Renaissance and EV Key Technologies
文艺复兴和电动汽车关键技术

Professor C.C. Chan, FIEEE, FIET, FHKIE
Academician, Chinese Academy of Engineering
Fellow, Royal Academy of Engineering, U.K.,
Founding President, World Electric Vehicles Association

陈清泉
中国工程院院士
英国皇家工程院院士
世界电动车协会创始主席

IET International Hybrid and Electric Vehicle Conference

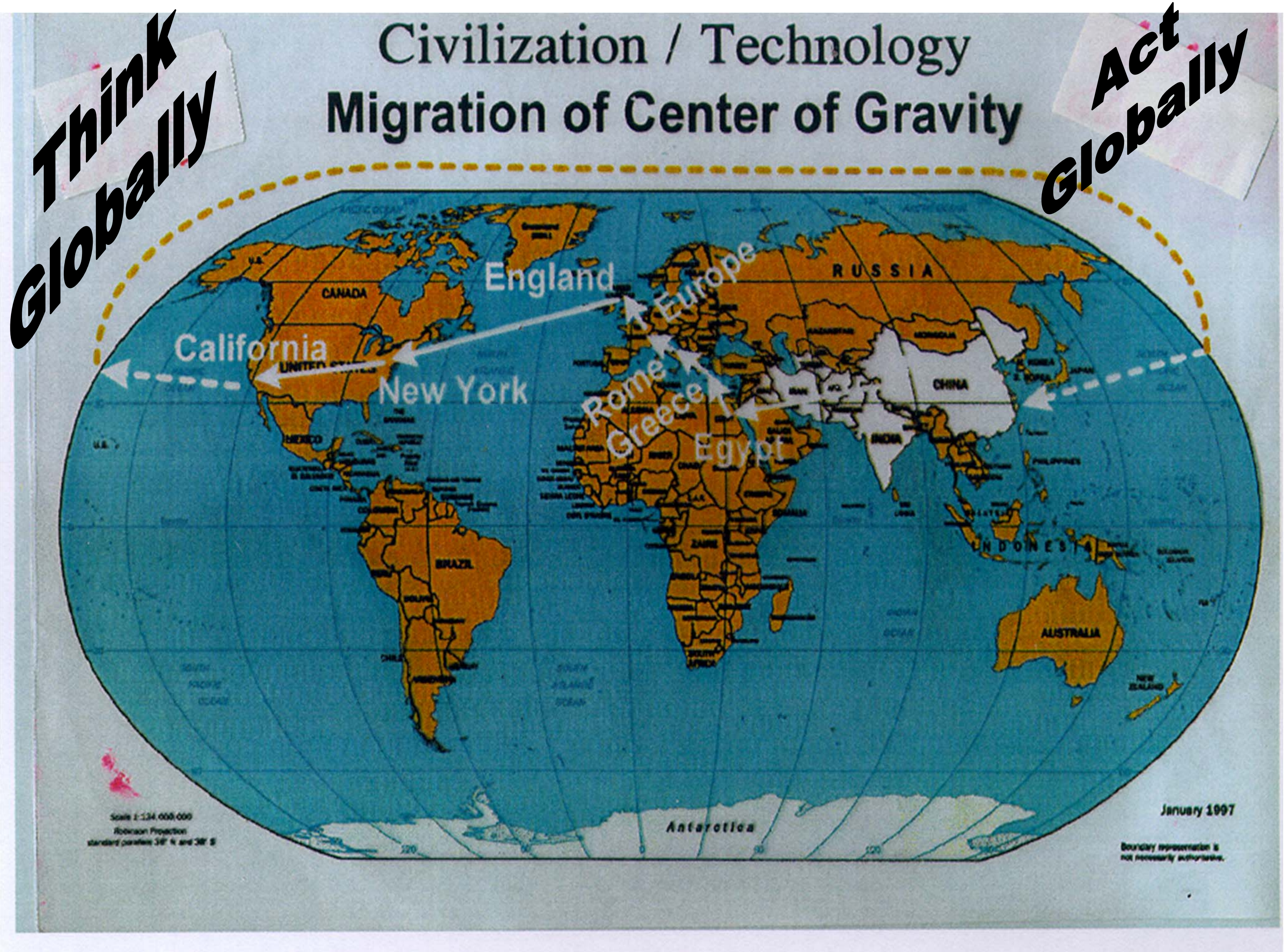
17 -19, October 20214

Civilization & Open Mind

人类文明史和解放思想

Civilization / Technology
Migration of Center of Gravity

January 1997

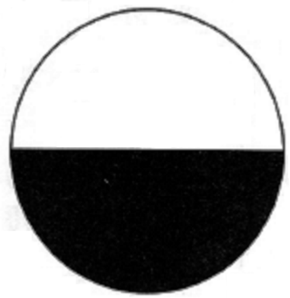

Think Globally
Civilization / Technology
Migration of Center of Gravity
Act Globally
England
Europe
California
New York
Rome
Greece
Egypt
RUSSIA
CANADA
CHINA
INDIA
BRAZIL
AUSTRALIA
INDONESIA
Antarctica
January 1997

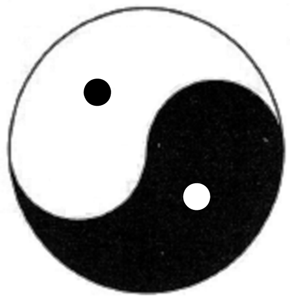
易经基本原理：变化、周期、平衡、对立统一

Yi-jing basic principles:
Change, Periodic, Balance, Unity of Opposites

直接、一成不变的思维
Straight Forward Approach

整体、辩证的思维
Holistic, Dialectic Approach



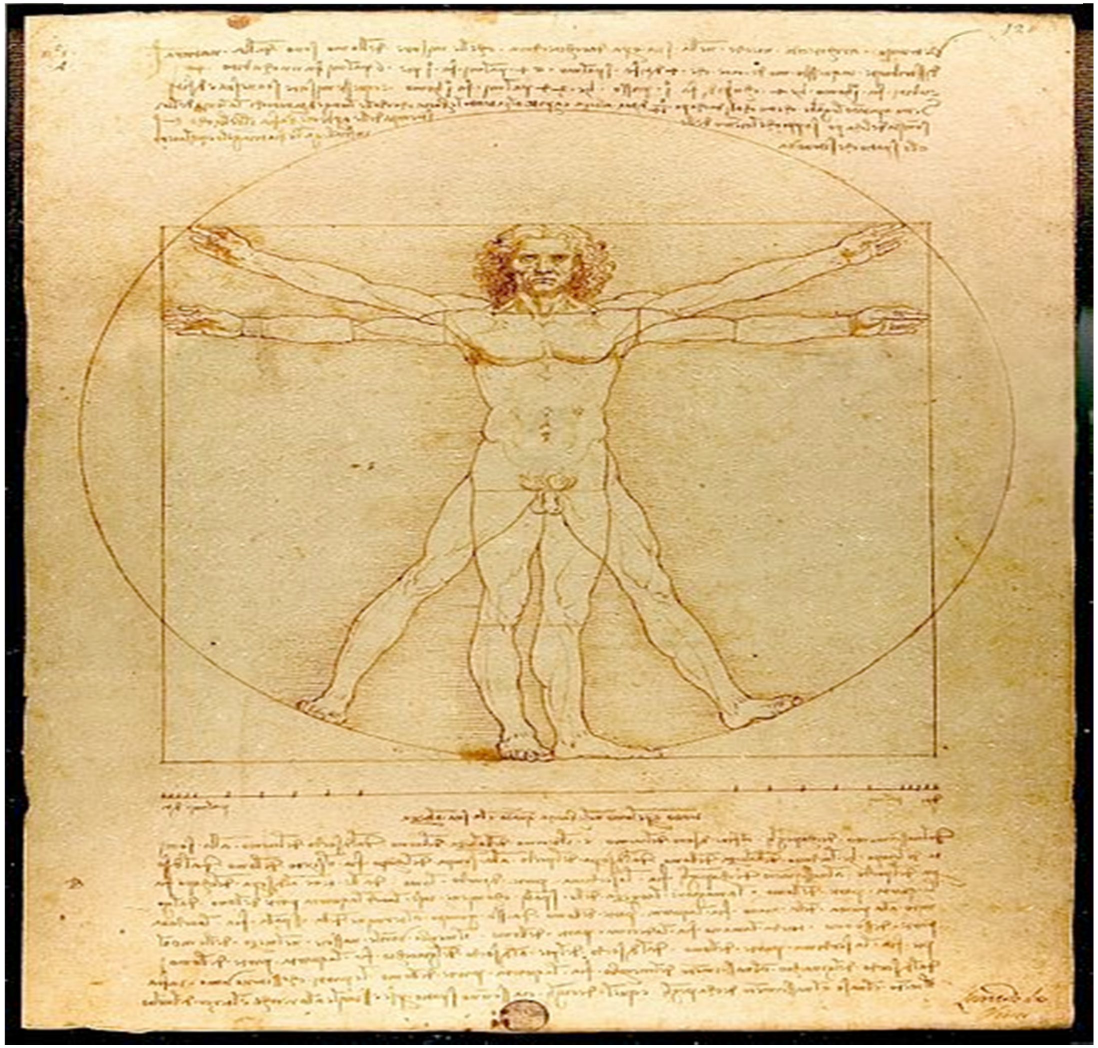


说"Yes"就是"Yes"
说"No"也不会变成"Yes"
"Yes" is "Yes"
"No" is "No"

"Yes"可转变为"No"
"No"也可转变为"Yes"
"Yes" can be turned into "No"
"No" can also be turned into "Yes"

《易经》的思维法则

The beginning of the cultural movement of the Renaissance



Leonardo da Vinci`s Vitruvian Man, an example of the blend of art and science during the renaissance

Open Mind
解放思想

- A closed Mind Can Not Change!
  封闭的思想不能进步！

- Saw Beyond What Was, to See What is!
  观察到以前的，更要看到今天和明天的！

Renaissance Scientists & Engineers
文艺复兴式的科学家和工程师

Renaissance Scientists & Engineers are those not only understand WHY and HOW THINGS work but also on WHY and HOW the WORLD works!

不仅要懂得事情是为何及如何运作的，更要知道世界是为何且如何运作的。

Characters of Renaissance Scientists & Engineers

文艺复兴式的科学家和工程师的**特征**

Think the World and not just the THINGS

思考全球而非局限于某些事物

- **Global thinking instead of local thinking;**
  纵览全球而非坐井观天；
- **Harmony thinking between human and nature;**
  天人合一思维；
- **Circle thinking instead of linear thinking;**
  环形思维取代线性思维；
- **Closed loop thinking instead of open loop thinking;**
  闭环思考取代开环思考；
- **Life cycle thinking instead of partial life thinking;**
  生生不息、全生命周期考虑，而非涸泽而渔、短暂考虑；
- **3R thinking (Reduce, Re-use, Recycle).**
  思考 减少消耗，再利用，回收。

EV Development

电动汽车的发展

Mobility is Freedom.
Mobility is the most apt expression for our quest for happiness.

移动意味着自由

移动最贴切地表达了我们对幸福的追求。

Historical Document Signed at EVS.9

Committing Support to Formation of World Electric Vehicle Association

16th November 1988

Memorandum of Understanding

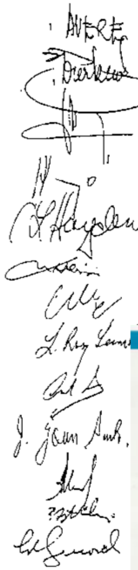
1 The undersigned, representing throughout the world a large majority of the organizations and people who, in their respective countries, undertake the development of electric road vehicles or, more generally, electric propulsion, indicate by this memorandum their desire to join forces and share their 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.

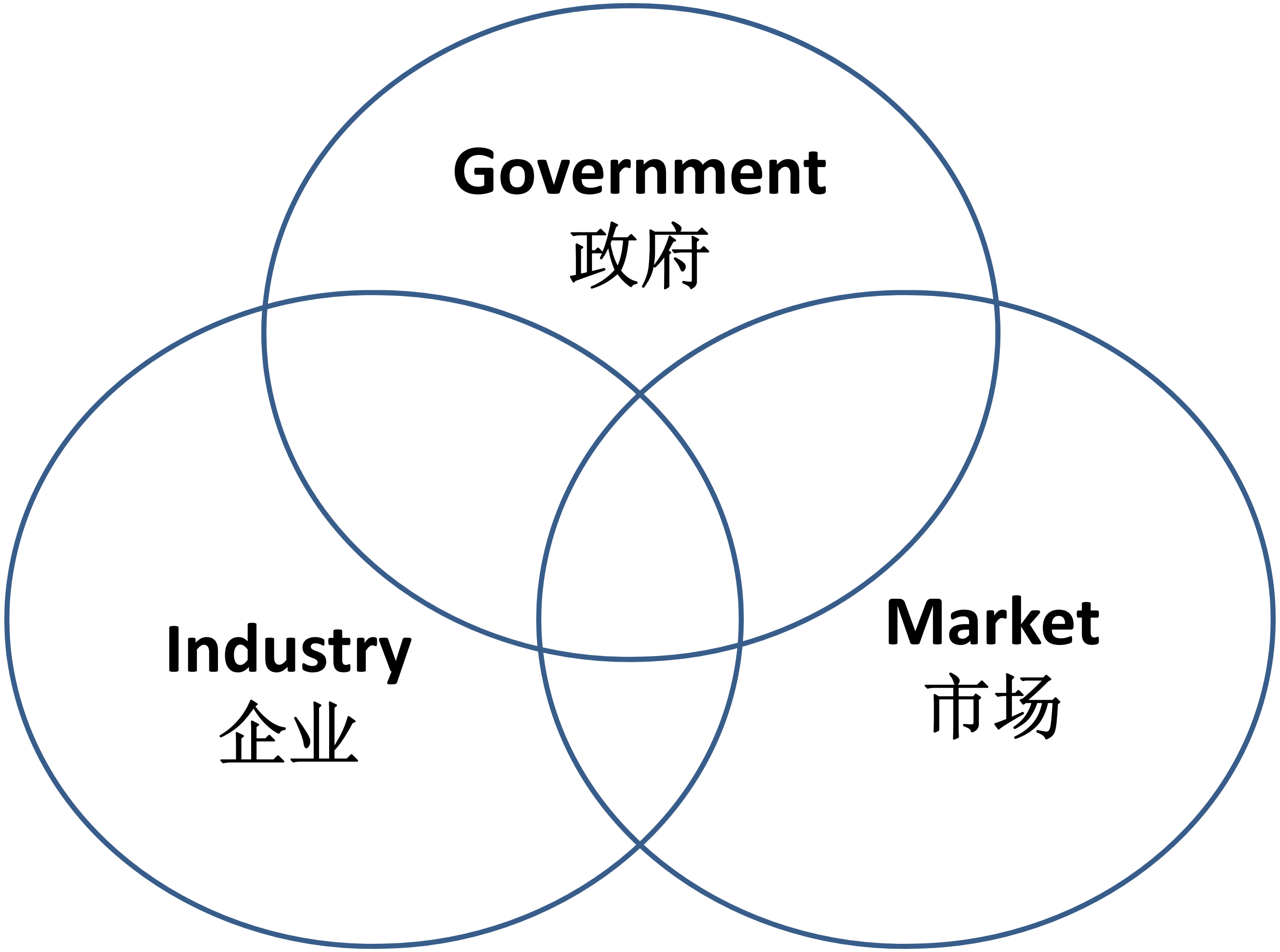
2 Les buts de cet organisme sont :

- 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 américain, 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.

Government, Industry and Market
政府、企业和市场

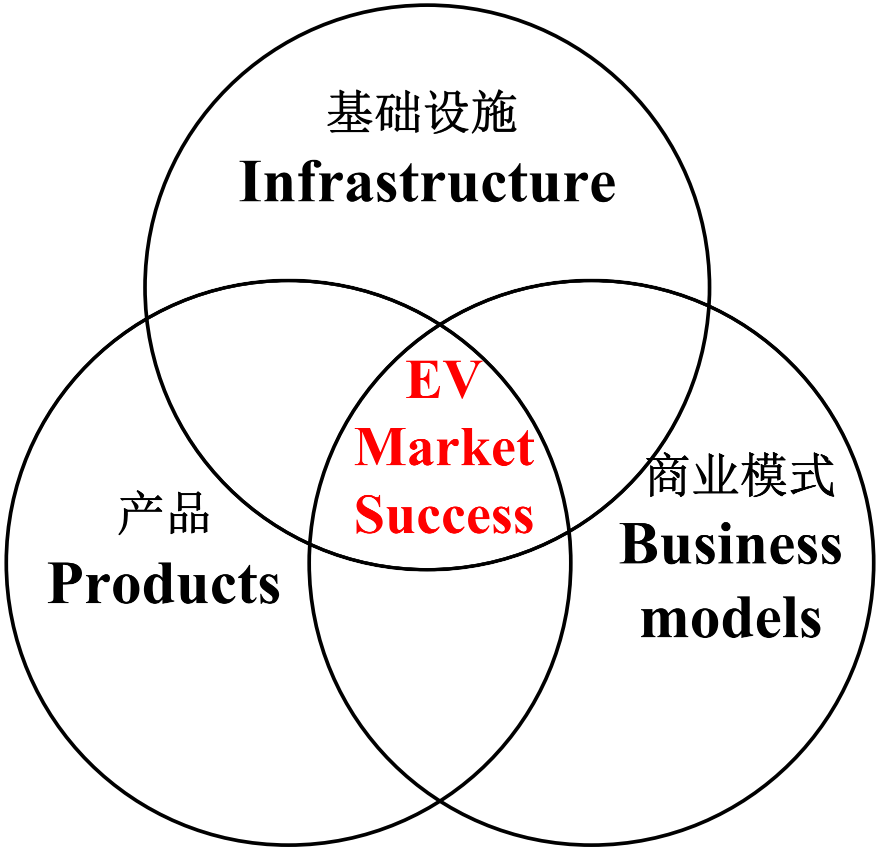


Key Issues 关键因素

三好：好的产品、好的基础设施、好的商业模式

Three Goodness Factor :

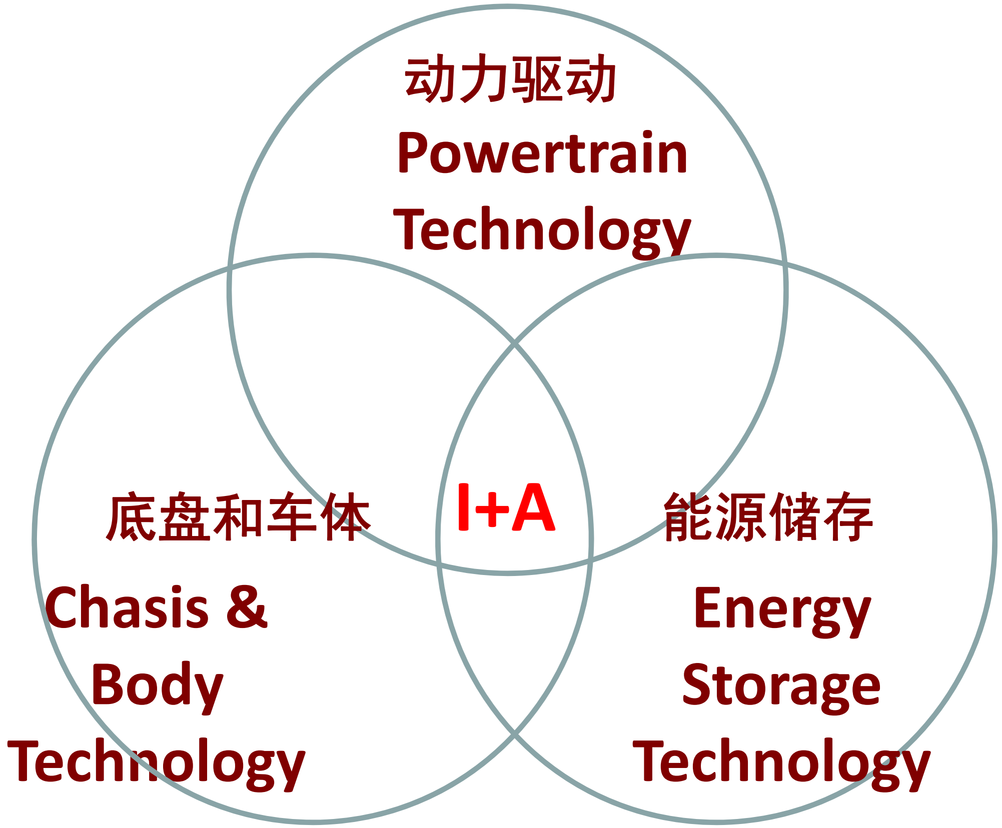
Good Products; Good Infrastructure; Good Business Model



好的产品：高性能、合理价格
Good Products:
High Performance @ Reasonable Cost

I: Integration of Automotive Technology and Electrical Technology

A: Alliance among Auto Makers and Key Component Suppliers



Executive Summary
执行摘要

- The train of EV commercialization has taken off. We are seeing the dawn. 电动汽车产业化的火车已开动，我们见到了曙光。
- Key challenges of success: Cost; Usage Convenience; Energy Saving and Emission Reduction. 主要挑战：成本、方便、节能减排。
- The market will not do it by self. Government incentives are essential at the beginning. 市场本身不能取胜，在一开始需要政府的激励。
- Innovative Regulatory Leadership is essential. 创新的政策引导是必须的。
- Technical solutions are available. 技术已可供协助。
- The shake hand and compromise between auto industry and electric power industry is crucial. 汽车企业和电力企业的妥协和合作是关键。

Key Issues – Three Goodness
关键因素 – 三好因素

The success of commercialization of electric vehicles depends on the satisfactory tackling of four factors:

Initial cost; 成本;

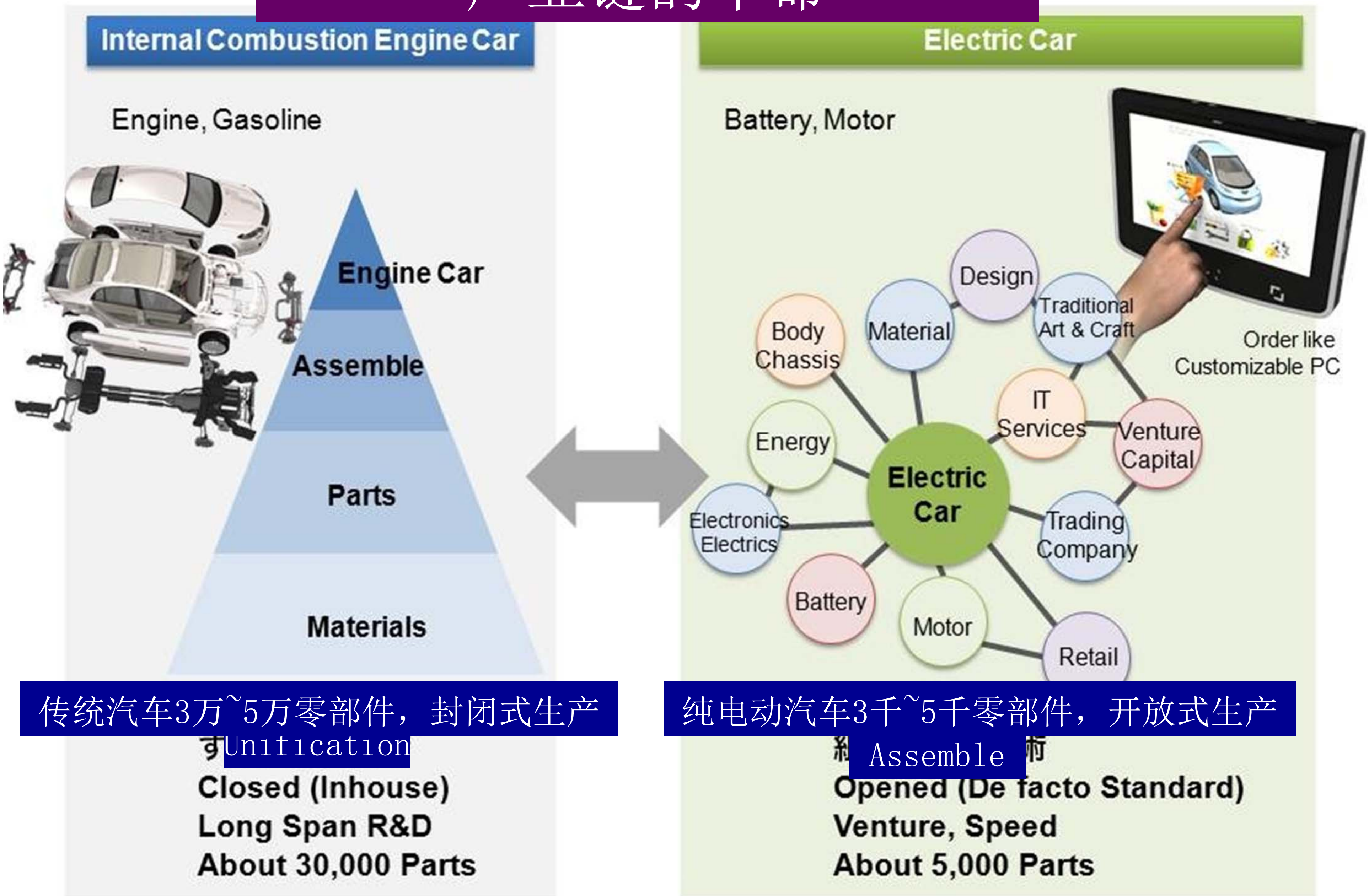
Convenience of use; 方便;

Energy consumption and exhaust emission. 节能减排。

Therefore, we need three goodness factors:

- 1. Availability of **Good Products** at affordable cost; **好产品**
- 2. Availability of **Good Infrastructures** that is efficient and friendly to use; **好的基础设施**
- 3. Availability of **Good Business Model** to leverage the cost of batteries. **好的商业模式**

产业链的革命



传统汽车3万~5万零部件，封闭式生产

Unification

纯电动汽车3千~5千零部件，开放式生产

Assemble

History of Electric Vehicles

电动汽车的历史:1828年~1932年的兴衰

- Early Inventions–Horseless Age

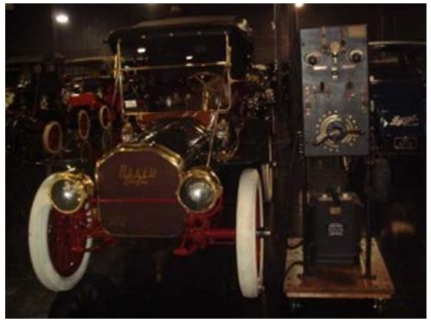
Thomas Parker EV, 1884, England

Morris & Salom Electrobat 1895, U.S.A

- Lessons to Learn: Key Issues: 教训
  - ➢ Cost, 成本
  - ➢ Convenient Use, 便捷性
  - ➢ Fuel Consumption, 能耗
  - ➢ Environment Impact. 排放

- Early Commercialization & Infra.

City Taxi, 1901, New York, U.S.A



Charging Station, 1900's GE, U.S.A

Philosophy of Engineering: ***System Integration and Optimization***

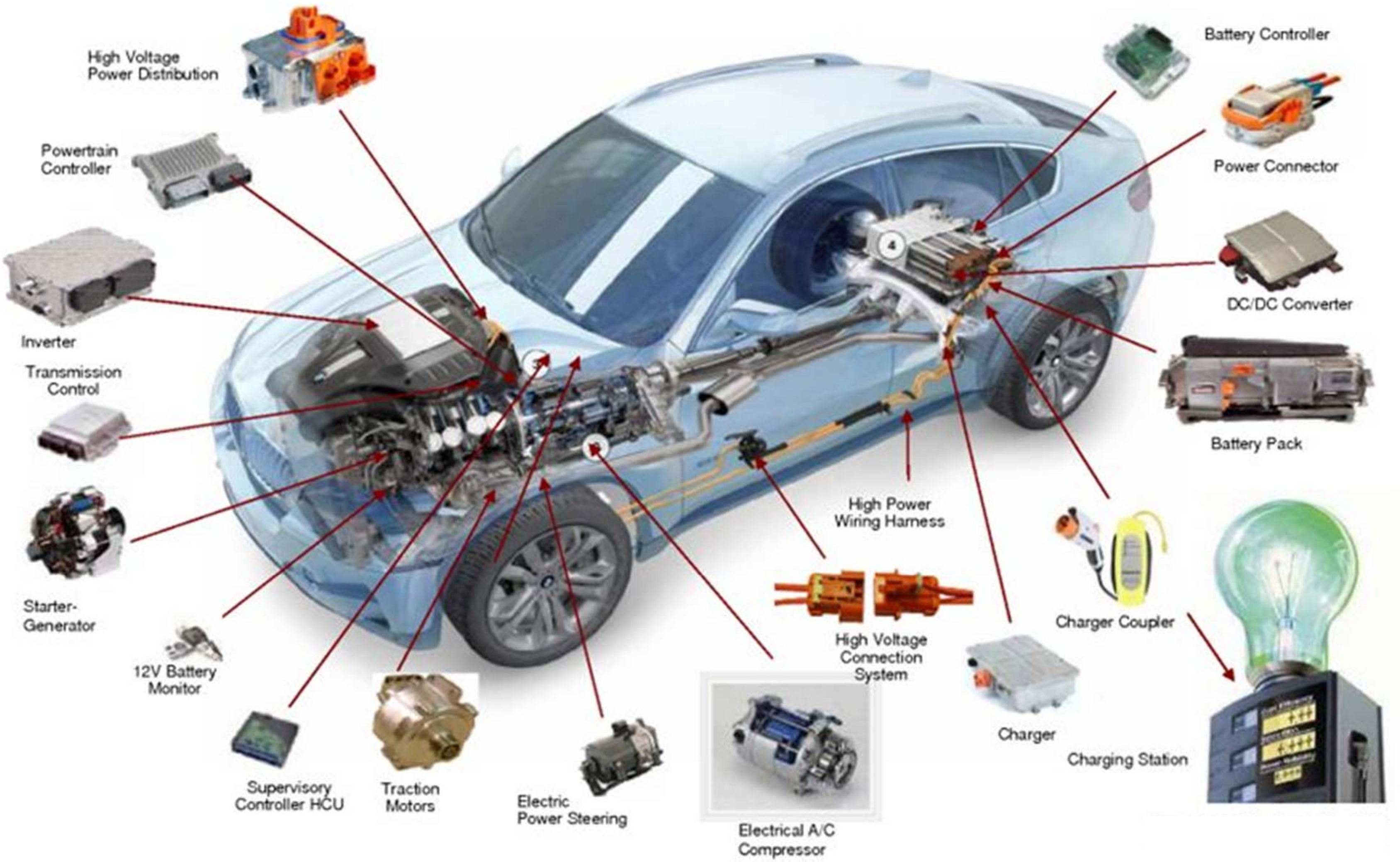
发展电动汽车的工程哲学：在社会层面的系统集成与优化

Key Points: ***Open mind;*** ***Courage;*** ***Yes, It Can Do!***

开放的思想，坚定的信心，无畏的勇气

Electric Key Components Play Vital Role in EV/HEV

三大电：电机、电池、电控；三小电：空调、转向、制动



EV Key Technologies 电动汽车关键技术

- **Three Big Electricity 三大电：**
  Motor 电机
  Battery 电池
  Controller 电控

- **Three Small Electricity 三小电：**
  Electric Steering 电动转向
  Electric Air-conditioning 电动空调
  Electric Braking 电动制动

Global EV Development Status

全球电动汽车发展战现状

Global EV Population 全球电动汽车数量

▲ In 2014: Total 500,000

- USA No.1; Japan No. 2; China No.3
- Norway per capita No.1 , 4EVs/1000 persons, Nation wide charging stations, quick charge along highway per 30-60 km.

▲ In 2012: Total 380,000

- Japan No.1; USA No.2; China No.3

全球电动汽车数量

Global Electric Vehicles Population

Country	PEV fleet (Cum sales or registrations)	Population as of December 2013	PEV market penetration per 1,000 people (Dec 2013)	PEV market share of total new car sales in 2013	Comments
United States	172,000	320,050,716	0.53	0.62%	(a)
Japan	74,124	127,143,577	0.58	0.85%	(b)
China	38,592	1,385,566,537	0.03	0.08%	(c)
Netherlands	28,673	16,759,229	1.71	5.37%	(d)
France	28,560	64,291,280	0.44	0.65%	(e)
Norway	20,486	5,042,671	4.04	5.60%	(f)

Note: Plug-in electric vehicle fleets include only highway-capable vehicles except where noted in comments. French and Norwegian registrations do not include plug-in hybrids.

Comments: (a) Sales between 2008 and December 2013. Includes only plug-in electric passenger cars. (**b**) Sales since July 2009 through December 2013. Kei cars not included for market share estimate. Includes plug-in electric cars and all-electric utility vans. (**c**) New energy vehicle sales between 2011 and 2013. Includes a significant number of all-electric buses. (**d**) Registrations between 2009 and December 2013.Includes plug-in cars and all-electric commercial vans. (**e**) Registrations between 2010 and December 2013. Includes only all-electric cars and 11,304 utility vans. Market share is 0.49% if only all-electric cars are considered. (**f**) Registrations between 2003 and December 2013. Includes only all-electric cars, vans and over 1,500 heavy quadricycles.

EV Market Share 电动汽车市场份额

Top 10 countries by market share of new car sales in 2013 by electric-drive segment[(a)]								
Ranking	Country	PEV market share (%)	Ranking	Country	BEV market share (%)	Ranking	Country	PHEV market share (%)
1	Norway	6.10%	1	Norway	5.75%	1	Netherlands	4.72%
2	Netherlands	5.55%	2	Netherlands	0.83%	2	Sweden	0.41%
3	Iceland	0.94%	3	France	0.79%	3	Japan	0.40%
4	Japan	0.91%	4	Estonia	0.73%	4	Norway	0.34%
5	France	0.83%	5	Iceland	0.69%	5	United States	0.31%
6	Estonia	0.73%	6	Japan	0.51%	6	Iceland	0.25%
7	Sweden	0.71%	7	Switzerland	0.39%	7	Finland	0.13%
8	United States	0.60%	8	Sweden	0.30%	8	United Kingdom	0.05%
9	Switzerland	0.44%	9	Denmark	0.28%	9	France	0.05%
10	Denmark	0.29%	10	United States	0.28%	10	Switzerland	0.05%

Note: (a) Market share of highway-capable electric-drive vehicles in the corresponding segment as percentage of total new car sales in the country in 2013.
Source: Zachary Shahan (2013-03-07). "Electric vehicle market share in 19 countries". ABB Conversations.

中国新能源车销售

Sales of highway-capable new electric cars in China by model between 2011 and March 2014

Model	Total sales 2011-1Q 2014	Market share[(a)]	Total Sales 1Q 2014[1]	Total Sales 2013[2][3]	Total Sales 2012[4]	Total Sales 2011[5][6]
Chery QQ3 EV	11,528	25.4%	2,016	4,207[(b)]	5,305	
JAC J3 EV	6,731	14.8%	163	2,500	2,485	1,585[(c)]
BYD e6	4,287[(d)]	9.4%	619	1,544	2,091	401
BYD F3DM	3,284[(d)]	7.2%		1,005	1,201	613
BYD Qin	2,526	5.6%	2,384	142		
BAIC E150 EV	1,354	3.0%		710	644	
Zotye TD100 EV	845	1.9%			845	
SAIC Roewe E50	648	1.4%	4	406	238	
Zotye M300 EV	354	0.8%		220	134	
Venucia e30	246	0.6%	30	216		
Chery Riich M1 EV	197	0.4%	107		90	
Zotye 5008 EV	142	0.3%			142	
Zoyte Zhidou E20	142	0.3%	142			
Chang'an CX30 EV	100	0.2%			100	
BAIC Senova EV	52	0.1%		52		
Shanghai-GM Springo EV	11	0.02%			11	
Zoyte T200 EV	8	0.02%	8			
Tesla Model S	2	0.004%	2			
Chevrolet Volt	2	0.004%	2			
Total sales[(e)][7][8][9][1]	45,445	71.5%	6,853	17,642	12,791	8,159

Notes: (a) Market share as percentage of the 45,445 new electric vehicles sold between 2011 and March 2014.(b) Only includes sales between January and October 2013[3] (c) Includes units sold during 2010 and 2011[6] (d) BYD e6 total includes 33 units sold in 2010. F3DM total includes 417 units sold in 2010 and 48 in 2009[10,11] (e) Total annual sales figures include all-electric bus sales.

Sources:

[1] China Auto Web (2014-05-20). "6,853 PEVs Were Sold in China in Q1 2014". China Auto Web.
[2] Staff (2014-01-10). "Plug-in EV Sales in China Rose 37.9% to 17,600 in 2013". China Auto Web. Retrieved 2014-02-09.
[3] Colum Murphy and Rose Yu (2013-11-27). "China Hopes Cities Can Help Boost Electric Car Sales". The Wall Street Journal (China Real Time). Retrieved 2013-11-30. A total of 4,207 QQ3 EVs, 1,005 F3DMs and 1,096 e6s were sold between January and October 2013.
[4] China Auto Web (2013-03-25). "Chinese EV Sales Ranking for 2012". China Auto Web. Retrieved 2013-04-20.
[5] Mat Gasnier (2013-01-14). "China Full Year 2012: Ford Focus triumphs". Best Selling Car Blog. Retrieved 2013-04-21. A total of 613 F3DMs and 401 e6s were sold during 2011 and 1,201 F3DMs and 1,690 e6s in 2012.
[6] China Auto Web (2012-09-30). "JAC Delivers 500 J3 EVs ("ievs")". China Auto Web. Retrieved 2014-05-31. A total of 1,585 of the first and second generation models were sold during 2010 and 2011..
[7] Jiang Xueqing (2014-01-11). "New-energy vehicles 'turning the corner'". China Daily. Retrieved 2014-01-12.
[8] China Association of Automobile Manufacturers (2012-01-16). "5,579 electric cars sold in China in 2011". Wind Energy and Electric Vehicle Review. Retrieved 2014-01-12.
[9] Cars21.com (2013-02-13). "EV sales increase 103.9% in China in 2012- Electric China Weekly No 17". Cars21.com. Retrieved 2014-01-12.
[10] "BYD Delivered Only 33 Units of e6, 417 F3DM in 2010". ChinaAutoWeb. 2011-02-23. Retrieved 2014-05-31.
[11] "BYD Plans to Start European Car Sales Next Year (Update 2)". Bloomberg News. 2010-03-08. Retrieved 2014-05-31. 48 F3DMs were sold in 2009.

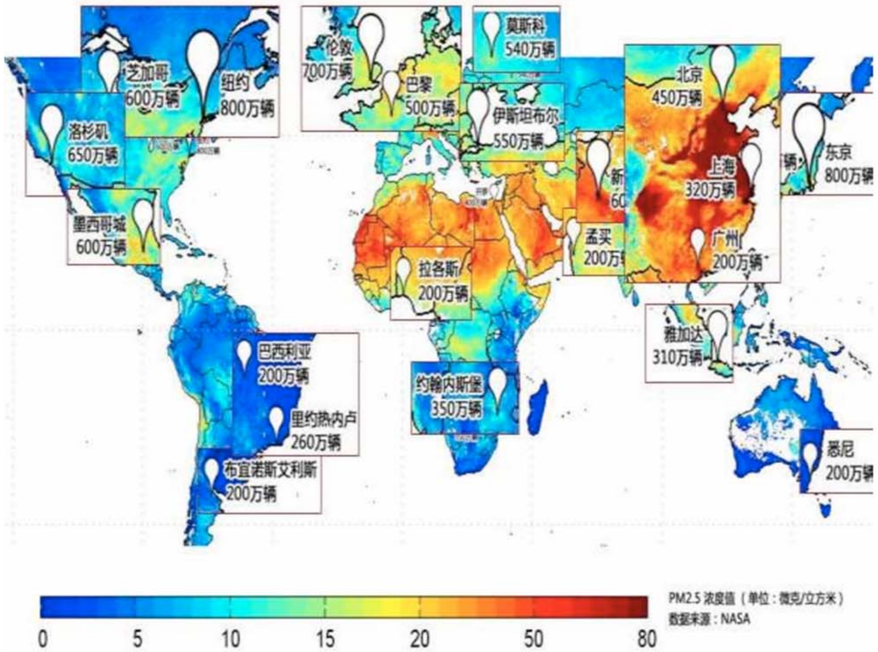
China EV Development Strategy

中国新能源汽车发展战略

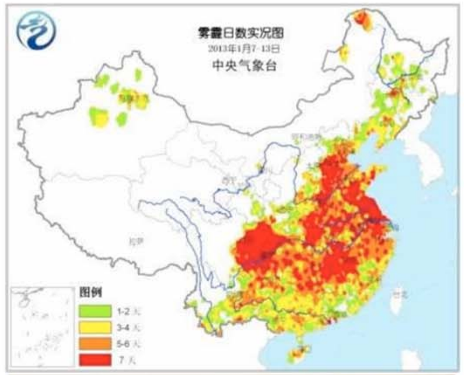
Pressure on Energy & Environment

Oil Consumption & Energy Saving

Challenges for Chinese Automotive Development



机动车保有量200万辆以上城市PM2.5 浓度值分布图



Automotive Development and City traffic jam and air pollution

▮ 新能源汽车发展战略目标路线图 China Road Map of New Energy Vehicles

时间阶段	现在~2020年	2020年~2030年	2030年~2050年
发展驱动力 Driving Force	减排为驱动力 PM2.5为主 Mainly PM2.5 Reduction	节能为主驱动力， PM2.5缓解，CO_2上升 Mainly Energy Conservation	减少CO_2为重点 Mainly CO_2 Reduction
标志性事件		自产气使用量超过石油	
发展战略 Strategy	公交车、出租车、物流运输车的推广，小型电动车推广运用 Bus, Taxi, Logistic, Small EV,	电动汽车大规模运用，氢燃料和燃料电池量上升 EVs in various applications	氢燃料和燃料电池量大规模推广，生物质燃料上升 Large scale hydrogen fuels and fuel cells; Increase in biofuels
新能源汽车（纯电动和插电式）所佔比率 Penetration %	2%	10% - 15%	50%

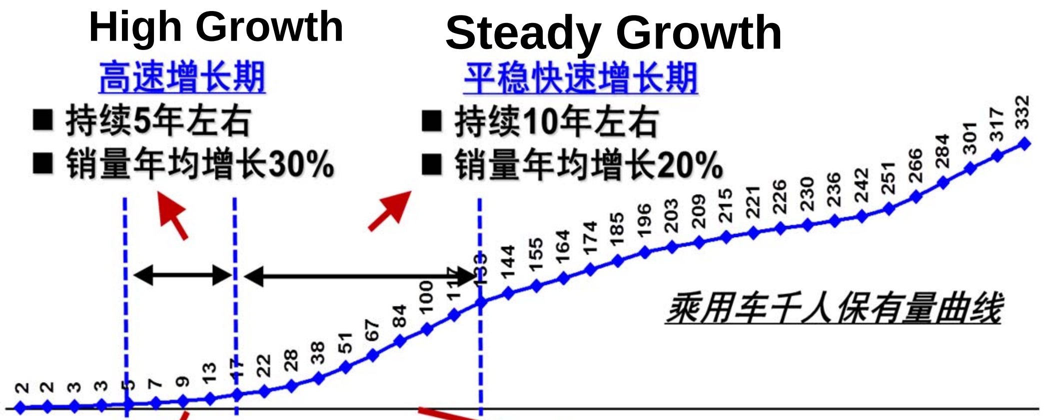
2020年减排为主，2030年节能为主。

Chinese Electric Mobility Achievement

一、发展新能源汽车是战略选择

◆ 中国汽车市场中长期趋势 Characteristics of Vehicle Population Growth

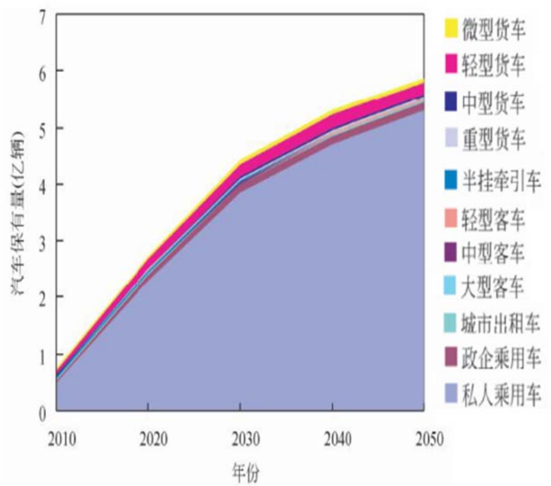
乘用车仍将以10%左右的年均速度再增长10年，大致相当于GDP速度的1.5倍。



	孕育期	销量平均增速
日本	1960-1964	35.8%
韩国	1981-1985	25.0%
中国	2001-2008	30.4%(25%)

	普及期	销量平均增速
日本	1965-1973	22.2%
韩国	1986-1997	20.0%
中国	2009-2023	13—15%

中国汽车市场中长期趋势



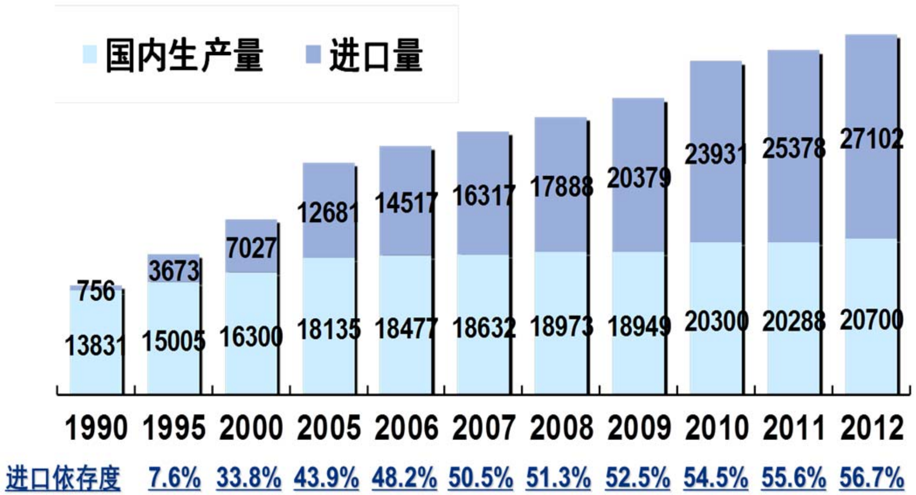
中国汽车保有量预测

根据GDP增长量预测和汽车千人保有量发展规律，预计中国汽车保有量2020年将达到2.7亿辆；2030年将达到4.4亿辆；2050年将达到5.88亿辆。

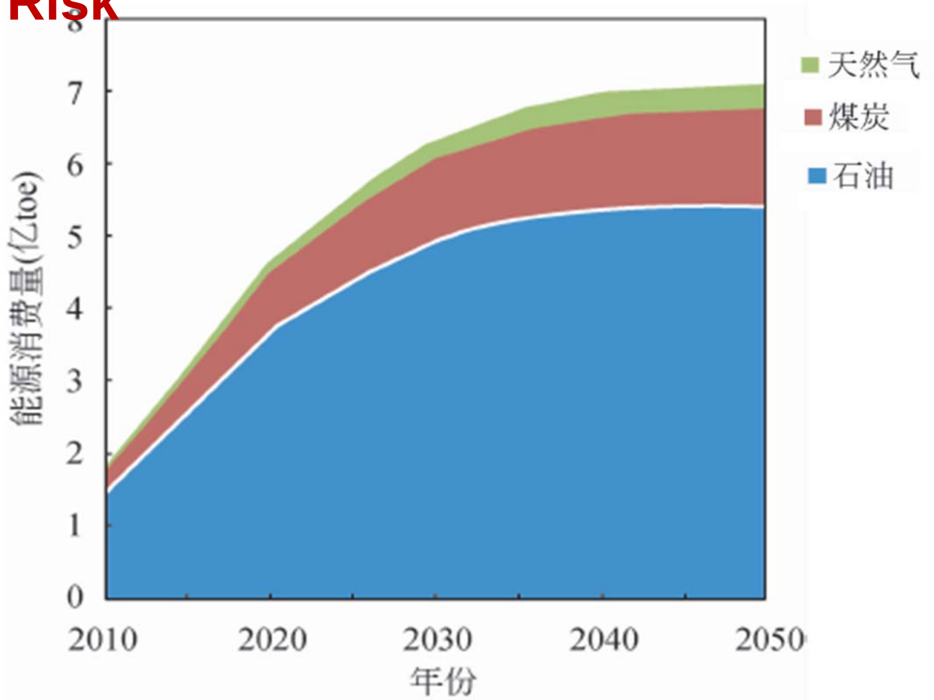
来源：《中国车用能源展望2012》清华大学中国车用能源研究中心

一、发展新能源汽车是战略选择

◆ 能源安全风险巨大 **Energy Security Risk**



当前国内原油产量和进口量 China Import Oil



未来石油需求量预测 Oil Demand Prediction

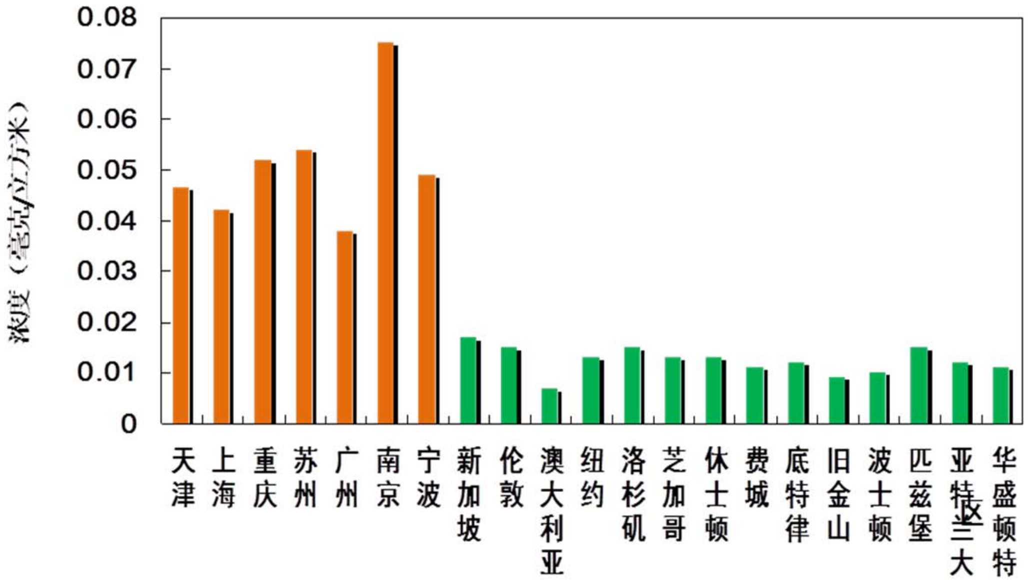
如果不大力发展新能源汽车，2050年车用WTW石油消费量超过5.4亿吨，是国内石油供应能力的2.7倍，有比较大的能源安全风险。

来源：《中国车用能源展望2012》清华大学中国车用能源研究中心

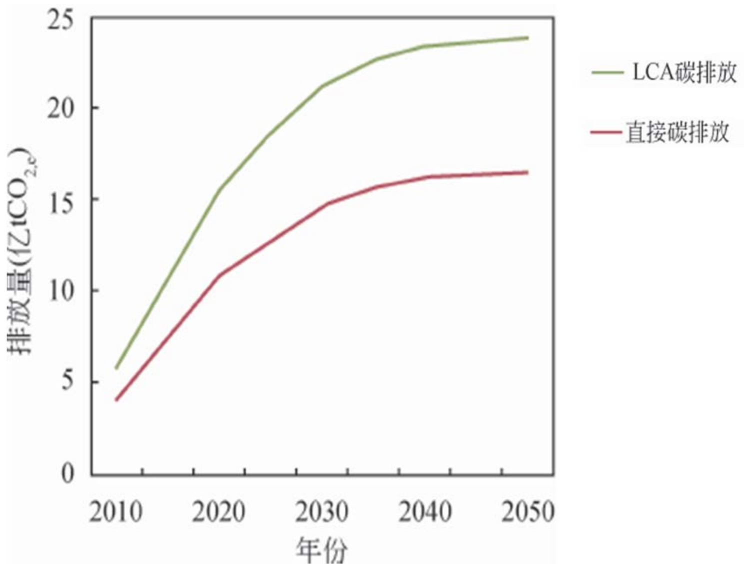
一、发展新能源汽车是战略选择

◆ 我国PM2.5形势严峻 Air Pollution Risk

我国城市与世界主要城市PM2.5年均浓度对比



温室气体排放预测



中国现行空气质量评价标准 → 城市超标率18%

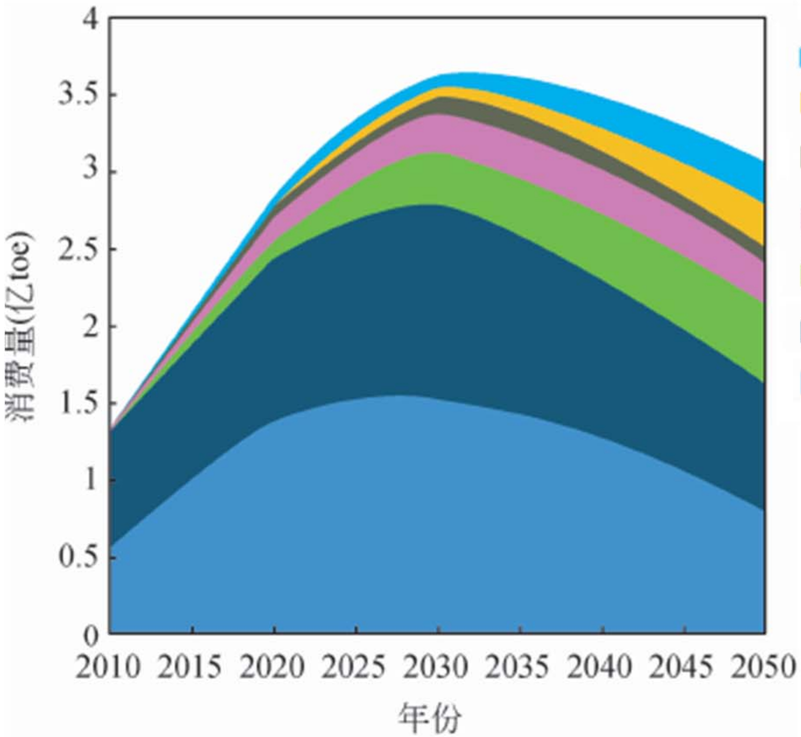
我国新修订的《环境空气质量标准》 → 城市超标率2/3

如果不大力发展新能源汽车，中国汽车交通部门造成的温室气体排放不断增长，2050年将接近24亿吨，成为中国温室气体排放增长的主要贡献者。

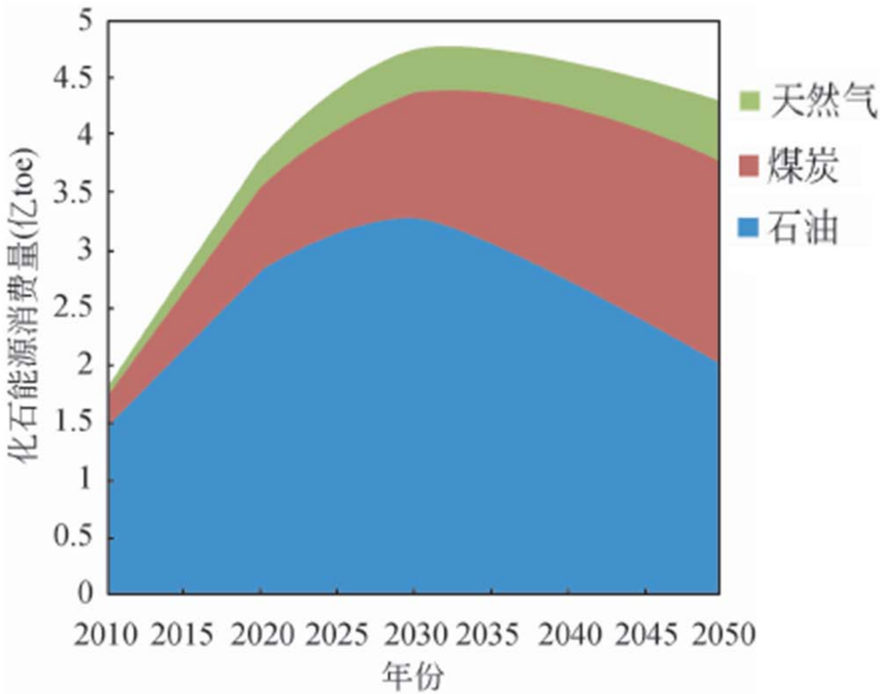
一、发展新能源汽车是战略选择

◆ 新能源汽车对我国未来能源的贡献

◆ **Contribution of New Energy Vehicles to Energy Consumption**



车用燃料消耗
Vehicle Fuels Consumption



全生命周期车用化石能源消费
Life Cycle Vehicle Fossil Fuels

中国车用燃料消费量2030年达到峰值，之后总量不断下降；

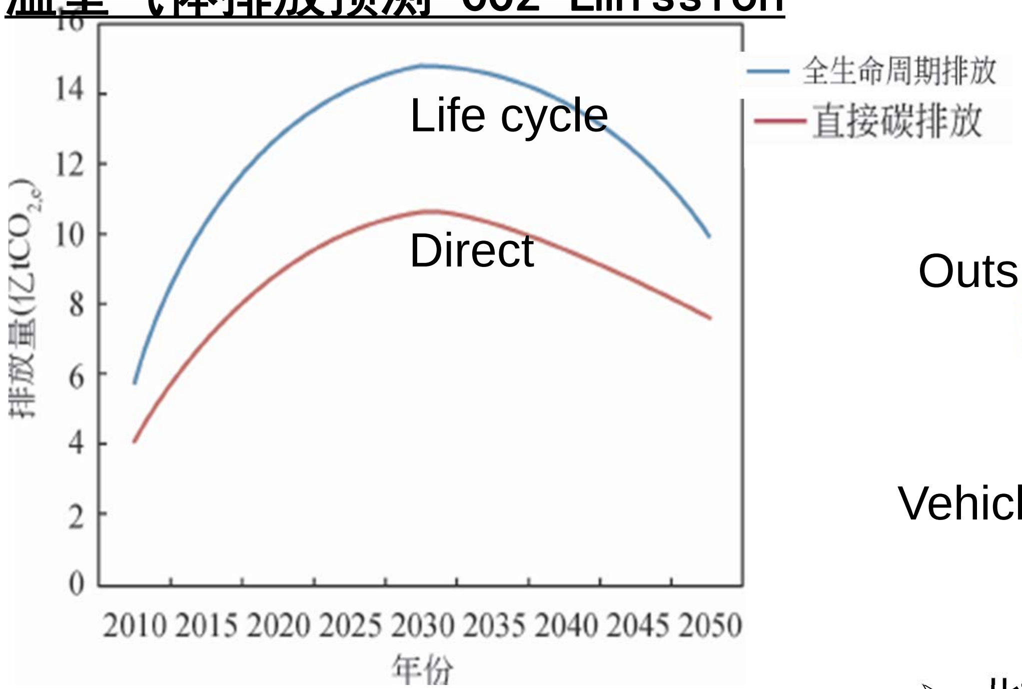
来源：《中国车用能源展望2012》清华大学中国车用能源研究中心

一、发展新能源汽车是战略选择

◆ 新能源汽车对我国未来环保的贡献

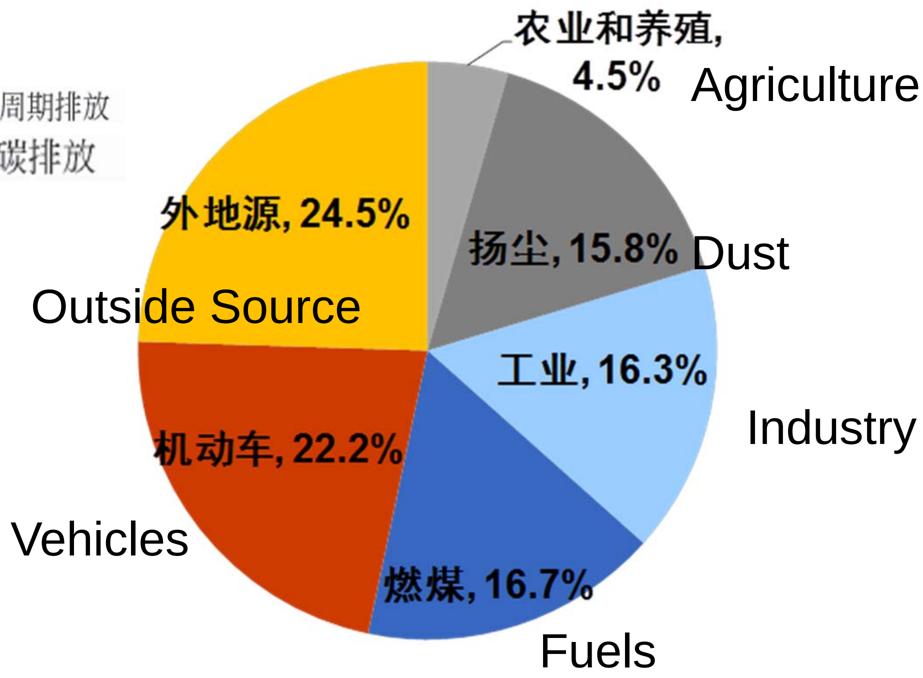
◆ **Contribution of New Energy Vehicles to Environment**

温室气体排放预测 CO2 Emission



2050年WTW温室气体排放减少53.5%左右，人均汽车交通WTW温室气体排放0.68吨；

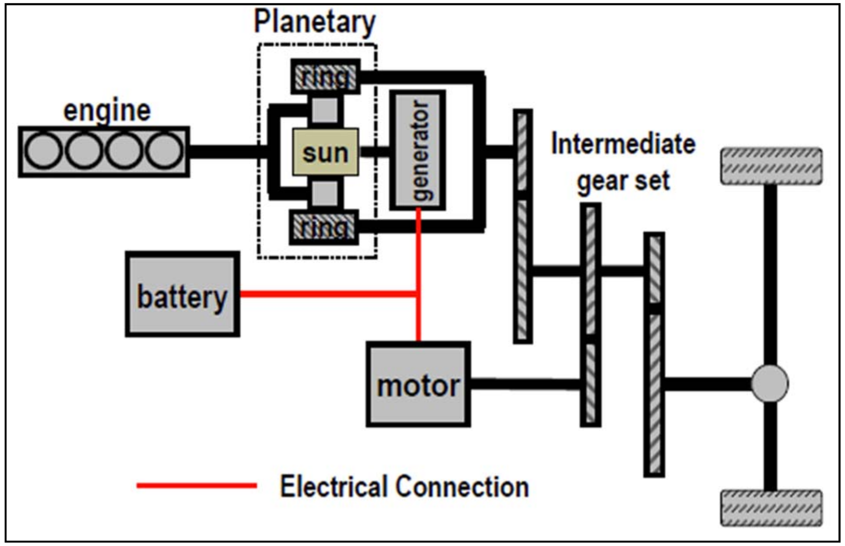
北京PM2.5来源解析 Beijing PM2.5 Sopurces



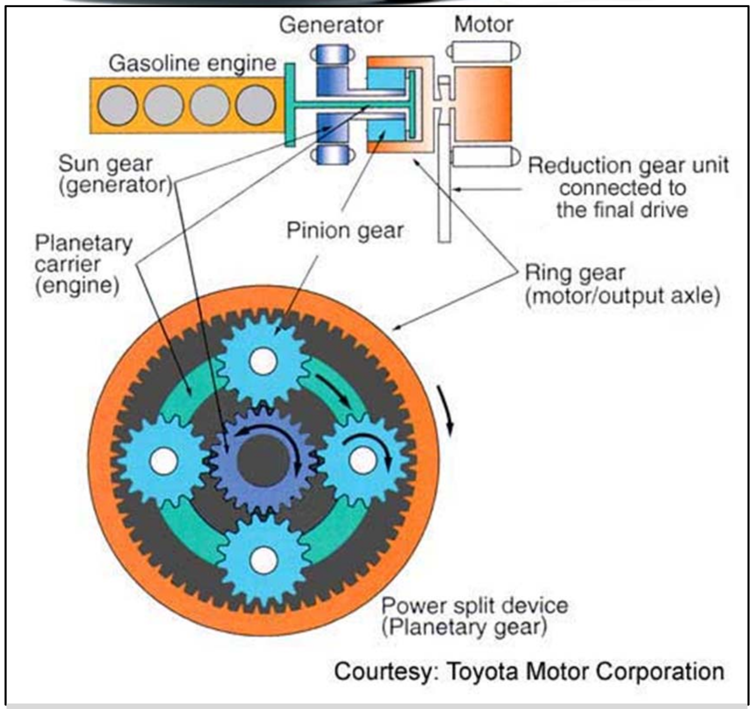
- 北京市汽车排放量占全市排放总量的22.2%；
- 如果按照2017年20万辆新能源汽车计算，占总量的3.3%，则能实现减排0.73%，对汽车行业减排贡献率为13.2%；

Typical Hybrid Powertrain

✓ Planetary Gear Power Split



Ford FHS

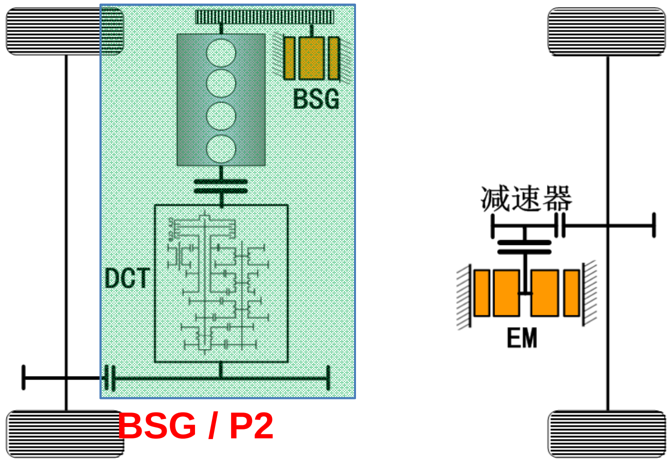


Toyota THS

Power-split是丰田、福特的主流构型方案，已有多款HEV车型量产，并推广到PHEV。

Typical PHEV Powertrain

✓ Four wheel drive



Volvo V60 PHEV

	Volvle V60 PHEV
Gross Weight	1724kg
Engine	160kW/440Nm
Real Axis Motor	52kW/200Nm
Battery	12Wh
Electric Range	50km

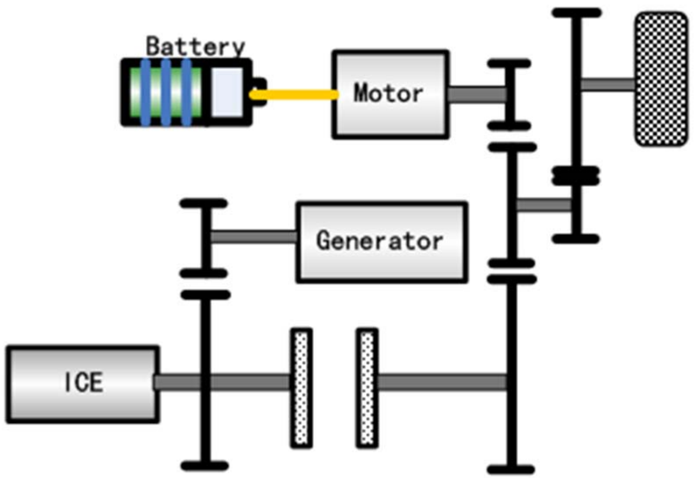
PSA 3008 PHEV

BMW i8 PHEV

- 四驱电桥方案也被多家公司采用，典型的为PSA公司，该构型易于PHEV化；
- 在原有混动技术基础上加入电驱动桥实现PHEV，也是国内值得重点研究的技术方案。

Typical Sedan PHEV Powertrain

✓ Two Electric Machines Drive



i-MMD Structure

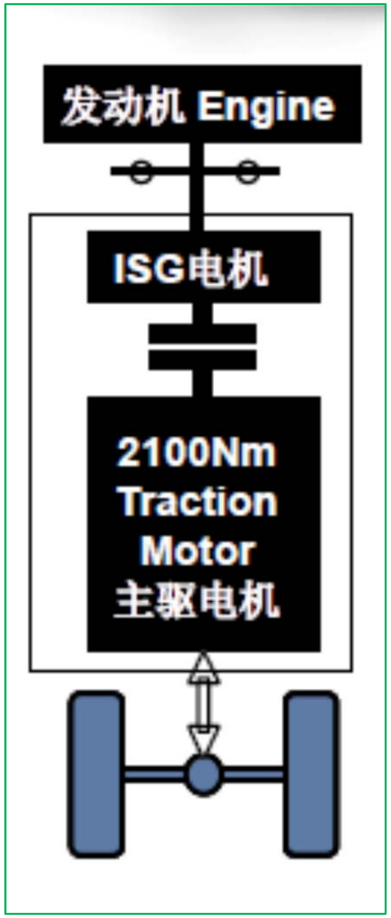
Features:
1） Integration of Transmission & Motor/Gen;
2） Motor & Generator different gear ratio;

		Honda Acxcord Plug-in
Gross Weight		1724kg
Engine		105kW/165Nm
Motor		124kW/307Nm
Generator		105kW
Generator Gear Ratio		8.38
Motor Gear Ratio		2.74
Battery		6.7kWh/41kW
Electric Range		20km
Fuel Consumpion （FTP75）	CD阶段	2.03L/100km
	CS阶段	5.06L/100km

- i-MMD技术应用于本田雅阁PHEV车型，是本田全新开发的高效混动系统；
- 通过创新高效的构型方案，是国内OEM取得技术优势的可选之路。

Typical Chinese Hybrid Bus Powertrain

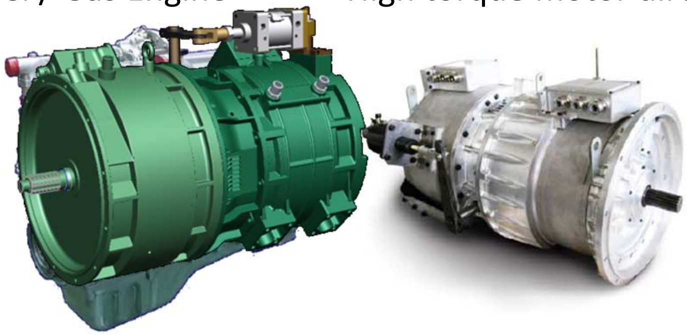
Without AMT



发挥我国永磁同步电机技术优势，取消变速器，用高转矩
高效率电机直驱技术打破跨国公司电驱动变速器的垄断

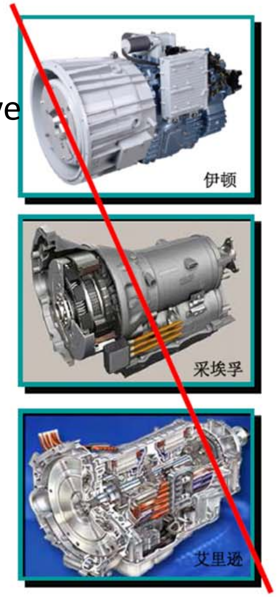
Diesel / Gas Engine

High torque motor direct drive



柴油机或气体燃料发动机

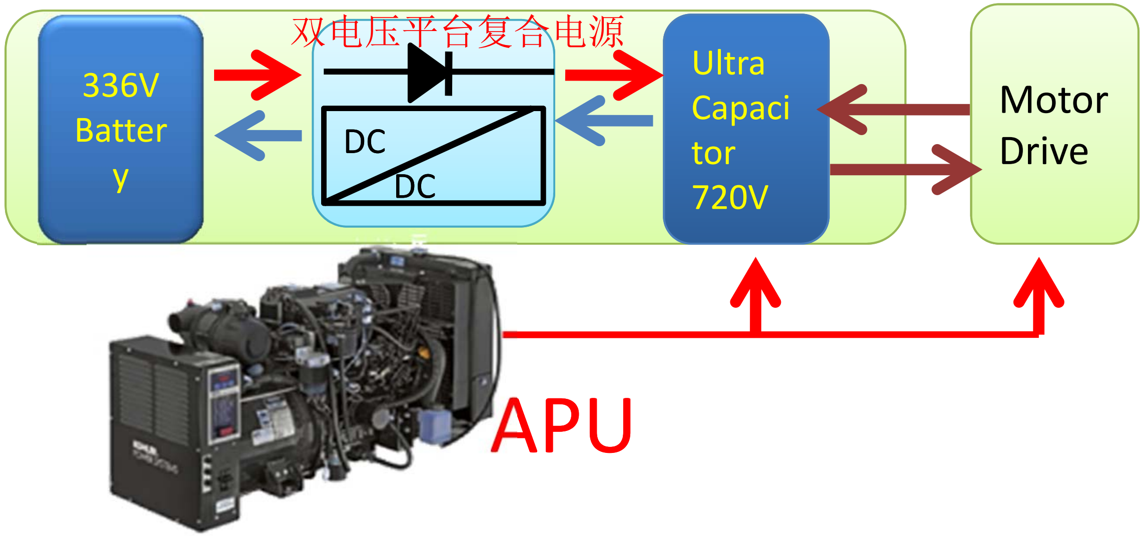
双电机直驱混合动力
单元（无变速箱）



12 m Bus Oil Consumtion 20L/100 km, oil saving over40%

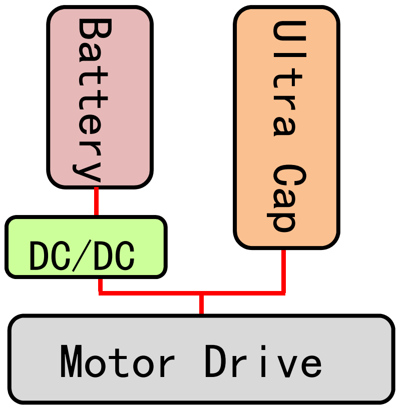
Range Extender Bus

Range Extender Configuration



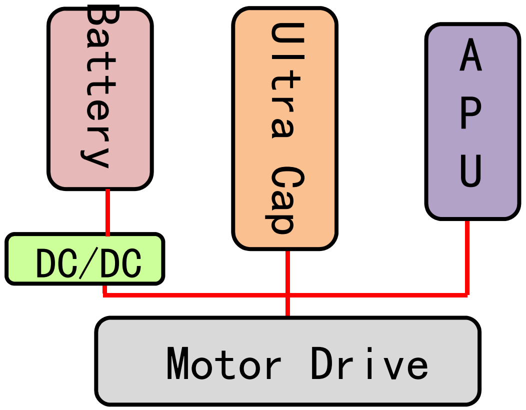
Pure Electric Mode

SOC：100%～60%



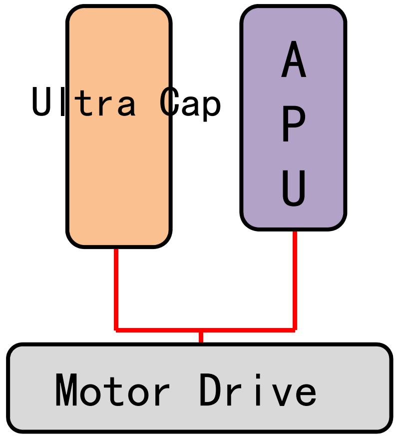
APU Assisted Mode

SOC：60%～30%

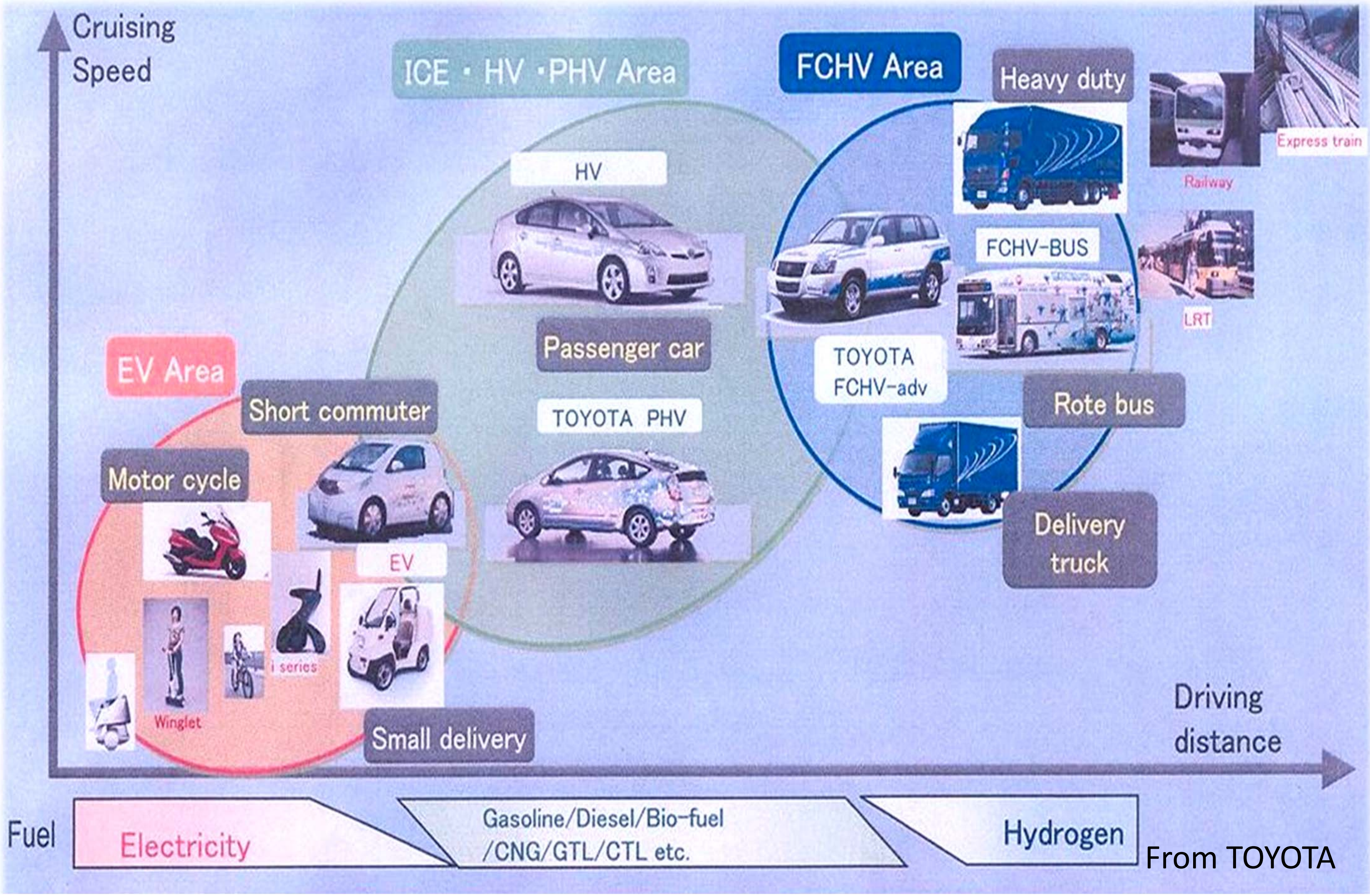


APU Mode

SOC：30%



Spectrum of New Energy Vehicles



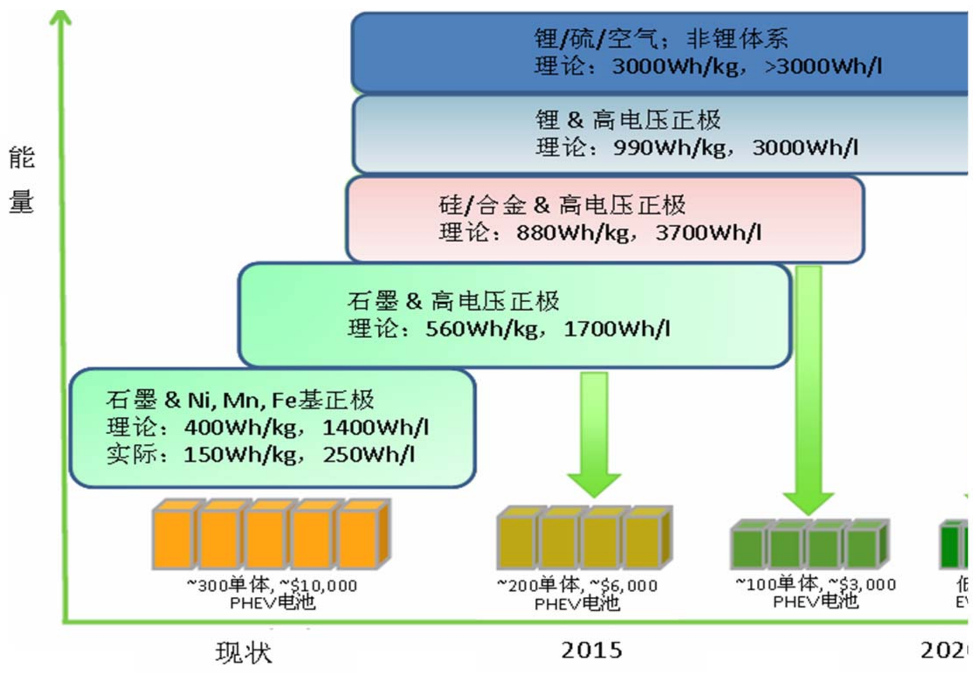
From TOYOTA

Battery Technology

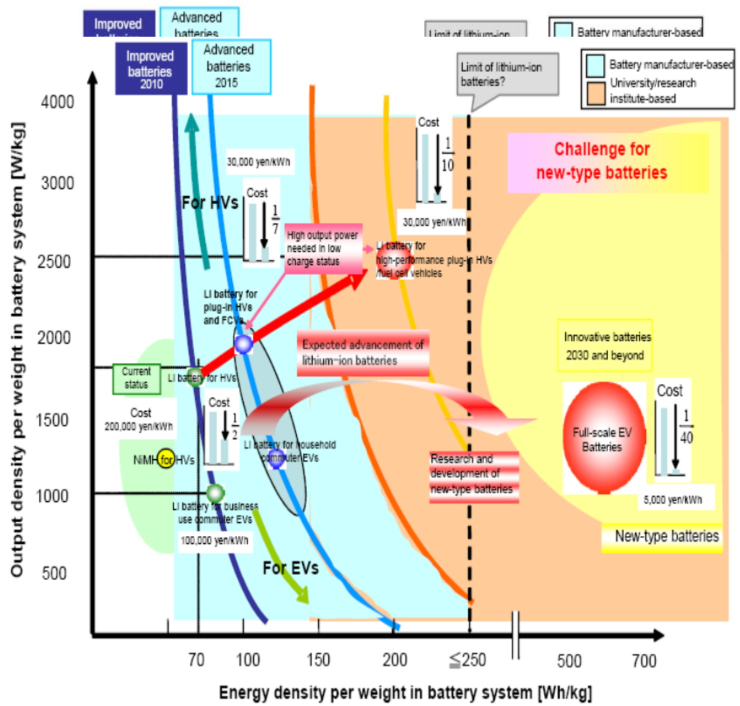
电池技术

新能源汽车发展的技术支撑

动力电池技术 Road Map of Battery Technology



USA 美国动力蓄电池研发路线图

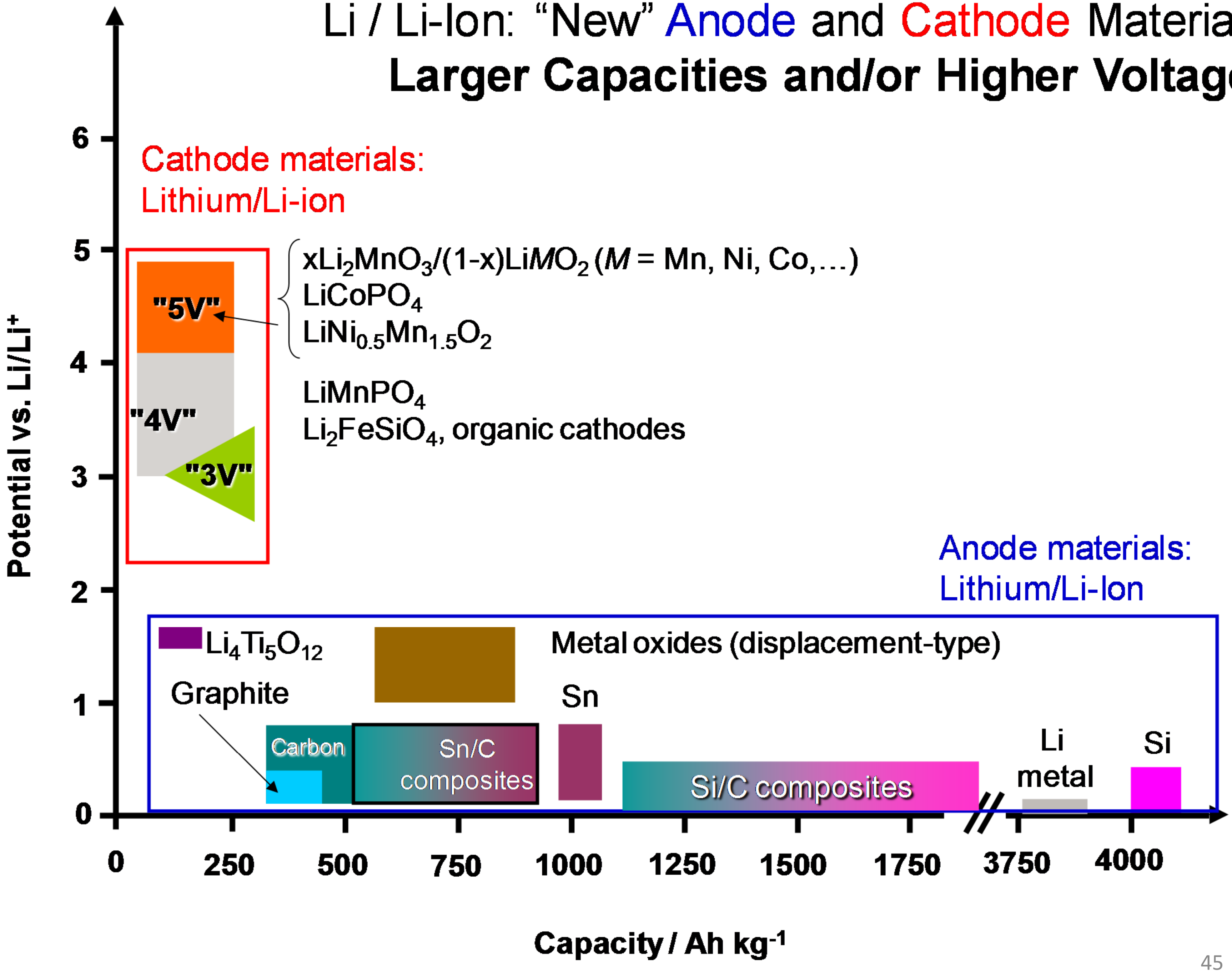


Japan 日本动力蓄电池研发路线图

我国动力电池发展建议：

- 持续提升磷酸铁锂、锰酸锂、三元等正极材料**和硬碳、硅基等负极材料的先进制备技术和工艺攻关功能电解液、高安全性隔膜等高性能动力**电池的关键技术，支持锂离子电池材料行业的技术进步；
- 组织国内的优势研发机构，跨领域联合开展新一代高容量锂离子正负极材料和以锂聚合物电池锂硫、锂空气、钠空气为代表的新型体系电池深度的基础研究和制造技术工艺研究开发，在下一代电池和材料发展过程中形成我国的高价值专利。

Li / Li-Ion: “New” Anode and Cathode Materials:
Larger Capacities and/or Higher Voltage



EV Battery System Research

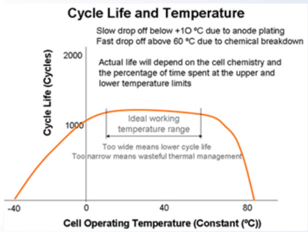
Safetey

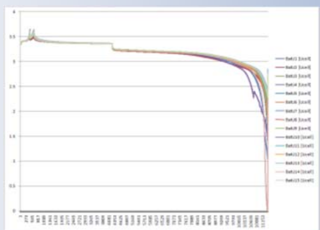
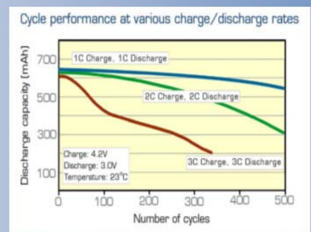
Over heat | Leakage | Contact | Abuse

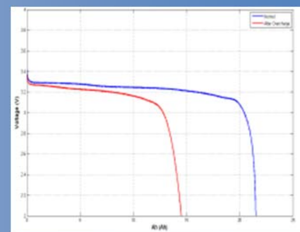



Endurance

High Low Temp | Over Charge | Over Discharge | Others

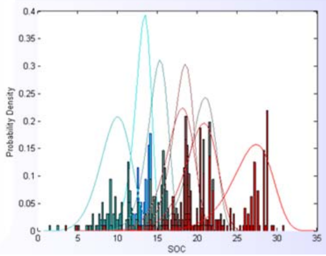


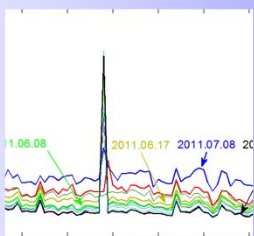



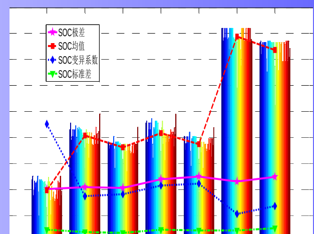
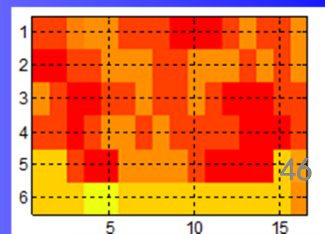


Consistency

Capacity | Resistance | Self Discharge | Thermal | Others





锂离子电池安全性技术研究

Research on Battery Safety

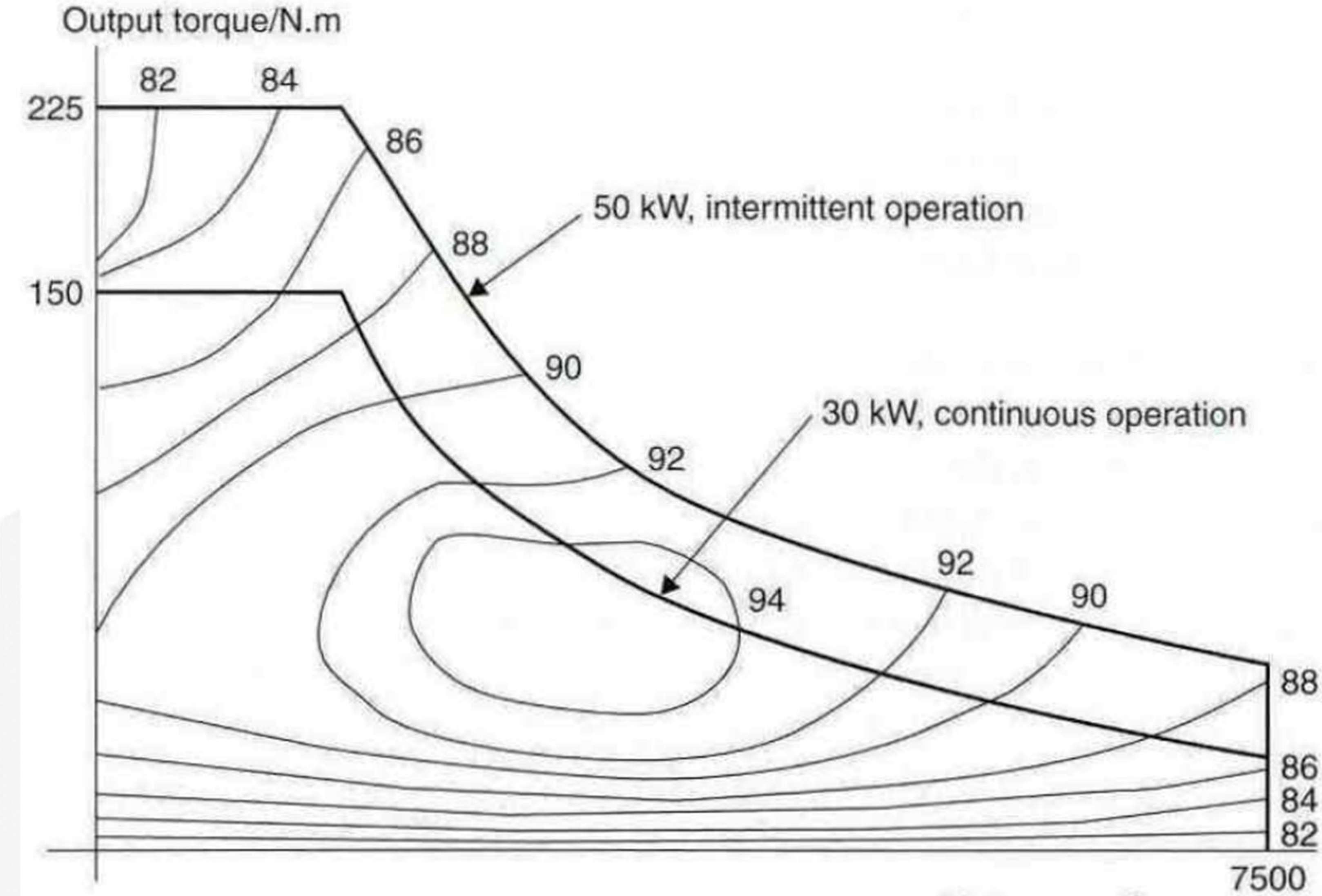
由于产生电池安全性问题并非单一因素，应在深入全面认识应用环境下电池反应机制及其伴生副反应的基础上，多角度、系统提高锂离子电池的安全可靠性。

- 强化复合隔膜与短路保护技术
  Composite Separator & Short Circuit Protection
- 电压敏感隔膜与过充保护技术
  Voltage Sensitive Separator & Over Charge Protection
- 安全性电极材料与自激活热保护技术
  Safety Electrode Materials & Self Temperature Protection
- 离子液体与安全性复合电解质材料
  Ionic Liquids & Safety Composite Electrolyte
- 电池安全性设计
  Battery Safety Design

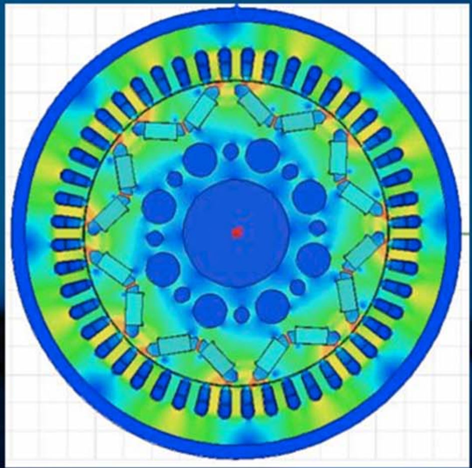
Motor Drives Technology

电机及电控技术

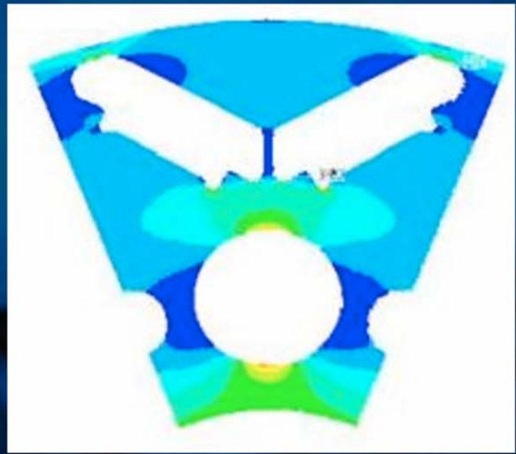
Typical Torque-Speed Characteristics
典型转矩－转数特性



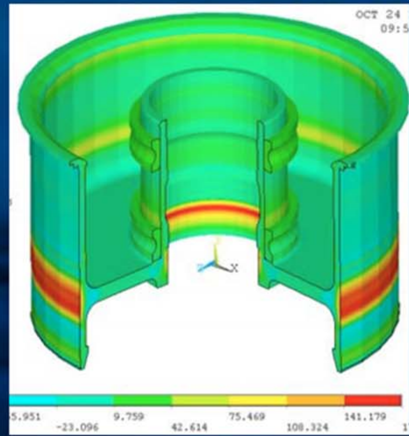
Motor Design /新能源汽车电机设计流程



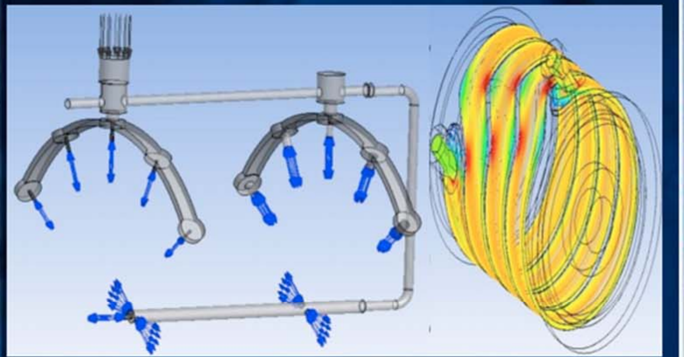
Electromagnetic Design
电机电磁设计



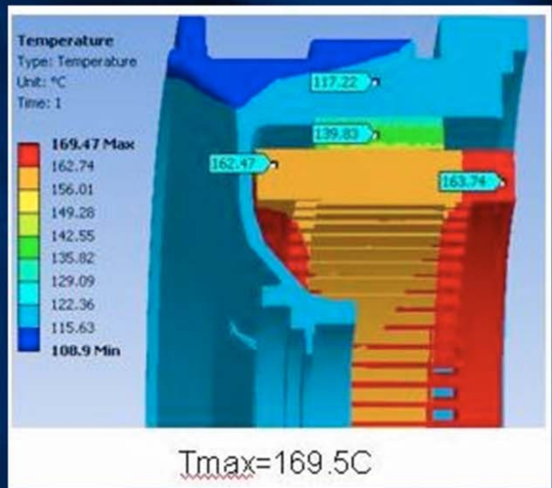
Rotor Stress Analysis
转子应力分析



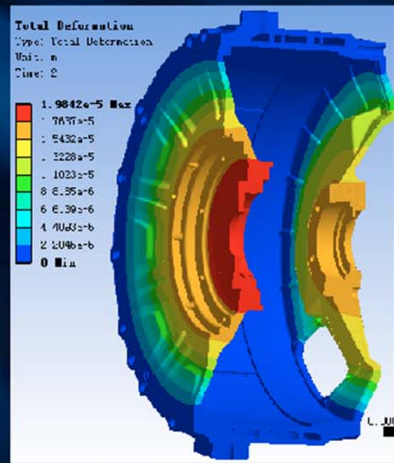
Structure Analysis
部件结构分析



Fluid Analysis/ 流体动态分析



Thermal Analysis/热分析



Mobility Analysis
车辆动态机壳变形校核

EV Infrastructure

电动汽车基础实施

电动汽车充电特征 Features of EV Charging

Complex Systems: 复杂系统 Involved science, technology, engineering, industry, finance and business model.

Connected: 联网 The charging plug is connected to the grid, affect the grid at various levels. Unlike the gas station is decoupled with oil pipeline.

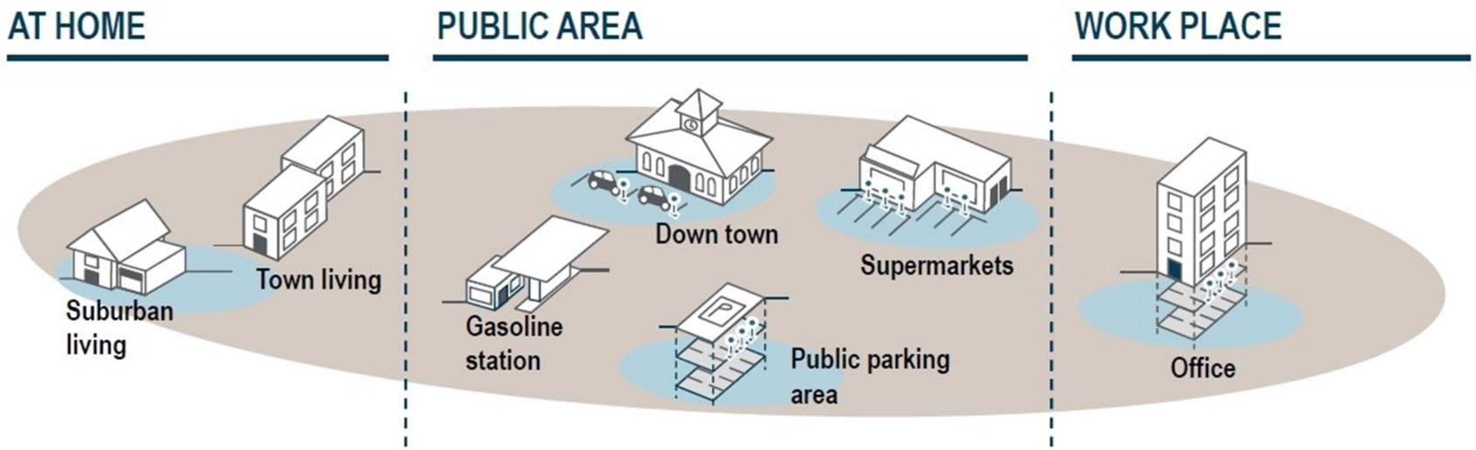
Dynamics: 动态 The charging has instant impact to the grid, unlike the gas station has no impact to the pipeline.

Interactive:互动 The mode of charging, the status of the grid and the status of the batteries are mutually interactive.

Integration: 集成 V2G, Active Distributed Power Systems, Smart City.....

Key issues: 关键 Integration of energy and information, win-win situation to grid, battery and user.

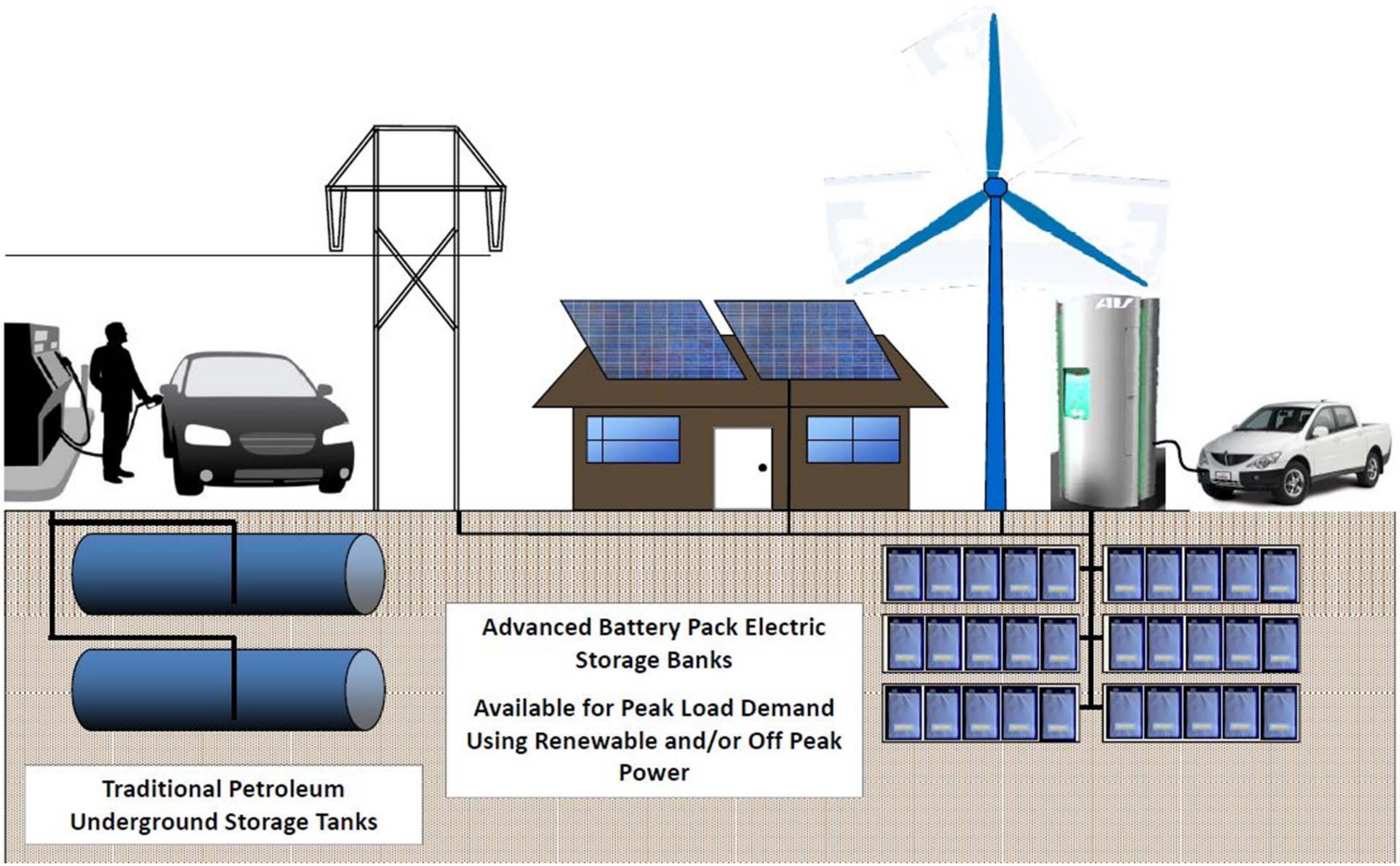
Good Infrastructure: Efficient & Convenience
好的基础实施：方便、经济、高效



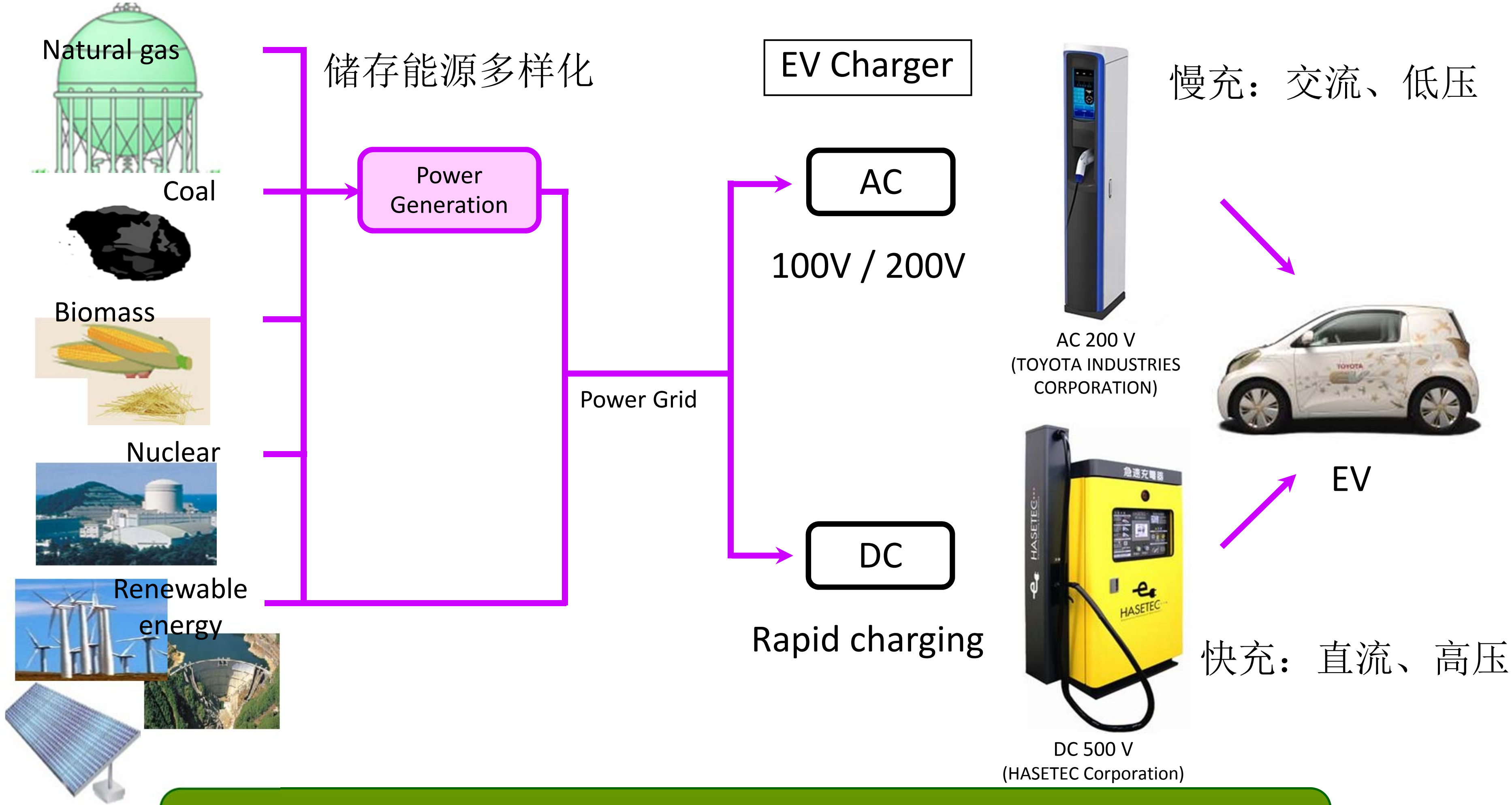
Parking Durations	14 hrs per day	2 hrs per day	7 hrs per day
Charging Points	1 charging point per vehicle	< 0.5 charging point per vehicle	1 charging point per vehicle
Power & Charing time Requirements	Low power and normal charging (e.g. 3kW, 10 hrs)	High power and quick charging (e.g. 22 kW, 2 hrs)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

EV Charging Infrastructure Solution
电动汽车充电基础设施

Comparison of Gas Station & Storage Quick Charging
储能快速充电站和加油站的比较

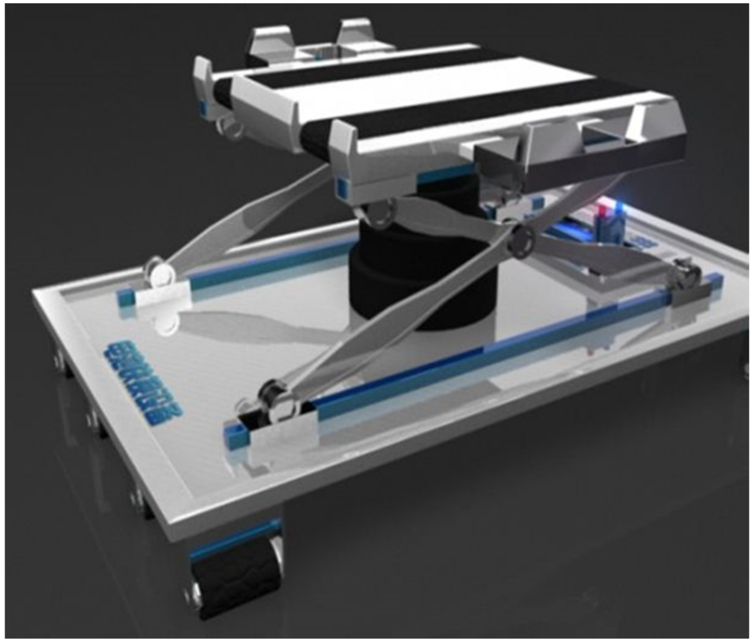


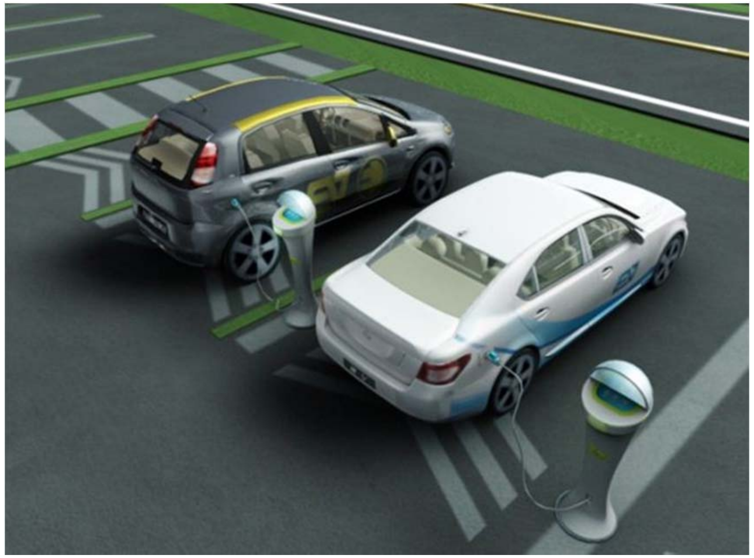
EV Charger 电动汽车充电



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

换电池　Battery Swapping





Smart Battery Charging, Swapping, Delivery Network
换电、充电、配送的综合服务

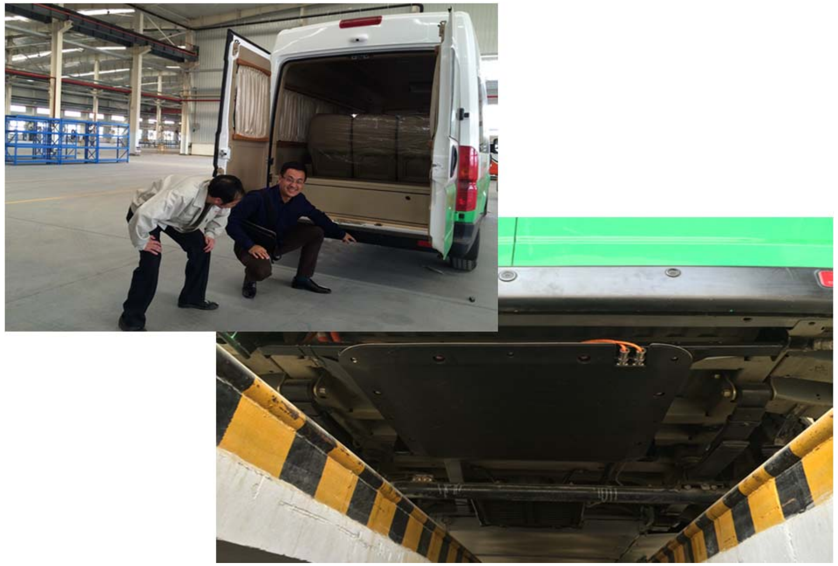
- AC charging
  - Long charging time
- DC charging
  - Battery technology does not support fast charging
  - Grid cannot sustain fast charging
- Battery swapping
  - Immediate replenishment of electricity
  - Easy battery maintenance and longer life

Inductive Charging for Passenger Cars

- Operation in Cherry eQ Evs,
- Range 250 km.

- Operation in Chang An EVs,
- Max power 107 kW.

Inductive Charging for Commercial Vehicles



- Operation in mid size commercial vehicles

- Operation in Chengdu；
- Operation in short distance van；

Inductive Charging for Buses. Unit Power 30kW, Max 300kW

- Power：30kW
- Gap：20cm
- Efficiency：90%
- Space：1 square meter

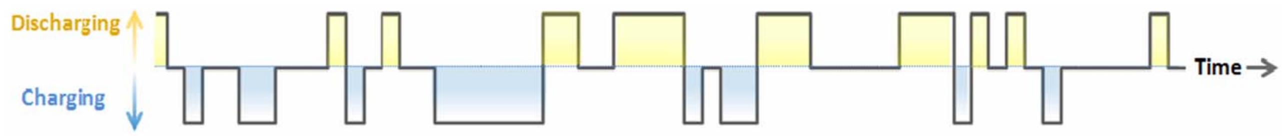
Operation in Deng Feng Bus in Xiangyang

Motivation

Smart charging
Charging is delayed or advanced in time based on e.g. energy cost or renewable contents.

Energy backup
Advance or postpone charging in time and to deliver the energy back to the grid at a later time.

Ancillary services
Continues short-duration charging and discharging operations to balance the grid.



Two Integration 两个结合

- Integrate EV with Smart Grid

电动汽车和智能电网的结合

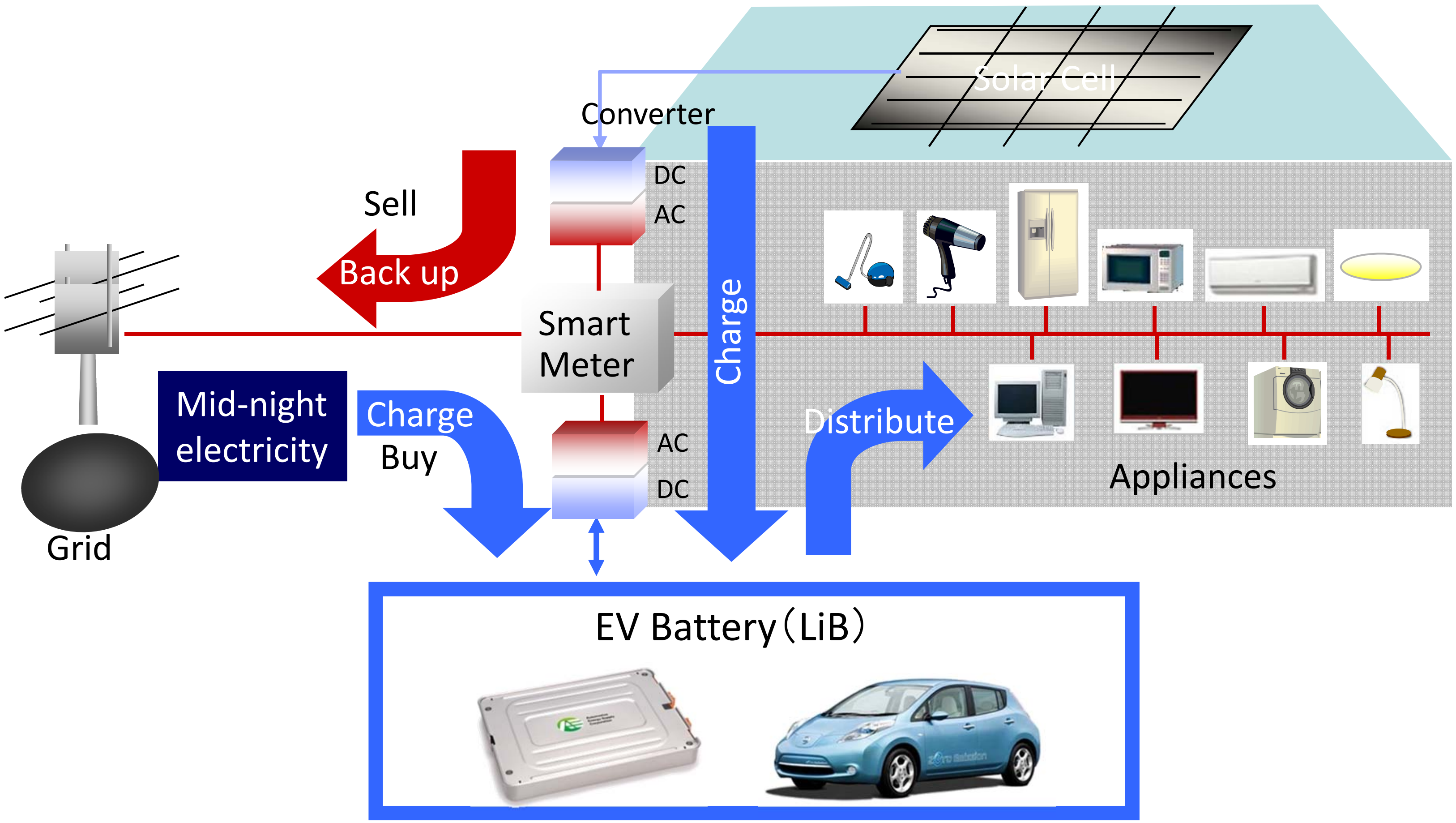
- Integrate EV with Telemetic / ICT

电动汽车和远程智能信息控制、智慧型城市建设相结合

Smart House：智能家庭

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

电动汽车是智能家庭不可分割的成员



Low Range Small Electric Vehicles

短途小型电动汽车

中国短途纯电动乘用车产品定义（讨论稿）
China Low Range Small EV Specification

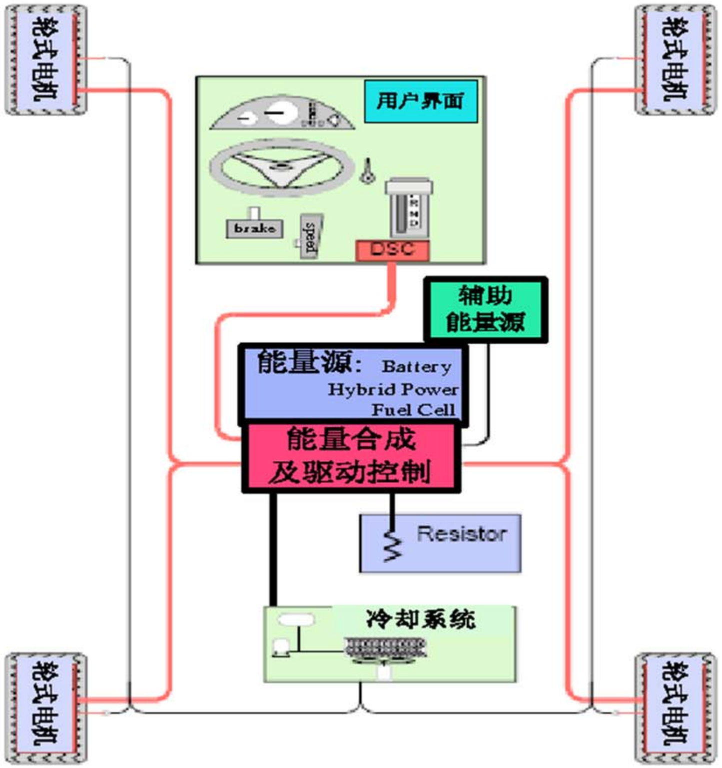
- 最高车速**Max Speed: 80 km/h**
- 加速性能 **Acceleration :0 – 50 km/h，10s**
- 爬坡性能 **Climbing Gradient:** 不低于**20%**
- 续驶里程 **Range： 50 km (**城市工况**)**
- 整车质量 **Vehicle Mass：** 不大于**1200 kg**
- 电池总质量与整车质量比值 **Battery Weight：<30%**

Technology Roadmap_ BEV Miniaturization

Through downsizing to realize scale commercialization

light electric vehicle → small battery electric car → full function electric car

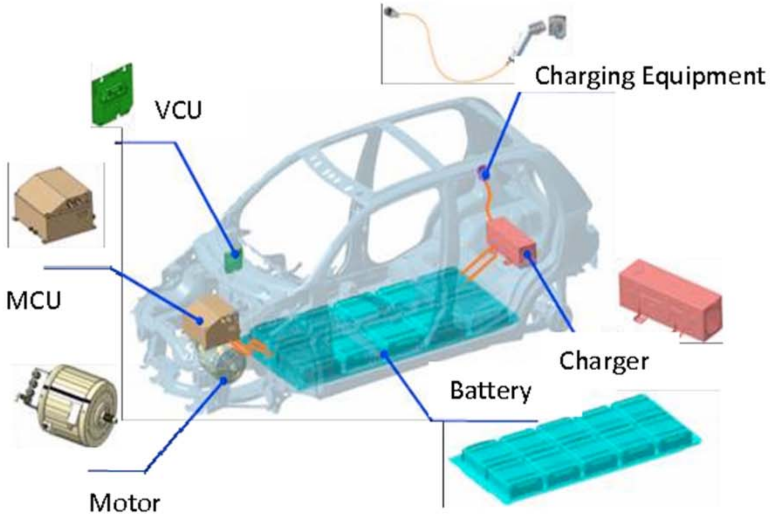
(lithium battery + in-wheel motor + chassis electrification + charge with household power



Typical Chinese Battery Electric Vehicles

Great progresses have been made in small electric cars.
Series products and models have entered industrial stage.

Maximum speed	100km/h
0~50km/h Acceleration time	6s
Battery type	LFP Li-ion
Energy	18kWh
Peek power	50kW
Driving range	150km
Normal-charging time	6~8h
Quick-charging time	30min



EV of JAC


EV of Chery


EV of Geely


EV of SAIC motor

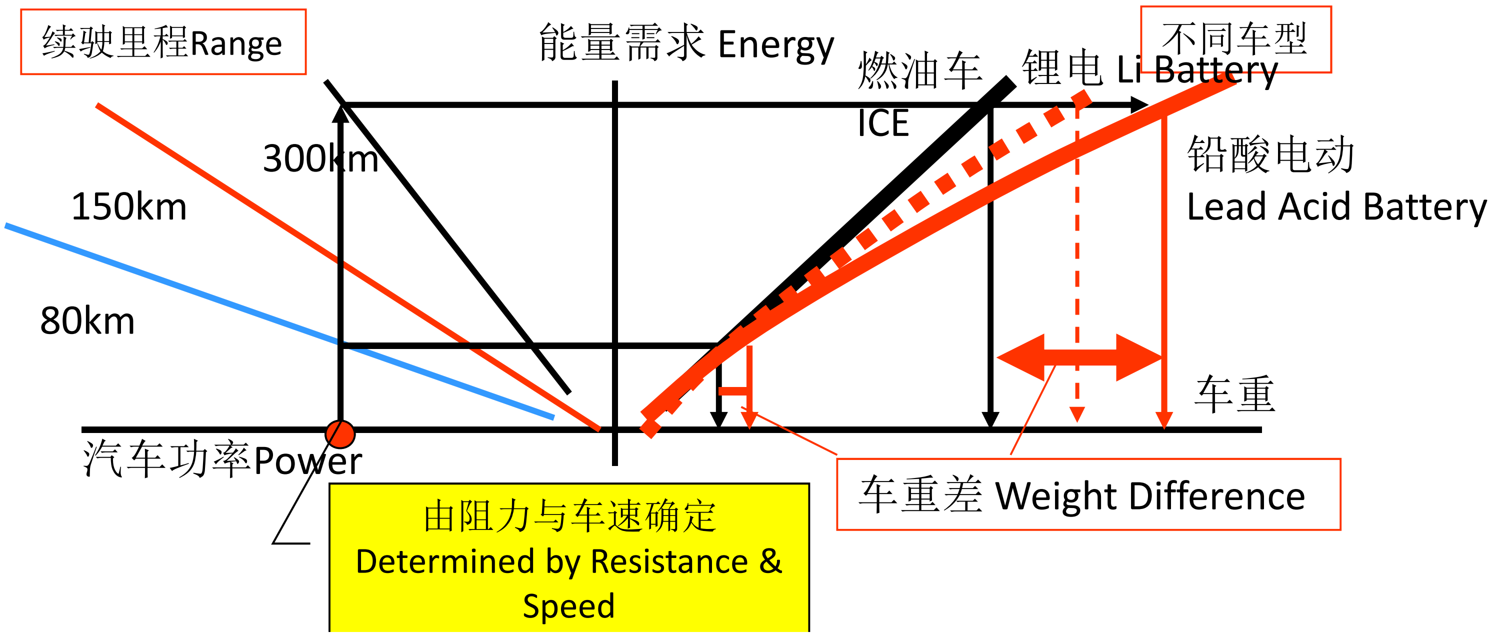

EV of CHANGAN


EV of FHC-Mazda


高强板热成形技术
High Strength Steel
Sheet Forming
2
计算机建模、仿真优化
Computer Modeling
Otimization
1
3
提高安全彩虹梁技术
Rainbow Beam
Technology
4
轻量化连接技术
Light Weight Joint
8
汽车黑匣子技术
Black Box
彩虹电动轿车
Rainbow EV
7
5
三维拉弯扭成形技术
3D Bending Torision
6
可降解汽车内饰材料
Biodegradable Interior
碳纤维增强复合板车身
Cmposite Fiber Body
彩虹电动车各项新技术 Key Technonoy for Small EVs

续驶里程、能量和车重的关系 —
Small EVs: Range, Energy & Weight Relationship

- **电动汽车的一个基本特点是作为能源的电池，价格高、重量大，一般都比同级别燃油汽车更重**
- 在车速要求一定下，续驶里程长则能量需求大，价格与重量猛增
- 在一定的续驶里程下，车速要求越高，则要求电池越多，车重车价急剧攀升；若车速、续驶里程要求都高，则电动车的使用经济性急剧恶化（背着长时间需要的粮食跑路！）
- **速度指标适当，续驶里程不太长的电动车，经济性显著提高！**



Intelligent Electric Vehicles

智能电动汽车

Human being versus intelligent EVs

	Human being (intelligent life)	Future intelligent EVs	Note on intelligent EVs
System architecture	Essentially identical but evolving	Diverse at current development stage	Potentially to be optimized for given applications
Brain (controller)	One	Three: driver; vehicle-oriented; ITS/IV-oriented	Emerging demands in coordinating the 3 'brains'
Energy management	Internal (control management, regen) + external (food, drink, etc)	Internal (control management, regen) + external (charging)	Preliminary stage & potential to optimize
Thermal management	Internal control + external (clothes, air conditioning, etc)	Internal (control management for different subsystems requirements)	Highly challenging
Health management	Evolution: millions of years (physical & mental)	Very new topic; hardware & software (control systems)	Emerging & critical
Performance envelope	Clear performance envelope & limitations while in slow evolution	Clear performance envelope & limitations while in rapid development	Advances in key components & system integration
Status of system synergy	Optimal & evolving	Very preliminary at current development stage	Significant potential & benefit to be synergised

Unmanned Ground Vehicles (UGVs) in DARPA (Defense Advanced Research Projects Agency) Grand/Urban Challenge

•Grand Challenge 2005

•Stanford Stanley

Velodyne
multi-plane lidar
360°x26° FOV, 60m

IBEO
180° FOV,
multi-plane, multi-echo

~16 Sensors total

Continental
ISF 172 lidar
14°, 150m

SICK Scanning Lidar
90/180° FOV, 40m

Applanix
GPS/INS

Continental
ARS 300 radar
60/17°, 60/200m

•Urban Challenge 2007

•CMU, Tartan

Intelligent Vehicle

Smart Mini EV

Internet of Vehicles

车联网

White Paper of Internet of Vehicles (IoV)

1. Concept of IoV

The Internet of Vehicles (IoV) is an integration of three networks: an inter-vehicle network, an intra-vehicle network, and vehicular mobile Internet.

2. IoV Technology Leads Industrial Revolution

The convergence of technology encompasses information communications, environmental protection, energy conservation, and safety. It will become the largest Internet of Things (IoT) infrastructure. The collaboration and interconnection between the transportation sector and other sectors (such as energy, health-care, environment, manufacturing, and agriculture, etc...) will be the next step in IoV development.

White Paper of Internet of Vehicles (IoV)

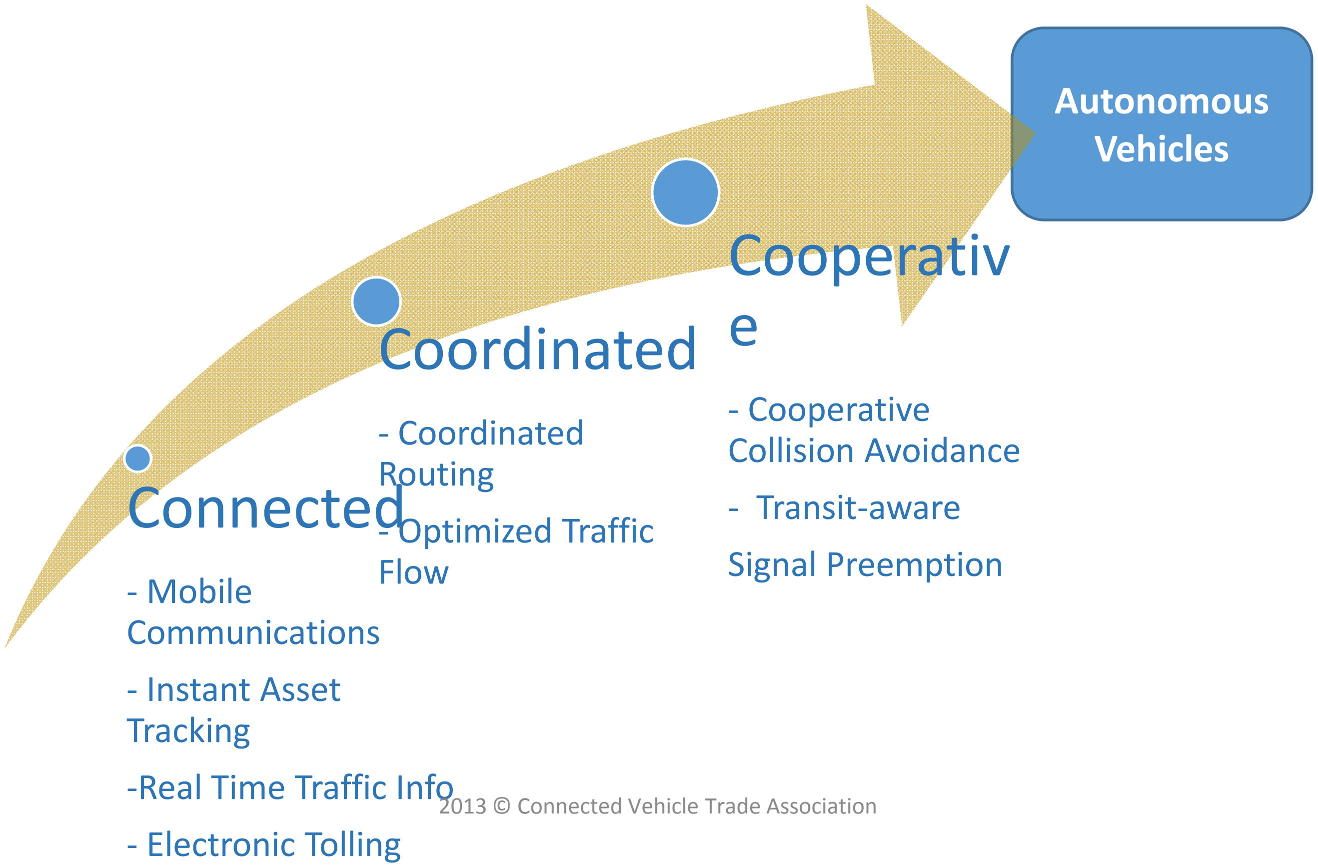
3. Opportunities and Challenges of IoV

The research and development, as well as the industrial application of IoV technologies will promote the integration of automotive and information technology. Lack of coordination and communication is the biggest challenge to IoV implementation. Lack of standards make effective V2V (vehicle to vehicle) communication and connection difficult and prohibits ease in scaling.

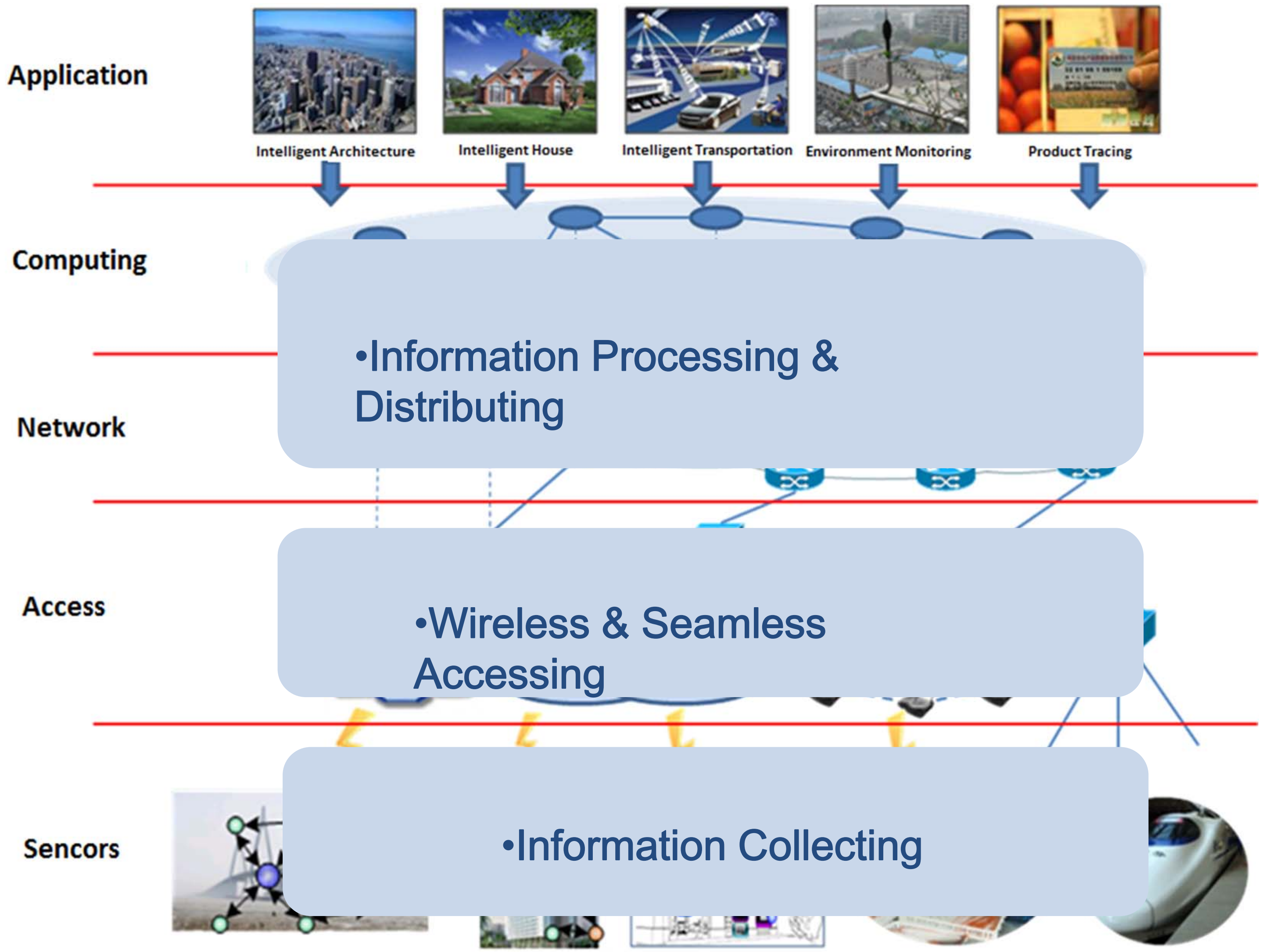
4. Reflection and Suggestion about the Development of IoV

- *Staged development and deployment of IoV systems*
- *Strengthen policy guidance and support from governments.*
- *Promote deep integration of IoV and vehicles.*
- *Cooperate to improve standards and industrial specifications.*
- *Plan for IoV data to be accessible as a resource to enable broader research.*

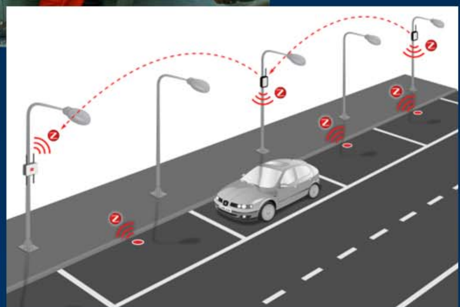
Evolution to Autonomous Vehicles



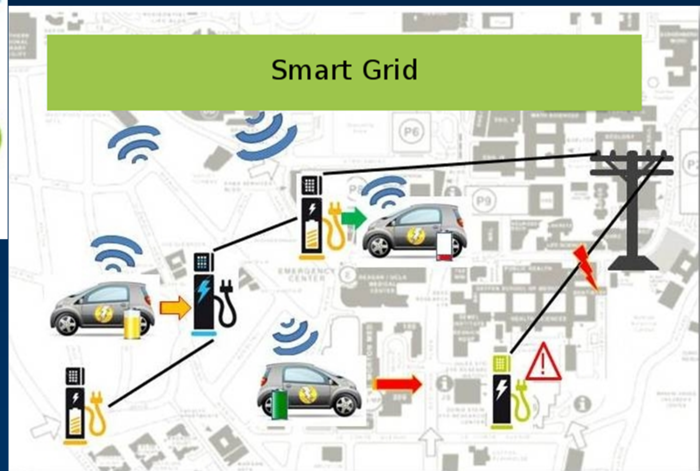
TECHNOLOGI
ES FOR THE
FUTURE
In-Vehicle
Infotainment (IVI)
Advanced Driver Assist
Systems (ADAS)
Autonomous
/Self Driving
Visit us at
www.intel.com/automotive
Follow me on Twitter @Intel_Joel
intel
Look Inside.


Application
Intelligent Architecture
Intelligent House
Intelligent Transportation
Environment Monitoring
Product Tracing
Computing
•Information Processing & Distributing
Network
Access
•Wireless & Seamless Accessing
Sencors
•Information Collecting

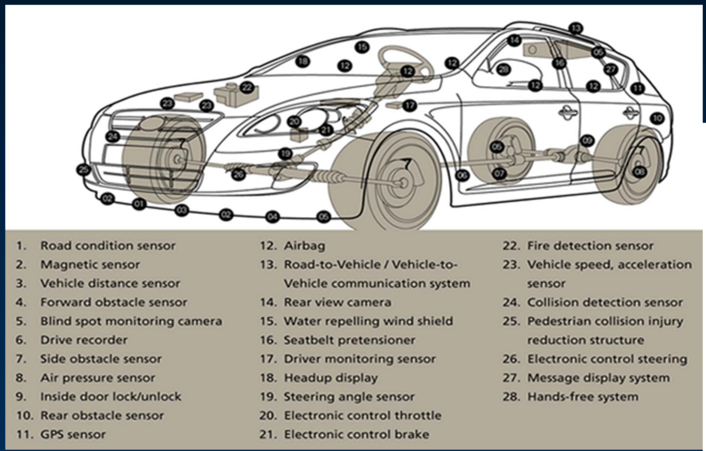
Smart Cars & Autonomous Driving

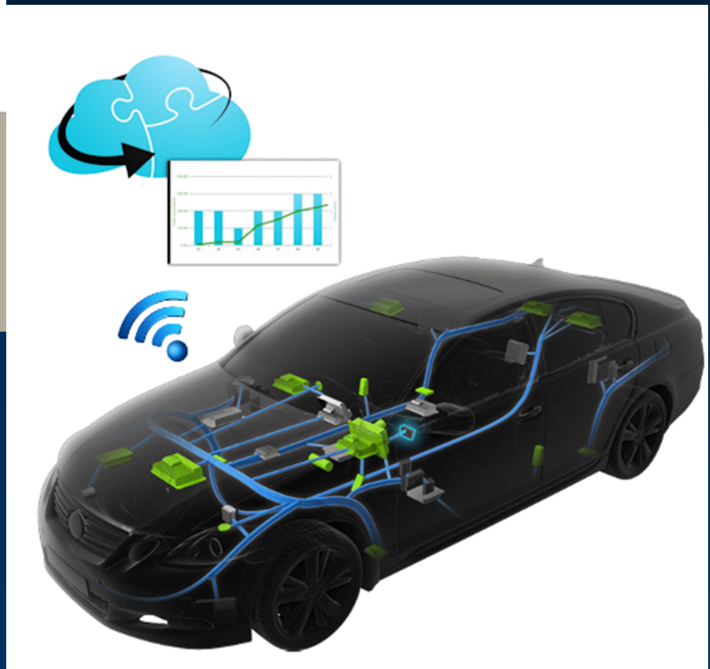


Electric vehicles and Smart Grid integration



Remote diagnostics



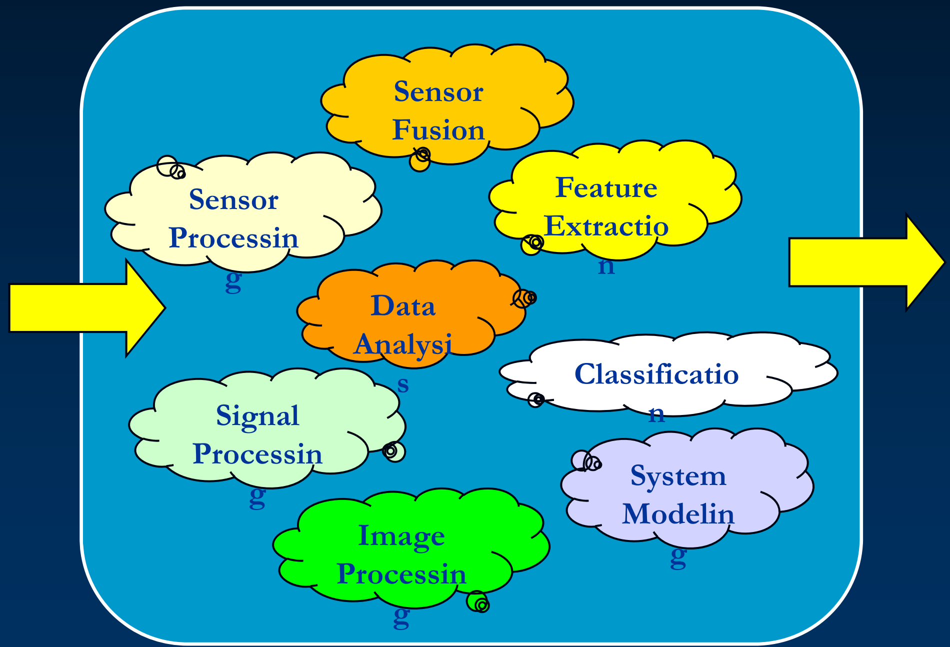


Smart Transportation Systems

Intelligent Traffic Management

Rental Services

A Comprehensive Design Methodology



Intelligent IoV

Internet of Cars: Unlocking $1,400 in Benefits

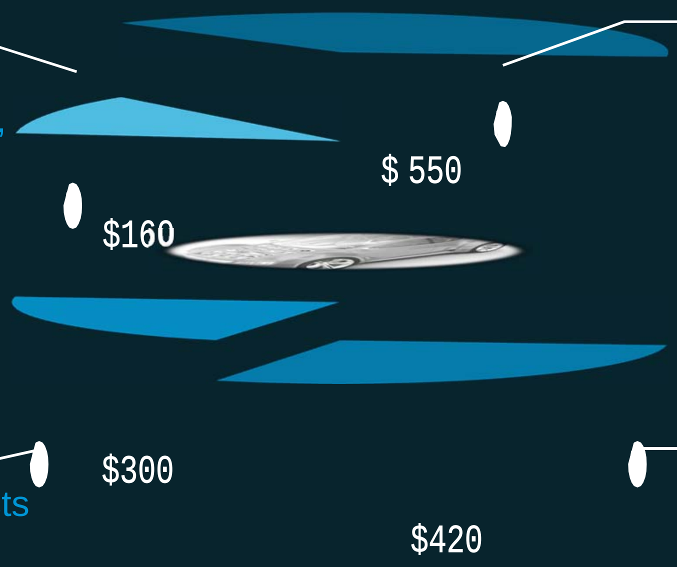
per Vehicle, per Year

Internet of Cars Service Providers

- Traffic guidance, navigation, emergency services
- "Google on wheels," PAYD insurance, location-based services

Vehicle User

- Lower insurance
- Lower operation cost
- Less time stuck in traffic, more productivity



Auto OEM/OES

- Lower service/warranty costs
- Connected CRM
- New profit pools
- Architectural savings

Society

- Fewer crashes
- Lower traffic/road/toll operation costs
- CO_2 reduction

Benefits per vehicle, per year

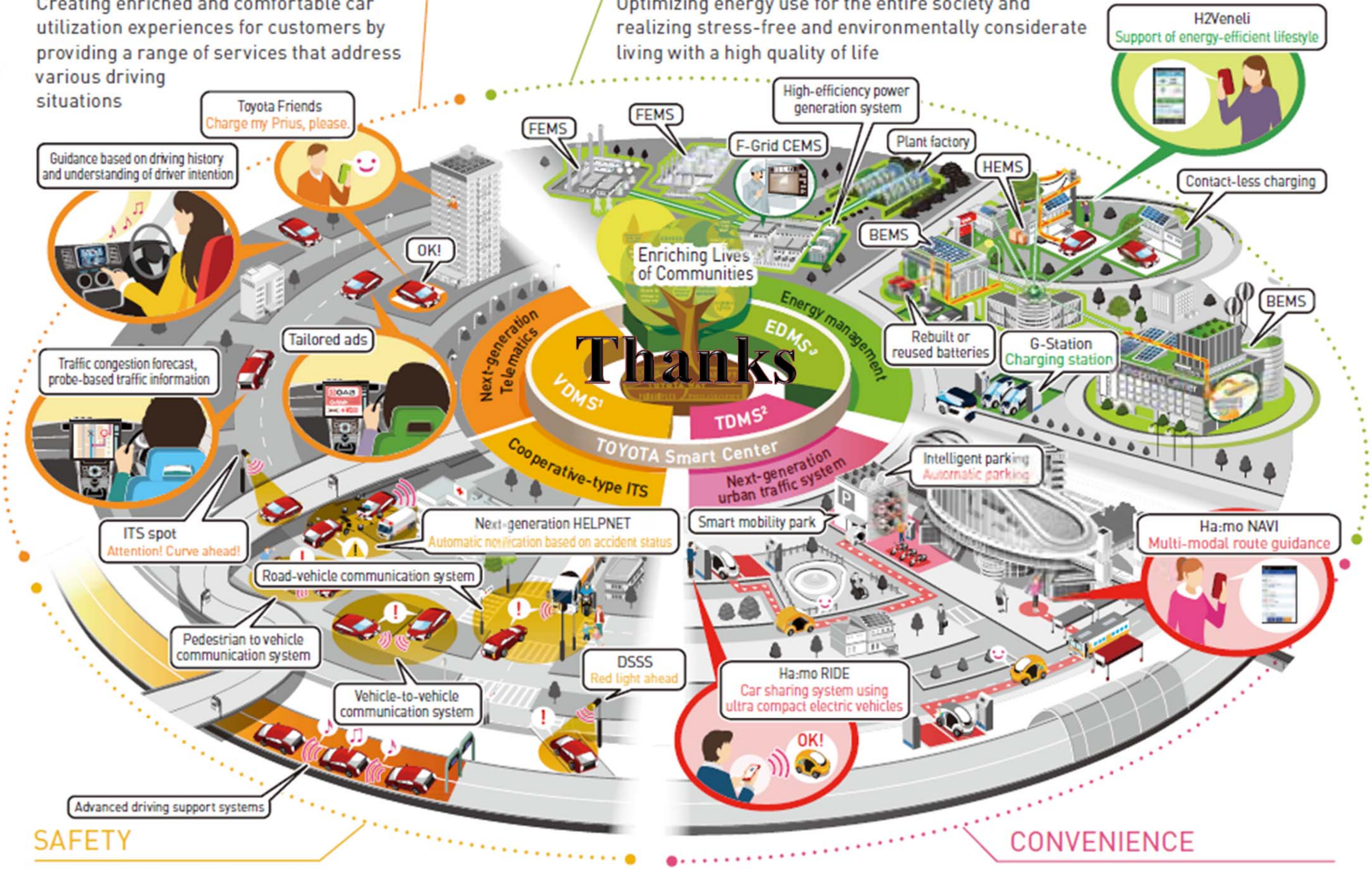
Source: Cisco IBSG Automotive and Economics Practices, 2011

COMFORT

Creating enriched and comfortable car utilization experiences for customers by providing a range of services that address various driving situations

ECOLOGY

Optimizing energy use for the entire society and realizing stress-free and environmentally considerate living with a high quality of life



SAFETY

Toward the realization of Toyota's ultimate goal: zero casualties from traffic accidents

For further information on Toyota's safety initiatives, please see pp 22-25 and also the webpage below

未来汽车社会

CONVENIENCE

Building a stress-free traffic environment where everyone can move around smoothly, exactly as they wish

Details on next page

SUCCESS

SUCCESS

Inspiration	激情
Imagination	想像力
Innovation	創新
Integration	集成
Implementation	實現
Investment	投資

Thank you!