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NRDC Comments on IEPR Workshop on Forecast Use in Electricity Planning

Additional submitted attachment is included below.

October 23, 2024

California Energy Commission
Docket Unit, MS-4
Docket No. 24-IEPR-03
715 P Street
Sacramento, California 95814-5512
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Re: Natural Resources Defense Council's Comments on CEC Workshop Regarding Forecast Use in Electricity System Planning

Dear Commissioners:

The Natural Resources Defense Council (NRDC) appreciates the opportunity to provide comments on the October 2, 2024, workshop hosted by the California Energy Commission (CEC) on the use of forecasts in electricity system planning. This workshop, part of the 2024 Integrated Energy Policy Report (IEPR) Update proceeding, examined how CEC's electricity demand forecasts inform key aspects of California's electricity system, including resource adequacy, integrated resource planning, and transmission and distribution system planning. Given the critical role that electricity demand forecasting plays in system planning, NRDC welcomes this opportunity to comment on how the state can prepare for emerging loads, including green hydrogen.

I. Introduction

Green electrolytic hydrogen made through the electrolysis of water using renewable electricity can be a potential solution to decarbonize some of California's hard-to-electrify sectors.[1] However, it is essential to plan for the potential electricity demand from hydrogen electrolyzers to avoid negative impacts on the grid and other electric customers, and so that unexpected load growth does

[1] Hydrogen is only "green hydrogen" if it is produced using zero-emission electricity. If connected to the grid, electricity used to produce green hydrogen must meet the 3 pillars of:
a. Incrementality – using new or otherwise curtailed energy rather than shuffling around existing resources that are already serving homes and businesses.
b. Hourly matching – using clean energy in the hour it is generated.
c. Geographic deliverability – using clean energy in the same region of the grid as its generated so it's not behind a transmission constraint.

not impede California's ability to meet its decarbonization goals. While the California Air Resources Board's (CARB's) 2022 Scoping Plan assumes that any green electrolytic hydrogen used in the state will be produced with off-grid renewables, there is no mechanism preventing hydrogen electrolyzers from accessing power from the grid. This memo analyzes different hydrogen production and consumption scenarios to demonstrate potential electric load growth impacts of hydrogen production. NRDC recommends the CEC consider different hydrogen production scenarios in its IEPR load forecasting to ensure the state is prepared to meet these potentially significant, currently unplanned for, new loads.

II. Discussion

A. *Planning for load uncertainties*

The IEPR plays a critical role in California's energy planning by forecasting energy demand, introducing emerging topics, and providing recommendations, while embedding equity and environmental justice. A key component of the report is the demand forecast, which is calculated using factors such as population growth, economic trends, technological advancements, energy efficiency measures, policy changes, and shifts in consumer behavior. Since this forecast informs the California Public Utilities Commission's (CPUC) Integrated Resource Planning (IRP) process, which in turn informs CAISO's Transmission Planning Process (TPP), accurately assessing demand forecasts is crucial to ensure timely development of renewable energy resources and associated infrastructure, especially those with long lead times requiring ten or more years of planning. At the same time, over-forecasting could result in excessive resource and grid infrastructure buildout, unnecessarily increasing costs.

NRDC appreciates CEC's efforts in estimating the financial and resource requirements for two scenarios of clean and renewable hydrogen production aimed at replacing fossil gas in electricity generation.[2] The first scenario is based on the California Air Resources Board's (CARB) Scoping Plan, and the second draws on the University of California, Irvine (UCI) study, which assumes that a portion of California's projected storage and zero-carbon dispatchable generation needs will be met by hydrogen. Additionally, the CEC evaluated hydrogen growth in the transportation sector

[2] California Energy Commission. "2023 Integrated Energy Policy Report." *California Energy Commission*, 2023, www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.

by focusing on hydrogen demand in 2040 from CARB's 2022 Scoping Plan Update and by developing a scenario based on the CEC's transportation demand forecast, Additional Achievable Transportation Electrification (AATE) 3 scenario.

CARB's 2022 Scoping Plan Update assumes green hydrogen production through electrolysis will be fully off-grid, but there is uncertainty about the reliability of that assumption. Indeed, as highlighted in an IEPR workshop presentation and a 45V comment letter, ARCHES establishes that their electrolyzers will utilize power both from the grid and from self-generation.[3] Since some hydrogen production is very likely to draw power from the grid, it's important for the CEC to develop scenarios that account for the potential increase in demand. The 2023 IEPR did not account for this demand, so including it in future forecasts is crucial for informed planning.

B. *Estimating potential electrolysis-induced load growth*

This analysis first assesses potential hydrogen demand in California, using the Final 2022 Scoping Plan Update hydrogen production demand data from the Energy & Environmental Economics (E3) sheet (CARB_E3_Pathwaysdata_2022).

Figure 1, below, shows potential projected "clean hydrogen" demand from 2023 through 2045. These demand projections represent the amount of hydrogen that CARB forecasts will be consumed in the Commercial, Industrial, Oil & Gas, Petroleum Refining, Residential, TCU and Transportation sectors to meet their Scoping Plan decarbonization targets.

[3] *See*, Jack Brouwer and Jeff Reed, "Hydrogen Electricity Demand Estimates," *California Energy Commission*, May 16, 2024, p. 16, available at: CEC e-filing and Angelina Galiteva, "Comment from Alliance for Renewable Clean Hydrogen Energy Systems (ARCHES) on the Proposed Regulations to Implement the Section 45V Credit for the Production of Clean Hydrogen," February 25, 2024, available at: https://www.regulations.gov/comment/IRS-2023-0066-29465.

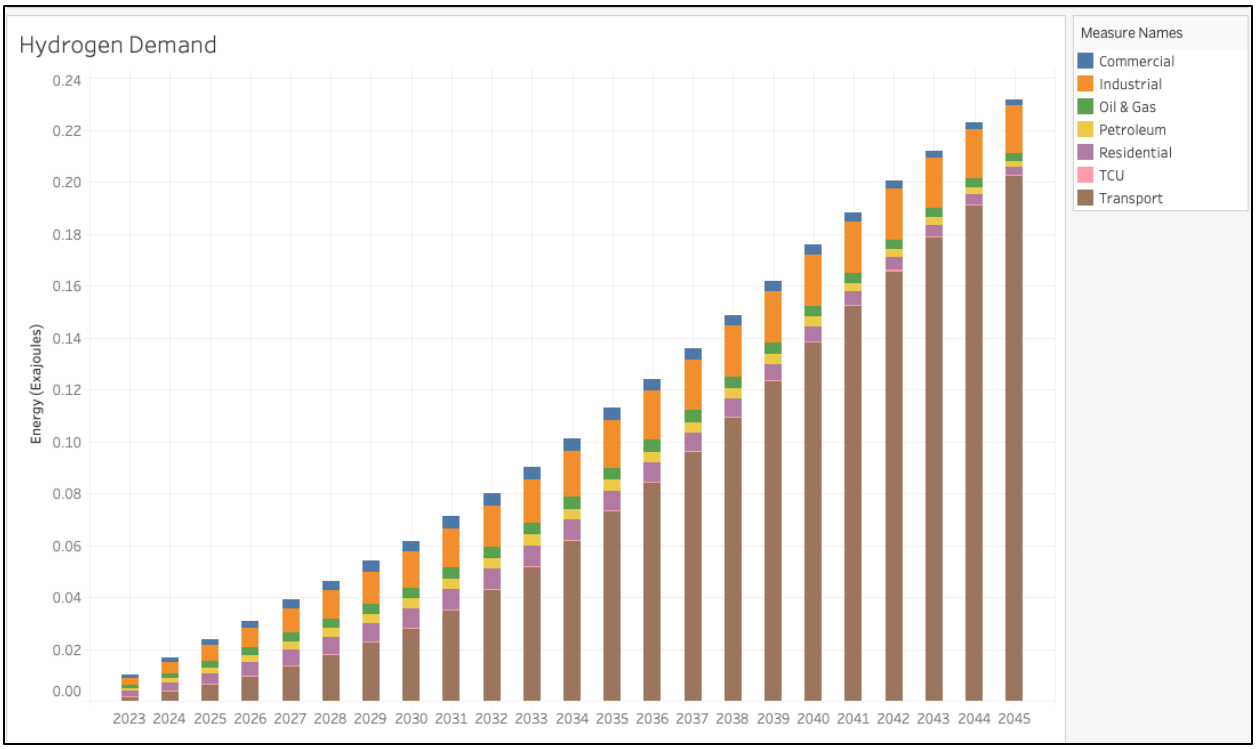

Fig 1: Potential "Clean Hydrogen" Demand from Sectors. Source: CARB_E3_Pathwaysdata_2022

In the CARB Scoping Plan scenario as visualized in the graph below, there are three types of "clean" hydrogen production:

1. Electrolysis: hydrogen is assumed to be produced off-grid.
2. Synthetic Methane Reformation with biogas: hydrogen is assumed to be all imported.
3. Bioenergy with Carbon Capture and Sequestration: hydrogen is assumed to be produced off-grid starting in 2028.

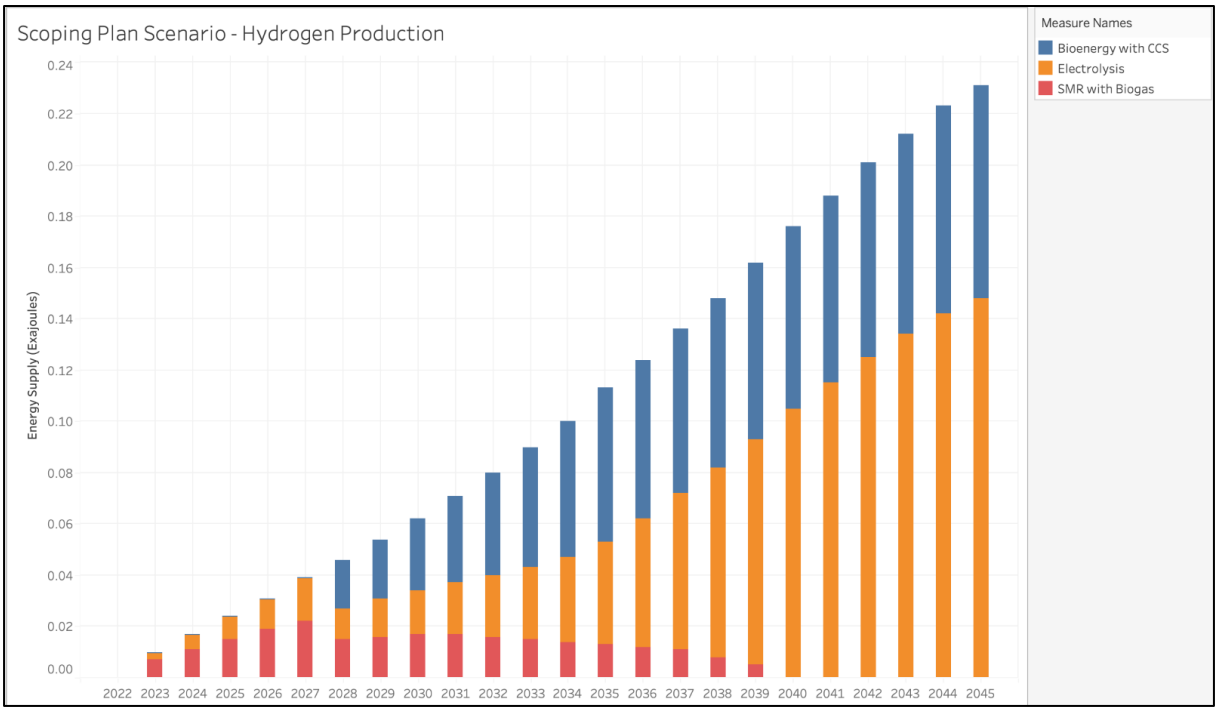

Fig 2: Hydrogen Production in Scoping Plan Scenario w.r.t source

CARB assumes that natural gas will be used for hydrogen production in its business-as-usual scenario.

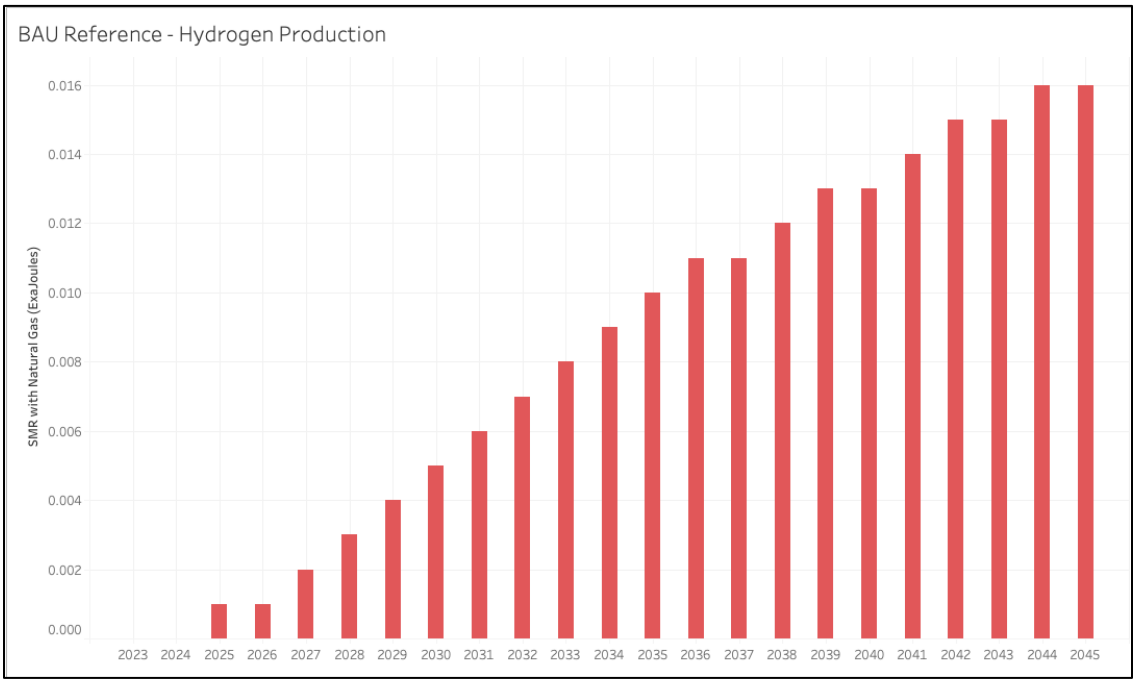

Fig 3: Hydrogen Production in BAU w.r.t source

For our analysis to determine potential grid impacts of production of hydrogen used in California, we make the following assumptions:

- The total amount of hydrogen produced by electrolysis in the Scoping Plan scenario as presented in Fig 2., 0.148 exajoules, is produced using grid power.
- Capacity Factor for electrolyzers is 65%.[4]
- The lower heating value for hydrogen is 120 MJ per kg of hydrogen.[5]

These assumptions are used in estimating the total electricity required to produce hydrogen:

Table 1: Electricity required to electrolytically produce hydrogen in 2045

Potential hydrogen demand in Exa joules in 2045	0.148
Lower heating value (MJ/kg of hydrogen)	120
Hydrogen demand in MMT	1.24
Hydrogen demand in kg	1,236,267,754
Hydrogen content (kWh/kg)	33.33
Capacity Factor (%)	65
Hydrogen content after CF correction (kWh/kg)	51.28
Estimated electricity required in TWh	63.40

Therefore, to produce 0.148 EJ of hydrogen in 2045 through electrolyzers, we need 63.40 TWh of electricity.

C. ***Scenario Analysis***

We have developed four scenarios for hydrogen electricity production:

1. Scenario 1: Full in-state production - 100% hydrogen from electrolysis is powered by grid electricity and produced in-state.
2. Scenario 2: Majority in-state production - 70% hydrogen from electrolysis is powered by grid electricity and produced in-state.

[4] Integrated Energy Policy Report 2023, https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report/2023-integrated-energy-policy-report.
[5] *Ibid.*

3. Scenario 3: Partial in-state production - 40% hydrogen from electrolysis is powered by grid electricity and produced in-state.
4. Scenario 4: limited in-state production – 25% hydrogen from electrolysis is powered by grid electricity and produced in-state.

Table 2: Electricity required in TWh under each scenario

Year	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2023	1.40	0.98	0.56	0.35
2024	2.51	1.76	1.01	0.63
2025	3.82	2.67	1.53	0.96
2026	5.29	3.71	2.12	1.32
2027	7.07	4.95	2.83	1.77
2028	5.25	3.67	2.10	1.31
2029	6.26	4.38	2.50	1.56
2030	7.28	5.10	2.91	1.82
2031	8.71	6.09	3.48	2.18
2032	10.15	7.10	4.06	2.54
2033	12.03	8.42	4.81	3.01
2034	14.28	10.00	5.71	3.57
2035	17.11	11.98	6.84	4.28
2036	21.30	14.91	8.52	5.32
2037	26.02	18.21	10.41	6.50
2038	31.65	22.15	12.66	7.91
2039	37.77	26.44	15.11	9.44
2040	44.72	31.30	17.89	11.18
2041	48.99	34.29	19.60	12.25
2042	53.22	37.25	21.29	13.30
2043	57.13	39.99	22.85	14.28
2044	60.82	42.57	24.33	15.20
2045	63.40	44.38	25.36	15.85

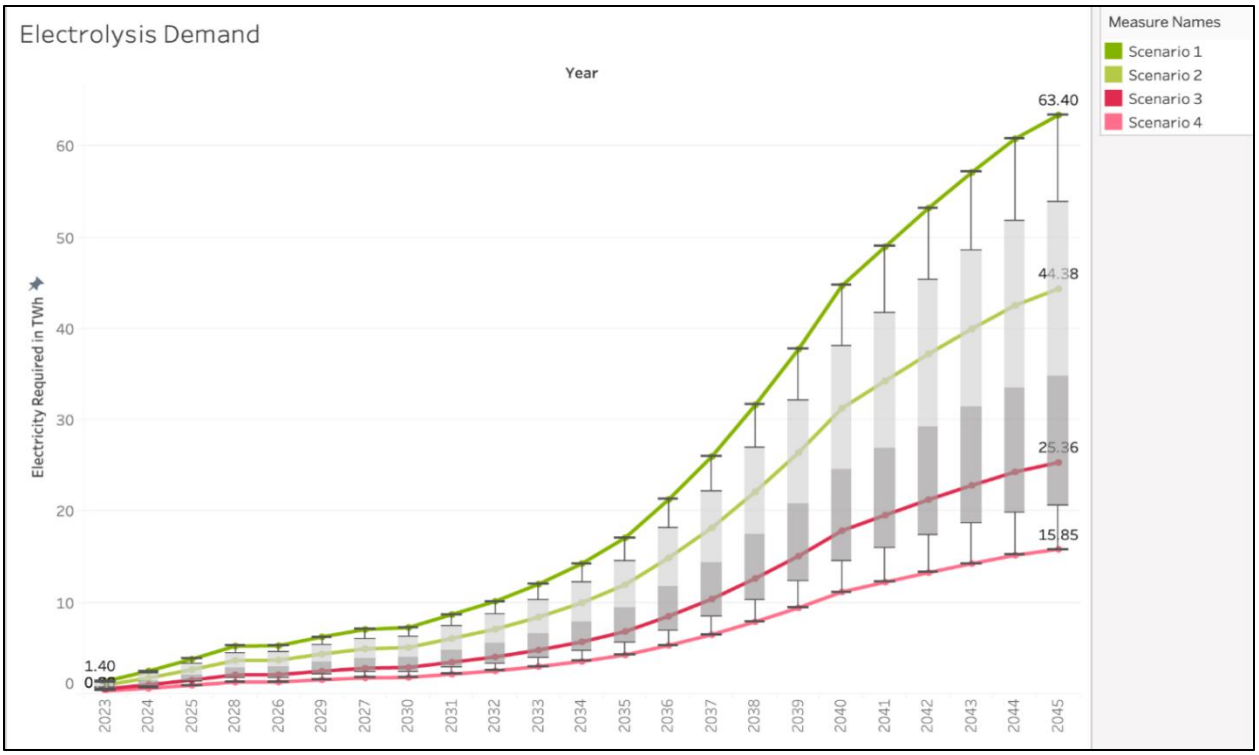

Fig 4: Electricity demand from scenarios

This figure shows the projected electricity demand specifically from green hydrogen production via electrolysis across four different scenarios from 2023 to 2045. The colored lines represent different scenarios about the percentage of hydrogen production through electrolysis, with Scenario 1 (green) showing the highest demand, reaching 63.40 TWh by 2045. In contrast, Scenario 4 (red) represents the lowest projected demand, with 15.85 TWh by 2045. The grey bars represent the range of uncertainty around these projections.

D. *Total Statewide Electricity Demand in Comparison with electrolysis demand*

To estimate the additional demand on top of the projected electricity load, we have outlined trajectories to track the added load from electrolysis. The figure below compares the four scenarios with the state's total electricity demand projected in the 2022 CARB Scoping Plan Update.

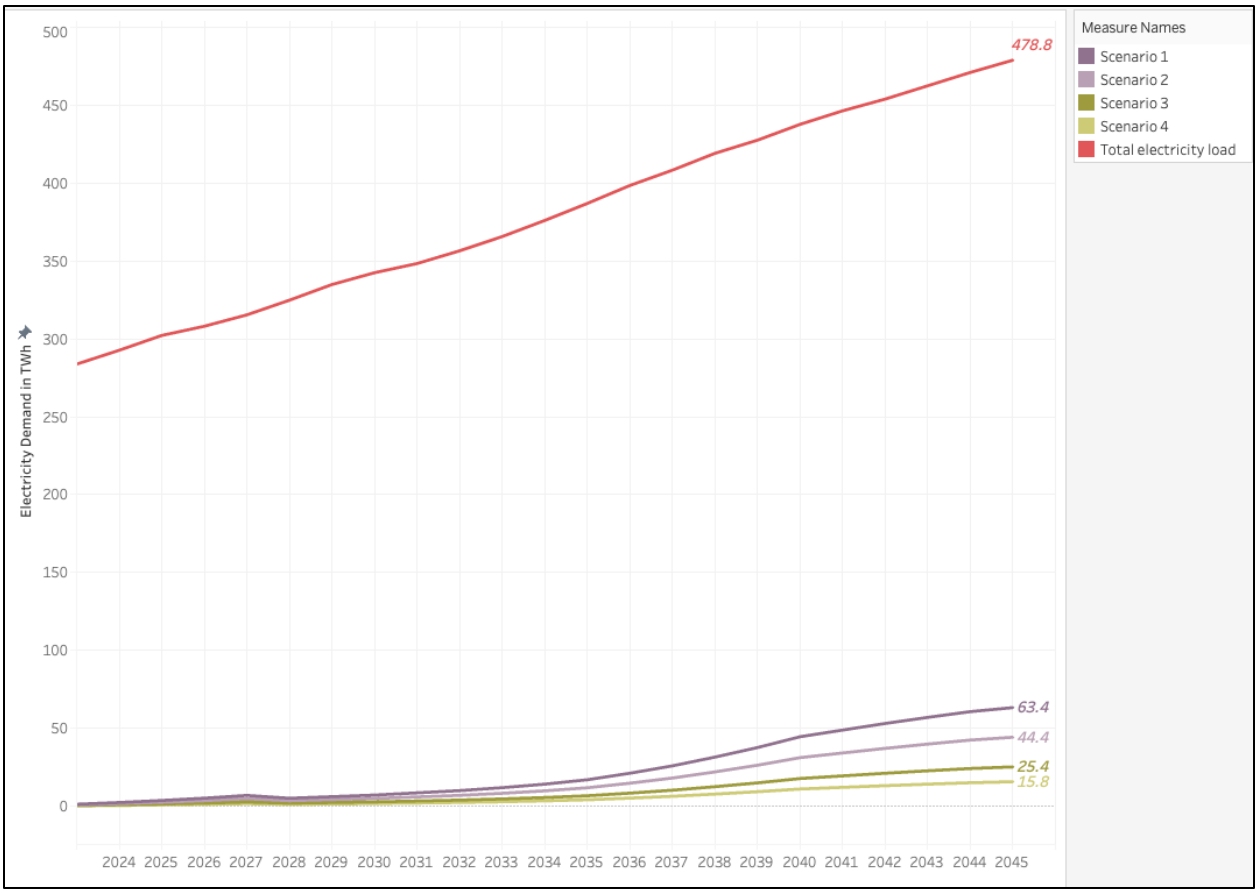

Fig 5: Total Electricity Demand

This figure illustrates the total projected electricity demand from 2024 to 2045, comparing four different scenarios for electrolysis load. The red line represents the total electricity load without considering electrolysis, while the other lines show different scenarios of load growth from electrolysis. Notably, Scenario 1 could lead to electricity demand 13 percent over what is currently being projected, a number that could have significant resource planning implications.

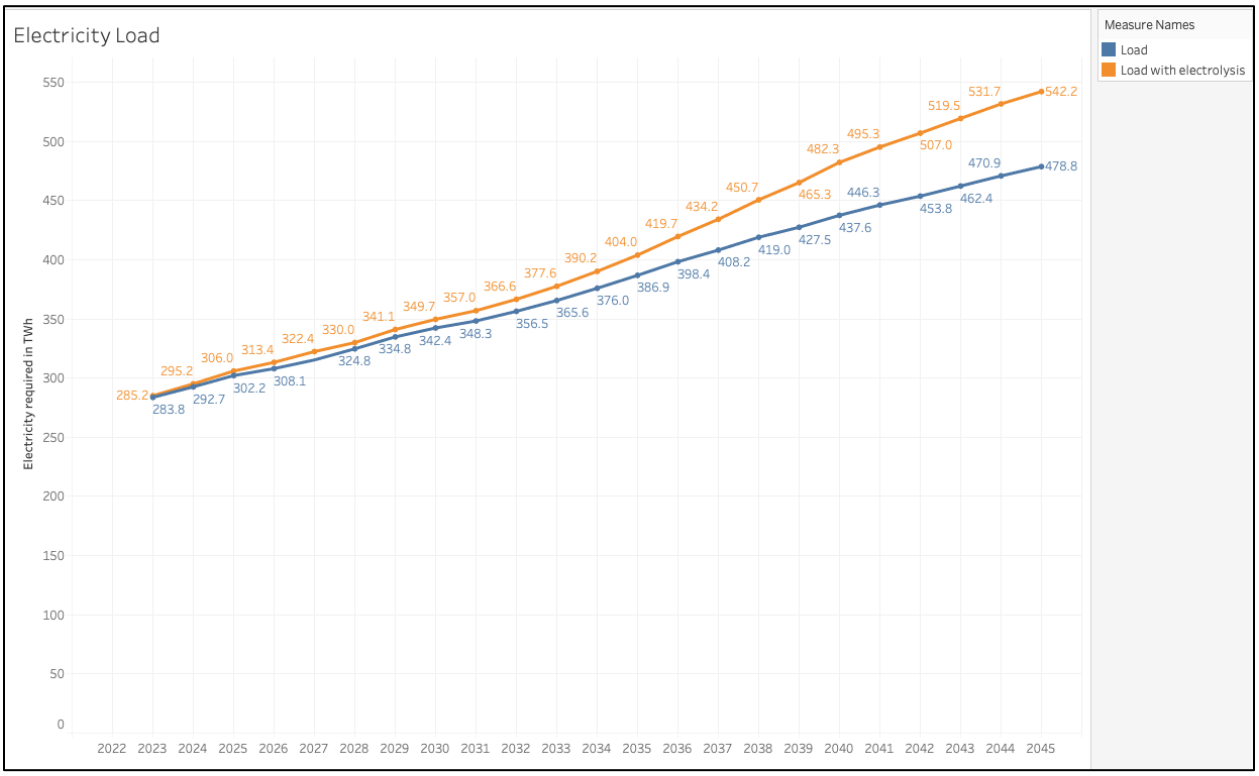

Fig 6: Electricity Demand Comparison with and Without Scenario 1 (Full in-State, Grid-Powered Production of Hydrogen)

This figure presents a comparison of projected electricity demand with and without the inclusion of electrolytic hydrogen production from 2022 to 2045. The blue line represents the baseline load forecast from various sectors based on the CARB Scoping Plan, including Agriculture, Buildings, Industrial, and Transportation. The orange line represents the total projected load when accounting for the additional electricity demand from green hydrogen production as presented as Scenario 1 in the analysis. As seen in the graph, the inclusion of electrolysis significantly increases the overall electricity demand trajectory over time, underscoring the importance of incorporating hydrogen production into future demand forecasting and planning.

III. **Conclusion**

NRDC appreciates the CEC's efforts in exploring scenarios for green hydrogen production and its potential impacts on electricity demand. As demonstrated in this analysis, varying levels of in-

state hydrogen production could have significant implications for California's grid and long-term planning efforts. Importantly, any hydrogen produced using grid electricity in California must meet the three pillars of incrementality, hourly matching, and geographic deliverability to mitigate the risk of new hydrogen loads increasing emissions. We recommend that CEC consider a range of hydrogen production scenarios and incorporate those into the state's electricity demand forecasting. Assessing a range of potential load growth scenarios, especially ones with such a potentially large impact, is essential to inform the IEPR, IRP, and CAISO transmission planning processes. Informed planning is essential to ensure that California remains on track to meet its decarbonization goals in a reliable, cost-effective, and equitable manner.

Sincerely,

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