

# Alternative Fuels

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The why, what, when and how

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# Objective - Why to read this report?

*To provide a context and framework to evaluate players' actions and strategies in this important future aspect of alternative fuels in automobile business*

## Tata Motors to roll out car that run on compressed air instead of fuel



22 Mar, 2008

KOLKATA: It's not official yet. But Tata Motors may soon be in a position to roll out cars that run on compressed air instead of fuel. This is because of an agreement the company inked in early 2007 with France's MDI to deploy the latter's path breaking air-powered auto-engine technology for the Indian market. The technology was at the development stage when the deal was signed.

Under the terms of agreement, Tata Motors will support further development and refinement of MDI's technology, its application and licencing for the India market.

Significantly, technology development is nearly complete, especially since MDI is slated to showcase its OneCATs car, which runs on air, at the New York. Subsequently, MDI will roll the small car for the French market by end-2008.

## Maruti launches LPG powered M800 Duo

6 Jun 2008, 15:49 hrs IST, PTI



NEW DELHI: At a time when the car industry is reeling under the fuel price hike, country's largest car maker Maruti Suzuki has launched a new LPG variant of its once flagship model M800, priced between Rs 2.05 lakh and Rs 2.26 lakh (ex-showroom Delhi). The new model, named M800 Duo will have dual fuel option of petrol as well as LPG, the company said in a statement.

"Dual fuel vehicles have always formed a prominent part of our overall product strategy. Besides, the car is economical to drive and being factory fitted, it is completely safe," Maruti Suzuki India Executive Officer, Marketing and Sales, Mayank Pareek said.

The new M800 will be available in two options—M800 Standard with LPG, priced at Rs 2.05 lakh ex-showroom Delhi and M800 AC LPG tagged at Rs 2.26 lakh.

Exuding confidence that the new M800 Duo will be successful, Pareek said the success of Maruti Suzuki's dual fuel models like the WagonR and the Omni Cargo is a clear reflection of the customer preference towards products that are safe and light on pocket as well as environment friendly.

MSI said it has sold almost 1,25,000 cars that are powered by LPG and CNG fuels.

Besides the M800 Duo, the company offers Omni and WagonR in dual fuel options (LPG-cum-petrol).

Designed in-house by a team of 24 engineers, the Maruti 800 Duo works on gas mixer system based on Integrated Gas Technology which results in optimum performance and superior emissions. The LPG variant emits 10 per cent lower CO2 than the petrol variant, hence is environment friendly, MSI said.

Maruti 800 Duo is manufactured at the company's Gurgaon plant and is available in a range of five colours. The components of the Maruti 800 Duo are fitted on-line along side the petrol variant of the car, it added.

Oil efficient



Chairman of Indian automobile manufacturer Mahindra and Mahindra, Keshub Mahindra (R), poses with Union Petroleum Minister Murli Deora (2R) in front of a Mahindra Micro Hybrid Utility vehicle at a ceremony in New Delhi on Tuesday

## M&M launches micro-hybrid Scorpio, Bolero

Press Trust of India  
New Delhi, October 21

AUTOMOBILE manufacturer Mahindra and Mahindra on Tuesday launched its 'micro-hybrid' technology-equipped variant of sports utility vehicles — Scorpio and Bolero priced between Rs 6.5 lakh and Rs 6.97 lakh.

"This is the technological innovation which we have developed with the support from Bosch. This will give

an average fuel saving of about five per cent from the normal vehicles," Mahindra and Mahindra President, automotive sector Pawan Goenka told reporters here. The Micro-Hybrid technology enables vehicle engine to turn off automatically when idle or in neutral gear. The engine restarts once the clutch is pressed.

The company is also considering to use the technology in its yet-to-be launched Ingenio Suvs, he said.

- \* Cars will most likely go all electric in the next 5-7 years
  - \* Battery technology (range, weight and cost) is the key technological challenge
- \* In the interim, various hybrid technologies will be popular
  - \* Experimentation with various degrees of hybridisation – mild, full, plug-in
- \* Other fuels, such as ethanol, bio-diesel and blends to grow but will be limited by supplies
  - \* Issues related to availability of crop area and impact on crop prices, and lifecycle carbon emission still unresolved
- \* In the medium term, Indian market will primarily be geared towards bio-fuel blends mandated by government.
  - \* CNG/LPG penetration to be limited by availability.
- \* Not sure of which approach will succeed, players are hedging their bets by investing in multiple technologies
- \* Home grown Indian players are taking small steps to position themselves, through in-house R&D, small acquisitions and alliances
  - \* Tata Motors – Miljobil acquisition in Norway for electric car, agreement with MDI of France for compressed air based car, in-house R&D on bio-fuels and hybrids
  - \* M&M – in-house R&D on hybrids and electric

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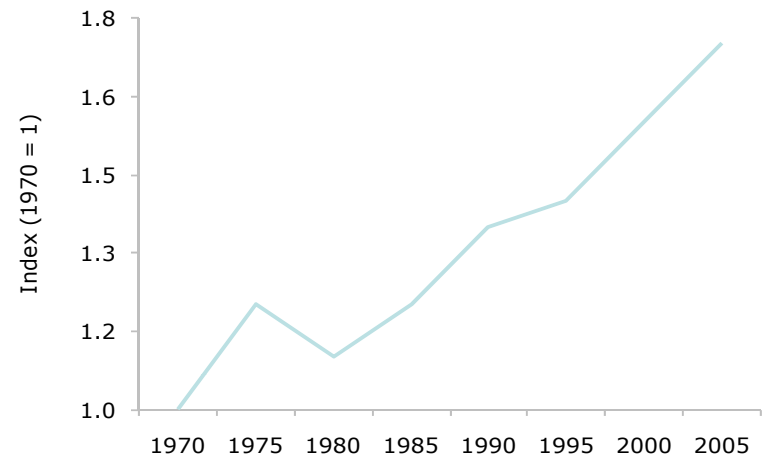
# Why Alternative Fuels??

Alternative fuels have come in sharper focus recently...

- \* Growing concern regarding environmental impact of carbon dioxide (CO<sub>2</sub>) emissions from automobiles
- \* High crude oil prices
- \* Depleting fossil fuel resources

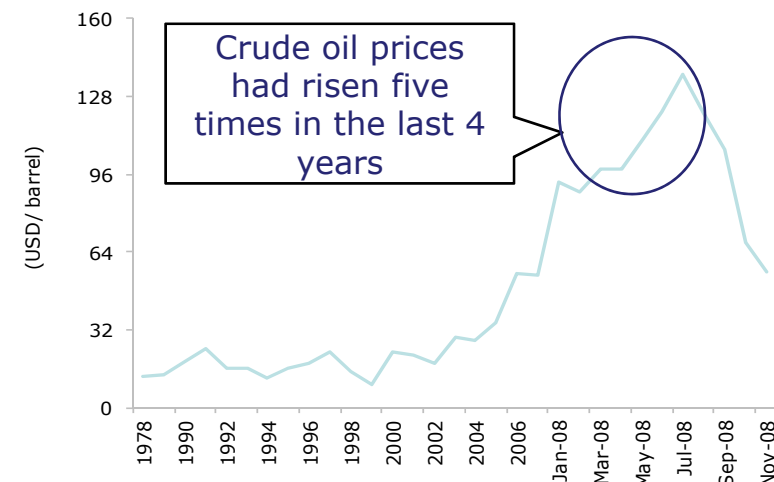
As a result, significant investments are underway by auto majors across the globe to develop alternative fuel based vehicles

## Trends in CO<sub>2</sub> emissions



Source: EPA and Environment Defense Agency, US.

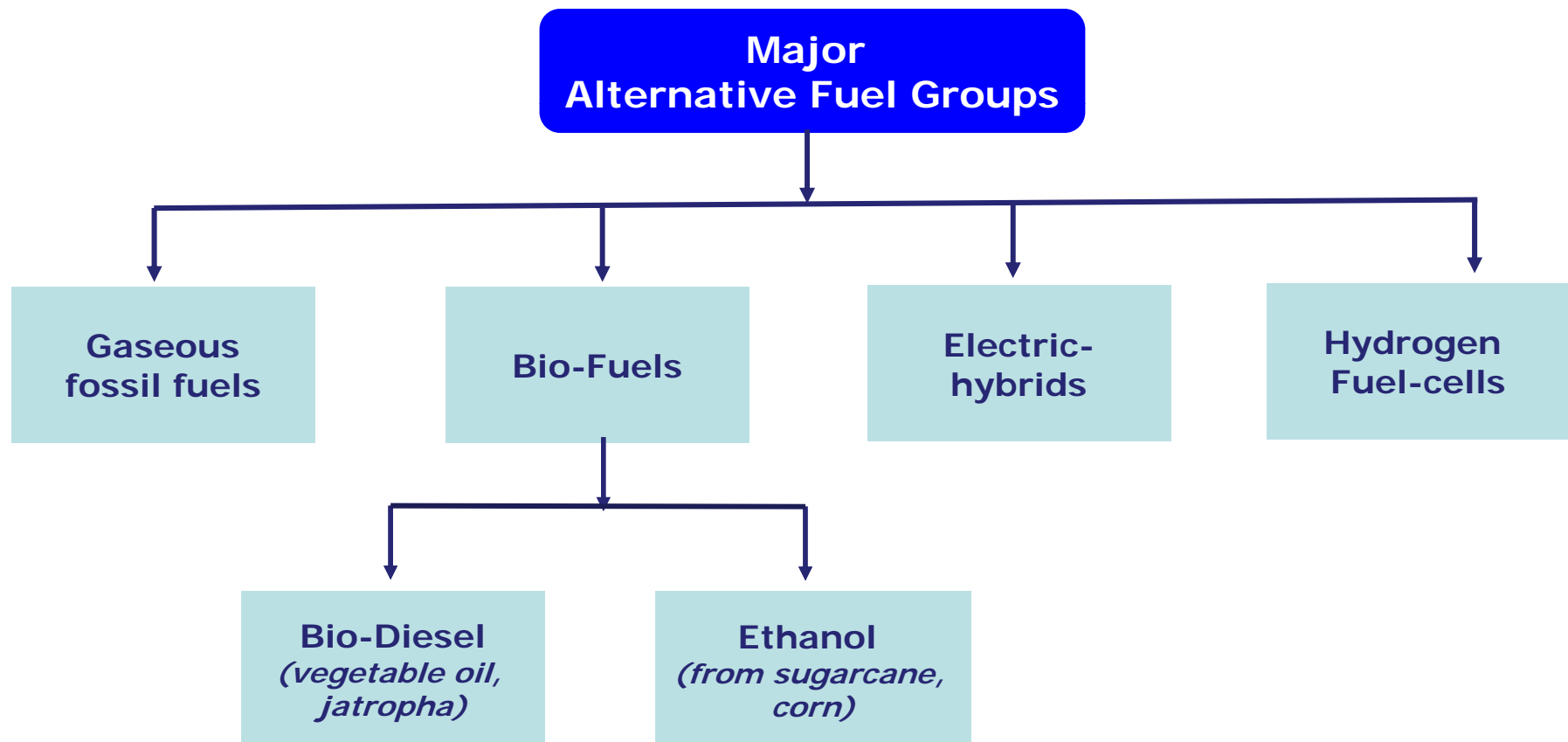
## World oil prices

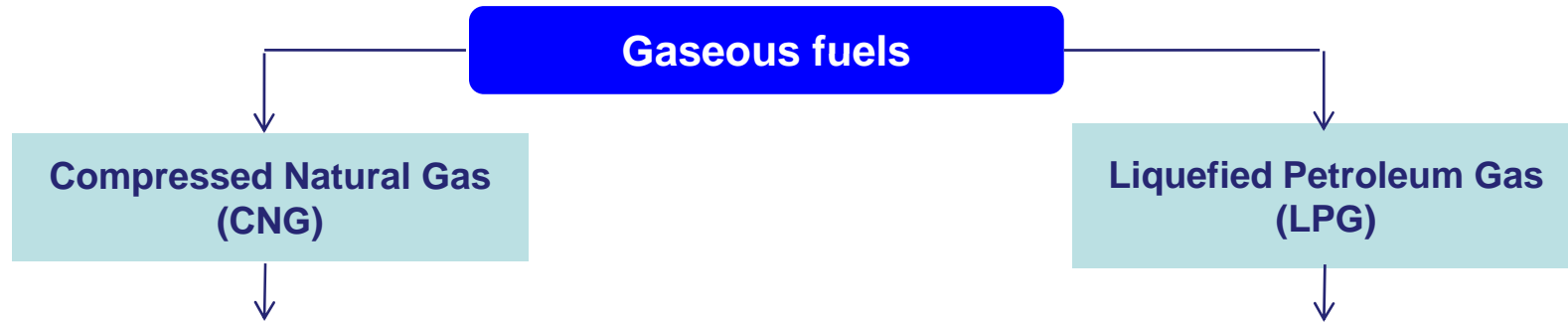


Source: Energy Information Administration (EIA), US.

# What are Alternative Automotive Fuels?

- \* Conventional automotive fuels include: petrol/gasoline and diesel
- \* Alternative fuels include: CNG, LPG, bio-diesel (vegetable oil, jatropha), bio-alcohol (ethanol), chemically stored electricity (batteries and fuel cells), hydrogen, etc.



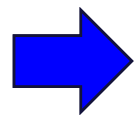


- \* It is made by compressing natural gas (87% is methane), and is stored and distributed in hard containers at a normal pressure of 200–220 bar.
- \* **Engine:** No modification required.
- \* **Storage** is an issue, since it takes most of the boot space in a car with big, heavy storage cylinders that weigh ~50 kg, when empty.
- \* **Availability:** At 376 stations, primarily Delhi and Mumbai (*refer appendix for details*).

- \* LPG is primarily produced as a by-product of petroleum refining, and is a mixture of propane (60%) and butane (40%).
- \* **Engine** – No modification to the engine required.
- \* **Storage** – Not much of an issue since the storage tank takes a much smaller space. LPG tank weighs ~ 5-7 kgs when empty.
- \* **Availability** – 619 stations primarily in Western and Southern India. (*refer appendix for details*)

Type of pollutants (lesser by...)	CNG (%)		LPG (%)	
	Compared to petrol and diesel		compared to petrol	compared to diesel
Carbon dioxide	25.0	15.0	15.0	10.0
Carbon monoxide	80.0	60.0	60.0	75.0
Nitrous oxide	40.0	33.0	33.0	40.0
Hydr carbons	90.0	90.0	90.0	85.0
Particulates	n.a.	50.0	50.0	90.0

**Environmental comparison**



# Comparative economics of CNG & LPG vs. petrol

Comparative economics of gas based fuels	Tata Indica (example)			
	Petrol car	Diesel car	CNG car	LPG car
Incremental cost over petrol car (Kit cost etc) ( <i>approx. in INR</i> )	not applicable	80,000	60,000	40,000
Mileage (km/litre) ( <i>in city driving condition</i> )	13	15	15	13
Price (per litre/per kg) (INR)	59.0	38.0	21.7	37.0
Cost/km (INR)	4.54	2.53	1.45	2.85
Payback period ( <i>keeping this as fixed variable</i> )	not applicable	1 year	1 year	1 year
Average km per day required for a payback period of 1 year (as compared to petrol)... <b>A</b>		133	65	79
No of days likely to travel in a year... <b>B</b>		300	300	300
No of kms in a year (A x B)... <b>C</b>		39,900	19,425	23,655
Savings in cost/km ( <i>as compared to petrol car</i> ) (INR)... <b>D</b>		2.01	3.09	1.69
Savings for the year as compared to petrol (INR) (C x D)		80,005	60,058	40,032
Incremental cost over petrol car		80,000	60,000	40,000

Note: 1 litre = 0.96 kgs.

Source: Edelweiss research

For a payback period of 1 year, when compared with petrol option:

- \* CNG fuel is economical for a passenger who travels at least **65 kms/day**
- \* LPG fuel becomes more economical if the daily travel is above **79 kms**
- \* Diesel fuel is desirable if daily travel exceeds **133 kms**



## \* What is Bio-diesel?

- \* **Sources** – Made from Jatropha plant, vegetable/plant oils, etc.
- \* **Blends** – Bio-diesel can be mixed with petroleum-diesel in any percentage, from 1 to 100, which is represented by a number following a B. For example, B5 (5% bio-diesel), B20 (20% bio-diesel) etc.

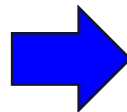
## Engine issues:

- \* Minor modification to the engine required if the bio-diesel blend increases beyond 25%. Also, there is need to add a heater to improve ease of fuel flow.

### Bio-diesel emissions compared to conventional fuels

Emissions	B100 (100% Bio-diesel) (%)	B20 (20% Bio-diesel) (%)
<b>Regulated emissions</b>	-	-
Total unburned hydrocarbons	(93.0)	(30.0)
Carbon monoxide	(50.0)	(20.0)
Particulate matter	(30.0)	(22.0)
Nitrogen oxide	13.0	2.0
<b>Non-regulated emissions</b>		
Polycyclic aromatic hydrocarbons (PAH)	(80.0)	(13.0)
NPAH (Nitrate PAH)	(90.0)	(50.0)
<b>Life cycle emissions</b>		
Carbon dioxide (LCA)	(80.0)	
Sulphur dioxide (LCA)	(100.0)	

Environmental  
comparison



Source: Planning Commission (2003)

## \* What is Ethanol Fuel?

### \* Sources

Can be produced from sugar cane, and maize (corn), sugar beet, as well as cellulose waste.

### \* Blends

Used in the form of blends with petrol/gasoline, which is represented by a number following a 'E'. For example, E10 (10% of Ethanol), E85 (85% of Ethanol) and E100 (100% of Ethanol).

### \* Engine issues:

Minor modification to the engine required if the ethanol blend increases beyond 24%. For example, in a cold country, engines using 30% to 100% ethanol blends, may need a cold-starting system.

- \* In India, ethanol (made from sugarcane molasses) is currently priced at **Rs.21.5 per litre** by the sugar companies for sale to oil companies for blending in petrol.

## **Present Scenario:**

- \* The Indian Government made 5% ethanol blend (E5) mandatory from November 1, 2007 across the country. However, currently the Oil Marketing Companies blend on an average only ~ 3% - mainly due to
  - unsolved issues like different sales tax across various states.
  - disagreements on the basis of pricing.
- \* The Indian Government plans to have 10% ethanol blended fuel (E10) mandatory from early 2009.
- \* Present capacity of ethanol production stands at ~850 million litres. However, at 10% blending rate, demand is likely to be ~ 1.5 billion litres.

## **The Way Forward – National Bio-fuel policy (*as approved by Cabinet in September 2008*):**

- \* **20% ethanol blended petrol (E20) across the country will be mandatory by 2017.**
- \* To remove all central taxes on bio-diesel and accord '**declared goods**' status to bio-fuels that could ensure a uniform 4% sales tax (VAT) on the product across states.

## *Basic facts*

- \* ~ 50% of the fuel used by gasoline powered passenger vehicles in Brazil is made up by ethanol in 2008.
- \* Flexible-fuel vehicle fleet of ~ **6 million**.
- \* Ethanol fuel is supplied from all the fueling stations in Brazil. It has **33,000 fuelling stations** spread across the country.

## *How Brazil implemented its Ethanol Strategy?*

- \* Brazilian tryst with ethanol started from mid 1970s, after the major oil crisis in 1973.
- \* To jump scale the ethanol production in the country, the Government formulated The National Alcohol Program titled '**Pro-Alcool**', a nationwide program which had the following 3 incentives:
  - guaranteed purchases of ethanol by the state owned oil company, Petrobras.
  - low-interest loans for agri-industrial ethanol firms.
  - fixed gasoline and ethanol prices, where hydrous ethanol sold for 59% of the government set gasoline price at the pump.
  - With this, the Government made the ethanol production competitive without resorting to any subsidy. The ethanol was to be produced from fermented sugarcane due to low cost of sugar at that time.
- \* Subsequently, to execute the ethanol program in the national automobile industry, the Government made it mandatory in 1977 to have 20% blend of ethanol with gasoline (E20).

## *How Brazil implemented its Ethanol Strategy? (contd...)*

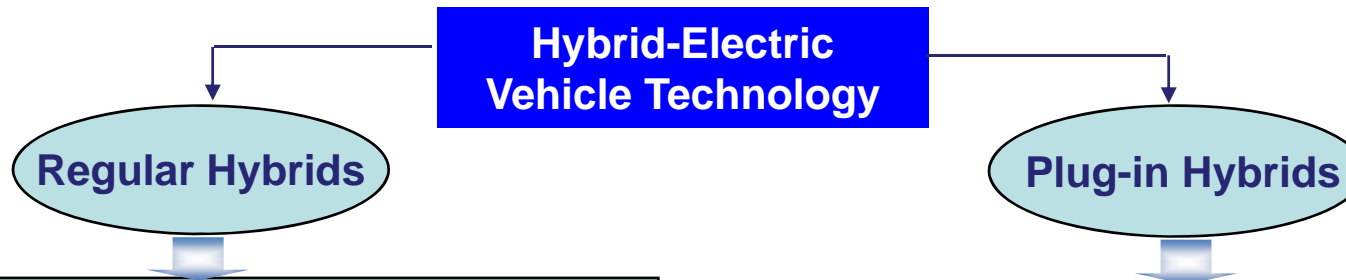
- \* As the ethanol program started showing positive results, the country moved towards E100 (100% ethanol) based vehicles. By 1988 vehicles running on 100% ethanol held almost 90% of the Brazilian's market.
- \* However, a crisis in ethanol supply in early 1990s left thousands of vehicles out of fuel. Sales of ethanol-only (E100) cars tumbled after this shortage, and were further hit by the prevalence of low petrol prices in the late 1980s to early 1990s. In 1990, production of E100 vehicles fell to 10.9% of the total car production.
- \* The proportion of E100 vehicles to total car production continued to decline till 2002. In 2003, Volkswagen built the first flexible-fuel car which could run on either petrol or ethanol. The fuels can either be mixed in the same tank or have separate tanks and fuel systems.
- \* The proportion of flex fuel cars rose sharply from ~ 3% in 2003 to 77% in June 2008. Currently the mandatory blend is allowed to vary nationwide between 20% to 25% ethanol (E25).

Year	Alcohol E100 cars mnfd.	Flex fuel cars mnfd.	Total cars mnfd. (Incl. exports)	% Ethanol cars
1979	3,328		912,018	0.4
1980	239,251		933,152	25.6
1986	619,854		815,152	76
1990	71,523		663,084	10.8
1998	1,188		1,254,016	0.1
2000	9,428		1,361,361	0.7
2002	48,022		1,521,431	3.2
2003	31,728	39.853	1,361,361	4.8
2004	49,796	282.706	1,862,780	17.8
2005	43,278	776.164	2,011,817	40.7
2006	758	1,249.062	2,092,003	59.7
2007	3	1,716,716	2,388,402	71.9
mid-2008*	0	1,054,518*	1,364,444*	77.2*

*Note: \* Data until June 2008.*

*Source: Brazilian Automakers Association (ANFAVEA), 2007 and 2008.*

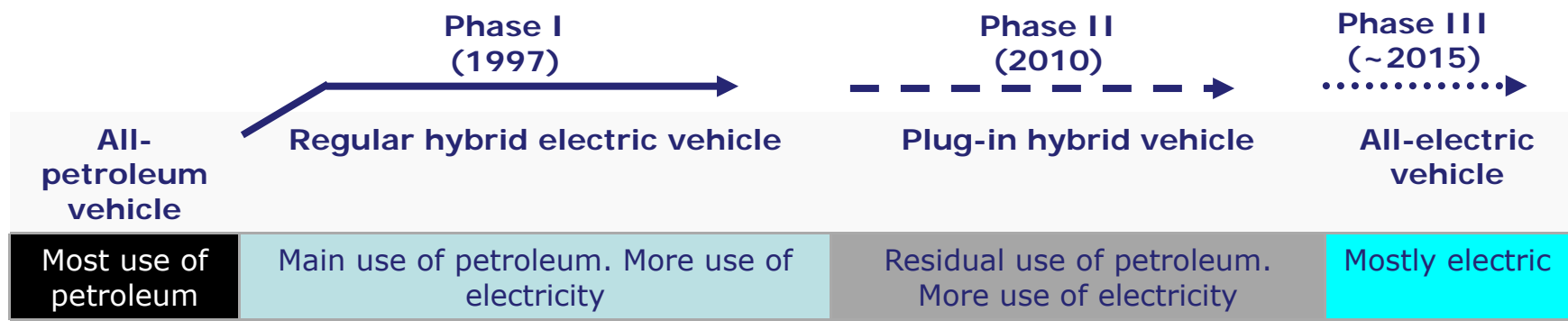
*Data shown for flex-fuels does not included light commercial vehicles.  
vehicles now*



- \* Dual powertrain with an internal combustion engine (ICE) and electric motors to power their propulsion system. Source of power is chosen based on driving conditions.
- \* ICE also charges the electric batteries. The batteries are also charged by capturing kinetic energy via regenerative braking.
- \* Some of the popular models include Toyota *Prius*, Honda *Civic*, Nissan *Altima*, Ford *Escape* etc.

- \* Vehicle with batteries that can be recharged by connecting a plug to an electric power source. In addition the batteries are charged by an on-board engine to extend the driving range.
- \* The prime source of power is the batteries unlike regular hybrids where the ICE is the prime source of power.
- \* Some of the models likely to be launched in 2010 include GM's Chevrolet *Volt*, Toyota's *Prius*, VW's *Golf*, etc.

**Gradual progression towards an all-electric vehicle**

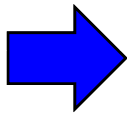


- \* 100% electric cars that run on electric motor and does not have any internal combustion engine on board.
- \* The batteries are charged from an external source. However, the battery capacity limits the driving range.

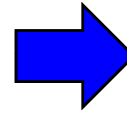
## Key Issues:

- \* Battery technology with large capacity for long driving range, currently limited to about 80-100 km
  - \* Weight and cost of batteries.
- \* Current available models:
- \* India: Reva – uses lead acid batteries.
  - \* US: Tesla Motors' Roadster – uses lithium-ion batteries.

Reva EV



Tesla Roadster



# Hydrogen Fuel Cells

Cars powered by Hydrogen fuel-cells – which combine stored hydrogen with atmospheric oxygen to generate electricity and water vapor.

## Storage issues:

- \* Hydrogen is stored in a compressed form in a cylinder.
- \* Stored at a high pressure of 350 bar. Since it has very low density, needs large on-board storage.

Hydrogen fuelled car



## How is Fuel cell different than battery operated electric vehicle?

### Battery operated Electric Vehicle

- \* Use electricity from an **external source**.
- \* Electricity is stored in the batteries which when in use power the electric motor.
- \* **Fuel source** – Electricity from mains

### Fuel Cell Vehicle (FCV)

- \* Create their **own electricity**.
- \* Create electricity through a chemical process using hydrogen fuel and oxygen from the air.
- \* **Fuel Source** – use hydrogen which is stored in high pressure tanks. FCVs can also be fueled with hydrogen-rich fuels such as methanol, or natural gas, but these must be first converted into hydrogen gas by an on-board device called a "reformer".



## Hydrogen Fuel-cell vehicles

Expected to be in mass production by ~2017 (the horizon has been slipping for years)

### Some of the major investments in the Hydrogen Fuel-cell technology:

- \* USA – **US \$ 1 bn** on Hydrogen Research, since the launch of Hydrogen Fuel Initiative in 2003.
- \* Europe – **US \$ 730 mn** (€ 470 mn), for fuel-cell and hydrogen initiative. Expects private sector to match this figure.
- \* Germany – **US \$ 777 mn** (€ 500 mn) through establishment of National Organization of Hydrogen and Fuel-cell Technology in Germany.

### Investment required for mass producing hydrogen fuel-cell cars:

*According to Oak Ridge National Laboratory, sponsored by US Department of Energy (DoE):*

- \* **US \$ 10 bn** of public funding – for 2 mn hydrogen fuel-cell cars on US roads by 2025 rising to US \$ 45 bn – for 10 mn cars.

*According to National Academy of Sciences, USA:*

- \* **US \$ 55 bn** of Government investment to put 2 mn hydrogen cars on roads by 2023.

### Fuel-cell costs to drop in future:

Currently fuel-cells cost ~ \$ 107 /kilowatt (typical mid-size car is 100 kW). As per Oak Ridge study, the cost is likely to drop to \$ 45 /kilowatt in 2010 and \$ 30 / kilowatt by 2015.

## General Motors (GM)

- **Biofuels** – Has **11 models** that run on E85 Flex-Fuels of ethanol & bio-diesel. Has a goal of having half of annual vehicle production be E85 or biodiesel capable by 2012.
- **Hybrids** – Has **8 hybrid cars** in its portfolio (*with limited availability*). Vehicles are powered by nickel metal hydride batteries.
- **Plug-in hybrids** – plans to launch ***Chevrolet Volt*** by end-2010.
- **Fuel Cells** – has tested a production model, '***Chevrolet Equinox***' powered by hydrogen. Still not for sale.

## Ford Motor

- **Biofuels** – goal to have half its production to be E85 ready by 2012. Has few truck and van models which run on B5 blend of bio-diesel. Presently working on B20 blends.
- **Hybrids** – 2 major brands, ***Ford Escape*** and ***Mercury Mariner*** hybrids; sold ~47,000 vehicles on hybrids to date. Plans to launch hybrid technology on ***Ford Fusion*** and ***Mercury Milan***. Ford expects to double its annual production of hybrid vehicles to 50,000 in 2008.
- **Plug-in hybrids** – ***Escape plug-in hybrid*** – is likely to be on the road only after five years.
- **Hydrogen vehicles** – called as 'HySeries' ; the company is presently working on vehicles that run on hydrogen fuel cells, hydrogen ICE (on a shuttle Bus), and plug-in hybrid.

## Toyota

- **Hybrid** – *Prius* (petrol-electric hybrid) is the most successful hybrid model. Plans to introduce Lexus and other models on the hybrid platform in 2009. Sold **4,29,000** units in 2007 (up by 33% Y-o-Y). Plans to sell ~ **1 mn units** p.a. by **2011-12**. Plans to have hybrid option on all its models by 2020.
- **Plug-in hybrids** – To launch plug-in hybrid version of *Prius* by end of 2009. By 2010, plans to build about 400 demo plug-in hybrid vehicles which can charge batteries from all sockets.
- **Electric** – Plans to launch all electric vehicles & mass produce them by early next decade. Plans to mass-produce lithium-ion batteries to feed the same.

## Honda

- **Natural Gas** – *Civic GX*
- **Hybrids** – *Civic hybrid, CR-Z* concept sports car.
- **Fuel Cells** – *FCX Clarity*.

## Nissan

- **Hybrids** – has '**Nissan Green Programme 2010**' where it is developing in-house an electric car with a 300 kg lithium-ion battery. It will go on sale in US & Japan in 2010, Israel & Denmark in 2011 and the rest of the world by 2012.
- **Electric** – Under partnership with Renault, Nissan is developing its first electric model in Israel, to mass market by 2011.

## Tesla Motors

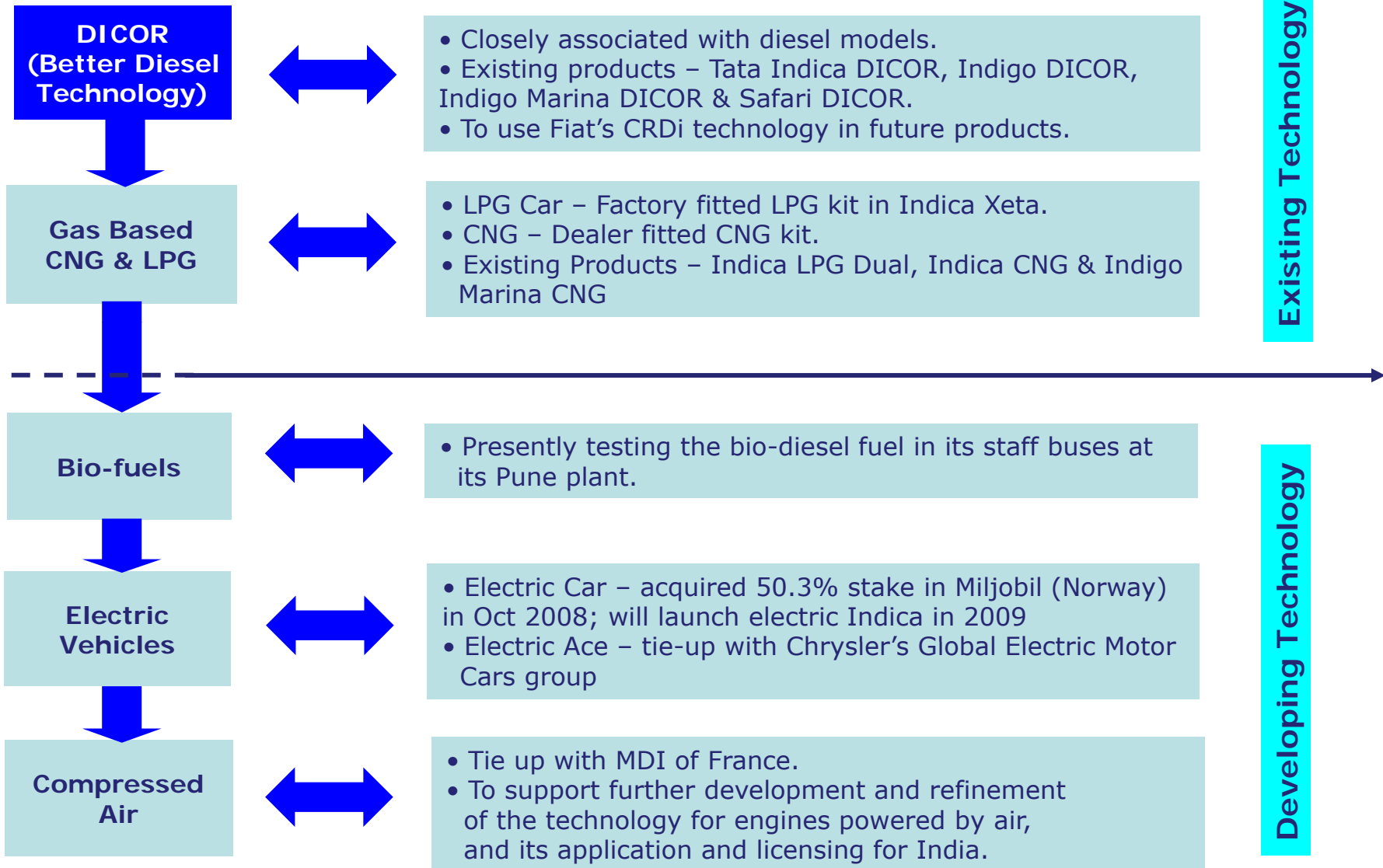
- **A 100%-electric car maker**, it started operations in 2003 and began producing electric cars in March 2008.
- **Volumes** – So far the company has delivered 30 Roadsters and has 1,200 orders pending for delivery.
- **Technology** – Plug-in electric car, powered by lithium-ion batteries that needs 3.5 hours to charge for the range of 220 miles (~393 kms).
- **Car Models:**
  - Tesla Roadster* – its first production car, an all electric sports car, with **starting price of ~US\$ 109,000**. Expects to sell **1,500 cars** in the model year 2009.
  - Model S* – an all new electric sedan with zero emission. Plans to launch this model in **late 2010** at a price of ~US\$ 60,000. The company expects to produce **~15,000 cars p.a.**

## Tesla Roadster (Electric sports car)

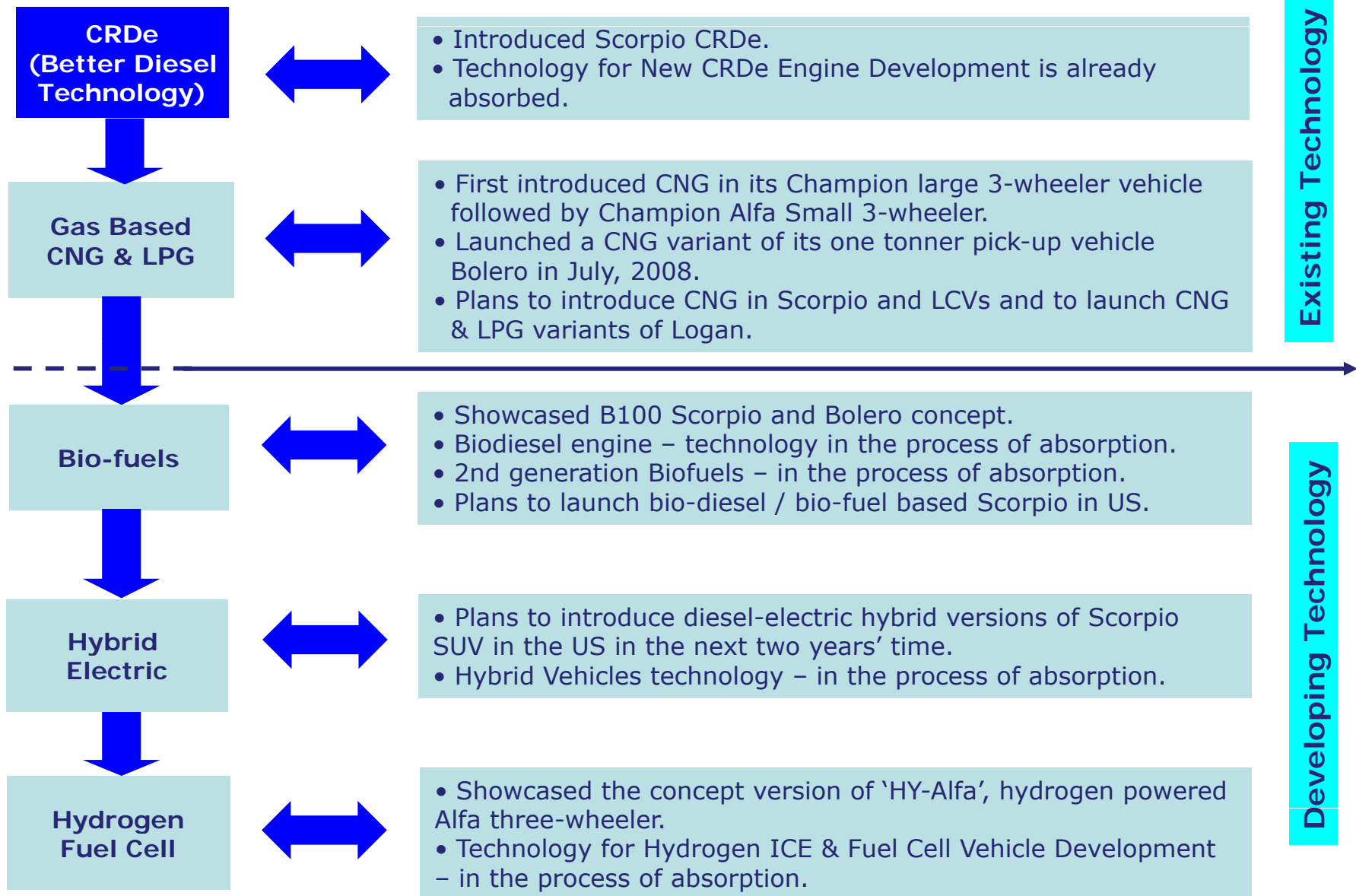
100% electric  
0-100 km/hr in 3.9 sec  
Top speed of 200 km/hr



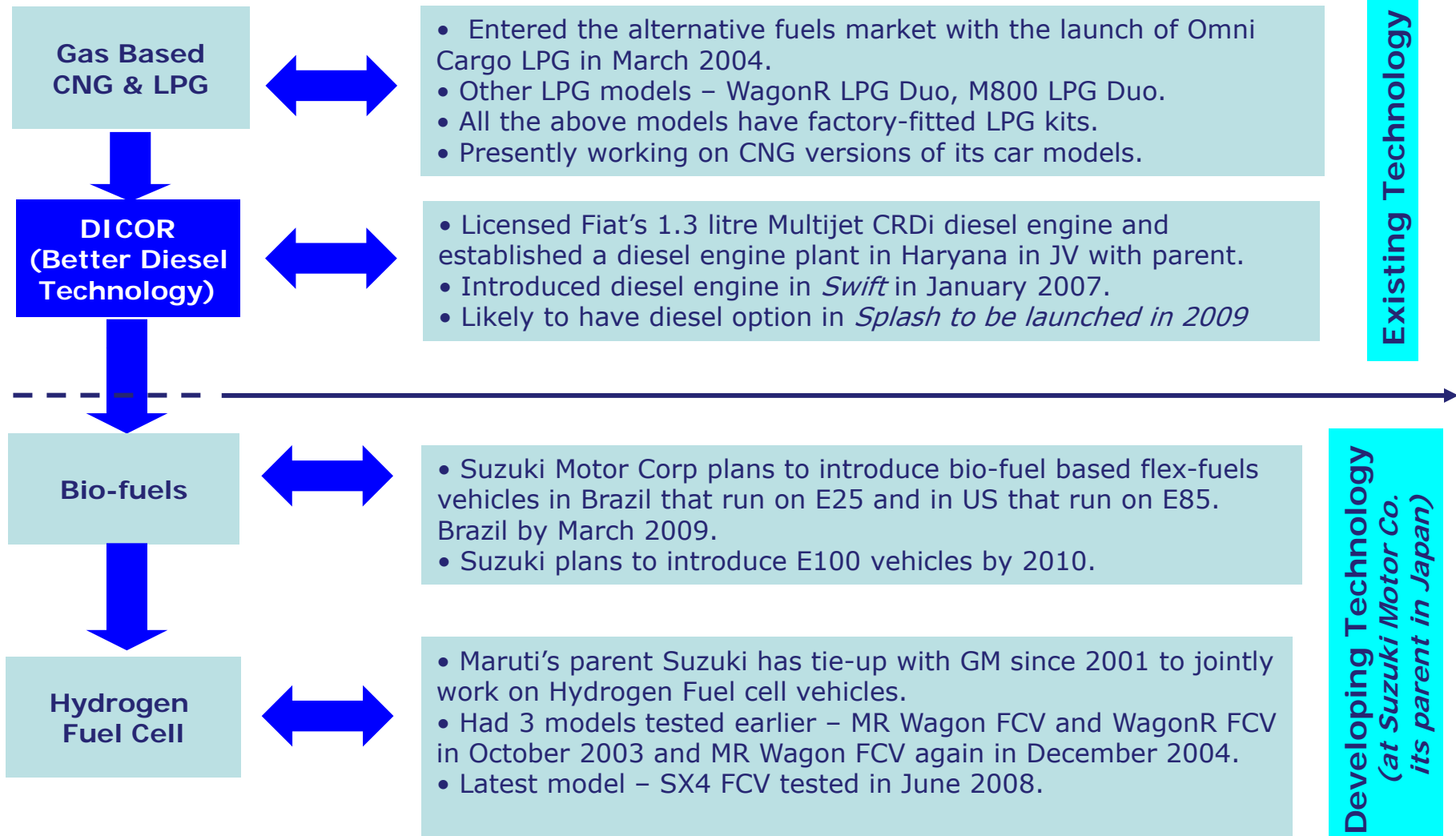
# Tata Motors' Alternative Fuel Strategy



# M&M's Alternative Fuel Strategy

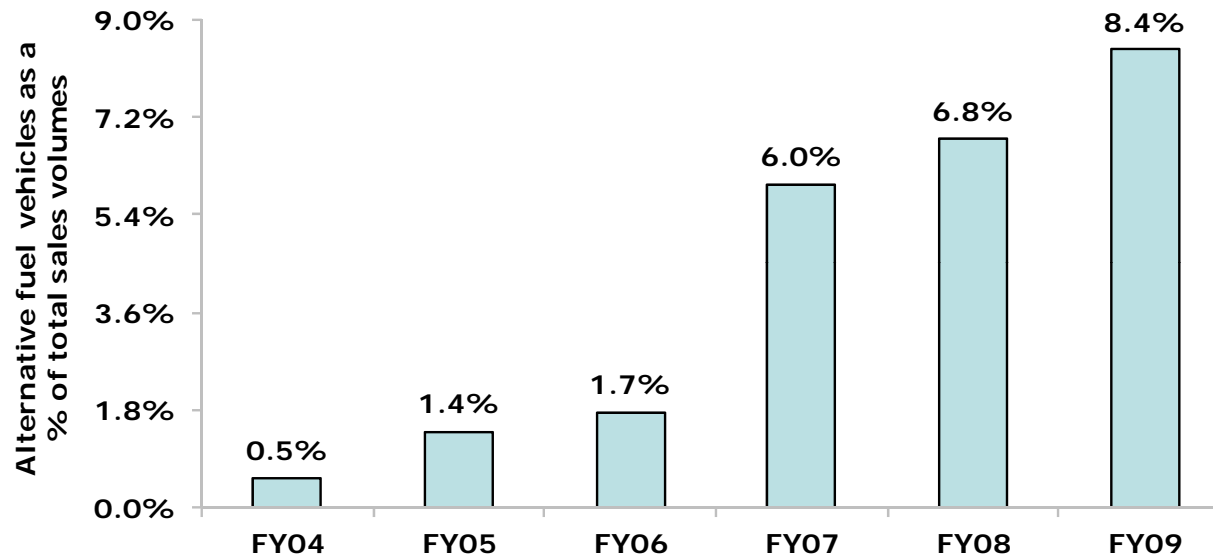


# Maruti Suzuki's Alternative Fuel Strategy



*Suzuki has a wide ranging alliance with General Motors for developing hybrid and fuel cell vehicles*

## Maruti Suzuki's Alternative fuels volumes as % of Total Volumes



*Note – The above sales volumes do not include sales of diesel vehicles.  
Source: Company data*

- \* Maruti's Sales Volumes from models that run alternative fuels recorded a 116% CAGR in the last 5 years to FY08.
- \* Volumes increased from 2,229 in FY04 to 48,403 in FY08.
- \* FY09 volumes are for the months April-July 2008.



- \* Production Capacity: 6,000 cars p.a., plans to increase to 30,000 units p.a. in near future.
- \* Sold ~ 3,000 cars so far.
- \* Price Range: **INR 3-4.2 lakhs**. Being an electric car, it does not attract excise duty.
- \* Battery costs ~ INR 50,000, has to be replaced once in three years.
- \* Running cost: 40 paise per km against INR 4/km for a petrol driven car.
  
- \* **Reva's Fuel cell drive:**
  - Reva's fuel cell prototype was launched in July 2004.
  - Still a prototype & not yet commercialized.
  
- \* **Tie-up with Argentum Motors:**
  - E-vehicle EV-1, is a 3.5 metre length concept vehicle to be produced in 6-8 months time.
  - powered by lithium-ion batteries.
  - Target markets – France and other European markets.
  - the two companies are looking at bigger vehicle (3.7 metre length) and a 4 seater car.

## Reva Electric car



***Besides India, Reva is sold in UK, Italy, Malta, Sri Lanka, Cyprus & Greece. It is being test marketed in US, Norway, Spain, and other European countries.***

## Background:

- \* YOBykes launched first in **February 2006**. Sales volumes – **16,500 units in FY08**.
- \* **Indian Plant** – at Samakhiyali, Kutch. Capacity of **1,50,000 units p.a.**
- \* **Sales & Distribution Network** – 200 YOWorld 3S points.

## Products:

- \* 6 models – with price range between INR 16,000 -28,000.
- \* Do not need registration and are exempt from road taxes.

## Technology:

- \* Operates on lead-acid sealed batteries.

## Future Plans:

- \* Plans to launch electric three-wheelers.
- \* Plans to launch Hybrid Electric Bus.

## *'YoSpeed'*



**JV between Hero Exports (part of the Hero Group) and Ultra Motor Company, UK.  
Got separated in May 2008 and now running separately**

## Background

- \* Products – Maxi (constituted 80% of sales), Optima, Marathon and Velociti electric scooters.
- \* Sold **21,000 units in FY08**, plans to sell **65,000 units in FY09**.

## Technology

- \* Uses lead acid batteries.

## Future Plans

- \* Looking at electric three-wheeler – to be rolled by beginning of FY10.
- \* Looking in making hybrid two-wheelers – that may work on electric & CNG/diesel.

## Initiative to increase charging stations

- \* Planning to set up 2000 outlets, hopes to expand the network to 10,000 recharging stations in the next 3 years.

### Marathon

(Price: **Rs.31,000**  
(ex-showroom Kochi)



### Velociti

(Price: **Rs.34,000**  
(ex-showroom Delhi)



Several countries offer wide ranging incentives to Electric Vehicles (EV) owners. Some of the incentives are listed below:

Countries	Incentives
<b>USA</b>	<ul style="list-style-type: none"> <li>USD 4,000 subsidy to each EV buyer</li> <li>Preferential parking areas</li> <li>Subsidy on the installation of charging infrastructure</li> </ul>
<b>United Kingdom (UK)</b>	<ul style="list-style-type: none"> <li>Free parking in some areas</li> <li>Certain areas in London are EV-only zones</li> <li>Exempt from GBP 8 per day congestion tax</li> </ul>
<b>Japan</b>	<ul style="list-style-type: none"> <li>Direct subsidy of USD 2,600</li> <li>Up to 50% subsidy of incremental cost of clean energy vehicles</li> </ul>
<b>Norway</b>	<ul style="list-style-type: none"> <li>No import duty on Reva</li> <li>EV can drive in bus lanes</li> <li>No congestion charge on city toll ring road</li> <li>Free parking in government-owned parking spots</li> <li>Cheaper insurance for EV</li> </ul>
<b>France</b>	<ul style="list-style-type: none"> <li>EUR 2,000 subsidy to each EV player</li> <li>Free parking for EV</li> <li>No tax on electricity used for charging an EV</li> <li>Lower road tax</li> </ul>
<b>Italy</b>	<ul style="list-style-type: none"> <li>EUR 1,800 subsidy to each EV player</li> <li>Free parking facilities in certain cities</li> <li>No road tax for first five years of ownership</li> </ul>
<b>Malta</b>	<ul style="list-style-type: none"> <li>Removed 50.5% registration tax on cost, insurance and freight</li> <li>No USD 55 charge for entering the capital city</li> <li>15% tax rebate (up to USD 1,300) on 18% VAT</li> </ul>

## Everest Kanto Cylinders (EKC) – CNG cylinders

- \* Manufacturer of high pressure cylinders for CNG and industrial applications.
- \* Will be in a advantageous position as CNG based vehicles proliferate across the country.
- \* Recently, EKC received orders for CNG cylinders (of over USD 13 mn) from Pakistan and few Middle Eastern countries.

## Minda Auto Gas Ltd. – CNG / LPG Kits.

- \* Provides CNG / LPG kits and other alternative fuel solutions to various Auto OEMs and for the replacement market.
- \* OE supplier to Maruti Suzuki for *WagonR Duo* and Bajaj Auto for its three-wheelers.

## Everest Kanto Cylinders *CNG cylinders*



## Minda AutoGas *Parts of CNG / LPG Kit*



# Snapshot of Alternative fuels technology

Fuel types	Engine issues	Storage issue	Availability	Economics	Environment impact
<b>CNG</b>	No modification to engine required	Large storage tanks minimises luggage capacity	Available mainly in Delhi and Mumbai	INR 21.7/kg; CNG Kit costs around INR 45K-60K; payback in one year on 65km/day	25% lower CO2 emissions as compared to petrol and diesel
<b>LPG</b>	No modification to engine required	Storage tank is smaller but still reduces luggage capacity	Available in around 619 stations mainly in Southern and Westren India	INR 37 / litre. LPG Kit costs around INR 25K to INR 40K; payback in one year on 79 km/day	15% lower CO2 and 50% lower particulate emissions as compared to petrol. 10% lower CO2 and 90% lower particulates as compared to diesel
<b>Bio-diesel</b>	Minor modification required if the blend is beyond 25%.	No issues as it goes into the normal fuel tank	Large scale crop is required but can be grown in waste land	n.a.	For B100 fuel, 30% lower particulate emissions and 80% lower CO2 for lifecycle emissions as compared to diesel
<b>Ethanol</b>	Minor modification required if the blend increases beyond 24%	No issues in storage	Depends on sugarcane crop and the processing capacity	INR 21.5/litre. E10 fuel is ~6% cheaper than petrol and E50 is ~ 32% cheaper than petrol in India	E100 fuel can reduce net CO2 emissions up to 100% on a life-cycle basis and ~22-50% on usage basis
<b>Hybrid-electric</b>	Internal combustion engine (ICE) and an electric motor co-exist	Electric batteries co-exist with petrol/diesel tank.	Fuel availability is not an issue	45% more fuel efficient than pure ICE; hybrid car is 40% costlier than petrol version	n.a.
<b>All-eletric</b>	Not applicable	No fuel storage required	Wide availability of charging stations will be critical to mass acceptance	Battery cost vs driving range is the primary economic trade-off	Nil emission at the time of usage; but emissions at power generation
<b>Hydrogen fuel-cells</b>	Technology development is not yet mature	Large high pressure tanks would be required	Huge investment required in distribution network; experimentation on-going on-board or local production of hydrogen	Fuel cells cost ~USD 10K additional for a typical mid-size car	Only produces water vapour

Source: Edelweiss research

**“Oil is the problem, cars are the solution.”**

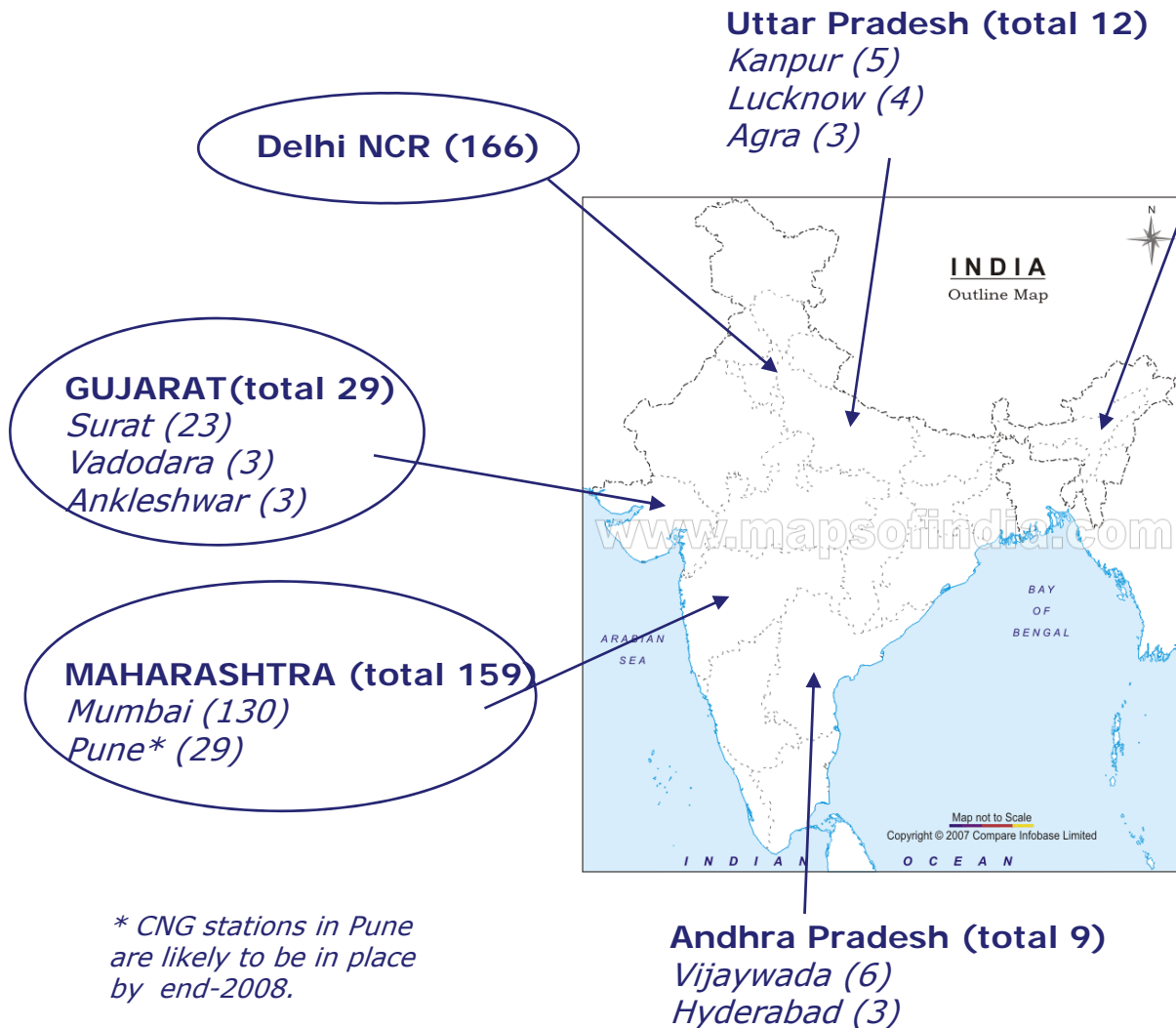
From the book “Zoom: The Global Race to Fuel the Car of the Future”,  
by Iain Carson and Vijay V. Vaitheeswaran  
(*The Economist* correspondents)

# Appendix

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## CNG Fueling Stations – 376 stations in few select cities



*Presently, CNG stations are concentrated in the select few cities like Delhi and Mumbai. However, plans suggest 20 major cities of the country would be covered by CNG by 2010.*

Some of the major companies that supply CNG are:

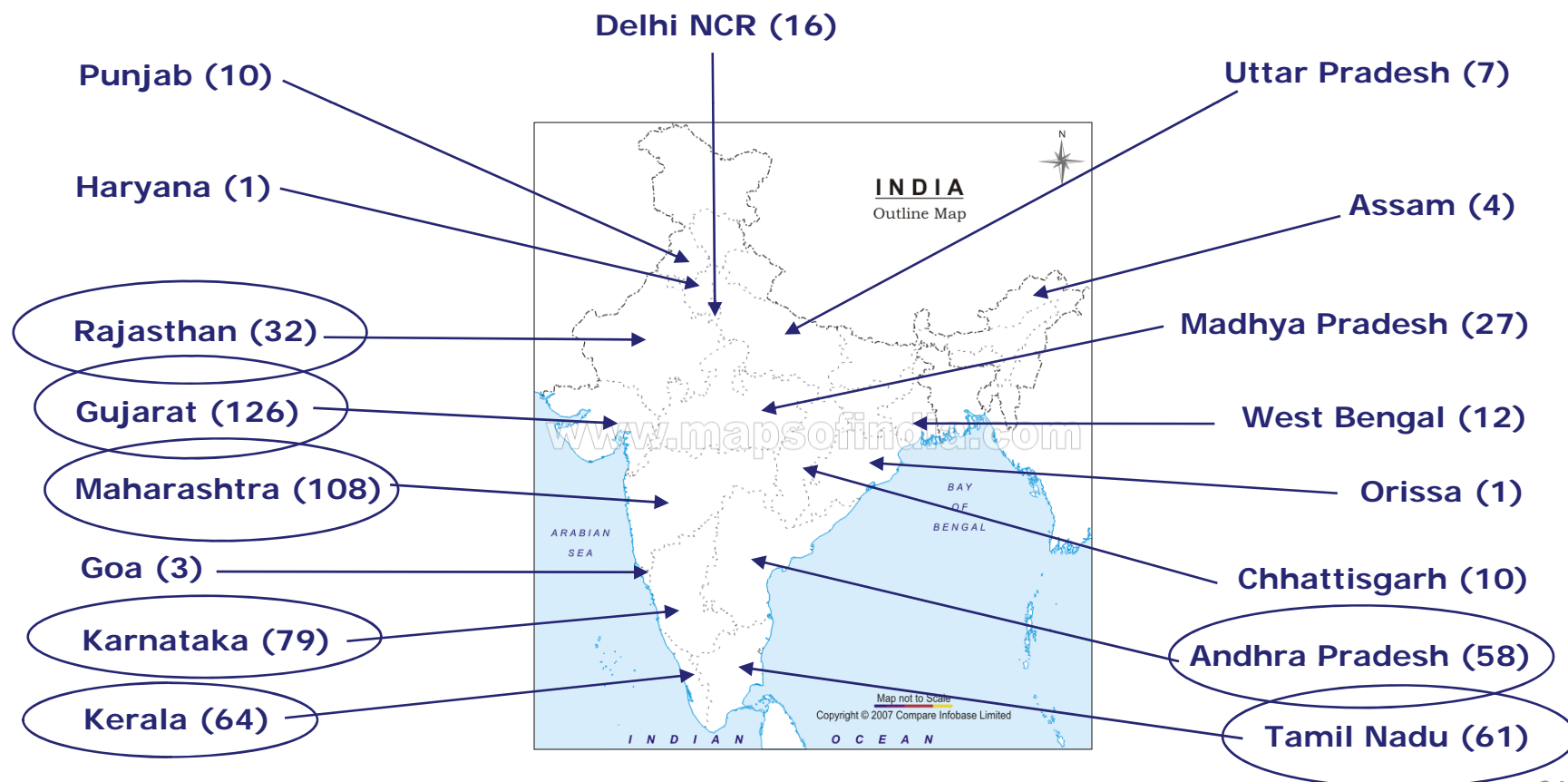
- Indraprastha Gas (Delhi),
- Mahanagar Gas (Maharashtra),
- GAIL & Gujarat Gas (Gujarat),
- Bhagyanagar Gas (AP),
- Green Gas (UP),
- Tripura Natural Gas (Tripura)

*\* CNG stations in Pune are likely to be in place by end-2008.*

# LPG – Availability of fuel

**LPG Fueling Stations – 619 stations across India covering 250+ cities**

*Southern & Western India – the regions where proliferation of LPG stations is more thereby leading to higher availability of Auto LPG as compared to other states / regions*



## \* **Gas based fuels –**

Over **7.5 mn vehicles** in 39 countries use Auto LPG .

## \* **Bio-fuels –**

\* **USA** – On road fleet of over **7.3 million** E85-capable vehicles.

GM leading in E85 flex fuel vehicles, with over 3 million flex fuel vehicles on the road in the U.S.

\* **Brazil** – Annual Sales of **~2 mn vehicles** running on E25.

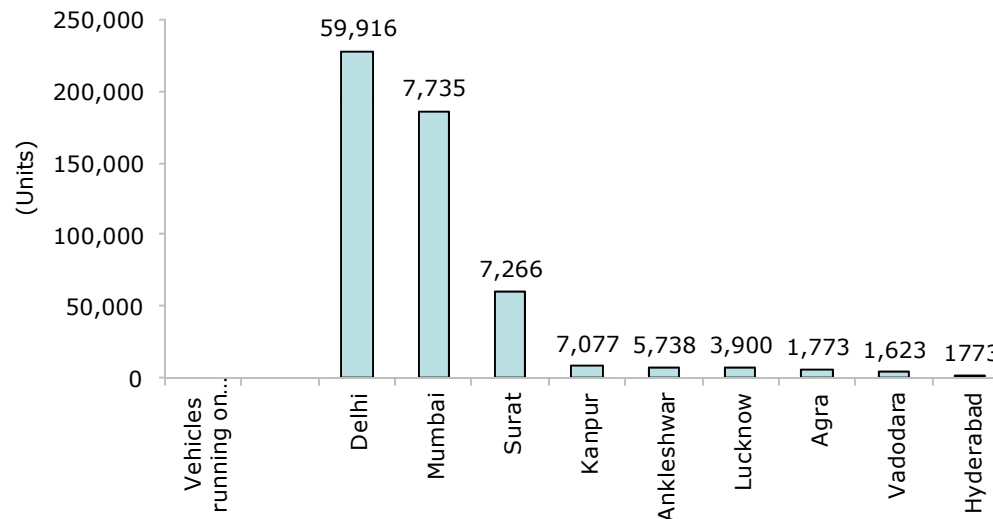
## \* **Hybrid-electrics –**

About **3.5 lakhs vehicles** sold in the US in 2007.

## ~ 5 lakh vehicles run on CNG across India...

*Total vehicles running on CNG stood at ~ 5 lakhs spread across major cities where CNG is available (as of April 2008)*

**81% of the CNG run vehicles are concentrated in Delhi and Mumbai combined.**



Source: Ministry of Petroleum and Natural Gas, India

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