Request for Proposals (RFP) "Aloha Synfuels Program"

29-May-11

Background

- **Market:** Hawaii visitors & local business need affordable & reliable air & road transport fuels. Present air, marine, utility and road transportation need: Jet fuel: 28 Mgal/y & road fuels: 120 Mgal/y for the Big Island. State-wide: ~ 750 Mgal/y
- **Resources:** Hawaii's abundant wind, solar and geo resources, whether new or curtailed-old, can provide all energy needed for the production of synthetic fuels.
- **Legislation:** Hawaii County is driving market demand though it's Greening the Government program where they will need to source 20% of their transportation fuels from a renewably made fuel for their fleet and mass transit. This kind of program will likely be adopted by other counties.
- **Trends:** Road transportation technology may shift from CVs to EVs in 20 years; but that is unlikely for for air transport

Objectives

- Implement local and sustainable production of aviation and interim road fuels, at a first rate of ~20 MGGE/y (more later), consisting of jet fuel, gasoline, diesel and H2

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Objectives and Approach

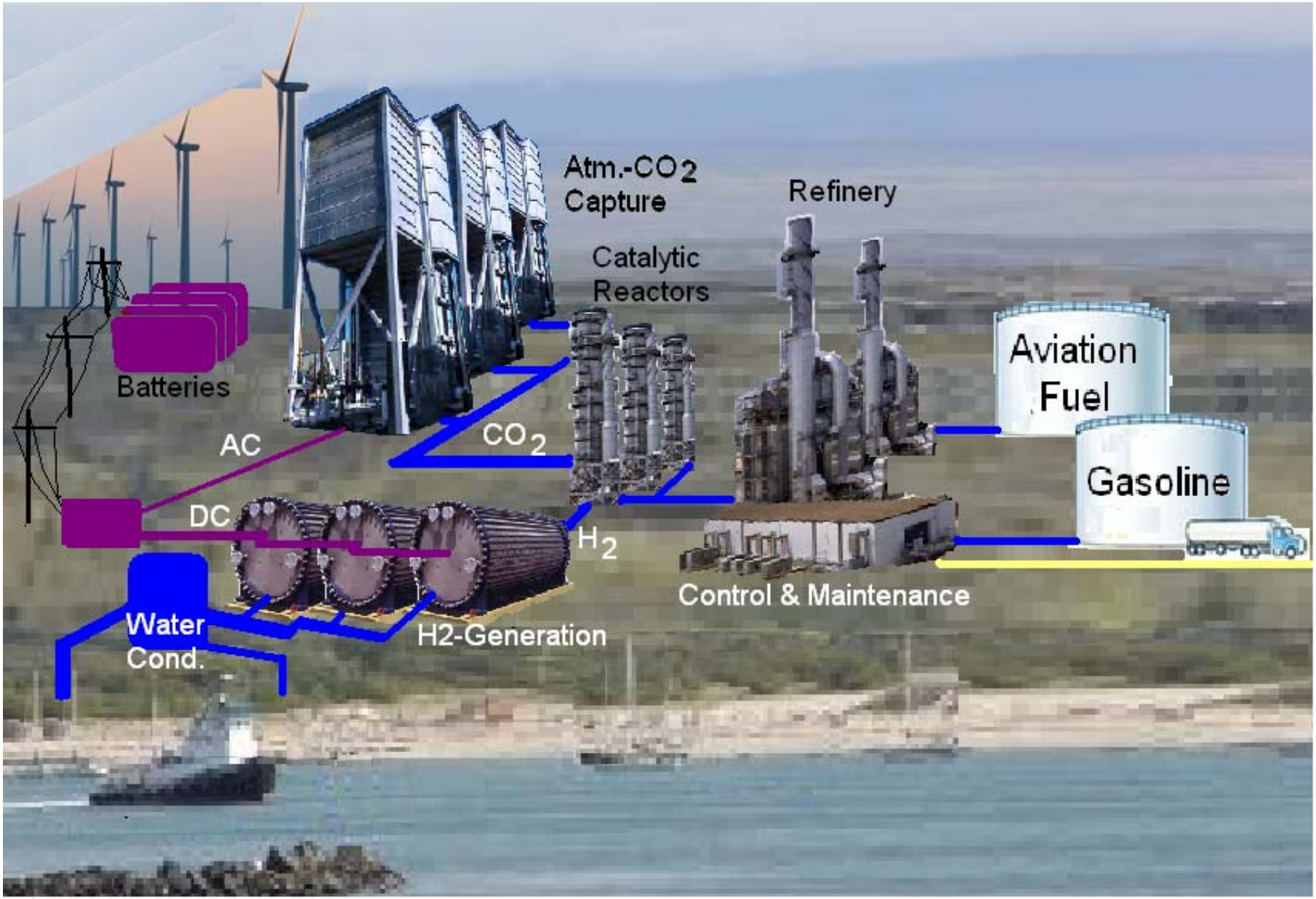
Objectives

- Implement local and sustainable production of **aviation and road synfuels**

Approach

- Verify technology (wind, CO2-capture, water source,…, reactors) & its economic feasibility
- Select partners to supervise, analyze, design, install and operate synthetic fuel production on the Big Island of Hawaii to phase-in and replace existing fuel imports, and meet the lower future needs for such fuels, after the market has saturated with EVs and PHEVs in 10-15 years
- **Propose a 3-phase (~7-year) program:**
  1. Analysis and planning
  2. Design & build a 0.2 MGGE/y, (w/~2 MW WT) pilot plant and plan for 100x scale up
  3. Design & build a 20 MGGE/y, (w/~160 MW) "semi-commercial" plant. More repeats later?
- **Include integration of these key plant system functions**
  1. Plant Operation; Analysis, Planning, Construction; Instrumentation, Monitoring and Control Network; Administration; Financing
  2. Electricity generation (wind turbines (DD), geo, etc) & storage (batteries, CA(air) hydro, fuels+generators) for ability to follow the plant demand independently of the County utility grid
  3. H2 production, using ocean water rather than well or municipal water, via high-temperature electrolysis
  4. Atm-CO2 Capture
  5. Reactors to use H2, H2O and CO2 to produce hydrocarbons
  6. Refinery to produce ASTM-certifiable fuels for air and road transportation
  7. Distribution by partnering with existing organizations

Goal: Wind & Water >> 20 MGGE/y Plant System



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Plant Specifications

Fuel Pilot Plant (PP) of 0.2 MGGE/y, 8 M$ (CO2 capture + CO2 hydrolysis* + refining)

-- Inputs: 2 MW(average) electricity: Two 2.3-MW(pk) direct-drive-PM WTs at ~10 M$
(2.2 $/W, incl. storage of "2 MW" / 10 MWh / 1.5 M$ / 150 $/kWh)

5.2 tons/day CO2 (captured from air)

2.2 tons/day H2O or 5300 gal/day, to make ~150 std-m3/h H2 (117,000 kg-H2/y)

-- Land area for plant: 0.5 to 1 acre

-- No waste water to County Waste Water system; no SOx, NOx, HC emissions

(discuss microchannel applicability to FT)

Fuel Plant (FP) of 20 MGGE/y, 190 M$

-- Inputs: 160 MW(average) electricity: 64 5-MW(pk)-PM WTs at 520 M$
(1.63 $/W, incl. storage of "100 MW" / 500 MWh / 50 M$ / 100 $/kWh)

520 tons/day CO2 (captured from air)

220 tons/day H2O or 430,000 gal/day, to make ~ 15,000 std.-m3/h H2 (11.7 Mkg/y)

-- Land area for plant: 10 to 20 acres

-- No waste water to County Waste Water system; no SOx, NOx, HC emissions

_____

* At least 4 options:

1. CO2-to-fuels as per ExxonMobile 1992 USPat on CO2 hydrolysis to olefins, paraffins and alcohols, w/refinery as last stage of the plant, to many grades of fuels and specialty products
2. CO2-to-methanol, plus Exxon's MTG, to selectively make gasoline, but no jet/diesel fuel
3. CO2-to-fuels via WGS + FT + refinery, as advocated by Accelergy (ExxonMobil affiliate)
4. CO2-to-fuels via _____ approach

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Vision and SOW

Vision. We envision a 3-phase program, equity and 30% Fed.-subsidy funded; to end with pilot and main syn-fuel plants of 0.2 & 20 MGGE/y as specified above, to produce ~ ≤ 3 $/GGE wholesale fuel (2011 dollars), before taxes, but after ROI-reserves and O&M expenses.

Partner with experts. Submit Monthly Progress Letters. Pass Go/no-go Milestone(>)

Objectives:

- Formulate & execute approach for local and sustainable production of **aviation and road syn-fuels**
- Verify technology (wind, CO2-capture, water source,…, reactors) & its economic feasibility

Phase-1. Analysis and design of 0.2 MGGE/y & 20 MGGE/y plant systems

1.1 Select action and supervisory team, study options, analyze technical and economic feasibility, prepare EIS, evaluate land and finance options. >

1.2 Sign up partners & subcontractors; verify technical and economic feasibility >;

1.3 Demo & analysis of CO2 capture >

1.4 Design pilot plant (PP) with CO2-capture, water-to-H2, synthesis reactor and refinery

1.5 Prepare, submit samples and complete tests to get certification of generated jet, diesel and gasoline fuels for commercial use.

Phase-2. Build pilot plant (PP) of 0.2 MGGE/y

2.1 Build Plant 0.2MGGE/y to operate with purchased CO2 (< 50 $/ton)

2.2 Debug, analyze, commission

2.3 Install WTs 4 MW(pk) + 10 MWh Storage

2.4 Build 0.6 Mgal/y CO2 pilot unit

Phase-3. Build fuel plant of 20 MGGE/y

3.1 Design 20 MGGE/y plant

3.2 Build and start plant. Debug, while plant is in start-up mode, to full production

3.3 Plan 320 MW(pk) wind farm

3.4 Install WTs 320 MW(pk) on < 2400 acres

3.5 Integrate plant and wind-farm intequipment with 1000 MWh Storage

3.6 Analyze, design & build CO2-capture unit of 60 Mgal/y CO2

3.7 Set up fuel station at plant to dispense fuel to wholesalers/distributors. Train personnel

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Schedule

Years after start, with Milestones as indicated (•); Go/no-go Milestone(>)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

Phase-1. Analysis and design of 0.2 MGGE/y & 20 MGGE/y plant systems

Study+EIS+land+finance>

(1 & 15 acres for plants and 24 & 2400 acres for wind-farm; water supply; energy transport)

E/T Analysis,approvls,contracting>

Demo & analysis of CO2 capture >

Design PP w/CO2-capture unit •

Prepare, submit samples and complete tests to get certification of generated jet, diesel and gasoline fuels for comm. use•

Phase-2. Build pilot plant of 0.2 MGGE/y

Build Plant 0.2MGGE/y•

Debug, analyze, commission•

Install WTs 4 MW(pk) + 10 MWh Storage•

~24 acres, “2 MW” storage

Build 0.6 Mgal/y CO2 plant•

Phase-3. Build fuel plant of 20 MGGE/y

Design 20 MGGE/y plant•. Build and start plant•. Debug•

Plan 320 MW(pk) wind farm•

Install WTs 320 MW(pk) on < 2400 acres•

with 1000 MWh Storage•

Prepare distr. and deliver fuel to customer(s)•

Analysis+design+build CO2-capture plant of 60 Mgal/y CO2•

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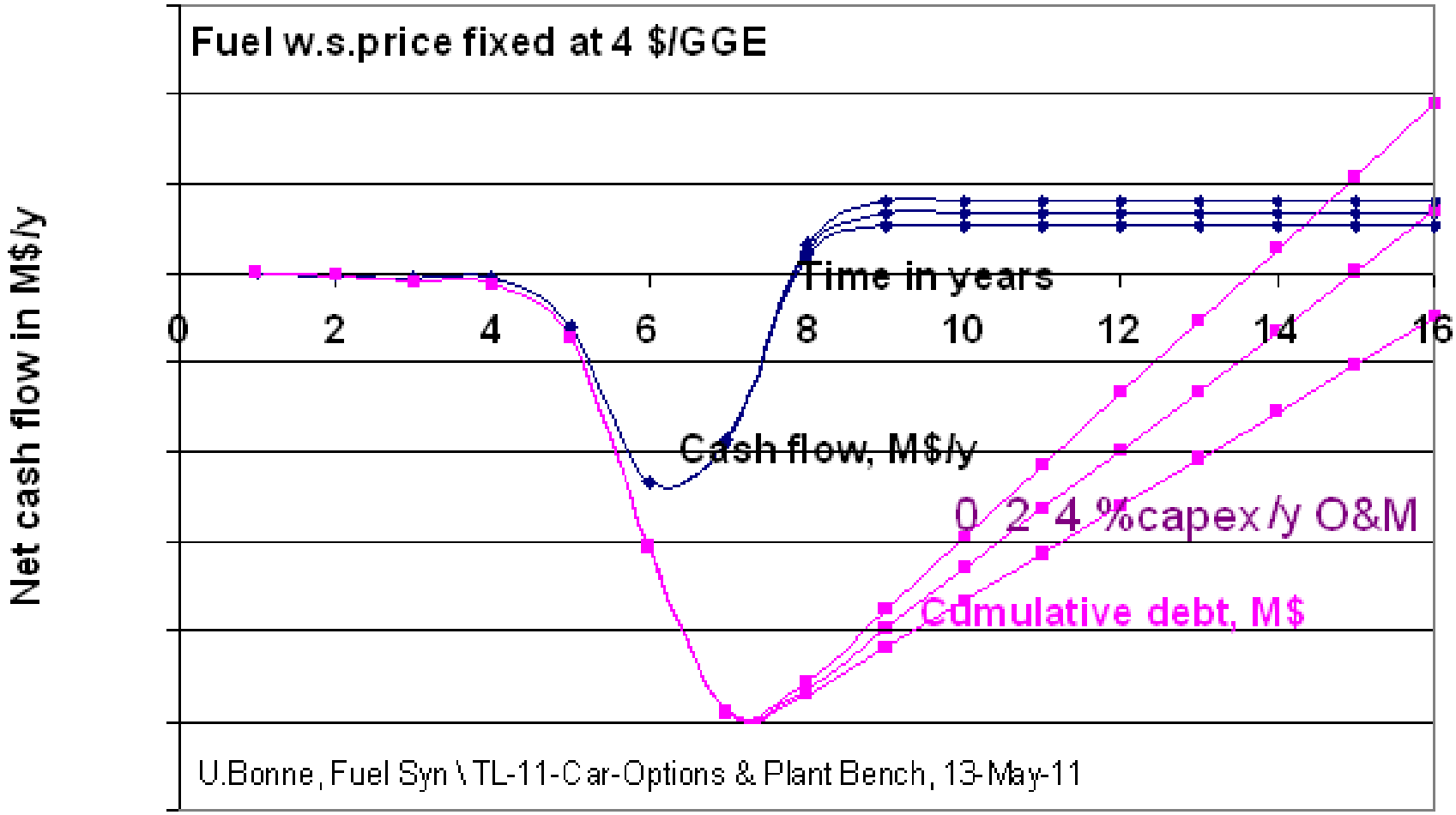
Cash Flow vs. Time



Cash Flow vs years after project start

WT+plant system output of 20 MGGE/y: equity-financed; 0% cost of money; 0-4 % O&M;
25-year service life; 30 % Fed. capex subsidy; 0%/y CPI or fuel-PI increase

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Process Intensification via Microchannel Tech.

Natural gas steam reformer
- **20 million std. cu. ft/day or**
- **54 million GGE/year**

- **With microchannels -- 90% size reduction to fit on skids**

http://www.velocys.com/docs/NGCS_Presentation_3-Jun-10_redacted.pdf by Jan J.Lerou (retired)

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