ILLINOIS INSTITUTE OF TECHNOLOGY

Plug-in Hybrid Electric Vehicle

IPRO 356

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IPRO 356/Isopomoto

Mission: To analyze the business opportunities for Plug-In Hybrid Electric Vehicles (PHEV) for the Grainger Power Electronics Lab and AllCell Technologies

Team Structure

- **Technical and business divisions**
- **Collaboration with Illinois Institute of Technology**

The Problem

1. Oil Prices:
   - Three fold increase in price, last five years
   - $2.4 billion, the avg. daily cost (U.S)
   - Cost will continue to increase

2. Finite resources:
   - Reserve estimated at 1 trillion barrels
   - 27.7 billion barrels produced in 2004
   - 33 billion bar/yr in 2010, expected

3. Environmental Pollution:
   - Global Climate Change
   - Ozone Depletion
   - Emissions and smog

Our Solution

HEV → PHEV Conversion Kits

- Advanced Technology
  - Externally charged battery
- Wide Application
  - Kit can convert any existing hybrid vehicle
- Value
  - Reduces oil consumption and emissions

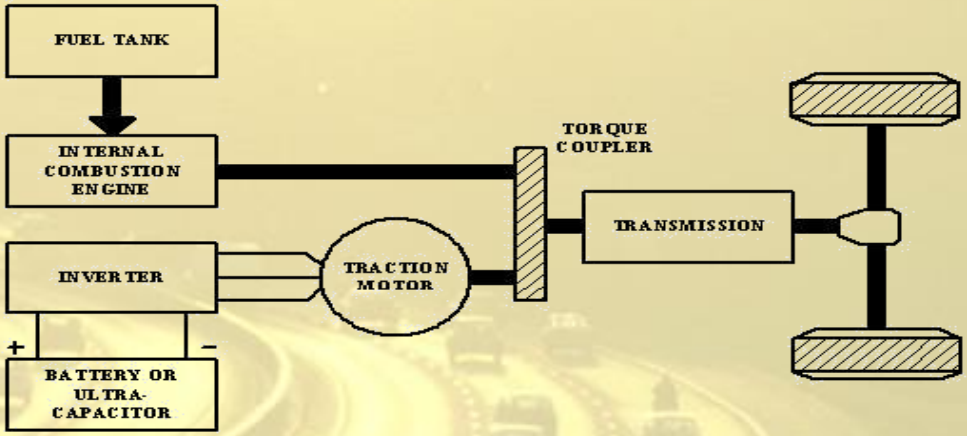
Introduction to the PHEV

Source: 2006 EDrive Systems LLC.

PHEV Kit

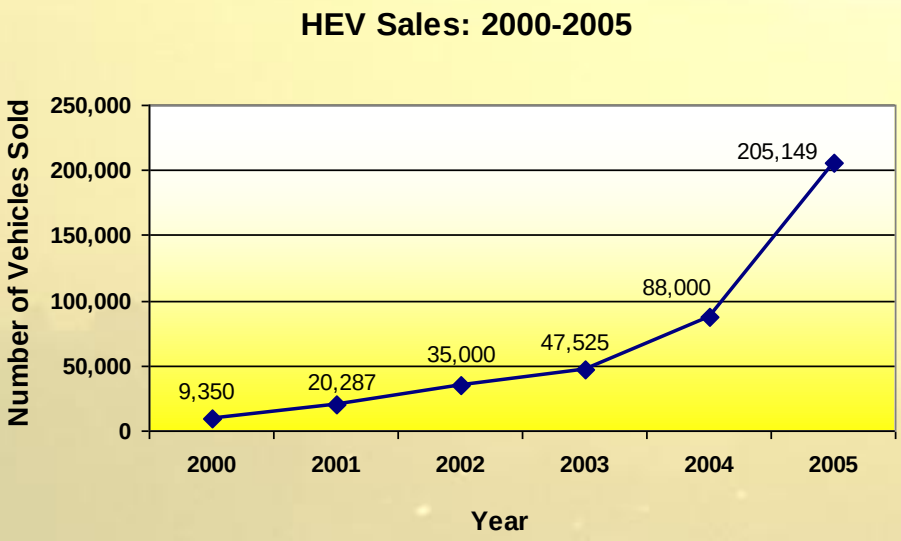
To Wall

Battery Pack (Li-ion or NiMH)



Conventional Hybrid

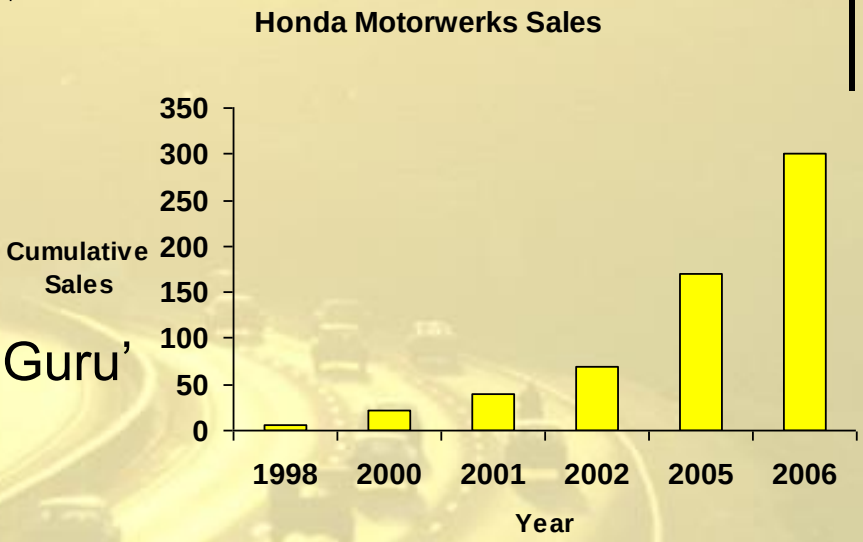
HEV Market Potential



Cumulative sales of major auto-manufacturers like Toyota and Honda

HONDA MOTORWERKS

- Owned by the 'Hybrid Guru'
- Top selling certified hybrid dealer



Introduction to the Simulation Software (ADVISOR)

- Developed by the National Renewable Energy Laboratory
- Predicts the performance of a vehicle
- Flexibility in design:
  - Choose an engine type
  - Determine an optimal electric motor and a battery
  - Decide a control strategy
  - Select drive cycle and number of cycles

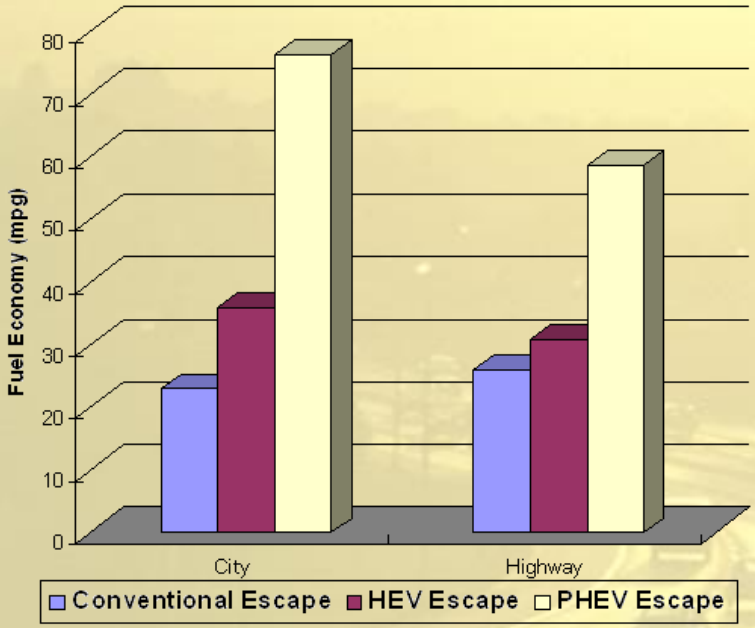
Plug-in Hybrid Escape Simulation Results

Fuel Economy (city)

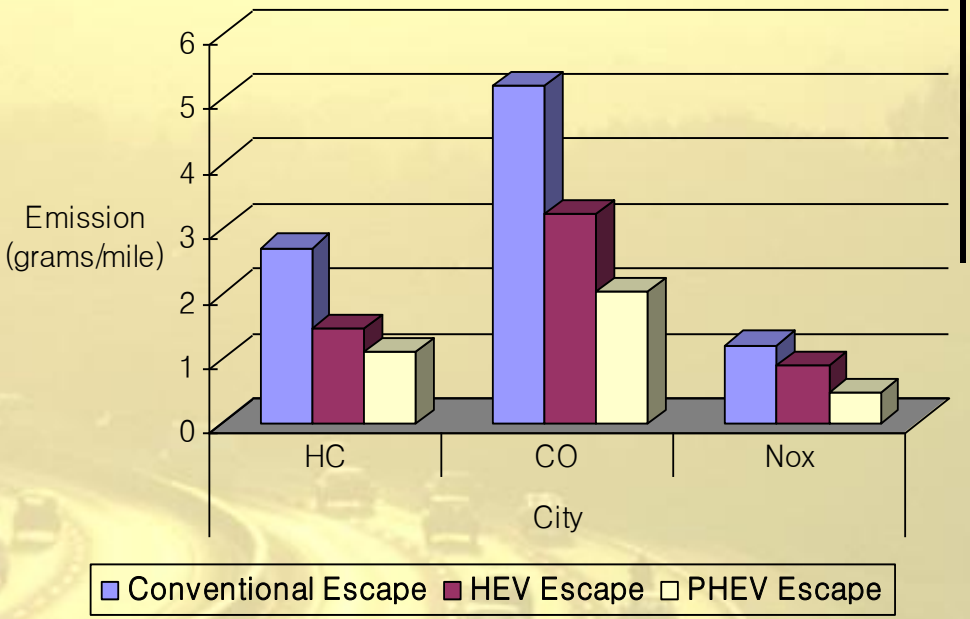
– Twice as efficient

Emissions

- Cut emissions in half



Fuel Economy Results



Emission Results

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Component/Cost Analysis

Component	Description	Cost per kit
Battery (Li-ion)	245V, 24Ah, 6kWh	10,000
Power Electronics System (AC/DC Converter)	AC Input Voltage 85 – 264 V AC DC Output Voltage 2 – 48 V DC	500
Power Electronics System (DC/DC Converter)	DC Input Voltage 12 V DC DC Output Voltage 350 V DC	300
Assembly Labor	$25/hr 20hrs per kit	500
Insulation / Packaging		500
Miscellaneous Components		200
Total		**12,000**

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ISOPOMOTO - SWOT Analysis

Strengths

- Technical Knowledge
- Productive and committed team

Opportunities

- High gasoline prices
- Increased environment awareness

Weaknesses

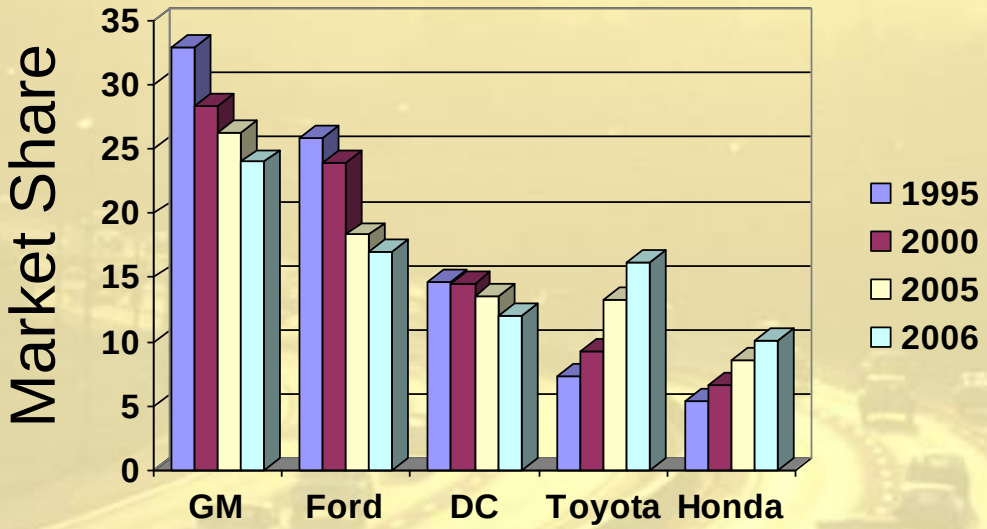
- Insufficient capital
- Lack of established customer base

Threats

- Alternative fuels

Major Industry Trends

- The gradual decline of the big 3 (General Motors, Ford, DaimlerChrysler)
- Alternative fuels gain popularity
- Fuel efficiency becomes key selling element (CAFE standards)
  - 27.5 MPG for passenger cars
  - 20.7 MPG for light trucks



Source: Plunkett Research Ltd.

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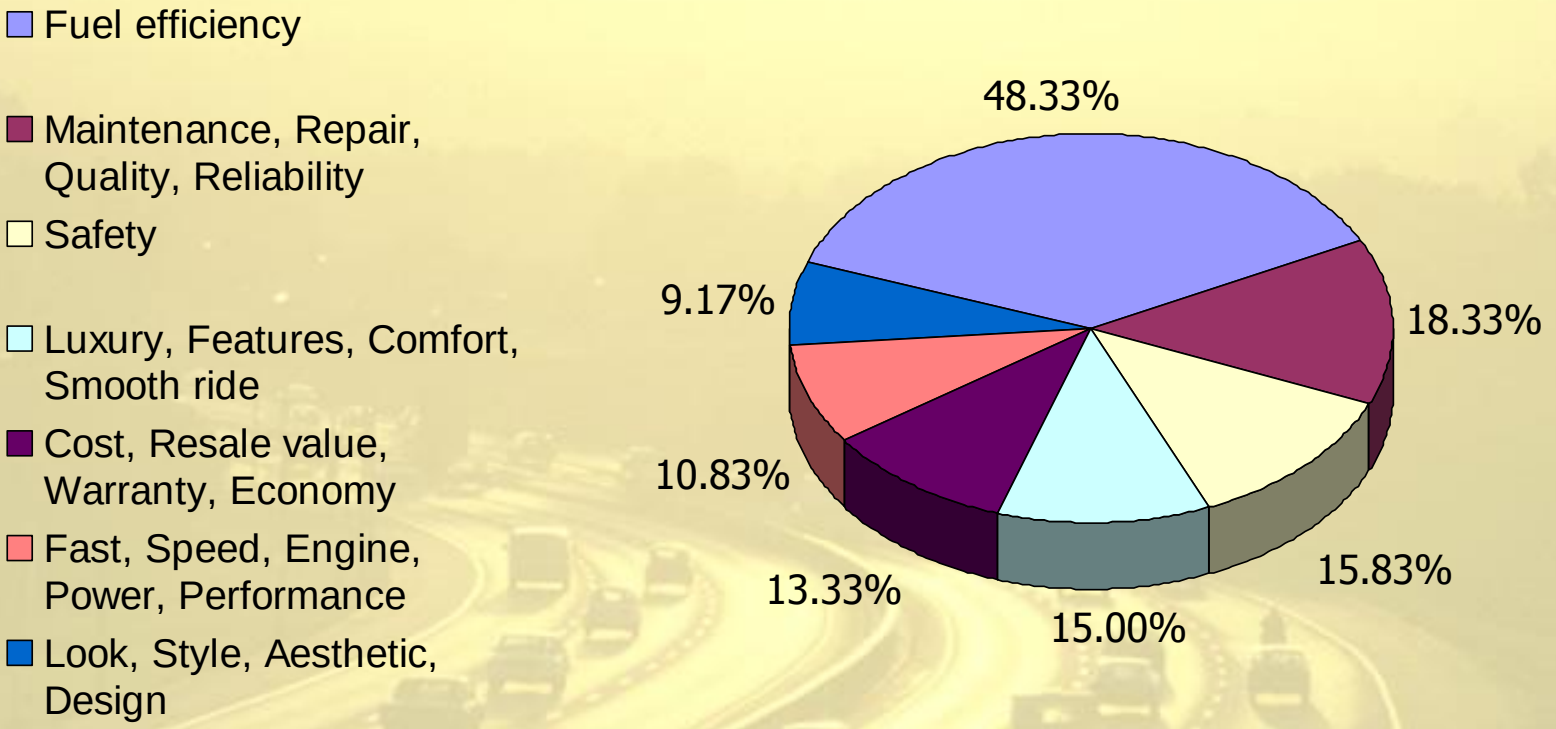
Fuel Efficiency becomes key selling element

Survey Results



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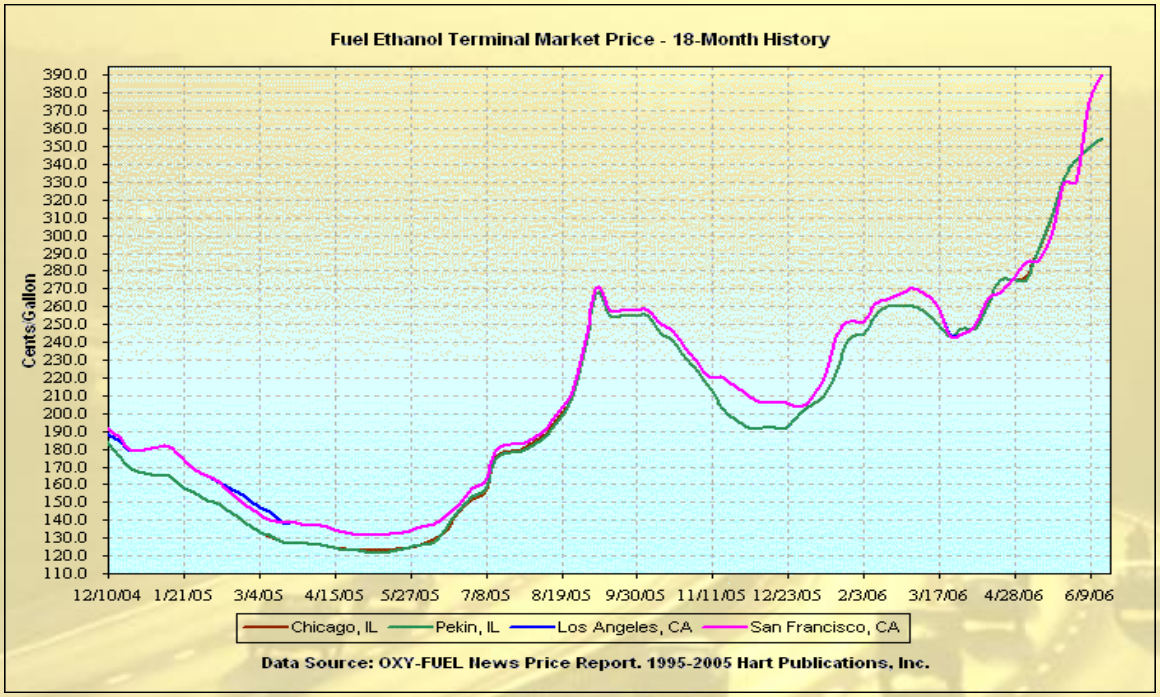
Alternative Fuels

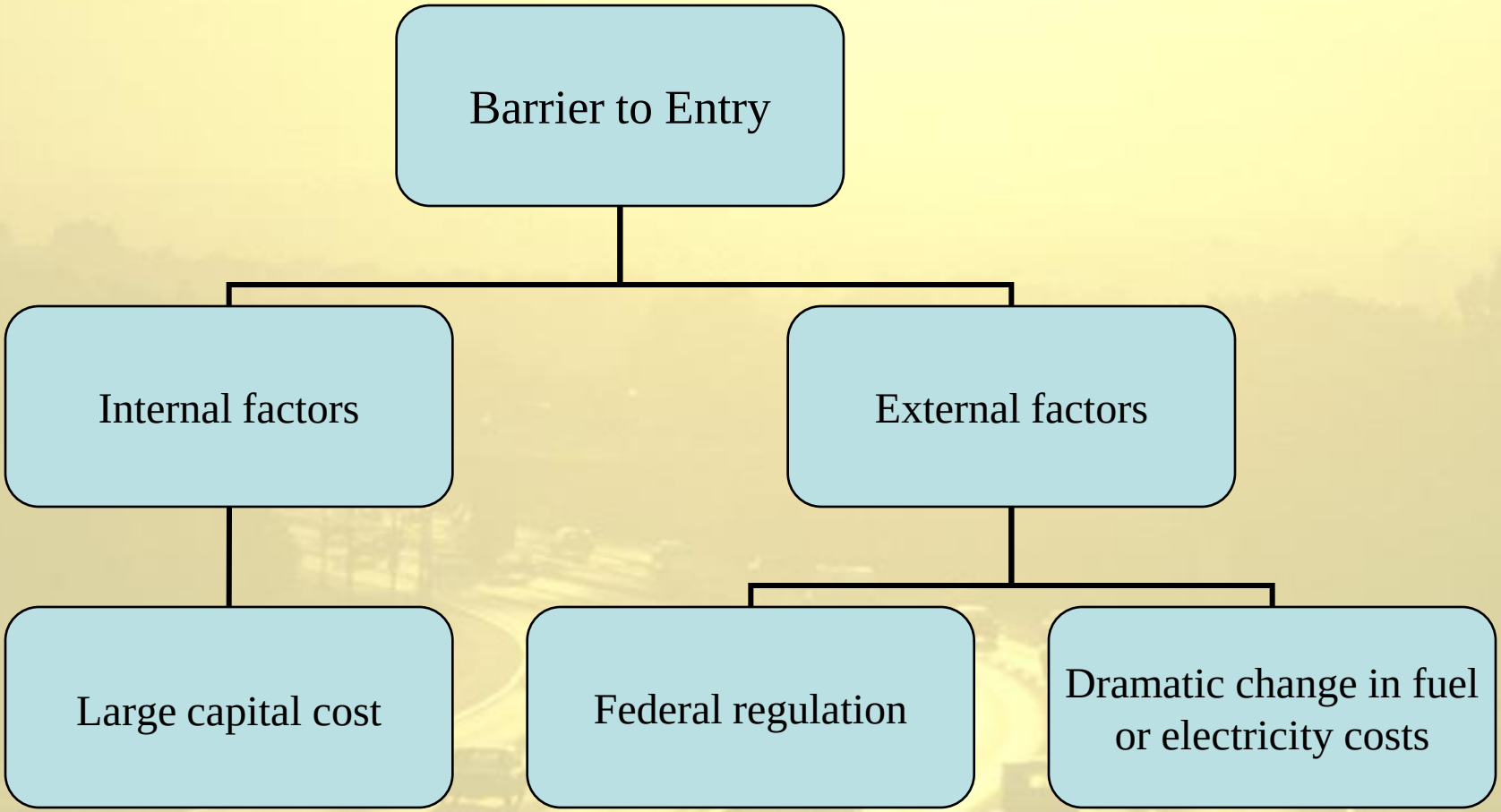
- Ethanol
- Diesel
- Hydrogen Fuel cells
- Bio-diesel
- Electricity – fully electric
- Natural Gas (compressed and liquid)



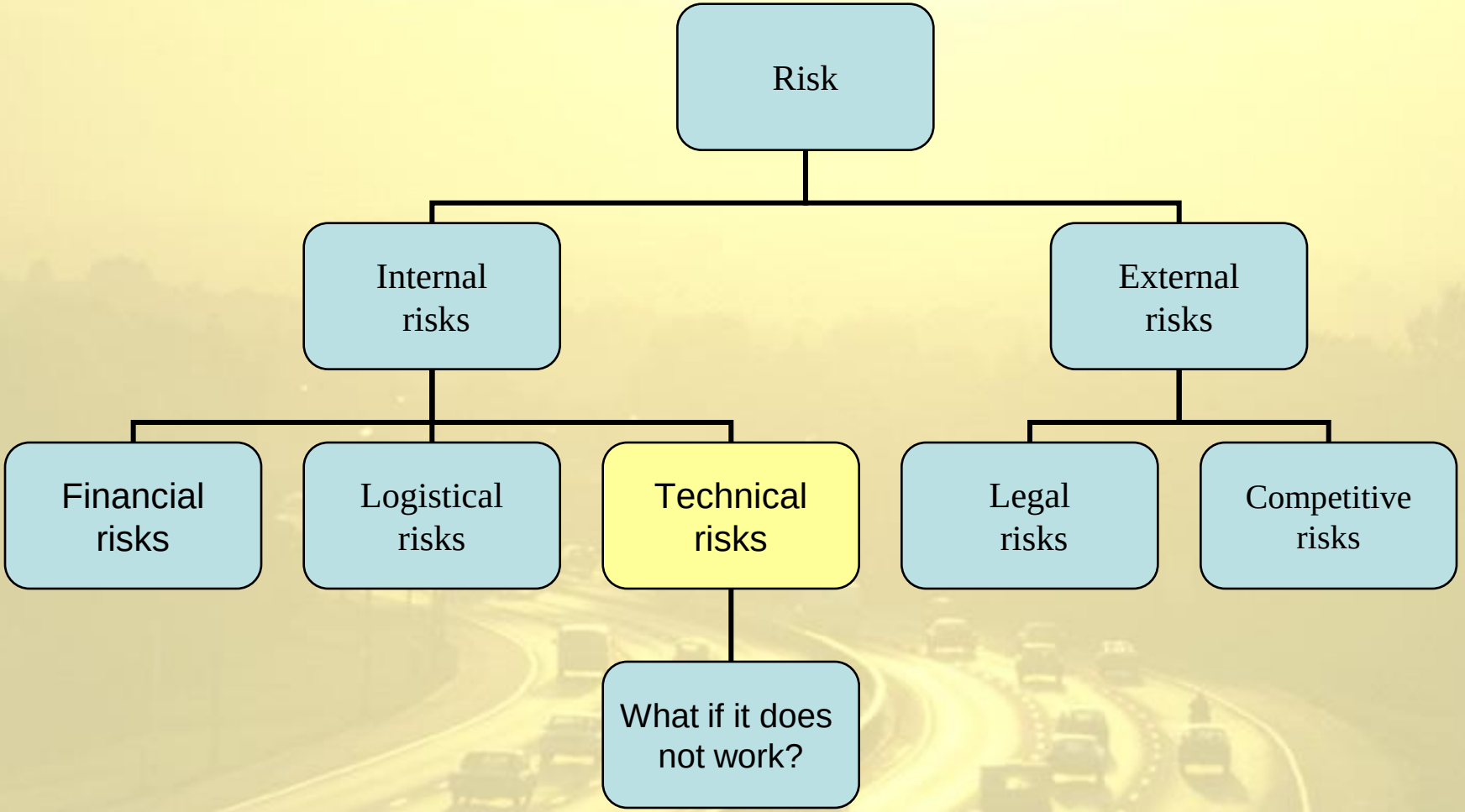
ISOPOMOTO – Political, Economic, Social and Technological Analysis

FACTOR	IMPACT ON ISOPOMOTO
Political 1. Federal safety regulations (high voltage) 2. Current tax reduction is $2,000	 Might delay acceptance Will encourage sales
Economic: Illinois is transitioning to a competitive market structure for electricity beginning Jan 1, 2007	 Less economic appeal
Social: Trends (Health, Environment etc)	 Will encourage sales
Technological: Development of alternative fuels	 May reduce sales

Barrier to Entry



Risk Analysis



Primary Competitors

Company	Background	Target Clients	Partnerships
EnergyCS **(www.energycs.com)**	• First to introduce PHEV commercially • 2007 target for direct consumer sales	• Toyota • Ford • Honda • Lexus	• UK company Amberjac Projects Ltd • Calcars • Valence Technology
Hymotion **(www.hymotion.com)**	• Introduced for fleet use • 2006 direct consumer sales • Target price for kit is $9,500	• Toyota • Ford • Saturn Mariner	• None

Comparison to Primary Competitors

Company	Price($)	Fuel Efficiency (city mpg)	Emission Efficiency (g/mile)	Battery type	Battery size (kWh)
Isopomoto	12,000 Goal price: 10,000	124.3 (Toyota Prius) 76.3 (Ford Escape)	Zero Emission (City drive cycle 2.97)	lithium-ion with thermal management	6kWh
EnergyCS	Goal price : 12,000	112 (Toyota Prius)	Zero Emission	lithium-ion	9kWh
HyMotion	12,500 Goal Price: 9,500	100 (Toyota Prius) 60 (Ford Escape)	Zero Emission	lithium-ion	L5 : 5kWh L12 : 12kWh

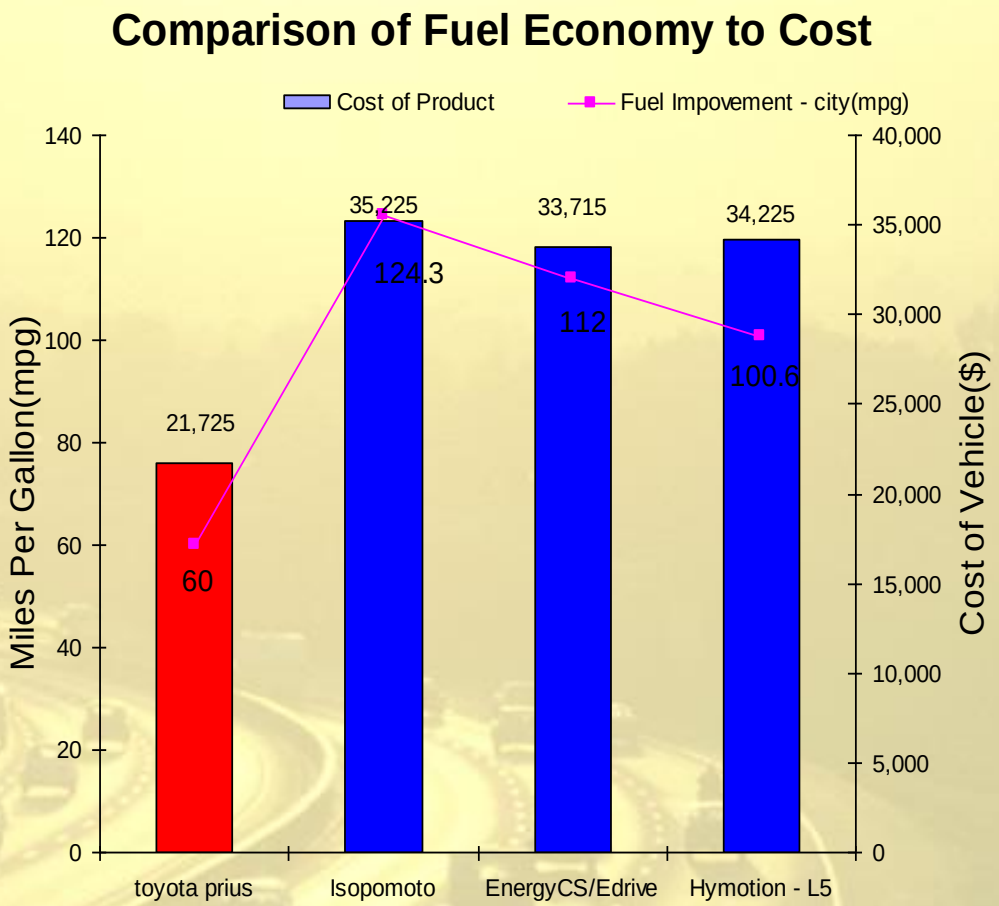
(emission efficiency is based on the city driving in 28mile/h)

Comparison to Primary Competitors

Isopomoto - 124.3mpg

EnergyCS - 112mpg

HyMotion - 100.6mpg



Customer Analysis

Three Main Types of Customers have been identified

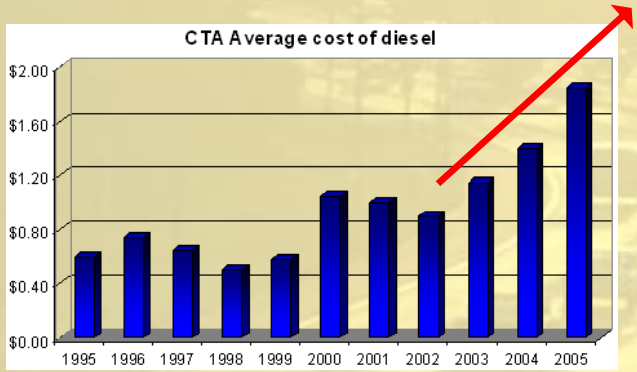
1. **Direct Consumer**
2. **Fleets**
3. **Indirect Customer**
    - i. **Partnership with a global auto company**
    - ii. **Licensing to major auto manufacturers**

Case Study: Chicago Transit Authority (CTA)

Second largest public transportation system in the U.S.

Over 1.6 million customers and 205 000 miles every weekday

Increase in fuel price generated $9.1 mil. additional operating cost



The Fleet in 2005

Number of buses	2033
Distance covered	74.8 million miles
Fuel consumption	24 million gallons
Cost of fuel	43 million dollars

CTA: Cost Analysis / bus

Fuel saving in 2007 will be $17,127 per bus

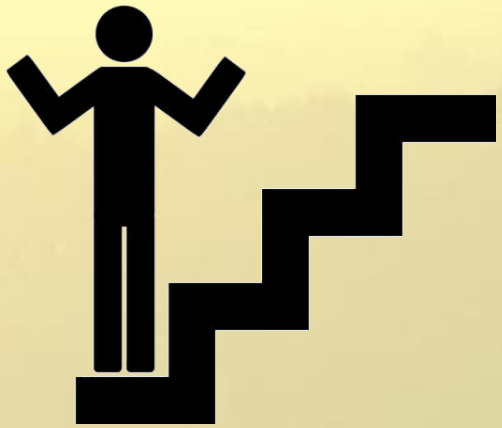
	2007 – conventional	2007- hybrid	2007 - plug-in hybrid	
Mileage	37,000 mi	37,000 mi	37,000 miles (22,400 gas + 14,600 electric)	
Fuel efficiency	3.13 mpg	4.9 mpg	4.9 mpg	4miles / kwh
Fuel consumption	11,805 gal	7,551 gal	4571.4 gal	3650 kwh
Cost of fuel	$2.41/gal	$2.41/gal	$2.41/gal	$0.0838 / kwh
Tot_fuel cost	$28,450	$18,198	$11,323 ($11,017 gas + $305 electric)	

$10,252 saving **$6,895 saving**

Cost Analysis

Start up costs

- Research and development costs
- Initial training of staff
- Facility and property costs
- Office equipment and furniture
- Legal fees

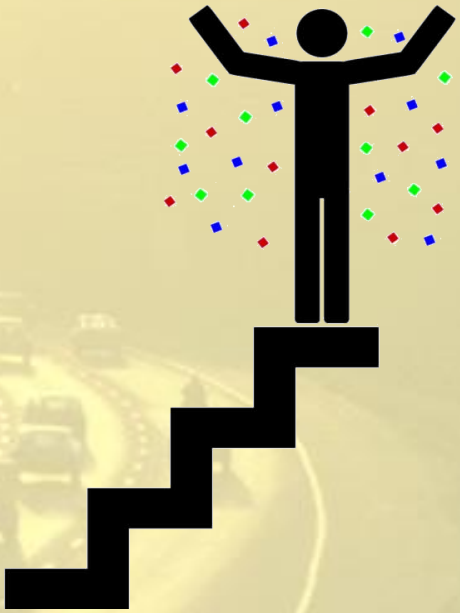


O&M Costs

- Wages and Benefits
- Parts and Shipping for kits
- Advertising
- Utilities
- Office Maintenance

Potential sources of cash include:

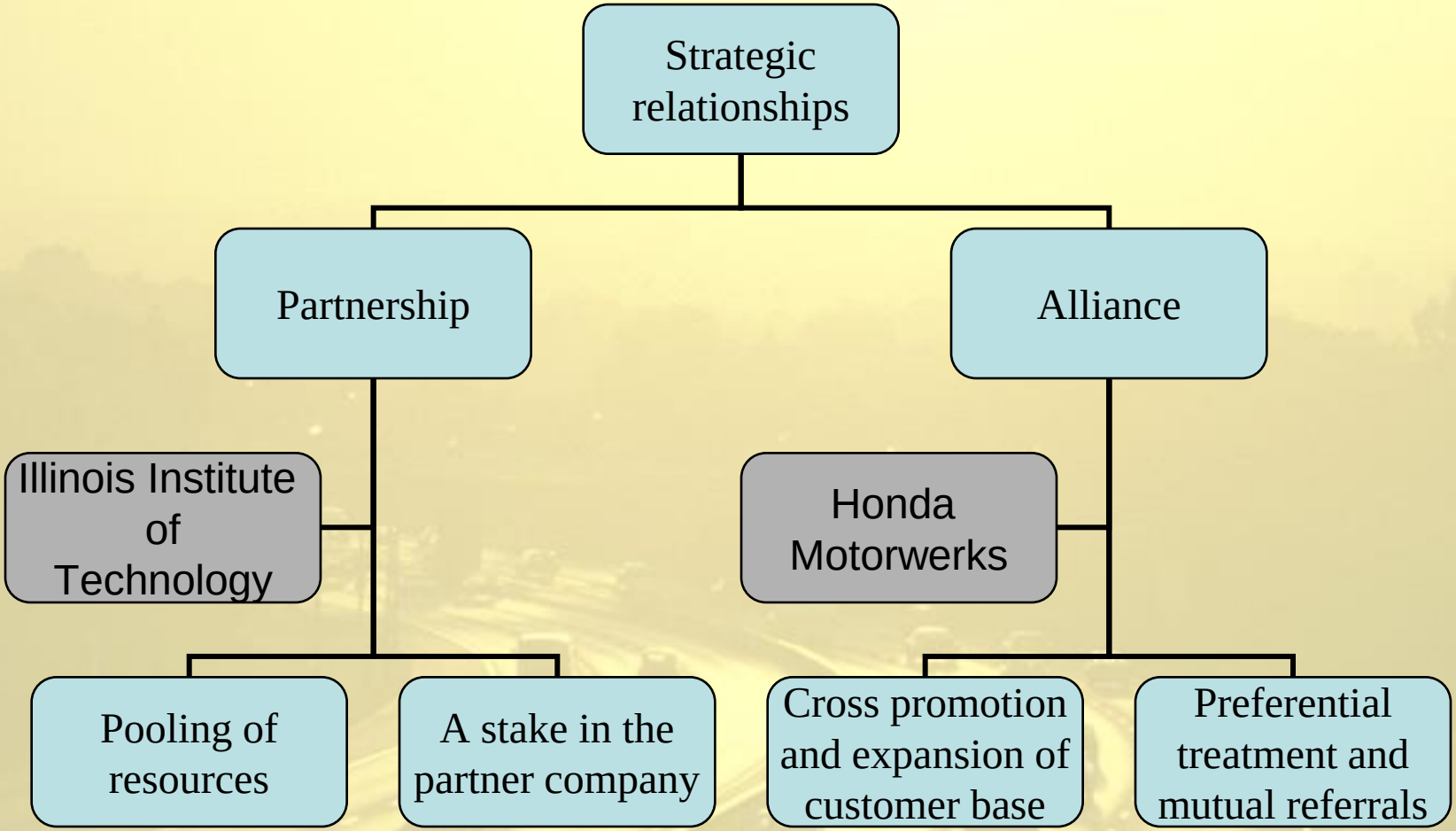
- Sales
- Fundraising and grants
- Investors
- Customers



Staffing

- **Assembly and installation**
  - **Troubleshooting**
  - **Quality Control**
- **Executive Staff**
  - **Marketing Team**
- **Support Staff**
  - **Advisors**
  - **HR Manager**

Partnership and Alliance



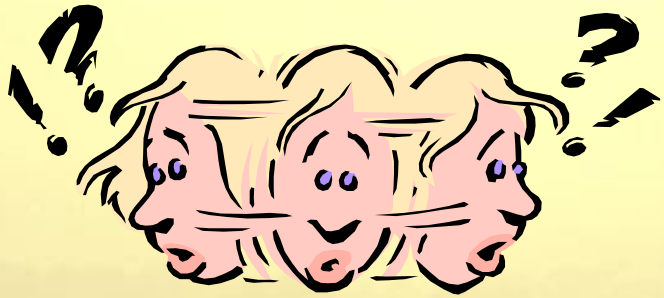
The future of EnPRO 356/Isopomoto

- Complete the cost analysis
- Recyclable parts
- More robust power electronics
- More options for the end-user
  - Same day installations
  - Vehicle Delivery
  - Rental Arrangements
- Vehicle-to-grid integration (V2G)

Acknowledgements

- Sanjaka Wirasingha
- Dr Ali Emadi
- Professor Bob Anderson
- Professor Jim Braband
- Chris Schneider, Honda Motorwerks

Questions



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