Cleantech matters: moment of truth for transportation electrification
Co-host:

Bloomberg
NEW ENERGY FINANCE

Global strategic supporting organization:

THE °CLIMATE GROUP

China strategic supporting organization:

US strategic supporting organization:

Electrification Coalition

Cleantech matters — moment of truth for transportation electrification
Every year for the past six years, Ernst & Young has hosted a series of Ignition Sessions to spark debate among a diverse group of stakeholders on opportunities and challenges facing one aspect of the cleantech industry. In 2011, we focused on the burgeoning electric vehicle (EV) industry for the second year in a row because synchronized and sustained investment, involvement and execution are imperative as EVs* shift from concept to product in this moment of truth for the industry.

Ernst & Young’s Global Cleantech, Power & Utility and Automotive Centers hosted the 2011 sessions in Bonn, Detroit and Beijing. The three sessions brought together entrepreneurs and thought leaders from government, non-profits, banks, venture capital firms and think tanks, as well as the automotive, technology, logistics and utility industries, to strategize and mobilize toward an EV future.

The conversation centered on real-world issues facing the fleet, consumer and infrastructure segments for actionable ideas on how to build a sustainable EV ecosystem and market. Participants discussed the burning issues related to business models, technologies, government involvement, incentive schemes, systems integration and storage – and how all the pieces can be integrated to spur faster adoption. Although there were welcome differences of opinion on the pace, problems and opportunities of EV deployment, a collaborative and creative mood permeated the meetings.

The Chatham House Rule applied to discussions. While insights arising from exchanges are crystallized in this follow-up report, nothing has been attributed to a specific person or organization, except by special permission. To offer takeaways from these meetings to the larger cleantech community and to foster the development of the EV industry, this report provides:

- A summary of key insights from discussions in Bonn, Detroit and Beijing
- Detailed summaries synthesizing the high notes, shared findings and varied perspectives around the sessions’ major themes of fleet, consumers and infrastructure
- Conclusions and suggestions for speeding up EV deployment

Supplemental sidebars, interviews and graphics illustrate the complex and multidimensional aspects of establishing the infrastructure, business models and customer experience necessary to realize the market potential of EVs.

We are once again grateful for the many contributions made by our co-host, Bloomberg New Energy Finance; by the Climate Group, our global strategic supporter; and by the China Business Update, our China supporter, and the Electrification Coalition, our US supporter.

Electric cars are rolling off production lines and onto our highways, with global hybrid, plug-in and battery-electric vehicle production set to grow significantly over the next several years. Companies across the spectrum are working overtime and partnering to embrace the EV opportunity and overcome deployment challenges. But the dress rehearsal is over. Hard work and cross-sectoral cooperation are required to build an enduring EV industry. We hope our findings will help spark ideas and action. Ernst & Young will continue to guide the conversation, share insights and foster partnerships in this disruptive, transformative era.

*For the purposes of this report, EVs include plug-in hybrids, battery electric vehicles and range-extended electric vehicles.
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Welcome and opening remarks

- What have been your biggest surprises during the year?
- What has changed in the last 12 months?

I. Corporate fleets

- What is the state of deployment in your geography? What are the lessons learned from early deployment? What can be learned from deployment in other geographies, including approaches to ownership vs. leasing, business models, corporate customer experience and education, and implementation?
- What has been the corporate experience? What are the drivers for continuing deployment within corporate fleets?
- What has not worked well? What are the key adoption drivers/barriers for corporate delivery fleets or corporate-owned passenger fleets?
- What is missing? Where do we need to see investments?
- What has been the compelling value proposition that will change corporate fleets’ purchasing behavior?
- What is required from a policy perspective?

II. Consumers

- What did the industry get right and what did it get wrong? What is the customer experience in your geography? Is there a robust and competitive ecosystem that provides appropriate choice and supply to support customer satisfaction?
- How are consumers reacting to vehicles? When and how are they really charging their vehicles? What do we know now about customer behavior across multiple EV models?
- Where do we need to see further investments?
- What is the role of big box retailers and distributors?

- Are current policies sufficient to offer incentives to the market, or do additional government policies need to be enacted?
- Is there a need yet for public infrastructure?
- Are there bottlenecks for implementation that technology can solve? Is there any anticipation of technology breakthroughs in the near future?
- What are some new technology innovations or business models that can change the paradigm?

III. Infrastructure

- What is missing in the “total experience offering” that could be solved through innovative partnerships?
- What are the emerging and feasible infrastructure business models? What can we learn from other markets?
- How will EVs be a platform for customer relationships beyond charging?
- Where are partnerships happening or needed to advance infrastructure development?
- How will emerging-market applications and business models impact developed markets?
- What has changed in the utilities’ involvement in the last 12 months?
- What is the role of each of the players in the infrastructure landscape?
- What is the way to move ahead?

IV. Conclusion — the moment of truth

- As an emerging industry, is it ready to deliver a complete consumer experience today?
- How does the industry ensure a sustainable ecosystem that will also deliver on market growth?
- What has the industry learned about how to develop a sustainable market? Is it sustainable yet? If not, why, and how can the gaps be bridged?
Graphic recording of Ignition Session discussion on “The electrification of transportation in China,” drawn by Oliver Prothero of the Ludic Group
Summary of key insights

Graphic recording of Ignition Session discussion on “Surprises in transportation electrification in China,” drawn by Oliver Prothero of the Ludic Group
EVs are moving into the fast lane. In 12 short months, they’ve gone from lofty aspirations to wheels on the street, with new models enthusiastically received by early-adopting consumers. Seeing the opportunity, manufacturers, utilities and service providers are forming unconventional alliances. They’re creating new business models to supply complementary services. In tandem, new entrants ranging from big box retailers to software makers to real estate companies and shopping centers are stepping in. The EV business is no longer theoretical. Major industry milestones since mid-2010 include:

- The celebrated launches of the Nissan Leaf and Chevy Volt and a growing pipeline of nearly 30 announced EV models to come by 2016. These include the Audi e-tron, BMW Megacity vehicle, Fiat 500, Honda Fit, Mitsubishi iMiEV, Tesla Model S and Volkswagen E-Up
- GE’s announcing plans to acquire 25,000 EVs for its corporate fleet
- The UK’s launching the world’s first nationwide roadside charging network
- Better Place’s opening Europe’s first battery-swapping station
- Germany’s setting a goal of 1 million electric vehicles on the road by 2020, supported by substantial additional research funding
- Accelerating deployment of 14,000 public EV chargers by the EV Project in the US

This fast pace will pick up. Examples of imminent accelerating events include the publication of China’s long-term EV development plan, the approval of three EV charging standards by Korea’s Agency for Technology and Standards, and the launch of Paris’ AutoLib 4,000 EV car-sharing program.

But many uncertainties and risks remain for the smooth, seamless delivery and operation of reasonably priced EVs and charging infrastructure needed to ensure continuing market growth. Chief among these are product scarcity, high EV prices, complex subsidy and permitting processes, infrastructure gaps, insufficient coordination between original equipment manufacturers (OEMs) and power providers, and still-high battery prices relative to performance.

Other challenges include conflicting charger standards that keep prices high and scale down, and a public whose perceptions lag the reality of electric vehicle technology and driving experience. In a world with high fuel prices and ongoing recession in the developed markets, this is a missed opportunity.

Session participants shared their insights and ideas for accelerating adoption and leveraging emerging areas of opportunity. While debate often sparks more questions than answers – and this year’s Ignition Sessions were no exception – a number of key observations emerged from the global discussions:

- **Dress rehearsal is over.** The defining moment for the industry has arrived as growing numbers of consumers become EV drivers. To provide the value, utility and customer experience necessary to make EVs broadly attractive alternatives to internal combustion engine vehicles (ICEs), all ecosystem players – OEMs, battery makers, utilities, integrators, charging providers, governments – must execute in concert and without serious missteps to ensure that this EV industry endures.

- **Public perception lags EV reality.** Despite much positive press about EV developments in recent years, public perception of the current capabilities of EV infrastructure and technology, for both passenger and commercial vehicles, has not caught up with the advances in the industry. A major challenge to EV adoption is simply convincing consumers that EVs are “real” cars that can meet their needs – today.
• The industry needs an “easy button.” Business model innovation is now at least as important as technology. Important EV technology improvements are still needed, but all the technology needed for a viable EV ecosystem exists today. What the industry badly needs is an “easy button” that puts all the pieces together for individual consumers and corporate fleet managers alike — education, incentives, financing, vehicle options, charging access and installed power supply. Residential and commercial solar installations accelerated when companies introduced innovative business models that eased and reduced the risk for the end user by packaging equipment leasing, power-purchase agreements and energy cost savings. EVs could take off too with the same kind of business model enablers. Creating the easy button will not be easy — it will require innovative partnering, business models and financing.

• The market needs more EVs. The lack of EVs in terms of quantity and model diversity is a major barrier to EV adoption. First, demand for EVs outstrips supply, and EVs are generally scarce. For consumers, this makes just getting behind the wheel of an EV a challenge, let alone purchasing one. This critical gap must be overcome because driving an EV generally wins over drivers and diminishes the concern that the vehicle’s battery range is insufficient to take them to their destinations (range anxiety). Consumers also want EVs in the market niche of their current vehicles — such as pickups, luxury sedans and sport utility vehicles — not just compacts and sports cars. For corporate and government fleet managers, supply constraints make it hard to purchase EVs in desired, customary volumes.

• Total up-front costs are still too high. And the total cost of ownership benefits has not been well-articulated. Whether for consumers or fleet managers, the initial cost of EVs compared to that of ICE alternatives is a high hurdle. While the price differential will diminish with large-scale EV production, the incentives designed to facilitate mass adoption are often insufficient or geared to impact corporate taxes rather than be felt at the point of purchase. At the
same time, the lifetime cost benefits of EVs — fuel at a fraction of the cost of petroleum, significantly less maintenance — have not been well-defined or well-communicated to the potential consumer base.

- **The question of residual battery values is not a barrier.** The potential for a secondary market for used EV battery packs remains unclear, and one may not emerge for years, if at all, yet financing solutions dependent on future battery values are needed today. Some have already begun to shape up. New leasing mechanisms are being designed to support EV financing while protecting end users from strong depreciation.

- **A mobility concept is gaining momentum.** The global conversation is evolving from “just individual EV ownership” to a mobility solution concept, where all transit choices are linked to provide many options to get from point A to point B — one in which the EV is just one piece of a larger transportation puzzle. This approach is most advanced in Europe but is also gaining traction in China, particularly in the country’s megacities, where individual vehicle ownership comes with many drawbacks. Even in Japan and the US, business models have emerged that don’t depend on individual car ownership. Examples include: car2go (Daimler), flikster (German Rail), Peugeot mu, or new entrants such as DriveNow (BMW) or Quicar (VW). However, currently, all are using ICE fleets. Overall, the EV industry stands to gain from the trend as potential car buyers have the opportunity to test the technology, and new markets are created to serve consumers who would not normally have access to an individual passenger vehicle. Further, some OEMs and vehicle-sharing businesses see the mobility concept as part of their overall EV offering — allowing customers to alternate their vehicle platform to match their usage — and helping to avoid the range anxiety issue.

- **More cross-sectoral collaboration is needed.** This is so particularly between OEMs and power providers, to enable synchronized, efficient and effective EV rollouts. Utilities need to be given proper incentives to make the appropriate investment in EV enablement, while their regulators must allow them to test demand and grid impact and gauge new business models in their communities.

**Key unanswered questions**

1. Will consumers pay for fast charging, given the necessary price premium?
2. Who will own, manage and control the various technologies in the EV ecosystem — the EV maker, the utility, the charging-station operator or the infrastructure builder?
3. What realistic improvements can we expect in battery life and miles per charge?
4. What should the role of government be in promoting EV development and adoption?
5. How should the industry in China tackle the consumer market?
6. The Chinese Government is expected to spur development of the local EV market over the next three to five years. What is the role of the multinational in China in this environment?
7. How can infrastructure investments be scaled to match the pace of EV adoption?
Vehicle fleets at large logistics companies, government agencies and corporations are ideal early-adopter customers for EV makers because they are volume buyers who are highly visible and boast an ideal daytime driving and overnight charging schedule. Their total cost of ownership (TCO) equation should thus be clearer than that for consumers because vehicle use and servicing are predictable and follow a clear depreciation path, as participants largely agreed in last year’s session. But this year, many in Bonn, Detroit and Beijing said justifying an uncertain (and potentially higher) TCO for commercial EVs was actually difficult. This shift in sentiment reflects how the discussion is moving from the theoretical to the practical as those deploying fleets bump up against real-world barriers.

Opinions on the viability of a secondary market for spent batteries varied widely, and it remains an open question. This is a key issue for fleet buyers because the future value of used batteries, for now, helps determine a vehicle’s current worth, along with the options and amounts required for lease financing. But many in Bonn believed that this was less of a concern because today’s EVs boast better battery performance and lower maintenance costs for a longer-lasting battery and vehicle than their ICE predecessors. “It’s certainly not an obstacle,” one European participant said.

In Detroit, by contrast, attendees generally believed that the battery’s afterlife value did matter. But there is still no consensus on the value of, applications for, and the size of the market for battery reuse because the batteries are not yet “plug and play.” The compelling need for more uniform and attractive fleet EV incentives at the time of purchase, and an “easy button” – or an outsourced solution to manage time-consuming purchasing, financing, incentive, charge installation and rollout tasks – were also much discussed in Detroit.

The Chinese fleet discussion focused less on the TCO and battery questions and more on government-backed buses and cabs, because the government drives (and approves) EV purchases and often influences prices and policy. To speed fleet adoption, participants proposed more buses for export, broader government purchases, lower-priced batteries and more publicity for showcase projects.

Bonn

“How can we create a business case for all stakeholders in the value chain? From the energy supplier, to the infrastructure builder, to the car manufacturer, to the customer? Nobody has a solution for this problem.”

Challenges include shortages, little government support

The Bonn session on fleets began with a frank assessment of the financial and operational challenges. Topics addressed included EV truck shortages, difficulties with the TCO equation, a lack of government support for commercial vehicles, uncertainty around a secondary battery market, and the importance of securing management buy-in for rollouts at all levels.

On the subject of TCO, participants largely agreed that different business models and EVs for fleets could help solve the range anxiety-cost trade-off, depending on a company’s needs and the local climate. The solution, said a participant from a delivery company struggling with an expected EV range nearing its own daily mileage requirements, may lie with lighter and lower-cost range-extending vehicles that perform well in cold weather.

Mid-management commitment key

Several attendees also asserted that securing mid-level management commitment among fleet customers was essential for smooth and efficient EV deployment. Doing so would ensure that EVs are driven rather than being used as a cosmetic and costly public relations exercise, they said. Proposing and jointly implementing a total mobility
solution as part of a transit ecosystem involving many transport modes and vehicle types were other recommendations. In China, for example, a low-priced car with a 12km range works well and costs 30% less than those with longer ranges, one participant noted.

“There’s a chasm between the CEO chasing green credentials and the fleet manager managing that on the ground. It’s a slow process. We need to work with them to make sure their vehicles do what they need to do,” one attendee said. “That solution may involve a bike, car or van, depending on whether heavy bulky packages are involved, or services. Most don’t consider that model. It’s a whole different view of what is needed. It’s that education, letting them know what’s on offer. Most don’t know. We have to do that with them and even if we don’t have the time, the benefit’s huge. But it’s quite an exercise.”

And, on the public sector front, buy-in also depends on education and hand-holding, even if no money is involved, a participant added. In Manchester, England, for example, which committed to replacing 5% of its fleet annually with EVs, officials were enthusiastic because the integrator was constantly available to answer queries and fix problems, he said. “We had to incentivize them to take part, give them the infrastructure, advise them on where to put it, and explain the business case, including tax benefits and maintenance. We do their no-brainer exercise.”

Covering the gap between what would be paid for a conventional vehicle and for EVs, due to high infrastructure costs (up to €30,000 per station), was also a challenge, one participant noted. But EV leasing isn’t the answer, he said, because high usage rates make resale difficult. Finally, fleet production needs to rev up to meet demand, participants said. “One fleet manager buys 6,000 vehicles every two years,” a Bonn attendee said. “But no OEM is prepared to sell him EVs, not even 2,000 vehicles. The market’s not ready.”

Detroit

“A lot of these fleets are extraordinarily understaffed. It’s just daunting. Many are sitting on vehicle fleets of between 10,000 and 20,000 vehicles with one person running the fleet. So if we as an industry don’t give them an ‘easy button,’ it’s going to be tough. Even if the financial metrics make sense and they believe that it’s the right thing to do, they just don’t have time to figure out how to do building permits and pick charger suppliers, and survey drivers, and pick locations, and deal with incentive reimbursement plans and all the stuff that goes into buying another 100 vehicles. We need to take some ownership and figure out, as an industry, how to solve this for them.”

Issues around TCO, rollout complications and a secondary battery market dominated the Detroit discussion on fleets, as participants wrestled with how to make a sound EV buying business case to in-house managers. The EV value proposition hinges on the acquisition cost, the fuel price trade-off, the set-up work entailed and residual battery value, one participant asserted. A novel approach to the economics is urgently needed. “We’ve got to crack the total cost of ownership code. The batteries are too expensive, the truck’s got to work. There can’t be a compromise,” he said.

Incentive shortcomings, insufficient product availability, among challenges

Other challenges cited included an overly complex incentive process and insufficient product availability. Repeatedly, big EV makers and fleet buyers complained of time-consuming and unwieldy government incentive schemes and permitting processes. Because tax credit benefits arrive later and are absorbed by the overall company, they don’t move the needle at a corporate level, several said.
Recommendations included immediate EV purchase-price rebates, which would boost the business case for those in the tax, finance or procurement departments that approve volume EV purchases, because lower expenses impact the bottom line. Participants thus called on national and state governments to replace existing complex back-ended incentive programs with rebates at purchase — something that the federal government has proposed for consumer EVs.

“We need to ask Washington for effective business incentives. Tax credits are unattractive because they’re hard to monetize at the operating level. They’re wrapped up in corporate taxes. Breaking out a couple hundred thousand dollars to reapply to project economics is very uninteresting at the corporate tax level,” a Detroit attendee said. “Invoice-based deductions at the OEM level are easier because they are cash flow-positive. Getting out in front, increasing the number of units we can buy up-front versus playing a cash flow game downstream is a much greater good. So we’ve been creative in our total capex request approach.”

The easy button

Animated discussion followed about the need for an easy button, similar to the suite of services available for today’s conventional vehicles. This would ease the EV transition for understaffed fleet managers who now must spearhead the practical implementation issues. The fleet manager often lacks the bandwidth and resources to finance and roll out EVs nationwide. Such complex, time-consuming work is pushing many to ask if EV benefits outweigh the effort. One major corporation, for example, provides a turnkey solution spanning the planning, design, implementation, deployment and operational phases. It manufactures chargers, handles requests for proposals, takes care of tax credits, provides home installers and orders EVs on an outsourced basis.

The secondary battery market topic also triggered many comments, with opinions mixed about a true market for spent batteries. Naysayers pointed to much uncertainty about actual values based on scant data for a market a decade away, and the lack of a “one-size-fits-all” approach, because battery chemistries are highly complex and variable.

“Too much data is likely. Today’s batteries have twice as many microcontrollers than those in the original internal combustion unit. But they all have slightly different mechanical and electrical configurations. So repurposing batteries is much more complex than we actually might think,” one participant cautioned.

By contrast, the optimists insisted on a near-certain end market. They singled out neighborhood-scale backup from localized brownouts as possible end markets. Connecting these heterogeneous, purpose-built batteries at an industrial scale, however, concerned some.

Other incentives

To shore up the TCO argument, participants pointed to “time is money” incentives that might boost productivity or sales, such as dedicated lane access, preferential docking treatment, incremental shelf space or promotional displays at an important buyer. “These are not intangible things, but create value,” one participant said. Other non-financial incentives might lure in fleet buyers, including playing a positive role in energy security and stewardship and reducing pollution. These metrics, including green PR and a bigger sustainability vision, matter to management, a participant said.

“We wanted to make a statement around an increasingly public sustainability strategy that ties our movement into health and wellness. To customers, energy-efficient solutions in manufacturing
don’t translate as well as seeing an electric vehicle on the road. Sustainability will become a more important currency of exchange among corporations and their customers,” said a major corporate fleet buyer.

**Beijing: e-buses and taxis pave the way**

Based on their widespread domestic use, and for the export market, Beijing participants were generally upbeat about e-buses and e-taxis. China should also chase the foreign EV fleet export opportunity due to pent-up demand, a participant advised. An e-truck’s range can be tailored so the TCO proposition is clearer.

With about 10,000 e-buses across many of China’s 25 model cities and small to mid-sized cities (like Qingdao – backed by State Grid – and Linyi in Shandong), China boasts the world’s largest fleet of electric buses. E-buses and e-taxis also traverse Guangzhou, Shenzhen, Zhongshan and Zhangjiagang, attendees added. With roughly 400,000 conventional buses on the road today, rising to 600,000 by 2015, great opportunity abounds, particularly if China maintains a good safety record and takes the lead in large battery development and applications, participants said.

Battery makers are indeed focusing on more lucrative and nearer-term public transportation fleet market opportunities because the consumer market is elusive. Despite its fragmented nature (about 50 bus makers, for example), the fleet market’s shorter sales cycle should bring quicker revenue. By tapping into the early-adopter, big-volume fleet market, battery, and power train technology should also help scale production for and bring lower costs to other segments, attendees said. This focus could strongly impact vehicle emissions too, they added, because buses emit considerably more CO2 than passenger cars.

**Cost and capacity among challenges**

But several fleet issues persist. Practical challenges include cost, capacity and space, participants said; among business challenges are insufficient domestic investment and lack of a sustainable business model. Batteries in an e-bus with a claimed range of 500km per charge crowded out passengers, for example, so just 10 were on board, one participant recounted; the many batteries needed also made these buses costly, so they are probably mothballed. Moreover, battery charging requires land, even for battery switching (ostensibly an issue at the Beijing Olympics.) Finally, because subsidies, tax policies and environmental awareness drive sales today, some said, the market’s long-term economic viability is unclear.

**Showcasing model e-bus and taxi projects suggested**

To expand the fleet market, participants suggested showcasing model e-bus projects and sharing relevant demonstration data from selected cities. Many domestic EV bus buys come from China, they said, pointing to big e-bus projects in Beijing, Shanghai and Guangzhou, and China’s BYD selling K9 buses in Shenzhen and Changsha and exporting them to Singapore and Canada. Shenzhen’s Wuzhoulong, they added, is also making EV buses for export. Finally, many Chinese-made e-taxis are on city streets – about 50 BYD E6 taxis in Shenzhen since May of 2010 – and some are in Changsha too; roughly 50 Foton taxis in Beijing, along with e-trucks; and Zotye operates an e-taxi fleet in Hangzhou. BYD currently sells the X3DM, E6 and K9 e-bus models.

China’s central Government should also order more e-buses and trucks for waste collection, sanitation, transport and emergencies, attendees suggested. A state decree that all city fleets be electric – particularly in China’s 100 eco-cities – rather than drilling down to individual buyers – might more effectively boost consumer EV awareness and purchases, another participant noted. E-buses have big volumes; they are high-profile, and the e-bus purchase decision normally requires just one decision maker. Indeed, the state is encouraging mayors and officials in demonstration cities to buy EVs for business, delivery and public services. Finally, a participant called on the Government to exempt EVs from downtown driving restrictions in certain cities.

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**Beijing, a year later – surprises**

Mixed views persist about how much progress had been made in the EV industry, particularly on a state level. Some asserted that the Government’s EV commitment is deep and broad, evident in State Grid’s proactive involvement in the industry. They also pointed to the country’s 16-company consortium to address outstanding EV issues and dovetailing positive political, economic and technical forces.

But others said that six months on, subsidies and grant money have not arrived as quickly as expected, with little evidence of central government action. An enthusiasm gap also persists between private OEMs, state-owned companies and local governments for the development of and promotion of EV technology and applications, they said, which demonstrates the importance of local implementation.

The industry is ahead of public perception. Because the media often portrays EV rollouts as isolated incidents rather than a big, broad story, the public may believe that EV deployment is piecemeal or a lower priority, they said.
China: think differently

The Chinese session struck a sober tone, as participants wrestled with an ongoing chicken/egg dilemma: how to line up all the moving parts of a huge and complicated market in its infancy. The country’s very different structure and capacity create different product, business model and implementation challenges and solutions, they said, with the Government and state-owned utilities playing a powerful role as both catalyst and coordinator. Technical solutions will help, participants said, but appropriate business models and the base infrastructure are the foundation for a successful Chinese EV industry. When the cost, range and confidence code is cracked for lower-income, first-time buyers in one-car households, sales will take off more quickly, they said.

“This market is different. And it will not develop by itself. It needs to be pushed, operated, integrated, until the whole ecosystem works together.” — Beijing session participant

China’s role as both the world’s biggest EV supplier and as a market with very active government involvement has perhaps pushed these upstream supply issues more to the forefront than elsewhere. EVs are a national priority to help cut CO2 emissions and foreign oil dependence as the Government grapples with the soaring energy demand and pollution that has come with blistering economic growth. But China's car market is saturated, and China’s key buyers are slowing down as the global economy slows. Participants noted that of the 10,000 EVs sold in China in 2010, just 800 were passenger cars (most were state-backed buses and cabs, and small, low-speed, lead-acid battery-powered vehicles). Within these constraints, Chinese EV makers must work overtime to have 1 million EVs on the road by 2015, as envisioned in the 12th Five-Year Plan.

Mixed views on government, industry progress

Participants had mixed views about true government and industry progress. Some pointed to big policy moves, such as China’s National Development and Reform Commission regulating key components for new energy vehicles and foreign investing, the 50% limit on foreign ownership (foreign battery makers are thus cozying up to domestic ones to access the market); and first-tier OEMs like FAW, SAIC and Dongfeng investing in and working hard on EVs. But others suggested that action has lagged announcements.

Graphic recording of Ignition Session discussion on “Infrastructure and business model issues in transportation electrification in China,” drawn by Oliver Prothero of the Ludic Group
Cleantech matters — moment of truth for transportation electrification

“With a strong push from very powerful, very influential institutions and the right technology, the market will develop much more quickly than that of other countries. The world needs to be ready for this market.” — Beijing session participant

Burning issues

The burning issues, many agreed, include insufficient standardization; still-insufficient battery performance (batteries must charge in half the time, and go much further); scant collaboration between OEMs and utilities to build the required infrastructure (plus workable business models to make the whole ecosystem profitable); and no-to-slow EV consumer adoption because of the high cost and limited range for China’s many low-income, one-car families.

“When transformative technology arrives, the market will develop much more quickly than elsewhere. So the country can’t be ignored. China will be a leader for both R&D but also in business model development.” — Beijing session participant

Resolving these issues related to the move from experiment to execution could push the industry forward. Solutions, many said, lie with stronger government regulations, guidance, action and investment; transnational collaboration on R&D, business model development and implementation; and material battery and power train technology improvements to cut costs and build scale. Showcasing cities with successful fleet, consumer and infrastructure stories would also build confidence, support, sales and investment, others said, particularly if the state encourages EV use in public transit and its own fleet. The business model is slowly taking shape, but cross-sector partnerships will be crucial to spur demand and for smooth execution, they said.
Feedback from the consumer session was overwhelmingly positive in the US and Europe, with most participants agreeing that last year’s hot button issue of range anxiety has faded to some degree as would-be buyers test-drive EVs. Using extended-range vehicles, some added, would help lessen, if not eliminate, those fears. Those in Beijing, by contrast, were much more cautious because of the consumer’s lower earning power, risk appetite and eco-consciousness.

E-mobility was the buzzword in Bonn, with car-sharing widely seen as a stepping-stone to consumer EV purchases after users familiarize themselves with the technology. Trains, bikes, buses and subways, they explained, are part of a big transit ecosystem, so in a finely tuned system, the EV’s popularity will likely rise, particularly in city centers. The ease of downtown driving in dense enclaves with congestion pricing or restrictions on conventional cars, they added, might spark purchases among those wishing to be seen as green, or as a status symbol, driving a car where most others can’t. Perhaps because the lessee bears more risk than the rental car company in Europe (the reverse is true in the US), companies across the continent are more apt to embrace the car-sharing model, they said.

Novel business models, many agreed, lay the groundwork for true e-mobility. Several examples of creative partnerships were mentioned, such as independent companies selling charging solutions. The dynamism and openness behind this cross-sector collaboration is perhaps why Europeans were more upbeat about progress on business model innovation over the last year.

To maintain the momentum, however, participants underscored the need to “walk the talk” by continuing the hard work of step-by-step creation of a consumer EV ecosystem.

**Bonn: more drivers needed**

“If you are buying iPhones®, it’s because they look nice, feel nice and you’re really cool if you have one. With EVs, it’s the same thing. Those that experience them say, ‘I want one.’ It’s an emotional thing, not how much it costs.”

Participants in Bonn were generally positive about the consumer EV experience based on company surveys and consumer feedback, with animated discussion about strategies that might spur growth. They reported that:

- Range anxiety eases after regular use
- Drivers enjoy the EV driving experience
- Many consumers associate a feel-good aspect of saving the environment with EV ownership

Selling more EVs, however, hinges on three interlinked things, one participant noted. They are: overcoming range anxiety (which improves with drive time, short trips and relying on other transit modes); the experience of driving an EV; and a reasonable price. “We need to watch big regions and cities for consumer behavior in the coming months. Because that’s when we will learn. Once we have proper scale, a lot will happen,” noted one participant.

**Strategies to trigger sales**

Given the pricing challenges, suggestions from attendees for boosting sales included generating buzz about EVs as a must-get appliance with a celebrated fun factor, such as the iPhone, and publicizing perks like the freedom to drive into restricted city centers. Congestion and pollution laws can help drive EV adoption, they said. Powerful public-private incentives like free bus-lane access for EVs, widely available plugs and state-backed charging station supply outside popular downtown venues, they said, would attract prospective drivers.

Other recommendations included showcasing projects in key rollout cities and raising the visibility of more expensive luxury EVs for drivers with deep pockets. Highlighting successful EV rollouts might also help other municipalities apply relevant lessons in their territory, another participant added. If the focus shifts to the highest-profile and more immediate opportunity for the performance enthusiast or devoted environmentalist, the market would likely grow, they said. “People who can afford more expensive things start things rolling, and afterward, those with less money want it too, and the chain reacts,” a Bonn attendee said.

**Next steps**

Moving forward, attendees said the industry needs to tailor vehicles to segments. Today’s two main segments of premium-priced, first-generation products and those for the mass market will grow in a pattern similar to that of the early Prius, they explained, suggesting that the chasm between the two segments isn’t so wide and includes many niches. OEMs should also continue producing extended-range cars, for one-car households, longer weekend trips, emergencies and driving conditions that might drain a battery, including extreme temperatures or hilly terrain, others added. But overall, the under 45km range seemed to suffice. Participants thus called for consumer education to assuage range fears because the key driving concern is reaching one’s destination.

**Detroit: time to do the work**

Enthusiasm among EV users was palatable at the US consumer session, both among those reporting on personal EV use and pilot program surveys. The dual win of promoting EVs among employees and learning from their use was another key takeaway from the Detroit session.
That wasn’t surprising because the group was familiar with the technology and benefited from often-free charging at work and information on charging station locations, which might not be available to the public. For those reasons, lack of awareness and the absence of infrastructure continue to be a big barrier to consumer adoption, said a representative from a large corporation trying out EVs among its employees.

“I walked into a gas station and said, ‘You’re not going to see much of me.’”

EV-driving pluses cited by participants include high gas mileage in the case of plug-in hybrids or the Chevy Volt, fewer unscheduled fuel stops, low-to-no maintenance fees (such as oil filter changes), a fun driving experience, an in-car guide on one’s daily drive and endless data to help one make wise driving decisions. The quick charge option also impressed current EV drivers.

Participants agreed that the EV ownership experience improves with time, the reverse of the experience with a conventional car, in which the honeymoon ends after three months. Most EV drivers asserted that after that period, returning to an ICE car is tough. Surveys among users also pointed to surprise at the ease with which EVs (and their limited range) suited their daily commute, which, they said, quickly eliminated range anxiety.

Early adopters unforgiving of poor service

One participant, however, noted that when glitches do occur, many early adopters are unforgiving of poor or slow customer service, rather than of the problem itself, because they are pioneering technophiles. The auto industry has been in business for more than a century, she said, and new customers paying a premium for first-generation products expect prompt, professional, two-way communication.

“Early adopters want much more communication, direction, to be involved, and they expect a dialogue through immediate notification, just as anyone else buying a US$30,000 object would want. The challenges aren’t about the product, even technical issues,” she explained. “But they’ll be less tolerant of the softer stuff. They’re very anxious to have a response when they have a problem. It’s probably more communication than we’re accustomed to. This is a very community-oriented environment, so if something happens, it’s heard instantly. You don’t get away with a whole lot.”

Another participant summed up the discussion by stating that “we can’t expect the consumer to hand it to us. We’ve got to do the work.”

Beijing: cost, range, risk concerns

“In China, you don’t have the consumer demographics of Europe and the US. So that really worries OEMs here – that there is no consumer market for EVs in China for the next three years. Consumers don’t have the income levels to purchase EVs, and if they do have the money, they will buy a BMW instead.”

Skepticism pervaded the Beijing consumer session, particularly regarding a near-term, viable Chinese consumer EV market, which contrasted sharply with upbeat comments from Europeans and Americans about buoyant demand. The EV’s high cost, low range, and the lack of a mature market will likely push China’s many risk-averse, low-income, first-time buyers toward ICE cars because of their century-long history, participants said, citing findings from national surveys. In addition, session participants noted that passenger cars are a status symbol in China and that buyers with the income necessary to purchase an EV will gravitate to high brand-value ICEs.

Beijing participants pointed to a consumer survey conducted in Guangzhou that found EVs currently too expensive even with subsidies. So because most Chinese consumers’ incomes and environmental awareness are low, they will likely opt for lower or comparably priced alternative ICEs over EVs, according to the survey. Moreover, responses point to the current 100km–200km range being too short because one car must serve all of a family’s needs, including longer trips. Finally, because the Chinese chase trends, with fewer EVs available and fewer trials and errors to fix glitches, EV repair and maintenance issues are likely to resonate loudly, according to those queried.

So, in these early stages when creating confidence is key, OEMs must pitch their products to that reality, participants advised. “There is no clear path to large-volume sales of these vehicles, short-term,” one participant cautioned.
And many other consumer questions remain, they added. Yes, trials, experiments and demonstration projects – largely government-financed – are under way. But the market is not yet established and experiences are poorly understood; overall, it’s too early; and technology improvements – particularly with batteries – are badly needed, many said. Battery performance must double and prices have to be economical, they said.

Protectionism, urban density also weigh
Other practical concerns that surfaced included local protectionism – cities want to support local industry by buying local – and insufficient chargers for China’s many high-rise urban dwellers. On the latter point, public garage charging stations like Icon’s New York City garages should help, some said; State Grid also confirmed its commitment to one charger per EV user and its current charger installation project with partner BMW in Beijing. Parking spots with chargers in pilot cities and hybrids, which benefit from modest subsidies, were also suggested. But Chang’an and Dongfeng’s hybrids don’t sell well because they are expensive, so eco-conscious drivers would normally opt for the more popular Prius, others said. Pure EVs, however, are tax-free. Given these complexities, participants urged urban planners to be involved in decisions surrounding the charging system infrastructure.

Proposed solutions included changing the way one thinks about vehicles to a mobility concept in which the EV is part of the total transit puzzle. EVs are ideal for short trips and tasks, with alternative modes preferable for longer journeys, provided viable choices are available. One participant observed that “the idea of ownership is shifting to sharing. We have to think of new concepts, not just apply old ones, to an entirely new industry.”

Is bigger better?
In this context, participants asked whether OEMs should focus on small, low-speed EVs (because overall vehicle costs would fall with battery sizes and volumes), or on bigger, more costly, higher-profile EVs. Most present leaned toward low-speed options. Making and selling such cars would be easier as they evolved from lead-acid battery-powered small cars to pure EVs, they said. Moreover, innovation in China and abroad will bring lighter and lower-cost materials and other sought-after features (like Japan’s vehicle body-embedded solar panels) to cut costs, offer choice and scale up. Pro-small car government policies, they said, could help speed adoption, provided the state regulates the segment for safety and promotes individual mobility.

But long-term, some participants said, the real opportunity may lie with larger EVs because most Chinese families own only one car. So this market should be studied and targeted for attitudes and preferences at home and abroad. One participant related his company’s US target profile: “Somebody who has a house, garage and a US$100,000 income – perhaps in the technology industry. It all drives you to a very specific sort of person.”

Capacity-wise, China has sufficient components to meet EV consumer demand, participants added, save for perhaps fast lithium-ion chargers. Although the Government controls ICE manufacturing, EV plant permits are easily obtained. Power supply, also, was deemed adequate, if utilities prepare now for the EV impact.

Other suggestions included a leasing model to learn from those 1,100 cars in a handful of cities today. Creating new business models will take time and testing because of the 100-year-old entrenched supply and sales chain. The US and Europe, they said, have better early product-testing processes.

“This is the start stage of a long journey. But the market needs people from different parts of the ecosystem to work together. Not just government, but third-party providers and OEMs. Because these are big numbers. And from a technical point of view, we don’t know exactly what consumers will buy in the future. Battery technology is not really mature, so OEMs may fall behind. So we need to engage the whole ecosystem.”
Opinions varied widely in the infrastructure session, particularly about unconventional ownership, charging and services business models to spur growth. Participants generally agreed on steps to boost EV take-up, like better and cheaper batteries and forging common global standards for batteries and chargers. But Europeans appeared more satisfied than their Chinese and North American peers about the moving parts coming together via creative partnerships between utilities, OEMs and integrators.

In Detroit, attendees underscored the need to fill gaps between who manages, owns and pays for the charging station. And to accelerate EV deployment, Chinese participants focused largely on the powerful role of government and state-run utilities in infrastructure; broader international R&D collaboration; a better business case; and initiatives like showcasing successful model projects.

**Bonn**

New business models were a hot topic in Bonn’s infrastructure session, where participants focused on financing, charging and use packages that might push the industry forward. Other subjects discussed included the mobility services concept, new telematic technologies and secondary battery deployment.

Several current financing business models were proposed, including EV leasing services (much like car dealerships) and monthly packages comprising the car, battery and charger. Leasing might appeal to consumers for smaller up-front payments plus installments, while OEMs and fleets seem to prefer the traditional ownership model – OEMs because they bear considerable battery risk with leases, and fleets because they want battery ownership, others added.
And for charging, the cell phone pricing model was referenced repeatedly for similar EV pay-as-you-use options, or bundled, unlimited monthly services on a subscription basis. But the industry should focus on network rollouts now and perfect the fee-for-services package later, a participant said.

**Car sharing to pave the way**

Car sharing also triggered much discussion in Bonn to entice prospective buyers through combined transit solutions. Car ownership matters less to younger generations, they explained, particularly in Europe and Japan, so mobility-on-demand or mobility packages might appeal. This approach might also please OEMs (by solving range anxiety and battery-leasing issues); consumers (who seek EVs on demand); organizations that want predictable, less costly and greener employee transit options (one Norwegian company, for example, limits company car use to those who arrive at work by train); and rental car companies, to complement weekday corporate EV use with weekend leisure use, participants said. But car sharing may not appeal in China because cars are a status symbol there, an attendee noted.

In Bonn, the need to involve the driving community early was also underscored. Consumers can help choose the perfect charging locations – and thus charging partners – for lower costs, more efficient networks that strengthen the business case for infrastructure investment, a participant said.

**Battery aftermarket issue unresolved**

But opinions were mixed about ultimate values of and applications for the secondary battery market, and how both of these metrics will impact an EV’s cost. Some said this issue matters less because the vehicle’s and battery’s useful lives are converging as battery performance and price improves. But others countered that grid storage is needed for alternative energy resources and demand growth if infrastructure build-out slows, so a market will develop. But one can’t wait 10 years for value and end markets. New laws and incentives, they said, might help speed market development. An open question is who will determine the value: risk or hedge fund managers, or institutions willing to take on a government guarantee?

Finally, because capturing, measuring and responding to a flood of data creates new business opportunities, the EV serves as catalyst for new technology applications, a participant said. That’s why Google, Microsoft, IBM, Siemens and Cisco are now involved.
Detroit

Residual value, total cost of ownership: those issues keep you from selling thousands or tens of thousands of vehicles, or maybe even hundreds of thousands of vehicles. But at the end of the day, isn’t it the infrastructure that keeps you from selling millions of vehicles? Are we spending a lot of time worrying about the issues that get in the way of early adoption? In reality, the infrastructure will stall this.

At the US session, the conversation shifted to business models, collaboration across sectors and rollout challenges. Though range anxiety, overall, has fallen, drivers still want sufficient public infrastructure, they said. But opinions were mixed as to how much public infrastructure is required.

Against this backdrop, different business models will emerge to meet wildly contrasting needs, participants said, as the automaking and utility industries overturn the long cycle times and planning and control approach from a very different era. Utilities’ needs will vary depending on whether the local utility is regulated; required to break even on investments; must convince public utility commissions before it can spend capital; or competes to sell electricity, they said.

Challenges include security, high cost

Among issues utilities grapple with are decentralized power, security, home control and applications, and the additional utility load. How can OEMs and utilities collaborate so that EVs help solve problems and glean benefits such as peak-shifting and load-balancing? a Detroit attendee asked. Creative incentive-based partnerships with utilities to justify infrastructural investment are urgently needed. One participant said, “We are in desperate need of an entrepreneur to come to the table and show interest.”

Recommendations included a good communication infrastructure, from the physical and natural interface to centralized distributed intelligence. One participant also noted that perfecting systems need not happen quickly because of a slow, gradual EV rollout. “We can adopt in phases and get the required technology to fix it,” he said.

Bonn, a year later – surprises

Participants’ views

- **The speed of commercialization.** A year ago, I was looking for a fast-charge pilot. Now we’re rolling out an intelligent network of 30 fast chargers before year’s end. Suddenly, it’s charging as a service instead of looking for a plug.

- **A lack of understanding of the financial value proposition.** Do the numbers make sense? They don’t seem to be measured in compelling ways.

- **The uncertainty related to business models and infrastructure.** Fundamental points like how the infrastructure will work, what the business world will look like, current battery benchmarks, and how they will prove out are still unclear. These key issues will drive the industry.

- **Germany abandoning nuclear and slowing momentum on nuclear plans elsewhere after Fukushima.** We face a major transition in the near future because of the strong rise of renewables. This imposes major changes on our energy system. EV deployment, combined with a smart grid interface, could accelerate in the wake of these changes given the expected growing need to store and handle renewable energy.

- **Difficulty in obtaining financing.** Getting technologies started and financed for renewable energy is still very challenging, even for established companies. And valuations remain low.

- **Little progress on secondary battery use.** Can batteries be used for storage in the network? There have been great intentions and pilot projects, but no discussion of initiatives leading to a sustainable business model.

- **Little visibility of EVs to the public.** If I were to ask my parents, they would never consider an electric vehicle. We need more visibility for this technology.

- **Insufficient interest in smarter technologies.** Our approach to e-mobility, both on the car side and the infrastructure side, surprises me. We are putting up €10,000 charging stations and not considering alternatives at a fraction of the cost. We should think more about investing in smarter technologies.

- **Little support for battery chemistry alternatives.** Despite big government backing and momentum, it is still incredibly difficult to suggest other battery chemistries for e-mobility.
Beijing: a better business case needed

Although Chinese EV infrastructure rollouts are slow and taking shape in different places and ways, the lack of a clear business case for infrastructure investment – particularly for utilities, which bear the most risk – preoccupied participants in the infrastructure session. Such a model must point to good profit potential to engage the whole ecosystem, they said. Other burning issues included possible grid charge flow volatility as more EVs hit the road (thus battery switching, rather than charging, is today’s non-peak charging norm) and the disruptive nature of the EV industry, which dissuades OEMs from collaborating with utilities.

Today, utilities are already stretched meeting China’s core electricity needs, because its economy – and electricity demand – is growing in the double digits, a participant from a large Chinese utility explained. Developing China’s grid is thus an economic need. To ensure that new technologies are built for the EV’s target launch date of 2015, the industry and the utilities need to prepare now. China has a current and future EV-charging capabilities roadmap because it has collaborated with 26 OEMs and battery makers since 2006, he said. Its three-prong approach to a smart EV network entails integrating the smart grid, intelligent transport and internet technologies. In this context, key EV issues include a battery bottleneck and sufficient sustained mileage.

“Government support is at first needed because a certain scale infrastructure is necessary for EV purchases. Without infrastructure, people won’t buy them. But when more EVs reach the market, the infrastructure business model needs to generate sufficient revenue and profit to make the infrastructure scale to the right scope to serve the whole city or country.”

To overcome these and other obstacles, government funds are flowing into subsidies and infrastructure, into companies and universities, into ideas and collaborative projects, and experiments, trials and testing. All of this is essential to understanding EV usability and applications, participants said. Current state players include the Ministries of Science and Technology, Finance and Industry, and Information Technology, plus the National Development and Reform Commission (NDRC). A Central Enterprises, State Grid, China Southern Power Grid and China National Petroleum Company (CNPC) union has also been formed. But government funds are falling short of expectations in terms of timing and size, participants asserted. “There are lots of collaborations,” a Beijing attendee noted. “But there is no real plan to develop a complete infrastructure.”

Regulations, standardization, to trigger sales

To move things forward, participants proposed clear top-down regulations, directives, investment, standardization and coordination, as well as international R&D collaboration, because so many moving parts in a chicken/egg scenario leave potentially destructive gaps.

Others suggested showcasing model cities pioneering EV infrastructures and ecosystems to capture public attention and accelerate investment and rollouts. But for successful deployment, the Government must engage central and city/local mayors or Party secretaries, because execution happens at the local level. Today, EV steering committees, headed by mayors and secretaries, along with government officials, OEMs and utility representative members, plus their national and local industry counterparts, focus on deployments. And because demonstrations depend on subsidies, EVs are high on the city agenda, they said, so mayors and secretaries would be motivated to compete and excel. But some have a clear strategy and implementation plans while others lag. Incentives vary; therefore, so may speed of adoption, they said.

Among suggested demo EV cities to showcase were Hangzhou (one of six with which State Grid is working); Shenzhen and Hefei because major OEMs are based there – BYD, Zotye and JAC, respectively – plus Beijing and Shanghai. Other noteworthy cities include Changsha and Linyi; also

Detroit, a year later – surprises

Participants’ views

- EV commitments by the large OEMs. Ford, Chrysler – that’s a big surprise. We didn’t see that coming. And the German OEMs, electric? A year or two ago, that wasn’t on their charter.

- Difficulty in establishing residual values of batteries. For an industry that’s been doing this for a very long time, introducing a vehicle where so much of its value is locked up in this one new component, the battery, makes it very challenging to establish residual value and, therefore, leases.
of note is Shandong province, where small villages and towns use low-speed EVs. International companies should also watch smart grid rollouts in Hangzhou, Qingdao and Xuji to learn more about EV/smart grid interaction over bidirectional charging, or sending energy back to the grid, commented someone from a large utility. But although this is technically possible, many problems persist, he said. They include unmet market and use requirements, because no environment exists for private cars and EV charging stations; the possible harm caused by discharging batteries; and a current distribution network that restricts supporting interaction between the charging station and the power grid.

Other recommendations included engaging the power company to foster EV development, and global R&D collaboration to accelerate technology adoption and EV sales across the world. China’s battery advantages and equipment could complement Europe’s and North America’s knowledge and analysis, a participant said.

“We make low-cost batteries quickly. China also has good evaluation equipment, and two EV battery-testing centers in Beijing and Tianjin with the best equipment, techniques and money. But we have weaknesses in in-depth analysis and evaluation — strengths foreign battery manufacturers have. So, there is room for international collaboration.”
Learning from Michigan’s plug-in EV collaboration

A discussion with Orjiakor Isiogu, Commissioner, Michigan Public Utilities Service Commission, and Knut Simonsen, Vice President of DTE Energy

To learn how utilities and regulators can work together to accelerate EV adoption, Ernst & Young turned to two organizations in a successful partnership in the state of Michigan: the utility DTE and Michigan’s Public Service Commission. The Commission is charged with the statewide regulation of energy, telecommunications and transportation services.

DTE first became involved in today’s EV industry in 2008 through a Michigan state grant it won with partners GM and the University of Michigan to study the impact of plug-ins on the grid. Big backing from the Commission helped ensure the project’s success, DTE’s Simonsen said, noting that since shareholder and state grant money was being deployed for this project, great effort was expended to ensure it was spent wisely.

Deep EV roots

According to Commissioner Isiogu, Michigan has deep EV roots going back to the turn of the last century, when the state had twice as many plug-in electric vehicles as conventional cars. Certain lessons can be learned from that and subsequent EV eras in the ‘60s and ‘70s, to help tackle today’s emergence of plug-in vehicles.

Because few EVs are on the road today, coming up with simpler solutions is easier. “We’ve been through a lot of waves. This time feels different. Utilities are embracing EVs in a more pragmatic fashion. There will be lots of interesting opportunities over time. Let’s make sure we do it well,” Isiogu said. Some utilities are very focused on EVs, others less so. Nonetheless, one advantage that utilities have in promoting EV adoption is that, given their regional franchise, they can be more collaborative with each other than the players in the auto industry can.

Task force forges ahead

The project’s first actions included forming a statewide task force to make charger installations and the transition to EVs as seamless, smooth and straightforward as possible for the customer. That task force met regularly with permitting agencies and electricians’ unions to boost collaboration and address any concerns.

Isiogu’s unique role as regulator, whose job is to ensure that power reaches customers at reasonable rates, to grow Michigan’s economy and to boost quality of life, allowed him to broker talks with the task force’s diverse stakeholders. They included representatives from automotive OEMs, government agencies, utilities, contractors, unions and environmental groups. Lessons learned from a regulatory perspective include that it is better to encourage people to become involved using a carrot rather than a stick.

Together, the group strove to identify possible obstacles to smooth EV adoption in Michigan. The task force also facilitated discussions between regulators and utilities so they would make prudent investments to enhance the grid, with some certainty of recovering investments in the future. “We need to get ahead of all this as our economic survival depends on the success of the electric vehicle being launched in the market,” Isiogu said.

An initial effort that yielded a wealth of foundational information was a customer survey DTE conducted that identified key concerns of

*For further details, please visit www.pluginmichigan.com.
potential owners and helped articulate the expected role of the utility in the owner’s experience.

Among key task force goals were setting up home-based charging systems so that customers would become accustomed to off-peak charging at home as the simplest, fastest way to meet most EV drivers’ needs, with plans for public charging stations later.

As a result, free Level 2 chargers at home and work, plus public chargers in locations around the state, were installed. But some headaches over getting electricians and inspections scheduled ensued in local municipalities. It was also made clear that, given the use and charging patterns of most drivers, Level 1 charging will be more than suitable for a majority of Chevy Volt owners.

**Key accomplishments**

The task force’s key accomplishments? The relatively quick creation of new building codes for separate home-based meters (with the help of the governor, who mediated with state agencies); two test-bed home and work charging stations; and experimental rates for home-based charging. “Every penny the utilities invest has to be just and reasonable,” Isiogu explained.

Regarding electricity sales related to EV charging, utilities want to sell electricity themselves (and in some states, only utilities are allowed to sell electricity) and avoid legal entanglements. But this rule can be circumvented through free energy for EV-charging in commercial areas. Companies may pay the utility a fee for services, which are incorporated into rates rather than hourly use.

Isiogu asserted that the supporting infrastructure will grow along with EV numbers for a sufficient capacity of 1 million EVs by 2015. “When enough vehicles challenge the grid, the infrastructure will be in place,” he said. “We have time to ramp up to that.”

Already, ongoing feedback from early EV adopters sharing data about car and charger use helps the utility pinpoint which transformers will most likely be impacted. According to utility estimates, a 10% increase in load will only require a 4% increase in energy generation due to the availability of excess nighttime capacity. But how to address the distribution circuits in need of some upgrading is one unresolved issue. Incentivizing utilities to continue installing chargers after some 2,500 free home installations is another challenge.

**Recommendations**

Isiogu closed with a few industry recommendations. He urged stakeholders to create an inventory of neighborhood transformers to add capacity quickly as transformers get overtaxed; to streamline the charging, installation and certification process to a single seamless process instead of three separate steps; and to give installers partial certification as inspectors after a predetermined number of installations, with spot inspections as backup. He also called on the industry to make EVs more affordable by pushing for government incentives that might lower the purchase price and to educate consumers to dispel myths and misconceptions about range anxiety.
Beyond the plug: finding value in the emerging electric vehicle charging ecosystem

Business strategy analysis from Ernst & Young’s Global Automotive Center

The charging infrastructure necessary to stimulate widespread adoption of the increasingly available EVs in the marketplace remains to be built. As the mainstream OEMs begin to roll out EVs, the role of charging infrastructure evolves to become a commercially viable business venture.

The billion-dollar question today is: how can companies package a commercially viable proposition and differentiate themselves in a nonexistent yet crowded marketplace?

Worldwide, we have identified 143 companies that have staked a claim to the emerging EV charging infrastructure, but despite all of their ingenuity and activity, the configuration of the value chain is still unclear. To try to decipher this chain, we closely analyzed these companies and chose 18 distinct business activities that were grouped to develop five potential business strategy variants. These business strategies are at different levels of complexity within the value chain and consequently bring different risks and rewards to the participants.

The five business strategies will evolve to maturity following different timetables, as they face different barriers to entry. Some companies intend to operate in several of them at once, or even to be active in all of them, such as the company Better Place.

Segmenting 143 business strategies allowed us to make several findings, some of which are presented in this report. Generally, we observe that:

- Most companies advertise that they offer solutions for a wide range of customers – from utilities to car rentals, to hotels and home users – but lack a differentiated package and convincing revenue model.
- Several players have not considered the role OEMs and energy utilities will play in this emerging ecosystem, and until these two central stakeholders decide where they want to sit, a stable value chain is unlikely to emerge.
- Charging station companies in the upper end of the value chain propose services that could be claimed by other, more natural players.

- To be a fast-mover is critical, but does not necessarily secure a market share. Manufacturing charging hardware will rapidly become a high-volume, low-margin business.
- Other segments of the EV charging value chain are likely to invest on services that can be offered by leveraging the growing network of charging stations. Overall, the biggest revenue opportunities will probably go to large-scale players or nimble start-ups that can reach scale rapidly.
- The emergence of the EV charging infrastructure will likely force OEMs to take a different look at managing the customer relationship. Some OEMs already recognize the challenge and are turning it into an opportunity.

The growth of the EV charging infrastructure is set to be an exciting chapter in the vehicle electrification process. Visit www.ey.com/cleantech to learn more.
GM and the Chevy Volt experience

A conversation with Tony Posawatz, Vehicle Line Director for the Chevrolet Volt and Global Electric Vehicle Development at General Motors

The ecosystem is everything

Posawatz kicked off his talk by noting the company’s great pains to keep the technology simple and please the customer. The Volt includes two 7-inch LCD screens and an integrated center stack. “But every time I think about these things, I get an alert about driver workload and distraction,” he joked. This underscores the importance of creating a balanced car that serves many stakeholders.

As with other retail products, subtleties make a big difference, he said. Customers want freedom and choice. But infrastructure, he underscored, is a cornerstone. History has shown us that fundamental changes can take decades.

The Volt’s key advantage is that it doesn’t need a fully developed EV ecosystem. “No silver bullet exists to help with the electrification of the automobile,” he said.

That ecosystem, he said, is much more than a charging station; it also involves many little things that have been fine-tuned for 100 years in the petroleum-driven transportation sector. “For EVs to succeed in becoming a mass market phenomenon and to shift the paradigm that every car needs to be driven by petroleum, they need that ecosystem,” he said.

Infrastructure

Posawatz went on to elaborate on the infrastructure challenges the industry faces. They include:

- Modernizing the patchwork grid system
- Integrating renewables
- Applying smart grid technology

“Infrastructure is really hard,” he said. “Jon Bereisia, the chief engineer for the EV1 electric vehicle, was my mentor in the very early days, because of the experience he had in NASA and with the infrastructure for the EV1 program.” As such, the Volt has focused first on getting home-charging right for its customers.

In the early days, he said, “We were driving crude engineering development vehicles.” The value, he said, lies in making the EV an integrated and seamless experience. We believe in experiments and demonstrations with partners, he said, in order to learn and improve.

GM’s early dabbling in infrastructure focused on hydrogen, biofuels (a logical choice because of a vast installed fueling station base), and electricity. Electricity as an energy source made the most sense, he said, because of its ubiquitous nature.

Business models

To spark interest in EVs, Posawatz encouraged OEMs to take bold, unconventional steps. One novel solution to triggering demand, he said, may lie with utilities offering free off-peak EV charging or other special plans and rates.

“We can step forward and initiate a solution and see what happens,” he said. “The value proposition is that the car costs a lot, but you get free electricity that displaces expensive gasoline.”

The evolutionary path of the Volt and other EVs is similar to that laid by cell phones, he said. “How many different rate plans have we had? They tuned and tweaked it and refined it and packaged it until they got it right,” he said. “We have a lot of work to do. We learn and work from trial and error,” he added, noting, “Edison made more mistakes than he had successes, thousands of experiments gone awry. You don't want to make the big mistakes, and you want to learn from the little mistakes, to tweak and tune the little mistakes,” he said.

“I'm not sure the ecosystem is right and ready yet. I hear stories about the permitting and inspection process,” he said. “It's not that technically complicated. Why isn't there an online system today that can work faster and better and get people their juice sooner? Because we want them to run on electricity so we can learn more to manage the associated load and understand driving and charging behavior,” he asked. “There won't be a national solution, but really good local and regional solutions that will then become the model.”
Posawatz advised industry to fill gaps in the ecosystem. “To go mass market, we have to shore up the things that the early adopters are telling us for both product and power users,” he said. Everyone has a role filling in the foundational ecosystem, ranging from thought leadership to execution. Opportunities abound on the financial and consulting side too, he said.

**The rollout**

After financing the Volt in low volumes, GM and its many suppliers slowly ramped up production in late July, using high-volume mass production techniques. Today, 2,600 dealers sell over 1,000 Volts monthly with the numbers continuing to rise. Some 60,000 Volts a year will roll out of a revamped Detroit plant annually beginning in 2012.

However, the company still does not have enough inventory for every dealership. Posawatz acknowledged that the company misjudged orders but linked tight supply to the company’s commitment to getting it right. “We were not going to build them fast until everyone knows their job really well,” he said. “Delighting customers, creating shared value. That is our fundamental business.”

The Volt’s early adopters include an ex-president (one-fourth of them; “We are working toward half,” he joked), senators, NASCAR race drivers and Academy Award-winning actors and directors – even author Stephen King.

Using the analogy of the leap to smart from mobile phones, Posawatz asserted that early adopters who drive EVs and love them are very reluctant to return to ICES despite initially higher prices. “Even though it costs a little bit more, they won’t go back,” he said. “This is significant, it is a difference. It will change the way we drive and look at vehicles when their stories are shared.”

“It is not about crunching the numbers – it’s about blending the numbers with your intuition,” he observed. Of drivers surveyed, 97% are completely or very satisfied, while 3% are “just satisfied,” and 74% are pleased with the charger location. “We have not had numbers like that ever on any car, including Corvettes,” he said.

**Launch challenges**

For the rollout, launch challenges included ramping up hundreds of suppliers, securing sufficient critical parts for cars (which may change with higher volumes next year), and interfacing with customers, different climates, utilities, the supporting infrastructure and charging station providers as production grows from the thousands to the tens of thousands a year. “There is a lot to this,” he said.

Meeting appropriate standards, streamlining the process and procuring EV permits were other challenges. But “it is really about creating customers, satisfying those customers,” he said.

Posawatz singled out connectivity as an additional selling point, and lauded the company’s “heroic efforts” to keep earlier modest production up after the tsunami in Japan amid GM’s reorganization efforts. But today’s interconnectedness, he said, made overcoming both obstacles possible.
A key concern, however, was how bankruptcies might upset the supply chain and damage the ecosystem. "Some said, 'If struggling companies fall by the wayside, it will have a chain effect, and impact the whole ecosystem,'" he said. But most OEMs have suppliers near plants, he explained, and sell locally produced vehicles locally. The best approach, he said, is to ignore the naysayers because more often than not, they have not driven an EV.

Prospective buyers will ultimately be won over by the driving and charging experience, by the joy of low fuel costs, and by the ease of overnight, at-home charging. “Driving the car will sell it better than my telling you about it,” he said.

Value
Concerning profitability, Posawatz said the Volt is less profitable than Chevrolet's most profitable cars. Though the investment is comparable, costs are higher than desired for the expected revenue. But the Volt is not its least profitable vehicle, and returns will improve with volume, he said.

Posawatz highlighted intangible payback like a new mindshare and a better corporate average fuel economy grade, so that hybrid engines need not be installed in every other car. "What value is it that 33% of the early buyers of a Chevy Volt have never been in a Chevy dealership in their lives?" he asked. "I asked my financial guys to quantify that. They are having a hard time."

"Is there an inherent value in the changed perception of the company? Doing a great car, engaging those first customers, letting them be the ambassadors for us" are goals, because they lead to other things. "Getting people in the car is a better deal than a glitzy dealership in their lives," he said.

Moving forward
Ultimately, GM plans to use the Volt brand as a launch pad for higher-volume, lower-cost sales in many regional markets based on scale, before fine-tuning and customizing the car locally. The company foresees Volt sales in Europe and China, will add the Opel Ampera and Vauxhall Ampera, and plans to expand sales to Israel and Australia later.

The company is also mulling different body styles, sizes and trucks based on emerging technology and different versions of batteries to meet different range and price needs as energy and power densities change.

Technology
Other plans include improving the technology, which will also attract drivers. Today roughly 24% of early buyers have or will have solar power, while more than 40% own an iPhone® or iPad®.

"So much of the Volt is the software that controls things behind the scenes. It is not about putting in extra black boxes, extra features or extra things that are additional costs. It is about taking the inherent architecture that was put in place and leveraging it, and creating more value by creating more applications," he said. Customers want information, he said, about charging station locations and how to be more efficient. The Volt helps change people's behavior by giving them feedback, and by "allowing them guilty pleasures."

Customers, he said, like mobile applications. But lengthy refreshing time for security reasons continues to be an issue. OnStar's headquarters authenticates security protocols and sends a signal back to the car to wake it up. Data is then sent to OnStar, reconfigured, packaged and pushed to cell phones, websites or e-mail, he explained.

New business models that build on today's operating cost and connectivity investments could also bring the Volt big returns, Posawatz commented. Moreover, mass Volt production brings component costs down by as much as half through volume and scale because no prior competition existed among the legacy charger part makers for golf carts and forklifts who are supplying GM. Just as most first-generation cell phone, PC and TV component costs fell sharply with scale, charger costs will fall too, he said.

And on the battery front, GM's battery lab work and investments suggest that battery costs could halve by mid-decade. But much work must be done, including creating a competent supplier base, and empowering more competition to supply the next wave. With more volumes, contracts and continuous improvements, the technology cost curve will fall, he said.

Surprises
Among the surprises Posawatz noted were most drivers opting for Level 1 (120 volts) versus Level 2 (240 volts) chargers to avoid the additional risk of and investment in the higher-voltage technology. These work well enough, are readily available and suffice for overnight charging, he said, for daily work trips, particularly for the Volt because of its extended range option.

Possible showstoppers? Charging too much for the Volt because early adopters want them, have the money and are prepared to pay. Such opportunism, he said, could backfire. Other issues include the lack of charging infrastructure and low gas prices (though this infrastructure challenge does not hinder the Volt).

Advice to stakeholders
Posawatz thanked the government for its support and called on the U.S. Department of Energy to extend its grant programs.

He also urged the industry to halve the price of batteries through R&D, competition, volumes and scale. Generation 2 will achieve break-even, he said, and by Generation 3, interesting technology will emerge, not to mention value captured from business model innovation.
Burning questions

As the session closed, participants were asked to propose questions that preoccupied their companies or organizations for debate in small groups. Questions, and the findings from the group discussions, follow.

Bonn

Question: Will fuel cells and batteries be complementary or competitive?

Conclusion: Fuel cell and electric vehicles will coexist and be complementary. The two technologies coming to market at the same time creates workforce tensions and a battle for talent. But the infrastructure is on its way. A fuel cell car will be on the market within five years.

Question: How easy is it for new entrants to compete with entrenched automakers in the EV industry?

Conclusion: OEMs don’t always dominate the car market. There are opportunities for new players, brands, and logistical and dealership concepts. One possible opportunity might lie in the production and sale of EVs, and perhaps an entirely different distribution approach, particularly for fleets. Smaller batches of more distinct cars priced between €5,000 and €10,000 could be designed, sold or supplied by entirely new players like Microsoft, Apple or IKEA.

Question: What opportunities exist for cross-sector partnerships?

Conclusion: Three or four years ago, EVs were conceptual and largely based on subsidies and regulatory issues. But today, companies are starting to see opportunities versus threats and barriers, so new opportunities are emerging.

Possible combinations include a bundled product a customer can’t refuse from a trusted company, such as an Apple, made in China and serviced by an integrator. Another possibility is a vehicle from a trusted car maker with a premium brand like Mercedes, charged by a trusted mobility provider like BP or Shell, and supplied by a trusted car-sharing or rental company such as Hertz.

Still others could partner on a complex package of services, such as Deutsche Bank guaranteeing a battery, Swiss Re providing insurance, and GE supplying large storage plus green power in a quick-charge park.

Question: How will new innovations dovetail with demand use and trends from rising middle classes in India and China? What about leapfrogging?

Conclusion: Because there are barriers to entry for Chinese-made conventional automobiles, Chinese EV sales in Europe might be a challenge. It is far more likely that Chinese OEMs will send their EVs to other fast-growing economies where barriers may be lower, for example, South America, Africa or Asia.

Detroit

Question: Is there a secondary market for batteries?

Conclusion: The seven-year-old battery has residual value given its high cost, with possible second- and third-generation lives. Afterlife applications could include additional heating capacity in countries adding to their capacity, like China, and in residential and commercial buildings elsewhere.

Rural applications in areas without electricity are also a possibility, for say, solar power recharging. Even in the US and Mexico, some rural areas are off-grid.

But start-of-life batteries should be standardized and a futures market created. More research and development into reclaiming efficiencies to improve lithium and other semiprecious metal yields, and government incentives to develop second-life alternatives, are needed.

“We applaud efforts under way toward battery reconditioning,” the group said, in which a used battery is reconditioned to recoup 60% to 80% of its capacity. This could lead to a primary and aftermarket – even with the battery’s maker – to replace a spent battery with one with slightly less capacity at half the price. For this market to solidify, it needs to move from concept to concrete.

Question: What incentives do OEMs have to work with start-ups for alternative business models?

Conclusion: One deterrent to OEM-start-up collaboration is a concern about the public exposure of affiliating with smaller companies linked to brand, image or product liabilities. Companies may worry about “a hit from a product that doesn't perform well in the marketplace,” one group member said. A large corporation with deep pockets will more often be pursued for compensation than a bankrupt start-up.

IP ownership is another issue. Smaller companies want to monetize new business models. Who will own the IP and control the value, David or Goliath?

Jurisdiction, too, brings complications. Will start-ups be restricted to local areas because they lack a distribution network? They may also have alternative financial corporate incentives or business models through, say, deals struck with venture capital firms. Financial incentives might drive big OEMs to pursue outside partnerships.
Government moves to help circumvent this resistance include credit sharing or regulatory benefits. But OEMs might not want to share vehicle architecture with outsiders. Similarly, start-ups are more likely to be suppliers than their partners, and would thus want to protect their IP.

Overall, OEMs have few natural incentives to collaborate or partner, because they want to retain control, save perhaps accelerating commercialization or improving an offer.

“OEMs are probably one of the biggest knotholes to adopting use because they hold those cards,” a group member said. They have financial disincentives to work together.

Government policies like credits for collaboration could help move things along. OEMs are highly incentivized to access outside innovation and bring it under their control. Collaboration is happening, but by the time the product hits the market, much of the creative spirit of innovation is squelched.

**Question: What is the future of fast chargers?**

**Conclusion:** Once drivers are familiar with ranges, batteries and the charging process, they will gravitate toward fast chargers. But concerns persist over different batteries, vehicles and vehicle control. On-board chargers are fundamentally dumb, so diagnostics must be stationary. Charging sequences must be scheduled by output so if a diagnostic fails, one must squeeze and pull the handle.

Many industrial problems must also be fixed. This will happen when the technology is fully accepted. In Japan, for example, a paid attendant with a special uniform and face shield fixes codes. But today, batteries still struggle with sucking up big charges and only have 20% of what they deliver on output because they were never engineered for that application. Once the electrical and mechanical engineering is improved, ideally through solar-mounted panels with 150-200 parallel volts on a 152-foot trailer, codes can be increased. Preferential parking will help. But, a group member asked, “Who will make the entire chain?” Big box stores like Best Buy or Costco were suggested.

**Question: How will it be possible to get global EV sales penetration?**

**Conclusion:** For the industry to be profitable, a minimum 25% penetration is needed. That is an aspirational but achievable goal. But...
are investors ready to fund this? The industry must know where it is headed. Today it is clearly supply constrained. Will it remain that way or become demand-constrained by decade’s end? What must change to support the enabling environment? Installations are being stress-tested today.

Current problems include inconsistent building and electrical codes and different ground rules for inspectors.

“This is not a technical problem. The technology exists, but houses aren’t wired. Everything is so fragmented and highly variable and out of control. And, on the commercial side, you can’t find someone willing to fix the gap in commercial settings,” said a group member.

Suggested solutions include better consumer education on how the process operates, and new policies and standards. “We need incentives to get consumers over the mental bumps and a new business model about ownership,” said the group.

China

Question: With the auto industry threatened by EVs and collaboration between OEMs and utilities required, is there a new paradigm to push things forward, especially on the supply chain side?

Conclusion: In the move from ICEs to EVs over this paradigm shift, it might be useful to think about e-mobility, even in one-car households. Factors in the vehicle-buying decision include size, speed, capacity, cost and the enjoyability aspect. But the overall goal of car ownership is reaching one’s destination. Thus the total solution may involve a bike, scooter and/or mass transit.

It’s all about lifestyle and choices and trade-offs, such as trading speed for green or the size or cost for speed. Or one rents, leases or pays per use.

EVs may cover less distance than conventional cars per charge, but perhaps that’s OK. So a small, low-speed EV, such as those already built by Shifeng that meet basic cost, convenience and energy consumption requirements, may suffice. Perhaps industry and governments need to analyze EVs from that perspective. Perhaps the real paradigm is strategy, starting with smaller range, traditional lead-acid battery electric vehicles.

Question: How can we persuade foreign companies to collaborate on technology when they are so worried about IP protection? The 50% stake is low. How can we accelerate investment and product development?

Conclusion: To invest in China’s EV market, foreign companies need 50% local ownership, which limits most multinationals’ operating environments. To tap into subsidies or capital investment or to get finished product to markets, multinationals must share ownership by investing in local research and development and manufacturing; by integrating key technologies into the overall package with a local brand (or through a more active marketplace participant); and by having a local partner, to operate more effectively in the environment.

And to get the benefits of new technology, Chinese companies must play by the rules. China’s need for technology is high, as is its need to play by the rules, albeit as smartly and strategically as possible. So Chinese R&D centers will be 99% staffed by Chinese, to help enable technology transfer to China. EVs are an industrial leap for China. The country can make a global impact.

Question: How can one push OEMs and utilities to collaborate on exploiting the battery’s value?

Conclusion: OEMs strongly believe that the battery should be under an OEM’s control and hold responsibility for integration with the utility. Power company representatives insist that utilities play a vital role in EV development. They need to be engaged, not restricted.

Chinese OEMs, such as State Grid and Zotye, are more open but are still at an impasse. Perhaps this should be left to the non-profits to sort out and form a Stage Grid-OEM working group? NGOs can facilitate, educate and play a catalyst or bridging role.

In the US, three groups – OEMs, charging station makers and the technology provider – all with different needs and goals, are vying for a piece of the pie. It’s not easy. Watch this group for takeaways, especially on driving habits and actionable data; a lot of data could prove profitable. The tension lies with a closed versus firewalled access to information.
The road ahead: steps forward

Three geographically diverse groups of stakeholders came together this year in Bonn, Detroit and Beijing to discuss progress, problems and opportunities as EVs leave plants for dealerships. With guidance from Ernst & Young, each group addressed a focused agenda of critical issues related to fleet, consumer and infrastructure needs. Their exchanges generated rich insights into ways to accelerate EV adoption in the coming years. Our analysis of the debate and points of view shared in these sessions lead us to make the following recommendations.

Supply more vehicle volumes and variety. The EV market needs breadth and depth to move beyond early adopters, so more volumes are needed to ensure availability and more vehicle types are needed to serve different market segments. At the consumer level, this will help to ensure that buyers can find an EV model in the class of vehicle they are looking for – an SUV driver is not likely to buy a subcompact – especially if that purchase requires being placed on a waiting list. For fleet managers, this means being able to purchase the right vehicle for service needs in volumes that make economic sense.

Graphic recording of Ignition Session discussion on “The road ahead in transportation electrification in China,” drawn by Oliver Prothero of the Ludic Group
Create infrastructure standards and protocols to accelerate business model development. Today's proprietary systems are too costly. Government and industry must work closely together to develop and adopt common standards, such as the EU automakers' agreement on plug standardization and software specifications. The lack of platform standards is inhibiting the rollout of broad-based solutions.

Create the easy button. Offer a seamless way to finance electric vehicles and have chargers ordered, permitted and installed, and the world will beat a path to your door. A patchwork of regional incentives and permitting requirements is deterring prospective buyers from pulling the trigger. Entrepreneurial companies that streamline a time-consuming and unwieldy process will help push those watching and waiting into EV seats, whether consumers or fleet drivers. Achieving this will likely require forging creative partnerships up and down the value chain.

Provide the total customer experience. A seamless system for financing, purchasing, fuelling and servicing has grown up around ICE vehicles over the past 100 years. The total customer experience must be offered to EV drivers too, and faster, to enable adoption.

Create an “iCar.” The electrification of transportation brings the automobile one step closer to being a consumer appliance. Marry EV technology with compelling industrial design and a revolutionary interface to create a vehicle mass consumer appeal – call it an “iCar.” Consumers are willing to pay more for cool and will become evangelists for cool products.

Solve the residual battery value riddle. An industry-level effort involving OEMs, researchers, utilities and entrepreneurs is needed to facilitate baseline projections for residual battery values. This could involve the creation of design standards to enable today's heterogeneous and purpose-built batteries to be packaged together for new uses or materially recharged (akin to printer cartridges) for reuse.

Educate the general public. Beyond industry stakeholders and early adopter enthusiasts, few people understand the true state of EV development. OEMs, governments and industry associations must develop communication strategies to increase mainstream consumer awareness and address misconceptions about EV technology. As long as the majority of consumers consider the EV to be tomorrow's technology, it will remain so.

Incentivize fleet adoption effectively. Corporate fleet managers, as we noted in last year's report, are the ideal early adopters of EVs, given the predictability of fleet routes, the total cost of ownership advantages of EVs and the intangible corporate benefits of driving electric vehicles. The higher up-front costs of EVs are a barrier, however, and government incentives for fleet adoption, if they exist, are often aimed at corporate taxes with minimal impact. Fleet managers need incentives that reduce the price of EVs at sale so that they can make a business case for choosing them over ICE alternatives.

Think differently. The systems, infrastructure and business models designed to support ICEs have developed over a hundred years – the assumptions and modes of thinking that accompany them are hard to escape. With the advent of EVs, now is the time to take a fresh perspective on the automobile, whether it is placing it in the context of a mobility concept, thinking about new business models or welcoming new players into the EV ecosystem.

Engage the whole ecosystem. As one participant observed, “This is the starting stage of a long journey, and the market needs people from different parts of the ecosystem to work together.” At this critical stage for the EV industry, OEMs, integrators, battery makers, utilities and infrastructure developers must work together to bridge gaps in the value chain and forge creative partnerships to create a sustainable EV ecosystem.

Collaborate across borders. EV trials and production are taking place around the globe. Sharing experiences and lessons learned will benefit the entire industry; so will finding opportunities for partnerships based on comparative advantage.
## Closing exercise: what does the EV industry need to achieve to ensure continued market growth?

The participants in each of the three Ignition Sessions were asked to suggest, and then vote on, the milestone or action items that the EV industry needs to achieve in the next 12 to 24 months to ensure continued market growth. Below is a comparison of the top three areas of needed progress identified in Bonn, Detroit and Beijing.

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<th>Bonn</th>
<th>Detroit</th>
<th>Beijing</th>
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<tbody>
<tr>
<td>1. A greater volume of EV production and more diversity in available vehicle types</td>
<td>1. Make more EVs available, both in production numbers and diversity of vehicle types</td>
<td>1. Consensus on EV infrastructure among OEMs, component providers, power companies and users</td>
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<tr>
<td>2. Agreed-upon standards and protocols for charging infrastructure</td>
<td>2. Successful performance of installed batteries and continuing performance improvements</td>
<td>2. Widespread adoption of EV technology in public transportation</td>
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<tr>
<td>3. CO2 emissions standards for OEM fleets in the major markets (US, EU, China)</td>
<td>3. Streamline installation of residential EV chargers</td>
<td>3. Increase awareness among consumers of EV performance capabilities and reliability</td>
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Among the groups, two areas of commonality can be seen:
1) the need to increase the volume and model diversity of current EV production; and 2) the need to accelerate EV infrastructure deployment, whether through the creation of industry standards and consensus or through improved processes for residential consumers.
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