density development scenario.

Methods and Approach

This tool was created by establishing what housing dwelling types are associated with different land use types, estimating average energy use for each dwelling type for different climate zones, and then using utility-specific GHG intensities to calculate associated emissions. The research used to create the tool derived the relationships between land use types and median size of dwelling units. To determine the electricity and natural gas use associated with different dwelling sizes in California, energy use was modeled as a function of dwelling size and heating/cooling degree-days in a given location using data from the 2005 Residential Energy Consumption Survey (RECS). The GHG emissions associated with residential energy use were calculated using anticipated utility-specific GHG intensities from 2012-2035 based on the Renewable Portfolio Standard goals. Finally, the calculator was evaluated using four methods: preliminary validation against the 2009 Residential Appliance Saturation Survey (RASS) dataset; field-testing with municipal planners; validation against actual electricity use data obtained from the Sacramento Municipal Utility District (SMUD) for the period between 2001 and 2011; and comparison with CalEEMod assumptions and results. Results of this evaluation collectively show that the calculator does a good job of producing estimates that closely match recent historical data.

Results

The Land Use and Residential Energy (LURE) tool allows users to input information available during both general planning and climate action planning processes to estimate and compare the residential energy use and GHG emissions associated with providing new housing in different land use types. The connection between land use types, density ranges, and typical building sizes, which was developed as part of this project, is an important contribution to the scientific literature.

Further, the research provides quantitative evidence that generally, California homes in higher density development patterns use less energy than homes in lower density development patterns. While these impacts are somewhat intuitive (we expect a large single family home to require more energy to heat and cool than a townhouse), this is the first project that we know of that links actual household energy consumption with land use patterns in California.

Implications and Recommendations

This tool provides an easy way to consider residential energy use and associated GHG emission impacts of land use decisions when evaluating alternatives during the general planning and other climate action planning processes. This tool is not intended to be used for site-specific project impact analysis under CEQA. If the LURE tool is used to test scenarios for a General Plan Update, the results from the tool could conceivably be incorporated into the General Plan Update Environmental Impact Review analysis of project alternatives.

It is important to note that land use decisions impact travel behavior, water use, resource consumption, and other sectors which all have GHG implications. Additional research is needed on these other sector impacts to more holistically evaluate all GHG implications of land use decisions.

The tool, final report, and summary for policy makers for the research project "Residential Energy Use and GHG Emissions Impact of Compact Land Use Types," are posted on the following ARB website: http://www.arb.ca.gov/research/single-project.php?row_id=65035

Additional ARB research focused on supporting Sustainable Communities can be found on the following ARB website: http://www.arb.ca.gov/research/sustainable/sustainable.htm