

South Coast Air Quality Management District Net Emissions Analysis Tool (NEAT) Sample Scenarios

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Introduction

This document provides documentation on how to run the Net Emissions Analysis Tool (NEAT) for three sample scenarios in which residential appliances are replaced by more efficient and less emitting alternatives. One of the sample cases demonstrate the use of NEAT to estimate the benefits of installing rooftop solar photovoltaic (PV) panels in conjunction with appliance upgrades.

Results are obtained using the NEAT tool version 1.11 Beta. Results presented here are meant to be illustrative and not suitable to inform policy or energy decisions. Users are advised to understand the assumptions and limitations behind the inputs and calculations used in these sample scenarios.

Residential Net Emission Analysis Tool (NEAT)

Version 1.11 Beta



Sample Case 1: Switch to High Efficiency Natural Gas Condensing Water Heater in Single-Family homes in Climate Zone 6

This sample scenario replaces all conventional natural gas water heater with new High Efficiency Natural Gas Condensing Water Heater. The scenario assumes also that 4.4% of natural gas comes from renewable sources from the state (2.4% from landfill gas, 0.3% from wastewater treatment plants, 0.9% from manure management and 0.8% from conversion of food and green waste).

Parameters for scenario:

High efficiency condensing water heaters have an energy factor of 0.9, in contrast with conventional water heaters that have an energy factor of 0.7. The assumptions for the new technology are shown in **Table 1**.

| Tech | UEC | NOX EF | CO2e EF | Unit Cost | Install Cost |
|----------------------------------|-----------|--------------|-------------|-----------|-----------------|
| NG Conv. Water Heater | 199.21 th | 0.0023 lb/th | 11.76 lb/th | \$647 | \$1,900 |
| HE NG Condensing Water Heater | 155.00 th | 0.0023 lb/th | 11.76 lb/th | \$1,000 | \$1,900 |

Table 1: Assumptions in the replacement of water heaters

First, we need to add the new technology by clicking on the "add technology" button, and input the parameters in each column:

| Fuel: | NatGas |
|-----------------|----------------------------|
| Technology: | High-Efficiency Condensing |
| Hourly Profile: | Water Heating |
| UEC: | 155 |
| NOX EF: | 0.0023 |
| CO2e EF: | 11.76 |
| Unit Cost: | 1000 |
| Install Cost: | 1900 |
| Lifetime: | 13 |
| | |

Then implement the technology replacement by using the "Replace Technology Tool" box. Select "single family" as housing type and climate zone 6 (see **Figure 1**).

| | lousing Category | Supply Economics Computation Climate Zone | | | | - (340) | |
|---|--|--|--|--|--|---|--|
| | Single-Family | Home Aggregate | 8 S. Near-Coasta | 9 N. Near-Coast | Il 010 S. Inland 015 S. Desert 0 | 16 Mountain O AII CZ MAP | (1) |
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| | Hot water heating Kitchen Laundry | Miscellaneous Pool Space heat | ting and cooling Tra | rsportation | | | |
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| | Di Natolas jouar Water Heat Will Cas Daouty | 150.0200 0.0025 11.7000 | 4343 3003 | | | 130.0200 0.0023 11.1000 | 4343 3003 |
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Figure 1: Define new technology and implement technology replacement

Advance to the next screen that displays the changes in appliances set up for the scenario, and if the changes are consistent with the scenario parameters, advance to the next screen to select the parameters for the electricity and natural gas grid (**Figure 2**).



Figure 2: Confirm technology replacement scenario

Select the mix of natural gas resources for the scenario (**Figure 3**). In this case, the mix assumes that there is a 4.4% of natural gas from renewable sources in California. The breakdown of sources is as follows (based on California Biomass Collaborative, 2015; UC Davis, 2016):

- 2.4% from landfill gas,
- 0.3% from wastewater treatment plants,
- 0.9% from manure management and
- 0.8% from conversion of food and green waste
- 95.6% from conventional North American natural gas

| Demand | Demand Input Summary | Power Supply | Economics | Computation | Results | | | | | |
|---------------|--|------------------------------------|--------------------------------|---|---|--|--|-------------------------------|--|--|
| Methane | e Emissions from Na | tural Gas | | | | | Electricity Generation from Grid | | | |
| Natural C | Gas Leak Rates (As percent | tage of usage) | Before Meter | | Before Meter | | Emission Factor of INCREASED Electricity Use | Emission Factor of | REDUCED Electricity | Use |
| | 8 EPA GHG Emissions Inve | entory: 1.27% | Leak Rate [%] | | Transmission/ Storage/ | 0.35 | All additional electricity from centralized photovoltaics. | Reductions in el | lectricity generation er | nissions deterr |
| O The | 16 Study Series Synthesis | Report: 1.7% | Behind Meter Leak Rate [%] | | Distribution | | wind, and centralized battery storage (Case 1) | with the basined | average dispatchable (| Jower emission |
| Alva | arez et al., 2018 Science Pa | per: 2.3% | | | Leak Rate [%] | | All additional electricity provided at the Basin-average dispatchable power emission factor (Case 2) | | electricity generation en er plant emissions | nissions arise |
| Cus | tom Value | | Global Warm. Potential | 84 (20 year) 🔻 | Heat Content [Btu/ft^3] | 1034 | All additional electricity provided by peaker plants (Case 3) | | actor changes modele | d with HiGRID |
| | | | T Otertitur | | [Bturie-3] | | Grid emission factor changes modeled with HiGRID | | | |
| GHG Er | mis. from Increased N | Natural Gas Pro | oduction | (- | | | Additional electricity provided by a mixture of technologies | Ele | ectricity Generation Mo | dule Documer |
| (For Adva | nced Users) | | | Reset to D | Default More In | nformation | [%] Case 1 [%] Case 2 [%] Case 3 | | | |
| Туре | Pathway Supp | ly Fraction CO2e En | mis. (Ib/therm) | Well to Dump F | min of Trans | nortation | | | Test HiGRID | |
| | landfill | 0.0240 | -0.8604 | Well-to-Pump E (For Advanced User | | portation | | | | |
| | wastewater | 0.0030 | -7.2321 | · | · | | Transmission and Distribution Loss in Power Grid (For Advance | d Users) | | |
| | manure food & green waste | 0.0090 | -73.1118 -17.0455 | | | x (lb/gal) | O Use Flat Loss Percentage for all Utilities Loss [%] | 5.4 | | More Inform |
| | natural gas | 0.9560 | 6.8368 | Gasoline Diesel | 6.3030 7.2201 | 0.0117 | O Use Hourly Loss Percentage for all Utilities | | | |
| | inaction" column | | | Diesei | 7.2201 | 0.0152 | Use Utility Specific Loss Percentages | | | |
| | sum to unity | et to Default More | e Information | Reset to I | Default More Ir | nformation | Utility Name Valid Y | | Loss [%] | |
| Distribut | ted Solar Photo oltai | ice | | | | | Azusa Light & Power | ears | 9 | 2.5 |
| | | | | | | | Bear Valley Electric Service | | 9 | 12.2 |
| Imp | lement Rooftop Sol | ar PV using PV | | | | | | | | |
| | | | vvalls | Rooftop Solar | PV Module Docun | inentation | · · · · · · · · · · · · · · · · · · · | | - | |
| For Adva | anced Users | | v vvalts | Rooftop Solar | PV Module Docun | nentation | Burbank Water & Power | | 10 | 3.5 |
| For Adva | | | | | Reset to D | | · · · · · · · · · · · · · · · · · · · | | - | 3.5 4.9 |
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| Solar | anced Users | _ | where " size in test cor | X" is defined as the p | Reset to D rd Test Fun More Infor | Default | Burbank Water & Power City of Anaheim Public Utilities Department Residential Battery Storage | ry Model 🛛 F | 10 10 | 3.5 |
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| Solar | anced Users Cost Function: TOST = 2 | 1135 * X | where " size in test cor | X" is defined as the p W DC under standar ditions. | Annel Reset to D dd Test Fun More Infor | Default Inction | Burbank Water & Power City of Anaheim Public Utilities Department Residential Battery Storage Implement Residential Battery using Batter For Advanced Users Battery Battery Battery Battery Setup B Battery Power Idv01 Battery Po | 6.2 Installatio | 10 10 Residential Battery Mo In Cost \$ 1400 | 3.5 4.9 Oute Documer |
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| Solar (Mo | anced Users Cost Function: VOST = 2 Odule Type / standard System Lins Value | •1135 * X | where " size in test cor | X" is defined as the p KW DC under standar ditions. Area Availability Ratic Useful Lifespan [yrs] | Area (Reset to I) Test Fun More Infor | Default inction mation 2.75 25 20 | Burbank Water & Power City of Anaheim Public Utilities Department Residential Battery Storage Implement Residential Battery using Batter For Advanced Users Battery Battery Battery Battery Setup B Battery Power KWM Battery Power | 6.2 Installatio 9.5 Batter | 10 10 10 Residential Battery Mc n Cost \$ 1400 y Cost \$ 6200 Reset to Default | 3.5 4.9 dule Documer Lifetime [years] |
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The scenario assumes default values for electricity and natural gas rates (**Figure 4**), so the user can advance to the 'Computation' tab (**Figure 5**). Here, the user clicks on the 'Compute Results' button, and some diagnostic messages appear in the prompt window. The time ruler should show progress, and after a minute, the simulation should be completed.

| 🚺 Residential Net Emissions | Analysis Tool version 1.11 Beta | | | | | | | | | | | | | — | – × |
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| ile Capture Screen He | lp | | | | | | | | | | | | | | |
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| Low Income Ra | tes Qualification | | | | | Net N | /letering | | | | | | | | |
| Load Default Low Incon | ne Fractions 🥚 | | | | | | t Metering et Metering | | Sell Electrici Sell Electrici | | | | s | 0.000 /} | W-hr |
| For Advanced Users | | | | | | Gaso | lino and | d Diesel F | Prices | | | | | | |
| View/Edit Low Income | e Fractions | | | | | | | | | | | | | | |
| Load Saved Low Incon | ne Fractions | | | | | | | (All Grades) Re n-Highway) Ref | | | per gallon per gallon | Set to Default | | rrent and Hi ices from El | |
| Electricity Rates | 5 | | | | | Natur | al Gas | Rates | | | | | | | |
| Load Default Rate Stru | ctures 🔴 | | | | | Load | Default Rate | Structures | | | | | | | |
| For Advanced Users | | | | | | For Adv | anced Users | 3 | | | | | | | |
| View/Edit Rate Struct | tures | | | | | Viev | v/Edit Rate S | tructures | | | | | | | |
| Load Saved Rate Stru | ctures 🔴 | | | | | Load | Saved Rate | Structures | | | | | | | |
| Natural Gas Ap | pliance Categoriza | | atural Gas applia | nces for gas I | rate calculator. Ev | ery appliance mus | t be assigned | d a single catego | TODY LISED when | an adding ne | w natural day | annliances) | | More Info | rmation |
| Category | Technology | Conv | entional Water H | eater Solar V | Vater Heat with Ga | is Backup Range | c | | | | | | Dryer | Othe | r |
| Hot water heating | Conventional Water Heater | | 1 | | | | 11. | Adva | nce to | o nex | t scre | en l | | | |
| Hot water heating | High-Efficiency Condensing | | | | | | | | | | | | | 1 | |
| Hot water heating | Solar Water Heat with Gas E | Backup | | | 1 | | | | | | | _ | | | |
| Kitchen | Range Oven Combination | | | | | | 1 | | | | | | | | |
| Laundry | Dryer | | | | | | | | | | | | | | |
| Miscellaneous | Other | | | | | | | | | | | | | | |
| Pool | Pool Heat | | | | | | | | | 1 | | | | | |
| Pool | Spa Heat | | | | | | | | | | | | | | |
| Space heating and coolir | ng Auxiliary Heat | | | | | | | | | | | 1 | | | • |
| | | | | | | | | | | (| 🔶 RETURN | TO PREVIO | JS AD | ANCE TO I | IEXT 🌩 |

Figure 4: Confirm economic parameters (no need to change anything here)

Computation of Scenario:

| | 承 Reside | ntial Net Emissions A | nalysis Tool version 1.11 Bet | ta | | | | | | | | – 🗆 X |
|------|----------|-----------------------|-------------------------------|-------------|---------------------|---------------------|-------------------|------------------------|----------------------|-------------------------|-----------------|---------------|
| | File Cap | pture Screen Help | | | | | | | | | | |
| | Demand | Demand Input Su | Immary Power Supply | Economics C | omputation Resu | ults | | | | | | |
| | Computa | tion | | | | | | | | | | |
| | Co | mputr Results | Save Setup and Results | ۱ | | | Wa | aiting for Input | | | | Computational |
| | Can | cel Computation | Clear History | 246810 |) 12 14 16 18 20 22 | 2 24 26 28 30 32 34 | 36 38 40 42 44 46 | i 48 50 52 54 56 58 60 | 62 64 66 68 70 72 74 | 76 78 80 82 84 86 88 90 | 92 94 96 98 100 | Methodology |
| | | | | | | | | | | | | |
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| 1. (| Com | pute Re | sults | | | | | | | | | |
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Figure 5: Compute results

Upon successful completion, the following message should appear at the top of the message list:

*** COMPUTATION COMPLETED SUCCESSFULLY! *** elapsed time: 28.0689 s

Once the simulation is completed, the user can choose to save the setup and results in a file. Additional messages are displayed to show the files being saved (**Figure** *6*). This file can be loaded at a later time to review the results. The NEAT tool keeps the latest run loaded, so the user can go directly to explore the results by clicking on the "Advance to Next" button.

| and | oture Screen Help Demand Input Summary Power Supply Economics Computatio | for later use |
|--|--|---|
| mputat | tion | |
| <u> </u> | mpute Results Save Setup and results | File Save Complete |
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| Cano | Clear History | |
|)-Oct- | -2019 10:06:56: File Save Complete | |
| | -2019 10:06:55: Saving | |
| | -2019 10:06:49: Saving | |
| | -2019 10:06:49: Saving | |
| | -2019 10:06:49: Saving | |
| | -2019 10:06:44: Saving | Constant Remain Constant UEN COMUL Rest No. Security but This many fails a unbits |
| J-OCI- 0.Oct. | E2019 10:06:44: Saving Results to text File: M:\MCS\NEAT\TestCases\Sample 2019 10:06:37: Saving Setup to Text File: M:\MCS\NEAT\TestCases\Sample C | Cases/SampleCase1_mEnCovin_Keinvo_results.tt. This may take a write |
| | -2019 10:06:37: Saving Setup to Text File. M: WICS/WEAT/TestCases/Sample Cases/Sample Cases/Samp | |
| | -2019 10:06:33: Saving Results to M:\MCS\NEAT\TestCases\Sample Cases\Sa | |
| 0-Oct- | -2019 10:06:32: Saving Results | |
| | -2019 08:59:57: *** COMPUTATION COMPLETED SUCCESSFULLYI *** elap | sed time: 85.6736 s |
| | -2019 08:59:41: Storing Output Data | |
| | -2019 08:59:41: Finished reducing data size | |
| | +2019 08:59:40: Reducing data size +2019 08:59:40: Finished expanding sample size to represent all households | |
| | -2019 08:59:40: Finished expanding sample size to represent all nouseholds -2019 08:59:40: Expanding: Task 1 of 1 | |
| | -2019 06:59:40: Expanding sample size to represent all households | |
| 0-Oct- | -2019 08:59:39: Finished computing Well to Pump Gasoline and Diesel Emissio | ins . |
| 0-Oct- | -2019 08:59:39: Computing Well to Pump Gasoline and Diesel Emissions | |
| 0-Oct- | -2019 08:59:39: Finished Computing Natural Gas Production Emissions | |
| 0-Oct- | -2019 08:59:39: Computing Natural Gas Production Emissions | |
| | -2019 08:59:39: Finished Computing Natural Gas Leak Rates | |
| 0-Oct- | -2019 08:59:39: Computing Natural Gas Leak Rates -2019 08:59:39: Finished Calculating Diesel and Gasoline Rates | |
| 0-001- | -2019 08:59:39. Finished Calculating Diesel and Gasoline Rates | |
| | -2019 08:59:39: Finished Calculating Natural Gas Rates | |
| | -2019 08:59:38: Calculating Natural Gas Rates | City Emissions 2. Advance to Results tab |
| 0-Oct- | -2019 08:59:38: Finished Calculating Optimal Panel Area and Change in Electri | city Emissions 2. Advance to Results tab |
| 0-Oct- 0-Oct- | -2019 08:59:37: Completed task 1 of 1 | |
| 0-Oct- 0-Oct- 0-Oct- | -2019 08:59:35: Using Utility-Specific Electricity Transmission/Distribution Loss -2019 08:59:33: Using Utility-Specific Electricity Transmission/Distribution Loss | |
| 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- | | Percentage in C26 |
| 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- | | |
| 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- | -2019 08:59:32: Finished Determining Most Cost Effective PV Panel Area | |
| 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- | -2019 08:59:32: Finished Determining Most Cost Effective PV Panel Area -2019 08:59:29: Determining Most Cost Effective PV Panel Area | sions |
| 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- 0-Oct- | -2019 08:59:32: Finished Determining Most Cost Effective PV Panel Area | nissions |
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Figure 6: Save setup and results to able to analyze the results at a later time

Results:

In the results tab, the user can select a subset of climate zones, housing types, natural gas and electric utilities (**Figure 7**). Since this case was already constricted to single-family homes and climate zone 6, the user can only select among the utilities that fall within climate zone 6. After clicking on 'Analyze', the display moves to the cost effectiveness selector (**Figure 8**).



Figure 7: If desired, select a subset of climate zone, housing category, NG utility, and electric utilities, and analyze results

The user can select three different options to calculate cost effectiveness:

- 1) Cost effectiveness based on total annual cost, with annualized purchase and installation costs plus utility costs
- 2) Cost effectiveness based on utility and fuel costs only
- 3) Cost effectiveness based on upfront total cost of purchase and installation

The user can select among four options for the purchase and installation cost of the appliances, in order to account for their amortization:

- 1) Appliances that are replaced are at the end of their life
- 2) Appliances that are replaced have 25% of their life remaining
- 3) Appliances that are replaced have 50% of their life remaining
- 4) Appliances that are replaced are brand new

In this scenario, the retrofit results in emission reductions and annual savings when accounting for the annualized cost of purchase and installation plus the changes in utility costs, when the water heaters are changed at the end of their useful life.



Figure 8: Analysis of the cost effectiveness space. Cost calculation has several options that include cost of equipment, installation and utility costs

The user can explore the distribution of cost-effectiveness amongst all the homes retrofitted with the new water heater (**Figure 9**). Results show that when an old NG water heater is replaced by a new high-efficiency condensing water heater, emissions of NOX and CO2 are reduced. In addition, annual costs would be lower than if the water heater was replaced by a conventional NG storage water heater, despite the higher price of the high-efficiency water heater.



Figure 9: Cost-effectiveness distribution among homes

The user can also explore the appliance mix that is present in the selected subset. This screen is useful when a combination of appliances is retrofitted. However, this scenario only replaces one appliance, so the results show only one bar that represents the water heater retrofit (**Figure 10**).

| Residential Net Emissions Analysis Tool version 1.11 Beta | | | | | | | | | _ | |
|--|------------------------------|----------------------------|------------------|-----------|-----------------------|---------------------|----------|-------------------|----------------------|-------------|
| File Capture Screen Help | | | | | | | | | | |
| Demand Demand Input Summary Power Supply | Economics Computation | n Results | | | | | | | | |
| Analyze Most Recent Results Analyze Saved Results | Select Cost Effectiveness Su | ibset Cost Effectiveness | Appliance Mix | Apply P | escribed Funding | Query Individual H | lomes | | | |
| Filter Homes | TECHNOLOGY MODIFICATI | ONS (hover over Technology | to see profile) | | | | | | | |
| Climate Zones | Show Column Information | BASELIN | E | | SCENARI | o | F | ARAMETER CHANGE | S (SCENARIO - BAS | SELINE) |
| 6 Coastal 0 10 S. Inland | # Category | Fuel Tech | nology | Fuel | Techr | vpology | UEC | NOX EF CO2e EF U | nit Cost Install Cos | st Lifetime |
| 0 8 S. Near-Coastal 0 15 S. Desert | 1 Hot water heating | NatGas Conventional Wate | | _ | High-Efficiency Cor | | modified | 0 0 | | 0 0 |
| 9 N. Near-Coastal 16 Mountain All Climate Zones | ,, | | | | ,, | , | | | | - |
| | | | | | | | | | | |
| Housing Category Only Single Family Homes Only Mobile Homes | | | | | | | | | | |
| Only Multi Family Homes Only Multier Homes | | | | | | | | | | |
| Natural Gas Utilities | | | | | | | | | | |
| ✓ Long Beach Gas & Oil Southwest Gas Corp. | | | | | | | | | | |
| Southern California Gas City of Vernon Gas System | | | | | | | | | | |
| Electric Utilities | | | | | | | | | | |
| Azusa Light & Power | | | | | | | | | | |
| Bear Valley Electric Service | | | | | 050 000 Tetel I I ama | - | | | | |
| Burbank Water & Power | Pan Left | | | | 359,206 Total Home | | | | | Pan Right |
| City of Anaheim Public Utilities Department | | - | -raction of Home | s with Sp | ecified Modificati | ions In Cost Effect | tiveness | Subset | | |
| City of Banning Electric Department | | | | | | | | | | |
| City of Corona Department of Water & Power | 1 | | | | + | | | | | |
| City of Riverside | | | | | | | | | | |
| City of Vernon Municipal Light Department | 0.8 | | | | | | | | | |
| Glendale Water & Power Los Angeles Department of Water & Power | 50 0.6 | | | | | | | | | |
| Moreno Valley Utility | La La | | | | | | | | | |
| Pasadena Water & Power | 0.4 | | | | | | | | | |
| Rancho Cucamonga Municipal Utility | | | | | | | | | | |
| San Diego Gas & Electric | 0.2 | | | | | | | | | |
| Southern California Edison | 0 | | | | | | | | | |
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Figure 10: Summary of modifications (this scenario has only one modification)

In the next screen, the user can evaluate the emissions and costs of retrofit based on a prescribed amount of funding and assuming a specific cost-sharing percentage by the homeowner (**Figure 11**). For instance, if the funding amount is \$1,000,000 and homeowners can pay for 50% of the cost of the appliance, the amount of funding would pay for 689 retrofits, which would result in emission reductions of 71.2 lbs/year of NOX and 260 tons/year of CO2e. The average savings in utilities among homes would be \$46.90 per year, whereas the annualized cost of purchasing and installing the appliance is \$13.58.

| emand Demand Input Summary Power Supp | y Economics emputation | Results | | | | | | |
|--|--|------------------------------|---|------------------------|--|-------------------------|----------------------------------|-----|
| Analyze Most Recent Results Analyze Saved Resu | Select Cost Effectiveness Sur | Cost Effectiveness | Appliance Mix A | opply Prescribed Fu | Inding Query Individual Hor | 1es | | |
| Filter Homes | Enter Funding Amount [\$] | | s applied only to househo ost Effectiveness Subset | | "Project" refers to all of the se a particular home | lected retrofits for | Cost Share by Homeowner [%] | |
| limate Zones | | Select Co | ost Effectiveness Subset | | a particular nome | | | |
| 6 Coastal 0 10 S. Inland | | | Description (click on a | variable to view his | stograms) | | Value | |
| 8 S. Near-Coastal 0 15 S. Desert | Approximate Number of Project | ts Funded | | | | | 689 | |
| 9 N. Near-Coastal 016 Mountain | Number of Possible Projects in | | | | | | 359206 | |
| All Climate Zones | SCAQMD Cost to Fund All Pro | jects in "Cost Effectiveness | Subset" (only considers | purchase and insta | Ilation costs) | | \$520,848,700.00 | |
| lousing Category | | | | | | | | |
| Only Single Family Homes Only Mobile Homes | Cumulative Change in NOx En | | | | | | -7.12e+01 | |
| Only Multi Family Homes O All Housing Types | Cumulative Change in NOx En | | | | | | -9.75e-05 | |
| | Cumulative Change in CO2e E | | | | | | -5.20e+05 | |
| atural Gas Utilities | Cumulative Change in CO2e E | missions [TPD] | | | | | -7.12e-01 | |
| Long Beach Gas & Oil Southwest Gas Corp. | Average Incentive Amount Pro | uided to Liemenumer to Due | shase and install Applica | and DV/ (if calculated | d) and Dation: (if calculad) | | \$1,450.00 | |
| Southern California Gas 🗌 City of Vernon Gas Sys | Median Incentive Amount Prov | | | | | | \$1,450.00 | |
| lectric Utilities | Average Cost-Share from Hom | | | | | | \$1,450.00 | |
| | Median Cost-Share from Home | | | | | | \$1,450.00 | |
| Azusa Light & Power | Average Change in Annual Uti | | | | (| | \$-46.90 | |
| Bear Valley Electric Service | Median Change in Annual Utilit | | | | | | \$-47.23 | |
| Burbank Water & Power | Average Change in Amortized | Appliance Purchase and Ins | stallation Costs Borne By | Homeowner Includ | ding PV and Battery (if selected) | | \$13.58 | |
| City of Anaheim Public Utilities Department | Median Change in Amortized A | ppliance Purchase and Inst | tallation Costs Borne By | Homeowner Includi | ing PV and Battery (if selected) | | \$13.58 | |
| City of Banning Electric Department | | | | | | | | _ |
| City of Corona Department of Water & Power | ×10 ⁴ Char | nge in Annual Utility Cost | s (all homes) [\$] | | | Annual Utility Costs (I | nomes with funded projects) [\$] | |
| City of Riverside | ° | | 1 | | 150 | ' | 1 1 | |
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| Glendale Water & Power | g 6 - | | | - | 0 | | | |
| Los Angeles Department of Water & Power | seu 6 - eu 6 - е | | | | Number of Homes 200 - | | | |
| Moreno Valley Utility | ÷. | | | | ÷ | | | |
| Pasadena Water & Power | 190 | | | | Del | | - | |
| Rancho Cucamonga Municipal Utility | Numper 2 | | | | 1 50 - | | | |
| San Diego Gas & Electric | Z 2 - | | | - | z | | | |
| Southern California Edison | | | | | | | | |
| 9,427 homes meeting filter critera above | | <u>n L U N L r</u> | | | | | | _ |
| 8813% of the total homes in SoCAB meet filter criteria | -55 | -50 -45 | -40 | -35 | -55 | -50 | -45 -40 | -3 |
| | Previous computation lo | aded from Press "/ | ANALYZE" to see r | oculto | | | | |
| More Information View CZ MAP ANALYZE | | aded nonit . 11633 7 | NALIZE 10 3001 | osuits. | | 🔶 RETURN TO PRI | EVIOUS ADVANCE TO NEX | т 🚽 |
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Figure 11: Analysis of prescribed funding and cost-sharing scenarios

In the next screen, the user can explore the characteristics of individual homes, and probe which households result in the most cost effective implementation (**Figure 12**). The NEAT tool provides the option to check the estimated appliance mix of the baseline and future scenario, the utilities that provide services to a particular house, and the average monthly changes in electricity and natural gas use due to the retrofit (**Figure 13**).

| Residential Net Emissions Analysis Tool version 11.1 Be | | $\overline{}$ | | | | | | | | |
|---|---------------|--------------------|----------------------|-----------------|--------------------|---|------------------------|-----------------|---------------------------------|------|
| le Capture Screen Help | ua | | | | | | | | | |
| emand Demand Input Summary Power Supp | Economics | Computation | Results | | | | | | | |
| nalyze Most Recent Results Analyze Saved Results | | ffectiveness Subs | | | e Mix 🛛 A | pply Prescribed Funding | Query Individual Homes | | | |
| Filter Homes | | ns of Cost Effecti | | Home Details | | | | | | |
| limate Zones | Green NO: | | en CO2e ow CO2e | Costs | | Variable | | | Parameter | |
| 6 Coastal 0 10 S. Inland | Red NOx | Red | | Fuel Use | Housing Climate | | | SingleFa CZ6 | mily | |
| 8 S. Near-Coastal 015 S. Desert | | | | Emissions | Electric u | | | | les Department of Water & Power | |
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| latural Gas Utilities | 3.2653e+05 | 25.8094 | 1 🔺 | | | se natural gas rate descriptio | | | 1 Low Income Discount | |
| Long Beach Gas & Oil Southwest Gas Corp. | 3.3831e+05 | 23.9299 | 1 | | | se natural gas rate appliance -case electric rate descriptio | | All Applia | 1 Low Income Discount | |
| Southern California Gas City of Vernon Gas Syste | 3.1734e+05 | 22.9180 | 1 | | | ⊢case electric rate descriptio ⊢case natural gas rate appli | | All Applia | | |
| | 3.3831e+05 | 23.9299 | 1 | | Stenant | Baseline Applian | | | Scenario Appliance Mix | |
| Electric Utilities | 3.3318e+05 | 23.6383 | 1 | | Fuel | Appliance | | Fuel | Appliance | Quar |
| Azusa Light & Power | 329616 | 25.5523 | 1 | | NatGas | Conventional Water Heate | | NatGas | | au |
| Bear Valley Electric Service | 4.4302e+05 | 26.2378 | 1 | | Electric | First Refrigerator | | | First Refrigerator | |
| Burbank Water & Power | 3.3831e+05 | 23.9299 | 1 | | Electric | Microwave | 1 | Electric | Microwave | |
| City of Anaheim Public Utilities Department | 3.5732e+05 | 24.8388 | 1 | | NatGas | Range Oven Combination | 1 | NatGas | Range Oven Combination | |
| City of Banning Electric Department | | 23.9299 | 1 | | Electric | Clothes Washer | | Electric | Clothes Washer | |
| City of Corona Department of Water & Power | 3.3831e+05 | | | | NatGas | Dryer | | NatGas | , | |
| City of Riverside | 3.1734e+05 | 22.9180 | 1 | | Electric | TV Outdoor Lighting | | Electric | TV Outdoor Lighting | |
| City of Vernon Municipal Light Department | 4.3235e+05 | 26.4498 | 1 | | Electric | PC | | Electric | PC | |
| Glendale Water & Power | 3.5732e+05 | 24.8388 | 1 | | Electric | Other | | Electric | | |
| Los Angeles Department of Water & Power Moreno Valley Utility | 3.0855e+05 | 24.9611 | 1 | | Electric | Attic Ceiling Fan | | Electric | Attic Ceiling Fan | |
| Pasadena Water & Power | 3.1734e+05 | 22.9180 | 1 | | Electric | Central Air Conditioning | 1 | Electric | Central Air Conditioning | |
| Rancho Cucamonga Municipal Utility | 3.3831e+05 | 23.9299 | 1 | | Gasoline | Light Duty Vehicle | 1 | Gasoline | Light Duty Vehicle | |
| San Diego Gas & Electric | 3.5732e+05 | 24.8388 | 1 | | | | | | | |
| Southern California Edison | 3 1734e+05 | 22 9180 | 1 * | | | | | | | |
| 9,427 homes meeting filter critera above | | | | | | | | | | |
| 3813% of the total homes in SoCAB meet filter criteria | 359,206 home: | s selected | | | | | | | | |





Figure 13: Analyze individual homes fuel use, and how that affects cost effectiveness

Sample Case 2: Electrification of water heating in single-family homes in Climate Zone 6

This sample scenario replaces all conventional natural gas water heaters with new Electric Heat Pump Water Heating.

Parameters for scenario:

Electric Heat Pump Water Heaters have a uniform energy factor (UEF) of 3.7, in contrast with conventional water heaters that have a UEF of 0.7. The assumptions for the new technology are shown in **Table 2**.

Table 2: Assumptions in the replacement of water heaters

| Tech | UEC | NOX EF | CO2e EF | Unit Cost | Install Cost |
|-----------------------|-----------|--------------|-------------|-----------|-----------------|
| NG Conv. Water Heater | 199.21 th | 0.0023 lb/th | 11.76 lb/th | \$647 | \$1,900 |
| Electric Heat Pump WH | 1,105 kWh | | | \$1,500 | \$1,700 |

First, we need to add the new technology by clicking on the "add technology" button, and input the parameters in each column:

| Electric |
|---------------|
| Heat Pump |
| Water Heating |
| 1,105 |
| 0.00 |
| 0.00 |
| 1500 |
| 1700 |
| 13 |
| |

Note that UEC in this case must be entered in kWh.

Then implement the technology replacement by using the "Replace Technology Tool" box. Select "single family" as housing type and climate zone 6 (see **Figure 1**).

This scenario uses all the other default values, so the user can advance through the 'Demand Input Summary', 'Power Supply' and 'Economics' tabs without any further modification, and advance to the 'Computation' tab.

Results:

Results show that annual costs (annualized purchase and installation + utility costs) would increase for most households, even with the assumption that the equipment is replaced at the end of life. The increase in annual costs is due to two factors: 1) the heat pump is more expensive than the NG water heater, and 2) electricity costs are higher than the savings in natural gas costs, despite the fact that the heat pump is substantially more efficient than the NG water heater. In this particular case, only 19,813 households out of 359,206 (5.5%) would experience savings in annual costs (**Figure 14**). If only utility costs are considered, 23,464 homes (6.5%) would experience savings in utility bills (**Figure 15**).



Figure 14: Analysis of the cost effectiveness space for the replacement of NG storage water heaters with electric heat pump water heaters, using annualized purchase and installation costs and annual utility costs, and considering replacement at the end of useful life



Figure 15: Analysis of the cost effectiveness space for the replacement of NG storage water heaters with electric heat pump water heaters, using annual utility costs only

Considering a funding amount of \$1,000,000 and assuming that homeowners can pay for 50% of the cost of the appliance, the amount of funding would pay for 625 retrofits, which would result in emission reductions of 226 lbs/year of NOX and 393 tons/year of CO2e (**Figure 16**). These reductions in emissions due to heat pump water heaters are larger than the emission reductions accomplished by retrofitting water heaters with high-efficiency NG water heaters. However, this appliance retrofit would cause an average increase in annual utility costs of \$69.63.

From querying individual homes, results show that the most cost-effective homes are the ones with lowincome utility rates. The lower rates for electricity in those households reduce the impact on the electricity bill caused by the increased use of electricity by the new electric appliance (**Figure 17**).

| Analyze Most Rocent Result: Analyze Saved Result: Select Ost Effectiveness Subset Appliance Mix Appliance Mix <th< th=""><th>emand</th><th>Demand Input Sun</th><th>nmary</th><th>Power Supply</th><th>Economics</th><th>Computation</th><th>Results</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<> | emand | Demand Input Sun | nmary | Power Supply | Economics | Computation | Results | | | | | | | |
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| Simula Category Only Mula Family Homes Only Homes Only Homes | | Filter Ho | mes | | Enter Funding | g Amount [\$] | 1000000 Funding i | s applied only to hou | seholds filtered on the | | | etrofits for | Cost Share by Homeown | er [%] |
| 0 Statistic To shimit of the shift of the shif | limate Zo | ones | | | | | 06/60/0 | Set Enectivenede Ob | 7001 | a particular non | 10 | | | |
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| All Climate Zones SCAQMD Cost to Fund All Projects in "Cost Effectiveness Subset" (only considers purchase and installation costs) \$\$74,729,600.00 Only Single Family Homes Only Multi Family Homes Only Multi Family Homes Comulative Change in NOx Emissions [Ib/y1] 2.26e+02 Cumulative Change in NOx Emissions [Ib/y1] 2.26e+02 3.09e-04 Cumulative Change in NOx Emissions [Ib/y1] -7.86e+05 Cumulative Change in CO2e Emissions [IPD] -1.86e+00 Average Incentive Amount Provided to Homeowner to Purchase and Install Appliances, PV (If selected), and Battery (If selected) \$1.600.00 Average Cost-Share from Homeowner to Purchase and Install Appliances, PV (If selected), and Battery (If selected) \$1.600.00 Average Cost-Share from Homeowner to Purchase and Install Appliances, PV (If selected), and Battery (If selected) \$1.600.00 Average Cost-Share from Homeowner to Purchase and Install Appliances, PV (If selected), and Battery (If selected) \$1.600.00 Average Cost-Share from Homeowner to Purchase and Install Appliances, PV (If selected) \$2.51.22 <td< td=""><td>58 S. N</td><td>Near-Coastal</td><td>) 15 S. De</td><td>esert</td><td>Approximate</td><td>Number of Projects</td><td>s Funded</td><td></td><td></td><td></td><td></td><td></td><td>625</td><td></td></td<> | 58 S. N | Near-Coastal |) 15 S. De | esert | Approximate | Number of Projects | s Funded | | | | | | 625 | |
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| 9.427 homes meeting filter critera above | | ~ | ipal Utility | | 5 4 | | | | | 5 | | | | |
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| 1813% of the total nomes in Socials meet filter criteria -150 -100 -50 0 50 100 150 200 250 -100 -50 0 50 100 150 | | | | | | | | | | | | | | ~ ~ |
| | 1813% 0 | t the total nomes in Sc | OCAR meet | Tilter criteria | -150 | -100 -50 | 0 0 50 | 100 150 | 200 250 | | -100 -50 | 0 | 50 100 | 150 |
| Previous computation loaded from . Press "ANALYZE" to see results. | | ormation View CZ | - | ANALYZE | | | | | | | | RETURN TO PRE | EVIOUS ADVANCE | O NEXT |

Figure 16: Analysis of prescribed funding and cost-sharing scenarios for Heat Pump Water Heater implementation

| Demand | Demand Input Summa | ary Power Supply | Economics | Computation | Results | | | | | | | | |
|-----------------------------|----------------------------|-------------------------|----------------------|---|---------------------|----------|--------------|----------------------|--|------------------------|------------|--|--------|
| Analyze N | 1ost Recent Results A | nalyze Saved Results | Select Cost E | ffectiveness Subse | et Cost Effec | tiveness | Appliance Mi | x Aj | oply Prescribed Funding | Query Individual Homes | | | |
| | Filter Homes | s | Specify Regio | ins of Cost Effectiv | eness Space | Home | Details | | | | | | |
| Climate Z | ones | | Green NO | | | Costs | | | Variable | | | Parameter | |
| 6 Coa | | 0 S. Inland | Vellow NO Red NOx | x Yello Red | | Fuel U | | Housing | | | SingleFa | mily | |
| | | 5 S. Desert | Red NOX | Red | LOZe | Emiss | iono | Climate a | | | CZ6 | | |
| | | 6 Mountain | Specify Units | of Cost Effectiven | BSS | | | Electric u | | | | California Edison | |
| | () A | All Climate Zones | O [Delta lb / | / Delta \$] 💿 [De | lta \$ / Delta ton] | Solar | | | ate low/standard income | | low | | |
| Housing C | ategory | | | ne to populate pa | | | | | e electric rate description -case electric rate descripti | 22 | | : Service: D - Baseline Region 6 CARE : Service: D - Baseline Region 6 CARE | |
| - | | Only Mobile Homes | | by clicking the co es are (Scenario- | | | | Gas Utili | | | | c Service. D - Baseline Region 6 CARE ach Gas & Oil | |
| | | All Housing Types | | L CO2e Cost Eff. | # Homes | | | | low/standard income | | low | | |
| | | | 5.2314e+05 | 71.6884 | 2 | | | Base-cas | e natural gas rate descript | on | Schedule | a 1 Low Income Discount | |
| | as Utilities | | 5.2314e+05 | 71.6884 | 2 | | 6 | Base-cas | e natural gas rate appliance | e criteria | All Applia | inces | |
| | | uthwest Gas Corp. | 5.2314e+05 | 71.6884 | 2 | | | Scenario | -case electric rate descripti | on | Schedule | a 1 Low Income Discount | |
| Souther | ern California Gas 🗌 Cit | y of Vernon Gas System | | | - | | | Scenario | case natural gas rate appl | iance criteria | All Applia | | |
| Electric U | tilities | | 5.2314e+05 | 71.6884 | 1 | | | | Baseline Applia | | | Scenario Appliance Mix | |
| Azusa | Light & Power | | 5.2314e+05 | 71.6884 | 2 | | | Fuel | Appliance | | | Appliance | Quanti |
| | /allev Electric Service | | 5.2314e+05 | 71.6884 | 2 | | | NatGas | Conventional Water Heat | | | | |
| | nk Water & Power | | 5.2314e+05 | 71.6884 | 2 | | | Electric | Range Oven Combination | | 1 Electric | | |
| | f Anaheim Public Utilities | Department | 5.2314e+05 | 71.6884 | 2 | | | Electric Electric | First Refrigerator Microwave | | 1 Electric | First Refrigerator Microwave | |
| | f Banning Electric Depart | | 5.2314e+05 | 71.6884 | 2 | | | Electric | Drver | | 1 Electric | Drver | |
| | f Corona Department of V | | 5.2314e+05 | 71,6884 | 1 | | | Electric | Clothes Washer | | 1 Electric | | |
| City of | f Riverside | | 5.2314e+05 | 71.6884 | 2 | | | Electric | TV | | 1 Electric | TV | |
| | f Vernon Municipal Light (| Department | 5.2314e+05 | 71.6884 | 2 | | 6 | Electric | Outdoor Lighting | | 1 Electric | Outdoor Lighting | |
| | ale Water & Power | | 5.2314e+05 | 71.6884 | 1 | | E | Electric | Home Office | | 1 Electric | Home Office | |
| Los A | ngeles Department of Wa | ater & Power | 5.2314e+05 | 71.6884 | 2 | | | Electric | PC | | 1 Electric | | |
| Moren | o Valley Utility | | | | | | | Electric | Other | | 1 Electric | | |
| Pasad | lena Water & Power | | 5.2314e+05 | 71.6883 | 1 | | | Electric | Conventional Heat | | 1 Electric | | |
| Ranch | no Cucamonga Municipal | Utility | 5.2314e+05 | 71.6884 | 2 | | | | Furnace Fan Light Duty Vehicle | | | Furnace Fan Light Duty Vehicle | |
| 🗸 San D | iego Gas & Electric | | 5.2314e+05 | 71.6884 | 2 | | | Gasoline | Light Duty vehicle | | Gasonne | Eight Duty Vehicle | |
| South | ern California Edison | | 5 2314e+05 | 71 6883 | 2 | · | | | | | | | |
| | mes meeting filter critera | | 359 206 home | s selected | • | | | | | | | | |
| .3813% 0 | f the total homes in SoCA | AB meet filter criteria | 555,200 Hollie | 0.000000 | | | | | | | | | |

Figure 17: Analyze individual homes details, and how that affect cost effectiveness

Sample Case 3: Electrification of water heating, space heating and clothes dryer, and installation of rooftop solar PV in Single-Family homes in Climate Zone 6

This scenario replaces natural gas appliances for water heating, space heating and clothes drying with electric appliances, and installs rooftop solar PV panels in single-family homes in climate zone 6.

Parameters for scenario:

Storage NG water heaters are replaced with electric heat pump water heaters, natural gas primary heat is replaced by electric heat pump space heater, and NG clothes dryers are replaced with electric clothes dryers. The assumptions for the new technologies are in the tables below:

| Tech | UEC | NOX EF | CO2e EF | Unit Cost | Install Cost |
|-----------------------|---------------|--------------|-------------|-----------|-----------------|
| NG Conv. Water Heater | 199.21 therms | 0.0023 lb/th | 11.76 lb/th | \$647 | \$1,900 |
| Electric Heat Pump WH | 1,105 kWh | | | \$1,500 | \$1,700 |

Table 3: Assumptions in the replacement of water heaters

Table 4: Assumptions in the replacement of space heaters

| Tech | UEC | NOX EF | CO2e EF | Unit Cost | Install Cost |
|--------------------|------------|--------------|-------------|-----------|-----------------|
| NG Primary Heat | 184 therms | 0.0066 lb/th | 11.76 lb/th | \$3,089 | \$1,696 |
| Electric Heat Pump | 994 kWh | | | \$1,972 | \$3,233 |

Table 5: Assumptions in the replacement of clothes dryers

| Tech | UEC | NOX EF | CO2e EF | Unit Cost | Install Cost |
|------------------------|-----------|--------------|-------------|-----------|-----------------|
| NG Clothes Dryer | 26 therms | 0.0136 lb/th | 11.76 lb/th | \$800 | \$100 |
| Electric Clothes Dryer | 719 kWh | | | \$750 | \$219 |

| nand Dei | mand Input Summary | Power Supply | Economics | Computation | Results | | | | | | | | |
|--|---|--|--|--|--|--|--|---|--|--|--|--|---|
| ising Catego | rv | | | Climate Zone | | | | | | | | | _ |
| Single-Family | | Mobile Home | Aggregate | 6 Coastal | 08 S. Nea | Ir-Coastal | 9 N. Near-Coa | astal 0 10 S | Inland () 15 S. Desert () | 16 Mountain | | $\square \bigcirc$ | |
| | | | | O o oddada | 000.110 | | | | | | | Q | 5 |
| | ne and Scenario Techn Parameters | ology MIX Parameter | 3 | | | | LIST OF New Tech lefault Paramete | | ssible Implementation t parameters in "Add Technolog | v for Scenario Selectio | n" | | 2 |
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| oad Saved I | Parameters | | | | | Load S | Saved Paramete | ers M:\ | MCS\NEAT\TestCases\GRID_4 | Iternative_NEAT_Sce | narios\Updat | AQ | ND |
| t water heati | ing Kitchen La | undry Miscellan | eous Poo | Space hea | ting and cooling | Transporta | ation | | | | | | |
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| Fuel | TECHNOLOGY Technology | | | w column informatio | n and units with "S | how Column Infom | nation" button | Fuel | TECHNOLOGY MIX F Technology | | NOX EF CO2e EF | | |
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| | lothes Washer | | | 0 0 | 850 | 100 13 | 0.9600 = | Electric Cloth | | 121 | 0 0 | 850 | 100 |
| NatGas Dr | ryer | 26 | 100 0.013 | 6 11.7600 | 800 | 100 18 | 0.5170 ≠ | Electric Dryer | ſ | 719 | 0 0 | 750 | 219 |
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| | HNOLOGY PARA | METER | ION: Default | appliance param | eters may not b | e appropriate foi | r most scenarios | s. For the most a | ccurate results, South Coast A | OMD Save Pace | line and Scenario Tec | hnology Miv P | rameters to P |
| Fuel | Technology | INCIERS recon | mends using Hourly Profile | actual values or | the appliances | that are being re | | | s of UEC vary based on fuel. | Replace Technol | | | |
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| Electric | Clothes Washer | | | iance Equipment iance Equipment | 014.7648 | - | | 50 218.5900 50 100.0000 | 18 General technology ca 13 General technology ca | replacement teo | h.) | | |
| NatGas | Dryer | | | iance Equipment | 24.5 47 | | | 00 100.0000 | 18 General technology ca | | technology to phase-o | ut: | |
| B Electric | Dryer | | Interior Appl | iance Equipment | 719.000 | 0 | 0 75 | 50 218.5900 | 18 General technology ca | | nology to replace bas | line technolog | |
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Figure 18: Implement technology replacement for Laundry and Space Heating and Cooling

Once the technology replacements have been selected, the user can confirm that the changes have been implemented in the next screen (**Figure 19**).

| and Dem | mand Input Summa | ary Po | ower Supply | Economics | Computation | Results | | | | | | | | | |
|----------------|------------------|----------|--------------|-----------|-------------------|----------------|----------|-------------------|-------------------------------|-------------|------------|------------|-------|------------|-----------|
| sing Category | ry | | | | Climate Zone | | | | | | | | | | |
| Single-Family | y 🔿 Multi-Family | / O Mol | bile Home | Aggregate | 6 Coastal | 0 8 S. Near-Co | astal (| 9 N. Near-Coastal | 10 S. Inland 0 15 S. Desert 0 | 16 Mountain | | MAP | | Show Colum | n Informa |
| | | | | | | | | | | | | | | | |
| SER-SELECT | TED TECHNOLOG | GY MODIF | FICATIONS | BASELI | | | | 0.00 | INARIO | | RAMETER CH | | | | |
| Cate | tegory | Fuel | Tec | hnology | Pro | file | Fuel | Technology | Profile | UEC | | CO2e EF Ur | | | ifetime |
| ot water heati | | | Conventional | | Water Heating | ino | | Heat Pump | Water Heating | modified | -0.0023 | -11.76 | 853 | -200 | liounio |
| aundry | | NatGas | Dryer | | Interior Appliant | ce Equipment | Electric | Dryer | Interior Appliance Equipment | modified | -0.0136 | -11.76 | -50 | 119 | |
| bace heating | g and cooling | NatGas | Primary Heat | | Space Heating | | Electric | Heat Pump | Space Heating | modified | -0.0066 | -11.76 | -1117 | 1537 | -7 |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Figure 19: Demand Input Summary for Appliance Replacement Scenario

In the next screen, the user should check the 'Implement Rooftop Solar PV using PVWatts' box. The default set up assumes a cost function that depends on the PV panel size. Users are able to change this function should they find more updated information.

| Residential Net Emissions Analysis Tool version 1.11 Beta | | | | - 🗆 🗙 |
|--|---|--|---|--|
| File Capture Screen Help | | | | |
| Demand Demand Input Summary Power Supply Economics | Computation Results | | | |
| Methane Emissions from Natural Gas | | Electricity Generation from Grid | | |
| Natural Gas Leak Rates (As percentage of usage) Before Mete Leak Rate 19 | | Emission Factor of INCREASED Electricity Use | Emission Factor of REDUCE | D Electricity Use |
| 2018 EPA GHG Emissions Inventory: 1.27% The 16 Study Series Synthesis Report: 1.7% Alvarez et al., 2018 Science Paper: 2.3% Custom Value Fortilat | Storage/ 0.35 | All additional electricity from centralized photovoltaics, wind, and centralized battery storage (Case 1) All additional electricity provided at the Basin-average dispatchable power emission factor (Case 2) All additional electricity provided by peaker plants (Case 3) | C Reductions in electricity g curtailing peaker plant em | eneration emissions determined spatchable power emission factor generation emissions arise by hissions ges modeled with HIGRID |
| GHG Emis. from Increased Natural Gas Production (For Advanced Users) | Reset to Default More Information | Grid emission factor changes modeled with HiGRID Additional electricity provided by a mixture of technologies I%I Case 1 I%I Case 2 I%I Case 3 | Electricity Ge | eneration Module Documentation |
| Type Pathway Supply Fraction CO2e Emis. (lb/therm) bio landfill 0 -0.8604 | Well-to-Pump Emis. of Transportation | [%] Case 1 [%] Case 2 [%] Case 3 0 ↓ 100 ↓ 0 ↓ | Test | t HiGRID |
| bio wastewater 0 -7.2321 bio manure 0 -73.1118 bio food & green waste 0 -17.0455 fossil natural gas 1 6.8368 | Fuel CO2e (lb/gal) NOx (lb/gal) Gasoline 6.3030 0.0117 Diesel 7.2201 0.0152 | Transmission and Distribution Loss in Power Grid (For Advance Use Flat Loss Percentage for all Utilities Use Hourly Loss Percentage for all Utilities Use Hourly Specific Loss Percentages | 5.4 | More Information |
| "Supply Fraction" column must sum to unity Reset to Default More Information | Reset to Default More Information | Utility Name Valid Y | Verra Los | is [%] |
| Distributed Solar Photovoltaics | | Azusa Light & Power | 9 | 2.5000 * |
| ✓ Implement Rooftop Solar PV using PVWatts | Rooftop Solar PV Module Documentation | Bear Valley Electric Service | 9 | 12.2000 |
| Fd. Advanced Users | | Burbank Water & Power | 10 | 3.5000 |
| For Rovanced Osers | Reset to Default | City of Anaheim Public Utilities Department | 10 | 4.9000 |
| Solar Cost Function: COST = 2135 * X size in | "X" is defined as the panel kW DC under standard nditions. Test Function More Information | Residential Battery Storage | | I Battery Module Documentation |
| Module type Standard Rooftop | Area Availability Ratio 0.75 | For Advanced Users | | |
| Syste Loss Value 0.14 Inverter Efficiency (%) 96 | Useful Lifespan (yrs) 25 Panel Tilt (degrees) 20 | Battery System Eattery Setup B Battery Setup C Battery Power [kW] | 9.5 Battery Cost \$ | 1400 Lifetime 10 6200 Image: state s |
| Select Rooftop Solar | Implementation | | | ADVANCE TO NEXT 🌩 |

Figure 20: Power Supply Set-up: select 'Implement Rooftop Solar PV using PVWats'

Results:

After the simulation is computed, results for this scenario show that most households fall within the cost-effective quadrant (green region, **Figure 21**). All homes reduce emissions due to the retrofit, and 363,756 homes out of 409,427 (89%) experience reductions in annual costs when replacing equipment at the end of their useful life. Reductions in annual costs occur in most homes despite the cost of installation of solar panels. The reduction in annual costs is due to the savings in electricity costs that rooftop solar PV provides. This scenario is an example how solar PV can enable electrification of homes by providing overall savings to homeowners.



Figure 21: Analysis of the cost effectiveness space for the electrification of water and space heaters and clothes dryers, in conjunction with rooftop solar PV installation.

NEAT analyzes the implementation of appliance retrofits at a regional level, and considers the appliance technology distribution from the 2009 Residential Appliance Saturation Survey (RASS). In this particular scenario, NG appliances are replaced with electric alternatives. NG water heaters are present in 87.7% of all single-family homes, whereas NG space heaters and NG cloth dryers are present in 85.5% and 51.7% of the single-family homes. Results show that the fraction of homes with the three retrofits with resulting cost savings (green quadrant) is 33.9% (**Figure 22**).

| Demand Demand Input Sur | mmary Power Supply | Economics | Computation | Resul | ts | | | | | | | | | | |
|--|--|-------------------------------|------------------|----------|--------------------|-----------------|----------|---------------------|--------------------|----------|-----------|----------|-----------|-------------|----------|
| Analyze Most Recent Results | Analyze Saved Results | Select Cost E | ffectiveness Sub | set C | ost Effectiveness | Appliance Mix | Apply F | rescribed Funding | Query Individual I | Homes | | | | | |
| Filter Ho | omes | TECHNOLOG | Y MODIFICATIO | NS (hove | r over Technology | to see profile) | | | | | | | | | |
| Climate Zones | | Show Column | Information | | BASELINE | E | | SCENARI | 2 C | F | PARAMETER | R CHANGE | S (SCENA | RIO - BASEL | NE) |
| 6 Coastal | 0 10 S. Inland | # Ca | ategory | Fuel | Techn | ιοίοαν | Fuel | Techr | ology | UEC | NOX EF | 02e EE L | Init Cost | nstall Cost | Lifetime |
| | 15 S. Desert | | ing and cooling | | Primary Heat | lology | | Heat Pump | (olog) | modified | -0.0066 | -11.76 | -1117 | 1537 | -7. |
| | 16 Mountain | 2 Laundry | ing and cooling | NatGas | | | Electric | | | modified | -0.0136 | -11.76 | -50 | 119 | -1. |
| | All Climate Zones | 3 Hot water h | eating | | Conventional Water | Heater | | Heat Pump | | modified | -0.0023 | -11.76 | 853 | -200 | |
| Housing Category | | e | | | e e e shar mater | | | concernation of the | | | 0.0020 | | 000 | 200 | |
| Only Single Family Homes | Only Mobile Homes | | | | | | | | | | | | | | |
| Only Multi Family Homes | All Housing Types | | | | | | | | | | | | | | |
| Natural Gas Utilities | | | | | | | | | | | | | | | |
| ✓ Long Beach Gas & Oil | Southwest Gas Corp. | | | | | | | | | | | | | | |
| Southern California Gas | City of Vernon Gas System | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Electric Utilities | | | | | | | | | | | | | | | |
| Azusa Light & Power | | | | | | | | | | | | | | | |
| Bear Valley Electric Service | 8 | | | | | | | 363,756 Total Home | | | | | | | (|
| Burbank Water & Power | | Pan Left | | | F | raction of Home | | pecified Modificati | | tiveness | Subset | | | | Pan Rig |
| City of Anaheim Public Utili | ities Department | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| City of Banning Electric Dep | partment | 1 | 837 | | | 187 | | | | | | | | | |
| | | | 0.837 | | | 0.8 | | | 6 | 87 | | | | | |
| City of Banning Electric De | | 0.8 | 0.837 | | | 0.8 | | | 007 | | | | | | |
| City of Banning Electric De | t of Water & Power | | 0.837 | | | 08 | | | | | | | | | |
| City of Banning Electric Dep City of Corona Department City of Riverside | t of Water & Power | | 0.837 | | | 08 | | 4 | | | | 8 | | | |
| City of Banning Electric Dep City of Corona Department City of Riverside City of Vernon Municipal Lig | of Water & Power | 50.6 | 0:837 | | 0.48 | | | 1394 | | | | 0.413 | | 38 | |
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Figure 22: Appliance technology mix in the implementation scenario

User can analyze the potential effects of funding strategies to reduce emissions in the 'Apply Prescribed Funding' tab. Considering a funding amount of \$1,000,000 and assuming that homeowners can pay for 50% of the cost of the appliance, the amount of funding would pay for 136 retrofits, which would result in emission reductions of 224 lbs/year of NOX and 750 tons/year of CO2e (**Figure 23**). On average, the annualized cost of the retrofit plus the PV system installation would cost homeowners \$237.21 annually, assuming that the equipment is replaced at the end of their useful life. However, the total annual savings in utility costs are estimated to be \$676.79 annually, which would result in net savings to homeowners. Because households have varying loads depending on their appliance mix and energy usage, the net savings would vary widely among homes (as shown in the bottom bar plot in **Figure 23**). Some homes could experience utility savings that are below the annual costs, whereas other homes could experience annual savings of up to \$1,400, making the retrofit very cost effective.

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Figure 23: Analysis of prescribed funding and cost-sharing scenarios for electrification scenario with rooftop solar PV

In the 'Query Individual Homes' tab, cost-effectiveness results can be sorted to display the most cost effective homes. In this scenario, the most cost effective homes turn out to be the ones with PV installation and no NG appliance replacement. The most cost effective homes achieve savings of \$3.5 million per ton of NOX reduced.

| Demand Demand Input Summary Power Supply | Economics | Computation | Results | | | | | | | | |
|--|-------------------------|---------------------------------------|---------------|-----------|------------------|-----------------------|--|------------------------|------------------------|--|----------|
| Analyze Most Recent Results Analyze Saved Results | Select Cost Effe | ectiveness Subse | et Cost Effe | ctiveness | Appliance Mix | : Ap | ply Prescribed Funding | Query Individual Homes | | | |
| Filter Homes | Specify Region | s of Cost Effectiv | eness Space | Hom | e Details | | | | | | |
| Climate Zones | Green NOx Yellow NOx | | | Cost | | | Variable | | | Parameter | |
| 6 Coastal 0 10 S. Inland | Red NOx | Vello | | Fuel | | lousing t limate z | | | SingleFar CZ6 | mily | |
| 0 8 S. Near-Coastal 0 15 S. Desert | | | | Emis | cione | limate z lectric u | | | | o Gas & Electric | |
| 9 N. Near-Coastal 016 Mountain | | f Cost Effectiven Delta \$1 () [De | | Sola | | | ate low/standard income | | standard | o Gas & Electric | |
| O All Climate Zones | | to populate pa | | | B | ase-cas | e electric rate description | | DR-LI - C | oastal Baseline Region | |
| Housing Category | (Sort homes b | y clicking the co | olumn header) | | s | cenario- | case electric rate descript | ion | DR-LI - C | oastal Baseline Region | |
| Only Single Family Homes Only Mobile Homes | | are (Scenario- | | | | ias Utilit | | | | California Gas | |
| Only Multi Family Homes All Housing Types | | CO2e Cost Eff. | # Homes | | | | low/standard income | | standard | to (| |
| Natural Gas Utilities | 35,4218 | 177.4249 | 28 | ^ | | | e natural gas rate descript e natural gas rate appliano | | GR clima All Applia | | |
| ✓ Long Beach Gas & Oil Southwest Gas Corp. | 3.3533e+06 | 169.7854 | 28 | | | | case electric rate descript | | GR clima | | |
| Southern California Gas 🗌 City of Vernon Gas Sy sem | 3.2133e+06 | 162.6965 | 29 | | | | case natural gas rate appl | | All Applia | nces | |
| Electric Utilities | 3.1102e+06 | 157.4773 | 28 | | | | Baseline Applia | nce Mix | | Scenario Appliance Mix | |
| Azusa Light & Power | 3055464 | 154.7036 | 22 | | | Fuel | Applianc | e Quantity | Fuel | Appliance | Quantity |
| Bear Valley Electric Service | 3055464 | 154.7036 | 154 | | E | lectric | First Refrigerator | 1 | Electric | First Refrigerator | |
| Burbank Water & Power | 2949191 | 149.3228 | 4 | | | | Microwave | 1 | Electric | Microwave | |
| City of Anaheim Public Utility's Department | 2949191 | 149.3228 | 44 | | | | Range Oven Combination Dryer | n 1 | NatGas | Range Oven Combination Drver | |
| City of Banning Electric Department | 2.9335e+06 | 148.5285 | 22 | | | | Clothes Washer | 1 | Electric | Clothes Washer | |
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| ick on column header to | 2 | 148.2763 | 154 | | | | PC | 1 | Electric | PC | |
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| rt effectiveness values i | n +06 | 141.8948 | 28 | | | | Central Air Conditioning Light Duty Vehicle | 1 | Electric | Central Air Conditioning Light Duty Vehicle | |
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| Woy.427 homes meeting filter critera above 7.3813% of the total homes in SoCAB meet filter criteria More Information View CZ MAP ANALYZE | 363,756 Previo | | - | | placem al hom | | t | | RETUR | N TO PREVIOUS | |

Figure 24: Analyze individual homes details, and how that affect cost effectiveness

Results show that the median size of solar panels installed in this scenario is 3 kW, whereas the most cost effective retrofit corresponds to homes with no NG appliance retrofit and a 1.5 kW solar PV installation (**Figure 25**).



Figure 25: Individual home details showing the optimum size of PV panels

Homes with the three electric appliance retrofits result in cost-effectiveness values of \$312K and below (**Figure 26**). The addition of electrical loads for water heating, space heating and clothes drying increases the overall electricity use in the home (**Figure 27**). But the addition of solar panels reduces the net demand of electricity from the grid. For the particular home shown in **Figure 27**, net electricity demand is reduced to zero in the months of June through August, because of the installation of a 6.1 kW system (**Figure 28**).

| Demand Demand Input Summary Power Supply | Economics | Computation | Results | | | | | | | |
|--|--|------------------|-----------------|------------------|------------------|---|---------------------------------|---|---|---------|
| Analyze Most Recent Results Analyze Saved Results | Select Cost Effer | ctiveness Subse | et Cost Effecti | veness Appliance | e Mix 🛛 A | pply Prescribed Funding | Query Individual Homes | | | |
| Filter Homes | Specify Regions | of Cost Effectiv | eness Space | Home Details | | | | | | |
| Climate Zones | ✓ Green NOx ✓ Green CO2e ✓ Yellow NOx ✓ Yellow CO2e Red NOx ⊂ Red CO2e | | | Costs | Variable | | | Parameter | | |
| 6 Coastal 0 10 S. Inland | | | | Fuel Use | | | | SingleFamily | | |
| 8 S. Near-Coastal 15 S. Desert | | | | Emissions | Electric utility | | | CZ6 San Diego Gas & Electric | | |
| 9 N. Near-Coastal 0 16 Mountain | Specify Units of Cost Effectiveness | | | Solar & Battery | | | | | | |
| All Climate Zones | [Delta lb / Delta \$] [Delta \$ / Delta ton] | | | Solar & Dattery | | | | standard DR-LI - Coastal Baseline Region | | |
| using Category Select a home to populate panels on right: | | | | | | | DR-LI - Coastal Baseline Region | | | |
| Only Single Family Homes Only Mobile Homes | (Sort homes by clicking the column header) All values are (Scenario-Baseline) | | | | | | | Southern California Gas | | |
| Only Multi Family Homes OAll Housing Types | NOx Cost Eff. 🗼 | | # Homes | | | low/standard income | | standard | ounorma ouo | |
| Natural Gas Utilities | 3.1210e+05 | 32,5826 | 154 🔺 | | Base-ca | se natural gas rate descripti | on | GR clima | te zone 1 | |
| | 3 1198e+05 | 47 5864 | 3 | | Base-ca | se natural gas rate applianc | e criteria | All Applia | nces | |
| Long Beach Gas & Oil Southwest Gas Corp. | | 37.9288 | 28 | | | -case electric rate description | | GR clima | | |
| Southern California Gas City of Vernon Gas System | | 37.9288 | 28 | | Scenario | -case natural gas rate appli | | All Applia | | |
| Electric Utilities | | | | | | Baseline Appliar | | 1 | Scenario Appliance Mix | |
| Azusa Light & Power | | 37.4691 | 44 | | Fuel | Appliance | Quantity | Fuel | Appliance | Quantit |
| Bear Valley Electric Service | | 37.9194 | 28 | | NatGas | Conventional Water Heate | | Electric | Heat Pump | |
| Burbank Water & Power | 3.1172e+05 | 37.9194 | 28 | | Electric | First Refrigerator Second Refrigerator | 1 | Electric | First Refrigerator Second Refrigerator | |
| City of Anaheim Public Utilities Department | 3.1167e+05 | 34.7426 | 29 | | Electric | Microwave | 1 | Electric | Microwave | |
| City of Banning Electric Department | 3.1154e+05 | 32.5244 | 154 | | NatGas | Range Oven Combination | 1 | NatGas | Range Oven Combination | |
| City of Corona Department of Water & Power | 3.1152e+05 | 37.4407 | 43 | | NatGas | | 1 | Electric | Drver | |
| City of Riverside | 3.1143e+05 | 48.5166 | 3 | | Electric | TV | 1 | Electric | TV | |
| City of Vernon Municipal Light Department | 3.1130e+05 | 37.8689 | 29 | | Electric | Outdoor Lighting | 1 | Electric | Outdoor Lighting | |
| Glendale Water & Power | 3 1097e+05 | 37 7429 | 154 | | Electric | PC | 1 | Electric | PC | |
| Los Angeles Department of Water & Power | | 37.3641 | 44 | | Electric | Other | 1 | Electric | Other | |
| | | 37.7279 | 22 | | NatGas | Other Pool Pump | 1 | NatGas Electric | Other | |
| Moreno Valley Utility | | | | | Electric | Spa | 1 | Electric | Pool Pump Spa | |
| Moreno Valley Utility Pasadena Water & Power | 3.1079e+05 | 37.7212 | 154 | | | Spa Heat | 1 | NatGas | | |
| | | 48.2203 | 154 | | Electric | Furnace Fan | 1 | Electric | Furnace Fan | |
| Pasadena Water & Power Rancho Cucamonga Municipal Utility San Diego Gas & Electric | | | | | | | | Classic | | |
| Pasadena Water & Power | | 37 3416 | 1 | | NatGas | Primary Heat | 1 | Electric | Heat Pump | |

Figure 26: Example of home with the all three appliance retrofits, showing home details

| Demand Demand Input Summary Power Supply | Economics | Computation | Results | | | |
|--|---|-------------------|---------------|-----------------------------------|--|-----|
| Analyze Most Recent Results Analyze Saved Results | Select Cost Effectiveness Subset Cost Effective | | | veness Applianc | e Mix Apply Prescribed Funding Query Individual Homes | |
| Filter Homes | Specify Regions of Cost Effectiveness Space | | Home Details | Fuel Type Fuel Use | _ | |
| Climate Zones | Green NOX Green CO2e | | Costs | Baseline electricity use [kw-hr] | 108 | |
| 6 Coastal 0 10 S. Inland | Yellow NOx Red NOx | Red (| | Fuel Use | Scenario electricity use [kw-hr] | 13 |
| 0 8 S. Near-Coastal 0 15 S. Desert | | f Cost Effectiven | | Emissions | Scenario electricity use with PV and Battery (if selected) [kw-hr] | 432 |
| 9 N. Near-Coastal 016 Mountain | | | | Solar & Battery | Baseline natural gas use [therms] | 469 |
| All Climate Zones [Delta B / Delta S] (Delta S / Delta S | | | | Scenario natural gas use [therms] | 108 509 | |
| Housing Category | (Sort homes b | y clicking the co | olumn header) | | Baseline gasoline use [gal] Scenario gasoline use [gal] | 509 |
| Only Single Family Homes Only Multi Family Homes All Housing Types | | CO2e Cost Eff. | # Homes | | Baseline diesel use (gal) | 505 |
| | 3.1210e+05 | 32.5826 | 154 A | | Scenario diesel use [gal] | |
| Natural Gas Utilities | 3.1210e+05 | 47.5864 | 3 | | | |
| Long Beach Gas & Oil Southwest Gas Corp. | 3.1198e+05 | 47.5804 | 28 | | 1500 Electricity Profile | |
| Southern California Gas City of Vernon Gas System | 3.1180e+05 | 37.9288 | 28 | | Ę | |
| Electric Utilities | 3.1176e+05 | 37.9200 | 44 | | Linculuy Pitone | |
| Azusa Light & Power | 3.1170e+05 | 37.9194 | | | | |
| Bear Valley Electric Service | 3.1172e+05 3.1172e+05 | | 28 | | Baseline Profile | |
| Burbank Water & Power | | 37.9194 | 28 | | + Scenario Profile | |
| City of Anaheim Public Utilities Department | 3.1167e+05 | 34.7426 | | | Scenario Profile with PV and Battery | |
| City of Banning Electric Department | 3.1154e+05 | 32.5244 | 154 | | J F M A M J J A S O N | |
| City of Corona Department of Water & Power | 3.1152e+05 | 37.4407 | 43 | | Month | |
| City of Riverside | 3.1143e+05 | 48.5166 | 3 | | Natural Gas Profile | |
| City of Vernon Municipal Light Department Glendale Water & Power | 3.1130e+05 | 37.8689 | 29 | | Natural Gas Profile Baseline Profile - Scenario Pro | |
| Los Angeles Department of Water & Power | 3.1097e+05 | 37.7429 | 154 | | ± 40 | / |
| Moreno Valley Utility | 3.1088e+05 | 37.3641 | 44 | | | |
| Pasadena Water & Power | 3.1084e+05 | 37.7279 | 22 | | S 20 - | |
| Rancho Cucamonga Municipal Utility | 3.1079e+05 | 37.7212 | 154 | | | |
| San Diego Gas & Electric | 3.1075e+05 | 48.2203 | 154 | | | |
| Southern California Edison | 3 1070e+05 | 37 3416 | 1 | | J F M A M J J A S O N | |
| 09,427 homes meeting filter critera above 3813% of the total homes in SoCAB meet filter criteria | 363.756 homes selected | | | | Month | |

Figure 27: Example of home with the all three appliance retrofits, showing changes in fuel use



Figure 28: Example of home with the all three appliance retrofits, showing optimum PV panel size