Study on the carbon peaking system and mechanism of the transportation industry—Lessons from Inner Mongolia

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Abstract. Transportation is one of the important fields of carbon emission. Promoting the Carbon Peak in transportation industry is a key point to accelerate the green and low-carbon transformation and promote the high-quality development of the transportation industry. The transportation sector covers a wide range of fields, and there are many coordination departments. The local transportation authorities still lack a strong grasp in carrying out the Carbon Peak work. It is urgent to further improve the Carbon Peak system and mechanism in the transportation sector. This paper refines the current situation and characteristics of carbon emission in the transportation field of Inner Mongolia Autonomous Region, summarizes the progress of Carbon Peak in the transportation field, analyzes the constraints of the system and mechanism of Carbon Peak in the transportation field, and puts forward suggestions to further improve the system and mechanism of carbon emission reduction in the transportation field of Inner Mongolia Autonomous Region.

1 Introduction

Climate change is a common challenge facing the mankind. On September 22, 2020, General Secretary Xi Jinping, in his speech at the General Debate of the 75th Session of the United Nations General Assembly, proposed for the first time the dual goals of carbon peak

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and neutrality: China will increase its national contribution and adopt more vigorous policies and measures, aiming to have CO2 emissions peak before 2030 and achieve carbon neutrality before 2060[1].

The dual carbon goals, major strategic decisions by the Party Central Committee upon integrating international and domestic situations, re related to the sustainable development of the Chinese nation and the construction of common community of shared future for the mankind. Achieving the two goals is China’s solemn commitment to the world involving profound socioeconomic transformation. The transportation sector accounts for about 10% of the national total carbon emissions [2,3,4]. Therefore, its emission peaking is vital to the sectoral low-carbon transformation and sound development, as well as the national strategy of the Construction of a Nation with Strong Transportation Network.

The dual carbon goals bring both opportunities and challenges to the local transportation sector, which covers wide range of areas and many coordinating authorities such as commercial vehicles, railroads, civil aviation, passenger vehicles, private vehicles, non-road mobile machinery (NRMM), etc. The transportation authority is mainly responsible for road energy saving and environmental protection, but sectoral peaking involves other departments such as railroad, civil aviation, public security, commerce, industry and information, ecology and environment, statistics, etc. Limitation of authority means the local transportation authorities lack the necessary levers to achieve peaking, so it is urgent to improve the institutional mechanism with better inter-departmental coordination.

2 Emissions from the transport sector of Inner Mongolia: present situation and characteristics

2.1 Present situation

Through a top-down approach of calculating emissions from the transport sector of 30 provinces and municipalities from 2007 to 2016, Shang Lingyu [5] analyzed the evolution as well as provincial similarities and differences. Statistics show that Inner Mongolia ranked 21st in total emissions with 16,225,100 tons in 2016 and decreased by 0.55% per year on average from 2007 to 2016, the most aggressive among the 30 provinces and municipalities. In terms of per capita transport emissions, Inner Mongolia was second only to Shanghai’s 1.71 tons per person with 0.95 tons in 2016, which indicate a manageable emission landscape of the local transportation sector. However, the per capita emission allows no negligence in the sparsely populated autonomous region.

2.2 Characteristics

2.2.1 Cross-provincial coal transportation is a major contributor to transport emissions

Inner Mongolia is typical coal-dependent province boasting abundant coal reserve, with a proven reserve 50 billion tons and retained reserve of over 800 billion tons, making it one of the largest coal producers in China. In China, the spatial distribution of coal supply and demand is highly uneven with the higher concentration in the north such as Inner Mongolia and Shanxi, while much lower in the demand centers such as Guangdong, hence the direction of coal transportation being from northwest to the south [6]. Cross-provincial coal transportation is a major contributor to transport emissions in Inner Mongolia.
2.2.2 Transport restructuring is significant to sectoral emission reduction

Studies [5] have show that the sectoral structure is one of the main determining factors of CO₂ emissions in the transport sector in Inner Mongolia because energy consumption per unit turnover varies greatly from one mode to another. In terms of transportation turnover, the share of railway decreased while it of the more unit-energy-consuming road increased from 2007-2011 to 2013-2016, significantly boosting emissions from the transport sector. Meanwhile, the rising share of railway during 2012-2013 curbed the spiraling emissions to a certain extent. Sensitive to the sectoral structure, emissions of Inner Mongolia’s transport sector can be effectively reduced through the optimization of resource allocation and sectoral restructuring.

2.2.3 Heavy-duty trucks hold the key to carbon peaking

Nationwide, road transport is a major contributor to transporte emissions, accounting for 86.76% of sectoral total, of which heavy-duty trucks take up the largest share of 54% in road transport [7], making it essential to energy conservation and emission reduction in road transport and the transport industry at large. With underdeveloped water transport in Inner Mongolia where the fleet is entirely dedicated to passengers, the contribution of heavy-duty trucks can only be higher than the national average, hence greening heavy-duty trucks is the top priority of the local transport in the context of carbon peaking. However, alternative fuels for heavy-duty trucks are shackled with technological constraints.

3 Carbon peaking of the Inner Mongolian transport sector: progress

3.1 Overview

3.1.1 Priority and planning

After launching the 1+N+X policy system for the dual carbon goals in May 2021, the Department of Transportation of Inner Mongolia has been dedicated to its implementation, with a carbon peaking taskforce formed in June 2021 for comprehensive coordination in addition to lectures by industry experts, learning groups, as well as night school classes, thematic research and discussions on the history of the Communist Party of China [8]. Cadres and members of the local transportation system have been well-trained to translate the concepts and thinking they have internalized to actions and decisions.

3.1.2 Collaboration and coordination

The Department of Transportation, as the leader in the taskforce, collaborated with the Development and Reform Commission with the support of the Department of Industry and Information Technology, the Department of Public Security, the Bureau of Statistics and the Department of Ecology and Environment, carried out in-depth surveys on key local railroad enterprises and logistics parks, collected nearly 10,000 entries of historical data, 107 industry plans and over 10 research reports, which serves as the foundation to ensure the comprehensiveness, accuracy and credibility of accounting as well as thematic researches on the pathways and policy measures pertaining to carbon peaking.
3.1.3 Reality-based Planning

In the same month of the establishment of the taskforce, the Department of Transportation Inner Mongolia conducted a research team to understand the baseline and prospective of emissions from the transport sector. Research shows that further rise can be expected in transport emissions and more efforts required. The provincial implementation plan, grounded in the local realities, has proposed the concepts and measures to reach the 2 carbon goals, and clarified the roadmap and blueprint for green and low-carbon development of the transportation sector.

3.2 Effectiveness of green and low-carbon development of the transportation sector

3.2.1 Upgrading transport infrastructure

Despite that the long and cold winter in Inner Mongolia hinders the roll-out of new energy vehicles, the province can leverage its abundance of industrial by-product hydrogen, wind and solar for hydrogen generation and rare earth for hydrogen storage to scale up the production and application of hydrogen-powered vehicles including heavy-duty trucks. In 2021, the first China-developed hydrogen fuel cell hybrid locomotive started a trial run on Friday on a railway line by SPIC (the State Power Investment Corporation) from Jinzhou to Baiyinhua, reducing emissions by about 80 kg per 10,000 ton kilometers compared with internal combustion locomotives. The SAIC (Shanghai Automotive Industry Corp) Hongyan's smart factory in Erdos target over 10,000 hydrogen heavy-duty trucks in annual production volume.

3.2.2 Decarbonizing the transport structure

Inner Mongolia has been gearing up towards road-to-rail shift in commodity transportation for structural optimization. First, build dedicated transport lines for large enterprises and logistics parks. At the end of the 13th Five-Year Plan, 35.5% coal mining entities with more than 1.5 million tons of annual production were connected to the dedicated lines, which aim to reach 85% by the end of the 14th Five-Year Plan. Secondly, continue to electrify the railway network, represented by the recently-launched Wulanchabu-Tongliao and completed Qiqihar-Harbin electrification and expansion projects, enlarging the railroad capacity with an established network of electric locomotives. In 2020, railroad mileage of the province registered over 14,000 kilometers, ranking atop in the country, a freight volume of 690 million tons, ranking the second with 15.1% of the national total, and the third largest turnover taking up 57.4% in China, much higher than the national average of 15.1%.

3.2.3 Scaling up battery swapping and charging facilities

Develop battery charging and swapping facilities along highways and passenger transport hubs for greater convenience of green transportation and mobility. In 2021, Inner Mongolia installed 490 charging poles at bus stops, passenger stations, and highway service areas, bring the total to 1,481. At the end of 2021, 24 of the 59 service areas along free artery roads were equipped with 71 charging facilities (including 20 for cars and 51 for RVs). By the end of the 14th Five-Year Plan, all service areas of Hohhot, Baotou, Erdos, Wuhai,
Chifeng and Tongliao highways will be covered with battery charging and swapping infrastructure.

3.2.4 Building green roads with industrial solid waste

Vigorously promote the utilization of industrial solid waste in transportation engineering. First, highway expansion projects including the G65 Baotou-Maoming and G55 Erenhot-Guangzhou have successfully applied 22,000 square meters of steel slag in the concrete surface layer of asphalt pavement, 28,000 square meters of cement-stabilized steel slag base in demonstration projects for steel slag utilization, which also saw the production of 3 local standards. Second, fly ash has been used in the engineering of Linhe section Linbai Highway and the Wuhai section of the Rongcheng-Wuhai Highway as an effective solution to the surface cracking in dry conditions with wild temperature variations, and one local standard was created as a result. Third, launch a series of green road pilot projects inspired by G1611 Highway, issue the Inner Mongolia Green Highway Design and Construction Technology General Guide to promote green and low-carbon infrastructure development.

4 Transport Emissions in Inner Mongolia: Restriction Factors

4.1 The railway sector

At the national level, restructuring the transport sector involves the National Development and Reform Commission (NDRC), the Ministry of Transport, and National Railway Group. At the provincial level, the local DRC’s railroad and civil aviation office is heads the research on sectoral strategies, plannings and policy measures, as well as the coordination between roadways, aviation and socioeconomic development. It analyzes the autonomous region’s railroad and civil aviation sectors, proposes policy recommendations, and reviews construction projects. The Department of Transportation of Inner Mongolia, the authority for the planning, construction, management, maintenance and safety pertaining to highways and waterways, lacks specific levers on the restructuring of the transport sector whereas the provincial DRC has a certain grip on railroad planning, construction and coordination. The Municipal transportation bureaus face similar challenges, for example, the adjustment of transport in eastern Inner Mongolia during the 13th Five-Year Plan was chaired by local authorities from Inner Mongolian in conjunction with the Shenyang Railway Bureau, where the railroad office under Chifeng Municipal Government and the railway and aviation branches of Chifeng and Tongliao Municipal DRCs carried out the program on the ground with the Shenyang Railway Bureau, while the municipal transport authorities focused on liaison and communication.

4.2 New-energy vehicles

Clean energy of transport facilities and vehicles is an important means of carbon emission reduction. Despite the rising sophistication of new energy technologies for small passenger cars and light logistics vehicles in recent years, heavy-duty trucks still lack mature technological solutions for cleaner fuels, duration and payload in the short term, and hydrogen fuel cell technology is still in its infancy in terms of equipment, safety, standards, and specifications. Large uncertainties remain in the scale application of new energy heavy-duty trucks, which depends on the synergy of multiple authorities including science and technology, industry, and information; Therefore, the emissions reduction of private vehicles is particularly essential. Such emissions are related to factors such as ownership,
energy efficiency, energy substitution, etc., over which transportation authorities have limited control, hence it requires the collaboration of ecological environment, industry and information, public security, transport, and other authorities to align and amplify their efforts in data sharing, research and development, standards, and specifications and so forth to achieve emissions peaking. Therefore, without the concerted support of the society, industries departments, the fundamental restructuring of the transportation energy with equipment upgrade, productivity upscaling, energy security, consumption strength and infrastructure maturity cannot be achieved.

4.3 The logistics sector

The logistics regulation have long been fragmented and managed by overlapping bureaucracies in China, leading to infighting and buck passing, as aptly captured by the Chinese idiom “nine dragons rule the waters”. At the state level, logistics-related planning has been issued jointly by the State Council or multiple departments. For example, the Medium and Long-term Plan for the Development of Logistics Industry (2014-2020) ([2014] No. 42) by the State Council on September 12, 2014 and the Thirteenth Five-Year Plan for the Development of Trade Logistics by the Ministry of Commerce, the Development and Reform Commission, the Ministry of Land and Resources, the Ministry of Transport and the State Post Bureau on January 19, 2017. At the provincial level, it is the autonomous region’s people’s government, transport department and municipal DRC that issue relevant planning. For instance, the People's Government of the Autonomous Region issued the Inner Mongolia Autonomous Region 2007 Development Plan for Modern Logistics Industry in 2007 ([2007] No. 124) in 2007, the General Office of the People's Government of the Autonomous Region published the Inner Mongolia Autonomous Region "Twelfth Five-Year" Logistics Industry Development Plan ([2011] No. 104) in 2011, the Department of Transportation of the autonomous region released the Inner Mongolia Autonomous Region Thirteenth Five-Year Transport Logistics Development Plan on August 9, 2016, and the Development and Reform Commission of Inner Mongolia produced the Inner Mongolia Autonomous Region Fourteenth Five-Year Modern Logistics Development Plan on January 28, 2022. From the departmental responsibilities, the Inner Mongolian Department of Transportation oversees infrastructure investment, the Development and Reform Commission park approvals, commerce authority audits, the postal department express delivery, and the park management committee specific park operations. Synergy through interdepartmental coordination is evidently of great significance.

5 Recommendations on Transport Emission Reduction for Inner Mongolia

5.1 A taskforce on carbon peaking of the transportation sector

The transportation sector involves a wide range of fields and many coordinating departments, covering operational vehicles, railroads, civil aviation as well as non-operational vehicles, private passenger cars and non-road mobile machinery. The field research on carbon peaking in the transportation sector in the autonomous region [9] has found that carbon peaking authorities are scattered across the fields of development and reform, land, commerce, energy, railroad, civil aviation, and postal services, requiring massive inter-departmental coordination. On the whole, sectoral carbon peaking requires not only the transportation department, which by itself can’t achieve the desired outcome with its limited reach, but also the efforts of other authorities. To implement the national
and provincial policies on carbon peaking and neutrality in the field of transportation and logistics, it is recommended that the autonomous regional government levels up the current carbon peak taskforce by appointing the provincial departmental leaders as persons in charge: major leaders from the Inner Mongolian government as directors, Department of Transportation as executive deputies, and provincial government as deputies with its office located within the Department of Transport of the autonomous region. The taskforce should deliberate and study major documents, policies, issues and cross-departmental coordination pertaining to carbon peak and neutrality in the transportation sector, distribute and supervise key tasks and their implementation. Located within the provincial Department of Transport, the taskforce should be set up working groups dedicated to different fields such as transport restructuring and new energy vehicle and fleet to maximize policy effectiveness.

5.2 An information sharing platform

It is recommended that the Inner Mongolia Autonomous Region leverages existing basic database resources (TOCC) to establish a data sharing mechanism covering multiple departments such as development and reform, industry and information, public security, ecology and environment, transportation and statistics, etc., and a database for province-wide transportation energy consumption and carbon emissions, which updates of data such as transportation equipment, activities, energy consumption and emissions, improving the communication and interconnection across departments and levels. Design top-level architecture of the provincial transportation energy consumption and monitoring system with a combination of monitoring and statistics, improve energy consumption statistics and accounting methods, and systematically build a carbon emission statistics and monitoring system in the transportation sector. Leverage big data analytics for precision management of sectoral carbon emission accounting and carbon peaking. Utilize digitalization and information technology, as well as the new media to demonstrate the autonomous region’s carbon peaking programs from different dimensions and perspectives, and promote the transformation to a sound, comprehensive, practical and effective information sharing platform for the transportation sector.

5.3 Dynamic evaluation with strict accountability

It is recommended that Inner Mongolia Autonomous Region should strengthen the top-level design in the carbon peaking action plan, clarify the specific efforts undertaken by each department, establish an inter-departmental collaboration mechanism based on the key actions of different fields while considering the security of land, capital, talents, technology, information and other factors, straighten priorities according to the urgency of tasks, define the accountability-based departmental responsibilities, promote the consensus among the public and private sector as well as awareness raising in order to form the synergy for effectiveness of policies, measures and results in carbon peaking of the transportation sector.

Focus on the three major indicators of effectiveness, tasks and capacity building, establish an evaluation system for carbon peaking efforts for regular assessment in multiple dimensions and levels, strategize future plans based on an understanding of the current progress, inform the provincial departments and local transportation authorities of the evaluation results, which can be used as a reference for awards and other incentives. At the local level, substantiate pilot projects and application demonstrations whose experience can be extrapolated into accomplishments with the characteristics of the autonomous region, thus deepening carbon peaking programs fanning out from points to areas.
6 Conclusion

Carbon peaking in the transport sector is a cause requiring the concerted efforts of multiple authorities, which, however, has long been fragmented and managed by overlapping bureaucracies in China. The Transport Department of Inner Mongolia faces tremendous difficulties in promoting sectoral carbon peaking alone considering its limitations in terms of mandate and authorities, as well as the lack of a coordination and communication mechanism with other departments. In particular, the unresolved responsibility division following the organizational reform, ineffective vertical coordination, industry regulation, guidance, services and so on are undermining the efforts in peaking carbon emissions in the transport sector.

Enhance top-level design and establish a provincial-level taskforce where leaders can strategize actions pertaining to the provincial transport sector, and form a synergy with the development and reform, industry and information, ecological environment, public security, land, housing and construction, commerce, science and technology, energy, railroad, civil aviation, postal service, statistics and other departments. Build a date sharing platform accessible to all departments to achieve dynamic update of basic data such as transportation equipment, activities, energy consumption and carbon emissions that is of structural integrity, comprehensive coverage and practicality, thus improving communication and connectivity across departments and levels. Meanwhile, refine departmental tasks with strict accountability to achieve the effectiveness of policies, measures and results of all carbon peaking programs. Conduct regular evaluation to map out the current progress and outline future directions. Substantiate pilot projects and application demonstrations whose experience can be extrapolated into accomplishments with the characteristics of the autonomous region, thus deepening carbon peaking programs fanning out from points to areas.

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