Persistent impacts of covid on residential electricity

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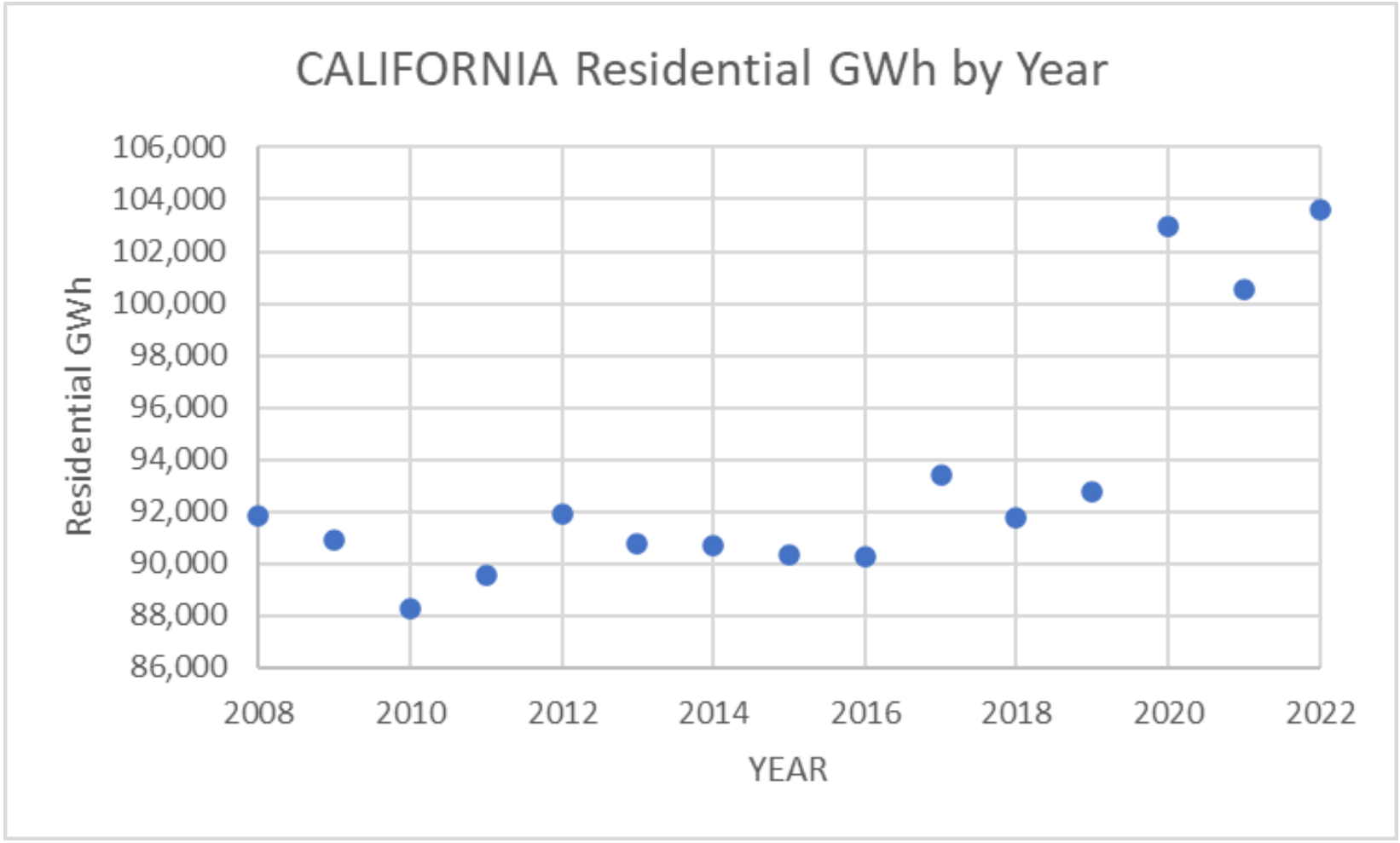
2024 October

EEDAL ‘24

RESIDENTIAL ELECTRICITY CONSUMPTION INCREASED IN CALIFORNIA IN 2020

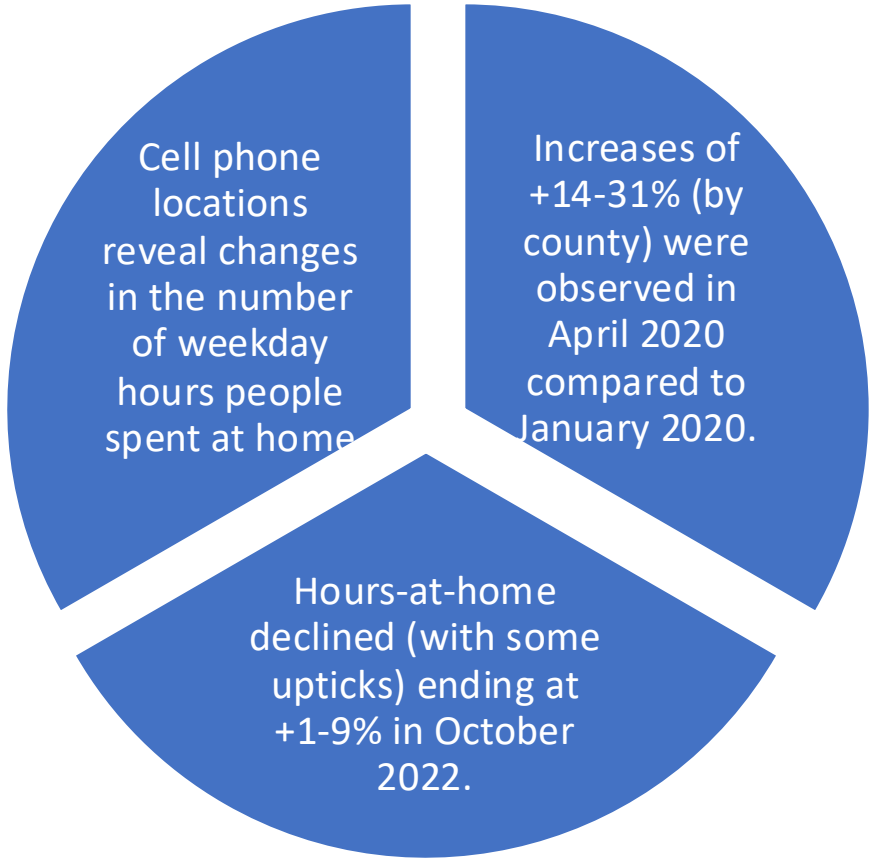
- Starting in 2020, annual residential electricity consumption increased compared to all previous years
- In 2020, 14.392 million California households consumed an average of 7 153 kWh.
- Stay-at-home orders caused many people to work from home rather than at their office or place of business.

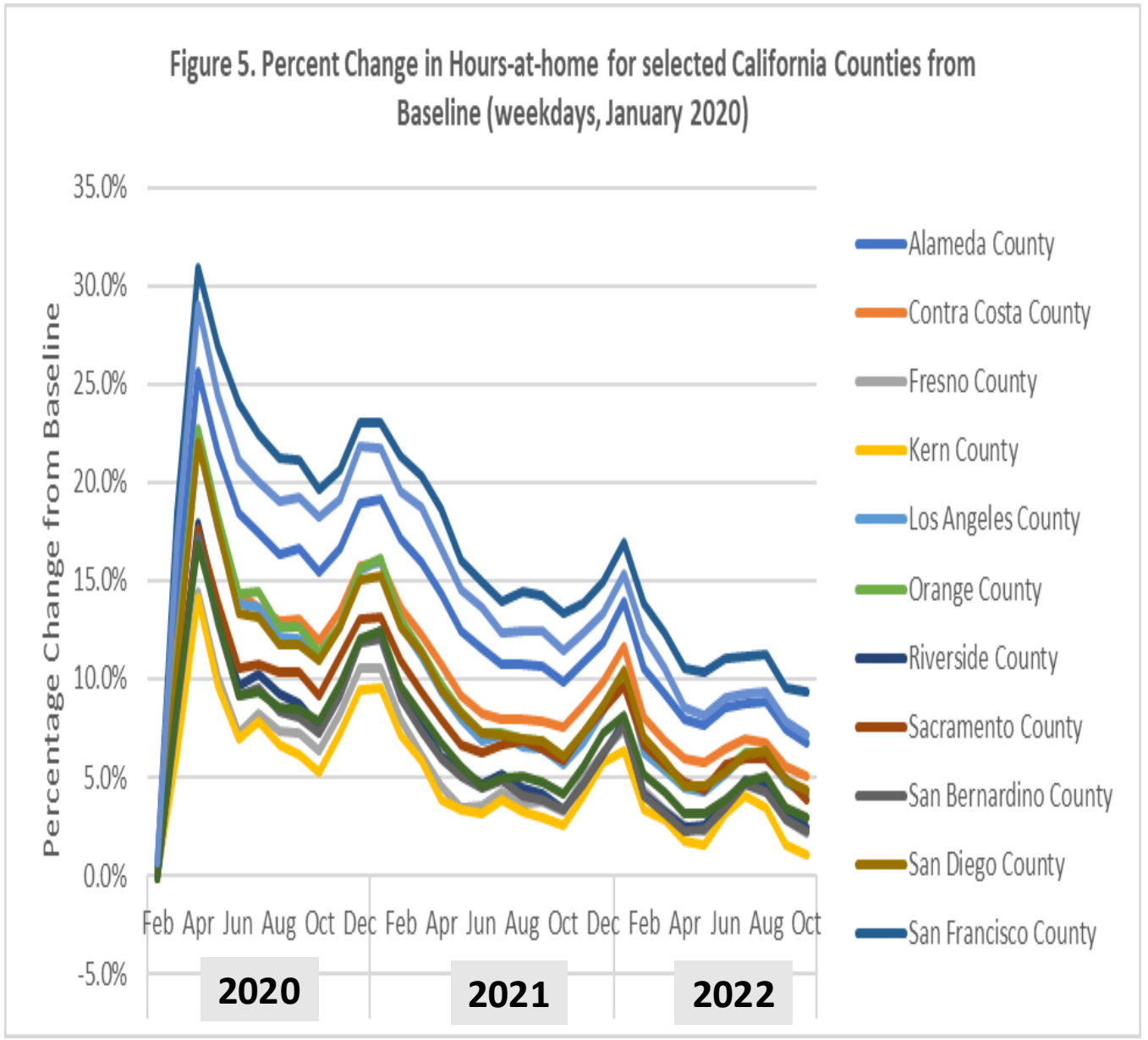


1 GWh (GigaWatthour = 10^6 kWh

Google knows where you live!

WEEKDAY HOURS-AT-HOME INCREASED DURING COVID THEN DECLINED THROUGH 2022

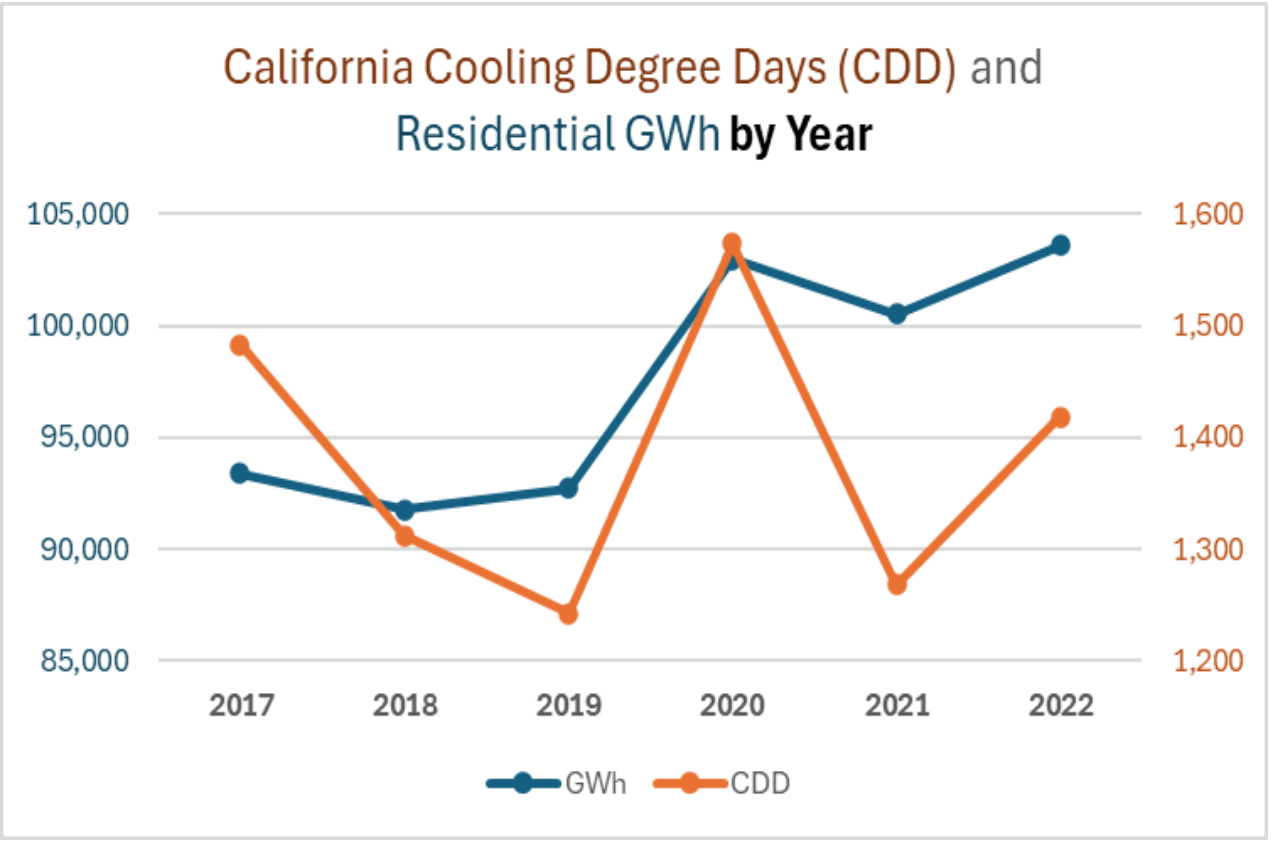




WARM WEATHER INCREASED ELECTRICITY USE IN 2020 –

BUT DOES NOT EXPLAIN 2021 AND 2022

- Hotter temperatures are associated with increased electricity use, primarily for air conditioning (space cooling) in summer months.
- 2020 (1 573 CDD) was warmer than 2019 (1 243 CDD).
- 2021 (1 268 CDD) was similar to 2019, but electricity did not return to previous level.
- 2022 (1 418 CDD) was similar to 2017 (1 483 CDD), but residential electricity consumption remained higher.

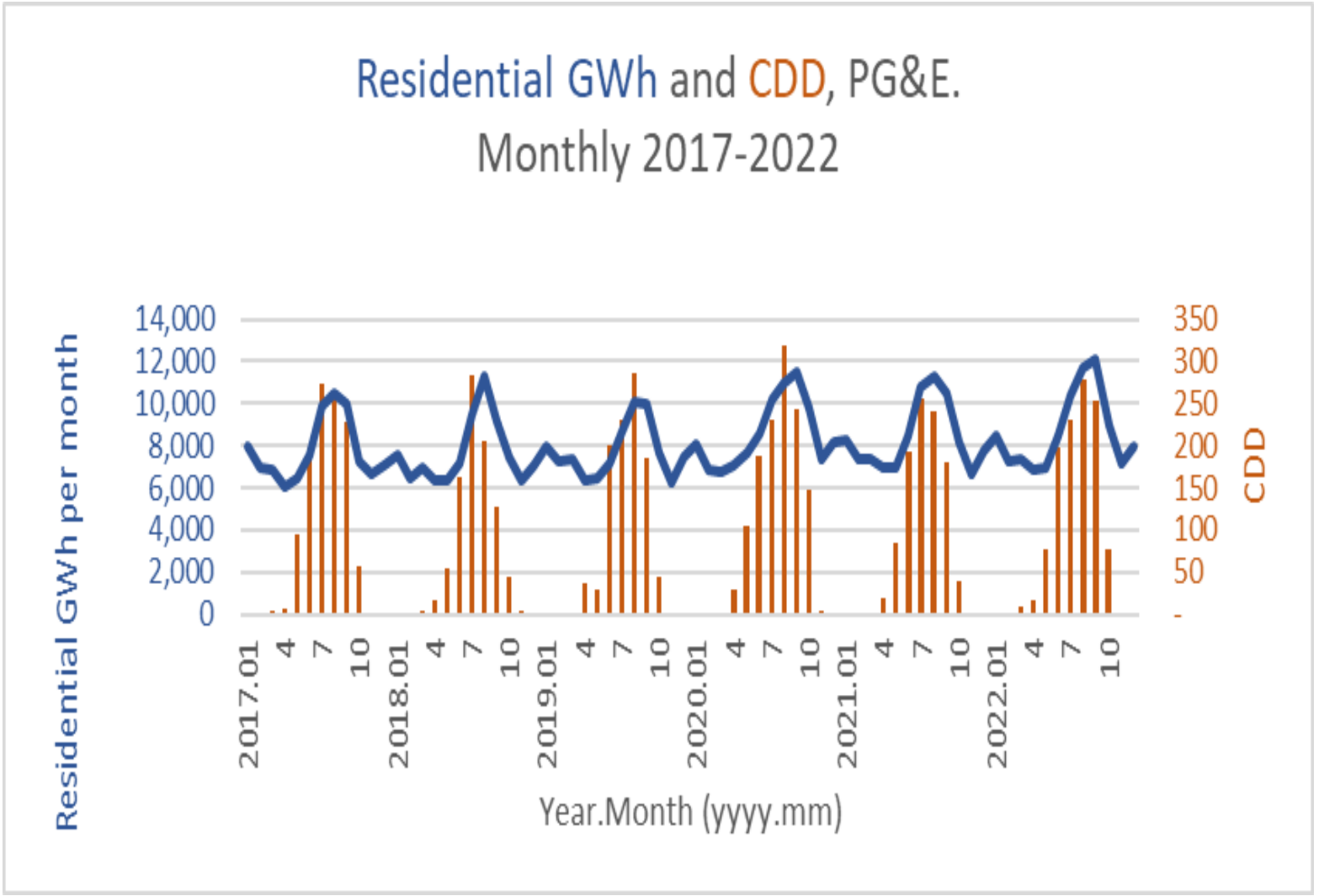


CDD = cooling degree days (base 65 F)

THREE-YEAR PERIODS	Residential GWh	Change from 2017-2019 GWh as %	California population weighted CDD	Change in CDD from 2017-2019 as %
2017-2019	277,859	0.0%	4,038	0.0%
2020-2022	307,070	**10.5%**	4,259	**5.5%**

MONTHLY DATA SHOWS RESIDENTIAL GWH and CDD, 2017-2022

- Residential electricity (GWh) is higher in hotter months (higher CDD), typically summer (months 7 July, 8 August, 9 September).
- A large share of residential electricity in independent of temperature (non-CDD)
- CDD is near zero for months 11-4 (November to April).
- HDD is not considered here. Electric heat is uncommon in California homes.

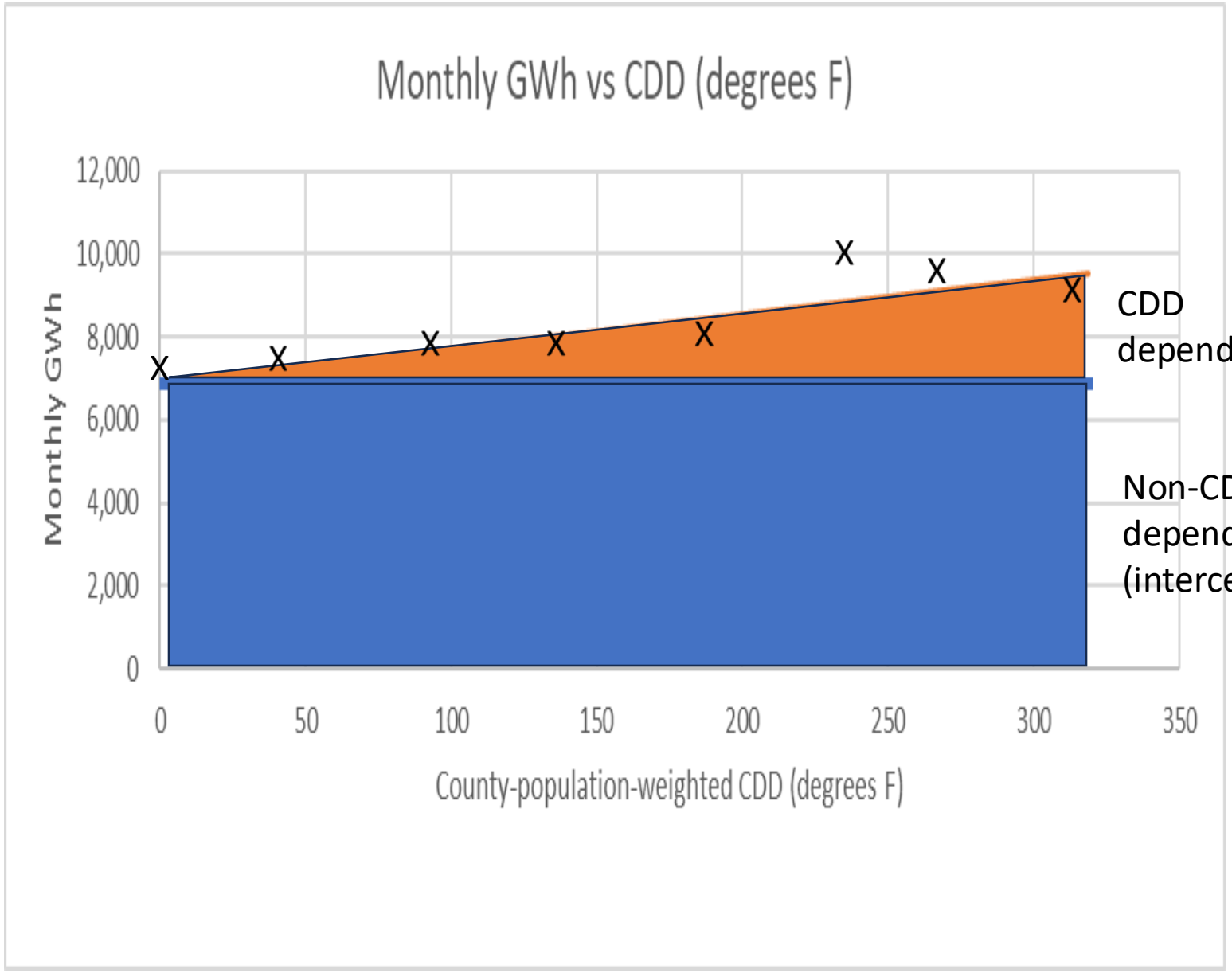


PG&E = Pacific Gas and Electric Company, a large utility in California

ILLUSTRATIVE EXAMPLE:

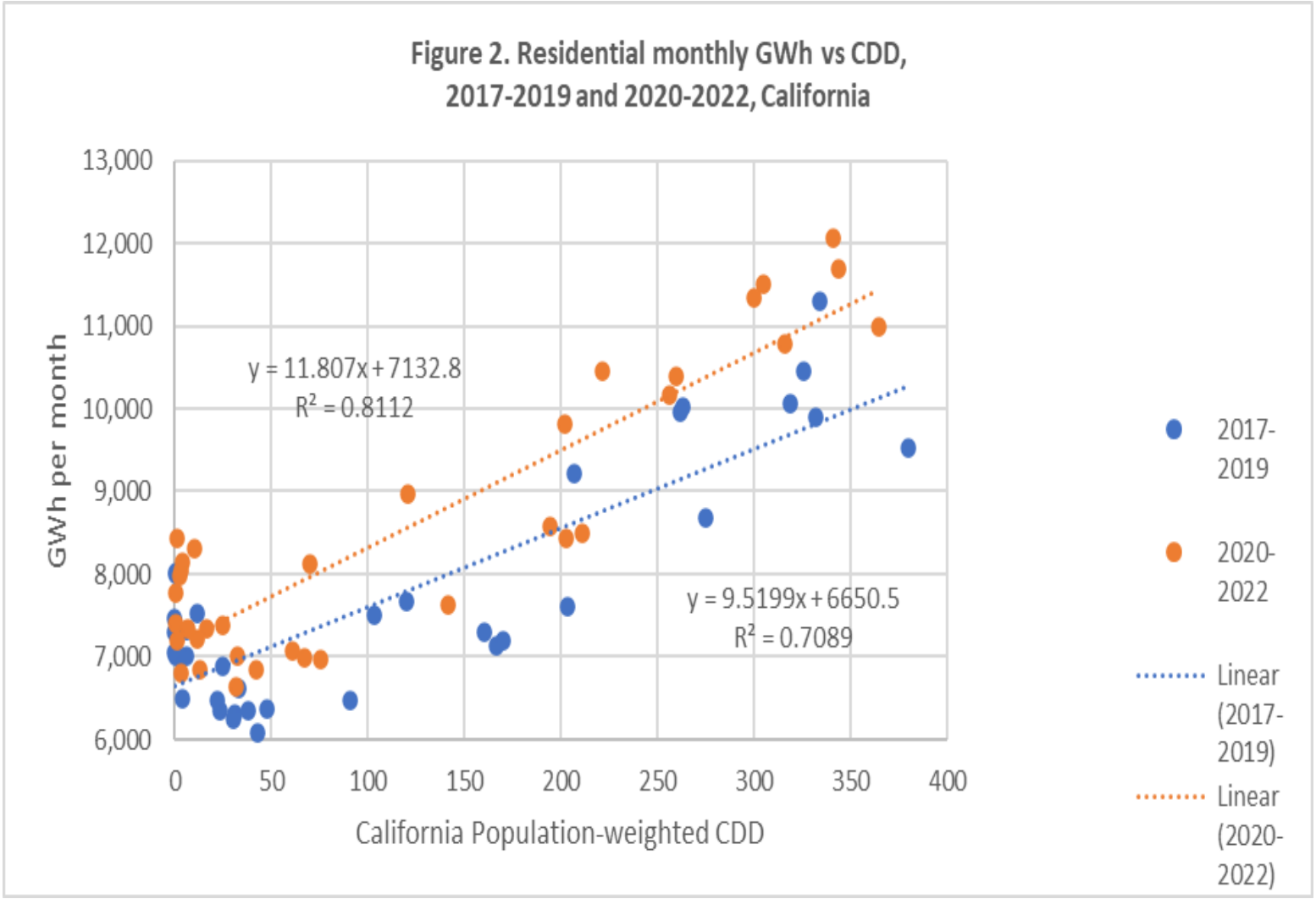
MONTHLY GWh IS CORRELATED WITH CDD (Cooling Degree Days, Base 65F or 18C)

- Regress residential monthly GWH vs CDD to separate CDD-dependent from non-CDD dependent (intercept)
- Compare 2017-2019 to 2020-2022



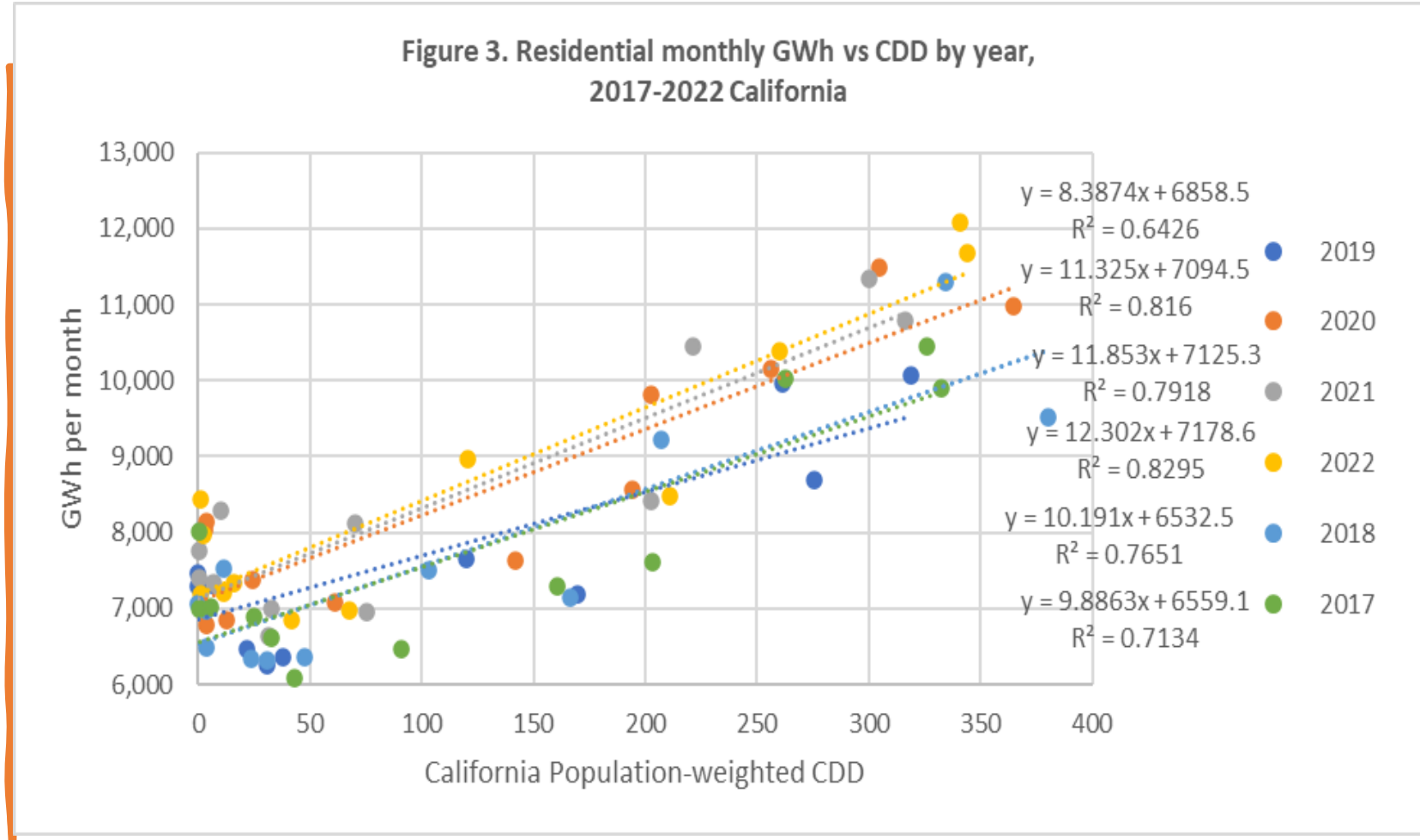
BOTH SLOPE (GWh/CDD) AND INTERCEPT (NON-CDD) INCREASED IN 2020-2022 COMPARED TO 2017-2019

(N=36 each)



- Intercept increased from 6 650 to 7 132 GWh/month (+7%).
- Slope increased from 9.519 to 11.807 GWh/CDD (+24%).

BOTH SLOPE (GWh/CDD) AND INTERCEPT (NON-CDD) INCREASED IN EVERY YEAR 2020-2022 COMPARED TO 2017-2019 (PRE-COVID) (N=12 each)



- Intercept increased from 6 532-6 858 (pre-covid) to 7 094-7 178 GWh/month.
- Slope increased from 8.38-10.39 (pre-covid) to 11.32-12.30 GWh/CDD.

THE INCREASE IN 2020 RESIDENTIAL ELECTRICITY PERSISTED IN 2021 and 2022 in California

The change from 2019 to 2020 was not followed by a return to pre-covid electricity consumption.

Average annual change in 2020-2022 from 2017-2019 is:

+9 737 GWh total (+10.5%)

+5 802 GWh non-CDD dependent (+7.3%)

+3 935 GWh CDD-dependent (+30.7%)

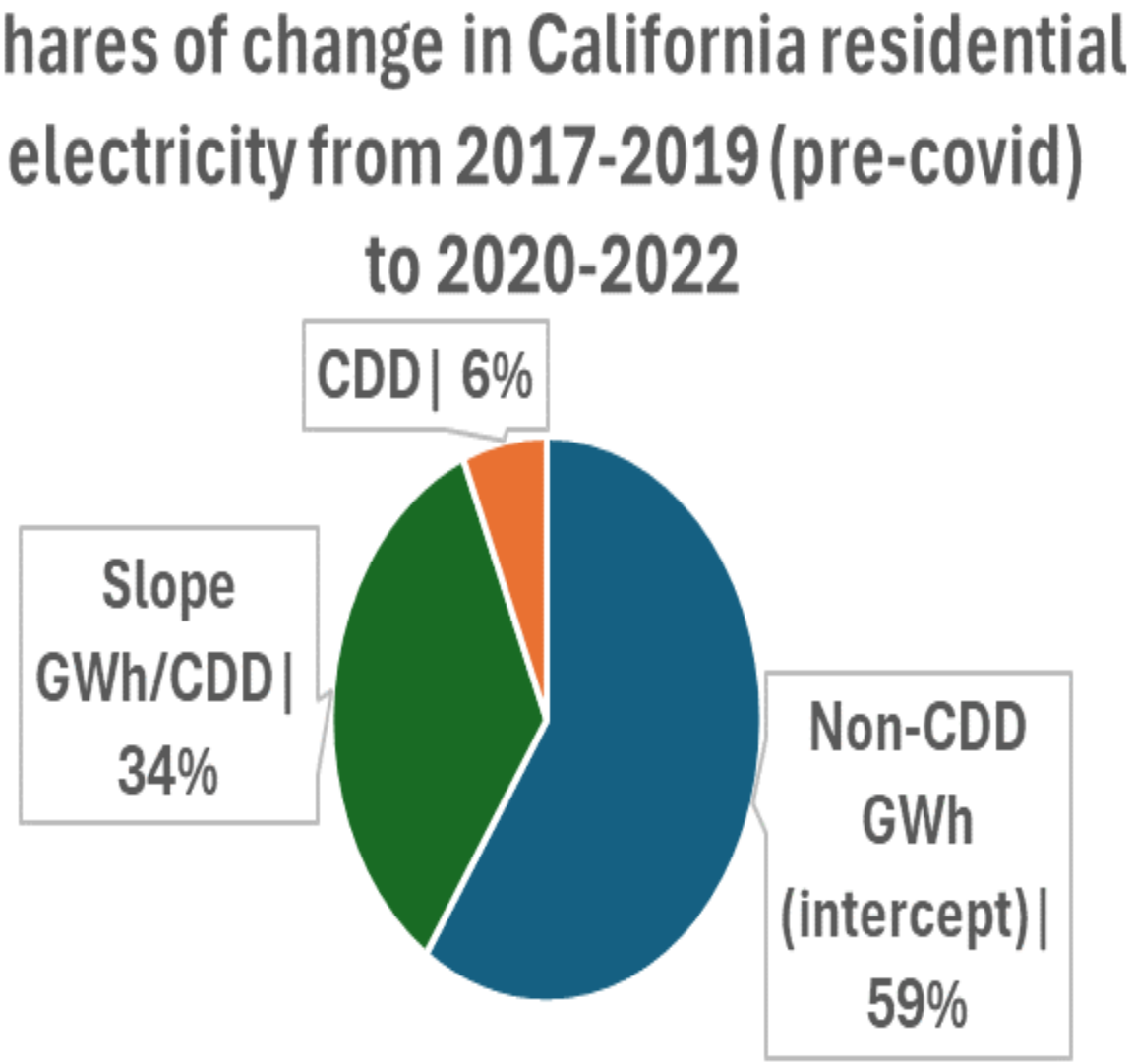
- **CDD (+5.5%) and change in slope GWh/CDD (+24%) combined**

Incre	Annual Residential GWh	Non-CDD dependent (12*intercept) GWh	CDD-dependent GWh
2017 Total	93,375	78,709	14,666
2018 Total	91,760	78,390	13,370
2019 Total	92,724	82,302	10,422
2020 Total	102,945	85,134	17,811
2021 Total	100,536	85,504	15,032
2022 Total	103,589	86,143	17,446

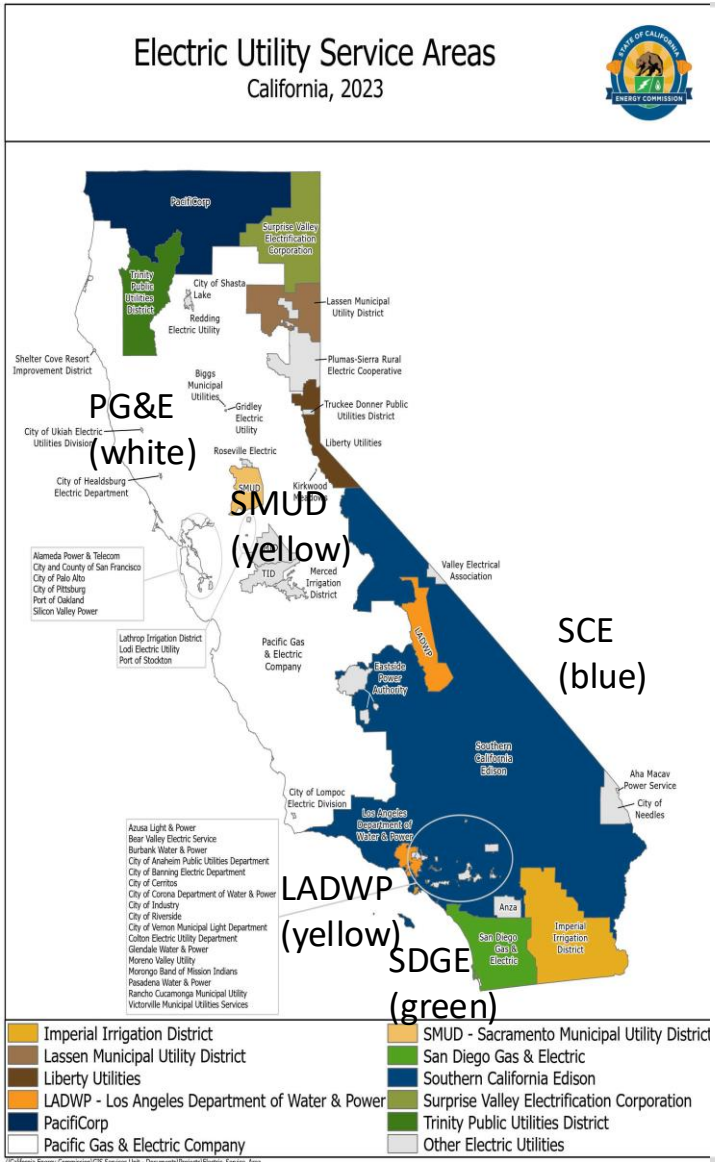
	Average annual Residential GWh	Average annual Non-CDD dependent GWh	Average Annual CDD-dependent GWh
2017-2019	92,620	79,792	12,828
2020-2022	102,357	85,594	16,763
Percent change:	**10.5%**	**7.3%**	**30.7%**

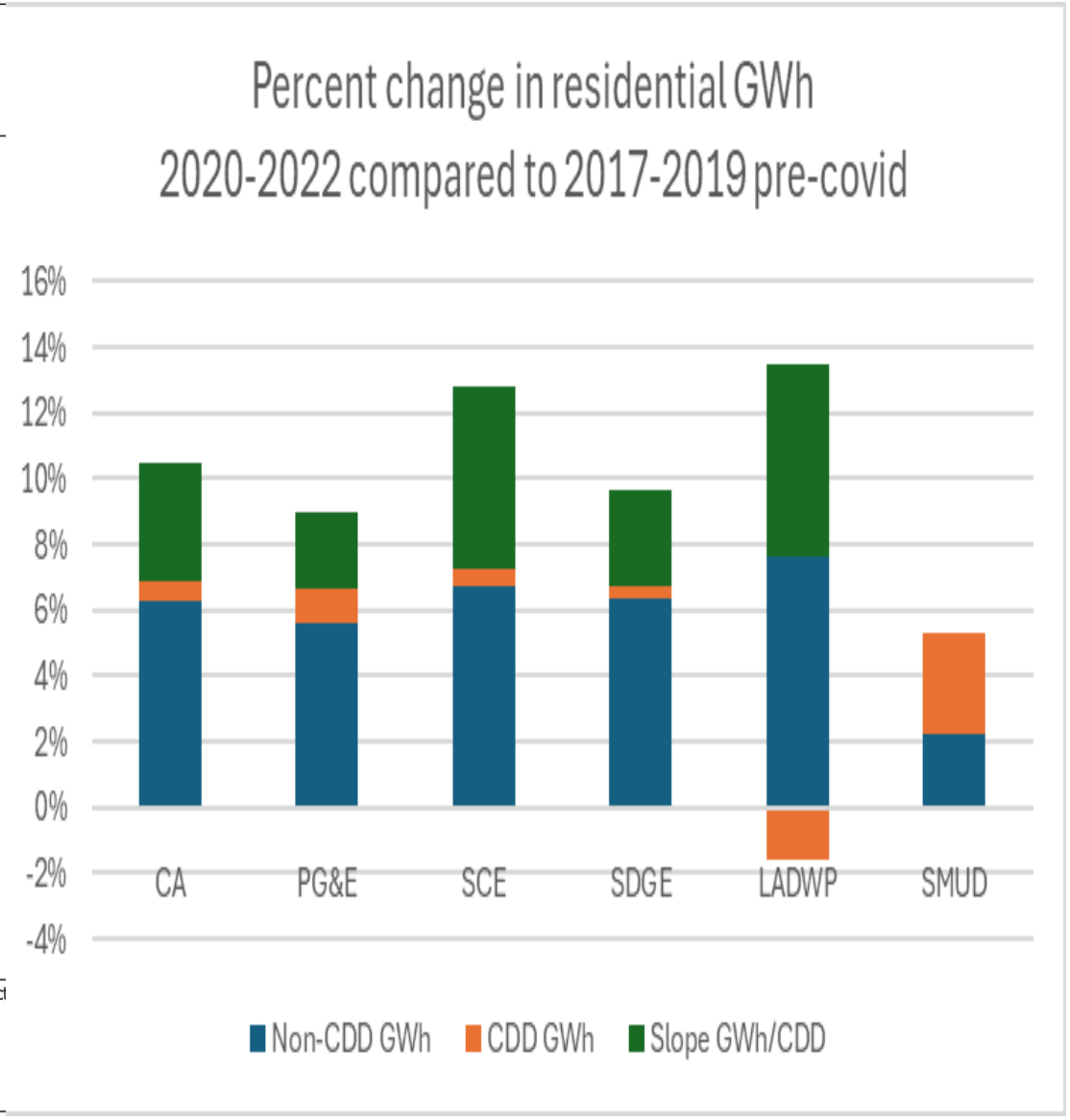
THREE CHANGES AFFECTED GWh

- Warmer weather (CDD) accounts for 6%
- Non-CDD-dependent GWh (intercept) accounts for 59% of the change
- Change in temperature-dependence (GWh/CDD) accounts for 34%



RESULTS DIFFERED AMONG SERVICE TERRITORIES

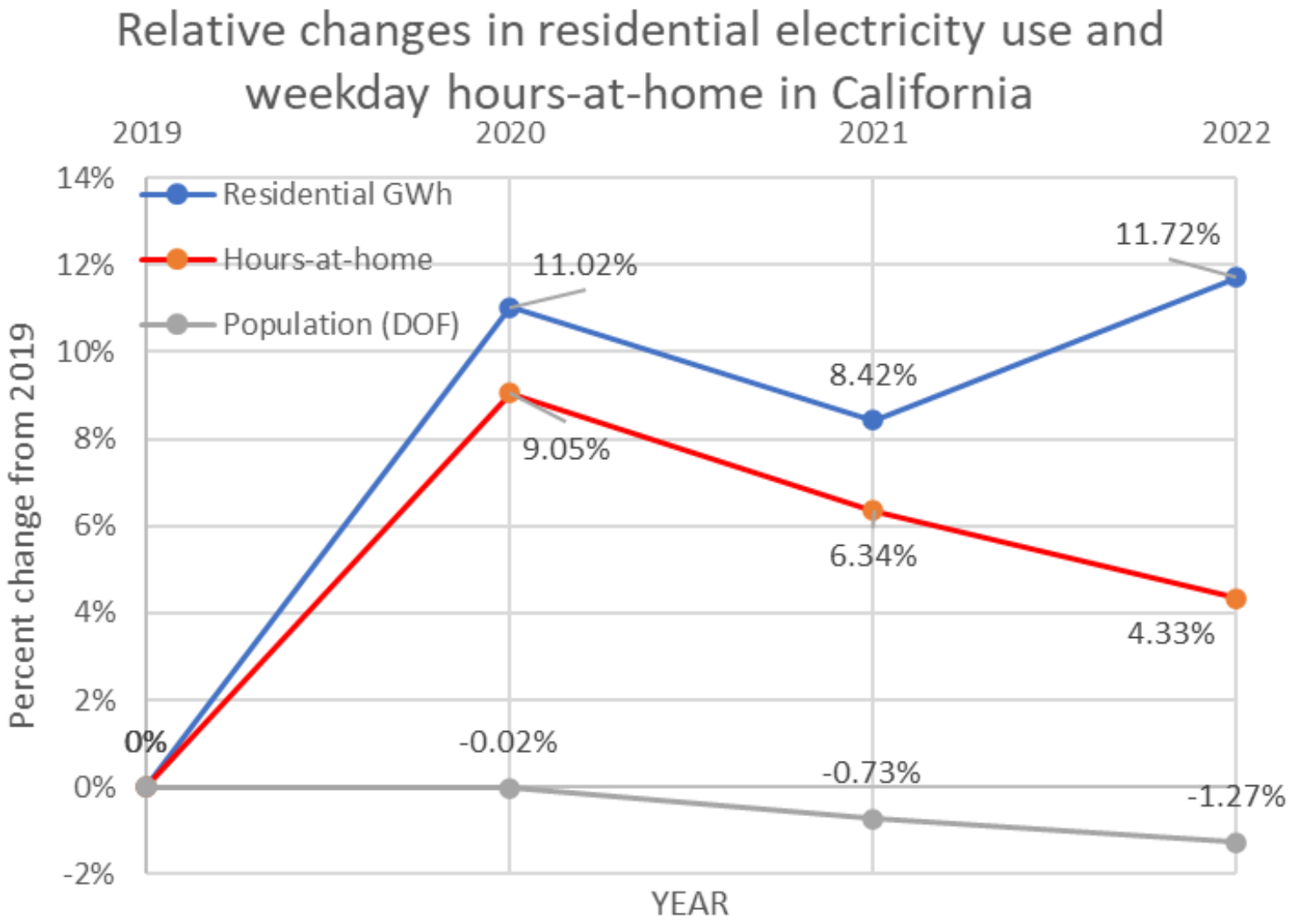




- All had increased GWh
- PG&E, SCE, SDGE factors were similar
- LADWP had cooler weather
- SMUD had warmer weather and no change in slope

CONCLUSIONS

- **Residential electricity increased in 2020 and remained higher than expected from 2019, even after most people returned to work in 2021 and 2022.**
- **Mobility data alone (weekday hours-at-home) and weather are not sufficient to explain the changes.**
- **More research is needed to allocate these changes to:**
  - **Changes in conditioned space**
  - **New equipment (e.g., air cleaners, office equipment)**
  - **Behaviors (comfort set-points)**



FUTURE WORK

- **Future analysis should be more disaggregated to analyze end uses**
  - **Load profiles by hour of day**
  - **Usage behaviors (e.g., thermostat setpoints)**
- **Longitudinal studies of individual households continuous from 2019 (or earlier) through 2022 (or later)**
- **Surveys and behavioral studies on usage**
- **Residential natural gas consumption**
- **Increased research on mobility data**
  - **Hybrid work schedules**
  - **If one person in a two-person household continues to work from home, does that explain the continued use of residential electricity?**

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