U.S. DEPARTMENT OF ENERGY

PNNL-26916

Prepared for the U.S. Department of Energy
Under Contract DE-AC05-76RL01830

Thailand Alternative Fuels Update 2017

Cary Bloyd

September 2017

Pacific Northwest
NATIONAL LABORATORY

DISCLAIMER

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm


This document was printed on recycled paper.
(9/2003)

PNNL-26916

Thailand Alternative Fuels Update 2017

Cary Bloyd

September 2017

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Acknowledgments

PNNL would like to thank Kevin Stork, Vehicle Technologies Office, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy for supporting this work.

Introduction

Thailand is called "Detroit of the East" due to its major production base for automobiles. Thailand is currently ranked the world's 12th largest car producer. The auto industry accounts for around 10 percent of Thai GDP. The government is currently implementing a roadmap for green automobiles. In a bid to promote new industries as part of Thailand's 4.0 modernization program, the Thai government has identified 10 potentially high-growth industries of which electric and other modern vehicles is one of them. The next generation vehicles in Thailand will be motor driven vehicles including Hybrid electric vehicles (HEV), Plug-in hybrid electric vehicles (PHEV), Battery electric vehicles (BEV), and Full cell vehicles.

Thailand has been a leader in Southeast Asia in alternative fuel infrastructure development and has demonstrated the benefit of coordinating activities both across alternative fuel production, transport, and use as well as the activities across various government agencies which can influence the implementation of a new transport fuel. The lessons learned from such coordination can benefit all countries interested in the development of alternative transport fuels as one means of supporting both domestic feedstock utilization and overall transport fuel energy security.

The previous reports have focused on the review of the development of ethanol based fuels and natural gas vehicles in Thailand.[1] This report will provide a summary update of biofuel production and vehicles fueled by biofuel and natural gas in Thailand, followed by a review of the activities Thailand is undertaking to promote the next generation vehicles—electric vehicles—with a goal of leading the development of EVs in Southeast Asia in the same way Thailand has led in the development of ethanol based fuels.

Thailand Energy Policy

Thailand was the first country in Asia to announce national policies for both bioethanol and biodiesel. The Thai government signed cabinet resolutions to promote bioethanol in September 2000 and biodiesel in July 2001. Several measures have been implemented to promote the production and consumption of biofuel in the country including investment promotion, biofuel standardization, price incentives, vehicle specifications, tax incentives, and R&D programs. Since 2003, the government has set a target for renewable energy to be at least 8 percent of the total energy consumption by 2011, of which 1.9 percent was targeted to be the contribution from biofuel. This target was replaced by new, more aggressive target in 2008 to have biofuel consumption be 14 percent of total energy consumption by 2022.

Thailand has designed the Alternative Energy Development Plan (AEDP) as a guideline for the country's energy future. AEDP 2012, for implementing periods of 2012-2021, set a target to

[1] An Update on Ethanol Production and Utilization in Thailand-2014, Cary Bloyd and Nikolas Foster, September 2014, PNNL-23673; Natural Gas Vehicles in Thailand: A Market Overview, Cary Bloyd and Nikolas Foster, September 2015, PNNL-024719; Thailand Alternative Fuels Update, Nikolas Foster and Cary Bloyd, September 2016, PNNL-25884.

increase alternative energy consumption by 25 percent of total energy consumption by 2021. AEDP 2012 plan replaced the previous 15-year Renewable Energy Development Plan, which targeted 20.3 percent of renewable energy consumption by 2022.

AEDP was revised in 2015. AEDP 2015 (2015-2036) which extended plan year coverage from 10 years to 20 years has increased the target to 30 percent renewables as a percentage of the total energy consumption by 2036, of which 20-25 percent of the target is to come from ethanol fuel and biodiesel. In order to accomplish this goal, the Thai government has set ethanol consumption targets of 4.1 billion litters by 2036 from 1.8 billion litters in 2015, and biodiesel consumption targets at 5.1 billion litters by 2036 from 1.24 billion liters in 2015. The cassava and molasses harvest areas for ethanol feedstocks is targeted at 1.36 million hectars and 2.56 million hectars, respectively, by 2036. The palm oil acreage targets was raised from 0.70 million hectars in 2015 to 10.20 1.63 million hectars by 2036.

The AEDP 2015 has recently been revised taking into consideration that the low global price for petroleum may continue for the long run. In addition, domestic feed stock supplies for ethanol and biodiesel production may not be able to meet the current biofuel consumption goals for 2036 as the domestic production of these feedstocks is far below the target under the biofuel development plan implemented over the past decade. Furthermore, production of crude palm oil which is the main feedstock for biodiesel production has been stagnate for the past couple of years and the outlook for future production is still uncertain. It is expected that later in 2017 the Ministry of Energy will endorse a reduced new target for both gasohol and biodiesel consumption in 2036 to 2.6 billion liters each. However, the target of 30 percent renewable energy consumption in total energy consumption will remain unchanged by increasing the role of renewable energy for electricity and heat consumption.[2]

Update on Thailand's Alternative Fuels

Thailand has led Asia in the development of alternative fuels since 2000 when the Thai government signed a cabinet resolution to promote bioethanol, and followed in 2001 with a cabinet resolution to develop biodiesel. The consumption of ethanol fuel in Thailand has been growing rapidly due to the promotion by the government through price incentives, excise tax reduction for cars compatible with E20 and E85 gasohol, and the mandate to blend all gasoline with 10 percent ethanol. Gas stations also receive a marketing subsidy for each liter of ethanol blends sold.

Biodiesel producers have also received various privileges such as exemption of machinery from import duties and exemption of corporate income tax. Manufacturers of higher-percent biodiesel compatible vehicles receive excise tax privileges. The government mandates the biodiesel blending rates in petroleum diesel supplied across all market sectors, and strictly monitors that petroleum refineries comply with the blending requirement. The requirement for biodiesel blending rates started with B2 or 2 percent biodiesel, but later the blending rates were increased

[2] Thailand Biofuel Annual, USDA Foreign Agricultural Service, Gain Report Number: TH7084 https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Bangkok_Thailand_6-23-2017.pdf

to B5, followed by B7 and most recently a target of B10 has been set for 2018. Quality standards for B100 were set in 2007 and that for community biodiesel was set in 2006, which helps ensure consumers' confidence in biodiesel.

Ethanol

The Thai government has promoted biofuels in a comprehensive manner with legislative support since 2004 by licensing for the biofuel factories, expanding the number of biofuel stations and promoting public relations to give people more confidence in biofuels. The first ethanol product in the market was E10. On January 1, 2008, E20 was introduced, and in the third quarter of 2008, E85 was introduced. Ethanol blended fuels are sold in Thailand as Gasohol 91-E10 (10-percent ethanol blended with 90 percent gasoline, octane 91); Gasohol 95-E10 (10-percent ethanol blended with 90 percent gasoline, octane 95); Gasohol 95-E20 (20-percent ethanol blended with 80 percent gasoline, octane 95), and Gasohol 95-E85 (85 percent ethanol blended with 15 percent gasoline, octane 95).

The government has structured oil pricing to make retail prices of gasohol lower than retail prices of gasoline, and gasohol with higher ethanol contents is less expensive than gasohol with lower ethanol contents. The price subsidies were provided by the State Oil fund making retail prices of gasohol 20 to 40 percent cheaper than that of regular gasoline (see Table 1).

Table 1: Retail Prices of Gasoline and Gasohol in Bangkok & Vicinities

Unit: Baht/Liter[3]

Fuels	Prices (Sept 9, 2017)
Gasohol 91-E10	27.18
Gasohol 95-E10	27.45
Gasohol 95-E20	24.94
Gasohol 95-E85	20.24
ULG-95	34.56

Source: Petroleum Division, Energy Policy and Planning Office, Ministry of Energy

The consumption of bioethanol did not increase significantly until the energy crisis in 2008 when crude oil price rose above $140 per barrel. Consequently, demand for biofuel, both ethanol and diesel, increased to replace oil imports. The consumption of bioethanol rose from 0.71 ml/day in 2007 to 1.29 ml/day in 2008.

In 2013 the gasohol consumption increased significantly because the government banned sales of unleaded gasoline 91 octane, which accounted for about 40 percent of the total gasoline

[3] $1 USD = 33.11 Baht

consumption, and replaced it with gasohol 91-E10. The ban consequently raised ethanol usage from 1.3 million liters/day in 2012 to 2 million liters/day in 2013. The government has also announced plans to further boost ethanol demand by phasing out gasohol 91-E10 by 2018, and gasohol 95-E10 by 2027, which will leave only higher blends of E20 and E85 in the market.[4]

About 98 percent of total ethanol production is used domestically and the rest is exported. Fuel ethanol is a controlled product and traders must have a license to either import or export the product. To date, Thailand imports only small quantities of ethanol for industrial and beverage uses. Feedstocks of ethanol in Thailand are about 60 percent molasses, with the remainder coming from cassava and sugarcane.

As of 2015, there are 22 ethanol production facilities in Thailand with a total combined capacity of 5.31 million liters per day and the demand of ethanol was at 1,185.50 million liters per year or equivalent to 3.25 million liters per day. As of April 2017, there are a total of 3,396 gasohol stations for E20 and 1,000 for E85 up from last year.[5]

With price incentives, sales of gasohol have continued to increase while sales of gasoline have continued to decline. About 10,118 million liters of gasohol were sold in 2016, of which 80 percent was E10 (See Table 2). Average sales of gasohol in 2017 from January to July is about 28.8 million liters per day as compared to 27.7 million liters per day in 2016,

[4] Asia-Pacific Economic Cooperation, Case Studies highlighting member economy experiences in developing their ethanol sectors, EWG 12/2015A, April 2017.

[5] Thailand Biofuel Annual, USDA Foreign Agricultural Service, Gain Report Number: TH7084 https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Bangkok_Thailand_6-23-2017.pdf

Table 2: Fuel Sales for Transportation

	Gasohol (million liters)					**Gasoline** (million liters)		
	E10-91	E10-95	E20-95	E85-95	Total	ULG91	ULG95	Total
2004	0.1	14	-	-	14.1	4,631	2,970	7,601
2005	29	646	-	-	675	4,333	2,240	6,573
2006	94	1,185	-	-	1,279	4,464	1,471	5,935
2007	244	1,519	-	-	1,763	4,467	1,107	5,574
2008	924	2,439	29	0.02	3,392.02	3,388	341	3,729
2009	1,415	2,972	83	0.3	4,470.3	2,877	177	3,054
2010	1,552	2,692	137	2.1	4,383.1	2,958	77	3,035
2011	1,860	2,122	222	9.1	4,213.1	3,077	42	3,119
2012	2,121	1,931	367	36	4,455	3,208	42	3,250
2013	3,337	3,030	963	141	7,471	147	616	763
2014	3,595	2,735	1,344	334	8,008	61	498	559
2015	4,019	3,283	1,511	317	9,130	81	502	583
2016	4,073	3,968	1,753	324	10,118	71	490	561
Jan-July 2017	2,284	2,483	1,087	220	6,074	35	265	300

Source: Department of Energy Business (www.doeb.go.th/info/data/datadistribution/y_sale.xls)

A comparison of the sales of gasoline and gasohol during 2004 to 2016 is given in Figure 1.

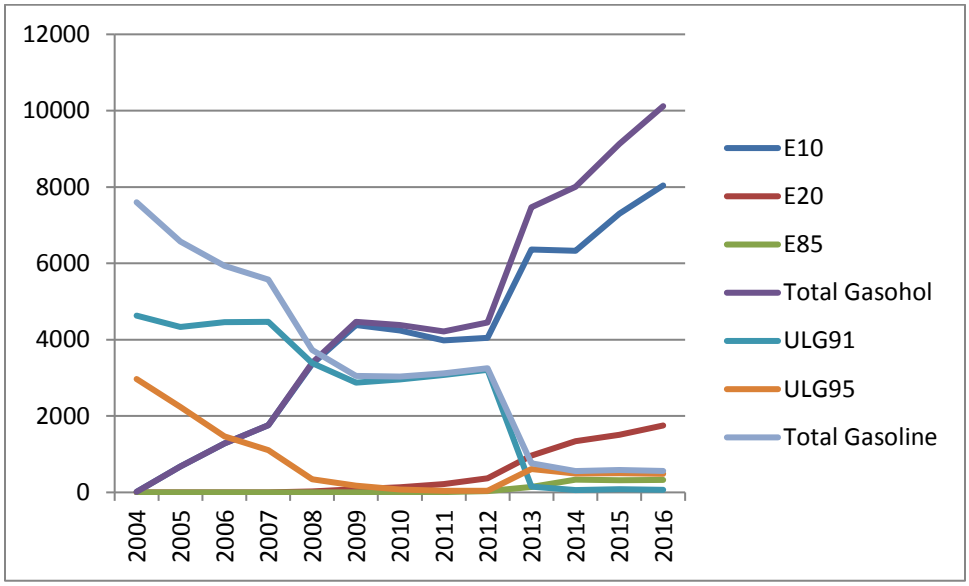

Figure 1: Comparison of Sales of Gasoline and Gasohol during 2004-2016 (million liters)
Source: Department of Energy Business (www.doeb.go.th/info/data/datadistribution/y_sale.xls)

A comparison of the sales of gasoline and gasohol during 2014-2016 is shown in Figure 1. Since the average yields of cassava and sugar cane have not increased as previously projected, it limits

domestic feedstock supplies for ethanol production. The government is also unwilling to import ethanol feedstocks. Therefore, it is expected that the government will lower the target for ethanol consumption under the revised AEDP 2015 to 2.6 billion liters in 2036 (down 37 percent from the initial target of 4.1 billion liters). In addition, it is expected that the government will delay the elimination of E10-91 sales in the country, as previously plan for January 1, 2018. As E10-91 accounts for about 40 percent of total gasohol sales, the cessation of its sale would double sale of E20 and increase ethanol consumption while the domestic production will not be sufficient.[1] However, the government's supports for the use of gasohol will continue with price incentives to consumers by subsidies at pumps to make gasohol cheaper than petroleum gasoline. The government will also continue to support manufacturers of FFVs with the new excise tax structure implemented on January 1, 2016

Biodiesel

Biodiesel for vehicle use can be categorized into two groups—one is a mixture of petroleum diesel with biodiesel, and the other is pure biodiesel. The government signed a cabinet resolution to promote biodiesel in Thailand in 2001. In the beginning, the mixtures of petroleum diesel with biodiesel came as B2, B5 and B100. B2 is a blend of 2 percent biodiesel and 98 percent petroleum diesel and B5 is a blend of 5 percent biodiesel and 95 percent petroleum diesel. B100 or neat biodiesel is pure biodiesel and is sold in the market at limited numbers of gas stations. The majority of B100 biodiesel is used to blend with petroleum diesel to be B2 and B5, and a small amount is used in the private sector for applications such as fleet vehicles. Small production of biodiesel for agricultural machine use is called community biodiesel and is mainly produced and sold in the community.

B2 was first introduced in the market in 2004 in Chieng Mai for local buses. B5 was sold in 2005, first in Bangkok and later in other provinces. Starting February 1, 2008, the government mandated the "one-grade" diesel policy requiring all high-speed diesel fuel sold in the country to contain 2% biodiesel, and thus there was no more product called B2. The mandatory blending of biodiesel in diesel production has been imposed since then but the blending requirement has been adjusted over the years. The government imposes and strictly monitors that all petroleum refineries comply with the biodiesel blending requirement. To increase the use of biodiesel, a mandate on B5 biodiesel blend was implemented in 2012, and B7 (7 percent biodiesel and 93 percent petroleum diesel) mandate was implemented in January 2014. However, the volumes of crude palm oil have seasonal fluctuations and in some years there were inadequate domestic palm oil feedstocks. The government strictly controls the import of palm oil and biodiesel production has to only come from domestic feedstocks. Thus the Ministry of Energy adjusted the mandatory biodiesel blending rates to balance domestic feedstocks. Due to a drought affecting crude palm oil production, the government lowered the mandatory biodiesel blending rates 3 times in 2016, from B7 to B5 in July 2016, and to B3 in August 2016, but increased to B5 in November 2016. Thus in the past the average mandatory biodiesel blending varied from 3-7

[1] Thailand Biofuel Annual, USDA Foreign Agricultural Service, Gain Report Number: TH7084 https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Bangkok_Thailand_6-23-2017.pdf

percent. Since May 8, 2017, the mandatory blending rate returned to B7. The government has a plan to implement the mandatory rate to B10 in 2018 for all diesel sales.

One contributing factor to the limited success of biodiesel penetration in the Thai market is the availability of domestic feedstock. Unlike ethanol whose feedstock supplies, molasses and cassava, can be cultivated in one year, the main feedstock for biodiesel is palm oil, and oil palms need 3-4 years from the time they are planted to the time they bear fruits. Suitable areas for oil palms in southern Thailand are limited and thus expansion of oil palm plantations is not easy and must compete with the cultivation of rubber plantations. With the ambitious target of producing biodiesel, the government put in place a program to increase oil palm plantations in the country, and encourage oil palm plantations in Laos, Cambodia, and Myanmar on a contract-farming basis. In addition, the government encouraged planting oil seeds as a rotation crop with rice farming as Thailand uses more than 10 million hectares for rice production.

In 2016 Thailand produced 1,240 million liters of biodiesel, and consumed about 1,233 million litters. Small amounts of biodiesel were imported and exported each year. The government restricts the import of biodiesel to protect domestic palm growers. Thailand imported B100 at about 5 million liters in 2016 as compared to 1.85 million liters in 2015. Thailand exported B100 at about 15.9 million liters in 2016 as compared to 2.81 million liters in 2015.[6]

Biodiesel production had continued to increase until 2016 when the production dropped for the first time from 1,250 million liters in 2015 to 1,240 million liters in 2016. It is forecast that biodiesel production will grow slightly in 2017 and 2018 to 1,400 million liters and 1,470 million liters, respectively, based on the likelihood that the mandatory requirement will remain between B5 and B7.[7]

As of August, 2017, Thailand has 13 biodiesel plants, with combined capacity of 6.618 million liters per day.[8] Currently, sales of biodiesel are about 3.74 million liter per day as compared to about 3.367 million liter per day in 2016.

The target for biodiesel consumption was lowered from 5.1 billion liters to 2.6 billion liters by 2036 due to stagnant domestic supply of crude palm oil, assuming crude palm oil import remain not permissible. Limited arable land and the profitable of crop alternatives from crude palm oil such as rubber and rice make increasing oil palm acreage more challenging than previously anticipated.

Biofuel consumption in Thailand has continued to increase. The total consumption of biofuel, ethanol and biodiesel combined, is about 7.5 million liters per day at present (see Table 3).

[6] Thailand Biofuel Annual, USDA Foreign Agricultural Service, Gain Report Number: TH7084 https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Bangkok_Thailand_6-23-2017.pdf

[7] Ibid

[8] http://www.doeb.go.th/info/data/dataoil/SaleB100.pdf

Table 3: Biofuel consumption

Unit: Million liters per day

	Ethanol	Biodiesel	Total
2011	1.2	2.1	3.3
2012	1.4	2.7	4.1
2013	2.6	2.9	5.5
2014	3.2	2.9	6.1
2015	3.5	3.4	6.9
2016	3.6	3.4	7.0
2017	3.8	3.7	7.5

Sources: Thailand Alternative Energy Situation 2015
http://www.dede.go.th/download/state_59/Thailand%20alternative%20energy%202015.pdf
and Thailand Biofuel Annual, USDA Foreign Agricultural Service, Gain Report Number: TH7084,
https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Bangkok_Thailand_6-23-2017.pdf

Ethanol-Fuel Compatible Vehicles

As Thailand has been promoting biofuel in the country, the government has provided various incentives for biofuel compatible cars. When E10 was sold commercially, there were not many problems with existing cars on the roads since cars with fuel injection systems that were manufactured from 1995 and onwards are safely fueled by E10. When E20 was introduced in 2008, it was recommended to be utilized on specific car models as suggested by the Original Equipment Manufacturer (OEM). The government announced a reduction of vehicle excise tax for E20 compatible vehicles 5 percent from previous rates. Excise taxes for E20 vehicles were lowered to 25 percent, 30 percent and 35 percent for cars with engine capacities not exceeding 2,000 cc, 2,500 cc, and 3,000 cc, respectively. In 2009, six automobile companies were selling E20 capable cars including Ford, Honda, Mazda, Nissan, Mitsubishi and Toyota. Since 2010 all new cars in the Thai market are E20-compatible cars.

The government pushed the introduction of E85 in 2008 to the local market and provided tax incentives for E85 fuel and E85-compatible vehicles (Flexible Fuel Vehicles). The government also mandated that E85 gasohol would have much lower excise tax per liter than normal fuel. Excise taxes for E85 vehicles were lowered 5 percent than that of regular cars, and it at the same excise taxes imposed on E20 vehicles. The government also waived import duties for 3 year periods for parts used for E85 technology that were unavailable locally.

As E85 gasohol was available three years earlier than the previous target, the availability of E85 compatible vehicles in the local market was an issue. At the beginning, Volvo was the only automaker to offer imported E-85 compatible cars, the Volvo C30 Sedan, to local customers.

Local automakers stated that the government needed to provide better incentives for them to invest in developing FFVs locally. Thus in 2009 the government lowered the excise tax on all FFVs (both imported and domestically manufactured) sold in the country to 3 percent and lowered the import duty from 80 percent to 60 percent for imported FFVs. In 2010 the government stopped tax privileges for imported FFV but continued to focus on promoting domestically manufactured FFVs of all cylinder capacities.

Since January 1, 2016, a new excise tax structure was enacted based on the emission rate of CO_2. This new excise tax is an effective policy from the government to promote the use of low emission vehicles and economy cars especially cars fueled by high ethanol blends and EVs. Eco-cars (1,300 cc to 1,500 cc engines) with CO_2 emission less than 100 gram/km will pay excise tax 14 percent, with an additional 2 percent reduction for the manufacturer of Eco-cars that use E85. Higher emission rates of CO_2 for the same sizes of eco-cars will pay 17 percent excise tax. E85 compatible vehicles smaller than 3,000 cc will pay 5 percent less excise tax than E10 and E20 compatible vehicles of same size and same CO_2 emission rates.[9]

Natural Gas Vehicles

In addition to ethanol and biodiesel, compressed natural gas (CNG) is another alternative fuel that the Thai government has promoted in the attempt to reduce its dependence on imported petroleum. The government used several means to promote CNG consumption and CNG compatible vehicles adoption. Those incentives included financial support for vehicle owners, low interest loans for engine conversions, subsidized CNG prices at pumps, and several tax exclusion and reductions for NGVs. Retail prices of CNG, locally known as natural gas for vehicles or NGV, were regulated by the Energy Policy and Planning Office (EPPO) and was subsidized for many years to keep it below the commercial breaking point. From 2002 to May 2005, CNG prices for private vehicles were kept pretty stagnant from 7.64 baht per kg to 8.50 baht per kg, and it stayed at 8.50 baht per kg for almost seven years until it changed to 9.00 baht per kg in January 2012. The price remained constant until October 2014 when the military-led government took power, and the government brought CNG price up to 11.50 baht per kg which was closer to market prices. The prices of CNG have been raised several times since then.[10] Retail price of CNG for private vehicles were unregulated in March 2016 and thus has moved toward the market price. However, the government is still subsidizing the price of CNG for public vehicles, which account for around 25 percent of total CNG consumed in Thailand. The current price of CNG for Bangkok and vicinity for private vehicles (as of September 15, 2017) is 13.19 baht per kg, and for public vehicles is 10 baht per kg.

With CNG price subsidization, and tax reduction for CNG compatible vehicles, sales of CNG for vehicles had continued to increase each year until 2015 when the sales dropped to 8.4 million kg per day from 8.8 million kg per day in 2014 (see Figure 2). The average sales of CNG in 2016 was 7.7 million kg per day, and in 2017 (during January to July) is 6.9 million kg per day.[11] The

[9] http://www.thaiauto.or.th/2012/news/news-detail.asp?news_id=3198

[10] http://www.eppo.go.th/epposite/index.php/th/petroleum/price/ngv-price-unit

[11] Department of Energy Business (www.doeb.go.th/info/data/datadistribution/y_sale.xls)

decrease in CNG sale volumes was due to an increase in price of CNG (as the government began to decrease the subsidies of CNG prices), and the lower oil price.

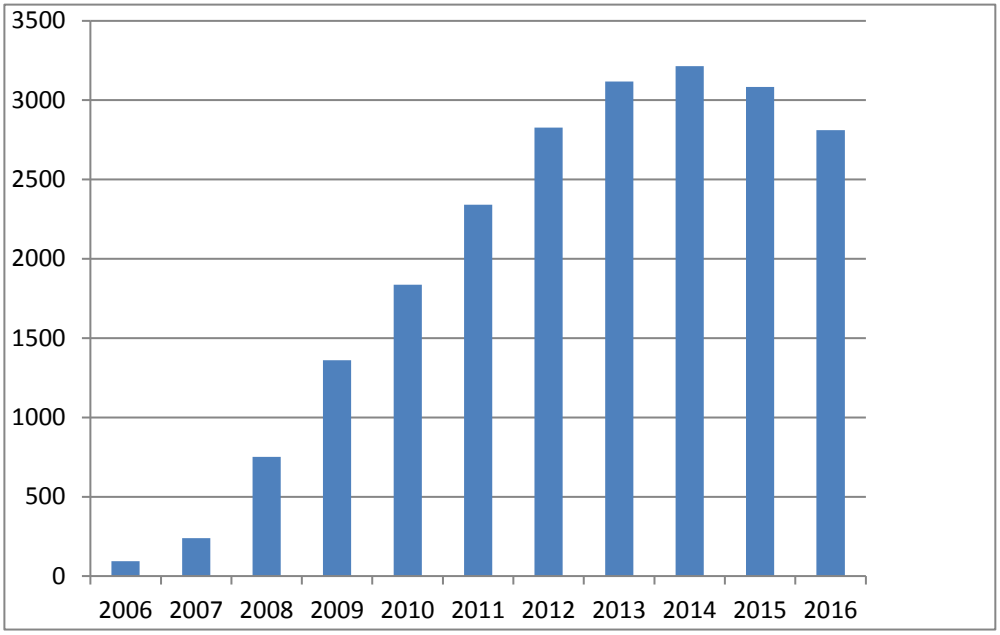

Figure 2: Sales of CNG in the transport sector (Million kg)
Source: Department of Energy Business (www.doeb.go.th/info/data/datadistribution/y_sale.xls)

The growth of NGVs sales were small in the first 5 years starting from 2001 due to a minimal expansion of NGV stations. When only 44 NGV stations in operation, the share of NGV usage stayed under 1 percent of total registered cars in 2005. Most people have viewed CNG as cheap vehicle fuel and CNG compatible cars as cheap cars. Over the past ten years when gasoline prices were high and CNG prices were relatively low, many vehicles were converted to use CNG to save money on fuel costs. The big jump in the number of NGVs was in 2013. Recently as demand for natural gas rose across all sectors, the Thai government ended subsidies in the CNG sector. That made NGVs became relatively more expensive. With gasoline prices decreased, CNG for vehicles became less popular and the drivers often went back to using gasoline.[12] The lack of increases in NGVs sales led to lack of investment in NGV infrastructure and fueling stations which consequently caused NGVs to become even less popular. As shown in Figure 3, NGVs sales have been stagnant during the past few years. As of 2016, there are 474,486 NGVs in Thailand as compared to 466,845 in 2015 and 457,110 in 2014.[13] These include CNG-only vehicles, dual-fuel CNG and gasoline vehicles, and a small number of dual-fuel CNG and diesel vehicles. With over 37 million vehicles registered in Thailand in 2016, NGVs represent only

[12] www.bangkokpost.com/learning/advanced/1194380/cng-lpg-saga-of-subsidized-gas-continues

[13] http://www.iangv.org/current-ngv-stats/

about 1.3 percent of the total vehicle stock. Currently, there are 504 NGV fueling stations.[14]

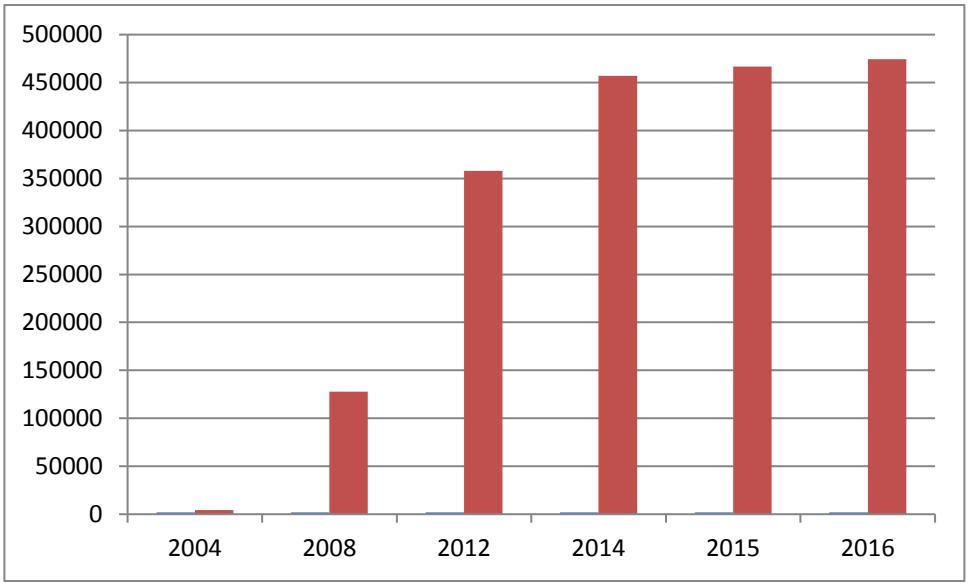

Figure 3: NGVs Sales
Sources: http://www.iangv.org/current-ngv-stats/ (2004, 2008, 2012, 2016)
http://www.ngvjournal.com/wp-content/uploads/pdfmags/asian94-011214.pdf (2014)
http://www.ngvjournal.com/wp-content/uploads/2016/03/ASIAN108febreroWEBok.pdf (2015)

The long-term viability of mass adoption of NGVs in Thailand is now in question. As the government ended subsidies to CNG prices, and as the global oil prices are decreasing, it makes CNG relatively more expensive. Demand for natural gas has been steadily growing in Thailand, and consumption began to outpace production for the first time in 1999. The CNG market is competing with other users of natural gas including the growing electricity sector for power generation. The declining availability of gas might force the government to raise CNG price even more. The other barriers to the wider spread of NGVs in Thailand are relatively few fueling stations, substantial costs of retooling engines to run on natural gas, the range limitation of NGVs, and the limitation of NGVs models. It is likely that the government will focus more on promoting the use of NGVs for heavy trucks and public transportation than private vehicles. In contrarily to CNG, ethanol has remained available as a fuel source for the transport sector and its production is utilized almost entirely for transport fuel use. The Thai government's commitment to ethanol and ethanol-fueled cars remains concrete. Also, future generation cars like EVs, FFVs, EVs, and fuel-cell cars might have more of a future in Thailand than NGVs.

Electric Vehicles

[14] http://www.eppo.go.th/epposite/index.php/th/petroleum/oil/status-oil-price?orders[publishUp]=publishUp&issearch=1

Thailand was the first country in Asia that produced and used electric vehicles. The use of electric vehicles in Thailand could actually be dated back to 1905 as a photograph showed one of His Majesty King Rama the V's son holding the steering wheel of an electric car made by the Carl Oppermann Electric Carriage company in England. That was an electric car with 5 horsepower, maximum distance at 50 miles, and ran at a maximum speed of 14 miles per hour. After this first car, the second electric car was recorded in 1909 made by the Baker Electric car company of the U.S for His Majesty King Rama the V for traveling close distances in Bangkok and metropolitan areas.

The next generation of electric cars in Thailand was the Toyota Camry Hybrid, the hybrid electric car (HEV) model that was manufactured and sold by Toyota Motor (Thailand) in 2009. The following year, Toyota Motor (Thailand) produced another model of HEVs, Toyota Prius 3rd Generation, and later Toyota Alphard Hybrid. In addition to the Toyota Motor Thailand, other car companies that produced HEVs in Thailand include Nissan Motor Thailand, Ltd (Nissan X-Trail Hybrid), Honda Automobile Thailand, Ltd. (Honda Jazz Hybrid, Honda Civic Hybrid, Honda Accord Hybrid), BMW Thailand, Ltd. (BMW Active Hybrid 3, 5, 7L, BMW i3 and i8, and BMW X5 xDrive40e PHEV), Mercedes-Benz Thailand, Ltd.(Mercedes-Benz C300 and E300 BlueTEC Hybrid), Lexus Thailand, Ltd. (Lexus IS, ES, GS, LS, CT and NX Hybrid). The AAS Auto Service Ltd., was an official importer and sales representative of Porsche hybrid electric cars in Thailand including Porsche Cayenne S Hybrid and Porsche Panamera S Hybrid.[15]

In addition to foreign companies, the first Thai electric car company, Vera Automotive, was founded on October 7, 2015 by five Thai engineers from King Mongkut's Institute of Technology Ladkrabang (KMITL). The Vera V1 car is powered with a battery capacity of 22 kW per hour, which can be registered with the Land Transportation Department as a passenger car. The maximum speed of the Vera V1 is up to 105 km/hour. It can run up to 180 km per charge which takes six hours to complete. All Vera cars are designed by Thai engineers under Thai brand but the company has hired the Chinese carmaker, Geely Automotive, for production and they are imported as completely built-up (CBU) vehicles to Thailand. Vera V1 is subject to all related taxes similar to other imported vehicles. The retail price of Vera V_1 is below 1 million baht (about US$ 30,200) which the company believes is affordable for Thai customers.[16]

Future Plan for Electric Vehicles

The current government administration has a strong interest in promoting the electric vehicle industry in Thailand. The government is now working to move from HEV to plug-in hybrid electric vehicles (PHEV) and battery powered electric vehicles (BEV). Thailand developed the Eastern Seaboard in the 90s as a global auto manufacturing hub. The production of EVs will be centered in the Eastern Economic Corridor, the three-province zone that is planned as a home for advanced industries.

[15] http://www.evat.or.th/15708247/ev-history

[16] Thailand's first electric car, the Vera V1, makes its debut. Bangkok Post 14 January, 2017, Piyachart Maikaew, https://www.pressreader.com/thailand/bangkok-post/20170114/281921657739627

On March 11, 2016, the National Energy Policy Council, Ministry of Energy, approved a roadmap for development of electric vehicles in Thailand. The EVs action plan states the development of EVs in three phases.

First Phase (2016-2017) introduced EV buses as pilot projects. A total of 200 electric public buses will be operated by the Bangkok Mass Transit Authority (BMTA) having the Metropolitan Electricity Authority (MEA) set up 4 charging stations for the fleet. PTT (a Thai state-owned oil and gas company), Provincial Electricity Authority (PEA), and Electricity Generating Authority of Thailand (EGAT) also introduced EV buses for test drive as personal transportation.

Second Phase (2018-2020) will focus on research on battery/motor capacity, car/charging station standards, and law and tax permission.

Third Phase (2021-2036) has set a goal of 1.2 million EVs, 690 charging stations, EV smart charging, and vehicle-grid system by 2036.

Currently, there are about 68,000 EVs and 20 public electric buses running in Thailand. There are currently 29 public EV charging stations (as of March 2017). Of the total, 12 stations are owned by the three electric utilities (MEA, PEA, and EGAT) for demonstration and internal use, 7 by Petro companies (PTT and BCP) as pilot stations, 3 by universities (KMUTT and Chulalongkorn University) for academic and research purposes, and 7 by public companies (such as at hotels, department stores, office buildings and service shops) for their customers.

PTT signed a contract in August 2017 with 6 major automakers for cooperation in developing electric cars. Those automakers were the Thai units of BMW Group, Mercedes Benz, Mitsubishi Motors Corp, Nissan Motor, Porsche, and Volvo. PTT is also building a network of 20 charging stations by 2017.

In addition, FOMM, a Japanese manufacture, established an assembly plant for its compact EVs in Thailand. With registered capital of 360 million baht, FOMM Asia held equal shares of 49.9 percent with a Thai partner, Trinex Assets Co. The other Thai company is Kusumoto Chavalit and Partners Co (KCP) held 0.2 percent of the investment. The Thai model meets European standards for compact EVs, and it will be sold in the Thai market, and exported to ASEAN and European markets. The prototype model has four seats and can drive 100-150 km per single charge which can take up to 6 hours. The maximum speed is 90 km per hour and has a guarantee of 30,000 km or five years. FOMM said the price of their EV excluding battery should be no more than 300,000 baht while 4 batteries will be rented for 1,000 – 2,000 baht per month. Local content will account for 70 percent of the production of FOMM's Thai-made vehicles with imported batteries and parts making up the remaining 30 percent. FOMM is seeking battery manufacturing partners in China, Japan, and Singapore. The company set a Thai sales target of 4,000 units by 2017, 16,000 in 2018, 30,000 in 2019 and 40,000 in 2020. FOMM will install normal plugs for charging at 200 Bangchak petro stations nationwide by 2017, [17] and plans to start exporting in 2018. [18]

[17] http://www.bangkokpost.com/learning/advanced/1062141/japanese-electric-cars-coming-to-thailand-soon

[18] https://m.bangkokpost.com/learning/advanced/1254209/japanese-electric-car-factory-this-year

The Ministry of Energy has established the EV charging station promotion program, and on April 27, 2016 approved 76 million baht from the Energy Conservation Promotion Fund (ECPF) to support government agencies, state enterprises and private sector in installing 150 charging stations. Government and state enterprises will receive 100 percent payment from the ECPF to build charging stations. The ECPF will provide financial support in 5 rounds. The private sector will receive 70 percent and 50 percent from the Fund in Round 1 and Round 2, respectively, 30 percent in round 3 and 4, and 20 percent in round 5. By the end of 2017, 43 charging stations are expected to be in operation. Of these 43 charging station, 23 stations will be normal charging outlets (charging BEV in 6-8 hours and PHEV in 1-2 hours) and 20 stations will be quick charging outlet (charging BEV in 15-20 minutes).[19]

On March 24, 2017 the Board of Investment (BOI) approved a plan to provide comprehensive support to companies involved in the production of electric car components and the battery-charging business. The support will cover HEV, PHEV, and BEV. They can be passenger cars, pick-up trucks, and buses. Tax incentives will vary according to the production technology applied.

- HEV manufacturers will be entitled to an import tariff exemption for relevant machinery.
- PHEV manufacturers will be entitled to a waiver on import tariff exemption on machinery, and a three-year corporate exemption. If they produce more than one key component, they will enjoy an additional year of corporate income tax breaks for each component but the combined tax exemptions cannot exceed six years.
- BEV manufacturers will receive a waiver on duty for imported machinery and a waiver of between five years and eight years on corporate tax. If they produce more than one key component, they will gain an additional year of tax breaks per component but the combined tax exemption cannot exceed 10 years.[20]
- Battery electric buses will be entitled to tariff exemptions for imported machinery and a three-year corporate tax exemption. They are also eligible for an additional year of corporate income tax exemption per piece with the combined tax exemption not to exceed six years.

BOI added that more important EV parts will enjoy corporate income tax exemption for 8 years. Those EV parts include batteries, traction motors, battery management services, EV smart charging systems, DC/DC converters, inverters, portable electric vehicle chargers, and electrical circuit breakers.[21]

---

[19] Atsawin Salee. EV Charging Station, Electric Vehicles Forum in Thaailnd, April 27th, 2017, see http://www.sti.or.th/uploads/files/files/20170427%20Infrastructure%20(Dr%20Atsawin).pdf

[20] http://www.nationmultimedia.com/news/business/EconomyAndTourism/30310205

[21] https://fronteranews.com/news/asia/the-thai-governments-latest-gamble-electric-vehicle-policy/

With the new excise tax structure implemented on January 1, 2016, EVs less than 3,000 cc will pay 10 percent excise tax. The Finance Ministry is offering to cut excise tax from 10 percent to 5 percent for HEVs and PHEVs. The excise tax for BEV that release CO_2 emissions below 100 gm per km is to be cut to just 2 percent.

There are several on-going government projects from related ministry and agencies. For example, the Ministry of Industry is setting standards for car charging electrical outlets. The Ministry of Transport is pilot testing of 200 electric buses and diesel-hybrid buses running on the Bangkok 137 bus routes. The iEVT and NSTDA are working on EV motor and battery development projects for manufacturers. The Synchrotron Light Research Institute under the Ministry of Science and Technology is working on several research projects to develop Li-ion batteries for EVs. As for the private sector, BMW was the first manufacturer to announce expansion of their production of plug-in hybrid vehicles (models X5 and 330e) in 2016. These cars will be sold domestically and exported to China, which is the world's largest EV market, where over 200,000 EVs were sold in 2015. PHEVs from European brands such as Mercedes-Benz and Porsche are also being imported to the Thai market.[22]

Conclusion

Thailand has made impressive gains in the introduction of alternative fuels to the domestic market. This resulted from aggressive policies of the government to reach its goal and cooperation among government agencies. As an example, when the government passed the cabinet resolution to promote the use of ethanol fuel, the Ministry of Energy approved funds from the Oil Fund to subsidize gasohol prices to make them attractive to consumers as compared to gasoline. The Department of Energy Business provided information to consumers on car models that can be fueled with E10. The Ministry of Finance reduced excise taxes for imported cars, and domestically manufactured ethanol based fuel cars. The Board of Investment gave tax privilege for E20 and E85 car manufactures. The Ministry of Agriculture set implementation targets for planting areas of ethanol feedstocks, and crop yields to promote ethanol production. The cooperation among agencies applied to biodiesel and NGVs. There is no doubt that the same aggressive policies and cooperation will be applied as Thailand is moving forward to the next generation of vehicles.

Thailand is implementing the national strategy called Thailand 4.0. Thailand 4.0 is an economic model that aims to unlock the country from several economic challenges resulting from past economic development models which placed emphasis on agriculture (Thailand 1.0), light industry (Thailand 2.0), and advanced industry (Thailand 3.0). Thailand 4.0 is designed to transform Thailand's economy into one driven by innovation, advance and green technologies, research and development, and creativity.[23] As part of Thailand's 4.0 modernization program,

[22] Paving the pathway to future of the Thai electric vehicles, 29 June 2016, Economic Intelligence Center, SCB, www.scbeic.com/en/detail/product/2441

[23] http://thaiembdc.org/2017/03/27/thailand-preparing-incentives-for-electric-vehicles/

the government has identified 10 potentially high-growth industries, of which electric and other modern vehicles is one of them.

Thailand is currently a major production base for automobiles. It is ranked as the world's 12th largest automobile producer. With its existing position in the global automotive market, Thailand has the potential to succeed in developing an electric vehicle industry as one of the country's new growth sectors. The government and private sector are working together to push forward policies to support EV production and infrastructure development like EV charging stations. The challenge is for the Thai government to provide sufficient incentives for consumers to switch to electric cars, and for car makers to produce electric cars.