



University of Ghana

PLACING ACP CORRECTLY IN THE BIO-OIL SUPPLY CHAIN

(As Contributors Of Technology And Innovation, Not Just As Feedstock Producers)

ACP Workshop On Bio-oil Supply Chain

April 3, 2013.

Presented by:-

Dr. Michael Addae-Kagyah

(Energy Research Group, Physics Department, University of Ghana)

PLACING ACP CORRECTLY IN THE BIO-OIL SUPPLY CHAIN

MOTIVATION AND OBJECTIVE

- **MOTIVATION:**

- ACP COUNTRIES HAVE BEEN HITCHING ON TO THE TAIL END OF INDUSTRIES THIS HAS RESULTED IN MANY ACP COUNTRIES BEING IMPOVERISHED.
- RECENT HISTORY HAS SHOWN THAT POOR NATIONS CAN BECOME RICH BY CORRECTLY PLACING THEMSELVES IN AN EMERGING INDUSTRY SUCH AS ICT
- BIO-OIL, AND RENEWABLE ENERGY, INDUSTRY IS STILL EMERGING AND THIS IS THE RIGHT TIME TO PITCH OUR TENTS IN ITS MAINSTREAM TECHNICAL PARTS.

- **MAIN OBJECTIVE:**

- TO SENSITIZE, CHALLENGE, AND ACTIVATE ACP SCIENTISTS, TECHNOLOGISTS ENGINEERS AND TO EMBRACE BIO-OIL PRODUCTION AS A QUICK PLATFORM FOR ACP'S SCIENTIFIC, TECHNOLOGICAL AND ECONOMIC RENAISSANCE.



PLACING ACP CORRECTLY IN THE BIO-OIL SUPPLY CHAIN

OUTLINE:

- **INTRODUCTION :**

- THE BIG PICTURE -- THE GLOBAL ENERGY SITUATION

- **RENEWABLE ENERGY SOURCES AND SYSTEMS:**

- BASIC NATURE, CONCEPTS, AND VARIETY

- **BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE:**

- NATURE, SUPPLY CHAIN, TECHNOLOGY, APPLICATIONS, AND CHALLENGES

- **PARTICIPATION IN BIO-OIL VENTURES (A SWOT ANALYSIS):**

- SWOT ANALYSIS, TECHNICAL SKILLS, CAPACITY BUILDING, AND R&D

- **CONCLUSION:**

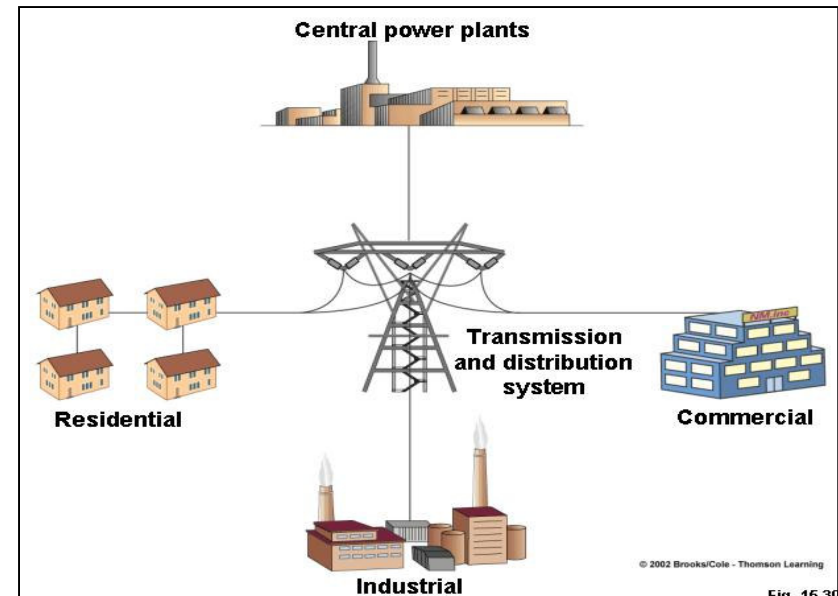
- IN THE ABUNDANCE OF WATER ... THE "WISE" IS THIRSTY!



INTRODUCTION:

THE BIG PICTURE 1 -- CURRENT GLOBAL ENERGY SITUATION

1. Energy systems based on non-renewable sources (fossil fuels, nuclear materials, etc).
2. Highly centralized power supply systems that often exclude access to the rural and poor areas.
3. Current energy systems create a lot of waste, pollution, etc.
4. Global fossil fuel reserves are diminishing at amazing rates.
5. Global oil geo-politics, and unwarranted speculation, has made fuel very costly.



INTRODUCTION:

THE BIG PICTURE 2-- GLOBAL ENERGY SITUATION-- SOME STATISTICS

Fuel type	<u>Average power in TW</u>		
	1980	2004	2006
<u>Oil</u>	4.38	5.58	5.74
<u>Gas</u>	1.80	3.45	3.61
<u>Coal</u>	2.34	3.87	4.27
<u>Hydroelectric</u>	0.60	0.93	1.00
<u>Nuclear power</u>	0.25	0.91	0.93
<u>Geothermal, wind, solar energy, wood</u>	0.02	0.13	0.16



Source: IEA/OECD, Population OECD/World Bank



INTRODUCTION:

THE BIG PICTURE 3-- GLOBAL ENERGY SITUATION -- MORE STATISTICS

Regional energy use (kWh/capita & TWh) and growth 1990-2008 (%)^{[10][11]}

	kWh/capita			Population (million)			Energy use (1,000 TWh)		
	1990	2008	Growth	1990	2008	Growth	1990	2008	Growth
USA	89,021	87,216	- 2 %	250	305	22 %	22.3	26.6	20 %
EU-27	40,240	40,821	1 %	473	499	5 %	19.0	20.4	7 %
Middle East	19,422	34,774	79 %	132	199	51 %	2.6	6.9	170 %
China	8,839	18,608	111 %	1,141	1,333	17 %	10.1	24.8	146 %
Latin America	11,281	14,421	28 %	355	462	30 %	4.0	6.7	66 %
Africa	7,094	7,792	10 %	634	984	55 %	4.5	7.7	70 %
India	4,419	6,280	42 %	850	1,140	34 %	3.8	7.2	91 %
Others*	25,217	23,871	nd	1,430	1,766	23 %	36.1	42.2	17 %
The World	19,422	21,283	10 %	5,265	6,688	27 %	102.3	142.3	39 %

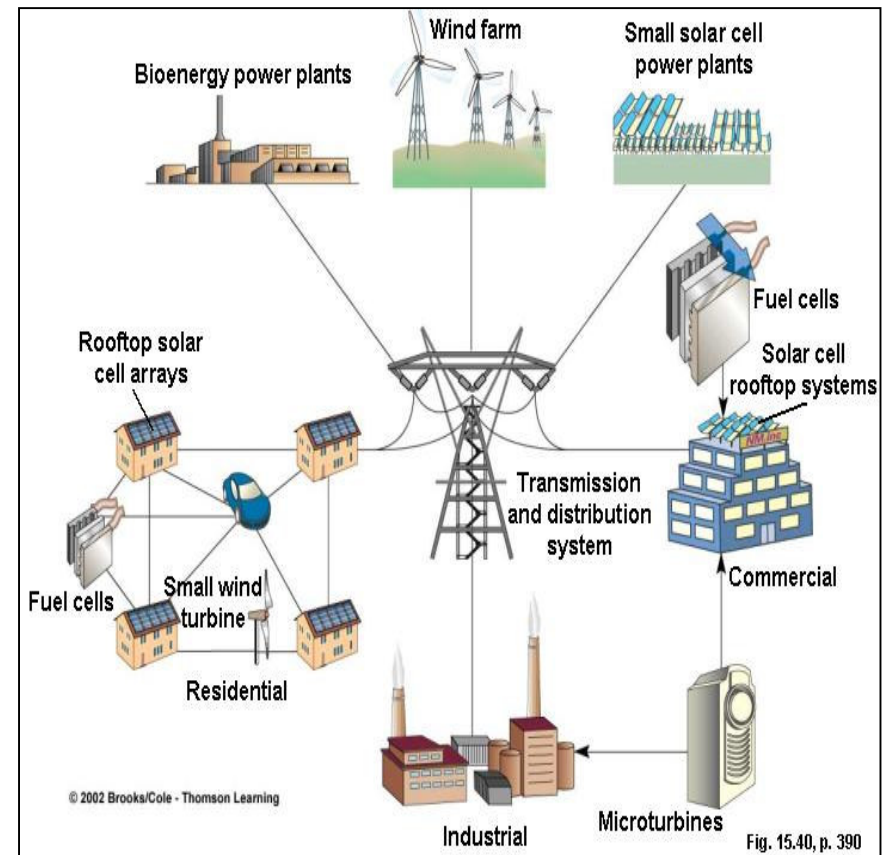
Source: IEA/OECD, Population OECD/World Bank



INTRODUCTION:

THE BIG PICTURE 4– THE DESIRED, NEW ENERGY PARADIGM

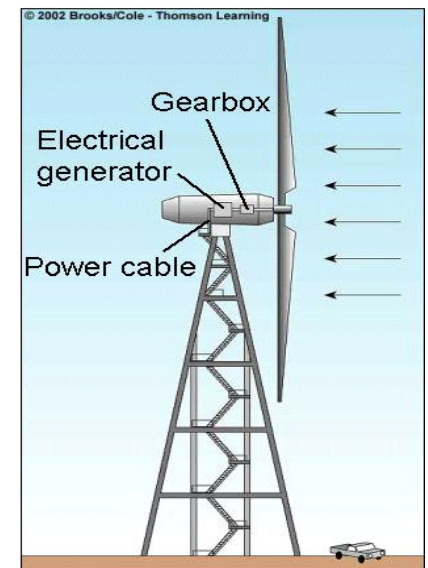
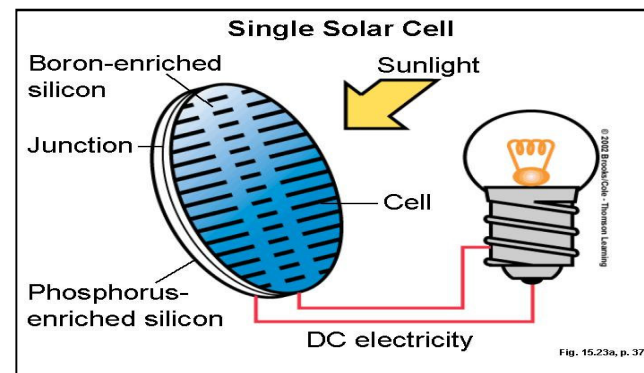
1. Energy systems based on renewable sources (biofuels, hydro, solar, wind, geothermal, tidal, etc).
2. Highly decentralized power supply systems that caters for all, even where grid connection or fuel transport is difficult, costly.
3. Production of energy at very little or no environmental cost.
4. Reduced fuel cost, and lowered influence of global oil geo-politics, and speculation.



RENEWABLE ENERGY SOURCES AND SYSTEMS: BASIC NATURE AND CONCEPT

Renewable Energy Sources are primary energy-producing resources (fuels), that come from nature, and are naturally replenished. Typical examples are the Sun, Wind, Water Bodies, etc.

Renewable Energy Systems produce energy (or power) through the use of Renewable Energy Sources.



RENEWABLE ENERGY SOURCES AND SYSTEMS: VARIETY

Variety is very wide.

Typical list of Renewable Energy Sources and Systems include:

Biomass (Bio-Waste, Bio-oil, etc)

Solar (Photovoltaic)

Solar (Thermal)

Hydro (and Micro-Hydro)

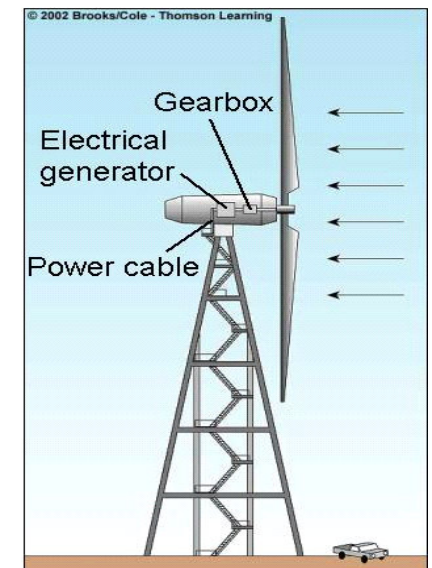
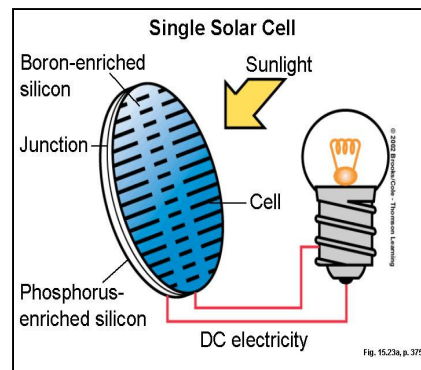
Wind Turbine

OTEC

Geothermal

Ocean (Tidal and Waves)

etc, etc.



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: NATURE AND ADVANTAGES

Bio-oil is a viable renewable energy source. Most importantly, It is a second generation bio-fuel produced from non-food feedstock.

The unique main advantages of bio-oil extraction and use include:

It is a liquid that can be stored and transported.

It can be use for fuel as well as stock in chemical production.

Fast Pyrolysis Liquid

Bio-oil is water miscible and is comprised of many oxygenated organic chemicals.

- Dark brown mobile liquid,
- Combustible,
- Not miscible with hydrocarbons,
- Heating value ~ 17 MJ/kg,
- Density ~ 1.2 kg/l,
- Acid, pH ~ 2.5,
- Pungent odour,
- “Ages” - viscosity increases with time



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: SUPPLY CHAIN



Renewable Energy Systems
Biomass is then fed into
pyrolysis reactors, then the bio-oil is supplied to various
Apps



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: TECHNOLOGY

Fast Pyrolysis of Biomass

Fast pyrolysis is a thermal process that rapidly heats biomass to a carefully controlled temperature (~500°C), then very quickly cools the volatile products (<2 sec) formed in the reactor

- Offers the unique advantage of giving a liquid that can be stored and transported.
- Has been developed in many configurations
- At present is at relatively early stage of development

Process Requirements

Drying

- <10% moisture. Feed and reaction water end up in bio-oil

Comminution

- -2mm (bubbling bed),
-6 mm (CFB)

Fast pyrolysis

- High heat rate, controlled T, short residence time

Char separation

- Efficient char separation needed

Liquid recovery

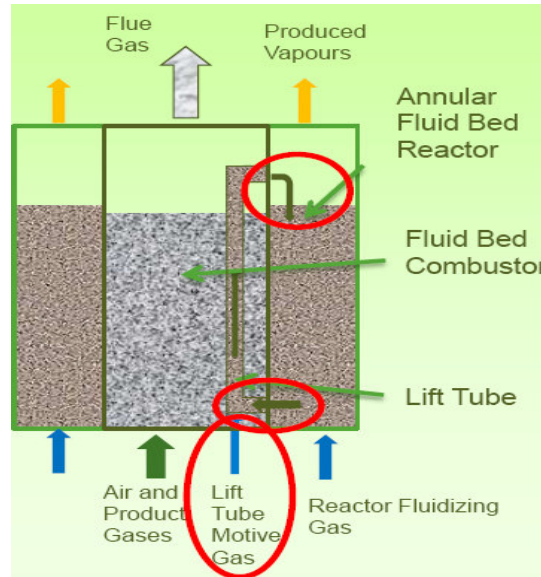
- By condensation and coalescence.



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: TECHNOLOGY

Operational Pyrolysis Units

Fluid beds	400 kg/h at Dynamotive 250 kg/h at Wellman (UK) 20 kg/h at RTI Many research units
CFBs	1000 kg/h at Red Arrow (Ensyn) 20 kg/h at VTT (Ensyn)
Rotating cone	120 kg/h at BTG (Netherlands)
Vacuum	3500 kg/h at Pyrovac
Others	350 kg/h (Fortum, Finland)

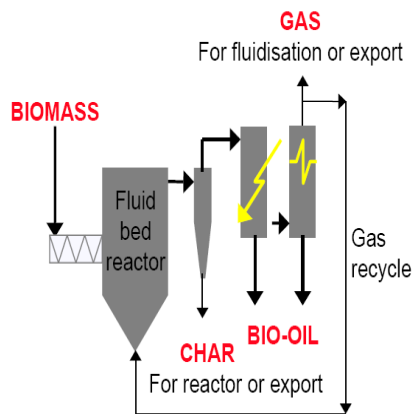


Bubbling Fluid Bed

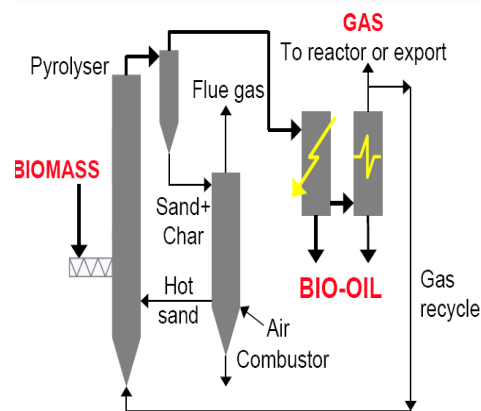


250 kg/h pilot plant at Wellman, UK

Bubbling Fluid Bed Pyrolysis

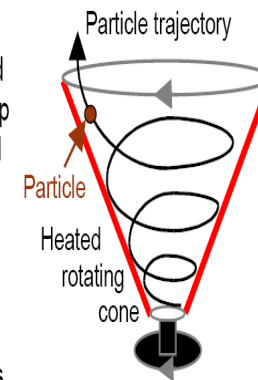


Circulating Fluid Beds



Rotating Cone (BTG)

- Centrifugation drives hot sand and biomass up rotating heated cone;
- Vapors are condensed;
- Char is burned and hot sand is recirculated.



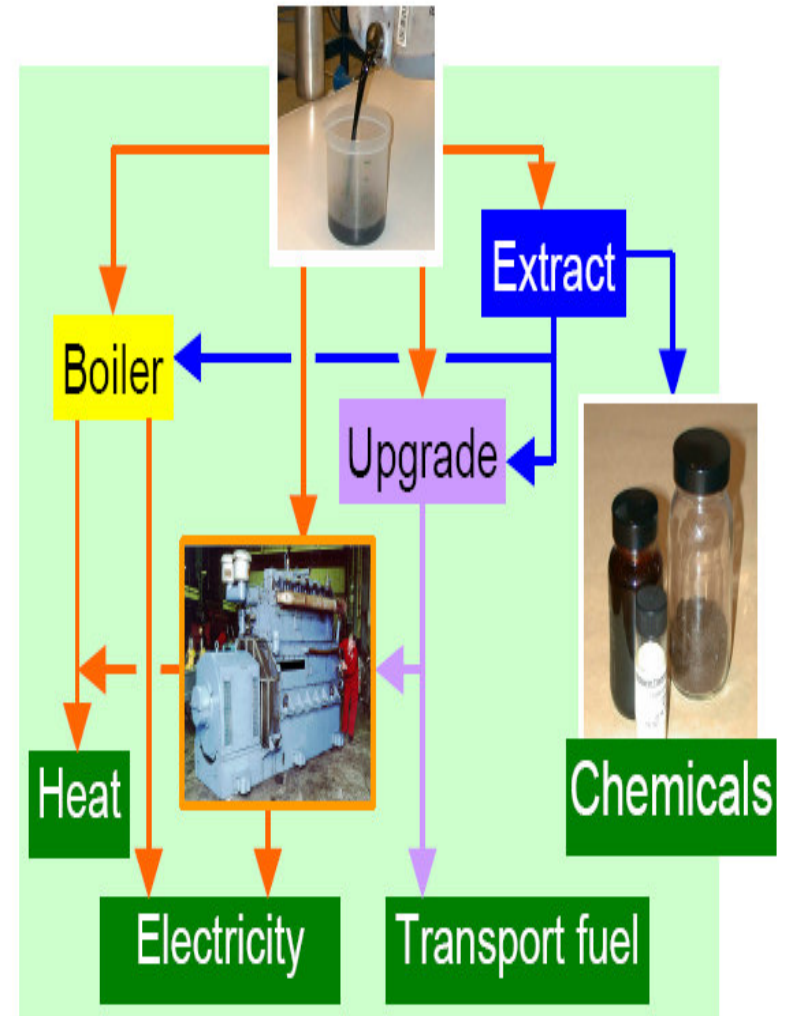
Agri-Therm unit: Mobile Pyrolysis



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: APPLICATIONS

Demonstrated Applications

Electricity	diesel, turbine, Stirling;
Heat	CHP and boiler;
Transport fuels	upgrading, emulsions;
Bulk chemicals	e.g. resins, fertilizers;
Fine chemicals	e.g. levoglucosan



BIO-OIL AS A VIABLE RENEWABLE ENERGY SOURCE: CHALLENGES

Many challenges including:

- Scale-up,
- Cost reduction,
- Better oil quality,
- Norms and standards for bio-oil,
- Information dissemination.

What Is Needed?

- Process development to improve product quality, reduce costs,
- Research into improving product quality including setting norms and standards for producers and users,
- Environment health and safety issues in handling, transport and usage,
- Encouragement for developers to implement processes; and users to implement applications.



SWOT ANALYSIS :

STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS (SWOT) MATRIX

The SWOT Matrix

	Strengths	Weaknesses
Opportunities	S-O strategies	W-O strategies
Threats	S-T strategies	W-T strategies



CONCLUSION:

IN THE ABUNDANCE OF WATER ... THE “WISE” IS THIRSTY!

- 1. Renewable energy sources (including biomass) are ubiquitous & cheap.**
- 2. Wherever one finds himself he would be right in the middle a one kind of renewable source, because of the wide variety.**
- 3. The world would never adequately make use of these resources if they are to depend on governments.**
- 4. We must be bold in developing systems. The time to act is NOW!**
- 5. We should not allow ourselves to be described by the words of the Late Bob Marley, thus:
“IN THE ABUNDANCE OF WATER ... THE “WISE” IS THIRSTY”.**



REFERENCES AND STATISTICS & PHOTO CREDITS:

- 1. US Department of Energy**
- 2. OPEC.**
- 3. International Energy Agency**
- 4. National Renewable Energy Laboratory (USA)**
- 4. The World Bank**



ACKNOWLEDGEMENT

**Thanks To ACP OC, The Physics Department, University of Ghana
and the US Department of Energy, and the Audience.**

