



Study on Large-scale PV Power Plant and Ecological Environment Restoration

October, 2022



CONTENTS

1

Research Background

2

**Relationship between PV Development
and Ecological Environment**

3

**Large-scale PV Power Plant + Ecological
Restoration Application**

4

**Application Method of Desertification
Control**

5

**Application Prospect of PV Power Plant
+ Ecological Restoration in Africa
countries**



PART 01

Research Background



1.1 Background

● Energy security & Environmental Protection

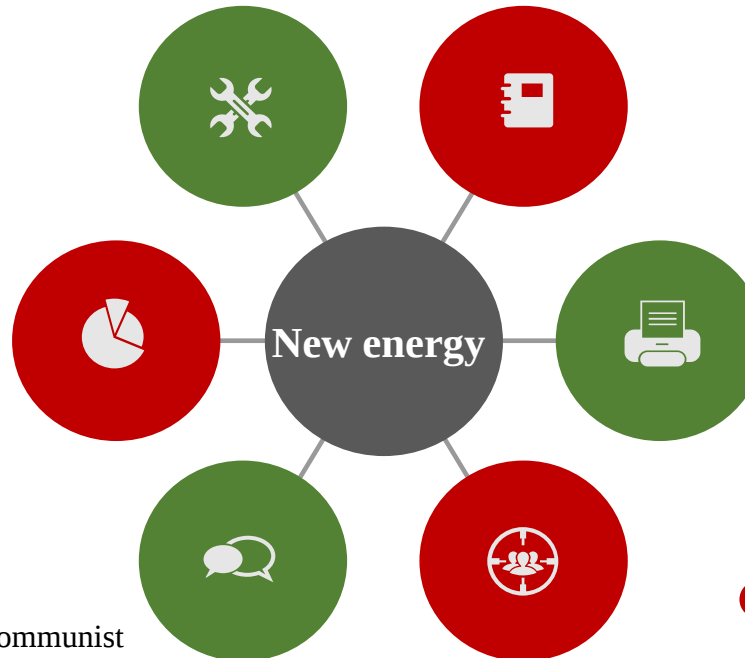
- ◆ Fossil energy is increasingly exhausted.
- ◆ Mankind is facing the problem of energy security.

● Conventional energy development is limited

- ◆ **Thermal power:** environment protection & energy consumption
- ◆ **Hydropower:** resources, environment protection and land acquisition

● National policy

- ◆ The 19th National Congress of the Communist Party of China requires **establishment and improvement of a green, low-carbon and circular economic system**, promotion of revolution in energy production and consumption, and **construction of a clean, low-carbon, safe and efficient energy system**.



● Peak carbon dioxide emissions and Accords de Paris

- ◆ Non-fossil energy: 20% in 2025
- ◆ Non-fossil energy: 25% in 2030

● Development of new energy

- ◆ With the progress of technology, new energy is increasingly feasible in economy, and **can compete with fossil energy in some countries and regions**.

● Problems Faced by New Energy

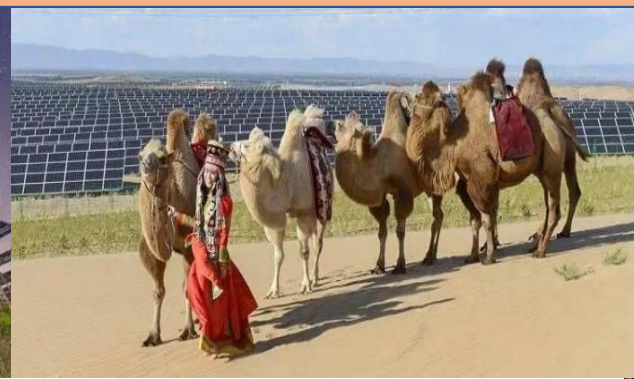
- ◆ Randomness
- ◆ Intermittency
- ◆ Uncontrollability
- ◆ Wind and PV-curtailment Power - electric quantity problem



1.2 Research Significance

Large-scale PV Power Plant + Ecological Restoration

- ☑ Achieve the goal of sustainable development, control desertification and build a community with shared future for mankind.
- ☑ Several countries with the highest degree of land desertification, rich in solar energy resources, not only urgently need to establish a clean modern energy system, but also have the demand for desertification control as well.
- ☑ Promote the development model of PV industry + ecological restoration for mutual benefit and multiple-win.



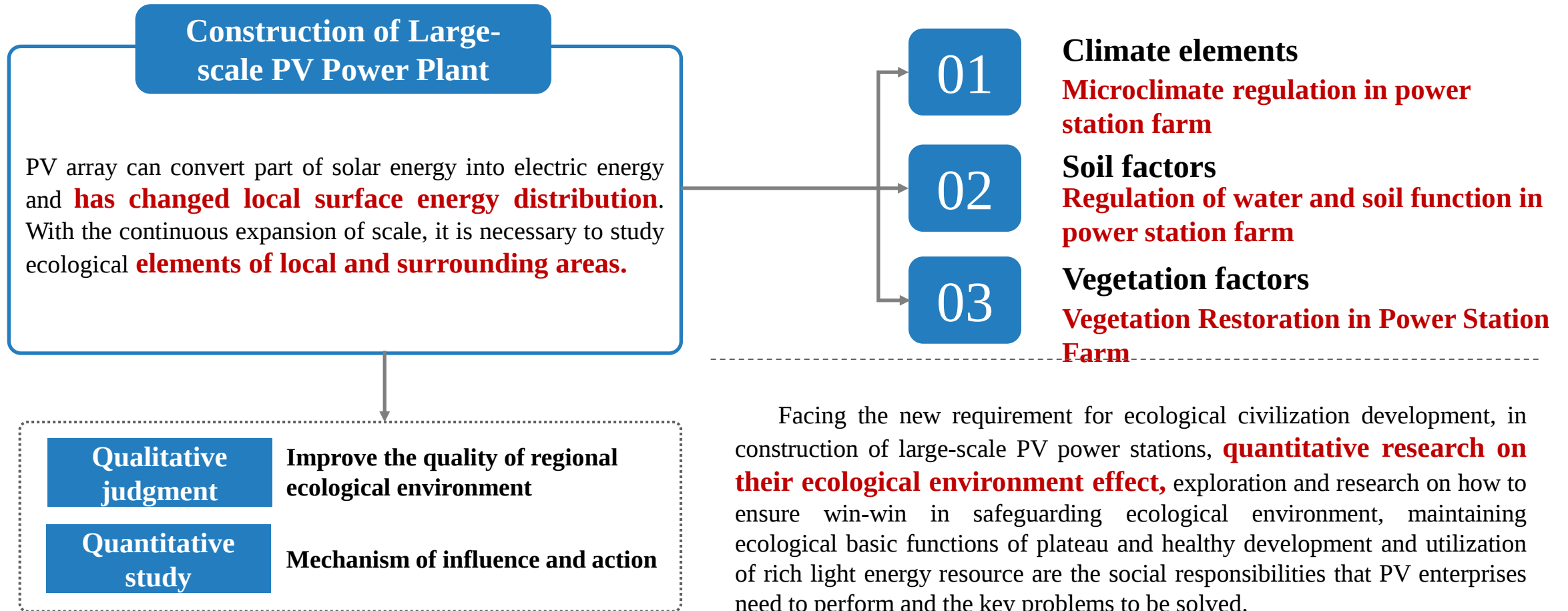


PART 02

Relationship between PV Development and Ecological Environment

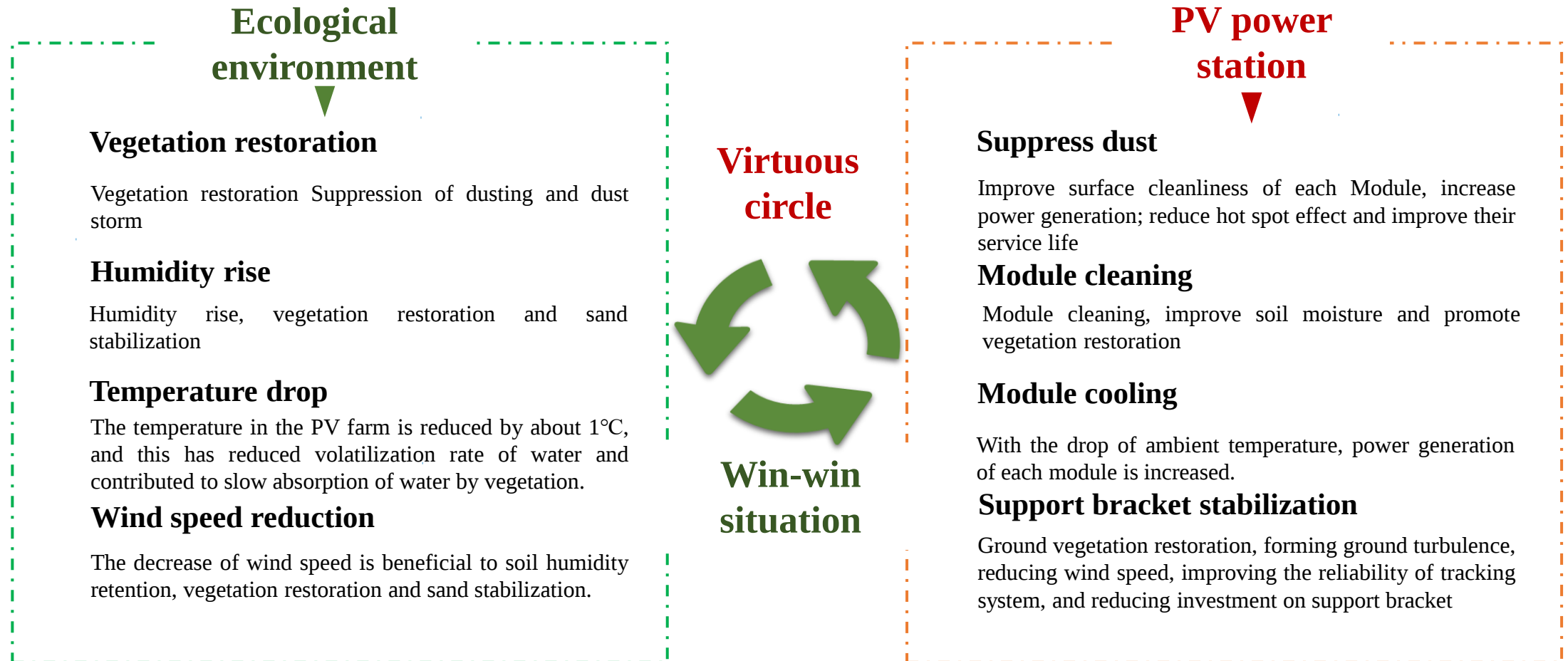


2.1 Large-scale PV Power Station Development and Ecological Environment Impact



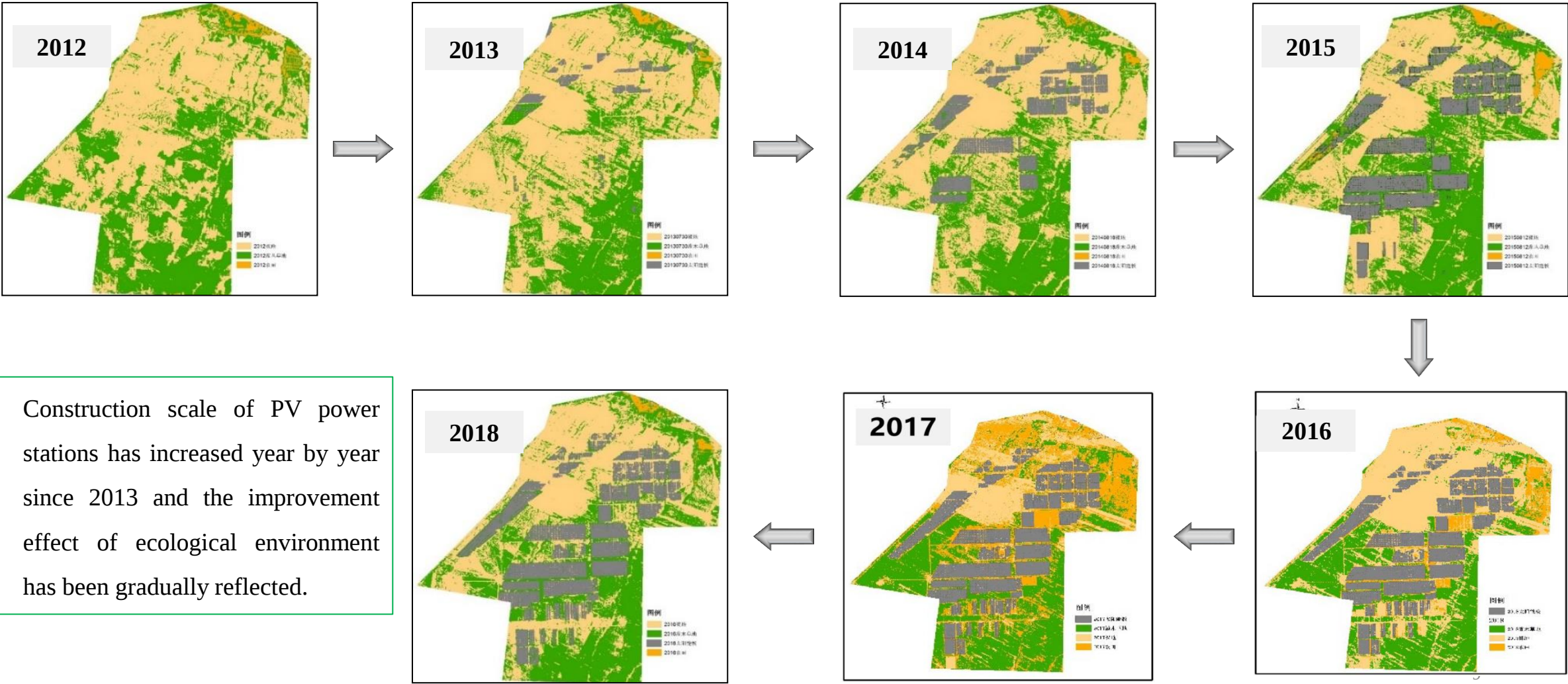


2.2 PV Power Station + Desertification Control





2.2.1 Longitudinal comparison of satellite remote sensing data

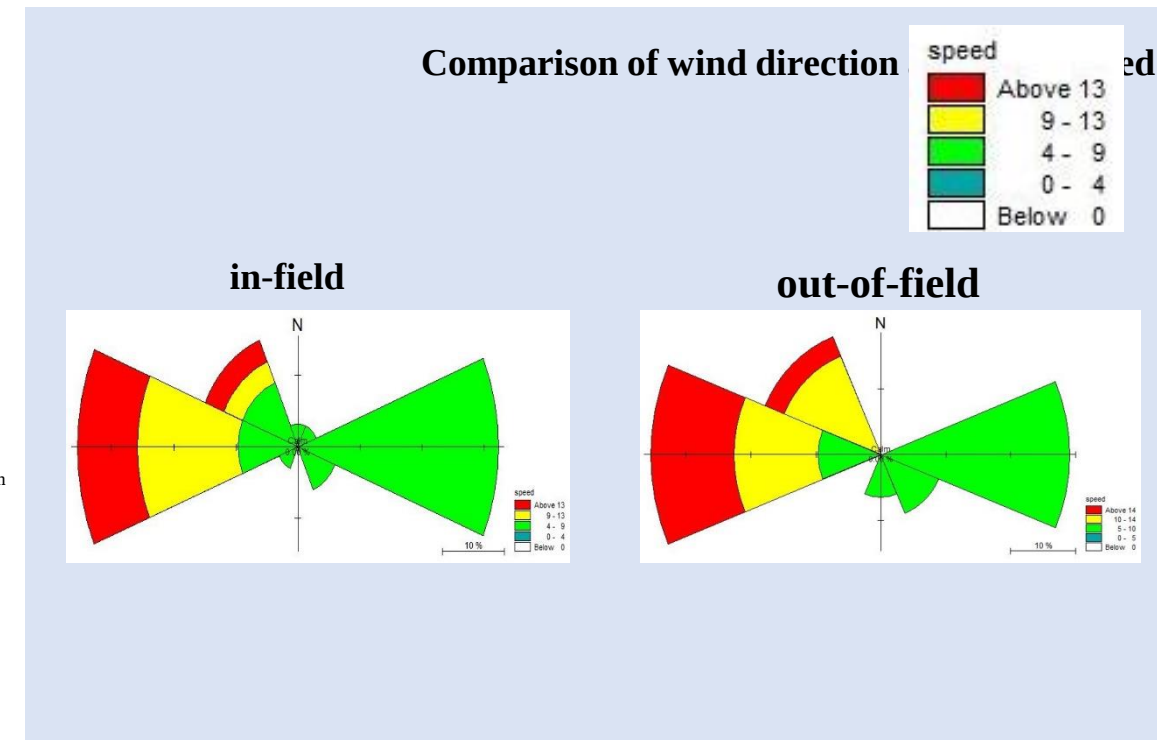
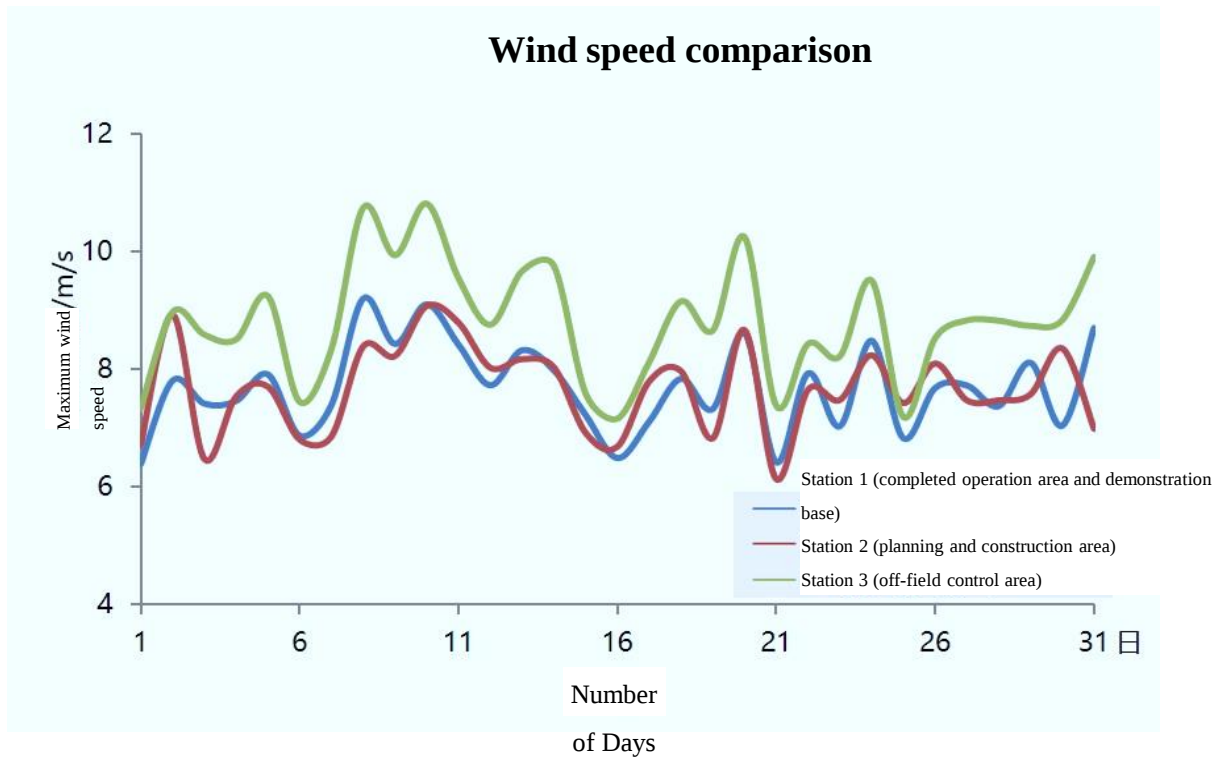


◆ Construction scale of PV power stations has increased year by year since 2013 and the improvement effect of ecological environment has been gradually reflected.



2.2.2 Horizontal comparison of measured data analysis

- Variation trend of wind speed and direction



- According to statistical data, the monthly maximum wind speed in the field is **13.4% lower** than that out of the field.



2.2.3 Research Findings

Original
landform



Vegetation
restoration



Coordinated
development



1. Longitudinal comparison: With the construction of large-scale PV power stations, their cumulative effect on the regional ecological environment has become gradually apparent and the vegetation coverage is gradually increasing.

2. Horizontal comparison: Large-scale PV power stations have changed local climate, especially reduced wind speed and increased air humidity, and in addition, the regional soil nutrient content has changed obviously, and the soil fertility has been greatly improved.

Coordinated Development of PV Power Generation and Ecological Environment

Large-scale PV power stations promote regional ecological restoration, which has improved their power generation and equipment safety and stability, which has initially formed a **win-win situation of development**. subsequently, we will continue to pay attention to the impact mechanism of large-scale PV power stations on ecological environment in combination with multiple research methods, and provide technical support for the decision-making of ecological environment protection and management in large-scale PV power station parks.

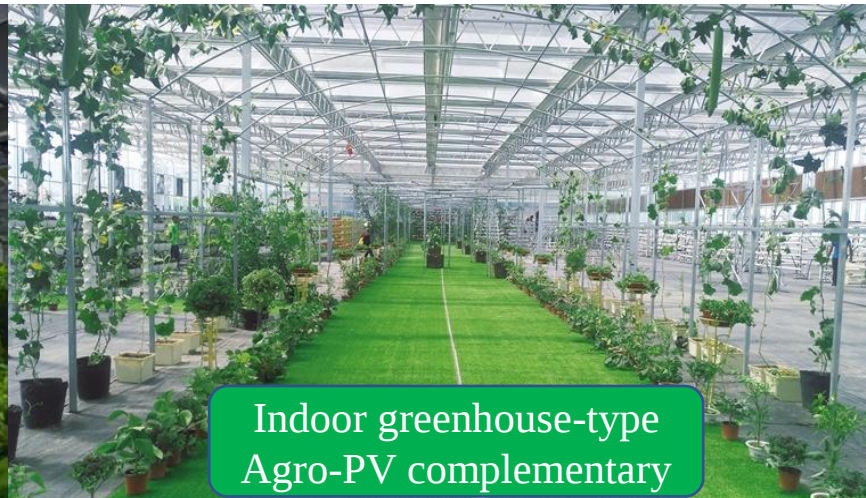
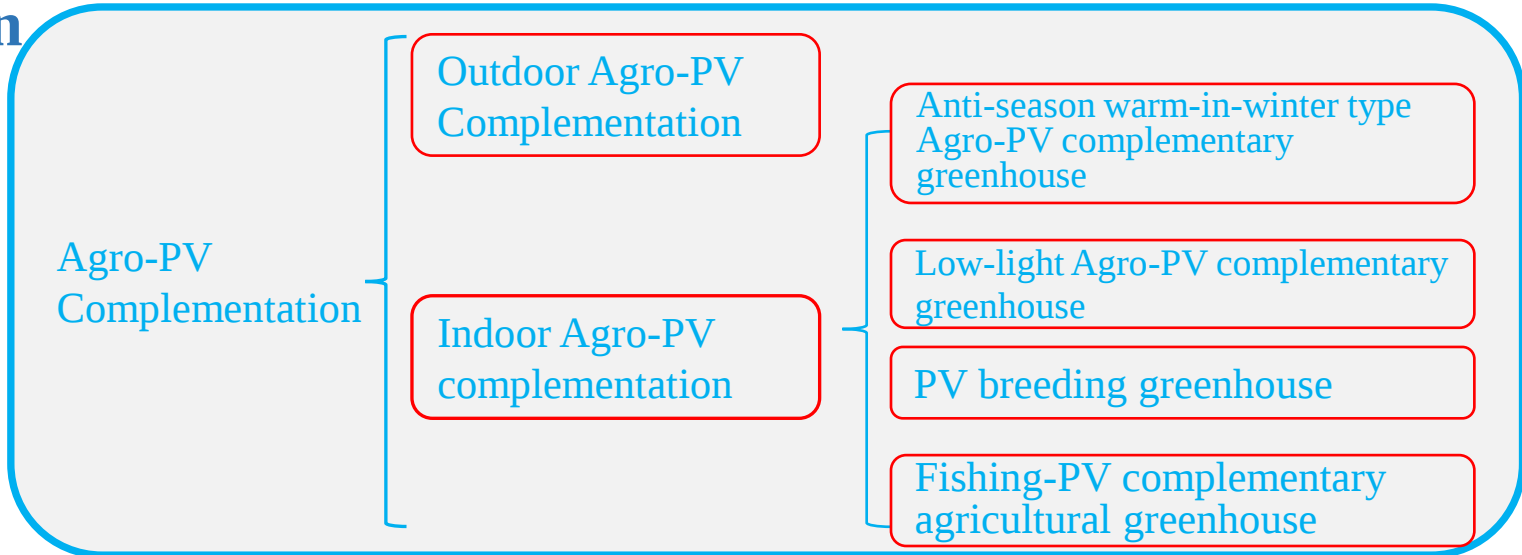


Relationship between PV Development and Ecological Environment

2.3 Application of Agro-PV Complementary Power Station

Agro-PV Complementation:

just a project of installing PV modules on existing agricultural and forestry facilities or breeding greenhouses for agricultural production, nursery or breeding under greenhouses.





2.3.2 Ecological environment change trend of Agro-PV complementary power station



Outdoor Agro-PV Complementary Power Station: Original Landform → Primary crop → Crops grow and change the original desert landform.



Outdoor PV greenhouse: Crops have afforested the original land.



Agro-PV complementation: change trend of green and sparse land.



Relationship between PV Development and Ecological Environment

2.3.3 Application Significance of Agro-PV Complementary Power Station

Protect the ecological environment

Turn desert into cropland;

Improve land utilization rate

PV is built in the upper part and crops are planted in the lower part;

Increase economic benefit

Desert turns waste into treasure and crops increase economic benefits;

Reduce investment cost

Combination of aquaculture to increase employment rate and economic benefit;





PART 03

Large-scale PV Power Station + Ecological Restoration Application



3.1 Qinghai PV Power Station + Desertification Control

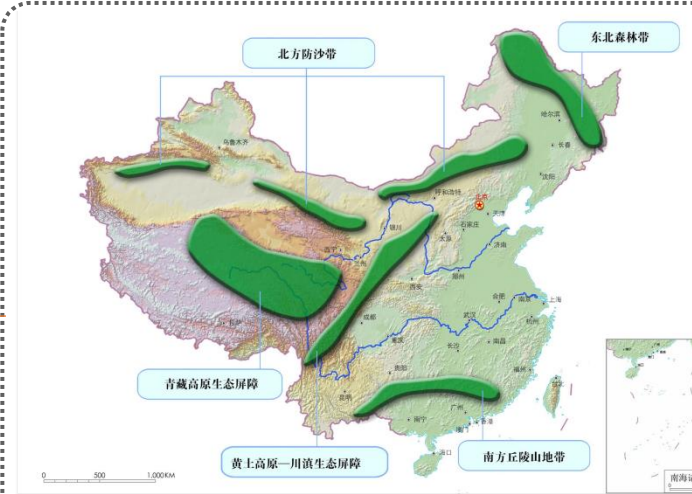


Ecological environment

Typical ecologically fragile areas with great environmental specificity and sensitivity.

PV industry

China's solar energy resource-rich region is the largest base of PV power generation.



- Involving the "ecological barrier of Qinghai-Tibet Plateau" in "two barriers and three belts", and playing an extremely important supporting role in the construction of China's ecological security strategic pattern;

Grassland degraded area

Source area of Three Rivers

Deserts and desertification areas

Farming-pastoral ecotone

Mineral exploitation area

- covering almost all the most concerned typical fragile ecoregion.

Coordinating the relationship between PV development and utilization and ecological environment protection is a major issue that must be considered in Qinghai's future clean energy development.



Hercynian PV Power Generation Base



Hainan PV Power Generation Base



3.1.1 Overview

Causes of Grassland Degradation in Qinghai-Tibet Plateau - Present Situation of Ecological Environment

Under the joint influence of global warming and human activities, the ecological environment of Qinghai-Tibet Plateau is mainly manifested in grassland degradation, especially in the hinterland of the plateau.

Natural factors

- **Climate warming and desiccating**

Temperature and precipitation are the main factors in climate change. Affected by global change, the temperature of Qinghai-Tibet Plateau generally shows a rapid upward trend. Rainfall increases in winter and spring, but decreases in summer and autumn. The change of seasonal distribution of rainfall leads to obvious drought in grassland. Climate warming and desiccating provide internal dynamic conditions for plateau grassland degradation.

- **Harm of rodents**

Plateau pika, plateau zokor, etc. have a very high breeding rate in degraded grassland.





3.1.1 Overview

Causes of Grassland Degradation in Qinghai-Tibet Plateau - Present Situation of Ecological Environment

Human factors

- **Overgrazing**

According to statistical data, the overgrazing rates in Qinghai and Tibet are 16% and 78% respectively, with an average of 45%. **The latest scientific research results show that the decrease of total nitrogen content and imbalance of nutrient flow caused by overgrazing and export of livestock products are the main reasons for degradation of grassland in Qinghai-Tibet Plateau.**

- **Man-made unreasonable interference,**

including blind grassland reclamation, road construction, gold mining and sand excavation, have also accelerated the process of grassland degradation. In addition, in order to find medicinal plants and Cordyceps sinensis, local herdsmen dig out complete turf and cut down shrubs, and this action is very harmful to grassland, such as forming "black soil beach" deteriorated grassland.

Human factors are the external driving force of grassland degradation in Qinghai-Tibet Plateau.

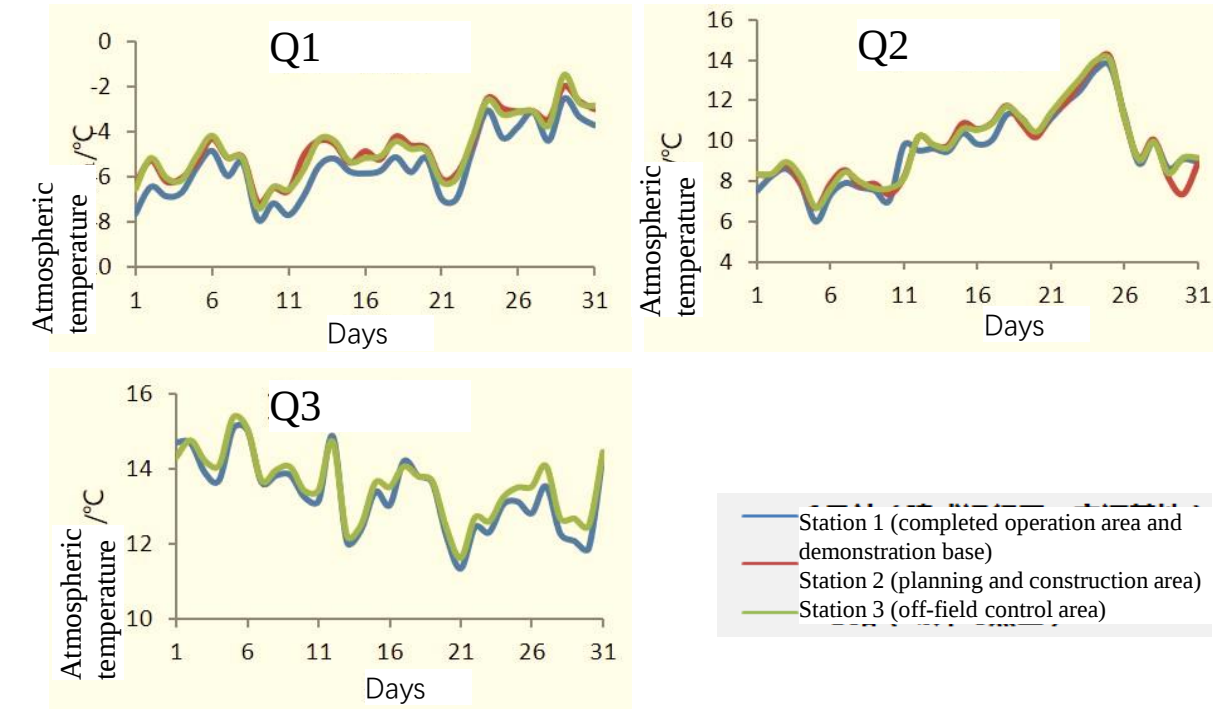




Large-scale PV Power Station + Ecological Restoration Application

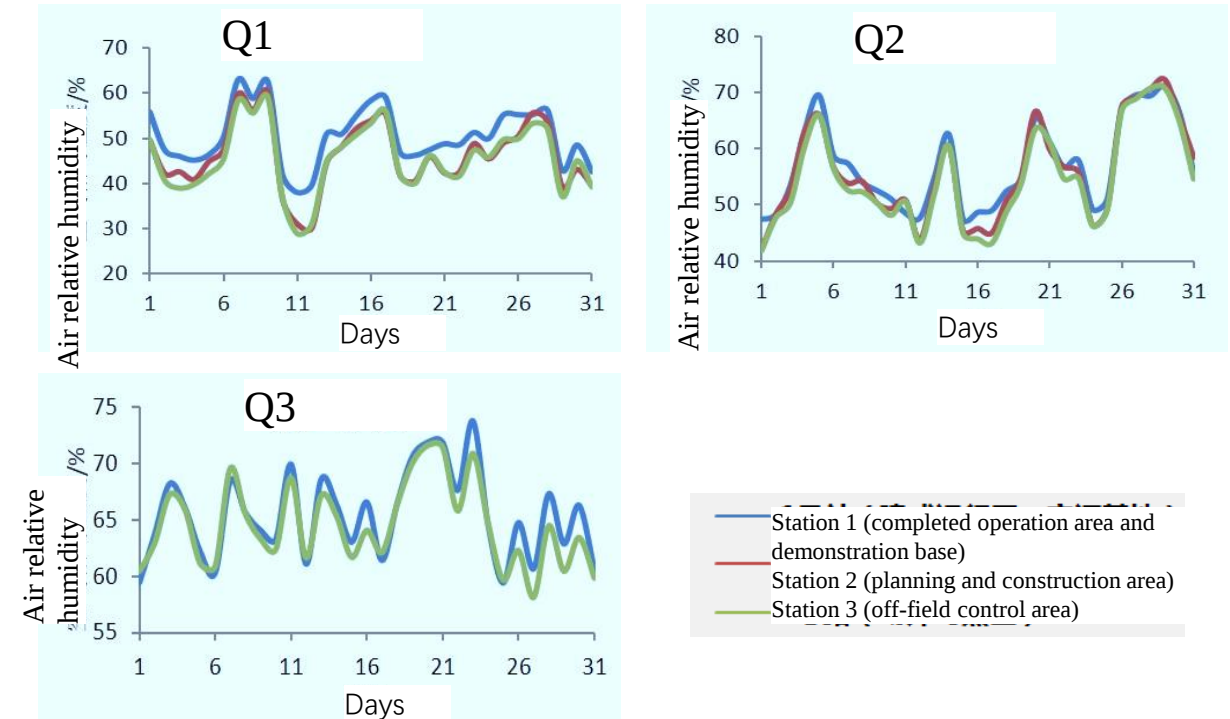
3.1.2 Desertification control result

Temperature comparison



- In the first, second and third quarters of 2019, temperature in PV park was 0.74°C, 0.26°C and 0.23 °C **lower** than that in the off-field control area.
- **Large-scale PV construction has certain attemperation effect.**

Humidity comparison

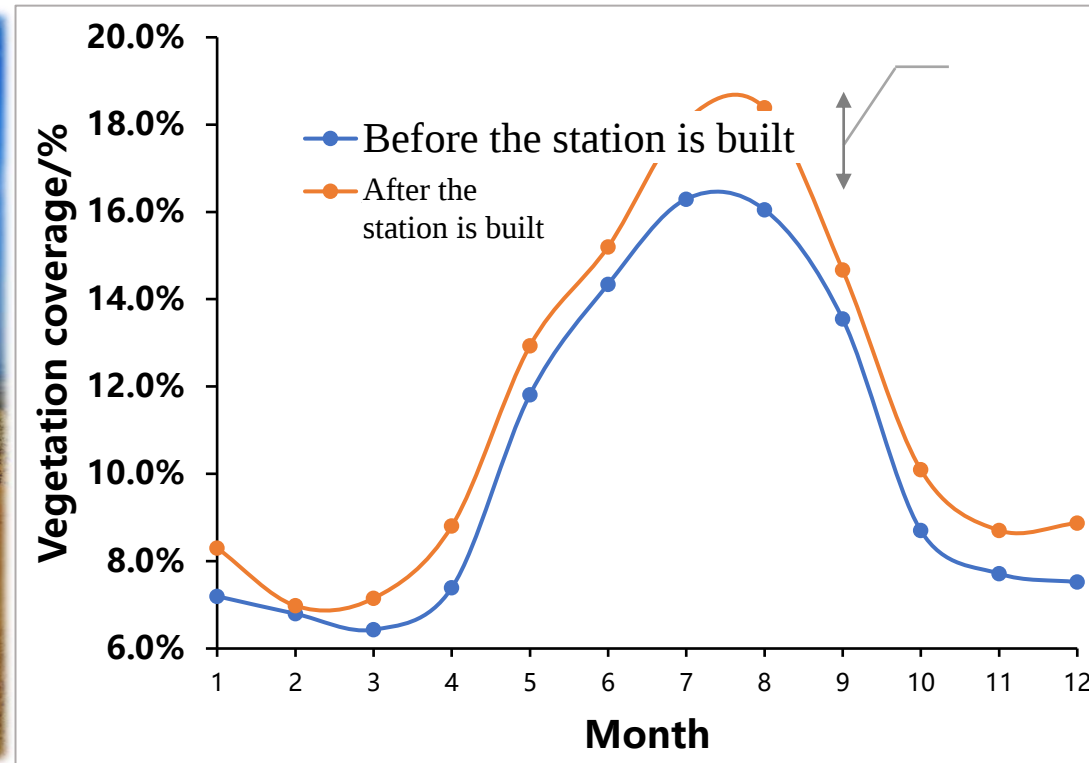


- In the first, second and third quarters of 2019, the air humidity in the PV park was 4.96%, 2.26% and 0.90% **higher** than that in the off-field control area.
- Large-scale PV development can increase local air humidity.



Large-scale PV Power Station + Ecological Restoration Application

3.1.2 Desertification control result



- Before and after establishment of the station, vegetation coverage in the park increased significantly, mainly in July and August, with the growth rate of 15%. With the commissioning of the power station, the vegetation improvement effect was significant.



Large-scale PV Power Station + Ecological Restoration Application

3.2 Ningxia Agro-PV Complementary Project





Large-scale PV Power Station + Ecological Restoration Application

3.2.1 Overview

Background

Ecological resources such as wetlands, lakes and deserts are rich and diverse in the riverside area of Yinchuan, Ningxia.

Ningxia, as the hometown of Lycium barbarum, leads the world in the quality of Lycium barbarum, and the combination of Lycium barbarum planting and PV power generation project has become a beautiful local landscape.

Mode

In the locality, the cooperative business mode of "enterprise + farmer" is adopted and the enterprises are responsible for investing, seedling, planting, purchasing, processing and selling in a unified way. Each poverty-stricken household is contracted to be responsible for daily field management and picking of 6 mu of lycium barbarum planting area at zero cost and they are both industrial workers and business owners.

Overview

The Region has given full play to the advantage of regional resources and the world's largest tracking-type Agro-PV complementary project has been developed in the vast desert area. Planting 100,000-mu Lycium barbarum under PV modules can provide 80,000 jobs for the poor. The desert covered by PV power stations is turning green little by little.



Large-scale PV Power Station + Ecological Restoration Application

3.2.2 Ecological environment change based on Agro-PV complementary project

Ningxia Agriculture and PV Complementary Project:

- Fig. 1 is a primitive desert landform;
- Fig. 2 is the topography during construction;
- Fig. 3 Planting Lycium Barbarum;
- Fig. 4 Environmental change after completion of PV power stations.





PART 04

Application Method of Desertification Control

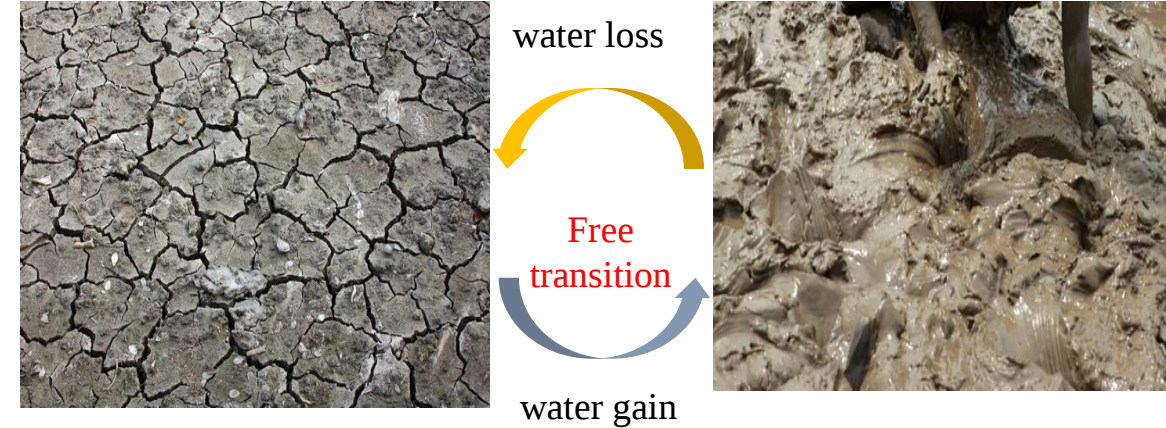


Application Method of Desertification Control

4.1 Traditional Scheme



1. **Engineering sand-stabilization machinery**, straw grid for sand stabilization, sand-blocking fence, sand barrier, etc. do not change the characteristics of sand particles, so their sand stabilization effect is not durable.
2. Sprinkling a layer of chemical cementing material on the surface of sand to be stabilized has great impact on environment and is very expensive, and it is difficult for seedlings to grow.
3. **Biological sand stabilization** covers planting *Salix psammophila* and *Caragana korshinskii* and aerial seeding to stabilize sand, however, it is difficult for them to grow in their infancy.



The ecological mechanical properties of soil are self-repairing and self-regulating.

- The failure and fracture of self-repairing soil in solid state can be recovered in rheological state.
- No matter how the arrangement of self-regulated soil particles changes, there is **always adhesion between them**.

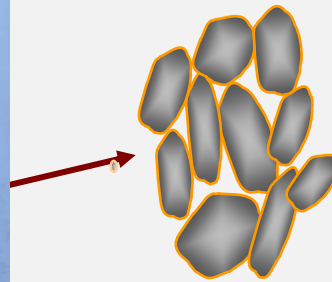


Application Method of Desertification Control

4.2 Desert "Soilization" Method



After Soilization: rheological state



After Soilization: microstructure of sand



Soilization: self-repair and self-regulation



After Soilization: moisture and fertilizer conservation



- The **technical principle** imposes a binding force on sand particles - ODI, enabling them to have functions of "self-repair and self-regulation" similar to soil, and at the same time have strong functions of storing water, nutrient and air, and become a good carrier for plant growth.
- **Implementation:** Binding Material + Water
- **Binding mechanism:** ODI binding and adhesion binding



Application Method of Desertification Control

4.3 Overview of Application Cases

The large-scale planting experiment of 4000 mu in Ulan Buh Desert, Alashan League, Inner Mongolia succeeded only with 6 months.



Before transformation: January 2017



During transformation: April 2017



During transformation: May 2017



After transformation: July 2017



After transformation: August 2017



After transformation: September 2017



Application Method of Desertification Control

4.3 Overview of Application Cases



**Xinjiang Hotan Taklimakan
Desert (Planting)**



**Sichuan Zoige Desertification
Grassland (Ecological Restoration)**



**Sandy Land in Tibet (Ecological
Restoration)**



**Abu Dhabi Desert, UAE
(Planting)**



**Sahara Desert, Niger, Africa
(Planting)**



Large-scale PV Power Station + Ecological Restoration Application

4.4 Desertification Control in U.A.E.





4.4.1 Overview of Desertification Control

Research Background



The United Arab Emirates covers an area of 83,600 square kilometers and its capital Abu Dhabi covers an area of about 67,300 square kilometers. Approx. 85% land in Abu Dhabi's inland area is classified as "desertified" by the Government.

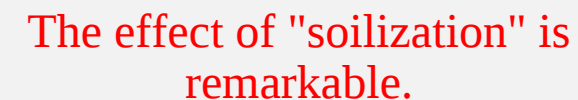
Overview of this Research



Professor Yi Zhijian's research team from Chongqing Jiaotong University studied and formed the original outcome of "desert soilization" from the perspective of mechanics, which has fully verified the feasibility of the project. According to the agreement reached between the Parties concerned, researchers from Chongqing Jiaotong University will try to plant various grasses, vegetables and shrubs within the extent of about 10 square kilometers in Abu Dhabi.



The effect of sand stabilization is remarkable: plant roots are spread all over the "soil strata" and deep in sand strata.



-
- OTU分析
- Y-axis: 0, 500, 1000, 1500, 2000, 2500, 3000
- X-axis: 8月12日, 9月8日, 9月24日, 10月14日, 11月6日, 12月5日, 1月, 3月, 5月, 6月, 7月













4.4.3 Ecological restoration impact based on large-scale PV power stations



With the completion of PV power stations, the wind speed and evaporation in the region covered by original landform decreased, and the green ring gradually improved, thus ecological protection by large-scale PV power stations have been greatly improved.



PART 05

Prospect of PV Power Station + Ecological Restoration in Africa Countries



Application Prospect of PV Power Station + Ecological Restoration in Africa Countries

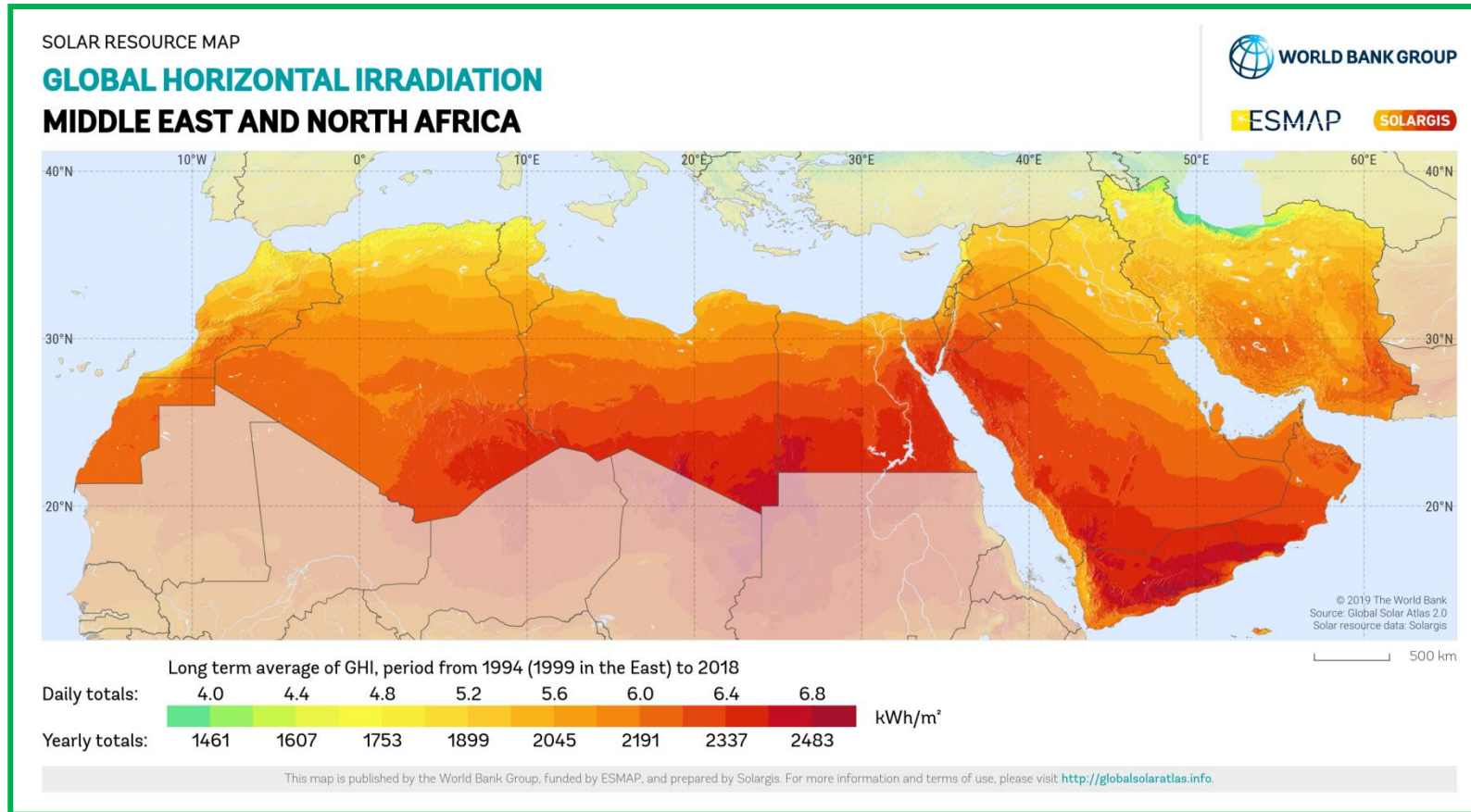
5.1 Background

- June 17th is the "World Day to Combat Desertification and Drought", and the theme of China in 2020 is "join hands to control sand and desert and protect green hills and clear waters".
- The biggest desert “Sahara Desert” in Africa, surrounding areas are a drifting desert. Under the action of directional wind, the drifting desert will continue to migrate along the wind direction. Whenever there is an opportunity, the yellow sand driven by wind will devour artificial roads and buildings.
- The global desertification area has reached 36 million square kilometers, representing 1/4 of the earth's land area. Desertification, as a major environmental problem facing the world, seriously threatens ecological security and sustainable development. Facing this worldwide stubborn disease - "Earth Cancer", how can the world effectively control desertification? How to effectively carry out global ecological restoration?
- **How can PV power stations + ecological restoration be effectively applied in Africa countries?**



Application Prospect of PV Power Station + Ecological Restoration in Africa Countries

5.2 Application Significance of PV Power Station + Ecological Restoration in Africa Countries



- The North Africa region and Middle East region is rich in solar resources and suitable for construction of PV power stations and development of sustainable energy;
- Desertification is serious in the region, however, an oases can be built through PV power stations + ecological restoration;
- PV power stations can effectively block drifting of desert;
- Through Agro-PV complementation, suitable green produces can be planted in desertified wasteland.



5.3 Feasibility Study on the Application of PV Power Station + Ecological Restoration in Africa

1. PV construction

Conditions permit development of large-scale PV power stations in the Africa countries.

- They may have made great efforts to develop PV power stations;
- Large-scale PV power stations drive construction of ecological civilization;
- Conditions permit PV development in Africa countries.

2. Development of agriculture and animal husbandry

Benefits of Application of Large-scale Agro-PV Complementary Power Station in Africa Countries

- Africa Countries can produce and sell green fruits and vegetables ;
- Self-supply and self-sufficiency of farming and animal husbandry;
- Economic benefits brought by agricultural produces reduce the cost of PV power stations.

3. Ecological restoration

To protect and improve our living environment, we must protect and improve our ecological environment

- A good ecological environment is the most inclusive welfare for people's livelihood;
- Protecting ecological environment means protecting productivity;
- Ecological environment management is a systematic project;
- Protecting ecological environment is priceless.



Application Prospect of PV Power Station + Ecological Restoration in Africa Countries

5.4 Application Prospect

PV power station + sand control + agricultural planting

- Sustainable Energy: Developing Green Sustainable Energy in Africa Countries
- Fruits and vegetables: A brand of fruit and vegetable products featuring "desert planting" has been created to supply Arab League countries.
- Pasture: Long-term supply of pasture for "desert sheep" breeding base.





Thank you for your guidance and support!