Algae in Donald Trump’s America
Challenges and Opportunities in a New Regime

AlgaEurope 2016
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Algae Biomass Organization

- U.S.-based trade association for the algae industry (est. 2008)
- Over 200 corporate, institutional and individual members from over 20 countries
- World’s leading developers of algae-based technologies and products + their customers, suppliers and other industrial partners
- Host of Algae Biomass Summit, world’s largest algae event (Oct 29 – Nov 1, 2017, Salt Lake City, Utah)
Diamond Members

Gold Members

Corporate Members
Outline

- 2016 U.S. Election Outcome
  - What Does It Mean for America?
  - What Does It Mean for Algae?

- State of U.S. Algae Industry
  - Diversified Portfolio Moving to Market – Upstream and Down

- Predictions for 2017 and Beyond
2016 U.S. Election
2016 U.S. Election Outcome

- Donald Trump is President-Elect
- Republicans also control Senate and House of Representatives
Trump Priorities

- Make America Great Again
- Economic Prosperity:
  - Invest in:
    - Manufacturing
    - Fossil Energy
    - Infrastructure
  - Reduce Regulations
  - Fight Terror and Illegal Immigration

JOBS!
Algae Policy Impacts

- **Federal Investment**
  - Renewable Energy Could See Big Cuts
    - DOE Bioenergy Program ($30 million)
  - Fossil Energy Could See Big Increase
    - Carbon Capture and Use ($10 million)
  - $1 Trillion in Infrastructure Investment
Algae Policy Impacts

- **Climate Policy**
  - Clean Power Plan (Probably) Dead
  - Paris Treaty ????
  - California, Northeast States Likely to Continue / Increase CO₂ Regulation
  - CCU Could See Significant Investment to Save Coal
Algae Policy Impacts

- **Tax Policy**
  - Republicans Want Comprehensive Tax Reform
    - Lower Corporate Tax Rate
    - Simplify Tax Code
  - Fate of Algae Biofuel, Carbon Capture Tax Credits Unclear

- **Agriculture Policy**
  - Current Farm Bill Expires 2018
2016 U.S. Algae Industry
U.S. Algae Industry Trends

- **Upstream: Waste Monetization**
  - Growing Recognition as CO₂, H₂O Mitigation / Monetization Platform

- **Product Innovation**
  - Rapid Diversification

- **Globalization**
  - International Partnerships
Upstream: Monetizing Waste

CO\textsubscript{2} Mitigation

1,000 acres of algae consume as much CO\textsubscript{2} as 20 million trees

- 1.2 tons CO\textsubscript{2} /ac-yr consumed by average US forest vs. 75 tons /ac-yr for direct-to-ethanol (EPA)
- Equivalent to 125,000 acres of average US forest
Beneficial Re-use of Carbon Using Microalgae
University of Kentucky / Duke Energy

- Pilot project at Duke’s East Bend Coal-powered Generating Station
- Recently awarded $1 million DOE Fossil Energy Grant
33-Acre Kauai Algae Facility

Co-located with naptha / fuel oil-powered steam-injected combustion turbine power plant
Gas fermentation technology converts C-rich gases to fuels and chemicals

40,000 combined hours on stream
Multiple runs exceeding 2000 hours

• Multiple demonstration plants at various scales
• First commercial facility under construction in Belgium
Upstream: Monetizing Waste

- Brand New DOE/ORNL Analysis*: Substantial U.S. Potential for Algae CCU:
  - 140,000 sq. miles suitable for open pond production (≈75,000 farms)
  - Even with highly conservative assumptions, using existing technology:
    - More than 500 viable point sources
    - Potential to utilize >200 million tons CO2/year

*2016 Billion-Ton Report [https://bioenergykdf.net/billionton2016/overview](https://bioenergykdf.net/billionton2016/overview)
Salt-water strain, current productivity case:

<table>
<thead>
<tr>
<th>Co-Location Opportunity</th>
<th>CO2 Captured</th>
<th>Biomass</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Suitable Point Sources</td>
<td>% of all Point Sources</td>
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<tr>
<td>Ethanol</td>
<td>134</td>
<td>42%</td>
</tr>
<tr>
<td>Coal</td>
<td>246</td>
<td>18%</td>
</tr>
<tr>
<td>Nat Gas</td>
<td>151</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td>531</td>
<td>19%</td>
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Algae Chapter Highlights

COAL - Saline Strain, Current Productivity

Coal Sourced CO₂ Stream for Co-location with Open Pond Algae Production
Saline Water: Nannochloropsis salina

- Annual Flue Gas CO₂ (T/yr)
- Co-located Site Biomass (T/yr1000ac)

- 0 - 500,000
- 500,001 - 1,000,000
- 1,000,001 - 2,000,000
- 2,000,001 - 4,000,000
- 4,000,001 - 6,000,000
- 6,000,001 - 8,000,000
- 8,000,001 - 10,000,000
- 10,000,001 - 15,000,000
- 15,000,001 - 20,000,000
- 20,000,001 - 25,000,000
- 25,000,001 - 26,000,426

- 5.689 - 6.000
- 6.001 - 6.000
- 6.001 - 6.000
- 8.001 - 10.000
- 12.001 - 14.000
- 14.001 - 16.000
- 16.001 - 18.000
- 18.001 - 20.000
- 20.001 - 22.000
- 22.001 - 24.000
- 24.001 - 26.000
- 26.001 - 28.000

Map showing distribution of coal sourced CO₂ and co-located site biomass production.
Algae Chapter Highlights

NATURAL GAS - Saline Strain, Current Productivity

[Map showing distribution of saline strain productivity across the U.S.]
Algae Chapter Highlights

ETHANOL - Saline Strain, Current Productivity

[Map of the United States with data points indicating locations of ethanol production from CO₂ streams co-located with open pond algae production]
Monetizing Waste

Wastewater Treatment

Flue gas or CO₂ → Raceway Ponds → Solar Radiation → Harvesting → Biofuels, Reclaimed Water, Fertilizers

- Wastewater N,P
- MicroBio Engineering
- SCHOTT glass made of ideas
- CLEARAS Water Recovery
Maturing Identity: Beyond Biofuels

- **Solazyme → TerraVia**
  - Shift to Food, Feed & Nutrition

- **Sapphire**
  - Shift to Nutritional Oils

- **Joule – Red Rock Merger**
  - Waste Biomass as Bridge to Algae-based Fuels
Product Innovation & Diversification

➢ Health & Nutrition
    Nutritional Oils (omega-3s, other PUFAs)
Product Innovation & Diversification

➢ Health & Nutrition
  ❖ Antioxidants, Natural Colorants

Astaxanthin – Powerful antioxidant

Phycocyanin – First natural blue food color
Emerging Big Market Opportunities

- **Aquaculture Feed**
  - 130 million tons, $9B / yr

- **Livestock Feed**
  - 1B tons, $370B / yr

- **Fertilizer**
  - 180 million tons, $90B /yr

Source: Bloomberg New Energy Finance Research Note 5 June 2015
Product Innovation & Diversification

➢ Therapeutic proteins and animal health
   ❖ Replacement for antibiotics agri-/aquaculture
Product Innovation & Diversification

➢ Foams and plastics
   ❖ World’s first algae surf board!
Product Innovation & Diversification

➢ Macroalgae
  o Harvested/grown for food/feed in Asia for centuries
  o Trending as sustainable food ingredient at high-end restaurants, farmers markets
  o Attracting attention of public and private investors
Globalization

- **Strategic Partnerships / Globalization**
  - Joule / Heidelberg Cement
  - LanzaTech / ArcelorMittal
  - Algenol / Reliance
Predictions for 2017 and Beyond

- Demand drives continued commercialization of algal food/feed; soil and H₂O gain traction
- Algae well positioned for Trump priorities
- Will need to make strong case for algae as Manufacturing/ Infrastructure/ **JOBS!**
2017 Algae Biomass Summit

Salt Lake City, Utah
October 29 – November 1, 2017