



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

## Contents

<b>Introduction</b> .....	3
<b>Sample Case 1: Switch to High Efficiency Natural Gas Condensing Water Heater in Single-Family homes in Climate Zone 6</b> .....	4
<b>Parameters for scenario:</b> .....	4
<b>Computation of Scenario:</b> .....	8
<b>Results:</b> .....	10
<b>Sample Case 2: Electrification of water heating in single-family homes in Climate Zone 6</b> .....	16
<b>Parameters for scenario:</b> .....	16
<b>Results:</b> .....	17
<b>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</b> .....	20
<b>Parameters for scenario:</b> .....	20
<b>Results:</b> .....	23

## 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**.

**Table 1:** 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
HE NG Condensing Water Heater	155.00 th	0.0023 lb/th	11.76 lb/th	\$1,000	\$1,900

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**).

Residential Net Emissions Analysis Tool version 1.11 Beta

File Capture Screen Help

Demand Demand Input Summary Power Supply Economics Computation Results

Housing Category:  Single-Family  Multi-Family  Mobile Home  Aggregate

Climate Zone:  6 Coastal  8 S. Near-Coastal  9 N. Near-Coastal  10 S. Inland  15 S. Desert  16 Mountain  All CZ MAP

Populate Baseline and Scenario Technology Mix Parameters

Populate List of New Technologies for Possible Implementation

Load Default Parameters Load Saved Parameters

Load Default Parameters Load Saved Parameters

Hot water heating Kitchen Laundry Miscellaneous Pool Space heating and cooling Transportation

BASELINE TECHNOLOGY MIX PARAMETERS										SCENARIO TECHNOLOGY MIX PARAMETERS									
Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Penetration		Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime		
A	Electric Water Heat	3169	0	0	361	1700	13	0.0500		Electric Water Heat	3169	0	0	361	1700	13			
B	Electric Solar Water Heat with Electric Backup	1877	0	0	1411	3869	13	0		Electric Solar Water Heat with Electric Backup	1877	0	0	1411	3869	13			
C	NatGas Conventional Water Heater	199.9600	0.0023	11.7600	647	1900	13	0.8770		NatGas High-Efficiency Condensing	155	0.0023	11.7600	1000	1900	13			
D	NatGas Solar Water Heat with Gas Backup	156.8200	0.0023	11.7600	4349	3869	13	0		NatGas Solar Water Heat with Gas Backup	156.8200	0.0023	11.7600	4349	3869	13			

NEW TECHNOLOGY PARAMETERS

CAUTION: Default appliance parameters may not be appropriate for most scenarios. For the most accurate results, South Coast AQMD recommends using actual values for the appliances that are being replaced or retrofitted. Note that units of UEC vary based on fuel.

#	Fuel	Technology	Hourly Profile	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Notes
18	NatGas	High-Efficiency Condensing	Water Heating	155	0.0023	11.7600	1000	1900	13	Values not specified
19	Electric	Heat Pump	Water Heating	1105	0	0	1500	1700	13	Values not specified
20	Electric	Standard Tank	Water Heating	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified
21	Electric	Point-of-Use Tankless System	Water Heating	2923	0	0	850	3400	13	Values not specified
22	NatGas	Heat Pump	Water Heating	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified
23	Undefined	New Technology	Undefined	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified

Replace Technology Tool

(All households with the baseline technology will switch to the replacement tech.)

Select baseline technology to phase-out:

C NatGas Conventional Water Heater

Select new technology to replace baseline technology in "scenario":

18 NatGas High-Efficiency Condensing

Implement

RETURN TO PREVIOUS ADVANCE TO NEXT

2. Enter Parameters

1. Click on "Add Technology"

3. Implement technology replacement

Residential Net Emissions Analysis Tool version 1.11 Beta

File Capture Screen Help

Demand Demand Input Summary Power Supply Economics Computation Results

Housing Category:  Single-Family  Multi-Family  Mobile Home  Aggregate

Climate Zone:  6 Coastal  8 S. Near-Coastal  9 N. Near-Coastal  10 S. Inland  15 S. Desert  16 Mountain  All CZ MAP

Populate Baseline and Scenario Technology Mix Parameters

Populate List of New Technologies for Possible Implementation

Load Default Parameters Load Saved Parameters

Load Default Parameters Load Saved Parameters

Hot water heating Kitchen Laundry Miscellaneous Pool Space heating and cooling Transportation

BASELINE TECHNOLOGY MIX PARAMETERS										SCENARIO TECHNOLOGY MIX PARAMETERS									
Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Penetration		Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime		
A	Electric Water Heat	3169	0	0	361	1700	13	0.0500		Electric Water Heat	3169	0	0	361	1700	13			
B	Electric Solar Water Heat with Electric Backup	1877	0	0	1411	3869	13	0		Electric Solar Water Heat with Electric Backup	1877	0	0	1411	3869	13			
C	NatGas Conventional Water Heater	199.9600	0.0023	11.7600	647	1900	13	0.8770		NatGas High-Efficiency Condensing	155	0.0023	11.7600	1000	1900	13			
D	NatGas Solar Water Heat with Gas Backup	156.8200	0.0023	11.7600	4349	3869	13	0		NatGas Solar Water Heat with Gas Backup	156.8200	0.0023	11.7600	4349	3869	13			

NEW TECHNOLOGY PARAMETERS

CAUTION: Default appliance parameters may not be appropriate for most scenarios. For the most accurate results, South Coast AQMD recommends using actual values for the appliances that are being replaced or retrofitted. Note that units of UEC vary based on fuel.

#	Fuel	Technology	Hourly Profile	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Notes
18	NatGas	High-Efficiency Condensing	Water Heating	155	0.0023	11.7600	1000	1900	13	Values not specified
19	Electric	Heat Pump	Water Heating	1105	0	0	1500	1700	13	Values not specified
20	Electric	Standard Tank	Water Heating	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified
21	Electric	Point-of-Use Tankless System	Water Heating	2923	0	0	850	3400	13	Values not specified
22	NatGas	Heat Pump	Water Heating	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified
23	Undefined	New Technology	Undefined	-9999	-9999	-9999	-9999	-9999	-9999	Values not specified

Replace Technology Tool

(All households with the baseline technology will switch to the replacement tech.)

Select baseline technology to phase-out:

C NatGas Conventional Water Heater

Select new technology to replace baseline technology in "scenario":

18 NatGas High-Efficiency Condensing

Implement

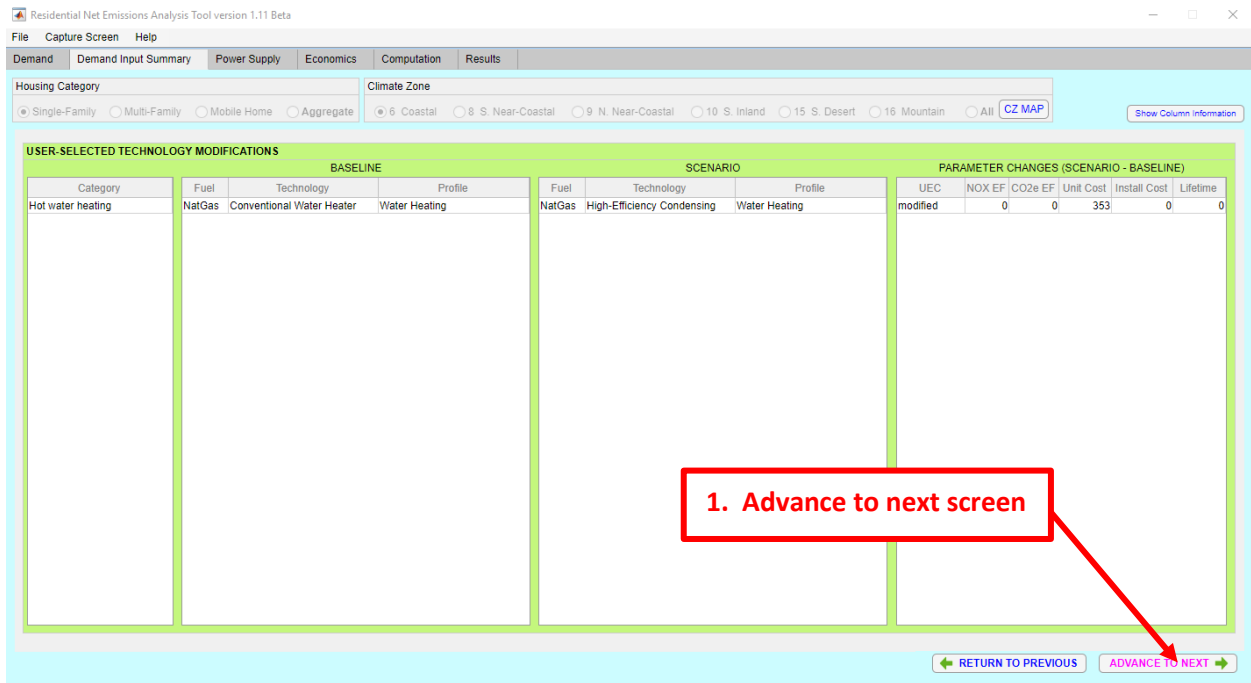
RETURN TO PREVIOUS ADVANCE TO NEXT

4. Select Housing Category and Climate Zone

5. Advance to next screen

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

The screenshot shows the 'Residential Net Emissions Analysis Tool version 1.11 Beta' interface. The 'Economics' tab is active. The 'GHG Emiss. from Increased Natural Gas Production' table is highlighted with a red box and an arrow pointing to the 'Supply Fraction' column. The table contains the following data:

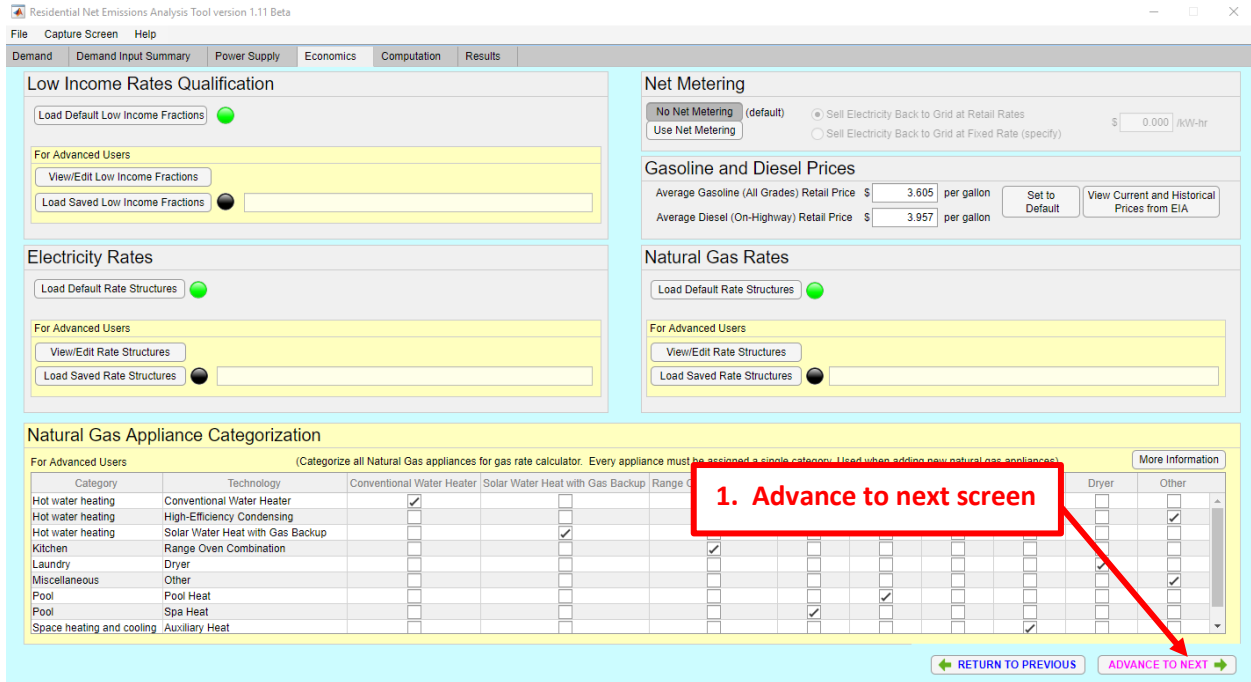
Type	Pathway	Supply Fraction	CO2e Emis. (lb/therm)
bio	landfill	0.0240	-0.8604
bio	wastewater	0.0030	-7.2321
bio	manure	0.0090	-73.1118
bio	food & green waste	0.0080	-17.0455
fossil	natural gas	0.9560	6.8368

At the bottom of the interface, there are two red boxes with arrows pointing to specific elements:

- 1. Change the Natural Gas mix to include Renewable NG** (points to the 'Supply Fraction' column in the GHG Emissions table)
- 2. Advance to next screen** (points to the 'ADVANCE TO NEXT' button)

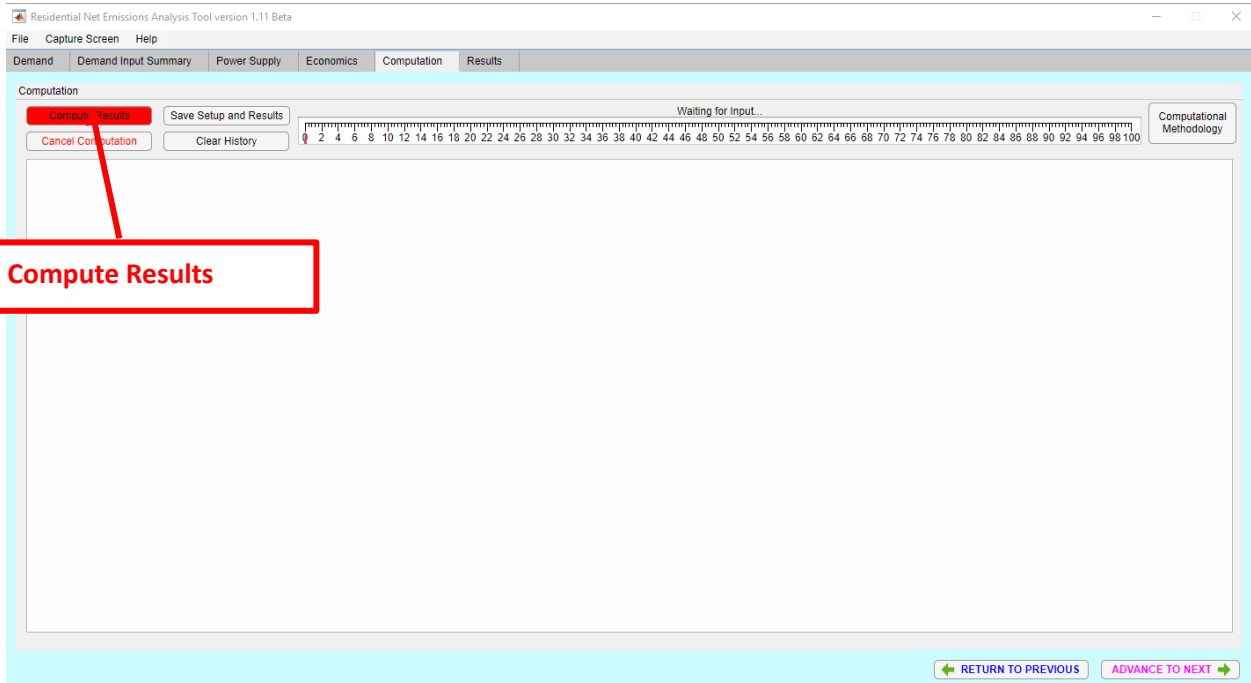
**Figure 3:** How to include renewable natural gas in the natural gas system

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.



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

### Computation of Scenario:



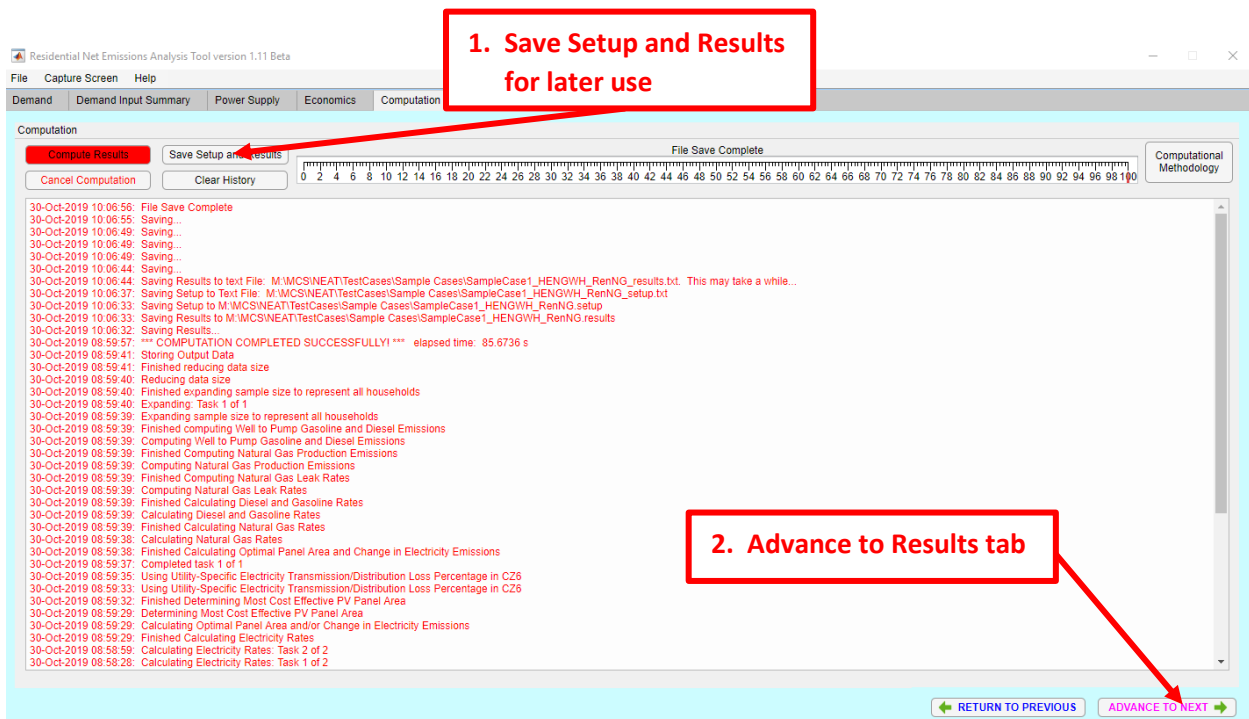
**Figure 5:** Compute results



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.



**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).

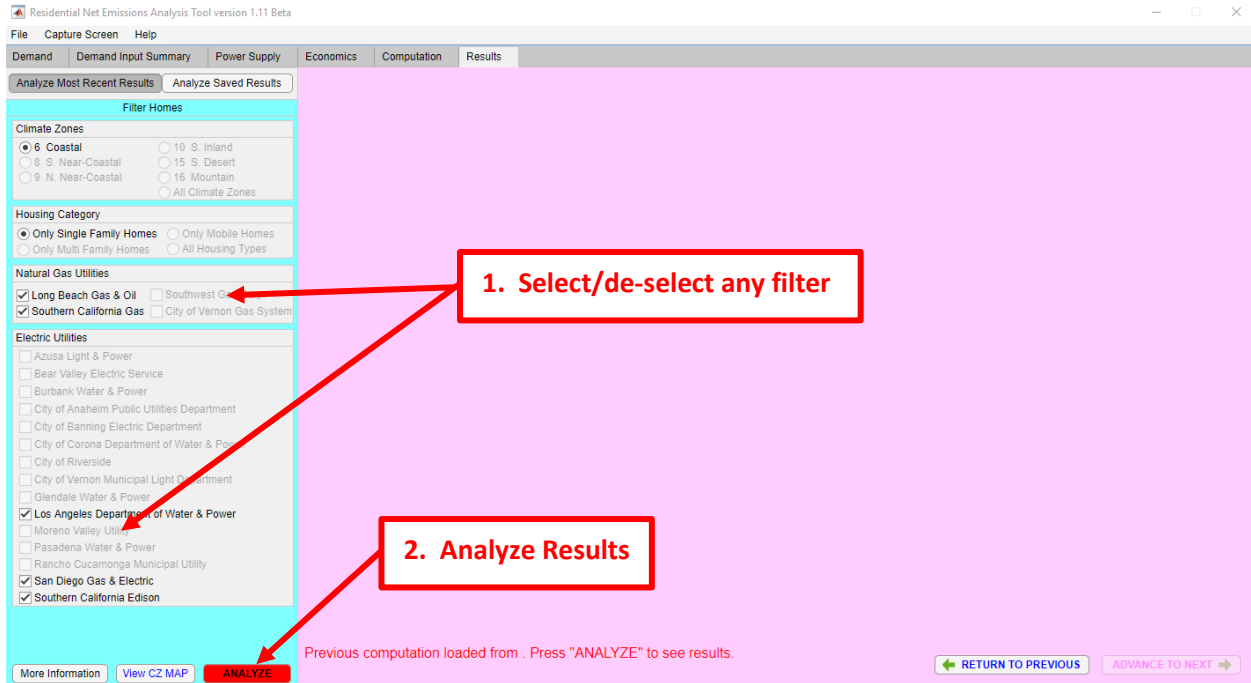


Figure 7: If desired, select a subset of climate zone, housing category, NG utility, and electric utilities, and analyze results

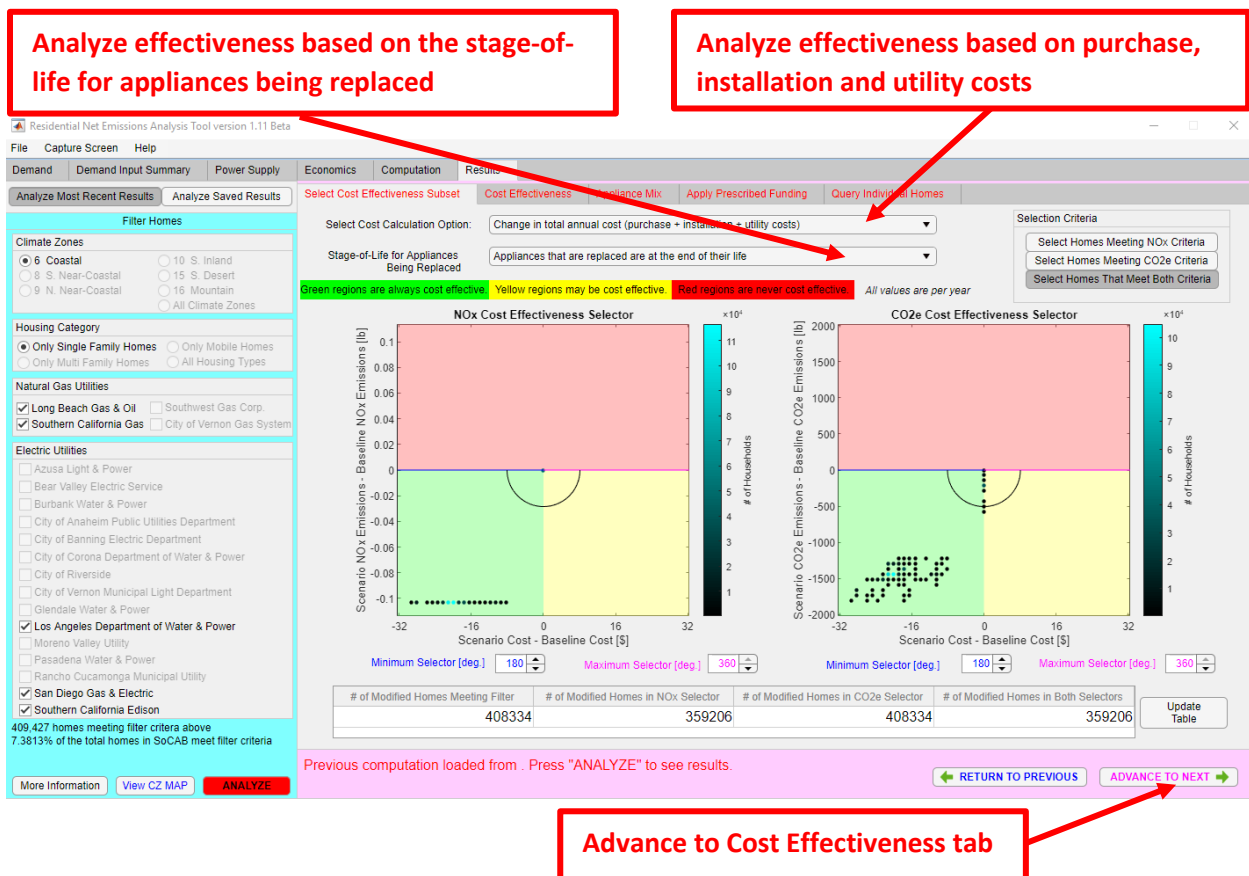
The user can select three different options to calculate cost effectiveness:

- 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:

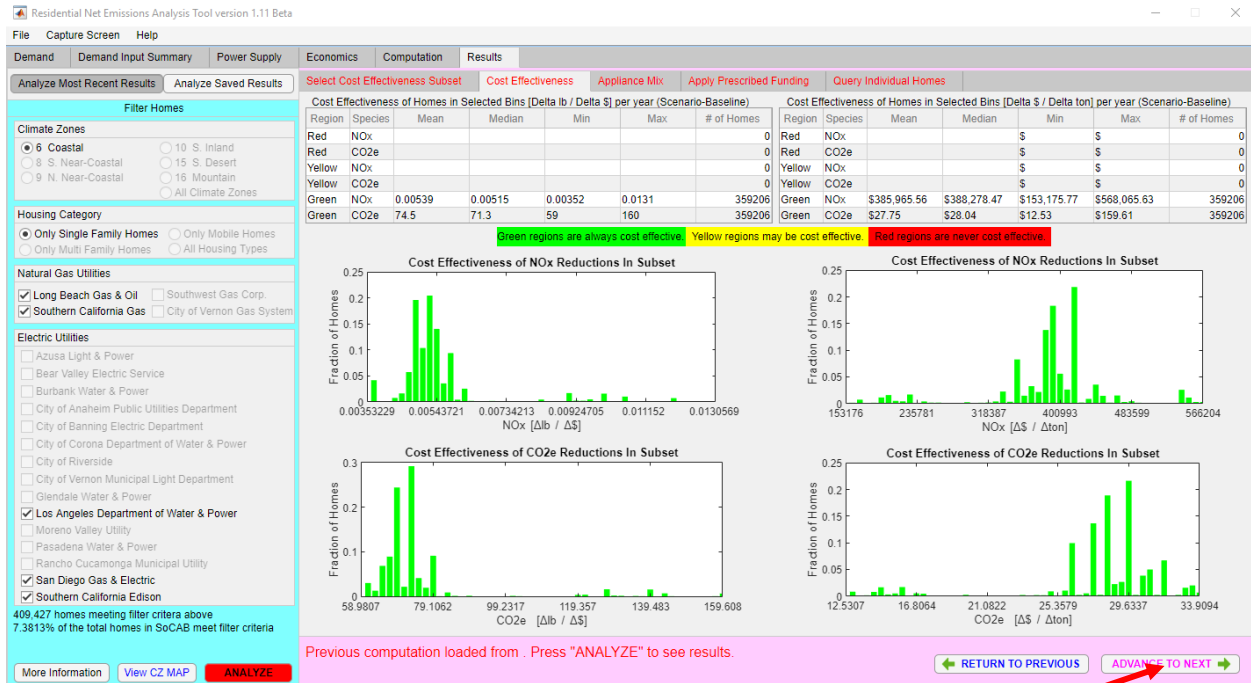
- 1) Appliances that are replaced are at the end of their life
- 2) Appliances that are replaced have 25% of their life remaining
- 3) Appliances that are replaced have 50% of their life remaining
- 4) Appliances that are replaced are brand new

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

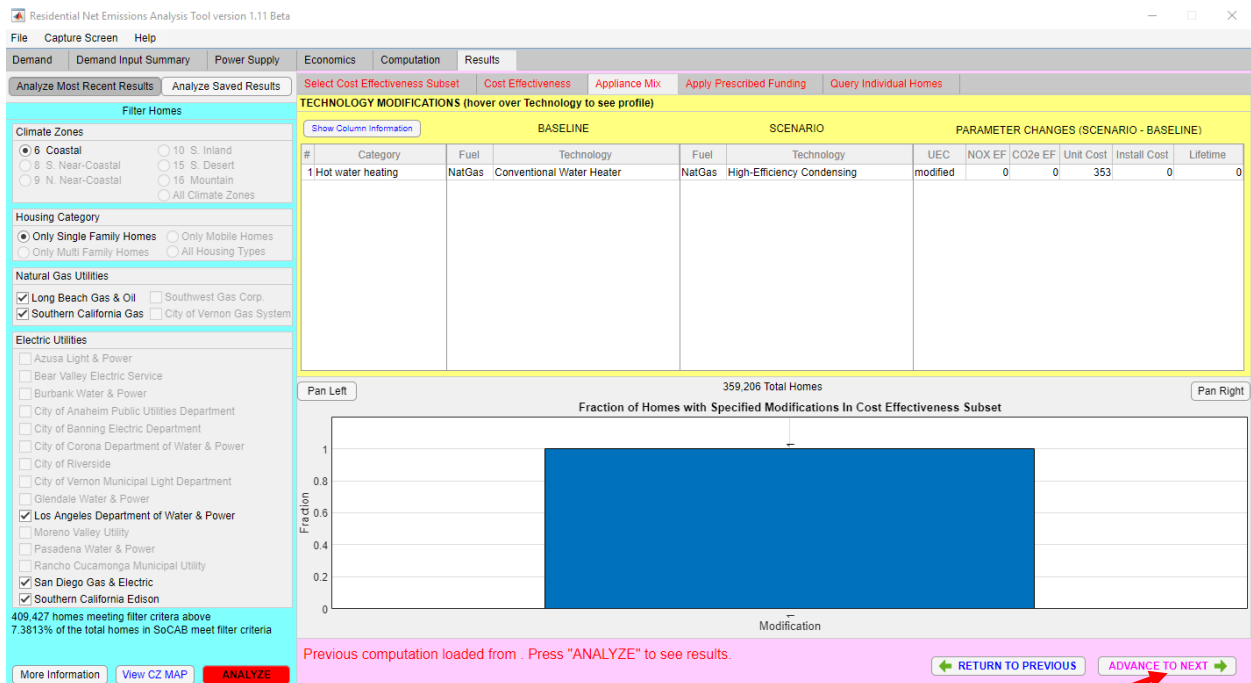
The user can explore the distribution of cost-effectiveness amongst all the homes retrofitted with the new water heater (**Figure 9**). Results show that when an old NG water heater is replaced by a new high-efficiency condensing water heater, emissions of NOX and CO2 are reduced. In addition, annual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



Advance to Appliance Mix tab

**Figure 9:** Cost-effectiveness distribution among homes

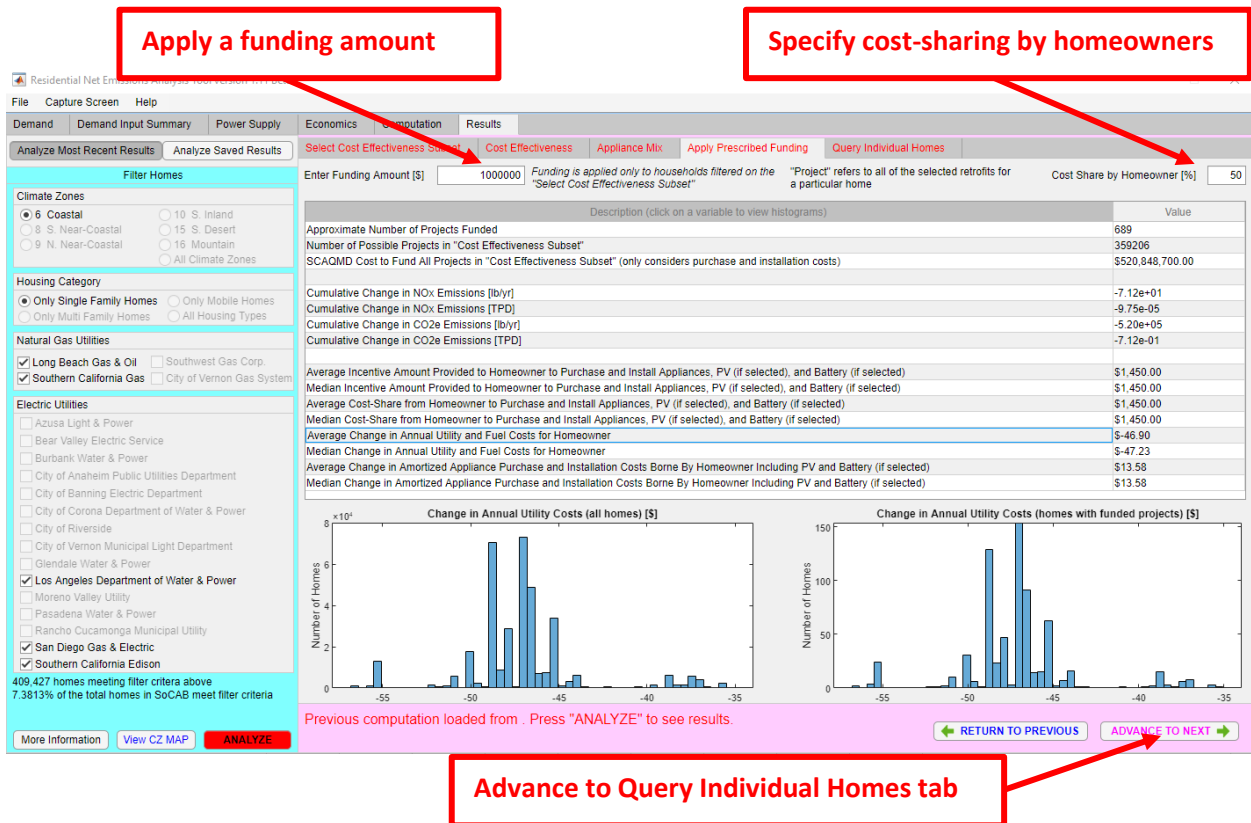
The user can also explore the appliance mix that is present in the selected subset. This screen is useful when a combination of appliances is retrofitted. However, this scenario only replaces one appliance, so the results show only one bar that represents the water heater retrofit (**Figure 10**).



Advance to Apply Prescribed Funding tab

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 CO<sub>2</sub>e. 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.



**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**).

**Check individual home details**

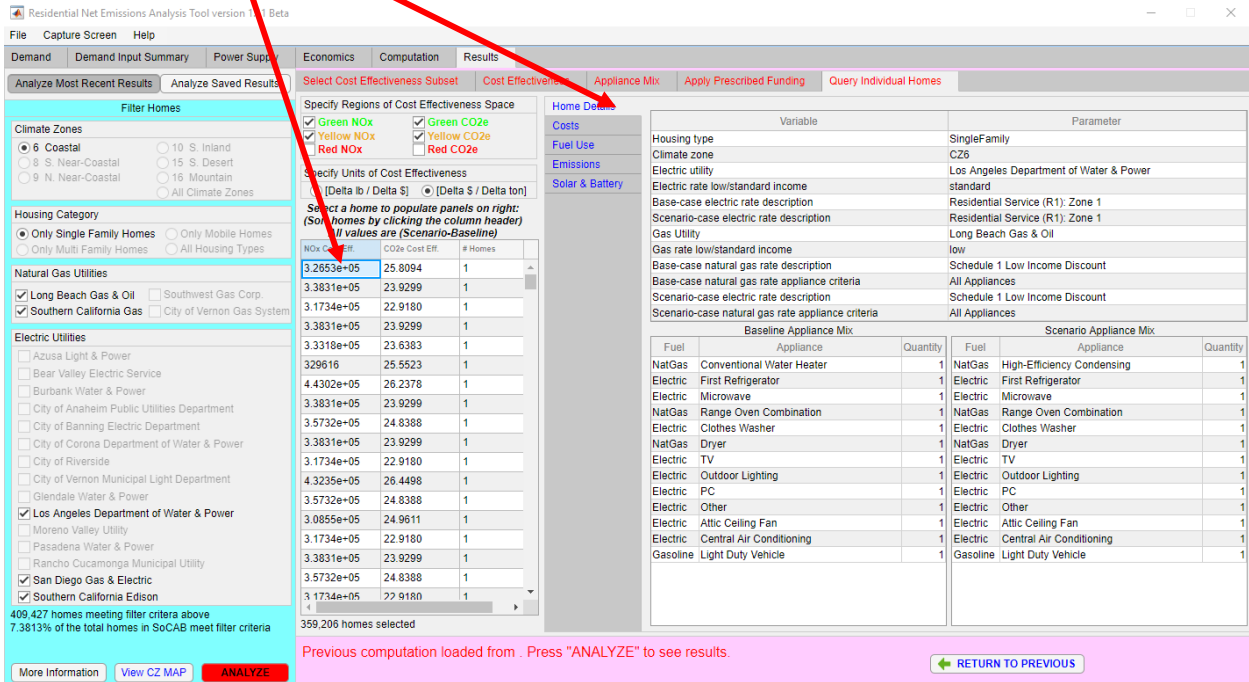


Figure 12: Analyze individual homes technology mixes, and how that affects cost effectiveness

**Check individual home fuel use**

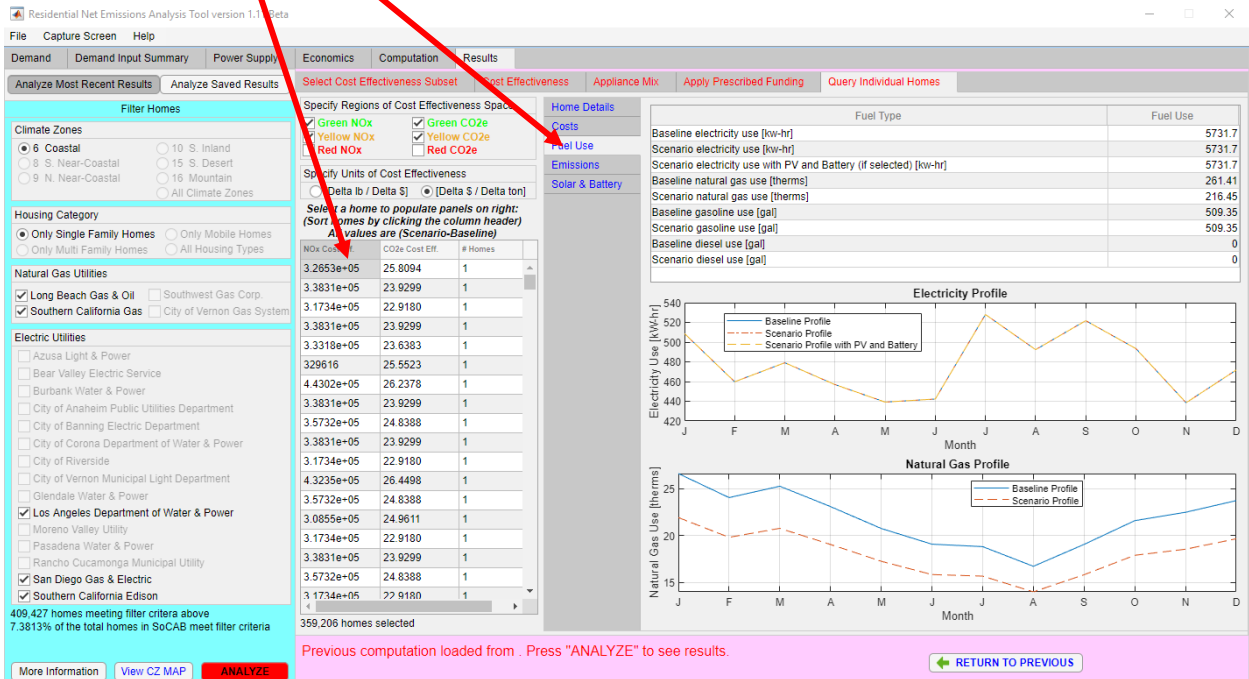


Figure 13: Analyze individual homes fuel use, and how that affects cost effectiveness

## 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:

Fuel: Electric  
Technology: Heat Pump  
Hourly Profile: Water Heating  
UEC: 1,105  
NOX EF: 0.00  
CO2e EF: 0.00  
Unit Cost: 1500  
Install Cost: 1700  
Lifetime: 13

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

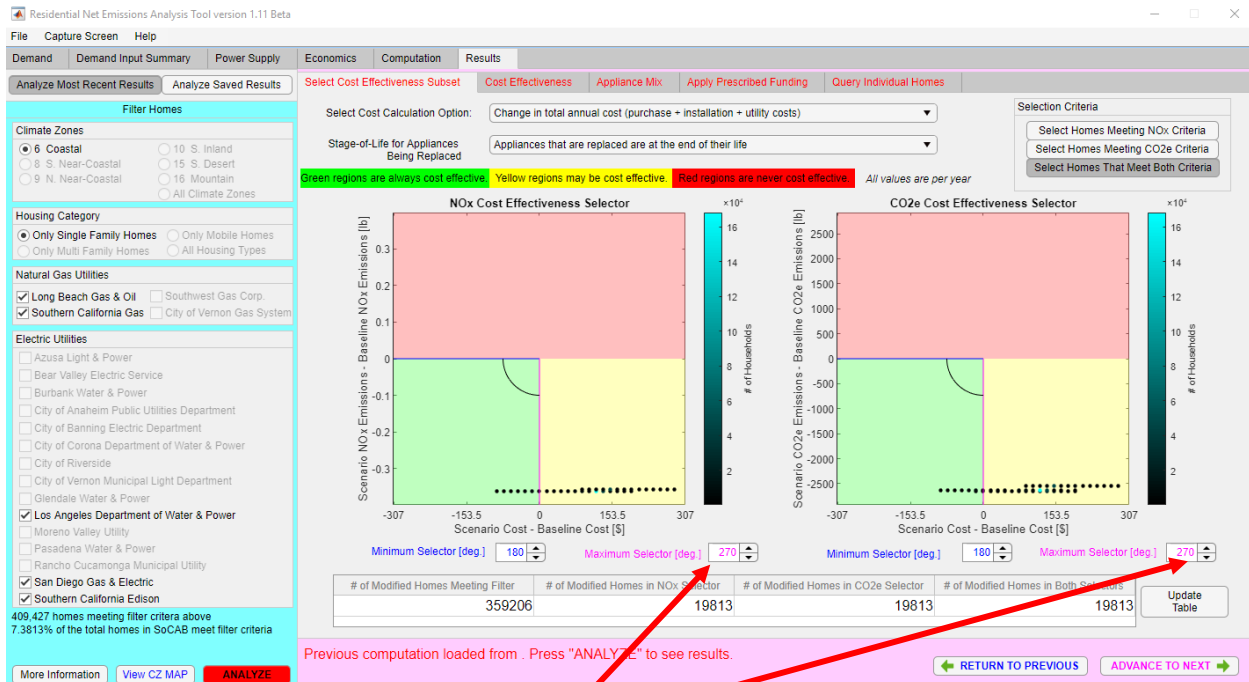
Then implement the technology replacement by using the “Replace Technology Tool” box. Select “single family” as housing type and climate zone 6 (see **Figure 1**).

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.



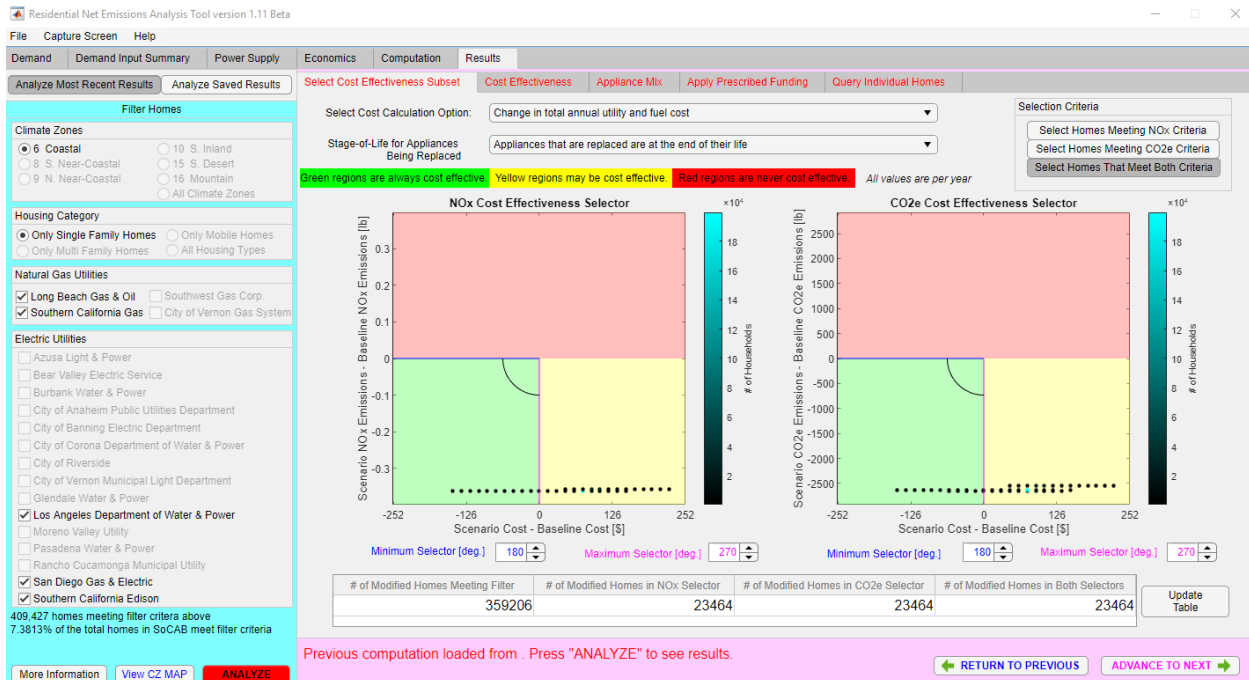
## Results:

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**).



Select the 'Green Region' with cost savings and emission reduction

**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 low-income 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**).

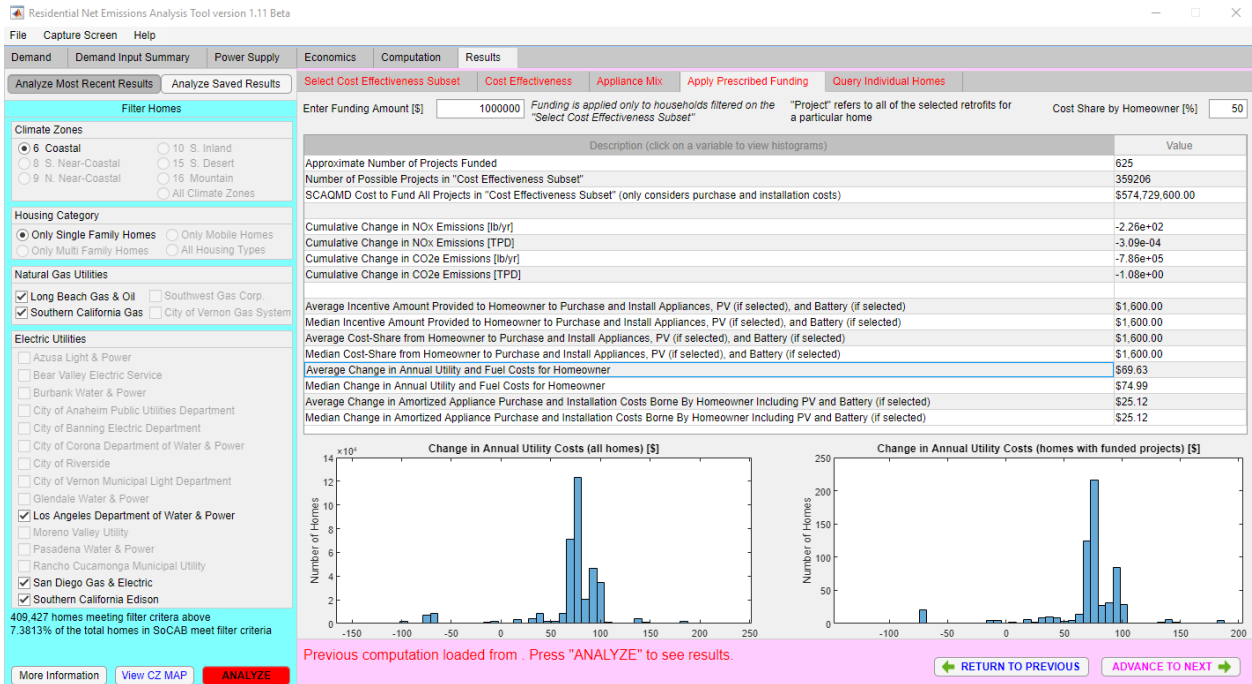


Figure 16: Analysis of prescribed funding and cost-sharing scenarios for Heat Pump Water Heater implementation

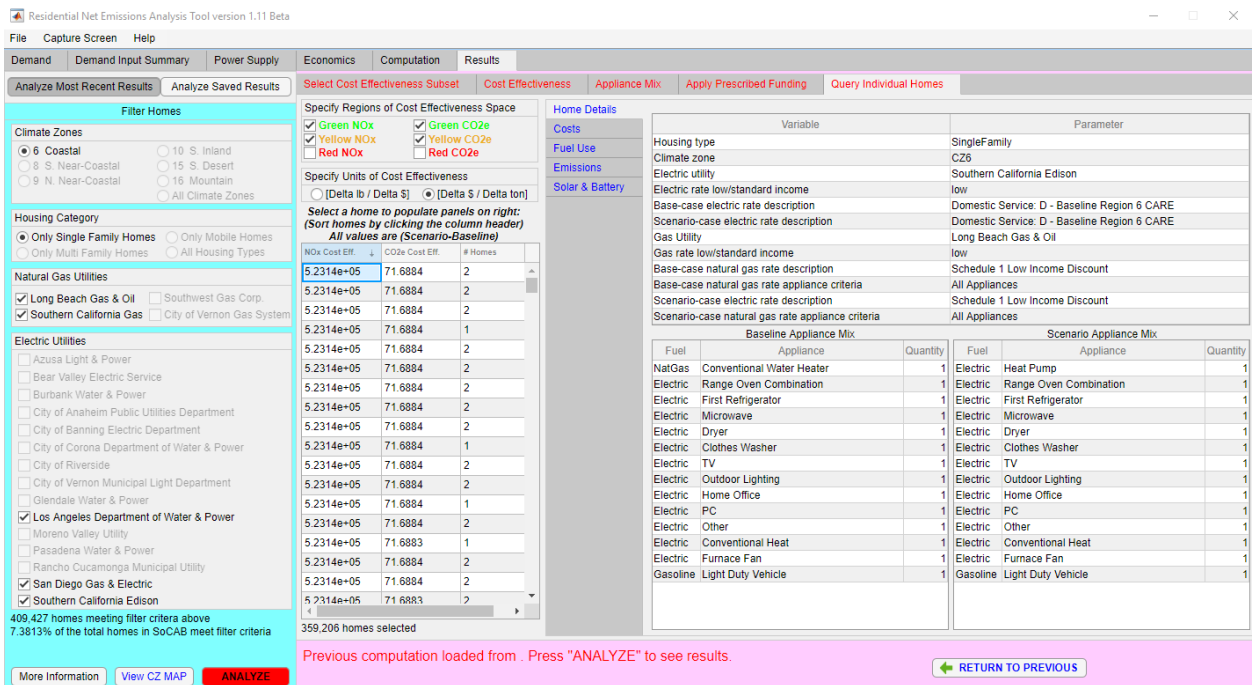


Figure 17: Analyze individual homes details, and how that affect cost effectiveness

### 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:

**Table 3:** Assumptions in the replacement of water heaters

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 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

**Residential Net Emissions Analysis Tool version 1.11 Beta**

File Capture Screen Help

Demand Demand Input Summary Power Supply Economics Computation Results

Housing Category: Single-Family Multi-Family Mobile Home Aggregate  
Climate Zone: 6 Coastal 8 S. Near-Coastal 9 N. Near-Coastal 10 S. Inland 15 S. Desert 16 Mountain All CZ MAP

Populate Baseline and Scenario Technology Mix Parameters  
Load Default Parameters Load Saved Parameters

Populate List of New Technologies for Possible Implementation  
Load Default Parameters Load Saved Parameters  
M:\MCS\NEAT\TestCases\GRID\_Alternative\_NEAT\_Scenarios\Updat

Hot water heating Kitchen Laundry Miscellaneous Pool Space heating and cooling Transportation

**BASELINE TECHNOLOGY MIX PARAMETERS**

Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Penetration
A Electric	Dryer	719	0	0	750	219	18	0.3300
B Electric	Clothes Washer	121	0	0	850	100	13	0.9600
C NatGas	Dryer	26.1100	0.0136	11.7600	800	100	18	0.5170

**SCENARIO TECHNOLOGY MIX PARAMETERS**

Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime
Electric	Dryer	719	0	0	750	219	18
Electric	Clothes Washer	121	0	0	850	100	13
Electric	Dryer	719	0	0	750	219	18

**NEW TECHNOLOGY PARAMETERS**

#	Fuel	Technology	Hourly Profile	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Notes
10	Electric	Dryer	Interior Appliance Equipment	514.7648	0	0	750	218.5900	18	General technology ca
11	Electric	Clothes Washer	Interior Appliance Equipment	17.7890	0	0	850	100.0000	13	General technology ca
12	NatGas	Dryer	Interior Appliance Equipment	24.5147	0.0136	11.7600	800	100.0000	18	General technology ca
13	Electric	Dryer	Interior Appliance Equipment	719.0000	0	0	750	218.5900	18	General technology ca
14	Electric	Clothes Washer	Interior Appliance Equipment	121.0000	0	0	850	100.0000	13	General technology ca
15	NatGas	Dryer	Interior Appliance Equipment	26.4124	0.0136	11.7600	800	100.0000	18	General technology ca

**Replace Technology Tool**

(All households with the baseline technology will switch to the replacement tech.)

Select baseline technology to phase-out:  
C NatGas Dryer

Select new technology to replace baseline technology in "scenario":  
1 Electric Dryer

Implement

RETURN TO PREVIOUS ADVANCE TO NEXT

**Click on the 'Laundry' and 'Space Heating and Cooling' tabs to implement the replacement**

**Residential Net Emissions Analysis Tool version 1.11 Beta**

File Capture Screen Help

Demand Demand Input Summary Power Supply Economics Computation Results

Housing Category: Single-Family Multi-Family Mobile Home Aggregate  
Climate Zone: 6 Coastal 8 S. Near-Coastal 9 N. Near-Coastal 10 S. Inland 15 S. Desert 16 Mountain All CZ MAP

Populate Baseline and Scenario Technology Mix Parameters  
Load Default Parameters Load Saved Parameters

Populate List of New Technologies for Possible Implementation  
Load Default Parameters Load Saved Parameters  
M:\MCS\NEAT\TestCases\GRID\_Alternative\_NEAT\_Scenarios\Updat

Hot water heating Kitchen Laundry Miscellaneous Pool Space heating and cooling Transportation

**BASELINE TECHNOLOGY MIX PARAMETERS**

Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Penetration
A Electric	Conventional Heat	498.8200	0	0	738	1694	20	0.0080
B Electric	Heat Pump	465.0800	0	0	1972	3233	12.5000	0.0070
C Electric	Auxiliary Heat	234.4300	0	0	0	0	0	0
D Electric	Furnace Fan	216	0	0	193	450	10	0.7300
E NatGas	Primary Heat	135.0600	0.0066	11.7600	3089	1696	20	0.8550
F NatGas	Auxiliary Heat	77.2700	0.0066	11.7600	0	0	0	0.0040
G Electric	Attic Ceiling Fan	96	0	0	90	471	20	0.1900
H Electric	Central Air Conditioning	578.6700	0	0	1537	1597	15	0.4660
I Electric	Room Air Conditioning	208.4300	0	0	300	276	15	0.1340
J Electric	Evaporative Cooler	650	0	0	439	959	20	0.0600

**SCENARIO TECHNOLOGY MIX PARAMETERS**

Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime
Electric	Conventional Heat	498.8200	0	0	738	1694	20
Electric	Heat Pump	465.0800	0	0	1972	3233	12.5000
Electric	Auxiliary Heat	234.4300	0	0	0	0	0
Electric	Furnace Fan	216	0	0	193	450	10
Electric	Heat Pump	465.0800	0	0	1972	3233	12.5000
NatGas	Auxiliary Heat	77.2700	0.0066	11.7600	0	0	0
Electric	Attic Ceiling Fan	96	0	0	90	471	20
Electric	Central Air Conditioning	578.6700	0	0	1537	1597	15
Electric	Room Air Conditioning	208.4300	0	0	300	276	15
Electric	Evaporative Cooler	650	0	0	439	959	20

**NEW TECHNOLOGY PARAMETERS**

#	Fuel	Technology	Hourly Profile	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Notes
10	Electric	Evaporative Cooler	Electric Cooling	650.0000	0	0	439	959.0100	20.00...	General technology ca
11	Electric	Conventional Heat	Space Heating	498.8176	0	0	738	1.6941e...	20.00...	General technology ca
12	Electric	Heat Pump	Space Heating	465.0778	0	0	1972	3233	12.50...	General technology ca
13	Electric	Auxiliary Heat	Space Heating	234.4280	0	0	0	0	0	General technology ca
14	Electric	Furnace Fan	Space Heating	216.0000	0	0	193	450	10.00...	General technology ca
15	NatGas	Primary Heat	Space Heating	135.0597	0.0066	11.7600	3089	1.6964e...	20	General technology ca

**Replace Technology Tool**

(All households with the baseline technology will switch to the replacement tech.)

Select baseline technology to phase-out:  
E NatGas Primary Heat

Select new technology to replace baseline technology in "scenario":  
12 Electric Heat Pump

Implement

RETURN TO PREVIOUS ADVANCE TO NEXT

**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).

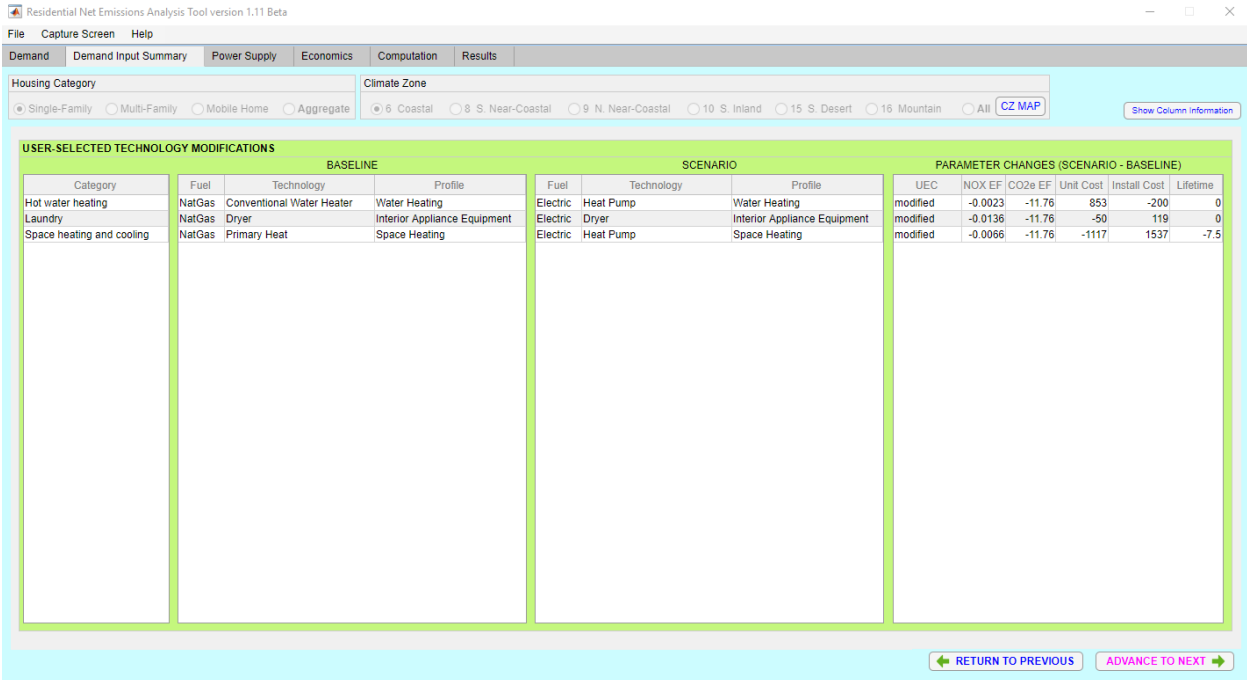


Figure 19: Demand Input Summary for Appliance Replacement Scenario

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.

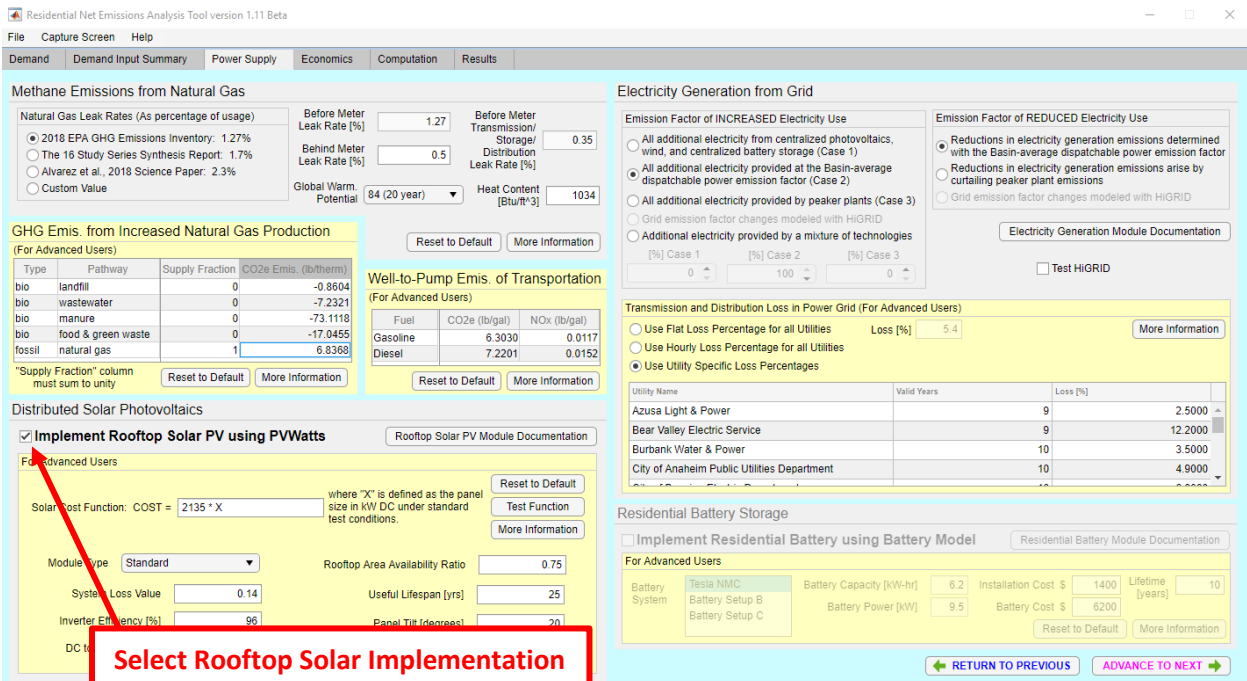
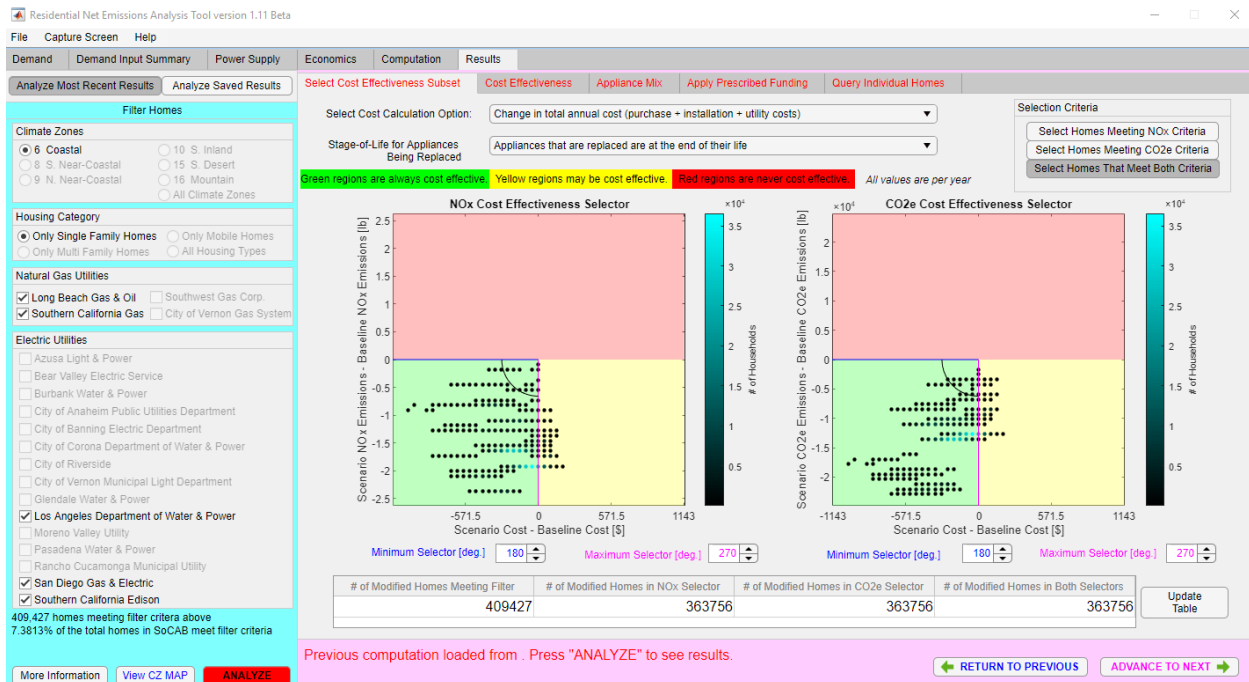


Figure 20: Power Supply Set-up: select 'Implement Rooftop Solar PV using PVWatts'

## 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**).

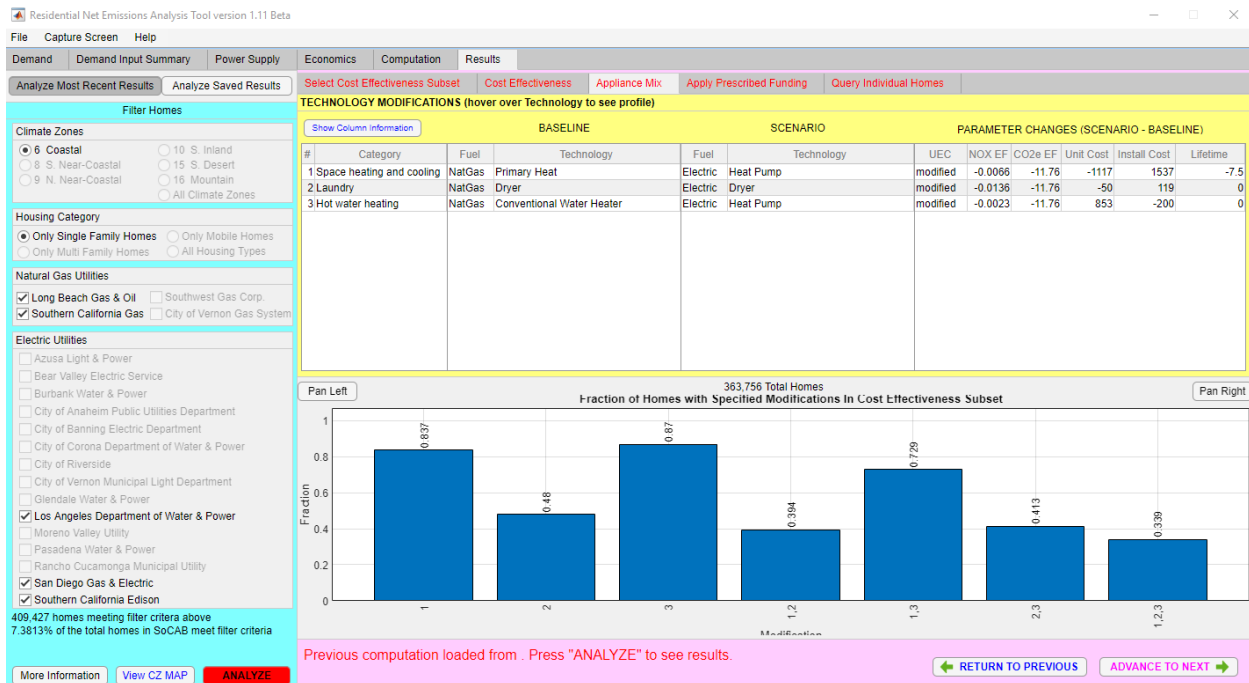


Figure 22: Appliance technology mix in the implementation scenario

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.



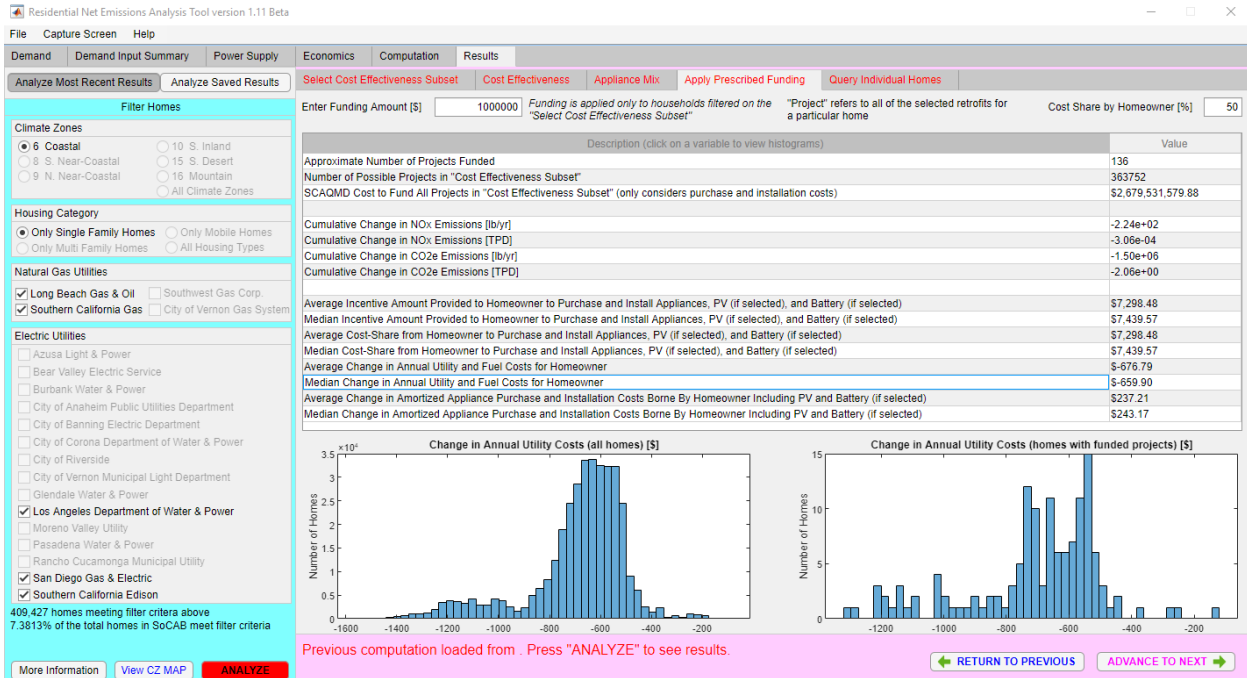


Figure 23: Analysis of prescribed funding and cost-sharing scenarios for electrification scenario with rooftop solar PV

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.

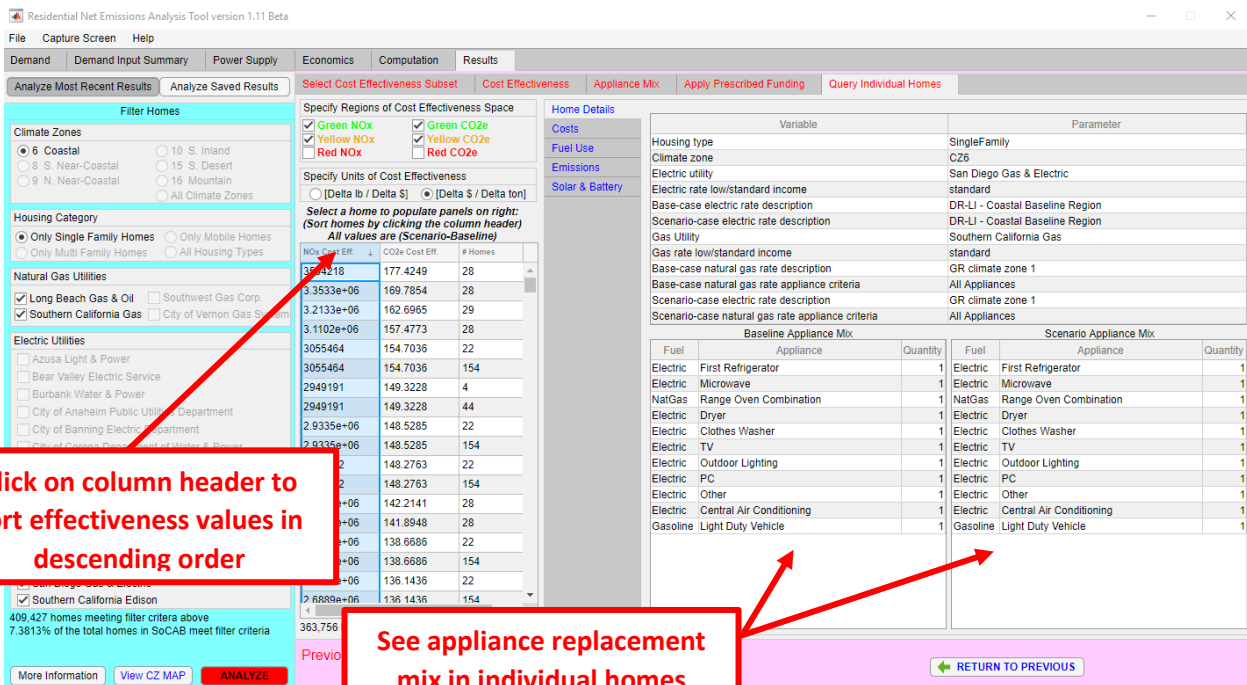
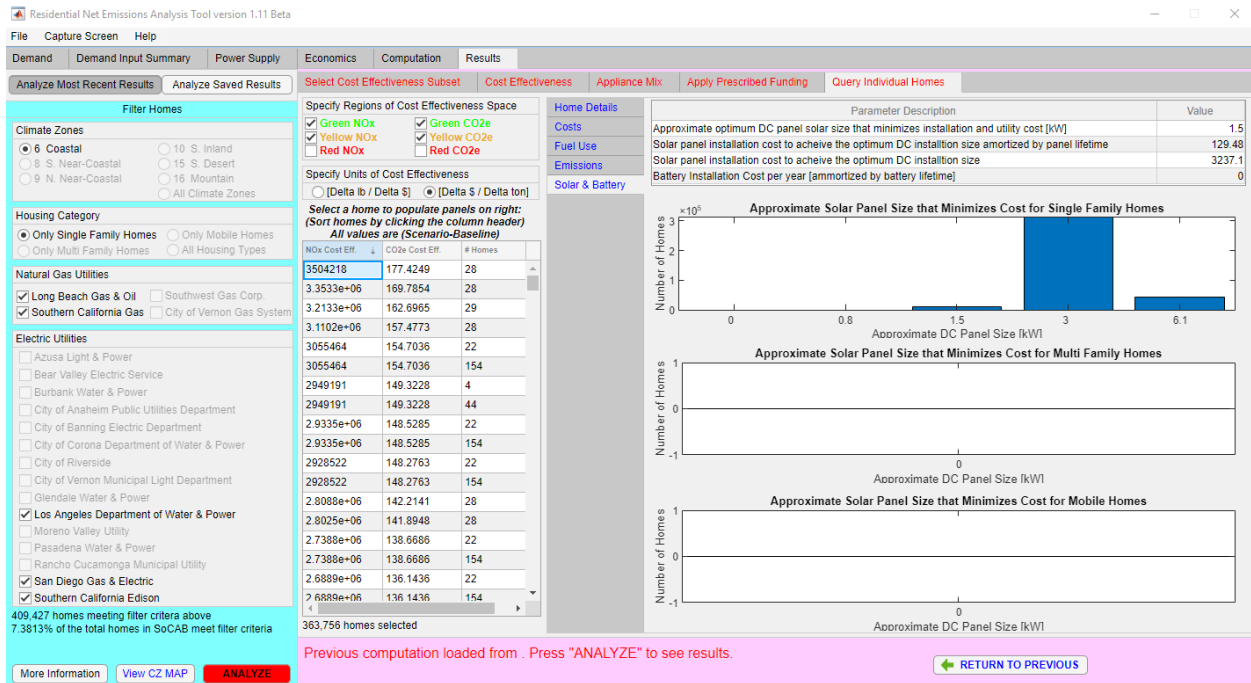


Figure 24: Analyze individual homes details, and how that affect cost effectiveness

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**).

**Residential Net Emissions Analysis Tool version 1.11 Beta**

File Capture Screen Help

Demand Demand Input Summary Power Supply Economics Computation Results

Analyze Most Recent Results Analyze Saved Results Select Cost Effectiveness Subset Cost Effectiveness Appliance Mix Apply Prescribed Funding Query Individual Homes

**Filter Homes**

**Climate Zones**

- 6 Coastal
- 8 S. Near-Coastal
- 9 N. Near-Coastal
- 10 S. Inland
- 15 S. Desert
- 16 Mountain
- All Climate Zones

**Housing Category**

- Only Single Family Homes
- Only Multi Family Homes
- Only Mobile Homes
- All Housing Types

**Natural Gas Utilities**

- Long Beach Gas & Oil
- Southern California Gas
- Southwest Gas Corp.
- City of Vernon Gas System

**Electric Utilities**

- Azusa Light & Power
- Bear Valley Electric Service
- Burbank Water & Power
- City of Anaheim Public Utilities Department
- City of Banning Electric Department
- City of Corona Department of Water & Power
- City of Riverside
- City of Vernon Municipal Light Department
- Glendale Water & Power
- Los Angeles Department of Water & Power
- Moreno Valley Utility
- Pasadena Water & Power
- Rancho Cucamonga Municipal Utility
- San Diego Gas & Electric
- Southern California Edison

**Specify Regions of Cost Effectiveness Space**

- Green NOx
- Yellow NOx
- Red NOx
- Green CO2e
- Yellow CO2e
- Red CO2e

**Specify Units of Cost Effectiveness**

- [Delta lb / Delta \$]
- [Delta \$ / Delta ton]

**Select a home to populate panels on right:**  
Sort homes by clicking the column header  
All values are (Scenario-Baseline)

NOx Cost Eff.	CO2e Cost Eff.	# Homes
3.1210e+05	32.5826	154
3.1198e+05	47.5864	3
3.1180e+05	37.9288	28
3.1180e+05	37.9288	28
3.1176e+05	37.4891	44
3.1172e+05	37.9194	28
3.1172e+05	37.9194	28
3.1167e+05	34.7426	29
3.1154e+05	32.5244	154
3.1152e+05	37.4407	43
3.1143e+05	48.5166	3
3.1130e+05	37.8689	29
3.1097e+05	37.7429	154
3.1088e+05	37.3641	44
3.1084e+05	37.7279	22
3.1079e+05	37.7212	154
3.1075e+05	48.2203	154
3.1070e+05	37.3416	1

409,427 homes meeting filter criteria above  
7.3813% of the total homes in SoCAB meet filter criteria  
363,756 homes selected

**Home Details**

**Costs**

Housing type: Single Family  
Climate zone: C26  
Electric utility: San Diego Gas & Electric  
Electric rate low/standard income: standard  
Base-case electric rate description: DR-LI - Coastal Baseline Region  
Scenario-case electric rate description: DR-LI - Coastal Baseline Region  
Gas utility: Southern California Gas  
Gas rate low/standard income: standard  
Base-case natural gas rate description: GR climate zone 1  
Base-case natural gas rate appliance criteria: All Appliances  
Scenario-case electric rate description: GR climate zone 1  
Scenario-case natural gas rate appliance criteria: All Appliances

**Baseline Appliance Mix**

Fuel	Appliance	Quantity
NatGas	Conventional Water Heater	1
Electric	First Refrigerator	1
Electric	Second Refrigerator	1
Electric	Microwave	1
NatGas	Range Oven Combination	1
NatGas	Dryer	1
Electric	TV	1
Electric	Outdoor Lighting	1
Electric	PC	1
Electric	Other	1
NatGas	Other	1
Electric	Pool Pump	1
Electric	Spa	1
NatGas	Spa Heat	1
Electric	Furnace Fan	1
NatGas	Primary Heat	1
Electric	Central Air Conditioning	1

**Scenario Appliance Mix**

Fuel	Appliance	Quantity
Electric	Heat Pump	1
Electric	First Refrigerator	1
Electric	Second Refrigerator	1
Electric	Microwave	1
NatGas	Range Oven Combination	1
Electric	Dryer	1
Electric	TV	1
Electric	Outdoor Lighting	1
Electric	PC	1
Electric	Other	1
NatGas	Other	1
Electric	Pool Pump	1
Electric	Spa	1
NatGas	Spa Heat	1
Electric	Furnace Fan	1
Electric	Heat Pump	1
Electric	Central Air Conditioning	1

Previous computation loaded from . Press "ANALYZE" to see results.

More Information View CZ MAP ANALYZE RETURN TO PREVIOUS

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

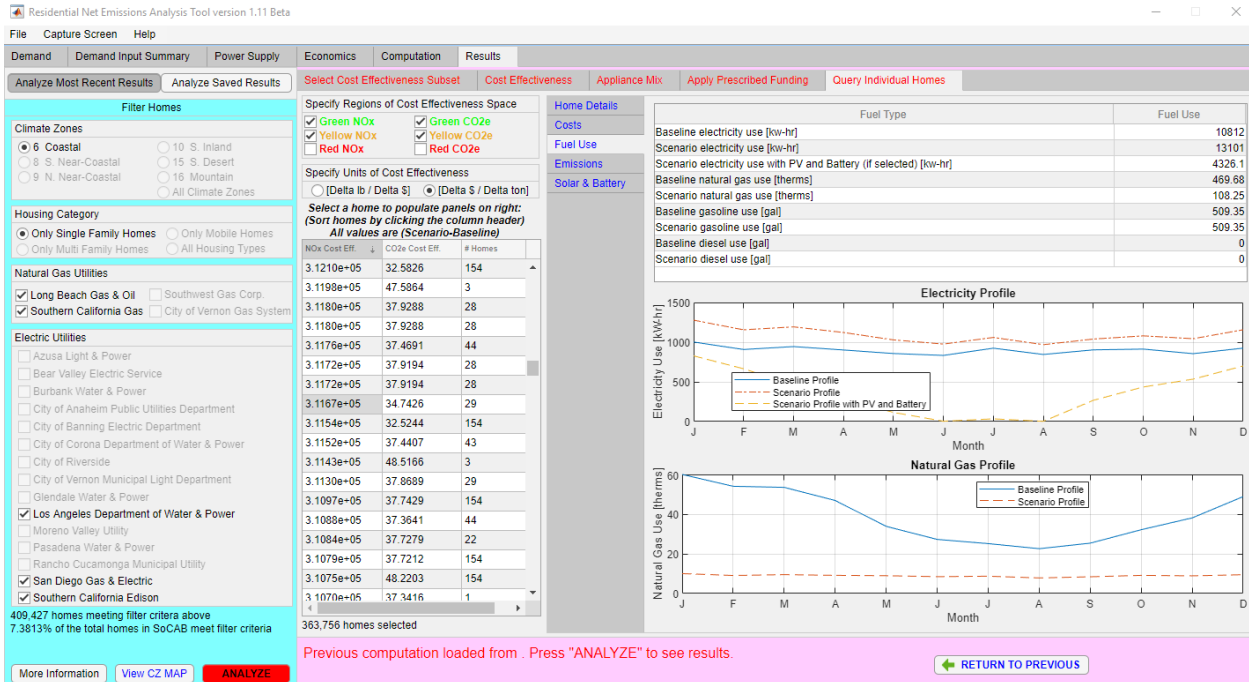


Figure 27: Example of home with the all three appliance retrofits, showing changes in fuel use

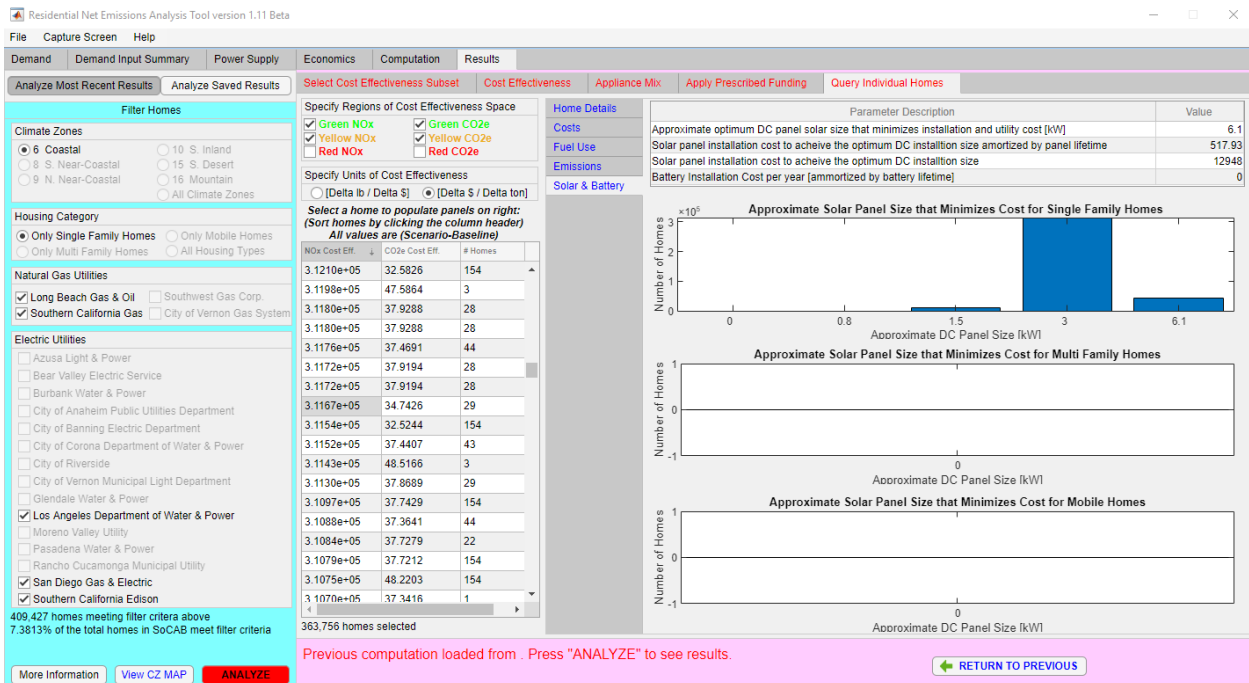


Figure 28: Example of home with the all three appliance retrofits, showing optimum PV panel size