Community Scale Solar Water Heating - Case Study Selection Criteria

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Table of Contents

Executive Summary

The *Case Study Selection Criteria* report summarizes the selection of case studies for the *Evaluation of Energy Savings from Community Scale Solar Water Heating in Los Angeles County*. The first section of this deliverable explains the development of selection criteria. The second section lists the selected case study sites and preliminary data about each.

Introduction

The *Case Study Selection Criteria* report describes how community scale solar water heating case study sites were chosen from a broader pool of potential candidate sites. The development of a putative energy community pool and brief descriptions of the energy communities chosen for further study are also included as part of this report.

The first part of this report describes how practical constraints (such as property ownership, number of residential units, etc.) and technological requirements of community scale solar thermal systems limit the selection pool. The influence of property ownership patterns and parcel-level characteristics, such as the number of buildings and their arrangement, are also discussed within this section.

The second section of this report describes the development of the pool of solar water heating energy communities. Data from the Los Angeles County GIS Office, the Los Angeles Regional Imagery Acquisition Consortium (LARIAC), and the California Center for Sustainable Community's Energy Atlas is used to develop a screening filter which incorporates the aforementioned practical and technological constraints.[1]

The third section of this report discusses the approach used to select specific case studies from the pool of candidate energy communities. Here, socioeconomic factors (more specifically, measures of social disadvantage) inform the selection of specific cases. Typical cases are also selected to assist in estimating county-wide costs and benefits of community scale solar water heating.

1 Practical and Technical Constraints on Community Scale SWH

Not all residential parcels are equally suitable for a community scale approach to solar water heating. This section lists and discusses the practical and technological constraints to which community scale SWH systems are subject. These constraints include property ownership patterns, transmission losses, available space for collector areas, and ease of permitting. The table below outlines constraint categories.

Table 1: Practical and Technical Constraints for Community Scale SWH

Constraints	Issues
Existing Infrastructure	- Heat Transmission Network - Retrofit vs. New Construction
Technical Limitations	- Transmission Losses
System and Property Ownership	- Land Use Patterns - Collective Ownership - Qualification for Incentives - Technical Limitations of Incentives

[1] California Center for Sustainable Communities. (2018). *About The LA Energy Atlas.* Retrieved from: http://www.energyatlas.ucla.edu/about/overview

1.1 Existing Infrastructure

The greatest constraint on the development of community scale solar energy systems is the presence and state of existing infrastructure. Regardless of scale or type, all solar energy systems include energy collection and transmission infrastructure.[2] Also, virtually all solar energy systems include energy storage to match the supply of thermal or electrical energy with demand. Integration of community scale solar energy systems with existing infrastructure may reduce the cost of construction and operation, and in some cases increase operational scale.[3]

1.1.1 Heat Transmission Network

Currently, there exists no large scale public heat transmission infrastructure in Los Angeles County. The largest central heating system in Los Angeles County belongs to the University of California at Los Angeles and supplies the Ronald Regan Medical Center as well as other campus buildings.[4] Large scale cogeneration and district level heating are more economically feasible in cities with colder climates and denser urban forms, such as New York, San Francisco, and Minneapolis/St. Paul.[5,6,7]

1.1.2 Retrofit vs. New Construction

As mentioned in the *Solar Water Heating (SWH)* and *Methodology* Reports, urban form impacts the feasibility of community scale SWH, and the performance of installed systems. Population density, characteristics of the building stock, and the impact of zoning rules are all potentially influential variables. Thus, in order to produce relevant and realistic estimates of energy savings, this report includes only retrofit case studies. Case studies should be representative of the urban environment in LA County as it currently exists, and reflect the potential community scale SWH to reduce energy consumption and emissions without additional assumptions about changes to urban form.

1.2 Technical Limitations

Unlike community scale PV systems, the physical nature of solar thermal systems limits the size of the geographies they can serve. Transmission losses from hot water distribution networks may be as large as 30%, even if pipes are buried and insulated according to code.[8] The performance of the community scale SWH systems considered in this study are more sensitive to total transmission distance than are systems with heat injection loops.

1.2.1 Transmission Losses

The efficiency and cost-effectiveness of central heating systems generally increase with scale, but the superior performance of large systems is due in part to how such systems store and transmit thermal energy. In district scale heating systems, heat injection loops act as thermal storage tanks, reducing the

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[2] Wiseman, H. J., & Bronin, S. C. (2012). Community-Scale Renewable Energy. *San Diego J. Climate & Energy L.*, *4*, 165.
[3] *Ibid.*
[4] Masunaga, S. (9 April 2009). *Co-gen helps UCLA go green.* The Daily Bruin. Retrieved from: http://dailybruin.com/2009/04/09/co-gen-helps-ucla-go-green/
[5] ConEdison. (2018). *Steam Service*. Retrieved from: https://www.coned.com/en/commercial-industrial/steam
[6] San Francisco Department of the Environment. (2018). *District Heating*. Retrieved from: https://sfenvironment.org/article/geothermal/district-energy
[7] District Energy St. Paul. (2018). *District Heating*. Retrieved from: http://www.districtenergy.com/technologies/district-heating/
[8] Anderson, K.R. (12 March 2018). Personal Communication.

need for heated fluid to travel long distances through comparatively narrow pipes to reach users, thus minimizing transmission losses.[9]

Future residential construction projects may include heat storage loops, but the expense and complexity of retrofitting existing residential housing stock with central heat injection loops makes such an approach infeasible. Instead, transmission losses may be diminished by selecting residential parcels that are both densely constructed and populated.

1.3 System and Property Ownership

Community scale SWH systems installed in LA County cannot take advantage of existing thermal energy infrastructure; thus, SWH system owners must bear the costs of construction and operation, offset by the applicable incentives. Land ownership patterns, utility billing practices, laws, and policies regarding SHW system financing all limit the number of candidate sites for community scale SWH that are available within LA County.

1.3.1 Land Use Patterns

LA County's diversity of urban forms and patchwork of single- and multi-family residential buildings increases the complexity of designing and building a SWH system that serves multiple properties and residences. Land use and ownership patterns affect the size of the geographies community scale energy systems may serve, and foremost among the factors constraining the size of community scale SWH systems is the separation of residential parcels by roadways.

Los Angeles is among the densest cities in the U.S., and correspondingly, has a relatively high roadway mileage per capita.[10] The extension of community scale systems beyond single parcels or city blocks would require system owners to secure permission from local authorities to lay insulated pipe across roadways. In the interest in minimizing uncertainty about system costs, the community scale SWH systems considered in this study will serve either single or contiguous groups of parcels. In some cases, energy communities may be spread over multiple parcels separated by streets, but in such an instance separate parcels will be served by separate community-scale SWH systems. However, the number of separate SWH systems per site may be greater than one per parcel, owing to practical considerations.

[9] Chen, W. (21 February 2018). Personal Communication.
[10] Manville, M., & Shoup, D. (2004). Parking, People, and Cities. https://doi.org/10.1061/ASCE0733-94882005131:4233

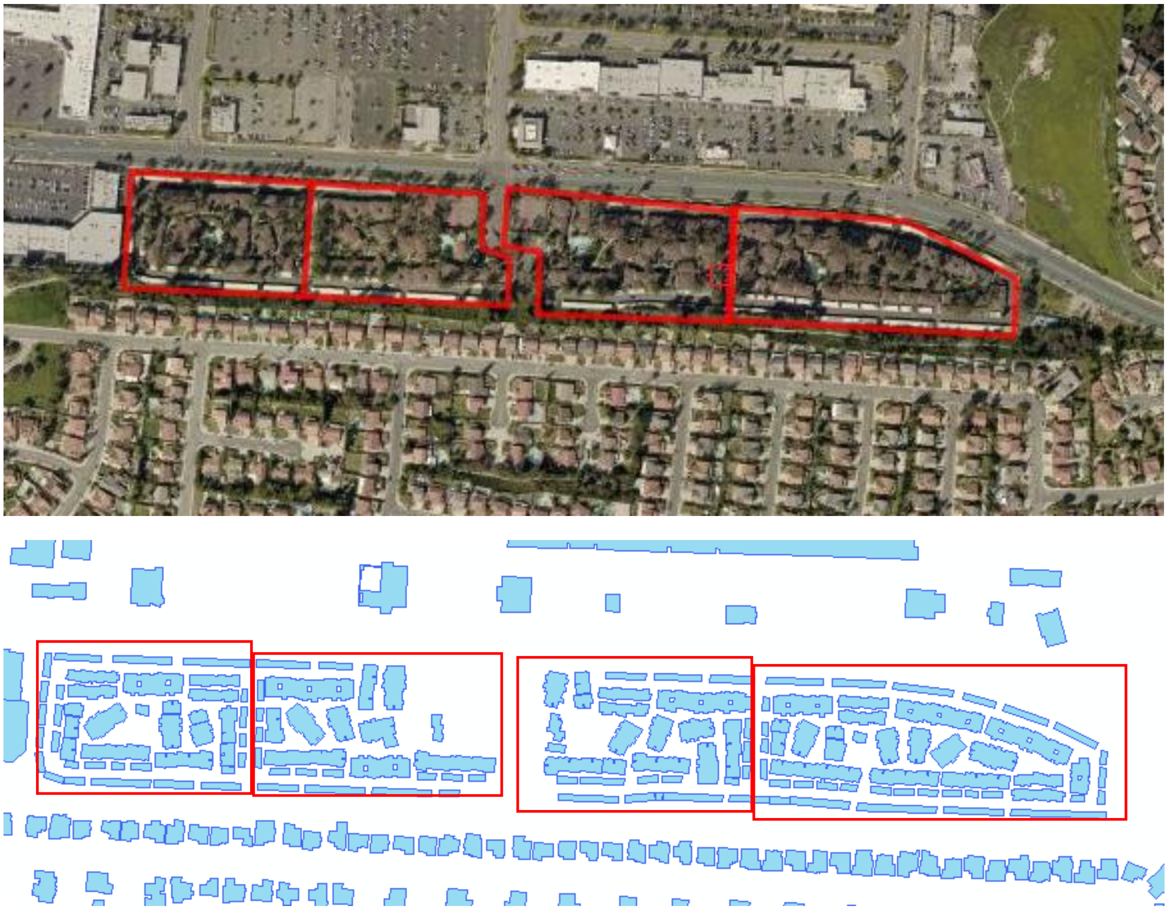


Figure 1: Aerial Image (Above) and Building Outlines (Below) for the Pheasant Ridge Apartments in Rowland Heights, CA.

For the apartment complex in Figure 1, there are 4 parcels, each with a different number of residential structures. The minimum number of solar water heating systems for this site is 4, and the maximum number of separate SWH systems is equal to the sum of the residential structures, approximately 70. The number of individual SWH systems per case study will be greater than or equal to the number of parcels, and less than or equal to the number of structures. The number of individual SWH systems per case study will depend on the conditions encountered, such as cost, the proximity of buildings to one another, etc.

1.3.2 Collective Ownership

Theoretically, community scale solar water heating systems could be constructed and operated like thermal microgrids: with a mixture of distributed and centralized collection and storage, depending on the population density and urban form of a given site. Such a system would need to be owned collectively by the people it serves, who pay for the cost of its construction and maintenance, one which could perhaps be offset in part by government incentives. While it may be possible to construct and operate such a community scale SWH system, collective ownership of a community scale system is presently infeasible.

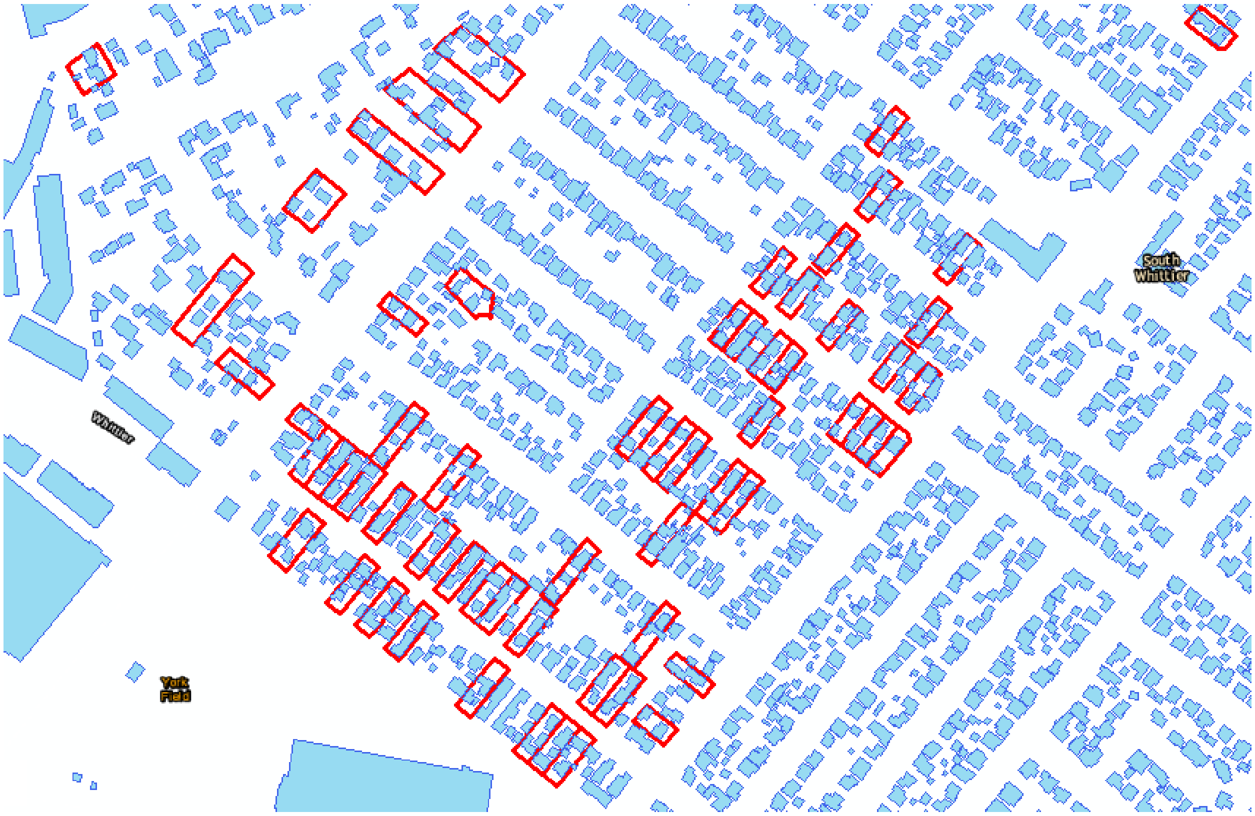


Figure 2. Adjacent Properties with 1 AIN (Single Owner) in Whittier, California – The image above (building outlines from aerial LiDAR) shows groups of adjacent residential properties (in red) where collective ownership of a solar water heating system is possible.

Communities intending to construct a collectively owned thermal microgrid like the one described in the previous paragraph face considerable transaction costs, and must structure and manage relationships between users and the firms who design, build, and manage the energy infrastructure.[11] This is a significant departure from how thermal energy is currently generated and distributed for residential use, and is the primary reason collectively owned systems are not considered in this study.

1.3.3 Qualifications for Incentives

In most cases, collectively owned community scale SWH systems are also ineligible for state and federal incentives. This study considers community scale SWH systems that are eligible for California's CSI-Thermal Multifamily Rebate, and the Federal Residential Renewable Energy Tax Credit. Specific technological and property qualifications for each are discussed in the *Solar Water Heating Report.*

The state thermal rebate and renewable tax credits are designed to offset the capital cost of solar water heating systems for the sole owner of a structure (or, more generally, a residential property) upon which

[11] Gui, E. M., Diesendorf, M., & MacGill, I. (2017). Distributed energy infrastructure paradigm: Community microgrids in a new institutional economics context. *Renewable and Sustainable Energy Reviews*, *72*, 1355–1365. https://doi.org/10.1016/J.RSER.2016.10.047

the systems are installed. This is the second reason why collective ownership arrangements are considered to be outside the scope of this study. In order for a residential parcels to be considered a candidate energy community for SWH, those parcels must have single owner to which incentive payments can be made.

1.3.4 Technical Limitations of Incentives

The *Solar Water Heating Report* explains how technologies for community scale SWH systems were chosen in part to qualify for state and federal incentives. Qualification for the CSI-Thermal rebate and the federal tax credit are important decision criteria for private installers of SWH systems, significantly reducing upfront costs.[12] However, historically, most residential solar water heating systems have been constructed to serve single residential structures, rather than "energy communities" consisting of many residential structures, and possibly tens to hundreds of residential units. Case study sites selected from the pools of candidate public and private residential properties may impose practical or technical constraints that disqualify a system (or systems) built on those sites from receiving incentives.[13,14] Such cases will not be abandoned, rather, they may provide valuable information about the limitations of current building and energy policy, and how it may possibly be improved.

2 Candidate Energy Community Pools

To select cases for further study, the constraints and issues discussed in the previous section will be used to develop parcel identification and ranking methods. Not all of the constraints mentioned above neatly classify a residential parcel as potential solar water heating energy community; some constraints do, but others, such as transmission distances, parcel size, number of residential units etc., affect the performance and design of potential community scale SWH systems.[15,16]

This section explains how a programmatic and explicable case study selection method is developed from the broader constraints on community scale SWH in LA County. The first subsection describes how absolutely qualifying/disqualifying characteristics are used to select large pools of candidate energy communities from the Energy Atlas's parcel data.[17] The second discusses the development and application of a parcel scoring metric for community scale SWH suitability. Parcel rankings and other practical considerations are then used to select case study sites.

2.1 Development of Public & Private Residential Parcel Pools

Selection of case studies begins with the Energy Atlas's two million tax assessor's parcels.[18] In order to select the public and private residential parcels on which community scale SWH is feasible, the search

[12] Chen, W. (21 February 2018). Personal Communication.
[13] United Stated Department of Energy. (2018). Residential Renewable Energy Tax Credit. Retrieved from: https://www.energy.gov/savings/residential-renewable-energy-tax-credit
[14] CPUC. (May 2018). CSI-Thermal Program Handbook.
[15] Hsieh, S., Omu, A., & Orehounig, K. (2017). Comparison of solar thermal systems with storage: From building to neighborhood scale. *Energy and Buildings*, *152*, 359–372. https://doi.org/10.1016/J.ENBUILD.2017.07.036
[16] Yaïci, W., & Entchev, E. (2014). Performance prediction of a solar thermal energy system using artificial neural networks. *Applied Thermal Engineering*, *73*, 1348–1359. https://doi.org/10.1016/j.applthermaleng.2014.07.040

[17] California Center for Sustainable Communities. (2018). *Los Angeles County Megaparcels* [Data set].
[18] *Ibid.*

filter described in Table 2 is applied.[19] The table below summarizes the set of parcel characteristics that make community scale SWH broadly feasible.

Table 2: Public and Private Property Energy Community Filter Criteria

Desired Energy Community Characteristics	Filter Conditions
Energy communities may have more than one building per site	Building Count ≥ 1
Energy communities must have more than one residential unit per site	Residential Units > 1
	First two digits of LA County Tax Assessor's Parcel Database Usecode indicate multi-family dwelling (02XX-05XX)
Minimize the number of parties involved in construction and operation	- **For Private Parcels:** 1 AIN associated with a private residential parcel. - **For Public Parcels:** Public parcels must have structures and facilities owned and operated by LA City or County
Parcels must have a single owner or ownership entity to which incentive payments can be made.	

The results of the query are as follows:

Table 3: Public & Private Parcel Counts from Community Scale SWH Filter

Private Parcels	Public Parcels
~19, 000 Multi-Family/ Mixed-Use Parcels	**213 City and County Public Housing Parcels**

As mentioned previously, the community scale filter identifies the residential parcels where community scale is feasible, but does not include any notion of how well-suited a particular parcel is to a community scale approach to SWH. To select specific case study site programmatically requires ranking different residential parcels according to their suitability for a community scale SWH system. This study's ranking is based on the available parcel data and the geographic and building-level variables know to influence the performance of SWH systems.[20,21,22] The ranking and selection method for private and public parcels is described below.

2.2 Parcel Suitability Ranking and Selection Method

Community scale SWH case study sites will be chosen according to the following criteria:

[19] *Ibid.*

[20] Dongellini, M., Falcioni, S., & Morini, G. L. (2015). Dynamic simulation of solar thermal collectors for domestic hot water production. *Energy Procedia*, *82*, 630–636. https://doi.org/10.1016/j.egypro.2015.12.012

[21] ASPE. (2015). Domestic Hot Water Systems, (March).

[22] Marini, D., Buswell, R., & Hopfe, C. J. (2015). A critical software review - how is hot water modelled in current building simulation ? Retrieved from https://dspace.lboro.ac.uk/2134/19285

1. **Parcel SWH Suitability Score**
2. **Number of Residential Units per Parcel**
3. **Urban Form and Climatic Considerations**

A residential parcel's suitability score is given by the following expression:

$$\textbf{Parcel Suitability Score} = \frac{\left(\frac{U_N A_B}{B_N P_B}\right)}{A_P}$$

Where:

- $U_N = Number\ of\ residential\ units\ per\ parcel$
- $A_B = Sum\ of\ building\ footprint\ areas\ on\ a\ parcel$
- $B_N = Number\ of\ buildings\ per\ parcel\ (\ with\ building\ outline \geq 300\ ft^2)$
- $P_B = Sum\ of\ building\ footprint\ perimeters\ on\ a\ parcel$
- $A_P = Area\ of\ the\ parcel$

Equation 1. Parcel Suitability Score

Parcels with higher ratios of building area to parcel area, and parcels with greater population densities (residential units/ unit parcel area) score better than parcels with more numerous buildings, lower built area ratios, and fewer residential units. The relationship is illustrated in Figure 3:

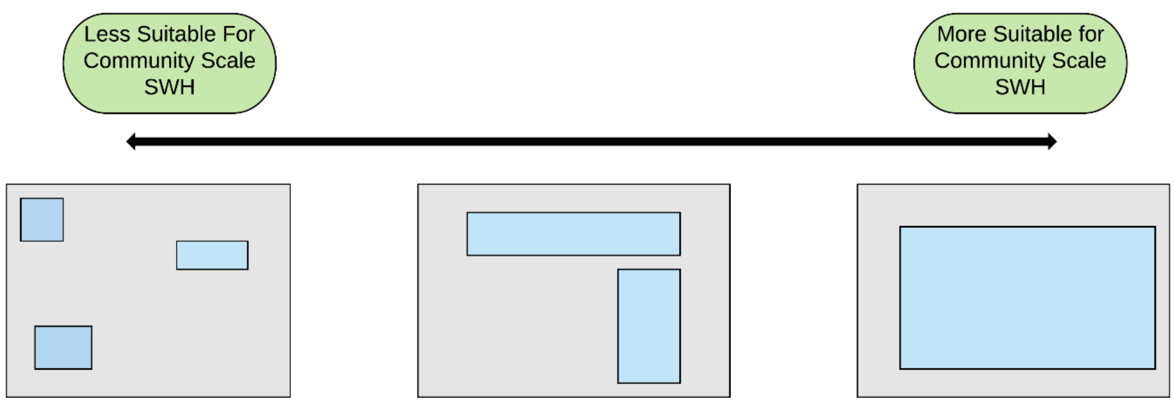


Figure 3. Parcel Suitability Score

The suitability score encapsulates how a parcel's built environment influences the performance and capital cost of a hydronic solar water heating system or systems. Parcels with small, distantly spaced structures may have insufficient rooftop space for collector arrays, possibly necessitating installation of collector arrays on the ground. Furthermore, long runs of insulated hot water pipe between storage tanks and residential units will increase both the cost of the system (both for materials and trenching), as well as heat loss. By contrast, parcels with fewer, larger, and more densely populated structures may adopt SWH at a lower cost, and without installing additional heat transmission infrastructure.

Because the suitability score computes a ratio of areas weighted by residential units and the number of buildings, it will also necessary to consider the absolute number of residential units. Case studies with different numbers of residential units (between 10-1000 units) will be chosen to elucidate the effect of population density on SWH system performance and design.

The cases selected for further study will also, to the extent possible, differ with respect to their urban form and climate zones. During scoring and selection it may be found that scores are distributed very unevenly between different types of residential development (i.e. mostly high-density apartment buildings) or regions of LA County. To the extent possible, cases will be chosen to exemplify LA County's variety of residential development patterns and region climate zones to the extent possible.

2.3 Private Parcel Ranking and Selection

Having identified approximately 19,000 privately owned parcels in LA County for which community scale SWH is feasible, the problem then becomes how to select 3 maximally instructive cases from the large private parcel pool. The following is known about each private parcel:

Table 4. Private Parcel Data

Variable	Description	Data Source
Building Count	Number of buildings per residential parcel with roof area > 300 ft^2.	LARIAC 4 Building Outlines
Unit Count	Number of residential units per residential parcel.	Energy Atlas
Parcel Area	Parcel area in m^2.	Energy Atlas
Parcel Perimeter	Parcel perimeter in m.	Energy Atlas
Building Area	Area of the i^{th} building's outline on the j^{th} residential parcel in m^2.	LARIAC 4 Building Outlines
Building Perimeter	Perimeter of the i^{th} building's outline on the j^{th} residential parcel in m.	LARIAC 4 Building Outlines

The first step in selection of private cases is to compute the parcel suitability score for each of the parcels in the private pool. The parcels are then divided into quintiles (~3000 parcels each) and classified according to their scores. Figure 4 illustrates the suitability ranking scheme, and shows the distribution of scores among the parcels

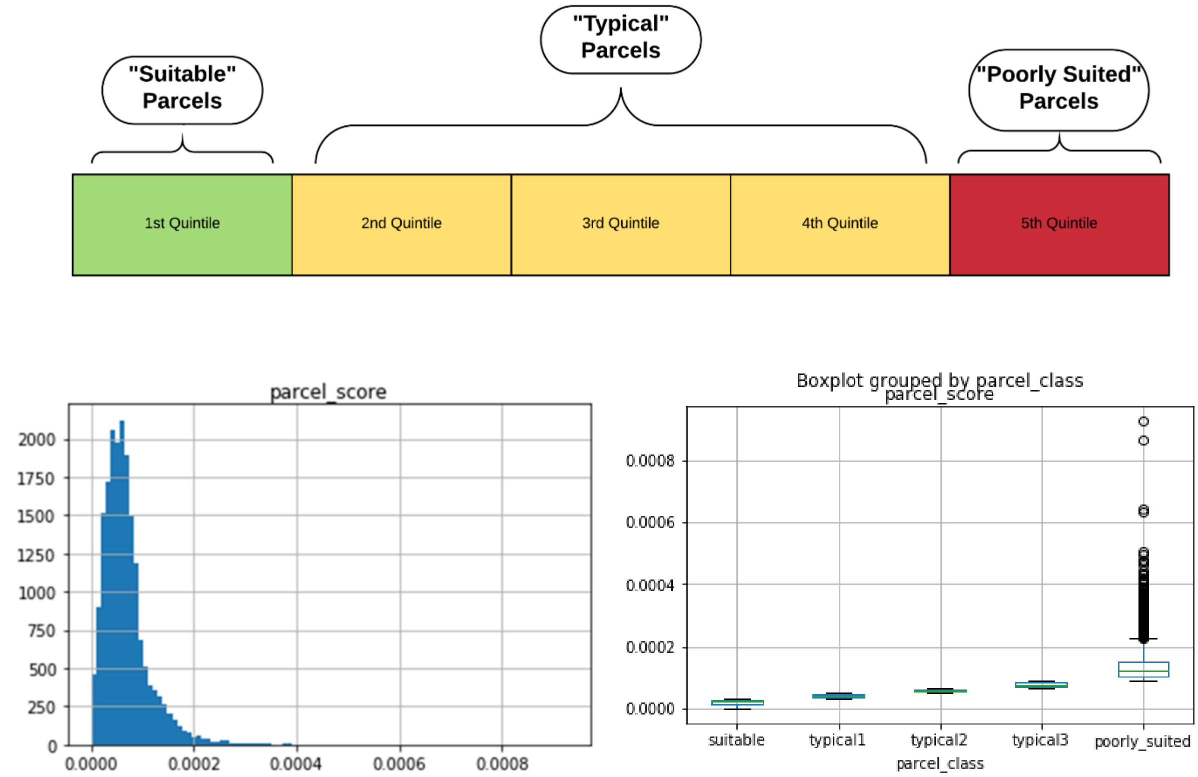


Figure 4. Parcel Ranking Scheme and Distribution of Parcel Suitability Scores by Quintiles

After sorting each quintile b~~u~~y counts of residential units per parcel, a "suitable" case was selected from the first quintile, a "typical" case from the middle three quintiles, and a "poorly suited" case from the 5th quintile. These cases were selected based on their parcel score, the number of residential units in each energy community, and the presence of other potentially instructive variation in urban form. Finally, if a parcel selected is part of a larger community (i.e. one parcel of an apartment complex spanning multiple parcels), the entire community is selected. Below are the private properties selected for further study:

2.3.1 Suitable Case – Pheasant Ride Apartments, Rowland Heights, CA.

The Pheasant Ridge Apartments is a large residential complex with approximately 800 1-and 2-bedroom units on two residential parcels, divided by an entrance road. Pheasant Ridge is composed of seventy residential structures, as well as covered parking and utility and management buildings. Rowland Heights is located in the far south eastern portion of Los Angeles County.

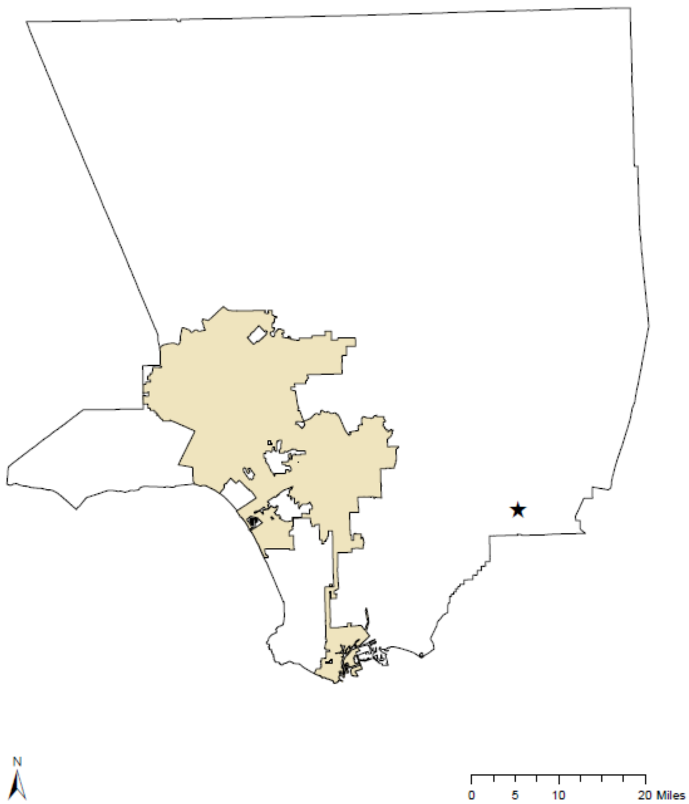
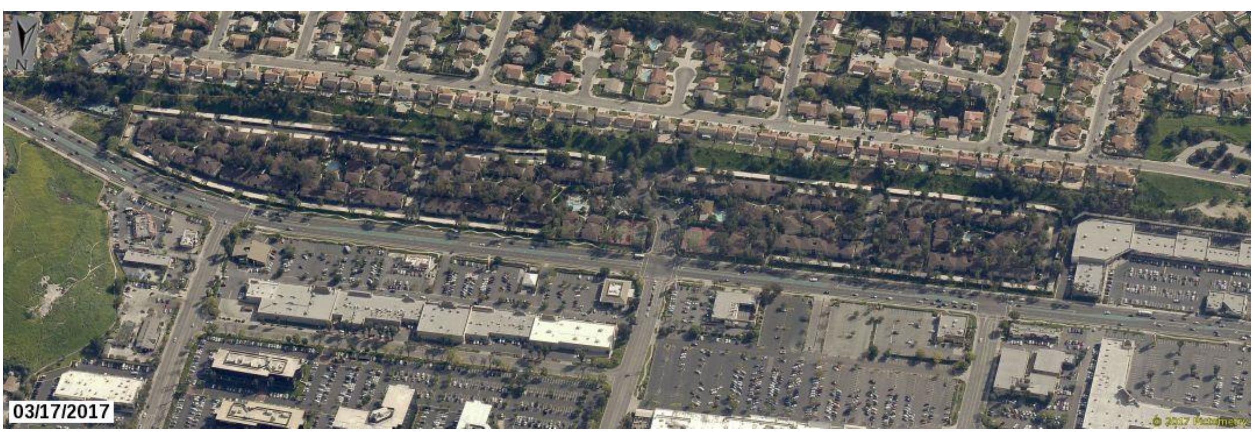


Figure 5. Location of the Pheasant Ridge Apartments



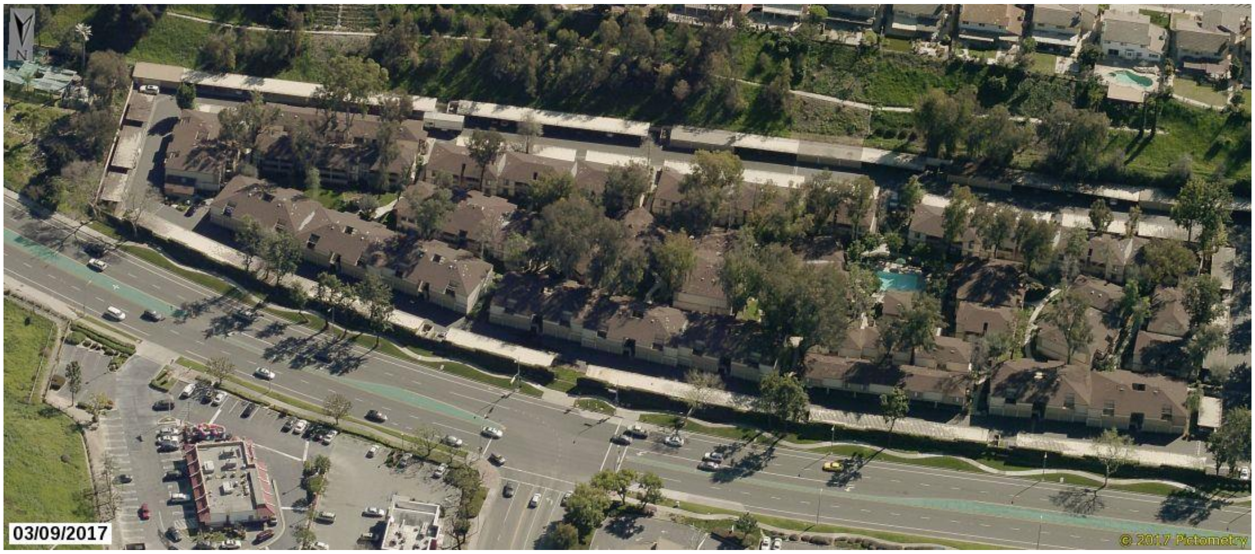


Figure 6. Aerial Images of Pheasant Ridge Apartment Complex – LARIAC Oblique Imagery

Pheasant Ridge is well-suited to community scale solar water heating due to its size and density. However, the pitched roofs of the buildings, and the presence of large trees on the property will complicate installation of collector arrays, and possibly reduce the performance of systems installed on the site.

Based upon publically available information and conversations with complex's management company, the following information will be used to parameterize hot water demand schedules and SWH system simulations:

Table 6. Pheasant Ridge Site Data

Site Area	99286.9 m^2
Site Perimeter	1939.54 m
Residential Units	836
Residential Structures	71
Current Water Heating Technology	Units have individual gas heaters
Additional Information	2-bedroom units contain dishwashers, 3 shared laundry facilities.

2.3.2 Typical Case – Promenade Apartments, West Covina, CA.

The Promenade Apartments is a ~100-unit affordable housing complex located near the I-10 Freeway in the San Gabriel Valley, East of downtown Los Angeles. The complex offers studio and 1-bedroom apartments, rented preferentially to families and seniors at below-market rates.[23] National CORE, a non-profit housing and community outreach organization, owns and manages the property.

[23] National Community Renaissance. (2018). *About Us.* Retrieved from: http://nationalcore.org/about-us/

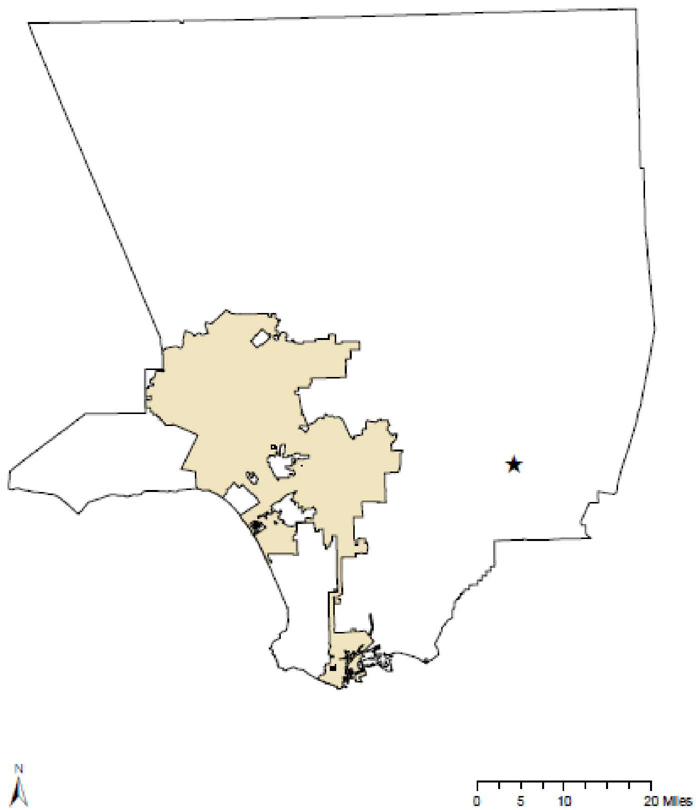
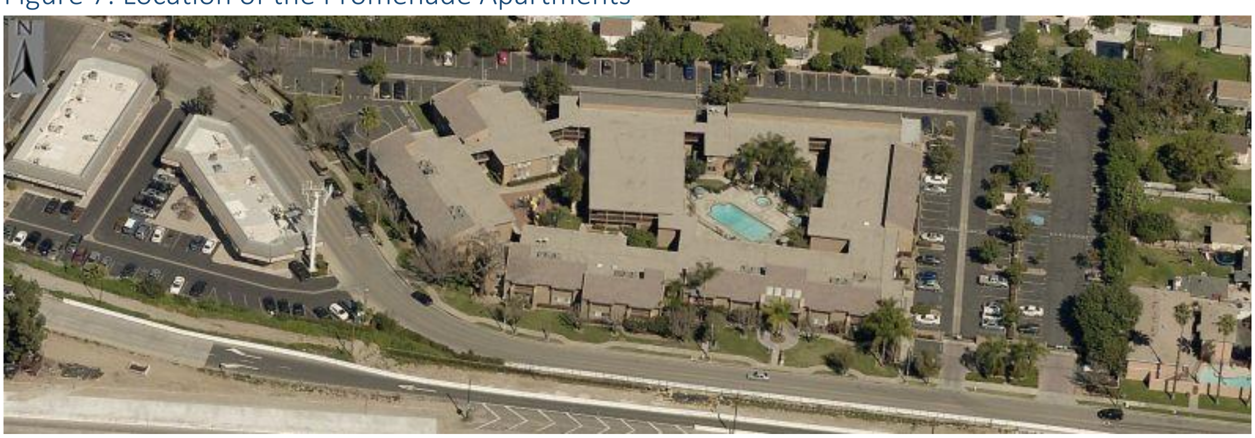


Figure 7. Location of the Promenade Apartments



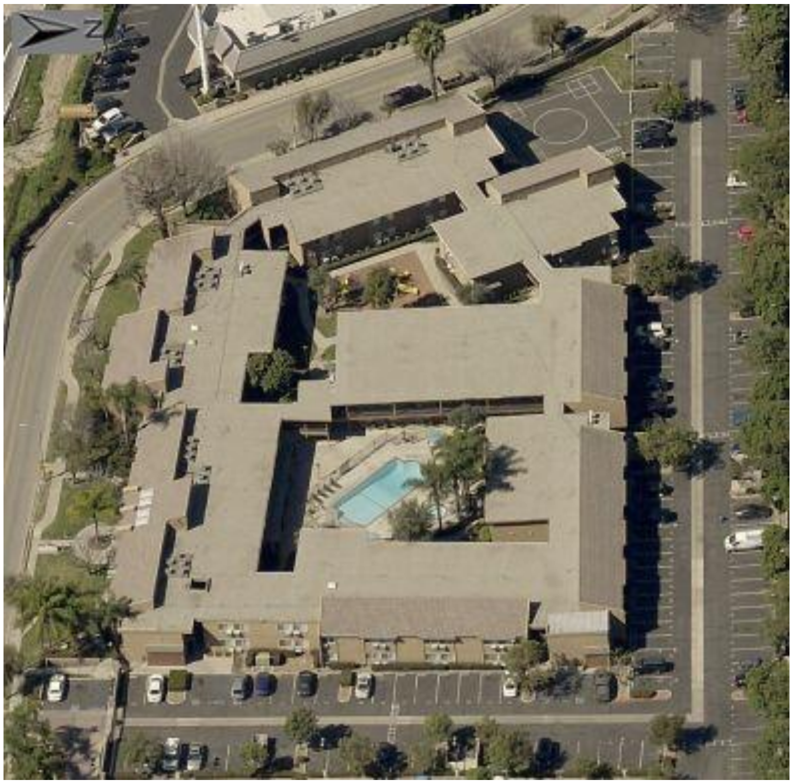


Figure 8. Aerial Images of the Promenade Apartments, West Covina, CA.

The Promenade Apartments represent typical medium-density apartment complexes common in LA County. The property features centralized laundry facilities, but residential units contain their own storage water heating units.

Table 7. The Promenade Apartments Site Data

Site Area	9032.49 m^2
Site Perimeter	309.64 m
Residential Units	124
Residential Structures	1
Current Water Heating Technology	1 storage water heater per unit
Additional Information	1-bedroom units contain dishwashers, shared laundry facilities.

2.3.3 Poorly Suited Case – Pacific Plaza, Santa Monica, CA.

The Pacific Plaza is a mixed-use high-rise apartment building with approximately 500 studio and 1-bedroom units.

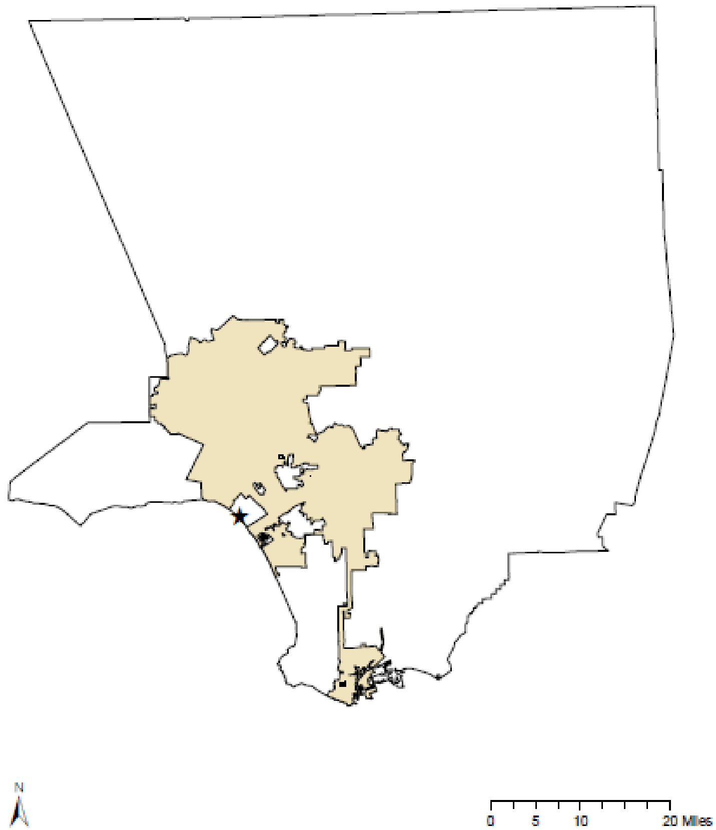


Figure 9. Location of the Pacific Plaza

Figure 10. Aerial Images of the Pacific Plaza Building

The Pacific Plaza Building features very little rooftop space relative to the other sites, and is the densest development in terms of residential units per parcel area included in this study. Furthermore, it may be necessary to locate solar storage tanks in the basement of the building if there is insufficient space for them on the rooftop.

Table 8. Pacific Plaza Site Data

Site Area	2330.16 m^2
Site Perimeter	194.45 m
Residential Units	485
Residential Structures	1
Current Water Heating Technology	Central Boiler
Additional Information	1-bedroom units contain dishwashers, shared laundry facilities.

2.4 Public Parcel Ranking and Selection

Selection of publically owned residential parcels begins with the aggregation of the City and County Housing Authorities' asset portfolios. The Housing Authority of the City of Los Angeles (HACLA) and the Housing Authority of the County of Los Angeles (HACoLA) publish the addresses of the properties that they own and maintain. These properties meet the sole ownership requirement discussed in Section 2.1 and Table 2, but further information is needed from the Energy Atlas database and other sources to develop a list of feasible properties.

Table 9. Public Property Parcel Data

Variable	Description	Data Source

Asset Location	HACLA/HACoLA Asset Portfolio addresses geocoded to tax assessor's parcel locations	HACLA Asset Portfolio, HACoLA Asset Portfolio, Google Geocoding API, Energy Atlas
Building Count	Number of buildings per residential parcel with roof area > 300 ft^2.	LARIAC 4 Building Outlines
Unit Count	Number of residential units per residential parcel.	Energy Atlas, City of Los Angeles Health Atlas[24]
Parcel Area	Parcel area in m^2.	Energy Atlas
Parcel Perimeter	Parcel perimeter in m.	Energy Atlas
Building Area	Area of the i^{th} building's outline on the j^{th} residential parcel in m^2.	LARIAC 4 Building Outlines
Building Perimeter	Perimeter of the i^{th} building's outline on the j^{th} residential parcel in m.	LARIAC 4 Building Outlines

First, the lists of addresses for properties owned by both housing authorities must be geocoded to associate the address with a residential parcel. This step is essential for scoring and selection as the number of buildings and residential units is required. Google's Geocoding API was used to accomplish this task.[25]

Two-hundred and thirteen HACLA and HACoLA residential parcels met the feasibility requirements listed in Section 2.1. The selection of case studies from the pool of 213 candidate parcels follows a similar procedure (scoring and sorting by number of residential units per parcel) to the private parcels. If a parcel belonging to a larger public housing site or development it selected, then the entire site is selected as a case study. Considering the smaller size of the public parcel pool, the following cases are chosen to represent the diversity in public housing stock.

2.4.1 Suitable Case – William Mead Homes, Los Angeles, CA.

The William Mead Homes are a public housing development located in the Lincoln Heights neighborhood of Los Angeles. The site consists of 24 2- and 3-story residential buildings and 415 units. HACLA manages and maintains the property, which was built by the federal government in 1945.[26] Families with children are given preference for open units.

[24] County of Los Angeles Public Health. (2013). *LA Subsidized Housing Units (2008) from the Health Atlas for the City of Los Angeles July 2013* [GIS Dataset]. Retrieved from: http://www.arcgis.com/home/item.html?id=419689b020704eae90221f086eb9815c
[25] Google Maps Platform. (2018). *Developer Guide – What is Geocoding?* https://developers.google.com/maps/documentation/geocoding/intro.
[26] HACLA. (2017). *About Public Housing*. Retrieved from: http://home.hacla.org/aboutpublichousing

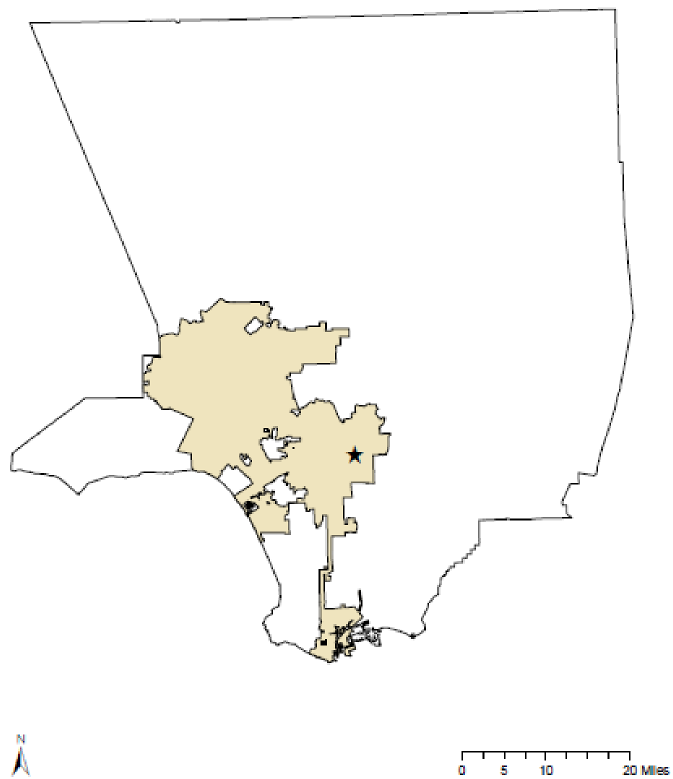


Figure 11. Location of the William Mead Homes

Figure 12. Aerial Images of the William Mead Homes

The William Mead Homes are high-density residential buildings with flat, unobscured roofs. The style of construction is ideal for the placement of rooftop collector arrays. There is also ample room to construct housing sheds for storage tanks near buildings.

Table 8. William Mead Homes Site Data

Site Area	83656.84 m^2
Site Perimeter	1425.1 m
Residential Units	415
Residential Structures	24
Current Water Heating Technology	30-gal A.O. Smith Gas Storage WH/ Unit
Additional Information	No dishwashers. ~50% of units have washing machines

2.4.2 Typical Case – South Bay Gardens, Los Angeles, CA.

South Bay Gardens is a 124-unit senior living center located in South Los Angeles. The property is owned and operated by HACoLA, and features a centralized heating system, a community kitchen, and shared laundry facilities.

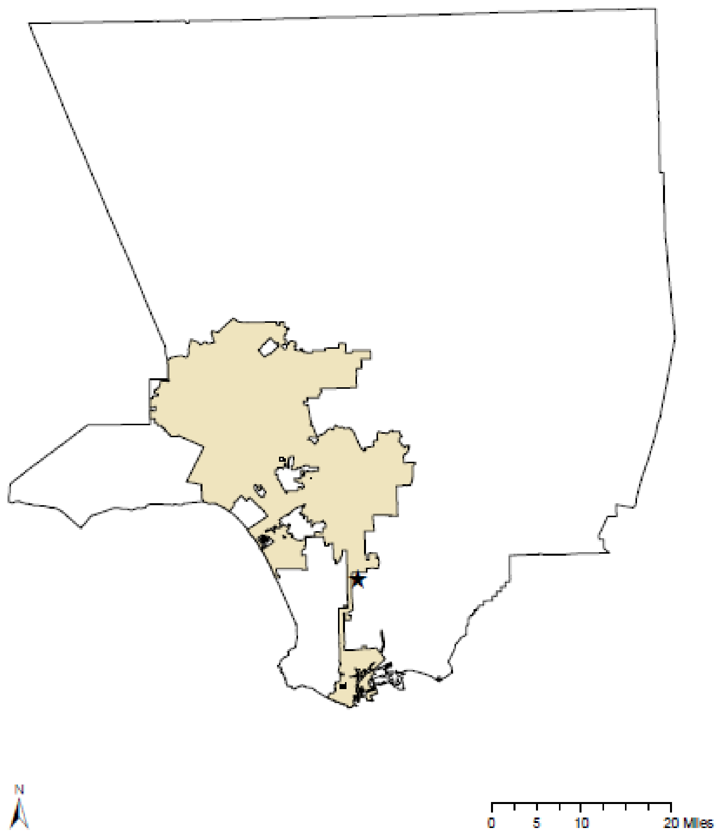


Figure 13. Location of South Bay Gardens Complex

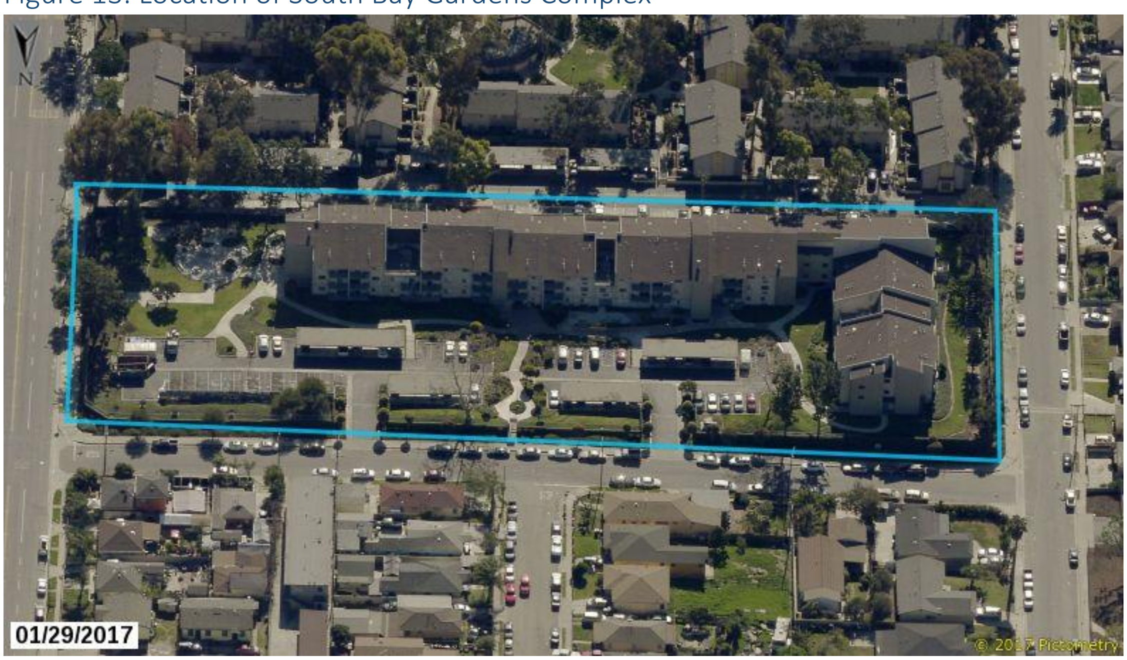


Figure 14. Aerial Images of South Bay Gardens

South Bay Gardens is a medium-density development made more suitable for community scale SWH by virtue of its construction. The unobscured roof space, central boiler, and the fact that the development consists of a single residential structure reduce retrofit costs, but since the system will only serve ~100 units, the payoff period may be longer than for comparable developments.

Table 11. South Bay Gardens Site Data

Site Area	12920.5 m^2
Site Perimeter	506.28 m
Residential Units	124
Residential Structures	1
Current Water Heating Technology	Central Boiler
Additional Information	Senior living. Central laundry and kitchen facilities.

2.4.3 Poorly Suited Case – Crescent Court Apartments, Los Angeles, CA.

The Crescent Court Apartments is a multi-family HACLA property located in the MacArthur Park neighborhood of Los Angeles. The 2-bedroom units are designed to accommodate larger families.

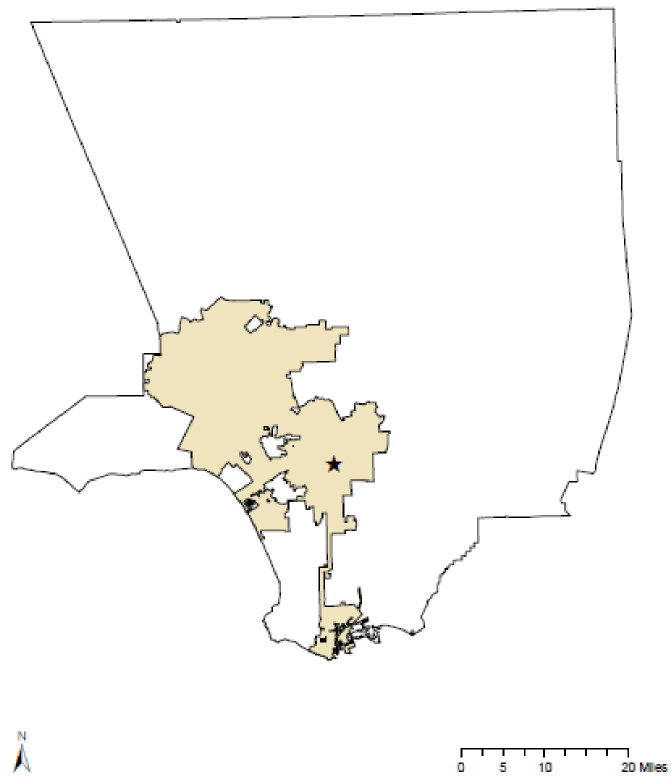


Figure 15. Location of the Crescent Court Apartments

Figure 16. Aerial Images of the Crescent Court Apartments

The Crescent Court Apartments are poorly suited to SWH because of the inefficient use of the available space (two units per structure), and the pitched roofs of the apartment buildings. The apartment buildings are also separated by paved alleyways.

Table 12. Crescent Court Apartments Site Data

Site Area	8153.16 m^2
Site Perimeter	363.94 m
Residential Units	32
Residential Structures	16
Current Water Heating Technology	40-gal storage WH per unit
Additional Information	Multi-family. Dishwashers in all but 2 units, washing machines in all units.

3. Conclusion

The process of designing and simulating community scale SWH systems for each of the six cases selected will provide insight into the technology's potential to reduce emissions from the residential housing sector, and the extent to which it can displace natural gas as the primary source of energy for water heating.

The design and simulation process will also include a financial analysis of construction costs for different types of residential properties (public, private, and nonprofit). Understanding the financial dynamics in each of these cases is essential to understanding community scale SWH potential as an emissions-reduction measure.