**DOE SPECIAL PROJECTS:
PLACE3S GIS MODULE
PROGRAM ID NO. DE-FG01-OEE 10768**

FINAL REPORT

PROJECT/PROGRAM DESCRIPTION

PLACE3S¹ is an analytical tool that can be used by land use planners to develop an understanding of the traffic, environmental and energy impacts of land use developments. PLACE3S creates alternative plans to identify mobility options, address traffic congestion, environmental and energy impacts of community growth. Through a grant from DOE, the Energy Commission:

- Upgraded PLACE3s software to include energy efficiency and generation technology for consideration in land use planning analyses.
- Constructed the energy efficiency and generation technology component to ensure that the user can assess the magnitude of benefit in adjusting land use and development patterns to encourage viable energy options.
- Included impact and benefit data as an output to estimate expected environmental and employment effects.

These modifications allow PLACE3S users to match energy efficiency and generation options with growth patterns and make investment recommendations.

SUMMARY OF OBJECTIVES/HOW ACCOMPLISHED

MATRIX OF EFFICIENCY OPTIONS. The matrix of efficiency options was created using information on current building construction (Nonresidential New Construction Baseline Study and Residential New Construction Study). Information that will be added to PLACE3s includes California Climate Zone data (or building physical location) and building orientation.

UPDATE DISTRIBUTED ENERGY RESOURCE MATRIX. Data and assumptions about Distributed Energy Resource Technologies were placed in a "master" Distributed Generation database from which the PLACE3s user selects a technology for analysis.

ARCVIEW SOFTWARE SCRIPTS. ArcView software scripts were developed to link technical and economic viability parameters to energy demand land use and demographic data in the PLACE3s model.

¹ PLACE3S is an acronym for PLAnning for Community Energy, Economic and Environmental Sustainability

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OUTPUT. A test of the software analytical capability was performed using a project located in San Diego, California. Graphic outputs that show a comparison of a current land use plan against an alternative plan were created.

SOFTWARE TEST. The software was tested using a project located in San Diego, California. An analysis of a current land use plan was used to generate the current energy impacts as well as two alternative scenarios. The results show comparative energy usage in terms of annual electricity use, yearly electricity peak and annual natural gas use.

FINAL REPORT. Attached are copies of a final report, which includes goals and approach, efficiency and generation matrices, ArcView scripts and output of the assessment.

MILESTONES

PRODUCT	MILESTONE
MATRIX OF EFFICIENCY OPTIONS	July 2002
UPDATE DISTRIBUTED ENERGY RESOURCE MATRIX	July 2002
ARCVIEW SOFTWARE SCRIPTS	July 2002
OUTPUT	July 2002
SOFTWARE TEST	July 2002
FINAL REPORT	July 2002

FINDINGS/CONCLUSIONS/RECOMMENDATIONS FOR FOLLOW-UP

There are a number of specific enhancements that would be useful additions to the PLACE3S software. These include an easier method for entering energy rate information, a method to incorporate tiered electric rates, a means to recognize sub-regional energy loads to accommodate larger energy generators that service multiple parcels.

STATEMENT OF FUTURE INTENT

Currently, PLACE3S is used as a desktop device to inform and excite the local government and citizen planning process with respect to a proposed land use project by analyzing impacts of a land use proposal and by developing alternative land use scenarios of that proposal.

The PLACE3S software is a public-domain product, however its operation relies on private software available from ESRI. The total cost of acquiring individual copies of ArcView and Spatial Analysis software is approximately \$4000. In addition to this cost, users must acquire or purchase GIS data for the specific physical location to be analyzed. Once these components are acquired, users

must enter data on land use restrictions, local permitting requirements or other factors affecting the land use-planning project.

The Energy Commission is developing a web-enabled version of PLACE3S that will allow users to access PLACE3S online and perform alternative land use analyses and assess their impacts. One step in moving to a web-enabled version of PLACE3S required that PLACE3S be updated to operate with a more current version of ArcView software. Once the web-enabled version of PLACE3S is complete, the licensing fees to maintain PLACE3S will be approximately \$150,000 per year.

The number of people who have achieved a level of competency sufficient to perform analyses with PLACE3S is quite small. In order to integrate the use of PLACE3S into regular local planning proceedings, it would probably be helpful to sponsor a major training program to ensure that there is at least one person on staff, at each of California's 550 local jurisdictions, who has the ability to use PLACE3S.

At this time the Energy Commission has no funding source to continue to develop or support PLACE3S.

ITEMIZED SUMMARY OF FINAL PROJECT/PROGRAM COST

See attached.

CONSOLIDATED LIST OF CONTRACTORS AND SUBCONTRACTORS

CONTRACTOR	ADDRESS	PROGRAM WORK	VALUE
Parsons Brinckerhoff	3840 Rosin Court Suite 200 Sacramento, CA 95834	Project management, integration of energy option/urban decision making component	\$29,000
Fregonese Calthorpe	421 SW Sixth Ave. Suite 1250, Portland, OR 97204	GIS coding of energy options	\$32,000
Charles Eley Associates	142 Minna Street San Francisco, CA 94105	Energy Efficiency options matrix	\$30,000
Alternative Energy Systems Consulting	1945 Camino Vida Roble Suite A Carlsbad, CA 92008	Energy Generation options matrix	\$30,000
ESRI, Inc	380 New York Street Redlands, CA 92373	Technical assistance with ArcView software	\$ 2,000

PLACE³S Energy Option Matching Module

Project Summary Report

Prepared for the

California Energy Commission in support of the
PLACE³S Community Energy Planning Program (#500-00-014)

By

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July 31, 2002

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ATTACHMENTS

- Attachment 1a: Generator Matrix
- Attachment 1b: Generator Data

INTRODUCTION

Energy technology specialists understand the range of energy efficiency and energy generation options that are currently available and generally under what circumstances they are cost effective. City, county, and regional governments study and adopt plans that direct development and urban growth over time. These planning decisions have long term effects upon the viability of most energy efficiency and generation options. However, energy technical specialists and government decision-makers have difficulty bridging the information gap between them to understand how to effectively include energy efficiency and generation opportunities into growth and development decision making.

The PLACE³S program is able to integrate urban growth and development planning with energy efficiency and generation opportunities. The PLACE³S method and supporting Geographic Information System (GIS) tool can search alternative development proposals for the conditions needed to implement cost effective energy efficiency and generation options. Mapping and quantifying the matches between energy system requirements and alternative growth plans allows decision makers to see, early in the planning process, the difference in energy-related benefits of each growth plan alternative. They are then able to take an energy-friendly course of action in policy and development decisions.

Development of the Energy Option Matching Module within the PLACE³S GIS tool will enable communities to evaluate the viability of energy efficiency and generation technology options during the process of developing land use plan alternatives, rather than at the end of the planning process. Using this module, planning professionals, community leaders, and the public will be able to learn about the environmental and economic characteristics of alternative land use scenarios. With this information, educated trade-offs can be made early to acquire the highest net energy planning benefits including the related air emission, noise, safety, resource conservation, and economic values.

BACKGROUND

In 1994, the California Energy Commission (CEC) teamed with state energy offices in Oregon and Washington and with urban planning consultants in Portland, Oregon, to initiate the PLACE³S Program. PLACE³S is an acronym that stands for PLAnning for Community Energy, Economic and Environmental Sustainability. The goal of the PLACE³S program was to provide local and regional governments with an energy-based framework method and GIS tools to work through the public process to create, adopt, and implement resource efficient land use plans, or "Smart Growth" plans. Development of the PLACE³S model was designed to function as a public domain GIS tool that would be useful to local and regional planning agencies to help increase the inclusiveness of the PLACE³S decision-making process and to educate citizens about the value of careful energy management.

Because PLACE³S contains a data base that includes a detailed accounting of a community's growth forecast, the model can be used to create maps showing where, when, and what type of energy demand can be expected in the future under existing and alternative growth and development scenarios. In 1999, the CEC funded additional development of the PLACE³S model to include the capability of creating maps of energy demand dis-aggregated by source of demand (i.e., residential, commercial, industrial, institutional, and transportation), fuel type demanded, and location of demand. Recent work to further advance the analytical capabilities

of the model commenced in 2000, with the development of the local government Energy Option Matching Module, or "Community Energy Calculator".

PROJECT GOALS AND OBJECTIVES

Current work to complete the Community Energy Calculator within PLACE³S was conducted during a 12-month period between 2001-2002. The goal of this project is to create a module within PLACE³S that can enlighten planners to the relative energy intensity of various development patterns and to create a method for evaluating the effect of energy efficiency measures on those intensities. It is intended to provide PLACE³S with the analytical capability to match energy efficiency and generation options with projected growth patterns and to make investment recommendations based on economic and environmental benefits per capita. Specifically, the objectives of this new module are to accomplish advanced functionality of the PLACE³S model that will:

- Allow users to identify candidate generation technologies for each land use or growth alternative under consideration;
- Allow users to assess the magnitude of benefit of adjusting land uses and development patterns to bring candidate energy options into viability; and
- Include impact and benefit data into the model output (e.g., for each energy option, output will estimate the expected environmental and employment effects).

This work is part of the CEC's plan to build, test, demonstrate, and distribute the PLACE³S model as a comprehensive energy-based decision-making program and GIS tool. PLACE³S will be successful when local decision-makers and planners, as a standard operating procedure, seek the net energy use and generation numbers of each growth management and development alternative they consider prior to forming a final decision. Using PLACE³S, they will clearly understand that reducing all forms of energy use and implementing cost-effective generation options results in cleaner air, more dollars in their local economy, and less traffic congestion, in addition to providing a broader range of affordable housing and mobility options to their constituents.

METHODOLOGY

The methodology developed for the new Community Energy Calculator is designed to maximize both flexibility and accuracy within the model, in order to give land use planners energy-related information that is relevant for a specific region of study. It allows a user to be shielded from much of the detail contained in the PLACE³S model and to work at a higher level of analysis. The methodology that is documented in this report has been summarized from a series of working papers and technical meetings conducted by the PLACE³S development team throughout the duration of this project. All preliminary thoughts, processes, and methodologies are documented and are on file with the CEC.

Integration of the Community Energy Calculator within PLACE³S provides the added capability of estimating the electricity and gas consumption of various patterns of land use development.

In estimating electricity and gas usage, heating, cooling, lighting, ventilation, and equipment within and around a building are modeled. The Community Energy Calculator does not address some of the energy uses associated with public infrastructure, such as street lighting, water pumping, and sewage treatment. Nor does the model address "embedded energy", which is, the energy used to manufacture building materials, deliver them to the site, and assemble them into the building. Transportation energy is, however, calculated separately by the model, using estimates derived from land use based energy consumption. Assumptions that are required to generate such mobile energy intensities (for automobiles, light trucks, buses, and rail transit) are input directly to the Neighborhood Administrative Variables dialog within the PLACE³S model and are used to derive an estimated vehicle load factor to calculate the indicator for "Annual Household Energy Use from Vehicles (in BTUs)".

ENERGY USAGE/EFFICIENCY

The Community Energy Calculator can produce estimates of both energy use and peak demand, the latter being important for electric system planning. The Community Energy Calculator works with both residential and non-residential building types. The relative differences between development alternatives are of greatest importance in assessing the energy efficiency of a development scenario, as opposed to absolute energy use.

Technical Approach

Energy parameters can be defined not only on a building-by-building basis (i.e., per Development Type), and on a general planning area or neighborhood level basis. The Community Energy Calculator requires these two separate levels of information in order to analyze energy usage.

At the Development Type level, information about building characteristics is used, such as type of development (i.e., building type), sector type, average building size, and number of stories. These assumptions are stored in the "Development Types Assumptions" menu within PLACE³S. At the neighborhood or general planning area level, the module requires information that can be applied "globally" to a particular project, such as climate zone and location. These parameters are input within the "Global Assumptions" menu of the PLACE³S model and include project location, building era, and fuel type used for heating.

When a Development Type is applied to a parcel, the energy numbers associated with a weighted average of the energy results are subsequently assigned to that parcel. Table 1 describes a sample database scheme for keeping track of this information and showing how it relates to the energy results.

Table 1 – Inputs for the Community Energy Calculator

Parameter Name	Notes
Sector Type	Reference Number, relates to energy sectors.
Sector Size	Size of sector in square feet.
Average Nonresidential Building Size	Reference Number, relates to the average building size. Note that if the user has chosen to base the building size on a function of the parcel size, the building size shall be calculated and then the appropriate option selected. <ul style="list-style-type: none"> • Small (<5,000 sq. ft.) • Medium (5,000 – 100,000 sq. ft.) • Large (>100,000 sq. ft.)
Average Residential Building Size	Average building size in square feet.
Average Number of Floors	Reference Number, relates to number of floors. <ul style="list-style-type: none"> • Single story (<= 3 stories) • Multi story (>= 4 stories)
Building Era	Reference Number, relates to Code periods: Pre 1960, 1960 – 1979, 1980 – 1989, 1990 – 1999, and Post 2000
Fuel Used for Heating	Gas, electric, none
Location	Zip Code

Development Type parameter defaults are based on information included in the model, such as maximum height (stories), percent of Development Type by sector, and average residential lot size. Additional information needed for the energy model will include parameters such as average building size and climate zone/location for non-residential sectors. was be specialized based on the information available in the model and intelligent defaults mined from survey data.

DISTRIBUTED GENERATION

The methodology developed to analyze the impact of Distributed Generation (DG) focuses on the application of self-generation technologies. Distributed Generation implementations for local grid power, such as installations at substations, are not included in this discussion.

Technical Approach

Distributed Generation screening requires three types of sets of data: location specific data, building characteristics, and DG technology specifications¹. Each data set contains data sub-elements (or attributes) that can be used to define a specific location DG application. These

¹ The major data sets that are necessary for DG technology screening are *Location, Building Type, and Generator Specifications*. A list of data elements within each data set for DG screening are described in a memorandum prepared by AESC, Inc., dated January 8, 2002.

sets of data are overlaid to determine "feasible" DG applications, which is the first step in determining DG impacts.

Figure 1 illustrates where the dots represent feasible intersections of these data sets. A "feasible DG application" is a DG technology that can be implemented within the technical constraints of the planning area. For example, *Location* data contains information on the availability of natural gas for a specific region. *Building* data will contain information on the available space, electric peak demand and energy consumption for a specific facility or group of facilities.² *Generator* data contains specifications on a variety of DG technologies. The comparison of these data for a specific facility results in a list of feasible DG technologies. Application of DG deployment objectives further results type and capacity size of DG implemented in the planning area.

Figure 1 – DG Data Type Overlay

Appropriate sizing of the DG technology is also dependent on the mode of operation. A natural gas fuel cogenerator is sized differently than a natural gas fuel peaking generator. In addition, the size of a photovoltaic generator is different for sites where net metering was available and utilized. A database of general DG technology characteristics (similar to the CADER technology matrix) was developed for this project, which includes a range of DG characteristics that are intended to assure the user that the results for a particular technology are correct (see Attachment 1).

Distributed Generation Indicators and Analysis Process

In terms of self-generation (a.k.a., on-site power generation) DG potentially affects a facility's fuel consumption and electric demand imposed on the utility's grid. However, DG, in itself, does not affect the facility's electric load, but rather provides an alternative way to service that load. These general features hold true for aggregated facilities when considering over-the-fence and regional/district DG applications.

A list of new PLACE³S energy indicators for DG analysis is shown below.

1. Annual grid electric energy (kWh) per dwelling and/or employee;
2. Peak annual grid electric (kW) demand per dwelling and/or employee (the highest rate of energy consumption through the year);
3. Annual natural gas consumption (Kbtu) per dwelling and/or employee;
4. Total installed capacity of each DG technology;
5. Total area used, by area type (roof, ground, underground parking) for each DG technology;
6. Economic indicators based on change in electricity and fuel usage. Two economic indicators are reported;
 - Return on investment (calculated as first year savings divided by capital investment); and

² Eley Associates developed a database of building energy consumption characteristics for DG screening within PLACE³S.

- Simple payback period (capital investment divided by first year savings). The first indicator is more familiar to developers and the second indicator is more familiar to the energy markets;
- 7. Total installed costs;
- 8. Operation and maintenance costs; and
- 9. Environmental impacts (air emissions, etc.).

Figure 2 describes the methodology developed for processing the Distributed Generation related energy indicators, on the following page. The methodology to calculate the DG indicators begins by establishing a feasible list of DG technologies (c), which is a subset of the master list of DG technologies from the DG master database. The logic for "feasible" DG technologies is largely driven by constraints in fuel availability and/or local permit regulations.³ Technologies that will be included in the master DG database (a) include:

- Reciprocating internal combustion engines, in both simple cycle and cogen configurations (natural gas only, 50 – 6000 kW);
- Micro-turbines, in both simple cycle and cogen configurations (50 – 250 kW);
- Small gas turbines, in both simple cycle and cogen configurations (500 – 10,000 kW);
- Solar photovoltaics;
- Wind turbines; and
- Fuel cells (phosphoric acid type only ~200 kW).

The master Generator Specifications from the DG database includes the following DG attributes in flat file format:

- Technology type
- Fuel;
- Full load capacity (kW);
- Heat rate (full and part load rates) (Btu/kWh HHV);
- Air emissions (lb/kWh);
- Minimum load (% of FL) (kW);
- Dispatchability (fully dispatchable, fuel following, baseload only, etc.);
- Footprint (square foot per kW installed);
- Capital Cost (\$/kW);
- Installation Cost (\$/kW); and
- Maintenance costs (\$/kWh).

Other inputs required for calculating the energy indicators as affected by DG, include:

- Regional & Building Data (obtained from PLACE³S model);
 - Fuel availability (natural gas, solar, wind);
 - Technology specific permit constraints; and
 - Space for generator (roof area, parking, etc.).
- Load Data (obtained from ELEY Associates Energy Efficiency data)
 - Monthly total kWh, peak kW
 - Weekday and Weekend hourly load profiles for each month of the year
 - Monthly cooling load, heating load (either kWh or BTU)
 - Chiller & boiler efficiency numbers (chiller SEER/IPLV – boiler AFUE)

³ PLACE³S does not have embedded information on fuel availability or permit requirements. Functionality can be implemented by providing tables of solar insolation, but other fuels such as wind resource and natural gas availability will have to be provided either by the user or from a local reference.

Figure 2 – Process for Analyzing Distributed Generation Indicators

The maximum potential capacity for each feasible DG technology is estimated from space and fuel requirements and availability (provided by the master DG database) and the Planning Area definition. The annual peak electric load of the parcel under consideration is calculated from the Development Type characteristics (b).

To facilitate the choice of a DG technology mix, the application runs each feasible technology through the DG impact analysis (h), using each technology's maximum potential capacity. The user is provided with a list of DG indicators (see page 5) for each of these technologies, based on using it to its maximum potential, and the annual peak load (c).

1. The following normalized data (per square feet) were prepared for each Development Type:
 - Monthly total kWh, peak kW;
 - Weekday and Weekend hourly load profiles for each month of the year;
 - Weekday and Weekend profiles of domestic hot water use;
 - Monthly cooling load, heating load (either kWh or BTU); and
 - Chiller & boiler efficiency numbers (chiller SEER/PLV – boiler AFUE, both independent of building floor area estimates).
2. The user inputs the desired DG technology mix (one or more generation types) (d) and the percentage of the peak load to be offset by self-generation (e). The user is prompted to enter the following information for each technology:
 - Generator type;
 - Generator configuration (simple cycle or cogeneration, where applicable);
 - Operating mode (baseload, load following, peaking, where applicable);
 - Percentage of total generating capacity to be provided by the technology;
 - Percent of roof and/or ground space available for each technology (some ground space can be co-occupied by photovoltaics and other generator technologies); and
 - Percentage of underground parking area available for DG use, where applicable.
3. The generator sizing (f) is calculated using the following steps:
 - The total desired capacity for each DG technology is determined from the percentage of peak load for combined self-generation and the percentage of combined generation capacity for each technology, entered by the user (see 3 & (d)).
 - The maximum potential capacity for each technology is determined from the space requirements and available roof/ground/underground parking space.
 - The suggested generator sizing for each technology will be the minimum of the total desired capacity and the maximum potential capacity.
 - If the maximum potential capacity for any technology is less than the desired capacity, this will result in a total combined capacity that is less than the desired total capacity.
4. The user then chooses whether to proceed with the suggested capacities or make changes to the data entered in the sizing algorithm (g). This gives the user the opportunity to alter the installed capacity of DG.
5. The application then analyzes the effect of operating each of the DG technologies (h), with capacities as determined in the steps above and using data from the DG Technology Database in conjunction with the Development Type load shapes obtained from the ELEY energy program.
6. The main DG indicators (i) are then calculated.

USER INTERFACE

The methodology and approach to completing the Community Energy Calculator was translated into a set of ArcView scripts that link the technical and economic viability parameters to energy demand, land use, and demographic data within the PLACE³S model. This functionality allows users to automatically prioritize and map matches between energy efficiency and generation technology options on alternative land use plans.

REGIONAL DYNAMICS

PLACE³S is both a regional and a local planning tool. Even when planning is conducted at the local level, it is important to recognize the characteristics of the entire region. To ensure the analysis reflects specific regional characteristics, interface and path flows were generated to allow users to enter relevant regional information. The Energy Assumptions input at the Neighborhood Global Development Assumptions level include the location, the building era composition, and the heating fuel preferences of the different building usage sectors. These parameters are not defined on a building-by-building basis, but on a general planning area, neighborhood level, or regional basis. A view of this dialog box is shown in Figure 3.

Figure 3 – Neighborhood Global Development Assumptions

Neighborhood Global Development Assumptions

SubArea Variables | Single Area Variables

Select a Development Type to review or edit: Energy Assumptions

Energy Sector	Natural Gas	Electric	No Heating
Detached Housing (%)	50	50	0
Attached Housing (%)	100	0	0
Rowhouse (%)	75	25	0
General Retail (%)	100	0	0
Hotel/Motel (%)	100	0	0
Restaurant (%)	60	40	0
Office (%)	0	100	0
Light Manufacturing (%)	100	0	0
Warehouse (%)	0	100	0
Public Assembly (%)	0	100	0
School (%)	50	50	0
Health Institution (%)	65	35	0

Building Era Composition

Pre 1960 (%) 5

1960 - 1979 (%) 25

1979 - 1989 (%) 40

1989 - 1999 (%) 30

Post 2005 (%) 0

Representative Zipcode for Determining Regional Weather Characteristics

Representative Zipcode: 95445

Update | Save As Default | Reset | Close | Help

Different building usages will often have different types of heating systems. For example, residential buildings in some areas will use baseboard electric heating systems, while in other areas, heating will be primarily served with natural gas furnaces. This section of the dialog allows the user to select how frequently buildings are heated by natural gas, electricity or not heated at all. Figure 4 shows the relationship of the database tables for DG screening within PLACE³S.

DEVELOPMENT TYPE DATA

In the summary Energy Assumptions dialog (Figure 5), the user is able to provide more detailed information about each Development Type, by sector. While the Physical Assumptions menu provides only five different sector types to choose from for each Development Type (i.e., residential, retail, office, industrial, and public), the Energy Assumptions dialog allows the user to select from a combination of twelve different sectors shown in Table 2. This greatly improves the level of detail that the energy information can provide.

Table 2 – Energy Sector Types vs. Development Type Sectors

Energy Sector Type	Development Type Sector
Residential Detached (low rise)	Residential Detached
Residential Townhouse (low rise)	Residential Attached (row house)
Residential High Rise (high rise)	Residential Attached
General Retail (low or high rise)	Retail
Hotel / Motel (low or high rise)	Retail
Restaurant (low rise)	Retail
Office (low or high rise)	Office
Light Manufacturing (low rise)	Industrial
Warehouse (low rise, no cooling)	Industrial
Public Assembly (low or high rise)	Public
Health Institution (low or high rise)	Public
School (low or high rise)	Public

The Energy Assumptions dialog also asks the user to select the average building size for a particular development. In many types of buildings, this will greatly affect the heating and cooling systems used. For example, a small health clinic may have a very different heating and cooling system than a large-scale medical school hospital. Therefore the user will be required to select an average building size, such as: 1) small (< 5,000 sq ft), 2) medium (5,000 – 100,000 sq ft), or 3) large (100,000 sq ft. and greater).

To specify a mix of DG technologies the user is first asked to specify the percentage of each parcel's peak electric load to be offset with DG. The peak electric load is defined as the maximum hourly electric use (kW) for a one-year period. The resulting value defines the combined capacity of the individual generators in the generator mix. A generator mix is defined for each development type, and this combination of generators is sized and placed separately on each parcel containing the development type.

Once this value (generation mix) is determined, the user can create a mix of up to three different generator technologies. The available generator technologies include solar photovoltaic, wind turbine and several natural gas powered generation technologies. Since all of the natural gas fueled technologies produce a significant amount of useable "waste" heat, the user can choose between a simple cycle configuration where the waste heat is rejected to the atmosphere, or a cogenerator system where the waste heat is utilized to supply part or all of the energy for space heating, domestic hot water heating and space cooling.

Figure 5 – Development Type Energy Assumptions

Development Type Assumptions

Select a Development Type to review or edit: **00 Small Lot SF/Townhouse**

Select the Assumption Category: **Energy Assumptions**

<p>Percent of Dev. Type by Energy Sector:</p> <p>Residential Sector: 100 %</p> <p>Detached Housing (%) <input type="text" value="100"/></p> <p>Attached Housing (%) <input type="text" value="0"/></p> <p>Rowhouse (%) <input type="text" value="0"/></p> <p>Retail Sector: 0 %</p> <p>General Retail (%) <input type="text" value="0"/></p> <p>Hotel/Motel (%) <input type="text" value="0"/></p> <p>Restaurant (%) <input type="text" value="0"/></p> <p>Office Sector: 0 %</p> <p>Office (%) <input type="text" value="0"/></p> <p>Indust Sector: 0 %</p> <p>Light Manufacturing (%) <input type="text" value="0"/></p> <p>Warehouse (%) <input type="text" value="0"/></p> <p>Public Sector: 0 %</p> <p>Public Assembly (%) <input type="text" value="0"/></p> <p>School (%) <input type="text" value="0"/></p> <p>Health Institution (%) <input type="text" value="0"/></p> <p>Other Sector: 0 %</p> <p>Other (%) <input type="text" value="0"/></p>	<p>Percent of peak load to offset with DG</p> <p>Total Percentage (0-100%): <input type="text" value="75"/></p> <p>DG Generator Breakdown</p> <p>Select a DG Generator: <input type="text" value="Gas Engine - simple cycle"/></p> <p>Enter a Percent of Peak Load Offset and Generator Location for each DG Generator</p> <p>Offset %: <input type="text" value="0"/> Total Offset: 75%</p> <p>DG Generator Location:</p> <p>☐ Landscaping/Surface Parking Area</p> <p>☒ Roof Area</p> <p>☐ Under Building Parking Area</p> <p>DG Generator Location Availability (%)</p> <p>Landscaping/Surface Parking Area: <input type="text" value="0"/></p> <p>Roof Area: <input type="text" value="60"/></p> <p>Under Building Parking Area: <input type="text" value="0"/></p>	<p>Select the Average Non-Residential Building Size:</p> <p>☐ Small (< 10,000 Sq. Ft.)</p> <p>☒ Medium (10,000 - 100,000 Sq. Ft.)</p> <p>☐ Large (> 100,000 Sq. Ft.)</p> <p>Select the Operating Mode:</p> <p><input type="text" value="load following"/></p> <p>Absorption Cooling: ☐ Yes ☒ No</p> <p>Commercial and Residential (Gas/Electric) Rate Sources</p> <p>Commercial Electric Rate Source: <input type="text" value="SDG&E A6-TOU,GS time m"/></p> <p>Commercial Gas Rate Source: <input type="text" value="SDG&E GN3,core commercial"/></p> <p>Residential Electric Rate Source: <input type="text" value="SDG&E"/></p> <p>Residential Gas Rate Source: <input type="text" value="SDG&E"/></p>
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ADD DELETE UPDATE RESET SAVE AS DEFAULT HELP PRINT CLOSE

For each generator, the user is asked to specify the percentage of the total offset load (which was determined in the first step above) to be supplied by that generator. The user is also given three choices of location for each generator: on the ground in the landscaping/surface parking area, on the roof, or in any enclosed parking area. There are certain rules regarding where each generator technology can be located. For example, a solar photovoltaic system can be placed on the roof or on the ground, but not in the enclosed parking area. The application will not place any generator technologies in locations where they are not feasible.

The user must also specify the percentage of space in each of the three location types that is available for DG. Each of the generator technologies requires a certain amount of space. A solar voltaic system, for example, requires quite a bit more space than a comparably sized system of any other type. If there is not enough space available for the generator technology

determined in the previous steps, the application will select a required technology that fits the space.

Some of the generator technologies have a minimum and/or maximum capacity. For example, the available microturbines range from 30 kW to 300 kW. If the sizing steps result in a generator that is smaller than the minimum capacity for the specified generator technology, then no generator will be used in the space. If the sizing steps result in a generator that is larger than the maximum capacity, then the largest available generator of the specified technology will be used.

Once the generator mix has been determined, the user is asked to specify an operating mode for the mix. There are three choices of operating mode: load following, peak1 and peak2. In a load following mode, the generator will match the electric load. If the electric load is greater than the generator capacity, the generator will operate at its maximum output. If the load is less than the minimum generator capacity, the generator will not operate. Peak1 and peak2 operating modes are similar to the load following mode, except in peak1 mode the generator will operate only during peak periods (as defined in the applicable electric rate), and in peak2 mode the generator will operate only during peak and mid-peak periods. The peak1 and peak2 modes should only be used if there is a commercial/industrial component in the development type because residential electric rates have no peak or mid-peak periods.

The user is also given a choice of whether or not to use absorption cooling as one of the end uses for which waste heat from the generator mix can be used. Absorption cooling is a technology that can utilize waste heat to offset part or the entire space-cooling load. Due to the significant cost of installing Absorption cooling (above the cost of installing a generator), the user can turn this option on or off.

Finally, the user must choose gas and electric rates that apply to the development type. Time-of-use commercial/industrial electric rates, commercial gas rates, and residential gas and electric rates were provided for the San Diego Gas & Electric, Southern California Edison, and Pacific Gas & Electric service areas.

ENERGY INDICATORS

The new energy indicators developed and modeled for the Community Energy Calculator include the following:

- Annual kWh of electricity;
- Yearly peak kW of electricity; and
- Annual kBtu of natural gas.

These indicators are accessed through the Compare Scenarios menu in the PLACE³S model (see Figure 6). Within this menu, the user is able to choose one or more land use plan scenarios to compare and then select the energy indicators to analyze for each comparison.

Figure 6 – Energy Scenario Comparisons

Neighborhood Energy Scenario Comparisons

1.) Enter the Title for the New Comparison ArcView and Internet Explorer documents.
Comparison Name:

2.) Select the Output option(s) for the Scenario Comparison
☒ View Data Text ☐ View Internet Explorer Charts

3.) Select the Scenario(s) to be compared.

4.) Provide the Filename to the Internet Explorer executable file (iexplore.exe).
 Filename:

In addition, the following information is provided within the module in order to analyze DG technologies.

Distributed Generation Energy Inputs

- Monthly totals:
 - ☐ MBTU;
 - ☐ peak kW;
- Weekday and Weekend profile for each month of the year:
 - ☐ Whole building kWh;
 - ☐ Whole building MBTU;
 - ☐ Heating (either electric or gas);
 - ☐ Water Heating (either electric or gas);
- Mechanical System Information;
 - ☐ Mechanical system type;
 - ☐ System cooling efficiency;
 - ☐ Heating source, system type;
 - ☐ System heating efficiency
 - ☐ DHW system type; and
 - ☐ System DHW efficiency.

PLACE³S ENERGY ANALYSIS & OUTPUT RESULTS

The methodology and user interface developed for the new Community Energy Calculator was tested and demonstrated using data from the Mid-City Transit Interchanges Project (MCTIP), located in San Diego. The PLACE³S model was used throughout the MCTIP process to measure and analyze the impacts of alternative redevelopment and urban design scenarios that were created and supported by the Mid-City community⁴. Two of the project's land use plan scenarios were used to test and demonstrate the new energy module, including the Mid City Current Land Use Plan (Figure 7) and the MCTIP Concept Plan (Figure 8).

Figure 7 - Mid City Current Land Use Plan

⁴ The MCTIP process is documented in "Mid City Transit-Interchanges Project, Tier One PLACE³S Urban Design Report" dated July 16, 2002. This report was prepared by Parsons Brinckerhoff in support of the PLACE³S Community Energy Planning Program.

Figure 8 - MCTIP Concept Plan

Results of the model's energy analysis demonstrate how the MCTIP Concept Plan compares against base case conditions in terms of energy usage. The energy assumptions generated for this project area are described below.

ENERGY ASSUMPTIONS FOR THE MID CITY PROJECT

The energy assumptions specified in the Global Development Assumptions menu remained constant for the two land use plan scenarios generated for MCTIP (i.e., the Current Land Use Plan and the MCTIP Plan). Heating fuel breakdowns for each energy sector were limited to natural gas and electric, with a value of 75 percent given to each sector for natural gas and 25 percent to electric. The "No Heating" option is displayed as a place holder for future development of the model. Percentages for building eras included 5 percent for pre 1960, 25 percent for 1960-1979, 40 percent for 1979-1989, and 30 percent for 1989-1999. The zip code "92111" was used as the representative zip code for the MCTIP study area, which indicated that the location of the study area was within Climate Zone 7.

Each Development Type was provided with detailed user defined inputs to further customize the energy output within the Development Type Assumptions dialog. These included energy assumptions such as percent of Development Type by energy sector, type of DG generator(s), DG generator location availability, operating mode, and rate sources.

Fifteen Development Types were created for the Mid City project. These Development Types are shown below, along with a description of the energy parameters that define each type.

MCTIP Development Types

01 Conventional Single Family

- Percent of Development Type by Energy Sector: 100% Detached Housing
- Percent of Peak Load to offset with DG: 75%
- DG Generator Breakdown by Generator: 75% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 0% Underground Parking Area
- Average Non-residential Building Size: N/A
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: N/A
- Commercial Gas Rate Source: N/A
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

02 Conventional Multi Family

- Percent of Development Type by Energy Sector: 100% Attached Housing
- Percent of Peak Load to offset with DG: 75%
- DG Generator Breakdown by Generator: 75% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 0% Underground Parking Area
- Average Non-residential Building Size: N/A
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: N/A
- Commercial Gas Rate Source: N/A
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

03 Medium Density Multi Family

- Percent of Development Type by Energy Sector: 100% Attached Housing
- Percent of Peak Load to offset with DG: 75%
- DG Generator Breakdown by Generator:
 - ☐ 50% Microturbine Cogen (surface)
 - ☐ 25% Solar PV (roof)

- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 0% Underground Parking Area
- Average Non-residential Building Size: N/A
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: N/A
- Commercial Gas Rate Source: N/A
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

04 Multi Family Retail Accessory

- Percent of Development Type by Energy Sector:
 - ☐ 80% Attached Housing
 - ☐ 20% General Retail
- Percent of Peak Load to offset with DG: 75%
- DG Generator Breakdown by Generator:
 - ☐ 65% Microturbine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 0% Underground Parking Area
- Average Non-residential Building Size: Small (<10,000 sqft)
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: SDG&E, A-6, small GS TOU
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

05 High Density MF

- Percent of Development Type by Energy Sector: 100% Attached Housing
- Percent of Peak Load to offset with DG: 75
- DG Generator Breakdown by Generator:
 - ☐ 67% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Small (<10,000 sqft)
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: SDG&E, AL-TOU, GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

06 Civic/School

- Percent of Development Type by Energy Sector: 100% School
- Percent of Peak Load to offset with DG : 85%
- DG Generator Breakdown by Generator:
 - ☐ 72% Gas Engine Cogen (surface)
 - ☐ 13% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 60% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Load Following
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: N/A
- Residential Gas Rate Source: N/A

08 Mixed Use Housing/Office/Retail

- Percent of Development Type by Energy Sector:
 - ☐ 20% Attached Housing
 - ☐ 20% General Retail
 - ☐ 60% Office
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Medium (10,000 – 100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

09 El Cajon Blvd Mixed Use

- Percent of Development Type by Energy Sector:
 - ☐ 75% Attached Housing
 - ☐ 13% General Retail
 - ☐ 12% Hotel/Motel
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)

- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Medium (10,000 – 100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E, AL-TOU, GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

10 University Ave Mixed Use

- Percent of Development Type by Energy Sector:
 - ☐ 66% Attached Housing
 - ☐ 34% General Retail
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E, AL-TOU, GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

11 El Cajon/Fairmont & 43rd Mixed Use

- Percent of Development Type by Energy Sector:
 - ☐ 75% Attached Housing
 - ☐ 25% General Retail
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 1 (peak period only)
- Commercial Electric Rate Source: SDG&E, AL-TOU, GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: SDG&E
- Residential Gas Rate Source: SDG&E

12 Small Conventional Retail or Office

- Percent of Development Type by Energy Sector:
 - ☐ 50% General Retail
 - ☐ 50% Office
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: N/A
- Residential Gas Rate Source: N/A

13 Large Conventional Retail

- Percent of Development Type by Energy Sector: 100% General Retail
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: N/A
- Residential Gas Rate Source: N/A

14 Mixed Use Office/Retail

- Percent of Development Type by Energy Sector:
 - ☐ 25% General Retail
 - ☐ 75% Office
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area

- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 1 (peak periods only)
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: N/A
- Residential Gas Rate Source: N/A

15 Retail Small Manufacturing

- Percent of Development Type by Energy Sector:
 - ☐ 50% General Retail
 - ☐ 50% Warehouse
- Percent of Peak Load to offset with DG: 85%
- DG Generator Breakdown by Generator:
 - ☐ 77% Gas Engine Cogen (surface)
 - ☐ 8% Solar PV (roof)
- DG Generator Location Availability:
 - ☐ 25% Landscaping/Surface Parking Area
 - ☐ 75% Roof Area
 - ☐ 10% Underground Parking Area
- Average Non-residential Building Size: Large (>100,000 sqft)
- Selected Operating Mode: Peak 2 (peak and midpeak periods)
- Commercial Electric Rate Source: SDG&E,AL-TOU,GS time in
- Commercial Gas Rate Source: SDG&E, GN3, core commercial
- Residential Electric Rate Source: N/A
- Residential Gas Rate Source: N/A

OUTPUT RESULTS

The indicator output results from the two Mid City scenarios, Current Land Use Plan and MCTIP Concept Plan, include estimates for annual electricity demand (kWh), total peak electricity demand (kW), and annual natural gas demand (kBtu). These indicators represent only a sample of the energy indicators that were researched and developed for Community Energy Calculator. Indicators for analyzing the DG technologies were modeled and reviewed separate from the analysis provided here. Figures 9, 10, and 11 show the comparative energy usage between the two land use plan scenarios.

Figure 9 – Annual Electricity Usage (Kwh)

Figure 10 – Yearly Peak of Electricity (kW)

Figure 11 – Annual Natural Gas Usage (kBtu)

The algorithms employed by PLACE³S to analyze the energy features are calculated using an Access database and the conversion of Excel spreadsheet formulas into Avenue scripting. While the conversion of Excel formulas can be replicated, queries to the Access database for accessing input parameters add significant processing time in calculating DG energy indicators. Therefore, the size of the "Results and Profiles" Access database is significant to allow for full study area development of the DG indicators. Processing a single or small grouping of parcels is also possible.

Review of the Avenue code and monitoring of the processing time for particular elements identified the initial query of the Access database as the key component for the decrease in the response time of the application. Due to the complexity of the input parameters, multiple queries can be made to the database on a parcel-by-parcel basis. Development of the Eley database and DG indicators focuses on the energy use of a single parcel with a single development type, era, and heating source.

ISSUES AND RECOMMENDED NEXT STEPS

The PLACE³S development team worked together for over five years to create and demonstrate both regional and neighborhood applications of the planning model. With the development of the new Community Energy Calculator, communities will now be able to quickly evaluate the viability of energy efficiency and generation technology options at a much higher level than previously possible. With this information, people will be better equipped to understand and analyze the impacts of different land use plans and the trade-offs that can be made to acquire the highest net energy planning benefits. To continue the momentum for developing energy features within the PLACE³S model, the development team prepared a summary of current issues and recommended next steps.

ENERGY INFORMATION AND POLICY LEVEL DECISIONS

While there is a wealth of information about improving energy efficiency, it is rarely focused on the kinds of issues and decisions that city planners have influence over. A number of initiatives over the years have produced results in the field and information to get people started. A sample of these initiatives include the Collaborative for High Performance Schools, the U.S. Green Buildings Council, the public goods charge funded utility efficiency programs, and the California energy efficiency standards code enforcement by building code officials. The goal of this project is to help cities and urban planners improve the energy efficiency of their planning areas without duplicating these efforts.

The recommended next steps involve bringing information from the programs referenced above to the city policy level. PLACE³S could be used to bring more visibility to existing programs and initiatives and to generate support for them within the city structure, by giving urban planners a tool to evaluate the programs. Specifically, the following items are recommended for further analysis:

- City leadership in innovative design for new and renovated buildings
- Improved energy code compliance
- Incentives to push buildings beyond simple compliance

By adding policy level decisions to the PLACE³S software, the urban planner would be able to simulate the effect of a policy on their particular region. Similar to the "dial up" feature within PLACE³S' current functionality, policy level decisions allow the user to create a new scenario, measuring the effects of an energy policy by following a wizard that applies the initiative to their location.

UTILITY PLANNING AND DISTRIBUTED GENERATOR ANALYSIS

For the new Community Energy Calculator, PLACE³S offers a good platform to analyze the benefits of self-generation (i.e., generation that produces electricity for use at a host site) when applied to part or all of a planning area. The primary benefit of this tool will be the ability to analyze the reduction in overall energy cost, including the net of decreased grid electric purchases and potential generator costs such as increased fuel purchases (if any), capital recovery, and other recurring costs associated with the generator such as maintenance and financing. Other benefits such as reduced environmental impact can also be assessed with the PLACE³S model.

In general, the impact to energy cost is a "participant" benefit, where the cost/benefit is assessed from the self-generation customer's point of view. However, collective grid-wide benefits (or costs) can not currently be captured by PLACE³S, whether DG is deployed at customer sites or installed at strategic locations within the electric grid infrastructure. Without this capability a single self-generation customer would typically be blind to costs or benefits that occur throughout the electric system because of their own actions.

Utilities and the ISO use GIS tools to plan for system expansion, determine operating constraints and identify areas of stress within the electric grid. In order to assess customer and grid-wide benefits PLACE³S must be bridged with utility GIS planning tools. This would not only form a pathway for collaborative data, but also opens the channels for integrated energy planning between utilities and land use planners.

With DG there is a need for a more iterative and collaborative process, where energy demand can be split between self-generation, shared generation (over-the-fence), community generation (district electric/heating/cooling) and central generation. The economic justification of DG depends on (if all benefits and costs are identified) the incremental changes of utility infrastructure. However, the change in utility infrastructure and the resulting benefit or cost is dependent on the amount and type of planned DG to be deployed. In addition, this relationship is distinctly unique to each planning area and time within the planning cycle.

APPLICATION PROGRAMMING AND DEVELOPMENT

Future development of the energy indicators should focus on more flexible tools to process the energy indicators. If future development of the Community Energy Calculator is to reside within the ArcView Avenue platform, then a review of alternative projections for profile information is recommended. Migration of the PLACE³S energy indicators to the ArcView 8.x platform would allow for greater development of the energy indicators and remove the reliance upon static databases. Within the ArcView 8.x platform, many of the processes to calculate results, profiles, and indicators can be developed within custom "dll" files. Dll files allow the user to greater flexibility with the inputs used to calculate the energy indicators.

LIST OF NEXT STEPS AND FUTURE ENHANCEMENTS FOR PLACE³S

1. Use PLACE³S to advance energy programs and initiatives to the city policy level, by incorporating policy level decisions into the PLACE³S software.
2. Develop a "simple" rate wizard so that the user can enter rate information from other utilities or other possible rate structures (for now we are using all TOU rates from the California IOU's).
3. Develop an algorithm for implementing the tiered electric rates now in use for residential users in California. This could be based on the zip codes that are part of the Eley database.
4. Develop a utility for entering localized solar insolation and wind speed data.
5. Develop an algorithm for calculating DG indicators quickly on a more global basis. This would be based on average parcel/building size per development type and scaled up to cover a neighborhood or planning area. It would include more defaulted values than the current approach and would provide an "instantaneous" estimate of DG benefits. This approach, while possibly decreasing the precision of the analysis, would also greatly speed up the processing.
6. Develop an algorithm that would allow for aggregation of loads within a sub-region of the planning area, so that a larger generator (e.g., large gas turbine or combined cycle) could serve multiple parcels/neighborhoods/development types. Although California regulations do not allow this configuration at this time, it could be used to show the advantages that might result.
7. Develop ability to incorporate real-time electric pricing in the DG algorithm.
8. Make the DG algorithm a separate module that would be called from, but run independently from PLACE³S to reduce the calculation time and allow for separate updates to the DG algorithm.

9. Incorporate stochastic modeling techniques to include uncertainty in forecasted energy load and price data.
10. Further programming and software development to add time and space saving efficiencies to the model.
11. Review and update PLACE³S Manual to incorporate new features and to add clarity to existing documentation.

ATTACHMENT 1

1a Generator Matrix

1b Generator Data

Generator Database

Gen. Description	Rated Capacity (kW)		Heat Rate Btu/kWh	Cogen Btu/kWh	Cogen Temp F	NOx	Air Emissions (lb/hr)				Installed Cost \$/kW	O&M Cost		Partial Load		
	Max.	Min.					CO	VOC	SOx	\$/kWh		\$/kW-yr	slope	intercept		
Natural Gas Generators																
IFC PC25c PAFC Fuel Cell Nat. Gas	200	20	9,866	0	#N/A	0.0000	0.0000	0.0000	0.0000	\$0	\$0.000	\$0				
IFC PC25c PAFC Fuel Cell Nat. Gas Cogen	200	20	10,074	7,517	140	0.0048	0.0027	0.0015	0.0000	\$6,058	\$0.019	\$361	0.009	0.000		
Capstone 330 Micro Turbine Nat. Gas	29	3	14,459	0	#N/A	0.0163	0.0101	0.0029	0.0010	\$1,387	\$0.005	\$10	0.015	0.000		
Capstone 330 Micro Turbine Nat. Gas Cogen	28	3	15,384	6,897	210	0.0163	0.0101	0.0029	0.0010	\$1,503	\$0.005	\$11	0.015	0.000		
Capstone 60 Micro Turbine Nat. Gas	60	5	14,843	0	#N/A	0.0310	0.0192	0.0055	0.0020	\$1,091	\$0.005	\$11	0.014	0.000		
Capstone 60 Micro Turbine Nat. Gas Cogen	60	5	13,913	6,545	210	0.0310	0.0192	0.0055	0.0020	\$1,174	\$0.015	\$9	0.014	0.000		
GE/Honeywell Parallon75 Micro Turbine Nat. Gas	75	5	13,059	0	#N/A	0.0782	0.0501	0.0103	0.0021	\$1,333	\$0.016	\$11				
GE/Honeywell Parallon75 Micro Turbine Nat. Gas Cogen	74	5	17,934	4,593	180	0.0782	0.0501	0.0103	0.0021	\$1,247	\$0.005	\$5				
Allied Signal Gas ASE8-1000 Turbine Nat. Gas	548	55	17,457	0	#N/A	1.1004	0.2539	0.0999	0.0339	\$1,426	\$0.005	\$5				
Allied Signal Gas ASE8-1000 Turbine Nat. Gas Cogen	548	55	14,407	6,950	300	1.1004	0.2539	0.0999	0.0339	\$1,322	\$0.005	\$5				
Pratt & Whitney ST6L-721 Gas Turbine Nat. Gas	508	50	15,255	0	#N/A	1.4522	0.3351	0.1318	0.0447	\$1,455	\$0.005	\$5				
Pratt & Whitney ST6L-721 Gas Turbine Nat. Gas Cogen	508	50	10,194	6,561	300	1.4522	0.3351	0.1318	0.0447	\$732	\$0.011	\$7				
Cat Engine 3512 90TA Gen Set Nat. Gas	555	300	11,078	0	#N/A	0.1835	0.3658	0.1835	0.0026	\$864	\$0.011	\$7				
Cat Engine 3512 90TA Gen Set Nat. Gas Cogen	555	300	12,076	3,621	250	0.1835	0.3658	0.1835	0.0026	\$713	\$0.010	\$7				
Cat Engine 3516 90TA Gen Set Nat. Gas	740	300	12,312	0	#N/A	0.2447	0.4878	0.2447	0.0035	\$820	\$0.009	\$7				
Cat Engine 3516 90TA Gen Set Nat. Gas Cogen	740	300	11,881	3,620	250	0.2447	0.4878	0.2447	0.0035	\$850	\$0.010	\$7				
Hess 85 Nat. Gas	80	40	10,625	0	#N/A	0.0355	0.0710	0.0355	0.0005	\$1,000	\$0.013		0.008	0.1780		
Hess 85 Nat. Gas Cogen	80	40	10,625	6,125	200	0.0355	0.0710	0.0355	0.0005	\$1,000	\$0.013		0.008	0.1780		
Hess 140 Nat. Gas	140	70	9,143	0	#N/A	0.0621	0.1242	0.0621	0.0008	\$1,000	\$0.013		0.008	0.1040		
Hess 140 Nat. Gas Cogen	140	70	9,143	4,786	200	0.0621	0.1242	0.0621	0.0008	\$1,000	\$0.013		0.008	0.1040		
Hess 200 Nat. Gas	200	100	9,000	0	#N/A	0.0887	0.1774	0.0887	0.0011	\$1,000	\$0.013		0.008	0.1200		
Hess 200 Nat. Gas Cogen	200	100	9,000	5,000	200	0.0887	0.1774	0.0887	0.0011	\$1,000	\$0.013		0.008	0.1200		
GENERAC DG50 Nat. Gas	50	25	11,298	0	#N/A	0.0222	0.0443	0.0222	0.0004	\$705	\$0.013		0.008	0.1505		
GENERAC DG50 Nat. Gas Cogen	50	25	11,298	5,814	200	0.0222	0.0443	0.0222	0.0004	\$955	\$0.013		0.008	0.1505		
CoastIntelligen 250-SG Nat. Gas	250	125	9,600	0	#N/A	0.1109	0.2217	0.1109	0.0014	\$900	\$0.010		0.009	0.279		
CoastIntelligen 250-SG Nat. Gas Cogen	250	125	9,600	4,840	220	0.1109	0.2217	0.1109	0.0014	\$1,000	\$0.010		0.009	0.279		
Wind Generators																
Bergey - 10 kW	10									\$1,750	\$0.005					
WTIC - 10 kW	10									\$1,100		\$100				
WTIC - 12.5 kW	13									\$1,100		\$100				
WTIC - 15 kW	15									\$1,100		\$100				
WTIC - 17.5 kW	18									\$1,100		\$100				
WTIC - 20 kW	20									\$1,100		\$100				
AOC - 50 kW	50									\$2,050		\$1,750				

Generator Data

No.	Gen. Description	Configuration	Type	Capacity Range Min	Capacity Range Max	Min time operation	Heat Rate Btu/kWh	Cogen Btu/kWh	NOx	CO	SOx	VO	VO	SOx	Installed Cost \$/W	O&M Cost \$/W-yr	shape	Partial Load Intercept	Footprint sq ft/hr	NOx	CO	VO	SOx	park	roof	garage	Con #	min area sq ft	max area sq ft	fuel	noise
11	Gas Engine - simple cycle	power only		1	50	1000	0.5	10,000	0	0.2447	0.4878	0.2447	0.0035	\$820	\$0.009	\$7	0.012	0.000	0.22	0.000331	0.000858	0.000331	0.000005	1	0	1	11	11	220	gas	
12	Gas Engine - simple cycle	power only		1	1000	6000	0.5	10,000	0	0.2447	0.4878	0.2447	0.0035	\$820	\$0.009	\$7	0.012	0.000	0.22	0.000331	0.000858	0.000331	0.000005	1	0	1	12	220	1320	gas	
21	Gas Engine - cogen	cogen		2	80	1000	0.5	10,000	3,500	0.2447	0.4878	0.2447	0.0035	\$850	\$0.010	\$7	0.012	0.000	0.31	0.000331	0.000858	0.000331	0.000005	1	0	1	21	15.5	310	gas	
22	Gas Engine - cogen	cogen		2	1000	6000	0.5	10,000	3,500	0.2447	0.4878	0.2447	0.0035	\$850	\$0.010	\$7	0.012	0.000	0.31	0.000331	0.000858	0.000331	0.000005	1	0	1	22	310	1860	gas	
31	Microturbine - simple cycle	power only		3	30	100	0.25	14,000	0	0.0310	0.0192	0.0055	0.0020	\$1,091	\$0.005	\$11	0.014	0.000	0.75	0.000518	0.000321	0.000092	0.000033	1	0	1	31	22.5	75	gas	
32	Microturbine - simple cycle	power only		3	100	300	0.25	14,000	0	0.0310	0.0192	0.0055	0.0020	\$1,091	\$0.005	\$11	0.014	0.000	0.75	0.000518	0.000321	0.000092	0.000033	1	0	1	32	75	225	gas	
41	Microturbine - cogen	cogen		4	30	100	0.25	13,000	6,545	0.0310	0.0192	0.0055	0.0020	\$1,174	\$0.015	\$9	0.014	0.000	1	0.000518	0.000321	0.000092	0.000033	1	0	1	41	30	100	gas	
42	Microturbine - cogen	cogen		4	100	300	0.25	13,000	6,545	0.0310	0.0192	0.0055	0.0020	\$1,174	\$0.015	\$9	0.014	0.000	1	0.000518	0.000321	0.000092	0.000033	1	0	1	42	100	300	gas	
51	Small Gas Turbine - single cycle	power only		5	500	2500	0.25	15,000	0	1.1004	0.2539	0.0999	0.0339	\$1,426	\$0.005	\$5	0.015	0.000	0.4	0.002859	0.000650	0.000259	0.000088	1	0	0	51	200	1000	gas	
52	Small Gas Turbine - single cycle	power only		5	2500	10000	0.25	15,000	0	1.1004	0.2539	0.0999	0.0339	\$1,426	\$0.005	\$5	0.015	0.000	0.4	0.002859	0.000650	0.000259	0.000088	1	0	0	52	1000	4000	gas	
61	Small Gas Turbine - cogen	cogen		6	500	2500	0.25	12,000	7,617	1.1004	0.2539	0.0999	0.0339	\$1,322	\$0.005	\$5	0.015	0.000	0.8	0.002859	0.000650	0.000259	0.000088	1	0	0	61	300	1500	gas	
62	Small Gas Turbine - cogen	cogen		6	2500	10000	0.25	12,000	7,617	1.1004	0.2539	0.0999	0.0339	\$1,322	\$0.005	\$5	0.015	0.000	0.8	0.002859	0.000650	0.000259	0.000088	1	0	0	62	1500	6000	gas	
71	Fuel Cell - Phosphoric Acid - power on power only	power on power only		7	50	100	0.1	9,868	0	0.0046	0.0027	0.0015	0.0000	\$6,058	\$0.019	\$361	0.009	0.000	4	0.000024	0.000013	0.000008	0.000000	1	0	1	71	200	400	gas	
72	Fuel Cell - Phosphoric Acid - power on power only	power on power only		7	100	200	0.1	9,868	0	0.0046	0.0027	0.0015	0.0000	\$6,058	\$0.019	\$361	0.009	0.000	4	0.000024	0.000013	0.000008	0.000000	1	0	1	72	400	800	gas	
81	Fuel Cell - Phosphoric Acid - cogen	cogen		8	50	100	0.1	10,074	7,517	0.0046	0.0027	0.0015	0.0000	\$6,364	\$0.022	\$337	0.009	0.000	4	0.000024	0.000013	0.000008	0.000000	1	0	1	81	200	400	gas	
82	Fuel Cell - Phosphoric Acid - cogen	cogen		8	100	200	0.1	10,074	7,517	0.0046	0.0027	0.0015	0.0000	\$6,364	\$0.022	\$337	0.009	0.000	4	0.000024	0.000013	0.000008	0.000000	1	0	1	82	400	800	gas	
91	Solar PV	power only		9	1	25	0	0	0	0	0	0	0	\$7,500	\$0.002	\$0	0	0	240	0	0	0	0	1	1	0	91	240	8000 solar		
92	Solar PV	power only		9	25	7500	0	0	0	0	0	0	0	\$7,500	\$0.002	\$0	0	0	240	0	0	0	0	1	1	0	92	8000	180000 solar		
101	Wind Generator	power only		10	10	15	0.01	0	0	0	0	0	0	\$1,263	\$0.000	\$100	0	0	5	0	0	0	0	1	0	0	101	50	75	wind	
102	Wind Generator	power only		10	15	50	0.01	0	0	0	0	0	0	\$1,338	\$0.000	\$100	0	0	5	0	0	0	0	1	0	0	102	75	250	wind	