2023

PROJECT FEASIBILITY REPORT
HOPL, BATHINDA. – 300 KLPD 1G
Grain to Ethanol Project

Praj Industries Ltd. India Pune

PROJECT FEASIBILITY REPORT

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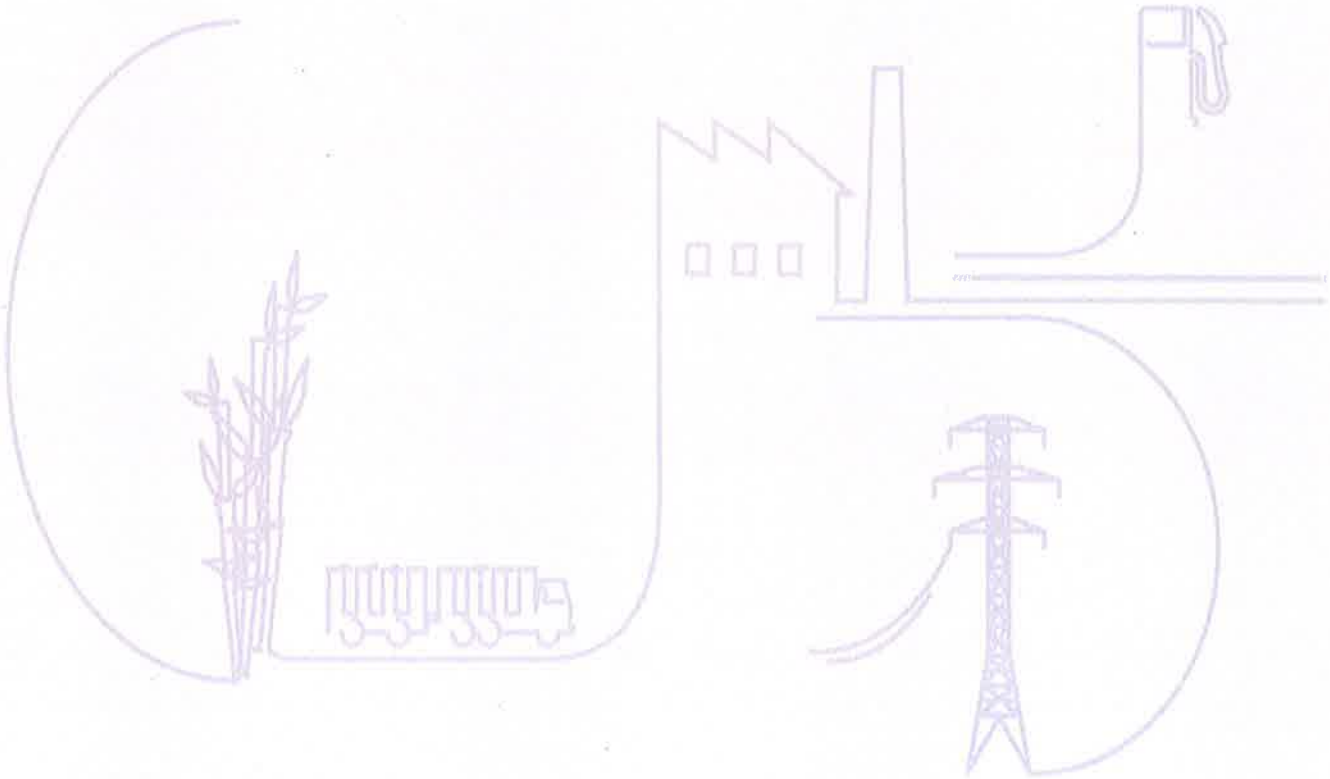
Abbreviations



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1G	1st Generation
ADY	Active Dry Yeast
ASME	American Society of Mechanical Engineers
BIS	Bureau of Indian Standards
Bar(g)	Bar gauge
CARB	California Air Resources Board A
CCEA	Cabinet Committee on Economic Affairs
CIP	Cleaning in Place
CO_2	Carbon Di-Oxide
COD	Commercial Operations Date
DDGS	Distillers Dried Grain soluble
DWGS	Distillers Wet Grain soluble
DFPD	Department of Food & Public Distribution
EBP	Ethanol Blending Programme
ENA	Extra Neutral Alcohol
EPC	Engineering Procurement Construction
EPCM	Engineering Procurement Construction Management
ETP	Effluent Treatment Plant
EU	European Union
FCI	Food Corporation of India
FRP	Fair and Remunerative Price
GHG	Green House Gas
GOI	Government of India
GST	Goods & Service Tax
HOPL	HMEL Organics Pvt Ltd
IOCL	Indian Oil Corporation Limited
ISBL	Inside Battery Limit
IRR	Internal rate of return
KLPD	Kilo Litres Per Day
MPR	Multi-Pressure Distillation
MT	Metric Ton
MTO	Material Take Off
OMC	Oil Marketing Companies
OT	Owner's Team
RED	Renewable Energy Directive
TEMA	Tubular Exchangers Manufacturers Association
TL	Term Loan
TPD	Tons Per Day
TPA	Tons Per Annum
USA	United States of America
V/v	Volume based
W/w	Weight based
WCM	Working Capital Management

Executive Summary

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HOPL plans to set up a bio-ethanol plant to cater to this demand for ethanol blending in petrol arising out of government regulations. This capacity addition would be in line with the Government of India's plan to ramp up the bio-ethanol production in the country.

This document studies the feasibility of constructing of 1st Generation (1G) bio-ethanol plant using rice and maize (corn) as raw material.

PROJECT DETAILS:

Products –

1. ***Fuel Ethanol - 300 kilo litres per day (300 klpd) (9.9 Cr Lit/annum)(78,500 Tons/annum)***
2. ***Distiller Dried Grain Solubles - 51,000 tons / annum,***
3. ***Food Grade Carbon Dixode - 49,460 Tons/annum, Food grade Carbon dioxide***

Raw material:

1. **Corn (Maize) – 235,520 ton/annum .**

Location:

The plant is enviasged to be set up adjascent to the Guru Gobind Singh Reinery (GGSR) in Bathinda.

Present fuel scenario in India:

1. About *98% of the fuel requirement in the road transportation sector is currently met by fossil fuels and the remaining 2% by biofuels.*
2. Today, India imports 85% of its crude oil requirement. India imported around 232.70 million metric tons (MMT) of crude oil in FY 22-23.
3. Future increase in vehicular population will increase the demand for transportation fuels. Domestic biofuels can help the nation in reducing the nation's dependence on imported crude oil.

Biofuels in India:

1. **Biofuel Policy**
    a. To achieve energy security and to transition to a low-carbon economy, the Government of India notified the National Policy on Biofuels 2018 on 4th June 2018 under the Ethanol Blended Petrol (EBP) program.
    b. The National Policy on Biofuels-2018, allowed the production of ethanol from a variety of feed-stocks like agricultural residues (rice straw, cotton stalk, corn cobs, saw dust, bagasse etc.); starch containing materials such as maize, cassava, rotten potatoes etc.; damaged foodgrains like wheat, broken rice etc; and foodgrains like rice apart from sugarcane and othersugar containing materials (like sugar beet, sweet sorghum etc).
    c. Government of India through Niti Aayog, MOPN&G has issued a Roadmap for ethanol blending in India 2020-25 issued in June 2021.
    d. As per Biofuel policy, an indicative target of 20% blending of ethanol in petrol by 2030 was laid out.Subsequently, the target year for achieving 20% ethanol blending in petrol was advanced to 2025.

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2. Ethanol Production and demand :

a. India has ***current ethanol production capacity for ethanol blending with petrol and other uses is about 947 Crores Litre which includes ethanol production through:***
   i. ***Sugarcane (molasses and Juice) - 619 crore litres***
   ii. ***Grain (Maize/Rice) - 328 crore litres***

Source: PIB dated 21st Dec'22

b. *The demand of ethanol has been estimated to be 1016 crore litres by ESY 2025-26 ba*ased on expected growth in vehicle population.

Crores Litre

	Sugarcane/molasses	Grain-based	Total
Fuel Ethanol requirement for 20% blending	550	466	1016
Alcohol requirement for other uses	134	200	334
Total ethanol/alchohal required	**684**	**666**	**1350**

Source: Niti Ayog

c. Actual demand in ESY 2025-26 will be much higher. BPCL on behalf all the Oil PSU has floated tender for Ethanol supply of 825 Crores litre for ESY 2023-24. Other than this there will be demand from private oil companies like Reliance Industries Limited, Nayara energy Limited also.
d. Taking the expected penetration of electric vehicles into account, the ethanol demand for petrol blending is estimated to be in the range of 722 to 921 crore litres in 2025.
e. The government plans to expand the capacity to 760 crore litres of ethanol from molasses-based distilleries and 740 crore litres from grain-based distilleries.

ETHANOL SUPPLY SCENARIO

Backed by slew of measures by the Government and strong support by the OMCs the ethanol blending targets are set to rise, but still would fall short to achieve 20 % blending

	Tendered Qty. (Cr. Lit)	Qty. Allocated (Cr. Lit)	Qty. Supplied (Cr. Lit)
2012-13	103	32.4	15.4
2013-14	115	70.4	38
2014-15	128	86.5	67.4
2015-16	266	130.5	111.4
2016-17	280	80.7	66.5
2017-18	313	161.04	150.5

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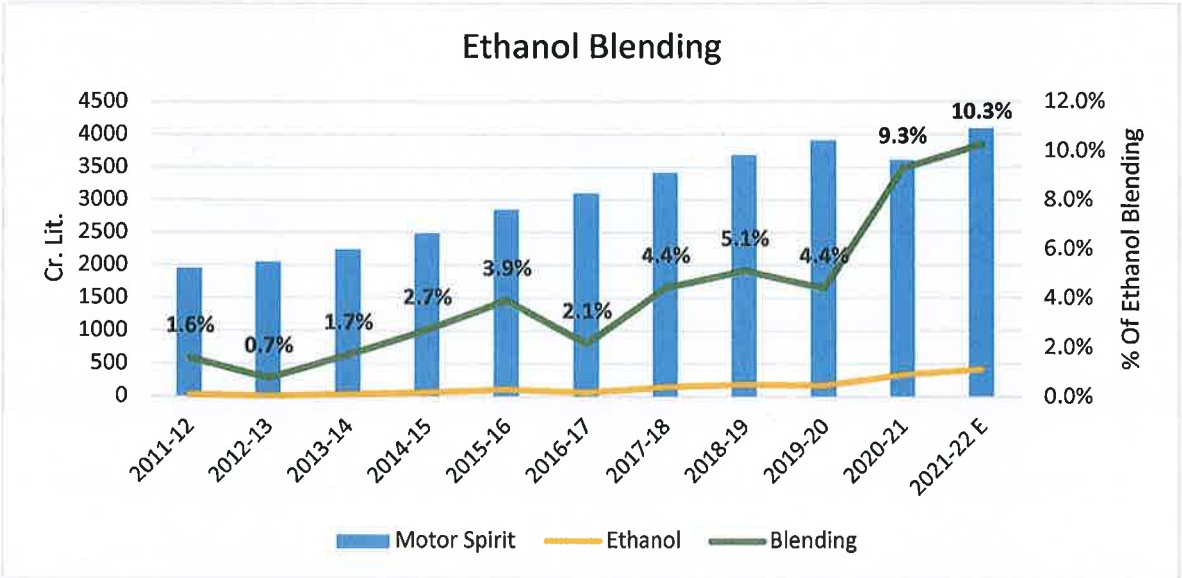
Ethanol supply in 2019-20 and 2020-21

	Total LOI Quantity (Cr. Lit)		Total Contracted quantity (Cr. Lit)		Total Receipt (Cr. Lit)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Sugar Cane Juice	17.43	47.36	15.35	44.49	14.83	38.16
B - Heavy Molasses	79.84	209.65	75.93	201.35	68.14	178.67
C- Heavy Molasses	93.4	63.82	85.02	60.21	74.12	38.07
Damaged grain	19.89	47.61	18.91	44.47	15.94	38.46
Surplus rice		3.55		2.99		2.19
Blending %					**4.4%**	**9.3%**
Total					**173.3**	**295.55**

Exisitng Production capacity and Capacity to be added to achieve 20% blending–

	Molasses	Grain	Total
No of Distilleries	231	113	344
Production capacity, Cr Lit	426	258	684
Capacity addition from sanctioned projects	93 (will be added by March,2022)	0	93
New capacity to be added, Cr. Lit	**241**	**482**	**723**

Ethanol Blending acheived



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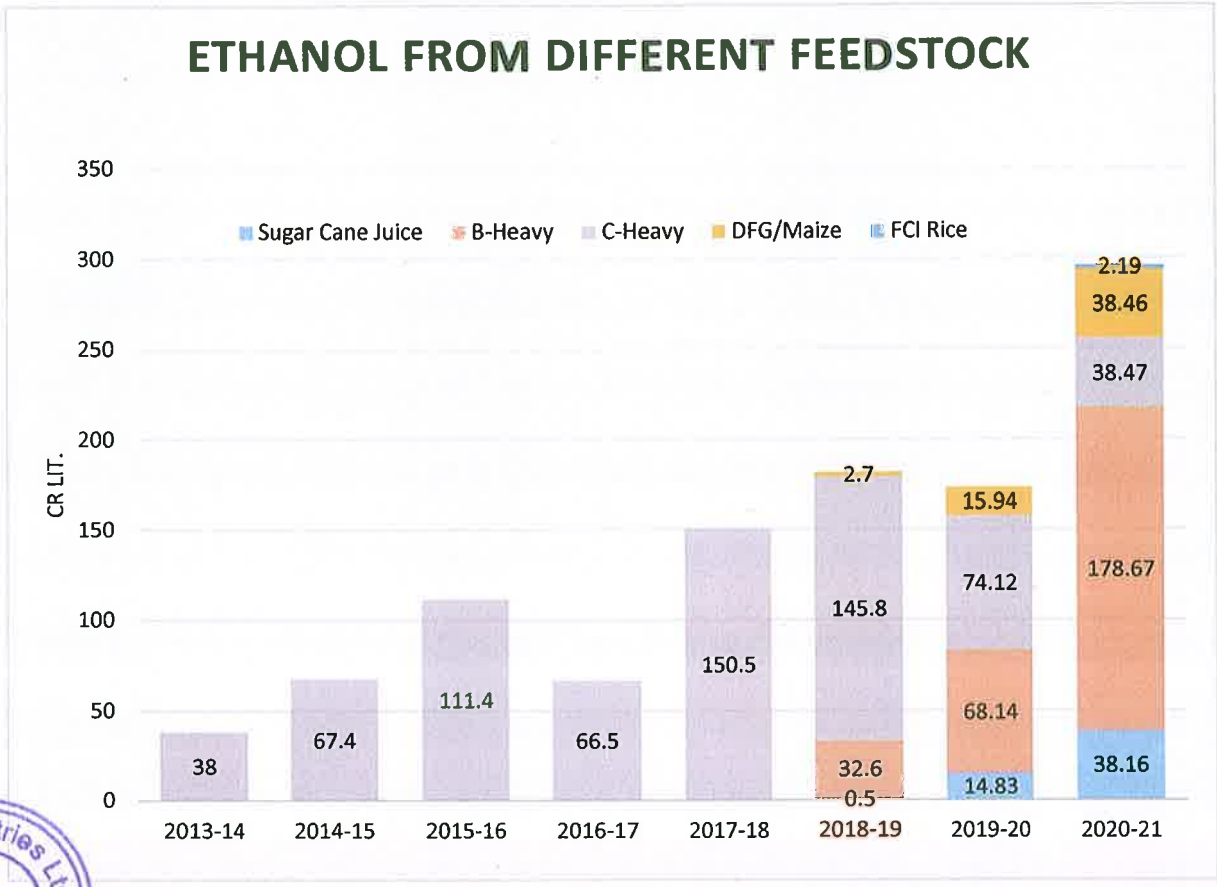
Ethanol Supplied for blending in petrol :

Source: DFPD presentation Jan2021

The key reason for this short supply being, currently the Ethanol blending is heavily dependent on Sugar industry which is cyclic in nature and caters to other ethanol demands based upon price variations. This underlines the need to focus on 1G grain to bio - ethanol projects

Ethanol supply from various sources



Source: Roadmap for Ethanol Blending in India 2020-25

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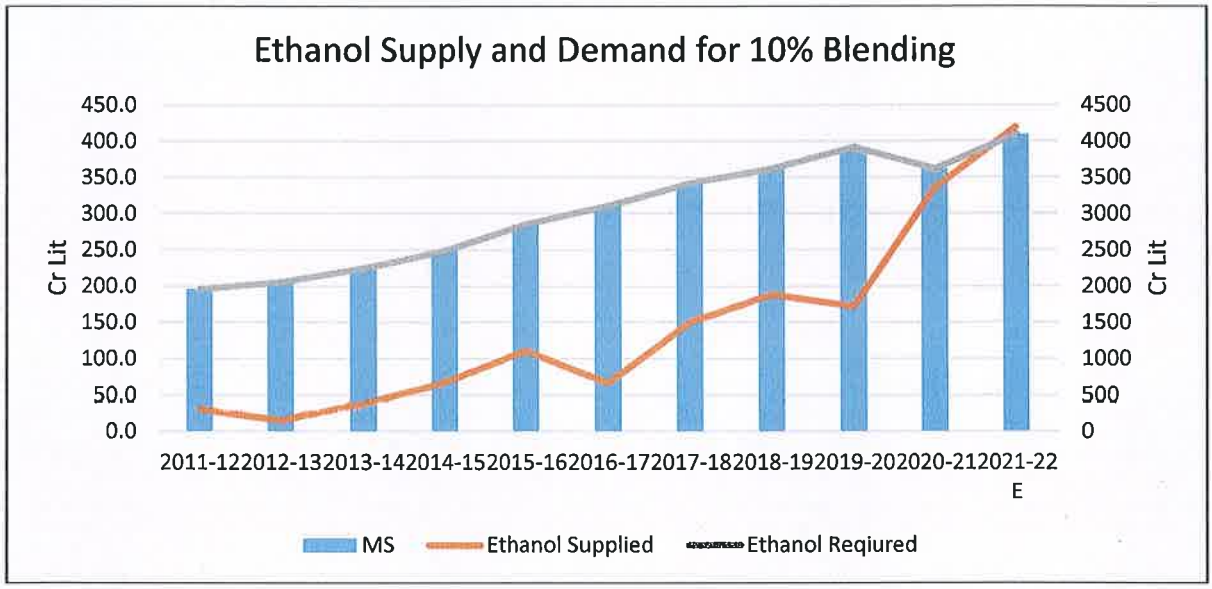
ETHANOL DEMAND SCENARIO

Blending of ethanol in Petrol achieved till 2021



Source: Roadmap for Ethanol Blending in India 2020-25

Presently all industrial ethanol demand is met by import. Present ethanol production is supplied for Fuel and Potable purpose.

Under EBP Programme, public sector oil marketing companies (OMCs) have blended approximately 509 Crores litres of ethanol in petrol during the ethanol supply year 2022-23 and met the blending target of 12%. In addition to the oil marketing companes there are also private oil marketing companies such as RIL and NEL who are using ethanol for blending in petrol under the EBP Programmes.

Ethanol Future projected Demand: (Based on estimated consumption pattern)

ESY	Petrol consumption (MMT)	Petrol consumption (Cr Ltrs)	Blending (in %)	Requirement of ethanol for blending in Petrol (Cr. liters)**
2022-23	35	4,823	12%	579
2023-24	38	5,196	15%	779
2024-25	39	5,326	20%	1,065
2025-26	40	5,459	20%	1,092

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As per Niti Ayog report the requirement of ethanol for blending is estimated at 1016 Crs litres for FY 2025-26. However, considering the Petrol growth rate of 2.5% on FY 23-24 Estimated MS Consumption as per PPAC the projected demand for ethanol will for ESY 2025-26 is estimated to be 1092 Crs Litre

Presently (2021-22), there is a gap of ethanol supply of 578 cr lit to achieve 20% blending. This gap will increase as Gasoline consumption will increase in coming years.

Raw material aviability:

Feedstock	Annual production, Mn Ton	Annual Consumption, Mn Ton	Surplus, Mn Ton
Sugar	32.0	26.0	6.0
FCI rice*	52.0 (Annual Procurement)	35.0 (Annual issue)	30.9#
Corn**	28.5	16.5	10.3##

** FY 2019-20, **as per Market Begin year, # stock in central pool as on 31.03.2020, ##expected after export,*
Source: Roadmap for Ethanol Blending in India 2020-25, by Niti Aayog

Rice production in India:

	Area, Mn Hectare	Production, Mn Ton	Average Yield Ton/ Hectare
All India	**43.78**	**118.43**	**2.705**
West Bengal	5.46	15.57	2.851
Uttar Pradesh	5.74	15.52	2.704
Punjab	2.92	11.78	4.035
Andhra Pradesh	2.29	8.64	3.770
Odisha	3.89	8.04	2.068
Telangana	2.01	7.34	3.649
Tamil Nadu	1.91	7.18	3.764
Chhattisgarh	3.67	6.5	1.773
Bihar	2.89	6.05	2.096
Assam	2.27	5.1	2.243
Haryana	1.45	4.82	3.334
Madhya Pradesh	2.02	4.8	2.382
Others	7.27	17.08	2.348

Source: Directorate of Economics & Statistics, DAC&FW

Average consumption of rice in India– 8 Kg/Person,

Total consumption is – 104 Mn ton

Surplus rice – 18 Mn Ton

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Financial Summary

1. Expected Investment (CAPEX)		- Rs 525.00 Cr
a. Land, Building & Road cost)		Rs 39.16 Cr (Estimated construction
b. Plant and Machinery	-	Rs 485.84 Cr (Excluding GST + Logistic)
2. Working capital margin		-Rs 26.60 Cr
Total (1+2)	-	**Rs. 551.60 Cr**

Note -
100% capacity will achieved in 2rd year of operation

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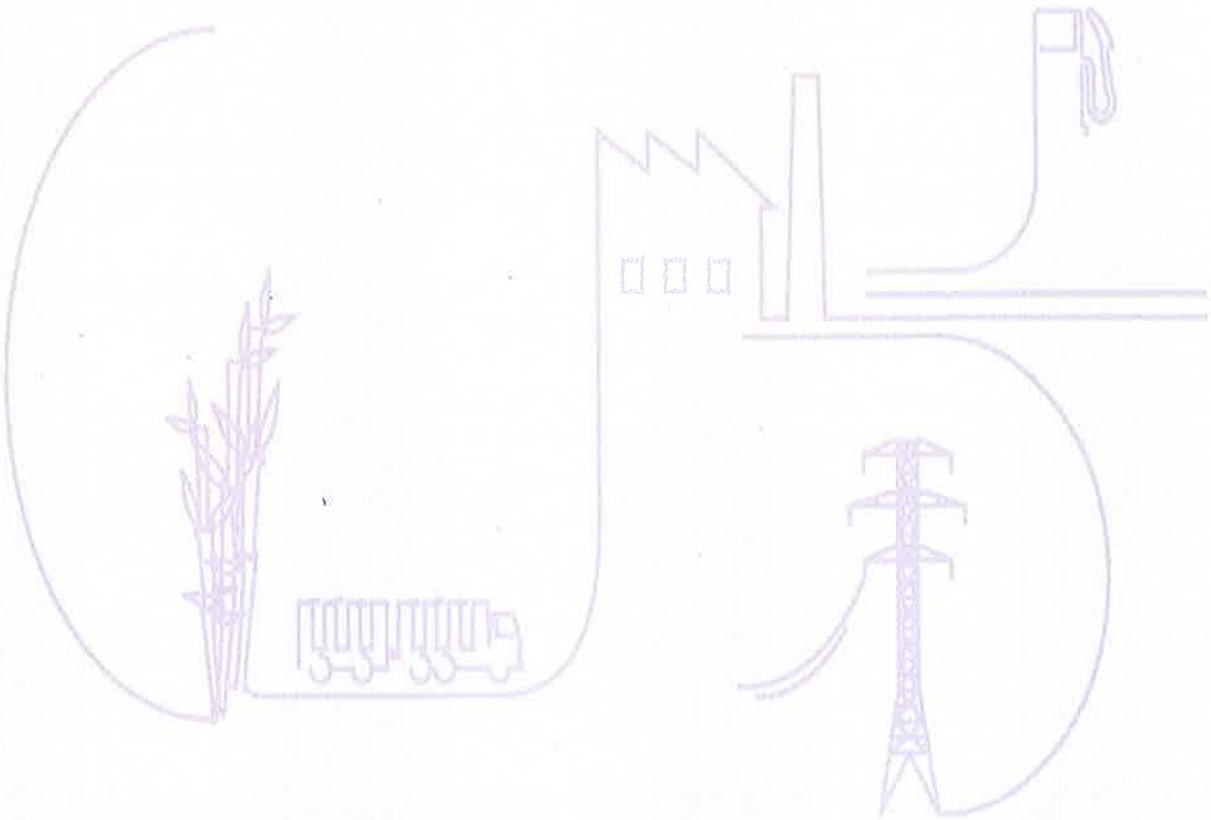
Promoters & Location



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1. **Background**

The bio-ethanol complex will be fully owned and operated by HMEL Organics Pvt Ltd (HOPL). HOPL is a wholly owned subsidiary of HMEL.HMEL is joint-venture formed as a public-private partnership between Hindustan Petroleum Corporation Limited (HPCL, a Government of India enterprise) and Mittal Energy Investments Pte Ltd., Singapore.

2. **About HOPL**

3. HOPL is a wholly owned subsidiary of HMEL.HMEL is joint-venture formed as a public-private partnership between Hindustan Petroleum Corporation Limited (HPCL, a Government of India enterprise) and Mittal Energy Investments Pte Ltd., Singapore.

HMEL owns and operates a 11.3 MMTPA best-in-class refinery complex named the Guru Gobind Singh Refinery at Bathinda. Through its subsidiary HPCL-Mittal Pipelines Ltd. (HMPL), HMEL also owns and operates a Single Point Mooring (SPM) to receive crude oil, a Crude Oil Terminal (COT) to store and blend the crude and 1017-kilometre-long cross-country pipeline to transport crude oil from Mundra, Gujarat to the Refinery situated in Bathinda, Punjab.

4. **Promoters**

HOPL is wholly owned subsidary of HMEL and details of the HMEL promoters are -

a. HPCL

HPCL, a Maharatna Public Sector Undertaking and a Forbes 2000 and Global Fortune 500 company is one of the largest oil refining and marketing organizations in India. HPCL owns and operates Mumbai refinery (7.5 MMTPA capacity), Visakhapatnam refinery (8.3 MMTPA capacity) and Mumbai lube refinery (428 TMT). HPCL has a marketing infrastructure comprising of over 19000 retail outlets, more than 40 terminals and tap off points and a pipeline network of over 3750 kms.

b. Mittal Energy Investments:

Mittal Energy Investments Pte Ltd. Singapore is a subsidiary of Mittal Investments Sarl, a Luxembourg incorporated company.

1. **Project Location**

The project would be located in Talwandi Sabo Taluka, of Bathinda District in Punjab adjacent to HMEL's existing Guru Gobind Singh Refinery (GGSR).

About the state :

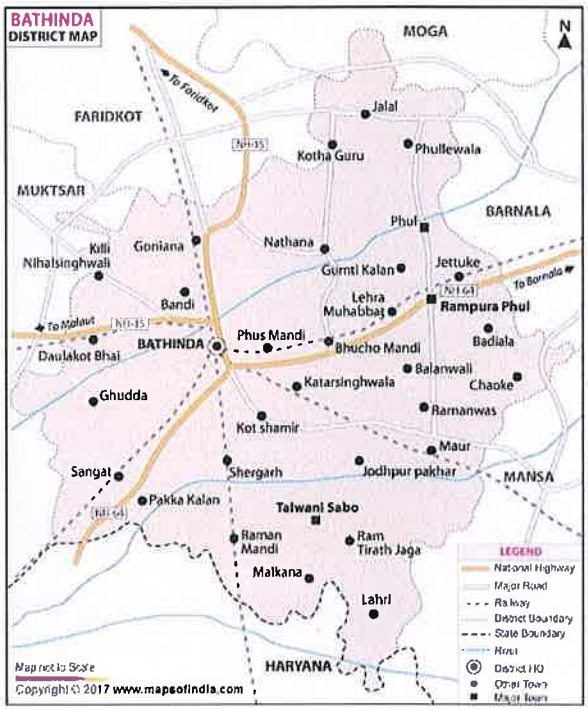
Punjab is a state in the northwest of the Republic of India, forming part of the larger Punjab region. The state is bordered by the Indian states of Himachal Pradesh to the east, Haryana to the south and

southeast, Rajasthan to the southwest, and the Pakistani province of Punjab to the west. To the north it is bounded by the Indian state of Jammu and Kashmir. The state capital is in Chandigarh, a Union Territory, and the capital of the neighbouring state of Haryana.

Agriculture is the largest industry in Punjab. It is the largest single producer of wheat in India. Other major industries include the manufacturing of scientific instruments, agricultural goods, electrical goods, financial services, textiles, machine tools, sewing machines, sports goods, starch, tourism, fertilizers, bicycles, garments, and the processing of pine oil and sugar. Punjab also has the largest number of steel rolling mill plants in India, which are in Steel Town Mandi Gobindgarh, District Fatehgarh Sahib.

About the district :

Bathinda is in the northwestern region of India and is a part of the Indo-Gangetic alluvial plains. The exact co-ordinates of Bathinda are 30.20°N and 74.95°E. It has an average elevation of 201 meters (660 ft.).



The surrounding districts are of Shri Muktsar Sahib, Faridkot, Mansa, Moga and Barnala in Punjab and Sirsa in Haryana.

Topography: The district lies in the South-western region of the State and in far away from the Shivalik ranges in the North of the state. It is the nearest to the Thar Desert of Rajasthan and also far away from the Major rivers lines that run through the state. The district is situated within the Sutlej-Ganga plain.

Temperature and Humidity: Because of the sub-tropical latitudinal nature of the Punjab state, temperature varies considerably from month to month. Though the minimum air temperature rarely drops below 0ºC, at times, it can go down to -2 to -3ºC. The maximum air temperature goes up to 47ºC. In the district, annual minimum and maximum temperature range (of extreme variation) is 1-47ºC.

Industries: Bathinda district was classified as industrially backward district by the Government in 1982. One of the Industrial Growth Centers, allocated to the State by the Govt. of India, has been set up here. As the economy of the district is primarily agriculture, agro based industries i.e., rice shellers, cotton ginning, oil expellers, flour mills, agriculture implement manufacturers, tractor accessories and electrical goods viz., Cooler geysers etc. manufacturing units have been set up. Two cement plants using fly ash of the thermal plants have been set up in the district. Guru Gobind Singh Refinery and a Petrochemical Complex have been set up in the district. The State Government has also announced developing Bathinda as 'Textile Centre' of Malwa Region and setting up of two large units in the private

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sector has been approved by the State level empowered committee. Further, a new power plant of 2100 MW capacity is proposed to be set up at Talwandi Sabo.

BATHINDA DISTRICT AT A GLANCE

S. No.	Parameter	Value
1.	Total Geographical Area of the district	3335 sq. km.
2.	Area under Forests	80 sq. km. (2.34%)
3.	Area under agriculture (including forest land)	2971.23 sq. km.
4.	Total population of the district	1,183,295
5.	Sex ratio (female: male)	882: 1000
6.	Literacy Ratio	54.51 %
7.	Population Density	350/sq. km.
8.	Administrative setup	
	Number of Sub-Division	3
	Number of Municipality	1 (Bathinda)
	Number of N.A.C.	1
	Number of Blocks	8
	Number of Police Station	12
	Number of Gram Panchayat	307
	Total Number of villages	285
	No. of Inhabited Villages	281
10.	Total cultivable area	297123 hectares
	Area under paddy cultivation	297123 hectares
	Total irrigable area (through any means other than rain water)	294000 hectares
11.	Agricultural economic pattern	
	Marginal farmers (below 1 hectare)	5825
	Small Farmers (1 to 2 hectare)	8095
	Semi medium farmers (2 to 4 hectares)	16299
	Medium farmers (4to 10hectares)	21062
	Large Farmers (10.09 hectares and above)	6680
12.	Crops production (MT/annum)	
	Paddy	384
	Wheat	1025
	Cotton	692
	Barley	7
	Oilseed	8
	Pulses	8
13.	% of village having electricity supply	98.5

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Selection of Site:

The basic criteria for the selection of site for the grain-based distillery project are as below;

- Raw material availability
- Raw material cost
- Transportation cost
- Accessibility to markets within and nearby states
- Availability of water
- Availability of land in abundance
- Connectivity of road/rail network.
- Market for final Product

Based on the above assumptions, Punjab, Haryana, Odisha, Jharkhand, Chhattisgarh, West Bengal etc. states are fit for the installation of the grain-based distillery projects.

Advantages of the location chosen – Talwandi Sabo, Tehsil and Dist. Bathinda (Punjab) for the proposed additional grain-based 300 KLPD Ethanol Plant (Biofuel)

- The promoters of the project already possess over 2000 Acres of industrial use land at the location which has been used to set up a 11.3 million Metric Tons per Annum (MMTPA) Refinery and an upcoming petrochemical complex.
- The promoters of the project are complying with all the conditions of Environmental Clearance and Consent to Operate issued by Punjab Pollution Control Board.
- Required raw material is **abundantly available** in the nearby adjoining area.
- Raw materials can also be **easily procured from grain surplus nearby states such as Uttar Pradesh, MP, Rajasthan, Chhattisgarh etc.**
- Availability water
- Well connected by road/rail network
- Skilled Manpower available for industrial purposes
- Availability of steam, power and other utilities from the existing refinery

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V.N.B

Products & Raw material

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Products

Production Capacity (Maize based)–

1. Fuel Ethanol – 300 KLPD (78,500 Tons/annum)
2. Distiller Dried Grain Solubles (DDGS) – 51,000 Ton/annum
3. Food Grade Carbon Dioxide - 49,460 Tons/annum

Product specification –

1. ***Fuel Ethanol confirming to Indian Standard : IS 15464:2004***

ANHYDROUS ETHANOL FOR USE IN AUTOMOTIVE FUEL —SPECIFICATION

Characteristic	Requirement
Relative density at 15.6 /15.6 ^{0}C, Max	0.7961
Ethanol content percent by volume at 15.6/15.6 ^{0}C, Min (excluding denaturant)	99.5
Miscibility with water	Miscible
Alkalinity	Nil
Acidity (as CH_3COOHH) mg/l, Max	30
Residue on evaporation percent by mass, Max	0.005
Aldehyde content (as CH_3CHO), mg/l, Max	60
Copper mg/l, Max	0.1
Conductivity, µS/m, Max	300
Methyl alcohol, mg/liter, Max	300
Appearance	Clear and bright

2. ***Distiller Dried Grain Solubles*** –

Product will confirming IS ***Indian Standard : IS 14325:1992***

BYPASS PROTEIN FEED FOR CATTLE - — SPECIFICATION

Characteristic	Requirement
Moisture, percent by mass, Max	11
Crude Protein (N X 6.5), percent by mass, Min.	30
Crude fat, percent by mass, min	3.5
Crude fiber, percent by mass, max	8
Acid insoluble ash, percent by mass, Max	2.5
Rumen undegradable protein, (UDP), percent by mass, Min.	20
Rumen degradable protein, (UDP), percent by mass, Min.	9
Common salt (as NaCl), percent by mass, Min	2
Calcium (as Ca) percent by mass, Min	1.2
Phosphorous (as P), percent by mass, Min	1
Vitamin A, IU/kg, Min	10,000

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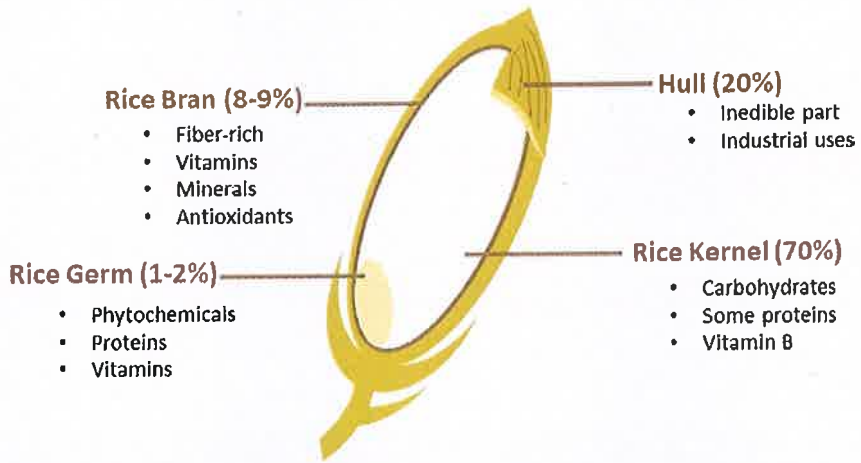
3. Food Grade Carbon Di Oxide:

Constiutent	Limit
Carbon Dioxide	>=99.5%
Moisture	<100 ppm
Oxygen	<25 ppm
Hydrocarbon	<25 ppm

Source : Air Liquide

Raw Material –
Project will use Rice, preferable broken, as raw material.

Rice



There are various type of rice varieties that are consumed in our country –

1. Basmati,
2. White,
3. Brown,
4. Red,
5. Jasmine,
6. Parboiled
7. Sticky Rice.

Basmati and White Rice are the ones that are most favoured in the country.

Typical Compoistion of Rice

		Brown Rice	White Rice
1	Water	10-12%	10-12%
2	Starch	68-70%	72%-80%
3	Protien %	6-8%	6-7%
4	Fat	3	0.5-1
5	Fiber	2-3	0.5
6	Crude Ash	1-1.5	0.5

Source : Agricultural Engineering Unit International Rice Research Institute (IRRI)

Typical composition of corn (Yellow Dent Corn):

Starch (including sugars)	63.0%
Fiber	8.1%
Oil (crude-FE & BE)	3.7%
Protein	8.1%
Moisture	14.5%
Other	2.6%

Source : FAO, USA

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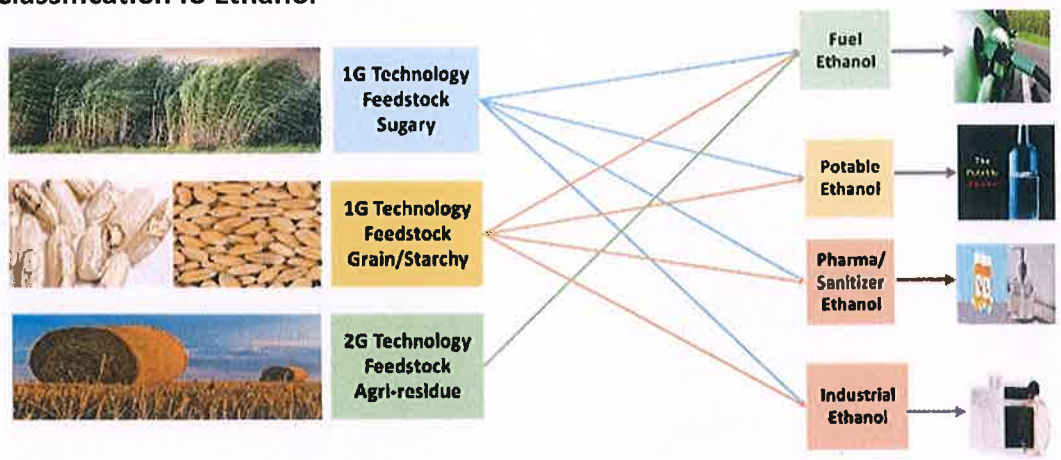
Technology

1. Classification fo Ethanol –



Ethanol is majorly classified into 4 categories namely –

- Fuel Ethanol
- Potable Ethanol
- Pharma Grade Ethanol
- Industrial Ethanol

2. Chemistry of the process –

$nC_6H_{10}O_5$ + nH_2O ⟶ $nC_6H_{12}O_6$

Starch Water Glucose

$C_{12}H_{22}O_{11}$ + H_2O ⟶ $C_6H_{12}O_6$ + $C_6H_{12}O_6$

Sucrose Water Glucose Fractose

Starch and sucrose hydrolysis reactions

$C_6H_{12}O_6$ ⟶ C_2H_5OH + CO_2

Glucose / Fractose **Ethanol** Carbon Dioxide

Monosaccharide conversion into ethanol

3. Process technologies used for Grain (Corn/Rice/Barley) to ethanol are –

a. Wet Milling
b. Dry Milling

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4. **Brief of technologies**

a. **Wet Milling** : mainly used for manufacturing starch and derivatives. Refined starch is used for ethanol manufacturing. Main ethanol manufactrurers using this technology are – Cargill USA and ADM USA.
ADM is second largest manufacturer of the ethanol, mainly from corn.

b. **Dry Milling** : used for ethanol manufacturing only. Except ADM and Cargill, rest all ethanol manufacturers uses Dry Milling technology.

World's largest ethanol manufacturer POET Ethanol, USA uses dry milling technology. Except ADM and Cargill, rest of all ethanol plants uses dry milling process. Largest single line ethanol manufacturer "Marquis Enerygy, USA", producing 500,000 Tons/annum from signle line, is using dry milling process.

5. **Comparasion between wet milling and dry milling**

S. No.	Dry Milling	Wet Milling
1	By products are – DDGS and Food Grade CO2	By products are – Fiber, Corn oil, Gluten (Protin).
2.	Low CAPEX	High CAPEX
3	Low OPEX	High OPEX
4	Short process	Long process
5	Used by ethanol only manufacturer	Used by starch manufacturers and refined starch is further processed for ethanol manufacturing.
6	Low procesing time	High processing time

Design parameters

1. **Main critaria** –
   a) Project will use Dry Milling process technology for Fuel ethanol manufacturing.
   b) Process technology should produce Fuel grade ethanol.
   c) Rice will be used as feed.
   d) Working days – 330 days
   e) By products – DDGS, Food grade CO_2, Technical ethanol (impure spirit) and Fusel oil
   f) Most efficient and modern plant, using most efficient milling m/c, Multi pressure distillation.
   g) DCS controlled
   h) Maximum recycle of water
   i) By products – DDGS confirming the internation standards
   j) Constrution of the plant as per international design standards.
   k) Products –
      - Ethanol – min . 99.8% w/w

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- DDGS – 20-25% protien in Corn based DDGS and 40-45% protein in rice based DDGS and rest as per IS 14325
- Food grade CO2 – CO2 min 99.8% and confirming to food standard.

l) **Consumption of raw material** –

- Rice – 2.7-2.9 Ton/ Ton of Ethanol
- Maize – 2.9 – 3.1 Ton/Ton ethanol

m) **Utilities** :

- Steam Approx – 4.0 ton / Ton of Ethanol
- Power – Approx 480 Kwh/Ton of Ethanol

2. Main process sections –

a) Feedstock preparation section:

- Rice / Maize Storage
- Rice / Maize Pre cleaning ,Handling ,conveying,

b) Main process plant:

- Milling, Flour Conveying
- Liquefaction
- Fermentation + CO2 system
- Distillation
- Dehydration

3. By product (DDGS) handling section:

a) Solid Liquid Seperation
b) Evaporation
c) Process Condensate Treatment Plant
d) DDGS Dryer

4. Utilities & auxiliaries:

a) Boiler and Turbine (Proposed to integrate with refinery)
b) Water Treatment Plant (Proposed to integrate with refinery)
c) Chemical Storage
d) ETP (Proposed to integrate with refinery)
e) Cooling Tower
f) Air Compressor (Proposed to integrate with refinery)
g) Product Storage
h) Enzyme and ADY Storage
i) Electrical System from grid to individual consumer
j) Instrumentation System- DCS

5 Off-site packages:

a) Fire Fighting System
b) Weigh Bridge

Construction package:

1. Civil and Structure
2. Installation

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Technology Salient features

1. Technology available indigenously with successful plants running based on the technology with focus on reducing water, energy, and carbon footprint
2. Provided with most efficient Fed batch Fermentation technology
3. Distillation operating on Multi-Pressure Technology – an efficiently heat integrated system, operating on fully automated PLC control system
4. Most efficient process technologies for liquefaction, fermentation, MPR distillation, dehydration, and evaporation to attain maximum and sustainable plant outputs
5. Extensively process and heat integrated system to reduce energy consumption
6. Water management design based upon three principles of reduce, reuse, and recycle water to minimize freshwater requirement.
7. Zero effluent and liquid discharge norms applied while designing the plant.
8. Ethanol produced from the proposed 1G ethanol facility will be as per Indian specifications (IS 15464:2004) of anhydrous ethanol for use of blending in automobile fuel.

Plant configuration

S.N	Particular	
1	**PLANT SECTIONS**	
A	Feedstock Handling Sections	Grain Pre cleaning, Storage Silos, Post Cleaning and Milling, Flour handling
B	Process Sections	i. Liquefaction ii. Fermentation iii. MPR Distillation + Dehydration iv. Decantation section – (For separation of wet cake v. Evaporation vi. Process condensate Treatment vii. Distillers Dried Grain Soluble Dryer viii. Process condensate Treatment
C	Balance of Plant	ix. Steam piping and distribution x. Electrical power distribution xi. Cooling towers, Instrument air compressor xii. Alcohol daily receivers and Storage – 30 Days xiii. Water Treatment Plant xiv. Fire Fighting, weigh Bridge, Lab Equipment xv. Plant structure xvi. Plant Civil
2	Feed Stock and yield	**Rice** @ 68-78 % w/w starch
		Maize / Corn @ 60-64 % w/w starch
		410 lit from 65% starch flour
3	Plant Capacity	**300 KLPD AA (Fuel Ethanol/Absolute Alcohol)**
4	Operating Days	**330 days / Annum**
5	Feedstock Requirement	**Maize ~ 695-720 TPD** **or** **Rice / Broken Rice ~ 700-730 TPD**

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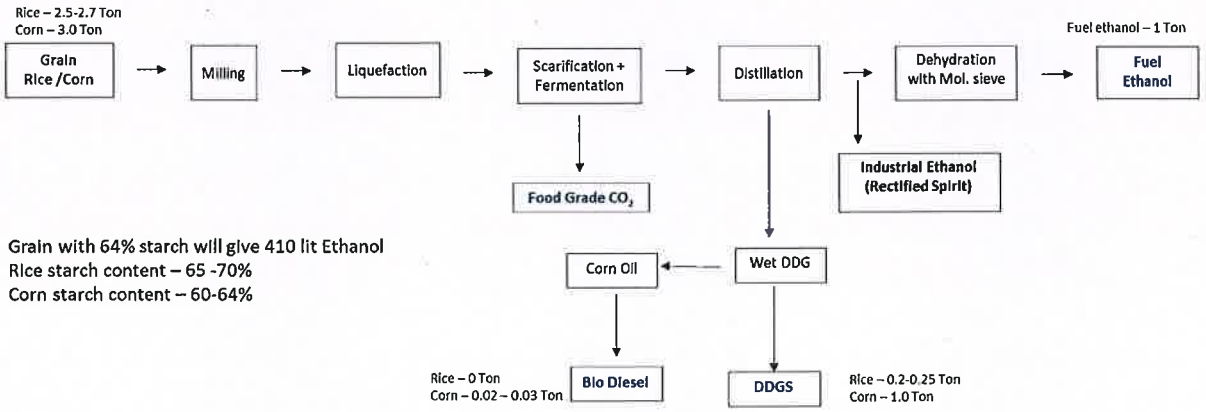
6	Steam and Power Requirement	**Steam Requirement~ 55 TPH Power Requirement ~ 4.25 MW Steam will be Supplied from refinery**
7	Water Requirement	**~ 1050-1150 m3/day**
8	Land Requirement	**36.8 Acres**
9	ESTIMATED PROJECT INVESTMENT (CAPEX) excluding working capital margin	**INR 525.0 Cr ****
10	Feed stock requirement	**Maize ~ 2.30 – 2.40 Lac MT / Annum**
11	Ethanol Output per annum	**~ 9.9 Cr lit**
13	DDGS (Distillers Dried Grain Soluble)	**Rice based: Approx 35300 MT/Annum Corn based: Approx 51,000 MT/Annum**

Grain to Ethanol Process Flow



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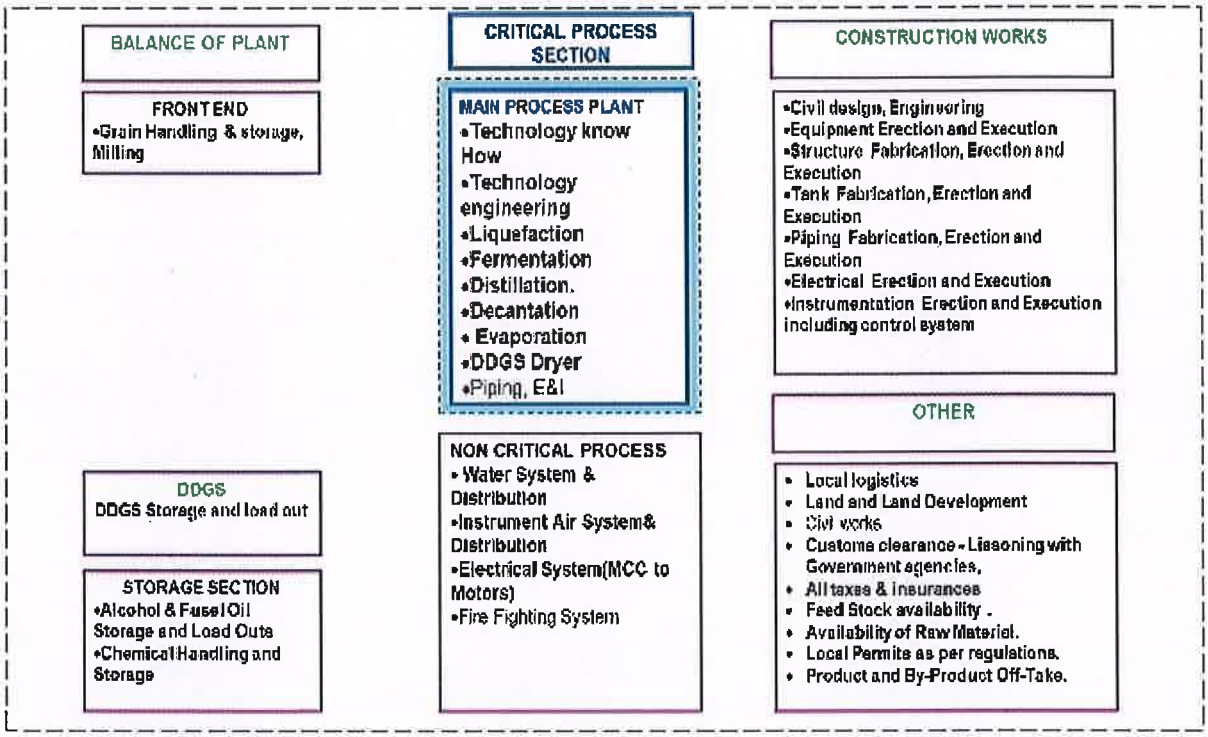
Grain to Ethanol Complex



Project Description

The project aims at construction of bio-ethanol complex that produces first generation ethanol from rice/maize (corn) as main feedstock.

The proposed 1G bio-ethanol complex will be based on the most experienced and globally recognized Indigenous technology available in India. The plant will be designed to produce 300 KLPD of 1G ethanol and will process ~ 690 MT (inclusive of handling losses) of rice having an starch range of around 68 % w/w – 80 % w/w per day.

Ethanol produced from the proposed 1G bio-ethanol complex will be as per Indian specifications (IS 15464:2004) of anhydrous ethanol for use of blending in automobile fuel.

Process Description:

The Project will comprise of following Sections:

1. Feedstock preparation section:
    - Rice/Corn Storage
    - Rice Pre cleaning ,Handling ,conveying, Milling, Flour Conveying and storage
2. Ethanol processing:
    - Liquefaction
    - Fermentation
    - Distillation
    - Dehydration

6 DDGS Section:

- Solid Liquid Seperation
- Evaporation
- Process Condensate Treatment Plant

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- DDGS Dryer

7 Utilities & Auxiliaries:
- Cooling Tower
- Air Compressor
- Product Storage
- Enzyme and ADY Storage
- Electrical System from GGSR to individual consumer
- Instrumentation System- DCS
- ETP

PROCESS DESCRIPTION

1. **GRAIN HANDLING AND MILLING:**

Pre-Cleaned Grains are stored in the Silos & from there they are conveyed through Screw Conveyer to Bucket Elevator. Bucket Elevator lifts the grains to approximately 18 meters' height and then passes the grains through Vibrating Screen, De-stoner, and Magnetic Separator to remove dust and Stones. The flow through these equipment's is under gravity.

The cleaned grains are then again conveyed by bucket elevator to an intermediate Hopper, which is provided with rotary air lock system for controlled flow in Hammer Mill. In Hammer Mill the practical size is reduced to as required by the process. From Hammer Mill the flour is pneumatically conveyed to Flour Bin (Intermediate storage for flour). From flour bin the flour is carried to Pre-masher unit. In pre-masher flour is mixed with water.

2. **LIQUEFACTION**

In liquefaction process, starch is hydrolysed to dextrin. The Liquefaction is carried out in Liquefaction Tanks. Feedstock Flour is transferred to Pre-masher and mixed with Recycle Streams, thin stillage, and liquefying enzyme. Slurry from Pre-masher is taken to Liquefaction tank where temperature is maintained by means of steam. Necessary retention time is maintained in the Liquefaction Tank. Contents in Slurry Tank are kept in suspension by Agitation. The Liquefied Slurry is then cooled in Slurry Cooler (wide Gap PHE) and transferred to Pre-fermentation and Fermentation section.

3. **FERMENTATION:**

Yeast Activation:

Yeast seed material is prepared in Yeast Activation Vessel (Pre-fermenter) by inoculating sterilized mash with yeast. Optimum temperature is maintained by circulating cooling water. The contents of the Yeast Activation Vessel are then transferred to Fermenter.
The purpose of Fermentation is to convert the fermentable substrate into alcohol. To prepare the mash for Fermentation, it is diluted with water. Yeast is added in sufficient quantity to complete Fermentation to produce alcohol.

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Significant heat release takes place during Fermentation. This is removed by passing the mash through heat exchangers to maintain an optimum temperature. The recirculating pumps also serve to empty the Fermenters into Beer Well. CO2 can then be taken to CO2 vent line where it is vented out. After emptying of Fermenter, it is cleaned with CIP using cleaning nozzles. After CIP, Fermenter is ready for next batch to be filled.

4. DISTILLATION :

Pre-heated fermented wash is fed into a series of Distillation Columns to increase the alcohol concentration and remove various impurities
Following Columns will be under operation

1. Analyser Column
2. Degasifying Column
3. Rectifier cum Exhaust Column
4. Alcohol Scrubber

5. MOLECULAR SIEVE DEHYDRATION PLANT (MSDH):

Rectified Spirit containing at least 95% v/v alcohol is pumped from RS feed tank to dehydration section. Superheated hydrous alcohol vapours are sent to twin Adsorbent Beds. The twin Adsorbent Beds operate in cyclic manner. Twin beds are provided to allow for bed regeneration in continuous operation. While one bed is in dehydration mode, the other is in regeneration mode.
The Adsorbent Bed will absorb moisture present in feed vapours and dehydrated product alcohol vapours are obtained from bottom of the bed.

The Product alcohol vapours are then passed through Product Condenser where product vapours are condensed with the help of cooling water. Condensed product alcohol (@ 99.8 % v/v strength as required for fuel blending) is collected in product receiver.
The Product alcohol from Product Receiver is pumped to Product Cooler where it is cooled with the help of cooling water and then sent for anhydrous alcohol storage.

6. DECANTATION

Decantation section comprises of a Centrifuge Decanter for separation of suspended solids from Spent Wash coming out of Grain Distillation Plant. Wet cake is removed from bottom of Decanter.

Thin slops coming out of Decanter are collected in a tank and partly recycled into the process & Evaporation for further concentration. The concentrated thin slops called as Syrup is mixed with Wet cake and sold in wet form as cattle feed (DWGS).

Or as an option, the entire mixture can be dried in a DWGS Dryer and then sold in dry form as Cattle feed (DDGS).

7. INTEGRATED EVAPORATION SECTION:

The suggested treatment scheme is a THREE EFFECT working on the principle of falling film Evaporation for Thin Slopg Evaporation Plant.
The following points will elucidate the basic working principle:

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2. Shell & Tube type Evaporators working on the principle of Falling Film Evaporation has been used.
3. Steam of medium pressure is fed to the first effect.
4. The product at the desired concentration is obtained at the outlet of the finisher.
5. The Pure steam condensate are collected in receiving vessels and can be pumped to desired battery limit
6. The plant is having high level of automation to get consistent output at required concentration.
7. The system operates under vacuum.

8. DDGS DRYER

Wet distiller's grains shall be fed into the dryer housing at controlled rate through a suitable feeding system. The Rotary Tube Bundle is enclosed in an insulated dryer housing and on its outer flights are fixed. Dry, saturated steam is to be supplied to the tube bundle through rotary joint at one end & the condensate is discharged through rotary joint mounted of another end.

The heat transfer is primarily by conduction. The water vapours are exhausted through an Exhaust Blower & passed through a cyclone separator for separating fines.

Dry product partially recycled back to Feed conditioner for feed conditioning through Product Screw & Recycle Conveyor.

9. EFFLUENT TREATMENT PLANT:

The effluent i.e., rejects from various streams -cooling tower blow down, and condensate from evaporator and dryer, will be collected in the tank and fed to ETP plant to recover maximum water. This is sent to refinery for treatment.

10. WATER TREATMENT PLANT:

The raw water from tank is feed to CLARIFIER & HRSCC then it is feed to filter feed tank. After DMF and ACF process, it is sent to process water tank. Around 1560 m3/day Process water is reused. And we get Around 750 m3/day soft water also 200 m3/day of water is used for domestic purpose. On the other hand, we get around 1030 m3/day steam condensate from various process like SAC, Degasser and SAB and passing through mixed BED.

11. PROCESS CONDENSATE TREATMENT:

The process condensate from the evaporation section is sent to refinery for treatment.

Add on offered to enhance the starch to ethanol conversion –

1. Separation of Oil from thin stillage. Oil can be used for biodiesel manufacturing. This is successfully adopted for corn to ethanol process. For rice, this process to be evaluate.
2. Fibre separation from DDGS
3. Selective milling – to increase the starch conversion.

Technology Suppliers –

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1. **ICM Inc., USA** –
   Design and built more than 100 plants across the world. ICM is leading ethanol plant technology supplier in world.
   ICM also provide equipments, including milling machines. They hold patents for distillation, and some other process.

2. **Katzen International Inc., USA**
   World leader in molasses to ethanol technology. Dr. Katzen has introduced process of saccharification and fermentation simultaneously.

3. **Praj Industries Ltd, Pune, India** –
   Leader in India for ethanol refineries. Praj has operations around the world.

4. **IBI Chematur Engineers Ltd, Mumbai, India** –
   A JV between IBI Ltd, an Indian company and Cheamatur Engineers AB, Sweden. IBI Chematur operates worldwide and constructed several plants in India and Europe. Chematur, Sweden have technology for Green chemicals also.

5. **VogalBusch GmbH, Austria**
   Leading ethanol supplier in world, especially in Europe. VogalBusch has proprietary technology for continuous fermentation and Multi Pressure distillation.

Other Indian Companies

1. Excel Engineers and Consultants, Pune
2. KBK Chem-Engineers Pvt. Ltd, Pune
3. Vapco Engineers Pvt. Ltd, Mumbai

Leading consultant to provide the engineering services –

1. **Lee Enterprises consulting, USA**
   Leading consulting services in biofuels, especially in ethanol.

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Ethanol Scenerio

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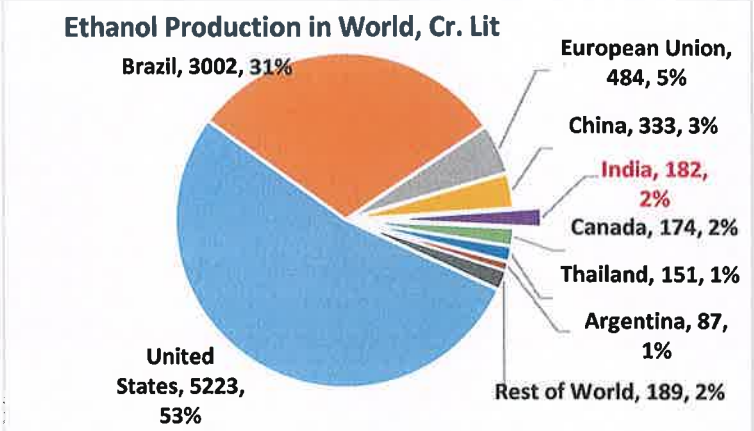
Ethanol scenario in India

Ethanol Production - World Vs India

- India is 5th largest ethanol producer in the world
- India is second largest sugarcane producer and largest producer of sugar, so majority of the ethanol comes from molasses.
- India has started ethanol blending program in 2003, but it gains momentum in 2017, when Indian government revised the ethanol price substantially.



- Ethanol blending program is limited to the ethanol produced from local feed only. Imported feed or products were not allowed.
- In 2018, government take a major decision and allow grain ethanol for blending.
- Prices of ethanol for blending is higher than average world ethanol price.
- Basic intentions of the government are to support sugar mill and grain owners. Through ethanol, sugarcane farmers and other grain (corn & rice) farmers can fetch a better price and assured market.

ETHANOL CURRENT DEMAND SUPPLY SCENARIO

GOI has announced the ethanol blending target of 20% by 2025.

Backed by slew of measures by the Government and strong support by the OMCs the ethanol blending targets are set to rise, but still would fall short to achieve 20 % blending

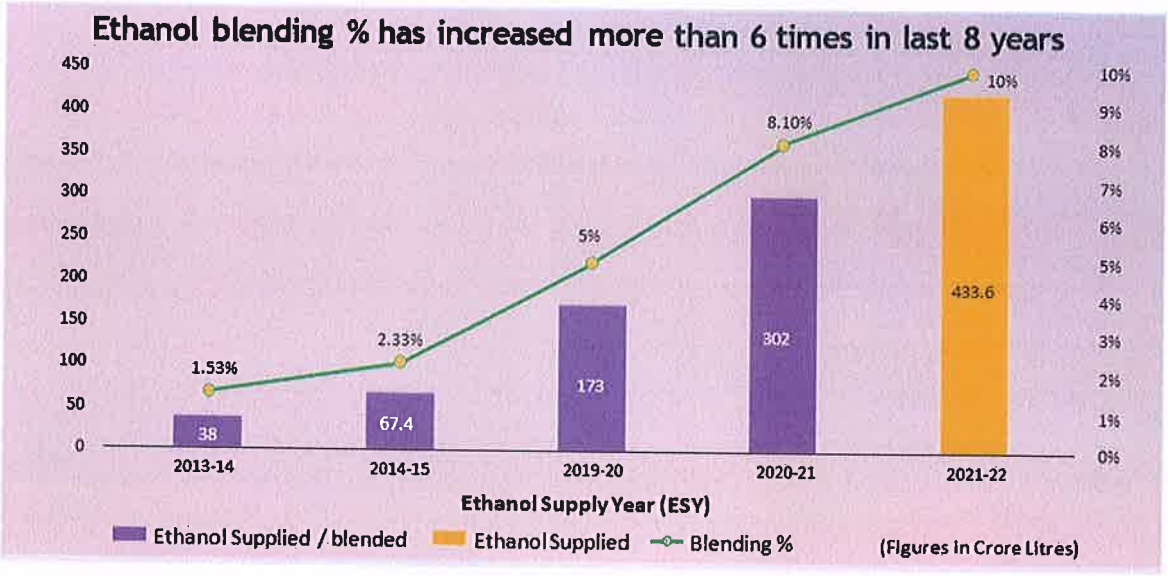
Year wise ethanol quantity blended in petrol

Qty in Crs Litre

ESY	Tendered qty	Allocated qty	Supplied qty	Blending % PSU OMC's
2013-14	115.0	70	38.0	1.53%
2014-15	128.0	87	67.4	2.33%
2015-16	266.0	131	111.4	3.51%
2016-17	280.0	81	66.5	2.07%
2017-18	313.0	161	150.5	4.22%
2018-19			188.6	5.00%
2019-20	211.0	195	173.0	5.00%
2020-21	372.0	354	303.0	8.10%
2021-22			434.0	10.0%
2022-23			509.0	12.1%
2023-24	825.0			

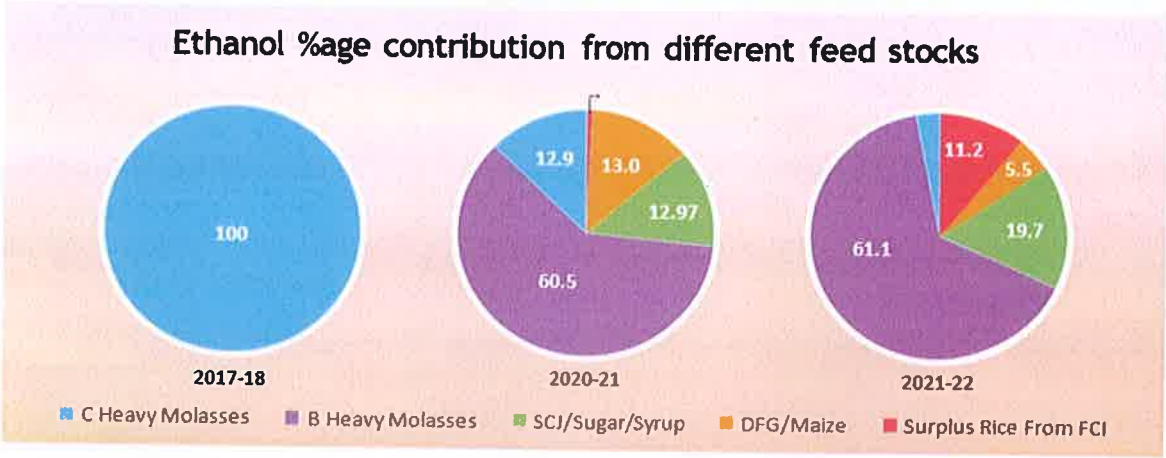
Ethanol Blending Achieved:

Ethanol blending % has increased more than 6 times in last 8 years



Source: Ethanol growth story document published by MOP&NG as on Nov-22

Feedstock wise Ethanol % Contribution till ESY 2021-22 :



Source: Ethanol growth story document published by MOP&NG as on Nov-22

The key reason for this short supply being, currently the Ethanol blending is heavily dependent on Sugar industry which is cyclic in nature and caters to other ethanol demands based upon price variations. This underlines the need to focus on 1G grain to bio - ethanol projects

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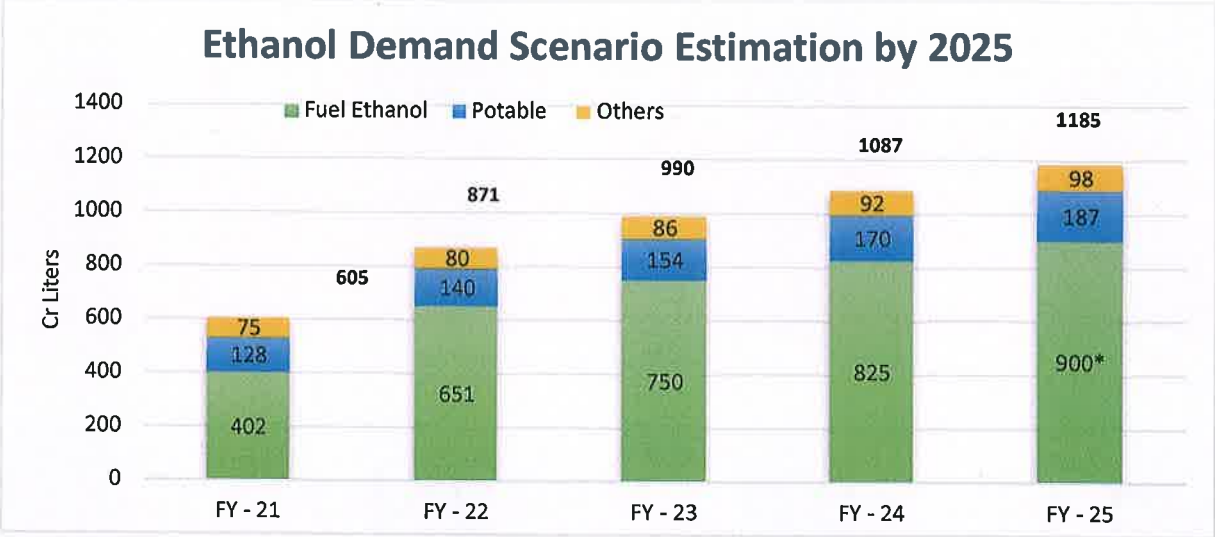
ETHANOL DEMAND SCENARIO

Estimation of India's Ethanol demand in various sectors



* Considering target of preponement by 2025

Source: VSI, PPAC
Others: Industrial+Pharma, etc.
*https://pib.gov.in/PressReleaseIframePage.aspx?PRID=16848616 dated (14/01/2021)

FURURE DEMAND:

Factor for high demand

The vehicle population in the country is around 22 crores two and three wheelers and around 3.6 crore four-wheelers (SIAM). The 2 wheelers account for 74% and passenger cars around 12% of the total vehicle population on the road. The two-three wheelers consume 2/3rd of the gasoline by volume, while 4 wheelers consume balance 1/3rd by volume. The growth rate of vehicles in this segment is pegged at around 8-10% per annum. An estimate of year-wise addition of gasoline based vehicles in the country is given below

Projected addition of gasoline vehicles (in Lakhs)

	FY 23	FY 24	FY 25	FY 26	FY 27	FY 28	FY 29	FY 30
Two Wheeler Gasoline	181	195	211	227	246	265	287	309
Passenger Vehicle (Gasoline)	24	26	28	30	33	35	38	41

* The estimate is based on the following assumptions: V-shape recovery in sales in FY22, followed by growth at CAGR of 8% in all segments. Share of petrol vehicles will be 83% of the total passenger vehicle sale

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Based on expected vehicle population, the demand projections of gasoline in India are given below –

Gasoline demand projections

	2024	2025	2026	2027	2028	2029	2030
Motor Gasoline (MMTPA)*	33	35	36	37	39	40	41
Motor Gasoline (Cr. Ltr.)	4656	4939	5080	5221	5503	5644	5785

*Interim figures from PPAC considering growth @ 3-4% YoY (Source: MoP&NG)
** Projection interval is for 5 years and the data has been linearly extrapolated. The effect of COVID pandemic and introduction of EVs are considered

Ethanol demand projection as per niti Ayog report

	Projected Petrol Sale (MMT)	Projected Petrol Sale (Cr. liters)	Blending (in %)	Requirement of ethanol for blending in Petrol (Cr. liters) **
2023-24	33	4656	15%	698
2024-25	35	4939	20%	988
2025-26	36	5080	20%	1016

* The petrol projections may undergo revision due various factors like penetration of EVs, etc.
** The figures are optimistic, as the E20 fuel will be consumed by new vehicles from April 2023 only. The demand for ethanol will, however, increase due to penetration of E100 two wheelers, which are now being manufactured in the country.
*** As per the Latest internal Projection for FY 2025-26, 1069 Cr Litres of ethanol is projected to be required for blending in petrol.

Ethanol demand projection from Sugar cane and Grain:

Sugarcane ethanol contributes for almost 67% of total supplies in ESY 21-22. Ethanol requirement as per Niti Aayog demand projection for 20% blending in 2025-26 considers 50:50 share between sugarcane and grain-based ethanol.

ESY	For Blending			Blending	For other uses			Total		
	Grain	Sugar	Total	(in %)	Grain	Sugar	Total	Grain	Sugar	Total
2021-22	72	361	434	10	160	110	270	232	471	704
2022-23	123	425	542	12	170	110	280	293	535	828
2023-24	208	490	698	15	180	110	290	388	600	988
2024-25	438	550	988	20	190	110	300	628	660	1288
2025-26	466	550	1016	20	200	134	334	666	684	1350

Source: Roadmap for Ethanol Blending in India 2020-25. The figures for ESY 21-22 has been actualised.

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PATH FORWARD TO ACHIEVE 20% BLENDING:

Ethanol supplied during ESY 21-22 is 509 Crores litres and there is a gap of more than 507 cr. Litres to achieve 20% blending requirement of 1016 Cr. litre in ESY 2025-26.

Ethanol capacity requirement by Year and Raw Material

Capacity Augmentation (in cr. Lt)			
Year	**Capacity Requirement**		
	Grain	**Molasses**	**Total**
2021-22	300	519	819
2022-23	350	625	975
2023-24	450	725	1175
2024-25	700	730	1430
2025-26	740	760	1500

Source: Roadmap for Ethanol Blending in India 2020-25

Ethanol Capacity augmentation (to achieve 20% blending by ESY 2025-26)

Ethanol Supply (Projection)			
Ethanol Supply (in cr. Lt.)	**Fuel ethanol**	**Other uses**	**Total**
(A) From sugar sector	550	134	684
(B) From grain/ maize etc.	466	200	666
Total Supply	**1016**	**334**	**1350**

Capacity Augmentation required for 20% blending by 2025			
Ethanol Capacity (in cr. Lt.)	**Molasses based**	**Grain based**	**Total**
Ethanol/alcohol capacity (ESY 21-22)	619 **(263 distilleries)**	329 **(123 distilleries)**	948
New capacity addition/undergoing project	141	411	552
Total Capacity required by to reach 1350 Crores litres supply	**760**	**740**	**1500**

- Additional capacity (90 % of 1500 = 1350) has been taken to account operational efficiency, raw material availability in various parts of the country due to natural calamity etc., increase in demand in ethanol due to economic factors and anticipated demand of ethanol in flex-fuel vehicles.
- Molasses based distilleries can produce 20% additional ethanol if sugar rich feed stocks like B- heavy molasses are used as the same capacity can cater the higher demand of ethanol.
- Total planned capacity is 1500 cr litres per annum, distribution between grain and molasses may change depending on various factors.
- It is relevant to mention that earlier on the inputs obtained from MoP&NG, 900 cr ltrs ethanol was estimated to achieve 20% blending and 300 cr ltrs was the requirement of other sectors, thus total requirement was assessed to be 1200 cr

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litres by 2024-25. However, as per the revised estimates of gasoline consumption obtained from MoP&NG, about 988 cr ltrs is required to achieve 20% blending by 2024-25 and total requirement of alcohol including other sectors would be 1288 cr litres. For 2025-26, ethanol requirement is 1016 cr ltrs to achieve 20% blending and total requirement of alcohol including other sectors would be 1350 cr litres.

Source: Niti Ayog and PIB dated 21.12.2022 Ministry of consumer Affairs

ETHANOL PRICE HISTORY

1. **Year 2015-16** – Ethanol price was fixed by government at Rs 48.5-49.5 a litre, inclusive of all taxes and transportation charges. Mill realization price was Rs 40/lit.

2. **Year 2016-17** – Mill realization price was Rs 38.97/litre, all duty and transportation up to depot were born by government.

3. **Year 2017-18** - Mill realization price was 40.85 a litre, all duty and transportation up to depot were born by government.

4. **Year 2018 -19** – Government announced new policy and cost structure, -
   a. Ethanol derived from C-heavy molasses @ Rs. 43.46/litre ex-mill
   b. Ethanol derived from B-heavy molasses at Rs.52.43/litre ex-mill;
   c. Ethanol from 100% sugarcane juice at Rs.59.13 per litre ex-mill.

5. **Year 2019-20** –
   a. Ethanol derived from the C-heavy molasses route has been increased to Rs 43.75/Litre, ex-mill
   b. Ethanol from B-heavy molasses route has been hiked to Rs 54.27 a litre, ex-mill
   c. Ethanol from sugarcane juice/sugar/sugar syrup route has been fixed at Rs 59.48/litre, ex-mill
   d. Ethanol from Damaged Food Grains at Rs.47.13 per lit, ex-mill.

6. **Year 2020 -21** -
   a. Ethanol from C heavy molasses route be increased from Rs.43.75 per lit to Rs.45.69 per litre,
   b. Ethanol from B heavy molasses route be increased from Rs.54.27 per lit to Rs.57.61 per litre,
   c. Ethanol from sugarcane juice / sugar / sugar syrup route be increased from Rs.59.48 per lit to Rs.62.65 per litre,
   d. Ethanol from maize (corn) as Rs 51.55/litre & rice available with FCI as Rs 56.87/litre.

7. **Year 2021-22**
   a. Ethanol from C heavy molasses route be increased from Rs.45.69 per lit to Rs.46.66 per litre,

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b. Ethanol from B heavy molasses route be increased from Rs.57.61 per lit to Rs.59.08 per litre,
c. Ethanol from sugarcane juice / sugar / sugar syrup route be increased from Rs.62.65 per lit to Rs.63.45 per litre,
d. Ethanol from maize (corn) as Rs 51.55/litre & rice available with FCI as Rs 56.87/litre.

During Jun 22 to Dec 22 the relief was provided on ethanol supply where the additional relief amount of Rs. 1.179/Litre provided on C-heavy molasse, Rs. 1.493/Litre on B-Heavy molasse, Rs. 1.604/Litre on sugarcane juice/sugar/sugar syrup, Rs. 2.337/Litre on Damaged food grain-based ethanol and Rs. 1.437/Litre on Surplus rice-based ethanol.

8. Year 2022-23

a. Ethanol from C heavy molasses route be increased from Rs.46.66 per lit to Rs.49.41 per litre,
b. Ethanol from B heavy molasses route be increased from Rs.59.08 per lit to Rs.60.73 per litre,
c. Ethanol from sugarcane juice / sugar / sugar syrup route be increased from Rs.63.45 per lit to Rs.65.61 per litre,
d. Ethanol from maize (corn) as Rs 56.35/litre & rice available with FCI as Rs 58.50/litre and from Damaged food grains it was 55.54/Litre.

From 7th Aug-23 the relief was provided on ethanol supply from Damaged food grains where the prices increased by Rs. 8.46/Litre for damaged food grain while relief provided for Rs. 9.72/Litre for Ethanol produced from maize.

Accordingly, the revised prices of ethanol from Maize/Corn is Rs. 66.07/Litre while from damaged food grains it is Rs. 66.96/Litre.

Supply period is from 1st December to 30th November till year 21-22. However, for year 22-23 the supply period is from 1st December to 31st October-23

Note:
1. The supply period is from 1st December to 30th November till FY 21-22. However, for FY 22-23 the supply period is from 1st Dec-23 to 31st Oct 23.
2. GST as per actuals & Transportation shall be paid extra.
3. B heavy molasses, sugarcane juice and DFG route allowed only in ESY 2018-19 onwards.
4. Surplus rice issued by FCI & Maize route allowed from 2020-21 onwards.

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Raw Material Scenerio - Rice

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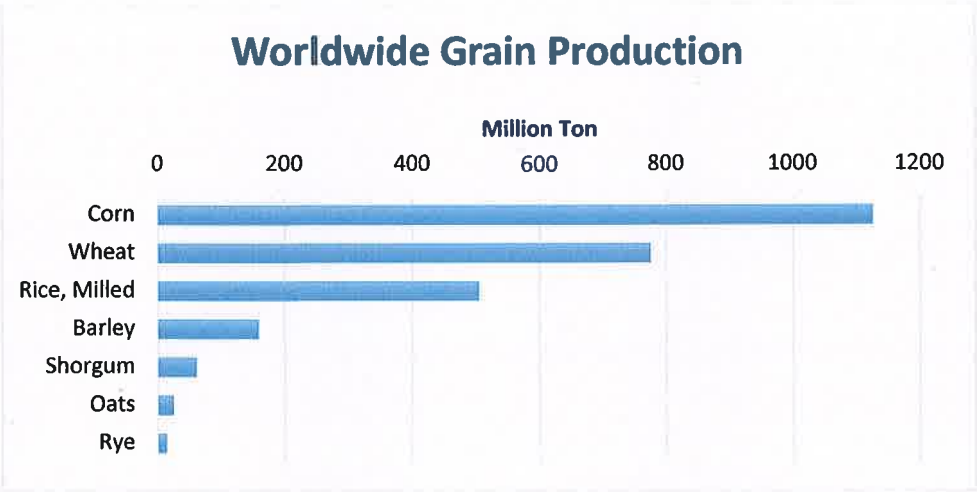
Feedstock assessment

Worldwide production of grain in 2020/21, by type



Source : Satista

Availability of feed-stocks for Ethanol in the Country (In Lakh Ton)

Feed-stock	Annual production	Annual Consumption	Surplus
Sugar	320	260	60
FCI rice	520 (Annual Procurement)	350 (Annual issue)	309
Corn	285	165	103
**** FY 2019-20, **as per Market Begin year, # stock in central pool as on 31.03.2020, ##expected after export***			

Source: Roadmap for Ethanol Blending in India 2020-25

INDIAN AGRICULTURE SCENARIO

India as an agricultural country and Food **grain production** covers the dominant part of the cropped area (65%) in **Indian agriculture**. **India** is the world's largest producer of millets and second-largest producer of wheat, **rice**, and pulses. India accounts for 7.39 percent of total global agricultural output. It is estimated that India's agriculture sector accounts only for around 14 percent of the country's economy but for 42 percent of total employment. As around 55 percent of India's arable land depends on precipitation, the amount of rainfall during the monsoon season is very important for economic activity. It is estimated that around 17.5 mn tonnes of surplus grain available in India. Around 11 mn tonnes of paddy is having major contribution in surplus.

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Land Use	Year	Value	Unit
Geographical Area	2019-20	328.75	Million Hectare
Reported Area for Land Utilization Statistics	2019-20	306.54	Million Hectare
Area under Forest	2019-20	71.75	Million Hectare
Percentage of Area under Forest to Reported Area	2019-20	23.41%	
Gross Cropped Area	2019-20	211.36	Million Hectare
Percentage of Gross Cropped Area to reported area	2019-20	68.95%	
Net Area Sown	2019-20	139.9	Million Hectare
Percentage of Net Area Sown to Reported Area	2019-20	45.64%	
Area sown more than once	2019-20	71.46	Million Hectare
Cropping Intensity (%	2019-20	151.08%	
Production			
Food grains Production (as per 4th Advance Estimates)	2021-22	285.71	Million ton
Kharif		141.03	Million ton
Rabi		144.68	Million ton
Procurement			
Rice- for Kharif Marketing Season 2022-23*		478.27	Lakh ton

Source : Agricuture statistics at Glance 2022, Ministry of Agriculture, India; DES, DGCI&S, DFPD, RGI and NSO

*As on 28.02.2023

Rice as Feedstock :

Most rice varieties are composed of roughly 20% rice hull or husk, 11% bran layers, and 69% starchy endosperm, also referred to as the total milled rice. Total milled rice contains whole grains or head rice, and brokens. The by-products in rice milling are rice hull, rice germ and bran layers, and fine brokens.

Rice production in world -

Rank	Country	Production in Tons
1	China	206,507,400
2	India	157,200,000
3	Indonesia	70,846,465
4	Bangladesh	52,325,620
5	Vietnam	44,974,206
6	Thailand	32,620,160
7	Myanmar	26,423,300
8	Philippines	18,967,826
9	Brazil	12,175,602
10	Japan	10,549,000

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India agriculture –

Target and Acheivement of Rice and Sugarcane

Million tons

	2014-15		2015-16		2016-17		XIIth Plan		2017-18		2018-19		2019-20*	
	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
Rice	106	105.48	106.1	104.41	108.5	109.7	529.6	531.48	108.5	112.76	114	116.48	116	118.43
Sugarcane	345	362.33	355	348.45	355	306.07	1747	1710.19	355	379.9	385	405.42	385.5	355.7

Source : Directorate of Economics & Statistics, DAC&FW

Overall glance of Rice (Average of 2016-17 to 2020-21)

Season	Area, Mn. Hectare	Production, Mn. Ton	Yield Ton/ Hectare
Kharif	39.54	99.44	2.51
Rabi	4.35	15.01	3.45
Total	43.90	114.45	2.61

Source : Directorate of Economics & Statistics, DAC&FW

Grain production in India

A - Area in Million Hectares
P - Production in Million Tonnes
Y - Yield in Ton/Hectare

	Kharif			Rabi			Total		
	A	P	Y	A	P	Y	A	P	Y
2011-12	72.08	131.27	1.821	52.67	128.01	2.43	124.75	259.29	2.078
2012-13	67.69	128.07	1.892	53.09	129.06	2.431	120.78	257.13	2.129
2013-14	69.05	128.69	1.864	55.99	136.35	2.435	125.04	265.04	2.12
2014-15	68.77	128.06	1.862	55.53	123.96	2.232	124.3	252.02	2.028
2015-16	69.20	125.09	1.808	54.01	126.45	2.341	123.22	251.54	2.041
2016-17	73.20	138.33	1.89	56.03	136.78	2.441	129.23	275.11	2.129
2017-18	72.00	140.47	1.951	55.53	144.55	2.603	127.52	285.01	2.235
2018-19	72.34	141.52	1.956	52.49	143.76	2.739	124.83	285.28	2.285
2019-20	70.86	143.81	2.029	56.13	153.69	2.738	126.99	297.50	2.34
2020-21	72.44	150.58	2.079	57.35	160.17	2.793	129.79	310.75	2.39
2021-22*	72.99	156.04	2.138	57.54	159.68	2.775	130.53	315.72	2.42

Source: Directorate of Economics & Statistics, DAC&FW

*** 4th Advance Estimates.**

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Rice production in India

	Area, Mn Hectare	Production, Mn Tons	Yield, Ton/Hectare
2010-11	42.86	95.98	2.239
2011-12	44.01	105.30	2.393
2012-13	42.75	105.23	2.461
2013-14	44.14	106.65	2.416
2014-15	44.11	105.48	2.391
2015-16	43.50	104.41	2.4
2016-17	43.99	109.70	2.494
2017-18	43.77	112.76	2.576
2018-19	44.16	116.48	2.638
2019-20	43.66	118.87	2.723
2020-21	45.77	124.37	2.717
2021-22*	46.38	130.29	2.809

Source: Directorate of Economics & Statistics, DAC&FW

* 4th Advance Estimates

Rice production state wise

Area – Mn Hectare
Production – Mn tons
Yield – Ton/Hectare

	2021-22*					2020-21				
	Area	% of All India	Production	% of All India	Yield	Area	% of All India	Production	% of All India	Yield
West Bengal	5.6	12.06	16.76	12.87	2.993	5.59	12.2	16.52	13.29	2.955
Uttar Pradesh	5.7	12.29	15.27	11.72	2.679	5.68	12.41	15.52	12.48	2.732
Punjab	2.97	6.4	12.89	9.89	4.340	2.93	6.4	12.78	10.28	4.362
Telengana	3.65	7.88	12.3	9.44	3.370	3.19	6.96	10.22	8.22	3.204
Odisha	3.94	8.5	9.14	7.01	2.320	4.04	8.82	8.81	7.08	2.181
Tamil Nadu	2.21	4.76	8.07	6.19	3.652	2.04	4.45	6.88	5.53	3.373
Chhattisgarh	3.76	8.1	7.9	6.06	2.101	3.79	8.28	7.16	5.76	1.889
Andhra Pradesh	2.25	4.84	7.79	5.98	3.462	2.32	5.08	7.88	6.34	3.397
Bihar	3.1	6.67	7.06	5.42	2.277	2.96	6.47	6.61	5.32	2.233
Assam	2.36	5.08	5.27	4.04	2.233	2.36	5.16	5.21	4.19	2.208
Others	10.86	23.41	27.84	21.37	2.564	10.88	23.77	26.76	21.52	2.460
All India	46.38	100	130.29	100	2.809	45.77	100	124.37	100	2.717

Source: Directorate of Economics & Statistics, DAC&FW

Note: States have been arranged in descending order of percentage share of production during 2021-22.

* Provisional # 4th Advance Estimates.

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Rice production, consumption and export:

Rice, Milled	2021/22		2022/23		2023/24 (Estimate)	
Market Year Begins	Oct-21		Oct-22		Oct-23	
	USDA Off.	**New Post**	**USDA Off.**	**New Post**	**USDA Off.**	**New Post**
Area Harvested (1000 HA)	46279	46279	47000	47000	0	46500
Beginning Stocks (1000 MT)	37000	37000	34000	34000	0	29000
Milled Production (1000 MT)	129471	129471	132000	128000	0	127000
Rough Production (1000 MT)	194226	194226	198020	192019	0	190519
Milling Rate (.9999) (1000 MT)	6666	6666	6666	6666	0	6666
Total Supply (1000 MT)	166471	166471	166000	162000	0	156000
TY Exports (1000 MT)	22119	22119	22500	22500	0	21000
Consumption& Residual (1000MT)	110446	110446	111000	110500	0	111000
Yield (Rough) (MT/HA)	4.1968	4.1968	4.2132	4.0855	0	4.0972

Source: USDA Grain and Feed Annual, 2023

There are various type of rice varieties that are consumed in our country –

1. Basmati,
2. White,
3. Brown,
4. Red,
5. Jasmine,
6. Parboiled
7. Sticky Rice.

Of these, Basmati and White Rice are the ones that are most favoured in the country.

The areas of Basmati Rice production in India are in the states of J & K, Himanchal Pradesh, Punjab, Haryana, Delhi, Uttarakhand and western Uttar Pradesh.

Basmati Cultivation Area in India

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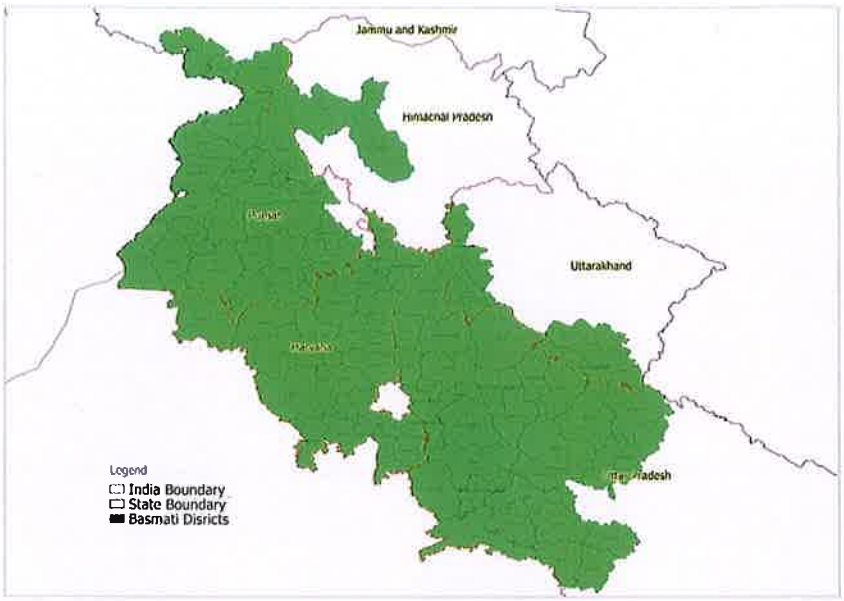

Source: Basmati Crop survey report by NCML, Gurgaon

Export price of 100% broken rice:

Year	Rest in Lakh	Quantity, thousand Kg	Rest /Kg
2015-16	201,980.69	1,133,942.50	17.8
2016-17	173,989.06	925,629.38	18.8
2017-18	244,445.95	1,200,355.38	20.4
2018-19	257,939.90	1,221,616.75	21.1
2019-20	59,372.57	270,338.34	22.0
2020-21	438,639.98	2,064,562.25	21.2
2021-22	439,403.97	2,055,959.25	21.4

Source: Import export data bank, Ministry of commerce, India

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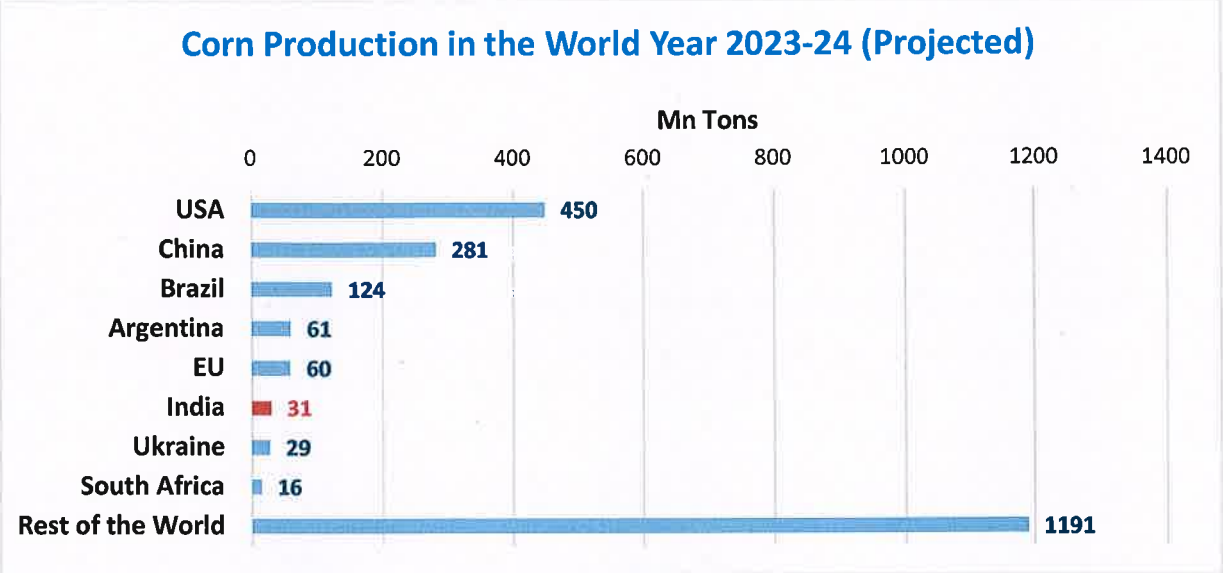
Corn (Maize)

Corn (Maize) production in the world



India is the leading Maize producer in the world and ranked 5th in the world. India and Ukraine are only non-GM maize producers. Rest of the countries are producing GM maize.

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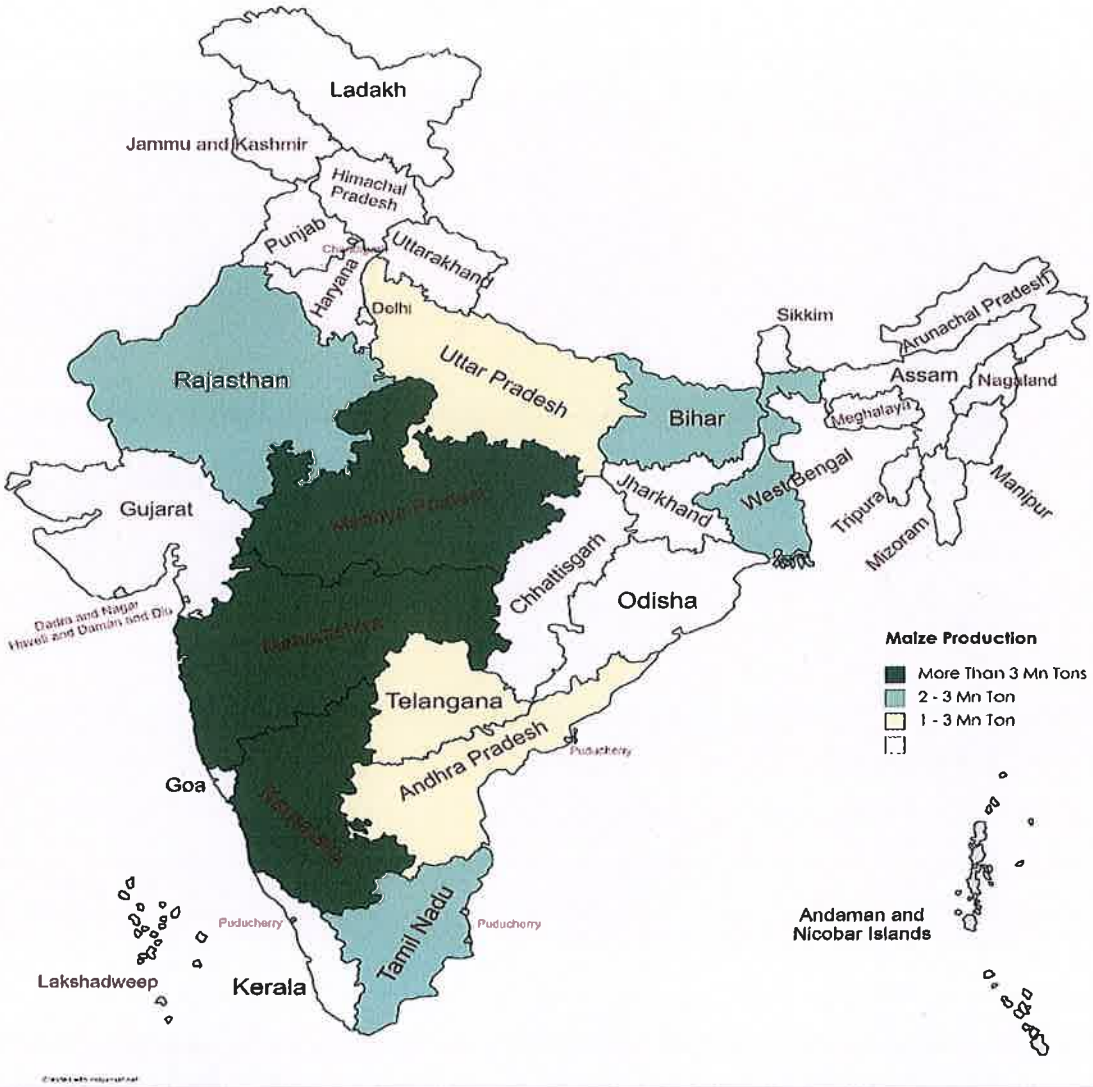
Corn production in India



State	Production Mn Ton	Yield Ton/Hectare
Karnataka	5.36	3.1
Madhya Pradesh	3.88	2.8
Maharashtra	3.52	3.0
Tamil Nadu	2.56	6.4
West Bengal	2.44	6.8
Rajasthan	2.27	2.3
Bihar	2.08	3.2
Uttar Pradesh	1.82	2.4
Andhra Pradesh	1.78	5.9
Telangana	1.76	6.8
Others	4.18	
Total	**31.65**	**3.00**

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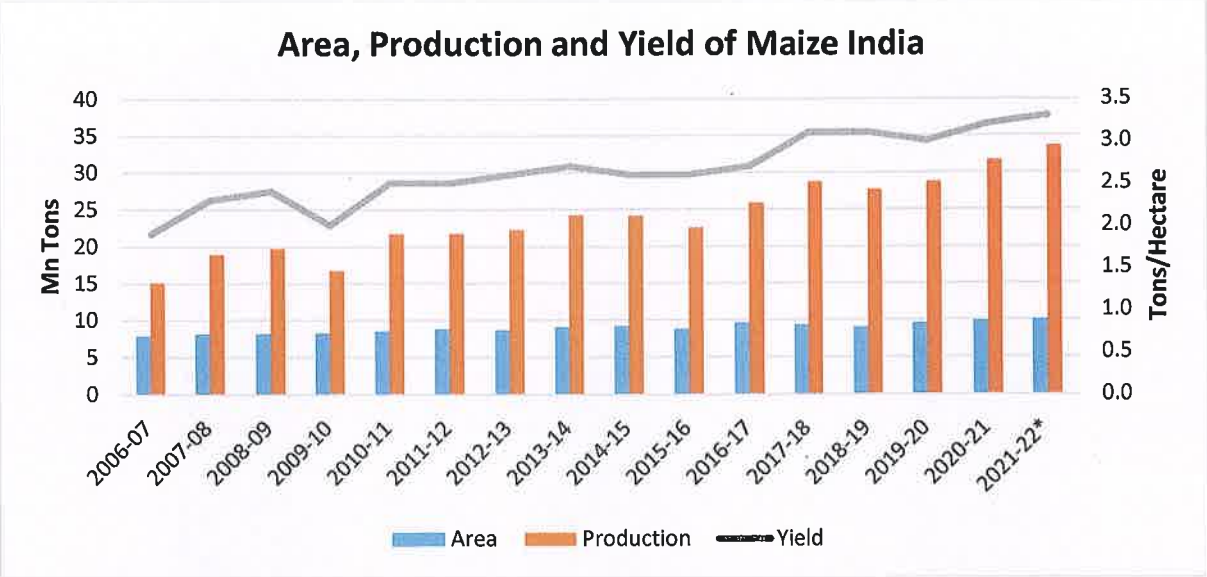
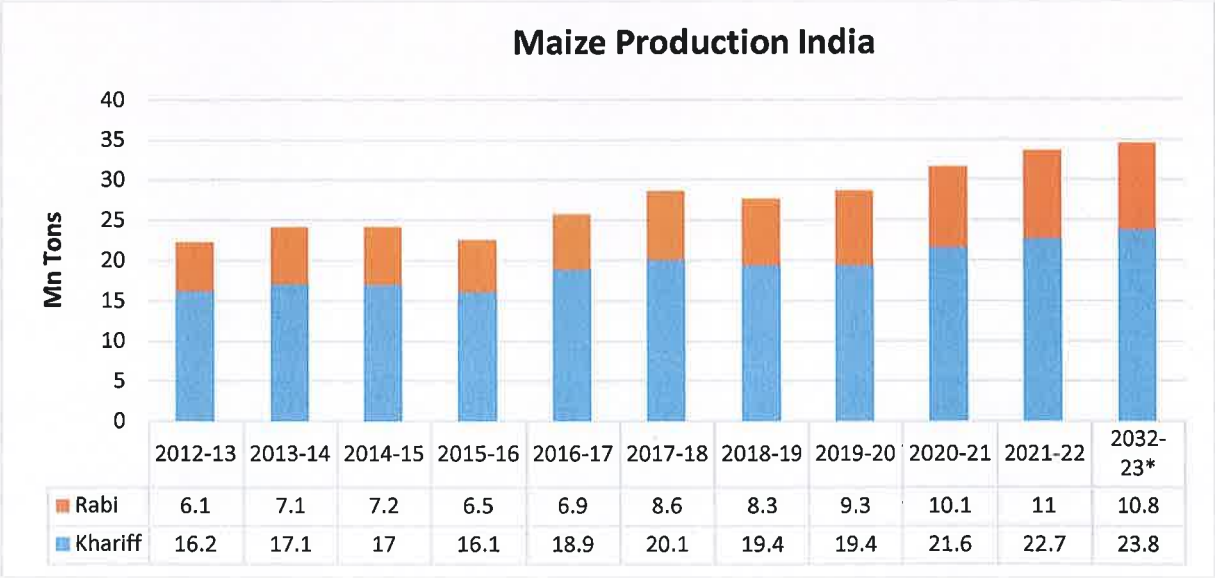
Every year area under maize production is increasing and yield is also increasing



Growth in Maize production in India



	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2032-23*
Rabi	6.1	7.1	7.2	6.5	6.9	8.6	8.3	9.3	10.1	11	10.8
Khariff	16.2	17.1	17	16.1	18.9	20.1	19.4	19.4	21.6	22.7	23.8

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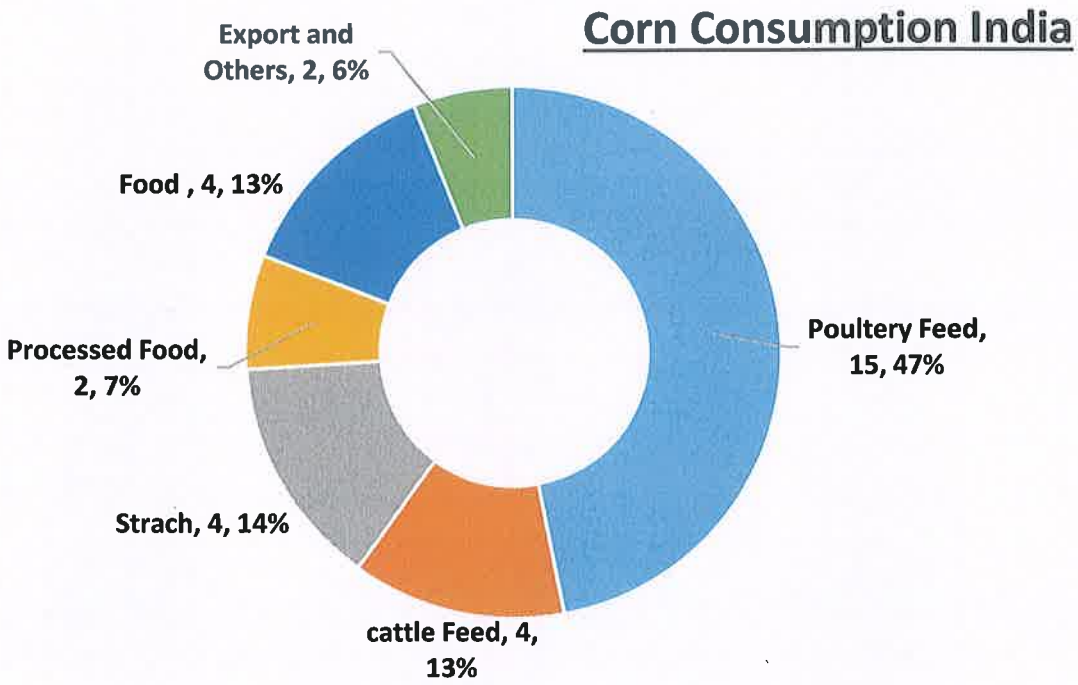
Maize consumption in India



Source: ICAR – Indian Institute of Maize Research, Delhi

Supply, consumption and stock in India

	2021-22	2022-23 (Estimated)	2023-24 (Projected)
Production	**33.62**	**35.91**	**31.18**
Import	0.29	0.04	0.12
Export	3.4	3.34	2.42
Domestic consumption	**29.1**	**29.5**	**29.6**
Total Demand	32.5	32.84	32.02

- **Government of India don't procure maize**
- **India is exporting 3.4 Mn ton of corn**
- **Government of India has declared MSP for maize**
- **India is using 16.25 Mn ton as feed to chicken and fishery meal.**

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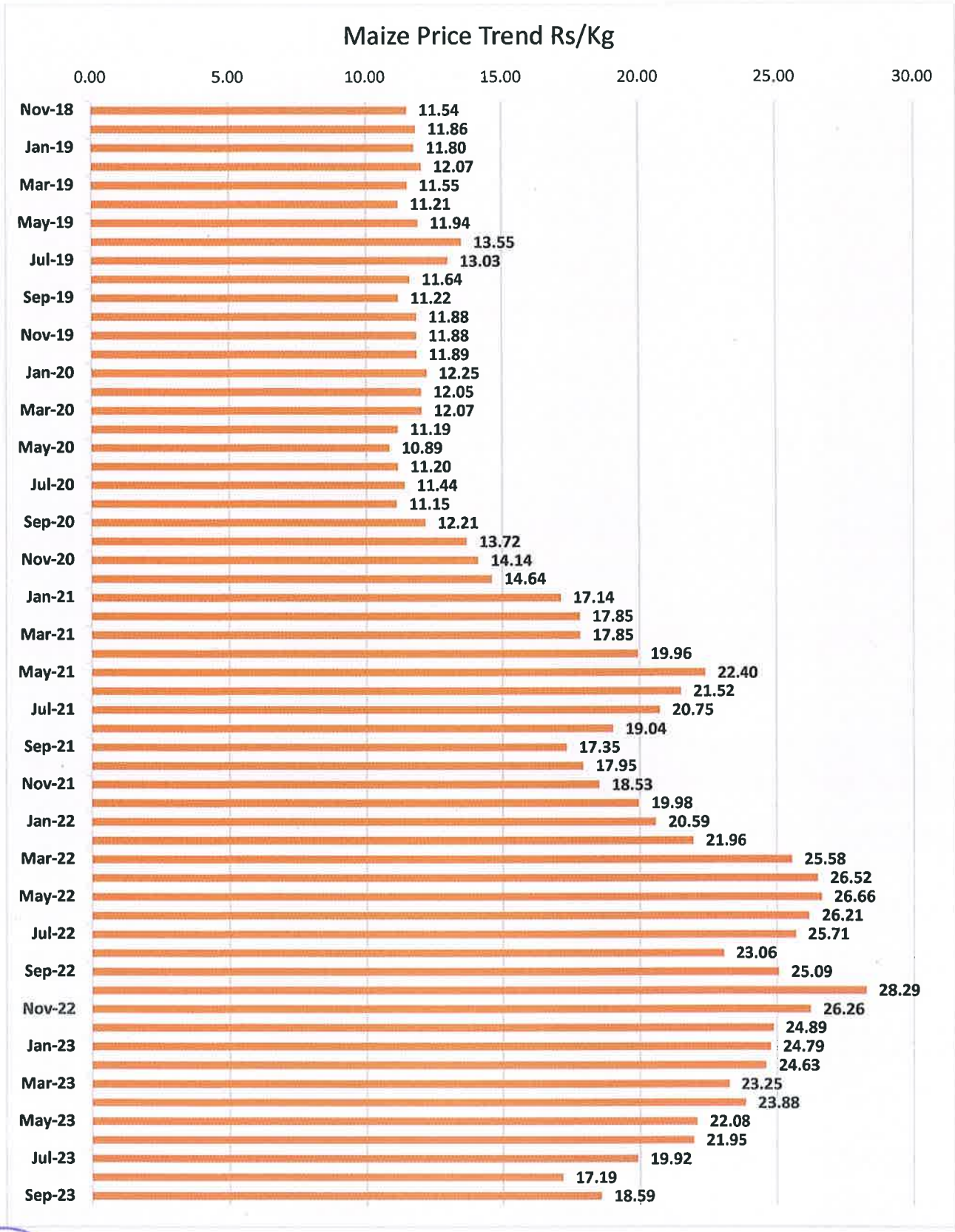
Price Trend of Maize –



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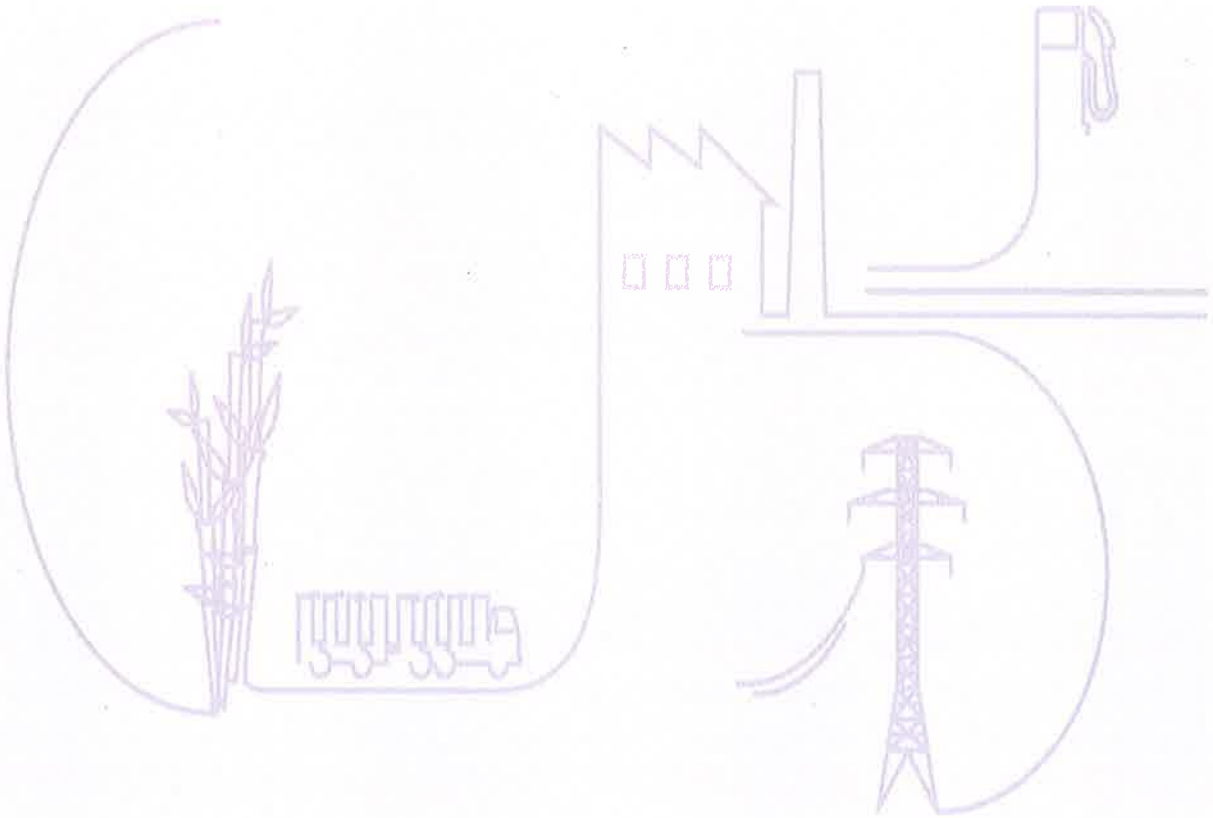
By Products Scenerio –
DDGS and Food Grade CO_2



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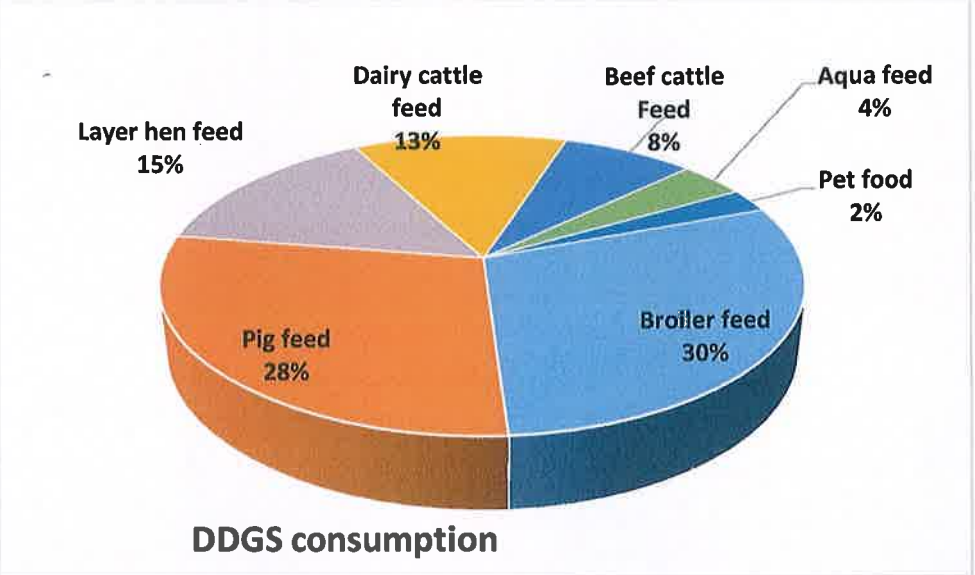
Consumption of DDGS

DDGS is main constituent for chicken feed and aqua feed. It is high in protein along with fibre makes it suitable for fast growth of chicken and fishes.



DDGS consumption

Animal feed and DDGS

Application in various animal feeds		
Animal Feed	**% Contribution**	**Blending Ratio per ton**
Cattle Feed	54%	19-24
Poultry Feed	37%	7-9
Aqua Feed	9%	4-6

Compound feed production for the BIG 7 -

All fig in Mn ton

Period	China	USA	Brazil	Mexico	Spain	India	Russia
2012	198.34	168.46	66.28	28.54	28.23	26.84	23.35
2013	189.13	168.68	66.9	29.12	28.9	26.42	24.51
2014	182.69	172.45	66.15	30.7	29.18	29.43	25.66
2015	179.93	173.73	86.7	31.11	29.38	31.54	29.09
2016	187.2	169.7	68.93	33.88	31.85	31.36	29.09
2017	186.9	173	69.9	34.4	33	34.2	37.6
2018	187.9	177.2	68.7	34.6	34.5	38.7	39.2

Source: Alltech

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Region wise demand of DDGS in India

S. No.	Region	Broiler Production, (Mn no.)	DDGS requirement, Mn Ton
1	Tamil Nadu	348	1.18
2	Kerala	60	0.2
3	Karnataka	259	0.88
4	Andhra Pradesh	375	1.27
5	Maharashtra	362	1.23
6	Gujarat	60	0.2
7.	West Bengal	330	1.12
8	Odisha	80	0.27
9	Assam	68	0.23
10	Punjab & Haryana	260	0.88
11	Rajasthan	48	0.16
12	Uttar Pradesh	186	0.63
13	Bihar & Jharkhand	168	0.63
14	Madhya Pradesh	57	0.19
15	J & K	27	0.09
16	Chhattisgarh	59	0.2
17	Himachal Pradesh	36	0.12
18	Uttarakhand	53	0.18
19	Other	82	0.28
	Total	2918	9.92

Indicative price of DDGS in India

Source of Raw Material	**% Protein**	**Average Indicative price (Rs/Kgs)**
Rice Based	40%-45%	22-24
Corn Based	20%-25%	16-18

* DDGS is being sold on ex-refinery basis

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Indicative prices state wise:

States	Avg. indicative price (Rs./kg)
Punjab	27-34
Haryana	32-37
Uttar Pradesh	31-39
Madhya Pradesh	26-31
Bihar	21-27
Maharashtra	31-34
Rajasthan	39-43
Jharkhand	29-34
Chhattisgarh	31-37

Market in India and Export potential –

Presently USA is the largest producer of DDGS and largest export in the world.
India's neighboring countries – Bangladesh, Thailand, Malaysia, Vietnam and China are buyers.
Export opportunity is available for these countries.
Australia can also be another major destination for export, as Australia prefer to buy non GMO DDGS.

As per USDA –

The Indian market has the potential to import more than 700,000 metric tons of U.S. distiller's dried grains with solubles (DDGS) annually, but technical barriers exist.

- In India, grain based distilleries were installed to manufacture potable alcohol. These are small in size and use various feed like – corn, rice and other available grain (if any).
- DDGS available is mainly rice DDGS and a small quantity of corn DDGS
- Price of DDGS varies from Rs 19,000 to 23,000 /Ton, depending upon the protein %age in product.

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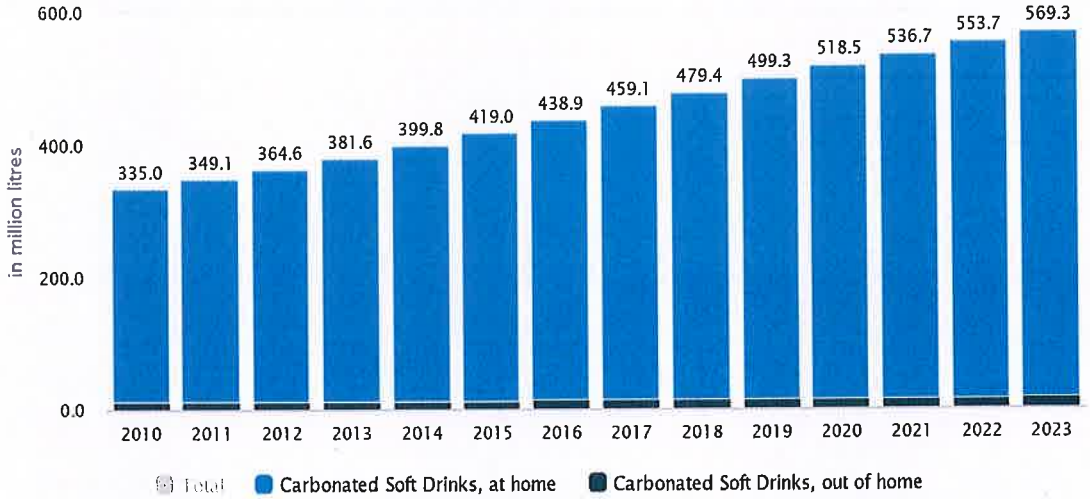
Food Grade Carbon dioxide

Application of Liquid Carbon Di Oxide

- Carbonation of beer and soft drinks for superior quality and a fresh, tingling taste.
- Grinding spices to preserve the aroma and for increased production rates.
- Packaging of foodstuffs in a controlled atmosphere for superior quality and fresh taste.
- Quick-freezing in tunnels and cabinets for fresh taste; reduction in loss of weight; and increased production rate.
- Preservation of meat during the mincing process.
- Transportation of chilled food with fairly low investment.
- As dry ice for the pharmaceuticals and food industry.



Source: Statista

- Multinationals such as Coca-Cola and PepsiCo dominate the segment with multiple offerings across different variants, such as cola, lime, and other fruit variants.
- Lemonade and lime-based carbonates are expected to experience the fastest growth due to their increasing popularity as mixers in alcoholic drinks.

Indicative price of C02 in India:

The indicative prices of C02 is in the range of Rs. 2.5/Kgs to Rs. 3.5/kgs

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Salient Features of Project

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Incentives for proposed 1G ethanol projects – Central Government

Pricing for Ethanol :

The pricing of the ethanol is assumed to be Rs. 66.07/ litre.

Socio-economic advantages of Proposed 1G ethanol project:

Reducing import dependency: The proposed 1G ethanol project will produce around ~10 Crore litres of Fuel Ethanol. This project is a step in utilizing renewable and environment-friendly sources of energy like ethanol to supplement fossil fuels.

Cleaner Environment: As per the ministry of petroleum notification on new biofuel policy, the proposed 1G ethanol project of HOPL will produce around ~10.0 Crore litres of Bio-Fuel Ethanol which has the potential to save around 45% – 50% of CO2 emissions per year by replacing gasoline with bio-ethanol if biomass is considered as possible fuel source.

Employment Generation: HOPL's proposed **300 KLPD** 1G ethanol project will create around 150+ direct jobs in plant operations, and about thousands of indirect jobs for personnel related to various supply chain & selling of by-products; village level entrepreneurs and Grain and DDGS supply chain. DDGS as a protein rich feed for animals will boost animal husbandry development in rural India. This will provide boost to rural economy in India.

Income to Farmers: Farmers will get sustainable income source by growing feedstock and there will be assured offtake and utilization of grains for biofuel production. This will help to increase farmer's income.

Infrastructural Investment in Rural Areas: Proposed 1G ethanol plant of HOPL will require Capital Investment of INR 525 Crores excluding working capital margin and GST. Investment in proposed 1G ethanol plant will spur infrastructural investment in rural areas.

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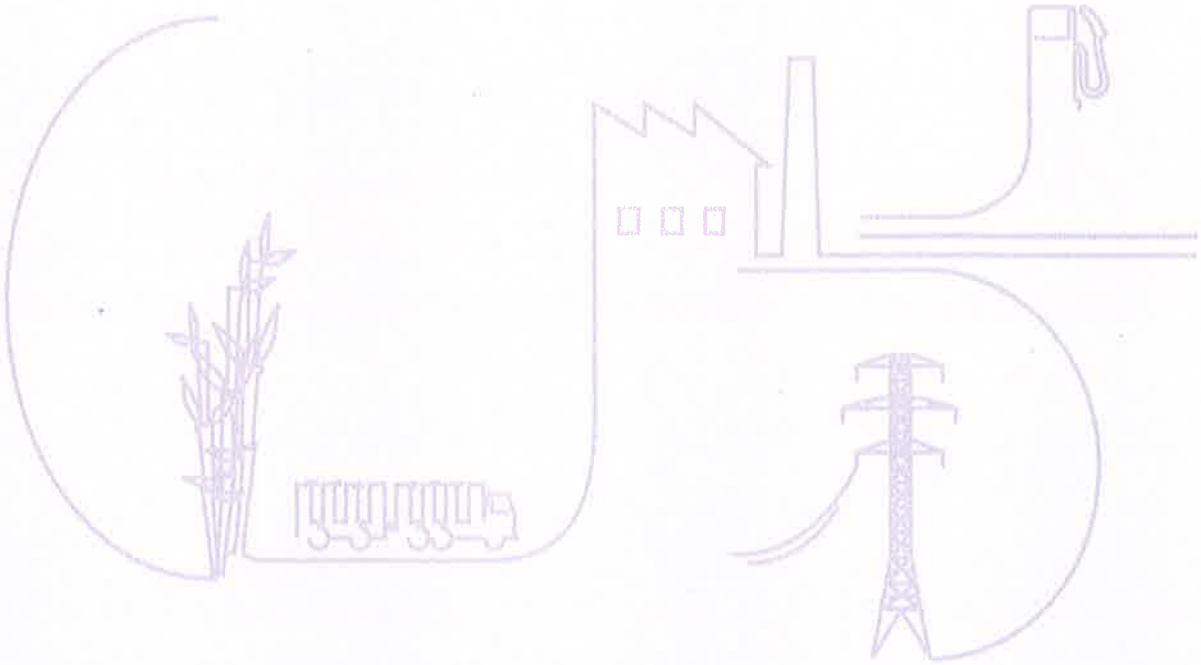
Ethanol Blending Programme



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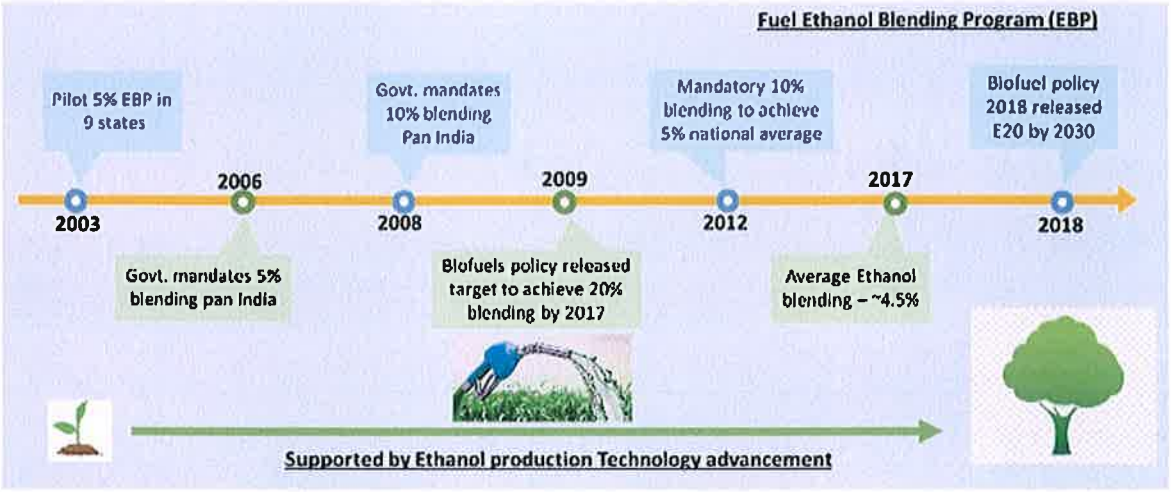
Indian Outlook for Bioethanol



Progressive Vision and Strong Policy Support

- The Government of India in January 2003 launched its Ethanol Blended Petrol (EBP) Programme for 5% ethanol blended petrol in 9 states. India's EBP Programme sought to improve fuel efficiency and ensure protection from the price shocks of the global crude market.
- In 2006, Government of India announced 5 % mandate for ethanol blending Pan India excluding the entire north-eastern region, Jammu and Kashmir, and Andaman and Nicobar Islands which were left out of the EBP Programme (source: Ministry of Petroleum & Natural Gas, 2015)
- In 2009, the Government of India introduced a National Policy on Biofuels. The Policy focused on further encouraging biofuel usage and reducing the prevailing dependence on fossil fuels, while it sought to mitigate environmental and fuel efficiency concerns. The Policy also recognized the significant opportunity that biofuels offer to India's agricultural and industrial sectors. This policy also mandated a phased implementation of ethanol blending in petrol in various states.
- In 2012, the CCEA decided that a stable EBP Programme would ensure sustainable benefits for sugarcane farmers across the nation, and the 5% mandatory ethanol blending with petrol should be implemented across the country and that the purchase price of ethanol would be decided between OMCs and the suppliers of ethanol. A Gazette Notification was issued, directing OMCs to sell ethanol blended petrol with percentage of ethanol up to 10% and as per the Bureau of Indian Standard (BIS) specifications (Ministry of Petroleum and Natural Gas, 2015).
- In 2014, to offer OMCs and suppliers clear signals, the CCEA fixed ethanol prices based on the distance of the mill/distillery from the OMC depot/installation (Cabinet Committee on Economic Affairs (CCEA), 2014).
- These policy measures and strong support the Indian EBP Programme managed to achieve an average blending ration of around 4.5 %

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- To give a further boost to the EBP Programme the Union Cabinet, chaired by the Prime Minister Shri Narendra Modi approved National Policy on Biofuels – 2018.

Highlights of national biofuels policy -

- Targets to achieve these key outcomes through the EBP programme.
- Ensuring energy security and self-reliance by enhancing biofuels production.
- Reducing import bill and conserving foreign exchange.
- Reduction in carbon emission
- Strengthening rural economy, Enhanced and sustainable income for farmers by providing boost to agricultural sector.
- Retain employment and additional employment generation in rural India.
- Targets 10% ethanol blending by 2022 and 20% blending by 2030 which later on advanced to 2025.
- Allowing additional feedstock for 1st Generation like sugarcane juice/syrup, surplus/damaged grains for production of ethanol
- Use of lingo cellulosic biomass such as agricultural crop residue, energy crops, etc. for production of 2nd Generation Bioethanol

Other major policy measures to support the EBP.

- Interest subvention schemes introduced for sugar cane and molasses-based distilleries
- Remunerative ethanol pricing for various feed stocks independent of crude pricing
- Assurance of OMCs to purchase ethanol for 10 years

KEY DRIVERS

- **AATMA-NIRBHAR BHARAT ABHIYAN** to promote local Energy resource.
- Aggressive Biofuel policy and Ethanol Blending Program
- Target to reduce GHG emission by 30 to 35% by 2030
- Enhance Energy self-reliance.
- Availability of plenty of agro based feedstock.
- Advancements in Ethanol production (enhanced feedstock basket) and application (Flex Fuel Vehicles) technologies.
- YoY increase in Potable and Industrial ethanol consumption.

- DFPD notifies modified interest subvention scheme for setting up new grain based / dual mode-based distilleries.

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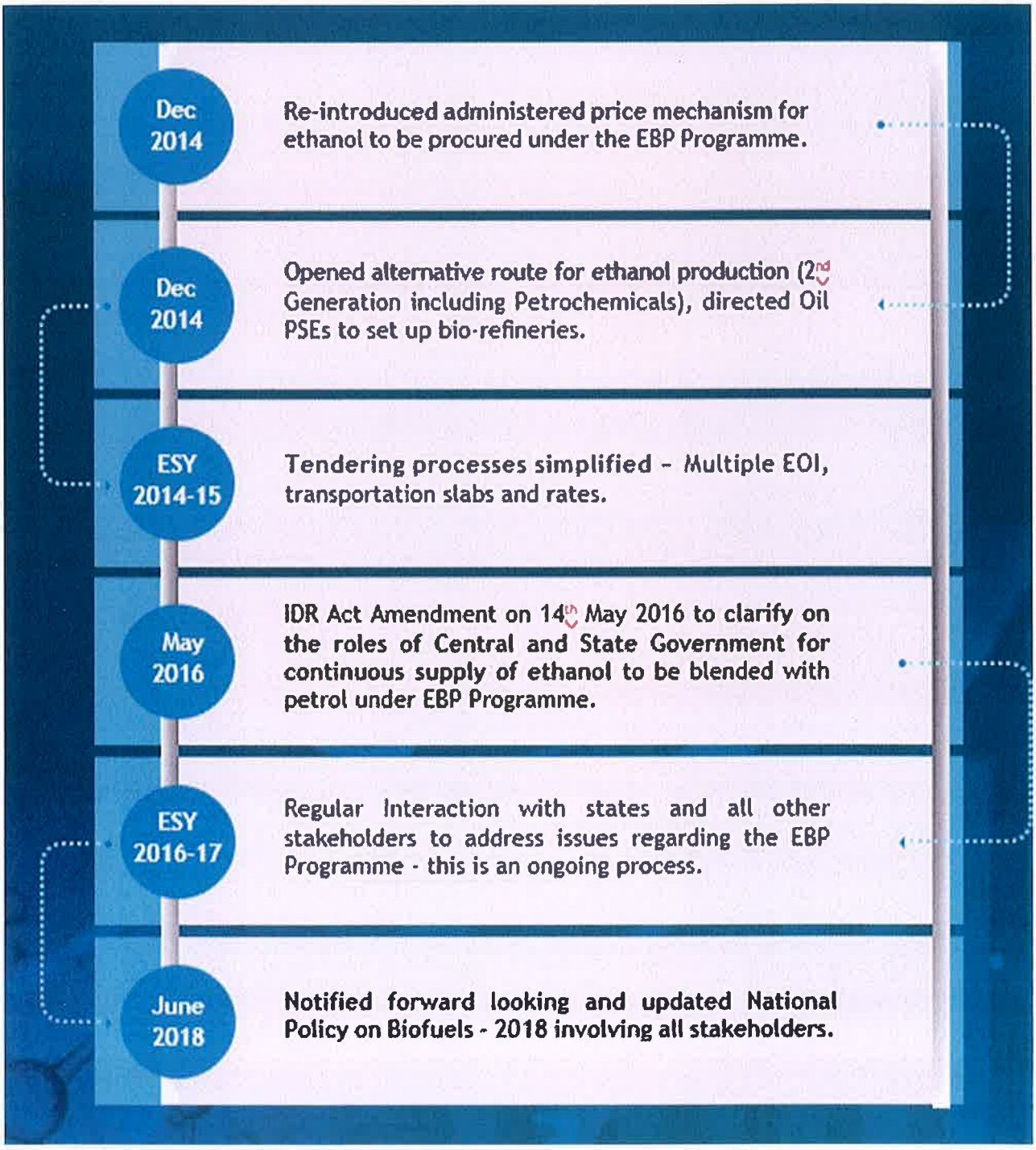
Ethanol Blending Programme (EBP) Roadmap in India



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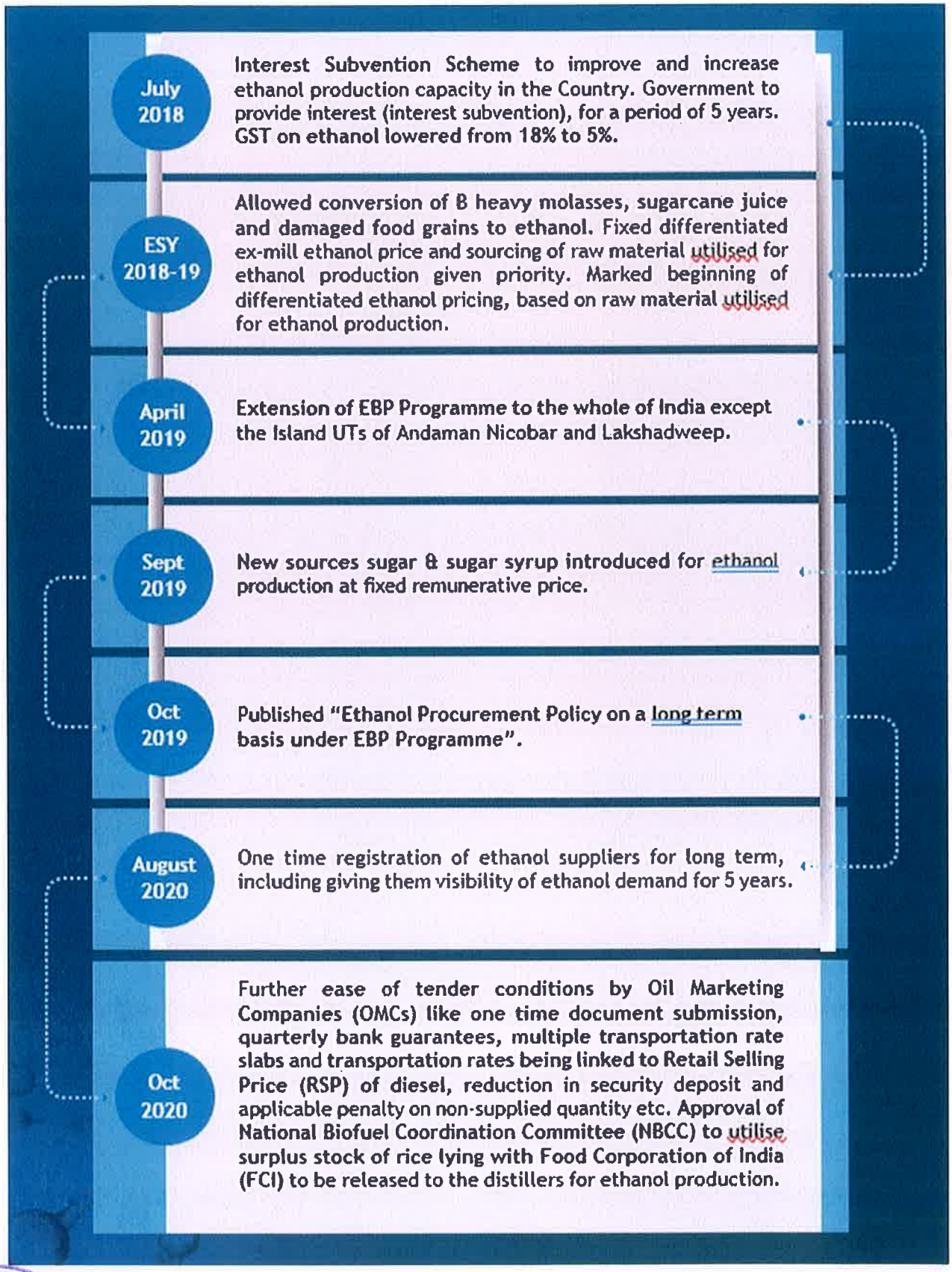

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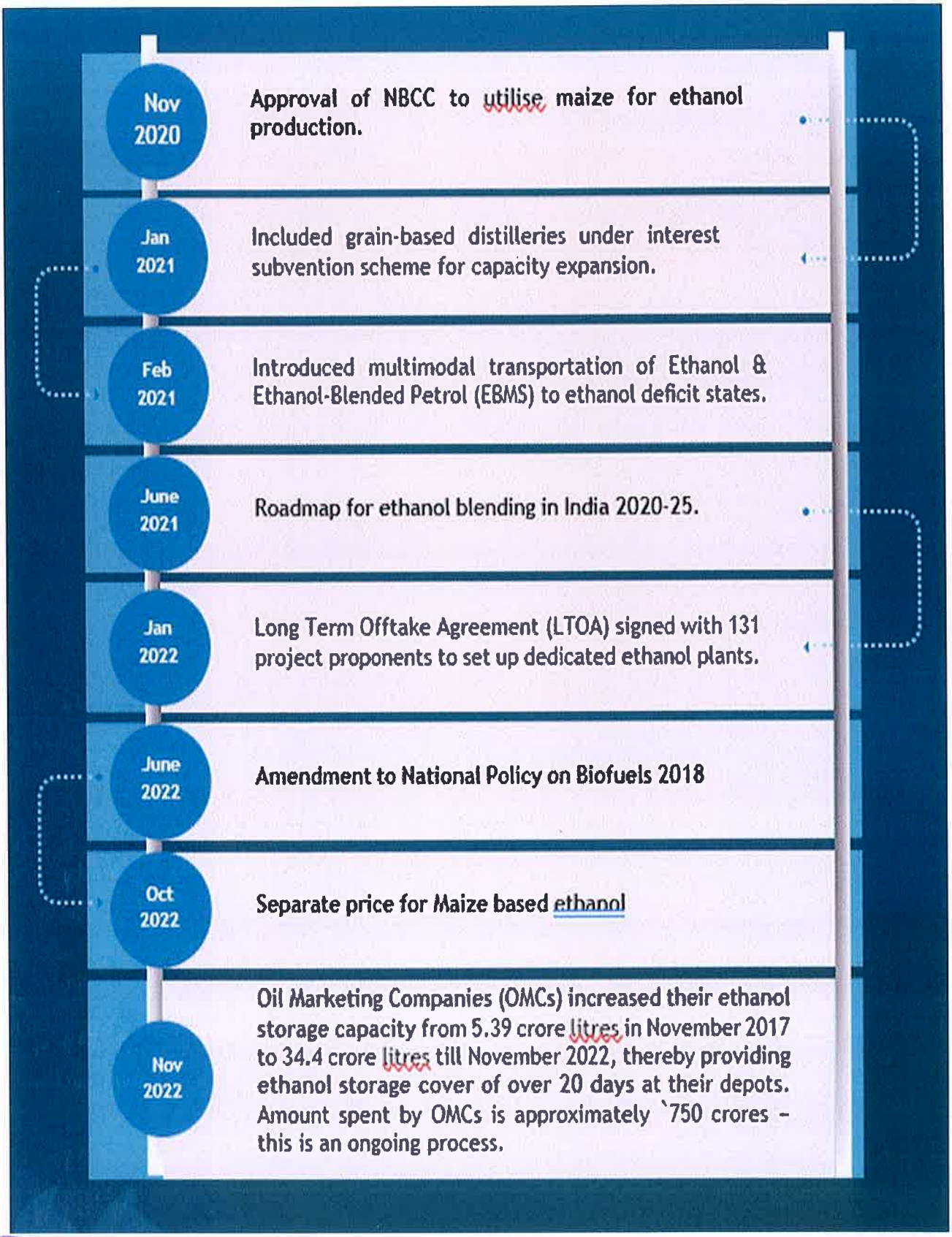

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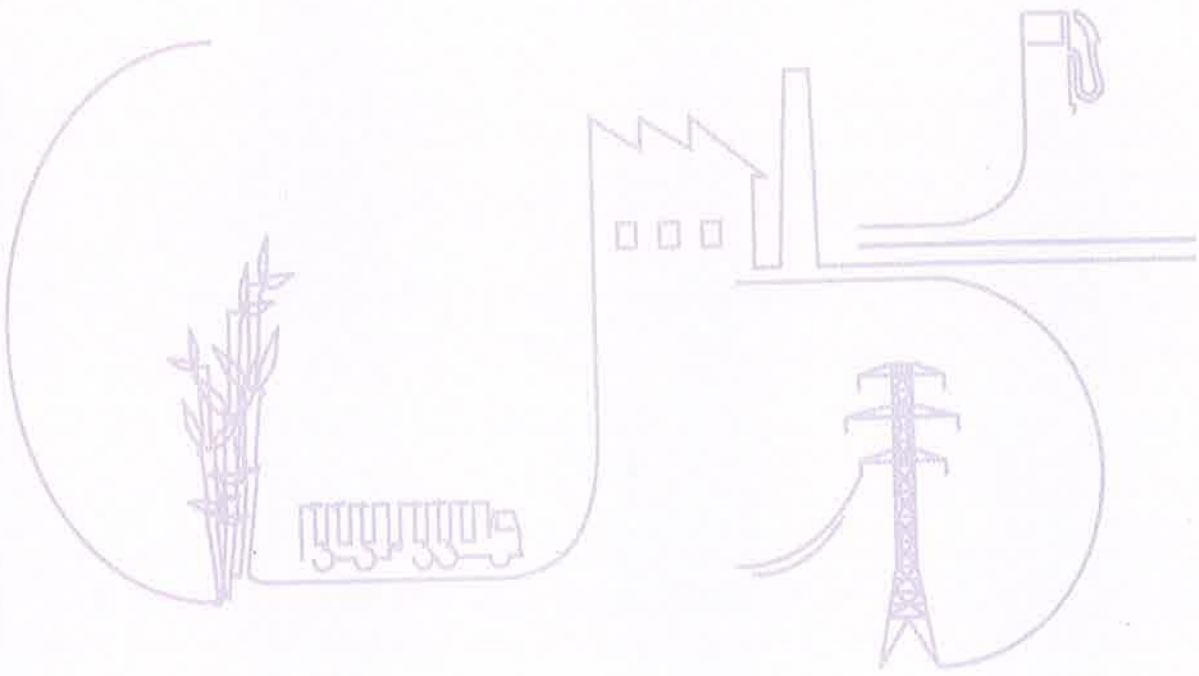
PROJECT JUSTIFICATION



Project Justification

GOI is planning to reduce crude oil import up to 10% by 2022. EBP is one of the key facilitators of reducing import bill by blending ethanol in gasoline thereby reducing gasoline requirement and providing sustainable income to farmers.

The following point's highlight the advantages of establishing such plants to bring sustainability to ethanol blending program:

1. In the current scenario Ethanol supply is dependent on Sugar sector.
2. Major Sugar Cane Crop Production is limited within Maharashtra, Uttar Pradesh, Bihar, and Karnataka. Due to this the major Alcohol Production is also from these four states only, making imbalance for demand and supply of other states.
3. Shortage in supply of fuel ethanol post diverting excess sugar.
4. Incremental Price pressure on account of sugarcane FRP increase and subsequent remunerative pricing of ethanol.
5. Alternative feedstock in the form of surplus grain (rice) is adequately available
6. Benefits of setting of grain to Ethanol plants:
   a. Control on Ethanol supply for non-sugar producing states and even Sugarcane crop deficit years.
   b. Ensuring minimum quantity sustainability of the EBP
   c. In case of Grain to Ethanol, ZLD can be achieved with value added - protein rich DDGS as a co-product.

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d. Decentralized units will boost in achieving state blending targets and reduce interstate transport. This will also reduce the carbon footprint due to reduction in vehicle travelling.

7. **Benefits of setting up higher capacity Grain to Ethanol plant**:

a. Can achieve better Economy of Scale and reduce production costs.
b. Provides cushioning against variation in Feedstock and by-product prices.

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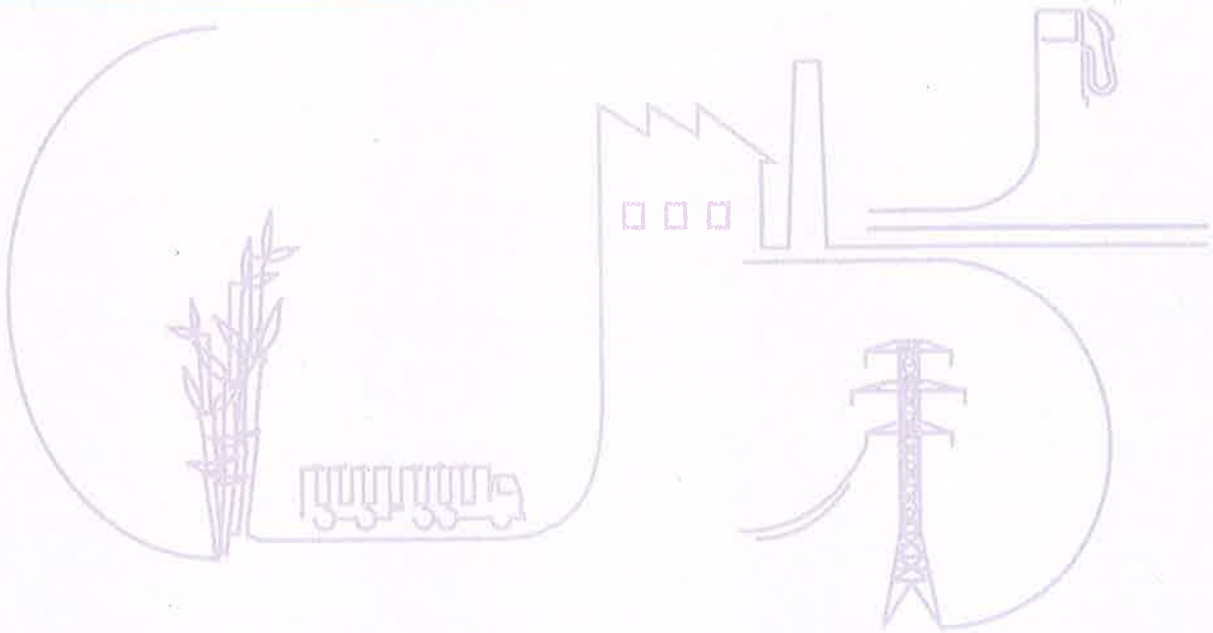
Overall Plot Plan



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V.N.B

Overall Plot Plan

The overall plot plan is developed as per layout for the process facilities. The utilities, Plant & Non-plant buildings as per requirements are provided. The safety distances from ethanol storage are adopted as per OISD-118 and PESO considering the ethanol storage as Class-A product. Other process sections and plant buildings like control room are adopted as per standard followed in Ethanol plant. Green belt area as available inside the boundary wall is shown. The overall plot plane is shown in *Annexure – I.*

The plant general layout has been designed to provide a rational disposition of production facilities, material logistics facilities, auxiliary & ancillary facilities, and plant utilities & services. A properly designed layout is obviously essential for operational efficiency, plant economy and saving of capital cost. *(Refer Annexure 1 for Overall plot plan)*

In developing the plant general layout, the factors which have been taken into consideration for appropriate flow of process materials are indicated below:

i) Economical and uninterrupted receipt of major incoming materials, in plant movement of product / by-product without hindrance and minimum counter-flow of materials

ii) Logical locational arrangement of the proposed Units, supporting facilities, plant services and ancillary facilities to ensure minimum capital and operating costs.

The overall area required for the 1 G bio ethanol complex is around 36.8 acres with major area classification as follows:

Sr. N.	Content	Area (Acres)
1.	Process Plant & Machinery	4-6
a	Process Plant (ISBL)	3-4
B	Utilities, mainly cooling tower	1-2
2.	Fuel Storage and Product Storage	5-6
3.	Other areas including parking, Admin Building, Roads, Common facilities etc.	1-2
		14-18
4.	Green Belt	6-7
	Total Area	**20 -25 Acres**

Plot plan is attached as Annexure 2

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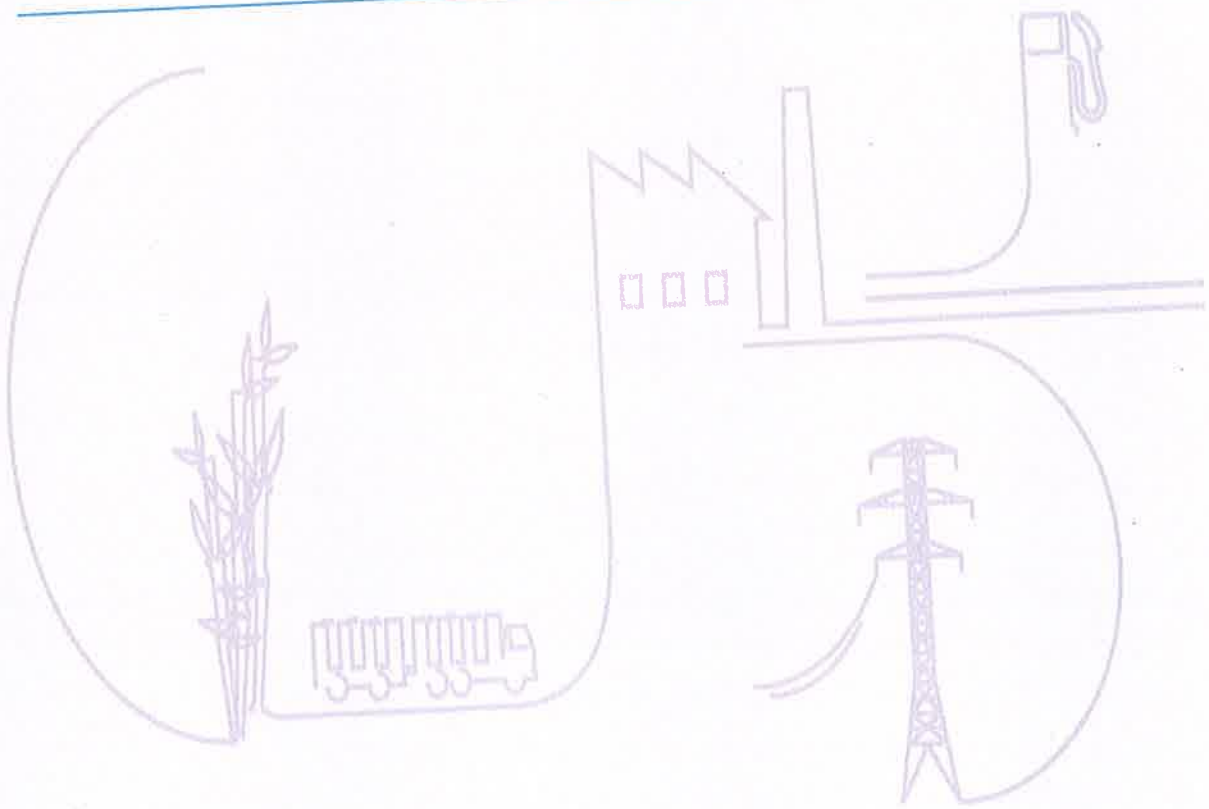
Project Capital Cost Estimate – 300 KLPD Grain To Ethanol



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Project Capital Cost Assumptions:

The capital cost will include Plant & Machinery, Land & Site Development Costs, Roads & Buildings, Construction & Erection expenses, start-up & commissioning expenses, etc.

Following assumption has been made during cost estimation:

- Estimation mentioned in this section of this report is exclusive of GST.
- Entire complex instrumentation & Control is based on conventional philosophy in Distillery Industry in India.
- Estimation accuracy is (+/- 20%)

Basis of Capital Cost Estimation:

Cost estimates has been done on the basis of the prior experience and cost of 100 KLPD plant are extra plotted.

Plant and Machinery

a. Grain Storage and Handling

SR.	EQUIPMENT	Qty.	Capacity	Cost in Rs Lakh
	Grain Receiving and Storage			
1	Bucket elevator with Receiving Hopper	2		
2	Silo	6	2500 MT	
3	Screw Conveyer	4		
4	Grain Distribution	1		
	Total Price			**1520**
	Grain handling & cleaning			
1	Bucket elevator with Receiving Hopper	1		
2	Vibrating screen	3		
3	Magnetic Drum separator	3		
4	De-stoner with accessories	3		
5	Buffer tank (1000kg) with accessories	3		
	Total Price			**562.5**
	Grain Milling & Flour Handling			
1	Rotary air lock with VFD	2		
2	Mill with motor (imported)	4		
3	Mill Venting dust control system	3		
4	Screw Conveyor	3		
5	Bucket Elevator	3		
6	Silo & Its Accessories	3		
7	Rotary Airlock Valve with VFD	3		
8	Weigh Hopper	3		
9	Batch hopper	3		
10	Rotary air lock feeder with VFD	3		

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11	Pre-masher SS304	3	
	TOTAL PRICE		**3831.5**
	Total of Grain Handling and Milling section		**5914.1**

b. Liquefaction

S. No	Equipment	MOC	Unit	Cap	QTY	
1	Slurry Tank	SS 304	M^3	30	2	
2	liquefaction tank	SS 304	M^3	56	3	
3	Retention loop	SS 304	M^3	6	3	
4	Flash tank	SS 304	M^3	2	3	
6	Condensate tank	SS 304	M^3	12	1	
7	Caustic dosing tank	SS 304	M^3	2	1	
	Total Price					**642.7**

S. No	Equipment	Technical specification				Cost In Rs Lakh
		Unit	Cap	MOC	QTY	
1	Mash cooler - I PHE	M^2	85	SS-316	3	
2	Mash cooler - II PHE	M^2	120	SS-316	3	
3	Pre-masher	MT/Hr	16	SS-304	3	
4	Agitator for Slurry tank	RPM	20	SS-304	3	
5	Slurry feed pump	M^3/Hr	40	CF8	6	
6	Steam jet cooker	M^3/Hr	20		3	
7	Agitator for Liquefaction tank	RPM	20	SS-304	3	
8	Liquefaction tank pump	M^3/Hr	40		6	
9	Condensate pump	M^3/Hr	1	**CF8**	6	
10	Enzyme dosing systems	M^3/Hr	0.5	CF8	6	
11	Caustic dosing pump	M^3/Hr	0.15	CF8	6	
	Total price					**357.3**

c. Fermentation

Sr. no	Equipment Description	Unit	Cap	MOC	Qty.	
1	CV 1	M^3	0.15	SS-304	3	
2	CV 2	M^3	0.53	SS-304	3	
3	CV3	M^3	5	SS-304	6	
4	Pre-fermenter	M^3	43	SS-304	6	
5	Fermenters	M^3	786	SS-304	12	
6	Beer-well	M^3	786	SS-304	3	
7	CO2 Scrubber				1	
8	CIP tank	M^3	18	SS-304	2	
9	Antifoam dosing tank	M^3	2	SS-304	2	
	Total Price					**1426.4**

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Sr. no.	Equipment Description	Technical Specifications				
		Unit	Cap	QTY	MOC	
1	Pre fermenter cooler	M^2		2	SS-316	
2	Pre-fermenter recirculation pumps	M^3/Hr	40	4	CF8	
3	Agitator for fermenter	RPM	25	2	SS-304	
4	Fermented wash recirculation pumps	M^3/Hr	250	2	SS-304	
5	Fermented wash cooler	M^2		2	SS-316	
6	Agitator for Beer well	RPM	25	2	SS-304	
7	Beer well transfer pumps	M^3/Hr	30	2	CF8	
8	Acid dosing system	M^3/Hr	0.5	2	SS-304	
9	Antifoam dosing system	M^3/Hr	0.5	2	SS-304	
10	CIP pump with motor	M^3/Hr	25	2	CF8	
11	Air filter	M^3/Hr	150	2	SS-304	
12	Air blower with motor	M^3/Hr		2	CI	
13	Breather Valve			3	SS-304	
14	Cleaning Nozzle	M^3/Hr	25	12	SS-304	
15	Anti-foam Spraying Nozzle	M^3/Hr	0.5	12	SS-304	
	Total Price					**223.6**

d. Distillation -

	COLUMNS	Dia	No of Trays	caps / Trays	Tray Spacing	MOC	QTY (Nos.)	
		mm			mm			
1	Analyzer Column	3,200	22	Grid	750	SS-304	1	
2	Degas Column	3,000	5	Grid	300	SS-304	1	
2	Pre-Rectifier Column	5,400	65	160	300	SS-304	1	
5	Rectifier cum Exhaust Column	4,750	72	180	250	SS	1	
8	Alcohol scrubber	1,800	8		250	SS-304	1	
	Total price							**1210**

	REBOILERS	MOC	QTY	
1	Analyzer Column Reboiler	SS-304	1	
2	Pre -Rectifier Column Reboiler	SS-304	1	
4	Rectifier cum Exhaust Column Reboiler	SS-304	1	
5	HCC/Recovery Reboiler	SS-304	1	
	Total price			200

	CONDENSERS	MOC	QTY
1	Degas Condenser -I	SS-304	1
2	Degas Condenser-II	SS-304	1
3	Rectifier condenser-I	SS-304	1
4	Rectifier Vent condenser-I	SS-304	1

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5	Pre-Rectifier Condenser - I BEER HEATER	SS-304	1	
6	Pre-Rectifier Condenser - II	SS-304	1	
7	Pre-Rectifier Vent Condenser	SS-304	1	
	Total Price			789.46
	COOLERS	**MOC**		
1	RS cooler	SS-304	1	
2	TA Cooler	SS-304	1	
3	FO Coolers	SS-304	2	
	Total Price			5.84
	PRE HEATERS	**MOC**		
1	Rectifier Pre heater	SS-304	1	
3	Beer Pre Heater (Spent wash Cooler) PHE	SS-304	2	
4	Thin Stillage/ Weak Wash Cooler -PHE		1	
	Total Price			2.4
	Other Items	**MOC**		
1	Fusel Oil Decanter		1	2.5
	Total Section			**1000.2**

	TANKS	Cap	MOC		
1	Rectifier Feed Tank	10	SS-304	1	
2	Rectifier reflux tank	5	SS-304	1	
3	ED Column feed tank	5	SS-304	1	
4	ED reflux tank	5	SS-304	1	
6	Heads Vacuum Pump drum	5	SS-304	1	
7	Condensate flash drum	10	SS-304	1	
8	Recovery column feed tank	3	SS-304	1	
9	Recovery Reflux Tank	3	SS-304	1	
11	Fusel oil Decanter	3	SS-304	1	
12	Vapor Liquid Separator	3	SS-304	1	
13	Vapor Liquid Separator for Degas vapor	3	SS-304	1	
14	Flash Vessel for Analyzer Reboiler	12	SS-304	1	
15	Impure spirit receiver	3	SS-304	1	
3	Beer Pre Heater (Spent wash Cooler) PHE		SS-304	2	
4	Thin Stillage/ Weak Wash Cooler -PHE			1	
	Total Price				**28.6**

Sr . No	Equipment Description	Technical Specifications				
		Unit	Cap	Hd/mts	QTY	MOC
1	Analyzer column re-boiler pump	M^3/Hr	20	20	2	CF8
2	Spent wash out pump	M^3/Hr	23	25	2	CF8

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3	ENA Column reflux Pump	M^3/Hr	10	60	2	CF8
4	Rectlfier Feed Pump	M^3/Hr	5	50	2	CF8
5	ED feed pump	M^3/Hr	2	30	2	CF8
6	Rectifier reflux pump	M^3/Hr	6	60	2	CF8
7	ENA Column Feed pump	M^3/Hr	10	60	2	CF8
8	ED Reflux Pump	M^3/Hr	8	45	2	CF8
9	ENA Column Bottom Pump	M^3/Hr	10	40	2	CF8
10	Recovery column feed pump	M^3/Hr	1	45	2	CF8
11	Recovery reflux pump	M^3/Hr	1	45	2	CF8
12	Polishing Column Reflux Pump	M^3/Hr	2	30	2	CF8
13	Final Product pump	M^3/Hr	2	20	2	CF8
14	Rectifier bottom/ Spent Leese pump	M^3/Hr	2	30	2	CF8
15	Vacuum pump	M^3/Hr	200		2	CF8
16	Condensate Transfer	M^3/Hr	7	20	2	CF8
	Total Price					**55.6**

	TANKS	Cap	MOC	
1	Rectifier Feed Tank	3.5	SS-304	1
2	Rectifier reflux tank	1.8	SS-304	1
3	ED Column feed tank	1.8	SS-304	1
4	ED reflux tank	1.8	SS-304	1
5	Reflux tank	1.8	SS-304	1
6	Heads Vacuum Pump drum	1.8	SS-304	1
7	Condensate flash drum	3.5	SS-304	1
8	Recovery column feed tank	1.2	SS-304	1
9	Recovery Reflux Tank	1.2	SS-304	1
10	Polishing reflux tank	1.2	SS-304	1
11	Fusel oil Decanter	1.2	SS-304	1
12	Vapor Liquid Separator	1.2	SS-304	1
13	Vapor Liquid Separator for Degas vapor	1.2	SS-304	1
14	Flash Vessel for Analyzer re-boiler	3.5	SS-304	1
15	Impure spirit receiver	1.2	SS-304	1

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3	Beer Pre Heater (Spent wash Cooler) PHE	SS-304	2	
4	Thin Stillage/ Weak Wash Cooler -PHE		1	
	Total price			**55.6**

e. Tanks

		Unit	Cap	MOC	Qty.	
1	Storage tank	M^3	3000	SS-304	3	
2	Fusel Oil Storage tank	M^3	500	MS	1	
3	Impure Storage tank	M^3	500	MS	1	
	Total price					**1400**

No.		Unit	Cap	Hd/mts	QTY	MOC	
1	Transfer pump Ethanol	M^3/Hr	30	30	2	CF8	
2	Transfer pump IMPURE	M^3/Hr	15	30	2	CF8	
3	ISSUE PUMP ENA	M^3/Hr	60	45	2	CF8	
4	ISSUE PUMP IMPURE	M^3/Hr	30	45	2	CF8	
5	FO TRANSFER PUMP	M^3/Hr	5	30	2	CF8	
	Total price						**18.1**

Decanter -

No.		QTY	MOC	
1	Decanter	9	CF8	
	Total price			**1050**

f. Evaporators -

	Shell and Tube Exchangers	MOC	QTY	
1	Effect -1	SS-304	1	
2	Effect -2	SS-304	1	
3	Effect -3	SS-304	1	
4	Effect -4	SS-304	1	
5	Finisher FC	SS-304	2	
6	Surface Condenser	SS-304	1	
	Total Price			1710.7

Equipment	MOC	QTY	
Vapor Liquid Separator -1	SS-304	2	
Vapor Liquid Separator -2	SS-304	1	
Vapor Liquid Separator -3	SS-304	1	
Vapor Liquid Separator -4	SS-304	2	
Thin Slope Feed Tank	SS-304	1	
Process Condensate tank	SS-304	1	
Steam Condensate Flash Tank	SS-305	1	
Steam Condensate Tank	SS-306	3	
Total price			30.5

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V.N.B

	Unit	Cap	Hd/mts	QTY	MOC	
Feed pump	M^3/Hr	15	20	2	CF8	
E1 Recirculation Pump	M^3/Hr	250	25	2	CF8	
E2 Recirculation Pump	M^3/Hr	250	25	2	CF8	
E3 Recirculation Pump	M^3/Hr	250	25	2	CF8	
E4 Recirculation Pump	M^3/Hr	250	40	2	CF8	
Steam Condensate Pump	M^3/Hr	4	30	2	CF8	
Process Condensate Pump	M^3/Hr	15	35	2	CF8	
Vacuum Pump Water Ring	M^3/Hr	500		2	CF8	
Process Condensate Pump	M^3/Hr	350	670mmhg	2	CF8	
Force circulation Pump	M^3/Hr	250	24	2	CF8	
Conc. Product Pump	M^3/Hr	10	30	2	CF8	
CIP pump	M^3/Hr	25	45	2	CF8	
Vacuum Pump Drum	M^3/Hr			1	CF8	
Total cost						35.5

g. Dryers

Twin Screw Conveyer	
Quantity	3
Capacity KG/HR	7500
Length MTS	4
MOC	SS-304
Screw Feeder	
MOC	SS 304
Quantity	3
Rotary Shell/Drum	
MOC	MS
Shell	CS (IS 2062)
Tube	CS, C class pipes
HTA m2	2500
Qty.	3
Cyclone Separator	
Quantity	3
MOC	SS 304
Rotary Discharge Valve	
Quantity	3
MOC	MS
Exhaust Air Duct	
Quantity	3

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MOC	MS	
Exhaust Fan		
Quantity	MS	
MOC	3	
Total Price		**2588**

h. Utilities -

	Equipment	Capacity	Qty
1	Cooling tower for Fermentation	410 M3/hr, 2 Deg delta T	6
2	Cooling water pumps for fermentation	410 m3/hr	6
3	Cooling tower for Distillation& evap.	850 M3/hr, 10 Deg delta T	1
4	Cooling water pumps for Distillation & Eva	850 m3/hr	2
5	Instrument Air Compressor	Standard	1
6	Water Treatment Plant	Standard	1
	Total price		**3200**

i. CIP

	Equipment	Unit	Cap	MOC	Qty.	
1	Hot Caustic Tank – I	M^3	10	SS-304	1	
2	Hot Caustic Tank – II	M^3	10	SS-304	1	
3	Hot Water Tank	M^3	5	SS-304	1	
4	Hot Water Recovered Tank	M^3	5	SS-304	1	
5	Caustic Dosing Tank	M^3	0.5	SS-304	1	
	Total price					48.0

	Equipment	Unit	Cap	Head, m	Qty.	MOC	
1	Caustic Dosing Pump	M^3/Hr	0.5	10	3	SS-316	
2	CIP Supply Pump	M^3/Hr	35	45	6	CF8	
3	CIP Return Pump	RPM	35	15	18	CF8	
4	Cleaning Nozzles	M^3/Hr	15	45	36	SS-304	
	Total price						32.2

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Cost Estimation of the Project

Description		Rs Lakh	Total Rs Lakh
Land, Buildings, infrastructure facilities			
	Land	**1528**	**1528**
	Building, structure, Road, Culvert etc.	2388	
	Other civil construction	4400	
Civil Total			**6788**
ISBL - Capital Costs:			
	Ethanol Process Plant Equipment		
	Grain Storage and Milling section	**5914**	**5914**
	Liquefaction section, + Jet cooker	1000	
	Fermentation section + CO2 scrubber	1650	
	Distillation section	2350	
	Ethanol Section		**5000**
	DDGS		
	Centrifuge / Decanter	1050	
	Evaporation section	750	
	Dryers + filling section	2588	
	DDGS Section		**4388**
	CO2 plant	**2000**	**2000**
	Bulk Material :		
	Pumps	600	
	Vessels	525	
	Piping & Safety Material	1000	
	Instrumentation and controls	1000	
	Electrical/Sub-station/distribution/PCC &MCC	6150	
	Total Bulk Material		**9275**
OSBL - Capital Costs:			
	Cooling water system/ Pumps	1200	
	DM, raw water system piping from refinery to Ethanol Plant	1000	
	Ethanol / Others storage Tank farm	1400	
	Fire Fighting System	550	
	Yard piping, structures and others	2200	
	Total OSBL Cost		**6350**
Total Plant and Machinery cost			**41243**
Basic Engineering			450
Detailed Engineering			550
Construction			9737
Sub Total Fixed Capital Investment			**51980**
Pre-operative Expenditure, and other misc. expenses		1.00%	520
Total Project cost			**52500**
Working capital margin (25%)			2659
Total Project cost including working capital margin			**55159**
GST @ 18% (Other than working capital)			9450
Grand Total (including GST)			**64609**

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Key assumptions for Capital Cost Estimation

Note –

1. Cost of piping, instrumentation, electrical and estimated on prior experience basis.
2. Cost of construction is estimated on the basis of construction of complete plant
3. Estimates are excluding GST and other taxes.
4. Investment figure estimated is on budgetary and is based upon the present plant design norms followed in 1G Indian Distillery.

Proposed 1G ethanol Project economics:

Project Cost will be expected to be funded mix of equity and debt. The key financial assumptions considered for calculation of IRR are as follows:

Key assumptions considered are as follows:

- Plant capacity – **300 KLPD ETHANOL**
- Operating Days – 330 Days/Annum
- Landed cost of the maize – INR 22000 -23000 / MT

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7. Financial Model and Sensitivity Analysis

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Financial Model & Sensitivity Analysis

1. **Introduction:**

HOPL is planning to set up a **300 KLPD** rice to 1G ethanol project. The plant will be designed to process rice sourced from OPEN MARKET and produce fuel grade ethanol. The land required for the process is around 30 acres. The project will be a green-field investment by HOPL

2. **Means of finance:**

The proposed project is expected to be financed through mix of equity and debt.
Working capital finance is currently considered whilst calculating the financial model.

Also, all the advantages provided by Punjab State through Bioethanol policy are not considered.

project evaluation has been done assuming 100% equity

Project cost and Financials feasibility

Please see Annexure 4

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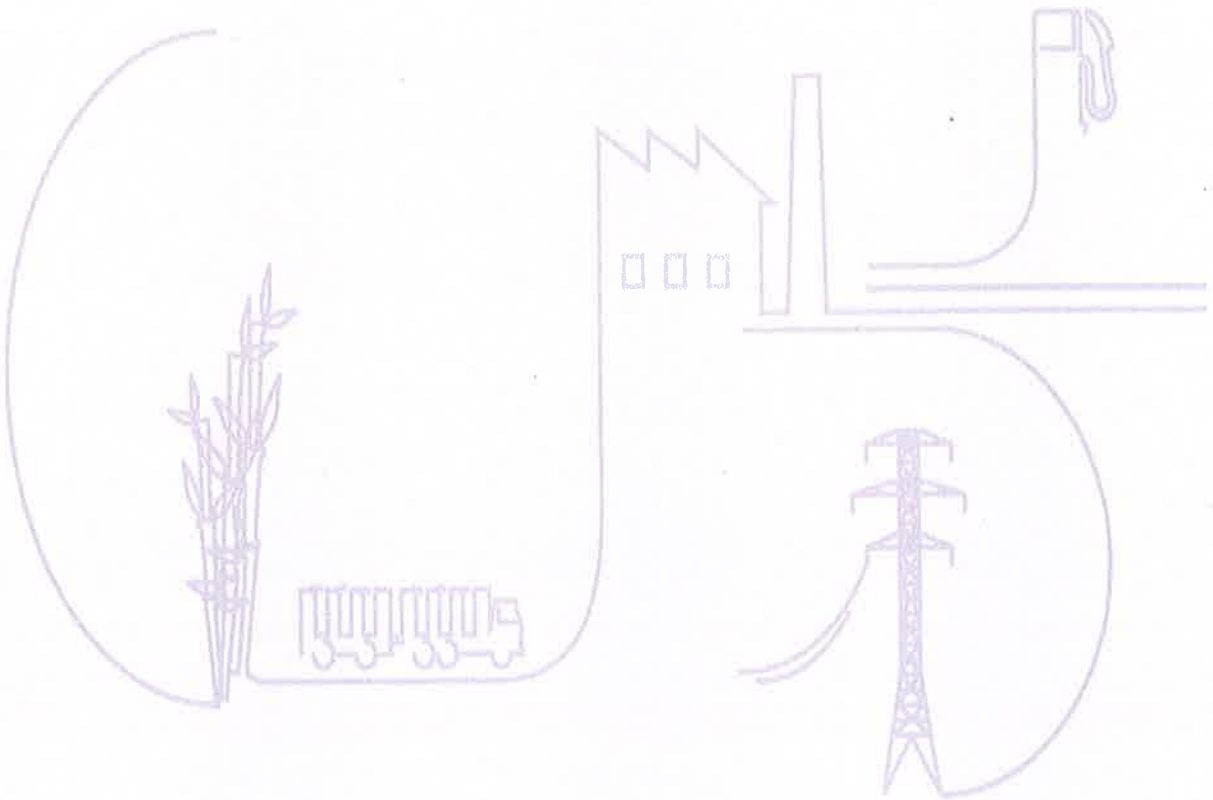
8. Manpower Planning



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Direct Employment:

Sr. No.	Section & Role	Proposed man power
1	General Manager (Plant In charge)	01
2	Production Manager	-
3	MechanicalMaintenance supervisor	01
4	Electrical/Instrument Maintenance Supervisor	-
5	Grain receipt supervisor	-
6	Product dispatch supervisor	-
7	Lab/QC in charge	01
8	Shift in charge	05
9	Grain procurement	02
10	Technical Service	-
11	Marketing / sales	01
12	Accounts / Excise	-
	Total	**11**

We propose –
Regular man power on payroll – 11 Nos
Additional requirement to be met through contract basis.

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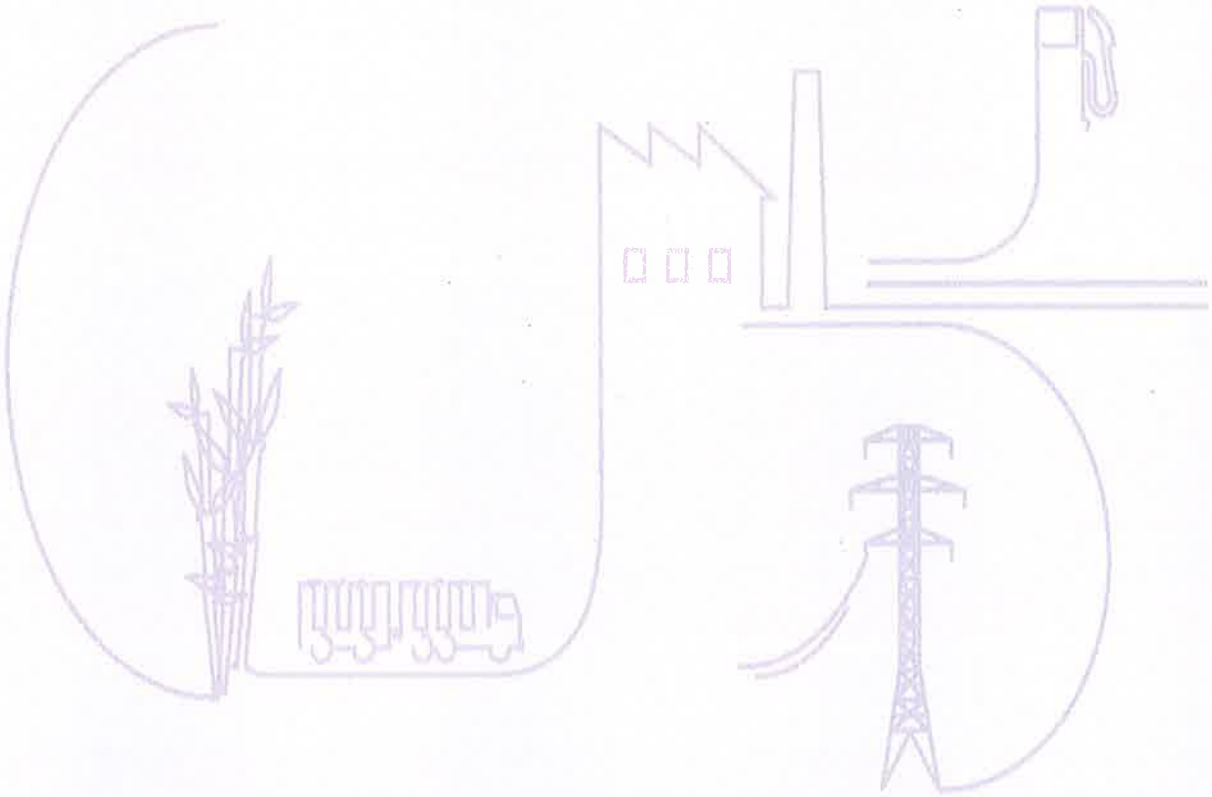
Environmental Management And Pollution Control



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1. Introduction

HOPL is planning to start a new greenfield Ethanol (Biofuel) project by installing a 300 KLPD grain-based Ethanol (Biofuel) plant at Malkana-Raman Pind Link Road, Kanakwal Urf Rattangarh, Talwandi Sabo Tehsil, Bathinda district, Punjab. During the operation of the Ethanol production unit, environmental pollution would be generated from different sources. The industry would adopt the latest technologies for the abatement of pollution generated by the production process.

2. Grain based distillery process

The impending water uses and consequent water pollution that would be caused by the grain-based ethanol plant may be because of the following:

a) Process and dilution water
b) Cooling water make-up
c) Washing (fermenter, floor, etc.)
d) Domestic consumption

3. Process water

The freshwater requirements in the process (in liquefaction) would be about 600 m3/day. Besides this, in the liquefaction process, the industry would be using MEE condensates and spent lees (hot water condensates generated from the process) directly without any pre-treatment @ 1260 m3/day. Additionally, 315 MT/day of direct steam would be consumed in the process for liquefaction section. The direct use of condensates in the process will reduce the steam requirements for the liquefaction process.

4. Cooling water make-up and blowdown

The cooling water throughput rate will be a maximum of 6000 m3/hour. Besides this, the industry would be installing a chiller unit for the cooling of fermentation tanks. The average temperature difference in the cooling water in the cooling towers would be 2Deg C and 6°C. Therefore, less than 1.00% of the total recirculation water would be lost in evaporation, drift, and blow-down losses. Fresh make-up water requirement in the cooling towers would be about 550 m3/day. Of the total makeup water requirements, treated condensates @ 200 m3/day would be used and the remaining 350 m3/day of fresh water would be used. The blow-down rate would be around 150 m3/day.

5. Washing

The wash water requirement (for washing of fermenter and floor) will be about 37.5 m3/day. Whole of this water will contribute to wastewater generation.

6. Domestic consumption

Some of the water will be required for cooking, drinking, sanitation, etc. Average daily requirement is expected to be about 15 m3/day. Of this, less than 90%, i.e., ~13 m3/day will be obtained as domestic wastewater.

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7. Overall Water Requirement

Total average freshwater consumption for the grain-based distillery project can be summarized as under:

S. No.	Purpose	Proposed (m3/day)
1	Process & dilution water	500
2	Cooling water	550
3	Washing Requirements	38
5	Domestic requirement	15
	Total	**1103**

8. Effluent Generation

The proposed Ethanol (biofuel) plant will result in generation of following types of effluents from the process operations:

a. **Spent Wash from Distillation Process:**
The project would result in generation of spent wash from the distillation process. Spent wash @ 1725 MT/day would be generated during the proposed production of Ethanol @ 300 KL/day. The spent wash would be sent to the decanter where wet cake @ 225 MT/day would be separated and thin slops @ 1575 MT/day would be treated in multi-effect evaporation system.

b. **Condensates from Process and MEE:**
The project would result in generation of process condensates from different distillation processes. Spent lees @ 450 MT/day, multiple effect evaporation condensates @ 1425 MT/day and condensates from dryer @ 300 MT/day, thereby totalling @ 2175 MT/day of condensates would be generated from the proposed 300 KLPD Ethanol plant. Out of the total condensate generation, 1260 MT/day of condensates would be directly reused in the liquefaction process. The remaining 915 m3/day would be sent to CPU for treatment, which after treatment would be reused in the cooling tower makeup water.

c. **Effluent from other processes:**
Besides the above-mentioned streams, effluent would be generated from misc. other streams such as – floor/fermenter washing effluent @ 37.5 m3/day, cooling towers blow down @ 150 m3/day, domestic effluent @ 13.5 m3/day, from the proposed plant. This effluent will be recycled

d. The details of Condensates/Effluent generation from the proposed plant and existing unit are as given below:

S. No.	Purpose	Proposed (m3/day)	Treatment
1	Spent Lees	450	Recycled
2	MEE Condensate	1425	Polished and recycled
3	Condensates from dryer	300	Polished and recycled
4	Fermenter/floor washing	37.5	Recycled
5	Cooling tower blow down	150	To be treated

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6	Domestic Effluent	13.5	To be treated

8. **Air Pollution Generation** – No air pollution from process
9. **Hazardous Waste Generation**
   The plant facility will result in generation of about 1.5 KL/year of spent oils (lubricants and transformer oil), which will be stored on site and sold to authorised recyclers.

10. **Pollution Control System (if we are not using Refinery ETP)**
    a. **Wastewater Treatment System**
    The industry would install multiple effect evaporators for the treatment of spent wash generated from the proposed unit. Whole of the spent wash after decantation would be sent to the MEE for concentration of solids. The details of the MEE for spent wash are as given below:

Multiple Effect Evaporation

Falling Film Evaporation (Stage –I)

- The spent wash from analyser column would be first taken into a feed tank and then fed to the falling film evaporation system through pre-heater in 1st effect in mixed feed mode and it flows from first to second and second to third effect.
- The concentrated syrup with 13.5 % w/w total solids is taken out from the third effect. The analyser vapours are fed to the first effect on shell side.
- Vapours generated in the first effect are used as a heating medium in the second effect& vapours generated in the second effect are used in the third effect.
- The spent wash feed would be concentrated from the initial concentration of 6 %w/w to 13.5 % w/w as it travels through the three-stage evaporation. The vapours evolved from the final effect are condensed in surface condensers. Each effect is provided with re-circulation pump.
- The condensate from third effect and surface condensers condensate is collected in a condensate tank. The condensate is transferred for further treatment using a centrifugal pump.
- The system operates under vacuum. Water-ring vacuum pumps would be used to maintain desired vacuum in the last effect. The last effect is at lowest temperature.
- Cooling water from cooling tower would be used in the condensers for condensing the vapours.

Falling Film Evaporation (Stage –II)

- Shell & Tube type evaporators with highly efficient liquid distribution working on the principle of Falling Film Evaporation and Forced Circulation would be used. Shell & Tube type preheaters for pre-heating of FEED stream would be used which would serve the purpose of energy conservation.
- Steam would be fed to the first effect evaporator on shell side at the given pressure and temperature as the heating medium.

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- The feed from the feed balance tank would be taken to the PHE-1 to make the best heat recovery.
- The feed after getting heated to the predetermined temperature in pre-heaters would be fed from the top of the second effect evaporator which is Falling Film Evaporator -2.
- Then the feed from the second effect would be given to third effect evaporator and follows the flow path
- Vapours generated in 1st effect VLS (Vapour Liquid Separator) would be used as heat source in the 2nd effect.
- Vapours generated in the 2nd effect VLS would be subsequently used as heat source for 3rd effect.
- Vapours from 3rd effect would be used on shell side of 4th effect and finally Vapours from 4th effect would be condensed on shell side of surface condenser of the evaporator.
- The product from the final effect at the desired concentration of 30 % w/w total solids is obtained.
- A shell & tube type multi-pass surface condenser is employed for condensing the shell side vapours.
- The condensates are collected in receiving vessels and are sent for treatment before its reuse for makeup water in cooling towers.
- Highly efficient operating pumps would be provided for pumping the required fluid.
- The operation of the plant would be under vacuum. Vacuum would be created with the help of a water ring vacuum pump.
- The plant would be having high level of automation to get consistent output at required concentration.

Cooling water from cooling tower would be used in the surface condensers for condensing the vapours in stage II falling film evaporation.

Treatment of Effluent from Different Streams

The plant would be generating less than 72 m3/day of effluent from different streams from the proposed 300 KLPD Ethanol plant. The effluent would be having organic impurities which need to be treated before its disposal on land for irrigation purposes. The industry will be existing effluent treatment plant in the GGS Refinery which would be sufficient to handle misc. stream effluent. The detailed drawings of existing ETP are attached with the report.

Septic Tank for Domestic Treatment

The septic tank will provide and effective HRT of at least 48 hours, for maximum daily flow, to biologically stabilize, partially, the organic pollution load. A two-compartment septic tank will be used for the purpose. The stabilization compartment (first compartment) will have volumetric capacity of 30 m3/day, with aspect ratio (length: width) of at least 3. Floor slope at 1:5 will be provided for sludge accumulation. The effective submerged depth of tank will

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not exceed 2.5 m. Provision will be made for periodic withdrawal (pumping out) of accumulated sludge. The actual tank dimensions will be worked out to suit the process and site requirements.

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9. Socio-Economic-Environmenal Benefits of Project

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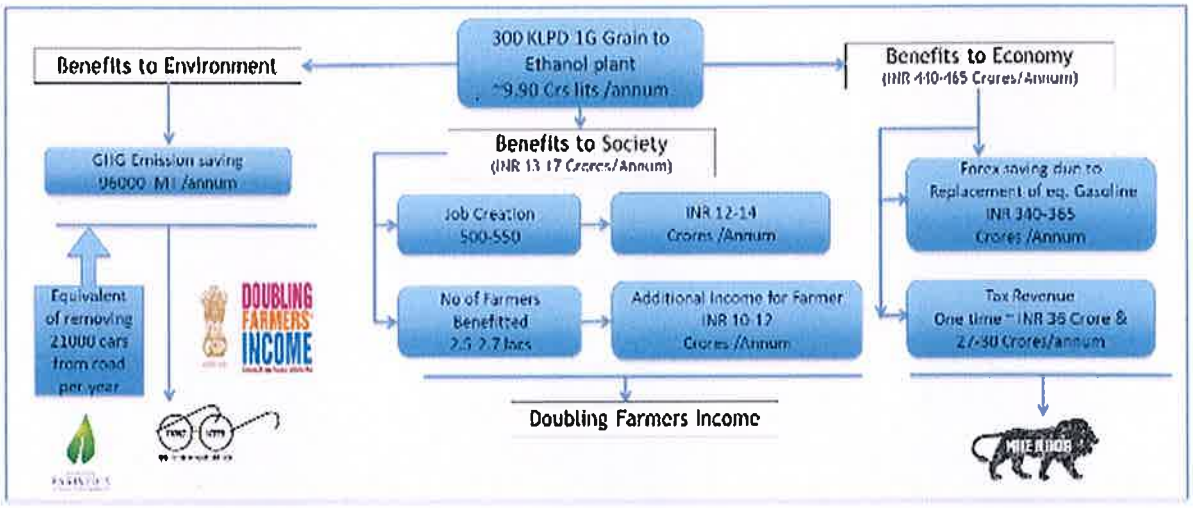
9.1 Introduction

Proposed ethanol project of HOPL-BATHINDA will have benefits to society, economy and to environment. The overall benefits of proposed 1G ethanol plant are shown in figure below:



Note –

Fuel for steam and power is considered as rice husk
Passenger car calculation done as per US EPA guidelines – Assuming 1 passenger car emits 4.5 MT of Co2 every year

The proposed 1G ethanol plant will produce around ~ 10.0 Crore litre of ethanol annually that will blend with gasoline thereby saving crude HMEL imports. The economy will also benefit by tax revenue and GST income on ethanol. The proposed project will revive rural society by creating jobs and benefitting farmers by increasing their income. The production of 1G ethanol will save GHG emission savings, thereby protecting our environmental from pollution of fossil fuel burning.

Environmental benefits

The proposed project will benefit environment by reduction in green house emission on account of ethanol blending into gasoline.

GHG emission savings

The proposed project has the potential to save 45% - 50 % CO2 (nearly 0.90 – 0.96 MMT) emissions per year by replacing gasoline with bioethanol if biomass is considered as possible fuel source **Benefits to Society**

The proposed project will revive rural economy by creating jobs and additional

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income to farmers. The proposed project will be required around ~ 2.25 Lacs MT of rice annually, which will be sourced from over Open Market thus directly around ~ 2.5 lakh farmers in the vicinity of project site. Collection of rice from farmers will help increase their income directly. In addition, the proposed project will create more than 500 agricultural jobs through sourcing of rice husk and setting up cattle feed distribution mechanism.

Benefits to economy

Ethanol blending into gasoline will reduce the crude imports for HMEL. The proposed project will contribute in reviving economy through forex saving, generating tax revenue and GST revenues.

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Annexures

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Annexure 1 - Procurement policy from FCI

Policy and System

1. The Central Government extends price support to wheat and paddy through FCI and State Agencies. Procurement at MSP is open ended i.e., whatever food grains are offered by the farmers, within the stipulated procurement period and which conforms to the quality specifications prescribed by Government of India, are purchased at MSP (and bonus/incentive, if any) by the Government agencies including FCI for central Pool. Some States also declare State bonus on wheat and paddy over and above MSP.
   Government agencies undertake MSP operation at mandis/ temporary purchase centers/aggregation points. Location and number of purchase centers to be opened are decided in consultation with /by the State governments.

2. **Systems of procurement:**

2.1 Wheat - FCI undertakes procurement directly and jointly with SGAs in non-DCP states. In the major procuring states like Punjab, MP and Haryana, wheat is mainly procured by state agencies and they preserve the stocks under their custody for which carry –over charges are paid to them. FCI takes over the stocks for dispatching to other consuming states as per requirement /movement plan. Payments are made to State Govt. /agencies as per Provisional cost sheets issued by GOI after taking over the stocks. In the states like UP and Rajasthan, the wheat procured by state agencies is immediately taken over by FCI.
In DCP States like MP, State Government agencies procure, store and distribute wheat (against Government of India's allocation for TPDS/OWS etc.) within the state. The excess stocks (wheat) procured by the State /its agencies are handed over to FCI in Central Pool for distribution/movement to deficit States.

2.2 Rice –

Custom Milled Rice (CMR)

CMR is manufactured by milling paddy procured by State govt. /State agencies and FCI. In the states like A.P, Telangana, Punjab, Haryana, Chhattisgarh, Odisha, MP, Tamilnadu, Maharasthra, UP & Bihar paddy is mainly procured by State government /State agencies and the resultant rice is delivered to State Government and FCI by getting the paddy milled from rice millers.
Major responsibility of procurement of wheat and paddy is borne by the State agencies whereas FCI procures almost 70% of total rice procured for Central Pool.

2.3 Coarse grains- Coarse grains are procured by the State governments based on their plan of procurement with prior approval of GOI & subject to distribution of procured coarse grain under TPDS in the procuring state itself.

3. In wheat and paddy procuring States like Punjab, Haryana & some parts Rajasthan procurement from farmers is undertaken by the FCI/State Agencies through Arthiyas as per State APMC Act. In other States procurement of wheat and paddy is made directly from farmers by FCI/ State Govt. Agencies.

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4. **Centralized and Decentralized procurement systems:**

4.1 Centralized (Non-DCP) procurement system:

Under centralized procurement system, the procurement of food grains in Central Pool is undertaken either by FCI directly or by State Govt. Agencies (SGA). Quantity procured by SGAs is handed over to FCI for storage and subsequent issue against GOI allocations in the same State or movement of surplus stocks to other States. The cost of the food grains procured by State agencies is reimbursed by FCI as per Provisional per cost-sheet issued by GOI as soon as the stocks are delivered to FCI.

4.2 Decentralized (DCP) Procurement:

Under DCP system, the State Government/ its agencies procure, store and distribute (against Government of India's allocation for TPDS & OWS etc.) rice /wheat/coarse grains within the state. The excess stocks (Rice & wheat) procured by the State /its agencies are handed over to FCI in Central Pool. The expenditure incurred by the State Government on procurement, storage and distribution of DCP stocks are reimbursed by Government of India on the laid down principles. The expenses such as MSP, arhatiya/society commission, administrative charges, mandi labor charges, transportation charges, custody & maintenance charges, interest charges, gunny cost, milling charges and statutory taxes are reimbursed on actual basis. The cost of excess stocks handed over to FCI is reimbursed by FCI to the State Government/agencies as per Government of India costs sheet.

As on date the following States are procuring rice/wheat under DCP system.

DCP for Rice		
S.N.	**State**	**With Effect From**
1	Uttrakhand	2002-03
2	Chhattisgarh	2001-02
3	Odisha	2003-04
4	Tamilnadu	2002-03
5	West Bengal	1997-98
6	Kerala	2004-05
7	Karnataka	2009-10
8	Madhya Pradesh	2007-08
9	Andhra Pradesh	Fully DCP for KMS 2015-16.
10	Bihar	2013-14
11.	Telangana	Fully DCP from KMS 2014-15.
12.	Maharashtra	2016-17
13.	Gujarat	2017-18
14.	Andaman Nicobar	2003-04
15.	Tripura	KMS 2018-19 & 2019-20 (Rabi Crop) and KMS 2020-21

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Food Grain Stock in Central Pool:

(Fig lakh tonnes)

Year	Commodity	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2019	Rice	182.9	227.96	263.91	293.94	290.56	275.81	284.21	275.30	261.48	249.16	231.05	212.79
	Wheat	271.2	239.31	201.09	169.92	331.60	465.60	458.31	435.88	414.90	393.16	373.77	351.75
	Total	454.1	467.27	465.00	463.86	622.16	741.41	742.52	711.18	676.38	642.32	604.82	564.54
	Unmilled Paddy	274.2	266.81	204.49	155.55	133.80	120.08	105.10	79.92	59.70	40.55	196.54	259.11
	Coarsegrain	2.01	2.01	1.15	0.58	1.51	1.46	1.46	1.47	1.47	1.11	3.88	3.21
2020	Rice	237.2	274.51	309.76	322.39(a)	285.03	274.44	271.71	253.40	221.95	192.61	167.92	145.40
	Wheat	328	303.66	275.21	247.00(b)	357.70	558.25	549.91	513.28	478.32	437.38	402.99	367.54
	Total	565.1	578.17	584.97	569.39(c)	642.73	832.69	821.62	766.68	700.27	629.99	570.91	512.94
	Unmilled Paddy	278.9	258.96	287.08	252.39	234.29	208.95	182.99	145.63	109.47	81.92	257.08	339.21
	Coarsegrain	3.24	3.24	0.24	1.27	1.27	2.11	2.11	1.87	1.37	1.34	4.99	10.01
2021	Rice	186.7	243.62	282.37	291.18	304.85	299.25	296.89	291.08	268.32	253.26	229.22	213.03
	Wheat	342.9	318.31	295.41	273.04	525.65	602.91	603.56	564.80	517.87	468.52	419.81	378.53
	Total	529.6	561.93	577.78	564.22	830.50	902.16	900.45	855.88	786.19	721.78	649.03	591.56
	Unmilled Paddy	404.2	387.91	345.02	310.61	262.20	286.94	289.87	229.12	176.03	140.67	254.69	358.78
	Coarsegrain	3.2	3.52	4.66	7.97	7.50	7.44	6.30	5.45	2.51	1.88	1.49	1.54
2022	Rice	221.5	263.36	295.75	323.22	332.68	331.20	317.07	279.52	244.63	204.67	165.97	115.42
	Wheat	330.1	282.73	234.00	189.90	303.46	311.42	285.10	266.45	248.22	227.46	210.46	190.27
	Total	551.7	546.09	529.75	513.12	636.14	642.62	602.17	545.97	492.85	432.13	376.43	305.69
	Unmilled Paddy	473.7	492.55	441.10	339.03	266.11	247.10	231.51	194.57	161.60	118.25	263.70	371.47
	Coarsegrain	1.8	2.88	3.31	4.83	4.13	2.71	3.96	3.58	3.01	2.63	2.64	2.90
2023	Rice	125.4	169.63	210.54	248.60	265.06	262.23	253.49	242.96	232.88	221.87	200.38	183.57
	Wheat	171.7	154.44	116.70	83.45	290.28	313.88	301.45	280.39	260.37	239.95	218.76	191.96
	Total	297.1	324.07	327.24	332.05	555.34	576.11	554.94	523.35	493.25	461.82	419.14	375.53
	Unmilled Paddy	476.2	452.32	371.80	276.43	226.94	226.85	232.99	196.13	160.77	138.36	262.61	376.29
	Coarsegrain	1.17	1.19	2.61	4.35	4.89	4.36	4.43	4.00	3.28	2.34	2.10	1.83

Source: FCI

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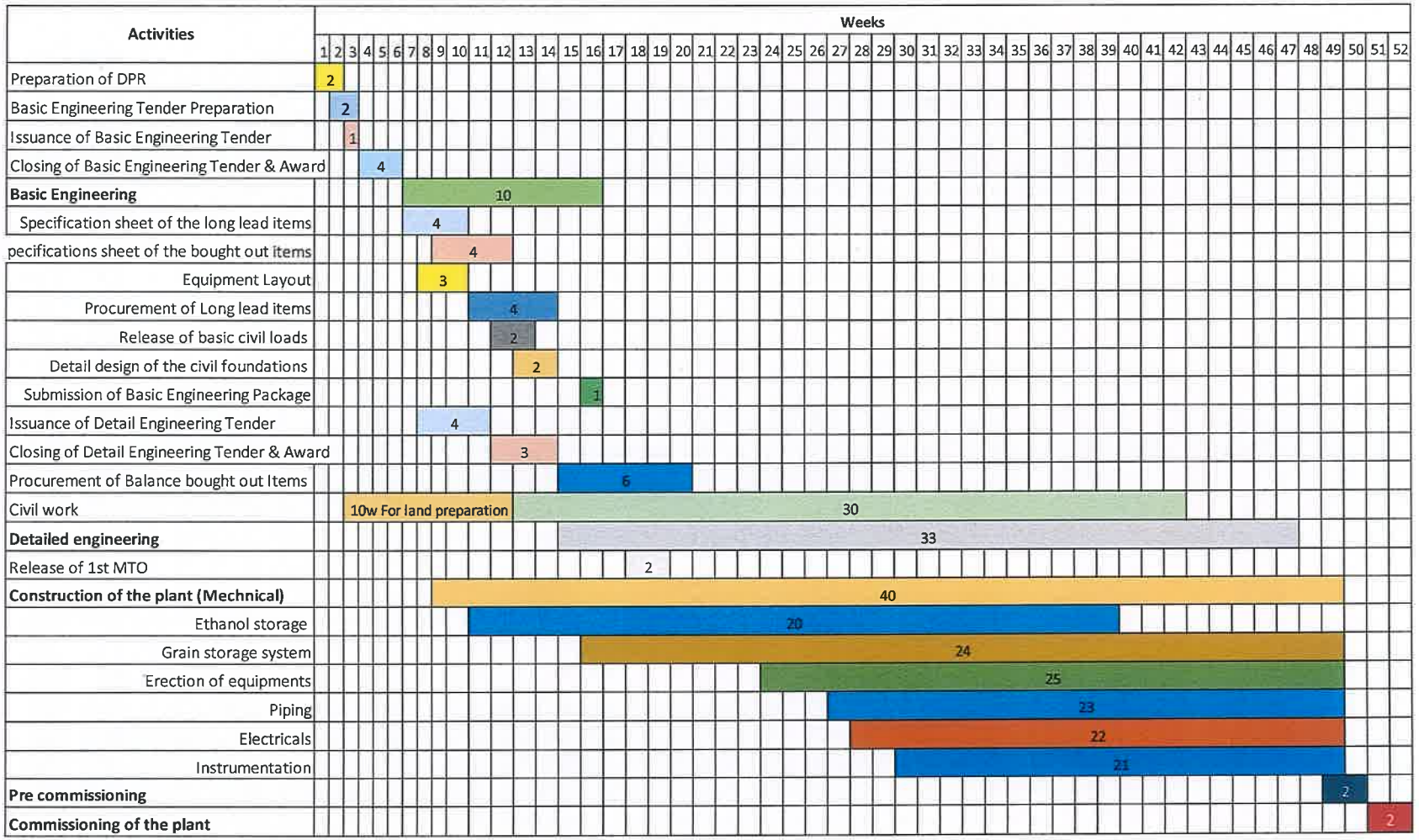
Annexure 2 Tentative project Schedule



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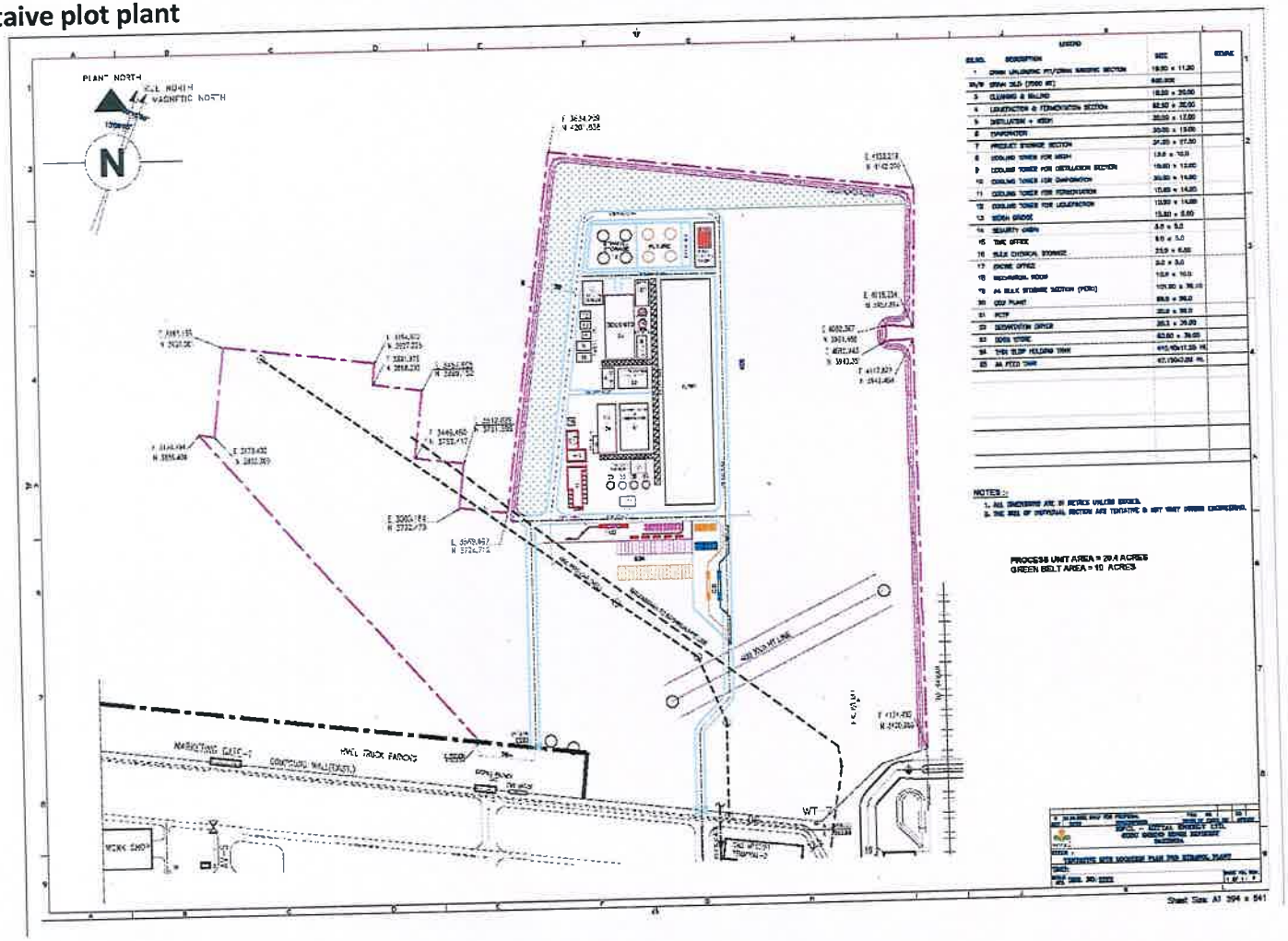
Annexure 3 – Tentaive plot plant



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ANNEXURE 4 FINANCIAL ANALYSIS

Project DFR Operation and Financial Summary

Total Project Cost, IRR & Means of Finance.

Capital Cost	Revised
As-Built Project Cost (including working capital margin)	**551.59**
GST on Project cost excluding WC Margin	**94.50**
Project Cost (net of GST)	**646.09**
Project IRR	**14.10%**
Equity IRR	**26.03%**

Note: Input credit of GST on project cost is available.

Project Cost **Rs. Crore**

Particulars	**Amt**
Land (36.8 acres)	15.28
Buildings and boundary wall	17.08
Road & Culverts	6.80
Plant and machinery	485.84
Hard cost - Total Fixed Assets	**525.00**
Working Capital Margin (25%)	26.59
As Built Project cost (excluding GST	**551.59**
GST @ 18% (Other than on WC)	94.50
Total Project cost including GST	**646.09**

Project phasing:

Project is almost complete and will be operational in February'2024.

Operating & Financial Assumptions – DFR

S. N	Description	Assumptions
1.	Plant Capacity (Ethanol)	300 KLPD
2.	Operation Days	330 Days/Annum
3.	Corporate tax rate (new regime for the plant under HOPL) @15% plus 10% surcharge and 4% cess	17.16 %*
4.	Capacity factor	1st year 90% (From Feb-23) 2nd year onwards 100%
5.	Depreciation as per companies Act -	Plant and machinery -40 Years Factory Building- 30 years
6.	Project Capacity (TPD) – DDGS (Maize based)	155
7.	Project Capacity (TPD) - CO_2	150
8.	Annual Consumption based on utilization - Maize (T) at 100%	235,500

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9.	Annual Consumption based on utilization – Rice (T)at 100%	219,500
10.	Working Capital Basis	Feedstock Storage – 30 Days Product Storage (bio ethanol) 15 Days DDGS & C02- 15 days Credit period (bio ethanol) – 21 Days & 15 days for DDGS &C02 Payable period (rice) – 25 Days
11.	Project life cycle	20 years
12.	Escalation for Revenue and cost	Considered 1% per annum

Pricing Assumptions for evaluation

Price	Price
Ethanol Price for Maize	INR 66.07 / lit
Maize landed price at factory gate	INR 22,500 / MT
Unit Price - DDGS (Maize based)	INR 17,000 / MT
Unit Price - CO_2 on boot basis	INR 3,000 / MT
Unit Price - Steam	INR 1,750 / MT
Purchased Power cost (Variable)	INR 6.1 / Kwh
Purchased Power cost (Fixed)	INR 1.2 Cr/Annum

Profitability projections for 10 years

A. Profitability

Particulars	Y1-23-24	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Capacity utilisation %	90%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Revenue from Ethanol	67	661	667	674	681	687	694	701	708	715
Revenue from other products	10	107.61	109	110	111	112	113	114	115	117
Total Revenue	77	768	776	784	792	799	807	816	824	832
Change in inventory	52	0	0	0	0	0	0	0	0	0
Value of production	129	769	776	784	792	800	808	816	824	832
Grain - Corn	-	-	-	-	-	-	-	-	-	-
Grain - Broken Rice	78	535	541	546	551	557	563	568	574	580
Total feed cost	78	535	541	546	551	557	563	568	574	580
Gross Margin	50	233	236	238	240	243	245	248	250	253
Operating cost										
Variable cost	15	101	102	103	104	105	106	107	108	109
Utilities cost (Power, stream, process water, effluent)	12	81	82.2	83	84	85	86	86	87	88
Chemicals and Enzymes	3	19.28	19.4	20	20	20	20	20	20	21
Contribution	47	214	216	218	221	223	225	228	230	232
Fixed cost	5	29	29	29	30	30	30	31	31	31
Power	0	2	2	2	2	2	2	2	2	2
Manpower cost	0	2	2	2	2	2	2	2	2	2
O&M	3	20	20	20	20	21	21	21	21	21
Maintenance cost	1	5	5	5	5	5	5	5	5	5
Insurance cost	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0
Total Operating Expenses	20	130	131	132	133	135	136	137	139	140
EBITDA (Gross Margin - Opex expenses)	31	104	105	106	107	108	109	111	112	113
Interest exp on short term loan	3	6	6	6	6	6	6	6	6	6
Interest exp. on Long term Loan	8	30	28	20	20	16	11	1	1	-
Deprication	6	12	12	12	12	12	12	12	12	12
Profit Before Tax	14	55.57	59	68	69	74	81	92	93	95
Income Tax Expenses	-	-	2	5	6	8	10	13	14	15
Profit after Tax	14	56	57	63	62	66	70	79	79	80

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B. DSCR

DSCR	Y1-23-24	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
DSCR	2.98	2.25	1.42	1.36	1.20	1.26	1.15	1.29	2.36	15.37

C. Cash flow Projections

Particulars	Y1-23-24	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Cash Inflow/(Outflow) from operating Activities										
EBIDTA	31	104	105	106	107	108	109	111	112	113
Income Tax payment	-	-	(2)	(5)	(6)	(8)	(10)	(13)	(14)	(15)
Cash flow from operating activities before WC changes	**31**	**104**	**103**	**101**	**101**	**100**	**99**	**97**	**98**	**98**
Working capital changes	(106)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Cash flow from operating activities after WC changes	**(76)**	**103**	**102**	**100**	**100**	**99**	**98**	**96**	**97**	**97**
Cash Inflow/(Outflow) from Investing Activities										
Capex expenditure	(525)	-	-	-	-	-	-	-	-	-
Cash Inflow/(Outflow) from Investing Activities	**(525)**									
Cash Inflow/(Outflow) from Finance Activities										
Interest Paid	(10)	(37)	(34)	(27)	(27)	(22)	(17)	(7)	(7)	(6)
Share capital received	170	-	-	-	-	-	-	-	-	-
LT Loan (Availed /repaid)	382	(10)	(38)	(48)	(57)	(57)	(69)	(69)	(34)	-
ST Loan (Availed /repaid)	80	-	-	-	-	-	-	-	-	-
Cash Inflow/(Outflow) from Financing Activities	**621**	**(46)**	**(73)**	**(75)**	**(84)**	**(79)**	**(86)**	**(76)**	**(41)**	**(6)**
changs during the period	**20**	**57**	**30**	**26**	**16**	**19**	**12**	**21**	**55**	**91**

D. Projected Balance sheet statements

Equity & Liabilities	Y1-23-24	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Share capital	170	170	170	170	170	170	170	170	170	170
Reserve and Surplus	-	14	70	127	190	252	318	388	467	546
Profit for the year	14	56	57	63	62	66	70	79	79	80
Shareholders Funds	**184**	**240**	**297**	**360**	**422**	**488**	**558**	**637**	**716**	**795**
Non-Current Liabilities	**382**	**372**	**334**	**286**	**229**	**172**	**103**	**34**	-	-
Long term Loan	382	372	334	286	229	172	103	34	-	-
Current Liabilities	**120**	**120**	**121**	**121**	**122**	**122**	**122**	**123**	**123**	**124**
Trade Payables	40	41	41	41	42	42	43	43	43	44
short term loan	80	80	80	80	80	80	80	80	80	80
Total Liabilities	**686**	**732**	**752**	**767**	**772**	**782**	**783**	**794**	**839**	**919**
Assets										
Fixed Assets (Gross Block)	525	525	525	525	525	525	525	525	525	525
Depriciation for the year	6	12	12	12	12	12	12	12	12	12
Earlier period depriciation (Accumulated)		6	17	29	41	52	64	76	87	99
Accumulated Depreciation	**6**	**17**	**29**	**41**	**52**	**64**	**76**	**87**	**99**	**111**
Net Fixed Assets(Net Block)	**519**	**508**	**496**	**484**	**473**	**461**	**449**	**438**	**426**	**414**
Current Assets	**167**	**225**	**256**	**283**	**300**	**321**	**334**	**356**	**413**	**505**
Bank Balance /(Bank Overdraft)	20	77	107	132	148	167	180	200	256	346
Security Deposit										
Trade Receivable	46	47	47	48	48	49	49	50	50	51
Inventory	100	101	102	103	104	104	105	106	107	108
Total Assets	**686**	**732**	**752**	**767**	**772**	**782**	**783**	**794**	**839**	**919**

Input and Product Slate including utility (Maize based)

	Value	Unit
Total capacity	300	KLPD
Number of days	330	
Ethanol	78,507	TPA
DDGS (Maize based)	51,030	TPA
Food Grade CO2	49,459	TPA
Fusel oil	210	TPA
Technical Ethanol	785	TPA
CO2 loss and moisture loss	55,530	TPA
Total Input - Maize	235,521	TPA
Raw Material Consumption		Tons/ton of Ethanol
Maize	3.0	Tons / Ton of Ethanol
Energy Consumption		
Power	480	Kwh/T of Ethanol

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Steam	4.00	Tons / Ton of Ethanol
Treated water	10.09	M3/Ton of Ethanol
Service Water	4.54	M3/Ton of Ethanol
DM Water	1.06	M3 / Ton of Ethanol

(Rs. Cr.)

IRR sensitivity

Project Economics

Indicative returns	
Project IRR	**14.10%**

IRR% sensitivity to Ethanol rate

Ethanol Rate (corn based)- Rs/Ltr	Project IRR
68.07	17.42%
67.07	15.78%
66.07	**14.10%**
65.07	12.39%
64.07	10.63%

IRR sensitivity to Input Maize Feed Stock

Corn Rate (Rs/MT)	Project IRR
20,500	22.06%
21,500	18.14%
22,500	**14.10%**
23,500	9.89%
24,500	5.34%

This is the last page of the report

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