Latest Development in Indian Sugar Industries for Energy Efficiency/Conservation

सत्यमेव जयते

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Overview..

- Introduction
- Why manage/conserve energy
- Why manage energy in a sugar plant
- Management of inputs
- Management of outputs
- Way forward

Introduction

Nature has given us resources such as Fuel, Water, Air etc. in limited quantity..

60% of coal and other fossil fuels have already been consumed in the last 200 years

85% of world industrial need is presently being met from non-renewable sources

Exploration, transportation and burning of fossil fuels create irreversible environment change

All Energy efficiency/conservation measures lead to reduction in GHG emissions ultimately

Resources have to be used Efficiently to improve profitability

Only by Energy Conservation/Energy Efficiency, **fossil fuels may last longer**

Overview..

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Why manage/conserve energy

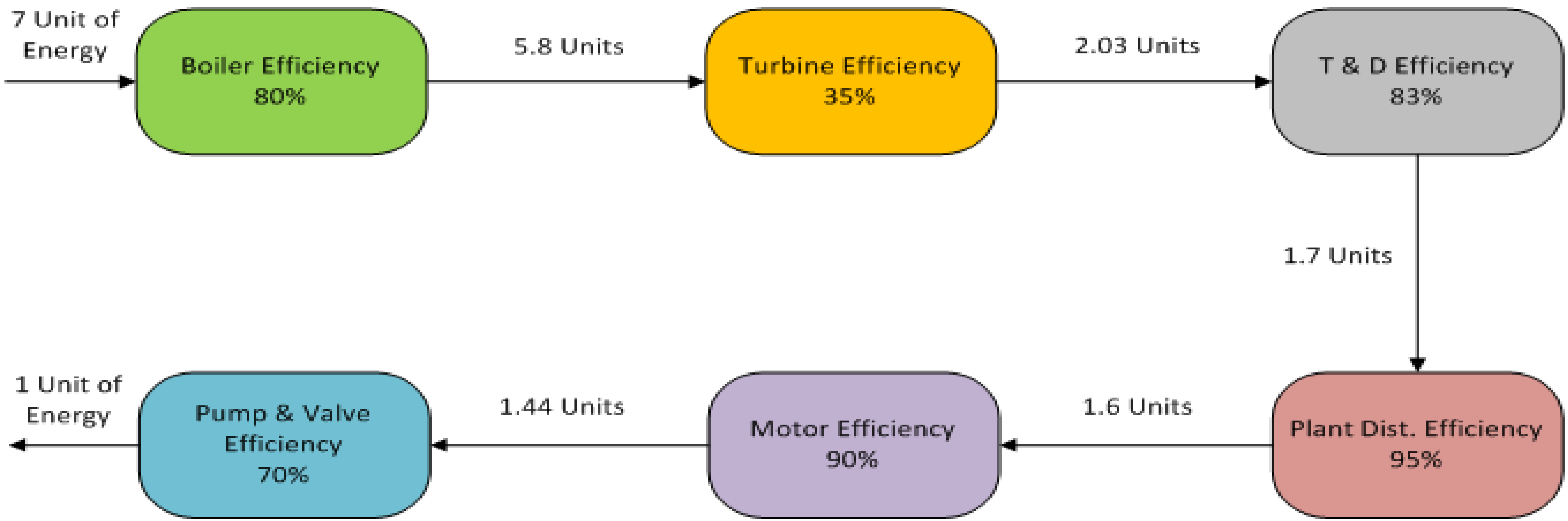
Why manage energy in a sugar plant

Management of inputs

Management of outputs

Way forward

Why Manage/Conserve Energy



For generating 1 KWh of electricity, 7 KWh equivalent energy of fuel is consumed

By saving 1 KWh of electricity, 1.6 kg CO_2 emission can be reduced

Overview..

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Why Manage/Conserve Energy

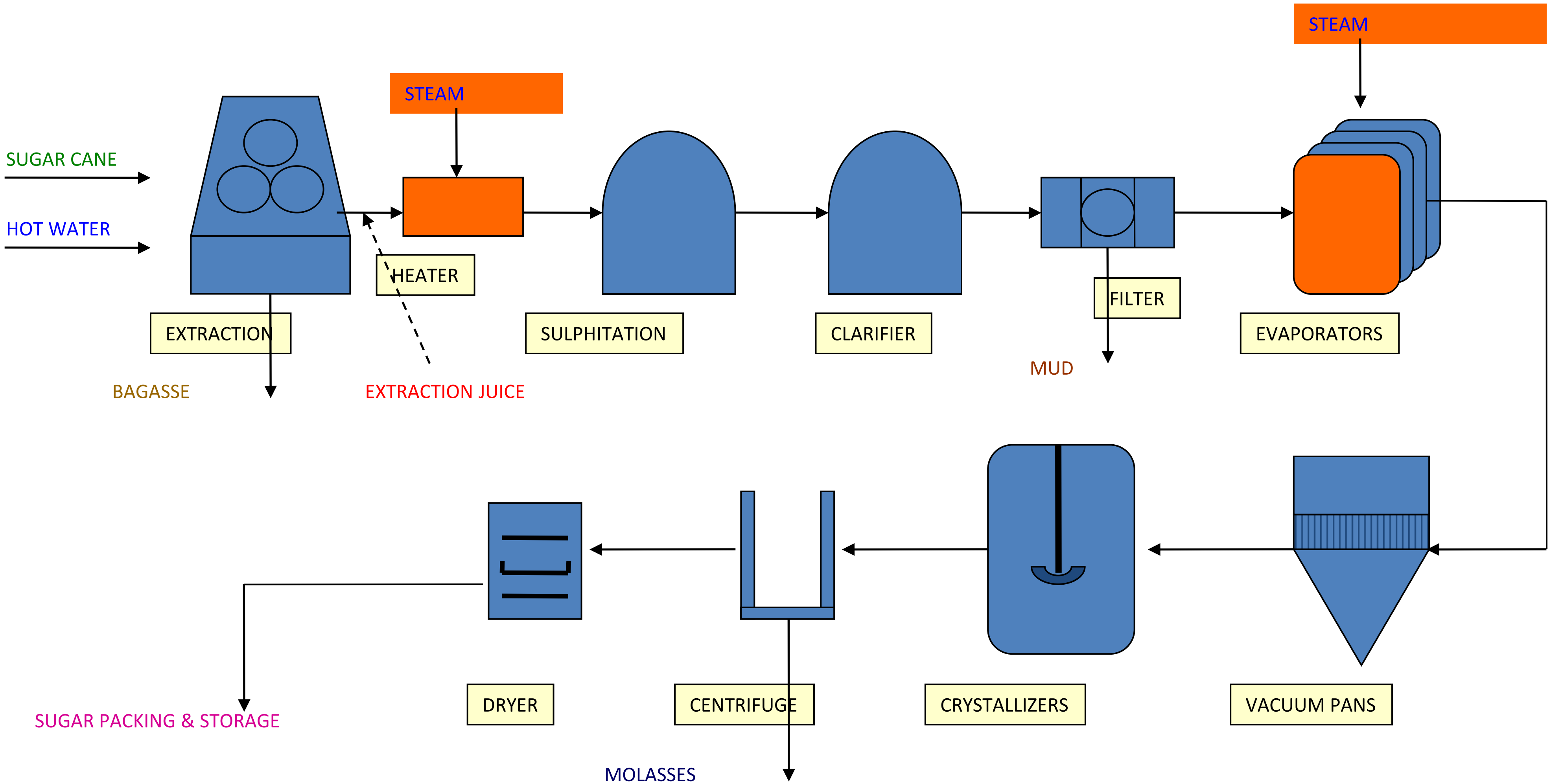
Why Manage Energy in a Sugar Plant

Management of Inputs

Management of Outputs

Way Forward

Use of Energy in Cane Sugar Process



Why Manage Energy in Sugar Plant

	Particulars	Government controlled	Company controlled
Inputs	Cane	Price and quantity	
	Steam Energy		Quantity and cost
	Captive Power		Quantity and cost
	Chemicals		Quantity and cost
	Over heads		Quantity and cost
Outputs	Sugar	Price and quantity	
	Bagasse- Surplus power export	Price	Quantity
	Molasses- Ethanol	Quantity	Price
	Filter Cake- CBG/ Bio-CNG		Quantity and Price
	CDM & REC	Approval Govt. controlled	Quantity and Price

Why Manage Energy in Sugar Plant..

- Indian sugar industry is highly energy-intensive
- At present, efficiency is well below that of other industrialized countries
- Energy conservation measures shall lead to reduction in cost of sugar production
- To make Indian Sugar Industry more competitive globally

Overview..

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Management of Outputs

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Why Manage/Conserve Energy

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Management of Inputs

- Cost of Inputs
- Industry Average and Scope for Improvement
- Why such a big gap
- How to bridge it

Management of Outputs

Way Forward

Cost of Inputs

Particulars	Per MT on Cane	Per MT on Sugar (Rs.)	% of Total
Cane	Rs. 3150/-	31500	77
Steam Energy	45.0%	3680	9
Captive Power	30 KWh	1500	4
Chemicals	Rs. 50/-	500	1
Over heads	Rs. 350/-	3500	9
Total	**-**	**40680**	

Overview..

Industry Average and Scope for Improvement

Particulars	Per MT on Cane	Industry best	Scope of improvement	Saving * (Rs. Lakh/ season)
Cane	Rs. 31500/-		-	-
Steam Energy	45.0%	35.0%	10.00%	655
Captive Power	30 KWh	22 KWh	8 KWh	400
Chemicals	Rs. 50/-			
Over heads	Rs. 350/-			

*Saving for 5000 TCD sugar plant at 100% CU

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Why such a big gap

- Most of the sugar process plants are a combination of old and new
- Most of the old equipments are Energy Inefficient
- Traditionally the cost of fuel (bagasse) was very low (Rs 300/MT as compared to the present cost of Rs 1800/MT)
- Before 2006 there was no policy in the UP State to sell surplus power to the SEB
- The cost of energy input used to be insignificant compared to the cost of cane
- Cane supply tapering in the start and end of season has become very prominent
- Equipments are not designed to operate efficiently on part load

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  - Reduction in Captive Power Consumption
  - Reduction in Process Steam

Management of Outputs

Way Forward

How to bridge it

Every plant has a unique configuration of process equipments, unique supply pattern of cane, unique power generation & distribution s/s and unique grid response etc.

Energy audits must be made on regular basis

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Management of Outputs

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Reduction in Captive Power Consumption..

- HT motors in place of LT motors at cane preparatory devices
- Planetary/ helical gearing system in place of conventional gearing system
- Fibrizer with swing type hammer in place of conventional one
- Domite tip knife in place of conventional knife
- Replacement of knife/ hammer tip as per electrical loading on preparatory devices
- High voltage (690 V) AC Variable frequency drives for milling/ juice extraction
- Antifriction bearings at head & tail shafts of cane carrier and mill transmission gears
- Complete automation of mill house i.e. Automatic cane feed control system (ACFCS)

Reduction in Captive Power Consumption..

- Cooling & Condensing water/ vacuum automation in boiling house
- Higher capacity batch centrifugal machines in place of lower one
- Complete automation of boiling house i.e. clarification/ pan/packing sections etc.
- Belt conveyors in place of slat/ chain conveyors
- Gravity controlled boiling house
- Screw pump in place of gear pump for molasses & melt pumps
- Complete automation (DCS & VFDs)of steam/power generating plant
- Automatic power factor control (APFC) system

Reduction in Captive Power Consumption

- Efficient water management/ minimize bore well water extraction
- Variable frequency drives in place of control valves/ throttle valves for fluid control
- Variable frequency drives in place of control valves/ dampers for air control
- Regenerative braking type drives at batch centrifugal machines
- Energy efficient electric motors
- Re-examining the rating of motors and pumps corresponding to new plant capacities
- Operate plant at rated capacity/ equipment rationalization as per crush rate
- Efficient lighting system

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Management of Outputs

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Reduction in Process Steam..

- Waste heat recovery units
- Condensate heat recovery
- Efficient evaporator configuration/ bleeding arrangement
- Proper equipment design for heat recovery
- Use of continuous pan on B and C massecuite boiling
- 1st vapor in place of exhaust steam for molasses conditioning & pan washing
- Increase exhaust condensate recovery by putting steam trap in all drains
- Use of continuous blow down flash in preheating of makeup water

Reduction in Process Steam

- Use of surplus hot condensate 80-85°C as maceration water to increase mix juice tem
- Automatic exhaust steam control system to minimize steam blow off
- Proper lightly resin bonded (LRB) insulation of pipelines
- Discouraging the production of bold grain sugar
- Complete automation & controls of process house

Waste heat recovery units

1 - Vapor line juice heaters

2 - Clarifier flash vapor utilization

3- Waste heat recovery boiler for sulphur melting

4 - LTEM in pans & evaporators

1 - Vapor line juice heaters

- Use of vapor line juice heaters after the last evaporator body to raise the temp. 30°C-48°C will result in reduction of steam
- Saving in steam is 0.7% on cane

2 - Clarifier flash vapor utilization

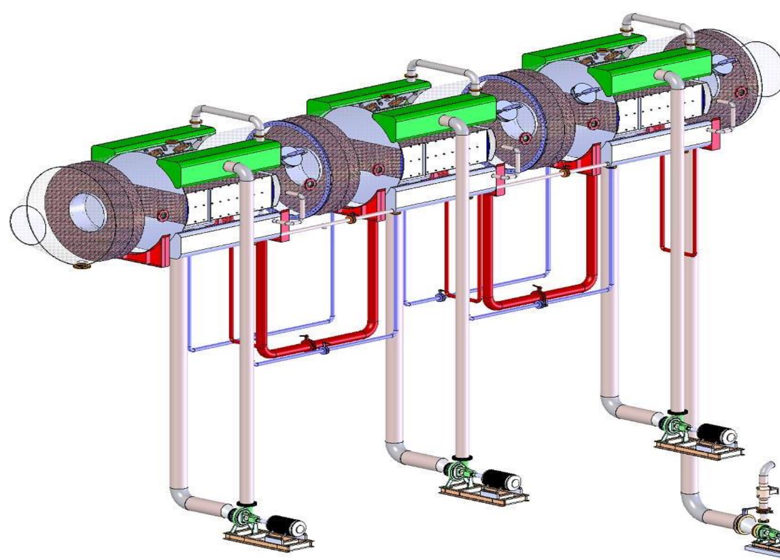
- Flash vapors going to the atmosphere from flash tank may be utilized for SJ (3rd stage) heating in a direct contact heater (90°C-93°C)
- Saving in steam is 0.12% on cane

3- Waste heat recovery boiler for sulphur melting

- Conventionally sulphur melting is being done by 7 Kg/cm^2 Steam
- Heat recovery from Sulphur burner may produce 7 kg/cm^2 Steam for sulphur melting.
- Scrubbing of excess heat of SO_2 gas through Heat Exchanger
- Saving in steam is 0.45% on cane

4 - LTEM in pans & evaporators

- Pan Vapors are going to condensing system and the **Energy is wasted** in the form of Evaporation losses in Spray Ponds.
- Introduction of Falling Film Plate evaporation for Pan vapors has enabled use of Low Temperature Pan vapors of 62°C for heating of Clear Juice and low temperature vapors of about 48°C is sent to spray pond
- Saving in steam is 4.0% on cane
- Heat load on Spray Ponds is also reduced substantially



Condensate heat recovery

1- Cigar for Flash vapor recovery

2- Use of Cigar condensate to heat raw and sulphited juice

3 - Use of pan condensate to heat FBD hot air

4 - Use of 1st grade condensate to heat SHWW

1- Cigar for Flash vapor recovery

- The condensate from each effect of evaporator is flashed in a flash vessel, leaving out only a flashed condensate of temperature 80°C.
- Thus, the differential heat from 115°C to 80°C is completely flashed out in cigar and used completely in the system.
- Saving in steam is 2.50% on cane

2- Use of Cigar condensate to heat raw and sulphited juice

- Use of Condensate to heat Raw & Sulphited juice (1st Heating) through tubular heaters.
- The condensate coming out from the cigar last compartment (80°C) may be used to heat raw juice (2nd Stage) from 55°C-70°C
- Saving in steam is 0.60% on cane

3 - Use of pan condensate to heat FBD hot air

- The condensate from pan may be utilized for heating air to 80°C for FBD in place of 7 Kg/Cm^2 Steam
- Saving in steam is 0.10% on cane

4 - Use of 1st grade condensate to heat SHWW

- Use of Exhaust condensate for heating of condensate from cigar for SHWW. The condensate from 3rd compartment cigar at 95°C may be taken out & heated with Exhaust condensate with a Plate type heat exchanger to a temp. of 115°C for SHWW
- Saving in steam is 0.25% on cane

1 - Quad to Quintuple

- Changing the configuration of evaporator from Quad to Quintuple and corresponding change in the bleeding /sweeping arrangement
- Saving in steam is 1.8% on cane

2 – A1 massecuite boiling

- Use of A-1 massecuite boiling on 3rd vapor
- Saving in steam is 0.50% on cane

Direct Contact Heater (DCH)

- Use of Direct contact heaters in place of Tubular. DC heaters are heat exchangers in which heating & the heated media come in contact with each other in a counter current flow.
- With these heaters sulphited juice heating may be done in 4 stages as
- 1st heating – 4th effect swept vapor (68°C-78°C)
- 2nd Heating with 3rd effect swept vapors (78°C-90°C)
- 3rd heating may be done with the flash vapors of flash tank (90°C -92°C)
- 4th heating may be done with the 2nd effect vapors (92°C-102°C)
- Saving in steam is 1.40% on cane

Efficiency Class of Induction Motor

European Efficiency Classification

Efficiency class	Motor	Efficiency
EFF - 3	Normal Standard Motor	<83%
EFF - 2	Improved Efficiency Motor	>87%
EFF - 1	High Efficiency Motor	>92%

Efficiency Class of Induction Motor

International Electro technical Commission (IEC) standards

Efficiency class	Motor	Efficiency
IE - 1	Standard Motor	<86%
IE - 2	High Efficiency Motor	>89%
IE - 3	Premium Efficiency Motor	>93%

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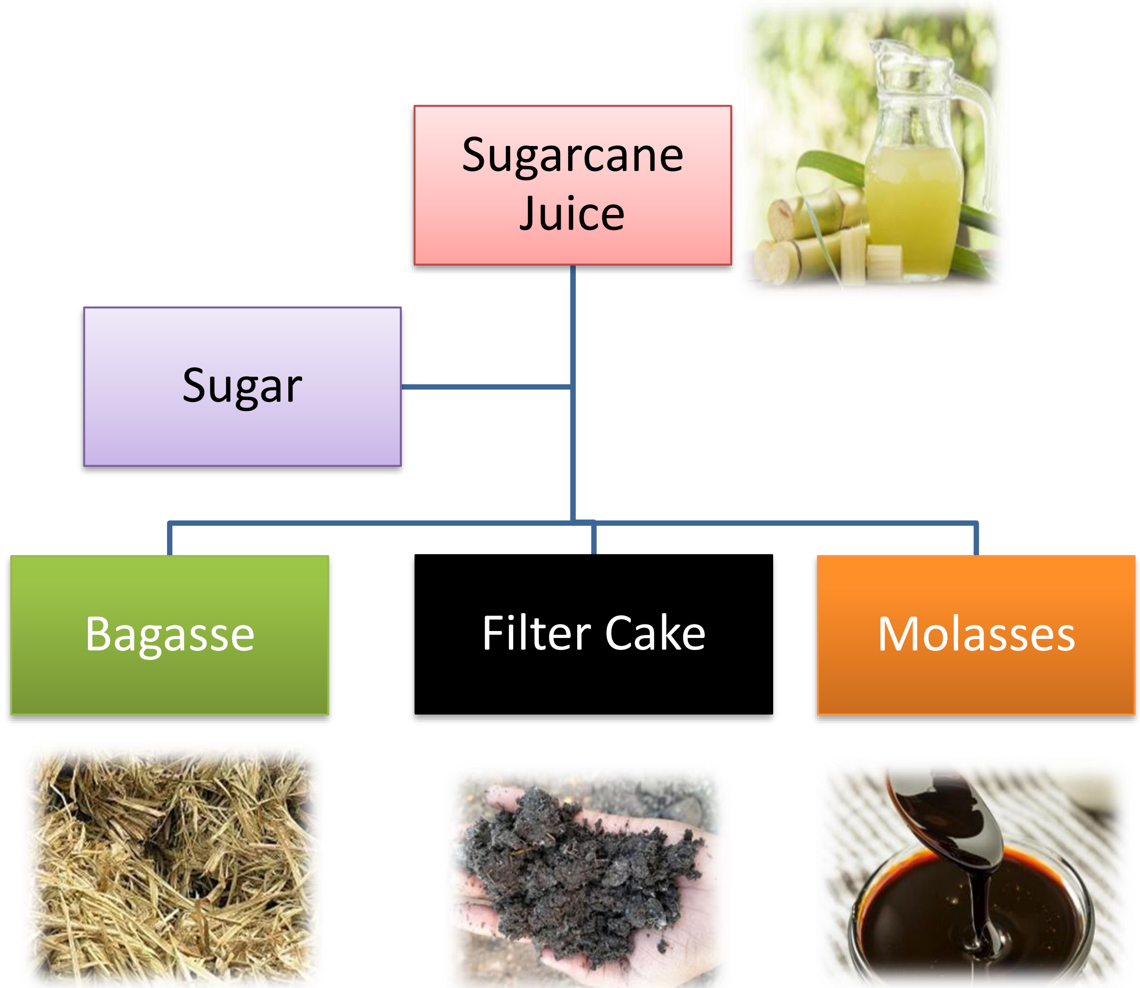
- Better Utilization of By-products

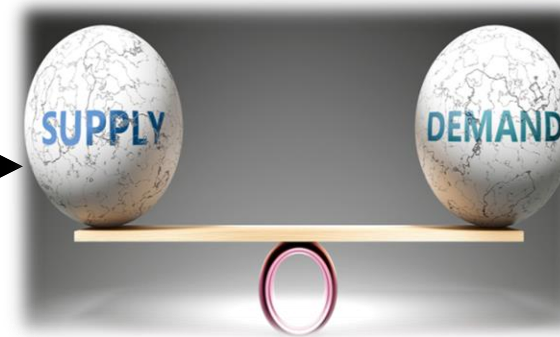
Way Forward

PAST...



NEED FOR TRANSFORMATION OF SUGAR INDUSTRY

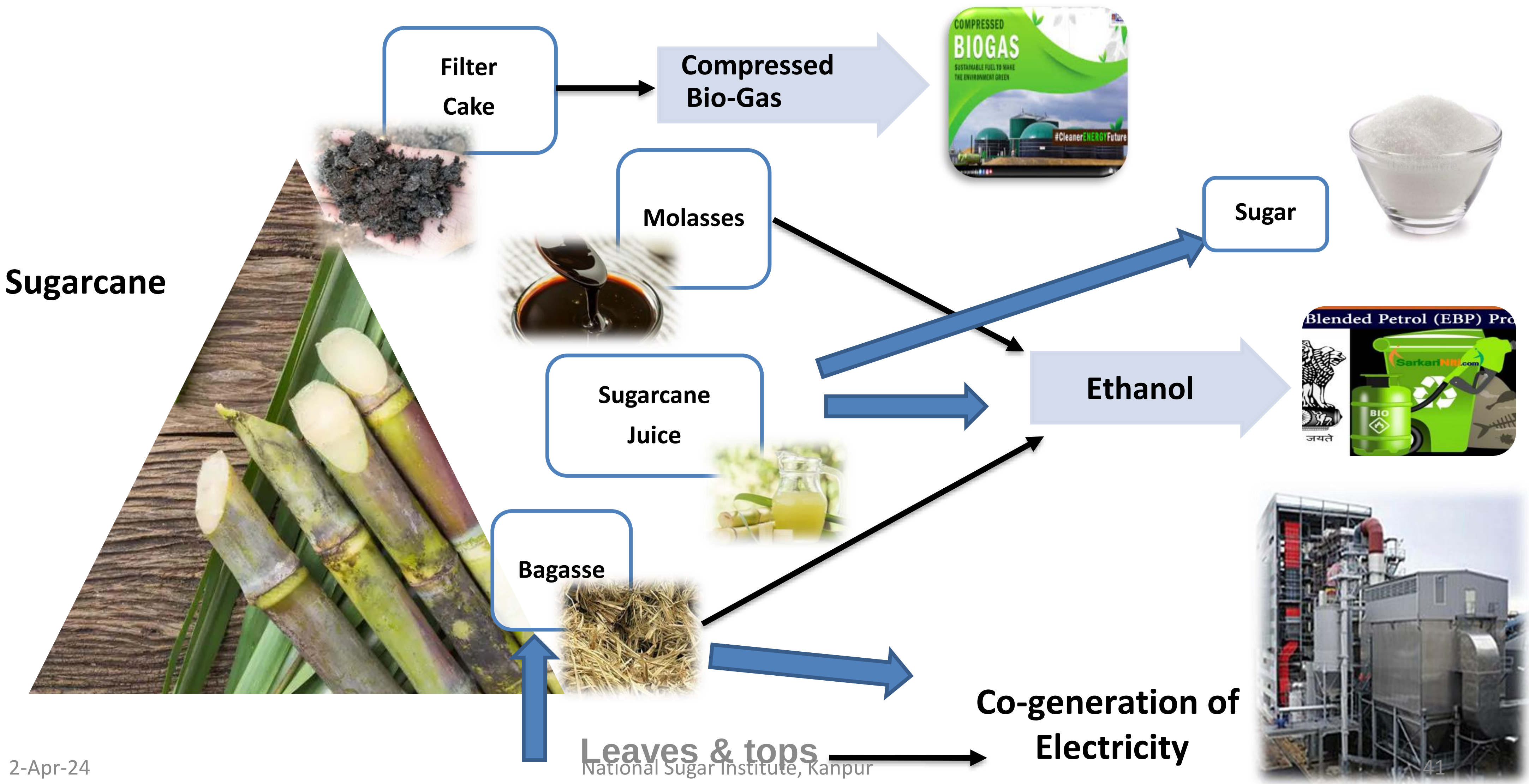
Energy security



Demand-supply balance

Economic & Environmental Sustainability

PRESENT (BIO-ENERGY HUB)



FUTURE
(Bio-Refinery)

Bagasse

- Bio-composites
- Tableware
- Particle Board
- Pulp
- Biochemicals
- Ethanol
- Renewable Electricity
- Dietary Fibre

Molasses

- Bio-fuels
- Pharma Products
- Industrial Products
- Cattle Feed
- Bio-plastics

Sugarcane

Filter cake

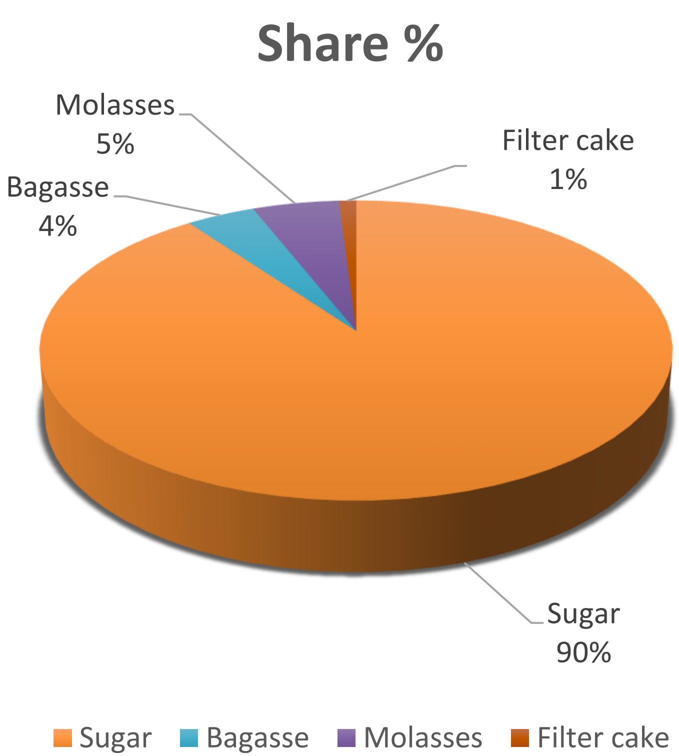
- Fertilizers
- Bio-gas/ Bio-CNG
- Wax

Sugar

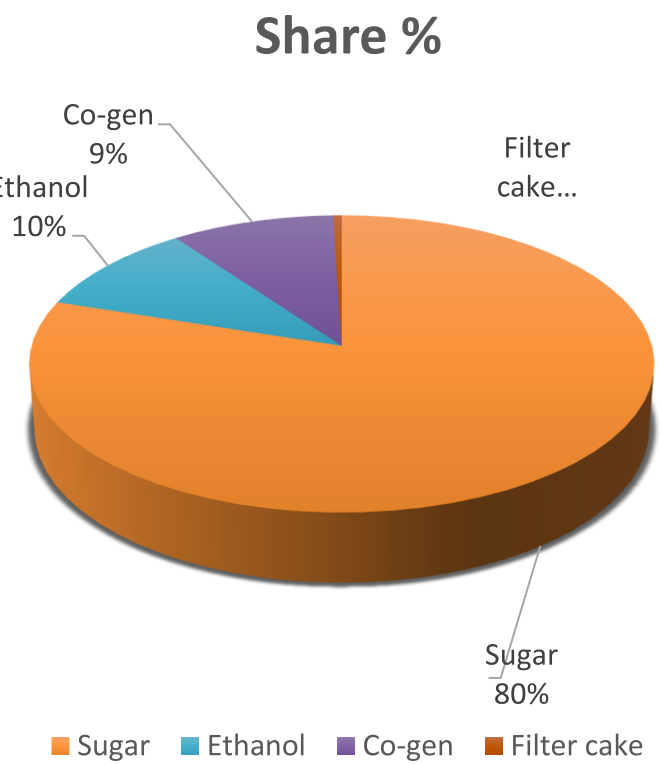
- Speciality Sugars
- High Value Chemicals

VALUE ADDITION AND ECONOMIC SUSTAINABILITY

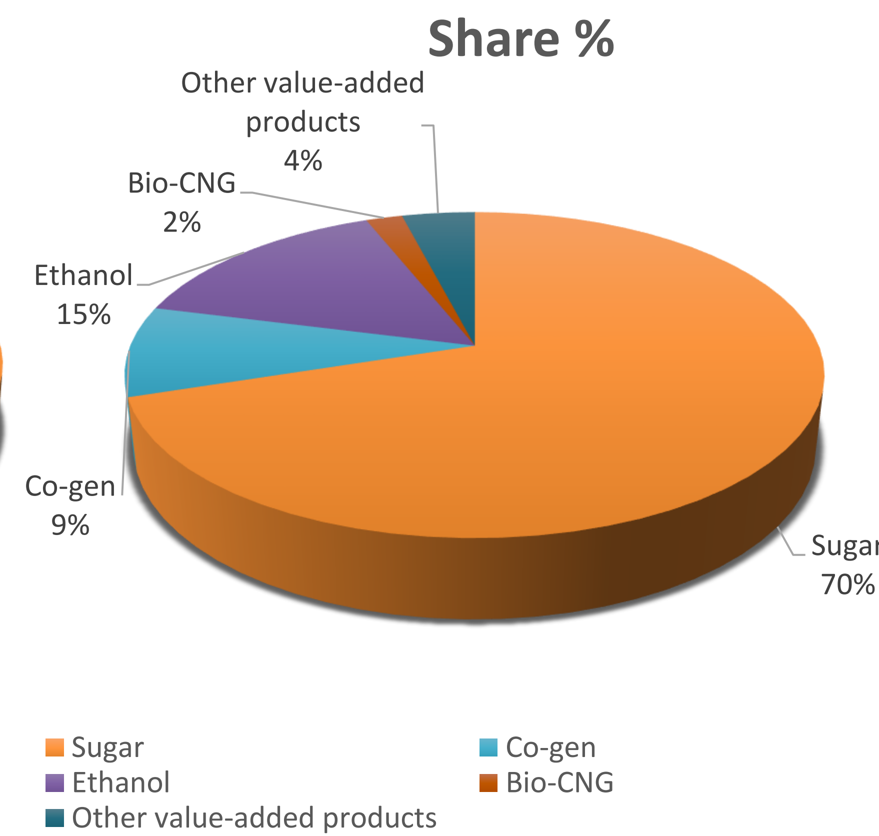
…. SHARE OF VARIOUS COMPONENTS IN TOTAL REVENUE GENERATION



PRIMARY SALE OF BY-PRODUCTS



SECONDARY UTILIZATION OF BY-PRODUCTS



VALUE ADDED PRODUCTS

Practical Approach Towards Bio-Refinery Concept

- Number of products can be thought of, but for many of them, greater research shall be required w.r.t. technology, cost of production, market competitiveness, market requirements and policies.

- However, some of the value added products which appear to have no technological barriers and market, can be considered for adoption as discussed subsequently.

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POWER GENERATION: IMPORTANCE OF SPR'S

S. No.	Part of the Sugarcane Plant	Dry Matter by Weight %	% Energy Content
1	Roots	2	1.23
2	Stalk	58	62.63
3	Leaves	14	24
4	Top	26	12.14

At present, only sugarcane stalk is processed to extract juice and bagasse, the fibrous residue left over after the milling. The balance 37.37 % of energy of the sugarcane plant remains unutilized.

It is fact that for the soil conditioning and its fertility improvement, part of the Sugarcane Plant Residue (SPR) should be used in mulching. Even, if 50% of the SPR is left for mulching, the balance 50% of SPR is a huge source of bio-energy.

POWER EXPORT POTENTIAL USING BAGASSE & SPR

Boiler Pressure (ata)	Cane Crushed (MMT)	Bagasse Available (MMT)	Exportable Power (MW)	Power from SPR's (MW)	Total Exportable Power (MW)
67	300	87.0	5093	800	5893
125	300	87.0	11111	1500	12611

……And potential may further increase by undertaking bagasse drying

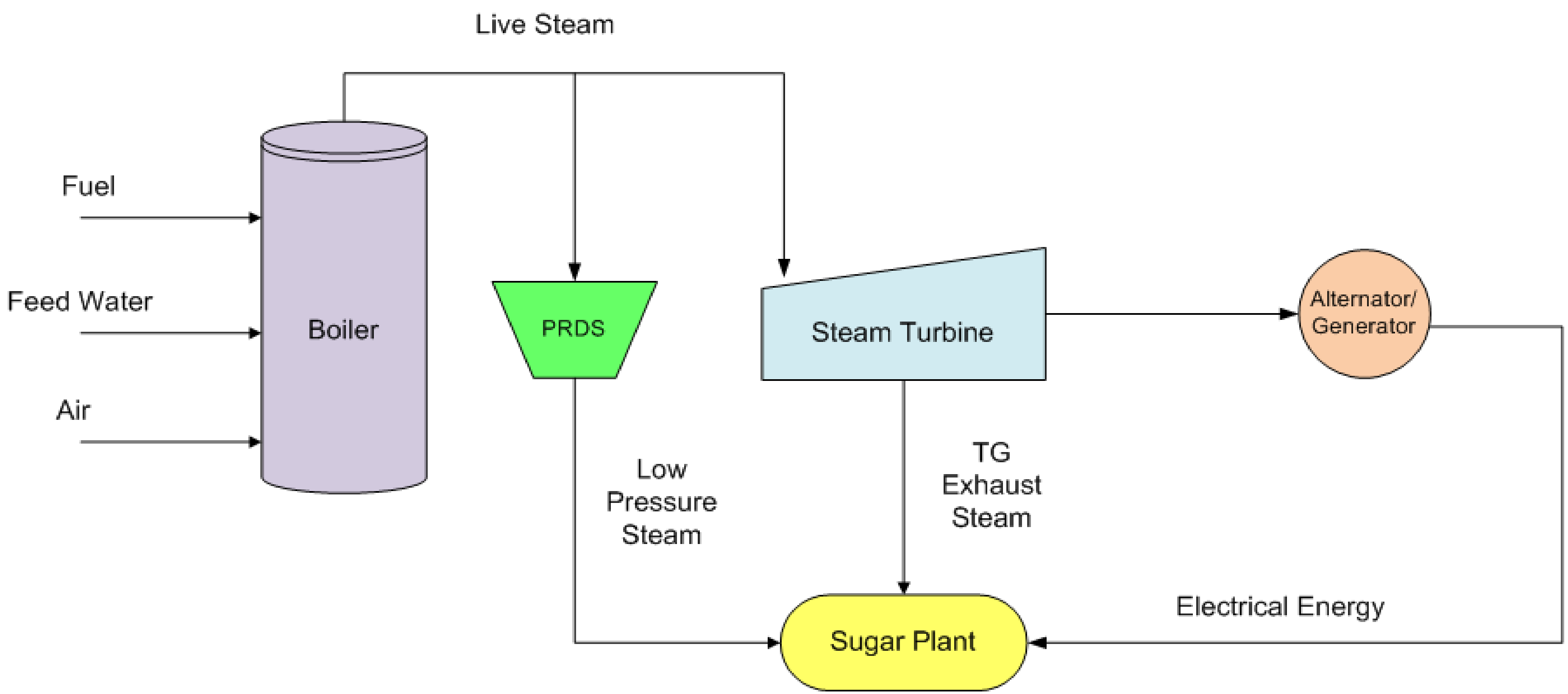
BIO-ELECTRICITY: GREEN ENERGY
-Environmental Sustainability

- A rich & renewable source and of high potential to substitute fossil fuels to meet energy demands of the country. It is also less expensive than fossil fuels.

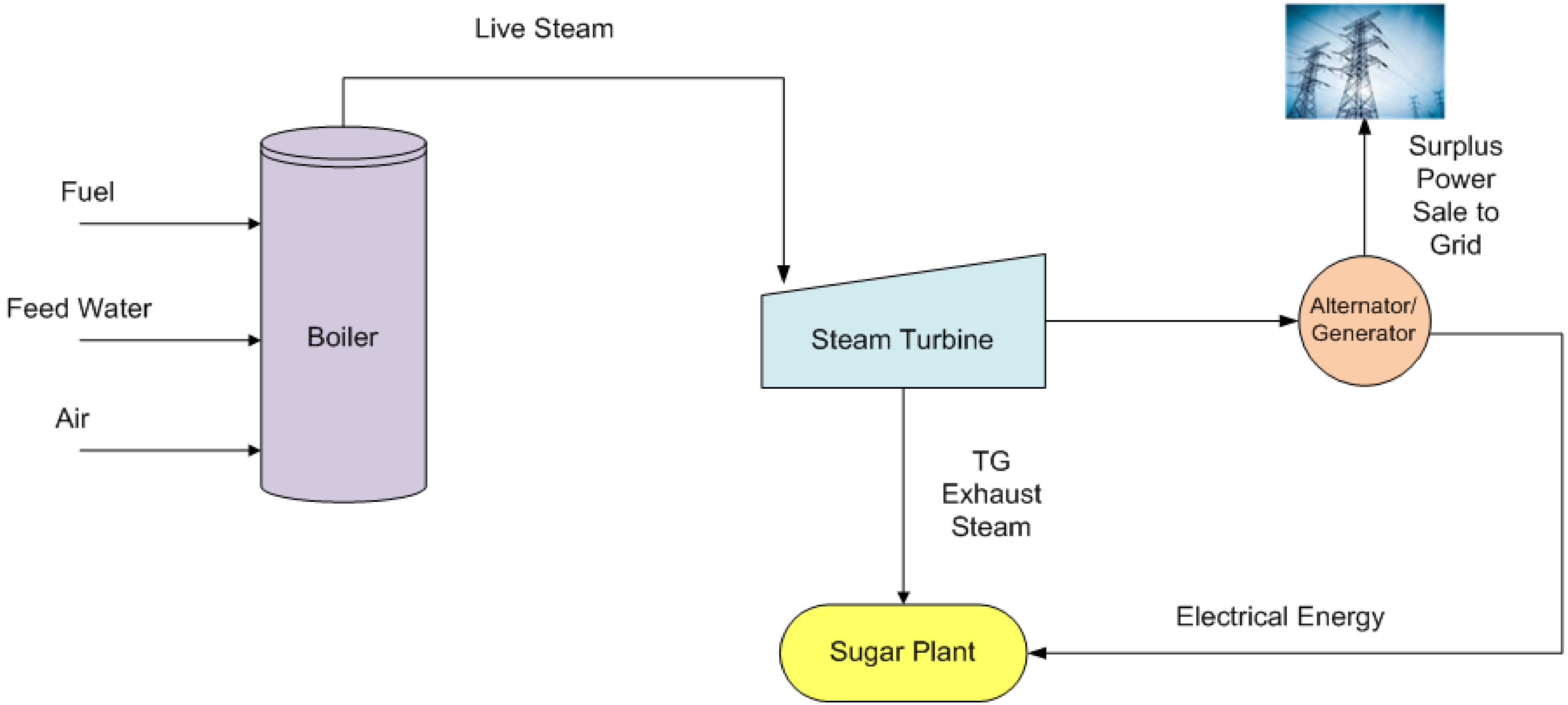
- It provides clean and green energy because of neutral emission of carbon dioxide (CO_2).
  - 1 MWh Electric Power Generation using Coal as fuel = 0.85 MT CO_2 production
  - 1 MWh Electric Power Generation using Bagasse as fuel = 0.23 MT CO_2 production

Conventional Co-Generation in Sugar Industry

-Only for Captive use

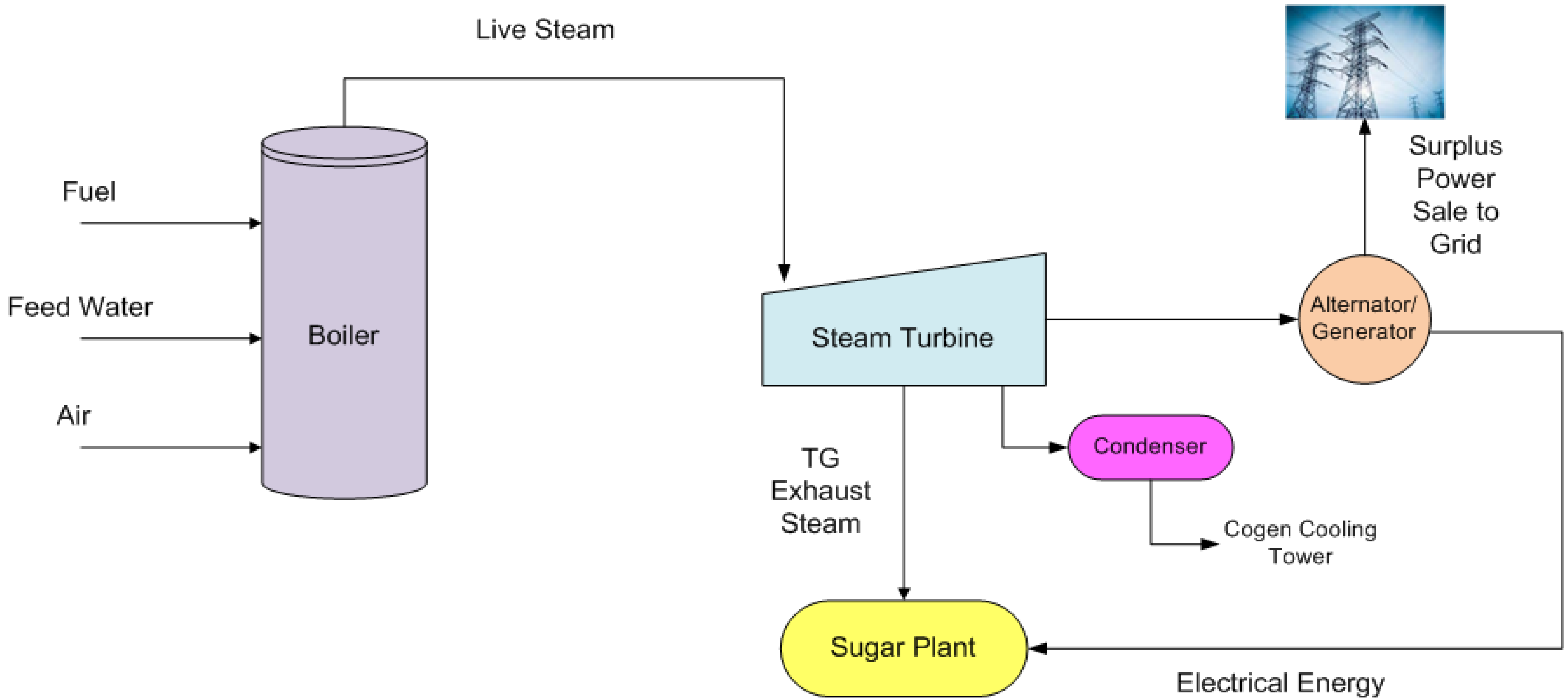


Incidental Co-Generation in Sugar Industry
-For Captive use & Surplus Power sale



Energy Efficient Co-Generation in Sugar Industry

-For Captive use & Surplus Power sale



Performance of Co-Generation System

Steam Parameters	Boiler	TG set
ata / Deg Cent.	Steam Raising	Specific Steam Consumption with back pressure mode
	Kg steam/ Kg bagasse or	Kg steam/ KW power or
	MT steam/ MT bagasse	MT steam/ MW power
21/340	2.00	14
32/390	2.10	12
42/400	2.20	10
45/440	2.25	8
67/490	2.30	6
87/510	2.40	5.5
110/535	2.50	5.2
125/545	2.60	4.8

Performance of Co-Generation System

Steam Parameters ata / Deg Cent.	Boiler Steam Raising Kg steam/ Kg bagasse	Steam Generation Kg/ 100 Kg bagasse	TG set SSC Kg steam/ KW power	Power Generation KW/ 100 Kg bagasse
21/340	2.00	200.0	14	14.3
32/390	2.10	210.0	12	17.5
42/400	2.20	220.0	10	22.0
45/440	2.25	225.0	8	28.1
67/490	2.30	230.0	6	38.3
87/510	2.40	240.0	5.5	43.6
110/535	2.50	250.0	5.2	48.1
125/545	2.60	260.0	4.8	54.2

TABLEWARE (CUTLERY) FROM BAGASSE

- India uses nearly 10,000 tonnes of single use plastic every day including plastic bags, multilayer laminates and disposable cutlery. Imminent ban on single use plastic is likely to create huge demand for alternatives that can replace such products.

- One such opportunity is emerging in the tableware sector, where use of plastic plates/takeaway boxes/bowls is rampant.

- Bagasse based tableware, an eco-friendly alternative to single use plastic, is gaining tremendous market preference as they are 100 % compostable. Such products also find its application in quick service restaurants, schools, cinema halls, railway services & take aways etc.

APPLICATIONS

Bio-degradable Cutlery/Tableware : Some Facts

Very stable and sturdy

Good thermal property

Water repellent and grease proof

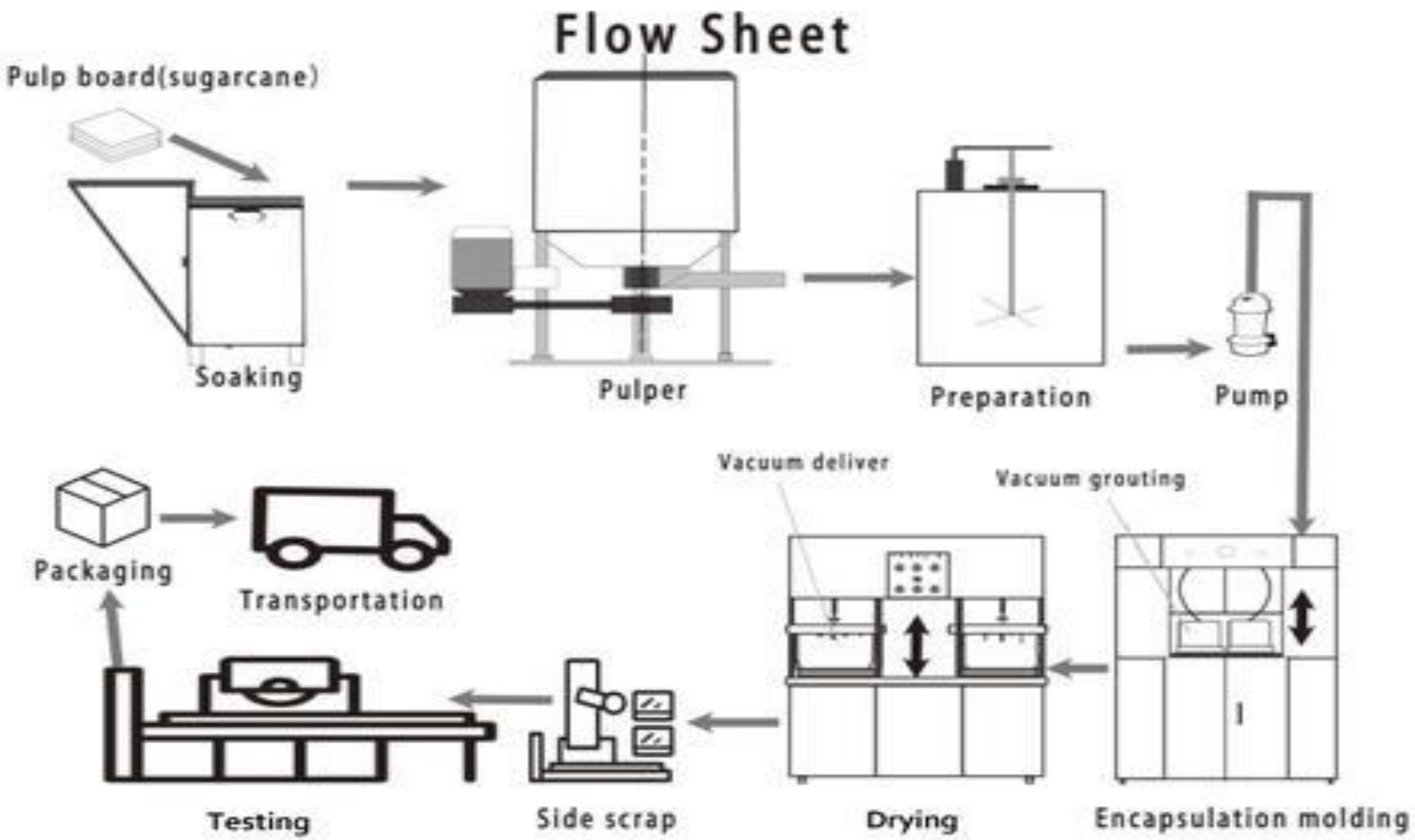
Light weight

Easy to use

Easy to dispose, completely bio-degradable & compostable

Hygienic

MANUFACTURING PROCESS FOR BAGASSE BASED TABLEWARE



BAGASSE BASED PARTICLE BOARD

- The continuous increase in global human population resulted in the continuous increase in consumption of resources raising concerns on the ability of the future generation to meet their own needs in the years to come.

- The solution is the principle of sustainable development. One of the ways to achieve sustainable development is by recycle of the waste in a way that can be useful to the economic, social and environmental goals.

- One such step is to divert the surplus bagasse for products such as particle board.

Uses of Bagasse based Particle Board

- Paneling
- Partitioning
- Ceiling
- Floors & Sub floors
- Door and Window shutters
- Furniture and built-in furniture
- Thermal insulation
- Acoustic insulation
- Rodent proof construction and exterior cladding

Manufacturing Process of Particle Board

Particle Preparation → Drying of Particle → Particles Classification → Blending with Resin & Additives

↓

Forming of Mat → Pre-pressing of the Board → Pressing of the Board → Finishing & Post-treatment

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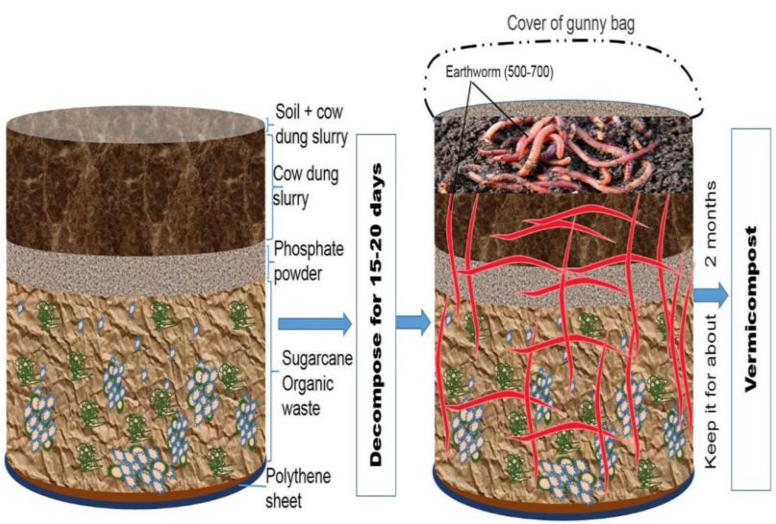
Filter cake

Bio-composting



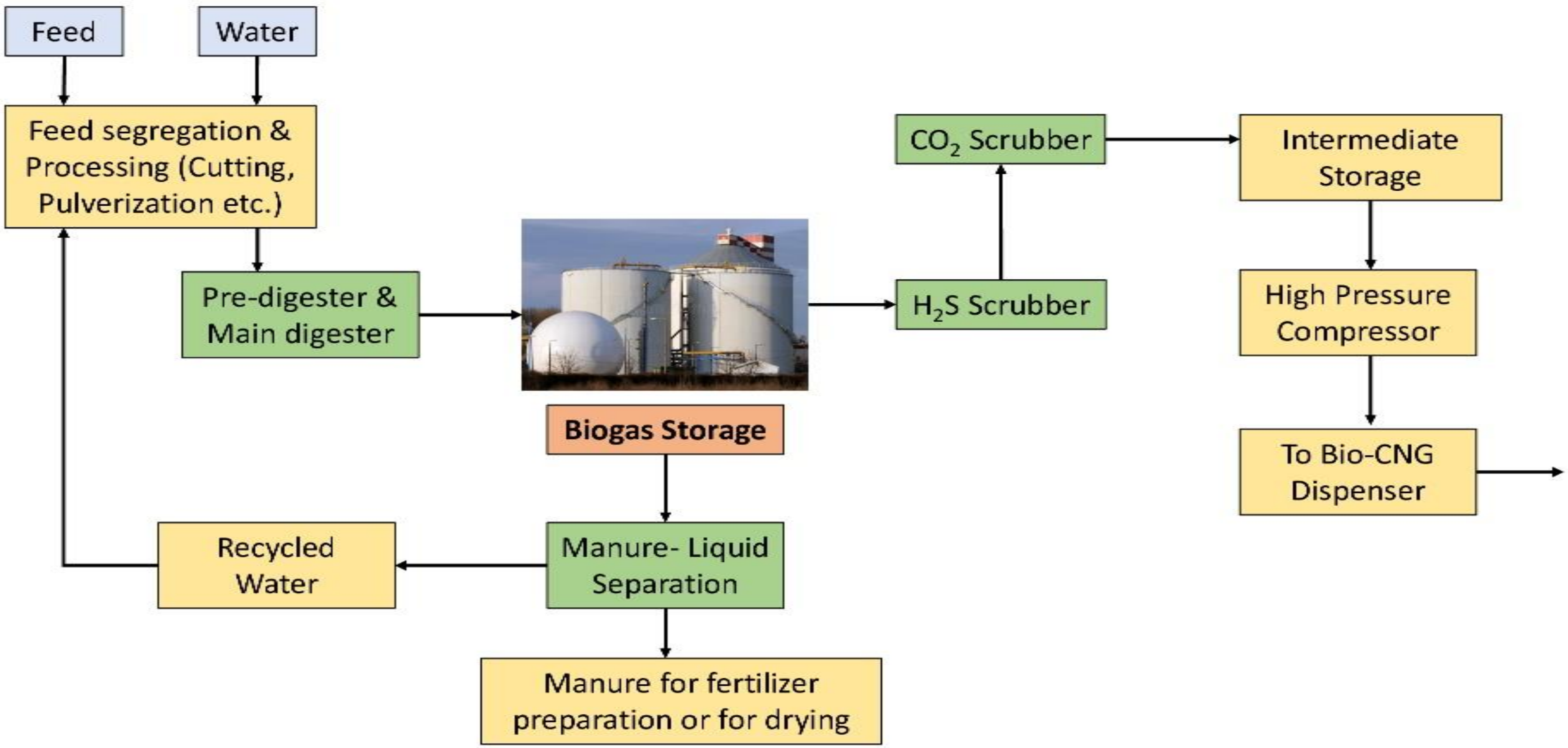
Cane wax

Bio-Gas/Bio-methane/Bio-CNG

FILTER CAKE AND CBG

- Sugar mills in India crush about 300-320 million tonnes of sugar cane every year.
- Indian sugar factories producing plantation white sugar produce filter cake @ 3.0-3.5% on cane per year. The quantity of filter cake is thus about 10 million tonnes per year.
- At present filter cake is used primarily for bio-composting and in many cases disposal is a problem. This is because of the fact that due to advent of Incineration technology bio-composting is not preferred by distilleries.
- Thus, utilization of filter cake for production of bio-gas/ compressed bio-gas may prove to be a tool for producing green energy and adding value to the revenue pot of the sugar factories.

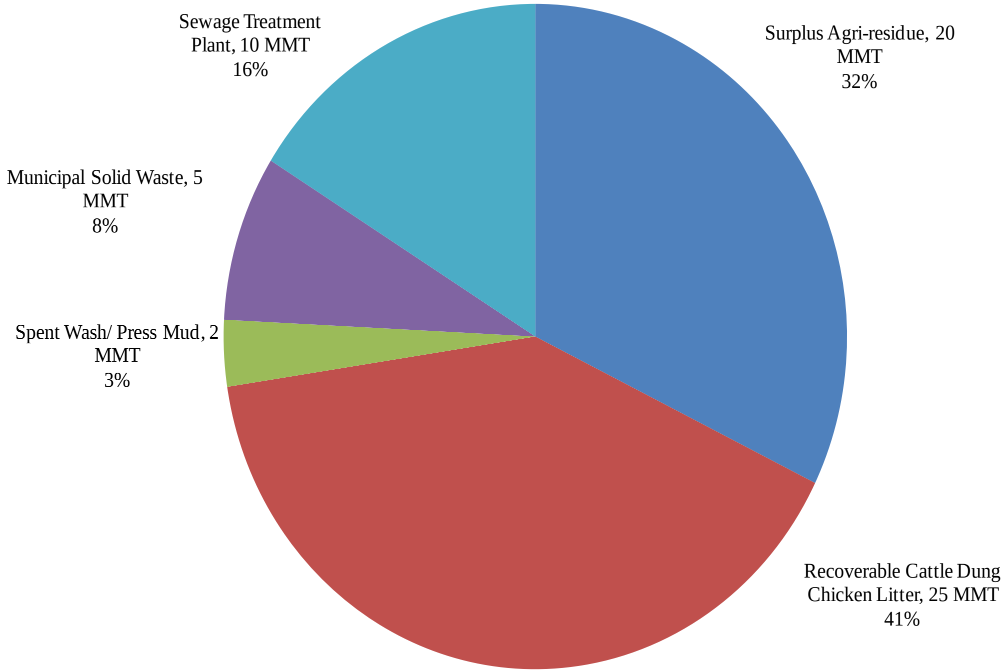
PRODUCTION OF CBG FROM FILTER CAKE



POTENTIAL OF COMPRESSED BIO-GAS (CBG) FROM INDIAN SUGAR INDUSTRY

- The total Compressed Bio-gas potential in the country is estimated to be about 62 million metric tonnes per annum out of which spent wash & filter cake (press mud) can contribute to the extent of about 2 million metric tonnes per annum.

- Spent wash from molasses based distilleries has become a potential source of bio-energy undertaking bio-methanation or using it as fuel in incineration boilers.



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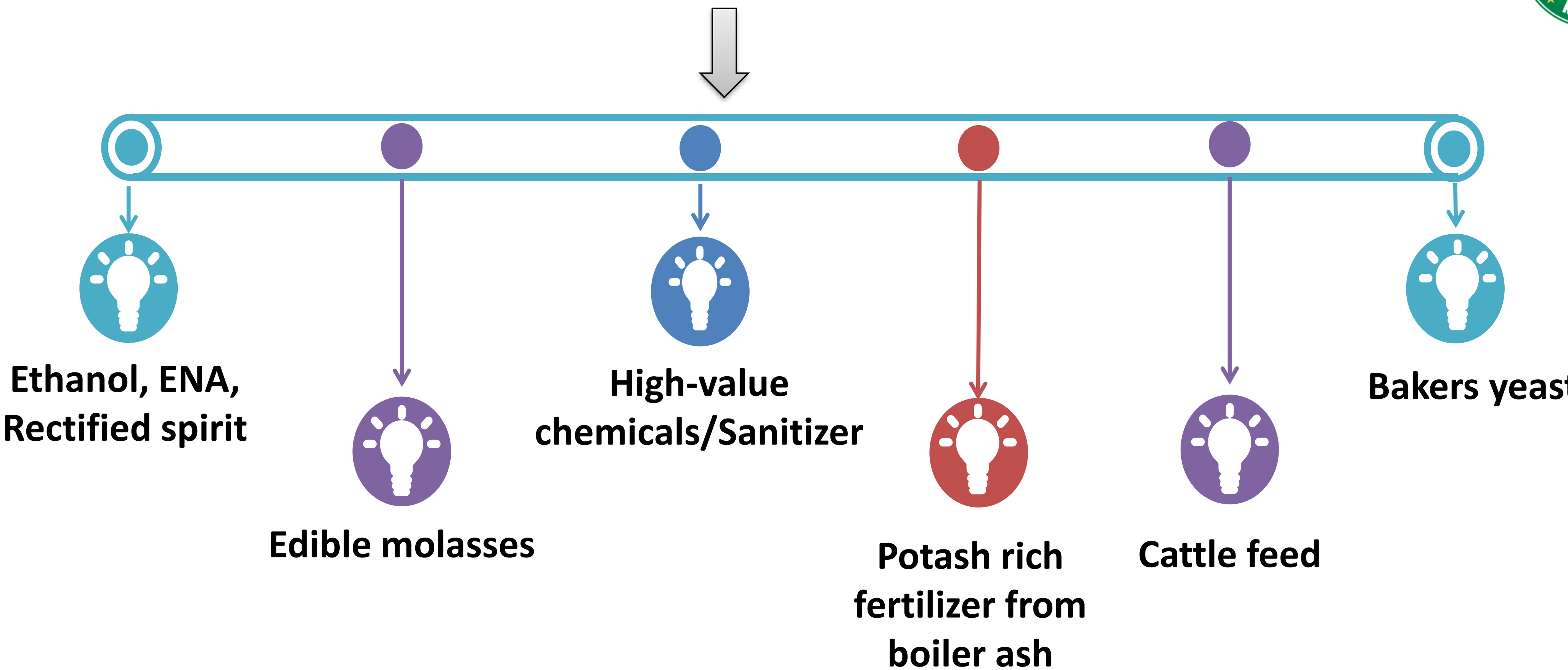
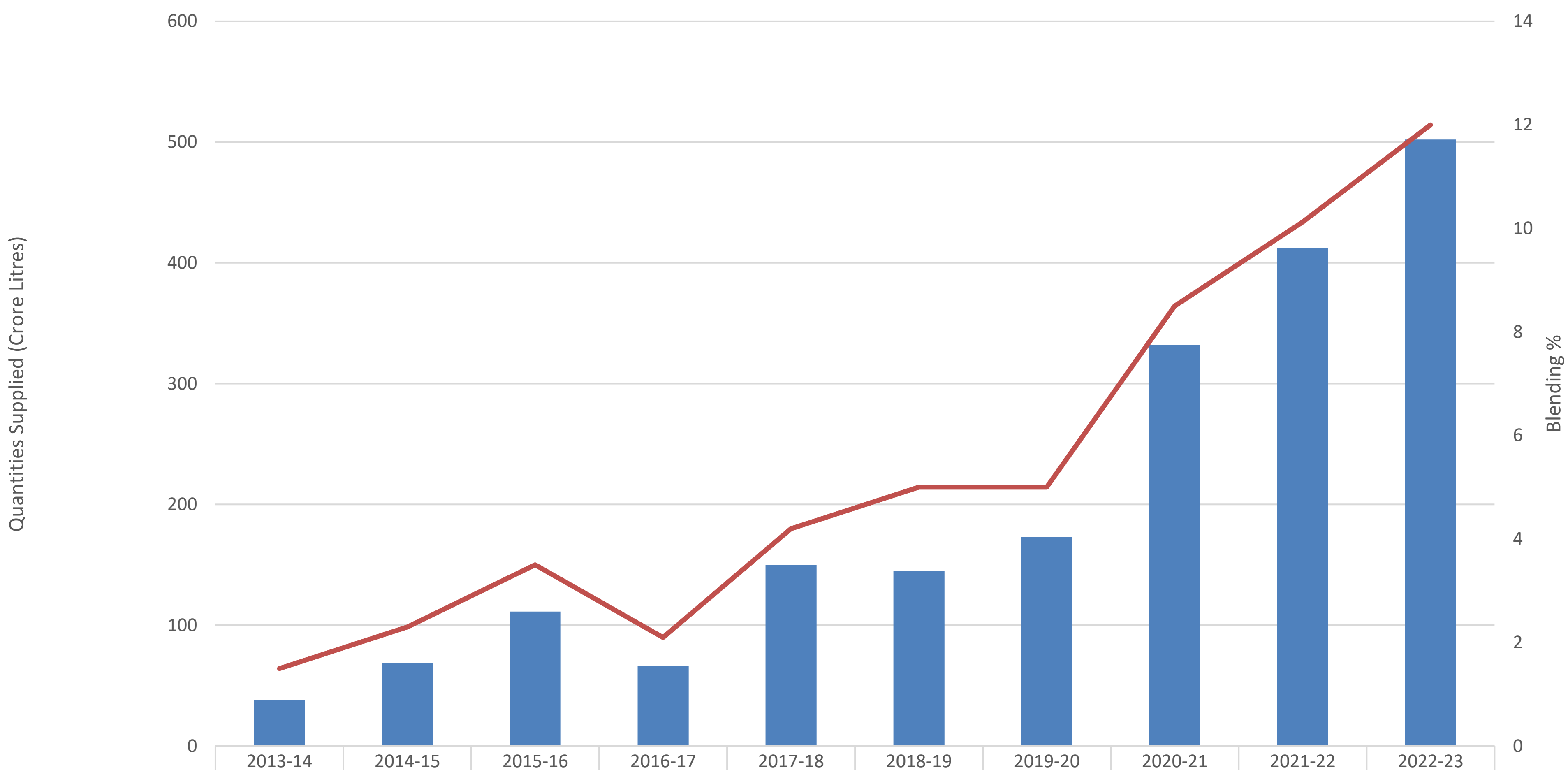
Molasses



Ethanol, ENA, Rectified spirit
Edible molasses
High-value chemicals/Sanitizer
Potash rich fertilizer from boiler ash
Cattle feed
Bakers yeast

ETHANOL BLENDING PROGRAME

Blending Levels Achieved



	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Quantity Supplied	38	68.7	111.4	66	150	145	173	332	412.4	502
Blending %	1.5	2.3	3.5	2.1	4.2	5	5	8.5	10.12	12

YEAR-WISE AND SECTOR-WISE ETHANOL PRODUCTION PROJECTIONS

ESY	Blending	For Blending (Crore Ltrs)			For Other Uses (Crore Ltrs)			Total (Crore Ltrs)		
	(%)	Sugar	Grain	Total	Sugar	Grain	Total	Sugar	Grain	Total
2019-20	5	157	16	173	100	150	250	257	166	423
2020-21	8.5	290	42	332	110	150	260	400	192	592
2021-22	10	330	107	437	110	160	270	440	267	707
2022-23	12	425	123	542	110	170	280	535	293	828
2023-24	15	490	208	698	110	180	290	600	388	988
2024-25	20	550	423	988	110	190	300	660	628	1288
2025-26	20	550	466	1016	134	200	334	684	666	1350

PRICE OF ETHANOL WITH DIFFERENT FEEDSTOCK

Feedstock	Quantity of Ethanol per MT Feedstock (Litres/MT)	Ethanol Price (Rs/Litre)
C-Heavy Molasses	225-235	56.28
B-Heavy Molasses	310-330	60.73
Sugar Syrup	300-320	65.61
Broken Rice	400-420	64.00
Surplus Rice available with FCI	440-460	58.50
Maize	370-380	71.86

Diversification of Sugar For Ethanol

CONVENTIONAL

Sugarcan
e

Conventional processing and diversion of C-Heavy molasses

B-HEAVY MOLASSES DIVERSION

Sugarcane

2 or 2 $^{1}/_{2}$ massecuite boiling & diversion of B-Heavy molasses.

CANE JUICE / SYRUP DIVERSION

Sugarcane

Sugarcane juice / syrup

100 % diversion

SYRUP & B-HEAVY MOLASSES DIVERSION

Sugarcane

- Partial diversion of syrup 35 – 40 ° or higher Brix during season as per distillery capacity.
- B-Heavy molasses diversion & storage for use during off-season

SYRUP & C-HEAVY MOLASSES DIVERSION

Sugarcane

- Partial diversion of syrup 35 – 40 ° or higher Brix during season as per distillery capacity.
- C-Heavy molasses diversion & storage for use during off-season

DUAL FEEDSTOCK

DUAL FEEDSTOCK

- Sugar industry based feed stock
- Grains

Overview..

Introduction

Why Manage/Conserve Energy

Why Manage Energy in a Sugar Plant

Management of Inputs

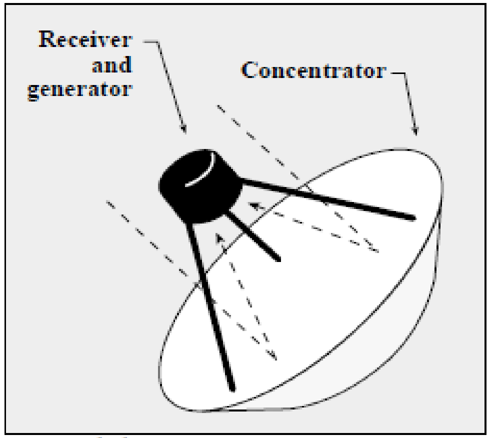
Management of Outputs

Way Forward

Way Forward

Solar Power

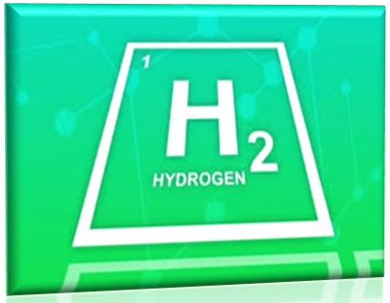
- Installation of Solar PV Panels at rooftop of sugar go-down etc.
- Boiler RO/ DM water (make-up water) heating by Concentrated Solar Thermal (CST) system.



Way Forward

Green Hydrogen

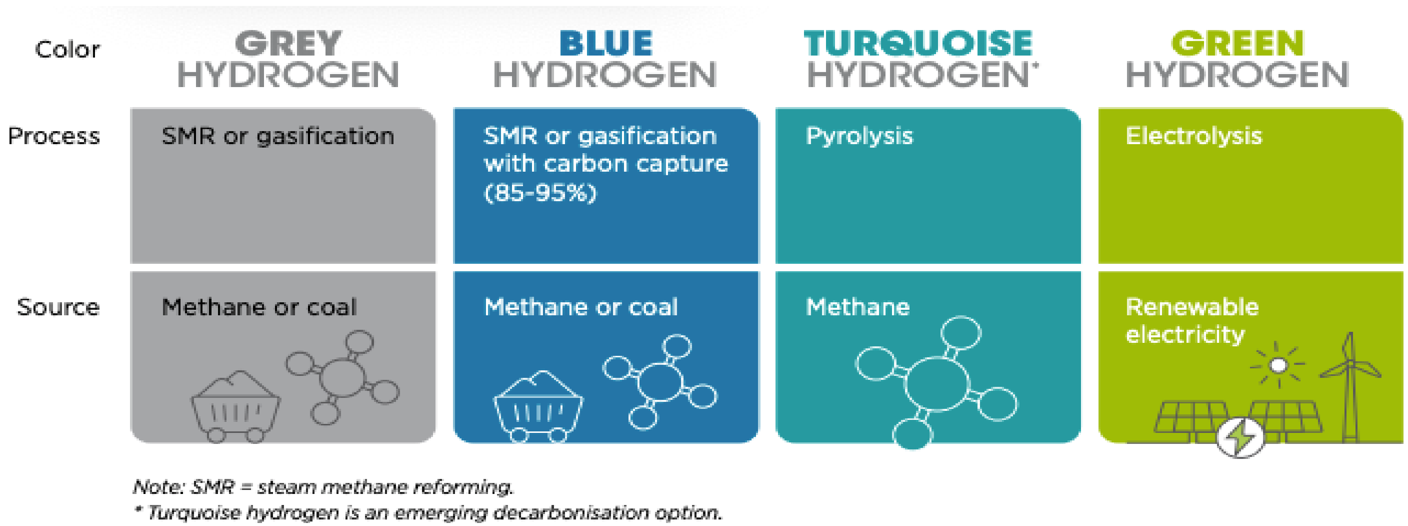
- Green Hydrogen is considered a promising and sustainable energy source because it is produced using renewable energy sources and does not generate greenhouse gas emissions.
- The Government of India has announced **National Green Hydrogen Mission** to promote the development and utilization of green hydrogen as a clean energy source.
  - Development of 5 MMT Green Hydrogen production capacity /annum by 2030.
  - To reduce a cumulative **Rs. 1 lakh crore** worth of fossil fuel imports by 2030.
  - Over **Rs. 8 lakh crore** in total investments
  - Create over **6 lakh jobs**.
  - Nearly 50 MMT per annum of greenhouse gas emissions are expected to be averted through production and use of the targeted quantum of Green Hydrogen.

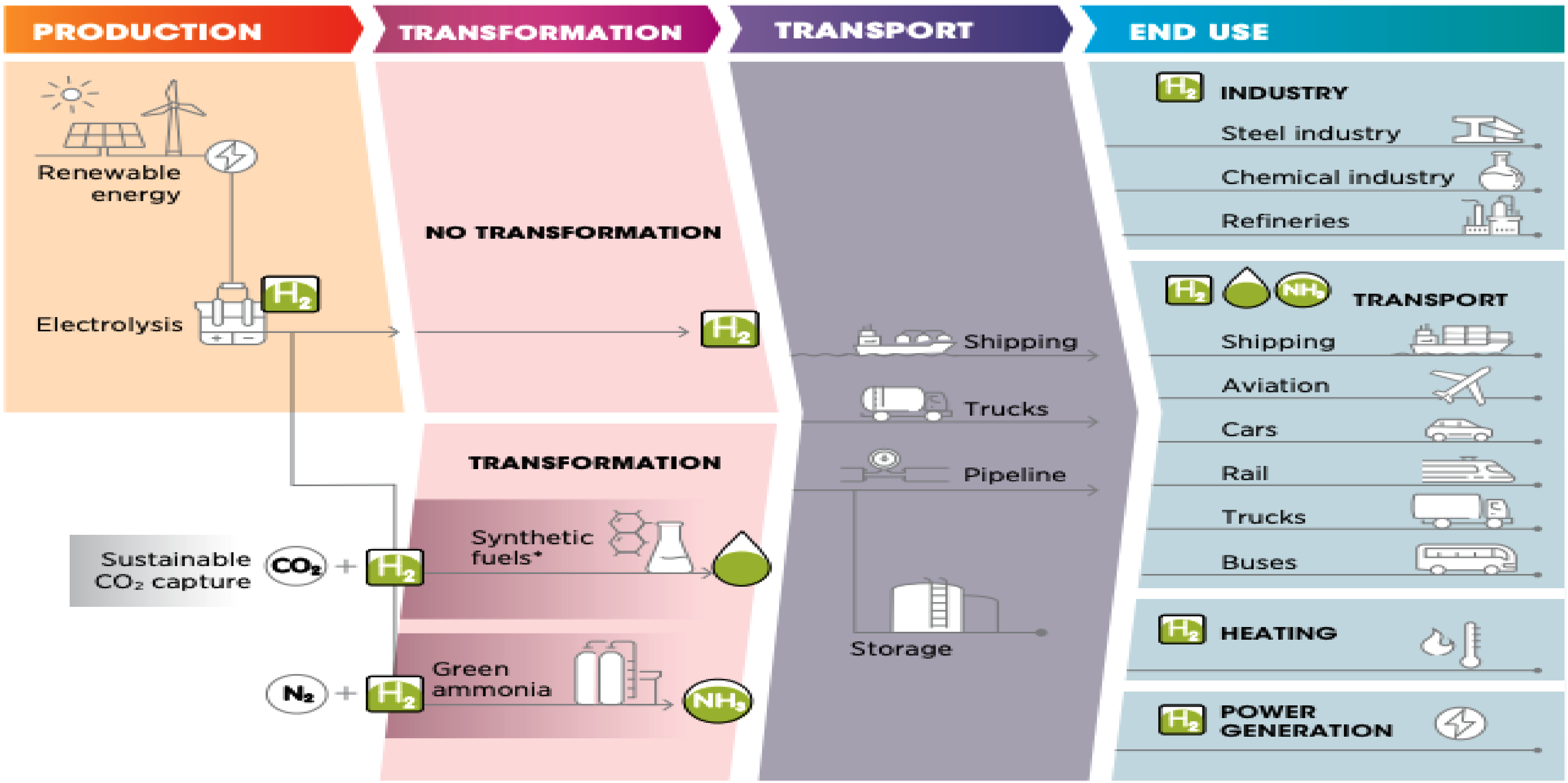


Way Forward

Green Hydrogen

- **Grey Hydrogen** is produced via coal or lignite gasification & from natural gas and tends to be mostly carbon-intensive processes, around 10 kg CO_2 equivalent per kg of H_2..
- **Blue Hydrogen** is produced via natural gas or coal gasification with carbon capture to reduce carbon emissions.
- **Pink Hydrogen** is produced through electrolysis powered by nuclear energy.
- **Green Hydrogen** is produced via electrolysis based or bio-mass based methods and emissions shall not be more than 2 kg CO_2 equivalent per kg of H_2 during whole process.





Source- International Renewable Energy Agency (IRENA)

Challenges..

- **High cost**: energy from renewable sources, which are key to generating green hydrogen through electrolysis, is more expensive to generate, which in turn makes hydrogen more expensive to obtain.
- **High energy consumption**: the production of hydrogen in general and green hydrogen in particular requires more energy than other fuels.
- **Safety issues**: hydrogen is a highly volatile and flammable element and extensive safety measures are therefore required to prevent leakage and explosions.

Way Forward

- There is need to come out of the conventional thought process and develop out of box thinking.
- Use of non-food feedstock for production of ethanol.
- Industry to keep on brainstorming and adopting innovative and other proven technologies.

Jai Hind

Thank You