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India

Biofuels Annual

2016

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Report Highlights:

Domestic ethanol production will decline by eight percent in calendar year (CY) 2017 (out-year) to 1.9 billion liters. The decline in ethanol production stems from the second consecutive year of decreased sugarcane acres. Fuel ethanol will achieve a two-percent national-level blending rate, a slight increase over 1.9 percent this year. Although biodiesel's market penetration remains minimal, B-5 (five-percent biodiesel) will be commercial available from a few government-owned retail outlets. Private manufacturers can sell biodiesel directly, provided they meet prescribed official standards.

Post:

New Delhi

Executive Summary:

Domestic ethanol production in CY 2017 will decline by eight percent to 1.9 billion liters due to the decline in sugarcane area planted for a second consecutive year (marketing year (MY) 2016/17). Fuel ethanol will achieve a two-percent national average blending rate, as ethanol will replace 700 million liters of gasoline. The current average for ethanol blending is estimated at 1.9 percent as parastatal petroleum companies (known colloquially as oil marketing companies or OMCs) are expected to blend an estimated 600 million liters of ethanol with gasoline.

Assuming normal market conditions in CY 2016, India is expected to import upwards of 440 million liters of ethanol. Import volumes will rise further to 600 million liters during the out-year to augment local supplies. Last year, the United States was the largest supplier of ethanol to India, followed by Brazil. In CY 2014, Brazil did not actively ship ethanol to India and the United States sold 66 million liters (62 percent of total imports) of denatured ethanol, valued at upwards of $51 million.

Compared to the benchmark price ($0.72 to $0.74/liter, landed-ethanol prices delivered at OMC depot), imported ethanol will sell on par with local supplies, thereby providing less incentive for imports. Usually, when local ethanol prices are high, Indian chemical and industrial end users prefer imported ethanol and sugar distilleries benefit by selling to OMCs.

Regarding biodiesel, the current average Indian blending rate is only 0.1 percent. However, B-5 will become available to customers across state-owned OMC retail outlets in select cities across India. Private biodiesel manufacturers are also encouraged to sell more biodiesel (made from multiple domestic feedstocks, as well as imported crude vegetable oil) directly to end-users provided they meet prescribe Bureau of Indian Standards (BIS) norms. Advanced biofuel production remains nascent, as commercial production and economic viability remain a challenge.

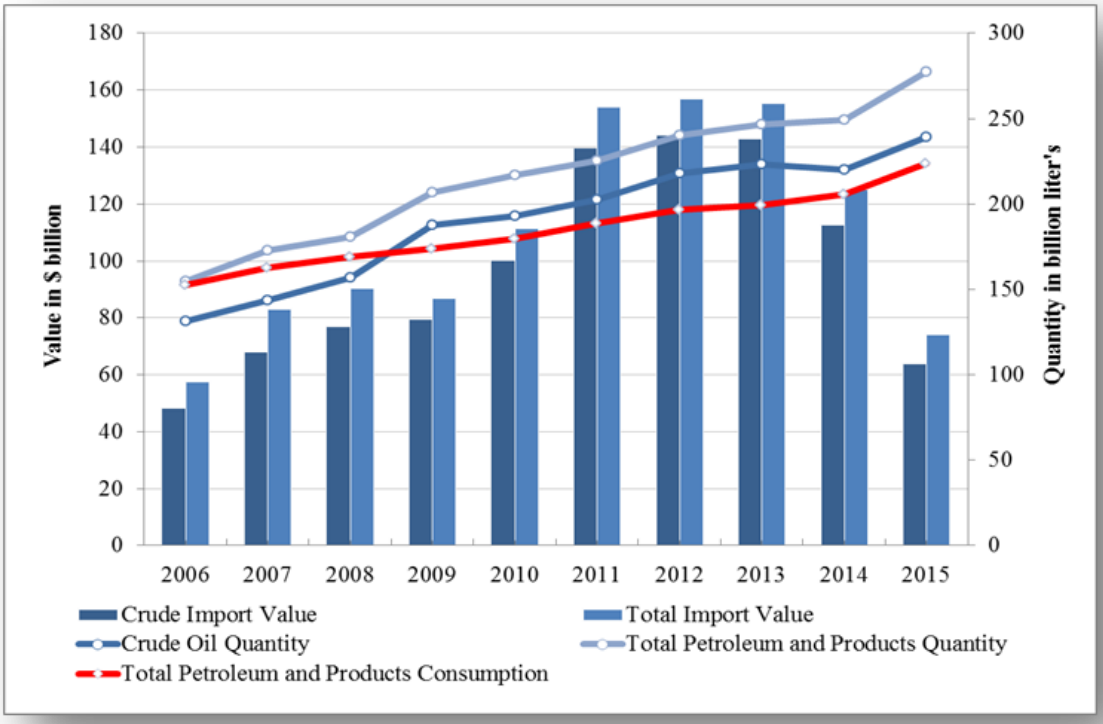
Author Defined:

Overview

India's economy is likely to remain stable during fiscal year (FY) 2016-17 (April-March), and should maintain at least seven-percent GDP. Last calendar year, India averaged about 7.3 percent GDP growth per capita (World Factbook) which was spurred largely due to low crude oil prices, which saved billions of dollars and enabled Indian to narrow its current account deficit. Recent World Bank reports indicate that India's economic activity may achieve upwards of 7.6 percent in FY 2017 based on private investment and infrastructure spending. Additionally, growth will be driven by private consumption, which has benefited from lower energy prices and higher real incomes (World Economic Outlook, IMF).

Although the energy consumption per capita (per industry estimates) is one-third of the global average, growth in Indian's economy will drive demand for energy across sectors. Hence, access to adequate and reliable sources of energy becomes vital; particularly when one-quarter of population lack access to electricity and dependence on fossil fuels (imported and local) continues to grow. The latter meets about three-quarter of India's energy demand.

Figure 1. India: Import of Crude Oil, Petroleum Products and Consumption



Source: Petroleum Planning and Analysis Cell, government of India (GOI),
Time scale in Indian fiscal year

India is the third-largest importer of crude oil after the United States and China and continues to rely on imports considerably. Lower crude oil prices have encouraged higher demand for gasoline and petroleum products, helped the exchequer save significantly in terms of import bills, and provided a cushion against the strengthening dollar. Over the last four years, import volumes grew modestly from 240 billion liters to 278 billion liters and associated cost dropped more than 50 percent to $74 billion (Figure 1).

Energy Consumption and End Use

44 percent of India's total energy consumption basket comes from coal. Energy rich resources such as petroleum and biomass contribute 22 percent each, followed by natural gas at seven percent, hydro-electricity at three percent, while nuclear and other renewables contribute just one percent each (U.S. Energy Information Administration (EIA)). The industry and transport sectors are the largest end-users of energy in India and account for half of the total energy consumed. The main fuels contributing to this end-use demand growth are coal (in industry), petroleum (in transport), and electricity (in buildings, industry, and agriculture) (International Energy Agency).

Petroleum use will continue to expand on growth in transport sector, particularly road transport, which account for significant share of passenger and freight movement. The share of road traffic as percent of

freight and passenger traffic is estimated at upwards of 60 percent and 90 percent, assuming vehicle population grows 10 percent annually. Currently, diesel alone meets an estimated 46 percent of transportation fuel demand followed by gasoline at 24 percent (Figure 2). Further, it is estimated that in next ten years, by the average demand for transport fuels will rise from an estimated 134 billion liters in CY 2015 to 225 billion liters in CY 2026 (Table 1).

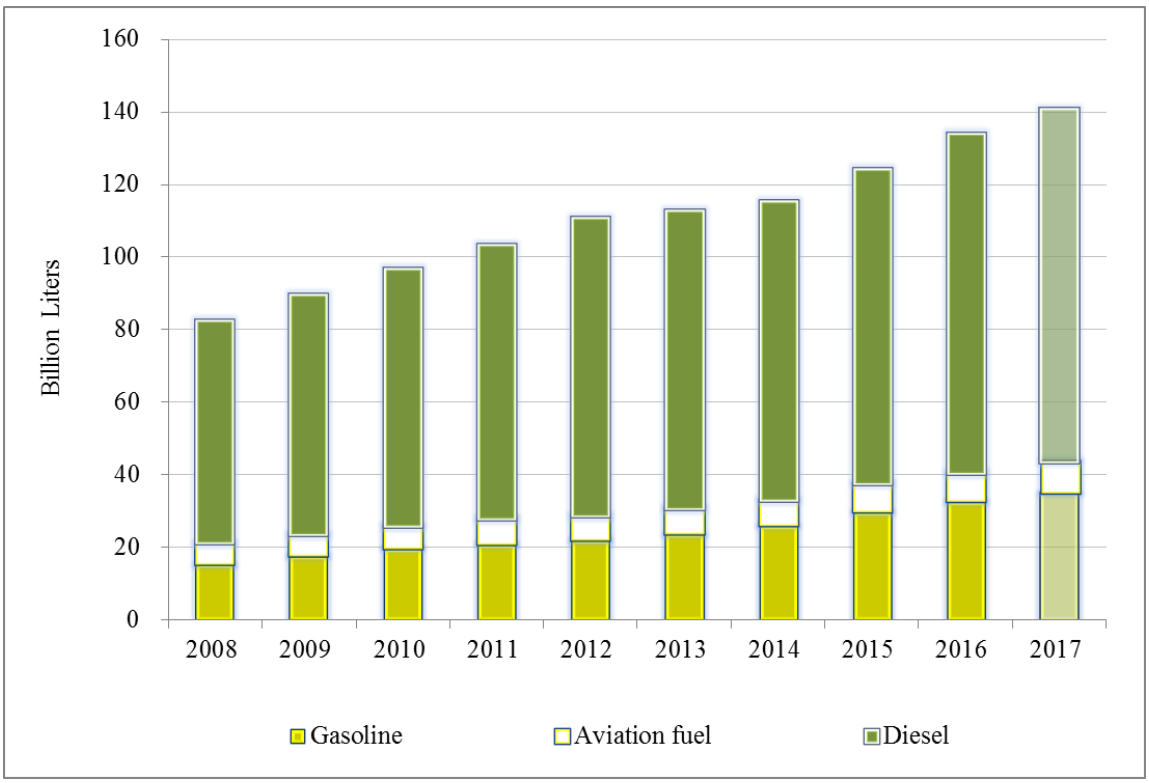
Why Road Transport: Easy availability, adaptability to individual needs, and cost saving are some of the factors which favor automotive transport. Road transport also acts as a feeder service to railway, shipping and air traffic. Additionally, continued economic growth, increasing urbanization, rise in consumer spending levels and with improving road infrastructure, new vehicle registration is expected to push the total number of registered motor vehicles past 245 million by end of the current fiscal. The number of registered vehicles in India as of March 31, 2013 was 183 million, wherein motorcycles constituted 73 percent and automobiles accounted for 14 percent of total share, respectively (Annual Report 2015).

India to Adopt Bharat Stage (BS)-VI Emission Norms by 2020

The current growth in transportation and consequent increase in petroleum consumption raises environmental concerns. As India is the fourth (energy data) largest global contributor to carbon emissions, the Government of India (GOI) is targeting EURO-III and IV as reference emission norms for vehicles, which in turn require adoption of clean and green fuel. Bharat Stage-III norms are already enforced across the country while BS-IV (equivalent to Euro-IV) emission norms are applicable across 12 to 14 major cities. To meet that objective, the Union Cabinet approved the National Policy on biofuels on December 24, 2009 (PIB press release).

The Ministry of Road Transport and Highways is now introducing BS-VI fuel norms after due consultation with Ministry of Petroleum and National Gas (MoPNG), Department of Heavy industry and Ministry of Environment and Forest all over the country by 01.04.2020. Accordingly, a draft notification to amend the Central Motor Vehicles Rules, 1989 has been forwarded to the Government of India Press on February 22, 2016 for publication in the Gazette of India, giving 30 days' time to the public, inviting suggestions/comments on the notification before finalizing the same. Official notification is due as on date of publication of this report (PIB Press Release).

Figure 2. India: Consumption of Fuels, In Calendar Year



Source: Petroleum Planning and Analysis Cell, government of India (GOI)
*: Estimated for IFY 2017

Table 1. India: Fuel Use

Fuel Use History (Million Liters)											
Calendar Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Gasoline Total	11,650	12,761	14,189	15,368	17,606	19,563	20,716	21,842	23,749	25,848	29,651
Diesel Total	47,810	51,084	55,597	61,491	66,390	71,041	75,866	82,238	82,256	82,674	87,064
On-road	28,686	30,651	33,358	36,894	39,834	42,625	45,520	49,343	49,354	49,605	52,239
Agriculture	5,737	6,130	6,672	7,379	7,967	8,525	9,104	9,869	9,871	9,921	10,448

Construction & Mining	1,912	2,043	2,224	2,460	2,656	2,842	3,035	3,290	3,290	3,307	3,483
Shipping & Rail	2,391	2,554	2,780	3,075	3,320	3,552	3,793	4,112	4,113	4,134	4,353
Industry	5,259	5,619	6,116	6,764	7,303	7,815	8,345	9,046	9,048	9,094	9,577
Heating	3,825	4,087	4,448	4,919	5,311	5,683	6,069	6,579	6,580	6,614	6,965
Jet Fuel Total	4,520	4,785	5,490	5,674	5,641	6,145	6,809	6,626	6,789	6,960	7,564
Total Fuel Markets	63,980	68,630	75,276	82,532	89,637	96,750	103,392	110,706	112,794	115,482	124,280

Fuel Use Projections (Million Liters)

Calendar Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Gasoline Total	32,409	34,916	37,616	40,526	43,661	47,038	50,676	54,596	58,819	63,368	68,270
Diesel Total	93,518	97,371	101,382	105,559	109,909	114,437	119,152	124,061	129,172	134,494	140,035
On-road	56,111	58,422	60,829	63,336	65,945	68,662	71,491	74,436	77,501	80,696	84,021

									3		
Agriculture	11,222	11,684	12,166	12,667	13,189	13,732	14,298	14,887	15,501	16,139	16,804
Constructn & Mining	3,741	3,895	4,055	4,222	4,396	4,577	4,766	4,962	5,167	5,380	5,601
Shipping & Rail	4,676	4,869	5,069	5,278	5,495	5,722	5,958	6,203	6,459	6,725	7,002
Industry	10,287	10,711	11,152	11,612	12,090	12,588	13,107	13,647	14,209	14,794	15,404
Heating	7,481	7,790	8,111	8,445	8,793	9,155	9,532	9,925	10,334	10,760	11,203
Jet Fuel Total	7,935	8,561	9,237	9,965	10,752	11,600	12,515	13,503	14,568	15,718	16,958
Total Fuel Markets	133,862	140,848	148,235	156,051	164,321	173,074	182,343	192,159	202,559	213,580	225,263

Source: Industry and trade sources
*: Heating / power generation
Proportion of diesel consumption through 2024 are indicative only.

Scope

Biofuels are viewed as a means to provide a higher degree of national energy security in an environmentally friendly, cost-effective and sustainable manner. The GOI believes biofuels can supplement conventional energy resources, reducing dependence on imported fossil fuels and meeting energy needs of India's vast rural population by use of non-food feed stocks.

Believing India to be endowed with significant potential for generating energy through renewable resources, the GOI is promoting and encouraging: a) ethanol derived from sugar molasses/juice for blending with gasoline, b) biodiesel derived from inedible oils and oil waste for blending with diesel, and c) bio-methanol and biosynthetic fuels.

Additionally, biomass plays an important role as fuel for sugar mills (captive use), textiles, pulp and paper mills, small and medium enterprises (SME) and has significant potential in breweries, textile mills, fertilizer plants, paper and pulp industry, solvent extraction units, rice mills, and petrochemical plants. The total estimated biomass power potential in India is estimated upwards of 40,000 MW of

which the power generation through bagasse cogeneration is estimated at 10,000 MW.

POLICY AND PROGRAM: 'INDIA'S BIOFUEL POLICY'

The GOI approved the National Policy on Biofuels on December 24, 2009. The policy encourages use of renewable energy resources as alternate fuel to supplement transport fuels and had proposed an indicative target to replace 20 percent of petroleum fuel consumption with biofuels (bioethanol and biodiesel) by end of 12th Five-Year Plan (2017).

In a bid to renew its focus and strongly implement the ethanol blending program (EBP), the GOI recommended 10 percent mandatory blending of ethanol with gasoline across all states. The GOI's target of five percent blending of ethanol in gasoline was partially successful in years of surplus sugar production and unfilled when sugar production declines. Presently, the contracted ethanol supply for CY 2016 is sufficient to meet 1.9 percent blending target.

Notably, few policy decisions such as deregulating diesel prices in line with gasoline, allowing private biodiesel manufacturers to sell biodiesel directly to consumers, fixed pricing mechanism for fuel ethanol procurement for OMCs and excise duty exemption for ethanol produced in MY 2015/16 will induce some momentum to the EBP, infuse cash into the local sugar industry, help millers clear partial debts, and help save millions of dollars in foreign exchange.

India's Biofuel Policy: Salient Features and Recent Developments

- On June 5, 2015, the Union Cabinet, GOI approved following decisions:
    - Sugarcane or sugarcane juice may not be used for production of ethanol and it be only produced only from molasses.
    - Ethanol produced from non-food feedstock besides molasses like cellulosic and ligno cellulosic materials and including petro-chemical route, may be allowed to be processed subject to meeting the relevant BIS standard.
    - The Motor Spirit (MS) and High Speed Diesel (HSD) control order may be **suitable amended** to acknowledge private biodiesel manufacturers, their authorized dealers, and JVs of OMCs authorized by MoPNG as dealers and give marketing and distribution functions to them for the limited purpose of supply of biodiesel to consumers. Earlier, on January 16, 2015, the Union Cabinet had decided to suitably amend Para 5.11 and 5.12 of the national biofuel policy to address direct sale of biodiesel.
    - Relaxation in marketing resolution No. 23015/1/20001 dated March 8, 2002 and a new clause give marketing rights for B-100 to the private bio-diesel manufacturers and authorized dealers.
    - The price of bio-diesel will be market determined (Source: Cabinet-decisions-on-Biofuels).
- On December 10, 2014, the GOI announced a price fixing scheme for fuel ethanol procurement

for parastatal OMCs. The program fixes landed-ethanol prices at OMC depots from INR 48.50 to INR 49.50 per liter, a three to five percent increase over the previous price.

- Derive biofuel from non-feed stock that would be grown on degraded soils or wastelands not otherwise suited to agriculture, thus avoiding a possible conflict of fuel versus food security.

- Strengthen India's energy security by encouraging use of renewable energy resources to supplement motor transport fuels. An indicative 20-percent target for blending of biofuel for both biodiesel and bioethanol is proposed by end of 12th Five-Year Plan (fiscal 2012/13 through fiscal 2016/17).

- Minimum Support Price (MSP) mechanism for inedible oilseeds to provide fair price to oilseed growers but subject to periodic revision.

- If necessary, GOI proposes to consider creating a National Biofuel Fund for providing financial incentives, including subsidies and grants, for new and second generation feed stocks, advanced technologies and conversion processes, and production units based on new and second generation feedstock.

- Thrust for innovation, (multi-institutional, indigenous and time bound) research and development on biofuel feedstock (*utilization of indigenous biomass feedstock included*) production including second generation biofuels.

- Meet the energy needs of India's vast rural population by stimulating rural development and creating employment opportunities and addressing global concerns about containment of carbon emissions through use of environment friendly biofuels.

- Bring biofuels under the ambit of "Declared Goods" by the GOI so as to ensure their unrestricted interstate and intrastate movement. Except for a concessional excise duty of 16 percent on bioethanol, no other central taxes and duties are proposed to be levied on biodiesel and bioethanol.

- Biofuel technologies and projects would be allowed 100 percent foreign equity through automatic approval to attract foreign direct investment (FDI), provided the biofuel is for domestic use only, and not for export. Plantations of inedible oil bearing plants would not be open for FDI participation.

- Setting up of National Biofuel Steering Committee (NBSC) under Prime Minister to provide policy guidelines.

- The objective of biofuel program is to support R&D, Pilot plant/Demonstration projects leading to commercial development of second generation biofuels.

For more information, please follow the link to biofuel policy.

Institutional Mechanism

The National Biofuel Policy proposes to set up a National Biofuel Coordination Committee (NBCC) headed by the Prime Minister. Given the role of different agencies and ministries in biofuel program, the role of NBCC is to provide high level coordination, policy guidance and review on different aspects of biofuel development, promotion and utilization becomes more imperative. The committee would meet periodically to review the progress and monitor the biofuel program. The policy also supports development of Biofuel Steering Committee headed by Cabinet Secretary to oversee implementation of its policies on regular basis.

Various state governments will work closely with respective research institutions, forestry department, universities etc. for development and promotion of biofuel program in respective states. Few states have drafted policies and set up institutions for promoting biofuel in their states. In order to deal with different aspects of biofuel development and promotion in the country, several ministries have been allocated specific roles and responsibilities such as

Ministry	Role
New and Renewable Energy (MNRE)	Policymaking and overall coordination concerning biofuels. Undertake Research and Development (R&D) on various applications of biofuels
MoPNG	Responsible for marketing biofuels as well as development and implementation of pricing and procurement policy
Agriculture (MoA)	R&D of biofuel feedstock through Indian Council for Agricultural Research and Indian Agricultural Research Institute (sweet sorghum, jatropha, *Pongamia*, and inedible oilseeds). Undertake jatropha plantation in non-forest land.
Rural Development	Plantation of jatropha on wastelands. Integrate biodiesel program with rural development schemes (such as Mahatma Gandhi National Rural Employment Guarantee Scheme). Coordinate R&D with other departments/agencies
Science and Technology (DST)	Support research on biofuel crops through bio-technology
Road Transport and Highway (MoRTH)	Plantation along highway rights-of-way and use biofuel blended fuel. Work with automobile manufacturers association in India for engine modification, emission norms
Railways (MoRail)	Undertake plantation of jatropha over wastelands along rail rights-of-way and trials of biodiesel blended fuel on railroad locomotives.
Environment and Forest (MoEF)	Ensure plantation of jatropha and tree borne oilseeds in forest wastelands; get Central Pollution Control Board to monitor health and environmental effects.

ETHANOL POLICY

Ethanol is produced in India from sugarcane molasses and partly from grains. Beginning in January 2003, the GOI mandated the use of five-percent ethanol blend in gasoline through its ambitious EBP. Ethanol and alcohol production in India depends largely on availability of sugar molasses (a byproduct of sugar production). Since sugarcane production in India is cyclical, ethanol production also varies

accordingly and therefore does not assure optimum supply levels needed to meet the demand at any given time.

At times, lower availability of sugar molasses and resultant higher molasses prices affect the cost of production of ethanol, thereby disrupting supply of ethanol for the blending program at pre-negotiated fixed ethanol prices. However, recently announced price fixing scheme for fuel ethanol procurement for OMCs and with sugarcane cycle expected to enter its sixth year of surplus production, the EBP is likely to accelerate but with slower pace.

Developments in EBP

Date	Action	Comments
January, 2003	The MoPNG made five percent ethanol blending (Gazette on EBP) in gasoline mandatory across 9 States and five Union Territories	Partially implemented due to unavailability of ethanol (due to low sugarcane production in 2003/04 and 2004/05)
September, 2006	Resurgence in sugarcane production in 2005/06 and 2006/07 led GOI mandate five percent blending of ethanol in gasoline across 20 states and four Union Territories (excludes Northeast, Jammu & Kashmir and Andaman & Nicobar) subject to commercial viability	OMC contracted for 1.4 billion litres of ethanol for EBP at Rs 21.50/litre from Nov 2006 to Nov 2009. Only 540 million litres of ethanol supplied till April 2009 due to short supply of sugar molasses. GOI deferred implementation due to short supply of sugarcane in 2007/08
September, 2008	Union Cabinet approved the National Biofuel Policy. Five percent blending mandatory across all states in the country.	GOI deferred the plan again due to short supply of sugarcane and sugar molasses in 2008/09.
October, 2008	Third phase of implementing EBP envisaged blending ratio to be increased to 10 percent.	Since there was no official notification released, oil marketing companies have not started 10 percent ethanol blending.
November 2009	Government held meeting to decide blending target for EBP	Status-quo remains, targets five percent EBP
August 2010	Government fixed an ad-hoc provisional procurement price of INR 27 per liter of ethanol by OMC for EBP program. Decision was taken to constitute expert committee under Chairmanship of Dr. Choudhary, Member of Planning Commission, to recommend a formula for pricing ethanol.	Expert Committee in March 2011 had recommended that ethanol be priced 20 percent lower than gasoline price. No consensus yet on pricing policy of ethanol. In any event when ethanol supply runs short, government proposed to reduce import duty on alcohol and molasses. OMC caveated the proposal that alcohol or molasses could not be imported for EBP; it has to be exclusively sourced from domestic produced molasses.

CY 2011	OMC unable to procure contracted ethanol supplies from sugar mills and ethanol manufacturers. The Ministry of Petroleum and Natural Gas, GOI has not been able to implement compulsory blending of five percent ethanol in gasoline.	Most of the domestic ethanol producers or suppliers were disqualified to supply ethanol. Non-finalization of ethanol pricing formula and procedural delays by various state governments delayed the procurement for EBP. Industry sources estimate that 365 million liters of ethanol was supplied against the contracted 570 million liters. During same period, a major share of molasses production was diverted as cattle feed to Europe.
CY 2012	OMC targets to procure one billion liters of ethanol for fiscal 2011/12.	After deducting the ethanol requirement for EBP in non-implementing states (such as Tamil Nadu, West Bengal, Odisha, Jharkhand, Chhattisgarh & Madhya Pradesh), the present requirement worked out to 720 million liters, of which suppliers had offered to supply 610 million liters. With lesser supply in few states, the contracted supply was subsequently drawn down to 430 million liters and further down to 305 million liters during Calendar Year 2012. Surplus molasses was exported as cattle feed to Europe.
CY 2013	In a bid to renew its focus and strongly implement the EBP, the (CCEA on November 22, 2012, recommended five-percent mandatory blending of ethanol with gasoline (the blending target was already decided by the CCEA in the past). Henceforth, the procurement price of ethanol shall be decided by between the OMC and suppliers of ethanol (CCEA recommendation). OMC floated a joint e-tender in first week of January for procuring 1.4 billion liters of ethanol to be supplied	The Union government under the Motor Spirits Act on January 2 notified that few states such as Uttar Pradesh, Delhi, Haryana, Punjab, Karnataka and Goa can even achieve up to 10 percent ethanol blending target, but the overall average for the country as whole should reach five percent by end of June 30, 2013. The interim (ad-hoc) price of INR 27 per liter would no longer hold as price would now be decided by market forces. Indian ethanol suppliers (sugar manufacturers) offered to supply 551 million liters. Price quoted by suppliers ranged from INR 38 to INR 54 per liter

	during April 2013 through March 31, 2014. With the validity of the offer for the domestic tender expiring on May 27, 2013, the offer was further extended on request by two months through July 26, 2013. Per one of the CCEA recommendations, in case of any shortfall in domestic availability, the OMCs and chemical companies were free to import ethanol for EBP. Since OMCs were falling short by more than 820.3 million liters of ethanol, they floated a global tender in third week of January to augment remaining supplies. The tender floated in January 2013 for 1.4 billion liters of ethanol supply through March 14 was extended to November 2014.	(*delivered at OMC depot*). The price quoted by few bidders was perceived to be on the higher side. OMCs received five offers from both Indian and international suppliers, of which one was rejected. (This was the first time the government had allowed foreign suppliers to offer ethanol for domestic EBP. Suppliers offered around 620 million liters of ethanol. However, the price quoted (INR 69 to 92 per liter of ethanol, C&F depot) was perceived to be high and therefore the global tender was rejected. Of the total ethanol offered by suppliers, the quantity accepted for lifting by OMCs was 382 million liters. Per industry sources, during CY 2013, all the contracts were valid for supplies until November 2014, but OMC got validity extended through May 2015. The fuel ethanol blend rate that could be achieved then was 1.6 percent.
CY 2014	OMCs floated another tender in July 2013 for procuring 1.33 billion liters of ethanol for supply during December 2013 through November 2014. In January 2014, OMCs floated an EOI for procuring additional ethanol. GOI considered raising EBP program from five to 10 percent in near future.	The quantity offered by sugar mills/ethanol manufacturers was 618 million liters. The quantity accepted by OMC for lifting was 247 million liters. Quantity offered by sugar mills was 53 million liters and the whole volume was accepted to be lifted by OMCs. Total quantity accepted by OMC was thus 247 + 53 million liters = 300 million liters. Assuming that OMC shall come out with another tender soon for ethanol procurement for CY 2015, Post anticipated that OMC shall procure another 50 million liters in December 2014. The cumulative volumes likely to be accepted by OMCs for blending with

		gasoline will be 350 million liters, which translates market penetration at 1.4 percent.
	There was a proposal to revise the formula to fix the benchmark price for ethanol procurement. The proposed formula would be based on the average of the refinery transfer price (RTP) or cost of petrol to the oil marketing companies for the previous financial year instead of the lowest RTP, which stands at INR 44 a liter. The revised formula was expected to be a win-win opportunity for both the stakeholders.	The EBP was being implemented in a total of 13 states with blending level of about 1.2 percent. Post expects some momentum when the new pricing formula was put in place and 'implemented'. Major distilleries were reported to have exported ethanol as well as molasses (as cattle feed) as way to infuse cash flows in otherwise surplus sugar season when sugar mills are finding difficult to break-even. The OMCs were offering a ceiling price of INR 44 per liter ($0.74), delivered at various depots. The ex-mill prices of molasses based products (rectified spirit, extra neutral alcohol and fuel ethanol ($.67 per liter)) ranged from INR 33-46 per liter. The offered price by OMC then was still attractive for some suppliers or sugar mills although prevailing (average) retail price of gasoline was still on a higher side.
	On December 10, 2014, GOI announced a price fixing scheme for fuel ethanol procurement for OMCs. The program fixes landed-ethanol prices at OMC depots from INR 48.50 to INR 49.50 per liter ($0.76 to $0.77/liter), a three to five percent increase over the previous price.	This will likely accelerate India's EBP, infuse cash into the local sugar industry, help millers pay down debts, and curtail (by some estimates) upwards of $750 million in crude oil imports. In previous years, Post has observed that India has the capacity to fulfill its ethanol blending mandate, provided there are equal incentives for both the producers and blenders. Read GAIN IN4121 for further information.
CY 2015	In July 2014, OMCs floated a tender for procuring 1.56 billion liters of ethanol from supply from December 2014 to November 2015.	The actual supply started from January 2015. Around 584 million liters was offered by sugar mills of which 375 million liters was believed to be accepted by the OMCs (INR 44.5/liters).

	Subsequent to above tender OMC floated an EOI in December 2014 seeking to procure upwards of 1.6 billion liters (970 + 670 million liters) of ethanol. Further, OMCs floated an EOI in March 2015 seeking 367 million liters of ethanol. A third and fourth EOI was floated in May, seeking (213 + 9) million liters, respectively and bidding opened on same month. In April 2015, GOI removed 12.36 central excise duty levied on ethanol supplied for blending with gasoline. Fifth and final EOI was floated I July 2015 for procuring 69 million liters against which the quantity offered was 39 million liters.	Quantity offered by sugar mills was 509 million liters of which 359 million liters was finalized by OMCs. The quantity offered by sugar mills was 125 million liters of which 94 million liters was accepted by OMC. Total quantity accepted by OMCs for blending is thus (375+359+94+21) = 849 million liters. The excise duty exemption will be applicable for ethanol produced from molasses generated during the next sugar season (October 2015-September 2016) and supplied for blending with gasoline (PIB Press Release). Industry sources claim that sugar mills are expected to benefit to an extent of INR five per liter on sale of ethanol for blending. Total quantity thus offered until November 2015 was 1.56 billion liters of which sugar mills/ethanol manufacturers offered 849+39 =888 million liters. Industry source estimate that around 675 million liters was lifted by OMCs until November 2015. By year-end total volume is expected to rise marginally to 685 million liters and therefore the expected blend rate will reach 2.3 percent.
CY 2016	In August 2015, OMC floated an EOI seeking 2.65 billion liters for supply in CY 2016. The intent is to make 10 percent blending compulsory. Subsequently, two more EOI were floated in December 2015 and February 2016 seeking 1.5 billion liters and 909 million liters, respectively.	The EOI was opened on September last year. Around 1.47 billion liters was the quantity offered by sugar mills. Actual quantity finalized was upwards of 1.03 billion liters. Sugar mills offered to supply 165 million liters and 183 million liters against EOIs. However, the quantity finalized by OMCs was 159.5 and 157.3 million liters. Total quantity finalized until May-end is 1.35 billion liters (1036 + 159.5 + 157.3).

		Against the finalized quantity, actual quantity lifted until May-end is 509 million liters and by year-end an estimated 600 million liters shall be lifted, which brings down the blend rate to 1.9 percent.
	Further, it is estimated that by end of CY 2017, India would require more than seven billion liters (Table 1) of ethanol to meet its ambitious target of 20 percent EBP.	The automotive industry seems to be gearing up for making vehicles compatible with the E-5 blends and will probably gear up for E-10 later. Industry sources believe that two vehicle wheelers /some models will be of some concern initially. Given the current pace of development, a target to meet five percent blending of ethanol (1.7 billion liters) with gasoline looks plausible but 10 percent is far-fetched.

Expanding domestic ethanol supply could address supply issues

- Both the private and public sectors claim to be successful in customizing technology (low-cost and indigenous) to generate power (pilot scale) and advanced biofuels from locally available bio-mass resources, particularly multi-feedstock ligno-cellulosic material. However, scaling up of such projects on a commercial scale is yet to be seen, while industry observers are optimistic.

- Promote use of alternate crops such as sweet sorghum, sugar beet, sweet potatoes, pearl millet and broken rice to supplement domestic ethanol production, though the efforts to produce ethanol from these feed stocks are only experimental or at pilot stage.

- The GOI offers subsidized loans through sugarcane development funds to sugar mills for setting up of ethanol production units.

Impediments

Procedural formalities such as delay in issuance of no-objection certificates (NOC), import/export permits, renewable storage license, and other permits hinder inter-state and intra-state movement of ethanol. Further, higher and non-uniform taxes and levies across different states have impeded the implementation of EBP. Additionally, rules and regulations, interstate charges, applicable to control alcohol for potable industry use are equally applicable for ethanol blending with gasoline, thereby severely constraining its availability and utilization for EBP.

BIODIESEL POLICY

The GOI had launched the National Biodiesel Mission (NBM) identifying jatropha (*jatropha curcas*) as the most suitable inedible oilseed for biodiesel production. The central government and several state governments provide fiscal incentives for supporting planting of jatropha and other inedible oilseeds. Several public institutions, government departments, state biofuel boards, state agricultural universities and cooperative sectors also supported the biofuel mission in various capacities.

The Planning Commission of India had set an ambitious target of planting 11.2 to 13.4 million hectares to jatropha by the end of 11th Five Year Plan (2011/12). However, the GOI's ambitious plan of producing sufficient biodiesel by 2011/12 (marketing year October/September) to meet its mandate of 20-percent blending with diesel was unachievable mostly due to unavailability of sufficient feedstock (jatropha seeds) and lack of high-yielding drought-tolerant jatropha cultivars. Hence most of the biodiesel units operating in India have shifted to alternative feed-stocks such as edible oil waste (unusable oil fractions), animal fat and inedible oils, utilizing almost 28 percent of their existing capacity to continue year round operations.

Meeting a hypothetical five-percent biodiesel blending target would require a dedicated plantation of energy crops or a probable switch to alternate sources of biodiesel from locally available tree-borne oilseeds, utilizing multiple feedstock and imported biodiesel (if viable).

GOI has deregulated diesel price in line with gasoline. Following up, the Union Cabinet has also allowed private biodiesel manufacturers, their authorized dealers and joint ventures (JVs) of OMCs authorized by the MoPNG to sell biodiesel directly to consumers subject to their product meeting prescribed BIS standards.

Developments in NBM:

Date	Action	Comments
April, 2003	Demonstration phase 2003 to 2007: Ministry of Rural Development appointed as nodal ministry to cover 400,000 hectares under jatropha cultivation. This phase also proposed nursery development, establishment of seed procurement and establishment centers, installation of trans-esterification plant, blending and marketing of biodiesel	Public and private sector, state government, research institutions (Indian and foreign) involved in the program achieved varying degrees of success.
October, 2005	The MoPNG announced biodiesel purchase policy in which OMC would purchase biodiesel across 20 procurement centers across the country to blend with	Cost of biodiesel production higher (20 to 50 percent) than purchase price. No sale of biodiesel.

	high speed diesel w.e.f January 2006. Purchase price set at INR 26.5 per litre	
CY 2008	Self-Sustaining Execution phase 2008 to 2012: Targeted to produce sufficient biodiesel for 20 percent blending by end of XIth (2008-12) five year plan	Lack of large scale plantation, conventional low yielding jatropha cultivars, seed collection and extraction infrastructure, buy-back arrangement, capacity and confidence building measures among farmers impeded the progress of this phase.
CY 2010	An estimated 0.5 million hectares has been covered under jatropha cultivation of which two third plant populations is believed to be new plantation and would take two to three years to mature	Assuming 80 percent biodiesel requirement is met though jatropha oilseeds, the biodiesel thus obtained will just meet 0.01 percent of total biodiesel required for five percent blending by 2010/11.
CY 2011	No additional wastelands have been brought under jatropha cultivation except for few captive plantations managed by OMCs.	The government may have to offer fiscal incentives (coupled with carbon credits) to growers to adopt better agronomic practices during first 2-3 years of plantation development besides marketing and price support mechanism to encourage jatropha plantation.
CY 2012	The production of biodiesel from jatropha seeds remained commercially insignificant.	According to the MoPNG, no biodiesel (from jatropha) has been procured by oil marketing companies for blending with diesel in last three to four years.
CY 2013	Biodiesel production from multiple feed-stocks (crude oil, used cooking oils, animal fats etc.) was an economically viable option left with the producers.	Most of the plants utilizing this technology were able to make commercial sales in last few years despite running close to third of their installed capacities (480 million liters estimated). Industry sources claim that small to medium scale industries are the major buyers of biodiesel (methyl ester) who blend it with conventional diesel. Industry sources claimed that the average purchase price of biodiesel in India then was around INR 45-48 per liter (includes freight) and seem viable for blending as regular diesel was selling at a price premium of 18-20 percent over biodiesel (methyl ester).
CY 2014	Industries engagement with tree-borne oilseeds as alternate to jatropha for	Seed yield from jatropha plantation (on pilot scale) were observed to be

	biodiesel production gets due attention. GOI in October 2014 deregulated diesel prices in line with gasoline.	significantly lower than stipulated. Consequently, cost of production of biodiesel from jatropha seed is too high providing little incentive for producers to go full throttle. Evidently, in last few years, few stakeholders (from private and government sector) were engaged in identifying tree-borne oilseeds (neem, pongamia, mahua and kusum) as alternate to jatropha for bio-diesel production, but on an experimental basis. However, availability, feasibility and sustainability of tree-borne oilseeds still need to be validated. Biodiesel producers claim to realize INR 38-40 from sale of a liter of biodiesel (excludes transportation cost). Hopes are high that if subsidy on diesel gets gradually phased out, then biodiesel producers may get a larger pie. The retail price will now be decided by the market forces and GOI will no longer have to compensate OMCs for selling diesel below market prices. This step will incentivize firms engaged in biodiesel production in India.
CY 2015	On January 16, the Union Cabinet chaired by the Prime Minister, Shri Narendra Modi, gave its approval for amending the MS) and HSD Control Order for Regulation of Supply, Distribution and Prevention of Malpractices dated 19.12.2005. The Cabinet has also decided to suitably amend Para 5.11 and 5.12 of the National biofuel policy for facilitating consumers of diesel in procuring bio-diesel directly from private bio-diesel manufacturers, their authorized dealers and JVs of OMCs authorized by the MoPNG. This decision will encourage the production and use of	The amendment will allow private biodiesel manufacturers, their authorized dealers and JVs of OMCs authorized by the MoPNG as dealers and give marketing and distribution functions to them for the limited purpose of supply of bio-diesel to consumers. The investment and production conditions (as applicable) specified in the marketing resolution dated March 8, 2002, of MoPNG will also be relaxed and a new clause added to give marketing rights for biodiesel (B100) to the private biodiesel manufacturers, their authorized dealers and JVs of

	bio-diesel in the country. On August 10, GOI had issued notification to allow the sale of Bio-diesel (B100) by private manufacturers to bulk consumers like Railways, State Transport Corporations and other bulk consumers (Gazette Notification No. GSR 621 (E)). On August 11, 2015, Minister of State (I/c), Petroleum and Natural Gas, launched sale of B-5 Diesel on World Bio Fuel Day. As part of the initial run, B-5 will be sold to customers at some retail outlets in New Delhi, Vijayawada, Haldia, New Delhi and Vishakhapatnam. (Source: News Release, IOC).	OMCs authorized by the MoPNG for direct sales to consumers. As the price of diesel is already deregulated, private biodiesel manufacturers are encouraged to sell biodiesel directly to consumers subject to their product meeting prescribed BIS standards (PIB Press release). Apparently, B5 diesel is retailed at the same price as conventional petroleum diesel and depending on its availability its sales may improve. Further, industry sources claim that few private firms are selling biodiesel at discount (three to five percent) to conventional diesel and still making decent profits.
CY 2016	Biodiesel development is still in nascent stage. Commercial availability of bio-diesel and its availability across major retail centers will take its own time.	Few bulk users such as road transport companies, state transport corporations (plying public buses) and railways depots (diesel locomotives) claim to have utilized biodiesel for transporting goods and people.

Impediments

Smaller land holdings and ownership issues with government- or community-owned wastelands has resulted in very little progress made by state governments to create large jatropha (and/or pongamia) plantations. Except for few pilot scale projects in Chhattisgarh, and Karnataka, negligible commercial production of biodiesel from jatropha seeds (through old technology) has stymied efforts and investments by both private and public-sector companies.

ETHANOL

India has around 330 distilleries which can produce over 4 billion liters of rectified spirit (alcohol) per year. Of this total, about 162 distilleries have the capacity to distill over 2 billion liters of conventional ethanol. India produces conventional bioethanol mostly from sugar molasses and partly from grains. Production of advanced bioethanol is in its research and development stage. Note: Year mentioned in context is calendar year unless mentioned specifically

Table 2. India: Ethanol Used as Fuel and Other Industrial Chemicals (Million Liters)

Calendar Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017***
Beginning Stocks	1,374	1,642	1,440	1,241	847	824	618	422	286	321
Production	2,150	1,073	1,522	1,681	2,154	2,057	2,002	2,292	2,085	1,918
Imports	70	320	92	39	34	33	107	217	450	600
Exports	12	14	53	119	177	234	175	200	140	140
Consumption	1,940	1,580	1,760	1,995	2,035	2,062	2,130	2,445	2,360	2,510
Fuel Consumption	280	100	50	365	305	382	350	685	600	700
Ending Stocks	1,642	1,440	1,241	847	824	618	422	286	321	189
Production Capacity										
No. of Refineries	115	115	115	115	115	115	115	160	162	162
Nameplate Capacity	1,500	1,500	1,500	1,500	2,000	2,000	2,000	2,000	2,050	2,050
Capacity Use (%)	143	72	101	112	108	103	100	115	102	94

Feedstock Use (1,000 MT)										
Feedstock A	8,958	4,469	6,342	7,004	8,975	8,573	8,343	9,551	8,689	7,994
Market Penetration										
Fuel Ethanol	280	100	50	365	305	382	350	685	600	700
Gasoline	15,368	17,606	19,563	20,716	21,842	23,749	25,848	29,651	32,409	34,916
Blend Rate (%)	1.8	0.6	0.3	1.8	1.4	1.6	1.4	2.3	1.9	2.0

Source: FAS/New Delhi Estimates based on information from trade sources
*: Forecast

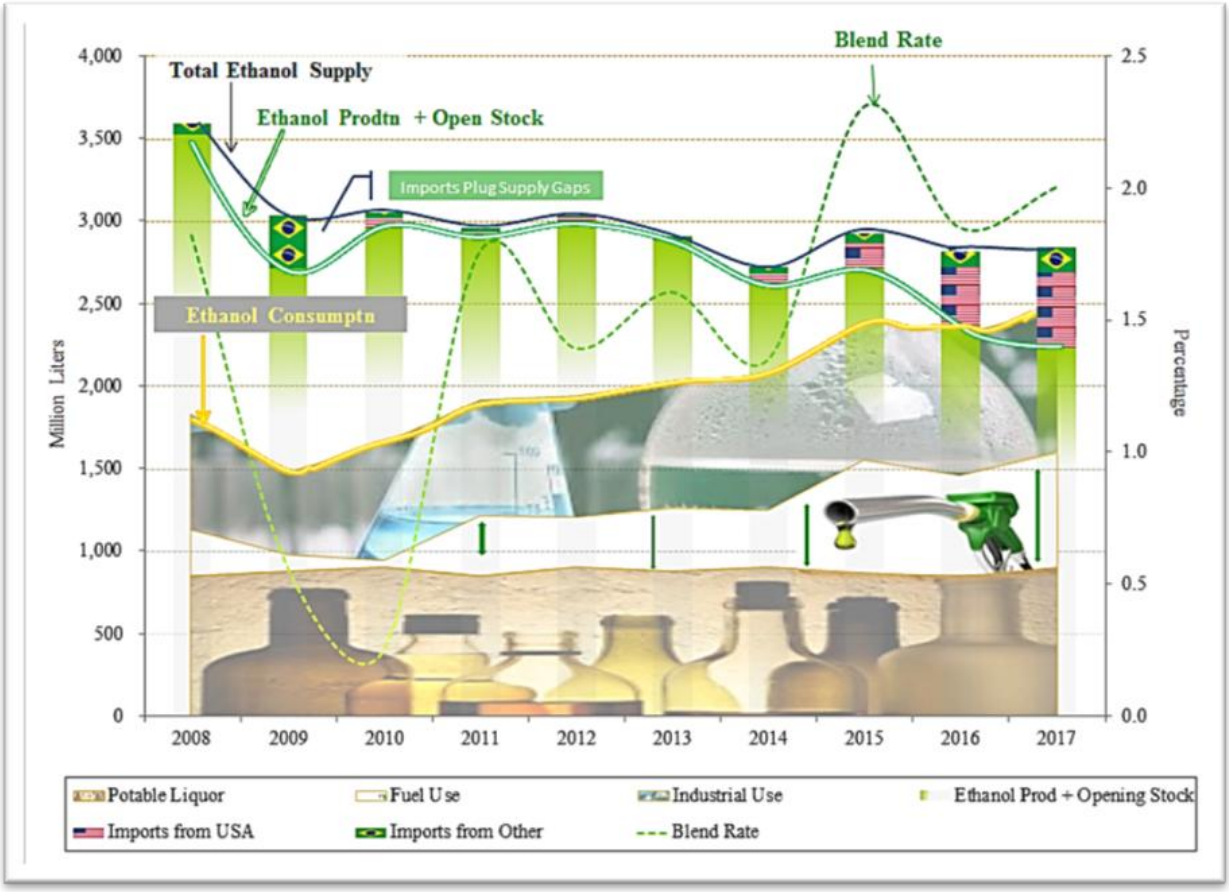
Production

Domestic ethanol production in last decade has remained stable except for steep decline in 2009 and historic high registered last year. Ethanol production in 2017 will decline eight percent to 1.9 billion liters due to decline in cane planting for second consecutive year. Acute water scarcity and abnormal weather conditions in major cane planting regions will discourage farmers to bring new areas under cane production.

Fuel Ethanol Market Penetration

Fuel ethanol market penetration in 2017 will be slightly higher at two percent compared to 1.9 percent expected in current year. Industry sources indicated that the OMCs may procure upwards of 700 million liters in 2017. Technically, given the current growth in gasoline consumption, the installed capacity will meet five to six percent of blend target. The fixed price for ethanol delivered at OMC depot is attractive for sugar mill given that average retail price of gasoline is on slightly higher side. On contrary, any procedural delay in EBP could encourage them to divert ethanol to chemical and potable industries. Additionally, mills could divert molasses as cattle feed or for exports if their prices are competitive.

Figure 3: India. Ethanol Production, Supply and Consumption



Source: FAS/USDA Data

Consumption

India is consuming more ethanol than it produces production (Figure 3). Throughout the last decade, ethanol consumption grew from 1.8 billion liters to 2.4 billion liters in 2016, and will continue to increase (albeit modestly) in 2017 to 2.5 billion liters. The consumption basket will comprise 700 million liters for fuel ethanol and 1.8 billion liters for the industrial and chemical sectors.

Since the inception of EBP in 2003 through 2014, fuel ethanol blending never crossed 380 million liters mark while remaining stocks were either sufficient or enough to meet demand from industry and chemical sector. For the first time in 2015, fuel ethanol demand grew upwards of 650 million liters and expected to rise by additional 50 million liters by end of 2017. Modest rise in fuel ethanol purchase will inflate consumption above production and deficit will be met through imports.

As a result, ethanol imports may increase considerably, from 200 million liters in 2015 to 600 million liters by 2017. A similar scenario occurred in 2008 and 2009. Since the GOI mandates the use of 'indigenous ethanol only' for EBP, ethanol supplies for blending will be relatively tight and the chemical and industrial sectors will rely more on imported ethanol.

Trade

Imported Ethanol Volumes Will Rise to Augment Local Supplies….
India will continue to be a net importer of ethanol. Assuming normal market conditions in 2016, India is expected to import upwards of 440 million liters of ethanol. Import volumes will rise further to 600 million liters in out-year to augment local supply. Since 2003 the trade balance for ethanol has been negative except for a brief period (2011 to 2014) when ethanol production was sufficient to meet local demand. Despite the negative trade balance, ethanol imports grew seven-fold during the last decade (30 million liters ($18 million) in 2006 to 218 million liters ($147 million) through 2015.

Presently, the United States is the Largest Ethanol (Denatured) Supplier to India…
Last year, the United States stood as the largest supplier of ethanol to India followed by Brazil. However, in 2014, Brazil didn't register any sales while the United States sold 66 million liters (62 percent of total imports) worth $51 million. Compared to benchmark price (landed-ethanol price delivered at OMC depot $0.72 to $0.74/liter), imported ethanol will presently sell at par with local supply thereby giving little incentive for imports except for competing with limited local supply. Usually, when local ethanol prices are strong, industry users prefer to buy imported ethanol and sugar distilleries benefit from selling it to OMCs.

Interestingly, trade data for last decade indicate that more than 96 percent of the import demand is met from five sources: the United States, Brazil, Spain, Bhutan, and Pakistan (in order of their export sales). Until 2011, Brazil dominated 60 percent of import market and U.S. ethanol just started to compete then. Post that period, sale of U.S. ethanol grew exponentially (>54 percent) to gain 72 of import market while Brazil sales shrunk to 20 percent and Spain retained four percent of India's import market.

African Countries are Major Importer of Indian Ethanol…
Ethanol exports to Nigeria (25 percent), Ghana (20 percent), Angola (seven percent), Sierra Leone, Cameroon, Kenya and Nepal constitute 70 percent of total exports from India. In 2015, India exported 164 million liters of ethanol worth $125 million. Compared to peak export in 2013, exports were down by 30 percent. However, in last decade export quadrupled. Assuming normal market conditions, India should be able to export 140 million liters in 2016 and similar quantity in 2017. Growing local demand will however push imports to 280 million liters through 2020 which at current price is worth $210 million.

In India, export of biofuel is only permitted after it meets the domestic requirement and the final decision is taken by the NBCC. The GOI provides no financial assistance for exports of biofuels. However, current trade regulations allow duty-free imports of feed stocks for re-export by certified export oriented units.

Figure 4: India. Ethanol Imports, in 1000 Liters

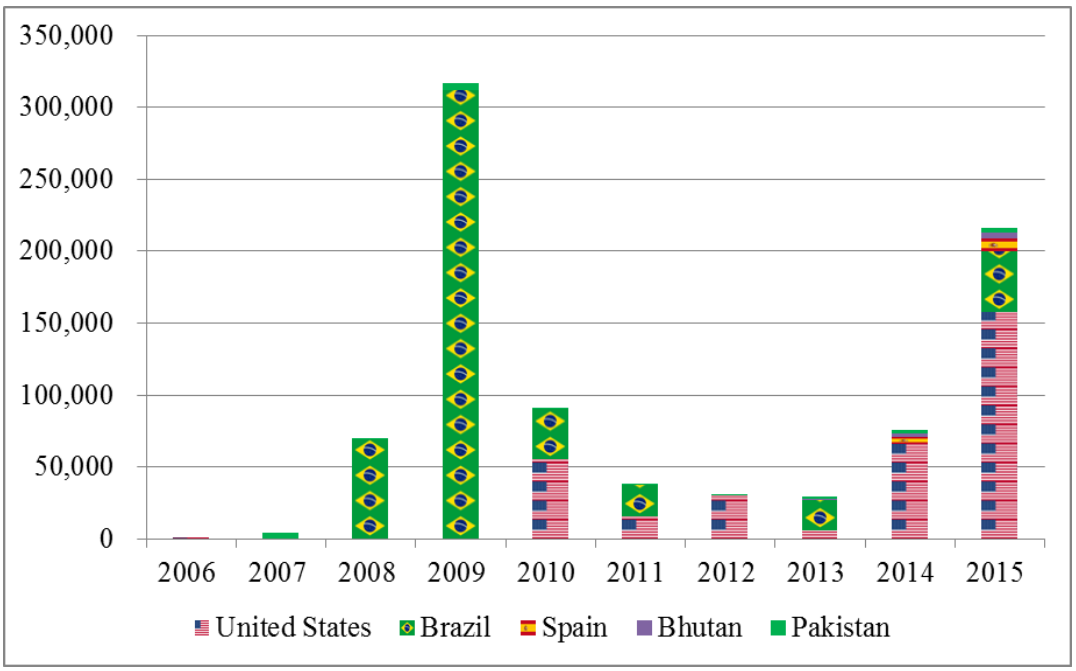
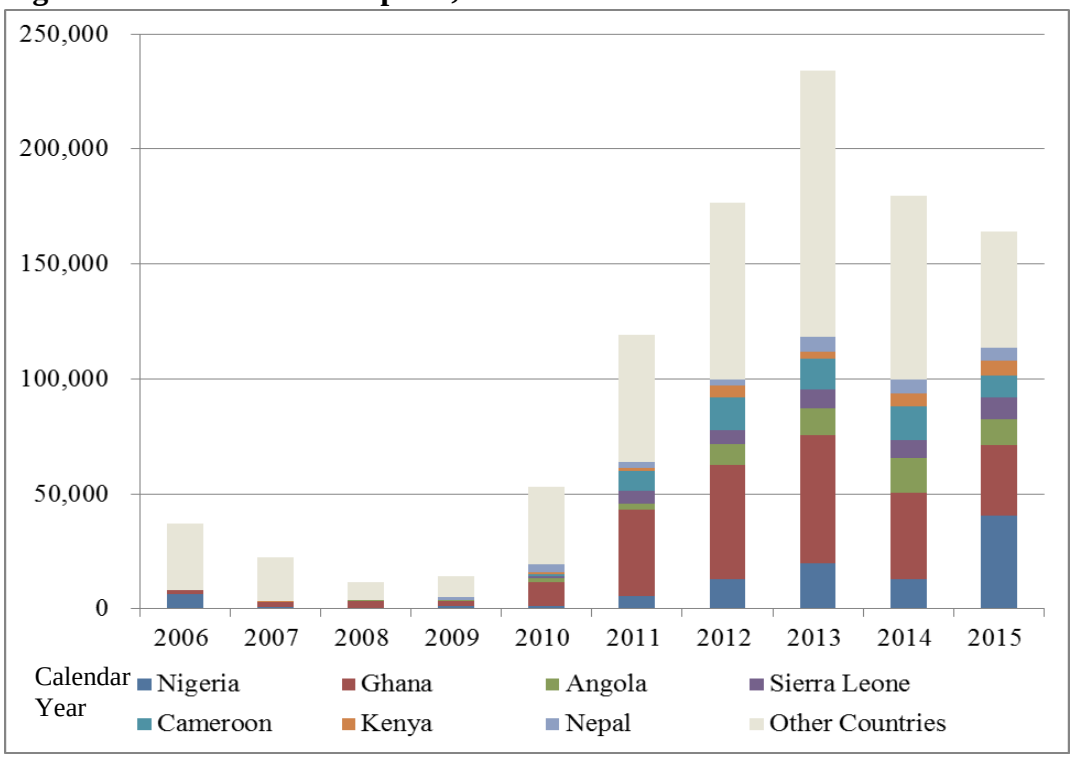


Figure 5: India. Ethanol Exports, in 1000 liters



Duties

During the latest budget announcement for Indian fiscal (April-March) 2016/17, the import duty on denatured ethanol reduced to 2.5 percent for manufacture of excisable goods, subject to actual user conditions (Customs Notification No.12/2016). Earlier, the import duty was reduced from 7.5 percent to

five percent (Customs Notification No.12/2014 dated July 11, 2014). Lower import duty helps make imports attractive and economically viable (especially when crude oil price are getting firm). Traditionally, India imports ethanol only to meet shortfalls in demand during years of lower sugar production. Demand is mostly for consumption across the potable liquor and chemical industries and not for fuel. There are no quantitative restrictions on import of biofuels as well.

Table 3. India: Import duty on biofuels (percent ad valorem on CIF value)

ITC HS Tariff Number	Total Import duty *
2207.20 Denatured Ethyl Alcohol and Denatured Spirits	2.5 and 18.12, respectively
3824.90 Chemical products not elsewhere specified (including biodiesel)	26.42

Source: Central Board of Excise and Customs, GOI

*: State Excise applicable (not calculated here). No CVD on ethanol produced from molasses generated from cane crushed in MY 2015/16 onwards for supply to OMCs for blending with gasoline (12-CE 17.03.2012 S. No. 40A)

Ending Stocks

Steady rise in consumption demand (CAGR four percent has led to steep decline in stocks from over 1.6 million liters in 2008 to just 320 million liters in 2016. Anticipating higher blend rate in 2017, end stock will remain tight (<190 million liters). In last decade the stock to use ratio has come down from over 78 percent to 13 percent.

BIODIESEL

The initial hypothesis that 'jatropha' (*Jatropha curcus*) could grow in semi-arid regions with little care and fertilization' is proven void, with research trials contradicting the initial claim. Limited availability of jatropha seeds (due to poor productivity), static plantations (inspite of being state subject, only a few states have been able actively to promote jatropha plantation with public and private sector participation), lack of promising varieties/cultivars, rising wage rates, and inefficient procurement and

marketing channels has risen the cost of production, making it economically unviable proposition.

Concurrently, there are no commercial sales of biodiesel across the biodiesel purchase centers set up by the GOI. Apparently, the enthusiasm of producing biodiesel from jatropha is fading, despite its potential claim to withstand drought and rehabilitate degraded wastelands. As a result, researchers have gradually shifted their focus and resources to study feasibility of producing bio-diesel from tree-borne oilseeds (TBOs) such as pongamia (*Pongamia pinnata*), neem (*Azadirachta indica*), kusum (*Schleichera oleosa*), mahua (*Madhuca longifolia*), and waste edible oils. Some firms claim to import smaller quantity of biodiesel (assuming they were viable) and sell it locally after meeting prescribed BIS standards.

Table 4. India: Biodiesel Production from Multiple Feedstock (Million Liters)

Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017 *
Beginning Stocks	45	38	42	45	45	50	45	40
Production	90	102	115	120	130	135	140	150
Imports	0	0	0	0	0	0	0	0
Exports	0	0	0	0	0	0	0	0
Consumption	52	60	70	75	80	90	100	115
Ending Stocks	38	42	45	45	50	45	40	35
Production Capacity								
No of Biorefineries	5	5	5	6	6	6	6	6
Nameplate Capacity	450	450	460	465	480	480	500	500
Capacity Use (%)	20.0%	22.7%	25.0%	25.8%	27.1%	28.1%	28.0%	30.0%
Feedstock Use (1,000 MT)*								
Used Cooking Oil	38	42	48	49	50	50	52	56
Animal Fats & Tallow's	6	6	7	7	6	5	6	6
Other Oils	50	58	65	70	75	85	85	90
Market Penetration								
Biodiesel, on-road use	26	30	35	38	40	45	50	60
Diesel, on-road use	42,625	45,520	49,343	49,354	49,605	52,239	56,111	58,422
Blend Rate (%)	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.10
Diesel, total use	71,041	75,866	82,238	82,256	82,674	87,064	93,518	97,371

Source: Industry and Post estimates

*: CY 2017 is projected | * Used cooking oil includes vegetable oils such as rice bran oil, palm stearine, cotton seed oil and fatty acid oils while 'Other Oils' include tree oils, palm sludge etc.

Currently, India has five to six large capacity plants (10,000 to 250,000 metric tons (MT) per year) currently utilizing 28 percent of the installed capacity to produce 130-140 million liters of biodiesel from multiple feed-stocks such as inedible vegetable oils, unusable edible oil waste (used-once), and

animal fats. The biodiesel thus produced locally (or imported) is bought by small and medium enterprises, sold to unorganized consumers such as brick kilns, cellular communication towers, progressive farmers, and to institutions that run diesel generators as source of power back-up. Further, it's also sold to state transport corporations, automobiles and transport companies (state sponsored or private trial runs), and retailed at privately owned outlets.

ADVANCED BIOFUELS

The Indian biofuel industry, both private and public sector, claim to be successful in developing and customizing technology for converting ligno-cellulosic materials in form of wood biomass, agricultural (corn cob, bagasse, stalk of forage crops) waste and forest waste. Trials are still underway to process municipal solid waste, micro-algae and photosynthetic organisms into advanced biofuels. However, given the technological challenges, commercial production and economic viability remains to be demonstrated.

Biomass for heat and power

Scope

Biomass resource has the potential to produce grid-quality power utilizing various conversion technologies notwithstanding the scope to optimize power generation from sugar bagasse. Wide benefits include its renewability, wide adaptability, carbon neutrality and the potential to generate employment in rural areas. The potential could be enhanced further if dedicated plantation in forest and degraded land are linked to biomass power (MNRE, GOI). Additionally, biomass (*non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms*) has been playing an important role as fuel for sugar mills, rice mills, textiles, and raw material for paper mills, small and medium enterprises.

Biomass material

Bagasse, rice husk, straw, cotton stalk, coconut shells, soy husk, de-oiled cakes, coffee waste, jute wastes, peanut shells, and sawdust are used a raw material for power generation The crop residues from non-fodder crops, e.g., cotton, oilseeds, chilies and bamboo residues may also be considered as good alternatives for biomass power production (DST, GOI). However, the use of biomass as cattle feed and part utilization by power industries may lead to a rise in cost of fuel for biomass power plant as it may not be available unless exclusively grown for power generation.

Biomass Availability and Power Potential

Biomass availability in India is estimated at upwards of 915 million metric tons which covers both agricultural (657 MMT/year) and 'forestry & wasteland' residues (260 MMT/year). The combined power potential from both resources is estimated at 33,292 MWe (agro: 18,730 MWe and forest and wasteland: 14,562 MWe)

Present Status

Presently, India has over 5,940 MW biomass based power plants comprising 4,946 MW grid connected and 994 MW off-grid power plants. Out of the total grid connected capacity, major share comes from bagasse cogeneration and around 115 MW is from waste to energy power plants (Table 3). Whereas

off-grid capacity comprises 652 MW non bagasse cogeneration, mainly as captive power plants, about 18 MW biomass gasifier systems being used for meeting electricity needs in rural areas, and 164 MW equivalent biomass gasifier systems deployed for thermal applications in industries (Source: ww.mnre.gov.in).

Bagasse power cogeneration

With modernization of new and existing sugar mills, surplus power generation through bagasse cogeneration in India's 550 sugar mills is estimated at 10,000 MW (target for 12th Five-year plan is to achieve 32 percent of total potential) if these mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse they produce.^ The optimum cogeneration capacity installed in Indian sugar mills is one of the highest among major sugar producing countries. The total estimated biomass power potential is thus estimated upwards of 40,000 MW. Note: Some think tank estimate bagasse based power generation potential close to 5000 MW. Considering the preceding estimate, total biomass power potential scales down to proportionate value.

The GOI has initiated several programs and schemes for promoting renewable energy sources. Seventeen Indian states have policies for development of biomass power. Biomass power projects attract fiscal incentives such as accelerated depreciation, concessional customs duties, and income tax exemptions. Emphasis will be put on development of fuel value-chain business models while encouraging the operating period of bagasse cogeneration projects from 180-220 to 300-plus days. Further details may be accessed from mnre.gov.in

Table 3. India's Biomass-Based Commercial Energy Achievement

Sectors	Cumulative Achievements *(March 31, 2016)*
A. Grid Interactive Power (Capacities in MW)	
Biomass power (combustion, gasification and bagasse cogeneration)	4831.33
Waste to power	115.08
Sub-total Grid Interactive	4946.41
B. Off-Grid /Captive Power (Capacities in MW_{EQ})	
Waste to energy	160.16
Biomass (non-bagasse) Cogeneration	651.91
Biomass Gasifiers	
i)Rural	18.15
ii)Industrial	164.24
Biogas based energy system	4.07
Sub-total Off-Grid	994.46
Total Biomass based power	5940.87

Source: Ministry of New and Renewable Energy, GOI | Notes: MW: Megawatts, MW eq: Megawatts equivalent