34th Symposium on "Bioenergy in Pakistan“

Innovative Bioenergy Technologies for Sustainable Biomass Utilization in Pakistan

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- https://scholar.google.com/citations?user=bmfIHmwAAAAJ&hl=en&oi=ao

- BIOMASS CONVERSION RESEARCH GROUP COMSATS Lahore.
- https://lahore.comsats.edu.pk/chemical/BCRG/index.aspx

Points of talk

- Potential of sustainable biomass utilization
- Current energy challenges in Pakistan
- Role of biomass in the energy mix
- Biomass Conversion technologies

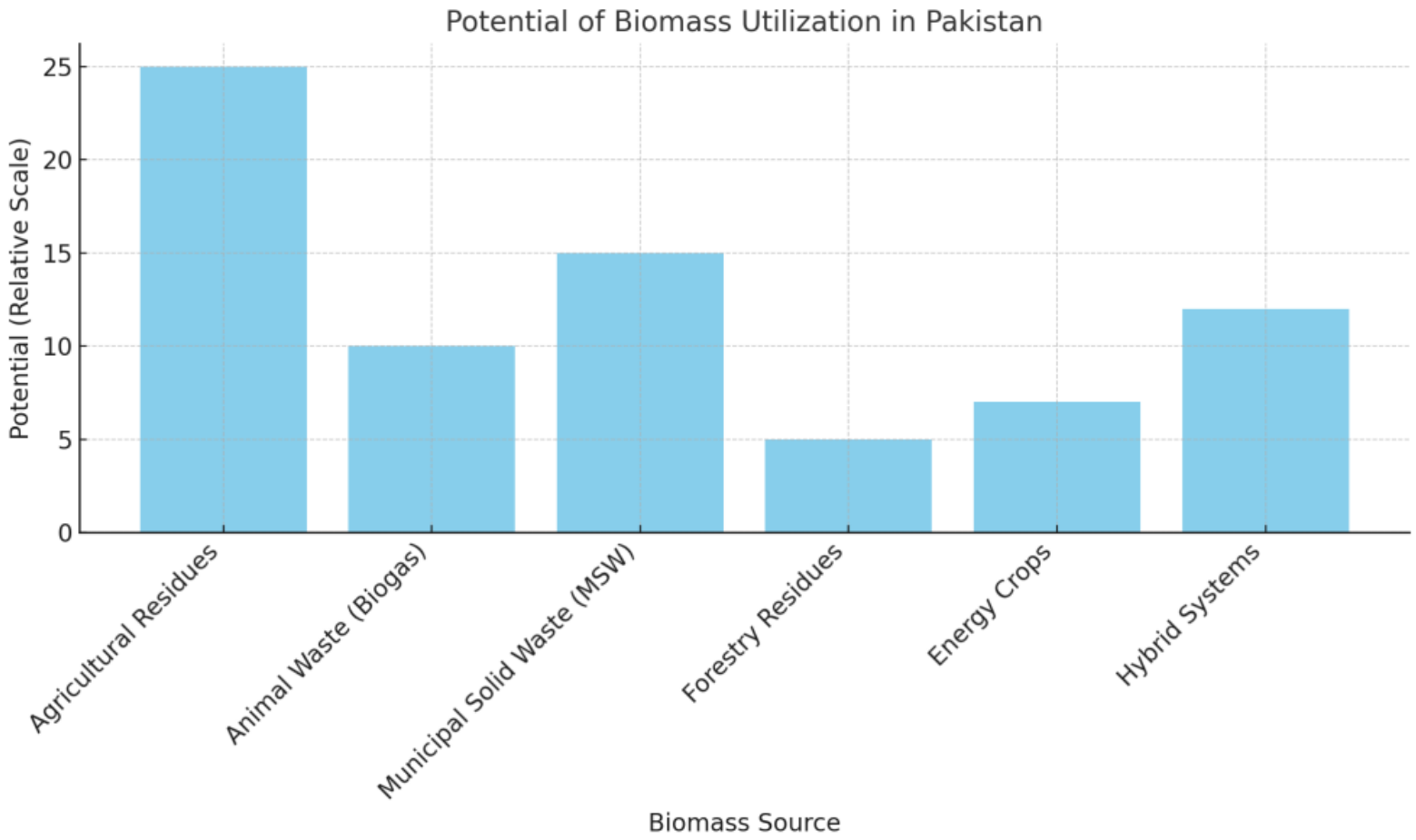
Biomass based energy Potential in Pakistan

•Pakistan generates substantial agricultural waste, including wheat straw, rice husks, sugarcane bagasse, and cotton stalks.

• These residues can be converted into bioenergy through technologies like
•gasification, pyrolysis, and anaerobic digestion.

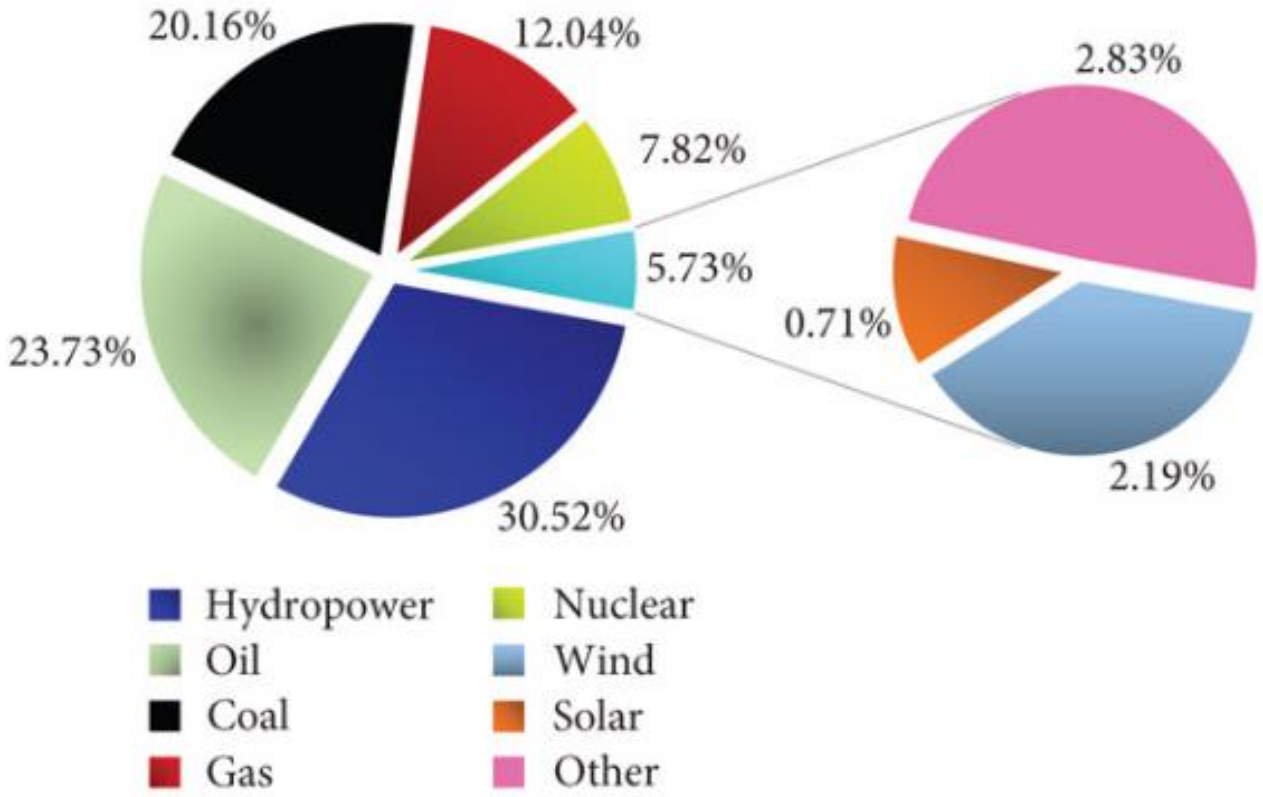
•**Potential Output**: Studies estimate that agricultural residues could contribute over
25 million tons annually for bioenergy production

Biomass Potential in Pakistan



Energy Mix in Pakistan

Biomass-based power generation, primarily from bagasse accounts for 249 MW which is just 0.54 %.



Biomass Based plants

Power Plant	Location	Capacity (MW)	In-Service Date
Jamal Din Wali-II	Rahim Yar Khan, Punjab	26	June 12, 2014
Jamal Din Wali-III	Rahim Yar Khan, Punjab	27	October 3, 2014
RYK Mills	Rahim Yar Khan, Punjab	40	March 24, 2015
Chiniot Power	Chiniot, Punjab	63	November 28, 2015
Hamza Sugar Mills	Rahim Yar Khan, Punjab	15	March 2017
The Thal Industries Corporation	Layyah, Punjab	20	N/A
Almoiz Industries	Mianwali, Punjab	36	February 2019
Chanar Energy	Faisalabad, Punjab	22	February 2019

Types of Biomass Resources in Pakistan

- - Agricultural residues: Wheat straw, rice husks, corn stalks, Bagasse, Sesame
- - Animal manure: Livestock waste
- - Municipal solid waste (MSW)
- - Forest residues

Period of availability of Biomass in Pakistan

- Cane trash November to March
- Corn stalks May to June
- Mustard stalks January to March
- Cotton sticks October to December
- Sesame residues August to September
- Wood sawdust Year-round, depending on local sawmill operations.
- Brassica January to March

- To make best use of the available biomasses, procured the double stage shredder to achieve the require particle size 0f 60mm.

Challenges in Biomass Utilization

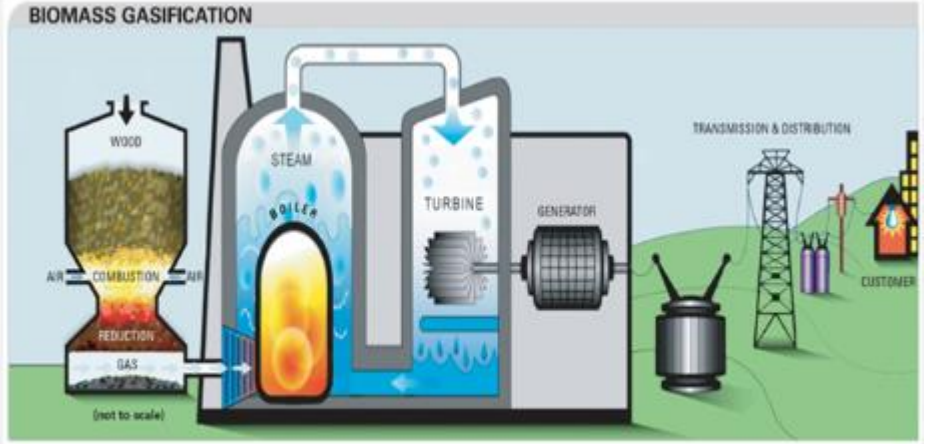
- - Collection and transportation logistics
- - Technological limitations
- - Lack of awareness and infrastructure
- - Policy and regulatory gaps

Innovative Bioenergy Technologies

- - Biomass Gasification
- - Pyrolysis for Biochar and Bio-Oil
- - Anaerobic Digestion (Biogas)
- - Algae-Based Biofuels
- - Hybrid Biomass-Solar Systems
- - Cellulosic Ethanol Production

Biomass Gasification Systems

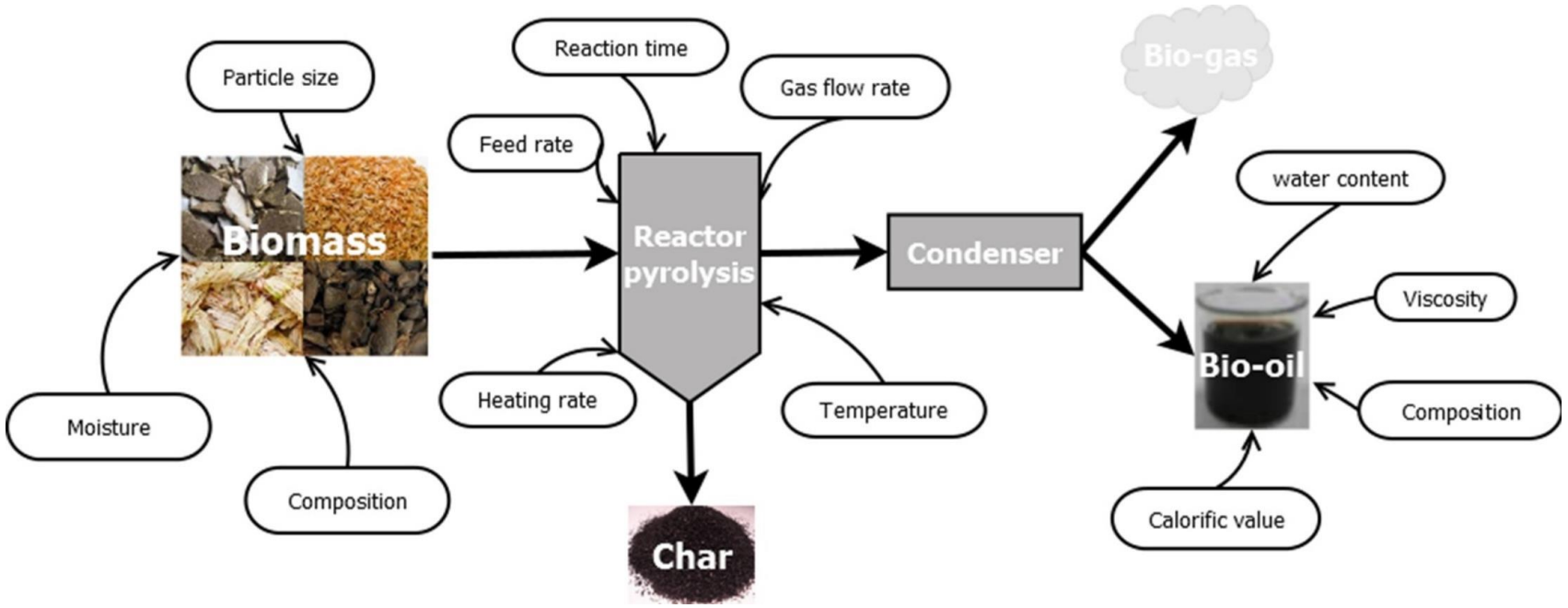
- - Process: Convert biomass to syngas (H_2, CO)
- - Applications: Electricity, heat, and chemical production
- - Benefits: High efficiency, lo
- w emissions



(Source: http://stlenergy.org/?attachment_id=461)

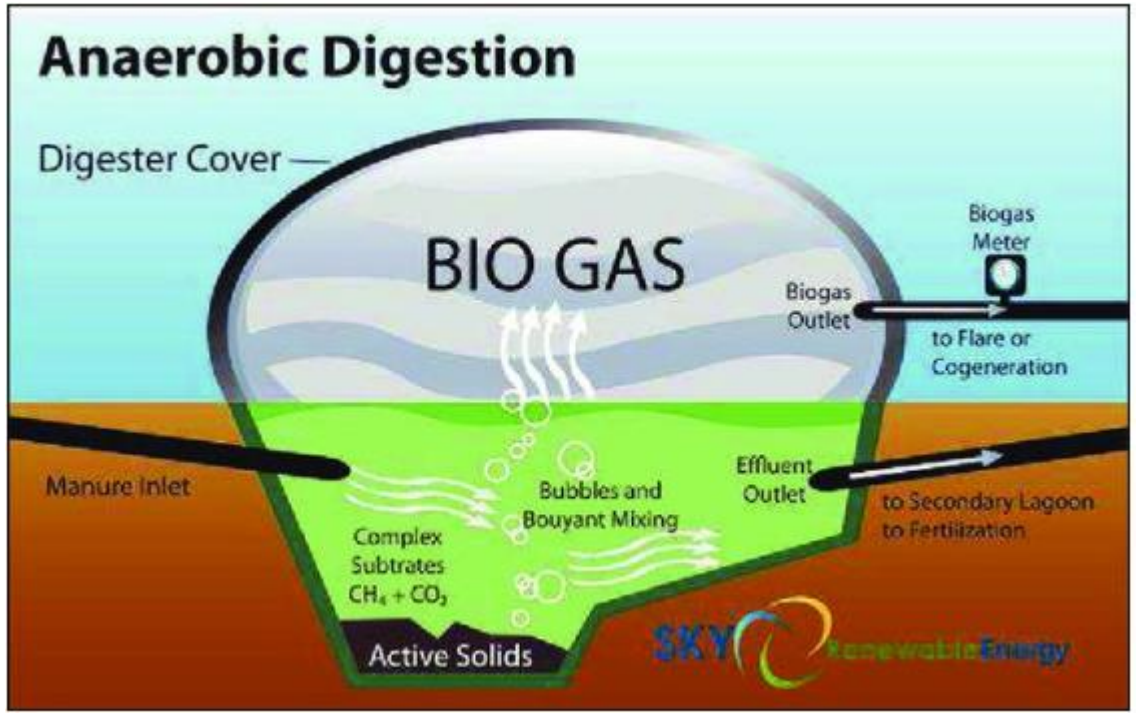
Pyrolysis for Biochar and Bio-Oil

- - Process: Thermal decomposition without oxygen
- - Products: Biochar (soil amendment), bio-oil (fuel)
- - Environmental Impact: Carbon sequestration through biochar



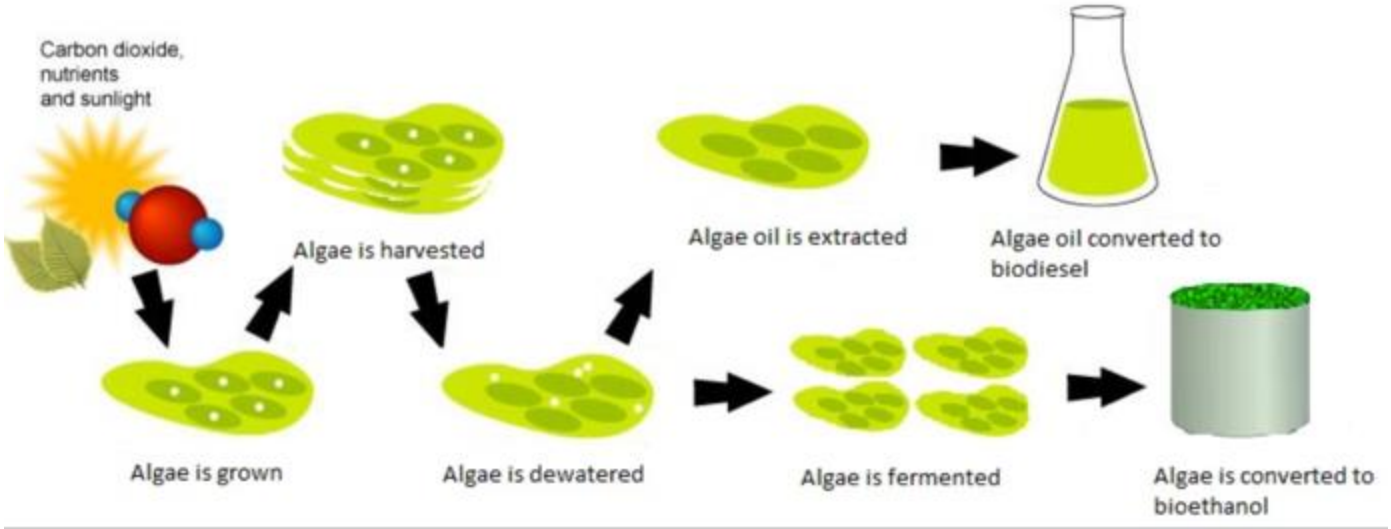
Anaerobic Digestion for Biogas Production

- - Process: Organic waste to methane and CO_2
- - Applications: Cooking fuel, electricity generation
- - Example: Small-scale biogas plants in rural areas



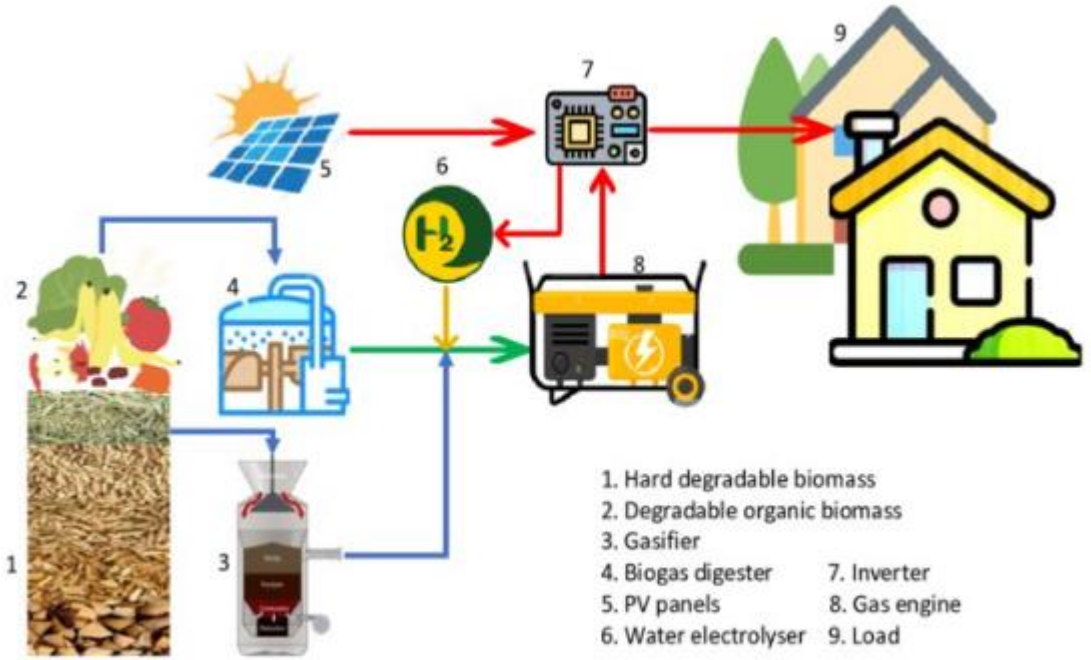
Algae-Based Biofuel Production

- - Advantages: High oil yield, grows on non-arable land
- - Wastewater utilization for algae growth
- - Potential for biodiesel and bioethanol



Hybrid Biomass-Solar Systems

- - Integrated approach for 24/7 power generation
- - Combines solar PV and biomass gasifiers
- - Applications in remote and off-grid areas



Electricity production cost and challenges

Sr.	Technology	Electricity Production Cost (USD/kWh)	Current Status in Pakistan	Challenges/Opportunities
1	Biomass Gasification	0.06–0.15	Limited deployment, with a few pilot projects.	- Requires investment in gasification plants. - Potential for rural electrification using agricultural waste.
2	Pyrolysis for Biochar and Bio-Oil	0.10–0.20	Experimental stage; mostly confined to academic and research institutions.	- Biochar production has potential for soil enhancement. - Lack of infrastructure for commercial scalability.
3	Anaerobic Digestion (Biogas)	0.05–0.12	Several small-scale biogas plants in rural areas; mostly used for cooking rather than electricity generation.	- Potential for agricultural and municipal waste utilization. - Needs policy support for large-scale deployment.
4	Algae-Based Biofuels	0.20–0.50	Very limited; still at the R&D stage in universities and research centers.	- High production costs due to lack of optimized algae farming. - Requires significant investment in biotechnology.
5	Hybrid Biomass-Solar Systems	0.08–0.18	Emerging technology; few integrated projects have been initiated.	- Synergy between biomass and solar is promising for remote areas. - Needs better financing models and subsidies.
6	Cellulosic Ethanol Production	0.12–0.25	Early-stage projects focusing on crop residues, but no commercial production.	- Abundant raw material availability. - High initial costs and lack of technical expertise hinder growth.

Key Insights:

- **Biomass Gasification** and **Anaerobic Digestion** are the most feasible and cost-effective options currently available in Pakistan.
- **Pyrolysis** and **Cellulosic Ethanol Production** require significant research and investment to scale up.
- **Hybrid Biomass-Solar Systems** have immense potential for energy-deficient rural regions, but their adoption is slow due to high initial costs.
- **Algae-Based Biofuels** remain the least developed due to their high production costs and lack of infrastructure.
- Pakistan needs a robust renewable energy policy with incentives, funding, and infrastructure to fully exploit these technologies for sustainable energy production.

Implementation Strategies for Pakistan

- - Policy support and government incentives
- - Public-Private Partnerships (PPP)
- - Community engagement and capacity building
- - Role of research institutions

Environmental and Economic Benefits

- - Reduced greenhouse gas emissions
- - Rural development and job creation
- - Energy independence and cost savings

Renewable energy Policy

The most recent comprehensive renewable energy policy in Pakistan is the **Alternative and Renewable Energy Policy 2019 (ARE 2019)**.

This policy outlines the government's ambitious plan to increase the share of renewable energy in the country's energy mix to 20% by 2025 and 30% by 2030.

Key features of ARE 2019:

- **Targets:** Sets clear targets for increasing renewable energy generation.
- **Incentives:** Provides various incentives to promote renewable energy projects, including feed-in tariffs, tax breaks, and simplified procedures.
- **Capacity Building:** Emphasizes the importance of capacity building and technology transfer to support the growth of the renewable energy sector.
- **Grid Integration:** Addresses the challenges of integrating renewable energy into the national grid.
- **Research and Development:** Promotes research and development in renewable energy technologies.

References:

- **Alternative and Renewable Energy Policy 2019:** https://eesr.uet.edu.pk/wp-content/uploads/2020/03/renewable_energy_policy_of_pakistan-draft_are_policy_2019_-_version_2_july_21_2019.pdf
- **Climate Change Laws of the World:** https://climate-laws.org/document/alternative-and-renewable-energy-policy-2019_991c
- **Ministry of Energy (Power Division):** https://power.gov.pk/Policies

Way Forward

- To unlock the full potential of sustainable biomass utilization, Pakistan needs to:
- Develop supportive policies and subsidies for biomass energy projects.
- Invest in R&D and capacity-building programs.
- Encourage public-private partnerships for large-scale biomass projects.
- Promote decentralized energy systems to leverage local biomass resources effectively.
- Sustainable biomass utilization can play a transformative role in Pakistan's energy sector, enhancing energy security, reducing emissions, and fostering economic development.

- Question and Answer