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King Abdullah Petroleum Studies and Research Center

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The Future of Transportation Energy Demand for Freight in Fast-Growing Economies

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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Key Points

Over the last decade, India and China have become leading consumers of energy, especially oil, with freight transportation accounting for a large portion. The growth in total transport energy use is directly correlated with the fast-paced urbanization and industrialization of these two economies. The impact of this road-transport growth has seriously degraded the urban air quality and increased congestion and accidents in cities. In response, a keystone strategy being explored by both countries is to use dedicated infrastructure investments to shift freight movement from road to other modes of transport, including rail. At the same time, road-based transport is becoming increasingly energy efficient, has policy support and retains its door-to-door delivery advantage. The workshop discussion highlighted the following key points:

- Technology efficiencies are not usually adopted unless there is a 'value gap' large enough to incentivize a shift in fuels or mode of transport.

- The long-term objective to shift from road to rail transportation could be aided by investment in infrastructure and economic policies that make rail a more economically attractive option. Effective first and last mile delivery will depend on the integration between road and rail infrastructure. Vehicle efficiency improvements, and the development of cleaner, alternative fuels and technologies, could provide short-term relief to the problem of urban air pollution.

- The modal shift could be expedited through increasing the capacity of the rail system, reducing freight time by developing an inter-modal network and competitive pricing strategies, and improving transfer efficiency. Rationalizing subsidies and policy support to road freight could also help achieve this modal shift.

- Conducting a well-to-wheel analysis on the efficiency of alternative fuels and technologies, considered to be low-carbon emitting, helps to understand their overall emissions. This allows policymakers to take the transfer of emissions from one phase of application of these technologies to another into consideration.

- Creating a master-plan for a multi-modal system that looks at the interactions of different modes in a particular economy could enable a more dynamic freight network.

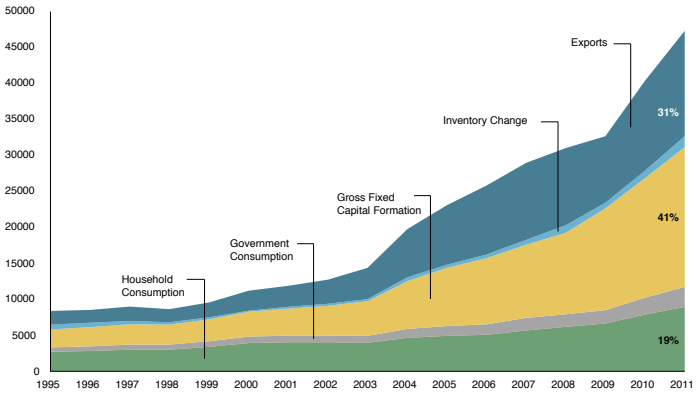


Figure 1. China's freight movement by final demand 1995–2011 (billion tonne kilometers).

Source: KAPSARC analysis.

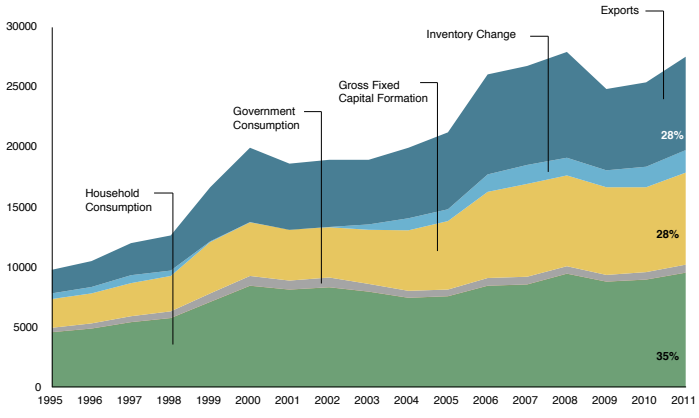


Figure 2. India's freight movement by final demand 1995–2011 (million tonne).

Source: KAPSARC analysis.

Summary for Policymakers

India and China are both pursuing strategies to shift modes of freight transportation, to increase the energy efficiency in the movement of goods, relieve traffic congestion and meet emissions reduction objectives. Transport represents the largest oil-consuming sector, with motor gasoline and diesel the predominant fuels of choice. Reforming this sector is a priority for both countries, to enhance their energy security and reach their decarbonization goals. Currently, freight in India and China is dominated by road-based transport, creating intensive regional road use. Indian national highways only make up an estimated 2 percent of all its roads but account for 40 percent of the country's traffic. Trucks in India and China are also often over-loaded, leading to the fast deterioration of road infrastructure. Around 48 percent of rail lines in India and around 65 percent of rail lines in China are electrified. Shifting freight from road to rail in both countries could help reduce road congestion and energy intensity.

Effecting such a shift requires a thorough understanding of urban and regional transport infrastructure and the policy ecosystem. Inefficiencies in policy execution can impede the development of new infrastructure.

Since mobility is a derived demand, the economic and geographic composition of demand within a country will affect how and what products are moved. With increasing economic development, the industrial economy is moving from low value-added goods to high value-added goods, creating demand for efficient and timely freight movement.

A lack of flexibility in the rail system could make it less competitive and less reliable than road transport. The increasing fuel efficiency of trucks goes some way to addressing emissions reduction in the short term, with new, more fuel-efficient, fleets being used for long haul.

Road freight has increased in India and China at the expense of rail. This is due to rail capacity constraints, first and last mile delivery issues, structural changes in economies and isolated policymaking. Trying to curb escalating domestic transportation energy consumption while meeting the rising demand of freight mobility represents a major challenge for policymakers. China's rail system had limited freight capacity when its economy began to strengthen. This limited capacity, combined with a lack of new infrastructure development, resulted in rail becoming a bottleneck to economic growth. The movement of goods, including bulk commodities, were shifted to road transportation, leading to the latter's significant growth. India has anticipated a high growth of freight mobility since its economic development began to accelerate in recent years. To accommodate this, it built dedicated rail freight corridors to connect raw materials in exporting regions with major production and consumption centers. However, the uncompetitive pricing of rail and the lack of efficient intermodal connectivity has caused the share of rail in India's freight industry to remain limited. This report offers insights into India and China's freight policies and infrastructure for other fast-growing economies at different stages of economic development.

Background to the Workshop

Fast-growing economies such as India and China have experienced significant growth in freight transportation in the last decade. Much of this growth is attributable to the increasing demand for raw materials, consumer goods, industrial equipment and buildings, residential housing, and public infrastructure. As a consequence of India and China's rapid economic development, their increased use of freight transportation has had a significant impact on the global transport fuel market. It has also contributed to social and environmental issues such as increased traffic congestion and air pollution. Governments in India and China are taking various measures to improve the operational and energy efficiencies of domestic transportation and logistics systems. They are also actively promoting research into alternative fuels and the viability of shifting modes of freight transport.

With these points in mind, the workshop explored the future of freight transportation energy demand in fast-growing economies by focusing on the following topics:

- The relationship between economic development and freight transportation demand.
- The transport modal shift from road to railway/waterway and the implications for energy consumption, infrastructure development and planning.
- Alternative energies for freight transport.
- The potential for efficiency improvements in the road freight sector and the associated institutional challenges.

Economic Development and Freight Transportation Growth in India and China

Since the beginning of the century, India and China have emerged as the world's largest consumers of energy in transportation. This has been primarily driven by their rapid economic development and population growth. China's accession to the World Trade Organization has transformed its role in the international economic system. It is now a major manufacturing powerhouse that imports substantial quantities of raw materials and energy products and exports various industrial goods. China's domestic reforms in the late 1990s led to substantial infrastructure and real estate development and played an equally significant role in fueling its demand for freight transportation. India's rapidly expanding middle-class population and its gross domestic product (GDP) growth rate, which has outpaced that of China since 2014, suggests further demand for freight mobility in the coming years.

There are several trends that may affect freight transportation and its energy demand in India and China. China's ongoing economic reform has focused on rebalancing the economy and removing the excess production capacity in many freight-intensive industrial sectors. This means that future economic development will increasingly come from the growth of higher value-added manufacturing sectors and service sectors that tend to make greater use of human, rather than physical, capital. The figure below depicts the growth in China's freight movement by final demand in billion tonne kilometers from 1995–2011.

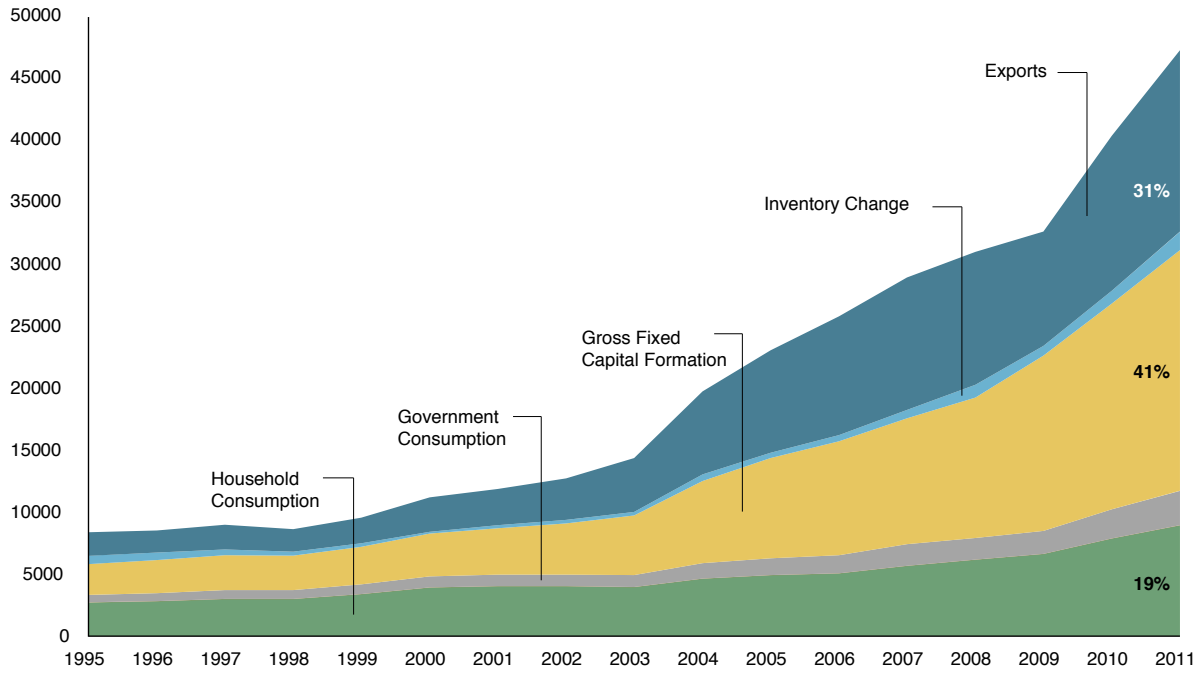


Figure 1. China's freight movement by final demand 1995–2011 (billion tonne kilometers).

Source: KAPSARC analysis.

As China's per capita income rises towards $10,000, and its population ages, demand may start to shift away from material goods to services such as healthcare and education. In the meantime, its current urbanization rate of around 57 percent compares to an average of 80 percent in the Organisation for Economic Co-operation and Development (OECD) countries. This indicates there is room for urban development in China, especially in infrastructure and housing.

India appears to have a much larger potential for growth in freight transport demand than China. With an urbanization rate of 33 percent and manufacturing accounting for merely 17 percent of GDP, India can expect strong growth in freight movement as a result of urban development and industrialization over the next few decades. The figure below showcases the growth in India's freight movement by final demand from 1995–2011 in million tonne. A young demographic and rising incomes will contribute to the growth of its domestic market, by providing a sufficient supply of economic input and demand for output. India's current domestic freight largely depends on road and railway. Without substantial changes to its relatively inefficient railway system and underdeveloped waterway shipping routes, most new freight demand will be met by road freight, the second most energy-intensive mode of freight transport, after aviation. India's greater involvement in the global supply chain could help it grow its domestic freight and energy-intensive industries.

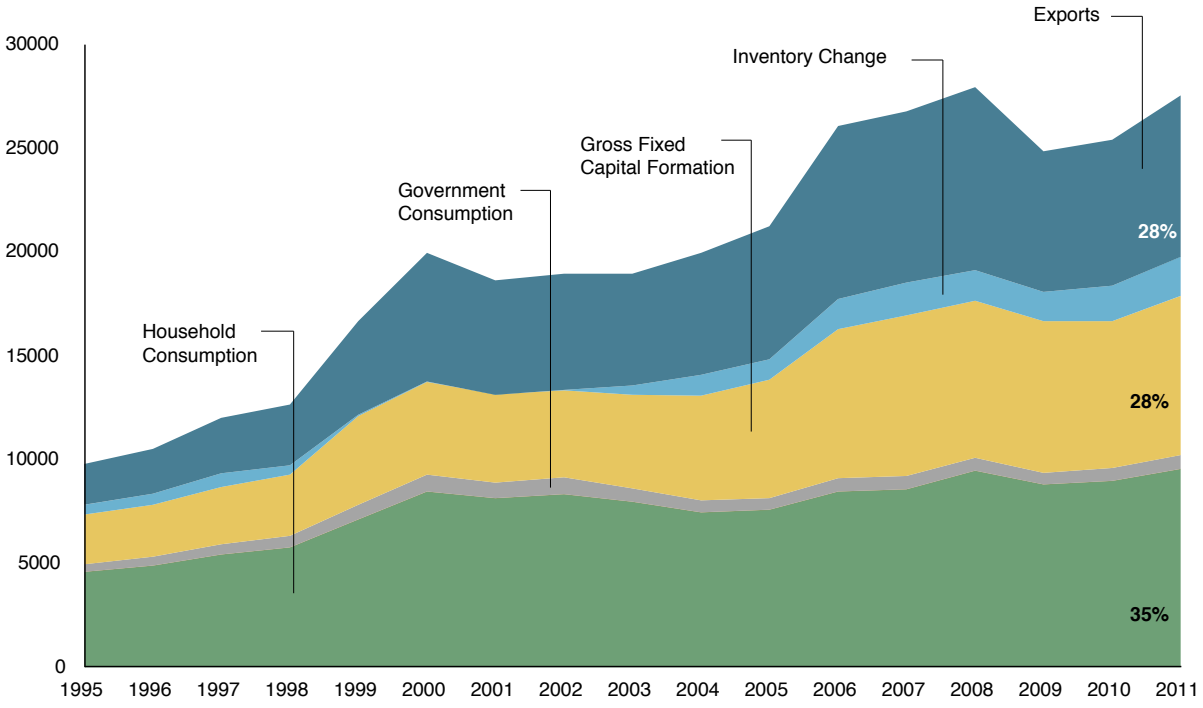


Figure 2. India's freight movement by final demand 1995–2011 (million tonne).

Source: KAPSARC analysis.

Policy and Efficiency: Why is Trucking Winning in Fast-Growing Economies?

Managing growing passenger and freight transport energy demand is a continuing challenge for policymakers. They have attempted to shift demand towards more energy efficient means of transport such as railways in India, and railways and inland waterways in China. However, the transport modal shares of India and China demonstrate that the share of freight has been steadily tipping towards the road sector, despite policy measures designed to enable a modal shift.

India's still largely agrarian economy has increased its dependence on road transport. This dependence has created difficulties for policymakers promoting a modal shift to railways. Underinvestment in railway infrastructure, and the subsidization of passenger rail services with revenues from rail freight, create a disincentive for a modal shift from road to rail freight transport.

The road freight share in India has increased from 55 percent in 2000/2001 to 64 percent in 2015/2016. The notion of efficiently transporting goods by road for short distances and rail for long distances is no longer viable. In fast-growing economies such as India, road freight is often economically and logistically more competitive than rail for long-haul transportation, due to the ample supply of trucks that can deliver from door to door. Policy measures designed to increase the penetration of non-bulk freight in rail transport have had the unintended consequence of consolidating loads for the trucking industry. For example, containerization in India was intended to increase non-bulk cargos for rail but instead facilitated freight consolidation for trucking. Tax reforms which have allowed easier movement of goods across state borders have also increased the attractiveness of road freight.

Future Trends: Changing Technologies and Infrastructure

Over the last few years, the governments of India and China have attempted to reform the transportation sector through policies to improve infrastructure and technology. In India, these policies include dedicated freight corridors, the National Highways Development Project to upgrade roads, and the National Waterway Project to develop inland waterways. However, since the implementation of these programs depends on a number of factors ranging from the availability of financing, access to land and impetus to execute, uncertainty regarding their future remains.

As the demand for movement of goods continues to grow in India, the lack of adequate infrastructure and technological support has caused bottlenecks in the logistics system. For example, the road freight sector is highly fragmented: The majority of trucks are owned by small operators with fleet sizes of less than five, prohibiting economies of scale and the application of new technologies. In the meantime, India's commercial vehicle stock has grown significantly and has outpaced the growth of road infrastructure in recent years. This shortage of infrastructure and the rapid growth of commercial vehicles has made it difficult for policymakers to plan for improvements to road efficiency.

Alternative fuels appear more relevant to light-duty vehicles than commercial vehicles. India's existing highway infrastructure does not support alternative fuels, and the investment needed to support their commercial use would be substantial at this point in time. Furthermore, the viability of electric road freight is dependent upon significant improvements to battery technology. It is currently uneconomical for India to use alternative fuel for commercial vehicles with its existing infrastructure. Policymakers face the challenge of reducing diesel use in road freight without disrupting existing transport networks. This challenge is exacerbated by the lack of viable commercial alternatives to diesel vehicles.

About the Workshop

KAPSARC convened a workshop in April 2018 jointly with The Energy Research Institute, India (TERI). Over 30 experts in the areas of transport, freight, shipping, rail, environment, academia and policy gathered in New Delhi to discuss the future of transportation energy demand for freight in fast-growing economies, focusing on China and India. The workshop was held under a modified version of the Chatham House Rule, under which participants consented to be listed below. However, none of the content in this briefing is attributable to any individual attendee.

List of Participants

Aman Agarwal – Research Associate, The Energy and Resources Institute, New Delhi

Dr. Anvita Arora – Program Director, KAPSARC

Shikha Bali – Research Associate, The Energy and Resources Institute, New Delhi

Dr. Saurabh Bandyopadhyay – Economist, National Council of Applied Economic Research, New Delhi

Shahad Albardi – Research Analyst, KAPSARC

Yagyavalk Bhatt – Senior Research Analyst, KAPSARC

Ravi Gadepalli – Research Scholar, Indian Institute of Technology, New Delhi

Abeer AlGhamdi – Research Associate, KAPSARC

Anil Gupta – Ex. Managing Director, Container Corporation of India Ltd, New Delhi

Aakansha Jain – Research Associate, The Energy and Resources Institute, New Delhi

Manjusha Jain – Indian Railways Accounts Service, Indian Railways

Dr Gautam Kalghatgi – Principal Professional, Saudi Aramco

Puneet Kamboj – Research Assistant, Brookings India, New Delhi

B. Sumit Kumar – Vice President, Supply Chain Solutions, Transport Corporation of India Ltd, New Delhi

Dr. Brantley Liddle – Senior Research Fellow, Energy Studies Institute, National University of Singapore

Leeza Malik – Senior Researcher, TRIPP, Indian Institute of Technology, New Delhi

Dr. Ritu Mathur – Senior Fellow and Director, The Energy and Resources Institute, New Delhi

Avni Mehta – Program Assistant (Transport), Shakti Sustainable Energy Foundation, New Delhi

Abhijit Narendra – Executive Director, PPP (Traffic), Railway Board, Indian Railways

Deepak Nath – Independent Consultant, Indian Railways (Retd.)

Nora Nezamuddin – Senior Research Analyst, KAPSARC

Xunmin Ou – Professor, China Automotive Energy Research Center, Tsinghua University, Beijing, China

Shri Prakash – Distinguished Fellow, The Energy and Resources Institute, New Delhi

B.N. Puri – CEO and Director, Asian Institute of Transport Development, New Delhi

Manish Puri – Managing Director, IndiaLinx, New Delhi

Sharif Qamar – Associate Fellow, The Energy and Resources Institute, New Delhi

Riya Rahiman – Associate Fellow, The Energy and Resources Institute, New Delhi

Jitendra Roychoudhury – Research Fellow, KAPSARC

Dr. Andreas Schafer – Professor (Energy and Transport), University College London

Maxime Schenckery – Visiting Researcher, KAPSARC

Swapnil Shekhar – Research Associate, The Energy and Resources Institute, New Delhi

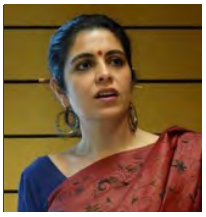
Jacob Teter – Energy Analyst, International Energy Agency, Paris

Dr. Rahul Tongia – Fellow, Brookings India, New Delhi

Dr. Xun Xu – Research Associate, KAPSARC

Yi Zhang – Research Fellow, China Academy of Railway Science, Beijing, China

About the Team



Anvita Arora

Anvita is the program director for Transport and Urban Infrastructures at KAPSARC. Previously, she was the CEO of Innovative Transport Solutions. Anvita holds a Ph.D. from the Indian Institute of Technology Delhi, India.

Yagyavalk Bhatt

Yagyavalk is a senior research analyst at KAPSARC. His research interests include evaluating Indian energy policies with a focus on renewable energy. He previously worked as a researcher, providing sustainable development and decentralised renewable energy system solutions to the rural areas of north India.

Dongmei Chen

Dongmei is a research fellow at KAPSARC focused on China-related policy studies and partnership coordination. She has more than 20 years' experience in the energy and climate field in China. Before joining KAPSARC she was head of the Institute of Industrial Productivity, China Office and director of the Climate Change and Energy Program for WWF China.

Nora Nezamuddin

Nora is a senior research analyst focusing on transport economic policy and modelling. She holds a B.Sc. in Business Administration and a B.A. in International Relations from the American University in Washington, D.C.

Jitendra Roychoudhury

Jitendra is a research fellow at KAPSARC working on global coal and India energy research projects. He previously worked in consulting, advising organizations on commodity flows and markets.

Xun Xu

Xun is a research associate working on KAPSARC's China/India future freight transport energy demand project. His research interests include freight transportation, development economics, population economics and the Chinese economy.

TERI Team

Shri Prakash

Shri Prakash is a distinguished Fellow at TERI. He is former Member (Traffic), Indian Railway Board, and former Chairman, Standing High Powered Committee on Infrastructure Planning, Ministry of Railways. He has over 40 years of specialized expertise in the railways sector and overall expertise in sustainable transport and infrastructure regulations.

Sharif Qamar

Sharif is an economist with over eight years' experience in the areas of freight and passenger transportation, focused on railway and highway sectors.

Aakansha Jain

Aakansha is an environmental economics professional working as a research associate in the field of sustainable mobility. She is currently working on the movement of steel on Indian Railways.

Narendra Verma

Narendra is a transport planner, currently working on freight transport issues related to fly ash transport in railways and road safety issues in urban and rural roads.

About the Project

The KAPSARC project

The objective of the project is to analyze the economic, institutional and policy determinants of freight transport energy demand in China and India. Both countries have witnessed strong freight-related energy consumption growth over the past decades due to their robust economic performance. They are expected to continue to account for the majority of the world's transportation oil consumption growth in the coming decade. Both countries are also top importers of crude oil from Saudi Arabia. This project explores current markets and future scenarios of transportation energy consumption in China and India with policy-relevant insights. It focuses on freight movement demand drivers among freight transport modes, freight transport modal choice and energy efficiency technology. This work provides an opportunity to study the best practice in transport planning to serve the needs of new infrastructure development and to increase the efficiency of domestic transport energy consumption in Saudi Arabia.

The TERI project

Despite the significant potential of the railways to reduce carbon emissions and save energy over the roadways, rail has gradually been losing its modal share over the years. Supported by the Shakti Sustainable Energy Foundation, TERI initiated a phased study in 2015 to investigate the reasons for this decline. The research intends to generate a better understanding of transportation demands for different commodities, and develop specific strategies to increase the modal share of rail transportation. The aim is to identify the underlying factors which have resulted in the decline of the share of rail transport and draw up specific implementable strategies to recoup its modal share.

Notes

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