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CEC HRS Funding Workshop

Additional submitted attachment is included below.

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California Energy Commission Workshop:
Staff Workshop on Hydrogen Refueling Infrastructure Alternative Funding Mechanisms

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Workshop Objective (as detailed in workshop slides):
The CEC has a fixed allotment of funds to contribute towards hydrogen-refueling station (HRS) financing to accelerate market development and meet the growing demand for fuel-cell electric vehicles (FCEV). Current FCEV adoption projections indicate a likely scenario in which FCEV hydrogen demand will exceed HRS capacity in the business-as-usual funding scenario. The question effectively posed by CEC is how to fund more HRS capacity (kg/day) with the same allotment of funds.

Note: Only supply-side solutions will be considered (no demand-side incentives are included in this analysis).

Potential Policy Solutions:
1. Tiered Capacity Incentive: Used a tiered incentive program based on the station capacity
2. Tiered Utilization Incentive: Tiered incentive program based on the station utilization
    a. Unused Incentive: Provide incentive per kilogram/day capacity unused
    b. Used Incentive: Provide incentive per kilogram dispensed

Policy Details and Simple Analysis:
There are three primary parties interested in changes in CEC HRS funding policy: CEC, the private firm building the HRS, and the consumer of FCEVs. Each policy option will be summarized, then briefly analyzed by assessing the impacts to each primary party.

1. *Tiered Capacity Incentive*
   Historically, the Energy Commission provides approximately $1.8M of funding per station. The average nominal station size funded is ~300g/day. Thus, the average funding per nominal unit of capacity is approximately $6000/(kg/day). To increase the nominal network capacity, the funding per kg/day must decrease. A potential tiered scale could be as follows[1]:

Table 1. Example Tiered HRS Funding Approach

Nominal Station Size [kg/day]	Financial Incentive [$/(kg/day)]
<200	1500
200-300	2500
300-400	3500
400-500	4500
>500	5500

[1] The tiered scaling will significantly impact the decision-making process on station size during project development. A more detailed analysis would be required to optimize the tiers.

Using this example tiered funding approach, the private firms would be incentivized to marginally increase nominal station size, providing increased capacity for the network of FCEVs. This also reduces the average funding per kg/day capacity, resulting in more stations funded as seen in Table 2.

Table 2. Potential Increase in Stations Funded Based on Example Tiered Funding Approach

Example Station Size [kg/day]	Funding Per Station [$M]	Maximum Stations Funded Under New Policy (per year)	Maximum Stations Funded Under Existing Policy (per year)
250	0.63	32	13
350	1.23	16	9
450	2.03	9	7
550	3.03	6	6

A simple financial analysis performed to understand the firm's implication shows that (as expected) overall profitability decreases due to lower CEC funding but the financial situation remains positive for large stations. It should be noted that this simple analysis does not account for potential increases in hydrogen demand due to the faster expansion of the HRS network nor many other market dynamics[2].

Table 3. Example Financial Analysis for the HRS Owner

	Existing Policy		Tiered Funding Mechanism	
Nominal Capacity [kg/day]	350	500	350	500
Leveraged, after-tax, nominal IRR	28%	119%	9%	43%
After-tax, nominal NPV @ 10% discount	0.75M	1.9M	-0.12M	1.7M

In summary, some of the main potential benefits and considerations are below.

Potential Policy Benefits:

- CEC: The energy commission is able to fund more stations and station capacity
- CEC / Consumer: HRS network capacity is increased with new, larger stations
- CEC: Straightforward administration process
- Firms: Larger stations improve economies of scale, reducing cost per kg dispensed
- Firms: Larger stations will have capacity to benefit in the future from higher hydrogen demand from FCEVs
- Consumer: More stations may reduce probability of having to wait to refuel

Potential Policy Considerations:

- All: Potential funding tiers must be analyzed and optimized
- CEC: Fewer, larger stations may be created which may negatively impact the goal of providing 100 total HRSs

[2] A more detailed, dynamic, and spatially resolved analysis should be completed to understand the impact across the entire state of California

- Consumer: Fewer stations may indicate less opportunity to refuel, thus increase the perceived cost of FCEVs due to lower convenience (may be negated by reduction in fueling wait-time)
- Firms: Firms receive reduced incentives for smaller stations, potentially inhibiting development and network growth in predicted low-demand areas
- CEC: Need to determine a standardized method for calculating a station's nominal capacity (kg/day)

2a. Tiered Utilization Incentive – Unused Capacity

Similar to the idea presented during the workshop, the Energy Commission could set up a system where stations are provided funding based on their actual utilization. However, an initial award could be added based on the nominal capacity of the station to further incentivize firms to develop the HRS. This provides funding for all stations regardless of future utilization, while also reducing the risk of HRSs that may not become fully utilized. For CEC funding planning purposes, this benefit should have a fixed time-horizon.

For example, assume a 450kg/day station has a predicted average utilization of 40% over the first 5 years of its life. If the initial award is 20% of a full award based off of a $6000/(kg/day) value[3], the initial reward would be $0.72M. This funding would be provided to the firm regardless of the future utilization rate. Future awards to the firm would be dependent on the actual utilization rate observed over the year. To ensure the funding remains below the existing policy level (and thus increase the amount of HRSs funded), the variable award will be dependent on the projected utilization of the station and the time horizon for which the benefits are applicable. Under the assumptions described above, an incentive basis of $2400/(kg/day) of unused capacity could be used to provide the equivalent total funding to each station as compared to the existing policy. Table 4 summarizes the cash flows for a firm in the 5 years of the program as well as the total number of stations the Energy Commission could fund.

Table 4. Example Tiered Utilization Policy

Year	Utilization [%]	Remaining Capacity [kg/day]	Incentive [$M/year]*
1	13.3	300	1.26
2	26.7	240	0.58
3	40.0	180	0.43
4	53.3	120	0.29
5	66.7	60	0.14
Total			**2.70**

*Note: Year 1 includes the 0.54M capital incentive as well as the 0.72M operating incentive

[3] $6000kg/day chosen to be consistent with the existing policy, although a reduced rate could be used or the Tier Finding Mechanism could be used to further increase the number of stations funded

As seen in Table 4, the total incentive to the 450kg/day station is 2.7M which is equivalent to the existing policy at $6000/(kg/day)[4]. A large potential benefit of this approach is to reduce the immediate funding provided to each station, freeing up capital to be invested in additional HRSs and bringing more HRSs online faster. However, the total number of stations built is the same given the same average award per station ($2.7M). This effect is summarized in Table 5.

Table 5. HRS Development Funding Timing

Policy Year	Yearly CEC Funds to Award ($M)	Funding to New Stations ($M)	Funding to Existing Stations ($M)	New Stations Funded ($M)
1	20	18.9	0.0	15
2	20	11.3	8.6	9
3	20	8.8	11.7	7
4	20	7.6	11.7	6
5	20	0.0	11.2	0
6	0	0.0	5.9	0
7	0	0.0	2.7	0
8	0	0.0	0.9	0
9	0	0.0	0.0	0
10	0	0.0	0	0
Total	**100**	**47**	**53**	**37**

As done for the Tiered Funding Mechanism, a simple financial analysis was completed for the Tiered Utilization Policy. As seen in Table 6, the profitability for the HRS owner decreases due to the reduced overall CEC funding, but remains positive for larger stations. However, as above, this analysis does not account for potential increases in hydrogen demand due to the faster expansion of the HRS network.

Table 6. Example Financial Analysis for the HRS Owner

	Existing Policy		Tiered Utilization Mechanism	
Nominal Capacity [kg/day]	350	500	350	500
Leveraged, after-tax, nominal IRR	28%	119%	8%	13%
After-tax, nominal NPV @ 10% discount	0.75M	1.9M	-0.18M	0.47M

In summary, some of the main potential benefits and considerations are below.

Potential Policy Benefits:

- CEC: The energy commission funds more stations early on
- CEC: The total number of additional stations funded depends on how the base incentive and HRS utilization is achieved
- Consumer: HRS development is accelerated in the short-term, bringing stations online faster, reducing perceived refueling convenience cost of FCEV

[4] Future cash flows were not discounted in this analysis

- Firms: Obtain initial incentive to reduce early CAPEX while reducing future under-utilization risk
- CEC/Consumer: This approach could be combined with the Tiered Funding Mechanism described in (1) to bring larger stations online more quickly

Potential Policy Considerations:

- All: Potential base incentive structure must be analyzed and optimized
- CEC/Firms: If stations utilization is below expectations, awards may have to be reduced to remain within the budget
- CEC/Firms: Stations developed earlier so they may be undersized given uncertain future demand
- Firms: Reduced funding for HRSs that achieve high utilization
- Firms: If combined with the Tiered Funding Mechanism described in (1), firms receive reduced incentives for smaller stations, potentially inhibiting development and network growth in predicted low-demand areas
- Firms: Smaller companies without access to capital could be pushed out of the market due to high fixed cost to build the HRS

2b. Tiered Utilization Incentive – Used Capacity

This policy aims to provide a simple metric to subsidize the HRS owner based on the amount of hydrogen dispensed. For every kg of hydrogen dispensed, the firm will get a subsidy depending on how many kgs per day the station typically dispenses. As in the prior policy, it is recommended to have a set time horizon for this policy (e.g. 5 years). An example marginal incentive schedule is shown in Table 7 below. The marginal incentive is reduced for higher dispensing rates since the HRS station should need less financial support if it is more highly utilized.

Table 7. Example Marginal Incentive Schedule

Up to Amount Dispensed [kg/day]	Marginal Incentive [$/kg dispensed]
100	8.86
200	7.86
300	6.86
400	5.86
500	4.86

Putting in perspective of a typical 450kg/day nominal capacity station with a linear utilization ramp rate over the first 5 years, the incentive cash flows to the firm would gradually increase over time as summarized in Table 8.

Table 8. Example Tiered Utilization Policy

Year	Utilization [%]	Capacity Used [kg/day]	Incentive [$M/year]
1	13.3	60	0.19
2	26.7	120	0.38
3	40.0	180	0.55
4	53.3	240	0.71
5	66.7	300	0.86
Total			**2.70**

Given this typical station incentive structure, the Energy Commission would be able to fund more stations earlier with the constraint of having funds in the future to meet the growing incentive allocation as HRS utilization increases over time. In theory, the maximum number of stations could be funded in the first year (37 stations) since they would always require less cumulative funding per year until their utilization ramps up. However, it is unlikely that 37 stations will be built in one year, so the same deployment schedule as the previous utilization mechanism was used to demonstrate the funding timing as seen in Table 9.

Table 9. HRS Development Funding Timing

Policy Year	Yearly CEC Funds to Award ($M)	Funding to New Stations ($M)	Funding to Existing Stations ($M)	New Stations Funded ($M)
1	20	20.0	0.0	15
2	20	37.1	5.7	9
3	20	49.6	11.7	7
4	20	56.5	18.3	6
5	20	57.1	25.5	0
6	0	31.6	16.0	0
7	0	15.6	10.3	0
8	0	5.3	5.2	0
9	0	0.1	0.0	0
10	0	0.1	0.0	0
Total	**100**	**273**	**93**	**37**

As done before, a simply financial analysis was completed for the Tiered Utilization Mechanism and is summarized in Table 10. The results indicate that smaller stations are more competitive in this scenario, however, larger stations still show a greater return on investment overall.

Table 10. Example Financial Analysis for the HRS Owner

	Existing Policy		Tiered Utilization Mechanism (b)	
Nominal Capacity [kg/day]	350	500	350	500
Leveraged, after-tax, nominal IRR	28%	119%	11%	14%
After-tax, nominal NPV @ 10% discount	0.75M	1.9M	0.07M	0.79M

In summary, some of the main potential benefits and considerations are below.

Potential Policy Benefits:

- CEC: The energy commission funds more stations early on
- CEC: The total number of additional stations funded depends on how the base incentive and HRS utilization is achieved
- Consumer: HRS development is accelerated in the short-term, bringing stations online faster, reducing perceived refueling convenience cost of FCEV
- Firms: Received funding based on amount dispensed, further incentivizing high-utilization stations
- CEC/Firms: Easier to monitor since kilograms dispensed is a known, accurately measurable quantity

Potential Policy Considerations:

- All: Potential marginal incentive structure must be analyzed and optimized
- CEC: If station utilization is above expectations, funding constraints could be limited
- Firms: If stations utilization is below expectations, awards may be lower than expected
- CEC/Firms: Stations developed earlier so they may be undersized given uncertain future demand
- Firms: If combined with the Tiered Funding Mechanism described in (1), firms receive reduced incentives for smaller stations, potentially inhibiting development and network growth in predicted low-demand areas
- Firms: Smaller companies without access to capital could be pushed out of the market due to high fixed cost to build the HRS