Net Emissions Analysis Tool (NEAT) Working Group

Formally the Residential Commercial Appliance Life Cycle Analysis Working Group

> Meeting #2 Nov 16, 2017

Scott A. Epstein Ph.D. Marc Carreras-Sospedra Ph.D.



South Coast Air Quality Management District

Outline

- 1. Project Objectives
- 2. The role of the NEAT workgroup
- 3. Development progress
- 4. Overview of "Demand" segment of the Residential NEAT
- 5. Overview of the Residential solar PV calculator module
- 6. Topics for open discussion
- 7. Public comments



Project Objectives

- Develop an analytical software tool that will help to evaluate the most cost-effective strategies for NOx and GHG emission reductions from the commercial and residential sector.
- The ideal characteristics of the tool:
 - Comprehensive, yet user-friendly for general-public
 - >Level of complexity determined by the user
 - Intuitive workflow with extensive documentation embedded into the software



The Role of the NEAT Workgroup

- Bring to light applicable data from peer-reviewed or government studies
- Ensure that assumptions and methodologies are scientifically valid and appropriate
- Help maximize tool usability
- Policy discussions are most appropriate after the model development phase





Development Progress

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



Topics for Today's Meeting

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



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Electric	Solar Water Heat with Electric Backup	0	0	1964	0	0	1411	3869	13			
NatGas	Conventional Water Heater	0.7160	0	193	0.0023	11.7600	653	1900	13			
NatGas	Solar Water Heat with Gas Backup	0	0	163	0.0023	11.7600	4349	3869	13			
										Save Parameters to File ADVANCE TO NEXT		



Demand Module Input Parameters

	Definition	Units	Source
UEC	Units of energy consumption	kWh/year for electric therms/year for NG gal/year for gasoline, diesel	CEC RASS 2009 for appliances EMFAC 2014 analysis for vehicles
NOX EF	Point of Use NOx emission factor	lb/therm for NG lb/gal for gasoline, diesel	AQMD Rule 1121, 1111, 1147 AP-42 from EPA, CEC funded LBNL study, BAAQMD methodology
CO2e EF	Point of Use CO2e emission factor	lb/therm for NG lb/gal for gasoline, diesel	AP-42 from EPA



Demand Module Input Parameters

	Definition	Units	Source
Unit Cost	Cost to purchase appliance	\$	Appliances: Consumer Reports, Amazon, Sears, Home Depot, 4—350 quotes per appliance Vehicles: weighted average calculated with fuel economy.gov, insideevs.com, hybridcars.com, goodcarbadcar.net
Install Cost	Cost to install appliance	\$	Appliances: Homeadvisor.com, home.costhelper.com, homewyse.com
Lifetime	Appliance lifetime	years	Appliances: epa.gov, nachi.org Vehicles: CARB EMFAC survival rates
Penetration	Fraction of households with specific technology	unitless	Appliances: CEC RAAS 2009 Vehicles: CARB EMFAC



Demand Module Input Parameters

	Definition	Units	Source
Unit Cost	Cost to purchase appliance	\$	Appliances: Consumer Reports, Amazon, Sears, Home Depot, 4—350 quotes per appliance Vehicles: weighted average calculated with fuel economy.gov, insideevs.com, hybridcars.com, goodcarbadcar.net
Install Cost	Cost to install appliance	\$	Appliances: Homeadvisor.com, home.costhelper.com, homewyse.com
Lifetime	Appliance lifetime	years	Appliances: epa.gov, nachi.org Vehicles: CARB EMFAC survival rates
Penetration	Fraction of households with specific technology	unitless	Appliances: CEC RAAS 2009 Vehicles: CARB EMFAC
% Adoption	Fraction of households with new/more efficient technology	unitless	Defined by user based on scenario



Hot water heating

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NatGas	Conventional Water Heater	0,7160		0 193	0.0023	11,7600	653	1900	13		
NatGas	Solar Water Heat with Gas Backup	0		0 163	0.0023	11,7600	4349	3869	13		
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Kitchen

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Electric	Range Oven Combination	253	0	0	1000	140	18		0.4560	Select technology to phase-out.	Electric Range Oven Combinatio	n	•
Electric	Disnwasher	755	0	0	1000	344	17 5000		0.6650	Select technology to use instead:	Electric Dishwasher		
Electric	Second Refrigerator	1003	0	0	1999	108	17.5000		0.2140	Select lectricity to use instead.	Liectric Distiwastier		
Electric	Freezer	882	0	0	630	108	20		0.1650			Impleme	nt
Electric	Microwave	119	0	0	180	158	12		0.9190	Adopt More Efficient Technology			
NatGas	Range Oven Combination	33	0.0092	11,7600	1890	150	18		0.6270	Adopt More Emclent lectinology			
										Select technology to improve efficiency:	Electric Range Oven Combinatio	n	•
										% of households with technology in the fu	iture that will adopt more efficient ve	ersion	
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-										US# FUTURE MORE EFFICIENT TECHN	OLOGY table to specify parameters	of more enicier	it tech.
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Fuel	Technology	Penetration	% adoptio	UEC	NOX EF	CO2e EF Un	it Cost Insta	II Cost	Lifetime				
Electric	Range Oven Combination	0.4560		0 253	0	0	1000	140	18				
Electric	Dishwasher	0.6650		0 69	0	0	800	344	12				
Electric	First Refrigerator	1		0 755	0	0	1999	108	17.5000				
Electric	Second Refrigerator	0.2140		0 1003	0	0	1999	108	17.5000				
Electric	Freezer	0.1650		0 882	0	0	630	108	20				
Electric	Microwave	0.9190		0 119	0	0	180	158	12				
NatGas	Range Oven Combination	0.6270		0 33	0.0092	11.7600	1890	150	18				
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Laundry

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Electric	Dryer		615	0	0	750	219	18	0.2890	Select technology to phase-out:	Electric Dryer	•
Electric	Clothes Washer Drver		25	0 0136	11 7600	850	100	13	0.7320	Select technology to use instead:	Electric Clothes Washer	
Tutous	Dijoi		20	0.0100	11.1000			10	0.0000			Implement
										Adopt More Efficient Technology		
										Select technology to improve efficiency:	Electric Dryer	•
										% of households with technology in the fu	iture that will adopt more efficient ve	ersion 0
										Use FUTURE MORE EFFICIENT TECHN	OLOGY table to specify parameters	of more efficient tech.
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Fuel	Technology		Penetration	% adopti	on UEC	NOX EF	CO2e EF Un	it Cost Insta	Il Cost Lifetime	L		
Electric	Dryer		0.2890	D	0 615	i 0	0	750	219 18			
Electric	Clothes Washer		0.7320	0	0 82	2 0	0	850	100 13			
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Miscellaneous

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DASE			•				Show	Column Ir	formation	Table values can be edited manually. Tools	to implement common editing scena	arios are provided.
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Electric	TV	681	0	0	300	288	15	,	1		(Flashia Thi	
Electric	Outdoor Lighting	298	0	0	37	194	40	1	0.5980	Select technology to phase-out.	Electric IV	•
Electric	Home Office	78	0	0	353	397	10.5000	ł	0.1990	Select technology to use instead:	Electric Outdoor Lighting	•
Electric	PC	588	0	0	329	397	10.5000	1	0.8410			Implement
Electric	Well Pump	559	0	0	185	1167	15	/	0.0430			
Electric	Other	1734	0	0	0	0	0 0		1	Adopt More Efficient Technology		
NatGas	Other	26	0.0136	11.7600	0	0	0		0.0930	Select technology to improve efficiency:	Electric TV	
										% of households with technology in the fi	ture that will adopt more efficient ver	sion 0
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Electric	TV	1		0 681	0	0	300	288	15			
Electric	Outdoor Lighting	0.5980		0 298	0	0	37	194	40			
Electric	Home Office	0.1990		0 78	0	0	353	397	10.5000			
Electric	PC	0.8410		0 588	0	0	329	397	10.5000			
Electric	Well Pump	0.0430		0 559	0	0	185	1167	15			
Electric	Other	1		0 1/34	0 0 1 2 0	11 7600	0	0	0			
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Pool

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Fuel Technology UEC NOX EF CO2e EF Unit Cost Install Cost Lifetime Penetration Electric Spa Heat 903 0 0 520 750 13 0.0400 Electric Spa Heat 520 0 0 230 188 10 0.0406 Electric Spa Heat 52 0.002 11.7600 2048 1000 13 0.0406 NatGas Spa Heat 52 0.0023 11.7600 2048 1000 13 0.0406 NatGas Pool Heat 151 0.023 11.7600 2048 1000 13 0.0308 Fuel Technology MIX FUTURE MORE EFFICIENT TECHNOLOGY Implement Adopt More efficient Version Implement Fuel Technology Penetration % adoption UEC NOX EF CO2e EF Init Cost Install Cost Lifetime Electric Pool Pump 0.0860 0 520 750 13	BASE	LINE TECHNOLOG	Y MIX PARAM	IETER	s				Show	Column Int	ormation	Table values can be edited manually. Tools	s to implement common editing scenar	ios are provided:
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Electric Spa 223 0 0 3960 8912 12.5000 0.0770 NatGas Spa Heat 52 0.0023 11.7600 2048 1000 13 0.0400 NatGas Pool Heat 151 0.0023 11.7600 2048 1000 13 0.0400 Vertice Spa Heat 151 0.0023 11.7600 2048 1000 13 0.0380 Future Future NatGas Pool Heat Vertice NatGas Pool Heat 0.023 11.7600 2048 1000 13 0.0380 Vertice Adopt More Efficient Technology Select technology to improve efficient version 0	Electric	Pool Pump		3502	0	0	230	188	10		0.0860	celect technology to phase out.		
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FUTURE TECHNOLOGY MIX FUTURE MORE EFFICIENT TECHNOLOGY Implement View Technology Penetration % adoption UEC NOX EF CO2e EF Unit Cost Install Cost Lifetime Electric Spa Heat 0.0400 0 903 0 520 750 13 Electric Pool Pump 0.0860 0 3202 0 230 188 100 NatGas Spa Heat 0.0400 0 52 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT												Use FUTURE MORE EFFICIENT TECHNO	OLOGY table to specify parameters of	more efficient tech.
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Electric Spa Heat 0.0400 0 903 0 0 520 750 13 Electric Pool Pump 0.0860 0 3502 0 0 230 188 10 Electric Spa 0.0770 0 223 0 0 3960 8912 12.5000 NatGas Spa Heat 0.0400 0 52 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT	Fuel	Technology	Per	netration	% adoptio	on UEC	NOX EF	CO2e EF Un	it Cost Insta	II Cost	lifetime			
Electric Pool Pump 0.0860 0 3502 0 0 230 188 10 Electric Spa 0.0770 0 223 0 0 3960 8912 12.5000 NatGas Spa Heat 0.0400 0 52 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT	Electric	Spa Heat		0.0400		0 903	0	0	520	750	13			
Electric Spa 0.0770 0 223 0 0 3960 8912 12.5000 NatGas Spa Heat 0.0400 0 52 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT	Electric	Pool Pump		0.0860		0 3502	0	0	230	188	10			
NatGas Spa Heat 0.0400 0 52 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT ADVANCE TO NEXT	Electric	Spa		0.0770		0 223	0	0	3960	8912	12.5000			
NatGas Pool Heat 0.0380 0 151 0.0023 11.7600 2048 1000 13 Save Parameters to File ADVANCE TO NEXT	NatGas	Spa Heat		0.0400		0 52	0.0023	11.7600	2048	1000	13			
Save Parameters to File ADVANCE TO NEXT	NatGas	Pool Heat		0.0380		0 151	0.0023	11.7600	2048	1000	13			
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Space heating and cooling

	ntial Net Emissions Analysis Tool versior	1.0 beta										>
Demand	Intermediate Results Power St	upply Econ	iomics p	blaceholder	l placeh	older2 R	esults					
Housing (Category		C	limate Zone								_
Cingle	Family O Multi Family O Mahila I			O.C. Canada		laar Caastal	0.0 M M		atal O			
Single	-raminy O mulu-raminy O mobile	Home • Agg	gregate	0 6 Coasta	II () 8 5.1	vear-coastar	09 N. N	ear-Coa	istal O	To S. Inland O 15 S. Desert O To Mit		(1)
Populate	Values											
Load D	efault Parameters 🔵 🔵											
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Hot wate	r heating Kitchen Laundry	Miscellaneou	JS Pool	Space	heating and	cooling T	ransportation	1				
BASE	LINE TECHNOLOGY MIX PA	RAMETER	s				Show 0	Column In	formation	Table values can be edited manually. Tools	s to implement common editing scen	arios are provided:
Fuel	Technology	UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Pene	tration	Replace Technology Tool		
Electric	Conventional Heat	454	0	0	739	1694	20		0.0330	Calastiashasiasu ta shasa sut	Flastria Conventional Lipst	
Electric	Heat Pump	547	0	0	1977	3233	12.5000		0.0090	Select technology to phase-out	Electric Conventional Heat	
Electric	Auxiliary Heat	194	0	0	0	0	0		0.0040	Select technology to use instead:	Electric Heat Pump	•
Electric	Furnace Fan	151	0	0	193	450	10		0.6000			Implement
NatGas	Primary Heat	126	0.0066	11.7600	3040	1696	20		0.7690			
NatGas	Auxiliary Heat	70	0.0066	11.7600	0	0	0		0.0120	Adopt More Efficient Technology		
Electric	Attic Ceiling Fan	184	0	0	90	471	20		0.1340	Coloct to chool age to improve officiency	Electric Conventional Heat	
Electric	Central Air Conditioning	669	0	0	1524	1597	15		0.5240	Select technology to improve eniciency.	Electric Conventional Heat	
Electric	Room Air Conditioning	223	0	0	300	276	15		0.2070	% of households with technology in the fu	uture that will adopt more efficient ver	sion 0
Electric	Evaporative Cooler	495	0	0	439	959	20		0.0500	Use FUTURE MORE EFFICIENT TECHN	OLOGY table to specify parameters	of more efficient tech
FUTU			FUTUR		FEFICIEN	TTECHN	OLOGY					Implement
Fuel	Technology	Penetration	% adoptio	n UEC	NOX EF	CO2e EF Un	it Cost Insta	II Cost	Lifetime	L		
Electric	Conventional Heat	0.0330		0 454	0	0	739	1694	20			
Electric	Heat Pump	0.0090		0 547	0	0	1977	3233	12.5000			
Electric	Auxiliary Heat	0.0040		0 194	0	0	0	0	0			
Electric	Furnace Fan	0.6000		0 151	0	0	193	450	10			
NatGas	Primary Heat	0.7690		0 126	0.0066	11.7600	3040	1696	20			
NatGas	Auxiliary Heat	0.0120		0 70	0.0066	11.7600	0	0	0			
Electric	Attic Ceiling Fan	0.1340		0 184	0	0	90	471	20			
Electric	Central Air Conditioning	0.5240		0 669	0	0	1524	1597	15			
Electric	Room Air Conditioning	0.2070		0 223	0	0	300	276	15			
Electric	Evaporative Cooler	0.0500		0 495	0	0	439	959	20			
											Save Parameters to File	ADVANCE TO NEX



Transportation

承 Resider	itial Net Emissions Analysis	Tool version	1.0 beta								- 🗆 X
Demand	Intermediate Results	Power Su	pply Eco	nomics	placeholder	1 placel	holder2 R	esults			
Housing C	ategory			C	limate Zone						
⊖ Single	Family OMulti-Family	O Mobile H	lome 💿 Ag	gregate	⊖6 Coasta	al () 8 S.	Near-Coastal	09 N. N	ear-Coastal	10 S. Inland 15 S. Desert 16 Mountain 💿 All CZ MAP	
Populate	Values										No.
Load De	efault Parameters 🛛 🔵										
Load S	aved Parameters										South Coast AQMD
Hot wate	r heating Kitchen	Laundry	Miscellaneo	us Pool	Space	heating and	cooling T	ransportation			
BASE	LINE TECHNOLOG		RAMETER	s				Show 0	olumn Informatio	Table values can be edited manually. Tools to implement common edit	ing scenarios are provided:
Fuel	Technology		UEC	NOX EF	CO2e EF	Unit Cost	Install Cost	Lifetime	Penetration	Replace Technology Tool	
Gasoline	Light Duty Vehicle		509	0.0060	18.6560	25204	0	13	1.049	0 Select technology to phase-out Gasoline Light Duty Vehi	cle 🔹
Electric	Light Duty Vehicle		419	0.0130	22.2220	3/849	0	19	0.008	0 Select technology to use instead: Diesel Light Duty Vehicle	•
											Implement
										Adopt More Emcient lechnology	
										Select technology to improve efficiency: Gasoline Light Duty Vehi	cle 🔻
										% of households with technology in the future that will adopt more eff	icient version 0
										Use FUTURE MORE EFFICIENT TECHNOLOGY table to specify par	ameters of more efficient tech.
FUTU	RE TECHNOLOGY	MIX		FUTUR	E MORE	EFFICIEN	T TECHN	OLOGY			Implement
Fuel	Technology		Penetration	% adoptio	on UEC	NOX EF	CO2e EF Un	it Cost Insta	I Cost Lifetim		
Gasoline	Light Duty Vehicle		1.0490	D	0 509	0.0060	18.6560	25204	0 1	3	
Diesel	Light Duty Vehicle		0.0080	0	0 419	0.0130	22.2220	37849	0 1	9	
Electric	Light Duty vehicle		0.0080		0 4975	0	0	39859	0	<u>•</u>	
										Save Parameters t	o File



Technology Mix Editing Tools

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Demand	Intermediate Results	Power Sup	ply Econo	omics pla	ceholder1	placeh	older2	Results							
Housing C	ategory			Clin	nate Zone										
O Single-	Family OMulti-Family	O Mobile Ho	ome 💿 Aggr	regate 🔿	6 Coastal	08 S.	Near-Coas	stal 🔿 9 N	. Near-Coas	tal 🔿	10 S. Inland O 15 S. Desert O 16 Mo	ountain	()		
Populate V Load De Load Sa	Values ofault Parameters) () aved Parameters) ()												South Coast AQMD		
Hot wate	r heating Kitchen	Laundry			Space he	eating and	cooling	Transporta	tion						
BASE	INE TECHNOLOG		AMETERS	3			rmation	Table values can be edited manually. Tools	to implement common editing scer	arios are provided	8				
Fuel	Technology		UEC	NOX EF C	O2e EF	ser	can	edit	Penetr	ation	Replace Technology Tool				
Gasoline	Light Duty Vehicle		509	0.0060	18.6560	25204		0	13	1.0490	Select technology to phase-out	Gasoline Light Duty Vehicle		•	
Electric	Light Duty Vehicle		4975	0	values manually or						Select technology to use instead:	Diesel Light Duty Vehicle			
						se t	hes	e too	ls fo	r			Implement		
					u	SEL	IIC3				Adopt More Efficient Technology				
					C	omr	non	edit	ing		Select technology to improve efficiency:	Gasoline Light Duty Vehicle	2	•	
					S	cena	ario	S			% of households with technology in the fu Use FUTURE MORE EFFICIENT TECHN	ture that will adopt more efficient ve DLOGY table to specify parameters	rsion 0	ch.	
FUTUF	RE TECHNOLOGY	NIX		FUTURE	MORE E	FFICIEN	T TECH	HNOLOGY	(Implement	D	
Fuel	Technology		Penetration	% adoption	UEC	NOX EF	CO2e EF	Unit Cost In	stall Cost	ifetime	<u>.</u>				
Gasoline	Light Duty Vehicle		1.0490	0	509	0.0060	18.6560	25204	0	13					
Electric	Light Duty Vehicle		0.0080	0	4975	0.0130	0	39859	0	16					
												Save Parameters to File	ADVANCE TO NE	EXT	



Baseline Demand

• For all electric appliances, *i*:

 $Elec_{Base,i,h} = Penetration_{Base,i} \times UEC_{Base,i} \times Load_{h}$

• For all gas appliances, *j*:

 $Gas_{Base,j,h} = Penetration_{Base,j} \times UEC_{Base,j} \times Load_{h}$

Hourly Loads, $Load_h$, are obtained from Building America House Simulation Protocol, NREL 2010



Hourly Loads by Climate Zone – January







Hourly Loads by Climate Zone – August





South Coast Air Quality Management District

AON

Future Case Demand

• For all electric appliances, *i*:

$$\begin{split} & Elec_{Future,i,h} = \\ & \left(Penetration_{Future,i} \times UEC_{Base,i} \times (1 - \%Adoption_i) \\ & + Penetration_{Future,i} \times UEC_{Future,i} \times \%Adoption_i \right) \times Load_h \end{split}$$

• For all gas appliances, *j*:

 $Gas_{Future,j,h} =$ $(Penetration_{Future,j} \times UEC_{Base,j} \times (1 - \%Adoption_j)$ $+ Penetration_{Future,j} \times UEC_{Future,j} \times \%Adoption_j) \times Load_h$



Example Calculation: Water Heating





Example Calculation: Water Heating







Emissions

• Baseline emissions:

 $Emissions_{Base,j,h,pol} = Gas_{Base,j,h} \times EF_{Base,j,pol}$

• Future emissions:

$$\begin{split} Emissions_{Future,j,h} &= \\ \left(Penetration_{Future,j} \times UEC_{Base,j} \times \left(1 - \%Adoption_{j} \right) \times EF_{Base,j,pol} \\ &+ Penetration_{Future,j} \times UEC_{Future,j} \times \%Adoption_{j} \times EF_{Future,j,pol} \right) \times Load_{h} \end{split}$$



Costs

• Baseline costs:

 $Costs_{Base,i}$

 $= Penetration_{Base,i} \times (InstallCost_{Base,i} + UnitCost_{Base,i}) / lifetime_{Base,i}$

• Future costs:

 $\begin{aligned} Costs_{Future,i} &= \\ (Penetration_{Future,i} \times (InstallCost_{Base,i} + UnitCost_{Base,i})/lifetime_{Base,i} \\ &\times (1 - \%Adoption_i) + Penetration_{Future,i} \\ &\times (InstallCost_{Future,i} + UnitCost_{Future,i})/lifetime_{Future,i} \times \%Adoption_i) \end{aligned}$



Example Calculation: Water Heating



Implementation of Distributed PV

🚮 Resident	tial Net Emissions Anal	ysis Tool version 1.0 be	ta			— D X							
Demand	Intermediate Result	s Power Supply	Economics	placeholder1	placeholder2	Results							
Natura	I Gas Produc	tion and Trans	port				Electricity Generation						
Distribu	uted Solar Ph	otovoltaics				Residential Battery Storage							
✓ Imple	ement Rooftop	Solar PV using P	VWatts				Implement Residential Battery using PVWatts Battery Model						
Rooftop	Solar PV Module Doc	umentation					Residential Battery Module Documentation						
For Advar	nced Users						For Advanced Users						
Solar C	ost Function: COST =	4466.83 * X + 1859.	02 where size in test co	"X" is defined as th kW DC under star nditions.	Reset t Indard Test F More In	to Default Function formation	Battery System (all fields editable) Battery Setup A Battery Setup B Battery Setup C Cost For First Battery \$ 6200 Cost Per Additional Battery \$ 5500 Installation Cost \$ 1400 Lifetime [years] 10						
Mode	ule Type Standard System Loss Value	•	Rooftop	Area Availability R	atio	0.75	Battery Capacity [kW-hr] 13.5 Battery Chemistry Lithium Ion						
In	verter Efficiency [%]	96					Battery Power [KW] 5 Battery Dispatch Peak Shaving (look behind)						
C	DC to AC Size Ratio	1.1			Reset t	to Default	Reset to Default						
	Panel Tilt [degrees]	20			More In	formation	More Information						
							(RETURN TO PREVIOUS) ADVANCE TO NEXT						



Implementation of Distributed PV

Implement Deoften C	olar DV using DV/M	****	
Implement Roonop 5	olar PV using PVVva	atts	
Rooftop Solar PV Module Docu	mentation		
or Advanced Users			
		where "V" is defined as the name!	Reset to Defaul
Solar Cost Function: COST =	4466.83 * X + 1859.02	size in kW DC under standard	Test Function
		test conditions.	More Information
Module Type Standard	•	Rooftop Area Availability Ratio	0.75
Module Type Standard System Loss Value	• 0.14	Rooftop Area Availability Ratio	0.75
Module Type Standard System Loss Value Inverter Efficiency [%]	▼ 0.14 96	Rooftop Area Availability Ratio	0.75
Module Type Standard System Loss Value Inverter Efficiency [%] DC to AC Size Ratio	▼ 0.14 96 1.1	Rooftop Area Availability Ratio	0.75 Reset to Defau



Implementation of Distributed PV

- How much panel area is available to the average single family and mobile home household in each climate zone?
- How much electricity can be generated by the average single family and mobile home household in each climate zone?
 - NREL's PVWatts used for calculation
- How many panels will minimize cost (construction and electricity bills)?



Solar Cost Function

- Function can be edited by advanced users
- CA distributed generation statistics
- Residential PV installations in SCE territory completed after 1/1/2014 were analyzed





Solar PV Module Input Parameters

(for advanced users)

Module Type	Standard	¥
System Los	s Value	0.14
Inverter Efficie	ency [%]	96
DC to AC Siz	e Ratio	1.1
Panel Tilt [d	egrees]	20

- Module type choices include "standard", "premium", and "thinfilm". This determines the panel efficiency and the power dependence on temperature
- System Loss Value is the product of several performance losses, i.e. shading, soiling, age, etc.
- Inverter Efficiency is the nominal rated DC-to-AC conversion efficiency
- Panel tilt is the angle from horizontal of all the panels in the PV array



Solar PV Module Input Parameters

(for advanced users)



- Maximum panel area / area of the average rooftop footprint
- Only applied to flat roofs and non-North facing sloped rooftops
- Takes into account space needed for roof vents, skylights, etc
- Only a minor impact on final calculation—used to determine theoretical maximum panel area on each building



Calculation of Solar PV Generation

- Based on PVWatts from NREL
- PVWatts is typically applied for individual buildings
- We apply PVWatts on a regional basis
- Calculate PV Generation for single family and mobile homes





Calculation of Solar PV Generation

- Hourly solar resource and meteorological data
 - Representative Typical Meteorological Year 3 measurement station selected for each climate zone
- Average high-slope and low-slope rooftop area of single family and mobile homes in each climate zone used to determine max panel area
 - Used building footprint data from the US Army Corps of Engineers
 - Used high-resolution land use data from SCAG

Average area [m ²]	CZ 6	CZ 8	CZ 9	CZ 10	CZ 15	CZ 16
single family high slope	177	172	168	178	178	174
single family low slope	159	139	164	145	145	152
mobile home high slope	136	126	130	141	141	133
mobile home low slope	152	135	172	154	154	153



Calculation of Solar PV Generation

 Max PV generation for single family and mobile homes in each climate zone calculated with 4 simulations



- 1. (Low slope area) x (rooftop area availability fraction) facing 180°
- ¼ x (high slope area) x (rooftop area availability fraction) with azimuth of 270°
- ¼ x (high slope area) x (rooftop area availability fraction) with azimuth of 180°
- 4. ¼ x (high slope area) x (rooftop area availability fraction) with azimuth of 90°



Implementation of Solar PV Results

- Hourly solar generation electricity profiles are subtracted from demand profiles to determine electricity needed from the grid
- Costs of the panel installation are calculated with the cost function and electricity costs are calculated with the electricity rates
- Process is repeated with several panel areas multipliers (0.1, 0.2,...) to determine panel area where costs are minimized



U.S. Air Force photo by Kenji Thuloweit



Topics for Open Discussion

- Documentation embedded in the software vs. a large documentation file
- Feedback on this meeting (structure, level of detail, etc.)





Public Comments



blog.cleanenergy.org

