HARMONIZING TRANSPORTATION FUEL QUALITY STANDARDS TO RESOLVE OIL TRADE AND ENVIRONMENTAL ISSUES IN APEC

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Background

Exhaust gases emitted from motor vehicles, like carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM), harm human health as well as the environment. To reduce the pollutants from vehicles, leading to improved air quality, with benefits to health and the environment, and to alleviate the undesirable side effects of automobile utilization, every APEC economy has adopted fuel quality standards, which set emission limits for car pollutants.

Table 1 and Table 2 present passenger car emissions standards for gasoline and diesel, respectively, in the European Union (EU). They are called "Euro-X" emissions standards and have become virtually a global standard, adopted in most APEC economies. Since Euro 1 in 1992, EU countries have gradually tightened emission limits to address air pollution as well as global warming.

Euro standards set by the EU were purposely designed to cope with environmental issues through the acceptable limits on the exhaust emissions in EU Member states. A low exhaust emission requirement inevitably suggests higher technology needs as well as cleaner fuels. These specifications are numbered in series; i.e., 1, 2, 3, 4, 5, and 6 according to their rigorous level of standards. The introduction of increasingly stringent standards is typically declared two years before the planned effective date. The previous standards are automatically terminated as soon as the new standards are in effect. The Euro emission standards also define the specifications of the fuel to be used to test the engines complying with the exhaust emission limits. They have been designed according to the Fuel Quality Directive (2009/30/EC) which resulted in the region-wide supply of both gasoline and diesel fuel (highway and non-road).

Table 1. European emission standards for gasoline passenger cars, 1992-present

	Year of implementation	**Emission limits**						
		CO (g/km)	**HC+NOx (g/km)**	**HC (g/km)**	**NMHC (g/km)**	**PM (g/km)**	**NOx (g/km)**	**PN (#/km)**
Euro 1	1992	2.72	0.97	-	-	-	-	-
Euro 2	1996	2.2	0.5	-	-	-	-	-
Euro 3	2000	2.3	-	0.2	-	-	0.15	-
Euro 4	2005	1.0	-	0.1	-	-	0.08	-
Euro 5	2009	1.0	-	0.1	0.068	0.005	0.06	-
Euro 6	2014	1.0	-	0.1	0.068	0.005	0.06	6.0×10^{11}

Note: NMHC is non-methane hydrocarbons; PN is the particulate number.
Sources: RAC (2018).

Table 2. European emission standards for diesel passenger cars, 1992-present

	Year of implementation	Emission limits				
		CO (g/km)	HC+NOx (g/km)	PM (g/km)	NOx (g/km)	PN (#/km)
Euro 1	1992	2.72	0.97	0.14	-	-
Euro 2	1996	1.00	0.70	0.08	-	-
Euro 3	2000	0.66	0.56	0.05	0.50	-
Euro 4	2005	0.50	0.30	0.025	0.25	-
Euro 5	2009	0.50	0.23	0.005	0.18	6.0×10^{11}
Euro 6	2014	0.50	0.17	0.005	0.08	6.0×10^{11}

Sources: RAC (2018)

It seems unavoidable that in different APEC economies, a variety of specifications have been implemented and utilized. At the same time, the APEC oil market, and particularly oil trade, finds itself in a state of uncertainty and flux because it is hampered by the differences in quality specifications. Among several key factors sustaining APEC trade flows, the harmonization of APEC fuel quality standards stands out as one of the possible long-term transitions to support the APEC oil trade market, minimize environmental emissions, and reduce unnecessary oil movement and its excessive logistics costs.

This research seeks to highlight the emerging threat of vast differences of qualities among petroleum products especially diesel and gasoline in APEC which have considerably limited trade among APEC economies and analyses the transition opportunities to harmonize the fuel quality standards in its oil market. This study also aims to help policymakers across APEC in improving the sustainability and security of their energy systems and integrating these indications into policy strategies by comparing the economic benefits of improving or harmonizing the quality standards with the investment costs to upgrade the quality standards to meet the specifications required by the government and industry.

The challenges of harmonizing product quality in APEC are a wide variety of fuel quality standards being used in the region, the different levels of awareness of the environmental impact of fuel quality, and the readiness to improve fuel quality standards to create economic value in this region.

Besides, the consistency of laws, regulations, working processes, and practices of quality standards of the economies in the region can be important obstacles when developing harmonized fuel quality standards to support the integration and ensure greater benefits to the APEC region as a whole.

Energy demand in APEC has grown in line with regional economic growth. Energy consumption is increasing every year in the transport sector. Transport has the largest share of energy consumption and contributes to increasing the number of vehicles in the region. For example, vehicle registrations in the USA have been on the rise since 2010 at the rate of 1.1% per year to reach 276 million units in 2019 while vehicle registrations in China have increased strongest in APEC at a rate of 12% per year since 2010 to reach 258 million units in 2019 (Statista, 2021). Southeast Asia is no exception to high growth. Indonesia had the highest number of total vehicle registrations at 154 million units (2019), followed by Thailand at 41 million units (2019), Malaysia at 30 million units (2018), and the Philippines at 12 million units (2018), respectively (ASEAN, 2020).

Methodology

The approach used in this research is gap analysis, SWOT analysis (Strengths, S; Weaknesses, W; Opportunities, O; and Threats, T), and the Asia Pacific Energy Research Centre (APERC) Financial and Economic Model.

The data on transportation fuel consumption and standards for APEC is from the Expert Group on Energy Data and Analysis (EGEDA) and the inputs from economy representatives at APERC.

The gap analysis is used to assess the differences in a variety of diesel and gasoline quality standards in APEC. The SWOT analysis identifies the key factors (both internal and external) associated with the harmonization and improvement of the product quality standards within APEC.

Based on the results from the SWOT analysis, the APERC Financial and Economic Model is used to evaluate the economic costs and benefits to APEC in upgrading and harmonizing the product quality standards. In this analysis, the economic costs and benefits to Thailand if it changes its diesel and gasoline specifications from Euro 4 to Euro 5 are calculated. The results obtained from the model are then evaluated to investigate whether Thailand's drive to Euro 5 quality in 2022-2023 is justifiable and beneficial to its economy. The same approach is carried out for other APEC economies and the results are consolidated into an estimate of APEC costs and benefits for the case that APEC's quality standards are harmonized to resolve the oil trade and environmental issues.

Results and Discussions

The gap analysis for fuel quality standards in APEC (Figure 1) summarizes the differences in fuel quality standards for diesel and gasoline transportation fuels in the APEC region. It seems unavoidable that in different APEC economies, a variety of specifications have been adopted and utilized.

The fuel quality standards utilized in some APEC economies are behind those in Europe and widely vary among economies. While passenger cars in many APEC economies such as Canada, China, Japan, Korea, New Zealand, Russia, and the USA are already subject to the Euro 5 standard or above, other APEC economies have adopted only Euro 2-4. For example, Indonesia progressed two levels from Euro 2 to Euro 4 for gasoline vehicles in 2018 and plans for Euro 4 diesel in 2021 while Thailand shifted from Euro 3 to Euro 4 for both diesel and gasoline in early 2016 and plans to upgrade to Euro 5 in the 2022-2023 timeframe, and Australia plans to upgrade its petrol to Euro 5 in 2027.

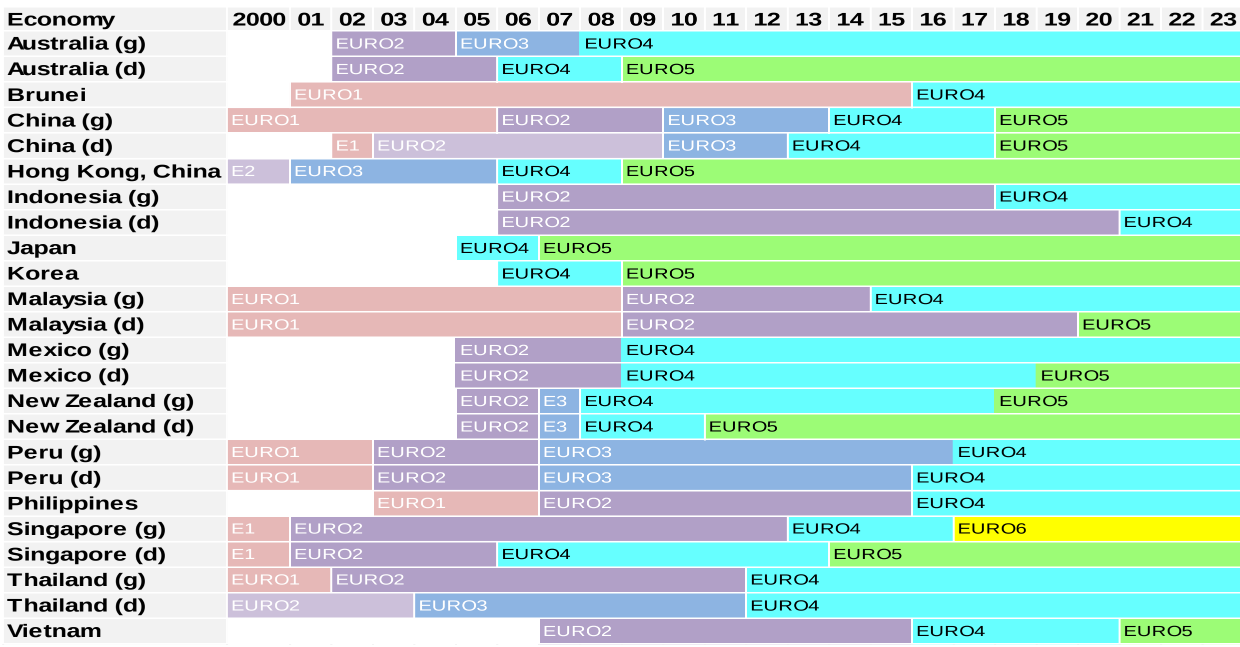
Utilizing fuels with common standards in APEC could contribute to more flexible product trade since differences in their qualities may hinder their active trade. That translates into extra costs when developing trade in the region. Should this barrier be resolved, more dynamic trade will strengthen APEC energy security. This is particularly true in Southeast Asia APEC, with significant intra-product trade flows and yet different quality standards in the region. The ongoing development of refineries that can produce Euro 5 applicable fuels in APEC such as Nghi Son in Vietnam and RAPID in Malaysia could contribute to a common standard.

Ideally, a region like APEC would have the following economic characteristics: (a) an integrated market and production base, (b) a highly competitive economic region, (c) a region of equitable economic development, and (d) a region fully linked into the global economy. Forming a single market could lead to a stronger economy, a better social life, and a cleaner environment for the whole region.

One way to facilitate a single petroleum market base with optimal production costs and flexible import-export capability in APEC is the harmonization of quality standards for transportation fuels in the region. Focusing on the need to improve the environment also implies that the harmonization of product quality is necessary for the region.

Therefore, the challenge is to convince APEC economies to harmonize their transportation fuels and quality standards and to encourage stakeholders to agree on the same standards to implement them in the future.

Figure 1: Gap analysis of fuel standards in APEC



Note: (g) = gasoline, (d) = diesel
Sources: PTIT (2016), European Environment Agency (2015), APERC Oil Report 2019 (2019)

The SWOT analysis on APEC economies shows that the health benefits to the community from cleaner air (S), market expansion (S), supply security (O), and petroleum product trading (O) are advantages but refinery investment (W) and differences in environmental policies (T) are barriers to the attempt to harmonize the quality standards in APEC. The identified factors from the strengths and opportunity categories can be used to evaluate the economic benefits while the factors from the weakness and threats categories can be used to calculate the economic costs associated with upgrading fuel specifications.

Table 3. SWOT analysis of harmonizing transportation fuel quality standards in APEC

Strengths	Weaknesses
Strategic location for expanding oil market within and outside APEC economies	Investments needed for some refineries to upgrade facilities
Excess and flexible-operational refinery capacities	
Better air quality, lower GHG emissions, and health risk reduction	
Opportunities	**Threats**
Fuel swap trading in APEC	Differential policy and quality standards in economies in APEC
Increased regional production capacity and consumption	A big gap in economic size and income per capita in the region
Strengthened cooperation in the oil quality standards in APEC	Increased trade competition because all economies focus on the same quality products
Increased security of supply in terms of Strategic Reserve	Lack of public awareness and recognition of the fuel quality standards

Sources: APERC analysis (2020)

The APERC Financial and Economic Model is then applied to evaluate Thailand's economic costs and environmental benefits in the transportation fuel transition from Euro 4 to Euro 5 as a case study. The benefit to Thailand in implementing Euro 5 diesel oil was calculated to be USD 540 million based on cleaner air with sulfur limits reduced from 50 ppm to 10 ppm (Table 4). Besides, less CO, NOx, and PM emissions would be realized in addition to the savings from health care cost reduction.

The benefits in this study were derived from the data analysis by the Pollution Control Department under the Ministry of Natural Resources and Environment of Thailand. The savings from decreasing the sulfur level in diesel oil from 350 ppm (Euro 3) to 50 ppm (Euro 4) and from 50 ppm to 15 ppm (Euro 5 equivalent) standard were evaluated from the health care expenses improvement due to fewer less lung disease and respiratory health patients.

On the other hand, the economic cost derived from refinery investment in de-sulfurization units to remove sulfur in the diesel, was equivalent to USD 201 million. The calculation was based on the price differential between low and high sulfur diesel. The model was also applied to estimate the economic costs and benefits to upgrade gasoline from Euro 4 (50 ppm sulfur) to Euro 5 (10 ppm sulfur). In this case, the economic benefit in implementing Euro 5 gasoline was calculated to be USD 202 million and the cost in adopting the Euro 5 gasoline standard was equivalent to USD 54 million. When comparing the costs (USD 201 million for diesel and USD 54 million for gasoline) to the benefits (USD 540 million for diesel and USD 202 million for gasoline), it is, therefore, justifiable for Thailand to advance to Euro 5.

Table 4. Costs and benefits of upgrading transportation fuel quality standards from Euro 4 to Euro 5 in Thailand (case study)

	Costs (USD million)	Benefits (USD million)
Better air quality, lower GHG emission, and health risk reduction (diesel)		**540**
Investments needed for desulfurizing diesel from 50 ppm to 10 ppm (60 mL per day consumption)	**201**	
Better air quality, lower GHG emission, and health risk reduction (gasoline)		**202**
Investments needed for desulfurizing gasoline from 50 ppm to 10 ppm (20 mL per day consumption)	**54**	
Total	**255**	**742**

Sources: APERC analysis (2020)

This systematic economic costs and benefits evaluation technique can also be applied to upgrading the product specifications in other APEC economies that lag behind Euro 5 gasoline and/or diesel specifications. In this study, the costs and environmental economics of upgrading the quality standards in several APEC economies, namely, APEC Southeast Asia economies (majority), Peru, Papua New Guinea, Australia (for gasoline), and Mexico (for gasoline) from Euro 4 to Euro 5 were analyzed. It was estimated that the total APEC investment cost was USD 2.2 billion and the environmental economic benefits were USD 6.7 billion (Table 5). Additional economic benefits can also be realized in the APEC trade, as mentioned in the SWOT analysis, where APEC trade flows can be smoother and consequentially larger when the specifications are harmonized. Improving the quality standards in the economies will subsequently help to support APEC product trade flows in the big picture.

Table 5. Costs and benefits of upgrading transportation fuel quality standards to Euro 5 in APEC

	Costs (USD billion)	Benefits (USD billion)
Better air quality, lower GHG emission, and health risk reduction (diesel)		**2.7**
Investments needed for desulfurizing diesel from ≥50 ppm to 10 ppm	**1.0**	
Better air quality, lower GHG emission, and health risk reduction (gasoline)		**4.0**
Investments needed for desulfurizing gasoline from ≥50 ppm to 10 ppm	**1.2**	
Total	**2.2**	**6.7**

Sources: APERC analysis (2020)

Potential applications of the systematic economic costs and benefits evaluation approach

One possible application of this technique includes the evaluation of costs and benefits of APEC economies that plan to have their oil markets re-structured, to install facilities, or to evaluate the supply security when disruption takes place.

Conclusions

The costs and environmental economics of upgrading the diesel and gasoline quality standards in several APEC economies, namely, APEC Southeast Asia economies, Peru, Papua New Guinea, Australia, and Mexico from Euro 4 to Euro 5 were analyzed using the APERC Financial and Economic Model. The environmental benefit is USD 6.7 billion versus an economic cost of USD 2.2 billion including the Thailand case with a benefit of USD 742 million versus an economic cost of USD 255 million. Following this systematic approach, it is possible to expand the technique to evaluate any economy that plans to upgrade its transportation fuel quality standards. Last but not least, the technique can be applied to evaluate the economic costs and benefits of oil market transition, oil trading, transportation pipelines, and oil supply disruptions.

References

APEC (2021), *Expert Group on Energy Data and Analysis (EGEDA)*, http://www.egeda.ewg.apec.org/egeda/database_info/annual_data.html

APERC (2019), *APERC Oil Report 2019*, https://aperc.ieej.or.jp/file/2019/6/7/APERC_Oil_Report_2019_20190607_rev1.pdf

ASEAN (2020), *ASEAN Statistical Yearbook 2020*, https://www.aseanstats.org/publication/asyb-2020/

Australia (2019), Australian Government, Department of the Environment and Energy, *Fuel quality standards (2019)*, https://www.environment.gov.au/protection/fuel-quality/standards/petrol

European Environment Agency (2015), *Adoption of the EU Euro emissions standards for road vehicles in ASIA*

PTIT (2016), *Harmonization of Fuel Quality Standards in ASEAN*, http://cleanairasia.org/wp-content/uploads/2016/03/6.-RuengsakThitiratsakul_Thailand_FEB23-PRESENTATION1.pdf

RAC (2018), *Euro 1 to Euro 6 video guide – find out your vehicle's emissions standard*, https://www.rac.co.uk/drive/advice/emissions/euro-emissions-standards/

Statista (2021), *Number of motor vehicles registered in the United States from 1990 to 2019 and cars in China from 2010 to 2020 (2021)*, https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/, https://www.statista.com/statistics/285306/number-of-car-owners-in-china/

UN Environment Programme (2017), *Peru adopts Euro 4 / IV vehicle emissions standards for improved air quality*, https://www.unenvironment.org/news-and-stories/press-release/peru-adopts-euro-4-iv-vehicle-emissions-standards-improved-air

The International Council on Clean Transportation (ICCT) (2016), *Case study: Adoption of low-sulfur fuel standards in Peru*, https://theicct.org/sites/default/files/publications/Case_study_lowsulfur_fuel_Peru.pdf

TransportPolicy.net (2018), *Fuels: Diesel and Gasoline: Australia, Canada, Chile, China, Indonesia, Mexico, and Thailand*, https://www.transportpolicy.net/standard/australia-fuels-diesel-and-gasoline/(Australia, Canada, Chile, China, Indonesia, Mexico, and Thailand)

Waka Kotahi (2020), *NZ Transport Agency*,

https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/vehicles/fuel-quality-regulations/