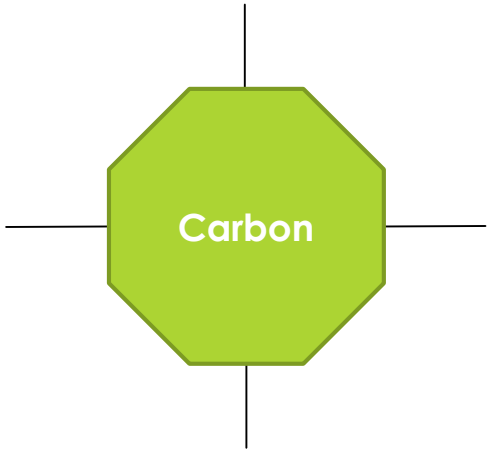
Energy Efficiency

USING CARBON AS AN ENERGY CARRIER

Carbon & Water

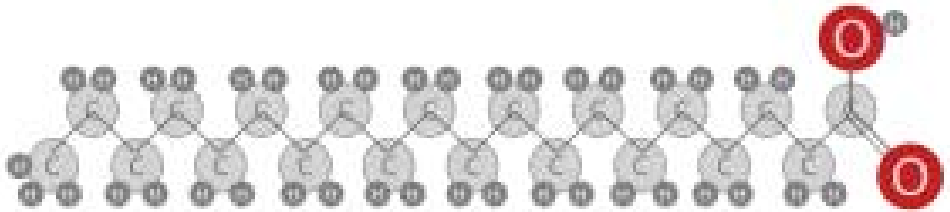
- Neutrality
  - Water
    - pH7
    - Electrical Dipole (+ and -)
  - Carbon
    - 4 outer bonds (+ and -)
    - Attracted to everything
      - Neutralizes everything

Carbon – Ultimate Electron Acceptor/Donator



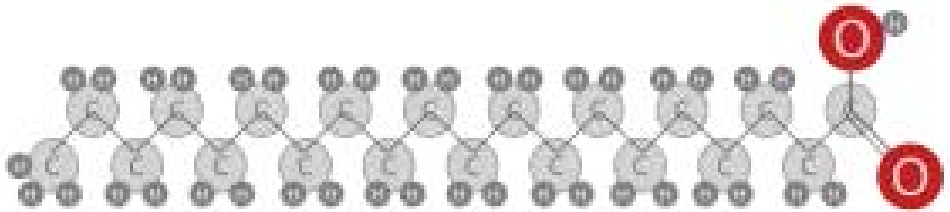
Electromagnetic
Radiation
Absorber

Fatty Acid



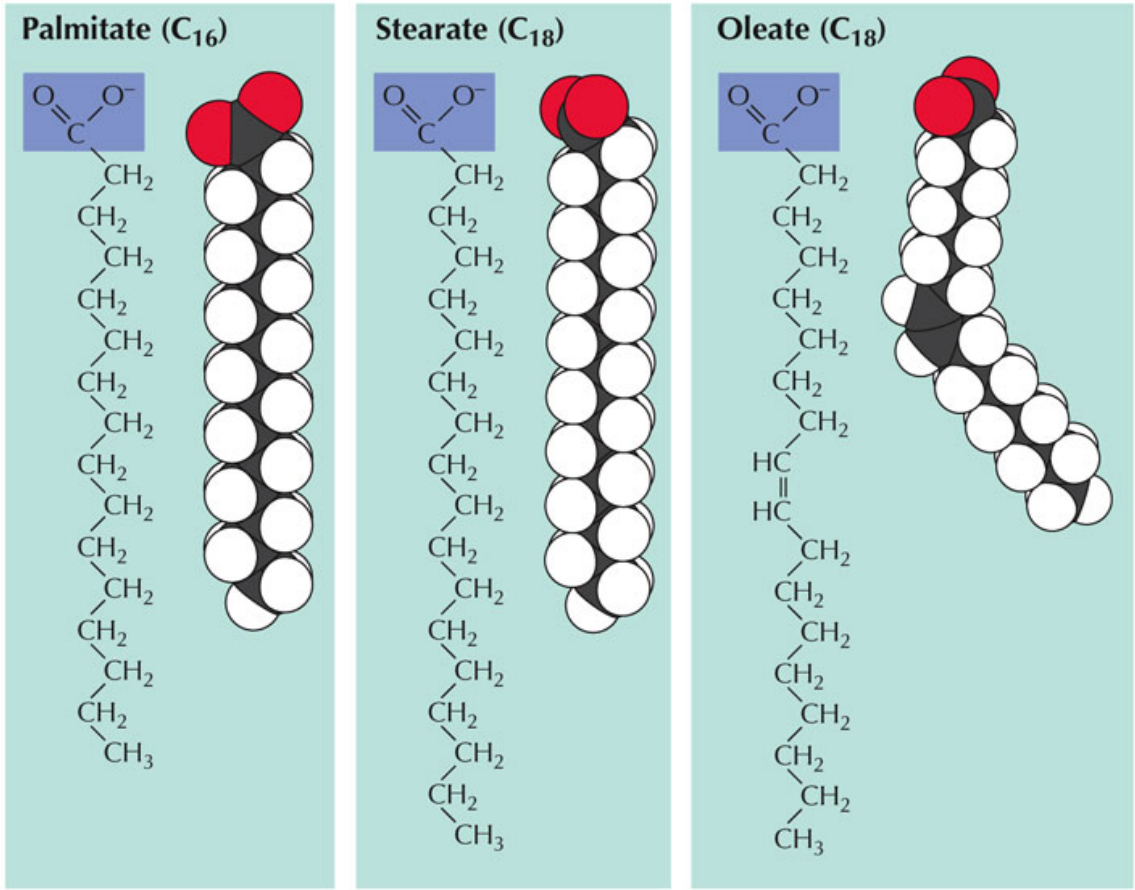
arachidic

Fatty Acid

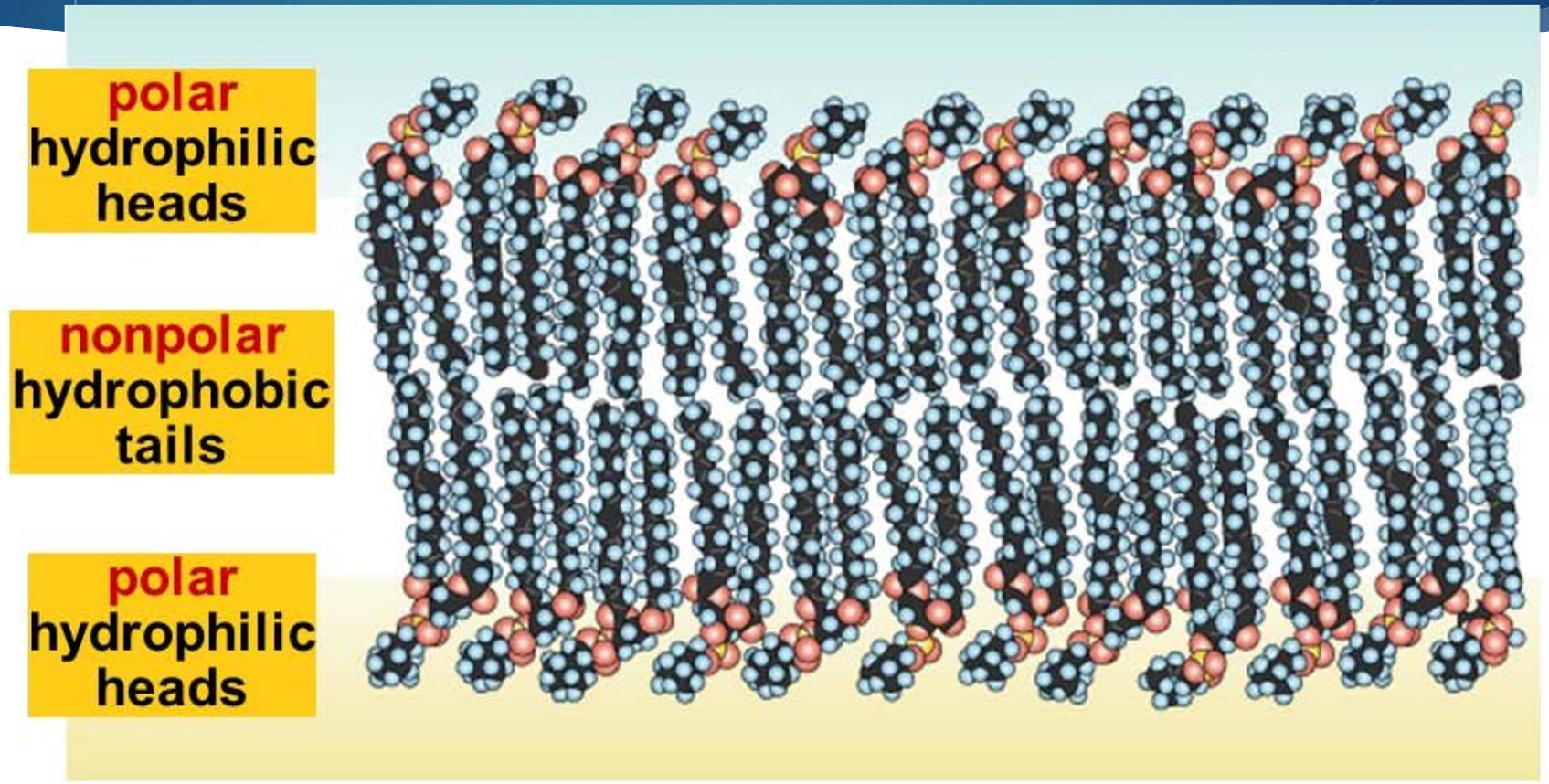


arachidic

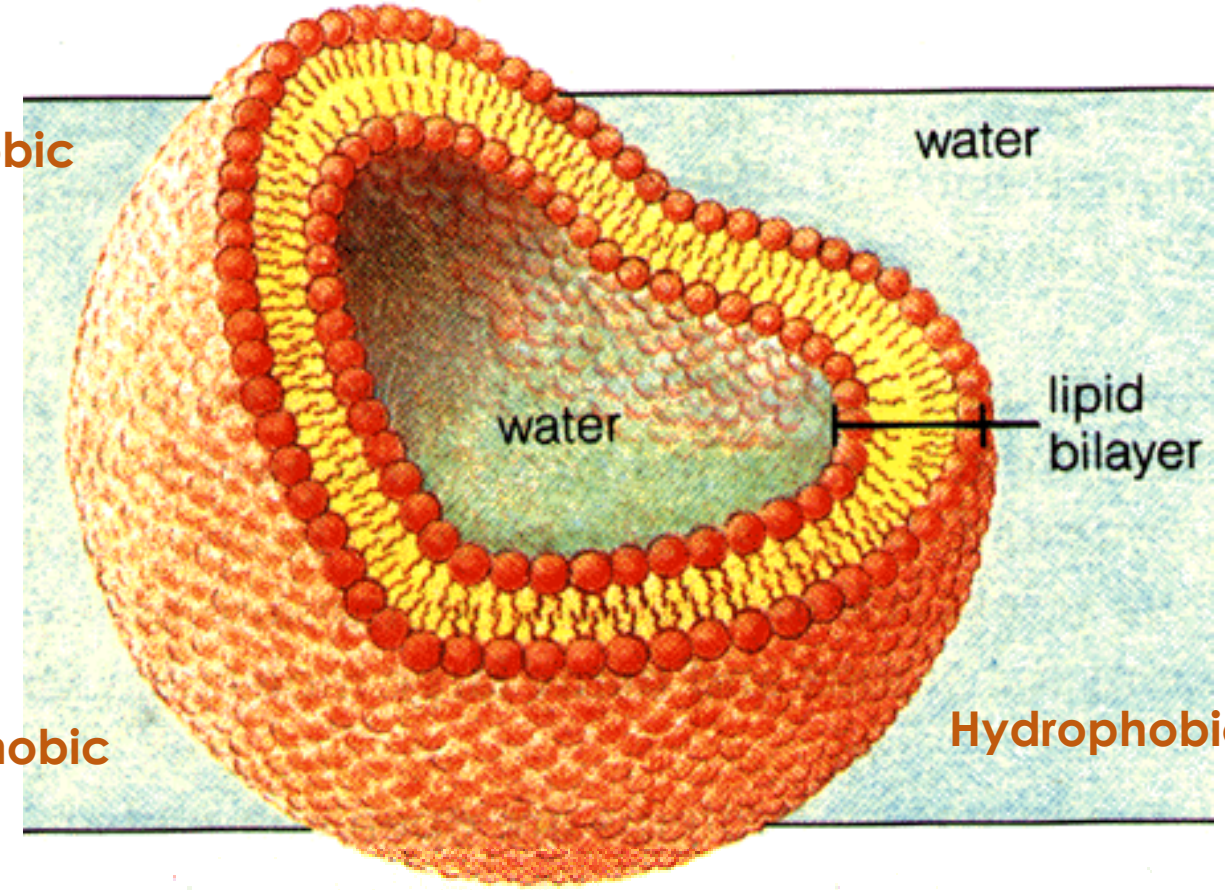
Fatty Acid



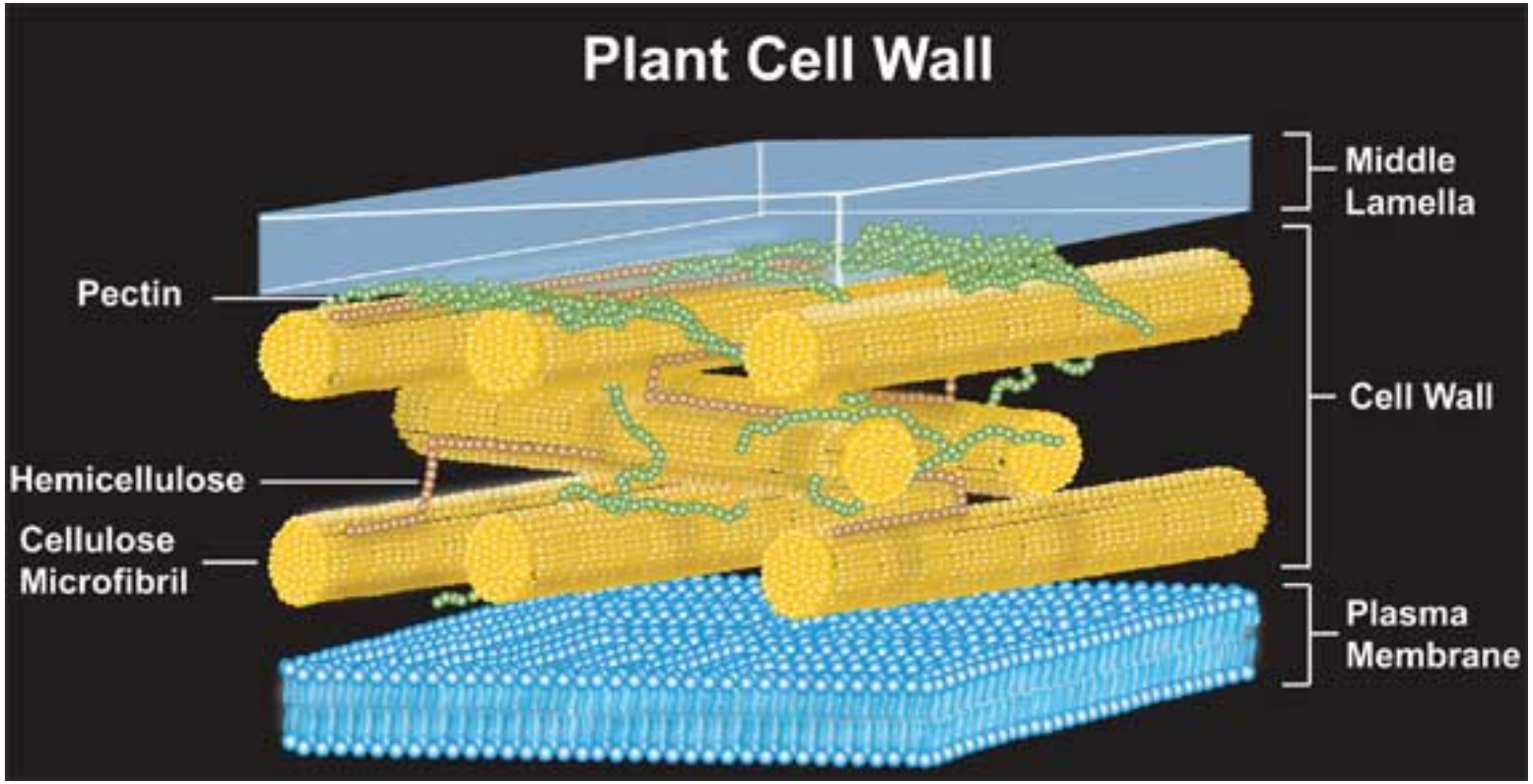
Phospholipid bilayer



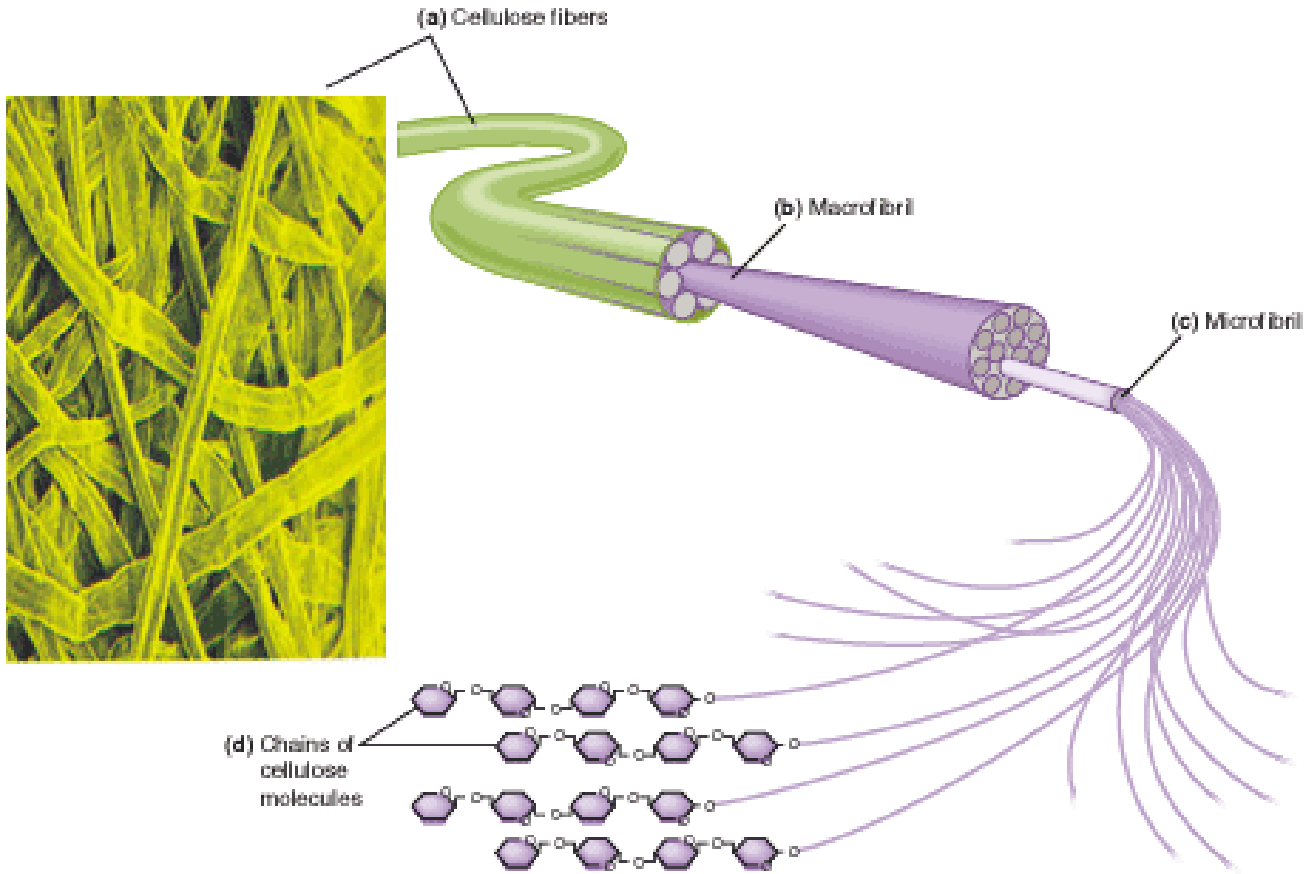
Cellular Membrane (Cellulose/Cell Wall precursor)



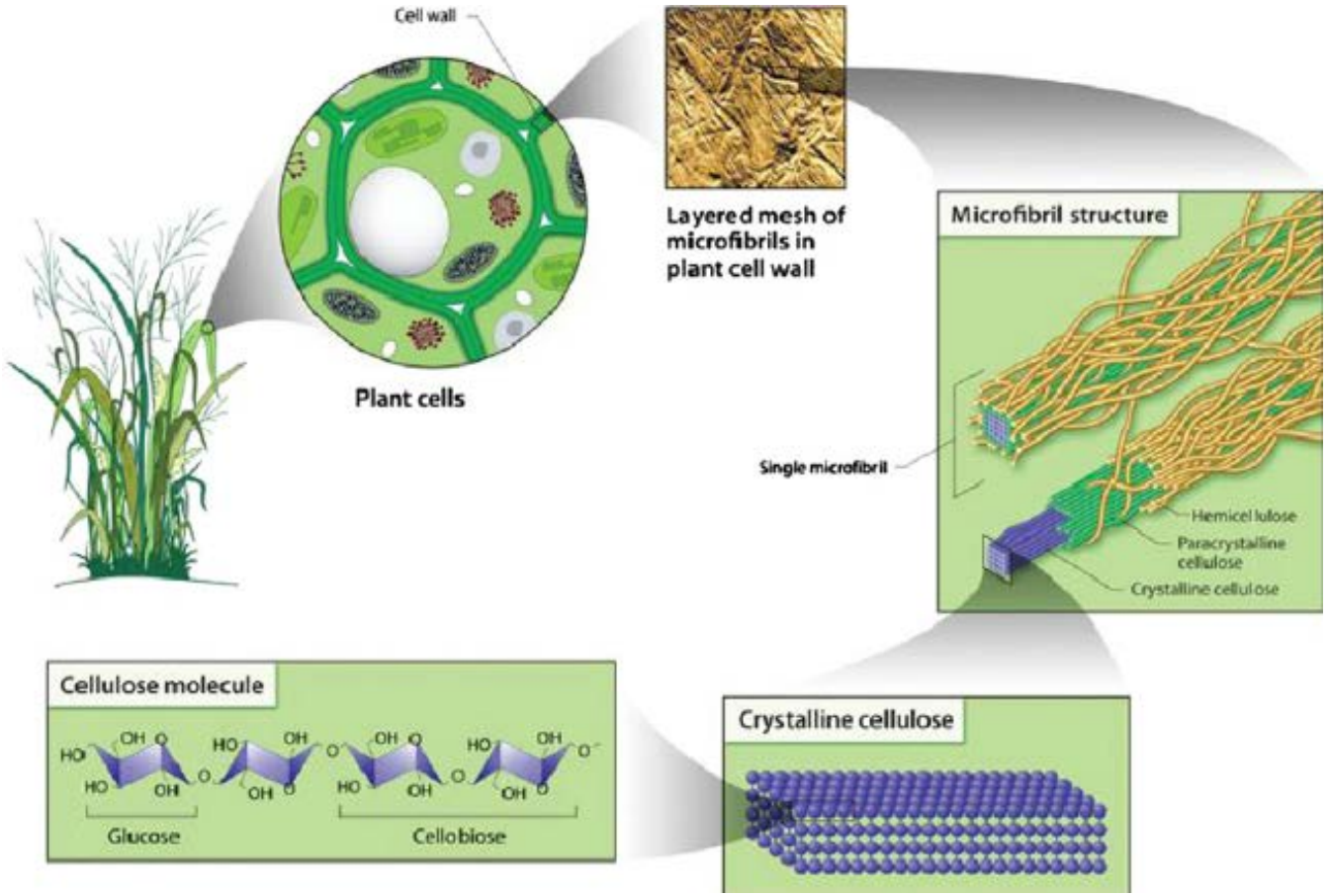
Cell Wall (Cellulose/Hemicellulose/Pectin)



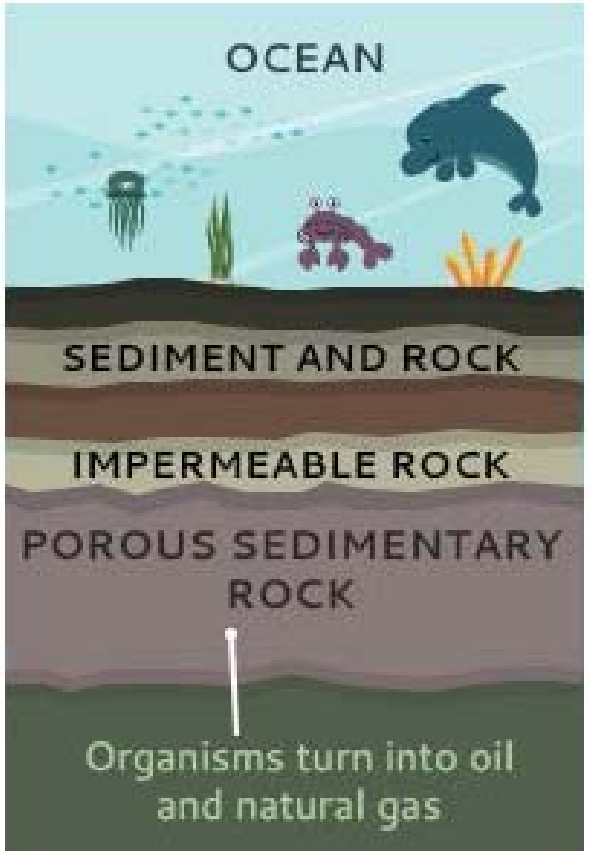
Cellulose Chain

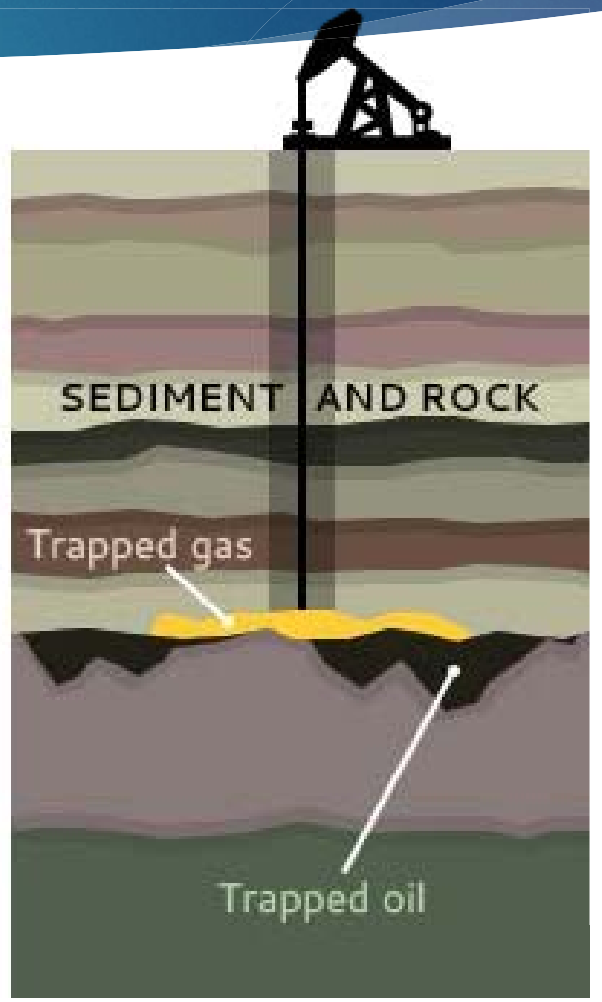


Increase Energy Density



Fossil Fuel Formation





Forms of Energy

- Coal
- Cellulose
- Hemicellulose
- Lignin
- Sugars
- Oil
- Natural Gas
- Carbon Monoxide
- Hydrogen

=

Energy Storage!

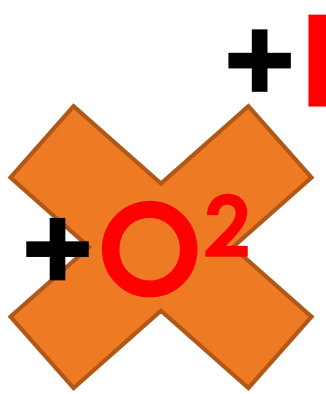
Forms of Energy

- Coal
- Cellulose
- Hemicellulose
- Lignin
- Sugars
- Oil
- Natural Gas
- Carbon Monoxide
- Hydrogen

$+O^2$ = **Energy Release!**

Carbon Preservation (pyrolysis/gasification)

- Coal
- Cellulose
- Hemicellulose
- Lignin
- Sugars
- Oil
- Natural Gas
- Carbon Monoxide
- Hydrogen



Energy Release!

but **No CO^2 Produced**

Carbon Preservation

Theoretical Energy Discussion

- The key to energy efficiency is getting the most energy out of source of energy (feedstock) while inputting the least amount of energy possible.

- **Energy losses**
  - **1. Feedstock supply & logistics**
  - **2. Biomass destruction & fractionation**
  - **3. Biomass synthesis & upgrading**
  - **4. Energy distribution, infrastructure, and end use**

1. Feedstock supply & logistics

- Biomass Waste Streams (within 150 miles radius)
  - **Forest Residue (15-20% energy loss)**
  - **Agricultural Waste (10% energy loss)**
  - **Food Waste (10-25% energy loss)**
  - **Municipal Solid Waste (5-15% energy loss)**
  - **Bio-solids (120% energy loss)**
- Energy Crops
  - Corn (86% energy loss)
  - Wheat (80% energy loss)
  - Beats (80% energy loss)
  - Sugarcane (7% energy loss)
  - Algae (92% energy loss)

2. Biomass destruction & fractionation

- Combustion (15% energy loss/requires water input)
- Pyrolysis/Gasification
  - Conventional (65% energy loss)
  - **Microwave (14% energy loss)**
  - **Radiowave + Variable Tuning (1% energy loss)**
- Anaerobic Digestion (30-80% energy loss/requires time input)
- Hydrolysis (30-50% energy loss)
- Hydrothermal Liquefaction (25-50% energy loss/requires catalyst)

3. Biomass synthesis & upgrading

- Biological Processing (20-50% energy loss)
- Catalytic Processing and Stabilization (requires catalysts) (10-50% energy loss)
- Intermediate Upgrading (10-30% energy loss)
- Fuel/Product Finishing (5-15% energy loss)
- **No Upgrading (No energy loss)**

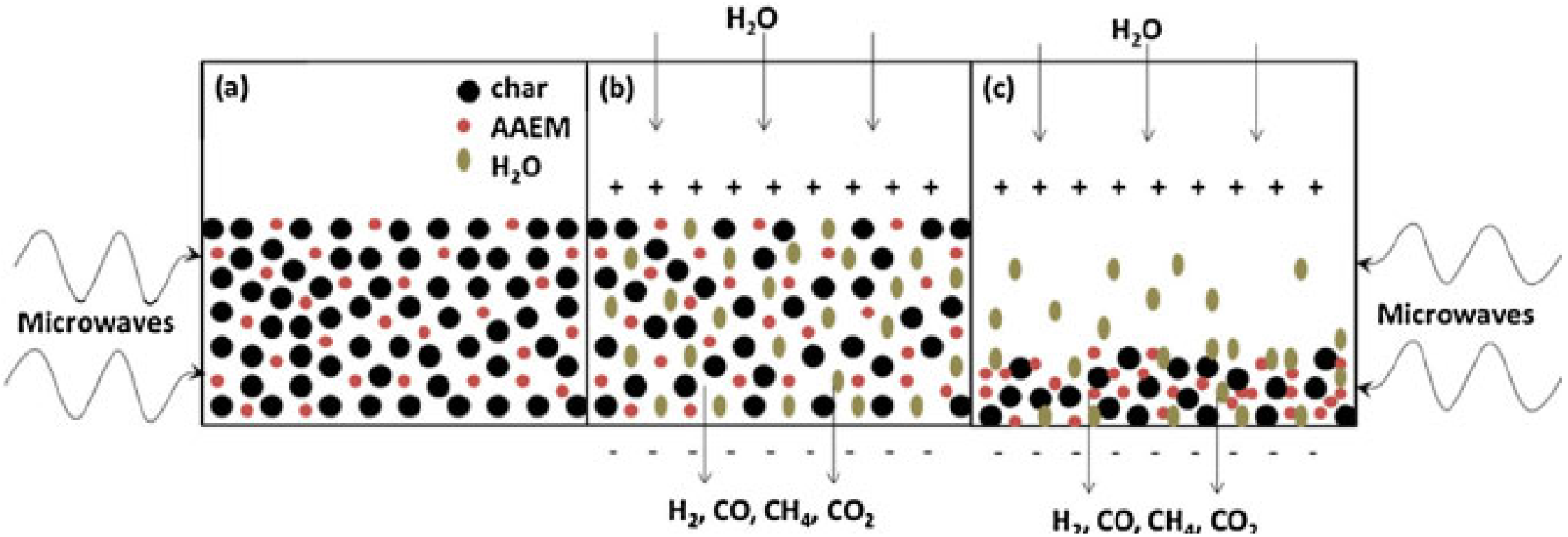
4. Energy distribution, infrastructure, and end use

- Energy Distribution
  - Oil/Gas Pipelines (2-4% energy loss per 100 miles)
  - Truck Transport Tanks (6-12% energy loss per 100 miles)
  - Rail Transport (3-6% energy loss per 100 miles)
  - **Power lines (0.5-1.5% energy loss per 100 miles)**
- Energy Infrastructure
  - Gas Tanks (No energy loss) (3-18% energy loss)
  - **Supercapacitor (carbon based) (1-2% energy loss)**
- End use (electrical output)
  - Gas Generators (65% energy loss)
  - Combustion/Boilers (50% energy loss/requires water input)
  - **Molten Carbonate Fuel Cell (40% energy loss)**

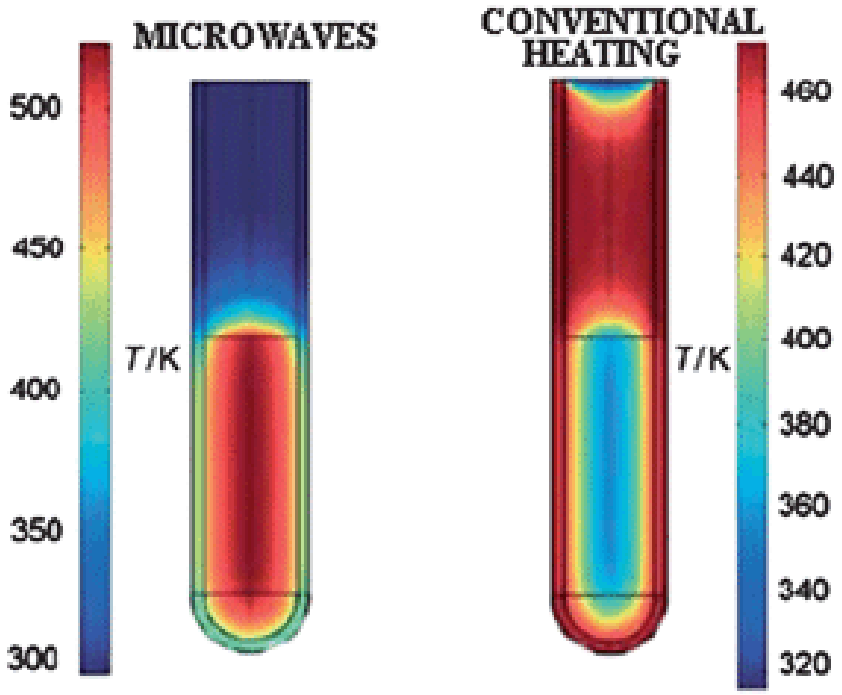
Biomass Energy Models

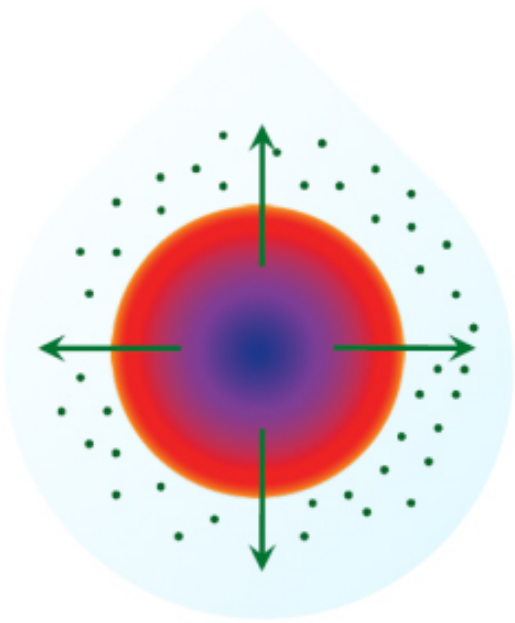
Feedstock supply & logistics	Biomass destruction & fractionation	Biomass synthesis & upgrading	Energy Distribution	Energy Infrastructure	End use	Total Efficiency
Biomass Waste (5-10% Energy Loss)	Microwave Gasification (1% Energy Loss)	No Upgrading (No energy loss)	Power Lines (0.5-1.5% Energy Loss)	Supercapacitor (1-2% Energy Loss)	Molten Carbonate Fuel Cell (40% Energy Loss)	**45.5-52.5% Efficiency** (47.5-56.5 % Energy Loss)
Biomass Waste (5-10% Energy Loss)	Combustion (15% Energy Loss)	No Upgrading (No energy loss)	Power Lines (0.5-1.5% Energy Loss)	Excess Power (5-10% Energy Loss)	Boiler (50% Energy Loss)	**14.5 to 24.5% Efficiency** (75.5-85.5 % Energy Loss)

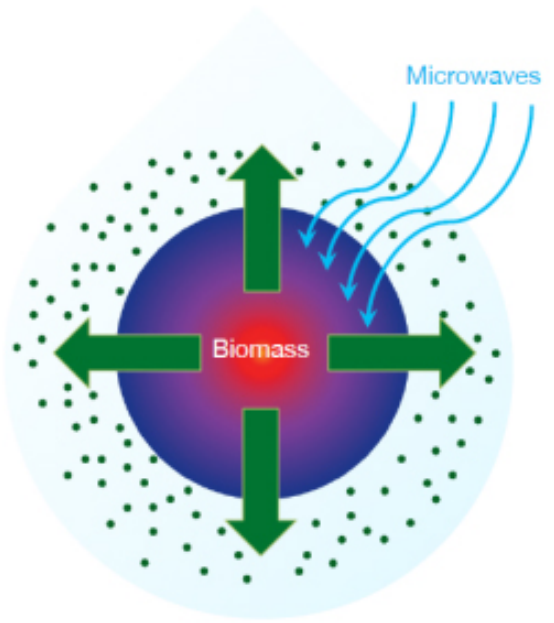
Microwave Gasification



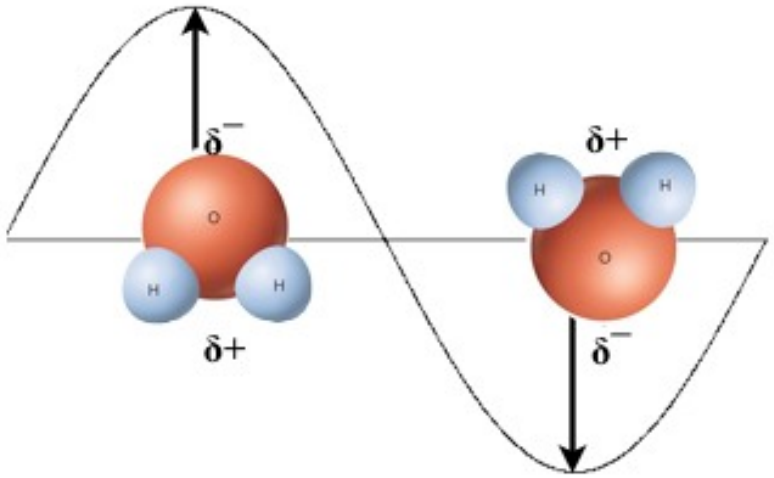
Microwave Heating

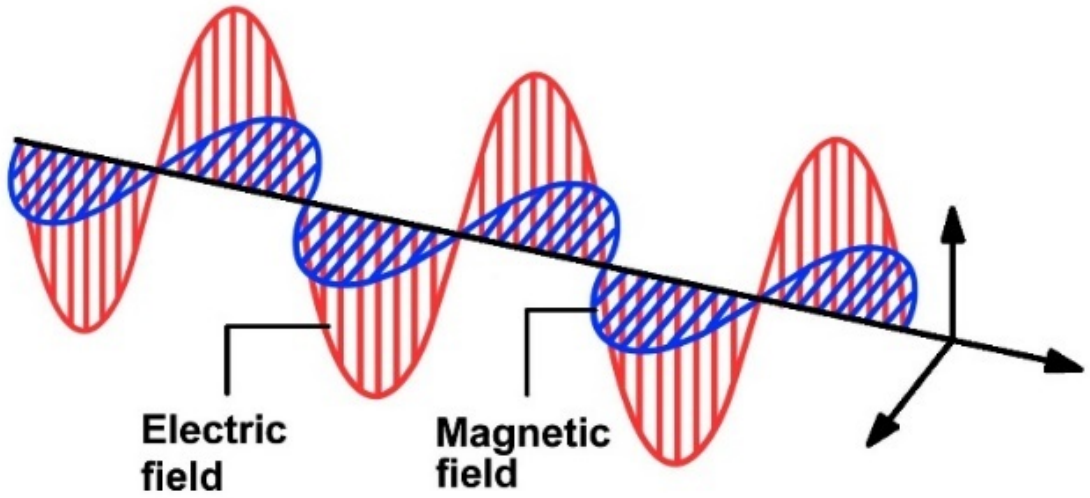




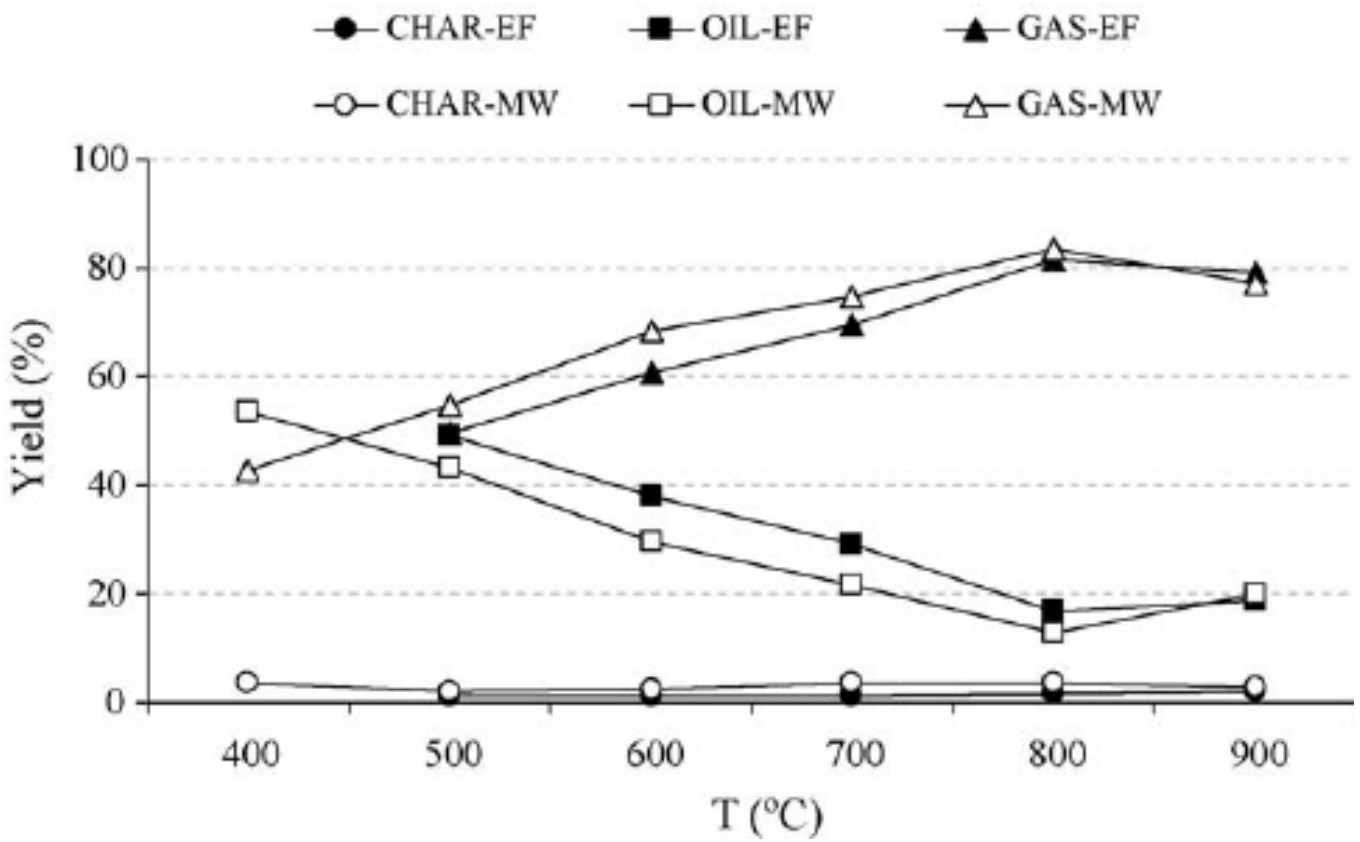


Electromagnetic Radiation on Water

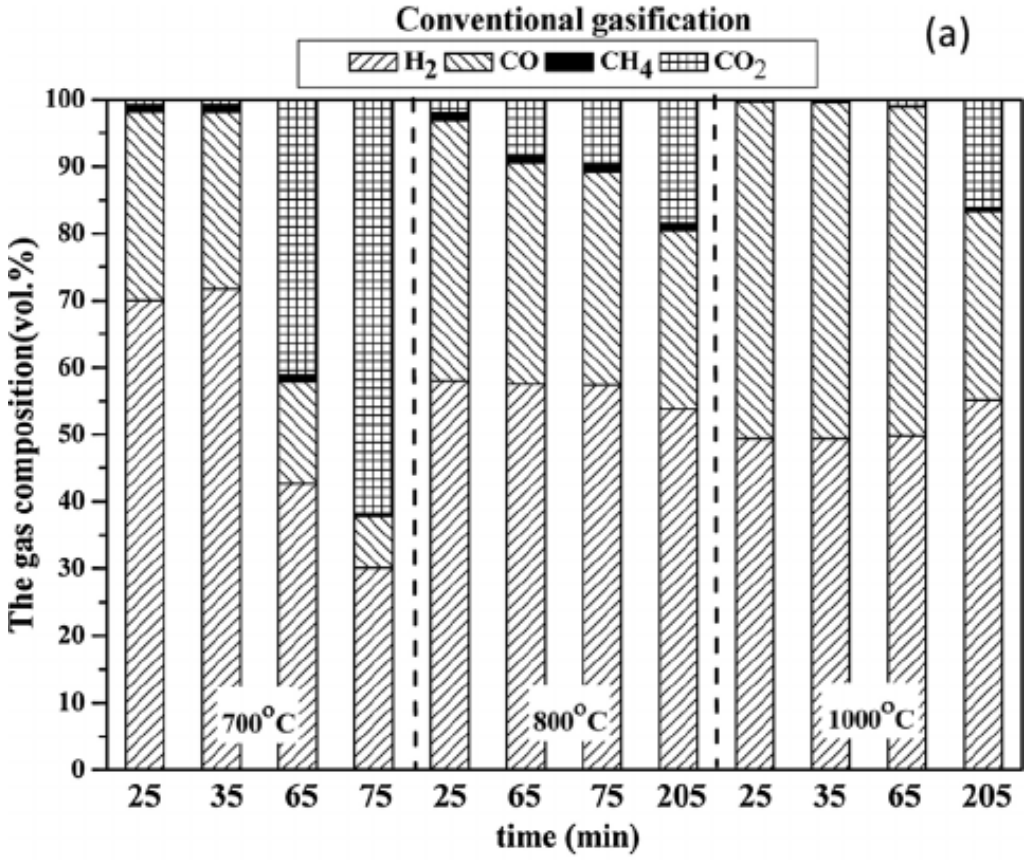


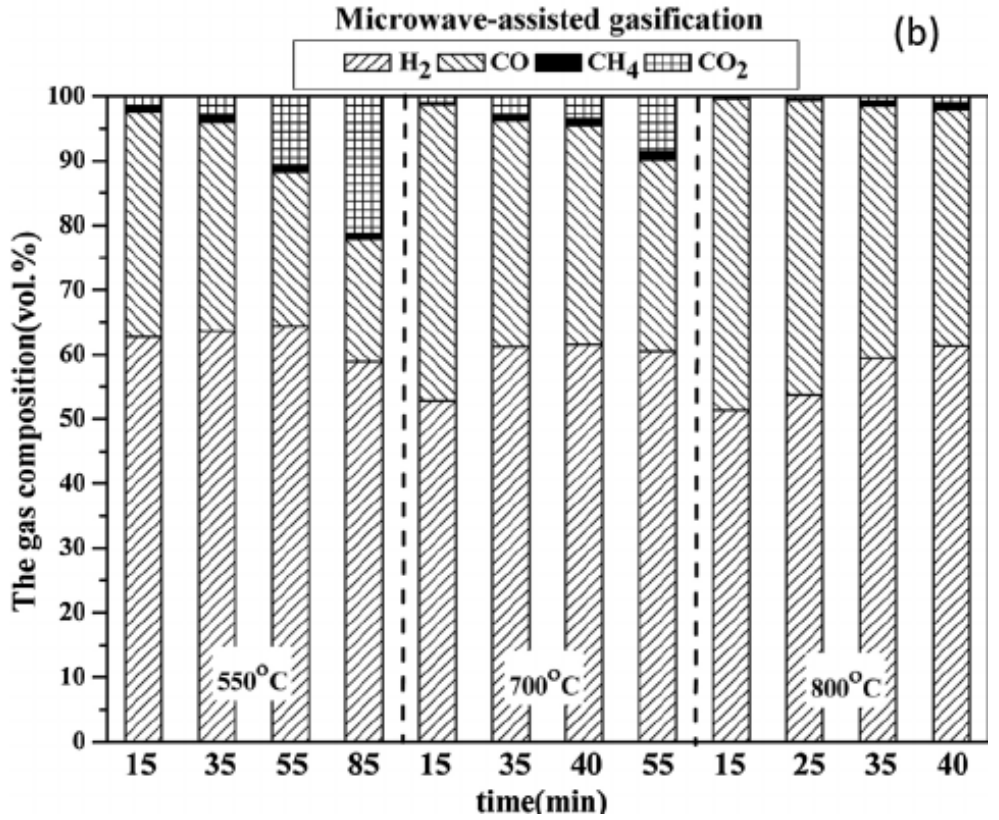


Relative Yields (Conventional VS Microwave Gasification)

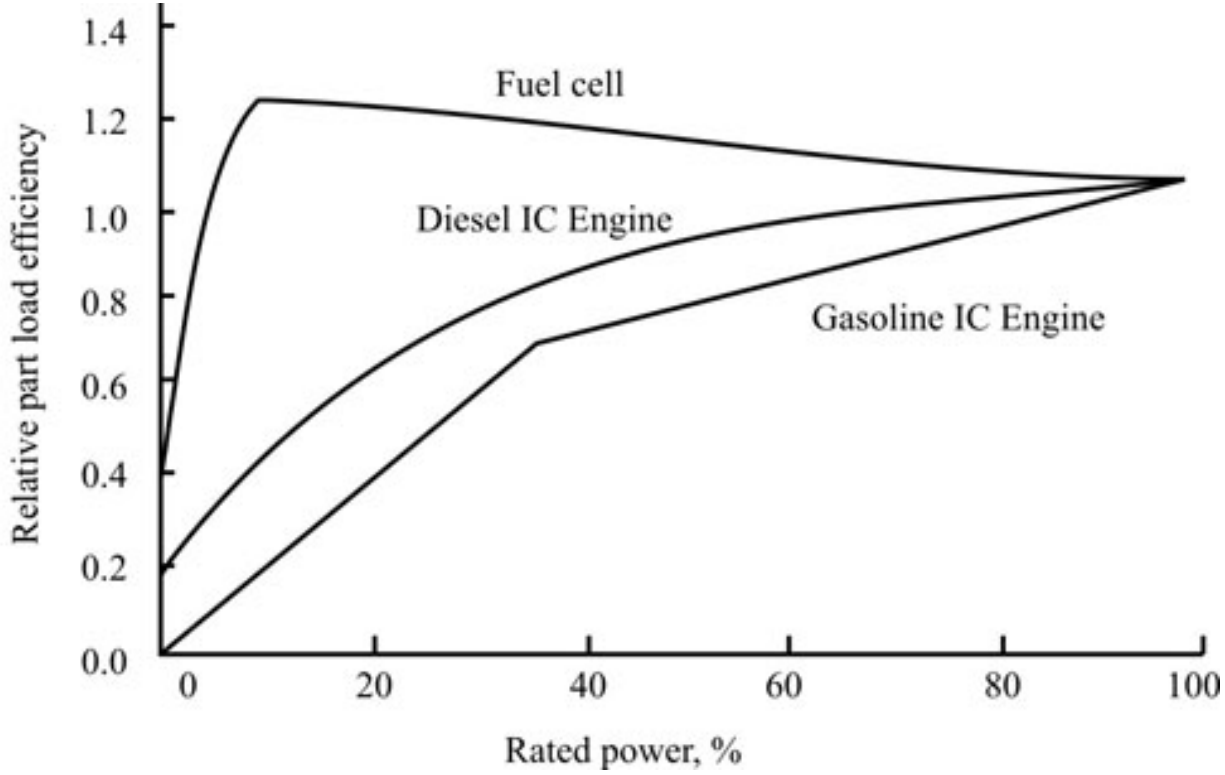


Syngas Composition (Conventional VS Microwave Gasification)

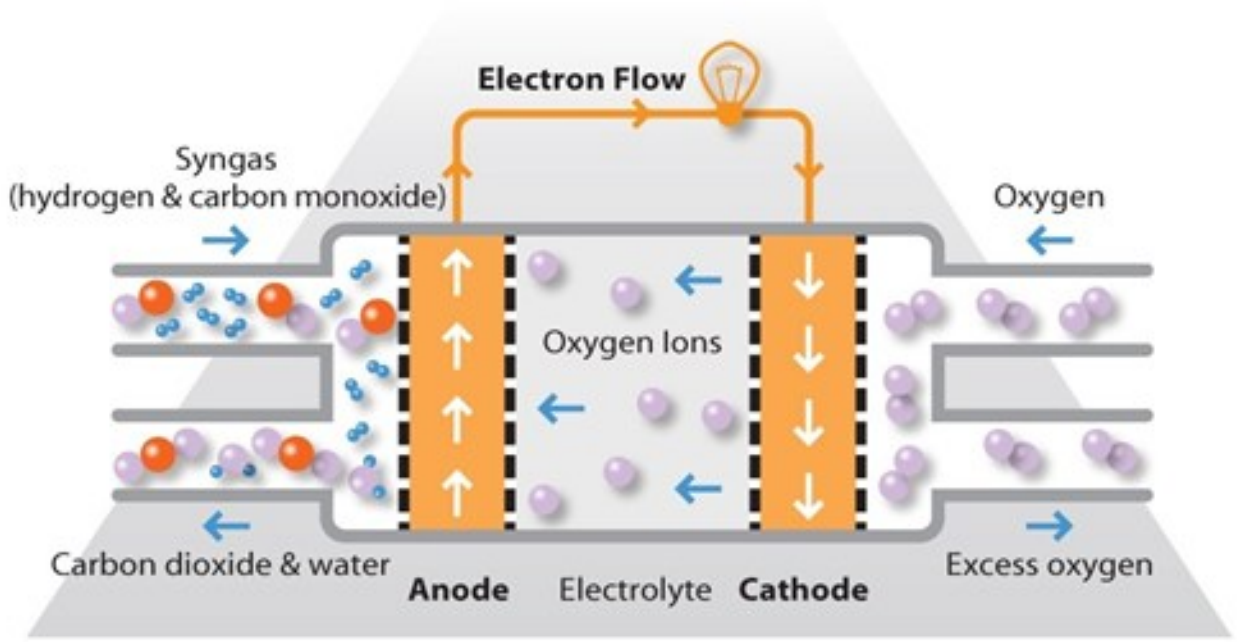




Relative Efficiency (Conventional VS Microwave Gasification)



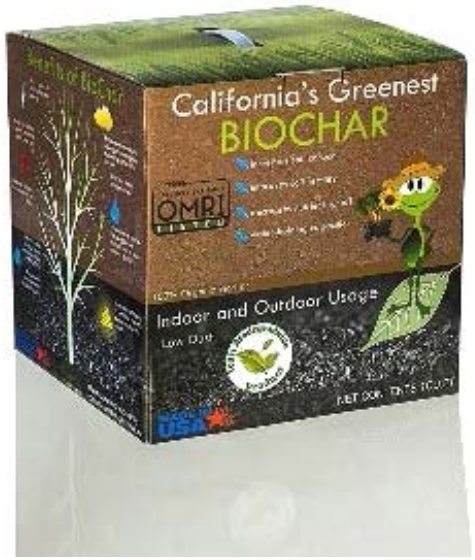
Syngas Fuel Cell

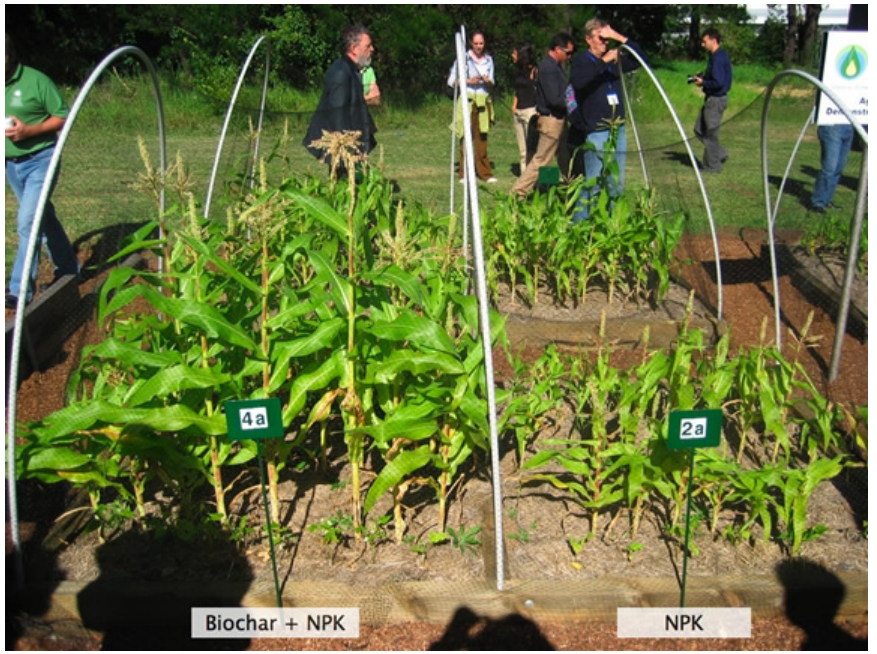


Waste By-Products

- Carbon Dioxide
- Water
- Solid Carbon
  - Biochar
  - Activated Carbon
  - Graphene Nano-Flakes

Biochar – Agricultural Soil Amendment





Biochar – Certification / Lab Analysis

OMRI Listed®

The following product is OMRI Listed. It may be used in certified organic production or food processing and handling according to the USDA National Organic Program Rule.

Product
California's Greenest BioChar

Company
Clean Green Hydrogen Power, Inc.
Johnny Lee
650 Kings Row
San Jose, CA 95112

Status	Category	Issue date
Allowed	NOP: Activated Charcoal	14-Nov-2016
Product number	**Class**	**Expiration date**
cgh-7268	Crop Fertilizers and Soil Amendments	01-Dec-2017

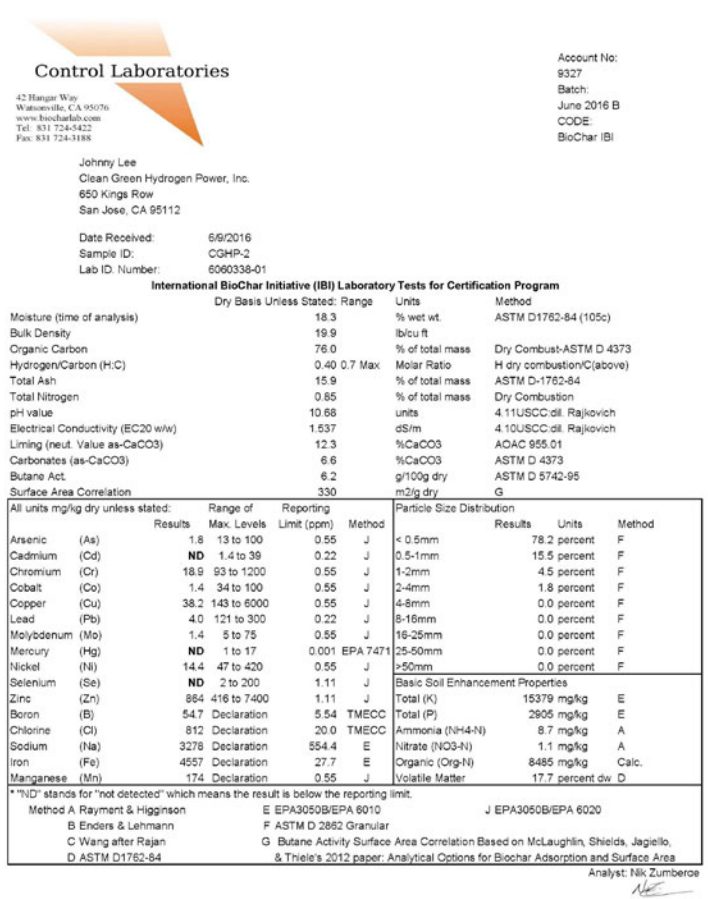
Restrictions
Not applicable.

Peggy Miars
Executive Director

Product review is conducted according to the policies in the current *OMRI Policy Manual*® and based on the standards in the current *OMRI Standards Manual*®. To verify the current status of this or any OMRI Listed product, view the most current version of the *OMRI Products List*® at OMRI.org. OMRI listing is not equivalent to organic certification and is not a product endorsement. It cannot be construed as such. Final decisions on the acceptability of a product for use in a certified organic system are the responsibility of a USDA accredited certification agent. It is the operator's responsibility to properly use the product, including following any restrictions.

OMRI LISTED For Organic Use

Organic Materials Review Institute
P.O. Box 11558, Eugene, OR 97440-3758, USA
541.343.7600 • fax 541.343.8971 • info@omri.org • www.omri.org



Control Laboratories
42 Hangar Way
Watsonville, CA 95076
www.biocharlab.com
Tel: 831 724-5422
Fax: 831 724-3188

Account No: 9327
Batch: June 2016 B
CODE: BioChar IBI

Johnny Lee
Clean Green Hydrogen Power, Inc.
650 Kings Row
San Jose, CA 95112

Date Received: 6/9/2016
Sample ID: CGHP-2
Lab ID. Number: 6060338-01

International BioChar Initiative (IBI) Laboratory Tests for Certification Program

	Dry Basis Unless Stated:	Range	Units	Method
Moisture (time of analysis)	18.3		% wet wt.	ASTM D1762-84 (105c)
Bulk Density	19.9		lb/cu ft	
Organic Carbon	76.0		% of total mass	Dry Combust-ASTM D 4373
Hydrogen/Carbon (H:C)	0.40	0.7 Max.	Molar Ratio	H dry combustion/C(above)
Total Ash	15.9		% of total mass	ASTM D-1762-84
Total Nitrogen	0.85		% of total mass	Dry Combustion
pH value	10.68		units	4.11USCC:dil. Rajkovich
Electrical Conductivity (EC20 w/w)	1.537		dS/m	4.10USCC:dil. Rajkovich
Liming (neut. Value as-CaCO3)	12.3		%CaCO3	AOAC 955.01
Carbonates (as-CaCO3)	6.6		%CaCO3	ASTM D 4373
Butane Act.	6.2		g/100g dry	ASTM D 5742-95
Surface Area Correlation	330		m2/g dry	G

All units mg/kg dry unless stated:		Results	Range of Max. Levels	Reporting Limit (ppm)	Method
Arsenic	(As)	1.8	13 to 100	0.55	J
Cadmium	(Cd)	**ND**	1.4 to 39	0.22	J
Chromium	(Cr)	18.9	93 to 1200	0.55	J
Cobalt	(Co)	1.4	34 to 100	0.55	J
Copper	(Cu)	38.2	143 to 6000	0.55	J
Lead	(Pb)	4.0	121 to 300	0.22	J
Molybdenum	(Mo)	1.4	5 to 75	0.55	J
Mercury	(Hg)	**ND**	1 to 17	0.001	EPA 7471
Nickel	(Ni)	14.4	47 to 420	0.55	J
Selenium	(Se)	**ND**	2 to 200	1.11	J
Zinc	(Zn)	864	416 to 7400	1.11	J
Boron	(B)	54.7	Declaration	5.54	TMECC
Chlorine	(Cl)	812	Declaration	20.0	TMECC
Sodium	(Na)	3278	Declaration	554.4	E
Iron	(Fe)	4557	Declaration	27.7	E
Manganese	(Mn)	174	Declaration	0.55	J

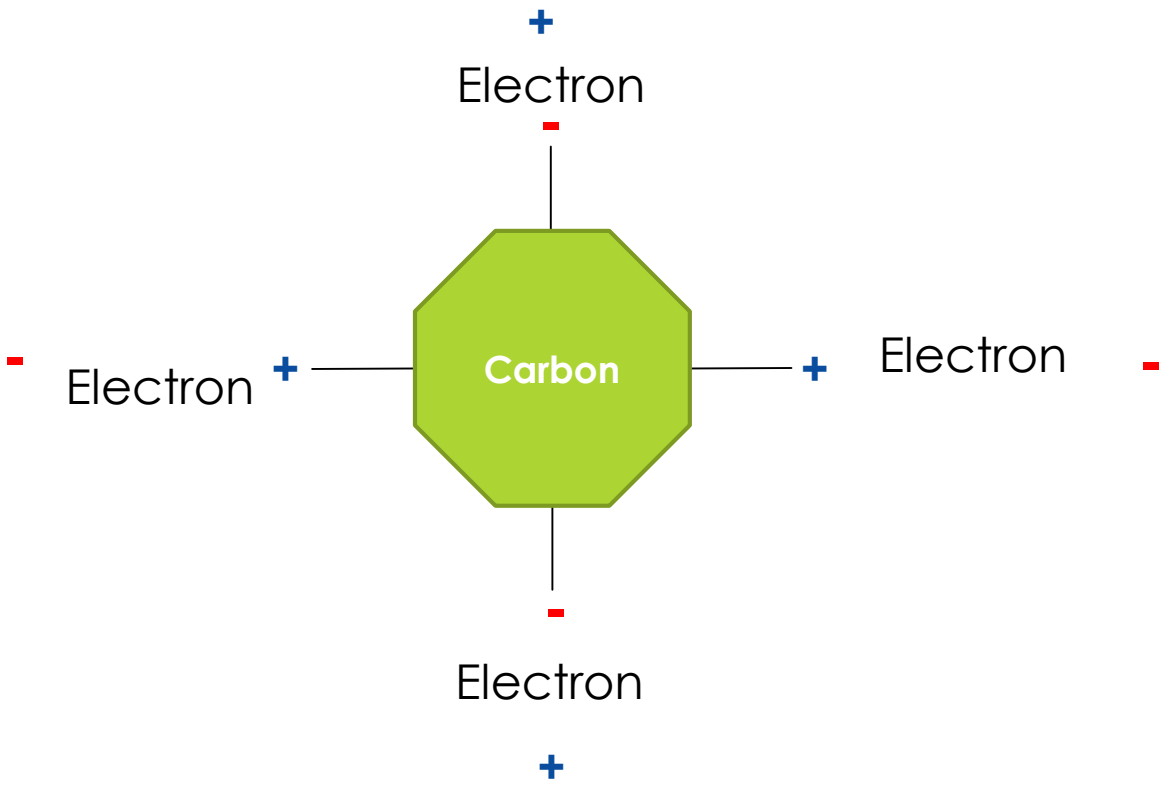
Particle Size Distribution	Results	Units	Method
< 0.5mm	78.2	percent	F
0.5-1mm	15.5	percent	F
1-2mm	4.5	percent	F
2-4mm	1.8	percent	F
4-8mm	0.0	percent	F
8-16mm	0.0	percent	F
16-25mm	0.0	percent	F
25-50mm	0.0	percent	F
>50mm	0.0	percent	F
Basic Soil Enhancement Properties			
Total (K)	15379	mg/kg	E
Total (P)	2905	mg/kg	E
Ammonia (NH4-N)	8.7	mg/kg	A
Nitrate (NO3-N)	1.1	mg/kg	A
Organic (Org-N)	8485	mg/kg	Calc.
Volatile Matter	17.7	percent dw	D

* "ND" stands for "not detected" which means the result is below the reporting limit.

Method A Rayment & Higginson
B Enders & Lehmann
C Wang after Rajan
D ASTM D1762-84
E EPA3050B/EPA 6010
F ASTM D 2862 Granular
J EPA3050B/EPA 6020
G Butane Activity Surface Area Correlation Based on McLaughlin, Shields, Jagiello, & Thiele's 2012 paper: Analytical Options for Biochar Adsorption and Surface Area

Analyst: Nik Zumberge

Electron Attractors/Donors

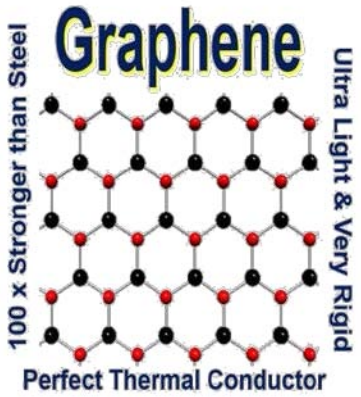


Activated Carbon (900-1800 m2/g)

Water Filtration

Air Filtration

Graphene Nano-Flakes/ Nano-tubes (2600-3200 m2/g)

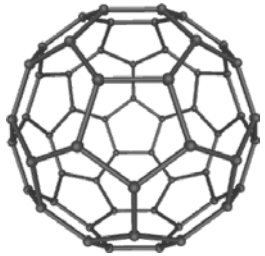


Super Conductive Wire (Engines/Electrical Transmission)

Graphene Filament (3D Printers)

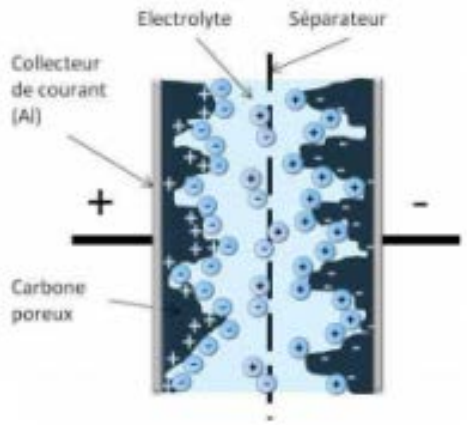
Carbon Building Materials

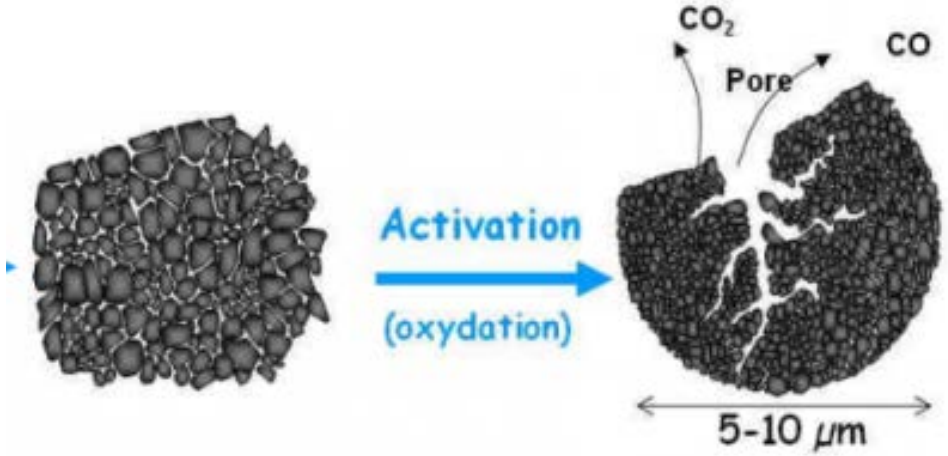
Carbon Supercapacitors (Energy Storage)



C60 Bucky Balls (Longevity)

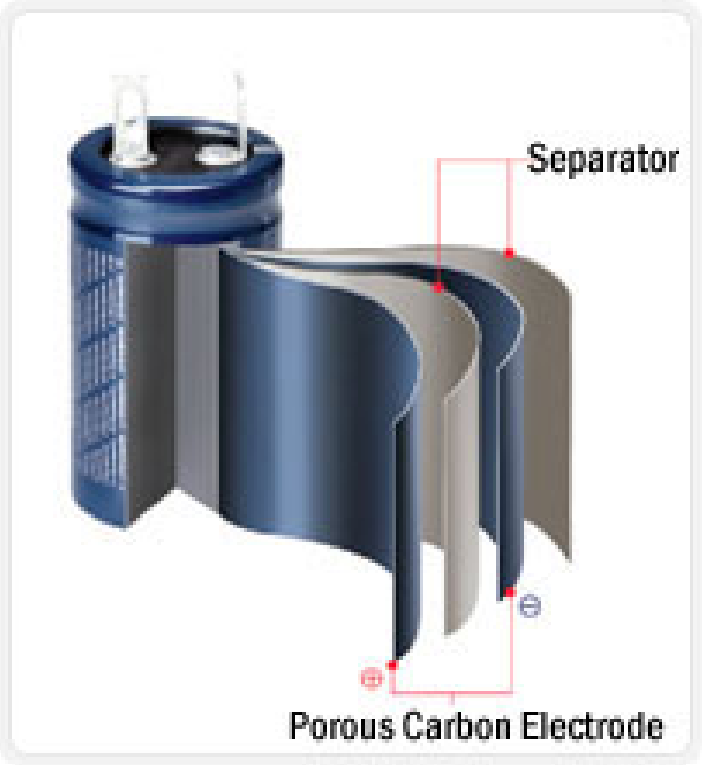
Carbon Supercapacitor



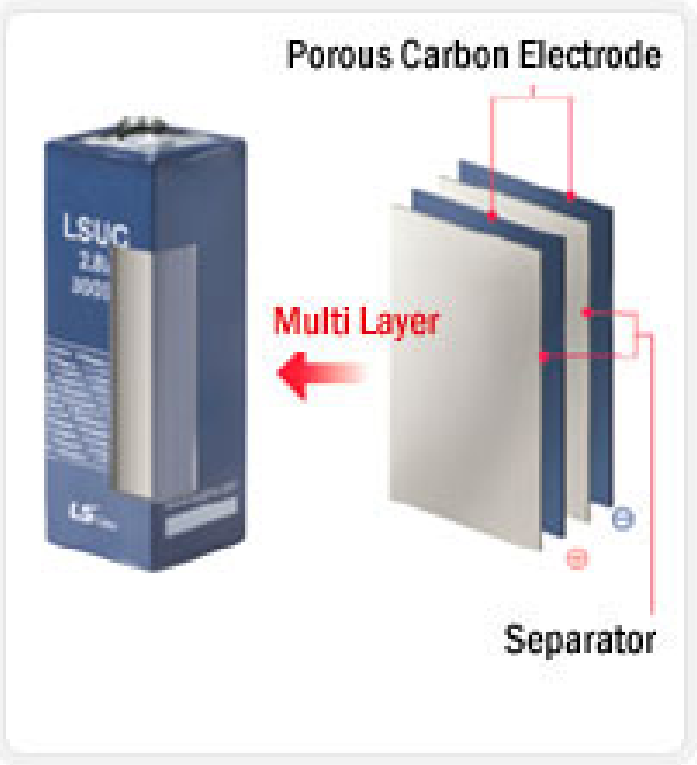


Supercapacitor

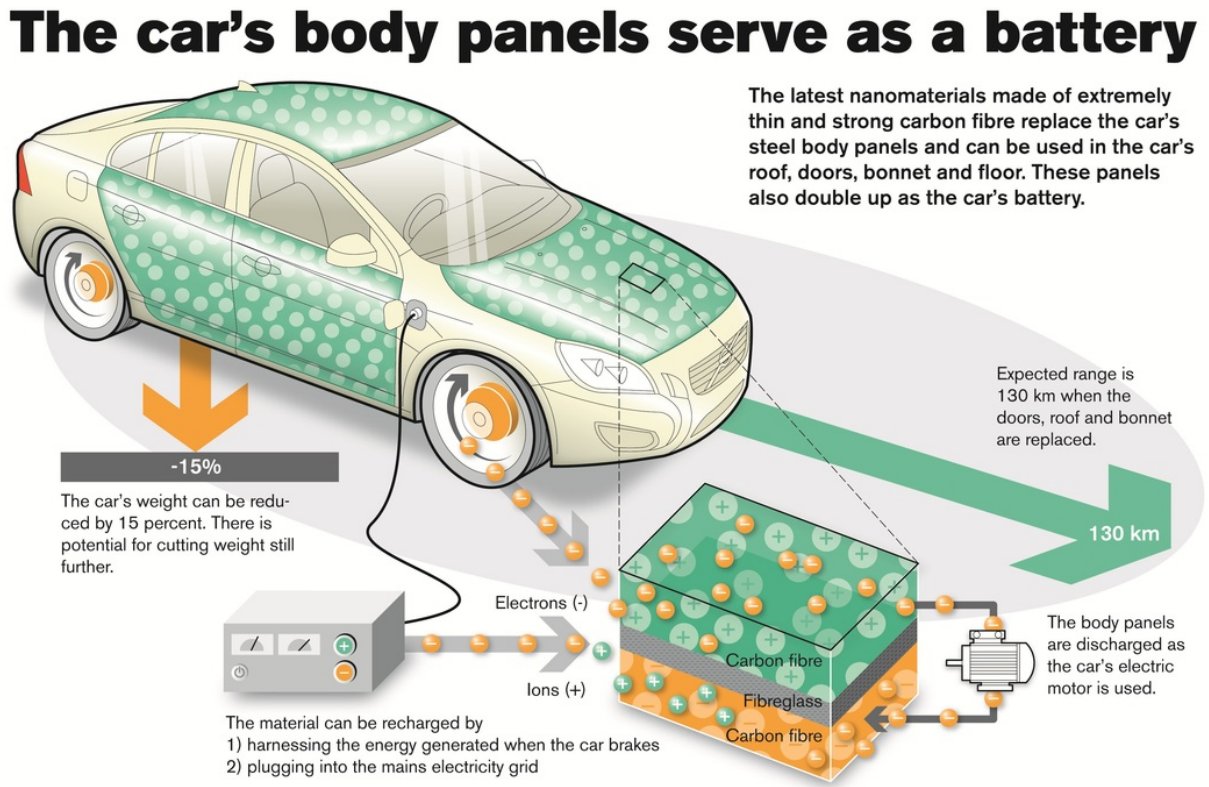
LS Ultracapacitor Cylindrical Type



LS Ultracapacitor Prismatic Type



All Carbon Vehicle



Graphene Planes

Tallest Buildings

Anti-Gravity


Scott Richard

California's Greenest

- Johnny Lee
- 650 Kings Row, San Jose, CA 95112
- johnny@californiasgreenest.com
- (408) 800-8834