

Role of Biomass Gasification in Energy Transition

Sunil Singhal
Soumya Jyoti Choudhury

Emerging Technologies / Solutions
for Waste & Biomass
Waste-to-Energy, 2022
November 15, 2022

FLUOR[®]

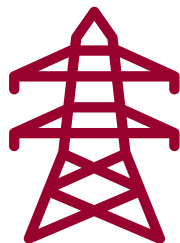
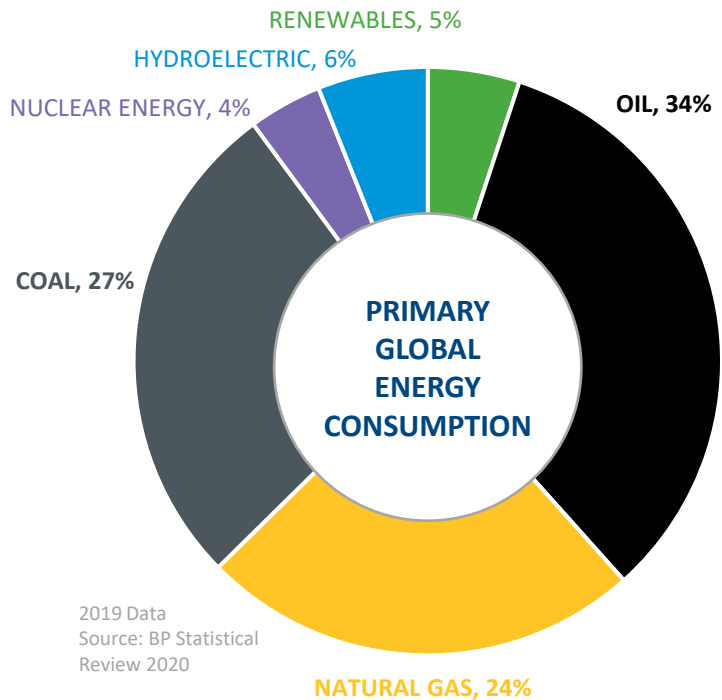
© 2021 Fluor Corporation. All Rights Reserved.



Agenda

- Global Energy Scenario
- Renewable Energy for Transport- How to Achieve It?
- Challenges with Continuous Supply of Green Power from Solar and Wind
- Other Sources of Green Power Generation
- Methods of Green Power Storage
- Role of Biomass as Source of Energy
- Biomass Gasification + Water Electrolysis Hybrid Plant
- Key Features of Gasification + Electrolysis Hybrid Process
- Summary

Global Energy Scenario



>20,000
terawatt-hour
2020 Global Electricity Consumption

www.yearbook.enerdata.net



www.iea.org

HOW MUCH FOSSIL FUEL IS LEFT?



COAL
>41 Billion BOE/yr



OIL
>35 Billion bbl/yr



NATURAL GAS
>3,500 Billion m³/yr

CURRENT CONSUMPTION LEVELS

www.worldometers.info

Renewable Energy for Transport- How to Achieve It?

- ▶ Batteries charged with green power, but has following challenges:
 - Not suitable for heavy vehicles and long-haul transport
 - High battery weight for heavy vehicles
 - Require multiple in transit charging
 - High overall transport time
 - Inadequate charging infrastructure
 - Continuous green power supply
 - Limited life of batteries
 - Disposal & recycling of spent batteries

Renewable Energy for Transport- How to Achieve It? (Cont...)

- ▶ Emerging alternates → Green H₂, NH₃, MeOH, etc.
- ▶ Water electrolysis → Most sought-after source
- ▶ Hinderance → Continuous supply of affordable renewable power

Challenges with Continuous Supply of Green Power from Solar and Wind

- ▶ Solar & Wind Energy → Most widely and abundantly available, but:
 - Availability is geography and weather dependent
 - Average availability → solar ~25% and wind ~35%
 - Somewhat complimentary, still leaves gap of ~40-50%
 - Needs to be complimented by other sources
 - Alternately power needs to be stored

Other Sources of Green Power Generation

Source of Energy	Advantages	Disadvantages
Biomass	<ol style="list-style-type: none">1. Easily & continuously available2. Process well proven3. Installation cost standardized4. Helps to promote local economy5. Helps in pollution control and waste management	<ol style="list-style-type: none">1. Low bulk density makes long distance transport expensive2. Ensuring consistent quality
Hydro	<ol style="list-style-type: none">1. Process well proven2. Naturally available	<ol style="list-style-type: none">1. Geography dependent2. Weather dependent3. Near saturation in most countries

Other Sources of Green Power Generation (Cont...)

Source of Energy	Advantages	Disadvantages
Geothermal	Naturally available	<ol style="list-style-type: none">1. Only limited small-scale installations2. Not easily accessible
Tidal	Naturally available	<ol style="list-style-type: none">1. Technology at nascent stage2. Only possible around seashores
Ocean Current	Naturally available	<ol style="list-style-type: none">1. Technology at nascent stage2. Not easily accessible
Ocean Wave	Naturally available	<ol style="list-style-type: none">1. Technology at nascent stage2. Not easily accessible

Methods of Green Power Storage

Method	Advantage	Disadvantage
Battery Storage	<ol style="list-style-type: none">1. Proven process2. Suppliers available3. Can be installed anywhere	<ol style="list-style-type: none">1. Battery self discharges & capacity ↓ with time2. Needs to be replaced every 5-6 years3. Need expensive large battery bank for commercial energy storage4. Safety issues like high voltage, arc-flash, fire and toxicity5. Scarcity of raw materials like Li, Co, Ni, V, etc.
Pumped Hydro	<ol style="list-style-type: none">1. Water can be reused	<ol style="list-style-type: none">1. Geography dependent2. High installation cost3. ~50% efficiency loss

Methods of Green Power Storage (Cont...)

Method	Advantage	Disadvantage
Compressed Air	<ol style="list-style-type: none">1. Can be installed anywhere	<ol style="list-style-type: none">1. High installation cost2. Limited equipment life due to cyclic operation3. ~50% efficiency loss
H2 Storage	<ol style="list-style-type: none">1. H2 is ready to use as source of energy2. Proven process2. Suppliers available3. Can be installed anywhere	<ol style="list-style-type: none">1. Oversized Electrolysis by 2-3 times2. Compression & storage is expensive3. Limited equipment life due to cyclic operation

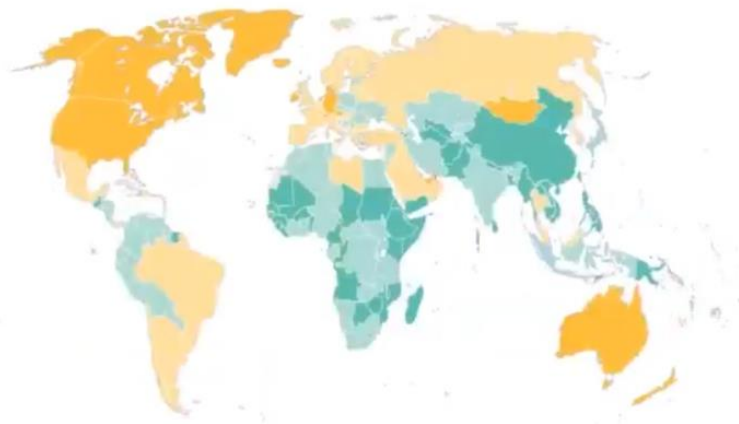
Role of Biomass as Source of Energy

- ▶ Biomass is generated continuously
- ▶ Can produce power, bio CNG, EtOH
- ▶ Can be gasified to produce H₂ and derivatives like NH₃, MeOH, Urea etc.
- ▶ Energy produced from biomass is carbon neutral
- ▶ Permanent and clean solution to waste disposal problem
- ▶ Ground water and soil contamination at landfill sites can be avoided
- ▶ CH₄ emission from landfill sites can be avoided
- ▶ CH₄ is 25 times more potent green house gas than CO₂
- ▶ Can free-up real estate at landfill sites
- ▶ Can promote local economy

Worldwide Biomass Generation Scenario

Annual municipal solid waste generated per capita
(kilograms/capita/day)

0-0.49 0.50-0.99 1.00-1.49 Greater than 1.50 No data

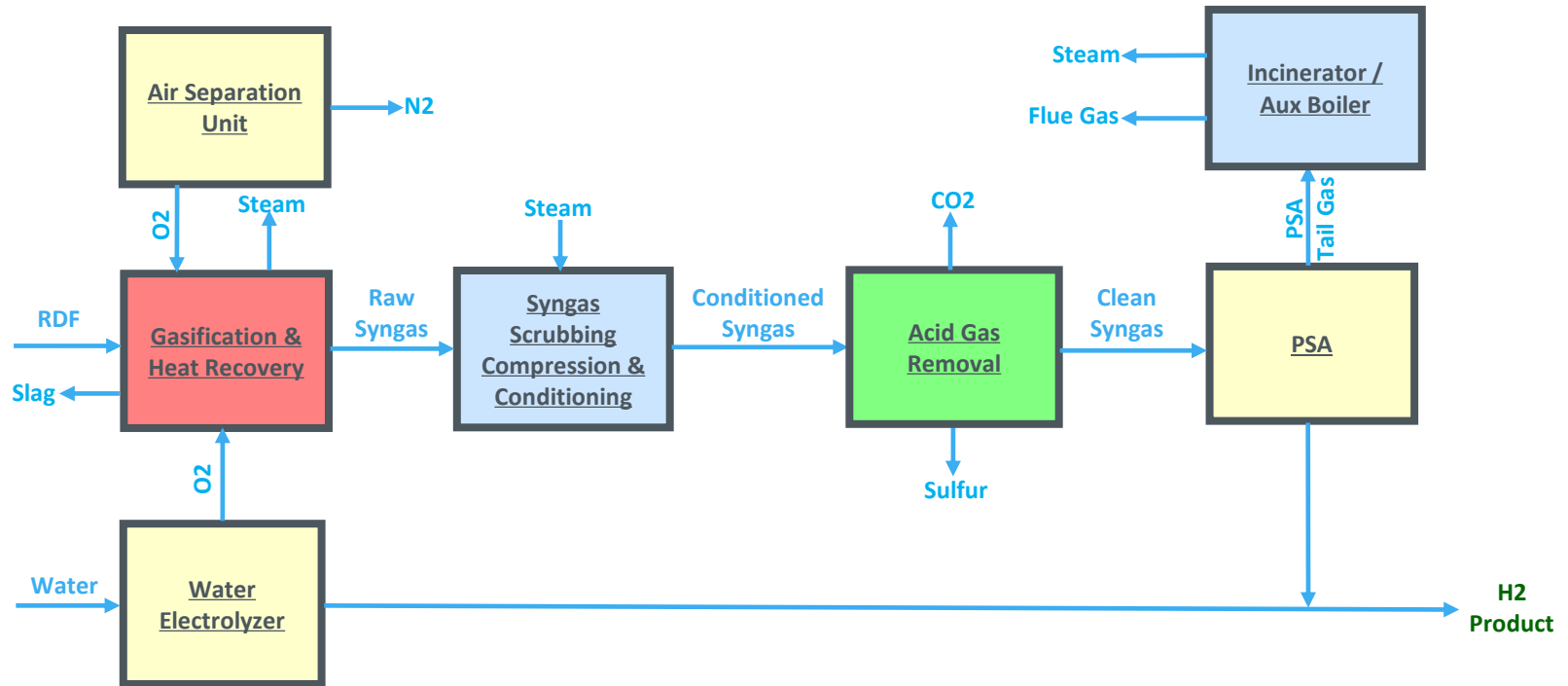


Source: Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018.
What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050.

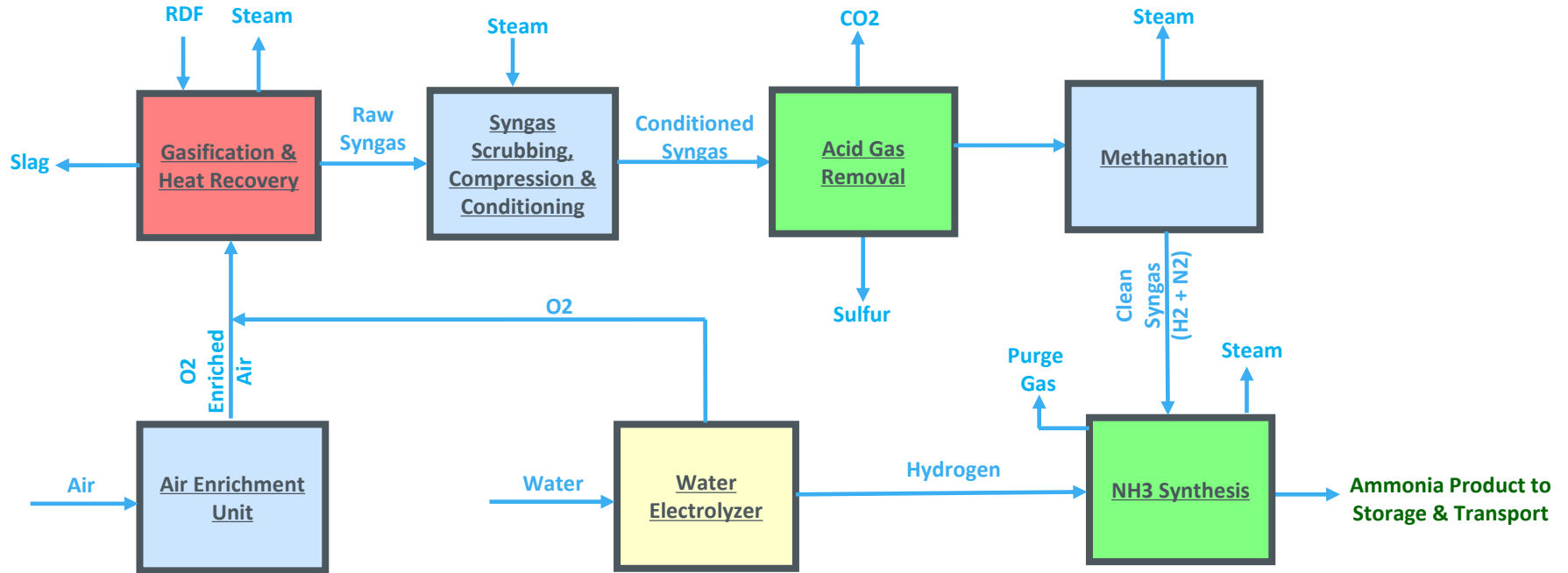
- ▶ 2.0 billion tonnes estimated in 2016
- ▶ Predicted to increase to 3.4 billion tonnes/year by 2050
- ▶ Other waste generation (kg/capita/day avg)
 - 12.73 industrial waste
 - 3.35 agricultural waste
 - 1.68 construction and demolition waste
 - 0.32 hazardous waste
 - 0.25 medical waste
 - 0.02 electronic waste

Biomass Gasification + Water Electrolysis Hybrid Plant for
Green Hydrogen / Green Ammonia / Green Methanol /
Green Urea Production

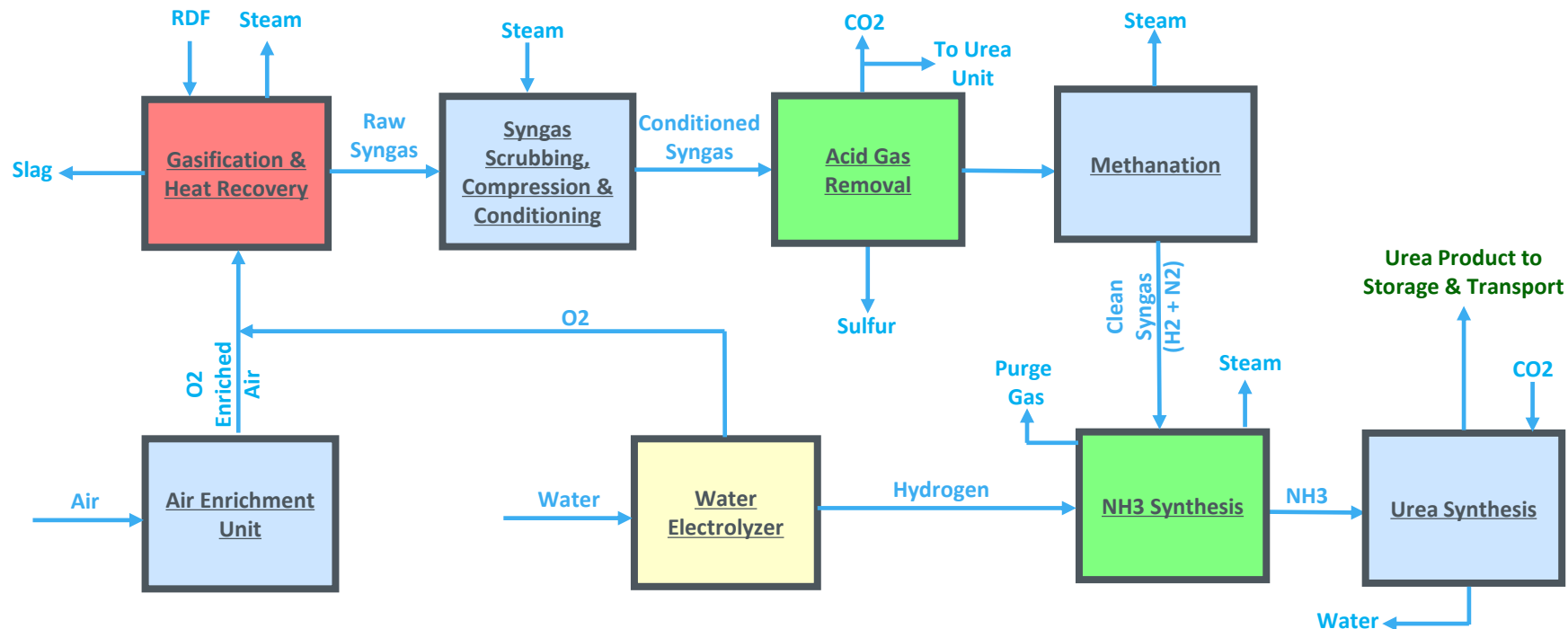
Biomass Gasification + Water Electrolysis to H2



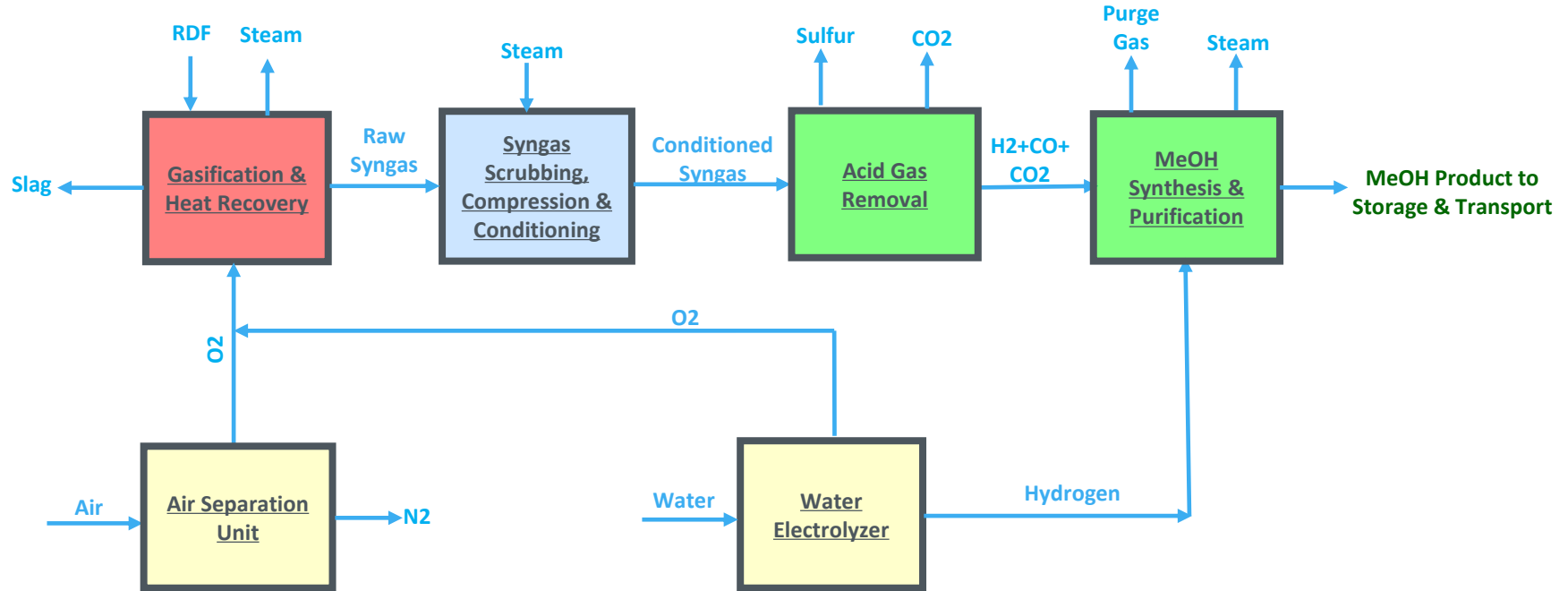
Biomass Gasification + Water Electrolysis to NH3



Biomass Gasification + Water Electrolysis to Urea



Biomass Gasification + Water Electrolysis to Methanol



Key Features of Gasification + Electrolysis Hybrid Process

- ▶ Maximizes potential of biomass gasification as well as electrolysis
- ▶ Baseload operation with biomass gasification and capacity ramp-up when solar / wind energy is available
- ▶ Captive power generation using biomass when solar/wind energy is not available
- ▶ Use of by-product O₂ from electrolysis in gasifier reduces ASU CAPEX and power consumption
- ▶ Cryogenic N₂ unit is required if NH₃ is produced using H₂ from electrolysis
- ▶ Liquid NH₃ is a great carrier of long-haul transport of H₂ using existing infrastructure

Key Features of Gasification + Electrolysis Hybrid Process (Cont...)

- ▶ Provides flexibility to produce green MeOH, EtOH, other liquid fuels, chemicals, urea and plastics using biogenic carbon from AGR section
- ▶ The hybrid process makes the products carbon negative
- ▶ Improved economics with utilization of synergy and by-products
- ▶ Provides long-term sustainable solution for waste management while generating high value carbon negative products

Summary

- ▶ To fully decarbonize the economy 24/7 green energy is required
- ▶ In addition to solar and wind which are intermittent, biomass can play an important role in achieving 24/7 green energy supply since it is renewable and available 24/7 round the year
- ▶ Hybrid solution of biomass gasification and water electrolysis can be a viable option for production of carbon negative products
- ▶ Syngas produced from gasification can be processed to give a wide variety of products depending upon market conditions and economic / strategic considerations
- ▶ Use of biomass also solves the problem of waste management, disposal and associated cost

One solution doesn't fit everywhere. To address the mega challenge of achieving 100% carbon neutral economy, all the renewable / carbon neutral sources of energy and associated technologies should be harmonized and used to compliment each other rather than compete.

STAY CONNECTED..

Sunil Singhal

Sunil.Singhal@fluor.com

+91.124.457.0700 Extn. 1649

Soumya Jyoti Choudhury

Soumya.Jyoti.Choudhury@fluor.com

+91.124.457.0700 Extn. 1395



<http://www.fluor.com>



<http://www.linkedin.com/company/fluor>



@FluorCorp



<http://www.youtube.com/user/FluorCorporation>