

Final Report
IPRO 351
Solar/Battery Hybrid Three Wheel Rickshaw for India

Executive Summary

India is plagued with pollution and dependence on foreign oil. This problem is largely attributed to the emissions caused by fossil fuel driven vehicles. With its rising population and growth in the urban sector, India's increasing demand for sufficient transportation has led to an increase in pollution and also a demand for alternative energy.

Amidst the various types of terrestrial transportation, this project focuses on a highly popular mode of transport called the Auto-Rickshaw. These vehicles are three-wheelers that perform the same duties as a taxi in terms of transporting people and goods from point to point. However, they are different because of their small size and ability to weave through traffic without being affected by the traffic rules. Auto-rickshaws are typically petrol driven, though the government is currently supporting the production and use of CNG (Compressed Natural Gas) driven rickshaws. This comes as a result of the government trying to reduce pollution and their foreign oil dependence. Even though CNG rickshaws resolve the pollution issue, India still has to import most of the CNG that is used in the country.

The team has come up with an alternative solution to combat both problems: the Solar/battery Hybrid Auto Rickshaw. The concept is simple, an electric three-wheeler that is powered by a battery source which in turn is recharged by a solar panel or electric outlet. This goes hand in hand with the objectives of the Indian government, as the technology is not only sustainable but renewable as well. To make this a reality, there are steps that have to be taken as well as necessary government support. The Indian government is pro-active about sustainable and renewable energies and is willing to support companies that will achieve substantial reduction in energy consumption as well as the use of alternative fuels including hybrids.

The suggested hybrid rickshaw will be launched in two stages. The initial introduction to the Indian market will be in the form of conversion kits. The target will be petrol-powered three-wheelers between the ages of 4-7 years, and upgrade them to electric powered rickshaws. This method is cheaper and makes an easier transition to the second stage, which would be the licensing of the technology for production of a new vehicle that comes straight from the manufacturers with the hybrid capabilities. Our economic evaluation shows that the daily cost of operating/owning the suggested hybrid rickshaw when properly subsidized is cheaper than the petrol fueled rickshaw, therefore our goal is to completely replace the petrol-powered three wheelers.

Project Outline

Mission statement

Background

Objectives

Research Structure

Business and Market Research Findings

Technology Research Findings

Next Steps

Conclusions

1. Mission Statement

By working together, learning, and utilizing the myriad of skills within our team, our mission is to complete phase one of IPRO 351 by presenting results of in-depth research that will determine the feasibility of solar/plug-in power hybrid auto rickshaws in India.

Through the unified effort of our multidisciplinary and diverse team, the goal of the IPRO 351 team is to determine the feasibility of introducing solar/ battery powered auto rickshaws into India's transportation industry.

2. Background

Auto rickshaws are one of the most popular means of transportation in India and other countries. Although they have many benefits, including small size, lightweight, and low cost; auto rickshaws are very noisy, inefficient, expel a high degree of pollutants and keep India dependent upon foreign oil consumption.

Auto rickshaws are available in diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG) models. The operating costs of these are lower than rickshaws running on gasoline; however, the higher initial costs keep the fare of these rickshaws the same as its gasoline counterpart.

The use of alternative energy in transportation is being explored as a solution to the problems experienced with the auto rickshaw.

The Research Title of IPRO 351 is *Solar/Battery Hybrid Three Wheeled Auto Rickshaw for India*. IPRO 351 is an entirely new project. It has been divided into five phases spanning five years, from September 1, 2006 through August 31, 2011. The first phase is scheduled for completion by mid-December of 2006.

3. Objectives

The team objectives for the first semester composed of three main phases:

Research Phase Objectives:

Perform Market and Business Analysis□

- Manufacturers of auto rickshaws; their sales and distribution figures.
- India's history and dependence upon foreign oil consumption

- Government regulations regarding transportation, pollution and alternative energy.
- The profile of the auto rickshaw owner/operator.
- The transportation industry in India.

Conduct Technical Research

- Electrical and mechanical component research.
- Cost analysis of solar/electrical components.
- The mechanics and performance characteristics of the conventional and hybrid auto rickshaws.

Design Objectives:

- Compile electrical and mechanical Specifications.
- Propose design and configuration.
- Evaluate economic viability requirements.

4. Research Structure

Phase 1:

Research Phase

- This task was led by the “Business and Market Research Sub-Team Coordinator,” and the “Technical Research Sub-Team Coordinator” and was composed of three team members each. Each sub-team member was responsible for a particular aspect of the research phase. Reports were created by the sub-team coordinators and turned in to the project team leader for final review and editing.
- This research was in-depth and included a myriad of secondary resources via databases, trade publications, scholarly journals, and credible websites with statistics and data on rickshaws and the automotive industry in India.

- The teams looked into the problems associated with select models and look at ways to address those problems. In addition the group looked into economical ways of addressing the problems.
- The primary role of the Business and Market Research sub-team was to mine for information and data on the background and history of auto-rickshaws in India, competition, governmental policies, risks and challenges, the economy, demographics, and contextual research on users.

Phase 2:

Design Phase

This phase comprised of a “Visual Design Sub-Team Coordinator” which gathered and created visual data for reports, the final presentation and generate simulations.

IPRO Deliverables Preparation and IPRO Day Rehearsal

This portion of the project was conducted by an “Exhibit/Final Presentation Sub-Team Coordinator” and will involve everyone within the organization. This task entailed the development of a poster, exhibit, Power Point presentation and a deliverables CD.

5. Business and Market Research Findings

The Business and Market research team discovered that India has several policies promoting alternative energy and local governments in major cities like Delhi have banned petrol powered auto rickshaws and only zero-emission auto rickshaws are allowed to operate in the city. The team also identified major players in this industry (primarily Bajaj) and tracked the development of other solar and electric projects in the works. From this data we decided that the best way to penetrate this market was to create a niche and offer solar/battery conversion kits to existing owners of petrol powered rickshaws. The design and specifications of these kits are yet to be determined.

Customer segment selection and needs analysis

By the end of 2006, the estimated total size of the three- wheeler industry will be 2.5 *millions rickshaws*. The target market within this industry consists of three-wheelers that are between 4-7 years old; vehicles that have at least 7 years of useful life remaining to get financed. The total size of these comes to an estimated amount of *800,000 vehicles*, of which will primarily be two-stroke engine three wheelers. Being the older and the more polluting of the two kinds of rickshaws, two-stroke engines will get bigger incentives to switch.

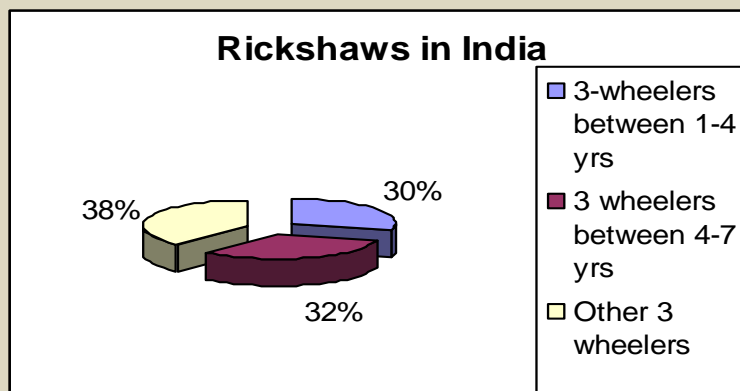
The major cities that will be targeted will be,
New Delhi, Mumbai, Chennai, Agra, Bangalore, Hyderabad, Calcutta.

How large is the opportunity

At this point, the estimated number of 3-wheelers is 2.5 million.

The size of the new vehicles is 250,000 per year

Retrofit (vehicles between 4-7 years) 800,000.



There are two ways that the business hopes to profit. They include licensing of the technology and the selling of upgrade kits. The first option is what the business model

will target first being that it is the larger of both segments (32% of total market size). The licensing of the unique technology will be presented to the manufacturers of the rickshaws in India and fees will be collected at a price that is yet to be agreed upon.

Types	Number	%
3-wheelers between 1-4 yrs	750,000	30
3 wheelers between 4-7 yrs	800,000	32
Other 3 wheelers	950,000	38
total	2,500,000	100

Economics of Plying

There are three categories of auto service suppliers:

- a) Autos run by owner-operators
- b) Small fleet owners who owned autos, possessed permits, but engaged auto drivers to operate the autos; (some owners also drove their vehicles).
- c) Financiers / fleet owners who owned autos, possessed permits to ply, and leased out the autos on a monthly/daily rental to persons who operated the autos.

Unfortunately only a small number are owner-operated now. Most autos are owned by fleet owners and financiers.

“The operator pays a fixed daily/monthly rental to the owner of the vehicle and runs the auto. The operator bears only the fuel costs (and minor repairs) and keeps the earnings from plying the vehicle i.e. revenues in excess of the daily rental are the earnings of the operator.”

“Auto rickshaw repair shops and mechanics are on nearly every corner of India’s major cities and small villages.”

Source: <http://www.indianarc.com/sponsorship3.php>

6. Technology Research Findings

The technology team looked into component specifications and performed a economic analysis of an all electric, petrol and a CNG auto rickshaw. The team also used software to perform an ADVISOR simulation to determine the energy efficiency of an all-electric rickshaw. Based on these simulations we concluded that in order to be successful the proposed conversion kits will have to meet or exceed the economics of a CNG auto rickshaw.

7. Next Steps

Although we conducted extensive research there is still much work that needs to be done. We have defined the following as future steps for subsequent teams.

- Establish a design and specifications of the solar/ battery conversion kits/ or an entirely new vehicle.
- Design a working prototype
- Determine the cost of the solar components
- Create an implementation strategy

Conclusions

From our research we determined that a solar-electric three-wheel rickshaw is indeed feasible. We also discovered that the opportunity lies in conversion kits. Throughout this semester we learned that India is dependent on foreign oil and that the consumption of this has created an environmental crisis. The government is concerned about this and has taken steps to resolve its dependency and pollution issues. However it has replaced one exhaustible resource (oil) with another (CNG). Unfortunately, this is not sustainable in the long run. Thus our solution addresses not only the pollution aspect but also the sustainability and dependency problems.