Net Emissions Analysis Tool (NEAT) Working Group

Formally the Residential Commercial Appliance Life Cycle Analysis Working Group

> Meeting #3 Jan 31st, 2018



Summary of Submitted Comments and Edits Made to Residential NEAT Based on Recommendations

> Scott A. Epstein Ph.D. Planning and Rules Division



Development Progress

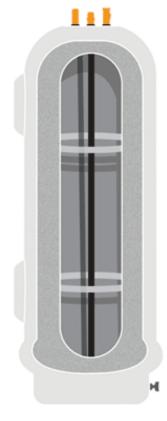
Residential NEAT	Not Yet Started	In Progress	Draft Complete	WG meeting #
Building of tool framework (GUI, file I/O)			Х	2
Collection of input data			Х	2
Demand segment of tool			Х	2 and 3
Implementation of distributed solar			Х	2
Implementation of distributed battery storage			Х	Future
Electric Rate Calculator			Х	3
Natural Gas Rate Calculator			Х	Future
Implementation of net metering			Х	3
Solar and battery cost calculator			Х	Future
Electric generation emission factors		Х		3
Gas leak and electricity transportation loss		Х		Future
Results analysis tools		Х		Future



Summary of Submitted Comments

Include thermal storage capabilities for electric water heaters

- We plan on including an additional load profile to simulate thermal storage electric water heaters
- Looking for suggestions on a reliable data source



energywisemn.com



Tie calculator more closely to other calculators used for retrofit rebates in California

- NEAT is a macro-scale tool that is designed to model the behavior of the entire housing inventory in the SoCAB
- Staff evaluated the applicability of other tools such as CBECC-Res and SAM
- NEAT uses tools from NREL's SAM to model distributed solar energy and residential battery storage
- Staff is unaware of other macro-scale tools that can inform our analysis



Specify the energy efficiency rating of each appliance

- Different appliance categories use different efficiency metrics but UEC (annual energy use) is widely available and is commonly published for most appliances
- UEC for clothes washers, refrigerators, dishwasher, dryer, A/C and air source heat pumps, furnaces, etc. are all available on energystar.gov
- Converting between various efficiency metrics and UEC can be complicated and is beyond the scope of work
- UEC simplifies calculation of emissions
- We plan to continue using UEC as the main efficiency measure within NEAT



Methodology recommendations for considering methane leakage

- Consider fugitive methane along all stages of the lifecycle of natural gas: exploration, production, processing, storage, transmission, distribution, end use
- Time horizon for GWP calculations
- Several citations for methane leak quantification provided
- Currently working on this module. Plan to present at next working group meeting.
- References on in-home leak rates needed



Update list of appliances for scenario implementation to include the most efficient appliances available

- Determining the optimal appliance for inclusion is non-trivial. Combination of efficiency, installation cost, and use profile must be considered
- Best appliance models change frequently
- We plan to include a comprehensive list of technologies that go beyond 2009 RASS study, but it will be up to the user to input cost and efficiency parameters
 - Significant changes implemented in tool to address this concern (details in subsequent slides)



Edits in "Demand" Module

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Additional Alternative Technologies Identified by the Workgroup

HOT WATER HEATING

Fuel	Technology
NatGas	Solar Water Heat with Gas Backup
NatGas	Standard Tank
NatGas	Whole House Tankless System
NatGas	High-Efficiency Condensing
Electric	Heat Pump
Electric	Standard Tank
	Solar Water Heat with Electric
Electric	Backup
Electric	Whole House Tankless System
Electric	Point-of-Use Tankless System

	KITCHEN
Fuel	Technology
Electric	Range Oven Combination
Electric	Dishwasher
Electric	First Refrigerator
Electric	Second Refrigerator
Electric	Freezer
Electric	Microwave
NatGas	Range Oven Combination

	LAUNDRY	
Fuel	Technology	
Electric	Dryer	
Electric	Clothes Washer	
NatGas	Dryer	



Additional Alternative Technologies Identified by the Workgroup

I	MISCELLANEOUS
Fuel	Technology
Electric	TV
Electric	Outdoor Lighting
Electric	Home Office
Electric	PC
Electric	Well Pump
Electric	Other
NatGas	Other

POOL
Technology
Spa Heat
Pool Pump
Spa
Spa Heat
Pool Heat

SP	ACE HEATING AND COOLING
Fuel	Technology
NatGas	Central Forced Air Furnace
NatGas	Floor or Wall Furnace
NatGas	Hot Water Gas Radiator
NatGas	Gas Fireplace
Electric	Resistance Heater
Electric	Central Foreced Air Furnace
Electric	Central Heat Pump
Electric	Through-The-Wall Heat Pump
Electric	Portable Heater
Electric	Furnace Fan
Electric	Attic Ceiling Fan
Electric	Central Air Conditioning
Electric	Room Air Conditioning
Electric	Evaporative Cooler



Edits in "Demand" Module

Old Approach

- Calculate the change in emissions and costs for the average household in each climate zone and classification
- Rates are non-linear so errors are introduced by taking average

New Approach

- Simulate a set of 1500* households for each climate zone and classification
- Simulated set matches user-defined penetration
- Perform entire calculation for every household



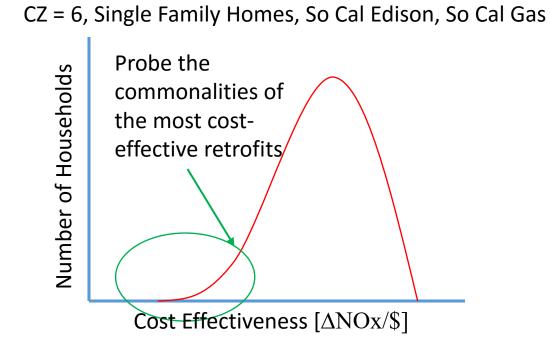
* 1500 households provides enough homes for accurate simulations without being too computationally expensive

- 1. User defines current mix of technology, penetration, Units of Energy Consumption, install cost, and lifetime
- 2. User defines scenario technologies for retrofit (ie all households with tech A replace with tech B), UEC, install cost, lifetime, presence of solar
- 3. Tool randomly generates 1500 homes with appliances that match user-defined penetration to serve as baseline
- 4. In "scenario", tool implements user-defined replacements



Edits in "Demand" Module

• New approach will lead to a histogram of cost-effectiveness





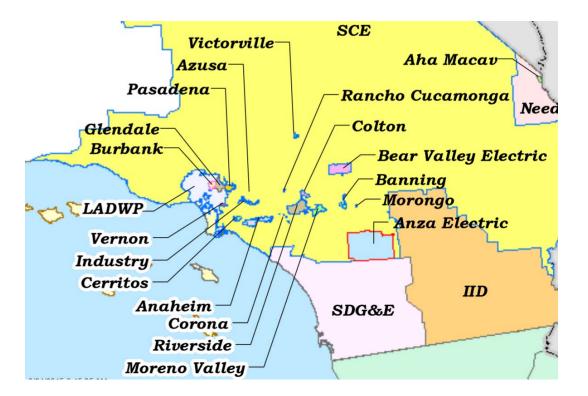
Calculation of Electric Rates and the Embedded Electric Rate Structure Editor Tool

Scott A. Epstein Ph.D. Planning and Rules Division



Electric Rate Structures

- Many electric utilities within the Basin
- Many different rate structures for each utility
- Analyzed census data and utility jurisdiction data to determine number of households in each utility, climate zone, category



Electric Rate Structure

Number of Households in CZ 9	CZ = 9	CZ = 9	CZ = 9	All CZ
	SingleFamily	MultiFamily	MobileHome	TOTAL
Azusa Light & Power	1453.9	791.57	49.576	2295.1
Bear Valley Electric Service	0	0	0	16359
Burbank Water & Power	19282	24245	52.118	43580
City of Anaheim Public Utilities Department	0	0	0	1.03E+05
City of Banning Electric Department	0	0	0	2954
City of Corona Department of Water & Power	0	0	0	761.97
City of Riverside	0	0	0	77001
City of Vernon Municipal Light Department	2.4413	2.2593	0.028312	812.92
Glendale Water & Power	27502	48678	92.233	76272
Los Angeles Department of Water & Power _Zone1	56310	1.85E+05	579.69	5.22E+05
Los Angeles Department of Water & Power _Zone2	2.94E+05	4.28E+05	4893.8	8.60E+05
Moreno Valley Utility	0	0	0	16832
Pasadena Water & Power	25104	32425	179.32	57709
Rancho Cucamonga Municipal Utility	0	0	0	846
San Diego Gas & Electric	0	0	0	1.17E+05
Southern California Edison	5.63E+05	2.83E+05	20457	3.60E+06



- Separate tool linked from NEAT
- Allows users to graphically view and edit electric rates
- Tool populated with default values but everything is editable
 - Choose rate to use for single family, multi family, mobile homes
 - Choose rate to use for net metering
 - Choose rate to use for each climate zone (So Cal Edison)
- Utility rates from OpenEI Utility Rate Database



Ability to view/edit rates

AOM

from overy utility in SoCAP

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Electricity Rate Structure Selector and Editor

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Electricity Rate Structure Selector and Editor _ X Rate Selector Analysis Next Utility + Add Custom Rate Time-of-use Tiered Domestic: TOU-D-T - Region 6 Select Utility Southern California Edison • **Previous Utility** Store Revised Check Marks Weekday Rates Weekend Rates Select a Rate to view Period Codes and Rate Schedule Period Codes Rate Zone SingleFam MultiFam MobileHome NetMeter Domestic Service: D - Baseline Region 13 13 1111 1111 9 1 Domestic Service: D - Baseline Region 9 Domestic Service: D - Baseline Region 8 8 Domestic Service: D - Baseline Region 10 10 14 1 Domestic Service: D - Baseline Region 14 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 16 16 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 15 15 뮾 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 14 14 Mor Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 13 13 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 10 10 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 9 9 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 8 8 6 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 6 5 Time-Of-Use Domestic Tiered Electric Vehicle Charging -TOU-D-TEV, Region 5 Domestic Service: D - Baseline Region 6 6 1 1 1 1 // 5 Domestic Service: D - Baseline Region 5 Domestic Service: D - Baseline Region 15 15 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 1 16 Domestic Service: D - Baseline Region 16 Hour Time-of-use Tiered Domestic: TOU-D-T-Region 5 5 Edit Period Codes 6 Time-of-use Tiered Domestic: TOU-D-T - Region 6 Time-of-use Tiered Domestic: TOU-D-T - Region 8 8 Period 0 Period 1 Period 2 Period 3 Period 4 Period 5 Time-of-use Tiered Domestic: TOU-D-T - Region 9 9 Rate information shown for selected period. NaN indicates no rate or maximum at that tier. 10 Time-of-use Tiered Domestic: TOU-D-T-Region 10 Tier1 Tier2 Tier3 Tier4 Tier5 Time-of-use Tiered Domestic: TOU-D-T - Region 13 13 Maximum monthly Usage [kW-hr] 379.6 NaN NaN NaN NaN 14 Time-of-use Tiered Domestic: TOU-D-T - Region 14 Comprehensive input and output NaN NaN Time-of-use Tiered Domestic: TOU-D-T - Region 15 15 0 0 16 Time-of-use Tiered Domestic: TOU-D-T - Region 16 Time-of-use Tiered Domestic (NEM 2.0): TOU-D-A all tools southat revised rates can be ore Edited Rate Values Time-of-use Tiered Domestic (NEM 2.0): TOU-D-B all Rate Structure Selector and Editor tool initialized at 17-Jan-2018 08:48:23. Select a rate to view and edit. used in NEAT directly

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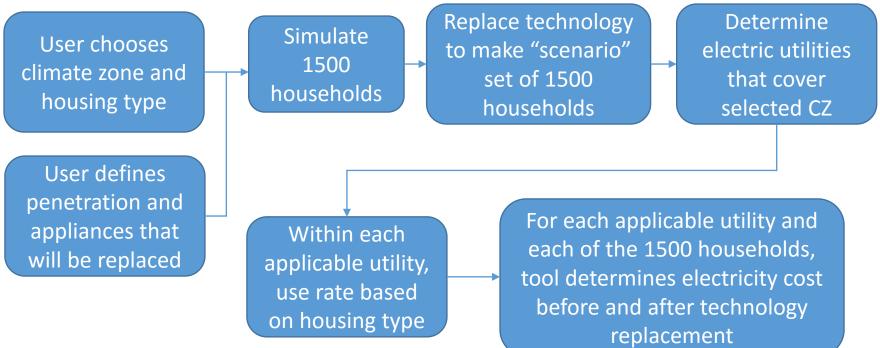
Analysis tool included to compare

electricity costs for average use profiles Electricity Rate Structure Selector and Editor X Rate Selector Analysis Southern California Edison Select Rate A Domestic Service: D - Baseline Region 9 ▼ View/Edit Rate A Climate Zone Map Select Utility • Select Rate B Time-of-use Tiered Domestic: TOU-D-T - Region 9 View/Edit Rate B CALCULATE Select Average Profile Climate Zone 9 (N. Near-Coastal) • Electric Vehicle Zoom Year Zoom Month Hourly Electricity Usage (Weekends are Highlighted) [kW-hr] Jan 01 Jan 15 Jan 29 Feb 12 Feb 26 Mar 12 Mar 26 Apr 09 Apr 23 May 07 May 21 Jun 04 Jun 18 Jul 02 Jul 16 Jul 30 Aug 13 Aug 27 Sep 10 Sep 24 Oct 08 Oct 22 Nov 05 Nov 19 Dec 03 Dec 17 Dec 31 2017 Annual Weekday Electricity Usage [kW-hr] Annual Weekend Electricity Usage [kW-hr] **Difference in Electricity Price** 22 10p 50 10p 8p 8p 20 45 6p 6p 18 Rate B [\$] 40 4r16 2p 2p 35 14 12p Hour 12p 30 10a 10a 12 \triangleleft -20 25 8a 8a Rat 6a 6a 20 -30 4a 4a 15 2a 2a 10 12a 12a -41 F M A M A SOND JFMAM J A SOND 1 F M A Μ J J A S O N D -1 -1 Month Month Month Feb Mar May Jun Jul Oct Nov Dec TOTAL Difference in -29.02 -33.36 -38.23 -37.95 3.37 2.69 Electricity Price [\$] 5.08 2.06 4.72 3.21 3.04 2.09 -112.30



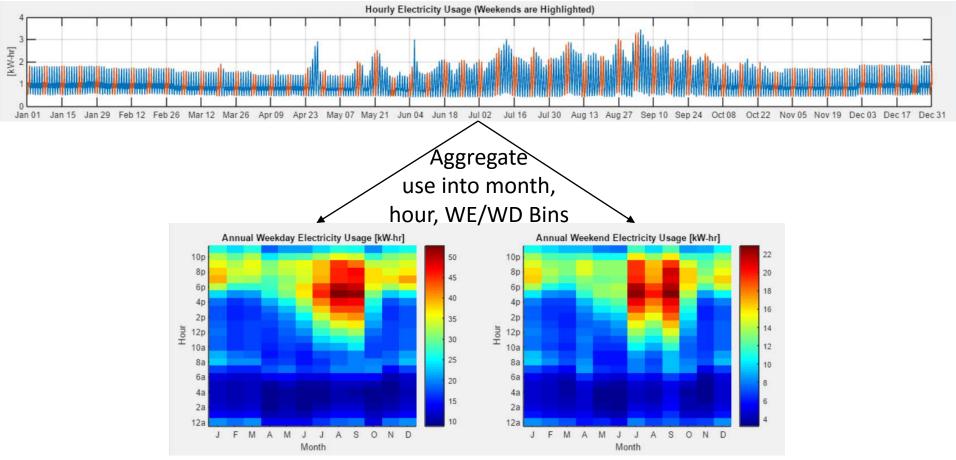
(Rate A - Rate B)

• For each of the 1500 simulated homes, electricity costs must be calculated before and after retrofit





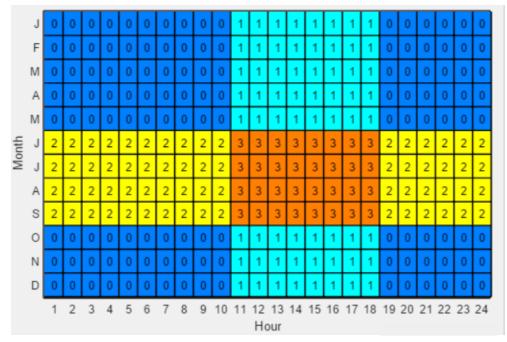
For Each Household:





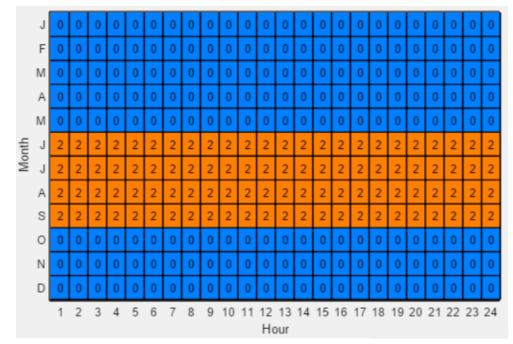
For each utility in the selected Climate Zone and each utility rate in the selected Housing Category:

Apply Period Codes to each month, hour, WE/WD



Weekday Period Codes

Weekend Period Codes





For utilities without flat rates, each period code has a set of tiers with a Maximum monthly usage and a corresponding rate:

Tier 1	Tier 2	High Usage
Up to	101-400%	>400% over
Baseline	over Baseline	Baseline
Allocation	Allocation	Allocation
17¢/	25¢ / kWh	35¢ /
KVVII	KVVII	KVVII
Energy Us	sage	www.sce.com



- Monthly usage is allocated between the tiers and multiplied by the rate of each tier to generate a monthly electricity charge
- Power access charges are added for selected utilities (LADWP)



• Only variable charges are calculated. Difference calculations make fixed charges irrelevant.



Treatment of Net Metering



- Residential solar panels may generate excess electricity
- Two options available if net metering is selected
 - Sell electricity back to the grid at retail
 - Uses the same rates for purchasing electricity unless specified otherwise in Electric Rate Structure Editor Tool
 - Sell electricity to grid at a fixed rate determined by the user

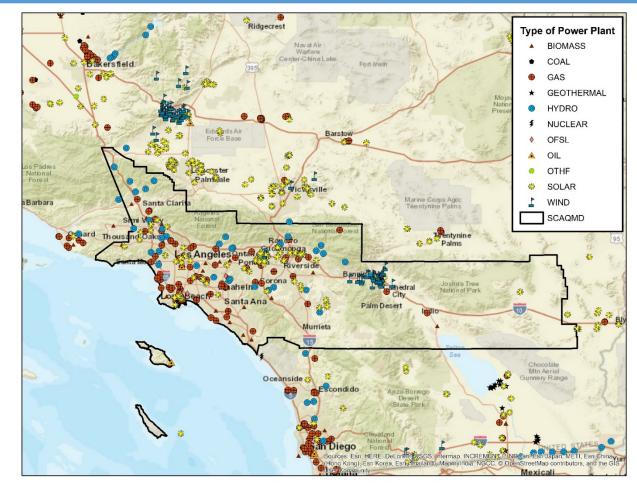


Electricity Generation Emissions

Marc Carreras-Sospedra Ph.D. Planning and Rules Division



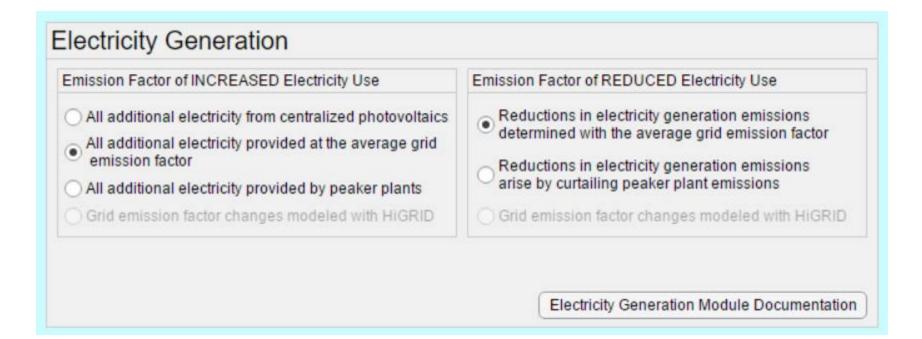
Electricity Generation in SoCal



Plant data from eGRID database for 2012 with size > 1MW: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid



Electricity Generation Emission Factor Options





Emissions from Photovoltaics

- Zero emissions from additional electricity generation
- Best case scenario for an increase in electricity demand

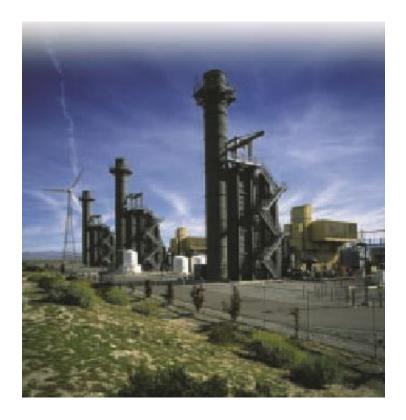




Source: zkenergy.com

Emissions from Peaker Plants

- Changes in electricity met by peaker plants
 - Emissions at 0.08-0.24 lbs/MWh NO_X (from permit data)
- Worst case scenario for an increase in electricity demand
- Best case scenario for a decrease in electricity demand





Emissions from Average Grid

- We assume changes in electricity will be met by the marginal grid
- For California, we assume marginal electricity is generated from dispatchable units, which are NG units
- Hourly load and emissions are obtained from the Continuous Emissions Monitoring system (Air Markets Program Data, https://ampd.epa.gov/ampd/)



Power Plant Data Availability

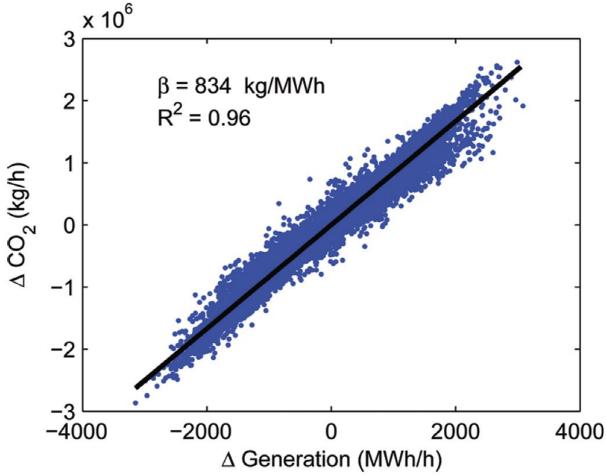
- Data availability for hourly emissions and throughput data:
 - Hourly data available from 2005 to 2017
 - 30 facilities in the basin for NOX emissions
 - 111 in the entire state for CO₂ emissions





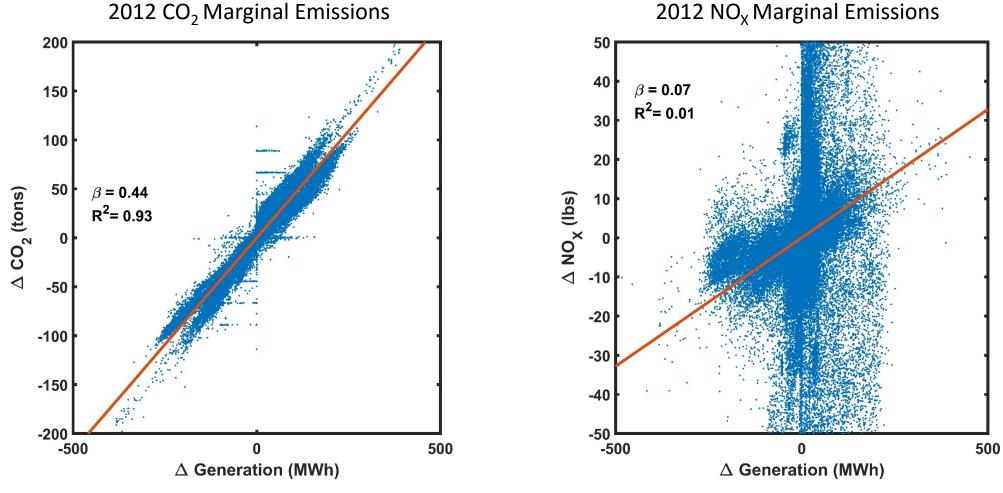
Methodology for Marginal Emissions

Methodology based on peer-reviewed work (Siler-Evans et al., 2012)





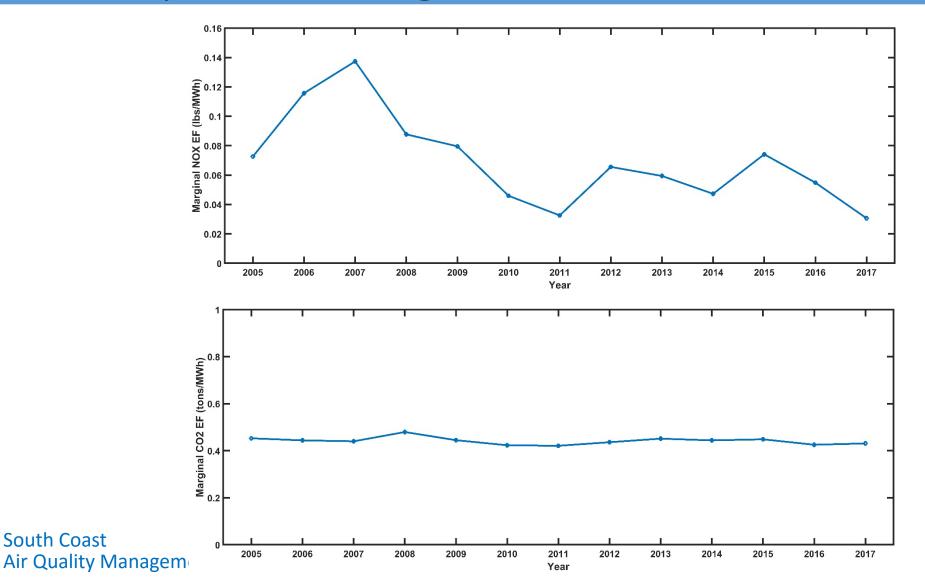
Sample Analysis for 2012 in SoCal



2012 NO_x Marginal Emissions

South Coast Air Quality Management District AQMD

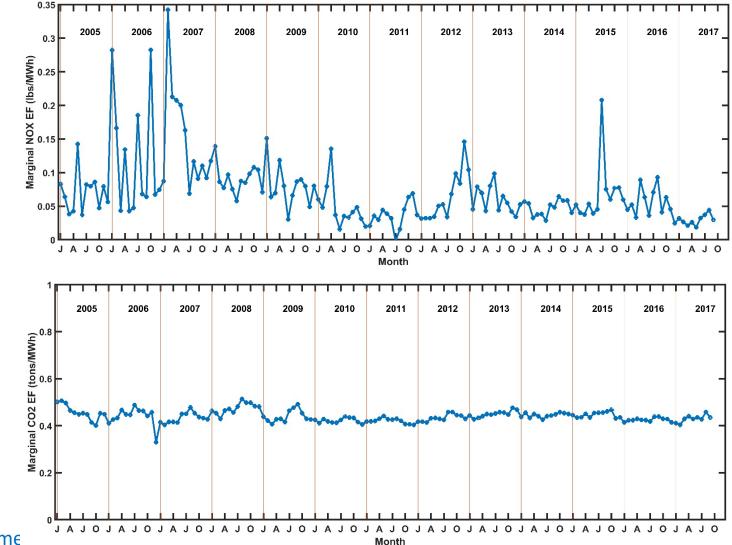
Year-by-Year Marginal Emission Factors



AQMD

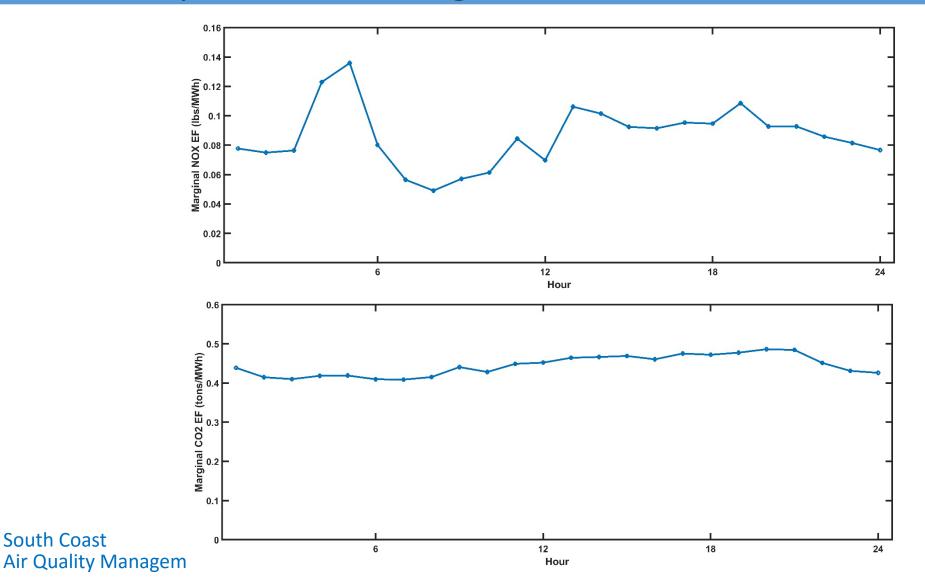


Month-by-Month Marginal Emission Factors





Hour-by-Hour Marginal Emission Factors



AQMD

43

Public Comment



blog.cleanenergy.org



Next Steps

Residential NEAT	Not Yet Started	In Progress	Draft Complete	WG meeting #
Building of tool framework (GUI, file I/O)			Х	2
Collection of input data			Х	2
Demand segment of tool			Х	2 and 3
Implementation of distributed solar			Х	2
Implementation of distributed battery storage			Х	Future
Electric Rate Calculator			Х	3
Natural Gas Rate Calculator			Х	Future
Implementation of net metering			Х	3
Solar and battery cost calculator			Х	Future
Electric generation emission factorsAdvanced EFs: Implementation of HiGRID	х	Х		3 Future
Gas leak and electricity transportation loss		Х		Future
Results analysis tools		Х		Future

