



Tech-Driven Energy Solutions in China:

Variable Renewable Energy (VRE) Planning & Integration

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China Electric Power Planning & Engineering Institute (EPPEI)

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Profile of EPPEI



China Electric Power Planning & Engineering Institute (EPPEI) is a national-level high-end consulting institute with a history of 70 years. EPPEI creates values for its industry partners by innovating technical solutions and drawing up forward-looking strategies, and also assists government to navigate clean energy transition by translating long-term energy targets into actionable plans.



Government Authorities	Financial Institutions	Energy Enterprises
Industrial Policy		
Development Strategy		
Development Planning		
New Technology		
Project Evaluation		
Consulting & Technical Services		

"A Leading Taskforce Supporting Energy and Power Green Transition"

Tackling challenges posed by increasing penetration of Variable Renewable Energy (VRE) in China

- ✓ *Planning studies for nation- and regional-level* renewable energy development and integration optimization.
- ✓ *Planning studies for WEST-EAST clean energy corridors* in China (Multi-GW clean energy bases transmitted to the east based on HVDC/HVAC technologies).
- ✓ *Technical and policy research for improving power system flexibility*, including thermal power plants retrofit, optimization of transmission and dispatch, and demand side management, etc.
- ✓ *Research on innovative solutions* for integrated energy systems with high-penetration of VRE.
- ✓ *Establish a comprehensive monitoring and evaluating system* for VRE consumption and utilization in national, provincial and local level, respectively.

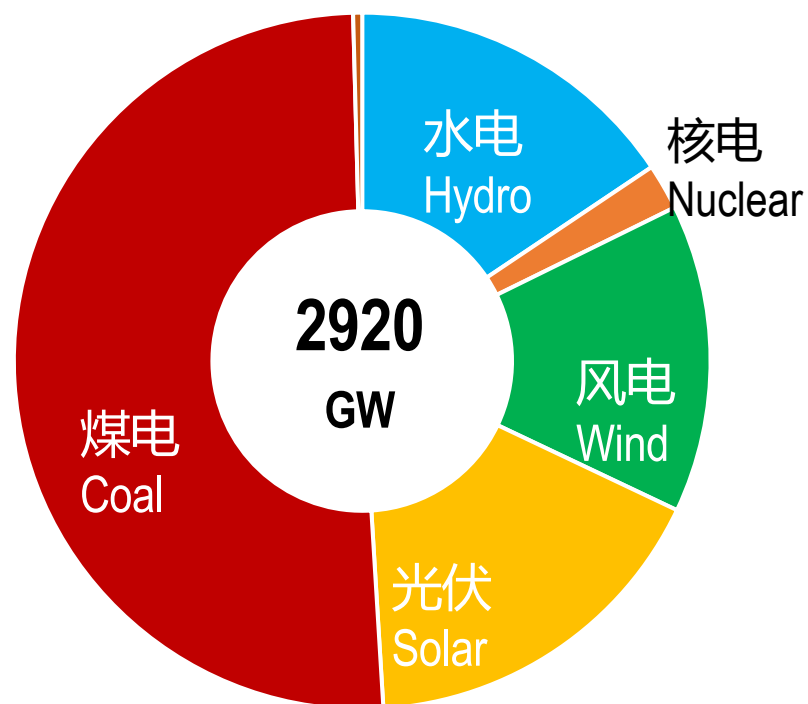


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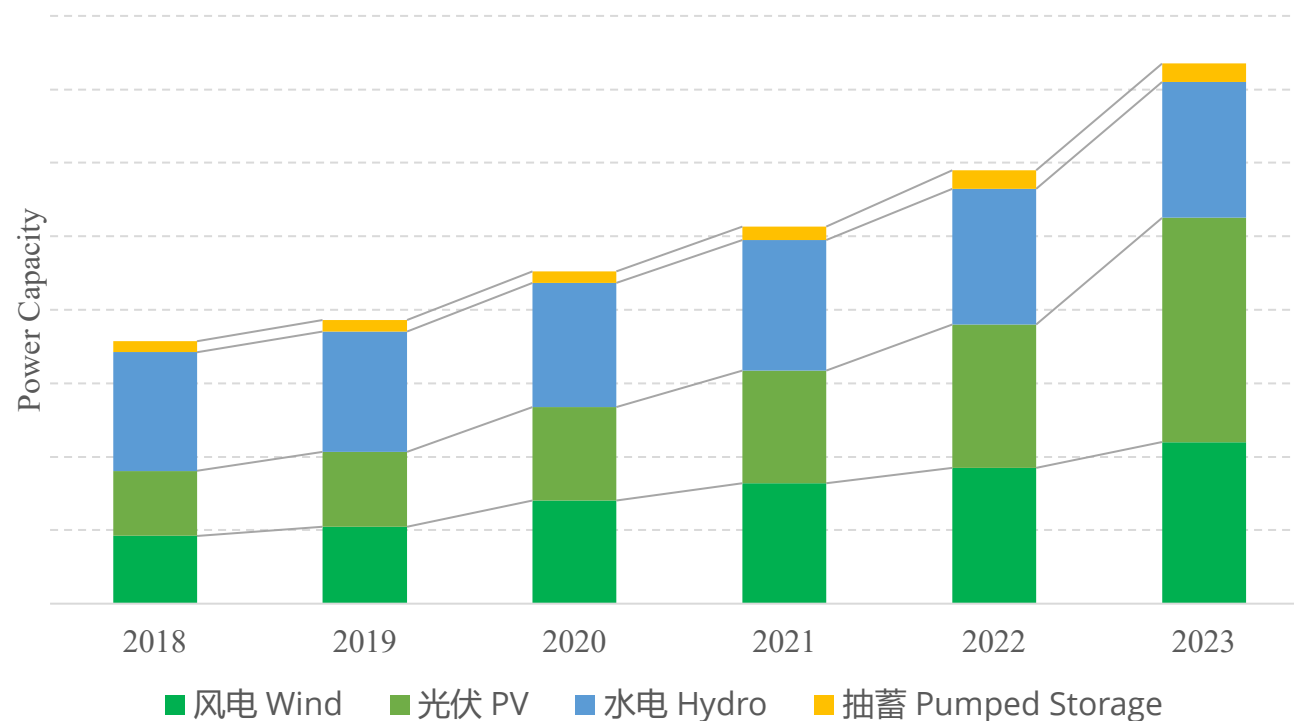
- 01 Overview of VRE Development in China**
- 02 Technical Solutions for VRE Planning & Integration Study**
- 03 Application Experiences**

I. Overview of VRE Development in China

Renewable energy (wind, solar and hydro) has become an important part of China's generation mix. China's renewable energy has been on the fast track for the past few years, with average annual growth rate exceeding 10%. The total installed capacity of renewable energy reached nearly 50% of the overall generation fleet.



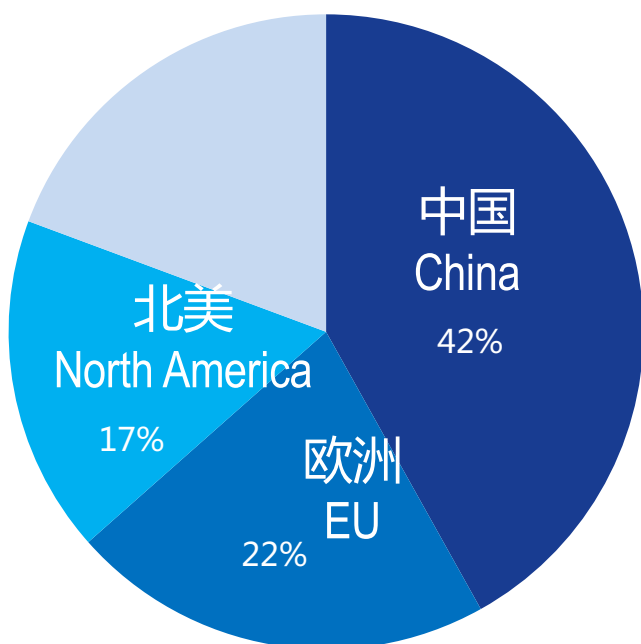
China's Power Generation Mix by 2023



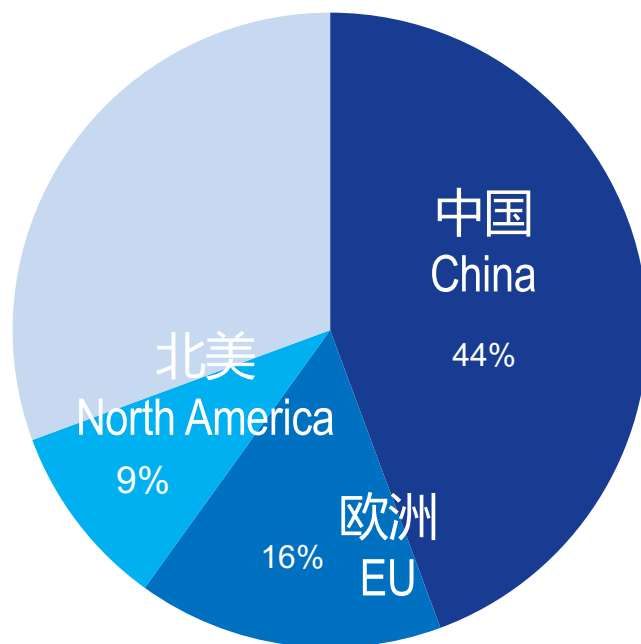
China's Renewable Power Capacity in 2018-2023

I. Overview of VRE Development in China

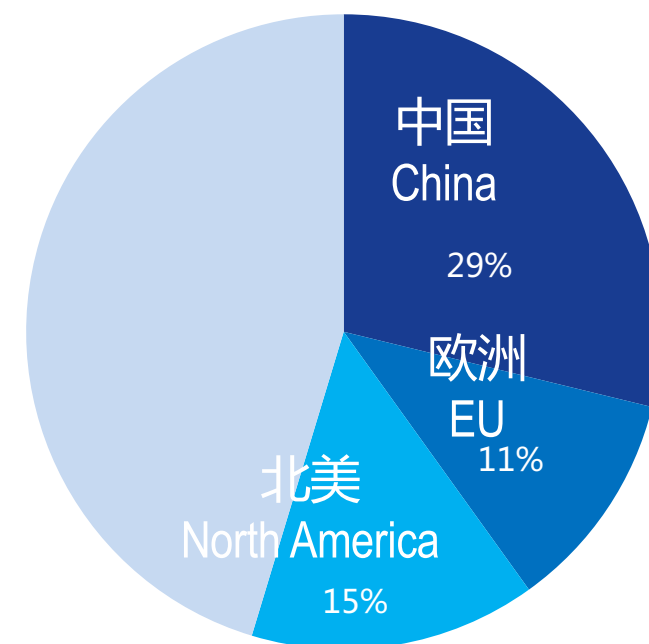
China has become an important engine for the green transformation of global energy sector. The installed capacity of wind power, solar power and hydropower accounted for 42%, 44% and 29% of the world respectively, ranking first in the world.



Global **wind power** installed capacity structure



Global **solar power** installed capacity structure



Global **hydro power** installed capacity structure

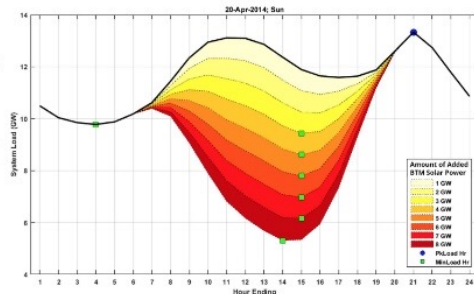
I. Overview of VRE Development in China

Challenges Faced by VRE Integration

Unlike traditional power generations, VRE have distinct characteristics and large-scale development of renewable energy will reshape the power system in multiple dimensions. It is necessary to pinpoint potential risks, identify challenges, and propose solutions to ensure the stable and economic operation of the power system.

Variability

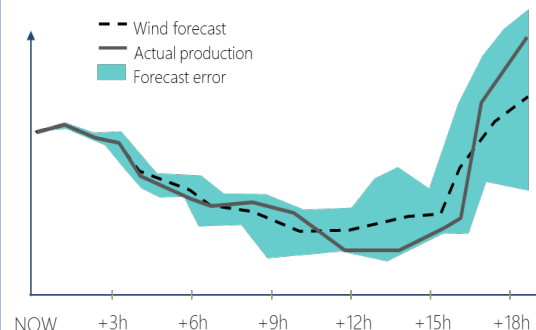
Fast change of power production



- System flexibility inadequacy
- Reduce system firm capacity

Uncertainty

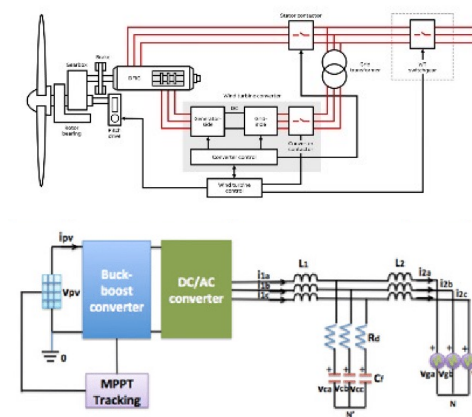
Impossible to perfectly forecast the VRE production



- Demands for high reserves
- Peak load regulation needs

Non-synchronous

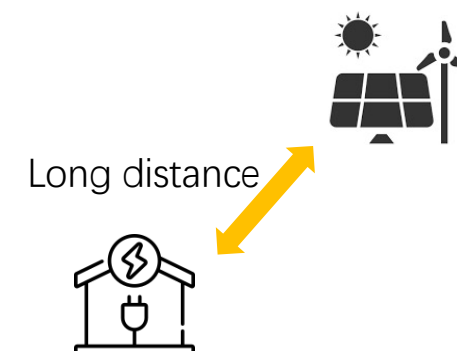
More power electronics devices decouple the power source from grid dynamics.



System stability Issues

Location constrained

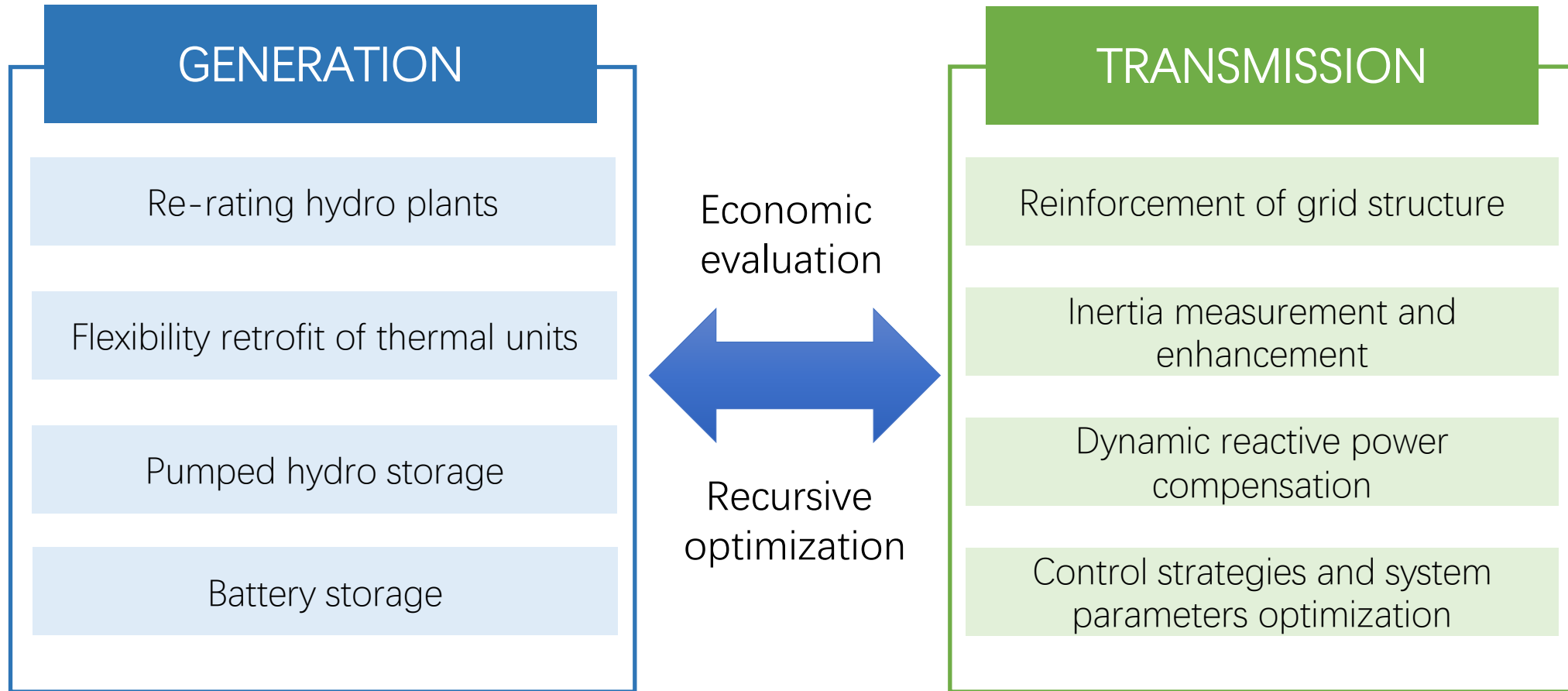
VRE resources are not always geographically aligned with the power consumption



Transmission Capacity inadequacy

I. Overview of VRE Development in China

Multiple Measures to Enhance Power Flexibility

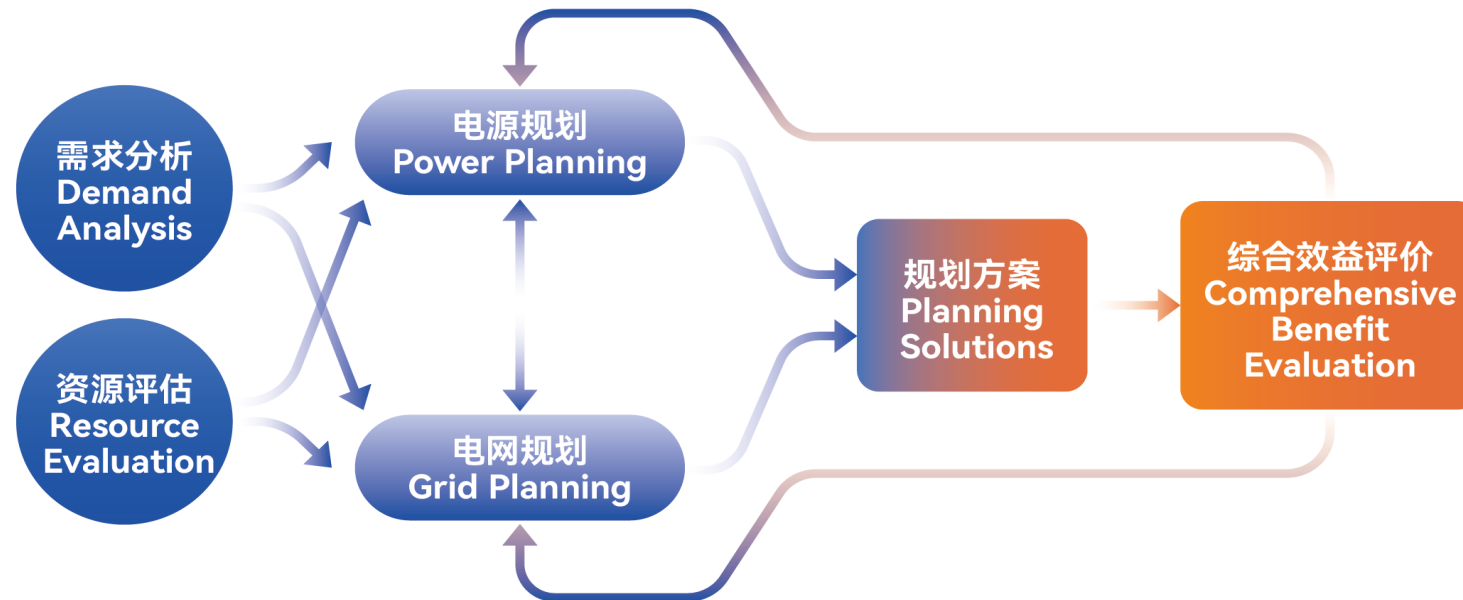


II. Technical Solutions of VRE Planning & Integration Study

Systematic Approach for VRE Study

The VRE study refers to resource evaluation and demand analysis, power and grid expansion, and comprehensive solutions for VRE integration and benefit evaluation. It is necessary to uphold systematic thought, comprehensively consider multiple factors, coordinate planning research, and promote harmonious development of source, grid, load and storage.

系统性规划关键路径 The Critical Path of Systematic Planning



II. Technical Solutions of VRE Planning & Integration Study

Green Power System Modeling and Simulation Toolbox

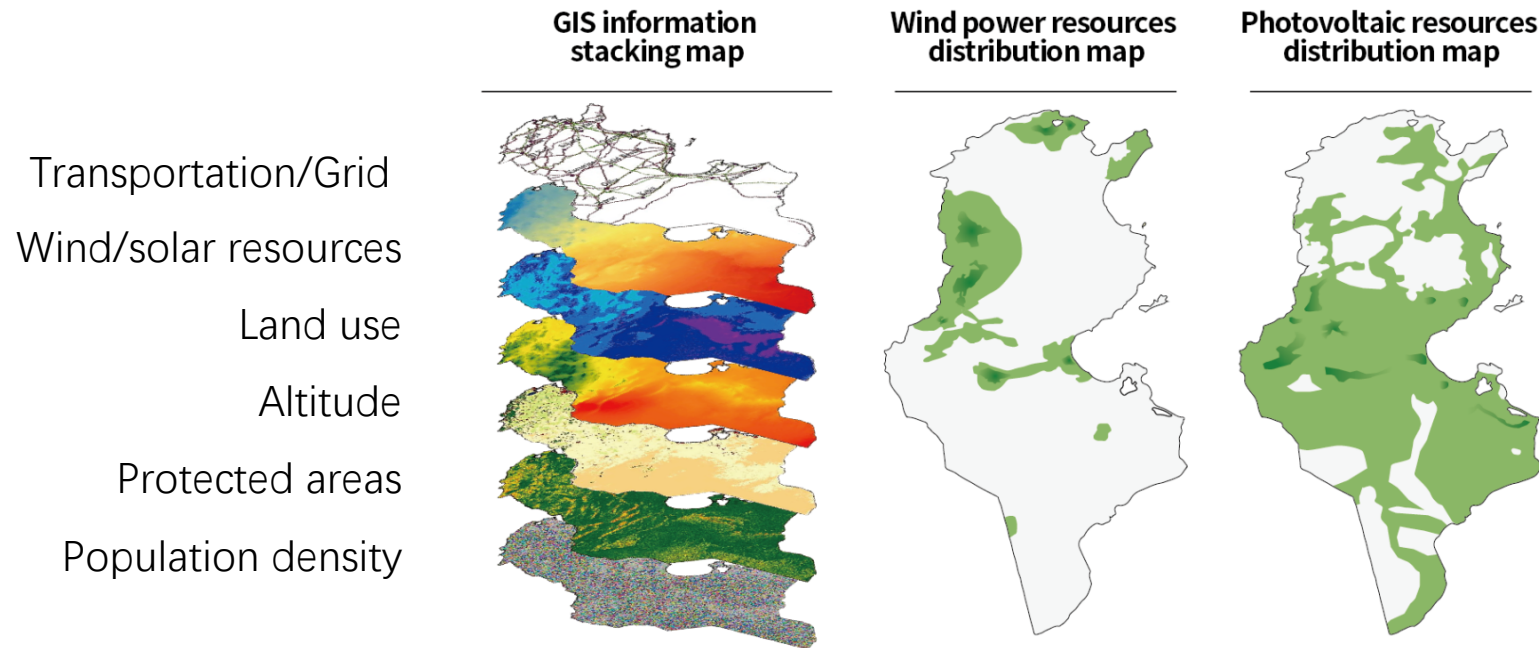
According to the characteristics of power system of developing countries and experiences accumulated in China's power planning research, EPPEI has developed green power system modeling and simulation toolbox, which includes renewable energy resources evaluation, production simulation & economic evaluation, power system stability analysis and integrated energy system analysis.



II. Technical Solutions of VRE Planning & Integration Study

Component I: Evaluation of VRE resources and site selection

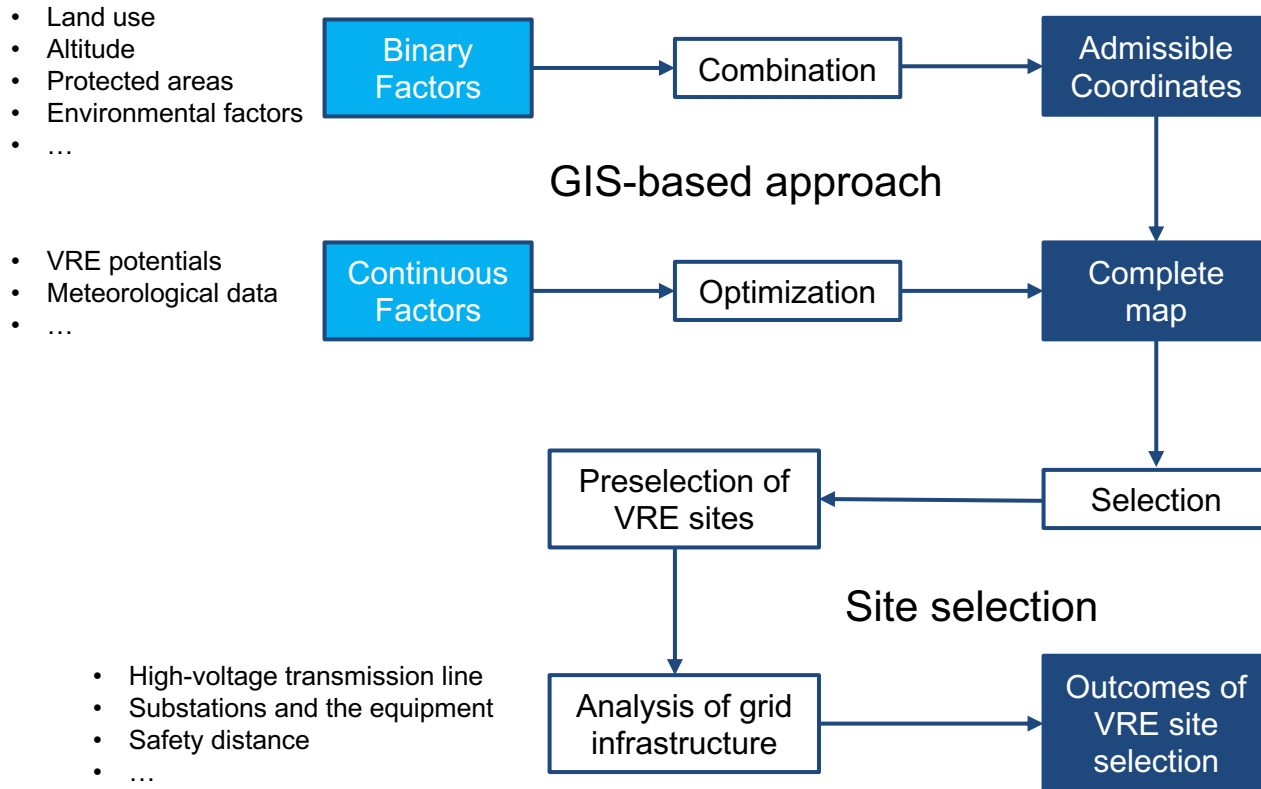
Resources evaluation is based on a multi-factor GIS-based approach, which synthesizes the meteorological data, infrastructure data and land data to find potential lands for VRE deployment and the maximum potential of VRE development.



Resource assessment and evaluation

II. Technical Solutions of VRE Planning & Integration Study

Component I: Evaluation of VRE resources and site selection

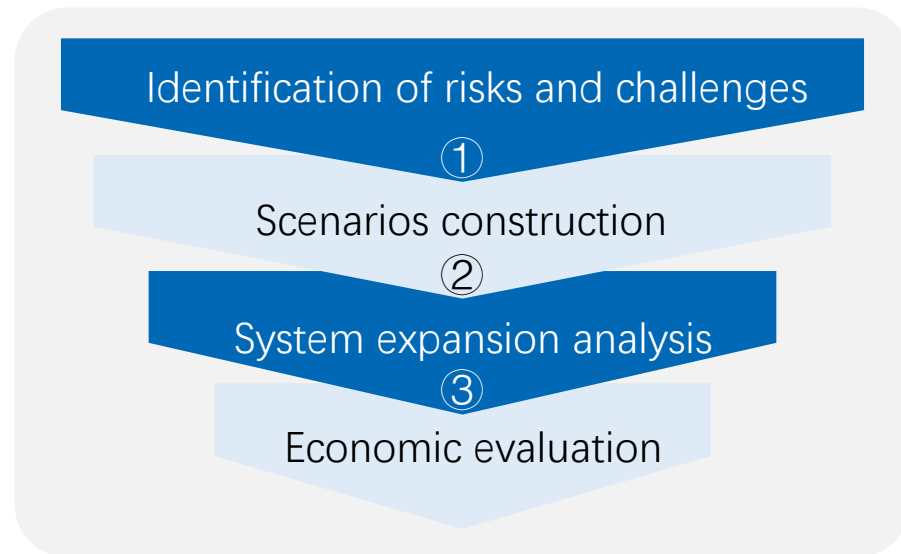


- **Data for site selection** comprises various inputs, including binary and continuous factors.
- **Binary inputs** are combined to select admissible coordinates, while continuous inputs are used to optimize suitable sites.
- **The whole GIS process** will lead to a complete map which covers all regions with relevant parameters for selection.

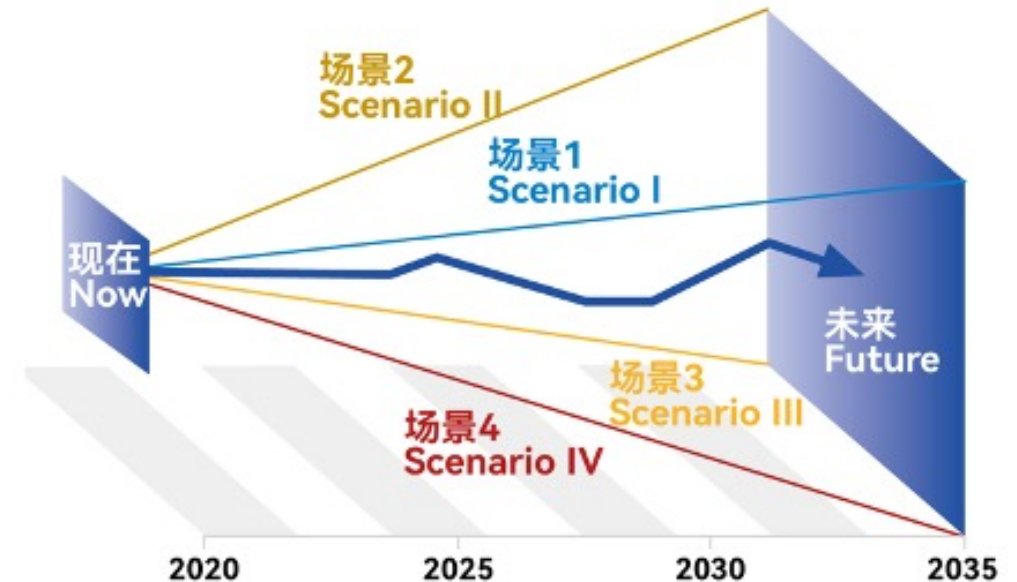
II. Technical Solutions of VRE Planning & Integration Study

Component II: Framework for VRE Integration and Transmission Study

A three-step approach has been developed to establish the framework for VRE integration and transmission study:



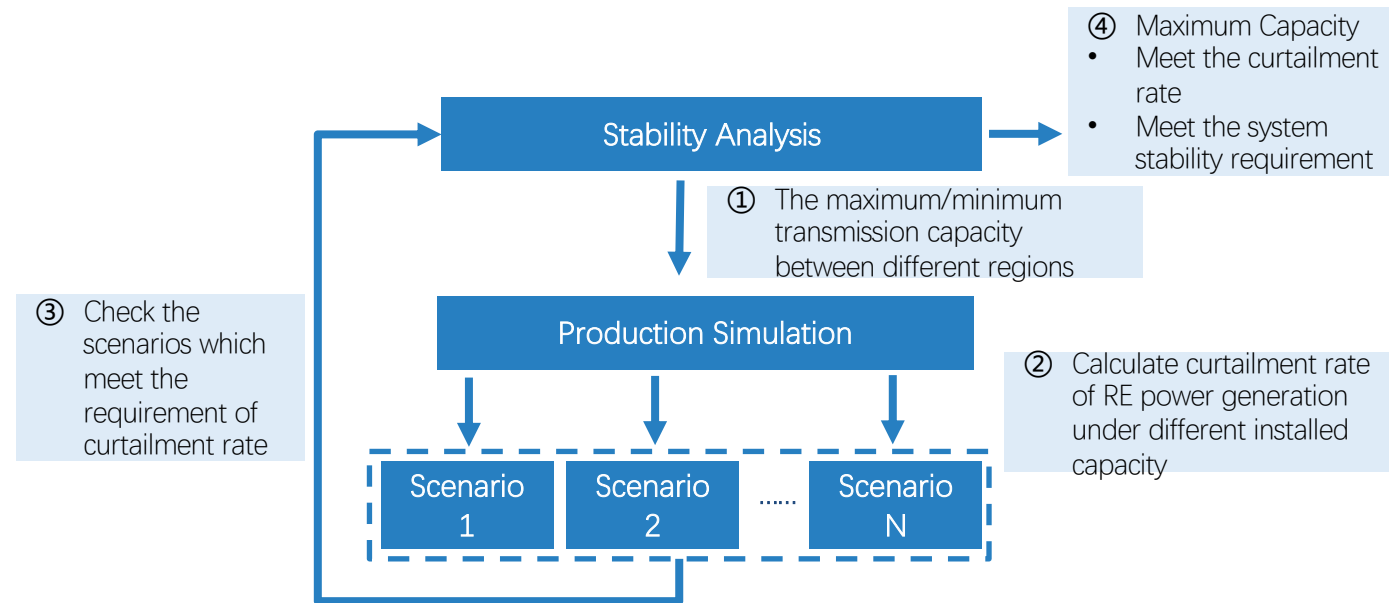
A four-step approach for the study



II. Technical Solutions of VRE Planning & Integration Study

Component II: Framework for VRE Integration and Transmission Study




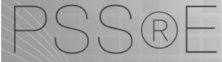

- **Production Simulation** to understand the economic consequences of different generation mixes, grid transmission capacities, and dispatching methods.
- **Stability Analysis** to verify the feasibility of proposed integration plan and to check the effects of stability enhancement measures.



Work Stream
Methodology and Approaches

II. Technical Solutions of VRE Planning & Integration Study

Component III: High-Fidelity Modeling and Simulation

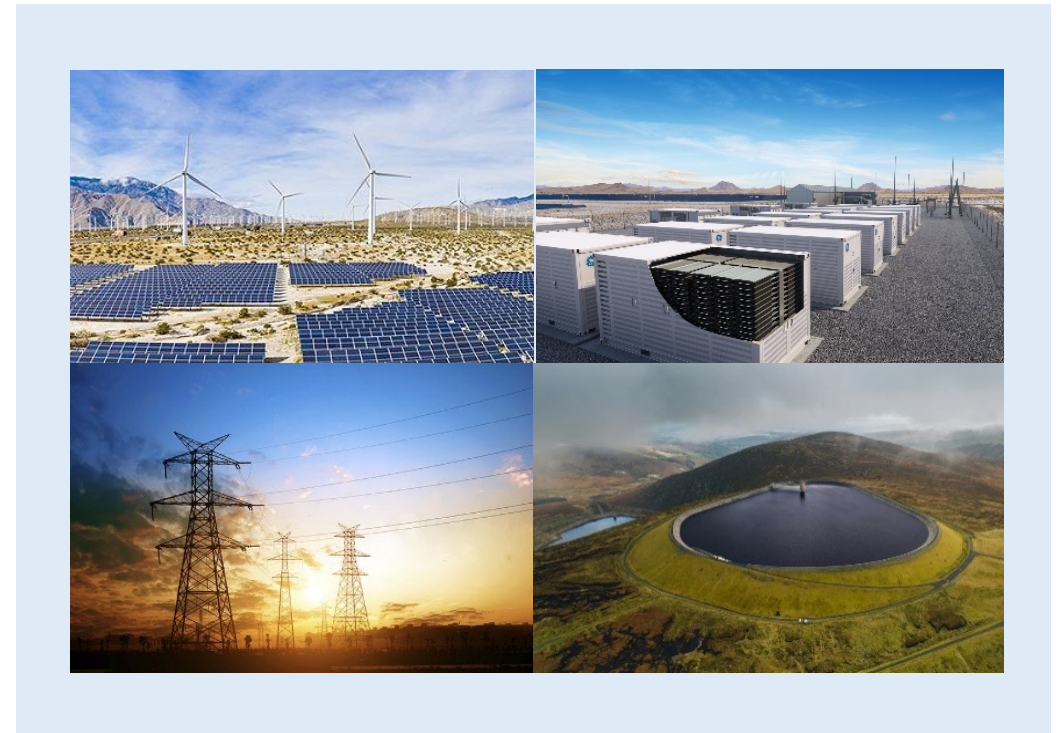
Software/Tools		
PlexOS		Market simulation Long-term planning/grid expansion
DigSilent/Powerfactory		Load flow calculation EMT simulations EMS/electromechanical simulations Contingency analysis Harmonics analysis Small-signal analysis
PSCAD		
PSS/E		
Dymola/Modelica		Multi-physics modeling of energy system

III. Application Experiences

National Power System Planning & Modelling

EPPEI serves Chinese governments in research for **National Energy and Power Development Plans**, effectively respond to rapid growth and imbalanced geographic distribution of VRE and power load, enhance VRE integration and power system flexibility to ensure safety and stability of power grid.

- *14th Five-Year Plan for Energy Development*
- *14th Five-Year Plan for Electric Power Development*
- *National Grid Networking Planning Research*
- *West-East Power Transmission Planning Research*
- *Institutional and Market reform of China's Power Sector*
- *medium and long-term energy flow and distribution*
- *Mechanism for Clean Energy Development, Accommodation and Storage in China*
- *Smart Grid Development Planning in China*
- *14th Five-Year Plan for Networking Planning System for China Southern Power Grid*



“Formulated the Guideline of Establishing Green Power System in China”

Prepared *BLUEBOOK ON NEW POWER SYSTEM DEVELOPMENT* Entrusted by Chinese government

—develops a roadmap for transitioning to a new power system that integrates large-scale VRE, with a staged implementation plan through 2060.

- ✓ *Stable and Secure Power Supply System*
- ✓ *Renewable Energy Development and Utilization System*
- ✓ *Large-scale Energy Storage Application System*
- ✓ *Intelligent Power System Operation*
- ✓ *Technical Research and Standard Innovation*
- ✓ *Policy, Market Mechanism and Regulation System*



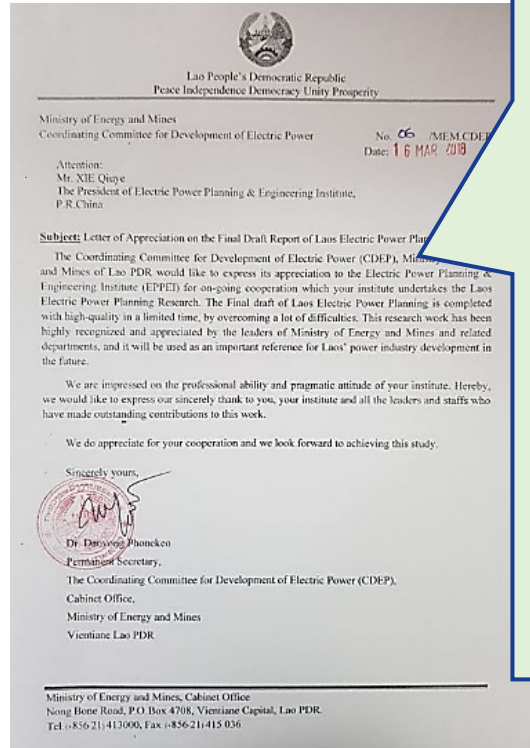
EPPEI has assisted governments and enterprises in countries including Laos PDR, Uzbekistan, Malaysia and Philippine to develop their **National / Regional Power System Planning & Modeling Research**. We offer tailor-made, feasible and forward-looking solutions to facilitate development of renewable energy and power system transition.



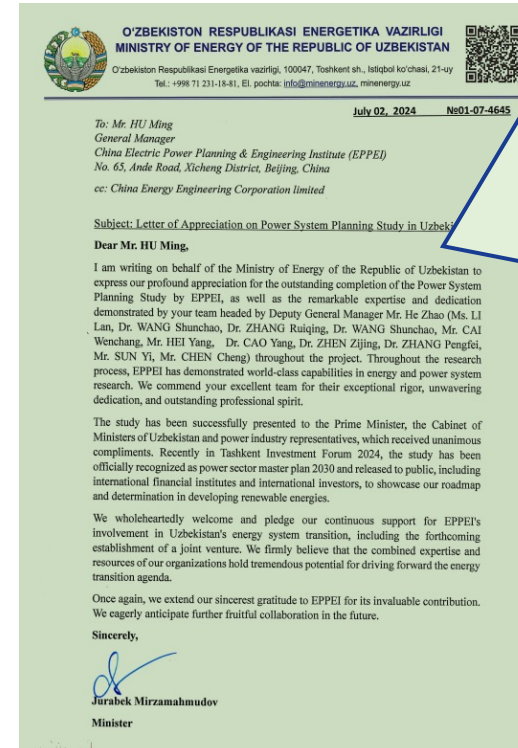
III. Application Experiences

Oversea Power System Planning & Modelling

The overseas power system planning research we conducted has been **highly praised** by government agencies and enterprises in various countries.



MEM of LAOS PDR: "... would like to express its appreciation to EPPEI for on-going cooperation... The final draft of Laos electric power planning is completed with **high quality** in a limited time... This research work has been highly recognized and appreciated by the leaders of MEM..."




MINISTRY OF ENERGY OF THE REPUBLIC OF UZBEKISTAN: "... express our **profound appreciation** for the outstanding completion of the **Power System Planning study by EPPEI**, as well as the remarkable expertise and dedication demonstrated by your team headed by Deputy General Manager..."

III. Application Experiences

Oversea Power System Planning & Modelling

Sarawak Energy Berhad (00199-0)



Our ref : SEB_SCD_SLR_001
Date : 9 August 2022

To :

Mr. Du Zhong Ming,
President of China Electric Power Planning & Engineering Institute (EPPEI)
Beijing, China

LETTER OF APPRECIATION

Dear Mr Du,


On behalf of Sarawak Energy, I would like to express our upmost appreciation on the commendable work delivered by EPPEI on the Sarawak Solar Power Integration Study.

We are impressed with the quality and agility of EPPEI on delivering the study's scope and milestones. EPPEI's responsiveness and strong technical competency is admirable. Our team at Sarawak Energy greatly benefited from the insights and experience working with EPPEI throughout the study period.

Once again, thank you on the work well done and the study rendered to us. Looking forward to collaborating on other future projects.

Thank you.

Yours faithfully,



Ting Ching Jung
Executive Vice President
Strategy and Corporate Development
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No. 1, The Istikom, 93050 Kuching,
Sarawak, Malaysia

T +6082 988 988
F +6082 341 063
Customer Careline 1900 88 318
www.sarawakenergy.com.my

SEB of Malaysia: “.. express our upmost appreciation on commendable work delivered by EPPEI on Sarawak Solar Power Integration Study. We are impressed with the quality and agility of EPPEI on delivering the study's scope and milestones. EPPEI's responsiveness and strong technical competency is admirable. Our team at SEB greatly benefited from the insights and experience working with EPPEI throughout the study period.”

NGCP

PURCHASE ORDER NO. 3600000574

Page 1 of 3

Vendor Name: ELECTRIC POWER PLANNING & ENGINEERING INSTITUTE CO., LTD.
Address: ANDE ROAD BEIJING 100120, China

Date: October 11, 2023
The order number must appear on all papers, invoices, packing list and correspondence.

Tel No.: 13520729168
Email: eppei@163.com
Fax No.:
Vendor No.: 900000675

PR No.: 0010063076

Delivery Date: See below **Terms:** without Advance Payment; with PS

ITEM NO.	ITEM CODE	SLOC/PR#	DESCRIPTION	QTY	UOM	UNIT PRICE	AMOUNT
00010		(10063076/10)	TECHNICAL PLANNING STUDY SERVICE FOR THE CONDUCT OF SYSTEM IMPACT STUDIES	1	LOT	10,000,000.00	10,000,000.00
Nothing Follows							Total (PHP) 10,000,000.00

AS PER APPROVED TECHNICAL EVALUATION.

NOTE/S:

1. Above items are in accordance with the bid price schedule, Terms of Reference (TOR), Table of Conformance and other bidding documents as applicable.

2. Any equipment or materials not specifically mentioned in the specifications and not included in the pay item under the bid price schedule but deemed necessary for the satisfactory operation of the system shall be provided. All costs of such equipment are presumed already included in the supplier's/contractor's proposal.

This Contract/PO is considered accepted and agreed by the Supplier/Contractor within seven (7) calendar days upon receipt of email or on the date of Supplier/Contractor's acknowledgement, whichever comes earlier.

PERFORMANCE SECURITY: Required.

A Performance Security shall be submitted within thirty (30) calendar days from the acceptance of the Purchase Order (PO) in the form of Surety Bond callable on demand issued by a bonding company accredited by NGCP, in the amount equivalent to Fifteen Percent (15%) of the Total Contract Price (TCP).

The Performance Security shall be valid from the date of confirmation of receipt of the PO until the lapse of thirty (30) days after the date of acceptance of the goods and services.

PROJECT DURATION: The first System Impact Study (SIS) Report shall be submitted within thirty (30) calendar days from the Notice to Proceed. Thereafter, a minimum of one (1) SIS Report shall be submitted every thirty (30) calendar days until the completion of the ten (10) SIS Reports in accordance with the agreed schedules. The manner of implementation is thru Virtual/Online only.

PAYMENT TERMS:

Important:
Goods are brand new and order is subject to the standard terms & conditions at the back hereof.

National Grid Corporation of the Philippines
This is a system-generated document. Signature of approver is not required.

Signify your acceptance and agreement with this order by signing below:
CONFORME: _____
POSITION: _____
DATE: _____

Office Address:
National Grid Corporation of the Philippines
Power Center Quizon Ave. Cor BIR Road Diliman, Quizon City
Philippines 1100

Tel. Nos.: +632 981 2100 **Fax Nos.:** +632 921 6753
 +632 981 2213 +632 922 8432
 +632 928 2926 +632 921 2308

(VAT Registered) TIN: 006-977-514-000
ISO 9001:2015, ISO 14001:2015, ISO 45001:2018, ISO 22301:2019
Website: www.ngcp.ph

ACKNOWLEDGEMENT CERTIFICATE CONTROL INVOICE NO. AC_101_000001_000001
AC NO. DATE ISSUED: MARCH 1, 2023
DOCUMENT NO. 000001_000001_000001
THIS DOCUMENT IS NOT VALID FOR CLAIM OF INPUT TAX.

Philippines NGCP: EPPEI secured the bid for the Technical Planning Study Service for the Conduct of System Impact Studies. The SIS includes 10 renewable energy projects, with a total installed capacity exceeding 1 million kilowatts.

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Thank you !

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