 

Can electricity replace gasoline?

Unlocking the potential of electric two-wheelers in Thailand

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Every day 19 million gasoline motorcycles crisscross Thailand's streets, bringing people to work, kids to school and goods to customers. However, they also release about 10 million tonnes of CO_2 each year (15% of total transport emissions) and contribute to air pollution. Electric two-wheelers can help improve the situation. They consume less energy and have substantially lower emissions per kilometre traveled. Looking at lifetime costs, some electric motorcycles are more expensive, but other models cost almost half as much as their gasoline counterparts.
So, why are electric motorcycles still a rare sight? Users often mention the following disadvantages: limited range, limited speed, and long charging time. The structural barriers that need to be addressed include incomplete life cycle assessment, lack of financial mechanism or supporting policies, low consumer trust, leadership and technology challenges.

The public sector has initiated demonstration projects, and several private companies have mature designs ready for mass-marketing. By removing structural barriers, electric motorcycles – and their positive impacts – can become a daily reality in Thailand.

Environmental performance

Electric two-wheelers consume less energy and produce substantially lower emissions per distance travelled than their gasoline counterparts. As shown in table 1, a gasoline-powered motorcycle emits approximately 1.5 to 5 times more grams of CO_2-eq per kilometre travelled than an electric motorcycle. The fuel economy of a conventional 125cc engine gasoline motorcycles in Thailand is 28–65 km/litre,[i] while an electric two-wheeler achieves 30–44 km/kWh. The very efficient electric motor, powered by a lead-acid or lithium-ion battery, is the driver behind the superior environmental performance.

Table 1: *Emissions comparison gasoline vs. electric*

	Gasoline (g/km)[a]	Electric (g/km)[b]
CO_2-eq	31.41 – 75.18	13.85 – 20.31
CO	1.02 – 2.42	-
NO_x	0.07 – 0.23	0.029 – 0.042
SO_2	-	0.010 – 0.014
THC	0.11 – 0.41	-
PM	n/a[c]	0.0005 – 0.0007

[a] Fuel economy and emissions of a Honda Wave 125i (Thailand Pollution Control Department, 2014).
[b] Calculations based on Thailand's electrical grid emission factors g/kWh (CO_2 - 609.3 g, NOx - 1.28 g, SO_2 - 0.43g, PM - 0.02 g).[ii] Grid transmission loss of 5.9% is included.[iii]
[c] PM emissions data for 125cc 4-stroke engine motorcycles is not collected in Thailand.

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Financial costs

Comparing costs over a typical 10-year operation period gives a mixed picture. Lithium-ion battery motorcycles are actually more expensive to use than gasoline-powered, about 3,438 THB more per year. On the other hand, a lead-acid battery motorcycle can bring in savings of 4,487 THB per year compared to conventional motorcycles.

Table 2: *Cost comparison of gasoline vs. electric motorcycles over a 10-year lifespan*

	Gasoline motorcycle	Electric motorcycle	
		Lithium-ion battery	*Lead-acid battery*
Vehicle cost	46,000 THB (1,432 USD)	143,000 THB (4,372 USD)	39,000 THB (1,193 USD)[d]
Fuel economy[a]	28 – 65 km/litre	30 – 44 km/kWh	
Annual fuel costs[b]	8,064 – 18,720 THB (247 – 573 USD)	870 – 1,274 THB (27 – 39 USD)	870 – 1,274 THB (27 – 39 USD)
Replacing a single battery pack	None	31,363 THB (960 USD)	8,000 THB (490 USD)
Estimated total cost over 10 years[c]	127,700 THB (3,990 USD)	162,082 (5,065 USD)	82,833 THB (2,600 USD)
Annualized cost	12,770 THB (399 USD)	16,208 THB (506 USD)	8,283 THB (260 USD)

[a] Fuel economy and emissions of a Honda Wave 125i (Thailand Pollution Control Department, 2014).
[b] Price of gasoline in Thailand is 48 THB/litre. Price of electricity in Thailand is 3.5 THB/kWh.
[c] Discount rate is 15%.
[d] Price for Toyotron motors vehicles (toyotron.com, accessed 01.10.2014).

Looking at the total 10-year lifetime expenses the cheapest option is a lead-acid battery motorcycle at 82,833 THB (2,600 USD), followed by the conventional gasoline motorcycle at 127,700 THB (3,990 USD), and finally the lithium-ion option at 162,082 THB (5,065 USD).[iv] Please consult table 2 for more detailed financial information.

The financial costs of electric two-wheelers are the vehicle itself, electricity, and battery replacements. The main ownership expenses of conventional motorcycles are similarly the vehicle, gasoline, and maintenance. The electric are virtually maintenance free, and their direct circuit electric motors have a typical life span of at least 10 years.[v]

The main difference between the two electric two-wheeler options is the vehicle price and the battery replacement cost. The lead-acid motorcycle can be purchased at a similar price as a conventional motorcycle. In comparison, buying a lithium-ion motorcycle is quite expensive – more than three times the other models.

Lithium-ion batteries have a life span of 50,000 km, while lead-acid batteries last for 10,000 km. On average, motorcycle users in Thailand drive 30–40 km each day.[vi] Based on this range estimate,

Source: Pulse Scooters

lithium-ion batteries and lead-acid batteries need to be replaced every 5 years and 1 year respectively. Over 10 years, owners of lithium-ion motorcycles have to spend 62,700 THB on batteries (39% of total cost), while lead-acid batteries will require 40,000 THB (48% of total costs). According to the data, cost is not the decisive factor for or against purchasing electric two-wheelers.

Barriers

Battery costs and vehicle performance are the main user barriers for electric motorcycles gaining more ground on Thailand's streets. Many Thai consumers are still concerned about the technology's overall performance compared to conventional motorcycles.

A recent study investigated the feasibility of electric motorcycle taxi services in Bangkok. Carried out by Silpakorn University among 124 motorcycle taxi drivers, it identified the following key barriers:

- long charging time (4–6 hours),
- the inconvenience of changing the battery,
- limited maximum speed (50–60 km/h),
- limited travel range (40–60 km).[vii]

For comparison, a conventional motorcycle takes less than 15 minutes to refuel and can cover 154–358 km on a 5.5 litre tank of gasoline.

These concerns are also shared by drivers of electric cars. The technical capacity could be addressed through advancements in electric two-wheeler powertrain technology. Another solution is to find a niche market or application for electric two-wheelers in Thailand. For example, the elderly who may prefer driving at slower speeds, and in certain towns and villages lower driving speeds are much more common.

Policies, plans, and programmes

Currently Thailand has no financial mechanisms or policies that directly encourage consumers to drive electric two-wheelers. While over 19 million motorcycles, 65% of the entire vehicle fleet, are registered in Thailand (Department of Land Transport, 2013), electric two-wheelers make up only 0.03% of the entire motorcycle fleet.[viii]

Electric motorcycles are indirectly mentioned in government planning documents and used in demonstration projects. The Ministry of Energy's 20-year Energy Efficiency Development Plan (2011–2030) includes the introduction of tax measures to promote energy efficient vehicles, like electric motorcycles. In April 2014, the Provincial Electricity Authority of Thailand (PEA) implemented a project in Nakhon Ratchasima to promote bike safety. PEA distributed helmets to motorcyclists and showcased their own brand of electric motorcycles, which can be purchased by individual consumers.

Source: Provincial Electricity Authority

PEA showcasing their electric motorcycles

Looking at the private sector, Toyotron Motors, UDA Motor, and Lion Bike are the three main producers and retailers. These and other emerging companies have developed electric two-wheelers with power ratings of 500 watts or higher and minimum speed of 45 km/hr (the minimum requirements for registering a vehicle with the Department of Land Transport).

Steps forward

Electric two-wheelers have been gaining more attention in Thailand and across Southeast Asia. The technology is maturing fast and is approaching competitive cost parity with conventional motorcycles. The energy saving and environmental benefits have already been documented.

Replacing 10% of the current motorcycle fleet with electric motorcycles could reduce greenhouse gas emissions from the road transport sector by 0.23 to 1.27 million tonnes CO_2-eq each year and reduce fossil fuel consumption by 320 to 740 million litres of gasoline annually. However for this projection to become reality the following additional key steps are needed:

❖ *Life cycle assessment*

Life cycle assessment should be used to evaluate the real environmental benefits of electric two-wheelers, examining the environmental impacts throughout the entire supply chain. The production and disposal of Lead-acid and lithium-ion batteries can be very environmentally damaging due to toxicity, depletion of metals, and terrestrial acidification.[ix]

Environmental impacts beyond greenhouse gas emissions and fossil fuel depletion should be considered and reduced. The life cycle assessment approach can play an important part in the development of adequate state policies for implementing this technology.

❖ *Battery performance*

Cost and recharging speed of batteries need to be addressed. Replacement cost is one of the main financial concerns for drivers. Technological advancements or financial incentives are needed to make lithium-ion batteries more competitive compared to lead-acid batteries.

❖ *Engaging the public*

Public policy discussions on electric two-wheelers should highlight the benefits of reduced noise pollution and improved safety from lower driving speeds. More attention should be given to their potential performance and user perception outside of Bangkok.

❖ *Leadership*

Additional public demonstration projects or electric two-wheeler rental programmes could help attract consumers and alleviate their concerns about lower maximum driving speeds and range anxiety. More research and development needs to explore how best to scale up this technology in the land transport sector.

Consolidating and sharing information and financial resources between the public and private sectors will be crucial for the advancement of electric two-wheelers in Thailand.

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Energy Efficiency and Climate Change Mitigation in the Land Transport Sector in the ASEAN Region

The Transport and Climate Change project (TCC) works on strategies and action plans towards the improvement of energy efficiency and the reduction of greenhouse gas emissions in cooperation with the Ministries of Transport and Environment of five countries (Indonesia, Malaysia, Philippines, Vietnam, Thailand) as well as with ASEAN bodies. The project was initiated upon request by the ASEAN secretariat to the German Federal Ministry for Economic Cooperation and Development (BMZ) and is part of the ASEAN German Cities-Environment-Transport Programme.

More Information
www.facebook.com/TransportClimateASEAN
www.TransportandClimateChange.org

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[iii] Department of Alternative Energy Development and Efficiency (2011): Electric power in Thailand.
[iv] Exchange rate on November 28, 2014: 1 USD = 32.77 THB
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