THE SEAWATER ENERGY AND AGRICULTURE SYSTEM
An Integrated approach to sustainable feedstock production

Panel Session 4: Partnerships
IATA Alternative Fuel Symposium
November 2018
About the SBRC – Who are the partners?

- The partners in the Sustainable Bioenergy Research Consortium (SBRC) are all technology and business leaders in their fields.
- The objective of the SBRC is to unlock the potential of seawater and arid land to produce biomass that can be converted into sustainable aviation fuel.
SEAS – Additional Outreach

UAE Government stakeholders:
- Ministry of Climate Change and Environment (MoCCaE)
- Ministry of Cabinet Affairs and the Future → Minister of State for Food Security
- Environment Agency Abu Dhabi (EAD)
- UAE GCAA

Other entities:
- Mexican Center for Innovation in Bioenergy – Bio Jet Fuel Chapter
Seawater Energy and Agriculture System (SEAS)

- The SEAS is a unique example of the new thinking in bioenergy and integrated systems
  - food
  - water
  - biomass
  - fuel
  - ecosystem services

What would happen if we are able to produce a barrel of vegetable oil at zero* cost?
Salicornia oil vs. Vegetable oil, commodity price (5Y)

Comparison: Vegetable oil commodity price, 5Y, with forecast Salicornia oil, farm-gate, $/ton

Source: International Monetary Fund; ISTA Mielke GmbH, Oil World; US Department of Agriculture; World Bank.
**SEAS – Project characteristics and financial analysis**

**Base case**: 20→100→200ha, *stage-gate* implementation

- **Baseline design**: 2:7:1 (A:S:M) area ratio of unit operations
- **Baseline Operation**:
  - 35:65 (fish:shrimp) aquaculture products,
  - 2 cycles/year

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>14%</td>
</tr>
<tr>
<td>IRR</td>
<td>19.79%</td>
</tr>
<tr>
<td>Payback time</td>
<td>7.58 years</td>
</tr>
<tr>
<td>NPV (Year 10)</td>
<td>$3,825 M</td>
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</tbody>
</table>

**INTERMEDIATES**

**YIELDS, mean**

- Fish: 23.34 t<sub>fish</sub>/ha/year (11.67 t<sub>fish</sub>/ha/cycle, 2 cycles/year)
- Shrimp: 15.86 t<sub>shrimp</sub>/ha/year (7.93 t<sub>shrimp</sub>/ha/cycle, 2 cycles/year)
- Seeds: 3 t<sub>oilseed</sub>/ha/year
- Biomass: 30 t<sub>biomass</sub>/ha/year
- Carbon (CCS): 799 t<sub>CO2,eq</sub>/ha (cumulative, Year 4)

**PRODUCTIVITY @ 200ha**

- 734 t<sub>seafood</sub>/year (311 t<sub>fish</sub> + 423 t<sub>shrimp</sub> per year)
- 420 t<sub>oilseed</sub>/year
- 4200 t<sub>biomass</sub>/year
- 16 kt<sub>CO2,eq</sub> (cumulative, Year 4)
SEAS – 200ha scenarios comparison

From the initial *base case*, multiple scenarios are assessed to understand the potential implications of alternative operational modes for the demonstration plant.

**The 200ha SEAS plant is profitable in all initial scenarios assessed**

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<thead>
<tr>
<th></th>
<th>Base</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
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</thead>
<tbody>
<tr>
<td>Design</td>
<td>2:7:1</td>
<td>3:6:1</td>
<td></td>
<td></td>
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<tr>
<td>Operation, # cycles</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation, fish:shrimp ratio</td>
<td>35:65</td>
<td>0:100</td>
<td>35:65</td>
<td>0:100</td>
<td></td>
</tr>
<tr>
<td>Discount Rate (DR)</td>
<td>14%</td>
<td>14%</td>
<td>6%</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>Payback time (years)</td>
<td>7.58</td>
<td>19.34</td>
<td>9.69</td>
<td>9.27</td>
<td>6.86</td>
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<tr>
<td>NPV(10)</td>
<td>$3.825 M</td>
<td>$(4.059 M)*</td>
<td>$0.505 M</td>
<td>$7.825 M</td>
<td>$0.432 M</td>
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<tr>
<td>IRR</td>
<td>19.79%</td>
<td>6.66%</td>
<td>15.38%</td>
<td>14.64%</td>
<td>24.93%</td>
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<tr>
<td>Fish (t/year)</td>
<td>311</td>
<td>245</td>
<td>-</td>
<td>368</td>
<td>-</td>
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<tr>
<td>Shrimp (t/year)</td>
<td>423</td>
<td>281</td>
<td>432</td>
<td>271</td>
<td>648</td>
</tr>
<tr>
<td>Seafood (t/year)</td>
<td>734</td>
<td>526</td>
<td>432</td>
<td>789</td>
<td>648</td>
</tr>
<tr>
<td>Seeds (t/year)</td>
<td>420</td>
<td>317</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Biomass (t/year)</td>
<td>4200</td>
<td>2761</td>
<td>2366</td>
<td></td>
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</tr>
<tr>
<td>Carbon Credits (cumulative)</td>
<td></td>
<td></td>
<td></td>
<td>16ktCO2_eq</td>
<td></td>
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</tbody>
</table>

* SEAS plant is profitable at longer payback time of 20 years (*i.e.* NPV(20) > 0)
Food for thought...

- By having other revenue streams, the cost of the feedstock for fuel can be reduced or eliminated.

- In the case of the SEAS, by reducing the IRR of the aquaculture operation (but still having it be an attractive investment option), it allows for the price of the oil from the salicornia plants to be reduced/minimized.

- Modular systems like the SEAS allow exploiting synergies with other industries.
  → Produced water from oil extraction.

- Strong partnerships are key to making sustainable aviation fuels a reality.
Thank you!

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