



CALIFORNIA ENERGY COMMISSION

Zero Carbon Retreat

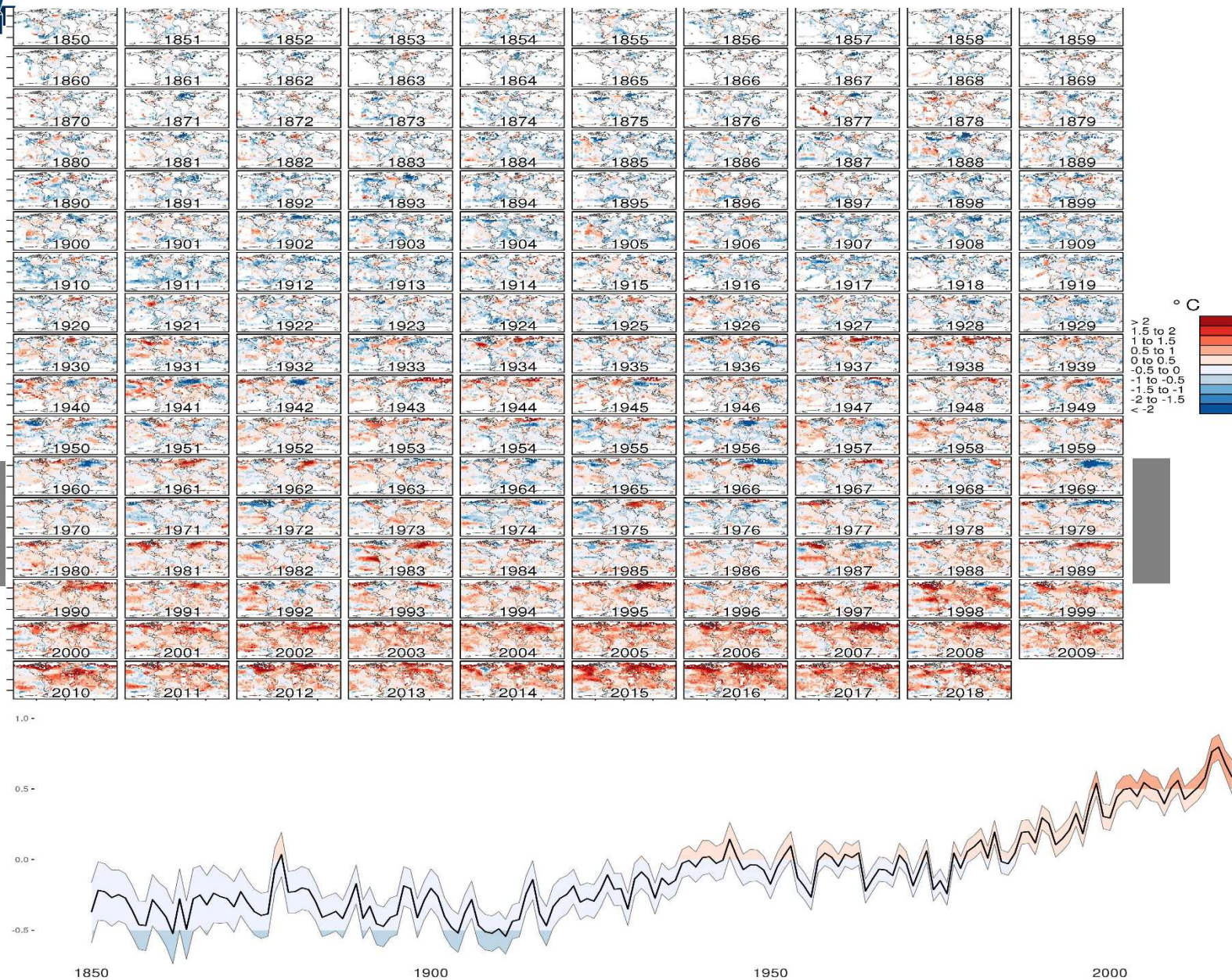
February 4, 2019

Martha Brook, P.E.
Advisor to Commissioner McAllister



CALIFORNIA ENERGY COMMISSION

1850-2018 Global Surface Temperature Anomalies
relative to 1961-1990 average
[reddit/dataisbeautiful/neilrkae](https://www.reddit.com/user/dataisbeautiful/neilrkae)

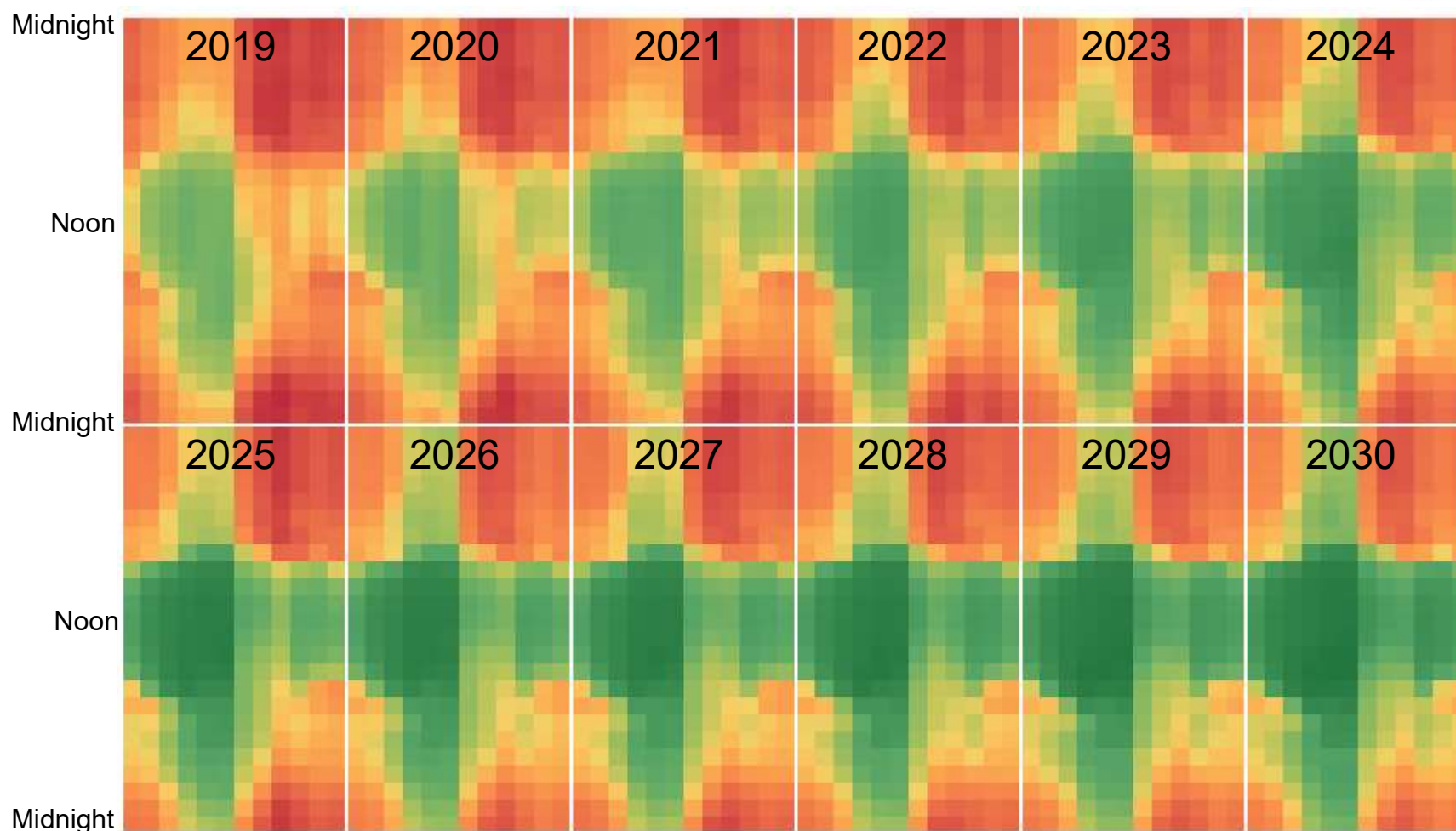
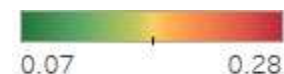




CALIFORNIA ENERGY COMMISSION

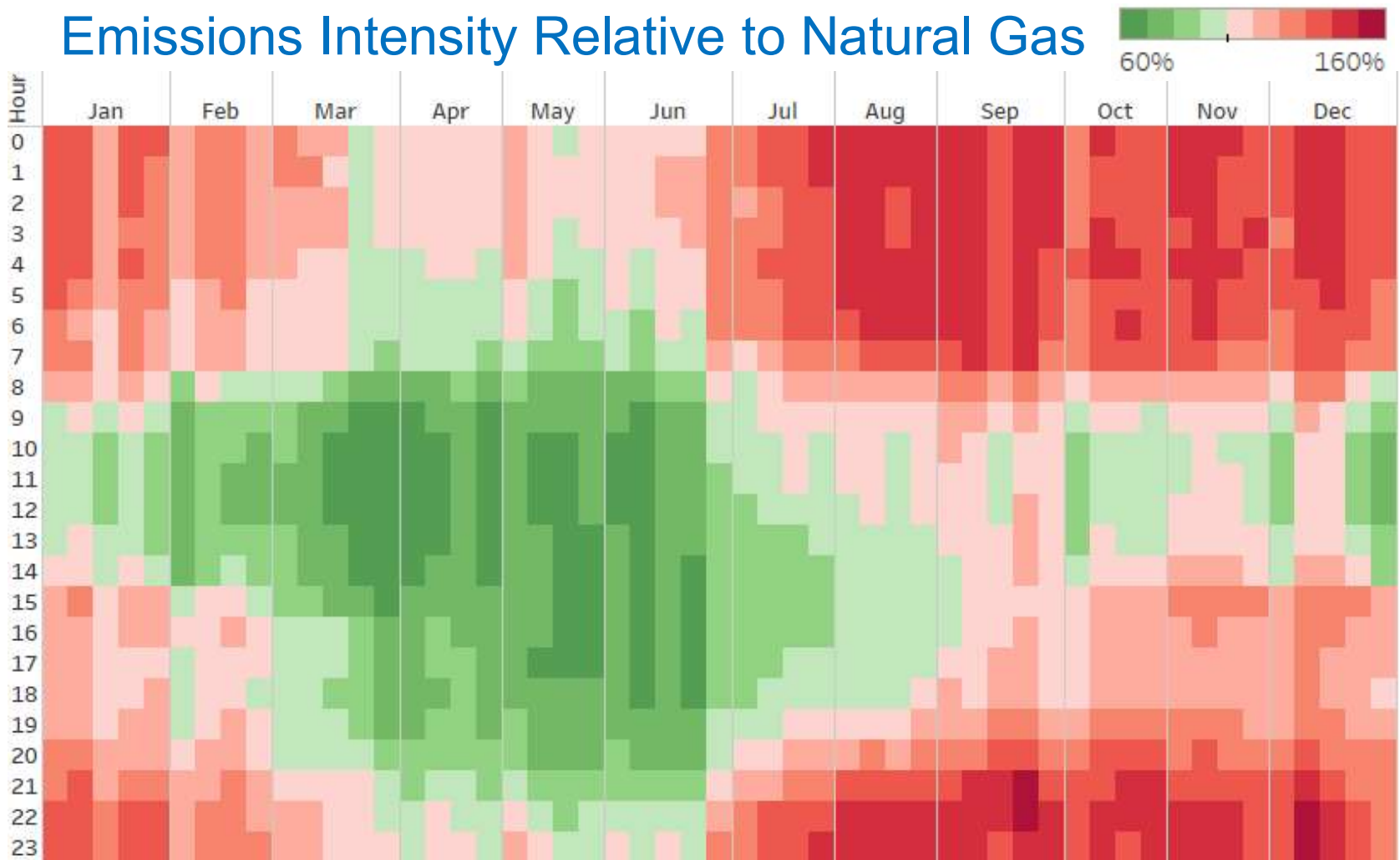
Electricity CO₂ Intensity

Electric Emissions (Tons/MWh), 2019-2030





Emissions Intensity Relative to Natural Gas





CALIFORNIA ENERGY COMMISSION

CZ 3 Space Heating - 2019 Std

1

1.60

0.40

2019 GHG Elec HP relative to Gas Furnace

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	792.6	452.1	231.7	166.4	19.8	13.9	0.0	0.0	0.0	51.6	411.9	807.6
2	887.6	568.2	290.5	248.1	37.3	11.8	0.0	0.0	0.0	43.7	493.6	888.9
3	969.1	649.8	352.7	315.1	59.1	13.1	0.0	0.0	0.0	58.0	585.5	975.0
4	134.8	731.3	429.0	384.8	78.8	15.0	0.0	0.0	0.0	74.9	671.6	1040.9
5	30.8	239.1	477.3	387.0	90.2	15.4	0.0	0.0	0.0	92.2	55.4	116.8
6	11.9	17.6	0.9	0.5	81.4	11.3	0.0	0.0	0.0	19.6	20.6	14.6
7	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.6	0.3
8	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.3	0.1	0.2
9	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.2	0.2	0.2
10	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.2	0.1	0.2
11	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.1	0.1
12	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1
13	0.2	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1
14	0.2	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.2
15	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
16	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
17	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
18	0.2	0.2	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.2
19	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.3
20	0.3	0.2	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.2	0.3
21	0.3	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3
22	0.4	0.2	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.3	0.3
23	0.4	0.3	0.5	61.7	4.4	0.0	0.0	0.0	0.0	16.8	0.3	0.4
24	703.3	332.5	163.7	101.1	10.6	2.4	0.0	0.0	0.0	19.6	349.0	685.9

Central HP: 8.2 HSPF



CALIFORNIA ENERGY COMMISSION

CZ 3 Water Heating - 2019 Std

HPWH ~ 3 COP

1

1.60

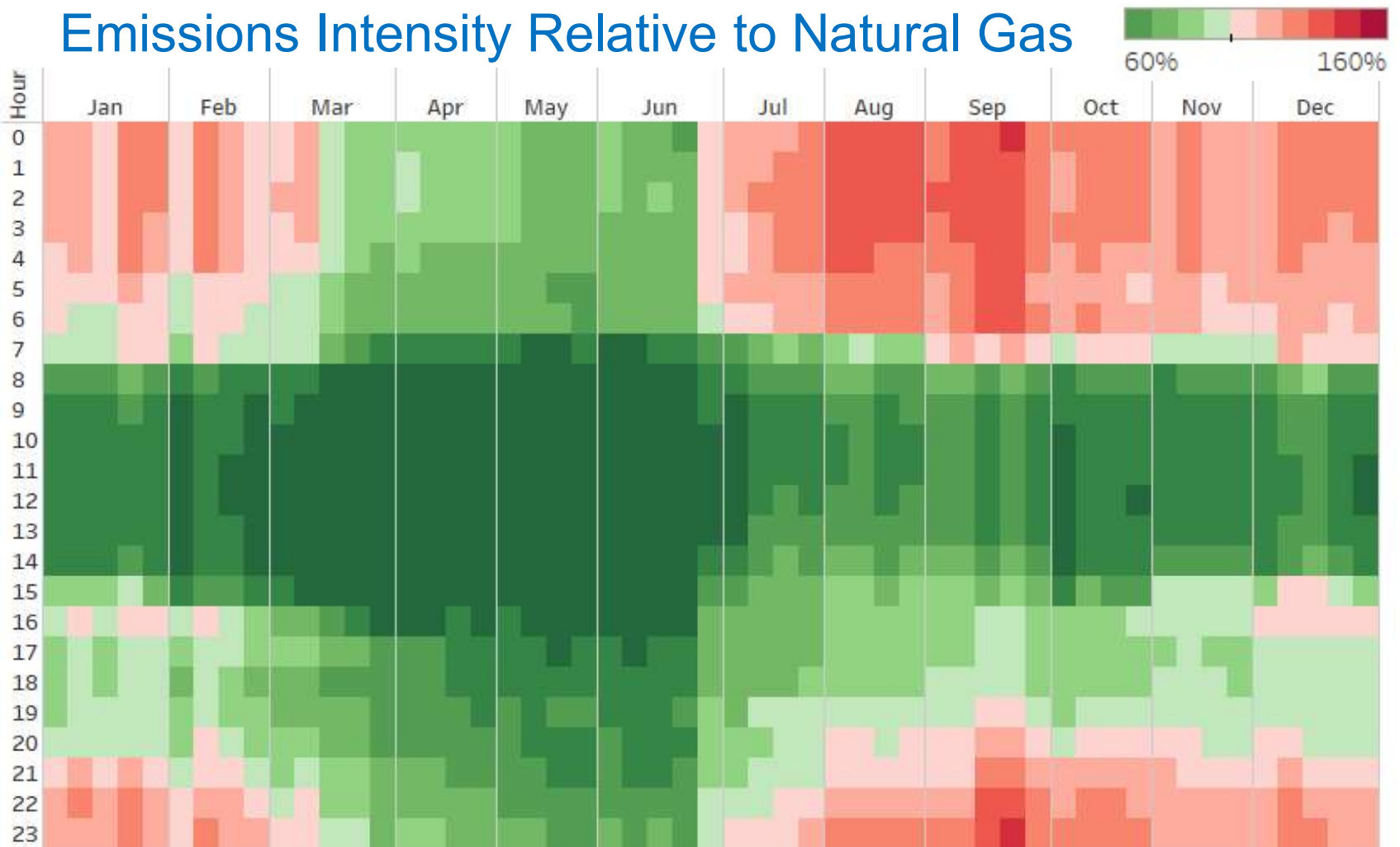
0.40

2019 GHG Elec HPWH vs. Gas Tankless

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.1	1.6	1.4	0.5	0.4	0.2	2.5	0.5	1.3	3.2	7.5	0.4
2	4.9	1.8	0.9	0.6	0.1	1.3	0.3	1.1	1.2	0.4	2.6	2.9
3	3.8	2.1	0.3	3.2	0.3	2.0	1.0	0.6	8.5	4.3	0.1	1.8
4	6.1	6.3	0.6	0.5	0.7	0.3	0.3	0.3	0.5	0.4	1.3	1.1
5	0.6	0.4	0.5	0.7	0.3	0.3	0.3	0.3	0.0	0.5	0.8	1.4
6	1.1	0.8	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.4	0.7	1.2
7	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.4
8	0.3	0.3	0.4	0.3	0.3	0.5	0.3	0.3	0.7	0.2	0.3	0.2
9	0.3	0.5	0.4	0.3	0.5	0.3	0.4	0.3	0.7	0.4	0.4	0.4
10	0.2	0.3	0.3	0.3	0.5	0.4	0.6	0.3	0.4	0.5	0.3	0.8
11	0.5	0.6	0.2	0.4	0.4	0.3	0.3	0.6	0.3	0.6	0.4	1.1
12	0.5	1.0	0.3	0.3	0.5	0.1	0.3	0.5	0.4	0.4	0.4	0.4
13	0.4	0.3	0.3	0.2	0.3	0.1	0.2	0.3	0.2	0.3	0.5	0.3
14	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.5	0.2
15	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.3
16	0.3	0.2	0.1	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1
17	0.3	0.4	0.1	0.5	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.2
18	0.9	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.3	0.2	0.3
19	0.7	0.3	0.3	0.3	0.2	0.1	0.3	0.1	0.2	0.4	0.3	0.3
20	0.5	0.4	1.0	0.2	0.2	0.4	0.3	0.5	0.5	0.4	0.3	0.3
21	0.6	0.5	0.3	0.2	0.2	0.6	0.3	0.8	0.5	0.2	0.5	0.7
22	0.3	0.8	0.7	0.7	0.4	0.2	0.8	0.6	0.7	0.7	0.5	0.9
23	1.1	0.3	0.8	1.6	0.5	0.7	0.9	1.3	1.2	0.9	1.4	2.9
24	0.7	0.3	1.9	0.7	1.3	0.4	0.9	3.0	0.7	1.1	0.7	1.4



Emissions Intensity Relative to Natural Gas





CALIFORNIA ENERGY COMMISSION

CZ 3 Space Heating - 2019 Std

1

1.60

0.40

2030 GHG Elec HP relative to Gas Furnace

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	708.9	435.7	210.0	134.5	14.5	8.9	0.0	0.0	0.0	47.1	351.1	704.0
2	799.3	542.7	262.3	198.9	27.7	7.6	0.0	0.0	0.0	39.4	420.5	779.7
3	875.3	618.5	323.1	251.0	43.9	9.0	0.0	0.0	0.0	52.6	496.9	856.7
4	121.2	695.6	388.5	307.0	57.0	10.0	0.0	0.0	0.0	69.1	568.1	913.9
5	26.8	221.4	422.4	305.0	63.5	9.8	0.0	0.0	0.0	78.3	46.2	100.6
6	10.2	15.7	0.8	0.4	58.9	7.5	0.0	0.0	0.0	16.4	16.7	12.3
7	0.2	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.3
8	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.2	0.1	0.1
9	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1
10	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
11	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1
12	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
13	0.1	0.1	0.1	0.1	Central HP: 8.2 HSPF					0.0	0.1	0.1
14	0.1	0.1	0.1	0.1						0.0	0.1	0.1
15	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
16	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.2
17	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
18	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.2
19	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
20	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
21	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.2
22	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.3
23	0.4	0.2	0.4	48.9	3.0	0.0	0.0	0.0	0.0	15.4	0.3	0.4
24	621.1	312.7	149.8	80.2	7.3	1.3	0.0	0.0	0.0	18.7	287.5	587.7



CALIFORNIA ENERGY COMMISSION

CZ 3 Water Heating - 2019 Std

HPWH ~ 3 COP

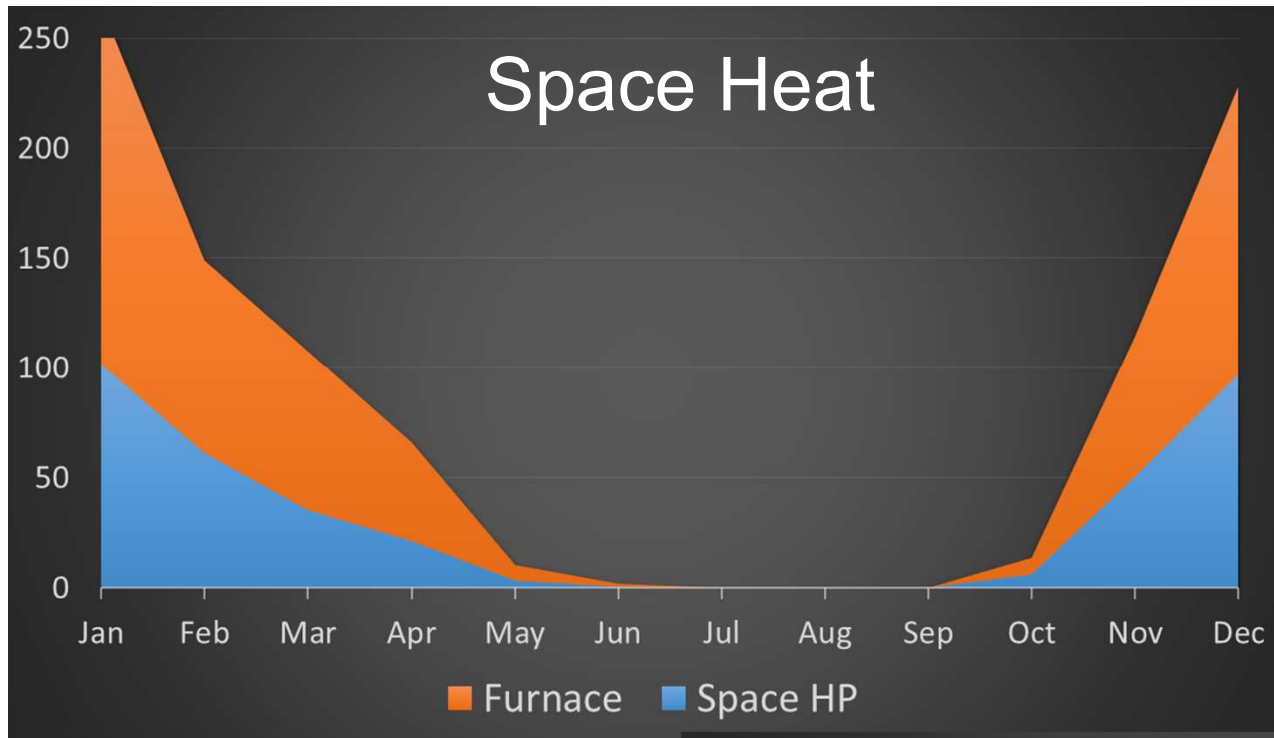
1

1.60

0.40

2030 GHG Elec HPWH vs. Gas Tankless

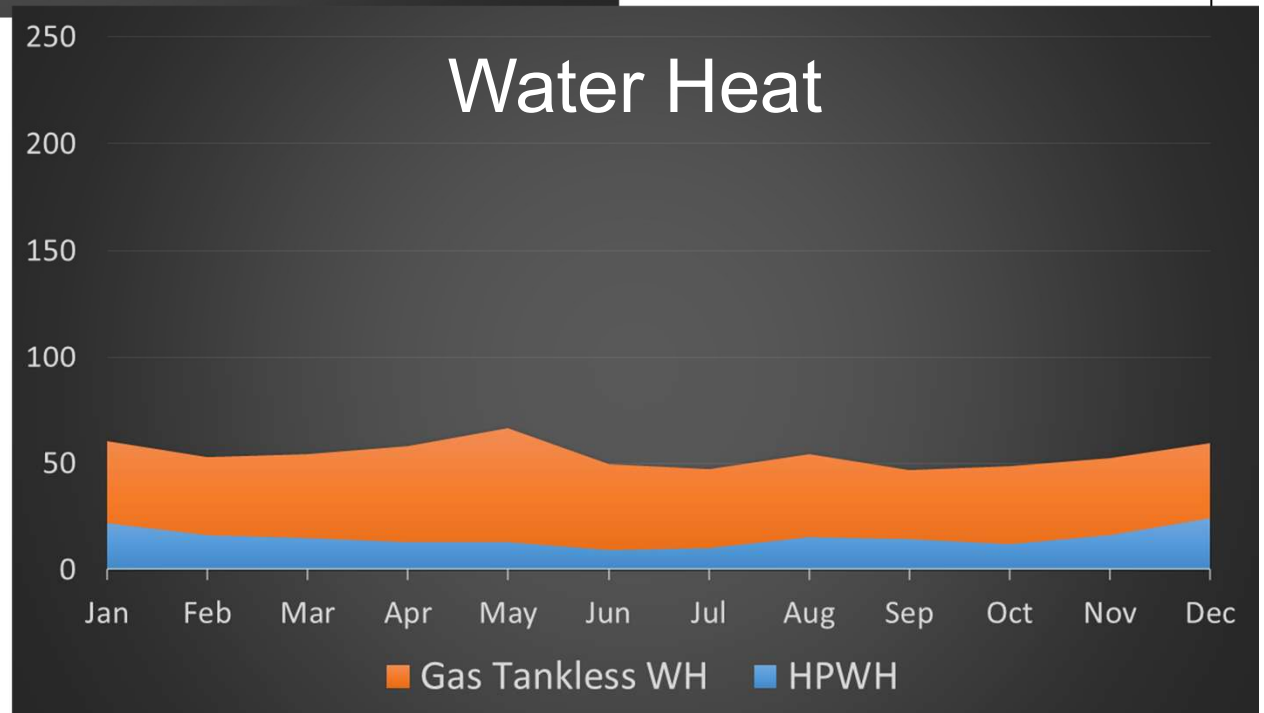
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.0	1.6	1.3	0.4	0.3	0.1	2.2	0.5	1.1	2.9	6.2	0.4
2	4.7	1.9	0.9	0.5	0.1	1.0	0.3	1.0	1.1	0.4	2.3	2.6
3	3.5	2.1	0.3	2.7	0.2	1.5	0.9	0.5	8.2	4.1	0.1	1.6
4	5.7	6.2	0.5	0.4	0.5	0.2	0.3	0.3	0.5	0.4	1.2	1.0
5	0.5	0.4	0.4	0.6	0.2	0.2	0.2	0.3	0.0	0.4	0.7	1.3
6	0.9	0.7	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.6	1.0
7	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.4
8	0.2	0.3	0.4	0.2	0.2	0.3	0.2	0.2	0.5	0.2	0.2	0.1
9	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.4	0.2	0.2	0.3
10	0.1	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.3	0.1	0.5
11	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.7
12	0.3	0.6	0.2	0.2	0.3	0.1	0.2	0.3	0.2	0.2	0.2	0.3
13	0.2	0.2	0.2	0.1	0.2	0.0	0.1	0.2	0.1	0.1	0.3	0.2
14	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1
15	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
16	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1
17	0.3	0.3	0.1	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1
18	0.8	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
19	0.6	0.3	0.3	0.3	0.2	0.1	0.2	0.1	0.2	0.3	0.2	0.3
20	0.4	0.4	0.8	0.1	0.2	0.3	0.2	0.4	0.4	0.3	0.3	0.2
21	0.5	0.4	0.2	0.2	0.1	0.5	0.2	0.7	0.5	0.2	0.4	0.6
22	0.3	0.7	0.6	0.6	0.3	0.2	0.6	0.5	0.6	0.6	0.4	0.7
23	0.9	0.3	0.7	1.2	0.3	0.5	0.7	1.1	1.1	0.8	1.1	2.5
24	0.6	0.3	1.7	0.5	0.9	0.2	0.8	2.7	0.6	0.9	0.6	1.2



MISSION

Monthly
2030 GHG
(kg)

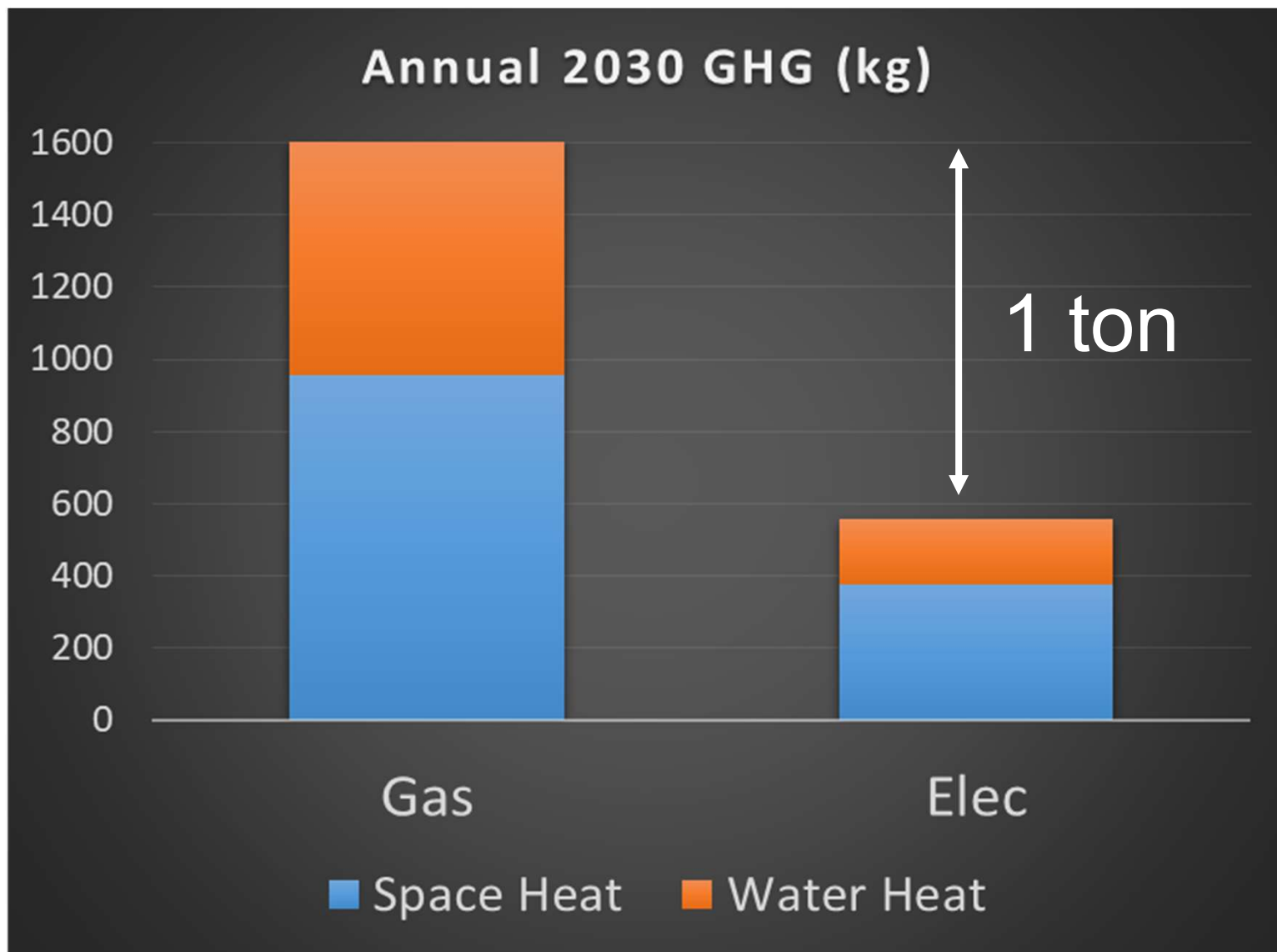
CZ 3
2019 Std
2100 sf





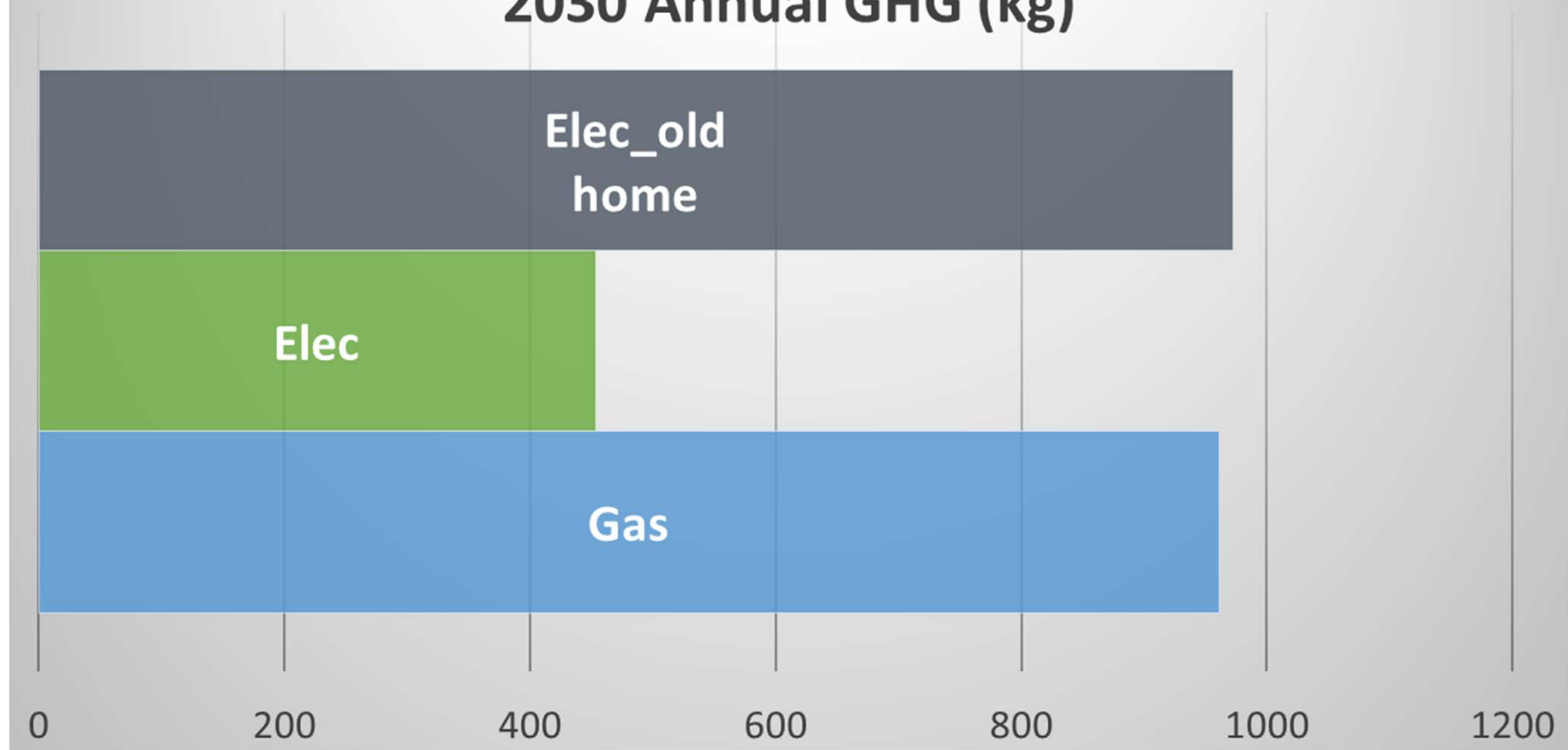
CALIFORNIA ENERGY COMMISSION

CZ 3 2019 Std – 2100 sf





Space Heat CZ 3 2030 Annual GHG (kg)



#electrifyenvelopeupgrades



CALIFORNIA ENERGY COMMISSION

