Caiazza Comment Electric Service and Distribution System Upgrades Needed for Electric Heating

Summary
These comments are based on the work of Kip Hansen. He estimated costs associated with the distribution network for upgraded residential electric service; electrical distribution system improvements so that all homes can heat with electricity and use the "more usual and affordable" overnight electric vehicle chargers; and disconnecting natural gas supplies. I applied his reference information to New York and found that these costs range from $16.8 to $43.1 billion. These costs don't include "the costs to homeowners, who must pay for the service upgrade, service entrance wires, and circuit breaker panel box. And, of course, does not include the purchase new appliances or the installation of EV chargers." This cost estimate also does not include disconnection costs for fuel oil or propane heated homes. Finally, these estimates only apply to single family homes and not the 4.2 million housing units that are in multi-family buildings.

I believe the Draft Scoping Plan should describe all the control measures, provide references for assumptions, list the expected costs for those measures and list the expected emission reductions for the Reference Case, the Advisory Panel scenario and the three mitigation scenarios. This information is not available so I could not confirm that these costs are included in the Integration Analysis or provide the opportunity to provide meaningful comments.

Introduction
The Climate Act requires the Climate Action Council to "[e]valuate, using the best available economic models, emission estimation techniques and other scientific methods, the total potential costs and potential economic and non-economic benefits of the plan for reducing greenhouse gases, and make such evaluation publicly available" in the Scoping Plan. I believe that there should be a summary of the costs that lists every control measure, specifies the costs and estimates the emission reductions expected in the Reference Case and the three mitigation scenarios.

This comment describes the problem of the electric service and distribution system upgrades that I don't think is addressed adequately in the Draft Scoping Plan. This comment is based almost entirely on the work of Kip Hansen. Mr. Hansen is a New Yorker who recently wrote a blog post, How Much of the Grid Must Be Upgraded, that addressed a topic that I had intended to comment on. Mr. Hansen did not have time to the submit a comment and graciously allowed me to use his material below. I provide italicized annotations to his article and then apply his findings to New York.

How Much of the Grid Must Be Upgraded?

Have you ever seen a transformer mounted on a power-pole explode? Marvelous fireworks. Why do they explode sometimes?   One energy company exec quipped "My experience and understanding of the way utilities do things is they just wait until the neighborhood is overloaded and then the transformer blows up." [source]

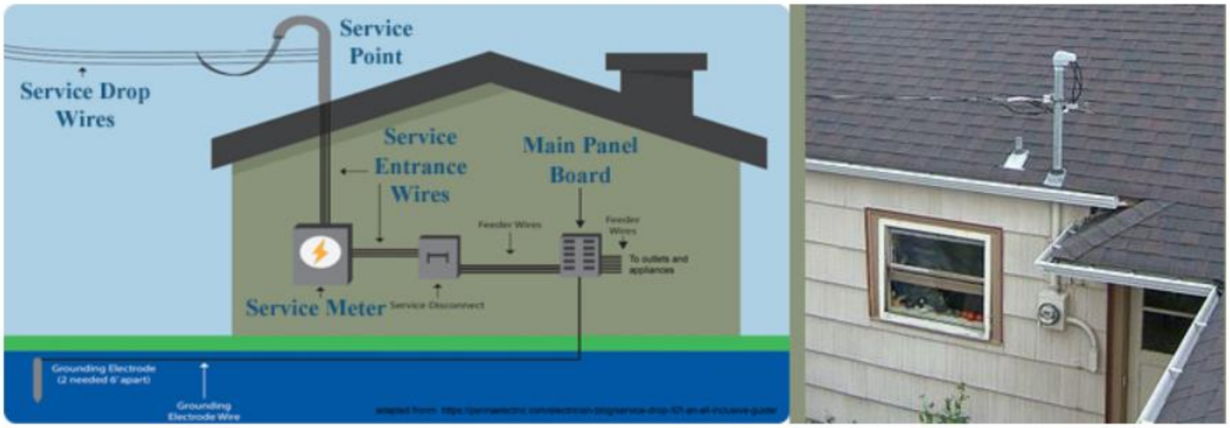
> *The statement that transformers blow up when the neighborhood is overloaded is incorrect but is a quote from the source listed. A commenter to the article noted that "Transformers do not blow up due to peak loads – they typically have this thing called a fuse. The reason that they do blow up is from an internal short when the insulating paper fails due to moisture. The moisture in turn comes from a breakdown of the insulating oil which in turn is highly dependent on temperature which in turn is dependent on both load and external temperature due to internal resistive electrical losses (gain) and external thermal losses.*

What would cause a home to draw too much power? Well, on a neighborhood level, summer or winter. When every home in the neighborhood turns their air conditioners up to maximum on a hot muggy summer afternoon or in winter, when too many all-electric homes kick their electric heating up to fight the cold on a cold, cold night.

Or when one or two neighborhood homes install electric vehicle fast-chargers.   What? Say again….

"Currently available DC fast chargers require inputs of **480+ volts and 100+ amps** (50-60 kW) and can produce a full charge for an EV with a 100-mile range battery in slightly more than 30 minutes (178 miles of electric drive per hour of charging)." **The more usual and affordable overnight chargers need 240v/50amps –** times two means you will need 100 amps available for car charging at night.

So, if your family were to have two EVs and wanted two overnight chargers – and who wants to argue with their spouse over who gets first dibs on the charger – your home would probably have to have a new electrical service panel and a new 200 amp service drop installed by your local utility — that is the wires that run from the nearest power pole to your home.



Pictured here is electrical service drop to a typical American home. Suburban homes in the United States usually have 100 amp service. My current home only had 60-amp service when we moved in in the 1980s which meant the lights dimmed whenever the water heater kicked in or the water-well pump motor started up.   Newer homes here usually have 200-amp service, though a larger all-electric home – as in electric heating, air conditioning, electric water heater, electric sauna, electric hot tub, electric stove top and two electric ovens, electric clothes dryer plus the entertainment systems – may require 250, 300 even 400 amps service depending on the overall size of the home and number of electricity gobbling appliances.

"If you're running large appliances frequently (central air, heating) or have items with large electric demands (in-home saunas, hot tubs), you could benefit from installing a **300- or 400- amp service** instead." [source]

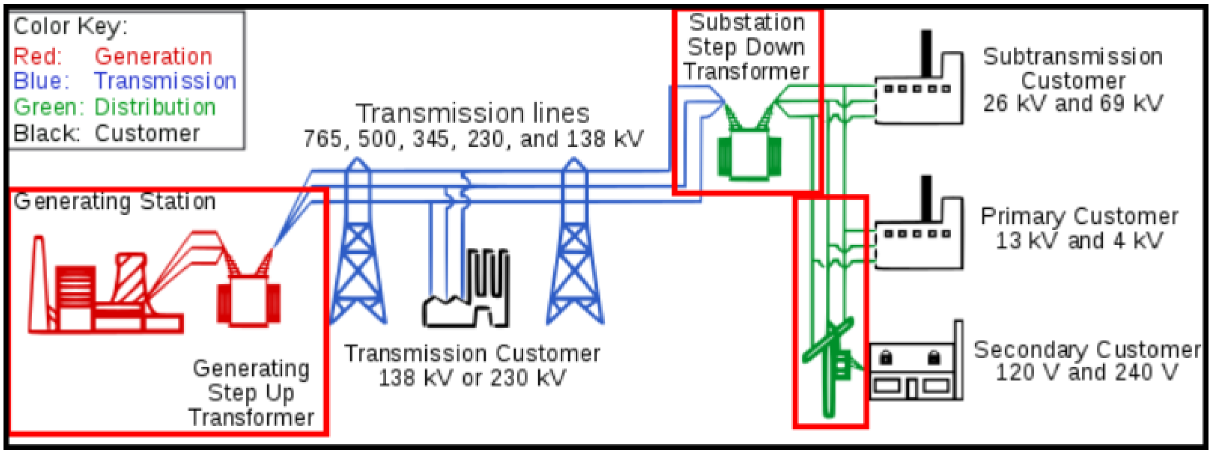
Large appliances include in the modern kitchen two electric ovens and electric stovetop, refrigerator, chest freeze, dishwasher and elsewhere in the home a washing machine, clothes dryer, heat-pump heating, whole-house air conditioning, window air-conditioner, hot tub, sauna, or pool heaters, electric water heaters (many larger homes have more than one). Look around your home, you may be able to add to the list.

And now, EV chargers. Repeating the data from above, almost all EV owners will want one overnight-charger for each vehicle. Each requires a **240v/50amp circuit breaker** in the panel box. In a modern home with normal electrical appliances, it is unlikely that local electrical codes will allow you to add two 240v/50amp circuits if you have only 100 amp service.

Note that this is not because 50 + 50 = 100. That's not how you determine circuits in your panel box, it is more complicated.

In the end, you may be looking at the rather expensive job of replacing your electrical system from the pole to the main panel (see illustration far above) — New service drop, service point, service entrance wires, service meter (usually supplied by your power company), probably a new service disconnect, and a new service panel. Cost? Up to $5,000.

What if you live in suburbia and everyone in your neighborhood wants two overnight chargers?



The items in the red boxes may need to be upgraded or duplicated – base load generating stations, substations, and local distribution lines including pole mounted transformers.

Let's look at a real example: Palo Alto, California , one of the principal cities of Silicon Valley. In this report:

City of Palo Alto Utilities Advisory Commission Staff Report (ID # 11639) 4 November 2020. [.pdf]

"**Highlights of Study Results: Impact to the Electric Utility**

The study shows that electricity demand for all-electric homes peaks on winter mornings due to heating, and averages around 3.62 kW per home, or 264% of a mixed-fuel home's peak demand. EV charging can add an additional 1.216 kW to the average peak demand of an all-electric home. Assuming each distribution transformer serves 8 houses, the load on each transformer under the all-electric SFRs scenario is calculated at 2.64 times the current transformer load plus 9.74 kW for EV charging.

As shown in Table 1 below, the additional load will trigger the need to upgrade some of the distribution transformers, secondary distribution lines (which connect the distribution transformer to the homes served by the transformer), and feeder lines (which connects the substation to the distribution points).

Table 1: Estimate of overcapacity equipment in the electric distribution grid under the all-electric SFRs scenario

Number of over-capacity distribution transformers	759 - 773 (95+%)
Number of over-capacity secondary distribution lines	162 – 155 (20%)
Number of over-capacity feeders	17 (25%)

https://www.cityofpaloalto.org/civicax/filebank/documents/78897

The total cost to upgrade the distribution system grid is estimated to range between $30 million and $75 million. Around 40% of this cost is equipment cost, and 60% is labor cost. This covers the cost to upgrade 95% of the distribution transformers, 20% of the secondary distribution lines, and 25% of the feeder lines. The cost estimate does not include additional undergrounding of feeder lines or secondary distribution lines."

How much is that going to cost?

2.9 Grand Totals, Electrical Upgrades

The estimated grand total for upgrading the electrical distribution system to support the increased load due to electrification can be found in Table 8.

Electrical Upgrades Grand Total		Conservative		Optimistic Flexible Load	
		Min	Max	Min	Max
Transformers	Like For Like	$15,365,750	$32,895,725	$12,573,187	$26,966,565
	Optimization	$14,597,606	$25,434,736	$8,299,292	$15,067,587
Secondary Distribution		$4,638,000	$7,730,000	$4,434,000	$7,390,000
Feeders		$17,000,000	$34,000,000	$17,000,000	$34,000,000
Total (assuming Optimized Upgrade costs for transformers)		**$36,235,606**	**$74,625,725**	**$29,733,292**	**$68,356,565**
Per SFR		**$2,414**	**$4,972**	**$1,981**	**$4,555**

Table 8: Estimated Cost to upgrade electric distribution system under two difference scenarios.

https://www.cityofpaloalto.org/civicax/filebank/documents/78897

Between $2,000 and $5,000 per home or in total for Palo Alto, somewhere *between 30 and 75 million dollars*.

Those costs don't include the costs to homeowners, who must pay for the service upgrade, service entrance wires, and circuit breaker panel box. And, of course, does not include the purchase new appliances or the installation of EV chargers.

To go all-electric in every **s**ingle **f**amily **r**esidence (**SFR**) in California also means replacing **all the natural gas usage** with electrical appliances – heating, cooking, domestic water heating, and for many homes, pool heating.

The cost?

3.5 Grand Totals Gas Disconnection

The grand totals and average prices per house for disconnecting all 15,008 SFRs in the city of Palo Alto can be found in the Table 12. The actual cost for disconnection will likely fall in between the optimistic and conservative estimates. These estimates are based on work completed by CPAU crew. The actual cost would be different if CPAU hires outside contractors to perform the work.

Grand Totals Gas Disconnection				
Type of Disconnection	**Optimistic**		**Conservative**	
	Min	**Max**	**Min**	**Max**
Mains	$4,986,240	$7,479,360	$4,986,240	$7,479,360
Service Lines	$4,160,000	$6,240,000	$24,012,800	$43,223,040
Meters and Risers	$2,251,200	$3,001,600	$2,251,200	$3,001,600
Total	**$11,397,440**	**$16,720,960**	**$31,250,240**	**$53,704,000**
Per SFR	**$759**	**$1,114**	**$2,082**	**$3,578**

Table 12: Grand Totals for sealing up gas pipelines as part of SFR electrification

https://www.cityofpaloalto.org/civicax/filebank/documents/78897

The cost of disconnecting the natural gas lines is estimated between $1,114 to $3,578 per home. That *does not include* the cost to the homeowner of replacing the appliances with electric models. All told, for this piece of going electric will cost *from $11 million to $53 million* – for Palo Alto's single family homes alone. This does not include businesses, apartment houses, retail shops and any other type of building.

Palo Alto's has about 15,000 homes, but there are approximately **7.5 million single family residences** in California. That means that the numbers given in the Palo Alto report will have to be multiplied by 500 to get an estimate for the state of California.

For pole mounted transformers, that will require up to 335,000 pole mounted transformers alone. Also, millions of new electric stove tops, millions of electric ovens, millions of electric water heaters. Not all of the 7.5 million homes in California use natural gas, but the California Public Utilities Commission tells us there are *11 million gas meters* in California. That's a lot of natural gas customers.

A gold star for the first reader to give the probable cost to the individual California home owner to upgrade home to all-electric with two EV over-night chargers. Give a list of what you are including.

For other readers, try to give an estimate of the materials needed to accomplish going all-electric *just in California*. Components needed for the grid upgrade, new appliances in homes, EV charges, 200 amp service entrance wire (currently costs about $20 per foot), new circuit panels, ... [this is a long list]. Give your opinion on whether or not you think that the manufacturing and supply chain is adequate to the task in today's world.

Please be aware that there are about 140 million homes in the United States. Anyone care to try the estimates for cost and time to convert all those homes all-electric?

This is the end of the blog post by Kip Hansen

Caiazza Comment on Cost Estimates for New York

The following table lists the New York cost range for the three components analyzed by Hansen. The total costs to upgrade residential electric service; upgrade the electrical distribution system so that all homes can heat with electricity and use the "more usual and affordable" overnight electric vehicle chargers; and disconnect from natural gas range from $16.8 to $43.1 billion. These costs don't include "the costs to homeowners, who must pay for the service upgrade, service entrance wires, and circuit breaker panel box. And, of course, does not include the purchase new appliances or the installation of EV chargers." This cost estimate also does not include disconnection costs for fuel oil or propane heated homes. Finally, these estimates only apply to single family homes and not the 4.2 million housing units that are in multi-family buildings.

How Much of the Grid Must Be Upgraded Estimated Costs Applied to New York Single Family Homes

Upgrade Component	Single Family Residences	Assumptions	Unit Cost Range		Component Cost Range ($Millions)	
			Low	High	Low	High
Residential Electric Service	3,340,248	Upgrade 90%	$1,350	$4,500	$ 4,509	$ 15,031
Electric Distribution Upgrades	3,711,386	All homes	$2,500	$5,000	$ 9,278	$ 18,557
Natural Gas Disconnections	2,668,620	Natural gas only	$1,114	$3,578	$ 2,973	$ 9,548
New York State Total					$ 16,761	$ 43,136

Conclusion

Jim Shultz recently described the text of the Draft Scoping Plan: "The plan is a true masterpiece in how to hide what is important under an avalanche of words designed to make people never want to read it". In addition, the Plan does not provide adequate documentation for the numbers. I believe the Draft Scoping Plan should describe all the control measures, provide references for assumptions, list the expected costs for those measures and list the expected emission reductions for the Reference Case, the Advisory Panel scenario and the three mitigation scenarios. If this information was available then reviewers could confirm that these costs are included in the Integration Analysis and provide the opportunity to provide meaningful comments. As it stands the public is expected to trust the numbers but without any details how can that be possible? In addition, given that the total costs and benefits that are available are inaccurate and misleading I don't trust any numbers in the Integration Analysis.

On May 12, 2022 the New York Public Service Commission issued an Order on Implementation of The Climate Leadership and Community Protection Act, CASE 22-M-0149. One of the biggest problems with the Climate Act is that it did not include a mandated feasibility analysis to determine if the transition to net-zero can be done without affecting affordability and reliability. The law does include a review in two years that can "temporarily suspend or modify its obligations under the program":

> The Commission will conduct a biannual review of the renewable energy program beginning July 1, 2024. Specifically, the CLCPA requires the Commission to issue for notice and comment a "comprehensive review" that considers "(a) progress in meeting the overall targets for deployment of renewable energy systems and zero emission sources, including factors that will or are likely to frustrate progress toward the targets; (b) distribution of systems by size and load zone; and (c) annual funding commitments and expenditures" (PSL §66-p. 3). The Commission is

> authorized to temporarily suspend or modify its obligations under the program should it make a determination, after a hearing, that the program interferes with its core responsibility of ensuring safe and adequate electric service, is likely to impair existing obligations and agreements or results in a significant increase in arrears or service disconnections (PSL §66-p. 4).

I think it is pretty obvious that a review meeting these requirements should be done before implementation proceeds. The Draft Scoping Plan has not proven that the net-zero transition can be implemented without adversely affecting reliability and affordability.

I prepared this comment because I believe that the cost documentation is insufficient and the costs have been covered up. This is an example of one of the cost components that has to be evaluated by independent analysts but cannot be reviewed due to the outrageous lack of documentation. I have written extensively on implementation of the Climate Act because I believe the ambitions for a zero-emissions economy outstrip available renewable technology such that it will adversely affect reliability and affordability, risk safety, affect lifestyles, will have worse impacts on the environment than the purported effects of climate change in New York, and cannot measurably affect global warming when implemented. The opinions expressed in this document do not reflect the position of any of my previous employers or any other company I have been associated with, these comments are mine alone.

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