

**CONCEPT PAPER**

**PILOT PROJECT ON ETHANOL FILLING STATION**



**0011-100000-017-001**

**ISSUE: 02**

**DECEMBER, 2005**

# APPROVAL SHEET

**TITLE** : Concept Paper: Pilot Project on Ethanol Filling Station

**DOCUMENT NUMBER** : 0011-100000-017-001 Issue: 02

**PREPARED BY** :



**(Salman Nazir)**  
Project Engineer

**APPROVED BY** :



**(Muhammad Ammad Riaz)**  
Director Systems Engineering

**DATE** : December, 2005

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0011-100000-017-001	ECP No -	
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 2 of 18

# TABLE OF CONTENTS

Page No

APPROVAL SHEET .....	2
TABLE OF CONTENTS.....	3
1 BACKGROUND .....	4
2. CONCERNS REGARDING USE OF ETHANOL AS A FUEL .....	4
2.1 Concerns of Oil Marketing Companies and Oil Refineries.....	5
2.2 Concerns of the Ethanol Producers .....	5
2.3 Concerns of the Government .....	6
3. EXPERIMENTAL RESULTS WITH USE OF ETHANOL FUEL .....	6
3.1 Fuel Efficiency .....	7
3.2 Savings to Consumers .....	7
4. THE DILEMMA .....	7
5. THE SOLUTION – SOFT LAUNCH BEFORE FULL COMMERCIAL ROLL-OUT .....	8
6. ETHANOL FUEL PILOT FILLING STATION.....	9
7. PARTIES INVOLVED IN THE PROJECT .....	9
8. SUPPLY METHODOLOGY.....	10
8.1 Blending at the Point of Sale .....	12
9. CPL’s SOLUTION FOR POINT-OF-SALE BLENDING .....	13
10. CPL AS ETHANOL DISTRIBUTOR FOR PILOT PROJECT .....	14
ANNEXURE - A.....	15
A-I: Comparison of Fuel Efficiencies between Gasoline and Blends of Ethanol .....	15
ANNEXURE - B.....	16
B-I: Cost Comparison between Gasoline and Blends of Ethanol .....	16
B-II: Comparison of Cost per Kilometer Traveled with Gasoline and Ethanol .....	17
B-III: Graphical Comparison .....	18

Title Concept Paper: Pilot Project of Ethanol Filling Station			Document No 0011-100000-017-001	ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 3 of 18

## **1 BACKGROUND**

Ethanol has been used as a transport fuel in many countries of the world for several years. The environmental benefits, energy security advantages and foreign exchange savings caused by use of ethanol as a fuel have been acknowledged. In Pakistan, distilleries produce ethanol for use in beverages, as an industrial chemical, and for export purposes. However, imposition of import duties by the EU has reduced the attractiveness of ethanol export.

The usage of indigenously produced ethanol as a transportation fuel has a long chain of activities and affects many segments/groups. Presently major stakeholders in the ethanol fuel chain are:

- Oil Marketing Companies (OMCs)
- Ethanol producers (most of which are sugar / molasses producers as well)
- Oil Refineries
- Ministry of Industries, Production and Special Initiatives
- Ministry of Petroleum and Natural Resources
- Ministry of Environment
- Consumers
- Environmental Activists

## **2. CONCERNS REGARDING USE OF ETHANOL AS A FUEL**

The long chain of activities in ethanol production and its use as fuel, and involvement of many stakeholders with conflicting interests necessitated a careful assessment of all important dimensions/factors. There are several concerns of different stakeholders regarding the fuel ethanol program.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 4 of 18

## **2.1 Concerns of Oil Marketing Companies and Oil Refineries**

- 2.1.1 Ethanol, if blended with petrol shall reduce sales of petrol. The excess petrol capacity in the country is a major concern of the oil industry. They argue that reduced gasoline production shall have negative impact on refinery margins and profitability.
- 2.1.2 There is no logistics mechanism for ethanol fuel; including infrastructure for blending, storage, transportation and retail dispensing. Putting these mechanisms in place for fuel ethanol will require heavy investments by the refineries and/or OMCs.
- 2.1.3 Blending of ethanol with gasoline at refinery or storage depots is complicated.
- 2.1.4 Blended ethanol has a higher octane rating, so sensitivity to engine can be a problem.
- 2.1.5 Use of ethanol may affect driving conditions.

Except for the profitability, rests of the concerns are technical in nature. A guideline from other ethanol using countries can be sought for answers to technical queries. Moreover, Clean Power (Pvt.) Ltd. (CPL) has conducted a practical experimentation to test the technical properties of fuel ethanol, details and results of which are given later.

## **2.2 Concerns of the Ethanol Producers**

The ethanol producers are pushing for a legislation permitting use of ethanol as a fuel. There are 4 plants in Pakistan currently producing fuel-grade ethanol, and several others are preparing to join the league. However, the major concern of the ethanol producers is the sale price of ethanol. According to them, the FOB Karachi price of molasses should be used as the basis for determining the sale price of ethanol in Pakistan.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 5 of 18

## **2.3 Concerns of the Government**

- 2.3.1 The biggest concern of the Pakistan Government is energy security, which is compromised with most of our energy needs being met from foreign sources.
- 2.3.2 Rising crude oil prices lay an enormous burden on our national exchequer. Also, high fuel prices may affect development growth in the country.
- 2.3.3 Environmental concerns associated with fossil fuel combustion are a source of increasing concern for the Government, particularly since the ratification, by Pakistan, of the Kyoto Protocol.
- 2.3.4 The Government is concerned about the price of fuel-grade ethanol. Unless the price of ethanol is less than that of petrol, the consumers will not be interested in purchasing it, and there will be no “pull” from the consumers.
- 2.3.5 The Government of Pakistan does not want to be in a compromised position at the hands of either of the two major groups of players (ethanol producers and OMCs/refineries). A sticky situation has already arisen with the cement sector, and the Government does not wish the same scenario to be repeated with the fuel ethanol program.

## **3. EXPERIMENTAL RESULTS WITH USE OF ETHANO FUEL**

CPL conducted a study for the Hydrocarbon Development Institute of Pakistan (HDIP); this study involved road runs on different blends of ethanol and petrol. Fuel efficiency and cost-effectiveness were analyzed in the experiment.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 6 of 18

### **3.1 Fuel Efficiency**

Fuel efficiency on volumetric basis for different blends of ethanol and premium gasoline is of great significance for financial aspects of ethanol economics. Road runs under controlled conditions are a practical way to compare fuel efficiencies. A summary of the results pertaining to fuel efficiency is enclosed as Annexure A.

### **3.2 Savings to Consumers**

As part of the study conducted by CPL, cost savings to the consumer through use of ethanol fuel have also been worked out. Results are enclosed as Annexure B.

## **4. THE DILEMMA**

In different countries the ethanol fuel program has met with dissimilar fate. It is not a success story everywhere. In India, the government has to reconsider its original policy of mandatory usage of ethanol fuel. One reason for this setback is conflicting interests between the oil and sugar industries. For both of them ethanol fuel is not the primary business.

The Indian scenario has some similarities with the Pakistani environment. To increase the probability of success of the ethanol fuel program in Pakistan, it is necessary to make it more practical and strong against inherent weaknesses like the following:

- There is no past practical experience by any of the stakeholders.
- There is conflict of interest between oil and sugar industries; neither of these is primarily dependent on ethanol fuel for their business survival.
- Data available to decision makers is very limited.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 7 of 18

As pointed out above, oil and sugar industries have conflicting commercial interests in the use of ethanol fuel. Hence each of them, at the time of decision, wants to secure and maximize its interests: but at the cost of consumers. The oil industry paints a bleak picture of their production surpluses of Naphtha and requirements for high investments in infrastructure to claim subsidies. Likewise, sugar mills provide data to government with inflated cost of production for ethanol.

## **5. THE SOLUTION – SOFT LAUNCH BEFORE FULL COMMERCIAL ROLL-OUT**

In this situation where previous data/experience does not exist and demand for ethanol fuel is likely to be small in initial period of usage, the option of indulging in legal framework to enforce use of ethanol can result in a lengthy procedure, as well as a difference in points of view of the stakeholders involved. This can cause delays and reduce the success of Pakistan’s ethanol program.

Therefore, before a full-fledged start, a soft launch in form of pilot project for commercial sale of ethanol fuel is proposed. It is important that this pilot project is handled by a neutral party other than above cited stakeholders. Moreover, the use of ethanol-petrol blend should be made optional by the Government rather than mandatory, so that a consumer “pull” and market forces determine the price of the product, as well as the overall demand.

The project in the form described above is expected to bring about the following benefits:-

- Actual problems related to commercial use shall be identified.
- Appropriate and practical solutions to identified problems shall be developed.
- More broad-base technical data and on-hand experience shall be attained.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 8 of 18

- A clearer picture to decision makers shall emerge.
- Public opinion about use of ethanol will be built.
- A balanced role of stakeholders shall be established.
- Government's dependence on genuine stakeholders shall be established.

## 6. ETHANOL FUEL PILOT FILLING STATION

A Pilot Project of Ethanol Filling Station is proposed, with real world logistics and on commercial basis, and will be monitored by a centralized Government agency.

The salient features of this solution are:-

- 6.1 Ethanol to be transported directly from the distillery to the point of sale in specialized containers (equipped with silica gel valves).
- 6.2 Storage of ethanol at the filling station to be done in specialized tanks, separate from the existing petrol storage tanks.
- 6.3 Blending of ethanol with petrol to be done at the point of sale (CPL has a solution for point-of-sale blending, explained ahead).

## 7. PARTIES INVOLVED IN THE PROJECT

The pilot project will include following players:-

- Ethanol producer
- Ethanol distributor/transporter
- Filling station owner
- Government agency

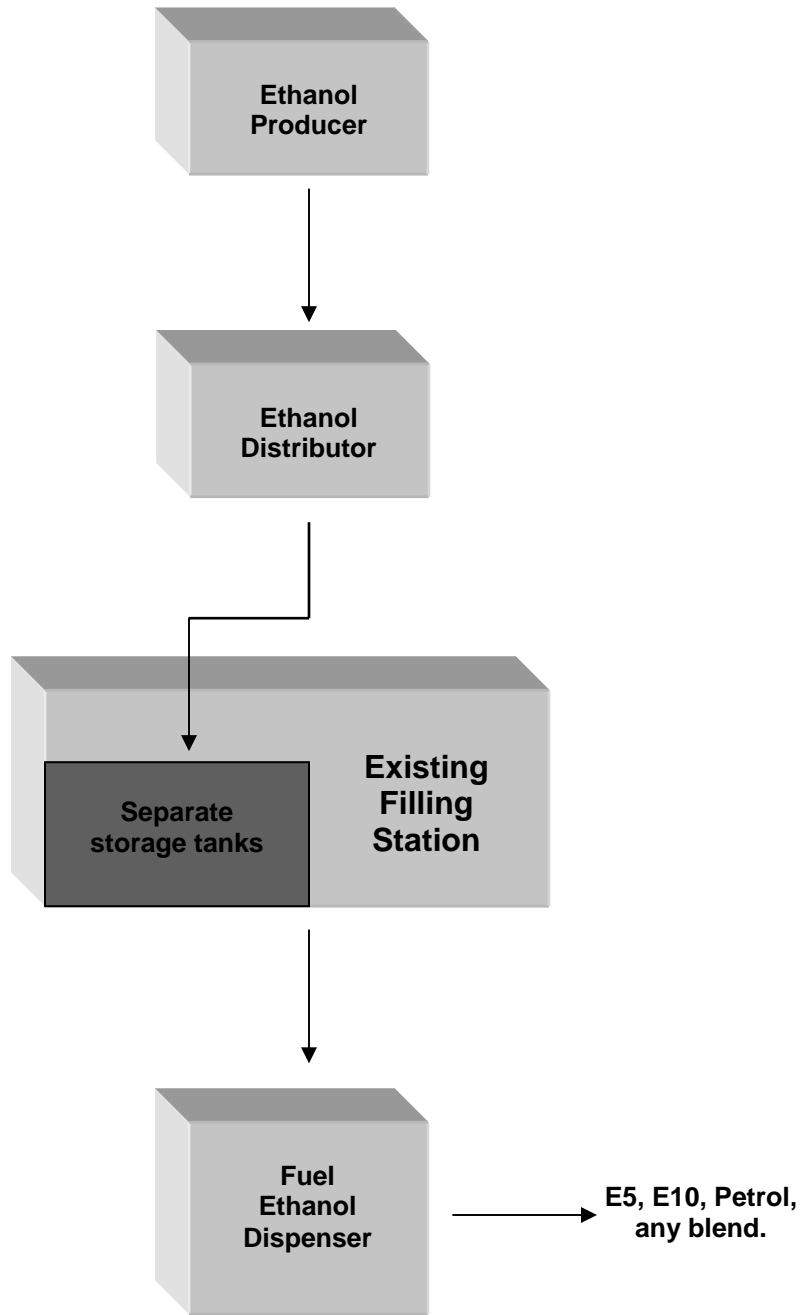
Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001	ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02
			Page 9 of 18

The ethanol producer will produce and sell ethanol to distributor who will transport directly to point of sale i.e. filling station. The filling station will sell ethanol to consumer. Development of storage and dispensing mechanism can be the responsibility of distributor or filling station owner.

## **8. SUPPLY METHODOLOGY**

The supply methodology for ethanol fuel is given in the figure on the following page:-

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001	ECP No -	
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 10 of 18



**Figure 1: Supply Methodology**

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 11 of 18

The ethanol distributor will purchase ethanol from the producer and transport it to point of sale. The price at which ethanol will be purchased by the distributor from the producer will be decided mutually between the two parties, based on a competitive selling price for ethanol-petrol blend, so as to give the consumer cost savings. With this model pre-hand **price fixation** and **infrastructure requirements at** OMCs or Oil refinery or with ethanol producers will not remain a critical issue. **The product is only viable once its sale price to consumer is less than that of pure petrol, and this will automatically come in place through the market forces.**

A centralized Government agency can monitor the progress of project with time and its potential to sustain. **Once such a model is successful by all means in its operations, it can be replicated to any number and magnitude.**

## **8.1 Blending at the Point of Sale**

Blending of ethanol with petrol is a logistic concern, which has cost implications. Blending either at oil refineries or depot of OMCs requires pure ethanol to be first transported to blending points and then from there to point of sale, hence the extra cost of transportation.

The proposed model eliminates such requirements and recommends blending of ethanol with petrol at point of sale. This is possible with specialized dispensing units. Ethanol is stored in separate storage tanks and blended at time of sale at the discretion of customer.

The model will accomplish the following:-

- By transporting the ethanol directly from the distillery to the point of sale, and blending at the point of sale, an extra cost element will be avoided.
- Extra logistics and time delays will be eliminated.

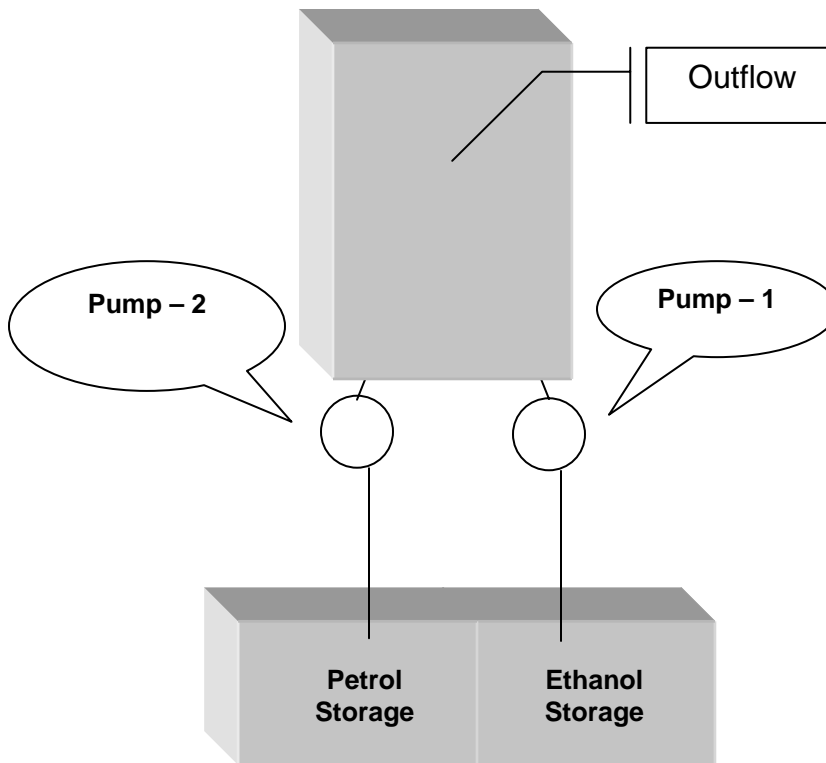
Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 12 of 18

- The supply of different blends of ethanol shall be at the discretion of customer.

## 9. CPL's SOLUTION FOR POINT-OF-SALE BLENDING

Separate and specialized dispensers of ethanol blends will be installed at filling stations (along with existing petrol dispensers) to offer both products to the consumer at his choice.

The dispenser for blends of ethanol will be specially designed; it will simultaneously take ethanol and petrol from separate storage tanks, blend them to a homogeneous solution close to nozzle, and pour the desired blend into the vehicle tank. The required blending ratio can be numerically adjusted on the dispenser and consumer can demand petrol or fuel ethanol (any blend) at the time of purchase. **CPL is developing such a specialized dispenser.** The functioning of the pump is shown in Figure 2.



**Figure 2: Specially designed pumps for dispensing fuel ethanol**

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001	ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02
		Page 13 of 18	

## 10. CPL AS ETHANOL DISTRIBUTOR FOR PILOT PROJECT

CPL is a technical consultancy and project management company in the renewable energy sector. Bio-fuels (including Bio-diesel and Fuel Ethanol) are a major area of expertise of CPL. Based on its background, expertise, and interest, CPL is keen to undertake the pilot project.

CPL will play the role of ethanol distributor and also govern the pilot programs with dedicated Government agency. Thus CPL will contribute to a lateral policy framework.

Title		Document No		ECP No
Concept Paper: Pilot Project of Ethanol Filling Station		0001-100000-017-001		-
Originator	Approval	Date	Document Issue No	Page
Salman	Ammad	December, 2005	02	14 of 18

## ANNEXURE - A

### A-I: Comparison of Fuel Efficiencies between Gasoline and Blends of Ethanol

<i>Test Performed By</i>	<i>Run Conditions Km/h</i>	<i>DISTANCE COVERED PER LITER</i>			
		<i>PETROL</i>	<i>BLENDS OF ETHANOL</i>		
			<i>E5</i>	<i>E10</i>	<i>E20</i>
<b>CPL</b>	<b>100</b>	17.12		15.99	15.8
<b>CPL</b>	<b>120</b>	13.22		13.62	12.84
<b>CPL &amp; HDIP</b>	<b>90</b>	18.596	16.414	18.186	
<b>CPL</b>	<b>CITY</b>	12.5		13.98	12.9
<b>CPL &amp; HDIP</b>	<b>CITY</b>	10.375	10.25	10.875	

Results indicate that E10 (10% ethanol and 90% petrol) performed better than petrol in city and at higher speeds. More appropriate ethanol blends and fine tuning of engine for use of ethanol is likely to increase this efficiency further. From these results, a rough impact of ethanol usage on national fuel requirement can be estimated.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 15 of 18

## ANNEXURE - B

### **B-I: Cost Comparison between Gasoline and Blends of Ethanol**

Based on the current sale price of petrol, the following table has been prepared. Price of ethanol has been arbitrarily taken as Rs. 32/-per liter, which has been provided by HDIP. The table given below compares the price of petrol with different blends of ethanol fuel.

<b>COST PER LITER OF FUEL</b>				
<b>PETROL</b>	<b>ETHANOL</b>	<b>BLENDS OF ETHANOL</b>		
Rs / Lit.	Rs / Lit	E5	E10	E20
56.65	32	55.4175	54.185	51.72

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 16 of 18

**B-II: Comparison of Cost per Kilometer Traveled with Gasoline and Ethanol**

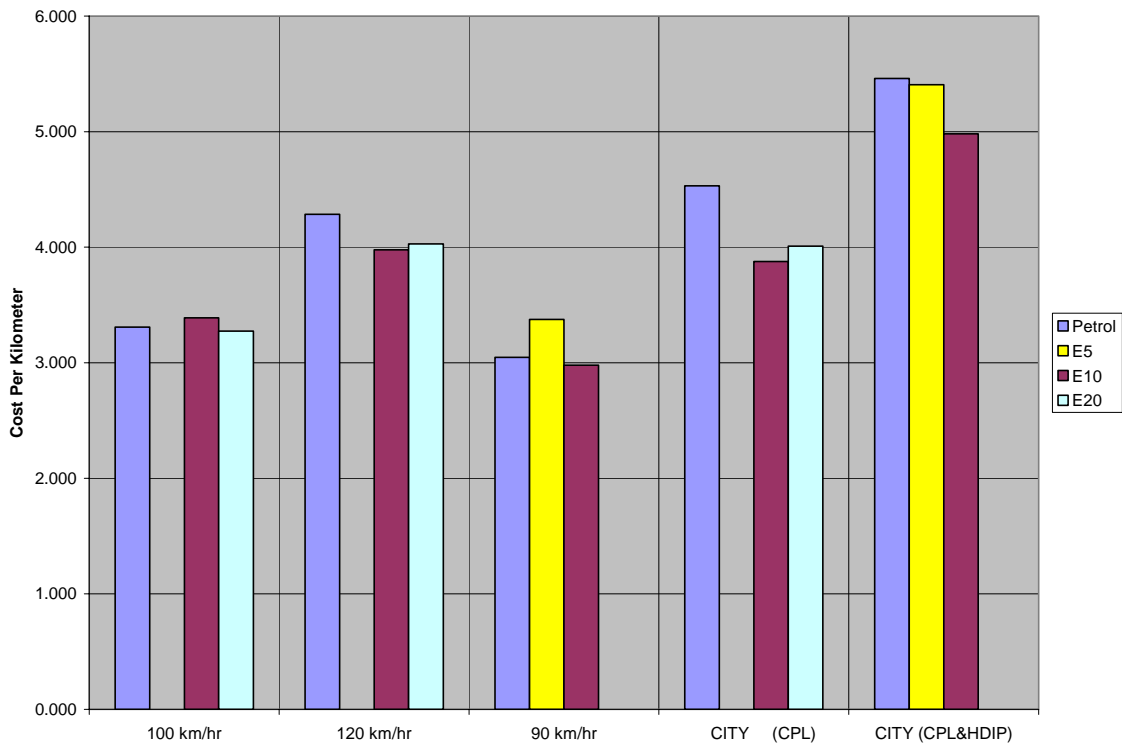
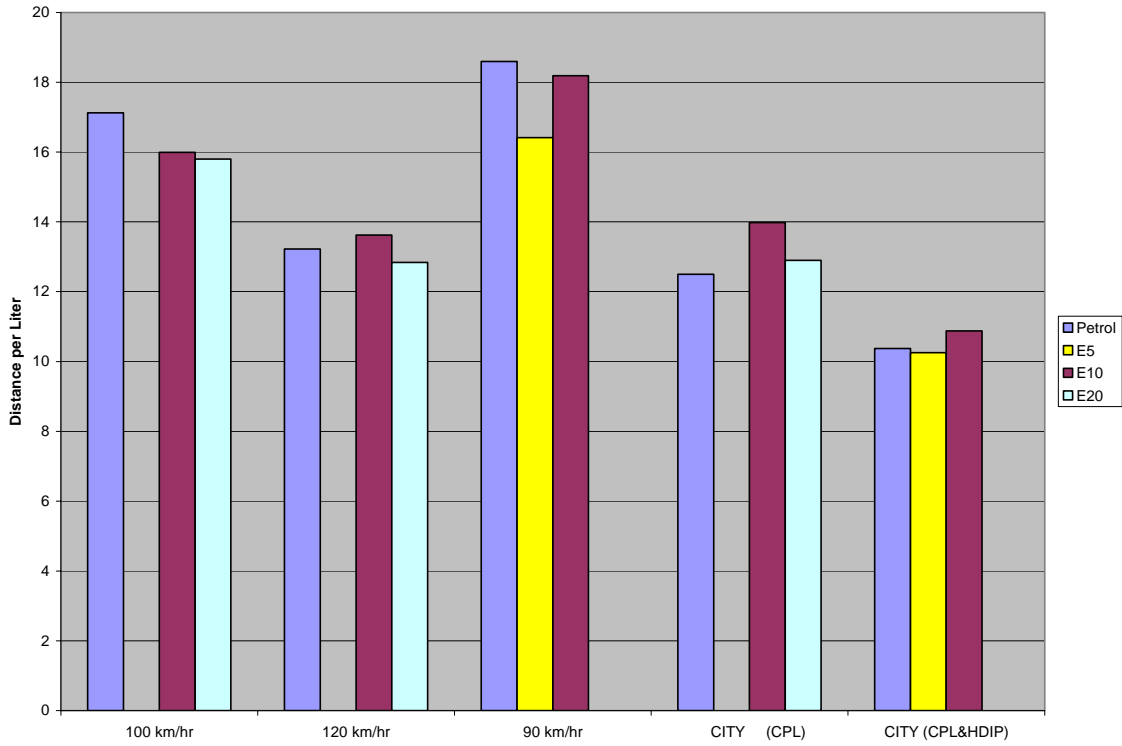
The cost of these fuels, compared on the basis of rupees per kilometer traveled, is shown in the following table.

<b>Test Performed By</b>	<b>Run Conditions Km/h</b>	<b>COST PER KM</b>			
		<b>PETROL</b>	<b>BLENDS OF ETHANOL</b>		
			<b>E5</b>	<b>E10</b>	<b>E20</b>
<b>CPL</b>	<b>100</b>	3.309		3.389	3.273
<b>CPL</b>	<b>120</b>	4.285		3.978	4.028
<b>CPL &amp; HDIP</b>	<b>90</b>	3.046	3.376	2.979	
<b>CPL</b>	<b>CITY</b>	4.532		3.876	4.009
<b>CPL &amp; HDIP</b>	<b>CITY</b>	5.460	5.407	4.983	

Results indicate that most of blends of ethanol, in all running conditions, cost less per kilometer of distance covered. The cost per kilometer covered on ethanol fuel is likely to decrease further with increased fuel efficiency.

Title Concept Paper: Pilot Project of Ethanol Filling Station		Document No 0001-100000-017-001		ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 17 of 18

### B-III: Graphical Comparison



Title Concept Paper: Pilot Project of Ethanol Filling Station			Document No 0001-100000-017-001	ECP No -
Originator Salman	Approval Ammad	Date December, 2005	Document Issue No 02	Page 18 of 18