Asia-Pacific
Economic Cooperation

Energy Efficiency Policy Workshop:
Developing Fuel Economy Regulations

Workshop Summary Report

Hong Kong, China
March 2019

APEC Energy Working Group

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APEC Peer Review of Energy Efficiency (PREE) Phase 8

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Introduction

This document is a summary report of the APEC Energy Working Group (EWG) Workshop: Developing Fuel Economy Regulations, held on 18th March 2019, at the Regent Kowloon Hotel, Hong Kong, China. Delivered by APERC and Retyna, it took place as a supplementary event to the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C) 53rd Meeting.

Photo: Some of the participants at the Workshop: Developing Fuel Economy Regulations

The Energy Efficiency Policy Workshops are part of the EWG Peer Review of Energy Efficiency (PREE). They aim to promote "high-performance" energy efficiency policy measures in developing economies in the APEC region by:

- Delivering capacity-building in energy efficiency policy
- Providing examples of effective energy efficiency policy
- Enabling the sharing of information and experiences among APEC economies
- Providing travel support for travel eligible economies

The key objectives of the PREE are to:

- Share information on energy efficiency performance, as well as policies and measures for energy efficiency improvement
- Explore how energy efficiency goals could be effectively formulated in each APEC economy under review, taking into account the diversity of the strategies and circumstances of individual economies

- Monitor progress toward attaining energy efficiency goals and the implementation of action plans. The monitoring process serves to identify recommendations that require more focus
- Improve capability on energy efficiency policy across APEC member economies
- Help economies that are still in the early stages of establishing energy efficiency action plans

PREE achieves these objectives by undertaking a broad review of energy efficiency policies and measures in economies and providing recommendations on how these policies and measures might be improved.

This project aims to provide capacity-building support for the following beneficiaries:

- Attendees of the EEP Workshop (mainly government officials with policy or programme implementation responsibilities, but may include researchers, academics and other experts) and their respective economies benefit from their improved capability to generate effective policy that results in reduced emissions, increased economic competitiveness, and reduced costs
- APEC economies can also benefit from PREE through APERC's results dissemination efforts such as the summary report and Workshop presentations. The widespread understanding of energy efficiency measures recommended in PREE in the APEC region can help to achieve the energy efficiency goals of APEC as a whole
- In the long term, businesses and consumers benefit indirectly from lower energy costs, improved energy efficiency policy and programmes, and reduced carbon and noxious emissions

Participating Economies and Organisations

There were 41 participants in the Workshop from nine APEC economies:

- Chile
- Hong Kong, China
- Indonesia
- Japan
- New Zealand
- Chinese Taipei
- Thailand
- USA
- Viet Nam

Representatives of the following organisations participated in the Workshop:

- APEC Sustainable Energy Center
- Asia Pacific Energy Research Centre (APERC)
- Bureau of Energy, Chinese Taipei
- CLP Power Hong Kong Limited
- China National Institute of Standardization
- Coordinating Ministry for Economic Affairs, Indonesia
- Electrical and Mechanical Services Department, Hong Kong, China
- Energy Efficiency and Sustainable Development, Viet Nam
- Fuel Technology Limited, New Zealand
- Industrial Technology Research Institute, Chinese Taipei
- Ministry of Economy, Trade and Industry, Japan
- Ministry of Energy, Chile
- Ministry of Energy, Thailand
- National Association of Regulatory Utility Commissioners (NARUC), USA
- Retyna Limited, New Zealand
- The Hong Kong and China Gas Company Limited
- The Hong Kong Electric Company Limited
- Transport Department, Hong Kong, China

Workshop Opening Session

The Workshop was opened by Mr Vy Ek Chin, Assistant Director, Electricity and Energy Efficiency at the Electrical and Mechanical Services Department (EMSD), Hong Kong, China. EMSD were the hosts for the Workshop and provided valuable assistance with the organisation and running of the Workshop from a practical viewpoint.

Opening remarks to the Workshop were provided by the Chair of the APEC Expert Group on Energy Efficiency and Conservation, Mr. Pengcheng Li, China.

An introduction to the Energy Efficiency Policy Workshop series, the topic of vehicle fuel economy regulations, and the Workshop agenda was delivered by Mr Hugh Marshall-Tate of the Asia Pacific Energy Research Centre (APERC). The Workshop topic of "Developing Fuel Economy Regulations" covers the following aspects:

- Testing protocols
- GHG emissions
- Vehicle fuel economy policy
- Policy drivers
- Policies in APEC economies
- Advanced Vehicles

The agenda for the Workshop is included as Appendix 1, and Mr Marshall-Tate's presentation is included as Appendix 2.

Photo: Mr Vy Ek Chin opens the Workshop: Developing Fuel Economy Regulations

Session 1: Context for Vehicle Fuel Economy Regulations

Transport CO_2 emissions in APEC 2000-50

Presenter: Alexey Kabalinskiy, APERC

The first presentation in Session 1 provided the transport sector greenhouse gas emissions context for APEC economies. Since 1971 road transport emissions have increased three-fold in line with total CO_2 emissions. In 2016 China and the US were responsible for nearly two-thirds of APEC's transport emissions.

APEC/APERC has modelled three scenarios of transport emissions through to 2025: Business-As-Usual (BAU); APEC target (TGT) driven by APEC goals of reducing energy intensity and increasing renewables; and 2 Degrees Celsius (2DC) based on the International Energy Agency (IEA) *Energy Technology Perspectives.*

Under BAU, transport sector emissions continue to grow and conventional fuels dominate, despite a 12% decline in gasoline consumption.

For the TGT scenario, the transport use of electricity and biofuels are roughly double that under BAU, and gasoline declines by 43% and diesel by 31%. This results in a plateau of fuel demand and CO_2 emissions falling to 2005 levels. This is achieved through improved fuel economy policies, mode switching, improved public transport, use of hybrid technologies and natural gas fuels.

With the 2DC scenario, there is a significant increase in electricity for transport of 81% over BAU, biofuels have a lower increase of 13%, and gasoline declines by 74% and diesel by 58%. Uptake of electric vehicles and hybrids, 80% of APEC residents having access to quality public transport and alternative fuels for freight contribute to limiting transport sector emissions towards a $2^{O}C$ future.

The full presentation is included as Appendix 3.

Overview of the suite of policy measures to improve vehicle fuel economy

Presenter: Elizabeth Yeaman, Retyna Limited, New Zealand

This session summarized the policy options for improving vehicle fuel economy. There is a wide variation in fuel economy even within vehicles of the same class. Vehicle electrification provides a step change in energy efficiency of vehicles, as well as fuel/energy switching.

Having reliable vehicle fuel economy data/CO_2 emissions data for vehicles underpins all policy measures. Vehicle fuel efficiency/CO_2 standards create market push and encourage manufacturers to supply lower CO_2 vehicles in the market. Fiscal incentives create market pull and encourage vehicle buyers to demand more efficient vehicles from the market. Policies such as vehicle fuel economy labelling and other information and market programmes provide support but are insufficient on their own to make a significant difference to fuel economy.

Corporate average standards are the norm internationally, and can be based on CO_2 emissions, fuel consumption or energy consumption. These standards encourage manufacturers to make, sell and promote lower CO_2 vehicles, including electric vehicles. Such standards have typically delivered a 30-50% reduction in CO_2 emissions to date.

One of the strongest policy measures yet is countries signalling that they will ban the sale of Internal Combustion Engine (ICE) vehicles by a certain year. The earliest ban is coming in 2021 in Costa Rica, with China signalling a ban from 2040.

The full presentation is included as Appendix 4.

Question: Is there any distribution problem or effect?

Answer: Yes, there are some distribution issues associated with subsidies policies. For example, some wealthy people who can afford expensive electric cars can be seen as being subsidised by less-well off people who need bigger vehicles but cannot not afford expensive technologies. In the long term, if you want to pull the subsidies out, the market can crash, people might lose confidence in the technologies and stop buying those vehicles. So it is very important to signal when the subsidies will end and plan a gradual phase out. Also, for people who are less well off, there are some other mechanisms government can use to support them.

Question: Are there any examples of designing a feebate scheme? We have difficulty setting up the benchmark for surcharges.

Answer: Very good modelling is important, and you need to analyse the pros and cons. The reality is you have to try and see and be prepared to adjust it.

Session 2: Vehicle fuel economy policies in APEC economies

Chile's path to develop fuel economy standards

Presenter: Luz Ubilla Bórquez, Ministry of Energy, Chile

Chile is introducing energy efficiency standards for light vehicles with the aim of achieving a 20% reduction is CO_2 emissions by 2025. The fuel efficiency of light vehicles in Chile is significantly worse than countries with fuel efficiency standards in place.

The metric for the standard will be energy efficiency in kilometers per liters of gasoline equivalent and its equivalence in grams of CO_2 per kilometer. The standards are being developed jointly by the Ministries of Energy and Transport.

In setting the standard two years of fuel efficiency data were examined for all vehicles in Chile. Vehicle model data was also checked to ensure that there were models available that could meet the standard without additional costs in all light vehicle market segments.

Chile already has vehicle fuel efficiency labelling in the light and medium duty vehicle sectors. It is now investigating labelling of buses, and has established a technical protocol to obtain energy consumption data from urban public transport buses in the city of Santiago.

The full presentation is given in Appendix 5.

Question: Santiago recently introduced 200 electric buses. Is this a central government initiative, or one from the City of Santiago?

Answer: The decision was made by the bus companies and the central government supported this initiative.

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Test protocols underpinning fuel economy regulations: the transition to Worldwide Harmonised Light Vehicle Test Procedure (WLTP) and its inclusion in CO_2 policies

Presenter: Andrew Campbell, Fuel Technology Ltd, New Zealand

Vehicle fuel emissions and fuel consumption testing protocols have over time resulted in a divergence of the test results from "real world" results, which has undermined policy efforts to improve vehicle fuel efficiency and reduce CO_2 emissions.

Development of the Worldwide Harmonised Light Vehicle Test Procedure (WLTP) is an initiative of the UN ECE GRPE (Working Party on Pollution and Energy) with inputs from wide-ranging economies. It is a better approximation of real world driving conditions, has stricter test conditions, considers vehicle "special equipment" and different power trains, including electric vehicles.

WLTP is being introduced in the EU from 2018. In APEC economies, Japan has introduced a modified version from late 2018, in the Republic of Korea from 2021, and in China for emissions from 2021. The change to WLTP has implications for vehicle fuel economy standards policies and fiscal measures. Fuel consumption labelling is yet to catch up with the changes to WLTP.

The full presentation is given in Appendix 6.

Question: How does the new protocol address the issue of GHG intensity of the electricity used by electric vehicles?
Answer: It doesn't. It only reports the kilowatt-hours that are consumed.

Question: Vehicles' performances are different under different climate conditions. Does it mean the test data needs adjustment?
Answer: The testing entity needs to provide good and detailed information on how to interpret the information, including the testing conditions of the test results.

Question: Are there standards for the testing input fuels?
Answer: Yes, there are specific standards for test fuels.

Panel discussion with Sessions 1 and 2 speakers

Moderator: Elizabeth Yeaman, Retyna Ltd, New Zealand

Question for Alexey Kabalinskiy:
We are expecting more autonomous vehicles in the future. There are also some potential disruptions coming up that may change how often vehicles are driven and numbers of vehicles on the road. How is your transport model looking at the potential disruptions?
Answer:
Japan has announced the launch of self-driving services in 2020 during the Olympics. In terms of the modelling, we have identified six types of vehicles, including man-driven and unmanned. We found out there is a great deal of uncertainty about how this is going to play out in the long term. Unmanned vehicles can be used in a lot of different ways, and many studies have shown that there will be a great deal of uncertainty around that. Therefore, our model adopts a more conservative approach for the unmanned vehicles.

Question for Luz Ubilla:
Earlier you mentioned Santiago city purchased 200 electric buses. What is the role of the electricity companies in this?
Answer:
Two electric companies own the electric buses and have built the charging stations. They lease the buses to the operators of the public transport routes..

Question for Andrew Campbell:
How do plug-in hybrid electric vehicles perform through the WLPT as plug-in hybrid electric vehicles have many user-driven variables, including situations in which they are hardly ever charged? For short distances, they can just use the electricity available, while for longer distances the proportion of electricity used for the journey is much less.

Answer:
A plug-in hybrid vehicle has the opportunity to get electricity from an external source. In this case, one of the WLTP tests provides its all- electric range. This is done by taking a driving cycle and identifying its pure electric range starting with a fully charged battery. This means that people know what the likely range is before they switch to gasoline.

Photo: Panel discussion at the Workshop

Session 3: Facilitating low emission vehicles in APEC economies

Wide scale promotion of low emission vehicles for HK – challenges and opportunities

Presenter: Ir. Raymond CHOI, Hong Kong Power Company, Hong Kong, China

As at the end of 2018, 2% of private cars (over 10,000 EVs), 1% of government vehicles and 0.5% of franchised buses in Hong Kong, China are electrified. From 2009 the economy has provided free electric vehicle charging and today there are over 2,000 EV public chargers, with around 500 of these being fast chargers. HK Electric's own vehicle fleet is 40% electric.

Some aspects of Hong Kong, China are ideally suited for EVs due to its reliable electricity system and typical daily travel distances for cars and buses are easily achievable with today's EV technology. The city has created a blueprint for a low-carbon smart city.

However, there are also challenges, particularly the predominance of parking in high-rise buildings and multi-storey carparks where the building owners and other tenants must give permission for charger installation.

Hong Kong, China has put in place a number of incentives to continue to encourage the uptake of EVs including: tax concessions, a HK$300 million Pilot Green Transport Fund, funding for EV bus purchase, and design concessions for new developments with EV charging. The economy is also considering ceasing first registration of private diesel cars.

The decarbonisation of the electricity system in the economy is continuing with greater use of natural gas and other low carbon generation. Future technologies including autonomous driving, shared vehicles and V2G will continue to help facilitate vehicle electrification in Hong Kong, China.

The full presentation is provided in Appendix 7.

Developing Strategies for EVs: Case Study from the Philippines

Presenter: Andrew Campbell, Fuel Technology Limited, New Zealand

Disruption is coming fast in the transport sector due to cheap communications and data, advances in battery technology reducing battery cost, shared vehicle ownership and autonomous vehicles. Change is also coming in the electricity sector enabling management of the electricity supply network in new ways and with new participants. The speed at which electric vehicles can be charged is also increasing.

Different economies rely on different types of transport vehicles. While light duty passenger cars dominate in economies like Norway and New Zealand, in many Asian economies it is bikes, motor scooters and tuk-tuks/trikes that provide the majority of trips, along with public transport.

The Department of Energy in the Philippines is responsible for a project that aims to deploy 3,000 e-trikes by May 2019. The e-trikes are manufactured in the Philippines using automotive-grade lithium

ion batteries. They are targeting first- and last-mile public transport journeys and will also help remove polluting 2-stroke trikes from the streets.

In developing any electric vehicle project, it is important to consider every stage of the electric vehicle life, from design and certification, through supply, re-sale and in-service requirements such as charging, servicing, repair and emergency response in case of accident, and eventual retirement and recycling.

Over the last 4 years, the APEC Automotive Dialogue, Energy Working Group and Transportation Working Groups have developed and workshopped the APEC EV Roadmap. It has identified further areas for work including: recycling protocols, cybersecurity, emergency response protocols, interoperability, and standards for 2- and 3- wheel EVs like the Philippines e-trikes.

Economies looking to facilitate electric vehicles need to consider: supporting the research and development of batteries and EVs, ensuring there is an interoperable EV charging network, collaboration to support impacts to the grid, and ensuring regulatory predictability and transparency.

The full presentation is given in Appendix 8.

Growth of electric vehicles in New Zealand

Presenter: Elizabeth Yeaman, Retyna Limited, New Zealand

Currently around 85% of electricity generation in New Zealand is from renewable sources. This means that EVs can deliver an 80% reduction in CO_2 emissions in comparison with gasoline vehicles.

The NZ Government's EV programme does not include direct purchase price subsidies, but does have some fiscal support. There is a contestable fund which provides financial support to first mover projects, in particular transport sectors, and to support an interoperable nationwide charging infrastructure. This has seen projects like EV car share, e-taxis, e-buses, EV couriers, e-trucks and ultra-fast charging of buses deployed. There is now 95% state highway coverage with 50kW DC fast chargers every 75km.

New Zealand's light vehicle fleet is heavily reliant on used import vehicles from Japan, and this is also the case for EVs. The majority of EVs in the economy are used imports at a capital cost comparable to used gasoline vehicles imports, and their numbers have doubled every year such that EVs are now around 2% of new entrants to the light duty vehicle fleet.

New Zealand has a very open, competitive and permissive electricity market. This has seen some companies offering electricity tariff rates for EV owners, and others offering rates to retail customers which change every half-hour with the wholesale market. As a result, the majority of EV owners are willing to charge overnight, when it is cheapest, grid productivity is improved and CO_2 emissions are lowest. Electricity retail pricing innovation is an enabling platform for future aggregated, managed EV charging.

The full presentation is given in Appendix 9.

Question: You mentioned the retail suppliers can provide different rate plans in New Zealand?

Answer: Yes, and it is not just in peak hours. For example, some companies set up and offer one hour of free power a day off-peak (they call it the Hour of Power), and consumers nominate in advance when it will be. This allows people to use more power in the off-peak time rather than peak time. Some other companies offer variable pricing on a half-hourly basis to household consumers.

Session 4: Workshop – Facilitating EVs and other very low carbon vehicles

Session 4 was an interactive breakout session to generate ideas and priorities for how fuel efficient vehicles and EVs can be facilitated within APEC economies.

The participants were divided into four groups (based on first letter of given name) and asked to discuss the following topics in turn:

- **Status:** What is the status of vehicle fuel economy policies and policies facilitating low carbon vehicles in your economy?
- **Barriers:** What are the barriers to introducing or updating policies in your economy?
- **Priorities:** Identify the top three activities that could be undertaken to progress policies in your economy
- **APEC facilitation:** Identify any activities that APEC could have a role in advancing

Each group then reported back to the Workshop participants as a whole on their key ideas.

Photo: One of the breakout session groups discussing ideas

Group 1 report back

- **How APEC can help us?**
  We suggest APEC can propose standards for electric vehicle charging stations, infrastructure, battery and testing methods. Currently each economy has different testing methods, and having standards could facilitate mutual recognition.
- **What can be done in our economy to boost fuel efficient vehicles?**
  Standardization, incentives and subsidies, as well as infrastructure support. For example, when we replaced the diesel taxis with LPG taxis in Hong Kong, China, we subsidized the oil company so they built LPG fuelling stations.

  Electric vehicle reliability and quality are also very important. If the vehicles are not reliable and the quality is not good, this will affect the users' impression of electric vehicles. For example, on a small island Peng Hu in Chinese Taipei, the government had a pilot EV project. The project chose certain families to have free use of electric motorcycles for two years. After two years, all these users chose not to use the electric motorcycles because there were no repair stations to fix the motorcycles when they had problems.

Group 2 report back

- **What can APEC do?**
  For EV users, one of the most common issues we have experienced is that we do not have have capability to service the batteries. This could mean expensive battery replacements. We suggest APEC establish standards for EVs, including EV safety requirements, EV battery replacements and essential EV parts. This would significantly help APEC economies to use more EVs.
- **Issues in the economies**
  In Chile, charging stations for EV are not free of charge, while, in Hong Kong, China currently charging stations are free as part of promoting the use of EVs. However, Hong Kong, China needs to consider if they will still continue to provide free power for EVs in the long term. Also, most of the buildings in the economy are high-rise buildings, with parking lots in the basement. It would be difficult to build EV charging stations inside these high-rise buildings, and this is one of issues the economy is facing when promoting the greater use of EVs.

Group 3 report back

- **Issues in economy**
  In Viet Nam, the main transport vehicle is the motorcycle, which will be banned by 2030. In order to achieve this target, the Viet Nam government released a Guideline last year, requesting that the private sector provides fuel consumption data of the vehicles they owned because most vehicles are now in private sector ownership. This data will help the government have a better understanding of current fuel consumption as they prepare to achieve the target in 2030.

  Thailand has released a number of policies to promote the use of EVs. For example, the government has proposed reducing the vehicle tax for EVs from 8% to 4%, and further to 3%. Also in 2016, a labelling scheme that targets cars and light trucks was introduced. The electricity companies in Thailand charge very high demand charges that make it difficult to commercialise EV buses outside of sponsored demonstrations.

Hong Kong, China also injected a huge amount of funding for EV promotion, including pilot projects on electric buses, hybrid minibuses and electric minibuses. The most critical problem that the economy has now is the scarcity of land. If we want to build an electric transport system, we need to build a certain number of depot charging stations for the electric buses and electric minibuses. However, the current priority for the economy's government is building homes for people rather than building depots for EVs. This makes using hybrid buses and hybrid minibuses a more feasible solution in the mid-term.

Group 4 report back

- **Policies in Hong Kong, China to promote EVs**
  There are several policies and schemes that are already been implemented in Hong Kong, China including a voluntary labelling scheme for vehicles, which is a great help for consumers to understand the fuel consumption when purchasing vehicles.

  Another is the development of LPG taxis. The government does not impose any tax for LPG, so that taxi drivers and passengers can both benefit from a low cost fuel.

  Hong Kong, China also has tax incentives for EV purchase meant to encourage more people to buy EVs.

- **Challenges in Hong Kong, China**
  There are not enough charging facilities for EVs in Hong Kong, China. What APEC can do is to line up some investors to facilitate the EV charging infrastructures in the economy. For example, the investors can build an EV charging building, so the cars can go in and they can charge and have their vehicle maintained at the same time.

Summary

Some common themes emerged from these sessions and included:

- Difficulty of providing charging infrastructure for EVs in dense cities with high-rise buildings
- Getting permission to install EV charging in apartment buildings due to difficulty in allocating costs for the electricity
- Need to create a sustainable business-model for EV charging
- Many Asian countries generate electricity from coal-powered charging stations which reduces the CO_2 benefits of EVs
- Lack of capability for servicing EVs and EV batteries
- APEC's role is seen as one leading standardization.

APPENDIX 1: Workshop Agenda

Energy Efficiency Policy Workshop
Developing Fuel Economy Regulations

Bringing together policymakers and experts to understand and share national experiences on developing vehicle fuel economy regulations to reduce emissions from the transport sector and mitigate the escalating threat of climate change.

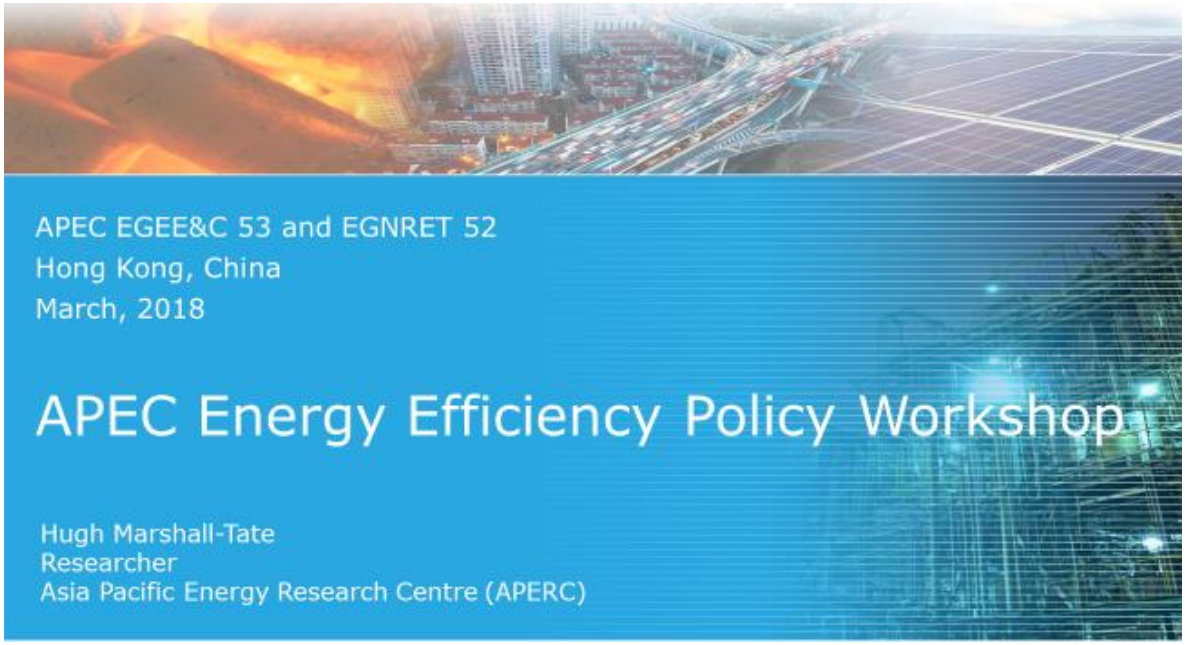
18 March 2019

Regal Kowloon Hotel, Hong Kong, China

8:30 - 9:00	**Registration**	
Welcome and introduction to the Workshop		
9:00 - 9:05	Brief introduction to the Workshop	Hugh Marshall-Tate, APERC
9:05 - 9:10	Welcoming remarks by the host economy	Vy Ek Chin, EMSD, Hong Kong, China
9:10 - 9:15	Opening remarks by the EGEEC Chair	Mr. Pengcheng Li, China
9:15 – 9:25	Introduction to the Energy Efficiency Policy Workshop series, the topic of vehicle fuel economy regulations, and Workshop agenda	Hugh Marshall-Tate, APERC
Session 1: Context for vehicle fuel economy regulations		
9:25 - 9:45	Transport contribution to GHG emissions in APEC economies	Alexey Kabalinskiy, APERC
9:45 - 10:30	Overview of the suite of policy measures to improve vehicle fuel economy	Elizabeth Yeaman, Retyna Ltd, New Zealand
10:30 – 11:00	**Tea and Coffee Break**	
Session 2: Vehicle fuel economy policies in APEC economies		
11:00 - 11:30	Chile's proposed fuel economy standards: the process of developing new legislation and features of the standard	Luz Ubilla, Ministerio de Energía, Chile

11:30 – 12:10	Test protocols underpinning fuel economy regulations: the transition to Worldwide Harmonised Light Vehicle Test Procedure (WLTP) and its inclusion in CO_2 policies	Andrew Campbell, Fuel Technology Ltd, New Zealand/Philippines
12:10 - 12:30	Panel discussion with Session 1 and 2 speakers	Moderated by Retyna
12:30 - 13:30	**Lunch**	
Session 3: Facilitating low emission vehicles in APEC economies		
13:30 – 13:50	Wide scale promotion of low emission vehicles for HK – challenges and opportunities	Ir. Raymond CHOI, Hong Kong Power Company
13:50 – 14:20	Facilitating locally designed and manufactured electric vehicles in the Philippines	Andrew Campbell, Fuel Technology Ltd
14:20 – 14:45	Growth of electric vehicles in New Zealand	Elizabeth Yeaman, Retyna, New Zealand
14:45 – 15:15	**Tea and Coffee Break**	
Session 4: Workshop – Facilitating EVs and other very low carbon vehicles		
15:15 - 16:00	Participants will break into smaller groups to discuss: • **Status:** What is the status of vehicle fuel economy policies and policies facilitating low carbon vehicles in your economy? • **Barriers:** What are the barriers to introducing or updating policies in your economy? • **Priorities:** Identify the top three activities that could be undertaken to progress policies in your economy • **APEC facilitation:** Identify any activities that APEC could have a role in advancing	All Participants, facilitated by Retyna
16:00 - 16:20	**Report Back** Presentations by breakout session leaders and group discussion	Facilitated by Fuel Technology
16:20 – 16:30	Summary of the Workshop, potential next steps and lessons learned	Elizabeth Yeaman, Retyna

APPENDIX 2: Introduction to the Workshop Series



Workshop Background

- Since 2009 with current format started in 2014
- Previous topics have included
  - Government and donor funding mechanisms
  - Policy and program evaluation
  - Conformity Assessment

2019 Workshop Topic

Transport fuel economy standards

- Testing protocols
- GHG emissions
- Vehicle fuel economy policy
- Policy drivers
- Policies in APEC economies
- Advanced Vehicles

The Workshop Organiser

retyna

A lens on renewable energy for transport

ELIZABETH YEAMAN

Managing Director, Retyna Ltd

APERC 1

Todays Agenda

Session 1:	**Context for vehicle fuel economy regulations**	
9:25 - 9:45	Transport contribution to GHG emissions in APEC	Alexey Kabalinskiy, APERC
9:45 - 10:30	Overview of the suite of policy measures to improve vehicle fuel economy	Elizabeth Yeaman, Retyna Ltd
10:30 11:00	**Tea and Coffee Break**	
Session 2:	**Vehicle fuel economy policies in APEC economies**	
11:00 - 11:30	Chile's proposed fuel economy standards: the process of developing new legislation and features of the standard	Luz Ubilla, Ministerio de Energía, Chile
11:30 –12:10	Test protocols underpinning fuel economy regulations: the transition to Worldwide Harmonised Light Vehicle Test Procedure (WLTP) and its inclusion in CO2 policies	Andrew Campbell, Fuel Technology Ltd
12:10 - 12:30	Panel discussion with Session 1 and 2 speakers	Moderated by Retyna
12:30 – 1:30	**Lunch**	

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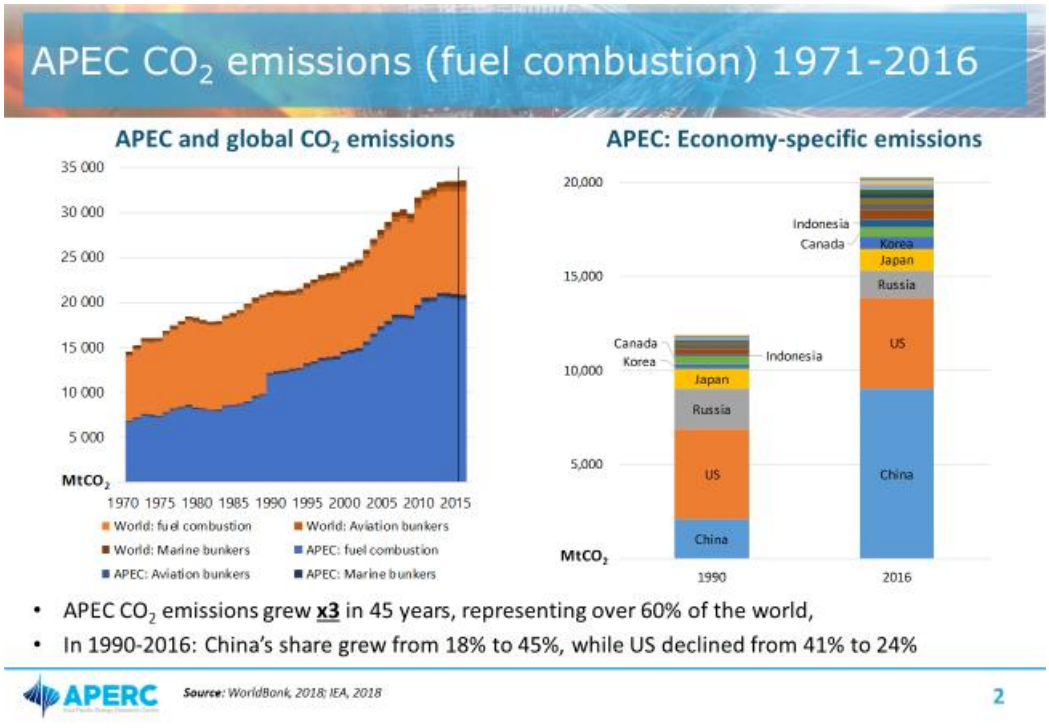
Todays Agenda

Session 3:	Facilitating low emission vehicles in APEC economies	
13:30 – 13:50	Wide scale promotion of low emission vehicles for HK – challenges and opportunities	Ir. Raymond CHOI, Hong Kong Power Company
13:50 – 14:20	Facilitating locally designed and manufactured electric vehicles in the Philippines	Andrew Campbell, Fuel Technology Ltd
14:20 – 14:45	Growth of electric vehicles in New Zealand	Elizabeth Yeaman, Retyna, New Zealand
14:45 – 15:15	Tea and Coffee Break	
Session 4:	**Facilitating EVs and other very low carbon vehicles**	
15:15 - 16:00	Breakout session	All Participants, facilitated by Retyna
16:00 - 16:20	Report Back	Facilitated by Andrew Campbell, Fuel Technology Ltd
16:20 – 16:30	Summary of the workshop, potential next steps and lessons learned	Elizabeth Yeaman, Retyna

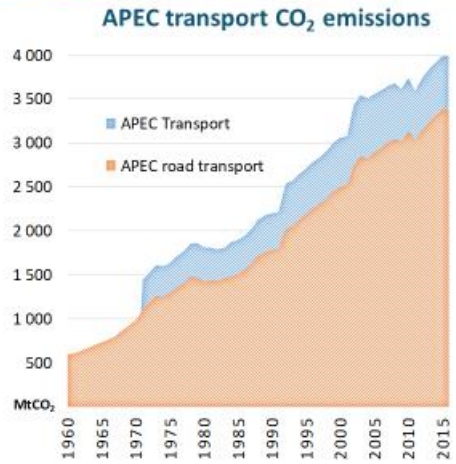
APERC 7

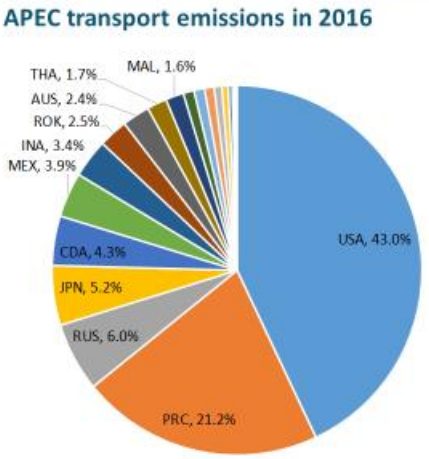
APERC Asia Pacific Energy Research Centre

APPENDIX 3: Transport CO_2 emissions in APEC 2000-50



APEC transport CO_2 emissions 1960-2016

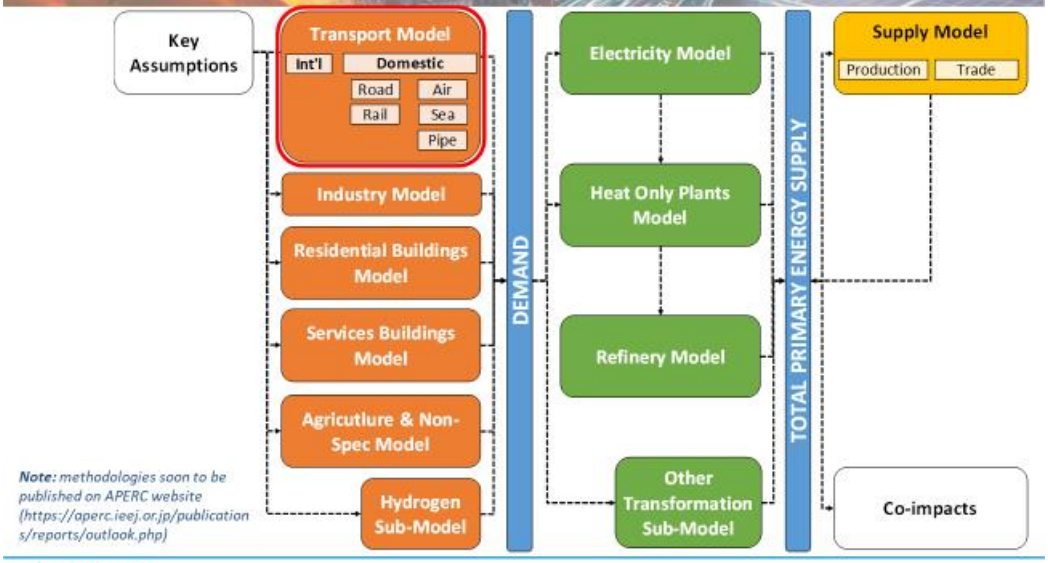




- Since 1971 road emissions grew **x3** in line with total emissions, road share grew from 78% to 85%,
- In 2016 China and the US were responsible for nearly 2/3 of APEC's transport emissions

APERC *Source: IEA, 2018; WorldBank, 2018* 3

APERC uses a suite of nine models for Outlook 7th Edition



Note: *methodologies soon to be published on APERC website (https://aperc.ieej.or.jp/publications/reports/outlook.php)*

APERC 4

Outlook 7th Edition: transport model

- Transport model projects APEC's transportation sector (following IEA's World Energy Balances) fuels demand,
- The model utilizes Excel and GAMS software packages,
- Passenger and freight activity are the key drivers
- International bunker fuels are modelled as f(GDP),
- Domestic non-road transport is split in passenger and freight and modelled top-down,
- Domestic road is modelled bottom-up with five vehicle types and ten powertrain technologies

Sub-sector	Passenger	Freight	Approach
International	-	-	Top-down
Aviation bunkers	-	-	Top-down
Marine bunkers	-	-	Top-down
Domestic	Y	Y	Mixed
Road	Y	Y	Bottom-up
2W	Y	Y	Bottom-up
LV	Y	-	Bottom-up
LT	-	Y	Bottom-up
BUS	Y	-	Bottom-up
HT	-	Y	Bottom-up
Rail	Y	Y	Top-down
Air	Y	Y	Top-down
Sea	Y	Y	Top-down
Pipe	-	Y	Top-down

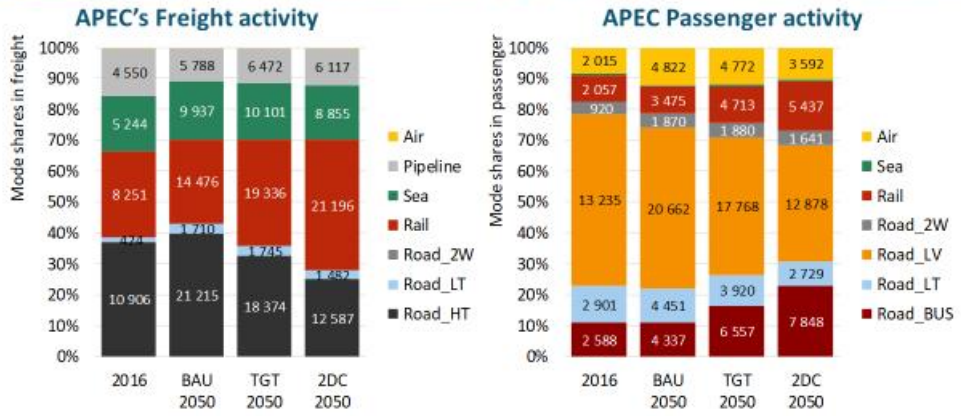
APERC **Notes**: *vehicle types include 2W (2-wheelers)*, LV (Light vehicles), LT (Light trucks), BUS (Buses), HT (Heavy trucks); road vehicle technologies include ICEG, ICED, HYBG, HYBD, LPGD, CNGD, FLEX, PHEV, BEVD and FCEV 5

Outlook 7th Edition includes three scenarios

- **Business-as-usual (BAU) scenario:**
  The BAU scenario reflects current policies and trends within the APEC energy sector. In turn, it largely projects past trends into the future.
  - Road vehicle fuel efficiency assumptions reflect current policy,
  - Otherwise 'passive' improvement of new vehicles at 0.5-2.0%/yr until 2030
- **APEC Target (TGT) scenario:**
  The TGT scenario is driven by APEC's goals of reducing energy intensity while increasing the share of renewables.
  - Progressively improving Passenger and Freight transportation activity,
  - Accelerated fuel efficiency improvement: current policy and 0.5-1.0%/yr improvement in 2030-40, and
  - Increased share of biofuels
- **2 Degree Celsius (2DC) scenario:**
  2DC follows the carbon emissions reductions included in the Energy Technology Perspectives by IEA.
  - Decoupling the transportation activity and economic growth,
  - Reduced vehicle ownership and vehicle mileage compared to TGT,
  - Fuel efficiency and energy intensity consistent with TGT,
  - Support for advanced fuels and vehicles, mode/technology shifting.

APERC 6

Freight and passenger is dominated by road

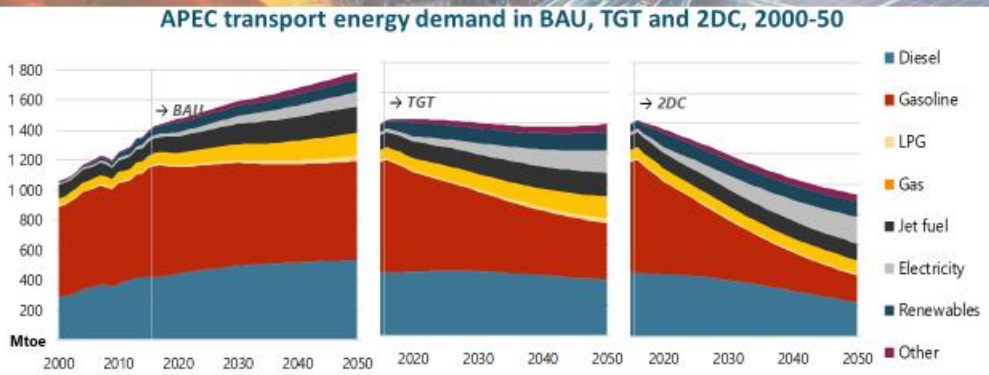


Source: APERC analysis;
Note: units are billion tonne-kilometres (Gtkm) for freight, and billion passenger-kilometres (Gpkm).

- Road freight expands under BAU, share of Rail grows in TGT and 2DC
- Road passenger is over 70% of , public transport grows in TGT and 2DC

APERC 7

Gasoline and diesel are key in BAU, electricity grows fastest in all scenarios

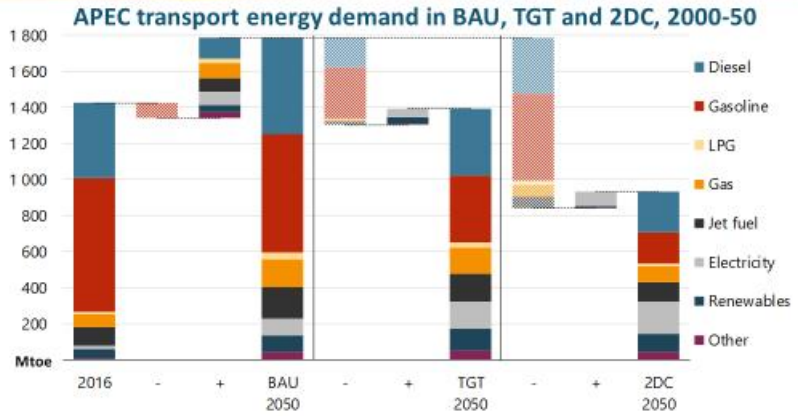


- Conventional fuels dominate under BAU,
- Gasoline for passenger transport declines in TGT and 2DC,
- Diesel remains strong in all scenarios for Road freight;
- Demand grows 25% in BAU, remains flat (-2.1%) in TGT and drops 35% in 2DC

Source: IEA, 2018; APERC analysis

APERC 8

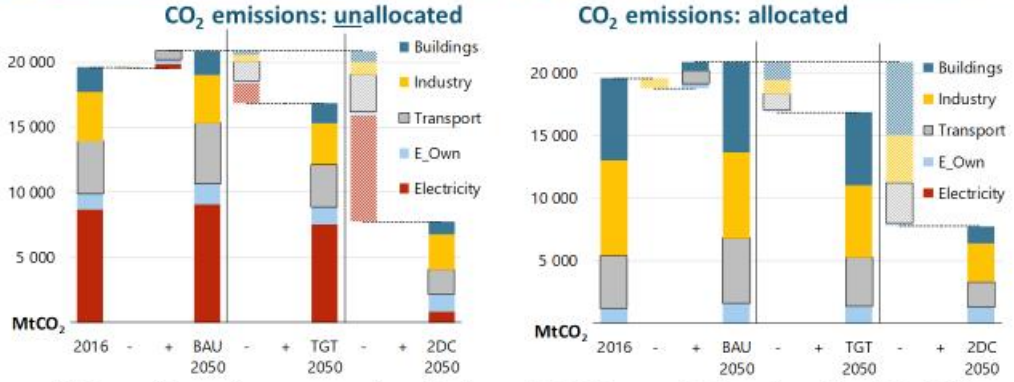
Gasoline and Diesel are key in BAU, Electricity and biofuels grow in all scenarios



- BAU: in gasoline (-12%),
- TGT compared to BAU: electricity (+52%) and biofuels (+42%); gasoline (-43%) and diesel (-31%),
- 2DC compared to BAU: growth only in electricity (+82%) and biofuels (+13%); declines in other fuels, especially gasoline (-74%) and diesel (-58%)

APERC *Source: IEA, 2018, APERC analysis* 9

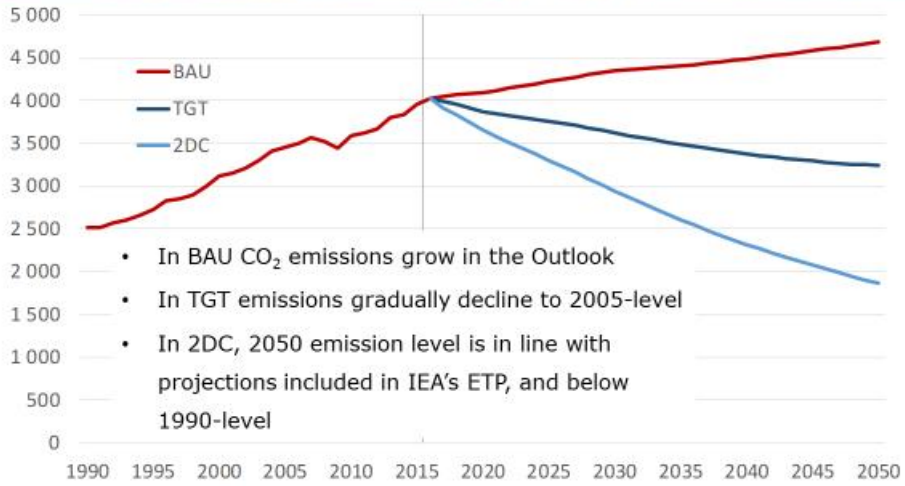
Although important, domestic transport is not the main source of direct and indirect CO2 emissions



- If CO_2 unallocated: transport share is about 19-22%, second after electricity (43-45%); except in 2DC: electricity drops to 11%, and transport (24%) is second to industry (35%),
- If CO_2 allocated: transport share is about 21-25% in all scenarios; significant share of buildings (33-35%), except 18% in 2DC; industry is the hardest to decarbonise with 33-39% share

APERC *Source: IEA 2018, APERC analysis* 10

In BAU, economic growth drives the demand, in TGT and 2DC: historical trend is reversed



- In BAU CO_2 emissions grow in the Outlook
- In TGT emissions gradually decline to 2005-level
- In 2DC, 2050 emission level is in line with projections included in IEA's ETP, and below 1990-level

Source: IEA 2018, APERC analysis

APERC 11

Conclusions

- **Strong demand for freight and passenger transport until 2050,**
- **Under BAU: increasing fuel demand and CO_2 emissions,**
- **In TGT: fuel demand plateaus, but emissions decline:**
  - **Through mode switching,**
  - **Longer-term and wider adoption of fuel efficiency policy,**
  - **Efficient public transport,**
  - **Hybrids as transition technology and natural gas as transition fuel,**
- **In 2DC: opportunities for deep decarbonization:**
  - **Alternative fuels and techs: hybrids, EVs and biofuels (although limited),**
  - **Fast and comfortable public transport for cities (80% of APEC residents),**
  - **Maximise alternative fuels and modes for freight**

APERC 12

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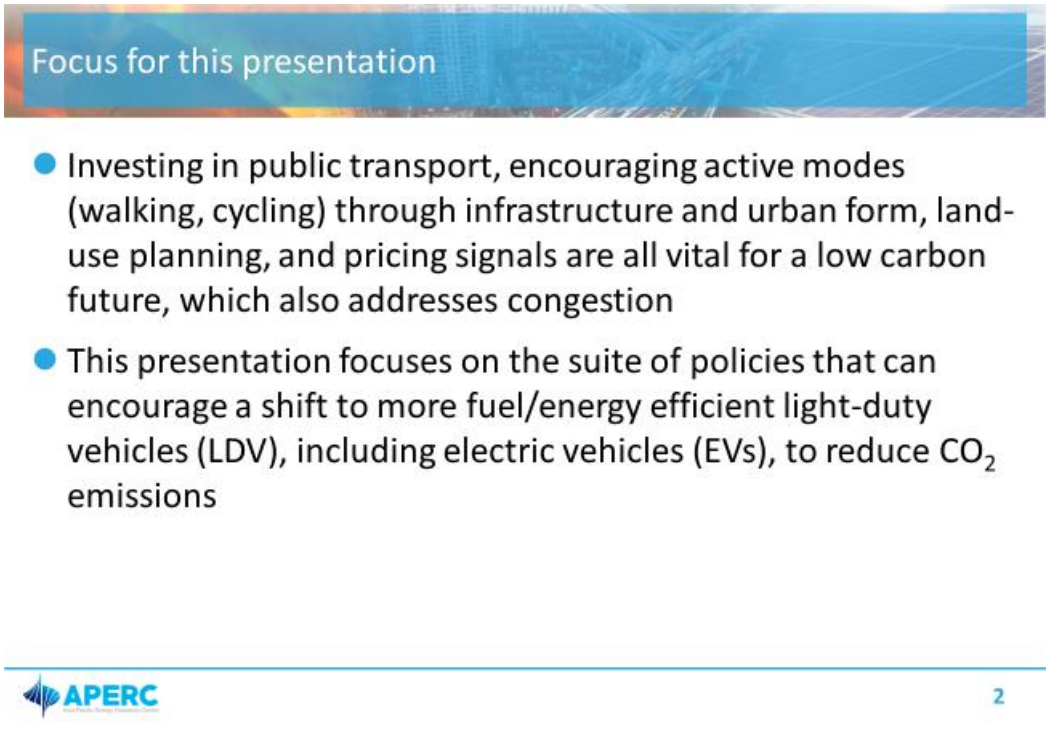
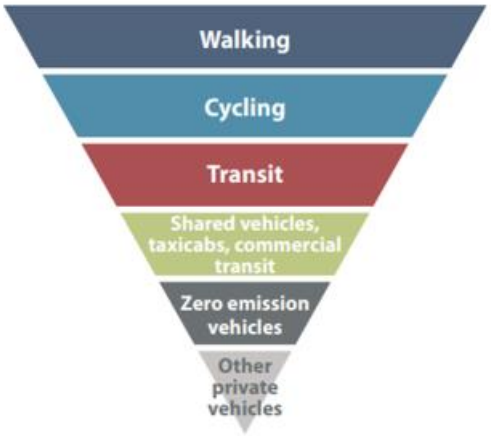
APPENDIX 4: Overview of the suite of policy measures to improve vehicle fuel economy



Transport hierarchy of people movement



- The purpose of transport is to help people access goods and services, work and education, family and friends
- Policies which encourage fuel efficient and low/zero emission vehicles should complement other transport policy measures reducing overall CO_2

Source: Portland EV Strategy 2017, https://www.portlandoregon.gov/bps/article/619275

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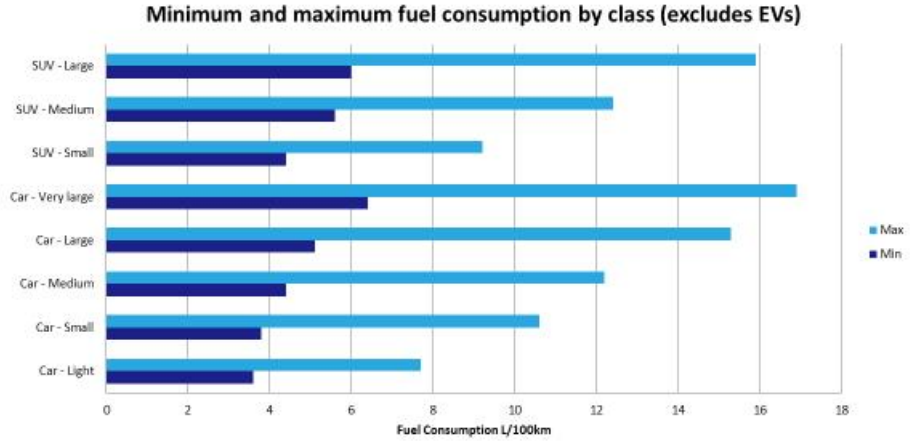
Big difference in fuel consumption within vehicle class



Data source: Yeaman, Car fuel efficiency labelling review, APEC TPT-39, Christchurch, 2014

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Justification for intervention in the market

- **Unpriced externalities:** GHG emissions, air quality emissions
- **Imperfect information:** vehicle buyers tend to underestimate or don't know fuel costs over the time they own the vehicle
- **Split incentives:** vehicle sellers tend to make bigger profits on larger, less fuel efficient vehicles, but do not pay ongoing fuel costs - the same model of vehicle gets larger over the years with each redesign, as bigger vehicles equal bigger profits

APERC 5

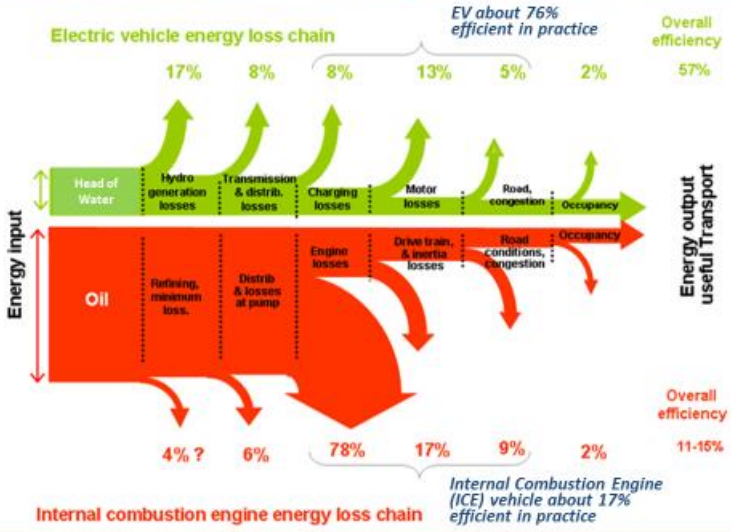
Technology changes have improved fuel efficiency

- Driven by policy, technology changes have resulted in significant fuel consumption improvements for internal combustion engine (ICE) vehicles

9.0 L/100 km	8.1 L/100 km	6.5 L/100 km
11 km/L	12.3 km/L	15.3 km/L
26 mpg	29 mpg	36 mpg

APERC 6

EVs are a step change in energy efficiency



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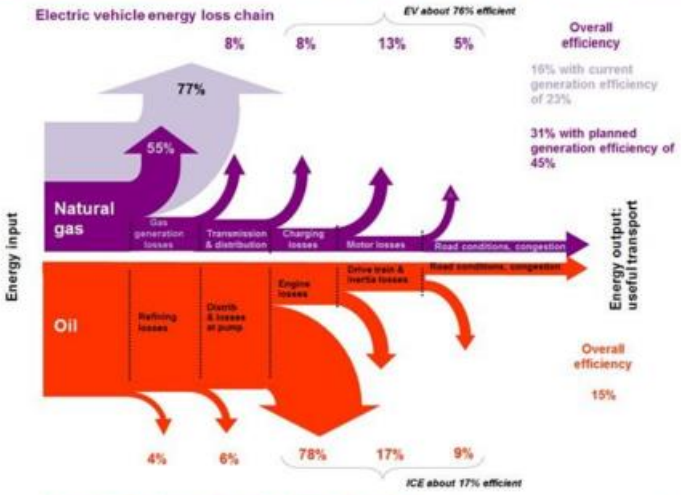
CO_2 benefits of EVs with fossil fuel electricity generation



https://aperc.ieej.or.jp/file/2014/2/5/PREE_201311_Brunei_Darussalam.pdf

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8

Suite of vehicle fuel efficiency / CO_2 policies

VEHICLE FUEL EFFICIENCY STANDARDS	• Introduce and regularly strengthen mandatory standards • Establish and harmonize testing procedures for fuel efficiency measurement.
FISCAL MEASURES	• Fuel taxes and vehicle taxes to encourage the purchase of more fuel-efficient vehicles. • Infrastructure support and incentive schemes for very fuel-efficient vehicles.
MARKET-BASED APPROACHES	• Voluntary programs such as U.S. SmartWay and other green freight programs
INFORMATION MEASURES	• Vehicle fuel economy labels • Improving vehicle operational efficiency through eco-driving and other measures.

VEHICLE FUEL / ENERGY EFFICIENCY AND CO_2 EMISSIONS DATA

Adapted from International Council on Clean Transportation (ICCT), 2018

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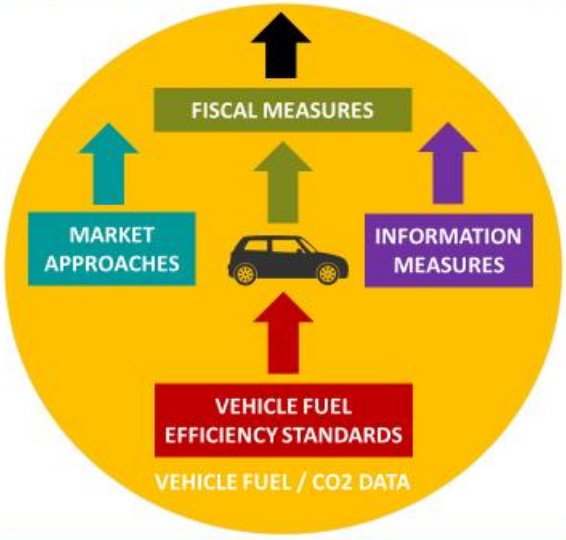
9

There are strong synergies between the measures



- Fiscal incentives create market pull - **demand** from buyers for efficient vehicles
- Support from information and market measures
- Vehicle fuel efficiency/CO_2 standards create market push - encourage manufacturers to **supply** lower CO_2 vehicles
- Data underpins everything

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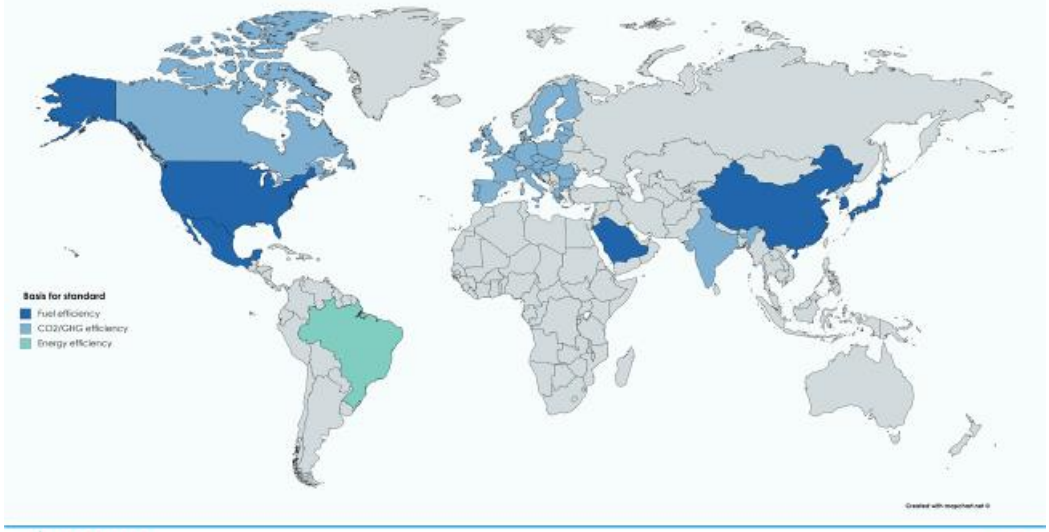
Where vehicle fuel efficiency/CO_2 standards operate



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11

Corporate average standards are the norm

Region	Target Year	Regulated metric	Unadjusted Fleet Target/Measure	Form of target curve	Test Cycle
Brazil	2017	Energy consumption	1.82 MJ/km	Weight-based corporate average	U.S. combined
Canada	2016 2025	GHG	217 gCO_2/mi[1] N/A[2]	Footprint-based corporate average	U.S. combined
China	2015 2020	Fuel consumption	6.9 L/100km 5 L/100km	Weight-class based corporate average	NEDC
EU	2015 2021	CO_2	130 gCO_2/km 95 gCO_2/km	Weight-based corporate average	NEDC[4]
India	2017 2022	CO_2	130 g/km 113 g/km	Weight-based corporate average	NEDC for low-powered vehicle
Japan	2015 2020	Fuel economy	16.8 km/L 20.3 km/L	Weight-class based corporate average	JC08[4]
Mexico	2016	Fuel economy/ GHG	39.3 mpg or 140 g/km	Footprint-based corporate average	U.S. combined
Saudi Arabia	2020	Fuel economy	17 km/L	Footprint-based corporate average	U.S. combined
South Korea	2015 2020	Fuel economy/ GHG	17 km/L or 140 gCO_2/km 24 km/L or 97 gCO_2/km	Weight-based corporate average	U.S. combined
U.S.	2016 2025	Fuel economy/ GHG	36.2 mpg[3] and 225 gCO_2/mi 55.2 mpg[3] and 147 gCO_2/mi	Footprint-based corporate average	U.S. combined

Data source: : https://www.theicct.org/publications/2017-global-update-LDV-GHG-FE-standards

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How corporate average standards work

- The average fuel/energy consumption or CO_2 emissions of all light duty passenger vehicles manufactured, sold or imported by one particular auto company must be within a certain level over a set period of time, or they face penalties
- This incentivises auto manufacturers/importers to develop, offer, promote and favourably price more efficient and lower CO_2 vehicles (including EVs)
- Different to a Minimum Energy Performance Standard (MEPS) as no individual vehicles are restricted
- Happens "behind the scenes" regarding consumers

APERC 13

Weight based vs footprint based targets

Basis for target	
Absolute	
Relative	Footprint based
	Weight based

- The heavier a vehicle is, the greater its fuel consumption
- Footprint is a measure of vehicle size defined as the area enclosed by the tyres of the vehicle (wheelbase x track width)
- Footprint based targets encourage light-weighting of vehicles
- Weight based targets recognize the utility of different types of vehicles, hybrid/EV battery weight and weight data available

https://www.globalfueleconomy.org/data-and-research/publications/gfei-working-paper-17

APERC 14

Mix of weight-based and footprint-based targets

Region	Target Year	Regulated metric	Unadjusted Fleet Target/Measure	Form of target curve	Test Cycle
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Data source: : https://www.theicct.org/publications/2017-global-update-LDV-GHG-FE-standards

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CO_2 emissions from LDV: historical and current standards

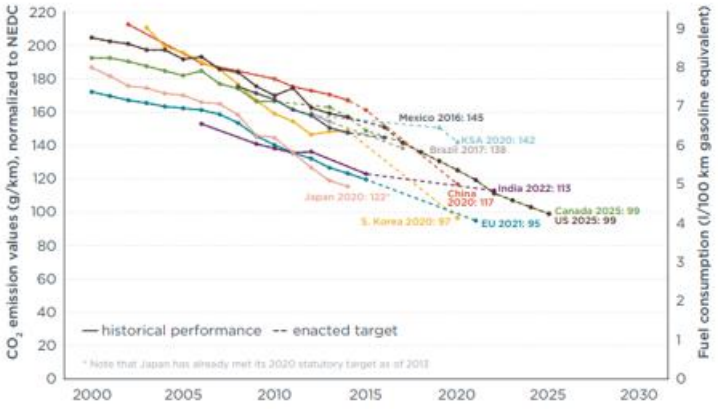

Figure 2. Historical fleet CO_2 emissions performance and current standards (gCO_2/km normalized to NEDC) for passenger cars

Data source: https://www.theicct.org/publications/2017-global-update-LDV-GHG-FE-standards

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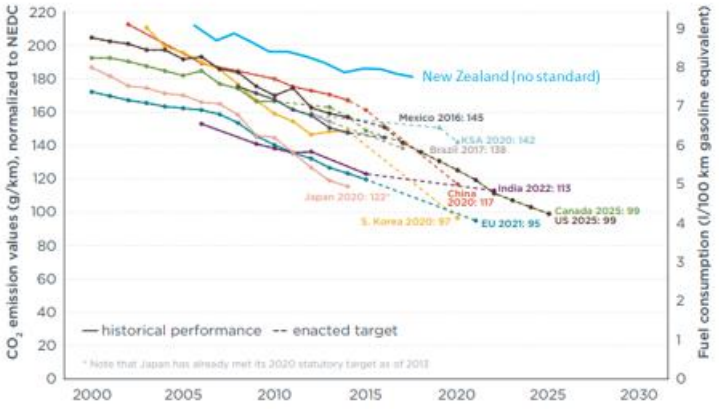
How this compares to an economy with no standards



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Data source: https://www.theicct.org/publications/2017-global-update-LDV-GHG-FE-standards

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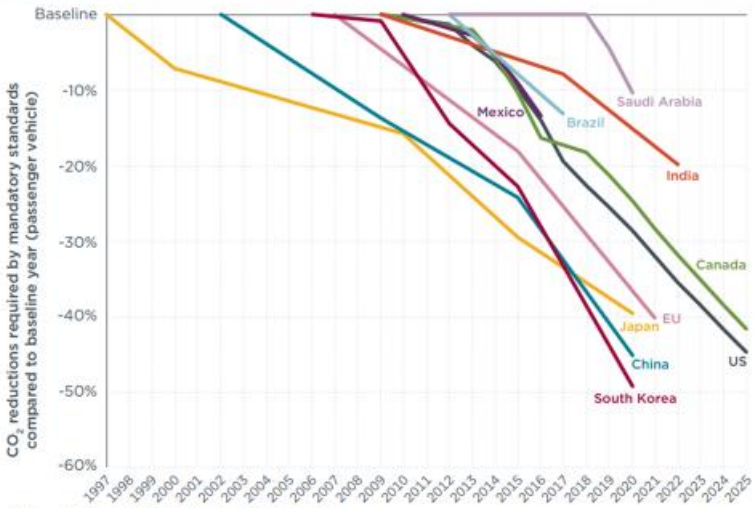
CO_2 emissions reductions from standards



Data source: https://www.theicct.org/publications/2017-global-update-LDV-GHG-FE-standards

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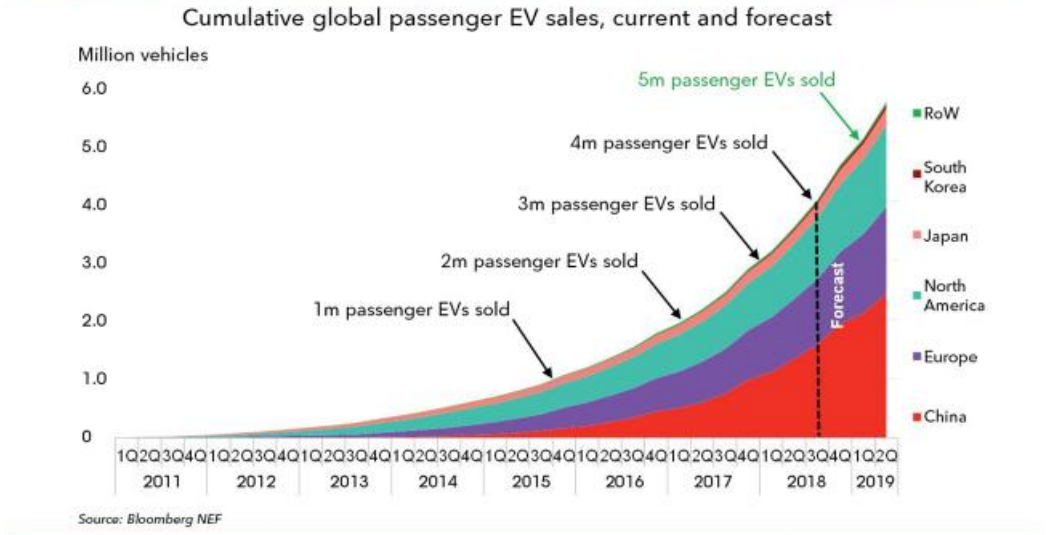
Global EV sales are growing exponentially



Source: Bloomberg NEF

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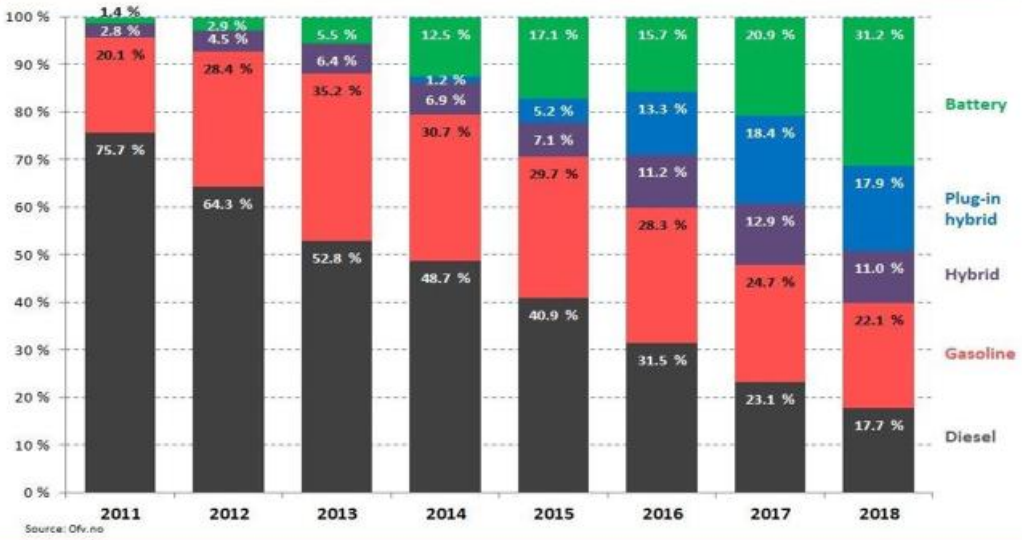
Norwegian new car sales by fuel type, 2011-2018



Source: Ofv.no

APERC 20

Strongest policy signal: ICE vehicle ban

Economy	Ban commences	Ban announced
Costa Rica	2021	2018
Denmark	2030	2019
Ireland	2030	2018
India	2030	2017
Israel	2030	2018
Netherlands	2030	2017
Norway	2030	2017
Sweden	2030	2019
Scotland	2032	2017
China	2040	2017
France	2040	2017
UK (except Scotland)	2040	2017

Data source: https://en.wikipedia.org/wiki/Phase-out_of_fossil_fuel_vehicles#List_of_jurisdictions

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Fiscal measures

Taxes/fees

Vehicle sales taxes increase with fuel use or CO_2

Vehicle registration and annual licensing fees

Fuel taxes and price on carbon

Driving restrictions; zero emission zones

Feebates

A fiscally neutral combination of fees and rebates

May be more politically acceptable

Incentives

Purchase price subsidies for low carbon vehicles

Exemptions from fees and tolls; free parking

Infrastructure incentives for EV charging

Priority access or parking for EVs

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Example: Singapore car registration feebate system

	Cars Registered From 1 July 2015 to 31 December 2017		
Band	Carbon Dioxide Emission (CO_2 g/km)	Rebate	Surcharge
A1	$CO_2 \leq 95$	S$30,000	
A2	$95 < CO_2 \leq 105$	S$15,000	
A3	$105 < CO_2 \leq 120$	S$10,000	
A4	$120 < CO_2 \leq 135$	S$5,000	
B	$135 < CO_2 \leq 185$	S$0	S$0
C1	$185 < CO_2 \leq 200$		S$5,000
C2	$200 < CO_2 \leq 215$		S$10,000
C3	$215 < CO_2 \leq 230$		S$15,000
C4	$230 < CO_2$		S$30,000

https://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/owning-a-vehicle/costs-of-owning-a-vehicle/tax-structure-for-cars.html

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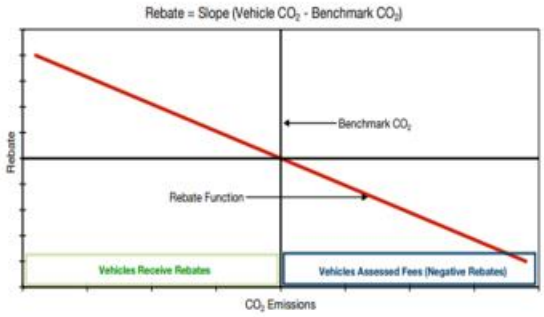
ICCT: Elements of a best practice feebate scheme

- A continuous, linear feebate rate line
- A pivot point making the system self-funding and sustainable
- A linear metric, such as CO_2 emissions or fuel consumption per unit of distance
- An attribute adjustment (if used) based on vehicle size, not weight



https://www.theicct.org/publications/best-practices-feebate-program-design-and-implementation

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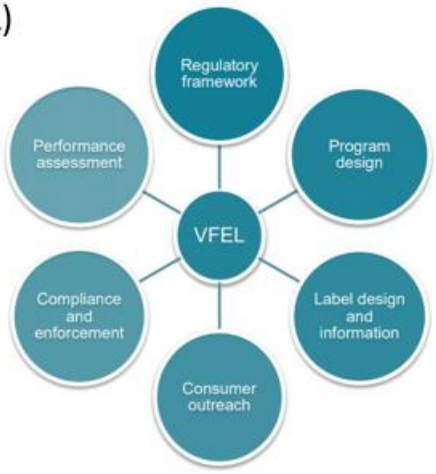
Information measures

- Vehicle fuel efficiency labels (VFEL)
- Websites, promotional materials



http://publications.apec.org/Publications/2015/12/A-Review-and-Evaluation-of-Vehicle-Fuel-Efficiency-Labeling-and-Consumer-Information-Programs

Market measures

- Voluntary sign-up programmes which provide facilitation support and recognition to fleets buying efficient and low CO_2 vehicles and supporting efficient driver training

SmartWay℠ Transport Partnership
U.S. Environmental Protection Agency

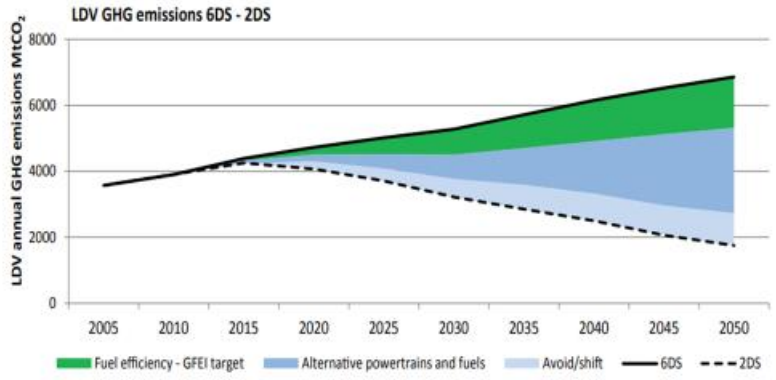
CGFI
中国绿色货运行动
CHINA GREEN FREIGHT INITIATIVE

Summary – vehicle fuel economy standards

- Approved and accepted vehicle fuel/energy consumption data is a vital enabler
- Corporate average vehicle fuel efficiency/CO_2 standards encourage manufacturers to make, sell and promote lower CO_2 vehicles
- Fiscal measures including feebates encourage consumers to buy lower CO_2 vehicles, creating demand
- Information and other measures can provide important support but are insufficient on their own

APERC 27

How standards contribute to meeting IPCC targets



This analysis includes a 20% reduction in new car fuel consumption (Lge/100km) in the 6DS; an additional 30% reduction is reflected in the 2DS scenario, reaching the GFEI target.

https://www.globalfueleconomy.org/media/460944/cop23-update-report.pdf

GFEI GLOBAL FUEL ECONOMY INITIATIVE

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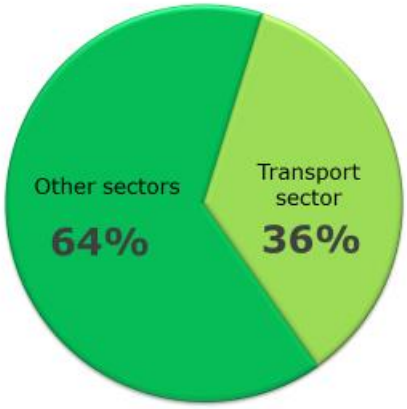
APPENDIX 5: Chile's path to develop fuel economy standards

- In 2014, it was proposed as an **energy efficiency goal** to achieve an energy saving of **20%** by **2025**.
- **Development of policies** that aim at an efficient use of energy in the **transport sector**.
- Implementation of minimum **energy efficiency standards** for light passenger vehicles.

Transport sector in Chile: energy consumption

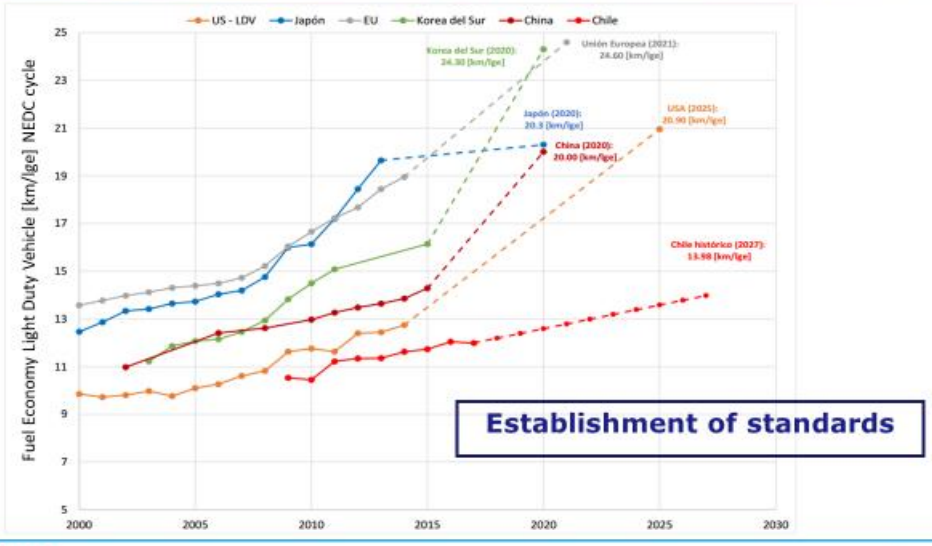


99%

Crude oil derivatives

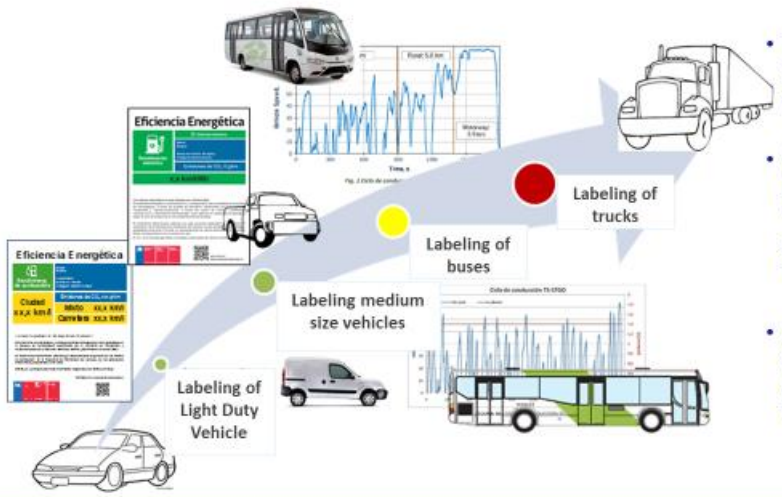
APERC 3

International context



APERC 4

Outlook



- **More than 350,000 new vehicle per year**
- **Collaboration between the Transport, Energy and Environment Ministries**
- **3CV - Center of Control and Certification of Vehicles.**

Proposed bill of law

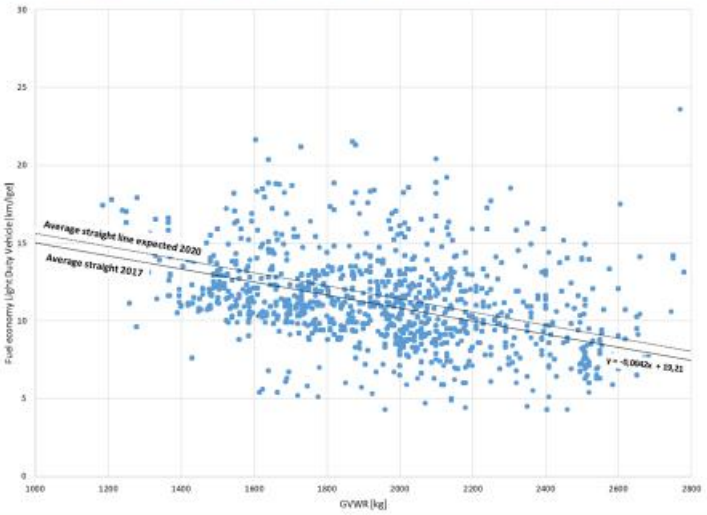
Objective: To establish an energy efficiency standard for the motorized vehicle fleet.

Standard: Will be set by the Energy and Transportation Ministries together, through fuel economy goals that must be met by manufacturers, importers or their representatives, with respect to the vehicles they commercialize.

Metric: Energy efficiency in kilometers per liters of gasoline equivalent and its equivalence in grams of CO_2 per kilometer, determined using the values obtained in the homologation of the vehicle.

How is the standard established?

- **At least two years (2016-2017) of a complete universe of light vehicles were studied.**
- **A common energy unit was taken.**



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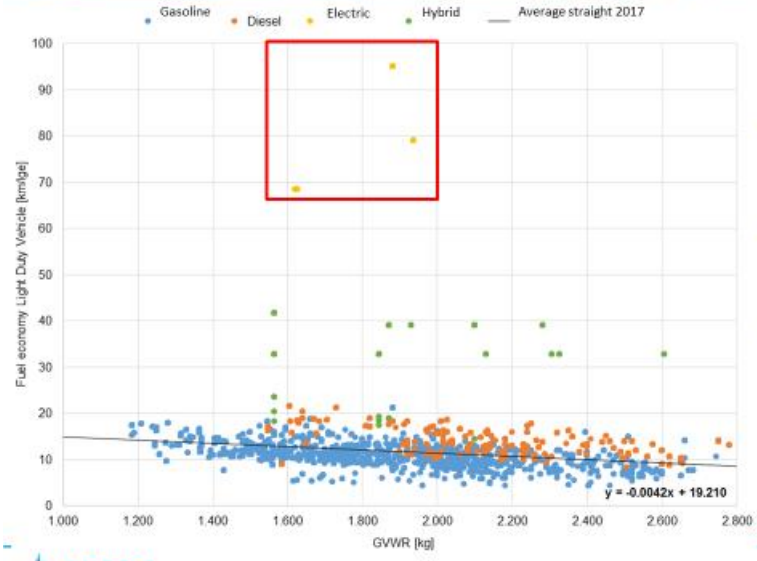
How is the standard established?

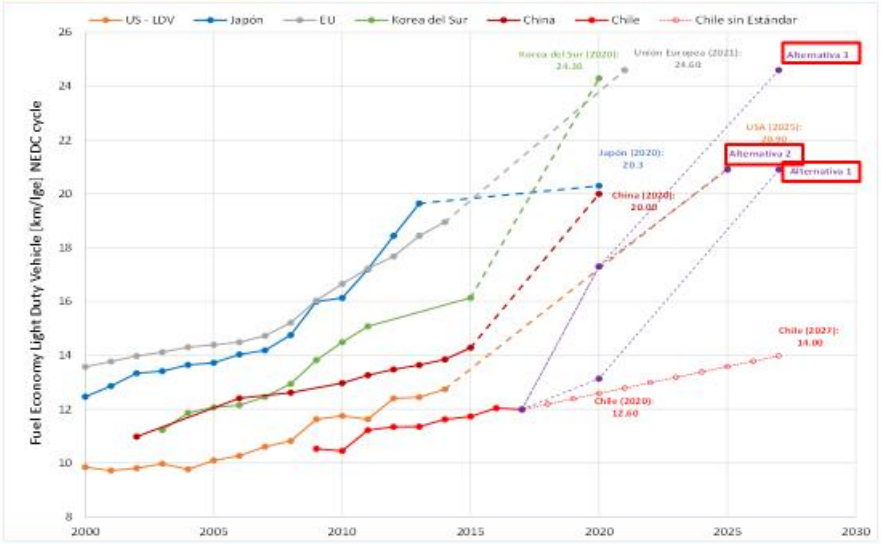


- **Performance with their respective technologies.**
- **Electric vehicle is more efficient.**
- **Wink to electromobility.**

APERC

8

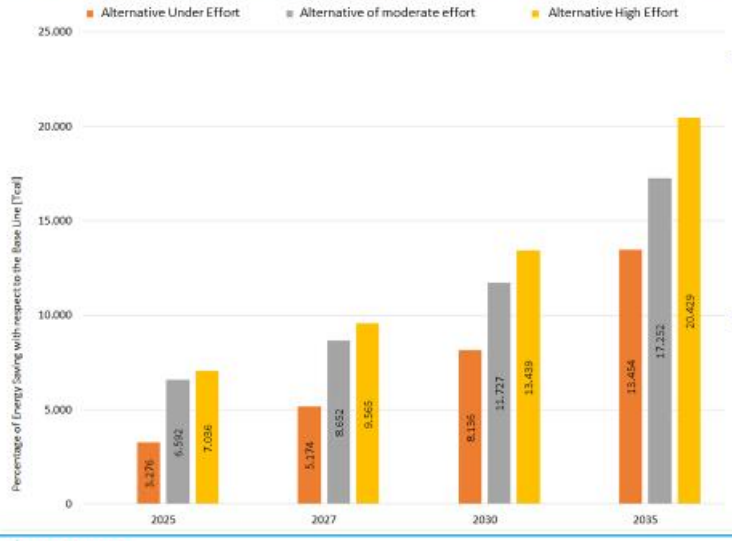
Application of EE vehicle standards



APERC

9

Quantifying savings by alternative

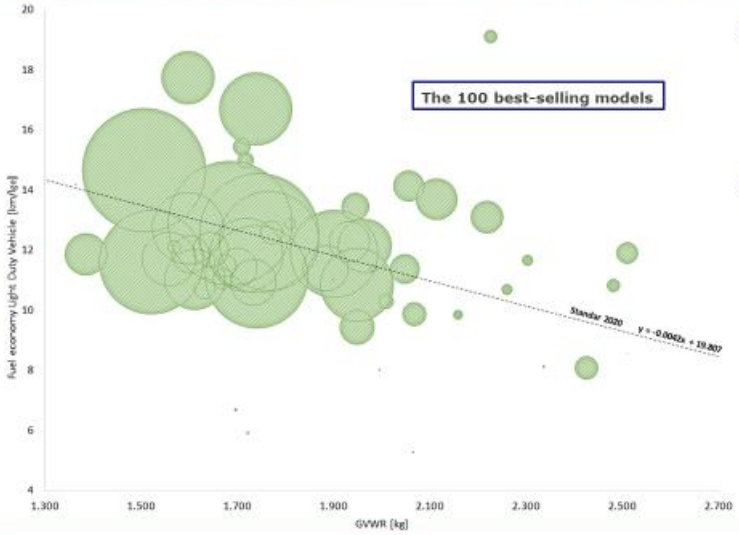


- **The establishment of standards can contribute between 19,3% and 40,9% to the fulfillment of energy efficiency goals.**
- **A contribution that is greater than the current proportion of the energy consumtion by light vehicles (13,5%).**

APERC

10

Impact on supply



- **In the segment of smaller vehicles there are multiple options that are above average.**
- **In the segments of greater weight, it was observed that for each of these there is an alternative that does not require a considerable increase in the price or a reduction in the size of the vehicle.**

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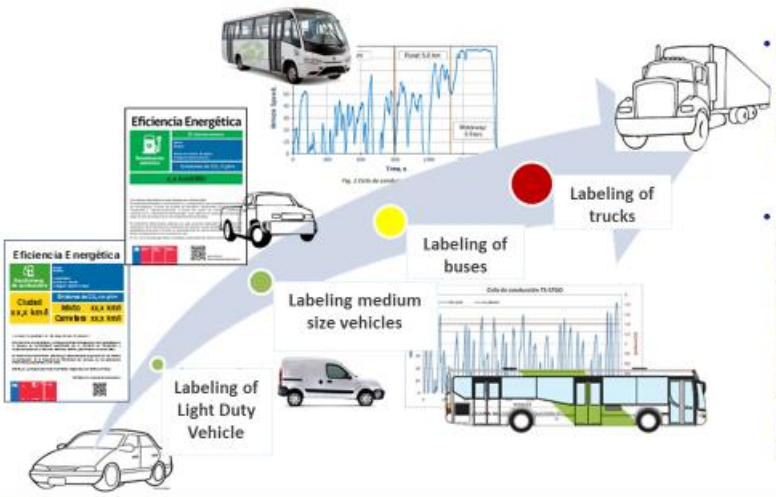
11

Conclusion



- **Faculties for labeling in all vehicles, we are with light and medium vehicles.**
- **As of July 2018 we have a technical protocol to obtaing energy consumption in urban public transport buses in the city of Santiago.**

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12

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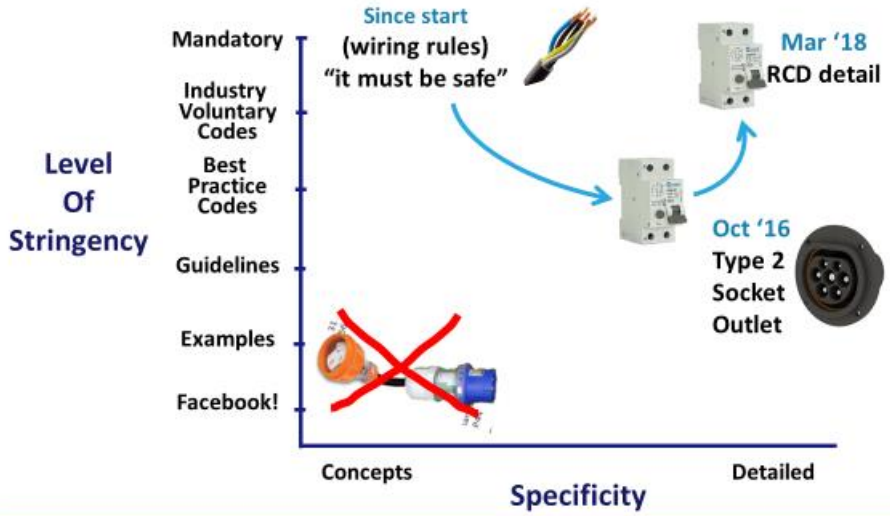
Asia Pacific Energy Research Centre

APPENDIX 6: Test protocols underpinning fuel economy regulations: the transition to WLTP and its inclusion in CO_2 policies

Different forms of standards:



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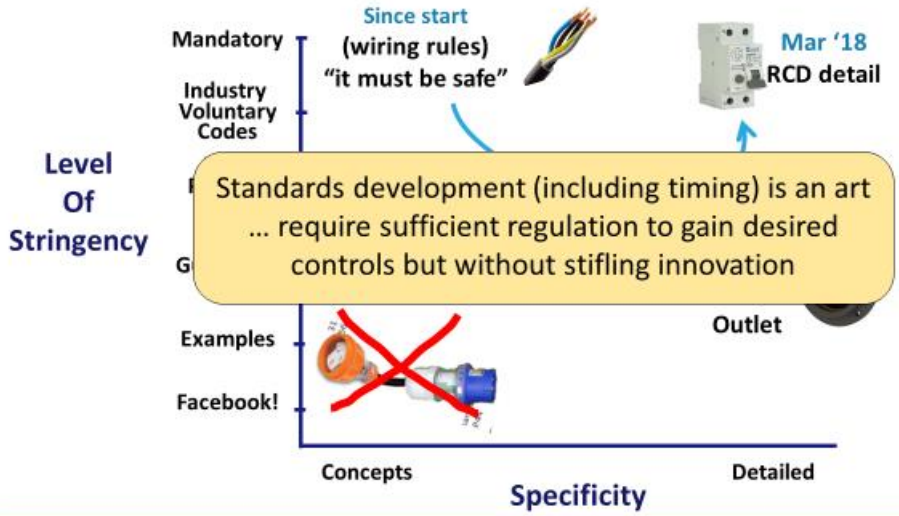
Different forms of standards:



APERC

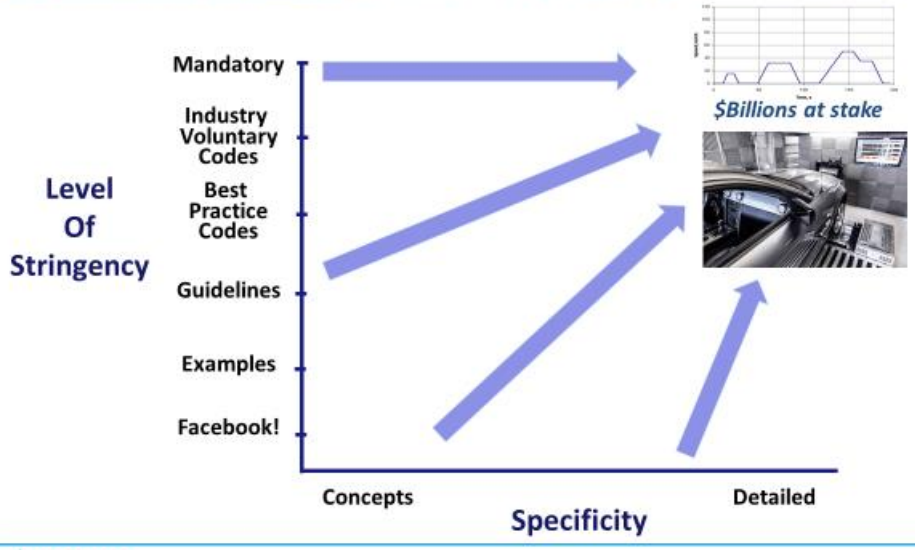
4

Vehicle Testing History

- 1950-60s: US studies identified vehicles as significant source of air pollution.
- 1960s: establishment of environmental agencies in California, then across US, for developing and administering emissions standards for vehicles.
- 1970s: Establishment of similar initiatives in Western Europe, Canada, Australia and Japan.
- Required reference to results from a repeatable test that aimed to simulate typical vehicle use.
- Mid 1970s: tightening emission standards required de-tuning of engine higher fuel consumption.
- Energy crisis of 1970-80s → fuel consumption result underpinned many energy reduction policy initiatives.
- Fuel consumption result now underpins many GHG reduction policy initiatives.

APERC 5

Vehicle Emissions (and Fuel Consumption) Testing:



APERC 6

Vehicle Emissions (and Fuel Consumption) Testing:

- $Billions at stake – test must be acceptable industry wide, repeatable and robust.
- Ideally providing a range of speeds and loads (and operating temperatures) representing typical vehicle use.
- Standardised: accurately specified to provide repeatability.
- Despite tight specification and staged development of previous tests:
  - Experienced testers could "game" and get better results.
  - Vehicles could be calibrated to perform well under the specific test conditions.
  - Test cycle specification considered vehicle technology available at the time.
- Over time greater divergence of test results and "real world" results.
- New technologies (e.g., EVs) not well catered for (New European Driving Cycle 20 years old).
- Different test cycles in different jurisdictions. Global vehicle supply more efficient/cost effective with one test (homologation).

→ **undermining policy efforts**

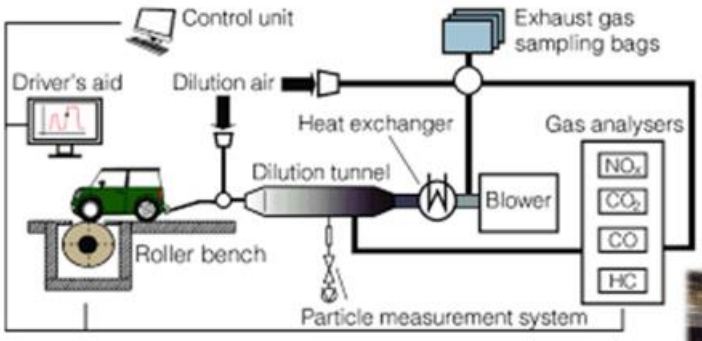
APERC 7

Introduction of the Worldwide Harmonised Light Vehicle Test Procedure (WLTP)

- Development process began in 2007.
- Developed by the UN ECE GRPE (Working Party on Pollution and Energy) with inputs from wide-ranging economies.
- An approximation of real-world operation.
- Stricter test conditions, higher speeds, longer test duration.
- Consideration of vehicle's "special equipment", including weight of A/C units, aerodynamics, and others.
- Consideration of different power trains … EV technology.

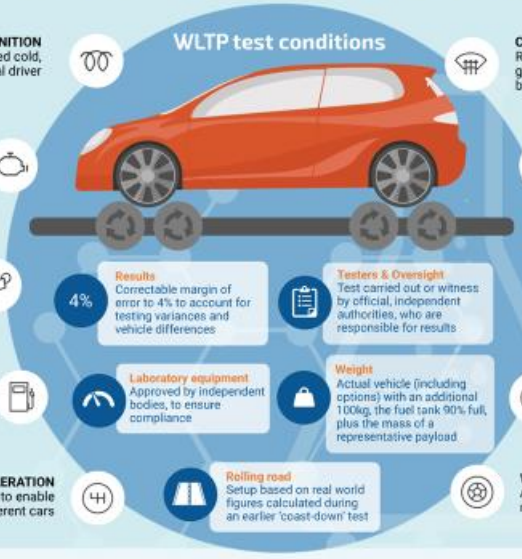
APERC 8

The Test Arrangement



APERC 9

HOW DOES THE CAR LAB TEST WORK?



IGNITION
The car is started cold, as it might be by a normal driver

ENGINE
Must have been run in at least 3000km, to ensure real-world vehicle performance

OILS
Standard specification oil for the conditions is used

FUELS
A standard reference fuel (petrol or diesel) is specified for the test

GEAR SHIFTS & ACCELERATION
Defined by regulation to enable comparability between different cars

CONSUMER ELECTRONICS
Radio, air conditioning, electronic gadgets are turned off; test is fair between differently equipped cars

DAY LIGHTS
Must be activated

TYRES
Standard road tyres, at specified pressure

BRAKES
Must be in normal working order; test includes braking phases

WHEELS
Aligned during setup to ensure that resistance of rolling road is realistic

Results
4% Correctable margin of error to 4% to account for testing variances and vehicle differences

Testers & Oversight
Test carried out or witness by official, independent authorities, who are responsible for results

Laboratory equipment
Approved by independent bodies, to ensure compliance

Weight
Actual vehicle (including options) with an additional 100kg, the fuel tank 90% full, plus the mass of a representative payload

Rolling road
Setup based on real world figures calculated during an earlier 'coast-down' test

APERC 10

New European Drive Cycle (NEDC) vs Worldwide Harmonised Light Vehicle Test Procedure (WLTP)

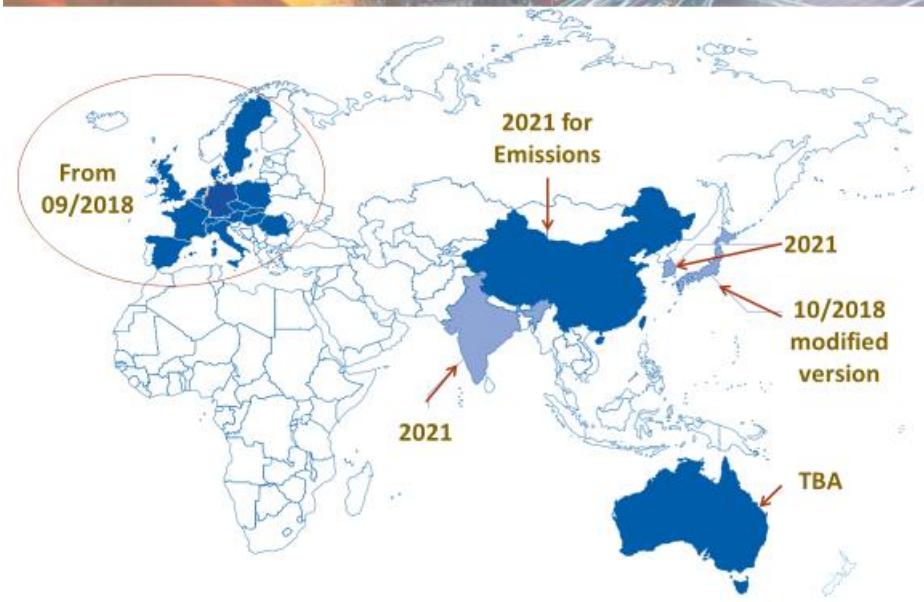
	NEDC	WLTP
Starting temp.	cold	cold
Duration	1.180 sec.	1.800 sec.
Idle time	25 %	13 %
Distance	10.966 m	23.274 m
Phases	2 phases: Urban and long-distance trip	Up to 4 phases: "Low", "Medium", "High" and "Extra-High"
Speed	mean: 34 km/h – maximum: 120 km/h	mean: 47 km/h – maximum: 131 km/h
Acceleration	mean: 0,50 m/s² – maximum: 1,04 m/s²	mean: 0,39 m/s² – maximum: 1,58 m/s²

APERC 12

The WLTC for PEVs, PHEVs and (Non-P)HEVs

APERC 13

Introduction of World Harmonized



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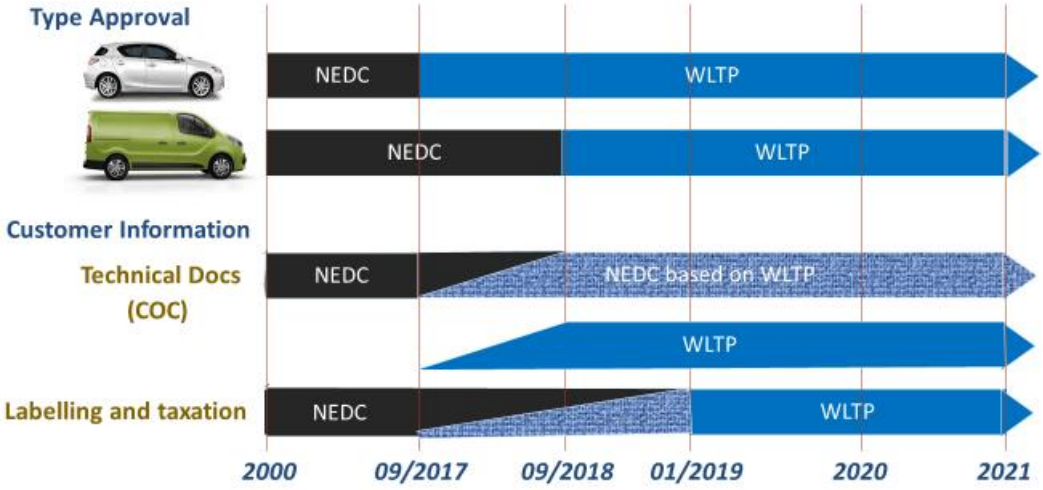
WLTP Timeframes



APERC

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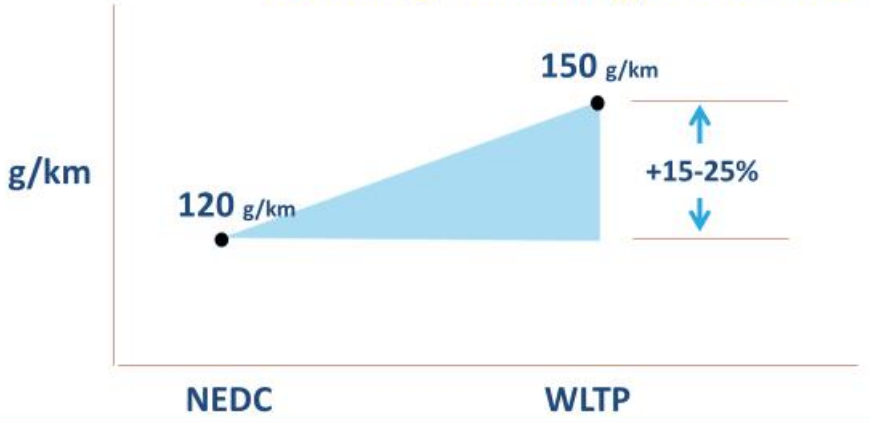
Implications of Higher WLTP Value:

Tax implications with g/km increase???
OEM obligations with g/km increase???



APERC

16

Consequences of WLTP Introduction

- Vehicle Type Approval data uses WLTP test, but labelling still requires NEDC data → high risk of confusing consumers where both NEDC and WLTP are displayed.
- European Union CO_2 targets for 2021, for vehicle manufacturers, based on old NEDC test.
  - European Commission developed a WLTP→NEDC translation algorithm.
  - Not exact, which has potential for significant cost implications.
- UK as an example of considerations: changes to the label are proposed for April 2020, when taxation will switch from NEDC to WLTP. Yet to be determined how difference in fuel consumption result/tax will be managed.
- EU automotive industry suggesting revision of labelling once WLTP transition complete → harmonised consumer information.

WLTP Summary

- Developed by the UN ECE GRPE (Working Party on Pollution and Energy)
- Part of the Worldwide harmonized Light vehicles Test Procedures (WLTP). The WLTP procedures define a number of other procedures.
- Cycle based on real-driving data with low, medium, high and extra high speed sections → expect closer to real-world fuel consumption.
- Phase-in began 2017. Few light vehicle models/vehicles now not tested to WLTP protocol.
- Introduction of modified form in Japan, and for exhaust emissions in China. Australia, India and South Korea will also implement the WLTP at a later stage
- Many factors involved in vehicle's fuel consumption and CO_2 emissions. Despite expected improvements, care still required interpreting WLTP.
- Fuel consumption labelling and other use of WLTP data yet to catch up.


Thank You
http://aperc.ieej.or.jp/
Thanks also to Gloria Esposita
for supporting materials
LowCVP
Low Carbon Vehicle Partnership
APERC
Asia Pacific Energy Research Centre

APPENDIX 7: Wide scale promotion of low emission vehicles for HK – challenges and opportunities

ASIA-PACIFIC ECONOMIC COOPERATION (APEC)
APEC Workshops

Wide Scale Promotion of Low-emission Vehicles for Hong Kong – Challenges and Opportunities

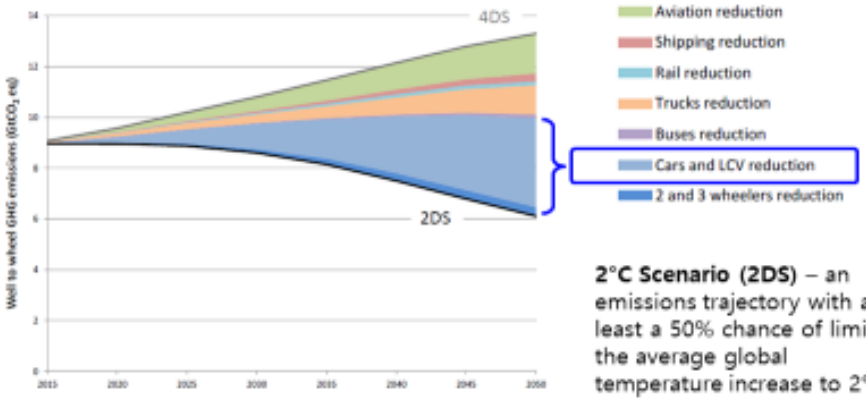
Mr. Raymond Choi
General Manager (Customer Services)
HK Electric

Date: 18 March 2019

Hong Kong, China

GHG Emissions – Transport

- Low-emission vehicles (i.e. electric vehicles) are a major component of the 2DS, and vital to achieving "well below 2 degree" ambitions

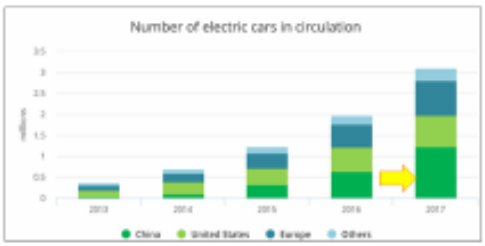


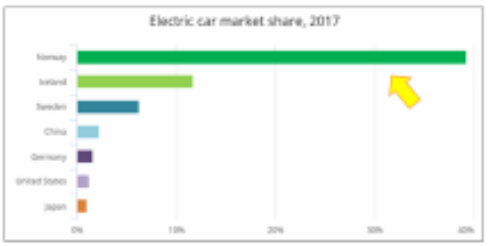
2°C Scenario (2DS) – an emissions trajectory with at least a 50% chance of limiting the average global temperature increase to 2°C

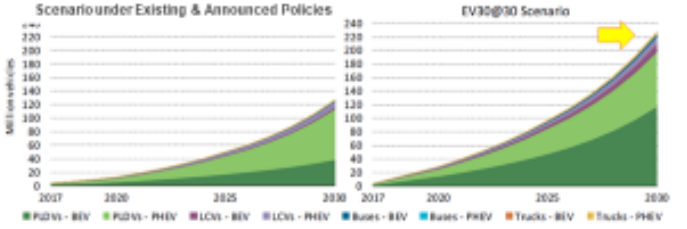
Source: Accelerating electric vehicle deployment and support policies (2016), International Energy Agency

Hong Kong, China

Global Outlook of EV







Notes: PLDVs = passenger light duty vehicles; LCVs = light commercial vehicles; BEVs = battery electric vehicles; PHEV = plug-in hybrid electric vehicles.

IEA Global EV Outlook 2018 (EV30@30)

- EV accounts for 30% new vehicle sales by 2030
- 220 million EVs on the road by 2030

Source: © OECD/IEA, Global EV Outlook 2018, IEA Publishing. Licence: www.iea.org/t&c

Hong Kong, China

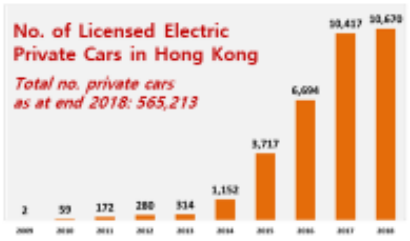
Electrification of Road Transport in Hong Kong

As at Dec 2018	Average Daily Passenger Journeys	Licensed Fleet	Electrified	
			No.	%
Franchised Buses	4.1 M	6,294 buses	33	0.5%
Public Light Buses	1.8 M	4,323 buses	0	0%
Taxis	0.9 M	18,143 taxis	0	0%
Private cars		**565,213**	**10,670**	**~2%**
Goods vehicles		115,804	83	~0.1%
Motor cycles		54,856	10	~0.1%
Government & Special vehicles		1,763	91	~1%
Other Buses/Coaches		7,629	8	~0.1%
Private Light Buses		3,346	6	~0.2%

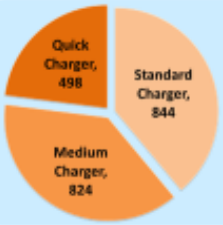
Source: Transport Department, HKSAR Government

Hong Kong, China

Trend of EV Adoption in Hong Kong



- Only a handful of public EV charger was available in 2009
- HK Electric has embarked free EV-charging service since 2009



- As at Jan 2019, there are 2,166 EV chargers for public use

Source: Transport Department and Environmental Protection Department, HKSAR Government

Hong Kong, China

Hong Kong – A Perfect City for EV?

- High density of high-rise buildings
- Sub-tropical weather
- Hilly terrain
- One of the cities with the most reliable electricity supply infrastructure
- Longest point-to-point commute is about 60 km (e.g. A to B, C to D)
- Daily mileage
  - Private cars: Few tens of kilometres
  - Public transport: >200/300 km

- Blue print for transforming to a low-carbon smart city
- Well-established fossil-fueled car market and networks of refueling stations

Source: Promoting the Use of Electric Vehicles (Feb 2019), LegCo EA Panel

Hong Kong, China

Wider Adoption of EV in HK - Challenges

High density of high-rise buildings	• Cars are parked in multi-storey car parks with parking bays either owned or rented by the drivers • Existing car parks are not designed for EV charger installation • Aged buildings may not have spare communal power capacity for EV chargers • Permissions from the building owners and other parking bay owners/users are required for EV charger installation and associated wiring work
Sub-tropical weather	• Air-conditioning is a must in hot and humid days, especially during traffic congestion
Hilly terrain	• Uphill climbing ability is a must, especially for buses & light buses
Long travel range for public transport	• Sufficient top-up/quick chargers or spare vehicles are required for fleet operation
Well-established fossil-fueled car market	• Keen competition with fossil-fueled cars on choices, prices and refueling convenience

Hong Kong, China

Wider Adoption of EV in HK -Opportunities

Aspiration for becoming a low-carbon smart city	• Policy support for EV development in Hong Kong as one of the means to reduce carbon intensity, improve air quality and transform to a smart city
High density of high-rise buildings	• EV as a key means to solve roadside emission problem given buildings are packed along road sides especially in urban areas
Private cars' short commute distance	• Present EVs are able to cope with the driving range requirement; "refueling" frequency can be on par with fossil-fueled cars
Reliable electricity supply infrastructure	• Adequate and reliable electricity supply supports the EV charging infrastructure development, especially top-up quick chargers

Source: Smartcity.gov.hk: Hong Kong's Climate Action Plan 2030+, Environment Bureau, HKSAR Government

Hong Kong, China

Overcome Challenges & Seize Opportunities
Governments' Policies

- **First registration tax (FRT) concessions** for EV
- **100% profits tax deduction** for the capital expenditure on EVs in the first year of procurement
- **A HK$300 million Pilot Green Transport Fund** to encourage trial of green innovative and low carbon transport technologies (including electric commercial vehicles)
- **$180 million for franchised bus companies** to purchase 36 single-deck electric buses
- **Gross Floor Area concession** for new development with all parking spaces EV charging – enabled
- **Guidelines for setting up EV chargers**
- **2018 Policy Address**: consider ceasing the first registration of diesel private cars subject to consultation with stakeholders
- **2019-20 Budget**: $120 million to extend the public EV charging networks at government car parks

Source: Hong Kong's Climate Action Plan 2050+, Environment Bureau, HKSAR Government

Hong Kong, China

Overcome Challenges & Seize Opportunities
HK Electric's Endeavours

Supply reliability of > 99.999% since 1997

Introduced EVs in early 1980's,
> 40% EVs in corporate fleet as at today

Free EV charging service since 2009

電動車 充電易
Drive EV · Charge Easy

- Grid supply capacity checks, site inspections and technical advisory services
- 2016-2018: helped customers install over 150 EV chargers at their premises

Hong Kong, China

Drivers for Further EV Adoption (1/5)
Advent of Technologies

Lowering battery cost, longer range per charge

	2010	2017
EV Li-ion Battery Installed Capacity (GWh)	0.4	94.2
EV Li-ion Battery Cost (USD/kWh)	1,000	209
Range of Commercially available EV (km)	~100	~500

Source: Global EV Outlook 2018, IEA, internet research

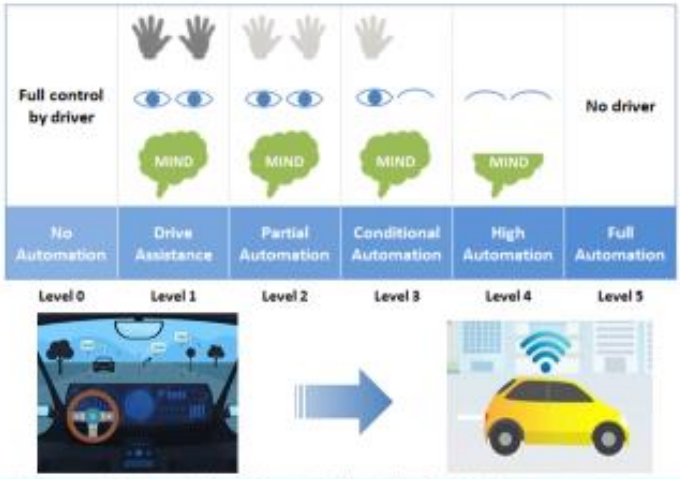
→ More affordable choice of EVs

Battery Charging or Swapping

→ More convenient "refueling" of EVs

Hong Kong, China

Drivers for Further EV Adoption (2/5)
Autonomous Driving/Vehicles



Source: Level of driving automation, SAE International, Automated Vehicles for Safety, National Highway Traffic Safety Administration, SAE International Ready To Tackle Automated Vehicle Safety Testing Standards, Forbes (1 Aug 2018)

Hong Kong, China

Drivers for Further EV Adoption (3/5)
On-demand & Sharing E-mobility

Photo taken in Berlin - sharing Segway

- BlueSG: 1,000 sharing EVs and 500 charging stations in Singapore (100 stations opened as at Oct 2018)
- VW will provide 2,000 sharing EVs in Berlin starting from Q2 2019

Photo taken in Berlin – sharing e-scooter (A Vattenfall-Emmy partnership)

Ford GoBike added in Apr 2018 250 power-assisted e-bikes to its bike sharing fleet in San Francisco

Hong Kong, China

Drivers for Further EV Adoption (4/5)
Regulations & Policies

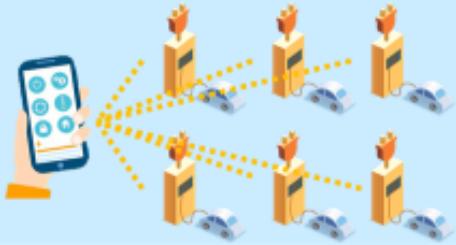
Banning on Sales of Fossil Fuel Vehicles

Region	Ban by	G: Gasoline D: Diesel
Austria	2025	G+D
Demark	2030	G+D
France	2040	G+D
Germany	2030	G+D
Hong Kong	TBC	D
India	2030	G+D
Netherlands	2030	G+D
Norway	2025	G+D
United Kingdom	2040	G+D

Incentives for EV

- Tax/levy waivers for owning EVs
- Incentives for EV charging infrastructure
- EV user incentives/privileges

Clarity of policies, legislations, regulations and insurance for personal & sharing mobility



Source: Internet research

Hong Kong, China

Drivers for Further EV Adoption (5/5)
Energy Transition & Digitalisation

- Continuous decarbonisation of power sector (use of more natural gas and low-carbon means for power generation) further reduces emissions "from EVs" at energy sources
- Electrified mobility devices are becoming distributed energy resources (DERs) using V2G technology, which will be better integrated with the smart grid

Hong Kong, China

Concluding Remark – A Visionary Picture of EV

Integrated solution & key smart city ingredient

Safe
Intelligent
Connected
On-demand/sharing
Environmental
Convenient
Efficient

We see challenges,
but we see more opportunities

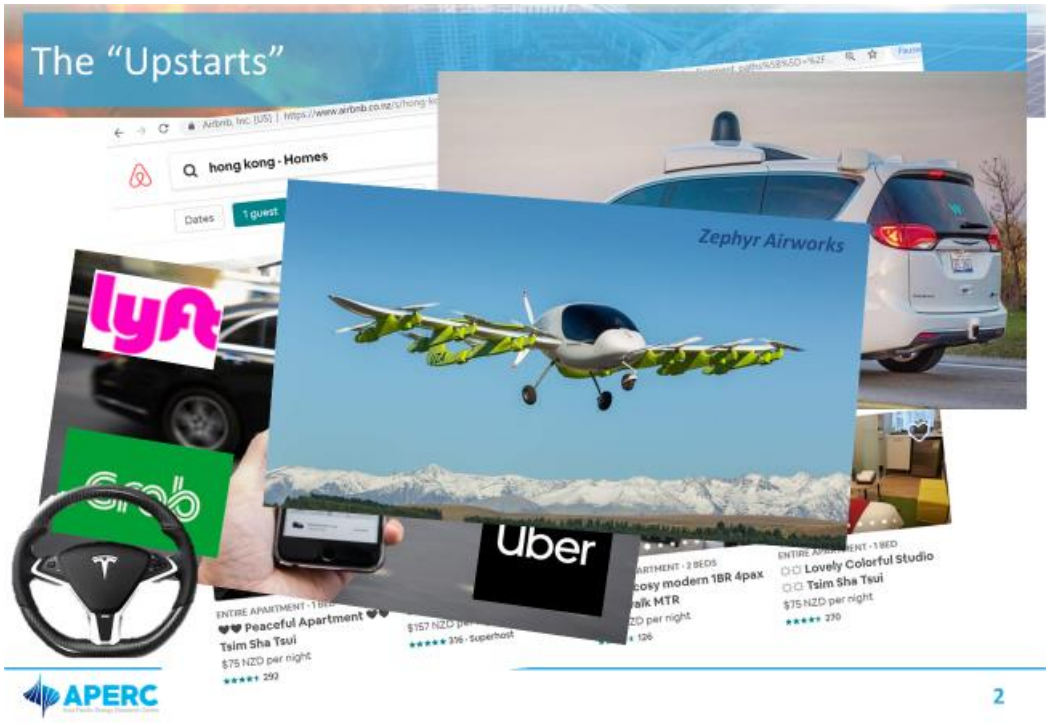
Image: e-Palette Concept Vehicle Toyota

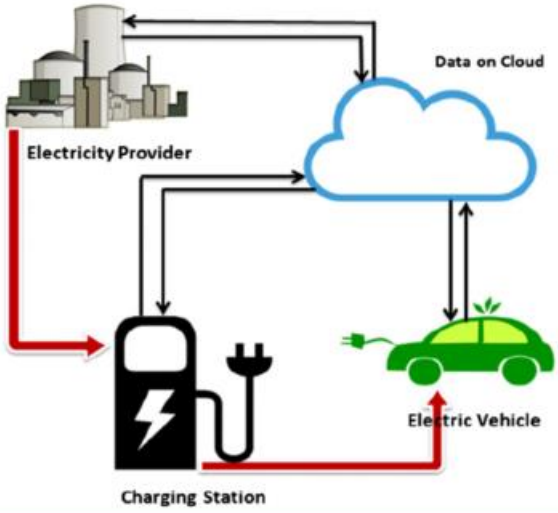
Hong Kong, China

Thank You

Hong Kong, China

APPENDIX 8: Developing Strategies for EVs: Case Study from the Philippines





APERC 3

Life is changing …

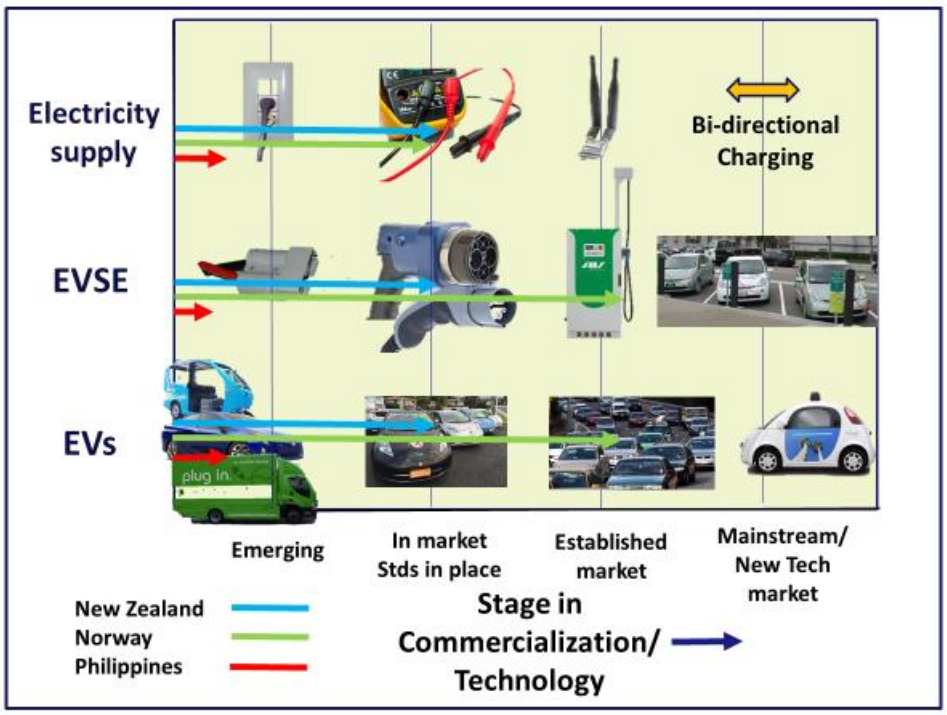
- Cheap electronics, cheap communications, and cheap data.
- Advances in battery technology and cost reduction.
- OEMs well aware of likely disruption to their business:
  - Flexible ownership and usership: car sharing, fractional ownership, pay-as-you-go.
  - Provision of (single trip) multi-modal urban solutions.
  - "Dynamic shuttles": near-taxi convenience and near-mass transit price.
  - Autonomy from assist to full control (Ford, Uber, Google … early target is SAE Level 4-capable autonomous vehicle for ride-hailing or ride-sharing services).

APERC 4

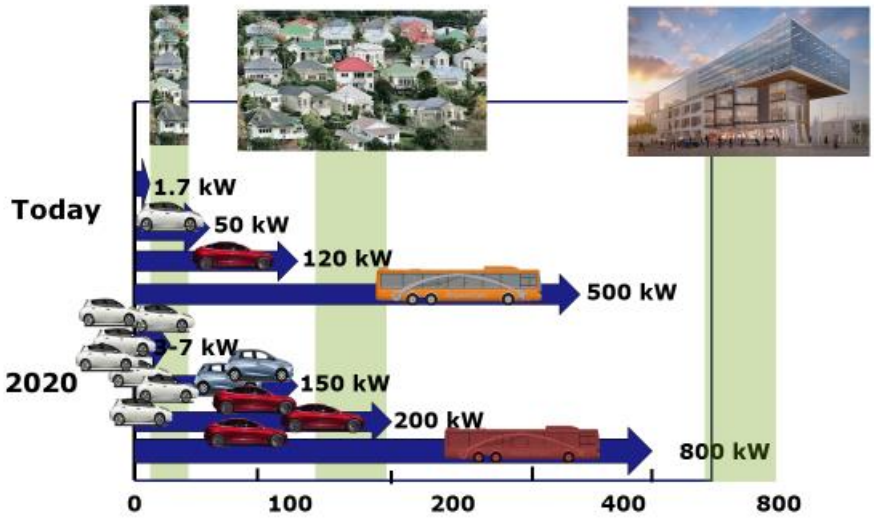
Also changing in the electricity supply sector …

- "Important changes underway in the provision of electricity" Utility of the future MIT
- Significant decrease in cost of enabling technology (hardware, data, comms and systems) → available, practical and affordable.
- → enabling management of electricity supply network:
  - Shifting demand to times when network use "free"
  - Opportunity for "Mum and Dad" "aggregators"
  - Response to supply-side: voltage and other management, load shedding …
  - More efficient consumption of electricity (network and local).
  - Greater utilization of lower GHG generation options.

APERC 5

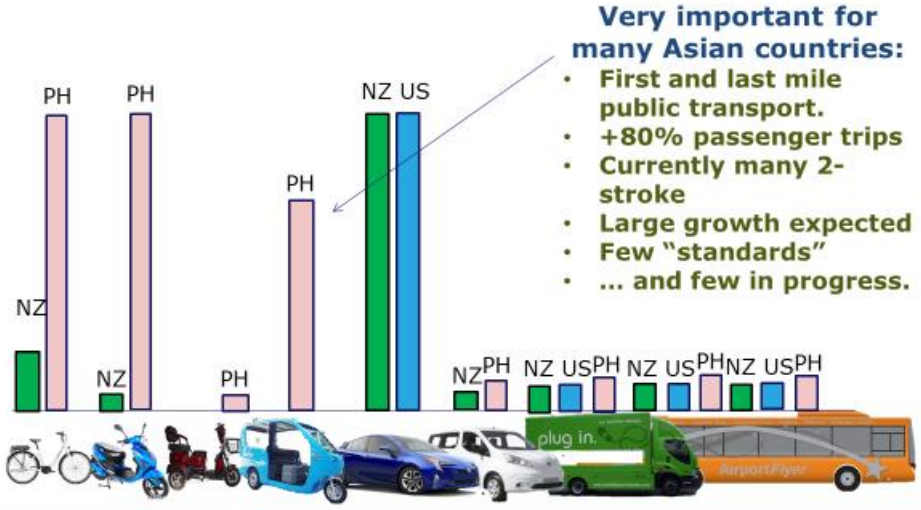


Charging requirements changing …



APERC 7 7

What Vehicles are Important to Your Economy?

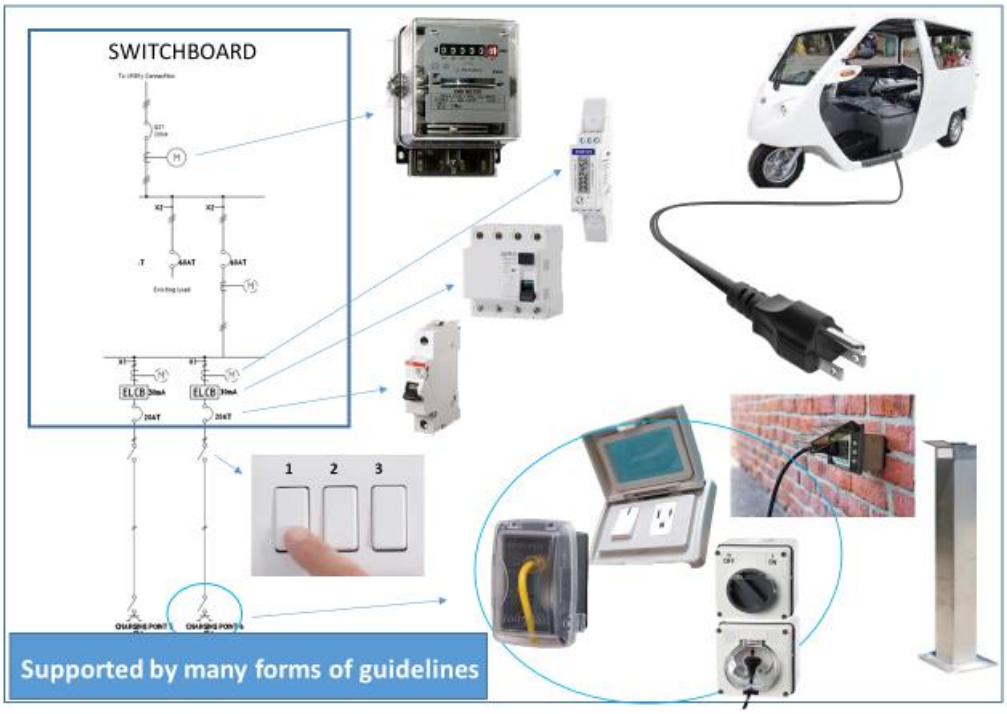


APERC 8

DOE E-trike Project Summary

- 3000 e-trikes to be deployed by May 2019.
- Manufactured in Philippines
- Design applicable to many Asian countries.
- Automotive-grade Li-ion batteries … and supply chain.
- Targeting (first-mile, last-mile) public passenger transport (and removal of two-stroke tricycles).
- Deployed through Local Government Units (who are responsible for setting up charging stations where at-home charging is not sufficient).
- Has stimulated private sector uptake of e-trikes.

APERC 10



Why e-trikes?

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The New Zealand Herald

BUSINESS

Electric scooter giant Lime recalled scooters amid fears that some could catch on fire

31 Oct, 2018 12:45pm

4 minutes to read

Time in Life Cycle	Electric Vehicles	Charging Infrastructure	Electricity to the Plug/Charger
Design	Standards, tech development, meeting market. Micro, LEVs, HEVs	Charging and related hardware and IT, NZ Inc. plan, compatibility. Connectors: Micro, LEVs, HEVs	NZ Inc. electricity supply system, planning. Looking at hard demand management tools
Build	Capacity, market demand by vehicle class	Capacity, demand by different type	Gen Co.s/Line Co.s
Supply	Availability, meeting demand, shipping, import, certification.	Availability, meeting demand, shipping, import, certification.	Gen Co.s/Lines Co.s, general information on
Purchase (and resell)	Awareness/information, experience, overcoming barriers, EV performance, fit for purpose, decision, available models.	Fit-for-purpose purchase decisions, future-proofing, grid-aligned, compatibility, available models	Gen/network upgrade, generation type switching … company and NZ Inc. plans
Installation	Insurance, warranty, registration, identification, WoF	Approval, site works, certification, industry training.	Gen Co.s/Lines Co.s
In-service operation	Monitoring	Monitoring	Monitoring
General use	Understanding, best driving practices.	Access/restrictions, signage, availability, NZ Inc map.	Awareness, controls (pricing and other).
Charging	Understanding of, options, costs, best practice	Understanding of, connectivity, time of charge, billing.	Connectivity, management time/rate of charging, billing
Servicing/ maintenance	Understanding of, industry capability and capacity, industry training	WoF, certification, industry training.	Gen Co.s/Lines Co.s
Breakdown	Guidelines/best practice	Response, industry training, map.	Gen Co.s/Lines Co.s
Accident	1st response, repair, fleet re-entry	1st response, repair, re-cert.	Gen Co.s/Lines Co.s
Retirement	Decision to, reuse of battery/electrics through scrap/recycle.	Decision to, re-use/upgrade through scrap	Gen Co.s/Lines Co.s

Background: APEC Electric Vehicle RoadMap History

- **2014:** APEC Trade and Foreign Ministers endorsed APEC Actions for promotion of EVs.
- **2015:** APEC EV Roadmap developed by Automotive Dialogue, Energy Working Group and Transportation Working Groups.
- **2016-2018** delivery of Roadmap Workshops
- **Identified areas for further work:**
  - Recycling (including protocols for re-use and re-manufacture of batteries)
  - Cybersecurity (hacking prevention)
  - Personal data (including autonomous vehicle routing info, driver info)
  - Emergency response (protocols/manuals, ability to convey help required)
  - Interoperability and related standards (high power, wireless, building/grid integration)
  - Standards for other EV types (2- and 3-wheel, emerging user models)
  - … and harmonisation of these standards ….

Example: First Response

Summary Position of First Response

- Two-step approach to managing risks:
  - Identify the risk
  - Manage the risk
- EVs introduces new battery types (and makeup is changing).
  → different response required, for fire and (water) emersion.
- Introduces high voltages:
  → Need to carefully identify cables if cutting (LV) to isolate.
  → Poor/no use of high voltage colour coding in 2- and 3-wheelers!
  → A minimum requirement?
- Several guidelines available (e.g., US: National Fire Protection Association (NFPA), but poor dissemination.

Battery Fire Quiz

Q. What method is recommended to respond to a fire of an electric vehicle?

a) Dry powder or CO_2 (i.e., electrical fire extinguishers).
b) Water.
c) Get out the marshmallows and watch.

Battery Fire Quiz

Answer:

b) Water based fire extinguishing agents best.

- Suppress and cool.
- Chance of re-ignition …… days later
- Remove vehicle to safe location.

- **Gas extinguishing agents and dry powder extinguishing agents are ineffective**

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Why do we have standards?

Safety

- Minimum performance
- Compatibility
- Security
- …

APERC 20

Challenges to EV Commercialization

- Cost of developing technologies
  - Low return on investment
  - Limited R&D $$$ for multiple technology trajectories
  - Batteries about half cost of EV and development critical
  - Govt support in latter has been critical.
- Adequacy of infrastructure
  - Must have interoperable network
  - The grid will be affected at all levels (generation, transmission and distribution) → critical for industries to collaborate.
- Regulatory environment
  - Still significant cost difference between EV and ICE
  - Constant updating making standardisation difficult
  - Support from government, universities and industry partnerships critical to make most of $$$ available
  - Regulatory predictability and transparency are key.

Thank You

http://aperc.ieej.or.jp/

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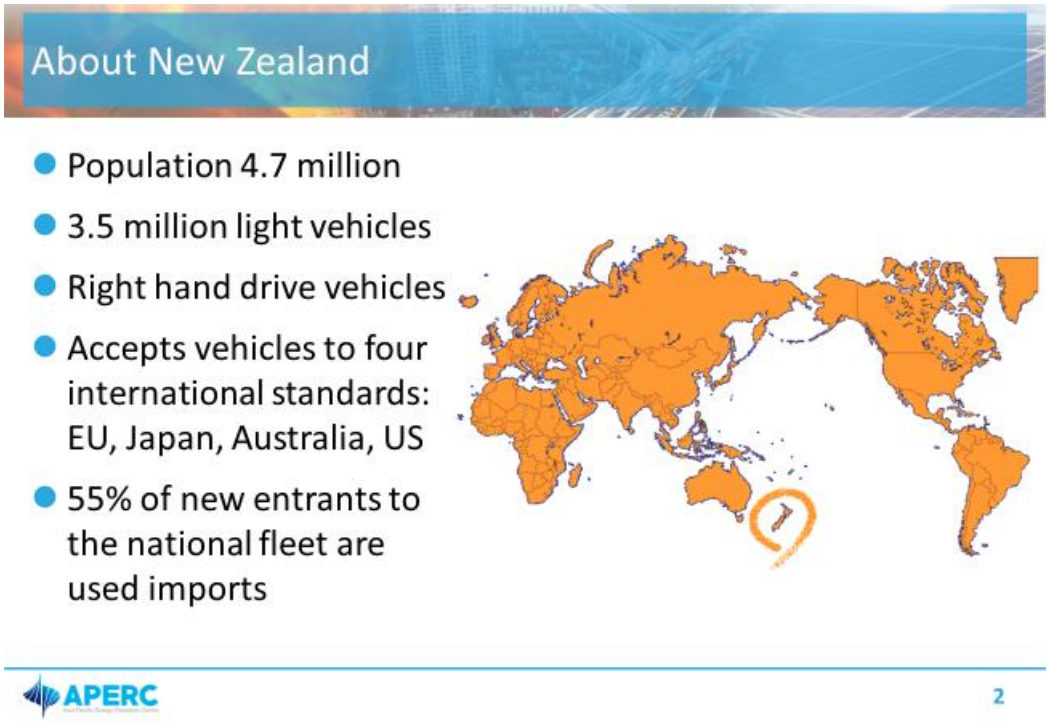
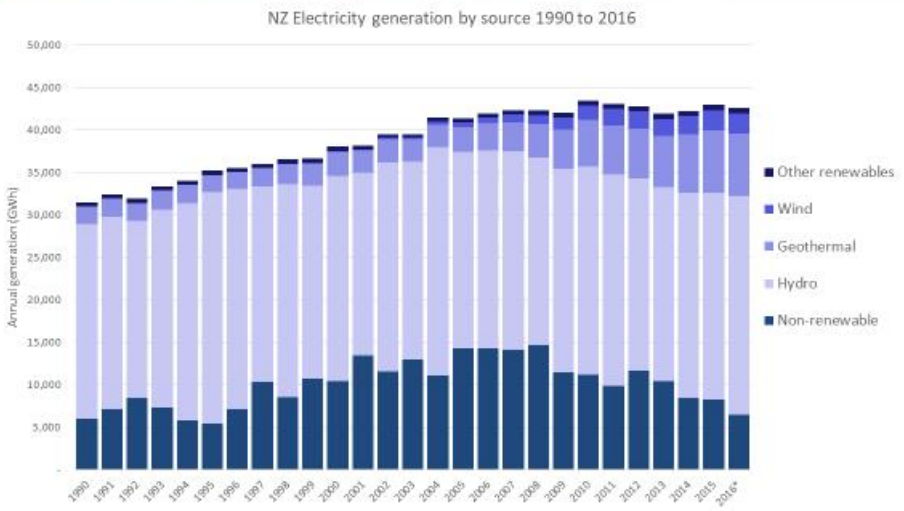
APPENDIX 9: Growth of electric vehicles in New Zealand



85% of electricity generation in NZ is renewable



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Advantages of EVs in New Zealand

- 80% reduction in CO_2 emissions compared with petrol vehicles
- Electricity for EV driving ≡ NZ$0.30 per litre (USD0.20/L) compared with NZ$1.80-$2.20 per litre for petrol
- Driving range of entry level EVs meets majority of driving tasks
- 85% of NZ residences have off-street parking

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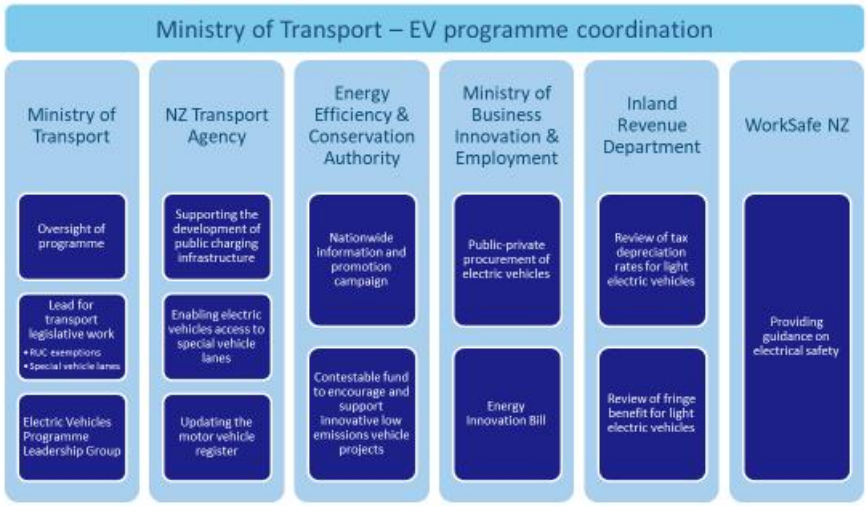
EV policy in New Zealand



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Some fiscal support for EVs

- Petrol vehicles pay fuel excise at the pump, all other vehicles including EVs and diesel vehicles pay Road User Charges (RUC) for each km driven
- **Light vehicles:** Light EVs (eg cars and vans) exempt from RUC until 2021
- **Heavy vehicles:** Heavy EVs are exempt from RUC until they make up 2% of the heavy vehicle fleet

NZD1.00≈USD0.67

Vehicle type	Definition	RUC rate	Example annual distance	Example RUC exemption saving
Light vehicle	Under 3.5 tonnes	NZ$62 / 1,000 km	15,000 km	NZ$ 930 / year
Small delivery truck	Under 6 tonnes, dual rear wheels	NZ$66 / 1,000 km	30,000 km	NZ$1,980 / year
Medium freight truck	12 – 18 tonnes, 3 axle	NZ$292 / 1,000 km	75,000 km	NZ$21,900 / year

APERC 6

EECA Low Emission Vehicles Contestable Fund

- Funding of $7 million/year to co-fund innovative projects
- Industry are the innovators and can move quickly. Fund is a clever way to encourage this private-sector growth and help overcome first mover risk.
- Foreign companies can be partners in a project in NZ, but the funding application must be led by NZ organisation
- www.eeca.govt.nz/funding-and-support/low-emission-vehicles-contestable-fund/

APERC 7

Examples of projects supported by the fund

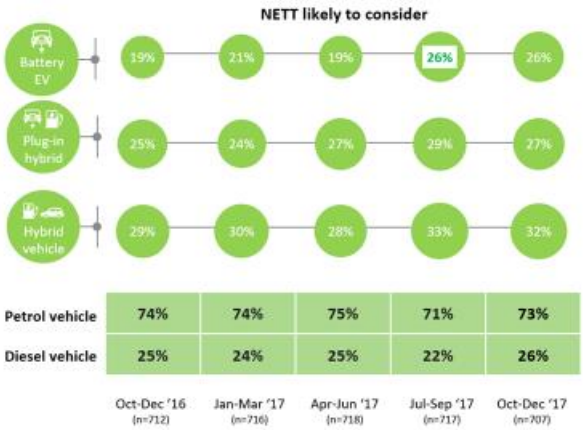
APERC 8

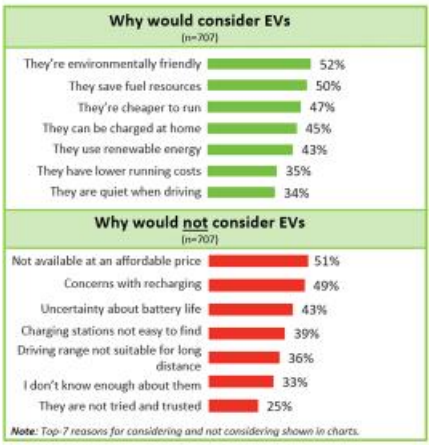
Support for fast charging infrastructure

- Over 90% of charging is at home
- Private investment in public 50 kW DC fast charging with co-funding from the EECA Fund
- Public charging guidelines in place
- Over 150 fast chargers covering 95% of state highway network
- NZTA national pubic EV charging database "EV Roam" provides API for apps and navigations systems

APERC 9

Promotional activities underpinned by market research



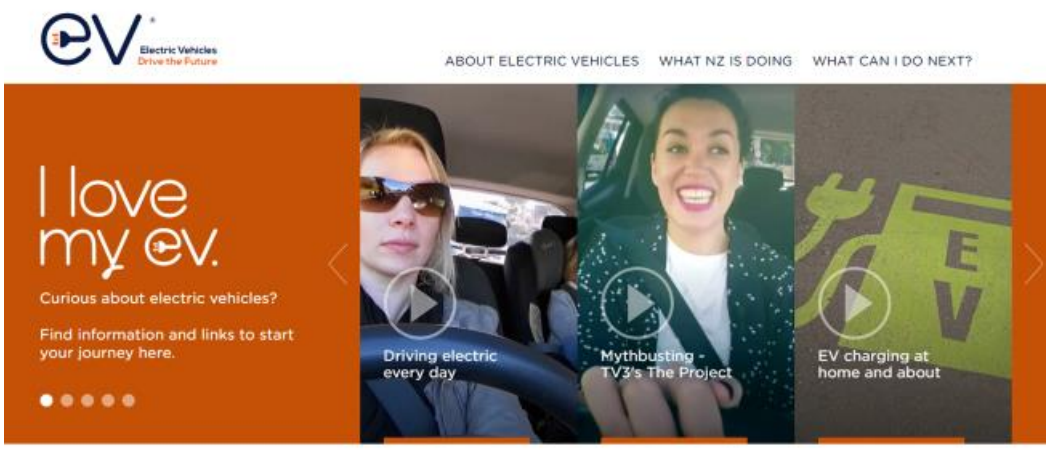


APERC 10

Public outreach important part of government campaign

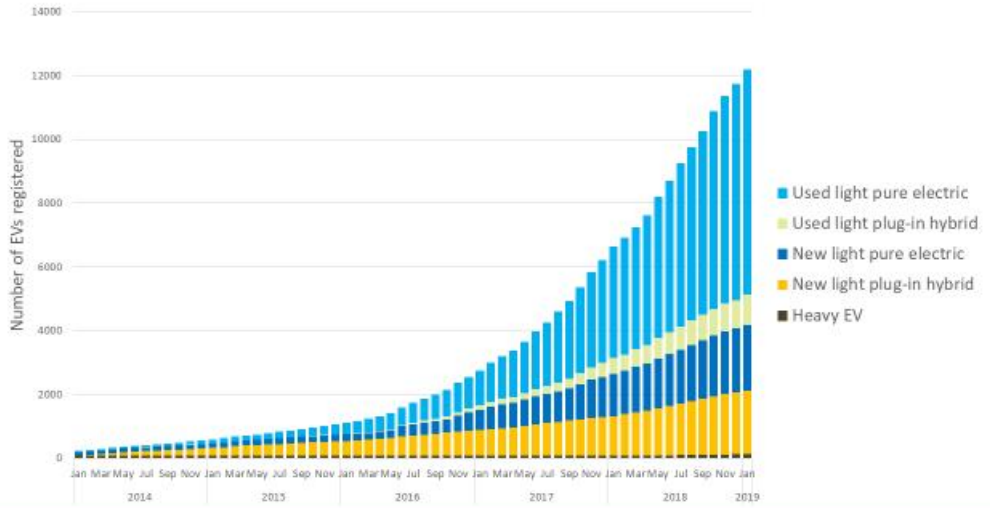
APERC 11

Information resources: www.electricvehicles.govt.nz



APERC 12

Growth of EV registrations in New Zealand



APERC

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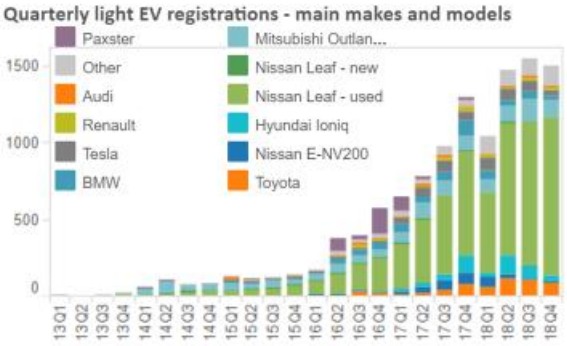
EVs now over 2% of all light vehicle registrations



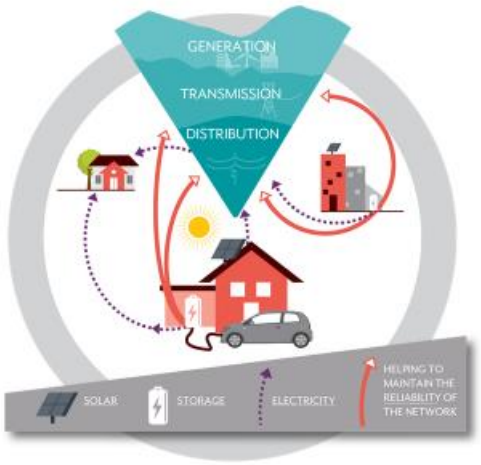
https://www.transport.govt.nz/mot-resources/vehicle-fleet-statistics/monthly-electric-and-hybrid-light-vehicle-registrations/

APERC

14

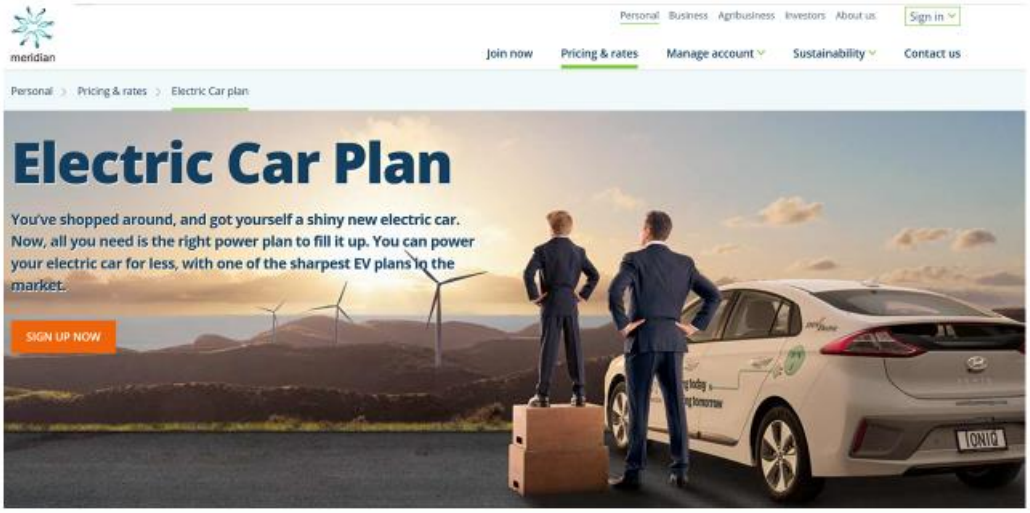
NZ's open and competitive electricity system

- Open, competitive, permissive electricity market
- Half-hourly spot market with wide diurnal and seasonal variations
- Markets for frequency keeping, voltage support, black start and demand response; hedge market
- 80%+ voluntary smart meter uptake
- 37 electricity retailers compete, setting their own pricing; annual switching rate over 20%
- 8 major generators, 650 small generators + PV



APERC 15

Some retailers offer special EV tariffs for EV owners



APERC 16

Innovation in retailing electricity

- Some retailers offer half-hourly spot market pricing to residential customers, plus fixed margin
- Customers set phones to receive an alert when prices or CO_2 emissions are low or high
- EV owners can use alerts to know when to start or stop charging

Most New Zealanders willing to charge off-peak

http://flipthefleet.org/2017/media-release-ev-owners-targeting-night-time-charging-deals/

What's coming next in NZ: 100% electric 130 pax ferry

APERC 19

Summary

- 85% renewable electricity generation
- Fiscal support: NZ$7 million/year fund for innovative EV projects and RUC exemption but no purchase price subsidies (previous failures with CNG and LPG vehicle subsidies)
- 95% state highway coverage with 50 kW DC fast chargers
- EVs now over 2% market share with no purchase price subsidies but with used-EV imports at close to price parity
- Electricity retail pricing innovation enabling platform for next generation of charging ... aggregated/managed charging

APERC 20


Kia ora