

INTERNATIONAL RESEARCH CENTER OF BIG DATA
FOR SUSTAINABLE DEVELOPMENT GOALS
可持续发展大数据国际研究中心

Big Earth Data in Support of Sustainable Development Goal 7

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Outline

1. Introduction of CBAS
2. SDG7.1.1 tracking by remote sensing
3. Influence of China’s Overseas power stations

1. Introduction of CBAS

Under the support of CASEarth Program, an interdisciplinary and cross-sector research team

150 Staff

> 100 Graduate Student

33 CAS Institute

96 Participating Organization

>1200 Scientist



Resources| SDG Satellite Launched on 5 November 2021

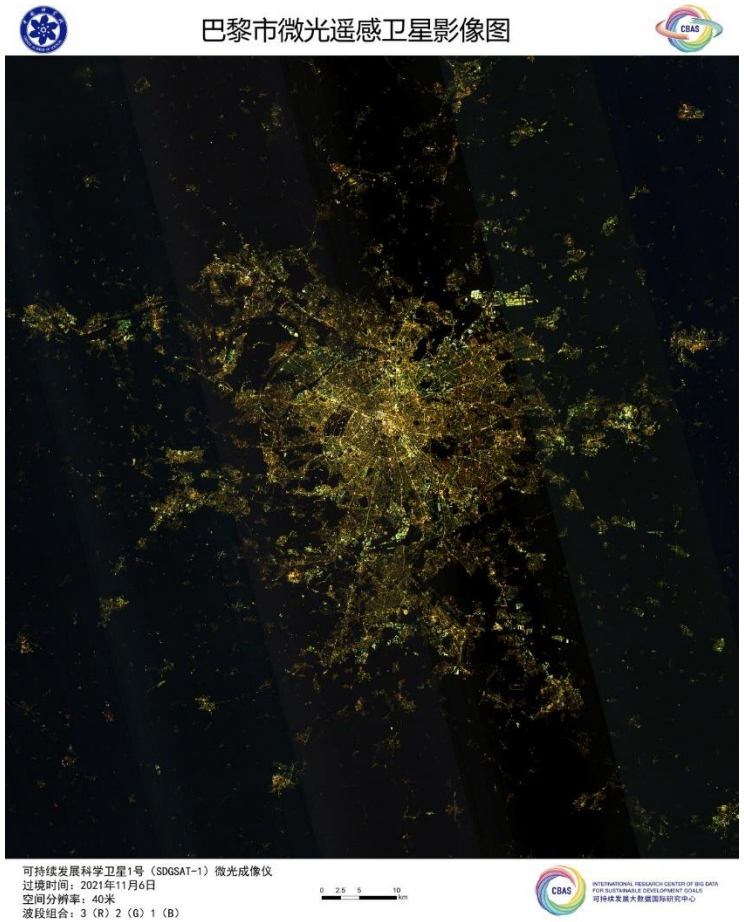


- Thermal infrared + glimmer + multi-spectral
- Wide scale (300 km)
- High-resolution (10 m)

Explore new methods to sense Earth's environment

Data will be accessible at the end of 2022

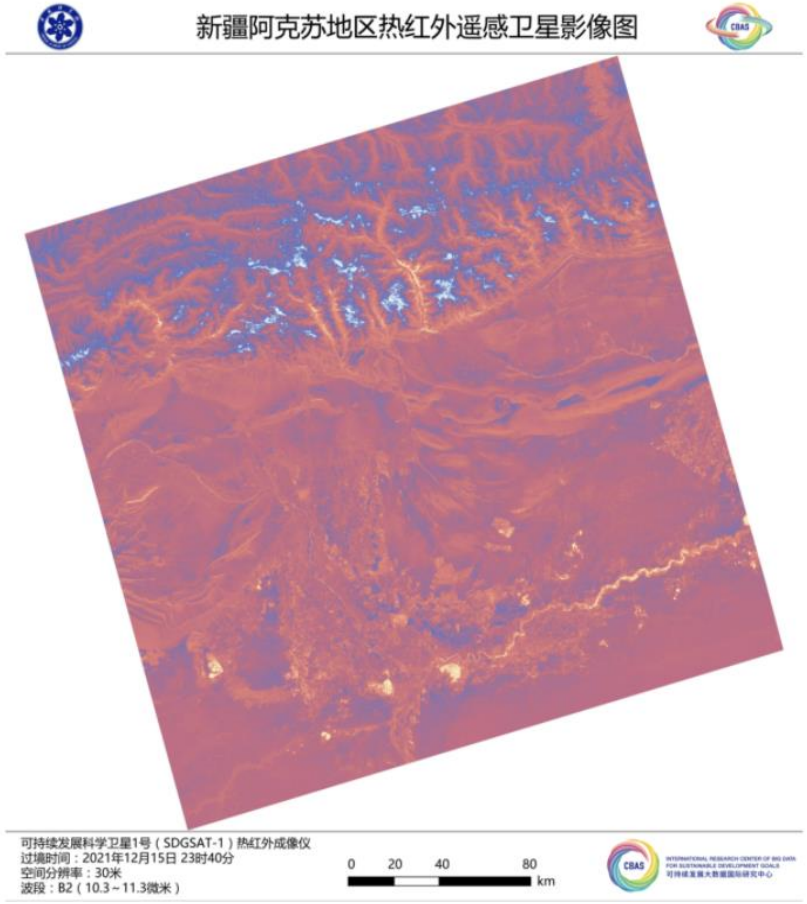
Resources| First set of images Released on 20 December 2021



Glimmer image of Paris /40m



Multispectral image of entry of Yellow River /10m



Thermal infrared image of Aqsu in Xinjiang Uygur Autonomous Region /30m

Achievements | Scientific Reports

Big Earth Data in Support of SDGs

Chinese Government released a series of Reports drafted by CBAS since 2019

Focusing on six SDGs, including Zero Hunger (SDG 2), Clean Water and Sanitation (SDG 6), Sustainable Cities and Communities (SDG 11), Climate Action (SDG 13), Life below Water (SDG 14), and Life on Land (SDG 15), the Report showcased the results of research, monitoring and evaluation of relevant SDGs and their indicators at local, national, regional and global scales.



2019 Report



2020 Report



2021 Report

Introduction of SDG7 team

New work group in 2022 for SDG7:

Lead: Dr. Mingquan Wu, CBAS, wumq@aircas.ac.cn

Members: Five organizations, Seven research teams, 20+ researchers

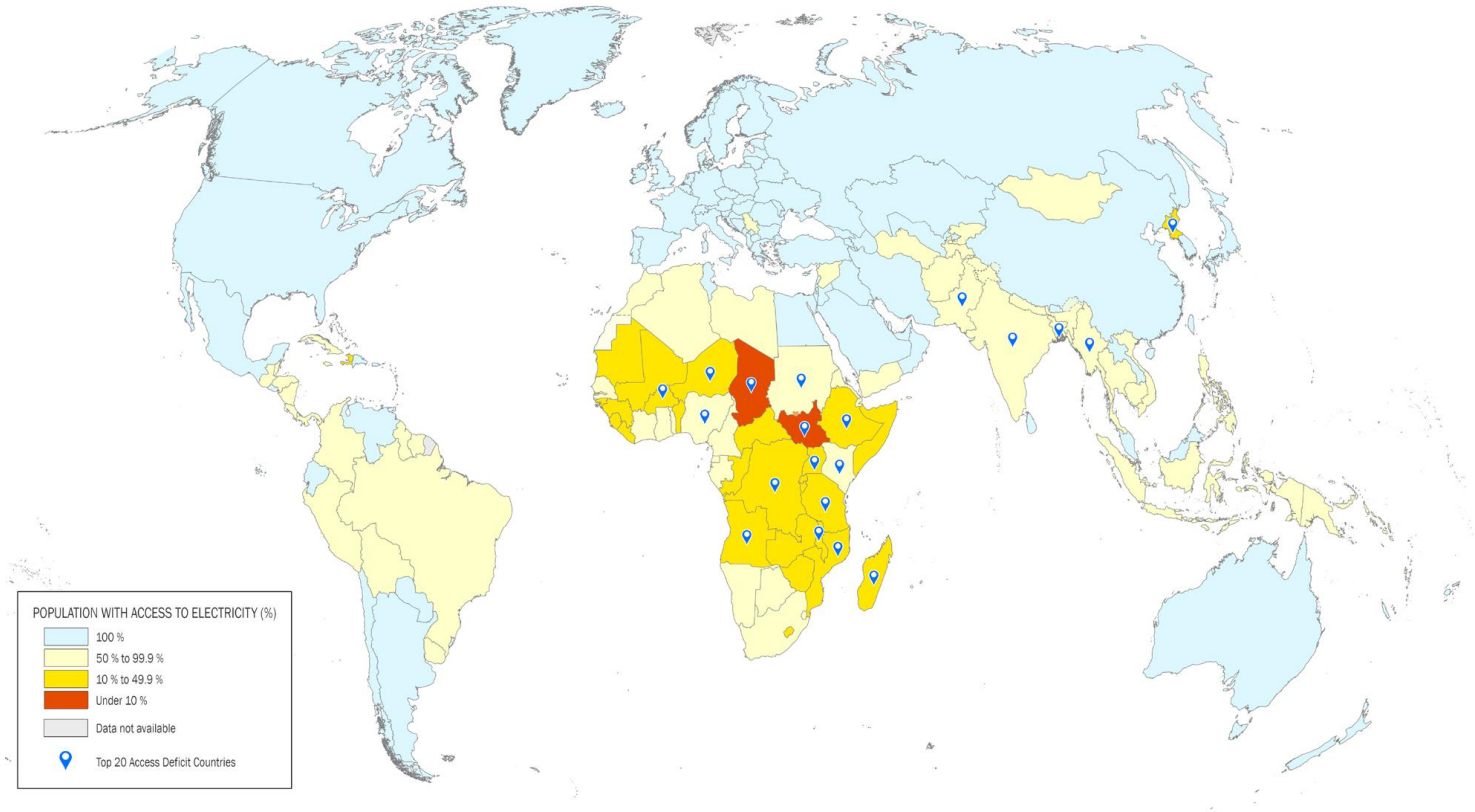
Objects: 1) Study the big data monitoring method for the tracking of SDG7 indicators (covering all sdg7 indicators); 2) drafte SDG7 cases reports.

No.	SDGs	Case name	Contributors	Affiliations
1	7.1.1	Global Identification of Unelectrified Built-Up Areas by Remote Sensing	Mingquan Wu	CBAS, CAS
2	7.a/7.b	Influence of China's Overseas power stations on the electricity status of their host countries		
3	7.1.2	Proportion of population in Southwest China relying on clean cooking fuel and technology	Jianping Pan	Chongqing jiaotong university
4	7.2	Development status and trend of renewable energy in China	Alun Gu	Tsinghua University
5	7.2	Benefit evaluation of photovoltaic poverty alleviation projects in China	Boqiang Lin	Xiamen University
6	7.2	AI extraction of centralized photovoltaic power plants in China	Hailong Zhang	CBAS, CAS
7	7.3	Remote Sensing Extraction of industrial heat sources in China	Caihong Ma	CBAS, CAS
8	7.a/7.b	China's transfer and promotion of solar energy technology to developing countries	Yagang Wang	Gansu Natural Energy Research Institute

2. SDG7.1.1 tracking by remote sensing

Tracking SDG7: The Energy Progress Report 2021 provides global *access to electricity* at the country level from 1990 to 2019.

In 2019, 759 million people still lacks access to modern electricity.



Source: World Bank 2021.

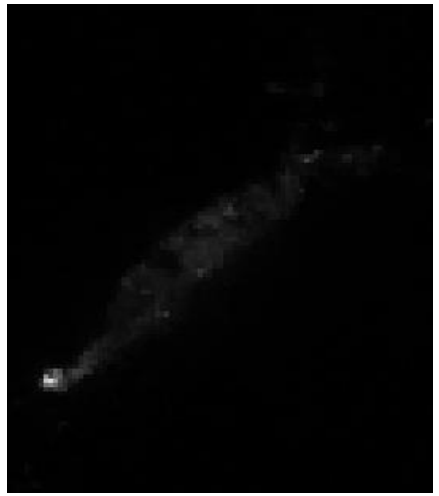
Weakness:

- Not updated in time
- Country level data, no enough for investment decision
- Data shortage in some countries
- Data quality varies from country to country

2. SDG7.1.1 tracking by remote sensing

Theoretical basis for global *access to electricity* esitmation using remote sensing：

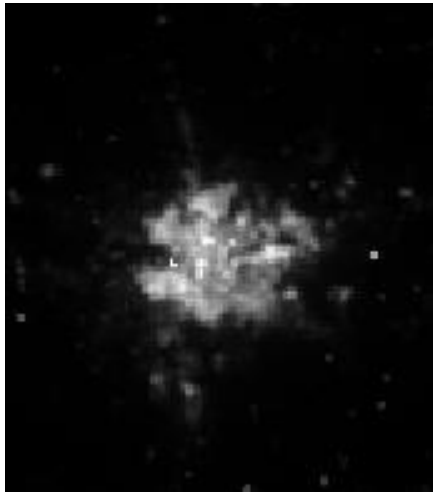
1) Electrified villages tend to be brighter than unelectrified villages (Min et al. 2013)



Conakry, Guinea



Beijing, China



Lusaka, Zambia

2) The global night light remote sensing image has been obtained since 1970s by DMSP-OLS, NPP-VIIRS. The SDGSAT-1 provides color night light image in 10m.

3) Remote sensing is wildely used to eatract Built-up Areas, e.g. GHS-BUILT, Globeland30.

2. SDG7.1.1 tracking by remote sensing

Data:

GHS-BUILT data, 2014/2020, 30m

NPP-VIIRS night light data, 2014/2020, 500m

Method:

1) Sample pool construction. 30,317 sample points. Unelectrified samples were selected from non-built-up areas. Electrified samples were elected from countries with 100% electricity access.
2) Identification of unelectrified or electrified Built-up Areas using threshold selected from histogram of nightlight data of 20,000 samples.
3) Accuracy verification using other samples.



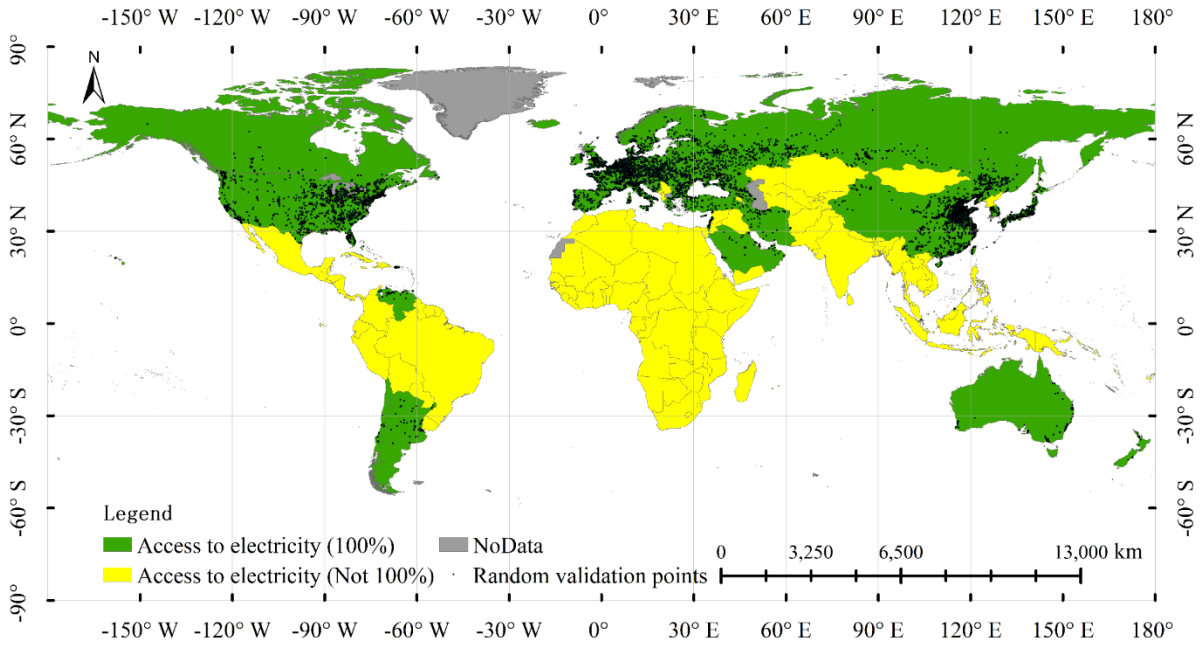
2. SDG7.1.1 tracking by remote sensing

Results:

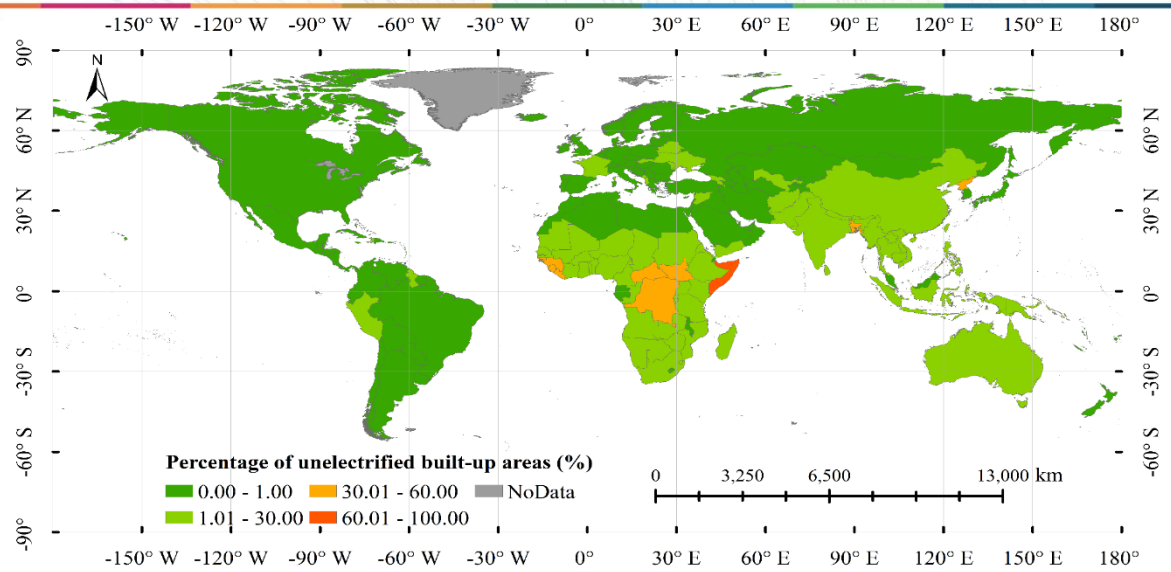
1) Globle **Pixel** unelectrified areas were extracted.

2) The final identification accuracy of unelectrified areas in 2014 and 2020 were 97.29% and 98.9%, respectively.

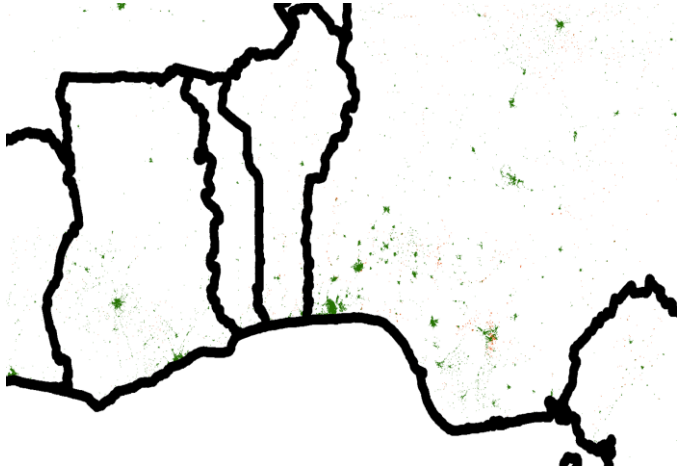
3) Same with WB data, the largest percentages of the unelectrified built-up area were mainly in Sub-Saharan Africa.



Distribution of 10,106 validation sample points.



Distribution of the percentage of unelectrified built-up areas by country, 2014



Access to electricity in West Africa:
Green-Electrified bluit, Yellow-Unelectrified bluit

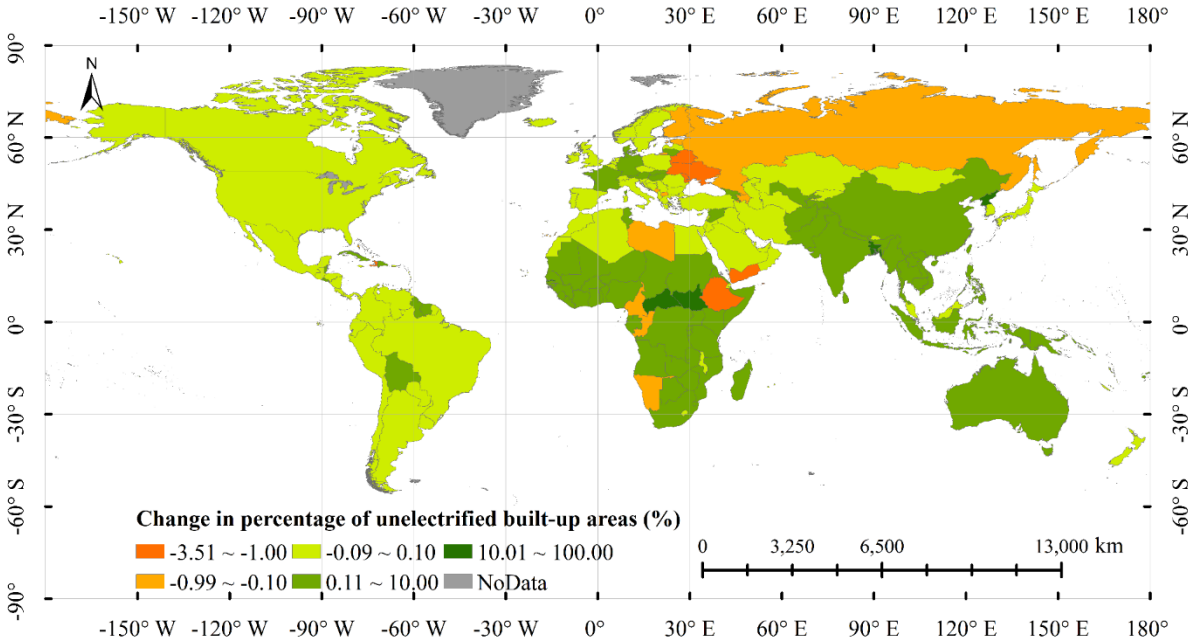
2. SDG7.1.1 tracking by remote sensing

Results:

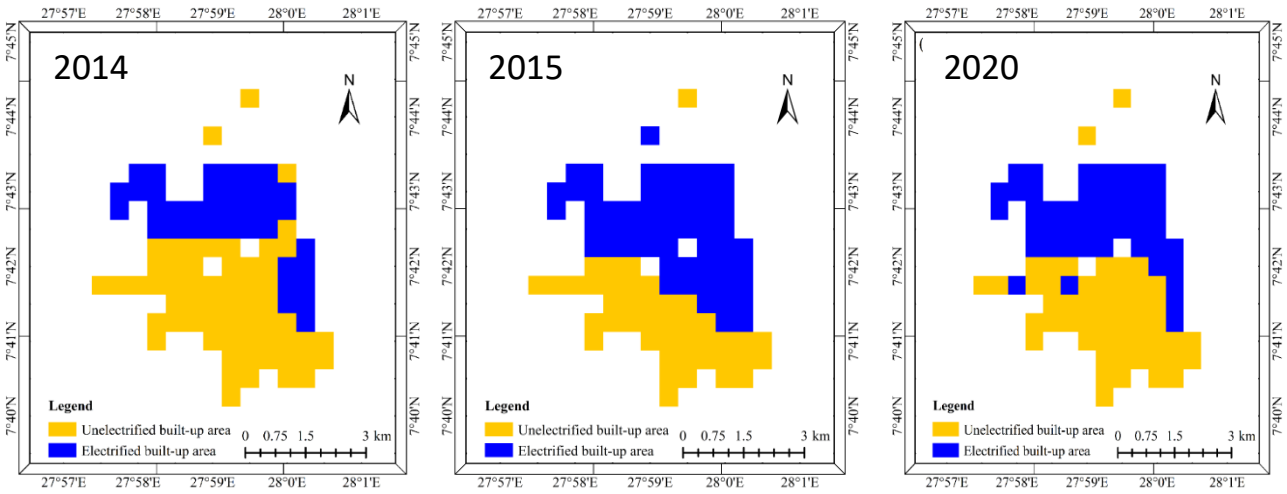
Global electrification rates improved from 2014 to 2020. The global unelectrified built-up area decreased from 51,301.14 km2 to 22,192.52 km2 (from 3.05% to 1.32% of the total built-up area).

117 countries or territories exhibited decreases in the share of the unelectrified areas be-tween 2014 and 2020.

32 countries or territories had increases in an unelectrified built-up area. **18** of these such as **Ethiopia, Yemen, Ukraine, Belarus** had increases > 0.1% **because of** the unrest such as war.



Changes in the percentage of the unelectrified built-up area between 2014 and 2020.



Unelectrified built-up areas in Wau, South Sudan, was increased in 2015 due to war.

2. SDG7.1.1 tracking by remote sensing

Discuss: limitation

1) **Human occupancy** within built-up areas is variable. If a building is electrified but unoc-cupied, the area may be misclassified as unelectrified. In China, from 2010 to 2020, **400 million** people migrated from rural China to cities. At the same time, a large number of people migrated from the countryside to the towns. This has resulted in a large number of uninhabited buildings in rural areas which was called “hollow villages”. Although China has achieved full electricity, we still monitor 10.54% of buildings in rural areas that are not lit.

2) The NPP-VIIRS night-light data has a **resolution** of 500 m. To ensure accuracy, only areas with built-up areas accounting for ≥ 25% of the 500 m night-light raster were selected. This **neglects smaller built-up areas**, which may bias the results. High resliution night-light data like SDGSAT-1 should be used in future.

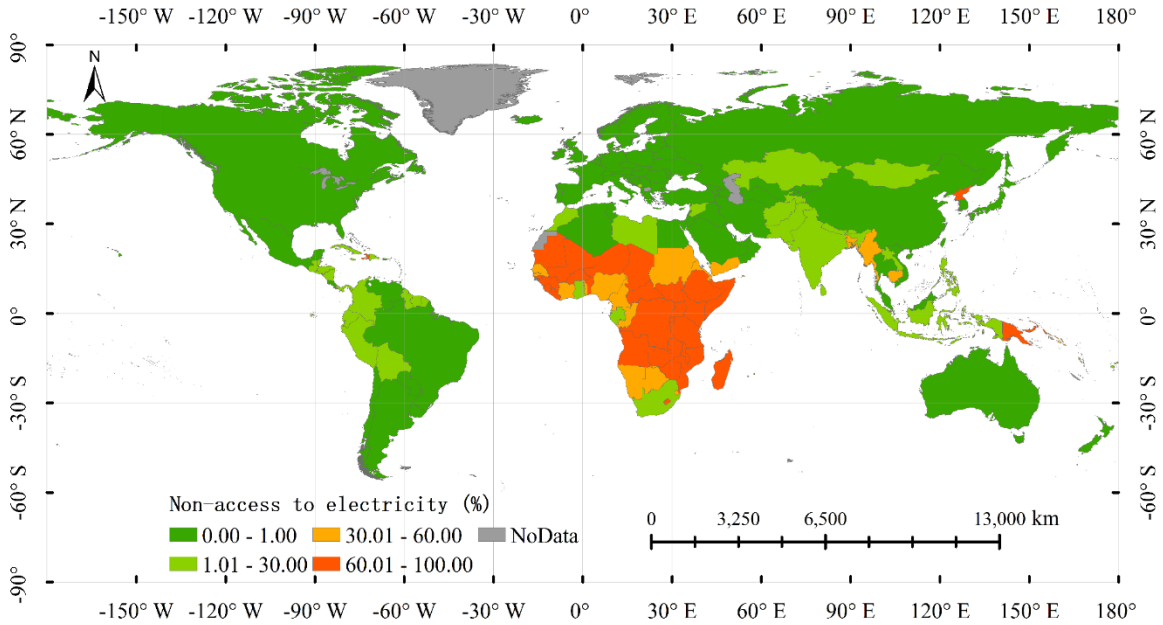
3) The balanced **accuracy of the EC's built-up area data** is 83%. Errors in the portrayal of built-up areas will directly affect the identification of electrification, and some built-up areas may not contain any human structures.

3. Influence of China's Overseas power stations

1) **Developing countries**, especially those in the Belt and Road Initiative area, face the problem of relatively undeveloped power facilities and problem of energy shortage.

2) Since the Belt and Road Initiative was put forward, China has **invested in and provided construction services** for many power station projects (known as China's overseas power stations, COPSs) in participating countries.

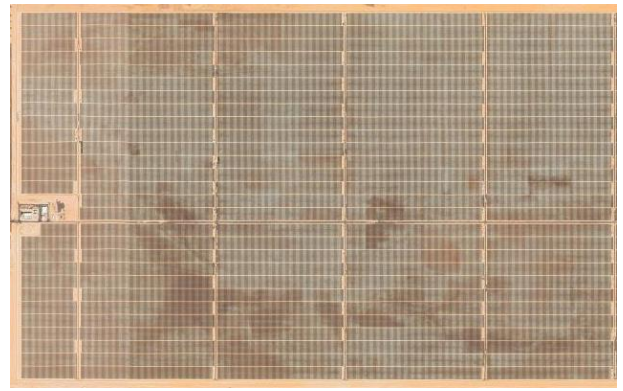
3) Recent statistics on global power development and the effects of electricity projects on electricity supplies are **not new enough** to reflect the impact of COPSs.



Spatial distribution of non-access to electricity by country, 2014



Sanghe II hydropower station in Cambodia



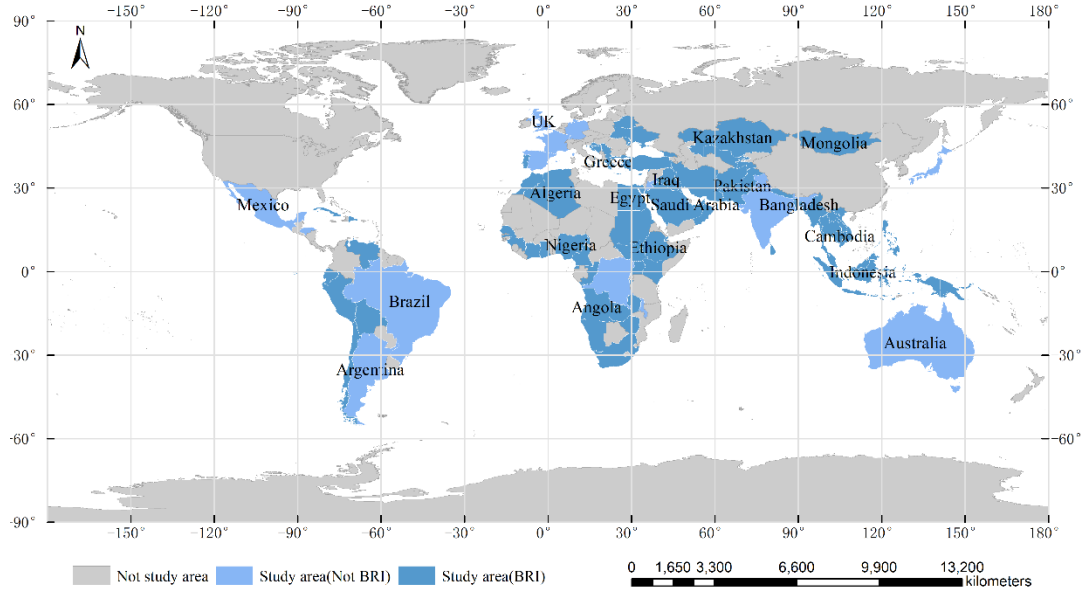
Dubai 700MW photovoltaic power station

3. Influence of China's Overseas power stations

1) COPSs: **437** power stations built with the strong participation of Chinese companies.

2) Hydropower: construction (70.9%), investment and construction (20%), investment (7.3%) and acquisition (1.8%)

3) Jiang data: engineering procurement construction (**EPC, 61.5%**), construction (20.5%), equipment supply (6.4%), investment and construction (4.3%), investment (2.1%), and other (5.2%)



80 countries with involved in Chinese power projects

Data sources used to study the 80 COPS host countries

Dataset	Date range	Source	Usage
National population changes	1971-2018	World Bank	Estimation of the electricity status of the 80 host countries
Global per-capita electricity consumption	1971-2014	World Bank	Estimation of the electricity status of host countries
Global proportions of electricity generated from thermal, nuclear, hydropower and other renewables	1971-2014	World Bank	Estimation of the impact of COPSs on renewable energy generation in host countries
Transmission and distribution losses worldwide	1971-2014	World Bank	Estimation of the electricity status of host countries
Global Power Plant Database	Updated to February 2018	World Resources Institute	Estimation of the electricity status of host countries
Per-capita electricity consumption in all countries	2015-2017	International Energy Agency	Estimation of the electricity status of host countries
Hydropower projects outside China from 2002 to 2019	2002-2019	Chinese Scientific Data	Estimation of the impact of COPSs on the electricity status of host countries
2000-2019 China foreign power projects	2000-2019	Chinese Scientific Data	Estimation of the impact of COPSs on the electricity status of host countries

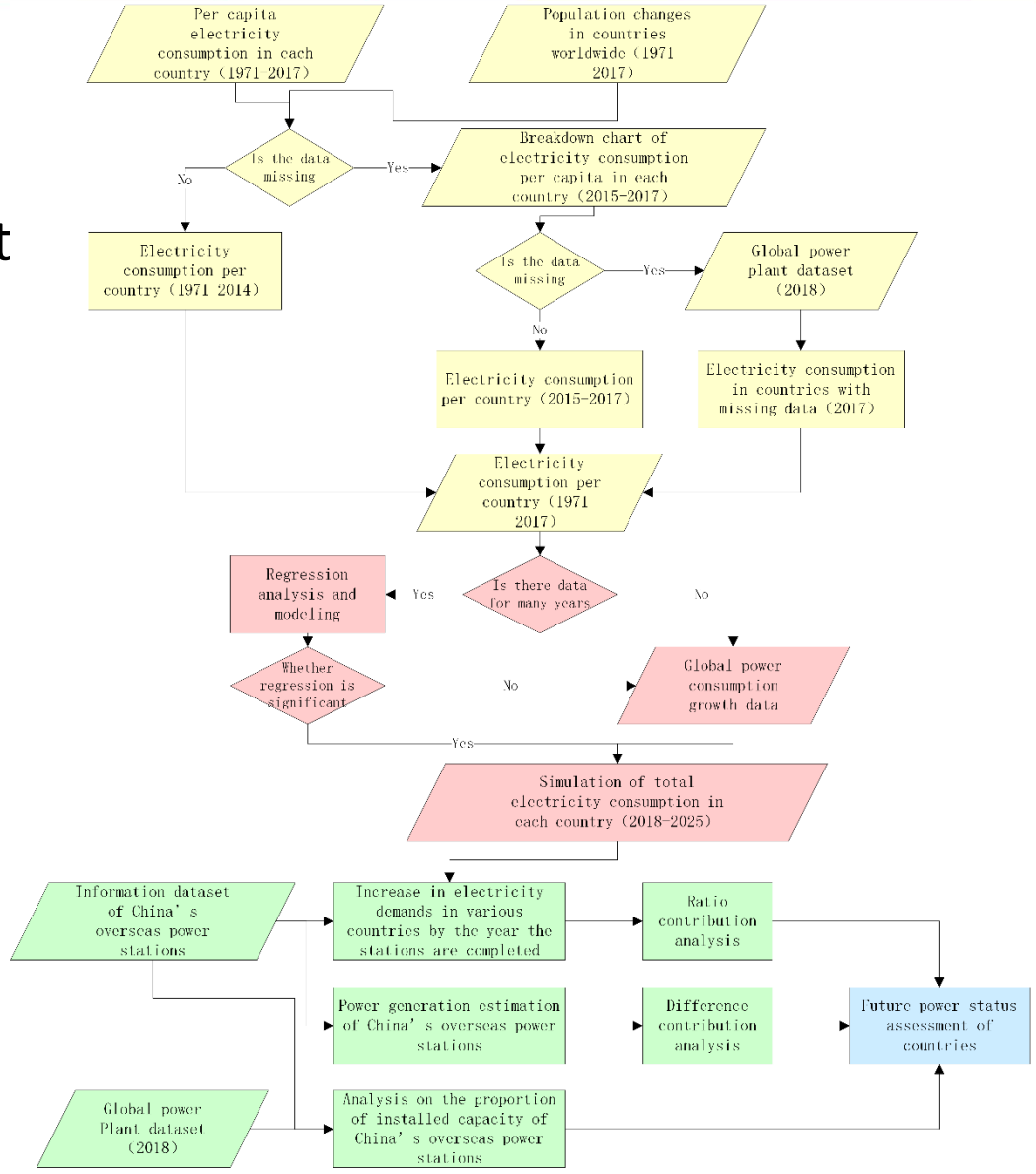
3. Influence of China's Overseas power stations

Method:

1) Data from the World Bank, WRI, and IEA were used to calculate the electricity consumption of the 80 host countries from 1971 to 2017.

2) Regression analysis was used to build a regression model to simulate their electricity consumption from 2018 to 2025.

3) data on COPSs were used to calculate each host country's (1) proportion of the total installed capacity provided by COPSs in 2018 and (2) proportion of annual increase in electricity consumption that was provided by COPSs.

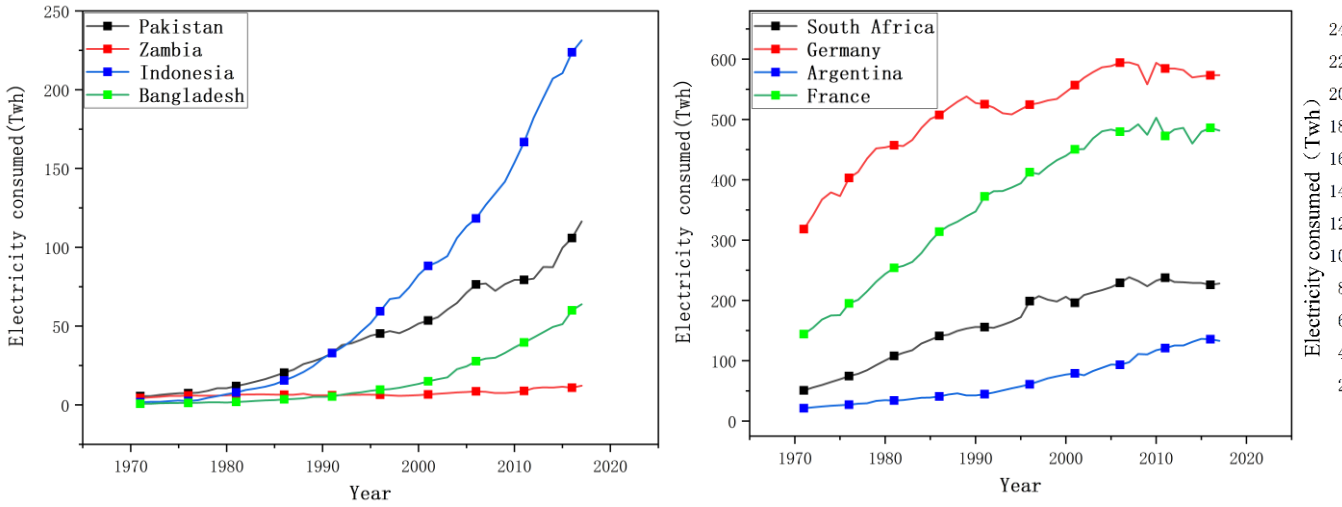


3. Influence of China's Overseas power stations

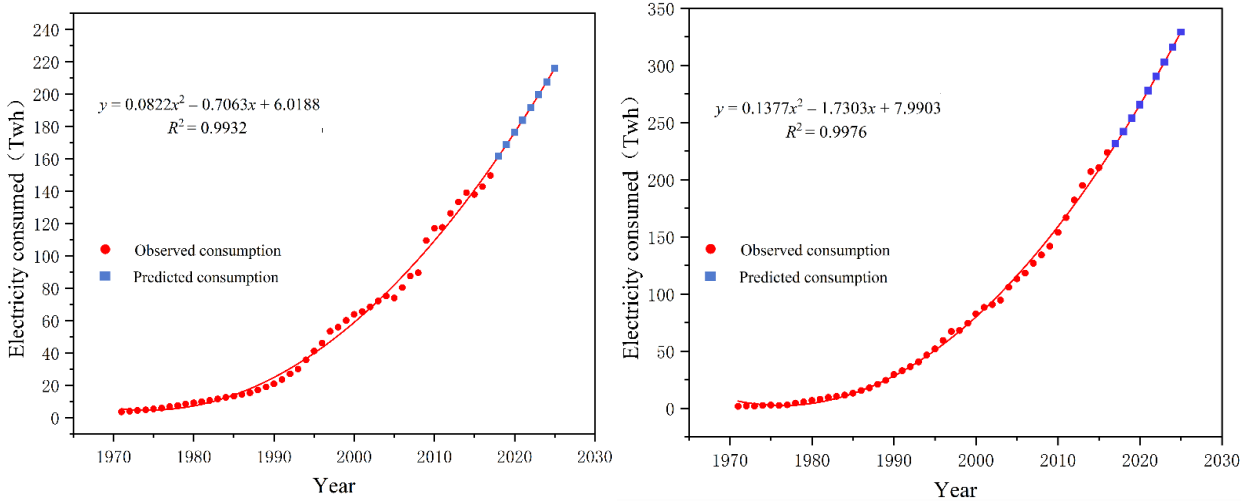
Results:

1) Electricity consumption survey of the 80 host countries, 1971–2017: Electricity consumption has **increased** over time in most countries. Electricity consumption has fallen slightly in recent years or remained stable in 10 countries (five **developed countries** and five developing countries that have experienced **developmental issues**).

2) Electricity consumption forecasts for COPS host countries, 2018–2025: regression analysis provided good simulations of changes in electricity consumption. Apart from Bangladesh (R^2 = 0.8677) and Belarus (R^2 = 0.8665), the **R^2 values** of the other countries' models were all > **0.9405**.



Electricity consumption in 8 countries, 1971–2017



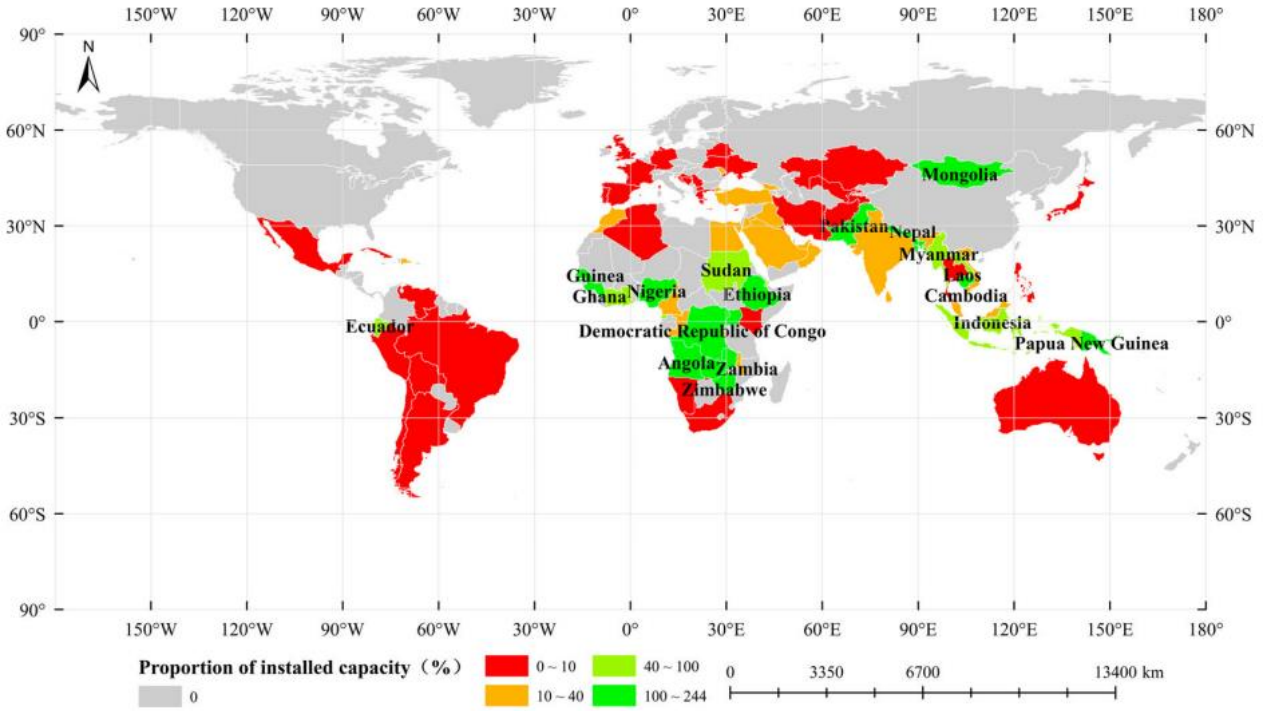
Historical and predicted electricity consumption in (a) Malaysia and (b) Indonesia, with fitted polynomial models

3. Influence of China's Overseas power stations

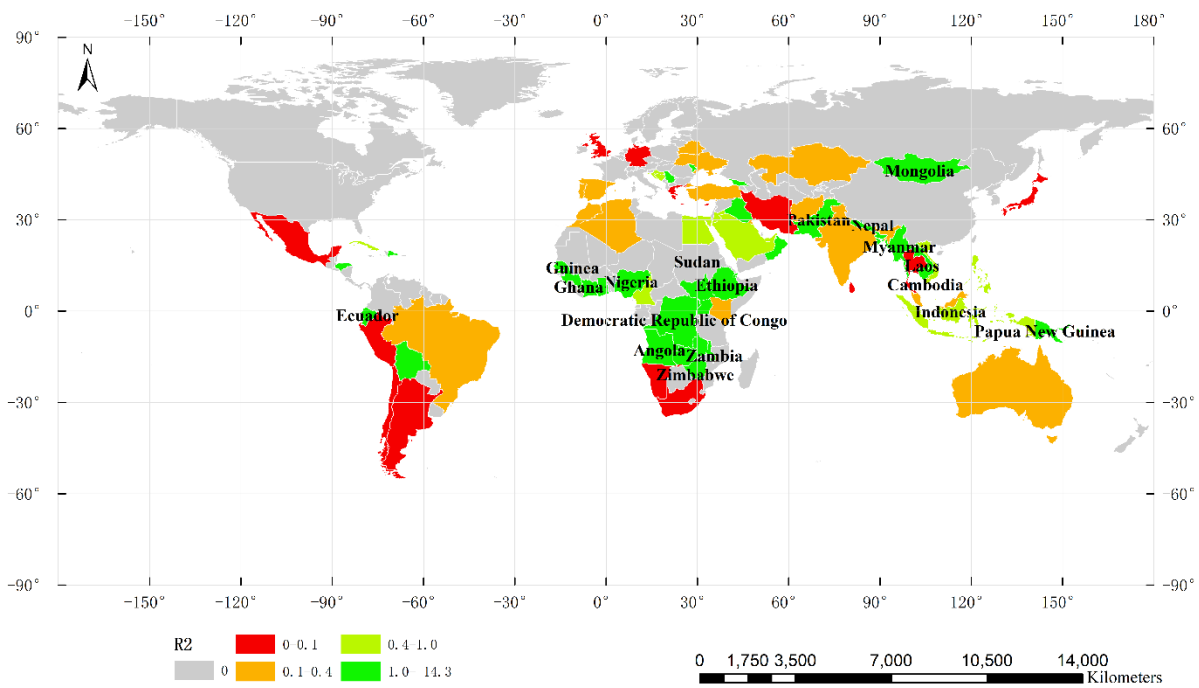
Results:

3) Impact of COPSs on the electricity supplies of host countries:

Ratio of COPSs installed capacity to total installed capacity of host countries of **15** countries were > 100% and those of the **20** other countries were > 20%. The generating capacity of COPSs will meet the growing demands of **32** of the host countries.



Proportion of installed capacity provided by COPSs in host countries

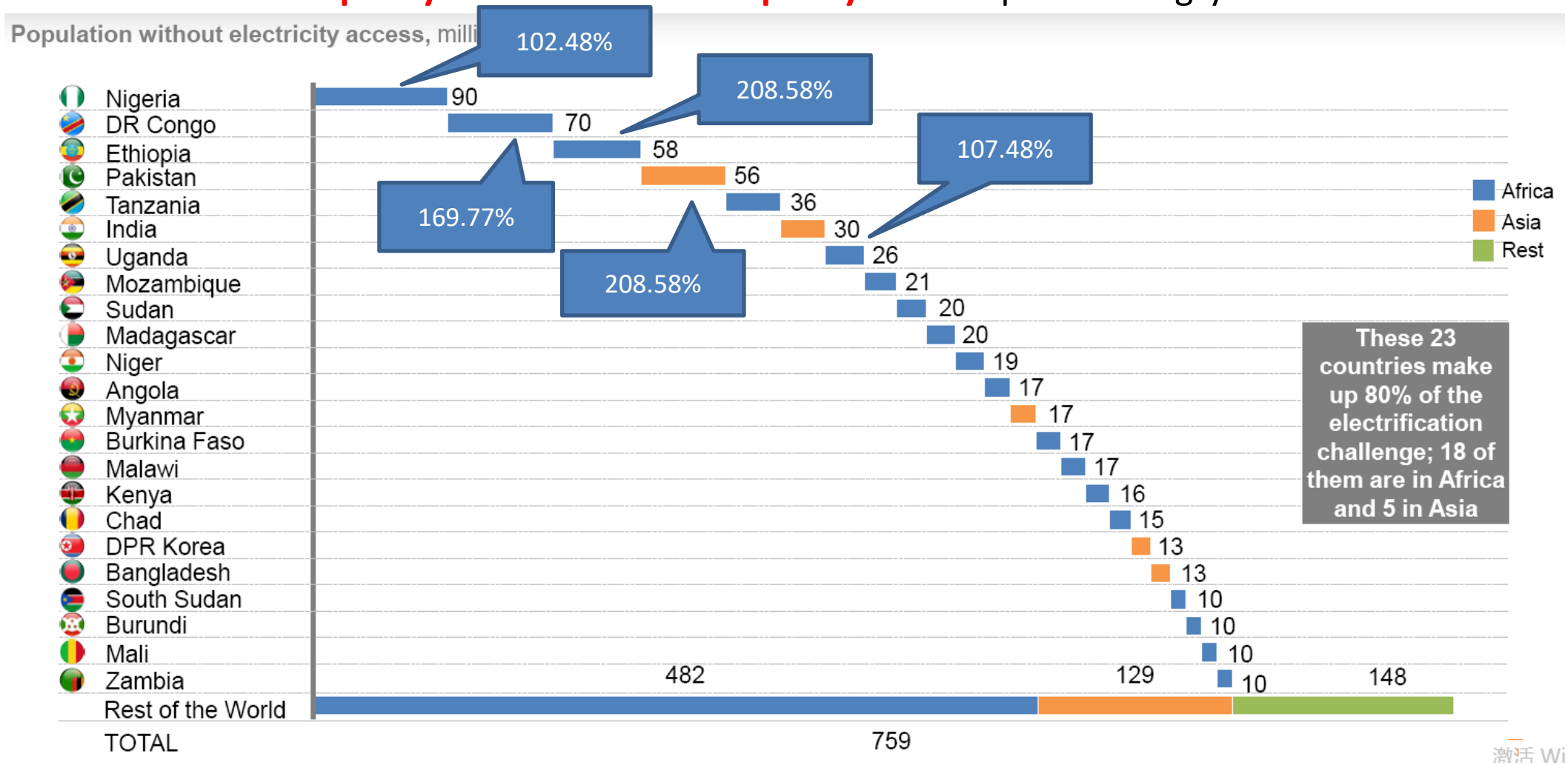


Ratio of the power generated by COPSs to each country's annual increase in electricity consumption

3. Influence of China's Overseas power stations

Results:

Ratio of COPSs installed capacity to total installed capacity of most power hungry countries countries > 100%

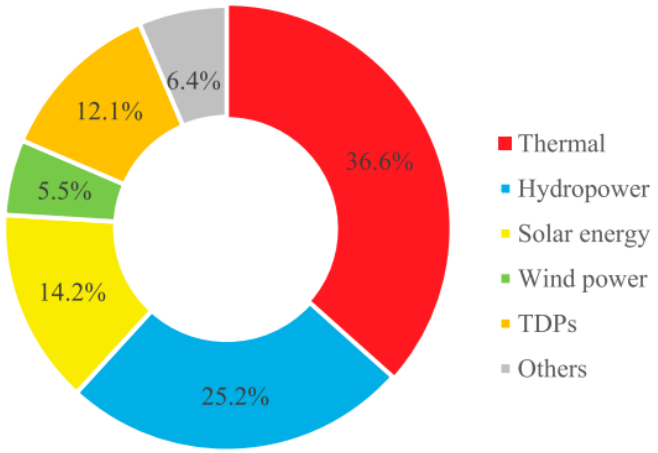


3. Influence of China's Overseas power stations

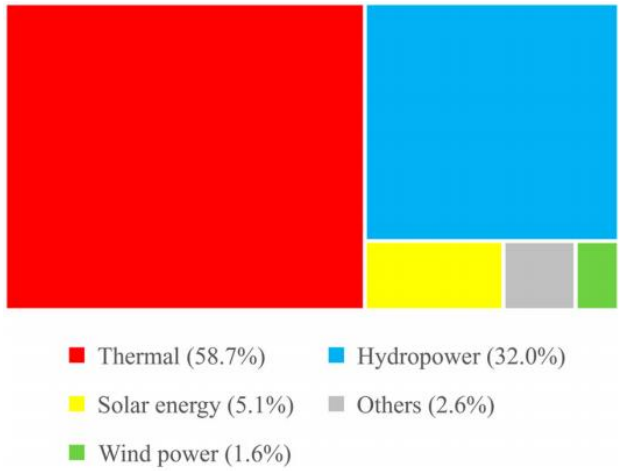
COPSs are becoming greener and greener. The number of renewable energy plants (including hydropower) account for **51.3%** of the total. The installed capacity of all renewable energy power stations (including hydropower) accounted for **41.3%** of the total, which is far greater than the 2018 global proportion of **33%**.

After 2016, the number and proportion of renewable power stations increased significantly. This is because the Chinese government put forward the policy *Guiding Opinions on Promoting the Construction of Green Belt and Road Initiative* in 2017.

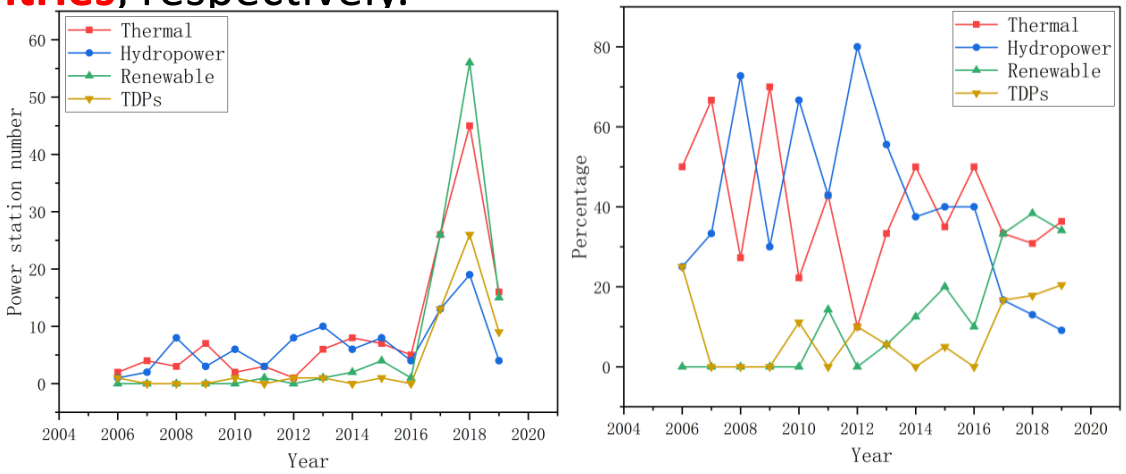
COPSs will increase the proportion of renewable energy generation, with average increases of **2.89% (exclude hydropower) and 3.7% (include hydropower) in 36 and 44 countries**, respectively.



Proportions of COPSs by energy type



Proportions of COPS types in terms of installed capacity



Trends in start-ups of various types of power projects from 2006–2019 in terms of (a) numbers and (b) proportions

Recent publications

1.Xumiao Gao, **Mingquan Wu***, Chao Li, Zheng Niu, Fang Chen & Wenjiang Huang (2022) Influence of China’ s Overseas power stations on the electricity status of their host countries, International Journal of Digital Earth, 15:1, 416-436.

2.Xumiao Gao, **Mingquan Wu***, Chao Li, Zheng Niu, Fang Chen & Wenjiang Huang (2022) Global Identification of Unelectrified Built-Up Areas by Remote Sensing. Remote Sens. 2022, 14, 1941. https://doi.org/10.3390/rs14081941.

3. Xumiao Gao, **Mingquan Wu***, Chao Li, Zheng Niu, Fang Chen & Wenjiang Huang (2022) Modelling Electricity Consumption in Cambodia Based on Remote Sensing Night-Light Images. Appl. Sci. 2022, 12, 3971. https://doi.org/10.3390/app12083971.



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Thanks

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