

Ethanol

The Fuel of the Future ?

This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

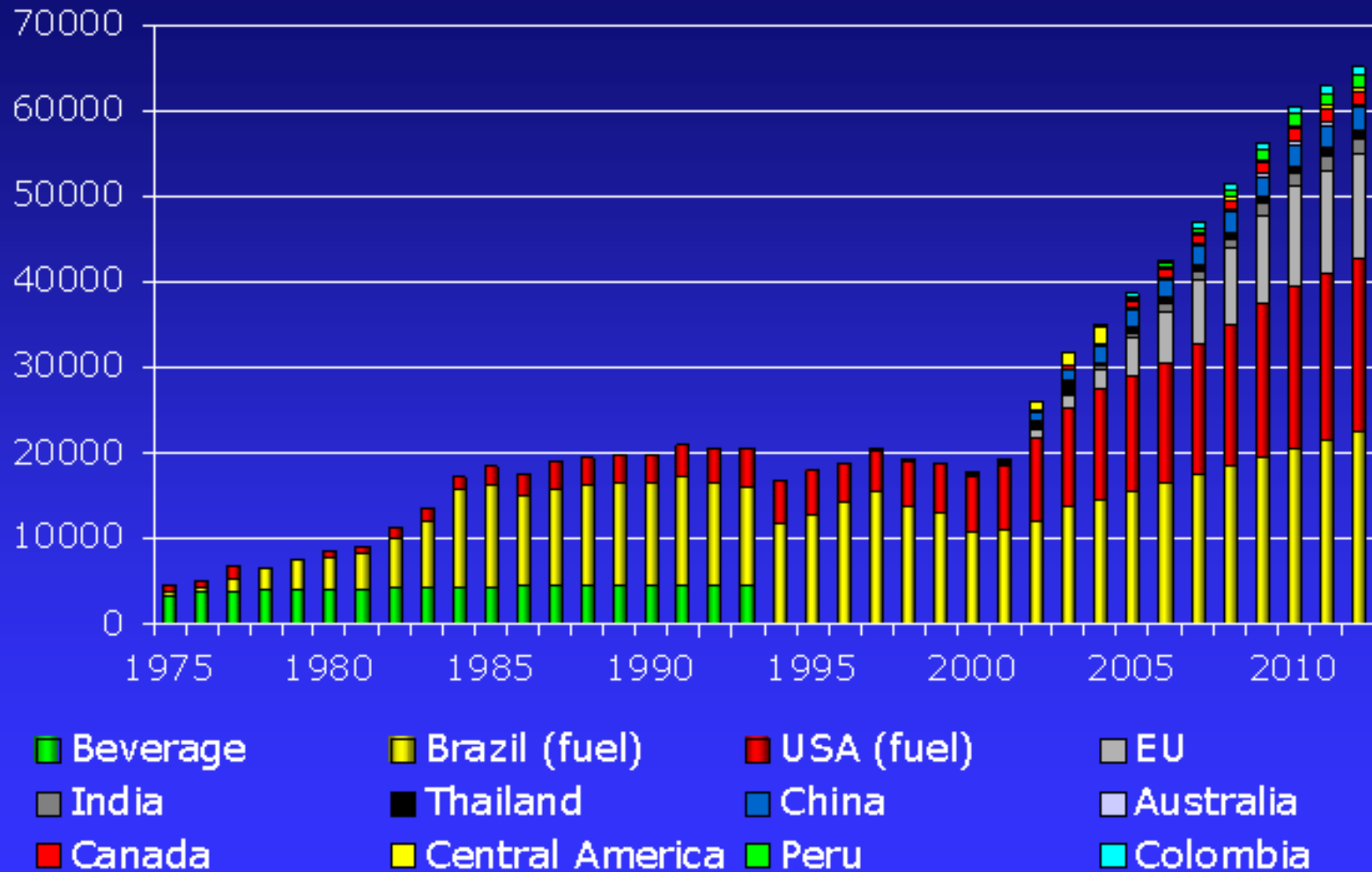
History of Use

- Ethanol has a long history of use as a fuel in internal combustion engines
- The Model T Ford was originally designed to run on ethanol, however when petroleum became available it was easier and cheaper to use with the engine technology available at the time, and it was readily available.
- USA and Brazil have been the major movers in recent years (1970's onwards) in seriously looking at ethanol as an alternative fuel.
- In Europe, Sweden has continued to develop technology in the transport sector with around 400 buses in Stockholm now running on 100% ethanol.
- Increasing interest is emerging in India and China to use ethanol as a fuel. China now hosts the largest fuel ethanol plant in the World. India appears to be developing a serious fuel ethanol program based on sugar cane.
- Canada, Central America, in particular Peru, have large fuel ethanol projects under way.
- Engine technology development now ensures there are few technical barriers going forward.

Ethanol Production

- Ethanol can be produced from the fermentation of crops rich in sugars and starches, this accounts for the bulk of the fuel ethanol used today. Typical feedstock include:
 - Sugar cane and beet
 - Corn
 - Wheat
 - Etc
- Ethanol is produced in two forms: Hydrous (96% ethanol) and Anhydrous (99%+ ethanol). Hydrous ethanol is used as a neat fuel, anhydrous ethanol is added to petroleum in blends.
- Synthetic ethanol can be made from fossil fuels. This has little environmental benefit.
- There are exciting early developments in the production of ethanol from cellulosic feedstock. Whilst the technology is proven, it is not yet at a commercial scale, but would have great application if it can be successfully be commercialised.
- With greater scale, technology improvements and cost reductions in processing are likely
- World fuel ethanol production is expected to increase significantly over the next decade

World Fuel Ethanol Production mIn litres



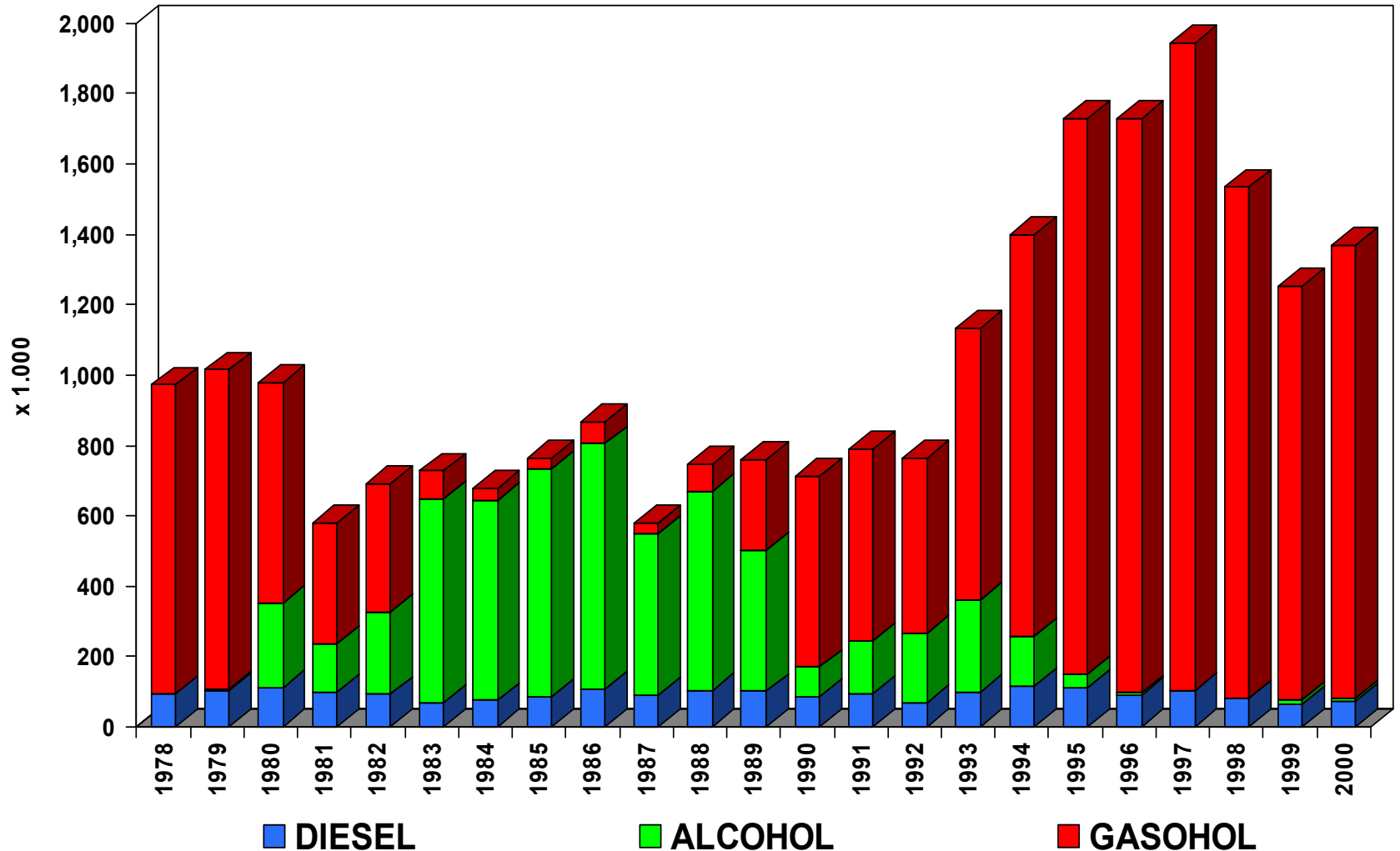
Source: World Fuel Ethanol Analysis and Outlook – Dr Christopher Berg , April 2004

This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

Brazil

- Motivated by the 1973 oil shock, Proalcohol programme introduced in 1975, to reduce dependence on petroleum based fuels, imports and pressure on balance of payments.
- Ethanol is produced from Sugar cane and planting increased rapidly to take advantage of the Proalcohol programme. Brazil now has the World's largest plantings of sugar cane.
- By 1986 more than 75% of the vehicles manufactured ran on 100% ethanol. Supply problems severely reduced this in the following years in favour of blended fuel.
- Legislated addition rate to petrol is 20-24%, (currently 24%).
- Today the 100% ethanol vehicles are slowly regaining market share, but are now less than 10% of new car sales, but still a significant portion of the fleet. They are likely to be phased out by dual fuel vehicles

Brazilian Automotive Market by Fuel

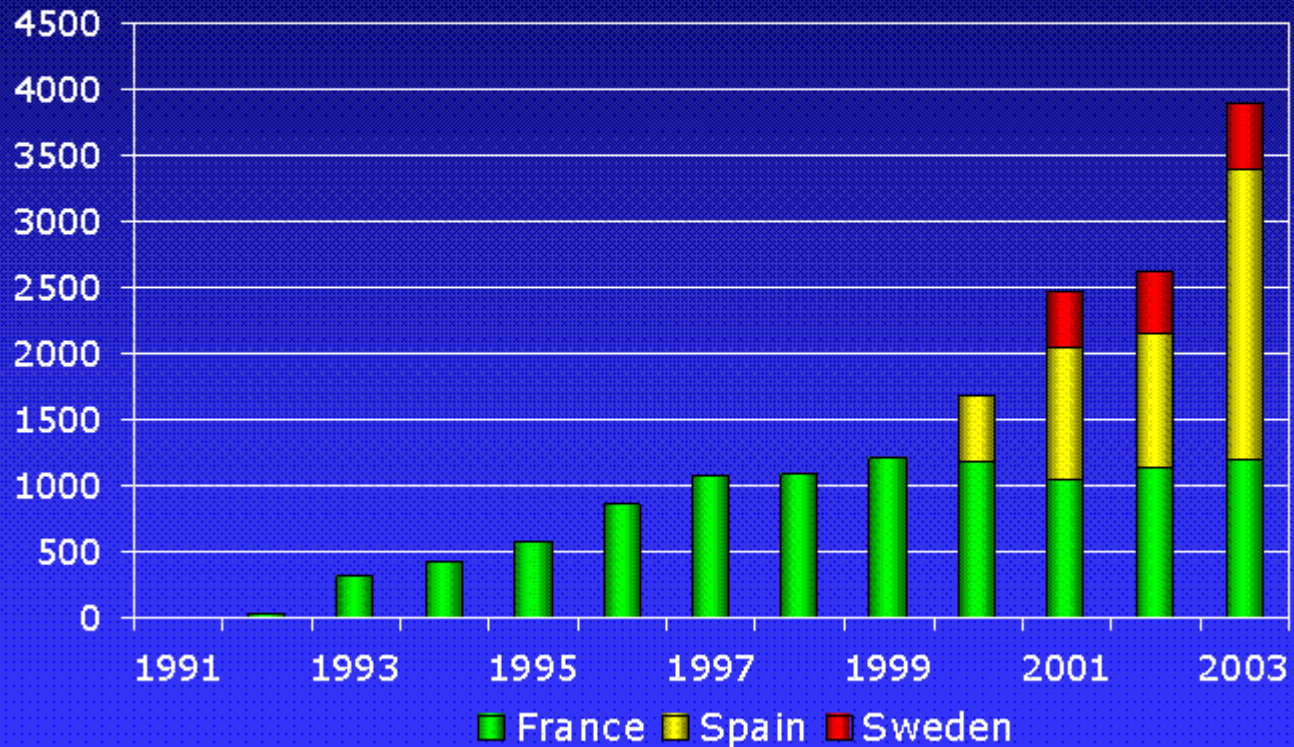


This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

Europe

- The EC Biofuels Directive was ratified in May 2003 and aims to support biofuels and renewable energy sources in the transportation sector. The directive requires national governments in the EU countries to set targets for continuous increase of the share of used biofuels in the transportation sector to 2 percent at the end of year 2005 and 5,75 percent at the end of 2010.
- In Europe the ethanol blending limit is controlled by the oxygen content limit of 2.7% which equates to 7.8% ethanol addition.
- Biodiesel is favoured over alcohol fuels in some countries because of the rapid growth in demand for diesel cars. Eg Germany, France
- Sweden has over 400 buses running on Ethanol.
- France converts Ethanol to ETBE , combining it with Isobutylene, before using as a petrol additive.

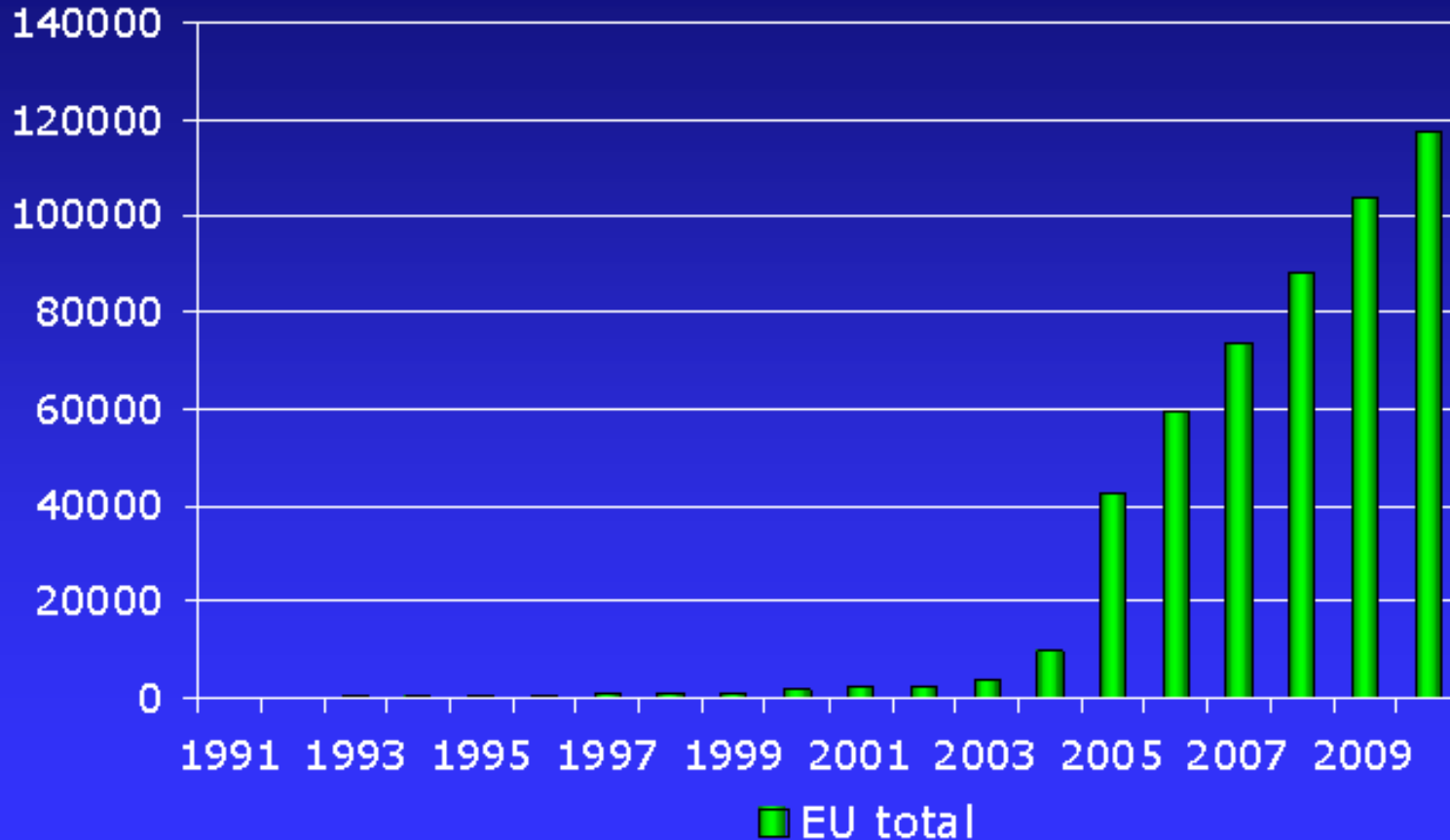
EU Ethanol Production 1000 hl



Source: World Fuel Ethanol Analysis and Outlook – Dr Christopher Berg , April 2004

This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

EU Ethanol Production under the Biofuel Directive, 1000 hl



Source: World Fuel Ethanol Analysis and Outlook – Dr Christopher Berg , April 2004

This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

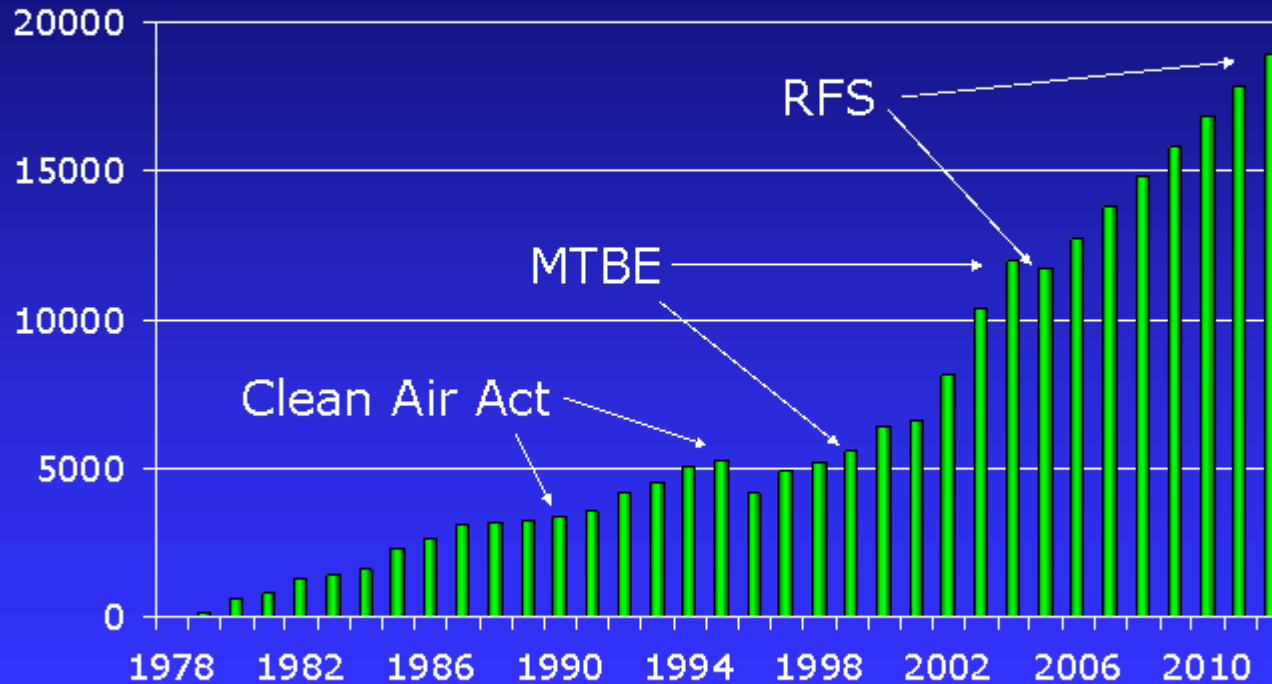
USA

- Legislation and Govt sponsored programs to reduce petroleum dependence, and meet environment targets. EPA Act 1992
 - Federal Fleet – from 2000, 75% of light duty vehicles acquired must be alternative fuel vehicles
 - Rules for State and Alternative Fuel Provider fleets also require up to 75% of light duty vehicles to be AFV's.
- Clean Cities Program – Sponsored by US Dept of Energy aimed at promoting Alternative fuel use.
- Legislation to add oxygenates to petrol in cold climates in winter to reduce CO emissions
- MTBE addition banned progressively
- Renewable Fuel Standard should drive further growth in demand.

USA

- All auto manufacturers offer full warranty on new vehicles running on E10. Ethanol production strongest in grain growing mid west.
- Two blends commonly available E10 and E85
- Now in excess of 2.5 million FFV's on the road.
- Growth in distribution, blending facilities needs to keep up to allow targets to be met.

US Ethanol Production mln litres



Source: World Fuel Ethanol Analysis and Outlook – Dr Christopher Berg , April 2004

Australia

- Ethanol has been added to Petrol parts of Australia for many years.
- Independent Service stations in the Sydney / Wollongong area have had up to 20% ethanol in fuel since 1992. In 1999-2000 530ML of E10 was sold in NSW and Victoria.
- Benzene used to improve octane rating. However Fuel Standards call for a progressive reduction in Benzene and ethanol could well be the answer as demand for 95 RON petrol is expected to increase.
- MTBE now not used and was only previously used in imported petrol from Singapore
- The issue has become highly politicised with oil companies and Auto manufacturers not keen to see ethanol mandated. Experience in the USA attracted the same reaction from the same groups prior to regulation.
- CALTEX are running trials in Cairns with E10 fuel sales to judge market acceptance. BP stopped trials in Brisbane.

Australia

- Between 1929 and 1957 all fuel sold in Queensland contained 10% ethanol.
- Ethanol is subsidised by a production subsidy of 38.1 cents per litre for ethanol used in fuel, equivalent to the excise on petrol. The subsidy is paid direct to producers.
- There is one significant producer of ethanol in Australia.
- New plants are being considered by new operators
- There have been a number of studies and more are under way

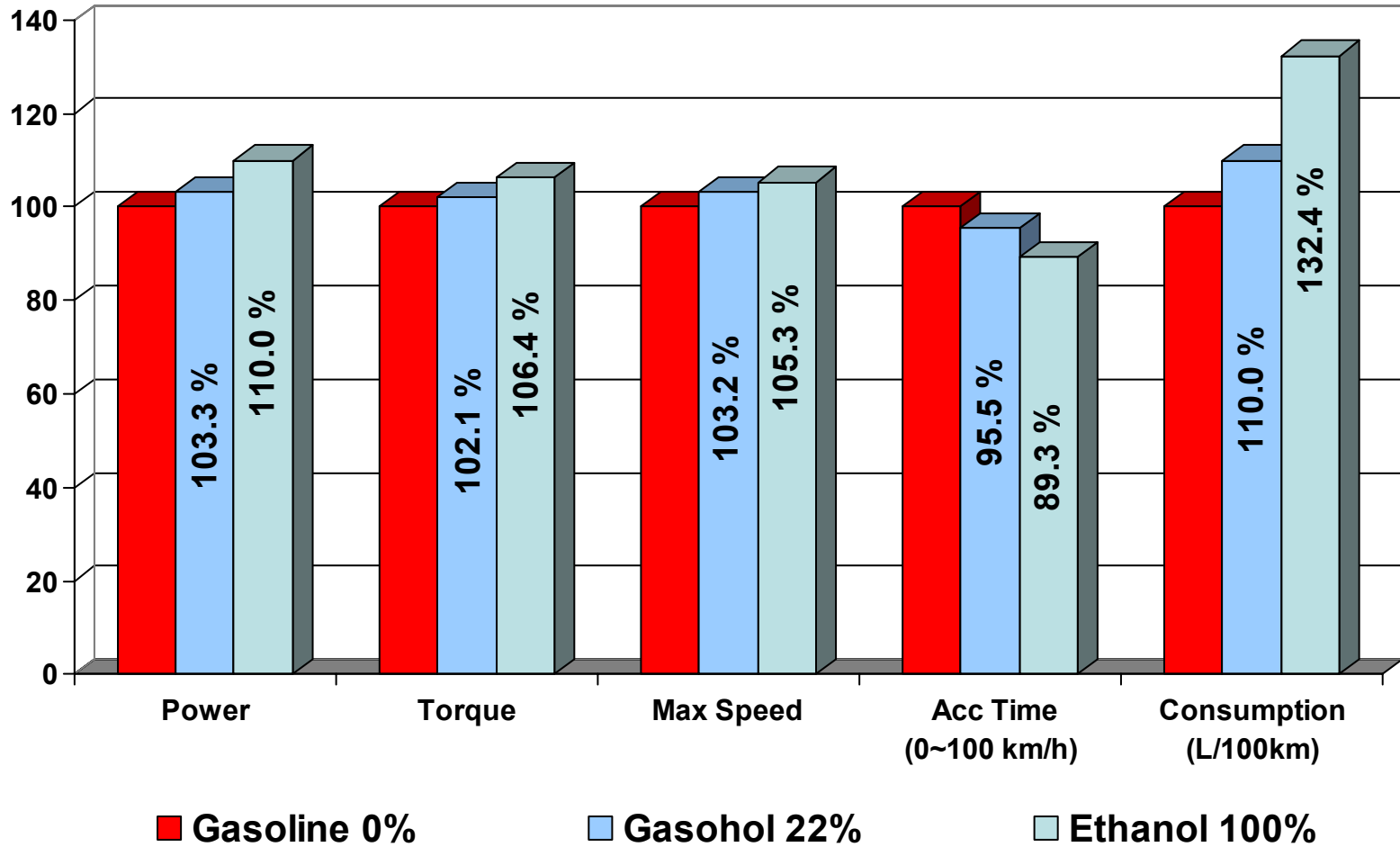
Australian Fuel Trends

- Australian fuel standards are tightening with Benzene addition to be reduced to 1% by volume by 1st Jan 2006.
- MTBE must be less than 1% from 1 January 2004
- Changes in fuel standards will require Australian refiners to look at additives other than benzene to achieve RON 95, which is likely to increase in popularity.
- Ethanol is the logical additive to fill this gap
- Ethanol addition was capped at 10% from 1 July 2003

Vehicle Technology

- Up to 10% ethanol, no detrimental effects on vehicle or performance. Many manufacturers make this claim for post 1986 vehicles, some make qualifications.
- 100% ethanol cars have been in use in Brazil since the 1980's and in 1986 comprised more than 90% of new car sales.
- FFV's – E85 fuel to straight petrol available in USA since 1998. Do not cost any more and there are now over 2 million on the road in USA.
- Dual fuel vehicles – New vehicles launched in Brazil in 2003 can use between 100% ethanol and 100% petrol. Pioneered by Volkswagen.
- Australian made Holden Commodores have been exported to Brazil since 1999 equipped to run on 24% ethanol substitution.
- The current level of technology is not a barrier to the use of ethanol or ethanol blends in Automobiles.

Ethanol Engine Relative Performance



Source: Volkswagen (Brazil)

This informal presentation was prepared in late 2004 by Michael Quinn for review within The Warren Centre for Advanced Engineering at Sydney University. No representation whatever is made with respect to the accuracy of the information contained herein or the veracity of any of the claims made. The Centre invites comment from anyone with alternate or additional relevant information.

Benefits of Ethanol Use

- Renewable Resource
- Cleaner burning engines – longer engine life ?
- Lower net carbon dioxide emissions
- Reduced CO emissions
- Less dependence on imported oil
- Expanded market opportunity for Australian farmers
- Economic opportunities and employment for rural areas
- Reduced particulate emissions and reduced health issues related to these, and OH & S issues associated with handling petroleum products, especially benzene.
- A safer option for enhancing Octane ratings

Some Concerns raised by from Oil Companies and Auto Producers

- Ethanol blending must be controlled
- Not all emissions are reduced, NOx and aldehydes increase
- Not all vehicles on the road are suitable for E10.
- Ethanol addition increases the vapour pressure of the fuel mix
- Ethanol addition will result in residues in fuel systems being released and fuel filter replacement will be more frequent.
- Lack of infrastructure in blending and distribution
- Extra cost of having to produce and handle E10 and unleaded fuel
- Some changes needed to handling and storage facilities
- Ethanol is hygroscopic so water intake by the fuel could be a problem if storage tanks leak
- etc

The Facts

- Ethanol is well established and proven as a suitable petroleum additive, and a fuel in it's own right and is growing in use worldwide
- Many countries are adopting fuel ethanol as part of their contribution to clean air.
- It does have environmental advantages over petroleum
- It does not have any noticeable impact on car performance or wear and tear at a 10% addition level
- Technology exists for vehicles that will run on any combination of ethanol and petroleum.
- The oil companies and automobile manufacturers in Australia are resisting, as they did in the USA.
- There are a number of hurdles to be overcome before any serious penetration of ethanol into the fuel market in Australia is likely to take place.
- The facts in Australia are not well compiled and communicated.
- Objections raised by the oil companies and auto groups appear to have been overcome in other countries.
- Government support is crucial.

Issues

- Cost of production and capital intensity
- Sustainable Supply
- Logistics
 - Identifying the best areas to focus on
 - Produced from seasonal crops, supply all year round
 - Regional infrastructure / blending
 - Transport to major population centres
- Government support
- Acceptability to consumers