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Ethanol Blending Policy: Issues Related To Pricing

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Abstract

The study examines the 'Ethanol Blending Programme' in India. The study examines the ethanol blended petroleum pricing mechanism in India in comparison with the globally accepted price mechanism. The study finds that the cost of producing ethanol in India varies largely with molasses prices and hence cyclical variations in sugarcane production chiefly determine the cost of ethanol production. The study analyzes the price fixation at Rs. 27 per litre by the government by providing estimates of different expenditure heads of ethanol production costs.

JEL Classification*: Q16, Q28, Q4.*
Keywords*: Biofuels, Ethanol, Energy, Energy Policy*

Executive Summary

India is one of the fastest growing economies of the world, with its gross domestic product (GDP) growing at an average annual rate of over seven per cent since 2004. To maintain this rate of growth, energy inputs are critical. However, concerns that the conventional sources of energy will be exhausted have prompted the nation to view bio-fuels as a potential alternative to conventional liquid fossil fuels. In this regard, ethanol has emerged as an important renewable fuel for transportation purposes.

The study examines the ethanol blended petroleum pricing mechanism in India in comparison with the globally accepted price mechanism. The study finds that the cost of producing ethanol varies with molasses prices and hence cyclical variations in sugarcane production largely determine the cost of ethanol production. It provides estimates for ethanol production costs under different expenditure heads to explain the price fixation at Rs. 27 per litre by the government. It attempts to calculate the price of ethanol for a generic standalone distillery and arrives at a price very close to the price fixed by the government. However, given the cyclical nature of sugarcane, a periodic review of ethanol prices becomes critical. The pricing issue is also complicated by the decontrol of petrol prices and administered pricing of sugarcane.

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Abbreviations

ADE	Additional Duty of Excise
BIS	Bureau of Indian Standards
CAGR	Compound Annual Growth Rate
CIF	Cost Insurance Freight
CII	Confederation of Indian Industry
CO_2	Carbon Dioxide
CST	Central Sales Tax
EBP	Ethanol Blending Programme
EGoM	Empowered Group of Ministers
ESMAP	Energy Sector Management Assistance Programme
FAO	Food and Agriculture Organisation
FDZ	Free Delivery Zone
FOB	Free On Board
GDP	Gross Domestic Product
GAIL	Gas Authority of India Limited
GoI	Government of India
HS	Harmonised System
ICC	Indian Chemical Council
IEA	International Energy Agency
ISMA	Indian Sugar Mills Association
MoPNG	Ministry of Petroleum and Natural Gas
MODVAT	Modified Value Added Tax
NBCC	National Biofuel Co-ordination Committee
OMCs	Oil Marketing Companies
PetroFed	Petroleum Federation of India
R&D	Research and Development
RPO	Retail Pump Outlet
SAP	State Advised Price
SMP	Statutory Minimum Price
SIAM	Society for Indian Automobile Manufacturers
STAI	Sugar Technologists' Association of India
UNCTAD	United Nations Conference on Trade and Development
USD	US Dollars
USDA	United States Department of Agriculture

Units of Measurement

Kcal/g	Kilo Calories per Gram
Kg	Kilograms
KJ	Kilo Joules
KLD	Kilo Litres per Day
Kmh	Kilometre hour
KWh	Kilo Watt hours
MJ	Mega Joules
MT	Million Tonnes

Ethanol Blending Policy in India: Pricing and Taxation Issues

Saon Ray, Amrita Goldar and Smita Miglani

1. Introduction

India is a developing country with an average gross domestic product (GDP) growth rate of more than 7.5 per cent per annum since 2005. Energy is a critical input required to achieve our socio-economic goals and sustain growth at the same rate. Of the total primary energy consumption of the country, a large share is accounted for by fossil fuels, of which oil constitutes a 32 per cent share. Like all other fuel-oil importing economies in the world, India too, is facing a shortage of conventional fossil fuels. Biofuels have emerged as a substitute for fuel oil for countries like India. Hence many countries including India have both mandated biofuel use as well as offered fiscal incentives for the promotion of biofuel. To promote biofuels, ethanol in particular, the Indian Government initiated an ethanol blending policy (EBP) in 2003. This study examines the pricing and taxation aspects of the ethanol blending policy while an earlier policy paper has examined the demand and supply issues.

2. Ethanol-blended petroleum pricing in India

Ethanol is currently being produced by many countries around the globe. The world ethanol production (as fuel) in 2007 was around 42 billion litres. A large part of this, i.e. 88 percent was produced in the United States (49.6 percent) and Brazil (38.3 percent). The contribution of the other countries was only around 12 percent (including the European Union (EU) at 4 percent, China and India at 0.4 percent respectively). (Pohit, et al. 2009). Internationally, sugarcane, sweet sorghum and sugar beet are used for the production of ethanol as sugar containing feedstock. Corn, wheat and other cereals contain starch that can relatively easily be converted to sugar. In India, ethanol is primarily produced using sugarcane molasses. This is an example of first generation biofuels that uses biomass containing large amounts of sugar or materials that can be converted to sugar such as starch, for the generation of ethanol. First generation fuels are generally made from sugars, grains or seeds, i.e. using only specific (often edible) portion of the above-ground biomass produced by a plant and relatively simple processing of the biomass is required to produce a finished fuel (Ruane et al., 2010).

There are three main uses of ethanol in India. This includes potable liquor manufacturing (45 percent), alcohol-based chemical manufacturing (as a solvent in the synthesis of other organic chemicals) (40 percent) and the rest is used for blending with petrol and other purposes.[1] While consumption of ethanol by the above users would be crucially dependent on ethanol availability in the future, the price of domestically

[1] Ethanol is also used as a feedstock to make ethers, also called Ethyl Tertiary-Butyl Ether (ETBE), an oxygenate with high-blending octane used in petrol. ETBE contains about 45 per cent ethanol.

available ethanol would have an implication on the consumption levels as well. This section provides a cost break-up for the interim ethanol price estimates (Rs. 27 per litre) for a generic stand-alone distillery. Assuming similar capacity and input assumptions (presented in Table 1), the molasses procurement cost for a generic standalone distillery has been calculated below using the Planning Commission's (2003) figures (Table 1). Table 1 shows that, following the Planning Commission cost structure, an ethanol price of Rs. 27 per litre assumes that the cost of molasses procured was Rs. 4,730 per tonne. The molasses cost would be Rs. 3,550 per tonne at an ethanol price level of Rs. 21.5 per litre.

Table 1: Estimates for Production Costs of Refinery-gate Production of Ethanol

	Standalone distillery	
Cost of molasses (per tonne)	**Rs. 4730**	**Rs. 3550**
Transportation cost (per tonne)	150	150
Total	4880	3700
Recovery of ethanol (litres/tonne)	220	220
Rs./litre		
Molasses cost after milling	22.18	16.82
Steam cost @ Rice Husk Rs. 500	0.25	0.25
Power cost @ Rs. 4.5/KWh	0.59	0.59
Chemical cost	0.20	0.20
Labour cost	0.25	0.25
Repair and Maintenance	0.15	0.15
Cost of Replacement of Molecular Sieve	0.02	0.02
Total Direct Cost	**23.64**	**18.28**
Finance and other costs		
Indirect costs, including overheads	0.56	0.56
Interest@12 per cent for borrowed capital for Rs.7.2 crores (Debt/Equity Ratio = 1.5)	0.96	0.96
Interest @12 per cent for working capital for one month of molasses and ethanol	0.49	0.38
Depreciation @10 per cent for Rs.12 crore	1.33	1.33
Total Finance and other costs	3.34	3.23
Total Costs	**Rs. 26.98**	**Rs. 21.51**

Source: Authors' calculations based on Planning Commission (2003)

By changing certain key assumptions our numbers (Table 2) show that a price very similar to Rs. 27 per litre is arrived as the price of ethanol for a generic standalone distillery. We have assumed a capacity similar to the above table but used different input assumptions, to show that, the cost of molasses of Rs. 4,500 per ton translates into a distillery-gate ethanol price of Rs.26.7 per litre (Table 2).[2]This calculation is based on

[2] While the assumptions differ slightly from earlier estimates, the broad technological parameters remain the same. Variations in costs stem primarily from the assumption of molasses cost which accounts for a significant proportion of the total cost, i.e., around 80 per cent. The specific molasses price has been chosen since it is in broad consonance with the prevailing ethanol prices. However, changes in energy

interactions with stakeholders regarding the assumptions underlying the prices of inputs. Details of the technological process of ethanol manufacture have been presented in Annexure 1. Since most of the ethanol feedstock crops like sugarcane, corn, wheat, sorghum, etc. have alternative uses, market price for food consumption purposes determine the opportunity cost of the feedstock. Thus, the cost of feedstock as well as technology costs and other inputs have been looked into while calculating the costs in the ethanol production process (Annexure 2).

Table 2: Revised Estimates for Ethanol Production Costs

	Our Estimates
Cost of molasses (per tonne)	4500
Transportation Cost (per tonne)	150
Total	**4650**
Recovery of ethanol from molasses (litres/tonne)	220
	Rs./litre
Molasses Cost after Milling (Recovery Cost)	**21.14**
Steam cost @ Rice Husk or Bagasse at Rs. 2,000/tonne	1.00
Power cost @ Rs. 4.5/KWh	0.59
Chemical cost	0.2
Labour cost	0.38
Repair and Maintenance costs	0.15
Cost of Replacement of Molecular Sieve	0.02
Total Direct Cost	**23.48**
Indirect costs including Overheads	0.56
Interest @ 9% for Borrowed Capital of Rs. 7.2 crore (assuming debt/equity = 1.5:1)	0.72
Interest @15% for Working Capital for one month of molasses and ethanol	0.60
depreciation @ 10% for Rs. 12 crore	1.33
Total Finance and Other Costs	**3.21**
Total Cost	**26.69**

Source: Authors' calculations.

It should be noted that some other studies/sources, have also computed the cost of producing ethanol for transportation purposes. These are Gonsalves (2006) (who also bases his estimates on the Planning Commission numbers), STAI (2003) and ICC (2010). Their cost estimation methodologies are explained in Annexure 3.

It is noteworthy that the valuation of molasses purchased depends crucially upon the price at which sugarcane is received as well as the revenues earned by sugar co-operatives through the sale of sugar. As has been discussed earlier, sugar constitutes the

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and financial costs, and increase in salary structure have also been taken into account for the cost calculation. The cost calculations as well as details of assumptions taken for the computation are listed in Annexure 2. The changes in assumptions made have been marked with an asterisk.

primary product of the entire milling process while molasses is a by-product that is sent to distilleries for further value addition. While in some cases sugar co-operatives own both the mills and the ethanol distilleries, in others the mills and distilleries are privately owned. The price received by the sugarcane producer is delinked from the entire ethanol value chain since the producer receives a statutory minimum price (SMP)/state advised price (SAP) per quintal of production that is declared by the government. Therefore, higher prices for molasses lead to greater revenue generation for sugar mills and distilleries rather than sugarcane farmers.

At present, the government controls the price of cane but directs the sugar mills to sell up to 20 per cent of output under the public distribution scheme (PDS). Sugarcane prices are fixed on the basis of the SMP, in lieu of the Minimum Support Price announced by the central government, and the SAP, which is usually fixed by state governments above the statutory minimum price. However, sugar prices are determined on the basis of market prices. In October 2009, the Ministry of Consumer Affairs, Food and Public Distribution issued an ordinance in which the Sugarcane (Control) Amendment Order, 2009 changed the pricing regime for sugarcane dictated by the Sugarcane (Control) Order, 1966. Under the new order, the support price for sugarcane (now called the Fair and Remunerative Price (FRP), instead of the earlier SMP) is to be fixed by the central government from time to time.[3] Sugar prices, on the other hand, do not increase in the same proportion every year.

Pricing of ethanol

The EGoM has fixed the interim refinery gate price of ethanol at Rs.27 per litre. Working backwards, a price of Rs.27 per litre implies that the cost of molasses to the distillery is around Rs. 4800 per tonne. The price of molasses in recent times has increased to Rs. 5000 per tonne in some parts of the country. The pricing issue is also complicated by the decontrol of petrol prices and administered pricing of sugarcane as we discuss below.

It should be noted that the comparison of the costs of ethanol-blended petrol and fossil fuel-based petrol has been done at the crude oil prices prevailing in April 2009. Changes in crude oil prices would result in a change in the financial aspects of the issue.

2.1 Ethanol Import Costs

To provide a comparative picture of the two sources of supply (domestic and imports), the price per litre of imported ethanol is presented in this section. In the harmonised system (HS) of classification, ethanol imports fall under the category of agricultural

[3] It was also announced that any other authority fixing a price for the crop above the FRP would have to bear the difference. Thus, effectively the new system would discourage the states from announcing their SAPs as they have to bear its burden. The FRP is fixed after taking into consideration the margins for sugarcane farmers on account of risk and profit on the cost of production of sugarcane.

products (HS Code 2207); covering both un-denatured (HS 220710) and denatured (HS 220720) alcohol (refer to Annexure 4). While India imports ethanol from a number of countries,[4] Brazil has been the single largest source for Indian ethanol imports over the years. In 2009–10, around 98 per cent of denatured alcohol and 99 per cent of un-denatured alcohol imports came from Brazil. Such high import dependence on a single country for ethanol is not without its problems. A comparison of the delivered cost of imported ethanol from Brazil and domestic ethanol shows that in recent months the cost of imports was higher.[5]

2.2 Transportation Cost Calculation

It follows from the above that, in addition to the cost differences between the two sources of ethanol supply, i.e., imports and domestic production, there will be differences in transportation costs as well. In the case of imports, this involves transportation from the landing port to the blending point's storage point or retail pump outlet (RPO), and in the case of domestic production, from the distillery to the blending point. Therefore, the resulting costs incurred would be quite different. Additionally, differences would crop up due to the state from which the ethanol is being sourced. In India, ethanol is primarily produced by three states – Uttar Pradesh, Maharashtra and Tamil Nadu.[6] At the same point of blending, the costs of procuring ethanol from each of these three states vary widely. For the current calculation, we assume that the average transportation cost per litre of ethanol is Rs. 3.5 per litre, based on chemical industry inputs.

2.3 International Pricing Scenario

While several countries around the world are currently producing biofuels, Brazil and the US are globally the largest producers. There is significant variation in the cost of production in different regions, due to differences in the crops used, agricultural practices, land and labour costs, conversion plant sizes, processing technologies and government policies in different regions (IEA, 2004). Due to lower agricultural production and therefore feedstock costs in tropical climates, developing countries have a natural comparative advantage in producing sugarcane-based ethanol. Figure 1 presents a comparative picture of international ethanol prices.

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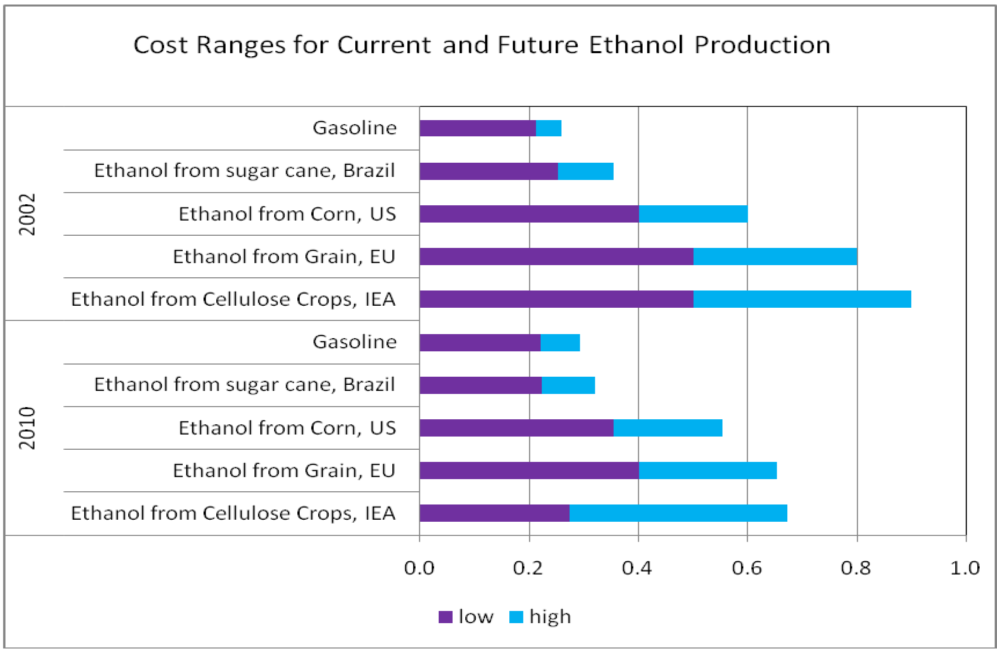
[4] India imported denatured alcohol from South Africa, Pakistan, China, Saudi Arabia and Russia in addition to Brazil.

[5] The landed price of ethanol if imported in Indian currency for the period 2000 to 2008 would have been in the range of Rs 17-31/litre.

[6] The Tamil Nadu government has not allowed the use of ethanol for petrol-blending purposes.

Figure 1: International Ethanol Costs of Production



Source: IEA, 2004.
Note: Figures for 2010 indicate the cost projections made by the IEA. These do not refer to actual values.

Brazil is one of the most efficient producers of ethanol in the world. While India has the distinction of being one of the largest producers of sugarcane, the lack of efficient processing technology has made its cost of production comparatively higher (Rs. 27 or USD 0.54). At the prevailing prices, the ethanol costs for India are comparable with the ethanol made from corn in the US. The comparability of the Indian and US cost figures is interesting since the production of ethanol from starch-containing feedstock such as corn is more expensive due to the additional processing required. Therefore, it would seem that the ethanol production processes are much more efficient in the US than in India. The EU, on the other hand, uses wheat, maize and sugar beet to produce ethanol, but it is a comparatively inefficient producer, primarily due to higher feedstock costs, energy costs and scale diseconomies prevalent in the region (IEA, 2004). While it is true that there is large potential for technology improvements in India, the prices prevailing in other countries are not just the result of the actual cost of production but also of producer supports given to the feedstock growers. Studies reported in IEA (2004) show that the actual cost of production of a litre of ethanol in the EU is about 18 cents higher than that reflected in cost estimates. Also, the market prices of ethanol feedstock crops are much lower than the true crop production costs (in the absence of agricultural subsidies). Further, it should be noted that the scale economies for the production of ethanol using corn and sugarcane are quite different. Since corn can be stored for a longer period, large-scale processing plants that enable scale economies are easier to develop. Sugarcane, however, has a shorter shelf-life and a higher risk of spoilage. Therefore, sugarcane-based ethanol processing plants in developing countries tend to have smaller sugarcane processing plants.

2.4 Futuristic Perspective of Costs: Endogenous Technology Learning Discussion

While the above section looked at the current level of prices, it should be noted that scale effects with respect to prices exist which have an impact on the movement of future prices. The concept of technical learning curves has been used in many renewable technologies to forecast how prices would fall in future with growing market sizes and through reaping of economies of scale. Bioenergy is a special case in this regard since learning takes place at two levels – production technology (agriculture) as well as processing technology (ethanol manufacturing) – both of which serve to reduce costs over time (Hettinga et al., 2009). Studies have looked at the cost of production over time of two of the leading ethanol producers in the world, i.e., Brazil and the US, and have found a major reduction in agricultural production and manufacturing costs in the period 1975–2005. Table 3 presents the results of such an analysis.

Table 3: Figures for Technology Learning/Experience Curve in Brazil and US

	Brazil (van den Wall Bake *et al.*, 2008)	**US (Hettinga *et al.*, 2009)**
Total cumulative ethanol produced by 2005 (million m^3)	300	125
Agricultural yield ($tonne_{cane}$/ha)	75–82	9–10
Ethanol yield ($m^3/tonne_{cane}$)	0.082	0.4
Feedstock Production (1975–2005)		
Cost reduction (percentage)	60	63
Number of doublings in cumulative production	3	1.9
Progress Ratio	0.68 ±0.03	0.55±0.02
2005 cost ($/$tonne_{cane}$)	14.9	107
Industrial Processing (start–2005)		
Cost reduction (percentage)	(1975–2005) 70	(1983–2005) 49
Number of doublings in cumulative production	5	7.2
Progress ratio	0.81±0.02	0.87±0.01
2005 costs ($/$m^3$)	103	128 (+ 50$ capital)
Current total ethanol production costs ($/$m^3$)	~188	~310
Current ethanol price ($/$m^3$)	365	430

Source: Hettinga *et al.* (2009).

Further, it should be noted that the scale economies for the production of ethanol using corn and sugarcane are quite different. Since corn can be stored for a longer period, large-scale processing plants that enable scale economies are easier to develop. Sugarcane, however, has a shorter shelf-life and a higher risk of spoilage. Therefore, sugarcane-based ethanol processing plants in developing countries tend to have smaller sugarcane processing plants.

To sum up, the cost of ethanol produced is crucially dependent on the market price of molasses. Thus, there is high likelihood that domestic ethanol prices would move in tandem with the sugarcane cycle. However, with improvements in technologies for both the production (sugarcane) and processing of ethanol, the variability can be reduced somewhat in the future.

3. Taxation of Ethanol Production in India

Several arguments have been offered to justify the taxation of fuels (Peters and Thielmann, 2008). These include internalisation of external costs caused by vehicle usage (road usage, environment, etc.), improvement in the efficiency of the tax system, and shifting of scarcity rent from producers of exhaustible resources such as petroleum products.[7] Taxation on fuels can be broadly divided into excise, customs duty and other cesses and levies. For developing countries, such as India, these taxes form an attractive source of government revenue.

The usual policy adopted internationally to overcome the cost difference between gasoline and ethanol has been to tax the gasoline for raising its price and to provide subsidies and/or tax rebates to ethanol to reduce its price. The subsidies could be in the form of concessions granted to the ethanol producers which would translate into lower retail prices or through farmer subsidies when the opportunity cost of the feedstock increases (Pohit, et. al. 2009).

In the following sections, we discuss the tax structure of ethanol. This will then be compared to the prevailing price of petrol to arrive at some estimate of the costs/benefits from ethanol-blended petrol usage.

3.1 Duty Structure for Ethanol

The current structure of taxes and other duties levied on industrial ethanol is presented in Table 3. In Section 2, we showed that, on average, the cost of production of ethanol for a generic producer (or the distillery-gate prices) is about Rs. 27 per litre. To compute the cost of the ethanol to a specific consumer, the following tax structure (Table 4) would need to be superimposed on the ethanol cost of production plus the denaturing charges (Rs.0.50) and transportation costs (Rs.3.50). Once taxes and other costs are added, the price of ethanol to the consumer amounts to roughly Rs. 36.6 per litre.

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[7] The theory presumes that the amount of petroleum products sold each year is fixed and exporters do not adjust their production if taxes or tariffs are imposed. This inflexibility affords the opportunity for importing countries to levy tariffs without triggering cutbacks in supply, thereby increasing government revenues and shifting the tax burden to the exporting country.

Table 4: Industrial Ethanol: Prevailing Tax and Levy Structure

Tax and Levy Structure			
Uttar Pradesh		**Maharashtra**	
For Sale in UP		*For Sale in Maharashtra*	
Purchase Tax *(Rs./Litre)*	0.8	VAT	5 per cent
Denaturation Fee *(Rs./Litre)*	0.15		
Central Excise Duty	10 per cent	Central Excise Duty	10 per cent
Education Cess	2 per cent	Education Cess	2 per cent
Higher Education Cess	1 per cent	Higher Education Cess	1 per cent
For Sale Outside UP		*For Sale Outside Maharashtra*	
Export Fees *(Rs./Litre)*	1	Export Fees *(Rs./Litre)*	1.5
Denaturation Fee *(Rs./Litre)*	0.15		
Central Excise Duty	10 per cent	Central Excise Duty	10 per cent
Education Cess	2 per cent	Education Cess	2 per cent
Higher Education Cess	1 per cent	Higher Education Cess	1 per cent
CST	2 per cent against Form C	CST	2 per cent against Form C
Import Fees *(Rs./Litre)*	1	**Import Fees** *(Rs./Litre)*	1.5

Source: Chemical Industry Sources.

Note: (a) In UP, only central excise duty is included under MODVAT. In Maharashtra, VAT and central excise duty comes under the purview of MODVAT.
(b) VAT: Value Added Tax; CST: Central Sales Tax; MODVAT: Modified Value Added Tax.

The tax and levy structures depend on the state from which ethanol is sourced. The tax structure also depends on the final use of ethanol. As mentioned earlier, to promote ethanol usage for blending with petrol, the excise duty levied on manufactured ethanol is exempt from excise duty in the next processing stage. Such exemptions are not given for usage in other sectors such as potable and alcohol -based chemical industries.

As far as imports of ethanol are concerned, a customs duty of 7.5 per cent needs to be paid, according to Customs Tariff Notification 2010–11. The customs duty on molasses imports is 10 per cent.

3.2 Cost Build-up for Petrol

To understand the revenue aspects of ethanol blending, the tax structure for the Indian petroleum sector (with a focus on petrol) has been reviewed. Petrol prices have traditionally been one of the four sensitive items that the government regulates to shield consumers from the adverse impacts of volatililty in international crude prices. A compensatory mechanism had been put in place to make up for revenue losses suffered by OMCs, which arose from the decision to keep domestic petroleum product prices low even when crude oil prices are rising in the international market. This mechanism involved financial support to OMCs from other public sector upstream companies, viz., Oil and Natural Gas Corporation (ONGC), Oil India Limited (OIL) and Gas Authority of India Limited (GAIL), by way of price discounts and from the government through the issue of bonds (Parikh Committee, 2010).

In India, petroleum product prices are administered at two levels:

1. At the refinery gate (the price at which products are sold to marketing divisions of OMCs) and
2. At the level of the consumer (the price that consumers pay for the products).

The Parikh Committee report on "A Viable and Sustainable System of Pricing of Petroleum Products" recommended that petrol prices should be market-determined, both at the refinery gate and at the retail level on two grounds. First, mounting under-recoveries (estimated as the difference between the entitled price and the selling price of OMCs) were turning the marketing companies unviable, and, second, it felt that motorised vehicle owners had the ability to bear higher product prices. Petrol price have therefore subsequently been decontrolled from June 2010.

Refinery Gate Pricing

For petrol, refinery gate prices are determined using 'trade parity prices'. Prices are computed as a weighted sum of the CIF price (80 per cent weight) and FOB prices (20 per cent weight) of petrol imports. Here, the CIF price is first determined on the basis of FOB charges and other associated costs for imports as follows:

> CIF = [FOB + Freight from the port of export to refinery port + Insurance] x (rupee/$) + Landing charges + customs duty

The FOB rate, on the other hand, is based on the rates prevailing in specified ports in the Gulf region. Finally, the refinery gate prices for petrol are determined using the trade parity price plus 75 per cent of the rail freight from the port to refinery (where the port chosen is the one that is the nearest to the refinery). The price that the OMCs are entitled to charge is the sum of the refinery gate price, 50 per cent of the rail freight from the refinery to the depot, marketing costs and marketing margin (Petrofed, 2009).

3.3 Selling Price to the Consumer

While the government has introduced the blending of ethanol with petrol, several issues arise from a consumer perspective. These relate to the excise benefits on offer on ethanol for blending, the pricing of ethanol-blended petrol and the compatibility of existing vehicles with ethanol-blended petrol. With the decontrol of petrol prices in 2010, the consumer is not shielded against international crude price volatility. With the ethanol blending programme and given that ethanol price is administered, a new dimension is entering the price of ethanol charged to the consumer. Table 5 below shows components of the price at the consumer level in major Indian cities in 2009.

Table 5: Price Build-up of Petrol in Major Cities as on April 1, 2009

(Rs./kilolitres)

	Delhi	Kolkata	Mumbai	Chennai
Revised Storage point price	18808.35	18808.35	18808.35	18808.35
State Surcharge	4.00	605.00	276.00	795.00
BMC Surcharge	0.00	0.00	859.00	0.00
Siding charge w.e.f. 19.7.07	58.83	0.00	0.00	0.00
Railway/Ocean/Freight	91.96	223.87	0.00	0.00
RPO Surcharge	36.00	36.00	36.00	36.00
RPO Charge	4.36	4.36	4.36	4.36
Price adjusted factor	0.00	84.79	(53.01)	(218.86)
Assessable Value	**19003.50**	**19762.37**	**19930.70**	**19424.85**
Basic Excise Duty Amount	1350.00	1350.00	1350.00	1350.00
ADE+SADE	7000.00	7000.00	7000.00	7000.00
Subtotal (1)	**27353.50**	**28112.37**	**28280.70**	**27774.85**
FDZ Charges	44.00	44.00	44.00	44.00
Basic Excise Duty Amount	5000.00	5000.00	5000.00	5000.00
Education Cess	400.50	400.50	400.50	400.50
Sub Total (2)	**32798.00**	**33556.87**	**33725.20**	**33219.35**
Delivery Charges beyond FDZ	0.00	19.20	0.00	0.00
Toll Tax	0.00	16.00	0.00	0.00
RPO Price	32798.00	33592.07	33725.20	33219.35
Sales Tax	6770.00	8398.02	8768.55	9965.81
Surcharge on Sales Tax	0.00	1000.00	1000.00	0.00
Dealer’s Commission	1052.00	1052.00	1052.00	1052.00
Retail Selling Price Rs./kilolitres	40620.00	44042.09	44545.75	44237.16
Retail Selling Price Rs./ltr	**40.62**	**44.05**	**44.55**	**44.24**

Source:MoPNGb (2010)

Note: BMC: Brihanmumbai Municipal Corporation; FDZ: Free Delivery Zone; ADE: Additional Duty of Excise; SADE: Special Additional Duty of Excise.

It should be noted that the Indian Petroleum and Natural Gas Statistics only provides figures for the storage point price without giving a breakup of its various constituents (discussed below). In this regard, an earlier study on the ‘Marketing Cost of Petrol and Diesel’ sponsored by the Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas (Government of India, 2006) had looked into this aspect and identified the following constituents:

1. Marketing costs: These cover compensation for infrastructure and salaries and wages of employees
2. Marketing margin: Return on net fixed assets employed in marketing of petroleum products
3. Return on working capital
4. Stock loss due to evaporation, leakage/spillage, etc.
5. Retail Pump Outlet (RPO) charges
6. ***Freight (equalised transportation costs)****
7. ***Domestic Logistics Adjustment Factor****

8. Terminalling charges
9. RPO surcharge
10. ***Delivery charges under-recovery****

The items indicated in asterisks were identified as sources of under-recoveries (estimated as the difference between the entitled price and the selling price) to the OMCs. While a breakup of these constituents for recent years is not available, the Ministry of Petroleum and Natural Gas has estimated the figures for total under-recoveries to OMCs from the sale of petroleum products (Table 6).

Table 6: Under-recoveries of Petroleum Products in India (Rs. crore)

	2005–06	2006–07	2007–08	2008–09	2009–10
Petrol	**2723**	**2027**	**7332**	**5181**	**5151**
Diesel	12647	18776	35166	52286	9279
PDS Kerosene	14384	17883	19102	28225	17364
LPG	10246	10701	15523	17600	14257

Source: MoPNG website.
Note: PDS: Public Distribution System; LPG: Liquefied Petroleum Gas.

From the reported petrol consumption for 2009–10, we can calculate the under-recovery per litre of petrol as shown in Table 7:

Table 7: Estimation of Under-recoveries of Petrol in India (2009–10)

(1)	Under-recoveries for Petrol in 2009/10 (Rs. crore)	5151
(2)	Petrol Consumption in 2009/10 (‘000 tonnes)	12818
(3) = ((1)*10)/(2)	Under-recovery for Petrol in 2009/10 (Rs./kg.)	4.0
(4) (from)	Petrol Density (Kg/litre)	0.737
(5) = (3)*(4)	Under-recovery for Petrol in 2009/10 (Rs./litre)	3.0

Source: Authors' calculations based on MoPNG website and MoPNGa (2010).

Thus, the computation shows that the effective subsidy per litre of petrol consumed was Rs. 3.0/litre.

3.4 Comparison of Costs Incurred under the Ethanol-blended Petrol Programme

Bringing together the points raised in the earlier sections, it can be seen that the blending of ethanol with petrol may lead to financial losses to the economy. A comparison of the value of petrol (Subtotal 2 in Table 5 assuming that blending occurs at the storage point), i.e., Rs. 33–34 per litre as against the ethanol cost of Rs. 26–37 per litre (assuming different refinery gate prices) – shows the magnitude of the difference in costs (Table 8). As a basis for comparison, three scenarios have been created that assume different refinery gate prices for ethanol. The refinery gate prices per litre of ethanol have been taken to be Rs. 18 [(from the estimations of the Planning

Commission (2003) and Gonsalves (2006)], Rs. 21.5 (from the earlier determined contract price of ethanol supply to OMCs), and Rs. 27 (price fixed by the EGoM/our estimates).

Table 8: Comparison of Ethanol and Petrol Prices

Ethanol Refinery Gate Price (Rs./litre)	Denaturing Charges (Rs./litre)	Duty Structure (Rs./litre)	Transportation Costs (Rs./litre)	Total Ethanol Price (Rs./litre)	Petrol Price in 2008* (Rs./litre)	Petrol Price in 2009 (Sub Total 2)# (Rs./litre)	Estimated E5 price (Rs./litre) (2008)	Estimated E5 price (Rs./litre) (2009)
18	0.5	4.2	3.5	**26.2**	37.5	**33.5**	36.94	**33.14**
21.5	0.5	4.7	3.5	**30.2**	37.5	**33.5**	37.14	**33.34**
27	0.5	5.6	3.5	**36.6**	37.5	**33.5**	37.46	**33.66**

Source: Authors' Calculations

**Data Source = Sub Total 2 of Price Build-up of Petrol in Major Cities April 2008, Indian Petroleum and Natural Gas Statistics*

#Data Source = Price Build-up of Petrol in Major Cities April 2009, Indian Petroleum and Natural Gas Statistics (refer Table 5.3.1)

*Note: E5 Price= 95% * Petrol Price + 5% * Ethanol Price*

It can be seen that that the cost of ethanol-blended petrol is less than the cost of petrol produced solely from fossil fuel in two cases – ethanol price of Rs. 18 and Rs. 21.5 per litre. Since ethanol-blended petrol and fossil fuel-based petrol are likely to be priced the same at the retail end, ethanol blending will result in losses for OMCs at the ethanol price of Rs. 27 per litre.[8] In case ethanol blended petrol and unblended petrol are priced at the same level, this would effectively imply that the lower ethanol purchase price is being used to finance petroleum sector under-recoveries.

However, whether the government would like to allow the OMCs to retain the higher margin or whether it would prefer the margin to be passed on to sugarcane farmers through higher support prices are issues that it needs to look into. Alternatively, the government could use the cost differential to offer ethanol-blended petrol at a price lower than for fossil fuel-based petrol to boost its off take. How the distributive share of consumers and producers pans out depends on which of these two alternatives the government decides to opt for. The incentives for promotion of ethanol could include a reduction in import duty on industrial ethanol from 7.5 per cent to 5 per cent, equivalent to the duty on petroleum products. Also a uniform taxation structure could be adopted to reduce regional price disparities. Efforts are currently on to introduce the

[8] It should be noted that the comparison of the costs of ethanol-blended petrol and fossil fuel-based petrol has been done at the crude oil prices prevailing in April 2009. To reduce risks involving any fall in the market price of ethanol, the government could also enter into long-term contracts with OMCs to purchase ethanol at a certain minimum price (as discussed earlier). Further, the companies bringing ethanol into the country may be given carbon credits. There was also a proposal to bring ethanol under the 'special goods' category and ensure that the tax structure on the product is uniform across India.

Goods and Services Tax (GST) by April 2012, which is expected to do away with most of the indirect taxes, levied by the centre and the states and bring in uniformity in tax rates. However, the inclusion of alcohol in the list of products covered under the tax is still a contentious issue.

Additionally, differences in the calorific values of both ethanol as well as petrol have not been considered in the ethanol-blending programme. While the calorific value of ethanol is 7.1 kcal/g, the calorific value of petrol is 11.3 kcal/g. Thus, the calorific value of ethanol is approximately 35 per cent less than that petrol. Therefore, the programme poses a problem when the blending is done according to fuel volumes rather than in terms of petrol equivalent litres (in calorific value terms). This implies that the useful energy output of blended fuel to the consumer would effectively be lower than that of neat petrol fuel. Lowering the price of ethanol might compensate consumers as well as provide an incentive for greater consumption. The downside is that this would require investment in additional infrastructure for the segregation of blended and unblended fuels as well as conformity with blending specifications. The point at which the blending of ethanol and petrol occurs is also an important determinant of the overall costs. The higher up in the value chain the blending occurs (such as the storage points), the lower would be the monitoring requirements and more efficient the ethanol transportation routes. Blending lower down the value chain (such as the RPOs) may lead to differences in quality, incremental investment requirements (for ethanol storage) as well as increased possibility of diversion.

It is interesting to note that crude prices play a role in ethanol consumption in both its major consuming sectors – transport and chemicals. The substitution possibility between fossil fuels and ethanol for the production of chemicals and between petrol and ethanol for transportation usage leads to crude oil prices entering twice in the cost calculation. On the one hand, these determine the floor prices at which ethanol should be priced (for equivalence with petrol) so that substitution occurs. The price of crude petroleum forms an upper-limit to the cost of ethanol that the oil marketing companies (OMCs) can profitably use. On the other hand, they effectively determine the ceiling price for ethanol usage in the chemical industry since, beyond this point, petroleum derivatives would be increasingly used in the manufacturing process.[9]

[9] The issue of surplus petrol production also needs to be considered before the large-scale implementation of the EBP. India has some of the most technically advanced refineries in the world. However, while these refineries can modify the production of petroleum derivatives to suit product demand in various centres, the increasing demand for diesel and therefore the production of diesel (an important input for transport, decentralised electricity generation, etc.) would lead to continued production of petrol as well. Falling petrol demand following the introduction of EBP and largely unchanged petrol production may require the export of large quantities of petrol to the international market and at the same time possibly the import of ethanol to meet the demands of various user groups.

4. Policy Recommendations and Conclusion

The study examines the pricing issues related to the Ethanol Blending Programme in India. The study examines the ethanol blended petroleum pricing mechanism in India in comparison with the globally accepted price mechanism. The cost of producing ethanol in India varies largely with molasses prices and hence cyclical variations in sugarcane production chiefly determine the cost of ethanol production. The study analyzes the interim price fixation at Rs. 27 per litre by the government by providing estimates of different expenditure heads of ethanol production costs. It attempts to calculate the price of ethanol for a generic standalone distillery and arrives at a price very close to the price fixed by the government. However, given the cyclical nature of sugarcane, a periodic review of ethanol prices becomes critical. The pricing issue is also complicated by the decontrol of petrol prices and administered pricing of sugarcane.

From the ethanol pricing point of view, supply constraints rather than demand would dictate price movement. Since sugarcane supply follows a cyclical trend, the ethanol price fixed by the government would need to be revised periodically to adequately reflect market conditions. It is understood that the frequent year-to-year fluctuations in ethanol availability are, to an extent, on account of the cyclical nature of the production of the raw material – sugarcane. Yet, to ensure that sectoral shortages are kept to the minimum, adequate investments in ethanol storage facilities and R&D should be encouraged. Other measures like the integration of the production and milling of sugarcane to the ethanol production stage can mitigate some of the problems referred to above.

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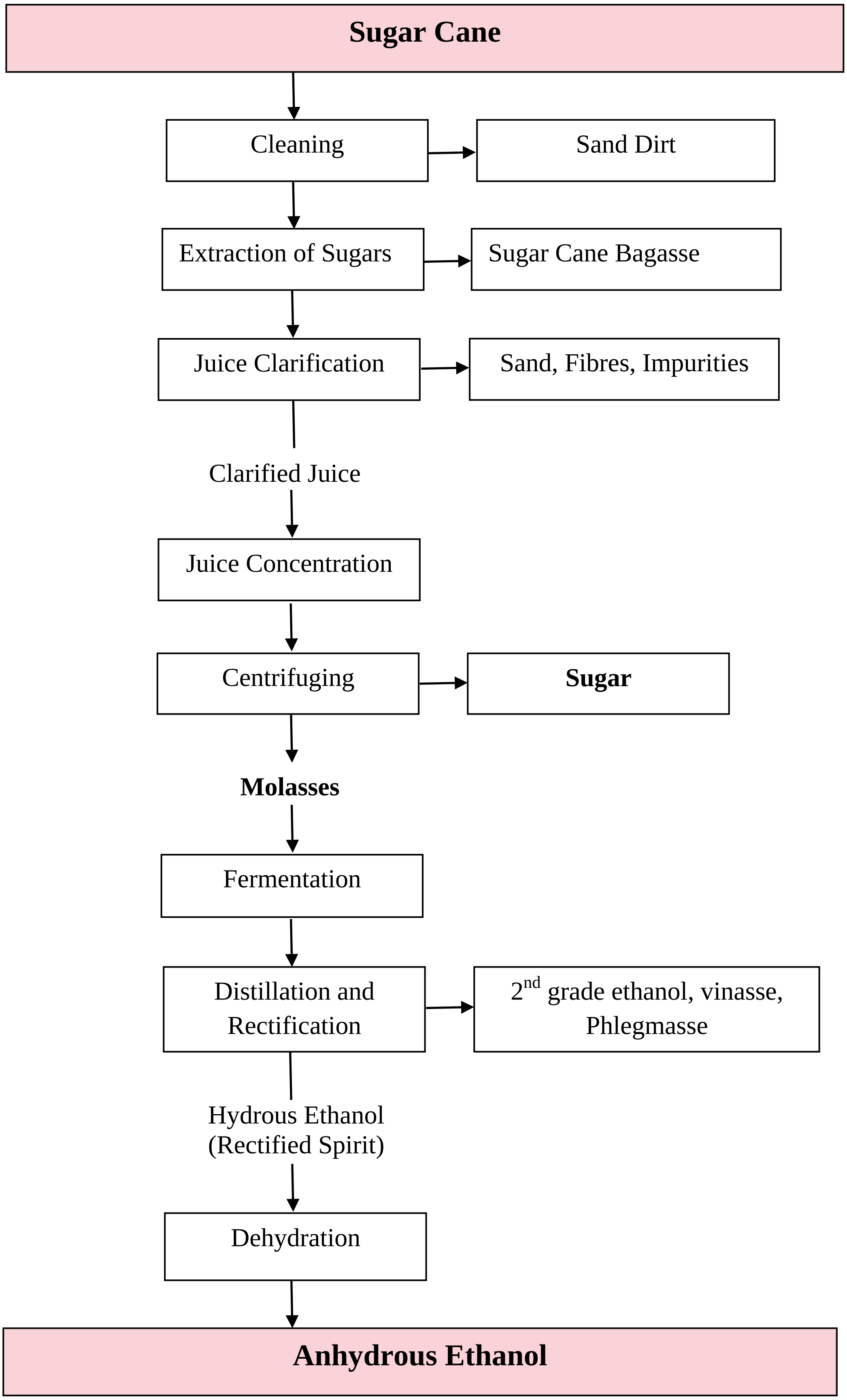
Annexure 1: Details of Ethanol Production Process



The production of ethanol from sugarcane involves the following processes (Kumar *et al.,* 2010; Ogden and Fulmer, 1990; Quintero *et al*., 2008):

1. **Sugarcane milling and Juice extraction:** Sugarcane is passed through roller mills to extract juice by squeezing it under high pressure. Extraction is enhanced by leaching cane with weak juice and make-up water in a process called 'imbibition'. The leftover fibrous material after the milling is called bagasse and is used for steam/electricity generation in many plants.
2. **Juice Clarification:** The juice obtained from sugarcane milling is heated to 60–65^{o} C in raw juice heaters. The heated juice is then treated with lime and sulphur dioxide gas under the 'double sulphitation' process to remove impurities in the juice in the reaction tank. It is then pumped to clarifiers after heating to 100^{o} C. Muddy juice which settles at the bottom of the clarifiers is filtered in vacuum filters and the filtrate is recycled back into the system. The heavy insoluble impurities (soil, mud, etc.) are removed and used as manure by farmers. The retention time in the clarifiers is around 2–3 hours and due to the ensuing temperature drop the juice needs to be heated again before it can be sent to the next process.
3. **Evaporation:** The clarified juice is sent to evaporators which boil the excess water under vacuum to increase the sugar concentration from around 15 Brix to 60 Brix.[10]
4. **Crystallisation:** Pan boiling or crystallisation of concentrated juice or 'massecuite' (containing both sugar and molasses) is done in batch-type vacuum pans. Next, the massecuite is transferred to crystallisers where the mass is cooled.
5. **Centrifuging:** The massecuite is sent to centrifuges where sugar crystals are separated from the molasses. These centrifugal machines can be batch type or continuous type. The molasses separated out is sent as raw material to distilleries.
6. **Fermentation:** The fermentation of molasses is done using commercial yeast such as Saccharomyces cerevisiae. As a first step the fermentation feedstock is hydrolysed to invert sugars (glucose and fructose) using invertase (an enzyme present in yeast) as a catalyst, i.e.,:

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

(sucrose) (water) (enzyme) (Glucose) (Fructose)

Next, another enzyme present in yeast (zymase) metabolises the invert sugars in the absence of oxygen into ethyl alcohol and carbon dioxide. Some energy in the form of heat is also released in the process.

$C_6H_{12}O_6$ = $2C_2H_5OH$ + $2CO_2$ + 31200 cal

(Glucose or Fructose) (ethyl alcohol) (carbon dioxide) (energy)

[10] Brix is a measurement of a soluble dry substance in a liquid.

7. **Distillation:** After fermentation, distillation is done to separate the ethanol from the mixture. This consists of introducing the mixture into first the concentration column and next the rectification column. The distillation process uses the fact that the concentrations are different for different components of the mixture in the gaseous and liquid phases, i.e., they have different boiling points. Since ethanol is more volatile, it will be highly concentrated in the vapour phase, i.e., with the application of heat in the column, the hot rising vapour rich in ethanol can be collected at the top of the component. Since water is in the liquid phase, it flows downwards towards the reboiler located at the bottom of the column. While in the 1^{st} column approximately 70–90 per cent pure ethyl alcohol can be collected, after passing through the rectifying column a 96.5 per cent pure hydrous ethanol solution can be obtained. It should be noted that at this stage the solution is an azeotrope, i.e., it has a single boiling point. Therefore, further distillation would not remove any more water from the solution.
8. **Conversion to Anhydrous Solution:** From the 96.5 per cent pure hydrous ethanol solution derived earlier, conversion processes extract a 99.5 per cent pure solution that can be used for industrial, transportation and other uses. Some of the processes generally followed include: azeotropic distillation where a constituent is added to the mixture to reduce the volatility of either water or ethanol, extractive distillation where a dehydrator, such as glycerol, is added to the mixture, separation using hyper-filtration membranes, and adsorption processes using molecular sieves that work on the basis of differences in the molecular size of water and ethanol.
9. **Denaturing of Ethanol:** For use in the transport and chemical sectors, a denaturant is added to the extracted ethanol to make it non-potable.

Annexure 2: Ethanol Production Cost Estimates

Assumptions for a generic standalone distillery:

1. Annual production of ethanol assumed at 30 kilolitres per day (KLPD) and 300 working days = 9000 kilolitres/year
2.* Molasses price of Rs. 4,500 per tonne assumed.
3. Recovery of 220 litres of anhydrous ethanol from one tonne of molasses
4. Alcohol plant assumed to be fully depreciated so capital-related charges ignored except that of putting up the facility for making anhydrous alcohol via molecular sieve. Thus, depreciation rate is assumed to be 10 per cent.
5.* Rice husk/Bagasse cost of Rs. 2,000/ton with steam rising @3T/T of rice husk/bagasse.
6. Power cost of Rs. 4.5/kWh assumed.
7. Biogas generation can provide enough energy to meet all energy demand but it has not been taken into account.
8.* Labour cost assumptions: It is assumed that the cost of labour has been increasing at least at the rate of increase in the cost of living. Therefore, the labour cost per litre of ethanol has been scaled up based on the Consumer Price Index for Rural Labourer to arrive at the current cost of labour.

Year	Consumer Price Index for Rural Labourer	Labour Cost (Rs./Litre)
2003–04	**333**	**0.25**[#]
2004–05	342	0.26
2005–06	355	0.27
2006–07	382	0.29
2007–08	409	0.31
2008–09	451	0.34
2009–10	**513**	**0.38 (Our Estimate)**

[#] Planning Commission (2003)

9.*Cost Calculation of Molecular Sieve:

Quantity (Kg.)	Initial Cost (Rs./kg)	Life (Years)	Annual Increase in Cost	Average Cost Per Year (Rs.)	Cost Per Litre (Rs. / ltr.)
3000	210	5	20%	182815	0.2

10. * Cost of Capital Assumption:

	Debt
Source of capital (Rs. crore)	7.2
Cost of capital (%)	9%
Capital cost per litre (Rs./litre)	**0.72**

11. * Working Capital financed through short-term loans @ 15%.
12. No taxes (excise or sales) on inputs considered.

Annexure 3: Alternative Ethanol Production Costs

Annexure Table A3.1: Ethanol Production Costs (Gonsalves)

	Standalone distillery	**Integrated with sugar production**
Cost of molasses (per tonne)	Rs. 3000	Rs. 3000
Transportation cost (per tonne)	Rs. 150	0
Total	Rs. 3150	Rs. 3000
Recovery of ethanol (litres/tonne)	220	220
Rs./litre		
Molasses cost after milling	14.32	13.64
Steam cost @ Rice Husk Rs. 500	0.25	0
Power cost @ Rs. 4.5/KWh	0.59	0
Chemical cost	0.2	0.2
Labour cost	0.25	0.25
Repair and Maintenance	0.15	0.15
Cost of Replacement of Molecular Sieve	0.02	0.02
Total direct cost	15.76	14.24
Finance and other costs		
Indirect costs, including overheads	0.56	0.28
Interest@12 per cent for borrowed capital for Rs.7.2 crore (Debt/Equity Ratio=1.5)	0.96	0.96
Interest @12 per cent for working capital for one month of molasses and ethanol	0.2	0.2
Depreciation @10 per cent for Rs.12 crores	1.33	1.33
Total Finance and other costs	3.05	2.77
Total Costs	**Rs. 18.81**	**Rs. 17.01**

Source: Planning Commission (2003), Gonsalves (2006).

Assumptions used for the cost estimation:

- Recovery of 220 litres of anhydrous ethanol from one tonne of molasses
- Molasses price Rs. 3000 per tonne
- Annual production of ethanol @30,000 litres per day and 300 working days = 900,000 litres/year
- Life of molecular sieve assumed to be 5 years and cost = 3,000 kg × Rs.250/kg = Rs. 7,50,000, avg. cost per year = Rs.150,000, cost per litre of ethanol = Rs.5/300=0.2
- Power cost of Rs. 4.5/KWh and rice husk cost of Rs.500/tonne with steam rising @ 3 T/T of rice husk
- Biogas generation can provide enough energy to meet all energy demand but it has not been taken into account.
- No taxes (excise or sales) on inputs are considered.

Annexure Table A3.2: Ethanol Production Costs (STAI)

Particulars	Cost of ethanol	
	Cane Molasses (Rs.)	*Cane Juice (Rs.)*
Cost of Raw Materials	10.00	13.30
Cost of Conversion to Rectified Spirit	3.00	3.50
Dehydration Costs	2.00	2.00
Other Costs	1.00	1.00
Total Costs (Rs./Litre)	16.00	19.80

Source: STAI (2003).
Note: Ethanol production from cane juice is not very prevalent in India.

Assumptions used by the study for cost calculation:

1. Cost of molasses: Rs.2,250/ton; cost of sugarcane; Rs.1,000/ton
2. Cost of juice extraction from cane: Rs.0.50/tonne
3. Alcohol yield: 225 litre/ton of molasses, 75 litre/tonne of cane
4. Distillery capacity: 45 kilo litres per day (KLD).

Annexure Table A3.3: Ethanol Production Costs (ICC)

Molasses Cost Landed (Rs./quintal)	300
Direct Cost of molasses (Rs.)	12.50
(assuming a recovery of 24 litres/quintal)	
Conversion Cost (Rs /litre)	
1. Chemicals	0.20
2. Steam	1.67
3. Power	0.53
4. Salary	0.20
5. Depreciation	0.47
6. **Cost of Hydrous Alcohol**	**15.56**
7. Hydrous to Anhydrous (extra alcohol of 4 per cent)	0.62
8. Conversion cost	0.5
9. **Cost of Anhydrous Alcohol**	**16.68**

Source: Indian Chemical Council (ICC)

They assume the following while calculating ethanol production costs:

1. Relevant figures derived from 2 plants with capacities of 1,148 litres/annum and 330 litres/ annum respectively
2. Calculation of steam and power inputs done as follows:

	Unit	Norms	Cost	Value (Rs/lit)
Steam	Mt/Kbl	1.6–1.7	900–1000	1.67
Power	Kwh/Kbl	100–110	5	0.50–0.55

Annexure 4: Trends of Ethanol Imports (1996/97–2009/10)

Year	HS 22072000: Denatured Ethanol			Year	HS 22071090:Un-denatured Ethanol		
	Value	***Quantity***	***Price***		***Value***	***Quantity***	***Price***
	(Rs. lakhs)	*(1000 litres)*	*(Rs./litre)*		*(Rs. lakhs)*	*(1000 litres)*	*(Rs./litre)*
1996–97	129	328	39.2	1996–97			
1997–98	3417	23655	14.4	1997–98			
1998–99	653	4830	13.5	1998–99			
1999–00	698	7646	9.1	1999–00			
2000–01	41	53	77.5	2000–01			
2001–02	61	134	45.3	2001–02			
2002–03	2650	19823	13.4	2002–03			
2003–04	978	7378	13.3	2003–04	7	11	64.3
2004–05	50908	313527	16.2	2004–05	1461	7765	18.8
2005–06	61127	310768	19.7	2005–06	1750	9015	19.4
2006–07	10788	39239	27.5	2006–07	99	145	68.4
2007–08	2771	5042	55.0	2007–08	94	86	109.1
2008–09	25660	71543	35.9	2008–09	121	111	108.4
2009–10	67535	278957	24.2	2009–10	11441	39176	29.2

Source: Export Import Database, Department of Commerce, Ministry of Commerce and Industry, GoI.

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