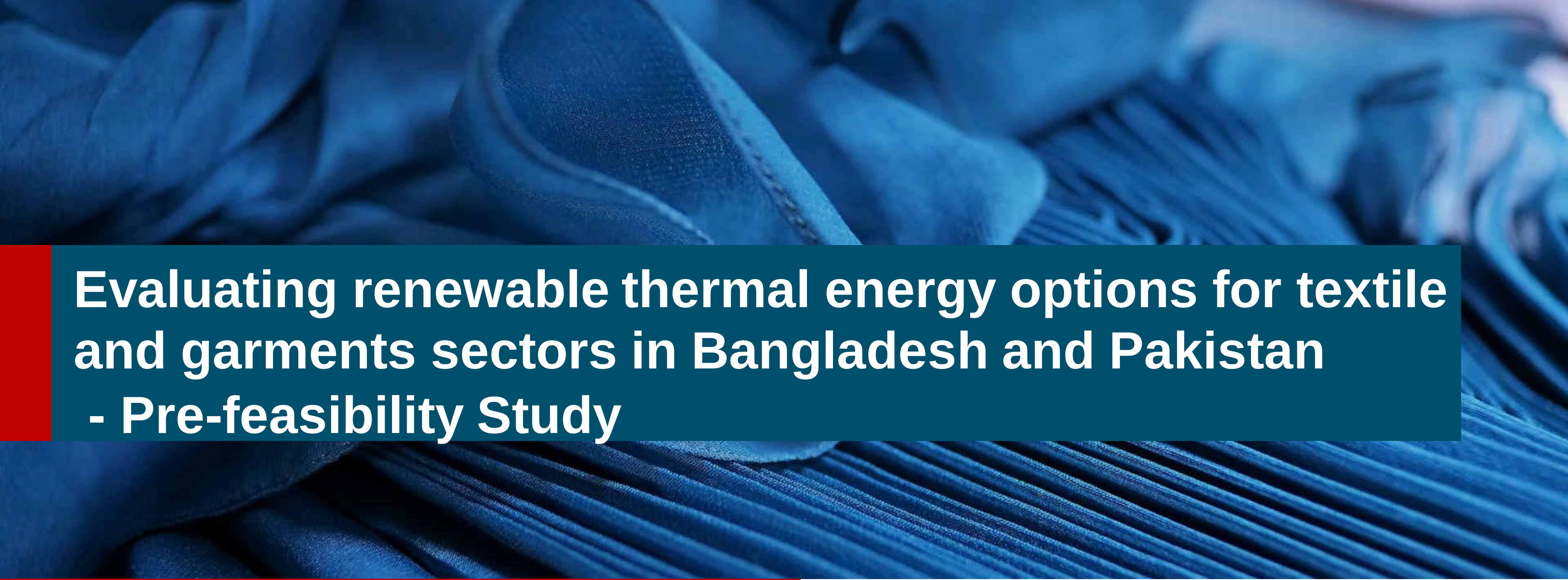
Module 7: Renewable energy potential in textile and garment factories

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

FABRIC Asia



Evaluating renewable thermal energy options for textile and garments sectors in Bangladesh and Pakistan
- Pre-feasibility Study

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At the end of this module you will be able to…

Develop prefeasibility for renewable energy in textile and garment factories

Resources

Evaluating renewable thermal energy options for textile and garments sectors in Bangladesh and Pakistan - Prefeasibility study — Asia Garment Hub

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Content

- Evaluation of options to generate steam using bio-mass and other fuels
- Evaluation of solar water heaters and comparison with solar PV systems
- Trends and feasibilities for textile and garments industry in Pakistan and Bangladesh

OBJECTIVE

The goal of the study is to identify potentials to reduce GHG emissions with focus on renewable energy resources in textile and garments sector

Phase – 1

To conduct a pre-feasibility study on renewable energy market and identify alternative renewable sources for boilers or thermal application replacing fossil fuel in textile and garments sectors of Bangladesh and Pakistan

Phase – 2

To conduct a detail study on the most relevant and suitable renewable energy source to use in the industry

AREAS OF THERMAL ENERGY DEMAND IN TEXTILE AND GARMENT FACTORIES

Woven & Knitted Fabric Processing (Non-denim)	Water	Steam
Fabric Bleaching	✓	✓
Fabric Washing	✓	✓
Fabric Dyeing and Printing (Reactive)	✓	✓
Fabric Finishing	✓	✓
Denim Fabric Processing		
Denim Rope Dyeing	✓	✓
Denim Fabric Processing	✓	✓
Denim Fabric Finishing (Sizing, Mercerizing etc.)	✓	✓
Denim Garment Process		
Denim Garment Dyeing	✓	✓
Garment Washing	✓	✓
Laundry Drying		✓
Garment Finishing	✓	✓
Knitted Garment Process		
Garment Finishing (pressing)		✓

BIO-MASS FOR STEAM GENERATION

RENEWABLE ENERGY OPTIONS EVALUATED

Biomass for Steam Generation
(Combustion and Gasification)

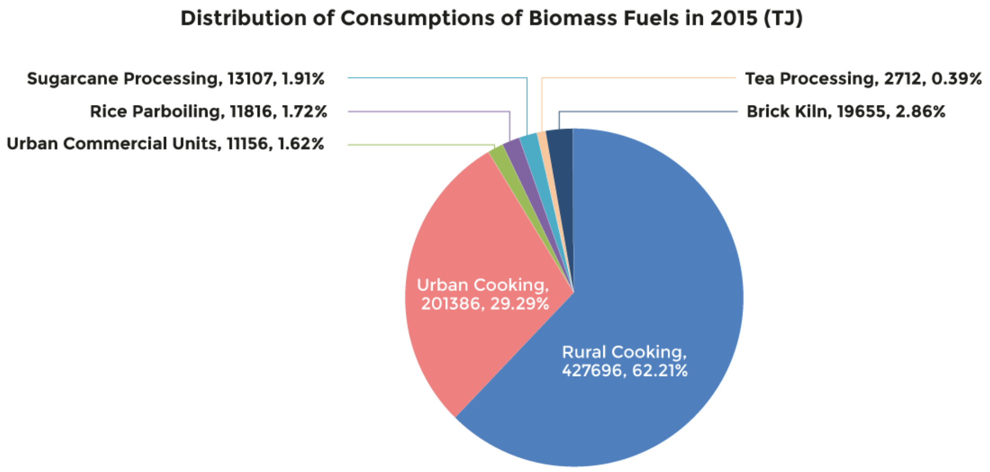
Solar Water Heating

BIO-MASS AVAILABILITY AND USE IN BANGLADESH

Agriculture is the biggest source of biomass

Urban and Rural cooking are biggest consumers of biomass fuel

Bio-mass	Annual Quantity (million tons)	Comments
Tree residues	16.18	Available as fuel as well. Village forest extraction decreasing generally; timber extraction increasing
Agricultural residues	111.00	Mostly used in higher economic value options; ~43 million available for fuel
Animal dung (dry)	10.90	Out of 23.64 million cattle, 97.3% are found in households; mostly used for domestic cooking
Total	138.08	



Source: A comprehensive assessment of the availability and use of biomass fuels for various end-uses with special attention to power generation, SREPGen Project, UNDP Bangladesh, June 2019

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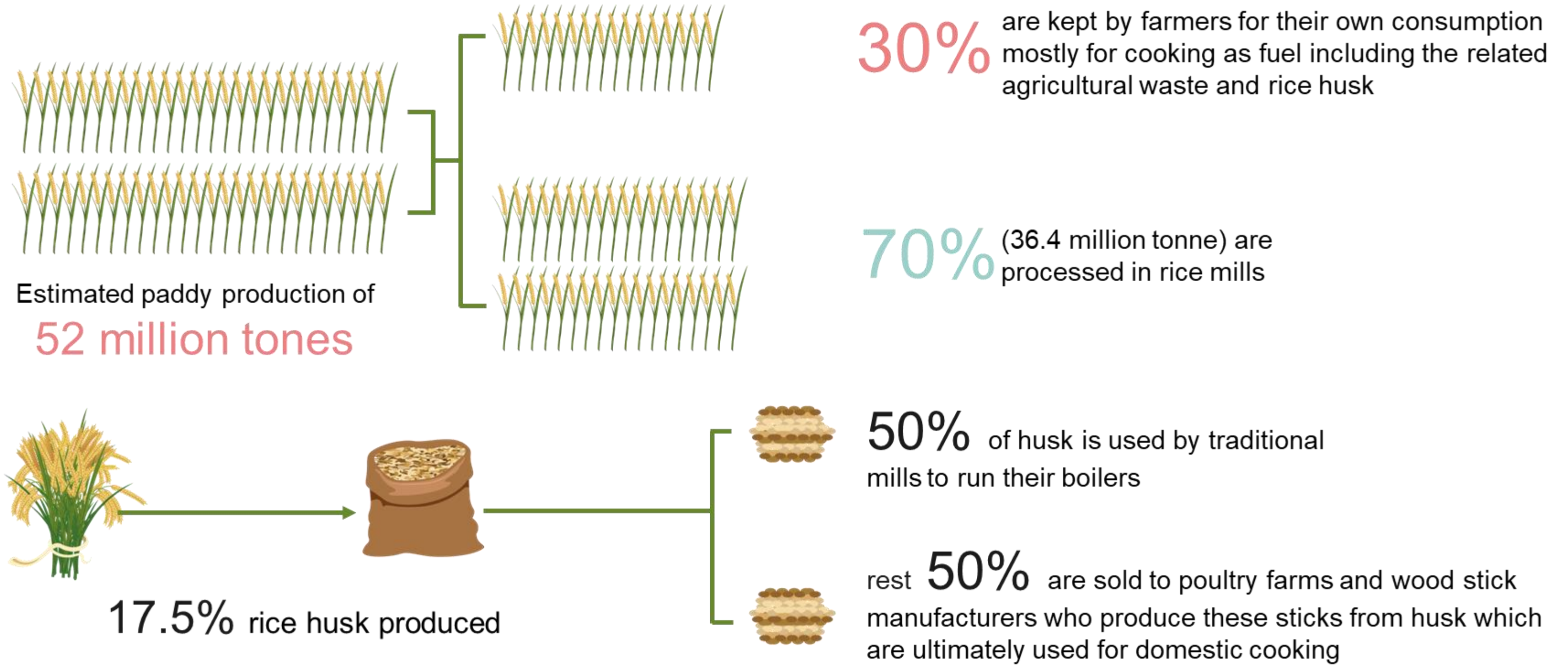
RICE HUSK AVAILABILITY IN BANGLADESH

Very limited quantity of rice husk is available as fuel to industrial sector

Fluctuating supply and price result in higher cost of steam production compared to most commonly available fuel (Natural Gas)



Source: Bangladesh Auto Major and Husking Mill Owners Association (2021)

CURRENT TRENDS IN BANGLADESH

Bio-mass	Price
Rice Husk	8 – 12 USD-cents/kg (7-10 BDT/kg)
Saw Dust	2.3 – 14 USD-cents/kg (2-12 BDT/kg; Average 5 BDT/kg)
Wood logs / chips	4.5 – 5.7 USD-cents/kg (4-5BDT/kg)
Other bio-mass	No reliable price data available

CURRENT TRENDS IN BANGLADESH

Tendency to shift from bio-mass to natural gas as soon as a gas connection is awarded	Lowest cost option for steam generation
	Capacity utilization of co-generation systems with Gas fired engines
	Fluctuation in supply and prices of bio-mass
	Storage requirements due to high moisture in bio-mass
Continuing users	Companies having access to cheap bio-mass (located near the sources)
	Using bio-mass boilers as back-up option in case of low natural gas pressure

BIO-MASS AVIABLITY FROM VAROUS SOURCES IN PAKISTAN

Bio-mass	Bio-mass available for energy generation (Million Tonne / Year)	NCV (MJ/kg)	Energy generation potential (GWhth/year)
Sugar Cane Trash	2.0	12.6	555.55
Rice Straw	2.23	12.5	619.44
Rice Husk	0.44	13.5	122.22
Cotton Stalk	2.67	15.0	741.66
Maize Cob	0.26	14.0	72.22
Maize Husk	0.173	11.6	48.05
Maize Stalk	0.985	13.0	273.61
Bagasse	Negligible	7.5	0.00
Wheat Straw	Not Considered	14.4	0.00
Sub-total	8.758		2,432.77

Estimated using updated crop data and Residue to Crop Ratio identified by World Bank Report in 2016.

2,432.77 GWhth
is equivalent to

73 MW power generation

or

361.2 TPH Steam generation

Not very significant considering the collection and supply chain challenges of bio-mass, and demand of textile and garment industry

CURRENT TRENDS IN PAKISTAN

Bio-mass	Price
Rice Husk	5.5 – 8.0 USD-cents/kg (9-13 PKR/kg)
Maize Cob	5.5 – 8.0 USD-cents/kg (9-13 PKR/kg)
Other bio-mass	No reliable price data available

CURRENT TRENDS IN PAKISTAN

Gas fired boilers converted by adding poorly designed refractory furnaces for bio-mass burning resulting in low efficiency and high maintenance cost

Rapid conversion to Rice husk was not supported by supply chain so price fluctuations were unprecedented

Heavy investments needed for pollution control (especially Particulate Matter)

Low availability of bio-mass due to seasonal affects

Post combustion issues: Ash equivalent to ~30% of fuel is generated. This ash was welcomed by farmers initially but then farmers slowly declined as it suited less to their needs.

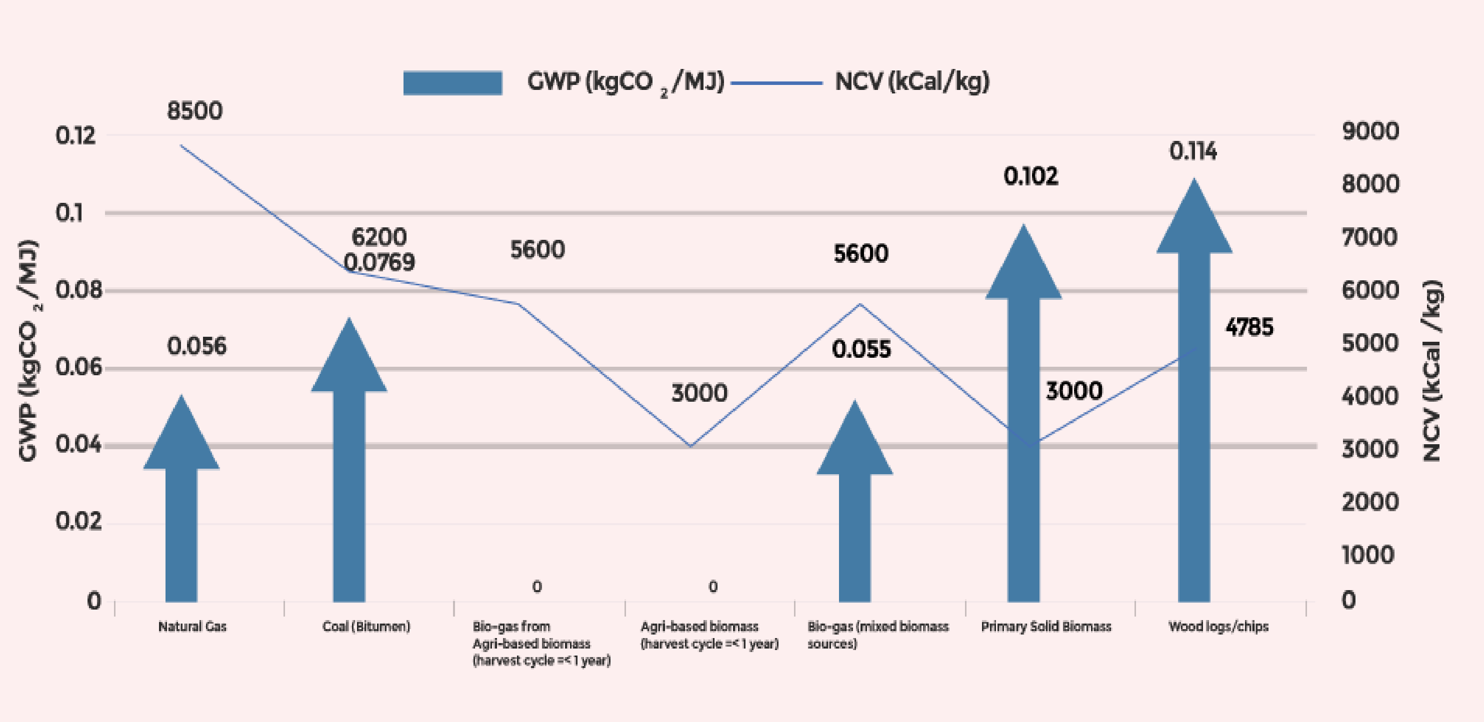
Very low calorific value and high moisture content compared to coal and other fuels

GLOBAL WARMING POTENTIAL AND CALORIFIC VALUES OF AVAILABLE FUELS FOR BOILERS

Agri-based bio-mass is considered to have Net-Zero Emissions as per IPCC 2019

General NCV of agri-based bio-mass is quite low compared to Natural Gas and other alternatives

Bio-gas contains higher NCV but becomes even more expensive, and requires larger scales



TECHNOLOGY OPTIONS FOR STEAM BOILERS (CONSIDERING 10TPH BOILER)

Fuel	Boiler technology	Investment (USD)	Investment for emission control equipment (USD)	Additional Space Required
Natural Gas	Fire tube	220,000	-	-
Rice Husk	Water tube Travelling Grate, Circulating Fluidized Bed	320,000 – 400,000	18,000 – 40,000	7,700 m^3
Rice Husk briquettes	Water tube Travelling Grate	Boiler 320,000 – 400,000 Briquetting machine ~5,000	18,000 – 40,000	9,000 m^3
Wood Logs / chips / saw dust / Maize Cob	Water tube Travelling Grate	320,000 – 400,000	18,000 – 40,000	7,700 m^3
Wood chip / saw dust briquettes	Water tube Travelling Grate	Boiler 320,000 – 400,000 Briquetting machine ~5,000	18,000 – 40,000	9,000 m^3 for storage
Bio-gas (Agri-based or sewage waste bio-mass)	Bio-gasification + fire tube boiler	860,000 – 1,100,000	-	7,700 m^3 for storage 1,676 m^3 for gasifier

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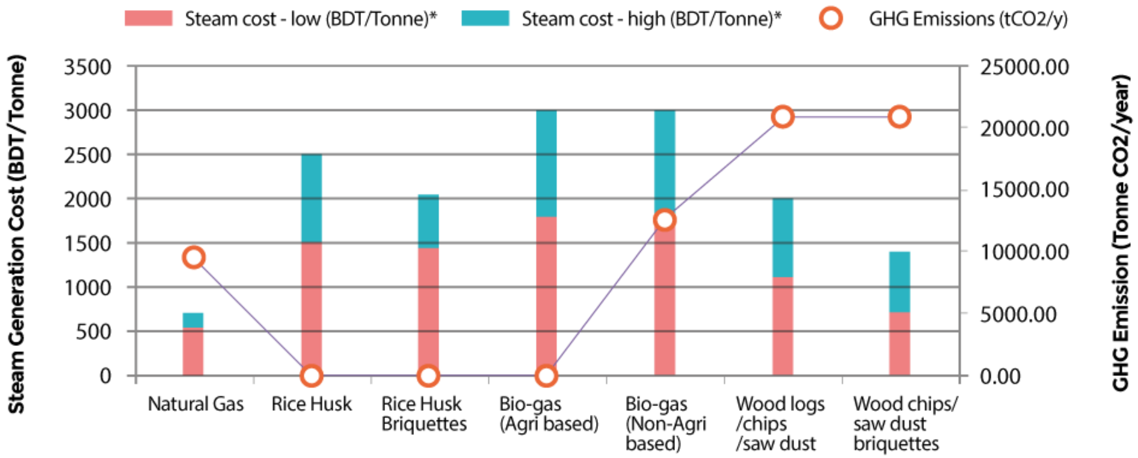
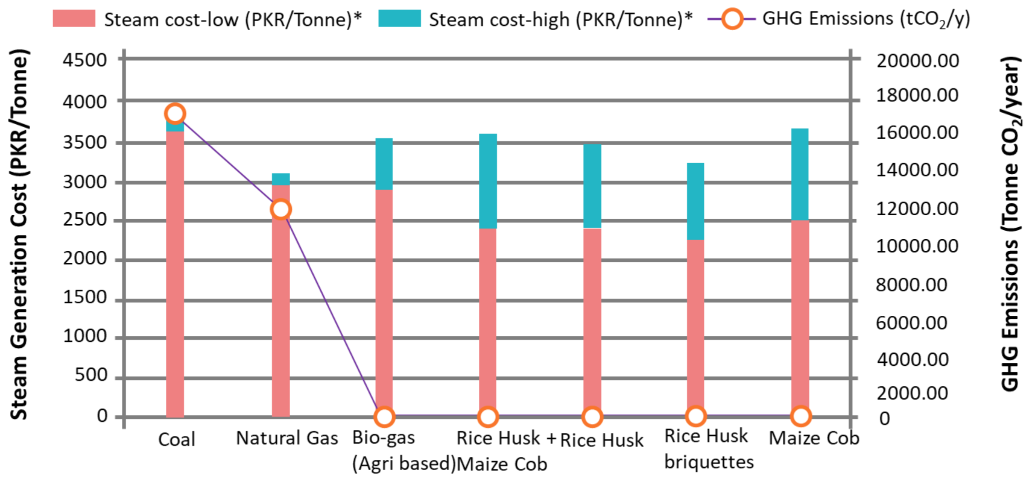
TECHNOLOGY OPTIONS FOR STEAM BOILERS (CONSIDERING 10TPH BOILER)



Steam cost and Annual GHG emissions for 10TPH Boiler on various fuels in Bangladesh



Steam cost and Annual GHG emissions for 10TPH Boiler on various fuels in Pakistan

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RATIONAL FOR SWITCHING TO AGRI-BASED BIO-MASS

01

Bio-mass is expensive but has lesser net GHG Emissions making it suitable in terms of climate improvement targets

02

Briquetting reduces the steam generation cost significantly as it has better calorific value due to reduced and controlled moisture in the bio-mass

03

Suitable fuel mix may be selected by trading-off between steam cost and GHG emissions

04

Latest trends of rapidly increasing Natural Gas and other fossil fuel prices in both countries as well as globally

LIMITATIONS OF BIOMASS BASED STEAM GENERATION SYSTEM

- Natural gas combustion efficiency is easier to control compared to solid fuels like bio-mass
- Bio-mass fuels require extensive monitoring and manual control by operators; automation works only if bio-mass type is fixed, and quality is consistent
- Not all boilers can fire all types of bio-mass materials
- Moisture in bio-mass varies across the year which significantly effects boiler combustion efficiency
- Large storage space and high man-power required
- Bio-mass price fluctuations result in significant variation in steam generation cost
- Challenging to manage the supply chain for bio-mass
- Special arrangements required for
  - filtering out the pollutants from air and water
  - drying, handling and storing the ash
  - safe disposal of ash

Not enough bio-mass available to drive a major shift from fossil fuels to bio-mass for energy generation in both countries.

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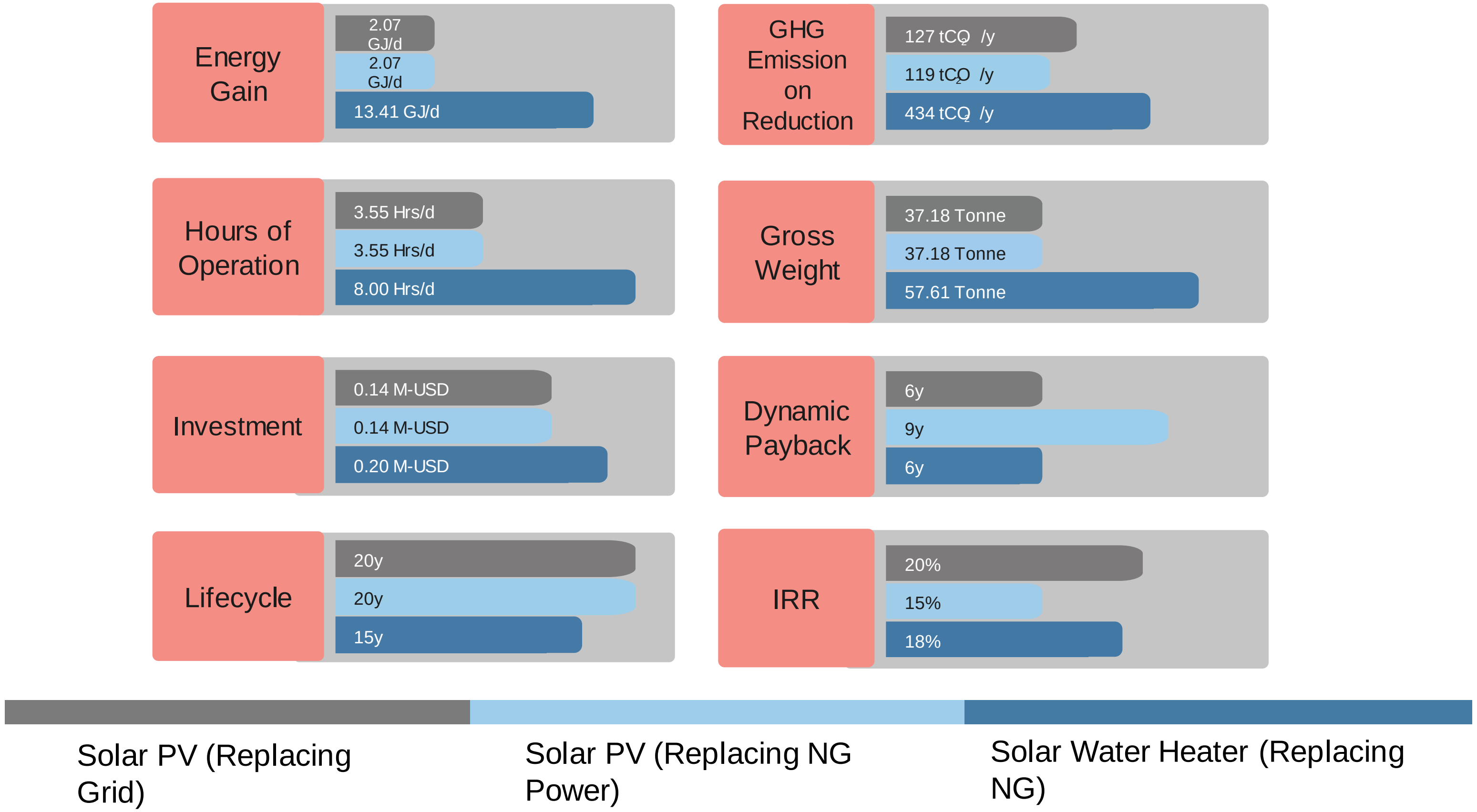
SOLAR THERMAL ENERGY

SOLAR WATER HEATERS ARE MORE FEASIBLITY COMPARED TO SOLAR PV – BANGLADESH

Comparison is made for similar rooftop area coverage by both systems
10 m³/hr Solar Water Heater Vs 203 kW-DC Solar PV



SOLAR WATER HEATERS ARE MORE FEASIBLITY COMPARED TO SOLAR PV – PAKISTAN

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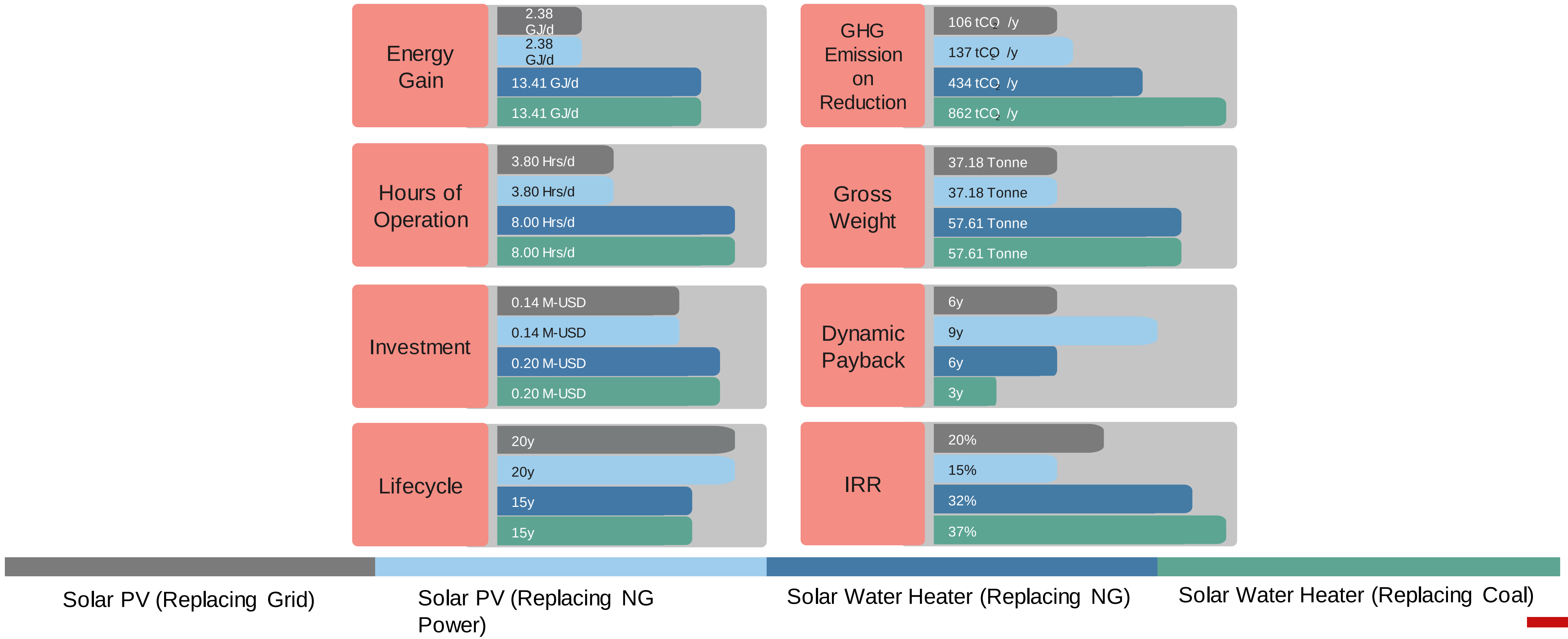

COMPARISON BETWEEN SOLAR WATER HEATER AND SOLAR PV

Companies prefer Solar PV due to ease of operation and lower operational and maintenance cost

Solar PV systems require much more investment for same amount of energy compared to solar water heater. Payback period for Solar PV replacing Natural Gas based power is even longer; hence the low IRR.

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COMPARISON BETWEEN SOLAR WATER HEATER AND SOLAR PV

Companies prefer Solar PV due to ease of operation and lower operational and maintenance cost

It is much easier to install and operate solar PV system as they do not require allied utilities like pumps, heat exchangers and storage tanks.

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COMPARISON BETWEEN SOLAR WATER HEATER AND SOLAR PV

Companies prefer Solar PV due to ease of operation and lower operational and maintenance cost

Specific weight of the Solar PV system is much lesser than that of solar water heaters reducing requirements for structural reinforcement.

COMPARISON BETWEEN SOLAR WATER HEATER AND SOLAR PV

Companies prefer Solar PV due to ease of operation and lower operational and maintenance cost

Potential to reduce GHG emissions is much higher for Solar Water Heater compared to Solar PV.

COMPARISON BETWEEN SOLAR WATER HEATER AND SOLAR PV

Companies prefer Solar PV due to ease of operation and lower operational and maintenance cost

Solar water heaters have shorter lifecycle compared to Solar PV and also have higher operations and maintenance costs.

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IMPORTANT FACTORS IN CHOOSING BETWEEN SOLAR ENERGY OPTIONS

01 Requirement of hot water in garment washing process is usually intermittent. However, careful planning and proper designing and insulation of water circuit may resolve this issue to some extent.

02 Industrial scale Solar Water Heaters may not be feasible for factories using steam only for garment pressing

03 Solar water heaters are highly suitable for factories having more stable hot water demand, such as fabric processing mills and large garment washing units.

04 Solar PV systems require much more investment for same amount of energy compared to solar water heaters. However, it presents considerably less challenges.

05 GHG emission reduction for solar PV is considerable when replacing grid power, however, potential significantly reduces when replacing natural gas power.

Key takeaways

MAPPING POTENTIAL FOR RENEWABLE ENERGY SOURCES

Renewable Energy Options	Energy Cost	GHG Emission	Nature and Direction of Regulation
Bio-mass	Increased steam cost compared to natural gas	No GHG emission accounted for agri-based bio-mass with harvest cycle equal or less than 1 year	No restriction
Solar Thermal	Financially feasible even when compared with Natural gas fired steam boilers	Significant reduction	Supportive
Solar PV	Financially feasible compared to grid; longer payback against natural gas-based power	Significant reduction	Supportive

MAPPING POTENTIAL FOR RENEWABLE ENERGY SOURCES

Renewable Energy Options	Geography	Seasonality	Key Vendors	Pricing Considerations	Current Uses
Bio-mass	Geographical variation in supply; Supply chain data only up-till 2015	Fluctuating based on crop harvesting cycle	No formal data of bio-mass suppliers; technology suppliers available but not formally organized	Basic price data available; concrete fluctuation data not available	Data only up-till 2015 for BGD. Estimates made for 2019-20 for PAK based on data of 2015.
Solar Thermal	Geographically variable irradiation potential	Seasonally variable irradiation potential	Limited suppliers for industrial solutions, not formally organized	Generally established prices but variable based on currency exchange rate	No mapping available for industrial sector
Solar PV	Geographically variable irradiation potential	Seasonally variable irradiation potential	Bangladesh Solar and Renewable Energy Association; Bangladesh Solar Energy Society. Multiple vendors in Pakistan.	Generally established prices but variable based on currency exchange rate	No mapping available for industrial sector

Plan next steps

- Identify and evaluate renewable energy options suitable to the site
- Develop business case for top management approval including technical and financial pre-feasibility

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