



西北勘测设计研究院有限公司  
NORTHWEST ENGINEERING CORPORATION LIMITED



# MIDAS SQUARE 2024

CLEAN ENERGY DEVELOPMENT TREND  
AND TYPICAL ENGINEERING NUMERICAL SIMULATION  
IN NORTHWEST CHINA

ZHANG YING

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01

# Introduction to NWH



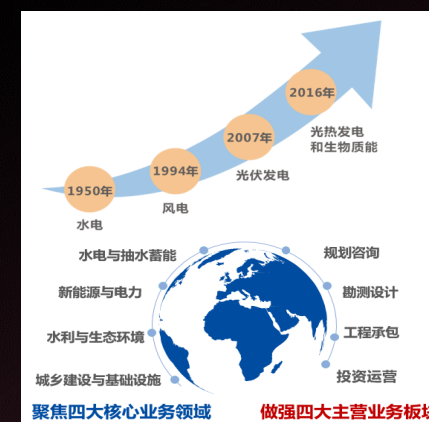
# Introduction to NWH

- **Northwest Engineering Corporation Limited** was established in 1950, it is **one of the first large-scale survey and design enterprises established in China.**



- The company holds "Four Comprehensive A" qualifications and credits. Its business covers many domestic provinces and regions and 21 overseas countries (regions), focusing on four major business areas: **hydropower and pumped storage, new energy and power, water conservancy and ecological environment, and urban and rural construction and infrastructure.**

- In 2020, 2021, and 2022, the operating income exceeded 10 billion yuan for three consecutive years.



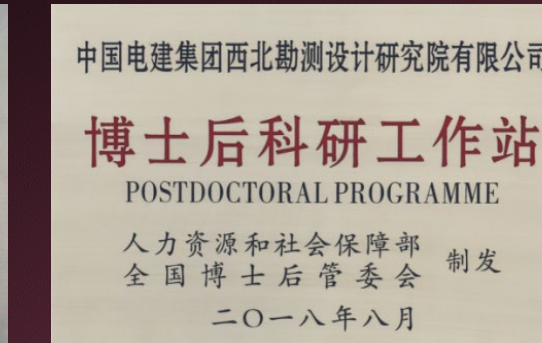
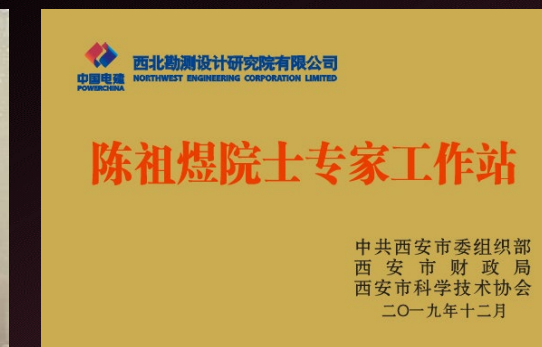
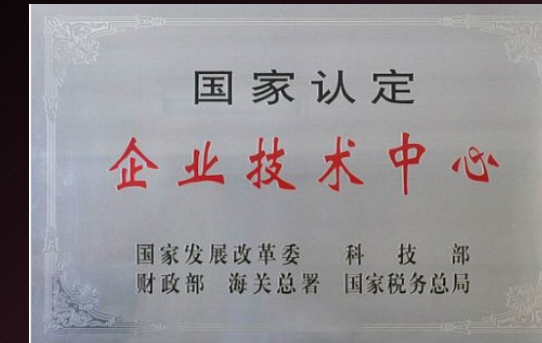
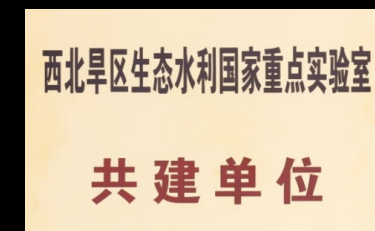
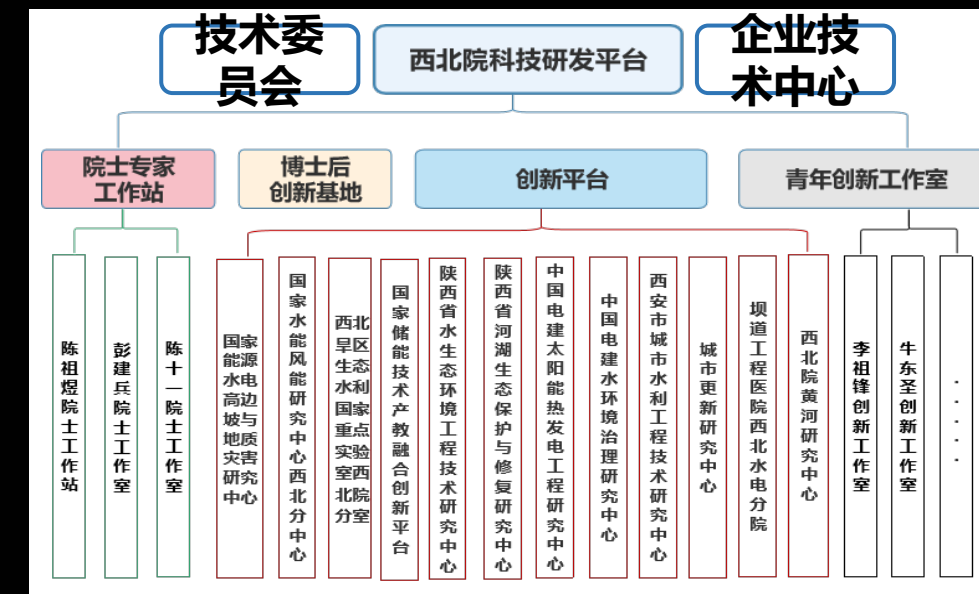
序号	证书名称	等级	发证部门
1	工程勘察资质证书	综合甲级	中华人民共和国住房和城乡建设部
2	工程设计资质证书	综合甲级	中华人民共和国住房和城乡建设部
3	工程监理资质证书	综合	中华人民共和国住房和城乡建设部
4	工程造价咨询资质证书	综合资信/专业资信	中国工程咨询协会
5	施工总承包	水利水电工程壹级	中华人民共和国住房和城乡建设部
		电力工程壹级	中华人民共和国住房和城乡建设部
		市政公用工程壹级	中华人民共和国住房和城乡建设部
		机电工程二级	陕西省住房和城乡建设厅
		建筑工程二级	陕西省住房和城乡建设厅
6	专业承包	河湖整治工程二级	陕西省住房和城乡建设厅
		电子与智能化工程一级	陕西省住房和城乡建设厅
		环保工程一级	陕西省住房和城乡建设厅
7	城乡规划编制资质证书	乙级	陕西省住房和城乡建设厅
8	测绘资质证书	甲级	国家测绘地理信息局
9	工程造价咨询企业信用评价	AAA	中国建设工程造价管理协会
10	企业信用等级证书	AAA	中国水利电力勘测设计协会
11	建设领域环境影响评价证书	甲级	中华人民共和国环境保护部
12	水利部论证资质证书	甲级	中国水利电力勘测设计协会
13	生产建设项目水土保持方案编制单位水平评价证书	4星	中国水土保持学会
14	生产建设项目水土保持监测单位水平评价证书	4星	中国水土保持学会
15	水文、水资源调查评价证书	甲级	中国水利电力勘测设计协会
16	地质灾害防治单位资质证书(勘察)	甲级	中华人民共和国国土资源部
17	地质灾害防治单位资质证书(设计)	甲级	中华人民共和国国土资源部



# Introduction to NWH

NWH is a national intellectual property demonstration enterprise. It has won more than 80 international and domestic leading technological achievements, more than 800 national and provincial and ministerial awards, more than 600 authorized patents and 40 construction methods, and edited more than 150 national industry standards during the past 70 years.

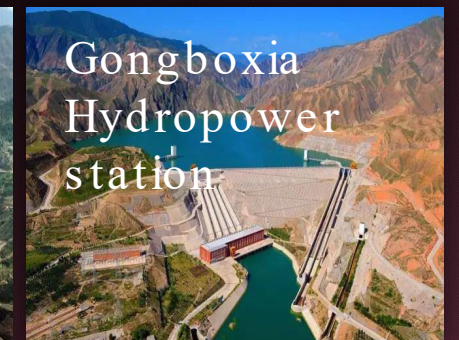
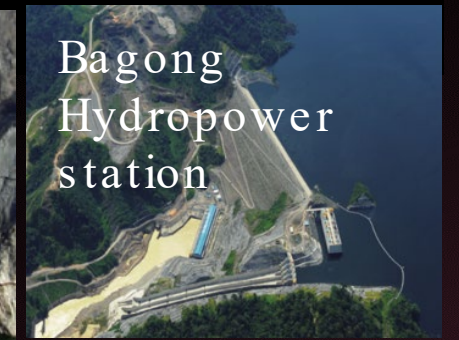
NWH has academician workstation, postdoctoral innovation base and 12 innovation platforms to strengthen the collaborative innovation of "production, university, research and application"





## Hydropower and pumped storage development

- Completed the planning of more than **40 rivers** at home and abroad, planned installed capacity of **76.5 million kW**. It has completed the survey and design of more than **300 water conservancy and hydropower projects**.
- The **Longyangxia, Liujiaxia and Gongboxia** engineering won the 60th engineering award of the founding of the PRC, Malaysia Bagong won the International Milestone Project Award. Programs like **Liujiaxia, Bikou, Longyang Gorge, Lijiaxia** are **representative projects of hydropower construction in different periods in China**.
- Plans for the selection of pumped storage sites and long-term development of pumped storage have been completed in Northwest China.

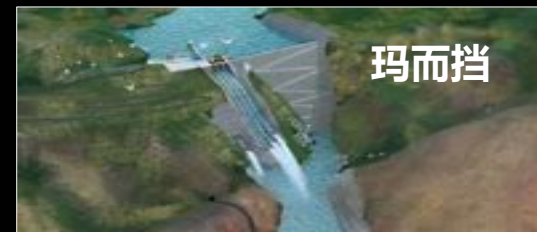




# Hydropower and pumped storage development



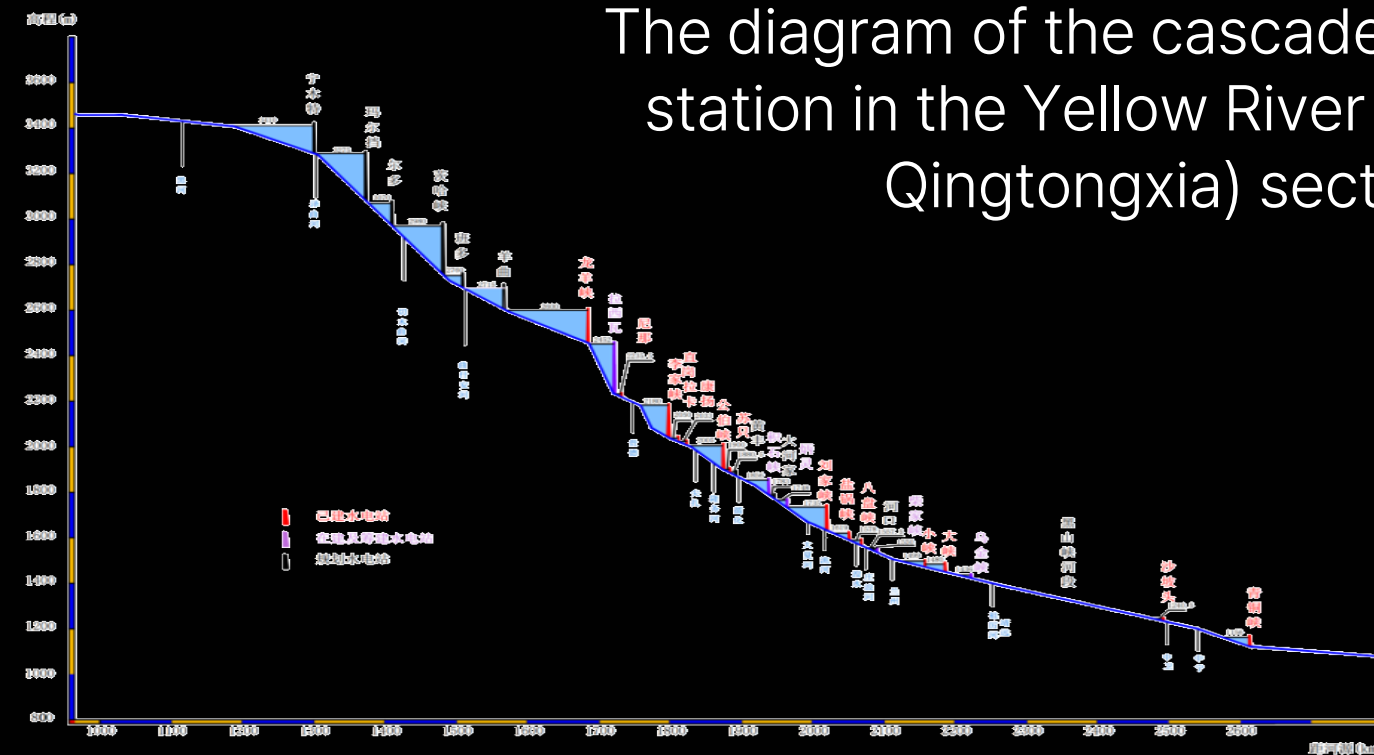
拉西瓦



玛而挡



羊曲



The diagram of the cascade hydropower station in the Yellow River (Ningmute-Qingtongxia) section

- The upper **main stream of the Yellow River is one of the thirteen major hydropower bases** in China
- **25 power stations** have been built in the Longyangxia to Qingtongxia section, **22 of which have been surveyed and designed by NWH**, with annual generating capacity of about 48 billion kWh
- 6 power stations are planned in Ningmute to Longyangxia section, with a total installed capacity of 11.04 million kW





# New energy development



Wind power survey and design in northwestern China

Province	Installed capacity (ten thousand KW)
Shaanxi	408
Gansu	1221
Qinghai	402
Ningxia	145
Xingjiang	1039
Summation	3215

NHW has completed the survey and design of wind and solar new energy with an installed capacity of over 60 million kilowatts, accounting for approximately 12% of the country's new energy production capacity.

## Wind resource development

- Pioneer in the development of domestic wind energy resources, the wind power business began in 1994.
- We have completed wind energy survey and design with an installed capacity of 45 million KW, including 32.15 million KW in the five northwest provinces and regions.
- Having undertaken the drafting of multiple wind power industry standards and specifications, it has played a significant role in promoting the development of wind power in China





## New energy development

### Light resource development

- In 2008, NHW fully carried out photovoltaic development work, completed over 500 survey and design projects, and installed a capacity of approximately 15 million KW
- 13.7 million KW** of photovoltaic survey and design business in the five northwest provinces and regions
- We have formulated the first batch of technical standards for China's solar power generation engineering industry and established **a national optoelectronic technology system**
- As one of the earliest units in China to research solar thermal power generation technology, NWH has carried out multiple research projects such as tower solar thermal power generation.



Province	Installed Capacity (MW)
Shanxi	281
Gansu	63
Qinghai	690
Ningxia	100
Xinjiang	236
Summation	<b>1370</b>



## Water energy, wind energy, and light energy complement each other



## NWH is one of the earliest companies in China to research on multi energy complementarity, accumulating a lot of practical experience

- Completed the world's first and currently the largest water and light complementary project – **Longyangxia Water and Light Complementary Base**, with a scale of 850000 kilowatts
- Plan and implement **four** of 10 million kilowatt-level wind power and **two** of 10 million kilowatt-level photovoltaic multi-energy complementary bases
- NWH has completed the planning and design of 8 new energy bases out of the **14** ultra-high voltage transmission channels in China
- Currently, a batch of large-scale water, **wind and light clean energy storage bases** are being planned

Serial Number	Project name	Power scale (ten thousand kW)	Province (region)
1	Water and Light Complementary in Longyangxia	213	Qinghai
2	Planning of Renewable Energy Base in Hainan state	1516	Qinghai
3	Planning of Renewable Energy Base in Haixi state	2550	Qinghai
4	Planning of Clean Energy Base in Maerdang	2772	Qinghai
5	Planning of Clean Energy Base in Longyangxia	3220	Qinghai
6	Planning of Clean Energy Base in Cihaxia	5770	Qinghai
7	Complementary Water and Light in the Kaidu River Basin of Xinjiang	1180	Xinjiang
8	Planning of Water Light Energy Storage Base in Naqu River	1104	Xizang
9	Planning of Water Light Energy Storage Base in Yigong Zangbu	1243	Xizang
10	Planning of Water Light Energy Storage Base in Palong Zangbu	2000	Xizang
11	Planning of Clean Energy Base in Southeast Xizang	2289	Xizang
12	Water light complementation of Pangduo water conservancy project in Xizang	36	Xizang

**NWH is a leader in national clean energy survey and design under the "30.60 dual carbon" goal**

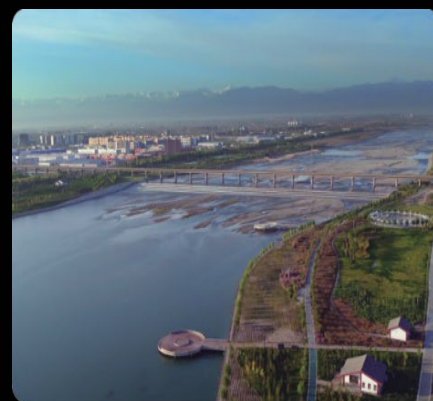


## Ecological environment governance and infrastructure

- Covering over 20 provinces and regions across the country, we have completed over 1300 kilometers of river management, over 1000 kilometers of various road projects, over 200 bridges, and over 150 kilometers of urban underground comprehensive pipe corridors
- High quality construction of Xi'an Xiaozhai Sponge City, 330KV cable landing, National Games main stadium, and other projects
- Participated in the construction of rail transit in nearly ten cities including Xi'an, Lanzhou, Xining, Zhongwei to Lanzhou, etc., and multiple dedicated railway passenger lines



陕西汉中西二环(龙岗)大桥



黑河(张掖市段)综合治理工程



汉江(汉中段)水生态系统保护与修复规划



330KV线缆落地



沪昆高速铁路



西安市灞河综合治理规划



多布水电站G310旧桥改建工程





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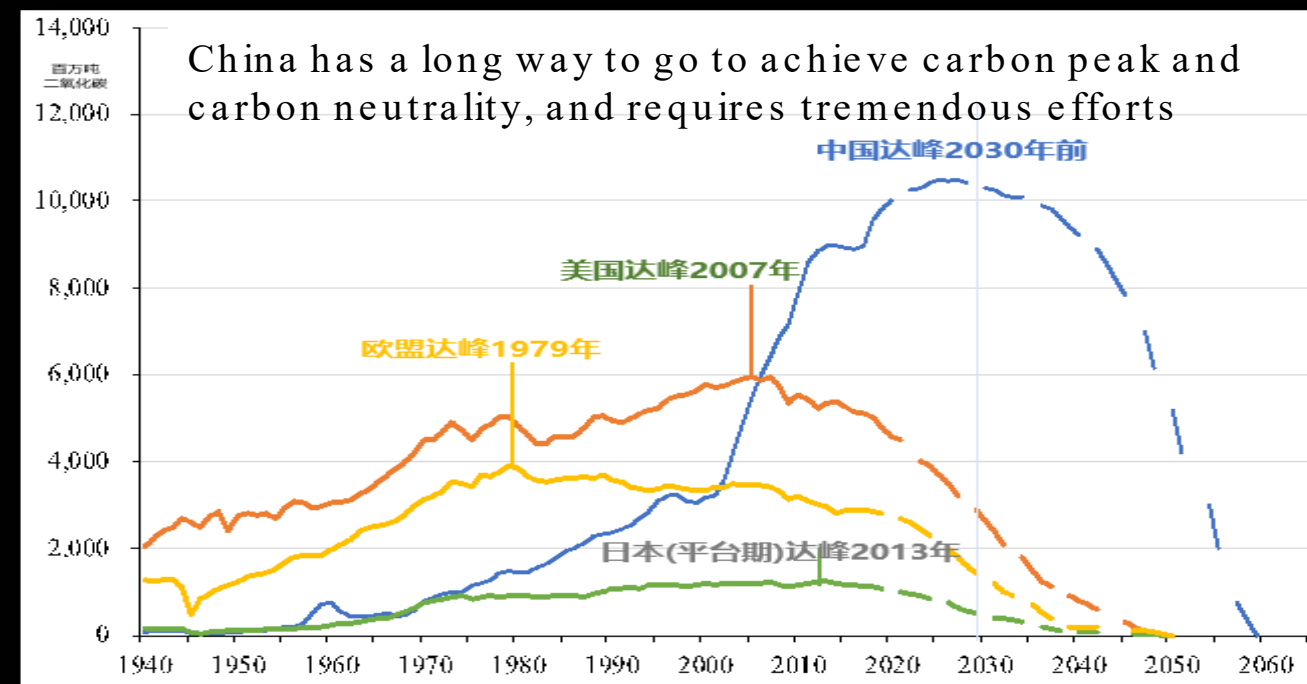
02

# Energy Development Trend



## Development background

- **September 2020**, China aims to achieve peak carbon dioxide emissions by 2030 and strive to achieve carbon neutrality by 2060.
- **December 2020**, By 2030, the proportion of non fossil fuels in China will reach around 25%, and the total installed capacity of wind and solar power will reach over 1.2 billion kilowatts



2060

- ✓ Comprehensive establishment of a green, low-carbon, **circular development economic system**
- ✓ The proportion of **non fossil fuels reaches over 80%**

2030

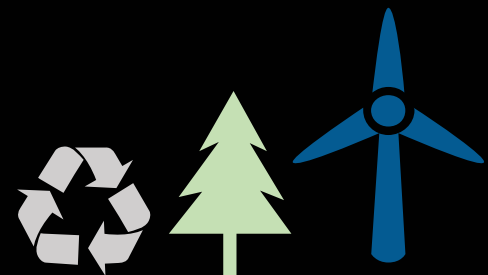
- ✓ **Significant achievements** have been made in the comprehensive green transformation of economic and social development
- ✓ The proportion of non fossil fuels reaches **around 25%**

2025

- ✓ **The preliminary formation of an economic system for green**, low-carbon and circular development
- ✓ The proportion of non fossil fuels reaches around 20%

2020

- ✓ **The opening year of the dual carbon target**
- ✓ The proportion of non fossil fuels is **15.9%**





# Development Situation

**NWH is one of the earliest companies in China to research on multi energy complementarity, accumulating a lot of practical experience**

## Hydropower Assists Clean Energy Consumption

- The functions of cascade hydropower need to be adjusted urgently to achieve a **transformation from power as the mainstay and regulation as the supplement to a pattern** in which power and regulation are equally emphasized or regulation as the main role and power as the supplement

## Pumped Storage Power Station Accumulated Energy Storage

- Pumped Storage Power Station: **Peak shaving of energy storage**, suppressing fluctuations in new energy, and ensuring stable operation of the power grid
- The demand for pumped storage power stations** in the northwest region **is huge**, with significant characteristics and **urgent development needs**

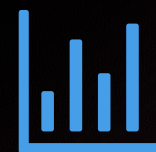


## Diversified development is the focus

- The scenery in the northwest region is infinitely beautiful, and diversified development can fully leverage the complementary advantages of resources
- Focus the integrated development of renewable energy in river basins** and the trend of integrated development of deserts and Gobi

## Ecological governance + clean energy leads to a new path

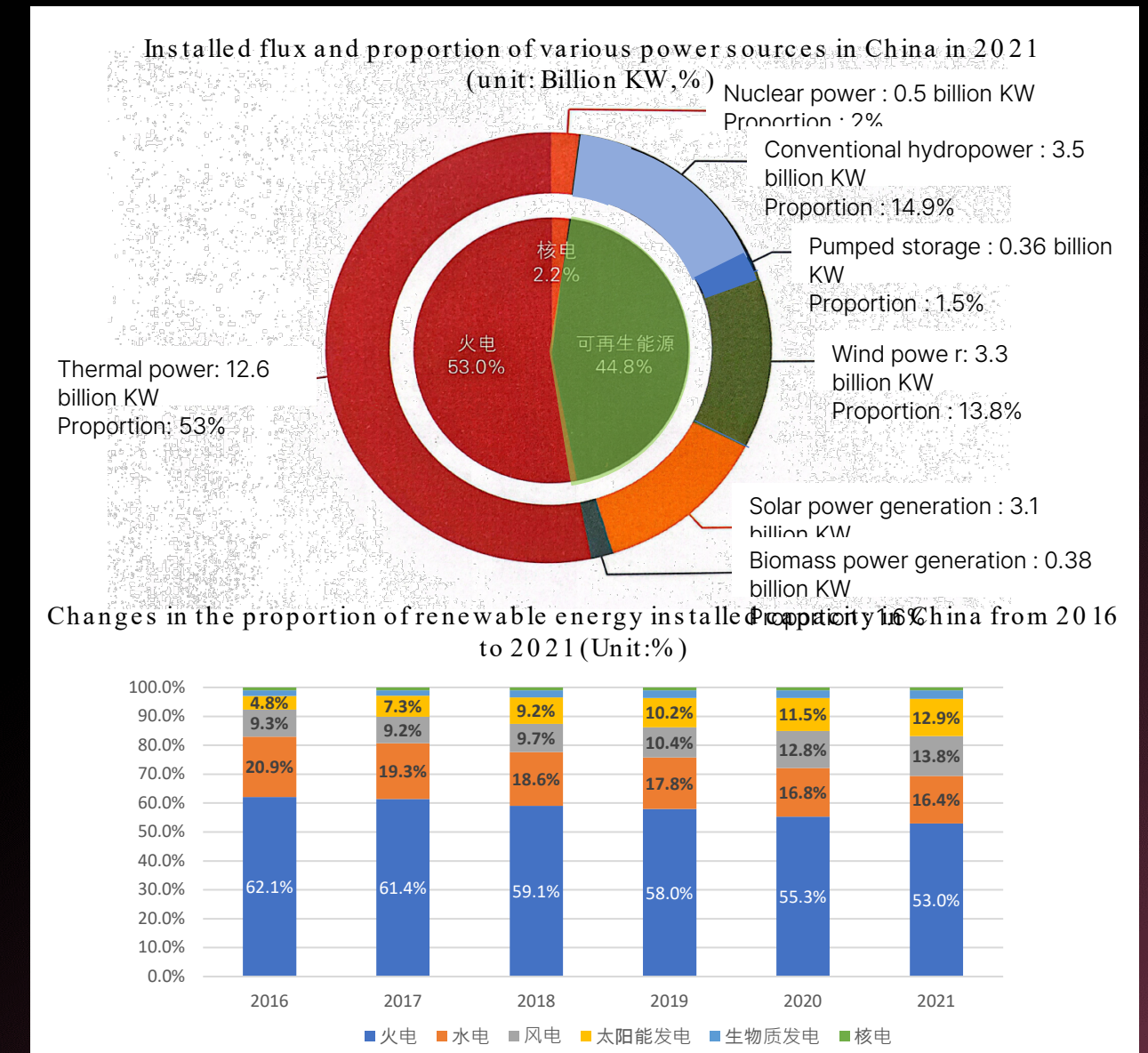
- Actively promote development models such as photovoltaic desertification control and complementary agriculture, animal husbandry, and photovoltaics, and **promote integrated development of ecological restoration and low-carbon transformation**





## Current situation of clean energy in China

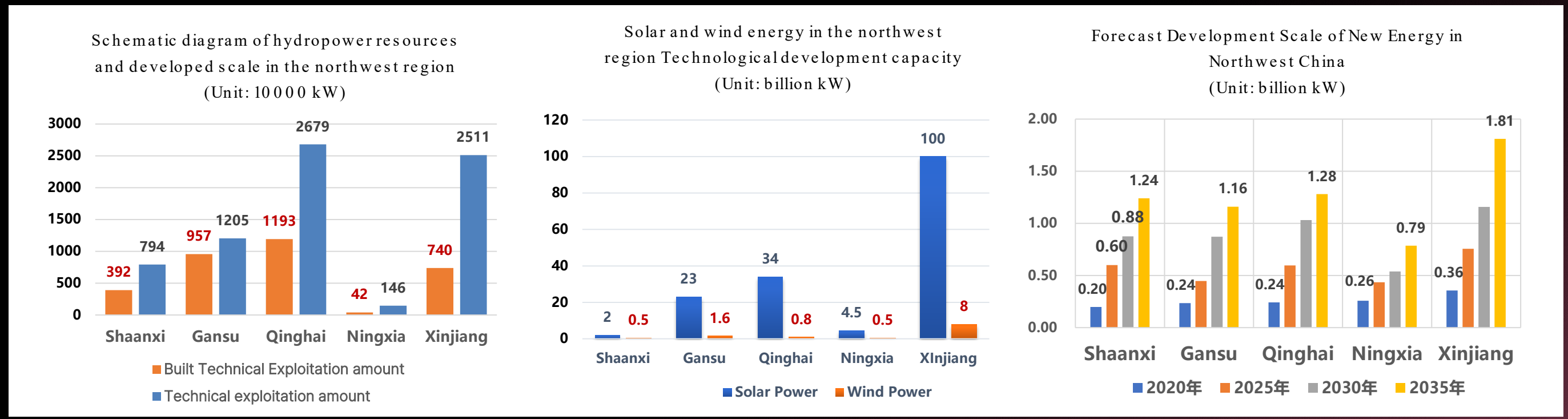
- As of 2021, the total installed capacity of power generation in China is 23.8 billion kW:
- Thermal power installed capacity **12.6 billion kW** (accounting for 53%)
- Renewable energy installed capacity **10.6 billion kW** (accounting for 45%): The installed capacity of hydropower is **3.5 billion kW** (accounting for 14.9%)
- Pumped storage capacity is **0.36 billion kW** (accounting for 1.5%)
- The installed capacity of wind power is **3.3 billion kW** (accounting for 13.8%)
- The installed capacity of solar power generation is **3.1 billion kW** (accounting for 12.9%)
- The installed capacity of biomass power generation is **0.38 billion kW** (accounting for 1.6%)
- Nuclear power installed capacity is **0.5 billion kW** (accounting for 2%)





# Conditions and Development Forecast of Clean Energy Resources in Northwest China

- **Water energy resources** : The total technically exploitable capacity of the five northwestern provinces is over **73 million kilowatts**, with over 33 million kilowatts already developed, accounting for **45%** of the technically exploitable capacity.
- It is expected that the newly added scale of hydropower will be **25 million kilowatts** by 2035, mainly in the upper reaches of the Yellow River.
- **New energy** : The wind power technology in the five northwest provinces can develop **11.4 billion kW**, and the photovoltaic technology can develop **163.5 billion kW**. The wind and solar resources are abundant, it is predicted that the installed capacity will be **4.5 billion kW by 2030**.







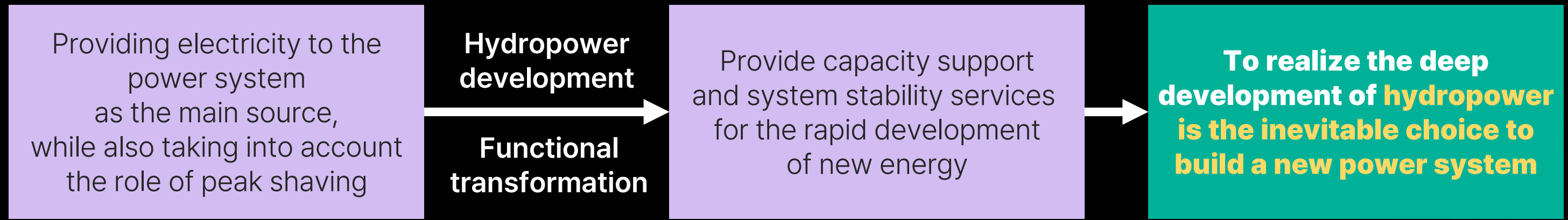
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03

# Clean Energy Development Path



# Deep Development of Hydropower : Capacity Expansion and Efficiency Enhancement of Cascade Power Stations



- During the 14th Five-year Plan period, the focus will be on developing nine major clean energy bases and four major offshore wind power bases, among which **five bases are related to hydropower development.**





## New Energy “Wall Breakers”: Pumped Storage Needs to be Developed Urgently

In the northwest region,  
pumped storage energy is  
largely developed  
in the new energy field as :

### Green giant Power Bank

- Effectively improving **the consumption and utilization rate of new energy**
- **Increase the transmission hours** of the transmission channel
- Ensure **the economic efficiency** of new energy development and construction in the northwest region

### Stabilizer

- **Flatten the fluctuation** of new energy generation output
- **Make up for the insufficient guaranteed output** of new energy power generation
- **Enhance the anti-interference ability** of the power system

### Booster

- Meeting **the peak shaving and energy storage needs** of the Northwest Power Grid
- Drive the development of **new energy industry in the northwest region**



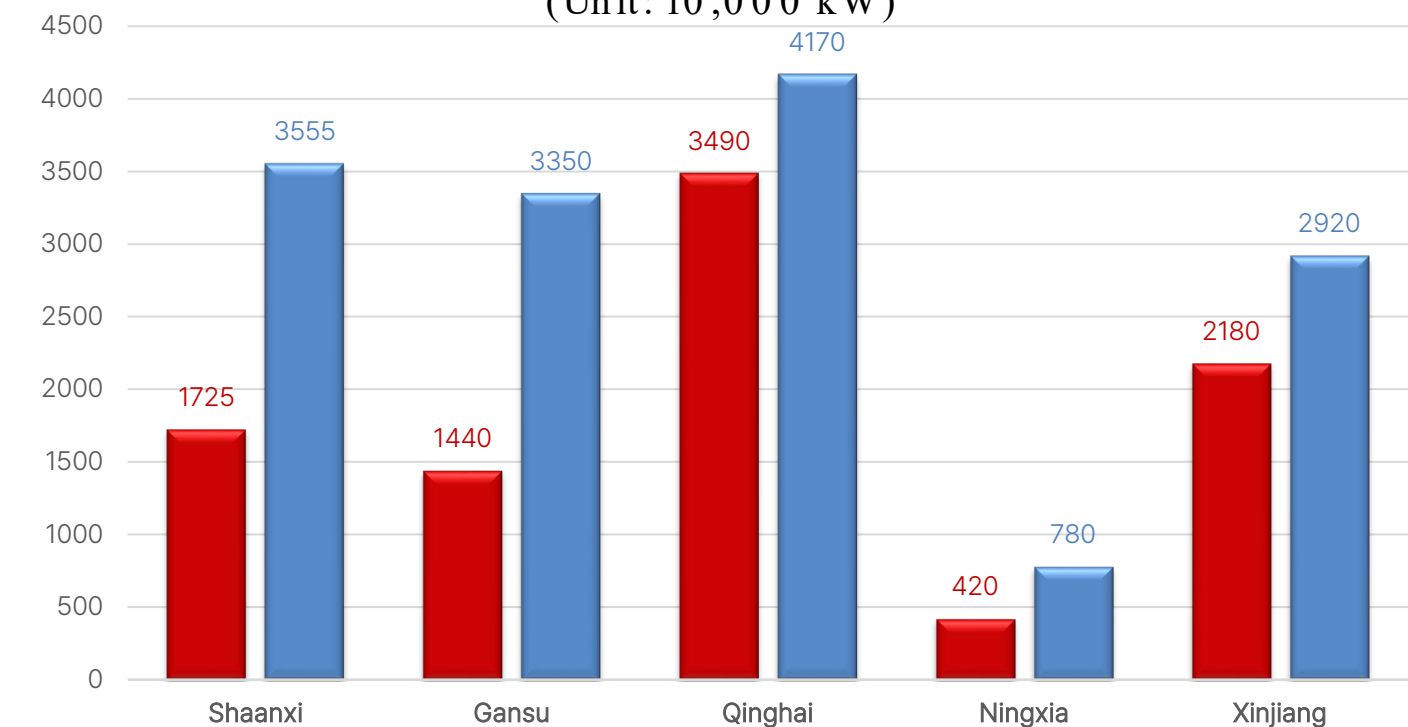
# New Energy “Wall Breakers”: Pumped Storage Needs to be Developed Urgently

- NWH has completed the medium and long-term site selection plan for pumped storage in the five northwest provinces.
- **121** medium and long-term pumped storage planning sites in Northwest China, with a planned scale of about **150 million** kilowatts. 74 key implementation projects, and 47 reserve projects
- In 2035, the new energy plan in Northwest China will reach **630 million** kilowatts, with an increase of nearly **500 million** kilowatts, and the scale of pumped storage demand will be nearly **100 million** kilowatts
- 40 million kilowatts will be carried out in the early stage, **with great potential to be developed**

The development of pumped storage power stations in the five provinces of Northwest China (Unit: 10,000 kW)

Province	Shaanxi	Gansu	Qinghai	Ningxia	Xinjiang	total
Built/Ongoing	140	0	0	0	240	380
Preliminary work	780	960	780	100	1360	3980

Overall situation of pumped storage station resources (Unit: 10,000 kW)





## River Basin Integration: Seeking the "Optimal Solution"

- On March 2, 2022, **the National Energy Administration (NEA) issued the Notice on the Research on the Integrated Planning of Renewable Energy in Major River Basins across the Country**
- Connotation: Relying on hydropower development in major river basins, fully utilizing the flexible regulation capacity of hydropower, supporting the construction of new energy power generation projects, and **building an integrated renewable energy development base,**
- **Integrated resource allocation / planning and construction / dispatching operation / market competition**



## 国家能源局

### 国家能源局综合司关于开展全国主要流域 可再生能源一体化规划研究工作有关事项的通知

各省（自治区、直辖市）能源局，有关省（自治区、直辖市）及新疆生产建设兵团发展改革委，水电水利规划设计总院，有关电力企业：

为落实《中共中央 国务院关于完整准确全面贯彻新发展理念做好碳达峰碳中和工作的意见》《国务院关于印发2030年前碳达峰行动方案的通知》《中华人民共和国国民经济和社会发展第十四个

附件：1. 主要流域清单

2. 规划研究报告起草大纲

3. 主要流域水电站可再生能源一体化综合项目布局

4. 主要流域可再生能源一体化综合基地布局





# Large Landscape base and supporting pumping and storage construction

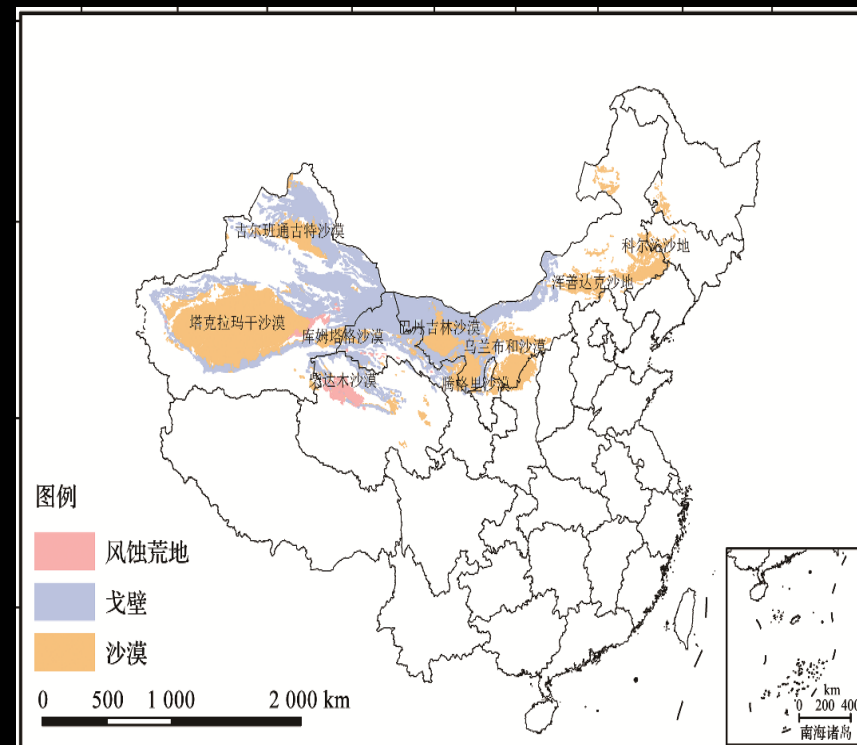
- Xi Announced at the Leaders' Summit of the 15th Conference of the Parties to the Convention on Biological Diversity
- **China will accelerate the planning and construction of large-scale wind power and photovoltaic base projects in deserts, Gobi and desert areas**

January  
2022

- The Planning will have **a total construction scale of about 455 million kilowatts in 2030**

May  
2022

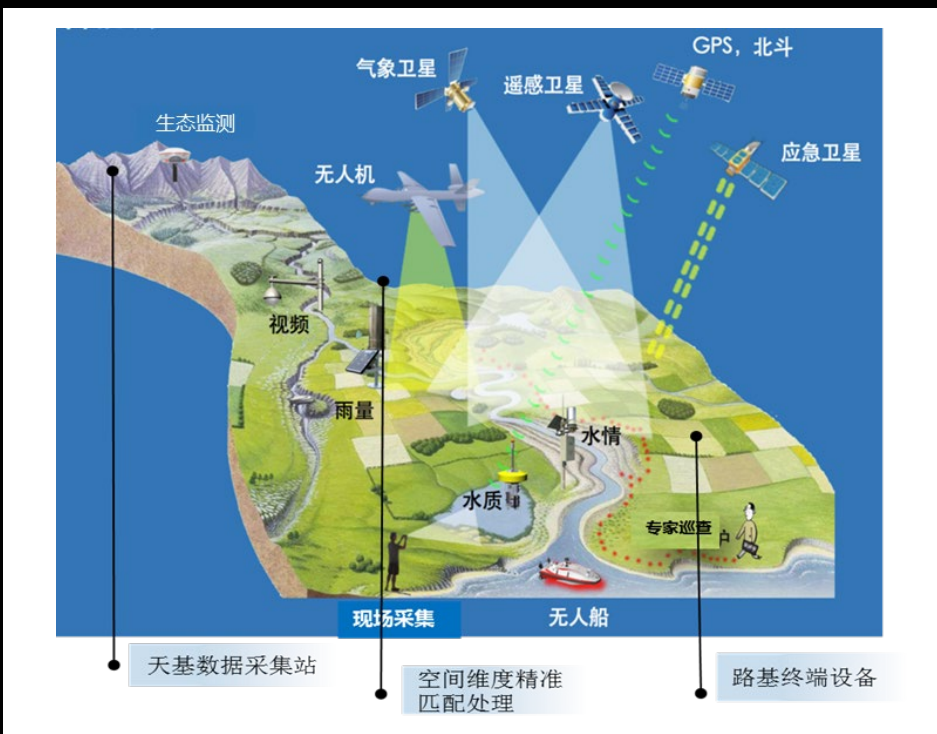
- **start the resource investigation and planning adjustment of pumped storage sites** in deserts, Gobi and wind-eroded wasteland





## Focus on Ecological Protection and High-quality Development

- Systematically planning hydropower development and ecological protection
- Carry out in-depth environmental protection work for hydropower, pumped storage, integrated bases and other projects
- Underwater and onshore overall consideration, holistic approach to conserving mountains, rivers, forests, farmlands, lakes, and grasslands
- Use information technology such as big data and the Internet of Things to gradually **achieve smart management and ecological environment protection**, achieve precise decision-making and rapid response, and provide support for ecological protection and high-quality development in river basins



Ecological Priority

Harmonious  
Coexistence



# Wind Power and Photovoltaic Development are Combined with Ecological Governance

1

Take advantage of the opportunity of the large-scale development of new energy bases to promote the construction of **"Photovoltaic + Ecological Restoration"** projects

2

Ecological protection and restoration projects such as photovoltaic + sand control, **coal mining subsidence area management**, and mining area management are integrated and **developed with new energy construction projects**







04

# Typical Engineering Numerical Simulation



# MIDAS Software in Engineering

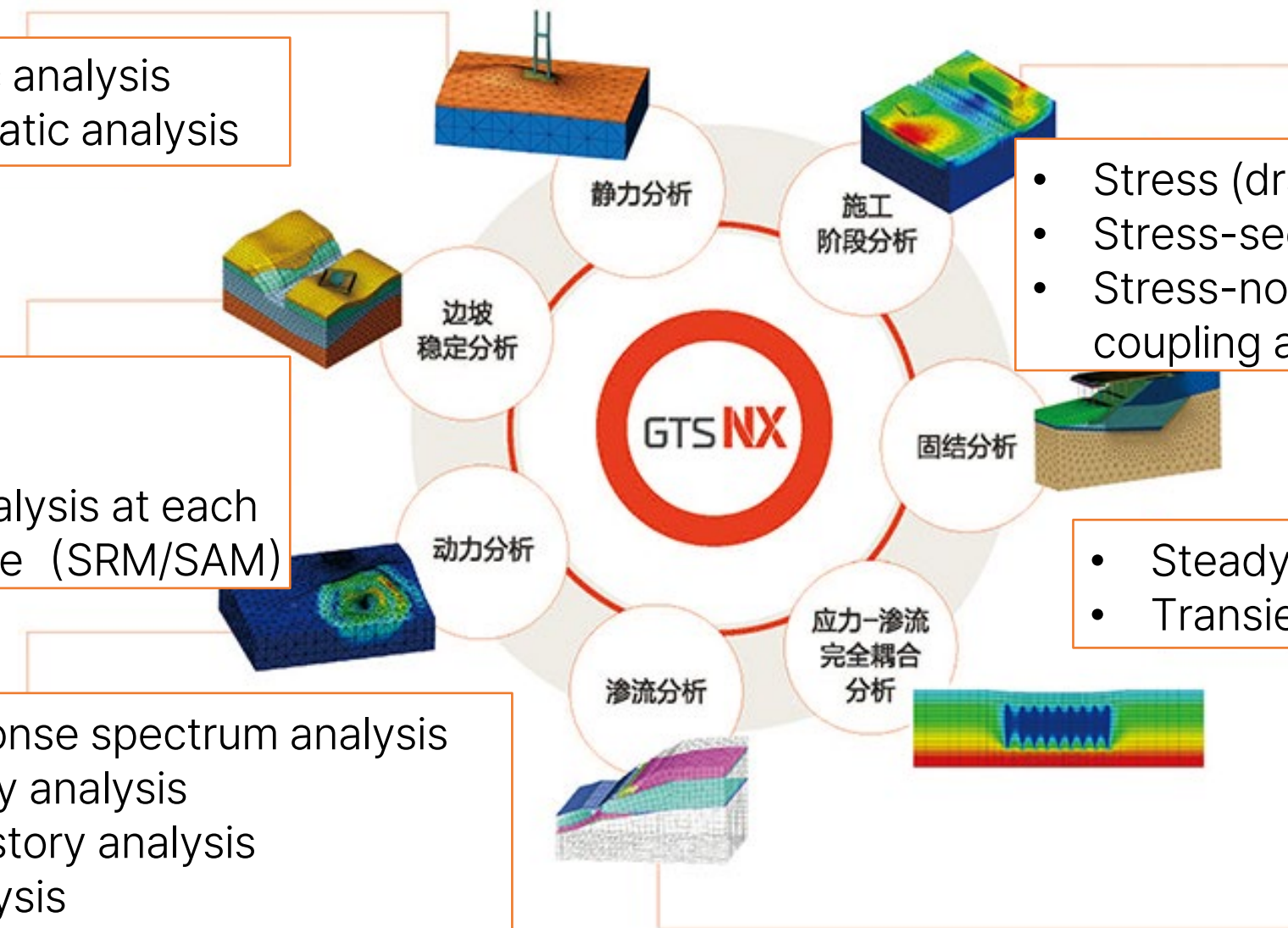
- Linear static analysis
- Nonlinear static analysis

- SRM
- SAM
- Slope stability analysis at each construction stage (SRM/SAM)

- Eigenvalue/ response spectrum analysis
- Linear time history analysis
- Nonlinear time history analysis
- 1D free-field analysis
- 2D equivalent linear analysis
- Nonlinear time history analysis+SRM

- Stress (drain/non-drain) analysis
- Stress-seepage coupling analysis
- Stress-nonlinear time-history coupling analysis

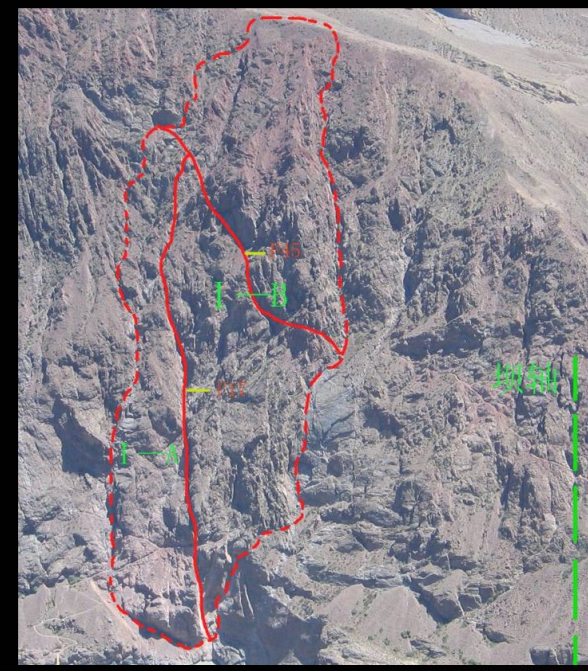
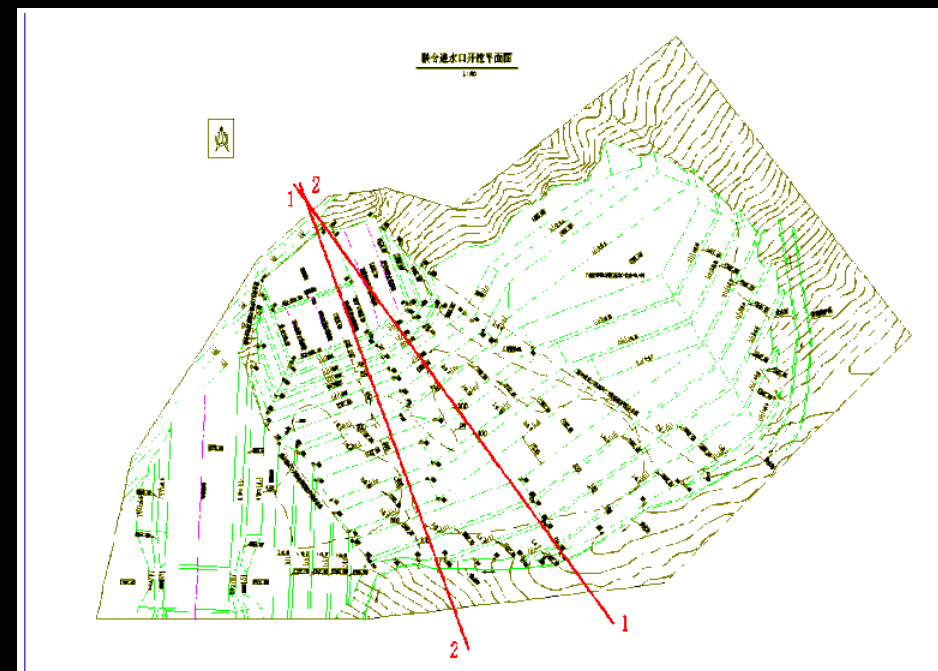
- Steady-state analysis
- Transient analysis



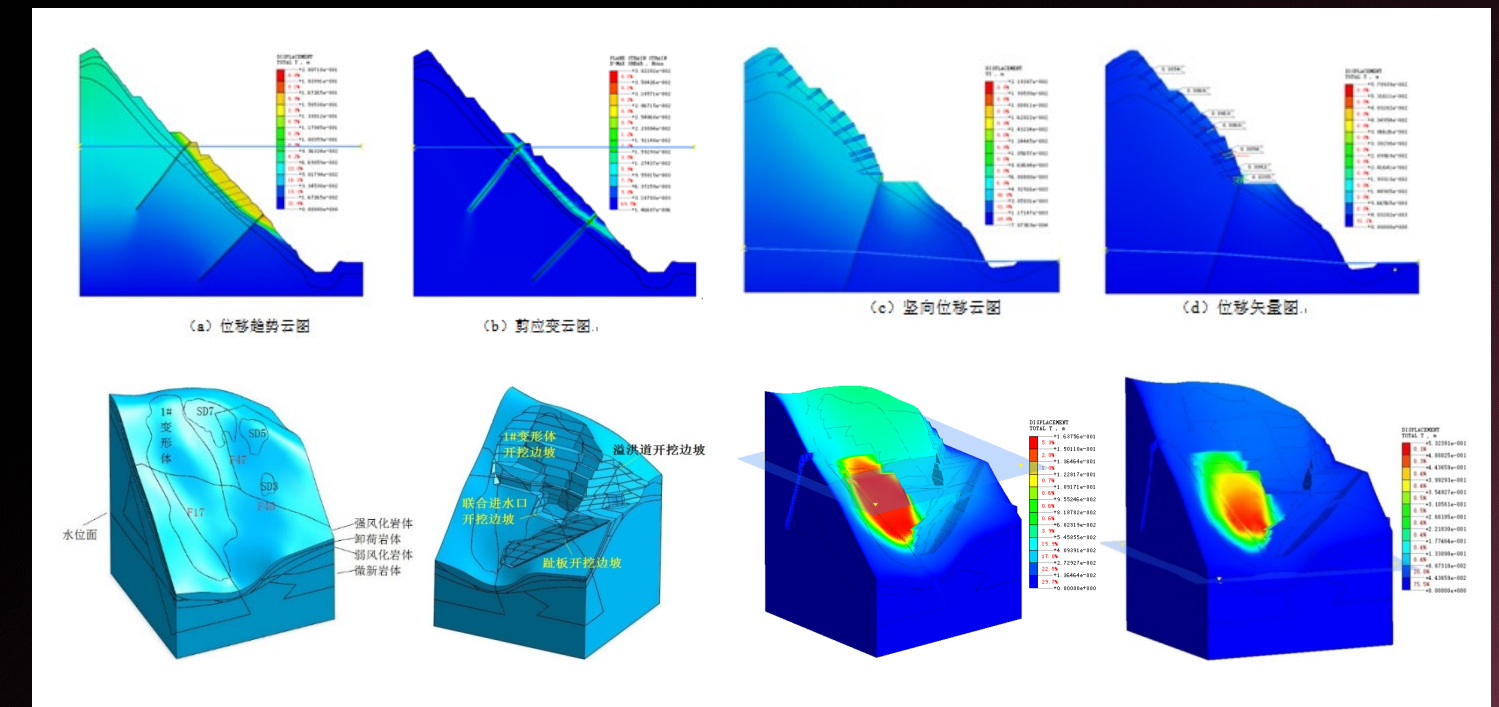


# 1# Deformed Body of a Hydropower Station

- The maximum excavation height of the slope is 200m, 1# The deformed body has a complex structure, fault tectonic development (F45, F47, F17)
- Located near the combined inlet, instability will directly affect the safety of the inlet
- In view of the actual condition of the deformation, a parameter inversion method controlled by **historical conditions (morphology, earthquake, and rainstorm)** is innovatively proposed, and the creep~stable critical state is in the rainstorm and historical seismic conditions



Combined inlet slope





# A Trench-Crossing Tunnel of Hydropower Station

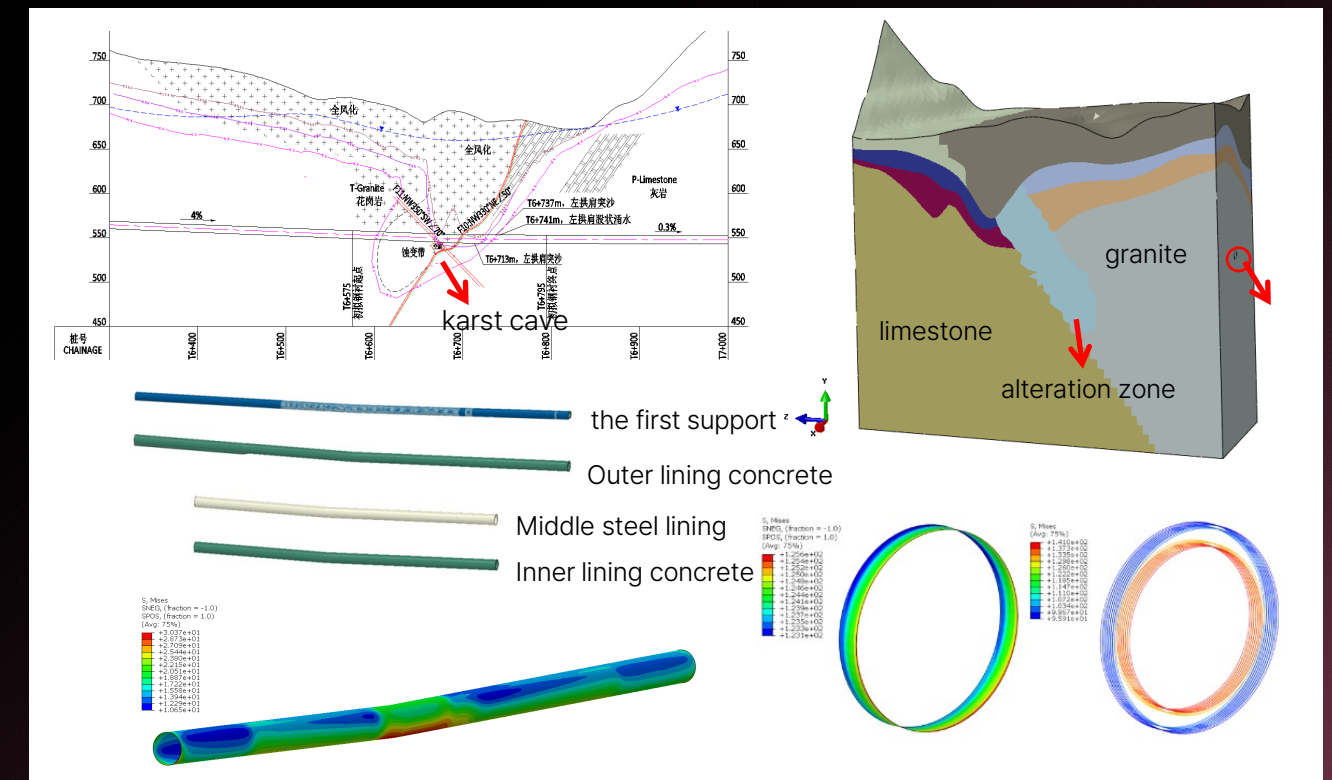
- The part is one of the worst for the whole diversion tunnel, fracture development, rock weathering is serious, low strength, poor integrity, **the tunnel through the erosion zone and karst area**, the external water head reaches 144m;
- The tunnel passes through the 3# trench section and innovatively proposes **a solution of middle steel lining + internal and external reinforced concrete**



T6+763m Serious water gushing on the face of the tunnel



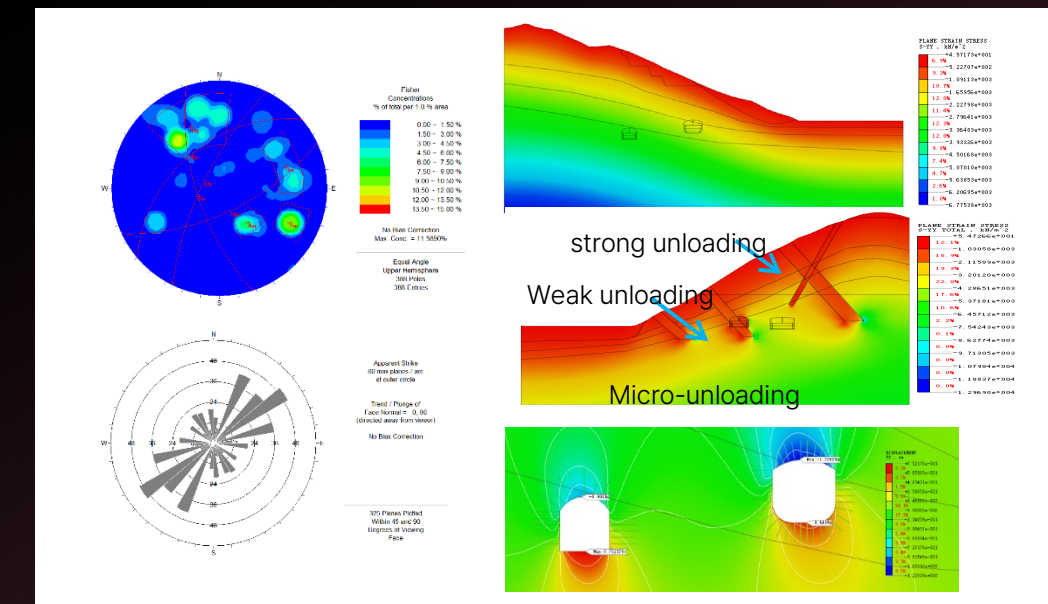
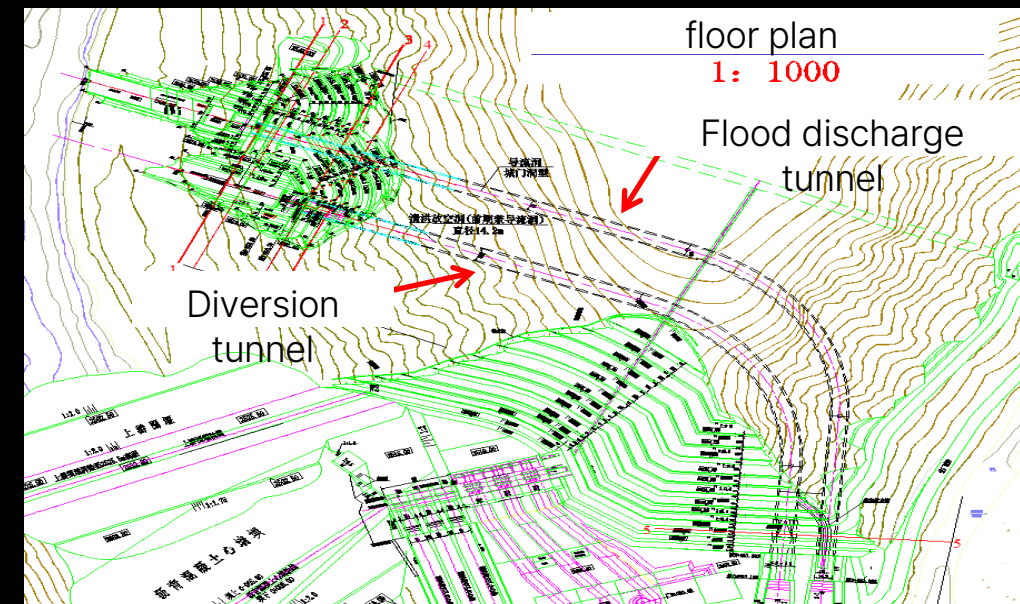
T6+737m Left arch shoulder protruding mud on the face of the tunnel





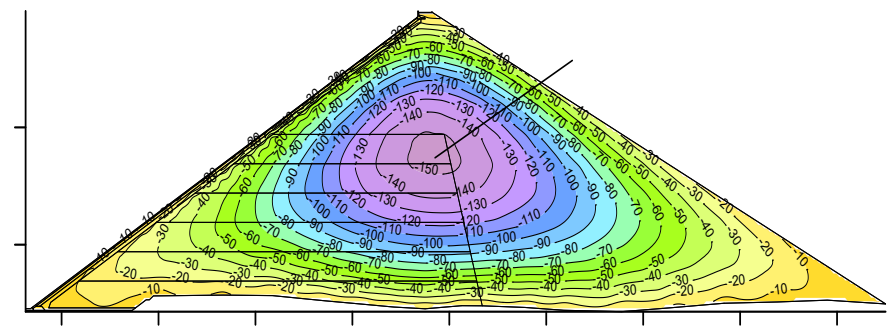
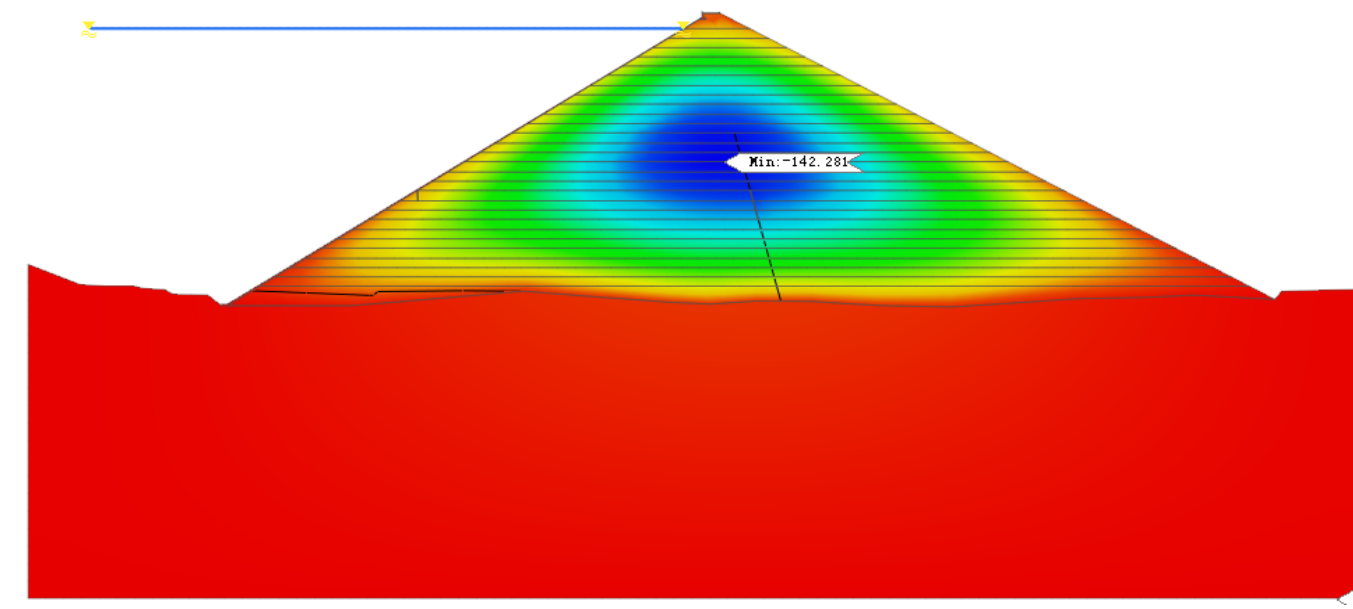
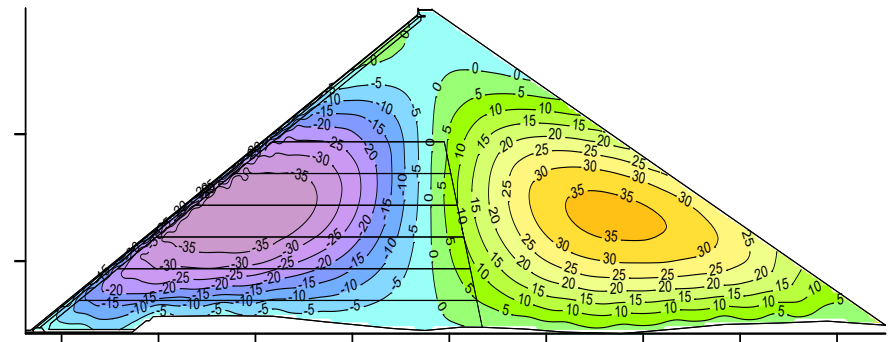
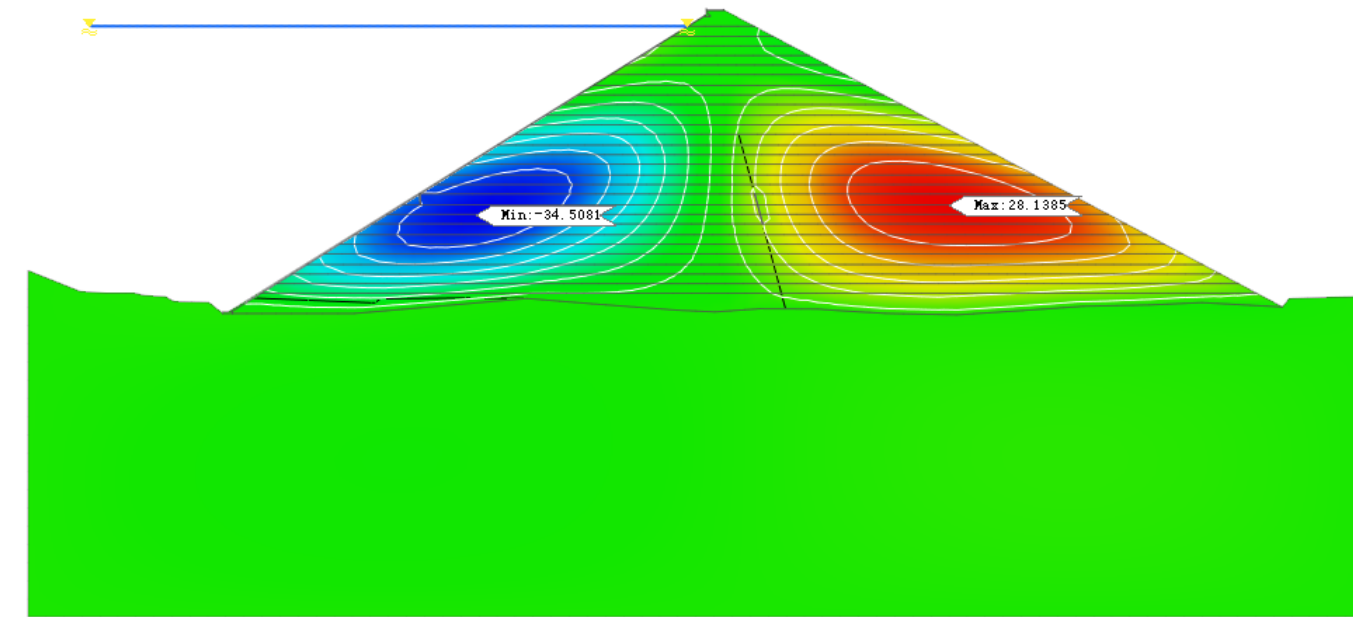
# A Spillway Tunnel and Diversion Tunnel of Hydropower Station

- The flood discharge tunnel and diversion tunnel of a hydropower station are located on a strip-shaped ridge formed by two rivers. The terrain is open on three sides, and the horizontal depth of the rock mass unloading zone reaches 50m~70m;
- Based on engineering experience, **the surrounding rock confining pressure load** release coefficient is innovatively introduced, and **the release coefficient ratio** is adjusted according to the excavation and support of the chamber, which is closer to the step-by-step completion of excavation and support during the actual construction process.





# Stress and Strain Analysis of Dam







05

# Conclusion



## Conclusion

With the international control requirements for room temperature gases and the national dual-carbon goals, it is the general trend **to build a new power system with clean energy as the main body**. The special regulating properties of hydropower (pumped storage) will surely show **special advantages in subsequent development and redevelopment**.

### 1

#### Strengthen the research on hydropower and new energy dispatching operation

Hydropower stations cooperate with the operation of new energy and pumped storage power stations, the dispatching operation mode will be more complicated

### 2

#### Explore new development models

The integrated development of water, wind and light improves the quality of power supply, the utilization rate of new energy, and the economy of power transmission

### 3

#### Relevant engineering and technical issues need to be strengthened

Further in-depth research is also needed on dam construction technologies such as reservoir basin anti-seepage in pumped storage projects under complex conditions such as high altitudes, cold areas, poor geological conditions, and collapsible loess





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# THANK YOU