Cool Planet Energy Systems (CPES): Path to Commercialization

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The global renewable fuels industry
A conceptual schematic of technology schemes

Inputs: sugars, starch
Process: fermentation
Products: alcohols

Inputs: cellulose
Process: thermocatalytic
Products: hydrocarbons

Carbon negative feature
at least one
Outline

Overview: Cool Planet Energy Systems (CPES)

Biomass to products philosophy

Process development to commercial

Cool Planet’s manufacturing strategy
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About Cool Planet Energy Systems (CPES)

Locations
- Headquarters – Denver, CO
- Research & Development – Camarillo, CA (2 locations)
- Commercial Plant – Alexandria, LA

History
- Started in 2009 in Camarillo, CA

  2009 to 2011 – Focused on fundamental R&D and financial viability, small lab scale units
    - Primarily founder driven
    - Changed name from Cool Planet Biofuels

  2012 to 2014 – Developed pilot units and co-developed commercial process
    - New management with traditional structure
    - Expanded to Denver (corporate), Louisiana, and 2nd site in CA

  2015 forward
    - Currently 65 employees
    - Focus on continued operation of pilot units and building of commercial module

Company Goal
- Commercialize a technology to create green fuels and biochar
Path to commercialization
Targeting plants worldwide

Ongoing support by key investors

Series A - $3MM
NRG
North Bridge Venture Partners

Series B - $18MM
ConocoPhillips

Series C - $25MM
NRG

Series D - $100MM
Shea Ventures
ExxonMobil
ConocoPhillips

Goal is to commercialize technology leading to IPO
International market
Four times the U.S. market

Build, own and operate
Joint ventures
Strategic discussions

Deploying plants through partnerships outside the U.S.
Cool Planet: A Green High Growth Company

**Technology**
Company began with a simple but innovative scientific breakthrough: create valuable products from biomass vapors & solids at minimal scale.

Through agile prototyping of its technology, Cool Planet has made this core scientific insight increasingly profitable.

**Investors & Team**
Supported by blue chip investors across multiple industries.

Experienced management team with a track record of building large-scale companies.

**Business Model**
Diverse market set and product portfolio provides optionality.

Distributed, modular business model reduces CAPEX, lowers OPEX, and enables continuous improvement.

Compelling returns, with quick long-term plant payback.

**Global Impact**
Removes carbon from atmosphere through the production of drop-in hydrocarbons and biocarbon.

Biocarbon product improves crop yield and reduces use of water and fertilizer.

Opportunity to change the world.
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The Cool Planet technology
Addresses the world’s major challenges
Biomass to Renewable Products

World population to reach almost 10 billion by 2050
Technology creates multiple opportunities

Input flexibility...

...with embedded optionality...

Biomass
Wood
Agriculture waste
Energy crops
Etc.

Hydrocarbons

Fuels
High octane gasoline, jet fuel, diesel

Chemicals
Chemical feedstocks, others

Other Applications

Biocarbon

Soil enhancer – CoolTerra™
Turf, horticulture, viticulture, others

Activated carbon
Water treatment, air purification, others

Other Applications

... enhances economics and reduces risk

... enhances economics and reduces risk
Why Pine?

Feedstock availability

   Readily available in SE United States

Composition

   Low ash content

Louisiana Commercial Site

   Depleted paper industry with many stands of pine
   Near Red River with barge access

Existing wood handling infrastructure

   Well developed and understood

Mountain Beetle Killed Pine

   Low value feedstock in other US locations
   Bioenergy Alliance Network of the Rockies (BANR) – Led by CSU

http://www.barkbeetles.org/mountain/fidl2.htm
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**General Process Diagram**

**Simple Process**

**Multiple products:**
- Renewable Fuel
- Biochar

1. **Preprocessing & Drying**
   - Wet Biomass
   - Water

2. **Thermal Conversion (Pyrolysis)**
   - Dry Biomass
   - Intermediate Char

3. **Biochar Collection**

4. **Biochar Upgrading**

5. **Upgrading**
   - Vapors

6. **Product Separation**
   - Hot Products
   - Light Gas
   - Fuel
   - Water
Cool Planet Fuels

Three main fractions:

Gasoline cut – up to 70%
   Similar to Reformate
   High octane: 100+

Middle Distillates – ~20 - 30%

Heavies / bunker cut – ~5 - 10%

Low oxygen fuel
Multiple design generations
A key technology target – cutting edge pyrolysis hardware

Original fractionator
- Race track – illustrated fractionation to char/fuel (vapors)
- Strawberry Field – demonstrated large scale production

Streamlined fractionator
- Simplified stationary lower platens
- Higher output heaters integrated with the platen plate – no re-heating required

Simple Continuous
- Continuous versus stop-start operation
- Mechanical simplicity
- Lower capital costs
- Higher reliability

Integrated Continuous
- Higher uptime – more fuel production
- Higher reliability

Enhancing performance and minimizing capital cost of the commercial design
Multiple stages of R&D and testing capabilities

Bench scale | Small Pilot | Integrated | Commercial

**Objective**
- Early-stage innovation
- Refine design basis
- Test at pilot scale
- Commercial production

**Functional focus**
- Chemistry
- Engineering
- Systems integration
- Operations

**Operations**
- Batch: 200 g
- Continuous: 1.5 kg/hr, 10 kg/hr, 1 to 10 t/hr

**Number of runs**
- 1500+
- 170+
- 50+
- N/A

*Bringing confidence in design, commercial results, and economics*
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What is Cool Planet’s design?

CPES’s plants:

Modular in construction

- Designing skid mounted equipment
- Not containerized or portable

Take months to construct

- Not weeks or years

Utilize standard equipment

- Minimizes custom equipment
Cool Planet Strategy

Small Plants – Up to 10MM gal/yr

Modular components

Centralized In-House Assembly

Long Term Hub and Spoke Strategies

International Markets

*Some aspects are well defined while others will be determined with continuing development*
Distributed Business Model

Large number of small, low-cost plants provides the foundation for compelling economics and ongoing innovation

**Standardized Low Cost Design**

- Distributed model with a large number of small modular facilities generating up to 10mm gallons of hydrocarbons per year – much smaller than typical refineries
- Standardized design reduces construction time and cost for subsequent plants

**Closer to Feedstock**

- Improved economics by locating plants near sources of feedstock – lowers the overall transportation costs and carbon footprint
- Facilities sized to match local feedstock availability

**Lower Capital & Operating Costs**

- Lower capital requirements and operating costs resulting from modular design, centralized assembly of plant components, and volume purchasing

**Continuous Improvement**

- Ongoing R&D further advances technology platform
- Incorporating latest technology advancements into subsequent plants
## Small Plants and Distributed Model

### Operating Economics
- Small yield improvement
- Value added product mix
- Improved energy efficiency

### Capital Cost
- Process integration
- Modular concept introduction
- Value engineering equipment

### Mid-term
- Approaching theoretical yield limits
- Feedstock diversification
- Tighter process integration & optimization (Heat, water)

### Long-term
- Ongoing technology innovation
- Design/component standardization
- Volume procurement
- Assembly manufacturing
Driving down CAPEX Over Time

“Experience Curve” reduces plant CAPEX with every plant constructed

Full 10MM gallon Facilities CAPEX Progression and Plant Rollout Forecast

- Strategic sourcing partnerships
- Modular deployment
- Process intensification & integration
- Improved pyrolyzer design
- Fuel yield/quality improvements (allows for smaller plants)
- Construction execution / experience

Base plant cost declines as plant deployment increases
First Commercial Plant Deployment Approach

Successful completion of the first commercial module will unlock full plant rollout

Deployment approach mitigates full-scale design risks

Full Commercial Plants may have multiple trains

- Small Module
  - Integrated Fuel / Biocarbon Prod.
    - More modules
    - More augers, same diameter
    - Same biomass handling system
  - Input
    - Pine Chips (t/year) 3,700
    - Provide maximum scale-up confidence at minimal cost
    - Deploy full scale auger size

- Full Scale Train
  - Commercial Scale Production
  - Input
    - Pine Chips (t/year) 90,000
    - Deploy full scale pyrolysis system
    - Full hydrocarbons and biocarbon production
    - Same auger diameter as FCM
    - Same biomass handling as FCM
Distributed Plant Model Enables Cost Efficiencies

Combining in-house fabrication and assembly with benefits of volume production

Assembly and deployment strategy

- Cost advantages enabled by Cool Planet’s distributed plant model
- In-house siting, permitting and commissioning capabilities replicated into multiple “tiger teams” focused on rapid deployment

Efficient manufacturing and deployment will ensure speedy execution
Distributed Plant Model Enables Cost Efficiencies
Combining in-house fabrication and assembly with benefits of volume production

Sources of cost and speed advantage

**In-house mass production**
• Save up to 80% of assembly cost

**Volume procurement**
• Reduce equipment cost by 25-40%

**Ongoing Innovation (experience curve)**
• Reduce cost by over 50% as per independent industry studies

Expected capital cost reduction after the first commercial plant
Centralized Fuel Upgrading Model
Distributed fuel production
Centralized distillation and/or upgrading of fuel
Distributed Biomass Model
Distributed production of uniform chips/pellets
Centralized conversion to fuel and char
Centralized Biochar Upgrading Model
Distributed raw char production
Centralized upgrading to agrichar or fuel
Plan Forward

Build and Test Commercial Module

Design and Build Full Commercial Train

Develop Full Commercial “2.0”

Increase the number of plants
Port of Alexandria Site

Currently installing sewer, fire lines, and roads . . .

Questions?