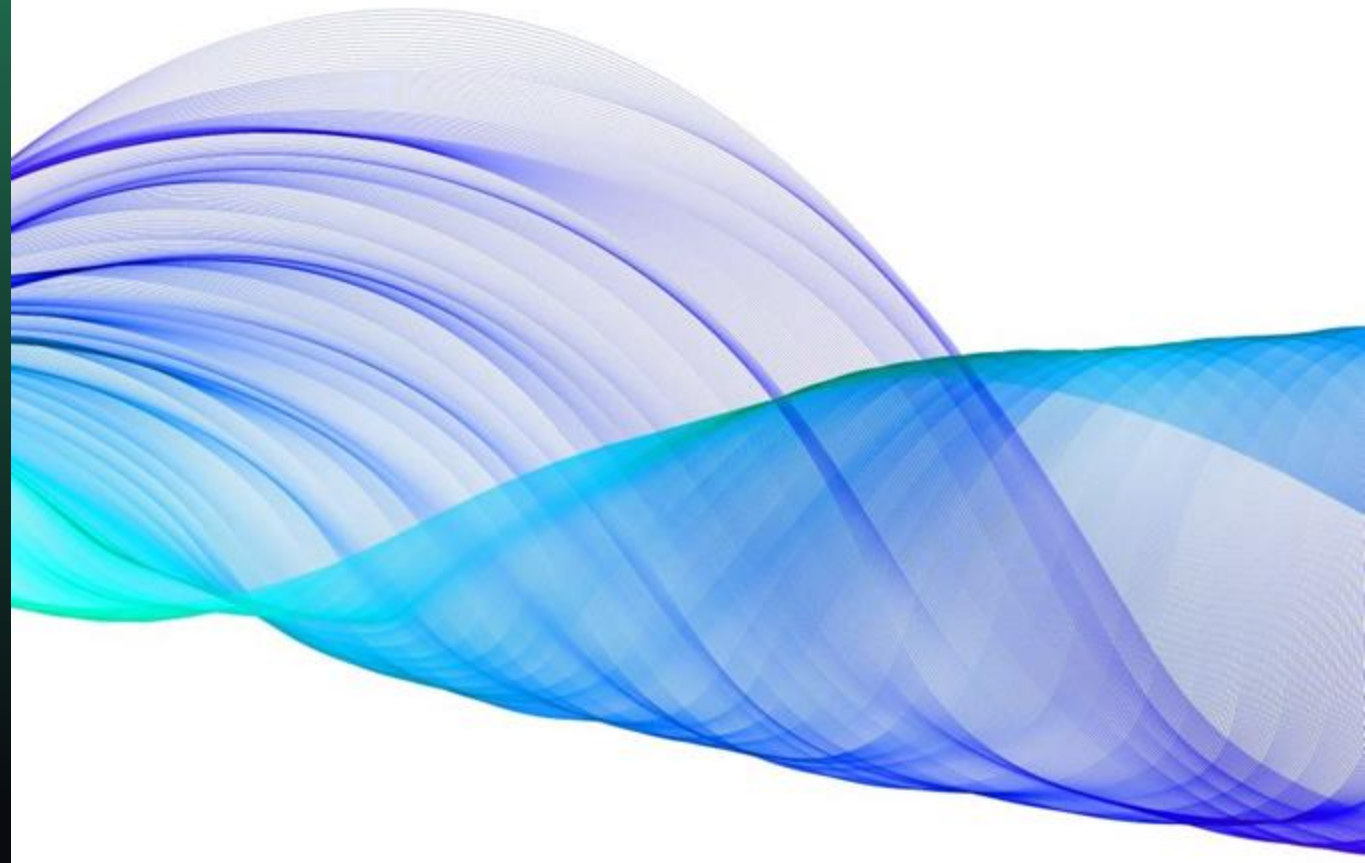
E^2X - Excess Energy Exchange



COI Energy - summer internship presentation by
Hemanth Hariharan

Projects

1. **Carbon accounting**

Building a more granular model to compute emissions avoided

2. **Customer site selection**

Analyzing historical data for identifying potential customers

3. **Financial modeling**

Calculating payback period of customers

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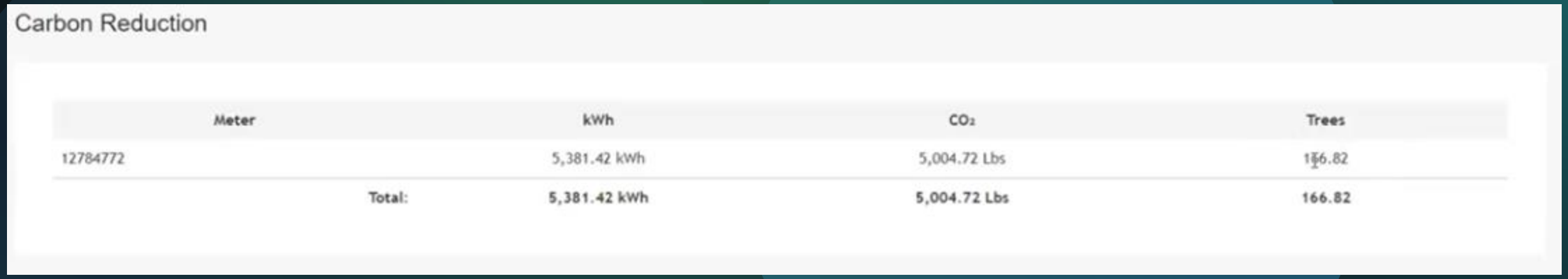
How it works right now…

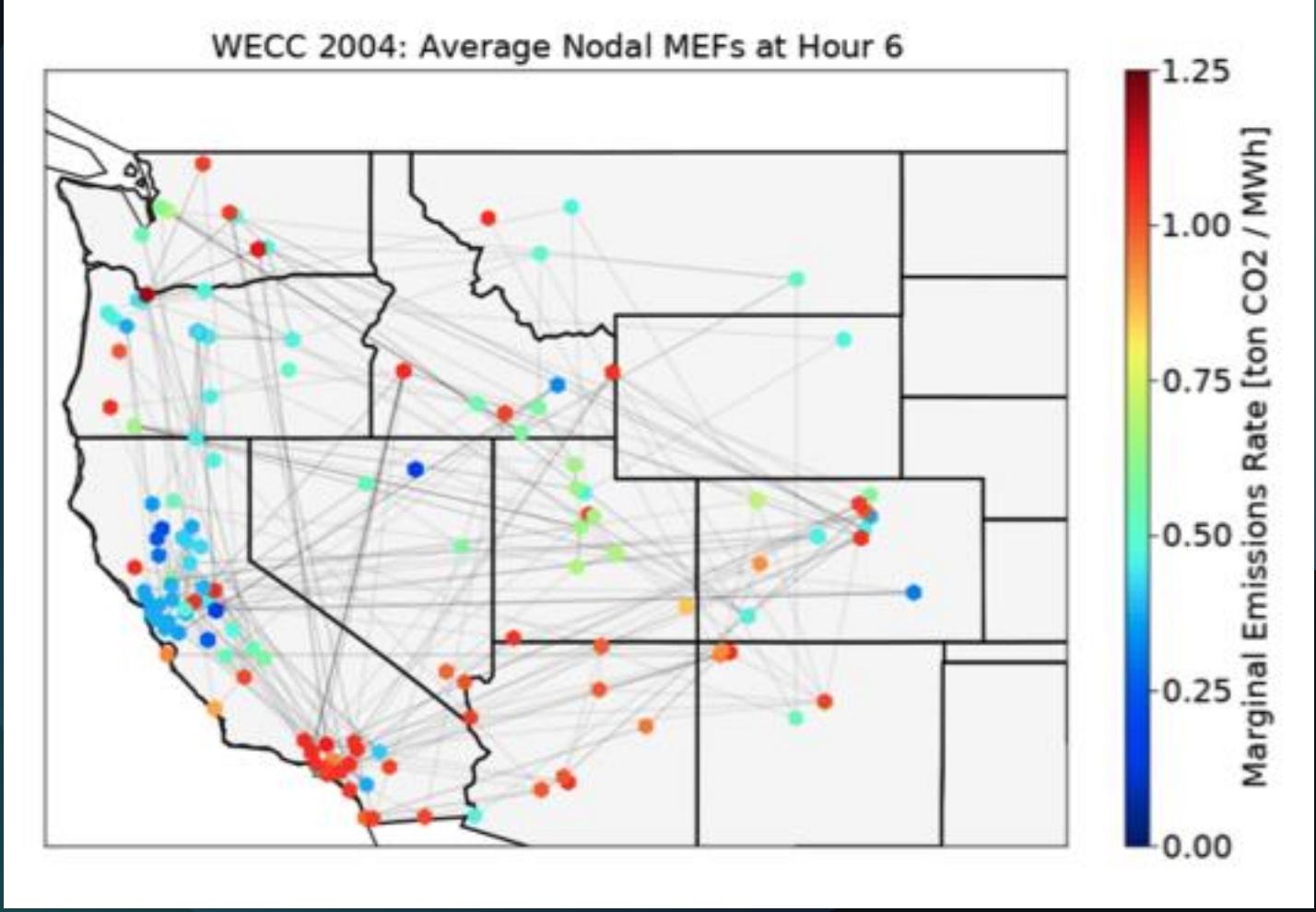


Carbon Reduction

Meter	kWh	CO_2	Trees
12784772	5,381.42 kWh	5,004.72 Lbs	166.82
Total:	5,381.42 kWh	5,004.72 Lbs	166.82

- Carbon reduction = 5381.42 kWh * 852.3 lbs of CO_2 / MWh * 1 MWh / 1000 kWh = 4586.584 lbs of CO_2
- However, the EPA emission factor is a US average, and the true carbon intensity of the grid has wide spatiotemporal variations.

Marginal emission factors

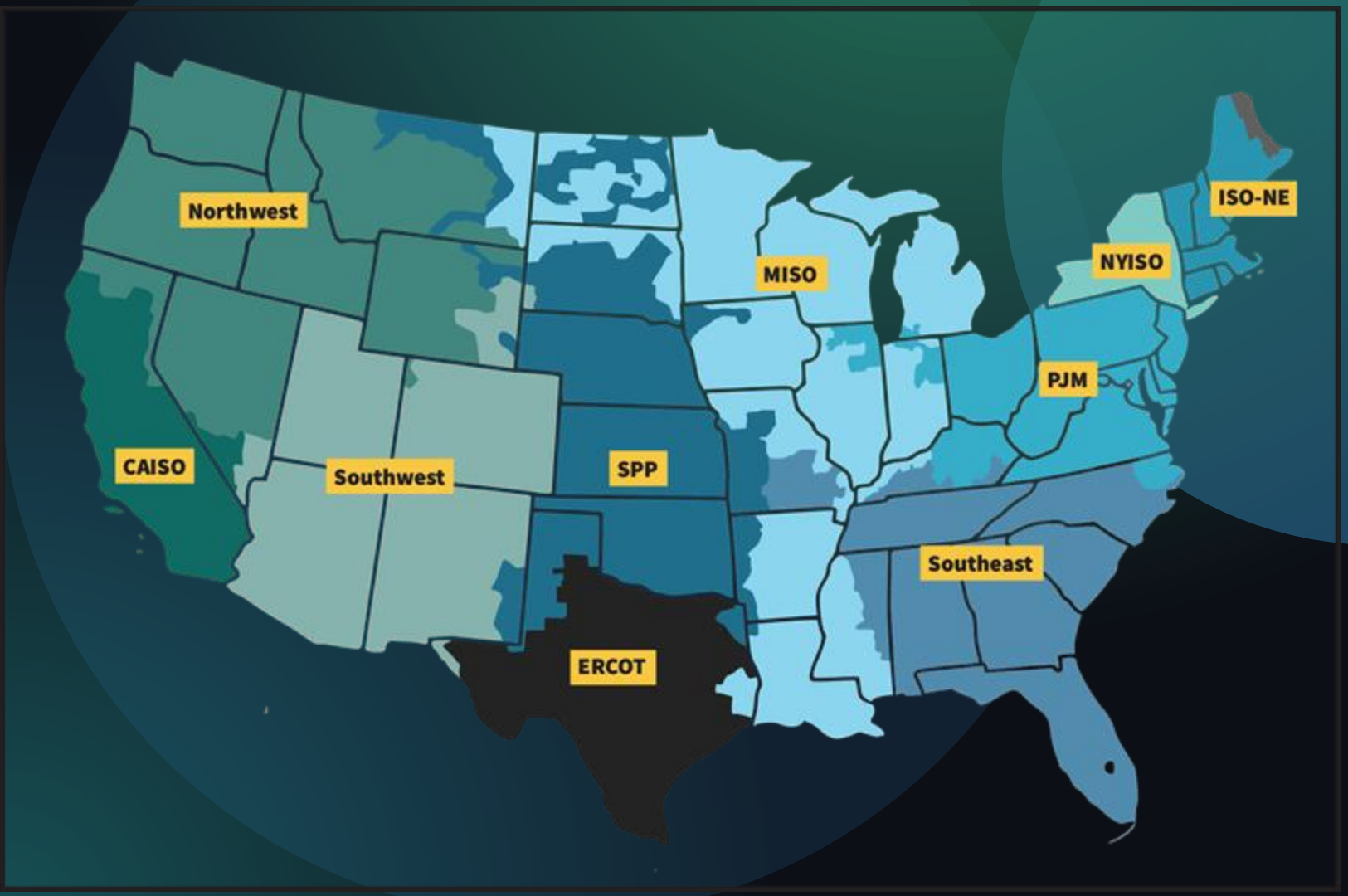


MEF varies with:

- Time of day
- Energy mix at node

However, MEFs are hard to obtain and vary spatiotemporally!

First level of granularity (by ISO)



- CAISO – 321.87 lbs of CO_2 / MWh
- ERCOT – 857.59 lbs of CO_2 / MWh
- PJM – 811 lbs of CO_2 / MWh

……

Next level of granularity (by state)

State	Grid	Generation Factor ($kgCO_2e$ per kWh)	T&D Factor ($kgCO_2e$ per kWh)	Year
UNITED STATES		***0.373138***	***0.0241***	2020 (published 2022)
Alaska (AK)	ASCC & ASCC Misc. - Alaska Grid	0.43823	0.025505	2020 (published 2022)
Alabama (AL)	SERC - South	0.32707	0.018305	2020 (published 2022)
Arkansas (AR)	SERC - South	0.43150	0.024149	2020 (published 2022)
Arizona (AZ)	WECC - Southwest	0.33429	0.018709	2020 (published 2022)
California (CA)	WECC- California	0.20553	0.011503	2020 (published 2022)
Colorado (CO)	WECC - Rockies	0.55304	0.030951	2020 (published 2022)
Connecticut (CT)	NPCC - New England	0.24030	0.013449	2020 (published 2022)
Washington DC (DC)	RFC - East	0.36338	0.020337	2020 (published 2022)
Delaware (DE)	RFC - East	0.34248	0.019167	2020 (published 2022)
Florida (FL)	FRCC - All	0.38200	0.021379	2020 (published 2022)
Georgia (GA)	SERC - South	0.32818	0.018367	2020 (published 2022)
Hawaii (HI)	HICC - Misc. & Oahu	0.69241	0.041075	2020 (published 2022)
Iowa (IA)	MRO - East	0.27905	0.015617	2020 (published 2022)
Idaho (ID)	WECC - Rockies	0.09679	0.005417	2020 (published 2022)
Illinois (IL)	MRO- East	0.25240	0.014126	2020 (published 2022)
Indiana (IN)	RFC - West	0.70282	0.039334	2020 (published 2022)
Kansas (KS)	SPP- North	0.36478	0.020415	2020 (published 2022)
Kentucky (KY)	SERC - Tennessee Valley	0.76425	0.042772	2020 (published 2022)
Louisiana (LA)	SERC - South	0.34552	0.019337	2020 (published 2022)
Massachusetts (MA)	NPCC - New England	0.39912	0.022337	2020 (published 2022)
Maryland (MD)	RFC - East	0.29271	0.016382	2020 (published 2022)
Maine (ME)	NPCC - New England	0.10350	0.005793	2020 (published 2022)
Michigan (MI)	RFC - Michigan	0.42548	0.023813	2020 (published 2022)
Minnesota (MN)	MRO - East	0.34943	0.019556	2020 (published 2022)
Missouri (MO)	SERC - South	0.73410	0.041085	2020 (published 2022)
Mississippi (MS)	SERC - South	0.40557	0.022698	2020 (published 2022)

State	Grid	Generation Factor ($kgCO_2e$ per kWh)	T&D Factor ($kgCO_2e$ per kWh)	Year
UNITED STATES		***0.373138***	***0.0241***	2020 (published 2022)
Montana (MT)	WECC - Rockies	0.41396	0.023168	2020 (published 2022)
North Carolina (NC)	SERC - Virginia/Carolinas	0.29413	0.016461	2020 (published 2022)
North Dakota (ND)	MRO-West	0.62965	0.035239	2020 (published 2022)
Nebraska (NE)	MRO-West	0.54461	0.03048	2020 (published 2022)
New Hampshire (NH)	NPCC - New England	0.11244	0.006293	2020 (published 2022)
New Jersey (NJ)	RFC - East	0.22330	0.012497	2020 (published 2022)
New Mexico (NM)	WECC - Southwest	0.57147	0.031983	2020 (published 2022)
Nevada (NV)	WECC - Rockies	0.32505	0.018192	2020 (published 2022)
New York (NY)	NPCC - LI, NYC, & Upstate NY	0.18901	0.010578	2020 (published 2022)
Ohio (OH)	RFC - West	0.56848	0.031815	2020 (published 2022)
Oklahoma (OK)	SPP- South	0.32144	0.01799	2020 (published 2022)
Oregon (OR)	WECC - Northwest	0.15495	0.008672	2020 (published 2022)
Pennsylvania (PA)	RFC - West	0.31639	0.017707	2020 (published 2022)
Rhode Island (RI)	NPCC - New England	0.37537	0.021008	2020 (published 2022)
South Carolina (SC)	SERC - Virginia/Carolinas	0.23308	0.013045	2020 (published 2022)
South Dakota (SD)	MRO-West	0.15449	0.008646	2020 (published 2022)
Tennessee (TN)	SERC - Tennessee Valley	0.25919	0.014506	2020 (published 2022)
Texas (TX)	ERCOT - All	0.38896	0.021336	2020 (published 2022)
Utah (UT)	WECC - Rockies	0.71022	0.039748	2020 (published 2022)
Virginia (VA)	SERC - Virginia/Carolinas	0.29250	0.01637	2020 (published 2022)
Vermont (VT)	NPCC - New England	0.01375	0.000769	2020 (published 2022)
Washington (WA)	WECC - Northwest	0.09674	0.005414	2020 (published 2022)
Wisconsin (WI)	MRO - East	0.54069	0.03026	2020 (published 2022)
West Virginia (WV)	SERC - Virginia/Carolinas	0.87304	0.048861	2020 (published 2022)
Wyoming (WY)	WECC - Rockies	0.90270	0.05052	2020 (published 2022)

A different approach - utility emissions data

- TECO (Tampa Electric)
  - Coal: 2.30 lbs CO2/kWh
  - Natural gas: 0.97 lbs CO2/kWh
  - Petroleum: 2.38 lbs CO2/kWh
- PG&E: 0.056 lbs CO2 per kWh (much lower than national average likely due to high solar penetration)
- ConEdison: 0.637 lbs of CO2 per kWh

A more granular estimate of emissions can be obtained based on the energy mix of the utility.

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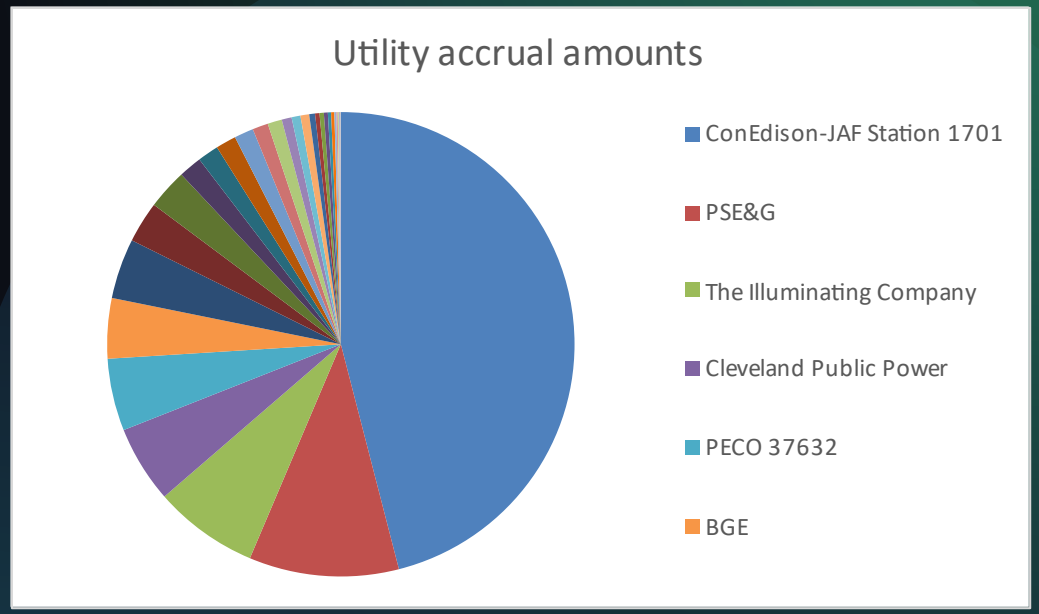
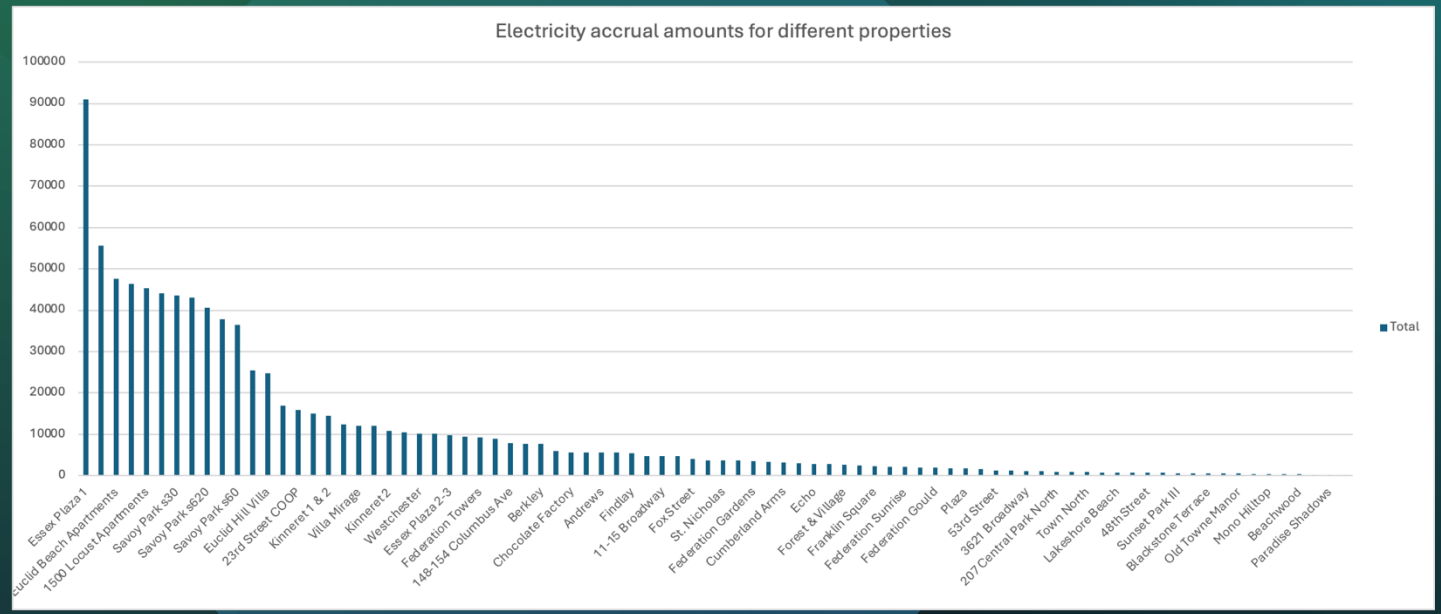
ConService Data Analysis





- Major consumers of electricity: Essex Plaza 1, Savoy Park s2300, Euclid Beach Apartments, Savoy Park – s15, 1500 Locust Apartments.
- Largest electricity utility providers to the properties are ConEdison, PSE&G, The Illuminating Company, Cleveland Public Power, PECO and BGE.

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Inputs tab

General Inputs	Quantity	Units
Utility demand charge	13.77	$/kW
COI demand charge (sellers)	9.639	$/kW
COI demand charge (buyers)	9.64	$/kW
Discount rate	10%	annual
Discount rate	0.80%	monthly
Savings towards kW for good	1%	
Transaction fee	15%	

Seller Inputs	Quantity	Units
Peak demand mean	300	kW
Peak demand standard deviation	50	kW
Baseload demand mean	150	kW
Baseload demand standard deviation	10	kW

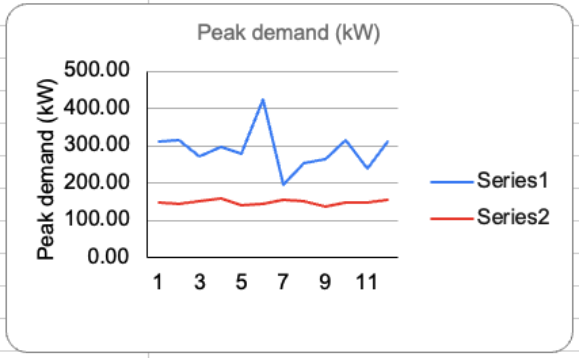
Buyer Inputs	Quantity	Units
Peak demand mean	300	kW
Peak demand standard deviation	50	kW
Baseload demand mean	150	kW
Baseload demand standard deviation	10	kW

Utility	Demand charge ($/kW)
PG&E	20.09
TECO	13.77

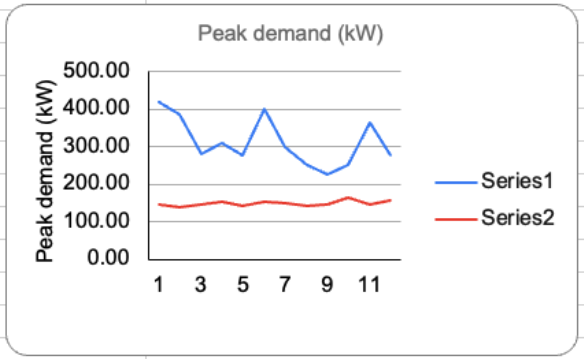
- COI demand charge assumed to be 70% of utility demand charge
- Seller and buyer demands are generated from normal distribution using assumed mean and standard deviation
- 1% of savings go towards the “kW for good” initiative

Calculation of payback period (seller)

	Month	1	2	3	4	5	6	7	8	9	10	11	12
Costs to customer for using E2X													
For both buyers and sellers	**One-time activation fee**	$ 7,200.00											
	Subscription fee (monthly)	$549	$549	$549	$549	$549	$549	$549	$549	$549	$549	$549	$549
	TOTAL	$ 7,749.00											
Seller (supply-side)													
	Business-as-usual scenario:												
	Peak demand (kW)	310.19	315.48	271.30	296.07	278.77	422.54	193.81	251.27	263.48	314.15	237.73	312.35
	Baseload demand (kW)	146.16	145.12	151.20	158.95	141.59	145.56	155.15	149.82	137.10	147.84	147.70	154.16
	Demand charge rate ($/kW)	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77
	Demand charges ($)	$ 4,271.35	$4,344.22	$3,735.75	$4,076.92	$3,838.60	$5,818.34	$2,668.81	$3,460.04	$3,628.18	$4,325.81	$3,273.55	$4,301.10
	Savings from E2X												
	Capacity sold (kW)	98.42	102.22	72.06	82.27	82.31	166.19	23.20	60.87	75.83	99.78	54.02	94.92
	COI capacity price ($/kW)	9.639	9.639	9.639	9.639	9.639	9.639	9.639	9.639	9.639	9.639	9.639	9.639
	Capacity savings ($)	$ 948.66	$ 985.30	$ 694.54	$ 793.01	$ 793.36	$1,601.90	$ 223.58	$ 586.77	$ 730.93	$ 961.81	$ 520.66	$ 914.90
	Contribution to kW for good ($)	$ 9.49	$ 9.85	$ 6.95	$ 7.93	$ 7.93	$ 16.02	$ 2.24	$ 5.87	$ 7.31	$ 9.62	$ 5.21	$ 9.15
	Net refund from COI ($)	$ 390.17	$ 426.45	$ 138.60	$ 236.08	$ 236.43	$1,036.88	$ (327.66)	$ 31.90	$ 174.62	$ 403.20	$ (33.54)	$ 356.76
	Break-even time period:												
	Discounted cash flows	$ 387.08	$ 419.73	$ 135.33	$ 228.70	$ 227.23	$ 988.62	$ (309.94)	$ 29.94	$ 162.57	$ 372.41	$ (30.74)	$ 324.32
	Cumulative savings	$ 387.08	$ 806.81	$ 942.14	$1,170.84	$1,398.07	$2,386.69	$2,076.75	$2,106.69	$2,269.26	$2,641.67	$2,610.94	$2,935.26
	Break-even in	13	months										



Calculation of payback period (buyer)



Buyer (demand-side)												
Business-as-usual scenario:												
Peak demand (kW)	417.41	384.09	279.65	307.56	276.15	400.68	298.84	250.40	225.94	250.77	364.19	275.19
Baseline demand (kW)	144.81	138.78	147.11	152.15	142.93	154.12	149.02	140.53	147.43	164.86	145.19	157.13
Demand charge rate ($/kW)	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77	13.77
Demand charges ($)	$ 5,747.77	$5,288.87	$3,850.71	$4,235.07	$3,802.54	$5,517.43	$4,114.97	$3,448.08	$3,111.13	$3,453.08	$5,014.93	$3,789.37
Using E2X												
New peak demand (kW)	144.81	138.78	147.11	152.15	142.93	154.12	149.02	140.53	147.43	164.86	145.19	157.13
New demand charges ($)	$ 1,994.01	$1,910.97	$2,025.76	$2,095.09	$1,968.11	$2,122.29	$2,052.06	$1,935.05	$2,030.13	$2,270.13	$1,999.32	$2,163.70
Capacity purchased from COI (kW)	272.60	245.31	132.53	155.41	133.22	246.56	149.81	109.88	78.50	85.91	219.00	118.06
COI capacity price ($/kW)	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64	9.64
COI capacity charges ($)	$ 2,627.63	$2,364.54	$1,277.47	$1,497.99	$1,284.10	$2,376.60	$1,444.03	$1,059.12	$ 756.71	$ 828.07	$2,110.93	$1,137.97
Total charges ($)	$ 4,621.64	$4,275.50	$3,303.23	$3,593.07	$3,252.21	$4,498.89	$3,496.10	$2,994.17	$2,786.83	$3,098.20	$4,110.25	$3,301.67
Savings												
Undiscounted savings ($)	$ 577.13	$ 464.37	$ (1.51)	$ 92.99	$ 1.33	$ 469.54	$ 69.87	$ (95.09)	$ (224.70)	$ (194.11)	$ 355.68	$ (61.30)
Discounted savings ($)	$ 572.56	$ 457.05	$ (1.48)	$ 90.09	$ 1.28	$ 447.69	$ 66.09	$ (89.24)	$ (209.20)	$ (179.29)	$ 325.93	$ (55.73)
Cumulative savings ($)	$ 572.56	$1,029.62	$1,028.14	$1,118.22	$1,119.50	$1,567.19	$1,633.28	$1,544.05	$1,334.85	$1,155.56	$1,481.48	$1,425.76
Break-even in	13	**months**										

Thank you!