ASPA SEMINAR 2021

BIOECONOMY FOR A LIVING AND BIODIVERSE COLOMBIA:

TOWARDS A KNOWLEDGE DRIVEN SOCIETY

For the industry and the academia

ORGANIZED BY:

AspA
Asociación Antioqueña de Profesionales con Estudios en Alemania

DAAD
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Biomasa y carbón Alternativas Limpias Para El Desarrollo De Colombia

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Red ABISURE

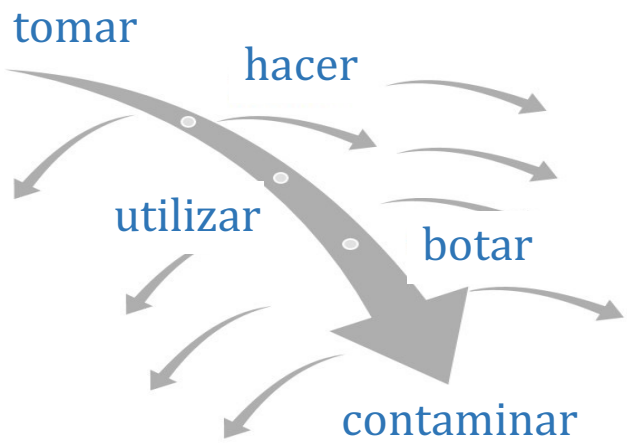
Agenda

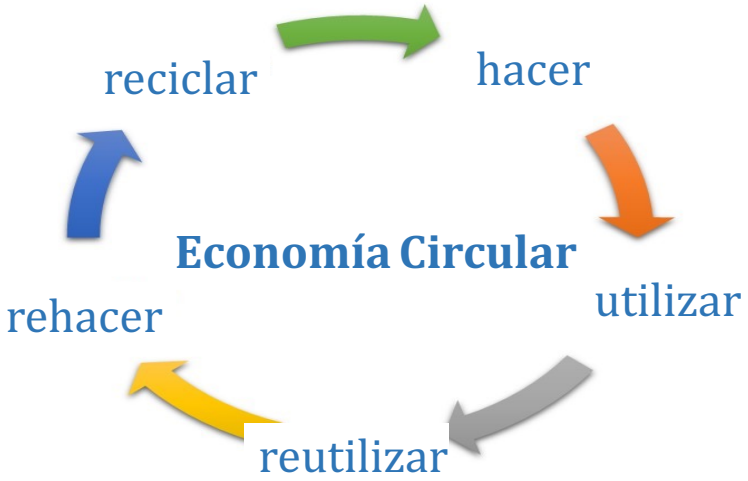
1. Introducción: Qué nos motiva hacer las cosas?
2. Qué tenemos?
3. En qué consiste lo que tenemos?
4. Cómo lo haríamos?
5. Comentarios finales

1. Introducción: Qué nos motiva hacer las cosas?


EFECTOS
Contaminación
Deforestación
Desequilibrio
Problema
Vulnerabilidad del sistema de suministro de energía confiable y sustentable,
Tecnología
Proyectos no rentables
Complementariedad
CAUSAS

Energías Limpias y Economía Circular





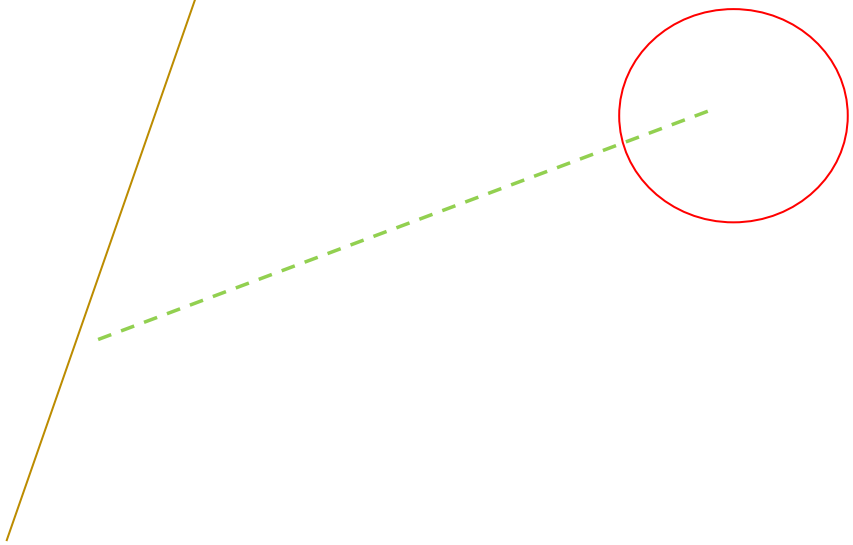
Energía y desarrollo económico social en un país

Existe correlación directa entre la energía y el crecimiento económico, desarrollo científico, tecnológicos y calidad de vida de una sociedad.

Transición energética

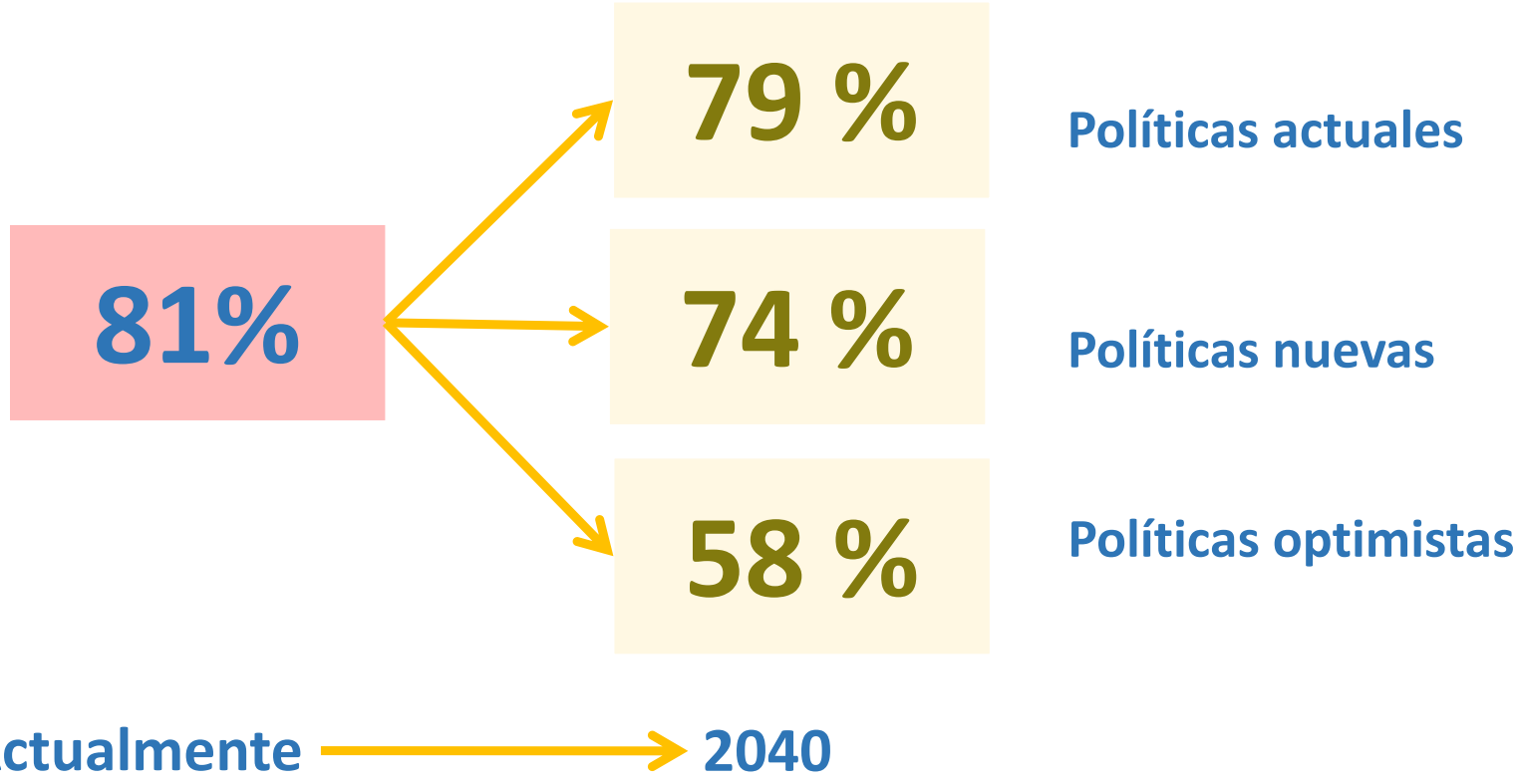
Consumo mundial de energía por recurso energético

Decisión de China a apostar por Solar FV



Tomado de: International Energy Outlook 2017, US EIA. https://www.eia.gov/outlooks/ieo/pdf/0484(2017).pdf

Los combustibles fósiles conservarán una participación relevante en la canasta energética mundial



investigación de alto nivel para

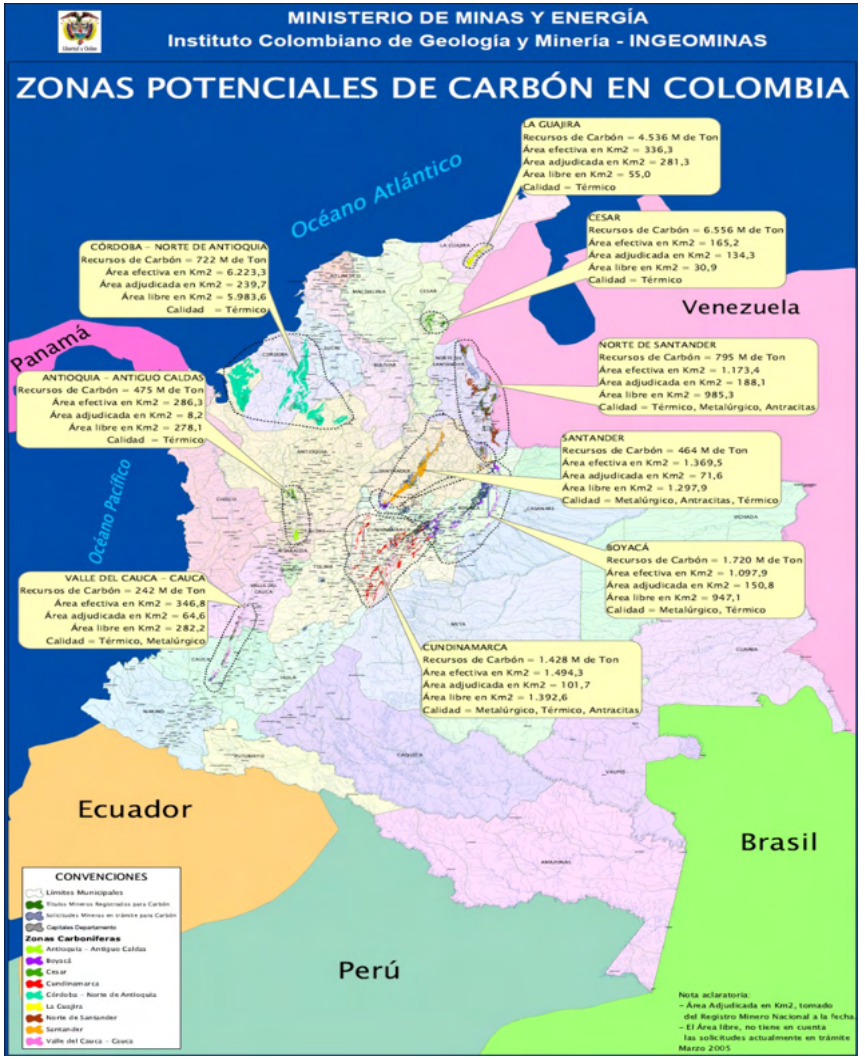
- Dar valor agregado a la biomasa y al carbón.
- Captura de CO2

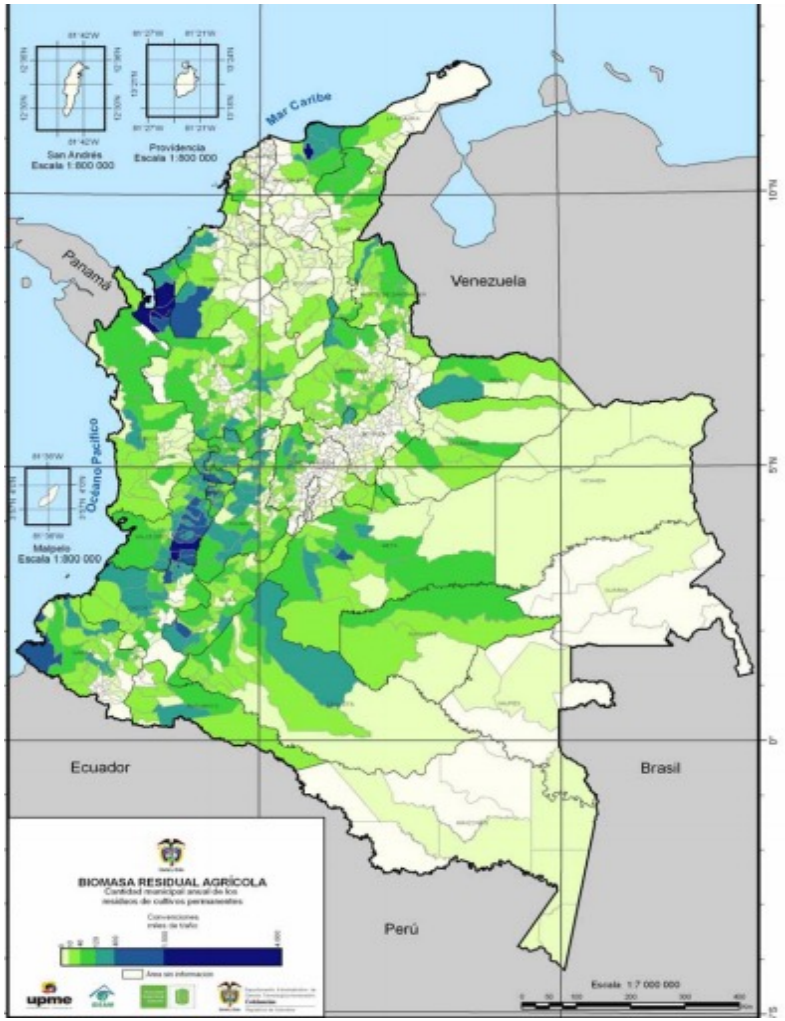
El carbón sigue participando de manera significativa.

El sector farmacéutico, el alimentario y el agropecuario son nichos de oportunidades.

2. Qué tenemos?

Reservas por más de 300 años y parte de ellas se explotan sin valor agregado





Alto potencial energético de la biomasa residual en Colombia, UPME 2013

Biomasa: Recurso Potencial en Colombia

Residuos lignocelulósico

Residuos de ganado

Residuos urbanos

Residuos agroindustriales

WWF ONG

WWF ONG

CENICAFÉ

UPME

Residuos Miles TON/año

Residuos de arroz	**360**
Residuos de palma de aceite	**460**
Residuos de banano	**78**
Residuos de plátano	**180**
Residuos de cacao	**40**

Residuos de café	
Miles TON/año	GJ/año
200	**3.3**

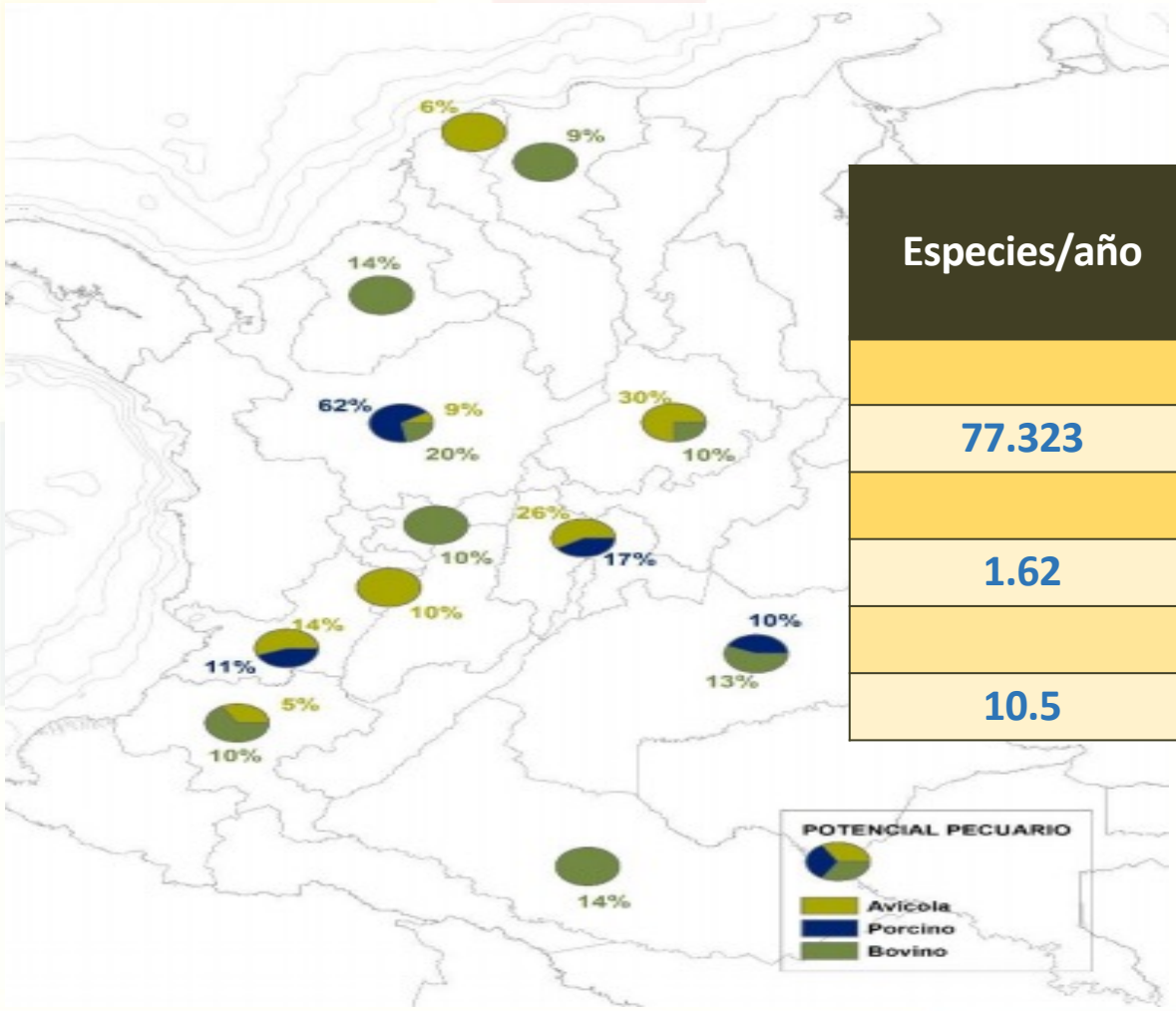
Residuos palma	
miles Ton/año	GJ/año
5600	73.72

Residuos en una planta de beneficio

Tusa	20.22 %
Fibra	13.65 %
Cuesco	5.63 %
Cenizas	0.53 %
Lodos	0.02 m^3/ton
Efluentes	0.8 m^3/ton
Biogás	0.2 m^3/ton

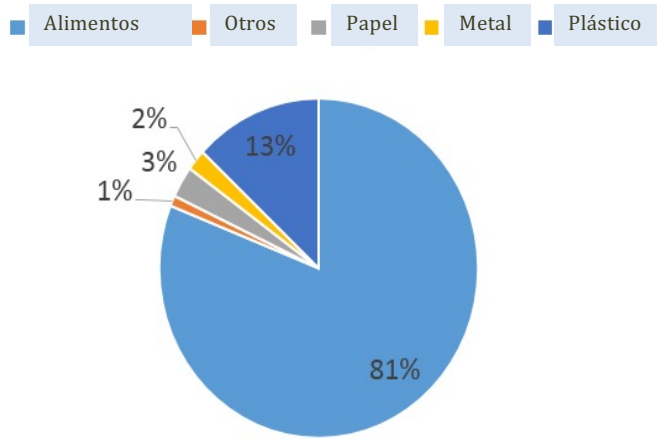
Biogás MWh/día	**Total** MWh/día	**Tusa** MWh/día
54.75	188.37	94.185

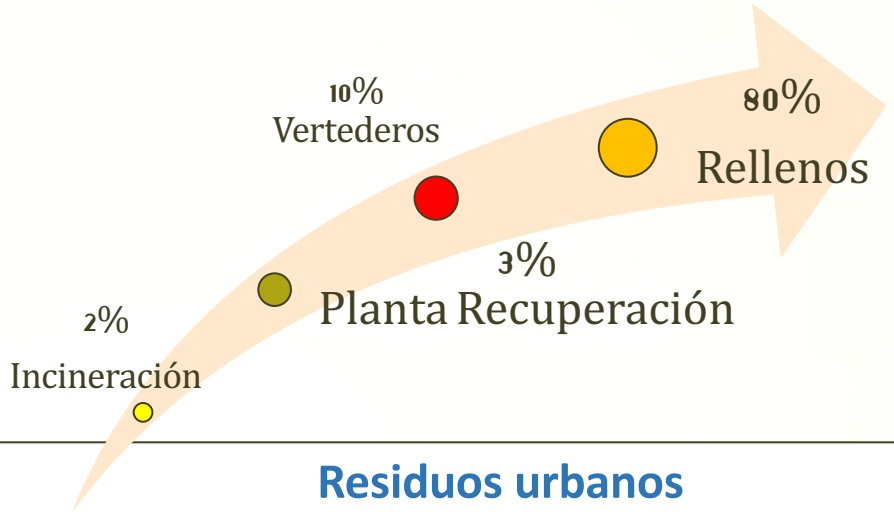
CELSIA



Especies/año	Estiércol (TON/año)	TJ/año
Industria avícola		
77.323	2440	17900
Industria porcina		
1.62	1320	2000
Industria bovina		
10.5	108000	41000

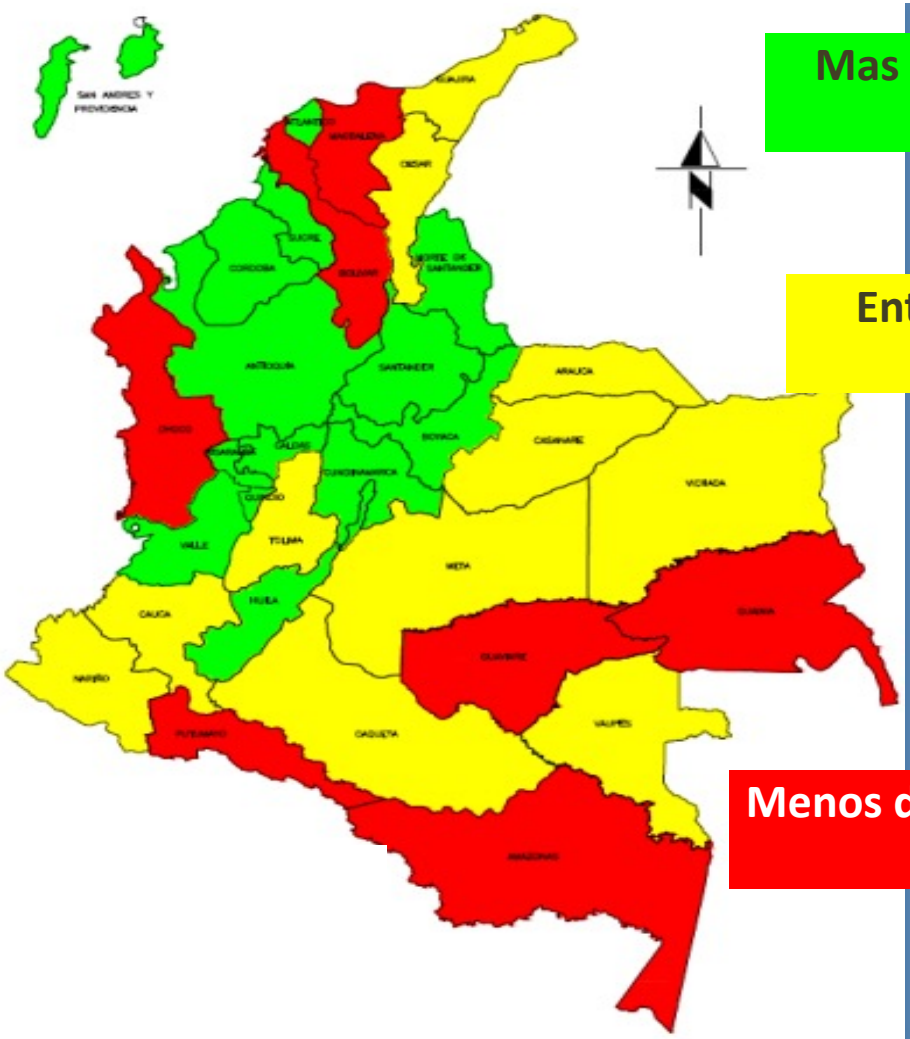
Fuente: UPME, 2018. Estrategias y planes indicativos para impulsar la bioenergía en Colombia.
https://www.ccc.org.co/bion/wp-content/uploads/pdf/27-abril-2018/RicardoHumbertoRamirezUPME.pdf





Residuos urbanos (desechos orgánicos)

Residuos urbanos (desechos orgánicos)			
Ciudad	**Población**	**Ton/año**	**TJ/año**
Bogotá	8.000.000	37000	35.96
Medellín	3.500.000	16000	11.70
Cali	3.000.000	20000	17.74
Barranquilla	2.000.000	10000	5.18
Bucaramanga	1.000.000	10000	2.00
Cartagena	1.000.000	1300	0.87



Mas del 90% disponen los desperdicios en lugares autorizados

Entre el 60%-90% disponen los desperdicios en lugares autorizados

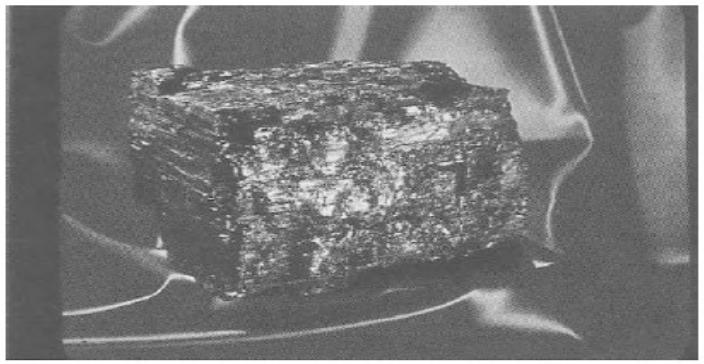
Menos del 60% disponen los desperdicios en lugares autorizados

Fuente:UPME

3. En qué consiste lo que tenemos?

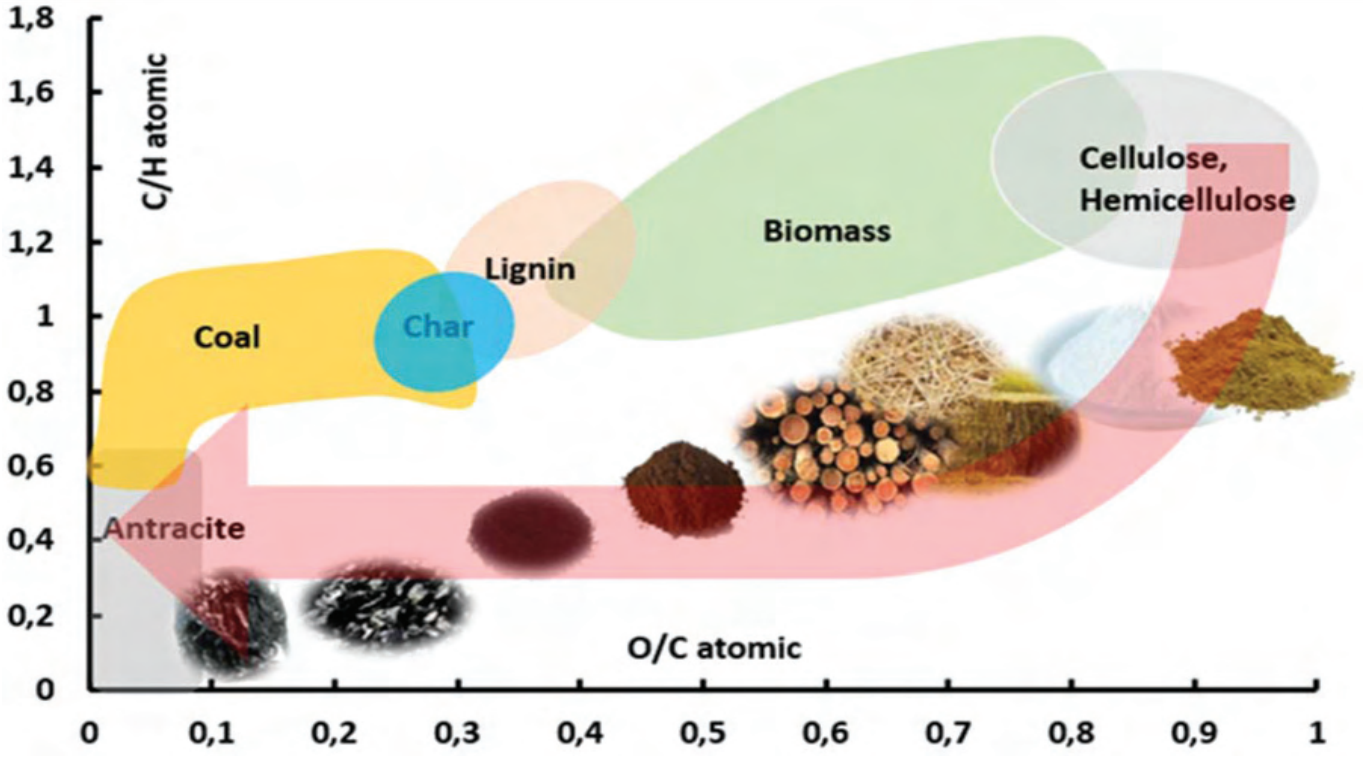
Buscar oportunidades de nuestros recurso para una economía sana y socialmente rentable:

Carbón



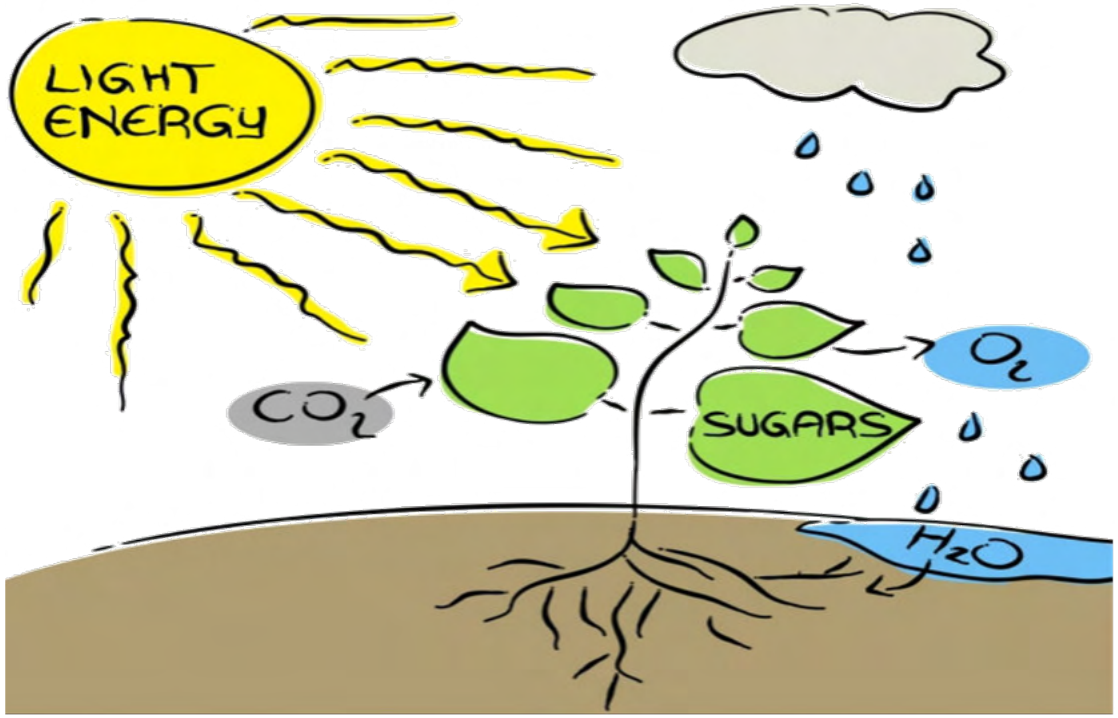
Biomasa

Diagrama de Van Krevelen.

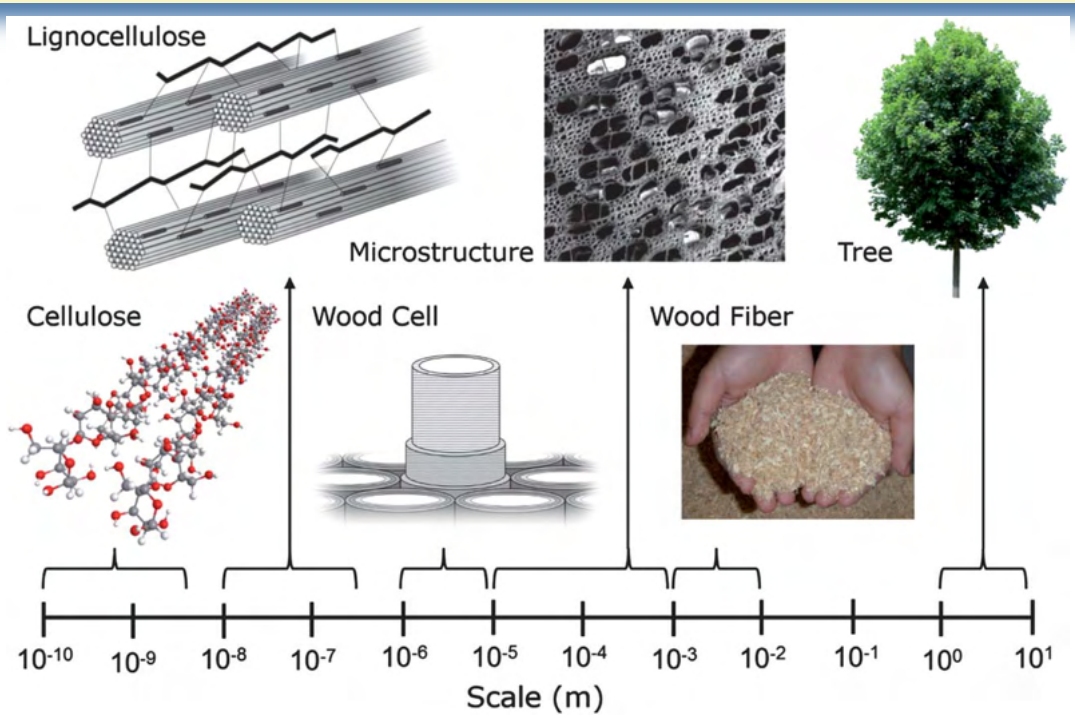


Source: Brennan et al, Green Chemistry, The Royal Society of Chemistry 2019

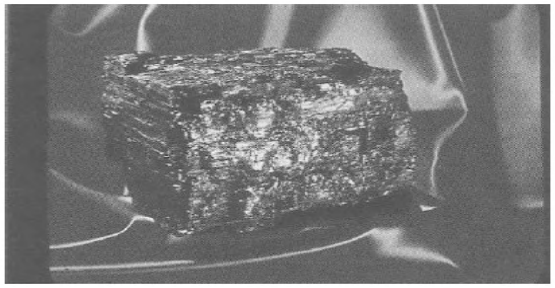
Biomasa: Producto de la fotosíntesis.



Biomasa, su complejidad está relacionada con la escala:



Adapted from: Alonso,et al , Chem. Soc. Rev. 41 (2012) 8075–98.



Carbón son cadenas desordenadas de grafenos

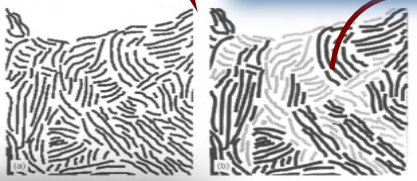
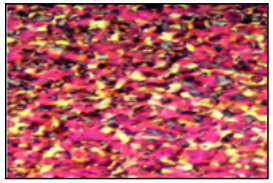


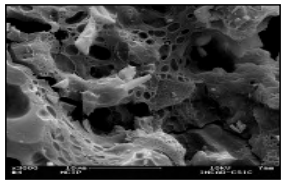
Figure 2.7. Drawings to illustrate the essential differences between (a) graphitizable and (b) non-graphitizable carbons (Franklin, 1950, 1951).

Carbón para producir:

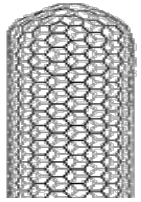
- **Gas Combustible**: Metano, syngas.
- **Líquidos**: **diesel,** metanol, amoníaco and químicos.
- **Sólidos**: Carbón activado, fibras, nanotubos, fulerenos, diamantes, grafenos, grafitos, carbono negro.



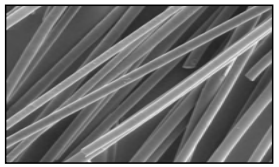
Carbones activados



Coques



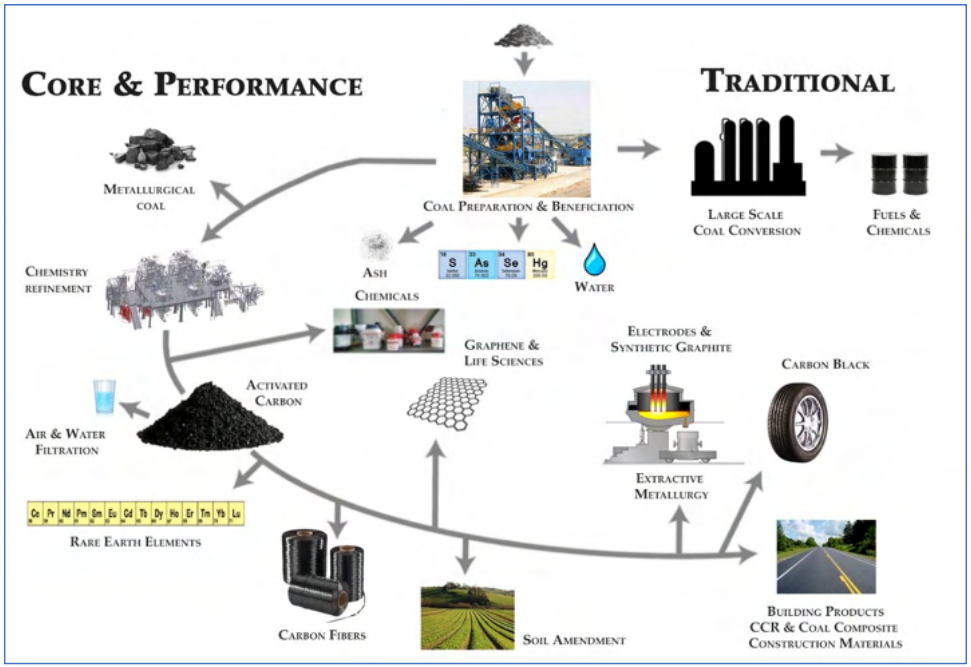
Nanotubos



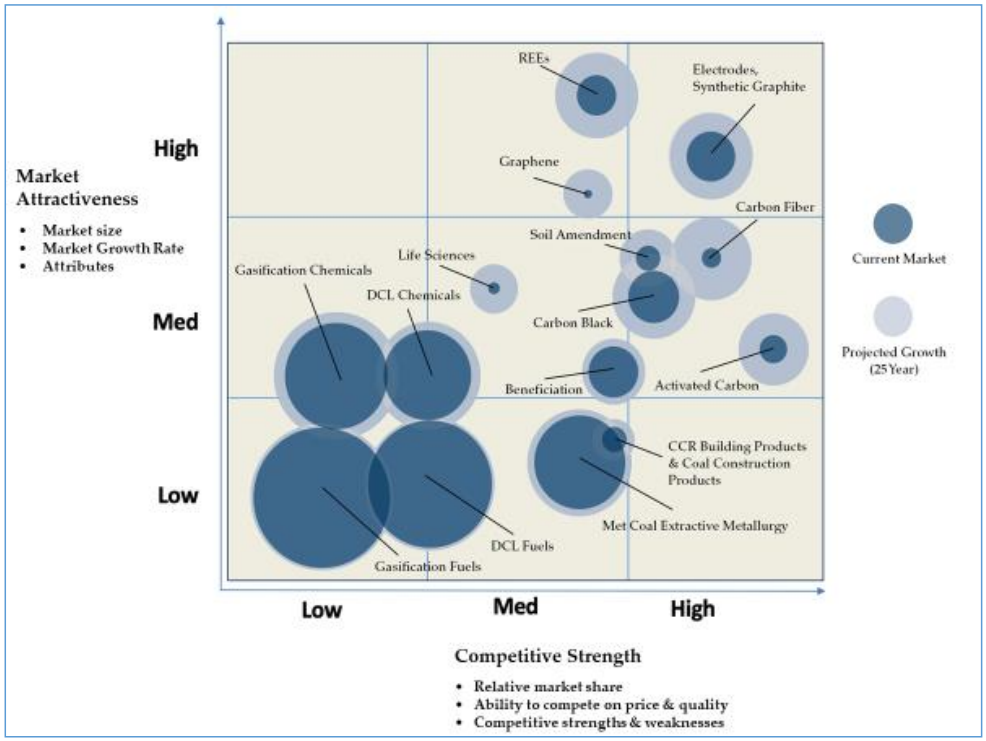
Fibras

4. Cómo lo haríamos?

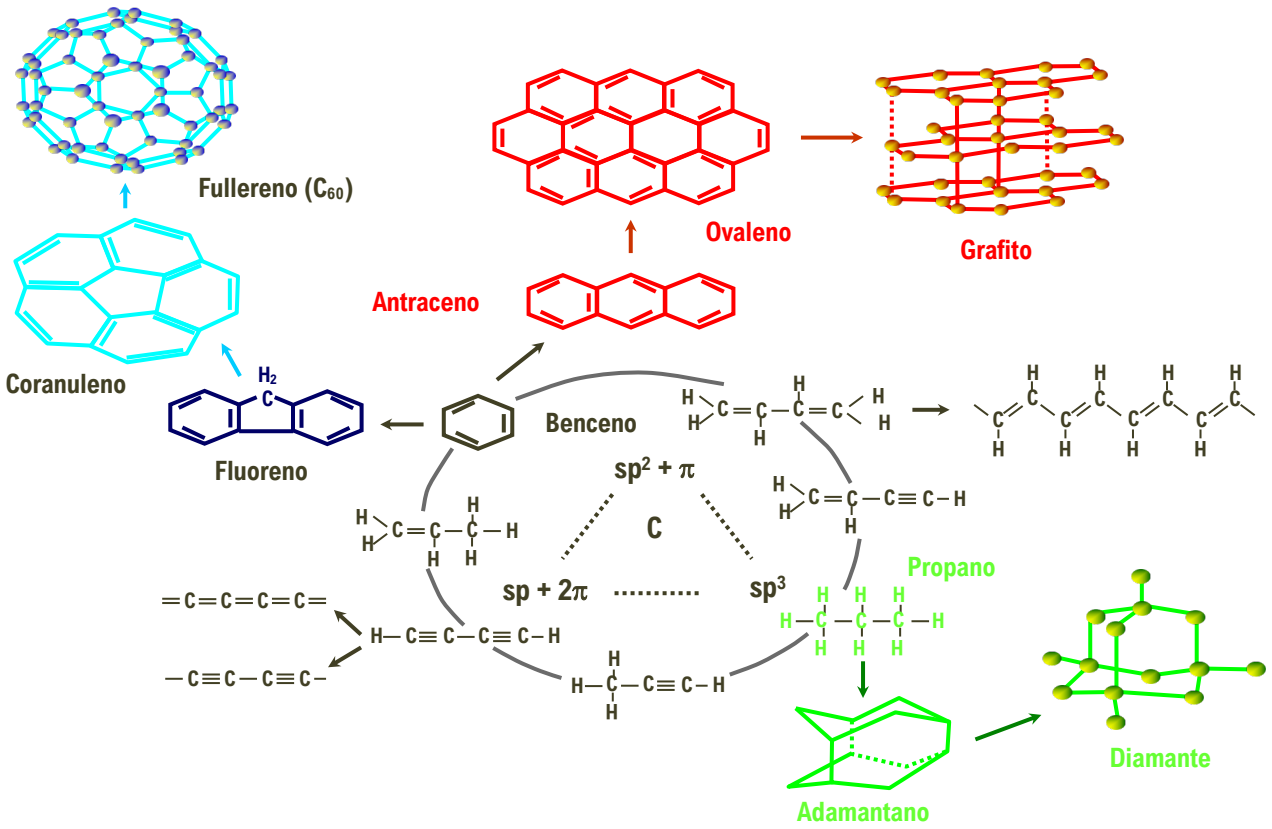
TRADITIONAL – Low Market Attractiveness-Low Competitive Strength
CORE – Medium Market Attractiveness-High Competitive Strength
PERFORMANCE – High Market Attractiveness-High Competitive Strength

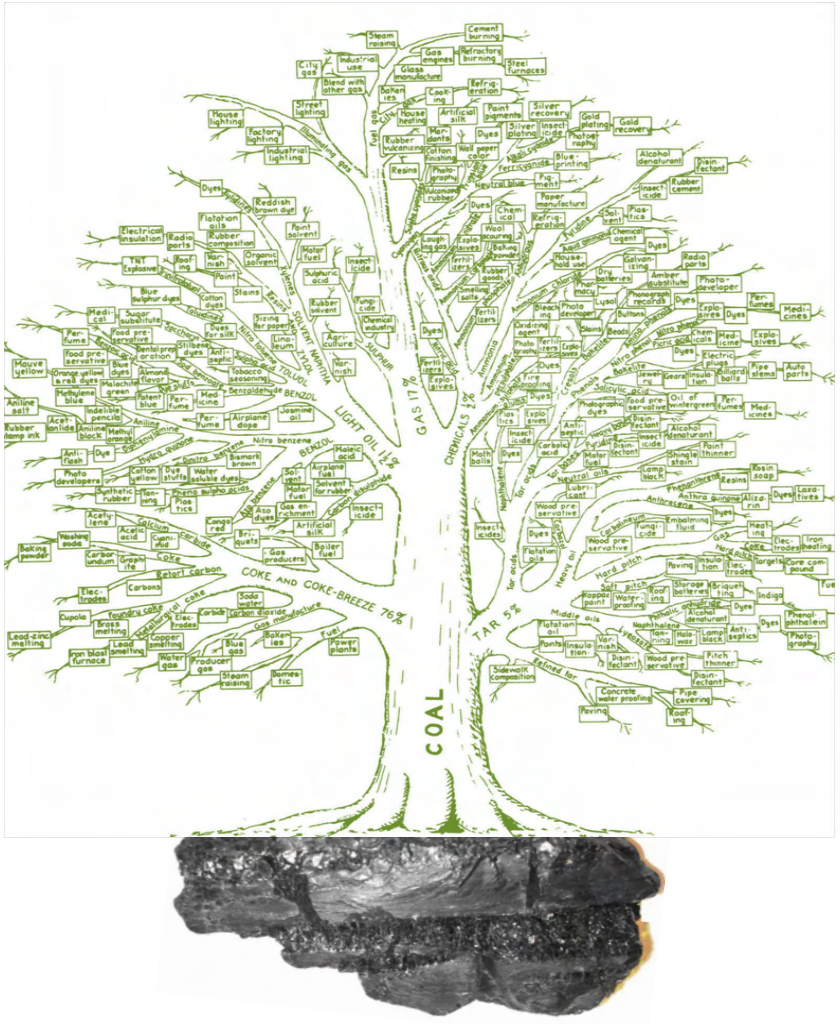


National Coal Council: COAL IN A NEW CARBON AGE. Powering a wave of innovation in advanced products & manufacturing



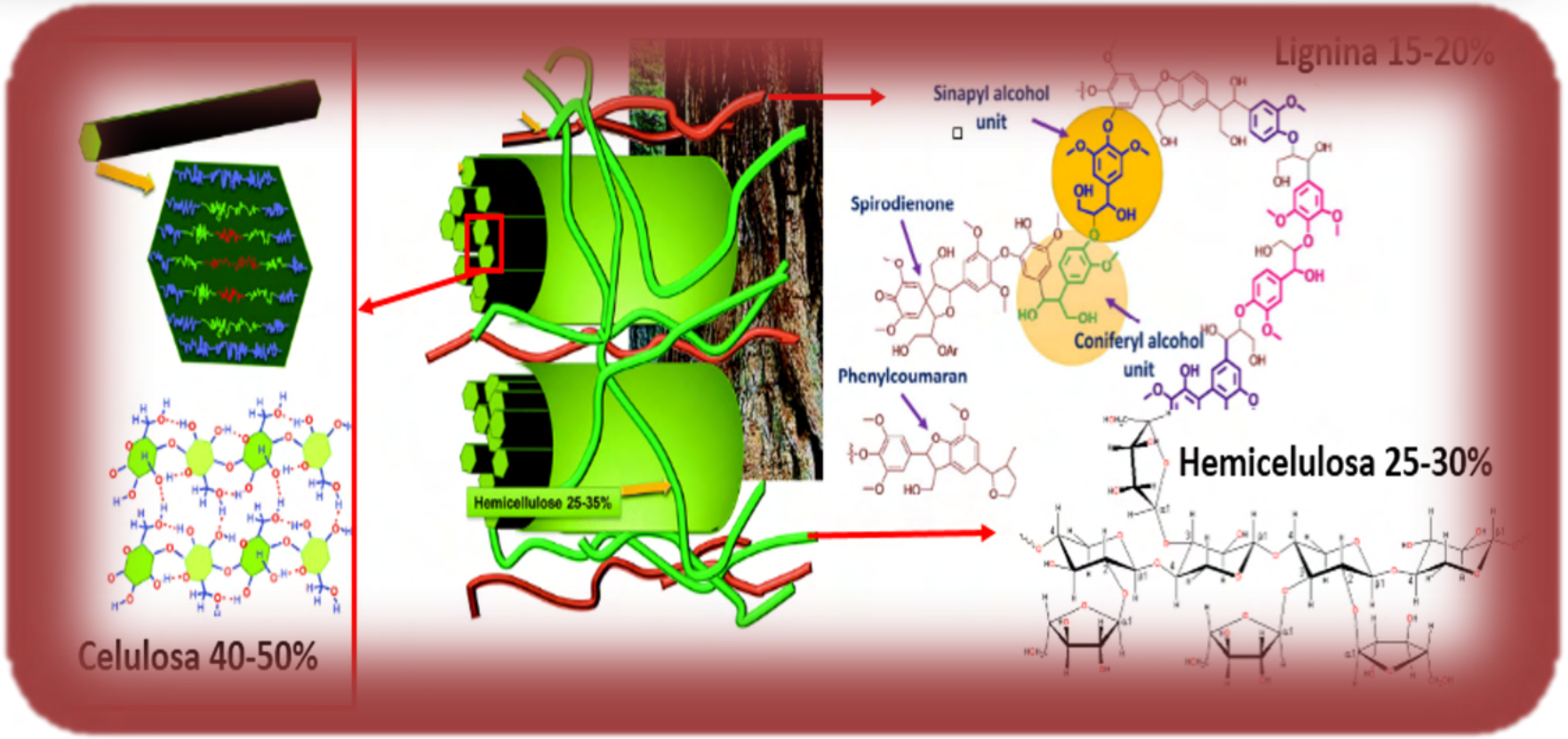
The National Coal Council is a Federal Advisory Committee established under the authority of the U.S. Department of Energy. Individuals from a diverse set of backgrounds and organizations are appointed to serve on the NCC by the U.S. Secretary of Energy to provide advice and guidance on general policy matters relating to coal and the coal industry.


Fullereno (C_{60})
Coranuleno
Fluoreno
Antraceno
Ovaleno
Grafito
Benceno
$sp^2 + \pi$
C
$sp + 2\pi$
sp^3
Propano
Adamantano
Diamante



Donado por Dr. Poveda

Biomasa: Son cadenas de moléculas complejas.



Adaptada de: Alonso,et al , Chem. Soc. Rev. 41 (2012) 8075–98.

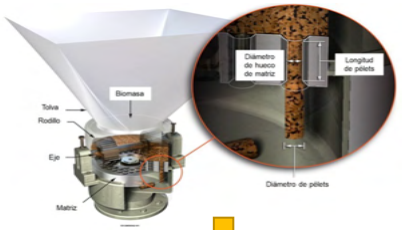
BIOMASA y CARBÓN

Torrefacción
Pirolísis
Gasificaciónn
Combustión

Energía térmica y eléctrica, Químicos, combustibles, pesticidas, and fertilizantes

Procesos termoquímicos para aprovechar biomasa y carbón

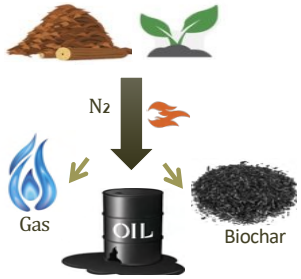
Peletización



Densidad:
600 a 1200 kg/m^3

HHV:
15 – 22 MJ/kg

Pirólisis

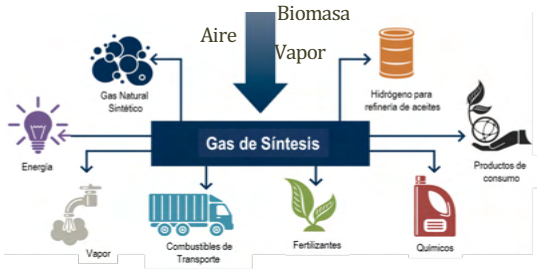


Bio-oil

Gases

Biochar

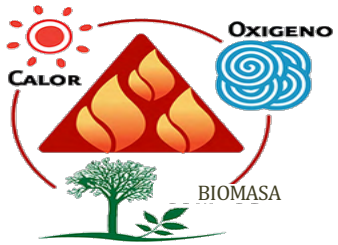
Gasificación



Gases

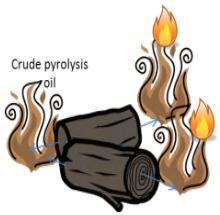
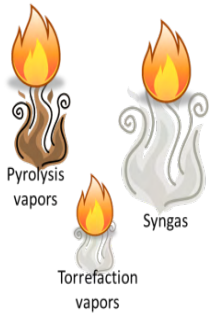
Alquitranes

Combustión

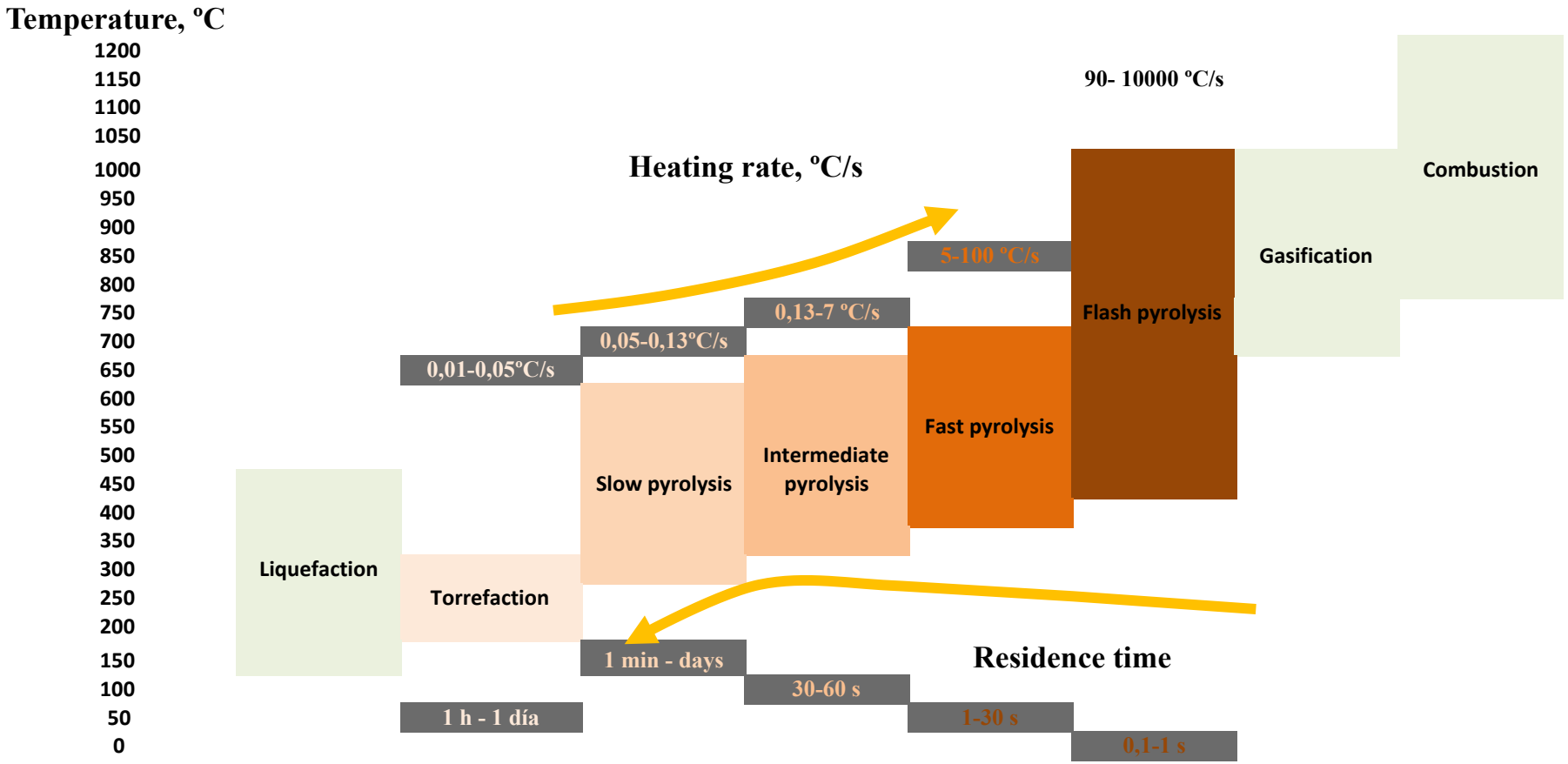


Gases calientes

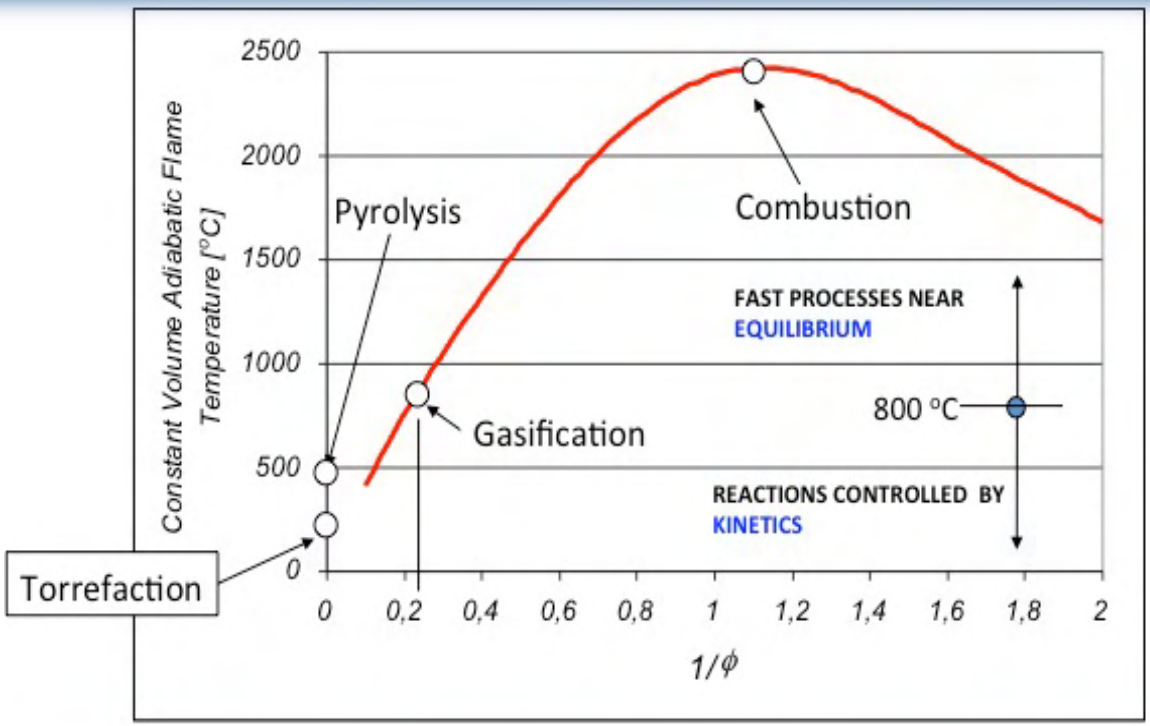
Procesos termoquímicos:

	1. Evaporation	2. Torrefaction	3. Pyrolysis	4. Gasification	5. Combustion of Vapors
					
°T	100-200 °C	225-300 °C	300-650 °C	700-850 °C	450-2000 °C
Products	Solid: Dried wood Vapor: Water	Solid: Roasted wood Vapor: Water, volatile organics	Solid: Charcoal Vapor: Light organics, heavy organics	Solid: Ash Vapor: Syngas (CO, CO_2, H_2. CH_4, H_2O)	CO_2, CO, H_2O
Description	Endothermic; Evaporation; External heat penetrates particle	Endothermic; Hemicellulose and amorphous cellulose decomposition, Light extractives evaporation, Intermolecular dehydration reactions; Mass density decreases; Volatile organics can combust	Endothermic for fast pyrolysis, exothermic for slow pyrolysis; Solid, liquid, and vapor reactions; Cellulose decomposition, Lignin decomposition; Mass density decreases; Volatile organics can combust	Endothermic if water is oxidizing agent, exothermic if oxygen is oxidizing agent; Volatilization of carbon, hydrogen, and oxygen in char; Gasification of volatile pyrolysis oil; Syngas can combust	Exothermic; Consumption of oxygen; Requires ignition at high temperatures and/or pressures
	Time & Temperature				

Fuente: Manuel Gracia-Perez, et. Al.

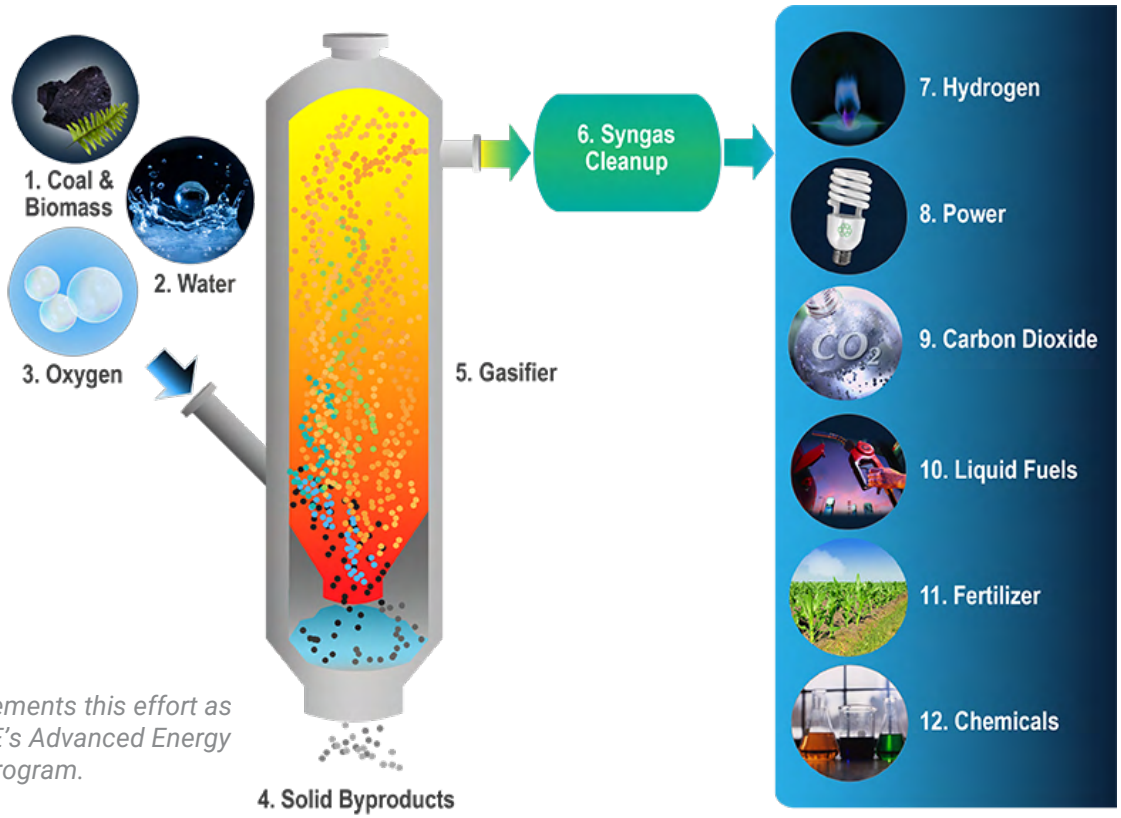

Temperature, ºC
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Heating rate, ºC/s
90- 10000 ºC/s
Combustion
Gasification
5-100 ºC/s
Flash pyrolysis
0,13-7 ºC/s
0,05-0,13ºC/s
0,01-0,05ºC/s
Fast pyrolysis
Intermediate pyrolysis
Slow pyrolysis
Liquefaction
Torrefaction
1 min - days
Residence time
30-60 s
1 h - 1 día
1-30 s
0,1-1 s

Procesos termoquímicos:



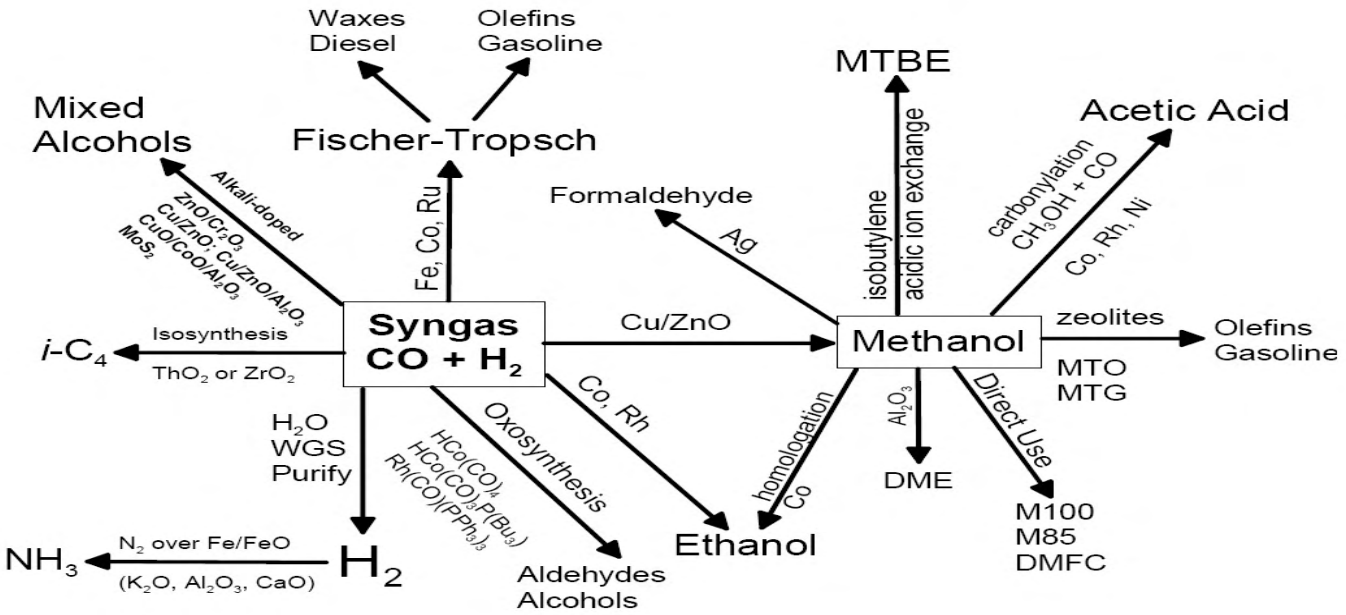
Combustion > 1500 °C, Gasification 600 – 1400 °C, Fast Pyrolysis 350 – 600 °C, Torrefaction: 220 – 300 °C

Fuente: Manuel Gracía-Perez, et. Al.

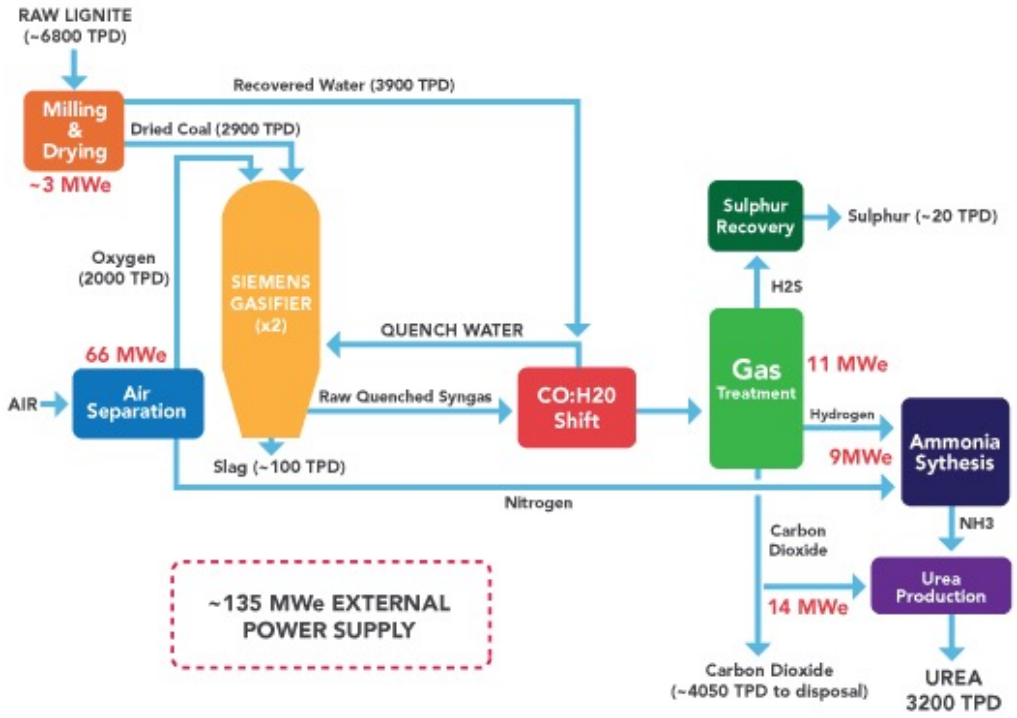


NETL implements this effort as part of DOE's Advanced Energy Systems Program.

Rutas para producir diferentes productos a partir de la gasificación

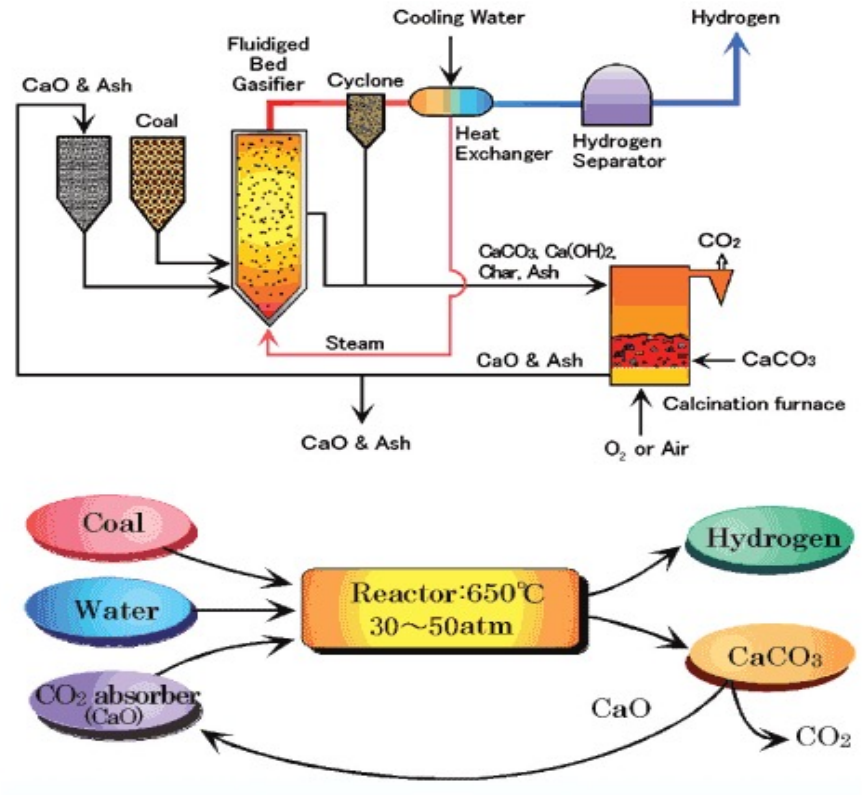


Gasification Process to produce UREA

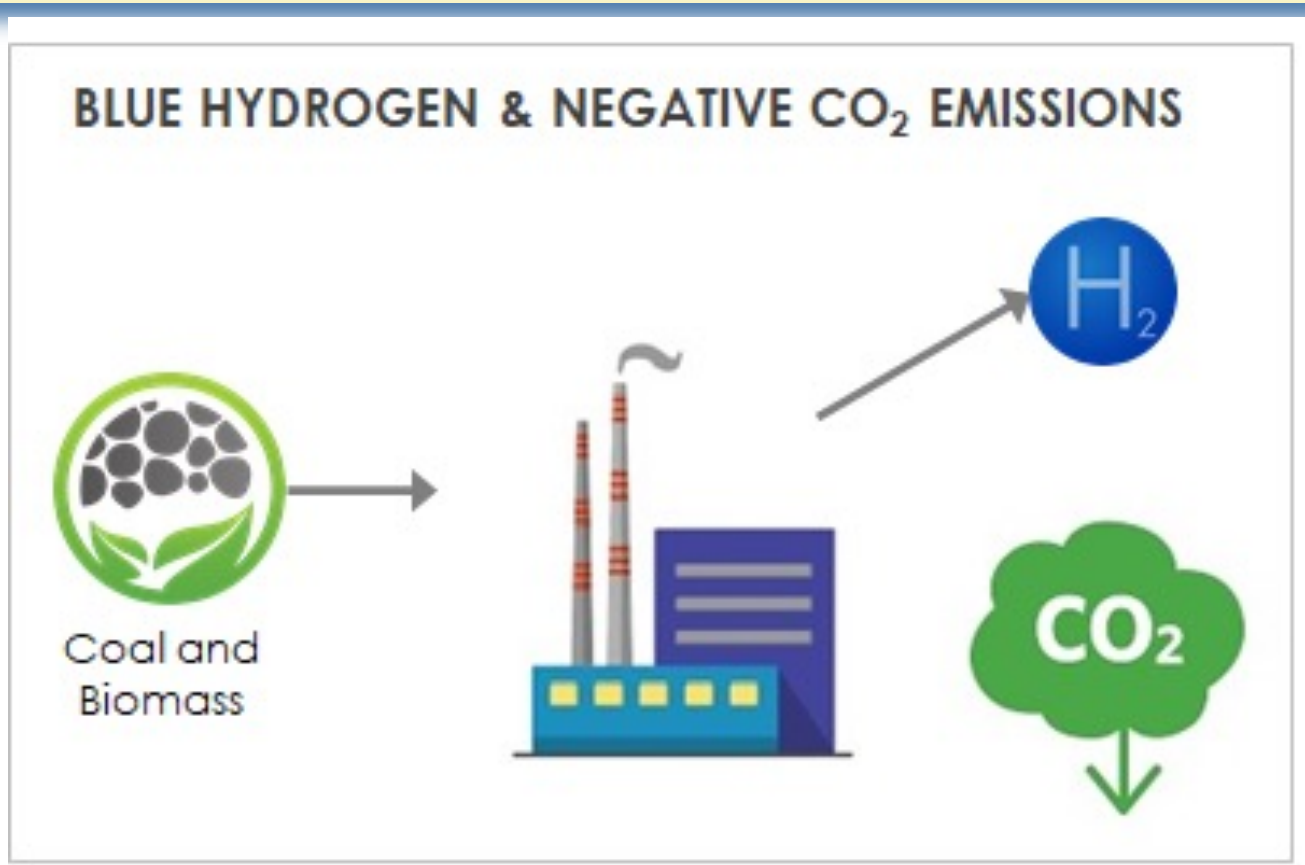


Phase 1: MTPA UREA PLANT with POWER IMPORT (Major Flows and Compressor Loads Shown)

Novel Gasification Process (HyPr-RING)

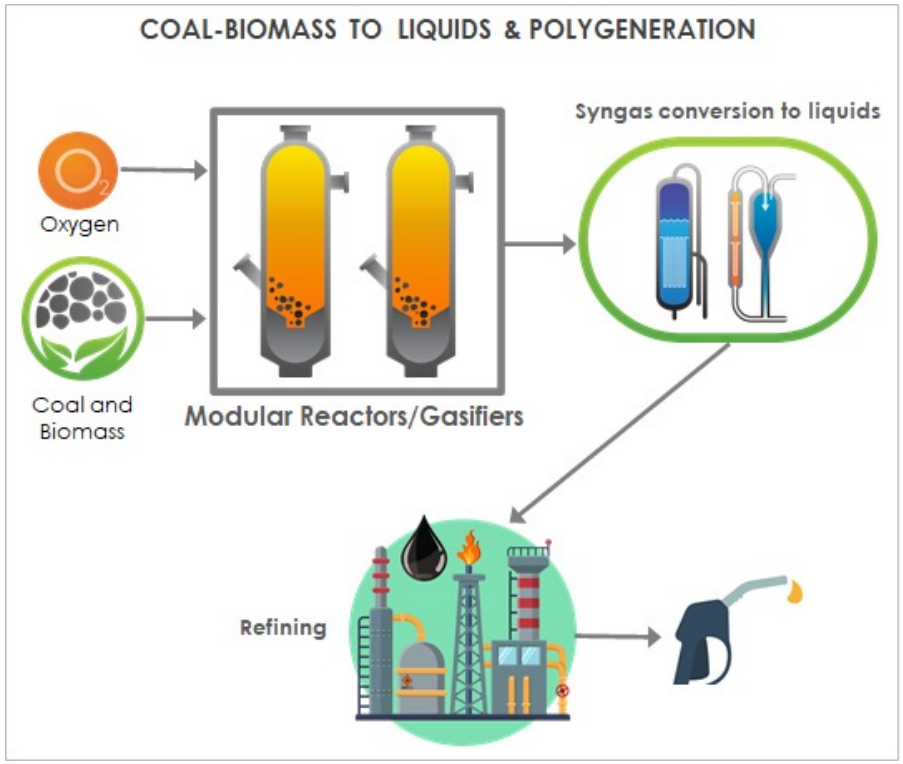


HYDROGENO Azul & EMISSIONES NEGATIVE CO2



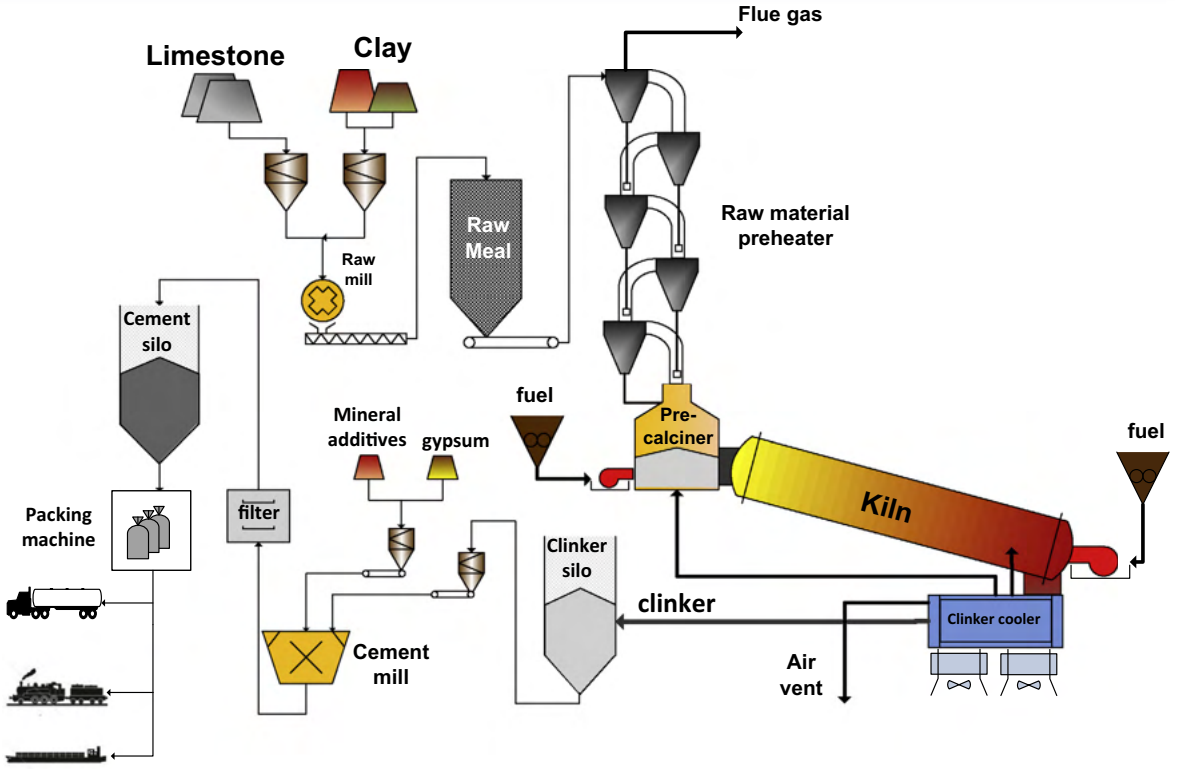
NETL implements this effort as part of DOE's Advanced Energy Systems Program.

COAL-BIOMASS TO LIQUIDS & POLYGENERATION

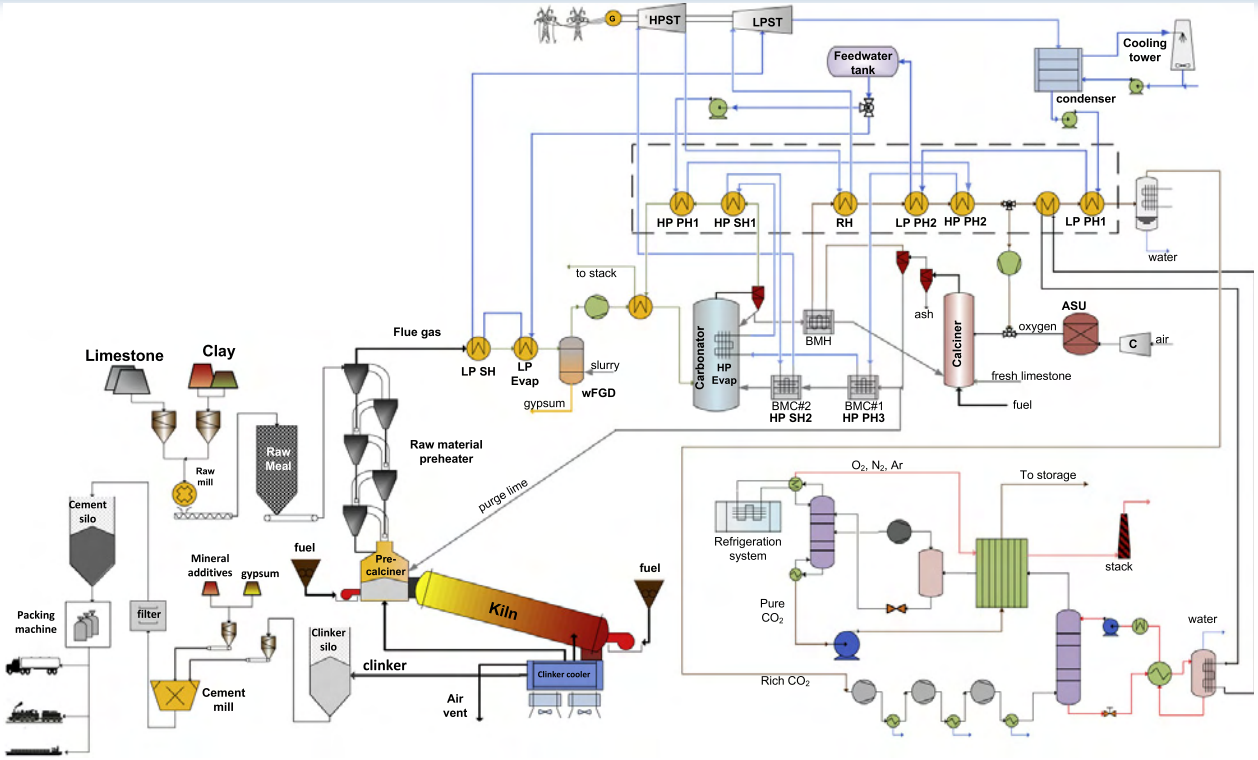


NETL implements this effort as part of DOE's Advanced Energy Systems Program.

Existing cement plant



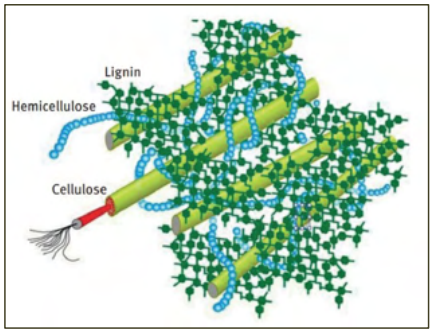
Integration of calcium looping technology in existing cement plant for CO2 capture



K. Atsonios et al. / Fuel 153 (2015) 210–223

Rutas para producir diferentes productos a partir de la pirólisis rápida

40-60%
15-30%
10-25%



S. Wang *et al.*

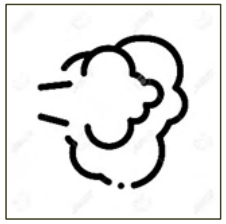
Char

Gases permanentes

Gases condensables

Aerosoles

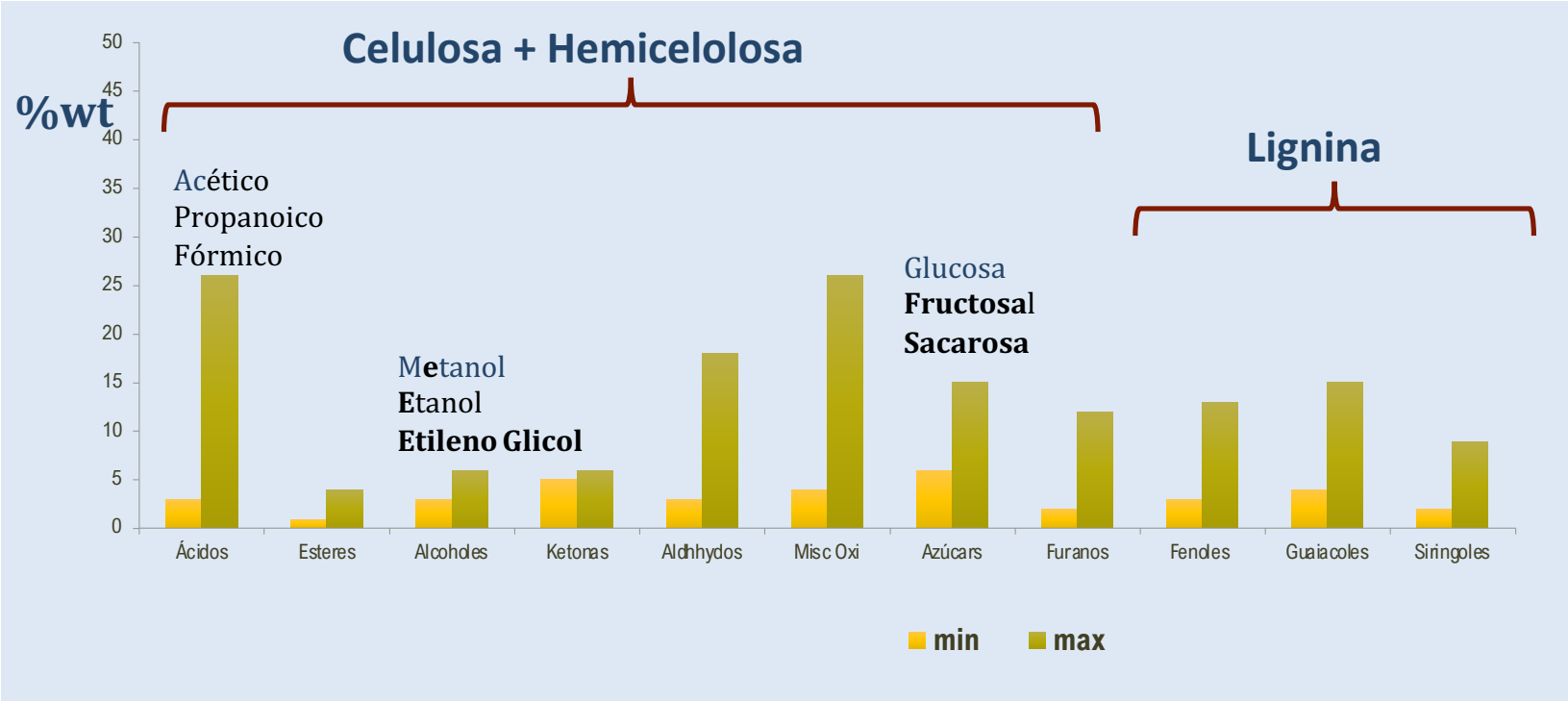
Fracciones
Resinas para plásticos, laminación, aislamiento térmico y adhesivos para madera (Han *et al.*).



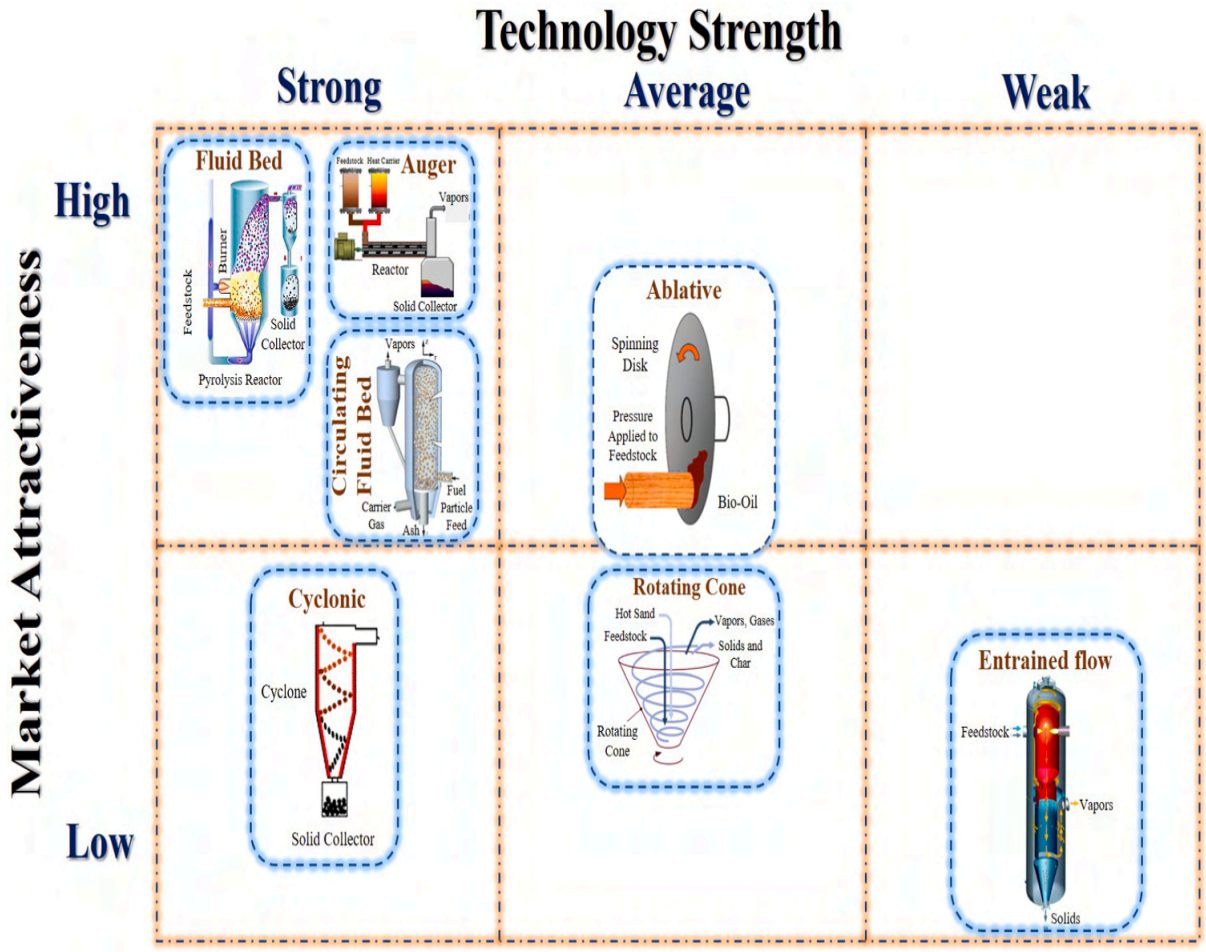
Combustible

Acetol, hidroxiacetaldehido, levoglucosan y ácido acético (Pineriro *et al.)*

Productos en el bioaceite obtenidos de la pirólisis rápida

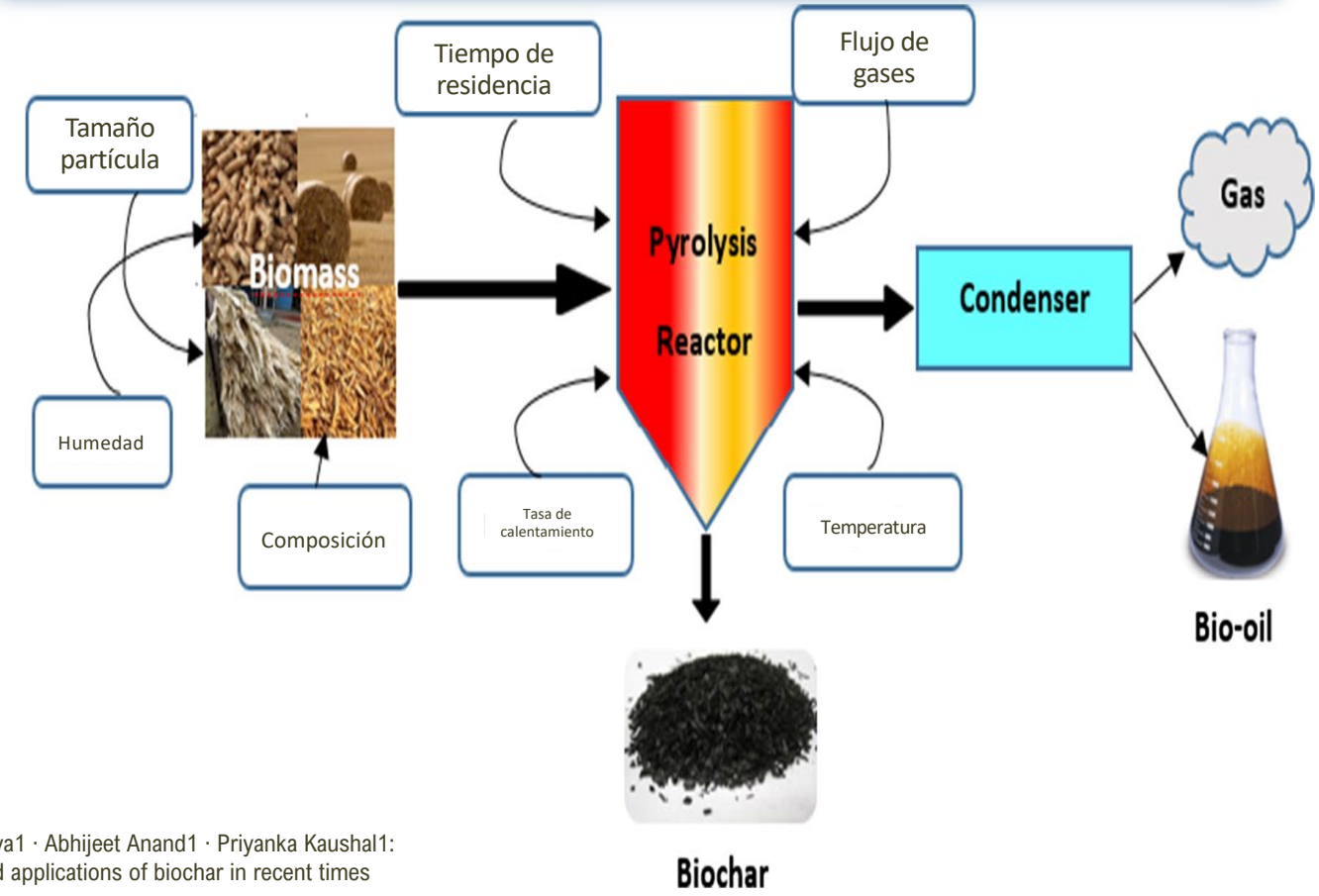


Produced by the Staff at Pacific Northwest National Laboratory (PNNL), National Renewable Energy Laboratory (NREL), Office of Biomass Program (EERE) For the Office of the Biomass Program T. Werpy and G. Petersen, Editors

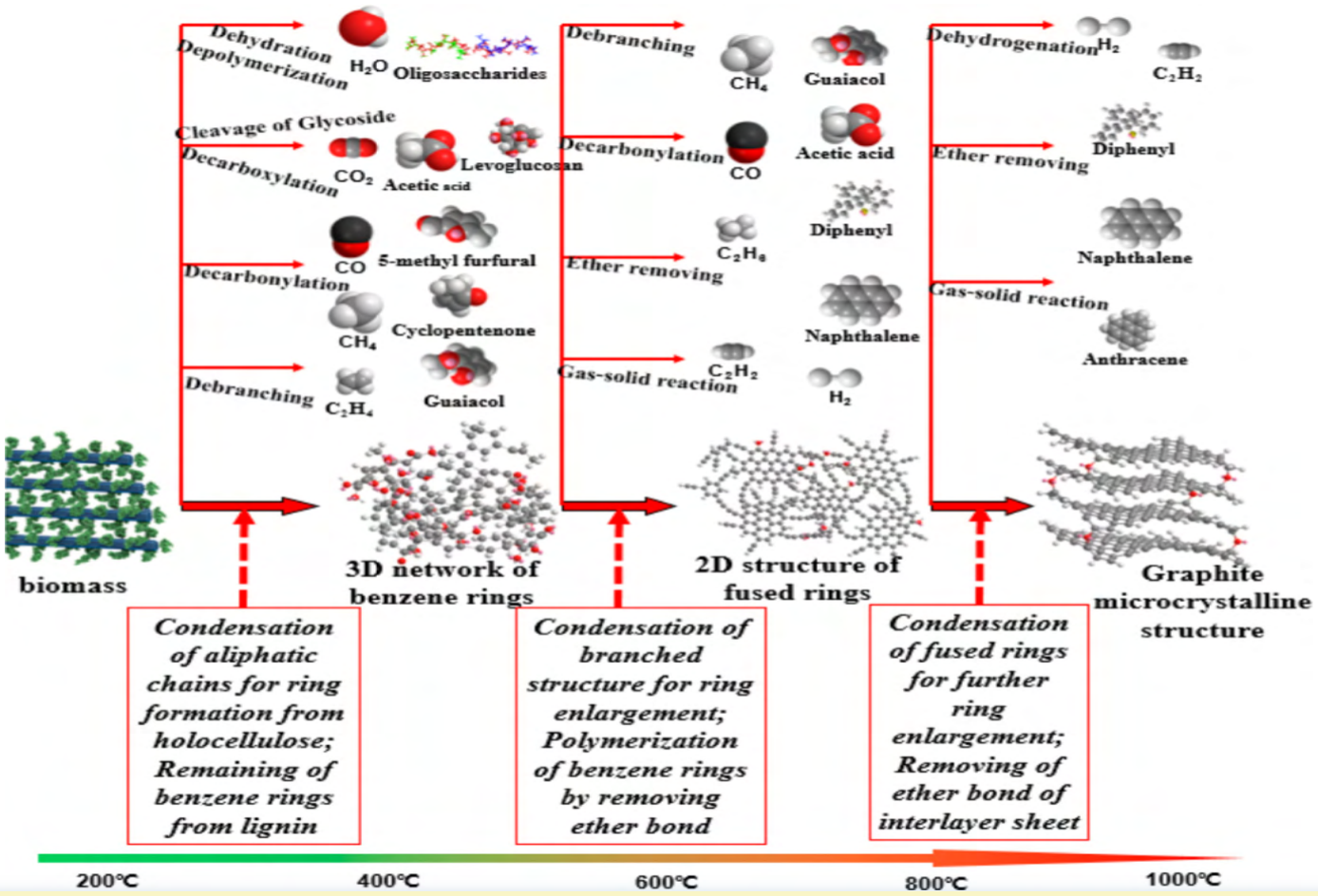


Source: Campuzanoa, Robert C. Brownb, Juan Daniel Martíneza: Auger reactors for pyrolysis of biomass and wastes Felipe. Renewable and Sustainable Energy Reviews

Productos a partir de pirólisis lenta

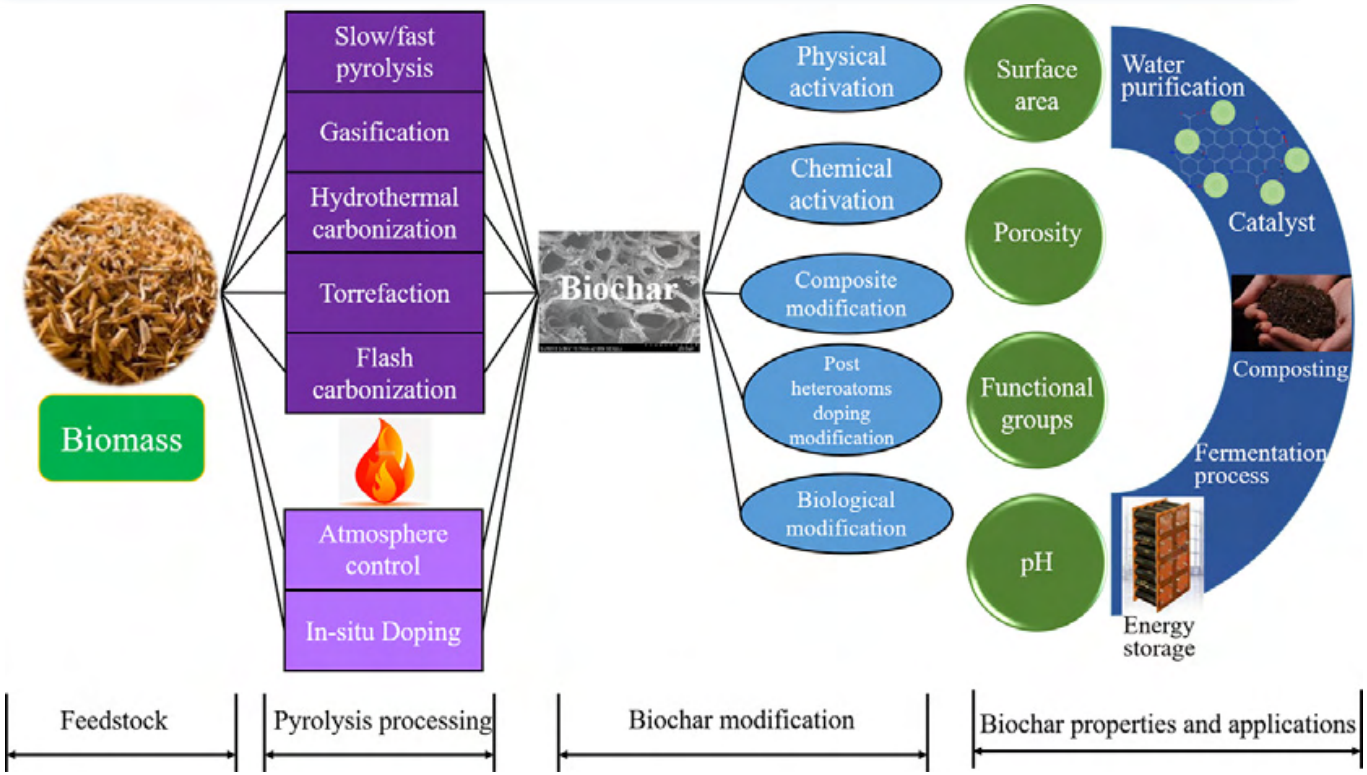


Source: Anil Kumar Sakhiya1 · Abhijeet Anand1 · Priyanka Kaushal1: Production, activation, and applications of biochar in recent times



Producción de Biochar: Yunchao Li, Bo Xing, Yan Ding, Xinhong Han, Shurong Wang: A critical review of the production and advanced utilization of biochar via selective pyrolysis of lignocellulosic biomass. Bioresource Technology

Productos de la pirólisis lenta:



Fuente: Yunchao Li, Bo Xing, Yan Ding, Xinhong Han, Shurong Wang: A critical review of the production and advanced utilization of biochar via selective pyrolysis of lignocellulosic biomass. Bioresource Technology

Biochar obtenido de la pirólisis lenta o torrefacción

Biomasa

- Composición
- Tipo
- Tamaño de partícula

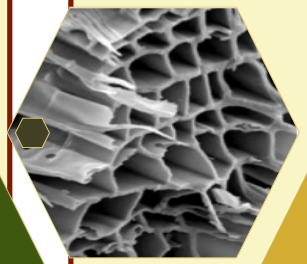
Pirólisis

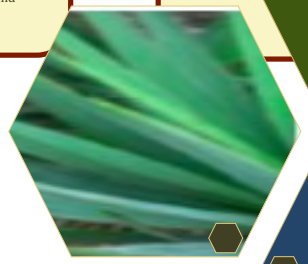
- Convencional.
- Microondas.
- Condiciones del proceso

Activación del Biochar

- Física
- Química

Took from Anil Kumar Sakhiya1 · Abhijeet Anand1 · Priyanka Kaushal1: Production, activation, and applications of biochar in recent times





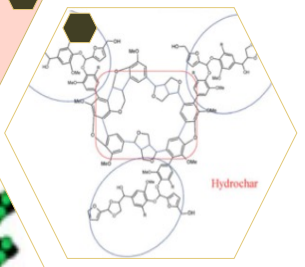
Combustible

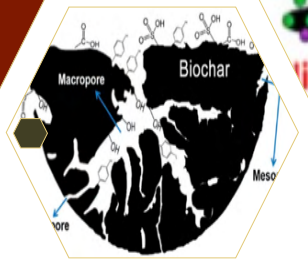
Catalizador

Aditivo

Adsorbente

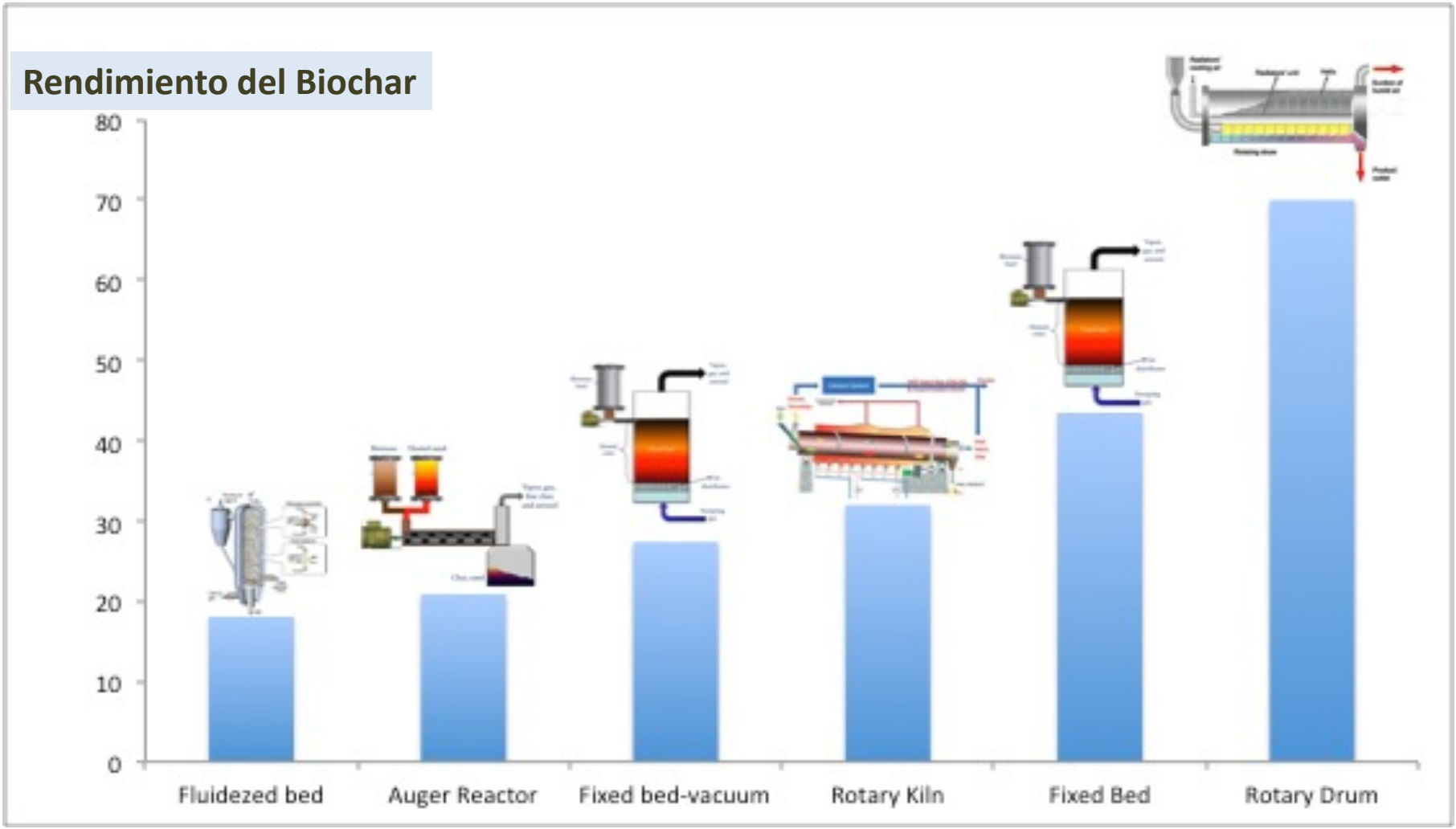
Remediación de suelos





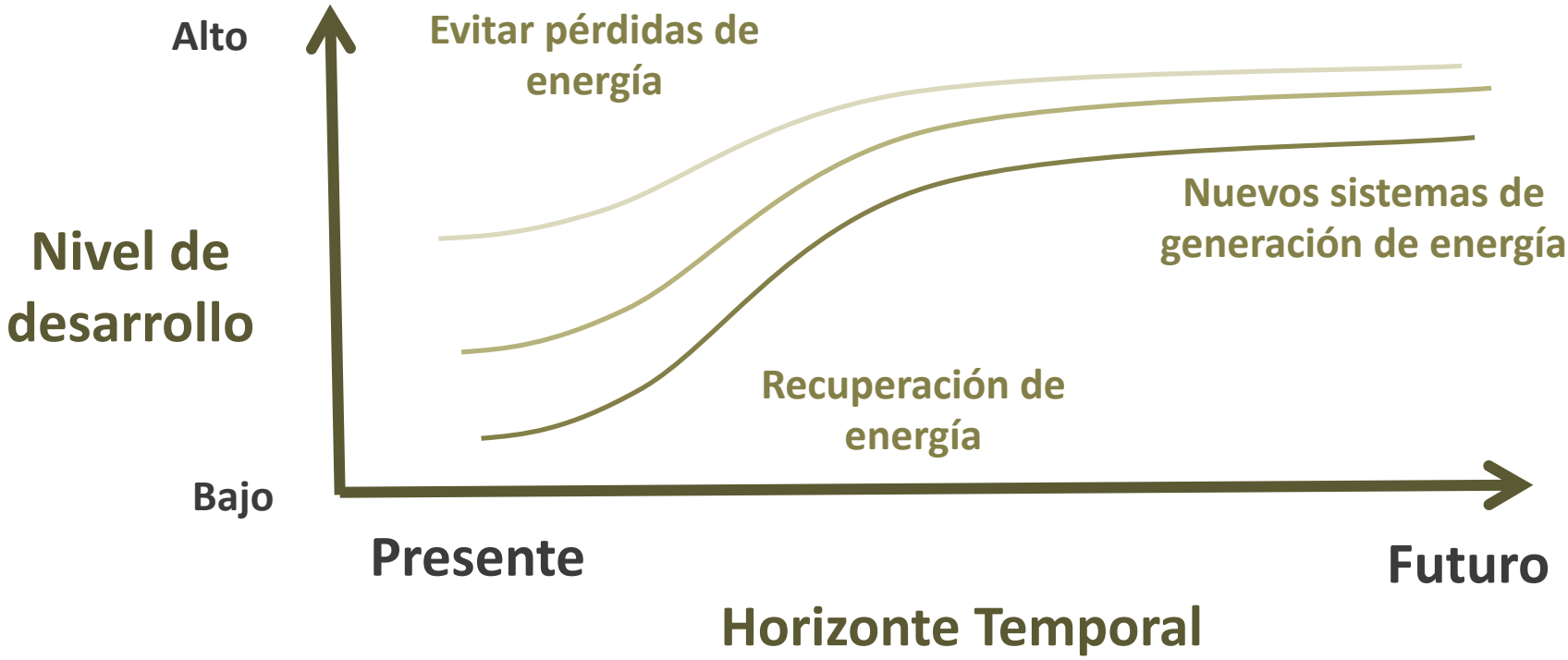
Fotos tomadas dFeng Cheng ID and Xiuwei Li, Preparation and Application of Biochar-Based Catalysts for Biofuel Production. Catalist Journal

Rendimiento del Biochar



5. Comentarios finales

La eficiencia energética en la industria Colombiana



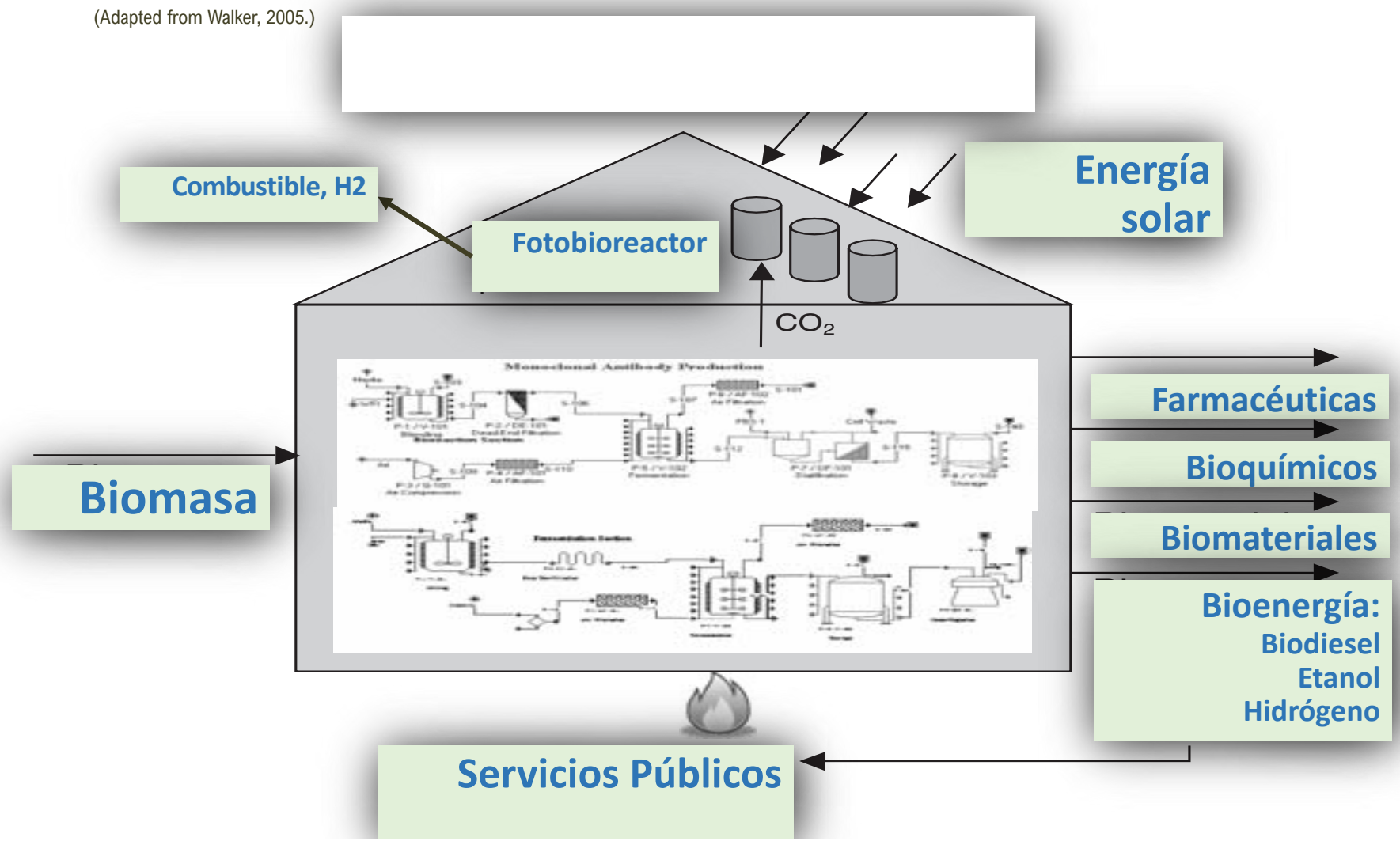
Es importante:

La ingeniería dura: tecnología de alto nivel.

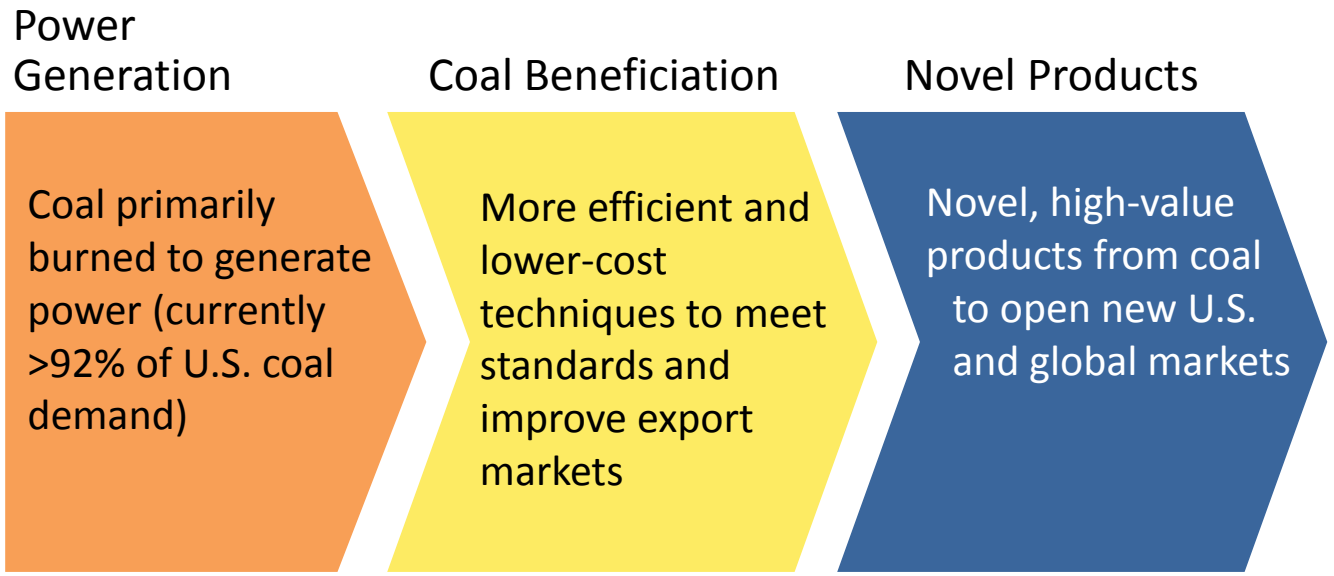
La ingeniería blanda: modelación matemática avanzada.

La ciencia básica: generar nuevo procesos eficientes

(Adapted from Walker, 2005.)



We need to change the equation..



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Gracias

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- the **Alliance for Biomass and Sustainability Research–ABISURE**- Universidad Nacional de Colombia, Hermes code 53024, for its support in the realization of this study.
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