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Report Requires Revision for High Performance Electric and All-Electric Housing

Additional submitted attachment is included below.

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September 20, 2017

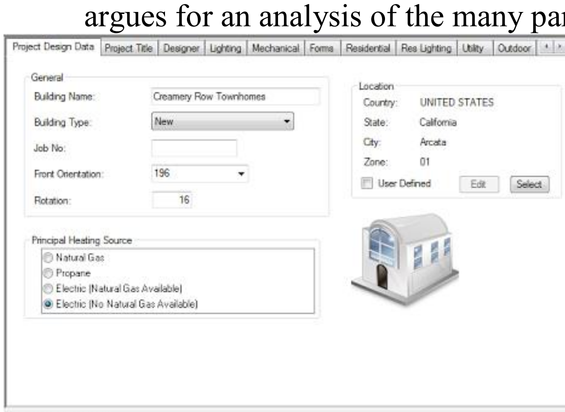
RE: A Recommendation for Updating And Addressing Absent Data in "Energy Efficiency Potential and Goals Study for 2018 and Beyond." **in Support of Electrification with High Performance Equipment as the Cost-Effective Compliance Pathway**

To the Honorable Commissioners of the CEC and CPUC, Staff and the Public:

Thank you for your hard work rising to the challenge placed in front of you by our elected officials—cost-effectively and dramatically reducing energy consumption in California. In the Sept. 7th workshop I noted missing data points in the analysis performed in *"Energy Efficiency Potential and Goals Study for 2018 and Beyond"* that I hope will be included in a revised report respecting the peer review process of professional science.

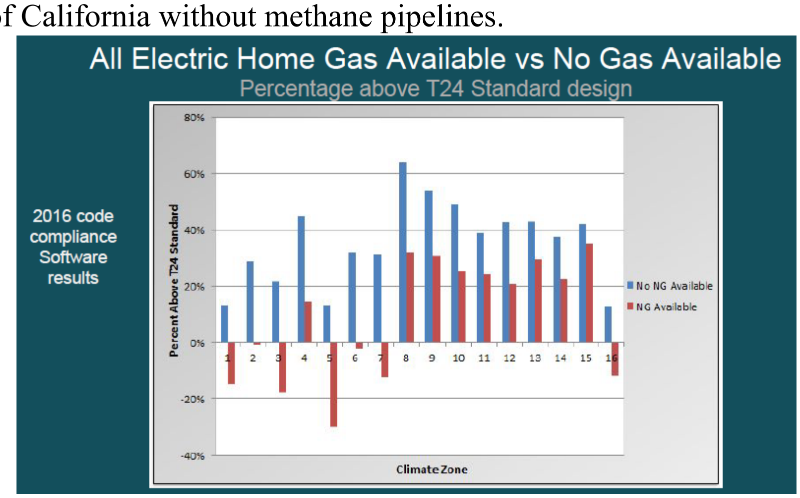
Specifically:

1. The CEC ACM guidance that modeling be performed with a natural gas baseline for space heating does not apply to areas without natural gas service. These low-income edges of developed cities, rural counties, Indian reservations and trailer home parks are occupied by California's citizens who do not have gas lines, and are all-electric or run Propane. This underestimate of Standard Baseline TDV allowances falsifies assertions of what is and is not a cost-effective fuel substitution measure. When Redwood Energy ran a 1500sf, Energy Star for Homes certified, all-electric home through the 2016 Code software we found about a 30% difference in TDV compliance if it was modeled with a Principal Heating Source of Natural Gas vs. Electric (No Natural Gas Available). This dramatic swing in results argues for an analysis of the many parts of California without methane pipelines.



Calculation	*Heating	*Cooling	Int	Ext	Applianc	Receptac	*IAQ	*Renewat	*DHW	Total	Savings
Standard	29.99	0.00	11.83	0.94	33.33	26.50	2.98	0.00	26.80	132...	0.0 %
Proposed	25.89	0.02	11.83	0.94	33.33	26.50	2.98	0.00	16.27	117...	24.4 %

Screen capture of Principal Heating Source choice in Energy Pro Title 24 software



The impact of modeling NG Available on an all-electric house

2. The assumed maximum technical limit of efficiency was derived from the DEER database of existing product efficiencies. This approach does not support the title of the analysis—"…2018 and Beyond", which implies a sensitivity analysis using products that are not available today, but likely will be in the future. Instead the analysis only looks backward to out-of-date, historic product efficiencies, and proposes these already out-of-date products predict the performance of future heat pumps. I consider this an unacceptable result—the entire planet is watching California implement its greenhouse gas laws, and to do so in ignorance of the efficiency of products on the market, advertised in magazines and installed in our own state is a counterproductive approach.

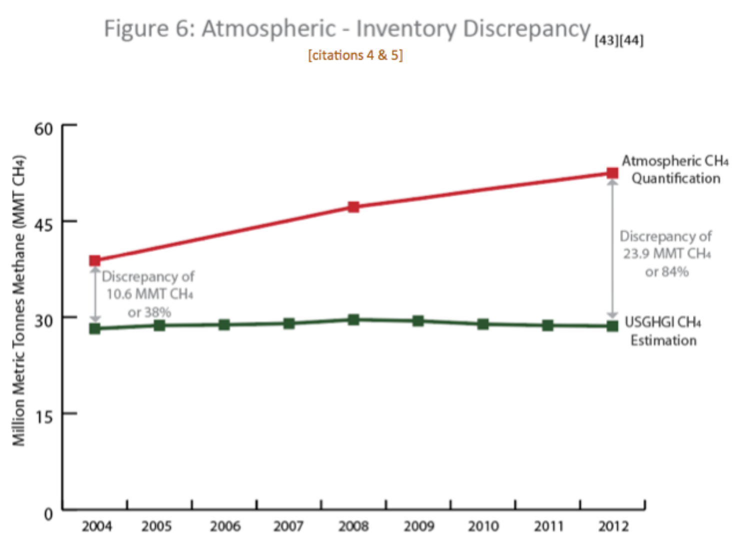
The recently updated DEER database still lacks data on high performance heat pumps. The AHRI database is usually kept current within a few months of products being available for sale in the U.S., and internet searches turn up even higher efficiency products in Canada, China and Japan. This analysis factually underestimates of heat pump efficiency in 2018 and beyond, and this falsifies assertions of what is and is not a cost-effective fuel substitution measure. Note that:

- SEER 20 air conditioning efficiency was the modeled technical limit, but ducted products at SEER 25 are commonly for sale. Ductless minisplit heat pumps for sale go up to SEER 34.
- HSPF 10 heat pump space heating efficiency was the modeled technical limit, but ducted products at HSPF 12-13 are commonly for sale. Ductless minisplit heat pumps for sale go up to HPSF 14.
- Average COP 3 water heating efficiency was the modeled technical limit, but COP 3.2 is for sale by many vendors, and COP 5 is for sale in advanced products.

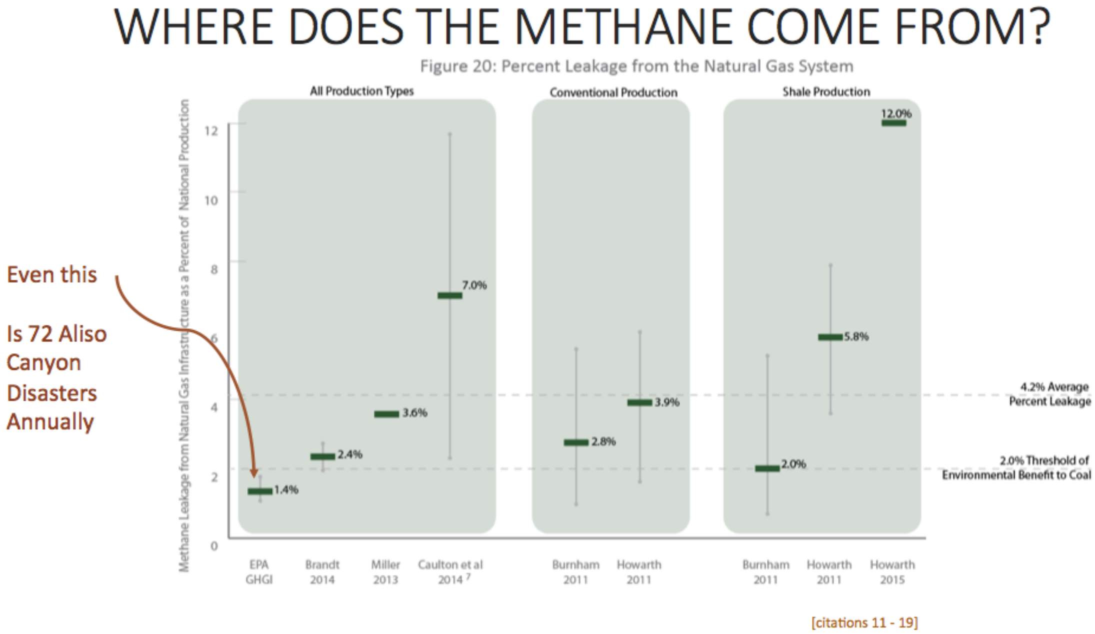
3. Naomi Wentworth, a Local Government Sustainability Analytics Consultant for San Francisco and Oakland, documented two critical facts in her literature review presentation entitled "Natural Gas: Our Underestimated Climate Change Catalyst":

    a. Studies of Methane gas leaks show an average leak rate of 4.2% from well to fixture
    b. The global warming potential of methane is greater than 100 times more powerful than CO2 over the 9-13 years methane is in the atmosphere.

The dismaying mathematical conclusion from these two facts is that every unit of Methane we count as burned actually represents less than 1/5th of its greenhouse gas warming impact. Leaked Methane is a powerful influence on today's climate change, helping explain why global warming is happening currently at worst-case scenario rate even as known emissions drop.



"Natural Gas: Our Underestimated Climate Change Catalyst"—Naomi Wentworth, 2017
Slide 7: Leaks help explain the large discrepancy in estimated vs. measured atmospheric Methane



"Natural Gas: Our Underestimated Climate Change Catalyst"—Naomi Wentworth, 2017
Slide 10: Averaged data on leaks is at 4.2%

The current draft of *"Energy Efficiency Potential and Goals Study for 2018 and Beyond"* asserts it is generally not cost-effective to electrify end uses. This does not match the market trends created by consumers in California since 2010, nor the market trend nation-wide since 2010, which again indicates the report has deficiencies in its scope that have led to discrepant results. Nation-wide utilities, developers and rate-payer advocacy groups have discovered it is no longer wise to invest or reinvest in new gas equipment—ICF International documented in their 2016 Propane Market Outlook that since 2010 electric space heating has gained market share over every other space heating fuel nation-wide, including in most of California. Regardless of advertising campaigns, in most parts of the U.S. market forces are demonstrating that gas is not cheaper- high performance electric equipment is cheaper. Although we are burdened with gas appliances, as new construction and retrofits are performed, nation-wide a quiet consensus among developers and retrofitting home-owners has emerged from the data:

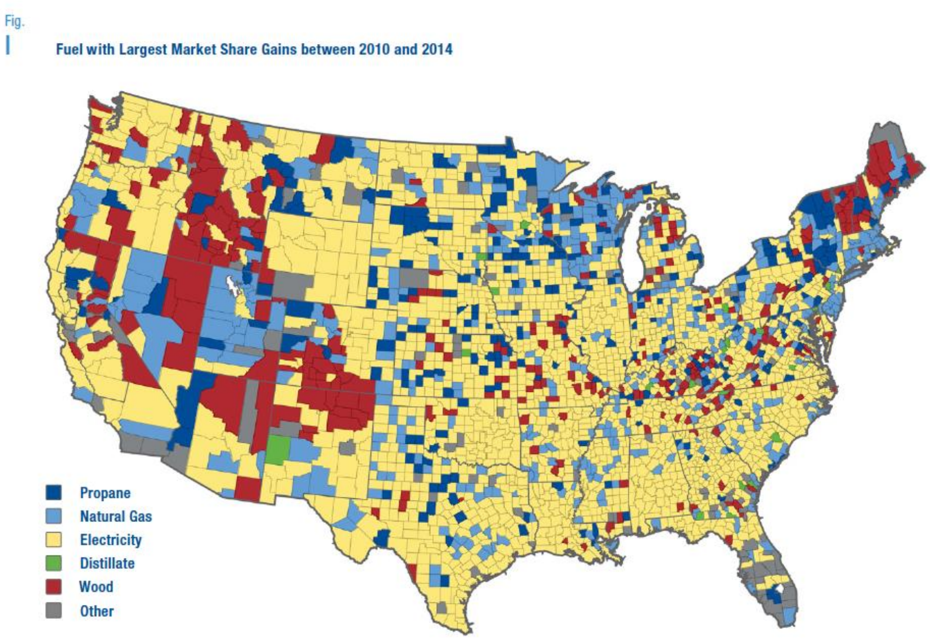


Figure 1, p.14
(*ICF International for the Propane Education & Research Council, 2016*)

Developers Pursue Fuel Substitution for Profit: As Managing Partner with Redwood Energy, since 2011 I have supported seven different developers performing fuel substitution in ten projects on 935 affordable housing residences. Fuel substitution is a profitable construction and ownership strategy. We have also supported the design of more than 2000 new, all-electric, 100% solar powered residences throughout California, and 4000 more partially solarized new and retrofitted residences. Working with many different developers, both rural and urban, has proven that everywhere using natural gas, and especially propane, costs more to install and can cost more to operate compared to high performance electric equipment. Purchasing PV pairs well with electrification—paying for PV up front is less expensive than purchasing electricity exclusively from the utility, with financial paybacks between 3 and 9 years, depending on whether it is an IOU with PV rebates or not.

The addition of low-cost PV electricity was helpful for many projects' finances, but was not necessary to convince them to retrofit with electric equipment. Each fuel substitution was chosen only because it delivered greater financial benefits to the developer. The basis of the cost estimates in this letter is derived from the following projects:

Sonoma Court, Escondido. Affirmed Housing: 60 residences (Cooking, Heating, Laundry, PV)
Willow Creek Apartments, Willow Creek. Pacific Communities: 24 residences, 6 fuel switched after a fire (Heating, DHW, Cooking, Laundry)
REFUGE, San Leandro. Refuge, Inc.: 1 residence with 14 beds (Heating, DHW, Cooking, Laundry)
Trinity River Elder Village, Hoopa Reservation. Yurok Indian Housing Authority: 13 new electric residences (Cooking, Heating, DHW, Laundry, PV) replacing propane fueled trailer homes
Downtowner/Eureka Lodge. Danco Communities: 52 residences (Cooking, Heating, DHW, Laundry), 48 of which are gut retrofitted to all-electric, 4 new
Hollywood Palms, San Diego. Affirmed Housing: 96 residences (Cooking, Heating, DHW, Laundry, PV)
Ethan Terrace, Sacramento. MRK Partners: 96 residences (Heating, PV)
Monterrey Pines, Richmond. MRK Partners: 324 residences (DHW, PV)
St. Marks, Oakland. St. Marks Apartments, LLC: 200 residences (DHW, PV)
Deliverance Temple, Richmond. MRK: 82 residences (DHW, PV)

Costs for a Complete Fuel Substitution Retrofit: Our recommendation is that each home serviced by Propane be provided a complete, coordinated package of fuel substitution retrofits that cost between $9000 and $23,000, which will save ratepayers $15,000 to $28,000 per house compared to installing methane gas services to these electricity customers.

This recommendation is based on the real-world costs of fuel substitution retrofits derived from the Developer and General Contractor value-engineering process, competitive bids and final construction costs we have collected on our projects. The below costs include all additional labor, parts and profit for each residential service retrofit. Please note that these are actual improvements to the residence, not just a new $38,000 gas line in the street and an potentially an unrecompensed need to retrofit or buy natural gas replacement appliances:

1. A new 200amp service: $1000-$1500
2. A new 200amp breaker panel: $600-$2000
3. A new ductless minisplit heat pump: $3500-$5500
   OR
   A new ducted heat pump: $7000-$12,000
4. A new heat pump water heater: $1800-$3000
5. A new induction range and oven: $1000-$3000
6. A new electric dryer: $800-$1200

Minimum All-Electric Retrofit Cost: $8,700
Maximum All-Electric Retrofit Cost: $22,700

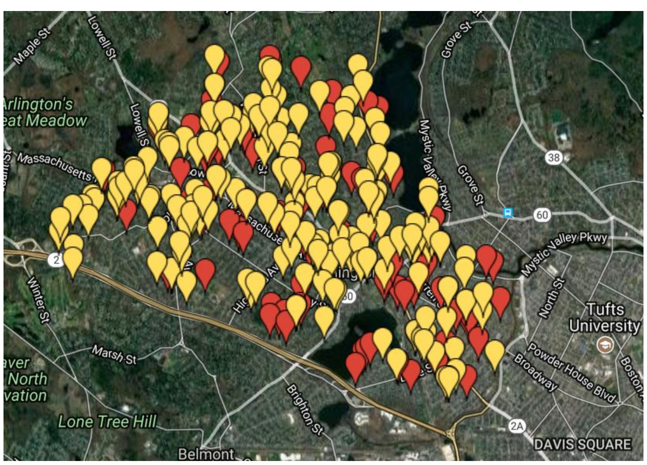
50-100% ZNE Offset requires 5kW of PV: $15,000 total of unsubsidized cost at $3000/kW

In the ongoing CPUC proceedings regarding extending methane pipelines to San Joaquin Valley communities, PG&E and SoCalGas/Sempra provided costs for installing new pipelines ands services averages between $36,073 and $37,929. Assuming that all mainlines and laterals must be replaced eventually, a $37,000 charge per house for gasline repairs is a huge cost that is obviously borne by ratepayers in their bills, but not with their knowledge of why or their consent to further investments in an expensive technology.

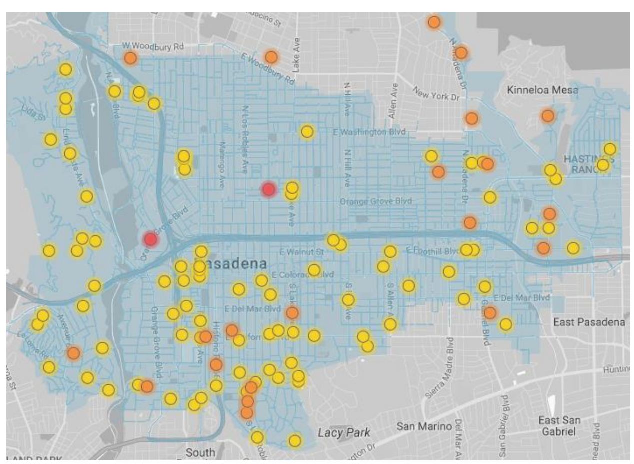
SoCalGas/Sempra							
City Name	California City	Rosamond	Buttonwillow	Selma City	Allensworth	Porterville City	
Services Per City	1796	619	23	44	125	133	
Price Per Service ($1277+ $1398)	2675	2675	2675	2675	2675	2675	
Total for services	$4,804,300.00	$1,655,825.00	$61,525.00	$117,700.00	$334,375.00	$355,775.00	
Main costs	$7,400,000.00	$7,260,000.00	$1,520,000.00	$3,675,000.00	$670,000.00	$3,360,000.00	
Pressure up project	$1,050,000.00					$495,000.00	
Total	$13,254,300.00	$8,915,825.00	$1,581,525.00	$3,792,700.00	$1,004,375.00	$4,210,775.00	Average/ Service
Total Per Service	**$7,379.90**	**$14,403.59**	**$68,761.96**	**$86,197.73**	**$8,035.00**	**$31,659.96**	**$36,073**

PG&E						
City Name	Huron	Madera Acres	S. Dos Palos	Le Grand	French Camp	
Services Per City	81	2426	104	512	256	
Per Service	$16,567.00	$16,567.00	$16,567.00	$16,567.00	$16,567.00	
Total for services	$1,341,927.00	$40,191,542.00	$1,722,968.00	$8,482,304.00	$4,241,152.00	
Main costs	$0.00	$25,767,080.00	$2,624,472.00	$19,745,050.00	$7,922,360.00	
Regulator station		$3,500,000.00				
Total	$1,341,927.00	$69,458,622.00	$4,347,440.00	$28,227,354.00	$12,163,512.00	Average Per Service
Total Per Service	**$16,567.00**	**$28,630.92**	**$41,802.31**	**$55,131.55**	**$47,513.72**	**$37,929**

Using PG&E and SoCalGas pricing for installing gas lines to each house vs. what ratepayers would pay to improve each home to all-electric, IOU ratepayers would save $15,000-$28,000 per service by abandoning the gas lines immediately and instead electrifying each service. The immediate need for repairing gas lines is evident in the innovative mapping of gas leaks by organizations like HEET in Massachusetts, and the Environmental Defense Fund's partnership with Google Maps to equip the Google Streetview cars with gas leak "sniffers."



Repaired and active gas leaks in Arlington, MA



Gas leaks in Pasadena, CA

Lower Utility Bills. Redwood Energy's primary service to affordable housing developers is predicting utility bills with the CEC-authored California Utility Allowance Calculator, which accurately predicts average utility bills. It was created to support cost-effective investments in efficiency and rooftop solar. Energy costs can decline dramatically when electrifying an existing Methane or Propane load by choosing high performance electric equipment. However, adding PV to a retrofit can reduce utility bills to nearly zero, with a payback of 3-9 years depending on pricing and rebates.

For example, the 13 all-electric homes at Trinity River Elder Village save each tribal elders $20 per month compared to high performance propane equipment. But had propane been in the project at all, the Yurok Indian Housing Authority would have failed at their larger goal of eliminating the elders' bills entirely with a ZNE-scale PV array for each house. Regardless of what fossil fuel is burnt on-site, an all-electric design allows the lowest possible utility bills.

Average Utility Bills in Energy Star Certified Two Bedroom Home at Trinity River Elder Village, Hoopa, CA			
Fuel Sources	**Electricity Bill**	**Propane Bill**	**Total Bills**
90% DHW and 95% AFUE Propane + Electricity	$28	$51	$79
HSPF 13, SEER 20.5, EF 3.42 All-Electric	$59		$59
All-Electric (any efficiency) + ZN-Energy PV	$5		$5

Note that commercial buildings also save money with a fuel substitution retrofit. The municipal utility of the City of Palo Alto hired TRC to study "Commercial Building Electrification in Palo Alto" (TRC, 2016). They comprehensively studied the cost and benefits of fuel switching their entire city's building stock to all-electric, including capping the laterals. Here is an example graph from their work on their commercial building stock, illustrating that after annualizing the *"associated utility bill, maintenance cost and amortized upfront cost over the lifetime of the equipment,"* the least cost option for small office buildings was to retrofit to all-electric:

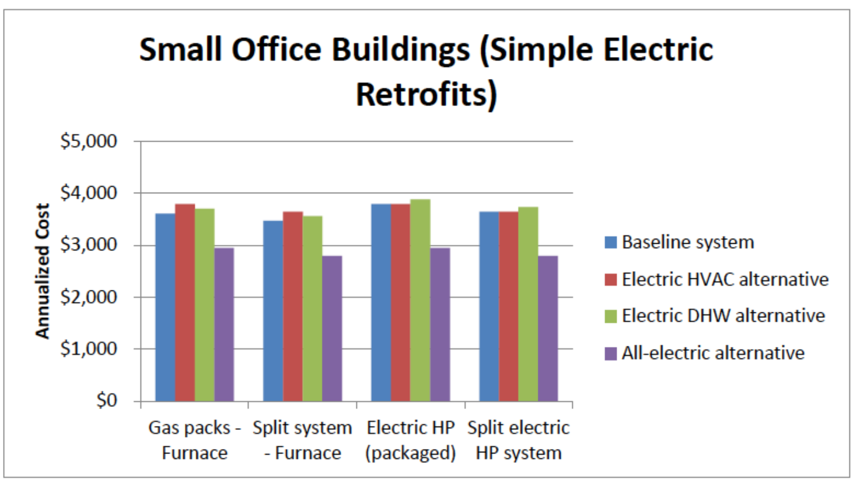


Figure 10 Annualized costs of HVAC and DHW systems in small office buildings with simple retrofits

Cooking: Cooking on gas is often pointed to by staff of SoCalGas in public forums as a prerequisite for customer happiness. Those who argue that a gas range is better than induction likely have no personal experience with an induction range. I have found my induction range to be my favorite part of fuel switching my home, because induction is a better cooking experience:

1. They are the preferred, high-end stove in France. My brother is an internationally successful artist represented by a gallery in Paris, and family trips to his openings have shown us that billionaires like Francois Pinault install high end induction stoves in their mansions, not gas ranges. This is because

French chefs prefer induction: www.treehugger.com/kitchen-design/induction-stoves-french-cooking-school.html

2. Induction has been preferred by chefs in NYC and culinary schools for twenty years now: http://www.nytimes.com/1998/01/07/dining/test-kitchen-future-kitchen-the-heat-is-easier-to-take.html?mcubz=3.

3. In 2011 Lawrence Berkeley National Laboratories (ehp.niehs.nih.gov/1306673/) studied gas ranges in 6,634 California homes to see if Formaldehyde (HCHO), NO_2, and Carbon Monoxide levels were safe for the cook, particularly if she was pregnant or a 2-5 year old was near the cook's knee in an hour of cooking. Below is a graph of Formaldehyde exposure levels from the research showing carcinogenic thresholds being exceeded by gas stoves:

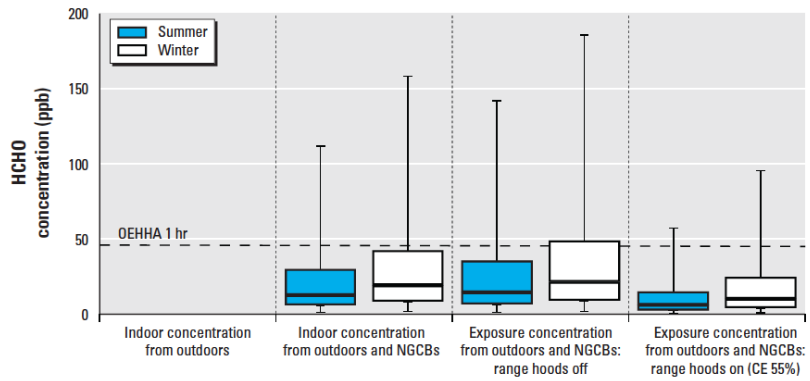


Figure 3. Highest 1-hr time-averaged indoor pollutant concentrations estimated by simulation modeling of the weighted sample of 6,634 SoCal homes and exposure concentrations for the weighted sample of 19,464 individual occupants. Estimated indoor concentrations presented for scenario 1 (winter) and scenario 2 (summer), both of which assume no range hood use. Estimated exposure concentrations presented in this figure all apply near-source proximity factors, with one pair of scenarios assuming no range hood use and the second pair of scenarios assuming use of a range hood with 55% capture efficiency (CE) during every cooking event. Boxes indicate 25th (bottom), 50th (line within box), and 75th (top) percentiles; whiskers represent 5th and 95th percentiles. Dashed horizontal lines are standards from Table 1 that are within ranges shown on graphs. Results presented for scenario 1 are the mean values from 15 model executions. See Supplemental Material, Table S3, for tabulated results.

"Results**: The simulation model estimated that—in homes using NGCBs without coincident use of venting range hoods—62%, 9%, and 53% of occupants are routinely exposed to NO2***, CO, and HCHO levels that exceed acute health-based standards and guidelines. NGCB use increased the sample median of the highest simulated 1-hr indoor concentrations by 100, 3,000, and 20 ppb for NO***2***, CO, and HCHO, respectively.*"

Logue JM, Klepeis NE, Lobscheid AB, Singer BC. 2014. Pollutant exposures from natural gas cooking burners: a simulation-based assessment for Southern California. Environ Health Perspect 122:43–50; http://dx.doi.org/10.1289/ehp.1306673

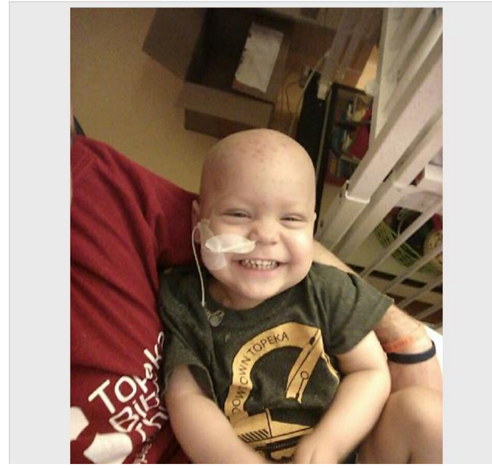
Formaldehyde is a scentless combustion by-product of methane that among its many toxic health impacts, it causes childhood leukemia, a rapid acting bone cancer. Two in three children survive acute myeloid leukemia, and one dies (Leukemia & Lymphoma Society, 2017). I suggest that that stoves are for cooking food, and should not be a game of involuntary Russian roulette with our children's lives:

Boy treated at CHOP for leukemia passes away after cancer returned

Image Gallery — 3 PHOTOS

Blake 'won the fight': 2-year-old passes following lengthy leukemia battle

KSNT News
Published: March 7, 2017, 2:37 pm | Updated: March 8, 2017, 9:39 pm



Post-Earthquake Fires: Supporting gas retrofits with SB 350 increases risks to public safety. In 2002 the State of California published a collaborative study (seen below) on the role of natural gas in fires after earthquakes. Every significant earthquake has produced wide-scale natural gas fires, going back to 1906 San Francisco Earthquake, where "The primary sources of ignition were the upsetting of oil lamps and oil and gas stoves, contact of flames from lamps and [lighting] gas jets, rupturing of chimneys and flues, and upsetting of boilers and furnaces." Gas leaks caused 13 of 25 fires after the 1989 Loma Prieta earthquake. After the 1994 Northridge Earthquake, 54 of 110 fires were caused by natural gas leaks; SoCalGas received 276,000 natural gas-related disaster orders and FEMA had more than 700,000 claims on damaged gas appliances.

Improving Natural Gas Safety in Earthquakes

Adopted July 11, 2002

Prepared by:
ASCE-25 Task Committee On Earthquake Safety Issues For Gas Systems

California Seismic Safety Commission

State of California
Gray Davis, Governor

SSC-02-03

Several common characteristics of earthquakes and their impacts on natural gas safety are identified in this report and summarized below:

1. Earthquake ground shaking will generally lead to substantially more instances of building damage than fire ignitions.
2. Ground motions that are sufficient to damage buildings are most likely to impact utility and customer gas systems and create a potential for gas-related fire ignitions.
3. The number of post-earthquake fire ignitions related to natural gas can be expected to be 20% to 50% of the total post-earthquake fire ignitions.

From Page 1: Summary

Images collected from Northridge earthquake news coverage of natural gas fires--S. Armstrong

In short, all factual evidence points to significant cost savings, energy savings, safety advantages, health benefits and building owner benefits derived by investing in electrifying loads. Total natural gas sales have declined in California every year since 2007, and nation-wide natural gas has lost market share to electrification every year since 2010. It is time to invest in the housing of the future, and the "Energy Efficiency Potential and Goals Study for 2018 and Beyond" report does not yet provide that analysis, but must in order to be accurate to the world outside of the Warren Alquist Building.

Sincerely,

Sean Armstrong

9/20/17

Sean Armstrong — Date

Partner and Project Manager
Redwood Energy