



**BTBU-ECOSF JOINT TRAINING CENTER ON
SCIENTIFIC, TECHNOLOGICAL & ECONOMIC
COOPERATION UNDER THE BELT AND ROAD
INITIATIVE**



**6th Training Report
Powering Belt & Road –
Lithium-Ion Batteries**

**Accelerating transition to low-carbon and climate-
resilient development in the Belt and Road Countries**

September 28, 2022

中国科协“一带一路”国际科技组织合作平台建设项目

China Association for Science and Technology (CAST) Program of International Collaboration Platform for Science and
Technology Organizations in Belt and Road Countries

北京工商大学——经济合作组织会科学基金会
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ABOUT THE BTBU-ECOSF JOINT TRAINING CENTER

The Belt and Road Initiative (BRI) is a massive global initiative aimed at connecting international trading partners in the east and the west. The BRI offers a tremendous potential to spur a new era of trade, economic and industrial growth for the countries in the Asia and beyond. In order to maximize the benefits of BRI, the participating countries require to develop adequate technological workforce and engage in an alliance for promotion of cross-border cooperation in the Science, Technology, and Innovation (STI) sectors.

Appreciating this need for skill development and capacity building in key economic sectors, the Beijing Technological and Business University (BTBU) and the Economic Cooperation Organization Science Foundation (ECOSF) collaborated and launched the BTBU-ECOSF Joint Training Center on Scientific, Technological and Economic Cooperation under Belt and Road Initiative in September 2020. The Center has won the financial support of China Association for Science and Technology (CAST) Program of International Collaboration Platform for Science and Technology Organizations in Belt and Road Countries.

BTBU is renowned as a one of the leading high-level research universities in Beijing. Having long been committed to promoting substantive exchanges and exchanges with overseas first-class universities and academic institutions, BTBU has achieved meaningful results in international exchanges and cooperation, personnel training, academic research, etc.

ECOSF is the specialized agency of the Economic Cooperation Organization (ECO), an intergovernmental organization for scientific and technological cooperation, with its 10-member states (Afghanistan, Azerbaijan, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Tajikistan, Turkey, Turkmenistan, Uzbekistan). ECOSF has an extensive exchange and cooperation network with international scientific and technological organizations in Asia-Pacific, Africa, Europe, and other regions, as well as other international organizations.

BTBU-ECOSF Joint Training Center aims to promote the sustainable economic and social development of BRI countries through training in the fields of technology application, industrial economics, S&T standards, and science communication.

TRAINING BACKGROUND

Energy storage market is on rise across the world. Every company, new or old, that is in the field of renewables or electric vehicles, is looking for even more reliable and affordable storage technology. Battery energy storage provides several valuable services and advantages in stationary, renewable grid services and electric mobility. In stationary storage and renewable grid service battery energy storage provides for frequency regulation, peak shaving as well as mitigating the fluctuations in generation from variability in renewable sources.

Lithium-ion (Li-ion) batteries today are poised to become the preferred choice for many applications across the electric mobility, grid storage and consumer electronics. This is because of inherent characteristics of the Li-ion batteries, which last longer and recharge faster, saving time, saving money, and reducing risk throughout the lifecycle. Hence, Lithium-ion batteries are the key technology to achieve net-zero carbon emissions in transportation, industrial equipment, and consumer electronics for the Belt and Road and ECO Member Countries.

The Joint Training Center fully recognizes the fact that the China has now been the world's largest lithium battery consumer market for five consecutive years. In 2021, the global lithium-ion battery market reached 545 GWh, and China accounted for more than half of the total¹. Strong demand for new energy vehicles is one of the main factors underpinning the recent surge in China's lithium battery industry. By the end of 2021, China's power battery production capacity accounted for about 70% of the global total. Additionally, six of the top 10 lithium battery manufacturers in the world are from China².

Hence, BTBU-ECOSF Joint Training Center hosted this virtual training on September 28, 2022, to bring China's extensive expertise and best practices to help guide investments to develop a regional lithium-ion battery manufacturing value chain that creates equitable clean-energy manufacturing jobs in the Belt and Road (B&R) countries while mitigating climate change impacts. In this respect, BTBU – ECOSF Joint Training Center is planning to host its 6th training program entitled on “Powering Belt and Road – Lithium – ion batteries”

In this backdrop, this training program sought to understand and learnt from China's expertise and capabilities about viable options for creating a strong lithium-ion manufacturing based in the B&R region, show cased best practices, success stories, and barriers on implementation of policies and programmes promoting low carbon development, and match the potential cooperation among BRI counties in Lithium-ion Battery production.

¹ White Paper on China Lithium Battery Industry Development Index (2021)

² Bloomberg New Energy Finance (BNEF) <https://www.bloomberg.com/news/articles/2022-05-16/lithium-sector-needs-42-billion-as-pivot-from-china-adds-costs> (2022)

OPENING REMARKS: MR. LIU MINHUA, VICE PRESIDENT BEIJING TECHNOLOGY AND BUSINESS UNIVERSITY



Mr. Liu Minhua, Vice President Beijing Technology and Business University in his welcome remarks emphasized that transformative powers of Science, Technology and Innovation (STI) will be at the heart of industrial decarbonization in the Belt and Road region. Prof. Minhua paid her gratitude to the expert trainers from China and Pakistan for delivering important and resourceful training for the audience.

Prof. Minhua concluded that the successful transition towards low carbon development would heavily depend on fostering public-private partnerships that can accelerate deployment of technologies, promoting research and development, and human resource skills development. Hence the critical challenge for us is to enable delivery of our national development visions and goals – through low-carbon, climate-resilient or climate-compatible development plans and strategies, whereby the role of science and technology is overarching and gigantic.

Mr. Liu Minhua, expressed the hope that more scientists and young scholars will join their exchanges and cooperation in the future to jointly implement the global development initiative and promote global sustainable development.

He assured robust cooperation and collaboration will continue by the Joint Training Center to achieve the intended goals and promote emerging trends in industrial development and STI in the belt and road region.

OVERVIEW AND OUTLOOK OF GLOBAL BATTERY METALS INDUSTRY.



Ms. Aidong Xu - Vice Chairman of Nickel & Cobalt Branch of China Non-Ferrous Metal Industry Association, Chief analyst of Beijing Antaika Information Co., LTD.

Ms. Aidong presented the global overview of the Lithium-ion battery metals industry with special focus on China. She underlined that China is the world's largest manufacturing country, and the world's largest importer of metal minerals, occupying an extremely important position in the international bulk metal minerals market. China, Japan, and Korea also dominate the Cathode materials production. While China is the biggest producer in the world, accounting for 77% of the global in 2021.

At present, the cost of power battery accounts for nearly 40% of the EV, and the cost of cathode materials accounts for nearly 40% of the power battery. So, in electric vehicle era, mining has been linked with automobile industry unprecedentedly.

The global Electric Vehicles (EV) sales amounted 6.52 million units in 2021, up 108% year-on-year, with penetration rate growing from 4.2% in 2020 to 8.3% in 2021.

According to the International Energy Agency (IEA) statistics, based on the prediction of global EV sales of 34.25 million units in 2030, the installed battery capacity will reach 3,000 GWh.

Ms. Xu added that the rapid development of EV means a greater demand for upstream raw materials including nickel, cobalt, and lithium. Based on the EV sales of 6.52 million units in 2021, and the installed battery volume is 292.1 GWh.

From the supply side, the distribution of global battery metals resources is very uneven. Congo have the world's largest number of high-quality reserves of copper and cobalt. Indonesia accounts for 22.0% of global nickel reserves, the South American lithium triangle (Bolivia, Chile, Argentina) accounts for 56% of the global lithium reserve, 22.7% of the global copper reserve.

From the demand side, the global manufacturing industry is concentrated in East Asia, Europe, and North America the bulk exports from Australia, Chile, Brazil and other resource countries and strong reliance on imports of East Asia, Europe and North America constitute the basic pattern of the international metal mineral trade flow.

BIG-DATA BASED CLOUD BATTERY MANAGEMENT SYSTEM.



Engr. Munan Hong Co-Founder of Hong Zhiliwulian (Hangzhou) Technology Co., Ltd.

Mr. Hong delivered his lecture on the applications of Cloud-Based Battery Management Systems. He highlighted that the Electrochemical energy storage is the most extensive way of energy storage. Lithium-ion battery storage is the best candidate as the most suitable energy carrier. Mr. Hong underscored that with high penetration of EVs and energy storage application in the grid, lithium-ion battery industry is growing at a very rapid pace.

One of the most critical challenges with Lithium-ion batteries is to ensure their safety because at certain conditions and if misused, the batteries could catch fire. Lithium-ion batteries pose

a high-risk which could result in catching fires or even explode if used under high stress conditions. Therefore, the role of Battery Management System (BMS) is important to maintain safe operations.

Mr. Hong underlined that the thermal runaway is usually caused by cell failure in the form of intermittent short circuit, lithium precipitation or other problems. It can also be caused by high voltage wire connection and voltage sampling wire shorted problems. The existing and traditional BMS current monitoring system has no ability to detect these problems in advance.

A cloud based BMS can early diagnose fault, identify and match operations conditions, using cloud terminal collaborated control. The way to do is to install the battery data box in the vehicle to solve the problems of low and fixed transmission frequency of data. This can provide high quality data transmission and bi-directional frequency control. Whereas traditional BMS cannot meet all those requirements.

A cloud based BMS can report abnormalities and indicate accurate operation and maintenance advice according to the specific reason. One of the major advantages of using cloud based BMS is that it can accurately identify and pinpoint the cause of fault and sends early warnings well ahead of the accident and allow ample time to respond and mitigate to prevent the damage. Hence, the cloud-based battery management system is the way forward to activate early warning system for accurate fault detection and precise assessment of battery value.

THE ESSENCE OF CARBON NEUTRALITY: ENERGY ELECTRIFICATION AND GREEN ELECTRICITY.



Mr. Keyu Li, Vice President of Green Harbor Investment delivered his lecture on investment prospects in the Lithium-ion battery market from the lens of carbon neutrality.

Mr. Li emphasized that carbon neutral targets in China, Europe, the United States and other regions have repeatedly exceeded expectations. As one of the most important scenarios on the energy demand side, energy vehicles have also become the focus of the development of all

countries in the world. Mr. Li presented that China, the United States and Europe have increased their policy designation targets. China's 2025 penetration rate is expected to reach 25 percent, 20 percent in the United States and 35 percent in Europe, he added.

Mr. Li highlighted that the time node and path of electrification in various countries are clear, and the future is the golden decade for the development of electric vehicles and batteries. Ban of Internal Combustion Engines, increasing penetration of EVs and declining costs coupled with government incentives are driving the growth of EVs globally.

He further presented a case that technological advancement lies in the innovation of materials and the improvement of structural process. Among them, material innovation includes high nickel, cobalt free, sodium ion, etc.; and in structural innovation includes semi solid- and solid-state battery technology are the promising candidates. With the rapid changing and innovative paradigm, a new batch of competitive enterprises are expected to emerge.

Key takeaways on major Lithium-ion battery technologies:

- Lithium iron phosphate and ternary routes will coexist for a long term, and still be the mainstream in the next 10 years.
- Lithium Iron Phosphate: Structural innovations such as blade battery and CTP technology to improve energy density
- Solid-state battery: The technology is still immature, and the core challenge is to improve the conductivity and cycle times. It is expected to take the lead to promote "semi-solid" batteries within 5 years.
- Fuel cells: At present, revenue depends on the implementation of subsidies, and it is difficult to commercialize before 2030. However, leading companies in the segments are worth a strategic layout.
- Lithium-ion: Requires years of technique accumulation, mass production experience and customers' certification. Relationship with auto manufacturers is important.

LITHIUM-ION BATTERY MANUFACTURING PROCESSES AND PRACTICES IN CHINA

Dr. Zhonghua Chen R&D Director of LongTTech Company LTD.

Dr. Chen gave an introduction of LongTTech Company which was established in 1999 and started its lithium-ion battery production back in 2006. The company now produces various lithium-ion cells with various geometrical shapes, including cylindrical and prismatic cells. Their flagship product is the lithium-iron phosphate cell and the total production of LFP was 2 GWh. LongTTech produce high quality cells that offer very long life with over 3500 cycles.

The LongTTech Pack production line has an annual capacity of 500 MW. It is equipped with advanced automatic process equipment and high precision classification facilities for sorting and matching, to ensure high consistency of capacity, internal resistance and voltage for each battery module.

The LongTTech lithium batteries offer excellent and high-rate performance and offer good low temperature performance and long-life cycle capacity. These are mainly used in low-speed electric vehicles, golf cart, vehicles with two/three wheels, scooter and forklifts. 48 V Series LFP Batteries are to provide reliable backup power for access network equipment, remote switch, mobile communications, transmission equipment and other systems.

WRAP UP AND SNAPSHOT OF LITHIUM-ION BATTERY MARKET IN BRI/ECO COUNTRIES

Engr. Khalil Raza, Scientific Officer, Economic Cooperation Organization – Science Foundation (ECOSF)



Mr. Raza presented the snapshot of Lithium-ion battery market in the ECO region. He emphasized that there is a tremendous growth potential of Lithium-ion batteries market in the ECO region due to growing traction of both electric vehicles and renewable energy market. To

achieve substantial penetration of electric vehicles and accelerate the transition to clean energy, the role of lithium-batteries is critical. Mr. Raza highlighted that currently, the role of ECO countries is limited in terms of local production of primary cells in the ECO Member States. Hence, most of the ECO Member Countries rely on import of batteries from China, Japan, and Korea, which translates into high import costs. The high volume of imports of Lithium-ion batteries in the region turns into high transaction and service costs for e-mobility and energy storage businesses. Thus, this high cost is unsustainable and results into low traction of e-mobility in the region.

Mr. Raza presented the global lithium-ion supply chain and the trade flows of major metals and products relating to Lithium-ion batteries. Lithium which is an important raw material for batteries is mainly extracted from South America; Argentina, Chile, and Bolivia which is also termed as the Lithium-Triangle.

The raw materials are then exported to mainly to China, Japan, and Korea where the raw material is processed into refined chemical products, included primary cells, and battery packs. In the ECO region, Turkey holds highest reserves of the Natural Graphite which is considered as a perfect Anode material for lithium-ion batteries. Mr. Raza also highlighted that with high reserves of Lithium in Afghanistan worth over billions of dollars, it is anticipated that in coming years Afghanistan could play a major role in Lithium mining and extraction.

Mr. Raza concluded that localization of lithium-ion batteries is the key to sustainable uptake of Electric Vehicles in the ECO Region with following recommendations:

- The ECO Member Countries need to develop a strategy for 'localizing' the EV and lithium battery supply chain. Major parts need to get localized in the ECO Countries;
- ECO Countries would have to secure supply of key raw materials; Lithium, Cobalt, and Nickel etc. for battery production;
- Leverage our existing partnership with China to establish manufacturing facilities in the B&R/ECO region;
- Develop local mining capacity in ECO Member Countries where critical metals for Lithium-ion batteries are prevalent;
- Achieve solid partnership with Chinese enterprises to build capacity in chemical refining in the ECO Countries;
- In the Short term – ECO Countries should focus on install battery assembly and pack manufacturing facilities;
- In the medium term – invest into cell manufacturing facilities;
- While in the long term– investments into local mining and chemical refining capacity should be ramped up;
- Mr. Raza concluded in order for the ECO region to achieve its intended Electric Vehicles (EV) penetration targets, respective Governments and relevant stakeholders need to strengthen their policy intervention in four key areas; (a) robust strategy (b) financial incentives (c) plan for reducing the cost of lithium-ion batteries.

CLOSING REMARKS: PRESIDENT ECOSF PROF. DR. SEYED KOMAIL TAYEBI



Prof. Seyed Komail Tayebi President, ECO Science Foundation gave his closing remarks towards the end of training workshop.

Prof. Seyed Komail Tayebi extended his deep appreciation to the leadership of Beijing Technology and Business University (BTBU) and especially Dr. Di Yuna, Director, BTBU-ECOSF Joint Training Center for their partnership and continuous support through this Center to promote the low carbon development in the Belt and Road countries, including ECO Member States.

President ECOSF Prof. Tayebi highlighted the fact that the China has now been the world's largest lithium battery consumer market for five consecutive years. Hence, realizing the importance of this topic, ECOSF would strive to bring China's extensive expertise and best practices to help guide investments to develop a regional lithium-ion battery manufacturing value chain that creates equitable clean-energy manufacturing jobs in the ECO Member Countries while mitigating climate change impacts, he underlined.

He was confident that this training on Lithium-ion batteries would be extremely valuable for the participants, and it will strengthen the exchange and cooperation between the Chinese green enterprises and participating BRI countries to explore investment and business expansion opportunities in the areas of renewable energy development, cleaner mobility solutions and smart and resilient power grid operations.

At the end Prof. Tayebi assured the partners that ECOSF will continue the cooperation and collaboration in the field of Science, Engineering, Technology, and Innovation for pursuing our common goals along the Belt and Road.

The recording of the entire training session is provided at the ECOSF's YouTube at <https://www.youtube.com/watch?v=5gn3jKVdBtQ>

BIONOTE OF THE RESOURCE PERSONS/EXPERTS

Xu Aidong, Vice Chairman of Nickel & Cobalt Branch of China Non-Ferrous Metal Industry Association, Chief analyst of Beijing Antaike Information Co., LTD. From 1993 to present, Mrs. Xu have been working at the Beijing Antaike Information Development Ltd. Co., engaged mainly in metal market consulting, investigation and research, and large-scaled market conference organization, esp. in nickel, cobalt & lithium battery materials. Ms. Xu is a veteran in Chinese nonferrous industry, and is active worldwide. Since November 2020, 2010, Ms. Xu hold the post of deputy chairwoman of CNNB (CNIA Nickel Branch). Since August 2022, Ms. Xu hold the post of deputy chairwoman of CNCB(CNIA Cobalt Branch).



Ms. Xu

Keyu Li, Vice President of Green Harbor Investment, a private equity Investment fund focused on the intelligent driving, carbon neutral and medical technology industries, with a management size of over 6 billion yuan.



Munan Hong received his BE and PhD in the Department of Vehicle and Mobility, Tsinghua University, China, in 2005 and 2010, respectively. From 2005 to 2010, his research focused on model-based hybrid powertrain system control. He worked as a Visiting Fellow in the Department of Engineering and Applied Sciences, Sophia University, Tokyo, Japan in 2008. He used to be the chief engineer of battery system in Changan Automobile Corporation. Now he worked in Zhiliwulian (Hangzhou) Technology Co., Ltd. His research interests include battery system design and Terminal-Cloud cooperated battery management. He has participated a series of projects of battery management and battery system and obtained Chongqing City S&T Progress Award, SAE-China S&T Progress Award, 2020 SAE Environmental Excellence in Transportation (E2T) Award.



Zhonghua Chen is the R&D director at LongTTech Company Ltd. He received his Ph.D in Physics from UiT The Arctic University of Norway. From 2007 to 2012, he worked as engineer and researcher at Renewable Energy Corporation ASA in Norway. After that, he started pursuing his Ph.D as a researcher at SINTEF research institute in Norway. Since the end of 2016, he has been responsible for R&D at state-owned new energy institute, and Li-ion battery companies. He has profound knowledge and experience in materials, electrochemistry, and new energy. His current research interests mainly include Li-/Na-/Fe-ion batteries, all-solid-state batteries, and new materials.



Khalil Raza is a sustainable energy professional with extensive experience in strategy management, project development and policy analysis, in the areas of science & technology, and clean energy. Currently, Mr. Raza works with the Economic Cooperation Organization Science Foundation (ECOSF), where he manages and implements ECOSF's research programs, notably in the area of global environmental challenges with a particular focus on sustainable energy, water, and climate change. Previously, Mr. Raza has worked with the World Bank, UNDP, and Planning Commission of Pakistan on vital strategic programmes, including renewable energy, energy planning, electric mobility and Sustainable Energy for All (SE4ALL). Mr. Khalil is a recipient of the prestigious Fulbright Scholarship and holds Masters in Renewable and Clean Energy from Wright State University, Ohio USA.



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