CALIFORNIA DREAMIN'
PATH TO NET ZERO ENERGY HOMES
CALIFORNIA ZERO-NET-ELECTRICITY NEW HOMES ENERGY CODE

RESNET CONFERENCE
FEBRUARY 2019
NEW ORLEANS, LOUISIANA

PIERRE DELFORGE AND DAVID B. GOLDSTEIN, PH.D.
NATURAL RESOURCES DEFENSE COUNCIL
PDELFORGE@NRDC.ORG AND DGOLDSTEIN@NRDC.ORG

CA has ambitious climate goals, but no explicit policy pathway to zero-emissions buildings yet

- 40% GHG reduction by 2030

SB 32 (2016)

Electric sector:
- 60% renewable / 2030
- 100% carbon-free / 2045

NEW!

SB 100 (2018)

- Carbon neutrality by 2045

NEW!

Gov. Exec Order (2018)

- 40% GHG reductions in buildings / 2030 (assessment)

NEW!

AB 3232

- $200M incentives for low-emissions buildings and equipment

NEW!

SB 1477

Regulators Have Agreed on Zero Energy Goals and Timetables

- Back in 2008 the California Energy Commission and the California Public Utilities Commission agreed to a goal of Zero Net Energy (ZNE) buildings:
  - Residential by 2020
  - Commercial by 2030
- This agreement spurred the Energy Commission to achieve greater reductions in energy use in the last four code cycles than had been the case before.
- Most recent (2019) residential code requires “zero net electricity”.
  - Solar is part of the prescriptive requirements

“Nothing is Better Than Zero”

- Zero Net Energy (ZNE) does not necessarily mean zero energy bills
- After Zero Net Energy facilities--or even stand-alone solar and wind energy--become common, Zero Net Energy does not mean zero emissions from the grid
- But the 2019 Title 24 takes steps in the direction of zero emissions

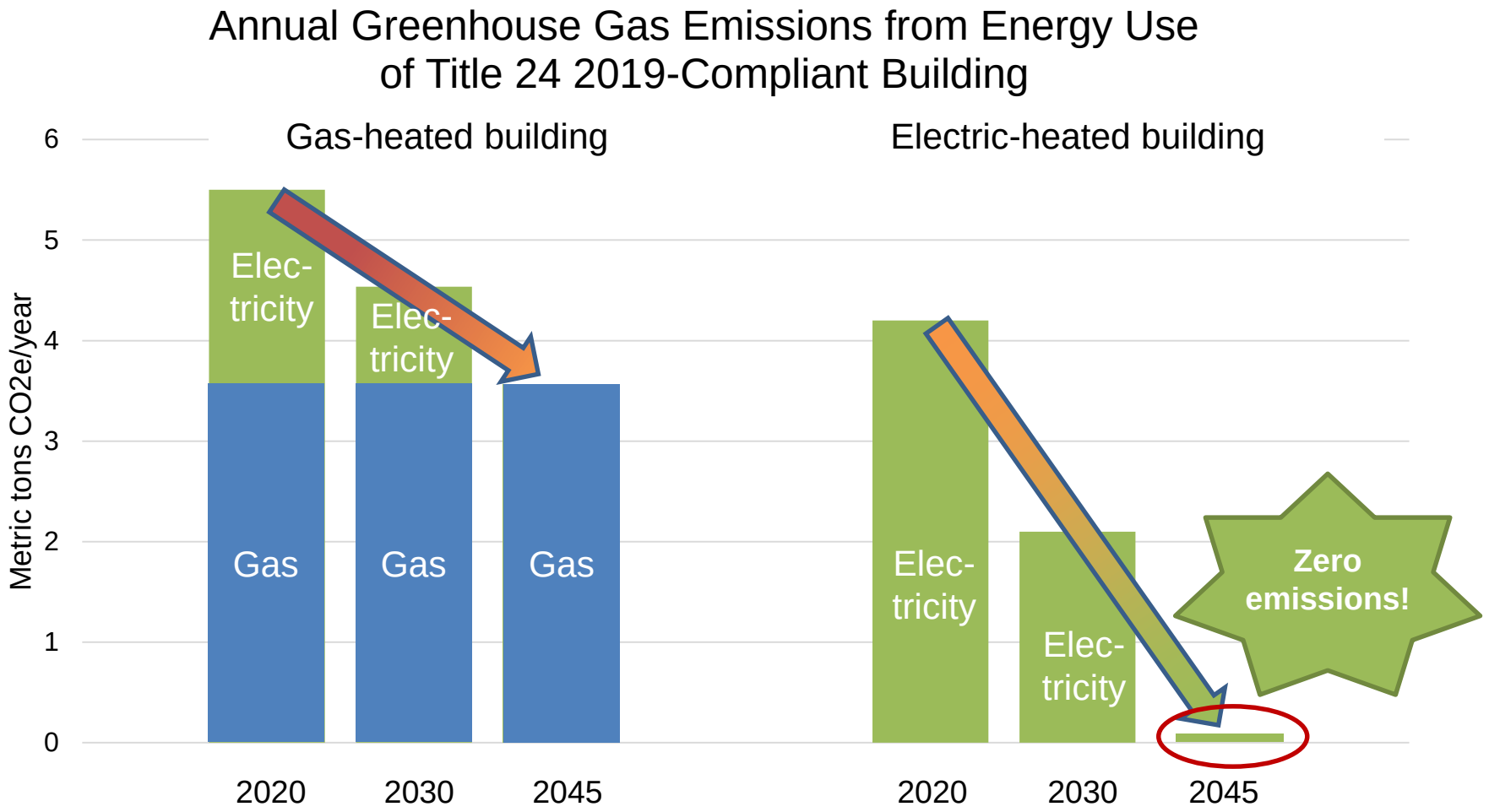
Title 24 2019 Residential: Key Advances

- Energy Efficiency
  - ✓ Solar/EE tradeoff now only for solar+battery. EE tradeoff limited to 2016 code EE requirements
  - ✓ High-performance walls, attics, windows, QII
- Independent gas and electric baselines for low-rise residential (similar to RESNET)
  - ✓ Level-playing field electric vs. gas
- Electric water heating ready
  - ✓ 240V dedicated outlet + breaker space in panel
- Variable capacity heat pumps
  - ✓ More favorable modeling in software (work-in-progress ACM)
- Heat pump water heater thermal storage
  - ✓ Credit for load shifting capability (work-in-progress ACM)

“Zero Net Electricity”

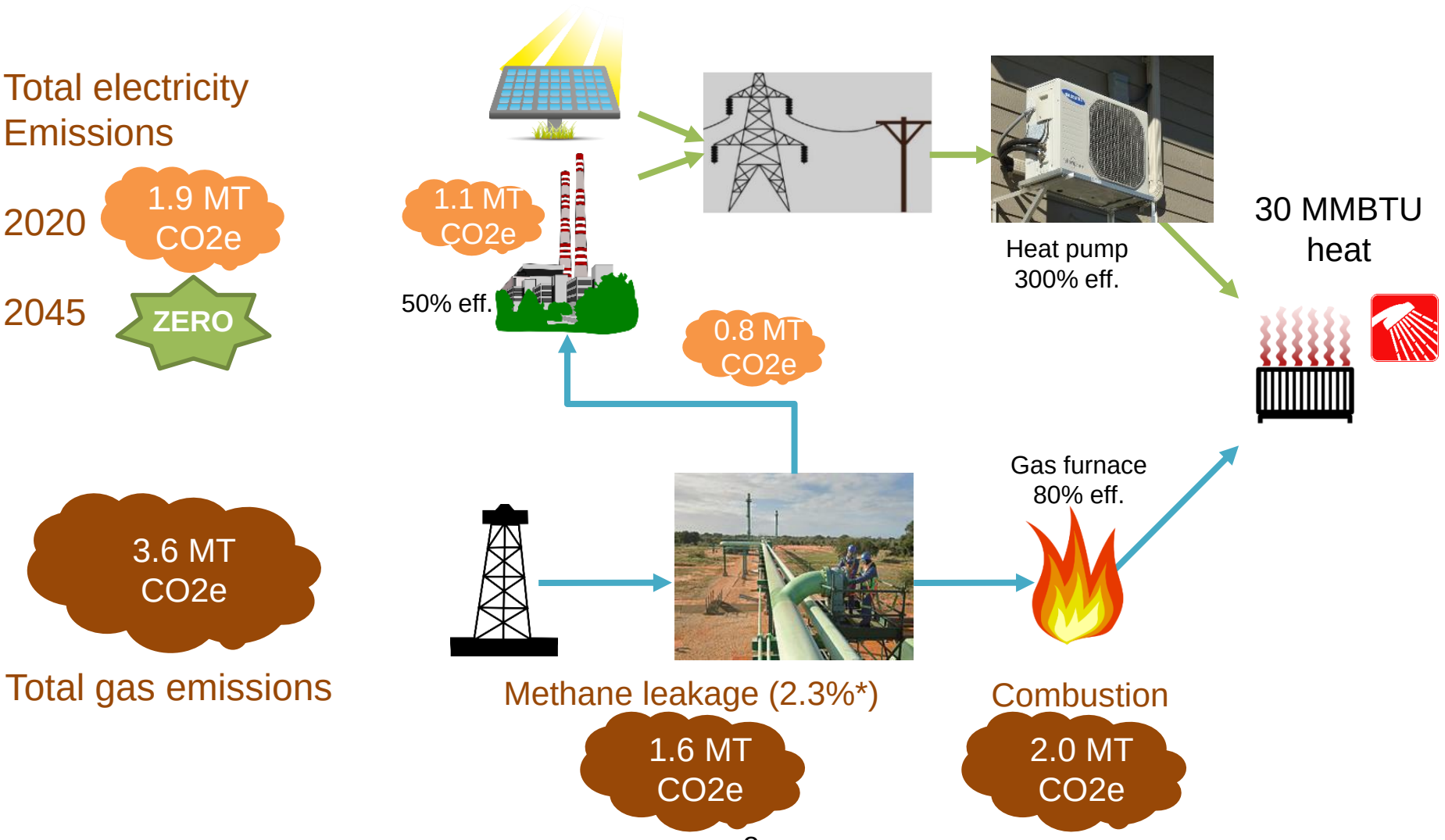
- Code only requires solar to offset as much electricity use (TDV) as mixed-fuel prototype
- Same for all-electric buildings (no solar “penalty” for going all-electric)
- Does NOT offset gas use (cost-effective constraints)
- Can add more solar than code minimum, but no compliance credit for the extra
- Also limited by CPUC connection rule
- Flexibility for solar: purchased, PPAs, lease, community solar

Electric Heat Offers Pathway To Zero Emissions



NRDC analysis, climate zone 13 (Fresno)
with rooftop solar. Including methane leakage

How about power plant emissions: Is electric heat really cleaner than gas heat?



NRDC calculations, climate zone 13 Fresno

* Alvarez A. et al, Science, 2018

Title 24 2019 Residential: Remaining Issues

- No longer penalizes all-electric, but still does not encourage it as the lowest emissions option
  - Still gas baseline for multi-family with central DHW and recirc.
- No standards for air-tightness (now different than RESNET)
- Inability to model central HPWH

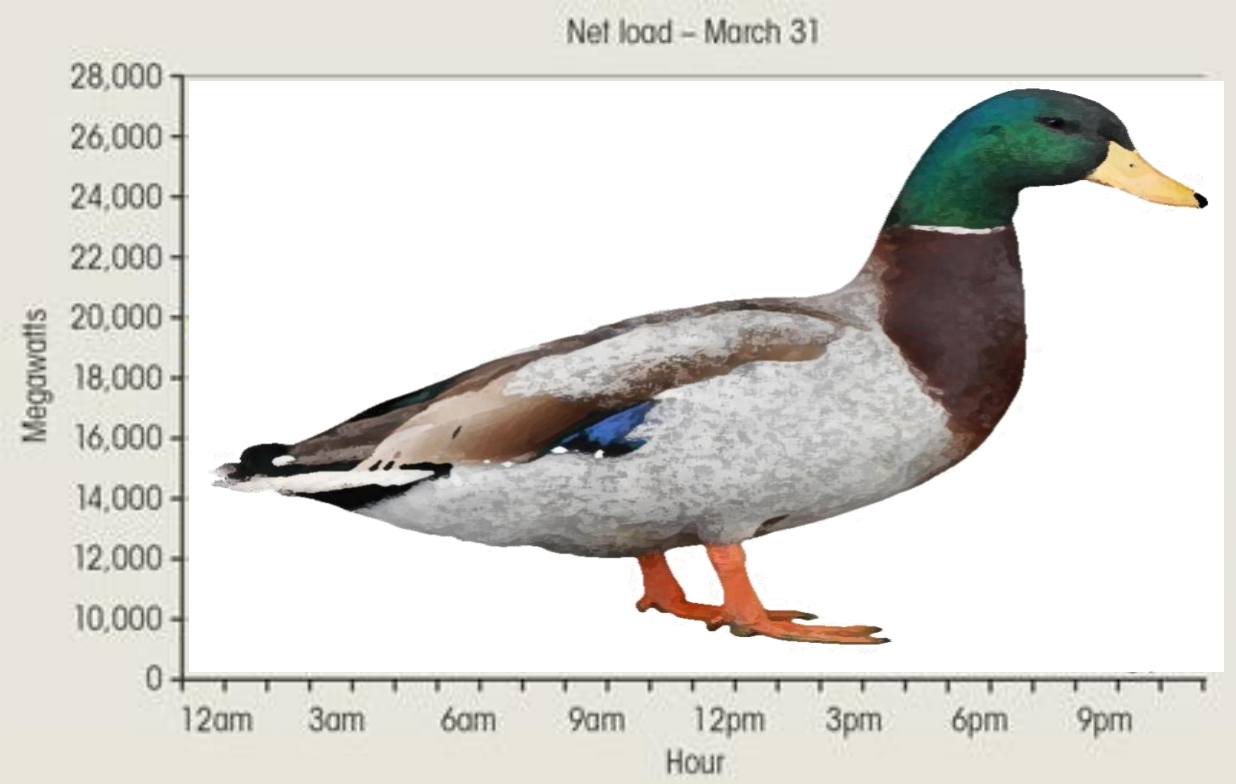
Title 24 2019 Non-Residential: Remaining Issues

- No mid-/high-rise multi-family prototype
- Same-fuel baseline for HVAC and DHW
- Issues with temperature maintenance in water heating loop modeling
- Heat loss from recirc not captured
- Return water temperature effect on COP/AFUE not captured
- DHW thermal storage modeling capability
- Inability to model air-tightness

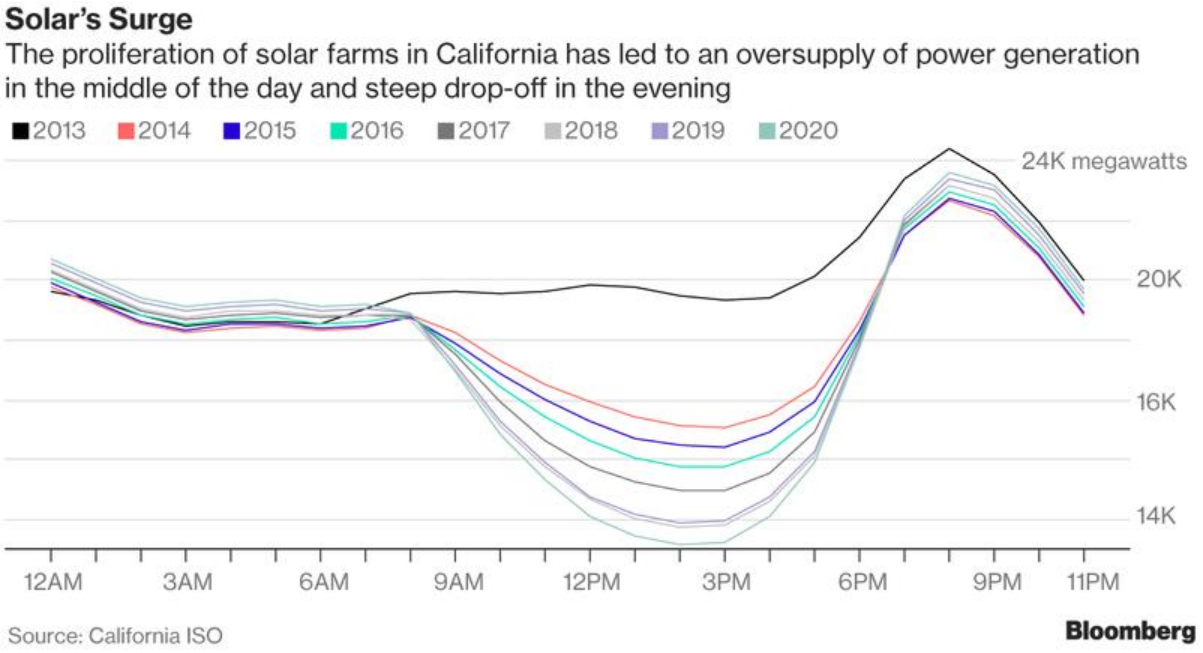
What about net zero emissions?

- As noted net zero energy equals net zero carbon only for a grid with minimal variable-output renewable energy sources. If most facilities achieve ZNE, this equality ceases to be the case:
  - Energy produced when the sun is shining is hard to use; and
  - Energy consumed after the sun goes down is more problematic
- There are two dimensions to this mismatch: Diurnal and Seasonal
  - Energy storage is not difficult (but not cheap) on a diurnal basis
  - but storage more challenging on a seasonal basis

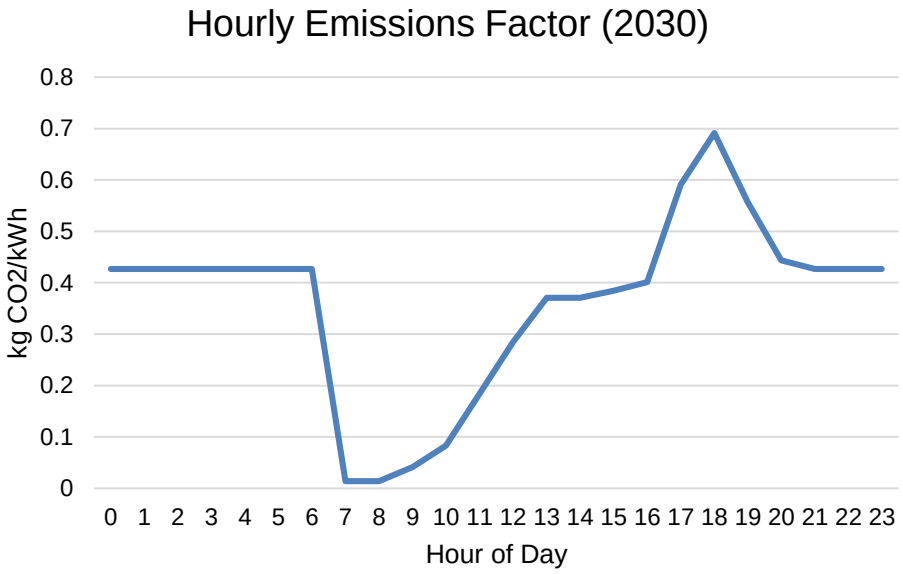
Diurnal Variation: the “Duck Curve”



This is the duck (net electricity loads in California vs. time of day)



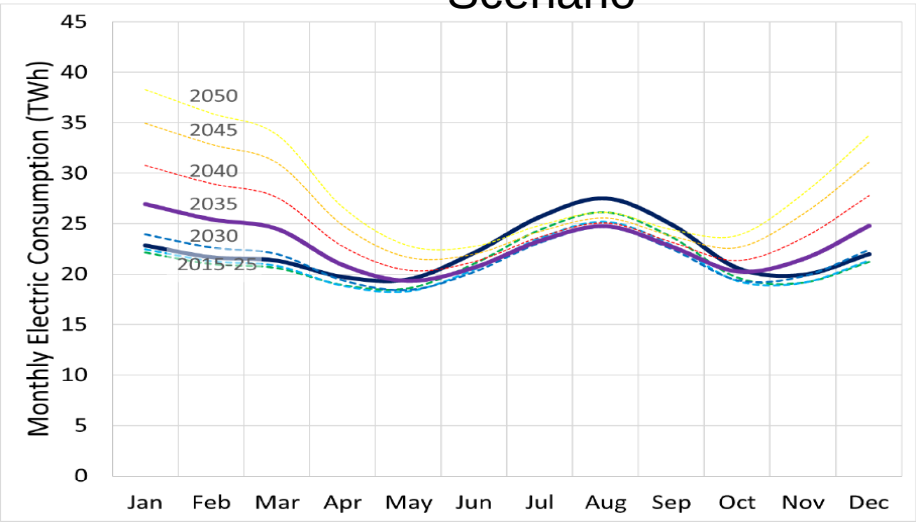
California GHG Emissions Factors 2018



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

Energy efficiency remains essential to address annual variation

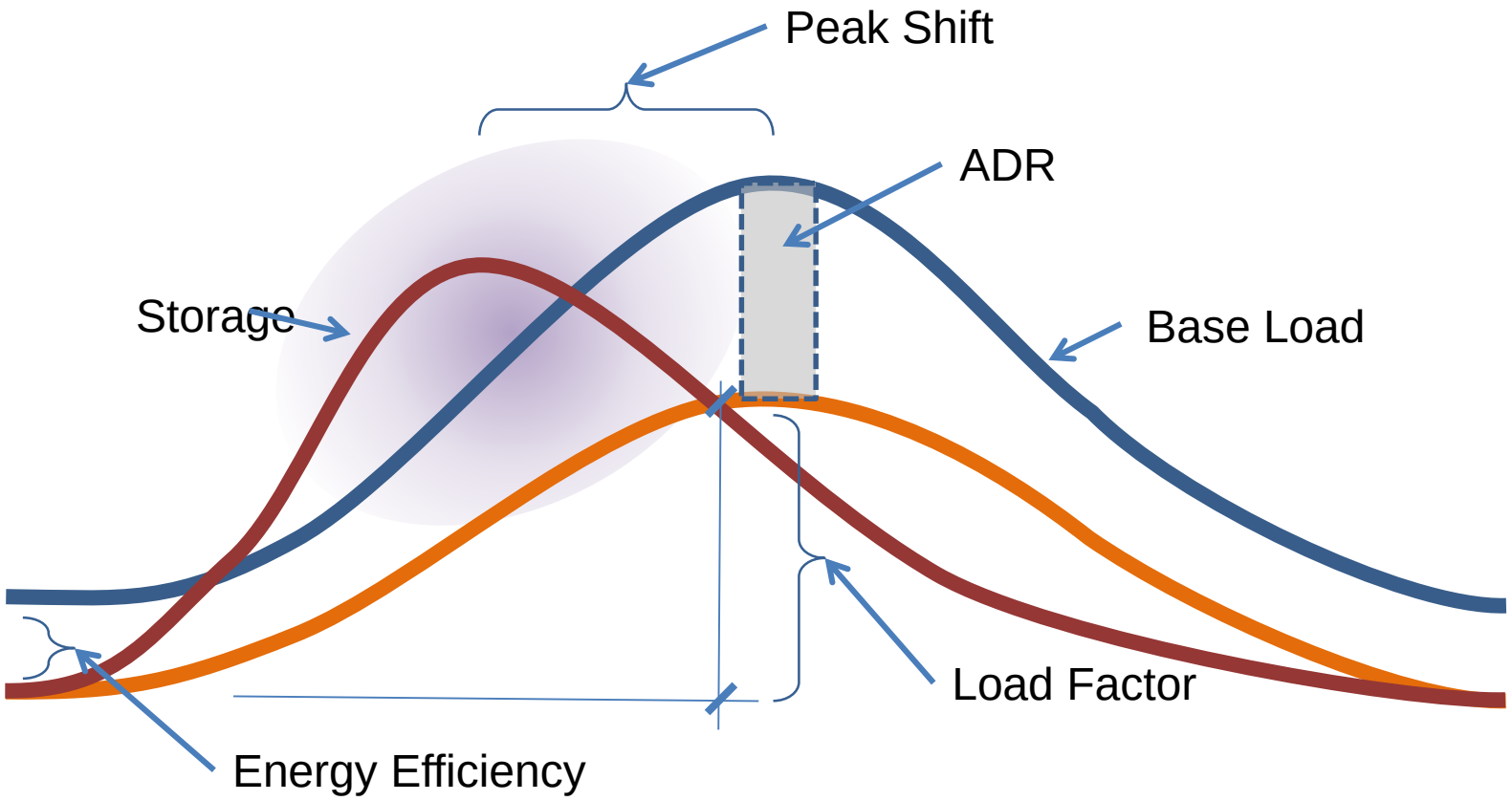
Potential Shift to Winter Peak Under High Electrification Scenario



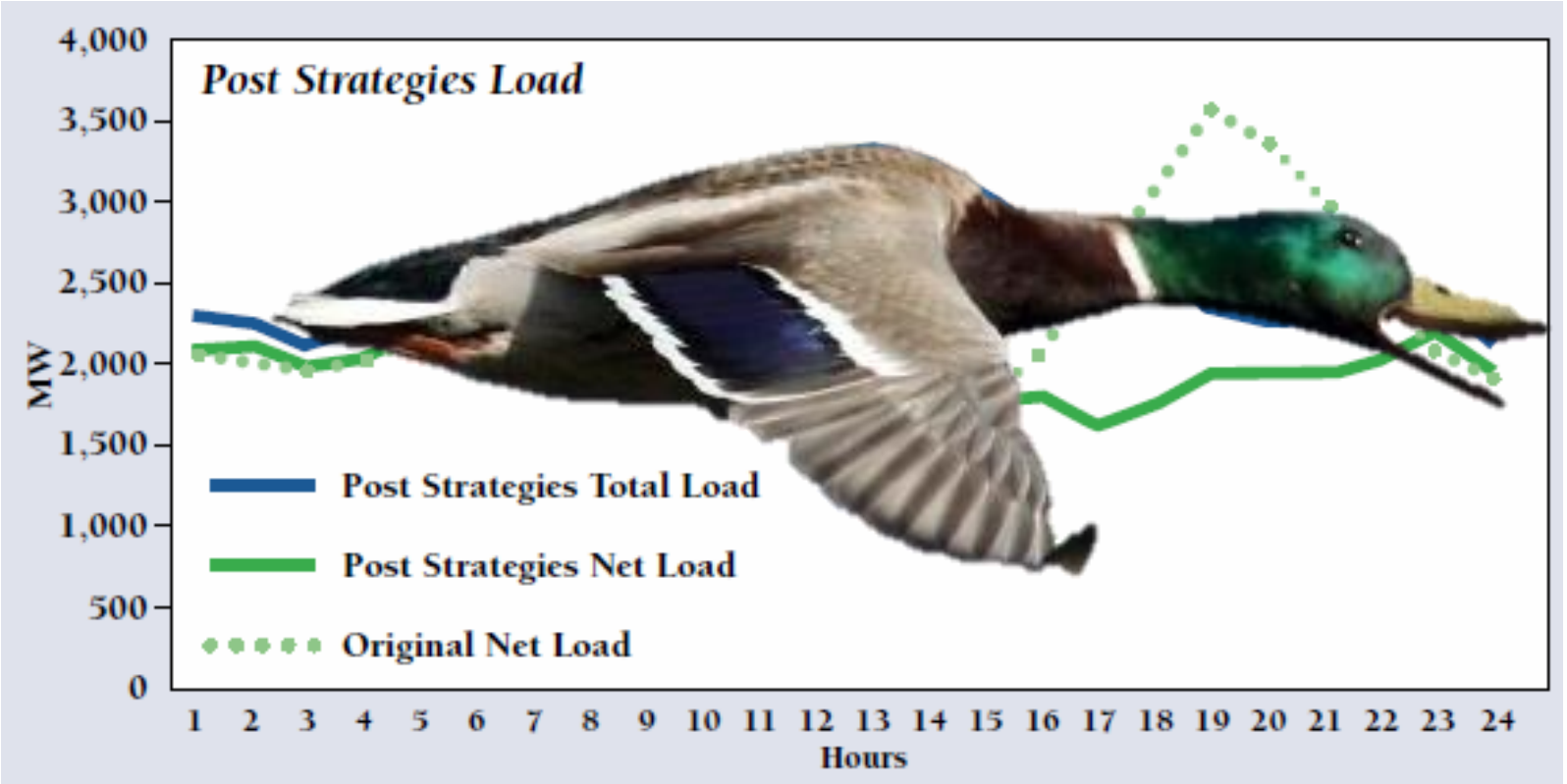
NEEP: Northeastern Regional Assessment of Strategic Electrification, July 2017

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

Building Load Curve



Teaching the Duck to Fly”



But these methods are not recognized in Title 24 or RESNET 301

- They would require weighting energy use by an hourly “source multiplier”
- They would require algorithms for modeling user-controlled or grid-controlled actions to shift time of use
  - Running water heater only when factors are low
  - Charging and discharging batteries, both standalone and in cars
  - Slowing down air conditioner/heat pump when factors are high
  - Postponing appliance use, refrigerator defrost, etc., subject to user override
  - Dimming lights or turning them off automatically

Conclusions

- ZNE goal led to major improvements in residential Title 24
  - Even though the 2019 code is not all the way there, it is far stronger than it would have been otherwise
- The code should evolve toward Zero Emissions Buildings (ZEB)
  - When coupled with future changes to encourage electrification, Title 24 methods could accommodate time of use emissions factors to provide Zero Emissions