Some Thoughts on Decarbonization and Resilience

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There are multiple aspects of resilience

- Preparation for troublesome events
- Recovery from them
- Access to emergency services
- Addressing troublesome sites (e.g., flood plains)
  - Mitigation of the trouble
  - Discouraging building there
- Community plans to minimize risk
- …
- Ability of a building to remain usable/habitable for hours/days/weeks after an interruption in energy supply

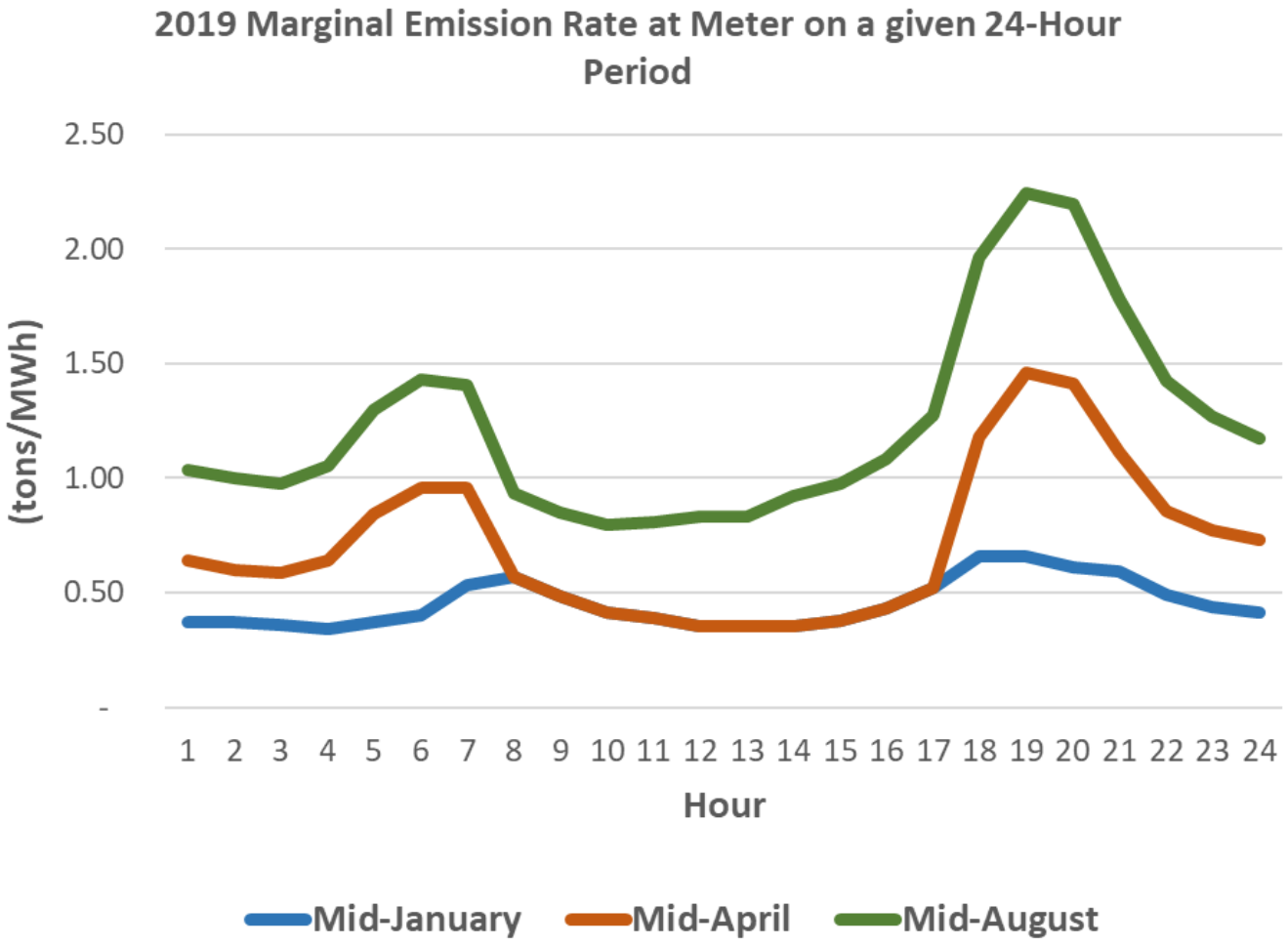
The criterion of habitability can be a matter of life and death

- Deaths from cold in Texas this winter
- Deaths from heat in the Northwest this June
- Deaths at a nursing home from failure of the AC after a hurricane disrupted power
- Lack of power for medical devices, communication devices…

Physical Elements of Decarbonization (in rough priority order)

- Envelope energy efficiency
- Highly efficiency heat pumps
- Energy storage, particularly thermal storage
  - This allows timing demand for times when the grid is cleanest
- Demand flexibility through automation (IoT)
- Consideration of extreme peak conditions for heating and cooling
- Solar PV
- [a metric for estimating carbon emissions]

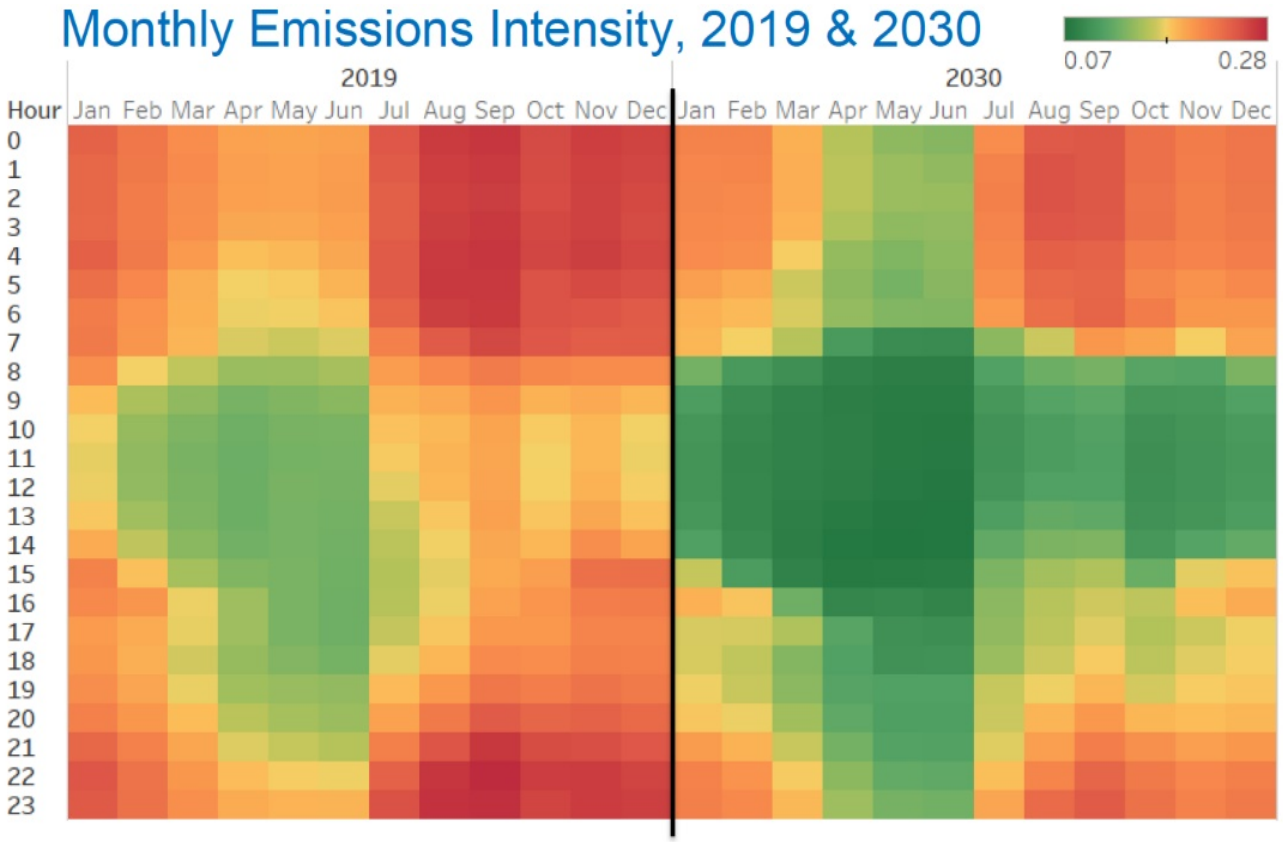
California GHG Emissions Factors 2019



* CPUC Avoided Cost Model 2018: http://www.cpuc.ca.gov/General.aspx?id=5267

Changing the timing of electricity consumption can reduce emissions from the grid

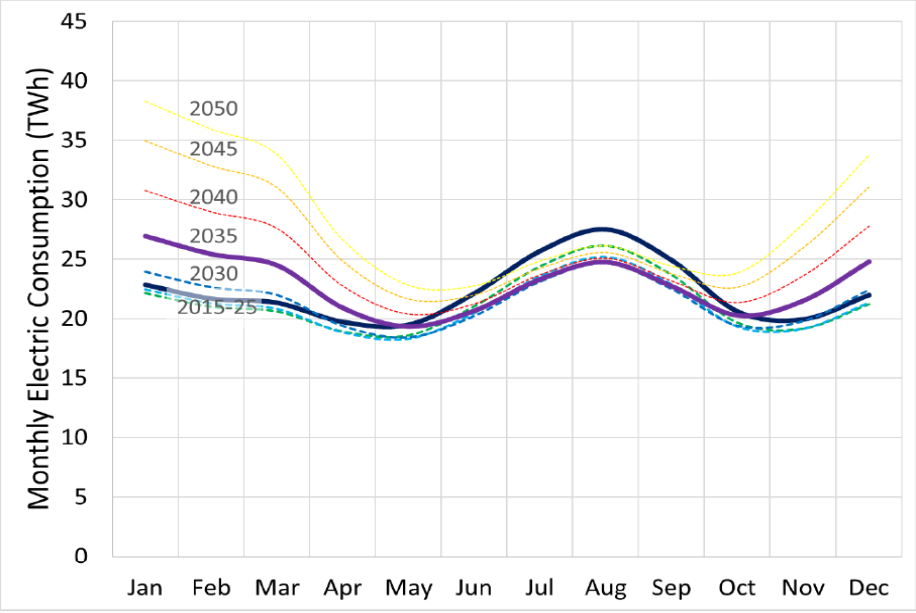
Energy Modeling



3D Electric Profile, Full Year

Energy efficiency remains essential to limit annual variation

Potential Shift to Winter Peak Under High Electrification Scenario Requires Mitigation



NEEP: Northeastern Regional Assessment of Strategic Electrification, July 2017

https://neep.org/strategic-electrification-regional-assessment

Estimating carbon emissions

- Existing rating systems (HERS/ERI, ASHRAE 90.1/LEED/IRS Section 179D) already require 8760-hour simulations of energy consumption
- It is a trivial software modification to multiply energy consumption by hourly emissions factors
- RESNET and ASHRAE 189.1 are in the process of developing details of this method
- Algorithms for crediting storage and demand flexibility are under development collaboratively by the California Energy Commission and RESNET

Why transition to a carbon metric?

1) Emissions can be reduced by Demand Flexibility:

   If a given building can absorb renewables when they otherwise would have been curtailed, or prevent the operation of expensive peaking power plants, they make the utility system more energy efficient and less emissive.

2) Electrification usually reduces emissions but gets little credit with a cost-based metric

   Building-level costs are determined by utility rates, which poorly represent wholesale electricity price variability and lag far behind changes in grid-scale costs driven by decarbonization policies and other trends

   a) Solar and storage are valued properly
   b) Metrics may need to address community-scale effects (e.g., cool roofs)

A Habitability Metric

- Could be based on the most extreme temperatures that would be encountered over n days or M months without HVAC
  - Or the 99.5 percentile worst
  - Might consider humidity as well
- Moderate indoor temperatures can be achieved by
  - Controlling solar heat gain to desired levels
  - Better insulation
  - Controlled and timed ventilation (both passive and mechanical*)
  - Effective placement of thermal mass

Overlap between decarb and resilience goals

- Decarb needs EE, Demand Flexibility, and low peak loads
- Solar and Demand Flexibility help with peak
- Demand Flex can involve triage of energy service needs
- Solar and batteries can provide permanent power at modest levels for modest cost
- The same controls that implement Demand Flexibility can run an independent microgrid when needed
- Key end uses; low level lighting, refrigerators, low level induction cooking, cell phone charging, mechanical ventilation for health…

EE as Comfort: Designing for Thermal Stability versus low HVAC needs

- Insulation helps with both
  - Cool roofs, too, especially community-wide
- Thermal mass helps more for stability than for low energy
  - It matters where you place it
- HVAC efficiency matters less
- You can maintain almost-comfortable temps anywhere in the US with 1970s technology (ignoring latent loads)

Further ideas or discussion, email me at dgoldstein@nrdc.org

THANK YOU!