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|---|---|
| **Docket Number:** | 17-HYD-01 |
| **Project Title:** | Renewable Hydrogen Transportation Fuel Production |
| **TN #:** | 215729 |
| **Document Title:** | Presentation - Renewable Electricity to Hydrogen - California |
| **Description:** | N/A |
| **Filer:** | Tami Haas |
| **Organization:** | Nel Hydrogen |
| **Submitter Role:** | Public |
| **Submission Date:** | 2/1/2017 1:48:16 PM |
| **Docketed Date:** | 2/1/2017 |

# Renewable electricity to hydrogen – California

**California Energy Commission – Pre-Solicitation Workshop on Implementation Strategies for Production of Renewable Hydrogen in California | January 30, 2017**

H2 LOGIC
Hydrogen fueling solutions

*Has changed name to Nel Hydrogen*

nel

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# Large scale hydrogen electrolysers since 1927

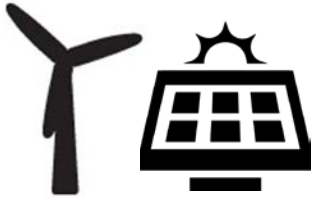

**Delivered the world's largest electrolyser in 1950s on 135 MW / 30,000 Nm3/h**

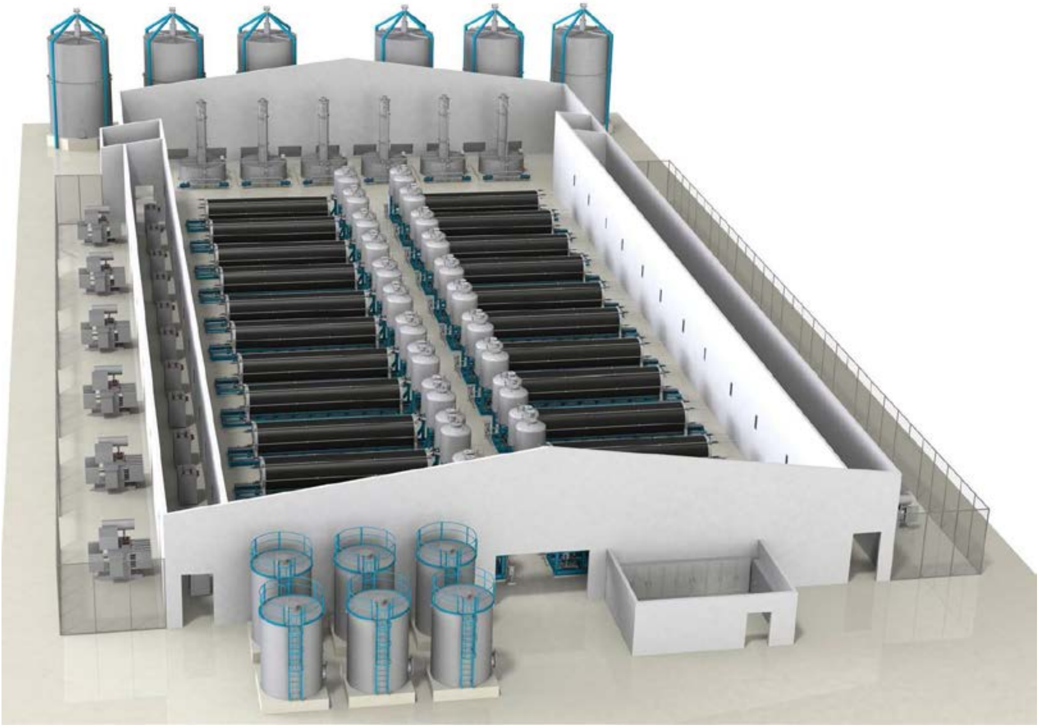
# 50MW electrolyser can fuel all California's FCEVs

**A Standardized 50MW electrolyser plant from Nel Hydrogen can support more than 40.000 FCEVs on annual basis.**

**This corresponds to 100% renewable hydrogen supply to all FCEVs in California by 2022 as projected by the ARB.**

Additional electrolyser capacity can easily be added and more plants build as hydrogen demand increases.





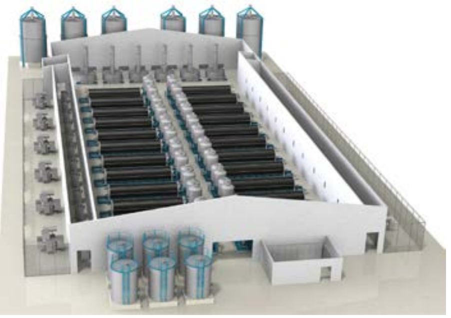
24 x NEL A-485 electrolysers – 50MW

40.000 FCEVs per year

# Renewables to make hydrogen competitive with gasoline

**Hydrogen pump price of $6.7/kg matches gasoline on a fuel cost per driven mile basis.**

**Renewable electricity at <$50/MWh and hydrogen infrastructure at scale can achieve this.**




Toyota Camry 

Toyota Mirai 

| | Pump price | | Fuel economy | | Fuel cost / mile |
|---|---|---|---|---|---|
| GASOLINE | **$2.8/gallon** | → | 28 MPG | → | $0.1/mile |
| | | | | | ↓ |
| HYDROGEN | **$6.7/kg** | ← | 66.85 miles/kg<br>(65 MPG equivalent) | ← | $0.1/mile |

# Scale drives competitiveness but requires demand

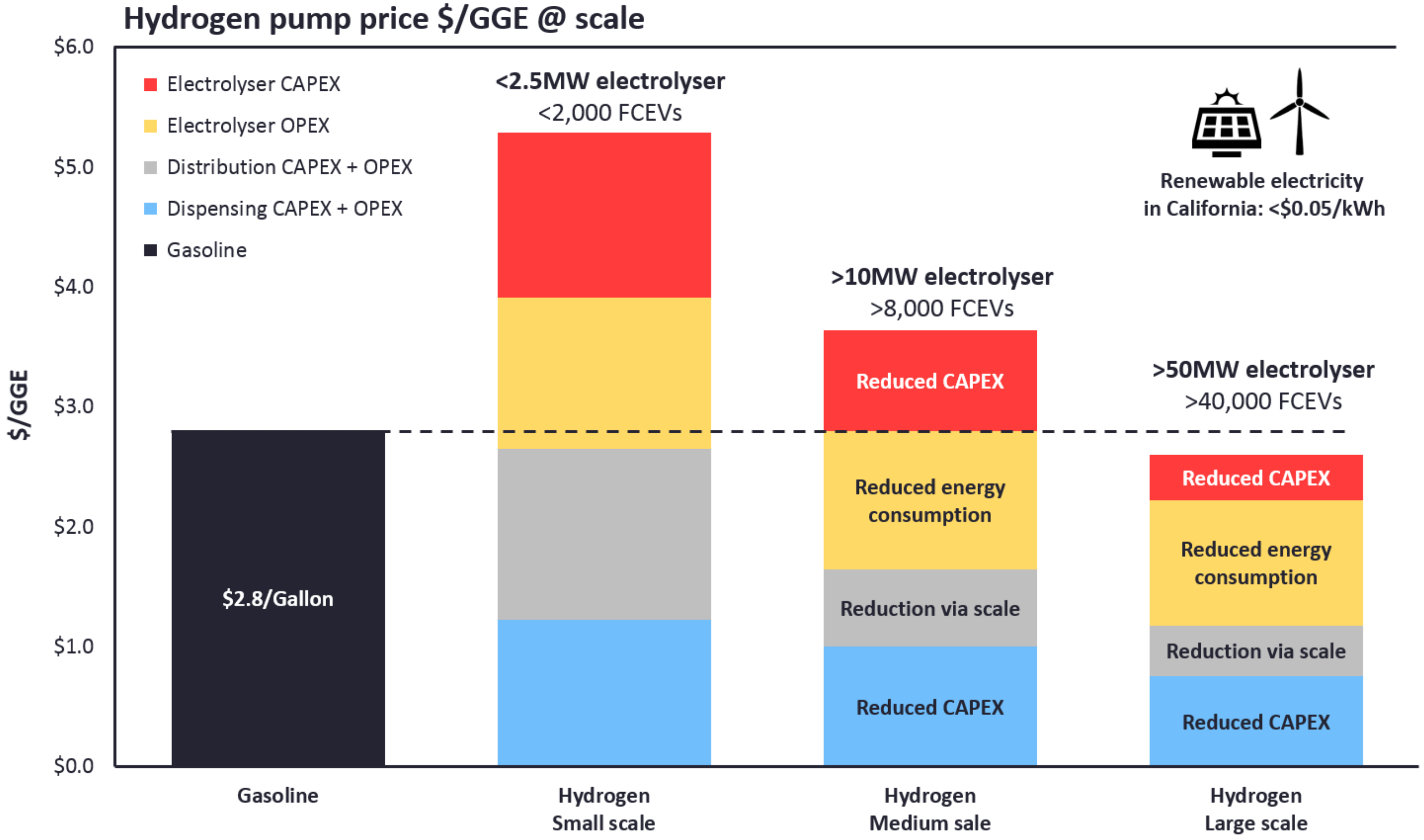
**One 50MW electrolyser for 100% RE H2 for all 40,000 FCEVs in California by 2022 can achieve competitiveness with gasoline.**

**Several factors will however delay achieving of scale and result in a price gap to gasoline:**

- Renewable hydrogen share is likely to be lower than 100% (only 33% required).
- Market demand will be addressed by multiple electrolyser plants (competition).
- Sufficient demand for one plant will require substantially more than 40,000 FCEVs.

**Public contributions could address gasoline price gap until sufficient scale is achieved:**

- CAPEX support (e.g. competitive grants).
- OPEX support (e.g. LCFS or waived grid fees).

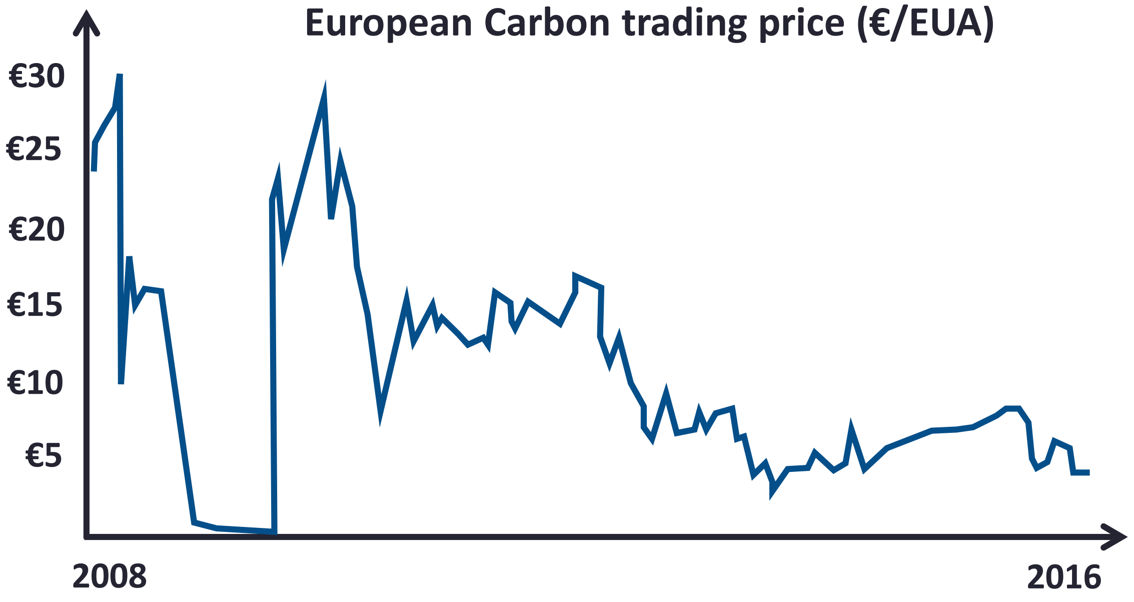


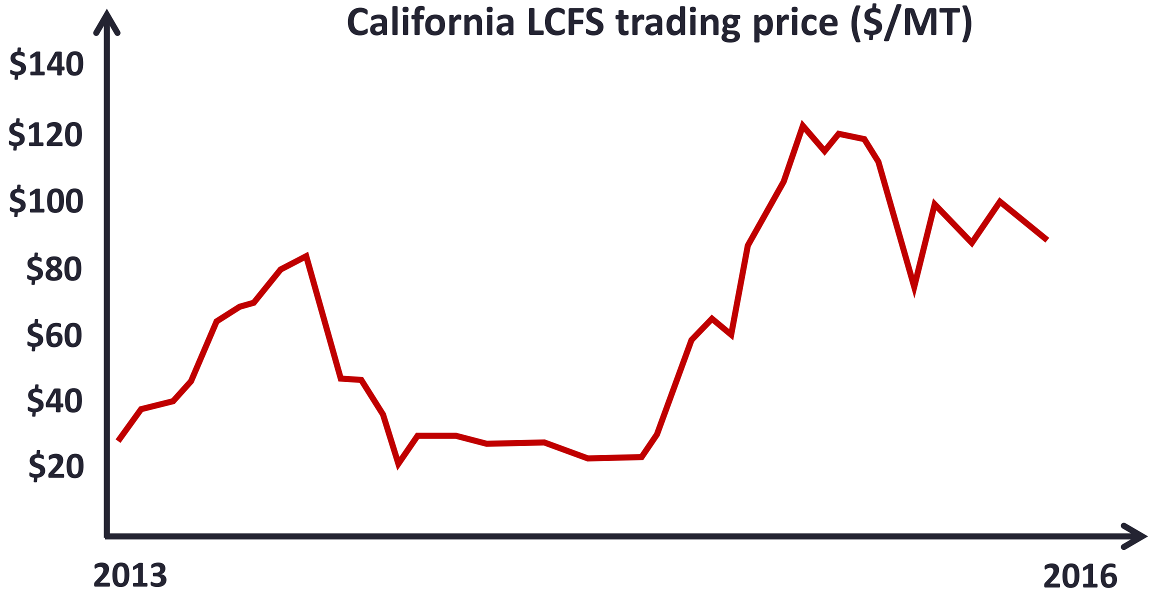
# “Bankability” of LCFS and compensating lost REC’s

- Bankability of a fluctuating LCFS credit value is challenging for the business case on renewable hydrogen production.
- Compensating the renewable power generator for lost REC’s is also likely to outbalance the LCFS value created.
- **LCFS credit multiplier for hydrogen – similar to ZEV credit multiplier**
  A variable LCFS credit multiplier for hydrogen could secure a stable credit value ($/kg) and cover the cost for compensating lost REC’s.

| LCFS hydrogen value generated [$/H2 kg] | | REC compensation affordable [$/MWh] |
|---|---|---|
| $0.5 | → | $8 |
| $1.0 | → | $16 |
| $1.5 | → | $24 |
| $2.0 | → | $32 |

*Example: an LFCS value of $0.5 per kg hydrogen can compensate $8 per MWh in lost REC value.*



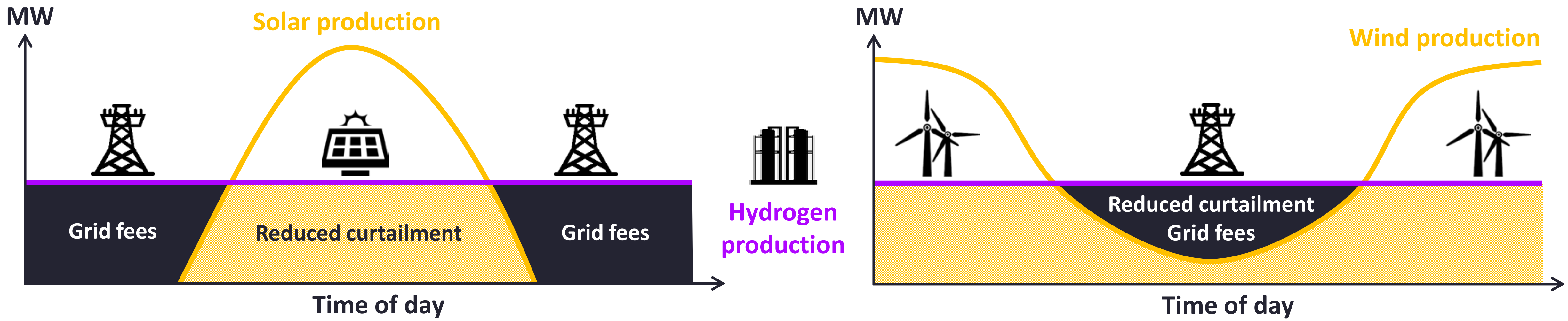
# Hydrogen production should not pay for helping the grid

**Hydrogen production connected to renewables can reduce risk of curtailment and enable a higher renewable share in the grid.**

- **Day time:** Electrolyser utilizes solar power or grid power and reduces risk of curtailment stemming from higher RE shares.
- **Night time:** Electrolyser draws power from the grid or wind and reduces production during high demand periods.
- Drawing power from both grid and renewables enables a more steady and less costly hydrogen production (more operation hours).

**Despite hydrogen production would help the grid – various grid fees still apply when hydrogen production draws from the grid.**

**Waiving of grid fees for hydrogen production e.g. under the Net Energy Metering (NEM 2.0) could help reduce hydrogen costs.**



# Input – public contribution to renewable hydrogen

Public contributions could advance renewable hydrogen and address the price gap to gasoline earlier than the market alone.

**CAPEX support for renewable hydrogen production plants**

- Support could address the price gap stemming from higher CAPEX on e.g. Medium Scale electrolyser plants (>10MW).
- A lower initial capacity (e.g. >2.5MW) but with the ability to scale as market demand grows – could limit the support need.
- Support could also include investments in high capacity gaseous distribution to further drive scale and cost reduction.
- Selection of projects e.g. via a competitive Grant Funding Opportunity (GFO) – potentially with synergy to DOE H2@Scale.

**LCFS credit multiplier for renewable hydrogen**

- Addition of a variable credit multiplier that would stabilize the credit value and cover costs for compensation of lost REC's.
- Could e.g. be implemented as part of the current ARB considerations on adjustments to *"Hydrogen in the LCFS"*.

**Incentivize use of hydrogen production for grid balancing and integration of renewables**

- Renewable hydrogen production that helps to integrate more renewables and reduces risk of curtailment should be incentivized.
- E.g. waiving of applicable grid fees for hydrogen production under the Net Energy Metering – NEM 2.0.

End of presentation

# Thank you for your attention

# Questions?

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