Future Technology of Smart Mobility

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About APAS...

- *Since 2006*
- *Established by ITC*
- *Hosted by HKPC*

150+
Completed Projects

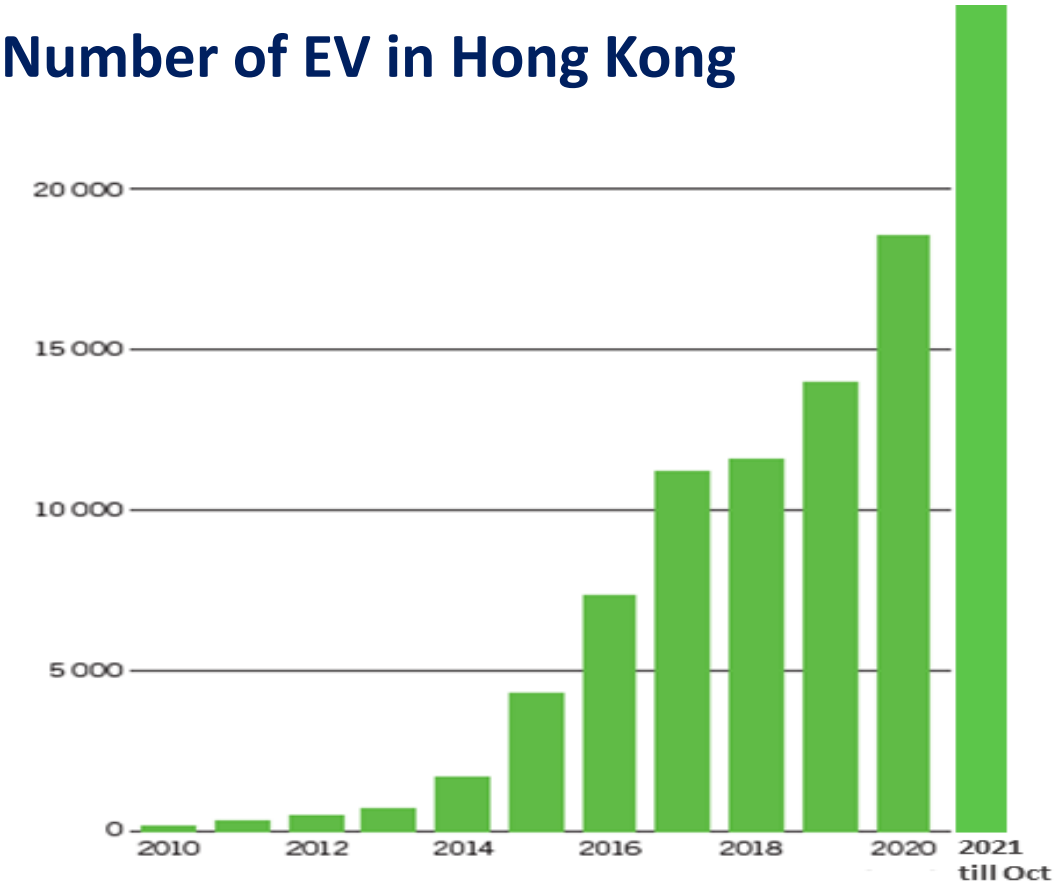
60+
On-going Projects

10
Local & International Awards

50+
Patents Granted

EV Popularisation in Green Way

Number of EV in Hong Kong



The wider or eventual full adoption of EVs will be a key element that drives Hong Kong towards the vision of "Zero Carbon Emissions • Clean Air • Smart City".

EV technology development suitable for Hong Kong local market

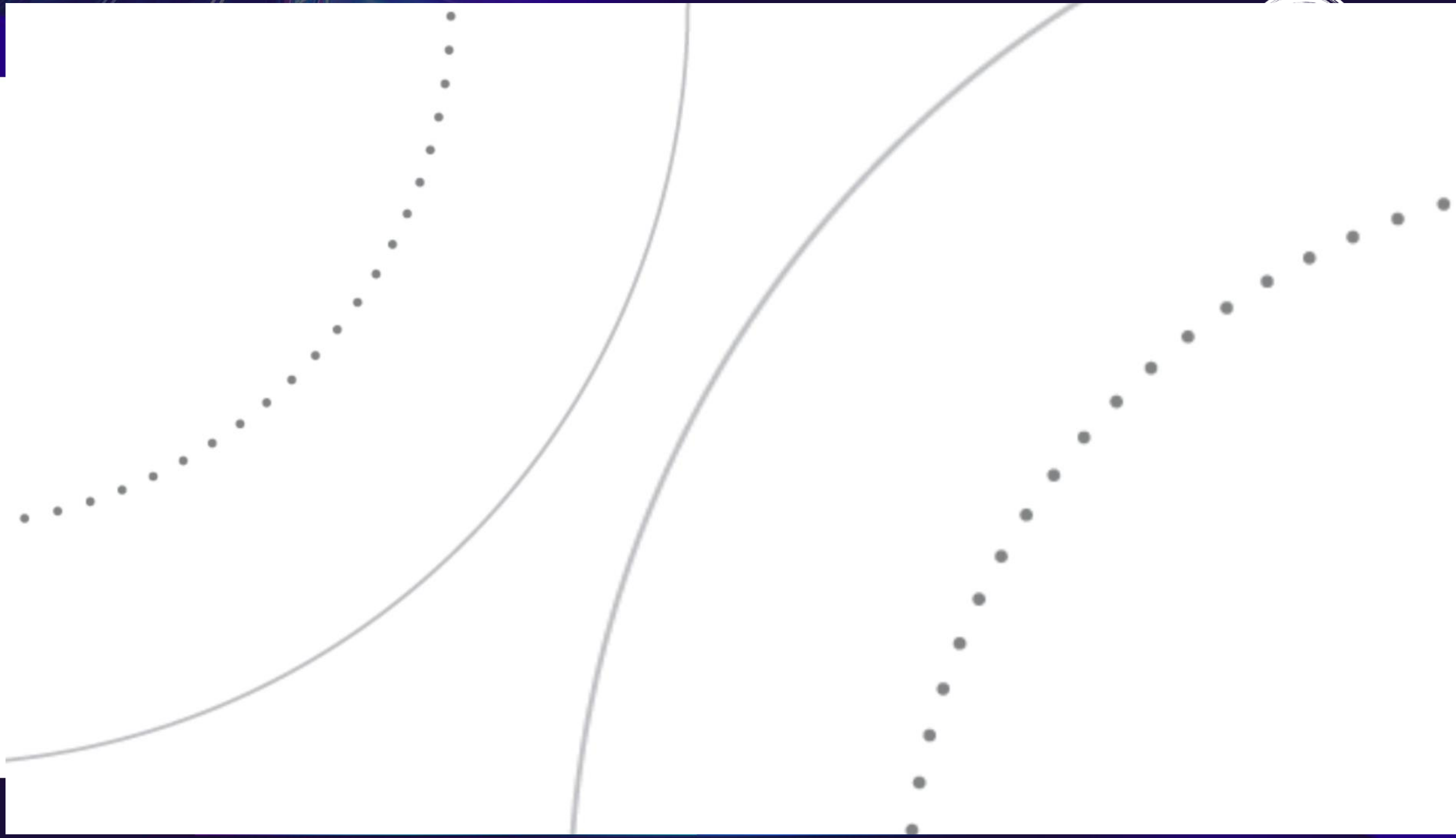
- Commercial vehicle application with pantograph HPC and swappable battery
- Hydrogen technology for automotive

Increased demand of charging

- Fast charging technology
- Off-grid application
- Adaption of clean, sustainable and renewable energy

Electric Vehicle Charging Technologies

	Plug-in	Pantograph	Wireless Charging	Swappable Bettery
				
Charging Power	50 kW – 450 kW	150 kW – 450 kW	3.7 kW – 100 kW	N/A
Standard	CHAdeMO / IEC-CCS / GB	IEC-CCS + OppCharge	SAE J2954 (up to 11 kW)	No Unified or International Standard
Advantages	• Most common and mature technologies • Relatively easy to install • Support smart charging	• Support different brands of vehicles (OppCharge) • Fully automatic operation	• Fully automatic operation	• Recharge electric vehicles in minutes
Disadvantages	• Manual operation required	• Installation is more complicated than plug-in chargers, the height of the column device is up to 4-5 metres high	• Temporarily supported up to 11 kW (SAE J2954) • Energy efficiency is slightly lower than contact type • The online charging while driving requires the wireless charging coil to be hidden under the road surface of the entire road section	• There is no unified or international standard for the time being • Require a lot of space to install the mechanical equipment of the replacement centre



Pantograph High Power Charging Solution for Electric Commercial Vehicles

- The-first-of-its-kind designed, developed and assembled in HK
- Support international CCS OppCharge standard
- Fulfil busy turnaround cycles required by commercial fleet
- Provide shuttle bus trial service for HKSTP in 2021

Swappable Battery Pure Electric Vehicle

- 7m pure electric vehicle for busy operation
- 7 minutes to swap the battery
- Low-floor design for safe and easy boarding
- Real-time passenger and vehicle running data feedback to fleet operation centre
- Include both minibus and delivery truck version models

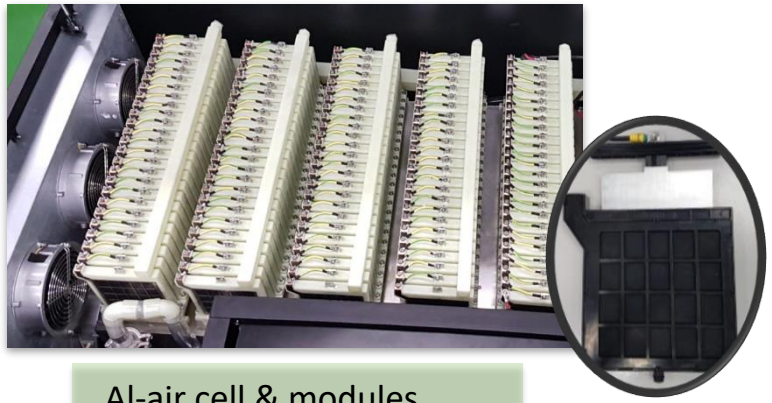
Co-developed with:

瑞昌汽車 SHUI CHEONG MOTORS

Electric Refrigerated Truck with Al-air & Li-ion Battery

- Al-air battery system for automotive application
- Quick loading system for replacement of Aluminum cathode
- Power control system for Al-air battery system
- Two electric refrigerated trucks with Al-air powered refrigerators

5-ton electric truck with Al-air powered refrigerator



Al-air cell & modules

8-ton electric truck with Al-air powered refrigerator

Sponsor:

Ever Crown Technology Development Limited

Solar Energy Powered EV Charging Station

ITT-019-18AP Public Sector Trial: Research and Development of a Smart Vehicle-to-Home (V2H) System for Electric Vehicles

The Police Driving and Traffic Training Centre, Fanling

LED x 8pcs

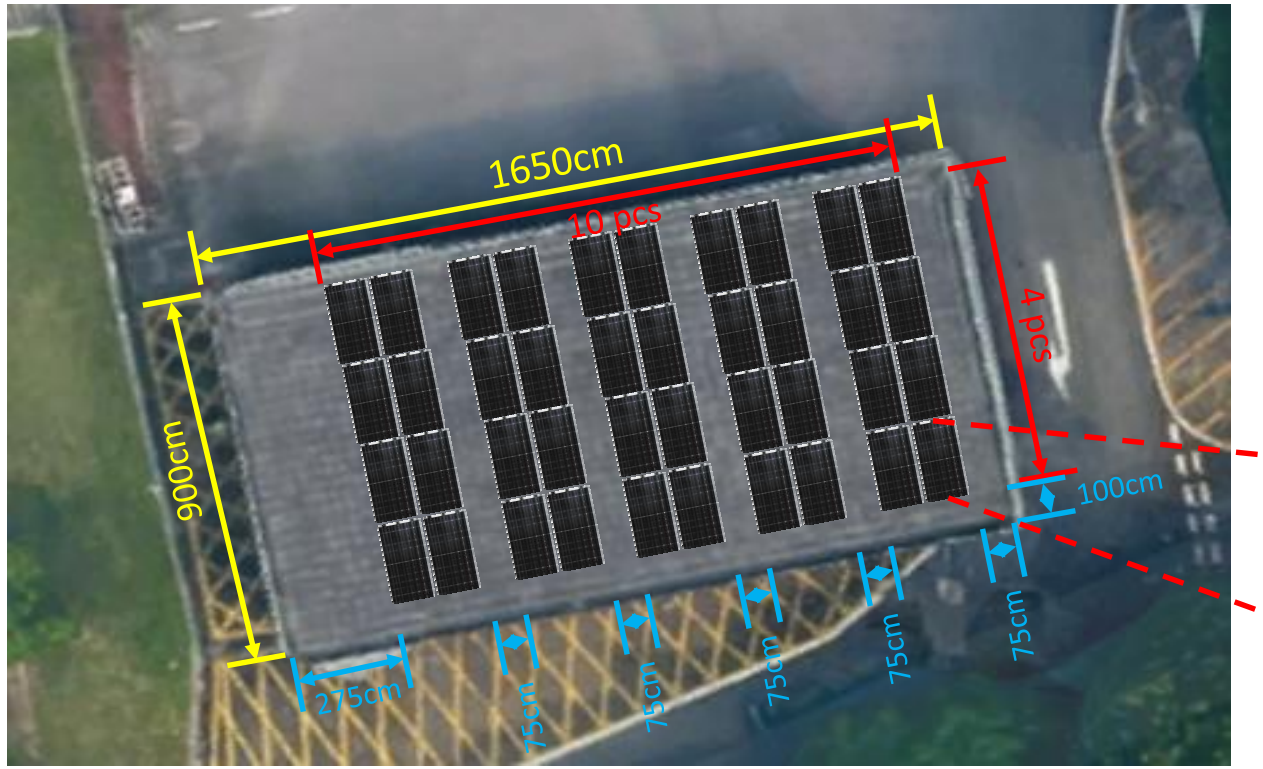
- Utilise only green energy
- Off-grid operation
- Scalable system for higher power
- Easy application with existing infrastructure

Key Figures

- 14.4kW Solar power output
- 104 sqm of 40 solar panels
- Medium Charge Support (7kW)
- 24x7 basis service
- Expandable 39kWh battery

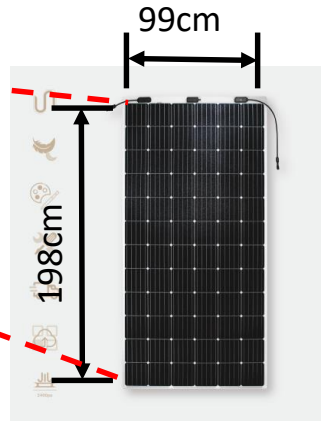
Rooftop Solar Panels Layout

Solar panels (total 40 pcs) are installed onto the rooftop by structural adhesives



Simple instalment method

- Clean the rooftop by high pressure water jet cleaner
- Secure the solar panel firmly onto the rooftop by structural adhesives
- Reserve 75cm space for the path of installation & maintenance



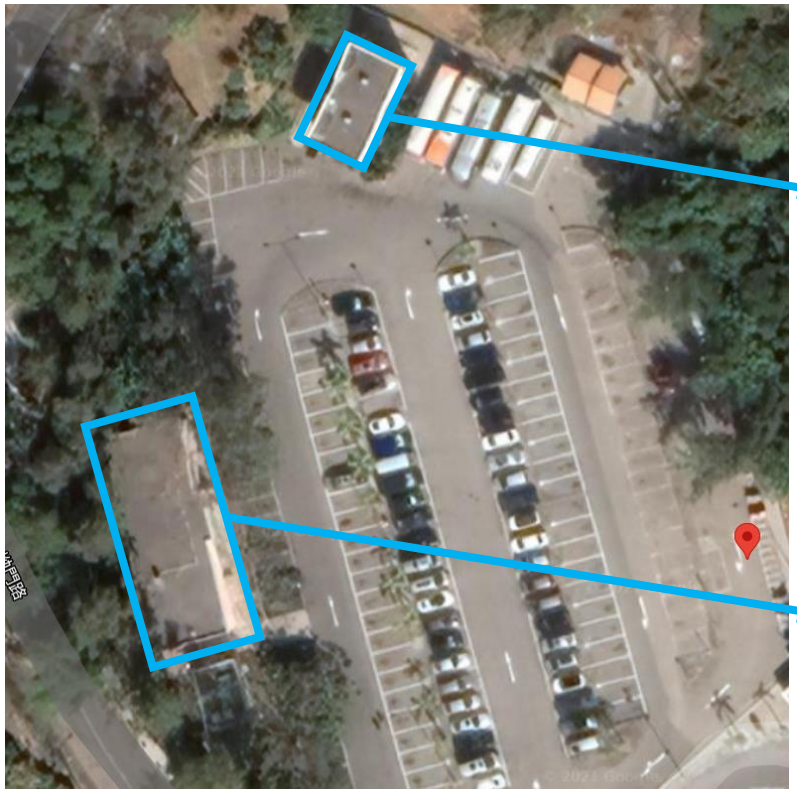
Solar Energy Powered EV Charging Station

Potential Off-grid Application

Charging service in suburban area with easy installation with existing infrastructure

P **Parking lot adjacent to conservation parks**

P **Parking lot with facilities feasible for solar panel installation**



Clear Water Bay Second Beach Carpark

Hydrogen Fuel Cell Powered Charger

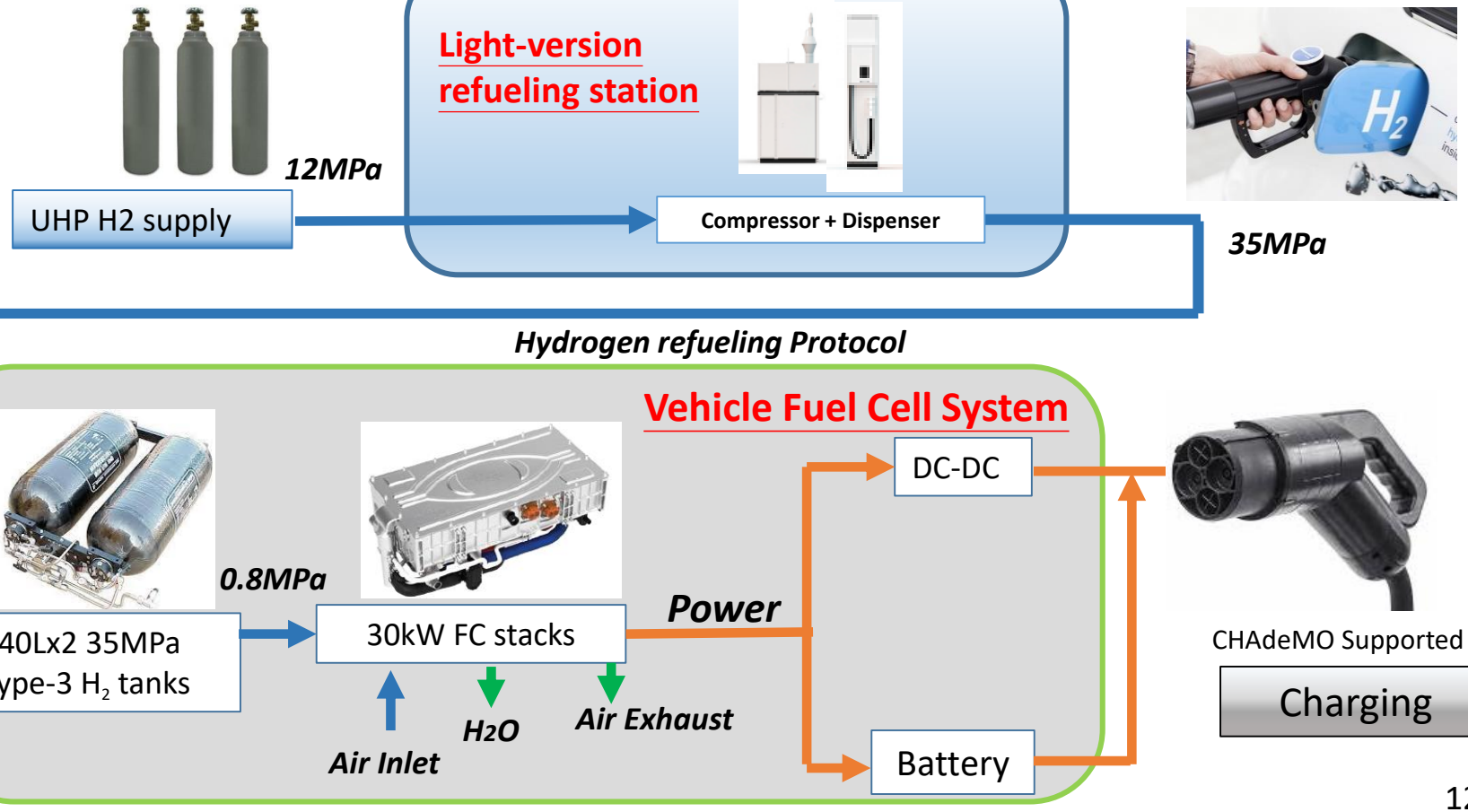
Application with Zero-Carbon Energy

ITP-072-18AP Development of PEM fuel cell technology platform for EV mobile charging system

Project Features

- 35MPa system
- PEM Fuel Cell Engine
- Compatible for on-board application

Green Hydrogen enables **carbon-free** new charging infrastructure



Retired EV Battery Mobile Charger

Application with recycled resources

Retired EV batteries hold 70% to 80% of electricity storage capacity

機電工程署 EMSD

- Mobile EV Charging Service
- Mobile Power Source
- Emergency Power Source

Project Features

- Mixture of different type of battery around 30kWh
- Off-grid portable operation
- Various power out including IEC charging socket

Benefits

- **Repurpose retired EV batteries**
- **Extend life cycle of EV batteries**
- **Moderate carbon emission for EV ecosystem**

EV Development Stages

1st Generation

- *Built from shared platform*
- *Development focus on conversion of powertrain and battery*
- *Twin-models for EV and ICE*

2nd Generation

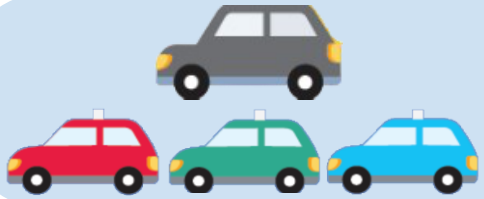
- *Dedicated platform for EV application*
- *Integration of advanced e-drive technologies (Integrated powertrain, new battery material, highly efficient power modules)*
- *Engineered for autonomous driving*

3rd Generation

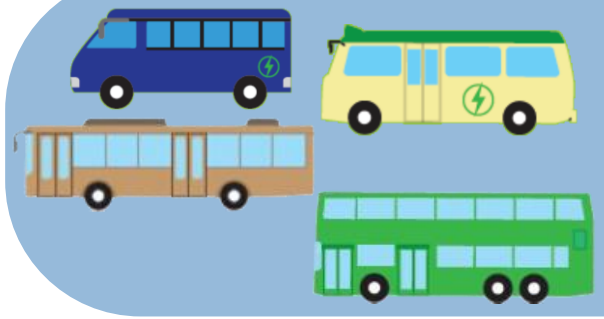
- *Developed for futuristic hydrogen energy*
- *Compatible with full autonomous driving*
- *V2X and IoT technologies onboard*

Opportunities and Challenges in NEV

BEV



- Proven technical maturity



Limited Options:

- Large battery capacity required
- Long charging time

Limited Options:

- Payload sacrificed for heavy battery

HFCEV

- Limited Option

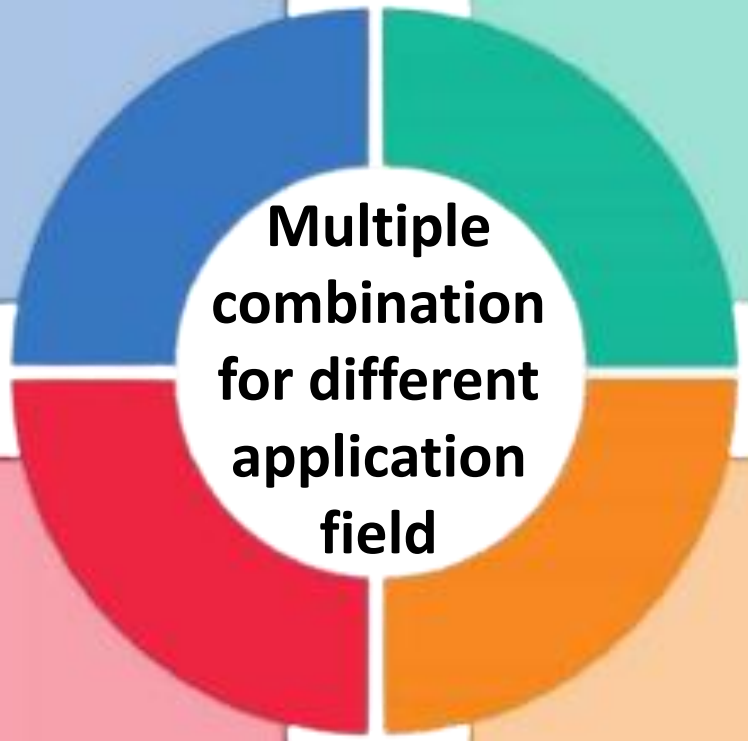
- Few commercial development for the narrow segment

- Technical concept proven in commercial trials

HIECV

- Relatively easy transition from conventional ICE
- Promising payload and efficiency for commercial profile of heavy duty and long distance

Technologies in Hydrogen Powered Vehicle



Hydrogen On-board Storage

Mature:

- Pressurised Tank

Developing:

- Ammonia
- Low-Temp Ammonia
- Metal Hydrides

Drivetrain

Mature:

- E-Drive
- Range Extender
- Hybrid
- Plug-in Hybrid
- Mechanical Drives

Energy Transformation

Mature:

- HFCEV

Developing:

- HICEV

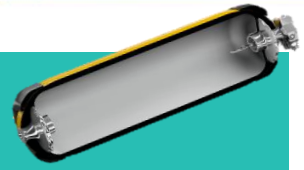
Electric Storage

Mature:

- Battery
- Supercapacitor

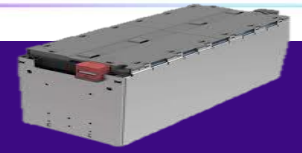
Automotive Fuel Cell Technology

Hydrogen Tank



Higher pressure of 70MPa become popular with lower material cost and process.

Battery



Adaptive battery selection for scalable Fuel Cell system to satisfy demands of power and efficiency performance.

Fuel Cell Engine

- Increase durability of Fuel Cell during load changing and start-stop condition
- Shorten initial time
- Optimise response to load request

E-drivetrain

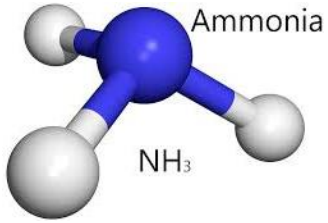
Beneficial from BEV development to adopt latest technology with integrated powertrain and higher voltage platform.

Innovation in Hydrogen Carriers

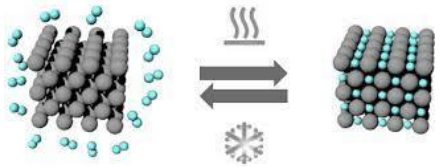
- Hydrogen has the highest energy per mass of any fuel
- However, its low ambient temperature density results in a low energy per unit volume
- Therefore, it requires the development of advanced storage methods that have potential for higher energy density

Material-based Hydrogen On-board Storage Technology

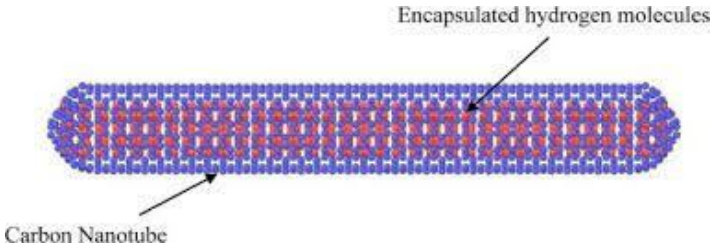
- Chemical Hydrogen
  Low-Temp Ammonia Cracking



- Metal Hydrides



- Sorbent: Carbon Nanostructures



Prospective HICEV

2007 *"World's first production-ready hydrogen vehicle"*

- Same 6L gasoline engine with modification
- Bi-fuel: Gasoline & Liquid hydrogen

Limited dispensing network supporting liquid hydrogen hurdled widespread of the product

OEM or powertrain developers continue development of Hydrogen ICE which suspended decades ago

Advantages of HICEV

- Zero CO_2 emission with Green Hydrogen
- Similar capital expenditure as diesel ICE system
- Better payload with same size as ICE today
- Lower level of hydrogen purity

Obstacles to Overcome

- Common difficulties in hydrogen storage
- Aftertreatment technology to eliminate significant NOx

Suitable Application

Area where BEV/FCEV is hesitantly applicable:

- Heavy-duty vehicles with high power demand and harsh conditions
- Off-road segments

APAS Approach on Hydrogen

- Building up know-how of Hydrogen Fuel Cell EV integration
- Deployment of Hydrogen Fuel Cell on vehicle with forward-looking manner on latest technology trend
- Exploring HICEV's potential where BEV or HFCEV are not applicable

“**Zero Vehicular Emission**” is promised by EV popularisation

“**Zero Carbon Emission**” will be realised with following steps taken:

- **Wider adoption of green energy resource in EV charging**
- **Proactive introduction of solutions with minimal carbon footprint**
- **Taking focus on efficiency during utilisation**

An Industry Study on EV Adoption in HK

Bottleneck & recommendations

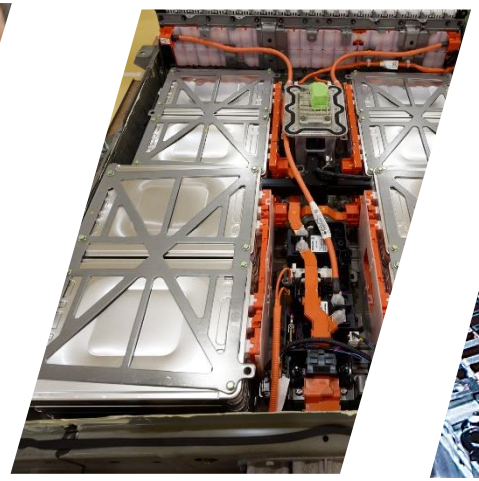
Infrastructure support for ePCs

eCommercial vehicles – RHD & incentives

Higher power charging facilities

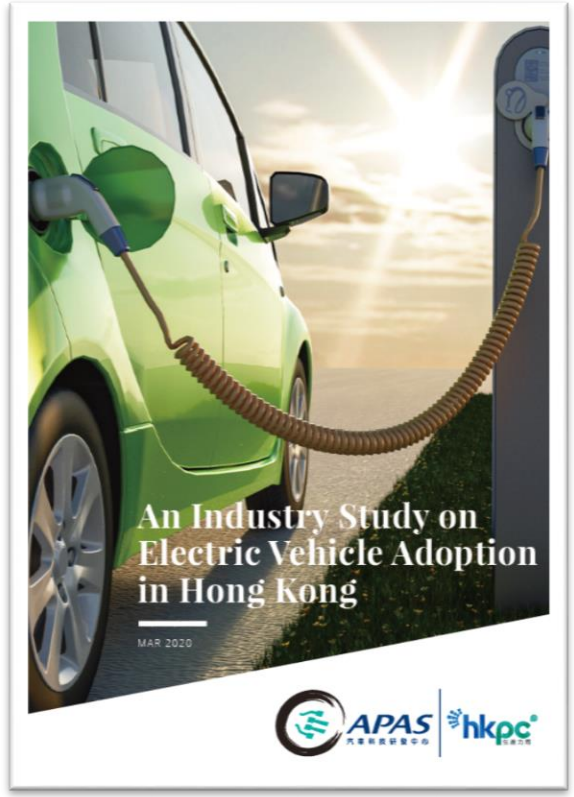
Innovative charging tech

Talent development for EV industry



Decommissioning EV batteries

Support for R&D and testing



EV Roadmap for HK

- APAS advised ePLBs suitable for most green minibus routes in HK
- APAS assisted EPD in selecting 301 possible sites for eTaxi charging and will implement trials in Sai Kung & Lantau regions
- APAS developed 2nd life EV battery prototypes for EMSD & HKAA
- Dedicated trials on 2 units of eCoach to HKIA & HK Anti-Cancer Society + eCV for solid waste handling

Public Light Bus

$80 million trial for e-public light buses to be commenced in 2023

Taxi

Explore with operators for suitable operational mode and EV models for trial

Green Technologies

Cover second life applications of EV batteries in the priority themes under the Green Tech Fund

Green Tech Fund

$200 million Green Tech Fund to fund R&D of green technologies, including EV projects

Green Tech Fund 低碳绿色科研基金

Dedicated Trials

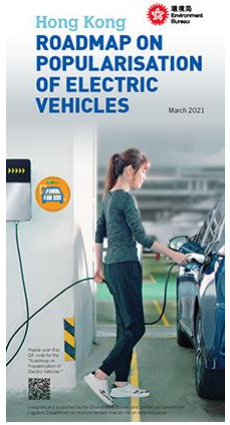
Promoting trials for electric public transport and commercial vehicles proactively, with a view to setting a more concrete way forward and timetable around 2025

APAS Insights for eCommercial Vehicles

- Low business justification for specific tailor-making for the small market in HK
- High power charging (e.g. Pantograph) needs cross-department support (LandsD/BD/HyD/District office/Power companies)
- eCVs restrained by battery capacity vs. payload & driving range e.g. HK cross-border trucks
- Fair feedback from local franchised bus companies
- Proprietary charging standards for eCVs

Green Tech Fund 低碳绿色科研基金

EV-CHARGING AT HOME SUBSIDY SCHEME



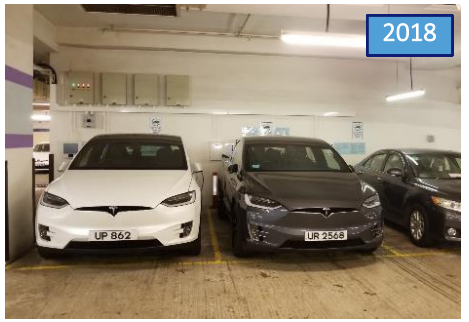
Driving force

- New Energy Transport Fund/Green Tech Fund
- Incentive for commercial fleet
- APAS & ITC fund to assist localisation & R&D e.g. ePLB/eCV
- ITC Public Sector Trial Scheme

APAS Development on Charging Facilities

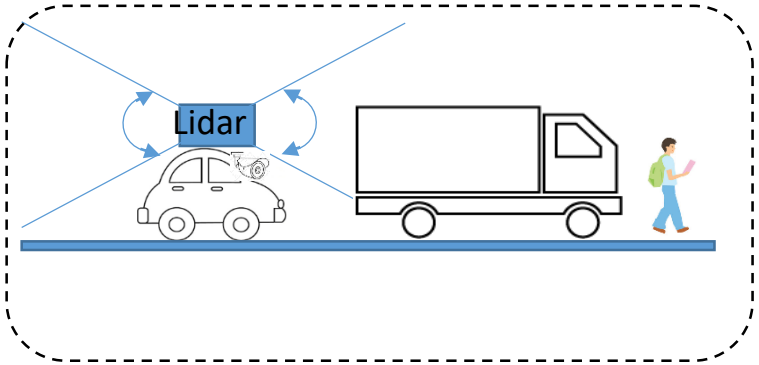
- Development of 13A to Superfast Quick Chargers
- Load management with OCPP capability
- Vehicle-to-Home (V2H)
- EPD - The EV-charging at Home Subsidy Scheme
- Super Fast Charging / Pantograph
- Consultancy service for EPD on identification of possible Quick Charger site locations in 18 Districts
- Feasibility study for EPD on ePLB and associated fast charging facilities

CLP 中電

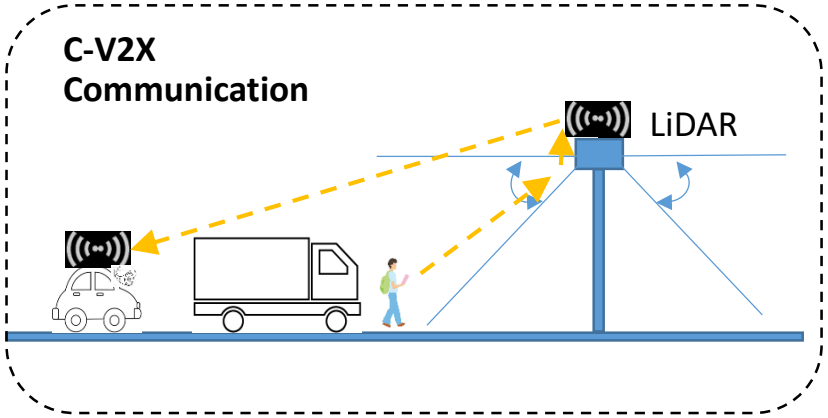


HONG KONG HOUSING SOCIETY

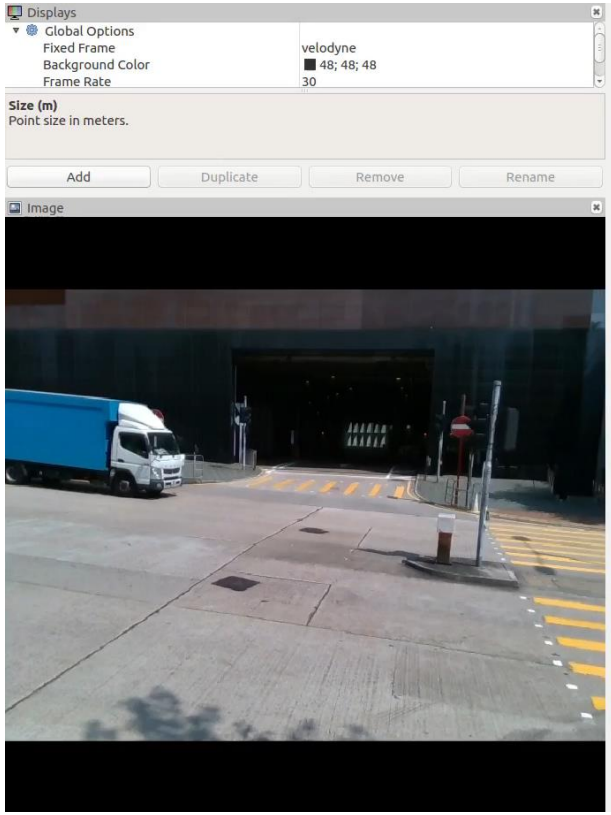
Autonomous Vehicle Active Safety Control System Based on Roadside LiDAR and V2X Communication

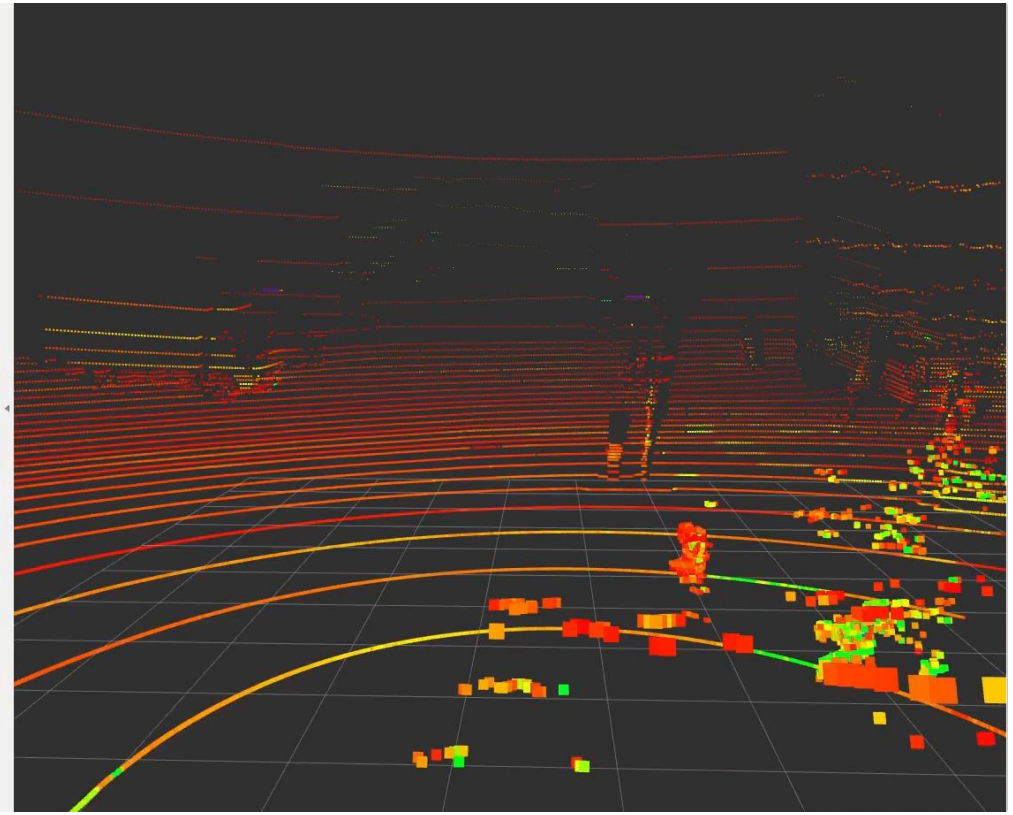


Current stage



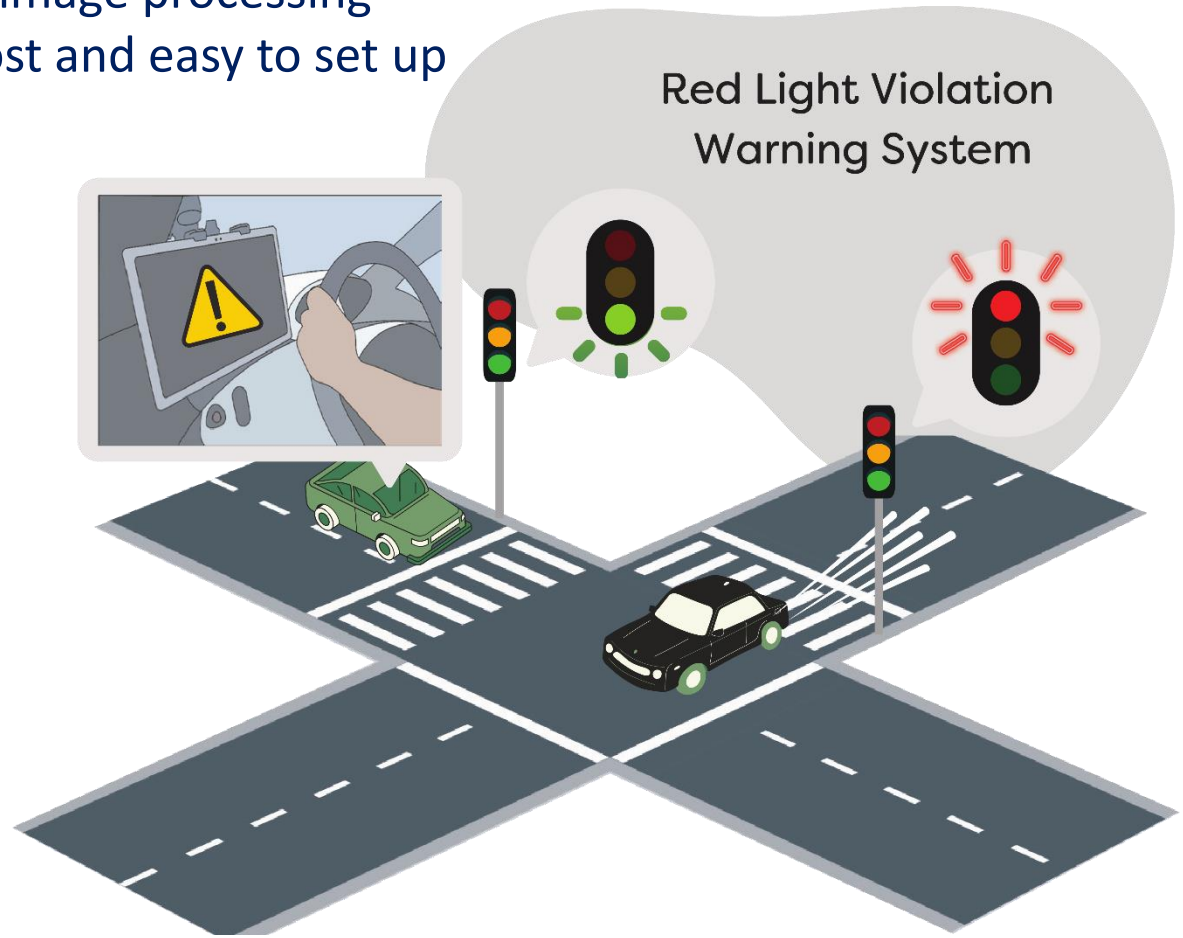
Roadside LiDAR with bird's-eye view perception for active safety control

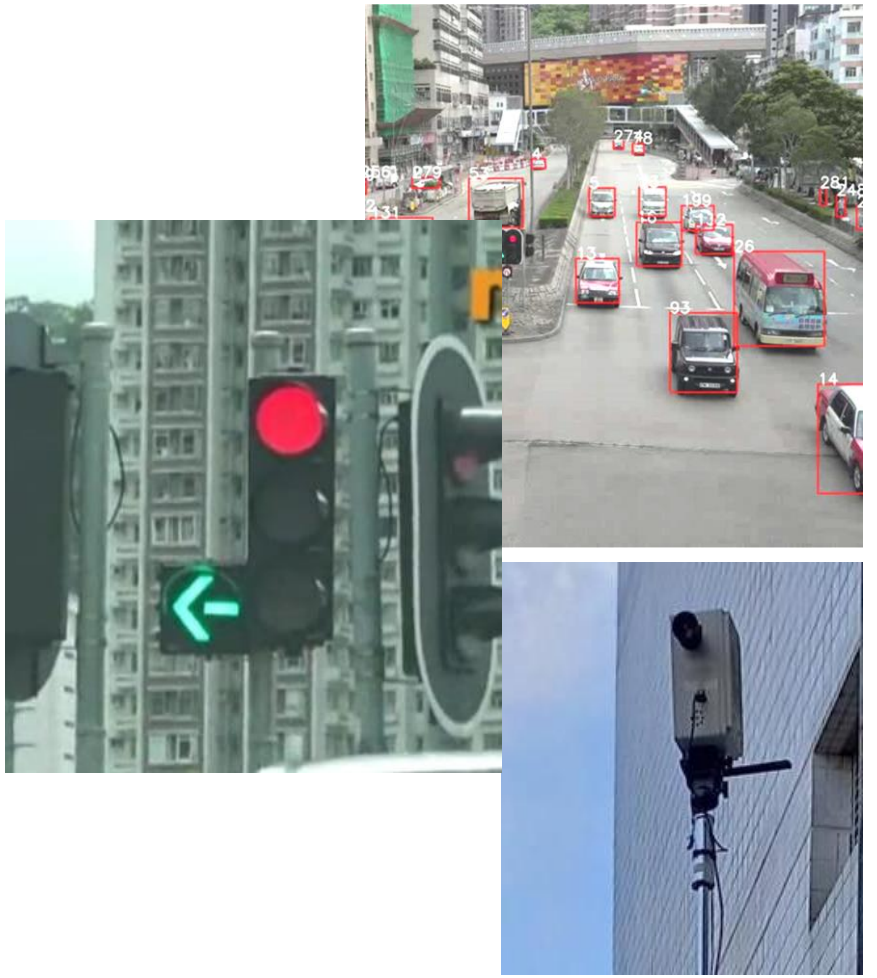




Red Light Violation Prediction System using Image Processing

- Roadside traffic safety monitoring and warning system
- Prediction for red light violation
- Purely image processing
- Low-cost and easy to set up





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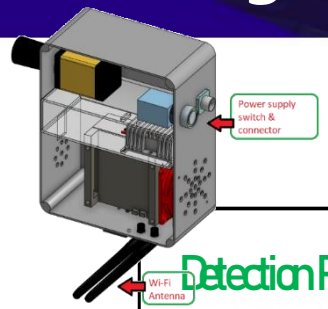


Detection Platform for Red Light Violation

4-direction Video captures for vehicle

Pedestrian video captures

Emulated traffic light signal status

Intersection Collision Avoidance Module

V2I interface

RSU

Coordinates of Intersection region

Vehicle violation location

Pedestrian violation location

Intersection Collision Warning (due to possible collision)

On Board Unit

If without GNSS signal from car

Equip GNSS signal

RSU/OBU: optional

①

HMI in car: On-board Unit

HMI interface

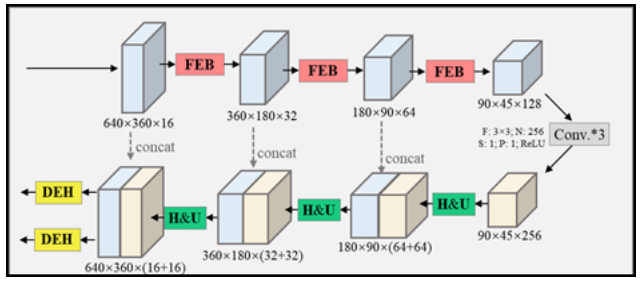
Safety alert to driver

In-car Gate way

ABS control module

Automatic emergency brake (partial brake / full brake)

② HMI: LED panel next to traffic light by local LAN (i.e. w/o C-V2X)



Distance Estimation Network (DEN)

Red Light Violation Prediction System using Image Processing

APAS 汽車科技研發中心

> 96%

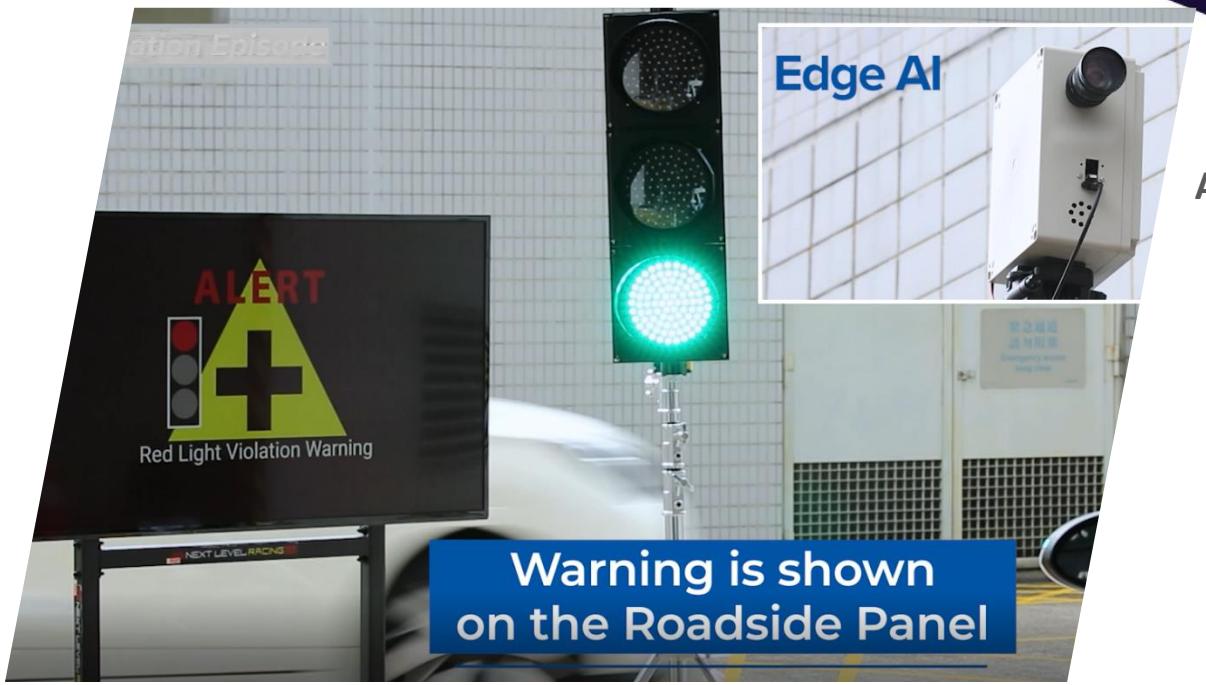
True Alarm rate on Vehicle RLV

- Left turn red light violation
- Right turn red light violation
- Straight pass red light violation

≤ 1%

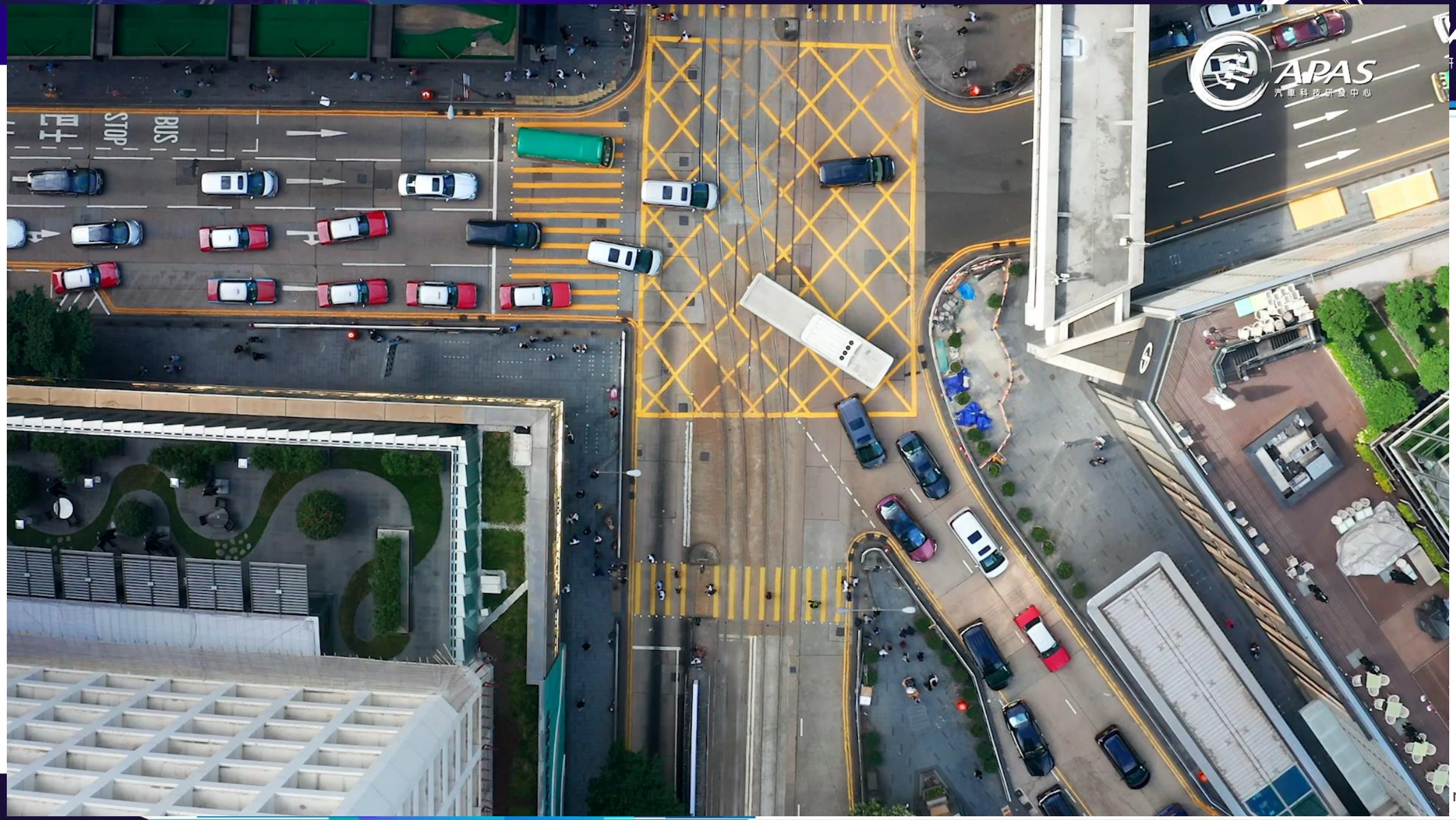
False Alarm Rate

False alarm



Achievement

Can provide reaction time (ΔT ~1sec) to subject vehicle & other road users near the intersection



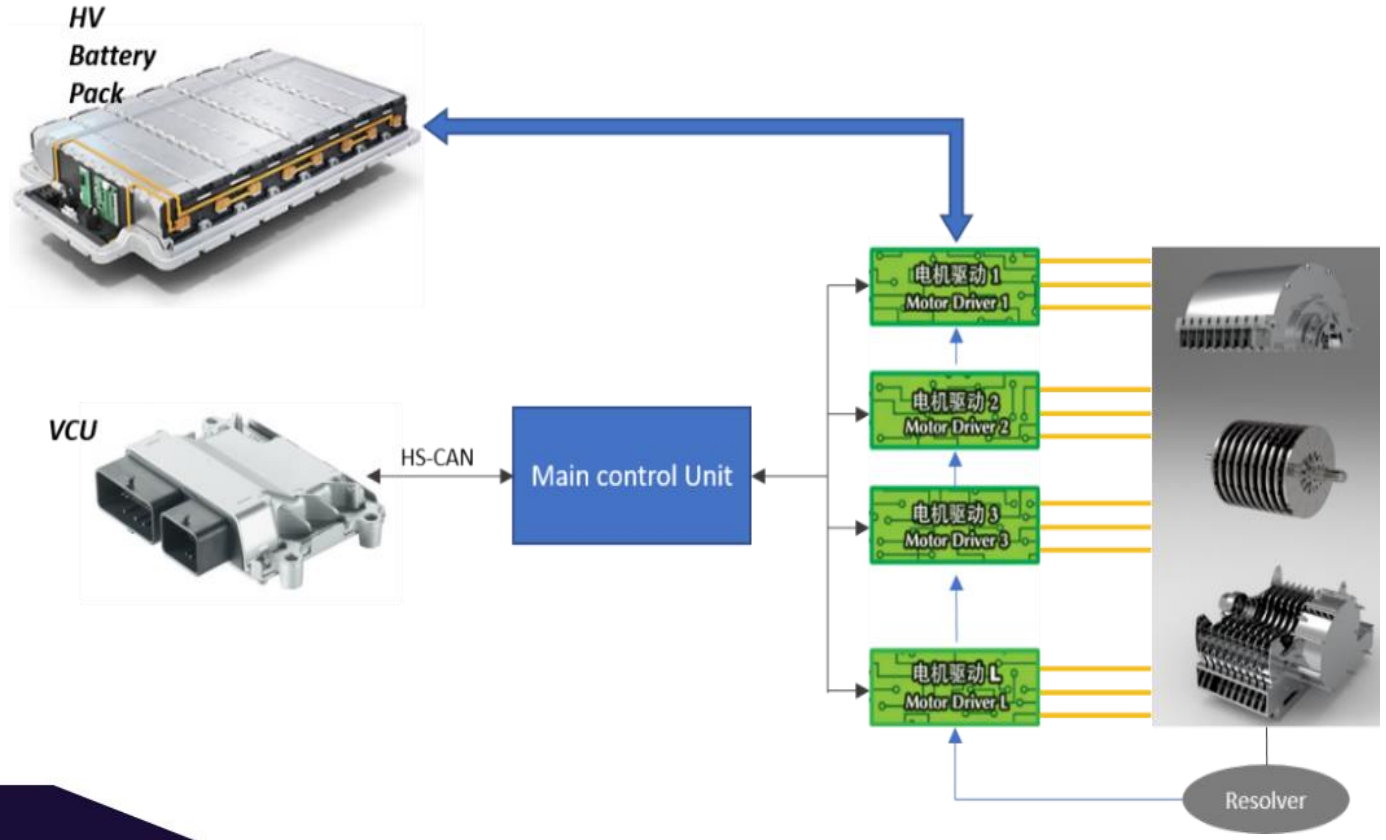
High-efficiency Multi-layered Axial Flux Motor Control System

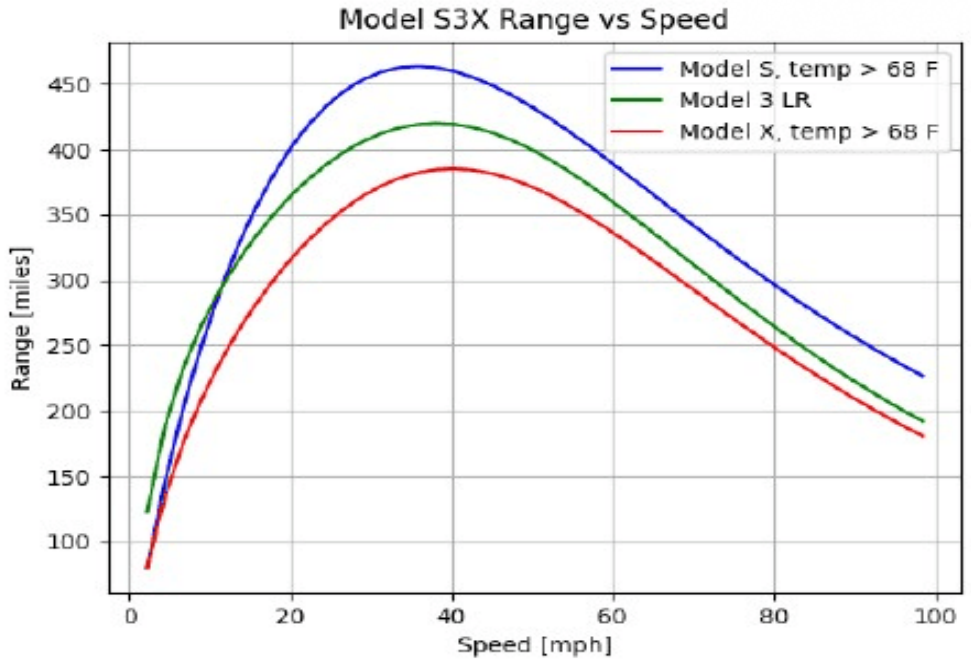
Problems:

As key part of EVs, conventional motor (radial flux) hit the bottleneck during extensive development.

1) Efficiency is reduced by ***20%~30%*** during low-speed high load or high-speed low load

2) Larger volume and higher weight



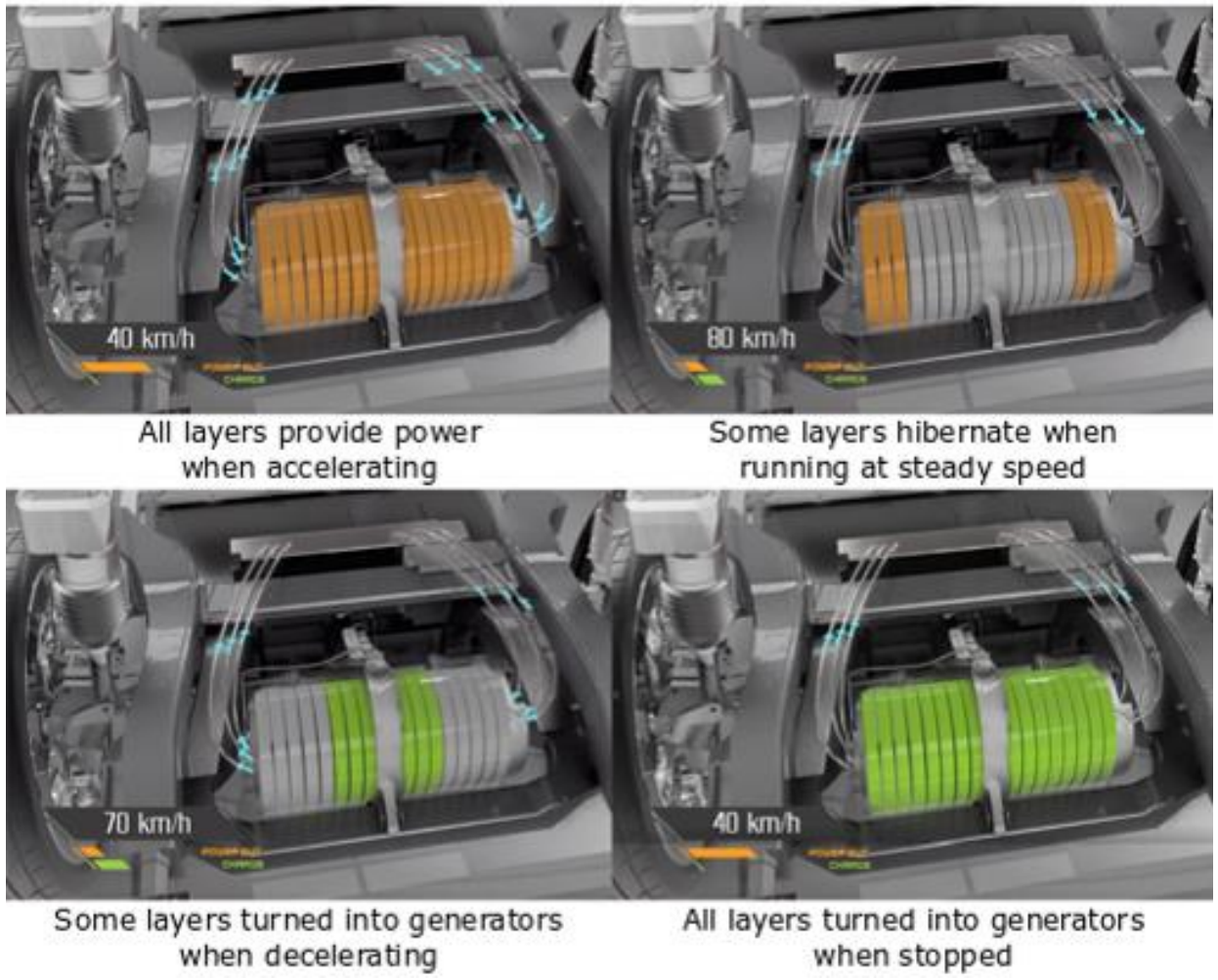


High-efficiency Multi-layered Axial Flux Motor Control System

Proposed Solutions:

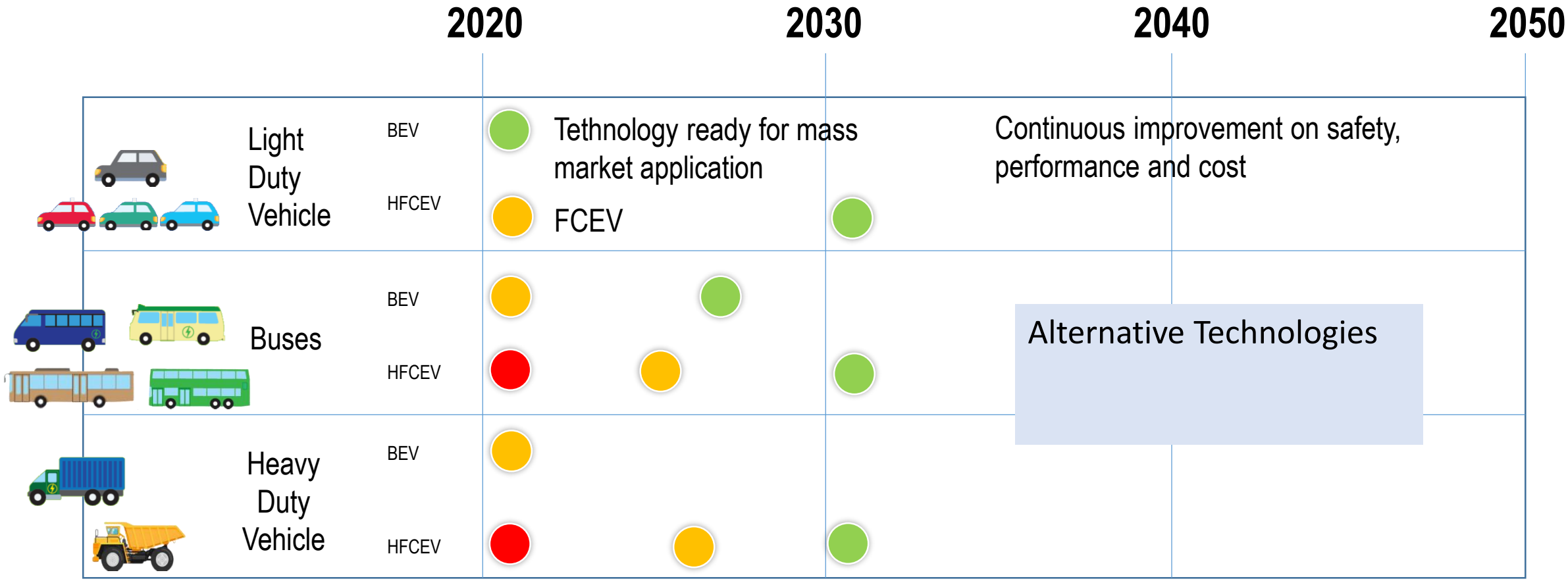
Develop a 100kW high performance multi-layered axial flux motor (MLAFM) control system.

- MLAFM with shorter flux path, no coil overhang, no iron core and multi-layered configuration
- SiC-based multi-channel drivers and main control module are integrated into one compact unit
- Control each layer separately to achieve high dynamic performance and efficiency, under different working conditions (acceleration, steady speed, deceleration)



THANK YOU

Timeline of Technology Readiness



EV Development Stages

PHEV

- *Phasing out in private cars segment under proactive regulations*
- *Still have potential as transitional solution for commercial cars*

BEV

- *Rapid technology innovations in key systems (battery, E-drive system) to improve safety, performance and economy*
- *Widely spread charging network and upcoming ultrafast charging enable a convenient use of E-Vehicle*

Hydrogen

HFCEV

- *Technology is commercially applicable*
- *Prospective future with supportive infrastructure network*

NEV = New Energy Veh.
PHEV = Plug-in Hybrid Electric Veh.
BEV = Battery Electric Veh.
HFCEV = Hydrogen Fuel Cell Electric Veh.