

The logo for Knowledgefaber is positioned in the upper left. The word 'Knowledge' is in a dark blue serif font, and 'faber' is in a green sans-serif font. To the right of the logo are two decorative circles, each composed of three concentric circles in shades of blue. A thin blue line runs diagonally from the top left towards the bottom right, passing through the circles. Another thin blue line runs diagonally from the top right towards the bottom left, also passing through the circles. A large, partially visible decorative circle is in the bottom right corner.

**Knowledgefaber**

## **Fuel Cell Opportunity in India**

A Knowledgefaber Study

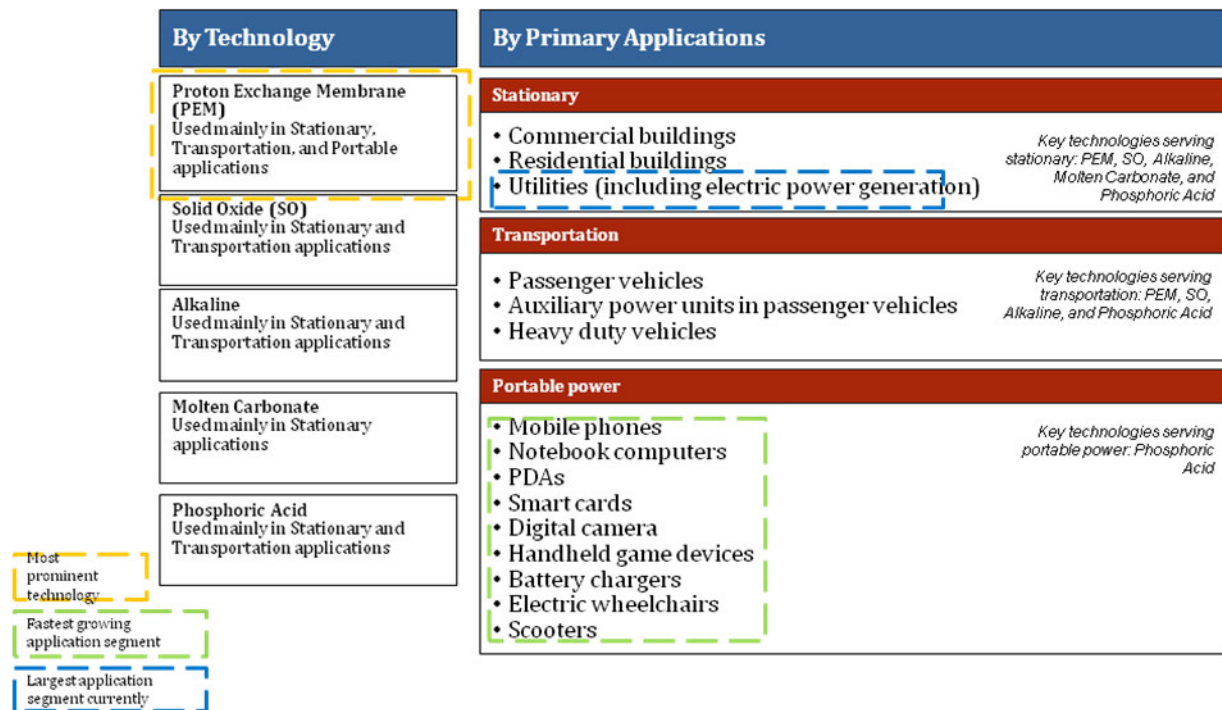
Drivers, Inhibitors, and opportunity for the fuel cell market in India has been discussed in the article

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Fuel cells have been called as the “microchip of the hydrogen age,” this clean renewable energy source is seen as alternative to fossil fuel used in running world’s economy. In this paper we will be looking at what is the current situation and potential of the fuel cell for an emerging economy like India who is heavily dependent upon imported fossil fuels for running wheels of its economy.

Why fuel cells are needed:

As India’s economy grows, demand for energy will also grow, for example Indian power sector has not been able to meet demand-supply gap, and this gap is expected to increase in foreseeable future (by 2010 it is expected that unmet power demand in India will be around 52 B KWH), a big chunk of this demand is expected to come from alternative energy sources like small hydro projects, biomass gas, biomass power, urban and industrial waste power, wind energy, *fuel cells*, etc.



## Drivers that can help the proliferation of fuel cells in India

**Increasing importance of renewable energy resources:** in 2007, share of power generated by renewable energy resources in India was only 8%, and Indian government has setup a target to increase this percentage to up to 12% by year 2012, benefits like tax holidays, lower customs duties, sales tax, and exemptions from excise tax are offered to promote use of alternative fuels. It is expected that fuel cells will have an increased share in this renewable energy pie.

**Increasing demand for captive power generation among Indian corporate:** Power supply in India face several problems like poor quality and reliability of grid supply, high tariffs, and high T&D losses, Fuel cells are modular and suit well for the captive power generation in industries. Therefore, it can be safely assumed that as the fuel cell technology advances, it will capture a decent share of captive power generation in India.

**Environmental concerns:** There has been a concentrated effort around the globe to curb rising levels of pollution so as to control global warming and its possible adverse effect on humanity in large. As fuel cell emits no harmful gases they are expected to be used in this war against climate change, resulting in there improved acceptance and use.

**Energy efficiency:** several studies shows that in comparison to a traditional fossil fuel vehicle having efficiency in the range of 20% (That is, only about 20 percent of the thermal-energy content of the fuel is converted into mechanical work), fuel cells will be having efficiency in the range of 65%, a concept vehicle from Honda (FCX Concept Vehicle), reportedly has 60% energy efficiency.

## Limitations with Fuel cells:

**Cost:** Cost is one of the most important problems with commercial production and use of fuel cells, some of the component pieces are made from highly expensive materials. For example there are fuel cells which can be operated on or near room temperature - requires precious metal platinum as catalyst for the reaction to take place. One very important challenge is to find a cheaper and alternative catalyst for the process. Significant research is being done in this area and solutions are on their way.

**Durability:** Fuel cells which are used in automotive units needs to have specialized materials as frequency of start and stop for a vehicle could be significantly high thus affecting stability and durability of the materials used in it, beside a slight impurity in fuel may raise the temperature of the overall fuel cell, so we require high tolerance material for the cell.

**Hydration:** Due to the chemistry involved in the electricity generation it is required that hydration level of the system doesn't go below specific limits. Having a high pressure hydration system and maintaining seal integrity of the system in itself is not a simple task to achieve.

**Infrastructure:** Fuel required for fuel cells is either pure hydrogen or some other chemical from which it can be produced easily, infrastructure required in generation, storing, delivery is expected to be very costly as well as unstable, requiring huge investment from all the stakeholders involved. Only hope for this infrastructure being built is - development of a highly efficient and successful marketable vehicle model - which is nowhere in sight as of now.

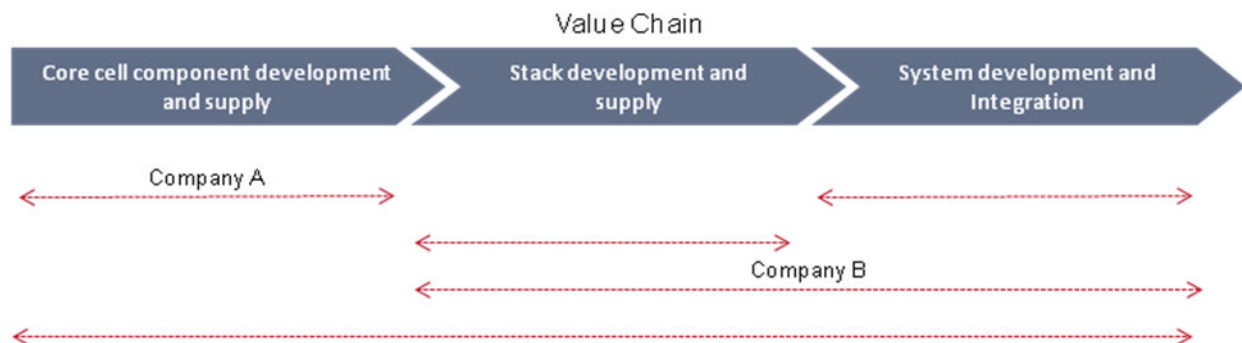
**Storage and other considerations:** A vehicle may need to run several hundred kilometers in a stretch, and for such a journey to take place with the help of a fuel cell driven automobile, it is required that it has a robust and safe hydrogen storage system, built in a vehicle with light weight, volume, cost, and high safety measures.

## Opportunity in Indian Market:

Though there are several problems with fuel cells being used on a wide scale basis in India, still it is considered a very promising technology. Several Indian and MNC firms are working on its development.

Some of the agencies involved in the research and development of fuel cells in India are Ministry of New and Renewable Energy Sources (MNES) and Delhi Transport Corporation (DTC), Indian Railways, Indian Institute of Science and Central Glass & Ceramic Research Institute, Tata Energy Research Institute (TERI), Bharat Heavy Electricals Ltd. (BHEL), and Reva Electric Car Company. Among these Reva is in most advanced stage of developing fuel cells whom company reportedly plans to use in its range of vehicles, company already has a leading position in electric vehicles in India.

A look at the value chain and players reveals that globally and in India players like A and B exists. While A exists in component development and supply B exists across stack development and system development and integration.



***There is an opportunity to play across the value chain of the fuel cell industry.***

**Captive power generation** is also expected to drive growth of Indian fuel cell industry:

Sector	Residential Power Generation	Rural Electricity	Industrial Application	Commercial Application
Typical Capacity Required	0.5 -10 KW	10-200 KW	01-500 KW	200 KW- 20 MW
Illustrative End-user	–	–	Manufacturing plants	IT companies, hospitals, hotels, etc.
Existing Competition	<ul style="list-style-type: none"> <li>■ Kerosene Oil Generator (Battery operated Invertors)</li> </ul>	<ul style="list-style-type: none"> <li>■ Diesel Generating set</li> <li>■ Solar cell</li> </ul>	Captive power plant	<ul style="list-style-type: none"> <li>■ Diesel Genset</li> <li>■ HFO Genset</li> </ul>
Success Potential in India	Very High	High	Moderate	Very High
Opportunity Size	\$ 1,800 M	\$ 2,000 M	\$ 900 M	\$ 5,000 M

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