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Pathways to Ultra-low Cost Green Hydrogen from Wasted Resources - T2M Global Response to IEPR Workshop

Comments are included in attached PDF titled "T2M Global Response to CEC - IEPR"

Additional submitted attachment is included below.

The T2M Global team has a CEC project (EPC-19-044) to develop green electrolytic Hydrogen technology using an Advanced Electrolytic System (AES). T2M's Advisory Board for AES technology includes California stakeholders for green electrolytic H_2 produced from wasted resources. These stakeholders include West Biofuels, PG&E, SoCalGas, PowerTap Hydrogen, Republic Services, Longitude 122 West, UC Berkeley, UC Irvine, Customized Energy Solutions, Berokoff Energy Solutions, US DOE and DOD.

To fully implement the directives of SB 1075, we recommend:

- **We encourage CARB and CEC to develop and validate innovative pathways for green electrolytic H_2 using currently wasted resources – including solid, liquid or gaseous sources.**
    a. **Give higher priority for funding to cross cutting technologies that provide solutions across multiple economic sectors. For example, feedstock supply from agriculture, forestry, and municipal solid wastes.**
    b. **On the user side, emphasize multi-use applications to minimize risks associated with new H_2 technology. This MUST include H_2 for grid support, energy storage, light and heavy-duty vehicles, EV charging, green chemical manufacturing, and refining.**

Waste biomass pathways for H_2 have multiple cross-sector benefits:

- Converting wasted resources to higher value (H_2, clean electricity).
- Reduced risk of forest fires and enhanced safety.
- Reduced loads on landfills by diverting waste biomass to higher value products.
- Eliminating methane emissions associated with waste biomass in landfills.
- Grid-support benefits – H_2 from excess electricity, and on demand electricity for EV charging.
- Decarbonization benefits: co-production of RNG and H_2 from waste biomass is a win-win solution to pollution while creating economic value for CA.

Refer to the work done under CEC contract number EPC-19-044 which has established the feasibility of electrolytic H_2 using a variety of dilute/waste streams. In CA for 100 million tons of waste biomass per year, at 5% yield to H_2, this translates to a potential 5 million tons of H_2 per year. This is over 250% of the current H_2 production capacity in CA.

Conventional pathways use water electrolysis.

- It is extremely energy intensive to separate H_2 (>50 MWh green electricity/ton H_2).
- Water electrolysis also takes up to 20 tons of water per ton of H_2.
- For 5 million tons of H_2 per year, this would require 100 million tons of water. A serious demand for the water constrained CA economy.

Alternate innovative H_2 carriers to water offer dramatically lower cost H_2.
Pathways for green electrolytic H_2 are included in the attached diagram.

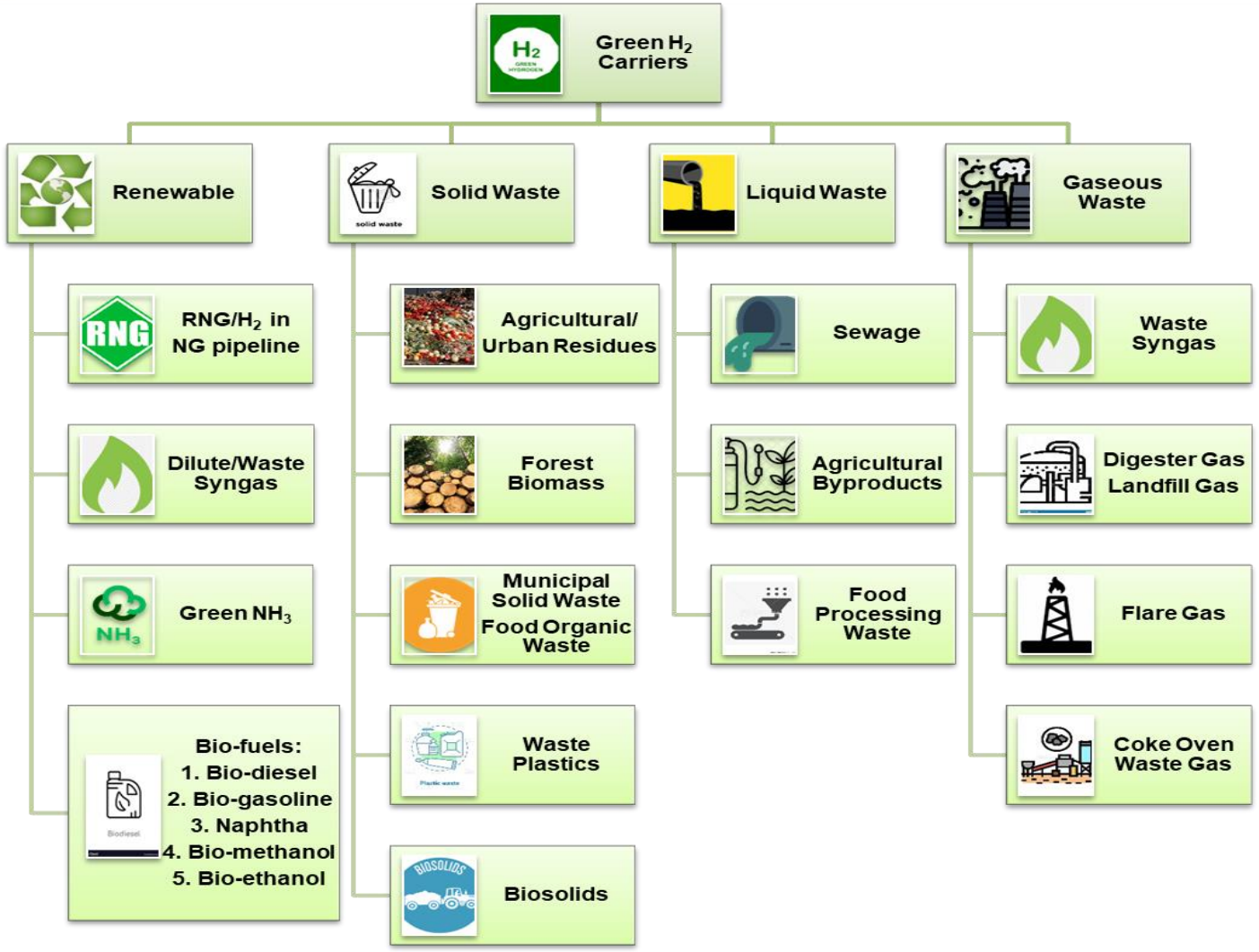
- These green electrolytic H_2 carriers are based on currently wasted resources.
- It includes dilute/waste streams of H_2, biogas derived syngas, fuel cell and reformer tail gases, biomass gasifiers (including air blown, oxygen blown, and pyrolysis reactors).
- These carriers can reduce the electricity consumption by <u>80%</u> compared to conventional water electrolysis.

- Some of these pathways offer multiple benefits to achieve CA mandates. In addition to co-production of H_2, they offer unique benefits that include RNG for decarbonization of natural gas pipelines and CO_2 capture for reuse.

SB 1075 Response Figures

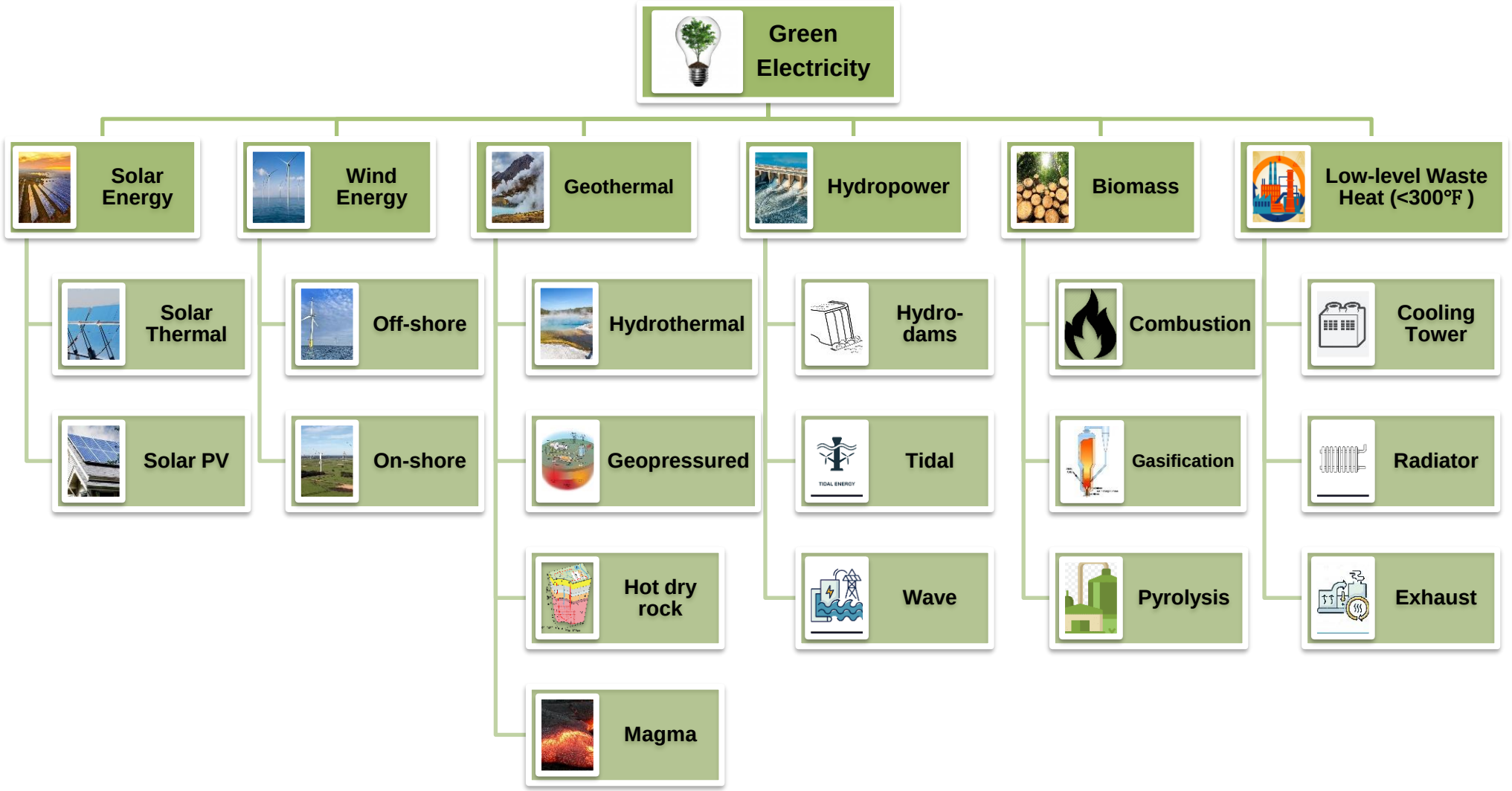
by T2M Global

Abundant Feedstocks of Waste/Dilute H_2 in CA

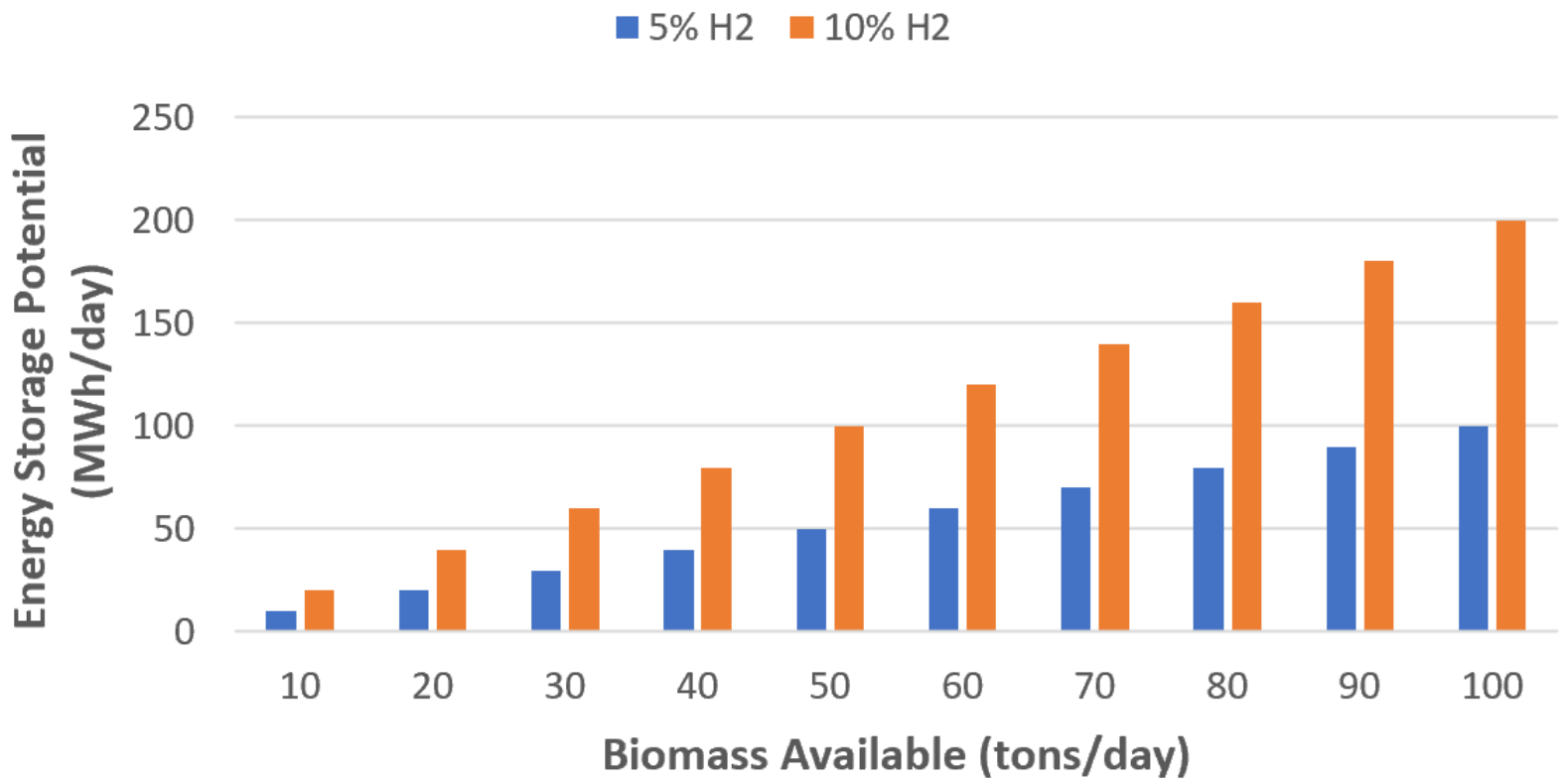


Widely Available Waste Feedstocks for Green Electrolytic H_2:
Significant sources of O_2-free H_2 carriers across many industries.

Sources of Green Electricity



Value from Forest-Fire Fuel: MWh of H_2 Energy



Win-Win Solution: Prevent Forest Fires & Support Renewables:
Opportunity for grid-scale energy storage.