Paper Number

International PNGV-Equivalent Programs:

Where does the United States stand?

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ABSTRACT

The Partnership for a New Generation of Vehicles (PNGV), while in a class of its own for trying to develop supercars, is confronted by numerous similar programs. By no means is the PNGV the one answer to the new generation of vehicle puzzle. Programs such as ACE (Japan), the Foresight Project (UK), and the Car of Tomorrow (EU) provide insight to where the United States stands in the competition, and possibilities for the program's future. The United States government is investing more money than other countries, yet other programs' initiatives and goals are not quite as comprehensive as PNGV's.

INTRODUCTION

The new generation of vehicles is on its way, and without technological developments initiated soon, many automotive companies are going to find themselves left with a car that is no longer considered an appropriate mode of transportation. Concerns of health, safety, and the environment are provoking the rush for a "supercar", with current car emissions accounting for an average of 15% of the world's CO_2 emissions. [1] Emerging and established programs are teaming up governmental agencies of automotive nations with their industry in order to expedite the race for the cars of tomorrow. The scramble to the front of the consumer market with cars that meet ever-stringent emissions and safety standards is ensuring that all programs continuously benchmark the competition. By examining the motivation for the investments into these supercar programs, and understanding what is going on outside the United States, it is possible to get an understanding of the future implications to the United States' Partnership for a New Generation of Vehicles (PNGV) program. This program links Ford, Chrysler, and General Motors with other resources and governmental agencies to develop the new clean car.

DRIVING FORCES OF SUPERCAR PROGRAMS

There are many objectives driving each supercar program, with a few factors underlying all programs. The obstacles that must be dealt with by today's automotive industry are the pollution of our air and the economic competitiveness that is growing fiercer as countries develop their industries. Additionally, but seemingly less urgent to the development of a supercar, is the safety of the drivers and the congestion of our roadways.

ENVIRONMENT

Currently, industrially developed countries are working on cleaning up the environment. In 1996, six billion metric tons of carbon was estimated to be released into the atmosphere annually, with the United States the leading contributor. [2]

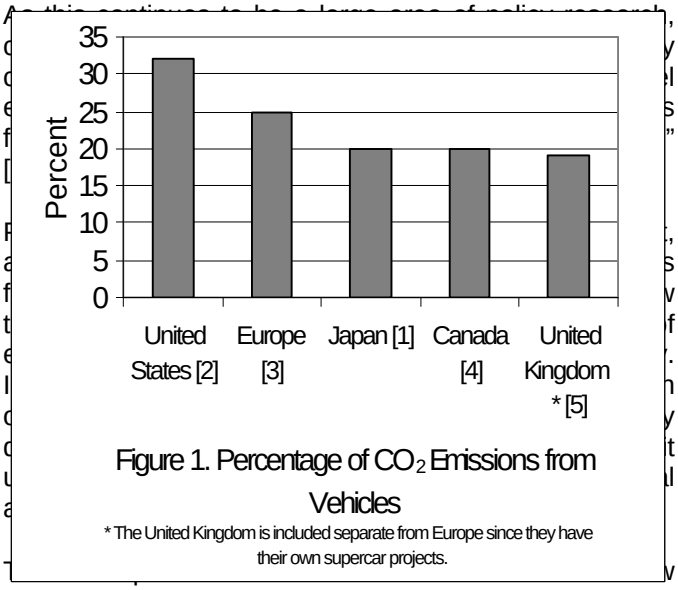

Figure 1. Percentage of CO_2 Emissions from Vehicles

* The United Kingdom is included separate from Europe since they have their own supercar projects.

emissions standards under the "Auto-Oil" Program, which intends to "further reduce pollution from road transport in the community." [6] The following chart provides comparison for emission levels, set to take effect in 2005 for both petrol and diesel engines.

Table 1. EC Emission Standards in G/Mile (current levels in parenthesis) [6]

	CO	HC	NO_X	HC + NO_X	Mass of Particulates
Petrol	1.6 (3.5)	0.16	0.13	XXXXX	XXXXXXX
Diesel	0.81(1.6)	XXXXX	0.4	0.48 (1.1)	0.04 (.13)

Despite reduced emissions standards the challenge continues to grow as more people are purchasing cars and vehicle miles traveled increase. "Reductions in absolute emissions levels have been offset by a growth in road transport demand and customer demands for higher performance, more fully equipped vehicles." [3] Since 1964, the vehicle population in the United States has grown six times faster that the human population. [7]

Plus, the distance traveled by people is also increasing a
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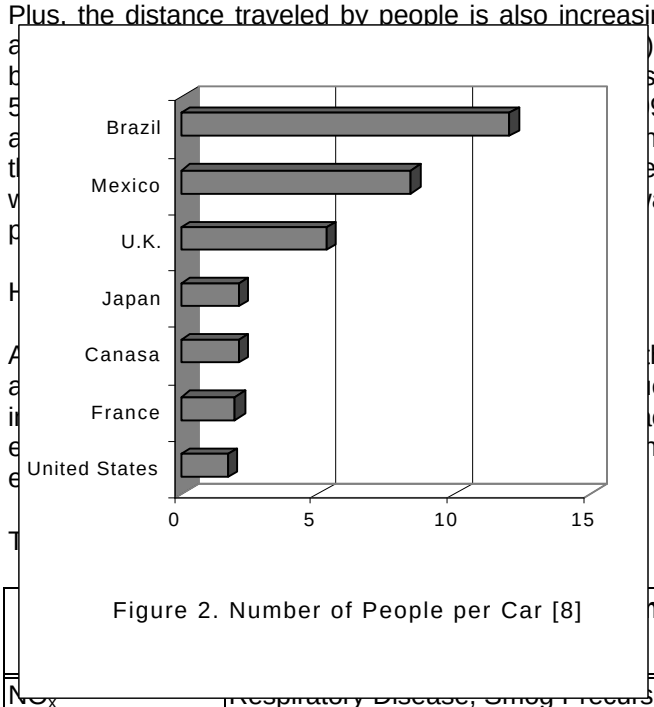

Figure 2. Number of People per Car [8]

NO_X	Respiratory Disease, Smog Precursor
VOC	Respiratory Disease, Smog Precursor
Benzene	Carcinogen
Fine Particulates	Respiratory Disease, Premature Death

Currently, it is estimated by the Canadian Council of Minister of the Environmental Task Force on Cleaner Vehicles and Fuels that "health benefits of up to $31 billion over 23 years would result from introducing cleaner fuels and more stringent vehicle emission standards into the Canadian marketplace." [4] In Europe it is estimated that .3-. 4% of GDP is spent on health problems related to transport emissions. [9]

INDUSTRY COMPETITIVENESS

The private industry's driving force for developing new cars is the need to stay in business. The car industry represents a large portion of many countries' Gross Domestic Product and employment. "Land transport is the world's largest industrial sector, employing the equivalent of the entire population of the UK." [10] With this being true, no country can afford to fall behind in the advancement of automotive technologies.

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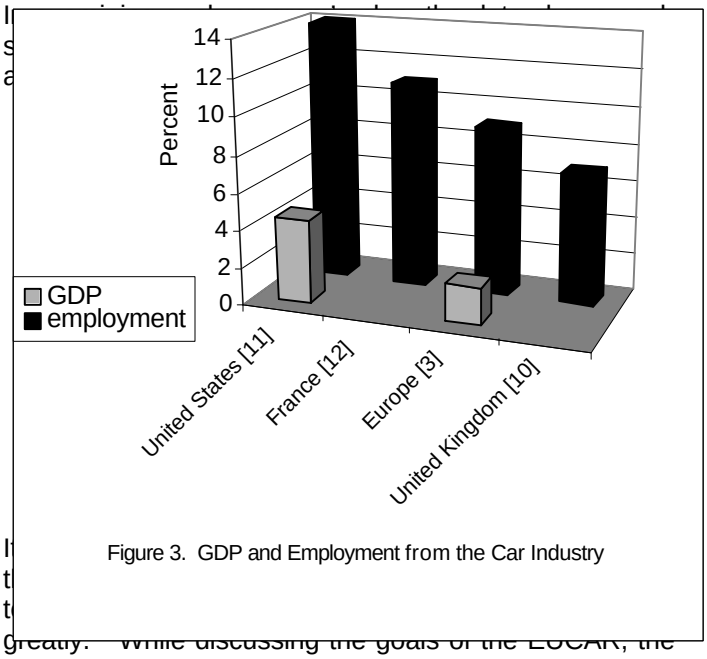

Figure 3. GDP and Employment from the Car Industry

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European Council for Automotive Research and Development, it was stated that "increased competitiveness in manufacturing will be a necessity to secure jobs in Europe." [15]

PNGV PROGRAM

The United States was one of the first governments to decide that a large investment in the automotive industry was a necessary investment. The Partnership for a New Generation of Vehicles was started in 1993 under the Clinton administration as a joint effort between industry and the government to make advancements in current car technology.

Since this partnership was established, over $1 billion has been invested in order to meet the specified goals and timelines. (See Appendix 1) All three members of the Big Three (Chrysler, General Motors, and Ford) are working to develop their own prototype vehicles, while collaborating on pre-competitive technologies. There are three main objectives of the project.

1. Increase the competitiveness in manufacturing.

2. Implement new technology into the new generation of vehicles.

3. Produce a three times more fuel efficient car (80 mpg)

In 1997, the project participants decided on the most promising technologies to focus on for the 2000 and 2004 milestones. The primary criterion that each technology was judged was by its ability to meet the performance rating of 80 mpg. Almost as crucial was the possibility of high volume consumer production of the technology. Finally, cost was an issue, but not as important as the previously mentioned areas.

The following list shows the main areas of focus that were decided on, as well as being used to investigate international equivalent programs.

- Hybrid Electric Vehicles (HEV) – Propulsion from two sources. The first converts fuel to energy, while the second helps to use a stored energy source.
  - Primary Power Sources
    - Fuel Cell
    - Direct Injection Internal Combustion Engine
  - Secondary Power Source
    - Electric Motor
- Direct Injection Engines (DI) – Fuel is directly injected into each cylinder in the engine, providing high fuel efficiency.
- Fuel Cells Engines – Electrical power is generated directly from a chemical reaction between hydrogen and oxygen. Once the technology is established, this will be a near zero emission system.
- Lightweight Materials – The new materials that are currently being analyzed are a mix of aluminum, steel, plastic, magnesium, and other composites. [16]

INITIATIVES BY OTHER COUNTRIES

It is vital that companies keep on top of what is going on around them in order to avoid mistakes that have been made and to ensure progress is advancing at an acceptable pace. Examining the reaction to the driving forces of these supercar projects shows countries that have investments in the car industry are reacting in a pro-active manner. Projects have already been organized by governments such as Japan and by the European Union.

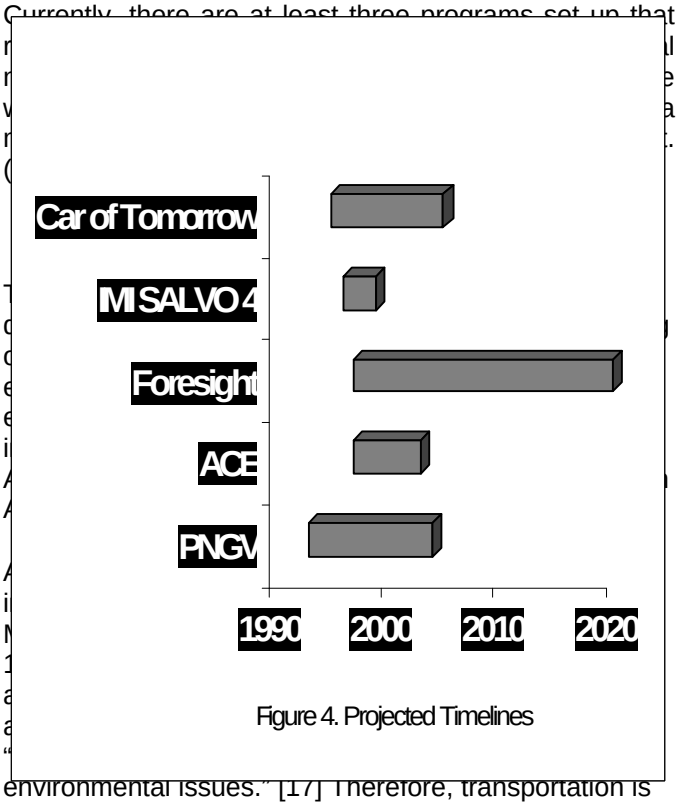


Figure 4. Projected Timelines

environmental issues." [17] Therefore, transportation is only a small segment of research, and the developments are intertwined among other energy advancement techniques.

EUROPE

The European Union[1] has established a cooperative project between the governments and industry for the "radical reduction of the environmental impact of the Car of Tomorrow, compatible with commercial acceptability of the Product." [3]

Similar to PNGV, the Car of Tomorrow is an umbrella program focusing on areas such as HEV, fuel cells, and light materials are being researched to establish a new car. Only one car will come out of the joining of over seven auto companies, and EUCAR, in the Car of Tomorrow project. (See Appendix 1)

Funding for the project is not from one source, but is from many sponsoring and relevant energy RTD programs. The Fourth Framework Program as well as the upcoming Fifth Framework, is the source for the majority of the financial support.

UNITED KINGDOM

[1] The European Union is a joint body made up of Germany, Netherlands, Belgium, France, Luxembourg, Denmark, Ireland, United Kingdom, Greece, Portugal, Austria, Finland, Sweden, Italy, and Spain.

The United Kingdom has a comprehensive program set up to address the supercar issue. While it is a smaller scale undertaking, the Foresight program (see Appendix 1) is still one which is actively seeking solutions. The areas of primary interest are advanced materials and structures, hybrid and electric vehicles, advanced electronics, and telematics. They are not covering the scope that PNGV hopes to research, yet progress is attempted.

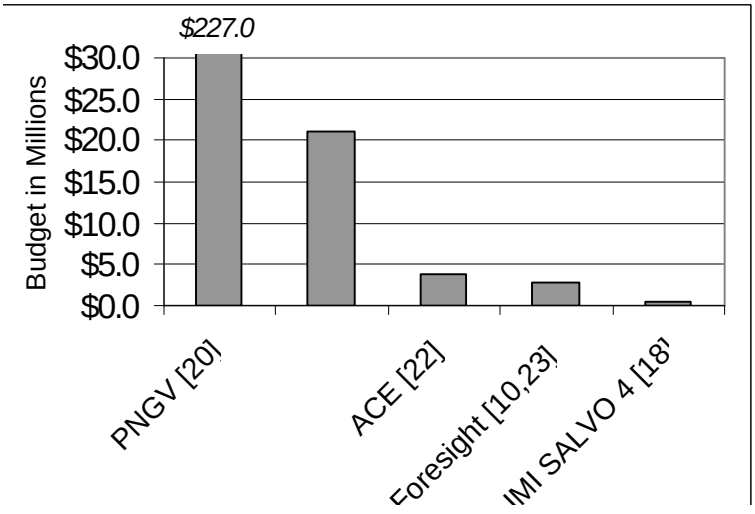
Additionally, more focused efforts are set up under the Innovative Manufacturing Initiative (IMI). The IMI is currently focusing their researching efforts on six fields, one of which is land transport. It is looking to "support high quality strategic and applied research." [18] One such example, the SALVO 4, is researching joining and safety aspects of lightweight materials used to produce cars.

GERMANY

An upcoming proposed German initiative may expand Germany's already growing success in new car technologies. As of 1997 Germany already reached a 3L per 100-km. target (equivalent to 80 mpg), and was on its way to a 2L per 100-km. [19] However, it is important to realize that there are no size requirements on the car, and therefore this achievement may not be directly compared to a PNGV goal. This new green car program will concentrate on the 3 L per 100-km. with alternatives to petrol or diesel engines.

COMPARISON BETWEEN UNITED STATES AND OTHER CLEAN CAR INITIATIVES

Trying to understand where the PNGV stands in comparison to other clean car initiative poses challenges. Countries handle budget allocations differently, as well as the economies of each country coming into play. Additionally, the comparison of fuel efficiencies does not convey the size of the car that is being discussed, which is one of the requirements for PNGV's new vehicles.



technology that is going to be researched. The major government initiatives fitting these criteria are understandably coming from Europe and Japan. These are the two other geographic areas that have numerous hours, and countless budgets invested in the car industry. Although these programs are similar in concept to PNGV, there are differences.

Differences in Approach

Another apparent difference between PNGV and other parallel initiatives is how the technology will later be applied. All programs will share the developmental information with the government, and be kept within the country's boundaries. The difference lies in where the technology is applied, and how to develop a final product.

Application Differences

In looking at the Car of Tomorrow, Foresight Vehicle, and ACE projects (See Appendix 1), solutions should be acceptable for buses and trucks, as well as cars. This added application requires greater transferability between transportation vehicles. A more universal approach must be utilized with other programs.

The ACE project has given individual assignments to each company. Isuzu will work on engine and capacitor arrangement for trucks, while Nissan has been assigned fuel cell and battery research for the passenger car, and so on through each participating company. [22] Comparatively, PNGV has allowed each company to work on all technologies collaboratively.

The Foresight and Car of Tomorrow program are looking for technologies that will be transferable between different transportation modes. The Foresight program, however, specifies that "The technologies will be suitable for all types of road vehicles from small cars to large goods vehicles." [10] Eventually the PNGV technologies may be applied to other transportation vehicles, but presently this is not a main objective.

Collaboration Differences

As well as trying to establish where the technology needs to be applied, how to achieve the required goals is also an issue. Collaboration between participating companies is something that is varied from program to program. PNGV works together on pre-competitive issues and then the companies work independently on proprietary applications.

Contrary to this, the Car of Tomorrow program and ACE programs are hanging on the extremes.

The Car of Tomorrow program must come up with only one car that will be put into production. This prevision is causing a delay in advancements. Each company is

afraid to share too much, since they could loose their rights to the technology.

Oppositely, the Japanese are preserving their own identity, and sharing little to no research information. All advancements are made within each private participant, independent of others progress. The reason for this is that many Japanese auto companies have already ascertained where their strengths are, and feel they have nothing to gain from sharing their information.

Budget Differences

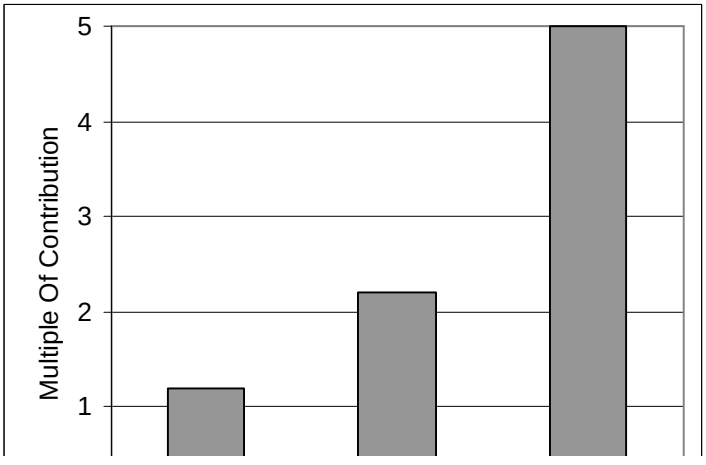
European and Japanese governments are taking the time and energy to aid in the development of a supercar, but with smaller governmental budgets. The United States government is investing multiples more to these efforts. However, the programs are still able to make advancements due to the fact that foreign industry is willing to put in more money than they are getting from the government.

Currently, 80% of all Japanese research and development, R&D, comes from the private sector. [17] However, according the chief representative of the representative office in Washington for NEDO, Naoki Kajita, this number may not be quite as drastic under programs such as ACE. [22] For comparison, the United States corporate R&D investments account for 65% of all investments made. [24]

Under the Car of Tomorrow program, there is not a budget reserved specifically for the program. In order for research to be supported under this agenda, proposals and requests must be submitted, and industry is heavily relied on.

In trying to understand what these figures are saying, it must be noted that the United States industry is investing money into automotive R&D without the help, or knowledge, of the government. The PNGV budget is used on collaborative research only, and is seen as "seed money" for the high risk R&D. In is hard to judge how much industry is supplying alone, yet independent research is taking place. Additionally, most of the money is going to the suppliers and universities for research, and not to the Big Three.

SMALLER FOCUS INITIATIVES



weight vehicles. By reducing the areas that need to be researched, and streamlining the goals of a project, strong advancements may be accomplished without wasted investments. All of the time and money is going into R&D was predetermined to be of value by the United Kingdom.

Segments of the New Sunshine Program also come under this more specified category. Attempts at high-performance batteries may be examined, as well as ceramic gas turbines, but the two investigations are going on independent of each other. Each endeavor has its own budget, with its own participants.

ALTERNATIVES

Although political officials feel that promoting technological developments in the automotive industry is a wise investment, there are other means by which the previously introduced problem areas are being addressed. The supercar is not the only answer.

SUSTAINABLE TRANSPORTATION

Briefly, there are other countries that believe trying to deter people from getting on the road altogether is a better approach. Strasbourg, France has forbidden the use of cars in the city, except for its residents. [25] At a minimum, these attempts look for ways to discourage people from driving long distances, and encourage use of public transportation. Some of these countries do not have as much invested in the automotive industry, so they look to other options.

Other countries have fewer options to explore in producing a supercar. For example, Sweden may not look at some hybrid vehicle options since the cold weather interferes with the cold start process. Therefore, projects and policies are being constructed to establish a new way for people to continue their lives as they did when there were no driving constrictions or concerns.

An Agenda 21 holds that the "government should stimulate the conversion of infrastructure, energy, and waste systems to become more sustainable. They should also direct market forces towards sustainable development." [26] Agenda 21, in Sweden and Australia is trying to develop public transportation as well as upgrade roadways to reduce the distance traveled by motorists. Since Sweden's transportation accounts for 40% of national emissions, yet they do not have direct control over the design of cars, Agenda 21 helps to attack this problem. [27] Below are the key factors that are addressed:

1. Infrastructure – "we must use the best means of transport for every situation, taking into account social, economic and ecological aspects." [27]

2. Energy and Fuel Efficiency in Transport – realize consumption needs to be reduced, and work with auto industry to achieve set standards

3. Clean Fuels – Only small advancements are being made since there is opposition from the auto and oil industries.

4. Spatial Planning – Better road design, as well as train and other modes of efficient public transportation

Along these same lines, Canada released the Report to Canadian Council of Ministers of the Environment (CCME) by the Task Force on Cleaner Vehicles and Fuels. Canada proposed to work with the United States on clean air initiatives. Additionally, the policy caused the government to start to set some of their own research on cleaner fuels. Since 8% of new cars are coming from Canada, they are concerned with what is going on with the car industry. [4] However, they have not moved beyond the research and standard setting phase and started to invest money directly into this effort. The government is doing all it can to push the industry to do this work under its own initiative.

POST-DEVELOPMENTAL INCENTIVES

Another possibility is for the government to wait until industry has made progress alone before they provide any aid or assistance. The way the post-development incentives work is that once a car has met the requirements for a supercar, rebates and tax incentives are available. Tax incentives and rebates are offered to the company that produce new automotive technology, as well as the consumers who choose to support the development by a purchase.

Japan is one of the few countries currently investing in this type of incentive, and it seems to be a worthwhile effort on both the producer and consumer end. The economics behind this type of incentive are very powerful. Since the technology has already proved itself, the government knows that is it investing with a worthwhile company. As for the customer, they know that they are getting a product that is environmentally friendly, and backed by the government, on top of receiving money for helping the cause.

This is a driver for industry to commercialize new technology. Toyota has the Prius, a gasoline-electric hybrid car, on the market, which is one of the first to qualify for such a program.

Another Japanese rebate program is aimed at the rental car industry in Tokyo and three of the capital's twenty-three wards. The rational is that the program will "help popularize low-pollution cars by promoting their use as rental cars, allowing many people to try driving them." Currently, the metropolitan government has around 49 million yen ($350,000) set aside in the 1998 budget for this program. [28]

The United States has invested in some tax incentives. A program started in 1980, and renewed 10 times, recently expired in June of 1998, but may be reinstated. A budget of $2 billion was available for firms investing in R&D, providing a "20% tax credit for the portion of qualifiable R&D exceeding base amount." [24] Although this program is not directed specifically at supercars, it's existence is worth noting.

THE BIG PICTURE

CARS TODAY

The beginning of the new generation of vehicles is upon us. General Motors was the first to release a "sporty" EV1 electric vehicle. Ford has an electric Ranger on the market that gets 50 miles per charge, and is twice as fuel-efficient compared with other cars in its class. Toyota's Prius will be in the United States late in the year 2000, with a 50% reduction in emissions, and two times more fuel-efficient. Additionally, Toyota's RAV4 hybrid is traveling 215 km. on one charge, reaching 125 km/hr. The challenge will be to make the new cars affordable and appealing to the public. "Even the plans of the most optimistic automakers suggest the era of clean cars has a long way to go before dawning on consumers in America and elsewhere in the world." [29]

The market is expanding, and the supply and demand curve is starting to take shape. All new technologies take time to become part of the market share. Currently, Indonesian government officials have decided that all government cars will be run on natural gas in attempt to set an example for the people of the country. [30] Japanese government officials are also engaging in such efforts. Currently, 10% of Japanese government cars are electric or natural gas to show support for the new energy products. [22] In Canada, there are 160,000 propane vehicle and at least 20,000 natural gas vehicle in operation. [4] These numbers represent the realization that new technology needs to be adopted. Although alternative fuels are not as sophisticated as the defined supercar, it represents the movement toward new technology.

DRIVING TOWARDS THE FUTURE

Future decisions regarding supercars must take all the facts of the automotive industry into account. After beginning to understand what other attempts are being made, it becomes increasingly apparent what technologies will succeed, and those that will eventually perish. Many different applications are possible, from electric to fuel cell to hybrid, and only time will tell.

Al Warner, Director, Motor Vehicle Division for the Office of Automotive Affairs in the Department of Commerce, believes that all of the technologies being looked at

should endure to some degree. In trying to decide on determining factors, he believes that climate and gas prices will become concluding factors. [31]

Globalization also pays a role. Different countries are advancing at different rates with different technologies. Discoveries are starting to be shared, and further advancements on all options (fuel cells, hybrids, batteries, etc.) suggest they will all survive in the market. Currently, GM Powertrain Group has divided up its engine and transmission development to "take advantage of expertise in regional pockets of vast cooperation and transfer it throughout the organization." [32] This division represents an already present apportioned market.

The money that has been invested has already shown results. "In the field of emissions, a 1992 passenger car emits 93% less CO and 91% less HC+Cox than the equivalent 1970 model." [14] The sulfur content in the air has also decreased tenfold and the "density of black fumes has dropped form 110 to 21 mg per cubic meters with 35 years." [33] Changes must continue to be made, after recognizing that there is still a problem. It is hard to tell just how much more money should be coming from the government, but results are seen every day.

ACKNOWLEDGEMENTS

Without the help of many patient and interested persons, the research for this paper would not have been possible. In particular, Dr. George Joy and Dr. Joseph Mercurio from the Department of Commerce who continuously provided insight and contacts. Additionally, the rest of the PNGV office for keeping a smile on our faces, although at my expense.

There is also the societies that support the Washington Internship for Students of Engineering (WISE), allowing interns from around the country to research an engineering related public policy issue in Washington, DC. SAE, and my sponsor, Doug Read, provided access to a great city and information on how our degree may be applied to the public policy field.

Finally, the people in the program who helped me learn about more than just the public policy issues going on around me. You know who you are – thank you.

REFERENCES

1. Treece, James B. "Search for Solutions." WARD's Auto World. March 1998: 30-32.
2. "Boosting Prosperity: Reducing the Threat of Global Climate Change Through Sustainable Energy Investments." World Wide Web page. http://www.crest.org/clients/ef/reports/execsumm/indux.html. 5 July 1998
3. European Commission. Car of Tomorrow Action Plan. 22 December 1995
4. "Report to Canadian Council of Minister of the Environment by the Task Force on Cleaner Vehicles and Fuels." World Wide Web page. http://www.ec.gc.ca/oged-dpge/level3e/ccme3.ccmesume.htm. 18 June 1998
5. "ARIC Briefing Note: Carbon Dioxide Emission Reduction." World Wide Web page. http://www.doc.mmy.ac.uk/aric/notes/bn3.htm . 5 July 1998
6. "Parliament – Council Conciliation Committee: The "Auto-Oil" Program is on the road." World Wide Web page. http://ue.eu.int/newsroom/Latest/English/262DC816.htm . 1 July 1998.
7. Wald, Matthes L. "Number of Cars Growing Faster Than Human Population." The New York Times National Sunday. 21 September 1997.
8. "Cars: The Road We Traveled." World Wide Web page. http://www.igc.org/wri/enved/car/tgc-nist.html . 5 July 1998.
9. Cresson, Edith. "Task Force: Car of Tomorrow." ISBN 92-827-5386-7: 1.
10. Sporton, Dr. Mike. "The Foresight Vehicle Link Program." Final Version. 5 October 1997.
11. "Executive Summary" World Wide Wed page. http://www.ta.doc.gov/pngv/goals/pp_es.htm . 7 June 1998
12. "Paris, The Automobile Capitol." World Wide Web page. http://france.diplomatie.fr/label_france/ENGLIISH/eco.html. 21 July 1998
13. "DTI Press Release P/97/714: Driving Into the Future." World Wide Web page. http://www.coi.gov.uk/coi/depts/GTI/coi4146.ok . 12 June 1998
14. Atkins in Bonn, Ralph. "Environment: Germany Combine Forces on Green Cars." World Wide Web page. Wysiwyg://franc2_7.com/jippocamus/q212a6.htm. 12 May 1998
15. "Draft: EUCAR Master Plan." 8 May 1996
16. National Research Council. "Review of the Research Program of the Partnership for a New Generation of Vehicles Fourth Report." National Academy Press. Washington, DC 1998: 117-120
17. "1997-98 AIST MITI Japan." : 9-12, 31-33
18. "Structural Analysis of Hybrid Material Concepts for Lightweight Vehicles (SALVO 4)." World Wide Web page. http://bprc.warwick.ac.uk/imi_land/html . 20 June 1998.
19. Warren-Smith, Paul R. "Automotive Parts and Services: Germany." U.S. & Foreign Commercial Service and U.S. Department of State, 1997: 4.
20. Joy, George. Interview. 17 July 1998
21. "Task Force Car of Tomorrow Newsletter Number 3." European Commission. February 1997: 4-6.
22. Kajita, Naoki. Interview. 14 July 1998.
23. Sporton, Dr. Mike. Electronic Mail Response. 13 July 1998.
24. Doremus, Paul N. Interview. 29 July 1998.
25. "Transport and air pollution in France." World Wide Web page. http://www.abo.fi/fak/esf/nat/hem/enfeco/papers/magalie1.html. 21 July 1998.
26. "The Sustainable Development Agenda 1998." World Wide Web page. http://www.sb.gov.se/databas/tal-873907271.html. 18 June 1998.
27. "Statement by Mrs. Anna Lindh, Swedish Minister for Environment, to the UN/ECE Conference on Transport and Environment on Thursday 13 November, 1997, in Vienna." World Wide Web page. http://www.sb.gov.se/databas/tal-881592016.html . 16 June 1998
28. "Governments to boost Eco-friendly cars." Nikkei English News via NewsEgde. July 7, 1998.

29. "Cost keeps clean cars out of reach." World Wide Web page. http://www.vehiclechoice.org/tech/cost.html . 13 July 1998.
30. "Indonesian Government to Use Natural Gas Powered Cars." World Wide Web page. http://www.theautochannel.com/c…/news03003.html . 20 July 1998.
31. Warner, Al. Interview. 10 July 1998.
32. Gardner, Greg. "Global Growing Pains." WARDS Auto World. March 1998: 42.
33. "Fuel Cells: a long road ahead (automobiles, energy)." World Wide Web page. http://www.adit.fr/Prodiuts/TF/Anciens?TF28a.html . 13 July 1998.
34. Advanced Clean Energy Project." NEDO
35. "EU Spotlight: Task Force Car of Tomorrow." ACEA Newsletter. January 1997: 21.
36. "Foresight Vehicle." World Wide Web page. http://www.foresight.gov.uk/documents/fszk00002/fszk00 0023.html. 12 June 1998.
37. "Creates New Energy." NEDO. September 1997.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

ACE – Advanced Clean Energy

CCME – Canadian Council of Ministers of the Environment

EU – European Union

EUCAR – European Council for Automotive Research and Development

HEV – Hybrid Electric Vehicle

IMI- Innovative Manufacturing Initiative

NEDO – New Energy and Industrial Technology Development Organization

PNGV – Partnership for a New Generation of Vehicles

RTD – Research and Technology Development

APPENDIX I – OVERVIEW OF PROGRAMS

ACE PROJECT [34]

Government(s) Involved: Japan

Industry Involved: Isuzu Ceramics Research Institute Co., Ltd., Nissan Motor Co., Ltd., Nissan Diesel Motor Co., Ltd., Hino Motors, Ltd., Honda R&D Co., Ltd., Mitsubishi Motors Corporation, Toyota Motor Corporation, Mitsubishi research Institute, Inc.

Government Budget: 4 billion yen ($31,000,000) over 6 years [22] (500 million yen in FY 1998)

Goals: 1. Improvement of fuel economy

At least 2.5 times more fuel-efficient

2. Better use of clean energy, and fuels

3. Lower emissions due to gas engines

4. Analyze the social and economic impact of supercars

Timeline: 2003 – tests and assessments of prototypes developed

CAR OF TOMORROW [3]

Government(s) Involved: European Commission (part of the European Union)

Automotive Industry Involved: Volkswagen AG, Fiat Auto S.P.A., Renault S.A., PSA Peugeot, Citroen, Mercedes-Benz, AB Volvo, BMW AG, EUCAR

Government Budget: 162 million ECU ($210.6 million) from the Fourth Framework Program over the ten years of the project [35]

Goals: 1. Stabilize greenhouse gas emissions at 1990 levels by 2000

2. Vehicles with ultra low and/or zero emissions

Timeline: 2000- prototype technology with fleet tests on the current state of advancement

2005 – prototype and consolidation of the most promising technology areas

FORESIGHT VEHICLE PROGRAM [10]

Government(s) Involved: United Kingdom

Industry Involved: 127 companies, 12 universities, 3 research associations, 2 trade associations, 1 consumer organization [36]

Government Budget: ≡20 million ($5,400,000) from government for each of four years of the program to be matched by industry

Goals: 1. Never fail electronics

2 2. Make driving easier for elderly

3. Telematic system

2. Reduce emissions and energy losses from braking and idling engines

Timeline: 2010- researched commercial niches

2020 – widespread use and production

GERMAN GREEN CAR [14]

Government(s) Involved: Germany

Industry Involved: BMW, VW, Daimler-Benz, MAN, Shell, RWE, Aral

Government Budget: *** since the program is still being set up, there is no number available. ***

Goals: 1. 100 km or more per liter of fuel

2. Concentrate efforts between participants on up to three alternative energy sources

Timeline: 1999- have three alternative energy sources decided and agreed upon

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IMI – SLAVO 4 [18]

Government(s) Involved: United Kingdom

Industry Involved: British Steel, GE Polymer Design Associates, Ove Arup & Partners, Rover Group Ltd., University of Warwick

Budget: ≡3566k ($2,021,000) Industry

≡703k ($400,000) government

Goals: Establish new lighter weight materials for cars

Develop joining methods for new materials

Develop strength and safety techniques for new cars

Timeline: May 31, 1999 is the set ending date for project

NEW SUNSHINE PROJECT [37]

Government(s) Involved: Japan

Industry Involved: Fuel Cells – Nissan

Batteries – Nissan, Mitsubishi

Ceramic Gas Turbine - Isuzu

Government Budget: Ceramic Gas Turbine – 1.9b yen ($15 million) (FY 1998)

Advanced High Performance Battery – 210m yen ($1.6 million)

Goals: Fuel Cells – 380 m yen ($2.9 million) The goal of the overall project is to come up with more efficient ways to use energy, as well as more efficient fuels.

Timeline: Each project has a different timeline

PNGV [20]

Government(s) Involved: United States

Industry Involved: Chrysler, General Motors, Ford, 19 government labs, 7 federal agencies: 300+ suppliers, companies, and universities

Government Budget: $227 million (FY 1998) per year

Goals: 1. Increase competitiveness in manufacturing

2. Implement new technology into the current generation of vehicles

3. Three times more fuel efficient (80 mpg)

Timeline: Prototypes by 2000 from each of the three automobile manufacturers

: Pro-production prototype by 2004, with each manufacturer having produced their own car

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VPE/PAC (CLEAN ECONOMY CAR/FUEL CELL) [31]

Government(s) Involved: France

Industry Involved: PSA, Renault

Government Budget: unknown

Goals: 1.1 kilo of hydrogen in 16-kilo bottle

2. 30 kW cell for 10,000 French francs

Timeline: 1992 – Project started

2010 – Pre-Industrialization