Translation

The following policy describes China's vision for the adoption of AI technology in its energy sector through 2030. A spinoff of the August 2025 "AI+" strategy, this plan identifies numerous ways that Chinese electric utilities and energy companies should use AI to improve their operations. These include areas such as predictive maintenance, coordinating supply and demand of renewable energy, and replacing dangerous or labor-intensive tasks in coal mining and offshore oil drilling. The plan covers applications of AI technology to support the energy sector, and does not address the flip side of the issue, namely how to supply enough electricity to meet the increasing energy needs of China's AI industry.

Title
Implementation Opinions of the National Development and Reform Commission and the National Energy Administration on Promoting the High-Quality Development of "Artificial Intelligence+" Energy
国家发展改革委 国家能源局关于推进"人工智能+"能源高质量发展的实施意见

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Implementation Opinions of the National Development and Reform Commission and the National Energy Administration on Promoting the High-Quality Development of "Artificial Intelligence+" Energy

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To the development and reform commissions and energy administrations of all provinces, autonomous regions, province-level municipalities, cities with independent planning status under the national economic and social development plan, and the Xinjiang Production and Construction Corps, and to relevant central enterprises, and

relevant industry associations:

In order to thoroughly implement the decisions and arrangements of the Party Central Committee and the State Council on the development of artificial intelligence (AI), carry out the relevant work requirements set forth in the *Opinions of the State Council on Deepening the Implementation of the "AI+" Initiative* ([2025] Document No. 11),[1] seize the major strategic opportunities in the development of AI, make our orientation toward applications more prominent, accelerate the deep integration of AI with the energy industry, and support high-quality development and high-level security[2] in the energy sector, the following implementation opinions are hereby put forward.

I. Overall Requirements

Adhering to Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era as the guide, thoroughly implementing the spirit of the 20th Party Congress and the Second and Third Plenums of the 20th Central Committee, and fully implementing General Secretary Xi Jinping's important instructions on promoting the deep integration of AI with the real economy and cultivating and expanding the AI industry, this work will rely on the expansion of application scenarios for the deep integration of AI with the energy sector as an important support, take the enhancement of the technological level of innovative applications of AI in the energy sector as its main focus, take the advancement of coordinated development between intelligent computing power (compute)[3] and electric power as a necessary support, and take the improvement of the innovation system for energy intelligentization (智能化) development as a key safeguard. We will strive to enhance the safe, reliable, flexible, and efficient operational capacity of the energy system, ensure the secure and stable supply of energy and its green and low-carbon transformation, accelerate the cultivation of new quality productive forces (新质生产力), and provide strong support for the construction of a new-type energy system.

By 2027, a preliminary innovation system for integration of energy and AI will have been established, the foundation for coordinated development of compute and

[1] CSET's English translation of the *Opinions of the State Council on Deepening the Implementation of the "Artificial Intelligence+" Initiative* is available online at: https://cset.georgetown.edu/publication/china-ai-plus-opinions-2025/.

[2] Translator's note: The Chinese word 安全 encompasses the meanings of both "safety" (protection from accidental harm) and "security" (protection from deliberate harm). In this translation, it is variously translated as "safety," "security," or "safety and security" at the translator's discretion.

[3] Translator's note: "Intelligent computing power" ("intelligent compute"; 智能算力; 智算) typically refers to computing power specifically designed and optimized for artificial intelligence (AI) model training, inference, or use.

electric power will be further consolidated, significant breakthroughs will have been achieved in AI-empowered core technologies for energy, and applications will be more extensive and in-depth. Five or more specialized large models will be promoted for deep application in industries such as power grids, power generation, coal, and oil and gas. Ten or more key demonstration projects that are replicable, easy to promote, and competitive will be identified. Pathways for empowering 100 typical application scenarios will be explored. A number of research and development (R&D) innovation platforms for AI technology applications in the energy industry will be fostered. One hundred technical standards will be formulated and improved. A number of hybrid talents (复合型人才) in energy and AI will be cultivated. Exploration will be carried out to establish a financial support system for research, development, and application of AI technology in the energy field. A development model for AI technology innovation in the energy sector that accords with China's national conditions will be formed, and initial results in energy intelligentization will emerge.

By 2030, China's dedicated AI technologies and applications in the energy sector will have generally reached a world-leading level. The mechanism for coordinated development of compute and electric power will be further improved, and an environmentally friendly, economical, safe, and efficient model of compute energy use will be established. Theoretical and technological innovation in the integration of energy and AI will have achieved notable results. AI technologies in the energy sector will empower cross-domain, cross-industry, and cross-business scenarios, achieving breakthroughs in areas such as intelligent power regulation, intelligent exploration of energy resources, and intelligent forecasting of new energy. Embodied AI and AI for science will achieve real-world applications in key scenarios. A number of globally leading "AI+" energy-related R&D innovation platforms and hybrid talent training bases will be established. A more complete policy system will be formed to continuously guide efficient, healthy, and orderly "AI+" energy innovation, laying a solid foundation for the high-quality development of energy.

II. Accelerating Empowerment of Energy Application Scenarios

(i) AI+ power grid. Focusing on the requirements of power grid security, new energy integration, and operational efficiency under a new-type power system, carry out applications such as power supply–demand forecasting, intelligent grid diagnostic analysis, and intelligent generation of planning schemes in grid planning and design, and strengthen smart construction and management of power grid projects. Advance multi-scale intelligent simulation and analysis of power grids, explore the application of AI models in intelligent auxiliary decision-making and dispatch control of power grids, and enhance the safe, reliable, and low-carbon operation of all elements of source–grid–load–storage in the power system. Steadily improve the intelligentization

level of R&D and manufacturing of key equipment such as transmission and substation facilities. Promote predictive maintenance of power equipment to prevent breakdowns, build intelligent agents for power equipment health management with autonomous sensing, decision-making, and execution capabilities, and enhance lean management of equipment. Advance integrated application of intelligent operation, distribution, and dispatching, build an intelligent support system for grid operation services, and improve the full-process intelligent service level for electricity customers. Promote the integration of AI technologies into the emergency power system and capacity building, and enhance the intelligentization level of power system disaster prevention, mitigation, and relief.

Box 1: Typical application scenarios of AI+ power grid

Intelligent grid planning, design, and construction. Build applications such as intelligent forecasting of power supply and demand, intelligent diagnostic analysis of grid operations, intelligent auxiliary decision-making for grid planning, and intelligent design of transmission and transformation facilities. Apply AI technologies to carry out planning, design, and techno-economic analysis, and promote the intelligentized transformation of grid planning and design operations. Focusing on task perception and operational monitoring during the construction stage, build applications such as AI-based violation identification in grid construction, progress simulation, online monitoring, real-time analysis of control indicators, and intelligent management of work processes, so as to promote the intelligent upgrading of grid project construction.

Grid dispatch and operations. In the context of building a unified national power market, build intelligentized applications in areas such as new energy power forecasting, load forecasting, offline simulation analysis, online security analysis, extreme emergency handling, auxiliary decision-making for dispatching, market clearing and operational optimization, and smart decision-making in the power market. Continuously improve the support system for new-generation intelligent regulation and control technologies, to ensure the safe and stable operation of the new-type power system.

Power equipment condition assessment and intelligent operations and maintenance (O&M). Build applications such as intelligent perception and early warning of equipment condition, intelligent defect pinpointing and diagnosis, intelligent decision-making for equipment condition-based maintenance, intelligent prediction of equipment disaster risks, and intelligent generation of service work orders, in order to improve lean management of equipment.

Intelligent operation and management of distribution networks. Build technical applications such as real-time perception, risk analysis, and intelligent decision-making in distribution networks, comprehensively enhance smart control capabilities and power supply reliability of distribution networks, and strengthen coordinated regulation of source–grid–load–storage at the distribution network level.

Emergency rush power repairs. Build auxiliary decision-making systems such as intelligent early warning of disaster risks in power systems, intelligent analysis of damage conditions, and intelligent decision-making for emergency response plans. Advance the intelligentization of technical equipment for power emergency rush repairs, and enhance the capacity of the power system for disaster prevention, mitigation, and relief.

(ii) New business formats (新业态) for AI+ new energy. Focusing on the needs of energy supply assurance and green, low-carbon transformation, advance the application of AI technologies in flexibly adjustable resources such as virtual power plants (including load aggregators), distributed energy storage, and vehicle-to-grid (V2G) for electric vehicles, in order to enhance load-side group control optimization and dynamic response capabilities. Strengthen the application of AI technologies in coordinated optimization and dispatching of new-type energy storage and power systems, as well as in total life cycle safety, and promote the intelligent optimization of renewable energy hydrogen production processes. Strengthen the empowerment of AI technologies in energy production processes for energy conservation and carbon emissions management, improve the total efficiency and carbon reduction level of multi-energy complementary integrated energy systems providing combined electricity, heat, cooling, and gas. Promote the application of AI in zero-carbon industrial parks, intelligent microgrids, and compute–power coordination, enhance the intelligent operational level of source–grid–load–storage integration, and facilitate local consumption of new energy.

Box 2: Typical application scenarios of new business formats for AI+ new energy

Precise control and intelligent operation of virtual power plants. The virtual power plant operator platform, based on grid dispatching instructions and market information and taking into account the dynamic changes of resource characteristics, conducts intelligent optimization of control strategies and intelligent generation of control instructions. This enables large-scale aggregated optimization and regulation of flexible resources, and supports smart trading decisions for virtual power plants participating in the electricity market.

Intelligent optimization of green hydrogen production processes. By integrating multidimensional data such as wind and solar power fluctuation forecasts, hydrogen storage tank capacity, electrolyzer temperature, and catalyst status, and leveraging AI algorithms, the system intelligently drives dynamic optimization of electrolyzer current density. This builds an intelligent regulation and control system covering the full chain of hydrogen production, storage, and utilization, achieving millisecond-level matching between renewable energy output fluctuations and the flexible load of electrolytic devices.

Industrial park-level intelligent carbon reduction. Based on operational data from photovoltaic, energy storage, and other equipment, industrial park-level intelligent carbon reduction collaborative control systems dynamically optimize energy dispatching strategies in real time. By incorporating electricity prices and carbon emission factors, they automatically adjust air conditioning temperatures, charging station power, and equipment start–stop sequences. Through augmented reality (AR) visualization interfaces and voice assistants, they provide users with personalized energy-saving recommendations, forming an intelligent "carbon–energy–cost" collaborative model.

Intelligentized operation of new-type energy storage. Addressing the dynamic adaptation of new-type energy storage to power system dispatching, wide-area collaborative interaction, weak grid support, battery equipment safety monitoring, and equipment assessment and O&M, AI technologies are used to enhance the coordinated control capability of multiple types of energy storage for weak grids. An application system is built encompassing wide-area collaborative optimization control of new energy with new-type energy storage, intelligent evaluation of energy storage power stations, smart O&M decision support, and total life cycle safety, improving the power supply assurance capacity of system-friendly new energy power stations.

Intelligent marketing services. For customer-facing service scenarios in oil, gas, and electricity, build intelligentized applications such as intelligent assistance for agent service handling (座席业务受理), intelligent customer service, intelligent generation of power supply solutions, intelligent generation of integrated energy use solutions, intelligent dispatching of O&M work orders, and intelligent diagnosis of abnormal user energy consumption. Create an interactive, companion-style new model of customer service, and enhance the level of intelligentized service across the entire customer process.

(iii) AI+ new energy. In response to the volatility and intermittency of new energy output, accelerate the application of AI in areas such as high-precision power

forecasting, electricity markets, smart operation of power plants, new energy planning, and post-project evaluation. Continuously promote the iteration and innovation of key materials and products for new energy. Advance the development of large models for power forecasting under complex scenarios and changeable weather toward smaller scales and higher precision, support wide-area coordinated optimization of new energy resources, and promote intelligent O&M of new energy power plants in remote areas. Build an integrated intelligent new energy production model of "meteorological forecasting + power forecasting + smart trading + intelligent O&M," and make every effort to support a stable supply of new energy.

Box 3: Typical application scenarios of AI+ new energy

Meteorological forecasting and precise new energy power forecasting. Build a meteorological service system with multitemporal and multispatial measurement-based (多时空尺度) meteorological forecasting at its core, establish algorithmic large models for multi-scenario and multi-period precise mining and analysis of nonlinear relationships between weather and power, and achieve precise forecasting of new energy power output.

Intelligent O&M for remote-area power plants. Utilize technologies and equipment such as large models, voiceprint detection, remote sensing, robots, and intelligent wearable devices to monitor surrounding environments and equipment operating conditions in real time. Achieve intelligent linkage among multiple systems such as unmanned aerial vehicles (UAVs), unmanned vehicles, unmanned surface vessels, and intelligent control, thereby improving equipment inspection efficiency and enhancing the overall operational efficiency of power plants.

New energy planning and design. Taking into account factors such as power generation efficiency and return on investment, build an intelligentized recommendation engine to provide optimal equipment matching solutions. Integrate large models with design software to rapidly generate multiple versions of design schemes and evaluate key parameters, improving both the efficiency and quality of design.

Smart work site construction. Promote the deep integration of AI technologies into the entire process of power project management, including project construction scheme selection, personnel management, risk early warning, and timeline control. Develop systems such as UAV inspection systems and automated risk assessment and early warning systems to capture violations by construction personnel in real time. Build a "smart work site" management platform covering the entire construction process, helping to improve the overall safety and quality level of

power projects.

(iv) AI+ hydropower. Focusing on intelligentized construction of hydropower projects in high-altitude and cold regions and smart scheduling and operation of cascade hydropower stations (流域水电站), advance the application of AI technologies in hydropower project construction, and enhance the level of intelligentization of design, construction, and management of hydropower projects. Promote the integration of AI technologies with traditional hydrological models, meteorological models, and large-scale reservoir scheduling technologies, improve the accuracy of bidirectional coupled forecasting of meteorology and hydrology, and develop intelligent applications for optimization of scheduling decision-making. Promote the integration of technologies such as knowledge graphs, large models, and intelligent agents into a new-generation smart operation brain for hydropower, and form intelligentized solutions in key areas such as smart O&M and lean maintenance of hydropower stations, and intelligent dam situational awareness and smart management.

Box 4: Typical application scenarios of AI+ hydropower

Intelligent hydropower project construction. Based on multisource remote sensing data fusion and intelligent robots, as well as other AI technologies, establish an intelligentized geological survey and design system for hydropower projects. Achieve digitalized and intelligentized installation and debugging of unit (机组) equipment, and improve the intelligentization level of construction management for hydropower projects.

Meteorological–hydrological joint forecasting. Based on large models for bidirectional coupled forecasting of basin meteorology and hydrology, build quantitative risk assessment tools for extreme events such as floods and droughts. Fully integrate meteorological knowledge, hydrological knowledge, and basin geographic information to improve the accuracy and lead time of meteorological–hydrological forecasting.

Comprehensive basin scheduling. Based on key technologies such as joint smart optimization scheduling for, risk control of, and simulation and emulation of station clusters within a basin, build intelligent applications for precise optimization of schedule decision-making. Achieve real-time monitoring, analysis, and evaluation of the implementation of water resource scheduling plans, optimize water resource allocation across time and space, improve hydropower utilization, and increase power generation efficiency.

Intelligent operation and inspection of equipment. Based on multisource data such as physical fields (物理场), acoustics, vision, and intelligent sensors, as well as technologies such as knowledge graphs and large models, promote end-to-end intelligentized upgrades in operational areas including holistic monitoring of equipment condition, total life cycle health management, intelligent O&M, and status-based maintenance for key hydropower equipment. Achieve structured management of O&M knowledge and build intelligent auxiliary decision-making systems based on large model–intelligent agent integration.

High-quality operation of dams. Establish a database and knowledge graph of typical dam defect characteristics, and apply theoretical methods for intelligent dam perception–fusion–diagnosis–prevention/control. Achieve early identification, self-diagnosis, automated adaptive warning, and intelligent feedback and control for multiple drivers of dam safety conditions, ensuring the operational safety of hydropower station dams and supporting the high-quality operations management of reservoir dams.

(v) AI+ thermal power. Focusing on the development direction of cleanness and carbon reduction, safety and reliability, efficient regulation, and intelligent operation of thermal power, collaboratively carry out AI empowerment and technological innovation in operational scenarios such as fuel management and control, production operation optimization and intelligent control, and total life cycle management of equipment. Accelerate the digitalized design and construction and intelligentized upgrading of thermal power, promote the intelligentized development and application of thermal power operational control systems, and enhance the intelligent monitoring and health management capabilities for the total life cycle of key thermal power equipment, helping to further strengthen the support and assurance capacity of thermal power.

Box 5: Typical application scenarios of AI+ thermal power

Intelligent fuel management and control. Based on multidimensional and multi-type data such as fuel market price fluctuations, inventory levels, coal consumption, three-dimensional structures of coal piles, and coal quality analysis, adopt advanced sensing, image recognition, rule understanding (规则理解), and intelligent agent technologies to achieve intelligent detection and intelligent management and control of fuel quantity and quality.

Production operation optimization. Based on large models and data from production and operation-related systems, achieve intelligentized upgrading of core operational scenarios in the production and operation process, including fuel

blending, operation optimization, intelligent flexible peak shaving (调峰), and intelligent safety management and control, thereby improving the intelligentization level and efficiency of production operations.

Total life cycle management of equipment. Based on large models and AI technologies such as robotics, carry out real-time condition monitoring of multiple types of data for key equipment including steam turbines (including gas turbines), generators, and boiler heating surfaces. Achieve panoramic monitoring of equipment condition, quantitative health assessment, hidden danger identification and failure early warning, residual life prediction, operational scheme adjustment, anomaly analysis and judgment, and closed-loop management of hidden dangers.

Intelligent technology supervision and evaluation. Relying on massive operational data of key equipment such as boilers, steam turbines (including gas turbines), and generators, together with materials related to thermal power technology supervision work, and leveraging the multimodal analysis capabilities of large thermal power models, deeply integrate with thermal power-specific scenarios to enhance the intelligentization level of technical supervision and the professional capabilities of personnel.

(vi) AI+ nuclear power. Focusing on the safe development of nuclear power, build intelligent support systems for nuclear power safety early warning, intelligent tracing and analysis of operating incidents at power plants, and emergency response. Conduct research on special O&M robot technology for the nuclear industry, continuously advance the technological upgrading and evolution of functions such as automatic startup and shutdown of nuclear power systems, explore technical pathways in which AI supports plasma prediction and control and controlled nuclear fusion, and promote the nuclear power industry's steady transformation toward a new model that is data-driven, model-guided, and intelligently managed and controlled.

Box 6: Typical application scenarios of AI+ nuclear power

Intelligent nuclear power safety management and control. Leveraging data governance and AI technologies, focus on operating incident tracing, technical specifications, and boundary conditions of operating parameters, intelligently identify unsafe states involving personnel, equipment, and the environment, and advance technological research and applications in scenarios such as safety early warning and intelligent emergency response.

Intelligent O&M for nuclear power. Using data from building materials, systems, and equipment/components at each stage, establish a data-driven nuclear

power plant model. Promote R&D on small nuclear power AI models and specialized large models, and advance the application of AI technologies in intelligent monitoring, early warning, diagnosis, and forecasting in nuclear power systems. Enhance unit performance intelligent diagnosis and optimization capabilities, improve one-button (一键) startup and shutdown capabilities of key equipment, systems, and units, and expand the range and depth of robotic operations in high-risk scenarios such as high radiation, underwater, and confined spaces.

Intelligent control of controlled nuclear fusion. Taking into account the coupling characteristics of controlled nuclear fusion devices under multiple physical fields, carry out research on intelligent control systems for controlled nuclear fusion based on AI technologies. Develop intelligent models for real-time prediction of plasma configuration and adaptive adjustment of magnetic confinement parameters, and achieve intelligentized control of the steady-state operation of tokamak plasma.

(vii) AI+ coal. Focusing on typical scenarios such as geological exploration, coal mine extraction (stripping), coal washing and processing, production scheduling, safety management and control, and equipment management, ensure stable acquisition of various operating data under complex geological conditions, multiple working conditions, and multitemporal and multispatial collaborative circumstances. Apply intelligent models in an integrated manner to achieve intelligent control and autonomous decision-making in the production process, support the normalized operation of reduced-personnel and unmanned work, steadily advance workforce reduction, safety enhancement, and efficiency improvement, and further consolidate coal's role as a fundamental safeguard for energy security.

Box 7: Typical application scenarios of AI+ coal

Intelligent empowerment of coal mine geological exploration. Based on specialized large models for coal mining and integrating new technologies for high-precision surface exploration and dynamic intelligent underground detection, build a geological database for coal mines under complex geological conditions. Achieve end-to-end dynamic collaborative management and early warning for mine geological information, and ensure efficient, rapid, environmentally friendly, and intelligent production in coal mines.

Optimization and intelligent control of underground coal mine extraction processes. Through multimodal perception, integration of large and small models, coordinated control of equipment groups, and dynamic process optimization, extract information about coal rock to drive intelligent cutting, autonomous decision-making,

and coordinated control of equipment groups at coalfaces and boring surfaces. Realize autonomous operation of coalface production systems, efficient coordination of boring surface processes (exploration, excavation, support, anchoring, and transportation), and normalized reduced-personnel and unmanned operations, greatly improving extraction efficiency and safety levels.

Autonomous loading and transport in open-pit coal mines. Promote the integration of large-model simulation of blasting parameters with drilling and blasting operations, and apply AI technologies to rapidly analyze mining and stripping progress. Achieve normalized remote or autonomous operation of excavators, spreaders, bulldozers, and other auxiliary operation equipment within the mining–transport–disposal production system, as well as scaled deployment of autonomous driving for mining trucks. Enhance the level of intelligentization and precision of drilling and blasting, significantly reduce the number of personnel working in pits, and improve the efficiency and safety of open-pit coal mine production.

Rapid coal quality testing and intelligent washing and processing. Collect and build a coal quality characteristic database, dynamically predict in real time key indicators such as ash content, sulfur content, volatile matter, moisture, and elemental composition, and achieve intelligent recognition of coal quality characteristics. Greatly improve the accuracy of online coal quality testing, provide real-time feedback on online testing data, optimize and adjust coal washing process parameters, and improve product quality pass rates and stability. Develop specialized models for coal rock washing and processing, establish an industrial digital twin, and achieve dynamic monitoring, trend forecasting, and collaborative management throughout the entire coal rock washing and processing process.

Status monitoring and intelligent O&M of major coal mining equipment. Establish large models that integrate real-time operating status data of major equipment with detection data such as lubrication, temperature, and vibration, and achieve failure diagnosis and intelligent early warning. Promote preventive maintenance of coal mining equipment, significantly reduce downtime caused by failures, and effectively lower maintenance costs.

(viii) AI+ oil and gas. Focusing on directions such as cross-specialization collaborative research, field operation control, and production operation management and control, promote intelligent evaluation of geological targets for exploration, intelligent optimization of development plans, intelligent adjustment of drilling and fracturing operation parameters, intelligent operation of refining and chemical processing units, and real-time simulation of pipeline operation. Accelerate the R&D

and application of intelligent production technologies and equipment such as intelligent drilling rigs, robots, UAVs, and intelligent sensing systems. Advance end-to-end intelligent linkage and automatic optimization at production sites, and promote the intelligentized upgrading and construction of the oil and gas production chain.

Box 8: Typical application scenarios of AI+ oil and gas

Intelligent empowerment of oil and gas exploration. Enhance the intelligentization level of software in exploration disciplines such as seismology, well logging, and core samples and outcrops. Build specialized large models for seismic and well logging data processing and interpretation, and develop intelligent application systems for comprehensive evaluation of favorable geological targets. Implement demonstration applications such as intelligent assisted driving of vibroseis [survey trucks] and robotic deployment of seismic geophones.

Intelligent management and control of oil and gas reservoir development and production. Develop intelligentized technologies for oil and gas development data and knowledge, intelligent development optimization software, and specialized large models. Build a collaborative research and production management decision-making platform driven by large models, and establish a new model for the management and control of smart oil and gas field development and production.

Prediction and maintenance of the offshore oil and gas production environment. Focusing on the needs of environmental protection and major risk prevention and control in the offshore oil and gas production process, use methods such as intelligent monitoring of the production environment with anomaly early warning, intelligent management and control of solid waste treatment, and intelligent identification and emergency prediction of oil spills. Build integrated capabilities that cover risk prediction, situational awareness, early accident detection, and cognitive decision-making for the ecological environment status across entire oil and gas fields.

Intelligent optimization of engineering technologies. Promote intelligent design of surface engineering, intelligent optimization of drilling parameters, real-time intelligent interpretation of mud logging, reservoir stimulation, and intelligent failure diagnosis and risk assessment. Implement demonstration applications of well control robots and ensure safe and efficient construction under complex geological conditions.

Pipeline network simulation and intelligent regulation. Promote market insight forecasting, real-time pipeline simulation and dynamic optimization, efficient

intelligent operation of stations and depots, integrated air-space-ground management of lines, and monitoring and early warning for key equipment. Achieve "black screen"[4] intelligent regulation, and enhance the safe production, stable supply, and equitable service capacity of oil and gas pipelines.

Integrated optimization of refinery production and operation. Focusing on areas such as end-to-end planning optimization, intelligent identification of safe production, and preventive equipment maintenance, research scientific computing large models for new materials R&D. Use methods such as collaboration among large and small models and hybrid modeling to reduce process fluctuations, lower the probability of safety incidents, and improve the intelligentization level of production and operations.

III. Strengthening the Supply of Key Technologies

Focusing on technological bottlenecks in the energy sector such as data silos, fragmented compute, black-box algorithms, and high energy consumption of compute, promote R&D efforts on general purpose key technologies in data, compute, and algorithms applicable to the energy sector.

(i) Consolidate the data foundation. In response to the need to build high-quality datasets and ensure data security in the energy sector, promote the application of technologies such as intelligent data labeling, intelligent enhancement, and data synthesis. Advance R&D on technologies such as energy data categorization and grading, privacy-preserving computing, intelligent dynamic data encryption, and cross-domain trusted traceability. Optimize data sharing mechanisms, accelerate the formation of high-quality datasets in the energy sector, and ensure the end-to-end security and reliability of energy data.

(ii) Strengthen compute support. In response to the need for integrated utilization of diverse heterogeneous compute under the combined model of leasing and construction in the energy sector, carry out R&D on key technologies such as unified scheduling of heterogeneous compute, intelligent orchestration of tasks, integrated storage-compute-network convergence, and compute pooling, so as to improve the level of intelligent computing services. Continue monitoring compute demand in the energy sector, coordinate planning of compute, electric power, and communication network resources, build a mechanism for coordinated development of compute and

[4] Translator's note: The Chinese term "black screen " (“黑屏”) refers to highly sophisticated automated control systems that monitor and operate industrial machinery and require little or no human input under normal circumstances. The term is used most commonly in the context of coal, oil, and petrochemical production.

electric power through deep integration, and continuously increase the proportion of green electricity used by compute centers.

(iii) Enhance model foundation capabilities. In response to the energy sector's demand for model security and explainability, advance the building of security capabilities for model algorithms and application systems, increase research on multi-agent collaboration (多智能体协同), explainability, and lightweight model inference technologies, and continue to deepen applied research on key AI technologies in the energy sector such as machine vision, multimodality, and time-series forecasting. Promote deep integration of AI and software in the energy sector. To address the problem of high energy consumption in AI computing, accelerate breakthroughs in green and low-carbon AI technologies, research energy supply technologies such as flexible direct current electricity generation (柔性直流供电) and small modular reactors, and encourage the application of efficient comprehensive energy utilization technologies such as liquid cooling in data centers, waste heat recovery, and intensive backup power (备电集约化).

IV. Assurance Measures

(i) Strengthen organization and implementation. Local main oversight departments (主管部门) for energy and relevant central enterprises must, in accordance with the requirements of these *Opinions*, establish and improve working mechanisms, coordinate and align relevant plans, and, in light of their actual conditions, accelerate the advancement of "AI+" energy development in their respective regions and work units (单位). They must ensure the provision of all necessary factors of production, explore the establishment of a security governance system, form a working structure characterized by vertical coordination, layered implementation, and safe development, and accelerate the R&D, pilot demonstrations, and promotion and application for integrated AI application in the energy sector.

(ii) Promote collaborative innovation. Focusing on key general purpose technologies and complementary dedicated technologies for integrated innovation and application of AI in the energy sector, promote the establishment of a number of industry R&D and innovation platforms. Encourage enterprises to take the lead in joining with research institutions, universities, social service organizations, and other work units to establish cross-domain and interdisciplinary "AI+" energy innovation alliances aimed at technological innovation and integrated application. Deepen industry-academia-research institute-user cooperation, and build an open, collaborative, co-creative (共创), and shared innovation ecosystem for energy intelligentization.

(iii) Strengthen development of standards and norms. On the basis of thoroughly

summarizing application demonstration practices, accelerate the formulation of a set of technical standards and norms in areas such as energy data governance, integration of heterogeneous compute, and design of typical use cases. Promote the establishment of a standards system for AI in the energy sector, explore the creation of an evaluation indicator system for AI applications and an industry-level standards testing platform for AI applications, and improve the level of safe application of AI technologies in the energy sector. Encourage energy enterprises to take the lead in formulating international standards, and "go global" ("走出去") in technical standards to promote the application of AI technologies and products in overseas energy markets.

(iv) Carry out pilot demonstrations. Organize pilot demonstrations of AI applications in the energy sector, and select a group of scenarios and enterprise benchmark applications that are replicable and easy to promote. Encourage demonstrations of typical cross-domain and cross-industry scenarios, such as the integration of energy and transportation, and the integration of oil and gas with new energy. Prioritize including technical equipment related to AI applications in the energy sector within the support scope for the first units (sets) of major technical equipment in the energy sector. Support qualified regions and enterprises in carrying out pilot demonstrations of various AI applications in the energy sector based on local conditions, and conduct in-depth exploration and pioneering trials in areas such as technological innovation, commercial models, development formats, and institutions and mechanisms.

(v) Increase support. Give full play to the stimulus role of central government funds, and, relying on national science and technology (S&T) major projects (国家科技重大专项) and key R&D programs in the energy and AI fields, steadily promote innovation in the application of AI technologies in the energy sector. Leverage the key hub role of multi-tier capital markets in supporting S&T innovation, and guide social capital[5] to participate in the implementation of AI S&T projects and achievement conversion (**成果转化**) and application.

(vi) Improve the talent cultivation ecosystem. Encourage energy enterprises to jointly establish "AI+" energy talent cultivation bases with universities and research institutes. Design interdisciplinary curricula oriented to industry needs, with a focus on training hybrid talents equipped with knowledge of energy systems and the ability to apply AI algorithms. Increase the supply of such hybrid talents through

[5] Translator's note: The Chinese term 社会资本, translated literally as "social capital," refers to any source of funding outside of government budget outlays. This term encompasses investment by private individuals and private institutions. However, investment from state-funded entities such as state-owned enterprises (SOEs), including state-run banks, also falls under the umbrella of "social capital."

industry–education collaboration.

National Development and Reform Commission and National Energy Administration

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