An initiative supported by

SHAKTI SUSTAINABLE ENERGY FOUNDATION

CII

Widening the coverage of PAT Scheme

Indian Distillery Industry

December 2013

Disclaimer

This report is part of Shakti Sustainable Energy Foundation (SSEF) and CII – Godrej GBC's effort to highlight energy consumption trends and energy efficiency improvement opportunities of the Indian distillery sector.

The views and analysis expressed in this document do not necessarily reflect that of Shakti Sustainable Energy Foundation. The company accepts no liability for the content of this document, or for the consequences of any actions taken on the basis of the information provided. While every care has been taken in compiling this report, CII-Godrej GBC and Shakti Sustainable Energy Foundation accept no claim for any kind of compensation, if any entry is wrong, abbreviated, omitted or inserted incorrectly either as to the wording space or position in the booklet. The report is only an attempt to highlight energy consumption trends and energy efficiency improvement opportunities of the Indian distillery sector.

Published by

Confederation of Indian Industry
CII – Sohrabji Green Business Centre
Survey # 64, Kothaguda Post,
RR District, Hyderabad – 500 084, India

ACKNOWLEDGEMENT

At the outset CII would like to thank Shakti Sustainable Energy Foundation for supporting this study. Shakti Sustainable Energy Foundation works to strengthen the energy security of India by aiding the design and implementation of policies that support energy efficiency and renewable energy.

CII would like to express its sincere thanks to the following people for their valuable inputs, support and association during the execution of this project.

1. Mr Om Narayan, Dhampur Sugar Mills
2. Mr Mathiyalagan, Rajshree Sugars & Chemicals Ltd
3. Mr Sanjay Patil, Vasantdada Sugar Institute
4. Mr V N Raina, All India Distillers' Association

CII highly appreciates the generous assistance of the following companies for accommodating visits to their plants and providing valuable inputs for this report.

1. EID Parry (I) Limited
2. Gayatri Sugars Ltd
3. KCP Sugar & Industries Corporation Ltd
4. Rajshree Sugars & Chemicals Ltd

CII would also like to thank the following organizations for their participation in the stakeholder workshops and inputs during stakeholder consultation.

1. Dhampur Sugar Mills Ltd.
2. Harinagar Sugar Mills Ltd.
3. JP Mukherji & Associates Private Limited
4. Madhucon Sugar and Power Industries Ltd.
5. Nordic Cleantech Pvt. Ltd.
6. Ponni Sugars (Erode) Limited
7. Raj Process Systems & Equipment Pvt. Ltd
8. Simbhaoli Power Pvt. Ltd.
9. Sri Sarvaraya Sugars Ltd.
10. The Puducherry Coop Sugar Mills Ltd.
11. The South Indian Sugarcane and Sugar Technologists Association
12. Veesons Energy System Pvt. Ltd.

CONTENTS

List of Tables

List of Figures

List of abbreviations

BEE	-	Bureau of Energy Efficiency
CII	-	Confederation of Indian Industry
CPCB	-	Central Pollution Control Board
EBP	-	Ethanol Blending Program
ENA	-	Extra Neutral Alcohol
EU	-	European Union
MEE	-	Multi Effect Evaporator
OECD	-	Organization for Economic Co-operation & development
PAT	-	Perform Achieve & Trade
RO	-	Reverse Osmosis
RS	-	Rectified Spirit
VFD	-	Variable Frequency Drive
VSI	-	Vasantdada Sugar Institute
ZLD	-	Zero Liquid Discharge

List of Measuring Units

Kg	-	Kilogram
KWh	-	Kilo Watt Hour
kCal	-	kilo Calorie
MTOE	-	Metric Tons of Oil Equivalent
MT	-	Metric Ton
TCD	-	Tons Crushed per Day
kLPD	-	Kilo Litres per Day

List of Conversion Factors

1 Gcal	=	10^6 kCal
1 kWh	=	860 kCal
1 MTOE	=	10^7 kCal
1 GJ	=	238,846 kCal
1 USD	=	55 Rupees

1. EXECUTIVE SUMMARY

This report is an attempt of CII to provide an overview of the Indian distillery sector's total energy consumption, Specific Energy Consumption (SEC), its variation and the energy reduction potential. The report also highlights the major energy saving opportunities available in the sector and provides an overview of growth opportunities & technology/ policy barriers faced by the sector. A set of recommendations which will assist the sector in improving energy efficiency have also been highlighted in this report. This report has emerged after a wide stakeholder consultation with sector experts, distillery plants, associations, institutes and technology suppliers. This report also examines energy saving possible if a mandatory energy efficiency scheme like Perform, Achieve and Trade (PAT scheme of Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India) is introduced in the Indian distillery sector. The scope of the report includes distilleries which manufacture Rectified Spirit (RS), Extra Neutral Alcohol (ENA) and fuel ethanol.

India is the second largest producer of sugar and the fifth largest producer of ethanol. About 80% of the alcohol production in India is molasses based, which is a by-product of the sugar industry. Hence most of the distilleries are attached to sugar factories. The states of Maharashtra, Uttar Pradesh, Karnataka and Tamil Nadu (including Pondicherry) which hold a major share in sugar production also accounts for 85% of the alcohol production.

The installed capacity of distilleries at present (molasses and grain based) is about 5.8 billion litres in 2011-12 and the production is 2.13 billion litres, a capacity utilization rate of 37%. The installed capacity is increasing with several sugar factories exploring the option of setting up distilleries.

The demand for ethanol in India is expected to increase significantly in the future owing to the huge expected demand from the three sectors: chemical industry, alcoholic beverage industry and fuel blending[1]. The demand for ethanol is expected to touch 9.2 billion litres by 2017, as per Planning Commission estimates, largely driven by ethanol blending policy of Government of India. This huge demand can be met if proper measures are taken by the government and the industry to improve the present capacity utilization and by augmenting installed capacity.

The distillery sector offers a huge co-generation potential of 1500 MW[2]. The spent wash from the distilleries is treated using bio-methanation/incineration and can be used to generate power to export it to the grid. This sector can also play a major role in contributing to the energy security of the nation.

The study involved secondary research (review of annual reports, data available with CII and other technical reports), visiting various manufacturing facilities and interaction with experts, industry association, research institutions and technology suppliers. Views, comments & suggestions from various stakeholders on energy trends, reduction opportunities, technology and policy barriers were gathered and deliberated upon during the stakeholder consultation workshops organized as a part of this study.

[1] Ethanol blending program of Government of India mandates blending of 5% ethanol with petrol at present and about 20% ethanol by 2017.
2 AIDA and CII estimates

In order to estimate the energy consumption of the sector, the following methodology was used:

- Distilleries can be classified into large, medium and small capacities
  - Large capacity (with 100 kLPD and above) - 36 distilleries
  - Medium capacity (with 51- 100 kLPD) - 60 distilleries
  - Small capacity (less than 50 kLPD) - 304 distilleries
- Specific Energy Consumption of electrical and thermal energies per litre was estimated
- The sector's total energy consumption is calculated based on the SEC values

Based on the questionnaires collected, plant visits, annual reports and stakeholder consultation, data on energy consumption for a distillery unit is collected and analyzed.

- **The energy consumption of the Indian distillery industry is estimated to be 0.99 million MTOE.**
- **Considering that 40% of the energy consumption is from renewable sources like bio-fuels and bagasse, the fossil fuel consumption is estimated to be 0.63 million MTOE.**
- **The average SEC in a distillery is estimated to be:**
  - **Distillery consumption: SEC electrical is estimated to be 0.27 kWh/L and thermal energy consumption is 2,220 kCal/L of alcohol produced.**
  - **Effluent treatment plant (ETP) consumption: SEC electrical is estimated to be 0.022 kWh/L and thermal energy consumption is 198 kCal/L of spent wash treated.**
  - The ETP energy consumption is almost equal to the distillery consumption.

The energy consumption of a typical 50 kLPD distillery is estimated in the report which can be used as a base plant. A typical 50 KLPD distillery consumes about 2,453 Metric Tons of Oil Equivalent (MTOE) in a year[1] to produce alcohol and about 2,169 MTOE units to process the spent wash generated in the process i.e., a total of 4,622 MTOE. Considering the energy input from renewable energy sources, the total energy consumption is about 3,000 MTOE.

- **Energy consumption of a 50 kLPD plant: 4,622 MTOE**
- **Energy consumption of a 50 kLPD plant excluding energy consumption from renewable sources: ~3,000 MTOE**

[1] Assuming fossil fuels are used in the process to generate steam.

The suggested threshold limit for inclusion in PAT scheme and the potential savings are estimated.

There is a huge energy reduction potential of 10-15% possible in the sector with implementation of latest technologies like multi-pressure distillation, continuous fermentation etc. The energy reduction is quite low at present and the plants have reduced energy consumption by around 2-6% over the last three years.

- **Suggested threshold limit for inclusion in PAT scheme, if considered = 3,000 MTOE**
- **Estimated number of plants above suggested threshold (designated consumers) = 96**
- **Contribution of designated consumers to overall sector's energy consumption= 40%**
- **Estimated energy saving from designated consumers if included under PAT with a 5% reduction target over a three year period = 0.019 million MTOE.**

The recommendations and various measures that need to be taken to further facilitate the sector in improving its energy efficiency include:

1. Awareness and capacity building campaign in distilleries.
2. Creating an energy efficiency / cogeneration mission (similar to Fly Ash mission under TIFAC, Department of Science & Technology) in distilleries.
3. Demonstration of specific technologies and best practices in a model plant.
4. Creation of a fund for distillery technology improvement similar to technology up gradation fund in textile sector.
5. Special policy schemes and setting up of state environment funds to provide incentives for energy efficiency improvement in distilleries. As the four states of Maharashtra, Uttar Pradesh, Karnataka and Tamil Nadu (including Pondicherry) account for 85% of the alcohol production, state funds can be set up in these states.
6. Collection of energy efficiency performance data from various facilities, sharing of best practices and benchmarking can help the Indian distillery sector accelerate its energy efficiency initiatives. This effort requires extensive data collection and analysis; Industry associations (CII, AIDA etc), BEE and other stakeholders can work with the distillery sector in this initiative.
7. Alternate feedstock usage need to be further explored to improve the capacity utilization.

Significant co-generation potential of 1500 MW exists in distillery industry which can be explored by encouraging bio-methanation/ incineration systems for treatment of spent wash. Industry associations (AIDA, CII) and MNRE can work with distillery industry in this initiative.

2. INTRODUCTION

2.1 Sector importance

The distillery sector is one of the important sectors in India with end users from three segments- potable alcohol, chemical sector (industrial use in manufacturing various chemicals) and as fuel ethanol for blending with petrol. The potable alcohol industry is valued at USD 6 billion[1], the alcohol based chemical industry is sized at[2] USD 1.1 billion, and the ethanol blending policy of the government is expected to be a key driver for the future growth of the distillery sector. The Indian distillery industry provides employment to 0.25- 0.3 million people[3].

2.2 International scenario

The size of the global ethanol industry[4] in 2010 was USD 227.3 billion. The ethanol production for the three end-use sectors was estimated to be around 100 billion litres in 2010. The sector provides employment to nearly 1.4 million people. The ethanol produced from the molasses route accounts[5] for 61% of the global production and the remaining 39% is grain-based.

The United States of America and Brazil together account for 70% of the world's production of ethanol. In the USA, the production increased[6] from 5.29 billion litres[7] in 1998 to 49.9 billion litres in 2010. Brazil is the major supplier of ethanol globally. The launch of its nation-wide program, (Pro A'lcool), in 1975 opened the doors for exploring new commercial use of sugarcane. Ethanol production had increased significantly from 10.7 billion litres in 2000 to 26.1 billion litres in 2009[8].

Most of the distilleries in the USA are corn based, while Brazil primarily uses sugarcane juice and molasses. In India, molasses is the major feedstock used.

2.3 International standing of sub sector

India is the fifth largest producer of ethanol in the world next to United States, Brazil, European Union (EU) and China. The global ethanol production is projected to continue its

---

[1] ICRIER Policy Series 2011
[2] Planning commission, working group report on chemical industry
[3] The manpower employed is high in Indian distilleries due to less automation and presence of more no. of distilleries for a given capacity, compared to other countries. The average capacity of Indian distilleries is low and the number of distilleries is more for a particular capacity. (i.e., instead of a single 300 kLPD facility, 10 nos of 30 kLPD facilities are found here).
[4] Renewable Fuels Association
[5] Ministry of Economy, Trade & Industry, Government of Japan
[6] Department of Commerce, U.S. Census Bureau, Foreign Trade Statistics, USDA International Agricultural Trade Report 2011
[7] 1 US gallon= 3.78 litres
[8] A, Economic Research Service using data from IBGE (2010a) and MME/EPE (2010b).

rapid increase to reach 155 billion litres[1] by 2020. Brazil, India and China would account for 39% of the global ethanol production[2] by 2020.

The installed capacity of molasses based distilleries in India was about 4 billion litres/annum and the installed capacity of grain based distilleries was 1.8 billion litres/annum in 2011, which increased to around 4.5 billion litres/annum and 2 billion[3] litres/annum, respectively in 2013.

2.4 Market scenario

The end products of a distillery include Rectified Spirit (RS), Extra Neutral Alcohol (ENA) and fuel grade ethanol. A typical distillery has facilities to produce any of the above three end-products or a mix of them and the production is mainly driven by market demand and profitability of the end product.

In 2011, the demand for potable alcohol was around 1,000 million litres; for industrial alcohol, the demand was approximately 1,000 million litres; and the demand for alcohol in fuel blending was around 1,040 million litres[4].

The Sector-wise utilization of alcohol[5] in million litres is given in the table below. The three end- users compete among themselves for the distillery end- products[6].

Table 1: Sector wise utilization of alcohol in India[7] (million litres)

Sector	2012	2011	2010	2009
Liquor Industry	1,010	950	900	880
Chemical Industry	775	750	720	700
Ethanol for blending	300	250	50	100
All India	2,085	1,950	1,670	1,680

[1] Organization for Economic Co-operation and Development, OECD
[2] OECD- FAO agricultural outlook 2011-2020
[3] Based on interaction from Vasantdada Sugar Institute
[4] Workshop on distillery effluent treatment and water conservation, 2011, AIDA and CPCB.
[5] Annexure referred to in reply to part (a) of the Un-Starred Question no. 1652 for answer on 4.12.2012 in the Lok Sabha.
[6] The actual supply/ utilization have been indicated in Table 1. It can be inferred that production and supply is much lower than demand.
[7] Source: GAIN Report No IN 1159 dated 07.01.2012 of USDA (FAS), Source: Ministry of consumer affairs, food and public distribution

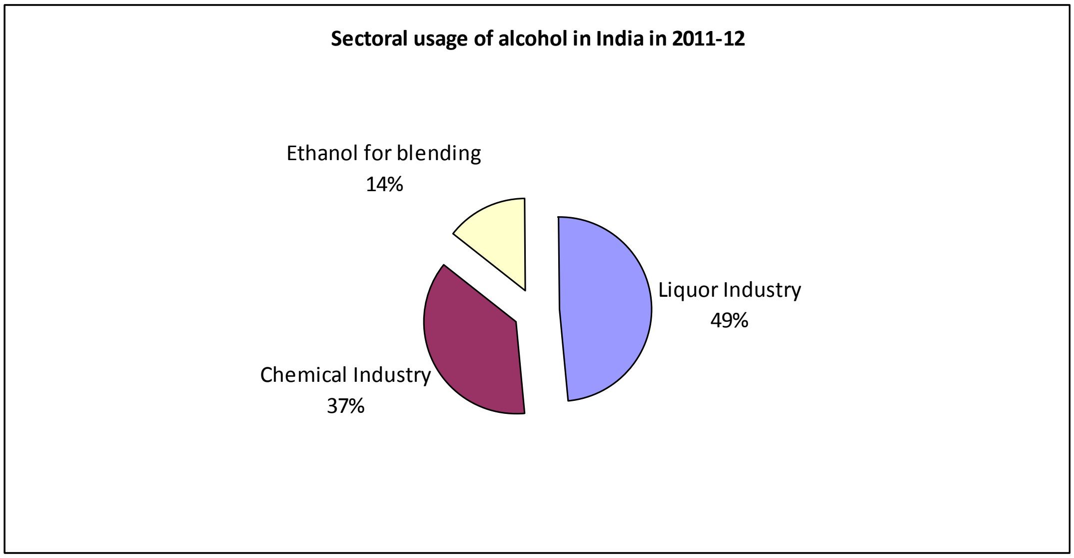

Figure 1: Sectoral usage of alcohol in India

2.5 Growth in past & future perspective

The alcohol industry in India came into existence in the 1930s as a means to deal with the molasses produced by the sugar industry. It was costly for distilleries at that time to dispose of molasses. With the state governments of Uttar Pradesh and Bihar recommending the establishment of distilleries for the production of molasses based alcohol and other sugar factories across the country following it, the sector has evolved to become one of the important segments of a sugar plant, along with co-generation.

As per the latest Planning Commission statistics, the production of alcohol[1] decreased from 2,500 million litres in FY07 to 1,830 million litres in FY10, registering a negative growth of 10% p.a. The decline in production resulted in an increase in imports to meet the growing demand. The import of industrial alcohol has increased considerably[2], from 39 million litres in 2007 to 270 million litres in 2010. The demand supply gap further widened with the increase in demand of alcohol for blending with petrol.

[1] Considering production from the ten major producing states: Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh and Uttaranchal, Bihar, Haryana and Punjab
[2] Planning Commission

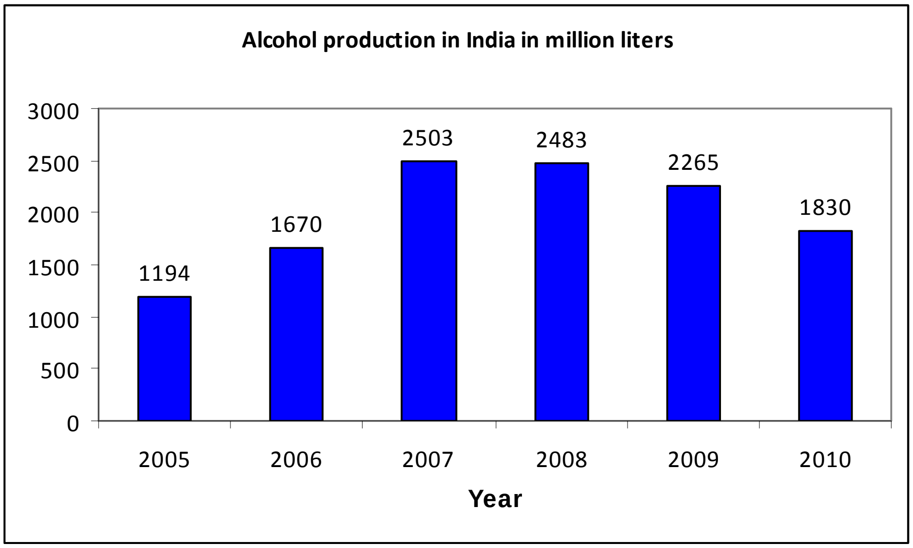

Figure 2: Alcohol production in India in million litres

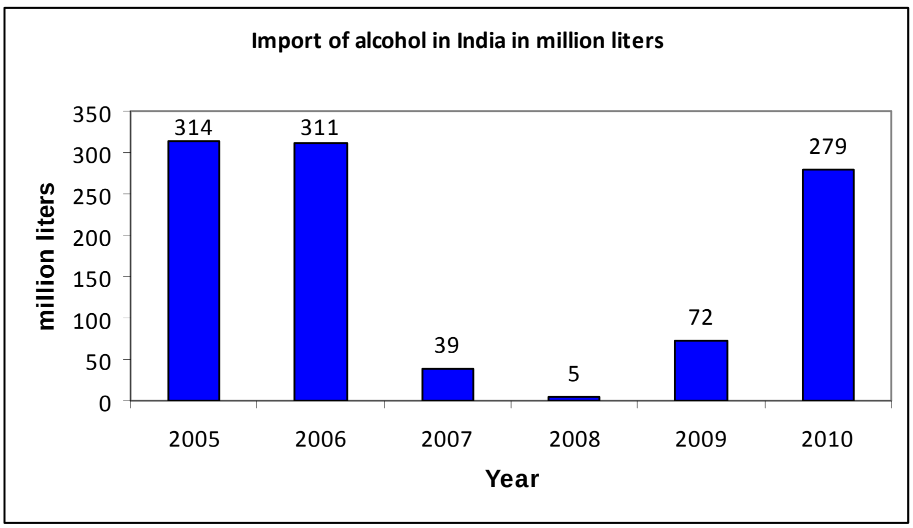

Figure 3: Import of alcohol in India

The production growth, however, is showing a positive trend from 2010 to 2013[1] as shown in the figure below[2]. The up and down surges in production of ethanol is attributed to the cyclical nature of the sugar industry. This necessitates the need for exploring alternate feed stocks (other than molasses) for manufacture of alcohol.

[1] There is a slight variance in the data indicated by Planning Commission and FAS, for the years 2006 to 2010, as seen in Figure 2 and Figure 4, respectively.

[2] Figures for 2012 are estimated, source: Dhampur Sugar Mills, Annual Report 2011-12.

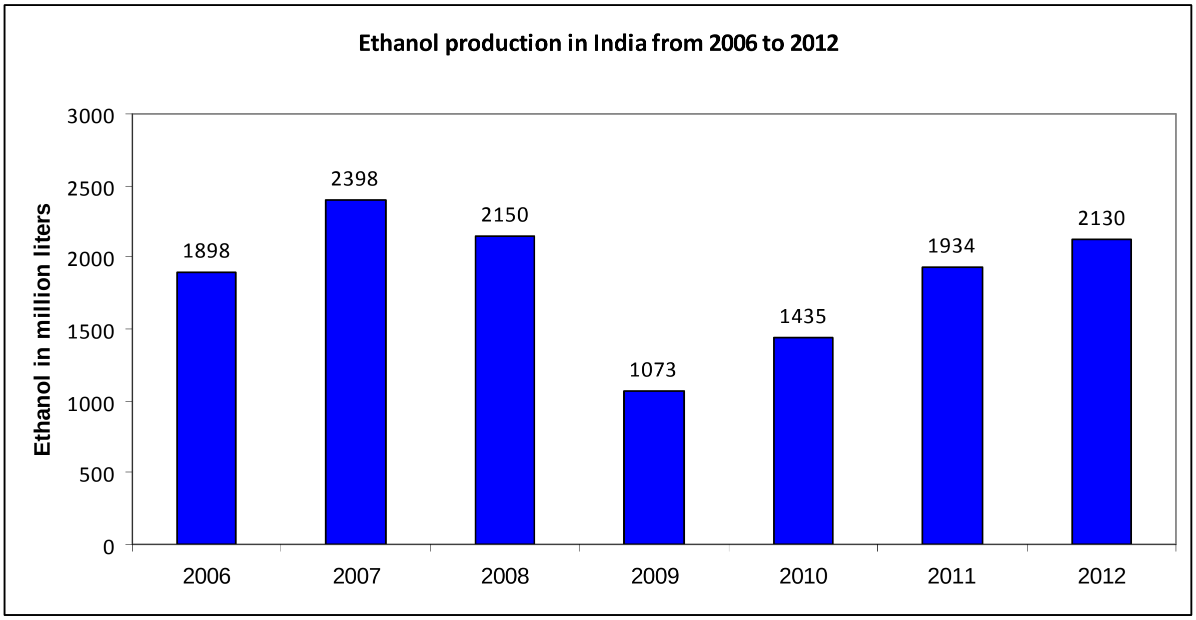

Figure 4: Ethanol production in India from 2006 to 2012[1]

For comparison, the molasses production data is given below. The production of molasses decreased from 2007 to 2009 and is showing an increase after that as can be seen from the graph below.[2]

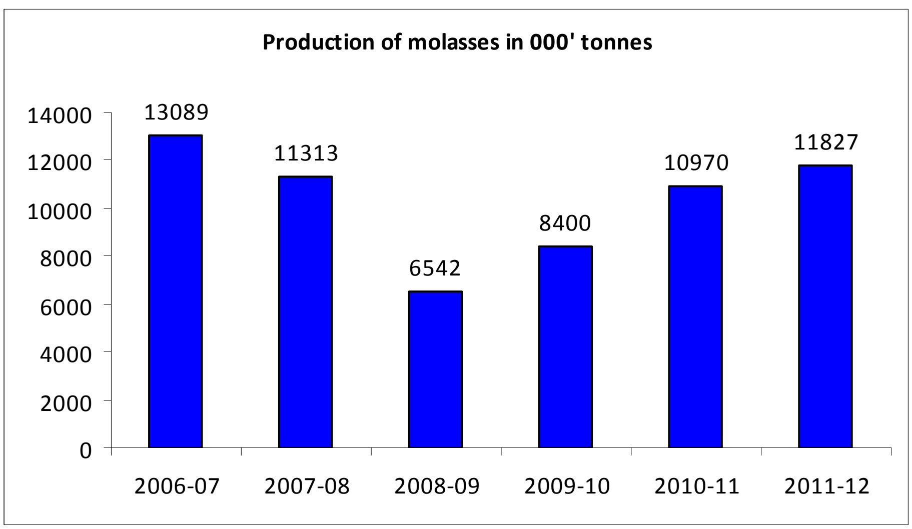

Figure 5: Production of Molasses in India

(Since Fig. 4 is on a calendar year basis and Fig. 5 is on a financial year basis, there is a difference in the trends in the two figures in years 2006, 2008 and 2009.)

With the constant increase in demand, alcohol production has been rising continuously. Due to the government promoting ethanol blending in petrol, there will be drastic demand

[1] Source: FAS/New Delhi
[2] ISMA Statistics

for ethanol, and capacity utilization is expected to increase. The demand for ethanol from chemical and beverages industry is expected to rise to 3.2 billion litres[1] by 2017. The current requirement of ethanol for Ethanol Blending Program[2] (EBP) is 1200 million[3] litres. At 5% blending, ethanol demand for EBP (Ethanol Blending Program) is expected to reach around 2 billion litres by 2017. With the National Policy on Bio-fuels mandating a 20% blending by 2017, the demand would rise to 6.5 billion litres.

Considering the above factors, the demand for alcohol from the three end use sectors is expected to reach 9.2 billion litres[4] by 2017. The average production of molasses based ethanol in India was 1.8 billion litres in the period from 2001 to 2011. This could rise to around 3.9 billion litres of molasses based ethanol by 2017, which would not be sufficient to meet the expected demand. The alcohol production is also affected by the cyclic nature of sugar industry with highs and dips every three years. To meet the growing demand, the possibilities of manufacturing ethanol from other feedstock are being explored.

At present, there are 529 sugar factories in operation in India[5], many of them without an attached distillery unit[6]. As more and more sugar factories are trying to set up distilleries keeping in view the huge demand for ethanol, the installed capacity is bound to increase in the future.

2.6 Production data[7]

In India, alcohol production mainly depends on molasses, which in turn depends on the sugar industry. About 60% of the sugar production is from two states - Maharashtra and Uttar Pradesh. These two states, hence, account for the major share of alcohol production. The other two states which are major producers of alcohol are Karnataka and Tamil Nadu (including Pondicherry). These four states, together, account for 85% of the alcohol production in India. Across most of India, inter-state movement of molasses is not freely permitted and it is not viable to procure molasses from different parts of the country. As a result, most of the distilleries are attached to the sugar factories that produce molasses.

---

[1] Working group report, planning commission

[2] According to EBP, it was proposed to blend petrol and diesel by fuel ethanol and bio-diesel respectively at 5% at present and to increase it to 20% by 2017 by implementing the policy in a phase-wise manner. There are a few hurdles at present due to lack of fuel ethanol for the same.

[3] AIDA newsletter, February 2012

[4] Planning commission

[5] Indian Sugar Mills Association

[6] 10 tons of sugarcane crushed produces 400- 450 kg of molasses. 1 ton of molasses can produce 240 litres of alcohol (this number varies based on the composition and TRS in the molasses at different plants and cane types). Considering the above factors, to set up a 30 KLPD distillery a minimum of 2500 TCD capacity is required.

[7] Annexure referred to in reply to part (a) of the Un-Starred Question no. 1652 for answer on 4.12.2012 in the Lok Sabha

The state wise production of molasses and ethanol from 2009 to 2012 is given in the table below.

Table 2: State wise production of Molasses and Ethanol

State	Production of Molasses (Lakh MT)				Production of alcohol*(million litres)			
	2012-13*	2011-12	2010-11	2009-10	2012-13*	2011-12	2010-11	2009-10
Uttar Pradesh	32.30	38.53	32.38	28.56	775.20	924.72	777.12	685.44
Maharashtra	32.00	31.54	32.90	24.41	768.00	756.96	789.60	585.84
Karnataka	14.50	25.23	15.20	10.74	348.00	605.52	364.80	257.76
Tamil Nadu & Pondicherry	10.00	12.49	10.08	6.89	240.00	299.76	241.92	165.36
Gujarat	5.80	4.44	5.88	5.1	139.20	106.56	141.12	122.40
Andhra Pradesh	4.80	5.44	4.79	2.66	115.20	130.56	114.96	63.84
Haryana	2.10	2.76	2.13	1.31	50.40	66.24	51.12	31.44
Bihar	2.00	2.25	1.98	1.25	48.00	54.00	47.52	30.00
Uttarakhand	1.50	1.75	1.55	1.52	36.00	42.00	37.20	36.48
Punjab	1.50	1.91	1.53	0.93	36.00	45.84	36.72	22.32
Others	1.30	1.45	1.29	0.63	31.20	34.80	30.96	15.12
All-India	107.80	127.79	109.71	84.00	2587.20	3066.96	2633.04	2016.00

* figures for 2012-13 are estimated; Production of alcohol has been calculated at the standard of 240 litres per MT Molasses production is based on Financial Manufacturing Report of Sugar Mills which is a statutory document

2.7 Important stakeholders

- **Department of Chemical and Petrochemicals:** The alcohol produced from molasses route comes under the purview of Department of Chemicals and Petrochemicals. The Department of Chemicals and Petrochemicals is under the Ministry of Chemicals and Fertilizer since 1991. The Department is entrusted with the responsibility of policy, planning, development and regulation of chemicals and petrochemicals industries. (www.chemicals.nic.in)

- **Ministry of Food Processing Industries:** Alcohol manufactured from routes other than molasses (such as grains), alcoholic beverages like wine and beer come under the purview of the Ministry of Food Processing Industries. (www.mofpi.nic.in)

- **All India Distillers Association (AIDA):** AIDA was formed in 1953 and the constituents of the association control more than 80% of the total distillation capacity of the country. Besides, ten state associations have also been constituted in Maharashtra, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Bihar, Uttar Pradesh, Punjab and Haryana, which are all affiliated to the parent body .The association works on issues related to harmonious employer-employee relationship, quality, industrial development, government- society partnership and to enhance the quality, technology and productivity of the distillery/ alcohol industry. (www.aidaindia.org)

- **Vasantdada Sugar Institute:** Vasantdada Sugar Institute is an autonomous body and a registered society. The Department of Alcohol Technology aims to help distillery industry in their efforts to achieve the economic development (with minimum use of resources and energy input) by assisting them in building their capacity and capability through trained manpower and by way of advancement, development and adoption of better technology in its area of focus viz. fermentation, distillation & integrated effluent treatment systems. (www.vsisugar.com)

- **National Sugar Institute:** The Indian Sugar Committee appointed by the Government of India in 1920 recommended the establishment of an all India institute for research in sugar technology. NSI was established in 1936. The main functions of the Institute are to provide technical education and training in research in all branches of sugar chemistry, sugar technology, and sugar engineering and allied fields. (www.nsi.gov.in)

- **State excise department:** In most of the states, state excise department closely monitors the amount of alcohol produced in the distillery. Lock and Key system is followed where every drop of alcohol produced is accounted for with an intention to avoid its misuse.

- **Pollution Control Boards:** With distilleries falling under the red category of industries, the effluent management and performance of distilleries is being closely monitored by the PCBs both central and state.

- **Sugar Industry:** With the production of alcohol directly dependant on its by-product, sugar industry is an important stakeholder.

The other important stakeholders include manufacturers of alcoholic beverages, manufacturers of carbonated drinks, organizations working on energy efficiency like BEE, CII and technology suppliers.

2.8 Product categorization and by-products

2.8.1 End products of a distillery

The alcohol produced in distilleries can be classified based on its concentration into:

1. Rectified spirit (RS): Alcohol content is 94.68 to 95.55 % v/v (v/v is percentage of alcohol by volume)
2. Extra neutral alcohol (ENA): 95 to 96 % v/v
3. Anhydrous fuel alcohol : 99.6 to 99.9 % v/v

Distilleries can produce any of the above products. The product mix varies based on the market demand and profitability.

2.8.2 By-products

The by-product of fermentation i.e., carbon dioxide, can be bottled or used to manufacture dry ice. Spent wash generated in the process is used in bio-methanation plants/ incineration systems to generate power and steam.

2.9 Major Players

As mentioned above, most of the distilleries are attached to sugar factories. Some of the major chemical manufacturers also have attached distilleries that manufacture alcohol for their in-house consumption. The alcohol production in India is heavily dependent on production of sugar and sugarcane. The major sugarcane producing states[1] (and hence, major ethanol producing states), in the country are Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh, and Uttarakhand, Bihar, Haryana and Punjab.

ENA is produced on a larger scale compared to RS and fuel ethanol owing to the high price of ENA and demand from potable alcohol manufacturers.

Some of the major private players include companies such as Balrampur Chini Mills Ltd, Bajaj Hindusthan Ltd, Shree Renuka Sugars Ltd, and Simbhaoli Sugar Mills Ltd. The list of some of the distilleries in India with an installed capacity of 100 KLPD and above is given below[2].

[1] The co-operative sector accounts for 40% of India’s sugar production (Indian Sugar Mills Association)
[2] State wise list of ethanol producers, Indian Sugar Mills Association (ISMA) and AIDA newsletters

Table 3: List of distilleries in India with 100 KLPD and above

Name of the distillery	Installed Capacity in KLPD	Location
Balrampur Chini Mills Ltd	100	Balrampur , UttarPradesh
Bajaj Hindusthan Limited (BHL)	160	Gangnauli, UttarPradesh
Bajaj Hindusthan Limited (BHL)	160	Kinauni, Meerut, U.P.
Dhampur Sugar Mills Ltd.	170	Dhampur, U.P.
DSM Sugar	100	Asmoli, U.P.
Mankapur Chini Mills Ltd.	100	Mankapur, U.P.
Naglamal Sugar Complex	120	Naglamal, Meerut, U.P.
Oudh Sugar Mills Ltd.	100	U.P.
Upper Ganges Sugar Mills Ltd.	100	Seohara, Dhampur, Bijnor
Jai Mahesh Sugar Ind. Ltd.	100	Pawarwadi, Majalgaon, Beed, Maharashtra
Davangere Sugars Ltd.	130	Kukkawada, Davangere, Karnataka
Vijaynagar Sugars Pvt. Ltd.	130	Gangapura, Mundargi, Gadag, Bagalkot
Shri Renuka Sugars Ltd.	300	Athani, Belgaum
Shri Renuka Sugars	300	Khopoli, Raigadh
Sakthi sugars	120	Sakthinagar, Erode dist.
S V Sugars	100	Kancheepuram dist.

The state wise production share of ethanol is as follows.

Table 4: Production share of ethanol- state wise in 2011-12

State	% Share of production
Uttar Pradesh	30.15
Maharashtra	24.68
Karnataka	19.74
Tamil Nadu & Pondicherry	9.77
Gujarat	3.47
Andhra Pradesh	4.26
Haryana	2.16
Bihar	1.76
Uttarakhand	1.37
Punjab	1.49
Others	1.13

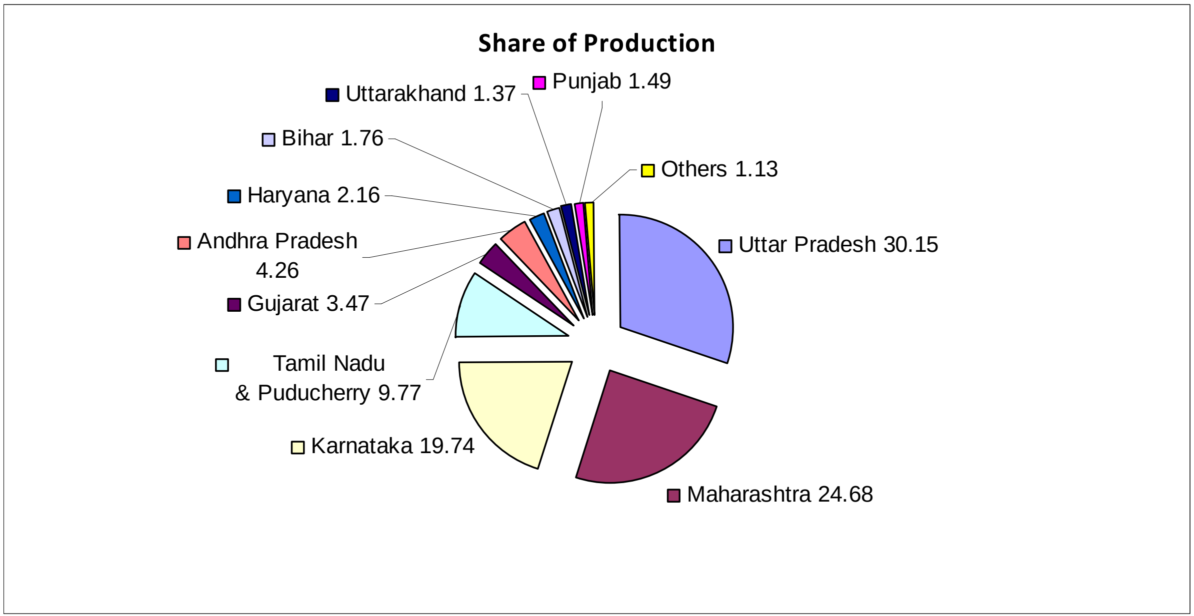

Figure 6: Share of production- state wise

2.10 Policy Scenario

With an almost equal demand from three end-users which are under the purview of different central and state governments, the distillery sector falls under various government regulations.

- The production of ethanol in India is mostly from molasses which is a by-product in the production of sugar. Soft loans up to 40% of the project cost[1] are provided to sugar mills for setting up ethanol projects to improve their viability through value additions to their by-product, namely molasses.
- Most states do not permit free inter-state movement of industrial alcohol, forcing the industry to purchase at higher prices locally. Import and movement is not allowed freely by state governments.
- The export/ import duty is high for inter-state transfer. Besides, fees are charged under various heads viz. transport fee, purchase tax, vend fee, de-naturalization fee etc.
- State government policies lead to uncertainty about the availability of alcohol as a raw material for the industrial sector which may not be able to purchase alcohol at higher prices like potable alcohol manufacturers. The Government dictates the proportion of molasses that may be used for the production of alcohol versus alternative end products.

[1] Ministry of consumer affairs, food and public distribution

- The Central Pollution Control Board (CPCB) closely monitors the effluent discharge and its treatment in the distilleries. The distilleries come under 'Red' category of industries.

- As per CPCB mandates, all distilleries should have achieved Zero Liquid Discharge (ZLD), failing with which, they are forced to shut down their operations.

2.10.1 Policies driving energy efficiency in distilleries

- To comply with the PCB norms, distilleries are forced to treat their spent wash. Most of the distilleries are using bio-methanation, where anaerobic digestion is used and the by-product methane is used as a fuel, thereby making the distillery self- sufficient to a large extent without depending on external sources for their energy requirements.

- Incineration systems are mandated when setting up new distilleries. However, the capital expenditure and operation cost of the incineration system is quite high- as high as the cost of setting up a distillery itself. As a result, these systems might be feasible only to large companies or groups.

3. ENERGY PERFORMANCE

3.1 Sector - level energy performance in recent years

The energy performance of distilleries has been improving over the years owing to adoption of latest technologies by new plants and up gradation carried out by old plants. However, in old plants where very few/no up gradations have been carried out, the energy numbers are quite high compared to the latest ones.

Considering the average SEC- electrical values over the years from 2009 to 2012, the energy consumption has been decreasing, varying between 2 to 6%. However, in some plants there has also been a slight increase in the energy consumption numbers. For comparison, the SEC values for some of the plants are given below.

Table 5: Energy performance of plants in terms of SEC- electrical[1]

	2009-10 (kWh/L)	2010-11 (kWh/L)	2011-12 (kWh/L)
Plant 1	0.20	0.18	0.16
Plant 2	0.27	0.27	0.32
Plant 3	0.33	0.31	0.26
Plant 4	0.39	0.31	0.31

There is a major variation in energy consumption across distilleries in India. An internal and national benchmarking, with latest technologies implemented by distilleries, can result in identification of opportunities that can, in turn, result in significant reduction in energy consumption.

3.2 International comparison

The Indian distillery industry is compared with USA and Brazil in this section. In the USA, ethanol produced with corn as raw material accounts for 97% of ethanol production[2]. The energy consumption values for a typical corn dry mill manufacturing ethanol in the USA are as given below.

Table 6: Energy consumption values of a typical corn mill plant in US[3]

Year	SEC- electrical in kWh/L	SEC- thermal in kCal/L
2001	0.29	2,380.95
2006	NA	2,054.89
2008	0.20	1,710.25

As per the latest data available (2008), the energy cost as a percentage of manufacturing cost accounts for about 2% in a Brazilian distillery[1] whereas the share of energy cost in an Indian distillery is about 7 % .

[1] Annual reports, questionnaire, CII data and plant visits
[2] Renewable Fuels Association. US
[3] 2013 Ethanol industry outlook, RFA, US

The energy consumption is higher in the Indian distilleries due to the inherent nature of the sector itself. Compared to India, Brazil has extended sugar season, high cane acreage and hence high quantity of molasses. Double- sulphitation process is used in India with 3-boiling system to manufacture sugar resulting in inferior quality of molasses. In Brazil, 2-boiling system is used and sugarcane juice is also used along with molasses. The distilleries in Brazil manufacture fuel ethanol from molasses directly, and there is no variety of product mix like in India. (For example, a 6- column multi-pressure distillation system in a molasses based distillery in India which has all the three end products - RS, ENA and fuel ethanol can be replaced with a 2- column system if it is used for the production of ethanol only, resulting in lower energy consumption).

The installed capacities are higher in USA and Brazil, which reduces the energy consumption per litre of alcohol produced. The typical distillery size in USA and Brazil is around 1,000 KLPD and 500 KLPD respectively, whereas, in India, it is around 30-45 KLPD. Moreover, in Brazil, spent wash is not treated for Zero Liquid Discharge (ZLD) like in India. The above factors contribute to the higher energy numbers in India compared to the global majors of USA and Brazil.

3.3 Technological movements

The energy consumption is lower in distilleries with continuous technology up gradation and adoption of energy efficient measures.

3.3.1 Alcohol production

The modern technologies in the manufacture of alcohol from sugarcane molasses include:

- Cascade continuous fermentation over batch fermentation
- Multi-pressure distillation over atmospheric distillation
- Ethanol manufacture adopting molecular sieve dehydration

3.3.2 Spent wash treatment

The distilleries need to comply with the norms of Zero Liquid Discharge as per the Pollution Control Boards (PCBs). The spent wash needs to be treated to comply with BIS standards and PCB norms. Though the operations carried out in a distillery are fairly uniform across the country, effluent volume and pollution load vary widely due to factors like condition of plant and machinery, mode of operation and water use.[2] The spent wash produced per litre of alcohol varies between 10-15 litres. The spent wash needs to be treated to reduce its Biological Oxygen Demand (BOD) and other pollution causing characteristics.

[1] USDA, Economic Research Service using data from IBGE (2010b)
[2] Indian standard guide for treatment of distillery effluents, BIS

Various methods are adopted by distilleries based on the economics and feasibility at their location which include:

- In grain based distilleries, the slops are passed through screens to remove the suspended matter, and then treated by pressing to increase the solid concentration to 30%. The liquor is concentrated in multi effect evaporators and the thick syrup obtained is mixed with pressed grain and dried in dryers. This can be used as cattle feed.

- Recovery of potash by concentration and incineration of spent wash.

- Spent wash after dilution with water was earlier used for irrigation in villages, which is now restricted by PCB.

- Anaerobic digestion/ anaerobic lagooning can also be used to treat distillery spent wash. Anaerobic digestion is said to remove 90% of the BOD and good amounts of methane is recovered as by-product.

- Conventional aerobic process such as trickling filters and activated sludge units can be adopted. Extended aeration can also be used.

Distilleries may adopt any one of the above practices to meet the BOD norms based on the composition of the spent wash. The treatment technologies for distillery spent wash in India include:

- Bio-methanation, followed by multi-effect evaporation, followed by drying/ incineration/co-processing/bio composting

- Bio-methanation, followed by reverse osmosis, followed by drying/ incineration/ co-processing/ bio composting

- Bio-methanation, followed by reverse osmosis, followed by multiple effect evaporation followed by drying/ incineration/ co-processing

- Concentration through reverse osmosis (RO)/ Multi effect evaporator (MEE) followed by drying/ incineration/ co-processing

- Bio composting with press mud after bio methanation in distilleries integrated with sugar mills. This is being sold as branded organic fertilizer by many mills.

- Integrated evaporation of spent wash, followed by concentration of spent wash in evaporator, followed by incineration.

Co-processing in cement kilns/furnaces of thermal power plants/ steel plants, though recommended, is not being carried out at present.

3.4 Capacity utilization

Capacity utilization of distilleries in India is estimated to be around 50-60%. The capacity utilization is low owing to the feed stock availability. During rainy season, when handling of effluent poses a problem, many plants are shut down.

The capacity utilization in some of the plants is given below[1]. The capacity utilization is not uniform across the country and depends on various factors. In the south of India, where the sugar season is extended compared to north and the quality of sugarcane and molasses is better, the capacity utilization is high.

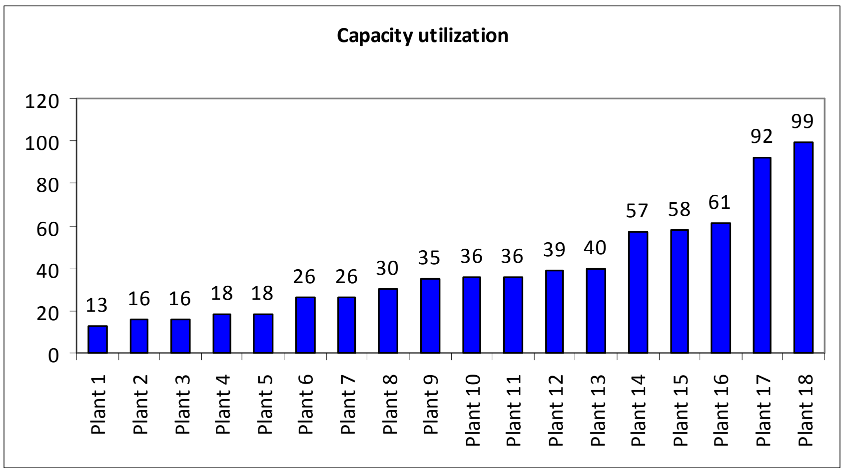

Figure 7: Capacity utilization in distilleries

The usage of alternate feedstock like grains, starchy tubers (potato) to produce alcohol is recommended to improve capacity utilization. Cassava chips are used in countries like Thailand. Waste potatoes are used in some countries for the production of fuel ethanol. Usage of sweet sorghum is being explored at present in India.

[1] AIDA data, February 2012 (these plants are different from the 11 plants considered for estimating the Specific Energy Consumption)

3.5 Major energy consuming areas

The energy and water requirements of a distillery plant include:

- Steam heating for distillation
- Power for pumping and cooling tower operation
- Evaporator in case of incineration systems
- Boiler & utilities
- Dryers in case of grain based distilleries
- Water for condensation
- Water for cooling the exothermic fermentation reaction

The typical process cycle includes:

- Transportation of corn or molasses (raw material)
- Storage of raw material
- Grinding of corn
- Hydrolysis by heating of corn meal with malt or acid to make mash
- Growth of inoculating cultures
- Fermentation
- Distillation
- Rectification/ purification
- Recovery of by-products: CO2, feed, potash salts
- Treatment of spent wash.

The major energy consuming areas in a distillery are pumps, distillation columns, evaporators and spent wash treatment systems.

3.6 Energy saving potential

The potential areas for energy saving in the major energy consuming areas- pumps, distillation and spent wash treatment systems are detailed in this report. The energy reduction potential is estimated at 10-15% and the plants have reduced energy consumption by 2-6% over the last three years.

In the distillery units, methane gas is available as a by-product in the digesters. The bio gas is used as a fuel in the boiler substituting commercial fuels like coal. This biogas can be purified and used in gas engines for generating power and steam as a byproduct. Back pressure steam turbines are used to meet the power and process steam requirements in some units.

The boilers are designed in such a way that they can operate on multi fuels. Along with coal, other agricultural by products like rice husk, cane agricultural waste are also used in the boilers.

4. ANALYSIS OF ENERGY CONSUMPTION DATA

4.1 Methodology

The methodology followed in this report for the estimation and analysis of energy consumption data is detailed below:

- Initial desk research was conducted and information was collected from various secondary sources like annual reports of companies, various technical reports, websites of Government Ministries, associations (AIDA, ISMA etc.) and other stakeholders.
- Distilleries were visited to understand the energy consumption, extent of technology adoption, the existing level of energy efficiency practices and constraints faces by them in taking up energy efficiency measures at their plants. A questionnaire was formulated & sent to select distilleries where visit was not feasible.
- Interactions and one-to-one meetings were done with associations (AIDA), research organizations (VSI), technology suppliers and experts.
- After the completion of initial draft, the report was circulated to select sector experts and stakeholders for their feedback and suggestions.
- Views, comments & suggestions from various stakeholders on energy trends, reduction opportunities, technology and policy barriers were gathered and deliberated upon during the two stakeholder consultation workshops organized as a part of this study and are incorporated in this report.

From the data collected, MTOE is estimated using the following conversion factors:

a) Electrical energy

Total electrical energy in kCal = Total electricity consumed in kWh * 860 kCal/kWh[1]

b) Thermal energy

- Thermal energy consumed in kCal= (Fuel 1 X Gross calorific value)+ (Fuel 2 X Gross calorific value) + …….
- If steam consumption is available, the thermal energy is estimated as:

Enthalpy in 1 kg of steam= 793 kCal/kg (Assuming that steam is generated at 45 ata and 450^{o}C) and

Thermal energy consumed in kCal= steam consumption in kg. *793

[1] 1 kilocalorie is equal to 4186.8 joules, and 1 joule/sec = 1 watt. So 1 kWh = 1000 x 3600 watt.secs = 3.6 x 10^{6} joules. => 1kWh=860kCal

c) Specific electrical energy consumed per annum

SEC = total electricity (kWh) / L

d) Specific thermal energy consumed

SEC = total thermal energy (kCal) / L

e) Total energy consumption for each plant (MTOE)

$$\text{Total energy consumption} = \frac{\text{Total electrical energy (kCal)} + \text{Total thermal energy (kCal)}}{10{,}000{,}000^{1}}$$

f) MTOE of the entire sector

The Metric tons of oil equivalent (MTOE) is a unit of energy: considered as 10,000,000 kCal.

The sources of data for estimation and analysis of energy consumption are:

- All India Distillers Association
- Questionnaires
- Plant visits
- Annual reports of about 20 companies
- CII data

Since the number of distilleries is around 400, the MTOE for the entire sector is estimated.

[1] 1 MTOE = 10000000 kCal

4.1.2 Estimation of Specific Energy Consumption (SEC)

The SEC values for some of the plants are indicated below[1].

	SEC- Electrical in kWh/l	SEC- Steam in kg/l
Plant 1	0.16	1.95
Plant 2	0.18	2.00
Plant 3	0.21	3.00
Plant 4	0.24	2.20
Plant 5	0.26	3.20
Plant 6	0.15	3.21
Plant 7	0.30	3.30
Plant 8	0.24	2.60
Plant 9	0.30	3.60
Plant 10	0.32	3.87
Plant 11	0.27	1.31

The SEC values vary widely in the distillery sector. The average SEC (electrical) for alcohol production is estimated to be around 0.27 kWh/L and the average thermal energy consumption is considered to be 2,220 kCal/L. This average is calculated after ignoring the extreme variations and calculating the average of the rest of the plants. Plants 1, 2 and 6 are excluded when calculating the average. This average number has been finalized after discussions with sector experts and plant managers during the stakeholder interactions.

The reasons for the variation of SEC can be attributed to different factors which are detailed below:

a) Type of fermentation system used: The energy consumption of continuous fermentation system is lower than that of a batch process.

b) No. of fermenters used in the process.

c) Quality of molasses: Higher the quality of molasses better is the alcohol recovery, and lower the spent wash generated per litre of alcohol resulting in lower energy consumption.

d) Effluent treatment system used: Energy consumption for an incineration system is higher than a bio-methanation system.

e) Distillation system used: Multi-pressure distillation system consumes less steam per litre of alcohol compared to atmospheric distillation but slightly higher power.

[1] Questionnaire, plant visits, CII data

f) Adoption of latest technologies like automation reduces the SEC values.

g) Type of end-product: RS consumes less amount of steam compared to ENA and fuel ethanol production.

4.2 Estimating plant wise energy consumption

There are around 400 distilleries in India. The average capacity in Indian distilleries is around 30-45 KLPD. There are a few major distilleries with 100 KLPD and above capacity.

The distilleries are divided into small, medium and large distilleries as follows:

- Large capacity: with 100 kLPD and above- 36 distilleries (approx.)
- Medium capacity: with 51- 100 kLPD- 60 distilleries (approx.)
- Low capacity: less than 50 kLPD- 304 distilleries (approx.)

With around 400 operating distilleries at a capacity ranging from 30 to 200 KLPD, a distillery with 50 KLPD capacity is considered to give an overview of a typical distillery.

Since energy consumption data for all the distilleries is not available in the public domain, and only a few distilleries responded to the questionnaire sent out to them, energy consumption for a typical 50 KLPD plant is estimated based on the following procedure:

- The average SEC values for electrical and thermal (steam consumption) are estimated based on plant visits, questionnaires, consultation with experts in the industry and the annual reports (based on the availability of data).

The energy consumption of a typical 50 KLPD is estimated below with the following assumptions (This may be used as a baseline plant for estimating energy consumption):

1. 860 kCal= 1 kWh
2. Effluent Treatment Plant (ETP) with bio-methanation exists in the distillery. The consumption of ETP for the above distillery plant is estimated assuming effluent concentration and incineration, considering the SEC values as 0.022 KWh/L of spentwash (electrical) and 198 kCal/L of spentwash (thermal).
3. The distillery operates for 200 days in a year.

Table 7: Annual energy consumption of a typical 50 KLPD plant (considering distillery consumption alone)

Capacity kL	Electric consumption kWh	Thermal consumption million kCal	MTOE	MTOE estimating 40% energy input is from renewable sources
10,000	2,710,000	22,200	2,453	1,565

The annual energy consumption of the Effluent Treatment Plant in a 50 KLPD distillery is as indicated in the table below.

Table 8: Annual energy consumption of the effluent treatment plant in a 50 KLPD distillery

Spent wash generated in kL	Electric consumption kWh	Thermal consumption million kCal	MTOE	MTOE estimating 40% energy input from renewable sources
100,000	2,200,000	19,800	2,169	1,377

The energy consumption of ETP is almost equal to the energy consumption of the distillery unit. Hence efforts must be directed to reduce the spent wash generated per litre of alcohol produced to reduce the overall energy consumption of the plant.

The total energy consumption of the distillery plant together with ETP is as follows:

Table 9: Total energy consumption of a 50 KLPD distillery

Capacity	Electric consumption kWh	Thermal consumption million kCal	MTOE	MTOE estimating 40% energy input from renewable sources
10,000	4.91 million	42,000	4,622	~3000

4.3 Sector - level energy consumption in terms of MTOE

The SEC values of 0.27 kWh/L and 2,220 kCal/L are considered for estimating the total MTOE of the sector. The sector's MTOE is estimated by multiplying the production of alcohol (which was 2,130 million litres in 2011-12) and the specific energy consumption per litre.

Total sector's energy consumption= SEC in MTOE/L * Annual production of alcohol in litres[1]

Table 10: Sector - level energy consumption calculation

	Production in kL in 2012	Average SEC-kWh/L of alcohol	Process steam kg/L of alcohol	Electricity consumption kWh	Thermal consumption kCal/L of alcohol	MTOE	SEC-MTOE /kL of alcohol
Indian distillery industry	2,130,000	0.27	2.8	577,230,000	2,220	522,671	
ETP (10 litres spent wash/ litre of alcohol)		0.22	2.5	468,600,000	1,980	462,039	
Total consumption including ETP	2,130,000	0.49	5.3	1,045,830,000	4,200	985,243	**0.46**
Assuming 40% generation is from renewables and 60% is from fossil fuels	2,130,000	0.49	5.3	1,045,830,000	2,522	627,123	**0.30**

The MTOE of distillery industry in India is estimated to be around 0.99 million MTOE.

The significant portion of energy input in most of the distilleries is either bagasse/ bio-fuel. In the first cycle of PAT, energy consumption from renewable sources is not included in estimating the MTOE. If the same procedure is followed here, on an[2] average 40% of the energy input in distilleries is from these renewable energy sources, the MTOE of the distillery sector is estimated to be around 0.63 million MTOE.

The MTOE of the distillery sector excluding energy consumption from renewable sources is 0.63 million MTOE

[1] 2130 million litres in 2011-12, source: Annual report 2011-12, Dhampur sugar mills
[2] Expert and stakeholder interactions

4.4 Plant versus energy consumption

The SEC values for distillery consumption of the plants considered (excluding ETP) are plotted below.

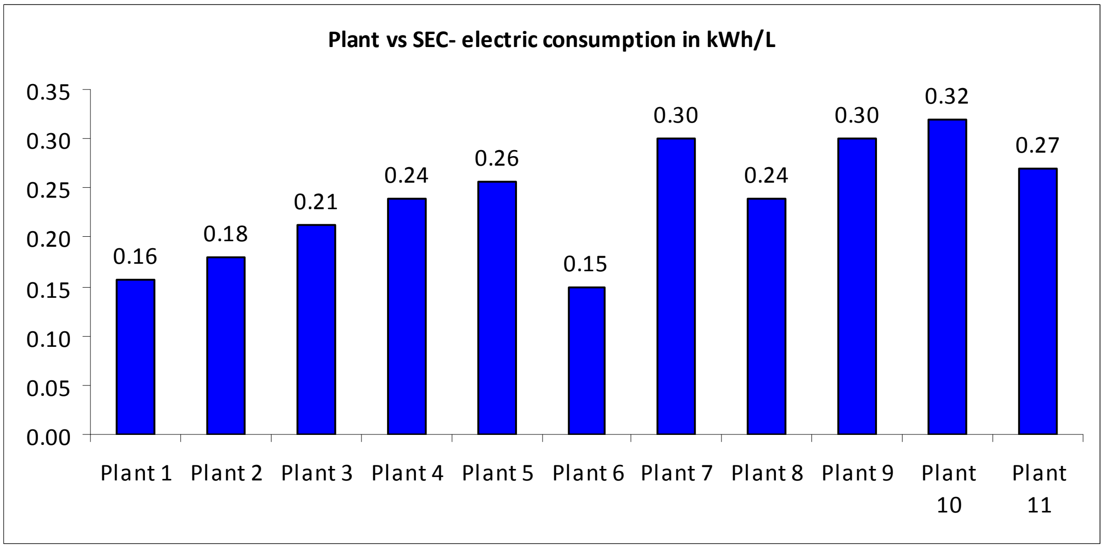

Figure 8: Plant vs SEC in kWh/L

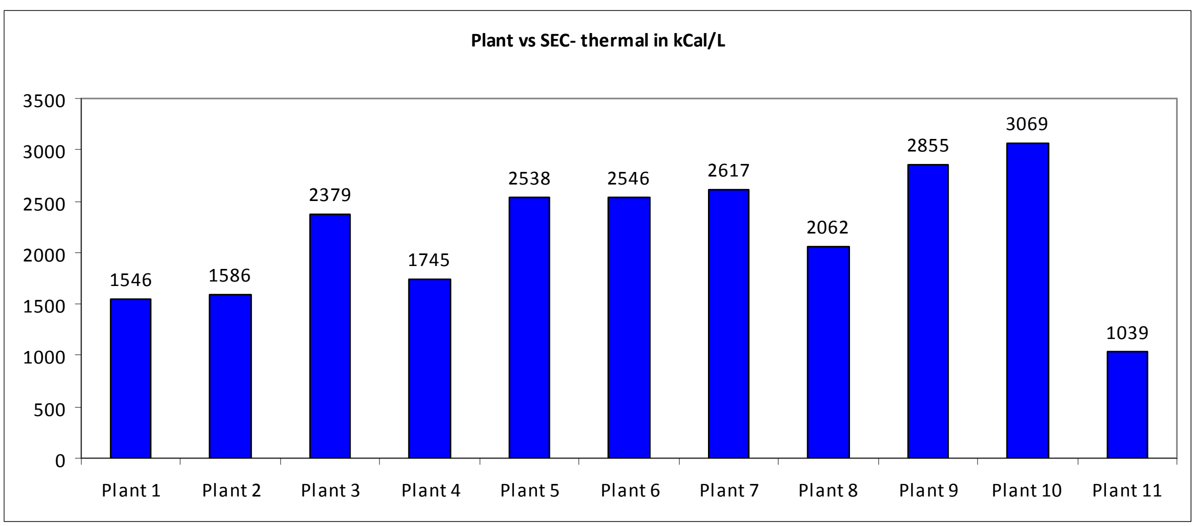

Figure 9: Plant vs SEC in kCal/L

4.5 Possible energy efficiency measures for key process/equipment

The major energy consumers and hence potential areas for possible energy efficiency improvement opportunities are detailed below. The measures to be taken to ensure high production per MT of molasses used are also elaborated.

4.5.1 Distillation systems

a) Multi- pressure distillation systems are energy efficient compared to the atmospheric distillation systems. Almost 50% of distilleries are operating with atmospheric distillation systems. The specific steam consumption is 3.2 kg/l of ENA and 2-2.5 kg/l of RS in a multi- pressure distillation system. This is comparatively high at 4.2-5.5 kg/l of ENA and 2.5- 3 kg/l of RS when atmospheric distillation is employed. Hence adapting multi-pressure system will offer significant benefits.

b) Employing molecular sieve de-hydration to distill fuel ethanol.

4.5.2 Treatment of spent wash

Since the energy consumption for effluent treatment is quite high, there is a need to reduce the amount of spent wash generated per litre of alcohol. Innovative treatment of spent wash also offers advantages like co-generation and reduction in overall water consumption.

a) The bio-gas generated in the anaerobic digesters after purification and de-humidification can be used to generate power. 10000 m^3 of bio-gas can produce 1 MW of power and 1.5 tons of steam.

b) Using integrated evaporative spent wash systems can reduce the spent wash generated from 10 litres per litre of alcohol produced to 5.5 litres. This spent wash which is at a concentration of 22-24 brix can be further concentrated to 60 brix in a stand-alone evaporator and then incinerated. Some of the distilleries also depicted successful operation of these systems where surplus power and steam is generated and exported to grid and sugar plants respectively. About 10% or less of distilleries have this system installed at present. The raw spent wash has high calorific value compared to the concentrated spent wash after bio-methanation. However, the short life span, high capital and operational costs, heavy corrosion are some of the challenges faced with incineration boilers.

c) The spent wash can be used to pre-heat the fermented wash before sending it to distillation columns for better waste heat recovery.

d) The recycled water obtained from reverse osmosis after bio-methanation can be used to meet process requirements.

4.5.3 Molasses handling for better recovery

The quality of molasses plays a major role in the amount of alcohol produced. The quality varies widely with various factors affecting it like: the amount of re-circulation done during sugar processing, the quality of juice and clarification done and the storage conditions of the molasses.

Alcohol recovery from molasses can be improved by:

a) Cooling the molasses to around 40°C immediately after its production to prevent loss of sugar

b) Ensuring adequate cooling during storage

4.5.4 Fermentation systems

Increasing alcohol concentration in the fermenters by using improved varieties of yeast will reduce the spent wash generated and the steam consumption.

4.5.5 Pumps

Pumps are the major electric power consumers in a distillery unit. The various energy conservation opportunities include:

a) Installation of VFD for pumps- Most of the distilleries do not have VFDs installed at present for pumps. This offers a significant energy reduction potential of at least 7% of the electrical energy consumed in the existing distilleries. To reduce the impact of harmonics generated in the system by VFD installation, harmonic filters need to be employed along with VFDs

b) The other energy conservation opportunities in pumps and cooling towers include installation of lower size impeller if pump is over capacity, installation of correct size high efficiency pump and avoiding design of pumps with excessive head, optimization of temperature difference across heat exchangers, interlocking the cooling tower fan operation with return water temperature, optimization of range and approach, optimizing cooling water flow, cold well temperature and the operation of cooling tower fans.

4.5.6 Boilers & Utilities

The energy saving measures that can be adopted in boilers and utilities include adapting better operational practices like excess air optimization, blow down control & automation, improving insulation in the pipelines and boiler, recovering heat from flue gas to economizers and air-pre heaters and replacing obsolete burners by new optimized boilers

4.5.7 Heat & steam distribution

Thermal energy accounts for a major share of the energy consumption in a distillery. The energy saving measures that can be implemented to optimize the thermal energy consumption include designing the distillery on a steam pressure of 1.5 Kg/cm^2 (g) instead of at 3.5-4 kg/cm^2, improved automation for further reduction in steam requirement by using online density measurements which now have an accuracy of +/- 0.1%, improving and maintaining insulation, recovering flash steam and condensate.

4.6 Recommendations

The recommendations to improve energy efficiency in the sector have been included after a wide stakeholder consultation. The consultation was done through workshops and one-to-one interactions with sector experts, distillery units, industry association, research institutes and technology suppliers.

Apart from energy efficiency, the recommendations also includes other points of discussion in the industry which includes usage of alternate feedstock, financial and policy constraints by the sector as opined by the stakeholders.

4.6.1 Data collection and benchmarking

In terms of energy consumption, when compared to industries like steel, cement and chemicals, distillery industry is not an intensive consumer of energy. It is estimated that on an average, 10-15% of energy can be saved in distillery plants. With the tremendous potential of energy generation available from distillery by-products, the industry is beginning to assume importance.

During the various stakeholder consultations done by CII and at the stakeholder workshops during this project, it was agreed that there should be a common platform where plants can furnish the energy data or share the same in the public domain to help each other improve.

As distilleries are regulated by the state governments, there is no data available at central level, for easy comparison across the country. Since distilleries are a part of sugar industry, many companies don't furnish the data for distilleries separately in their annual reports. Once these details are available, these can be used to estimate the present level on energy consumption in distilleries more accurately, explore the potential to reduce the same in future and formulate India specific standards.

The industry association can support BEE by collecting the data in the following format and widely circulating it across its members to enable energy benchmarking.

Table 11: Suggested data collection format for benchmarking energy consumption

Name of the Plant	Location	SEC-electrical in kWh/kl or kWh/l	SEC-thermal in kCal/l or Steam in kg/l	Type of ETP	Spent wash generated per litre of alcohol	SEC-in kWh/l of spent wash	SEC-steam in kg/l of spent wash	Type of distillation system used

The other recommendations include:

4.6.2 Awareness and capacity building campaign in distilleries

Creating a platform for continuous interaction of suppliers and plants will drive plants towards adopting new energy efficient technology.

a) There is a wide variation in the sector in terms of energy consumption. Awareness and capacity building programs need to be taken up for increasing knowledge dissemination.

b) Energy efficient technologies are available in the market but the investment required is high for small players. Most large scale plants have already adopted the latest technology. These large players may support missions to their plants to demonstrate the working of the equipment and the savings achieved at their plant. This will help smaller players to have a clear picture of the technology and the savings and will drive them to implement these measures at their plant. Missions to best performing distilleries in particular technologies like incineration, co-generation, bio-methanation, and continuous fermentation need to be taken up.

c) Benchmarking and improvement should be done on a continuous basis and distilleries should be helped to achieve this.

d) Sharing of best practices needs to be facilitated to help distilleries continuously improve. This can be done by releasing best practice manuals.

e) An award for best performing distilleries will definitely encourage the distilleries to pursue energy efficiency.

4.6.3 Create an Energy Efficiency/ Cogeneration mission in distilleries

a) A mission can be initiated in distilleries similar to bagasse based co-gen mission in sugar plants in 1990s[1] or Fly Ash mission under TIFAC, Department of Science & Technology.

b) Apart from this several activities can be initiated under the theme of “world class energy efficiency in Indian distilleries” like awareness building programs, technology support and creation of funds to facilitate the Indian distillery industry become world-class.

c) Industry Associations and Ministry of New & Renewable Energy can work together to explore the complete co-generation potential available in distillery sector.

4.6.4 Demonstration of technologies/ best practices in a plant and sharing information

Specific technologies can be installed/ identified in a particular plant and this can be made a model plant which will help in demonstrating all the best practices at one place. This will also help in estimating the best standards possible in Indian distillery industry.

4.6.5 Creation of a fund for distillery energy efficiency improvement/ ETP

a) A fund can be created similar to the technology up gradation fund in textile sector for distillery energy efficiency improvement/helping distilleries in installing incineration systems etc. particularly in the context that the sector can contribute to energy security of the nation. This would push the sector towards implementing energy efficiency measures. This could be done with the support of central / state government or with support from organizations like the World Bank, IFC etc., or with support from banks and other financials institutions.

b) The option of considering power generation from spent wash treatment under the Clean Technology Fund[2] can help small players to set up expensive systems like incineration and reap the benefits.

---

[1] MNRE offered loans and subsidies for sugar mills going for bagasse based co-generation

[2] One of the Climate Investment Funds (CIF), the USD 5.2 billion Clean Technology Fund (CTF) provides middle income countries with resources to explore options to scale up the demonstration, deployment, and transfer of low-carbon, clean technologies. The CTF is channeled through the multilateral development banks (MDBs), and financing focuses on large-scale, country-initiated projects in renewable energy, sustainable transport and energy efficiency. https://www.climateinvestmentfunds.org/cif/Clean_Technology_Fund

4.6.6 Special policy schemes/ environment funds

Policies to encourage distilleries to take up energy saving measures are not in place. Incentives can be given for improving energy efficiency or ETP performance in a plant year-on-year. As four states account for the major alcohol production, state funds can be set up in each of these states for the distillery sector.

4.6.7 Ferti-irrigation

The possibility of exploring spent-wash application for ferti-irrigation can be explored. NEERI had done an analysis of the impact of ferti-irrigation in the fields around distillery. Based on the recommendations from it and CPCB, the same can be further explored. This reduces the energy required for treatment of spent wash, but at the same time might increase water consumption and also the possibility of co-generation goes untapped.

5. APPLICABILITY OF EXTENDING THIS SECTOR INTO PAT SCHEME

5.1 MTOE threshold and Challenges

In the PAT cycle 1 the lowest threshold limit for a plant to be mandated as a designated consumer was 3,000 MTOE for textile sector. This was the lowest threshold limit among the 8 sectors included in the PAT cycle 1.

In PAT cycle 1, the MTOE is estimated based on the energy input to the plant from fossil fuels like coal, furnace oil and their calorific value. In most of the distilleries, the fuel used is either bagasse/ bio-fuels to a large extent. The share of these non-conventional energy sources is as high as 100% in certain plants to around 40% in small plants.

For a 50 KLPD distillery, the MTOE is estimated to be approximately 4,622. Assuming that 40% of the energy requirement is met through non-conventional sources, the MTOE is around 3,000.

There are approximately 96 distilleries in India with capacity above 50 kLPD. If 3,000 is considered as the baseline MTOE, 96 distillery plants are above this threshold level.

5.2 Potential saving in case extended to PAT scheme

Based on CII's experience and stakeholder consultation in the distillery sector, we believe that plants in the distillery sector have energy savings potential of about 10-15% by implementing energy efficiency measures mentioned in this report.

The potential energy saving from the distillery sector assuming a 5% reduction potential over a three year period is about 0.019 million MTOE.

Table 12: Potential energy saving

No. of distilleries above 50 kLPD	Energy consumption in MTOE	% contribution to sector's energy consumption	Estimated reduction at 5% over a three year period
96	397,440	40	19,872

The potential energy saving from the distillery sector, in case extended to PAT scheme is (assuming a 5% reduction over a three year period) is about 0.019 million MTOE.

6. CONCLUSION

The demand for ethanol in India is expected to increase significantly in the future owing to the huge expected demand from the three sectors: chemical industry, alcoholic beverage industry and fuel usage[1]. The demand for ethanol is expected to touch 9.2 billion litres by 2017, as per Planning Commission estimates. This demand will be mainly driven by the ethanol blending policy of the Government of India. This huge demand can be met if proper measures are taken by the industry and the government to improve the present capacity utilization and by augmenting the installed capacity.

The distillery sector offers a huge co-generation potential of 1500 MW. The spent wash from the distilleries is treated using bio-methanation/incineration and can be used to generate power to export it to the grid. This sector hence also plays a major role in contributing to the energy security of the nation.

Thermal energy contributes to around 90% of the distillery energy consumption in terms of MTOE. By implementing the energy saving measures detailed in this report, a potential energy saving of 10-15% is possible in the sector.

The sector's energy consumption is at 0.99 million MTOE and the energy consumption of a typical 50 kLPD facility is 4,622 MTOE.

Considering the energy input from renewable sources like bagasse, bio-fuel to contribute to 40% of the energy requirement:

- **The MTOE of the sector is 0.63 million MTOE.**
- **The energy consumption of a 50 kLPD facility is ~3,000 MTOE.**

If considered under the second cycle of PAT, 96 distilleries are above the threshold level of 3,000 MTOE. The energy reduction potential, considering a 5% reduction over a three year period is estimated to be 0.019 million MTOE.

There is a huge energy reduction potential of 10-15% possible in the sector with implementation of latest technologies like multi-pressure distillation, continuous fermentation etc. The energy reduction is quite low at present and the plants have reduced energy consumption by around 2-6% over the last three years.

The recommendations and various measures that need to be taken to further facilitate the sector in improving its energy efficiency include: awareness and capacity building campaign in distilleries, creating a energy efficiency mission in distilleries, demonstration of specific technologies and best practices in a model plant, creation of a fund for distillery energy efficiency improvement, setting up of special policy schemes and state environment funds.

[1] Ethanol blending program of Government of India mandates blending of 5% ethanol with petrol at present and about 20% ethanol by 2017.

7. REFERENCES/BIBLIOGRAPHY

1. Planning commission, working group report on chemical industry
2. Workshop on distillery effluent treatment and water conservation, 2011, AIDA and CPCB.
3. Renewable Fuels Association
4. Ministry of Economy, Trade & Industry, Government of Japan
5. Organization for Economic Co-operation and Development, OECD
6. OECD- FAO agricultural outlook 2011-2020
7. Vasantdada Sugar Institute
8. AIDA newsletters
9. Indian Sugar Mills Association
10. Ministry of Consumer Affairs, Food & Public Distribution
11. 2013 Ethanol industry outlook, Renewable Fuel Association, US
12. Indian standard guide for treatment of distillery effluents, BIS

8. ANNEXURE: MANUFACTURING PROCESS IN DISTILLERIES[1]

The distilleries in India are molasses based and grain based. Grain based distilleries mostly manufacture potable alcohol.

Different types of liquor are manufactured from ENA by blending suitable colours, flavors, additives, etc.

1. Distilleries based on cereals

Malt is the starting material in the distilleries based on cereals.

Yeast propagation is done separately in the medium of malt mash of about 15% solids content and, added to the prepared wort in fermenters. The alcohol concentration rises to 6.5 - 8.5% by volume. The fermented wash is then sent to distillation columns.

Sequentially, cereal-based distilleries involve the following major process steps.

- Milling - Reduction of particle size prior to hydration
- Cooking - Hydration and gelatinization of starch
- Conversion - Enzymatic hydrolysis of starch
- Fermentation - Production of ethyl alcohol
- Distillation - Product recovery

2. Distilleries based on molasses

Molasses, a by-product of sugar industry is used as raw material by most of the distilleries for production of alcohol by fermentation and distillation processes. The molasses contains about 40-50% sugar, which is diluted to bring sugar contents to 10-15% for further fermentation process.

The pH is adjusted by addition of sulphuric acid.

Yeast culture is done in the laboratory and propagated in a series of fermenters. The diluted molasses is inoculated with about 10% by volume of yeast inoculum.

In the fermenters the reducible sugars are broken down to ethyl alcohol and carbon dioxide (CO_2). The reaction is exothermic and cooling water is sprayed on the fermenter walls to maintain the temperature at 29 - 32°C.

[1] Source: Technical EIA guidance manual for distilleries, Ministry of Environment and Forests, Government of India.

Sludge is produced and discharged from the bottom, while the clear fermented beer from the top is sent to the degasifying section of the analyzer column after the heat exchange with the spent wash to preheat it to about 90°C.

In the analyzer which is a bubble-Cap fractionating column, the beer is heated by live steam and fractionated to give a 40% alcohol stream from the top.

This stream is further fractionated in the rectifier column to obtain rectified spirit. Part of the rectified spirit is sent back to the column, and the condensed water from this stage, known as 'spent lees' is usually pumped back to the analyzer column. The bottom discharge from the analyzer column is known as the spent wash, which is drained off after heat exchange with the incoming beer from the fermenters.

The plant practices are practically uniform throughout the country.

Shakti Sustainable Energy Foundation

Shakti Sustainable Energy Foundation works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage energy efficiency as well as renewable energy. Based on both energy savings and carbon mitigation potential, it focuses on four broad sectors: Power, Transport, Energy Efficiency and Climate Policy. Shakti acts as a systems integrator, bringing together key stakeholders including government, civil society and business in strategic ways, to enable clean energy policies in these sectors.

Shakti is part of an association of technical and policy experts called the ClimateWorks Network. For more information, please visit http://www.shaktifoundation.in

Confederation of Indian Industry (CII)

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes. CII is a non-government, not-for-profit, industry led and industry managed organization, playing a proactive role in India's development process. Founded over 116 years ago, it is India's premier business association, with a direct membership of over 8,100 organizations from the private as well as public sectors, including Small and Medium Enterprises (SMEs) and multinationals, and an indirect membership of over 90,000 companies from around 400 national and regional sectoral associations. For more information, please visit www.cii.in

CII - Sohrabji Godrej Green Business Centre (CII - Godrej GBC), a division of CII is India's premier developmental institution, offering advisory services to the industry on environmental aspects and works in the areas of green buildings, energy efficiency, water management, environment management, renewable energy, green business incubation and climate change activities.
For more information, please visit www.greenbusinesscentre.com