Net Emissions Analysis Tool (NEAT) Working Group

Formally the Residential Commercial Appliance Life Cycle Analysis Working Group

Meeting #3
Jan 31st, 2018

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

Scott A. Epstein Ph.D.

Planning and Rules Division

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Development Progress

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

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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

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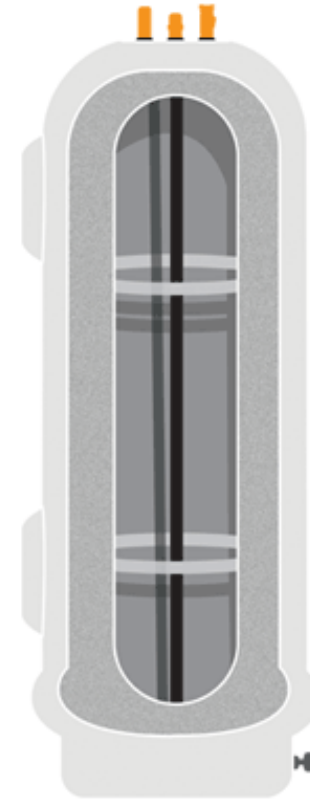
Summary of Submitted Comments (continued)

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*

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Summary of Submitted Comments (continued)

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*

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Summary of Submitted Comments (continued)

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*

Summary of Submitted Comments (continued)

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)*

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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
Electric	Solar Water Heat with 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

MISCELLANEOUS

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

POOL

Fuel	Technology
Electric	Spa Heat
Electric	Pool Pump
Electric	Spa
NatGas	Spa Heat
NatGas	Pool Heat

SPACE 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

Edits in "Demand" Module

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

CZ = 6, Single Family Homes, So Cal Edison, So Cal Gas

Probe the commonalities of the most cost-effective retrofits

Number of Households

Cost Effectiveness [$\Delta NOx/\$$]

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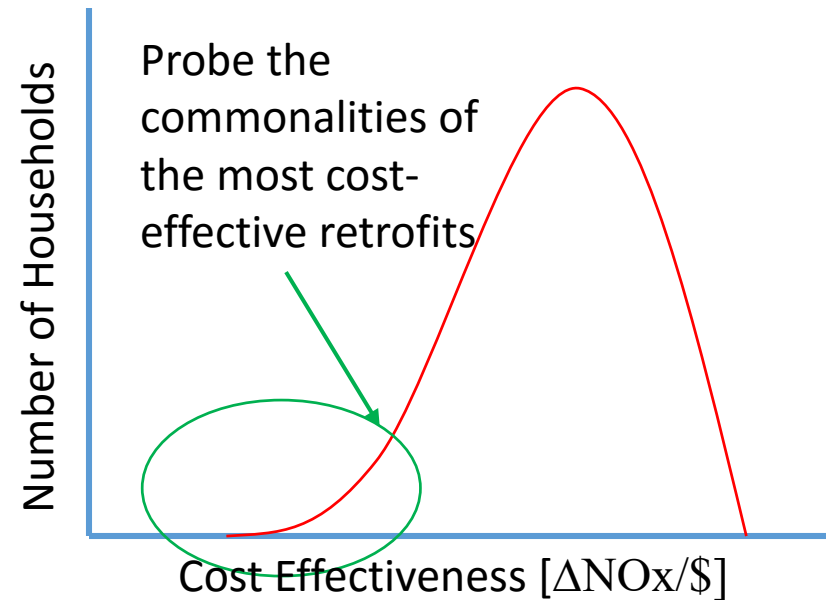
Calculation of Electric Rates and the Embedded Electric Rate Structure Editor Tool

Scott A. Epstein Ph.D.

Planning and Rules Division

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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
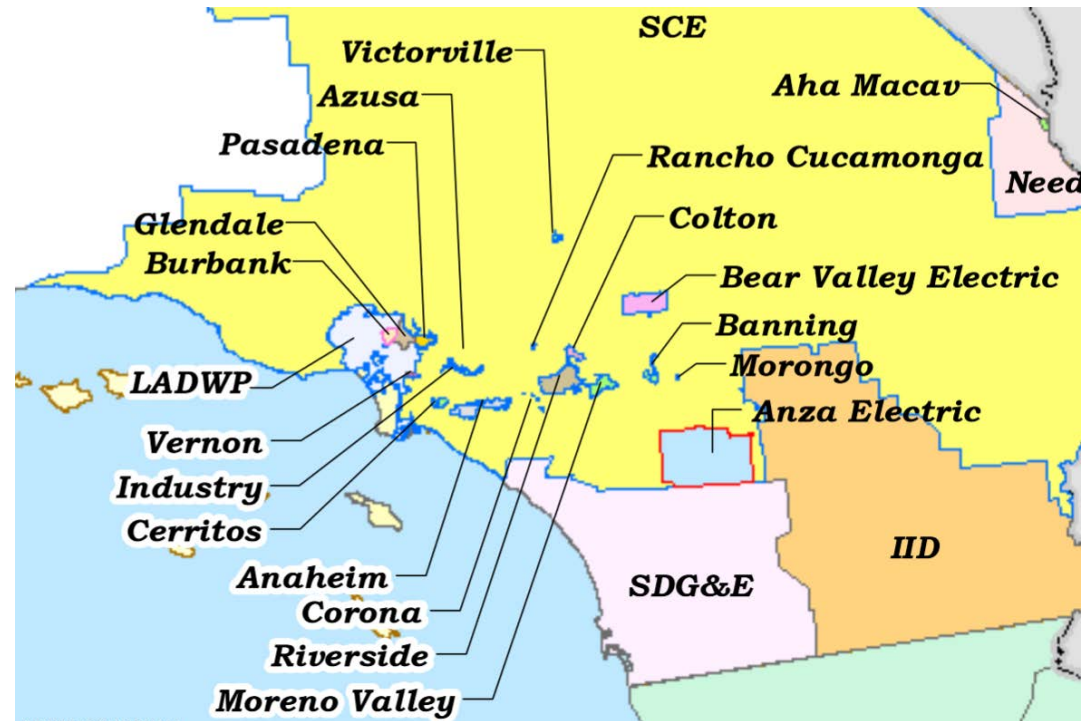
Electric Rate Structure

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

Electric Rate Structure Editor Tool

- 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

Electric Rate Structure Editor Tool

Ability to view/edit rates from every utility in SoCAB

Electric Rate Structure Editor Tool

Electric Rate Structure Editor Tool

Electric Rate Structure Editor Tool

Electric Rate Structure Editor Tool

Ability to edit rates and tiers for each period. Power access charges also included

Electric Rate Structure Editor Tool

Comprehensive input and output tools so that revised rates can be used in NEAT directly

Electric Rate Structure Editor Tool

Analysis tool included to compare electricity costs for average use profiles
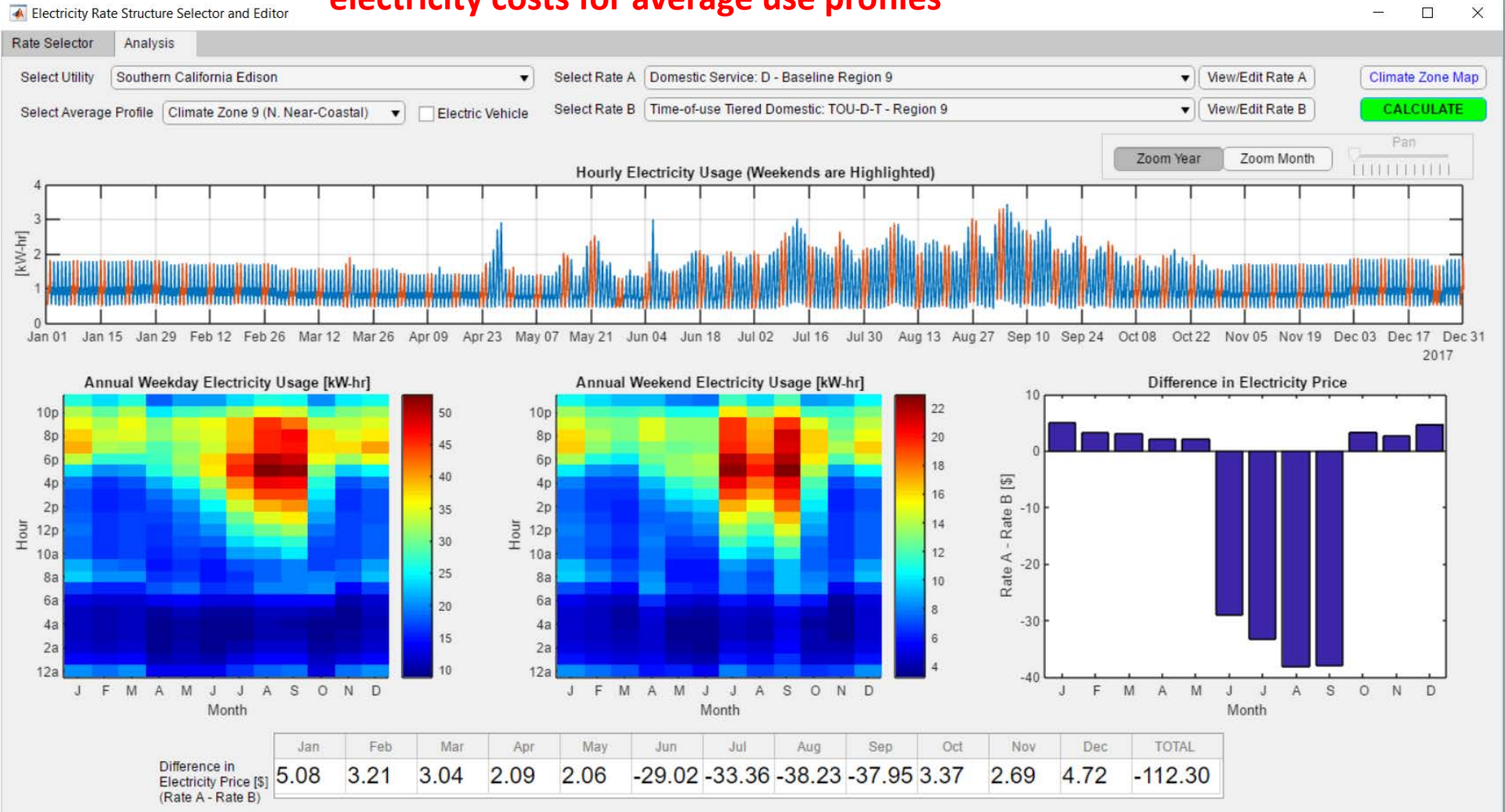
Calculation of Electricity Rates

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

User chooses climate zone and housing type → Simulate 1500 households → Replace technology to make "scenario" set of 1500 households → Determine electric utilities that cover selected CZ

User defines penetration and appliances that will be replaced

Within each applicable utility, use rate based on housing type → For each applicable utility and each of the 1500 households, tool determines electricity cost before and after technology replacement

Calculation of Electricity Rates

For Each Household:
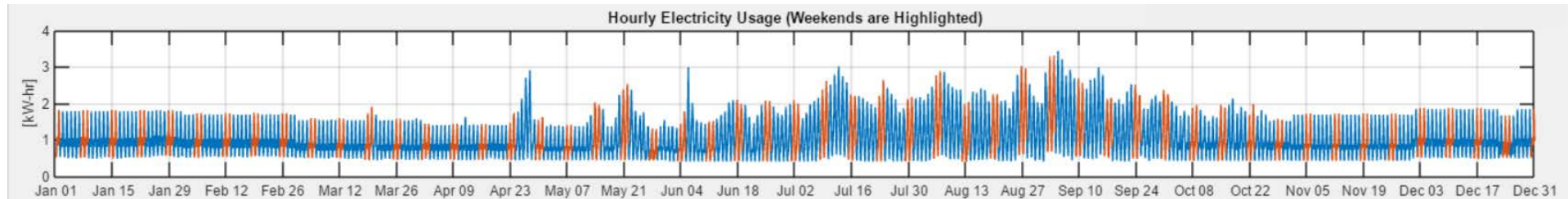
Aggregate
use into month,
hour, WE/WD Bins
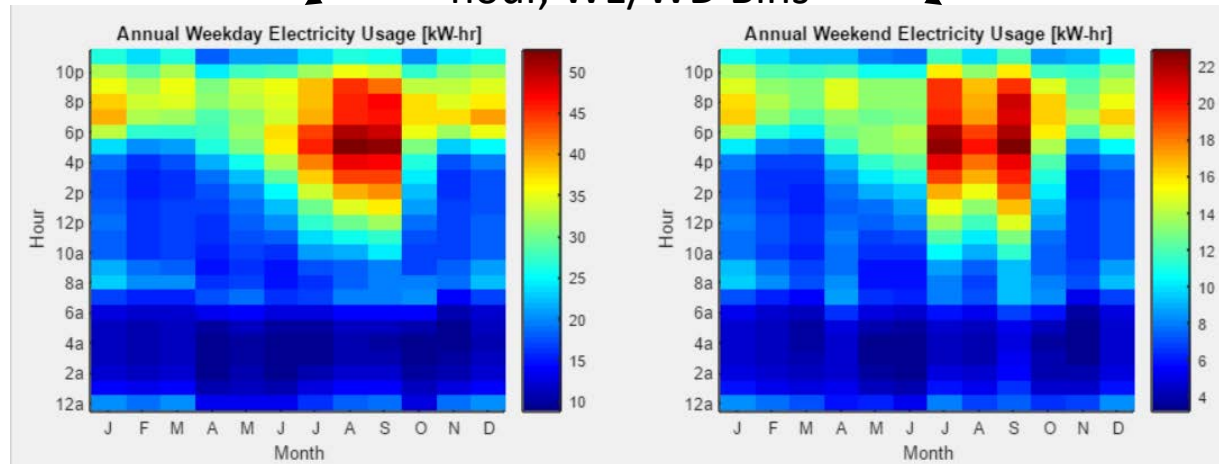
Calculation of Electricity Rates

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

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Calculation of Electricity Rates

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 Baseline Allocation	101-400% over Baseline Allocation	>400% over Baseline Allocation
17¢ / kWh	25¢ / kWh	35¢ / kWh

Energy Usage

www.sce.com
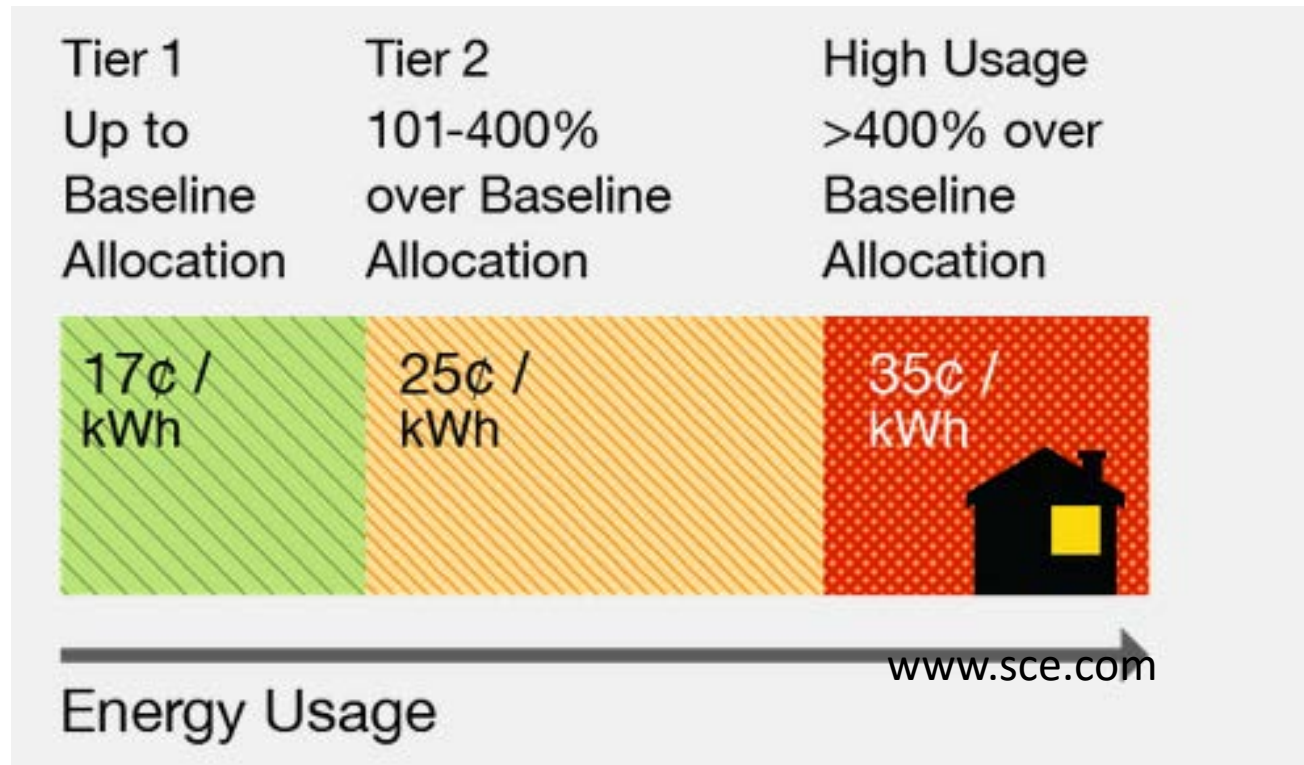
Calculation of Electricity Rates

- 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.

By Varistor60 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=59368531

Treatment of Net Metering

Net Metering

| No Net Metering | (default) | ◉ Sell Electricity Back to Grid at Retail Rates | $ 0.000 /kW-hr |
| Use Net Metering | | ○ Sell Electricity Back to Grid at Fixed Rate (specify) | |

- 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

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Electricity Generation Emissions

Marc Carreras-Sospedra Ph.D.

Planning and Rules Division

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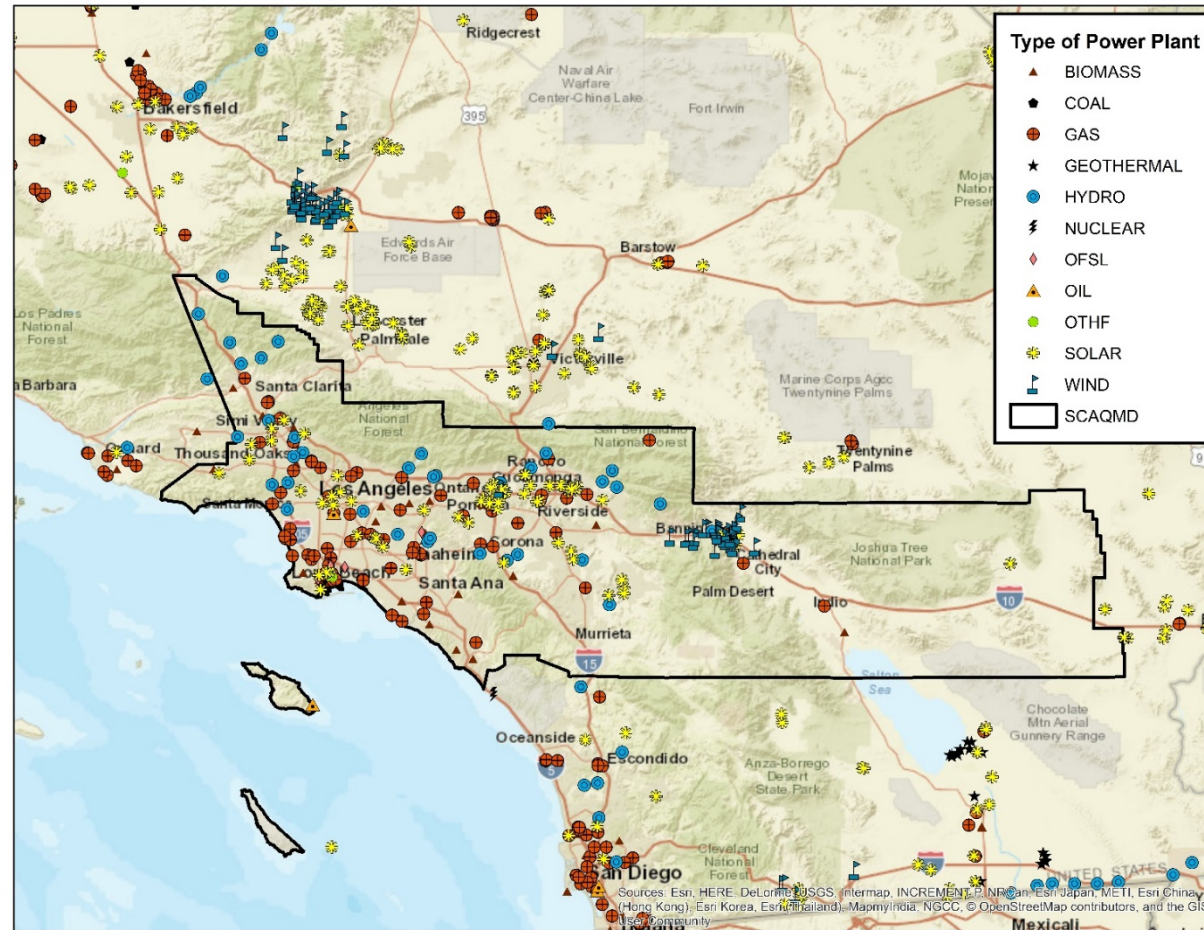
Plant data from eGRID database for 2012 with size > 1MW:
https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid

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Electricity Generation Emission Factor Options

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Emissions from Photovoltaics

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

Source: zkenergy.com

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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
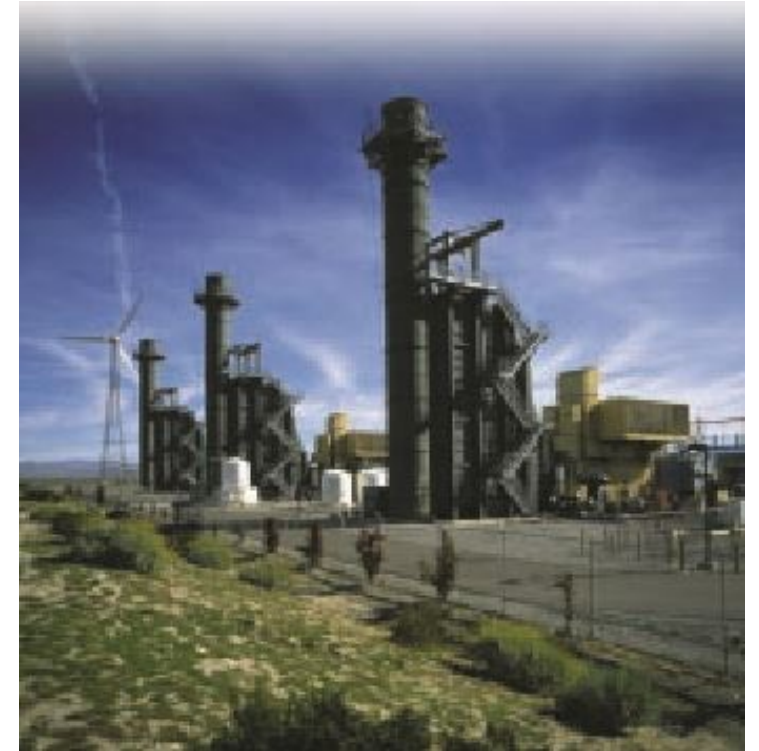
Emissions from Average Grid

- 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 CO_2 emissions
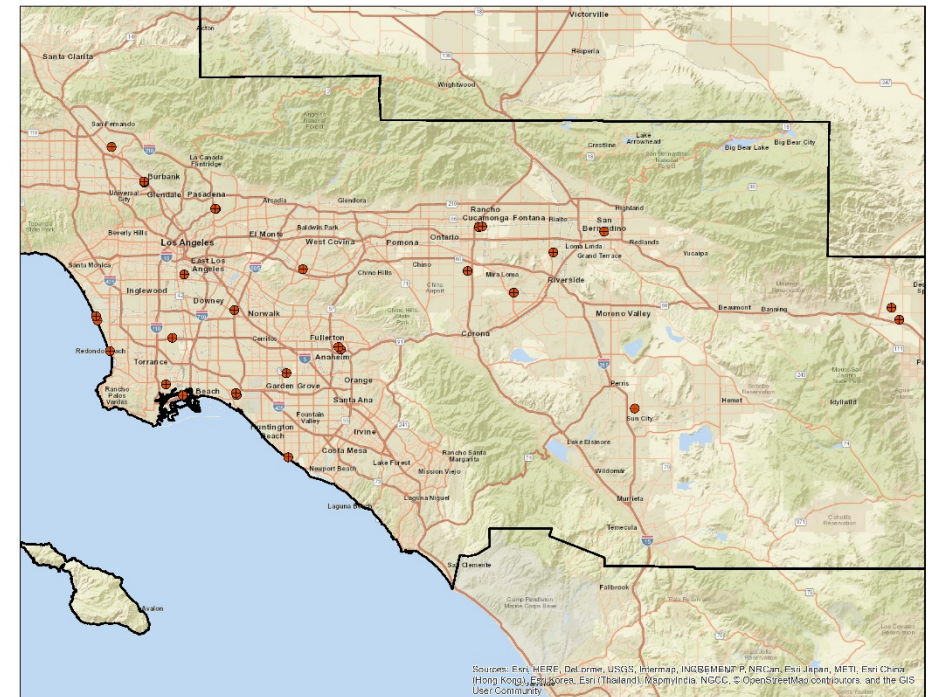
Methodology for Marginal Emissions

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

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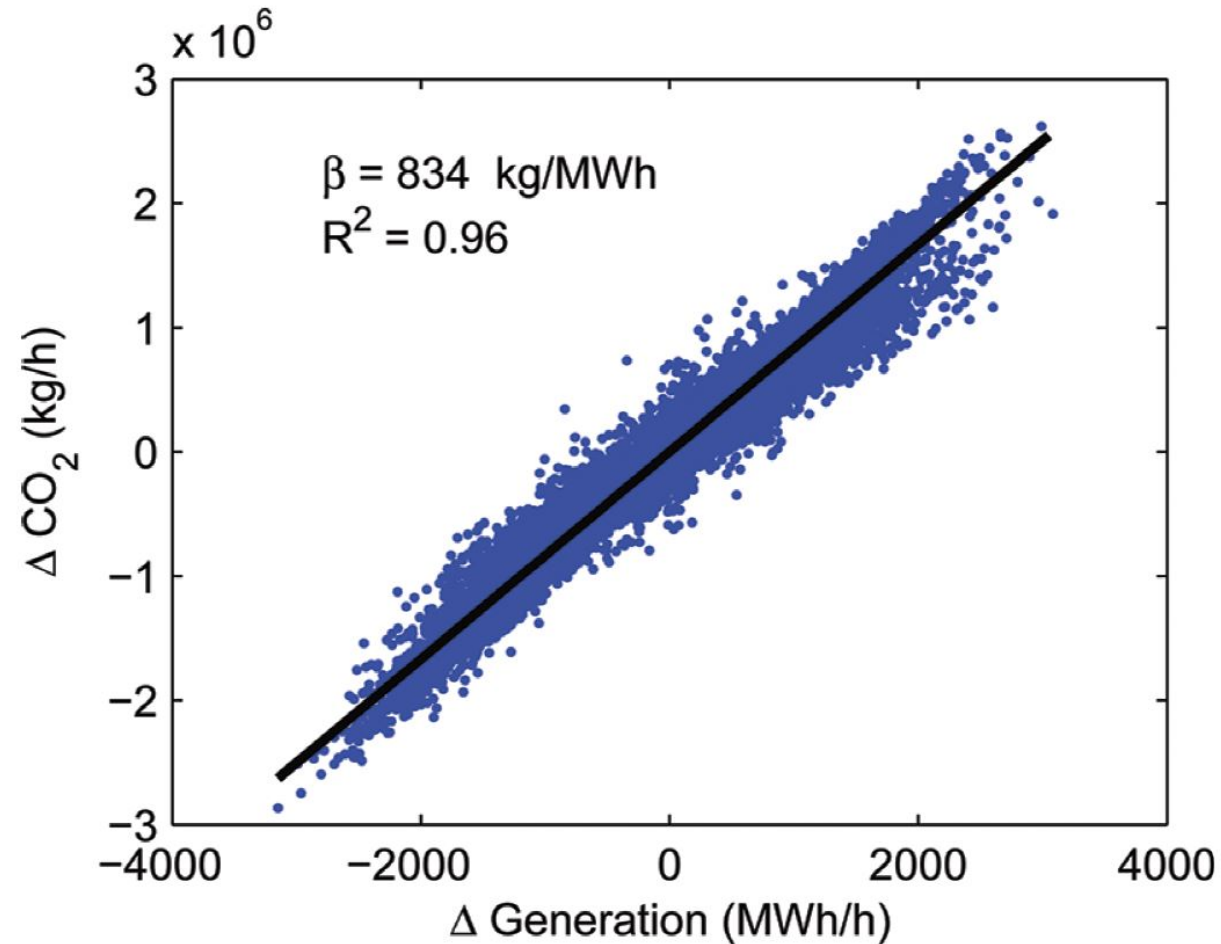
Sample Analysis for 2012 in SoCal

2012 CO$_2$ Marginal Emissions

β = 0.44
R^2 = 0.93
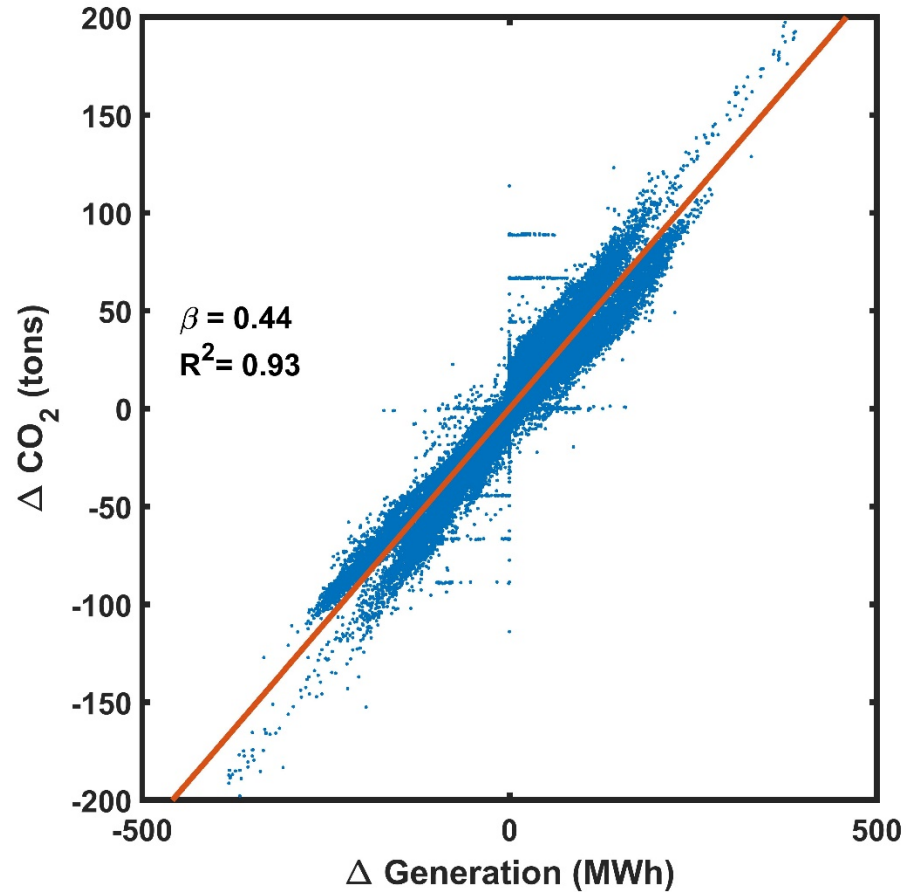
2012 NO$_X$ Marginal Emissions

β = 0.07
R^2 = 0.01

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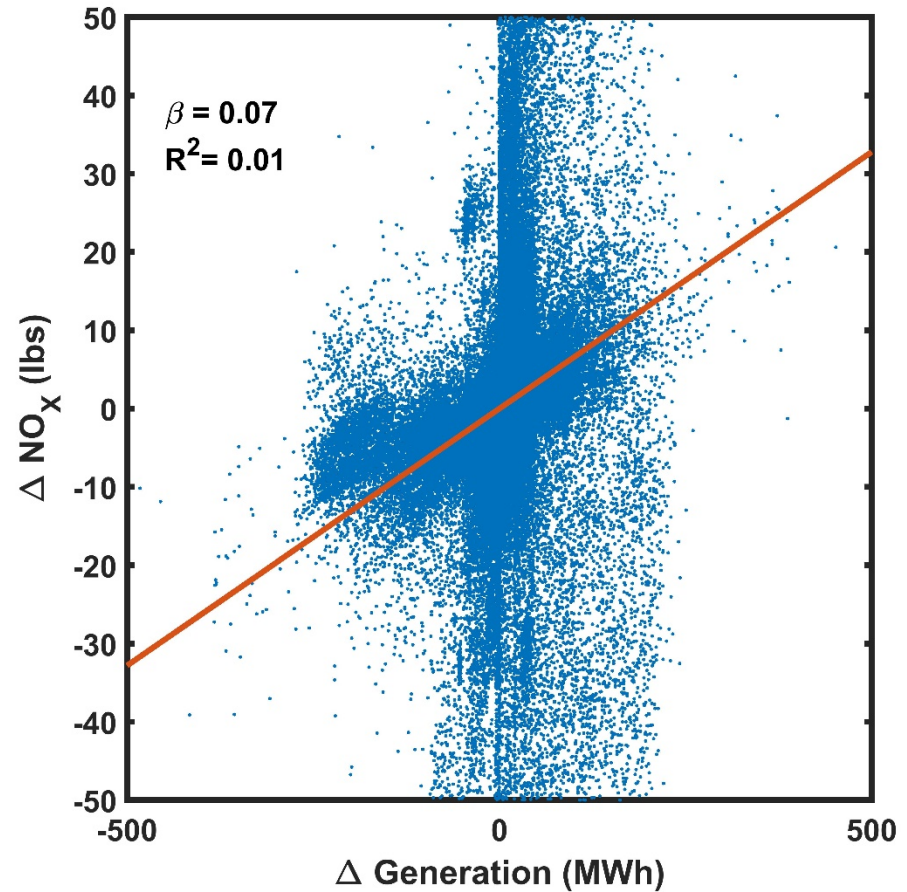
Year-by-Year Marginal Emission Factors

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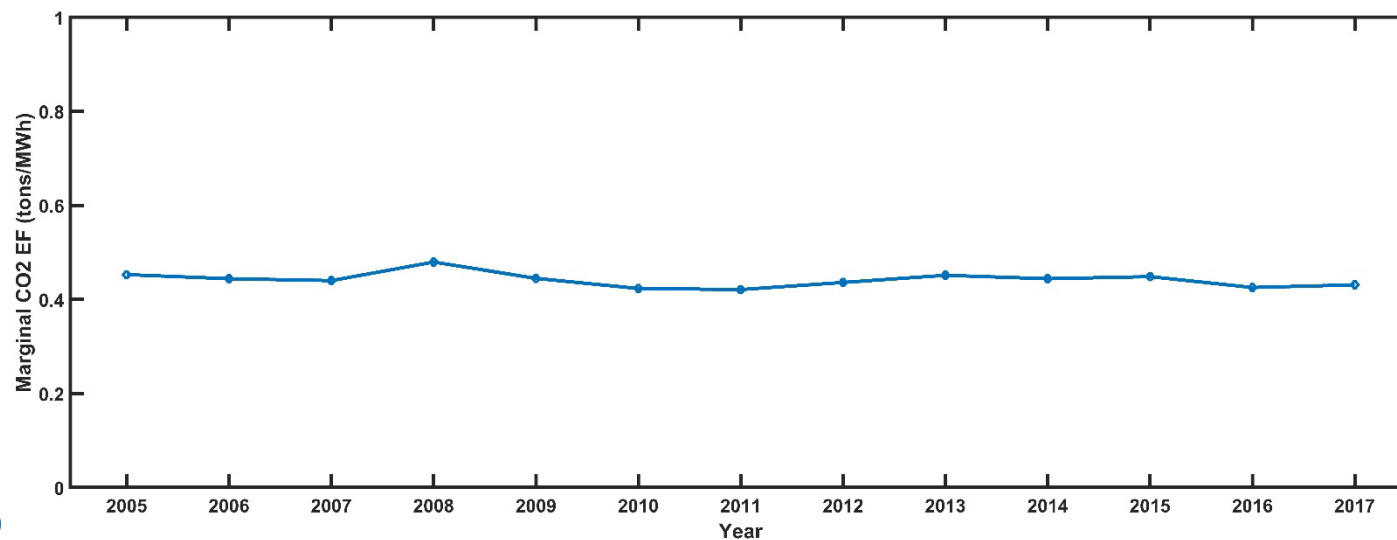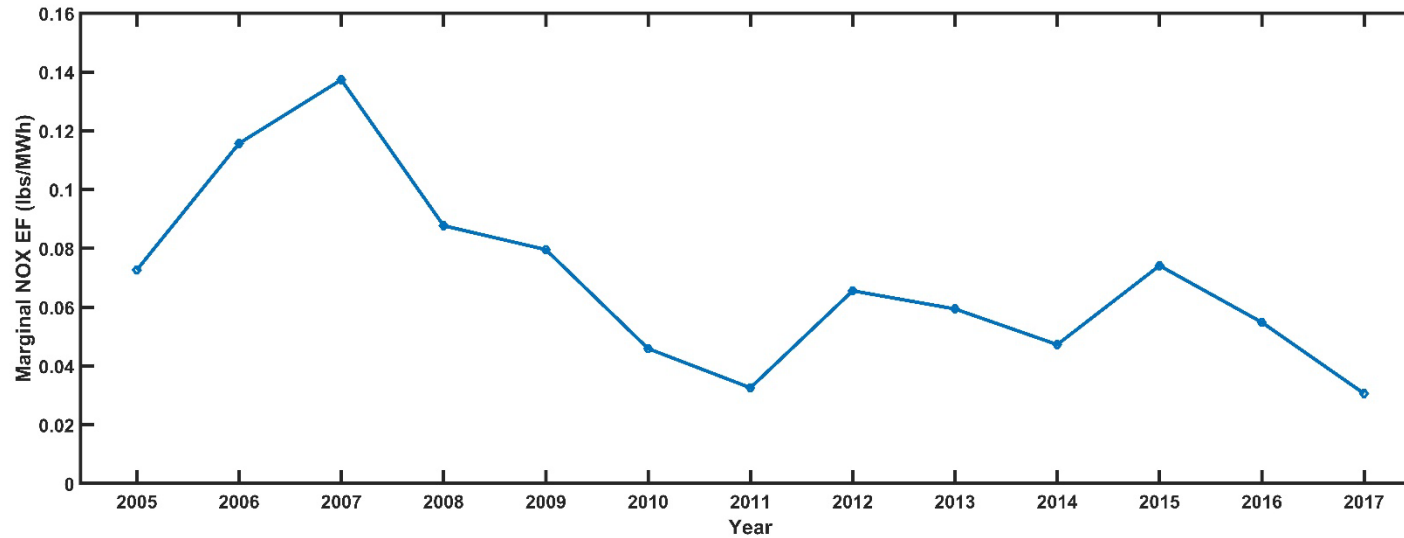
Month-by-Month Marginal Emission Factors
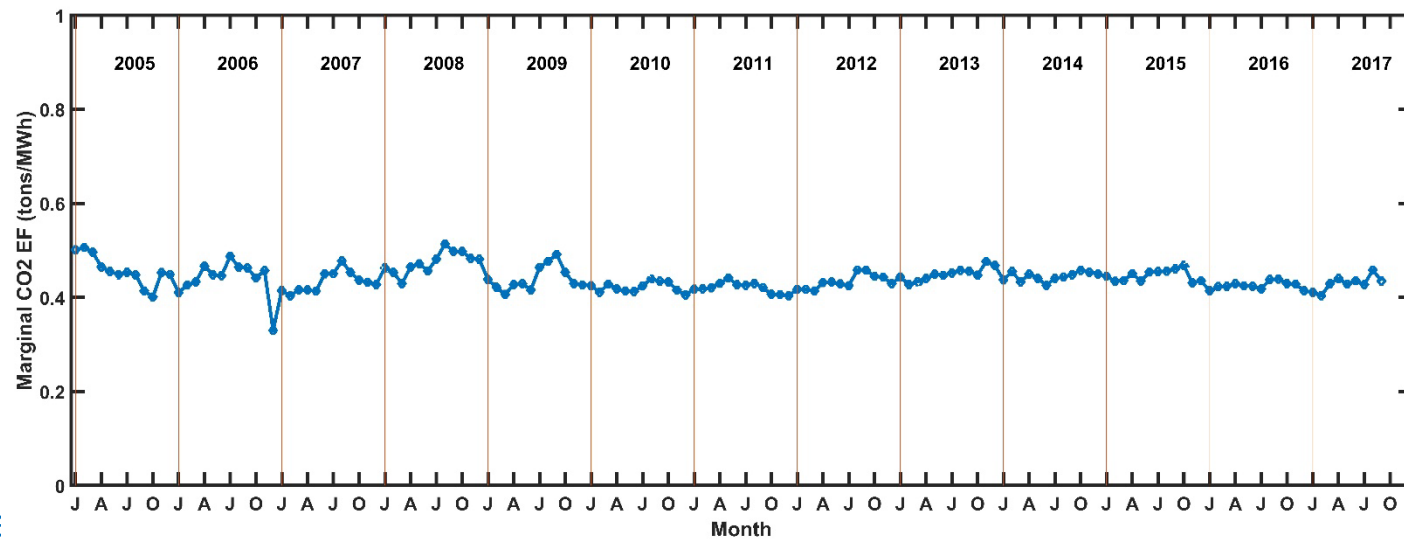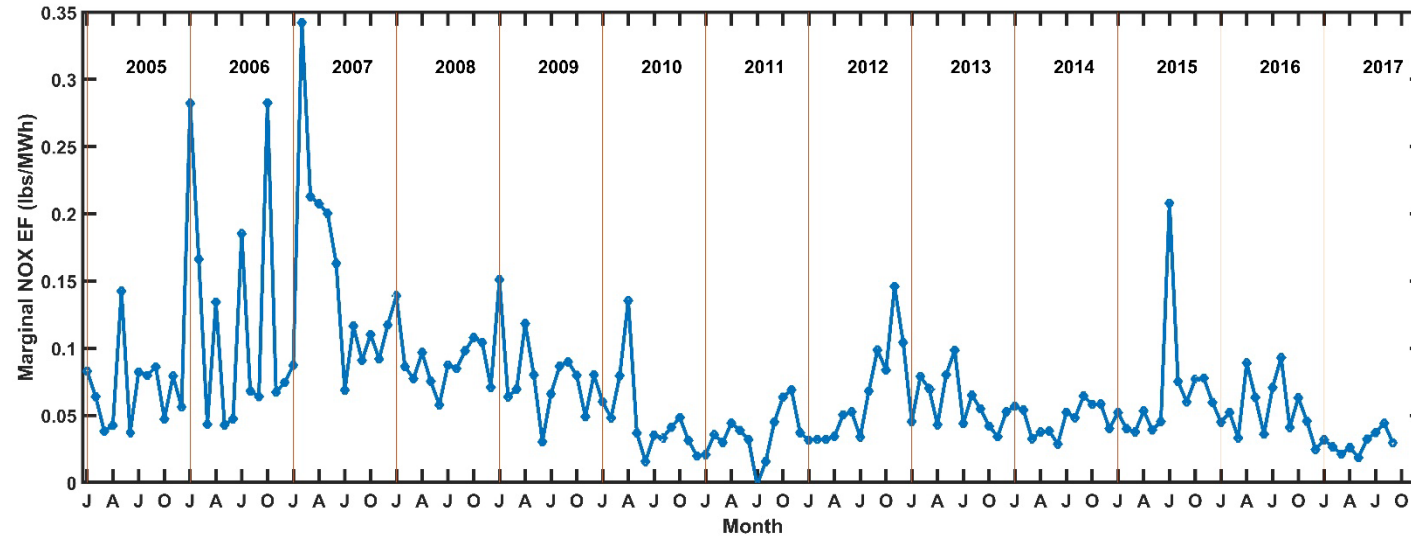
Hour-by-Hour Marginal Emission Factors

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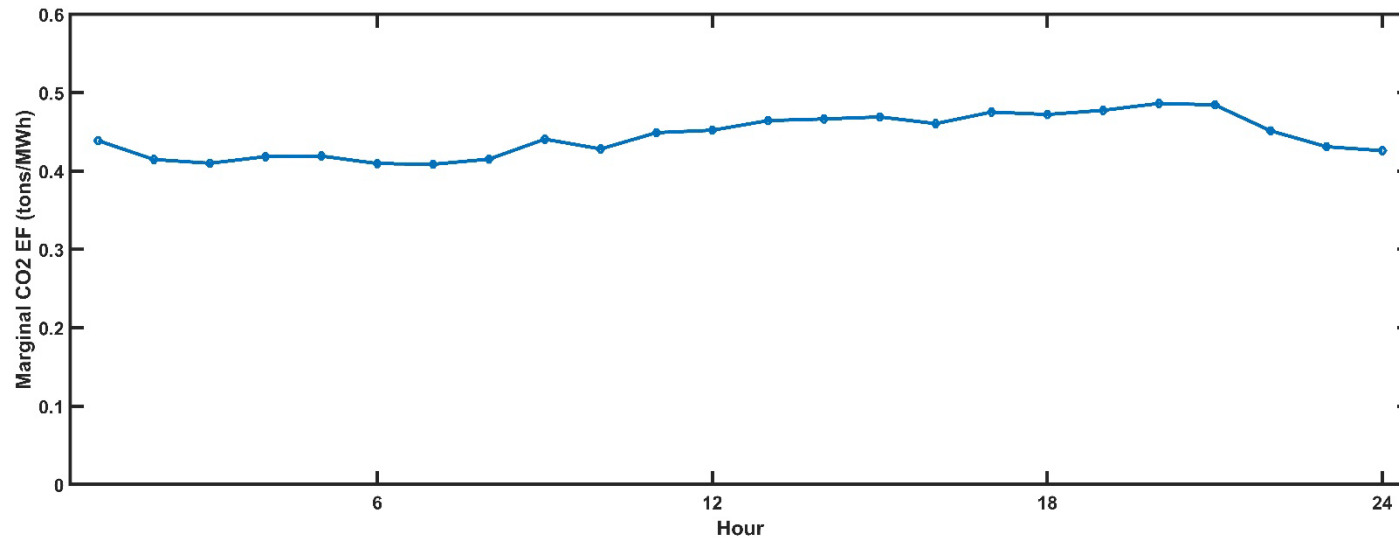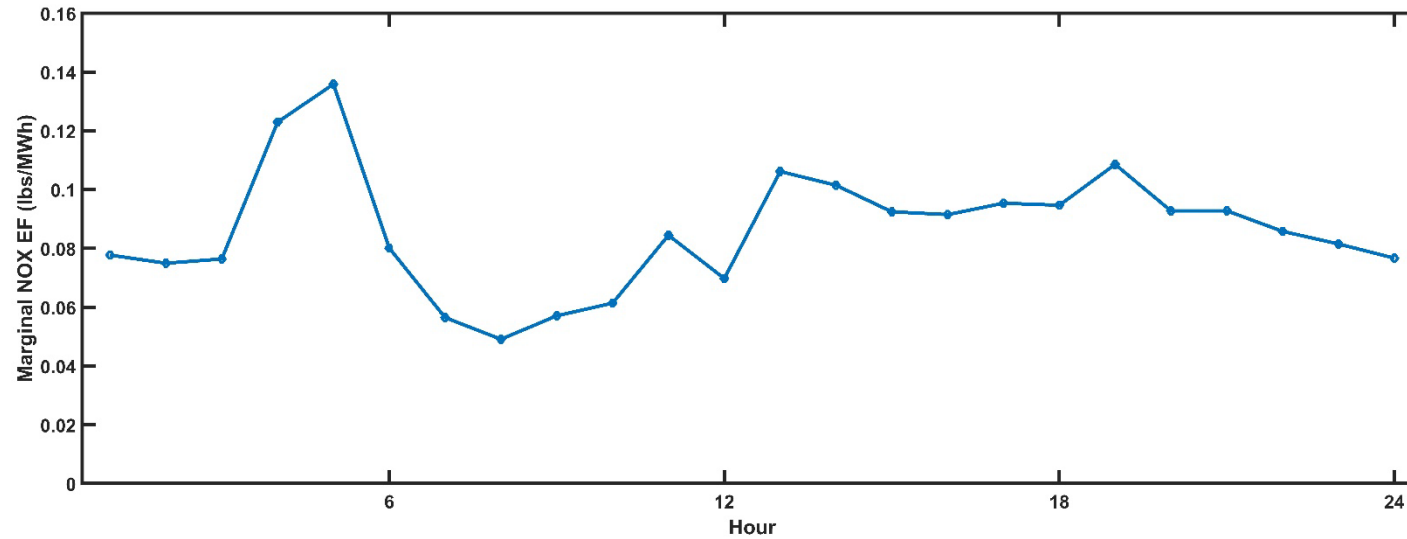
Public Comment

blog.cleanenergy.org

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Next Steps

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Implementation of distributed battery storage			X	Future
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Natural Gas Rate Calculator			X	Future
Implementation of net metering			X	3
Solar and battery cost calculator			X	Future
Electric generation emission factors		X		3
• Advanced EFs: Implementation of HiGRID	X			Future
Gas leak and electricity transportation loss		X		Future
Results analysis tools		X		Future