Global Outlook of Electric Vehicle Development & Their Infrastructure

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Academician, Chinese Academy of Engineering
Fellow, Royal Academy of Engineering, U.K.,
Founding President, World Electric Vehicle Association
Honorary Professor, University of Hong Kong

Keynote Speech
2012 APEC Workshop on EV Connectivity

Historical Document Signed at EVS.9

Committing Support to Formation of World Electric Vehicle Association

16th November 1988

Memorandum of Understanding

1 The undersigned, representing throughout the world a large majority of the organizations and people who, in their respective countries, undertake the development of electric road vehicles or, more generally, electric propulsion, indicate by this memorandum their desire to join forces and share their experiences.
Therefore they resolve to convene within the framework of a worldwide organization, the aims and structure of which are described hereunder.

2 The aims of the worldwide organization are:
- to facilitate the exchange of information which encourages the development of electric vehicles;
- to coordinate the schedule of "EVS" symposia to be held once every two years and, by rotation, in the three geographical zones: American continent, Asia and Pacific, Europe and Africa
Using this principle, EVS 10 will be held in the Asia-Pacific zone and EVS 11 in the Europe-Africa zone, following EVS 9 in Canada
This world organization has strictly no authority over national or regional meetings but specifically reserves all rights for future "EVS" worldwide symposia, avoiding, by appropriate contacts, duplication and fruitless competition

3 To establish this world organization and achieve the above aims, avoiding costly administration, Canada has been asked to help for an initial period and has graciously agreed to provide a centralised Secretariat, under the direction of a Steering Committee composed of a limited number of representatives of the three geographical zones nominated by the organization active in electric vehicle development within these zones

This Steering Committee is entrusted to propose as soon as possible general working rules for the world organization, to the success of which the undersigned are committed and for which they pledge to devote benevolently their utmost efforts.

Toronto, Canada
November 15, 1988.

16 novembre 1988

DÉCLARATION

1 Les personnalités soussignées, représentant sur le plan mondial une large majorité des organismes et personnes participant dans leur pays respectif ou zone d'influence au développement du véhicule électrique routier ou de façon plus générale des engins de propulsion électrique, marquent par le présent mémorandum leur volonté de joindre leurs efforts et de partager leur expériences..

C'est pourquoi ils conviennent de se rencontrer au sein d'un organisme à l'échelle mondiale dont les buts et la structure sont définis ci-après.

2 Les buts de cet organisme sont :

- de faciliter l'échange de toutes informations susceptibles de favoriser le développement du véhicule électrique;

- de coordonner l'organisation des symposium "E.V.S." au rythme d'un tous les deux ans, par rotation entre les trois zones géographiques : continent américan, Asie-Pacifique, Europe-Afrique. Ce principe de rotation entraînera l'organisation d'E.V.S. 10 dans la zone Asie-Pacifique et d'E.V.S. 11 dans la zone Europe-Afrique, après EVS 9 tenu au Canada.

MEMORANDUM SIGNED FOR WORLD ELECTRIC VEHICLE ASSOCIATION

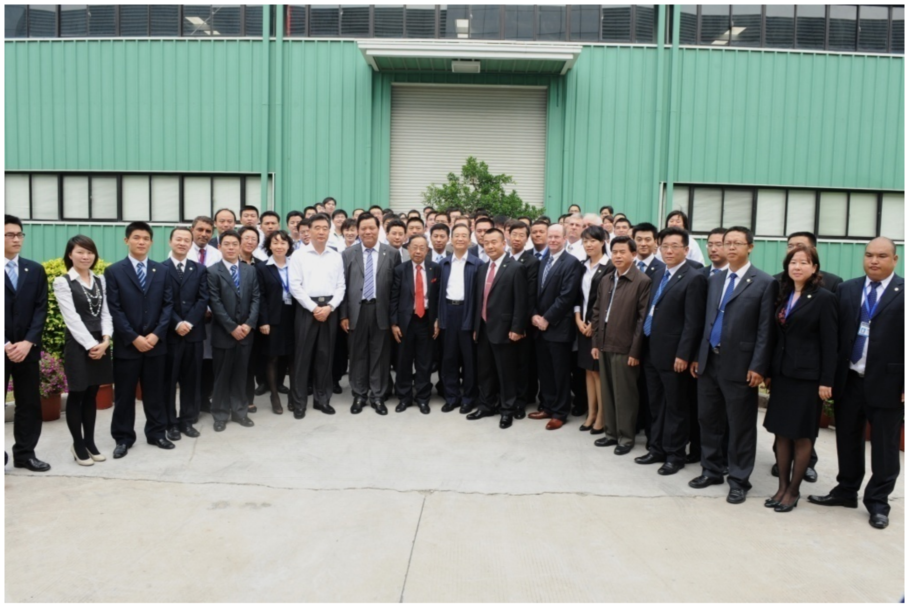
Participants from Top left: B. Fijalkowski (Poland), R. Atanassov (Bulgaria), H. Payot (France), C. Hayden (U.S.), Z. Feng (China), W.A. Adams (Canada), Bottom left: M. Chiogioji (US), R. Leembruggen (Australia), J. Lea (Korea), L. Secord (Canada), C.C. Chan (Hong Kong), F. Dierkens (A.V.E.R.E.), A. Ananthakrishna (India), T. Matsuo (Japan). The above gentlemen signed the memorandum of agreement for the formation of a World Electric Vehicle Association during EVS.9 last November. Cliff Hayden (US), Ferdinand Dierkens (Europe) and Dr. C. Chan (Asia) have been appointed a steering committee.

总理情切关怀
Premier’s Consideration

温总理：
我国电动汽车产业正处在一个关键时期

Premier Wen Jia-bao:
In our country, EV Industry is in crucial phase.

2010年11月15日



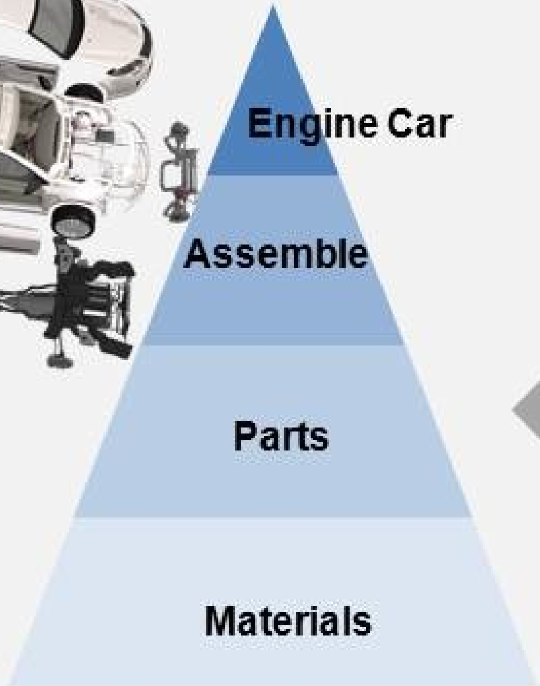
Executive Summary

- The train of EV commercialization has taken off. We are seeing the dawn.
- Key challenges of success: Cost; Usage Convenience; Energy Saving and Emission Reduction.
- The market will not do it by self. Government incentives are essential at the beginning.
- Innovative Regulatory Leadership is essential.
- Technical solutions are available.
- The shake hand and compromise between auto industry and electric power industry is crusial.

Changes in Automotive Industry

Internal Combustion Engine Car

Engine, Gasoline



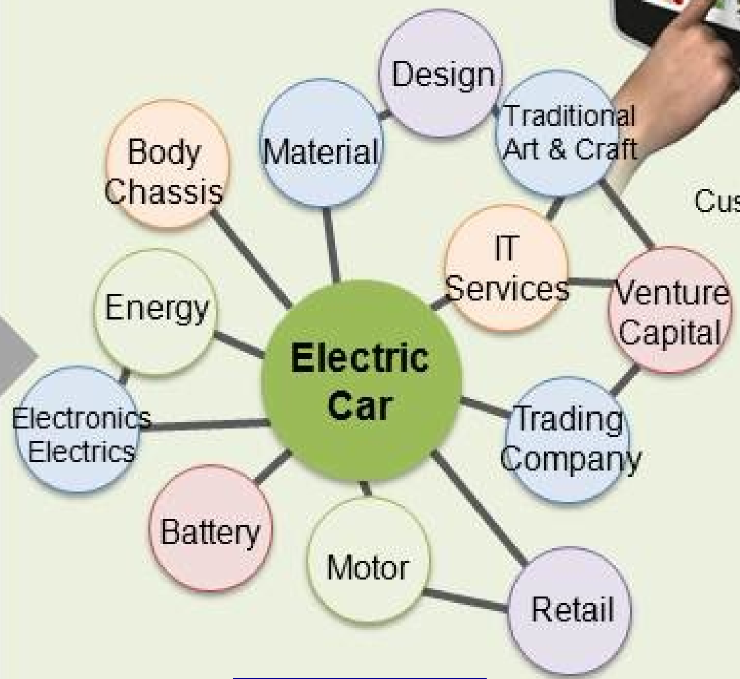
Unification

Closed (Inhouse)
Long Span R&D
About 30,000 Parts

Electric Car

Battery, Motor

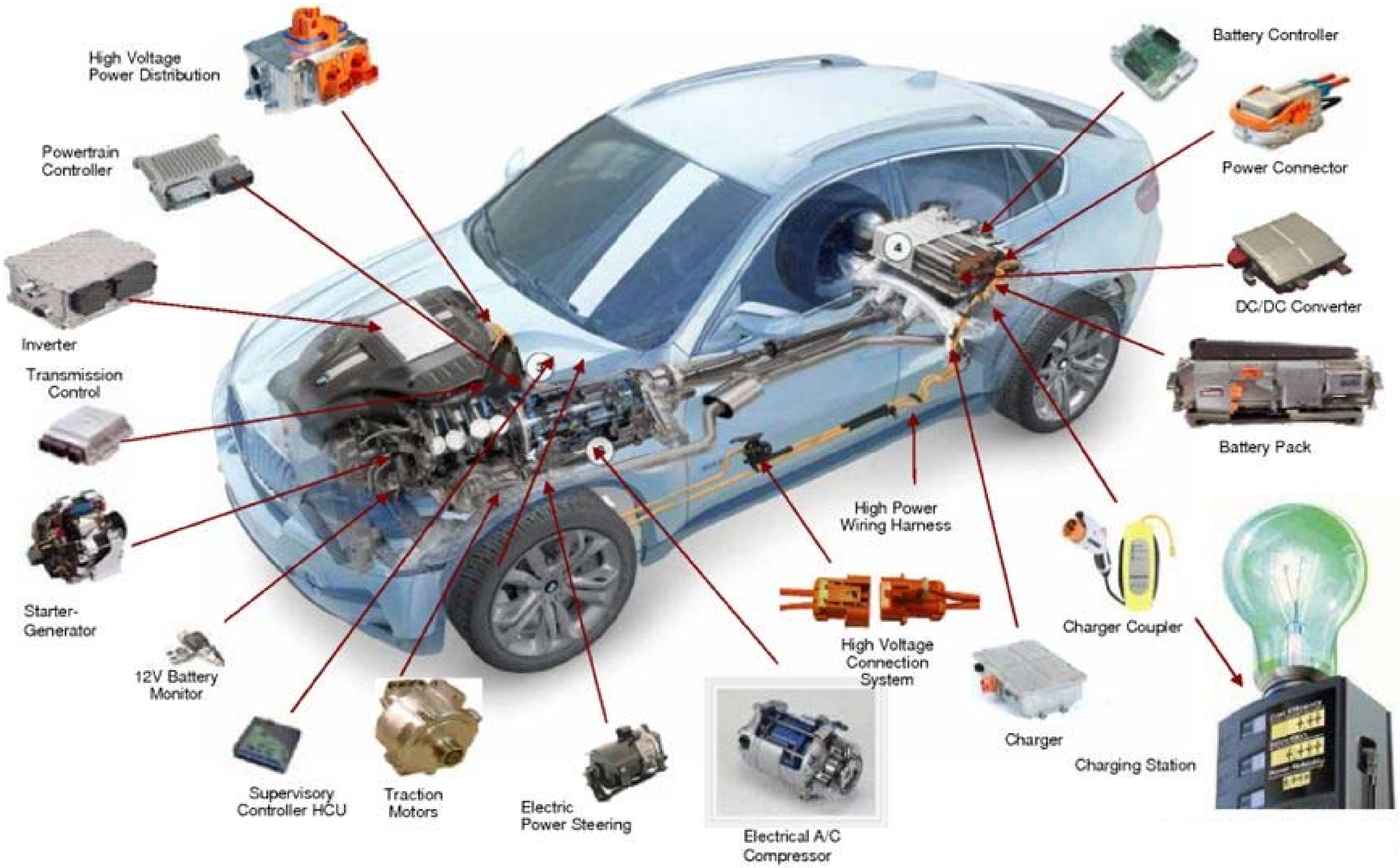
Order like Customizable PC



Assemble

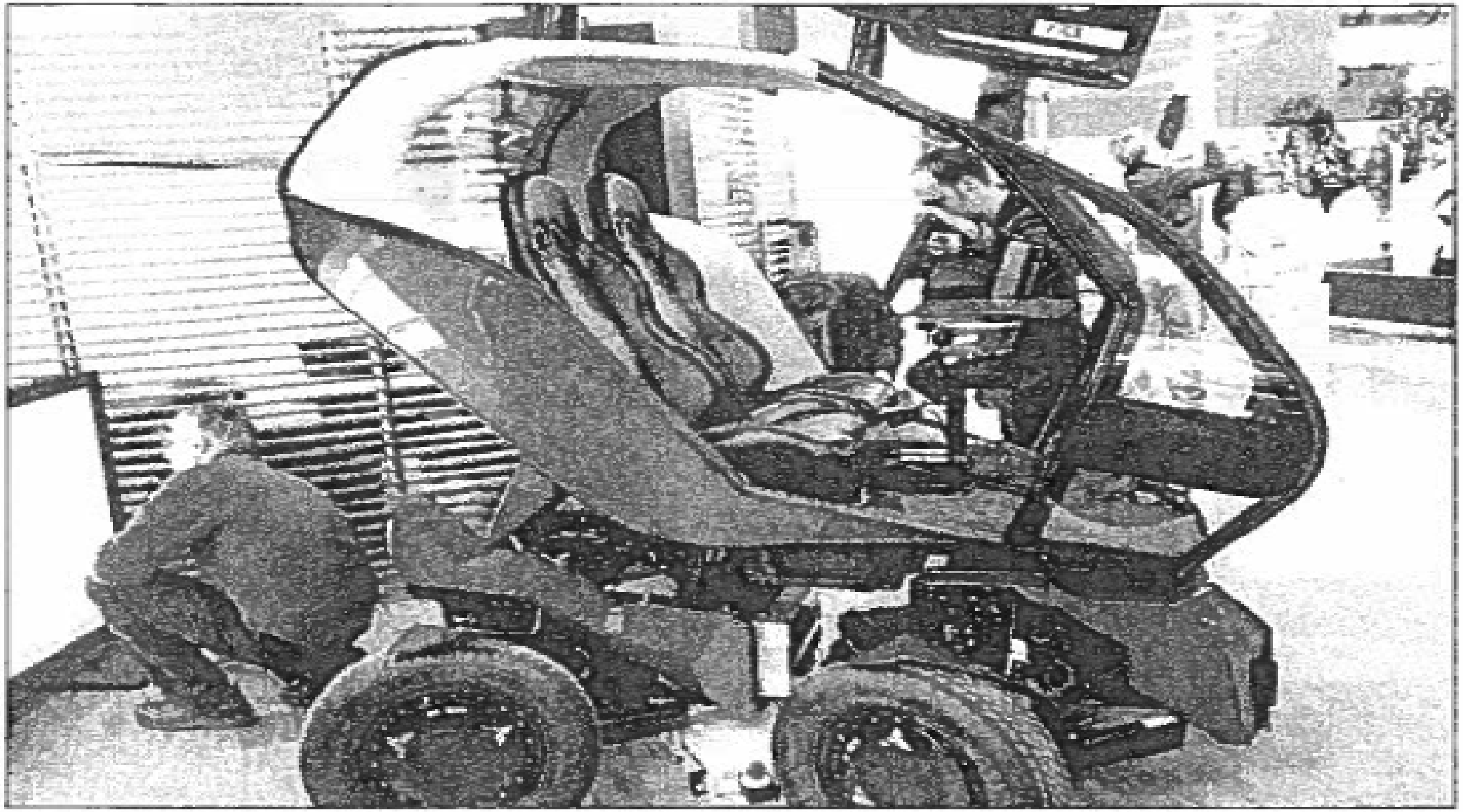
Opened (De facto Standard)
Venture, Speed
About 5,000 Parts

Electric Key Components Play Vital Role in EV/HEV

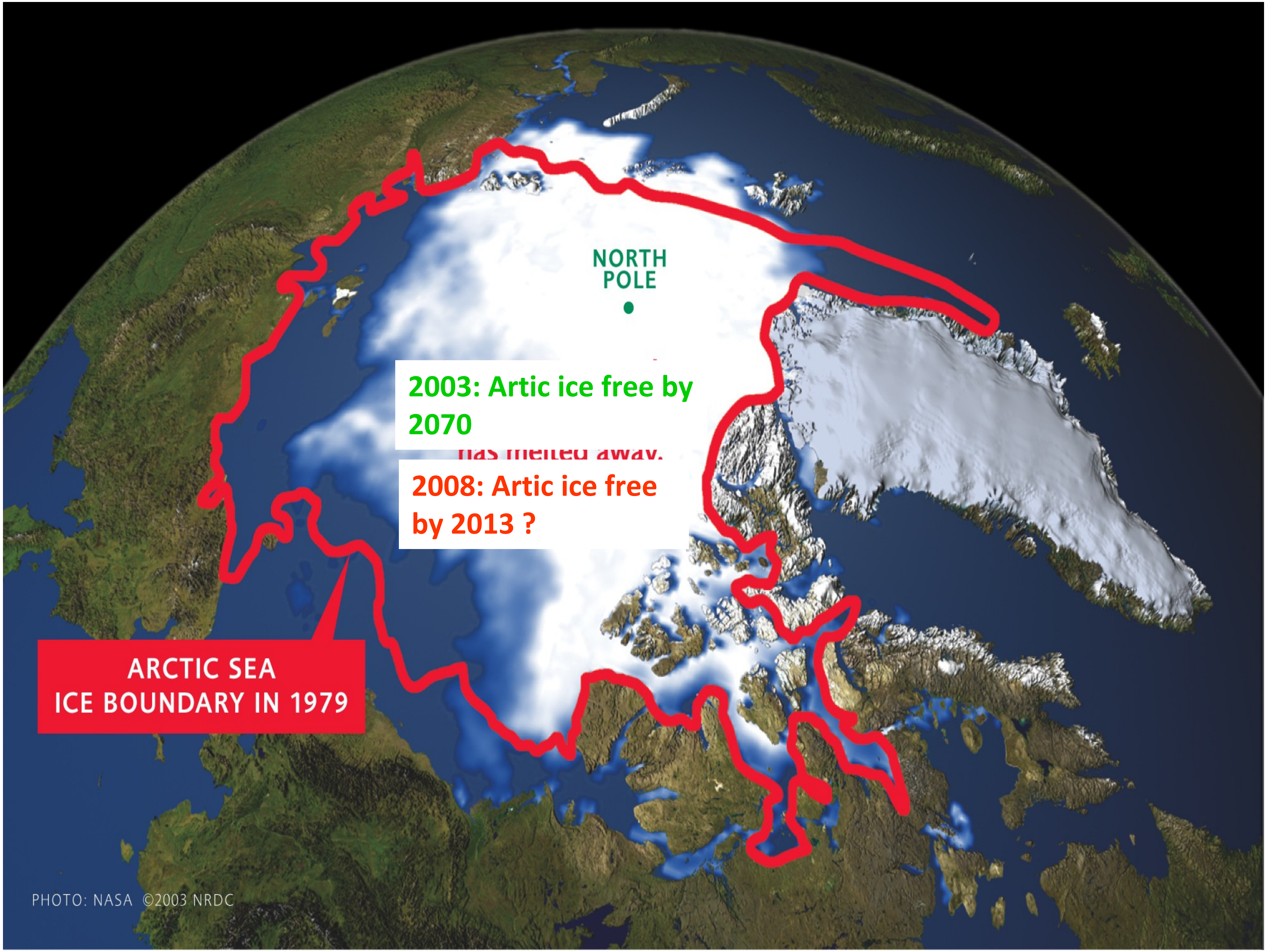


The electric vehicle is has a lot of publicity but : E-mobility is all electric transports, not just EVs

High speed trains, electric buses, people transporters, city merchandise, electric ferry boats, trolley buses two-wheelers, …



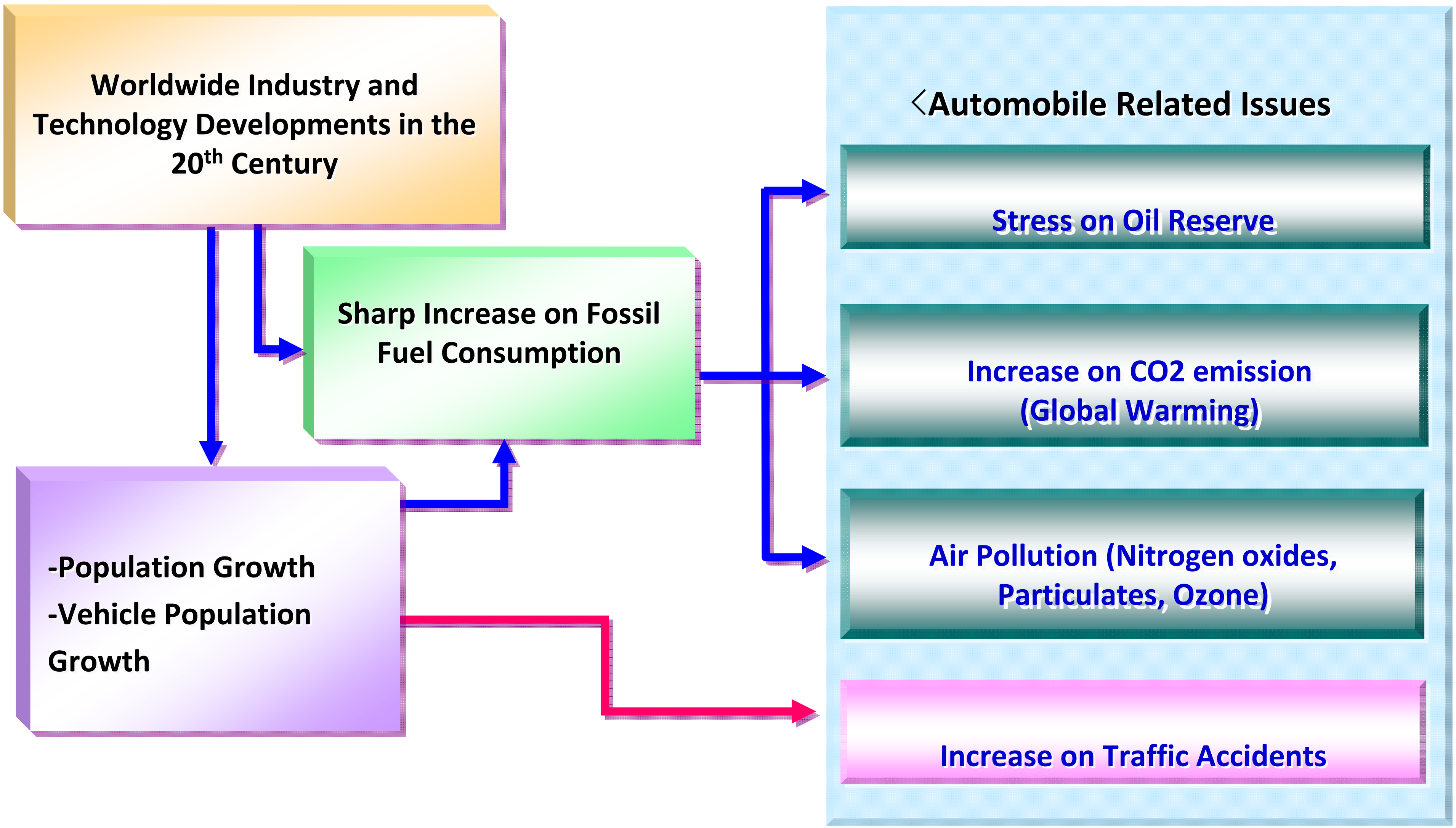
A PLANE?
A LUNAR ROVER?
NO. THE CAR OF TOMORROW


NORTH
POLE
2003: Artic ice free by 2070
2008: Artic ice free by 2013 ?
ARCTIC SEA
ICE BOUNDARY IN 1979
PHOTO: NASA ©2003 NRDC

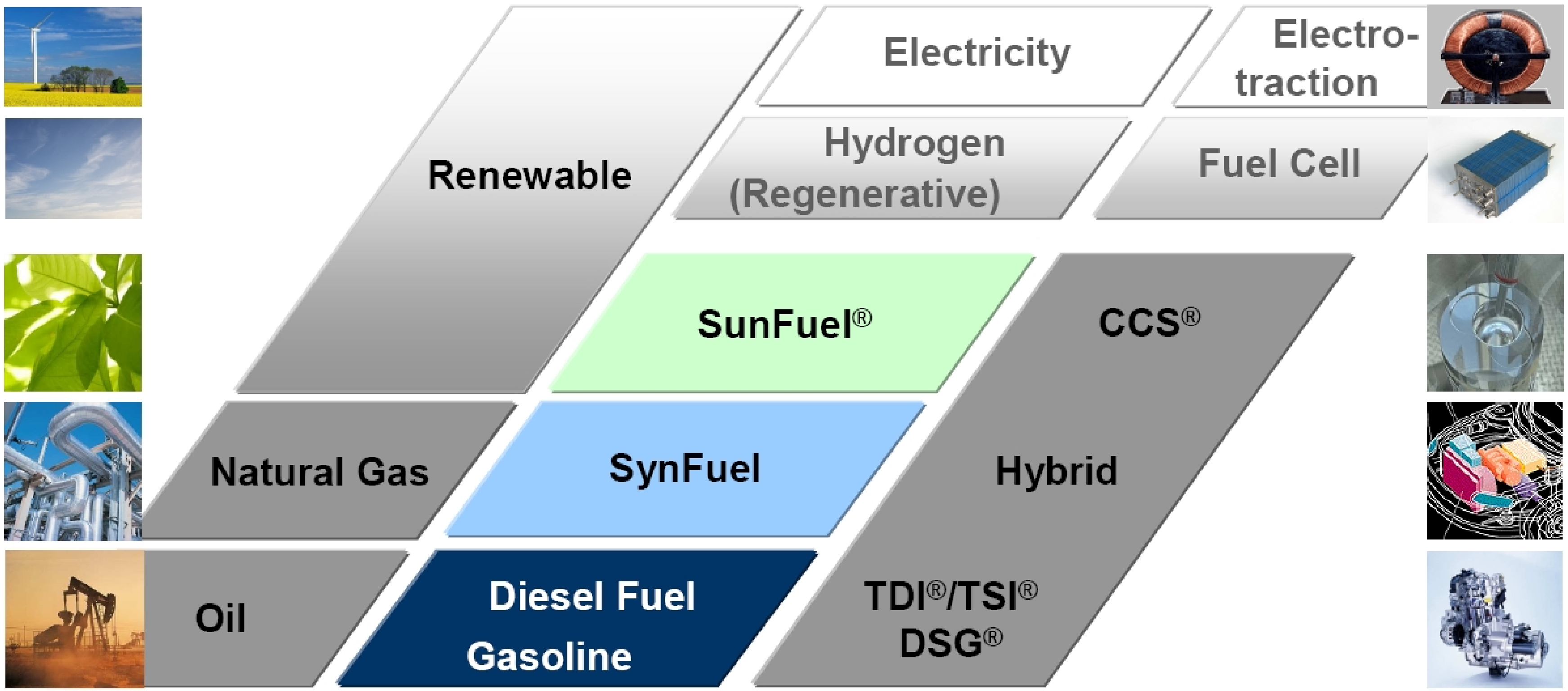
2050: 50% Reduction of Global Emission

- '50 by 50' is not enough…
- 2010: 850 million vehicles in the global car parc
  - Using 55% of oil production
  - Approx 15% of global CO_2 emissions
- 2050: 3 billion vehicles
- 2050: 50% reduction in global emissions needed for '2°'
- Must reduce vehicle emissions by at least a factor of 6
- That means 180g/km down to less than 30g/km
- We will need some disruptive solutions…

Problems from Automobiles



Fuel-and Powertrain Strategy
能源和动力驱动



Challenges

Let EVs to be competitive !

Price lower than conventional vehicles

Convenience same as conventional vehicles

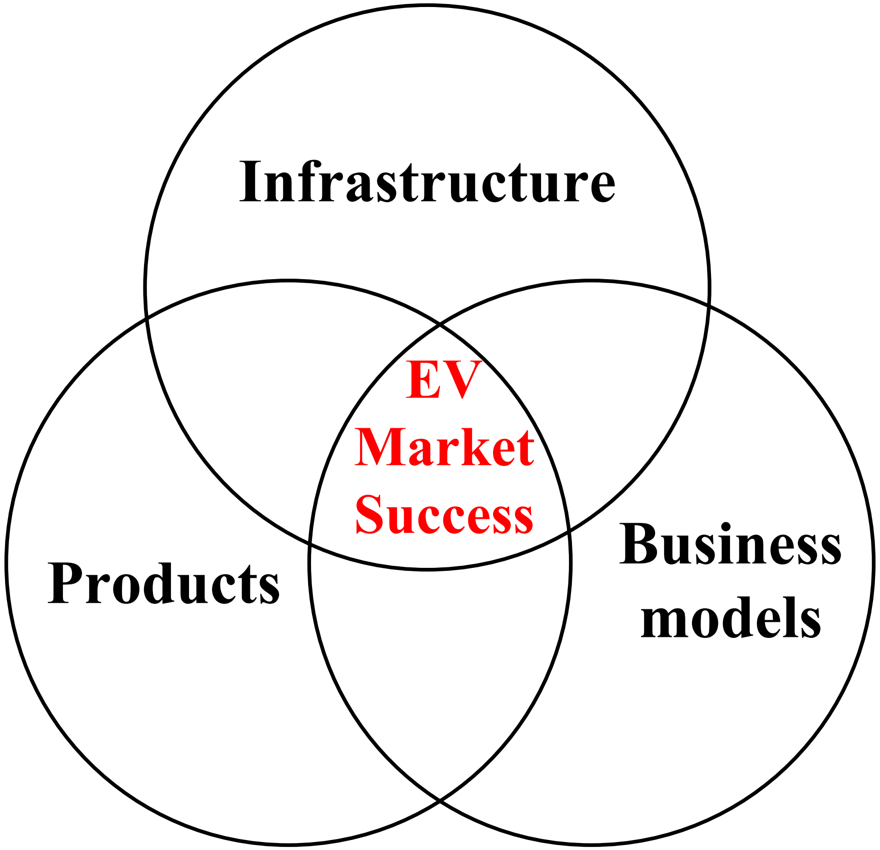
Energy consumption lower than conventional vehicle

TO EXPLORE THE RESIDUAL VALUE OF THE BATTERY

Key Issues

Three Goodness Factor :

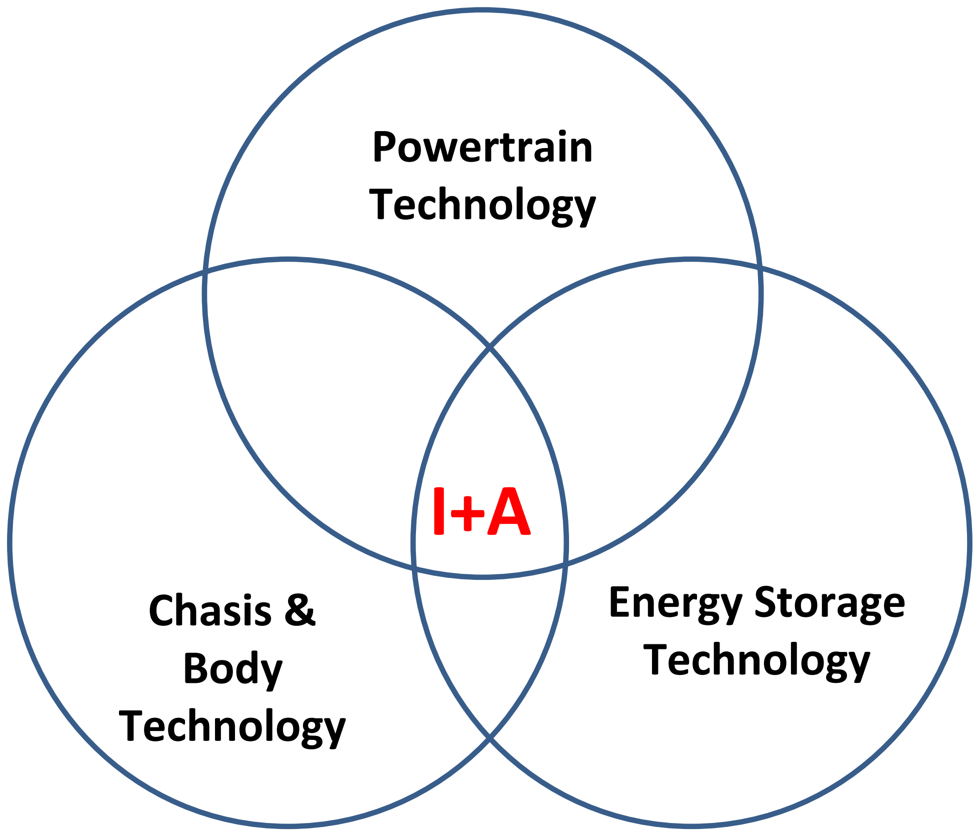
Good Products; Good Infrastructure; Good Business Model



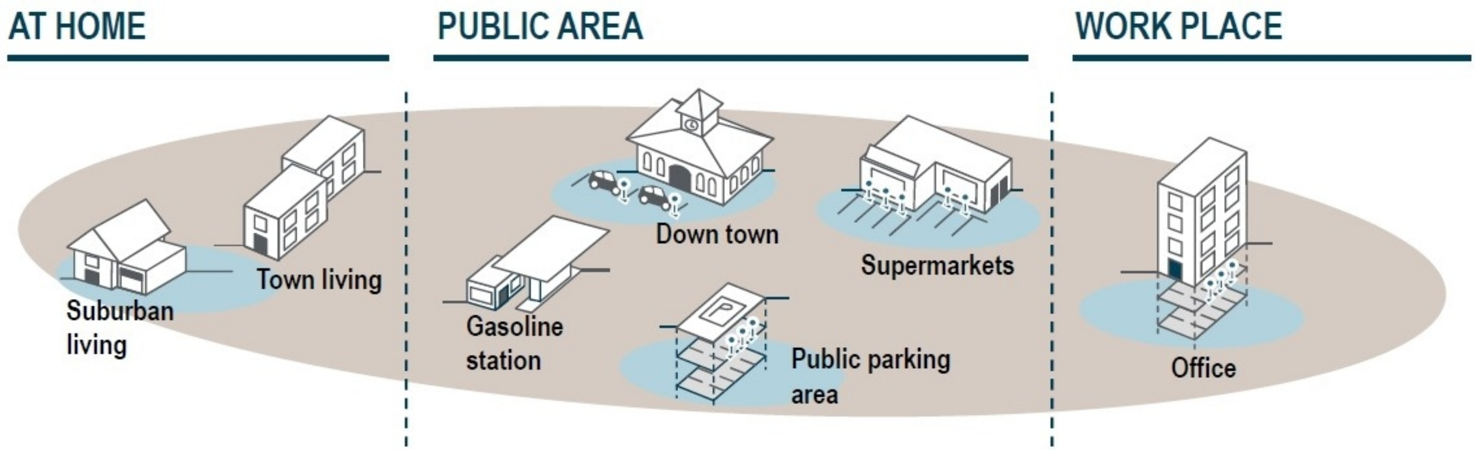
Good Products:
High Performance @ Reasonable Cost

I: Integration of Automotive Technology and Electrical Technology

A: Alliance among Auto Makers and Key Component Suppliers

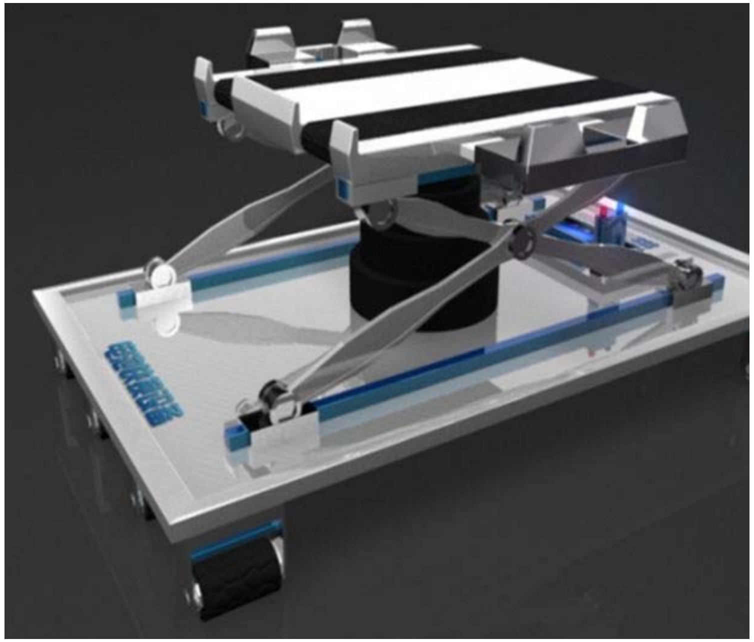


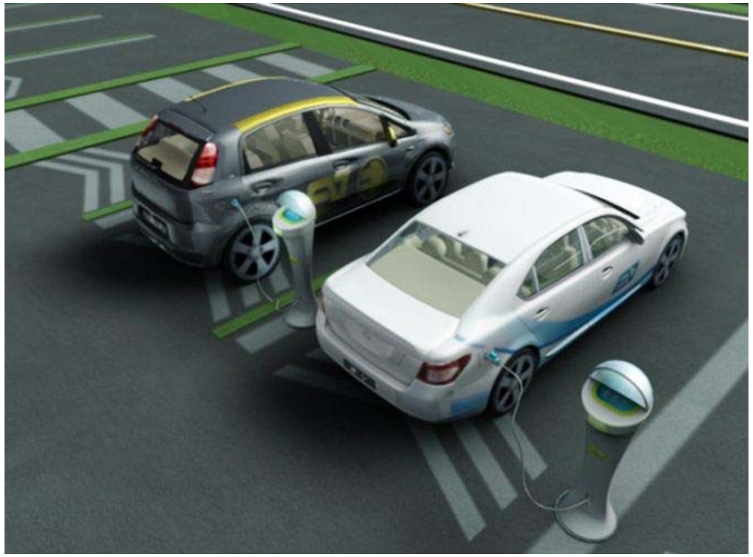
Good Infrastructure: Efficient & Convenience



Parking Durations	14 hrs per day	2 hrs per day	7 hrs per day
Charging Points	1 charging point per vehicle	< 0.5 charging point per vehicle	1 charging point per vehicle
Power & Charing time Requirements	Low power and normal charging (e.g. 3kW, 10 hrs)	High power and quick charging (e.g. 22 kW, 2 hrs)	Low power and normal charging (e.g. 3kW, 7 hrs)

Battery Swapping



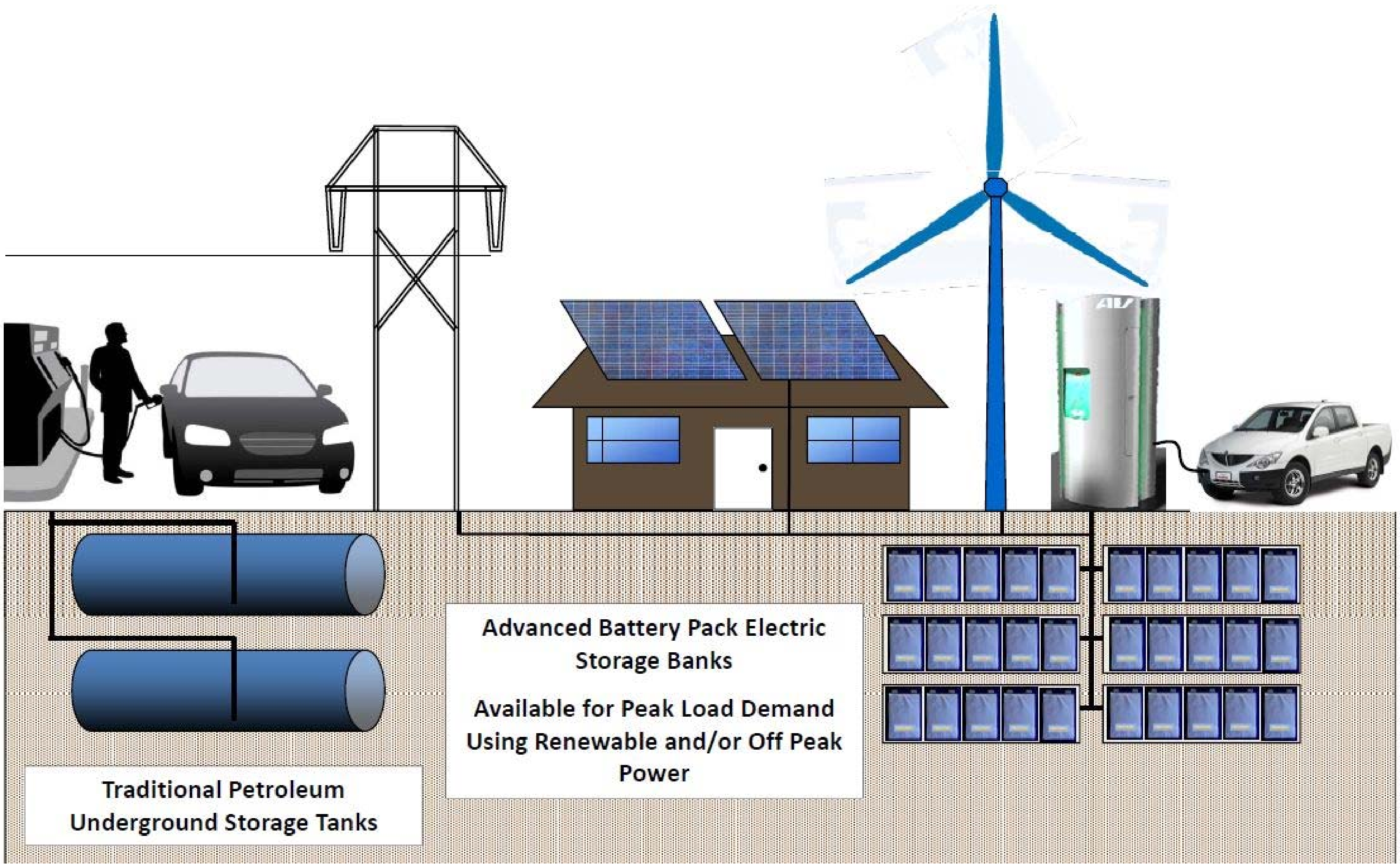


Battery Charging, Swapping, Delivery Network

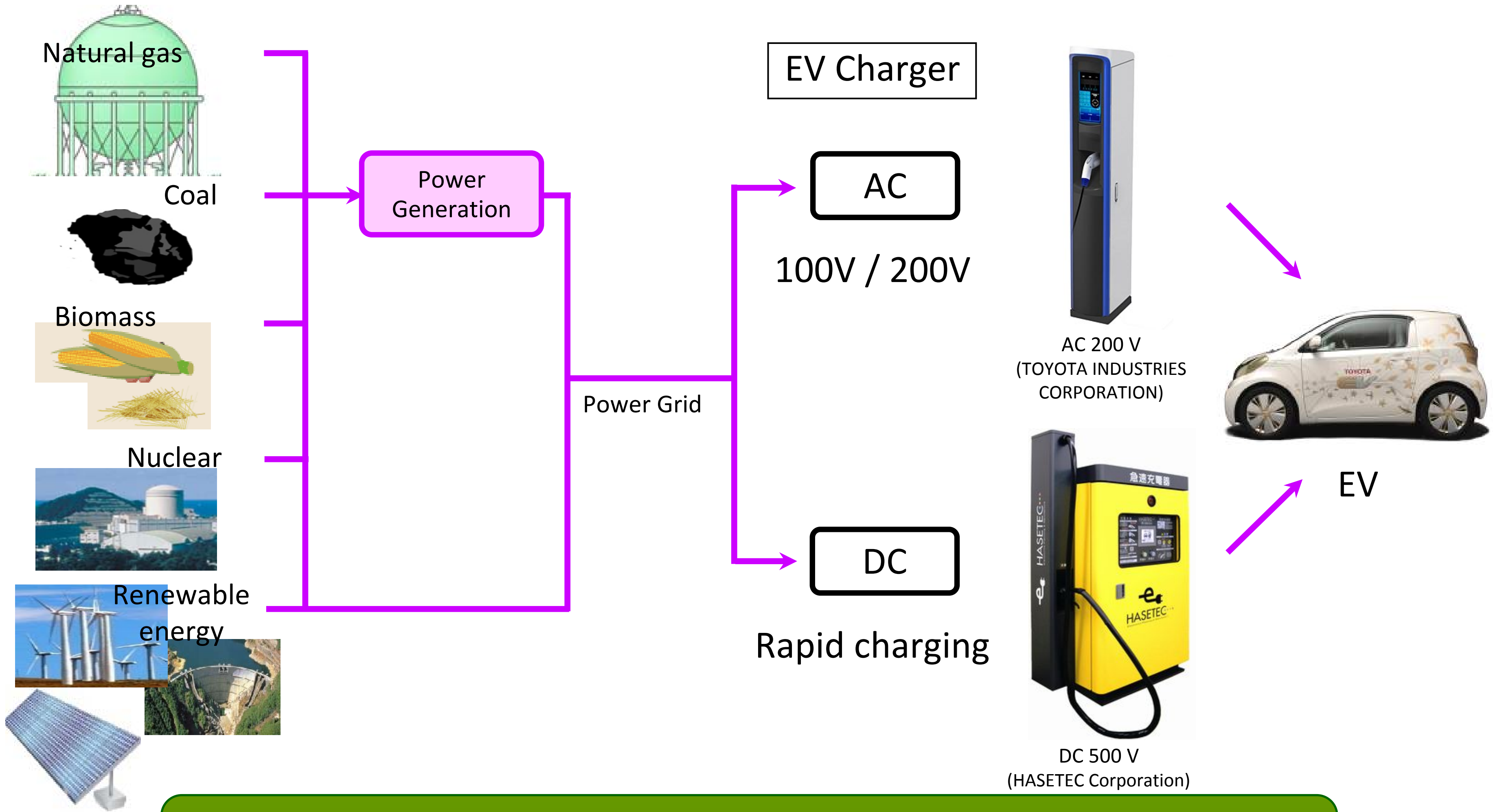
- AC charging
  - Long charging time
- DC charging
  - Battery technology does not support fast charging
  - Grid cannot sustain fast charging
- Battery swapping
  - Immediate replenishment of electricity
  - Easy battery maintenance and longer life

EV Charging Infrastructure Solution

Comparison of Gas Station & Storage Quick Charging

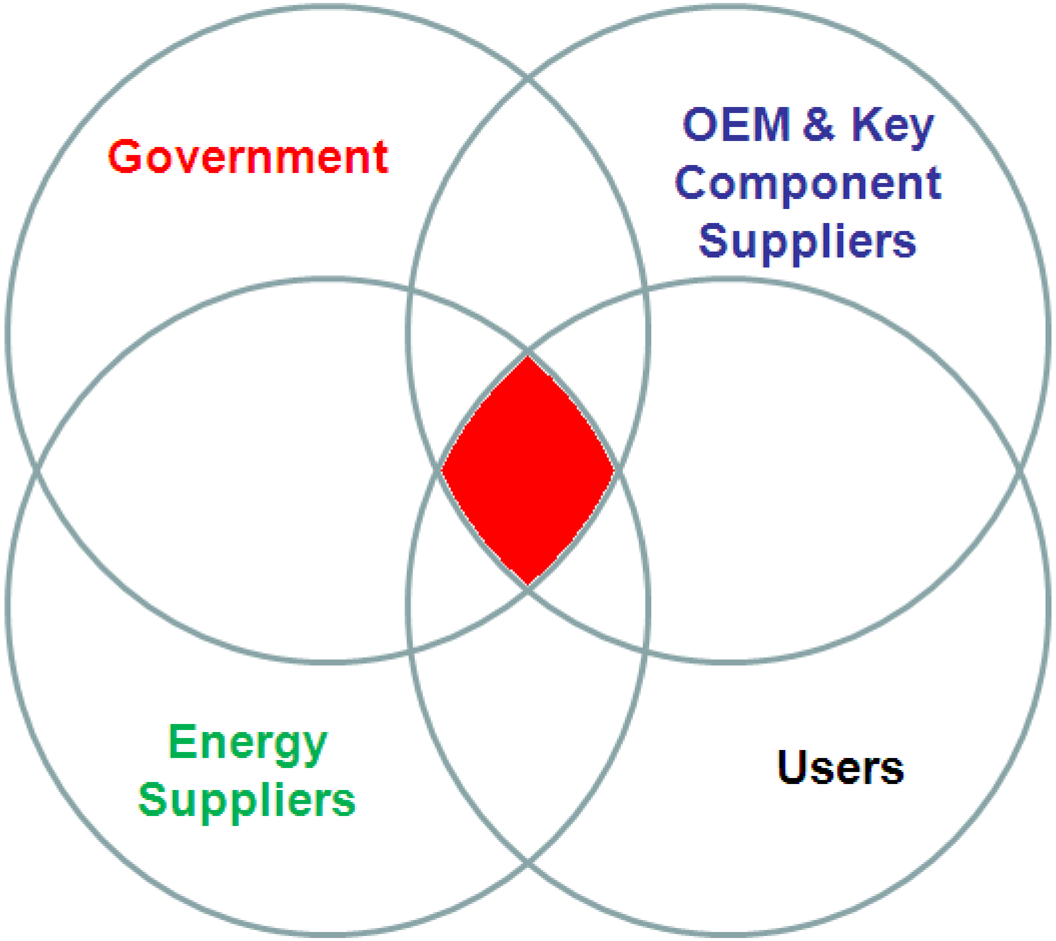


EV Charger

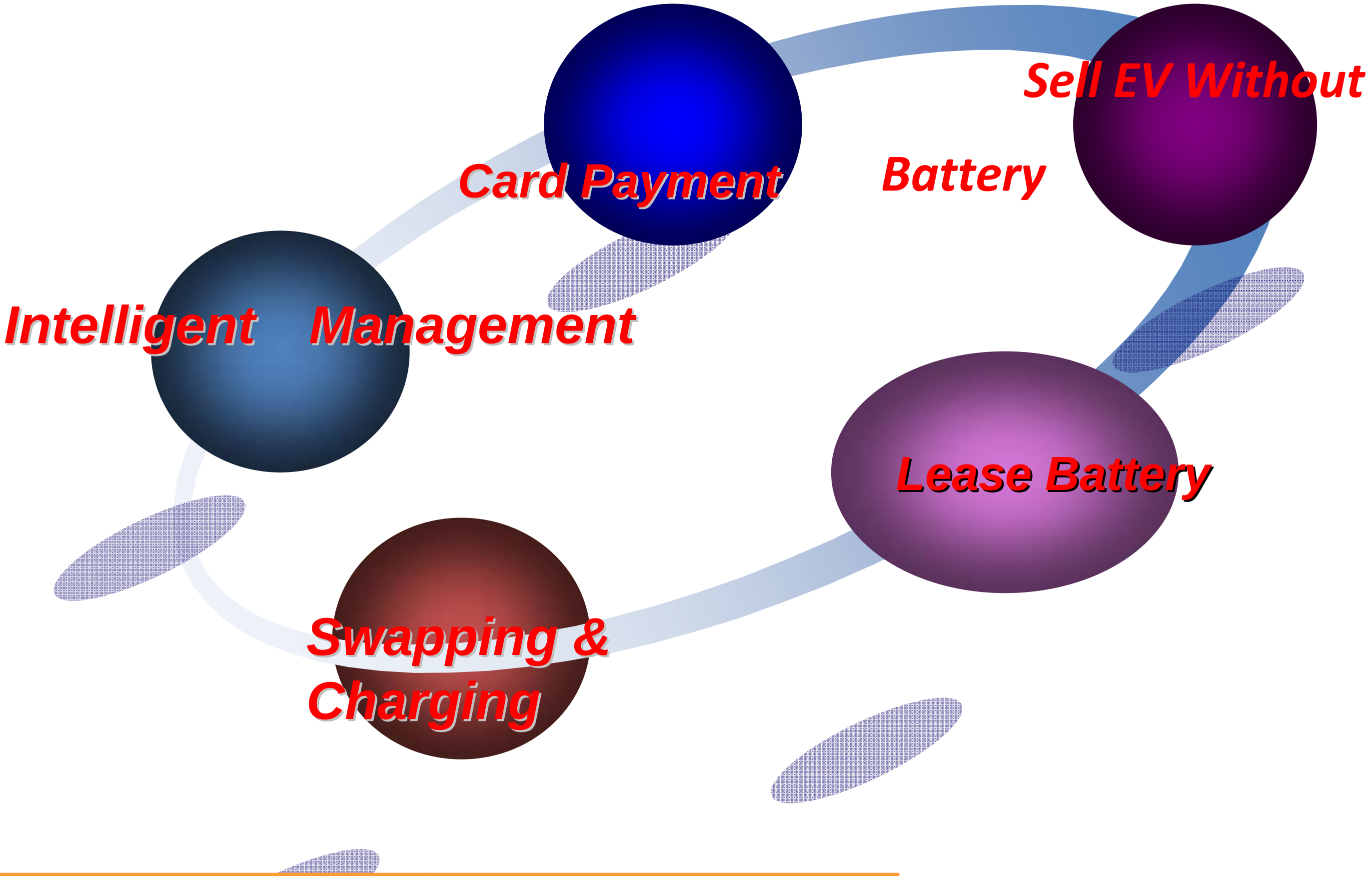


AC charger (100V/200V) for daily use
DC charger (rapid charging) for emergency use

Innovative EV/PHEV Business Model



Innovative Business Model



EV Business Model Exploration

Charge, Swap

85% cars daily range is only 50 - 80 km

EV range should not comparable with ICE
Not necessary to fully charge. Just charge sufficient for next trip.

Depending on vehicle typrs anf applications

Focus on public transportation, taxi, short range small EVs

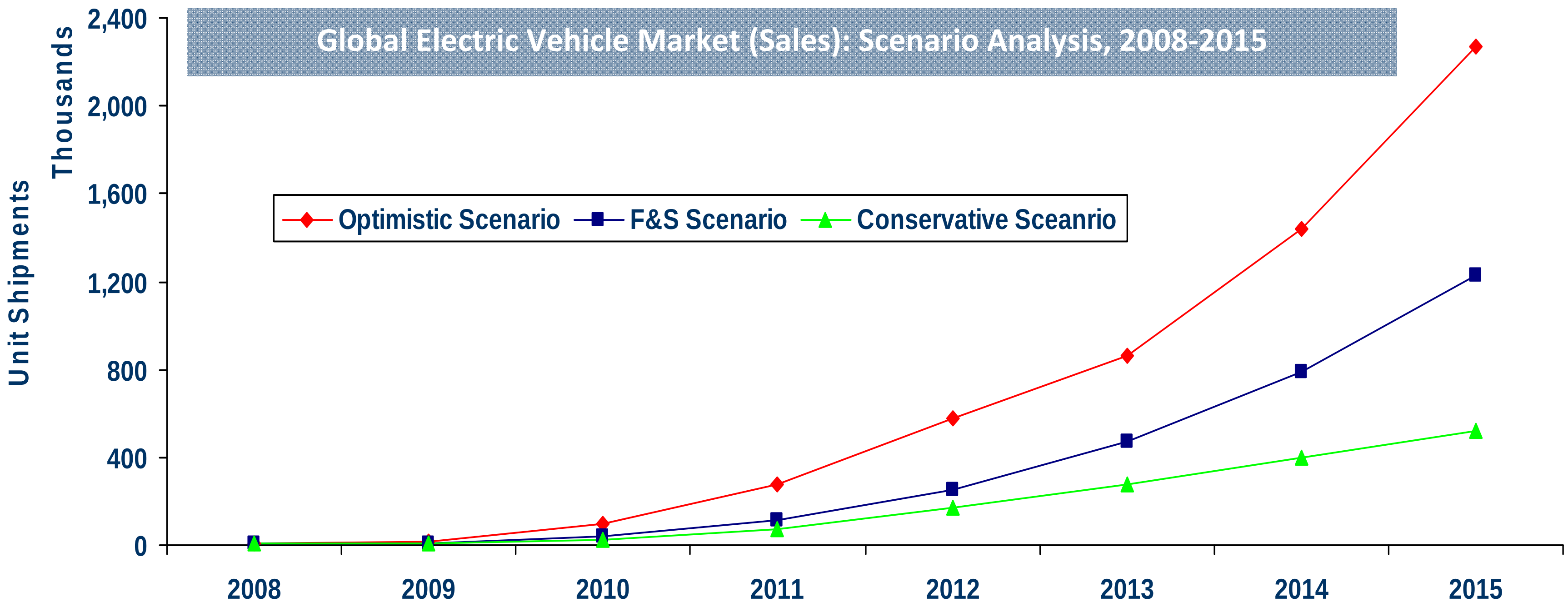
Two Integration

- Integrate EV with Smart Grid
- Integrate EV with Information & Communication Techno;ogy (ICT)

Goal: Four Zero

- Zero Emission
- Zero Fossil Fuel
- Zero Traffic Accident
- Zero Traffic Congestion

By 2020, EVs would be about 7-12% of total volumes, China may reach 15-20%

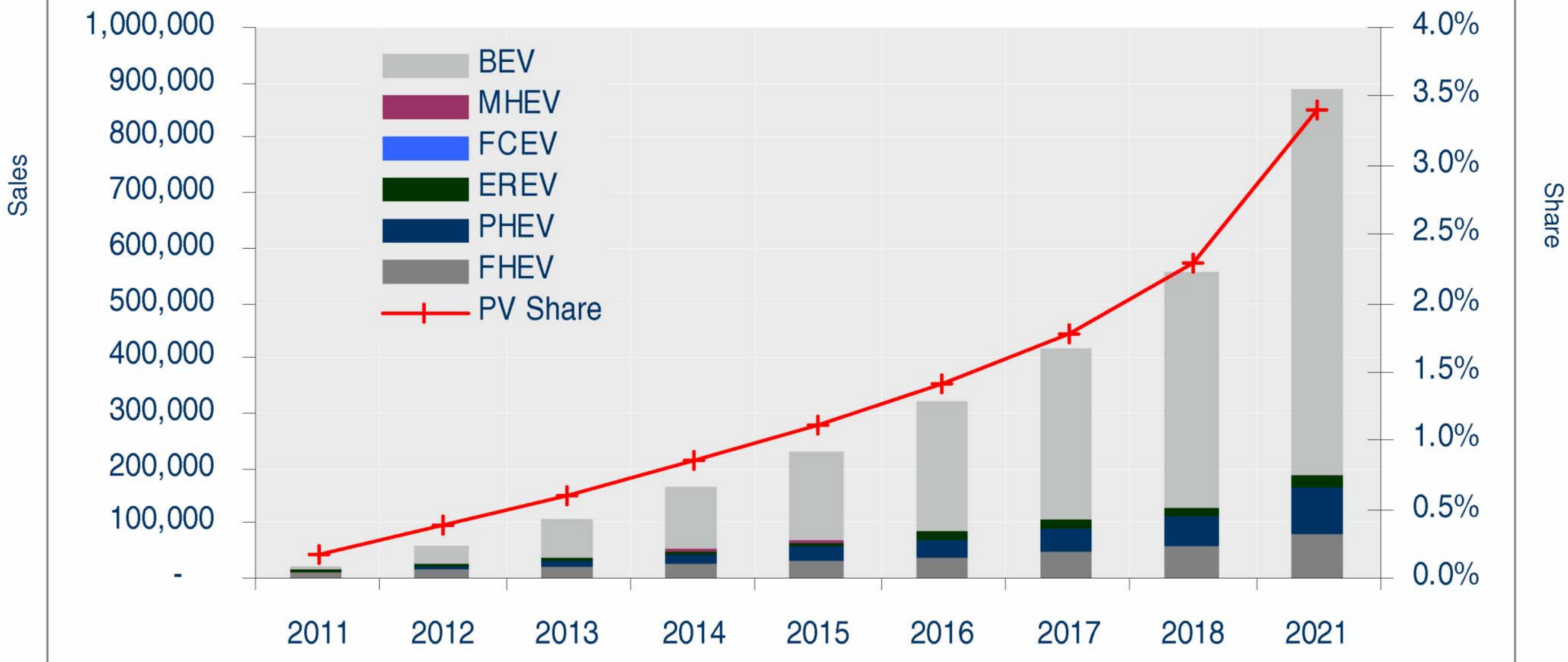


Scenario's	2008	2009	2015	2020 (% of total car sales)
Optimistic Scenario	5,103	17,475	2,266,450	12%
F&S Scenario	5,103	8,911	1,226,607	7%
Conservative Scenario	5,103	7,550	520,953	4%

Outlook: Hybrid/EV Remain on Test Water Level in Our Forecast Horizon
展望: 乘用车领域混合动力以及电动车在2021年前都处于试水阶段

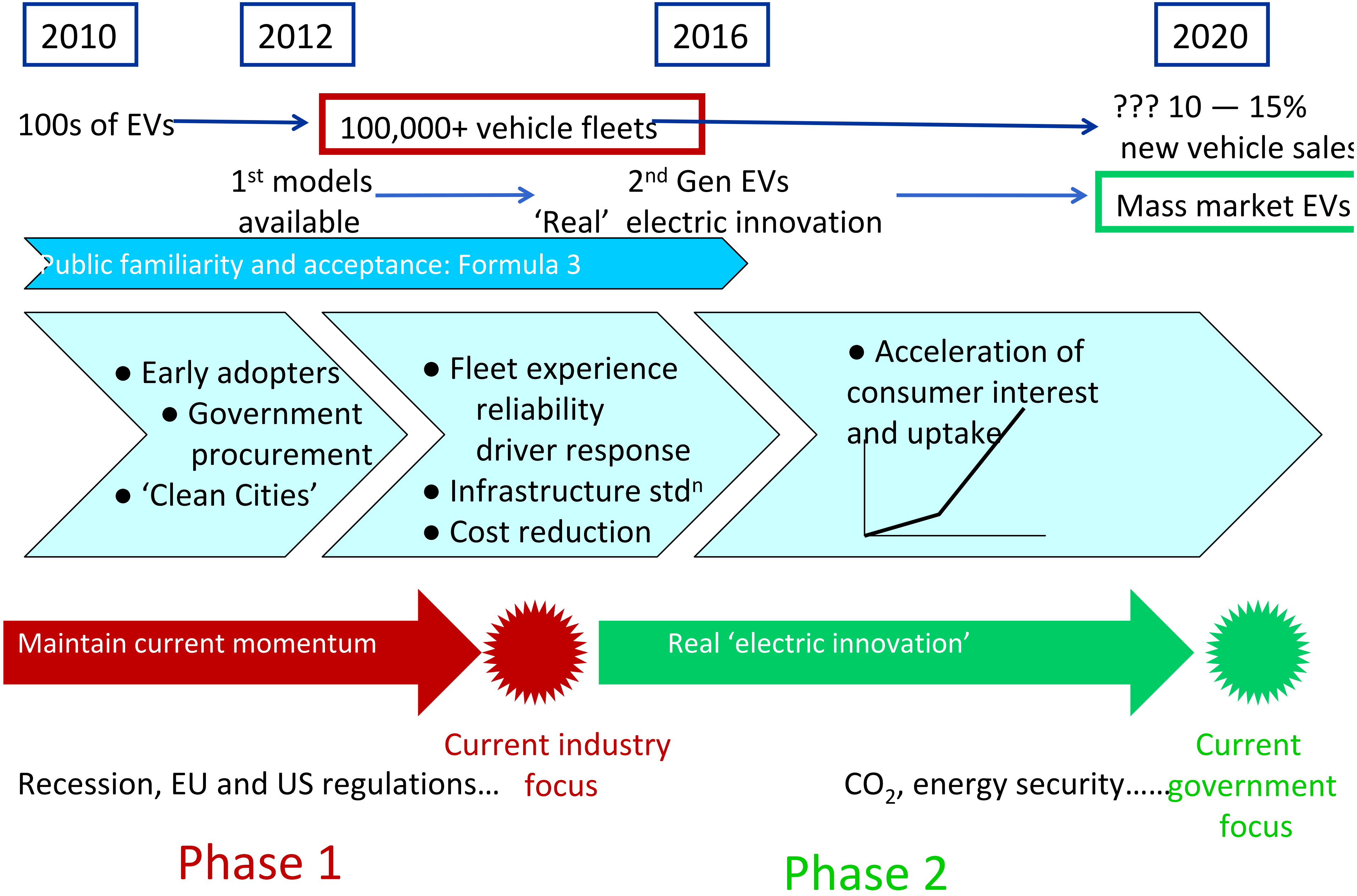
中短期内，新能源汽车将有更大的机会在公共服务领域先进行商业化运作

HYBRID/EV OUTLOOK in Passenger Car Market



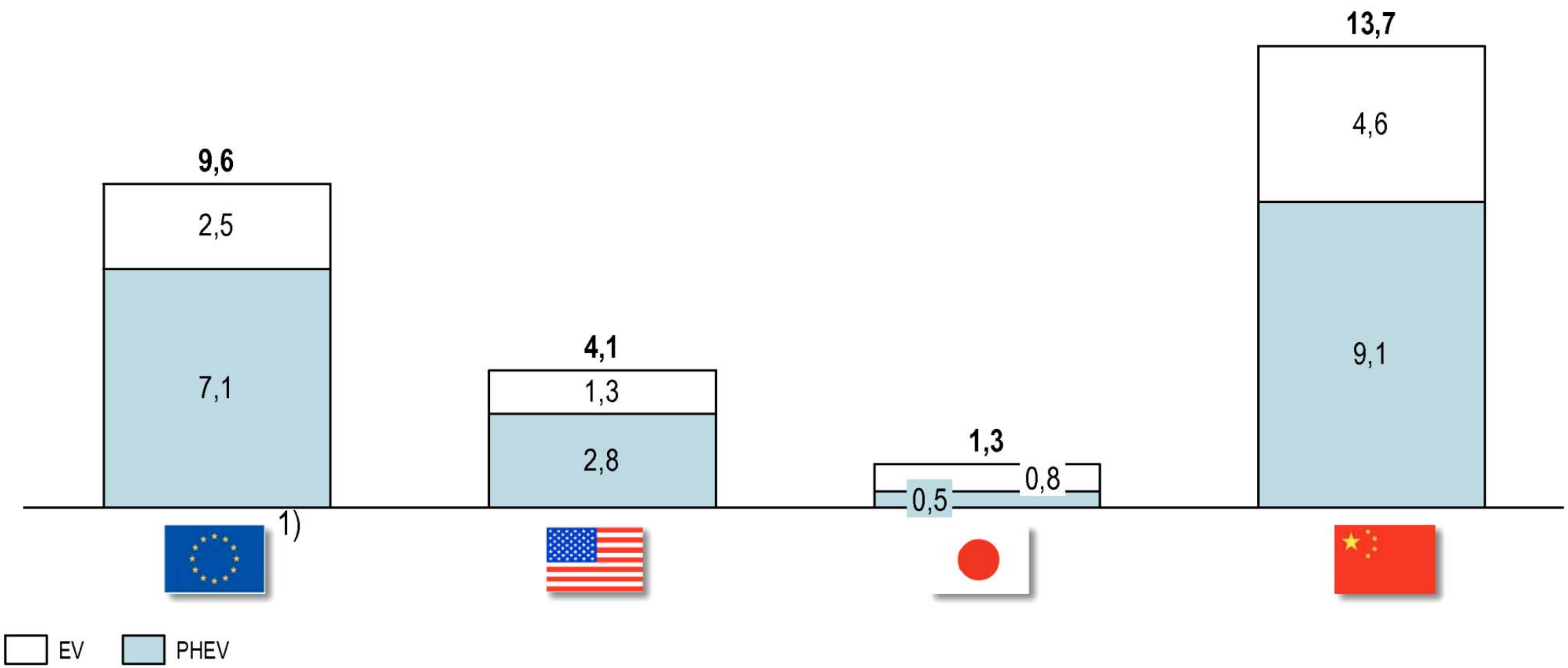
LMC Automotive

Electric Vehicle Roadmap



By 2020, China is expected to become the largest market for EVs/PHEVs with over 13 million cumulated vehicles

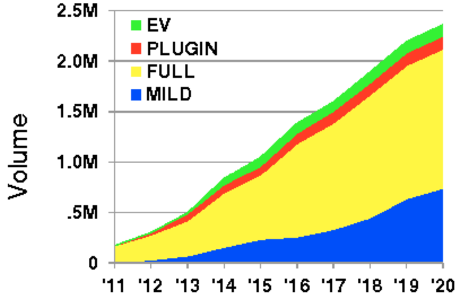
Cumulated EV/PHEV car park in 2020 [Mio units] – High scenario



1) Western Europe

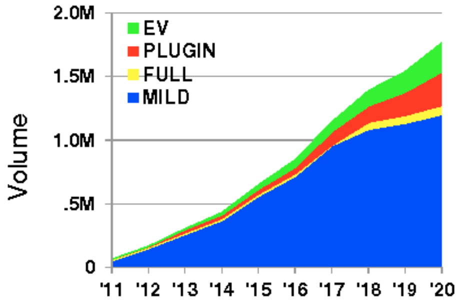
Electrifiation Market Emerging in Each Region

Varies by region as policies distort market



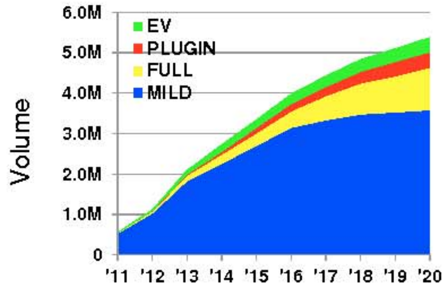
North America

- CAFE: cars and light-duty trucks: 34.1 mpg by 2016 (enacted), 54.5 mpg by 2025 (proposed)
- Medium and heavy-duty vehicles: MY 2014-2018, up to 20% improvement in emissions and fuel economy depending on class
- Consumer and manufacturer's incentives, mfg. penalties
- Hybrid will dominate, EV will be niche for urban areas



China

- Heavy government funding (~$15B USD over the next decade)
- Chinese government signaling increased support for HEV and PHEV; reduced emphasis on EV
- Foreign investment catalogue changes
- Mild hybrid gaining interest
- Manufacturers and consumer incentives and tax treatment



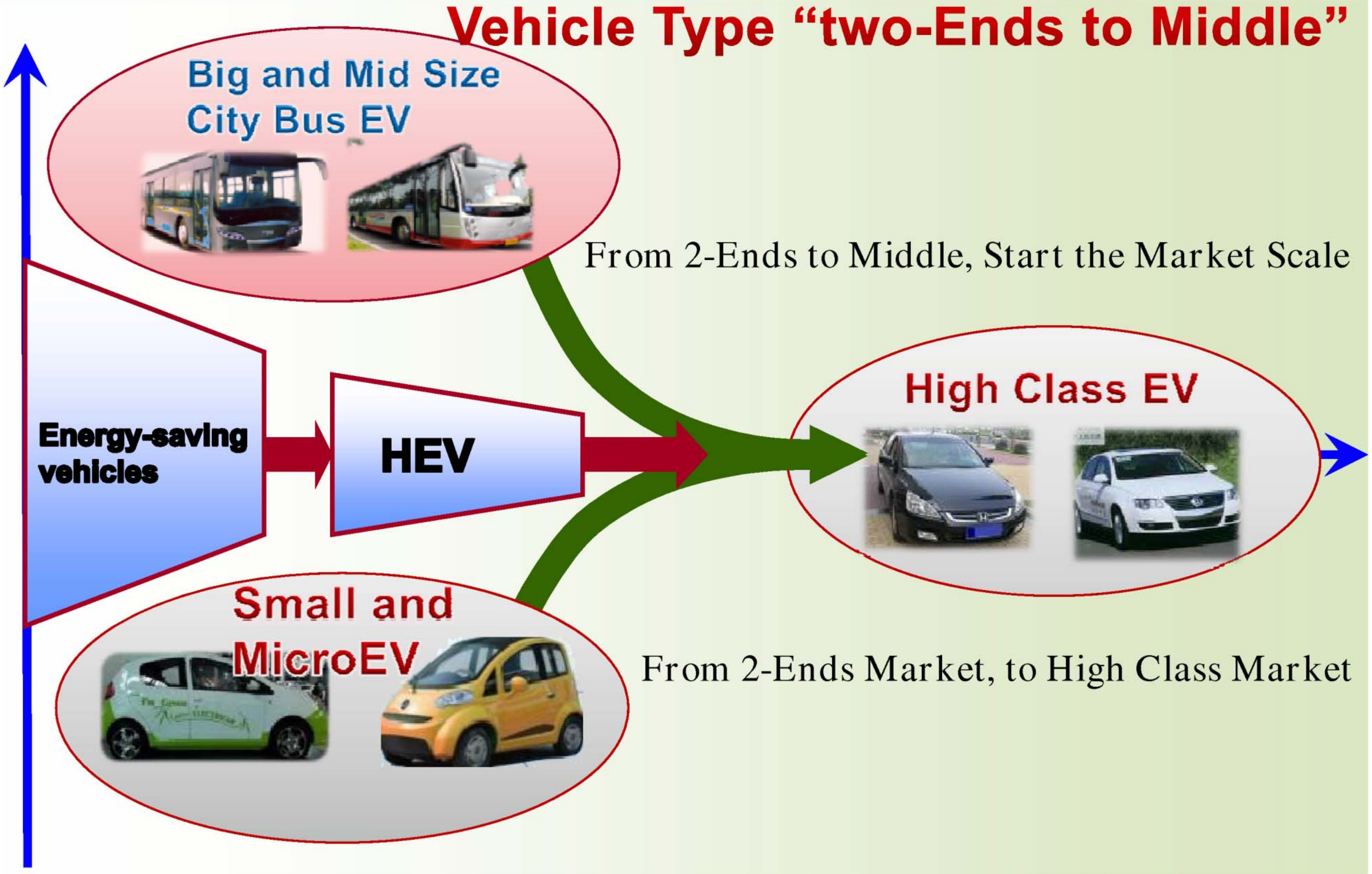
Europe

- Aggressive emissions regulations drive EV/Plug-in penetration
- Hybrid/EV portfolio will be organized by vehicle type: EV for city cars, full hybrid for luxury and sports cars
- Current legislation does not pick technology favorites
- Manufacturers penalty and consumer credits

DELPHI

CHINA

Overall strategy and objectives



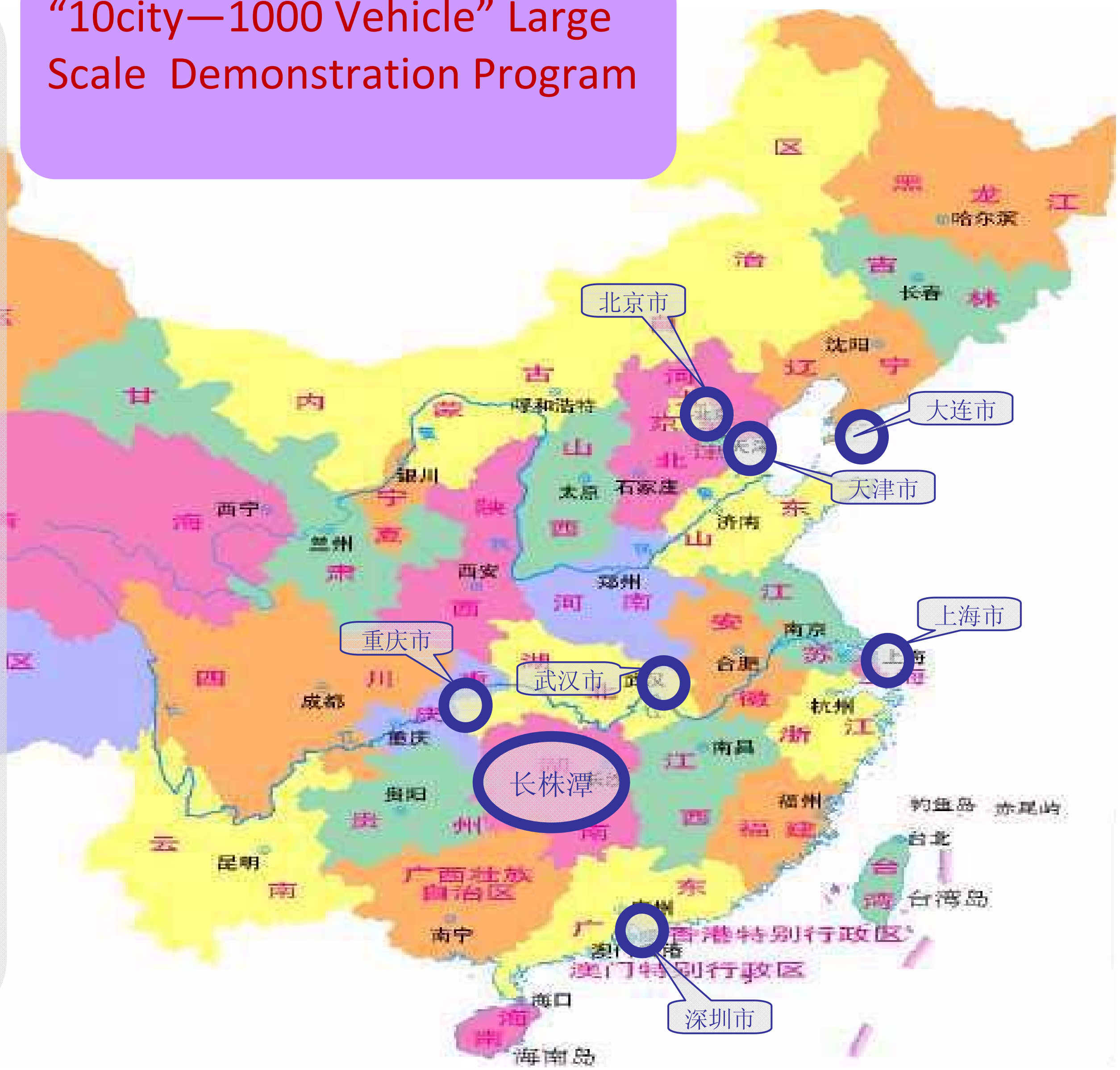
Progress in demonstration

"10city—1000 Vehicle" Large Scale Demonstration Program

●1、 Examine the key components technology ;

●2、 to form a virtuous cycle of "policy support ←→lower price ←→market spread" ;

●3、 to stride over the market cultivation phase and enter the fast growth phase.



Japan

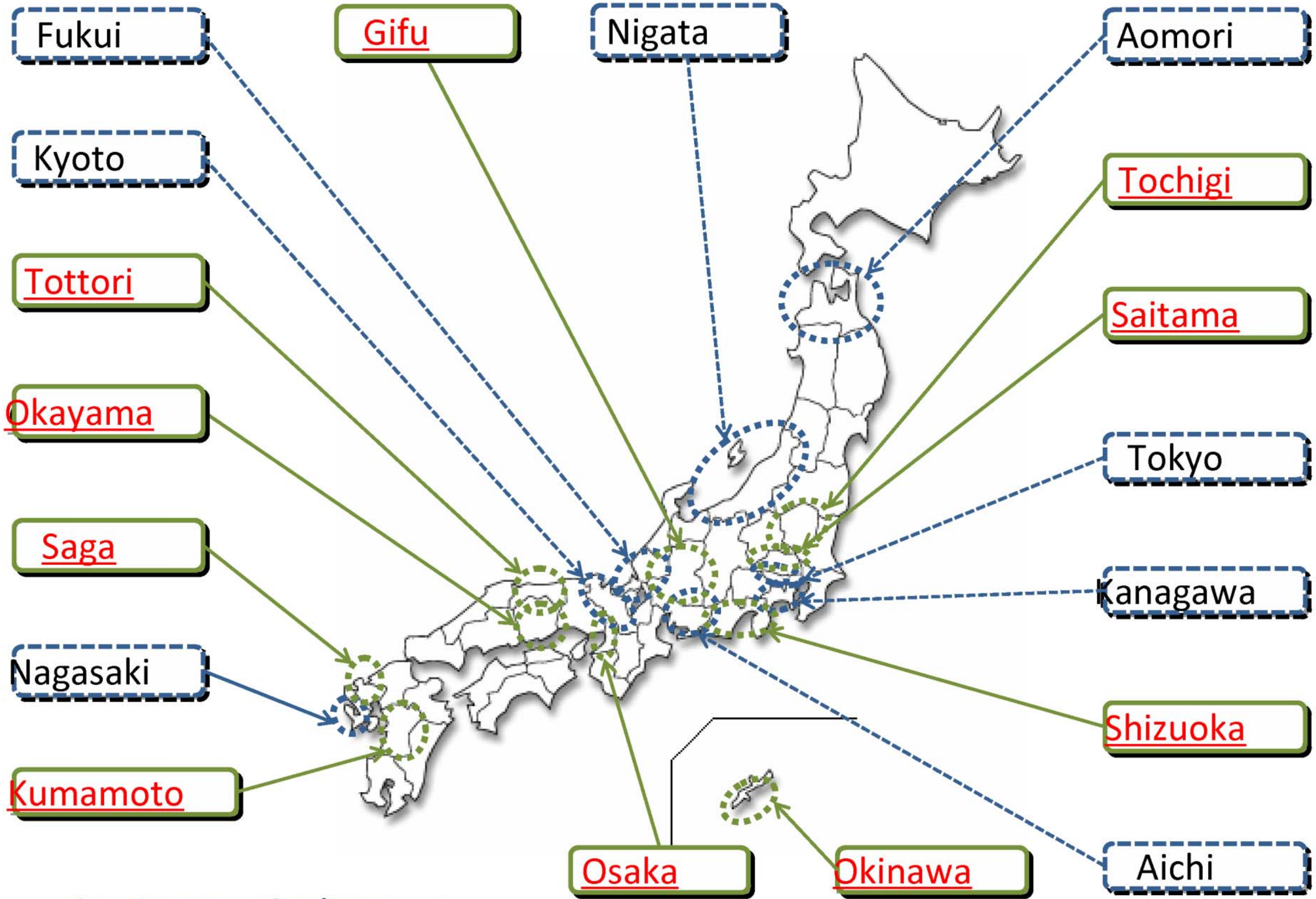
Diffusion projections & Targets

	Projections (private-sector efforts)		Government Targets	
	2020	2030	2020	2030
Conventional Vehicles	80% >	60-70%	50-80%	30-50%
Next-Generation Vehicles	< 20%	30-40%	20-50%	50-70%
HEV	10-15%	20-30%	20-30%	30-40%
EV/PHEV	5-10%	10-20%	15-20%	20-30%
FCV	Miniscule	1%	0-1%	0-3%
CDV	Miniscule	0-5%	0-5%	5-10%

Japan
Battery Technology Roadmap

	Current batteries (2006)	Improved batteries (2010)	Advanced batteries (2015)	Innovative batteries (2030)
	Lithium-ion Battery			Post Lithium-ion
Performance	1	1	150%	700%
Cost	1	1/2	1/7	1/40
Main Driver	Private initiative	Private initiative	Industry-government-academia collaboration	University and Institutes

EV/PHV Towns (Second group: Total 18 towns) **Japan**



Blue: First group of EV/PHV towns
Green: Second group of EV/PHV towns

Creation of initial demand & Promotion event

Aichi

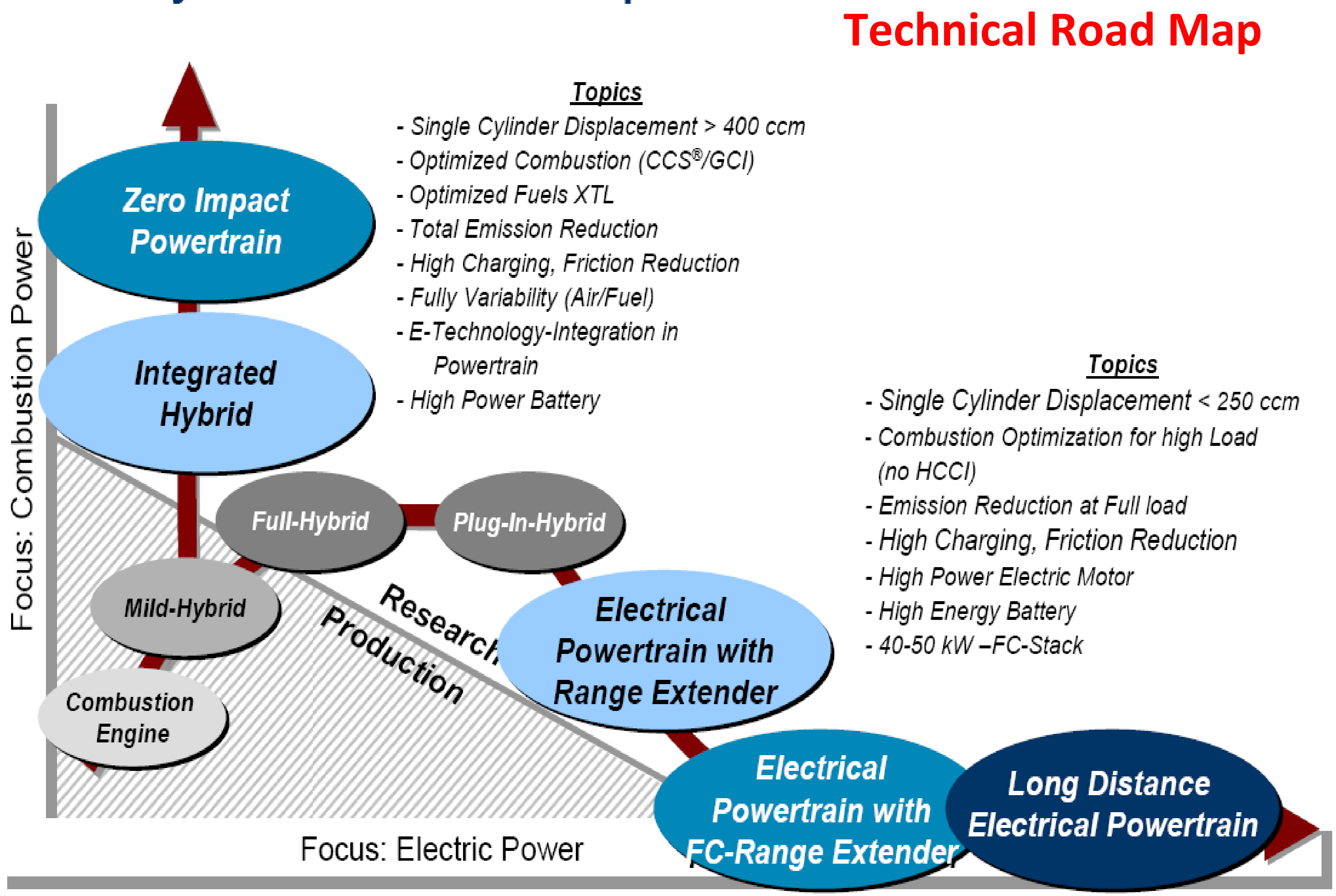
Aomori

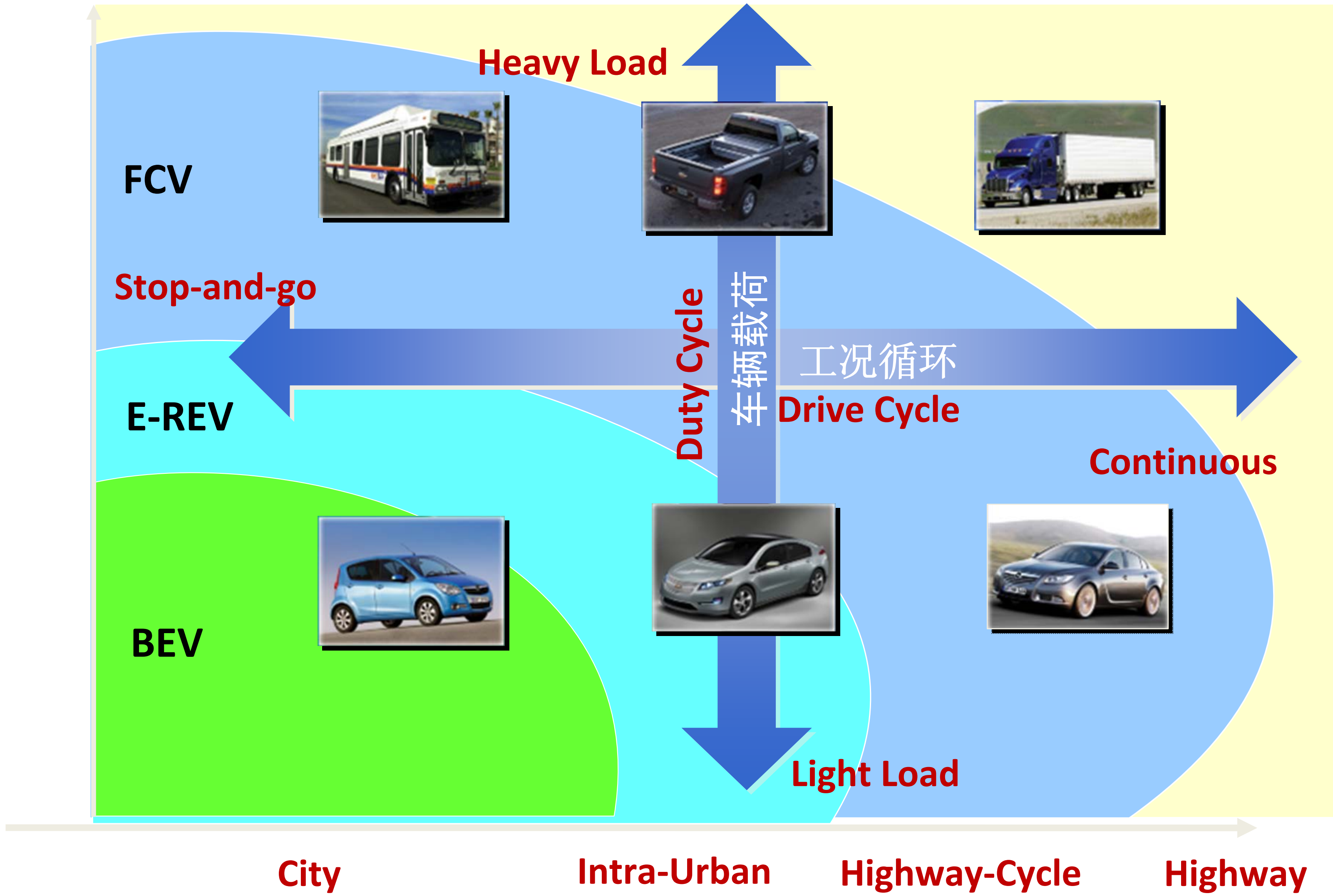
Kanagawa

Aichi (Promotion Event)

Two Pathways for HEV Technology Development

Two Way Powertrain Roadmap





BEV———Battery Electric Vehicles

E-REV— Range Extender Electric Vehicles

FCV—— Fuel Cell Electric Vehicles

Energy Conservation and Displacement
能源节约与替代

Using electrification technologies to reduce consumption and displace petroleum
应用电气化技术降低和替代石油消耗

Petroleum and Biofuels 石油和生物燃料
(Conventional and Alternative Sources 常规与替代来源)

Electricity and Hydrogen 电力和氢能
(Zero Emissions Energy Sources 零排放能源)

eAssist™	Full Hybrid 完全混合动力	Plug-in Hybrid 插电混合动力	Extended Range Electric 增程电动汽车	Battery Electric 纯电动汽车	Fuel Cell Electric 燃料电池
HEV		PHEV		BEV	FCV

NEV Catalogue China
中国新能源车公告

Increasingly Electrified Powertrains
动力总成电气化程度增加

GM

Energy Conservation and Displacement
能源节约与替代

Using electrification technologies to reduce consumption and displace petroleum
应用电气化技术降低和替代石油消耗

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HEV		PHEV		BEV	FCV

NEV Catalogue China
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CONSERVATION 节约

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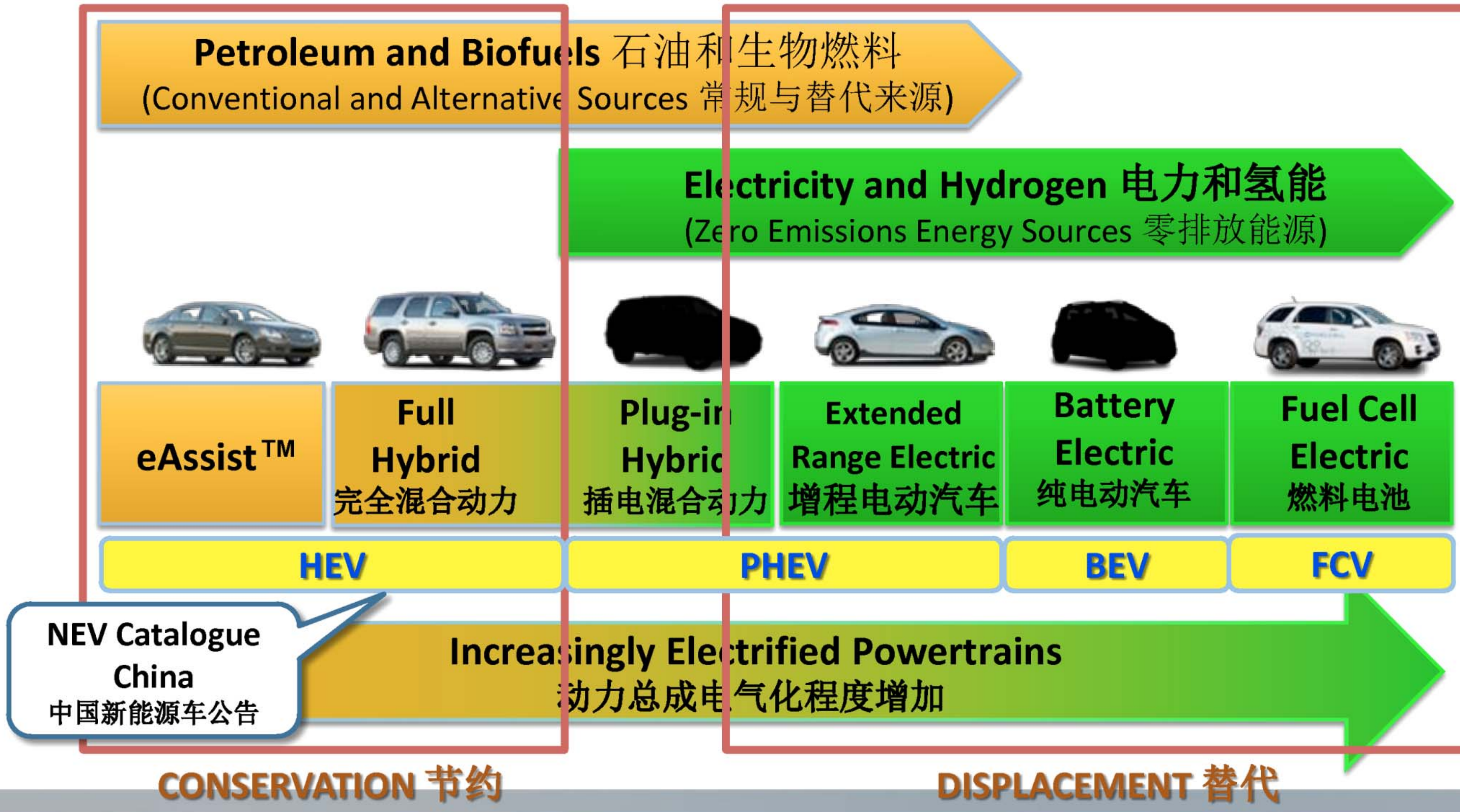
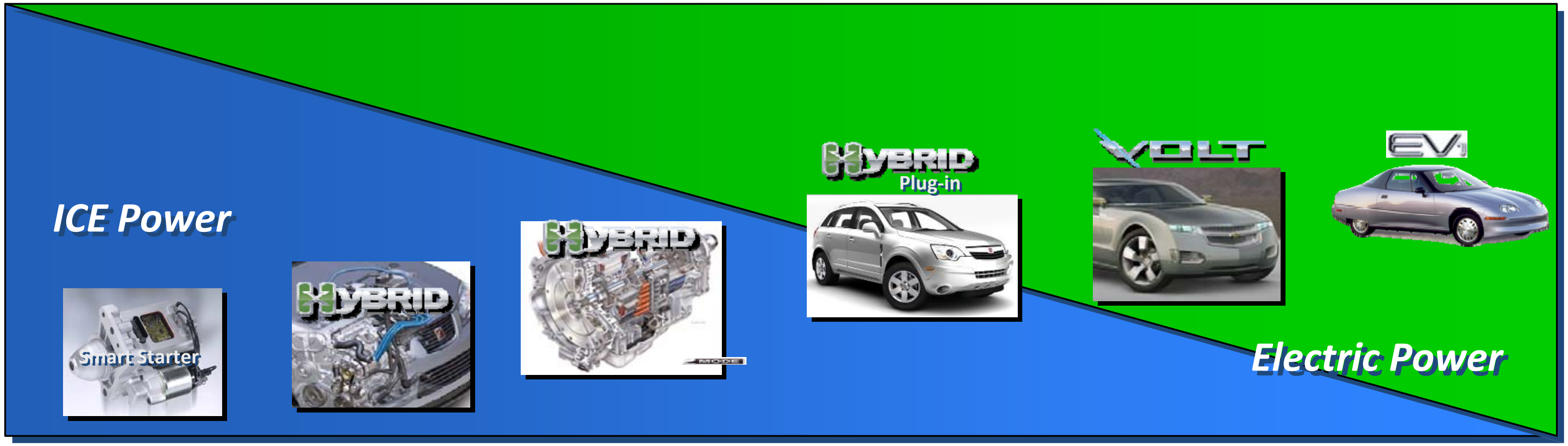


Hybrid Engineering Philosophy: 1+1>2

Hybrid Mule = Horse (Mother) + Moke (Father)

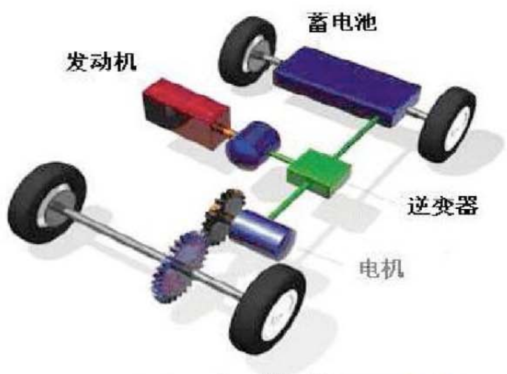
Mule is the hybrid of horse and moke, mule takes the best DNA of horse and moke, hence more powerful and endurance.

HEV should have added value gained from the integration of engine propulsion and motor propulsion, fully sizes the intelligent electrical, electronic and control technologies

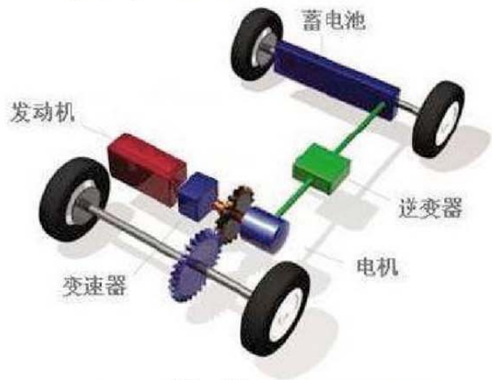


	Start-Stop	Mild Hybrid	Full Hybrid	Plug-in Hybrid	Plug-in Range Extender EV/	Electric Vehicle/
Functionality/	• Engine start-stop at idle	• Engine off on deceleration • Mild regenerative braking • Electric power assist	• Full regenerative braking • Engine cycle optimization • Electric launch • Limited pure electric drive • Engine downsize	• Plug-in rechargeable • More electric drive during charge-depletion • Reduced refueling	• Full-function electric drive • Initial pure electric range • Significantly reduced refueling	• Plug-in recharge only • 100% pure electric range/100% • No refueling
FUEL ECONOMY	• +2-4%	• +10-20%	• +30-50% Cars • +20-40% Trucks	• +100% in charge depletion/100% • same as full hybrid afterward	• Electricity only in EV range/在EV • same as full hybrid afterward	• Electricity only

混合动力技术的分类



(1) 串联式(serial)



(2) 并联式(parallel)

(3) 混联式(serioparallel)

(4) 复合式(parallel serial)

Battery Electric & Plug-in Hybrid Vehicles

BEV – Nissan Leaf

- All Electric Range: 60 to 200 Miles, depending on battery size
- Level II Charging
  - 240 v (40 amp)
  - 4 to 6 hours charge
  - Target markets:
  - Urban Commuters
  - Second Car in Every Home

PHEV – Chevy Volt

- Unlimited range on gasoline
- 10 to 40 mile all electric on battery
- Level I and Level II Charging
  - 120 v – 240 v
  - 6 to 8 hours Level 1
  - 3 to 4 hours Level 2
  - Target Market: all automotive applications

Roland Berger
Strategy Consultants

Understanding customer requirements related to electric performance are critical for delivering the right product

Comparison of electric performance of selected PHEVs – Volt vs. Prius Plug-in

	Chevrolet Volt	Toyota Prius Plug-in
EV range [km]	64	20
Max. speed on electrical mode [km/h]	164	100
Battery size / technology [kwh]	16 (Li-ion)	~5 (Li-ion)

Comments

> Different Plug-in concepts today vary greatly in their electrical performance

> Bigger battery size increases EV range but also vehicle price

> Clear understanding of customer requirements is critical for providing the expected performance at the minimum possible price

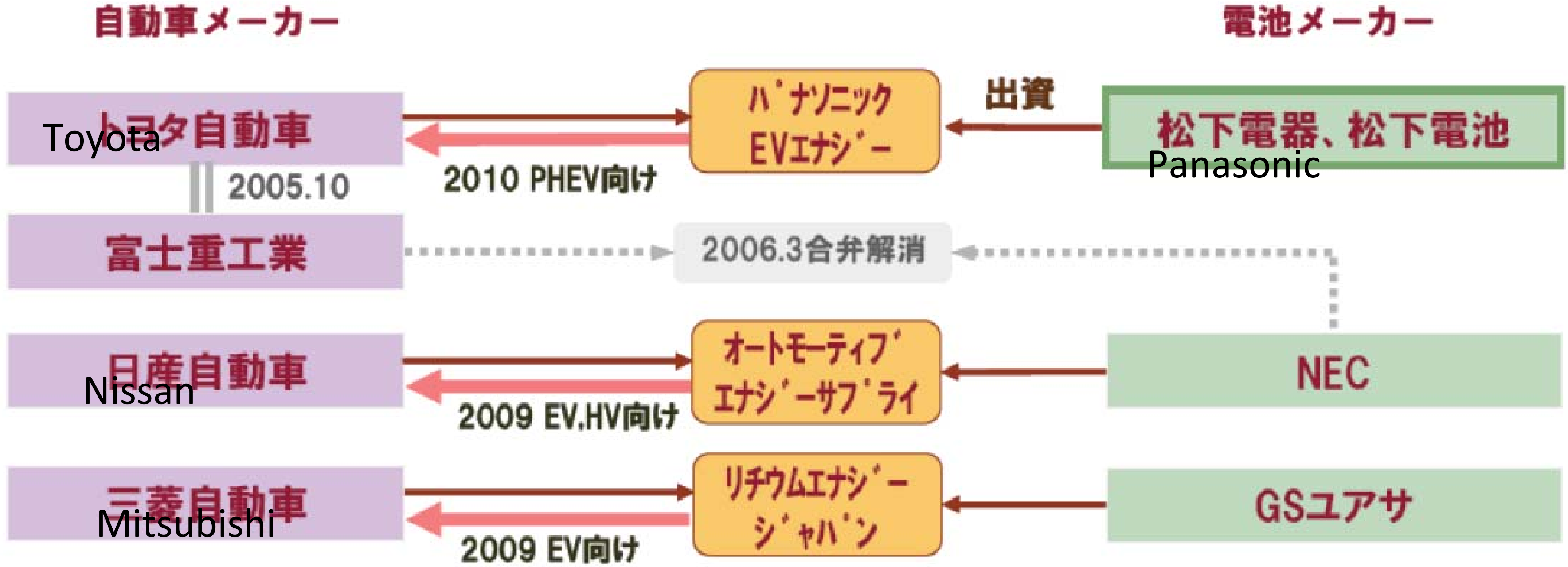
Source: Chevrolet; Toyota; Roland Berger

日本的经验：

Japan Experience: 電池廠的結盟

Alliance between OEM & Battery Manufacturer

- 車廠+電池廠



RIE, 2008

Lead Engineering Groups have been defined in order to face the complex challenge....

Technical LEG-structure within the project

Electronics

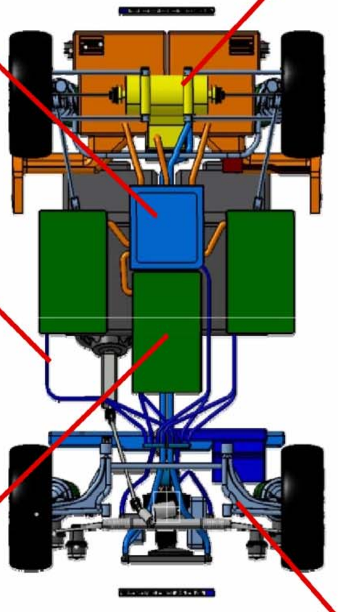
- Energy nets
- Data buses
- Wiring

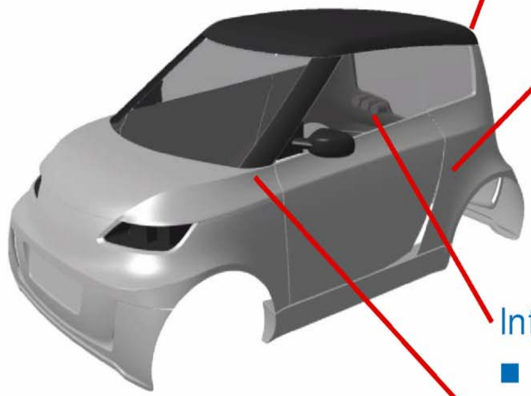
Powertrain

- Motor
- Power electronics
- Gear box

Body

- Structure
- Hang-on parts





Thermal Mngt.

- Climatisation system
- Cooling system powertrain
- Isolation

Exterior

- Paddings
- Glazing
- Lights

Interior

- Cockpit
- Seats

Battery

- Cells
- Battery pack
- Battery Management System

Chassis and Security Systems

- active security
- passive security
- Chassis

Full Vehicle

- Packaging
- NVH
- Homologation
- Design

LEG: Lead Engineering Group

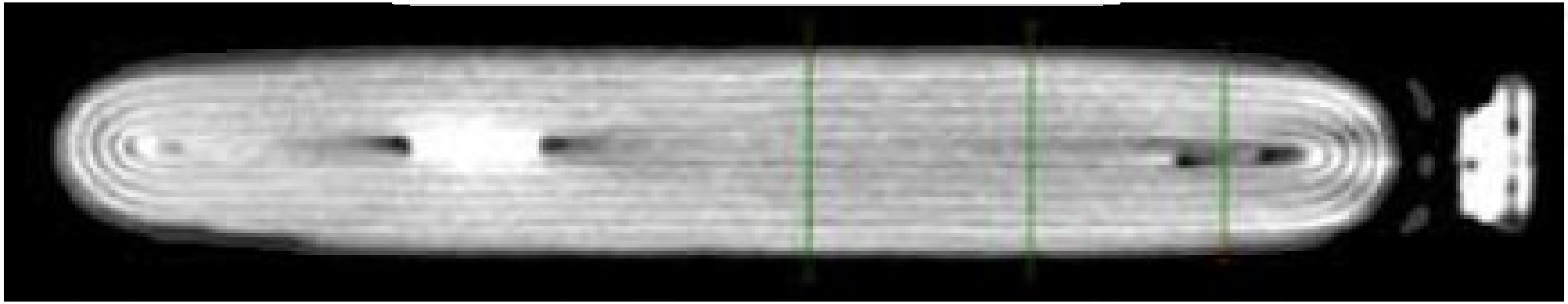
RWTH AACHEN UNIVERSITY

Requirements for lithium ion batteries

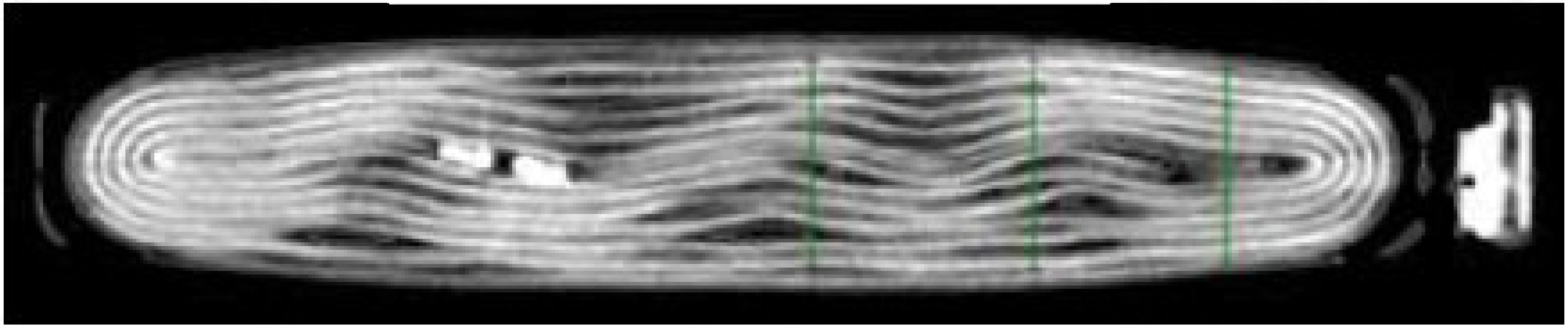
Cycle Life > 2000
Cost < RMB 3000 (USD 375)/kWh
Reliability: Volume of million vehicles
Mileage of 150000 km

Impact of Temperature and Duty Cycle

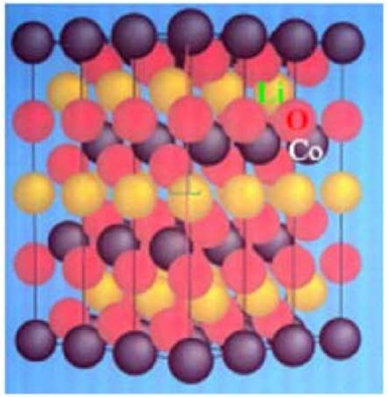
Normal Operation



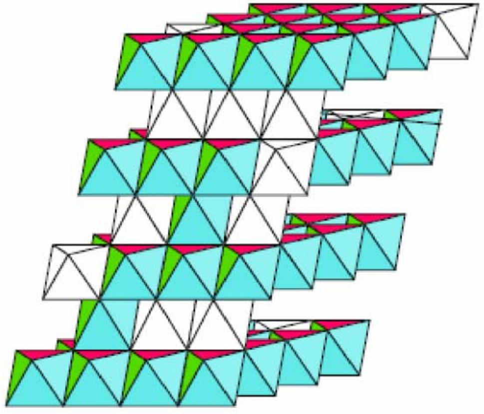
Abnormal Operation



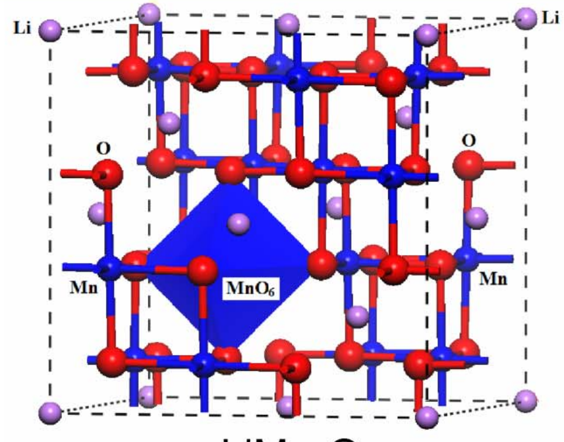
Materials used in current Li-ion batteries (10-20 um)
(Intercalation compounds)



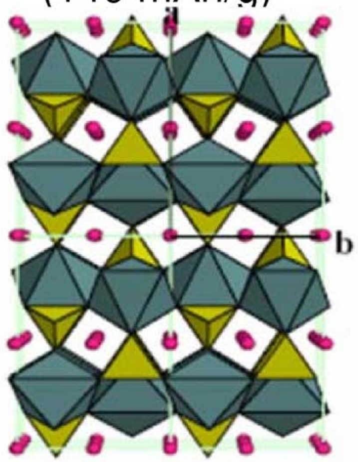
$LiCoO_2$
(140 mAh/g)



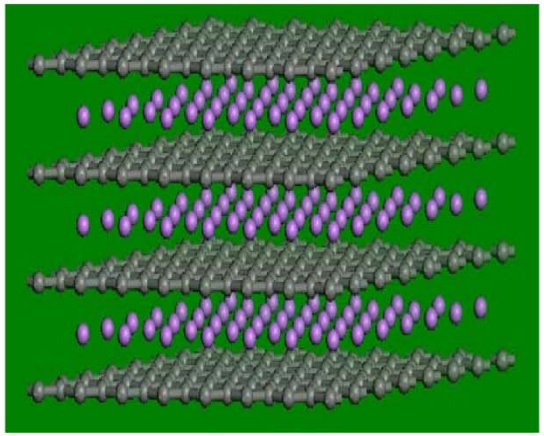
$LiNi_xCo_{1-2x}Mn_xO_2$
(>160 mAh/g)



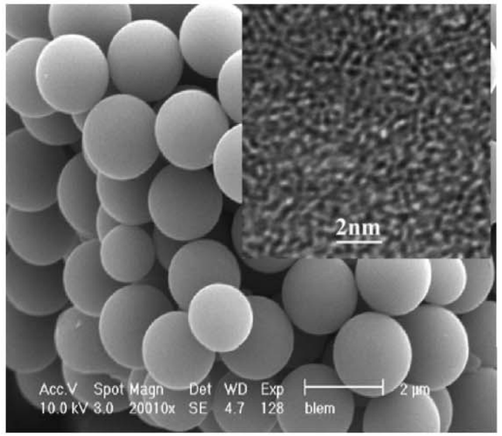
$LiMn_2O_4$
(120 mAh/g)



$LiFePO_4$
(150 mAh/g)



Graphite
(370 mAh/g)

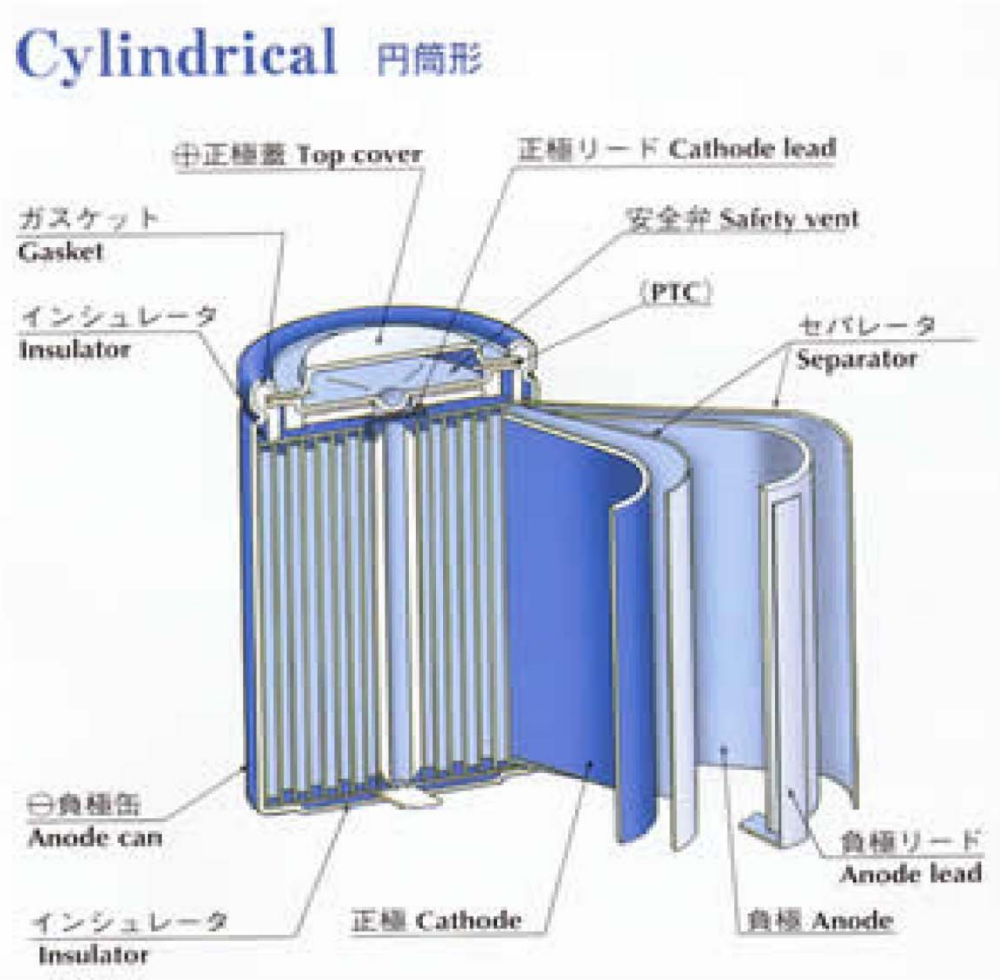


Disordered carbon
(200-500 mAh/g)

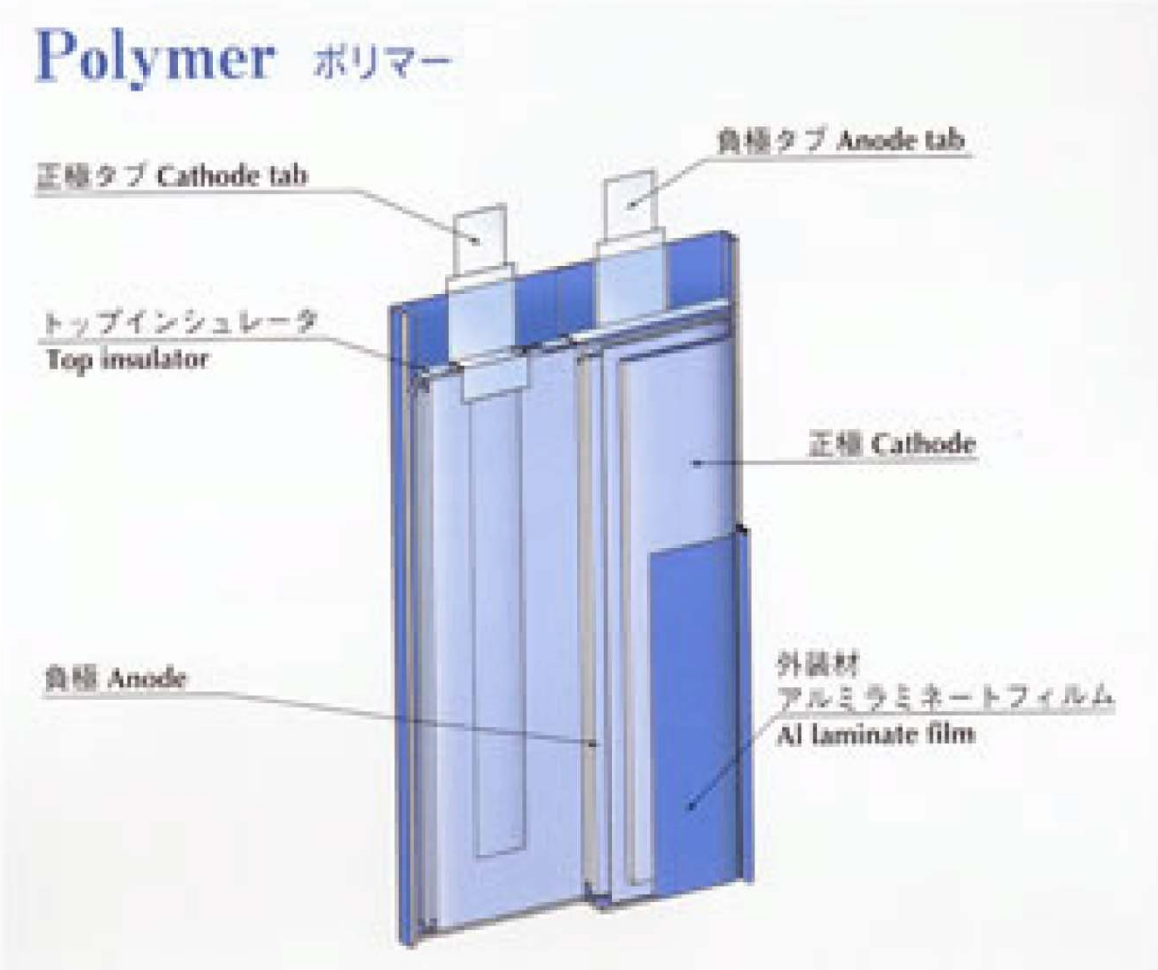
一、从结构划分：

1、方形锂离子电池结构图

2、圆柱形锂离子电池结构图

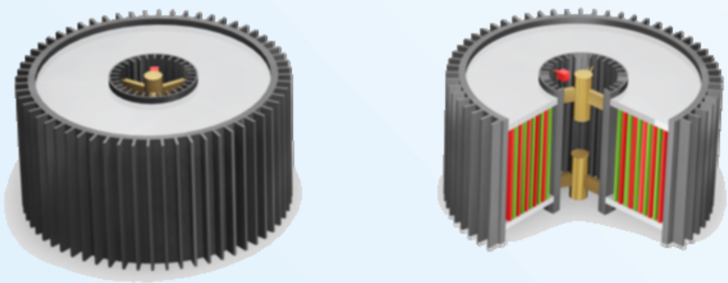


3、软包装锂离子电池结构图



YTE's Innovative Ring-type Cell Design

Ring-type Li-ion cells



100Ah

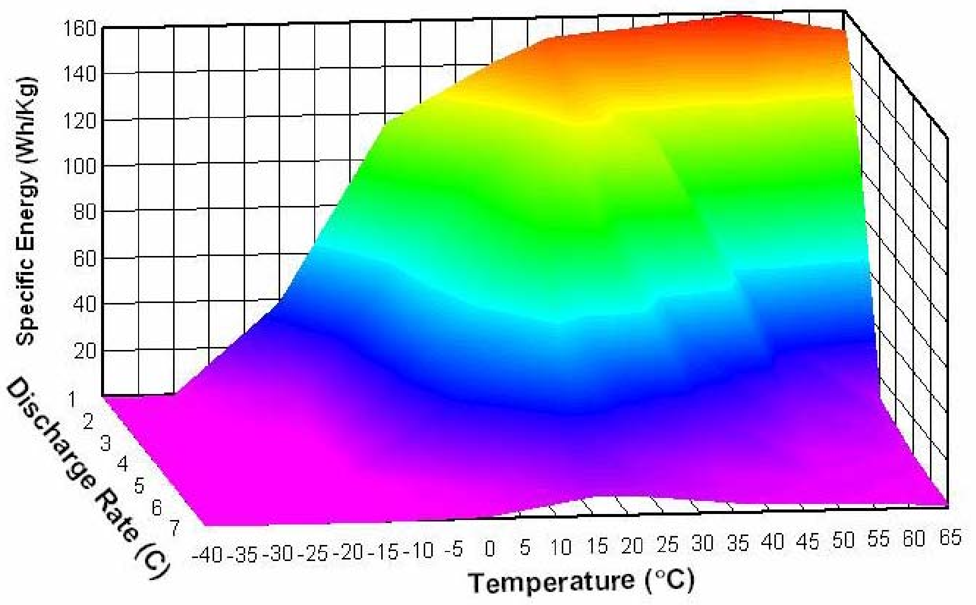
Comparison of Various Batteries

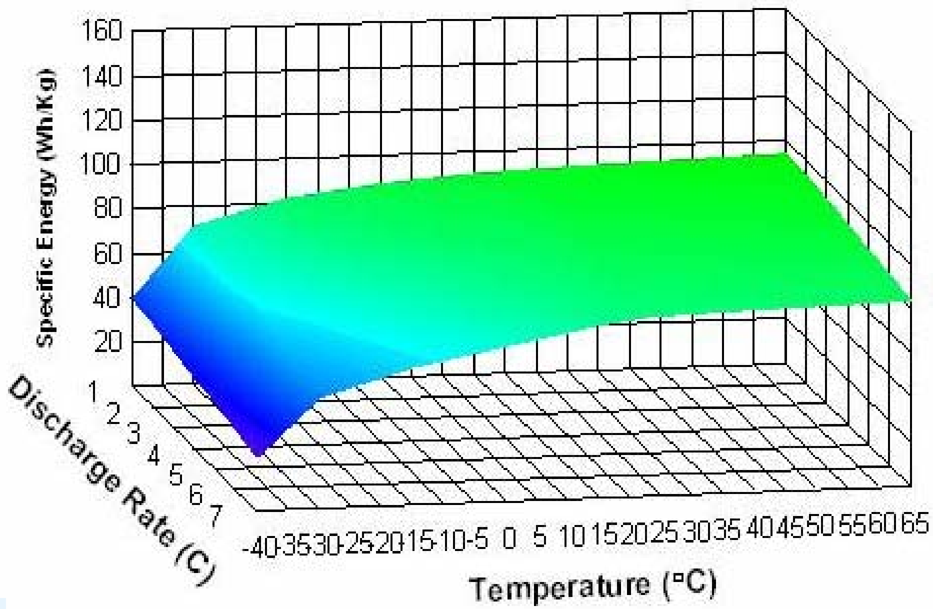
Feature	Lead Acid	NiCd	NiMH	Li Ion	Titanate
Specific Energy (Wh/Kg) Wh/Kg – Cold (<0°C) Wh/Kg – Hot (>65°C) Wh/Kg - High Rate (>6C)	30-40 0 - 15 0 - 15 15 to 35	40+ 0 to 15 Danger 25	60 0 to 20 Danger 35	160 0 to 40 Danger 0 to 50	70-90 50 - 70 80 - 100 70 - 90
Cycle Life @ 100% Discharge **(Typical Rate)**	50 -180 **(4 to 12 hrs)**	300 – 600 **(2 to 4 hrs)**	300 – 500 **(2 to 4 hrs)**	500 – 750 **(1 to 4 hrs)**	25,000 **(6 minutes)**
Safety (Fire Hazard)	Fire Hazard	Moderate	Fire Hazard	Fire Hazard	Safest
Charge Time (0 - >95%)	~ 8 Hours	1- 2 Hours	1 - 2 Hours	1-2 Hours	6 Minutes
Operating Temp Range	-10° to 60°C	0° to 50°C	0° to 40°C	0° to 40°C	-40° to 70°C
Environmental Impact	Toxic	Toxic	Low	Minimal	Minimal
Pulse Power Utilization Range	Narrowest	Narrow	Moderate	Moderate	Broadest
Leakage (Dissipation)	Lowest	High	Highest	Low	Low
Memory Effect	Very Low	High	Moderate	None	None
Power Delivery	Good	Moderate	Moderate	Moderate	High
Manufacturability	Easy	Adequate	Adequate	Easy	Easy
Maintenance	High	Moderate	Moderate	None	None
Market Position	High Volume	Sliding	Modest	Good	Rising
Cost	Cheap	Tied to Ni	Tied to Ni	Moderate	Moderate

Superb HT/LT Performance

Conventional graphite cells perform poorly at -20ºC.

LTO cells perform well at -40ºC.





LTO cells show superb temperature performance at both high and low temperatures.

Cell Manufacturing

- Equipment
- Materials
- Man-power

LOW HUMIDITY ROOM | CLAMSHELL VACUUM OVENS

MIX → COAT → CALENDER → DRY → CUT → STACK → WELD → PACKAGE → ACTIVATE → FORM → DEGAS RE-SEAL

	MIX	COAT	CALENDER	DRY	CUT	STACK	WELD	PACKAGE	ACTIVATE	FORM	DEGAS RE-SEAL	
EQUIPMENT	MIXERS (POS / NEG) JACKETED MIX VESSEL (4 to 8) VISCOCITY TOOLS <25% HUMIDITY ROOM	DOUBLE SIDED COATER (2) SOLVENT RECOVERY SYS <25% HUMIDITY ROOM	CALENDER (2) <25% HUMIDITY ROOM	CLAMSHELL VACUUM OVENS (OVENS INTERFACE HIGH TO LOW HUMIDITY)	ELECTRODE CUTTERS <0.5% RH DRYROOM	PICK AND PLACE MACH <0.5% RH DRYROOM	ULTRASONIC SYSTEM <0.5% RH DRYROOM	CUPPING MACH WRAPPER SEALER(S) <0.5% RH DRYROOM	INJECTION EQUIP SEALER <0.5% RH DRYROOM	CYCLERS THERMAL CHAMBERS	CUTTER VACUUM SEALER	
MATERIALS	POSITIVE ACTIVE MAT NEGATIVE ACTIVE MAT BINDER CARBON BLACK GRAPHITE ADITIVE SOLVENT					SEPARATOR	ELECTRODE TABS	LAMINATE PACKAGING CPP	ELECTROLYTE			
EQUIP CAP	$750,000 $1,000,000	$2,000,000 $500,000	$1,000,000	$1,000,000	$500,000 $8,000,000	$2,000,000	$500,000	$500,000	$500,000	$1,000,000	$500,000	
TOTALS	$1,750,000	$2,500,000	$1,000,000	$1,000,000	$8,500,000	$2,000,000	$500,000	$500,000	$500,000	$1,000,000	$500,000	GRAND TOTAL $19,750,000
PERSONEL												
ENGINEERS	1	1			0.5	0.5	0.5	0.5		0.5	0.5	5
TECHS	2	2	2	2	1	1	1	1	1	6	6	25
											TOTAL HEADCOUNT	30

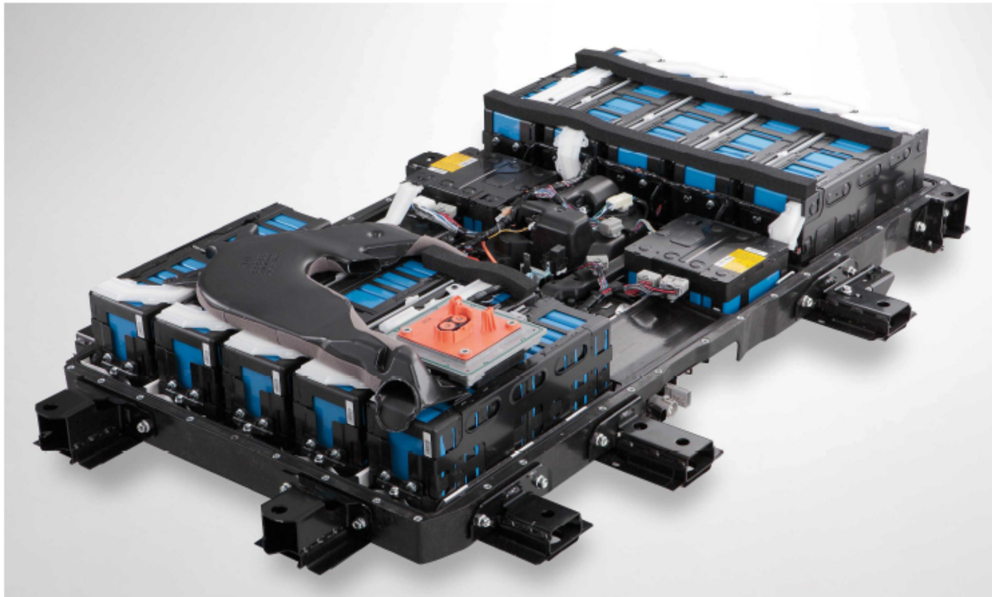
Cell manufacturing is 90% experience, skill, & know-how, 10% buildings and machinery

Lithium-ion Battery

High capacity battery module (16kWh) can be placed under the floor panel without being modified, regardless of the vertical or transverse position.

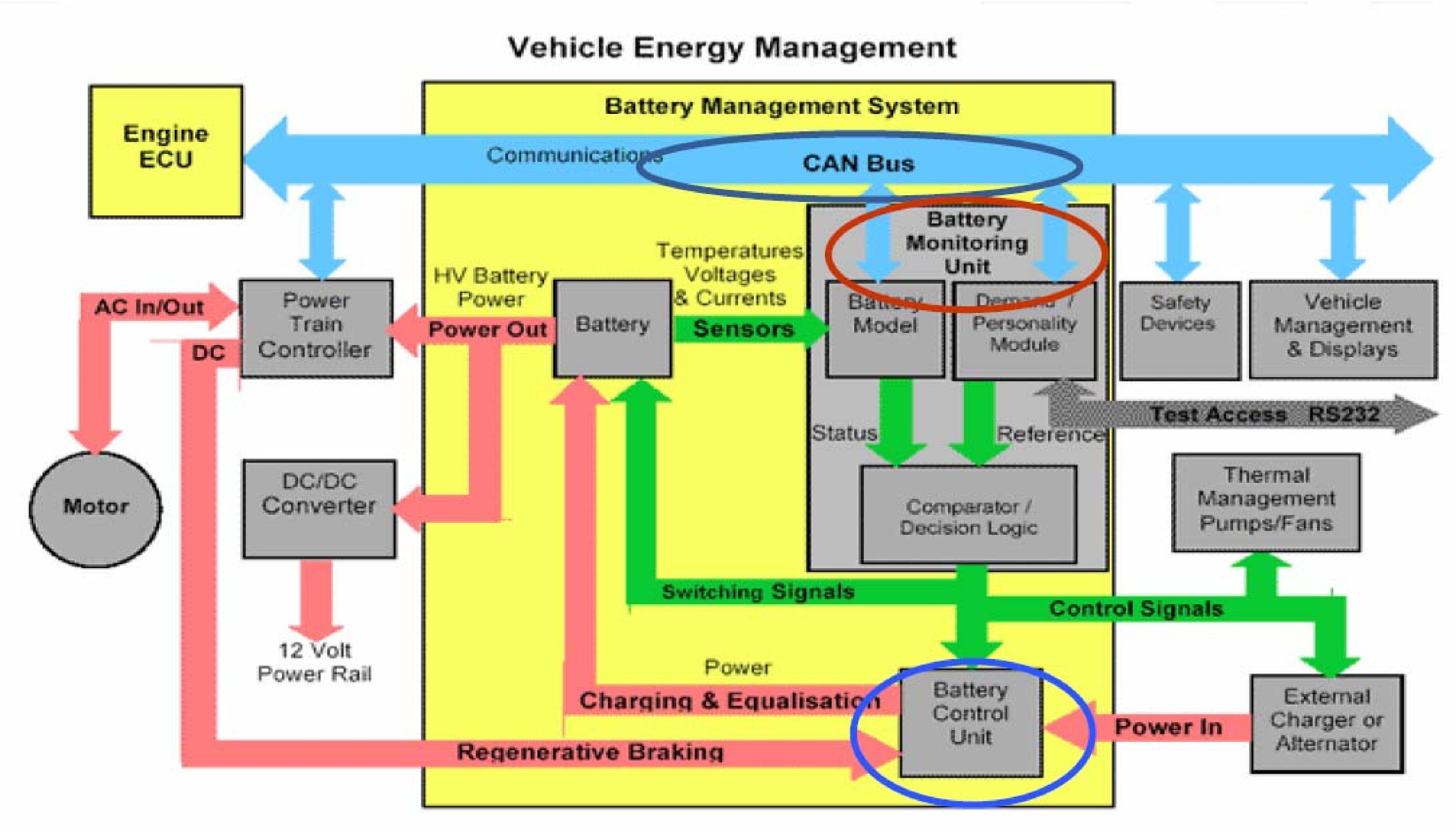
Cell

Module

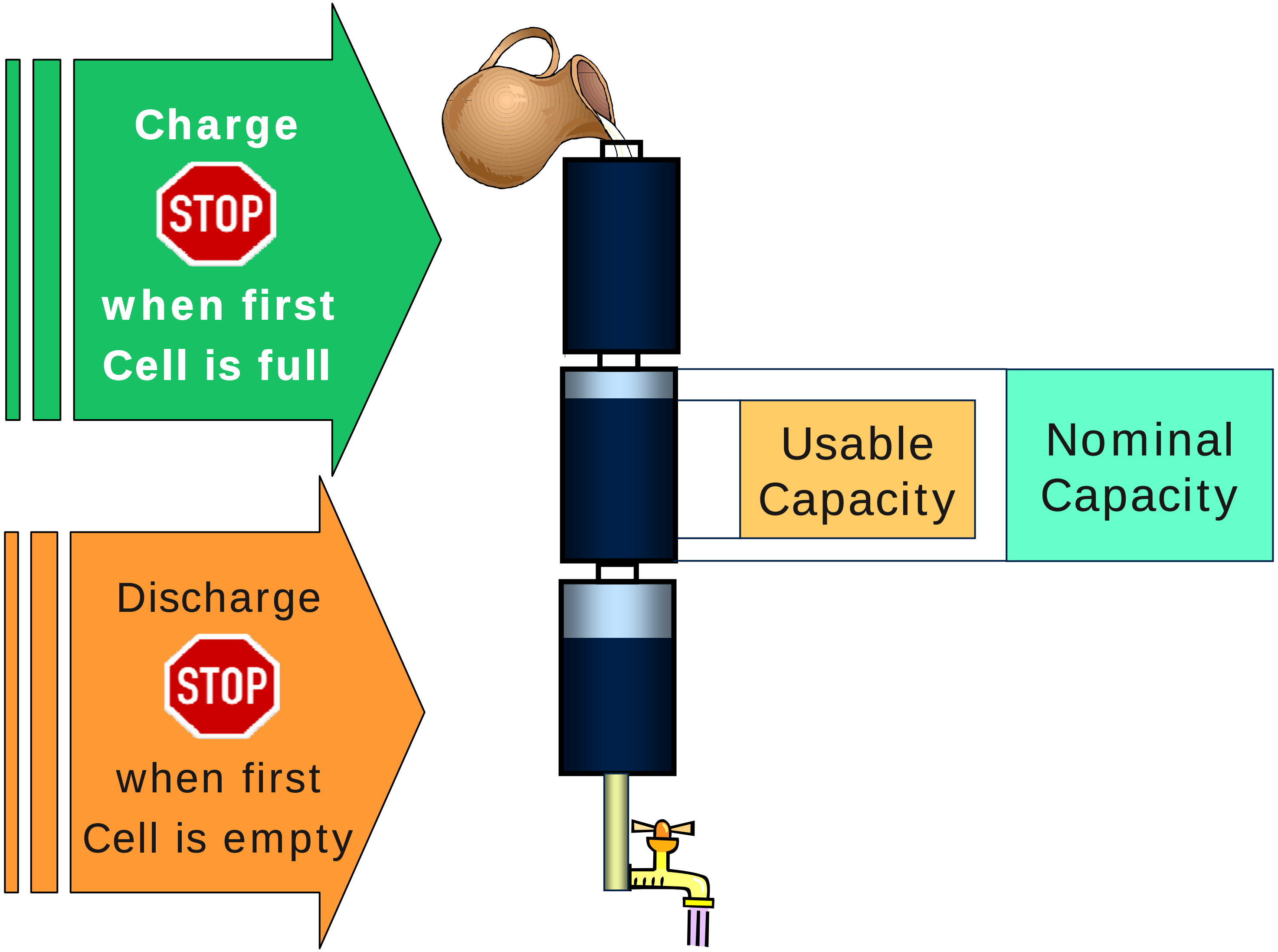


Battery Package

Battery Management System – Architecture



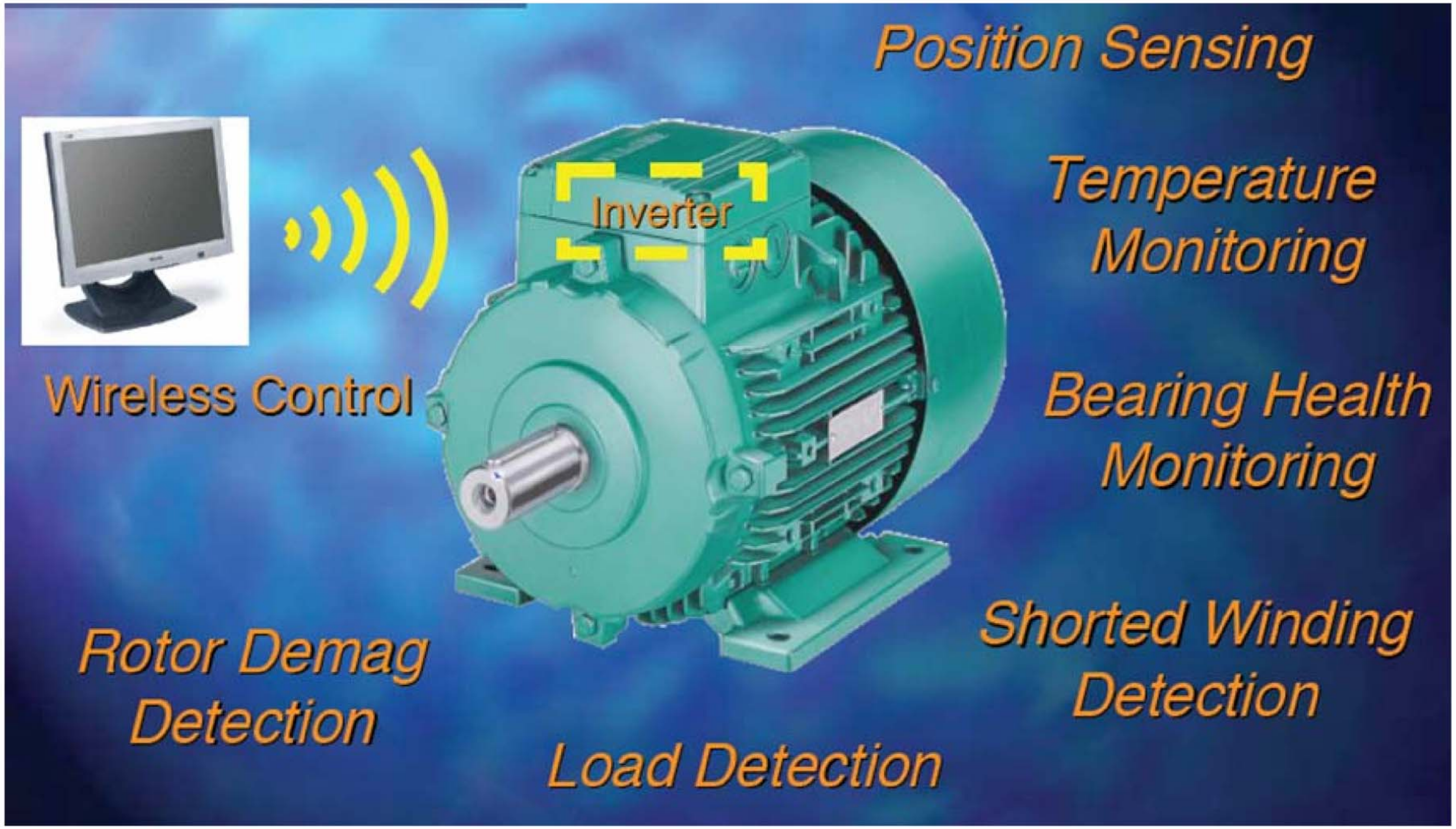
Necessity of Balancing – Unbalanced Stack



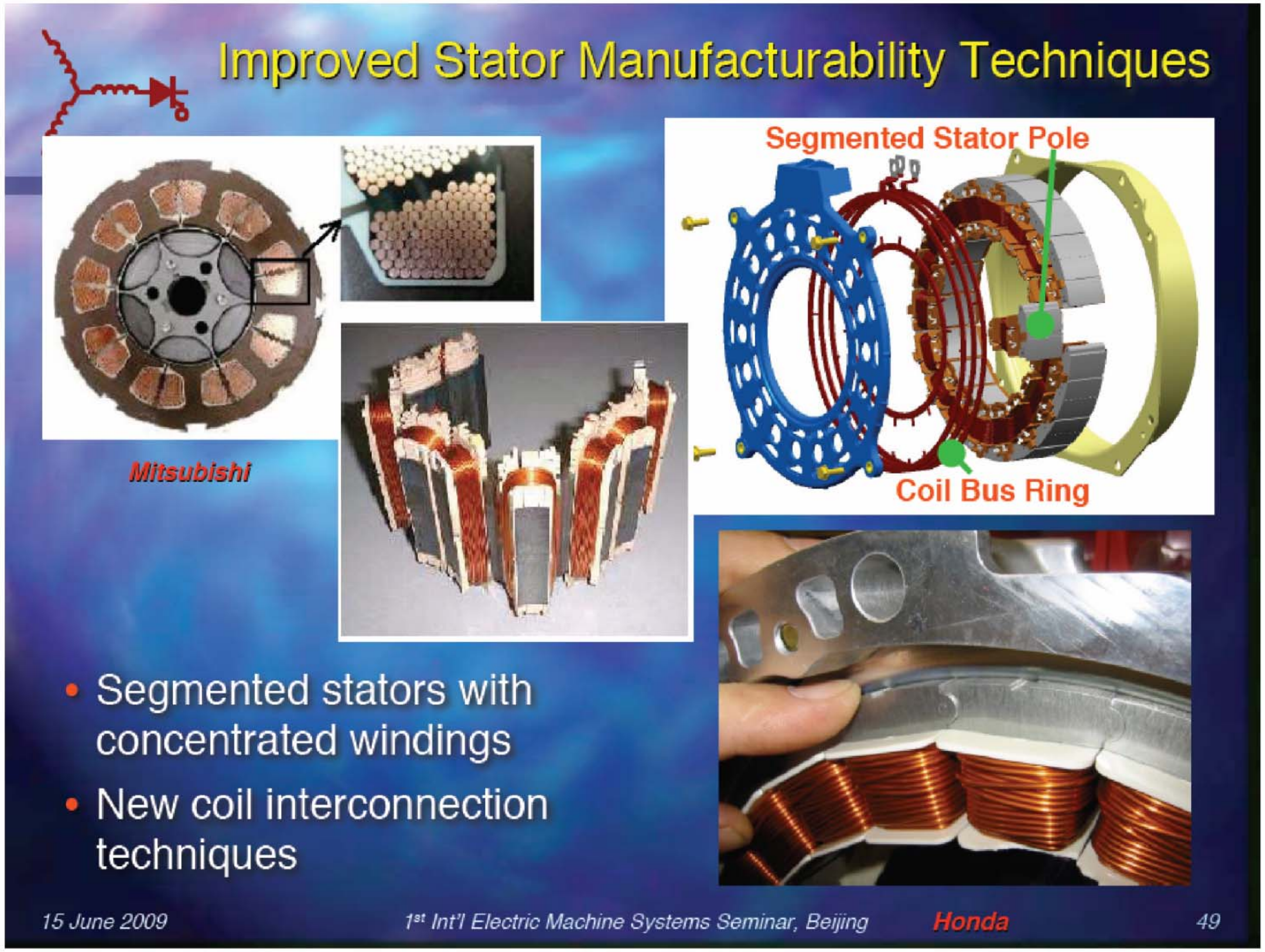
Family Energy Storage（FES) unit

The wind, solar & battery system combination will be a perfect source for all families including those in the remote area.

当前研究重点： 温度监控、冷却与导热以及热能管理技术，安全与故障容错技术，网络信息化技术

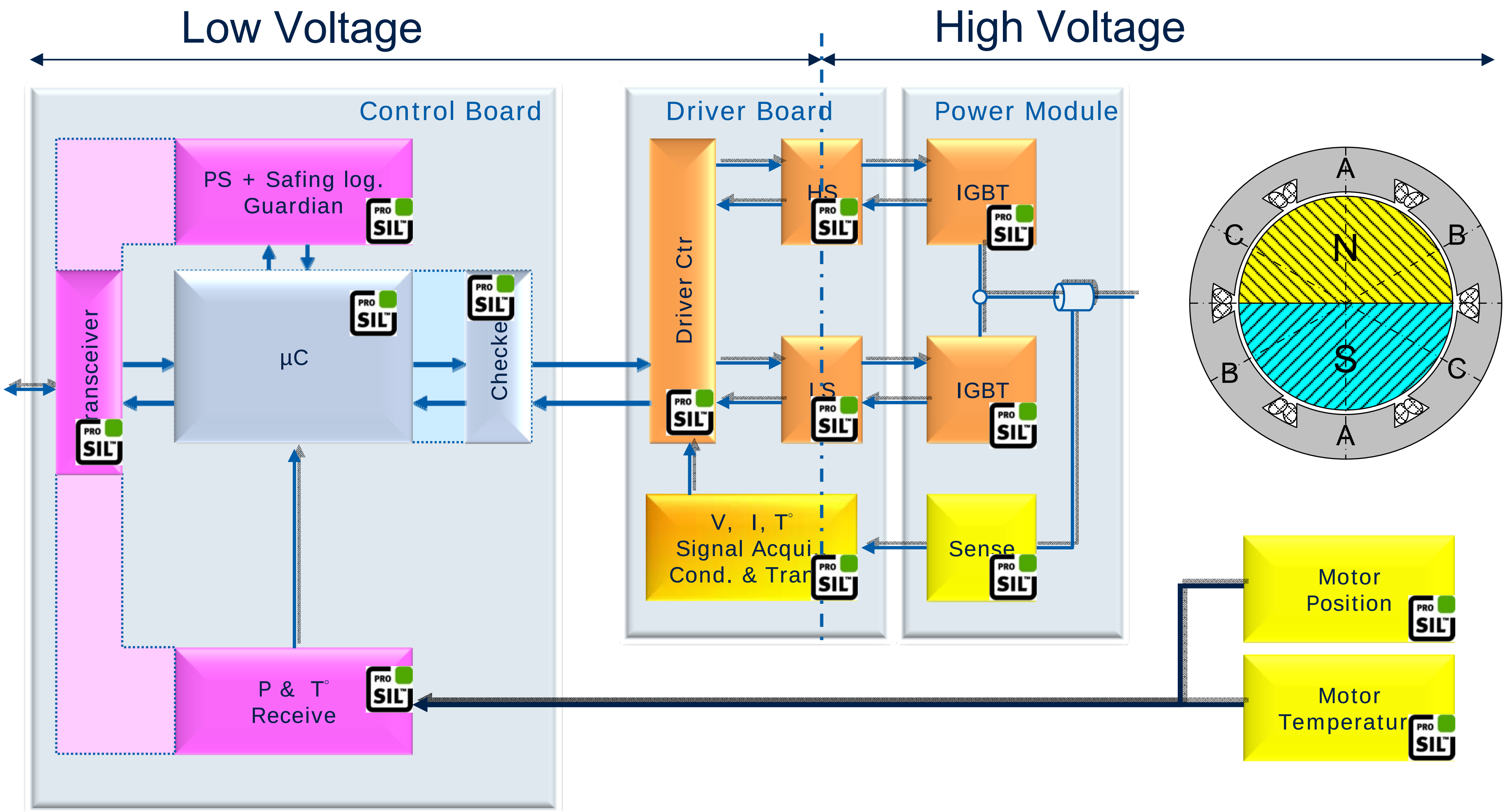


分块定子铁芯/激光拼接技术



2010年8月21日

Inverter System:
Safety is a System Approach

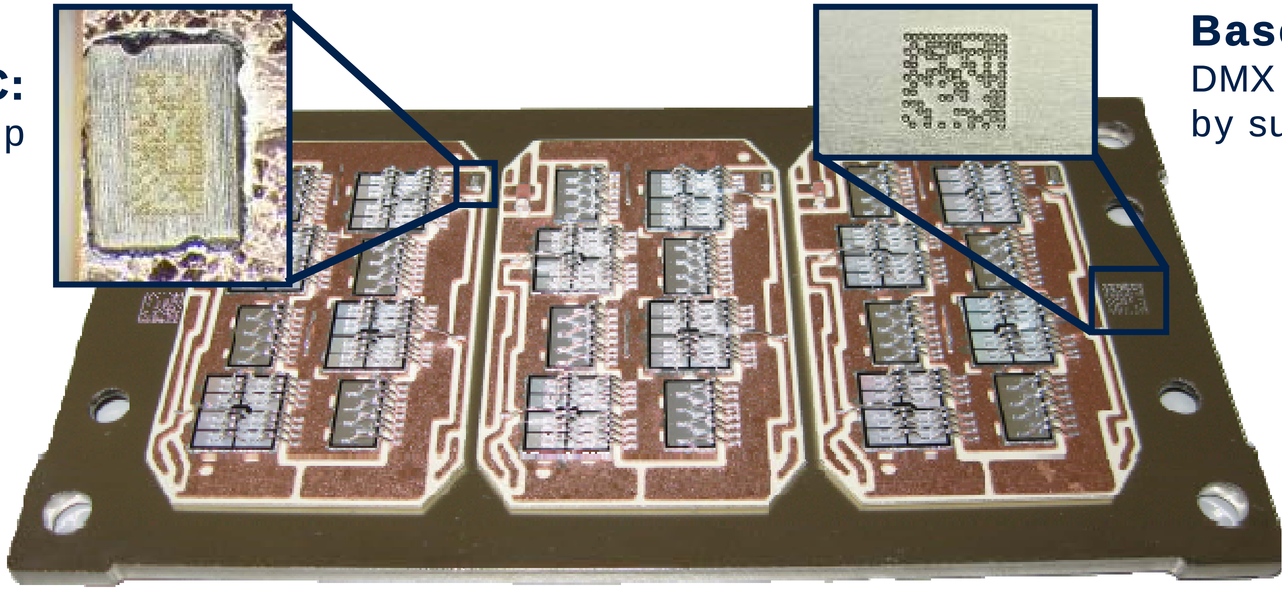


 Confidential

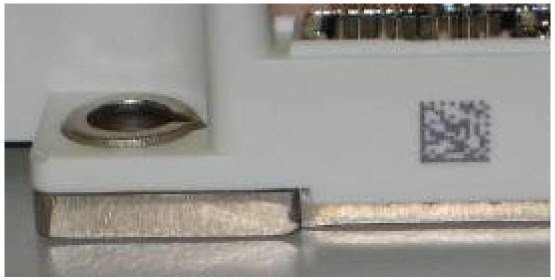
Improved Traceability: Preparation for Single Component Tracking

DBC:
DMX code chip

Base plate:
DMX code
by supplier



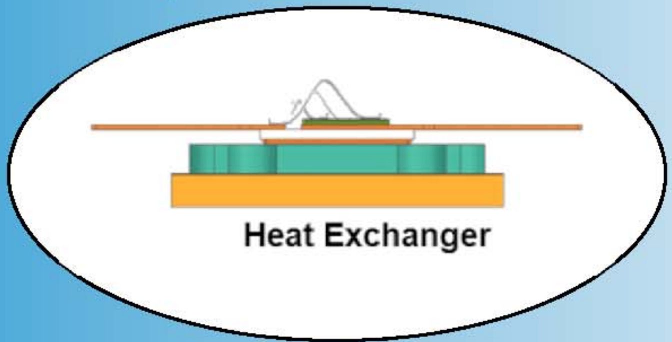
Frame:
DMX code by supplier



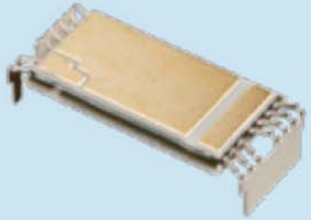
Module: DMX code label by final tester

2X Improvement in Heat Transfer

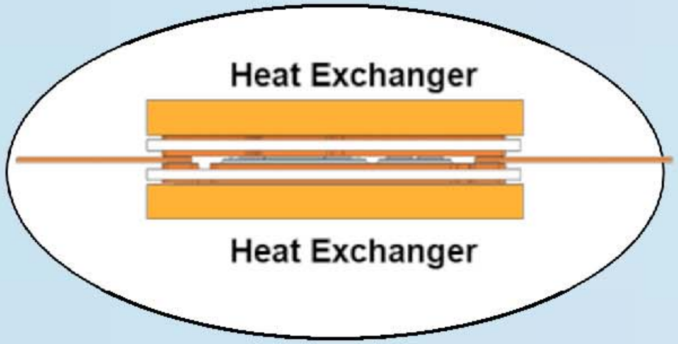
Typical IGBT Power Module
- **Single Side Cooling to IGBT**
- **Top Side Wire Bond**



R_{th} = 0.3 C°/W



Delphi Double Side Cooled IGBT Power Package
- **Double Side Cooling to IGBT**
- **No Wire Bonds**



R_{th} = 0.15 C°/W

DELPHI

ChinaNEVforum

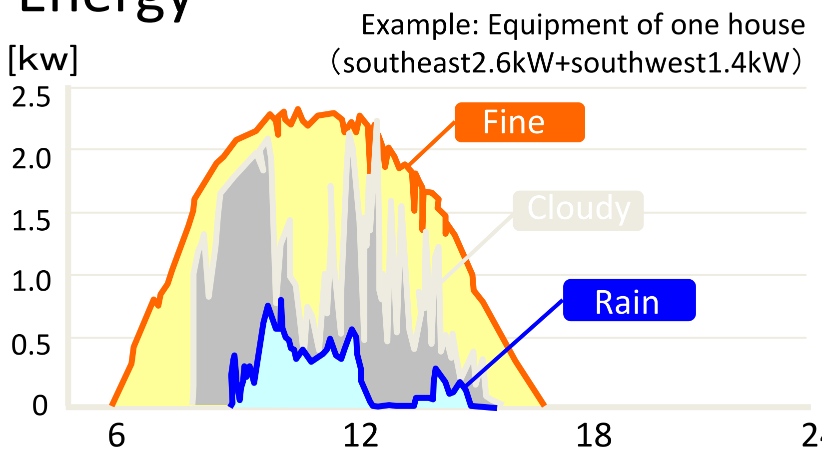
Stability use for renewable energy by electric vehicle

- The renewable energy of sunlight, wind, etc. into which the amount of power generation greatly changes depending on the weather and time is saved in storage battery (LiB) with high efficiency.

Renewable Energy

Solar power

Wind power



※Uncontrollable electric power

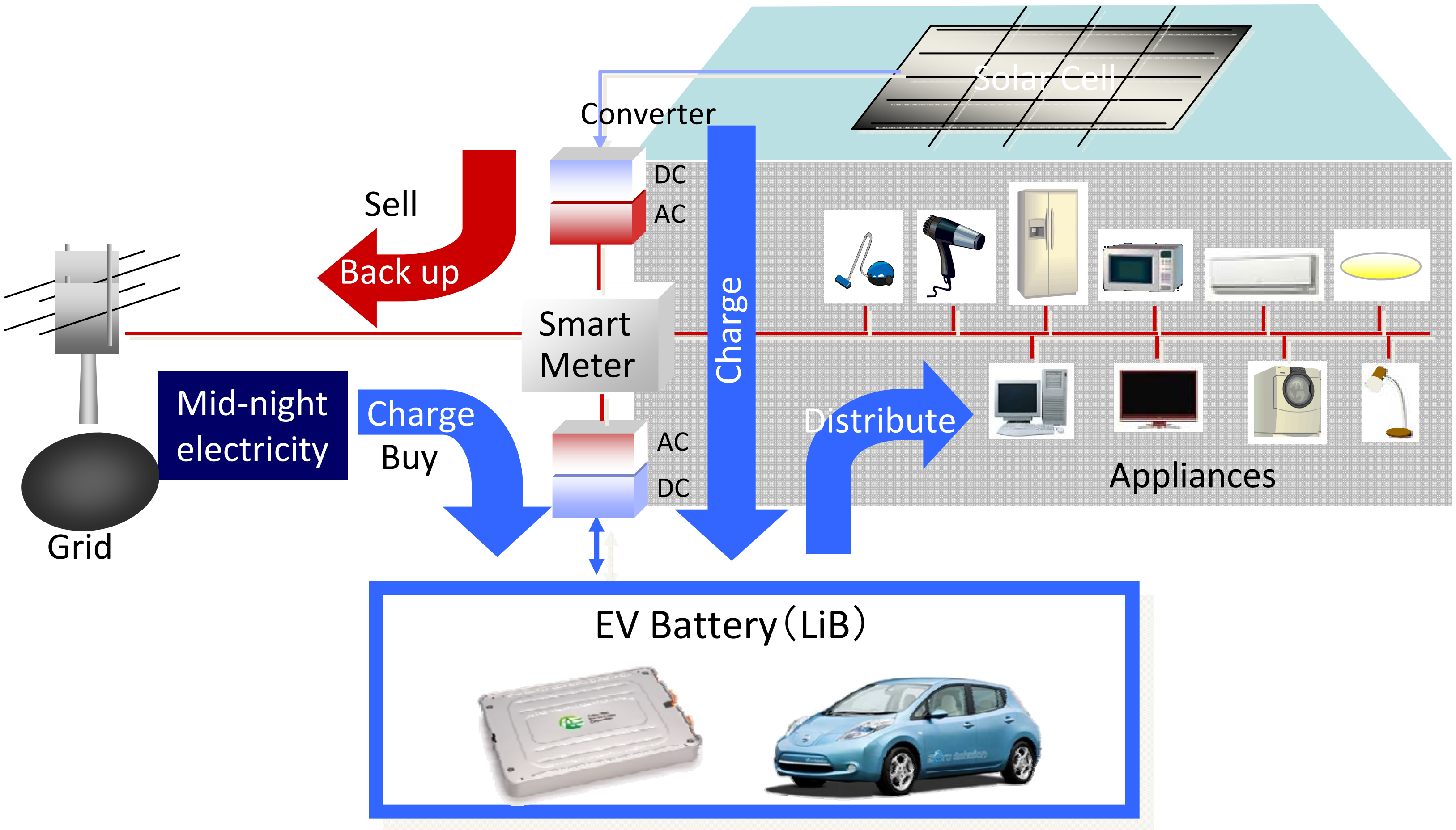
Source data : the Research Center for Photovoltaics, National Institute of Advanced Industrial Science and Technology (AIST) HP

Charging / Discharging

Battery (LiB)

Smart House

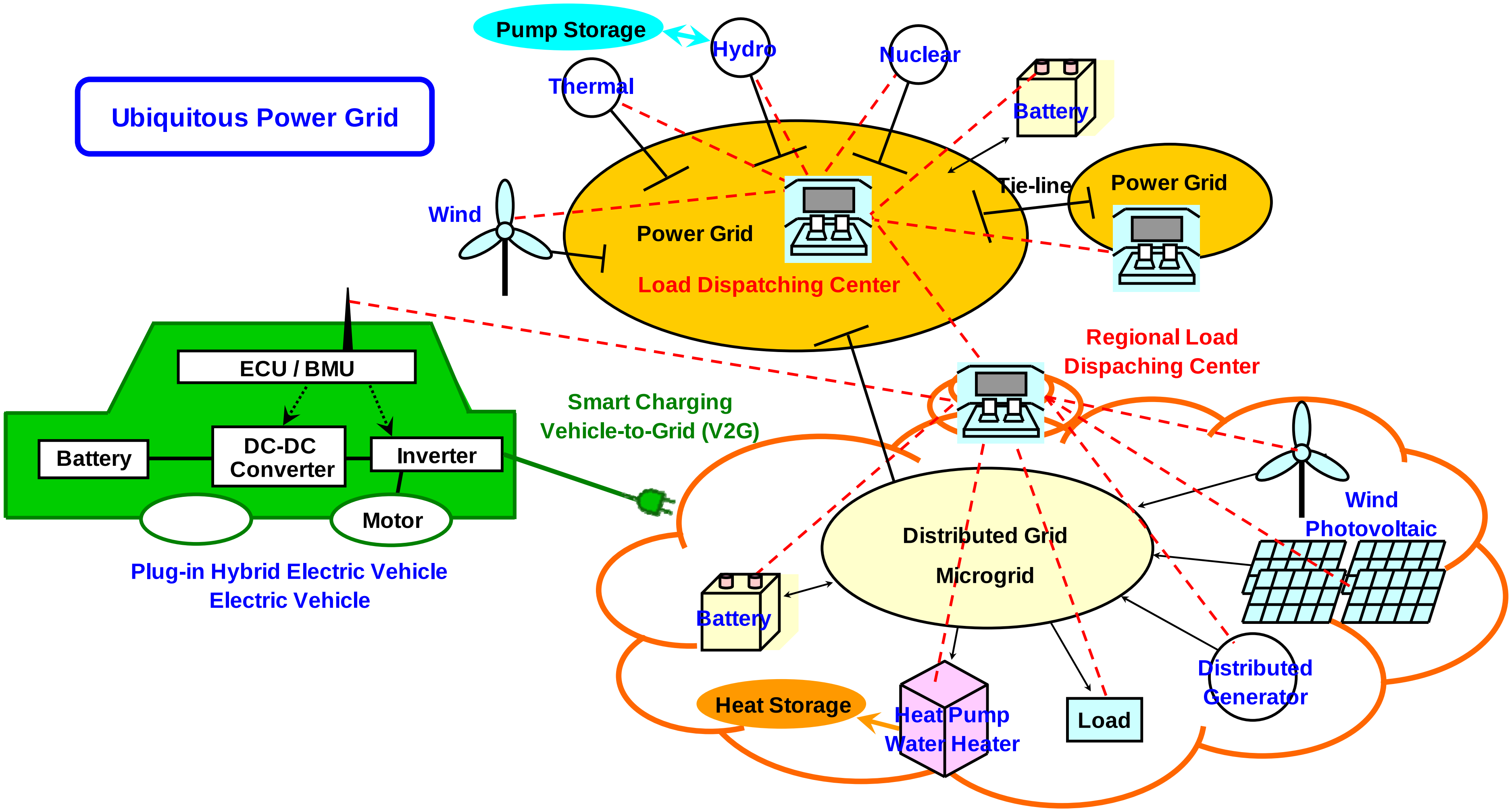
- Increasing low carbon electricity and reduce peak electricity consumed
- Management of electricity storage by EV and/or Lithium ion battery



EVs would be plugged into **home outlet for hours**.
High-speed response with synchronization could be realized by using **self-terminal frequency measurement**.
Maintaining **battery condition** and **charging request** by itself

Autonomous Distributed V2G

...Centralized control scheme dispatching LFC signals to storage devices



EVs are at the frontier of two worlds electricity and automobile

Domains	Electricty	Other sectors	Telecomunication
International	IEC	ISO	ITU
Europe	CENELEC	CEN	ETSI

EV Charging standardisation is at the frontier

Two worlds that must learn to work togeth

Electricity industry

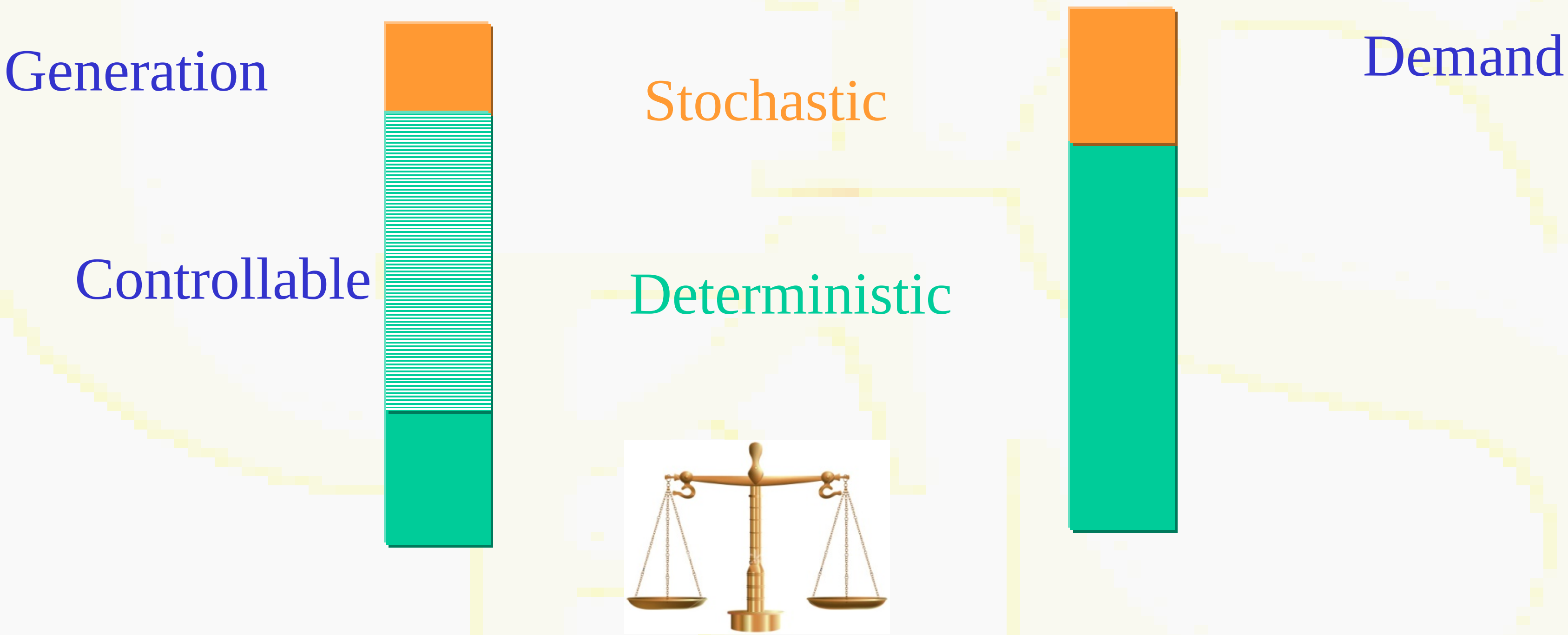
Automotive industry

Different clients
Different standards
Different working methods
Different regulations
- Regional regulations : global market !

One objective : simple, cheap, efficient and global solution

Traditional Power System

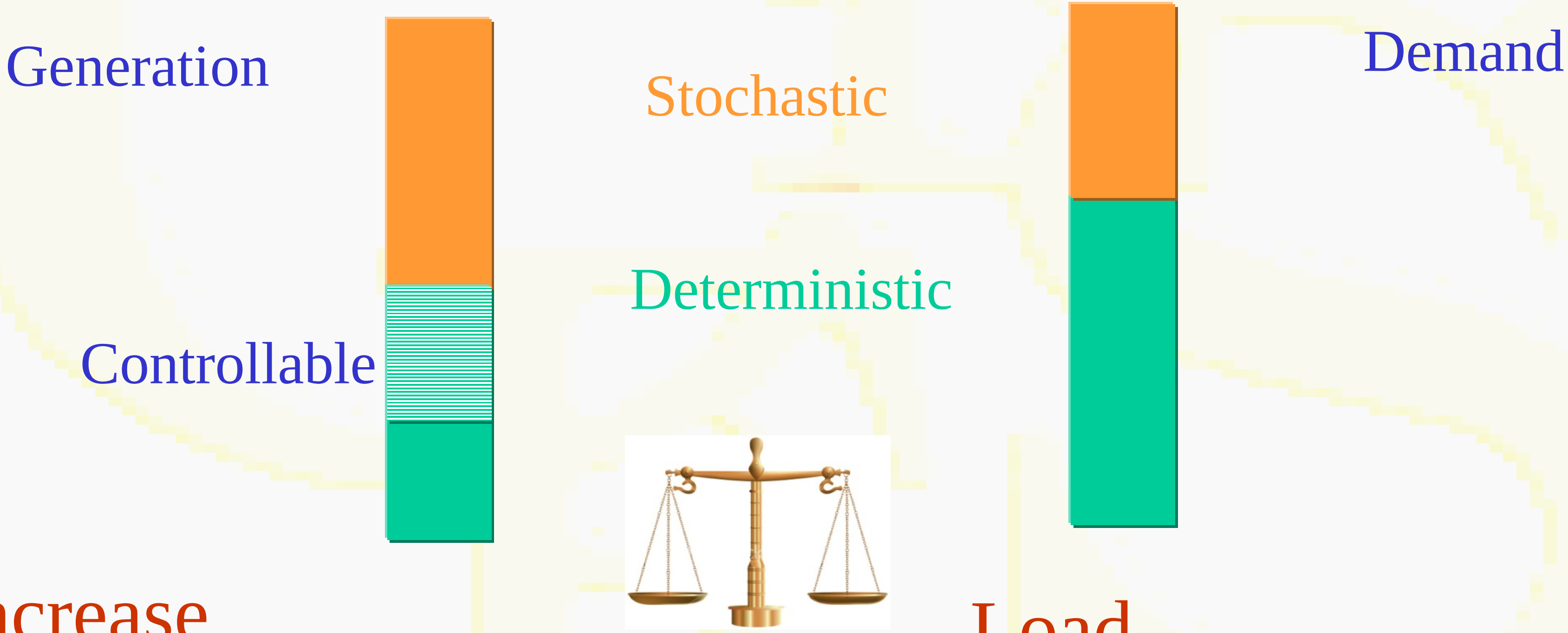
- Enough deterministic and controllable generation



Generation follows the load

Smart Grid Environment

- Increase in (stochastic) renewable generation

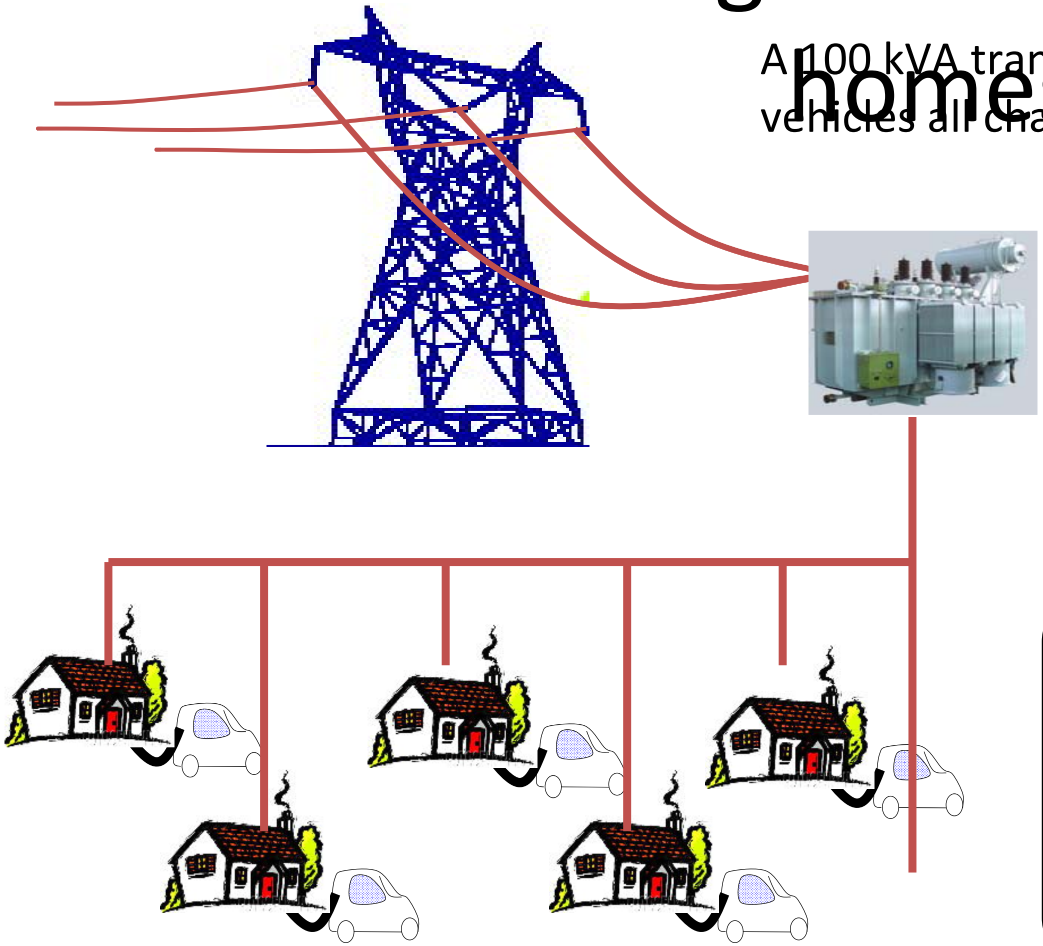


Increase
energy storage

Load
follows generation

Just an example :
20 fast charge Evs in a town of 75 homes

A 100 kVA transformer typically serves 75 homes : If 20 vehicles all charge at the same time :

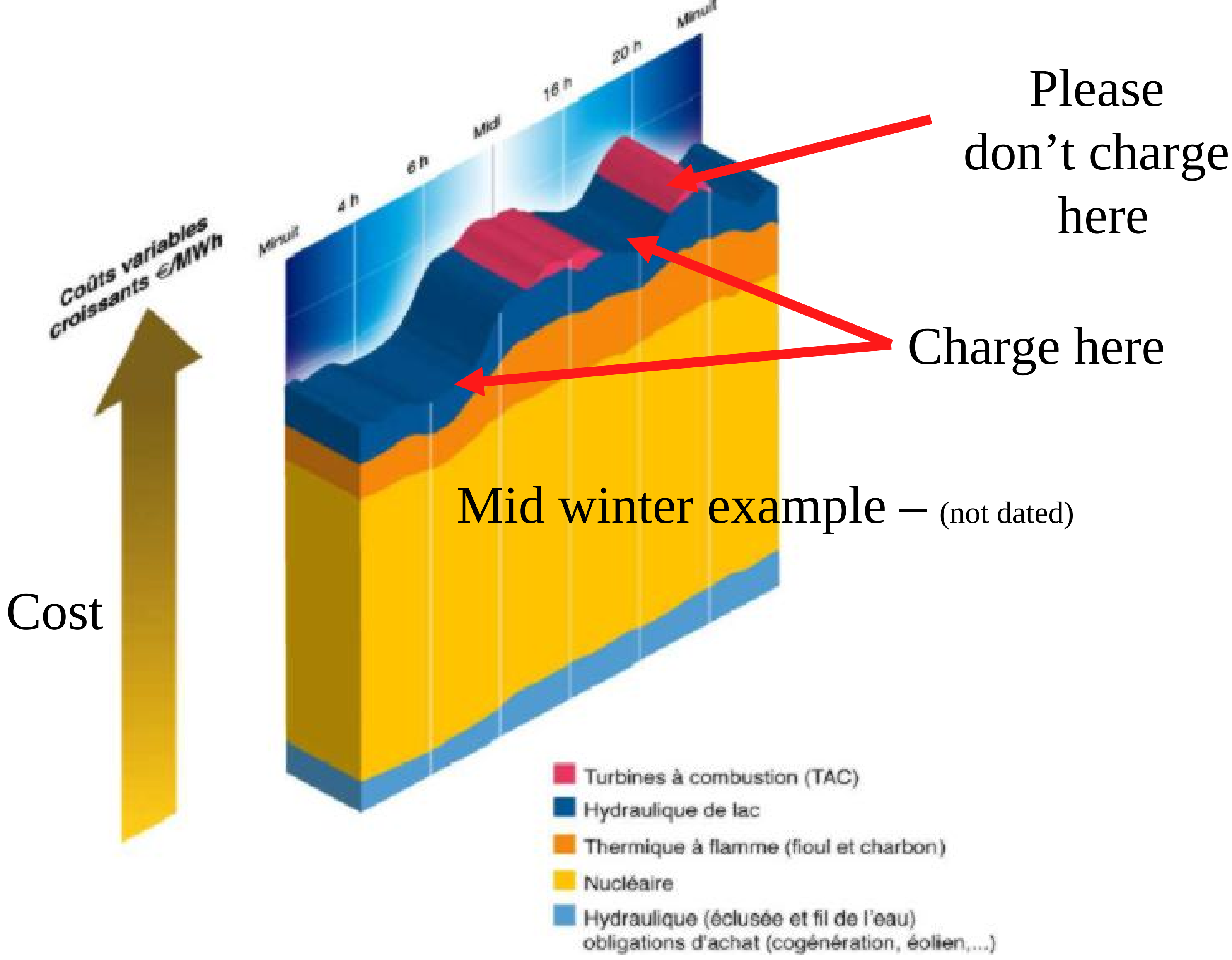


75 to 100 house holds (1.2 kW/house)

3,3 kW charge = 66 kW
22 kW charge = 440 kW
44 kW charge = 880 kW

- Load control is necessary
- Fast charge cannot be done simultaneously
- Smart grid is necessary

In the future we must orientate the client to chose the optimum charging time for cost and CO2



Such load control requires :

- Require : Pricing policy because present price differences may not be dissuasive to the client for day-time charging
- Require : Intelligent grid
- Require : Vehicle to grid communication
- Require : Client incentives
- Require : A new relation and client communication

Billing of Electricity

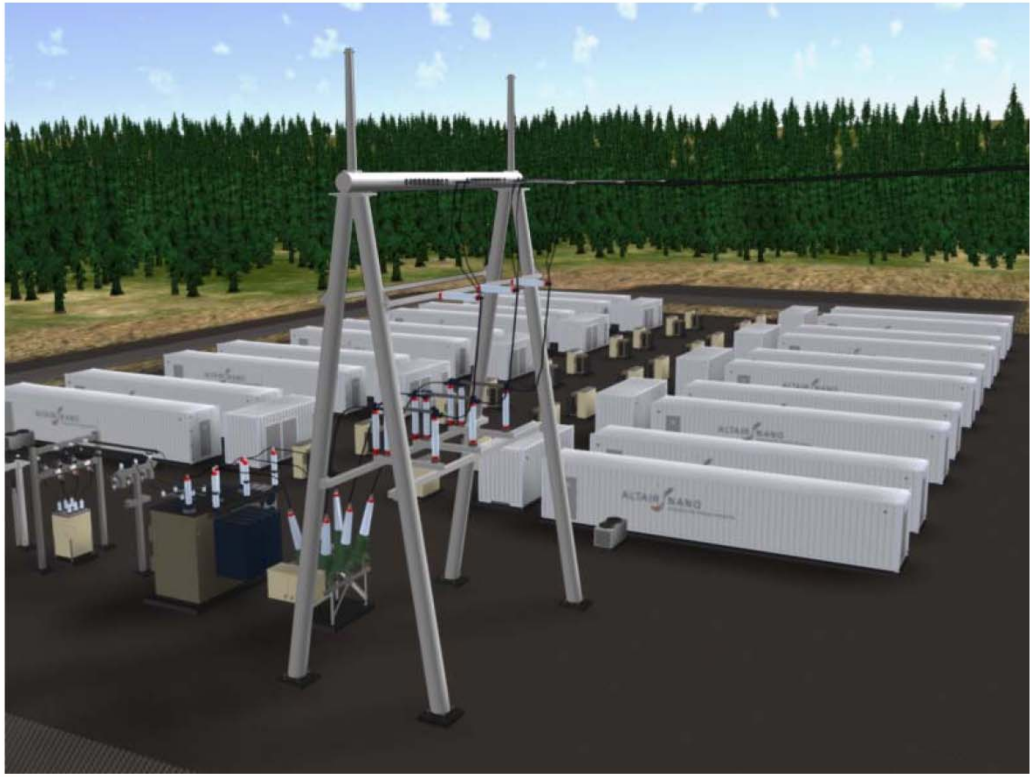
- **Electricity costs are low compared to the other costs (infrastructure and parking)**
- **Home charging and all office charging will normally be done directly from the client meter**
- **Night / day tariffs permit the balancing of domestic power consumption**
- **Electricity costs on public charging areas are far lower than the parking fees. The electricity could be directly integrated into the fees.**
- **Complex payment systems (Roaming) does not seem warranted**

But almost all govenrments and companies seem to want roaming. It is difficult to understand why as simple systems are possible

The ALTI-ESS 20MW/5MWh Grid Stability System

Designed for rapid response power management applications

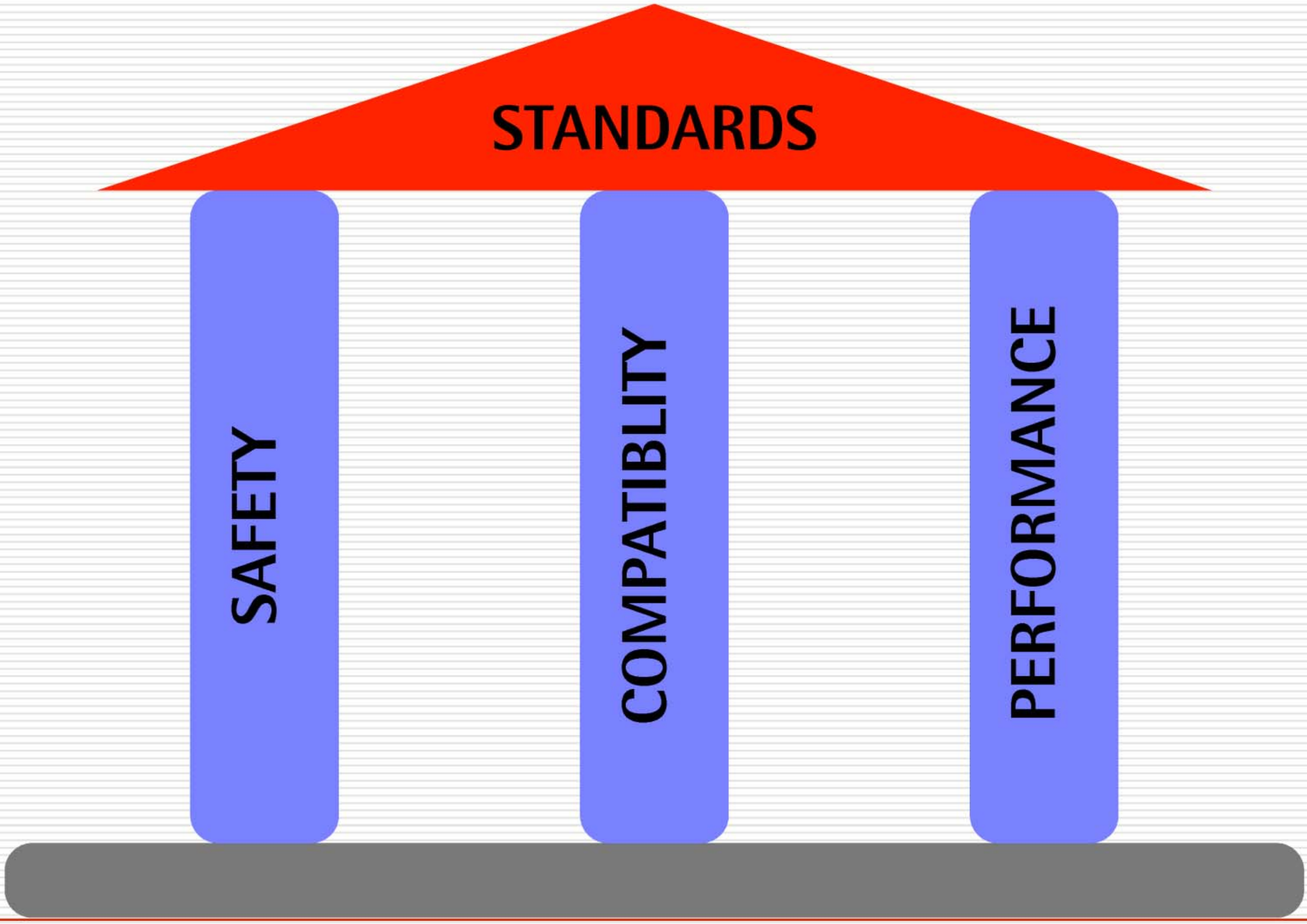
- Frequency regulation
- Photovoltaic smoothing
- Wind smoothing
- Micro-grids/Island grids



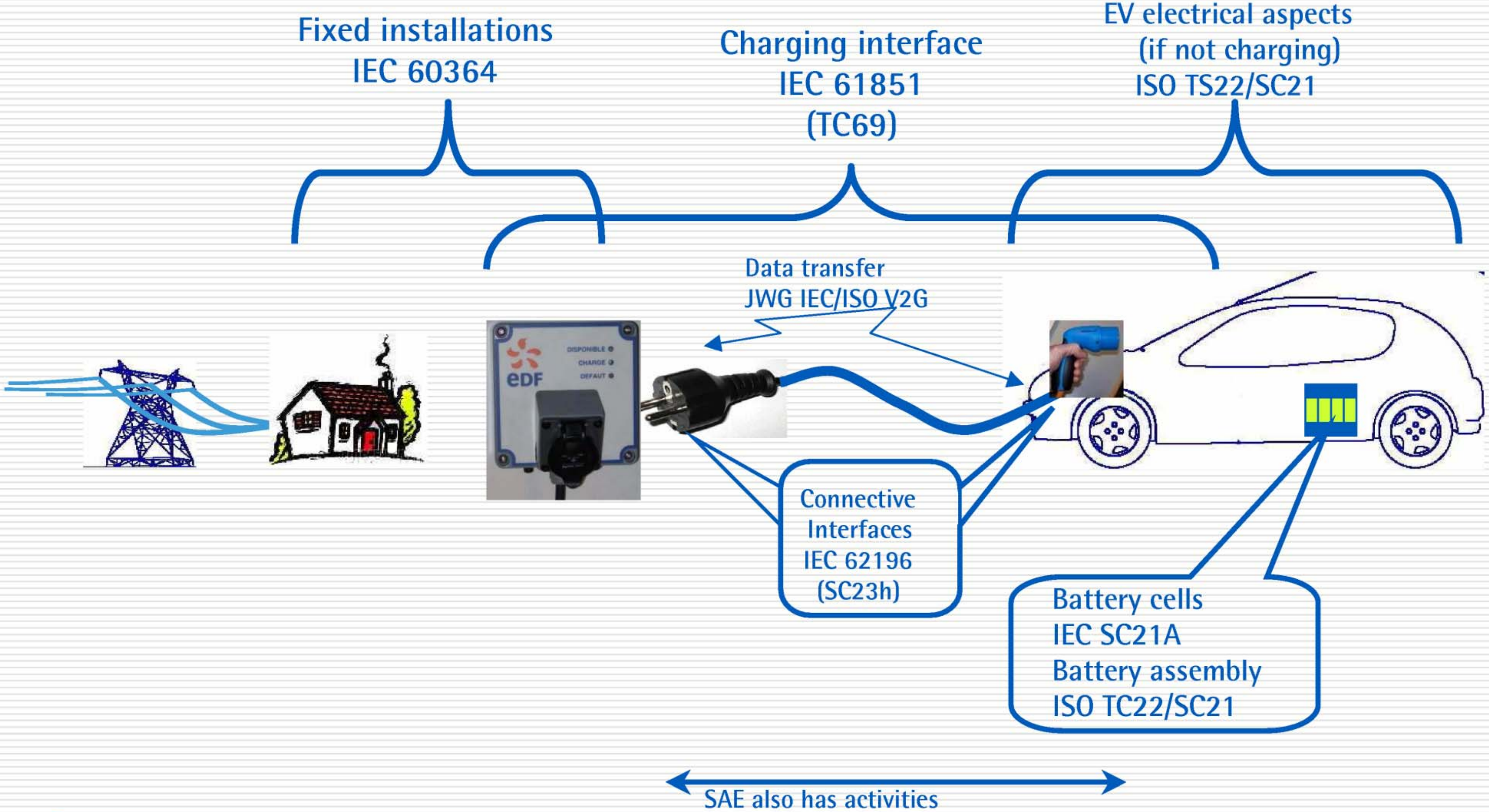
Improves equipment utilization and operational efficiency

- Zero direct emissions
- High efficiency
- Reduced fuel consumption

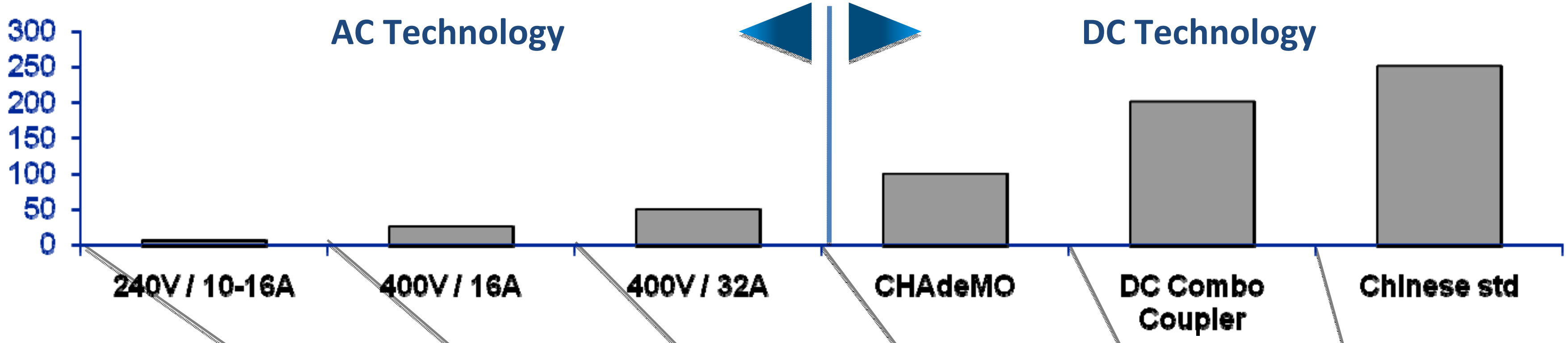
The House of Standardization



Committees in charge



Range added through 30 min charging [km]



Connection						
Cars on OEM roadmap until 2013	Practically all EVs				German / US OEMs	

AC charging systems for EVs are generally much slower than DC variants

Charging Modes and Plug Types

Modes/ Levels IEC 61851 / SAE J1772	Current type IEC max Power (1P / 3P) [kW]	Operation Characteristics	Type 1 Yazaki SAE J1772 		Type 2 Mennekes VDE-2623-2-2 		Type 3 EV Plug Alliance 		CHΛdeMO 
			1P	3P	1P	3P	1P	3P	
1	AC 3,7 / 11	Domestic plug (not allowed in US)	12A	-	16A	16A	16A	16A	-
2 / 1	AC 7,4 / 22	Domestic plug + ICCB (control pilot)	32A	-	32A	32A	32A	32A	-
3 / 2	AC 57,5 / 100	Charging station (V2G planned)	80 A (USA only)	-	63A	63ª	32A	32A	-
4 / 3	DC 240 kW	Offboard Charger	New Combo 		Combo2		-		125A

Country support:


Segmentation of charging infrastructure – new customer patterns

	At Home	Workplace	Public Area
			
Investment	Private Individuals	Companies / Mobility providers	Companies / Mobility providers
Parking duration	14h per day	7h per day	2h per day
Charging time/ Output	< 8h (< 4 kW)	< 4h (< 8 kW)	< 2h (≥ 20 kW DC/ 3ph/32A AC)
Charging priority	Nighttime	Daytime fast charging	Daytime
Impact on the Grid	Positive	Neutral	Neutral → Load management necessary!
Share of consumption	**80 %**		20%

According to given charging table calculated with a standard battery (20 kWh)

Charging at home/ workplace with 80% share of consumption is the “Enabler” for E-Mobility because it is possible **everywhere** and **every time**!

Segmentation of charging infrastructure – new customer patterns

At dedicated parking places (home and working place)

Sufficient Charging still possible

Sufficient Charging still possible

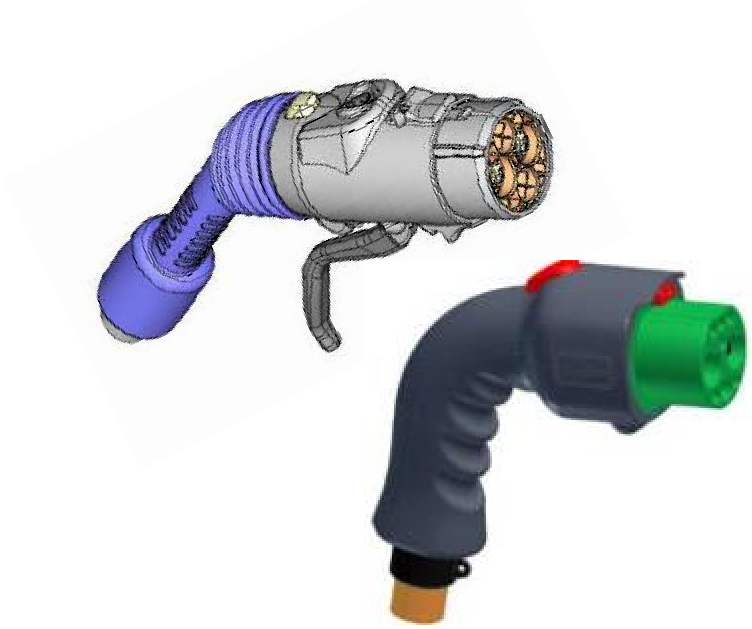
Socket	10A (8A used)	16A (13A used)	16A	32A
Parking duration	7 - 14h per day			
Charging time/ Output	< 14h (< 2 kW)	< 10h (< 3 kW)	< 8h (< 4 kW)	< 4h (< 8 kW)
Charging priority	Nighttime & Daytime			
Share of consumption	**80 %**			
Investment	**-**	**$**	**$$$**	**$$$$$**

According to given charging table calculated with a standard battery (20 kWh)

Charging at home/ workplace with 80% share of consumption is the “Enabler” for E-Mobility because it is possible **everywhere** and **every time**! Even with the smallest power supply, customer can achieve sufficient charging during nighttime

DC Charging Systems

CHAdeMO/ China DC vs. **Combo 1 / Combo 2**

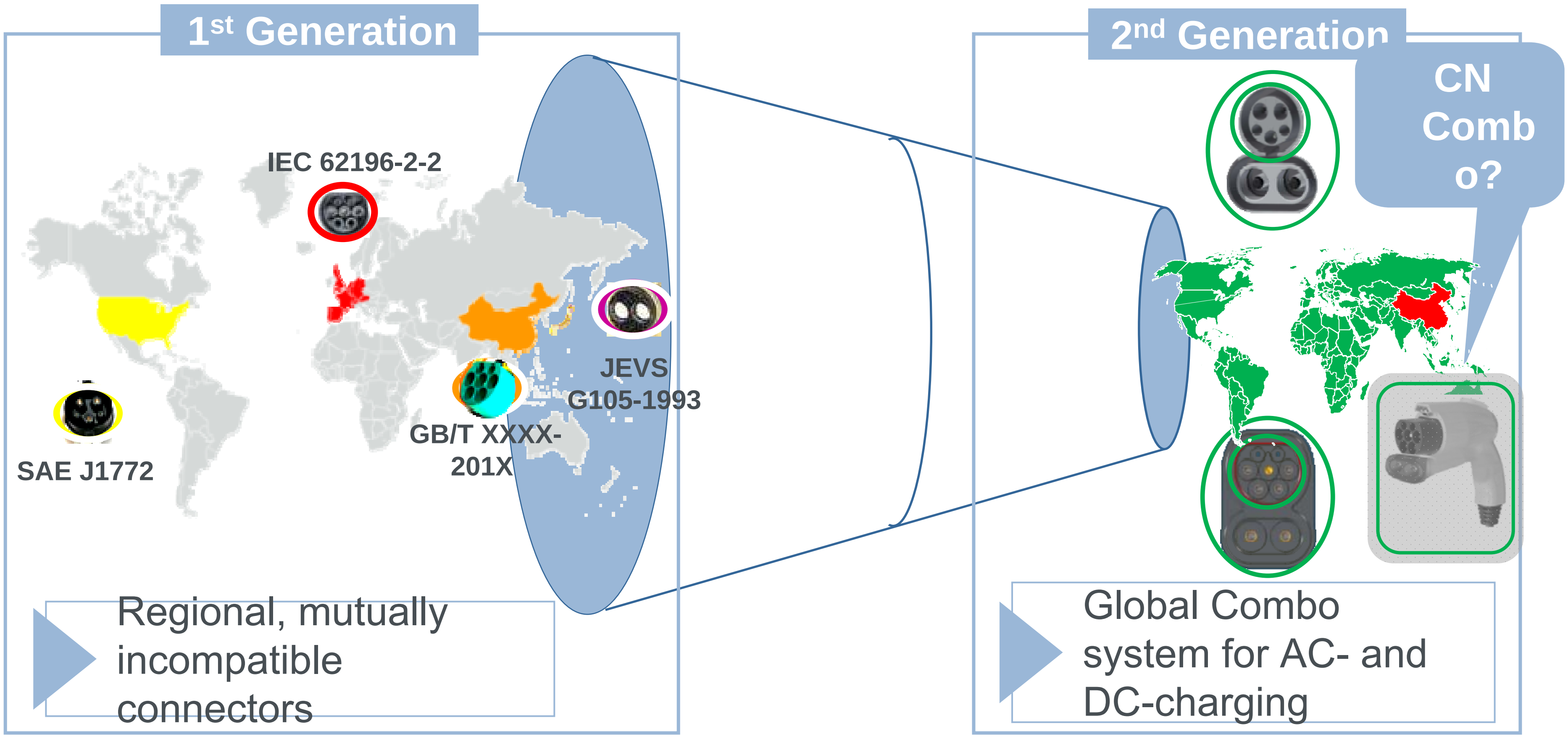


- Bulky, very heavy
- Expensive
- Complicated to use
- Can’t support integration into smart grid
- Can’t support value added services

- Compact design
- Less expensive
- Easy handling
- Ready for integration into smart grid
- Support additional value services

Current Status Charging Connectors

Various regional connectors should be migrated into one global solution in the second generation.



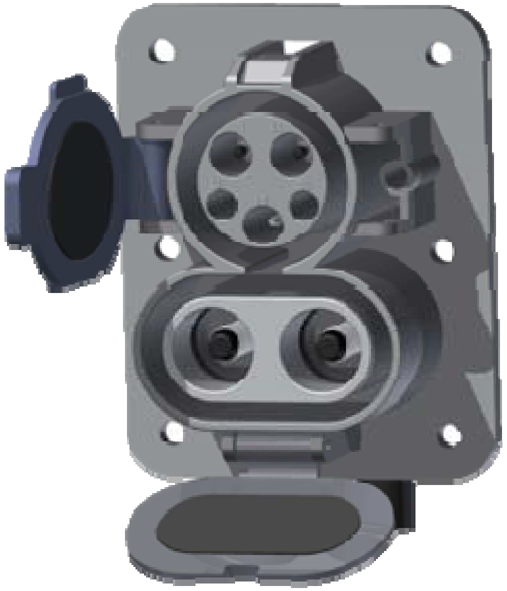
Design Principle for the Combined Charging System

AC regional approaches will stay in service.
Two additional pins allow DC charging in the same vehicle inlet.

Type 2 Core

Type 1 Core

High Power DC Extension

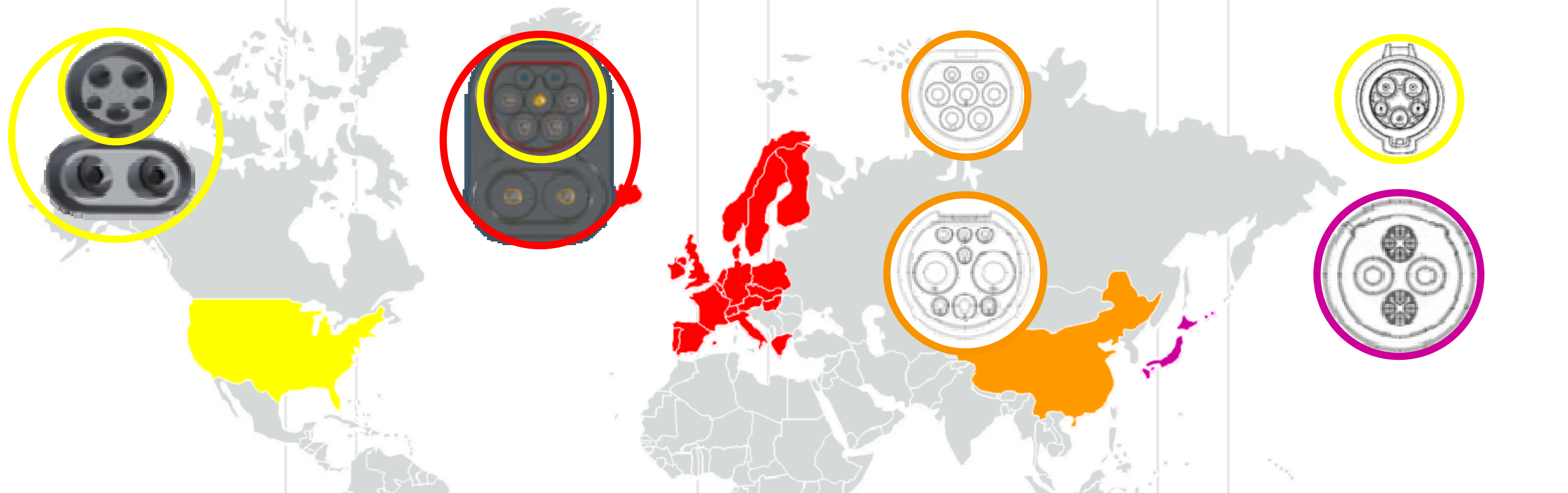


Design Principle for the Combined Charging System

Backward Compatibility: The Combo Inlet accepts existing conventional AC Connectors as well as new, high power Combo Connectors.

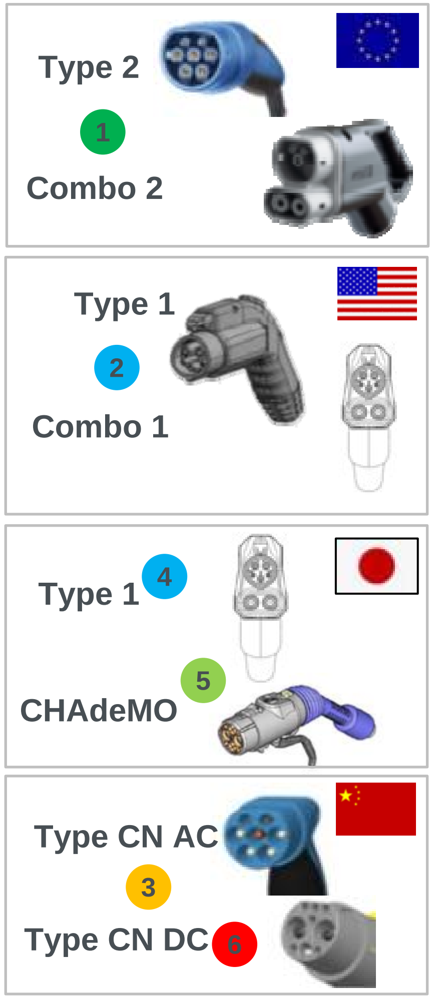
Current State: Standardization of Connectors

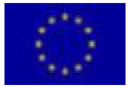
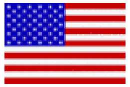
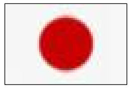
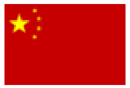
Main regions for e-mobility have developed individual charging systems. Combo system is driven by US and German OEMs.



USA	Europe	China	Japan
AC: Type 1	AC: Type 2	AC: China Type 2	AC: Type 1
DC: Type 1, Combo 1	DC: Type 2, Combo 2	DC: China DC	DC: CHAdeMO
Communication: PLC	Communication: PLC	Communication: CAN/ PLC	Communication: CAN

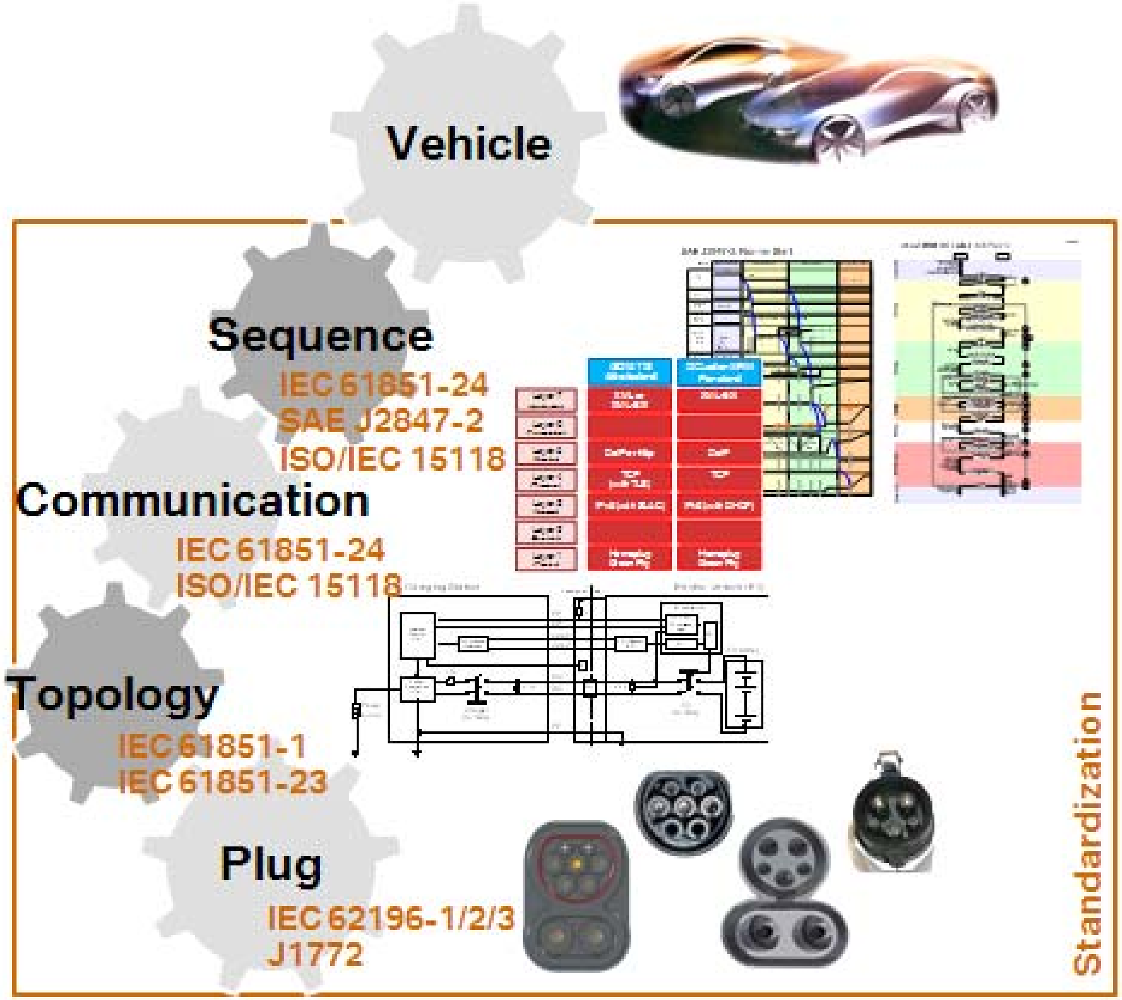
Application of Combo System offers significant reduction of complexity for electric vehicles



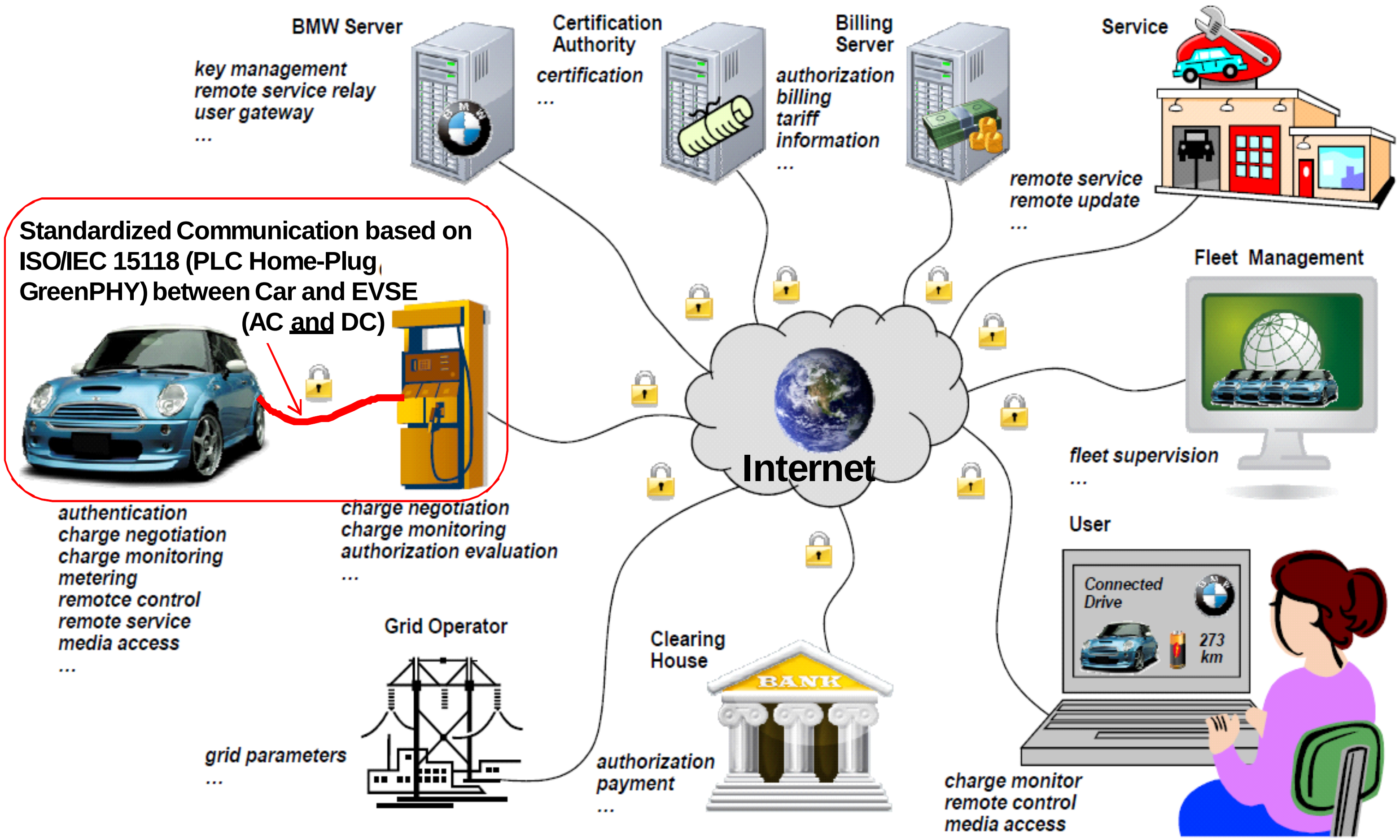
Region	Current situation	Scenario 1	Scenario 2
	1 Type 2 / Combo 2	1 Type 2 / Combo 2	1 Type 2 / Combo 2
	2 Type 1 / Combo 1	2 Type 1 / Combo 1	2 Type 1 / Combo 1
	4 5 Type 1 / CHAdeMO	2 Type 1 / Combo 1	2 Type 1 / Combo 1
	3 6 Type CN AC / Type CN DC	3 6 Type CN AC / Type CN DC	1 Type 2 / Combo 2
	4 5 Type 1* / CHAdeMO*	2 Type 1 / Combo 1 or 1 Type 2 / Combo 2	2 Type 1 / Combo 1 or 1 Type 2 / Combo 2
Connector Systems	6	4	2

* Korean version   x – connector system

Standards needed to complete a charging system



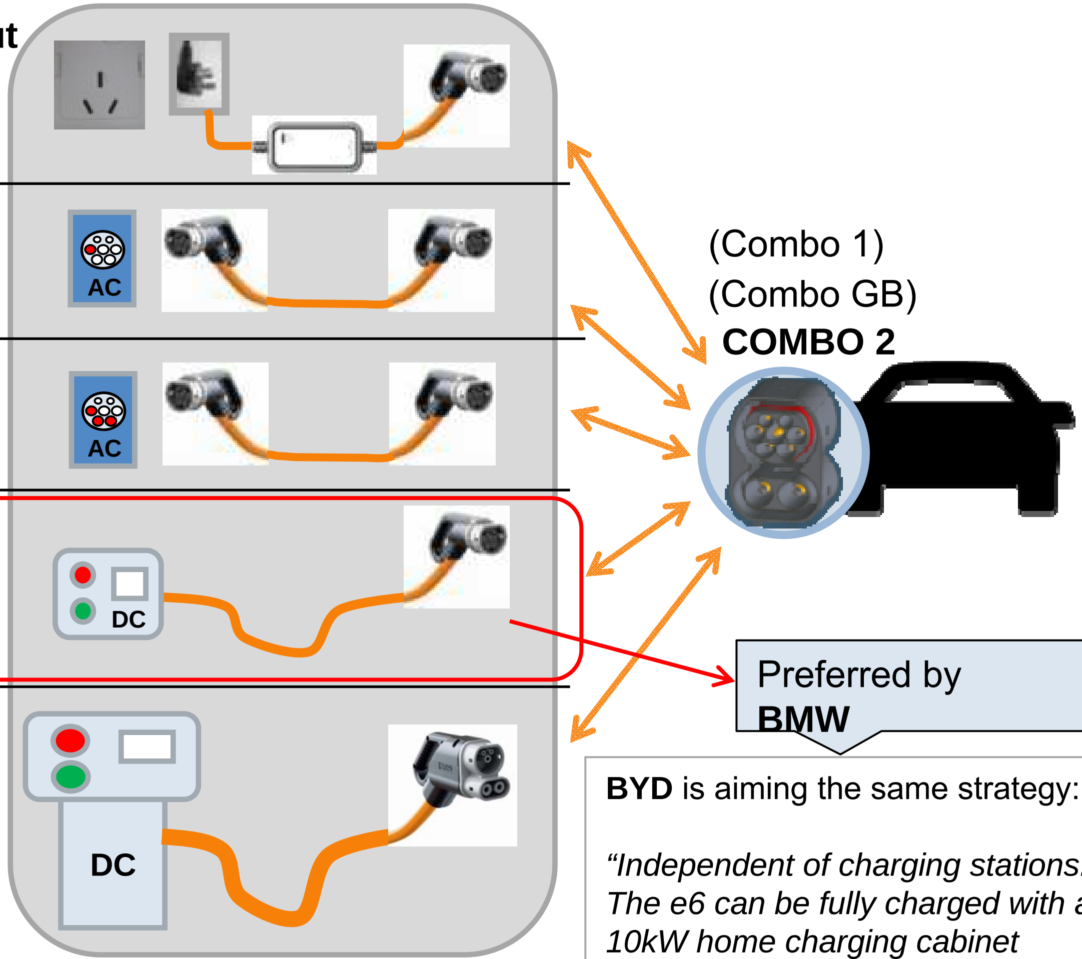
Advantages of the Combo-System
With PLC HomePlug GreenPHY technology, the system can cover a lot of additional Functions and Services:



OEM Roadmap charging solutions

COMBO supports all charging modes → Therefore all different OEM strategies!

	Max. Output
Mode 2 - 3,6KW	**3,6 kW**
Mode 3 1ph - 7kW	**19 kW**
Mode 3 3ph - 22kW	**43 kW**
Mode 4 - 10kW **Home Use (input 3x16 A AC, 380/400V)**	**10 kW**
Mode 4 - 100kW **Public Use**	**100 kW**



BYD is aiming the same strategy:

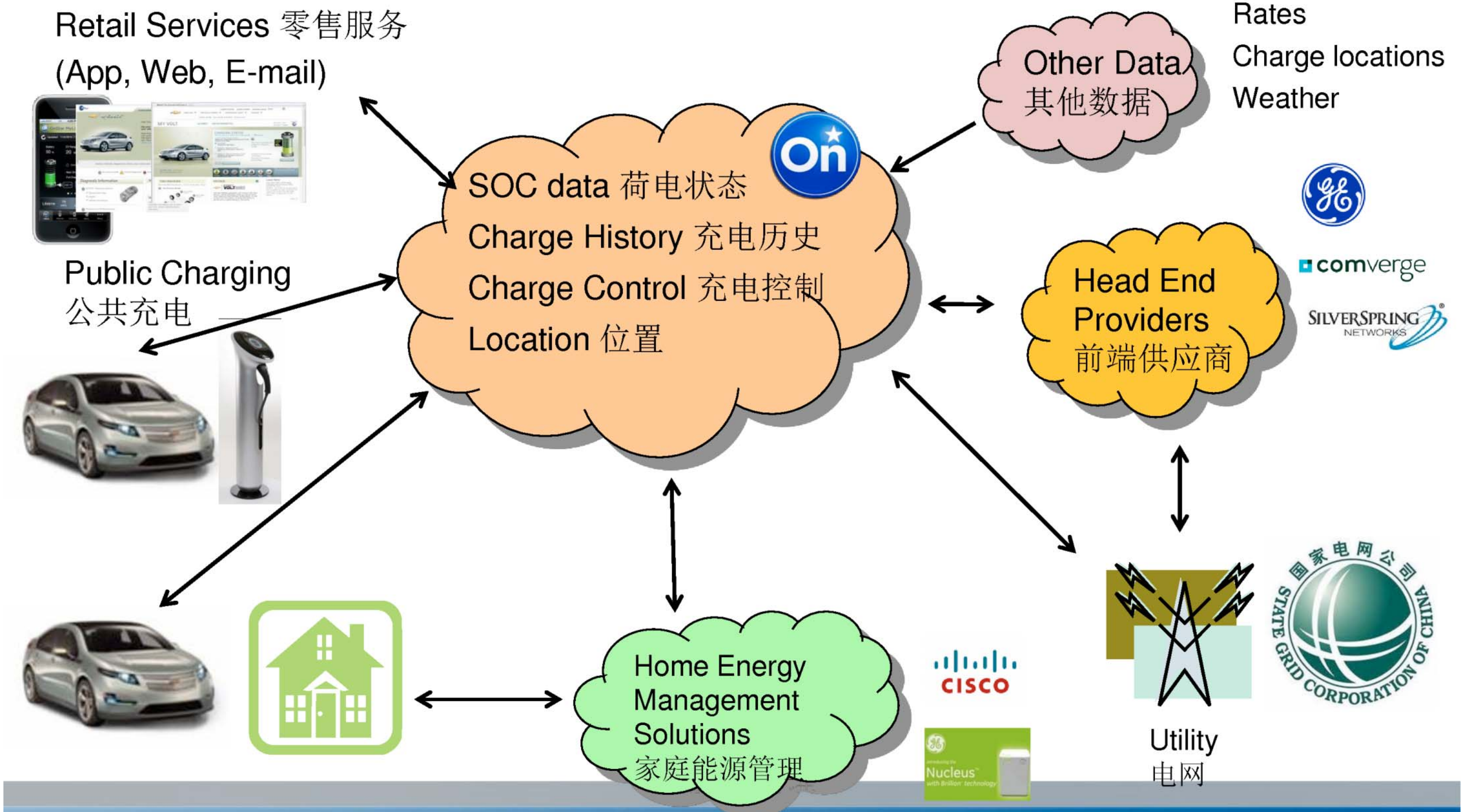
"Independent of charging stations. The e6 can be fully charged with a 10kW home charging cabinet within 6 hours" (Source: from current BYD catalogue)

Where do we go from here

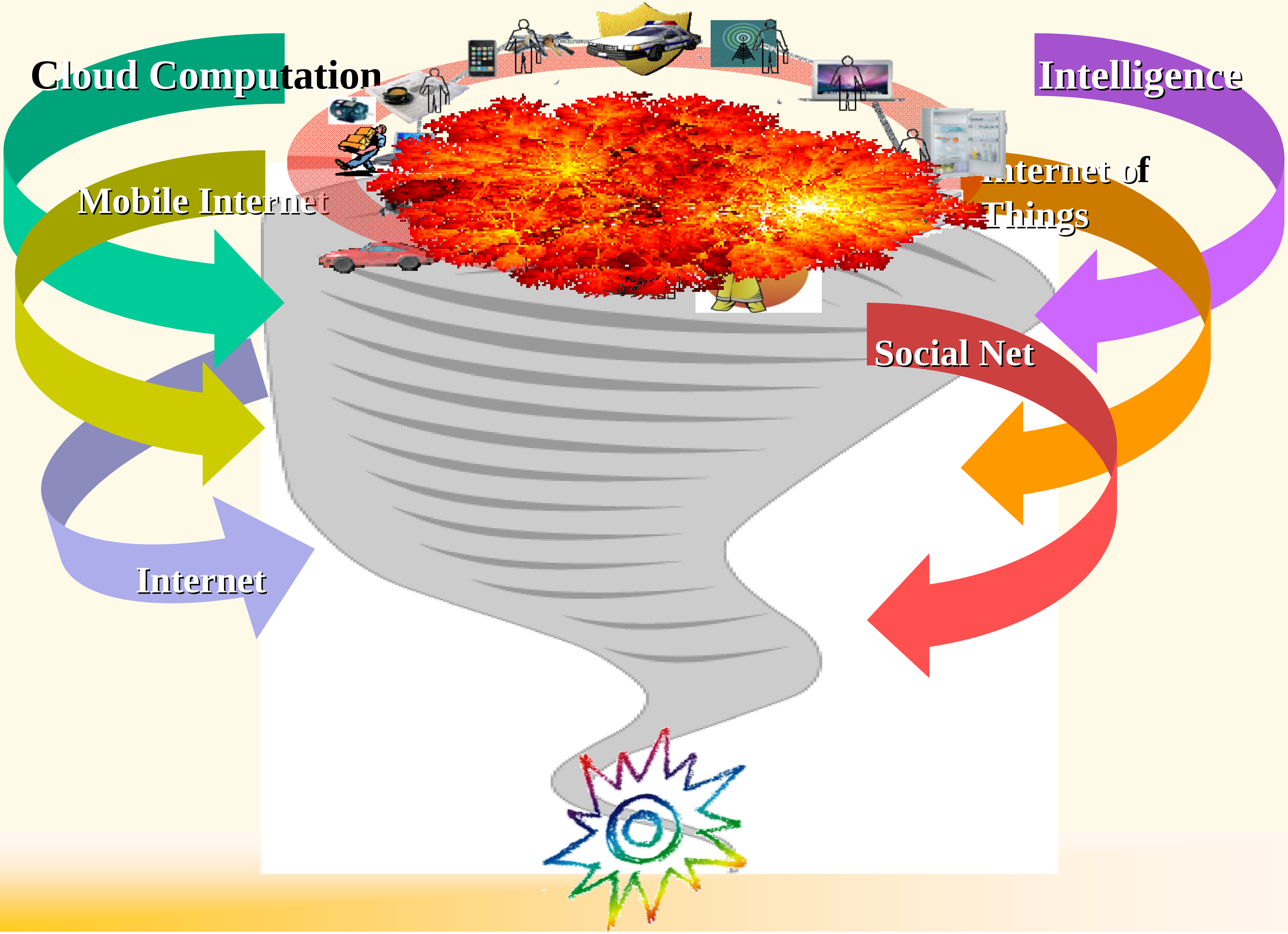
- Need for international collaboration
- Defining of competence areas
- Danger of overstandardization

- The ideal of infrastructure standards
  - **Any vehicle can safely charge anywhere**

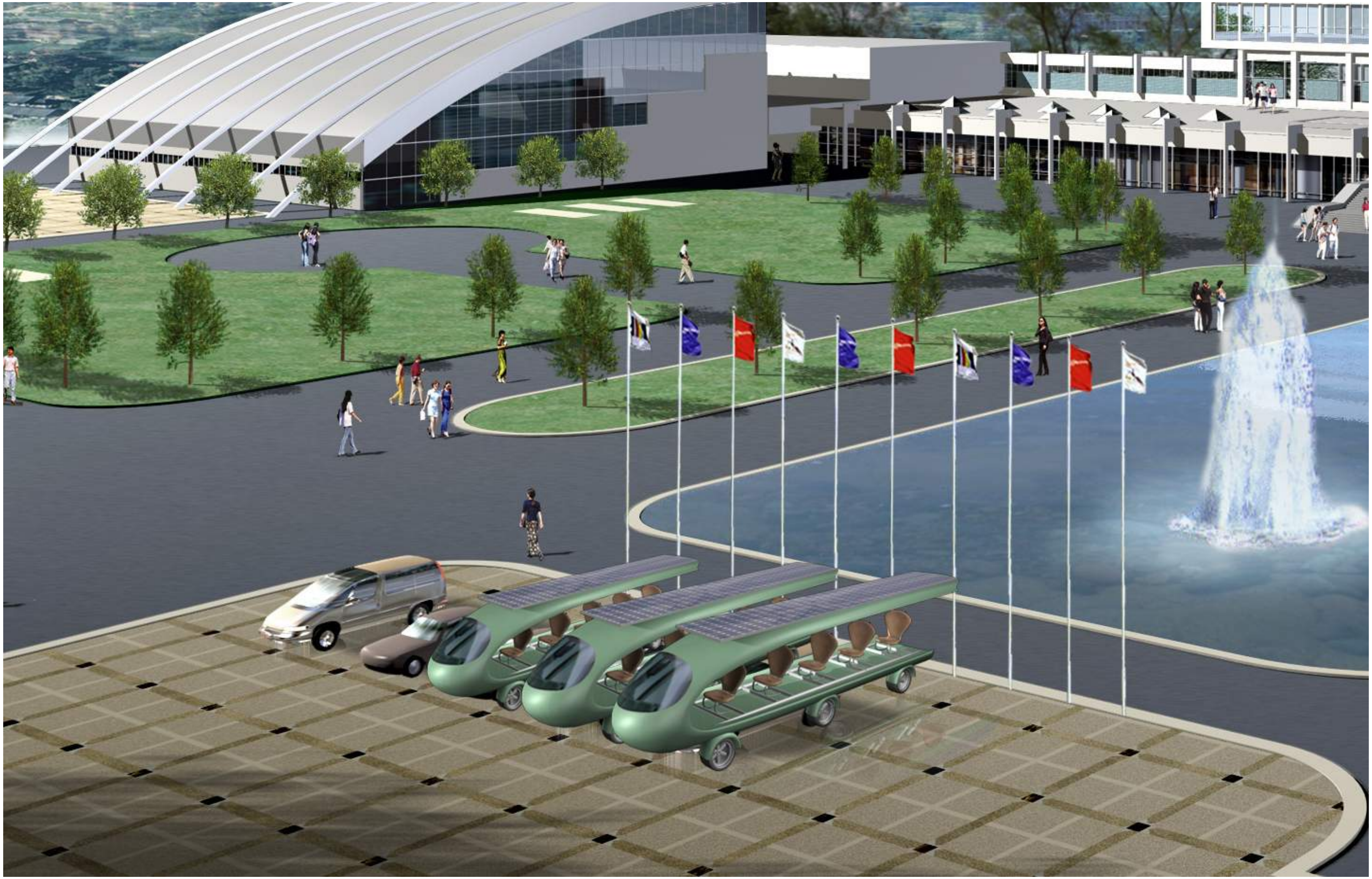
Standardization enables the Vision
标准化将促进愿景的实现



Mobile Internet & Cloud Computation



ADAPTING: THE NEW ENERGY PARADIGM



SUCCESS

SUCCESS

Inspiration

Imagination

Innovation

Integration

Implementation

Investment

Thank you!