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Final Report

Widening the coverage of PAT Scheme

Sectoral Manual - Sugar Sector

Prepared for

Shakti Sustainable Energy Foundation

The Energy and Resources Institute

...towards global sustainable development

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Disclaimer

This report is part of Shakti Sustainable Energy Foundation (SSEF) and The Energy and Resources Institute's (TERI) attempt to study the sugar sector energy consumption trends and energy efficiency improvement opportunities in the sugar sector in India. The views expressed in this document do not necessarily reflect the view of Shakti Sustainable Energy Foundation. The organization 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, TERI and Shakti Sustainable Energy Foundation accepts 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 report.

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The Energy and Resources Institute (TERI)

Preface

The industrial sector represents more than one third of both global primary energy use and energy-related carbon dioxide emissions. In developing countries, the energy supply consumed by the industrial sector is frequently in excess of 50% and so can create tensions between economic development goals and a constrained energy supply. Particularly, countries like India, with an emerging and rapidly expanding industrial infrastructure, have an opportunity to increase their competitiveness by applying energy-efficient best practices from the outset in its new industrial facilities.

Despite the potential, policymakers frequently overlook the opportunities presented by industrial energy efficiency to make a significant impact on climate change mitigation, energy security and sustainability. The common perception is that achieving energy efficiency of the industrial sector is too complex to be addressed through public policy and, further, that industrial facilities will achieve energy efficiency directly through competitive pressures in the marketplace. One such initiative under the National Mission on Enhanced Energy Efficiency (NMEEE) is the Perform Achieve and Trade (PAT) scheme. This is a market based mechanism having the objective to enhance energy efficiency (target based) in India with an option to trade the additional energy savings in the form of energy saving certificates.

In the first phase eight industrial subsectors were covered under the PAT scheme. There are further plans to widen the coverage by adding new industrial subsectors based on the energy consumption levels. Shakti Sustainable Energy Foundation (SSEF) and The Energy and Resources Institute (TERI) intend to assist the Bureau of Energy Efficiency (BEE) in expanding the PAT scheme to new sectors in subsequent phases.

As a part of this exercise, the India country profile of a few selected subsectors along with their energy intensity has been established. It was done after interactions with relevant industrial associations / industry heads and compiling data from secondary sources. For this report on the Sugar sector inputs were received from the Indian Sugar Mills Association (ISMA), National Federation of Cooperative Sugar Factories Ltd (NFCSC) and The Sugar Technologists' Association of India (STAI). Statistics about sugar mills, crushing capacities, annual country-wide crushing and average operational day details were collected from the Sugar India Yearbook 12. Secondary data available in other public sources were also reviewed while preparing this report.

We believe that this sector manual will act as a guide for next steps and establish a need to study the energy consumption thoroughly to set the threshold limit for eligibility for designated consumers.

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Abbreviations

AC	-	Alternating Current
AIDA	-	All India Distillers Association
ARTI	-	Appropriate Rural Technology Institute
BEE	-	Bureau of Energy Efficiency
BIS	-	Bureau of Indian Standards
BOOT	-	Build, Own, Operate, Transfer
CACP	-	Commission for Agricultural Costs & Prices
CMIE	-	Centre for Monitoring Indian Economy Pvt. Ltd.
DC	-	Direct Current
DCs	-	Designated Consumers
DEVC	-	Double Effect Vapour Cell
DM	-	De-Mineralised
DSCL	-	DCM Shriram Consolidated Limited
ESCerts	-	Energy Saving Certificates
EU	-	European Union
FD	-	Forced Draft
FRP	-	Fair & Remunerative Price
GCV	-	Gross Calorific Value
GDP	-	Gross Domestic Product
GHG	-	Green House Gas
GoI	-	Government of India
HP	-	High Pressure
ICUMSA		International Commission for Uniform Methods of Sugar Analysis
ID	-	Induced Draft
IREDA	-	Indian Renewable Energy Development Agency
ISEC	-	Indian Sugar Exim Corporation Ltd
ISMA	-	Indian Sugar Mills Association
kCal	-	Kilo Calories
kW	-	Kilo Watt
kWh	-	Kilo Watt Hour
LP	-	Low Pressure
MSP	-	Minimum Support Price
mTOE	-	Million Tonnes of Oil Equivalent
MW	-	Mega Watt
NAPCC	-	National Action Plan on Climate Change
NCDEX	-	National Commodity and Derivatives Exchange
NCG	-	Non Condensable Gases
NFCSF	-	National Federation of Co-operative Sugar Factories Ltd
NMEEE	-	National Mission on Enhanced Energy Efficiency
NPC	-	National productive Council
P.A	-	Per Annum
PA	-	Primary Air

PAT	-	Perform, Achieve and Trade
PCRA	-	Petroleum Conservation Research Association
PDS	-	Public Distribution System
RSCL	-	Rajshree Sugars & Chemicals Ltd
SA	-	Secondary Air
SAP	-	State Advised Price
SEC	-	Specific Energy Consumption
SPM	-	Suspended Particulate Matter
SSEF	-	Shakti Sustainable Energy Foundation
STAI	-	The Sugar Technologists Association of India
TCD	-	Tonnes of Crushing per Day
TCH	-	Tonnes of Crushing per Hour
TERI	-	The Energy and Resources Institute
TOE	-	Tonnes of Oil Equivalent
TPD	-	Tonne per Day
TPH	-	Tonnes Per Hour
VSD	-	Variable Speed Drive
WTO	-	World Trade Organisation

Executive Summary

The Ministry of Power and Bureau of Energy Efficiency (BEE) are entrusted with the implementation of the National Mission on Enhanced Energy Efficiency (NMEEE) under the National Action Plan on Climate Change (NAPCC). One of the key components of the mission is Perform, Achieve and Trade (PAT) mechanism. This is a market based mechanism to improve the energy efficiency in large energy intensive industries and facilities cost-effectively by certifying energy savings that could be traded. The PAT mechanism is designed to facilitate the Designated Consumers (DCs) to achieve their legal obligations under the Energy Conservation Act (EC Act) of 2001, which was amended in 2010.

The ensuing PAT scheme applies to 8 industrial sub-sectors, which are Power Plant, Aluminium, Pulp & Paper, Chlor- Alkali, Cement, Iron & Steel, Textile and Fertilizer. During the first phase of the PAT cycle (3 years starting from 1st April 2012), as per the recent notification, 478 designated consumers (DCs) have been identified. They are obliged to reduce their energy consumption by a specific target set by the BEE. The expected energy savings from this scheme is about 6-8 million tonnes of oil equivalent (mMtoe) in this period. The over achievers will earn tradable Energy Saving (ESCerts) whereas the under achievers will be liable to comply through purchase of ESCerts or by paying penalty.

The BEE plans to widen the coverage of the PAT scheme in phases by adding new industrial subsectors depending on the energy consumption. However, there is a need to study the energy consumption in detail for the new industrial segments to establish the threshold limit for the eligibility for DCs. Shakti Sustainable Energy Foundation (Shakti or SSEF) operates as a partner institution of the Climate Works Foundation, and has been focusing its efforts on clean and secured energy future for all in India. SSEF in consultation with TERI is assisting the BEE in widening the net of the PAT scheme by adding new subsectors in subsequent phases of the PAT scheme. The four subsectors identified by SSEF to study the energy consumption in detail so as to establish the threshold limit for the eligibility as DCs are

- Copper & zinc
- Glass & ceramics
- Sugar
- Vegetable oil refineries

The initial task has been to map the identified four sub sectors in the Indian context and prepare a broad sectorial report. This subsector overview report on Sugar Industry covers information on large and medium manufacturers, number of plants existing, production capacity, technology types and technological development in the last decade, capacity utilization, energy efficiency levels, estimated energy saving potential, GHG inventory, mitigation potential and barriers to implement energy efficiency measures, and regulatory and policy issues having a bearing on improving the efficiency in the sector.

The purpose of the sectorial report is mainly to understand the energy intensity of the subsector, technology adopted and its energy efficiency levels. It also assesses the potential for reduction in energy consumption across the subsector and the gaps in technology. It

provides an overall energy scenario about the subsector to all the stakeholders. This overview report is prepared based on secondary information available in the public domain. Information and data were also collected by interacting with industrial associations and industrial experts in this subsector.

The sugar industry is one of the largest energy users among industry sector using bagasse for meeting both thermal energy and electricity requirements. Out of the 527 operating sugar mills in India, about 99 sugar mills have installed capacities of 5000 TCD and above. These sugar mills can be brought under two broad categories viz. (1) sugar mills with steam driven mills and (2) sugar mills with electrical motor driven mills. Hence the sugar mills above 5000TCD capacity may be taken up for detailed study in the upcoming phase. The estimated annual energy consumption of these sugar mills vary between 45,000 toe per year to 90,000 toe per year. A large number of these sugar mills have adopted cogeneration route to meet their overall energy requirements. As per the collected information and discussions with stakeholders during the sectoral workshop, there exists a significant energy saving potential of about 20% in sugar industries. Therefore it is suggested that these 99 large sugar mills (which operate either separately or as a group) may be considered as DCs under the PAT scheme with a threshold limit of 30,000 toe as the minimum annual energy consumption per mill.

1.0 Introduction

1.1 Sector Importance

The sugar industry is a sector of significant importance to the national economy. While sugar consumption has been growing over the years, the production has been cyclical. Currently, the sugar industry is regulated across the value chain from production to end consumer. Investments to generate by-products are at a nascent stage, and the sector has struggled to generate a return on invested capital in excess of its cost of capital in most years, primarily due to a high mandated fixed cane price and a volatile sugar price.

Sugarcane is primarily grown in nine Indian states: Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Uttar Pradesh and Tamil Nadu. More than 50 million farmers and their families are dependent on sugarcane produce for their livelihood. The sugar industry caters to an estimated 12% of rural population in these nine states through direct and indirect employment. Effectively, each farmer contributes to the production of 2.9 metric tonnes of sugar every year.

The sugar industry is a green industry and is largely self-sufficient in energy needs through use of bagasse for generating electricity and steam. In fact, the sugar industry generates surplus exportable energy through cogeneration and contributes in reducing the energy deficit that India is currently facing. The sugar industry is also the primary source of raw material for the alcohol industry in India. The annual economic contribution of the sugar industry to the exchequer through indirect taxes amounts to more than INR 2800 Crores.

The sugarcane price accounts for approximately 70% of the ex-mill sugar price. However, fundamental changes in the consumer profile and the demonstrated ability of the sector to continuously ensure availability of sugar for domestic consumption has diluted the need for sugar to be considered as an essential commodity. According to a recently conducted nation-wide survey, nearly 75% of the total non-levy sugar is consumed by industrial, small business and high income household segments.

1.2 Prevailing National / International Scenario

Sugar is produced in 115 countries across the world. It is extracted from different raw materials such as sugarcane and sugar beet. Sugarcane is cultivated in tropical climate, while sugar beet is grown in temperate regions. Of the 115 sugar producing countries, 67 produce sugar from cane, 39 from beet and 9 from both cane and beet. Brazil, India, Thailand, Australia and Cuba are the largest sugarcane producers. The beet sugar producing countries include the US, Turkey, Ukraine, Poland and Russia.

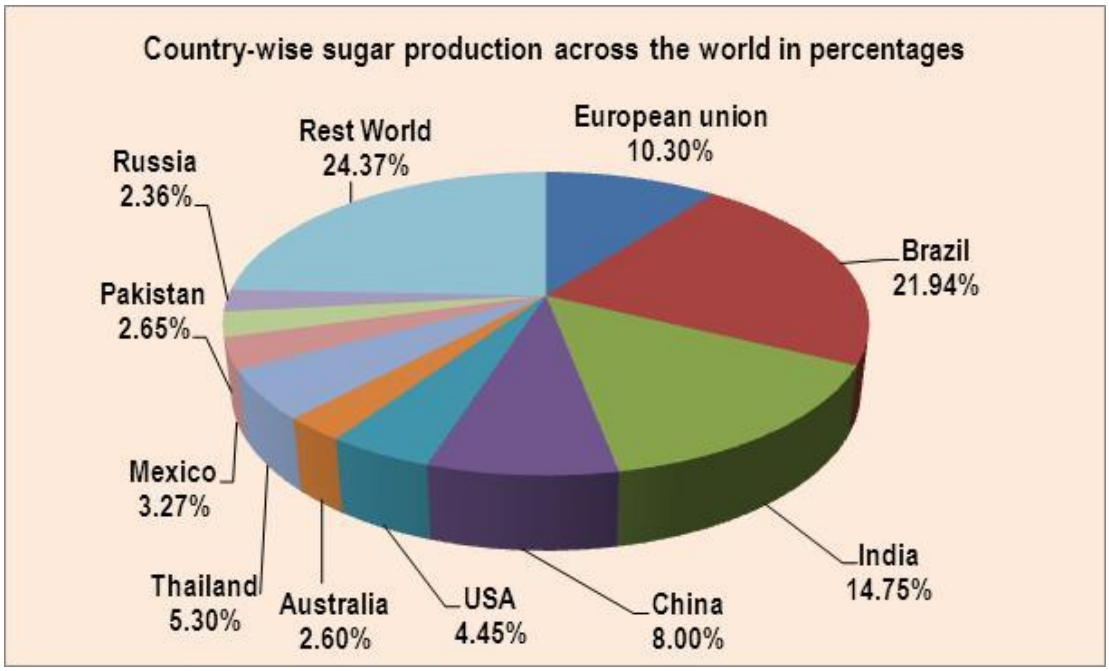
The Indian sugar industry also has a significant standing in the global sugar space. Like in Brazil and Thailand, the sugar sector is highly regulated in India too. Since 1993, the regulatory environment has considerably eased, but sugar still continues to be listed as an essential commodity under the Essential Commodity Act. There are regulations across the entire value chain, which includes land demarcation, sugarcane price, sugarcane procurement, sugar production and sale of sugar by mills in domestic and international markets.

India's sugar sector competes with Brazil's as the largest in the world, and is the second largest agriculture-based industry in India, after textiles. A majority of its production is destined for domestic markets. The number of sugar factories in operation in India during the crushing season 2010-11 was 527 and the total sugar production was 24.39 million tonnes. Based on cane crushing, mill size ranges from 1250 to more than 10,000 Tonnes Crushed per Day (TCD). The average crushing capacity of the sugar mills in India is 3,650 TCD.

Approximately 40% of India's sugar sector is owned and run by farmers through co-operatives, a situation that is unique to the country, while private sugar mills in India are the second largest producers. The co-operative system generally suffers from poor coordination and is therefore less efficient than the plantation system most common in other sugar producing countries such as Brazil.

1.3 International standing of the subsector

India is the largest consumer and second largest producer of sugar in the world only next to Brazil. India accounted for about 14.75% of the total world sugar production during 2011 - 12. The country-wise sugar production across the world during 2011-12 is represented in Figure 1.3.



Source: http://www.vsisugar.com/india/statistics/international_sugar.htm

Figure 1.3: Country-wise sugar production across the world in percentages

1.4 Current/ Future Market Scenario

The 10 largest sugar producing nations represent roughly 78% of the world sugar production. Brazil accounts for almost 22% of the world production and its share is increasing, although the country's output has witnessed some setback since the 2008-2009 crisis. There was considerable expansion in sugar production till 1980, when world sugar consumption reached nearly 90 million tonnes, i.e. an annual growth rate of 3.1%. Since

early 2000 sugar consumption has grown at a good rate, notably in Asia (+4.9% p.a.), the Middle-East (+4.6% p.a.) and Africa (+4.1% p.a.). The world population comprising 7 billion people, of which 4.0 billion are concentrated in Asia, consumes about 165 million tonnes of sugar. The 10 largest sugar consuming nations consume roughly two-thirds of the total world's sugar. White sugar consumption in developed countries can be considered as saturated markets (flat/ low population growth and maturity of food markets), whereas developing countries are considered as growing markets, particularly in Asia, and, to a lesser extent in Middle-East and Africa.

1.5 Past growth and future prospects

Sugar production in India is closely linked to sugarcane production. Sugarcane production has increased from 279.59 million tonnes to 339.17 million tonnes from 1997-98 to 2010-11. It fell to 233.86 million tonnes in 2003-04. An increase in sugarcane production thereafter was again followed by a decline in 2008-09 to 285.09 million tonnes. In India sugar production follows a 5-7 year cycle. Sugar production increases over a 3-4 year period, reaches a high, which in turn, results in lower sugar prices. Lower sugar price and increased sugarcane arrears results in lower sugarcane production for the next 2-3 years. A graphical representation of the Indian Sugar Cycle is given in Figure 1.5a. The sugarcane and sugar production trends in India are given in Figure 1.5b.

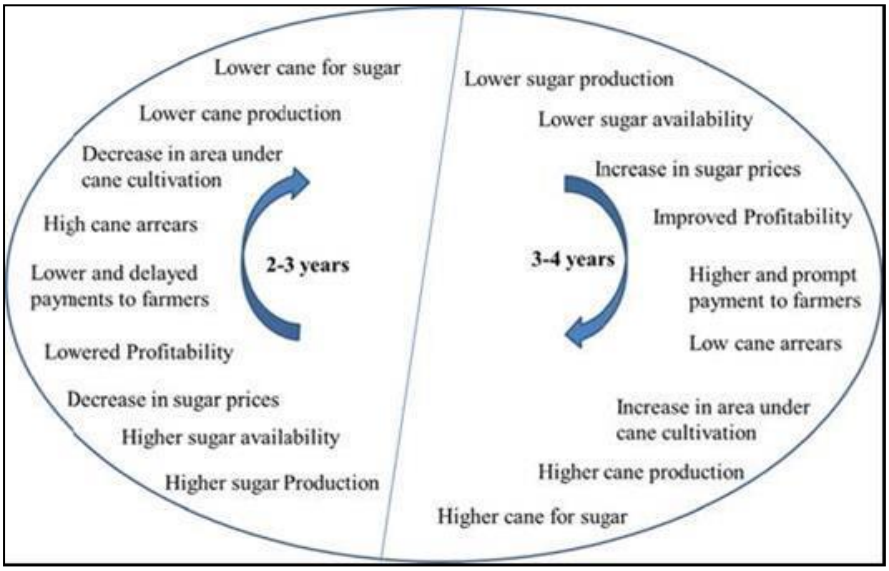


Figure 1.5a: Indian Sugar Cycle

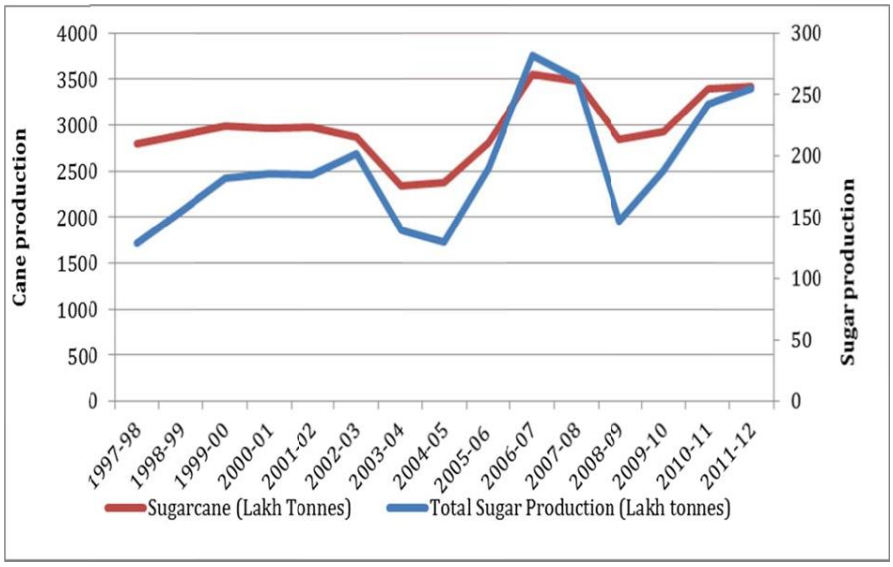


Figure 1.5b: Trend of Sugarcane and Sugar Production in India

Source: Directorate of Economics and Statistics, Ministry of Agriculture and Department of Food and Public Distribution, Government of India

The number of sugar factories in operation in India from 2006-07 to 2010-11 is given in Table 1.5.

Table 1.5: Sugar factories in operation in India year-wise

Year	Number of sugar factories in operation
2006-07	504
2007-08	516
2008-09	489
2009-10	490
20010-11	527

1.5.1 Domestic demand opportunity

In 2010-11, the domestic sugar consumption was 20.7 million tonnes. It is expected that the drivers for consumption i.e. the GDP growth and population growth will continue to grow at current rates. Based on the past 10 years' growth in consumption and estimates from various independent sources, it is expected that the domestic sugar consumption in 2017 would be approximately 28.5 Million tonnes. (Source KPMG Analysis). Given the high cost of imports and the strategic importance of food security, India will need to set its production targets in excess of its domestic consumption. Given the past trend in production cyclicality, sugar equivalent to 1.5 months of consumption i.e. an additional 3.5 million tonnes of sugar will need to be produced by 2017. (Source KPMG Analysis).

1.5.2 International trade opportunity

India has the potential to export to major Indian Ocean markets, due to freight competitiveness with respect to key competitors such as Brazil and Thailand. With the EU exports reducing by 4.5 million tonnes, the world price per metric tonne of sugar is expected to increase in the range of USD 50 to USD 100. This could potentially make exports more viable for India. However, due to the increasing emergence of destination refineries, key markets are importing a greater share of raw sugar, and India's competitiveness for raw exports is relatively lower currently. India's competitiveness is higher in markets, where the share of white sugar imports as a percentage of cumulative imports is higher. Going forward, India will need to build the capability to produce raw sugar and refined sugar of international quality standards, in order to leverage the export opportunity.

The target markets are estimated to import 10 million metric tonnes of sugar by 2017. India would be able to leverage this opportunity through productivity improvements and alignment of cane and sugar prices in the domestic market. India's competitiveness can also be increased by enhancing export infrastructure. Since the current cost structure of the Indian industry is uncompetitive for exports, in case of a large sugar surplus, the government could consider using WTO compliant subsidies to enable exports while creating stability in the domestic market. The industry could also explore ways of collectively sharing losses due to exports, if any, since exports will lead to lower availability of stocks in the domestic market, thus benefiting both mills and farmers through higher sugar realization. (Source KPMG Analysis)

1.5.3 Future potential, impacts and investments

The potential, impacts and investments related to the various opportunities in sugar sector by 2017 are summarized below.

(i) Domestic consumption

The domestic consumption is expected to rise by 5 million tonnes of additional sugar. This would require about Rs 6000 crores of investment to meet the domestic demand.

(ii) By-products

Sugar industry provides good opportunities for production of by-products such as ethanol, electricity, etc that would help in energy security related issues through green sources. The estimated investments is about Rs 52,320 crores.

(iii) Productivity improvements

It has been estimated that India can meet about 82% of the estimated increment in domestic consumption (4.1 million tonne of sugar) by 2017 by improving productivity through marginal acreage increase, farm practices and infrastructure improvements.

(iv) Product innovations

There is also significant potential for product innovation i.e. sugar based products based on consumer needs. It would be necessary for the sugar industry to invest in R&D activities for this purpose.

1.6 Production of sugarcane and white sugar in India

The production of sugar in India is highly dependent on the availability of sugarcane. A schematic representation of sugarcane and white sugar production in India is given in Figure 1.6.

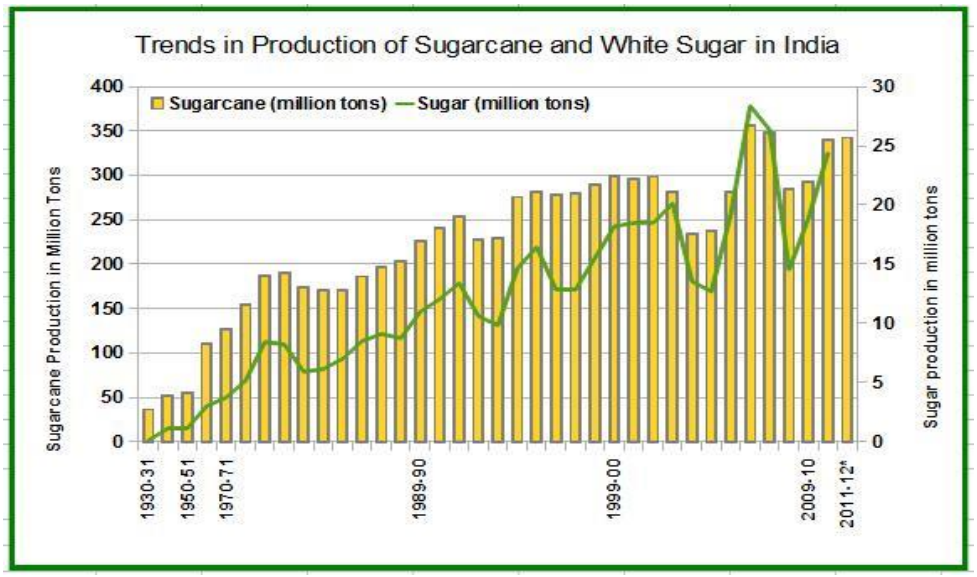


Figure 1.6: Year-wise trend in production of sugarcane and white Sugar in India

The details of sugarcane crushing, sugar production, percentage recovery of sugar from cane, molasses production and molasses recovery percentage from cane for the seasons in 2010-11 is given in Table 1.6.1.

Table 1.6.1: Cane crushing, sugar and molasses production statistics

S.No	Particulars	Crushing season
		2010-2011
1	Number of sugar factories in operation	527
2	Average actual crushing capacity (million TCD)	1.92
3	Average crushing period (Days)	136
4	Annual Crushing Capacity (million tonnes)	261.6
5	Annual Sugarcane Crushed (million tonnes)	239.8
6	Capacity Utilization (%)	92
7	Sugar Produced (million tonnes)	24.4
8	Recovery % from Cane	10.17
9	Yield of sugarcane (tonnes per hectare)	70.1
10	Molasses production (million tonnes)	10.74
11	Molasses recovery from cane (%)	4.57

Source: Sugar India Year Book – 2012

The sugar production & consumption trends from 1999-2000 to 2010-2011 is given in Table 1.6.2.

Table 1.6.2: Sugar production and consumption statistics in India

Year	Sugar Production (Million tonnes)	Sugar Consumption (Million tonnes)
1999-00	18.2	15.5
2000-01	18.5	16.2
2001-02	18.5	16.8
2002-03	20.1	18.4
2003-04	13.5	17.3
2004-05	12.7	18.5
2005-06	19.3	18.9
2006-07	28.4	20.2
2007-08	26.4	22.0
2008-09	14.5	23.0
2009-10	18.9	21.0
2010-11	24.4	20.7

Source: Sugar India Year Book – 2012

India is the 3rd largest exporter of sugar after Brazil and Thailand. The sugar import and export trends from 1999-2000 to 2010-2011 is given in Table 1.6.3.

Table 1.6.3: Sugar imports and exports from India

Year	Sugar Import (Million tonnes)	Sugar Export (Million tonnes)
2003-2004	0.07	1.20
2004-2005	0.93	0.11
2005-2006	0.56	0.32
2006-2007	0.00	1.75
2007-2008	0.00	4.64
2008-2009	0.36	3.33
2009-2010	1.97	0.04
2010-2011	1.00	3.25

Source: DGCI & S, Kolkata

1.7 Important stakeholders

The key stakeholders of the sugar industry are farmers' associations, millers, private & cooperative mills' associations, international traders, policy makers. The different industry associations in the sugar industry include the following:

- The Sugar Technologists Association of India - (STAI)
- Indian Sugar Mills Association – (ISMA)
- National Federation of Co-operative Sugar Factories Ltd – (NFCSF)
- All India Distillers Association - (AIDA)
- Indian Sugar Exim Corporation Ltd – (ISEC)
- Regional and state level sugar & distillers' associations

These industrial associations are involved in issues such as technology, pricing, policy, sales and exports / imports related issues. The Research and development institutes in the sugar sector include (i) National Sugar Institute, (ii) Vasantdada Sugar Institute and (iii) Sugar Research Institute. These institutes are involved in activities such as consultancy, setting sugar standards, co-ordinated research, patents and analytical services.

1.8 Product categorisation

Sugar comes in three forms: Large crystals (L-grade), Medium crystals (M-grade) and Small crystals (S grade). M and S grades form about 80% of total sugar production and are traded on the NCDEX platform. The quality of sugar is gauged using a parameter known as the ICUMSA number, which assesses the chemical properties of sugar for grading. The lower the ICUMSA number, the better the quality.

1.9 Major players

1.9.1 State-wise segregation of sugar mills

There were 671 sugar mills in India in 2010-11 including the closed / non-operating mills. Based on ownership, these can be classified as (i) public, (ii) private and (iii) co-operative sugar mills. Private sugar mills account for highest number of mills followed by co-operative sugar mills. The state-wise breakup for number of sugar mills in India is given in Table 1.9.1. Maharashtra and Uttar Pradesh have the maximum number of sugar mills.

Table 1.9.1: State-wise number of sugar mills

State	Public	Private	Co-operatives	Total
Punjab	-	9	15	24
Haryana	-	4	12	16
Rajasthan	1	1	1	3
Uttar Pradesh	23	106	28	157
Uttarakhand	2	4	4	10
Madhya Pradesh	2	12	5	19
Chhattisgarh	-	-	3	3
Gujarat	-	2	22	24
Maharashtra	-	56	153	209
Bihar	15	13	-	28
Assam	-	1	2	3
Orissa	-	4	4	8
West Bengal	1	1	-	2
Andhra Pradesh	1	30	14	45
Karnataka	3	49	15	67
Tamil Nadu	3	27	16	46
Pondicherry	-	1	1	2
Kerala	-	1	1	2
Goa	-	-	1	1
Nagaland	1	-	-	1
Dadar Nagar & Haveli	-	-	1	1
Total	**52**	**322**	**297**	**671**

**Includes closed down mills based on ownership*

Source: Sugar India Yearbook'12

1.9.2 Classification of sugar mills based on capacity

The sugar mills are classified into five categories based on their installed crushing capacity (Tonnes of Cane crushed per Day – TCD) and the classification number of sugar mills

classified based on capacity is given in Table 1.9.2. The country wide average crushing capacity in 2010-11 was 3650 TCD and the average crushing duration was 136 days.

Table 1.9.2: Number of sugar mills in India based on capacity

Capacity	Number of sugar mills
Higher than 10000 TCD	11
5001 to 10000 TCD	88
3501 to 5000 TCD	85
2001 to 3500 TCD	234
Up to 2000 TCD	104

1.9.3 Segregation of Sugar Mills based on Co-generation Facility

Many of the sugar mills have co-generation facilities which produce steam and power used in the sugar production process. The number of sugar mills in operation state-wise and those having co-generation facility are given in Table 1.9.3. Out of the 527 sugar mills in operation, only 144 of them have Co-generation facilities.

Table 1.9.3: Sugar mills with and without co-generation facility in various states

Sl.No	State/ Location	Mills in operation	Mills with co-generation
1	Punjab	16	5
2	Haryana	14	2
3	Rajasthan	1	1
4	Uttar Pradesh (East)	42	11
5	Uttar Pradesh (Central)	83	15
6	Uttar Pradesh (West)	34	6
7	Uttarakhand	10	1
8	Madhya Pradesh	13	0
9	Chhattisgarh	3	1
10	Gujarat	19	0
11	Maharashtra (South)	167	34
12	Bihar	10	3
13	Orissa	5	1
14	West Bengal	1	0
15	Andhra Pradesh	37	21
16	Karnataka	59	30
17	Tamil Nadu	44	19
18	Pondicherry	2	0
19	Goa	1	0
	Total	**527**	**144**

(Source: Sugar India Year Book-2012)

1.10 Sugar policy and regulations in India

India does not have a reasonable degree of predictability in its production and trade policy with respect to sugar. The sector is characterised by controls across the entire value chain of sugar production and sale, which not only hampers its efficiency but also exacerbates the cyclicality in sugar and sugarcane production. This characteristic of unpredictability in sugarcane production, coupled with the controls, does not allow the sugar sector to tap its full potential and thereby adversely impacts the interests of stakeholders (sugarcane growers, sugar mills and consumers) across the value-chain. Some important policies in sugar industry include the following:

i. Trade policy for sugar

Depending on mill-wise monthly production and stocks, local production levels and world market conditions, quantitative controls on both exports and imports are common in the sector. This is an avoidable source of uncertainty for the industry.

ii. Regulations relating to by-products

There are several regulatory hurdles with respect to the by-products of the sugar industry. With respect to the molasses, these are decisions at the state government level related to fixation of quotas for different end uses of molasses, restrictions on movement (particularly across state boundaries), etc. With respect to co-generation from bagasse, there are regulatory and implementation issues relating to freedom of selling power to consumers other than the local power utility. The state governments or their electricity boards resort to restriction on open access sale by frequent or routine invocation of statutory provisions meant to deal with emergencies.

Other policies related to Indian sugar industry include (i) cane sugar area and bonding, (ii) sugarcane pricing, (iii) levy sugar obligation and (iv) regulated release of free sale (non-levy) sugar).

1.11 Support for bagasse co-generation

The existing capacity of bagasse based cogeneration is 711 MW. The estimated co-generation potential in Indian Sugar Mills is around *6000MW (Source: Industrial Cogeneration India, Vol.XIX, October, 2010)*. Over the last decade, bagasse co-generation faced a dynamic and varied set of substantial information, technical, regulatory and financial barriers. Each of the programmes designed to support bagasse co-generation had a role to play in supporting the 711 MW of bagasse co-generation currently installed. However none of these programmes would have been successful on its own. The promotional policies of the Ministry of New and Renewable Energy (MNRE) including capital and interest subsidies, and a variety of tax benefits and guidelines to the states to implement the preferential tariffs made bagasse co-generation cost-effective for implementation in India. Various multilateral lines of credit were offered through IREDA to some of the mills who were unable to access credit through other institutions. However, till date support programmes have done little to address the unique financial barriers facing the cooperative mills due to institutional structure of these mills.

1.11.1 MNRE support and initiatives

MNRE initiated new co-generation projects for co-operative/ public sector sugar mills which are based on the Build, Own, Operate, Transfer (BOOT) model. Two BOOT model co-generation projects in co-operative sugar mills of Maharashtra, 12 co-operative/ public sector sugar mills in Tamil Nadu are provided assistance under this initiative. The Ministry has also initiated in 2012, a new scheme for providing Central Financial Assistance for boiler up-gradation of co-generation project in co-operative sugar mills. Three co-operative sugar mills in Maharashtra with an aggregate capacity of 36 MW (20 MW export during season) were provided financial assistance.

2.0 Energy Performance

2.1 Energy performance at sectoral level

Sugar mills are energy intensive and are notified as energy intensive industries as per 'The Energy Conservation Act, 2001'. Energy consumption in sugar mills depends on various factors such as (1) capacity, (2) steam generation parameters, (3) age of installed equipment and (4) type of equipment used. The specific electricity consumption per tonne of sugar production varies from 200~500 kWh / tonne of Sugar Produced (Source: CMIE Database) based on the year of production. The average cane crushing in Indian mills in 2010-11 was 3650 TCD. The average energy consumption in an Indian sugar mill is about 26~40 kWh / tonne of cane (*Source: TERI Energy Audit reports*). The total power requirement in a standard sugar mill of 3400 TCD crushing capacity is about 4.0 MW. The steam consumption varies from 30% to 50% of steam per tonne of cane based on capacity, evaporator vapour bleeding arrangement and age of equipment used.

The cane to bagasse ratio is around 30% in the Indian Sugar mills and the GCV of bagasse with 50% moisture is around 2200kCal/ kg. This is equivalent to 0.22 toe/ tonne of bagasse. Considering 239.8 million tonnes of cane during 2010-11, the bagasse generation is about 71.94 million tonnes and the total energy availability is 15.83 toe. Based on the national average of 136 days of cane crushing in 2010-11, sugar mills with a crushing capacity of 3400TCD and above will fall under the category of energy intensive industries. The input energy (bagasse) available in each of these sugar mills is 30,000 metric tonnes of oil equivalent and above. The number of sugar mills state-wise having a crushing capacity of 3400TCD and above is given in Table 2.1. The details of the 230 sugar mills are given in annexure 1.

Table 2.1: Number of sugar mills state-wise with 3400TCD and above

State	Number of sugar mills
Punjab	7
Haryana	3
Uttar Pradesh	91
Uttarakhand	6
Gujarat	8
Maharashtra	42
Bihar	6
Andhra Pradesh	18
Karnataka	28
Tamil Nadu	21
Total	**230**

2.2 International comparison

The size of the sugar mills in India is small by international standards. The average milling capacity at different countries is given in Table 2.2.

Table 2.2: Average milling capacity of sugar mills in different countries

Country	Average cane crushing capacity (TCD)
US Cane	14500
Australia	11000
Thailand	10,300
EU	9500
Brazil	9000
South Africa	7500
Colombia	6,000
India	3,650

(Source: http://www.indiansugar.com)

The sugar mills in Southeast Asia use low pressure cycle for co-generation plants and most of the mills are inefficient. In some of the sugar mills, up to 40 kWh electricity is consumed and up to 600 kg of steam is consumed for milling every tonne of sugar cane. As low as 30 kWh of electricity is produced from the bagasse generated from milling one tonne of sugar cane. Some of the sugar mills are even installed with 'used' co-generation equipment. There is a huge potential in existing sugar mills to reduce the steam and electricity requirement for milling process. In the new co-generation plant, it is possible to produce electricity up to 110-125 kWh for every tonne of sugar cane milled.

In the 1960's, efficient bagasse co-generation was pioneered in Mauritius and Hawaii. The implementation of higher pressure (60 bar and higher) and higher temperature (450 deg C and higher) boilers, and corresponding turbines allowed the more efficient burning of bagasse with export of electricity to the grid. There was a phenomenal growth in sugar co-generation in India for the past 15 years. India started implementing the 67 bar cycle 15 years ago. Based on the experience gained and lessons learnt from the operation of those plants, several 87 bar cogeneration systems were installed few years before. Now, the industry is moving towards very high pressure systems of up to 110 bar. Few such systems are already in operation and there are more than 25 projects under various stages of implementation. Several developments are also taking place on the processing side. Due to several innovative energy efficiency measures, technology options and improved house keepings, the steam consumption has come down to as low as 350 to 360 kg of steam per tonne of cane milled.

2.3 Manufacturing process

Sugar occurs in greatest quantities in sugarcane, from which it is extracted. The natural sugar stored in the sugarcane is separated from the plant material through a process schematically represented in Figure 2.3.

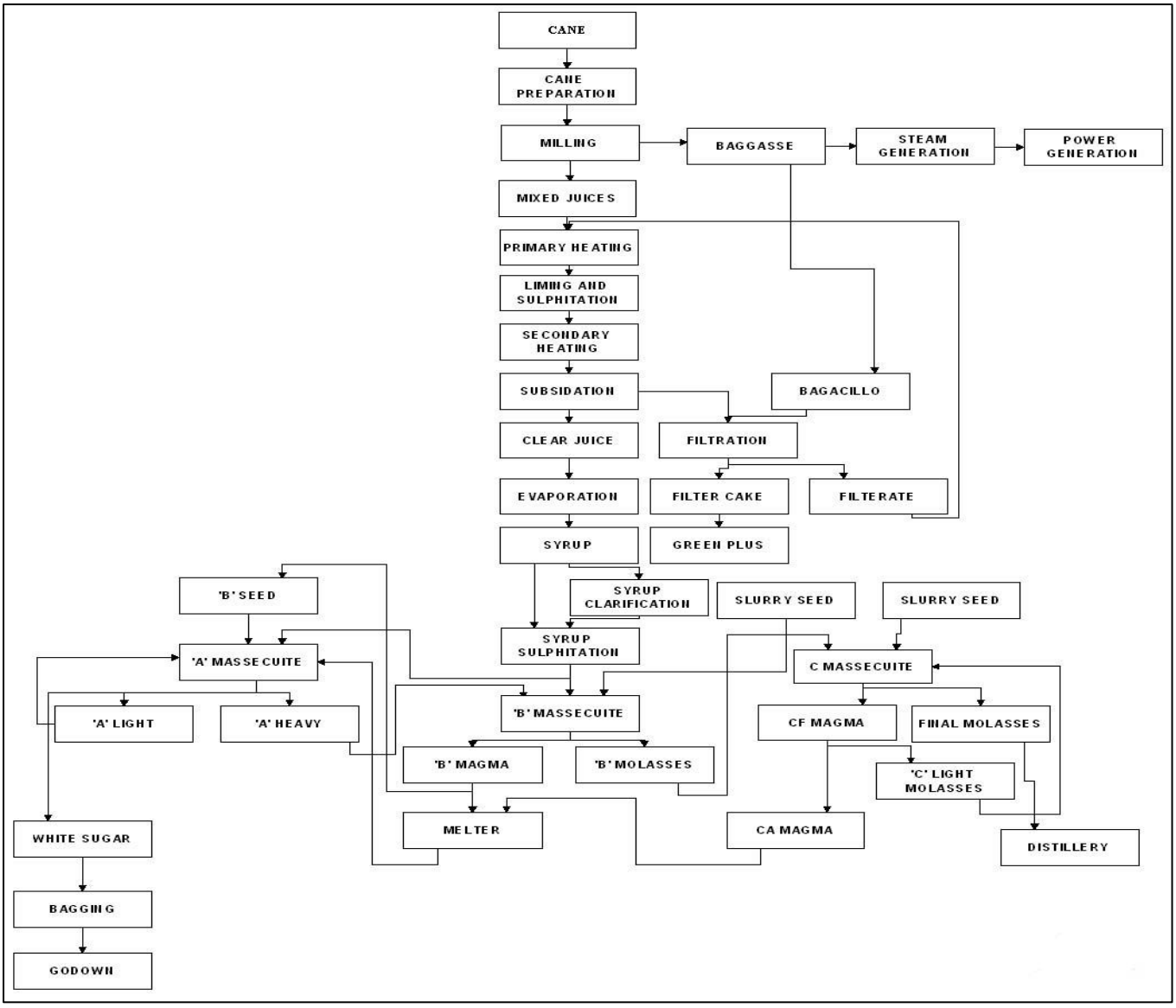


Figure 2.3: Sugar manufacturing process

2.3.1 Various stages in sugar manufacturing process

The sugar manufacturing process normally comprises

1. Juice extraction
2. Juice clarification and evaporation
3. Crystallization
4. Centrifuging
5. Drying and packing

Steam and electricity generation using bagasse as the fuel, mostly through backpressure turbines, forms an important part of any sugar factory.

1. Juice Extraction

The juice extraction plant consists of cane handling, cane preparation and milling sections.

a) Cane handling

Cane, brought to the mill, is mechanically unloaded by a grab type attachment. A truck tippler is sometimes provided to unload cane, facilitating loading of sugar cane to cane carrier.

b) Cane preparation

The sugarcane is levelled in the leveller before it is fed to the cutter. The cutter shreds the cane to smaller sizes and prepares it for the fibrizer where the cane is converted to a pulp-like mass.

Juice extraction from the prepared cane is done by two types of processes. About 95~97% of the sugar factories follow milling process and 3~5% of the sugar factories follow diffusion process.

c) Milling

The prepared cane is passed through a milling tandem composed of four to six three-roller mills. The juice is extracted from the cane by squeezing under high pressure in these rollers. Extraction is maximised by leaching the disintegrated exposed cane with weak juice and make-up water in a counter current system. The fibrous matter or bagasse', which is left after milling, is used as a fuel for steam generation.

d) Diffusion

Diffusion process is based on a systematic counter current washing of the cane or bagasse by means of imbibition water. Water is added at the discharge end of the conveyor and percolates through the bed of bagasse and the perforated slats of the conveyor. The water dissolves the sugar in the bagasse and the thin juice thus formed is collected in a hopper. This juice is moved forward one stage by pumping and the process is repeated until the juice reaches maximum concentration at the feed end of the diffuser. The diffuser may be conditioned either for single-flow or for parallel-flows juice circulation.

2. Juice clarification

The purification of juice involves (a) juice heating (b) sulphitation (c) clarification and (d) filtration.

The mixed juice from the mills is heated in raw juice heater(s). The heated juice is treated with chemicals to precipitate various dissolved impurities in the mixed juice. The precipitated impurities are separated to obtain clear sparkling juice in clarifiers. The clear juice is again heated to obtain a temperature of about 105^0C.

3. Evaporation

The juice is concentrated from 15 Brix to around 60 Brix in a multiple-effect evaporator. The vapours are bled from the evaporators for juice heating in various heat exchangers and for boiling of massecuite (a mixture of molten liquid and crystals) in vacuum pans. This is the major steam consuming section of the plant.

4. Crystallisation

Crystallisation is an important unit operation, which in sugar industry is known as Pan boiling. A major part of the crystallization process is done in most of the sugar mills in batch type vacuum pans. The massecuite is then transferred to crystallizers where the process is completed by cooling the mass under stirred condition.

5. Centrifuging

The massecuite from the vacuum pans is sent to the centrifuges, where the sugar crystals are separated from the molasses. These centrifugal machines can be batch type or continuous type. There are separate centrifugal machines for `A' type, `B' type and `C' type massecuites. The molasses separated out from this section is a useful by-product, which is an excellent raw material for distilleries.

6. Drying, grading and packing

The moist crystals obtained from centrifugal machines normally contain about 15-20% surface moisture. They are dried in traditional dryers, graded according to crystal sizes and then packed in bags.

2.3.2 By-products

The main by-products from any sugar industry are (i) bagasse, (ii) molasses and (iii) filter cake. The details are given below.

i. Bagasse

Bagasse is an important by-product of sugar. It is used as a major substitute raw material in the paper and pulp industry, replacing wood and bamboo thus reducing deforestation. Presently, almost all the sugar mills utilize this bagasse as an in-house fuel in boilers for steam generation. A number of mills are now planning to utilise bagasse efficiently in high-pressure boilers for co-generating electricity for export to the grid/ neighbouring units.

ii. Molasses

Molasses, the other important by-product, is a storehouse of organic chemicals. Industrial alcohol is produced from molasses, which in turn can be used to manufacture chemicals like ethyl benzene, lactic acid, tartaric acid, citric acid, diethyl phthalate, etc. Industrial alcohol can be used as a fuel extender as a substitute to the scarce petroleum products.

iii. Filter cake

When cane juice is clarified and filtered, the resulting cake is known as filter mud or filter cake. It contains most of the colloidal matter precipitated during clarification and has around 63% organic matter. This cake is of great manure value and is mostly taken by growers using their own transport, after delivering cane to the factory, for use in their fields.

2.3.3 Cogeneration in sugar mills

The sugar industry by its inherent nature can generate surplus energy in contrast to other industries, which are only consumers of energy. With liberalization and increased competition, the generation and selling of excess power to electricity boards, offers an excellent source of revenue generation to the sugar mills. This is referred to as commercial co-generation and has been only marginally tapped in our country. The sugar mills have

been adopting co-generation right from the beginning. However, the co-generation has been restricted to generating power and steam only to meet the operational requirements of the plant. Only in recent years, with an increasing power demand and shortage, commercial co-generation has become attractive, both from the state utility and the sugar mill point of view. The sugar mills derive additional revenue by selling power to the grid, while the state is able to marginally reduce the 'demand-supply' gap, with reduced investments.

2.3.4 Distillery in sugar mills

An associated distillery may employ batch or continuous fermentation, followed by distillation, to produce ethanol with a purity of 95%. This ethanol can be used in other industries or further processed and blended with gasoline. Waste from the distillation process is known as vinasse or spent wash. Anaerobic digestion of this waste is used to produce biogas, which can be utilized for the production of boiler fuel for the distillery or to fuel combined heat and power engines. The remaining waste can be returned to agricultural fields and / or used in the composting of organic solids emanating from processing.

2.4 Technological movements

Various technologies for energy efficiency improvement are discussed briefly. Many of these technologies are already in use in India while some are in the development phase or not yet commercialized in India. Besides these technologies, one important step that the Indian sugar mills can adopt is to produce smaller sized sugar instead of bolder sugar grains. This is because the production of bolder grain sugar leads to an increased consumption of 2 to 3% energy by the industry. Some of the technological movements that are implemented / can be implemented are listed below:

- Capacity enhancement
- Adoption to co-generation to meet both steam and power demand
- Installation of electrical mill drive based sugar extraction in place of steam mill drives
- Changing the evaporator configuration to (DEVC + Quad to Quintuple/ quadruple mode)
- Modification in vapour bleeding arrangement system (For plants using quintuple effect system)
- Hot condensate management: Using hot condensate from 2nd body of multiple effect evaporators for superheated wash water heating instead of exhaust steam or vapour bled from multiple effect evaporator bodies
- Use of low grade vapour for pan boiling by employing mechanical circulators
- Step-wise recovery of flash heat steam from the condensate from evaporators, juice heater and pans
- Selective incorporation of direct contact heaters for juice heating, syrup, filtrate and molasses conditioning
- Use of low temperature vapours for pan washing
- Heating the air by hot condensate at sugar dryer/ hopper
- Chilled water generation using hot vapour condensate in vapour absorption system

2.5 Capacity utilisation

The capacity utilisation of the sugar mills plays a major role in the overall energy consumption of the plant. During the start and end of crushing seasons, when cane availability is less than requirement, the sugar plant energy consumption will be much higher compared to full capacity operation. Failure of equipment, during the season, also forces the plants to be operated at lower capacity till the maintenance of equipment is completed and brought back to line. Under capacity utilisation of plant and over sizing of equipment considering future expansion also leads to higher energy consumption. The average capacity utilization of the sugar factories in India during 2010-11 was 92%.

2.6 Major energy consuming areas

The section wise electrical energy consumption and steam consumption in sugar mill is given in Table 2.6a and Table 2.6b respectively. The major user areas of steam are multiple effect evaporators, final juice heaters and sulphur melter. Plants installed with distillery make use of steam in distillation columns.

Table 2.6a: Section wise electricity consumption in a sugar mill

Section	Percentage
Cane Handling	5~10%
Cane Preparation	15~20%
Milling	25%
Juice purification	10~15%
Sugar Crystallization	5~10%
Sugar Centrifugal	10~15%
Co-generation	5~10%

Table 2.6b: Section-wise steam consumption in a sugar mill

Section	Sugar mills with electric drives for milling (%)	Sugar mills with steam drives for milling (%)
Medium pressure steam		
Mills	0%	40~50%
Turbine & generator	90~100%	40~50%
Low pressure steam		
Evaporation	93~95%	93~95%
De-aerator	2~3%	2~3%
Sulphur melting	1~2%	1~2%
Distillery	3~5%	3~5%

2.7 Energy saving potential

2.7.1 Scope for improving energy efficiency

Analysis of the energy consumption pattern in the sugar mills reveals that there exists a significant scope for improving the energy efficiency in the Indian sugar industry. The major reason for the high energy consumption in the industry is the presence of a large number of old, small capacity sugar mills which have not invested much over the years in modernizing

or upgrading their process equipment. The periodic expansion of the plant and installation of new equipment as per the plant expansion has led to increased use of many numbers of small capacity equipment which can be replaced with minimum number of higher capacity equipment to improve energy efficiency and reduce maintenance cost. By incorporating the latest energy efficient process equipment mentioned in section 3.4 (technological movements) around 20% of electrical energy consumption and 25% steam consumption can be reduced in the sugar mills.

2.7.2 Scope for co-generation potential

The all-India potential of bagasse-based cogeneration with the implementation of extra high pressure (87 kg/ cm^2 or 110 kg/ cm2)/ temperature (515 or 540 deg C) configuration, is around 6,000 MW. For the co-generation opportunity, in 2017, there is a total exportable power potential of approximately 9,700 MW (KPMG analysis- 2017 forecast). This can fulfill almost 6% of the additional power requirement of 128 GW by 2017. As of 31 March 2010, only 1,344 MW (134 projects) of capacity have been commissioned, while another 530MW of capacity (39 projects) are under construction. This means that only 31% of the potential has been actually achieved. Table 2.7.2 gives the state-wise potential for bagasse based co-generation projects.

Table 2.7.2: State-wise bagasse co-generation potential

States Potential	MW
Maharashtra	1,500
Uttar Pradesh	1,500
Tamil Nadu	540
Karnataka	540
Andhra Pradesh	360
Bihar	360
Gujarat	420
Punjab	360
Haryana & others	420
Total	**6,000**

Source: Industrial Co-generation India, Vol.XIX, October 2010

3.0 Analysis of energy consumption data

3.1 Energy consumption in sugar mills

The energy requirements in a sugar mill are in the form of steam for process heating/ turbo drives and electricity for running various drives. The sugar industry has the unique advantage of utilizing a captive fuel (bagasse), to meet its energy requirements. However, depending upon factors like fibre content in the cane, quantity of juice, type of clarification process and evaporation effects, type of prime movers (steam driven or electric driven) etc., some sugar mills produce a small quantity of surplus bagasse while others are deficient by a small quantity. The sugar mills depend, in a very limited way, on external fuels like fuel oil, LSH, coal etc., to supplement their energy requirements. Some sugar mills during the season can produce a marginal surplus power while others would be deficient in power by a small margin and hence the dependence on grid power is minimal.

3.1.1 Electricity consumption in sugar mills

Table 3.1.1 provides the electricity consumed and specific energy consumption (Electrical) of sugar mills / group of plants under single owner for production from 2010 to 2012. The electricity power consumption includes electricity purchased from grid, electricity generated from steam generator and electricity generated by diesel generators.

Table 3.1.1: Electricity consumption and Specific Energy Consumption (Electrical) of sugar mills

S.No	Plant	Capacity, TCD	Electricity Consumption, Million kWh*			Estimated SEC (Electrical), kWh/MT of cane#		
		Year	2010	2011	2012	2010	2011	2012
1	Andhra Sugars Limited	16,000	287	331	337	32	33	38
2	Bannari Amman Sugars Ltd.	19,000	51	90	101	28	28	28
3	Ganpati Sugar Inds. Ltd.	5,000	28	9	61	26	24	24
4	Gayatri Sugars Ltd.	7,000	8	43	41	36	70	74
5	Godavari Biorefineries Ltd.	12,000	118	206	N.A.	16	26	N.A.
6	Indian Sucrose Ltd.	5,000	24	10	17	37	34	N.A.
7	Jeypore Sugar Co. Ltd.	8,500	16	22	12	25	24	23
8	J K Sugar Ltd. [Merged]	5,000	18	16	22	35	38	35
9	Kakatiya Cement Sugar & Inds. Ltd.	3,200	32	35	35	56	4	31
10	K C P Sugar & Inds. Corpn. Ltd.	11,500	31	42	45	50	42	47
11	Mysore Paper Mills Ltd.	2,500	170	171	172	43	43	31
12	Nahar Industrial Enterprises Ltd.	2,500	272	288	384	52	40	49
13	Nava Bharat Ventures Ltd.	4,000	9	311	394	32	26	27
14	Parrys Sugar Industries Ltd.	12,500	20	49	109	35	89	76
15	Rai Bahadur Narain Singh Sugar Mills Ltd.	8,400	579	68	75	37	38	37
16	S B E C Sugar Ltd.	8,000	22	25	26	28	30	32
17	Sir Shadi Lal Enterprises Ltd.	11,250	36	42	38	32	29	29

S.No	Plant	Capacity, TCD	Electricity Consumption, Million kWh*			Estimated SEC (Electrical), kWh/MT of cane#		
18	Shakumbari Sugar & Allied Inds. Ltd.	5,500	14	13	13	43	40	44
19	Sudalagunta Sugars Ltd.	2,500	9	10	13	35	28	15
20	Trident Sugars Ltd.	3,000	7	10	12	22	25	28
21	Uttam Sugar Mills Ltd.	23,750	93	127	134	38	39	41
22	Wahid Sandhar Sugars Ltd.	7,000	11	18	22	18	51	52
23	Wave Industries Pvt. Ltd.	18,800	21	45	N.A.	30	31	N.A.
24	Kanoria Sugar & General Mfg. Co. Ltd.	6,000	9	8	N.A.	N.A.	N.A.	N.A.
25	Dewan Sugars Ltd.	3,125	8	12	13	23	22	22
26	Gobind Sugar Mills Ltd.	7,500	16	18	22	25	25	25
27	Kesar Enterprises Ltd.	7,200	20	20	22	23	22	22
28	Lakshmi Sugar Mills Co. Ltd.	4,500	12	16	N.A.	28	32	27
29	Oudh Sugar Mills Ltd.	28,700	51	73	83	36	32	32
30	Tikaula Sugar Mills Ltd.	5,000	30	38	N.A.	38	N.A.	N.A.
31	Upper Ganges Sugar & Inds. Ltd.	18,000	33	37	45	25	26	27
32	Venus Sugar Ltd.	3,500	4	4	N.A.	49	N.A.	N.A
33	Bajaj Hindusthan Sugar & Inds. Ltd. [Merged]	40,000	89	N.A.	N.A.	27	35	37
34	Bajaj Hindusthan Ltd.	136,000	195	298	363	N.A.	N.A.	N.A
35	Balrampur Chini Mills Ltd.	76,500	133	330	225	27	28	28
36	Dwarikesh Sugar Inds. Ltd.	21,500	121	213	213	N.A.	N.A.	N.A
37	India Sugars & Refineries Ltd.	2,500	2	1	4	29	21	20
38	Kashipur Sugar Mills Ltd.	6,250	8	12	9	N.A.	N.A.	N.A
39	Rana Sugars Ltd.	15,000	125	237	201	115	123	123
40	Saraswati Sugar Mills Ltd.	13,000	26	39	N.A.	32	N.A.	N.A
41	Sri Sarvaraya Sugars Ltd.	4,000	3	1	N.A.	23	N.A.	N.A
42	Shree Renuka Sugars Ltd.	48,250	399	652	1,089	11	19	N.A
43	Simbhaoli Sugars Ltd.	20,100	55	78	N.A.	210	N.A.	320
44	Thiru Arooran Sugars Ltd.	8,500	35	23	N.A.	35	N.A.	31
45	Triveni Engineering & Inds. Ltd.	61,000	147	315	349	28	33	34

**CMIE database;* *# Based on 10% sugar recovery*

The specific power consumption of sugar mills is also evaluated based on power consumption and tonnes of cane. The typical specific energy consumption will be in the range of about 26~32kWh/ tonne of cane. The break-up of section wise specific power consumption is given below:

- Milling tandem including cane handling – 10~12 kWh/ tonne of cane
- Clarification, Boiling, curing & sugar handling – 7~8 kWh/ tonne of cane
- Power plant including ESP – 7~8kWh/ tonne of cane
- Factory lighting & other utilities – 2 kWh/ tonne of cane

With the implementation of the latest energy efficient technologies the specific power consumption can be brought down to 22kWh/ tonne of cane.

(Source: All India seminar on latest energy efficient technologies in Indian sugar industry – organised by STAI)

3.1.2 Steam consumption in sugar mills

Some important features of steam consumption in sugar mills are given below.

- Steam consumption is about 30 to 50% on cane (i.e., 300kg to 500kg per tonne of cane crushing)
- Less number of vapour bleeding stages results in less steam economy
- Lot of HP steam is also used for process viz. sulphur burner, pan washing, sugar drying & melting, molasses conditioning and centrifugal station
- Non-utilization of the heat available in condensers, waste gases (NCG), vapours going to atmosphere and flue gas
- Steam generation/ fuel ratio in average sugar industry is 1.9/ 2.00%. Hardly 2% of the sugar industry has achieved 2.6% steam-fuel ratio

The trend of steam consumption share on cane over the past in Indian sugar mills is given in Figure 3.1.2.

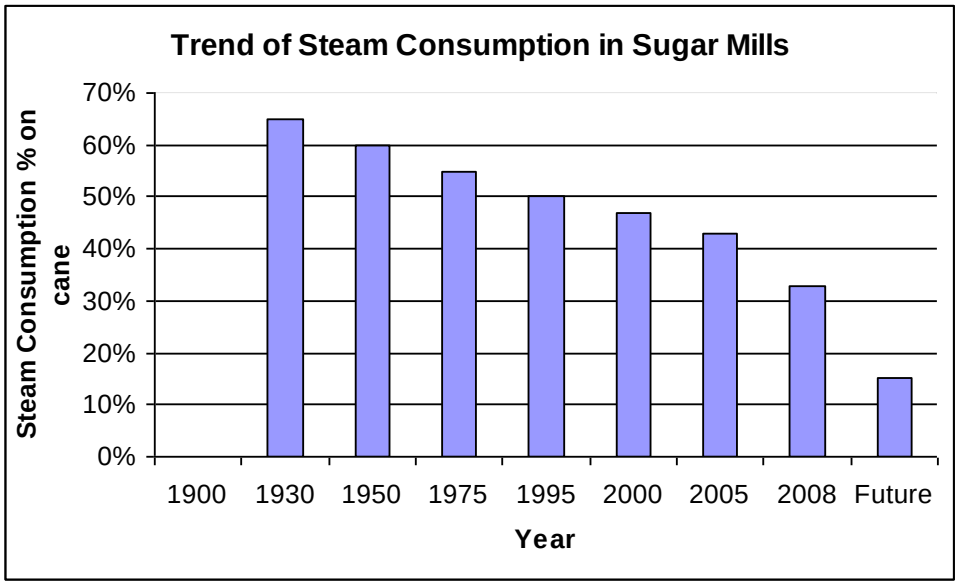


Figure 3.1.2: Steam consumption trend over decades

(Source: All India seminar on latest energy efficient technologies in Indian sugar industry – organised by STAI)

The specific steam consumption data of individual sugar mills is not published in public domain. Based on the energy audits carried out by TERI in various sugar mills across India, the range of steam consumption in sugar mills whose installed capacity lies between 3000 TCD and 5000 TCD is varying from as low as 28% on cane to as high as 45% on cane depending upon the type of juice extraction process and subsequent vapour bleeding arrangement.

3.2 Plotting plant vs energy consumption

Based on the energy audits carried out by TERI, energy consumption pattern in some of the sugar mills is given in Table 3.2.

Table 3.2: Energy consumption of sugar mills audited by TERI

Name of the sugar mill	Technology	Crushing Capacity (TCD)	Specific energy consumption (kWh/tonne of cane)	Steam consumption (% of cane)	Co-generation Capacity (MW)
EID Parry, Haliyal	Diffuser	4,800	26-27	40-41%	24.2
Madhucon Sugar & power Industries Ltd, Andhra Pradesh	Mills	3,200	25-26	45%	24.2
Navabharat Ventures Ltd, Sugar Division, Andhra Pradesh	Mills	3,500	22-23	28-30%	9.0
EID Parry, Sankili, Andhra Pradesh	Mills	4,000	22-23	31-33%	16.0
Rajshree Sugars, Villupuram, Tamil Nadu	Mills	5,000	32-33	39-40%	22.0
Rajshree Sugars, Theni, Tamil Nadu	Mills	3,000	38-40	44-45%	12.0
EID Parry, Bagalkot	Mills	4,500	23-25	36-37	15.5

3.3 Possible energy efficiency measures in sugar industry

Sugar mills cannot control the energy prices, Government policies and the Global economy. But they can improve the way they manage their energy. Improved energy performance can provide rapid benefits for the industry by maximizing the use of energy sources and energy related assets, thus reducing both energy cost and consumption. Various technologies for energy efficiency improvement are discussed briefly. Many of these technologies are already in use in India while some are in the development phase or not yet commercialized in India. Besides these technologies, one important step that the Indian sugar mills can adopt is to produce smaller sized sugar instead of bolder sugar grains. This is because the production of bolder grain sugar leads to an increased consumption of 2 to 3% energy by the industry.

3.3.1 Improved reliability and economics of steam & power generating systems with film forming polyamines

Corrosion and scaling in boilers and turbines continue to cause heat insulating deposits in boilers resulting in failures, loss of efficiency, frequent cleaning and increased cost of operations. A “film barrier approach" has been gaining increasing acceptance. It utilizes the film forming properties of aliphatic amines on divalent wet metal surfaces providing much superior protection to the metal surfaces in boilers and turbines against corrosion scaling and carryover.

3.3.2 Direct production of white sugar in a cane sugar mill

White sugar can be directly produced from clarified juice through an economical process. Juice from a cane sugar mill, or sugar beet juice, is first contacted with hydrogen peroxide, before passing through granular activated carbon. The juice is then passed through cationic and anionic resins to remove inorganic compounds, colorants, and other impurities. Then the juice may be concentrated and sugar crystallized. White sugar is produced directly,

without the need for intermediate raw sugar crystallization and the process is thereby economical.

3.3.3 Sugarcane waste conversion into char

The Appropriate Rural Technology Institute (ARTI) in Pune has developed a charring process for converting sugarcane trash into high value char. Char obtained by this process can be converted into briquettes easily by a variety of well-established briquetting methods. The kiln has a conversion efficiency of 30 per cent and operates as a continuous-batch process.

3.3.4 Quintuple 3rd effect vapour for sugar melting

In a multiple effect evaporator, vapour bleeding in the later bodies will bring steam economy. But extensive use of this vapour is presently limited to first two bodies due to low temperature of vapours and high scaling patterns in later bodies. Extensive use of vapour of the third body in a quintuple effect evaporator can be planned. With an increase in pressure of the exhaust steam used at the first body of evaporator, the pressure conditions of individual bodies changes to higher side matching with the pressures of the quadruple effect. Steam saving upto 3.5% is achieved through extensive use of vapour from the third body by converting the evaporator system into quintuple from quadruple. Use of this system would help in reducing the steam consumption.

3.3.5 Condensate flashing system

When juice is concentrated by separating water content in multiple effect evaporation, the vapour condensate takes away heat utilized for heating, often into the drain. As was the case of reducing pressure in bodies of multiple effect evaporators in sequence, it is proper to use flash heat in hotter vapour condensates, in subsequent bodies by circulating the condensate sequentially.

3.3.6 Film type sulphur burner

Sugar juice clarification (purification) process requires sulphur dioxide as a clarification and bleaching agent. In Indian factories, it is produced from expensive (imported) sulphur in the conventional tray type batch burners, which are inefficient resulting in high processing cost, poor clarification and poor sugar quality. The new "film type sulphur burner" produces SO2 with consistent quality, high efficiency, low consumption and well regulated operation made possible by the new 'film burning' concept and requisite automation. The film type sulphur burner technology has been adopted in more than 64 sugar factories all over India. Operation of the burner is controlled in accordance with process demands i.e. SO2 quantity and quality, sulphur feed rate etc. through use of instrumentation and control system etc.

3.3.7 Bagasse drier

Bagasse Drier is a novel concept of drying bagasse as well as controlling air pollution. It is a unique device wherein the hot flue gases are mixed with the wet bagasse from mills. This wet bagasse gets dried up and accumulates all the ash and unburnt carbon with it. The system would help in improving the efficiency and in pollution control.

3.3.8 Planetary gearbox for crystalliser

Planetary gearbox is energy efficient, cost effective compact alternative to the conventional drive comprising gear trains and also hydraulic drive. Some plants have successfully replaced the existing worm wheel reduction system with the planetary gearbox arrangement for all the crystallizers.

3.3.9 Advanced bagasse based co-generation

Sugar mills employ co-generation system having 480 deg C and 65 bar (atm). With technological advancement, some sugar mills in India have implemented the advanced co-generation system of 515 deg C and 105 bar (atm) pressure for increasing energy efficiency and financial profitability.

3.3.10 Mechanical Vapour Compression (MVR) technology to recover low-pressure waste steam

The need for reducing energy costs has led to multi-effect plants, then to thermal vapour compression and finally to the use of mechanical vapours compression systems. In mechanical vapour compression, positive displacement compressions or multi-stage centrifugal compressors are generally used to raise the pressure and temperature of the generated vapours. Since mechanical compressors do not require any motive steam, all vapours can be compressed to elevated pressure and temperature, eliminating the need for a subsequent recovery system. The energy supplied to the compressor constitutes the additional energy input to the vapours. After the compression of the vapour and its subsequent condensation, through transfer of heat to process fluid, the hot condensate leaves the system, which can be used as feed water/ liquid for boilers.

3.3.11 Mill Drives

DC mill drives are used in most sugar mills in India to drive the milling tandem with four to five 500-1000 HP drives. This is in vogue in most of the plants now, with conversion of turbo-steam drive to electrical drive with co-generation of power for export being popular. However, the new development of using AC drive instead of DC drive has the following advantages. The advantages include the following:

- Efficiency of AC motor is higher than DC motor
- Low maintenance cost than DC motor
- Less harmonics than DC motor
- Overall power saving of 3-5% is possible with AC drive for milling tandem in place of DC drives

3.3.12 Vertical continuous vacuum pan for massecuite boiling

The use of batch type vacuum pans in most of the mills results in considerable fluctuations of steam consumption and irregular sugar quality. It results in variation in the syrup brix. The use of fully auto controlled continuous pan helps in maintaining a steady consumption of vapours thus eliminating the problems associated with fluctuating vapour flows. This ensures the uniform functioning of the evaporator station, and also boiler steam generation.

3.3.13 Low pressure extraction (LPE) system

The new LPE system is an efficient alternative to conventional methods of juice extraction, which utilizes combination of solid-liquid extraction and conventional milling technology at low hydraulic pressures. The system uses perforated rollers in modules of 2. A total of eight

modules (16 rollers) were used during the trial runs. Hydraulic pressure of 110 bar is used. Due to perforations in the rollers, the extracted juice is quickly drained out. Re-absorption of juice is negligible. The system is driven by electric motors and operation is automatically controlled.

3.3.14 Membrane filtration for sugar manufacturing

Membrane filtration is the process for production of sulphur free, refined quality sugar without going through conventional refining. In this process, high temperature tolerant polymeric membrane modules are employed for sugarcane juice clarification for production of high quality sugar. These membrane modules are capable of withstanding continuous exposure to hot juice without any visible signs of deterioration.

3.3.15 High pressure co-generation system

Apart from improving the end use efficiency in the plants, the other most promising energy conservation measure for the industry is to install extra high pressure (87 kg/ cm^2 or 110 kg/ cm^2)/ temperature (515 or 540 deg C) configuration co-generation systems.

3.4 Conclusions

The sugar industry is one of the largest energy users among industry sector using bagasse for meeting both thermal energy and electricity requirements. Out of the 527 operating sugar mills in India, about 99 sugar mills have an installed capacity of 5000 TCD and above. These sugar mills can be brought under two broad categories viz. (1) sugar mills with steam driven mills and (2) sugar mills with electrical motor driven mills. The sugar mills above 5000TCD capacity may be taken up for detailed study in the first phase. The estimated annual energy consumption of these sugar mills vary between 45,000 toe per year to 90,000 toe per year. The estimation of annual energy consumption was based on sugar recovery and average crushing period of sugar mills in India. A large number of these units have adopted cogeneration route to meet their overall energy requirements. As per the collected information and discussions with stakeholders during the sectoral workshop, there exists a significant energy saving potential of about 20% in sugar industries. Therefore it is suggested that these 99 sugar mills (which operate either separately or as a group) may be considered as DCs under the PAT scheme with a threshold limit of 30,000 toe as minimum annual energy consumption per plant (figure 3.4).

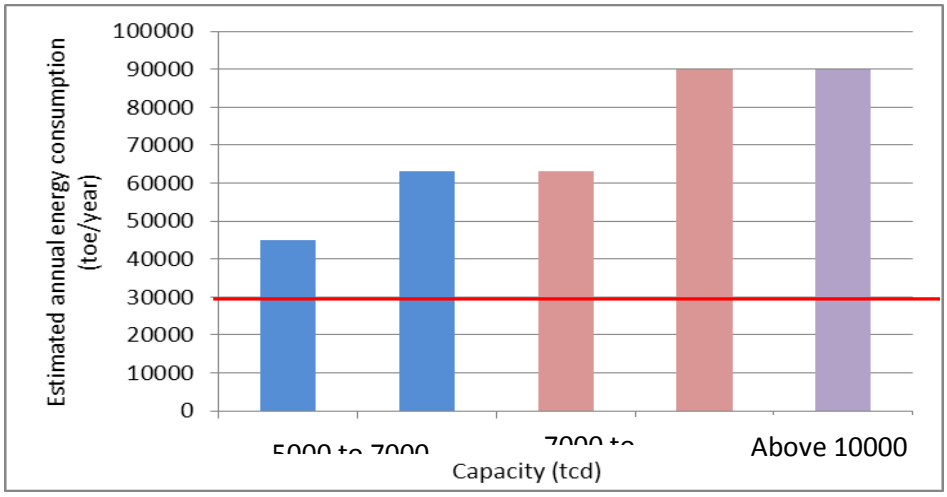


Figure 3.4: Estimated annual energy consumption

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5.0 Annexure 1

State Wise Sugar Plant Information

Name of the State: ANDHRA PRADESH **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	The Chodavaram Co-op. Sugars Ltd., Chodavaram	4,000	5.19	6.25
2	NCS Sugars Ltd.	6,000	3.99	20
3	Parry Sugar Industries Ltd., Varalakshmi	5,000	4.04	16
4	K.C.P. Sugar And Industries Corporation Ltd., Vuyyuru	7,500	8.06	15
5	K.C.P. Sugar And Industries Corporation Ltd., Lakshmipuram	4,000	2.5	5
6	Nava Bharat Ventures Ltd., (Sugar Division), Samalkot	4,000	4.01	9
7	Sri Sarvaraya Sugars Ltd., Chelluru	5,000	3.31	12.65
8	The Andhra Sugars Ltd., Tanuku	5,000	2.24	-
9	The Andhra Sugars Ltd., Taduvai	5,500	3.55	7
10	The Jeypore Sugar Company Ltd., Chagallu	8,500	9.53	25
11	The Andhra Sugars Ltd., Bhimadole	5,500	1.89	
12	Madhucon Sugar & Power Industries Ltd., Rajeswarapuram	3,500	1.98	20
13	Gayatri Sugars Ltd., N.C.S. Gayatri	3,500	3.29	6
14	Ganpati Sugar Industries Ltd., Sangareddy,	5,000	5.62	15
15	VDB Sugars Ltd., G.S. Complex	3,500	2.25	
16	Madhucon Sugar & Power Industries Ltd., Rajeswarapuram	3,500	1.36	24
17	Sagar Sugars & Allied Products Ltd., Nelavoy	4,000	1.87	20.4
18	NSL Krishnaveni Sugars Ltd., Krishnaveni	3,500	1.08	28

Name of the State: Bihar **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	Riga Sugar Co. Ltd., Righa	5,000	4.45	
2	Jay Shree Sugar Mill, Majhaulia	5,000	3.87	
3	New Swadeshi Sugar Mills	7,500	6.4	5
4	Harinagar Sugar Mills Ltd., Harinagar	10,000	9.17	14.5
5	Bharat Sugar Mills, Sidhwalia	5,000	3.69	15
6	Vishnu Sugar Mills Ltd., Gopalganj	3,500	3.85	

Name of the State: GUJARAT **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)
1	Shree Khedut Sahakari Khand Udyog Mandli Ltd., Bardoli	10,000	20.27
2	Sahakari Khand Udyog Mandal Ltd., Gandevi	5,000	12.79
3	Shree Madhi Vibhag Khand Udyog Sahakari Mandli Ltd., Madhi	7,000	13.49
4	Shree Chalthan Vibhag Khand Udyog Sahakari Mandli Ltd., Chalthan	5,000	9.82
5	Shree Mahuva Pradesh Sahakari Khand Udyog Mandli Ltd., Mahuva	3,500	7.41
6	Shree Sayan Vibhag Sahakari Khand Udyog Mandli Ltd., Sayan	5,000	10.97
7	Shree Valsad Sahakari Khand Udyog Mandli Ltd., Valsad	5,000	5.25
8	Shree Ganesh Khand Udyog Sahakari Mandli Ltd., Vataria	4,000	6.94

Name of the State: HARYANA **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)
1	Saraswati Sugar Mills Ltd., Yamunanagar	13,000	12.62
2	Piccadily Agro Industries Ltd., Bhadson	5,000	3.19
3	The Shahabad Co-op.Sugar Mills Ltd., Shahabad	3,500	4.42

Name of the State: KARNATAKA **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	Coromandel Sugars Ltd., (A Unit of India Cements Ltd.,)	3,500	7.65	2 X 6
2	The Mysore Sugar Co.Ltd., Mandya	3,500	2.81	-
3	The Pandavapura S.S.K. Ltd., Mysugar Unit-II	3,500	2.81	-
4	Sri Chamundeswari Sugars Ltd., Chamundeswari	4,000	8.14	26
5	NSL Sugars Ltd., Koppa	3,500	9.75	-
6	The Ugar Sugar Works Ltd., UgarKhurd	10,000	18.12	44
7	Shri Hiranyakeshi Sahakari Sakkare Karkhane Niyamit, Sankeshwar	5,000	9.77	26
8	Shri Malaprabha S.S.K. Niyamit, Malaprabha	3,500	5.19	-
9	Shree Doodhaganga Krishna S.S.K. Niyamit, Chikodi	5,500	11.19	20.7
10	Shree Renuka Sugars Ltd., Manoli	7,500	16.81	35.5
11	Athani Farmers Sugar Factory Ltd., Madbhavi	4,500	8.49	24
12	Venkateshwara Power Project Ltd., Venkateshwara	5,000	9.05	21
13	Satish Sugars Ltd., Hunshyal	7,500	12.15	31

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
14	Vishwanath Sugar & Steel Industries Ltd., Bellad Bagewadi	5,500	8.84	39
15	Shree Renuka Sugars Ltd., Burlatti	15,000	15.82	38
16	The Bidar Sahakari Sakkare Karkhane Ltd., Bidar	3,500	3.95	-
17	The Godavari Biorefineries Ltd., Sameerwadi	14,000	19.34	45.56
18	Nirani Sugars Ltd., Mudhol	6,250	12.38	32
19	GEM Sugars Ltd.	5,000	10.16	16.5
20	Shri Prabhulingeshwar Sugars & Chemicals Ltd., Siddapur	8,500	14.08	38.5
21	Sadashiva Sugars Ltd., Sadashiva	3,500	4.07	15.5
22	Indian Cane Power Ltd., Uttur	5,000	10.44	-
23	The Nandi S.S.K. Niyamit., Bijapur	5,000	10.14	18.1
24	Davangere Sugar Co.Ltd., Davangere	3,500	4.49	24.45
25	Bannari Amman Sugars Ltd., Bas	7,500	12.73	36
26	Shree Renuka Sugars Ltd., Unit V, Havalaga	10,000	11.82	25. 5
27	Core Green Sugar & Fuels Pvt. Ltd.	5,000	0.63	-
28	Vijayanagar Sugars Pvt.Ltd., Mundargi	5,000	3.94	26

Name of the State: MAHARASHTRA **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	Baramati Agro Ltd., Shetphalgade	4,000	8.81	-
2	Bhima Sahakari Sakhar Karkhana Ltd., Patas	5,000	11.39	-
3	Shri Chhatrapati Sahakari Sakhar Karkhana Ltd., Bhavaninagar	3,500	9.51	-
4	Daund Sugar Ltd., Alegaon	3,500	9.32	18
5	Karmayogi Shankarroji Patil Sahakari Sakhar Karkhana Ltd., Indapur	5,000	15.48	-
6	The Malegaon Sahakari Sakhar Karkhana Ltd., Malegaon	4,000	10.58	-
7	Shri Someshwar Sahakari Sakhar Karkhana Ltd., Nira	3,500	10.49	-
8	Shri Vighnahar Sahakari Sakhar Karkhana Ltd., Junnar	5,000	12.73	-
9	Yashwant Sahakari Sakhar Karkhana Ltd., Theur	3,500	1.73	-
10	Shri Pandurang Sahakari Sakhar Karkhana Ltd., Pandurang	3,500	12.69	9
11	Sahakar Maharshi Shankarao Mohite-Patil S.S.K. Ltd., Akluj	4,500	12.06	-
12	Shree Siddheshwar Sahakari Sakhar Karkhana Ltd., Kumathe	5,000	9.6	-
13	Shri Vitthal Sahakari Sakhar Karkhana Ltd., Gursale	5,000	14.21	-
14	Vitthalrao Shinde Sahakari Sakhar Karkhana Ltd.,	3,500	15.99	10.5

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
	Pimpalner			
15	Dr. Baburao Bapuji Tanpure Sahakari Sakhar Karkhana Ltd., Rahuri	4,250	6.85	-
16	Padmashri Dr. Vitthalrao Vikhe Patil S.S.K. Ltd., Pravaranagar	4,000	11.63	30
17	Shri Dnyaneshwar Sahakari Sakhar Karkhana Ltd., Bhende	5,000	12.15	12
18	Mula Sahakari Sakhar Karkhana Ltd., Sonai	3,500	9.83	16
19	Shri Saikrupa Sugar & Allied Industries Ltd., Hiradgaon	7,500	2.69	-
20	Sahakar Maharshi Bhausaheb Thorat Sahakari Sakhar Karkhana Ltd., Sangamner	3,500	11.22	-
21	The Shrigonda Sahakari Sakhar Karkhana Ltd., Shrigonda	3,500	7.52	-
22	Niphad Sahakari Sakhar Karkhana Ltd., Niphad	3,500	4.81	-
23	Jai Mahesh Sugar Industries Ltd., (A unit of NSL Sugars Limited), Pawarwadi	7,000	5.11	30
24	Majalgaon Sahakari Sakhar Karkhana Ltd., Majalgaon	3,500	6.01	-
25	Gangakhed Sugar & Energy Ltd.	6,000	6.21	-
26	Natural Sugar & Allied Industries Ltd., Rajani	5,000	7.85	22
27	Terna Shetkari Sahakari Sakhar Karkhana Ltd., Terna	5,000	2.59	14
28	Shree Bhogawati Sahakari Sakhar Karkhana Ltd., Bhogawati	4,000	6.95	-
29	Shree Chhatrapati Shahu S.S.K.Ltd., Kagal	3,500	8.68	12.5
30	Shree Datta Shetkari S.S.K. Ltd., Shirol	7,000	15.93	30
31	Daulat Shetkari S.S.K. Ltd., Daulat	3,500	3.86	-
32	Shree Dudhganga Vedganga S.S.K. Ltd., Bidri	4,500	8.75	-
33	Deshbhakta Ratnappanna Kumbhar Panchganga S.S.K.Ltd., Ichalkaranji	5,000	6.82	30
34	Jawahar Shetkari Sahakari Sakhar Karkhana Ltd., Hupari	7,500	18.5	15
35	Shri Tatyasaheb Kore Warana S.S.K. Ltd., Warana	7,500	16.35	-
36	Hutatma Kisan Ahir S.S.K. Ltd., Hutatma	3,500	8.19	-
37	Rajarambapu Patil Sahakari Sakhar Karkhana Ltd., Rajaramnagar, (Plant Name- Walwa, Code-15501)	4,000	11.60	-
38	Vasantdada Shetkari Sahakari Sakhar Karkhana Ltd., Sangli	5,000	7.81	-
39	Kisanveer Satara Sahakari Sakhar Karkhana Ltd., Bhuinj	4,000	11.56	2
40	Sahyadri Sahakari Sakhar Karkhana Ltd., Yashwantnagar, Tal. Karad, Dist. Satara 415 115,	7,500	15.99	-
41	Yashwantrao Mohite Krishna S.S.K. Ltd., Krishna	7,200	14.82	16

Name of the State: PUNJAB **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	Wahid Sandhar Sugars Ltd., Phagwara	4500	2.38	18 MW.
2	Bhagwanpura Sugar Mills, Dhuri	3500	2.84	-
3	Rana Sugars Ltd., Baba Bakala	5000	4.05	46 MW.
4	Indian Sucrose Ltd., Mukerian	5000	4.86	
5	A.B. Sugars Ltd., Dasuya	7000	4.54	33 MW.
6	Nahar Industrial Enterprises Ltd., Amloh	5000	3.07	8 MW.
7	Chadha Sugars & Industries Ltd., Kiri	5000	2.18	

Name of the State: TAMIL NADU **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	E.I.D. Parry (India) Ltd., Nellikuppam	5000	10.96	
2	Shree Ambika Sugars Ltd.	7500	7.86	40 MW.
3	Rajshree Sugars and Chemicals Ltd., Mundiyampakkam	5000	9.76	22 MW.
4	Sakthi Sugars Ltd., Sakthi	7500	14.46	
5	E.I.D. Parry (India) Ltd., Pugalur	4000	8.89	22.6 MW
6	Thiru Arooran Sugars Ltd., Thiru Arooran	3500	5.55	18.68 MW
7	Shree Ambika Sugars Ltd., Kottur	4000	0.63	16.2 MW.
8	Thiru Arooran Sugars Ltd.	6000	3.45	28.42 MW,
9	NPKR Ramasamy Co-op. Sugar Mills Ltd., Mailaduthurai	3500	3500	
10	Bannari Amman Sugars Ltd., Bannari	4000	4.42	20MW.
11	Sakthi Sugars Limited, Shivganga	4000	4.22	
12	Dharani Sugars & Chemicals Ltd., Polur	4000	5.83	15 MW.
13	E.I.D. Parry (I) Ltd., Aranthangi	4000	6.53	18.5 MW.
14	Kothari Sugars & Chemicals Ltd., Sathiyamangalam	5000	3.47	
15	Sakthi Sugars Ltd., Unit IV, Modakurichi	4000	1.82	
16	Rajshree Sugars & Chemicals Ltd., Semmedu	3500	6.61	20.5 MW
17	Dhanalakshmi Srinivasan Sugars Pvt.Ltd., Udumbiyan	3500	3.66	23 MW
18	Dharani Sugars & Chemicals Ltd., Kalayanallur	3500	8.1	
19	Bannari Amman Sugars Ltd., (Unit IV), Tiruvannamalai	5000	7.71	28.8 MW
20	Empee Sugars Ltd., Idaikkal	7500	0.65	
21	Madras Sugars Limited, Thirukovilur	3600	1.88	25 MW

Name of the State: U.P **Season: 2010-11**

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	The Simbhaoli Sugars Ltd., Chilwaria	4.41	3.97	11.75 + 22
2	Parle Biscuits Pvt.Ltd., Parsendi	3.73	3.2	18.23 + 9
3	Rauzagaon Chini Mills, (A Unit of Balrampur Chini Mills Ltd.),	5.34	5.12	29.75

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
4	Bajaj Hindusthan Ltd., Pratappur	2.15	2.01	
5	The Kanoria Sugar & General Manufacturing Co. Ltd., Captainganj	3.27	3	
6	Triveni Engineering & Industries Ltd., Ramkola	5.01	4.92	
7	The United Provinces Sugar Co.Ltd., Seorahi	5.2	4.76	
8	Saraya Sugar Mills, Sardarnagar	2.43	2.21	
9	J.H.V. Sugar Ltd., Gadaura	2.78	2.58	20
10	The Basti Sugar Mills Co. Ltd., Basti	2.88	2.56	
11	Govindnagar Sugar Ltd., (Unit of Bajaj Hindusthan Ltd.)	3.05	2.75	
12	Balrampur Chini Mills Ltd., Babhnan	8.74	8.22	5
13	Balrampur Chini Mills Ltd., Balrampur	10.85	9.92	
14	Tulsipur Sugar Co., (Unit of B.C.M. Ltd.), Tulsipur	5	4.78	
15	Haidergarh Chini Mills, (A Unit of Balrampur Chini Mills Ltd.), Haidergarh	3.24	2.95	23.25
16	K.M. Sugar Mills Pvt. Ltd., K.M. Sugar	5.48	5.18	
17	The Seksaria Biswan Sugar Factory Ltd., Biswan	8.81	8.26	
18	The Oudh Sugar Mills Ltd., Hargaon	12.48	11.79	15
19	Dalmia Chini Mills, Ramgarh	6.26	5.8	25
20	Kamlapur Sugar & Industries Ltd., Kamlapur			
21	Akbarpur Chini Mills, (A Unit of Balrampur Chini Mills Ltd.) (Plant Name- Akbarpur, Code- 56501),	6.63	6.45	
22	Dalmia Chini Mills, (Plant Name- Jawaharpur, Code- 69401)	7.19	6.68	27
23	Kumbhi Chini Mills, (Plant Name- Kumbhi, Code- 59301),	9.62	9.34	
24	Mankapur Chini Mills, (A Unit of Balarampur Chini Mills Ltd.),	8.22	7.7	37
25	Bajaj Hindusthan Ltd., (Plant Name- Khambarkhera, Code- 57701),	8.63	8.03	
26	J.H.V. Distilleries & Sugar Mills Ltd, (Formerly Cawnpore Sugar Works Ltd.,) (Plant Name- Padrauna, Code- 08001),	1.67	1.49	
27	Bajaj Hindusthan Ltd, Rudhauli	2.01	1.83	
28	Bajaj Hindusthan Sugar & Industries Ltd., Kundarki	8.01	7.5	
29	Bajaj Hindusthan Ltd, Ita Maida	4.38	4.11	33
30	Gularia Chini Mills (A Unit of Balrampur Chini Mills Ltd.), Gularia	8.99	8.4	31.3
31	New India Sugar Mills Ltd., (Unit - The Oudh Sugar Mills Ltd.)	5.05	4.88	
32	Rosa Sugar Works, Rosa	3.18	2.71	
33	Kesar Enterprises Ltd., Baheri	7.38	7.18	
34	J.K. Sugar Ltd.	4.19	3.74	19 + 7.0
35	L.H. Sugar Factories Ltd., Pilibhit	8.57	7.82	46
36	Upper Ganges Sugar & Industries Ltd., Seohara	11.61	11.35	
37	The Dhampur Sugar Mills Ltd., Dhampur	12.74	12.75	60 MW

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
38	Dwarikesh Sugar Industries Ltd., Dwarikesh	6.88	7.1	7.5 MW,
39	Dwarikesh Sugar Industries Ltd., Dwarikeshpuram	5.87	5.56	
40	Bajaj Hindusthan Ltd., Bilai	8.34	8.55	
41	Uttam Sugar Mills Ltd., Pudrikhurd	6.95	6.68	
42	Wave Industries Pvt. Ltd., Dhanaura	8.29	7.6	
43	Venus Sugar Ltd., Venus	0.83	0.64	
44	DSM Sugar Mills Asmoli , Asmoli	7.34	6.71	30 MW
45	Dewan Sugars Ltd., Agwanpur	2.83	2.54	
46	DSCL Sugar, Rupapur	5.84	5.08	
47	Gobind Sugar Mills Ltd., Aira	8.26	7.44	
48	Bajaj Hindusthan Ltd., Gola	13.99	13.73	
49	Bajaj Hindusthan Ltd., Palikalan	11.84	11.04	
50	Sarjoo Sahakari Chini Mills Ltd., Belrayan	6.28	5.51	
51	Kisan Sahakari Chini Mills Ltd., Sampurnanagar	4.73	4.18	
52	DSCL Sugar - Ajbapur, J.B. Ganj	11.83	11.17	38 MW.
53	Anand Agrochem India Ltd., Anandgopi	0.65	0.49	
54	Triveni Engineering & Industries Ltd., Chandanpur	4.95	4.39	
55	Triveni Engineering & Industries Ltd., Milak Narayanpur	3.85	2.99	
56	Triveni Engineering & Industries Ltd., Rani Nangal	3.94	3.73	
57	DSCL Sugar - Hariawan, Hariawan	5.8	5.5	15 MW.
58	DSCL Sugar -Loni, Loni	6.22	5.6	25 MW
59	Bajaj Hindusthan Ltd., Barkhera	6.77	6.2	
60	DSM Sugar – Rajpura	5.6	5	
61	Dalmia Chini Mills, Nigohi	7.36	6.91	
62	Rana Sugars Ltd, Belwara	4.8	4.22	25 MW.
63	Bajaj Hindusthan Ltd, Maqsudapur	4.82	4.48	
64	Rana Sugars Ltd., Dhadha Bujurg	4.3	3.63	
65	Dwarikesh Sugars Industries Ltd., Dwarkadishdham	6.11	5.22	
66	Baghauli Sugar & Distillery Ltd., Bikapur	1.59	1.32	
67	Mawana Sugar Works, Mawana	12.96	12.13	
68	SBEC Sugar Ltd., Malakpur	8.97	7.64	
69	Daurala Sugar Works, Daurala	14.03	12.73	
70	Bajaj Hindusthan Ltd., Kinauni	10.97	9.4	10 MW.
71	Nanglamal Sugar Complex, Nanglamal	5.34	4.81	20 MW.
72	DSM Sugar Mansurpur, Mansurpur	7.42	6.79	
73	Triveni Engineering & Industries Ltd., Khatauli	13.03	11.89	45 MW.
74	Upper Doab Sugar Mills, Shamli	8.13	7.28	
75	Titawi Sugar Complex, Titawi	10.28	9.09	28 MW
76	UNN Sugar Complex, UNN	4.6	4.1	
77	Tikaula Sugar Mills Ltd., Tikaula	6.26	5.96	10 MW
78	Bajaj Hindusthan Ltd., Unit Bhaisana, Bhaisana	9.1	8.29	
79	Bajaj Hindusthan Ltd., Unit Thanabhawan, Thanabhawan	7.07	6.26	
80	Modi Sugar Mills., Modinagar	6.08	5.39	

Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
81	Simbhaoli Sugars Ltd., Simbhaoli	8.72	7.95	
82	Anamika Sugar Mills Pvt. Ltd.	2.51	2.23	
83	Triveni Engineering and Industries Limited., Sabitgarh	5.47	4.69	
84	Triveni Engineering and Industries Limited, Deoband	9.82	9.38	22 MW
85	Daya Sugar Ltd., Naya Bans	1.5	1.27	
86	Kisan Sahkari Chini Mills Ltd., Nanauta	5.18	4.35	
87	Shakumbari Sugar & Allied Industries Ltd., Todarpur	3.28	2.9	
88	Bajaj Hindusthan Ltd., Gangnauli	4.1	3.76	
89	Uttam Sugar Mills Ltd., Khaikheri	3.24	2.89	
90	Uttam Sugar Mills Ltd., Shermau	4.67	4.16	
91	Simbhaoli Sugars Ltd., Brijnathpur	3.57	3.14	

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Sl. No	Name of the Plant	Crushing Capacity (M.T)	Sugar Produced (Lakh/Qtl)	Co-generation Capacity (MW)
1	Kashipur Sugar Mills Ltd., Kashipur	6250	2.16	
2	Kichha Sugar Company Ltd., Kichha	4000	2.82	
3	The Bazpur Co-op. Sugar Factory Ltd., Bazpur	4000	2.55	
4	Rai Bahadur Narain Singh Sugar Mills Ltd., Lhaksar	8400	7.82	30 MW
5	Lakshmi Sugar Mills Company Ltd., Iqbalpur	4500	4.07	
6	Uttam Sugar Mills Ltd., Libberheri	6250	4.38	