Energy Conversion Devices, Inc.

India and Hydrogen

Path Meeting (Partnership for Advancing the Transition to Hydrogen)

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San Antonio, Texas
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India – a good economic story!

- 1.1 Billion people (49% under 19 years)
- Second largest emerging market after China
- Fifth largest economy in the world
- English is the business language
- GDP growth: 9% (2005/2006)
- GDP (purchasing power parity/PPP): $4.042 trillion (2006 est.)
- GDP per capita: $3,700; & $714 at nominal
- Exports: $112 billion (2006 est.)
- Imports: $187.9 billion
- Main partners: US 18%, China 8.9%, UAE 8.4%, UK 4.7%, HK 4.2%
- Light vehicle market reached 1 million units in 2003
- 2005-2006 electricity mix: hydro 15%, renewables 2.3%, nuclear 2.5%
  The rest 79.7% fossil based
- Aim: to triple share of renewable power to more than 8% by 2032

India Grows the Equivalent of Another New York City Every Year in its Urban Population

Picture: Courtesy P. Tikku of NATRIP, India

Changing Scenario

Driving India into the Future

NATRiP

Picture courtesy Pamela Tikku

Vehicle Emissions Threaten the Taj Mahal

Vehicle emissions threaten Taj Mahal

India's Commitment to Hydrogen Energy

"…there are distinct differences in the drivers for a hydrogen economy in India and in the U.S. With half its population still without access to electricity, India's motivation for a hydrogen economy is largely driven by the need for ***distributed power generation*** and demand for energy to fuel industrial growth."

"…. within the automotive sector, India's quest for a hydrogen fuelled vehicle is driven more by the ***two and three wheeler segment***, that is likely to achieve commercialization based on metal hydride storage and direct combustion of Hydrogen, ahead of fuel cell based cars and buses."

Extracts from address by K.C. Pant, Planning Commission; Government of India, at the *International Partnership for a Hydrogen Economy (IPHE)*, Washington, D.C., November 20, 2003

April 1, 2005

USAID sponsored a US-India Hydrogen Energy Round Table Dialog

Most promising applications identified were

- Transport sector; focus on buses and 3 wheelers
- Distributed generation for rural electrification; and
- Development of fuel cells

May 31, 2005

US-India Energy Dialog launched

October 11, 2005

Air Products installs hydrogen fuelling station India

November 21, 2005

India's National Hydrogen Energy Roadmap released. Calls for $5.5 billion spending over the next 15 years ($220M for R&D and demonstration of technology; $5.3 billion to create infrastructure for hydrogen production, storage, transportation & distribution)

January 16, 2006
Minister for Non-conventional Energy Sources (MNES) emphasizes the need to implement the hydrogen energy roadmap in all its dimensions

April 3, 2006
US-India sign historic agreement through which India becomes the first country to participate on the government steering committee of the $1 billion FutureGen project Initiative to build and operate the world's first coal-based power plant for electricity and **hydrogen** production and Carbon sequestration

2006

HEC signs agreement with Grasim Industries, India for hydrogen Engine project using hydrogen from Chlor-alkali plant

November 28, 2006

"By early 2007 a dispenser each for filling pure hydrogen and hydrogen mixed with CNG will be available" (IOC announcement)

December 16, 2006

Ashok Leyland, a leading manufacturer of commercial vehicles in India signs an agreement with Brehon Energy for use of Hythane

January 16, 2007

Consortium of Indian Auto companies decide to collaborate in testing various kinds of vehicles using hydrogen-CNG blends

Suggested Time Frame for India's Hydrogen Roadmap: Vision 2020

GIFT: Green Initiative for Future Transport
1 million hydrogen fuelled vehicles
GIP: Green Initiative for Power Generation
1,000 MW of electrical power from hydrogen

• Short term	H_2+ CNG in IC Engines
• Medium term	Pure H_2 ICE
• Long term (2015)	Fuel cells in HEV's

Ovonic H_2-ICE Three-Wheeler With Onboard Solid-State Metal Hydride Storage

Specifications:

- Cold start capability
- Range – 130 km
- Fuel economy – 7.5 g/km
- Reversible H_2 capacity – 1 kg
- Refueling – 80% in 15 minutes @ 300 psig
- Performance: not less than CNG powered version

ECD's H2-ICE developed for Indian market under a USDOE/USAID funded program

THE HINDU

Hydrogen fuelled auto unveiled

Online edition of India's National Newspaper
Friday, Sep 02, 2005

Asian Development Bank president Haruhiko Kuroda gives a mock ride to Confederation of Indian Industry president Y.C. Deveshwar and Rahul Bajaj, CMD, Bajaj Auto Limited (right), on the hydrogen fueled autorickshaw,

Extensive Coverage of ECD's Technology

The Indian EXPRESS

The Sunday EXPRESS

Move over CNG, a hydrogen auto?

US company develops hydrogen-fuel-run three-wheelers, trial runs successful

LALIT K JHA

Posted online: Sunday, July 17, 2005 at 0220 hours IST

MINNEAPOLIS, JULY 16: The great Indian autorickshaw may have just shifted to the eco-friendly CNG but it's ready for the generation-next fuel.

Krishna Sapru with Stan Ovshinsky, ECD founder, and Iris Ovshinsky, co-founder and a senior vice-president of the ECD

Taking a major leap towards Indo-US co-operation in the energy sector, the United States Department of Energy (DOE) and US Agency for International Development (USAID) have helped develop a hydrogen-run three-wheeler for Indian roads.

The Rochester Hills (Michigan)-based Energy Conversion Devices (ECD) has successfully converted and developed a CNG-run three-wheeler of Bajaj Automobiles into one run on hydrogen fuel.

H2CARSBIZ

Hydrogen Cars Business eMailing List | About | H2CARSBIZ Magazine

Dates: January 25 [Wed.] – 27 [Fri.], 2006 Venue: Tokyo Big Sight, Japan
Organised by: Reed Exhibitions Japan Ltd.
Co-organised by: Hydrogen Energy Systems Society of Japan (HESS)

NEWS

STATE OF THE UNION: NATIONAL HYDROGEN ASSOCIATION 2005 CONFERENCE AND EXPO

By MJW
Apr 12, 2005

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Printer friendly page

The most modest of these was an Indian 3 wheel taxi with a single piston ICE converted from CNG to metal hydride by ECD Ovonics. This is to be shipped back to India to be the production prototype, and so it will almost certainly become the first commercial production hydrogen vehicle in the world …….

The Hydrogen & Fuel Cell Letter

Alternative Energy News Since 1986 **April 2005** Vol. XX No. 4 ISSN 1080-8019

HOME | April 2005

The Indian Bajaj three-wheeler single-cylinder i.c. engine taxi converted by Energy Conversion Devices from

The four-day event was noteworthy for what seemed like an unprecedented number of hydrogen-fueled vehicles both inside the 15,000 sq. ft. exhibition hall but also outside in the traditional "Ride & Drive" event. Some 20 vehicles were on hand, ranging from a tiny 1-cylinder Indian cargo Bajaj three-wheeler adapted by Energy Conversion Devices to hydrogen that took participants for rides around the parking lot of the Marriott Wardman Park Hotel to a sleek, long 12-cylinder BMW record-breaking race car (*H&FCL Nov. 04*) on display in the exhibition area.

APP (Asia Pacific Partnership)

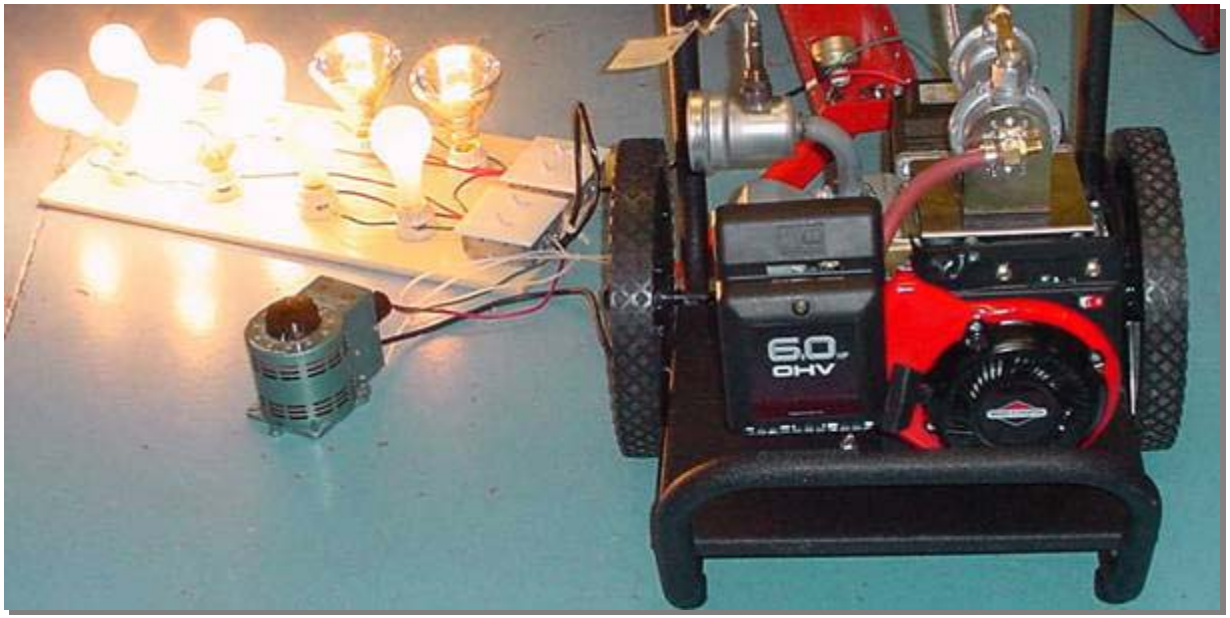
India is one of six APP countries (the others are Australia, China, Japan, the Republic of Korea and the United States) that are cooperating to address the following issues:

- Increased energy needs
- Air pollution
- Energy security
- Green house gas intensities

These six countries account for 45% of global GDP, 50% of greenhouse gas emissions and 48% of global energy use.

Task forces in eight key sectors have been established. One of which is ***"Renewable Energy and Distributed Generation"***

Ovonic H_2-ICE Generator With Metal Hydride Storage



Briggs & Stratton generator running on hydrogen

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