IMPROVING EFFICIENCY IN CHINESE TRUCKING AND LOGISTICS

PROCEEDING AND INSIGHTS FROM THE DESIGN CHARRETTE ON CHINESE LOGISTICS AND TRUCKING EFFICIENCY HELD APRIL 26–27, 2016, IN SHENZHEN, PRC

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ABOUT ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in the United States in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and in Beijing, People's Republic of China.

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01: EXECUTIVE SUMMARY

Freight is a critical opportunity

In order to successfully transition to a middle-income economy, resolve its acute urban air quality inefficiencies, and achieve its climate goals, China must resolve the inefficiencies in its trucking and logistics industry. Improving logistics efficiency can also bring cost reductions of up to RMB 1T annually to the Chinese economy.

1. Benefits of logistics improvements to owners range between RMB 200,000 and 300,000 per truck per year.
2. Currently, freight transportation is 4% of China's total CO_2 emissions. This figure is projected to grow to 16% under business-as-usual (BAU) assumptions. Mitigating this runaway growth is critical for China to meet its emissions reductions targets.
3. Motor vehicle traffic, particularly truck traffic, accounts for 30–40% of urban PM2.5 emissions in economically developed Chinese cities. Existing technologies, heavily used in US and the EU, can reduce emissions by over 90%.[1]
4. Key Chinese policy goals, such as the development of a service-based economy, the shift toward higher value-add manufacturing, and accelerated development of the Central and Western provinces, are all threatened by a disorderly and inefficient freight transportation sector.

China's freight problems are multistakeholder, the solutions to those problems must also be multistakeholder

1. A multistakeholder charrette—or interactive system design and problem-solving workshop—convened over 50 high-ranking participants from industry and government to explore structured solutions to China's freight challenges. Representatives from every major group in the ecosystem of Chinese trucking and logistics worked together to understand the desired future state of the sector, barriers to achieving that vision, and solutions capable of overcoming those barriers.
2. The solutions generated at the charrette were all multistakeholder, involving collaboration between groups.

Barriers to energy and operational efficiency in Chinese logistics are complex and intertwined

1. Barriers to entry are excessively low, leading to an oversupply of low-quality trucks and carriers.
2. Protectionist local regulations and tax codes discourage scale and the resulting operational efficiency.
3. High levels of regulatory fragmentation and multiple, opaquely enforced, overlapping standards reduce the effectiveness of regulation.
4. High fragmentation of carriers, shippers, and logistics firms leads to small scale and low efficiency.
5. Competitive pressures alongside lagging enforcement frequently result in illegal operating practices such as overloading or use of non-compliant equipment. The result is that those who operate lawfully are often at a cost disadvantage. Excessive tax burdens exacerbate cost pressures. Legal operation of trucks is unable to cover costs.
6. Poor management lowers annual use and a combination of overloading and low initial truck quality shortens truck life, reducing the payback for fuel economy.
7. There is low confidence in both the technical and cost effectiveness of fuel economy technologies—efficiency technology verification is inadequate.
8. International experience with fuel economy improvements is not always relevant due to differing duty cycles (e.g., much lower average speeds).
9. Poor standardization of equipment reduces efficiency in truck loading and hinders techniques like drop-and-hook.
10. Experience in modern logistics management techniques and IT systems is limited, especially in smaller firms.
11. A focus on cost minimization from shippers leads third party logistics providers (3PLs) to focus on cost minimization rather than providing higher price/higher quality services.

An example described at the charrette shows the complexity of the problem. Truckers do not want to overload because it is illegal and very dangerous, greatly increasing braking distances and leading to fatal crashes. However, widespread illegal operating practices that lower prices to unsustainable levels, combined with unhealthy tax codes and toll rates, greatly reduce margins. Because regulation is not enforced transparently and shippers put a high focus on cost minimization, the revenue from operating a truck falls below the cost of operating it legally. Overloading is a common response to improve competitiveness. Overloading, combined with poor logistics management, leads to low lifetime truck utilization. This low lifetime use reduces the business case for fuel economy improvements—the fuel saved cannot cover the upfront cost. At the same time, overloading forces engines to operate outside of design specs and also forces trucks to operate at lower speeds, greatly reducing actual fuel savings from efficiency technologies like aero and transmission upgrades. In addition, claims of fuel economy improvements from efficiency technology are often false. This combination of poor management, harsh operating conditions and poor transparency of fuel economy claims effectively eliminates any business case for fuel economy gains.

In this case, various levels of government, carriers, shippers, and OEMs all have a part in creating a system that is expensive, inefficient and unsafe, but no single stakeholder group can improve the system on its own. Fixing this system could increase revenue, decrease costs, reduce emissions, and save lives, but no group can act alone. Coordinated action by multiple stakeholders is required.

The workshop identified five solution areas that could help to improve the efficiency of Chinese logistics markets

1. Create a logistics information platform to efficiently match loads with trucks, reducing empty running for carriers and increasing supply chain efficiency for shippers and logistics providers. The focus should be on designing a system that has benefits to all stakeholders, especially shippers and logistics firms (i.e., those contracting for trucking services) who currently see little benefit in using platforms.
2. Create a mechanism for sharing best practices to increase confidence in energy efficiency technologies and practices through analysis and sharing of real-world usage data. The mechanism should develop actionable business cases for investment in fuel economy and logistics efficiency.
3. Create an alliance that will adopt equipment and technology standards to improve operational efficiency and reduce costs. Participants should focus on standards that can improve truck utilization and reduce costs, such as standards to support drop-and-hook trucking.
4. Work with a city to design an urban logistics master plan to improve the efficiency of urban freight. The key focus areas of the plan would be the efficient loading and routing of trucks, the adoption of efficient urban delivery trucks, adequate provision of logistics infrastructure, and land use and zoning regulations to support efficient transportation.
5. Work with government to reform and rationalize taxes and tolls, reducing costs for the logistics industry and removing disincentives to scale and efficiency. A particular focus is on China's extraordinarily high toll burden and the cost increases it brings to long-haul trucking.

The current state of freight transportation in China is not ideal. However, strong motivation exists in both government and industry to make the necessary reforms. The benefits are large and clear. Improving efficiency in Chinese trucking will reduce cost, reduce CO_2 emissions, support fair and sustainable economic growth, and improve public health and urban quality of life.

02 INTRODUCTION

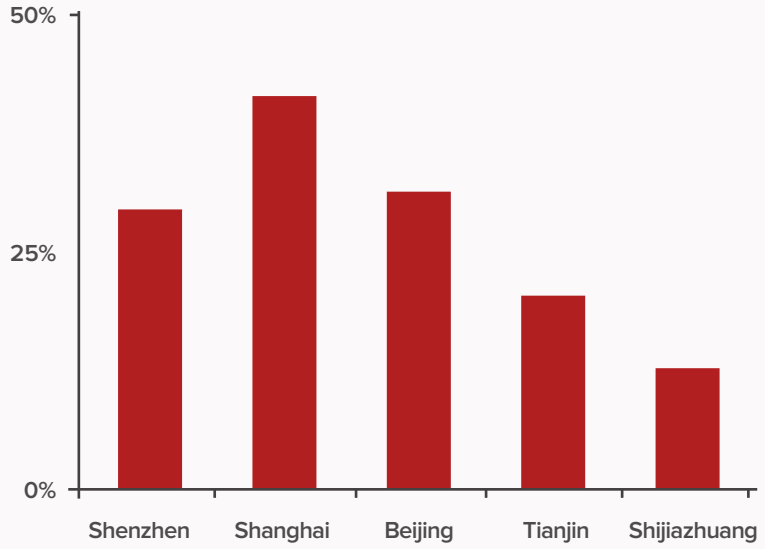
The energy efficiency of Chinese trucking is a critical opportunity and a government priority.

	Diverse benefits	A government priority
Economic	• Logistics **cost:** currently 18% of GDP in China compared to 8–12% in U.S. and EU. If China could reduce logistics cost share of GDP to US levels, it would save approximately RMB 1T per year based on the current size of the Chinese economy. • Logistics quality: improved **speed**, **reliability**, and **transparency** • Critical component of **service sector** and a prerequisite for **higher value goods** manufacturing, and Western development	"Accelerating logistics development is urgently needed for China's economic and social transformation. Logistics is an important component of a modern services industry and it enables economic reform, development model shift, and increased international competitiveness."[2] **Ministry of Transportation**
Energy and climate	• Diversified fuel mix, reduced **oil imports** • Supports government **peaking goals for CO_2 emissions**	"Along with the rapid growth of logistics, energy and environmental problems are growing more severe… traditional logistics operational models cannot continue. In accord with the demands of an ecological society, we must adopt the concepts of modern logistics management, ceaselessly improve IT use, standardization and automation… and develop green logistics to save energy and reduce emissions."[3] **Development Research Center of the State Council**
Air pollution and urban quality of life	• Saved fuel and avoided trips equate directly to **removed air pollution** • Cleaner fuels and improved **emission control technology** are related benefits • Improved **safety** and **congestion**	"China is currently undergoing enormous urbanization, which is leading to a concentration of logistics activities in urban areas. Pollution is increasing, congestion is getting worse and road safety is deteriorating. Efficiency gains in urban and intercity logistics are urgently needed, as is the establishment of an integrated urban delivery system."[4] **Development Research Center of the State Council**

Freight transport is an increasingly important part of China's CO_2 and PM2.5 emissions.

MOTOR VEHICLE PM2.5 EMISSIONS[5]

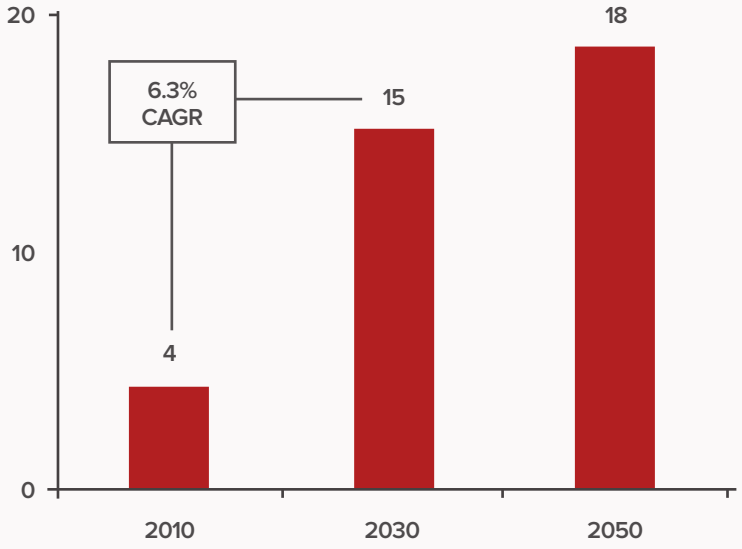
SHARE OF LOCALLY EMITTED PM2.5



- In the most advanced cities (Shanghai, Shenzhen, Beijing), motor vehicles are the largest source of local pollutant emissions (excludes emissions that blow in from other areas)
- In Guangdong medium and heavy trucks accounted for nearly 70% of on-road PM2.5 emissions[6]

PROJECTED CO_2 EMISSIONS FROM FREIGHT[7]

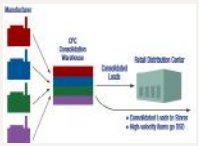
100 MILLION TONS



- Rapid growth, especially in near term, leads freight to grow by 4x and increase from 6% to 18% of total Chinese emissions

Opportunities exist to improve long-haul and urban-delivery segments for both logistics and equipment.

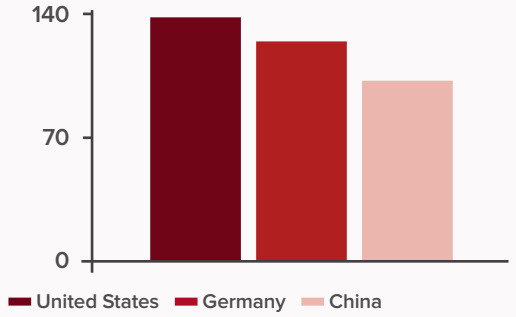
	Long-haul	Urban delivery
Logistics management	• Freight market platforms (load matching, routing, tracking, etc.) • Third-party logistics • Drop and hook	• Freight market platforms • Consolidation • City planning, including layout and time of delivery
Trucks and equipment	• Improved tires and tire pressure monitoring • Advanced engine and transmission technology • Natural gas fuel (CNG or LNG)	• Many long-haul technologies apply here as well • Hybrid drivetrains (electric or hydraulic) • Electric and plug-in hybrid electric vehicles



Logistics in China is wasteful, both in terms of energy and cost.

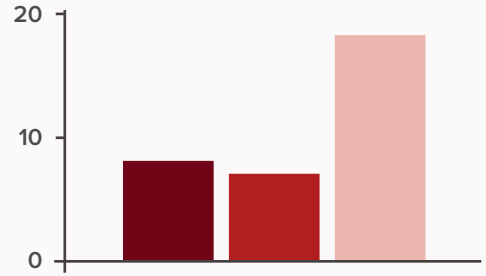
HDT ANNUAL UTILIZATION*

1,000 KM/YEAR



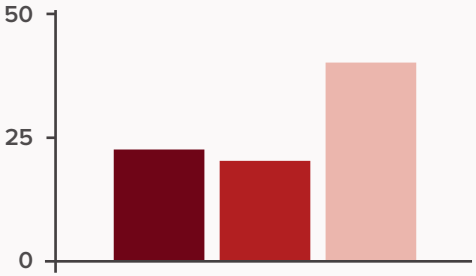
LOGISTICS SHARE OF GDP

% GDP



HDT EMPTY RUNNING†,8

% KM DRIVEN



The Challenge

China's logistics is described as "small, fragmented and disorderly."

Carriers are primarily owner-operators with low levels of expertise and very limited capital to invest. There is a very high focus on upfront cost minimization.

Regulation is not enforced. Ruinous competition means lawful enterprises can't cover cost. Markets are opaque, information is not shared, and trust levels are low.

Most enterprises do not achieve the economies of scale that come with large networks and many pathways to improving efficiency are not cost-effective for small-scale enterprises.

The Opportunity

As operations gain scale and efficiency, the ability to invest in efficiency grows. Improved management and regulatory enforcement brings stability to the market.

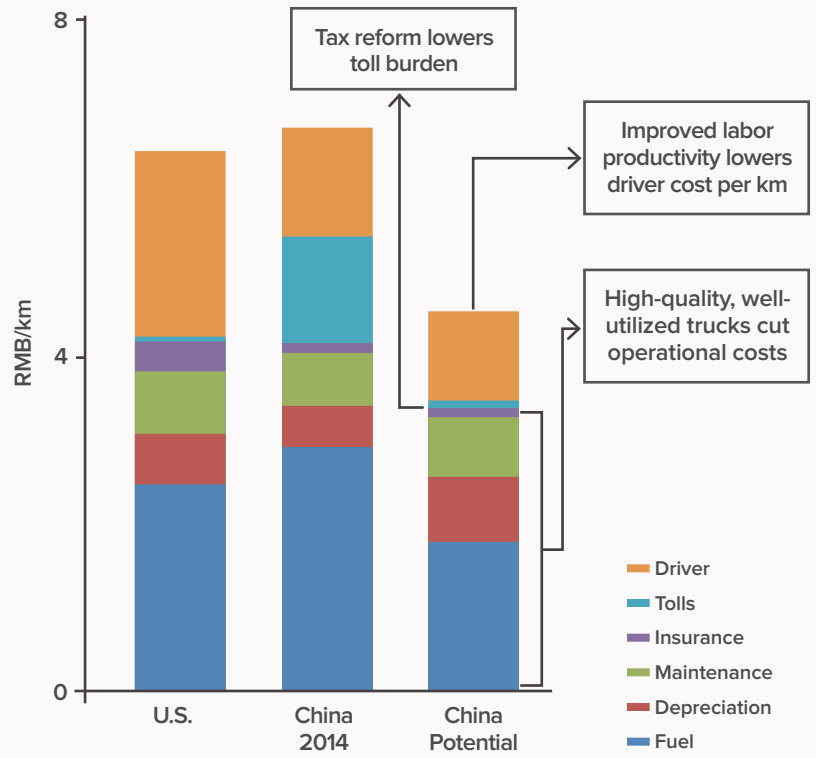
Large fleets develop economies of scale while national 3PLs bring similar efficiency to owner-operators. As scale grows and the business case for efficiency strengthens, sector expertise and professional management allow businesses to harvest those benefits.

Regulatory enforcement becomes more effective allowing margins to expand as minimum operational standards are upheld. Information flows more feely and trust between market players is restored.

**Utilization was estimated through expert interviews. Numbers are in range of published estimates for China[9] and the U.S.[10,11] No estimate for Germany was found.*
†No comprehensive survey of Chinese or U.S. empty running exists, 40% is a common estimate for China. Expert interviews suggested a range of 30%–40% for China and 20%–25% for the U.S.

Improved logistics and trucking efficiency could reduce the cost of trucking by 33%.

ROAD FREIGHT COST STRUCTURE COMPARISON [12,13]



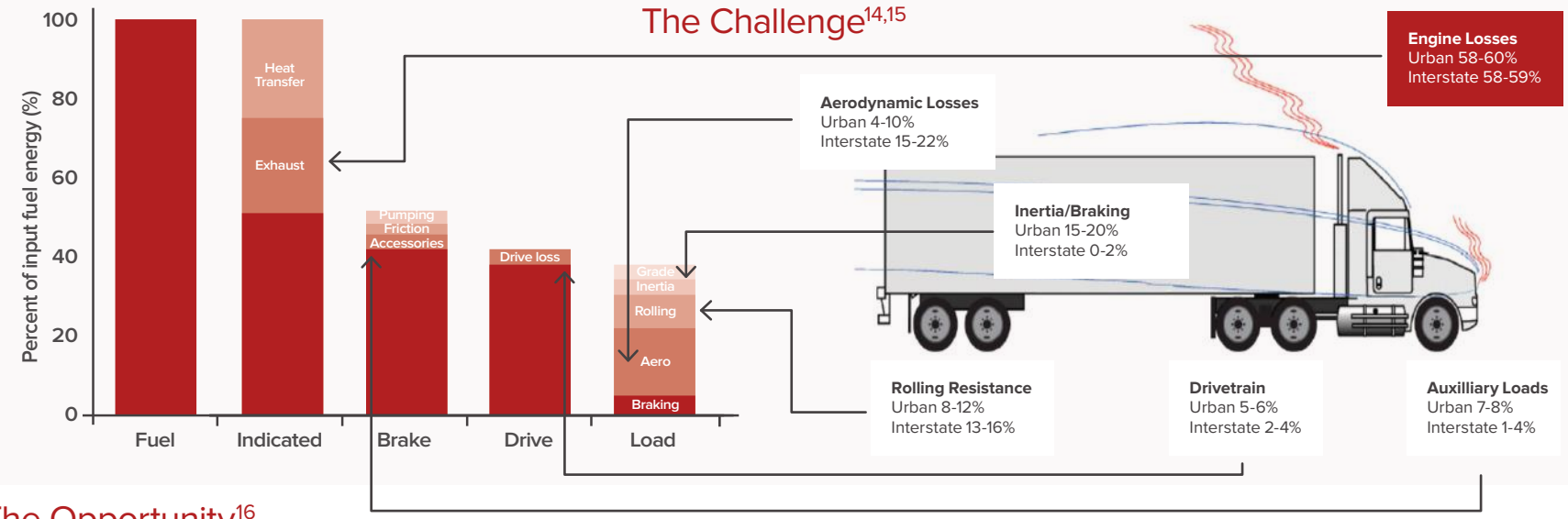
Improving truck utilization to U.S. levels, reforming toll collection, and adopting cost-effective fuel economy improvements could lower costs by up to one-third. The annual value to a truck owner ranges between RMB 200K to 300K. The total value to the Chinese economy is up to RMB 550B per year.

- **Driver:** In China total annual cost for a driver was estimated at approximately RMB 235K vs. RMB 425K in the U.S. If China's driver costs climb to U.S. levels, the 25–30% annual productivity (km/yr) gaps remain. China's per km labor cost would be 25% higher than in the U.S
- **Tolls** 15 times higher in China due to excessive toll burden (more discussion on slides 50–51)
- **Depreciation** Nearly the same as U.S. levels despite lower truck cost in China. Contributing factors include lower annual utilization and shorter truck life
- **Fuel cost:** After normalizing for fuel price differences, China's fuel cost per km is 5% higher than in the U.S., despite lower emissions control technology and lower speeds

**Methodology Note: Fuel and depreciation adjusted based on cost curves from RF-China – diesel prices equalized per World Bank data. Driver productivity equalized based on ATRI and YH Boost estimates of annual kilometers logged. Tolls equalized at U.S. levels. Insurance costs assumed constant.*

Proven technology/design improvements can cut energy losses.

The Challenge[14,15]



The Opportunity[16]

AREA OF IMPROVEMENT	EXAMPLE TECHNOLOGIES	REDUCTION POTENTIAL
Thermal efficiency	Improved combustion, reduced friction, waste heat recovery, etc.	10–15%
Aerodynamics	Gap fairings, nose cones, side skirts, vortex generators, etc.	5–15%
Rolling resistance	Tire pressure monitoring systems and low rolling resistance tires	6–7%
Drivetrain	6x2 axles, automated manual transmissions, dual clutch transmissions, etc.	3%
Inertia/braking	Regenerative braking, hydraulic hybrid	Not HDT applicable
Auxiliary loads	Electrified auxiliaries (fans, pumps, etc.), auxiliary power units	3–13%
Driver behavior	Driver efficiency monitoring and feedback systems, idle shutdown	3–10%

03 HOLDING A DESIGN CHARRETTE

03: HOLDING A DESIGN CHARRETTE

Over 50 industry and government leaders gathered for an interactive design charrette focused on this opportunity.

RMI and partners held a design charrette in Shenzhen, PRC, to better understand and capture the opportunity for improved Chinese trucking efficiency.

Design charrette goals:

- Identify business-led opportunities to enhance the efficiency of China's logistics and trucking industry—solutions will reduce pollution and carbon emissions while saving money
- Start by building a shared understanding across key stakeholders of the biggest opportunities and barriers
- Explore collaborative solutions to overcome barriers and spark action
- Organize subgroup of committed participants to champion follow-up pilots/initiatives

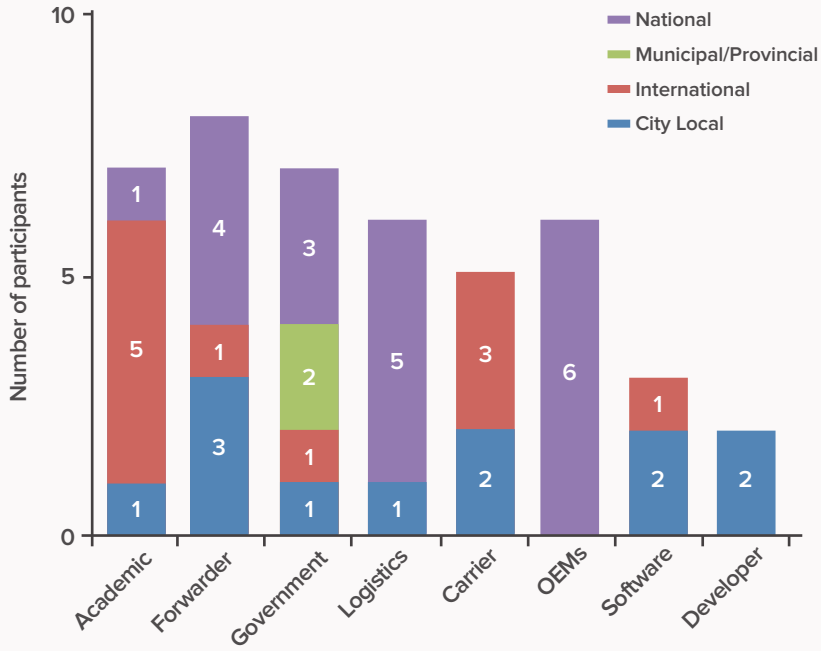
Benefits to participants:

- Show company leadership and be a part of the solution for protecting the environment, reducing emissions, and improving Chinese logistics and trucking energy efficiency
- Have a voice in the conversation with high-ranking representatives from China's largest and most innovative trucking and logistics companies as well as local and national policy makers
- Collaboratively identify profitable solutions that align with societal interest

Diverse participants were the key ingredient—over one thousand years' collective experience in the room!

- Over 50 leading stakeholders in attendance, representing entire ecosystem—industry, government, local and international subject experts
- Focused on industry decision makers at director, general manager, or C level

CHARRETTE ATTENDEES



The two-day agenda was designed to build group understanding and create collaborative solutions.

Day 1 - April 26, 2016

Morning: arrive 08:00, begin 08:30

- Introductions & orientation
- Shared vision & objectives for this event
- Key findings from Reinventing Fire
- **Breakout #1:** understanding the current reality
- Plenary Synthesis: group & prioritize barriers

Lunch: 12:30

Afternoon: 13:30–17:00

- **Breakout #2:** find leverage points, collaboration opportunities to overcome barriers, give room for new ideas to emerge
- Plenary synthesis
- **Breakout #3:** idea generation
- Plenary synthesis & closing remarks

Dinner: 18:00 bus from hotel to restaurant

- Cocktails & opportunity for short participant presentations
- Dinner
- Bus back to hotel: 21:30. Taxis available for earlier/later departure

Day 2 - April 27, 2016

Morning: arrive 08:00, begin 08:30

- Choose top ideas to pursue further
- **Breakout #4:** test & iterate ideas to overcome barriers & move forward
- Synthesis: discuss ideas across groups & gather feedback

Lunch: 12:30

Afternoon: 13:30

- **Breakout groups:** additional working time to finish presentation
- Unveiling solutions: present to group
- Open discussion/reflection, call to action, & discuss next steps
- Closing remarks

End 16:00

We use a “charrette” approach to break through on complex, multistakeholder problems.

Principles of an Effective Charrette:

Open Conversation

- Start from beginner’s mindset: be ready to exchange ideas, listen, question your assumptions, think across disciplines
- Remove hierarchy
- Work in small groups
- Speak your mind: you can say who was here, you can say what was said, but you cannot say who said what

Cross Cutting

- Include diverse participants across all stakeholder groups
- Bring outside expertise
- Develop shared understanding of opportunity and barriers
- Roadmap collaborative solutions

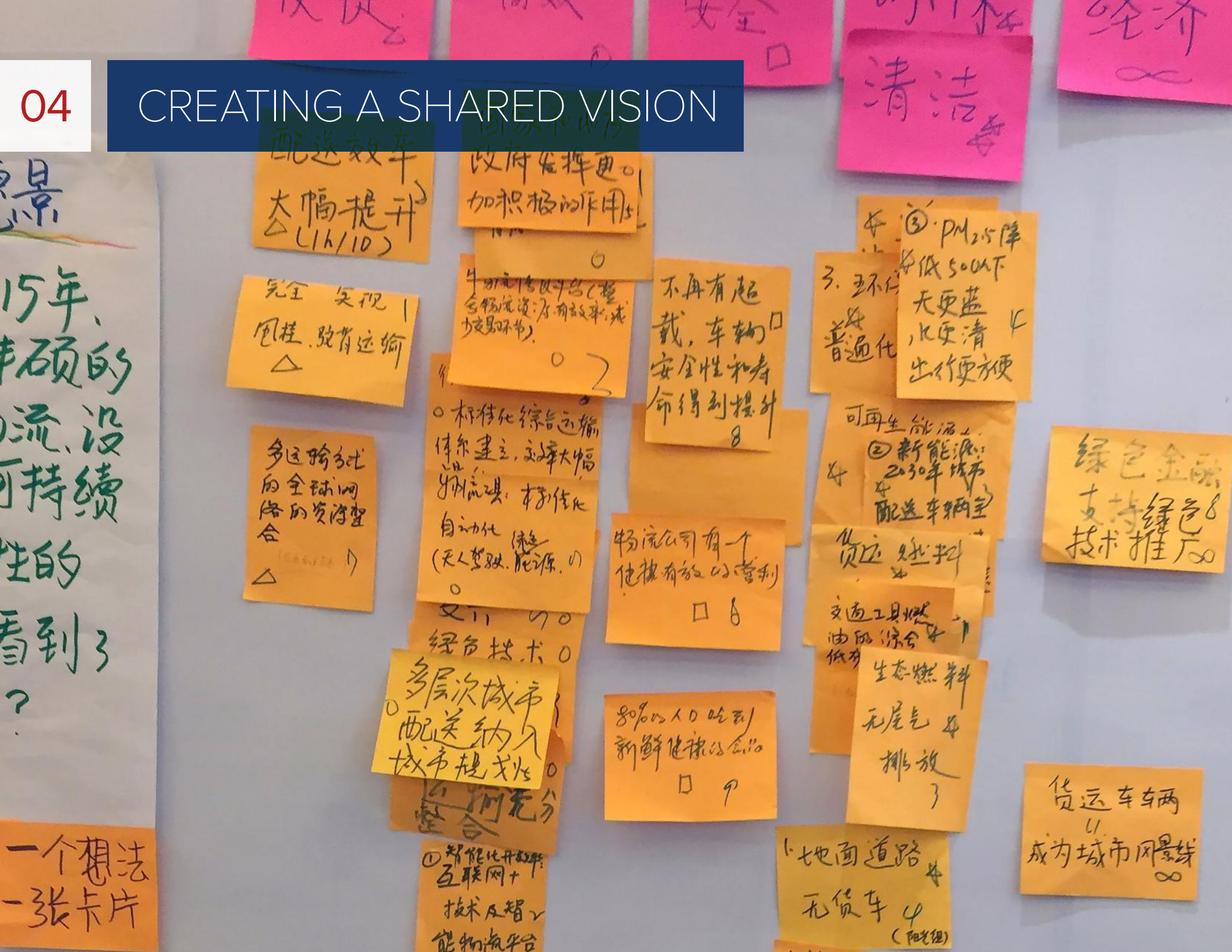
Rapid Prototyping

- Active participation
- Alternate smaller working groups with group sessions
- Generate new ideas, test, and iterate

Actionable Results

- Organize and prioritize necessary solutions
- Find champions to work with government and move forward
- Demonstrated results in many prior engagements

04 CREATING A SHARED VISION



04: CREATING A SHARED VISION

Participants began by creating a shared vision for the future of China's freight industry.

Participants identified five key criteria for the future of China's freight industry.

Creating a shared vision for what's possible by 2030

Clean & Safe

- NEVs adopted
- Trucks are standardized and automated
- Green technologies achieve cost and technical maturity
- AQI reduced to 50, pollution is controlled
- Overloading is eliminated
- Diversified renewable fuels for trucks (EVs and biofuels)

Well-Regulated

- National and local governments improve effectiveness
- The fragmented disorderly market is fixed, logistic firms develop healthy margins
- Multitier urban distribution included in urban planning
- Transportation vehicles are standardized

Fast & Reliable

- Consolidation and electrification greatly increase efficiency of urban delivery
- Infrastructure and management capacity for a seamless global intermodal system is developed
- Rail and IWT are revitalized for long-distance transportation, truck use falls

Low-Cost & Efficient

- Empty running is reduced to 20%
- Energy efficiency of trucks is improved
- Consolidation and specialization bring efficiency
- Efficient cold chains reduce food spoilage and provide fresh food for all
- Lean supply chains reduce cost
- Drop-and-hook and piggy back become common

IT Enabled

- Big data and internet + technologies increase efficiency
- Smart, web-enabled vehicles improve energy efficiency
- Logistics information platforms aggregate information, increase efficiency, and reduce transaction costs

05 UNDERSTANDING BARRIERS

05: UNDERSTANDING BARRIERS

Next, the participants diagnosed barriers and mapped stakeholder interactions.

Long-haul segment barriers (page 1 of 2)

	Barrier Description	Consequence
Market Conditions	• Highly fragmented with an oversupply of trucks and thin margins (90% owner operators) • Regulatory dodging, especially for smaller companies struggling to stay afloat • Regulation (e.g., taxes and tolls) discouraging geographic and enterprise scale as well as specialization (e.g., non-asset based 3PL) • Inability to invest in equipment upgrades • Weak industry coordination and lack of reliable equipment standards • Unreliable fuel quality can destroy some advanced engine and emissions control technologies	• Economies of scale scope and density not achieved • Excessive focus on upfront cost or inability to invest in technology upgrades (even w/ clear benefit/payback) • Prevalent overloading in order to break even • Limited scale, specialization, and innovation. • Unpredictable pallet sizes and tractor-trailer compatibility. Drop and hook uncommon with lots of time spent loading/unloading • Emissions control technologies removed after certification (either factory or consumer)
Business Case	• Many logistics improvements require scale to be effective • Pressure to minimize cost and underbid. Higher value services typical for advanced logistics (e.g., packaging, inventory management, etc.) are not a priority • Poor utilization and short equipment life (due to overloading) hurt payback	• Equipment and management upgrades that make sense elsewhere don't pay back in China • Manufacturers/suppliers don't offer upgrades in response to uncertain demand

Long-haul segment barriers (page 2 of 2)

	Barrier Description	Consequence
Information	• Lack of creditable info on expected benefits and payback • Counterfeit or unreliable product specifications • Online freight markets/load matching uncommon • Awareness of technical options low, especially among small carriers	• Focus on upfront cost at the expense of future maintenance and fuel cost • Upgrades don't perform as expected • Little incentive for companies to invest in quality or innovation
Technology	• Need more R&D for some advanced techs, but current demand is limited/uncertain • Overloading forces engines to operate outside of conditions that they were designed for. Unclear how technology upgrades will perform in the field	• New technologies slow to reach market with limited adoption • Small scale keeps cost high • New technologies break or underperform in real-world conditions
Expertise	• Most organizations don't possess the required IT and management expertise	• Truck productivity low, empty running high. Overall logistics costs stubbornly high

Barriers are complex and interconnected.

Proven technology and design improvements from developed markets can have a hard time catching on in China.

Unreliable Info

- Counterfeit/mislabeled products are common
- Product specifications and testing are inconsistent/ unreliable
- Performance data unavailable for many upgrades
- Data doesn't come from independent/unbiased sources

Equipment Life/Utilization

- Even if reliable info is available, the business case is challenging
- Low utilization (due to poor logistics) and short equipment life (due to overloading) hurts the payback for upgrades
- Unreliable fuel quality can destroy some advanced kits

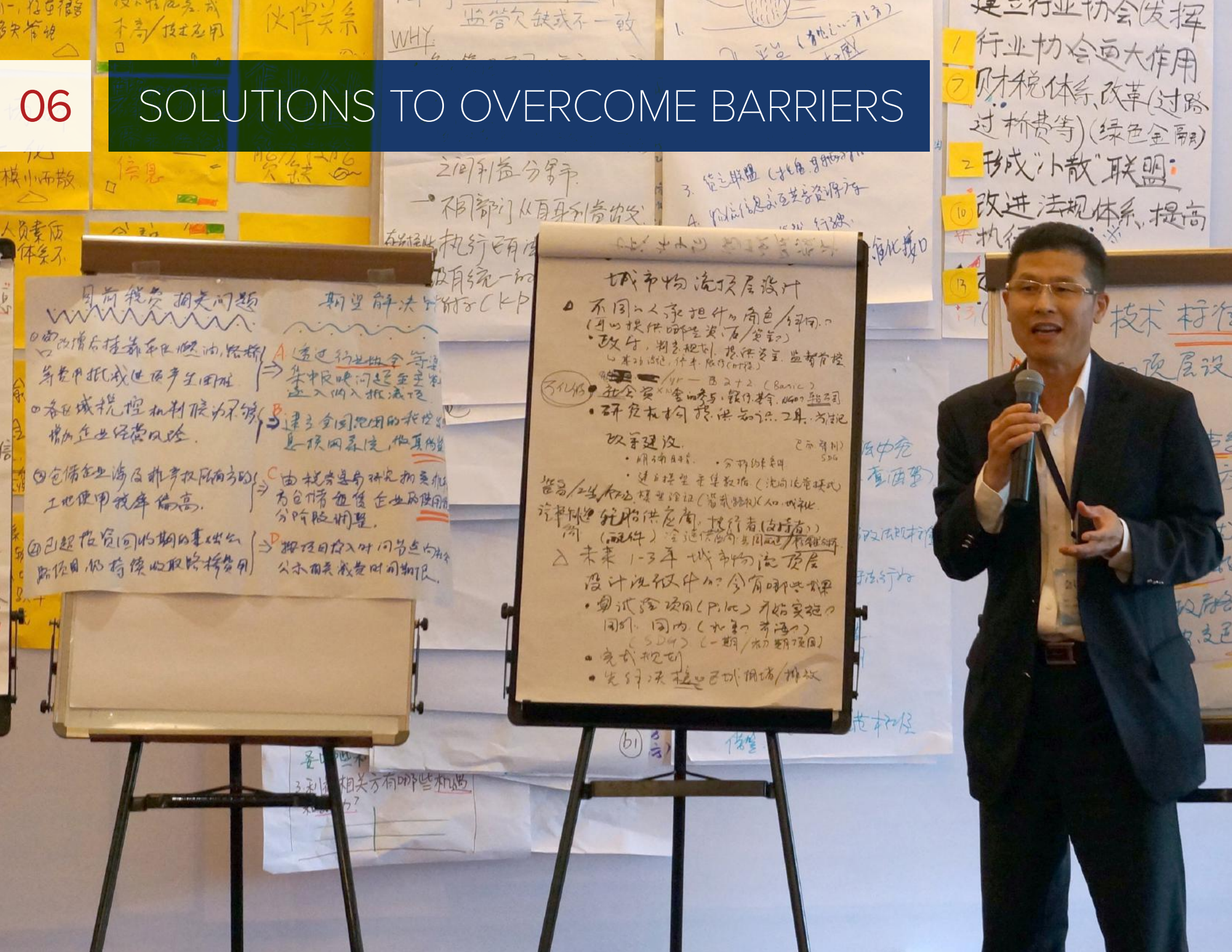
Tech Availability

- Demand for upgrades is low due to info and equipment life/utilization barriers
- Manufacturers/developers hesitant to develop and bring upgrades to uncertain market
- Upgrades are unavailable or high cost due to small scale

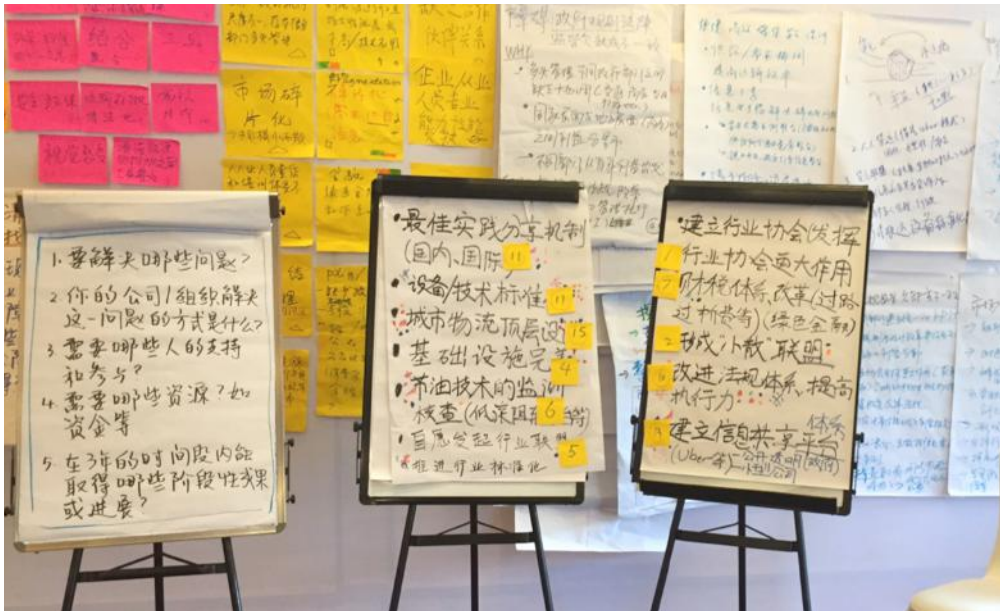
Urban-delivery segment barriers

	Barrier Description	Consequence
Business Case	• Need scale to be cost-effective • Upfront cost is high • Need to align incentives for shared savings • Payback depends on duty cycle for hybrid and electric trucks • Established/efficient supply chains opt out of consolidation	• Poor load factors • Failure to adopt NEVs for urban duty cycles • Brute force regulatory solutions to deal with excessive truck activity (e.g., total restrictions on daytime urban entry for trucks)
Expertise	• Consolidation increases management complexity • Long-term city planning must consider freight flows, parking, and timing of delivery • Difficult to enforce regulation of freight flows into city	• Lack of freight specific infrastructure planning leads to poor efficiency of urban delivery • Regulatory dodging on entry restrictions by using modified LDVs
Technology	• Need more R&D for elec and hybrid trucks, but current demand is limited/uncertain • High costs for today's techs. Capabilities low	• Uncertainty inhibits adoption. Low demand inhibits scale. Cost remains high
Infrastructure	• Planning/placement of consolidation centers • Charging infrastructure	• Excessive urban freight activity. High external costs in congestion, smog, safety, etc.

06 SOLUTIONS TO OVERCOME BARRIERS



06: SOLUTIONS TO OVERCOME BARRIERS



Participants chose five top solutions for overcoming barriers through collaborative action.

SOLUTION 1: Logistics information platform

Status Quo

Logistics platforms help to match supply and demand for trucking services and provide value-add capabilities to shippers such as shipment tracking, process automation, etc.

- Many platforms exist in China, but they are often limited to a particular region or an individual logistics service provider
- APP platforms have been an area of intense entrepreneurial interest but little success
- Platforms struggle with imbalanced supply and demand. Shippers have little incentive to use the platform, and there are many more carriers than available loads
- Technical capabilities of platforms are improving rapidly, but still lack features targeted toward shippers (e.g., GPS tracking, verification of credentials, auto document generation, etc.)

Solution Description

Develop an IT system that enhances operational efficiency and reduces costs for all users

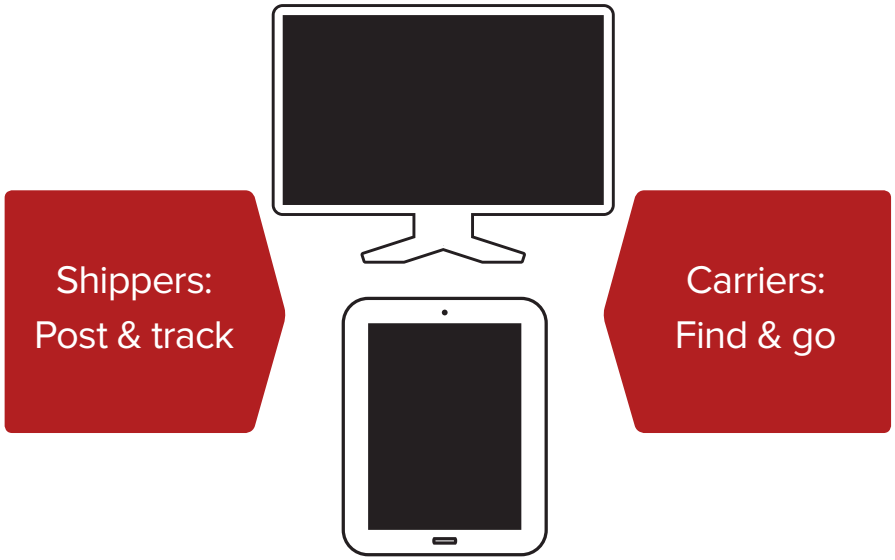
- Carriers benefit from improved asset utilization
- Shippers benefit from improved supply chain visibility
- All parties benefit from automation of business processes
- Could focus on either long-haul or urban freight

Energy Savings Mechanism

- Energy savings comes from reduced empty running through an improved match between freight and trucks
- Reduced dwell time while looking for loads increases utilization—improves the business case for fuel efficiency technologies

Key features:

- Load matching
- GPS tracking
- Payment processing
- Integration with client systems
- User feedback/ratings and verification of credentials
- Auto document generation
- Route optimization



Background and next steps

Focus Areas

Asset Utilization

- Reduced empty running through GPS-based match
- Faster matches reduce dwell time as trucks look for loads
- Shorter, faster routes due to route optimization
- Partial load matching for urban freight

Supply Chain Visibility

- Real-time shipment tracking and monitoring
- Automated breakdown and arrival alerts
- Software as a service transportation management systems for firms without an in-house system

Data Efficiency

- Real-time updates on freight and capacity of availability
- Fully electronic market with automated document generation
- Integration with client-side systems. Cost, late arrivals, and other key data captured and delivered to TMS from platform

Barriers

Barriers this solution addresses:

- Logistics information being fragmented, opaque, and not shared

Barriers to the success of this solution:

- Oversupply of trucks—shippers can find trucks quickly and cheaply without the use of a platform
- Lack of trust that inhibits freight owners from sharing data
- Low levels of IT expertise and poor standardization of logistics data inhibit platform adoption by logistics firms

Next Steps

- Ensure that we have the partners needed to design and implement a successful platform—are current solution providers best positioned to add these new features or do we need someone focused on providing a software solution as opposed to ongoing logistics management?
- Identify an initial market segment for the platform (urban vs. long haul) needs to be determined.
- Identify the requirements that key users will have for system functionality to ensure adoption

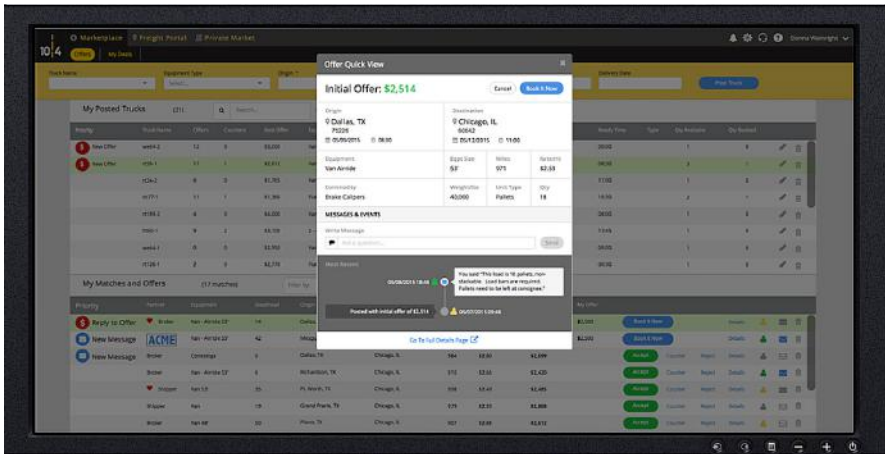
Milestones

Year 1: Consult with industry and government on platform design to ensure that platform has the capabilities to add value for the all stakeholders
End of year 1: Issue RFP
Years 2–5: Award contract. Build user base and enhance platform capabilities in response to user demand

Next-generation freight-market platforms offer an integrated management solution.

INFORMATION PLATFORM CASE STUDY 1: 10-4 SYSTEMS

Electronic Marketplace

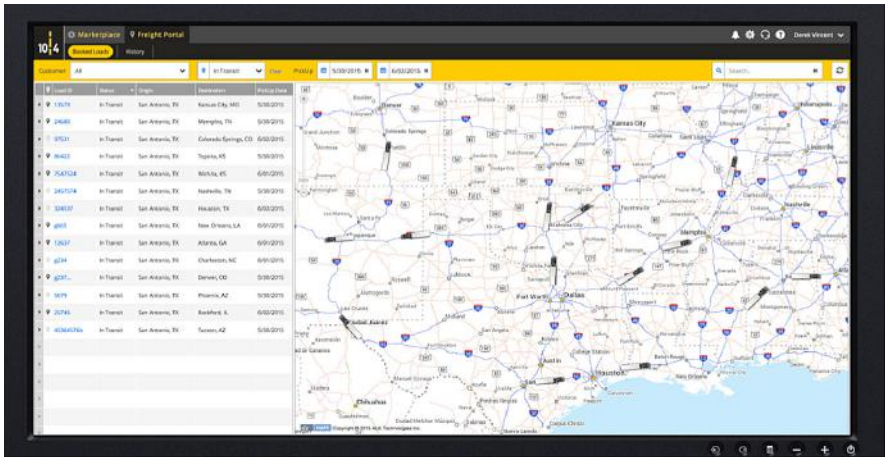


10-4 systems is a fully automated electronic freight market that includes capabilities that are important for shippers, brokers, and 3PLS. It provides automated matching of trucks and freight, an online platform for rate negotiation tendering and payment, shipment tracking with arrival and delay alerts, truck routing optimization and a cloud-based TMS for data collection and analysis and full interoperability with user end systems.

Business case and other benefits

- Reduced empty running, improved carrier selection, improved supply chain visibility, improved data management and use
- Can deliver functionality of a TMS as a cloud-based, software as a service (SaaS), application with low upfront costs

Real-Time Load Tracking



- Integrates functionality of a traditional TMS system, online electronic freight markets, and load tracking and routing optimization systems

Key considerations

- Load matching platforms and APPs, known as ‘Ubers of freight’, have had a poor track record in China. Efficient integration with user end systems requires standardized data transmission formats which may not be widely used in China

Innovative freight-market platforms can improve productivity for urban delivery in addition to long-haul trucking.

INFORMATION PLATFORM CASE STUDY 2: CARGOMATIC

Cargomatic is an app-based platform to match loads with trucks for short-haul freight in major metropolitan areas. It uses GPS to find empty or partially loaded trucks that are well positioned to pick up advertised loads.

Business case and other benefits

- Truckers increase revenue by 15%–25%[17]
- Shippers see cost reduced by up to 70% with shorter delivery times compared to express delivery services like UPS
- Location tracking and arrival alerts help to manage congestion at delivery points and increase productivity
- 90% of advertised loads are successfully booked, providing a reliable tool for shippers in market with tight trucking supply[18]

Key considerations

- Cargomatic's initial success came from L.A., a port city with a very large drayage market. This approach could be applicable in Shenzhen, but may have less demand in other cities. The effectiveness of the platform could be enhanced through integration with government systems like congestion charging, etc. A PPP could be a promising model for implementation

App-based Load Matching

SOLUTION 2: Mechanism for sharing best practices domestically and internationally

Status Quo

- Best-practice sharing in China is rare
- Best-practice sharing that does exist is anecdotal and does not give firms the confidence to act
- Tech verification results are viewed as unreliable or biased by the industry
- Very little business case analysis or aggregation of real world data is published

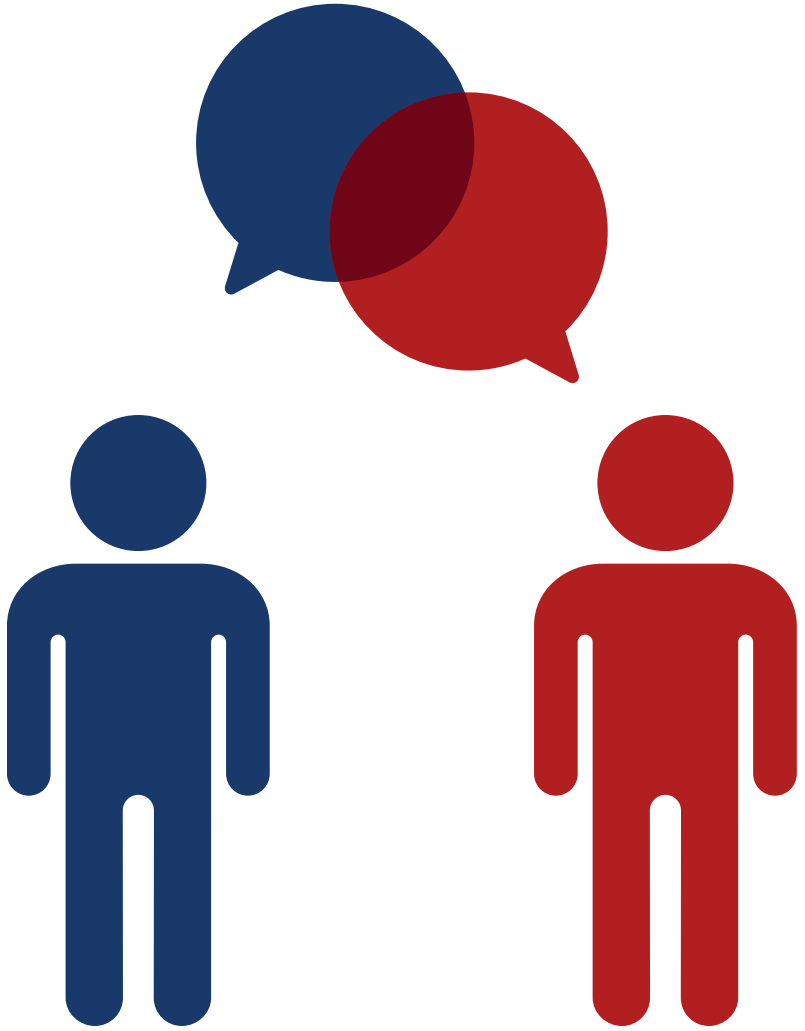
Solution Description

Pool industry experience with fuel efficiency technologies to support the decision to invest in energy efficiency

- Fleets are typically aware of options to improve fuel economy but cannot evaluate their business cases
- Four key areas: technology verification, piloting, economic analysis, and real-world data gathering
- Technology verification can credibly establish the effectiveness of the technology
- Piloting can give real world results with limited risk
- Economic analysis can clarify total costs and benefits
- Real-world data gathering can clarify costs and benefits in actual operations

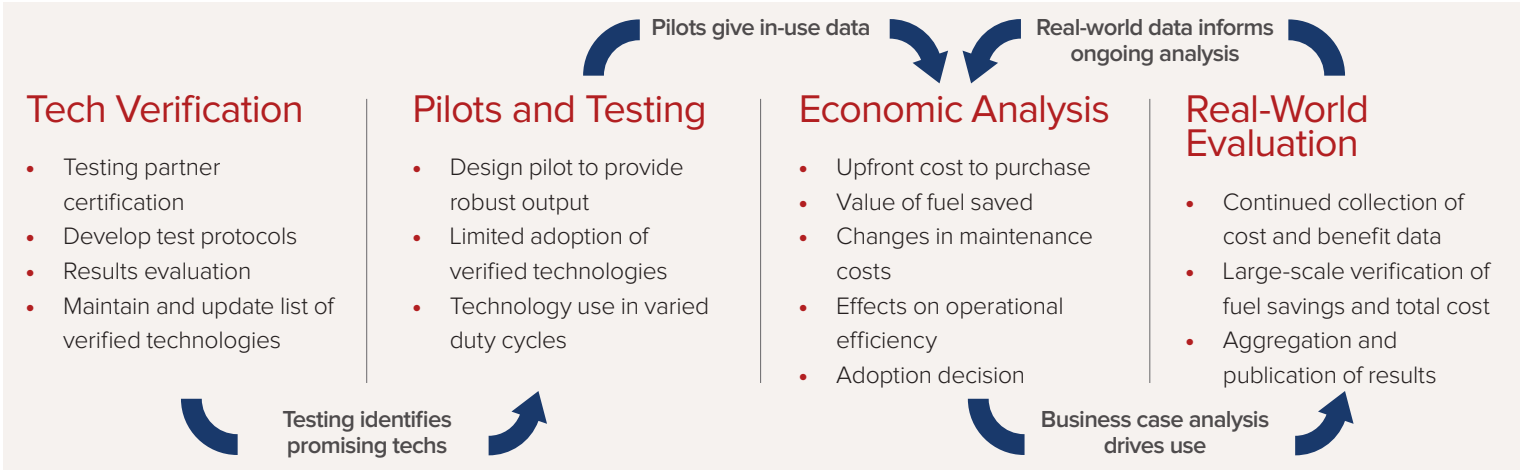
Energy Savings Mechanism

- Potential to focus on any and all potential avenues for energy efficiency
- Most likely focus on technical measures to increase fuel economy
- Operational efficiency is a very promising area for energy savings, but solutions are not easily transferable



Background and next steps

Focus Areas



Barriers

Barriers this solution addresses:

- Opaque and unreliable information about the technical and cost effectiveness of fuel efficiency technologies
- Lack of partnership mechanisms and low levels of training for industry players

Barriers to the success of this solution:

- Building collaborative relationships between competitors, especially if sharing data threatens competitive advantage

Next Steps

- Build a group of industry players that can deliver on the premise of effective information sharing—need initial set of anchor partners that can then draw critical mass after launching
- Determine funding model/source (e.g., membership dues) and hold a founders meeting to officially launch

Milestones

3 Months: a committed group from industry agree on a process for tech verification, data gathering, analysis, and sharing
1 Year: First analysis (e.g., base fuel economy of trucks in real-world operation) completed and results published
Subsequent years: expanded portfolio of technologies identified and experience shared

EPA SmartWay provides a robust technology verification platform.

BEST PRACTICE CASE STUDY 1: U.S. EPA SMARTWAY TECH VERIFICATION[19]

U.S. EPA SmartWay provides technology testing and verification services for three classes of technologies to reduce fuel consumption—idle reduction, aerodynamics, and low rolling resistance tires—as well as devices to reduce air pollutants from diesel engine emissions. This certification process is respected by industry and commonly acknowledged to be highly robust. Key features of EPA's tech verification protocol include:

Basic testing procedure

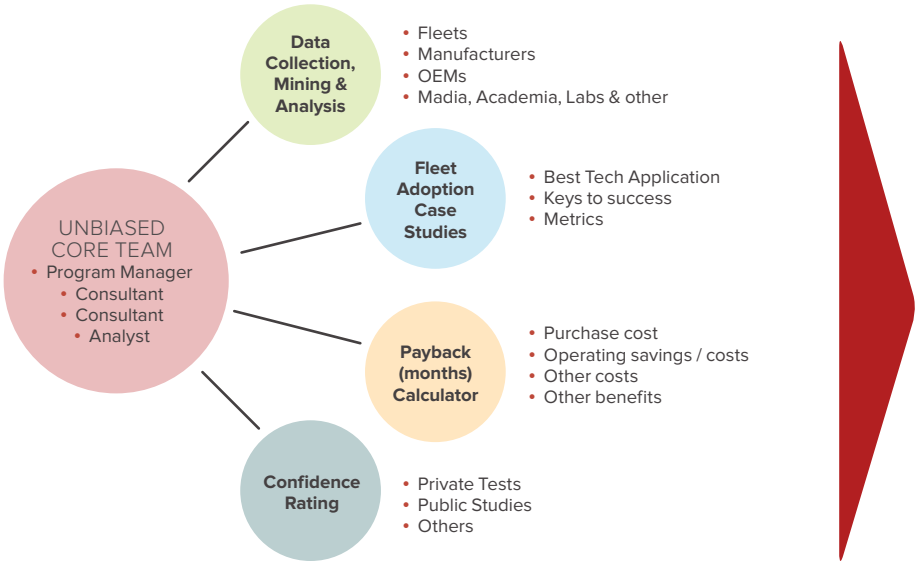
- EPA collaborates with technology provider to design test plan—all test plans require EPA approval
- Testing must be carried out by licensed test partners complying with EPA testing guidelines
- EPA monitoring of testing if deemed necessary
- EPA evaluation of test results, including data and conclusions from test provider

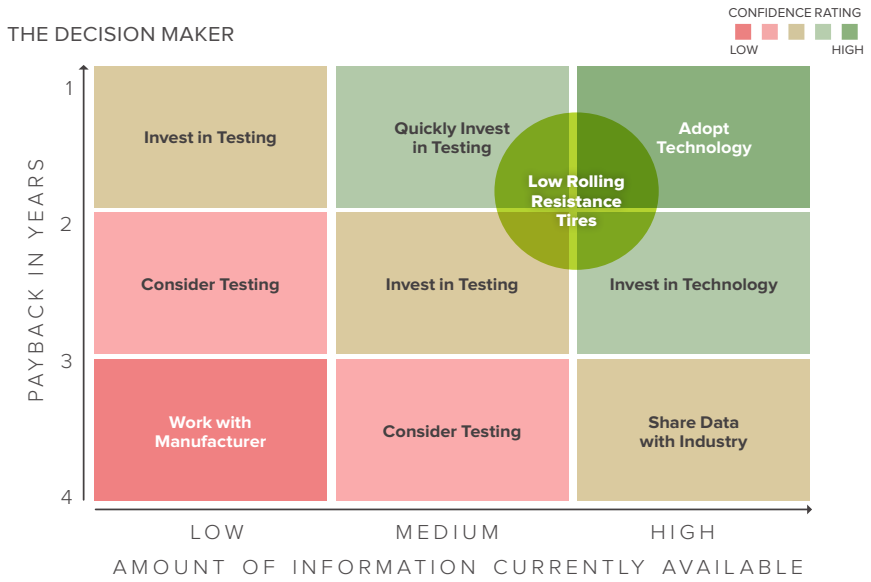
Key considerations

The standards and criteria for effective testing are difficult to design. EPA has extensive experience which China may not have. Partnership with EPA on the design and implementation of effective verification mechanisms could accelerate progress in China.

Clear quantification of the business case for fuel efficiency has been a key driver of technology adoption.

BEST PRACTICE CASE STUDY 2: NACFE CONFIDENCE REPORTS[20]





The North American Council for Freight Efficiency's (NACFE's) confidence reports provide evaluations of individual technologies and make recommendations on adoption. Evaluation is based on payback potential and quality of data about the technology as well as its effect on operational efficiency (e.g., maintenance downtime). Technologies covered include engine, transmission, tires, weight reduction, and aerodynamics, as well as various auxiliary systems.

Business case and other considerations

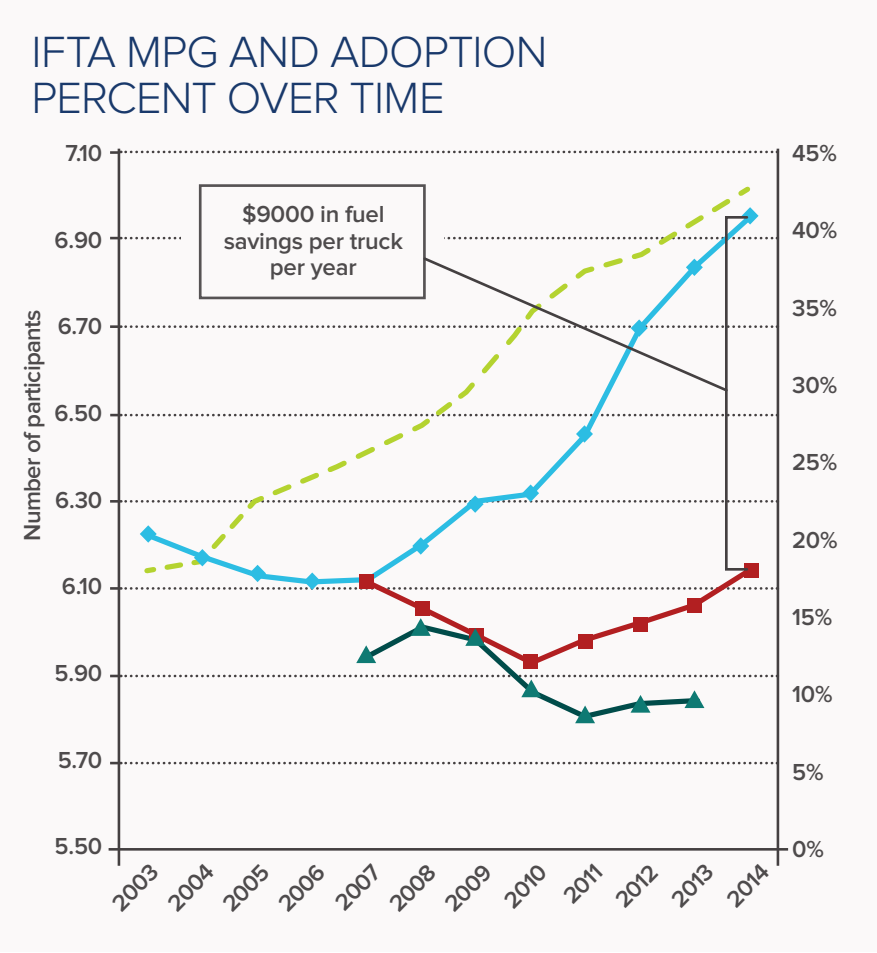
- Cost-driven recommendations on technology adoption based on payback and risk
- Financial modeling tools that allow potential purchasers to model payback for a range of duty cycles and fuel prices
- Valuable resource for government in formulating rigorous but achievable regulatory targets—consulted as a resource for the new round of U.S. HDT fuel economy regulations

Key considerations

- NACFE was founded for and by the industry, giving it access to confidential information. That information might not be collected in China and is currently not available to the public

Large-scale data collection on benefits of tech adoption are a check on initial conclusions.

BEST PRACTICE CASE STUDY 3: NACFE FLEET FUEL ECONOMY STUDY [21]



NACFE is a U.S. nonprofit that aims to increase the fuel efficiency of North American trucks. NACFE evaluates the business case for technologies to improve fuel economy in U.S. trucking fleets. Its research combines laboratory evaluations with real-world use data and financial modeling. Many of the top American fleets, 3PLS, and OEMs participate in NACFE and hold board seats.

Business case and other considerations

- Adoption rate of NACFE-recommended technologies in participating fleets went form 18% to 42% between 2003 and 2014
- Adoption of recommended technologies improved fuel economy by 15% to date (38.5 L/100 km to 33.5 L/100 km), saving $9,000 per year, per truck

Key considerations

- NACFE was founded for and by the industry, giving it access to confidential information. That information might not be collected in China and is currently not available to the public
- NACFE recommendations are customized to duty cycles typically seen for U.S. long-haul class 8 trucks. Technology recommendations are not directly transferable to China

SOLUTION 3: Gain logistics and energy efficiency through improved standardization

Status Quo

- Standardization in Chinese logistics markets is low
- Many different sizes and types of trucks exist, creating difficulty for freight owners who need predictability
- Poor standardization reduces efficiency (e.g., trailers can't connect to trucks and pallets don't fit in trailers)
- Poor standardization makes retrofits difficult (e.g., aero.)
- Poor data standardization make systems integration difficult, reducing supply chain visibility

Solution Description

Create an alliance of logistics firms who implement a set of equipment standards to increase logistics efficiency. Potential standardization opportunities include:

- Coordinated truck and pallet sizes to facilitate optimal loading
- Standardized truck, trailer, and connecting components to support drop-and-hook trucking
- Data standardization to enhance systems integration and improve supply chain visibility
- Standardization of energy efficiency equipment to facilitate truck upgrades

Energy Savings Mechanism

- Truck and pallet standardization can increase load factors and reduce overall activity
- Data standardization improves supply chain visibility allowing for better planning and scheduling that enables consolidation and reduces empty running
- Standardization of connecting components improves truck utilization and the cost-effectiveness of fuel efficiency

SAE standard J560: a standard for the 7-pin connector for tractors and trailers. Poor component standardization reduces truck and trailer interoperability in China

Background and next steps

Focus Areas

Dimensions

- Standardized heights and widths of trucks and trailer
- Standardized vehicle weights and loading capacities

Interoperability

- Standardized connections between trucks and trailers
- Coordinated pallet and truck sizes
- Data standards for information systems interoperability

Scale and Demand Pull

- Technologies selected for standardization in the alliance should provide cost reductions when universally adopted by alliance members (e.g., standardized, interoperable trucks and trailers)
- Observed and documented cost reductions from standardization support ongoing adoption
- Logistics companies can require third-party carriers to conform with standards to win business, helping standardization spread in fragmented market

Barriers

Barriers this solution addresses:

- Uneven enforcement of laws and standards and multiple, overlapping standards

Barriers to the success of this solution:

- Outsourced transportation to small fragmented carriers makes coordination difficult
- Difficulty of forming partnerships among logistics firms who traditionally are competitors

Next Steps

- Form partnership and founders meeting to identify sources for ongoing funding and key standards to be developed
- Work with a standards organization, such as SAE, to develop technical standards for identified areas

Milestones

6 Months: Build group capable of driving standardization; identify key areas for standardization
Year 1: Work with standards organization (e.g., SAE, ISO) to develop technical standards
Years 2–5: Implement developed standards as existing fleets turn over

Equipment standardization enabled global trade.

STANDARDIZATION AND INTEROPERABILITY CASE STUDY 1: ISO CONTAINER [22]

Image: Thomas Maersk loading at Copenhagen in 1970 courtesy of Shipfax, Mac Mackay

Before the ISO container, cargo was lifted off docks in nets and manually loaded onto ships. The process was slow and labor intensive, the container was introduced in 1955 to replace it. In the absence of standards, two types of containers—24' and 33' containers—emerged. Between 1968 and 1970 ISO issued the sets of standards that define the now universal 20' and 40' containers.

Business case and other benefits

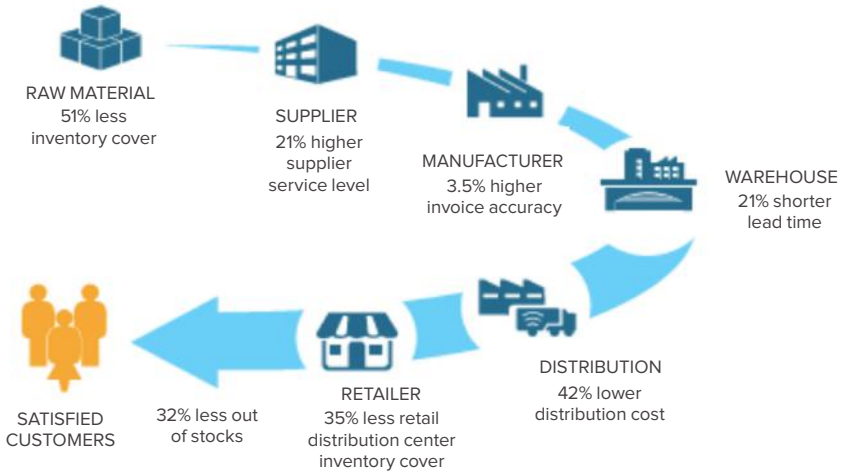
- The cost to ship cargo has fallen by 90% since the beginning of containerization
- Between 1956 and today, the cost of loading cargo fell from $5.86/ton to $0.16/ton
- Port cargo loading rates before 1956 were 1.3 tons/hour, by 1970 they were 30 tons/hour

Key considerations

- In order for standards to be created, the original inventor of the shipping container had to open patents on key components. Standardization can create losses for stakeholders who benefit from a pre-existing monopoly.

Data flows can also be standardized, creating similar efficiencies.

STANDARDIZATION AND INTEROPERABILITY CASE STUDY 2: EDI/XML DATA STANDARDIZATION[23]



Supply chains span many actors: producers, carriers, freight forwarders, warehousing and storage firms, etc. Goods can only move along a supply chain as efficiently as information moves. EDI is a data standard that allows for easy electronic communication and transactions between trading partners. In addition to reducing labor and inventory costs, data standardization can greatly reduce transport costs. When incoming shipments are visible, loads can be consolidated and trucks optimally loaded, saving transport costs and fuel.

Business case and other benefits

- Data standardization, such as EDI/XML, brings multiple benefits including time savings, increased accuracy in order management, transport cost reductions, improved tracking and visibility, lower stock out rates, lower inventory levels, etc.
- Cost of data handling reduced from $10–$20 (or more) per document reduced to $0.01–$0.02
- Shipment consolidation and optimization of truck loads

Key considerations

- Data standardization benefits from a network effect. Costs to implement decrease and benefits increase as a standard's user base grows larger and more established.

SOLUTION 4: Urban logistics planning and design

Status Quo

- Both carriers and consignees are small scale and fragmentation is high
- Trucks are poorly loaded and inefficient, large opportunities exist for consolidation and optimization
- The most common response to externalities caused by urban delivery are brute force tactics, such as day-time entry restriction on trucks
- Responses to regulation, such as modifying passenger vehicles to deliver goods during daylight hours, further erode efficiency

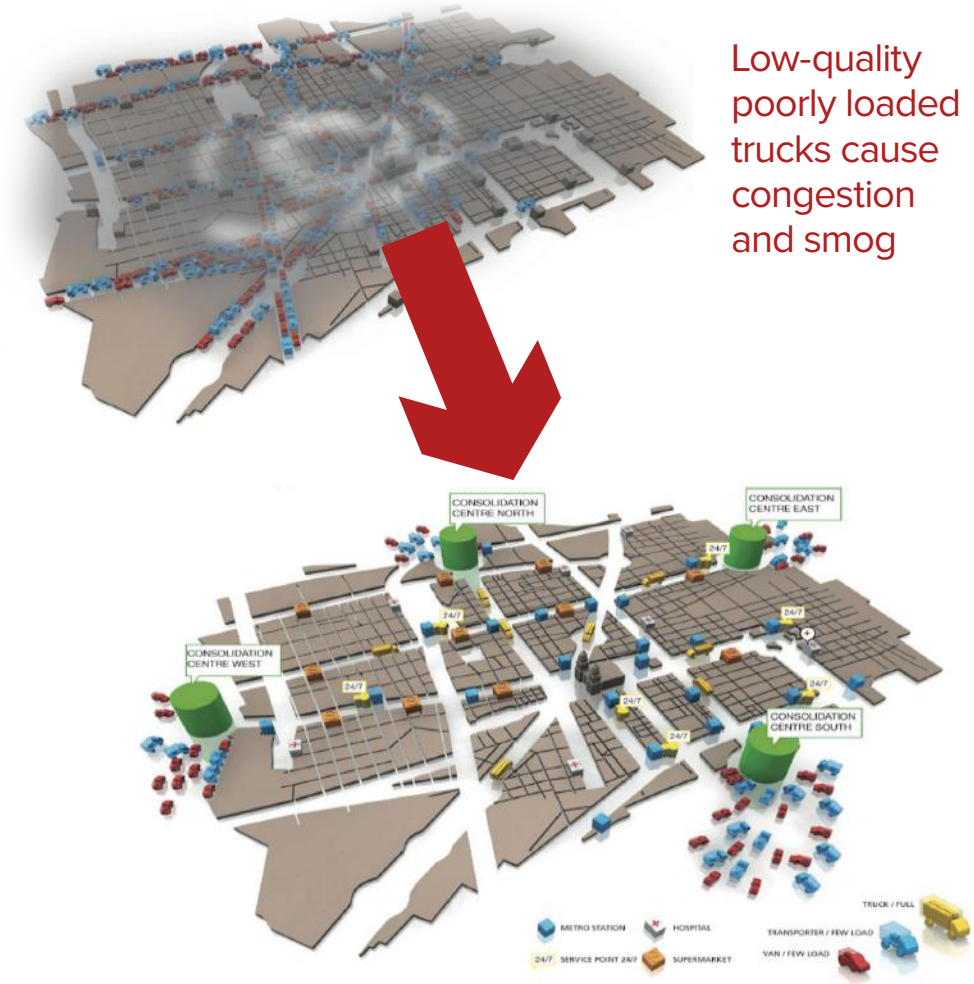
Solution Description

Multistakeholder approach on the design of an urban logistics system

- The design of an urban logistics system is a complex activity which, if successful, can greatly enhance efficiency of final-mile delivery—one of the most challenging steps in the supply chain
- Engaging with various stakeholder in the logistics system design phase (shippers, carriers, consignees, policy makers, developers, etc.) can create a system that minimizes energy use in the final mile and meets the needs of all stakeholder groups

Energy Savings Mechanism

- Consolidation of urban deliveries to improve load factors
- Zoning and land use to shorten lengths of haul and provide better access to arterial roads
- Infrastructure improvements to reduce idling and improve traffic flow
- Identification of appropriate markets for NEVs



Low-quality poorly loaded trucks cause congestion and smog

Efficient, low-emissions trucks deliver consolidated loads on optimized routes[24]

Background and next steps

Focus Areas

Asset Utilization

- Design and location of urban consolidation centers and cross docking facilities
- Optimization of routing and loading of shared delivery trucks
- Business models to encourage participation

Land Use and Zoning

- Efficient location of industrial and commercial facilities
- Avoiding logistics sprawl through effective location of warehousing facilities

Infrastructure

- Urban truck routes to minimize negative externalities of urban trucking
- Truck parking and unloading facilities to reduce logistics costs and improve traffic flow

Technology

- Data collection and analysis
- Urban logistics platforms and ITS
- Low and zero emissions urban freight vehicles

Barriers

Barriers this solution addresses:

- Fragmentation, poor access to information and infrastructural deficiencies reduce efficiency of urban delivery

Barriers to the success of this solution:

- Cost: Both NEVs and consolidation are cost effective in theory but have had poor results in real-world use
- Complexity: the volume, type, and fragmentation of goods flows makes planning difficult
- Business model: Costs and savings accrue differently to different stakeholders, fair allocation is necessary for participation

Next Steps

- Stakeholder engagement and data gathering.
- Creation of a framework for collaborative delivery, infrastructure development needs and roles for EVs.
- Identify policy, market, and financial mechanisms to support successful implementation.

Milestones

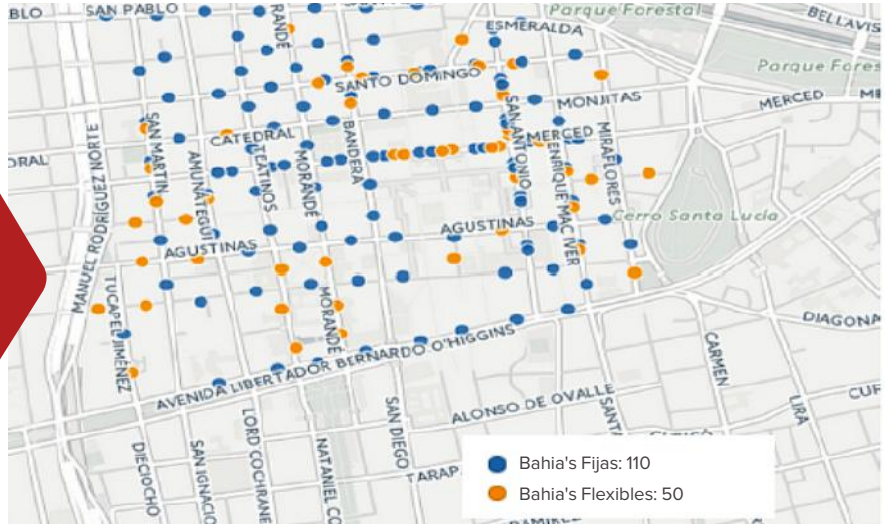
6 months: stakeholder consultation and data analysis completed
Year 1: completion of design and start of implementation
Ongoing: tracking and documentation of results and lessons learned

Data collection and analysis enables infrastructure optimization.

URBAN LOGISTICS PLANNING CASE STUDY 1: SANTIAGO LOADING BAYS[25]

Data collection on urban freight hot spots

Provision of parking and unloading bays



MIT's Megacity Urban Logistics Lab worked with the government of Santiago, Chile, to allocate space for loading and unloading bays for urban trucks. The resulting analysis gave quantity and locations for bays that would meet logistics demand, including surge capacity.

Business case and other benefits

- Reduced circling and driving looking for a parking spot—saving fuel and improving labor and truck productivity
- Reduced double parking by unloading trucks, improving traffic flow and saving energy lost to cars stuck in gridlock and stop-and-go traffic

Key considerations

- This solution was customized to Santiago, insufficient downtown truck parking may not be an issue for all Chinese cities, especially given strong daytime entry restrictions for trucks in many large Chinese cities.

The London Construction Consolidation Center applied consolidation to building materials delivery.

URBAN LOGISTICS PLANNING CASE STUDY 2: LONDON CONSOLIDATION CENTER[26]

National Suppliers

Consolidated Last-Mile Delivery

The London Construction Consolidation Center (LCCC) was initiated in order to reduce truck traffic to and from construction projects in downtown London. LCCC received and warehoused bulk shipments from 341 Suppliers all over the UK. As materials were needed at the site, daily deliveries from the consolidation center were made by a single truck to all 4 projects.

Business case and other benefits

- Reduced vehicle journeys into the city center by 60–70% leading to CO_2 reductions of 70% to 80% due to reduced truck driving
- Deliveries arrived correctly and on time with 97% reliability compared with a baseline of 39%
- Time savings of 10% for contractors due to more timely deliveries, 20% for suppliers due to avoided urban driving

Key considerations

- Downtown congestion pricing mechanisms enhanced business case for consolidation. Construction supply chains tend to be less efficient than for higher-value goods, there is more room for improvement. Adding the UCC to supply chain made it difficult to attribute responsibility for late or lost orders. Building materials market is very relevant to a rapidly urbanizing China.

Hybrid-electric drivetrains are cost-effective for urban delivery applications, and plug-in hybrids are near the tipping point.

URBAN LOGISTICS PLANNING CASE STUDY 3: HYBRID URBAN DELIVERY VEHICLES

Hybrid Delivery Vans[27]

Image: UPS Hybrid Electric Vehicle courtesy UPS

UPS is a leading logistics provider with an extensive urban delivery network. It piloted hybrid delivery vehicles to reduce cost and emissions.

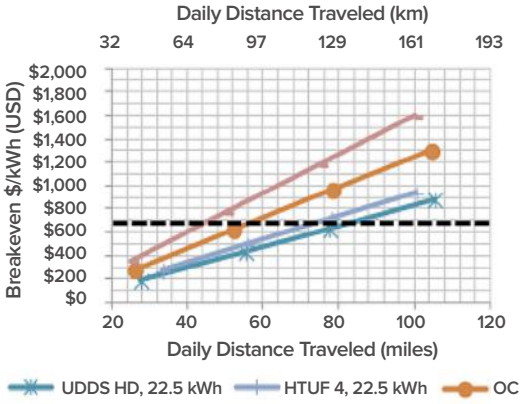
Business case and other benefits

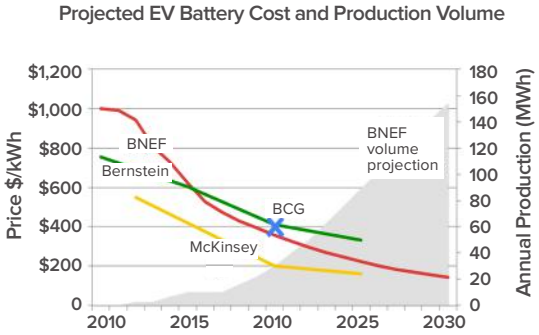
- 23% gain in fuel economy, 19% savings in fuel cost/mile
- UPS was satisfied with investment and increased purchase of hybrid vans

Key considerations

- Favorable duty cycle: 70 miles per day, primarily urban and residential. About 15% of time idling.

PHEV Light Duty Trucks[28]





Plug-in Hybrid Electric trucks rely on electric propulsion until batteries run out, then switch to normal diesel propulsion.

Business case and other benefits

- On a typical urban duty cycle, approximately 90 miles per day are needed to break even
- At $400/kWh and $3.23/gal diesel PHEVs become cost effective for many applications and duty cycles
- Currently, batteries are $300/kWh but diesel cost has fallen to $2/gal.

Key considerations

- The value of PHEV technology is greater for more stop-and-go duty cycles, like NYComp and OC Bus.

SOLUTION 5: Reform of taxes and tolls

Status Quo

Current taxes are excessive and distort incentives.

- Tolls account for between 10–20% of expenses for Chinese trucks, 15x higher than the U.S.
- Local and provincial taxes often favor local enterprises, reducing the cost advantages of large, efficient national operations and perpetuating fragmentation and small scale
- Other tax policies discourage certain types of specialization (e.g., certain land use taxes increase costs for non-asset based 3PLS)

Solution Description

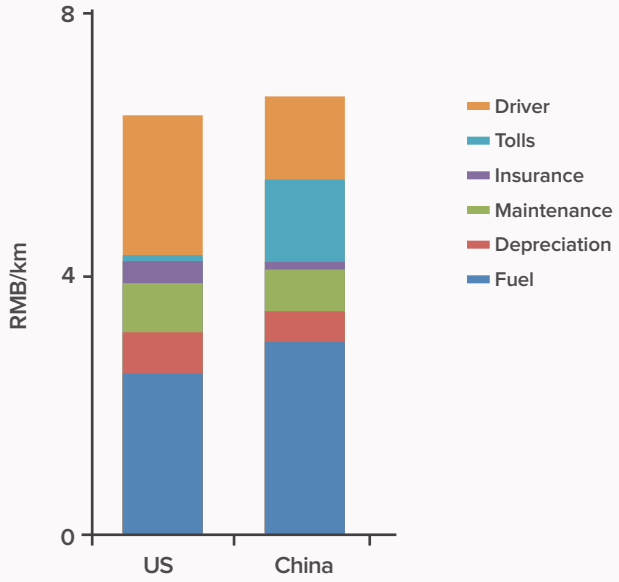
Reform the current tax collection and monitoring system, reduce the tax burden on transport companies, and increase coordination in local tax collection policies

- Rationalize excessively high tax rates to expand margins and reduce the need for aggressive cost minimization through overloading and illegal modification of trucks and the purchase of low-cost/low-quality trucks
- Reduce costs of long distance transportation through toll reform
- Reform protectionist local and provincial tax frameworks that favor local logistics enterprises

Energy Savings Mechanism

- Increase carrier margins, enabling to invest in fuel savings technologies with longer paybacks
- Eliminate taxes that disincentivize scale and specialization in order to foster the expertise and scale that create logistics efficiency

Tolls in China are much higher than in the U.S.



Background and next steps

Focus Areas

VAT

- Business VAT reform eliminated deductions for fuel and tolls, thus effectively reducing driver income, which was already at subsistence levels

Regional Taxes

- Regional taxes are disparate and often protectionist. This complexity and favoritism disincetivizes scale

Land Use Tax

- The land use tax for companies who lease warehouses is high, hampering development of asset light 3PLs and increasing inventory costs

Tolls

- High tolls continue to be charged even after the cost of infrastructure has been recovered, greatly increasing costs of long distance transport

Barriers

Barriers this solution addresses:

- Inefficient tax codes inhibit scale and specialization and the ability to invest in technologies with longer paybacks, like fuel economy

Barriers to the success of this solution:

- Regulatory overlap and differing incentives for different levels of government. For example, the central government may focus on logistics efficiency as a development priority, while local government may focus on revenue maximization and protecting local business

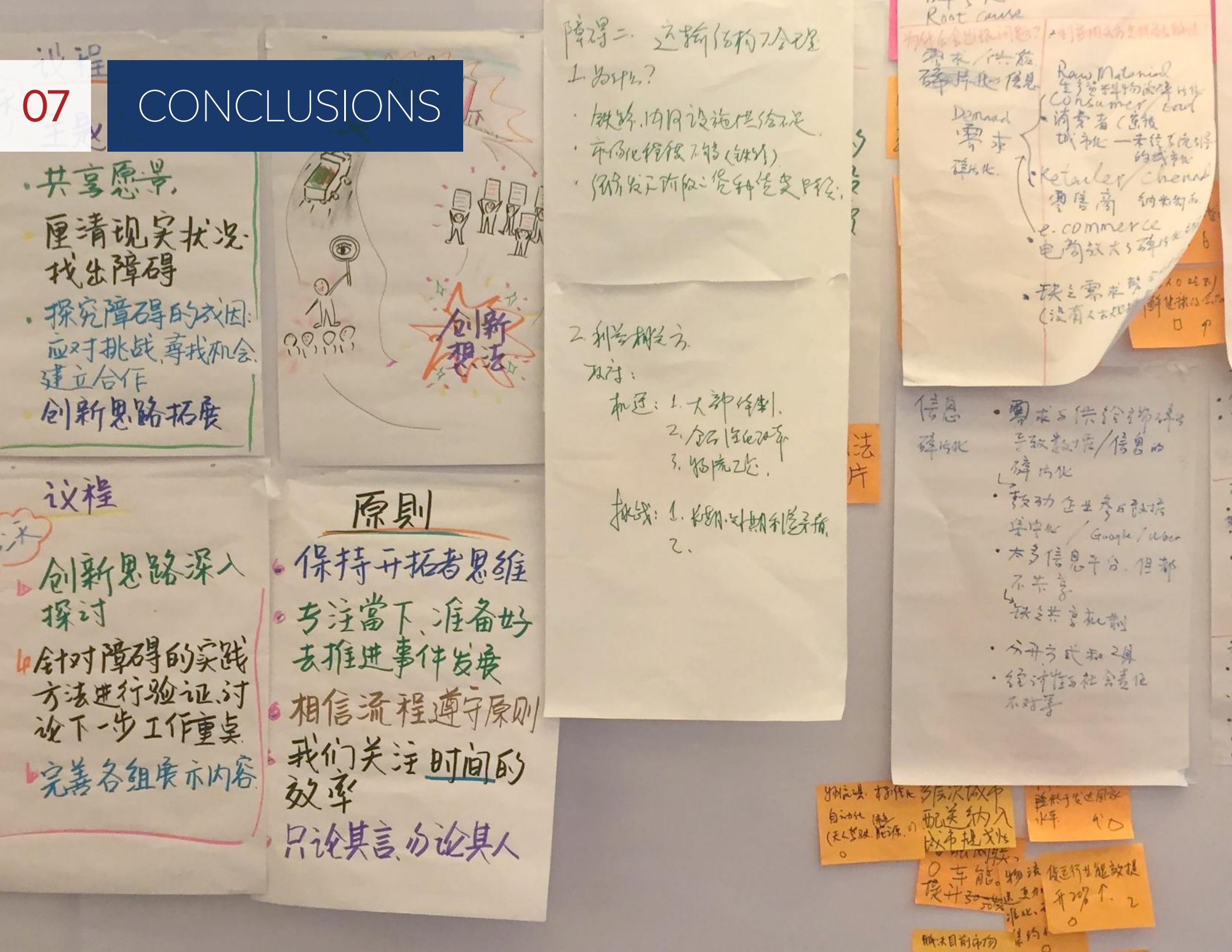
Next Steps

- Consultation between industry and government to identify key areas of tax inefficiency
- Consultation between different levels of government to ensure that tax reform is implementable and that potential revenue losses for local and provincial government are manageable

Milestones

3 months: Working group assembled
Year 1: Document outlining key tax reforms published

07 CONCLUSIONS



07: CONCLUSIONS

The problems in Chinese logistics markets are systemic; no single stakeholder can solve those problems by itself. Progress must be based on coordinated collaborative action by all relevant stakeholders.

Government can help the system by:

1. Improving transparency and effectiveness of enforcement. Upholding minimum operating standards to ensure that only qualified enterprises can enter market.
2. Evaluating current tax and toll systems to identify taxes that create disincentives to efficiency, scale, and specialization.
3. Unifying overlapping and conflicting standards and policies; coordinating tax codes at various levels of government.
4. Coordinating with industry for the design of urban delivery systems that meet logistics demand but minimize external costs.

Carriers and logistics providers can help the system by:

1. Investing in management and IT capabilities that improve truck utilization and operational efficiency.
2. Working with OEMS and suppliers to formulate and adopt standards, both for equipment and data, that increase logistics efficiency—improving truck utilization and reducing empty running.
3. Recording and sharing data about the cost and technical effectiveness of equipment and practices to improve energy efficiency. Identifying manufacturers and products that claim fraudulent efficiency gains.
4. Collaborating with municipal governments to design and implement effective urban logistics plans.
5. Devising business models to engage in collaborative logistics that transparently and fairly share cost savings.

OEMs can improve the system by:

1. Investing in the capabilities to produce high-quality and highly fuel efficient trucks.
2. Working with government to formulate rigorous testing procedures that give the market the confidence to invest in efficiency.
3. Working with government to craft effective, implementable regulations on fuel economy.

Technology providers can improve the system by:

1. Working with shippers, carriers, logistics providers, and government to design and implement public logistics information platforms that can help to bring organization and operational efficiency to a trucking market that is dominated by owner operators and other very small firms. Identifying and implementing features that will encourage adoption from critical user groups, like shippers and freight forwarders.
2. Working with shippers and supply chain mangers to implement data standards that can give transparency and predictability to supply chains.

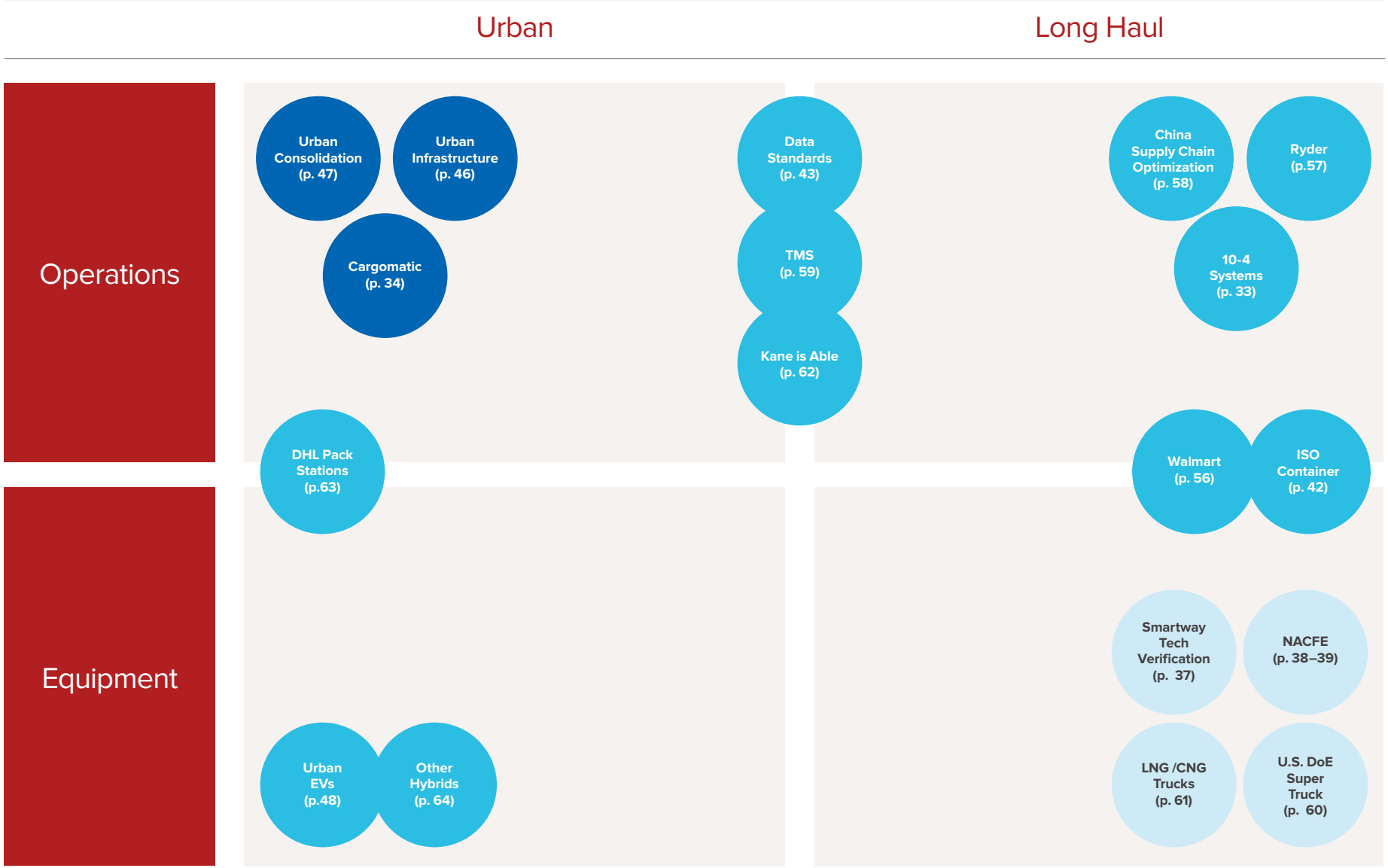
Shippers can improve the system by:

1. Evaluating the tradeoff between price minimization and quality of service provided to ensure that they are minimizing total cost and not incentivizing destructive behavior.
2. Identifying and rewarding carriers and logistics firms that can deliver superior energy and environmental efficiency at equivalent cost.

Thank you to all of our participants!

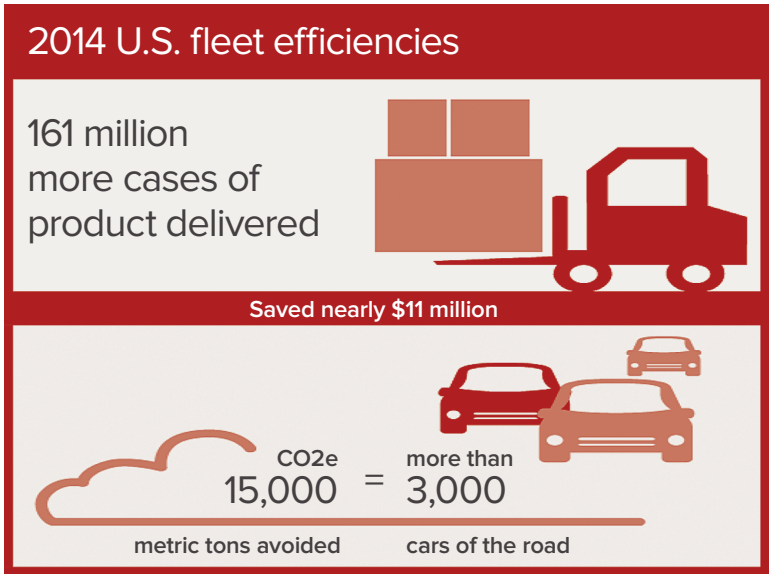
08 APPENDIX

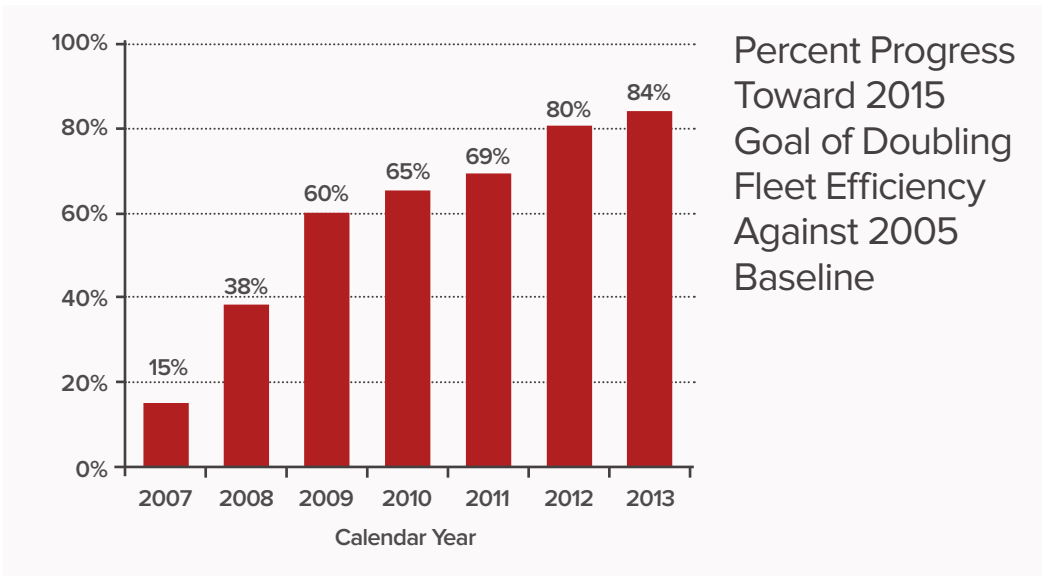
Selected Case Studies



Walmart is doubling the efficiency of its fleet.

EFFICIENT LOGISTICS CASE STUDY #1: WALMART[29,30]





In 2005, Walmart set a goal to reduce fuel use per pallet delivered by 50% by 2015, by the end of 2014 that goal was nearly 90% accomplished.

Walmart focused on several key areas to realize those gains. It worked with suppliers to reduce packaging; improved pallet configuration when loading trucks—improving capacity use; optimized routing to shorten trips, avoid congestion and reduce empty miles; replaced 2/3 of tractors in fleet with newer more efficient models; added side skirts to trailers to improve aerodynamics; and trained drivers on efficient truck operation.

Business case and other benefits

- $1 Billion in savings, compared to 2005 baseline, primarily from reduced driving.
- 650,000 metric tons of CO_2 abated, also compared to 2005 baseline.

Key considerations

- Walmart owns a large fleet enabling it to train drivers and make equipment purchase decisions. It also has and manages its own supply chain, which increases its ability to optimize the system. For example, correctly assembled pallets were key to being able to improve loading efficiency. Strong purchasing power allowed it to influence suppliers in areas like reduced packaging.

Third party logistics providers (3PLs) manage customer fleets and small carriers as efficiently as large shippers.

EFFICIENT LOGISTICS CASE STUDY #2: RYDER

3PLs are a key means of increasing trucking efficiency through effective use of trucking capacity. In the U.S. the 3PL industry is relatively mature. 34 3PLs in the U.S. have annual revenue of over USD 1 Billion. Ryder is one example of a highly efficient U.S. 3PL. Ryder helps clients optimize distribution networks to improve truck productivity, manages clients fleets to help shippers fill backhauls and aggregates small carriers and owner operators to bring scale and expertise to a fragmented market.

Business case and other benefits

- Network design and truck routing shortened travel distance and saved $200,000/year for a truck component manufacturer[31]
- 3PL solution led to 45% better use of truck volume, or “cube”, saving client $280,000/year single corridor
- Filling backhauls with incoming raw materials saved $500,000/year for a building materials company[32]

Key considerations

- Trucking markets are relatively healthy in the U.S., regulation is well enforced, and market players have confidence in contractual arrangements. National scale is more easily reached in the U.S. because interstate commerce is federally regulated, there is very little local protectionism. In U.S. trucking markets, in contrast to Chinese markets, there is a shortage of trucking capacity—adding incentives to invest in improving truck productivity.

Supply chain optimization can improve asset productivity and mode selection.

EFFICIENT LOGISTICS CASE STUDY #3: PETROCHEMICAL SUPPLY CHAIN OPTIMIZATION

Supply chain optimizations brings many benefits, including reduced transport cost, improved customer service, shorter lead times and lower inventory costs. One China based 3PL worked with a petrochemical producer to optimize its supply chain. The resulting hub-and-spoke network model improved mode selection and truck productivity.

Business case and other benefits

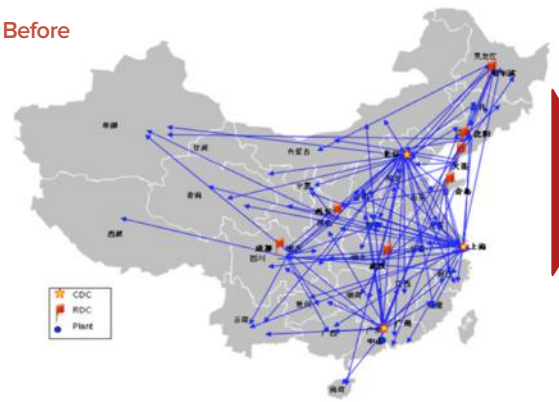
- Average load factor, a productivity metric closely linked to empty running, increased by 60% (15.2 tkm/km to 24.3 tkm/km)
- Energy intensity of transportation fell by 33% (from 2.2 L/100 tkm to 1.48 L/100 tkm)
- Truck operating costs fell by 32% (from RMB 0.5/tkm to RMB 0.34/tkm)[33]

Key considerations

- This company had a national scale distribution network, making optimization a sensible step. The nature of the product they were shipping, wet bulk, is well suited to transport by low cost modes such as water.

Optimized Truck Routing

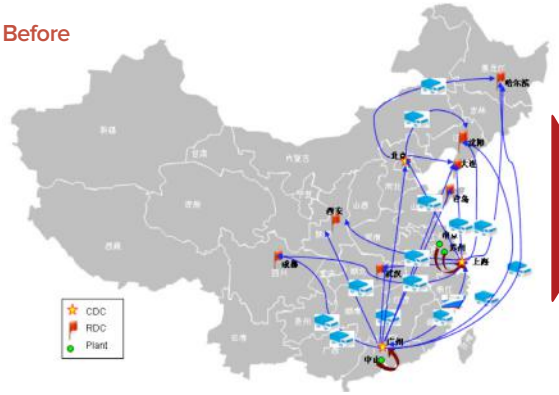
Before



After

Improved Mode Selection

Before



After

Transportation management systems (TMS) are a key enabler of management efficiency.

EFFICIENT LOGISTICS CASE STUDY #4: ROI ANALYSIS OF TMS[34]

High levels of IT deployment have been a key factor for logistics efficiency in the U.S. and EU. Transportation management systems collect and use data about transportation use and cost. They have a wide variety of financial benefits with the most significant savings coming from energy savings opportunities such as mode selection, efficient truck routing, and effective equipment loading.

Business case and other benefits

- Users who switched to TMS from a manual system enjoyed cost savings in nearly 90% of cases. In 75% of cases cost reductions were greater than 5%. In 25% of cases cost reductions were greater than 10%
- Knock-on efficiencies can be achieved through transport optimization with a TMS that include: Improved customer satisfaction (63% of adopters), warehouse efficiencies (38%), Inventory reductions (26%), improved cash flow (21%)

Key considerations

- Primary users are 3PLS who provide transport services and shippers who operate their own fleets. IT Solutions such as TMS and computerized vehicle routing systems (CVRS) provide increasing benefit as the size of the fleet they manage increases. This technology is not applicable to owner operators or very small logistics service providers.

Key Areas in Which TMS Reduces Freight Spend

SAVINGS BUCKETS	NO SAVINGS	SAVINGS <2%	SAVINGS 2-4%	SAVINGS 5-7%	SAVINGS 8-10%	SAVINGS >10%
Increased Usage of Preferred Carriers	32.7%		Most Common		Largest Possible	
Better Procurement Negotiations	42.3%		Most Common		Largest Possible	
Lower Cost Mode Selections	30.8%		Most Common			Largest Possible
More Fully Loaded Equipment	44.2%		Most Common		Largest Possible	
Better Routing	30.8%		Most Common			Largest Possible
Reduction in Carrier Overcharges	38.5%	Most Common	Most Common			

Cost-effective, proven technologies exist to meet and surpass the fuel economy standards being implemented by regulators today.

HEAVY DUTY TRUCK CASE STUDY #1: U.S. DOE SUPERTRUCK PROGRAM[35]

Supertruck was a U.S. DoE program which challenged OEMs to increase the efficiency of trucks by 50% over the current baseline with a technology package that would pay back in 3 years or less. Participants included the top HDT OEMs supplying America markets (Volvo, Cummins, Daimler, and Navistar). All participating OEMs found pathways to meeting or surpassing the target.

Business case and other benefits

- Real world efficiency of increases of 115% were achieved—Volvo truck reached 22.7 L/100 km
- Navistar tracked economics of a 20% improvement in engine brake thermal efficiency (BTE). All improvements paid back in less than 2 years, some in as little as 6 months under real-world operating conditions

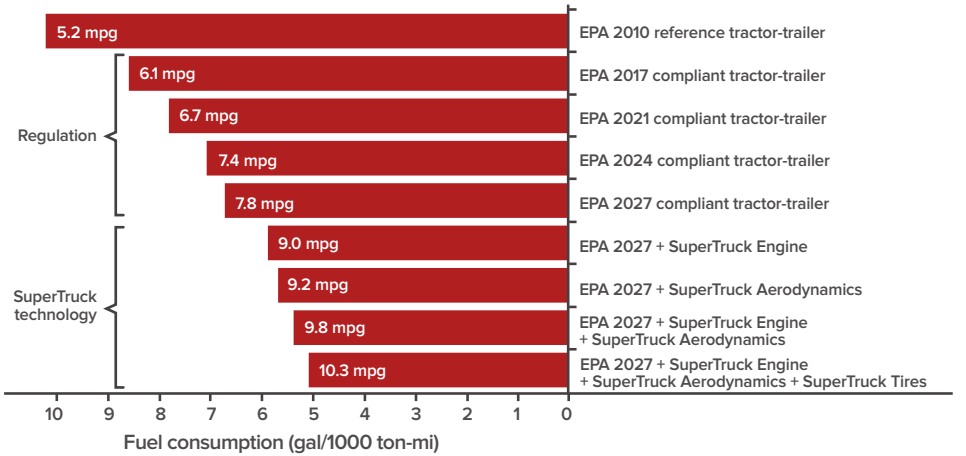
Key considerations

- Technology impact and business case assessment assumes an American duty cycle. Assumed average speeds of 65 mph put a large focus on aerodynamics, which may not be as applicable in China. Not all OEMs published data on cost effectiveness, some technologies not currently considered cost effective for HDTs, such as advanced waste heat recovery systems and hybrid drivetrains were included in the supertruck designs.

Economics of Engine Efficiency

TECHNOLOGY	BTE IMPROVEMENT (%)	PAYBACK (YEARS)
Combustion	7.7	0.5
Air Systems	2.2	1.2
Friction Accessories	2.7	0.5
Turbo Compounding	4.8	1.6
Overall	17.4	0.9

Achieved Efficiency Gains by OEM



Natural gas trucks can displace diesel at reduced cost.

HEAVY DUTY TRUCK CASE STUDY #4: HYBRID URBAN DELIVERY VEHICLES

Heavy Duty Trucks – USA[36]

Image: Truck running on natural gas; Pavaglione CC Attribution-Share Alike 3.0 Unported

Enviro Express is in the business of commercial and residential waste removal and ash removal from trash incinerators.

Business case and other benefits

- $90,000 incremental cost for LNG truck
- Fuel costs of $0.36 /mile vs. $0.69/mile, approximately 100,000 miles per year produced 3 year payback
- 25 tons CO_2 emission reduction per truck-year

Key considerations

- 2 trips of 220 miles per day—within 300 mile range limit. Begins and finishes day at depot. Duty cycle of 80% interstate highway 10% arterial roads avoids congestion and limits risk of running out of gas.

LNG Trucks – Guangdong[37]

Trucks using natural gas have advantages over diesel trucks in several aspects including emission control and fuel cost. Refueling infrastructure shortages and uncertainties around business case have limited market size, but growth is accelerating. Currently most of the companies using LNG trucks are vocational trucks like dump trucks.

Business case and other benefits

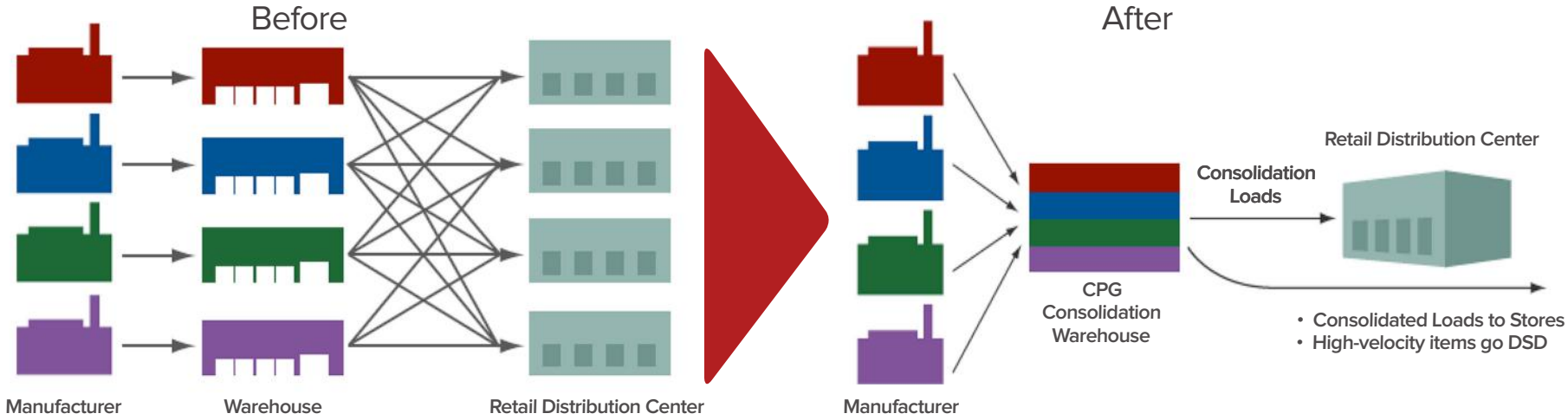
- Truck cost is $50,000–$60,000—an incremental cost of approximately $15,000 per truck over diesel truck
- Infrastructure costs of $18,000–$23,000 per truck, including refueling station, pipeline construction, liquefaction and other equipment. Fuel savings of $10–$13 per 100 km
- GHG emissions reductions of 30% per km versus diesel truck
- Great reductions in pollutant emissions(PM > 90%, SOx >95%, Nox >15%)

Key considerations

- Market is currently small. Only 290 LNG trucks were in use in Guangdong by 2013, far less than 1% of the total truck population. These trucks are typically vocational trucks with short range duty cycles (e.g., dump trucks).

3PL management of multiple supply chains can help enable consolidated delivery without government support.

URBAN LOGISTICS CASE STUDY #1: KANE IS ABLE[38]



Kane Is Able is a U.S.-based 3PL that specializes in collaborative warehousing and distribution for consumer products. Under this scheme companies which supply the same retail outlets—typically large stores such as Walmart or Carrefour—store products at a 3PL managed warehouse. As outlets restock, the 3PL consolidates orders from various suppliers and delivers them with a single trip.

Business case and other benefits

- Documented transport cost reductions of up to 62% through cost sharing of delivery. Savings grow with participation[39]
- Documented lead time reductions of 20% or more
- Improved unloading dock usage at stores, decreasing parking lot congestion and increasing worker productivity
- Increased efficiency at stores as consolidated pallets are ready to go directly to shelves with no further sorting

Key considerations

- Market served, large retail outlets, is different from smaller corner stores that are common in China. Participants worry that confidential information (i.e., who they sell to) could be shared. Allocating cost reductions of consolidation can be contentious.

Delivery points can also be consolidated.

URBAN LOGISTICS CASE STUDY #4: DHL PACKSTATIONS

Home Parcel Delivery

“Packstation” Delivery

Urban goods movement can also be consolidated at the point of delivery. DHL delivers packages to kiosks—known as “packstations”—from which customers can retrieve packages with a secure PIN rather than receiving them at home. This approach reduces truck driving from making home deliveries and reduces idling as drivers carry packages to customers’ door steps.

Business case and other benefits

- Flexible, secure, 24/7 pickup for customers. Mature infrastructure and strategic deployment allows 90% of German population to be within 10 minutes of a packstation. Proximity to public transport infrastructure encourages pickup during commutes
- Reduced delivery point discretization reduces driving and idling of trucks. Elimination of missed deliveries reduces costs
- Increased efficiency at sorting facilities. 40% increase in sorting center throughput attributable to packstations[40]

Key considerations

- Applicable to parcel delivery, especially in the B2C market. A robust network of packstations is necessary to support customer adoption but the Chinese urban delivery market is more fragmented than Germany’s. Many urban deliveries in China are made by e-bike, reducing benefit of packstations.

Hybrid and electric vehicles can also be appropriate for certain heavier trucks.

URBAN LOGISTICS CASE STUDY #5: HYBRID URBAN DELIVERY VEHICLES

Utility Trucks[41]

PG&E is a large utility that operates approximately 200 electric bucket trucks.

Business case and other benefits

- Over $700,000/year in fuel savings
- 2.5-year payback from fuel savings

Key considerations

- Majority of fuel used while idling to power auxiliary functions especially bucket. Engine is often acting as generator rather than for propulsion. Return to depot at night to charge.

Garbage Trucks[42]

Several U.S. cities use hydraulic hybrid garbage trucks such as Portland, Orlando, Miami, and others.

Business case and other benefits

- 45% fuel economy gain saving $10,000/yr
- $12,000/yr in brake cost savings
- $9,000/yr other savings
- $100,000 extra cost, 3-year payback

Key considerations

- Vehicles make up to 1,000 stops per day, reduced break wear was key for cost effectiveness.

Short-Range Drayage[43]

Port of LA has designed an electric truck for short distance container hauls.

Business case and other benefits

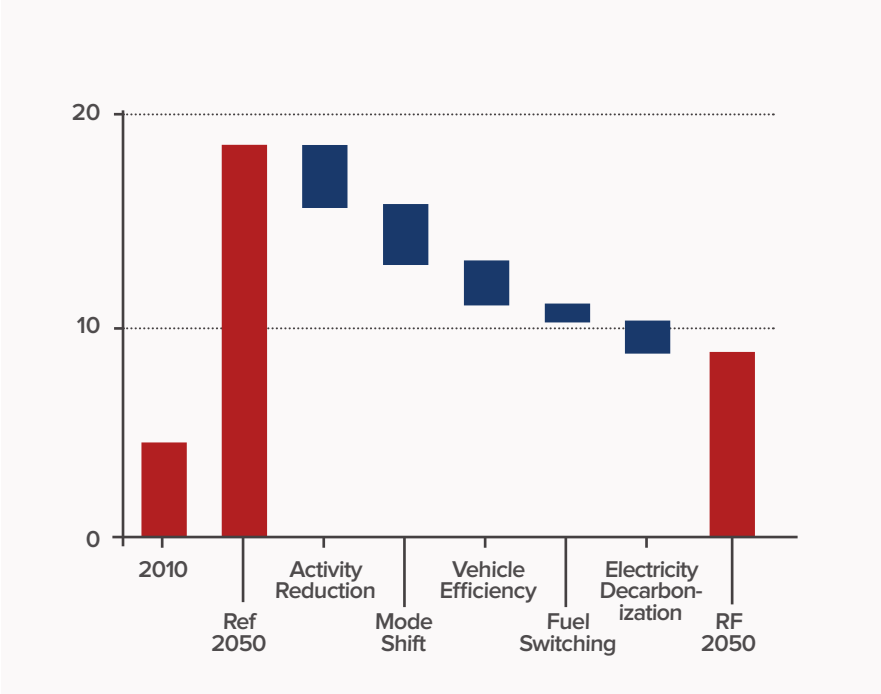
- $208,000 total cost—comparable to other drayage trucks
- Operating cost of $.20/mile vs. $0.90–$1.80/mile for diesel truck (depends on idle time)

Key considerations

- Short routes between ports and intermodal yards. Idling up to 50% of time. Returns to port to charge.

Efficiency in trucking can reduce emissions, save money, and meet key policy goals.

Cost-effective carbon reductions in freight transportation



Policy and development goals that high-efficiency freight transportation can help to accomplish

Economic Development "Accelerating logistics development is urgently needed for China's economic and social transformation. Logistics is an important component of a modern services industry and it enables economic reform, development model shift, and increased international competitiveness."
Ministry of Transportation

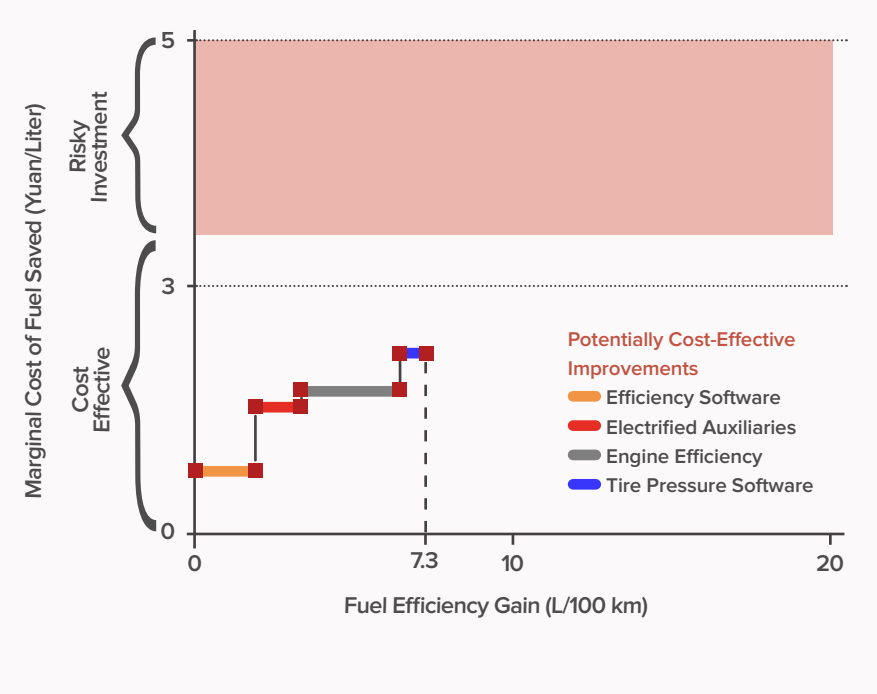
Energy and climate: "Along with the rapid growth of logistics, energy and environmental problems are growing more severe... traditional logistics operational models cannot continue. In accord with the demands of an ecological society, we must adopt the concepts of modern logistics management, ceaselessly improve IT use, standardization and automation... and develop green logistics to save energy and reduce emissions."
Development Research Center of the State Council

Air pollution and urban quality of life: "China is currently undergoing enormous urbanization, which is leading to a concentration of logistics activities in urban areas. Pollution is increasing, congestion is getting worse and road safety is deteriorating. Efficiency gains in urban and intercity logistics are urgently needed as is the establishment of an integrated urban delivery system."
Development Research Center of the State Council

Until recently lax regulatory enforcement and poor management greatly limited cost-effective efficiency.

HEAVY DUTY TRUCK COST ANALYSIS CASE #1: CHINA BEFORE 2010

Cost Curve for HDT Fuel Efficiency



How to read this chart:
This cost curve shows the marginal cost of investing in improved efficiency (y-axis) and gain in fuel efficiency from those improvements (x-axis). The marginal cost is expressed in RMB/Liter of diesel saved—to calculate this metric upfront cost is annuitized and the yearly payment is divided by the yearly amount of fuel consumed. A range of fuel prices are cost-effective depending on discount rate

In this scenario, trucks are widely overloaded and poorly maintained, leading to very short truck life and reduced life for components like tires. Poor management and an oversupply of trucks lead to long dwell times while looking for loads. Slow speeds due to overloading also contribute to low annual utilization.

Modeled Duty Cycle

- 5-year truck life. 65,000 km per year. Tire life reduced by half due to overloading. Average speed of 50 KPH. 38 L/100 km base fuel economy. 10% discount rate

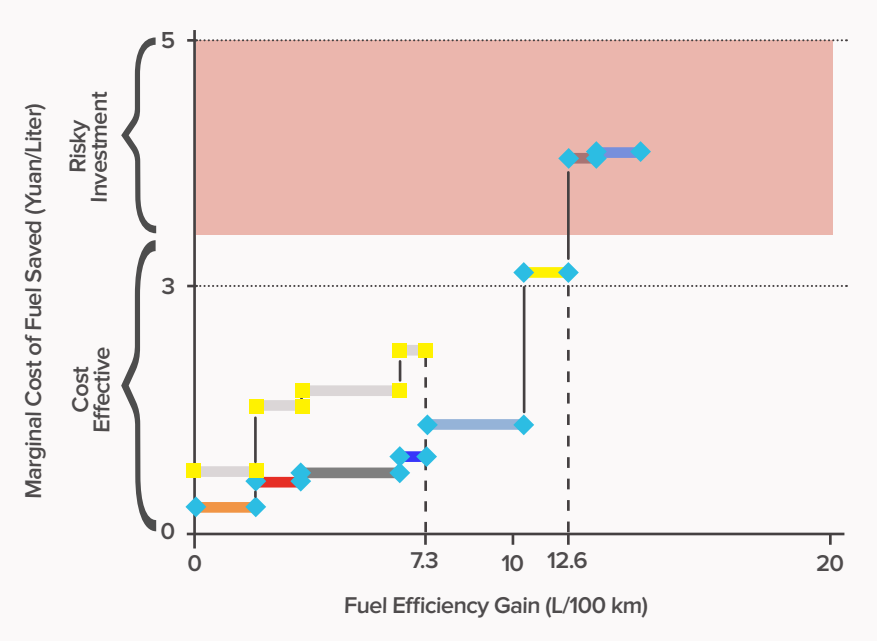
Business Case

- Only most basic technologies are cost effective such as tire pressure monitoring or driver behavior feedback software
- Improvement potential from engine efficiency and electrified fans and pumps exist, but gains from these techs is unpredictable and duty cycle dependent.
- Total reduction of 7.3 L/100 km is cost effective at an incremental cost of approximately USD $4,000–$5,000 per truck

Over the past few years the business case for efficiency has improved.

HEAVY DUTY TRUCK COST ANALYSIS CASE #2: CHINA CURRENT REALITY

Cost Curve for HDT Fuel Efficiency



Potentially Cost-Effective Improvements

- Efficiency Software
- Electrified Auxiliaries
- Engine Efficiency
- Tire Pressure Software
- Aero Improvements
- Transmission/Axle

Technologies with Marginal Business Case

- Turbocompounder
- LRR Tires

In this scenario, logistics practices improve and truck productivity increases. Regulatory enforcement for overloading has improved, especially on East Coast corridors. Truck life is longer and maintenance downtime is reduced. Speeds increase, making aerodynamics increasingly important.

Modeled Duty Cycle

- 8-year truck and tire life. 100,000 km per year. Average speed of 65 kph. 38 L/100 km base fuel economy. 10% discount rate

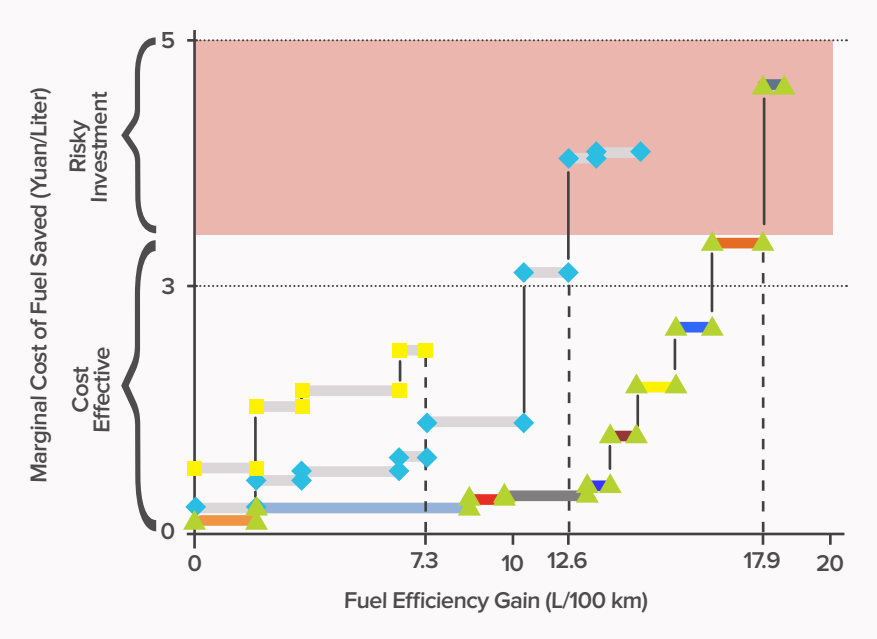
Business Case

- Upgrades to drivetrain efficiency, such as transmission and axle improvements become cost-effective
- Increased speeds make aerodynamics improvements like side skirts, roof deflectors, and gap fairings cost-effective
- Total cost-effective reduction of 12.6 L/100 km is cost-effective at an incremental cost of $20,000–$25,000 per truck

Achieving developed country levels of management enables even further cost-effective efficiency measures.

HEAVY DUTY TRUCK COST ANALYSIS CASE #3: DEVELOPED COUNTRY MANAGEMENT

Cost Curve for HDT Fuel Efficiency



Potentially Cost-Effective Improvements

- Efficiency Software
- Aero Improvements
- Electrified Auxiliaries
- Engine Efficiency
- Tire Pressure Software
- LRR Tires
- Transmission/Axle
- Turbocompounder
- Rankine cycle WHR

Technologies with Marginal Business Case

- Weight Reduction

In the final case, high penetration of advanced IT and management techniques greatly improve utilization. Higher quality trucks last longer, with overloading completely eliminated. Demand for prompt delivery and the need for productivity further increases truck speed.

Modeled Duty Cycle

- 12-year truck and tire life. 185,000 km per year. Average speed of 80 kph. 38 L/100 km base fuel economy. 10% discount rate

Business Case

- Waste heat recovery strategies such as Rankine cycles and turbocompounding become cost-effective
- Complete elimination of overloading extends tire life, creating demand for low rolling resistance tires, and increases speed, further increasing the value of aerodynamics
- Total cost-effective reduction of 18 L/100 km become cost-effective at an incremental cost of $35,000–$40,000 per truck

Charrette background and agenda

Charrette Background & Purpose

- The freight industry in China is an inefficient and highly interlinked system. The problems of the industry cannot be solved by any single actor. Multiple contractors and subcontractors handle shipments as they make their way out of a factory, over roads, through warehouses, and ultimately to their final destination. The costs and rewards for improved efficiency are spread unequally over shippers, carriers, freight forwarders, logistics companies, governments, and society at large. This charrette convened a representative subset of the logistics industry in China to identify and advance whole systems solutions to energy use and emissions in the Chinese logistics industry.

Vision

- The first step in building China's freight system of the future is imagining it. Participants worked together to paint a picture of an ideal freight system that could be implemented in China by 2030.

Barriers and Root Cause

- Vision in hand, participants then diagnosed the barriers that were in the way of achieving their 2030 freight vision. First, participants identified and grouped barriers. After that the participants broke up into groups and selected the most important barriers for further analysis. During this root-cause analysis session, small groups diagnosed the reasons barriers existed and the contributions needed from various stakeholder groups to overcome them.

Solution Generation

- Participants first brainstormed solutions to overcome barriers to the vision. After brainstorming, solutions were grouped together and participants voted for the top five. Participants then broke into small groups to further develop the solution areas. At the end of the charrette participants left contact information on projects they were interested in working on further.

Charrette background and agenda

A CLEAN, EFFICIENT, SAFE, RELIABLE, CONVENIENT, AND COST-EFFECTIVE LOGISTICS SYSTEM	CLEAN, LOW-EMISSIONS VEHICLES ARE UNIVERSALLY ADOPTED	POLICIES, STANDARDS, AND REGULATIONS ARE PERFECTED	EQUIPMENT	THE EFFICIENCY AND COST-EFFECTIVENESS OF TRANSPORTATION INCREASES	CLEAN AND ENVIRONMENTALLY FRIENDLY	SAFE AND ENVIRONMENTALLY FRIENDLY	EQUIPMENT BECOMES STANDARDIZED AND CLEAN	VISUALLY APPEALING	INTEGRATED
Logistics information platforms (aggregate information, increase efficiency, reduce transaction costs)	Electric vehicles are universally adopted for urban delivery by 2030, rail increases for long distance transport	A standardized intermodal transport system is built and efficiency greatly increases	Global Intermodal networks integrated	Cities become smart and electrified	PM2.5 is reduced to 50 or less, skies are blue, water is clean, transport is convenient	Overloading is eliminated, the safety and usable life of trucks improves	Food spoilage is reduced to below developed country levels	Trucks become a pleasant sight	Urban logistics are consolidated and cities become smart, low carbon, and clean
Increase efficiency through IT: Internet + technologies, smart logistics platforms (Big Data)	Green technologies and measures achieve scale	National and local governments improve their effectiveness	Transport vehicles are standardized and automated	Drop-and-hook and piggy-back become common	The problem of a small, fragmented, and disorderly market is solved	Green finance supports the spread of green techs.	Renewable energy trucks spread		
Delivery efficiency greatly increases	A comprehensive low carbon solution for transport fuels (electric & driverless)	Information is integrated and shared across transport modes	Non-road transport modes (rail, IWT) are revived	Empty running is reduced to 20%	Truck fuel supply is diversified	Logistics companies develop health margins and profits	80% of the population has access to fresh health food		

Charrette shared vision (cont'd)

A CLEAN, EFFICIENT, SAFE, RELIABLE, CONVENIENT, AND COST-EFFECTIVE LOGISTICS SYSTEM	CLEAN, LOW-EMISSIONS VEHICLES ARE UNIVERSALLY ADOPTED	POLICIES, STANDARDS, AND REGULATIONS ARE PERFECTED	EQUIPMENT	THE EFFICIENCY AND COST-EFFECTIVENESS OF TRANSPORTATION INCREASES	CLEAN AND ENVIRONMENTALLY FRIENDLY	SAFE AND ENVIRONMENTALLY FRIENDLY	EQUIPMENT BECOMES STANDARDIZED AND CLEAN	VISUALLY APPEALING	INTEGRATED
Consolidation, specialization and standardization in logistics and delivery	Green trucks are commonly used	Different modes are seamless and efficiency integrated.	Diverse modes are all integrated	Giti tires' production facilities don't need warehouses (lean supply chain)	Biofuels with zero tail-pipe emissions				
Energy efficiency in freight transport increases by 20%	NEVs are universalized	Multi-level urban distribution is included into urban planning	Trucks are eliminated from roads						
Smart, web-enabled vehicles improve energy efficiency by 50%									

Key barrier categories

MARKET	REGULATORY	FINANCIAL	INFORMATION	HUMAN CAPITAL	TECHNICAL
Disorderly Markets	**Enforcement is lacking or uneven**	Lack of financial support for green vehicles and systems	**Information is fragmented, opaque and not shared**	Lack of skills and abilities in industry participants	The capabilities of NEVs are low and costs are high
Markets are fragmented—enterprises are small in scale	Lack of policy tools, barriers to entry are low, monitoring is poor		Public awareness of issue is low (consumers, drivers, management)	Awareness and training systems for industry participants are low	
Lack of partnership	Policies, laws, and regulations exist but enforcement is uneven, many agencies with overlapping authority		Asymmetric information creates poor load factors and high empty running		
Market is fragmented—supply, demand, and information					

*Barriers in **bold** were selected by group for further in depth analysis—see notes for results*

A brainstorming session proposed solutions that could overcome barriers.

INFORMATION IS FRAGMENTED, NOT SHARED, AND OPAQUE	REGULATORY ENFORCEMENT LACKING OR UNEVEN	DISORDERLY MARKET AND COMPETITION	LACK OF FINANCIAL SUPPORT FOR GREEN VEHICLES AND SYSTEMS
Industry organizations receive data from government (cases studies, technical standards, training	Reform in the tax system to eliminate conflicts of interest between different levels of government	Understand why illegal activity happens, make laws that can be obeyed and can be enforced	Tax support for logistics companies who adopt green trucks, equipment, and tech
Establish a club or association for sharing information	Single set of KPIs for all regulatory authorities	A public incentive system to recognize lawful operation	Fair distribution of burden of corporate social responsibility
Normal standards like in the aviation industry	Industry associations play a greater role	A small operators alliance	A system for recording and subsidizing green operations
Request the government opens data (licensing, manufacturing, etc.)	Adopt regulatory approaches from the U.S. and Europe	Identify a role for industry associations in elevating barriers to entry	A green finance system for logistics
An innovative platform supported with government resources	Government involves stakeholders in decision-making process	Study and adopt specs and standards from U.S. & EU	Government or PPP invests in green logistics infrastructure (parking, charging, delivery)
An interactive database for sharing logistics information	Tolls and infrastructure use fees are reduced	A shipper-carrier platform	
		An Uber for freight	
		Freight alliance (palettes, drop-and-hook)	

Other solutions identified in brainstorming session.

Coordinate supply and demand to improve transport efficiency	Information sharing: use IT to deal with fragmentation especially for demand aggregation (pack stations, neighborhood delivery)	Top-level design for urban logistics systems	Increase the length of containers
Allow road trains on highways	Allow trucks to fly	Strengthen leadership in the industry	Improve the quality of roads and bridges
Smart trucks (loading and driving)	Standardization of connections for intermodal equipment		

Project ideas were grouped and voted on for further development.

AGGREGATED PROJECT CONCEPTS AND VOTES RECEIVED			
A mechanism for best practice sharing domestically and internationally (11 votes)	**Standardization of equipment and technology (11 votes)**	**Top-level design for urban logistics (15 votes)**	Infrastructure development and completion (4 votes)
Monitoring and verification of energy efficiency technologies (e.g., low rolling resistance tires) (6 votes)	The formation of a voluntary alliance (5 votes)	Found an industry association or increase the effectiveness of current associations (1 vote)	**Reform of the tax system (tolls, taxes, etc.) (7 votes)**
Create a small enterprise alliance (2 votes)	Improve the regulatory system and enforcement mechanisms	**Establish an information sharing system (Uber, etc.) to increase transparency (government, small companies) (13 votes)**	Energy efficiency for LDTs. Engine and drive train efficiency, reduced rolling resistance, light weighting, aerodynamics (2 votes)
Electrification in urban delivery	Natural gas for HDTs	A mechanism for incentivizing companies	Training system to enhance capabilities of industry participants (1 vote)
Information about green logistics (1 vote)	Increased shipper participation (1 vote)		

09 ENDNOTES


CAUTION
9'6"
HIGH
MAX. GROSS
32.500 KG
71.650 LB
TARE
3.830 KG
8.440 LB
MAX. CARGO
28.670 KG
63.210 LB
CU. CAP.
76.4 CU.M.
2.700 CU.FT.

09: ENDNOTES

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