

## **Highlights of speeches by experts at International High-level Forum on "Green and Low-carbon Energy Revolution"**

On August 19, the International High-level Forum on "Green and Low-carbon Energy Revolution" was held in Beijing, bringing together nearly 20 academicians as well as renowned scholars at home and abroad, experts and representatives from energy companies and industry associations. Centering on the hot topics, key points and difficulties in the green and low-carbon transition and development of the global and China's energy industry, the participants analyzed opportunities and challenges, proposed strategic plans, explored development pathways, and put forward policy suggestions, to contribute wisdom and strength to the achievement of China's carbon peak and carbon neutrality goals and accelerate the construction of an energy powerhouse.

Hosted by Chinese Academy of Engineering (CAE) and co-organized by CNPC and the Chemical, Metallurgical and Materials Engineering Division of CAE, the forum was held in a hybrid format. Comprising the main forum of "Pathways for Global and China's Low-carbon Energy Transition", and three thematic sub-forums of "Green and Low-carbon Transition and Development of the Oil and Gas Industry and Technological

Innovations", "Development of New Energy and Renewable Energy and Technological Innovations", and "Green and Low-carbon Transition and Development of the Petrochemical Industry and Technological Innovations". The following are highlights of the statements by some academicians and experts:

## **I. The role of the energy industry in the green and low-carbon transition**

### **China's Energy Security and Development Strategy in the Context of Green and Low-carbon Development**

—*Dai Houliang*

*(CAE academician, Chairman of CNPC)*

We've been keenly aware of the following facts: Firstly, economic and social development is inseparable from the support of energy, and it is very important to improve the country's energy security capability in the setting of profound changes unseen in a century. Secondly, energy activities are the main factors affecting climate change. Under the carbon peak and carbon neutrality goals, it is very important to plan energy development strategies and grasp the pace of transition. Thirdly, the energy and chemicals industry is the pillar of the national economy, and it is crucial to achieve high-quality development of the energy industry and properly handle the relationship

between "development" and "carbon reduction". Fourthly, innovation is the primary driving force for development. It is crucial to promote technological innovation in the energy field, to empower the present and sustain the future.

Adhering to the values of " Pursuing green development and supplying reliable energy to fuel our customers' growth and power people's happy life", CNPC will faithfully fulfill its responsibilities and missions, and continuously improve the supply capacity and quality of clean energy, and strive to play a demonstrative role in the implementation of the Seven Major Undertakings, viz. energy conservation, decarbonization, innovation, intelligentization, energy reserve, energy support and energy cooperation. We will focus our efforts in four aspects. The first is enhancing oil and gas supply to ensure national energy security; the second is developing new chemical materials, and striving to become a world-class supplier of high-quality chemical materials; the third is strengthening the driving role of innovation, and endeavoring to become an incubator for original energy and chemical technologies; the fourth is promoting green development, promoting energy transformation and accelerating the achievement of the carbon peak and carbon neutrality goals.

## **Key Issues and Innovative Development in Global Green and Low-carbon Energy Transition**

—*Daniel Yergin*

*(An internationally renowned energy scholar, Vice Chairman of S&P Global)*

The objective of energy transition is to lower emissions to eventually get to net zero emissions. Energy transition is more complicated and challenging than some may have thought. If (energy transition is) not handled properly, we'll see more global energy crises with big economic and social risk, like economic setback and social political turmoil. Managing carbon emissions is the essential point, but oil and gas will continue to have a major role.

Energy transition depends on energy security. It has always been a major concern in China, and China has always taken energy security as a central responsibility. The supply security goes with low carbon, and they are the two one needs the other. You can't have energy transition without energy security, because it would be disruptive, and that means a continuing need for robust oil and gas industry and investment in oil and gas.

The oil and gas industry has a dual role, a dual mandate in energy transition, in delivering hydrocarbons to keep economies

running, but also contributing to the transition to a low-carbon world. Especially gas has made important contributions to global carbon emissions reduction. Oil and gas remains the bedrock of economies. The oil and gas industry delivers reliable supplies that growing economies require, at the same time applies its great capabilities and innovative capacity, developing new solutions and opening new windows to meet the challenges of the future.

### **China's Plan for Achieving the Carbon Peak and Carbon Neutrality Goals**

—*Du Xiangwan*

*(CAE academician, Deputy Director of the National Energy Expert Advisory Committee)*

Carbon peak and carbon neutrality is the only way to green, quality and sustainable development. To achieve its carbon peak and carbon neutrality goals, China has to overcome difficulties and challenges such as large emission cuts, heavy transition tasks and small time window. Through active exploration, proactive actions, and accelerated technological progress, China, is determined to achieve its strategy as scheduled.

In order to make steady progress in carbon peak and carbon neutrality, China, as the world's largest developing country and

a major carbon-emitter, has put forward strategic measures on energy conservation, energy efficiency, energy security, non-fossil energy substitution, resource recycling, further electrification, carbon sequestration, digitalization, and international cooperation. China is optimizing and upgrading industrial structures, creating a clean, low-carbon, safe and efficient energy system, building a new power system based on new energies, promoting continuously the electrification and deep decarbonization technology, improving electrification in transportation sector, making breakthroughs in key green building technologies, formulating carbon plans for carbon removal and perfecting carbon trading system.

Facing the problems of large base emissions and short time window from carbon peak to carbon neutrality, China has to make major breakthroughs in key technologies, so as to maintain sustainable quality development in achieving carbon neutrality. We have to improve the green and low-carbon technology innovation system, and the low-carbon technology standards, establish a technology innovation consortium, encourage joint research by the industries and academia, and build a data hub for the digital development of low-carbon energy.

## **Green and Low-carbon Transition in the Oil and Gas Industry and Technological Innovations**

— *Sun Longde*

*(CAE academician, Chairman of China Petroleum Science and Technology Association)*

Under the carbon peak and carbon neutrality goals, China's oil and gas industry is facing dual pressure of development and transition. Green and low-carbon transition becomes the must-go pathway for upstream enterprises.

Nowadays, the oil and gas development presents multiple aspects: greenhouse effect and extreme energy poverty seriously threaten human development; oil and gas still plays a dominant role in the global energy structure; there's great potential for exploration and development of global oil and gas resources; the intensifying global warming demands green and low-carbon development of oil and gas production; energy security plays a more prominent role in the oil and gas transition and development.

Under the carbon peak and carbon neutrality goals, oil and gas are the main energy sources of the world. With the decrease of upstream investment and the increase of supply uncertainty, oil and gas security becomes the core of energy security. Under the

carbon peak and carbon neutrality goals, oil and gas production in the green and low-carbon mode and oil and gas stable supply are facing intensified pressures. It's urgent to accelerate the core technology innovation in the fields of smart technology, multi-resources and multi-energy green synergy in super basins, new generation engineering technology and equipment, and oil and gas field carbon dioxide capture, geological utilization and storage, centering on the four domains of onshore deep and ultra-deep oil and gas exploration and development, new generation EOR technology, offshore oil and gas exploration and development, and unconventional oil and gas exploration and development.

The oil and gas industry will shoulder the three missions of energy security, stable oil and increased gas production, and green and low- carbon development in the future. It will still be irreplaceable, given oil and gas's properties as energy and material.

# **Green and Low-carbon Transition and Upgrading of the Petrochemical Industry and Technological Innovations**

— *Chen Jianfeng*

*(Academician and Secretary General of CAE)*

The birth and rapid development of chemistry discipline and the chemical industry have provided an important material basis and energy guarantee for the development of human society. The chemical industry has become a pillar industry of the national economy, bringing a good life rich in green and low-carbon materials to mankind. In the context of the carbon peak and carbon neutrality goals, profound changes unseen in a century are taking place at an accelerated pace, green and low-carbon transition has become a general trend of global development, the traditional development model is in urgent need of transformation and upgrading, and China's petrochemical industry is entering a critical period for the transition from bigger to stronger development.

To promote the high-quality development of the petrochemical industry, we must vigorously develop green technology, to build a green system, and achieve green and low-carbon transition, aiming for high-quality, high-efficiency and low-carbon development with low energy consumption. We should

practically accelerate the green transformation and development of the petrochemical industry leveraging innovative technology. We should step up efforts to increase energy efficiency to promote carbon reduction in production, vigorously adjust the energy consumption structure to promote carbon emission reduction from the source, improve product recycling to promote carbon reduction in market consumption, and increase comprehensive utilization of resources to promote carbon reduction in the downstream. We should effectively promote the green transformation and development of petrochemicals leveraging innovative technologies.

The "green molecular" manufacturing strategy should be implemented in the petrochemical industry, to support the changes of manufacturing model in the industry and the integration of multiple disciplines, and contribute to the building of a "green molecular" manufacturing industry. Research can be carried out from the perspectives of theoretical arithmetic in combination with AI-Chem, chemical process enhancement technology, research and development of efficient and environmentally friendly catalytic materials, high-end specialty chemicals manufacturing, technological upgrading of digital empowerment, to identify the priority development direction of "green molecular" manufacturing technology.

## Thoughts on the Integrated Development of New Energies and Traditional Energies

— *Wu Yin*

*(Former deputy director of the National Energy  
Administration)*

Energy conservation and reduction of pollution and carbon emissions are the core elements for the integrated development of new energies and traditional energies. The process of rapid development of new energies is also the process for traditional energy players to explore new pathways, seek new breakthroughs, and find new scenarios.

The main objective for the integrated development of new energies and traditional energies is to improve the quality of energy transition, shorten the span of energy transition, facilitate the coordinated development of regional energy resources, promote the optimal combination between fossil energies, new energies and fossil and new energies, and seek an optimal solution to the energy eternal triangle.

Systematic and logical thinking can be a tool in the integrated development of new energies and traditional energies. Strategically and ideally, breakthroughs need to be made before new construction. Tactically, green ideas should be adopted and

new energies should be developed before phasing out traditional energies. We need to scientifically refine the top-level design, build global optimization models, seek optimal solutions for safety, ecology, and economy, and constantly revise and improve them in practice. We should give play to the decisive role of the market in allocating resources, deepen reforms in energy and related fields, and form effective incentive and restraint mechanisms leveraging the market mechanism. To enable the government to play a better role, we should enable policy design to conform to the general trend of energy transition, encourage the healthy development of new energies, eliminate the constraints to the development of new energies from traditional energies, facilitate the traditional energies to play an effective role in supporting the fast and steady development of new energies, and guarantee the orderly phase-out of traditional energies.

The integrated development of new energies and traditional energies should be based on carbon control and utilization, and realized via the five pathways of "carbon consumption reduction, carbon emissions reduction, carbon utilization, zero carbon emissions, and carbon recycling".

# Evolution Trend and Technology Development Prospect of New Power System

— *Shu Yinbiao*

*(CAE academician, Chairman of China Huaneng Group)*

Energy power is the key to achieving carbon peak and carbon neutrality. The new power system itself will become a zero-carbon power system, promoting energy transition from both the power production side and the energy consumption side. It is an important pillar for the high electrification of the whole society and the achievement of the carbon peak and carbon neutrality goals.

The optimization of the power supply structure of the new power system should focus on the research on medium and long-term power demand, new energy resources and output characteristics, and the optimization of new energy and various power supply structures, with safety and economic evaluations continuously carried out, the proportion of new energy power generation gradually increased, and the forms and functions of power generation enriched, to realize a highly intelligent power system.

Power and energy balance, and security and stability, are the two major issues faced by the construction of new power

systems at present. Compared with traditional energy power, the daily output of new energies fluctuates greatly, and the weekly output has strong uncertainty, which greatly increases the difficulty in maintaining power and energy balance. In addition, the safe and stable operation mechanism of the "double-high" power system (with high proportion of new energy sources and power electronic equipment) has fundamentally changed, which is the most prominent problem of the new power system.

Therefore, for the construction of a new power system, on the one hand, overall research should be carried out from the perspective of basic principles, control theory, and analytical methods; on the other hand, nine key technological breakthroughs, including carbon capture and storage (CCUS), biomass with carbon capture and storage (BECCS), hydrogen energy and electricity market, and carbon market, require the active involvement, continuous exploration and joint promotion of all sectors of society.

## II. Thematic Sub-forum 1

### Digital Transition and Intelligent Development Trend Forecasts for the Oil and Gas Industry

Technologies that the oil and gas industry should develop to adapt to the low-carbon era

— *Liu He (CAE academician)*

Oil and gas field companies are resource-based enterprises and are greatly affected by geographical factors. Due to objective conditions and resource capabilities, they face challenges in digital transformation, but also usher in many opportunities. At present, the oil and gas industry is still in the initial stage of digital transformation, but digitalization has penetrated into all aspects of the industry, and the time for transformation is ripe. Actively embracing the digitalization wave will provide a breakthrough tool for the efficient operation and management of enterprises. Taking large international energy companies as benchmarks, Chinese oil and gas companies should join forces with IT companies, to speed up their digital layout, and empower the industrial chain upgrading of the oil and gas sector leveraging big data and artificial intelligence. In addition, digital transformation is a complex systematic project. Therefore, it is necessary to replace the previous philosophy of "reserve

prevails" with new philosophy of "data prevails", strengthen data governance, and enhance the value of data.

## **Status and Development Prospect of Natural Gas in China's Energy Transition**

—*Huang Weihe (CAE academician)*

Through the efforts in onshore conventional gas, offshore oil and gas, tight gas, shale gas and other fields, and the construction and improvement of multiple channels, China's gas industry will give full play to its seasonal peak-shaving role in the context of carbon neutrality. In the future, natural gas will serve as the "stabilizer" and "regulator" in China's energy system, and support the long-term development of renewable energies, through the integration with renewable energies. The natural gas industry should give full play to the driving role of technological innovation and create new advantages for development. Scientific and technological research on natural gas exploration and development should be continuously carried out, to increase domestic production. The localization of large gas turbines should be accelerated to reduce the cost of end-use energy. The characteristics of integration of multiple energy sources need to be studied, to build a smart energy network. Research on CCUS potential and related technologies need to be carried out to ensure the development space for natural gas.

# Global Status of CCUS Industry, Technology Trends, and Lessons

—*Jarad Daniels*

*(CEO, Global CCS Institute)*

By Mid-21st Century, CCS capacity will scale from 40 million tons today to multiple gigatons. It is estimated capital investment of \$655 billion - \$1.28 trillion will be required over the next 30 years. Factors such as Net Zero commitments from countries, zero-carbon strategies of major enterprises, the strengthening of the global carbon dioxide capture and storage (CCS) network, the development of blue hydrogen projects, and the commercial prospects of carbon-negative technologies provide strong momentum to the large-scale application of CCS. The development of CCS demonstrates two technology trends, viz. modularization and process intensification. Process technology (e.g. adding enzymes) is leveraged to enhance the efficiency of carbon dioxide as a solvent, centrifugal separation technology is applied to reduce the volume and cost of traditional equipment, etc., to improve the efficiency and benefit of CCS projects.

## **Prospect and Technical Pathways of Energy Conservation and Environmental Protection in the Oil and Gas Industry**

—*Zhou Aiguo (Chief QHSE expert, CNPC)*

The oil and gas industry should give priority to the development of energy conservation and environmental protection technologies that conform to the low-carbon transition. Methane management and control is the key link for hydrocarbon decarbonization. To achieve effective control over methane, we have to strengthen construction of systems for detection, accounting and verification and accelerate development of technologies for efficient and low-cost emission reduction. Electrification is the main means to achieve substantial reduction of greenhouse gas emissions. It's necessary to promote the low-carbon transition of the refining and chemical industry through primary and flexible electrification. Digitization provides solutions for reengineering of zero-carbon production systems. Digital energy plants, digital twins and other measures have presented affordable technical and economic solutions for the oil and gas industry. CCUS is a technical measure to guarantee carbon neutrality. By promoting the construction of demonstration projects, the oil and gas industry can accelerate the establishment of cross-industry CCUS model.

# **Suggestions on Mechanisms and Policies for China's Oil and Gas Industry Transformation in the Context of Green and Low-carbon Development**

— *Yang Lei*

*(Deputy Dean, Institute of Energy, Peking University)*

Carbon neutrality is a global competition that changes trade rules and reshapes the investment landscape. It's an industrial competition to upgrade development models and promote technological innovation. Also, it's a superpower game that reshapes geopolitical relations and reallocates discourse power. Sound market mechanisms and price signals are the guarantee and foundation for a new energy system, and low-carbon technologies should replace resources as the cornerstone of the system. To facilitate the transition and development of China's oil and gas industry, we should first take the initiative to establish short-term and long-term strategies in terms of efficient natural gas development, energy conservation and efficiency enhancement, overall solution making of "power supply, power grid, power load and energy storage", and renewable energy system construction. We should take the initiative to reform and gain greater impetus for development in a market-oriented environment. Also, we should increase technology investment in new strategic directions, innovate in

business models, and take the road of user-centered development.

### **III. Thematic Sub-Forum 2**

#### **Pathways for technological innovation to empower green energy development**

##### **Research on Development Strategy of Hydrogen Energy and Fuel Cell**

— *Peng Suping (CAE academician)*

As the human is working towards a low-carbon future, hydrogen energy, a green, efficient and widely used secondary energy has become the "ultimate energy of the 21st century", and an important direction of technology revolution and industrial development for all the countries including China. With unique advantages, and application technologies, hydrogen energy has great potential in various fields of energy consumption (industry, transportation, construction and power generation). The next 10 to 20 years will be an important strategic opportunity period for the development of China's hydrogen energy and fuel cell industry. Based on domestic situation, we should take the initiative to establish strategies from the aspects of strategy, policy, technology, capital and international cooperation, solve

problems through reform and innovation, to facilitate the high-quality development of hydrogen energy and fuel cells.

**Opportunities and Challenges for Green Circular  
Development of the Biomass Energy Industry and  
Technological Innovations**

— *Han Buxing*

*(CAS academician)*

Science and technology is the foundation for the achievement of carbon neutrality which involves multidisciplinary fields. With conversion of the materials and energy as the core issues of carbon neutralization, chemistry has become irreplaceable. More researches have to be done, based on the basic principles of green chemistry, on evolution of carbon chemical bonds throughout the whole course of carbon resource processing, energy utilization, carbon fixation and carbon recycling, so as to promote transformation of production and lifestyle and achieve sustainable development.

Green chemistry and technology is of great significance for China that has just embarked on the journey to achieve the long-term task of carbon neutrality. To lead chemical industry onto the road of green and sustainable development, China has to overcome challenges through persistent innovation.

# **Prospect and Technological Innovation of Solar Energy and Other New Energy Resources under the carbon peak and carbon neutrality Goals**

—*Li Meicheng*

*(Dean of the School of Renewable Energy, North China Electric Power University)*

Energy resources are main factors, and electricity is the major contributor, for the achievement of carbon peak and carbon neutrality goals. New energy power generation faces many problems — how to achieve efficient consumption? How to ensure safe and stable operation? How to eliminate the imbalance of resources and the construction of new energy power generation? The key is technological innovation, which can push the construction of new power system with increasingly high proportion of new energy sources.

To build a new energy-based smart system, and effectively reduce carbon emissions, we have to integrate new technologies in solar energy, wind energy, biomass energy, and energy storage, introduce AI algorithms, block-chain technology, energy flow, information flow, and value flow. We have to engage in new energy technology innovation, set up new

large-scale scientific installations, build new inter-disciplines, so as to realize the grand blueprint of carbon neutrality.

**Development and Prospect of Energy Storage Industry  
under the carbon peak and carbon neutrality Goals**

— *Cheng Huiming*

*(CAS academician)*

Energy storage technology plays an irreplaceable role in the efficient utilization of renewable energies and clean utilization of coal, oil and gas.

With the vigorous development of smart grid, renewable energy power generation, distributed power generation and microgrid, a large number of distributed power sources are connected to the grid. However, the problems of randomness and high load brought by distributed systems need to be solved by distributed energy storage, a key technology for developing renewable energy power generation business.

Energy storage is one of the goals of the transformation of the petroleum industry. It can be integrated with oil and gas and has a wide range of application scenarios. Combined with the geothermal resources in the oil field, the energy storage technology can be assorted with geothermal power generation

for peak shaving and frequency regulation of the geothermal power station; with the support of energy storage facilities, the oilfields and mining areas can actively carry out the effective utilization of wind and solar resources and realize local consumption; the energy storage technology can also effectively support the traditional petroleum engineering energy, to achieve energy saving and emission reduction.

### **Digital Energy Supports the Development of Smart Energy**

— *Wang Dan*

*(Senior expert, Huawei Digital Power)*

In the future, the high proportion of renewable energies, power electronic equipment, and distributed energy in the new power system will pose new challenges to the power grid. Given this, the power generation, transmission, distribution and utilization should be systematically and comprehensively integrated to cope with the challenges.

With the development of technology, especially the continuous iteration of multi-string technology, the diversified energy supply becomes visible, manageable and controllable. Energy storage will move from battery integration to intelligent string architecture, to enable the building of efficient and safe energy storage system.

Through multi-energy complementarity of wind, solar, hydro, thermal, and storage, and efficient coordination of source, network, load and storage, a comprehensive smart energy system will be built, to facilitate energy scheduling, energy efficiency management, capacity management, equipment management, comprehensive application, etc.

The development of digital energy, which integrates digital technology and power electronics technology, will promote the energy revolution and contribute to a green and beautiful future.

#### **IV. Thematic Sub-Forum 3**

**New ideas for the green and low-carbon transition and development of the petrochemical industry; directions for technological development**

**Low-carbon Development Approaches of Polymer Materials  
in the Future**

— *Wang Yuzhong*

*(CAE academician)*

Improper disposal of polymer material wastes will cause environmental pollution, resources wasting and carbon emissions, and it is estimated that by 2030, the worldwide carbon emissions from the production and incineration of

plastics will approach 1.4 billion tons. There are three pathways for the green and low-carbon development of polymer materials: the first is utilizing biomass resources to produce bio-based polymer materials, and developing green production technologies therefor and improving the cost performance of products in the future; the second is developing biodegradable polymer materials so as to reduce the environmental pollution caused by polymer material product wastes; and the third is developing the recycling and upgrading recovery technologies of polymer material wastes so as to reduce the consumption of fossil energy and the pollution to the environment. For newly-synthesized polymer materials, besides the use performance, the recyclability and recoverability should be considered. For disposable products, the biodegradability should be considered.

**Intelligent Technology Innovation Empowering Low-carbon  
and High-Quality Development of the Petrochemical  
Industry**

*— Qian Feng*

*(CAE academician)*

Building a new pattern of the digital economic development of the petrochemical industry through digital transformation is the

key to the high-quality development of the petrochemical industry, which can help achieve the national goals of carbon peak and carbon neutrality. The intelligent control technology of virtual and real fusion is the core of the digital transformation of the petrochemical industry. By means of intelligent collaborative decision-making for the supply chain, the production value and the value chain, the real-time autonomous intelligent control on the manufacturing process, the intelligent control on the HSE maintenance, etc., it can realize the efficient utilization of resources and energy in the manufacturing process, the green and low-carbon production, the high-value and high-end products and the maximum value chain in the petrochemical industry, promote the upgrading of the industrial base and the modernization of the industrial chain of the petrochemical industry in an all-round way, and seize the commanding point of the new track of the industrial digital development.

# **Molecular Recognition and Separation Engineering Technologies and Applications**

—*Ren Qilong*

*(CAE academician)*

Novel acetylene preparation technologies, such as the thermal plasma technology, a process intensification technology based on cross science, have broad prospects. It can play an important role in the fields of waste treatment, energy conservation and emission reduction, efficient preparation of materials and raw materials, clean transformation of resources, etc. The coke cleaning technology for coal to acetylene by plasma pyrolysis can be applied for the in-situ cleaning of coke in reactors, and is safe and effective.

## **Challenges, Opportunities and Technological Innovation Prospects of the Petrochemical Industry in the Context of Energy Consumption "Dual Control" for the Achievement of carbon peak and carbon neutrality Goals**

—*Xie Zaiku*

*(CAS academician)*

Opportunities and challenges coexist in the petrochemical industry under the carbon peak and carbon neutrality goals, and

the development trend is mainly reflected in the adjustment and change of oil demand structure, decarbonization and electrification of petrochemical process, multi-energy complementation and process reengineering, and high-quality development of petrochemical products. Technological innovation will play a supporting and leading role in the green and low-carbon development of the petrochemical industry under the carbon peak and carbon neutrality goals. The priorities of scientific and technological development in the petrochemical industry mainly include the following aspects: developing molecular refining, making breakthroughs in heavy oil processing, oil conversion, and high-value refining products; developing green and low-carbon chemicals, making breakthroughs in new reactions and new processes; developing high-end chemical materials, focusing on high-performance, high value, degradable synthetic materials; developing new energy-saving technologies, making breakthroughs in energy-saving and consumption-reducing separation materials and processes; developing recycling chemicals, making breakthroughs in plastic recycling and source engineering; developing carbon dioxide technology to help achieve the goal of carbon neutrality; developing green hydrogen, bioenergy, photovoltaics and renewable energies, and promoting the development of green hydrogen refining; developing artificial

intelligence (AI) to help achieve intelligent manufacturing in oil refining and chemicals, etc.

## **Electrification for Petrochemical Processes, Leading to A Low-carbon Future**

—*Andrew Howel*

*(Executive Vice President Technology, KBC)*

The petrochemical industry is a main contributor to global emissions, and requires more complex decarbonization path than any other sector. Chemicals players must move quickly and fund net-zero projects as soon as possible, or risk getting locked out of key technologies. Investments today will be key to managing longer-term costs and pay dividends post-2035. \$759 billion is required for a net-zero petrochemicals sector by 2050. Electrification and carbon capture and storage are likely to play a central role in reducing emissions from the production of petrochemicals. Electrification for petrochemical processes will lead to a low-carbon future.

## **Innovation and Practice of Green and Low-Carbon Development in China's Petroleum Refining Industry**

—*Yang Weisheng*

*(President, CNPC Petrochemical Research Institute)*

CNPC adopts the three-step overall scheme of "Clean Alternative, Strategic Replacement and Green Development", adheres to the development principle of "decarbonization of fossil fuels, large-scale development of clean energy, integration of multiple energy sources, re-electrification of end use energy" and implements four measures "carbon reduction, carbon utilization, carbon replacement, carbon storage", striving to achieve "near-zero" emissions by around 2050. Technological innovation is the most important driver for the low-carbon sustainable development of petrochemicals. The low-carbon development of CNPC's refining and chemical business is mainly achieved through six pathways, viz. strengthening process energy conservation and improving energy efficiency; accelerating clean energy substitution; promoting low-carbon materials; developing low-carbon/carbon negative/disruptive technologies; abating low-efficiency and high-emission production capacity, developing high-performance materials; attaching importance to carbon sequestration, carbon assets, and carbon trading.