Solena Group
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USAID – USEA WORKSHOP: RENEWABLE ENERGY TECHNOLOGY OVERVIEW – BIOENERGY SYSTEMS

September 01st, 2009

Summary

1. Solena Technology

2. Solena BioEnergy Platform
    1. Bio Power plants
    2. Bio Jet Fuel plants

3. Solena CO_2 Sequestration Program

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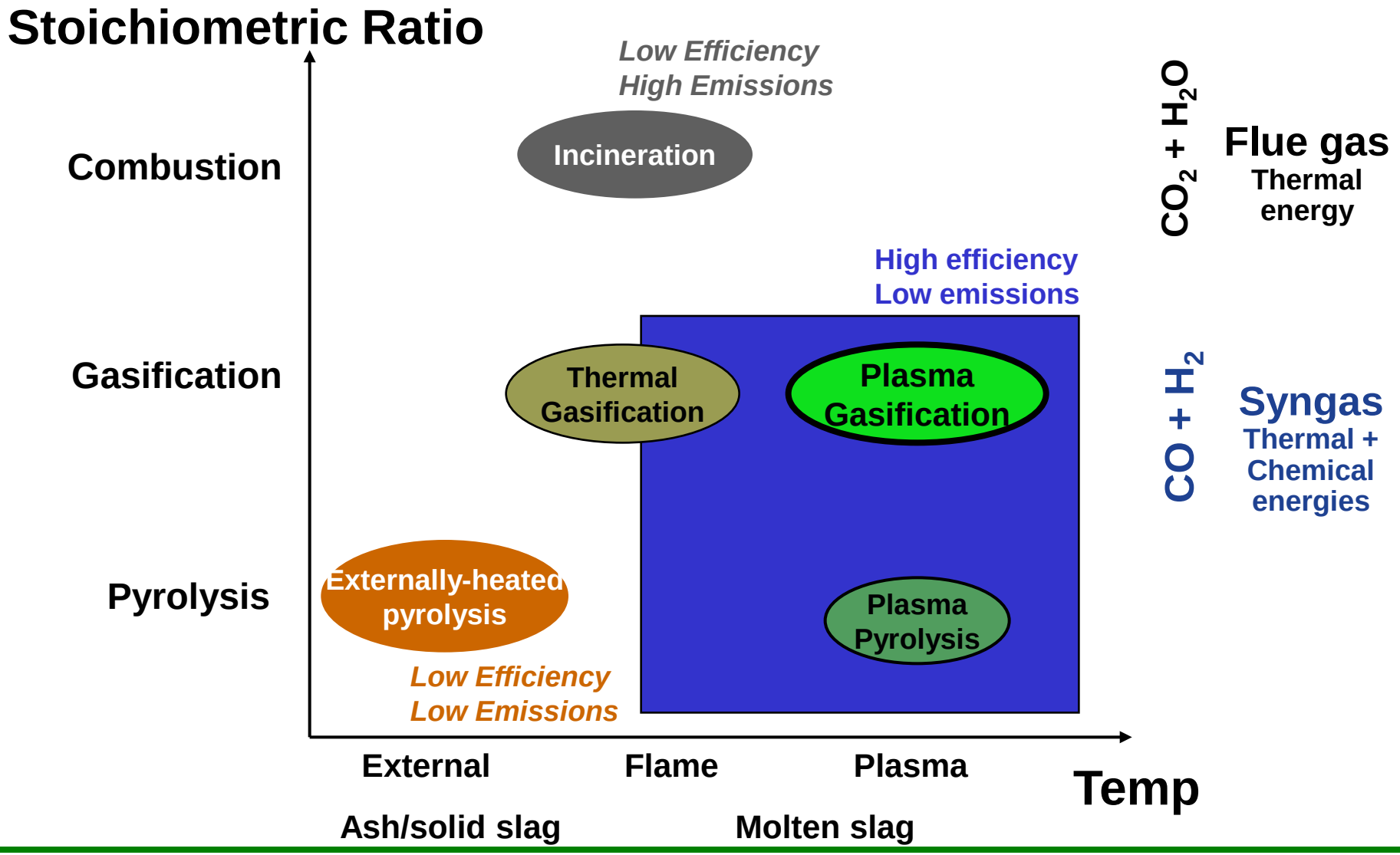
1. Technology

1 Energy Contained in Biomass Fuels

- **Biomass / Organic residues are composed of hydrocarbons, and as such, contain energy.**
- **Biomass fuels are characterized by their proximate and ultimate analyses, as well as their heating content (HHV & LHV):**
  - **Proximate: Moisture, Volatile (given at 960 °C), Fixed-Carbon, and Inert**
  - **Ultimate: C, H, O, N, S, Cl**
  - **HHV & LHV = f (C, H, O, N, S, Inert)**

1 kg of biomass = 4000 kcal = 16.8 MJ
1 tonne per hour = approx. 5 MW

1 Thermal Conversion Technologies



1 Thermal Conversion Technologies

	End-Product	By Product	Emissions
Incineration / Boiler	Hot flue gas (500°C)	Bottom Ashes Fly Ashes	Particulates, NOx, SOx, dioxins / furans
Ext. heated Pyrolysis	Oil ultimately upgraded into diesel / gasoline	Char and Syngas that contains soot and tar	Particles Low emissions
Plasma Pyrolysis (better efficiency than ext. heated pyrolysis)	Oil ultimately upgraded into diesel / gasoline	Char and Syngas that contains soot and tar	Particles Low emissions
Solena Plasma Gasification	Syngas Fuel (1100 °C) to produce electricity, biofuel, etc.	Inert Slag	Low emissions

1 Innovative Patented Technology

Solena Plasma Technology

- **Plasma** technology: 5,000 °C
- **O_2 deprived environment**: No combustion
- **Residence time** in plenum > 2 seconds
- Solena's process is **fuel flexible**.
- I&C to **control operations** and reach steady state
- Independent variables to **control the Gasification process**.

- **Conclusion**: Solena BioSynGas characteristics:
  - **HHV = 300 BTU/scf (1/3rd Nat Gas)**
  - **High CO & H_2 concentration (> 90% vol.)**
  - **Absence of SOx, NOx, CxHy, dioxins, furans**

1 Innovative Patented Technology

Solena has developed and patented a thermal gasification technology

- **Solena's plasma gasification vitrification (SPGV) technology is designed to be a cost effective and technically efficient atmospheric thermal gasification process**
- **Converts any biomass into a clean, high calorific BioSynGas**
- **Inorganic compounds are melted into an inert, non-toxic vitrified slag**
- **Average production of 2,000 kWh of electricity produced per ton of biomass processed(1) (2)**
- **Developed by Solena team members over 10+ year period**

(1) Source: Solena; assumes mixed (RDF, wood waste and forestry) feedstock containing 4,000 kcal/ kilo

(2) Compared to 500 kWh per ton of biomass by means of traditional incineration

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2. Process

2. Solena BioEnergy Platform

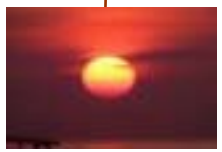
Solena's platform is a complete bioenergy and CO_2 harvesting platform which can produce electricity or liquid transportation fuels

Waste

Biomass

Algae

CO_2



Exclusive Algae to Gasification JV

BFS bio fuel systems

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Solena Complete SPGV and IPGCC System

Solena BioSynGas

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CHP

BioPower

BioJetFuel/SJ-8

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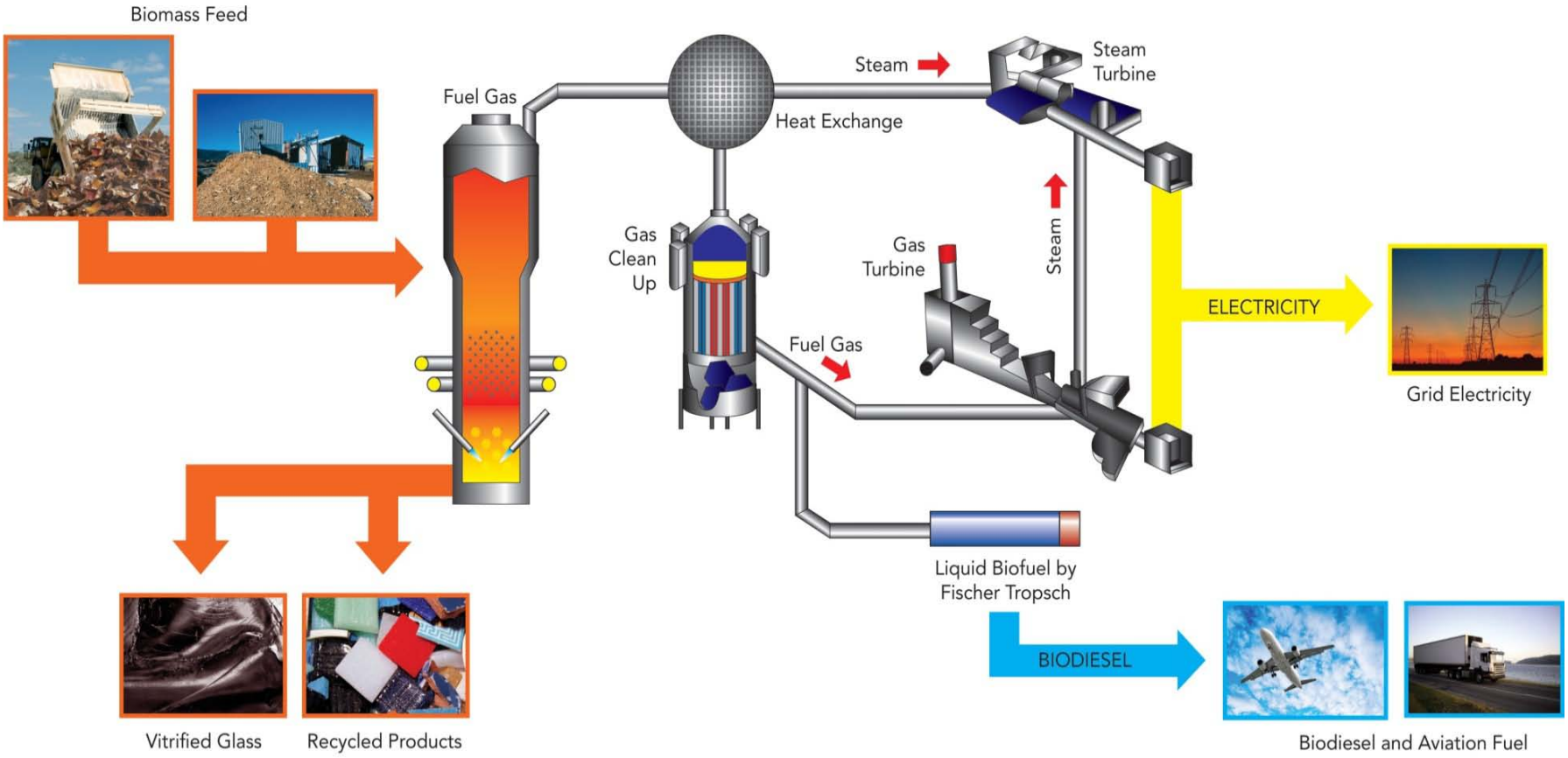
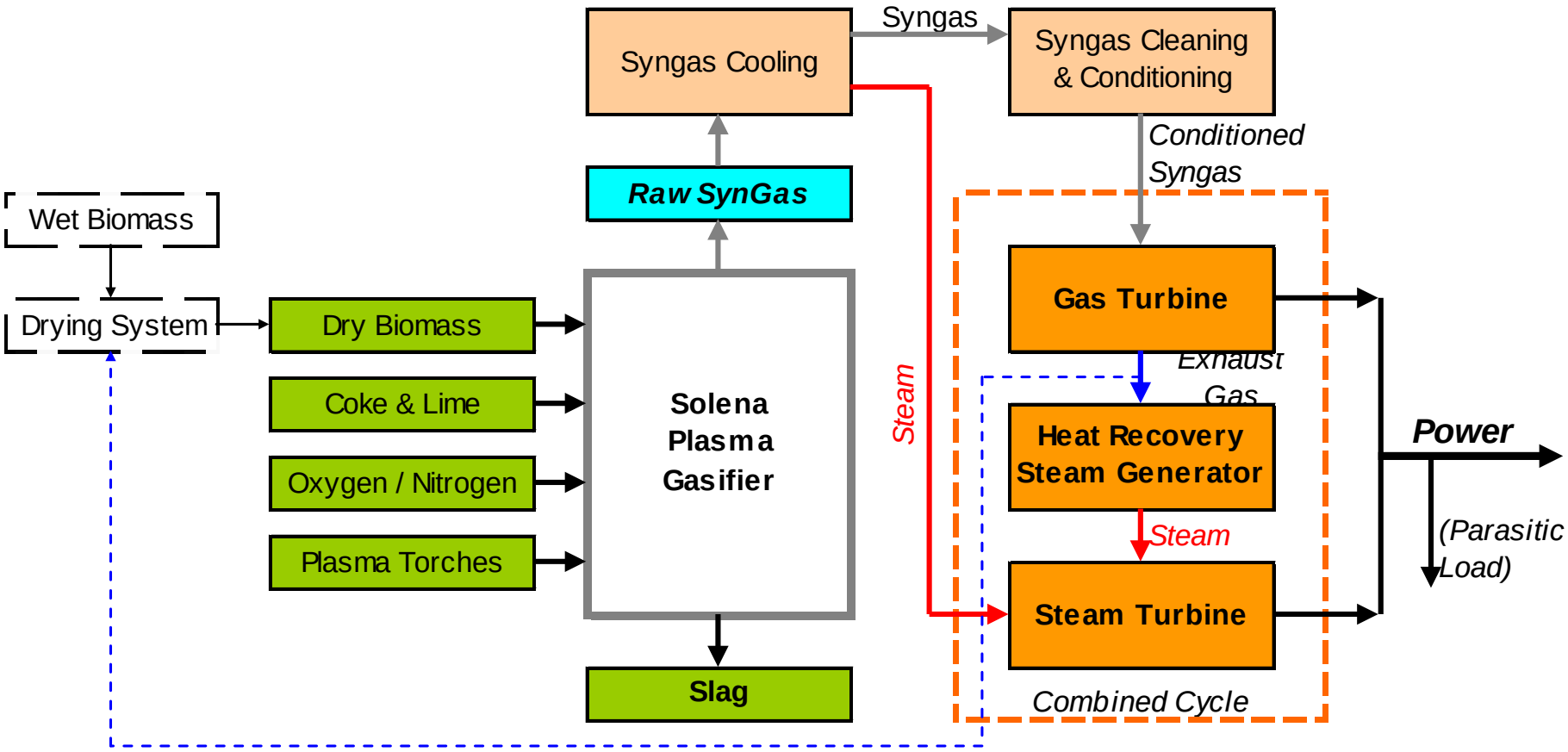
2. Solena's Process

Solena's SPGV island is a core, proprietary technology which can be used in multiple, end-to-end solutions



2.1 BioPower Plants



2.1 BioPower Plants

Solena's SPGV island produces BioSynGas which can be used to power traditional gas-fired electric turbines

- **BioPower Plants utilize BioSynGas to generate electricity via standard industrial gas turbines (GE MS5001 CC)**
- **20 tonnes / hour of RDF to generate 42 MW**
- **3 tonnes / hour of RDF to generate 6 MW**
- **Syngas treatment / cleaning system**
- **Combustion Gas Turbine + Combined Cycle**

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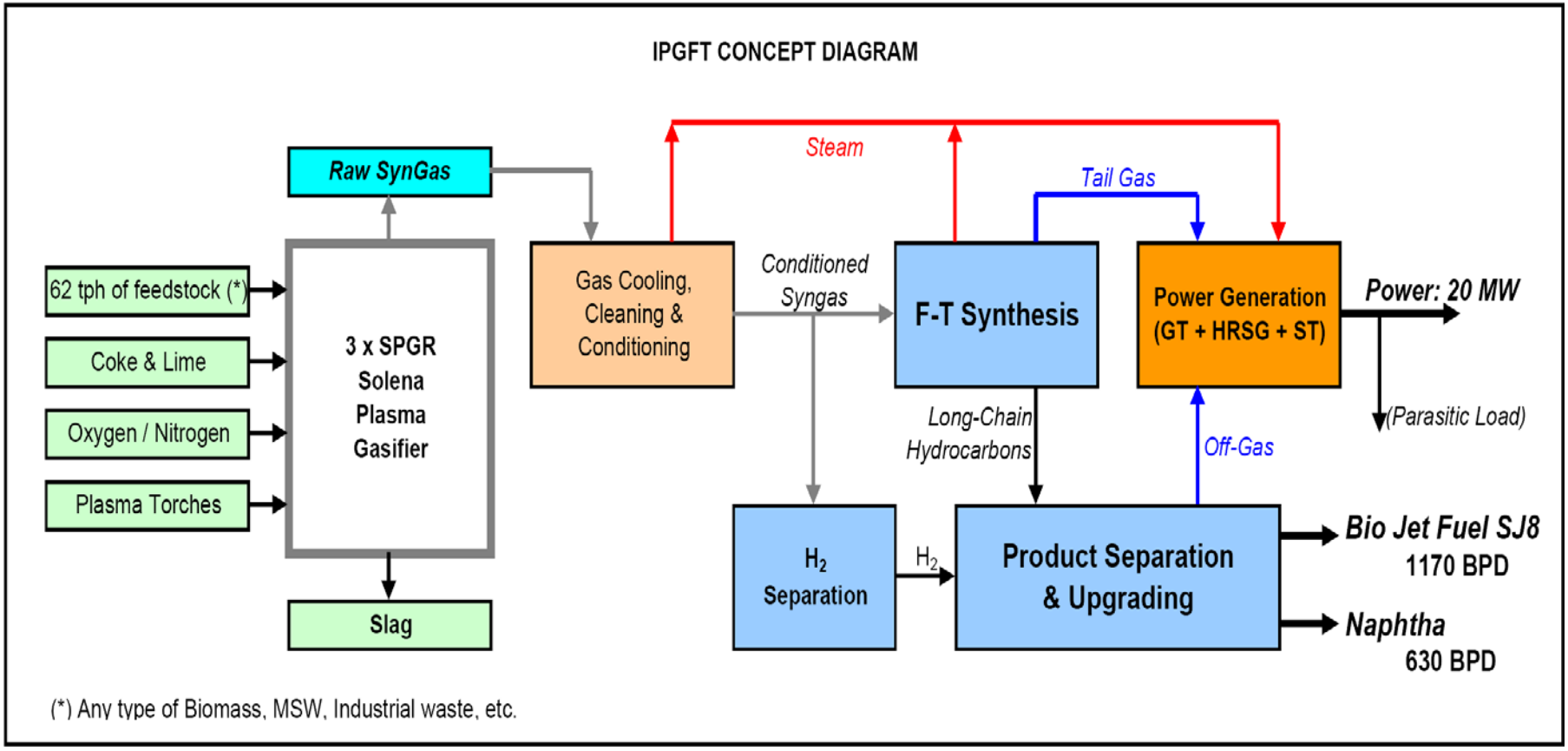
2.2 BioJetFuel Plants



2.2 BioJetFuel Plants

- **BioJetFuel Plants utilize BioSynGas to produce JP8/SJ8 Fuel via standard industrial Fischer Tropsch**
- **60 tph of feedstock to produce 1800 barrels per day of Bio Jet Fuel and 20 MW net**
- **3 x Solena Plasma Gasification Reactor**
- **Syngas treatment /cleaning system**
- **1 Fischer Tropsch reactor**
- **1 MS5001 Gas Turbine + CC**

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3. CO_2 Sequestration

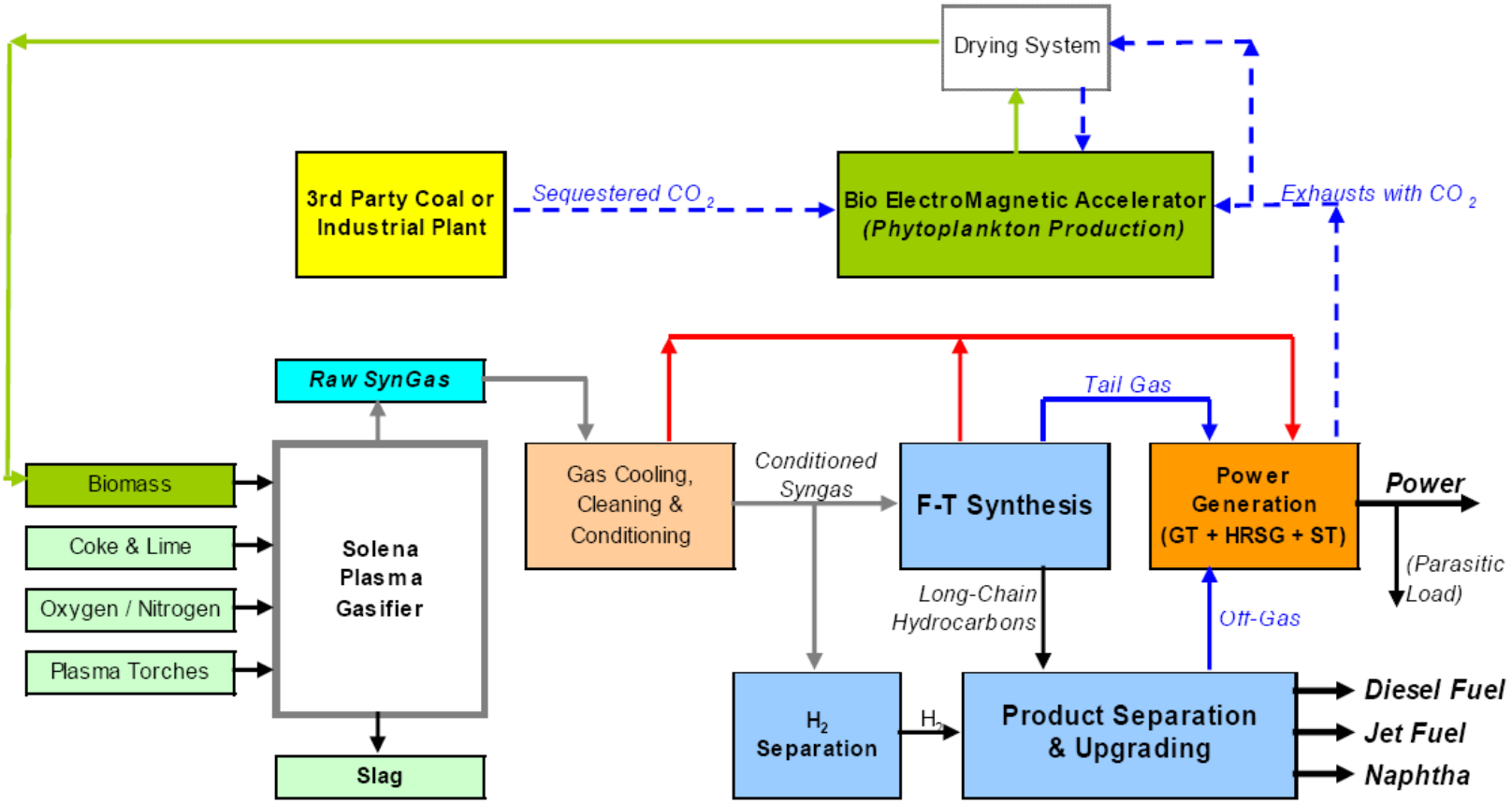
3. CO_2 Sequestration

Strategic JV Solena - BFS for Gasification of highly calorific algae

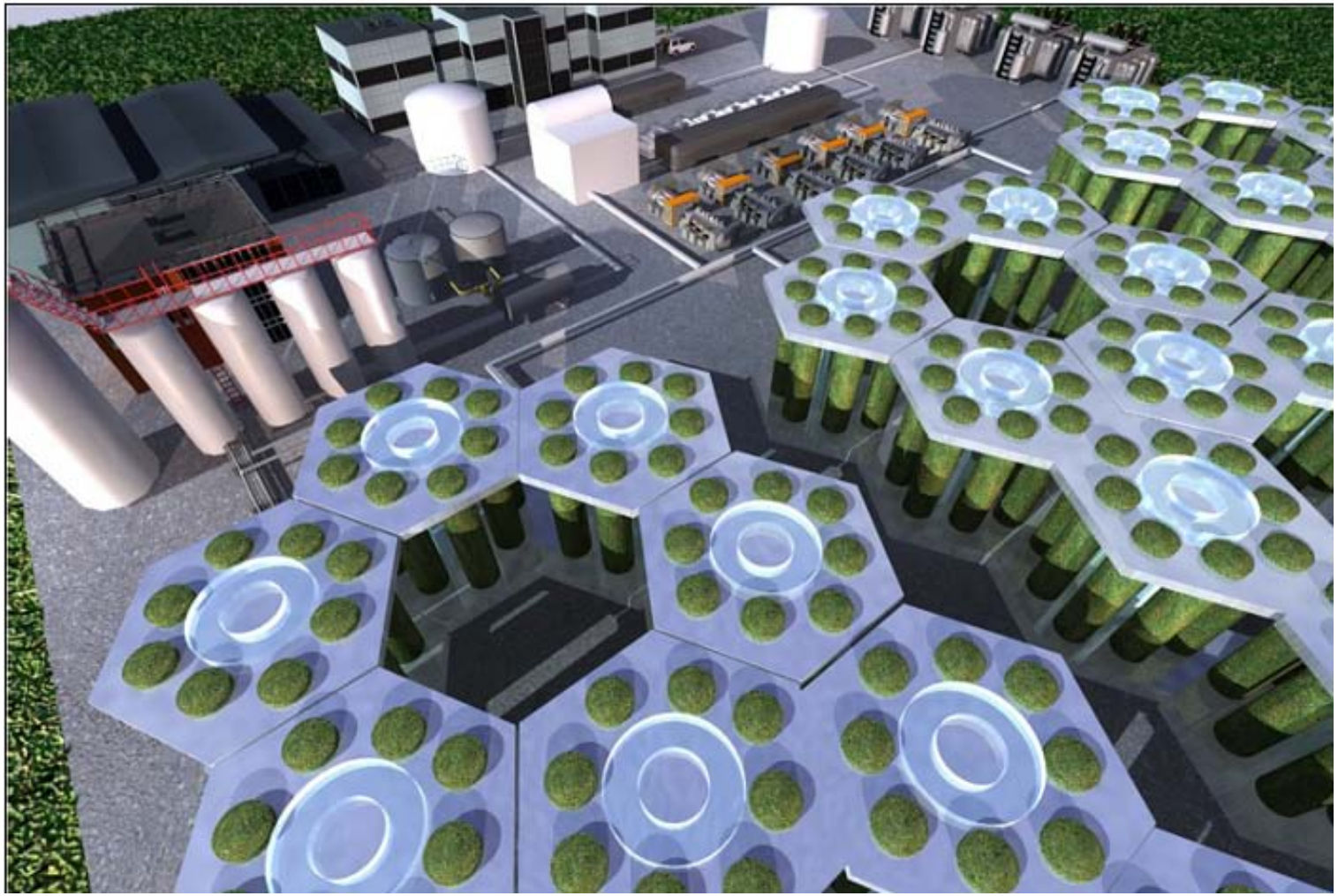
- Partnership with Bio Fuel Systems, S.L.
- Complete Sequestration of Exhaust gas from GT including CO_2 & NOx
- Closed Loop Production by Photosynthesis of Phyto-Plankton Species
- Biomass w/ 5500-6500 kcal/kg:
  - 35-40% Triglycerides Oils, 35-40% Hydrocarbon, depending on the algae species

3. CO_2 Sequestration

Solena-BFS BioJetFuel Production



3. CO_2 Sequestration



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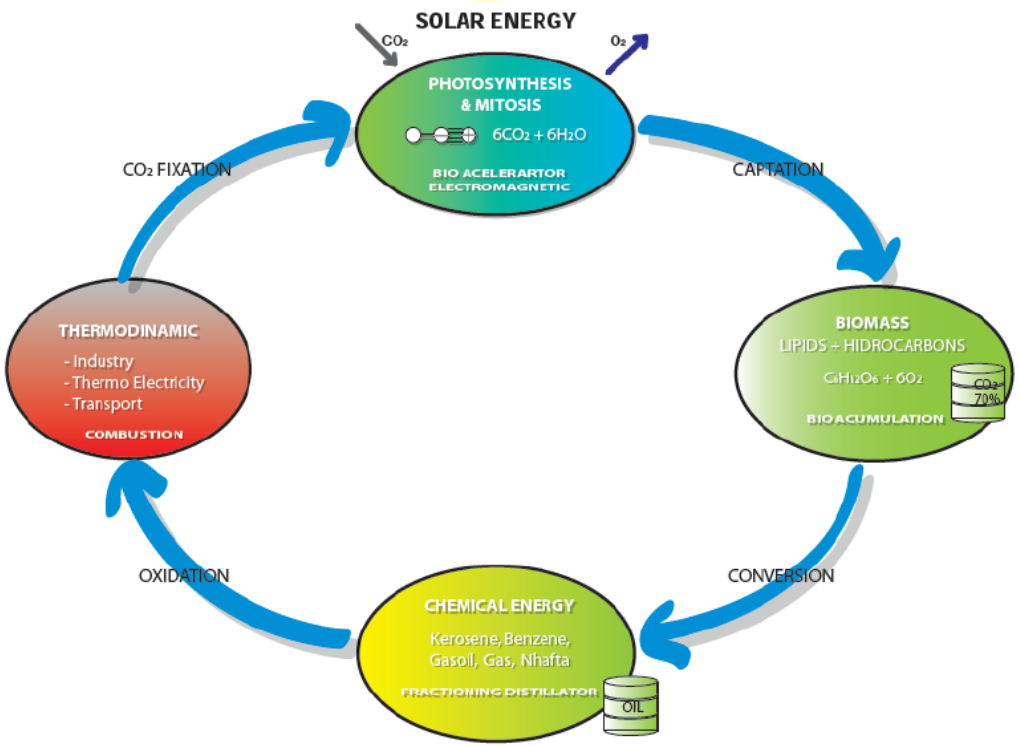
3. CO_2 Sequestration



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3. CO_2 Sequestration

Solena BFS Production

- High Calorific Value = 6000 – 6500 kcal/kg
- Algae Bioreactor can produce 1 ton of dry algae from 1.8 ton of CO_2
- 1 Ha (2.47 acres) of Solena BioFuel plant produces 10,500 tpy of algae VS 10 tpy of crop (straw).
- Production of algae from CO_2 entirely controlled within Bio-Electromagnetic Accelerators
- No competition with Food Market
- Solena BioFuel Process acts a carbon sink
  - Carbon credits
  - CO_2 sequestration

- **BioPower**
  - **28 tph of CO_2**
  - **Power generated 42 MW**
- **BioJetFuel**
  - **90 tph of CO_2**
  - **FT Reactor produces 1800 bpd**
  - **Power generated: 20 MW net to export**

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Thank you

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