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# I-PLACE3S ENERGY MODULE VALIDATION TESTING

*Prepared For:*  
**California Energy Commission**  
Public Interest Energy Research Program

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PIER FINAL PROJECT REPORT

November 2010  
CEC-500-2010-022



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Commission Work Authorization 06-017-P-R

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## Preface

The California Energy Commission's Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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- Transportation

*IPLACE3S Validation Testing* is the final report for the IPLACE3S validation project (Contract Number 500-06-013, Work Authorization Number 06-017-P-R) conducted by Alternative Energy Systems Consulting, Inc. The information from this project contributes to PIER's Energy-Related Environmental Research Program.

For more information about the PIER Program, please visit the Energy Commission's website at [www.energy.ca.gov/research/](http://www.energy.ca.gov/research/) or contact the Energy Commission at 916-654-4878.



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## Abstract

The I-PLACE3S energy module validation testing involved a comparison of I-PLACE3S' output against Sacramento Municipal Utility District electrical energy consumption data for four Sacramento neighborhoods for 2005. The four neighborhoods were Downtown, Natomas, Midtown and Metro Center. The accuracy of the output from the program depends significantly on the accuracy of the inputs. The I-PLACE3S results showed the greatest accuracy in the Midtown neighborhood, where it came within 5 percent of the SMUD data on an annual basis with a maximum difference of 31 percent in February, a minimum difference of zero percent in October. With this level of accuracy, I-PLACE3S is not a good tool for predicting electrical load for neighborhood project areas. However, the energy module has the potential to benefit California by providing planners a tool that is well-suited for evaluating the relative effect on energy use of different land-use planning scenarios at the neighborhood level.

**Keywords:** I-PLACE3S, energy module, placetype, Downtown, Natomas, Midtown, Metro Center, SACOG, SMUD

Please use the following citation for this report:

Salour, Dara. (Alternative Energy Systems Consulting, Inc.). 2010. *I-PLACE3S Energy Module Validation Testing*. California Energy Commission. Publication Number: CEC-500-2010-022.



## Executive Summary

The California Energy Commission developed the Planning for Community Energy, Economic, and Environmental Sustainability (PLACE3S) program in the 1990s. It is a desktop computer-based geographic information system software application for land-use planning. The program allows planners to compare the impacts of different land use and development scenarios by evaluating vehicle miles traveled, housing, employment, amount of urbanized land, preservation of agricultural land, and others. An energy component was added to the desktop version in 2001. This energy module included algorithms to calculate energy demand and weigh options for distributed energy generation for any given geographic area in California. Due to PLACE3S' incapability in handling the data volume, speeds, and complexity necessary for sophisticated assessments and real-time response, the Energy Commission contracted with EcoInteractive Inc. to convert it from a desktop personal computer program to an Internet version—called I-PLACE3S. This dramatically improved processing times and accessibility. However, the initial Internet version did not include any of the more complex desktop energy module calculations for the energy impacts of building energy efficiency or distributed generation. Consequently, the Energy Commission contracted again with EcoInteractive Inc. to create an Internet-based energy module. This equips planners with the capability of determining energy use at the parcel and neighborhood level and evaluating the relative effect on energy use of different scenarios. The validation testing of the I-PLACE3S energy module has focused on evaluating the accuracy of the program for larger project areas such as whole neighborhoods, where more generalized land use information is available. The validation testing has been a collaborative effort. The Sacramento Municipal Utility District (SMUD) has provided the load data with which to do the validation. The Sacramento Area Council of Governments (SACOG) has provided the input data to the I-PLACE3S program to characterize the project areas at the parcel, placetype—land uses that are user defined and are created in I-PLACE3S—and neighborhood levels. SACOG has also provided expertise in running and troubleshooting the I-PLACE3S program. Alternative Energy Systems Consulting, Inc. has provided expertise in energy systems and has been involved in running and validating the energy module.

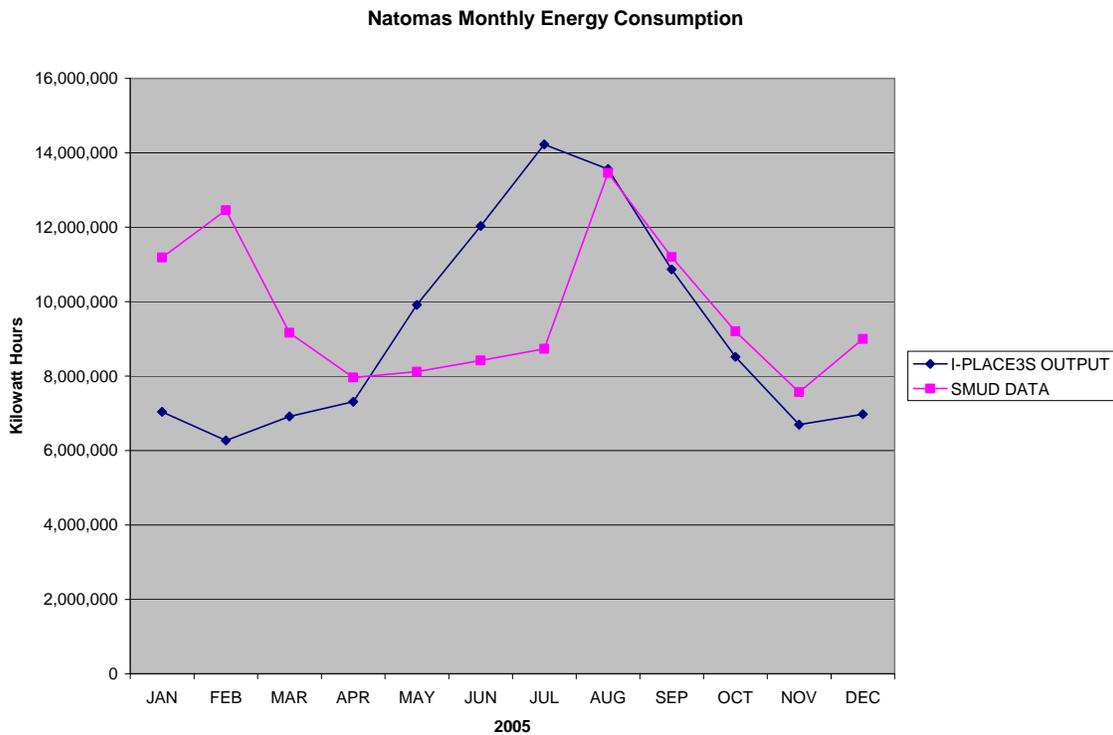
The method used in validating the I-PLACE3S output was to compare SMUD billing data that has been aggregated by placetype for 2005 with the I-PLACE3S Energy Reports for the Sacramento Downtown, Midtown, Metro Center, and Natomas areas. Once an initial comparison had been made, modifications were made to the sector percentages and the average dwelling unit size for those placetypes where there was a greater than 10 percent difference between the I-PLACE3S output and the SMUD data. This process was repeated until the output for all placetypes was within 10 percent of the SMUD data or as close to it as possible. Finally, where possible, the average dwelling unit size for residential placetypes was compared to Sacramento County Assessor's data.

The results at the neighborhood level are shown in Table 3-1.

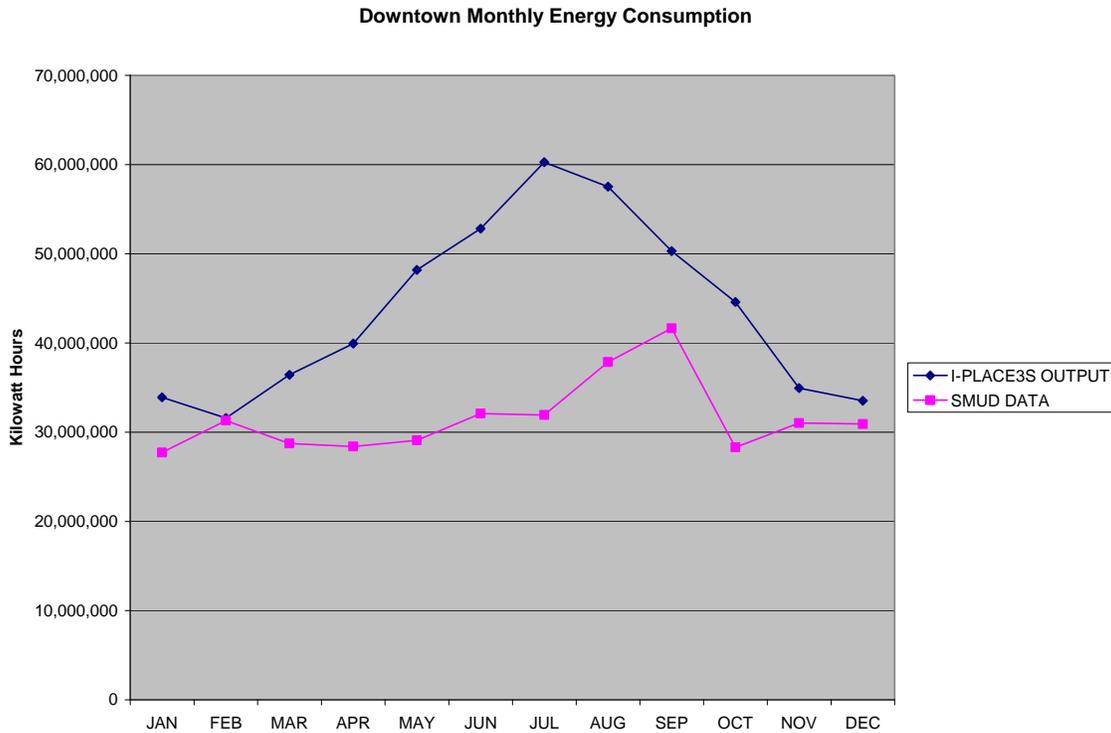
**Table 3- 1 Comparison of the Percent Difference between I-PLACE3S Output and the SMUD Data on a Monthly and Annual Basis at the Neighborhood Level.**

NEIGHBORHOOD	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION			% DIFFERENCE
	MAX	AVERAGE	MIN	ANN. ELEC. CONS.
Downtown	88%	38%	0%	38%
Natomas	63%	24%	1%	5%
Midtown	31%	13%	0%	5%
Metro Center	29%	16%	0%	15%

The difference between the load profiles can be seen when comparing the neighborhood load profile for Natomas, which is primarily driven by residential electrical consumption, and the Downtown load profile, which is primarily driven by office load.



**Figure 3- 1 Natomas Monthly Electrical Energy Consumption**



**Figure 3- 2 Downtown Monthly Energy Consumption**

In Figure 3 -2 above, it can be seen that the I-PLACE3S output over predicts the SMUD data significantly in the Downtown load profile. This is potentially due to errors in the SACOG input data set for the High Intensity Office placetype and the Central Business District (CBD) Office placetype.

In the Natomas neighborhood, once the actual average dwelling unit size (from the Sacramento County Assessor’s data) was input into I-PLACE3S the Natomas Low Density Residential and Medium Density Residential and Medium High Density Residential placetypes exhibited a range of correlations with respect to the annual SMUD load data, at 21 percent, 5 percent, and 48 percent difference respectively.

In general, the I-PLACE3S output tends to follow the outside air temperature for 2005 which peaks in July. Whereas, the SMUD load data tends to peak in August and in most cases does not have a bell-shaped curve.

In the testing of these four areas, it appears as though I-PLACE3S does not do a good job of predicting the load for the Light Industrial Placetype. This placetype is driven by internal equipment loads and has a non-outside air temperature-driven load profile. The erroneous results produced in the model could be a factor of a number of things: 1) The light industrial load in these neighborhoods is not typical and is much higher than I-PLACE3S could predict 2) the placetype has been assigned incorrectly or 3) there was

not enough information about the use of the buildings to characterize it correctly in the energy settings.

K-12 schools were evaluated only in the Natomas neighborhood where I-PLACE3S under predicted the SMUD data by 43 percent for this placetype. Unlike the above example, this error is unlikely due to the energy settings being incorrectly defined; however, a possible explanation would be that there was an error in the placetype assignment by SACOG.

I-PLACE3S does a good job of modeling the medical facility in the Midtown neighborhood and comes within 8 percent of the SMUD load data on an annual basis.

It is recommended that there be further investigation into those placetypes discussed above where I-PLACE3S fell short in predicting the load. This can be done by first updating the SACOG input data set, and if that does not improve performance then secondly by updating the look up tables used by I-PLACE3S for those particular placetypes.

Throughout the validation study it became clear that the accuracy of the SACOG input data set made a great deal of difference in the accuracy of the output. Therefore SACGO made an extra effort to rectify the input data set for the Metro Center neighborhood and a comparison was made between the results before and after the rectification:

**Table 3- 2 Comparison of Percentage Difference between I-PLACE3S Output and SMUD Load Data for Two Different Input Characterizations of the Metro Center Neighborhood.**

I-PLACE3S METRO CENTER INPUT CHARACTERIZATION	% DIFFERENCE ANNUAL ELEC. CONS.	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
		MAX	AVERAGE	MIN
Original	28%	41%	28%	9%
Rectified	15%	29%	16%	0%

The correct input characterization of the Metro Center neighborhood did much to improve the accuracy of the I-PLACE3S output. At the neighborhood level the percent difference in annual electrical consumption went from 28 percent to 15 percent, which is a 13 percent improvement.

In conclusion I-PLACE3S is a good tool for comparing the relative energy usage of different scenarios at the neighborhood level. It was most accurate in predicting energy usage for the Midtown neighborhood. However, even there, it showed a maximum difference of 31 percent between the SMUD load data and the I-PLACE3S output. The minimum difference on a monthly basis was 0 percent and the average over the course of the year was 13 percent. The percent difference in annual consumption was 5 percent. With this level of accuracy it cannot be considered a good tool for predicting energy consumption at the neighborhood level. In general, its accuracy does improve when the

inputs to the program are accurately determined. It is suited for use with new developments where input information can be gathered accurately from permitting data. I-PLACE3S tends to lose its accuracy with areas where land uses have changed and up-to-date information is not available.

## 1.0 Introduction

The Planning for Community Energy, Economic, and Environmental Sustainability (PLACE3S) Program was developed by the California Energy Commission in the 1990s. It is a desktop computer-based geographic information system software application for land use planning. The program allows planners to compare the impacts of different land use and development scenarios by evaluating vehicle miles traveled, housing, employment, amount of urbanized land, preservation of agricultural land, and others. An energy component was added to the desktop version in 2001. This energy module included algorithms to calculate energy demand and weigh options for distributed energy generation for any given geographic area in California. Due to PLACE3S' incapability in handling the data volume, speeds, and complexity necessary for sophisticated assessments and real-time response the Energy Commission contracted with EcoInteractive Inc. to convert it from a desktop personal computer program to an Internet-version—called I-PLACE3S. This dramatically improved processing times and accessibility. However, the initial Internet version did not include any of the more complex desktop energy module calculations for the energy impacts of building energy efficiency or distributed generation. Consequently, the Energy Commission contracted again with EcoInteractive Inc. to create an Internet-based energy module. This equips planners with the capability of determining energy use at the parcel and neighborhood level and evaluating the relative impact on energy use of different scenarios.

The validation testing of the I-PLACE3S energy module has focused on evaluating the accuracy of the program for larger project areas such as whole neighborhoods, where more generalized land use information is available. The testing has involved the coordination of three separate organizations: the Sacramento Municipal Utility District (SMUD), the Sacramento Area Council of Governments (SACOG), and Alternative Energy Systems Consulting, Inc. (AESC). Each entity has played a unique role in the validation process.

SMUD is the sixth largest publicly owned utility in the country in terms of customers served, and serves Sacramento County and part of Placer County. SMUD has been in operation for 60 years and their innovative energy programs are known throughout the state, nation, and world. SACOG is an association of local governments in the six-county Sacramento Region. Its members include the counties of El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba as well as 22 cities. SACOG provides transportation planning and funding for the region, and serves as a forum for the study and resolution of regional issues. In addition to preparing the region's long-range transportation plan, SACOG approves the distribution of affordable housing in the region and assists in planning for transit, bicycle networks, clean air, and airport land uses. AESC, Inc. is an engineering firm founded and incorporated in 1994, to provide consulting and technical services to utilities, energy service providers, energy technology developers, government agencies, and industrial/commercial clients. Its staff consists of Mechanical, Electrical, Environmental and Software engineers with specialized expertise in energy

production, delivery, and use. AESC has offices in Concord, Pasadena, Carlsbad, and San Diego, California.

SMUD has provided the billing data in GIS format for four Sacramento neighborhoods to facilitate the comparison of the load in these neighborhoods against the I-PLACE3S energy module output. The four neighborhoods are:

- Downtown
- Natomas
- Midtown/Winn Park/Capital Ave (abbreviated to Midtown)
- Metro Center

A map of the neighborhoods within the boundaries of the City of Sacramento is seen in Figure 4.1.

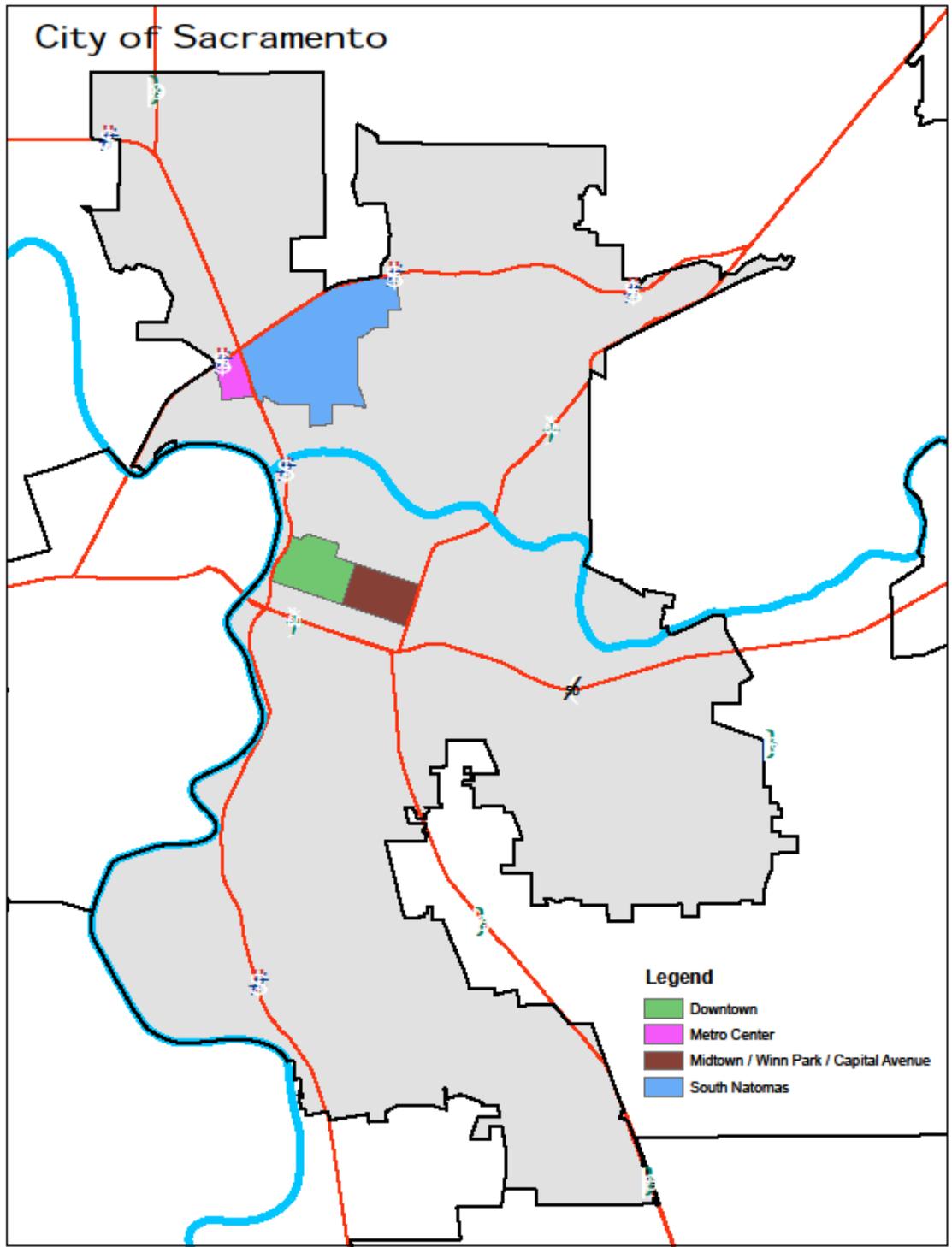


Figure 4- 1 Layout of I-PLACE3S neighborhoods within the City of Sacramento boundaries.

SACOG is the organization most familiar with the I-PLACE3S program and has been instrumental in inputting parcel level data in to the program in order to characterize the neighborhoods and prepare the four project areas for validation testing. SACOG is also the primary user of I-PLACE3S as part of its planning activities for the Sacramento region and will benefit directly from the results of this validation testing. AESC has been involved in technical review of the I-PLACE3S energy module since its inception, and has so far served as an advisory role to the Commission on the project. With the validation testing, AESC has taken on a more active role in evaluating the I-PLACE3S output and comparing it to the SMUD load data.

The parcel level data input by SACOG includes among other things, employment data, building size, parcel size, parking access, and the placetype. Information at the parcel level is aggregated by placetype and calculations are reported by placetype.

Placetypes are basically land uses that are user defined and created in I-PLACE3S using inputs such as transit friendliness, pedestrian friendliness, percent of placetype by sector, square footage by sector, parking ratios, etc. Some of the sectors a placetype could belong to are:

- Residential
- Retail
- Office
- Industrial
- Public

A full list of the sectors available are provided in the Appendices with the Placetype Energy Settings for each of the neighborhoods.

For this project, SACOG regional placetypes were used. SACOG's placetypes and 2005 existing land use was the best existing land use data available for this project. Ideally, more specific placetypes would be created when working at the neighborhood level (as we did with these four study areas). Some examples of the SACOG placetypes used in this project are provided below in Figures 4-1 and 4-2.

CODE AND NAME		EXAMPLES		DU/ACRE RANGE	FAR RANGE	DESCRIPTION
<b>RESIDENTIAL BUILDING TYPES*</b>						
RR	Rural Residential			<= 1.0	--	Rural residential includes very large lot residential (2 acres per lot) as well as agricultural residential (5-20 acres per lot).
VLDR	Very Low Density Residential			1.1 – 4.0	--	Arden Park has mainly large lots in the ¼ to 1/3 acre size. Gardenland (South Natomas) has grid-streets with 1 acre lots and small houses.
LDR	Low Density Residential			4.1 – 8.0	--	Standard SF lot of 52x100' min. Allows cul-de-sacs or grid pattern, w/cul-de-sac subdivisions at low end of range. Curtis Park at high end of range.
MDR	Medium Density Residential			8.1 – 12.0	--	Small lot subdivisions: Villa Palazzo in Pocket (3,500 sqft lots), standard lots in Laguna West and some low density suburban garden apartments.
MHDR	Medium-High Density Residential			12.1 – 25.0	--	Metro Square in midtown is detached townhouse project at approx. 20 DU/ac. Most standard 2-story apts w/ surface parking are in this range.
HDR	High Density Residential			25.1 +	--	2+ story Attached units with structured parking (e.g., tuck-under).
URB	Urban Residential			50 – 100+	--	Fremont Mews at 16 <sup>th</sup> /P is a mixed use project; the 3 floors of housing are at a density of 78 DU/acre.
<b>NON-RESIDENTIAL BUILDING TYPES*</b>						
HOFF	High-Intensity Office			--	1.1+	5% Retail 95% Office
MOFF	Moderate-Intensity Office			--	0.3 - 1.0	5% Retail 95% Office
CRET	Community/ Neighborhood Retail			--	0.2 – 0.3	100% Retail
RRET	Regional Retail			--	0.2 – 0.3	95% Retail 5% Office
LI-OFF	Light Industrial-Office			--	0.2 – 0.3	75% Office 25% Industrial
LI	Light Industrial			--	0.2 – 0.3	25% Office 75% Industrial
HI	Heavy Industrial			--	0.1 – 0.2	100% Industrial
PQP	Public/ Quasi-Public			--	0.2 – 0.3	100% Public

**Figure 4- 2 Residential and Non-Residential Placetypes**  
(Source SACOG)

CODE AND NAME		EXAMPLES		DU/ACRE RANGE	FAR RANGE	DESCRIPTION
<b>MIXED USE BUILDING TYPES*</b>						
RCO	Regional Commercial/Office <sup>2</sup>			--	0.3 – 0.4	75% Retail 25% Office
CNCO	Community/Neighborhood Commercial/Office <sup>2</sup>			--	0.2 – 0.3	75% Retail 25% Office
MU1	Mixed Use Employment Focus			15 – 25	0.75 – 1+	45% Residential 40% Retail 15% Office
MU2	Mixed Use Residential Focus			60 – 90	1.5 – 2.5	70% Residential 25% Retail 5% Office

**Figure 4- 3 Mixed Use Placetypes**  
(Source SACOG)

The description sections of these illustrations describe typical sector percentages for these placetypes. The Floor Area Ratio (FAR) for non-residential buildings is the total building square footage (building area) divided by the site size square footage (site area). DU/Acre Range describes the typical range of dwelling units per acre. As the SMUD load data is also aggregated by placetype it is possible to do a direct comparison at the placetype level of the I-PLACE3S output with the SMUD data. The testing methodology is described in the next section.

## 2.0 Project Approach (Testing Methodology)

The testing methodology employed to validate the I-PLACE3S program involved the following steps:

1. Compared SMUD billing data that had been aggregated by placetype for the year 2005 with the I-PLACE3S Energy Reports for the Sacramento Downtown, Midtown, Metro Center and Natomas areas as defined by SACOG.
2. Determined those placetypes where there was a greater than 10 percent difference between the I-PLACE3S output and the SMUD data.
3. Modified the I-PLACE3S output by changing the input to the Placetype Manager and the Placetype Energy Settings for sector percentages and also by average square footage of dwelling units such that the I-PLACE3S output for all placetypes was within 10 percent of the SMUD data. Where it was not possible to come within 10 percent of the SMUD data we attempted to approach it as close as possible.
4. Verified that the average square footage of dwelling units was accurate by checking against Assessor's data from the Sacramento County Assessor's office.

The reason for using billing data from 2005 was that the most current SACOG data for input into I-PLACE3S at the parcel level was from the year 2005. SACOG data is derived from a number of sources including aerial photographs, permitting data, employment data and land use data. It was originally intended to compare kW demand by placetype for each neighborhood. However, SMUD did not have this data available for the year 2005. It was also originally intended to compare I-PLACE3S output for gas usage in these neighborhoods against PG&E billing data. Unfortunately, due to the limited time and budget for this project it was not possible to conduct that part of the analysis.

The Community/Neighborhood Commercial Office placetype shows up in a standard format and in a modified format. This variation was originally intended to highlight different sector percentages in Placetype Energy Settings and shows up in all of the neighborhoods. Invariably, due to the similarity in the two placetypes they ended up with the same sector percentages as part of the analysis.

### 3.0 Test Results

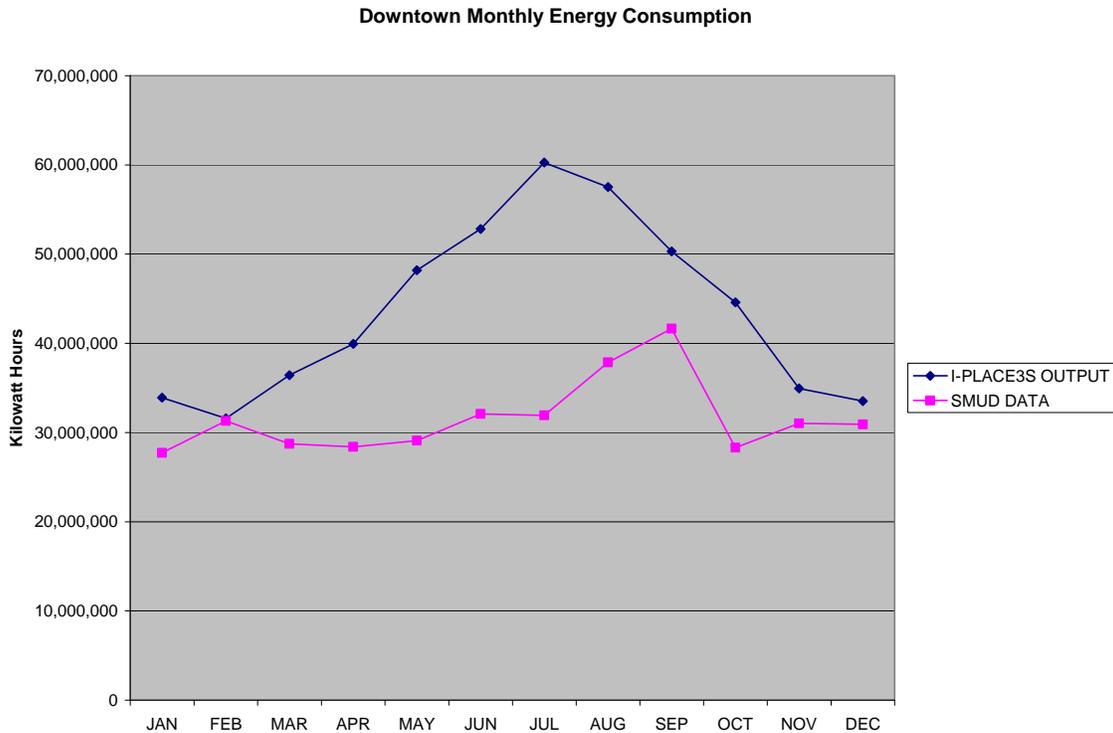
#### 3.1. Downtown

In the Downtown neighborhood almost 76 percent of the electrical load is attributed to office placetypes. The percentage of neighborhood electrical load by placetype can be seen in Table 6-1.

**Table 6- 1 Percentage of Downtown Electrical Consumption by Placetype**

<b>PLACETYPE NAME</b>	<b>% OF TOTAL CONSUMPTION USING SMUD DATA</b>
Low Density Residential	0.003%
Medium Density Residential	0.01%
Medium-High Density Residential	0.88%
High Density Residential	2.54%
Urban Residential	1.18%
High-Intensity Office	21.44%
Moderate-Intensity Office	15.22%
Community/Neighborhood Retail	4.54%
Regional Retail	1.70%
Light Industrial - Office	0.05%
Light Industrial	0.18%
Public/Quasi-Public	6.36%
Community/Neighborhood Commercial/Office	4.02%
Community/Neighborhood Commercial/Office - Modified	0.51%
Regional Commercial/Office	7.43%
Mixed Use Employment Focus	0.22%
Mixed Use Residential Focus	0.03%
Sac CBD High Intensity Mixed Use Office	0.04%
Intense Urban Residential	0.76%
CBD Office	32.90%

At the neighborhood level, the SMUD data shows a fluctuation in energy consumption between 28 million and 42 million kWh. The I-PLACE3S output fluctuates between 30 million and 60 million kWh. The monthly energy consumption at the neighborhood level is illustrated in Figure 6-1.



**Figure 6- 1 Downtown Monthly Energy Consumption in 2005**

The annual energy consumption by placetype is described in Table 6-2.

**Table 6- 2 Downtown Annual Energy Consumption by Placetype**

PLACETYPE NAME	ANNUAL ELECTRICAL CONSUMPTION (KWH)		
	I-PLACE3S OUTPUT	SMUD DATA	% DIFFERENCE
Low Density Residential	9,446	10,385	9%
Medium Density Residential	30,693	23,468	31%
Medium-High Density Residential	928,571	3,341,080	72%
High Density Residential	10,002,549	9,685,446	3%
Urban Residential	4,267,157	4,488,265	5%
High-Intensity Office	78,005,349	81,674,257	4%
Moderate-Intensity Office	17,534,365	58,003,800	70%
Community/Neighborhood Retail	16,380,029	17,286,853	5%
Regional Retail	6,148,205	6,459,689	5%
Light Industrial - Office	180,866	195,320	7%

Light Industrial	1,021,812	667,274	53%
Public/Quasi-Public	19,205,999	24,248,891	21%
Community/Neighborhood Commercial/Office	13,725,666	15,325,252	10%
Community/Neighborhood Commercial/Office - Modified	619,044	1,952,575	68%
Regional Commercial/Office	4,520,383	28,315,688	84%
Mixed Use Employment Focus	735,777	851,414	14%
Mixed Use Residential Focus	148,156	110,520	34%
Sac CBD High Intensity Mixed Use Office	1,960,348	154,567	1168%
Intense Urban Residential	2,033,883	2,878,932	29%
CBD Office	346,646,321	125,357,417	177%
Total	524,056,637	381,031,093	38%

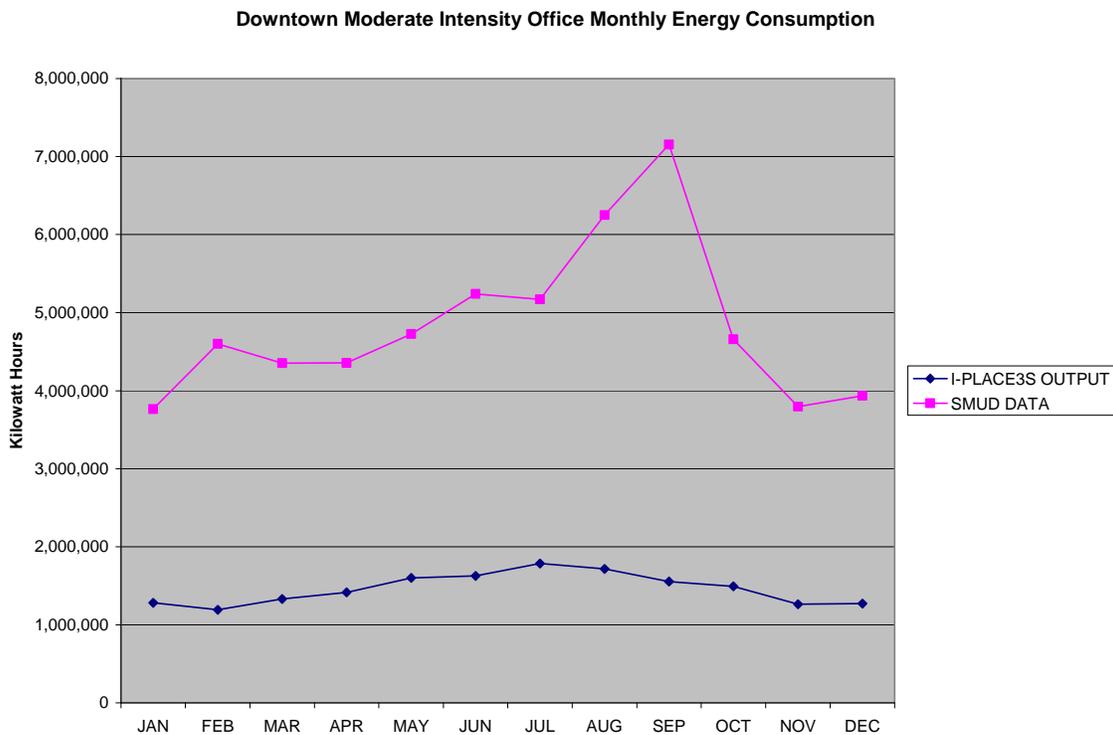
The difference between the I-PLACE3S output and SMUD load data on a monthly basis is described in Table 6-3.

**Table 6- 3 Downtown Percentage Difference in Monthly Electrical Consumption by Placetype**

PLACETYPE NAME	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
	MAX	AVERAGE	MIN
Low Density Residential	89%	33%	13%
Medium Density Residential	135%	45%	1%
Medium-High Density Residential	89%	70%	35%
High Density Residential	53%	23%	0%
Urban Residential	26%	16%	3%
High-Intensity Office	33%	15%	1%
Moderate-Intensity Office	78%	69%	65%
Community/Neighborhood Retail	35%	15%	1%
Regional Retail	23%	14%	2%
Light Industrial - Office	50%	21%	4%
Light Industrial	170%	58%	12%
Public/Quasi-Public	56%	22%	7%
Community/Neighborhood Commercial/Office	28%	12%	3%
Community/Neighborhood Commercial/Office - Modified	74%	68%	63%
Regional Commercial/Office	88%	84%	79%
Mixed Use Employment Focus	42%	19%	6%
Mixed Use Residential Focus	106%	40%	2%
Sac CBD High Intensity Mixed Use Office	1929%	1242%	562%
Intense Urban Residential	58%	27%	0%
CBD Office	302%	184%	72%

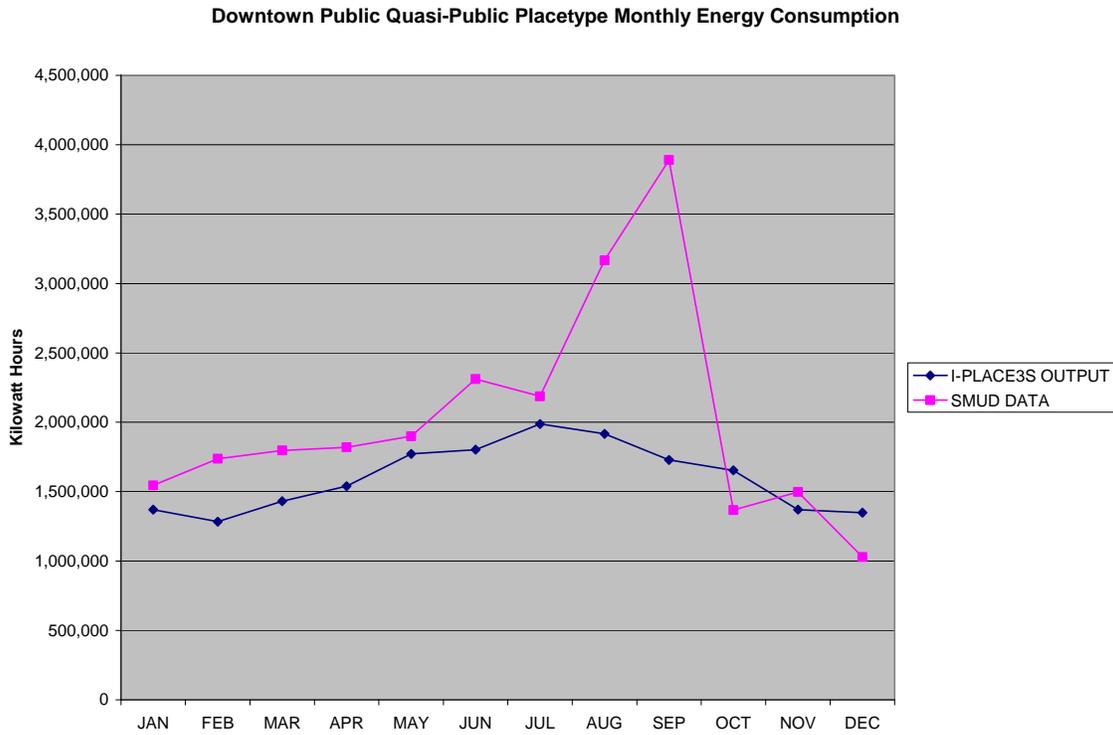
With the High Intensity Office placetype I-PLACE3S was over predicting the load and was made to reduce its energy consumption by assigning a five percent weighting factor to the large office sector and a 95 percent weighting to the small retail sector. This resulted in a four percent annual difference between the I-PLACE3S output and the SMUD data but is not an accurate depiction of the High Intensity Office placetype which more likely consists of 95 percent large office and five percent small retail. When this switch is made the I-PLACE3S output over predicts the SMUD data by 57 percent annually.

With the Moderate Intensity Office placetype I-PLACE3S is under predicting the annual energy consumption by 70 percent. Figure 6-4 illustrates the difference in energy consumption on a monthly basis. This under prediction is present despite assigning a 95 percent weighting factor to the large office sector and a five percent weighting to the small retail sector in Placetype Energy Settings.



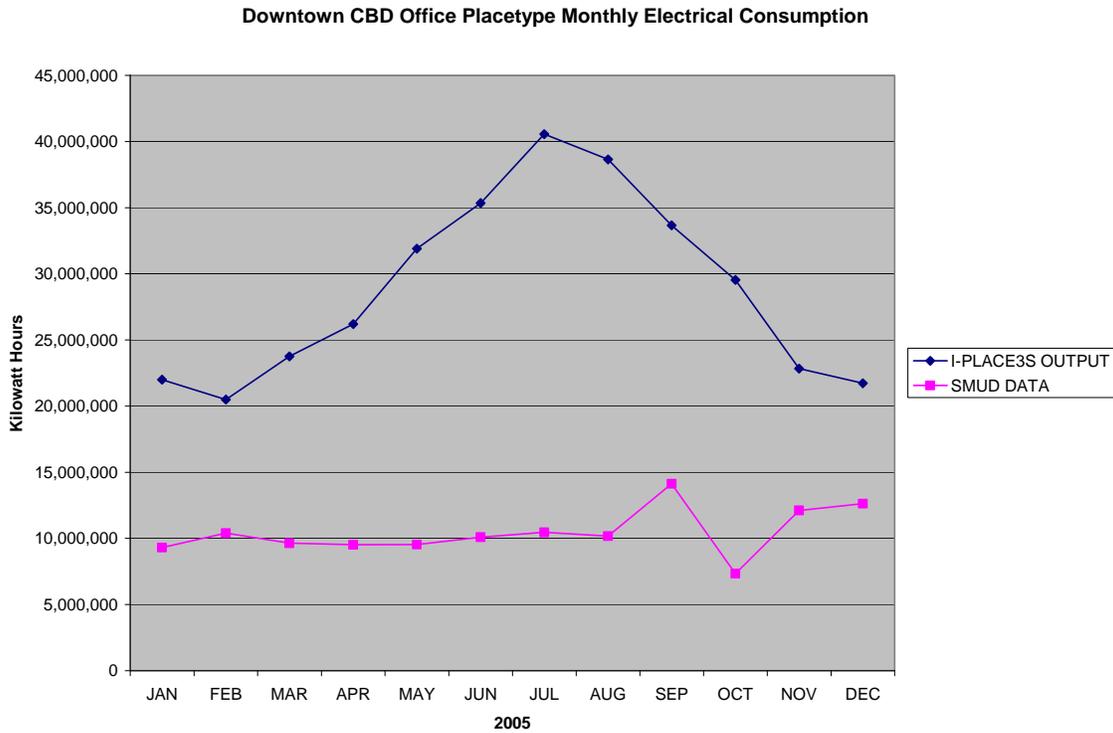
**Figure 6- 2 Downtown Moderate Intensity Office Placetype Monthly Energy Consumption**

I-PLACE3S also under predicts the annual energy consumption for the Public Quasi-Public placetype by 20 percent. This placetype was also assigned a sector weighting factor of 95 percent for large office and five percent for small office. The monthly variation in energy consumption is shown in Figure 6-3.



**Figure 6- 3 Downtown Public Quasi-Public Placetype Monthly Energy Consumption**

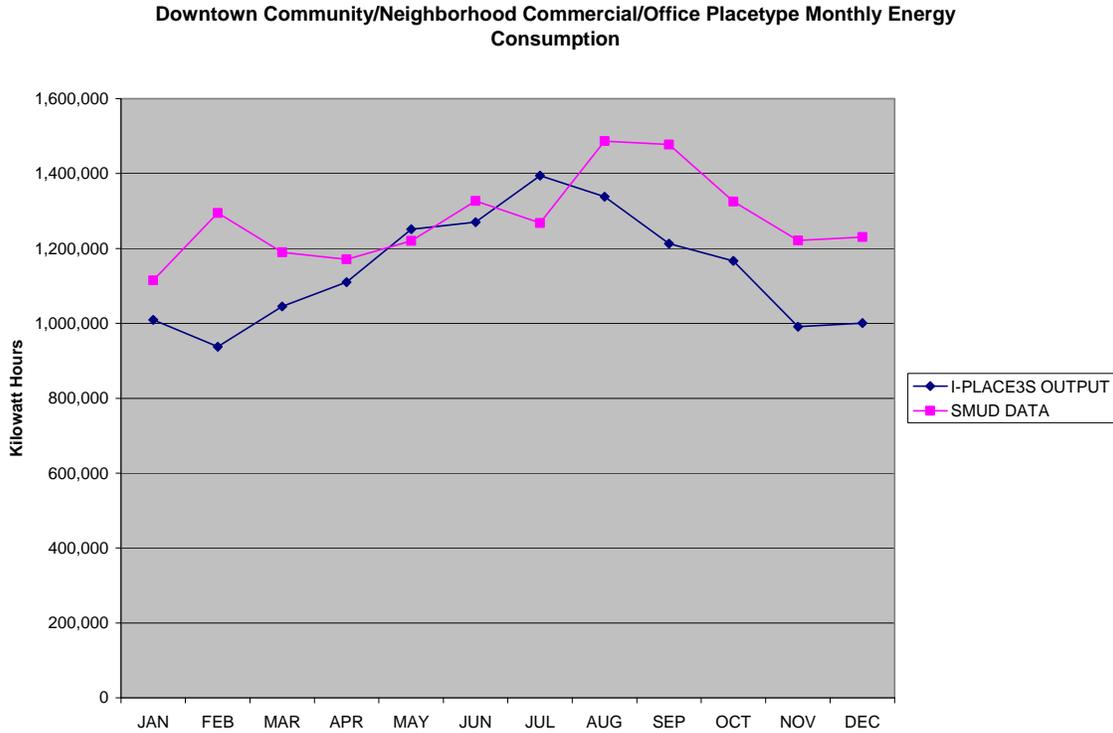
The I-PLACE3S results follow the SMUD data fairly closely until August and September 2005 when there is a spike in energy consumption that I-PLACE3S cannot follow. With the CBD Office placetype the I-PLACE3S results vastly over predict the SMUD load data which is fairly constant for the first part of the year followed by a peak in September and a dip in energy consumption in October. This is illustrated in Figure 6-4.



**Figure 6- 4 Downtown CBD Office Placetype Monthly Electrical Consumption**

At 32.9 percent of the load this placetype is by far the largest contributor to the Downtown annual electrical consumption. Therefore the over prediction of the load by such a wide margin skews the closeness of the results for the whole neighborhood. In order to reduce the degree of over prediction the weighting for the large office sector was set at five percent and the weighting for small retail sector was set at 95 percent. Despite this obvious manipulation of the input to I-PLACE3S, the annual results show an over prediction by I-PLACE3S of 177 percent. If the sector weighting were reversed, as it should be, the over prediction of the load data would be significantly greater.

The I-PLACE3S annual results for the Community/Neighborhood Commercial Office placetype is within 10 percent of the SMUD data, although this was achieved by assigning a weighting factor of 95 percent to the large office sector and five percent to small retail. In reality this placetype is a mix of the small office sector and small retail. When the weighting factors are changed to 95 percent small office sector and five percent small retail it results in a 27 percent under prediction of the SMUD data annually. The monthly variation of energy consumption for this placetype is shown in Figure 6-5.

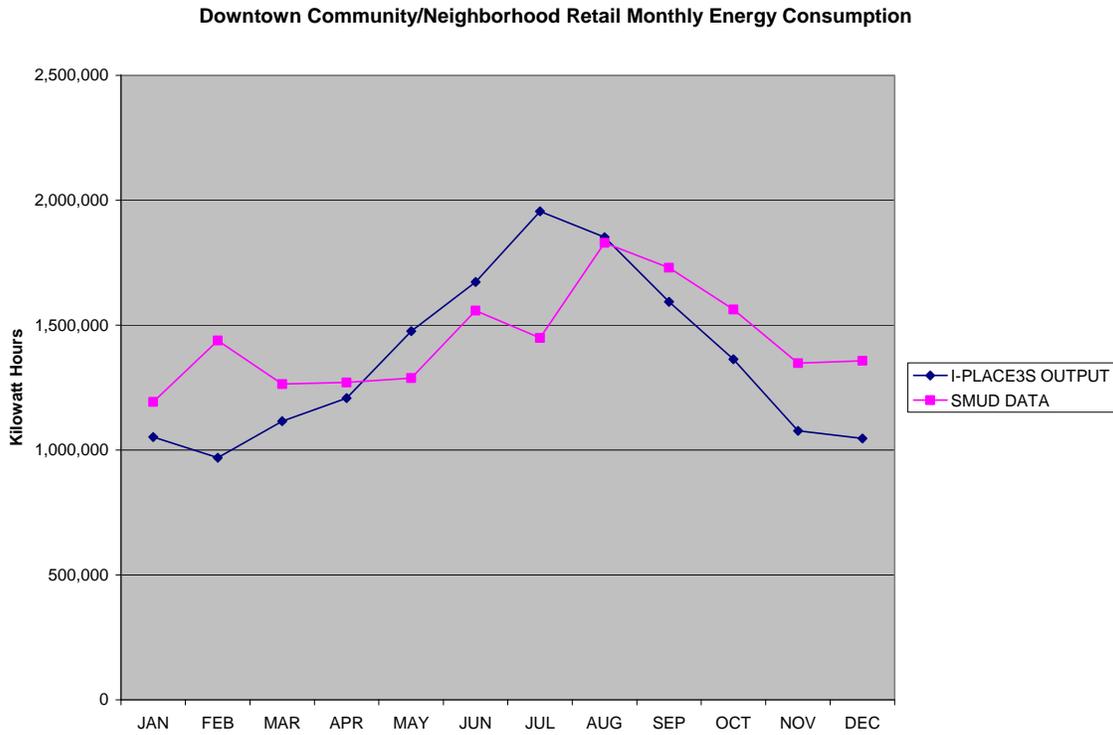


**Figure 6- 5 Downtown Community/Neighborhood Commercial/Office Placetype Monthly Energy Consumption**

The results for the Regional Commercial Office placetype are similar except more extreme. The annual results under predict the SMUD data by 84 percent.

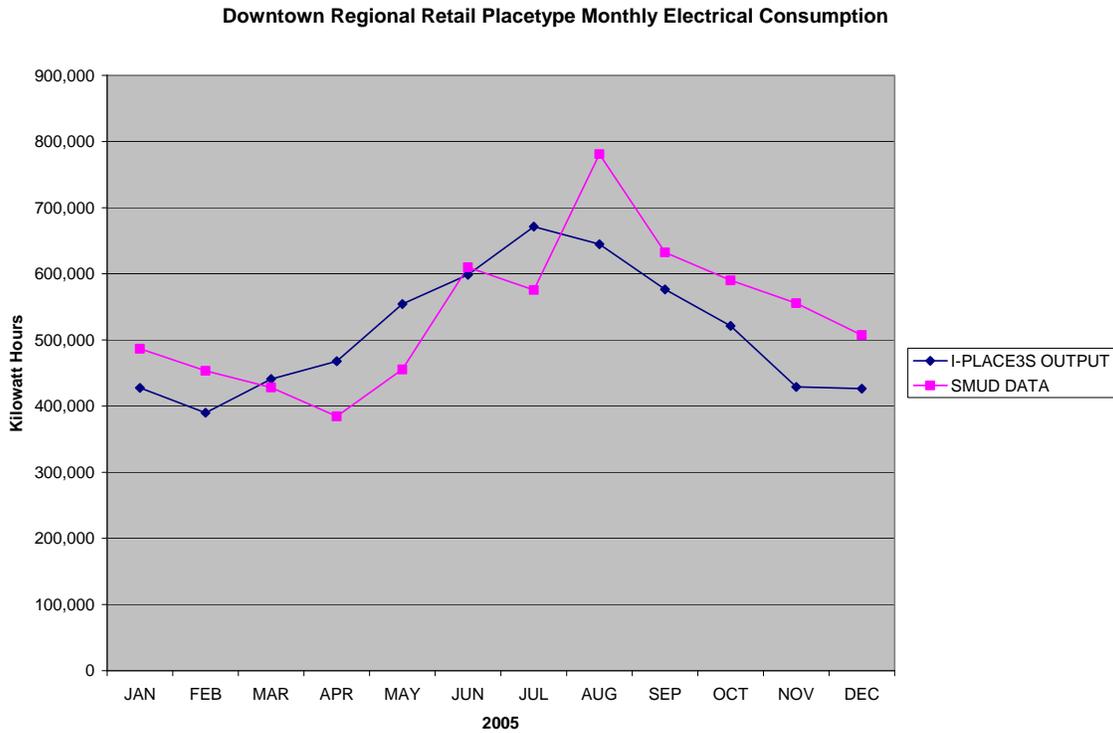
Of the three largest load office placetypes reviewed, the High Intensity Office placetype and the CBD office placetype exhibited significant degrees of over prediction of the SMUD data in the I-PLACE3S output, whereas with the Moderate Intensity Office placetype, there is an under prediction of the load data. All three placetypes were assigned the large office and small retail sectors. Therefore, some of the parcels with the High Intensity Office placetype and the CBD office placetype must be improperly characterized with those placetypes. This emphasizes the need for accurate input into I-PLACE3S.

As shown in Table 6-2 the annual I-PLACE3S results for the Community/Neighborhood Retail and the Regional Retail placetypes are both within five percent of the SMUD Data. The sector percentages for the Regional Retail placetype are 95 percent large retail and five percent small office. The sector percentages of the Community/Neighborhood Retail placetype are 75 percent restaurant and 25 percent small retail. The monthly variation in energy consumption for the Community/Neighborhood Retail placetype is shown in Figure 6-6.



**Figure 6- 6 Downtown Community/Neighborhood Retail Placetype Monthly Energy Consumption**

The I-PLACE3S results under predict the SMUD data in the summer especially in the month of July and over predict in the winter especially during February and December. The monthly variation in energy consumption for the Regional Retail placetype is shown in Figure 6-7.

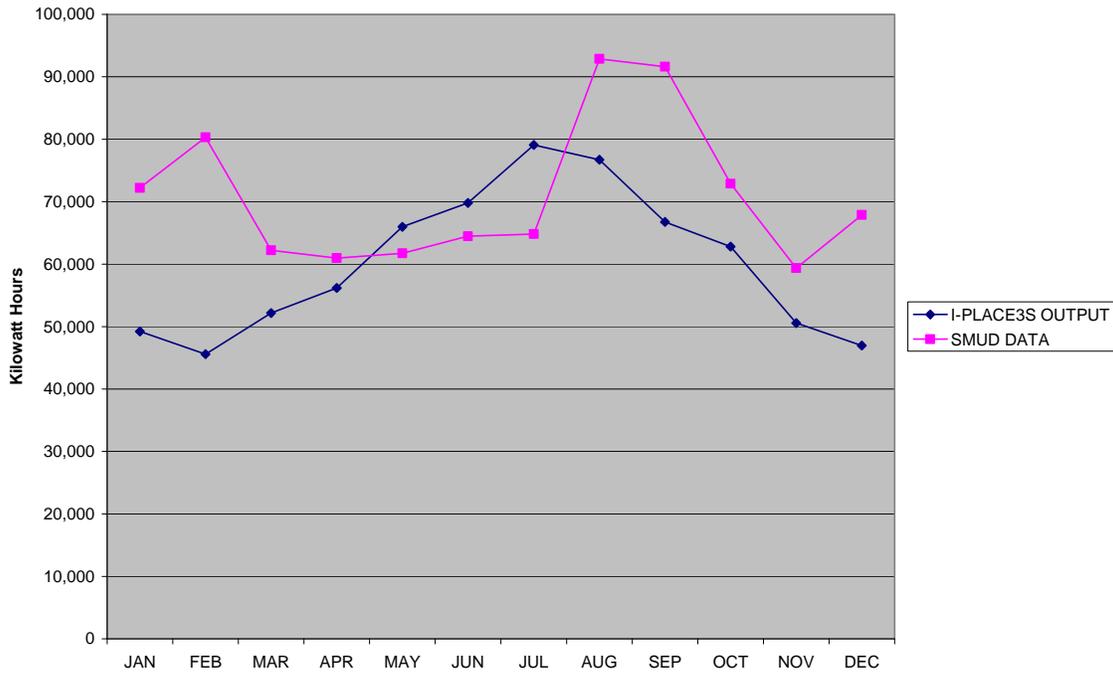


**Figure 6- 7 Downtown Regional Retail Placetype Monthly Electrical Consumption**

The monthly differences between the two sets of data indicate a maximum difference of 23 percent in August, a minimum difference of two percent in June and an average difference of 14 percent over the course of the year.

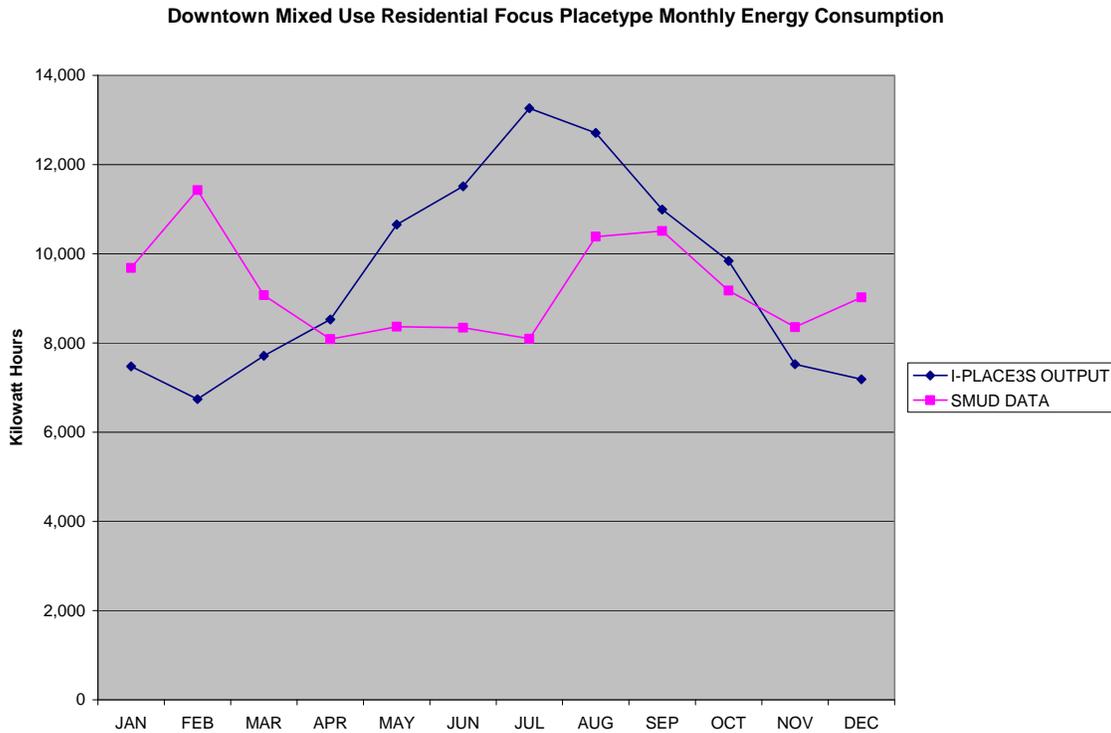
The buildings in much of the downtown area are of a mixed use, with a combination of office space, retail and residential. This is reflected in three of the placetypes used to characterize the downtown neighborhood: the Mixed Use Employment Focus, the Mixed Use Residential Focus and the Sac CBD High Intensity Mixed Use Office placetypes. The annual I-PLACE3S results for the Mixed Use Employment Focus placetype is under estimating the SMUD data by 15 percent. To get the results to be this close the sector percentages assigned were five percent residential, 90 percent small office and five percent small retail. The actual distribution may be higher for the residential and small retail sectors, and lower for the small office. The monthly variation in energy consumption for this placetype is shown in Figure 6-8.

**Downtown Mixed Use Employment Focus Placetype Monthly Energy Consumption**



**Figure 6- 8 Downtown Mixed Use Employment Focus Placetype Monthly Energy Consumption**

The Mixed Use Residential Focus placetype annual I-PLACE3S results over estimate the annual SMUD data by three percent. The mix of sector percentages assigned is as follows: 40 percent residential (greater than three stories), 35 percent small office and 25 percent small retail. The monthly variation in energy consumption for this placetype is shown in Figure 6-9.



**Figure 6- 9 Downtown Mixed Use Residential Focus Placetype Monthly Energy Consumption**

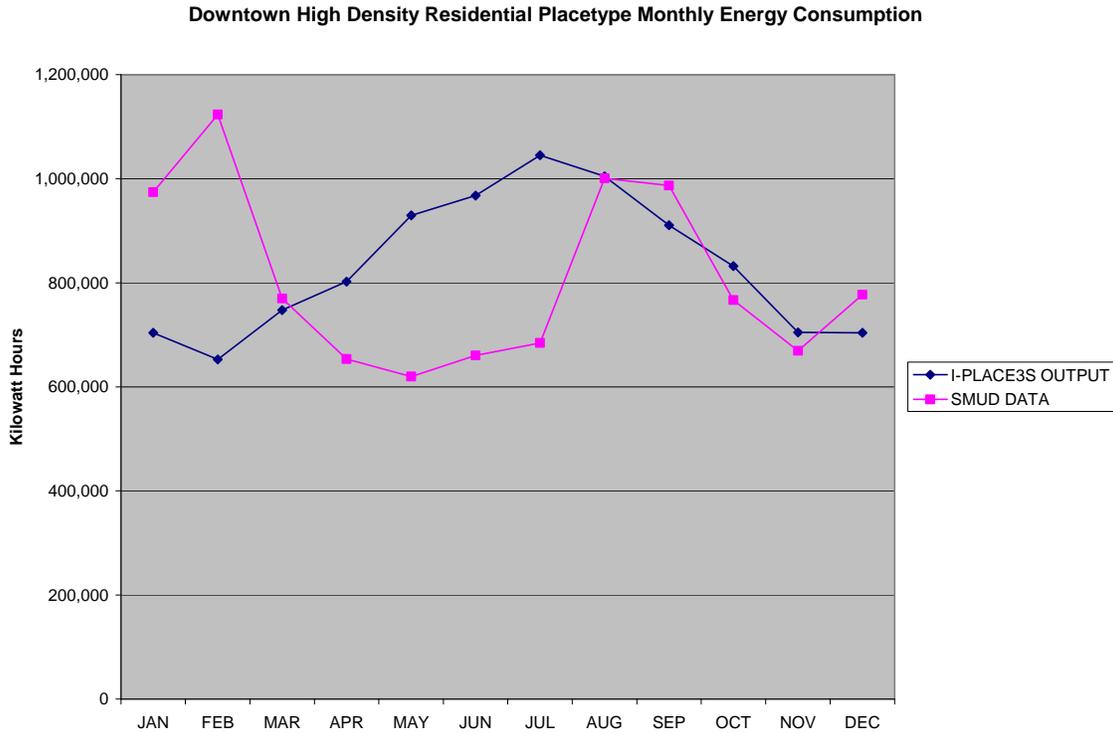
The I-PLACE3S results under predict the SMUD data in the winter time and over predict it in the summer. The results are fairly close in the spring and fall. The annual results for the Sac CBD High Intensity Mixed Use Office placetype show an 1168 percent over prediction of the SMUD data. This is most likely caused by a mischaracterization of the building square footage at the parcel level. If, for example, the parking lot is mistakenly included in the building square footage for a number of parcels, it will inflate the energy consumption for those parcels and subsequently the whole placetype.

The residential placetypes in the Downtown neighborhood include:

- Low density residential
- Medium density residential
- Medium high density residential
- High density residential
- Urban density residential
- Intense urban residential

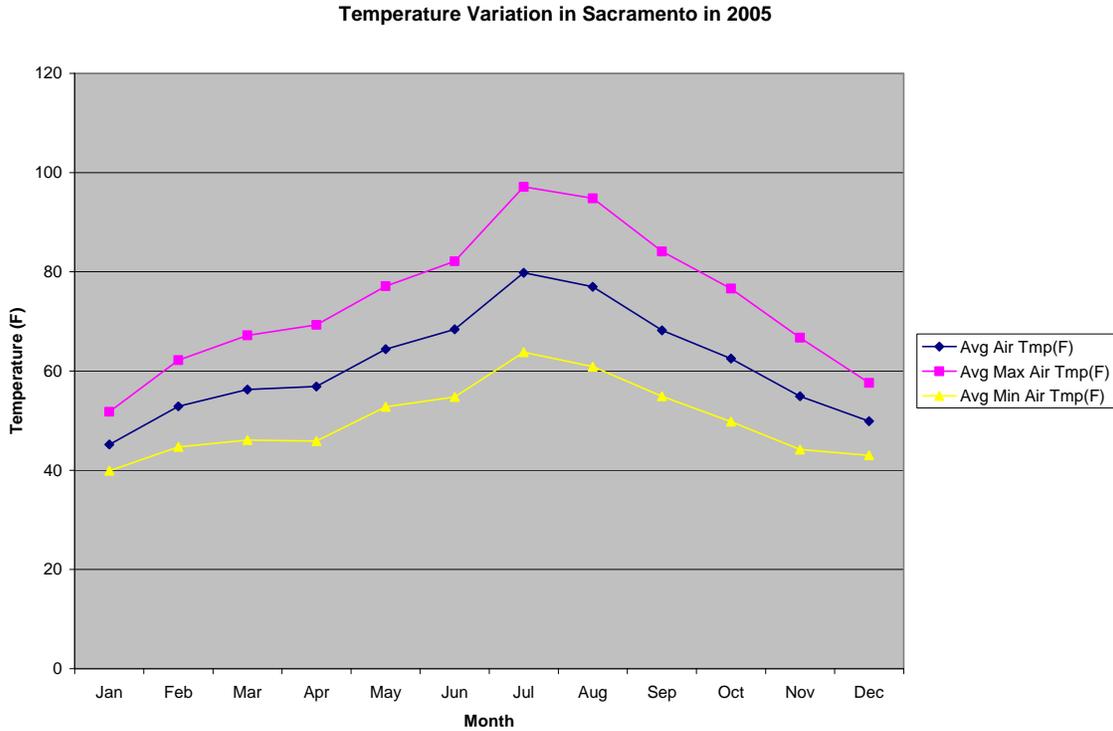
Of these the high density residential placetype is the largest end user of electricity with 47% of the total residential electrical consumption. Within the I-PLACE3S Placetype

Energy Settings this placetype was defined as being 100 percent greater than three stories and having an average dwelling unit size of 800 square feet. No average square footage data was available from the Sacramento County Assessor's data for this placetype. On an annual basis the I-PLACE3S output is within three percent of the SMUD data. The monthly energy consumption for this placetype is shown in Figure 6-10.



**Figure 6- 10 Downtown High Density Residential Placetype Monthly Energy Consumption**

The I-PLACE3S output follows the SMUD data fairly well from August on but over predicts the data in April through June and under predicts in January and February. The temperature variation in Sacramento during 2005 is represented in the figure below.



**Figure 6- 11 Temperature Variation in Sacramento in 2005**

The load profile predicted by I-PLACE3S for all of the placetypes tends to follow outside air temperature with a peak in July. The SMUD data for the high density residential placetype shows low loads in April through July and then a peak in August. In fact in many of the placetypes it appears that the summer peak for the SMUD data follows the I-PLACE3S output by one month. Also, the SMUD load data for the high density residential placetype shows a peak in February. This could be due to the use of electrical heaters in the housing units. In general, SMUD has indicated a low usage of electrical heat and electrical domestic water heating in their territory. Therefore, electrical heating and domestic hot water usage was not counted as one of the end uses in the I-PLACE3S modeling. However, within this placetype, for this neighborhood, this may not be true.

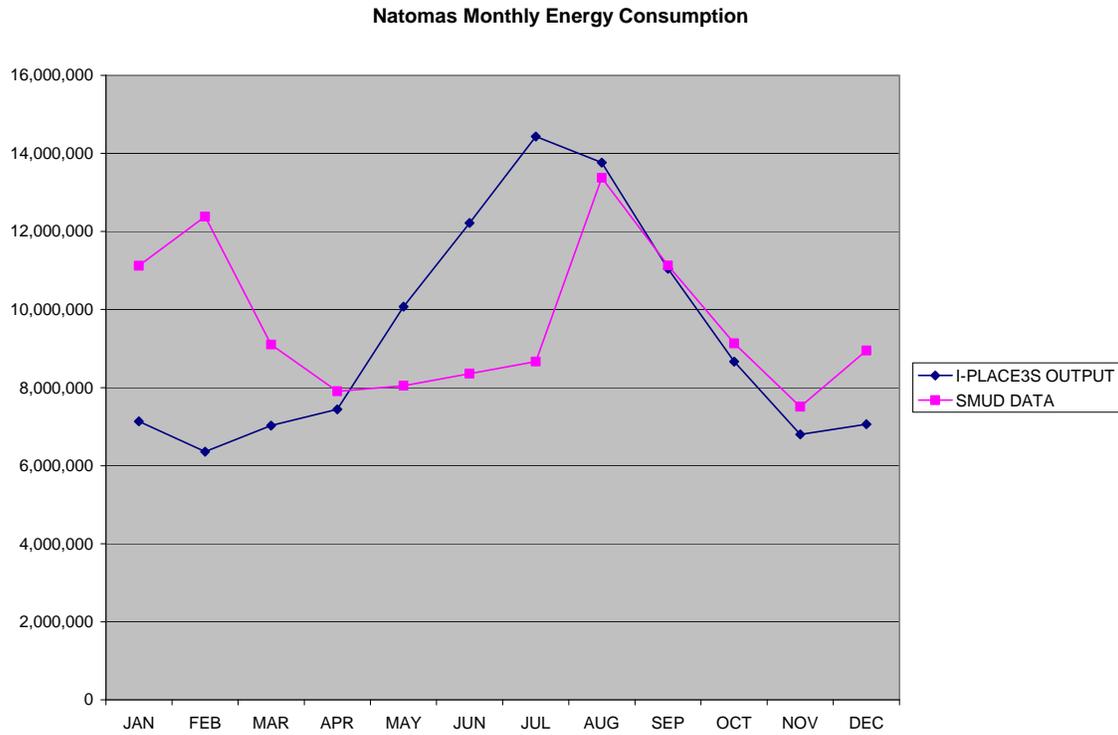
### 3.2. Natomas

The Natomas area is primarily residential with close to 73 percent of the electrical energy consumption being for residential purposes. This can be seen in Table 6- 4.

**Table 6- 4 Percentage of Neighborhood Electrical Consumption by Placetype**

<b>PLACETYPE NAME</b>	<b>% OF TOTAL CONSUMPTION USING SMUD DATA</b>
Rural Residential	0.01%
Very Low Density Residential	1.66%
Low Density Residential	29.35%
Medium Density Residential	13.47%
Medium-High Density Residential	29.60%
High Density Residential	0.49%
Community/Neighborhood Retail	6.83%
Regional Retail	2.24%
Light Industrial - Office	1.17%
Light Industrial	5.37%
Public/Quasi-Public	2.38%
Community/Neighborhood Commercial/Office	5.37%
Community/Neighborhood Commercial/Office - Modified	0.68%
K-12 Schools	1.35%

The load profile for this neighborhood is similar to the load profile seen for the high density residential placetype in the Downtown area with a peak in February and a peak in August. This load profile can be seen in Figure 6-12.

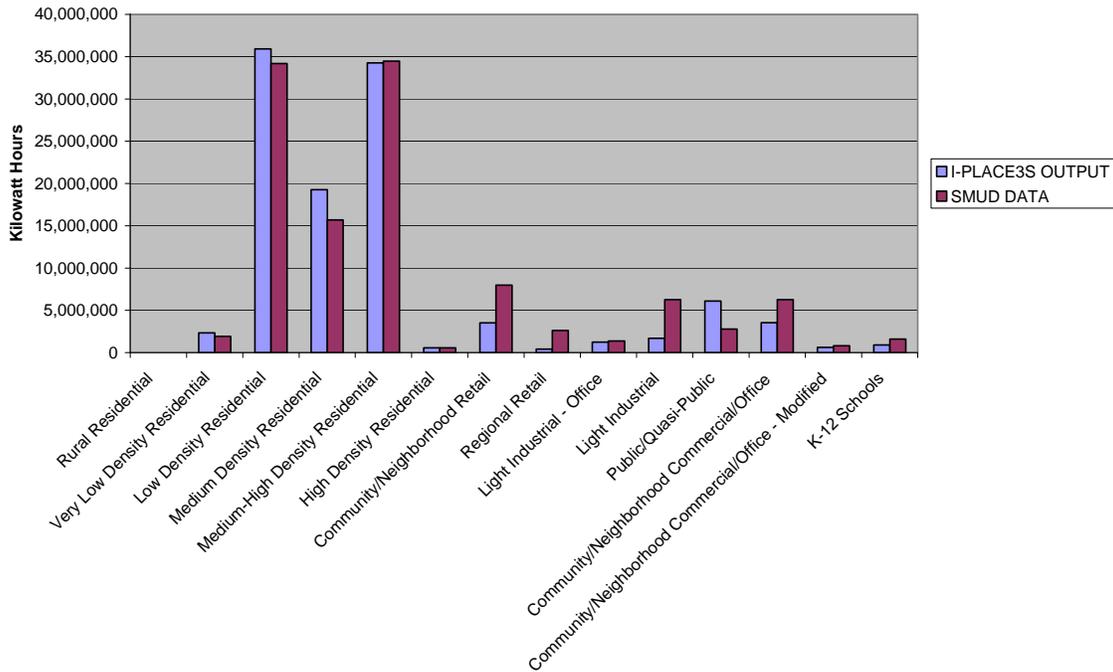


**Figure 6- 12 Natomas Monthly Energy Consumption**

The annual percentage difference between the SMUD data and the I-PLACE3S output when comparing energy consumption for the whole neighborhood is only five percent. However, it can be seen that this is only because the under prediction of the load in January, February and March is being compensated by its over prediction in May, June and July.

The Natomas annual electrical consumption by placetype is shown in Figure 6-13.

**Natomas Annual Electrical Consumption by Placetype**



**Figure 6- 13 Natomas Annual Electrical Consumption by Placetype**

A breakdown of this data is shown in Table 6-5.

**Table 6- 5 Natomas Annual Electrical Consumption by Placetype**

PLACETYPE NAME	ANNUAL ELECTRICAL CONSUMPTION (KWH)		
	I-PLACE3S OUTPUT	SMUD DATA	% DIFFERENCE
Rural Residential	8,215	7,791	5%
Very Low Density Residential	2,327,514	1,928,716	21%
Low Density Residential	35,919,751	34,184,667	5%
Medium Density Residential	19,261,164	15,693,380	23%
Medium-High Density Residential	34,254,575	34,481,752	1%
High Density Residential	567,045	568,082	0%
Community/Neighborhood Retail	3,521,933	7,959,995	56%
Regional Retail	406,861	2,614,387	84%
Light Industrial - Office	1,239,776	1,367,166	9%
Light Industrial	1,695,127	6,258,085	73%
Public/Quasi-Public	6,090,192	2,777,003	119%
Community/Neighborhood Commercial/Office	3,527,047	6,257,756	44%
Community/Neighborhood Commercial/Office - Modified	616,508	797,826	23%
K-12 Schools	896,933	1,578,120	43%
<b>Total</b>	<b>110,332,641</b>	<b>116,474,726</b>	<b>5%</b>

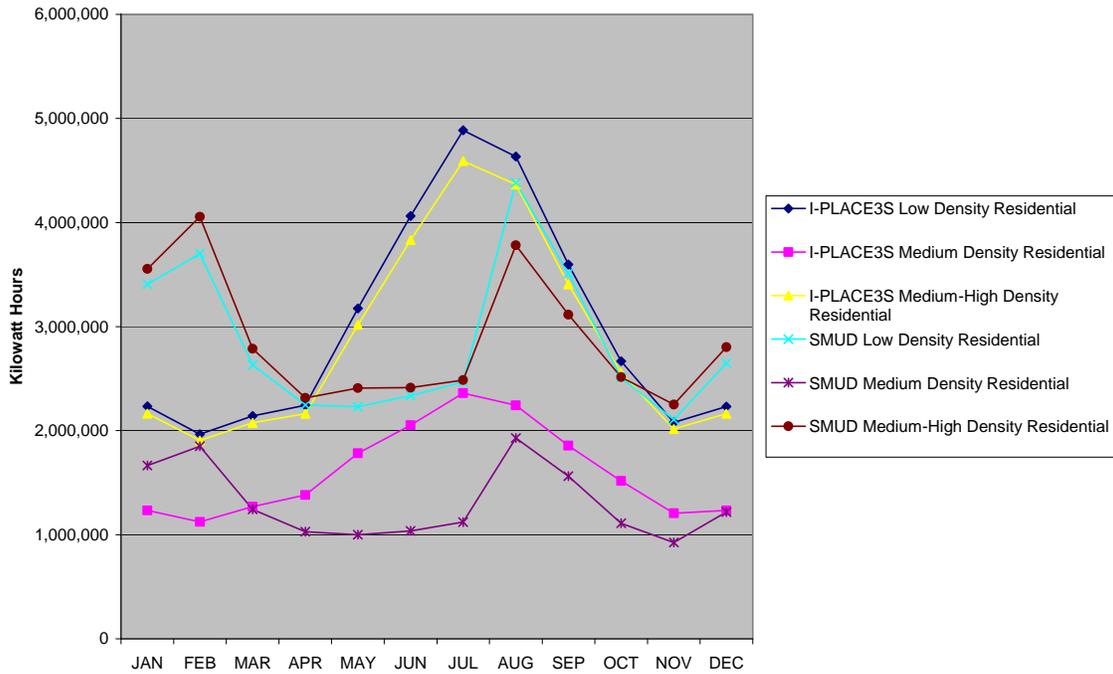
The percentage difference in monthly electrical consumption between the I-PLACE3S output and the SMUD load data can be seen in Table 6-6.

**Table 6- 6 Natomas percentage difference in monthly electrical consumption**

PLACETYPE NAME	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
	MAX	AVERAGE	MIN
Rural Residential	83%	30%	4%
Very Low Density Residential	135%	40%	7%
Low Density Residential	98%	29%	0%
Medium Density Residential	110%	41%	1%
Medium-High Density Residential	85%	29%	2%
High Density Residential	70%	30%	1%
Community/Neighborhood Retail	67%	56%	38%
Regional Retail	89%	84%	79%
Light Industrial - Office	44%	15%	0%
Light Industrial	82%	71%	55%
Public/Quasi-Public	192%	119%	53%
Community/Neighborhood Commercial/Office	63%	44%	21%
Community/Neighborhood Commercial/Office - Modified	51%	23%	1%
K-12 Schools	68%	42%	2%

The monthly load profile for the three largest contributors to the neighborhood electrical load can be seen in Figure 6-14. All three of the contributors are residential placetypes.

**Natomas Residential Monthly Energy Consumption**



**Figure 6- 14 Natomas Residential Monthly Energy Consumption**

It can be seen that all three of the placetypes follow a similar trend both with regard to the SMUD data and with the I-PLACE3S output. The trend they follow is similar to that described for the overall neighborhood. In fact, it is these three placetypes that are influencing the neighborhood load profile the greatest. The percentage difference in monthly and annual electrical consumption between I-PLACE3S output and the SMUD data for these placetypes is shown in Tables 6-4 and 6-5. In order to get as close a correlation as possible based upon the annual energy consumption these placetypes are defined as follows in the Placetype Energy Settings:

- Low Density Residential – 1800 sq ft average dwelling unit size  
100 percent Detached
- Medium Density Residential - 1100 sq ft average dwelling unit size  
50 percent Detached, 50 percent ≤ 3 Stories
- Medium High Density Residential - 1800 sq ft average dwelling unit size  
95 percent Detached, 5 percent > 3 Stories

According to the Sacramento County Assessors data there are 5560 single family homes in the Natomas area with an average square footage of 1350 sq. ft. These homes correspond to the low density residential placetype. There are also 3997 low rise

apartments that are less than 4 stories. Unfortunately no square footage data was given for these apartments. These apartments correspond to the Medium High Density residential placetype. There are also 360 duplexes and single family condos that have an average square footage of 853 sq. ft. These buildings correspond to the Medium Density Residential placetype. It is clear that in order to match the SMUD load data as closely as possible the average square footage of the dwelling units had to be exaggerated and in the case of the Medium High Density residential placetype a very large percentage of the units had to be defined as being detached; as detached housing is more energy intensive than an apartment unit. These inputs are corrected to the following in Placetype Energy Settings in the next iteration for the Natomas neighborhood:

- Low Density Residential – 1350 sq ft average dwelling unit size  
100 percent Detached
- Medium Density Residential - 853 sq ft average dwelling unit size  
50 percent Detached, 50 percent <= 3 Stories
- Medium High Density Residential - 800 sq ft average dwelling unit size  
(educated guess) 50 percent <= 3 Stories, 50 percent > 3 Stories

However, the results show that the annual I-PLACE3S output under predicts the SMUD load data by 21 percent and 48 percent for the low density residential and the Medium High Density Residential placetypes respectively. For the Medium Density residential placetype the annual I-PLACE3S output over predicts the SMUD load data by five percent.

It is interesting to note that the Community Neighborhood Retail and the Regional Retail placetypes are under predicting the SMUD data by 56 percent and 84 percent respectively on an annual basis. Please refer to Table 6-4 for the monthly differences between the two sets of data. In the Downtown neighborhood the annual difference from the SMUD data for both placetypes was only five percent while the sector weighting for both neighborhoods is very similar:

Downtown

- Regional Retail 95% large retail 5% small office
- Community Neighborhood Retail 75% restaurant 25% small retail

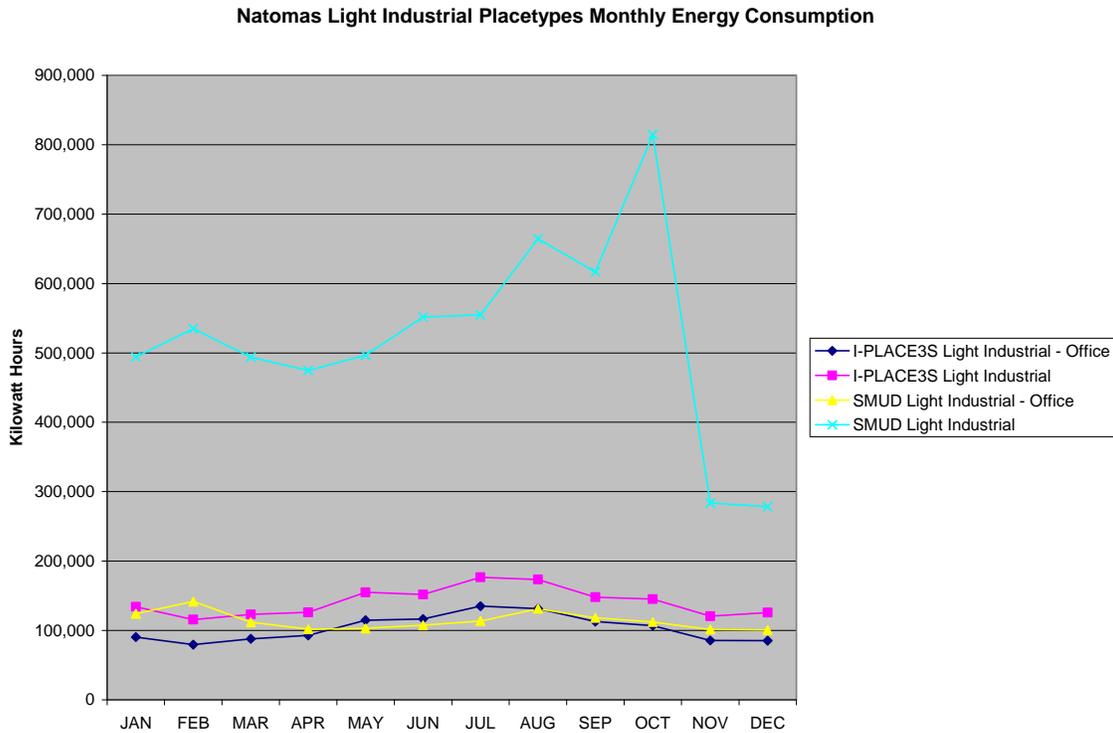
Natomas

- Regional Retail 95% large retail 5% small office
- Community Neighborhood Retail 50% restaurant 25% fast food  
25% small retail

This implies that the parcels assigned the Regional Retail placetype and the Community Neighborhood Retail placetype in the Natomas neighborhood are more energy intensive than those in the Downtown neighborhood and that the I-PLACE3S retail look-up tables are not accurately predicting the energy consumption for these parcels. It could also be that there was an error in the placetype assignment by SACOG.

The office placetypes in the Natomas neighborhood are Public Quasi-Public and Community/Neighborhood Commercial/Office. I-PLACE3S is over predicting the annual load for the Public Quasi-Public placetype by 119 percent even though the sector assigned to it is small office rather than large office. With the Community/Neighborhood Commercial/Office placetype the output is going the other way and under predicting the annual load by 44 percent. The differences in the two sets of data on a monthly basis is similar (please refer to Table 6-4). One possible explanation for these discrepancies might be that the 2005 SACOG data set used to assign placetypes to some of the parcels was in error, resulting in an over prediction or an under prediction based upon the total number of parcels assigned a particular placetype. In the case of K-12 Schools this reasoning may not hold. Table 6-5 indicates that I-PLACE3S is under predicting the SMUD data by 43 percent for this placetype. A possible explanation would be that there was an error in the placetype assignment by SACOG.

The light industrial and light industrial-office placetypes also have varying annual results. The light industrial-office placetype output in I-PLACE3S under predicts the SMUD data by only nine percent, whereas I-PLACE3S under predicts the SMUD data for the light industrial placetype by 46 percent. The monthly load profiles can be seen in Figure 6-15, and the differences in the monthly data can be seen in Table 6-4.



**Figure 6- 15 Natomas Monthly Energy Consumption for Light Industrial Placetypes**

With the light industrial-office placetype I-PLACE3S output follows the SMUD data fairly closely although it is exhibiting the same trends seen in the residential placetypes with under prediction in the winter and over prediction in the first part of the summer. With the light industrial placetype I-PLACE3S vastly under predicts the SMUD data. It is important to note that this placetype constitutes only 5.37 percent of the energy consumption for the whole neighborhood. It is likely that there are only a few parcels with this placetype, and as can be seen from the SMUD data they have a large peak in energy use in October. In general, the energy intensity for this placetype in the Natomas neighborhood is a lot higher than is being predicted by I-PLACE3S. It should be noted that the electrical consumption for this placetype is driven by equipment loads and can vary significantly from site to site. Other possible reasons for the erroneous output are that the placetype has been assigned incorrectly or that there was not enough information about the use of the buildings to characterize it correctly in the energy settings.

### 3.3. Midtown

The three largest contributors to electrical energy consumption in the Midtown neighborhood are the Moderate Intensity Office placetype, the Medical Facility placetype, and the High Density Residential placetype. Their combined load constitutes over 50 percent of the total energy consumption for the neighborhood. Another 18 percent of the load is taken up by the Community/Neighborhood Retail and the Light Industrial placetypes. This is illustrated in Table 6-7.

**Table 6- 7 Percentage of Midtown Neighborhood Energy Consumption by Placetype**

PLACETYPE NAME	% OF TOTAL CONSUMPTION USING SMUD DATA
Low Density Residential	0.56%
Medium Density Residential	0.16%
Medium-High Density Residential	3.13%
High Density Residential	10.89%
Urban Residential	1.49%
High-Intensity Office	7.75%
Moderate-Intensity Office	20.40%
Community/Neighborhood Retail	8.95%
Light Industrial - Office	0.72%
Light Industrial	8.60%
Public/Quasi-Public	4.65%
Community/Neighborhood Commercial/Office	2.71%
Community/Neighborhood Commercial/Office - Modified	1.86%
Regional Commercial/Office	0.01%
Mixed Use Employment Focus	0.28%
Mixed Use Residential Focus	0.91%
Intense Urban Residential	0.90%
CBD Office	6.71%
Medical Facility	19.31%

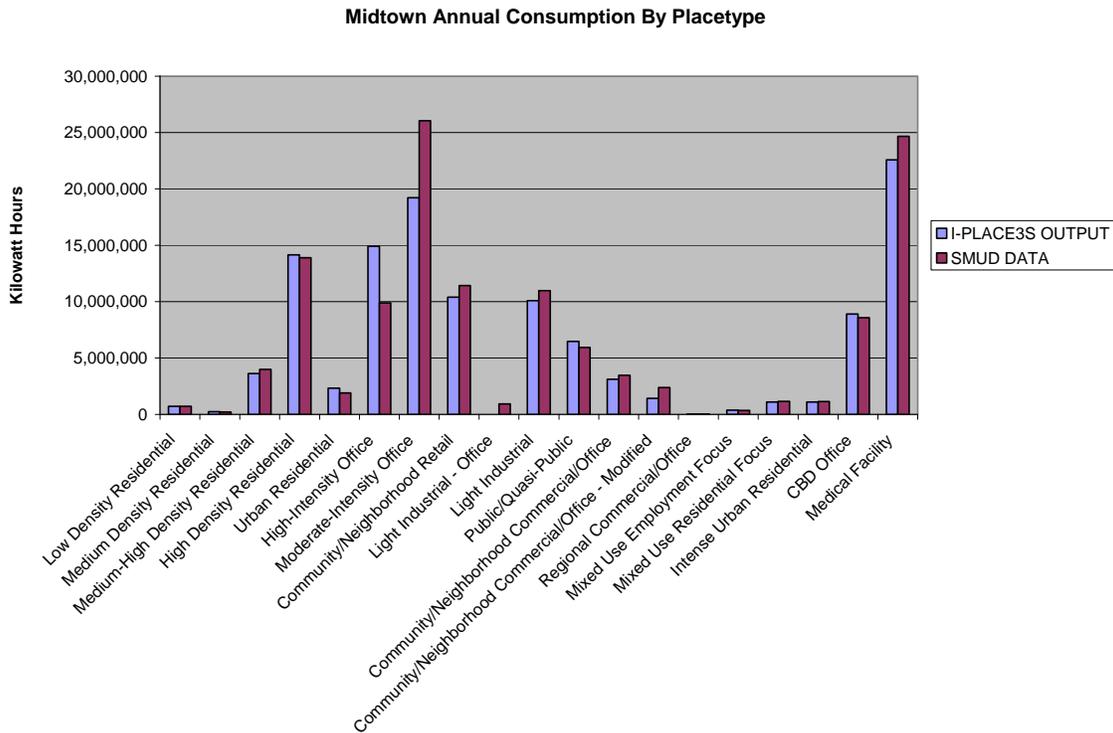
A comparison of the I-PLACE3S output and the SMUD load data on an annual basis is provided in Table 6-8.

**Table 6- 8 Midtown Annual Electrical Consumption by Placetype**

PLACETYPE NAME	ANNUAL ELECTRICAL CONSUMPTION (KWH)		% DIFFERENCE
	3S OUTPUT	SMUD DATA	
Low Density Residential	710,946	719,406	1%
Medium Density Residential	236,754	205,520	15%
Medium-High Density	3,624,548	3,992,928	9%

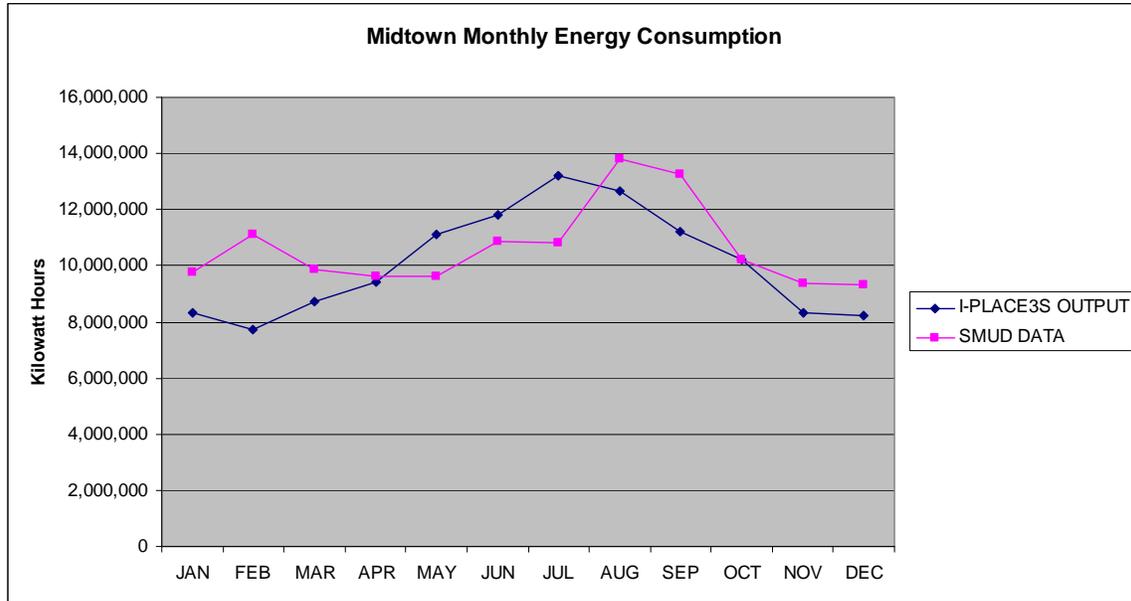
Residential			
High Density Residential	14,148,735	13,901,395	2%
Urban Residential	2,331,845	1,901,799	23%
High-Intensity Office	14,905,466	9,891,799	51%
Moderate-Intensity Office	19,219,423	26,048,162	26%
Community/Neighborhood Retail	10,392,391	11,431,974	9%
Light Industrial - Office	0	920,168	100%
Light Industrial	10,084,519	10,983,601	8%
Public/Quasi-Public	6,478,616	5,935,260	9%
Community/Neighborhood Commercial/Office	3,121,583	3,466,500	10%
Community/Neighborhood Commercial/Office - Modified	1,422,414	2,380,199	40%
Regional Commercial/Office	11,851	13,790	14%
Mixed Use Employment Focus	369,784	355,942	4%
Mixed Use Residential Focus	1,096,801	1,156,562	5%
Intense Urban Residential	1,097,524	1,147,040	4%
CBD Office	8,896,482	8,570,120	4%
Medical Facility	22,571,612	24,661,169	8%
Total	120,982,670	127,683,334	5%

With the exception of the Moderate Intensity Office placetype, all the largest energy consuming placetypes, mentioned above, have I-PLACE3S output that is within 10 percent of the SMUD load data. This data is illustrated in Figure 6-16.



**Figure 6- 16 Midtown Annual Electrical Consumption by Placetype.**

The monthly load profile for the entire neighborhood can be seen in Figure 6-17.



**Figure 6- 17 Midtown Monthly Energy Consumption**

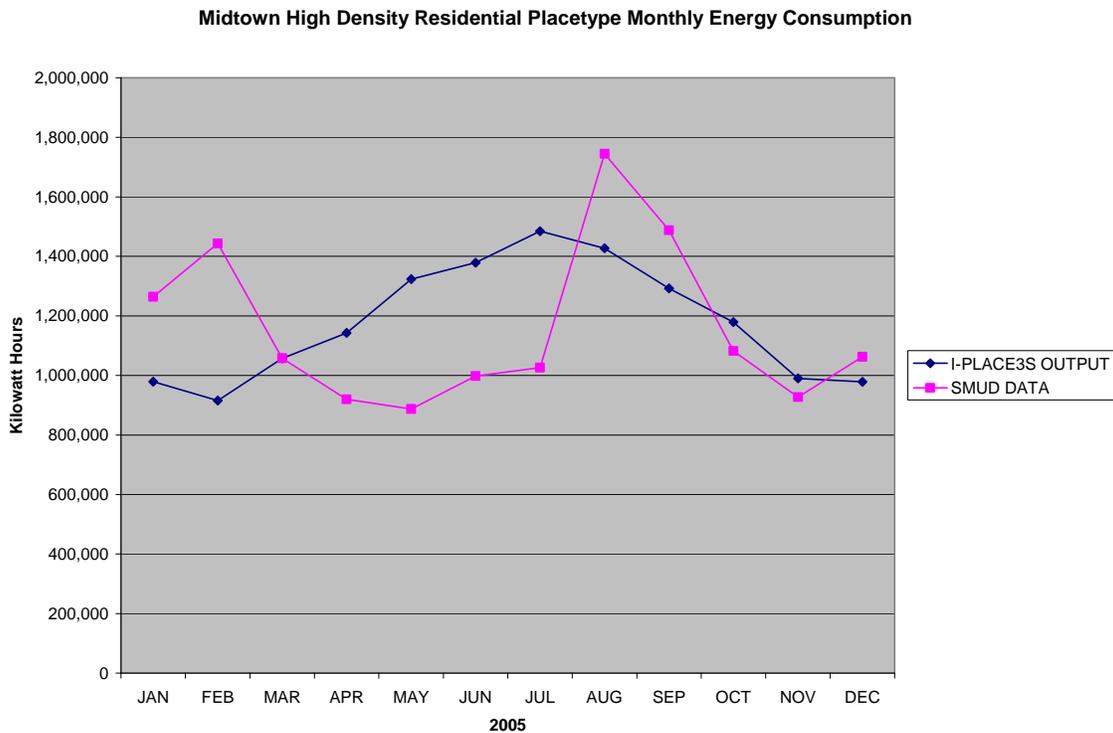
The Midtown neighborhood exhibits similar trends to the Downtown and Natomas neighborhoods in that the SMUD peak load tends to trail the I-PLACE3S peak load by a month. However, the difference between the I-PLACE3S output and the SMUD load data is not as pronounced as for the other two neighborhoods, and on an annual basis the difference between the two is only five percent. The difference between the two load profiles on a monthly basis is described in Table 6-9.

**Table 6- 9 Midtown Percentage Difference in Monthly Electrical Consumption**

PLACETYPE NAME	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
	MAX	AVERAGE	MIN
Low Density Residential	96%	34%	4%
Medium Density Residential	105%	40%	0%
Medium-High Density Residential	72%	32%	4%
High Density Residential	49%	23%	0%
Urban Residential	77%	29%	0%
High-Intensity Office	101%	54%	1%
Moderate-Intensity Office	37%	26%	10%
Community/Neighborhood Retail	34%	17%	5%
Light Industrial – Office	100%	100%	100%
Light Industrial	37%	18%	6%
Public/Quasi-Public	44%	16%	4%

Community/Neighborhood Commercial/Office	27%	15%	3%
Community/Neighborhood Commercial/Office - Modified	56%	40%	20%
Regional Commercial/Office	142%	61%	18%
Mixed Use Employment Focus	28%	12%	1%
Mixed Use Residential Focus	31%	15%	2%
Intense Urban Residential	58%	26%	11%
CBD Office	494%	115%	1%
Medical Facility	24%	9%	1%

The monthly energy consumption for the high density residential placetype is illustrated in Figure 6-18 below.

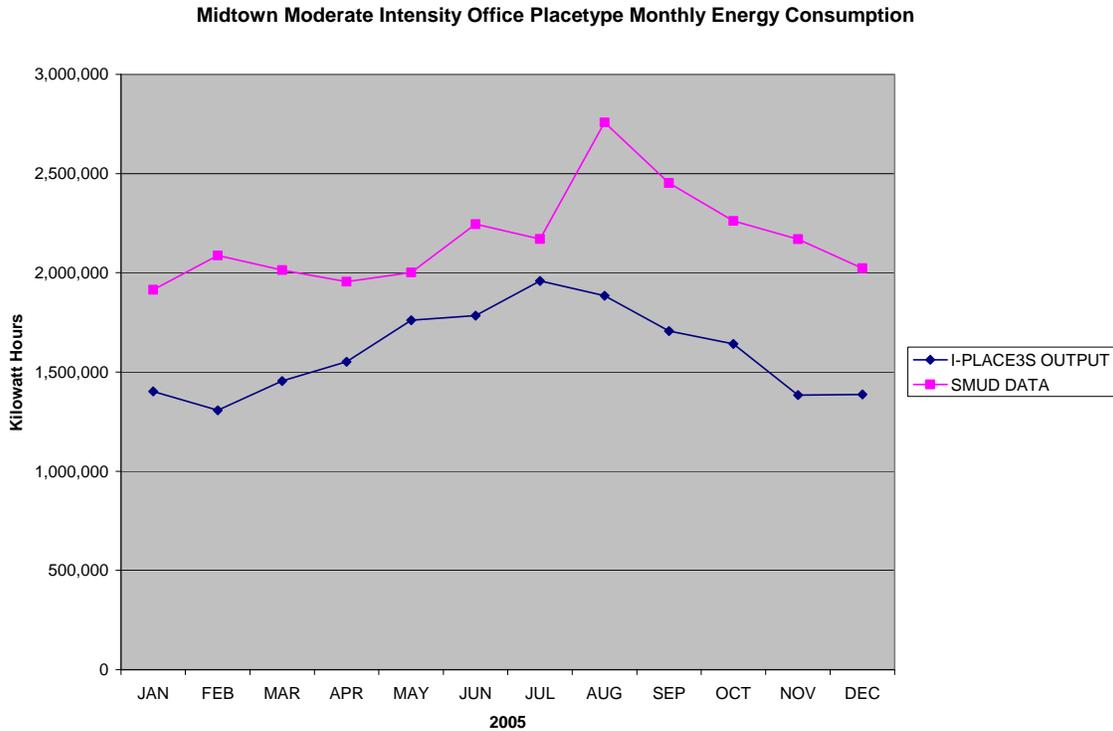


**Figure 6- 18 Midtown High Density Residential Placetype Monthly Energy Consumption**

The maximum difference between I-PLACE3S output and the SMUD load data is 49 percent. The minimum difference is zero percent and the average difference is 23 percent over the course of the year. This placetype exhibits similar trends to the residential placetypes in the Downtown and Natomas neighborhoods. To get this close of a correlation the average dwelling unit size used for this placetype was 600 square feet and it was defined as being 100 percent greater than three stories. According to the Sacramento County Assessors Data there are 1172 residences in the Midtown

neighborhood and the average dwelling unit size for the whole neighborhood was 1240 square feet. Within the neighborhood the largest number of residences are fourplexes (384). Followed by single family homes (304). Therefore it could be that some of the parcels in the SACOG 2005 data set have been mischaracterized as high density residential when in reality they should be low or medium density residential.

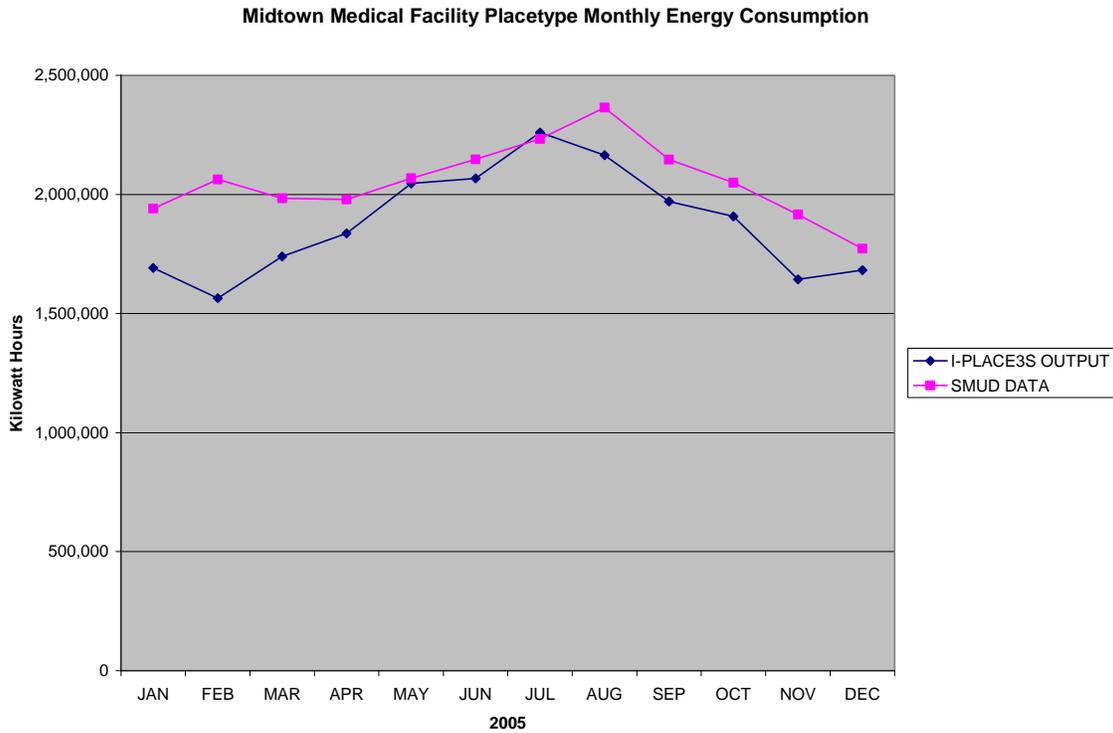
The monthly energy consumption for the Moderate Intensity Office placetype is illustrated in Figure 6-19.



**Figure 6- 19 Midtown Moderate Intensity Office Placetype Monthly Energy Consumption**

On an annual basis I-PLACE3S is under predicting the SMUD data by 26 percent. When evaluated month by month the maximum difference is 37 percent. The minimum difference is 10 percent and the average over the course of the year is 26 percent. This placetype is exhibiting the same behavior in this neighborhood as it did in the downtown neighborhood except the under prediction is not as pronounced. This placetype is defined as 100 percent large office in Placetype Energy Settings which has the highest energy intensity of all the office placetypes and produces the highest possible I-PLACE3S output.

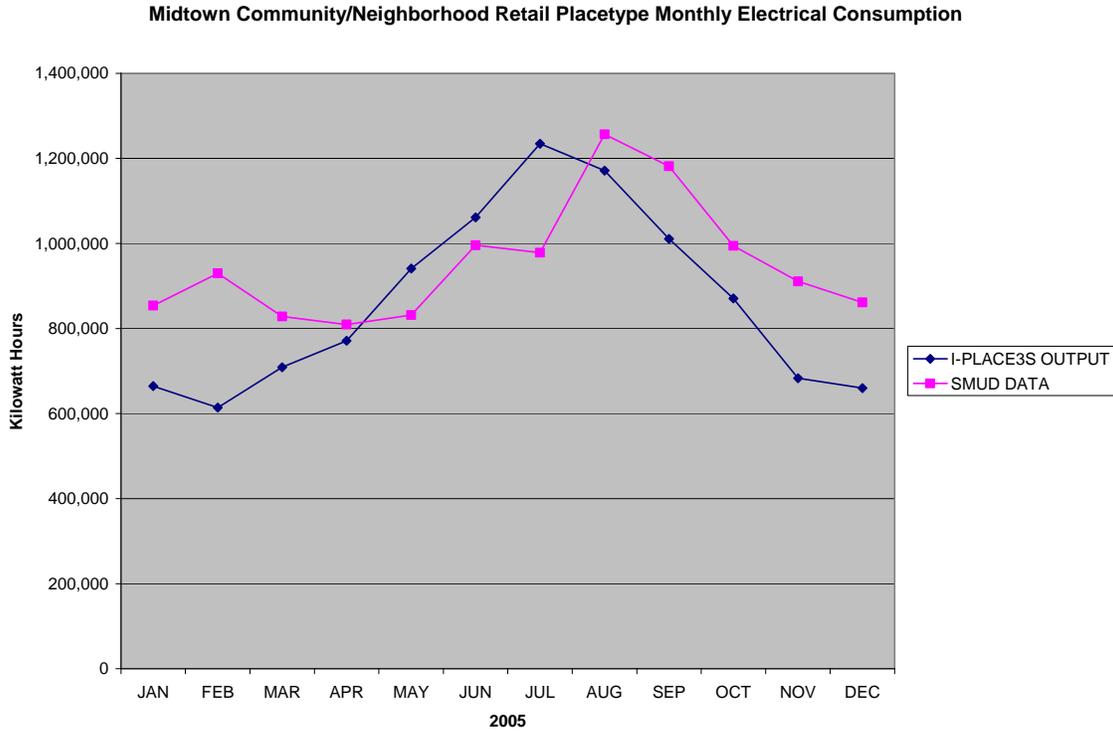
The monthly energy consumption for the Medical Facility Placetype is shown in Figure 6-20.



**Figure 6- 20 Midtown Medical Facility Placetype Monthly Energy Consumption**

The Midtown Medical Facility Placetype refers to the Sutter Medical Facilities in Midtown Sacramento. The I-PLACE3S output under predicts the SMUD load data on an annual basis by eight percent. The maximum difference seen in the two data sets is for the month of February and is 24 percent. The minimum difference is in July with only one percent. The average over the course of the year is nine percent. This correlation is fairly close although the classic lagging of the peak load can still be seen. Even though medical facilities have a high internal load they are also highly susceptible to variations in outside air temperature because building codes require that they use 100 percent outside air. Therefore the reason for the August peak in the SMUD load data is unexplained given the peak in outside air temperatures in July.

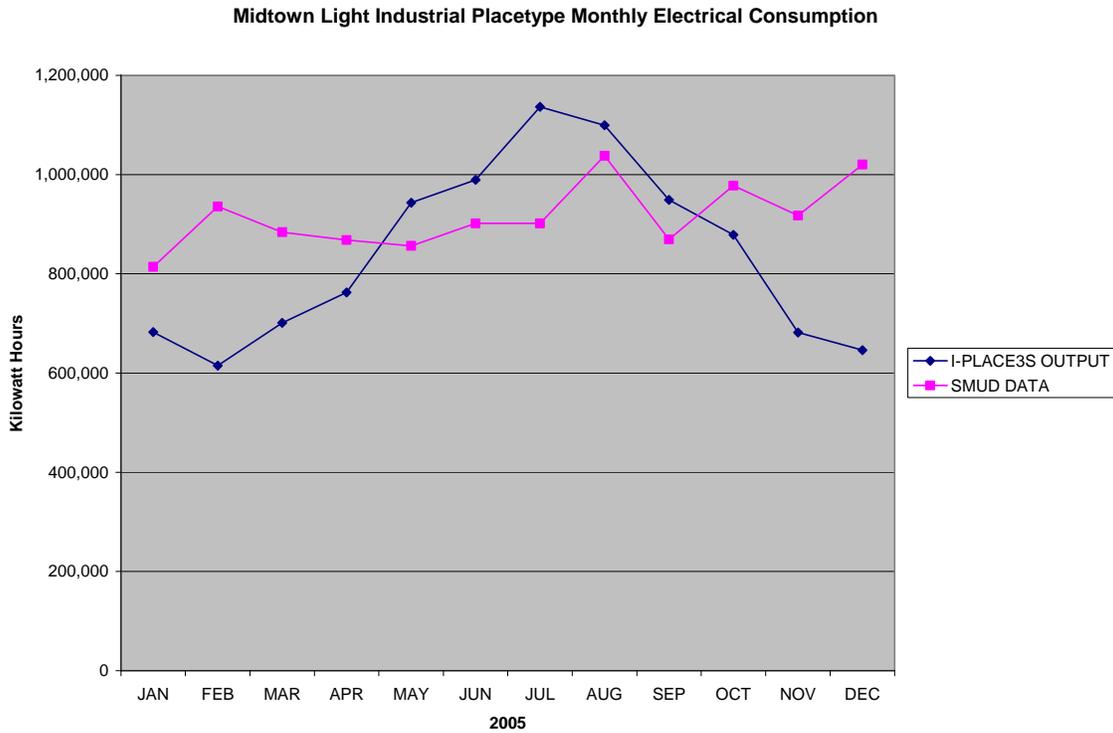
The monthly electrical consumption for the Community/Neighborhood Retail placetype is shown in Figure 6-21.



**Figure 6- 21 Midtown Community/Neighborhood Retail Placetype Monthly Electrical Consumption**

The I-PLACE3S output under predicts the SMUD load data on an annual basis by nine percent. The maximum difference seen in the two data sets is for the month of February and is 34 percent. The minimum difference is in April with only five percent. The average over the course of the year is 17 percent. The sector percentages for this placetype within Placetype Energy Settings are 50 percent restaurant and 50 percent small retail.

The monthly electrical consumption for the Light Industrial placetype is shown in Figure 6-22.



**Figure 6- 22 Midtown Light Industrial Placetype Monthly Electrical Consumption**

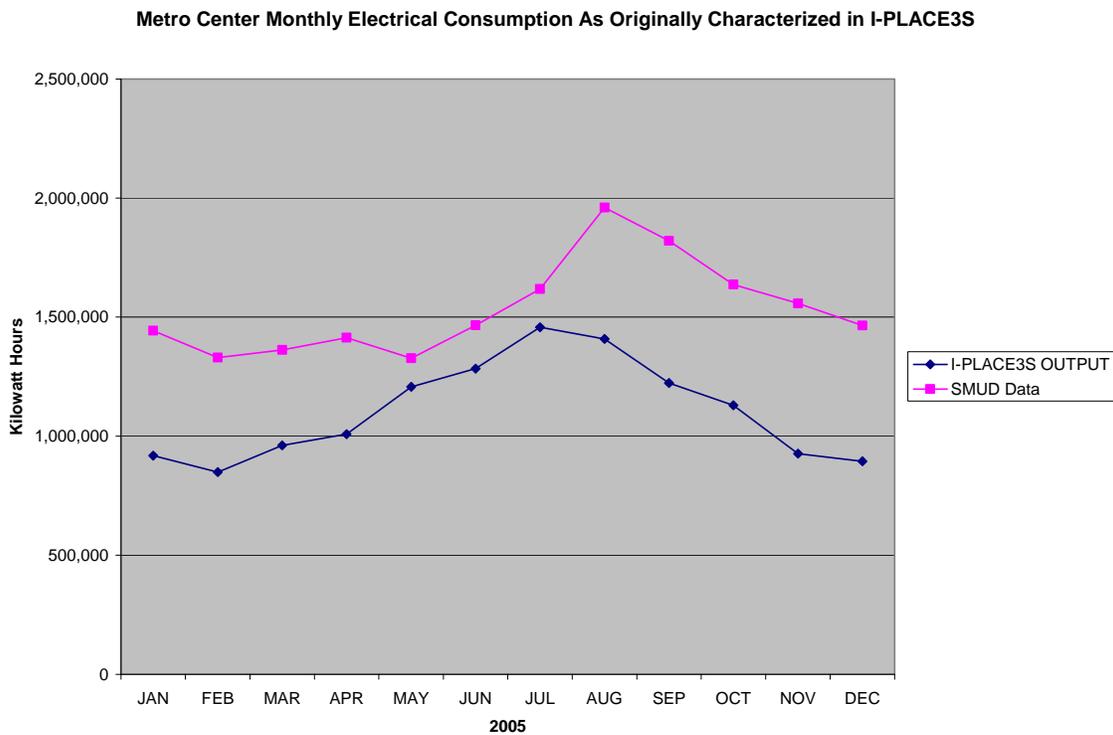
The I-PLACE3S output under predicts the SMUD load data on an annual basis by eight percent. The maximum difference seen in the two data sets is for the month of February and is 37 percent. The minimum difference is in August with only six percent. The average over the course of the year is 18 percent. The sector percentage for this placetype within Placetype Energy Settings is 100 percent light industrial. The load for this placetype constitutes only 8.6 percent of the total load for the neighborhood. Therefore there are a relatively small number of these facilities, such as the Blue Diamond Almond Factory, and their load profile indicates that the load is relatively constant throughout the year and is driven by equipment on site. The I-PLACE3S output appears to follow the temperature profile for Sacramento and does not closely follow the SMUD load data. This is to be expected as the load for light industrial facilities is equipment specific and its timing is related to production demands.

The I-PLACE3S output for the Light Industrial Office placetype in the Midtown neighborhood comes out as zero because that placetype had not been activated within I-PLACE3S by SACOG.

### 3.4. Metro Center

Due to discrepancies found in the 2005 SACOG data set used to characterize the parcels for the four neighborhoods in I-PLACE3S, it was decided to try and accurately characterize the parcels in the Metro Center neighborhood as much as possible. This was done by SACOG using four sets of data: aerial photography, permitting data, employment data and land use data from the Sacramento County Assessor's Office in order to provide I-PLACE3S with the most accurate inputs possible at the parcel level and compare its output accurately with the SMUD data. This was not possible with the other three neighborhoods due to time and budget constraints for the project.

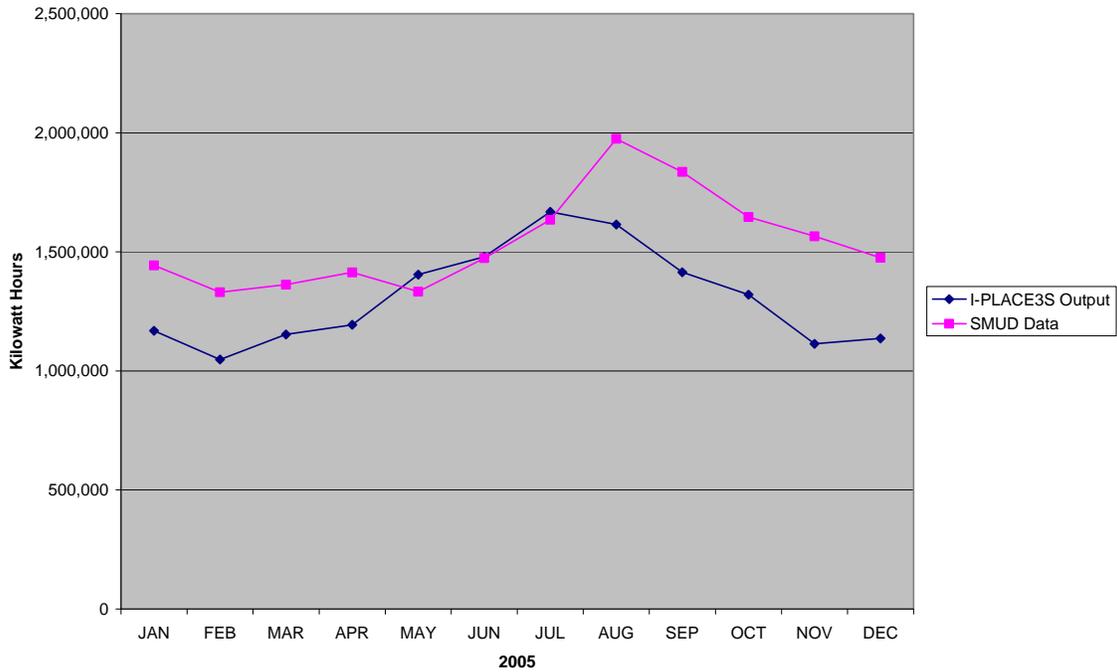
The following figure illustrates the Metro Center neighborhood load as originally characterized by SACOG:



**Figure 6- 23 Metro Center Monthly Electrical Consumption As Originally Characterized in I-PLACE3S**

The next figure illustrates the Metro Center load as accurately characterized (or rectified) in I-PLACE3S.

**Metro Center Monthly Electricity Consumption as Accurately Characterized in I-PLACE3S**



**Figure 6- 24 Metro Center Monthly Electricity Consumption as Accurately Characterized in I-PLACE3S**

The numerical difference between the I-PLACE3S output and the SMUD load data for these two input characterizations can be seen in Table 6-10.

**Table 6- 10 Comparison of Percentage Difference Between I-PLACE3S Output and SMUD Load Data for Two Different Input Characterizations of the Metro Center Neighborhood.**

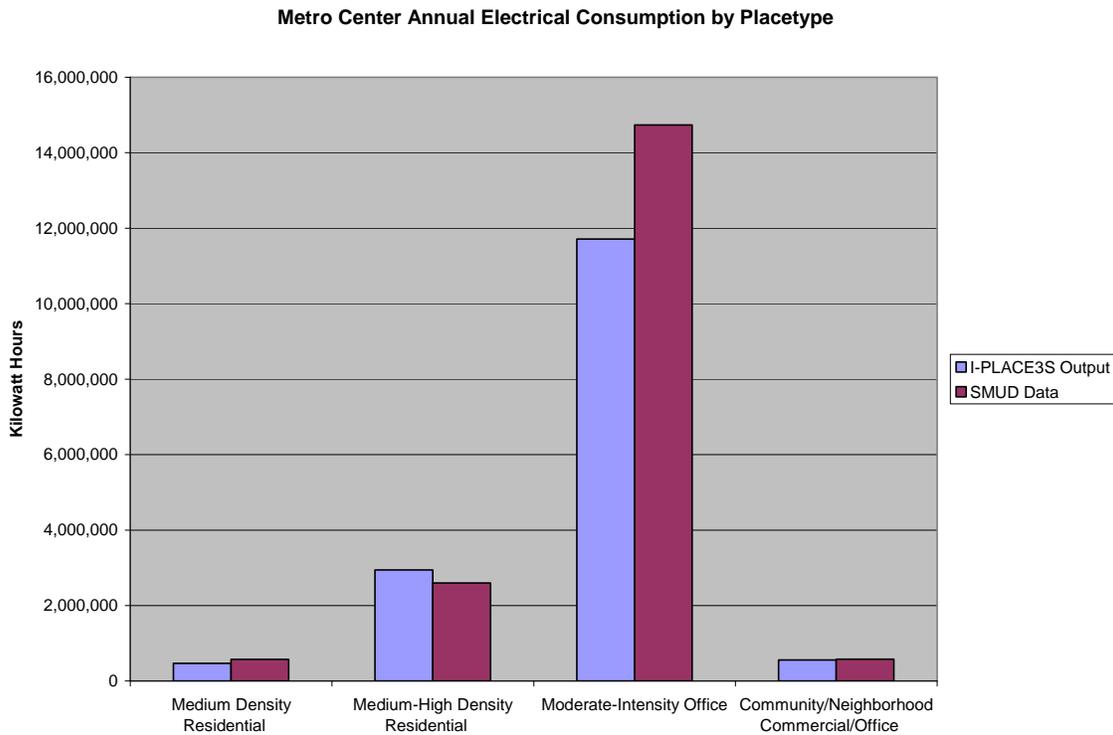
I-PLACE3S METRO CENTER INPUT CHARACTERIZATION	% DIFFERENCE ANNUAL ELEC. CONS.	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
		MAX	AVERAGE	MIN
Original	28%	41%	28%	9%
Accurate (rectified)	15%	29%	16%	0%

As can be seen the more accurate characterization of the input data provides more accurate output in I-PLACE3S. Therefore the remaining discussion will focus on the results from the more accurate characterization of the input data. The percentages of the total electrical consumption by placetype are shown in Table 6-11.

**Table 6- 11 Percentage of Metro Center Electrical Consumption by Placetype**

PLACETYPE NAME	% OF TOTAL CONSUMPTION USING SMUD DATA
Medium Density Residential	3.10%
Medium-High Density Residential	14.06%
Moderate-Intensity Office	79.71%
Community/Neighborhood Commercial/Office	3.13%

The annual electrical consumption by placetype is shown in Figure 6-25.



**Figure 6- 25 Metro Center Annual Electrical Consumption by Placetype**

A breakdown of this data is provided in Table 6-12.

**Table 6- 12 Metro Center Annual Electrical Consumption by Placetype**

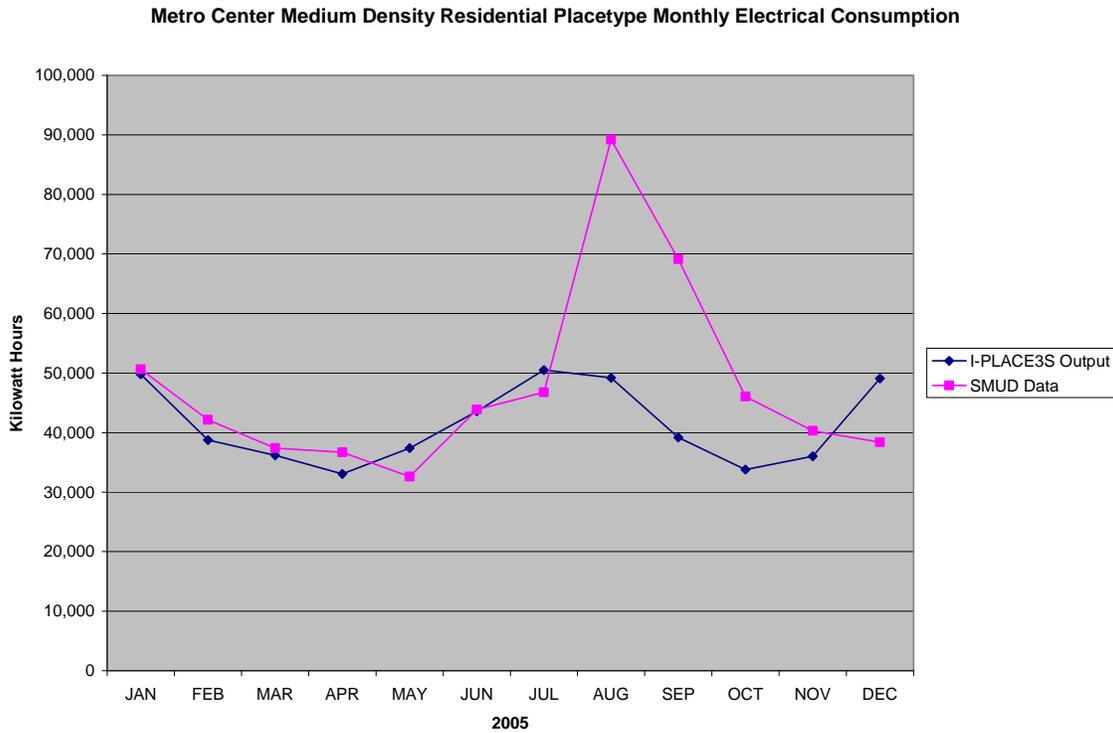
PLACETYPE NAME	ANNUAL ELECTRICAL CONSUMPTION (KWH)		
	I-PLACE3S OUTPUT	SMUD DATA	% DIFFERENCE
Medium Density Residential	469,508	573,227	18%
Medium-High Density Residential	2,946,818	2,598,362	13%
Moderate-Intensity Office	11,710,610	14,733,099	21%
Community/Neighborhood Commercial/Office	559,861	578,640	3%
Total	15,686,797	18,483,328	15%

The percentage difference in the monthly electrical consumption can be seen in Table 6-13.

**Table 6- 13 Metro Center Percentage Difference in Monthly Electrical Consumption**

PLACETYPE NAME	% DIFFERENCE IN MONTHLY ELECTRICAL CONSUMPTION		
	MAX	AVERAGE	MIN
Medium Density Residential	45%	17%	1%
Medium-High Density Residential	49%	23%	7%
Moderate-Intensity Office	36%	20%	2%
Community/Neighborhood Commercial/Office	32%	15%	2%

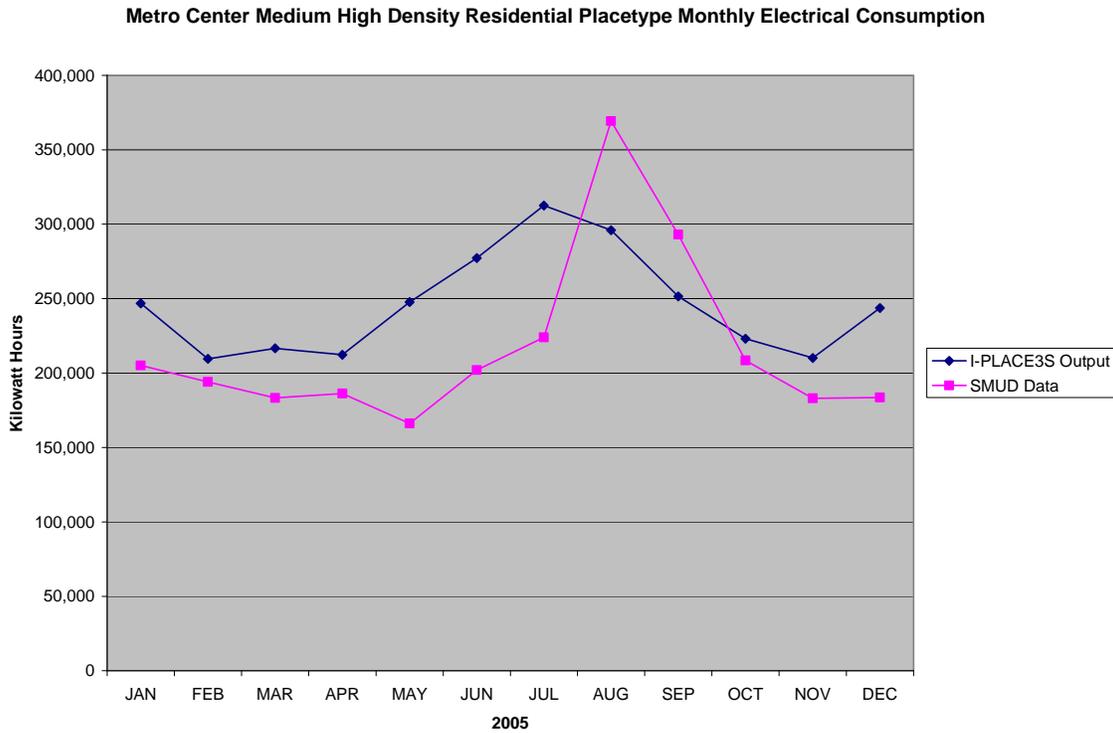
The load profiles for the four placetypes present in Metro Center are shown below.



**Figure 6- 26 Metro Center Medium Density Residential Placetype Monthly Electrical Consumption**

For the Medium Density Residential placetype I-PLACE3S follows the SMUD load data quite closely until the month of August where there is a large spike in electrical consumption. I-PLACE3S continues to under predict the SMUD data in September and October. The November data points are again close followed by an over prediction in December. Over the course of the year the maximum difference between the two data sets is 45 percent. The minimum difference is one percent. The average difference over the twelve months is 17 percent. When comparing the annual consumption I-PLACE3S under predicts the SMUD data by 15 percent.

The load profile for the Medium High Density Residential placetype is shown in Figure 6-27.

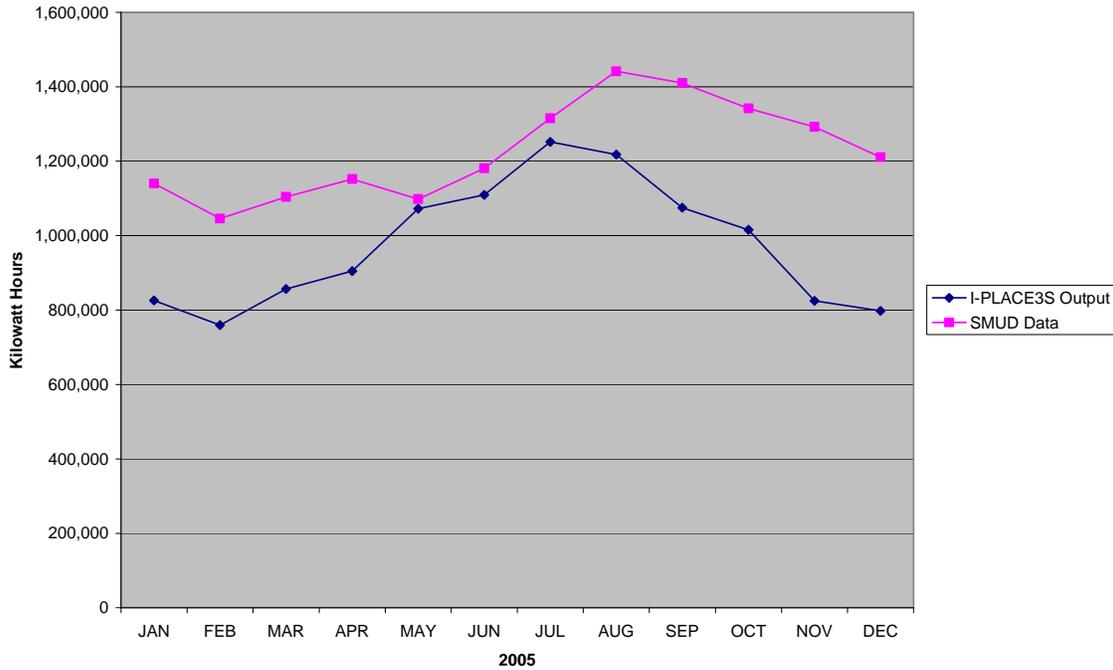


**Figure 6- 27 Metro Center Medium High Density Residential Placetype Monthly Electrical Consumption**

For this placetype I-PLACE3S tends to over predict the SMUD load data except for the months of August and September. The maximum difference between the two data sets is 49 percent. The minimum difference between the two is seven percent, and average difference over the course of the year is 23 percent. With regard to annual consumption I-PLACE3S over predicts the SMUD data by 13 percent. The Sacramento County Assessor’s Data indicates that there are 456 low rise apartments less than four stories and 93 single family homes in the Metro Center neighborhood. Unfortunately, the average square footage of these dwellings is not provided.

The Moderate Intensity Office placetype constitutes close to 80 percent of the neighborhood load. Its load profile is illustrated in Figure 6-28.

**Metro Center Moderate Intensity Office Placetype Monthly Electrical Consumption**

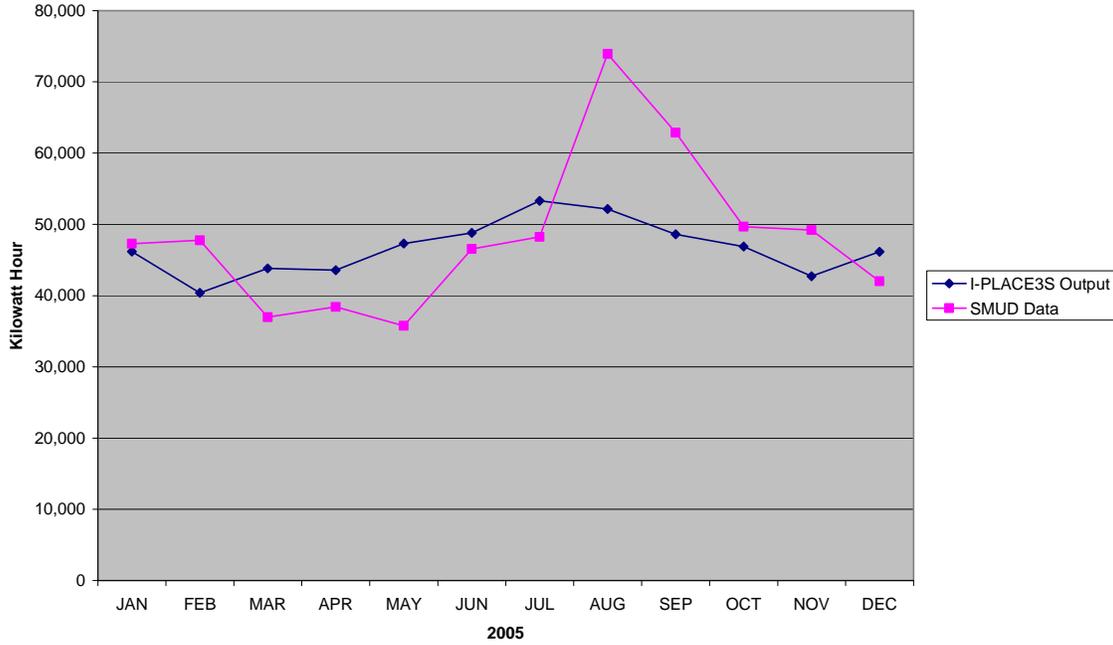


**Figure 6- 28 Metro Center Moderate Intensity Office Placetype Monthly Electrical Consumption**

For this placetype I-PLACE3S follows the same pattern it has in the other neighborhoods with an under prediction of the SMUD data overall and the peak load in July preceding the peak for the SMUD data by one month. The maximum difference between the two data sets is in December with I-PLACE3S under predicting the SMUD load data by 36 percent. The minimum difference is in May and is two percent. The average difference over the course of the year is 20 percent.

The load profile for the Community/Neighborhood Commercial/Office placetype is illustrated in Figure 6-29. Please note that in the Metro Center neighborhood the standard and the modified version of this placetype have been combined.

**Metro Center Community/Neighborhood Commercial/Office Placetype Monthly Energy Consumption**



**Figure 6- 29 Metro Center Community/Neighborhood Commercial/Office Placetype Monthly Energy Consumption**

The I-PLACE3S output follows the SMUD data fairly closely for this placetype except for the months of August and September where there is a spike in the SMUD load data. The maximum difference between the two data sets is 32 percent in the month of August. The minimum difference is two percent in January and the average difference over the course of the year is 15 percent. The difference between the annual electrical consumption calculated by I-PLACE3S and the load data from SMUD is three percent.



## 4.0 Conclusions and Recommendations

The following observations can be made from the validation study:

- The I-PLACE3S output tends to follow the outside air temperature for 2005 which peaks in July. Whereas, the SMUD load data tends to peak in August and in most cases does not have a bell shaped curve.
- The I-PLACE3S output for the High Intensity Office and CBD Office placetypes tends to over predict the SMUD load data whereas the I-PLACE3S output for the Moderate Intensity Office placetype tends to under predict the SMUD data. This is mostly evident in the Downtown neighborhood and points to a mischaracterization of the parcels assigned those placetypes and potential problems with the 2005 SACOG input data set.
- I-PLACE3S does not do a good job of predicting the load for the Light Industrial Placetype. This placetype is driven by internal equipment loads and has a non-outside air temperature driven load profile. The erroneous results produced in the model could be a factor of a number of things: 1) the light industrial load in this neighborhood is not typical and is much higher than I-PLACE3S could predict 2) the placetype has been assigned incorrectly or 3) there was not enough information about the use of the buildings to characterize it correctly in the energy settings.
- K-12 Schools were only evaluated in the Natomas neighborhood where I-PLACE3S under predicted the SMUD data by 43 percent for this placetype. Unlike the above example, this error is unlikely due to the energy settings being incorrectly defined; however, a possible explanation would be that there was an error in the placetype assignment by SACOG.
- There is a discrepancy between the close correlation of I-PLACE3S output and SMUD data for the Regional Retail placetype and the Community Neighborhood Retail placetype in the Downtown neighborhood versus the large differences in the Natomas neighborhood. One explanation could be that the retail outlets in Natomas being newer are more energy intensive than those in the Downtown area and that I-PLACE3S has a difficult time accurately modeling the newer retail stores. The other is that there was an error in the placetype assignment by SACOG.
- Once the actual average dwelling unit size (from the Sacramento County Assessors data) was input into I-PLACE3S the Natomas Low Density Residential and Medium Density Residential and Medium High Density Residential placetypes exhibited a range of correlations with respect to the annual SMUD load data, at 21 percent, five percent and 48 percent difference respectively.
- I-PLACE3S does a good job of modeling the medical facility in the Midtown neighborhood and comes within eight percent of the SMUD load data on an annual basis.

- The correct input characterization of the Metro Center neighborhood did much to improve the accuracy of the I-PLACE3S output. At the neighborhood level the percent difference in annual electrical consumption went from 28 percent to 15 percent, which is a 13 percent improvement.

The following conclusions and recommendations can be made for its future development and use:

- I-PLACE3S is a good tool for comparing the relative energy usage of different scenarios at the neighborhood level.
- It was most accurate in predicting energy usage for the Midtown neighborhood. However, even there, it showed a maximum difference of 31 percent between the SMUD load data and the I-PLACE3S output. The minimum difference on a monthly basis was zero percent and the average over the course of the year was 13 percent. The percent difference in annual consumption was five percent. With this level of accuracy it cannot be considered a good tool for predicting energy consumption at the neighborhood level.
- In general, its accuracy does improve when the inputs to the program are accurately determined. It is suited for use with new developments where input information can be gathered accurately from permitting data. I-PLACE3S tends to lose its accuracy with areas where land uses have changed and up to date information is not available.
- Further investigation should be made into those placetypes where I-PLACE3S fell short in predicting the load first by updating the SACOG input data set and secondly if that does not improve performance, by updating the look up tables used by I-PLACE3S for those particular placetypes.

## 5.0 Glossary

Placetype – Placetypes are land uses that are user defined and are created in I-PLACE3S using inputs such as transit friendliness, pedestrian friendliness, percent of placetype by sector, square footage by sector, parking ratios, etc.

Sector – A specific type of use for a parcel. Some examples of sector include retail, residential, office, and industrial.

Parcel – Any area of land in the city under one ownership as shown on the last assessor's roll of the county or the records of the city.

Neighborhood – An area of land constituting a large number of parcels.

Placetype Energy Settings – A menu in the I-PLACE3S Program that allows one to define sector percentages for a placetype that will be used specifically by the energy module. It also allows one to define average dwelling unit size. The sector percentages are used by I-PLACE3S to look-up electrical consumption on a per square foot basis.

Placetype Manager – A menu in the I-PLACE3S Program that allows one to define percent of placetype by sector, square footage by sector, parking ratios per 1000 square feet or per dwelling unit, parking types distribution and number of levels, transit friendliness, pedestrian friendliness, etc.

**6.0 Appendix A – Downtown**

Downtown Placetype Energy Settings

PLACETYPE NAME	Avg. DU Size (sqft)	Detached	Group Home	> 3 Stories	<= 3 Stories	Mobile Home	Rural	Townhouse	Assemb	Edu Prim	Edu Sec	Com Col	Univer	Reloc	Groc	Hospital	Nursing	Hotel	Motel	Bio/Tech	Lt Ind	Lrg Off	Sml Off	Restaurant	Fast Food	Retail 3
1. RURAL RESIDENTIAL	3200						100																			
2. VERY LOW DENSITY RESIDENTIAL	2800	100																								
3. LOW DENSITY RESIDENTIAL	1250	100																								
4. MEDIUM DENSITY RESIDENTIAL	900	10			90																					
5. MEDIUM-HIGH DENSITY RESIDENTIAL	1700	100																								
6. HIGH DENSITY RESIDENTIAL	800			100																						
7. URBAN RESIDENTIAL	1100			100																						
8. HIGH-INTENSITY OFFICE																						5				
9. MODERATE-INTENSITY OFFICE																						95				
10. COMMUNITY/NEIGHBORHOOD RETAIL																								75		
11. REGIONAL RETAIL																								5		
12. LIGHT INDUSTRIAL - OFFICE																						25		75		
13. LIGHT INDUSTRIAL																						95		5		
14. HEAVY INDUSTRIAL																										
15. PUBLIC/QUASI-PUBLIC																							95	5		
16. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE																							95			
16A. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE - MODIFIED																							95			
17. REGIONAL COMMERCIAL/OFFICE																							95			
18. MIXED USE EMPLOYMENT FOCUS	900				5																			90		
19. MIXED USE RESIDENTIAL FOCUS	750				40																			35		
31. FUTURE GROWTH AREA																										
32. NEW AREA EMP																										
33. NEW AREA MF																										
34. NEW AREA SF																										
35. ROADS																										
36. URBAN RESERVE																										
37. WATER																										
40. SAC CBD HIGH INTENSITY MIXED USE OFFICE	800				90																		5			
41. R STREET HIGH DENSITY MIXED-USE CENTER																										
42. RICHARDS BLVD RESIDENTIAL MIXED USE																										
43. NATOMAS JOINT VISION MEDIUM DENSITY MIXED-USE																										
44. RAILYARDS HIGH DENSITY RESIDENTIAL MIXED USE																										
45. INTENSE URBAN RESIDENTIAL	800				95																					
46. CBD OFFICE																							5			
47. MEDICAL FACILITY																										
48. AIRPORT																										
50. K-12 SCHOOLS																										
51. UNIVERSITY/COLLEGE																										
PARKING LOT																										
RAILYARDS TEST 3																										

Downtown													
I-PLACE3S OUTPUT													
PLACE TYPE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
3. Low Density Residential	549	485	525	583	855	1,096	1,347	1,252	986	704	516	549	
4. Medium Density Residential	1,902	1,759	2,028	2,306	2,934	3,294	3,737	3,517	2,973	2,441	1,900	1,902	
5. Medium-High Density Residential	54,203	47,661	52,055	55,667	83,649	109,367	133,264	124,948	95,570	67,711	50,318	54,159	
6. High Density Residential	703,969	652,430	747,535	802,032	929,249	967,421	1,044,866	1,004,683	910,320	831,699	704,525	703,821	10,000
7. Urban Residential	301,068	278,916	319,407	342,254	396,013	411,975	444,792	427,813	387,929	354,860	301,127	301,003	4,260
8. High-Intensity Office	4,937,431	4,620,623	5,375,560	5,916,917	7,175,038	7,943,193	9,106,225	8,686,208	7,565,381	6,650,649	5,149,229	4,878,893	78,000
9. Moderate-Intensity Office	1,282,763	1,193,331	1,330,424	1,415,997	1,601,443	1,626,305	1,786,768	1,715,948	1,554,207	1,492,879	1,263,428	1,270,873	17,530
10. Community/Neighborhood Retail	1,052,206	969,420	1,115,367	1,207,568	1,476,029	1,672,958	1,955,182	1,851,651	1,592,918	1,363,630	1,076,743	1,046,358	16,380
11. Regional Retail	427,551	389,869	440,797	467,947	554,308	598,513	671,322	644,759	576,476	521,251	429,132	426,280	6,140
12. Light Industrial - Office	12,255	10,986	12,507	13,613	16,967	17,757	20,451	19,779	17,045	15,755	12,161	11,591	180
13. Light Industrial	79,375	68,719	73,805	76,035	93,733	92,539	107,649	105,488	90,162	87,649	72,188	74,471	1,020
15. Public/Quasi-Public	1,370,638	1,283,829	1,431,288	1,539,086	1,772,711	1,802,026	1,988,302	1,917,160	1,728,739	1,653,095	1,370,582	1,348,546	19,200
16. Community/Neighborhood Commercial/Office	1,009,071	937,426	1,045,033	1,110,072	1,251,164	1,269,937	1,394,060	1,337,958	1,212,806	1,166,433	991,017	1,000,690	13,720
16a. Community/Neighborhood Commercial/Office - Modified	44,051	41,304	46,071	49,579	57,145	58,195	64,231	61,898	55,823	53,249	44,099	43,400	610
17. Regional Commercial/Office	305,375	290,716	324,564	356,597	425,278	435,215	484,195	469,347	420,183	396,001	315,349	297,562	4,520
18. Mixed Use Employment Focus	50,183	46,504	53,208	57,321	67,291	71,160	80,549	78,106	68,024	63,951	51,543	47,938	730
19. Mixed Use Residential Focus	9,901	9,012	10,333	11,308	13,804	14,754	16,702	16,034	14,039	12,677	9,969	9,623	140
40. Sac CBD High Intensity Mixed Use Office	136,540	127,514	146,536	157,445	182,013	189,406	205,479	197,838	178,871	164,679	137,990	136,039	1,960
45. Intense Urban Residential	142,518	131,939	151,137	162,082	188,237	197,069	214,184	205,894	185,982	169,621	142,899	142,321	2,030
46. CBD Office	21,999,980	20,493,915	23,757,620	26,200,771	31,896,852	35,346,090	40,550,187	38,653,582	33,657,075	29,531,240	22,832,410	21,726,598	346,640
TOTAL	33,918,131	31,593,176	36,432,131	39,941,269	48,180,256	52,823,676	60,268,597	57,519,137	50,311,188	44,596,172	34,953,696	33,519,208	524,050

SMUD DATA													
	1	2	3	4	5	6	7	8	9	10	11	12	
Low Density Residential	677	793	763	670	696	659	712	1,799	1,434	834	644	704	1,000
Medium Density Residential	2,278	2,393	1,779	1,675	1,664	1,660	1,593	3,123	2,512	1,472	1,396	1,923	2,000
Medium-High Density Residential	376,294	426,679	291,016	243,607	229,800	239,817	206,234	342,719	294,105	227,560	202,049	261,200	3,340
High Density Residential	974,222	1,123,378	769,718	653,242	619,930	660,342	684,076	1,000,848	986,738	766,836	669,050	777,066	9,680
Urban Residential	341,815	379,269	328,588	319,425	320,613	354,210	357,784	503,164	474,161	405,500	352,112	351,624	4,480
High-Intensity Office	6,271,121	6,600,921	6,258,743	6,290,821	6,439,992	6,781,989	6,869,342	8,615,999	7,650,507	7,143,617	6,479,435	6,271,770	81,670
Moderate-Intensity Office	3,764,652	4,600,235	4,353,716	4,356,287	4,727,047	5,238,833	5,171,402	6,248,796	7,154,973	4,658,815	3,795,268	3,933,776	58,000
Community/Neighborhood Retail	1,192,956	1,438,196	1,263,886	1,270,567	1,287,986	1,557,600	1,449,002	1,829,029	1,730,040	1,562,791	1,347,446	1,357,354	17,280
Regional Retail	486,747	453,191	428,231	384,605	455,455	609,811	575,675	780,733	632,282	590,138	555,518	507,303	6,450
Light Industrial - Office	20,120	21,920	14,440	11,360	13,200	14,600	16,720	19,000	19,040	16,640	14,680	13,600	190
Light Industrial	53,886	61,402	54,439	66,456	34,699	55,639	55,152	66,833	61,980	59,673	49,197	47,918	660
Public/Quasi-Public	1,544,973	1,737,015	1,796,141	1,820,278	1,899,222	2,311,947	2,187,649	3,167,004	3,890,398	1,367,937	1,497,654	1,028,673	24,240
Community/Neighborhood Commercial/Office	1,114,885	1,294,902	1,189,567	1,170,820	1,220,203	1,326,595	1,267,894	1,486,620	1,477,125	1,325,229	1,221,196	1,230,216	15,320
16a. Community/Neighborhood Commercial/Office - Modified	144,131	157,788	154,285	141,251	157,733	171,048	172,028	204,857	174,387	174,195	150,788	150,084	1,950
Regional Commercial/Office	2,012,989	2,331,727	2,034,712	1,987,203	2,040,118	2,520,974	2,332,823	3,182,311	2,751,220	2,505,998	2,427,484	2,188,129	28,310
Mixed Use Employment Focus	72,228	80,317	62,215	60,962	61,756	64,471	64,839	92,882	91,625	72,879	59,361	67,879	850
Mixed Use Residential Focus	9684	11429	9072	8088	8364	8344	8093	10386	10508	9175	8356	9021	1,100
Sac CBD High Intensity Mixed Use Office	17,934	19,267	13,424	11,010	11,195	10,041	10,128	13,539	13,157	11,682	10,428	12,762	150
Intense Urban Residential	156,947	317,470	238,261	207,830	202,790	237,069	213,896	328,409	273,937	246,333	226,939	229,051	2,870
CBD Office	9,307,633	10,403,150	9,635,455	9,527,568	9,531,848	10,098,138	10,463,331	10,179,168	14,126,353	7,339,140	12,114,728	12,630,905	125,350
Total	27,866,172	31,461,442	28,898,451	28,533,725	29,264,311	32,263,787	32,108,373	38,077,219	41,816,482	28,486,444	31,183,729	31,070,958	381,030

## 7.0 Appendix B – Natomas

Natomas Placetype Energy Settings

PLACETYPE NAME	Avg. DU Size (sqft)	Detached	Group Home	> 3 Stories	<= 3 Stories	Mobile Home	Rural	Townhouse	Assemb	Edu Prim	Edu Sec	Com Col	Univer	Reloc	Groc	Hospital	Nursing	Hotel	Motel	BioTech	Lt Ind	Lrg Off	Sml Off	Restaurant	Fast Food	Retail 3 Stry	Lrg R
1. RURAL RESIDENTIAL	3200						100																				
2. VERY LOW DENSITY RESIDENTIAL	3000	100																									
3. LOW DENSITY RESIDENTIAL	1800	100																									
4. MEDIUM DENSITY RESIDENTIAL	1100	50			50																						
5. MEDIUM-HIGH DENSITY RESIDENTIAL	1800	95			5																						
6. HIGH DENSITY RESIDENTIAL	1800				100																						
7. URBAN RESIDENTIAL																											
8. HIGH-INTENSITY OFFICE																											
9. MODERATE-INTENSITY OFFICE																											
10. COMMUNITY/NEIGHBORHOOD RETAIL																								50	25		
11. REGIONAL RETAIL																							5				
12. LIGHT INDUSTRIAL - OFFICE																											
13. LIGHT INDUSTRIAL																						73	27				
14. HEAVY INDUSTRIAL																						100					
15. PUBLIC/QUASI-PUBLIC																											
16. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE																								55	20	10	
16A. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE - MODIFIED																								55	20	10	
17. REGIONAL COMMERCIAL/OFFICE																											
18. MIXED USE EMPLOYMENT FOCUS																											
19. MIXED USE RESIDENTIAL FOCUS																											
31. FUTURE GROWTH AREA																											
32. NEW AREA EMP																											
33. NEW AREA MF																											
34. NEW AREA SF																											
35. ROADS																											
36. URBAN RESERVE																											
37. WATER																											
40. SAC CBD HIGH INTENSITY MIXED USE OFFICE																											
41. R STREET HIGH DENSITY MIXED-USE CENTER																											
42. RICHARDS BLVD RESIDENTIAL MIXED USE																											
43. NATOMAS JOINT VISION MEDIUM DENSITY MIXED-USE																											
44. RAILYARDS HIGH DENSITY RESIDENTIAL MIXED USE																											
45. INTENSE URBAN RESIDENTIAL																											
46. CBD OFFICE																											
47. MEDICAL FACILITY																											
48. AIRPORT																											
50. K-12 SCHOOLS										25	75																
51. UNIVERSITY/COLLEGE																											
PARKING LOT																											
RAILYARDS TEST 3																											

NATOMAS

I-PLACE3S OUTPUT

PLACE TYPE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1. Rural Residential	509	447	482	505	725	949	1,132	1,064	823	599	471	500
2. Very Low Density Residential	142,381	124,792	134,718	141,985	206,001	271,009	324,526	304,834	234,484	168,987	131,576	142,220
3. Low Density Residential	2,234,733	1,966,812	2,141,331	2,242,711	3,175,131	4,062,570	4,886,599	4,633,770	3,596,993	2,667,105	2,079,320	2,232,670
4. Medium Density Residential	1,233,284	1,122,719	1,269,824	1,382,859	1,782,601	2,053,005	2,360,970	2,243,604	1,855,374	1,517,612	1,206,486	1,232,820
5. Medium-High Density Residential	2,164,441	1,906,174	2,074,978	2,162,767	3,016,478	3,832,096	4,591,909	4,365,325	3,405,399	2,556,379	2,016,181	2,162,440
6. High Density Residential	39,991	36,907	42,108	45,184	52,672	55,020	59,506	57,191	51,613	47,014	39,848	39,990
I-PLACE3S Community/Neighborhood Retail	230,441	210,268	237,670	257,819	314,964	358,251	418,990	395,909	341,529	292,225	231,979	231,880
I-PLACE3S Regional Retail	28,293	25,800	29,170	30,967	36,682	39,607	44,425	42,667	38,149	34,494	28,398	28,293
I-PLACE3S Light Industrial - Office	90,619	79,646	87,785	92,743	114,917	116,641	135,036	131,497	112,835	107,108	85,634	85,310
I-PLACE3S Light Industrial	134,082	115,577	123,183	125,931	154,995	151,673	176,713	173,516	148,120	145,082	120,581	125,670
15. Public/Quasi-Public	402,790	363,452	418,098	459,223	573,370	605,478	696,303	672,078	579,910	531,829	406,118	381,540
16. Community/Neighborhood Commercial/Office	233,647	211,619	240,721	261,984	323,581	353,319	410,182	391,995	337,717	300,121	234,423	227,730
16a. Community/Neighborhood Commercial/Office - Modified	40,840	36,990	42,077	45,793	56,560	61,758	71,698	68,519	59,031	52,459	40,976	39,800
50. K-12 Schools	66,590	68,322	75,634	61,076	104,612	70,737	45,861	80,914	108,429	95,394	73,804	45,550
TOTAL	7,042,642	6,269,524	6,917,779	7,311,547	9,913,289	12,032,113	14,223,850	13,562,882	10,870,405	8,516,408	6,695,795	6,976,400

SMUD DATA

Month	1	2	3	4	5	6	7	8	9	10	11	12
1. Rural Residential	685	814	664	613	559	625	617	907	660	518	489	640
2. Very Low Density Residential	195,789	207,187	151,272	128,082	129,169	131,910	138,301	240,919	193,807	137,458	121,587	153,220
3. Low Density Residential	3,408,255	3,701,371	2,632,803	2,247,164	2,230,628	2,336,930	2,469,023	4,383,786	3,512,047	2,509,404	2,106,498	2,646,770
4. Medium Density Residential	1,665,779	1,850,875	1,243,279	1,029,033	999,554	1,037,115	1,121,710	1,929,549	1,562,328	1,111,005	924,518	1,218,630
5. Medium-High Density Residential	3,554,385	4,056,095	2,786,415	2,314,820	2,408,378	2,412,310	2,486,113	3,781,365	3,113,969	2,514,444	2,251,980	2,801,470
6. High Density Residential	70,275	81,835	49,302	37,188	39,975	33,056	35,014	56,514	45,286	35,253	38,956	45,420
SMUD Community/Neighborhood Retail	579,436	641,481	602,484	591,944	618,280	662,098	670,806	838,291	744,385	723,606	642,011	645,170
SMUD Regional Retail	209,340	228,140	208,837	209,134	217,778	215,957	207,936	264,092	222,533	218,172	195,111	217,330
SMUD Light Industrial - Office	124,025	141,566	111,841	101,699	102,806	107,676	113,515	131,361	118,361	112,123	101,443	100,770
SMUD Light Industrial	494,160	534,805	493,849	474,847	496,771	551,671	554,803	664,432	616,555	814,319	283,598	278,270
15. Public/Quasi-Public	209,059	237,181	216,192	207,854	204,710	230,546	238,586	274,100	267,627	251,395	228,773	210,980
16. Community/Neighborhood Commercial/Office	498,432	564,382	491,935	466,427	492,445	521,838	522,298	645,724	564,635	542,697	458,934	488,000
16a. Community/Neighborhood Commercial/Office - Modified	68,473	75,630	61,667	57,138	68,604	62,124	68,154	86,500	73,299	65,736	59,638	50,800
50. K-12 Schools	110,560	135,285	114,482	97,401	106,803	116,625	108,401	163,753	163,971	163,782	155,201	141,800
Total	11,188,653	12,456,647	9,165,022	7,963,344	8,116,460	8,420,481	8,735,277	13,461,293	11,199,463	9,199,912	7,568,737	8,999,430

## 8.0 Appendix C – Midtown

Midtown Placetype Energy Settings

PLACETYPE NAME	Avg. DU Size (sqft)	Detached	Group Home	> 3 Stories	<= 3 Stories	Mobile Home	Rural	Townhouse	Assemb	Edu Prim	Edu Sec	Com Col	Univer	Reloc	Groc	Hospital	Nursing	Hotel	Motel	Bio/Tech	Lt Ind	Lrg Off	Sml Off	Restaurant	Fast Food	Retail 3 Str
1. RURAL RESIDENTIAL	3200						100																			
2. VERY LOW DENSITY RESIDENTIAL	2800	100																								
3. LOW DENSITY RESIDENTIAL	1800	100																								
4. MEDIUM DENSITY RESIDENTIAL	900	15			85																					
5. MEDIUM-HIGH DENSITY RESIDENTIAL	1500	75		25																						
6. HIGH DENSITY RESIDENTIAL	600			100																						
7. URBAN RESIDENTIAL	500			100																						
8. HIGH-INTENSITY OFFICE																						5				
9. MODERATE-INTENSITY OFFICE																						100				
10. COMMUNITY/NEIGHBORHOOD RETAIL																								50		
11. REGIONAL RETAIL																								5		
12. LIGHT INDUSTRIAL - OFFICE																						25		75		
13. LIGHT INDUSTRIAL																						100				
14. HEAVY INDUSTRIAL																										
15. PUBLIC/QUASI-PUBLIC																							40	60		
16. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE																								95		
16A. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE - MODIFIED																								95		
17. REGIONAL COMMERCIAL/OFFICE																								95		
18. MIXED USE EMPLOYMENT FOCUS	900			60																				5		
19. MIXED USE RESIDENTIAL FOCUS	900			40																				5		
31. FUTURE GROWTH AREA																										
32. NEW AREA EMP																										
33. NEW AREA MF																										
34. NEW AREA SF																										
35. ROADS																										
36. URBAN RESERVE																										
37. WATER																										
40. SAC CBD HIGH INTENSITY MIXED USE OFFICE																										
41. R STREET HIGH DENSITY MIXED-USE CENTER																										
42. RICHARDS BLVD RESIDENTIAL MIXED USE																										
43. NATOMAS JOINT VISION MEDIUM DENSITY MIXED-USE																										
44. RAILYARDS HIGH DENSITY RESIDENTIAL MIXED USE																										
45. INTENSE URBAN RESIDENTIAL	800			95																						
46. CBD OFFICE																							25			
47. MEDICAL FACILITY																							100			
48. AIRPORT																										
50. K-12 SCHOOLS																										
51. UNIVERSITY/COLLEGE																										
PARKING LOT																										
RAILYARDS TEST 3																										

Midtown

I-PLACE3S OUTPUT

PLACE TYPE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3. Low Density Residential	40,510	35,582	38,873	41,902	64,380	84,991	104,064	97,268	73,911	51,455	37,534	40,471
4. Medium Density Residential	14,532	13,415	15,430	17,585	22,608	25,626	29,240	27,478	23,087	18,741	14,483	14,532
5. Medium-High Density Residential	208,569	183,907	199,084	221,950	328,353	423,424	521,642	484,351	380,095	269,121	195,641	208,569
6. High Density Residential	979,096	915,621	1,057,560	1,142,614	1,323,708	1,378,533	1,484,713	1,426,891	1,292,772	1,179,137	989,731	978,366
7. Urban Residential	161,937	151,340	174,667	188,366	217,846	226,640	243,966	234,586	212,727	194,391	163,563	161,937
8. High-Intensity Office	942,909	883,291	1,028,398	1,131,492	1,370,914	1,517,362	1,739,263	1,659,286	1,445,263	1,271,043	984,397	931,848
9. Moderate-Intensity Office	1,401,929	1,306,469	1,454,147	1,551,257	1,760,694	1,783,536	1,958,887	1,883,669	1,706,644	1,641,291	1,384,228	1,386,671
10. Community/Neighborhood Retail	664,449	614,357	709,122	771,403	941,171	1,061,348	1,234,615	1,171,400	1,010,900	870,696	683,241	659,696
12. Light Industrial - Office	0	0	0	0	0	0	0	0	0	0	0	0
13. Light Industrial	682,311	614,832	701,143	762,678	943,098	989,225	1,136,627	1,099,480	948,844	878,564	681,533	646,188
15. Public/Quasi-Public	459,292	425,542	480,142	513,623	591,572	612,751	684,165	660,821	585,707	557,918	461,087	445,996
16. Community/Neighborhood Commercial/Office	212,871	197,223	225,598	243,030	285,361	301,840	341,976	331,667	288,636	271,535	218,699	203,141
16a. Community/Neighborhood Commercial/Office - I	95,795	87,851	100,684	109,312	131,520	139,173	158,650	153,514	133,149	123,851	97,697	91,271
17. Regional Commercial/Office	811	754	862	926	1,080	1,142	1,291	1,253	1,092	1,031	835	771
18. Mixed Use Employment Focus	24,232	22,810	26,608	28,930	34,194	36,844	41,213	39,527	34,921	31,352	25,154	23,996
19. Mixed Use Residential Focus	69,724	66,594	78,654	85,546	101,094	110,118	124,402	119,352	104,680	93,591	74,023	69,023
45. Intense Urban Residential	75,432	70,313	81,074	87,499	102,107	107,395	117,071	112,378	101,067	91,550	76,298	75,343
46. CBD Office	578,440	534,991	607,018	672,934	824,761	897,514	1,023,983	978,296	857,177	762,116	591,216	568,031
47. Medical Facility	1,691,679	1,563,901	1,739,360	1,836,000	2,045,775	2,066,859	2,259,692	2,165,012	1,970,125	1,907,555	1,643,543	1,682,111
TOTAL	8,323,718	7,706,598	8,738,357	9,428,153	11,113,951	11,788,558	13,232,117	12,671,772	11,193,912	10,237,060	8,341,749	8,206,721

SMUD DATA

	1	2	3	4	5	6	7	8	9	10	11	12
3. Low Density Residential	68764	76901	57580	49700	47211	51431	52971	86153	70752	55201	46202	56511
4. Medium Density Residential	23,212	24,559	15,397	14,372	11,986	13,915	14,284	25,068	20,069	13,870	11,934	16,811
5. Medium-High Density Residential	366,015	416,372	315,227	269,803	258,527	280,562	303,963	506,054	408,823	301,564	261,219	304,711
6. High Density Residential	1,264,395	1,443,447	1,057,873	919,846	887,664	997,738	1,026,176	1,744,347	1,488,168	1,081,995	926,918	1,062,811
7. Urban Residential	156,349	175,516	135,569	126,744	122,746	151,183	145,308	229,921	213,055	153,371	137,238	154,711
8. High-Intensity Office	442,021	888,138	699,054	759,954	729,113	893,685	865,061	1,105,468	1,091,678	870,388	799,364	747,811
9. Moderate-Intensity Office	1,913,997	2,086,895	2,013,390	1,954,634	2,001,538	2,244,637	2,170,449	2,757,862	2,451,787	2,260,878	2,169,019	2,023,011
10. Community/Neighborhood Retail	853,815	929,832	828,285	809,391	831,618	995,947	978,462	1,256,547	1,181,408	994,433	910,952	861,211
12. Light Industrial - Office	95,340	110,364	77,657	59,027	71,391	70,389	63,657	85,350	75,029	71,607	70,941	69,411
13. Light Industrial	813,793	935,572	883,865	867,939	856,262	901,774	901,779	1,038,029	869,206	977,595	917,544	1,020,211
15. Public/Quasi-Public	476,509	554,693	508,514	489,840	445,930	481,597	474,697	580,755	520,123	501,870	426,158	474,511
16. Community/Neighborhood Commercial/Office	241803	271733	249690	250198	248162	290170	302200	411051	365169	310326	269507	256411
16a. Community/Neighborhood Commercial/Office - I	180,254	200,463	168,591	160,889	169,674	207,194	197,105	289,813	259,999	203,575	177,710	164,911
17. Regional Commercial/Office	260	312	470	1,125	1,493	919	896	2,775	1,762	1,542	1,099	1,111
18. Mixed Use Employment Focus	26,229	27,342	26,406	25,548	26,838	30,659	32,157	42,727	38,264	29,933	24,898	24,911
19. Mixed Use Residential Focus	86,454	96,600	80,191	82,347	84,226	91,890	103,847	130,740	123,653	105,238	88,210	83,111
45. Intense Urban Residential	67,920	59,680	71,040	72,480	64,480	84,400	95,120	161,120	138,000	123,600	106,400	102,811
46. CBD Office	733,098	778,865	719,813	719,096	712,595	907,733	830,874	995,771	1,789,962	128,322	123,756	130,211
47. Medical Facility	1,940,373	2,062,728	1,983,771	1,978,957	2,068,085	2,146,903	2,232,862	2,364,649	2,146,119	2,049,426	1,915,174	1,772,111
Total	9,750,601	11,140,012	9,892,383	9,611,890	9,639,539	10,842,726	10,791,868	13,814,200	13,253,026	10,234,734	9,384,243	9,328,111

## 9.0 Appendix D – Metro Center

Metro Center Placetype Energy Settings

PLACE TYPE NAME	Avg. DU Size (sqft)	Sectors																											
		Detached	Group Home	> 3 Stories	<= 3 Stories	Mobile Home	Rural	Townhouse	Assemb	Edu Prim	Edu Sec	Com Col	Univer	Reloc	Groc	Hospital	Nursing	Hotel	Motel	Bio/Tech	Lt Ind	Lrg Off	Sml Off	Restaurant	Fast Food	Retail 3 Stry	Lrg Retail	Sml Retail	Con Stor
1. RURAL RESIDENTIAL	3200						100																						
2. VERY LOW DENSITY RESIDENTIAL																													
3. LOW DENSITY RESIDENTIAL	2000	100																											
4. MEDIUM DENSITY RESIDENTIAL	2000	100			50																								
5. MEDIUM-HIGH DENSITY RESIDENTIAL	1000							100																					
6. HIGH DENSITY RESIDENTIAL																													
7. URBAN RESIDENTIAL																													
8. HIGH-INTENSITY OFFICE																													
9. MODERATE-INTENSITY OFFICE																						95						5	
10. COMMUNITY/NEIGHBORHOOD RETAIL																													
11. REGIONAL RETAIL																													
12. LIGHT INDUSTRIAL - OFFICE																													
13. LIGHT INDUSTRIAL																													
14. HEAVY INDUSTRIAL																													
15. PUBLIC/QUASI-PUBLIC																													
16. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE																			100										
16A. COMMUNITY/NEIGHBORHOOD COMMERCIAL/OFFICE - MODIFIED																						95						5	
17. REGIONAL COMMERCIAL/OFFICE																													
18. MIXED USE EMPLOYMENT FOCUS																													
19. MIXED USE RESIDENTIAL FOCUS																													
31. FUTURE GROWTH AREA																													
32. NEW AREA EMP																													
33. NEW AREA MF																													
34. NEW AREA SF																													
35. ROADS																													
36. URBAN RESERVE																													
37. WATER																													
40. SAC CBD HIGH INTENSITY MIXED USE OFFICE																													
41. R STREET HIGH DENSITY MIXED-USE CENTER																													
42. RICHARDS BLVD RESIDENTIAL MIXED USE																													
43. NATOMAS JOINT VISION MEDIUM DENSITY MIXED-USE																													
44. RAILYARDS HIGH DENSITY RESIDENTIAL MIXED USE																													
45. INTENSE URBAN RESIDENTIAL																													
46. CBD OFFICE																													
47. MEDICAL FACILITY																													
48. AIRPORT																													
50. K-12 SCHOOLS																													
51. UNIVERSITY/COLLEGE																						100							
PARKING LOT																													
RAILYARDS TEST 3																													

# Original Results

Metro Center

I-PLACE3S OUTPUT

PLACE TYPE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
3. Low Density Residential	2,928	2,584	2,798	2,768	3,493	4,293	5,093	4,958	3,824	3,084	2,722	2,923	41,468
4. Medium Density Residential	23,941	21,131	22,879	22,633	28,563	35,100	41,647	40,538	31,269	25,218	22,256	23,900	339,074
5. Medium-High Density Residential	182,711	164,528	180,192	181,392	222,692	259,397	298,863	281,503	233,341	198,744	175,981	182,565	2,561,907
9. Moderate-Intensity Office	580,885	541,681	618,701	657,060	780,732	808,076	911,689	886,919	782,734	739,416	594,305	561,261	8,463,460
16. Community/Neighborhood Commercial/Office	2,236	2,132	2,457	2,513	2,813	2,928	3,209	3,133	2,908	2,762	2,361	2,264	31,716
16a. Community/Neighborhood Commercial/Office - Modified	11,416	10,645	12,159	12,913	15,343	15,880	17,917	17,430	15,382	14,531	11,679	11,030	166,325
51. University/College	114,150	106,602	121,880	129,329	153,456	158,368	178,513	173,831	153,510	145,485	117,059	110,187	1,662,371
TOTAL	918,267	849,303	961,065	1,008,608	1,207,092	1,284,042	1,456,931	1,408,312	1,222,969	1,129,241	926,363	894,129	13,266,322

SMUD Data

Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
3. Low Density Residential	3,423	3,041	2,598	2,927	2,098	3,186	3,521	6,524	4,004	2,698	2,883	2,409	39,312
4. Medium Density Residential	47,233	39,105	34,785	33,773	30,512	40,684	43,232	82,708	65,142	43,369	37,397	35,975	533,915
5. Medium-High Density Residential	205,166	194,061	183,343	186,315	166,198	201,961	223,982	369,302	292,935	208,447	183,032	183,620	2,598,362
9. Moderate-Intensity Office	1,047,048	957,103	1,018,727	1,060,530	999,017	1,072,140	1,200,940	1,307,173	1,282,620	1,229,754	1,190,875	1,115,546	13,481,473
16. Community/Neighborhood Commercial/Office	47,280	47,760	36,960	38,400	35,760	46,560	48,240	73,920	62,880	49,680	49,200	42,000	578,640
16a. Community/Neighborhood Commercial/Office - Modified	89,640	85,844	82,499	86,436	87,216	94,187	94,756	117,089	109,008	98,980	89,464	80,850	1,115,969
51. University/College	3,445	3,074	2,815	5,055	6,370	6,610	3,622	3,621	3,566	4,055	4,552	4,552	51,337
Total	1,443,235	1,329,988	1,361,727	1,413,436	1,327,171	1,465,328	1,618,293	1,960,337	1,820,155	1,636,983	1,557,403	1,464,952	18,399,008

# Rectified Results

<b>SMUD Data Aggregated to new Place Type</b>													
Place Type	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year (Total kWh)
4. Medium Density Residential	50,656	42,146	37,383	36,700	32,610	43,870	46,753	89,232	69,146	46,067	40,280	38,384	573,227
5. Medium-High Density Residential	205,166	194,061	183,343	186,315	166,198	201,961	223,982	369,302	292,935	208,447	183,032	183,620	2,598,362
9. Moderate-Intensity Office	1,140,133	1,046,021	1,104,041	1,152,021	1,098,043	1,180,937	1,315,158	1,441,643	1,410,074	1,341,909	1,292,411	1,210,708	14,733,099
16. Community/Neighborhood Commercial/Office	47,280	47,760	36,960	38,400	35,760	46,560	48,240	73,920	62,880	49,680	49,200	42,000	578,640
	1,443,235	1,329,988	1,361,727	1,413,436	1,332,611	1,473,328	1,634,133	1,974,097	1,835,035	1,646,103	1,564,923	1,474,712	
													18,483,328
<b>I-PLACE3S Outputs for "Totally Adjusted Existing Conditions Scenario"</b>													
Place Type	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year (Total kWh)
4. Medium Density Residential	49,796	38,733	36,183	33,050	37,383	43,580	50,505	49,185	39,189	33,799	36,015	49,091	469,508
5. Medium-High Density Residential	246,774	209,536	216,567	212,201	247,694	277,228	312,497	296,005	251,533	222,993	210,077	243,663	2,946,818
9. Moderate-Intensity Office	825,824	759,500	856,789	904,331	1,072,085	1,109,446	1,251,696	1,217,708	1,074,717	1,015,870	825,008	797,635	11,710,610
16. Community/Neighborhood Commercial/Office	46,186	40,382	43,807	43,568	47,311	48,790	53,318	52,149	48,607	46,881	42,723	46,140	559,861
	1,168,580	1,048,151	1,153,346	1,193,150	1,404,473	1,479,044	1,668,016	1,615,047	1,414,046	1,319,543	1,113,823	1,136,529	
													15,686,797