Asia-Pacific
Economic Cooperation

Biofuel Transportation and Distribution Options for APEC Economies

APEC Energy Working Group

APEC Biofuels Task Force

May 2011

APEC Project EWG 20/2009

Produced by
BBI Biofuels Canada
P.O. Box 205
Delaware, Ontario
Canada
N0L 1E0
Telephone: (519)203-2191
Fax: (519) 488-3621

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

APEC#211-RE-01.4

NOTICE

This report was prepared as an account of work sponsored by APEC. Neither BBI Biofuels Canada nor any of its employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement, recommendation, or favouring by BBI Biofuels Canada.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APEC BIOFUELS INFRASTRUCTURE - EXECUTIVE SUMMARY

As biofuel markets expand in a wide range of APEC economies, and as technologies advance for the cost-effective production of biofuels from abundant second-generation feedstocks like farm and forest residues and algae, it is important to consider the cost-effective expansion of infrastructure to transport and distribute the ethanol and biodiesel that are produced. The transportation of biofuels from biorefineries to local blending stations or distribution hubs, and the distribution of biofuels from distribution hubs through to retail fueling stations, may entail significant costs. Thus, it economies need to expand this infrastructure in tandem with production and demand mandates in order to manage transportation and distribution costs.

There are several possible transport modes for biofuels: truck, rail, ship, barge and pipeline. Most biofuels today are transported by a combination of truck, rail, ship or barge. Truck transport is generally most cost-effective distances less than 500 kilometers. Rail can be attractive for distances of 500 to 1500 kilometers. Transport by barge and ship are feasible if there is access to water, and can be cost effective over short, medium, and long distances. At greater inland transportation distance distances, pipelines may also become a cost-effective transport proposition.

Dedicated ethanol pipelines, in particular, require very long transportation distances coupled with large volumes, on the order of ten to twenty billion liters per year at least, to be cost-effective alternatives to conventional modes of transport. Among individual APEC economies, biofuel mandates and second-generation resource potential in China and the United States appear adequate to justify ethanol pipelines. However, for groups of economies, perhaps in Asia with China as locus or in North America with the United States as locus, multi-economy ethanol pipelines could also make sense.

Most biofuels today are distributed in blends of up to 20 percent with conventional petroleum-based fuels – ethanol with gasoline (petrol) and biodiesel with conventional diesel. These blends can be distributed with minor modification of existing vehicles and filling stations. However, as production expands or as biofuel mandates are implemented, a "blend wall" may be reached beyond which consumption cannot expand without the marketing of high level blends such as E85 (85 percent ethanol). The use of such high level blends requires more extensive modification to filling stations, and costs for dedicated retail biofuels infrastructure. Thus, economies may need to implement policies to expand networks of E85 filling stations in tandem with growing demand or ethanol production – at a pace sufficient to market all of the biofuel produced or targeted for consumption.

1.0 Introduction

The APEC Biofuels Task Force, established in May 2006 at the direction of APEC Energy Ministers, is developing consensus messages on biofuel economics and trade, fuel-flexible vehicles and infrastructure, and biofuel resources. A central focus for the Task Force effort is the potential for biofuels to cost-effectively displace the use of oil in transport.

The main objective of this project is to develop criteria and best practices for cost-effective expansion of the infrastructure needed to transport and distribute biofuels as biofuels markets expand. With respect to transportation, where the options include fuel products pipelines, road, rail, and ships/barges, a set of criteria needs to be considered before making a valid assessment. These criteria include projected biofuels production, geographic concentration of such production, ability of local markets to absorb the production, the quality of existing transport networks, costs of building transportation infrastructure, including dedicated biofuels pipelines, and the durability of supply and demand at the sending and receiving ends of pipelines.

With respect to distribution, there are also several approaches to be considered. Government-industry partnerships could identify regions where biofuel production is expected to be concentrated. Targeted expansion of biofuel filling stations could help demand and supply to evolve in a systematic, reinforcing fashion. Financial incentives could be provided for construction of biofuel filling stations.

The project report is divided into four chapters to analyse and evaluate current and potential transport and distribution options for biofuels in APEC economies:

- Chapter 1 provides background information on biofuels transportation and distribution.
- Chapter 2 discusses issues related to bioethanol and biodiesel transportation.
- Chapter 3 develops a methodology for analysis of biofuel transportation and distribution.
- Chapter 4 describes metrics for evaluating infrastructure needs.

Statistics and data for APEC member economies are presented in the appendices, covering current production, feedstocks, and potential production or requirements based on mandates.

1.1 Biofuel Transportation Overview

Transportation of biofuels in APEC economies refers to the movement of biofuels from where they are produced to where they are gathered or blended for distribution to local markets.

A methodology for evaluating alternative transportation options for biofuels should consider:

- Current modes of biofuel transportation and their costs;
- Differences in modes and costs of biofuels transportation between APEC economies;
- Restrictions on biofuels transportation in APEC economies; and
- Costs of dedicated biofuels pipelines, as a function of factors such as volume and distance, compared with the costs of transportation by current modes.

At present, biofuels production is typically concentrated in grain or palm growing regions. This means that as markets grow and production expands beyond the absorptive capacity of local or regional markets, biofuels must be transported over greater distances. At early stages of market development when production of biofuels is limited, a large share of the production may be absorbed locally. As production increases, local markets may become saturated, resulting in a higher percentage of the biofuel production being transported over greater distances.

Almost all ethanol and biodiesel is currently transported by truck, rail or barge. But in the future, as production expands, investors may also consider the construction of dedicated long-distance ethanol pipelines. Dedicated biofuels pipelines can provide significant economies of scale, allowing large volumes of ethanol to be transported at far lower costs. Moreover, this is a superior mode of transport from a greenhouse gas (GHG) standpoint. Trucks, ships/barges and rail can take advantage of the huge network of existing vehicular transport infrastructure, which allows enormous flexibility in moving ethanol between a large number of production and distribution points (gas stations). As lignocellulosic technology improves, making new feedstocks such as forest residues and grasses cost-effective for ethanol production, geographic sources of ethanol may shift in ways that are hard to anticipate, giving a more flexible approach a major advantage.

Several pilot, demonstration, and commercial-scale cellulosic ethanol plants have been funded in the United States with the expectation of producing ethanol from a variety of lignocellulosic feedstocks by 2012. However, there are questions looming around timing for commercial sized plants. If the circumstances prove favourable, and production increases dramatically, much larger biofuels volumes could potentially support construction of dedicated pipelines. However, it would be important to build such pipelines in the right places (connecting major production centres with major population centres), on an appropriate scale, with the right timing.

The other key consideration for future biofuels transportation requirements is the role of "drop-in" fuels. These are biofuels that can be shipped in the existing fuel products pipelines, either as neat biofuels or after blending into petroleum fuels. Such "drop-in" fuels include biobutanol, HRDD (Hydrogenated Renewable Diesel) and alkanes/hydrocarbons produced biologically or thermochemically from renewable feedstocks, aiming to replace petroleum-derived gasoline, diesel and jet fuels. Drop-in fuels can be shipped via existing fuel products pipelines in blends or as blended biofuels with relatively minor adjustments needed. This mitigates the transportation infrastructure issues that surround ethanol and biodiesel. However, production costs of "drop-in" biofuels are currently prohibitive, and production is limited. Their potential role in future supply must be considered in assessing the requirements for dedicated biofuels pipelines.

Dedicated biofuel pipelines would be expensive and would pose a higher financial risk to construct than petroleum pipelines. Petroleum fuel products pipelines carry a variety of products and distribute the cost over a variety of products. Dedicated pipelines are constructed based on secure demand. The demand for biofuels must be driven by market forces and mandates to ensure sufficient biofuels demand before dedicated pipelines can be built.

1.2 Biofuel Distribution Overview

Distribution of biofuels in APEC economies refers to the movement of biofuels from storage and blending facilities through fuelling stations to retail markets. A methodology for evaluation of alternative biofuel distribution options should consider:

- Plans and incentives for construction of biofuel filling stations;
- Regions where biofuel production is expected to be concentrated; and
- How to expand the network of biofuel filling stations in tandem with growing supply.

At present, most liquid biofuels are distributed and sold in the form of blends. Typical blends range from 2 to 5 percent for biodiesel (B2 to B5) and from 2 to 15 percent (E2 to E15) for ethanol. B20 blends are not sold at retail pumps in some APEC economies. The storage and blending of biofuels at blending terminals requires dedicated storage tanks with associated piping and metering systems. Biodiesel storage tanks may also need to be heated, depending upon the climate and feedstock used to prepare the biodiesel. Allowable blends are considered to be compatible with existing automobile fuel tanks and existing fuelling stations. However, different economies have different standards as to how much biofuel can be present in the fuel blend without requiring adaptation of the fuel tanks and fuelling stations.

Biofuel distribution requirements can be expected to expand over time as mandates for increased biofuels use become effective in various APEC economies, as the costs of second-generation biofuels from lignocellulosic and algal feedstocks decline with improved technology, and as conventional petroleum-based gasoline and diesel fuel becomes more expensive. As production of biofuels expands, the volumes of ethanol produced may exceed what can readily blended with existing infrastructure. In the United States, a “blend wall” was reached for E10 in 2010 in many areas. The United States Environmental Protection Agency has approved a 15 percent blend (E15) for light duty vehicles of model year 2001 and newer, but legal challenges are pending from vehicle manufacturers, retail distributors and petroleum producers, due to concerns that blends above 10 percent ethanol may cause corrosion unless costly adaptations to pumping stations are made.

Once the “blend wall” is reached, further expansion of ethanol production would require fuelling stations and “flex-fuel” automobiles that are designed to use blends up to 85 percent (E85). A limited number of E85 retail pumps are already present in many APEC economies. Automakers already offer flex-fuel vehicles that run on E85, with only a nominal increase in the vehicle cost. But E85 and biodiesel must be readily available at enough fuelling stations in order for consumers to comfortably choose and use vehicles that run on those fuels. Since the availability of E85 and biodiesel filling stations in most APEC economies is quite limited, and the construction of such filling stations (or conversion of other stations to provide these fuels) is costly, penetration of these fuels may be limited if ways cannot be found to expand such stations in a strategic fashion.

A Survey of Biofuels Resource Assessments,[1] completed for the Biofuels Task Force in 2008, indicates that second-generation biofuels from farm and forest residues could potentially displace about 40 percent of gasoline (petrol) on a sustainable basis once the technology becomes cost-effective. If any economy were to realize production on such a scale, the blend wall would be surpassed. Effective approaches are therefore needed to ensure that E85 filling stations expand to meet market demand in a strategic way as biofuel production from farm and forest residues grows.

[1] http://www.biofuels.apec.org/pdfs/ewg_2008_biomass_resource_assessment.pdf

1.3 Current Biofuel Transportation and Distribution

In North America, ethanol (E100)[2] and biodiesel (B100) are transported via rail or truck to primary storage terminals where they are stored in dedicated B100 or E100 storage tanks. The biofuels are then blended in tanker tucks for retail dustribution, or rail cars for secondary terminal distribution. From there, the biofuel blend is trucked to retail stations. Figure 1.3.1 illustrates the transportation and distribution of biodiesel in Canada; the diagram would be similar for ethanol. The grey arrows represent options that may not be utilized in all cases.

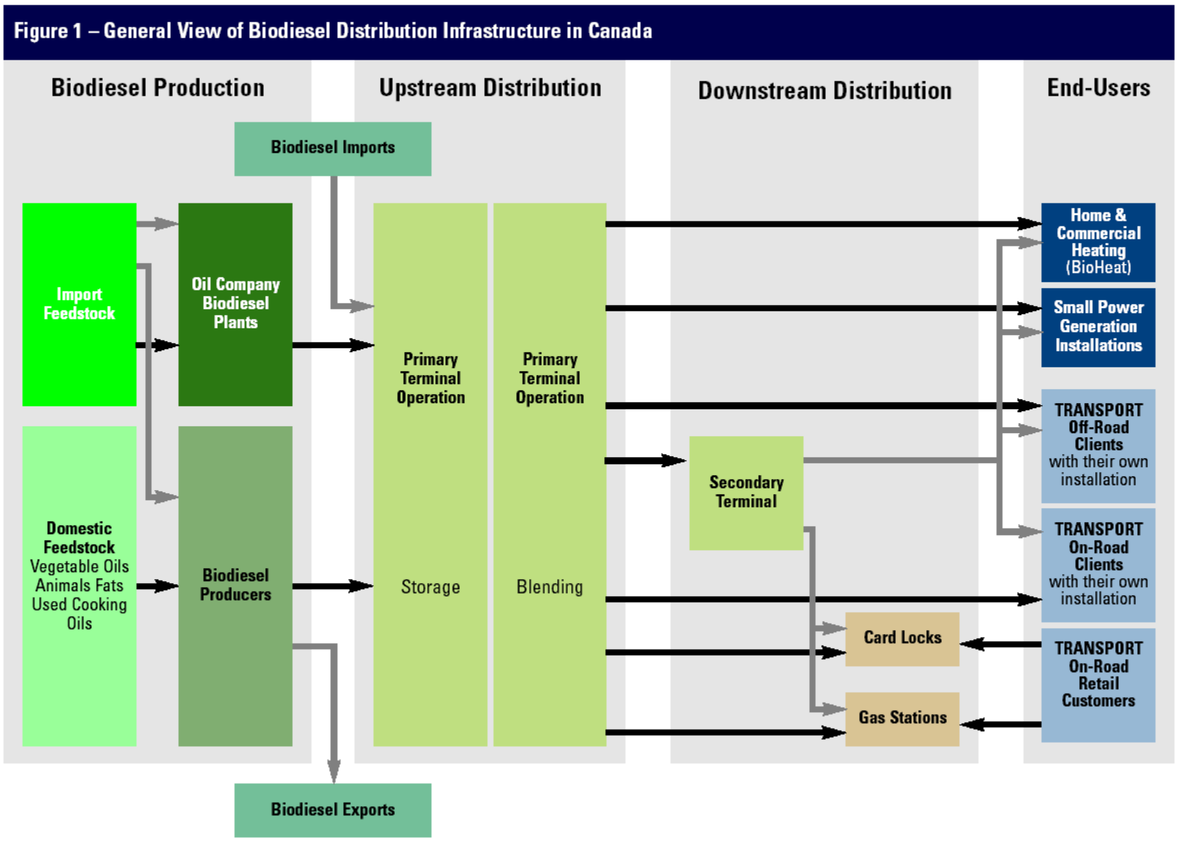

Figure 1.3.1 Biodiesel Transportation and Distribution Infrastructure in Canada[3]

As the diagram suggests, the biodiesel (or ethanol) transportation and distribution network can be divided into four components:

- **Production**: Including feedstock providers;
- **Transportation ("Upstream Distribution")**: Primary terminals (located at refinery or at a remote location) for storage and injection blending;
- **Downstream Distribution**: Secondary or regional terminals for storage and blending (primarily in-line or splash blending) and retail outlets (card locks, gas stations); and
- **End-Users**: On-road (with or without fuelling infrastructure), off-road (rail, marine, on-farm use, and industrial), building heating (home, commercial and industrial) and small power generation.

[2] In many markets, ethanol is denatured with 2 to5% natural gasoline, while in other markets, it may be sold in hydrous form. We will collectively refer to these as E100, even though they might be E95 or E98
[3] http://www.sinenomine.ca/Download/Roadmap%20-%20Final%20Version.pdf

1.3.1 Typical Biofuel Transport Modes

Biodiesel and biodiesel blends are transported primarily by dedicated (or washed) tanker trucks and rail cars. If the truck or railcar was used for diesel shipment in the previous load, no washing is needed, but if another type of petroleum fuel was shipped, the tank must be washed.

Ethanol and ethanol blends are also transported mainly by dedicated (or washed) tanker trucks and rail cars. If the truck or railcar was used for gasoline shipment in a prior load, no washing is needed, but if another type of petroleum fuel was shipped, the tank has to be washed. Ethanol and ethanol blends are generally not transported via pipeline due to some concerns regarding corrosion and contamination which are detailed in the following chapter.

Primary terminals (also called "product terminals") are generally located near major markets and transportation modes. Some terminals are located at refineries, while others are separate tank farms that receive fuel products by pipeline, tanker truck, rail car or marine tanker. Primary terminals are equipped with product delivery and loading racks that vary from one terminal to another. For example, some terminals linked via pipeline will not necessarily have racks that are adapted for other modes of transportation (train or truck).

In regions with ample waterways, petroleum products may be transported to primary terminals by marine tankers. In regions that are essentially land-locked, products are often transported from refineries to terminals by pipeline. For marine shipments of biofuels, there may be additional storage infrastructure required at the marine terminal. From the marine terminal, the biofuel would be delivered by truck or rail, unless a dedicated biofuels pipeline could be justified.

Since primary terminals are designed to provide downstream distribution of finished products, they all have tanker trucks and high-performance fuel injection equipment at the loading rack to prepare fuel blends (i.e., in-line blending).

In larger APEC economies, pipelines are often a key part of the petroleum fuel transportation infrastructure. The petroleum fuels are transported via pipeline to primary or secondary terminals, which then serve as distribution points to nearby retail sites that are supplied by tanker trucks. It is typically at these terminals that biofuels are blended with petroleum fuel for distribution. At present, biofuels are usually transported to the blending terminals by truck, since there are no dedicated biofuel pipelines and the terminals are not generally linked to the railway network.

Rail Cars: Biodiesel (B100) or ethanol (E100) could move by rail from the biofuel production plant to destination terminals (mainly primary terminals or, in some cases, secondary terminals equipped with rail spurs). Rail shipment is generally the most cost-effective delivery method for medium-range and longer-range destinations (i.e., 500 to 5,000 km) that are incapable of receiving product by barge, tanker or pipeline. Rail line coverage and access vary from region to region. Some terminals lack rail receipt capability, requiring biodiesel (B100) and ethanol (E100) to be transported by truck. Rail delivery might also prove infeasible in colder climates, unless the rail cars are heated and a heating system is in place at the destination terminal.

Because of the number of railcar units, the smaller volume of biofuel shipped per unit, and the laborious process of cargo unloading and inspection, rail shipments require more effort compared with ocean tankers, for example. The transportation of biodiesel and ethanol via train also requires more complex logistics (availability of heated or dedicated rail cars, delays due to cleaning rail cars in the case of non-dedicated rail cars or heating rail cars at the terminal, etc.). In some cases, installing heating systems or rail spurs adds to the terminal adaptation costs.

Marine Tankers: Large volumes of B100 or E100 may be shipped via tankers to longer range marine destinations. For the same reasons as for rail or truck shipments, the equipment used must be dedicated (or previously cleaned) and adequately heated. The cost of moving biodiesel and ethanol by marine tanker can be lower than that for rail transport, depending on the distance. Marine cargoes provide a significant benefit for the destination terminal, due to simplified logistics for a single shipment of large quantities, as opposed to the more time consuming task of spotting, inspecting, and unloading numerous rail cars, accompanied by product quality testing for each car. This also reduces strain on the biodiesel producers' rail car fleets.

Tanker Trucks: In many cases, a tanker truck delivers B100 or E100 directly from the production plant to nearby terminals. In distant markets, tanker trucks may also pick up biofuel blends at primary terminals (that have received biodiesel or ethanol by tanker or rail), for delivery to secondary terminals that either cannot take product other than by truck or that have insufficient tankage for larger quantity deliveries. The redistribution of biofuel blends to retail outlets and end-users is also made by trucks.

1.3.2 Operational and Logistical Aspects of Biofuel Transport

Dedicated Equipment: Preferably, transport of B100 or E100 should use dedicated equipment, whether it's rail car, truck, barge or compartment. In cases where this is not possible, equipment should be cleaned or washed (providing a Wash Certificate) each time prior to use.

Shipping and Operating Costs: Biodiesel (B100) or ethanol (E100) has been up to now priced on a destination market basis (local or regional rack price + premium) or FOB at the producer's plant. For that reason, the cost of the shipment is usually paid by the biodiesel or ethanol marketers. Even if the shipping logistics are managed by biodiesel and ethanol producers or marketers, they will try to utilize the lowest cost shipping method available within the confines of shipping capabilities and customer preferences.

1.3.3 Typical Blending and Distribution Practices

Ethanol is usually "splash blended" into tanker trucks or rail cars that already contain gasoline. The ethanol blended with the gasoline mixes readily and does not stratify. Biodiesel is also generally splash blended or blended in tanks near the point of use in most APEC economies. In the European Union (EU), blending is primarily done "in line" at refineries. The "splash blending" of biodiesel may result in some shock crystallization, depending on the temperature during blending or the means by which the splash blend is administered. In-line blending provides contact between the diesel and the biodiesel and mitigates this risk.

At primary terminals for ethanol blending, E100 is injection or splash blended into trucks (or rail cars) before being taken to secondary terminals or to retail. Similarly, at primary terminals for biodiesel blending, the B100 is blended with the diesel by injection (or in some cases splash blending) before being distributed in its blended form (B5 - B20) to secondary terminals or retail outlets (service stations, card locks, users with their own storage facilities). At this stage, the modes of shipment used no longer have to be insulated and heated. Similarly, at secondary terminals, storing fuels blended with biofuels does not require specific handling in cold weather.

In some APEC economies, storage terminals already have tanks, in-line blending systems for preparing blends at the rack, and equipment that can be reassigned for biodiesel or ethanol. However, in some cases, the seals must be adapted due to materials incompatibility.

Existing petroleum distribution terminals usually do not have rail access, creating a distribution infrastructure challenge for biofuels. Petroleum distribution facilities were generally designed for pipeline distribution of petroleum fuel products. In remote or smaller petroleum distribution terminals, product receipts were designed around truck receipt and delivery. In most cases, therefore, distribution of E100 or B100 or blended biofuel product by rail is usually impractical.

From secondary terminals (or depots), blended biofuel product is moved mainly by tanker truck to retail outlets (fuelling stations – petrol and gasoline stations) with direct delivery to end-users. Delivery distance, costs and carbon footprint of distribution may be greater for biofuel blends than for purely petroleum-based fuels due tho the concentration of biofuel feedstocks and refineries in agricultural regions which are remote from many key urban population centers.

1.4 Biofuel Transportation and Distribution Options

There are several basic modes of transportation that could be used to move biodiesel (B100), biodiesel blends, ethanol (E100) or ethanol blends to destination markets. These include truck, rail, barge, tanker, and pipeline, and in some cases, a combination of two or more modes. In addition, as the market expands, product exchanges and marketing agreements will be used to minimize unnecessary ethanol and biodiesel transportation and associated costs. The preferred least-cost transportation mode depends on the distance between the production plant and the primary terminals, the volumes transported, the infrastructure and storage capacity at the destination terminal, and other operational factors. However, as a general rule, larger quantities are generally moved by the mode that requires the least number of individual movements.

Depending on the transportation mode utilized, it may also be necessary to make terminal modifications to accommodate receipt of the biofuel product (e.g. rail spur, tanker truck unloading). In this scenario, the route taken by biodiesel (B100) or ethanol (E100) from the production plant to the primary terminals can potentially be carried out by all modes of transportation available in the industry (truck, ship, rail car, and in some cases, pipeline), as long as the equipment used is dedicated (or washed). For ethanol, a vapour recovery system at the receiving terminal is also needed, while for biodiesel, heated railcars or heated trucks and heated storage tanks are needed for winter shipments in cold climates.

If the B100 or E100 must be transported between a primary terminal located near a refinery and a secondary terminal, the same modes of transportation and conditions will apply, although it is unlikely that a dedicated biofuels pipeline would be used or built for that purpose. Storage tanks at primary terminals must be large enough to meet anticipated product demand and to receive the minimum delivery size while still having an adequate working inventory.

2.0 Biofuels Transportation and Distribution Considerations

Biofuels transportation and distribution are now fairly similar in many APEC economies. But going forward, considerations will differ depending upon mandates, anticipated capacity and other factors affecting development of the biofuels markets in different economies. The mandates and policies of each economy will determine the biofuel volumes required. Biofuel production capacity, the geographic distribution of that production capacity, and the location of demand centers relative to production centers will in turn affect the amounts of infrastructure needed to supply those volumes.

The transportation of pure biofuels and distribution of blended biofuels will differ between APEC economies. Some may utilize marine infrastructure, including offloading and storage facilities and associated piping systems on rivers and seacoasts. In other economies, truck or rail infrastructure will suffice. Economies with very high biofuel production or utilization may consider pipelines.

The cost of shipping feedstocks greater than 100 miles (160 kilometers) is generally prohibitive. In the case of advanced biofuel feedstocks such as biomass for cellulosic ethanol, even with densification technologies, the transportation costs become prohibitive beyond 100 miles. Thus, the location of future cellulosic ethanol plants is likely to be dictated by proximity to feedstock as opposed to proximity to market, similar to the current situation with first generation biofuels. This also implies that most feedstocks will be delivered by truck, and that most biofuel production facilities will be located in rural areas close to feedstock, rather than close to urban fuel markets.

Transportation factors to consider as biofuel production continues to expand include:

- The capacity of the transportation system to move biofuel, feedstock, and co-products produced from biofuel, especially over long distances to fuel markets.
- The availability of feedstock close to biofuel plants (within 100 miles or 160 km).
- The proximity of feedstocks and biorefineries to co-product markets.
- Uncertainty about the size and location of biofuel demand from terminals which consolidate, trans load, and distribute biofuels for blending. Government policies towards biofuels may decrease this uncertainty.

The lack of excess transportation capacity reduces flexibility in case of sudden changes in transportation demand and distribution patterns. Changes in these patterns brought on by rapidly increasing biofuel production could impact the logistics of rail networks, highway congestion, and marine logistics. These may in some APEC economies necessitate the need for other options such as dedicated biofuels pipelines.

The key point in looking at strains on the transportation systems is that all modes of transportation and existing infrastructure and all impacts on potential constraints on the transportation system must be considered. For first and second generation biofuels alike, the truck or rail shipments of feedstock to the biofuel production facility, the transportation of the biofuel produced, and shipment of co-products all impact the required transportation infrastructure.

2.1 Ethanol Transportation and Distribution

Ethanol Transportation

There are currently limitations on the number of railcars available for use and constraints on rail system logistics in many APEC economies. Where ethanol production is highly concentrated in a feedstock-rich region far from urban markets, expanded production might best be transported by expanded rail or pipeline infrastructure. While E100 may also be transported by truck, this is more costly than rail or pipeline over long distances if sufficiently large volumes must be transported. The larger volumes might come from expanded use of conventional feedstocks, from second-generation use of agricultural residues, or from second-generation use of forest residues. Some details of cost as a function of distance and volume are discussed later in this report.

Ethanol Retail Distribution

Substantial expansion of biofuels production would likely require expansion or modification of the retail distribution network for biofuels. An example is currently observed in the United States, as it seeks to certify use of E15. Ethanol is claimed to contribute to corrosion of vehicle fuel pumps and fuel lines, and seals/gaskets in older model vehicles and small engines may not be compatible with oxygenated fuels. Consequently, E15 is not yet fully certified by automakers, and fuel retailers are evaluating costs associated with pump and tank conversion, and potential issues with "mis-fueling". The U.S. Environmental Protection Agency has approved E15 blends in 2001 and later model year vehicles, but this decision is facing legal challenges. Fuel station and convenience store operators do not want to be faced with the liability issues if a customer fills a 1999 model year auto with E15, and the cost to deploy separate E15 pumps/tanks, E10 pumps/tanks, and other pumps/tanks for other grades of fuel is prohibitive. This has created a push for blender pumps that allow the consumer to customize the blend according to their wishes or model/year of vehicle. This might also involve the design of different fuel nozzles and receptacles on vehicles, similar to the leaded/unleaded fuel distribution strategy used in the 1970s.

2.2 Biodiesel Transportation and Distribution

Biodiesel Transportation

In many places, rail transportation of biodiesel is limited by the number of railcars available, by rail system logistics, and by the need for heated railcars in colder climates. Most biodiesel production is thus marketed locally and transported by truck. Production of biodiesel will likely continue to be concentrated in agricultural regions where feedstocks are grown. In certain APEC economies, there may eventually be sufficient biodiesel production from palm oil, jatropha or other feedstocks to warrant expansion of railway networks or construction of a dedicated biodiesel pipeline. But many of these economies also have ready access to marine transportation that could also be a logistically and economically viable method for exporting or importing biofuels.

Biodiesel Retail Distribution

Biodiesel blends are typically trucked to local fuelling stations, where they are dispensed by regular diesel pumps. However, if distances between blending terminals and fuelling stations are great, distribution by truck is more costly and emits more carbon than distribution by rail or pipeline.

2.3 Biofuel Transportation as it Relates to Biofuel Production Location

In general, biofuels production facilities are located in close proximity to the feedstock. When determining potential feasibility of a biofuels production facility, feedstock within a 100 mile (160 kilometer) radius is considered, taking into consideration factors such as "disappearance" and "carry over." In this context, "disappearance" is a measure of feedstock use (e.g., canola or rapeseed for biodiesel production or corn for ethanol production), and "carry over" is the amount of the crop or feedstock from the previous year that remains at the start of the new crop year.

Although feedstock access is generally the driving force in biofuels production facility location, proximity to rail and transportation infrastructure to access markets is also a critical factor. In the unusual case where a significant portion of the feedstock is imported, access to waterways may be a driving force. A critical issue relative to transportation infrastructure is that the location of biofuels production facilities is generally not determined by proximity to fuel market or blending facilities. However, some countries in the EU, such as Germany, have some production facilities located close to petroleum refineries. The fact that biofuels production facilities are often not located close to blending facilities creates particular logistical and infrastructure challenges.

In the future, as cellulosic biofuels are developed, producers may face transportation infrastructure challenges for both feedstock and biofuel product. The cost to transport biomass rises sharply with distance, and is also much higher for agricultural residues compared to forest residues, due to the very low free fall bulk density of agricultural residues. These factors limit both the size and location of the biofuels facility. Although densification strategies have been proposed to facilitate longer-distance transportation of agricultural residues, these densification strategies also render the resulting feedstock much more difficult to process via conventional biological methods. Consequently, densification may only prove useful for thermochemical production of biofuels. Facilities that use biochemical technologies are much more likely to be located closer to feedstock, with a greater need for product transportation infrastructure. However, if dedicated pipelines are built, some cellulosic ethanol plants may locate closer to the ethanol pipelines, because this would simplify the downstream product distribution.

2.3.1 Transportation Implications of Biofuels Location

As biofuel production increases, so should demand for all modes of biofuel transportation. Using the corn ethanol case in the United States as an example, the contribution of different transportation modalities to domestic and export market deliveries is apparent. In 2005, rail carried 60 percent of United States ethanol produced, trucks 30 percent and barges 10 percent. Even without further expansion of ethanol markets, the U.S. Department of Transportation has projected nearly a doubling of rail freight by 2035 and of truck freight by 2020. Significant driver shortages are anticipated by 2015.[4] Expanded ethanol markets would lead to even greater transport demands.

As an example of alternative means to address both truck congestion and environmental impacts, an example of one option is shown in the following news release.

[4] U. S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, 2006.

> In June, 2011, American Feeder Lines will begin weekly calls at the three ports in Halifax, Nova Scotia with a chartered vessel and it has plans to build 10 environmentally friendly container ships to maintain the service in the coming years. *The fact that Canadian and United States authorities are involved in a serious effort to get trucks off highways for environmental reasons should help bolster the viability of the new container-ship shuttle service. "The U.S government wants to get trucks off I-95 and this service will offer a more environmentally friendly alternative" Oldfield said.* A modern container feeder vessel with a capacity for 1,000 to 1,300 standard-sized containers will be used to start the service. *"One of these new-generation green vessels, using gas and biodiesel, can save the equivalent of 24 million gallons of diesel per year when compared with traditional trucking", American Feeder said.*[5]

Lack of excess capacity limits flexibility to respond to major changes in transportation and distribution patterns. Changes brought on by rapidly increasing biofuel production could therefore slow down rail, highway and barge traffic. Issues that may arise as production grows include:

- Uncertainty about the location of and demand from terminal markets that consolidate, trans load, and distribute biofuels for blending.
- Shifts in transportation demand for biofuels feedstocks, biofuels and biofuels co-products among rail, truck, and barge, in the context of future ethanol production locations.
- Adequacy of transportation infrastructure to efficiently ship biofuels and biofuel co-products.

Much of the additional biofuel feedstock will likely be trucked to biofuel production facilities as it is today. If truck or rail transportation becomes constrained due to increased volumes of second-generation feedstocks, it may lead to a shift in transportation modes. Transportation shifts for feedstocks would then continue until commodity markets adjust to increased demand.

2.3.2 Supply Chain Issues with Biofuel Location

Several supply chain issues could inhibit growth in the ethanol industry. The efficiency of the ethanol transportation system may be limited by the ability of the blending market to accommodate additional quantities of ethanol.

Issues for Particular Transport Modes

Rail Capacity: Rail capacity typically depends on several factors, including locomotive power and railcar availability and utilization, which are affected by train speeds, dwell time, loading and unloading times, and track capacity. In addition to an efficient logistics infrastructure, an adequate supply of railcars and other transportation equipment for ethanol and DDGS are needed to sustain growth in the ethanol industry.

[5] http://thechronicleherald.ca/Business/1240455.html

Ethanol Rail Tank Cars: Ethanol is shipped in standard rail tank cars (approved for flammable liquids)—DOT 111A or AAR T108 rail cars. As of January 1, 2007, 41,000 rail tank cars capable of shipping ethanol were in use in the United States. Orders for new cars increased substantially in 2006 with a surge in ethanol plant construction, and are expected to almost double this fleet in the next 2–2½ years. Rail tank cars in the United States are nearly all privately owned, either by leasing companies or shippers. The U.S. Environmental Protection Agency's Draft Regulatory Impact Assessment projects that an additional 26,600 rail cars would be needed to handle an additional 20.9 billion gallons (79.1 billion liters) per year of biofuel under the 2007 biofuels mandate. This implies that a rail car is required for every 800,000 U.S. gallons (3.0 million liters) of biofuel production, although strictly speaking, rail tankers are only needed to service regional and national markets more than about 450 miles (700 kilometers) from the production facility.

Barges: The role of barges for biofuels transport within an economy is typically small. In the United States, for example, barges move an estimated 10 percent of the ethanol produced. Ethanol is typically shipped in tanks barges with a capacity of 10,000 to 15,000 barrels (1 barrel = 159 liters). Few ethanol plants are located on rivers, but those that are could generate value-added co-products and platform chemicals for broader distribution. Barge transportation could also play a more significant role in APEC economies with a high percentage of coastline, allowing biofuel and co-products to be moved from one coastal production area to another.

Co-Product Transportation Issues

Ethanol plants that use corn and other grains as feedstock produce a co-product called distillers grains (DDGS dried distillers grains with solubles, WDG-wet distillers grains, and MDG-modified distillers grains). For every 56-pound bushel of corn, 17.5 pounds of DDGS and 2.76 gallons of ethanol are produced, on average. Slightly different yields of DDGS are produced from other grains. Dairy cattle operations and cattle feedlots are the primary domestic users of distilled grains as a protein supplement for the ruminant animals. Research is ongoing for increasing the DDGS use by poultry and hog operations, which currently is limited due to nutritional challenges DDGS present to non-ruminant animals. DDGS are initially marketed locally, and delivered by truck. However, as production grows, access to wider markets may rely on rail or marine transport. Facilities using grain may also choose to adopt fractionation technologies to extract fibre, protein, starch or sweeteners as co-products. These food-grade co-products would also require transportation infrastructure to deliver these products to market.

Advanced biofuels such as cellulosic ethanol may have other co-products that also require transport to markets. For example, lignocellulosic feedstocks could produce lignin residues that could be used on site or densified and shipped to facilities for energy generation. These co-products could be destined for a variety of Asia Pacific markets, requiring marine terminals and transport infrastructure. These facilities might also generate a number of high-value platform chemicals (e.g., succinic acid, levulinic acid, polyols) as co-products. Although the overall volumes are likely to be low, market distribution will likely involve trade across economies, with specific transportation infrastructure needed to facilitate market access.

Ultimately, the transportation infrastructure must be able to move both the primary biofuel product and any associated co-products. The current infrastructure of each APEC economy and the capacity to absorb additional traffic as biofuels expands will need to be analyzed internally within each APEC economy.

Summary of Locational Issues

Transportation factors to consider as biofuel production expands include:

- The capacity of the transportation system to move ethanol, feedstock, and co-products.
- The availability of feedstock close to ethanol refineries (50 miles or 80 kilometers).
- The proximity of refined Biofuels and co-products to retail markets.

Proximity to feedstock, biofuel markets and co-product markets will be key to facility economics, and the transportation infrastructure is critical to ensure access to feedstock and markets. As production grows, the transportation infrastructure needs to be developed to move products over greater distances, both within and across economies. Truck deliveries may be sufficient when production levels of biofuel and co-products are low, but rail, barge, and pipeline transport will grow in prominence as production grows and more distant markets need to be accessed.

2.4 Considerations for Ethanol Pipeline Transportation in APEC economies

Some ethanol producers are evaluating the feasibility of dedicated pipelines. Biofuel transport currently relies upon traditional transport modes such as railway and tanker truck. Options to improve biofuel transport have been limited, and constraints on transport infrastructure can limit the ability to meet biofuel production targets in APEC economies. A dedicated biofuels pipeline could address these limitations by providing a viable alternative to existing transportation methods, in cases where the volumes and demand justify the economics.

A key consideration is whether a new dedicated pipeline should be built, and if built, where it should be located. The other key question is whether long-term prices and demand would be able to support the building of a vast trans-national pipeline. In the United States, even the Renewable Fuels Association (RFA)[6] has stated that it is not certain that a dedicated ethanol pipeline would provide the same transport security as the more traditional barges, rail cars, and trucks.

The Association for Oil Pipelines (AOPL) is conducting a study to determine the feasibility of transporting gasoline blends containing up to 20 percent ethanol. The trade group is also considering whether such blends could utilize existing oil pipelines. It is their hope that this study will conclude that such blends can be transported safely through existing pipelines, and that doing so will help relieve the current bottlenecking dilemma of ethanol travel.[7]

Obstacles to Ethanol Pipeline Shipments

There are two types of challenges involved in moving ethanol through a pipeline:

1. Challenges due to the corrosive nature of ethanol.
2. Challenges due to incompatibility with other products and substances within the pipeline.

[6] http://www.ethanolrfa.org/
[7] http://www.alternative-energy-news.info/ethanol-pipeline-proposed/

The obvious challenge is that ethanol behaves so much differently than the refined petroleum products that are typically moved through pipelines. More work is needed to find ways to overcome ethanol's effects on the pipe, the valves and the pipeline systems themselves.

Ethanol Solvency Issues: Ethanol's solvent properties pose additional challenges. Over years of use, small quantities of residual sulfur and dirt from petroleum products can build up in existing pipeline systems. Although these are not soluble in petroleum products, they can be in ethanol, which can lead to discoloration and product contamination. Ethanol (and biodiesel) can strip lacquers and deposits from internal pipeline surfaces and carry them as impurities. A dedicated ethanol pipeline would not encounter these issues, because these contaminants/deposits only arise from prior transport of petroleum products.

Materials Compatibility: Compatibility and corrosion issues can arise because of the way ethanol reacts with some materials in the pipeline and associated equipment. Ethanol and biodiesel can also degrade materials used in gaskets, o-rings, and seals used in fuels transportation and storage systems. Elastomers can experience swelling, shrinking and cracking when exposed to ethanol or biodiesel. Polymers used for coatings may be degraded by certain biofuels as well. Corrosion of certain non-ferrous metals used in gauges, meters, valves, and pumps may occur. Any part of the supply system that will be converted to biofuels service needs to be assessed for materials compatibility and refitted with more resistant materials where required.

Stress Corrosion Cracking: Another challenge experienced in ethanol transportation by pipeline is Stress Corrosion Cracking (SCC) associated with ethanol movement and storage in pipelines and storage tanks. Stress corrosion cracking (SCC) can be defined as the slow growth of cracks along the inside of the pipeline, which are caused by mechanical stress and exposure to a corrosive environment. Research, largely funded by pipeline companies, has made great strides in addressing this problem. Industry/government research by Pipeline Research Council International, Inc. (PRCI)[8] has found that ethanol-gasoline blends containing up to 15 percent ethanol by volume (E-15 and below) can be transported in existing pipelines without any design or operational modifications. PRCI also found that higher ethanol-containing blends (E-20 and above) and fuel-grade ethanol can be transported without SCC when certain commercial inhibitors are added. The efficacy of commercial inhibitors to mitigate SCC must be assessed prior to their use.

Water and Biofuels Fuel Quality: Small amounts of water enter pipeline systems from petroleum fuels, terminals and tank roofs. This is generally not a problem during pipeline transportation of refined petroleum products, because the water can separate in a tank and can be drained off. Unlike petroleum products, ethanol has an affinity for water as it flows through the pipeline network. The water-ethanol mixture has the potential to separate from petroleum products with which it may be mixed, resulting in degraded fuel quality. This can be managed by taking steps to cover tanks and remove excess water at certain points in the supply and distribution system.

Possible Solutions to Pipeline Corrosion: In an effort to overcome the problems associated with traditional steel piping, the All Fuels & Energy Company plans to build a new resin-based multiproduct pipeline. The pipeline system would extend through the U.S. Midwest

[8] http://www.prci.org/

and later to the East Coast. The polymer used to make the pipe will weld (or bond) with the fiberglass. This is called a chemical weld because it can bond to form what's referred to as a fiberglass reinforced pipe. The cost of the resin-based pipeline is expected to be comparable to the cost of steel piping, although this may be influenced by commodity price fluctuations.

Use of Existing Fuel Products Pipelines for Biofuels Shipments

Ethanol cannot easily be shipped via fuel products pipeline because it is a good solvent and would remove sulphur and other impurities from the pipeline system, resulting in contamination of the shipped ethanol. Biodiesel is also a good solvent and could remove sulphur and other impurities from the pipeline system, resulting in contamination of the shipped biodiesel.

In addition, there is concern regarding traces of biodiesel left over in the pipeline system. There is a possibility that trace methyl ester (biodiesel) could disarm the coalescers in aircraft fuel and potentially compromise the safety of the aircraft. There is thus a proposal to limit the methyl ester content in the pipeline system in the United States to 5 PPM as a result of this concern. This is viewed by some as unduly restrictive as there are ways to buffer fuel products pipeline shipments to mitigate this risk. Nevertheless, this is the current situation regarding shipment of biodiesel via pipeline. This is discussed in more detail in Section 2.5.1.

In the United States, there have been a few short E100 pipeline transfers, and there are currently some proposed ethanol pipeline projects under discussion. To date, there is only one case of a company shipping ethanol (E100) through a fuel products pipeline in the United States. Others are in the process of evaluating the risks and costs of moving forward with large projects. The Kinder Morgan terminal in Orlando was the first fuel products pipeline in the United States to provide commercial ethanol deliveries. The 104 mile Central Florida pipeline, which has been in operation since December 2008, is the only pipeline currently moving commercial ethanol batches to major United States markets. Regular batches of E100 are shipped on a 104-mile, 16-inch line and delivered between gasoline batches. E100 batches range from 30,000 to 65,000 barrels. This implies that 100 percent of the greater Orlando demand for ethanol can be supplied by pipeline. Kinder Morgan invested approximately $10 million to modify the line for ethanol shipments, which involved chemically cleaning the pipeline, replacing pipeline equipment that was incompatible with ethanol and expanding storage capacity at its Orlando terminal to handle ethanol shipments. The key point is that the fuel products pipeline was a gasoline pipeline prior to shipping E100 and the distance was short. Both of these contributed to the ease of transition to E100 shipments. Kinder Morgan has developed a process to clean existing pipelines for ethanol use and a system for maintaining a water free environment. The United States Department of Transportation (DOT), which is in charge of safety regulations for hazardous liquid pipelines, is also getting involved with ethanol pipeline projects, including Kinder Morgan's Central Florida Pipeline.

Key Considerations for Utilizing Existing Pipelines for Ethanol Shipment

Pipeline age, prior use (including prior product history), pipeline topography, length of the pipeline and the number of product offloading destinations are all key considerations in assessing the suitability of an existing pipeline for use to ship ethanol (E100).

Water is a key issue in shipping ethanol. Trace water that may be in the pipeline from shipping petroleum products may be in small enough quantities as to not degrade the quality of the petroleum products being shipped. However, ethanol is hygroscopic and has the ability to dissolve these minor amounts of water in the pipeline. If the water content in the pipeline is not minimized, it can have an adverse impact on the ethanol being shipped. This is why Kinder Morgan developed a system for maintaining a water free environment, in order to utilize an existing pipeline. Kinder Morgan also developed a process to clean existing pipelines, and developed/identified additives that address SCC.

The degree to which this technical and operating information will be available to other pipeline companies is unknown; this may be a proprietary “additive package” for Kinder Morgan. Thus, the costs of this additive package are currently unknown and difficult to quantify.

The age and prior service of the pipeline must be used to assess materials compatibility issues with respect to ethanol and a cost to replace impacted valve seats, etc. The age and service of the pipeline will also factor into the risk of SCC associated with ethanol shipment.
There is a significant cost to clean the pipeline and also increased maintenance and testing costs.

Extensive lab testing needs to be conducted to identify measures that would need to be made to prevent the ethanol from damaging its pipe’s steel. It is also recommended that all non-steel parts of the pipeline be documented and included in the lab testing to assure its compatibility with ethanol. Incompatible parts that may need to be replaced include seals, gaskets and possibly other components.

Small amounts of free water can be properly managed when shipping ethanol (E100) by fuel products pipeline. However, ethanol blends transported by pipeline are very sensitive to water, more so than E100. If ethanol blends encounter free water in sufficient quantities in the pipeline, it can result in phase separation after downstream blending, which is a significant quality issue.

Construction of Dedicated Ethanol Pipelines

Magellan Midstream Partners announced that it has signed a joint development agreement with POET to assess the feasibility of constructing a dedicated ethanol pipeline in the United States. The proposed ethanol pipeline system would deliver E100 from the Midwest to distribution terminals in the Northeast United States. There are no plans for pipeline shipment of E10 blends at this time. The proposed common carrier pipeline system would gather ethanol from production facilities in Iowa, South Dakota, Minnesota, Illinois, Indiana and Ohio to serve terminals in major north-eastern markets. The project, preliminarily estimated to cost in excess of $3.5 billion, would span approximately 1,700 miles (2,700 kilometers) and would take several years to complete.

Although there are many hurdles to overcome to make this ethanol pipeline project a reality, Magellan and POET are optimistic that a pipeline to deliver ethanol from the Midwest to distribution terminals in the north-eastern United States would be viable and successful. A positive assessment will allow one or both partners to enter into a subsequent agreement to construct a dedicated ethanol pipeline.

The feasibility of this project is dependent upon the successful outcome of ongoing studies addressing technical and economic issues associated with the transportation of ethanol via pipeline. In addition, both parties have indicated that federal legislation revising the U.S.

Department of Energy's loan guarantee program is critical for a project of this nature to move forward. Magellan and Buckeye Partners, L.P. originally announced their intent to jointly study the feasibility of a large-scale renewable pipeline project in February 2008. Although Buckeye continues to believe pipelines are the most effective way to transport large volumes of liquid fuels, they recently decided to focus on other priorities and have discontinued their role in this project. The following press statements indicate the key role that the government is expected to play in the development of a dedicated biofuels pipeline:

> Washington, D.C. - United States Senators Tom Harkin (D-IA), John Thune (R-SD) and Tim Johnson (D-SD) today introduced legislation that authorizes loan guarantees for the construction of renewable fuel pipeline projects.[9] The bill's key provision is an 80% government loan guarantee. Without it, says Magellan CEO Don Wellendorf, there won't be a pipeline: "We're not willing to spend the kind of money it would take on a project that's viable only as long as the government continues its interest in ethanol." [10]
>
> "There is a bill sponsored by United States Senators to provide loan guarantees for the construction of renewable fuel pipeline projects."[11] These pipelines are expected to reduce energy costs across the country as well as create an estimated 25 jobs for every $1 million of construction. [12] Access to ethanol-dedicated pipelines will benefit both consumers and the ethanol industry for years to come. Many experts believe that a pipeline network to transport biofuels is necessary to achieve the aggressive renewable fuel requirements, which would be more difficult to achieve given limited transportation options of truck, rail and barge. Pipelines are necessary to get this fuel moving to where the people are. These loan guarantees will spur pipeline development and help create new jobs and lower the GHG footprint of biofuel use. The importance of a pipeline is not just the lower costs of transportation. Pipelines have 30 percent less GHG emissions than rail cars and 87 percent less than trucks.[13]

Even so, financial incentives may be needed to support these projects. Additional factors to be assessed include but are not limited to; existing or potential barriers to construction, market risks, risk mitigation options, financial incentives that may be needed and technical issues that may need to be overcome.

Magellan has been working with the Association of Oil Pipe Lines for several years on ethanol pipeline transport, particularly aiming to address the Stress Corrosion Cracking issues noted above. Magellan thinks the solution will be a combination of potential additives to help protect the pipe and the use of different welding techniques. POET is taking the lead on market analysis for the project, while Magellan is addressing technical issues. The two companies are working together on legislative challenges. They hope for a decision on whether to move forward by early 2011.

---

[9] http://www.midwestagnet.com/Global/story.asp?S=10127494&nav=menu1585_4

[10] http://sugarcaneblog.com/2010/03/12/fortune-building-the-worlds-longest-ethanol-pipeline/

[11] http://domesticfuel.com/2009/04/06/midwest-senators-sponsor-biofuels-pipeline-bill/
[12] ibid
[13] ibid

The United States Department of Energy (DOE) released a study showing that "in spite of the documented challenges and risks, a profitable, dedicated ethanol pipeline is feasible under certain scenarios," something that bolsters a plan by Midwest corn ethanol producers. To be competitive, the pipeline would need "adequate demand," said the agency, citing 4.1 billion gallons per year (15.5 billion liters per year) of demand for the hypothetical pipeline. DOE said higher levels of ethanol blending with gasoline, above the current 10% ethanol blend for First Generation vehicles, would be needed to make the line economic "and/or greatly expanded use of E85. In all cases, government financial incentives would likely be needed given current capital market constraints and the dependence on legislation to sustain support for ethanol demand," said the DOE.[14]

While the Midwest and Plains states in the center of North America produce the majority of the biofuels in the United States, the economy currently lacks the optimal infrastructure to efficiently transport these liquid fuels to population centres on the East Coast and elsewhere. Legislative proposals such as those noted above would address this issue by encouraging the construction and use of pipelines which can easily transport these fuels.[15]

Dedicated ethanol pipelines are also under development in non-APEC Brazil, which pioneered ethanol development. Petrobras and Brazilian construction firm Camargo Correa are partners in an 850 kilometer (528 mile) ethanol pipeline project that will connect Ribeirao Preto, Brazil's main cane producing area, to Paulinia, an important fuel distribution and refining hub. The pipeline will then be expanded northward through some states in the center-west such as Goias, where several cane mills have recently been built. The second phase of the project is expected to be complete by 2014, and will also involve ethanol producers Cosan, sugar and ethanol trading group Copersucar, construction firm Odebrecht and about 80 other mills under the pipeline venture Uniduto (now Logum). Investments in the entire pipeline project, whose capacity should reach 21 billion liters per year, are estimated to surpass 6 billion reais ($3.6 billion). The project aims to address chronic infrastructure problems that have undermined Brazil's competitiveness in ethanol export markets.[16,17] The project is also expected to reduce ethanol transportation costs by 20 to 50 percent compared to truck transport, which is currently the dominant mode of ethanol transport in Brazil.

The United States has put in place measures to facilitate ethanol pipeline development which might be considered by other APEC economies with large potential resources. The DOE Loan Guarantee program aims to help finance ethanol pipeline projects by providing financial surety to back up anticipated market demand. The Economic Stabilization Act of 2008 revamped the tax code that had blocked publicly traded partnerships (PTPs) from claiming income generated from the storage and transportation of biofuels as qualifying income. PTPs can now earn qualifying income from handling any liquid fuel approved by the U.S. Environmental Protection Agency (EPA).

2.5 Considerations for Biodiesel Transportation in APEC economies

There have been small distance pipeline shipments of low level biodiesel blends in the APEC economies, and broader discussion about pipeline shipments of low level biodiesel blends in general. However, there are no concrete plans for pipeline shipment of B100 so far.

[14] http://www1.eere.energy.gov/biomass/pdfs/report_to_congress_ethanol_pipeline.pdf
[15] http://www.midwestagnet.com/Global/story.asp?S=10127494&nav=menu1585_4
[16] http://uk.reuters.com/article/2010/11/22/ethanol-petrobras-idUKN2227513520101122
[17] http://af.reuters.com/articlePrint?articleId=AFN0114014220110301

Where biodiesel blends are being moved in existing pipelines, these are pipelines that do not carry jet fuel and where distances are short and pipeline movements are controlled by the pipeline company. Two such examples in the United States include B2 on the Portland-to-Eugene Pipeline and B5 on the Plantation Pipeline. The Portland-to-Eugene Pipeline in Oregon is 114 miles long and all ULSD shipments on this line are at a 2 percent blend, serving the greater Eugene market. The Plantation Pipeline in Florida includes regular shipments of B5 to markets up to 500 miles from the origin at Collins, Mississippi.

In the fall of 2008, Kinder Morgan Energy Partners successfully tested a plan to move a biodiesel blend through the Plantation Pipeline system, which runs through northern Georgia on its way from Louisiana to Virginia. It was hoped that the Plantation Pipeline project would help meet demand for biodiesel blends across the Southeast. But the Plantation Pipeline project will not solve the problem of biodiesel contaminating other types of fuel in pipelines.[18]

Aviation Industry Concerns with Biodiesel Pipeline Shipments

The aviation community has raised concerns about pipeline shipment of low level biodiesel blends. One key concern is that methyl esters can disarm the coalescers in jet fuel loading systems, and potentially allow water into the aircraft fuel system. At high altitudes, with ambient temperatures well below the freezing point of water, this could potentially be a serious risk, as some aircraft components and parts may have materials compatibility issues with biodiesel (methyl ester).

An international study is underway to address this concern as part of the JIG (Joint Inspection Group) / EI (Energy Institute) Biodiesel in Jet Fuel Task Group. There have been some delays in accomplishing the work to address these concerns. The current methyl ester limit in jet fuel in both the ASTM specifications (ASTM D1655) and the MOD (UK Ministry of Defence) is 5 parts per million. There are no test methods to effectively test for these levels at this time. That is being addressed at both ASTM and the EI regarding methyl ester limits in jet fuel specifications. It has been identified that the current test methods and limits for jet fuel do not address potential issues related to small amounts of methyl ester. The testing program for methyl ester materials (part of the JIG/EI Biodiesel in Jet Fuel Task Group) is expected to be completed in the first half of 2011.

[18] http://atlanta.bizjournals.com/atlanta/stories/2009/02/02/story6.html

3.0 Approach to Analysis of Biofuel Transportation and Distribution Options

3.1 Factors Affecting Development of Biofuel Transportation and Distribution

Today, biofuels are primarily transported by rail, truck, barge, or marine transport, but these transport modes generally have a larger environmental footprint and higher cost than pipeline transportation. However, some data and proposals assert that rail transport may be more cost effective and lower in carbon emissions than pipeline transport, for certain products and situations.[19] Blended biofuels are typically distributed by truck from the blending and storage terminals in the same manner as gasoline or diesel.

The origin points for petroleum fuel products pipelines do not always line up with locations where biofuels are produced or available. One way to resolve this would be to build new dedicated biofuels pipelines to transport ethanol closer to a larger number of blending and storage terminals, which would facilitate greater distribution of biofuels to retail outlets. This could benefit consumers, gasoline blenders, and the environment.

For each of the APEC economies, the need for biofuels transportation and distribution infrastructure will be different, based on existing infrastructure and upon projected demand for biofuels. The type of infrastructure will depend upon the anticipated volume of biofuel produced and/or used, the type of biofuel, geography and topography. In some cases, aggregate demand over a contiguous region may facilitate joint transportation infrastructure development.

Factors that influence biofuel infrastructure development in each APEC economy include:

1) The amount of biofuel feedstock and production capacity within the economy
2) The amount of biofuel that is expected to be consumed within the economy
3) Existing infrastructure that may be converted to biofuels use
4) Geographic considerations that may preclude certain types of infrastructure development

The implications of each of these four points are as follows:

1) Amount of biofuel feedstock and production capacity within the economy

This determines whether or not the APEC economy is likely to produce significant quantities of biofuel. If biofuel production is substantial, it may be sold into both internal and export markets, either of which may require development of additional transportation and distribution infrastructure. If there is little available feedstock, biofuel mandates could only be met through imports, and collaborative ventures with neighboring feedstock-rich economies might make sense.

2) Amount of biofuel expected to be consumed within the economy

This factor is tied to overall energy consumption and biofuels mandates. If projected biofuel consumption is low, truck transportation will be the focal point. As consumption grows, more capital-intensive transportation infrastructure gains prominence, such as rail and pipeline.

3) Existing infrastructure that may be converted to biofuels use

[19] CN/Altex Gateway Project January 2011

It may be cost effective to convert existing rail, marine, and pipeline infrastructure from petroleum to biofuels. However, in growing economies with growing energy demand, new infrastructure may be needed. The type of the new infrastructure will depend upon the mix of biofuels and petroleum products with which incremental energy demand is intended to be met.

4) Geographic considerations that may preclude certain types of infrastructure

APEC economies with coastline could use marine shipments for imports, exports, or internal transportation of biofuels. APEC economies with shared borders may collaborate on infrastructure to facilitate trade and meet their energy needs, or to reach critical volumes needed for large scale infrastructure development. APEC economies with rugged or mountainous terrain may find the cost of pipeline construction prohibitive. Small economies, especially those comprised of small islands, may not have the contiguous land mass or distance to justify dedicated rail or pipeline infrastructure, even if there is sufficient demand for liquid transportation fuels. In such economies, the modes of transportation currently used for petroleum provide an indication of potential modes of biofuel transportation if biofuel volumes grow to sufficient levels.

Factors (1) and (2) basically speak to biofuels supply and demand, while factors (3) and (4) address effective methods to match supply and demand through development of infrastructure. The most effective infrastructure may be controlled by economic or logistical factors.

3.2 Transportation Infrastructure Categories for APEC economies

In terms of biofuels transportation, APEC economies generally fall into one of three categories:

I) **Economies with sufficient biofuel production or demand to consider dedicated biofuel pipelines.** These economies could produce or consume enough biofuel to justify a dedicated biofuel pipeline, and they have the geography or existing infrastructure that could support pipeline transport.

II) **Economies with high biofuel production or demand, yet unlikely to develop a dedicated biofuel pipeline.** These economies could produce or consume enough biofuel to justify a dedicated biofuel pipeline, but geographical or topographical features likely preclude pipeline transport, and/or enhance the viability and logistics of other modes of transport (either marine, truck, or rail).

III) **Economies with low levels of biofuel production or demand.** These economies are expected to consume sufficiently low levels of biofuels that their transportation requirements can likely be met mainly by truck.

Each of these groups may face additional infrastructure needs, to varying degrees, including the development of fuel terminals for biofuel products, infrastructure for retail distribution of biofuels, infrastructure for feedstock transportation and storage, and infrastructure for delivery and distribution of co-products from biofuel production facilities, which could include electricity, animal feed, food products, or high value chemical precursors.

Many APEC economies do not have petroleum fuel products pipelines as part of their existing infrastructure. In some cases, the size of the economy does not warrant pipelines for fuel distribution. In other cases, if the APEC economy does not have a strong refining base, so that there is less need for fuel products pipeline infrastructure. In still other cases, the topography of the economy may make pipeline (or rail) distribution of fuels impractical. Furthermore, many APEC economies have river or ocean access to many supply and demand centers, which may make marine delivery a more practical means of fuels distribution compared to pipelines or rail.

For APEC economies with limited biofuel feedstock, imports may be required to meet biofuels demand. Where coastline is available, the imports might utilize marine transport infrastructure, including offloading and storage facilities and any associated piping. In general, the size of tankage and volume of fuel imports are publicly available, so estimates may be done on potential available storage. For APEC economies with sufficient biofuel production, and an established transportation and distribution infrastructure for petroleum fuels, existing fuel products pipelines or new dedicated biofuels pipelines could be used for biofuels transportation or biofuel blend distribution. The degree to which biofuels demand may be met by "drop in" biofuels in future will ultimately influence future infrastructure needs. The term "drop in" biofuels, refers to fuels such as biobutanol and renewable hydrocarbons (HVO), that could be blended at the refinery and transported and distributed through the existing petroleum infrastructure with minor modifications. Although appealing from an infrastructure perspective, the more costly production economics of these drop-in fuels may limit their implementation.

For each economy, several key factors affect the viability of dedicated biofuels pipelines:

- Anticipated demand for (including imports and exports of) gasoline and diesel
- Existing and planned fuel transportation infrastructure (pipeline, rail and truck)
- Physical and economic potential for biofuels production
- Mandates for biofuels consumption (demand)
- Proximity of potential biofuels trading partners

These factors affect opportunities to capitalize on existing infrastructure, the types and extent of infrastructure that would need to be developed to meet projected biofuels supply and demand, and potential trade opportunities or joint development of infrastructure projects.

Assessment of dedicated pipelines requires careful judgment about where and when to commit capital to fixed assets. Capital expenditure decisions such as these are undertaken weighing costs and benefits and supply and demand dynamics. The ethanol supply chain includes feedstock production and logistics, and biofuels production, distribution and end use. In addition, sustainability and carbon footprint are becoming more of a key long term consideration, recognizing that this is more likely impacted by policy as opposed to monetary considerations.

The minimum ethanol volume required for an economically viable dedicated pipeline remains to be definitively determined. One of the key factors along with distance is topography. However, the proposed Magellan/Poet in the United States project anticipates 240,000 barrels per day (3.7 billion gallons per year or 13.9 billion liters per year). The Petrobras/Logum pipeline in Brazil is expected to handle 360,000 billion barrels per day (5.5 billion gallons per year or 20.9 billion liters per year).

Even so, financial incentives may be needed to support these projects. Additional factors that will need to be assessed include existing or potential barriers to construction, technical factors or issues such as corrosion that may need to be overcome, market risks, and risk mitigation options.

The analysis for each economy or region assesses potential supply and demand of ethanol, which determines the volume of ethanol that could be carried by a dedicated pipeline. This potential volume is then compared to anticipated volumes required to support an economically viable pipeline project, based on market-based return on equity (ROE), pipeline construction costs, transportation tariffs and other industry parameters. Ultimately, pipeline transportation costs need to be competitive with other transportation options.

3.3 Issues for Biofuels Distribution Infrastructure in APEC economies

There are several key issues for biofuels distribution infrastructure in APEC economies. Some of these resolve around the system of fuelling stations and pumps. Other potential issues include the type of biofuel available in the APEC Economy, the fleet of vehicles, and their capacity to use different fuels and fuel blends.

For retail distribution infrastructure such as pumps and underground tanks issues include:

- What is the threshold demand to economically justify retail biofuels infrastructure and various ethanol and biodiesel blends?
- What changes are required to the retail infrastructure in order to handle/supply low level biofuel blends?
- What should be the mix of low-level and high level blends at the pump?

For distribution infrastructure issues include:

- The extent to which legacy engines/automobiles can handle biofuels which have different properties compared to petroleum fuels. If so, what blend levels are permissible?
- Is the wide-scale deployment of flex-fuel vehicles required in order to develop the market and stimulate changes to the retail infrastructure?

Details about distribution infrastructure that would merit assessment in specific cases:

- Distribution capacity of existing fuels product pipelines and which of those could potentially accommodate biofuels blends;
- Regulatory policies that restrict distribution of biofuels in existing fuel product pipelines;
- The number and capacity of existing primary and secondary terminals, their locations, their biofuels handling capacity and the means by which they receive and deliver products;
- The locations and capacities of off-load facilities from pipelines and rail facilities to trucks.

3.4 Methodology and Key Metrics for Biofuels Infrastructure

As illustrated above, a number of factors will dictate the type and extent of infrastructure required for deployment of biofuels in APEC economies. Specific policies related to biofuels, the availability of feedstock, the development of production capacity, geography and opportunities for trade could all play a key role influencing biofuels supply, demand, distribution and utilization. These factors ultimately will influence infrastructure requirements.

The types of infrastructure that could be required include:

- Trucks for local/regional transportation, typically for distances up to 600 km
- Rail cars for regional transportation, typically over distances greater than 600 km
- Pipelines for long-distance transportation, typically for distances greater than 2000 km
- Marine transportation, either in the form of barges or ocean-tankers
- Storage tanks and blending equipment for biofuels at primary and secondary terminals
- Retail distribution infrastructure – pumps, nozzles, and underground storage tanks

Chapter 4 of this report outlines, where appropriate, typical capital costs for several of these types of infrastructure, and where available, volume thresholds needed to support the deployment of certain types of infrastructure. This includes capital cost metrics for pipelines, costs for installed storage at primary and secondary terminals, and costs for retail distribution structure. These metrics will almost certainly vary between APEC economies, due to differences in costs of energy, labor, interest rates, and other economic factors. Nonetheless, the metrics in Chapter 4 are illustrative of the types of costs that need to be considered, even as they are adapted to local conditions. Capital costs for barges and ocean tankers are not considered, as these items will not be dedicated exclusively to biofuels, and the degree to which they are used for biofuels will depend significantly upon broader economic activity, local production, demand and trade. Chapter 4 does not delve into detailed operating costs per unit volume, which are highly variable, dependent upon the type of biofuel, underlying energy and materials/commodity costs, and the degree to which biofuel infrastructure is developed from new installations or retrofits of existing equipment.

Chapter 4 also considers biofuel demand and production volumes in various APEC economies, along with geographical considerations, to offer a preliminary indication of types of infrastructure that may be required. The ultimate quantity and types of biofuels used in each economy will be affected by several factors. In particular, biofuels production costs and policies that affect production and demand could facilitate or exclude certain biofuels. Furthermore, different levels and types of infrastructure may be required, depending upon whether or not the resulting biofuels require dedicated infrastructure (such as ethanol or biodiesel) or are directly compatible with existing infrastructure (such as hydrogenation-derived renewable diesel or renewable alkanes derived from biomass). Any projections of infrastructure needs must be interpreted with caution, due to the great uncertainty about the future volumes and types of biofuels that may be deployed.

4.0 Metrics for Evaluating Biofuel Infrastructure Options

4.1 Transportation Cost Metrics

To evaluate the most suitable infrastructure for biofuel transport, it is necessary to compare the costs of different transport options. The following sections of the report focus on capital costs for different types of infrastructure.

4.1.1 Pipeline Costs

Pipelines can be an efficient mode for transportation and distribution of biofuels, but there is a threshold volume required for them to be economically viable, and if the pipeline can only carry a dedicated biofuel (FAME or ethanol), the development of a pipeline is less attractive, unless specific guarantees are provided to ensure a long-term market. Dedicated pipelines also tend to be smaller in diameter, because the total volume of fuel transported is less compared to pipelines that carry a large number of products and distribute the cost widely over those products. Pipelines also face challenges due to terrain and environment, which could force the use of additional pumping stations if the terrain is mountainous, or bridges in the event large valleys or rivers must be traversed. The economics of pipeline transport must therefore be assessed on a case-by-case basis, taking into account the intended volume, market, topography, and rights of way.

In a survey of North American pipeline construction costs published in the Oil and Gas Journal, it was noted that, on average, material costs represented about 35 percent of the total pipeline cost, labor costs 38 percent, rights of way cost 7 percent of total project costs, and “miscellaneous” costs 20 percent. However, it is important to note that there were wide variations across each of these categories, partially attributable to differences in pipeline diameter and distance, but also partially attributable to differences in terrain and land ownership issues requiring negotiation of rights of way.

Figure 4.1.1 illustrates the fairly strong correlation between pipeline diameter and the percentage contribution of materials to total project cost. As illustrated in Figure 4.1.2, the pipeline diameter also has a fairly strong impact on the materials cost per kilometer of a pipeline, not surprisingly. The labour to install a pipeline is also strongly correlated to the length of the pipeline (Figure 4.1.3). However, there is virtually no relationship between labor cost and pipeline diameter, which is a disadvantage for the smaller diameter pipelines likely to be used for dedicated biofuels transportation, because the labor costs per km of pipeline will remain the same in spite of the reduced capacity.

Engineering costs are virtually independent of capacity and diameter, although they may vary with length and total project cost. Other miscellaneous costs, including the number and capacity of pumping stations, are highly dependent upon geography, line size, and fluid properties. Data for over 20 pipelines show miscellaneous costs ranging from 5 to 45 percent of total project costs, reflecting the large variation between engineering, pumping and other infrastructure costs between projects. Rights of way can vary from near zero to as much as 25 percent of a total project cost, and may be controlled by a small fraction of the overall length of the pipeline that, for example, traverses an environmentally sensitive area.

Overall, materials costs and costs for pumping infrastructure are a function of pipeline length and diameter. In contrast, labor and engineering costs are primarily a function of pipeline length, but independent of diameter. Costs for rights of way would tend to be independent of pipeline diameter. Fluid properties also impact diameter and pumping costs, and terrain can have huge cost impacts. Collectively, the variety of cost factors make it difficult to create a typical engineering scale-up factor that could predict costs as a function of line capacity.

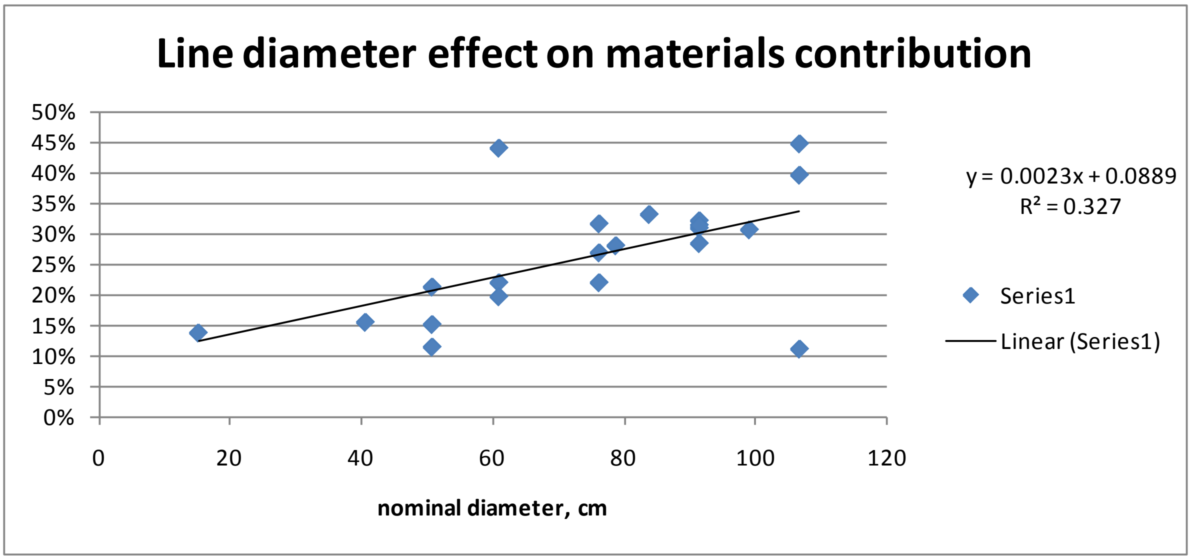

Figure 4.1.1 Effect of Line Diameter on Contribution of Materials to Overall Pipeline Cost

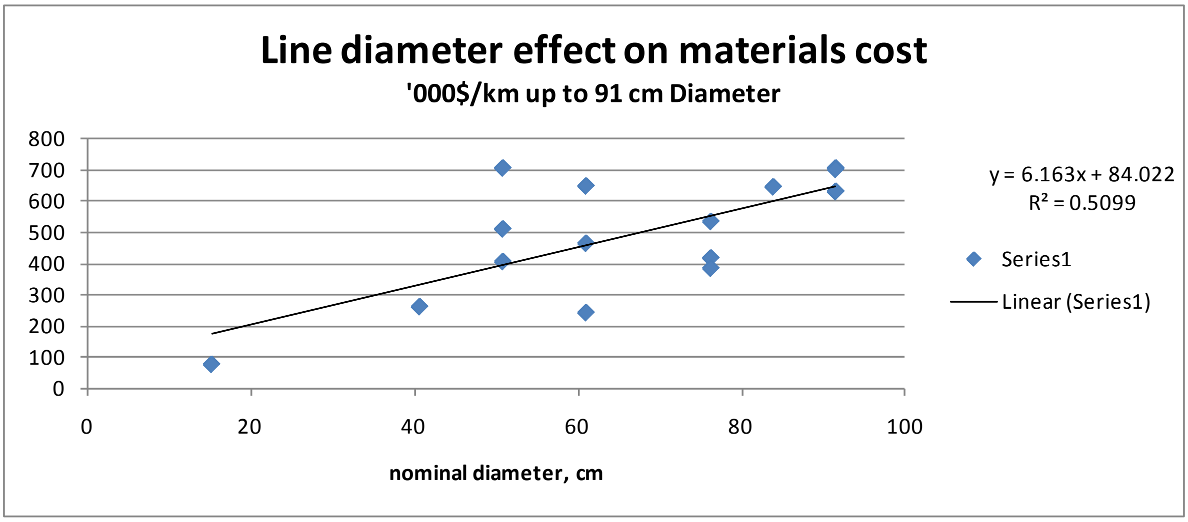

Figure 4.1.2 Effect of Line Diameter on Pipeline Cost of Materials

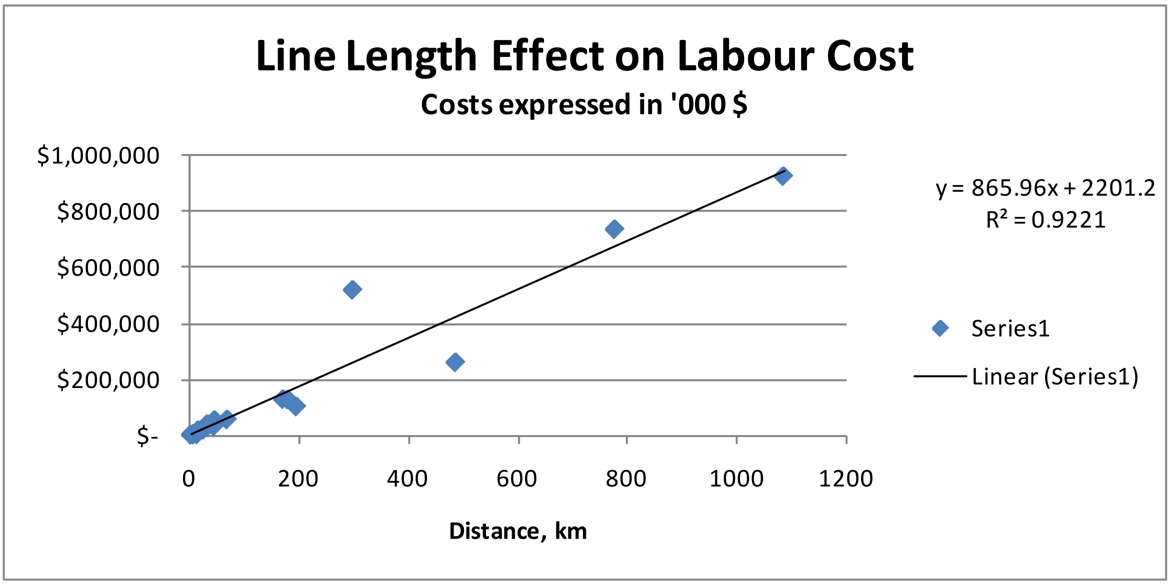

Figure 4.1.3 Effect of Pipeline Length on Labour Costs to Install a Pipeline

Table 4.1.1 summarizes costs for various liquid pipeline projects proposed or built recently.

Company	Project	$, billions	Distance, km	diameter, cm	Capacity, barrels per day	Cost per km ($millions)	Cost per cm(dia)-km
TransCanada	Keystone XL	12.2	3187	91	500,000	1.84	$20,083
Enbridge	Alberta Clipper	3.7	1599	91	450,000	2.31	$25,301
Enbridge	Northern Gateway	5.5	1179	91	525000 [1]	2.33	$32,801
			1179	51	193000 [2]		
Holly	UNEV	0.3	653	30	120000 [3]	0.46	$15,064
	East Siberia Pacific	14.1	4727	107	1,600,000	2.98	$27,958
China National Petroleum	Myanmar	1.5	776	81	230,000	1.93	$23,797
Logum	Brazil	3.6	1300	91	360,000	2.77	$30,277

1. Oil Transport; 2. Condensate Transport; 3. Liquid Products Transport

Table 4.1.1 Liquid Pipeline Project Cost Summary

The data in Table 4.1.1, which were gathered from regulatory filings and press releases, suggest an average cost of $2.4 million per kilometer of pipeline, consistent with data registered with the U.S. Federal Energy Regulatory Commission (FERC) for liquid pipelines, and published in the Oil and Gas Journal[20], which averaged $2.3 million per kilometer. For comparison, the Logum/Petrobras ethanol pipeline in Brazil has a projected cost of $2.8 million per km.

Some suggest that the cost should be normalized with respect to pipeline diameter, although labor costs, miscellaneous (e.g., engineering) costs and costs for rights-of-way are virtually independent of pipeline diameter. For pipeline diameters of 20 inches (51 cm) or greater, the average cost shown in Table 4.1.1 is approximately $27,000 per cm-km, which is comparable to the average of $26,000 per cm-km for pipelines longer than 160 km implied by FERC data.

In many jurisdictions, pipeline tariffs are regulated. Based on an aggregate of data supplied to FERC, pipeline transportation costs averaged 0.26 and 0.27 cents per barrel-mile (0.16 to 0.17 cents per barrel-kilometer) in 2007 and 2008, respectively. These figures correspond to a cost of 11 to 11.5 cents per U.S. gallon (approximately 3 cents per liter) for transport over 1800 miles (2900 km), or about 3 cents per U.S. gallon (0.8 cents per liter) for transport over 500 miles (800 km). These costs primarily represent transport in large diameter pipelines which would have a lower fixed cost per unit of fuel transported than the smaller diameter pipelines that would be used for dedicated biofuels transport. Furthermore, it is likely that within the data cited above, surcharges were present for shorter-distance transport, and thus, the per-liter cost likely does not scale linearly with distance. Costs would be greater for dedicated ethanol/biodiesel pipelines, because the fixed costs cannot be distributed over a larger number of products, and the smaller pipeline diameter would lead to greater pumping costs and more pumping stations due to pressure losses in the line, which increases costs.

In a recent report by the U.S. Department of Energy (DOE) on the feasibility of an ethanol pipeline from the Midwest to the East Coast, it was concluded that a minimum annual transport volume of 4.1 billion U.S. gallons (15.5 billion liters) would be needed to ensure a viable project. This corresponds to tariffs between 16 and 19 cents per U.S. gallon (4.2 to 5.0 cents per liter) for a 1700 mile (2700 km) shipment. These rates are comparable to the intermodal (truck/rail) transport cost currently charged for transport over the same distance (see Figure 4.1.4 for rail costs). By comparison, the Draft Regulatory Impact Study by the

[20] C. Smith, Oil and Gas Journal, September ,2009.

U.S. Environmental Protection Agency (EPA) suggests transportation costs on the order of 10 to 14 cents per U.S. gallon (2.6 to 3.7 cents per liter) to ship ethanol from Midwest producers to either the Pacific or Atlantic coasts, but these are based on a 2002 cost assessment.

A primary challenge for pipeline transport is the relatively high proportional allocation of the tariff to fixed costs. For example, the $3.6 billion dollar Logum pipeline is projected to carry 20 billion liters of ethanol annually. As noted in Section 4.1.3, below, a single rail car is projected to carry 2.8 million liters of ethanol annually; thus approximately 7,000 rail cars at a total capital cost of approximately $0.8 billion dollars ($114,000 each) could transport the same amount of ethanol as the Logum pipeline. Of course, the pipeline capital cost covers all costs, while the total railway cost needs to include costs for locomotives and track. However, costs for these latter two components are spread across a wide number of commodities, not just the biofuel, and therefore, the fixed cost per unit volume of biofuel is thus dramatically lower for rail than for a pipeline.

If liquid fuels are transported over long distances, however, the energy cost associated with rail transport becomes significant, while pumping energy costs for pipelines tend to be comparatively lower. At some threshold distance, based on the price of energy and the properties of the liquid being shipped, the higher energy-related operating cost for rail exceeds the fixed cost differential between pipelines and rail, and pipeline transport becomes an economically viable option. The feasibility of pipeline transport is thus predicated on volume, shipping distance, and energy costs. However, unlike rail, pipeline infrastructure cannot be built incrementally, or redeployed to other products if markets change. It is also difficult to finance a pipeline without debt, whereas incremental expansion of a rail car fleet can occur using free cash flow from either the biofuel producer or the rail line.

Further data and comparisons to truck, rail and marine transport in the United States is provided in the *Strategic Assessment of Bioenergy Development in the West* study, which calculates biofuel supply curves for 2015 in the Western region of the United States.[21] Tables 4.1.2, 4.1.3 and 4.1.4 are drawn from this study as illustrations.

Relative costs of transport modes will differ by economy based on topography, existing infrastructure retail distribution network, proximity of existing transportation network to existing distribution network and other factors, not the least of which is the volumes being transported and the transport distance.

4.1.2 Trucking Infrastructure Costs

Trucks can be a cost-competitive transport mode for biofuels over shorter distances, especially where rail is not available. However, over longer distances, trucks are less attractive because of high fuel costs and labor costs.

	Liquids	**Bulk solids**	**Comments**
Loading/unloading	$0.02/gallon	$5/wet ton	
Time dependent	$32/hr/truckload	$29/hr/truckload	Includes labor and capital
Distance dependent	$1.30/mile/truckload	$1.20/mile/truckload	Includes fuel, insurance, maintenance, and permitting
Truck Capacity	8,000 gallons	25 wet tons	Moisture content varies with feedstock

Table 4.1.2 Example of Trucking Cost for Transportation in the United States

[21] Strategic Assessment of Bioenergy Development in the West – Spacial Analysis and Supply Curve Development, Final Report. (University of California, Davis – 1 September 2008)

4.1.3 Rail Infrastructure Costs

Most regions already have some rail infrastructure (i.e., trackage and locomotives), but many lack dedicated tank cars or unit train handling capacity at fuel terminals. A unit train of 100 cars would carry 3 million U.S. gallons (11.3 million liters) of biofuel. On an annual basis, each 30,000 gallon tanker car would carry about 750,000 gallons of biofuel. The EPA cites a cost of $90,000 for a tanker car, while Empire Railcar indicates the cost is $114,000. Over a typical 30-to-50-year lifespan for a rail car, 22 to 37 million gallons (83 to 140 million liters) of biofuel could be transported, at a fixed cost of 0.3 to 0.5 cents per gallon (0.08 to 0.13 cents per liter) for the railcars.

Terminal infrastructure to handle rail is projected to cost approximately $60 million for a terminal that processes a 100 car unit train and handles about 160 million U.S. gallons (600 million liters) of biofuel annually. This cost includes track, loading and unloading equipment, piping, and vapour recovery systems, but excludes storage tanks, treated separately in section 4.1.5. The rail infrastructure cost is thus estimated at approximately $0.46 per gallon (12 cents per liter) of annual throughput at the terminal.

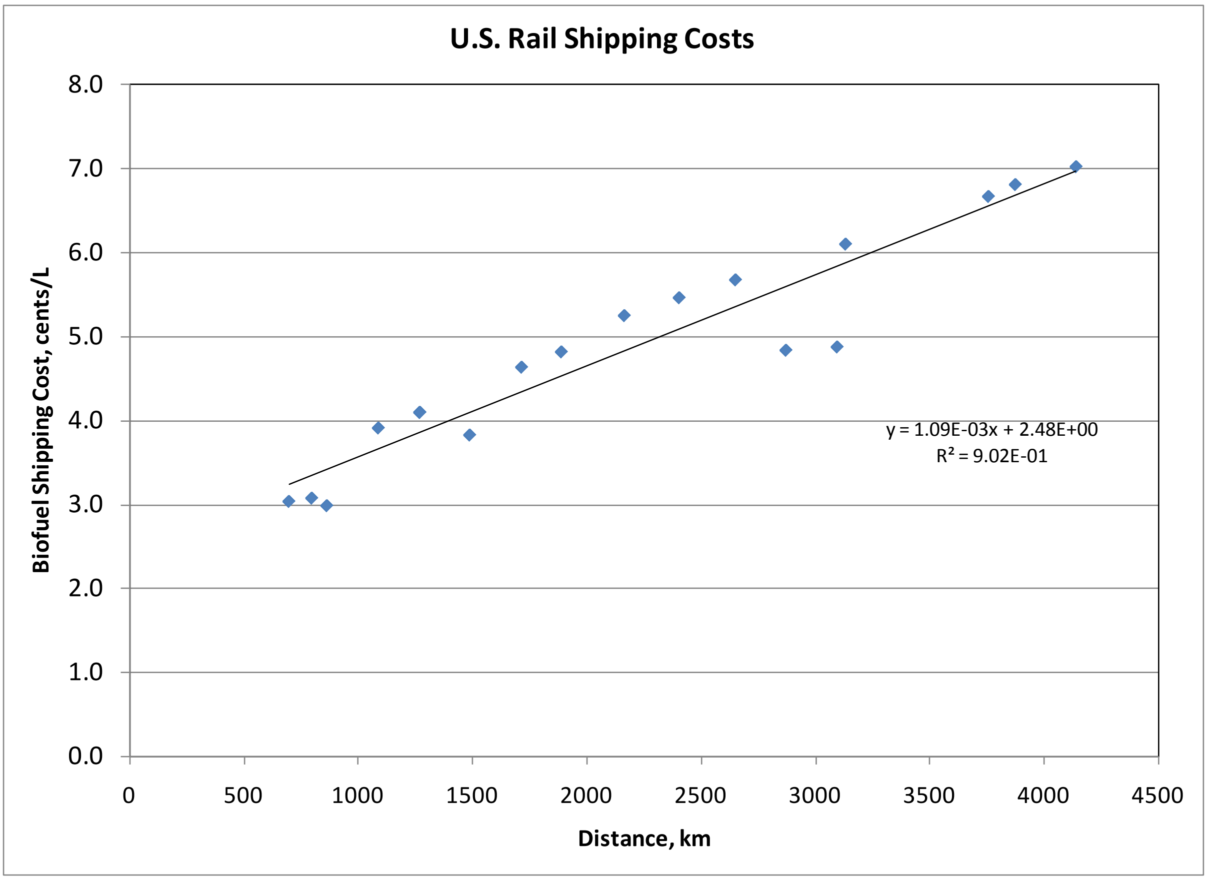

Figure 4.1.4 United States Ethanol Rail Shipment Costs, April 2011

	Liquid	Bulk Solids
Loading/unloading	$0.015/gallon	$5/wet ton
Fixed Cost	$8.80/100 gallons	$27/wet ton
Distance dependent	$0.0075/mile/100 gallons	$0.023/mile/wet ton
Rail Car Capacity	33,000 gallons	106.5 wet tons

Table 4.1.3 Example of Rail Cost for Transportation in the United States

4.1.4 Marine Infrastructure Costs

The main costs for marine transport of biofuels would be the costs of the ships or barges dedicated to transport and the costs of the shipping terminals. According to Vopak[22], there is little difference in cost between tanks at marine terminals and tanks at conventional rail or other terminals. However, marine terminals would also need vapour recovery equipment, piping, pumps and fittings, at an estimated cost of $3.5 Million per facility (EPA DRIA). Including 200,000 barrels of tank storage would bring the total cost to approximately $12 Million per facility. If the marine terminal also requires rail infrastructure for distribution, an additional $0.5 Million cost would be incurred.

	Liquid	Bulk Solids
Loading/unloading	$0.015/ gallon	$5/wet ton
Fixed Cost	$1.40/100 gallons	$3.85/wet ton
Distance dependent	$0.015/mile/100 gallons	$0.043/mile/wet ton
Barge Capacity	1.26 million gallons	4,000 wet tons

Table 4.1.4 Example of Marine cost for transportation mode comparison in the United States

4.1.5 Comparison of Transportation Costs

Using the costs from tables 4.1.2 – 4.1.4 and Figure 4.1.4, it is possible to estimate transportation costs per liter of fuel transported for an economy. These calculations include fixed an operating costs for each mode of transportation, based upon circumstances in the United States. Similar comparisons could be developed in other APEC economies, using appropriate capital, fuel and labor costs.

Truck delivery is only considered for relatively short distances, rarely beyond 400 kilometers, to facilitate delivery and return in a single day. Even so, hypothetical costs for truck delivery of biofuel over 500 kilometers and 1,000 kilometers are presented in Table 4.1.5. Similarly, costs for rail transport are presented for distances up to 3,000 kilometers, based on Figure 4.1.4. Marine transportation costs are also included, using data from Table 4.1.4. Loading and unloading costs in Tables 4.1.2 - 4.1.4 can be converted to costs per liter. Distance-dependent costs can be converted to values per liter of fuel carried by each mode of transportation. Finally, time-dependent costs for truck transport can be normalized on a per-liter basis, taking into account time for the return trip when the dedicated biofuel truck is likely empty.

As shown in Table 4.1.5, truck and marine transport appear to be the lowest cost options for distances less than 500 kilometers. However, transport by barge is often intermodal, with short-distance truck transport required to and from the barge. Consequently, the real cost for barge transport is often a blend of the barge and truck costs.

At a distance of 500 km, costs for rail, barge and truck are comparable. Beyond this distance, trucking costs escalate rapidly, while rail costs remain lowest among the three options. Barge transport costs are competitive with rail at distances up to 2,000 kilometers if intermodal transport is not required.

Notably, it is only at distances greater than 1500 kilometers that pipeline transport at the DOE benchmark rate of 4.2 to 5.0 cents per liter would have a reasonable chance to compete with rail or marine transport.

[22] http://www.vopak.com/

	Transportation Cost per Liter		
Distance, km	**Truck**	**Barge**	**Rail**
200	1.6	1.3	N/A
500	3.2	2.0	3.0
1,000	5.9	3.2	3.6
1,500	N/A	4.5	4.1
2,000	N/A	5.7	4.7
2,500	N/A	7.0	5.2
3,000	N/A	8.2	5.8

Table 4.1.5 Illustration of Comparative Transportation Costs of Liquid Biofuels
Note: Time dependent costs of trucking are calculated with an average speed of 80 kilometers per hour.

4.1.6 Terminal Storage Costs

Storage costs vary widely by jurisdiction and tank size, and are also influenced by the choice between new (Greenfield) installations versus retrofits of existing facilities. The EPA's draft regulatory impact analysis[23] projects installed costs for new field erected tanks in the United States would be $40 per barrel of capacity, while retrofits to existing tanks would cost $5 per barrel. The cost for new storage tanks is based upon terminals with approximately 200,000 barrels (30,000 cubic meters) of storage capacity. The EPA's cost estimate for new tanks is in line with other data for smaller tanks, which range between $32 per barrel for a bare tank to $91 per barrel for an installed field erected tank. Cost estimates from various vendors consistently indicated a scale factor of 0.7 to 0.75 based upon installed costs, and an installation factor of 3 to 4 taking into account concrete pads, piping and instrumentation, labor and engineering. When these scale factors and installation factors are applied to actual costs known to BBI, the resulting installed cost for a new 30,000 cubic meters storage tank in North America ranges between $35 and $55 per barrel (22 to 35 cents per liter) of capacity.

Cost estimates from vendors for new installed storage tanks in China range between $21 and 32 per barrel, for tanks with 6,300 to 31,500 barrels (1000 to 5000 cubic meters) of capacity. The scale factors cited above lead to an estimated cost of $19 per barrel to purchase and install four 50,000 barrel tanks.

There is a much greater disparity in costs for retrofit tanks, likely due to different levels of refurbishment and accessories needed, depending upon the original use of the tank. The EPA's $5 per barrel estimate is for the tank only, and does not include vapour recovery equipment, new instrumentation, and "miscellaneous" costs, which add up to as much as $7 per barrel. Other vendors have cited retrofit costs as high as $25 per barrel, which seems high considering the cost of a new tank and the fact that most of the tank components should be available/suitable for the retrofit. However, if the tank is old or in poor condition, and requires installation of new floors and injection equipment, such a cost is conceivable.

4.1.7 Blending Equipment Costs

Based on the EPA DRIA, the cost for blending equipment at petroleum terminals can range between $0.3 and $1.4Million per terminal, corresponding to terminals that are retrofit versus terminals with a completely new installation. It is expected that each new terminal would

[23] EPA Draft Regulatory Impact Analysis (DRIA): Changes to Renewable Fuel Standard Program, Report EPA-420-D-09-001, May 2009

have storage capacity for 8.2 Million USG (31,000 cubic meters) of biofuel. These costs include blending equipment, vapour recovery equipment, piping, and miscellaneous costs.

4.2 Distribution Cost Metrics

Distribution metrics include costs for retail storage tanks, pumps and dispensers. For so-called drop-in fuels that are interchangeable and miscible with alkanes, the existing infrastructure will suffice. However, some biofuels require specialized equipment, either for heating to address gelation issues, or special tanks due to their corrosive character and impact on seals.

4.2.1 Retail Storage Costs

Retail storage of biofuels can take several forms. Some biofuels blended fuels may require replacement of storage tanks due to incompatibility or age of legacy tanks. Some retail pumps may have materials compatibility issues, depending on the age of the pump and the biofuels blend level being dispensed, due to specific properties of the biofuel, such as corrosivity, interactions with polymers. So-called drop-in fuels should be able to use existing infrastructure with little or no modification.

Storage can be provided by either installation of new tankage or by retrofitting existing storage tanks. Underground storage tanks typically range in size from 4 thousand to 12 thousand USG. As noted in the DOE's Clean Cities report[24], "The vast majority of underground storage tanks (UST) being used for petroleum-based fuels can also be used for E85 after proper conversion. Converting an existing tank (midgrade gasoline, kerosene, diesel, etc.) to E85 is the most cost effective way to add high-blend ethanol capabilities to a station."

New storage tanks are projected to cost $30 to $60 thousand per tank. The EPA DRIA suggests a cost of $84 thousand to install an 8,000 U.S. gallon underground storage tank for E85. The reasons for this discrepancy are unclear, but would certainly have a significant impact on overall costs to install dedicated biofuel equipment at retail facilities.

The need for E85 tanks is determined by a number of factors, as discussed in section 4.2.3.

4.2.2 Retail Pump Costs for E85

The number of retail stations is linked to the total biofuel market. The installation of special equipment for E85 is predicated on sufficient numbers of flex-fuel vehicles in the local market area. Studies indicate that local E85 demand can be stimulated by government fleets of flex-fuel vehicles, along with policies that mandate use of E85 whenever the vehicle is available[25]. This study suggests that an E85 station is economically viable if a government fleet of 100 to 170 vehicles is present in the market area; by comparison, approximately 500 to 600 private flexible fuel vehicles (FFVs) are needed (locally) to sustain an E85 station. The large difference indicates that private vehicle purchases are often made without regard to their FFV capability, and that private FFVs, once purchased, are more likely to be run on conventional gasoline.

[24] M. Melendez, K. Moriarty et al., Status and Issues for Ethanol (E85) in the United States, U.S. DOE Clean Cities Draft Report, September, 2009.

[25] K. Corts, J. Env. Economics and Mgmt, 59, 219-234 (2010)

The viability of an E85 retail pump is also linked to the volume of E85 sold. Various studies have examined this metric. Tyner[26] cites a range of 45,000 to 100,000 U.S. gallons (170,000 to 380,000 liters) annually, while Corts[27] cites a range of 80,000 to 100,000 gallons (300,000 to 380,000 liters), and NREL's E85 business case report[28] cites a value of 70,000 gallons (270,000 liters) annually. This is consistent with data from the state of Minnesota, where E85 stations dispense an average of 74,000 U.S. gallons (280,000 liters) annually. The EPA report[29] also projects that approximately 24,000 new E85 facilities and 77,000 new dispensers would be needed to process an additional 20.9 billion U.S. gallons (79 billion liters) of fuel annually, implying a much higher volume per dispenser than projected in other reports.

The cost for a new tank and dispenser is estimated at $50,000 to 75,000[30,31,32]; this cost can be reduced by $30,000 to $40,000 if the tank and dispenser are retrofit from existing equipment. The EPA's Draft Regulatory Impact Assessment[33] projects a much higher cost for new installations – approximately $136,000 – but this is based upon installation of two E85 pumps and four dispensers per facility, and also includes the much higher cost for an underground storage tank.

The profitability and economic viability of an E85 installation (or similar dedicated fuel installation) is tied to the annual volume of fuel sold. NREL's E85 business case report[34] projects that the necessary margin is approximately 16 to 19 cents per U.S. gallon (4.2 to 5.0 cents per liter) when a new tank is installed or a mid-grade tank is replaced, provided that the station sells 70,000 gallons of biofuel annually. This range falls to 8 to 10 cents per gallon (2.1 to 2.6 cents per liter) if the station sells 200,000 gallons (760,000 liters) per year. The lower value of each range is based on tanks and pumps that are retrofit from existing service, while the higher value in each range assumes new equipment must be installed.

4.2.3 Metrics for Determining E85 Pump Requirements

Requirements for the number of E85 pumps in a given economy or jurisdiction can be influenced by several factors. Some of these include:

- Ethanol consumption growth as a fuel blend with petroleum, e.g., E10.
- Ethanol consumption growth as a high-ratio blend (i.e., E85)
- The level of FFV adoption in the region.
- FFV use of E85 versus gasoline
- Average annual distance travelled by FFVs (11,500 miles)
- Average vehicle fuel economy.

Section 4.2.2 suggests numbers of FFV and economic criteria that could be used to justify installation of E85 pumps.

---

[26] W.E. Tyner et al., Alternative pathways for Fulfilling the RFS Mandate, Amer. J. Agric. Econ., Advanced Access published Dec 17, 2010. *(Amer. J. Agr. Econ.* 1–8; doi: 10.1093/ajae/aaq117)
[27] K. Corts, ibid
[28] C. Johnson and M. Melendez, NREL Technical Report TP-540-41590 (2007)
[29] EPA Draft Regulatory Impact Analysis (DRIA), ibid
[30] K. Corts, ibid
[31] C. Johnson and M. Melendez, ibid
[32] M. Melendez, K. Moriarty et al., ibid.
[33] EPA Draft Regulatory Impact Analysis (DRIA): Changes to Renewable Fuel Standard Program, Report EPA-420-D-09-001, May 2009
[34] C. Johnson and M. Melendez, NREL Technical Report TP-540-41590 (2007)

E85 pump deployment is expected to grow significantly in APEC economies where a "blend wall" has been reached. At that point, further increases in biofuel penetration into the market are contingent on higher level blends. Alternatively, if the blend limit is increased, e.g., from E10 to E15 or E22 (as in Brazil), the need for dedicated E85 retail equipment diminishes significantly. In view of the costs to transport biofuels over long distances, E85 pump deployment will likely be concentrated initially in areas where biofuels are produced, before expanding into urban demand centers. However, significant displacement of petroleum and large scale deployment of E85 ultimately means most E85 retail infrastructure will need to be deployed in areas with the greatest fuel demand.

An NREL study titled *Effects of Intermediate Ethanol Blends on Legacy Vehicles and Small Non-Road Engines, Report 1* showed that there was on average only a 7.7 percent reduction in fuel economy (reduction in miles per gallon) in E20 compared to E0, supporting the extension of the E10 blend level to E20. Such an extension would greatly reduce the number of E85 pumps required.[35]

The National Retail Petroleum Site Census – 2008 (MJ Ervin & Associates) study examined retail pumps, margins, and volumes processed at service stations in Canada. This study identified that there is a fundamental relationship between retail gasoline sites per capita and the annual amount of fuel processed at each site. This study found that fewer pumps per capita are present in locations where the population is more concentrated in large centers. High volume stations (e.g., in urban areas) incur a lower operating cost per litre than similar, low volume stations, thus enabling them to either be more profitable or to be more price-competitive, or both.

In total, there are 12,684 retail stations in Canada, or 3.8 outlets for every 10,000 people. This metric includes fuels distributed as B2-B5 blends in diesel or E10 blends in gasoline, as these are invisible to the consumer and require little or no modification to the retail infrastructure. A similar set of data from the United States is found in Table 4.2.1 below. Similar data may be used in any APEC economy to estimate retail fuel distribution requirements.

Metric	**Values**
United States Gasoline stations [a]	161,768
United States Population, millions[b]	307
United States Gasoline consumption, liters per year[c]	525 billion
United States E85 stations	31,221
Stations selling biofuels	48,530
E85 stations per million people	102
Fuel consumption per capita (USG/person)	451 (1708 L/person)
Gasoline consumption per station (U.S. gallons)	856,164
Stations per 10,000 people	5.27
E85 stations per billion Liters of fuel	60

Table 4.2.1: Gasoline Retail Distribution in the United States
[a] *NPN, 2008*
[b] *U.S. Census 2009*
[c] *EIA, 2010*

[35] http://www.nrel.gov/docs/fy09osti/43543.pdf

4.3 Biofuels Statistics for APEC economies

Biofuels Production Targets and Mandates in Various APEC economies

Several APEC economies are looking to emulate the Brazilian model, wherein volumetric mandates will create market demand for biofuel products. Most APEC economies already have limited volumetric mandates in place. Goals of mandated biofuel volumes are to:

- Address high domestic oil prices;
- Provide long-term energy security;
- Mitigate air pollution and abate greenhouse gas emissions; and,
- Create markets for surplus crops and other farm products.

Chinese ethanol production eclipses that in all of the other Asian APEC economies, and has caused increased demand for first generation feedstocks such as corn. Forbes reported in 2007 that corn usage for ethanol production is well over the official limit of 3 million tonnes per annum, with reports citing up to 16 million tonnes per annum being used[36]. It is for this reason that government approvals for first generation ethanol plants have now been halted.

Some APEC economies do not have significant amounts of agricultural feedstock and would have to import biofuels feedstocks or biofuels. Table 4.3.1 shows ethanol mandates in some of the APEC economies.

Table 4.3.1 Ethanol Mandates in Some APEC economies

APEC Economy	Mandate	Limit	Market Availability	Future Mandates (Year Effective)
Australia		E10	E10	
China	E10 (1)	E10	E10	
Indonesia		E10	E10	E5 - E15 (2009) E15, E85 (2011) E20, E85 (2016)
Japan		E3	E3	
Korea		E10	E10	
New Zealand		E10	E10	E3.4 (2012)
The Philippines		E10	E10	E5 (2009) E10 (2011)
Thailand		E10	E10	

(1) E10 required fully in six provinces and partially in four provinces as of April 2008

[36] http://www.forbes.com/feeds/afx/2007/04/09/afx3596016.html

Table 4.3.2 shows biodiesel mandates in some of the APEC economies.

Table 4.3.2 Biodiesel Mandates in Some APEC economies

APEC Economy	Mandate (Year Effective)	Limit	Market Availability	Future Mandates (Year Effective)
Australia		(1)	B5, B10, B20	
China				
Indonesia		B10	B1	B5 (2009) B10 (2011) B15 (2016)
Japan				
Korea	B1 (2008)	B5	B1	B1.5 (2009) B2 (2010) B2.5 (2011) B3 (2012)
New Zealand		B5		
The Philippines	B1 (2007)	B1	B1	B2 (2009)
Thailand	B2 (2008)	B2	B2	B5 (2011) B10 (2012)

(1) Up to B100 be marketed. B5 limit proposed in January 2008

Table 4.3.3 shows biofuel production and blending targets for some of the APEC economies.

Table 4.3.3 Production and Blending Targets for some of the APEC economies

APEC Economy	Production Targets	Blending Mandates	Economic Measures	2nd Generation Policy
China	Biofuels to comprise of 15% of transportation energy by 2020. Planned	Trial period for 10% ethanol blending mandate in some regions	Incentives, subsidies and tax exemptions for ethanol and FAME production	Ceased approvals process for grain based ethanol projects.
Malaysia	Feedstock commitment in conjunction with Indonesia for 6 Million tonnes of palm oil production to be diverted to FAME	5% palm oil FAME in diesel	Blended Diesel Subsidies	Active promotion of second generation feedstocks (Jatropha)
Indonesia	Domestic biofuel production to form 2% of "energy mix" by 2010. target for 5% biofuels in "energy mix" by 2025	1% blend for public transport sector. 2.5% blend for commercial sector	Subsidies apply to biodiesel blends at the same levels as fossil fuels	Jatropha being considered as second generation feedstock
Korea	None Identified	Current 0.5% biodiesel blend to be increased to 3% by 2012	Tax exemptions for biodiesel	Investigating energy crops (for cellulosic ethanol production?)
Japan	500ML/year target for liquid biofuels in 2010.	None. Blending limits apply at 3% ethanol, and 5% FAME	Subsidies exist for ethanol production; Planning tax exemptions	Investigation / Promotion of cellulosic ethanol
The Philippines	None Identified	5% volume mandate by 2009, 10% by 2011. Diesel mandates of 2% by 2009	Tax exemptions and priority finance arrangements for biofuel projects	Studies and Pilot projects ongoing for jatropha
Singapore	None Identified	None Identified	"Promoting Investment" in biodiesel plants	Planning to focus policy around 2nd gen processes
Chinese Taipei	20% replacement of motor vehicle fuel consumption with biofuels and natural gas by 2012. Alternative energy target of 20.4 % by 2022	2% Palm oil FAME for all diesel vehicles from 2008	Tax exemptions for ethanol production	Research / Promotion of 2nd generation production integrated into 3 phase biofuels plan 2008 -2022
Viet Nam	500 Mlpa Ethanol and 50Mlpa of FAME use by 2020		Plans for tax incentives and low interest loans for biofuel projects	R&D focus on developing advanced conversion techniques for cellulosic ethanol

4.4 First Generation Biofuels Production in Various APEC economies

Biofuel production is rapidly increasing in developing Asian APEC economies as infrastructure becomes established. China's biofuel production is all used domestically, with the economy even importing small amounts of product from Indonesia and Malaysia. Huge growth for the Chinese car market over the last ten years and even larger growth potential means that development of both biofuel production and transport infrastructure for biofuel blends will be a priority in order to satisfy market demand.

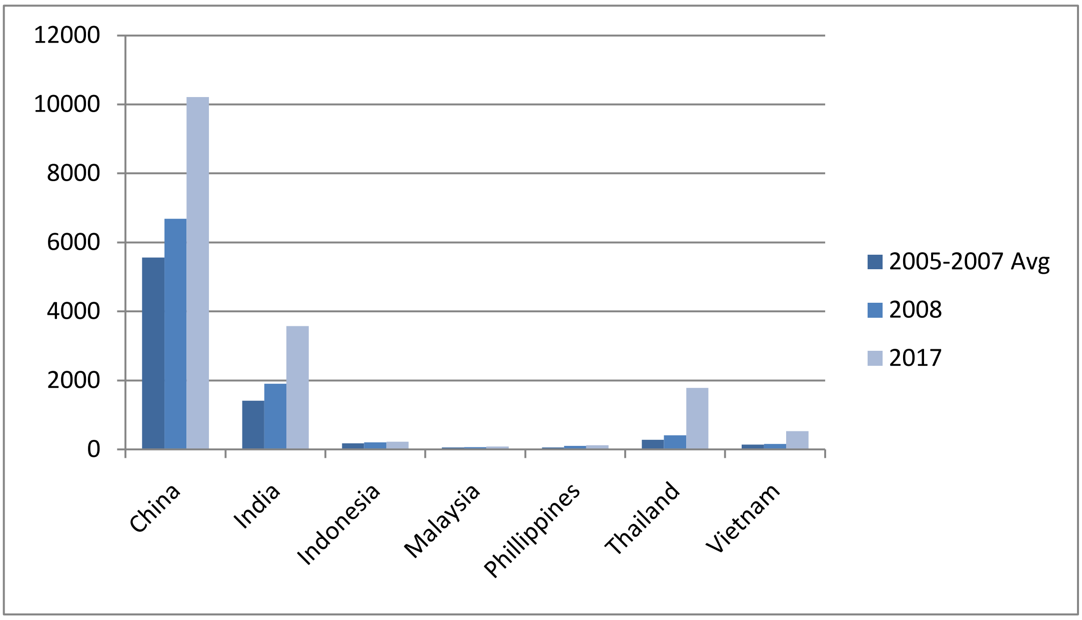

Figure 4.4.1 Asian Ethanol Production: Current and Predicted in 2017 (Million Litres per Year)
Source: OECD-FAO Agricultural Outlook 2008-2017[37]

Figure 4.4.1 shows growth rates and predictions for 2017 in million litres per year indicate that Thailand, Viet Nam and the Philippines will experience the largest growth rates for biofuels production. Section 4.5 on Biofuels Trade Patterns also shows that these economies may increase their biofuel exports, which makes them key targets for infrastructure improvement in order to export bulk amounts of product.

[37] http://www.fao.org/es/esc/common/ecg/550/en/AgOut2017E.pdf

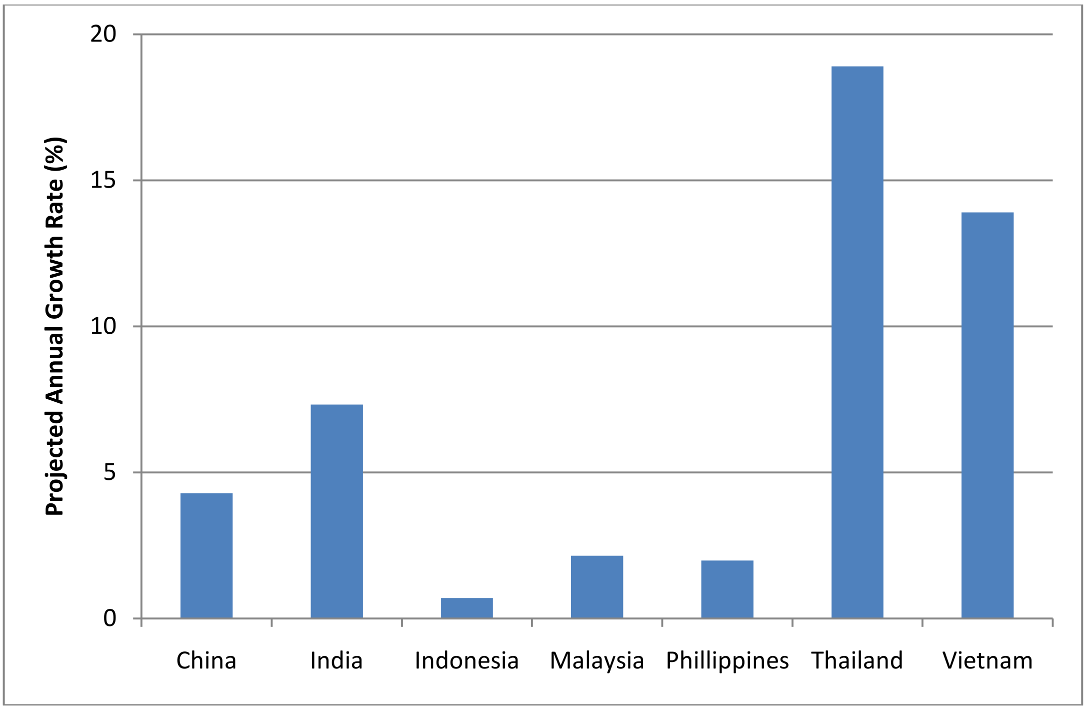

Figure 4.4.2 Asian Ethanol: Projected Growth Rate 2009-2017
Source: OECD-FAO Agricultural Outlook 2008-2017

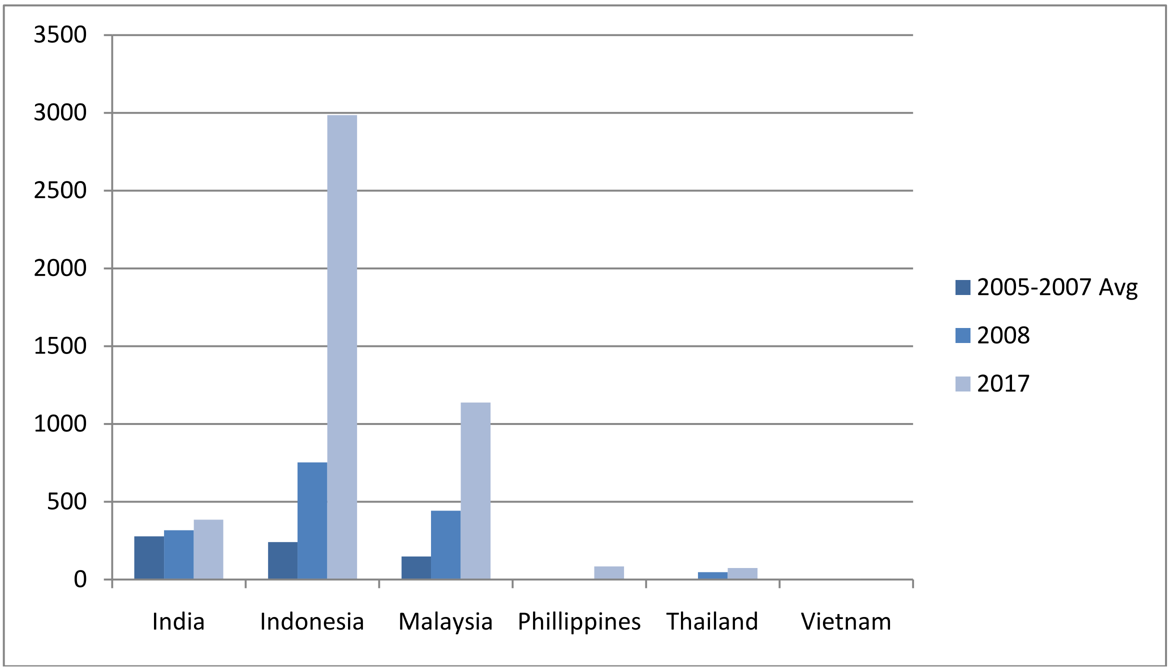

Figure 4.4.3 Asian Biodiesel Production: Current and Predicted in 2017 (Million Litres per Year)
Source: OECD-FAO Agricultural Outlook 2008-2017

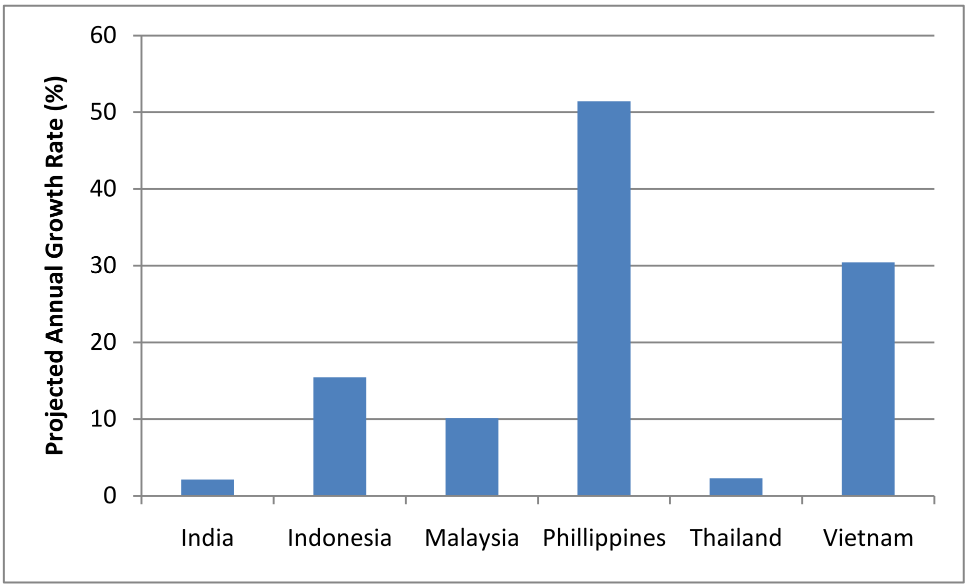

Figure 4.4.4 Asian Biodiesel: Projected Growth Rate 2009-2017
Source: OECD-FAO Agricultural Outlook 2008-2017

Table 4.4.1 below shows the projected volumetric makeup of biofuels in automotive transport in the year 2030.

Table 4.4.1 Projected Contribution of Biofuels to Total Transport Fuel Demand in 2030 (USAID, 2009)

APEC Economy	2030 Projection
China	6%
Indonesia	11%
Malaysia	3%
The Philippines	8%
Thailand	14%
Viet Nam	8%

Source: USAID Policy Brief[38]

4.5 Biofuels Trade Patterns

Traditionally, small profit margins on biofuel production serve to limit the extent of trade over large distances, and as a result, the majority (90 percent) of the world's biofuel production is produced domestically. The Asian biofuels market historically has utilised Singapore, a key hub for trading of oil and petroleum products, as a transhipment point. However, this situation has come into jeopardy due to an anti-circumvention probe currently being conducted by the European commission.

Indonesia and Malaysia are currently the major exporters of the region, as seen in Figure 4.5.1 and Figure 4.5.2. Predictions indicate that Thailand and Viet Nam will be major future players in bioethanol trade. While Indonesia and Malaysia do export biodiesel, CPO (Crude Palm Oil) remains the main trading commodity until domestic production facilities increase in capacity, which could result in either additional biofuel export, or diversion of CPO stocks

[38] http://usaid.eco-asia.org/programs/cdcp/reports/PolicyBrief_Biofuels_in_Asia.pdf

into the domestic market. The main export market for Indonesian ethanol is Japan. The future of ethanol export is uncertain, considering the growth of domestic fuel ethanol demand[39].

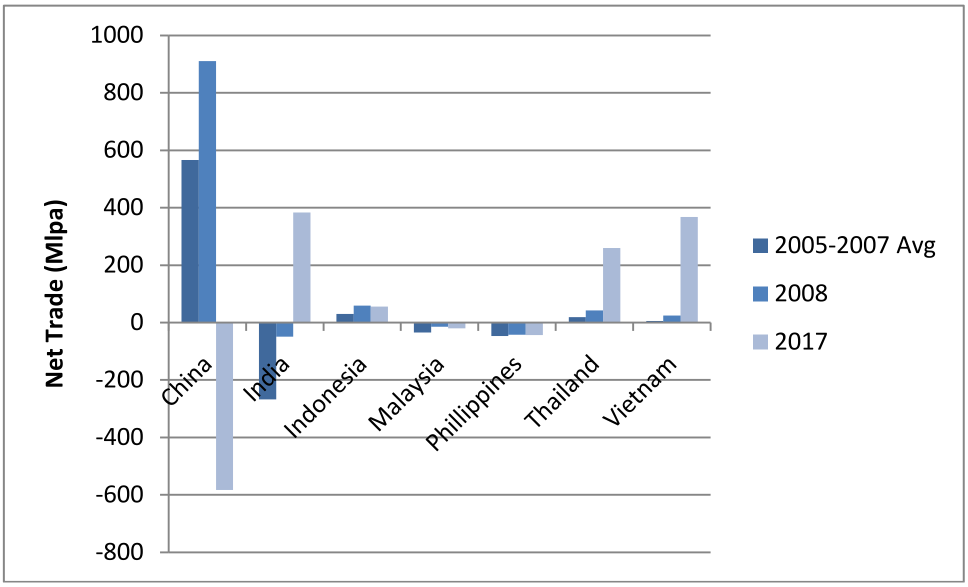

Figure 4.5.1 Asian Ethanol Net Trade: Current and Projected 2017
Source: OECD-FAO Agricultural Outlook 2008-2017

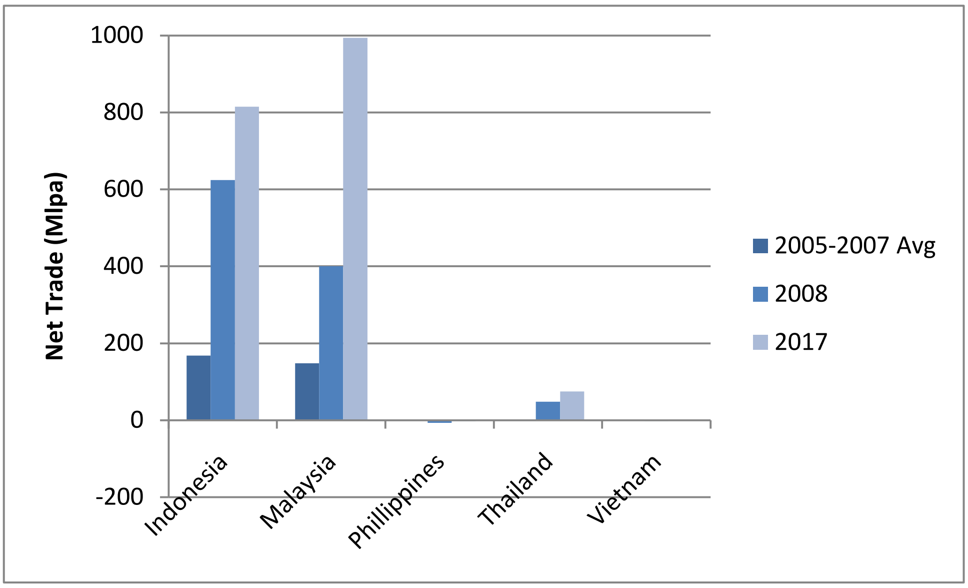

Figure 4.5.2 Asian Biodiesel Net Trade: Current and Projected 2017
Source: OECD-FAO Agricultural Outlook 2008-2017

---

[39] http://www.biofuels.apec.org/me_indonesia.html#economics

4.6 Second Generation Biofuel Potential and Impact on Retail Distribution Infrastructure

Some of the biofuel production targets and mandates presented in Tables 4.3.1 and 4.3.3 are predicated on the availability of second generation biofuels. This report will not explore technical or economic challenges to the development of second generation biofuels, but will explore potential production levels should these challenges be met. Various reports have included “biomass inventories” in APEC economies, including a 2008 Survey of Biofuel Resource Assessments by the U.S. National Renewable Energy Laboratory (NREL)[40] and the comprehensive Asian Biomass Handbook[41]. There can be significant debate over biomass availability, based on suitability, location, cost, and competing uses. The amount of biofuel that could be produced from these resources is also the subject of conjecture – reasonable estimates project that approximately 300 to 355 liters per tonne of biomass could be produced in a technologically advanced biorefinery, depending upon the technology and biomass composition. The data in Table 4.6.1 should thus be viewed as a crude estimate of potential second generation ethanol production from biomass, but nonetheless sufficient to gauge whether or not the potential volumes may warrant large scale infrastructure development.

Most of the biomass data in Table 4.6.1 were derived from the NREL survey of biomass resources, supplemented by data from other reports for Malaysia, Peru, Papua New Guinea, and Singapore. In some cases, the Asian Biomass Handbook and the NREL report provide markedly different estimates of available biomass; for example, the NREL report cites a study suggesting a total of 32 megatonnes per year of biomass residues would be available in Malaysia, while the Asian Biomass Handbook projects approximately double that amount. A factor of two difference (either higher or lower) was also noted in other APEC economies, including Japan, Korea, and Singapore.

Among APEC economies, the United States and China have the greatest potential for second generation biofuels production. Other APEC economies may have lower potential production volumes, but these volumes could still represent a significant fraction of total liquid fuel demand. In some cases, such as Malaysia, biofuel production from first and second-generation sources could exceed internal demand, allowing exports to other APEC economies.

The last two columns in Table 4.6.1 provide an estimate of the range of E85 pumps that may be required in conjunction with growth of second generation biofuel production. The lower estimate assumes only 1 percent of the available ethanol is sold as E85, consistent with EIA projections based widespread ethanol sales as a blend component[42], with each pump processing 100,000 U.S. gallons per year, meeting the economic threshold discussed in section 4.2.2. The higher estimate represents a case where the blend wall has been reached, and thus assumes 20 percent of the ethanol produced is sold as E85; at this high level of penetration, each facility processes 850,000 U.S. gallons per year, in line with typical gasoline throughput. These estimates assume that all of the available biomass is converted into ethanol, and exclude other potential bioenergy/biofuel uses for these feedstocks. Consequently, these values represent practical upper limits for each scenario.

[40] “Survey of Biomass Resource Assessments and Assessment Capabilities in APEC economies”, NREL report TP-642-43710, November 2008

[41] “The Asian Biomass Handbook: A Guide for Biomass Production and Utilization”, Chapter 7, The Japan Institute of Energy, January 2008.

[42] Richard Newell, Energy Information Administration, and 2011 Annual Energy Outlook

	Estimated Available Biomass (NREL, 2008)	potential ethanol, BLY		Potential E85 Pumps	
	Mt/y	low yield	high yield	1% penetration	20% penetration
Australia	36.7	11	13	344	809
Canada	71	21	25	665	1,566
Chile	3.25	1.0	1.2	30	72
China	788	237	280	7,385	17,376
Indonesia	74	22	26	693	1,632
Japan	15	4.5	5.3	141	331
Korea	13.1	3.9	4.6	123	289
Malaysia	9.6	2.9	3.4	90	212
Mexico	74.5	22	26	698	1,643
New Zealand	5.5	1.7	2.0	52	121
Papua New Guinea	23.6	7.1	8.4	221	520
Peru	1.2	0.4	0.4	11	26
Phillipines	17.7	5.3	6.3	166	390
Russia	100	30	35	937	2,205
Singapore	1.4	0.4	0.5	13	31
Chinese Taipei	1.9	0.6	0.7	18	42
Thailand	47.8	14	17	448	1,054
United States	1,277	384	453	11,967	28,159
Viet Nam	93	28	33	872	2,051

Table 4.6.1 Second Generation Ethanol Potential and Projected Retail Distribution Infrastructure

4.7 Criteria and Conditions for Pipeline Transport of Biofuels in APEC economies

As noted previously, construction of a dedicated biofuels pipeline must meet both technical and economic feasibility criteria. Factors influencing technical feasibility include geography and topography, in addition to biofuel properties. APEC economies that have a very rugged, mountainous terrain would be less likely to use pipelines for shipment of liquid fuels, because of the added technical, environmental and economic challenges associated with construction around mountains, over deep valleys, over wide rivers and around large bodies of water.

Factors influencing economic viability include the volume of fuel to be transported, the distance the biofuel is transported, and the cost and availability of alternative modes of transportation. For example, countries with a well-developed, existing rail infrastructure may find it more cost and time effective to build dedicated rail terminals and invest in rail cars to deliver fuel than to construct a dedicated pipeline. However, once a certain volume threshold has been met, the economics may favour pipeline construction – a point where the amortized capital cost of the pipeline can be spread out over a sufficient volume of biofuel that the effective cost per liter can now compete with the cost for rail, truck, barge and marine transport.

While this threshold volume will depend upon cost of construction in the economy and the cost to use conventional infrastructure, it is apparent from the POET-Magellan ethanol pipeline proposal and the related DOE study that this volume will be on the order of several billions of liters annually. The Magellan-Poet pipeline proposes to transport about 3.7 billion U.S. gallons (14 billion liters) of biofuel annually, over 1700 miles (2,700 kilometers), and there is still some debate over whether or not this proposal is economically viable without some government support. A shorter pipeline would have greater fixed costs, because engineering, design and project development costs are not strongly influenced by line length. Consequently, the volume required for economic viability will increase for shorter pipelines.

A detailed summary of existing pipelines in APEC economies is presented in Appendix B. The pipeline maps and analysis of liquid petroleum products transport provides an indication of economies that have sufficient liquid fuels demand to warrant a pipeline, and geographical attributes amenable to pipeline development. The pipeline maps also illustrate possible avenues for transportation infrastructure collaboration across APEC economies, but also illustrate regions where pipelines may not be feasible. Some key outcomes and observations are summarized below:

- Many APEC economies currently do not have pipelines for refined petroleum products, and are thus unlikely to develop pipelines specifically for biofuels. Examples include Brunei Darussalam; Hong Kong, China; Japan; New Zealand; Papua New Guinea; Peru; Singapore and Chinese Taipei.

- APEC economies with short fuel products pipelines confined close to coastal regions include Chile; Indonesia; Malaysia; The Philippines; Thailand and Viet Nam.

- Significant pipeline infrastructure for liquid fuels is present in Australia, Canada, China, Mexico, Russia and United States; this may serve as the platform for building dedicated pipeline infrastructure for biofuels, provided there is sufficient demand.

- China's has a unique position as a growing energy consumer, an APEC Economy with significant existing pipeline infrastructure and extensive borders with adjacent APEC economies, including Hong Kong, Russia and Viet Nam. While China has the capability to develop dedicated biofuels pipelines independently, it has also shown an interest in jointly developing pipelines with its neighbors, which could enhance the likelihood of a dedicated biofuels pipeline in these neighboring APEC economies.

- Similarly, the significant demand for liquid fuels in the United States and extensive pipeline networks that extend into Canada and Mexico could increase the potential for a dedicated biofuels pipeline in these latter two APEC economies.

As noted previously, based on the DOE study and the POET/Magellan and Logum/Petrobras projects, approximately 16 billion liters per year of biofuel has been suggested as the threshold volume needed for a dedicated pipeline to be economically viable. Furthermore, such a volume would represent only part of the total biofuel production, since a significant fraction would be used locally or regionally, without requiring pipeline transport. Based on the data in Table 4.6.1, it is apparent that only China and the United States could clearly justify a dedicated biofuels pipeline based on potential second generation biofuels production. In all other economies, a dedicated biofuels pipeline would be contingent on sufficient aggregate volumes of first generation and second generation biofuel production, and/or collaboration with adjacent APEC economies. This is further explored below.

Based on the foregoing analysis, and projected biofuels volumes cited in Figures 4.4.1, 4.4.3, 4.5.1, and 4.5.2 and the Appendix, we can project which economies will be likely to have sufficient volumes of biofuel to justify a dedicated biofuels pipeline. Biofuel handling can take the form of internal production or trade; the latter may require bi-directional pipelines.

Figures 4.5.1 and 4.5.2 indicate that with the exception of China, none of the Asian APEC economies would be likely to import or export sufficient first generation biofuels to justify a dedicated biofuels pipeline. The largest projected import/export volume for biodiesel is approximately 1 billion litres per year (Malaysia), while the largest projected import/export volume for ethanol is 0.6 to 0.9 billion litres per year (China). Both levels are by a large factor smaller than the projected volumes for projected economic viability of a dedicated ethanol pipeline for that purpose. Even with second generation biofuels included, Malaysian biofuel production will likely fall below the volume threshold needed to support a dedicated biofuels pipeline. Indonesia is in a similar (but slightly better) position; it has significant second generation biofuel potential, which, when coupled with 3 billion liters per year of biodiesel production, may be sufficient to spur development of a dedicated biofuels pipeline. However, its extensive coastline makes marine transport a more attractive alternative.

The data in Figure 4.4.1 indicate that, by 2017, ethanol demand in China could rise to about 12.7 billion litres per year, close to the level that could justify a dedicated biofuels pipeline. No other Asian APEC economy comes close to this level of utilization. Moreover, China’s potential second generation biofuel production is on the order of hundreds of billions of liters per year, sufficient to warrant consideration of dedicated biofuels pipelines. Furthermore, China has some existing fuel products pipelines that might be modified/adapted for ethanol transport. The fact that much of China’s ethanol production is fairly concentrated in the east-northeast region might also create the right conditions for pipeline transport. However, most of these same regions also border the Pacific Ocean, which might make transport by water a more attractive option.

As shown in Table 4.6.1, the second generation biofuel potential in some other APEC economies also exceeds the volume threshold of 16 billion liters per year (BLY) anticipated for cost-effective construction of a dedicated ethanol pipeline. These include Canada (25 BLY), Indonesia (26 BLY), Mexico (26 BLY), Russia (35 BLY), Thailand (17 BLY), and Viet Nam (33 BLY). However, it is unlikely that all of the available biomass will be used to make ethanol, and furthermore, it is unlikely that even 50% of the biofuel production will be transported by pipeline. Furthermore, some of these economies have well developed marine transport infrastructure, which may be used for biofuels in a similar manner to their existing use for petroleum. Thus, these APEC economies are unlikely to independently develop dedicated biofuel pipeline. Nonetheless, biofuels trade may facilitate joint pipeline development in some geographically contiguous APEC economies.

Table 4.7.1 summarizes the situation in various APEC economies, considering the three classifications listed in section III:

I) APEC economies with high levels of biofuel production or demand sufficient to consider development of biofuel pipeline

II) APEC economies with high levels of biofuel production or demand, but unlikely to develop biofuel pipeline infrastructure

III) APEC economies with low levels of biofuel production or demand

Table 4.7.1 distinguishes between economies with and without significant biofuels mandates, and among those with significant biofuels programs, which APEC economies produce or consume greater than 16 billion liters per year of biofuel, a level considered sufficient to justify a dedicated biofuels pipeline. Table 4.7.1 also highlights the presence or absence of existing pipeline and rail infrastructure, and feedstock available for biofuels production.

APEC Economy	Option I Current Production and/or Mandates to Produce more than 4 MGY biofuels	Option II Current Production and/or Mandates to Produce Biofuels but less than 4 MGY	Option III Current Production and/or Mandates to Produce Little or no Biofuels	Limited or no Biofuels Mandates	Have Biofuels Mandates	Have Feedstocks to Produce Biofuels	May need to Import Feedstocks to Produce Biofuels	Limited or no Rail Line Shipment Infrastructure	Established Rail Lines Shipment Infrastructure	Limited or no Transportation Fuel Products Pipelines (excl. NGL)	Transportation Fuel Products Pipelines (excl. NGL)	Net Importer of Transportation Fuels
Australia												
Brunei Darussalam												
Canada												
Chile												
China												
Hong Kong, China												
Indonesia												
Japan												
Malaysia												
Mexico												
New Zealand												
Papua New Guinea												
Peru												
Philippines												
The Russian Federation												
Singapore												
South Korea												
Chinese Taipei												
Thailand												
USA												
Vietnam												

Table 4.7.1 Summary of Infrastructure and Biofuel Development in APEC economies

4.8 Policies to Promote Biofuel Infrastructure Expansion

The expansion of biofuels production and consumption in APEC economies will be influenced by a number of government policies. Some of these policies will aim to utilize agricultural and forestry resources, providing incentives or mandates to support biofuel production from farm and forest residues. Economies with abundant feedstocks may consider such policies, even if the biofuels produced were primarily destined for export markets. Other economies may adopt policies to support biofuel utilization, driven either by environmental considerations, or to ensure markets for the biofuels produced by domestic biorefineries, or to develop substitutes for imported petroleum. The overall impact of these policies is to create a baseline market and infrastructure for biofuel production, distribution and consumption. Policies to encourage fuel retailers to construct or renovate fuel pumps at retail level will also likely be required. This may include E85 pump conversion strategies. In addition, some policy to facilitate storage tank conversion and blending infrastructure for biofuel blends should be considered. Some economies are considering the strategy of flexible fuel pumps that would enable mid-range ethanol blends to be blended on the retail site. This type of strategy may stimulate the market for higher ethanol blends, and has been proposed in the United States.[43] However, others have suggested that although this approach would minimize storage site infrastructure, the downside of approach is that it can result in non-compliant fuel being blended at the retail site. A better approach may be the creation of a mid-range ethanol blend. Policies may consider this option.

Some policies may also be required to encourage production and collection of second generation feedstocks. At low biofuel production levels, the infrastructure impacts are fairly small, relying on existing road or rail infrastructure. Some adaptation of terminals, installation of fuel tanks, and adjustments to the vehicle refuelling infrastructure may be required, depending upon the baseline fuel and vehicle fleet used in the economy. Progressive growth in biofuel production and demand will ultimately create greater demands on infrastructure, to the point where some dedicated biofuel infrastructure is required. Over the long term, this may take the form of extensive construction of rail or pipeline infrastructure as the biofuels are shipped to more distant demand centers, changes to the vehicle refuelling infrastructure, and more extensive changes to the vehicles themselves, to accommodate the different fuel properties. Policies to encourage automakers to produce more flex-fuel vehicles will likely be needed. Finally, policies and incentives to facilitate large scale infrastructure development will be essential, encompassing fuel terminals, marine infrastructure, rail tankers and pipelines. As demonstrated from the experience in Brazil and the United States, these policies will likely be implemented incrementally, allowing a gradual transition to biofuels and spreading out infrastructure costs over many years, even decades. However, long term planning and signals of a long-term commitment to adoption of biofuels underpin all policy development.

Policies are also needed to stimulate distribution infrastructure growth to ensure that biofuels distribution infrastructure keeps pace with anticipated expansion of biofuels production. Policies need to be considered to encourage construction of biofuel filling stations. The development of E85 stations is likely to focus initially on rural areas where biofuels are produced. Incentives and policies to facilitate expansion of biofuel filling stations in distant markets could help demand and supply to evolve in a balanced manner, leading to expansion of biofuels infrastructure in areas outside regions where biofuels are produced. Simultaneous deployment of Flex-Fuel Vehicles in government fleets and mandated use of biofuels in government fleet vehicles can help to create sufficient demand to justify a dedicated biofuels pump or station.

[43] http://www.growthenergy.org/ethanol-issues-policy/fueling-freedom-plan/?/fuelingfreedom

5.0 Summary and Recommendations

The metrics and analysis presented in Section 4 illustrate that infrastructure costs comprise several key categories, including (i) initial transportation of the product, (ii) storage and blending at terminals, (iii) distribution to retailers, and (iv) retail sales. Requirements and costs for (ii) – (iv) are essentially the same, irrespective of the initial mode of product transportation. Nonetheless, these costs can be significant, and often need to be the primary focus of incentives and policies to foster initial growth of biofuel consumption in an economy.

Initial product transportation can occur by truck, rail, barge, boat, or pipeline. Marine transport is practical and cost effective if the APEC economy has extensive coastline or inland waterways. Truck transport is cost effective over shorter distances, usually up to 600 km, while rail transport generally becomes cost effective over longer distances. Pipeline transport may become attractive for large biofuel volumes that need to be transported over long distances, projected to exceed 16 billion liters per year over 2,000 km. The exact cost "breakpoints" between truck versus rail versus marine versus pipeline will vary between APEC economies, and even within APEC economies, depending upon geography, costs of capital, energy and labor costs, existing infrastructure, biofuel volume and distance. Among these, pipelines are most capital intensive, and carry the most financial risk due to the larger initial capital investment, whereas truck, rail, and marine transport can grow incrementally as biofuel production grows. These latter modes of transportation are also the most flexible and best able to capitalize on existing infrastructure (roads, railways, ports), a distinct advantage compared to a pipeline. However, for long distance inland transport of large volumes of fuel to a major hub or distribution point, pipelines can provide a safer, more cost effective and less GHG intensive method of delivering biofuel to its ultimate market. Collaboration between APEC economies may facilitate pipeline development in regions where biofuel volumes might otherwise be too low to economically justify construction of a dedicated pipeline.

The biofuel volume likely to trigger expansion of the distribution network and retail infrastructure is dependent upon the distance between demand centers and feedstock and production centers. If feedstock is widely dispersed, and most of the major markets fall within an approximate 600 km radius of the production facilities, distribution by truck will dominate, until these markets are saturated at the blend limit. Conversely, if production is concentrated in a small geographic region, and most markets are far away from the production facilities, long distance transportation by rail, boat, barge or pipeline is essential, even if the aggregate volume of biofuel production is well below blending limits.

Biofuels may be sold as low level blends, which have minimal impact on retail distribution infrastructure, or as high level blends that require dedicated pumps and storage. The latter become more important once local biofuels production exceeds the blending limit in the local market. Once this blend limit is reached, there are two expansion options – sell fuel as a high level blend, or export the fuel outside of the local market area to more distant markets. Both options have infrastructure implications. High level blends such as E85 require dedicated retail infrastructure that may cost upwards of $100,000 for new installations, and require annual E85 sales approaching 400,000 liters. Incentives or policies to ensure the development of this retail infrastructure may be needed. Alternatively, longer distance transportation requires rail infrastructure, including rail cars, rail spurs and blending equipment at fuel terminals, or marine infrastructure, with boats, barges, and portside storage and blending equipment. As noted above, if volumes and distances warrant, pipeline transport may become an economically viable option.

To be economically attractive, pipelines must have substantially lower operating costs than rail in order to compensate for the substantially higher cost of capital. This is more difficult to achieve in dedicated fuel pipelines that typically process smaller volumes and cannot spread out the cost of capital over a broad range of products. However, in APEC economies with large biofuels volumes, dedicated biofuels pipelines help to broadly distribute biofuel and reduce clustering of retail distribution close to production regions.

Glossary of Terms

Biodiesel: A fuel comprised of mono-alkyl esters of long chain fatty acids, derived from vegetable oils or animal fats, designated B100.

B100: The neat methyl ester meeting ASTM D6751 or EN14214 (or equivalent) and used for making biodiesel blends.

Biodiesel Blend: A blend of biodiesel with petroleum-based diesel fuel, designated BXX, where the XX is the volume percentage of biodiesel.

Biomass: The common name for organic materials that may be used as renewable energy sources. These may include wood, crops, crop residues, and municipal and organic wastes.

Biomass Densification: The process of biomass densification is typically a mechanical process and involves transforming loose biomass into dense pellets or other forms for more economic transport and more efficient utilization.

Disappearance: The distribution of feedstocks into the market place, via various pathways, including food, feed, industrial uses, reservation for seed, and handling losses..

Dedicated Biofuels Pipelines: Those pipelines that would carry only biofuels. For the sake of this report, sometimes simply referred to as dedicated pipelines.

Drop-in Fuels: "Drop-in" fuels are those that would be expected to be able to blended with the petroleum fuels (i.e. gasoline or diesel or jet fuel), without requiring infrastructure modifications. Nonetheless, they are still a blending component (much like ethanol or biodiesel), and thus require some adaptation of the fuel blendstock (gasoline or diesel) to meet specifications or standards for the final blended fuel. Examples of "drop-in" fuels would include biobutanol, Fischer-Tropsch diesel (F-T diesel) and HRDD (Hydrogenated Renewable Diesel).

E100: The neat ethanol meeting ASTM D4608 (or equivalent) and used for making ethanol blends.

E85: An E85 blend is by definition a blend of 85 percent ethanol and 15 percent gasoline. Some E85 blends may contain as little as 70 percent ethanol in order to meet the seasonal and regional specifications of use.

E10: An E10 blend is a blend of 10 percent ethanol with 90 percent gasoline.

Ethanol Blend: A blend of ethanol with petroleum-based gasoline fuel, designated EXX, where the XX is the volume percentage of ethanol.

Flex Fuel Vehicles: Vehicles which can run on fuels containing between 0 and 85 percent ethanol, i.e., up to an E85 blend.

Fuel Products Pipelines: These are pipelines which carry fuel products such as gasoline, diesel and jet fuel. Some of these may also include some other fuel component products such as LPGs (Liquefied Gas Products).

Green Diesel: A biofuel produced from renewable feedstocks (vegetable oils, fats) by hydrogenation rather than esterification. An example of this would be HRDD.

Liquefied Gas products (LPG): In the context of this report, these are products such as butanes which may be used as gasoline blending components or may share a Fuel Products Pipeline.

Natural Gas Pipeline: These pipelines are for the transport of natural gas only.

Marginal Land: This refers to land that is not suitable for production of agricultural-food crops, for either economic reasons or land quality reasons. It typically refers to land formerly used for crop production, but fell out of use because yields were too low for economically viable crop production. It can include land with excess salinity, or land depleted of some key nutrients. It nominally would NOT include marshland or similar ecologically sensitive areas.

Oil Pipelines: Oil Pipelines are for the transportation of crude oil and are not suitable for use in transporting finished fuel products such as gasoline, diesel or jet (or biofuel blends) due to product contamination issues.

Primary Terminal: A petroleum fuels terminal where fuel is transported from a pipeline or refinery and stored or blended with biofuels prior to distribution to retail storage.

Secondary Terminal: A petroleum fuels terminal where fuel is transported from a Primary Storage terminal and stored or blended with biofuels prior to distribution to retail storage.

ULSD: Ultra Low Sulphur Diesel (ULSD) is diesel which has sulphur content equal to or less than 15 mg/kg (PPM) sulphur.

USG: (United States Gallon): The United States gallon (USG) is 3.78 liters as compared to the Imperial Gallon which is 4.54 liters.

ULSK: Ultra Low Sulphur Kerosene (ULSK) is diesel which has sulphur content equal to or less than 15 mg/kg (PPM) sulphur.

APPENDIX A:

BIOFUELS IN APEC MEMBER ECONOMIES

INDEX – APPENDIX A

TABLES

FIGURES

A. Biofuels in APEC Member Economies

A.1 Biofuels in Australia

In Australia, total petrol consumption in 2009 was 19 gigaliters and they imported more than 22% of those needs.[1]

A.1.1 Biofuel Mandates in Australia

There was a biofuels production target of 350 MLY by 2010. However, this has effectively been dropped with the government no longer referring to this policy. [2]

Ethanol Mandates

Although there are no economy-wide ethanol mandates in Australia, some state governments in this APEC economy are promoting ethanol blends, especially in Queensland (QLD) and New South Wales (NSW). No plans have been announced by the government to mandate the blending of ethanol or biodiesel with First Generation fuels or increase the biofuels target beyond 2010.

Queensland (QLD) was the first state in Australia to encourage the use of ethanol blends, and has mandated the use of ethanol blends in the government fleet since 2005 wherever possible. The state of Queensland has committed to a mandate of volumetric inclusion of five percent by 2011 (From 31 December 2010 onwards). As part of the preparation process for this legislation, the State Government of Queensland published a public benefit test which outlines the impact of a five percent volumetric mandate. The report suggested that the mandate would likely increase current demand in the State of Queensland to 183 ML, up from 60 ML at present. There is also a five percent biofuel target in Victoria as of 2010.

New South Wales (NSW), through its Biofuel (Ethanol Content) Bill 2007, has become the first state to have an ethanol mandate. That mandate requires ethanol in at least 2% of total gasoline sold in the state as of 1 October 2007 (based on three month average volumes). However, the bill also provides for suspension of the operation by the NSW Premier under the following conditions: if the price is not economically viable (or if there are industry-wide ethanol shortages), or if for retail customers, the ethanol blend results in a retail price increase. The current mandate in New South Wales is two percent. The state of New South Wales will increase its volumetric mandatory inclusion policy for ethanol. Under this legislation, by 2011, the mandatory volumetric inclusion level of ethanol in petrol will be ten percent. Industry sources believe that this will equate to roughly 120 ML of ethanol per year, while government sources believe this could generate as much as 380 ML of demand. According to sources, the NSW mandate is expected to become the primary driver of ethanol demand in Australia.

---

1 http://www.biofuelsassociation.com.au/index.php?option=com_content&view=article&id=70&Itemid=87

2 http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Canberra_Australia_07-06-2010.pdf

Biodiesel Mandates

Rather than having biodiesel mandates, the government has opted to amend the diesel standard to allow the addition of up to five percent by volume of biodiesel and to allow the supply of higher biodiesel blends such as B20 in the short term through the Fuel Quality Standards Act 2000.

A.1.2 Biofuel Market in Australia

Ethanol

In August 2006, the Ethanol Distribution Program was launched with the intent to implement over the next 8 years. Production grants were to be given to encourage the development of facilities at service stations to sell ethanol blended gasoline and effectively offset the excise tax on ethanol production in Australia. <u>The Australian government also recognized that lack of access to distribution infrastructure as one of the barriers to the penetration of E10</u>. To address this, an additional AUS$17.2 million was to be provided over three years to reduce the infrastructure cost of installing new pumps or converting existing pumps to E10 blends and to encourage sales of E10.

The Australian government was to allocate up to AUS$20,000 per station to the cost of converting service stations to supply E10. Up to AUS$10,000 was to be provided after the conversion is complete and an additional AUS$10,000 after an ethanol blend sales target is reached. Oil majors including BP, Shell and Caltex have been marketing ethanol blends in Australia since 2001.

Table A.1 Availability of Ethanol Blends in Australia

Company	Biofuel Blend	Location	No. of Service Stations
Caltex	E10	NSW, QLD, ACT	266
United Petroleum	E10	NSW, QLD, ACT, NT, SA, VIC	262
Shell	E10	NSW, QLD, ACT	181
BP	E10	NSW, QLD, ACT	147
Neumann Petroleum	E10	QLD, NSW	62
Freedom Fuels	E10	NSW, QLD	53
Evolve Fuels	E10	QLD	6

Notes: ACT – Australian Capital Territory, NSW – New South Wales, NT – Northern Territory, QLD – Queensland, SA – South Australia, VIC – Victoria, WA – Western Australia
Source: Global Biofuels Center, May 2008

In spite of the above market initiatives, lack of consumer confidence and access to distribution, infrastructure still remain the major barriers to the uptake of E10.

Biodiesel

Australia has over 900 biofuel refuelling stations. The majority of these sell E10 with some stations selling biodiesel blends typically B2, B5 and B20. United Petroleum intends to sell E85 from two sites one in Melbourne and another in Sydney. Although there is currently very little biodiesel for commercial sale in Australia, biodiesel blends including B5 and B20 are already sold in various locations. As shown in Table A.2 the oil majors and smaller players such as Freedom Fuels, United Petroleum, Neumann Petroleum, Gull Petroleum and

Australian Farmers Fuel have successfully launched E10 and various biodiesel blends in different parts of Australia, especially in NSW and Queensland.

Table A.2 Availability of Biodiesel Blends in Australia

Company	Biofuel Blend	Location	No. of Service Stations
Caltex	B2	NSW	128
Neumann Petroleum	B20	QLD, NSW	62
Freedom Fuels	B20	NSW, QLD	53
Australian Farmers Fuel	B20, B100	SA, NSW, NT, WA, VIC	49
Gull Petroleum	B20	WA	33

Notes: ACT – Australian Capital Territory, NSW – New South Wales, NT – Northern Territory, QLD – Queensland, SA – South Australia, VIC – Victoria, WA – Western Australia
Source: Global Biofuels Center, May 2008

In addition, a number of biodiesel plants have stopped operations since end-2007 due to rising prices of feedstocks such as tallow and palm.

A.1.3 Biofuels Demand & Supply in Australia

Biofuels capacity for 2009 is estimated at 739 MLY, representing about 456 MLY of ethanol and 283 MLY of biodiesel.

Ethanol

Ethanol production capacity increased in 2009 by around 267 ML to reach 456 ML. Actual ethanol production increased by around 54 MLY in 2009 to reach 203 MLY.
The first commercial scale first generation plant was commissioned in Dalby, Queensland in early 2009, producing 80 million liters of fuel ethanol per year. It has recently gone into receivership, due to a number of factors , particularly high capital costs, and unfavourable off take agreements. Although Australia has the potential to meet its ethanol demand in the near term, market fluctuations in feedstock prices remain a concern.

As there are currently no announced federal mandates for ethanol and only a voluntary target stands, a low economy-wide blending level of E5 is assumed until 2010, and is based on the ethanol blending target that the state of Queensland has set, and on typical blending pathways that many other Provinces are following. Assuming that the blend is increased and does not go beyond the current blending limit of E10 by 2015, supply would be able to keep up with demand, as additional plants are expected to come online before this time. Note that this would very much depend on the government's plans to mandate the use of ethanol blends.

Australia has placed tariffs on imported ethanol. The excise equivalent customs duty reduces the competitiveness of imported fuel ethanol, particularly from Brazil. According to government sources, imported ethanol also attracts a tariff of five percent. These measures have effectively prevented commercial trade in ethanol for consumption as transport fuel.
On 22 June 2010 Australian Customs and Border Protection Service launched concurrent dumping and countervailing duty investigations into United States exports of pure biodiesel, specifically B99, and biodiesel blends. The investigation findings should result in

recommendations being made on or before 24 November 2010 and may result in anti-dumping and/or countervailing duties being levied against United States biodiesel.

Biodiesel

Biodiesel capacity for 2009 was estimated at 283 MLY, up on 136 MLY estimated for the previous year. Biodiesel production for 2009 was estimated to be 98 MLY in 2009, up on the 54 MLY estimated for the previous year.

According to an Australian government reports, biofuel accounts for around 0.4 percent of total transport fuel consumption.

Some of the largest biodiesel plants in this APEC economy are owned by Natural Fuel and the Australian Biodiesel Group, with more than 150 million liters (39.6 million gallons) of annual capacity each. However, they stopped operations in 2007-2008, along with another producer known as Australian Renewable Fuels, because of high feedstock prices and sustained production losses. The market is currently sustained by smaller producers such as Australian Farmers Fuel, Biodiesel Industries Australia, Biodiesel Producers, etc.

Although there are currently no announced mandates for biodiesel and only a voluntary target stands, B5 is assumed to be blended economy-wide up until 2015, based on the current blending limit of five percent biodiesel by volume in diesel fuel. As a result, biodiesel supply is expected to meet demand up until 2015 based on announced capacities that would be built. However, a B5 blend is not possible given current feedstock prices and sustained production losses; thus, ethanol is expected to meet the majority of the 350 million litre (92.5 million gallon) biofuels target by 2010.

A.1.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Australia

A.1.4.1 Ethanol

Feedstock

Australian ethanol is produced from sorghum, wheat and sugar cane, with barley as a potential candidate. Production of ethanol feedstock is primarily located in the South and Southeast, as well as the East Coast (USDA, 2010). Table A.3 below is used to illustrate crops with the greatest potential for usage for biofuels.

Table A.3 Potential Ethanol Feedstocks in Australia

	Corn	Wheat	Barley	Sugarcane	Sorghum
Australia Production (Thousand metric tons per year)	310	24,000	7,900	31,457	1,600 (2009)

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Uncertainty in feedstock supply, due to severe drought, which began in 2002, has caused for extremely low levels of production in grains in past years and is of great concern to ethanol producers. However, it is expected that crop production should return to average levels in the year 2010 (USDA, 2010). If this remains to be the trend over the next few years, it is expected that current domestic ethanol feedstock supply will be sufficient for the ethanol market. This is also dependent upon the states mandates and/or government's plan to implement E10 over the next five years.

Production

With plant capacity increasing to 456ML in 2009, Australian ethanol production has the capability to increase to 2015 should governments mandates prove to be favourable and feedstock available. Up to this point, actual production has increased to about 203 ML, due to government sources. Any significant increase in demand is most likely to be driven by state mandates, such as with QSLD and NSW (USDA, 2010).

Table A.4 First Generation and Advanced Ethanol in Australia (million liters)

First Generation and Advanced Ethanol (million liters)						
Year End July	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	40	84	149	203	260	320
Imports	0	0	0	0	0	0
Exports	0	0	0	0	0	0
Consumption	40	84	149	203	260	320
Ending Stocks	1	2	3	4	5	6
Production Capacity (First Generation Fuel)						
No. of Biorefineries	3	4	4	4	4	4
Capacity	120	120	189	456	456	480

Source: USDA Australian Gain Report, 2010

At this point, it is unlikely that Australia will import any ethanol feedstocks or liquid ethanol, as with past years, and is unlikely that this will change in the near future. Feedstock production has returned to average yields, and current facilities are largely under capacity due to little incentives from government resources. It is clear that the current domestic grain production and liquid ethanol production is sufficient in keeping up with demand in the near term (USDA, 2010).

A.1.4.2 Biodiesel

Feedstock

Currently, biodiesel is produced from mainly used cooking oil, animal fats and canola. In areas considered marginal land, alternative oilseed crops (i.e. jatropha) have been considered as possible feedstocks for biodiesel production. It is estimated that production of biodiesel from used cooking oil will remain the same, where production from animal renderings will increase over the next few years due to seasonal improvements (USDA, 2010). The table A.5 below is used to illustrate crops with the greatest potential for usage for biodiesel production.

Table A.5 Potential Biodiesel Feedstocks in Australia

	Soybean Oil	**Rapeseed Oil**	**Cottonseed Oil**	**Sunflower Oil**
Australia Production (Thousand metric tons per year)	17	274	103	26

Source: USDA FAS, 2010/2011 Production Year

Production

Biodiesel capacity for 2009 was estimated at 283 MLY, up from 136 MLY estimated for the previous year. Biodiesel production for 2009 was estimated to be 98 MLY in 2009, up from the 54 MLY estimated for the previous year (USDA, 2010). Table A.6 below shows potential for first and second generation biofuels in Australia.

Table A.6 First Generation and Advanced Biodiesel in Australia (million liters)

First Generation and Advanced Biodiesel (million liters)						
Year End July	2006	2007	2008	2009	2010	2011
Production	44	43	54	98	60	60
Imports	2	5	4	12	3	3
Exports	0	0	0	0	0	0
Consumption	46	47	58	110	63	63
Ending Stocks	2	2	2	6	7	9
Production Capacity (First Generation Fuel)						
No. Biorefineries	7	7	9	8	8	8
Capacity	612	174	136	283	283	283

Source: USDA Australian Gain Report, 2010

In 2009, approximately 12.9 million liters of biodiesel was imported for use. It is likely that Australia will continue with this trend in the near term. However, with four additional plants in various stages of construction, with a combined capacity of 945 ML by 2014, it is likely that Australia's overall production of biodiesel should be sufficient for domestic demand (USDA, 2010), provided that there is sufficient feedstock and the economics are favourable. It may be the case that biodiesel feedstock must be imported in.

A.1.4.3 Infrastructure Requirements in Australia

Feedstock Transport

With domestic crop production expected to average out in 2010, it is likely that Australia will continue to utilize these crops grown domestically for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. Locally grown wheat, sorghum, and sugarcane molasses will continue to be the major feedstocks for ethanol production in the near term. At this point, current domestic supply is sufficient in meeting the market demands, and further infrastructure requirements for feedstock transport due to increase in demand can be met by truck/rail. For biodiesel, tallow and waste oils will likely continue to utilize trucks for feedstock transport and in cases where the biodiesel is imported in marine.

Biofuel Storage, Blending and Distribution

Ethanol and biodiesel (E100 and B100) and/or blends are currently trucked from the production/storage facility to the retail pumps. The majority of fuelling stations that carry biofuel blends are located in NSW and QSLD, where biofuel blends have been encouraged on a provincial level, and where the majority of production occurs. Further infrastructure requirements for fuel transport due to increase in demand from other states (due to a mandated blend) can be met by truck/rail.

In order to implement fuelling stations at other locations outside of production area, namely QSLD and NSW, retailers may take advantage of grants provided for conversion of gasoline pumps to E10 pumps, or implementing new ones offered by the Government of Australia.

A.1.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Australia

Ethanol Technology Ltd in 2007 had begun work on a A$20 million cellulosic ethanol project in New South Wales, using such feedstocks as wood residues, bagasse, etc. via biochemical conversion (EWG, 2008). Transport of these will likely be accomplished by truck or rail, utilizing wastes in close proximity to the facility.

Australia is also exploring the option of using jatropha and other alternative oilseed crops for biodiesel production (EWG, 2008). Available land identified as marginal and useful for jatropha production could incur costs in transport of the feedstock to a potential facility, unless the facility will be located close to where the plant is grown. However, this may not be ideal if retail stations are located at a farther distance, and cost of transport could increase accordingly.

The Australian government has also committed to a $15 million grant program for second-generation biofuel technologies. The National Collaborative Research Infrastructure Strategy has also committed to $7.72 million in R&D for novel biofuel production technologies (EWG, 2008).

Sources:

1. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Australia Biofuels Annual 2010 report (6 July 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Canberra_Australia_07-06-2010.pdf
3. Renewable Fuels Australia http://www.renewablefuels.com.au/frameset.htm
4. Biofuels Association of Australia http://www.biofuelsassociation.com.au/index.php?option=com_content&view=article&id=70&Itemid=87
5. http://faostat.fao.org/
6. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.2 Biofuels in Canada

A.2.1 Biofuels Mandates in Canada

A.2.1.1 Federal Renewable Fuels Standard (RFS) Mandates

The Regulations will require fuel producers and importers to have an average renewable fuel content of at least 5% based on the volume of gasoline used. The Regulations include provisions that govern the creation of compliance units, allowing trading of these units among participants and also require record keeping and reporting to ensure compliance.

Ethanol
Certain provisions of the Federal RFS Regulations will come into force on the day on which they are registered, while the 5% requirement and provisions for compliance units came into force on 15 December 2010 volumes.

Biodiesel
The Federal RFS Regulations also include provisions requiring an average 2% renewable fuel content in diesel fuel and heating distillate oil based on annual production. The proposed start date for this is 1 July 2011.

A.2.1.2 Provincial Mandates

Provincial Ethanol Mandates

Table A.7 Legislated Provincial Renewable Fuel Mandates for Ethanol in Gasoline in Canada

Province	Regulated Level	Implementation Timeframe
British Columbia	5%	2010
Saskatchewan	7.5%	2007
Manitoba	8.5%	2008
Ontario	5%	2007
Alberta	5%	In 2011
Quebec	5%*	In 2012

Source: USDA Canadian Gain Report, 2010
** Target by 2012 from advanced biofuels*

The existing mandated provincial percentages are based on the volumes used or sold to end users, rather than on volumes of gasoline produced.

The penetration of renewable fuel from the legislated mandates is expected to be significant. Indeed, projections suggest that provincial requirements currently in force would result in the use of nearly 1.3 billion liters of renewable fuel by 2010, or about 3.2% of the projected Canadian gasoline pool and 67% of the proposed regulatory requirement.

Provincial Biodiesel Mandates

Table A.8 Legislated Provincial Renewable Fuel Mandates for Renewable Diesel in Diesel in Canada

Province	Regulated Level	Implementation Timeframe
British Columbia	3%*	2010
Manitoba	2%**	2007
Alberta	2%	April 1, 2011
Saskatchewan	2%***	July 1, 2012

Source: USDA Canadian Gain Report, 2010
**Increase from 3% to 5% by 2012*
***Manitoba mandate is biodiesel (methyl ester) specific*
**** Saskatchewan mandate was announced March 23, 2011*

A.2.2 Biofuels Distribution and Storage in Canada

The total production of refined petroleum products was approximately 123 billion liters, of which motor gasoline is the dominant refined product, representing about 36% of the total production. Diesel accounts for another 23%.

There are 1,833 storage terminals spread across Canada, comprising of 76 primary terminals, 614 bulk plants and 1,143 cardlock facilities. The majority of these terminals (approximately 67%) are located in the West, with Ontario and the eastern provinces accounting for 16% and 17% of these storage terminals, respectively. Ontario, British Columbia and Quebec account for 66% of the primary terminals in Canada. Primary terminals are, for the most part, located close to major markets and transportation modes. The bulk plants, representing the second level of storage facility, account for 33% of all storage facilities in Canada and are located in areas where retail distribution is not economical. They operate as secondary points of storage and distribution, but also of sales, and as such are typically not shared facilities (unlike primary terminals).

Cardlock facilities provide fuel to commercial truckers such as long-distance haulers and delivery vehicles. These are controlled access facilities, as opposed to retail stations. Diesel is the main fuel offered for sale at these facilities primarily because the principal fuel used by commercial fleets is diesel. Due to the lack of availability of total cardlock supply data for Canada, it is difficult to accurately estimate the share of cardlock sales volume. However, it is likely that cardlock operations account for roughly 70% of all on-road diesel demand in Canada.

Approximately 28% of retail stations are owned or operated by integrated refiner-marketers. Independent marketers (the remaining 72%) buy their product from Canadian fuel producers or import their fuels, and tend to be smaller operators, even though most of their stations are "branded" with signs and logos from the major oil companies.
The number of retail stations has declined steadily from around 20 000 in the late 1980s to less than 13 000 in 2008. The total volume of gasoline sold by the retail stations in 2007 was approximately 37.6 billion liters (and 5.7 billion liters of diesel).

A.2.3 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Canada

A.2.3.1 Ethanol

Feedstock
In Canada, there is quite an abundance of wheat and barley crops, with some corn production as well. Wheat and corn represent the main feedstocks for ethanol production in Canada to date. Corn is the primary feedstock for Canadian ethanol production, and is estimated to account for 64 and 68 per cent of ethanol feedstock in 2010 and 2011 respectively. More than half of the corn-to-ethanol facilities are located in Ontario, where most of the corn is grown. In 2006, approximately 7% of the corn grown was used for ethanol. The majority is used in the livestock industry (USDA, 2010).

The remainder of ethanol is produced from wheat. Estimates for 2010 and 2011 predict that wheat will account for 35 and 31 per cent of grain-based ethanol, respectively. In 2006, approximately one percent of wheat produced was used for ethanol production, although the production of wheat was seventeen million tonnes annually (versus corn which was nine million tonnes annually) (USDA, 2010). Table A.9 below illustrates crops with the greatest potential for usage for biofuels.

Table A.9 Potential Ethanol Feedstocks in Canada

	Corn	**Wheat**	**Barley**
Canadian Production (Thousand metric tons per year)	11,000	22,200	8,250

Source: USDA FAS, 2010/2011 Production Year

Production
Ethanol production has remained constant as a result of recent delays in plant construction. If the proposed facilities come online, the five percent federal mandate would still not be met (1,900 million liters), with a total production of 1,360 million liters, at 67 percent economy capacity, although capacity will be in the order of 2,044 million liters in 2010.

Competition for wheat as a feedstock is inevitably going to increase as the biofuels industry grows. Wheat varieties for the ethanol industry are in direct competition with livestock producers, i.e. wheat which contains higher levels of starch and lower levels of protein. On the contrary, food producers/milling facilities seek wheat varieties with higher protein and lower starch contents.
The table below represents current ethanol production in Canada. It is likely that Canada will continue to import some of its ethanol to meet demand in the near term. Most of these imports currently arrive by truck, but rail transport could also be a long-term option.

Table A.10 First Generation and Advanced Ethanol in Canada (million liters)

First Generation and Advanced Ethanol (million liters)						
CY	**2006**	**2007**	**2008**	**2009**	**2010 (e)**	**2011 (f)**
Production (a)	255	800	1,153	1,348	1,360	1,400
Imports (b)	89	481	615	215	230	240
Exports (c)	80	84	289	171	145	150
Consumption (d)	265	1,195	1,476	1,393	1,450	1,490
Production Capacity (First Generation Fuel) (g)						
No. of Biorefineries (g)	5	10	12	14	15	15
Capacity	1,555	1,579	1,810	1,931	2,044	2,100
Production Capacity (Advanced Fuel)						
No. Biorefineries	0	0	0	1	1	1
Capacity	0	0	0	4	4	5
Co-product Production (1,000 metric tons)						
DDGS (h)	220	700	1,020	1,190	1,201	1,240
Feedstock Use (1,000 metric tons) (i)						
Corn	510	1,395	1,815	2,180	2,255	2,455
Wheat	135	645	1,140	1,270	1,220	1,115
Other	-	-	-	5	40	50
Total	645	2,040	2,955	3,455	3,515	3,620

Source: USDA Canadian Gain Report, 2010
Notes- Sources
(a), (d) Energy Information Association (Branch of United States Department of Energy)
(b), (c) Global Trade Atlas Network
(e) Estimated
(f) Forecast
(g) Renewable Fuels Association
(h) Conversion Rate-Every ton corn/other feedstock produces 33 percent DDGs, Every ton wheat feedstock produces 37 percent DDGs. Numbers are rounded to convey these figures are derived from formulas, not actual reported statistics.
(i) Conversion Rate- One ton of corn will provide enough feedstock to produce 400 liters of bioethanol and one ton of wheat will provide enough feedstock to produce 375 liters of ethanol according to the Canadian Renewable Fuels Association. Numbers are rounded to convey these figures are derived from formulas, not actual reported statistics.

A.2.3.2 Biodiesel

Feedstock

Biodiesel production in Canada utilizes mainly animal fats, recycled cooking oil and canola as feedstock. Canola is Canada's primary vegetable oil crop, with 30 million acres grown annually, and with annual exports of approximately 80%. In sheer volume alone, canola is the most dominant candidate for biodiesel production.
Table A.11 below is used to illustrate crops with the greatest potential for usage for biofuels.

Table A.11 Potential Biodiesel Feedstocks in Canada

	Canola Oil	**Soybean Oil**
Canada Production (Thousand metric tons per year)	2,230	260

Source: USDA FAS, 2010/2011 Production Year[3]

[3] http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Ottawa_Canada_7-13-2010.pdf

Soybean oil is also a possibility as a biodiesel candidate, as soybeans are grown in Ontario. However, soybean oil is priced under the food market, and current prices and current production mostly spoken for to be a significant biodiesel feedstock option.

Production

There are currently seven commercial-scaled biodiesel producing plants operating in Canada, accounting for approximately 118 million liters per year of production in 2007. There are also many other plants are under development or construction, mostly in the Prairie Provinces. When considering all these biodiesel plants, the Canadian biodiesel industry would have a total production capacity of 521 million liters. This production capacity is based on existing biodiesel production capacity plus NRCan EcoEnergy funding approved biodiesel production projects in Canada. Table A.12 below represents current biodiesel production in Canada.

Table A.12 First Generation and Advanced Biodiesel in Canada (million liters)

First Generation and Advanced Biodiesel (million liters)						
CY	**2006**	**2007**	**2008**	**2009**	**2010 (e)**	**2011 (f)**
Production (a)	43	92	135	187	190	195
Imports (b)	340	358	268	363	370	375
Exports (c)	320	355	308	445	445	450
Consumption (d)	65	95	98	105	115	120
Ending Stocks	**3**	**3**	**0**	**0**	**0**	**0**
Production Capacity (First Generation Fuel) (g)						
No. of Biorefineries (g)	3	4	4	7	13	13
Capacity	97	214	322	457	478	485
Production Capacity (Advanced Fuel)						
No. Biorefineries	0	0	0	0	0	0
Capacity	0	0	0	0	0	0
Feedstock Use (1,000 metric tons) (h)						
Rapeseed Oil	5	5	5	25	35	105
Animal Fats	40	80	110	130	125	65
Mixed	0	0	10	20	20	15
Total	45	85	125	175	180	185

Source: USDA Canadian Gain Report, 2010
Notes- Sources
(a), (d) Energy Information Association
(b), (c) Global Trade Atlas
(e) Estimated
(f) Forecast
(g) Canadian Renewable Fuels Association
(h) Conversion rate used: Diesel density is about 0.85 kg/liter, thus 1 metric ton is approximately 1,276 liters. Numbers are rounded to convey these figures are derived from formulas, not actual reported statistics.

It is interesting in Table A.12 above that the USDA GAIN report estimates that there will be a shift in feedstock utilization in Canada from tallow to more canola oil use.

A.2.3.3 Infrastructure Requirements in Canada

Feedstock Transport
It is likely that Canada will continue to utilize these crops grown domestically for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. Locally grown corn and wheat will continue to be the major feedstocks for ethanol production in the near term, as facilities are located within close proximity to their respective feedstocks.

The concentration of corn to ethanol facilities are in Ontario. Corn imported from the United States Midwest could also be a potential source of feed, should capacities and production increase, which could cause the need for transport from the United States to Ontario. As well, wheat to ethanol facilities can utilize the flexibility of using corn as a feedstock, for example, in times where wheat is not an economically feasible option. In this case, corn would need to be transported to these plants. Currently, Ontario is a net importer of corn, and these imports could increase if the five percent mandate is met with first-generation ethanol. For biodiesel, tallow and waste oils will likely continue to utilize truck/rail for feedstock transport.

E100 and B100 Transport, Blending and Distribution
Storage terminals for petroleum, both primary and secondary, are located in Canada's East, West and in Ontario. Construction of new storage terminals or retrofitting a portion of these for storage of ethanol is already in progress as the five percent ethanol mandate commenced on 15 December 2010. It is anticipated that the conversion and installation of biodiesel terminals is soon to be if not already in progress with the 2% renewable diesel mandate anticipated to be announced to commence in 2011.

Ethanol and biodiesel (E100 and B100) and/or blends are currently trucked from the production/storage facility to the retail pumps. The majority of biodiesel fuelling stations are located in Canada's east, west and in Ontario. Ethanol blends can be found in British Columbia, Saskatchewan, Manitoba, and Ontario, where provincial ethanol mandates have been already put in place. Further infrastructure requirements for fuel transport due to increases in supply can be met by truck/rail, as near-term volumes are insufficient to justify dedicated biofuel pipeline options.

A.2.4 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Canada

Canada has ample cellulosic ethanol resources, and is a prime candidate for cellulosic ethanol production. These include both agricultural and forestry residues.
The Agricultural Bio-products Innovation Program offers $145 million grant for R&D in biomass conversion technologies. The Agri-Opportunities Program is a $134 million loan dedicated to advancing the commercialization of agricultural products currently not produced in Canada. The NextGen Biofuels fund offers $500 million in second-generation biofuels (USDA, 2010).

The government's plans to support cellulosic ethanol indicate the growing need for infrastructure to be implemented. Canada has a vast amount of forestry and agricultural residue that could potentially be used as feedstock for cellulosic ethanol. However, the location of the facility will depend on feedstock location, in order to bring down the cost of transport. Cellulosic ethanol could penetrate the local market, as Canada is a large APEC economy with several areas of agricultural and cellulosic feedstocks, indicating that there are many different opportunities across Canada to produce ethanol and supply individual local markets.

Fuel product pipeline infrastructure is already implemented in Canada, and is a more economical option and could provide a lower GHG footprint. This may also play an important role in fuel transport in the longer term, should the demand for biofuel incur a demand for a more flexible mode of transport. However, in the near and medium term, biofuel production volumes are likely too low to justify the expense of a dedicated biofuels pipeline.

There are also only a handful of E85 stations economy-wide. Large scale expansion of ethanol production could drive the implementation of more E85 stations, particularly if Government fleets (100 – 170 automobiles) were present in a local market area, and fleet purchases were directed towards biofuels.

Sources:

1. Canadian Renewable Fuels Association http://www.greenfuels.org/en.aspx
2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Canada Biofuels Annual 2010 report (13 July 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Ottawa_Canada_7-13-2010.pdf
3. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.3 Biofuels in China

China is the second largest energy consumer in the world. Consequently, China is looking at biofuels to reduce its foreign energy dependence and reduce the use of petroleum products. Although China is the third-largest ethanol producer in the world (after Brazil and the United States), most of China's ethanol production is used in the beverage industry at this time.

A.3.1 Biofuels Mandates in China

There are no economy-wide mandates in China at this time, although targets were introduced. As of 2007, E10 distribution was taking place in five provinces and 27 designated cities in four other provinces. At that time, NDRC Energy Bureau Director General Xu Dingming proposed a plan to boost renewable energies share of the primary energy demand to 16% by 2020.[4]

Ethanol Targets
2010 – 2.0 million tons (approx. 2.53 billion liters)
2020 – 10 million tons (Approx. 12. 67 billion liters)

Five provinces of Jilin, Heilongjiang, Henan, Anhui and Liaoning, and parts of four provinces including Hebei, Hubei, Shandong and Jiangsu, were designated by the government to switch to E10 by year-end 2005, excluding gasoline used in military vehicles, economy-wide reserves and by the state. The five provinces of Heilongjiang, Jilin, Liaoning, Henan and Anhui fully switched to E10 during 2003-2005. Some cities in the provinces of Jiangsu, Hebei and Hubei switched to E10 at year-end 2005, and in Shandong, starting March 1, 2006. In addition, the Guangxi province became the tenth province to fully switch to E10 starting 15 April 2008.

Biodiesel Targets
2010 – 200,000 tons
2020 – 2 million tons (approx. 2.53 billion liters)

China has set a target of increasing renewable energy use from the present 10% to 20% of the total energy consumption by 2020 to meet increasing energy demand and reduce GHG emissions. Under its guidelines for the 11th Five-Year Plan, China proposes production targets of 2 million tons (670 million gallons) of fuel ethanol and 200,000 tons (60 million gallons) of biodiesel by 2010, which would be expanded up to 10 million tons (3,348 million gallons) of fuel ethanol and 2 million tons (600 million gallons) of biodiesel by 2020.

At the moment, there are no indications that the ethanol blending percentage would be increased in the future or mandated economy-wide, although NDRC has indicated that ethanol blends may also be introduced to other major cities. These cities mainly include Beijing, Shanghai and Tianjin, which are located close to the listed provinces. No exact timeline has been announced.
Table A.13 below shows the current E10 use in China.

[4] http://eneken.ieej.or.jp/en/data/pdf/383.pdf

Table A.13 E10 Use in China

Effective Date	Provinces	Cities
November 2003	Jilin	All
October 2004	Heilongjiang	All
November 2004	Liaoning	All
December 2004	Henan	All
April 2005	Anhui	All
November 2005	Hebei	6 cities: Shijiazhuang, Baoding, Xingtai, Handan, Cangzhou, and Hengshui
December2005	Hubei	9 cities: Wuhan, Xiangfan, Jingmen, Suizhou, Xiaogan, Shiyan, Yichang, Huangshi and Ezhou
December2005	Jiangsu	5 cities: Xuzhou, Lianyungang, Huai'an, Yancheng and Suqian
March 2006	Shandong	7 cities: Jinan, Zaozhuang, Tai'an, Jining, Linyi, Liaocheng and Heize
April 2008	Guangxi	All

A.3.2 Biofuels Market in China

Seeing that over 95% of the refuelling stations in China are state-owned, fuel ethanol production is dominated by the government and will not be influenced by public awareness or consumer demand in the short or medium term.

E10 blending has already been established in six provinces of Jilin, Heilongjiang, Henan, Anhui, Liaoning and Guangxi and in 27 cities located in four provinces of Jiangsu, Hebei, Hubei and Shandong.

Generally speaking, China's biodiesel industry is still very much in its infancy. However, seeing the heavy reliance of the transportation and agricultural industry on diesel in China, biodiesel may emerge as a solution in helping to meet growing demand. Refuelling stations run by economy-wide oil companies Sinopec and PetroChina do not yet offer biodiesel to the transportation sector, and biodiesel produced locally is currently limited to use in captive fleets.

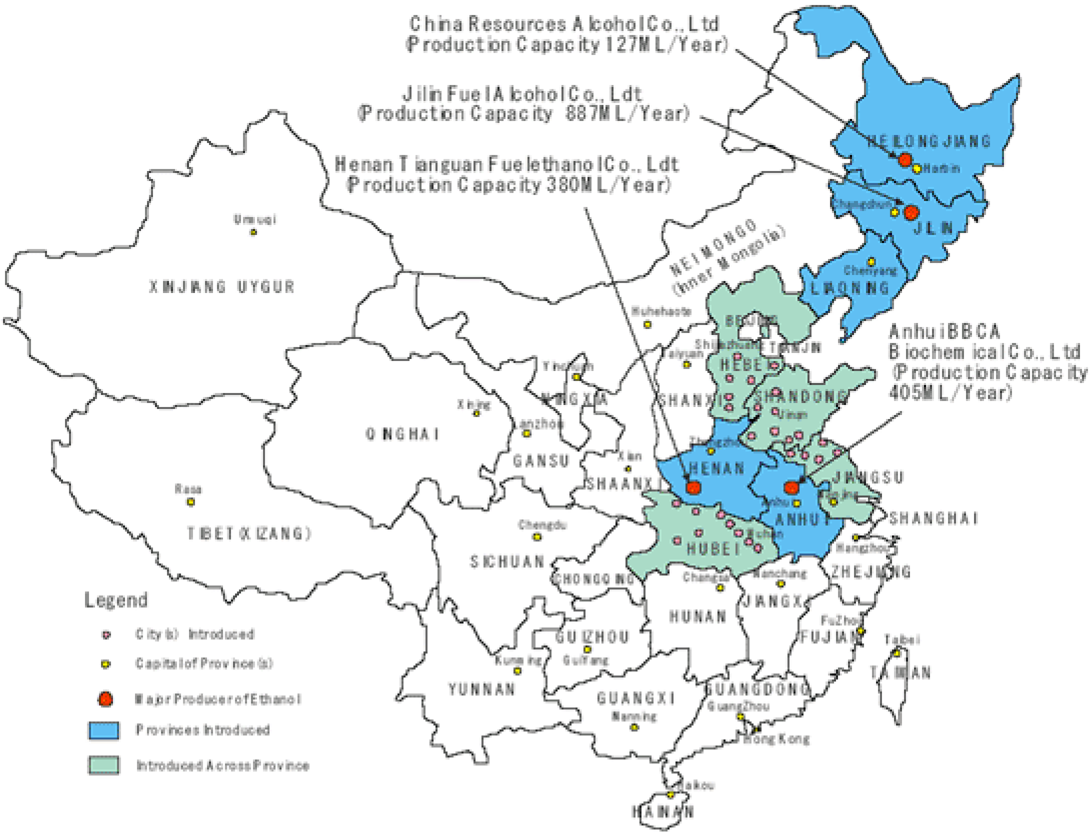

Figure A.1 China Ethanol Producers and Areas with E10 Consumption
Source: Institute for Energy Economics, Chew Chong Siang[5]

A.3.3 Biofuels Demand & Supply in China

Ethanol

Under the revised National Plan, fuel ethanol production is to increase to three million tonnes/year by 2010 and to 10 million tonnes/year by 2020. According to the plan, E10 sales are to expand in more provinces in 2010, and E20 and E85 possibly will be introduced, as well as B5 or B10 in 2020.

Currently, ten provinces participate in the fuel ethanol program. These ten provinces will remain the priority for use of an E10 gasoline (with a fuel/ethanol mix rate of 10 percent). Six of these provinces use E10 within their entire provinces, while four provinces have only partly adopted the product. Close to full adoption by these four provinces remains a priority for the government's fuel ethanol program.

To date, there are five plants licensed for fuel ethanol production. Among them, there are four plants (located in Jilin, Heilongjiang, Henan, and Anhui Provinces) that use grain-based feedstock. It is estimated that 80 percent of production is corn based and the remaining 20 percent is wheat or rice based. The fifth plant (in Guangxi Province), which started trial operations in December 2007, was designed to produce at an annual capacity of 200,000 tons, using only cassava as its feedstock. Its fuel ethanol production reached 120,000 tons in 2008,

---

[5] http://www.biofuels.apec.org/me_china.html

as prescribed in the E10 mandate (10 percent ethanol blended into fuel) the province has already implemented.

As there are currently no announced economy-wide mandates for ethanol and only a voluntary target stands, and assuming that China intends to expand its E10 program into the rest of its provinces within the next few years, ethanol supply is not expected to meet demand within the short-term up until 2010.

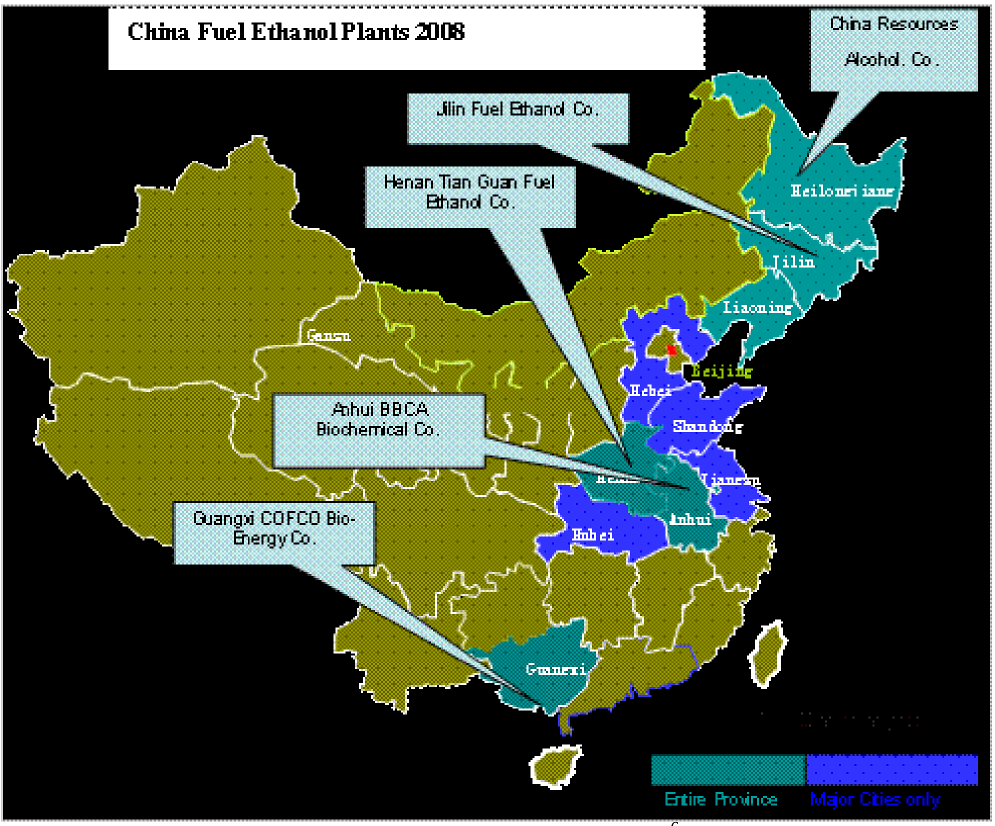

Figure A.2 China Ethanol Plants[6]

Biodiesel

Current biodiesel producers are mainly local suppliers and small-scale producers, each having capacity of less than 100,000 tons (30 million gallons) per year. In the short term, most new plants will still be small scale, although bigger plants are expected to come online by 2015. Also, foreign players have indicated their interest in the Chinese market. Some of them are situated in areas that are close to transportation corridors to facilitate export into other regions, such as Europe. As there are currently no announced mandates for biodiesel and only a voluntary target stands, a economy-wide B5 blending is assumed up until 2015 based on the government's current plans to draft a B5 blend standard, which may imply allowing B5 blending in this APEC economy.

---

6 http://gain.fas.usda.gov/Recent%20GAIN%20Publications/BIOFUELS%20ANNUAL_Beijing_China%20-%20Peoples%20Republic%20of_2009-7-17.doc.pdf

A.3.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in China

As stated earlier, although there are no federal or provincial mandates set in place, China has implemented targets for both ethanol and biodiesel blends.

A.3.4.1 Ethanol

Feedstock

Prominent feedstocks used in ethanol production in China are both corn and wheat. Of the five ethanol plants, located in five of China's provinces, 80 per cent used grains such as corn and wheat as their feedstock. The remaining facility, a start-up plant, is based on using cassava, which is a non-grain feedstock. Tubers like cassava, sweet sorghum and sweet potatoes are being viewed as transitional feedstocks in the long term, as they are considered a non-grain crop (USDA, 2009). With the food versus fuel debate that occurred in 2007-2008, government officials have denied any new ethanol plants from grain feedstocks, stating that any biofuels production should not utilize any land that can be used for food production.

Thus, indicating that future biofuels facilities that utilize crops for ethanol must use crops that can be produced on marginal or non-arable land. This makes cassava and other tubers particularly favourable in the nearer term, as they are able to grown in less ideal conditions. In the long-term, cellulosic feedstocks would be the most favourable option (USDA, 2009). Table A.14 below is used to illustrate crops with the greatest potential for usage for biofuels.

Table A.14 Currently Available Biofuels Feedstocks in China

	Corn	Wheat	Barley	Sorghum	Cassava	Sugarcane	Sugar Beets
Chinese Production (Thousand metric tons per year)	168,000	114,500	2,400	1,700	4,512	113,746	9,500

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

In 2008, total fuel ethanol production was approximately 1.6MMT, with 80% of ethanol production based on grains, and the remainder utilized tubers. China only imports a minor amount of ethanol to meet demand, as it is cheaper to produce ethanol domestically than it is to import it due to cheaper feedstock prices. Following the trend seen below, it is estimated that China will continue to import only a fraction of its ethanol, as both feedstock and production are cheaper domestically.

Table A.15 China Ethanol Imports

China Ethanol Imports 2004-2008 in Thousand Liters					
Year	2004	2006	2006	2007	2008
Total Ethanol	4,253	19,590	7,972	678	402

Source: USDA Chinese Gain Report, 2009

In terms of feedstock, cassava is imported and used to ethanol production due to a zero tariff on this crop from southeast Asian countries, and the fact that it can be more price competitive than domestically grown tubers. It is likely that China will continue to import this as a feedstock as it is a non-grain crop and is relatively cheap (USDA, 2009).

Table A.16 China Cassava Imports

China's Cassava Imports from the World (in metric tons)							
Year	2003	2004	2005	2006	2007	2008	2009
Total Imports (Thailand, Viet Nam, Indonesia)	2,368,260	3,442,412	3,335,415	4,950,435	4,625,427	1,976,418	2,495,359

Source: USDA Chinese Gain Report, 2009

A.3.4.2 Biodiesel

Feedstock

Rapeseed and soy oils are the most prominent crops that may be used for biodiesel production, in terms of volume of feedstock. However, these vegetable crops are the main feedstock for food production. Waste grease and cooking oils are produced in large capacities, in the range of 3 million tonnes per annum, and represents a possible feedstock for biodiesel production as well (USDA, 2009).

Table A.17 Potential Biodiesel Feedstocks in China

	Rapeseed Oil	Soy Oil	Sunflower Oil	Peanut Oil	Cotton Oil
Chinese Production (Thousand metric tons per year)	5,291	10,317	270	2,184	1,378

Source: USDA FAS, 2010/2011 Production Year

Table A.17 above is used to illustrate crops with the greatest potential for usage for biofuels.

Production

Overall capacity for biodiesel facilities is in the range of 250 MT, with annual production rates of 3 MT. This lack of production is largely due to the unavailability of feedstock. However, importing biodiesel feedstocks is highly unlikely due to the fact that China already imports a significant amount for human consumption, and is in fact a net importer of vegetable oils for food. The use of waste oils and greases has the potential to meet the demand; however, access to this feedstock is sporadic and insufficient to meet plant capacity needs. Thus, this is probably not a viable option. Current facilities are in operation for only a few months out of the year (USDA, 2009). It is prudent that government takes the initiative and provides subsidies for biodiesel producers and programs which will support the use of biofuels in transportation fuels.

A.3.4.3 Infrastructure Requirements in China

Feedstock Transport

With current ethanol facilities that utilize corn, wheat, and sugarcane, feedstock will likely continue to be transported by truck/rail. As China plans to transition to utilizing tubers for feedstock, additional feedstock will need to be imported from surrounding South East Asian countries, which will require an increase in use of marine as well as truck and rail. As well, production of cassava is planned for areas of land considered marginal. This will require transportation from these areas to the facility. In cases where new cassava ethanol facilities are built, consideration of proximity to rail would be ideal; however, it is likely that trucks will be utilized for transport. For biodiesel, tallow and waste oils will likely continue to utilize trucks for feedstock transport. However, in order for biodiesel to take off, a network for waste oils must be implemented, as biodiesel facilities are only in operation a few times of the year due to the sporadic nature of supply. It is unlikely that China will import any oils for biodiesel, as it is already a large importer of oils for human consumption.

E100 and B100 Transport, Blending and Distribution

E10 blending has been implemented in six provinces in China, as well as in various cities. Sale of E10 is concentrated to where production of ethanol occurs. Three of the five provinces that produce ethanol are located along the coast, and have the ability of utilizing marine transport. The majority of fuel sales will likely continue to be enforced in these areas in the short term.

In the longer term, if a nation-wide blending of E10 should become mandated, ethanol imports from other countries will likely have to increase in order for China to meet demand. This will involve an increase in marine, truck and rail infrastructure. Current ethanol facilities are located in coastal provinces, which is ideal for import/export. The production volumes and projected demand might also be suitable for pipeline transport.

Ethanol and biodiesel is currently trucked from the production facility to the retail pumps. Some fuelling stations will require conversion to E10 pumps.

Figure A.3 shows the railway map for China. Since there is significant existing fuel products pipeline infrastructure in China, some of that could potentially be used for biofuels distribution.

Figure A.3 Railway Distribution in China[7]

[7] http://en.ndrc.gov.cn/hot/W020060531535879127185.jpg

A.3.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in China

As stated previously, the Chinese government has denied any new facilities that would use grain-based crops as potential feedstocks. The government plans on using transitional feedstocks such as cassava and sorghum, due to the fact that they are not grain crops and may be grown on non-arable land. Infrastructure related to feedstock transport of these from marginal locations will likely be implemented in the long term.

China's ultimate goal is to move towards cellulosic feedstocks, using primarily agricultural residues. There are several pilot-scale facilities which already utilized crop residues to produce ethanol (EWG, 2008).

The government's plan to support cellulosic ethanol indicates the growing need for infrastructure to be implemented. China has a vast amount of forestry and agricultural residue that could potentially be used as feedstock for cellulosic ethanol. However, the location of the facility will depend on feedstock location in order to reduce transport costs. Production of biofuel could satisfy the local market, as China is a large APEC economy with several areas of agricultural and cellulosic feedstocks, indicating that there are many different opportunities across China to produce ethanol and supply individual local markets. However, areas rich in cellulosic feedstocks could likely export biofuels and co-products to adjoining regions, using either rail or marine infrastructure, or eventually dedicated biofuels pipelines.

Sources:

1. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) China Biofuels Annual 2009 report (17 July 2009) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/BIOFUELS%20ANNUAL_Beijing_China%20-%20Peoples%20Republic%20of_2009-7-17.doc.pdf
3. China's Medium to Long Term Renewable Energy Development Plan – Promotion of Bio-ethanol Introduction and Strategic Developments (IEEJ =February 2007) http://eneken.ieej.or.jp/en/data/pdf/383.pdf
4. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
5. http://faostat.fao.org/
6. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.4 Biofuels in Hong Kong

A.4.1 Mandates

There are no Biofuels mandates in Hong Kong, China. There is no further Hong Kong government support for implementing biodiesel at this time.

A.4.2 Biodiesel Market in Hong Kong

Currently, there is hardly any biodiesel infrastructure in Hong Kong, China. Currently there are two smaller players active in Hong Kong (together producing max 6,000 – 7,000 MT/year) producing biodiesel from used cooking oil. ASB Biodiesel (Hong Kong, China) Ltd. is constructing a new plant producing biodiesel using mainly waste products. The state-of-the-art plant will be located in the Tseung Kwan O industrial area of Hong Kong, China. The 100,000 metric ton per year facility will be the first of its kind in Asia.

A.4.3 Biofuels Demand and Supply in Hong Kong

There is little in the way of biofuels demand or supply at this time. Once the aforementioned ABS plant is completed, this will significantly impact Hong Kong, China biodiesel supply.

A.4.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Hong Kong

Hong Kong, China currently has no mandates for ethanol or biodiesel use.

A.4.4.1 Ethanol

Feedstock
Data on potential ethanol feedstocks was not available.

Production
There is currently no ethanol production in Hong Kong, China.

A.4.4.2 Biodiesel

Feedstock
The primary feedstock for biodiesel production includes waste cooking oils and animal fats. There is approximately 10,000 liters produced per annum (EWG, 2008).

Production
There is a small biodiesel facility which utilizes waste cooking oils to produce biodiesel. Total capacity is approximately 4.3 ML per annum, and is used domestically. A second biodiesel facility is expected to come online, with a capacity of approximately 112 ML per annum, using waste oils and greases as well. The biodiesel in this case is for both domestic use and export (EWG, 2008).

A.4.5 Infrastructure Requirements in Hong Kong

Biofuels Transportation and Distribution Infrastructure

The petroleum fuels are transported in Hong Kong, China by truck. Ethanol (E100) and biodiesel (B100) are transported to blending facilities by truck. The blended ethanol and biodiesel are transported from the blending facilities to retail by truck.[8] For biodiesel, waste cooking oils will likely continue to utilize trucks for feedstock transport, as well as with the blended fuel.

A.4.6 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Hong Kong

There is currently no plan for second generation biofuels. First generation biofuels will likely be implemented as a starting point before moving towards biomass derived fuels.

Sources:

1. Environment Bureau – the Government of Hong Kong, China Special Administration Region http://www.enb.gov.hk/en/index.html
2. ASB-Biodiesel Announces 100,000 tonne biodiesel plant in Hong Kong, China http://www.biofuelsdigest.com/blog2/2008/02/28/asb-biodiesel-announces-100000-tonne-biodiesel-plant-in-hong-kong/
3. Correspondence with ASB-biodiesel General Manager of Commerce.
4. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

[8] Email information from Hong Kong Environment Bureau was received via email from T L Cheung

A.5 Biofuels in Indonesia

A.5.1 Biofuels Mandates in Indonesia

The Government of Indonesia (GOI) enacted Regulation No. 32/2008 as of 13 October 2008 and effective in January 2009, which mandates a minimum of 1 percent biofuel mixture in fuel sold in petrol stations in two major cities in Indonesia - Jakarta and Surabaya.

Table A.18 Minimum Mixture of Biodiesel in Indonesia (B100)

Sector	Oct 08 - Dec 08	Jan-09	Jan-10	Jan-15	Jan-20	Jan-25
Transportation - PSO (Public Service Obligation)	1%	1%	2.5%	5%	10%	20%
Transportation - (non PSO)		1%	3%	7%	10%	20%
Commercial & Industrial	2.5%	2.5%	5%	10%	15%	20%
Power Plants	0.1%	0.25%	1%	10%	15%	20%

Table A.19 Minimum Mixture of Ethanol in Indonesia (E100)

Sector	Oct 08 - Dec 08	Jan-09	Jan-10	Jan-15	Jan-20	Jan-25
Transportation - PSO (Public Service Obligation)	3%	1%	3%	5%	10%	15%
Transportation - (non PSO)	5%	5%	7%	10%	12%	15%
Commercial & Industrial		5%	7%	10%	12%	15%

The government plans to increase the bioethanol blend in gasoline to five percent by 2010 from 3 percent, using cassava and cane molasses - a thick syrup residue produced from sugar cane during the sugar extraction process - as feedstocks.

The President set a target in July 2006 to reduce petroleum demand with ten percent biofuels in 2010 and for biofuels to contribute at least five percent of total economy energy consumption in 2025. The President's target was followed by the "Biofuel Blueprint," which was released by the National Biofuel Development Team in December 2006. The Blueprint recommended a strategic plan for biofuels from 2006-2025 to the government, which is currently under approval. Table A.20 shows the planned targets for ethanol and biodiesel blending.

In February 2008, after long-term meetings with the Indonesian Biodiesel Producer Association (APROBI), the National Biofuel Development Team proposed that the government should mandate B1 economy-wide starting in 2009. Although the government released its biofuels strategic plan in 2006, followed by a roadmap released by the economy oil company, PERTAMINA, in the same year, the implementation date has yet to be set.

Table A.20 The Indonesian Government's Strategic Plan for Biofuel Blending in Indonesia, 2006-2025

Fuel Usage	2006	2007 - 2008	2009 - 2010	2011 - 2015	2016 - 2025
Biodiesel					
(High Speed Diesel)	B5	B5	B5	B10	B15
(Low Speed Diesel)		B5	B5	B5	B5
(Power Generation)		B20	B20	B50	B50
(Kerosene)		B5	B5	B5	B5
Ethanol(Gasoline Blends)	E15	E5 - E15	E5 - E15 (1)	E15, E85 (2)	E20, E85 (2)

Source: National Biofuels Development Team, 2007
(1) Approximately 2% from energy mix.
(2) Approximately 3% from energy mix.

A.5.2 Biofuels Market in Indonesia

Indonesia currently allows for blending of up to 10 vol% ethanol in gasoline.
The current maximum allowable biodiesel blend in diesel is 10 vol% (B10). Neat biodiesel (B100) to be blended with diesel must meet the economy biodiesel standard. There are no separate specifications for biodiesel blends.

Ethanol

By the end of 2008, at least four ethanol plants were expected to come online with a projected annual production capacity expected to reach 502 million liters (133 million gallons). By 2015, total ethanol production capacity in Indonesia is expected to reach 3.5 billion liters (940 million gallons) per year. Although there is no mandate economy-wide for ethanol usage, PERTAMINA sells E3 at various stations in Jakarta, Malang, East Java province and Bali. Current ethanol usage in Indonesia is limited to E3 sold in several cities only.

Since 2006, PERTAMINA has been selling E3 in selected cities and provinces. In addition to the government's plan, PERTAMINA set a biofuels road map to continue the introduction of E5 in other large cities including Jakarta in 2007, and subsequently, E10 in large cities in 2008. Eventually, PERTAMINA aims to introduce E10 economy-wide by 2010 and even further to E100 (using FFVs) economy-wide by 2015.

Biodiesel

Biodiesel production in Indonesia has been largely spurred by promising domestic demand for biodiesel, with the possibility of a government mandate regulating usage of biodiesel blended with diesel fuel. Based on biodiesel plant licenses approved by the Investment Coordinating Board, Indonesia's total potential production capacity in 2008 stood at 4,271 million liters (1,130 million gallons) with a further capacity of 7,500 million liters (1,986 million gallons) expected to come online in 2010. However, because of high feedstock prices, most of the biodiesel plants in Indonesia are operating at less than 30% of their production capacity. Since 2006, PERTAMINA has been selling B5 in selected cities and provinces. PERTAMINA's biofuel roadmap also introduced biodiesel blends, beginning with B5 for big cities in 2007, followed by B10 economy-wide and also for industry fuel in 2010. By 2015, PERTAMINA aims to introduce the usage of B30 for industry fuel and B15 economy-wide.

However, the inability to cope with rising production cost from biofuel feedstocks, combined with a lack of the government's will to mandate biofuel usage, led PERTAMINA to lower biodiesel blends from B2.5 to B1 in April 2008. Furthermore in May 2008, they announced their intention to stop marketing biofuel blends if conditions remained the same.

A.5.3 Biofuels Demand & Supply in Indonesia

Energy demand in the transport sector is expected to increase by 3.3% between 2009 and 2030. Passenger light duty vehicles (PDLV) ownership is anticipated to increase from 25 vehicles per 1,000 people in 2007 to almost 70 vehicles per 1,000 by 2030. Indonesia is anticipated to have a fleet of 19 million vehicles by 2030. Biofuels use is anticipated to increase to 48,000 barrels per day (kb/d) in 2030 which would account for 5% transport oil demand (IEA World Energy Outlook 2009).

Ethanol
The government's proposed ethanol roadmap in the Biofuel Blueprint requires E5 until 2010 and increasing to E15 by 2015. It is expected that until 2015, Indonesia will need to import ethanol to meet their demand. The region's abundant coastline makes it suitable for strategic development of marine terminal infrastructure that could be linked to interior regions by rail or truck.

Biodiesel
The projected biodiesel demand is based on the government's proposed "Biofuel Blueprint" which requires B5 until 2010 and B10 by 2015. Up until 2015, it is anticipated that the biodiesel supply in Indonesia will meet the demand.

A.5.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Indonesia

A.5.4.1 Ethanol

Feedstock
Currently, Indonesia produces all of its ethanol from sugarcane molasses. Production of sugarcane represents approximately 30 million tonnes per year, and is one of the top producers worldwide. Cassava is another crop that has been considered a potential feedstock for ethanol production as well (USDA, 2009). Cassava production is expected to increase from 52, 195 ha to 782,000 ha (EWG, 2008). Table A.21 below illustrates crops with the greatest potential for usage for biofuels.

Table A.21 Currently Available Ethanol Feedstocks in Indonesia

	Corn	Cassava	Sugarcane
Indonesian Production (Thousand metric tons per year)	8,400	22,039	26,500

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production
Currently, there is enough feedstock and production to meet the 1% ethanol blend mandate set for Jakarta and Surabaya. There is no future mandate for ethanol blends; however, Pertamina sells E3 at various stations as stated above. With four new plants coming online, it may be possible to meet any future mandates (i.e., E5 and E10) should the economics be favourable (USDA, 2009).

Table A.22 Current Ethanol Feedstock Utilization in Indonesia

Quantity of Feedstock Use in Biofuels Production					
Year	2005	2006	2007	2008	2009
Ethanol – Sugarcane (in MT)	0	27,000	23,436	25,000	27,000

Source: USDA Indonesian Gain Report, 2009

A.5.4.2 Biodiesel

Feedstock

Palm oil represents the primary feedstock for biodiesel usage in Indonesia, and Indonesia is the world leader in palm oil production, surpassing Malaysia (USDA, 2009). There are currently six million ha of palm plantations, with a production rate of 17.4 million tonnes of crude palm oil in 2007 (EWG, 2008). Coconut oil is another major contender for biodiesel, with 2006 production rates of approximately 880,000 tonnes per annum (450,000 to 550,000 were exported). Finally, jatropha has been under consideration for a possible biodiesel feedstock; however development is still in its early stages (USDA, 2009). Table A.23 below illustrates crops with the greatest potential for usage for biofuels.

Table A.23 Currently Available Biodiesel Feedstock in Indonesia

	Palm Oil	Peanut Oil	Coconut Oil
Indonesian Production (Thousand metric tons per year)	23,000	21	968

Source: USDA FAS, 2010/2011 Production Year

Production

Table A.24 represents the amount of crops used for biodiesel production from 2005 to 2009.

Table A.24 Current Biodiesel Feedstock Utilization in Indonesia

Quantity of Feedstock Use in Biofuels Production					
Year	2005	2006	2007	2008	2009
Biodiesel – Palm Oil (in MT)	15,560	16,600	18,300	19,500	20,750

Source: USDA Indonesian Gain Report, 2009

A.5.4.3 Infrastructure Requirements

Feedstock Transport

It is likely that Indonesia will continue to utilize domestic sugarcane for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility.

For biodiesel, palm oils will likely continue to utilize truck/rail for feedstock transport. It is likely that in the near term, biodiesel production in Indonesia will likely keep up with demand; import is not necessary.

E100 and B100 Transport, Blending and Distribution

Ethanol and biodiesel (E100 and B100) is currently trucked from the production facility, to the retail pumps. Fuelling stations that carry biofuel blends are located in Jakarta and Surabaya, where 1% ethanol blended in gasoline is mandated, as well as at a few other stations where E3 and B1 are sold. Further infrastructure requirements for fuel transport due to increase in demand can be met by truck/rail.

E10 is the maximum allowable blend in Indonesia. Ethanol imports will likely occur should the demand for E10 increase across Indonesia, as current supply will not likely meet demand. This would result in an increased usage of marine, rail and truck, depending on where the feedstock is imported from.
In order to implement fuelling stations at other locations outside of production area, retailers are required to undergo conversion of gasoline pumps to E10 pumps, or implementing new ones. Should biofuel blends be transported to locations outside of their current areas, an increase in truck/rail access is necessary.

A.5.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Indonesia

Indonesia is considering cellulosic ethanol production using feedstocks such as palm fruit shells, rice husk, bagasse, as well as agricultural and forestry residues, all of which are readily available in great amounts. The government's plans to support cellulosic ethanol indicate the growing need for infrastructure to be implemented. Local production of a particular feedstock would drive the location of future biomass to ethanol facilities, and in turn, would sell to the local market. The utilization of truck (and rail) will be necessary to transport between each stage of production.

Jatropha is also being considered as a possible feedstock for biodiesel, as it is not a crop for human consumption, and can be grown on non-arable land (EWG, 2008). Available land identified as marginal and useful for jatropha production could incur costs in transport of the feedstock to a potential facility, unless the facility will be located close to where the plant is grown. However, this may not be ideal if retail stations are located at a farther distance, and cost of transport could increase accordingly.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Indonesia Biofuels Annual 2009 report (1 June 2009) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_Jakarta_Indonesia_6-1-2009.pdf
2. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
3. Policy brief – Biofuels in Asia: An Analysis of Sustainability Options http://usaid.eco-asia.org/programs/cdcp/reports/PolicyBrief_Biofuels_in_Asia.pdf
4. http://faostat.fao.org/
5. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.6 Biofuels in Japan

Japan is the world's third largest petroleum consumer behind the U.S and China. The GOJ aims to introduce 500 ML (oil basis) of biofuels by 2010 and to produce next generation biofuels domestically by 2015. This is to increase to 800 ML (oil equivalent) by 2018.[9]

A.6.1 Biofuels Mandates in Japan

There are currently no announced mandates for ethanol or biodiesel.
In February 2007, the Executive Committee on Biomass Nippon Strategy released a report titled “Boosting the Production of Biofuels in Japan”. According to the Japan Automobile Manufacturers Association (JAMA), there are 74 million automobiles in Japan (gas and diesel) and domestic fuel consumption is around 60 BL per year for gasoline and 36 ML per year for diesel. If a three percent ethanol blend gasoline (E3) were nationalized, it is estimated that demand for ethanol could be around 1.8 BL. In the case of 10 percent ethanol blend gasoline (E10), demand could be six BL per year.

In Japan, the transportation sector is 98% dependent on petroleum-based products and Japan set a target to reduce that figure to around 80% by 2030. The strategy includes the following recommendations pertaining to biofuels use:

- Increase the upper blending limit of oxygenated compounds that contain ethanol by 2020 by accelerating improvements to the biofuels supply infrastructure (specifically, adding appropriate environmental and safety measures to gasoline stations) and by encouraging the automobile industry to accept E10 blends; and,
- Examine the support for regional efforts to expand domestic fuel ethanol production and to develop import support for biofuels.

A.6.2 Biofuels Market in Japan

Ethanol

The Japanese gasoline market is made up of large companies. There are almost no independent dealers, and only a handful of companies import oil and/or gasoline. These roughly ten companies are organized into five groups, and they sell to their own contacts through a formalized distribution system. Since 2003, Japan has allowed the sale of E3, which is reflected in the gasoline specifications. There are no separate ethanol blend specifications in place.

Given the industry’s reluctance and the lack of market potential for domestic crops, Japan’s renewable fuels prospects are largely guided by government policy rather than market forces. Although E3 was allowed since 2003, adoption of ethanol blends in Japan has made little progress, as the necessary facilities for on-site blending at service stations do not yet exist. Although a number of oil companies jointly conducted a 12-month E3 trial in selected prefectures in January 2005, the industry’s preference is still to blend ETBE with gasoline rather than ethanol.

---

[9] http://www.iea.org/papers/2011/biofuels_roadmap.pdf

In April 2005, the Petroleum Association of Japan (PAJ), which is a body composing of Japanese refiners, set a target to replace crude with 500,000 kiloliters (132.1 million gallons) oil equivalent of biofuels by 2010 to help meet the Kyoto target. Subsequently, in January 2006, PAJ announced that it aimed to blend 360,000 kiloliters (95.1 million gallons) of fuel ethanol (210,000 kiloliters or 55.5 million gallons oil equivalent), which is equivalent to 840,000 kiloliters (222 million gallons) of ETBE with gasoline by 2010. PAJ recommends that ethanol be converted to ETBE for blending with gasoline, as it can be directly added to gasoline at refineries, thus reducing necessary infrastructure investments.

In the summer of 2007, Japanese refiners began blending 7 vol% ETBE with regular gasoline as a trial at 50 service stations in Tokyo and 3 adjacent prefectures of Saitama, Kanagawa and Chiba. Refiners imported ETBE from Europe, which is blended with regular gasoline at Nippon Oil's refinery located at Negishi, Yokohama. Starting April 2008, the number of service stations blending ETBE increased to 100. Of the 50 additional outlets, 39 are in Tokyo and the three prefectures, and the remaining 11 are in five other prefectures, namely Osaka, Miyagi, Gunma, Ibaraki and Shizuoka. PAJ aims to extend sales of ETBE-blended gasoline to all service stations economy-wide around 2010. The use of ETBE and its ease of blending in the current gasoline infrastructure reduces concerns regarding biofuels infrastructure and distribution for Japan.

Biodiesel

Starting in March 2007, the government allowed up to B5 blends in Japan and released B100 specifications as a voluntary guideline.

A.6.3 Biofuels Demand & Supply in Japan

Ethanol

There are no known large-scale ethanol plants announced to be built up until 2015. Ethanol production for fuel in 2009 is 200 KL, and ETBE imports were roughly 57 ML. A economy-wide blending level of E3 is assumed until 2015 based on the current blending limit of 3 vol% ethanol in gasoline. As a result, local ethanol supply is not expected to meet demand in the long-term. It is therefore anticipated that ethanol would have to be imported in the long run. The long coastline is well suited to strategic development of marine terminal infrastructure that could feed into a distribution network of rail and roads to interior regions.

The majority of the ethanol demand is expected to be met with imports from Brazil as Japan has limited agricultural produce to be used for fuel ethanol production. Thus, it is looking to import fuel ethanol from Brazil’s state-owned oil company Petrobras, and ETBE from Europe for blending with gasoline. There are plans to increase the upper blending limit of oxygenated compounds that contain ethanol by 2020 by accelerating improvements to the biofuels supply infrastructure and encouraging the automobile industry to accept E10 blends. PAJ aims to increase the ETBE-blending target beyond 2010 and prepare a market infrastructure that enables gasoline blends with more than 3 vol% ethanol, although no further details have been released at this stage.

Ethanol Blending

There are two methods for blending bio-ethanol with gasoline, “direct blending” and “ETBE.” In Japan, the MOE (Ministry of the Environment) promotes direct blending while METI (Ministry of the Economy Trade and Industry) supports the ETBE method. The reason for the latter is that it is more costly for oil distributors to renovate the facilities for direct blending. Under this model, the blending would take place at the retail sites. One report estimates the cost to replace or upgrade existing infrastructure would be Y300-500 billion ($3-5 billion). MAFF (Ministry of Agriculture Forestry and Fisheries) has favoured promoting direct blending. However, it is yielding to support the ETBE method in order to secure the distribution channel for domestically produced bio-ethanol. In 2009, two MAFF supported bio-refineries, Hokuren, the federation of agricultural cooperatives in Hokkaido, and Oenon Holding started to sell the bio-ethanol they produce to PAJ for blending with ETBE. E3 usage is still quite limited in Japan. For example, in Osaka, one can easily count the number of cars that are registered to use E3 gasoline: 576. Only six gasoline stations in the Osaka and nearby Hyogo prefectures sell E3 gasoline.

Biodiesel

Biodiesel production for fuel in 2009 was roughly 10 ML. Since Japan is very much gasoline-driven, biodiesel is not widely available commercially in Japan. However, biodiesel blends have been promoted in the city of Kyoto since 1997. B20 blends are used in city buses and B100 in municipal garbage trucks. About 1.5 million liters (0.4 million gallons) per year of biodiesel are used in the city. Existing biodiesel producers mainly use waste cooking oil as feedstock, bringing the total annual production capacity to four million liters (one million gallons). Therefore, the majority of biodiesel currently blended in Japan is imported. It is anticipated that that would continue to be the case in the long term.

A.6.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Japan

A.6.4.1 Ethanol

Feedstock

Ethanol production in Japan is based upon a variety of feedstocks, including rice and wheat unsuitable for human consumption, sugarcane and wood residues (USDA, 2010). Table A.25 below is used to illustrate crops with the greatest potential for usage for biofuels.

Table A.25 Currently Available Ethanol Feedstock in Japan

	Corn	Wheat	Barley	Sugarcane	Sugar Beets
Japanese Production (Thousand metric tons per year)	1	843	180	1,515	3,649

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

Current ethanol production capacity is approximately 30,000 liters, and is in its early stages (EWG, 2008). At the moment, the 3% ethanol blend in gasoline is a voluntary target; therefore, it is expected that in order for Japan to meet demands in the long term, the remainder will have to be imported. This indicates that the available crops in Japan will not be able to sustain and increases fuel blends and will not be able to keep up with demand.

Table A.26 First Generation and Advanced Ethanol in Japan

First Generation and Advanced Ethanol (KL)						
CY	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	30	9	200	200[1]	50,000 [2]	60,000[2]
Imports	0	0	0	0	330,000[3]	-[3]
Exports	0	0	0	0	0	0
Consumption	30	90	200	200	50,000	60,000
Ending Stocks	0	0	0	0	0	0
Production Capacity (First Generation Fuel)						
No. of Biorefineries[4]	4	8	8	8	8	8
Capacity	821	31,821	31,821	31,821	31,821	31,821
Production Capacity (Advanced Fuel)						
No. of Biorefineries[4]	2	2	4	8	8	8
Capacity	116,400	116,400	116,479	117,216	117,216	117,216
Feedstock Use (1,000 metric tons)						
Rice (non-food)	minimal	minimal	minimal	minimal	minimal	minimal
Wheat (off-spec)	minimal	minimal	minimal	minimal	minimal	minimal
Sugar cane	minimal	minimal	minimal	minimal	minimal	minimal
Rice Straw	minimal	minimal	minimal	minimal	minimal	minimal
Wood wastes	minimal	minimal	minimal	minimal	minimal	minimal

Source: USDA Japanese Gain Report, 2010
1) Production as of March 2009
2) The GOJ's short term goal
3) Forecast by PAJ. Imports of bio-ethanol for fuel started in 2010 and will likely increase in future years.
4) The refineries are for feasibility studies. There are no commercial refineries

A.6.4.2 Biodiesel

Biodiesel production in Japan is still in its early stages, and the available crops will not be able to sustain capacities to meet economy mandates in the future. Used cooking oil represents a possibility. However, Japan will have to import any feedstock/biodiesel in order to meet demand. Table A.27 below, illustrates crops with the greatest potential for usage for biofuels.

Table A.27 Currently Available Biodiesel Feedstocks in Japan

	Rapeseed Oil	**Soy Oil**	**Peanut Oil**	**Cotton Oil**
Japanese Production (Thousand metric tons per year)	880	452	1	6

Source: USDA FAS, 2010/2011 Production Year

Production

Currently, approximately 20 million liters of biodiesel are produced per year and is increasing.

Table A.28 First Generation and Advanced Biodiesel in Japan (Thousand liters)

First Generation and Advance Biodiesel (Thousand Liters)						
CY	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	5,000	5,000	10,000	10,000[6]	20,000[7]	20,000[7]
Imports (MT)[8]	16,929	12,808	12,576	10,197	-	-
Exports	0	0	0	0	0	0
Consumption	-	-	-	-	-	-
Ending Stocks	0	0	0	0	0	0
Production Capacity (First Generation Fuel)						
No. of Biorefineries[9]	-	-	-	-	-	-
Capacity	-	-	-	-	-	-
Production Capacity (Advanced Fuel)						
No. of Biorefineries[9]	0	3	11	20	20	20
Capacity	80	2,800	6,777	8,496	8,496	8,496
Feedstock Use (Thousand metric tons)						
Recycled Cooking Oil	minimal	minimal	minimal	minimal	minimal	minimal
Rapeseed Oil	minimal	minimal	minimal	minimal	minimal	minimal
Sunflower Oil	minimal	minimal	minimal	minimal	minimal	minimal

Source: USDA Japanese Gain Report, 2010
5) Because some data was given in weight, the volume was calculated with the specific gravity of 0.7955.
6) Production as of March 2009
7) The GOJ's short term goal
8) HS Code: 382490-200; Including other than biodiesel; The unit is MT. As it includes products other than biodiesel, the unit is kept unconverted.
9) The refineries are for feasibility studies. There are no commercial refineries

A.6.4.3 Infrastructure Requirements in Japan

Feedstock Transport

It is likely that Japan will continue to utilize these crops grown domestically for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. Locally grown wheat, sugarcane, and rice will continue to be the major feedstocks for ethanol production in the near term. Biodiesel production is also in its very early stages, with tallow and waste oils which will likely continue to utilize truck/rail for feedstock transport.

E100 and B100 Transport, Blending and Distribution

Some retail stations are selling E3 direct blend supported by a MOE project.
However, the majority of biofuel in Japan is blended to gasoline as form of ETBE and treated the same as First Generation gasoline. All economy-wide refiners are selling as ETBE as a commercial operation. The ETBE is blended only at refineries, which makes the biofuels infrastructure a non-issue as it is treated just like First Generation gasoline. In Japan, 1530 service stations out of a total of 40,000 are selling gasoline with ETBE. There is no discussion to replace ETBE with ethanol. Since the ratio of stations offering ETBE is small, it seems that increasing the number of stations selling gasoline with ETBE is the near-term priority.[10]

[10] Information was received via email from Ikeda, IEEJ

Japan's current preference is to blend gasoline with ETBE. However, ethanol blend trials began in various cities across Japan. Blending occurred on site at Nippon's refinery. Current infrastructure in place for ETBE blending indicates that infrastructure related to ethanol production, blending and distribution in Japan could be implemented as well. With the E3 blend being a voluntary target, current domestic supply is insufficient to meet the market demands, and further infrastructure requirements for importing fuel is required, including marine, truck and rail. Japan will likely continue to import its ethanol supply in order to keep up with market demand in the near term. There is no pipeline infrastructure in Japan. In cases where the biodiesel is imported, marine infrastructure will be required. Conversion to ethanol capable pumps, implementation of new fuelling capabilities will likely occur in the near term, if a mandate is implemented on a nation-wide basis.

A.6.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Japan

The government of Japan is hoping to utilize non-arable land for future production, as well using waste agricultural and forestry residues to produce cellulosic ethanol (EWG, 2008). Local production of a particular feedstock would dictate the location of future cellulosic ethanol facilities, which would become the local market for the feedstock. Truck (and rail) may be necessary to aggregate feedstocks and transport them from existing industrial facility to a new biofuel production facility. Any infrastructure will likely be implemented once production and distribution for first generation biofuels is already in place.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Tokyo_Japan_6-24-2010.pdf
2. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
3. IEEJ (Institute of Energy Economics, Japan) http://www.ieej.or.jp/
4. http://faostat.fao.org/
5. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008
6. Technology Roadmap – Biofuels for Transport, International Energy Agency (IEA) http://www.iea.org/papers/2011/biofuels_roadmap.pdf

A.7 Biofuels in Korea

Korea is ranked as the seventh largest oil consumer in the world. This is significant as they will have a developed petroleum fuel infrastructure for transportation and distribution of petroleum fuels. The government has set a goal to have renewable energy sources contribute up to 2% of the nation's total energy demand by 2006, and 5% by 2011.

A.7.1 Biofuels Mandates in Korea

Ethanol
The government has yet to set a policy framework for ethanol blends with gasoline.

Biodiesel
Although Korea lacks enough land to produce agricultural resources, Korea is actively promoting biodiesel through the use of tax exemptions. Oil companies were required to supply diesel fuel blends containing 0.5 vol% biodiesel from July 2006 until December 2007 because of feedstock supply constraints. The blend was then increased to 1 vol% starting January 2008 and is expected to increase by 0.5 vol% every year until the B3 target is met in 2012. Blends up to B20 are currently allowed for use in captive fleets such as large buses or trucks.

In September 2008, the Ministry of Knowledge and Economy (MKE) announced that the government has set its sights on increasing the use of renewable fuels from the current level of 2 percent of total energy consumption to four percent by 2012, and 12 percent by 2030. As part of this plan, the current biodiesel blend ratio of 1 percent would be increased 0.5 percentage points annually until it reaches three percent in 2012. The long-term objective is to eventually raise the blend ratio to five percent. As a part of this broader plan, the Ministry of Knowledge and Economy (MKE) convened an inter-ministerial meeting during the first half of 2010 to discuss revisions to the Korea's Biodiesel Supply Plan (BSP). The discussions focused on revising the target biodiesel blend ratios, industry tax breaks, biodiesel feedstock sources and the development of renewable fuel standards (RFS). The agreed-upon revisions to the BSP were to become effective starting in 2011.

A decision to raise the current targeted biodiesel blend rates for 2011 (2.5%), 2012 (3%) and beyond was expected at the inter-ministerial meeting. Although it is uncertain what the final targets will be, there is more than sufficient production capacity to double the current blend ratio to four percent. The blend ratio is currently set at two percent, up half of a percentage point from last year. The Ministry of Knowledge Economy (MKE) and the Korea Institute of Petroleum Management held a public hearing on 27 October 2010 regarding the implementation of the Renewable Fuel Standard (RFS), but failed to present the exact date of implementation. They announced other details, such as the party that needs to implement the standard, the method and system for implementation, and building of the necessary infrastructure. The date could not be set because its agreement with the Ministry of Strategy and Finance (MOSF) had not yet been reached. An official at the MKE who attended the public hearing said that since the results of the research on RFS implementation were already out, they had to release the details with the exception of the date. He said, "We have deferred it for a year aiming to implement the RFS from 2013, but this is also tentative," and added, "We need to push ahead with it regardless of tax exemptions."[11]

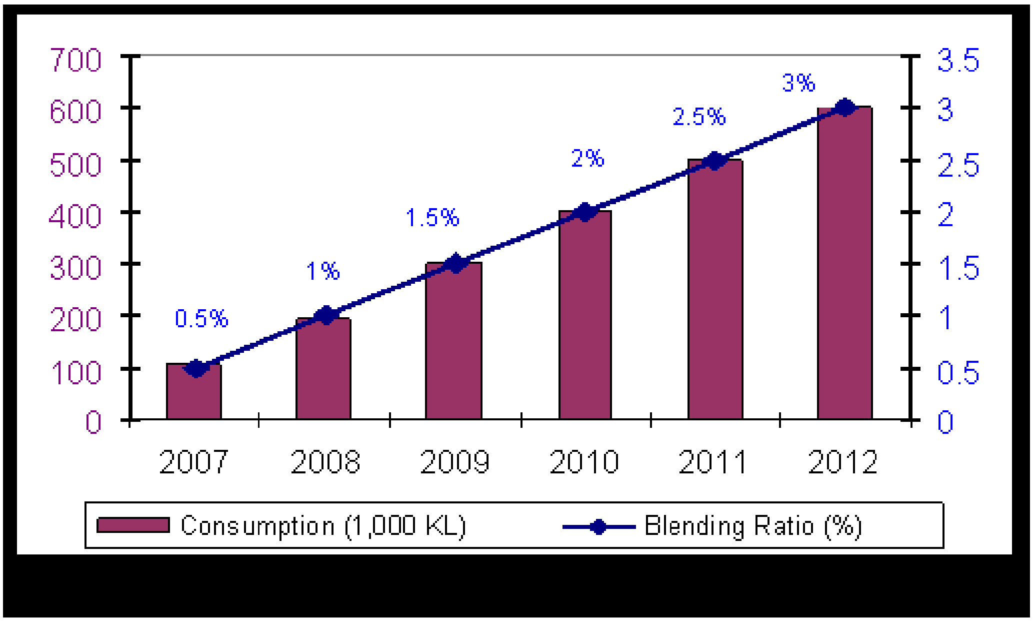

Figure A.4 Korea's Biodiesel Supply & Blending Ratio by Year
(Source: Ministry of Knowledge & Economy)
Note: Biodiesel Supply & Blending Ratio for 2011 & 2012 will be revised in 2010.

A.7.2 Biofuels Market in Korea

Ethanol
So far, MTBE is the main oxygenate used in Korea and the oxygen limit in gasoline is set at 1.0-2.3 wt%, depending on the season. A study conducted by the NKE concluded that the introduction of E3 or E5 would be possible with a few infrastructural and logistical adjustments. The study also showed 300,000 kiloliters of bio-ethanol would be required to successfully introduce E3 into the market. Implementation of this has been delayed.

Biodiesel
The Petroleum and Alternative Fuels Business Act sets the biodiesel limit in diesel fuel at five percent maximum by volume. The biodiesel industry estimates current production capacity at 800, ML. However, actual production was only 300 ML in 2009. Total petroleum diesel consumption was estimated at 20 BL in 2009. The use of biodiesel blend has since expanded and the product is currently available at most filling stations across Korea. The most commonly produced biodiesel blend is B5. Table A.29 shows biodiesel demand over 2002-2007 in Korea.

[11] http://english.etnews.co.kr/news/detail.html?id=201010290007

Table A.29 Biodiesel Blending Roadmap in Korea

Biodiesel Consumption	2002	2003	2004	2005	2006	2007
Volume- million liters (million gallons)	1.8 (.5)	4.2 (1.1)	7.8 (2.1)	17.1 (4.5)	56.3 (4.9)	123.4 (32.6)

Source: Global Biofuels Center, May 2008

A.7.3 Biofuels Demand & Supply in Korea

Ethanol

There are no known dedicated fuel ethanol plants except for Changhae Institute in Korea; ethanol is mainly imported from Brazil. There are also no mandates or targets to blend ethanol in the Korea; therefore, no supply and demand outlook is available for Korea. If an ethanol (E3) mandate were enacted, most of the ethanol would have to be imported, likely via marine terminals that would connect with road and rail infrastructure.

Biodiesel

Currently, there are 15 companies registered as certified biodiesel suppliers, of which total production capacity stands at 583 million liters (154 million gallons) per year (see appendix 1). The largest biodiesel plant is owned by Kaya Energy, with an annual production capacity of 100 million liters (26.4 million gallons). Based on the announced biodiesel blending roadmap for Korea, biodiesel demand is shown in Figure A.4 at B1 levels in 2008, B2 by 2010 and B3 in 2012. For all three timeframes, biodiesel supply is expected to meet demand at low blend levels. However, if the blending levels were required to increase beyond B3 after 2012, then domestic biodiesel production would have to increase, depending on feedstock availability, or biodiesel would have to be imported.

A.7.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Korea

A.7.4.1 Ethanol

Feedstock

Table A.30 below illustrates crops with the greatest potential for usage for ethanol.

Table A.30 Currently Available Ethanol Feedstocks in Korea

	Corn	Wheat	Barley
Korean Production (Thousand metric tons per year)	80	27	260

Source: USDA FAS, 2010/2011 Production Year

Production

As stated above, there is currently no fuel ethanol production on the commercial level in Korea. MKE planned to start a pilot program which would incorporate E3 and a number of filling stations; however, this plan was delayed due to high grain prices (USDA, 2009).

A.7.4.2 Biodiesel

Feedstock

Table A.31 below illustrates crops with the currently available feedstock for biodiesel production.

Table A.31 Currently Available Biodiesel Feedstocks in Korea

	Soy Oil	Cottonseed Oil
Korean Production (Thousand metric tons per year)	164	15

Source: USDA FAS, 2010/2011 Production Year

Nearly 70-80% of the biodiesel in Korea is produced from imported soybean and palm oil and 20-30% from used cooking oil produced domestically. The soybean oil is primarily imported from Argentina and Brazil, while the palm oil is imported from Malaysia and Indonesia. This demand for imported feedstock is expected to increase over the next few years as the Korean government will likely increase its blending ratio. Used cooking oils remain an uncertainty as collection methods are still underdeveloped (USDA, 2009).

Production

As of 2009, current total capacity was approximately 800,000 kiloliters, with actual production ranging at approximately 300,000. The number of biodiesel producers had reached 22; however, only 9 of these have contract with local refineries, which give the authorization for blending. It is expected that if the Korean government increases its mandated blend of biodiesel, the total capacity of all facilities will be sufficient to keep up with demand (USDA, 2009). Local production of rapeseed, for use as biodiesel feedstock, is being explored as another option. MKE is also considering the use of animal fats. Table A.32 below illustrates crops with the feedstock potential for usage for biodiesel production.

Table A.32 First Generation and Advanced Biodiesel in Korea (Metric Tons)

Korea's Rapeseed Area for Biodiesel Feedstock			
	2007	2008	2009
Projected Area (Ha)	1,500 Ha	1,500 Ha	1,500 Ha
Cultivated Area (Ha)	794 Ha	965 Ha	820 Ha
Production (Metric Tons)	725 tons	860 tons	700-800 tons

Source: USDA Korean Gain Report, 2009

A.7.4.3 Infrastructure Requirements in Korea

Feedstock Transport

For biodiesel, soy and palm oil, as well as used cooking oils will likely continue to utilize marine for import, and trucks for transport from the port of entry to the facility. It is estimated that current supply will not be able to keep up with demand, and production of biodiesel is likely to increase. That being said, if current supply cannot meet demands, additional feedstock must be imported, in addition to the feedstock imported currently. This could possibly involve increased access to marine, truck and rail for transport of feedstock from the port to the facility.

E100 and B100 Transport, Blending and Distribution

B100 and/or biodiesel is trucked production site and then to retail pumps. It is likely that this scenario will continue over the next few years. Storage facilities for B100 are necessary to store the fuel at the producer's site or at a secondary terminal. If current supply cannot meet demands, additional biodiesel must be imported. This could possibly involve increased access to marine, truck and rail for transport from the port to the facility.

B5 is the current maximum allowable blend sold in Korea, and is the primary volume percentage sold in the Korea. Infrastructure related to storage, blending and transport of ethanol must be implemented in order to accommodate domestic production and distribution. Trucks for transport of blended fuels to fuelling stations across Korea will also be required.

A.7.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Korea

Korea is considering the use of jatropha for second-generation biodiesel production, with feedstock available in Philippines, Thailand and SE Asia (EWG, 2008). MIFAFF has announced a $270.5 (USD) million expenditure over the next 10 years in R&D for seaweed use as a potential feedstock. The primary objective is to produce 12.5 million tons of seaweed on 35,000 ha by 2020 (USDA, 2010).

Jatropha is being considered as a possible feedstock for biodiesel, as it is not a crop for human consumption, and can be grown on non-arable land (EWG, 2008). Available land identified as marginal and useful for jatropha production could incur costs in transport of the feedstock to a potential facility, unless the facility will be located close to where the plant is grown. However, this may not be ideal if retail stations are located at a farther distance, and cost of biofuel transport could increase accordingly.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Korea Biofuels Annual 2010 report (10 February 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Bio-Fuels%20Production_Seoul_Korea%20-%20Republic%20of_2-10-2010.pdf
2. Republic of Korea Biofuels Production Report 2008 http://www.thebioenergysite.com/articles/210/republic-of-korea-biofuels-production-report-2008
3. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
4. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.8 Biofuels in Malaysia

Malaysia is currently the world's largest palm oil producer and exporter, accounting for more than 80% of global production. Malaysia is also looking to use biodiesel to reduce its dependence on diesel fuel and to export biodiesel to foreign markets. There is presently no biodiesel limit in force in Malaysian diesel fuel specifications.

A.8.1 Biofuels Mandates in Malaysia

Ethanol
The National Biofuel Policy that was officially released by MPOB does not cover the use of fuel ethanol in Malaysia.

Biodiesel
In August 2005, the government announced its plans to adopt a National Biofuel Policy that was officially released by MPOB (Malaysian Palm Oil Board) in March 2006. The government's initial aim was to expand the use of B5 in government and privately owned vehicles economy-wide in 2007, before making its use mandatory in 2008. At the end of 2006, a Biofuel Industry Bill 2006 requiring all oil companies to blend diesel fuel with five percent processed palm oil was introduced in the parliament, and was approved as the Biofuel Industry Act 2006 in mid-2007. However, the government has yet to implement the act due to increasing crude palm oil prices since January 2007. Although the act aims to use processed palm oil to blend in diesel fuel, the auto manufacturers are not willing to provide guarantees on the palm oil-blended fuel when used in their vehicles. Thus, it is still unclear whether processed palm oil or palm oil methyl ester (POME) will be used to blend with diesel fuel locally. The potential impact of this from a transportation and distribution infrastructure standpoint is unclear at this time.

The government continues to put on hold the proposed mandatory blend of five percent of palm olein in diesel for the domestic market. The lack of clear direction in implementing the mandatory blend of five percent of palm methyl esters in diesel (referred to as B5) in the domestic market is causing concern in the bio-diesel sector. The original plan to implement a B5 mandate on 1 January 2010 has long passed and since then, the Government of Malaysia has been quiet on the next deadline. It is estimated that at least 500,000 tons of palm olein (less than three percent of current palm oil production) would be required annually to fulfil the B5 mandate. The government delayed a move to require oil companies to sell it alongside First Generation fuels. The plan was originally due to take effect in 2007 but will now planned to come into force in June 2011.[12]

A.8.2 Biofuels Market in Malaysia

Ethanol
There is no existing fuel ethanol production, although there are plans by some companies to construct ethanol plants in Malaysia.

---

12 http://www.google.com/hostednews/afp/article/ALeqM5gx34dM8YQz3bKvJ_EASaamQk4yWA?docId=CNG.00d3a788da59b4d2dfdc54a9f9881671.3e1

Biodiesel
There are 91 licenses for biodiesel production but only seven are in operation. Although diesel fuel consumption is generally about 15% higher than gasoline, biodiesel is currently not sold on the open market for transportation use because of insufficient existing infrastructure to blend biodiesel. In March 2006, B5 was launched under the government's voluntary program to introduce biodiesel to a fleet of selected government vehicles. Local oil companies such as Petronas and Shell are waiting for the government to put the Biofuel Industry Act 2006 in place before marketing diesel fuel blends with processed palm oil or methyl ester. All existing and proposed biodiesel plants are aiming to produce palm oil methyl ester rather than processed palm oil. This is in line with Malaysia becoming a major exporter of biodiesel to satisfy demand s in Europe and other countries. However, a large number of biodiesel producers have temporarily stopped producing biodiesel, as the increased cost of production (feedstock) has negatively impacted their profit margins.

A.8.3 Biofuels Demand and Supply in Malaysia

Passenger car ownership in Malaysia is expected to rise to approximately 476 per 1,000 people by 2030. Urban transport depends very much on passenger vehicles, as the rail infrastructure is not yet well developed. Demand for freight vehicles is anticipated to double by 2030 from 2007 levels. Biofuels is anticipated to increase to 9,000 barrels per day (kb/d) in 2030 which would account for two percent of transport oil demand. (IEA World Energy Outlook, 2009).

Ethanol
There are also no mandates or targets set to blend ethanol in this APEC economy; therefore, no supply and demand outlook is available for Malaysia.

Biodiesel
In response to the National Biofuel Policy, several companies announced or disclosed their intentions to build plants producing biodiesel, primarily from palm oil. MIDA is the central agency approving licenses to companies that are looking to build biodiesel plants in Malaysia. So far, MIDA has approved licenses for more than 90 plants with a combined annual capacity of more than 10 million tons (three billion gallons). Most plants were expected to come online during 2007-2008 if they did not encounter financing or technological difficulties. However, this has not occurred as they were mainly hindered by high palm oil prices and sustained losses during production.

Malaysia has expressed concern over a directive by the European Union (EU) that sets sustainability criteria for biofuel: the material used should initially reduce greenhouse gas (GHG) emissions by 35 percent (November 2010), increasing to a 60% reduction by 2018. The problem for palm oil production lies in the default GHG savings value of only 19 percent (assigned by the EU) and hence, eliminated from the EU's list of qualified biofuel. The low GHG reduction is linked to perceived direct and indirect land use impacts – a subject under intense debate. On the international front, the EU's elimination of palm oil from the qualified list of biofuels will have a negative impact on Malaysia's exports of bio-diesel in 2011. Malaysia and Indonesia are working to find a solution. In addition, Malaysia is also looking to lay the foundation for palm oil to qualify as an advanced biofuel source in the United States under its Renewable Fuels Standard mandate (RFS2).

Biodiesel Blending
The new rule on biofuel sales was on track for June 2011, with the government providing funds to several oil firms, including Malaysia's Petronas, to set up B5 blending facilities. Plantation Industries and Commodities Minister Tan Sri Bernard Dompok said the initial incentive given to the five petroleum companies reflected the Government's intention to fully implement the mandatory B5 biodiesel programme by the middle of2011.[13]

A.8.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Malaysia

A.8.4.1 Ethanol

Feedstock
There are currently no ethanol mandates or facilities for ethanol production in Malaysia. It is unlikely that ethanol consumption will be realized as gasoline prices are subsidized. However, there are limited ethanol feedstocks, and any ethanol demand in the future must be met by imports. There is the opportunity for palm biomass to be utilized; however, the technology is still in its early stages (USDA, 2010). Table A.33 below illustrates crops with the greatest potential for usage for ethanol.

Table A.33 Currently Available Ethanol Feedstocks in Malaysia

	Corn	Cassava	Sugarcane
Malaysia Production (Thousand metric tons per year)	105	430 (2008)	700

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production
There is no current production of ethanol in Malaysia.

A.8.4.2 Biodiesel

Feedstock
Palm oil represents the greatest opportunity for biodiesel production, as Malaysia is one of the world leaders in palm oil production (USDA, 2010). Approximately 62% of Malaysia's agricultural land is palm, with approximately 16.5 million tonnes produced per annum (EWG, 2008). Table A.34 below illustrates crops with the greatest potential for usage for biodiesel.

Table A.34 Currently Available Biodiesel Feedstocks in Malaysia

	Soy Oil	Palm Oil	Peanut Oil	Coconut Oil
Malaysia Production (Thousand metric tons per year)	69	18,600	1	32

Source: USDA FAS, 2010/2011 Production Year

Production
The combined capacity of biodiesel facilities is approximately 275 million tons. With approximately 20 facilities in various stages in production, and 7 in operation, it is anticipated

[13] http://biz.thestar.com.my/news/story.asp?file=/2010/10/5/business/7159562&sec=business

that Malaysia will be able to keep up with future mandates based on feedstock and available capacity. Malaysia is pushing to become a net exporter of palm methyl esters. Table A.35 below shows biodiesel production and consumption in Malaysia.

Table A.35 First Generation and Advanced Biodiesel in Malaysia (Thousand Liters)

Biodiesel Production/Consumption/Trade (000 Metric Tons) in Malaysia					
Year	**2007**	**2008**	**2009**	**2010**	**2011**
Beginning Stocks	2	7	20	15	19
Production [1]	100	195	222	275	100
Imports	0	0	0	0	0
Total Supply	102	202	242	290	119
Exports	95	182	227	270	100
Consumption	0	0	0	1	1
Ending Stocks	7	20	15	19	18

Source: USDA Malaysian Gain Report, 2010

(1) One ton of Palm Oil has a 94% yield in term of methyl ester output.

A.8.4.3 Infrastructure Requirements in Malaysia

Feedstock Transport

There are no existing ethanol facilities in Malaysia. Production is not likely to occur over the next few years. Hence, and infrastructure involved in ethanol production is not necessary at this time. For biodiesel, palm oil feedstocks will likely continue to utilize truck/rail for feedstock transport. Malaysia is a net exporter of palm oil. Feedstock will likely be able to keep up with demand in the near term. Access to rail for current and future biodiesel production sites is ideal. Trucking of feedstock to production facility will also continue to be utilized.

E100 and B100 Transport, Blending and Distribution

In the case that ethanol blends become mandated, infrastructure related to import and blending, as well as conversion of retail pumps, will be implemented. Biodiesel is not currently sold for retail in the transportation sector, due to lack of infrastructure in place for blending. Proper facilities or tanker trucks for blending are likely going to be implemented should the Government's implementation of the B5 programme become a reality. Trucks for blended fuels to fuelling stations across Malaysia will also be required. Transportation greatly depends on the availability of transportation modes at specific distribution area. For locally produced biofuel to be consumed domestically, land transportation by trucks is still the preferable mode as not many biofuel manufacturing facilities are located nearby railway network or are equipped with pipeline by the port. Transportation of B100 by land is done using 20 or 40 footer container / road tankers. The distance travelled typically covers 25 - 400 km. Distribution of blended diesel to retail service stations are also by road tanker.[14]

A.8.5 Outlook on Second Generation Biofuels, Infrastructure Requirements 2015 and Beyond in Malaysia

Malaysia is exploring the production of cellulosic ethanol using palm biomass residues. This strategy is at early stages of production (EWG, 2008). Any infrastructure implemented

[14] Information provided via email by Datuk Dr. Choo Yuen May, Director-General of the Malaysian Palm Oil Board

related to this will likely occur once production and distribution in first generation biofuels is already in place.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Malaysia Biofuels Annual 2010 report (16 July 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Kuala%20Lumpur_Malaysia_7-16-2010.pdf
2. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
3. http://faostat.fao.org/
4. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.9 Biofuels in Mexico

Mexico exports crude oil, and imports gasoline and fuel additives. With regards to the sales of domestic fuels, PEMEX reported in 2008 the following breakout: 52% gasoline, 22% diesel, 14.2% fuel-oil and the rest in other fuels like jet-oil, asphalts and other products.

A.9.1 Biofuels Mandates in Mexico

There is an E2 mandate in Guadalajara, Mexico. This is to be expanded to Monterrey and Mexico City by 2012.[15] The Government of Mexico is proceeding cautiously, planning pilot programs and gathering information regarding developing biofuels policies. Mexico's bio-fuel public policies are derived from several government planning documents. The 2007-2012 National Development Plan, (Plan Nacional de Desarrollo, or PND) sets the current Administration's general objectives and strategies. The Government of Mexico published the Bio-Fuels Promotion & Development Law (Ley de Promoción y Desarrollo de los Bioenergéticos, or LPDB) on 1 February 2008, establishing the legal framework from which all bio-fuel public policies will develop. The Law also sets up a bio-fuel regulatory inter-agency mechanism: the Inter-Agency Bio-fuel Development Commission (Comisión Intersecretarial para el Desarrollo de los Bioenergéticos), made up of SAGARPA, SENER, SEMARNAT, ECONOMIA and the Ministry of Finance (Secretaría de Hacienda y Crédito Público, or SHCP). Formally established on 28 February 2008, the commission will overview and coordinate all Government of Mexico efforts related to bio-fuel production, storage, transportation, distribution, commercialization and final use.

A.9.2 Biofuels Market in Mexico

Ethanol

Another specific activity outlined in the Mexico test Program was to conduct an experiment where ethanol is mixed with regular gasoline. This test, which has been carried out in Monterrey, involved 16,000 barrels (2.54 ML) of base gasoline that where stored in a storage and distribution facility. The gasoline was then mixed with 3,500 liters of ethanol daily for 42 days between December 2008 and January 2009 and distributed in two service stations at a rate of 60,000 liters per day.

Biodiesel

The general consensus between the Government of Mexico, researchers, agricultural associations and private organizations is that Mexico should introduce at least five percent of biodiesel in the transportation sector by 2012, with some organizations pushing for ten percent.

---

[15] http://www.iea.org/papers/2011/biofuels_roadmap.pdf

A.9.3 Biofuels Demand and Supply in Mexico

Ethanol

Currently, Mexico does not produce fuel ethanol. There are 25-30 sugarcane mills in Mexico that have attached distilleries, but very few are operating, and operating mills only produce about 60 million-80 million liters a year. At full capacity and efficiency, it is estimated that total production capacity for ethanol is currently almost 170 million liters annually (USDA 2007).

Mexico already produces ethanol, but not for fuel purposes. The current ethyl alcohol produced is only used to produce alcoholic beverages and in the pharmaceutical industry. According to the Mexican Sugar Cane Producers Association, only two mills have the capability of producing ethanol with the technical requirements specified by PEMEX, equating to about 10 MLY. Mexico gasoline specifications require that the gasoline should have no more than 2.7% (by weight) of fuel oxygenate, the Government of Mexico is aiming to produce 200 million liters of ethanol per year, which will be used in a 2% mix with the gasoline distributed in Guadalajara. This project was expected to begin during the last three months of 2010 and, depending on the results, is likely to extend to Mexico City (with a need of 530 MLY) and Monterrey (with a need of 150 MLY) by 2012. The following table below summarizes the pilot project.

Table A.36 Mexico Ethanol Project Volumes

Metropolitan Area	Ethanol (MLY)
Guadalajara	200
Monterrey	150
Mexico City	530
Total	880

Biodiesel

Biodiesel production levels in Mexico are small-scale (3.7 MLY). A biodiesel pilot plant in the state of Chiapas is expected to produce 100 ML of biodiesel by 2012.

A.9.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Mexico

A.9.4.1 Ethanol

Feedstock

Currently, Mexico does not produce ethanol for transportation fuels. There are, however, sugarcane facilities which have the capacity to produce 170 million liters per annum (USDA, 2007). This is the most promising feedstock, as ethanol-producing facilities could be co-located to the existing sugar mills. Possible crops to be used for ethanol production include the following: sorghum, corn, wheat, cassava, sugarcane and sugar beets. Table A.37 below illustrates crops with the greatest potential for usage for ethanol.

Table A.37 Currently Available Ethanol Feedstocks in Mexico

	Corn	Wheat	Barley	Sorghum	Sugarcane	Cassava
Mexican Production (Thousand metric tons per year)	24,500	3,900	781	7,100	51,107 (2008)	14 (2008)

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production
There are currently no ethanol production facilities for transportation fuels in Mexico. However, it is estimated that 1 million ha of sugarcane and sugar beets are needed to produce enough ethanol to displace 10% of gasoline. This is a likely scenario, as only 21.8 million ha out of 30 ha of available are being used for agriculture; hence, the possibility to produce new crops could be realized (EWG, 2008).

The cost of ethanol production per ton of cane is high compared to that in countries like Brazil, where sugar cane is sold for between $15 and $18 dollars per ton (in Mexico, sugar cane is about $37 to $40 dollars per ton). There are, however, provisions within the Sugar Law that contain overall goals focused on the possibility of producing ethanol. Thus far, however, necessary government policies have not been implemented and Mexico's investments in ethanol have focused on corn-based production.[16] Also, if future mandates come into play, it is possible that current domestic feedstocks would be sufficient to supply ethanol production.

A.9.4.2 Biodiesel

Feedstock
Biodiesel production in Mexico essentially relies on animal renderings and used cooking oils. Potential biodiesel crops in Mexico could include palm, sunflower, safflower, canola and soybean. Mexico is also considering the usage of jatropha as a possible feedstock, and has estimated approximately 1 million ha of available land to be used to cultivate the plant (USDA, 2007). Table A.38 below illustrates crops with the greatest potential for usage for biodiesel.

Table A.38 Currently Available Biodiesel Feedstocks in Mexico

	Rapeseed Oil	Soy Oil	Palm Oil	Sunflower Oil	Cotton Oil	Peanut Oil	Coconut Oil
Mexican Production (Thousand metric tons per year)	475	645	27	4	70	1	145

Source: USDA FAS, 2010/2011 Production Year

Production
Production levels are still small-scale using used animal fats and cooking oils. The Government of Mexico is leaning towards a five or ten percent inclusion in diesel by 2012. It is likely that with future mandates, current crop production could not meet the demand, and that Mexico will have to import biodiesel (USDA, 2007).

[16] http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Sugar%20Semi-annual_Mexico%20City_Mexico_10-1-2010.pdf

A.9.4.3 Infrastructure Requirements in Mexico

PEMEX would be the sole buyer of biofuel products, thus it would be the responsibility of PEMEX to make necessary upgrades to its own refining, storage, and distribution systems (USDA 2007). It would cost $77M-120M to convert Mexico's existing gasoline storage and distribution terminals to allow for the blending of ethanol (F.O. Licht 2007).

Feedstock Transport

There are no existing ethanol facilities in Mexico. Small-scale production is set to occur over in ending months of 2010. Sugarcane transport by truck/rail to the two existing sugar mill sites deemed appropriate for production is likely to continue. For biodiesel, waste cooking oils and animal renderings will likely continue to utilize trucks for feedstock transport. Increases in demand due to the implementation of five percent biodiesel in the diesel pool could cause facilities to look to crop-based biodiesel production, and in that case, truck/rail transport of feedstock will likely occur.

E100 and B100 Transport, Blending and Distribution

E100 production set for 2010 will utilize current storage infrastructure set for the alcohol industry. Access to truck and rail to blend and distribute the fuel to the two service stations in Guadalajara is necessary for the near term. Truck and rail will also need to be implemented accordingly, should the pilot trial blend continue to both Mexico City and Monterrey.

Conversion or implementation of new ethanol pumps at retail stations will likely occur in the near term should sales of blended ethanol and gasoline take place. Proper facilities or tanker trucks for blending are likely going to be implemented if the mandated blends are set in place. Trucks for blended fuels to fuelling stations across Mexico will also be required. Imports of B100 and E100 can be met by marine, truck and rail sources.

A.9.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Mexico

Jatropha is being considered as a possible feedstock for biodiesel, as it is not a crop for human consumption, and can be grown on non-arable land (EWG, 2008). Approximately 1 million ha of land could be available. Land identified as marginal and useful for jatropha production could incur costs in transport of the feedstock to a potential facility, unless the facility will be located close to where the plant is grown. However, this may not be ideal if retail stations are located at a farther distance, and the cost of transport could increase accordingly.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Mexico Biofuels Annual 2010 report (15 June 2009) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_Mexico_Mexico_6-15-2009.pdf
2. http://faostat.fao.org/
3. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008
4. Technology Roadmap – Biofuels for Transport, International Energy Agency (IEA) http://www.iea.org/papers/2011/biofuels_roadmap.pdf

A.10 Biofuels in New Zealand

As part of their National Energy Efficiency and Conservation Strategy (NEECS), the government has set a voluntary target of 2 petajoules (PJ) or approximately 65 million liters of renewable transportation fuel by 2012. New Zealand currently allows blending of up to 10 percent ethanol by volume in gasoline and up to five percent biodiesel by volume in diesel fuel.

A.10.1 Biofuels Mandates in New Zealand

In 2007, the Ministry of Transport proposed a sales obligation for biofuels to further reduce vehicle emissions, increase energy security as well as meet Kyoto targets. The proposal required oil companies to sell a minimum percentage of biofuels in transportation fuels based on the gross volumetric energy content of gasoline and diesel, beginning with 0.53% of total combined gasoline and diesel sales in 2008, and rising progressively to 3.4% in 2012 and beyond. The biofuels sales obligation basically required firms that sell gasoline or diesel in New Zealand to also sell biofuels. The amount to be sold is set as a percentage of total combined gasoline and diesel sales per year, measured in PJ, based on the energy content of each fuel. The yearly levels that were proposed are shown in Table A.39 below.

Table A.39 New Zealand's Biofuels Sales Obligation

	2008 (April - Dec)	**2009**	**2010**	**2011**	**2012 +**
Obligation - as a percentage of previous sales (measured in PJ)	0.53%	1.06%	1.67%	3.35%	3.40%
Approximate PJ (petajoules)	0.83	2.22	3.55	7.18	7.25

Source: Ministry of Transport, March 2007

However, the biofuel sales obligation was repealed in November 2008.[17] In May 2009, the New Zealand Government announced a NZ $36 million grant program for biodiesel production to help kick start the industry. The announcement follows a decision by the new government to rescind legislation, passed in February 2007 by the former labour-led government, which would have required oil companies to blend a minimum percentage of their gasoline and diesel with biofuels. In December 2008, the new Minister of Energy, Gerry Brownlee, a member of the new economy-led Government, announced that he had tabled a bill in Parliament that would repeal the requirement.

A.10.2 Biofuels Market in New Zealand

The size of the transport fuel market in New Zealand is approximately 6.3 billion liters, including 3.4 billion liters of petrol and 2.9 billion liters of diesel. Total biofuel usage in New Zealand is in the region of six to eight million liters per annum.

[17] Correspondence from Senior Policy Analyst, Fuels & Crown Resources, Energy & Communications Branch of the Ministry of Economic Development

Ethanol
E10 has been sold in New Zealand by private oil company Gull Petroleum since August 2007. According to the Ministry of Transport, locally produced ethanol sourced from dairy industry by-products is available only to replace 0.3% of gasoline. Therefore, to meet the sales obligation, ethanol will most likely be imported. Biodiesel blends have yet to be commercially available in New Zealand. E10 is marketed by Gull Petroleum, 98 RON at all sites and 91 RON at a small number of sites. Mobil Oil New Zealand Limited has been selling ethanol-blended petrol (E3 91 RON and E10 98 RON) at selected service stations in the greater Wellington region since mid-2008. The ethanol blending ratio has received attention with opinions mainly supporting less than ten percent blends – either three percent maximum or five percent maximum (by volume). Concerns about the ability to honour manufacturer warranties have been raised, mainly by the Japanese car manufacturers, if more than three percent ethanol is blended with gasoline. Approximately 50% of the vehicles in the New Zealand market are from Japan, where currently only three percent maximum ethanol is allowed to be blended with gasoline.

Biodiesel
Mobil is sourcing tallow-based biodiesel domestically and running a trial selling B5 at two sites on the North Island.

A.10.3 Biofuels Demand and Supply in New Zealand

Ethanol
Fonterra Co-operative Group Ltd. is currently the only ethanol producer in New Zealand. It has a production capacity of 10 million liters (2.65 million gallons) per year. Annual ethanol production capacity is expected to increase to 250 million liters (66 million gallons) when the new plants come online in 2010-2015. In the meantime, additional ethanol to meet the obligation is currently imported from Singapore. In order to meet the obligation, oil companies have options to combine the sale of ethanol blends and biodiesel blends. E3 was sold in the period of 2008-10. Based on projected gasoline demand, it estimated that to be able to meet the obligation, oil companies should increase ethanol blending to E10 starting in 2011. As the obligation was expected to be implemented starting July 2008, projected ethanol demand and supply in 2008, stand at 7.5 million liters (2 million gallons) and 10 million liters (2.6 million gallons) respectively. The ethanol demand is calculated based on the July - December period.

Biodiesel
Current biodiesel production capacity stands at 34 million liters (9 million gallons) per year with BioDiesel Oils (NZ) Ltd. leading the market at a production capacity of 23 million liters (6.1 million gallons) per year. Another significant player is Flo-Dry Engineering Ltd., with an annual production capacity of 9.09 million liters (2.4 million gallons). The annual biodiesel production capacity is expected to reach 220 million liters (58.2 million gallons) in 2010 and 340 million liters (90 million gallons) in 2015. The obligation was to be implemented beginning in July 2008, with a projected biodiesel demand of five million liters (1.3 million gallons) and a projected supply of 33 million liters (8.9 million gallons). The maximum biodiesel supply based on available tallow feedstock is 132 million liters (35 million gallons). In the future, it is therefore anticipated that biodiesel producers will import additional feedstock to meet additional demand. This would be an additional logistical consideration for biodiesel transportation. However, feedstock prices remain a concern, and new feedstocks may be considered, to further complicate the biodiesel transportation picture.

A.10.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in New Zealand

A.10.4.1 Ethanol

Feedstock
Ethanol production in New Zealand relies solely on whey, which is a by-product of the dairy industry. In this case, it is unlikely that current crop production could sustain a biofuels industry, as the amount of available feedstock is not enough to be economically viable (USDA, 2010). Table A.40 below illustrates crops with the greatest potential for usage for ethanol.

Table A.40 Currently Available Ethanol Feedstocks in New Zealand

	Corn	**Wheat**	**Barley**
New Zealand Production (Thousand metric tons per year)	172	277	400

Source: USDA FAS, 2010/2011 Production Year

Production
As stated earlier, although there are no current mandates, New Zealand does allow up to 10%vol of ethanol in gasoline. Anchor Ethanol Ltd solely produces ethanol from whey for industrial purposes; however, approximately 15-20 million liters of fuel grade ethanol are produced per year (USDA, 2010). However, current production of ethanol from whey is insufficient to meet the E10 blend. With one facility producing ethanol to date, importing ethanol to meet the sales obligations is necessary, and should capacity increase, it can be estimated that the produced ethanol will be sufficient to keep up with demand (USDA, 2010).

A.10.4.2 Biodiesel

Feedstock
Biodiesel production currently uses tallow as its primary feedstock, with canola under consideration as well (USDA, 2010). Approximately 130,000 tons are produced per year, surpassing domestic requirements (EWG, 2008).

Production
There are currently 7 production facilities in operation in New Zealand, with a combined capacity of 70 million per annum (USDA, 2010). The majority of these facilities use tallow; the remainder uses waste vegetable oil and rapeseed oil. There are plans for expansion over the next few years (USDA, 2010).

Biodiesel based on tallow alone is insufficient in meeting the sales obligations, which is why other feedstocks must be considered due to high costs in importing feedstocks. New Zealand is currently looking at the possibility of producing biodiesel from rapeseed and waste vegetable oil (USDA, 2010).

A.10.4.3 Infrastructure Requirements in New Zealand

There is only one fuel products pipeline from the Marsden Point Refinery to the Wiri Terminal in Auckland, which is First Generation fuel only (no biodiesel or ethanol or biofuel blends) mainly because it also carries jet fuel.

Feedstock Transport
It is likely that New Zealand will continue to utilize whey produced domestically for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. For biodiesel, tallow will likely continue to utilize trucks for feedstock transport. It is estimated that current supply will not be able to keep up with demand, and that additional feedstock must be imported. This could possibly involve increased access to marine, truck and rail services for transport of feedstock from the port to the facility. If canola is used in the next few years as a feedstock for biodiesel, additional trucking and rail requirements will be necessary to transport the feedstock to the facility.

E100 and B100 Transport, Blending and Distribution
Both domestic and imported E100 is trucked to the storage site at the port for blending, and trucked back to retail pumps. It is likely that this scenario will continue over the next few years. Storage facilities for E100 and B100 are necessary to store the fuel at the producer's site or at a secondary terminal. Current storage for B100 occurs on the producer's site. Blending occurs in tanker trucks at the producer or customer locations. This is likely to continue in the near term.

Trucks for blended fuels to fuelling stations across New Zealand will also be required. E10 is currently sold at various stations in New Zealand. B5 is currently sold at 2 stations in the North Island. Nation-wide sales would require conversion of gasoline pumps to E10 pumps. Mobil's distribution of biofuels from Chile relies on marine and truck for blending and distribution. Any expansion over the next few years would require a higher volume of trucks. Additional imports of B100 and E100 (from Singapore) to meet demand can be met by marine, truck and rail.

Biofuels blending and infrastructure
Domestic production is trucked to port storage, blended with petrol at the port. Blended product is trucked to retail service stations. Imported ethanol is trucked to port, blended with petrol at port and trucked to retail service stations.[18] Biodiesel is blended by the producer in truck and delivered to customer, or blended on customer's site, or blended on producer's site for direct dispensing.[19] Mobil is now distributing bio-fuels through ten sites, with its biofuels reportedly sourced from Chile.

A.10.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in New Zealand

New Zealand has an abundance of cellulosic biomass, favourable for advanced biofuels production. This APEC economy is exploring the option of lignocellulosics from dedicated forestry feedstocks grown on marginal land (USDA, 2010). Local production of a particular feedstock would drive the location of future biomass to ethanol facilities, and in turn, would sell to the local market. The utilization of truck (and rail) will be necessary to transport between each stage of production. Three major research institutes – GNS, AgResearch, and Scion – are responsible for the research and development in lignocellulosics (USDA, 2010).

[18] Information received via email from Andrew Saunders, Fuels & Crown Resources / Energy & Communications Branch, Ministry of Economic Development, New Zealand

[19] ibid

New Zealand is also experimenting with the use of algae for biodiesel production (EWG, 2008). This will likely not become realized until the technology advances.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) New Zealand Biofuels Annual 2010 report (26 June 2009) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/New%20Zealand%20Biofuel%20Report_Wellington_New%20Zealand_6-26-2009.pdf
2. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
3. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.11 Biofuels in Peru

A.11.1 Mandates in Peru

Challenges for the biofuels industry in Peru are implementation of strong policies and incentives. Supreme Decree N°013-2005 EM – Regulation of the Biofuels Market Promotion: This law establishes percentages of biofuel contents in fuels. Gasoline must contain 7.8 percent of ethanol and diesel must have five percent of biodiesel. Under Peru's biofuels legislation, beginning in 2011, gasoline was to contain 7 percent ethanol and diesel must include five percent biodiesel. Ethanol production in 2011 is estimated to reach 130 million liters. Peru's biodiesel consumption in 2011 is estimated at 227,000 MT. On 28 September 2010, the government of Peru published Supreme Decree 061-2010-EM establishing a new schedule for enforcing the 7.8 percent ethanol inclusion in gasoline. The highlight of this new schedule is that it postpones until 1 June 2011 mandatory ethanol inclusion in the Region of Lima which is about 60 percent of the market. Originally, Lima was supposed to come on line in January 2010, and then it was delayed to 1 October 2010.

A.11.2 Biofuels Market in Peru

Ethanol

Ethanol consumption is estimated at 30 million liters in 2010. However, once the ethanol blending schedule reaches this entire APEC economy in 2011, consumption is estimated to reach 80 million liters. Lima accounts for 65% of the ethanol market in Peru. As of January 2010, E7.8 was to be offered at retail service stations.

Biodiesel

As of 2008, there were no stations offering biodiesel or ethanol blends in Peru. B2 was to be offered at service stations beginning July 2009, and in January 2010 E7.8 was offered for use. Biodiesel consumption in 2011 is estimated at 227,000 MT. United States biodiesel exports in 2009 increased almost 700 percent, reaching 71,742 MT, or 78 percent of Peru’s biofuels imports. Other relevant suppliers are Ecuador and Argentina. However, the United States exports will likely decline due to duties imposed by Peru, including an anti-dumping duty of $212 per tonne and a countervailing duty of $178 per tonne that was imposed by INDECOI, the Peruvian consumer agency, in August 2010 on pure biodiesel (B100) and biodiesel blends of greater than 50 percent.

A.11.3 Biofuels Demand and Supply in Peru

Ethanol

As of March 2008, there were two ethanol plants under construction, both in Sullana, Piura, each with 100 million liters per year capacity. Production of ethanol for fuel in Peru began in August 2009. Currently, there is one operation up and running and another one in a pre-operation phase. Both of these operations are in the northern region of Piura. Ethanol production in 2010 was expected to reach 100 liters per year capacity. Two more plants, also in the Northern region, are planned with a total capacity of 200 liters per year capacity.

Biodiesel

Biodiesel production in 2010 is estimated to reach 30,000 metric tonnes.

A.11.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Peru

A.11.4.1 Ethanol

Feedstock

Ethanol production is primarily from sugar cane, with total production around 10 million tonnes in 2009. Sugar mills in Peru have a total milling capacity of 37,000 tonnes of cane per day. Table A.41 below illustrate crops with the greatest potential for usage for ethanol.

Table A.41 Currently Available Ethanol Feedstocks in Peru

	Corn	Wheat	Barley	Sorghum	Cassava	Sugarcane
Peru Production (Thousand metric tons per year)	1,600	185	200	1	1,221	10,100

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

There is one ethanol production facility in operation in Peru, one under construction, and two in the planning stages, with a total combined capacity 400 million liters per year (EWG, 2008). Should mandatory ethanol blended in gasoline occur in 2011, it is estimated that production is able to satisfy demand, using the available sugarcane and ethanol facilities (USDA, 2010). The majority of feedstock is sugarcane, which is likely to be the only viable feedstock should future mandates arise.

Table A.42 First Generation and Advanced Ethanol in Peru (Million Liters)

First Generation and Advanced Ethanol (million liters)						
Current Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	-	-	-	50	100	130
Imports	-	-	-	0	0	0
Exports	-	-	-	49	70	50
Consumption	-	-	-	0	30	80
Ending Stocks	-	-	-	1	1	1
Production Capacity (First Generation Fuel)						
No. of Biorefineries	-	-	-	1	1	2
Capacity	-	-	-	126	126	256
Production Capacity (Advanced Fuel)						
No of Biorefineries	-	-	-	-	-	-
Capacity	-	-	-	-	-	-
Feedstock Use (1,000 MT)						
Sugarcane	0	0	0	410	960	2,200

Source: USDA Peru Gain Report, 2010

A.11.4.2 Biodiesel

Feedstock

Palm oil is the current feedstock for biodiesel production in Peru, with approximately 41,000 tonnes of feedstock produced per annum. Significant quantities are exported, and will likely continue unless there is a significant increase in mandated biofuel consumption (USDA, 2010). Table A.43 below lists crops with the greatest potential for usage for biodiesel.

Table A.43 Currently Available Biodiesel Feedstocks in Peru

	Palm Oil
Peru Production (Thousand metric tons per year)	41

Source: USDA FAS, 2010/2011 Production Year

Production

Current biodiesel capacity is approximately 127 million liters per year, with plans of expansion (EWG, 2008).

Table A.44 First Generation and Advanced Biodiesel in Peru (Million Liters)

First Generation and Advanced Biodiesel (million liters)						
Current Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	-	10	10	10	30	60
Imports	-	12	20	92	114	167
Exports	-	0	0	0	0	0
Consumption	-	21	30	102	143	227
Ending Stocks	-	1	1	1	2	2
Production Capacity (First Generation Fuel)						
No. of Biorefineries	-	1	1	1	2	2
Capacity	-	25	25	25	200	200
Production Capacity (Advanced Fuel)						
No of Biorefineries	-	-	-	-	-	-
Capacity	-	-	-	-	-	-
Feedstock Use (1,000 MT)						
Vegetable Oil	-	10	10	10	31	61

Source: USDA Peru Gain Report, 2010

A.11.4.3 Infrastructure Requirements in Peru

Feedstock Transport

It is likely that Peru will utilize domestic sugarcane for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. For biodiesel, palm oil will likely continue to utilize trucks for feedstock transport. This could possibly involve increased access to marine, truck and rail for transport of feedstock from the port to the facility.

E100 and B100 Transport, Blending and Distribution

Domestic E100 is trucked from the production site to retail pumps. It is likely that this scenario will continue over the next few years. Since Peru borders on Brazil, ethanol could easily be imported from Brazil in future as an option. Storage facilities for E100 and B100 are necessary to store the fuel at the producer's site or at a secondary terminal. Trucks for blended fuels to fuelling stations across Peru will also be required, with the government's mandated blends of 7.8% for ethanol and 5% for biodiesel. Conversion to ethanol pumps at retail stations will be a near term necessity should the government enforce the mandate for ethanol blending.

A.11.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Peru

There are currently no plans for second generation biofuels production. Requirements for infrastructure related to second generation biofuels will be based upon a market that has grown from current first generation production.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Peru Biofuels Annual 2010 report (31 August 2010)

http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Lima_Peru_8-31-2010.pdf

2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Peru Biofuels Update (1 October 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Update_Lima_Peru_10-1-2010.pdf
3. http://faostat.fao.org/
4. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.12 Biofuels in the Philippines

Ninety-six percent of the Philippines total petroleum supply is imported.

A.12.1 Biofuel Mandates in the Philippines

On 12 January 2007, President Gloria Macapagal-Arroyo signed into law Republic Act 9367 (RA 9367) or the Biofuels Act (outlined below). The Act mandated a minimum one percent biodiesel blend into all diesel fuels within three months from the effectivity of the law, to increase to a two percent blend two years later. RA 9367 likewise mandated that two years after taking effect, at least five percent ethanol shall comprise the annual total volume of gasoline sold and distributed by oil companies in this APEC economy, subject to the requirement that all ethanol blended gasoline shall contain a minimum of five percent ethanol by volume. Within four years after the law takes effect, the NBB shall determine the feasibility and recommend to the DOE to mandate a minimum of ten percent blend of ethanol by volume into all gasoline fuel distributed and sold all oil companies in this APEC economy. Lack of feedstock and processing facilities to supply the demand of the National Biofuels Program set by the government is a potential constraint in the Philippines. Table A.45 summarizes the minimum biofuel blending timeline in the Philippines.

Table A.45 Ethanol and Biodiesel Blending Timeline in the Philippines

	2007 - 2008	**2009 - 2010**	**2011**
Biodiesel	B1	B2	B2
Ethanol		E5	E10

Ethanol

The Biofuels Act minimum was to increase to 10 vol% within four years thereafter, by February 2011, as recommended by the NBB (National Biofuels Board). In the event of a shortage of supply of fuel ethanol produced locally during the four year period, oil companies will be allowed to import fuel ethanol, but only to the extent of the shortage determined by the NBB. <u>However, ethanol imports will no longer be allowed starting in early 2011</u>. Consequently, the mandated ethanol blend will likely be adjusted to that level which local production can supply. The National Biofuels Board (NBB) will likely not endorse a 10 percent mandated ethanol blend as proposed in 2011. Instead, the NBB is anticipated to recommend that the mandate stay at the current five percent, or recommend a lower level that will approximate what local production can supply until such time as domestic ethanol production is increased.

Biodiesel

As of 2008, which is within three months from the effectivity of this Act, a minimum of one percent biodiesel by volume was blended into all diesel engine fuels sold in the Philippines; provided that the biodiesel blend conforms to the Philippine National Standards (PNS) for biodiesel. As of 2010, which is within two years from the effectivity of this Act, the NBB created under this Act is empowered to determine the feasibility and thereafter recommend to DOE to mandate a minimum of two percent blend of biodiesel by volume which may be increased taking into account considerations including but not limited to domestic supply and availability of locally-sourced biodiesel component (Republic Act No. 9367).

A.12.2 Biofuels Market in the Philippines

Ethanol

The current allowable ethanol in gasoline is a maximum 10 vol%. Local independent oil companies have been actively marketing biofuel blends in the Philippines. E10 is currently sold at service stations operated by Seaoil, Flying V and Pilipinas Shell. Ethanol consumption will remain weak during the 2010 due to insufficient supply. Compliance with a higher ethanol blend by next year is remote as ethanol imports will no longer be allowed starting early 2011. Consequently, the mandated ethanol blend will likely be adjusted to that level which local production can supply.

Biodiesel

For diesel fuel, the initial allowable biodiesel was a minimum of 0.7 percent by volume and a maximum of 1.2 percent by volume. The allowance was increased to two percent by volume in mid-2009. B1 is available through all service stations in the Philippines and it has been successfully used by thousands of vehicles in the Philippines since 2002.

A.12.3 Biofuels Demand and Supply in the Philippines

Ethanol

Currently, almost all of the ethanol used for blending with gasoline in the market is imported, mainly from Brazil and Australia. There are only three ethanol production facilities with a combined annual production capacity of about 69 MLY. Negros Occidental is the largest sugar-producing province; thus, most fuel ethanol plants are expected to be located there.

Biodiesel

Biofuels production in the Philippines is currently limited to biodiesel only. This current production capacity exceeds the requirement of the mandatory volumes set by the Biofuels Act.

A.12.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in the Philippines

A.12.4.1 Ethanol

Feedstock

Potential feedstocks in the Philippines include sugarcane, molasses, cassava and sweet sorghum. Table A.46 below lists crops with the greatest potential for usage for ethanol.

Table A.46 Currently Available Ethanol Feedstocks in the Philippines

	Corn	Sugarcane	Cassava
Philippines Production (Thousand metric tons per year)	6,800	22,933	2,044

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

There are only three ethanol production facilities with a combined annual production capacity of about 69 MLY. The majority of ethanol used for blending is imported. In 2011, the government mandated that it will no longer import ethanol, thus making future blends dependent on the domestic capacity of the Philippines. A five percent or lower blend, depending on mandate from the NBB, has to be met with the current domestic feedstock supply (USDA, 2010). The table below illustrates the production and capacities of ethanol facilities over a six year period. Please note that imports are expected to decrease after 2010 due to the ban on ethanol imports after 2011. There are no expected ending stocks

Table A.47 First Generation and Advanced Ethanol in the Philippines (Million Liters)

First Generation and Advanced Ethanol (million liters)						
Current Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	0	0	0	25	50	95
Imports	0	0	0	50	150	5
Exports	0	0	0	0	0	0
Consumption	0	0	0	75	200	100
Ending Stocks	0	0	0	0	0	0
Production Capacity (First Generation Fuel)						
No. of Biorefineries	0	0	0	2	3	4
Capacity	0	0	0	40	70	100
Production Capacity (Advanced Fuel)						
No of Biorefineries	0	0	0	0	0	0
Capacity	0	0	0	0	0	0
Co-product Production (1,000MT)						
Product (Bagasse)	0	0	0	115	231	438
Feedstock Use (1,000 MT)						
Feedstock	0	0	0	385	769	1,462

Source: USDA Philippines Gain Report, 2010

A.12.4.2 Biodiesel

Feedstock

Currently, coconut oil is the primary feedstock for biodiesel production in the Philippines. Potential feedstocks include both palm oil and jatropha (EWG 2008). Table A.48 below lists crops with the greatest potential for usage for biodiesel.

Table A.48 Currently Available Biodiesel Feedstocks in the Philippines

	Soy Oil	**Palm Oil**	**Coconut Oil**
Philippines Production (Thousand metric tons per year)	12	70	1,690

Source: USDA FAS, 2010/2011 Production Year

There are currently seven biodiesel facilities in operation, using coconut oil as raw feedstock. This represents a total capacity of approximately 300 million liters per annum (USDA, 2010). There are also a few pilot scale biodiesel facilities which use palm oil as a feedstock (EWG, 2008). In the Philippines, the three largest biodiesel plants are operated by Chemrez, Inc. with an annual capacity of 75.6 million liters (20 million gallons), Senbel Fine Chemical Co. Inc., with 72 million liters (19 million gallons), and Pure Essence International with 60 million liters (15.9 million gallons). Should higher blends be mandated, the copra (coconut meat) producers have assured biodiesel producers that the supply will be sufficient to meet the mandates. The allowable biodiesel percentage is 0.7%vol-1.2%vol max, and increased to 2%vol in 2009. B1 is available at all stations in the Philippines (USDA, 2010). The table below displays the production and capacities of biodiesel facilities in the Philippines. There are no expected imports of feedstock over the next few years, as with past trends.

Table A.49 First Generation and Advanced Biodiesel in the Philippines (Million Liters)

First Generation and Advanced Biodiesel (million liters)						
Current Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	2	70	72	150	124	182
Imports	0	0	0	0	0	0
Exports	0	0	0	0	1	2
Consumption	2	70	71	89	271	564
Ending Stocks	0	0	0	0	0	0
Production Capacity (First Generation Fuel)						
No. of Biorefineries	0	0	0	2	3	4
Capacity	0	0	0	40	70	100
Production Capacity (Advanced Fuel)						
No of Biorefineries	10	12	12	12	7	10
Capacity	150	325	325	395	300	600
Feedstock Use (1,000 MT)						
Feedstock (CME)	2	70	72	150	124	182

Source: USDA Philippines Gain Report, 2010

A.12.4.3 Infrastructure Requirements in the Philippines

Feedstock Transport

It is likely that the Philippines will utilize sugarcane feedstocks produced domestically for ethanol production in the near term, and hence utilize truck and/or rail for transport of the feedstock to the facility. For biodiesel, coconut oil (and some palm) will likely continue to utilize trucks for feedstock transport. It is estimated that current supply will not be able to keep up with demand, and that additional feedstock must be imported, as with past trends. This could possibly involve increased access to marine, truck and rail for transport of feedstock from the port to the facility.

E100 and B100 Transport, Blending and Distribution

Petron operates over 1200 gasoline stations economy-wide, Pilipinas Shell has about 800 stations and Caltex / Chevron as two import terminals and around 850 retail gas stations.

Ethanol

As of now, imported E100 is trucked to the storage site for blending, and trucked back to retail pumps. However, the government has banned any ethanol imports after early 2011. The government then in turn will implement a mandate based upon the amount of domestic supply. Infrastructure related to storage, blending and transport of ethanol must be implemented in order to accommodate domestic production and distribution. Since ethanol production is already in existence, it is possible to utilize current facilities for storage and distribution if it makes economical and logistic sense. E10 is the current maximum allowable blend sold in the Philippines. The government has set a mandate for E5 up to 2010, and E10 for 2011 and beyond. Oil company applicants must also submit proof of their technical and physical or logistical capability to handle fuel ethanol products, including provision for dedicated storage tanks and/or especially retrofitted retail outlets where ethanol blends shall be marketed.

Biodiesel

B1 blends are already sold throughout the economy since May 2007, while Flying V, Seaoil, Unioil and Eastern Petroleum have been marketing B100 at their stations. B1 is sold at stations all over the Philippines. Future blends of B2 are likely for the near term. Distribution infrastructure of biodiesel is currently in place; any increases in demand due to a B2 mandate will likely drive an increase in storage facilities. Trucks for transport of blended fuels to fuelling stations across the Philippines will also be required.

A.12.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in the Philippines

The Philippines have announced plans of cultivation of approximately two million ha of jatropha to produce biodiesel. Jatropha is being considered as a possible feedstock for biodiesel, as it is not a crop for human consumption, and can be grown on non-arable land (EWG, 2008). Available land identified as marginal and useful for jatropha production could incur costs in transport of the feedstock to a potential facility, unless the facility will be located close to where the plant is grown. However, this may not be ideal if retail stations are located at a farther distance, and cost of transport could increase accordingly.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Philippines Biofuels Annual 2010 report (9 July 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Manila_Philippines_7-9-2010.pdf
2. Global Ethanol & Biodiesel Outlook 2008 – 2015 Asia Pacific http://www.globalbiofuelscenter.com/
3. http://faostat.fao.org/
4. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.13 Biofuels in Russia

As one of the largest exporters of crude oil and gas, there is little interest in developing a domestic biofuel industry.

A.13.1 Biofuel Mandates in Russia

Currently there is neither federal legislation nor incentives to encourage the production and consumption of fuel ethanol in Russia. The government currently charges an excise tax to sell fuel ethanol and it is prohibitive to use in blending with gasoline. Prime Minister Viktor Zubkov had announced (2007) that a government program to develop biofuels in Russia would start in 2008. The announcement stipulated that there would be construction of 30 new ethanol plants and upgrades of existing facilities, producing 2 million tonnes of ethanol per year (although no target date for the program was mentioned in the announcement). This, however, has yet to come to fruition.

A.13.2 Biofuels Market in Russia

Ethanol

Russia does not produce fuel ethanol. The driver to create a biofuels market and to change the excise tax is driven by agriculture. When alcoholic products are exported, the excise duties are returned to the producer. Essentially, bio-ethanol could be produced for foreign markets duty-free without changes in the domestic legislature. Thus, any efforts to build fuel ethanol plants or convert existing alcohol production plants to fuel ethanol plants would be with the intent of exporting the fuel ethanol until such time as the excise tax on fuel ethanol for blending with gasoline is lifted. Wheat yields have improved in Russia and continue to improve. However, this results in grain oversupply in some years. Thus, an ethanol market in Russia would be good for agriculture.

Biodiesel

There is no biodiesel production in Russia, but a number of companies have recently announced plans to build biodiesel plants, with rapeseed as the feedstock. Russia may become a biodiesel producing nation or a biodiesel feedstock exporting nation. As with the ethanol industry, biodiesel produced from the proposed biodiesel plants are also intended for export markets in the EU (IADB 2007).

A.13.3 Biofuels Demand and Supply in Russia

Ethanol

There is no fuel ethanol demand in Russia. For ethanol the issue is a government excise tax for anything above 2% ethanol. Until this is resolved there will be no improvement in the biofuels market in Russia. Some companies have looked at alternative options such as ETBE, but have not moved forward for reasons related to the excise tax. There are efforts to develop biobutanol in Russia.

Biodiesel
There is no current biodiesel distribution in Russia.

A.13.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Russia

A.13.4.1 Ethanol

Feedstock

As one of the world's largest exporters of grains, such as wheat, barley and corn, a biofuels industry could be implemented based on feedstock availability alone. Table A.50 below lists crops with the greatest potential for usage for ethanol.

Table A.50 Currently Available Ethanol Feedstocks in Russia

	Corn	Wheat	Barley	Sugar Beets
Russia Production (Thousand metric tons per year)	3,000	42,000	8,500	24,892

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

There is currently no fuel ethanol production in Russia

A.13.4.2 Biodiesel

Feedstock

Possible feedstocks for biodiesel include sunflower oil, canola oil and soy oil.
Table A.51 below is used to illustrate crops with the greatest potential for usage for biofuels.

Table A.51 Currently Available Biodiesel Feedstocks in Russia

	Rapeseed Oil	Soy Oil	Sunflower Oil
Russian Production (Thousand metric tons per year)	177	409	2,082

Source: USDA FAS, 2010/2011 Production Year

Production

There is no current production of biodiesel in Russia. However, several companies in Russia have announced plans of producing biodiesel using canola oil (EWG, 2008).

A.13.4.3 Infrastructure Requirements in Russia

There is no current need for infrastructure related to biofuels in Russia. There are few fuel products pipelines used for gasoline distribution in Russia. However, most of the gasoline and diesel is delivered by rail. It is expected that when there is a biofuels market, some of the retail gas pumps would need to be upgraded. However, it is not anticipated that this would be an issue until there is an ethanol market in Russia.

A.13.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Russia

Russia has no current plans for second generation biofuels production. Second generation infrastructure requirements will be dependent upon a market for first generation biofuels.

Sources:

1. Russian Biofuels Association (RBA), http://www.biofuels.ru/
2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Russia Biofuels Annual 2007 report (4 June 2007) http://www.fas.usda.gov/gainfiles/200706/146291296.pdf
3. http://gain.fas.usda.gov/Pages/Default.aspx
4. http://faostat.fao.org/
5. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.14 Biofuels in Singapore

A.14.1 Mandates in Singapore

There are no biofuels mandates in Singapore at this time.

A.14.2 Biofuels Market in Singapore

Ethanol
Singapore has a negligible ethanol market at this time.

Biodiesel
Singapore has a negligible biodiesel market at this time. The biodiesel produced will be mostly for export.

A.14.3 Biofuels Supply and Demand in Singapore

Ethanol
Singapore does not produce ethanol. However traders do import ethanol from Brazil, Indonesia, Pakistan, Thailand and Korea.

Biodiesel
Two biodiesel plants will be built on Jurong Island, Singapore's petrochemicals hub. The first plant, by Peter Cremer (S) GMBH, will have a capacity of 200,000 tons/year and it is expected to be ready by early 2007, while the second is a joint venture between Wilmar Holdings and Archer Daniels Midland Company, to be operational by end 2006 with an initial capacity of 150,000 tons/year.

Renewable Diesel
Neste Oil announced that the construction of its new NExBTL renewable diesel plant at Tuas in Singapore, is completed and operations commenced by the end of 2010. This plant will be the largest renewable diesel plant in the world with an annual capacity of 800,000 metric tons. The new plant in Singapore will be using palm oil and palm oil derivatives sourced from the region such as Malaysia and Indonesia.[20]

A.14.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Singapore

There are no current mandates for biofuel blends in Singapore.

A.14.4.1 Ethanol

Feedstock
There are no biofuels feedstock data available.

Production
Singapore currently does not produce ethanol.

[20] http://www.greenbusinesstimes.com/2010/05/27/neste-oils-nexbtl-renewable-diesel-plant-in-singapore-to-start-operations-by-year-end/

A.14.4.2 Biodiesel

Feedstock

Table A.52 below lists crops with the greatest potential for usage for biodiesel.

Table A.52 Currently Available Biodiesel Feedstocks in Singapore

	Soy Oil
Soybean Production (Thousand metric tons per year)	3

Source: USDA FAS, 2010/2011 Production Year

Biodiesel facilities in various production stages use palm oil, soy oil, and used cooking oil as potential feedstocks, which are imported. Total capacity is approximately 700,000 tonnes per year (EWG, 2008).

Production

Should mandates for biodiesel become realized, Singapore will likely continue to import its feedstock.

A.14.4.3 Infrastructure Requirements in Singapore

The majority of ethanol produced is for export. Infrastructure related to import of feedstock and transfer to production site, as well as export of B100 to other countries likely will continue, utilizing marine, truck and/or rail.

During the last week of August 2010, the European Commission accused the port of Singapore of consolidating and trans-shipping uncertified or dumped biodiesel to Europe. At least some of the biodiesel is thought to have originated from producers in Indonesia and Malaysia who are currently shut out of the European market and are petitioning the WTO for inclusion. But the European Biodiesel Board asserts that much of it may have been sold by the United States and consolidated with shipments from other countries to evade the EU's anti-dumping duties – either through triangular trading through Canada and Singapore or through the importation of B19 which is not covered by EU duties. As a result of the EU investigations, shipments of biodiesel were halted, and the EU is requiring shipments of palm methyl ester en route from Singapore to post a bond equivalent to the countervailing duty. However, there may be other transportation opportunities for use of the trans-shipment infrastructure in place.

Singapore, Asia's key regional hub for oil trading, is no longer used as a transhipment point for biodiesel because of the current anti-circumvention probe by the European Commission, said an industry source Wednesday. The Singapore's Ministry of Trade and Industry (MTI) circulated a note last month to Singapore companies exporting biodiesel to the European Union to assist in the investigation. "MTI has since notified and been in close touch with the affected companies," a MTI spokesman said, without giving further details. The European Commission has launched an investigation into imports of United States produced biodiesel to Europe as it seeks to determine if antidumping measures that were imposed on the United States in March 2009 are being circumvented. Traders will not be able to store biodiesel in Singapore. Palm methyl ester was being stored in Singapore during the northern winter period, but now traders will not be able to use Singapore storage, the source noted, who has already emptied out his storage tanks in Singapore.[21]

[21] http://biofuelsdigest.com/asia/2010/09/08/biofuels-busted-in-singapore/

However, as there is infrastructure in place for transhipments, this may create other biofuels distribution opportunities.

A.14.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Singapore

Singapore plans to utilize jatropha when supplies become available (EWG, 2008).

Sources:

1. Current Status of Biodiesel Technology Development in Singapore (July 2008) http://tistr-foodprocess.net/APEC_website/Document/2nd%20APEC%20biodiesel/2nd%20APEC%2016Jul%2008/11.%20Current%20Status%20of%20Biodiesel%20Technology%20Development%20in%20Singapore.pdf
2. http://gain.fas.usda.gov/Pages/Default.aspx
3. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.15 Biofuels in Chinese Taipei

Chinese Taipei presently imports 98 percent of its energy needs.

A.15.1 Biofuels Mandates in Chinese Taipei

Ethanol
Chinese Taipei also intends to implement an E3 mandate to replace MTBE in 2011.

Biodiesel
In 2008, the demand estimated for the B1 mandate was 4.5 million MMLY and for the 2010 B2 mandate was estimated at 10 MMLY. There was some concern that Chinese Taipei would not be able to domestically supply enough biodiesel to meet the 2010 B2 mandate, but it stated a willingness to import enough biofuel to make up any shortfall. Chinese Taipei, Trading Markets is reporting that the Ministry of Economic Affairs has ordered the doubling of the biodiesel mandate for 2010 to B2, which will boost biodiesel demand for the island to 100 MLY (23 MGY). [22]

A.15.2 Biofuels Market in Chinese Taipei

Ethanol
E3 sales started in 2006 but are not strong with E3 being supplied by only 8 stations.

Biodiesel
Biodiesel is offered at different blending levels from B1 to B20. Nearly 300 service stations offer B1. By 2010, the mix of the biodiesel fuel will be increased to 2 percent, resulting in the consumption of an estimated 100,000 kiloliters (26 million gallons) of biodiesel fuel in total a year.[23]

A.15.3 Biofuels Demand and Supply in Chinese Taipei

Ethanol
There is no commercial fuel ethanol production in Chinese Taipei at this time.

Biodiesel
Lands for growing crops for biofuels tend to be small and separated. This makes the transportation of the feedstocks to a biofuels production facility more costly. However, according to the China Post, projects initiated in Chinese Taipei since 2007 have built up 55MLY (10 MGY) of biodiesel capacity, while 10 certified producers have now been established on the island with a combined capacity of 105 MLY (25 MGY).

---

[22] http://www.tradingmarkets.com/news/press-release/jpclf_briefing-asia-energy-april-5-2010-890190.html

[23] http://www.smh.com.au/news/Technology/Taiwan-introduces-biodiesel-fuel-blend-for-cars/2007/07/29/1185647724205.html.

A.15.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Chinese Taipei

A.15.4.1 Ethanol

Feedstock
Chinese Taipei is considering ethanol production from sugarcane, sweet sorghum, molasses and other biomass from agricultural wastes (USDA, 2009). Table A.53 below lists crops with the greatest potential for usage for ethanol.

Table A.53 Currently Available Ethanol Feedstocks in Chinese Taipei

	Corn	Sorghum
Chinese Taipei Production (Thousand metric tons per year)	53	20

Source: USDA FAS, 2010/2011 Production Year

Production
As stated above, there is no commercial fuel ethanol production in Chinese Taipei at this time. There are, however, eight demonstration E3 stations in Taipei City and five in Kaohsiung City. Chinese Taipei also intends to implement an E3 mandate to replace MTBE in 2011. It is estimated that 300,000 kiloliters must be imported to meet future E3 mandates (USDA, 2009).

A.15.4.2 Biodiesel

Feedstock
Feedstocks for biodiesel include used cooking oil, with some soy and sunflower oil (EWG, 2008). Table A.54 lists crops with the greatest potential for usage for biodiesel.

Table A.54 Currently Available Biodiesel Feedstocks in Chinese Taipei

	Soy Oil	Peanut Oil
Chinese Taipei Production (Thousand metric tons per year)	397	4

Source: USDA FAS, 2010/2011 Production Year

Production
Total production capacity for 9 plants in 2009 was approximately 99,000 kiloliters, an increase from 45,000 kiloliters and five plants in 2008. Total demand for B1 is estimated to be 45,000 kiloliters, two-thirds coming from domestic suppliers, and the remainder from the EU. It is estimated that Chinese Taipei will be able to meet current and future B1 and B2 mandates based on the current feedstock availability and overall capacity (USDA, 2009).

A.15.4.3 Infrastructure Requirements in Chinese Taipei

Feedstock Transport
For biodiesel, soy oil, as well as used cooking oils will likely continue to utilize trucks for feedstock transport.

E100 and B100 Transport, Blending and Distribution
B100 is trucked to the storage site for blending, and trucked back to retail pumps. It is likely that this scenario will continue over the next few years. Storage facilities for B100 are necessary to store the fuel at the producer’s site or at a secondary terminal. If current supply cannot meet demands, additional biodiesel must be imported. This could involve increased access to marine, truck and rail for transport of feedstock from the port to the facility. B20 is

the current maximum blend sold in Chinese Taipei; however, B1 is the primary volume percentage sold in the Chinese Taipei.

E100 is currently all imported. Storage and blending infrastructure, as well as trucking of the blended fuel to the fuelling station is required. Strategic deployment of marine terminal infrastructure seems appropriate, in conjunction with road and rail infrastructure to distribute fuel to non-coastal areas. Conversion of E10 pumps at various stations has occurred in eight stations across Chinese Taipei.

Infrastructure related to storage, blending and transport of ethanol must be implemented in order to accommodate domestic production and distribution. Trucks for transporting blended fuels to fuelling stations across Chinese Taipei will also be required.

A.15.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Chinese Taipei

Chinese Taipei has put forth continual research in cellulosic ethanol, specifically agricultural wastes and miscanthus. Seaweed is also being researched for possible use (USDA, 2009). This is still in its infancy.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Chinese Taipei Biofuels Annual 2007 report (29 May 2007) http://www.fas.usda.gov/gainfiles/200706/146291267.pdf
2. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.16 Biofuels in Thailand

A.16.1 Biofuels Mandates in Thailand

Thailand has made a serious effort to reduce oil imports and carbon emissions by planning to replace at least 20 percent of its vehicle fuel consumption with renewable energy sources such as ethanol and biodiesel by 2012. As the transportation sector consumes about 34% of total energy in the Thailand, in September 2003, the government set a economy-wide renewable energy target of 8% of total expected energy use in 2011, of which 3% would come from biofuels.

Ethanol Mandates

Thailand has implemented a 15-year ethanol plan (2008 – 2022).

Table A.55 Year Ethanol Production Plan in Thailand (Million liters/day)

	2008	2009	2010	2011	2012 - 2016	2017 - 2022
Target	3.0	3.0	3.0	3.0	6.2	9.0
Capacity	1.6	1.7	2.9	N.A.	N.A.	N.A.
Production	0.9	1.1	2.5	N.A.	N.A.	N.A.

Source: Thailand Ministry of Energy

Biodiesel Mandates in Thailand

In 2005, Thailand began a campaign to promote biodiesel production and consumption to ease its reliance on fossil fuels. Initial production of biodiesel was insignificant until February 2008, when the Government adopted a policy requiring compulsory production of B2 biodiesel (high-speed diesel with the two percent of B100 content by weight).
The Energy Policy Management Committee agreed that all high speed diesel (HSD) fuel (for automotive use) must contain 2 vol% biodiesel (B2) starting April 2008. In fact, B2 was already implemented economy-wide, ahead of the target, starting February 2008. There are plans to mandate a B5 blend by 2011 and B10 by 2012 (see Table A.56). The government expects that diesel fuel demand will increase to approximately 85 million liters per day by 2012, which means that 8.5 million liters per day of biodiesel must be produced by 2012 in order to meet the economy-wide diesel requirements at a B10 blend.

Table A.56 Biodiesel Blending Roadmap in Thailand

Year	2008 - 2010	2011	2012
Biodiesel Blend	B2	B5	B10

Currently, only two grades--B2 and B5 biodiesel are available in Thailand. The mandatory use of B5 will be enforced in Thailand from January 2012 onwards, when it will be the only diesel product on sale. Currently, B2 requires 600,000 liters a month of pure biodiesel and B5 needs a further 1.8 million liters per month. In 2011, under the Thai Government's current biofuel policy, all diesel sold in Thailand must be B5 biodiesel. If implemented, Thailand will need to import 200,000 tons of feedstock in 2011 to meet demand. These imports would continue until 2015 when domestic production is expected once again to offset imports.[24]

[24] http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Bangkok%20Newsletter%20-%20June%202010_Bangkok_Thailand_6-4-2010.pdf

On 15 February 2010, Thailand has delayed the mandatory use of B3 biodiesel. The introduction of compulsory B3 biodiesel was delayed because the ministry wasn't sure at the time if the raw material supply of palm oil was sufficient, he said. He said the ministry was confident its raw material supply was now adequate, but didn't explain why the mandatory use couldn't be introduced immediately. The introduction of mandatory B3 will raise pure biodiesel demand by 300,000 liters a month, he said.[25] The B3 economy-wide mandate commences 1 May 2011.[26]

A.16.2 Biofuels Market in Thailand

Ethanol

MTBE is mainly used as an additive to increase octane in RON 95 gasoline. Due to increasing yearly imports to meet demand in gasoline, the government has been aiming to phase out MTBE gradually and replace it with fuel ethanol produced locally. However, the government identified many problems in the E10 plan, mostly because of uncertainty over local ethanol supply, storage inspection and the fuel's incompatibility with more than 500,000 existing older model vehicles. As a result, the 2007 plan was not carried out; sale of RON 95 gasoline continued and the choice to buy E10 has been left up to consumers. In spite of this, the Ministry of Energy continues to promote E10 by maintaining price differentials between First Generation gasoline and E10. Starting in January 2008, Thailand introduced E20 on the market alongside E10. In fact, Thailand is the first to introduce E20 blends in the region. Thailand had also announced plans to introduce E85 in the market through PTT and Bangchak .

Total ethanol production by the end of 2010 is expected to increase to 490 million liters, or 1.3 – 1.4 million liters/day, in anticipation of a recovery in gasohol consumption in the second half of the year. Domestically, due to legislatively mandated replacement of traditional gasoline with at least 3% ethanol 'E3 gasohol' by 2012, ethanol use is set to double in the next two years. Separate E10 and E20 specifications have been set to ensure quality of ethanol blends. Specifications for E85 are currently being drafted although the implementation timeline is unknown. PTT as well as local major private oil company Bangchak Petroleum started marketing ethanol blends in the 1980s. E10 has been available in selected stations, mainly in Bangkok, since 2003, where ethanol was initially blended with premium gasoline and later with regular gasoline. Currently, the blend is sold alongside First Generation gasoline at stations operated by other downstream retail players including Shell, Esso, Caltex, IRPC, PT, Susco, Pure and Petronas.

---

[25] http://www.tradingmarkets.com/news/stock-alert/apln_dj-thailand-delays-introduction-of-mandatory-b3-biodiesel-minister-776997.html

[26] Information from Petroleum Authority of Thailand (PTT) via email correspondence from Peesamai Jenvanitpanjakul

Thailand currently sells gasohol (E10), which accounts for around 20 percent of total petroleum sales, through its service stations. PTT as well as local major private oil company Bangchak Petroleum started marketing ethanol blends in the 1980s. E10 has been available in selected stations, mainly in Bangkok, since 2003, where ethanol was initially blended with premium gasoline and later with regular gasoline. Currently, the blend is sold alongside conventional gasoline at stations operated by other downstream retail players including Shell, Esso, Caltex, IRPC, PT, Susco, Pure and Petronas.

The state-owned c ompanies PTT and Bangchak started supplying E20 in 2008 – a first in Asia – and announced plans that year to introduce E85. Some E20 compliant cars are on the roads, and the Department of Energy Business expects that more will be sold. The auto industry reported that it would take three to six months to import E85 compliant cars, while it would take two to three years to produce E85 compliant cars domestically. The government projected ethanol of roughly 1.3 to 1.4 million liters per day by late 2010. However, ethanol production remained lower than the government's target of 3.0 million liters per day. Although there is a legislative mandate to replace traditional gasoline with a 3 percent ethanol blend by 2012, higher blends of ethanol are voluntary.

Biodiesel

The current biodiesel blending level in diesel fuel is set at 1.5 percent minimum to 2.0 volume percent maximum. Separate B5 and B100 standards were made effective August 2005. B2 is available throughout the economy. PTT (Public Company Limited –PTT) which is the economy-wide integrated energy company in Thailand and also Bangchak started selling B5 in 2007. B2 replaced all HSD fuel since February 2008. About 400 petrol stations are now distributing B5 (5% biodiesel with 95% diesel) in Chiangmai and Bangkok. The nationwide biodiesel standard has been developed based on the European standard. The target of the government is to mandate B2 by 2 April 2008 and to increase to B5 by 2011 which will require almost four Million liters/day of biodiesel.

B100 biodiesel consumption, which is determined by the sale of the different blended ratios of biodiesel, increased from 62 million liters in 2007 to 446 million liters in 2008 and 609 million liters in 2009. B100 consumption is anticipated to further grow to 655 million liters in 2010 and 935 million liters in 2011. Thailand has not imported or exported any B100 biodiesel products thus far since the government practically restricts trade by not issuing import/export permits for these products.

A.16.3 Biofuels Demand & Supply in Thailand

Ethanol

Targets have been set to expand the use of ethanol to 9 million litres per day in 2022 (IEA World Energy Outlook, 2009). In Thailand, more than 45 ethanol plants have been granted permits by BOI to be built. In 2008, new capacity was added by companies such as International Gasohol Corporation, Fakwanthip, Ekarat Patana, Ratchaburi Ethanol, Thai Roong Ruang Energy and PetroGreen. As a result, there are currently a total of 14 fuel ethanol producers with an annual capacity of 500 million liters (132 million gallons). The two largest ethanol plants are owned by Thai Alcohol and PetroGreen, with 60 million liters (15.9 million gallons) of annual capacity each. In 2009, ethanol production totalled 400.7 million liters or 1.1 million liters/day.

However, ethanol production remained lower than the government's target of 3.0 million liters/day. In 2010 and 2011, ethanol production should continue to grow sharply by 20-22 percent in line with domestic consumption driven by the government's price-incentive policy. On the export side, after a declining in 2009, ethanol exports should increase significantly due to large excess supplies of ethanol. Most ethanol exports went to Asian countries, particularly Japan and Singapore.

Biodiesel

Over 60 percent of Thailand's currently vehicles currently operate on diesel, due in large part to the popularity of medium sized light duty pickup trucks. Targets have been set to expand the use of biodiesel to 4.5 million litres per day in 2022 (IEA World Energy Outlook, 2009). Since 2008 it has been mandatory to use two percent palm oil derived biodiesel in diesel in Thailand. Similar to ethanol plants, new biodiesel plants would also have to be granted permits in order to be built. As of August 2007, nine plants were granted permits. In Thailand, the largest local biodiesel producer is Thai Oleochemical, with a capacity of 180 million liters (47.6 million gallons) per year.

Biodiesel production increased significantly within two years from 68 million liters in 2007 to 448 million liters in 2008 and 610 liters in 2009 due to a compulsory B2 production policy. It is anticipated that production will grow an additional 10 percent in 2010 and 42 percent in 2011, as B3 production mandate comes into effect in mid-2010 and will be replaced by B5 production mandates in 2011. A compulsory B2 production policy has led B100 biodiesel production to increase ten-fold within two years from 68 million liters in 2007 to 448 million liters in 2008 and 610 million liters in 2009.

A.16.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Thailand

A.16.4.1 Ethanol

Feedstock

Approximately 60-70% of the 19 total ethanol plants use molasses as their feedstock. New tapioca-based plants have recently come online, and now account for approximately twenty to thirty percent of the ethanol produced. The government expects to increase sugarcane production to 95 million tons and tapioca production to 30 million tonnes by 2011 (USDA, 2010). Table A.57 lists crops with the greatest potential for usage for ethanol.

Table A.57 Currently Available Ethanol Feedstocks in Thailand

	Corn	Sorghum	Cassava	Sugarcane
Thailand Production (Thousand metric tons per year)	3,900	60	30,088	66,816

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

Thailand's production of ethanol in 2009 has increased 19% to 400.7 million liters per annum, although production still had not met the government's goals (three million liters per day) due to lower consumption of the ethanol/gasoline blend, and overstock of feedstock. This lower consumption was likely due to the fact that there are no current mandates for ethanol usage in Thailand, on top of the fact that the price differential between regular gasoline and ethanol blended gasoline is not enough to incur changes in usage (USDA, 2010).

2010 has brought forth an increase in production, with approximately 2.9 million liters of ethanol produced per day. It is estimated that in 2011, 23 plants will be operating at 4.6 million liters per day, which is still far below full capacity (USDA, 2010).

A.16.4.2 Biodiesel

Feedstock
Biodiesel is produced from palm oil cultivated domestically. Production is based upon domestic demand for biodiesel blends; Thailand does not import (or export) palm oil or biodiesel (USDA, 2010). Table A.58 lists crops with the greatest potential for usage for biodiesel.

Table A.58 Currently Available Biodiesel Feedstocks in Thailand

	Soy Oil	Palm Oil	Peanut Oil	Coconut Oil
Thailand Production (Thousand metric tons per year)	290	1,500	7	46

Source: USDA FAS, 2010/2011 Production Year

Production
Production has increased ten times, which has been linked to a mandated B2 blend nation-wide. An increase from 68 million liters per year in 2007 to 610 million liters per year in 2009 was seen. In 2009, 14 biodiesel facilities had a total capacity of 5,955,800 liters per day, with actual production capacities of 1,466,157 per day (USDA, 2010).

A.16.4.3 Infrastructure Requirements in Thailand

Feedstock Transport
Sugarcane molasses and tapioca will continue to utilize truck/rail to transport to production facility. For biodiesel, domestic production of palm oil will likely continue to utilize trucks for feedstock transport.

Biofuels Blending and Distribution
With the government set on phasing out the use of MTBE over the next few years, infrastructure related to the production, distribution and sale of ethanol-gasoline blends will likely be implemented. This will likely be a relatively smooth transition as some infrastructure is already in place. E10 use is being promoted by the government across Thailand, and in fact, E20 blends can also be found. However, the government has only mandated the use of E3 and E6.2 over the next few years. On top of domestic supply and infrastructure, export of ethanol (and the infrastructure related to this) is already in place, and will likely continue this trend in the near term. There are thousands of retail pumps selling ethanol blends across Thailand.

B100 is also trucked from the production facility, blended, and trucked to retail pumps. It is likely that this scenario will continue over the next few years. B2 is available at all retail pumps in Thailand, and B5 can be found at almost one thousand pumps in Bangkok.

The Government of Thailand is committed to developing their biofuels infrastructure and production capacity to serve both the domestic and export markets. On the export side, Thailand has already been identified by other East Asian countries as a major biofuels supplier. In 2010, Thailand's ethanol stock was up to 57 million liters. Potential export markets for Thai ethanol include the Philippines, Korea and most notably, Japan. E3 ethanol is mandatory, but Japan lacks significant ethanol production capacity of its own.[27]

Biofuels Distribution Infrastructure

Northern and Central Parts of Thailand

Gasoline and diesel are transported to the Saraburi Oil Terminal (Northern Part) and Lam Lukka Oil Terminal (Central Part) by Pipeline. Ethanol and Biodiesel are transported by trucks from the processing plants to Saraburi Oil Terminal and Lam Lukka Oil Terminal to be blended with Base Gasoline and Base Diesel respectively. The E10,E20 and E85 gasoline ethanol blends and the B3 biodiesel blends are transported mainly by truck and some parts by rail to retail service stations.[28]

Southern Part of Thailand

Transportation of base gasoline and base diesel to several Oil Terminals in the Southern Part of Thailand by barge. Ethanol and Biodiesel are transported by trucks from the processing plants to Oil Terminals to be blended with Base Gasoline and Base Diesel respectively. The E10,E20 and E85 gasoline ethanol blends and the B3 biodiesel blends are transported mainly by truck and some parts by rail to retail service stations.[29]

In May 2005, a target was introduced under the new economy-wide energy strategy to increase the number of RON 95 gasohol service stations from 730 to 4,000 stations and the consumption of gasohol to four million liters (one million gallons) by year-end 2005, or half of current RON 95 gasoline consumption. There were 3,822 gasohol service stations in Thailand as of December 2007. Currently, 40 stations in Greater Bangkok sell E20 (February 2008). B2 is available at all stations throughout Thailand; 976 stations offer B5 in Greater Bangkok.

A.16.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Thailand

One of the molasses-based facilities is currently using bagasse as a feedstock for cellulosic ethanol, and is in its early stages producing approximately 10,000 liters per day (USDA, 2010). Co-locating a cellulosic ethanol facility can reduce costs in terms of trucking the initial feedstock to the plant, and transporting the fuel across Thailand. Thailand also plans on using jatropha as a biodiesel feedstock at one of their facilities (EWG, 2008).

---

[27] http://www.biofuelsdigest.com/bdigest/2010/05/17/thailand-biofuels-feedstocks-and-market-opportunities/

[28] Information from Petroleum Authority of Thailand (PTT) via email correspondence from Peesamai Jenvanitpanjakul

[29] ibid

Jatropha is being considered as a possible feedstock for biodiesel, as it is not a crop for human consumption, and can be grown on non-arable land (EWG, 2008). Land identified as marginal and useful for jatropha production could lead to costs for transport of the feedstock to a potential facility, unless the facility will be located close to where the jatropha is grown. However, if retail stations are located at a farther distance, the cost of biofuels transport could increase accordingly.

Sources:

1. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Thailand Biofuels Annual 2010 report (7 July 2010) http://www.unece.lsu.edu/biofuels/documents/2010Aug/bf10_14.pdf
2. USDA Foreign Agricultural Service Global Agricultural Information Network (GAIN) Thailand Biofuels Update (4 June 2010) http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Bangkok%20Newsletter%20-%20June%202010_Bangkok_Thailand_6-4-2010.pdf
3. Department of Alternative Energy Development and Efficiency – Ministry of Energy http://www.dede.go.th/dede/
4. http://faostat.fao.org/
5. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

A.17 Biofuels in the United States

A.17.1 Biofuels Mandates in the United States

Between now and 2022, "The Renewable Fuel Standard (RFS) created under the United States Energy Policy Act of 2005 and under the Energy Independence and Security Act of 2007 (RFS2 requires obligated parties to use increasing amounts of cellulosic biofuels, biomass-based diesel and other advanced biofuels each year. Successful implementation of the RFS2 biomass-based diesel and advanced biofuels requirements will help provide a stable, reliable and enforceable demand for biofuels in the United States marketplace. The mandates for cellulosic biofuel, biomass-based diesel and undifferentiated advanced biofuel are nested standards, and in aggregate, equal the total advanced biofuel standard.

In 2006, the United States production and use of nearly five billion gallons of ethanol reduced dependence on imported oil by 170 million barrels equivalent. The Energy Independence and Security Act of 2007 guarantees a market for renewable fuel volumes, beginning with 9 billion gallons in 2008 and ending with 36 billion gallons in 2022; this will provide some long-term stability for the industry. There is also a cap on renewable biofuel (i.e., corn ethanol), with the mandate set at 15 billion gallons annually for 2015 and beyond. Table A.59 presents RFS requirements for each class of biofuel, from 2008 through 2022.

Table A.59 RFS Requirements under EISA in the United States (Data in billions of U. S. gallons per year)

Year	Renewable Biofuel	Advanced Biofuel	Cellulosic Biofuel	Biomass-based Diesel	Undifferentiated Advanced Biofuel	Total RFS
2008	9.0	-	-	-	-	9.0
2009	10.5	0.6	-	0.5	0.1	11.1
2010	12	0.95	0.1	0.65	0.2	12.95
2011	12.6	1.35	0.25	0.8	0.3	13.95
2012	13.2	2	0.5	1	0.5	15.2
2013	13.8	2.75	1	-	1.75	16.55
2014	14.4	3.75	1.75	-	2	18.15
2015	15	5.5	3	-	2.5	20.5
2016	15	7.25	4.25	-	3.0	22.25
2017	15	9	5.5	-	3.5	24
2018	15	11	7	-	4.0	26
2019	15	13	8.5	-	4.5	28
2020	15	15	10.5	-	4.5	30
2021	15	18	13.5	-	4.5	33
2022	15	21	16	-	5	36

In July 2010, the EPA issued a proposed rule regarding the 2011 volume requirements for biomass-based diesel. Consistent with the law, the EPA proposed that 800 million gallons of biodiesel must be used in the commercial marketplace in 2011. RFS2 requires the use of 500 million gallons of biomass-based diesel in 2009, increasing gradually to one billion gallons in 2012. From 2012 through 2022, a minimum of one billion gallons must be used domestically, and the Administrator of the EPA is given the authority to increase the minimum volume requirement. To qualify as Biomass-based Diesel, the fuel must reduce greenhouse gas (GHG) emissions by 50 percent compared to petroleum diesel. Biodiesel is currently the only fuel available in commercial quantities in the United States that meets the definition of Biomass-based Diesel.

A.17.2 Biofuels Markets in the United States

Ethanol

Table A.60 2010 Monthly United States Fuel Ethanol Production/Demand[30]

Month	Production, b/d (1000s)	Production (1000 barrels)	Stocks (1000 barrels)	Production (1000 gal)	Imports (1000 gal)*	Demand (1000 gal)	Demand, b/d (1000s)
Jan	818	25366	17800	1065372	1428	1021062	795
Feb	833	23328	18897	979776	1134	934836	784
Mar	847	26270	19691	1103340	1134	1071126	823
Apr	832	24962	19682	1048404	1512	1050294	834
May	847	26244	19721	1102248	1638	1102248	847
Jun	854	25631	18610	1076502	1680	1124844	893
Avg	837	25300	19061	1062607	1421	1050735	829

As shown in Table A.60, the current ethanol demand is met by supply of conventional ethanol in the United States. One of the factors limiting additional production has been corn prices. However, the other bottleneck in some jurisdictions has been the ability to utilize blends greater than E10.

The market for alternative fuels such as E85 is growing, driven by many factors, including fluctuating gasoline prices and energy security. With consumer demand for alternative fuel vehicles increasing, auto manufacturers are working to produce more flex-fuel vehicles (FFVs), which are capable of operating on 85% ethanol and 15% gasoline, or any blend in between. The number of E85 fueling stations continues to grow economy-wide. As of early 2010, there are more than 2,300 retail stations (out of 160,000 stations economy-wide), offering E85 across the United States.

[30] http://www.ethanolrfa.org/pages/statistics#EIO

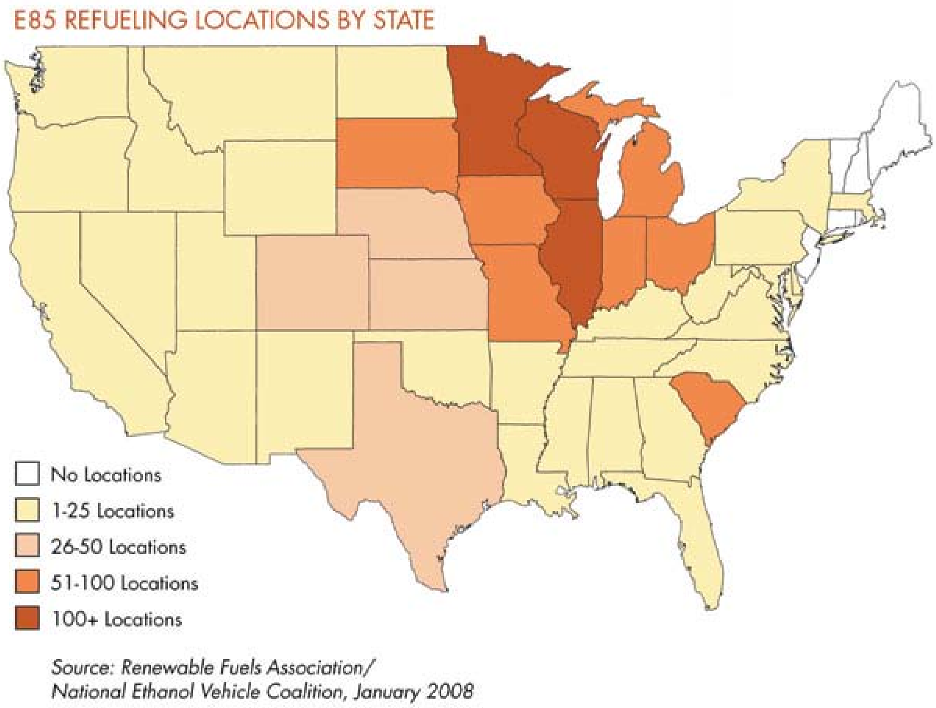

Figure A.3 E85 Filling Stations by State in the United States[31]

Biodiesel

The biodiesel market in the United States has been adversely impacted by two key factors. Firstly, the global commodity prices for feedstocks used to produce biodiesel spiked in 2008 for a number of reasons, and remain high still, compared to ten year average prices. Secondly, the Blender's Credit, a one dollar per gallon incentive, reached its sunset in December 2009 was not renewed until 17 December 2010. Consequently, the production of biodiesel dropped off sharply in 2010. Although the extension of the Blenders Credit is only extended until the end of 2011, it is anticipated that production will increase substantially in 2011.

In 2008, production was 678 million gallons per year, and in the period from January – September 2009, only 324 million gallons were produced.[32] It is believed that in 2010, in absence of the Blender's Credit, most of the biodiesel produced in the United States was being exported in an effort to obtain higher prices and returns. However, any shipments to the EU were curtailed based on the European Commission "Anti-dumping investigation" and "Anti-subsidy investigation" concerning the possible circumvention of anti-dumping measures by Council Regulation (EC) 599/2009 and countervailing measures imposed by the Council Regulation (EC) 598/2009 on imports of biodiesel originating from the United States. Thus, the market for biodiesel is very much in flux at the present time and accurate production and consumption volumes within the United States are difficult to obtain. The RFS2 will assist in stabilizing the demand and supply for biodiesel in the United States.

---

[31] http://www.ethanolrfa.org/pages/e-85

[32] http://www.eia.doe.gov/cneaf/solar.renewables/page/biodiesel/biodiesel.pdf

A.17.3 Biofuels Demand & Supply in the United States

Ethanol

The installed ethanol production capacity in the United States is 14.2 billion gallons per year.[33] However, several plants remain idle or are under-utilized due to either high commodity prices or limits in market penetration. Thus, the annualized production for 2010 is only 10 billion gallons per year, implying a significant opportunity for market expansion without requiring further construction. Approximately 95% of fuel ethanol in the United States is manufactured from corn, and it follows that the majority of production capacity of fuel ethanol is in the Midwest Corn Belt. Even so, ethanol is used in nearly every state in the United States including Alaska. Currently, there are over 180 commercial ethanol production facilities in the United States (as of January 2010) with 15 new plants under construction. The nested RFS mandates under EISA (2007) foresee production of First Generation ethanol from corn to grow to 15 billion gallons per year by 2015. The current production capacity and additional capacity under construction are sufficient to produce that volume, and, given the cap for conventional biofuels in the EISA mandate, it seems that very little additional production capacity for corn ethanol will be constructed.

Biodiesel

The installed biodiesel production capacity in the United States is 2.4 billion gallons per year.[34]

The 2010 advanced biofuel requirement of 0.95 billion gallons would, in theory, be met by the biomass-based diesel standard for 2010 using simple RFS2 math: the equivalence value of biodiesel (1.5), multiplied by the mandated volume of biomass-based diesel for 2010 (0.65 billion gallons) equals 0.975 billion gallons. Since biodiesel is nested within the advanced biofuels standard, and since the above number exceeds 0.95 billion gallons, the advanced biofuel standard would be automatically met in theory. However, EIA biodiesel production figures show an industry that is producing approximately 34 million gallons per month for the first half of 2010. EIA's June Monthly Energy Review shows a net deficit between biodiesel imports and exports of 737,000 barrels, or roughly 31 million gallons, during the first quarter of 2010. When biodiesel is exported, RFS2 statutes demand that exporting parties establish a renewable volume obligation in biomass-based diesel using the physical volume exported, multiplied by its equivalence value. Removing biodiesel gallon renewable identification number (RIN) credits from the domestic pool by exporting biodiesel simply demands more domestically consumed biodiesel to make up the deficit. Without a substantial increase in biodiesel production over the second half of 2010, combined with a large decrease in net exports, it is possible that less than 300 million gallons of domestically consumed biodiesel (and their 450 million associated RINS) will be available to meet the combined 2009-10 biomass-based diesel standard.[35]

[33] http://ethanolproducer.com/plant-list.jsp

[34] http://www.biodieselmagazine.com/plant-list.jsp

[35] http://www.biodieselmagazine.com/article.jsp?article_id=4391

A.17.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in the United States

A.17.4.1 Ethanol

Feedstock

The United States is a significant agricultural producer, and is a world leader among first and second generation biofuels feedstocks. The majority of ethanol production in the United States is from corn. Other minor feedstocks include sorghum, barley, cheese whey, potato waste, wood waste, brewery waste, energy cane/sugarcane bagasse (RFA, 2010).

The United States is the leading producer of corn, which makes this crop a natural choice for ethanol production due to availability and volume alone. The United States is also the world leader in sorghum production, and is often used as a feedstock in corn to ethanol facilities (BBI, 2007).

Table A.61 lists crops with the greatest potential for usage for ethanol.

Table A.61 Currently Available Ethanol Feedstocks in the United States

	Corn	Wheat	Barley	Sorghum	Sugarcane	Sugar Beets
US Production (Thousand metric tons per year)	318,522	60,103	3,925	8,576	27,456	26,779

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production

The RFS2 states that the United States must produce 36 billion gallons of renewable fuels per year by 2022, with no more than 15 billion from traditional feedstocks.

There are currently 189 facilities in operation as of January 2010, with 11 in various stages of construction. Total capacity of ethanol plants are at 13,028.5 mgy, with operating capacities at approximately 11,877.4 mgy. Plants under construction have a total combined capacity of 1.432 mgy (RFA, 2010).It is evident that the United States will fulfil its 15 billion gallon per year mandate, based on current production (USDA, 2010).

A.17.4.2 Biodiesel

Feedstock

Ninety per cent of biodiesel in the United States is produced from soybeans. The remainder uses animals fats or waste restaurant greases. The United States also leads in world production of soy, with 87 million tons produced in 2006/2007. Approximately 10% is used for biodiesel production.

Table A.62 lists crops with the greatest potential for usage for biodiesel.

Table A.62 Currently Available Biodiesel Feedstocks in the United States

	Soy Oil	Rapeseed Oil	Sunflower Oil	Peanut Oil	Cottonseed Oil
United States Production (Thousand metric tons per year)	8,609	531	284	70	363

Source: USDA FAS, 2010/2011 Production Year

Production
The RFS2 mandates that 1 billion gallons of the 36 billion gallons of biofuel must be biomass-derived diesel, which could be either methyl esters or hydrogenation-derived renewable diesel.

There are 173 facilities, and production reached 550 million gallons in 2009. Another 29 companies are in various stages of construction, and have the combined capacity to produce another 427.8 million gallons per year (USDA, 2010).

A.17.4.3 Infrastructure Requirements in the United States

Feedstock Transport
It is likely that the United States will continue to utilize domestic crops for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. Locally grown corn will continue to be the major feedstock for ethanol production in the near term, as facilities are located within close proximity to feedstock. Long term, lignocellulosic feedstocks will grow in prominence.
Current ethanol feedstock supply is being met by demand, and it is likely that this will continue in the near term, even as demand, and hence production, increases.
For biodiesel, soy oil and waste oils will likely continue to utilize truck/rail for feedstock transport.

Over the next few years, the volume of feedstock supplied domestically should be able to keep up with demand. However, with the current high prices for soy oil, and low domestic prices for biodiesel, the majority of biodiesel has been exported to maximize revenues. Infrastructure related to export of the product could involve truck, rail and marine pathways.

E100 and B100 Transport, Blending and Distribution
Storage terminals for petroleum, both primary and secondary, are located across the United States. Construction of new storage terminals or retrofitting a portion of these for storage of ethanol and biodiesel will likely be required as mandated volumes increase.

Ethanol and biodiesel (E100 and B100) and/or blends are currently trucked from the production/storage facility to the retail pumps. Ethanol and biodiesel blends can be found at retail stations all across the United States. In fact, E85 is sold across the majority of United States, although E85 pumps are heavily concentrated in the Midwest, while some states have only a few E85 pumps. The market for biofuels has been substantially developed, and hence the infrastructure related to production, distribution and sale has been developed, although further expansion is in the offing. Flex fuel vehicles are being produced and used across the United States, and will likely continue this trend as the demand for biofuels increases in the near term.

A.17.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in the United States

Twenty billion gallons per year of next generation biofuels have been mandated to fulfil the RFS2 mandate by 2022. The United States government has placed significant importance on the research and development of advanced biofuels. Switchgrass, agricultural residues, forestry residues, and algae are some of the advanced biofuels feedstocks that are being researched in the United States. It is estimated that a combination of these advanced biofuels feedstocks will be able to produce enough advanced biofuels to meet the 20 billion gallon mandate, with some biofuels import expected (USDA, 2010). The government's plans to support advanced biofuels such as cellulosic ethanol, biodiesel, renewable gasoline and renewable diesel indicate the growing need for infrastructure. The United States has a vast amount of forestry and agricultural residue that could potentially be used as feedstock for cellulosic biofuels. However, the location of facility will depend on feedstock location, in order to minimize the cost of transport. Production of biofuel could satisfy local markets in a wide swath of the United States is it is a large APEC economy with several areas of agricultural and cellulosic feedstocks, thus many different opportunities to produce advanced biofuels and supply individual local markets.

Sources:

1. Renewable Fuels Association http://www.ethanolrfa.org/pages/statistics#EIO
2. United States DOE Monthly Renewables Reports http://www.eia.doe.gov/cneaf/solar.renewables/page/biodiesel/biodiesel.pdf
3. United States Department of Energy – Energy Efficiency & Renewable Energy http://www.afdc.energy.gov/afdc/ethanol/ethanol_locations.html
4. http://gain.fas.usda.gov/Pages/Default.aspx
5. http://faostat.fao.org/

A.18 Biofuels in Viet Nam

Viet Nam is strongly investing in biofuels. The government has instructed ministries to give incentives for the production and use of biofuel. Under the plan for biofuel development to 2015, with a vision to 2025, Viet Nam will produce 1.8 million tons of ethanol and vegetable oils for use as fuel annually, meeting five percent of domestic petrol and diesel demand in the next 15 years.[36]

A.18.1 Biofuels Mandates in Viet Nam

There are currently no biofuels mandates in Viet Nam.

A.18.2 Biofuels Markets

Biofuel has been designated a key industry and biofuel production projects enjoy the highest level of investment incentives. The legal framework for biofuel production and trading in Viet Nam is nearly complete. Presently, there is a limited penetration of ethanol and biodiesel into the fuel distribution system in Viet Nam.

Ethanol

Petrolimex began selling bio-petrol (5% ethanol and 95% petrol) in August 2010 at filling stations in HCM City, Hanoi, Vung Tau, Hai Phong and Hai Duong, and will add sales points in Da Nang, Hue and Can Tho this year.

Biodiesel

According to Government planners, from 2007 to 2010, Viet Nam will finalise a legal framework to encourage the production and use of biofuel, design the roadmap for using biofuels in Viet Nam, and build biofuel plants to meet 0.4 percent of the Viet Nam's need for petrol by 2010.

A.18.3 Biofuels Demand and Supply in Viet Nam

From 2011-2015, according to planners, Viet Nam will begin to produce additives, enzymes and other materials for biofuels and expand their production, and expand biofuel plant capacity to satisfy 1 percent of Viet Nam's need for petrol by 2015. From 2016 to 2025, Viet Nam plans to build an advanced biofuel industry that will produce 100 percent of the economy-wide requirement for E5 and B5 fuels, i.e., will provide five percent of the fuel needed to run the nation's motor fleets.[37]

Ethanol

Dong Xanh JSC's ethanol plant has an annual capacity of 100,000 tons of biofuel a year. The plant is already working at 70-80 percent of its designed capacity, supplying ethanol to state-owned Petrolimex. Its principal feedstock is cassava grown in Quang Nam and Binh Dinh provinces. Three more ethanol plants with capacities in the 100,000 tons per year range are being built in the centre and north.

---

[36] http://www.commodityonline.com/news/Vietnam-joins-race-for-biofuel-32124-3-1.html

[37] http://english.vietnamnet.vn/reports/201009/Vietnam-invests-in-a-biofuels-industry-937422/

By the end of 2011, Viet Nam will have five biofuels plants with a total capital of 365,000 tons of ethanol, which, when mixed with gasoline, will yield 7.3 million tons of E5 petrol.

Biodiesel
In Viet Nam's far south, refiners in Can Tho and An Giang are making bio-diesel from catfish fat. The Mekong Delta factories currently process 30,000 tons of catfish fat each year. The first plant producing biodiesel from catfish fat was inaugurated in the Mekong Delta city of Can Tho in early 2009, ran by Minh Tu Co., Ltd. This plant can produce 50,000 liters of biodiesel a day. The plant has exported its product to Singapore.

A.18.4 Outlook on First Generation Biofuels, Infrastructure Requirements 2010-2015 in Viet Nam

A.18.4.1 Ethanol

Feedstock
Ethanol feedstocks include both sugarcane molasses and starches, namely corn and cassava (EWG, 2008). Table A.63 lists crops with the greatest potential for usage for ethanol.

Table A.63 Currently Available Ethanol Feedstocks in Viet Nam

	Corn	Cassava	Sugarcane
Viet Nam Production (Thousand metric tons per year)	5,500	8,557	15,246

Source: USDA FAS, 2010/2011 Production Year; FAO 2009 Production Year

Production
Production of one facility is estimated at 100,000 tonnes of ethanol per year, based on cassava as feedstock.

A.18.4.2 Biodiesel

Feedstock
Possible feedstocks for biodiesel production include catfish oil, used cooking oil and rubber seed. Table A.64 lists crops with the greatest potential for usage for biofuels.

Table A.64 Currently Available Biodiesel Feedstocks in Viet Nam

	Soy Oil	Peanut Oil	Coconut Oil
Viet Nam Production (Thousand metric tons per year)	36	59	153

Source: USDA FAS, 2010/2011 Production Year

Production
Production from catfish oils has a 50,000 litre biodiesel capacity per day.

A.18.4.3 Infrastructure Requirements in Viet Nam

Feedstock Transport
It is likely that Viet Nam will utilize cassava feedstocks produced domestically for ethanol production, and hence utilize truck and/or rail for transport of the feedstock to the facility. For biodiesel, catfish oil, as well as used cooking oils will likely continue to utilize trucks for feedstock transport.

E100 and B100 Transport, Blending and Distribution

E100 and B100 is trucked to the storage site for blending, and trucked back to retail pumps. It is likely that this scenario will continue over the next few years. Storage facilities for B100 are necessary to store the fuel at the producer's site or at a secondary terminal. If current supply cannot meet demands, additional biodiesel must be imported. This could possibly involve increased access to marine, truck and rail for transport of feedstock from the port to the facility.

E5 is the current blend sold in Viet Nam at various stations. Infrastructure related to storage, blending and transport of ethanol must be implemented in order to accommodate domestic production and distribution. Trucks for blended fuels to fuelling stations across Viet Nam will also be required. Higher blends are not likely to become realized in the near term. Imports of biodiesel and ethanol are not likely unless demand increases, which would influence marine, rail and truck transport of the fuel.

A.18.5 Outlook on Second Generation Biofuels, Infrastructure Requirements Beyond 2015 in Viet Nam

Cellulosic ethanol is of particular interest in Viet Nam, with vast amounts of agricultural residues such as rice husk, straw, bagasse and cane leaf, with approximately 45.6 million tonnes available. There is also approximately 1.6 million tonnes of available forestry residue. Dedicated energy crops, such as elephant grass, have also been explored as a potential feedstock, with plantations set up in several provinces (EWG, 2008). The government's plans to support cellulosic ethanol indicate the growing need for infrastructure to be implemented. However, location of facility will depend on feedstock location in order to control transport costs. Production of biofuel could satisfy the local market, but areas with excess feedstock could export biofuel to regional and economy-wide markets. Jatropha for biodiesel production is also under consideration as a potential feedstock (EWG, 2008).

Sources:

1. http://gain.fas.usda.gov/Pages/Default.aspx
2. http://faostat.fao.org/
3. The Future of Liquid Biofuels, APEC Energy Working Group, May 2008

APPENDIX B

EXISTING PIPELINE

INFRASTRUCTURE IN APEC ECONOMIES

INDEX – APPENDIX B

B. Pipeline Infrastructure in APEC Member Economies

The presence of existing petroleum and gas pipelines in an APEC member economy implies that the economy's geography is suitable for pipeline construction provided there is sufficient demand. Most relevant to the development of dedicated biofuel pipelines is the presence of petroleum products pipelines, as these are typically land pipelines, unlike oil and natural gas pipelines, which can include off-shore pipelines that deliver oil and natural gas to on-shore processing and distribution facilities. Pipeline maps can also provide an indication of supply sources, demand, imports and exports; these factors may ultimately play a role in biofuels transportation as well.

In this appendix, pipeline maps for some of the APEC economies are presented. The pipeline routes on the map are labeled with the codes that are explained in the table. Pipeline label codes are colored green for crude oil, red for natural gas and blue for fuel products, such as gasoline and diesel.[38] Solid lines indicate existing pipelines, while dashed lines indicate pipelines under construction.

B.1 Pipelines in APEC Oceania

B.1.1 Pipelines in Australia

Australia has four crude oil pipelines and several natural gas pipelines but only one fuel products pipeline (Figure B.1). Papua New Guinea is the only APEC economy that is within proximity to Australia, and there is a shared natural gas pipeline between the two countries. Most of the Australian pipelines connect to the coast, reflecting the fact that approximately three-quarters of Australia's oil consumption is satisfied from imports, while half of its production is exported. This implies that regions of oil production are not easily connected with Australia's demand centers, and it is more economically (or geographically) advantageous to import or export via nearby ports than it is to construct a trans-continental pipeline. The longest "liquids" pipeline (either crude oil or fuel products) connects Brisbane with oil production near Jackson.

[38] http://www.theodora.com/pipelines/asia_oil_gas_and_products_pipelines.html

Figure B.1 Pipelines in Australia and New Zealand and Papua New Guinea

B.1.2 Pipelines in New Zealand

New Zealand also has two oil pipelines that deliver oil from internal production basins to its coasts, mainly near Auckland and New Plymouth. Like Australia, New Zealand is a net importer of oil. New Zealand also has four natural gas pipelines but no fuel products pipelines. The nearest APEC economy is Australia but the two are separated by a considerable expanse of ocean.

B.1.3 Pipelines in Papua New Guinea

Papua New Guinea has one crude oil pipeline and one natural gas pipeline but no fuel products pipelines. As noted in Figure B.1, there is one shared natural gas pipeline with Australia.

B.2 Pipelines in APEC North America

B.2.1 Pipelines in Canada

Canada has four crude oil pipelines, several natural gas pipelines and four fuel products pipelines (Figure B.2). Canada also shares five crude oil pipelines, several natural gas pipelines and one 3170 km long fuel products pipeline with the United States. The oil pipelines typically originate in the North, and terminate at the oil refinery operations near Edmonton. Oil also moves from Edmonton to the Pacific Coast and to refiners in Colorado, Wyoming, Illinois and Michigan. Oil is imported by pipeline from Portland, Maine into Montreal. Most of the Canadian fuel products pipelines are fairly short, in the Edmonton-Calgary corridor, or the Windsor-Montreal corridor. There is also the aforementioned trans-economy fuel products pipeline that moves refined products from Edmonton to

Windsor. Canada's 7350 km shared border with the United States (excluding the Alaska border) facilitates fuels transport between the two APEC economies.[39]

Figure B.2 Pipelines in Canada

B.2.2 Pipelines in Mexico

Mexico has seven crude oil pipelines, a dozen natural gas pipelines and a dozen fuel products pipelines (Figure B.6). The network is extensive, drawing on oil supply from the Gulf of Mexico and other regions of the Mexico. Fuel products pipelines also cross a large portion of the Mexico. There is also one natural gas pipeline shared between Mexico and the United States. The 3140 km shared border with APEC economy the United States may facilitate more joint development of energy infrastructure.

Figure B.3 Pipelines in Mexico

---

39 https://www.cia.gov/library/publications/the-world-factbook/fields/2096.html

B.2.3 Pipelines in the United States

The United States has dozens of natural gas pipelines, dozens of natural gas pipelines and dozens of fuel products pipelines. There is one crude oil pipeline and two natural gas pipelines shared with APEC economy Canada originating from the United States. Canada and the United States share several crude oil and natural gas pipelines. There is also a natural gas pipeline that services both Mexico and the United States.

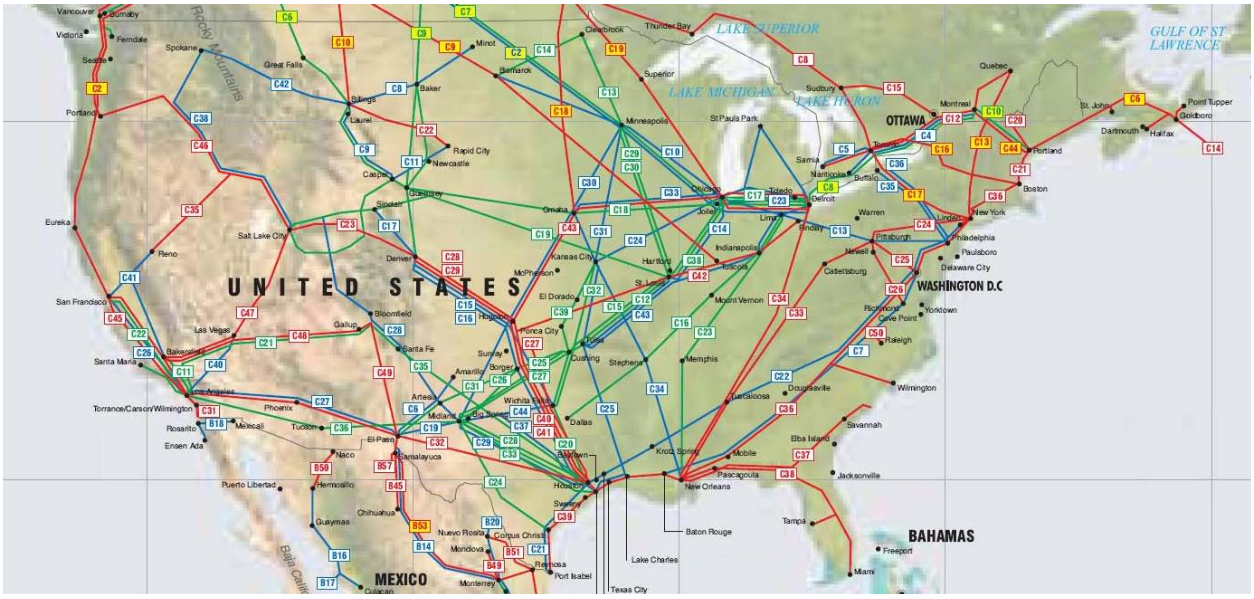

Figure B.4 Pipelines in the United States

B.3 Pipelines in APEC South America

B.3.1 Pipelines in Chile

Chile has no oil pipelines, at least one crude natural gas pipeline and one short fuel products pipeline (Figure B.5). Chile shares a 170 km border with APEC economy Peru, and also shares a long border with non-APEC Argentina, across the Andes. The same telluric displacements that created the Peru-Chile Trench make Chile highly prone to earthquakes. Although there is a natural gas pipeline between Chile and Argentina, the Andes Mountains are a major barrier to pipeline construction.

B.3.2 Pipelines in Peru

Peru has at two crude oil pipelines and one natural gas pipeline and no fuel products pipelines. The oil pipelines are located in the North, moving oil from inland production regions to the coast, for export. Peru shares a 170 km border with APEC economy Chile. The Andes and the Amazon rainforests provide a barrier to multi-jurisdictional pipeline projects with Brazil and Bolivia. Peru is also at the risk of earthquakes, tsunamis, landslides and mild volcanic activity.

Figure B.5 Pipelines in Chile and Neighbors in South America

B.4 Pipelines in APEC Northeast Asia

B.4.1 Pipelines in China

China has at least 14 oil pipelines, several natural gas pipelines and at least four fuel products pipelines (Figure B.6). Many of the oil pipelines are centered around Beijing, bringing oil from coastal regions to the capital. Most of the China's oil production is used internally, while approximately half of China's demand for oil is satisfied by imports. Crude oil pipelines between China and Kazakhstan and between China and Russia have been proposed or are under construction. These cross-border efforts reflect China's growing demand for energy, and capitalize on China's land border of 4670 km (northeast) and 40 km (northwest) with Russia. China also has a 1280 km border with Viet Nam and is contiguous with Hong Kong, China.

B.4.2 Pipelines in Hong Kong

Hong Kong has no crude oil, natural gas or fuel products pipelines, but borders China.

Figure B.6 Pipelines in China, Hong Kong and Chinese Taipei

B.4.3 Pipelines in Japan

Japan has two natural gas pipelines but no crude oil pipelines or fuel products pipelines. Japan is the third largest importer of crude oil in the world, and most of its oil refineries are long coastal areas. Japan has a total of 6,852 islands extending along the Pacific coast of Asia. Korea is the nearest APEC economy, but separation by water diminishes opportunities for a shared biofuels pipeline.

B.4.4 Pipelines in Korea

Korea has one natural gas pipeline and no crude oil pipelines. There are two pipelines that deliver refined fuel products from the coastal port cities of Ulsan and Yeosu to Seoul. Korea does not share a border with any other APEC economy.

B.4.5 Pipelines in Russia

Russia has nearly 50 oil pipelines, approximately 20 natural gas pipelines and approximately 10 fuel products pipelines (Figure B.7). Most of these pipelines are in western Russia, to meet internal and European demand. There are also shared pipelines that move crude oil through various countries to the Black and Caspian Seas. In eastern Russia, there is a proposed 2880 km pipeline project to deliver crude oil to China. Russia has a border of 4670 km (northeast) and 40 km (northwest) with China.

Figure B.7 Pipelines in the Russian Federation

B.4.6 Pipelines in Chinese Taipei

Chinese Taipei has a natural gas pipeline but no crude oil or fuel products pipelines. Chinese Taipei's 1.2 million bbl/d refining capacity exceeds its domestic demand; surplus refined products are exported via marine terminals to nearby trading partners. Chinese Taipei does not share any borders with any APEC economies.

B.5 Pipelines in APEC Southeast Asia

B.5.1 Pipelines in Brunei Darussalam

Brunei has at least one crude oil pipeline and at least one natural gas pipeline but no fuel products pipelines. The nearest APEC economy is Malaysia and Brunei and Malaysia share 380 km of border. It is the only sovereign state completely on the island of Borneo, with the remainder of the island belonging to Malaysia and Indonesia. It is too small in land mass to justify a shared biofuels pipeline.

B.5.2 Pipelines in Indonesia

Indonesia has approximately 16 crude oil pipelines and four natural gas pipelines but only two fuel products pipelines (Figure B.8), the largest of which is near Jakarta. Most of the pipelines are fairly short (less than 200km), and several bring offshore oil to coastal refineries or export depots. Indonesia shares a 1780 km land boundary with Malaysia on the Island of Borneo, and an 820 km land boundary with Papua New Guinea. As seen Figure B.8, there is no pipeline infrastructure between Malaysia and Indonesia; however, Indonesia and Singapore share a natural gas pipeline.

Figure B.8 Pipelines in Brunei, Indonesia, Malaysia, Singapore, Thailand and Viet Nam

B.5.3 Pipelines in Malaysia

Malaysia has four crude oil pipelines and several natural gas pipelines but no fuel products pipelines (Figure B.8). The oil pipelines all bring offshore crude to coastal depots and refineries. Malaysia is a net exporter of crude oil. Malaysia shares natural gas pipelines with APEC economies the Philippines and also Thailand and Singapore.

There are two distinct parts to Malaysia: Peninsular Malaysia to the west and East Malaysia on the Island of Borneo. Peninsular Malaysia is located south of APEC economies Thailand, north of Singapore and east of the Indonesian island of Sumatra (see Figure B.8). Peninsular Malaysia shares a 505 km border with APEC economy Thailand. East Malaysia is located on the island of Borneo and shares a 380 km border with APEC economy Brunei and a 1780 km border with Indonesia.

B.5.4 Pipelines in the Philippines

The Philippines is an archipelago comprising 7,107 islands. The 11 largest islands contain 94 percent of the total land area. The largest of these islands is Luzon at about 105,000 km^2. The archipelago is around 800 km from the Asian mainland and is located between Chinese Taipei and Borneo. There are two major oil refineries, one located near Manila on Luzon, and the other near Tabango on Samar Island. Both are located on the coast, facilitating marine distribution of fuel products, both within the Philippines and to nearby economies. There are no major pipelines present, but some short pipelines for fuel products and oil are used to move feedstock and products from coastal areas.

B.5.5 Pipelines in Singapore

Singapore is a small island in Southeast Asia, located at the southern tip of the Malayan Peninsula between Malaysia and Indonesia. It is separated from Indonesia by the Singapore Strait and from Malaysia by the Straits of Johor. The three economies share a natural gas pipeline. Owing to its location, Singapore is a major hub for oil and refined petroleum products, with oil imports exceeding domestic demand, and significant export of refined products. The refineries are mainly in southern coastal regions, to facilitate marine transport.

B.5.6 Pipelines in Thailand

Thailand has three natural gas pipelines, no crude oil pipelines and two fuel products pipelines. The fuel products pipelines are relatively short, concentrated in the region around Bangkok. Thailand shares a 645 km border with Malaysia and controls the only land route from Asia to Malaysia and Singapore. Thailand shares a natural gas pipeline with APEC economy Malaysia.

B.5.7 Pipelines in Viet Nam

Viet Nam has a natural gas pipeline and one fuels products pipeline. Viet Nam is reliant on imports of refined oil products due to a lack of refining capacity. Viet Nam shares a 1280 km border with China.