



Forum 3 Summary 论坛三 总结

## Forum 3 Summary: Electrification – Plugging into the Future 电气化-未来驱动力



### Objective

The objective of the Electrification – Plugging into the Future Forum was to assess the effort and achievements that have been made to reduce the automotive industry’s dependence on petroleum through vehicle electrification. Participants representing the government, business and academic communities addressed the steps required to ensure the steady development of more environmentally friendly vehicle technology.

### Background

The world is faced with many urban transportation issues, including congestion, infrastructure demands, increasing air and noise pollution, regulatory issues and energy demands. The electrification of the motor vehicle is addressing these issues.

Government institutions, including those in China, and the world’s automakers have made great progress. However, a series of ongoing critical challenges must still be overcome.

### Chinese Government Support

The Chinese government has made the electrification of the automobile a priority. It has launched several important programs as part of its development strategy, which includes a focus on the development of electric vehicles through public transit, the development of pure electric vehicles with a special emphasis on compact vehicles, and continued progress in electrification and energy-efficient internal combustion engines. The government’s goal is to have from 500,000 to 1 million electric vehicles on China’s roads by 2015.

The China “Three Verticals and Three Horizontals” strategy refers to the focus on the three vehicle platforms of hybrid power, pure electric vehicles and fuel cell vehicles along with the three common building blocks of motors, controls and battery technologies. The “1,000 New-

### 目标

汽车行业正积极通过电气化减少对石油的依赖，电气化—未来驱动力论坛旨在对电气化领域的各项努力与成效进行评估。来自政府、企业以及学术团体的专家们共同探讨了如何共同行动，推动更环保的汽车技术的稳步发展。

### 背景

全球城市交通正面临着诸多挑战，如交通拥堵、对交通基础设施更高的需求、日益增长的空气和噪音污染、相关监管措施以及能源需求上升等问题。车辆电气化的相关技术正力求解决这些系列问题。

包括中国在内的各国政府机构与全球的汽车制造商已经在电气化方面取得了重大进展，但仍面临一系列挑战。

### 中国政府的支持

中国政府已将汽车电气化作为一项战略重点，并在国家发展规划中推出多项重要计划，包括通过公共交通拉动电动汽车发展、开发纯电动车尤其是小型车、继续推动电气化和节能内燃机发展等计划。中国的目标是到2015年中国电动汽车保有量达到50万至100万辆。

中国政府确定了“三纵三横”的研发布局，即以混合动力汽车、纯电动汽车和燃料电池汽车为“三纵”，以电机、电控和电池为“三横”。中国四个国家部委共同启动了“十城千辆”（十城千辆节能与新能源汽车示范推广应用工程）计划，并已列入国家“十二五”规划。

Energy Vehicles in 10 Cities” program is being jointly promoted by four government ministries and commissions. It is part of China’s 12th Five-Year Plan, which is being finalized.

The State Grid has already signed agreements with many governments above the prefecture city level to construct electric vehicle charging facilities. By the end of 2010, the government hopes to have 75 charging stations and 6,000 charging poles in 27 cities. It aims to have about 10,000 charging stations by 2016.

The Chinese government is also promoting battery development, investing more than RMB 6 billion. Both the energy density and power density of batteries developed in China are increasing, bringing costs down. China also has a natural resource advantage in critical materials for motors.

Hydrogen also shows promise as a solution in China. A survey of Shanghai’s hydrogen resources found that if all byproduct hydrogen was used for fuel cell vehicles, it could support about 400,000 vehicles. And at a price of about RMB 35 per kilo and 1.1 kilos of hydrogen able to drive a vehicle for 100 kilometers, it would be cheaper than gasoline as a fuel.

More than 200 vehicles, including the fuel cell Chevrolet Equinox from GM, are taking part in the government-supported fuel cell vehicle demonstration program at World Expo 2010 Shanghai. An ecological construction plan has been created for Shanghai’s Chongming Island. Post-Expo 2010, it will serve as a test bed for new business models and a new automobile culture in China.

## GM’s Contributions

GM has become a leader among global automakers in adopting an advanced propulsion technology strategy that includes a commitment to both energy efficiency and energy diversity. Its goal is to ultimately reduce tailpipe emissions to zero and displace petroleum.

GM is preparing to roll out the Chevrolet Volt electric vehicle with extended range capability later this year in the U.S. and in the second half of next year in China. The Volt is a “customer’s car” because it does not ask the user to make any compromises, while it addresses the broader issues of energy independence and the environment.

A major achievement of the Volt is its advanced lithium-ion battery. With a cell level energy density that is close to 200 watt hours per kilogram and power density in excess of 3,000 watts per kilogram, lithium-ion offers a substantial advantage over lead-acid and nickel metal hydride. In addition, lithium-ion has experienced a cost reduction of 14-15 times since its commercial introduction in 1991; the cost can be expected to continue dropping. And with lithium-ion, the chemistry and cell size can be optimized for a given application without sacrificing economies of scale.

The Volt’s battery design represents a substantial reduction in size and weight compared to the lead-acid battery technology that was

中国国家电网已经和多个地市级以上政府签署了建设电动车充电设施的协议。中国政府计划到2010年末在27个城市建立75个充电站和6,000个充电桩。其目标是到2016年建设1万个充电站。

中国政府还将投入60亿元人民币大力促进电池研发。近期在中国研发的电池的能量密度和功率密度都不断上升，成本也随之降低。同时，中国在电机的关键材料稀土矿产方面也具有无可比拟的资源优势。

中国氢燃料的发展前景也十分广阔。对氢气资源的统计显示，上海地区的工业副产氢气可以支持40万辆燃料电池汽车。这种氢气的价格约为每公斤35元人民币，1.1公斤氢气可供汽车行驶100公里，其价格比汽油更加便宜。

在2010年上海世博会上，参与由中国政府支持的燃料电池电动车示范项目的车型超过200款，其中包括通用汽车的雪佛兰Equinox燃料电池车。中国政府已经为上海崇明岛制定了生态建设规划。2010年上海世博会后，生态崇明岛将成为中国新型商业模式和新型用车文化的试验基地。

## 通用汽车的贡献

通用汽车在先进驱动技术方面是全球领先的汽车制造商，并致力于节能增效和能源多样化。其最终目标是达到零尾气排放，并取代石油燃料。

通用汽车计划于今年年底在美国推出雪佛兰Volt增程型电动车，该车将于明年下半年在中国上市。Volt电动车在解决对能源的依赖和保护环境等问题的同时，无须车主在任何方面做出妥协，是一部真正适合消费者的车型。

Volt电动车的一个重大成就在于其先进的锂离子电池系统。锂离子电池能量密度接近200瓦小时/千克，功率密度超过3000瓦/千克，与铅酸蓄电池和镍氢电池相比具有明显的优势。此外，锂离子电池自1991年上市以来，其成本已经下降了14至15倍，而且有望继续降低。锂离子电池的化学特征和电池大小可以根据特定的应用进行优化调整而无需牺牲规模效益。

Volt电动车的电池与通用汽车EV-1电动车使用的铅酸电池相比，其体积和重量都有明显的降低。Volt电动车的T-Pack电池组是首个为大规模量产车设计的液体冷却式电池组。该电池组将化学和电池管理系统优化结合，在整个汽车使用周期内提供稳定可靠的动力。

used in GM’s EV-1. The Volt battery’s T-Pack is the first liquid-cooled pack designed for a mass-produced vehicle. The chemistry and battery management system have been optimized in tandem to provide smooth and consistent power flow over the life of the vehicle.

There are huge known reserves of lithium – enough for an estimated 32 billion vehicles. As a result, a raw material shortage will not become an issue over the short and medium term.

GM plans to establish battery electric vehicle demo fleets in multiple regions of the world and in different vehicle segments later this year. GM’s aim is to obtain real-world data on battery electric vehicle acceptance, market needs, driving patterns and charging behavior.

## Ongoing Challenges for Vehicle Electrification

**Charging.** One of the critical challenges that must be resolved is the problem resulting from potentially large numbers of electric vehicles being charged on the power grid at the same time. If all existing automobiles in China were replaced by electric vehicles, the country would need to double its installed gross electrical generation capacity. However, maximizing the smart grid during peak and valley hours should remedy this issue.

**Cost and Convenience.** About 70 percent of the cost of a lithium-ion battery is in the cell bundle, and more than half of the cost of a cell bundle is for the raw materials. Any cost reduction effort therefore should focus on reducing the cost of cells. One way to get the cost down is through volume-driven cost reductions, which can be expected assuming that by 2020 one in five new production vehicles is electrified to some extent.

One way to bring down the cost of the battery and improve convenience for consumers is through alternative business models such as battery leasing or swapping. At the end of an electric vehicle’s life, its battery will still have a lot of value, enabling it to be reused for other applications such as stationary power. That will help lower the cost of electric vehicles significantly without requiring any changes to the battery or vehicle. Such alternative business models would also help eliminate warranty anxiety among electric vehicle purchasers.

**Commonality.** To ensure the ready acceptance of electric vehicles, common standards for batteries and charging facilities are required. It’s hard for an electric power company to deal with this issue if different automakers have different specifications. Common standards would also make it easier to carry out battery swapping. However, if automakers wish to pursue personalization, it could be very hard to achieve standardization – even with the involvement of government institutions and other stakeholders.

**Cooperation.** Making electric vehicles more than niche products will require a comprehensive, reliable infrastructure. The creation of such an infrastructure will require cooperation. Cooperation will also contribute to the development of global standards for electric vehicle technology as well as the formulation of unified global guidelines and regulations.

目前，已探明的锂储量非常丰富——预计足够供320亿辆电动车使用。因此，中短期内不存在原材料缺乏的问题。

通用汽车计划于今年年底在全球多个地区为各款车型进行纯电动车测试，希望获得全球用户对纯电动车的接受度、市场需求、驾驶模式和充电方式的实际应用数据。

## 车辆电气化面临的挑战

**充电。**因大量电动车同时充电带来的问题是必须解决的一项重大挑战。如果将中国现有的汽车全部替换为电动车，国家需要将其现有电力总装机容量翻番。但是，如果我们可以充分利用智能电网，避开用户高峰时段，在用电低谷时段充电，这个问题是可以得到解决的，并且可能提高电力系统的利用效率。

**成本与便利性。**锂离子电池大约70%的成本来自于电池组，而电池组超过一半的成本来自于原材料。因此降低电池原材料成本是降低电池成本的关键，方式之一是大批量生产，预计2020年生产的汽车中约有五分之一为电动车。

降低电池成本、提高便利性的另一个方式是转换商业模式，如电池租赁或交换，以及电池的梯次利用，即电动车车辆使用周期结束后，其电池仍然具有很大价值，可以用于固定型发电系统等其它用途。这将在无需对电池或汽车进行任何改动的情况下，大大降低电动车的成本。新商业模式还有助于消除电动车消费者对于质保的担忧。

**通用性。**为确保消费者接受电动车，需要对电池和充电设施制定通用标准。电力公司很难处理汽车厂商各不相同的产品规格。通用的标准也会让电池的交换更加便利。但是，如果汽车厂商有意追求独特化，即便有了政府部门与其它利益相关方的参与，也很难达成这一目标。

**合作。**要使电动汽车为大众消费者普遍接受需要广泛、可靠的基础设施。建设这些基础设施需要多方合作。合作还有利于制定电动汽车技术的全球标准及全球统一的准则和规定。

## Speaker Highlights

### Karl Stracke

Vice President, GM Global Vehicle Engineering

- GM's advanced propulsion technology strategy involves commitment to both energy efficiency and energy diversity; the ultimate goals are to reduce tailpipe emissions to zero and displace petroleum.
- Cost, lifecycle, safety, reliability and environmental impact of batteries are challenges along the road to electrification.
- Volt offers a “no compromise solution.” It will be affordable, independent, capable of being your primary vehicle, safe and fun to drive.
- GM will intensify the research and testing of advanced propulsion systems in China through the China Science Lab and GM China Advanced Technical Center.
- GM plans to establish battery electric vehicle demo fleets in multiple regions in different vehicle segments later this year to provide real-world data on customer acceptance, market needs, driving patterns and charging behavior.
- We need very strong partnerships to enable the electrification of the motor vehicle and the support of key stakeholders working aggressively together to provide infrastructure, guidelines and regulations.

### Prabhakar Patil

CEO, Compact Power, Inc.

- Volt's battery design is the key, representing a substantial reduction in size and weight compared to lead acid battery technology used in the EV-1.
- Volt's T-Pack is the first liquid-cooled pack designed for a mass-produced vehicle. The chemistry and battery management system are optimized together to provide smooth and consistent power flow over the life of the vehicle.
- Lithium-ion is poised to dominate; it has undergone a 14-15 times cost reduction since its commercial introduction in 1991 and will continue to improve.
- As 70 percent of the cost structure of a lithium-ion battery pack is in the cell bundle, this is where any cost reduction effort has to be focused. About half the cost of the battery pack is the raw materials that go into making the cell. That cost can be reduced through volume-driven cost reduction in materials.
- Battery leasing/swapping shows possibility. If an independent entity owned the battery and leased it to the customer it could recapture the battery and redeploy it for other applications, saving the customer money and eliminating warranty anxiety.

## 嘉宾观点精粹

### 卡尔·斯塔克

通用汽车车辆工程全球副总裁

- 通用汽车的先进驱动技术战略致力于节能增效和能源多样化，其最终目标是达到零尾气排放，并取代石油燃料。
- 电气化面临的挑战包括电池的成本、寿命、安全性、可靠性和其对环境的影响。
- Volt电动车提供“毫不妥协的解决方案”。该车具有消费者可接受的价格、不受行驶里程限制、安全可靠、具有驾驶乐趣，可以作为首选出行用车。
- 通用汽车将通过通用汽车中国科学研究院和通用汽车中国前瞻技术研究中心加强对先进驱动系统的研究和试验。
- 通用汽车计划于今年年底在全球多个地区为各款车型进行纯电动车测试，以获得全球用户对纯电动车的接受度、市场需求、驾驶模式和充电方式的实际运用数据。
- 我们要加强合作以推动电气化发展，需要重要的利益相关方在基础设施建设、标准和法规制定等方面提供大力支持。

### 普拉哈卡·帕提尔

Compact Power, Inc. 首席执行官

- Volt电动车的电池设计是关键，与通用汽车EV-1电动车所采用的铅酸蓄电池相比，其体积和重量都有明显的降低。
- Volt电动车的T-Pack电池组是首个为大规模量产车设计的液体冷却式电池组。该电池组将化学和电池管理系统优化结合，在整个汽车使用周期内提供稳定可靠的动力。
- 锂离子必将占领市场主导地位，自1991年上市以来，锂离子电池的成本已经下降了14至15倍，而且有望继续降低。
- 锂离子电池组70%的成本来自于电池组，降低电池组成本是降低锂离子电池组成本的关键。电池组大约一半的成本来自于制造电池的原材料。通过大批量生产，可以有效降低电池组成本。电池租赁/交换商业模式具有可行性。如果一个独立机构拥有电池并将其出租给消费者，它能够回收电池并用于其它用途，从而节省消费者支出并消除其质保担忧。

## Yu Zhuoping

Director, Tongji University Automotive Institute

- “Three Verticals and Three Horizontals” is focused on hybrid power, pure electric vehicles and fuel cell vehicles and three common building blocks of motors, controls and battery technologies.
- “1,000 New-Energy Vehicles in 10 Cities” is key target for China’s 12th Five-Year Plan. The goal is to have from 500,000 to 1 million electric vehicles on China’s streets.
- Three-step development strategy is proposed in the 12th Five-Year Plan for the development of electric vehicles: development of EVs through public transit; focus on PEVs, particularly compact vehicles; and more progress in electrification and energy-efficient internal combustion engines.
- New business models have to be devised for the development of electric vehicles. If a transfer payment method can be devised for a new business model in which the price of a vehicle is exclusive of the battery price, the vehicle will be even cheaper than today’s gasoline vehicles.
- An ecological construction plan has been devised for Shanghai’s Chongming Island to test new business models and a new automobile culture.

## Lai Xiaokang

Director, Institute of Superconductivity, China Electric Power Research Institute

- From 2009-2010, China plans to construct 75 charging stations and 6,000 charging poles in 27 cities. By 2016, there will probably be 10,000 charging stations.
- The State Grid has signed agreements with many governments above the prefecture city level and will construct electric vehicle-related charging facilities.
- If all of China’s existing automobiles were replaced by electric vehicles, China would need to double its installed gross generation capacity.
- Electric vehicles can store energy and will bring about benefits to the power grid, including the improvement of power supply quality.
- The most urgent and challenging problem in infrastructure construction for electric vehicles is the electrical transformer district, or the service radius of an electrical transformer. This problem can be resolved with smart grid technology.

## 余卓平

同济大学汽车学院院长

- “三纵三横”的研发布局以混合动力汽车、纯电动汽车和燃料电池汽车为“三纵”，以电机、电池和电控为“三横”。
- “十城千辆”（十城千辆节能与新能源汽车示范推广应用工程）计划是国家“十二五”规划的重要目标。目标是中国的电动汽车保有量达到50万至100万辆。
- “十二五”规划中提到电动汽车发展的三步发展战略，包括：通过公共交通来拉动电动汽车的发展；开发纯电动汽车，特别是小型电动车；电动化与节能型内燃机的齐头并进。
- 电动汽车的发展一定要考虑新的商业模式。如果新的商业模式中采用转移支付模式，将电动汽车的价格与电池的价格分开，那么电动汽车将会比现在的传统汽车更加便宜。
- 上海的崇明岛已经制定了生态建设规划，将成为中国新型商业模式和新型用车文化的试验基地。

## 来小康

中国电力科学研究院超导电力研究所所长

- 2009到2010年，国家电网覆盖区域内的27个城市将建设75个充电站，6000多个充电桩。到2016年将建成1万个左右的充电站。
- 国家电网已经和很多地市级以上政府签署了建设电动车充电设施的协议。
- 如果将中国现有的汽车全部替换为电动车并为这些车辆同时充电，则国家需要将现有的电力总装机容量翻番。
- 电动汽车具有储能作用，它将为电网带来一些益处，比如供电质量的改善。
- 目前在基础设施方面面临的最迫切问题是电动汽车对台区，也就是配电变压器服务半径较小。该挑战可通过智能电网技术来解决。