Announcement of Low Carbon Development Cooperation in Southeast Asia Through the Belt Road Initiative (BRI) and China's South-South Climate Cooperation (CSSC)

Global Climate Action Summit
San Francisco, CA
September 12-14,2018

Introduction of renewable energy cooperation in China and Guangzhou Huangpu pilot project

CCS GIEC GEI

OUTLINE

- Brief Introduction of GIEC
- CCS-GIEC-GEI Cooperation
- Pilot Project - Huangpu Economic Development Zone
- Next Steps

Brief Introduction of GIEC

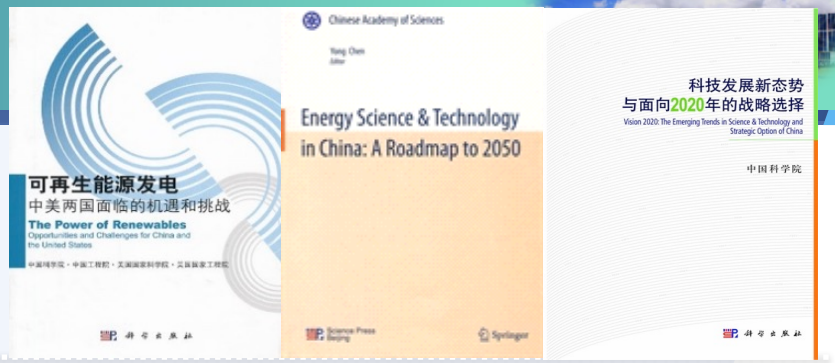
❖Guangzhou Institute of Energy Conversion(GIEC),Chinese Academy of Sciences

- Key Laboratory of Renewable Energy, CAS
- Key Laboratory of Gas Hydrate, CAS
- Guangzhou Center for Gas Hydrate Research, CAS
- International R & D Center of Renewable Energy, MoST
- National Energy Research Center for Bio-fuels， NEA
- Guangdong Key Laboratory of New and Renewable Energy
- Guangdong Engineering and Technical Center of Biomass Energy
- Guangdong CDM Research and Service Center

Energy Strategy and low-carbon development Research Center

Research Fields

1. Energy Economy and Policy Analysis and Energy Development Strategy
2. Sustainable Energy Technical Assessment
3. Path to Cope with Climate Change and Mitigation Strategies
4. Carbon Trading System Design



Planning Projects

- ✓ National low carbon pilot city program in Guangzhou
- ✓ Provincial- level Low-carbon development planning methodology
- ✓ The 12th five-year plan of low-carbon development in Guangdong
- ✓ The 12th five-year plan of energy conservation and carbon reduction potential research in Guangdong
- ✓ The 12th five-year plan of energy development planning in Guangzhou
- ✓ Guangzhou Low-carbon development planning of Sino-Singapore Knowledge City
- ✓ The 13th five-year plan of low-carbon development in Jiangmen
- ✓ The 13th five-year plan of energy development in Hainan
- ✓ The 13th five-year plan of renewable energy development in Hainan
- ✓ GHG accounting approach and ability construction for Chinese cities

Policy Technical Projects

- ✓ Low carbon development roadmap in Guangdong
- ✓ Carbon emissions trading pilot in Guangdong (system research and design)
- ✓ Guangdong carbon trading implementation effects evaluation and recommendations for policy adjustments
- ✓ Energy technology roadmap to 2050 in China
- ✓ China low carbon development macro strategy - global renewable energy development prospect
- ✓ China and the US renewable energy generation progress
- ✓ Smart grid development in China and the US
- ✓ Guangdong ecological civilization development evaluating indicator system study
- ✓ Guangdong CCUS development roadmap

CCS-GIEC-GEI Cooperation

the cohesive cooperation of CCS, GEI and GIEC

- GIEC
  - pilot application of tools for industrial rooftop solar photovoltaic (PV) program in the Huangpu Economic Development Zone (EDZ) in Guangzhou, Guangdong Province, China
  - pilot application of tools for solar photovoltaic (PV) program and biomass energy in Guangdong Province, China
  - Technology Implementation Document
- CCS
  - Provide RE planning methodology and toolkit to GIEC
  - Guangdong Solar Resource Assessment
  - Technology Implementation Document
- GEI
  - Marketing the methodology and toolkit to other developing countries
  - Coordination work in the project
  - Technology Implementation Document

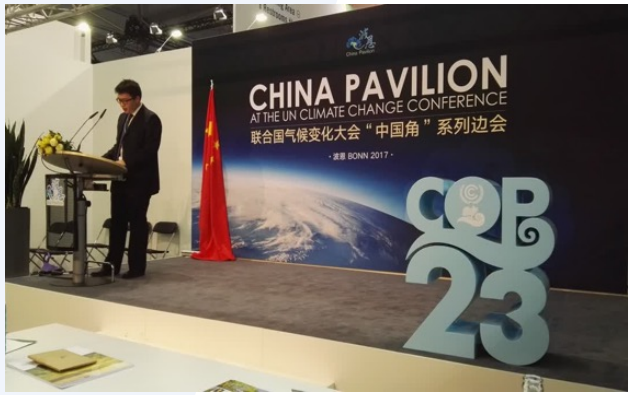
the Renewable Energy Implementation (REI) Toolkit

CCS, and its partners in China (GIEC and GEI) have developed a series of tools, including workbooks, document templates, and guidance documents, to assist jurisdictions (cities, provinces/states, and countries) in the implementation of comprehensive renewable energy (RE) systems. The REI Toolkit was developed to bridge known gaps between energy/emissions/economic planning and the actual implementation of RE projects and programs at the local and regional scales.

CCS-GIEC-GEI Cooperation

R&D OF the Renewable Energy Implementation (REI) Toolkit and Methodology

- June 2017: Guangzhou workshop
  - RE Planning Toolkit and methodology Training
  - Pilot project target region and renewable energy sector identification: rooftop PV in Huangpu District
  - The workplan and tasks allocation
- Nov 2017: COP23, Bonn Germany
  - China Pavilion and South Africa Pavilion
    - Promoting our LCD development methods
    - Presenting our Guangzhou Huangpu Pilot Project results



CCS-GIEC-GEI Cooperation

- January 2018: Renewable Energy Planning and Implementation toolkit application and methodology Workshop
  - Introduce the Huangpu pilot project
  - Hear from the suggestions and opinions from the experts
  - Adjust and improve the toolkit so that it can be implemented better in Southern China.

- June 2018: Guangzhou workshop
  - Discussion of the long-term strategies of REI project
  - Completion review and expansion potential of the TID in 2017
  - Determine the 2018 workplan and tasks
  - Start the biomass resources assessment of Guangdong province and the main approaches.

CCS-GIEC-GEI Cooperation

- June 2018：RENEWABLE ENERGY WORKSHOP IN MYANMAR
  - Identify the energy and climate change challenges facing Myanmar's INDCs
  - Deepen Myanmar government officials' and research institutions' understanding and knowledge of low-carbon and renewable energy implementation toolkits
  - Discuss the process for adapting renewable energy implementation toolkit into Myanmar, including technical exchange and pilot project selection
  - Promote the renewable energy implementation toolkit into other developing countries, so that these countries can achieve their NDCs

Pilot Project - Huangpu Economic Development Zone

- Project Overview
- Step 1: Local Resource Assessment
- Step 2: Selection of RE technology application and sector
- Step 3: Selection of Target Area
- Step 4: Implementation and Business Model For Industrial Rooftop
- Step 5: Results

Pilot Project - Huangpu Economic Development Zone

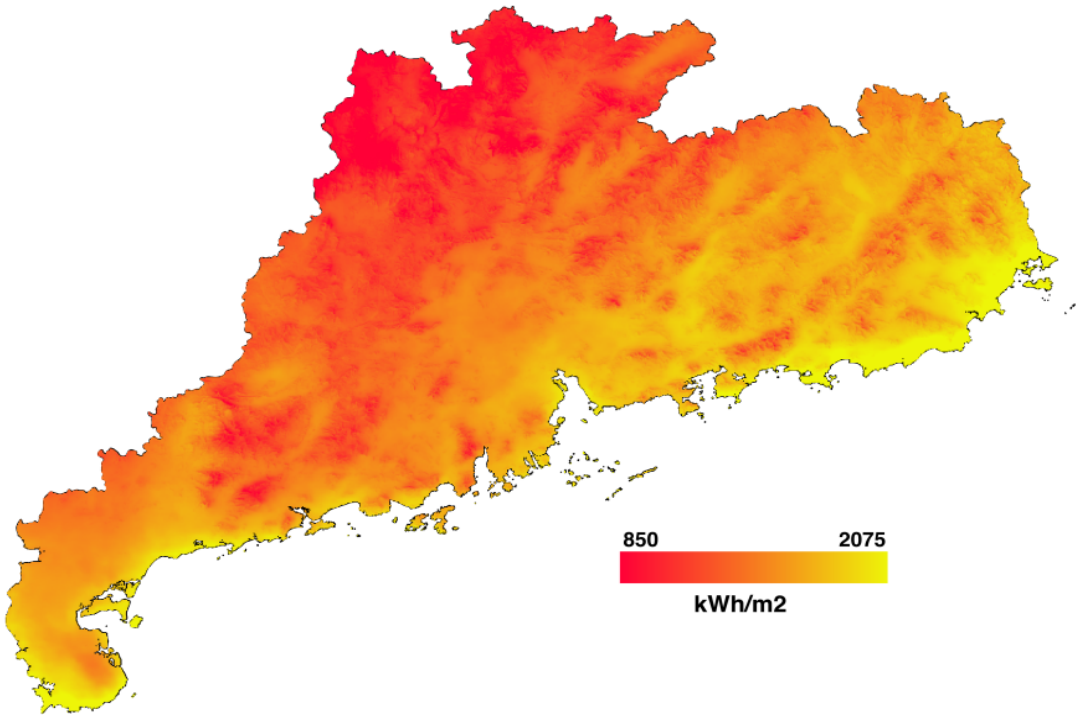
Key components of the REI Toolkit are:

- Spatial Analysis Tool: an open-source geographic information system (GIS).
- RE Technology Multi-Criteria Assessment (MCA) Scoping Tool: assess and present results of both quantitative (empirical benchmarks) and qualitative (expert ratings) criteria to inform selection of high-priority RE technology applications.
- RE MCA Screening Survey Tool: gather and summarize expert input on selection of RE technology applications.
- LCD Toolkit Baseline Modules: assess local to provincial scale energy supply and demand.
- Business Implementation Model template to identify necessary mechanisms, procedures, and requirements of participants at the upstream, intermediary, and downstream levels
- Financial Risk and Return Assessment and Social Impact Analysis Tool: assess key financial and social impact metrics (e.g. discounted cash flows, return on investment, energy and environmental impacts).
- RE Technology Implementation Template: a comprehensive document that includes the technology implementation description, design, business implementation model, participant requirements, and the expected financial risk and return and social impacts of the project/program (energy, emissions, economic), as well as the approach to analysis and key elements such as data sources, methods, and key assumptions.

Step 1: Local Resource Assessment

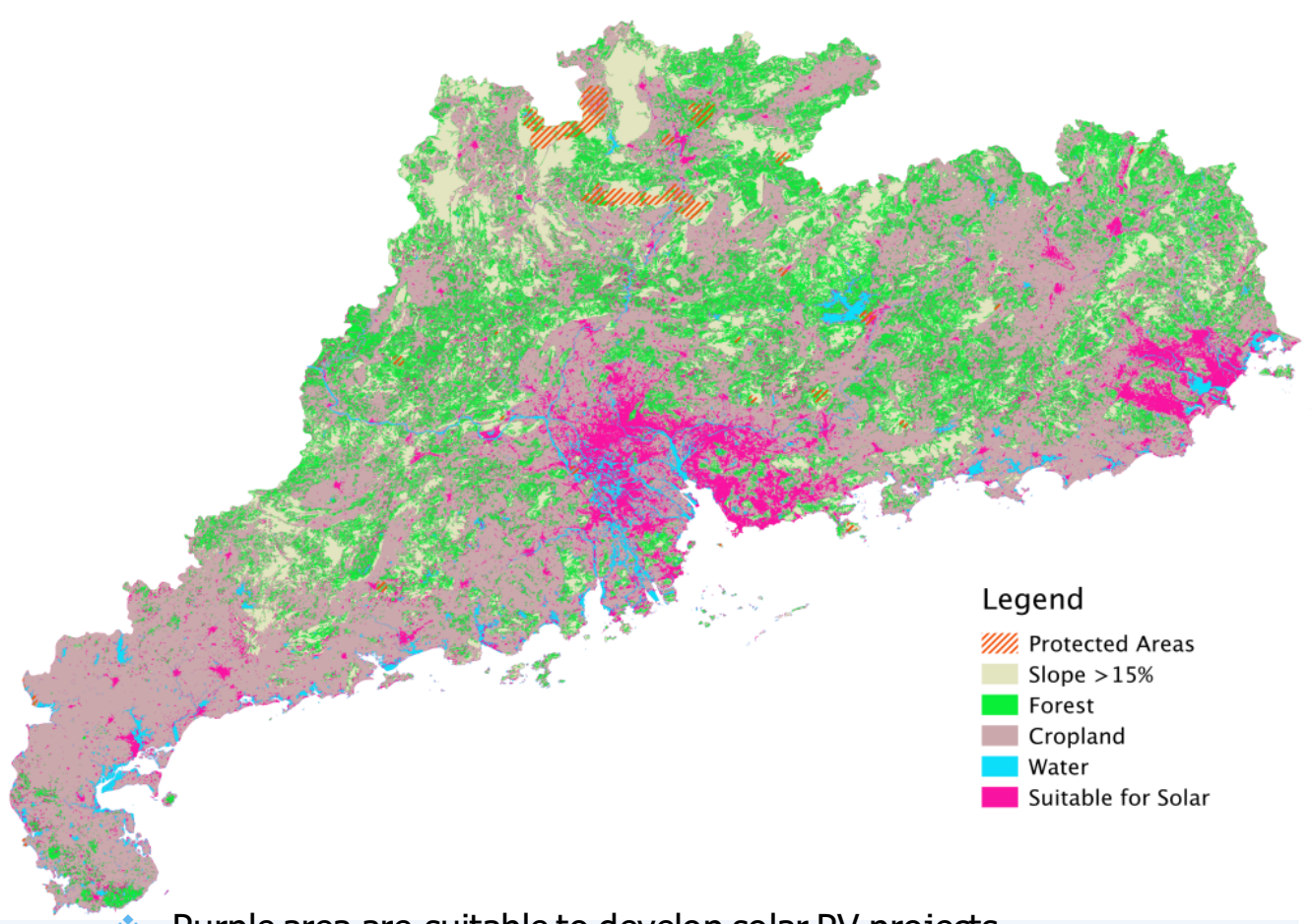
Guangdong Province Solar Resource Assessment

Solar irradiation intensity



Guangdong Province Solar Resource Assessment

Using GIS to do the assessment and spatial analysis



- Land types that need to be excluded
  - Forest
  - Cropland
  - Water area
  - Protected areas
  - Slope > 15%[1]

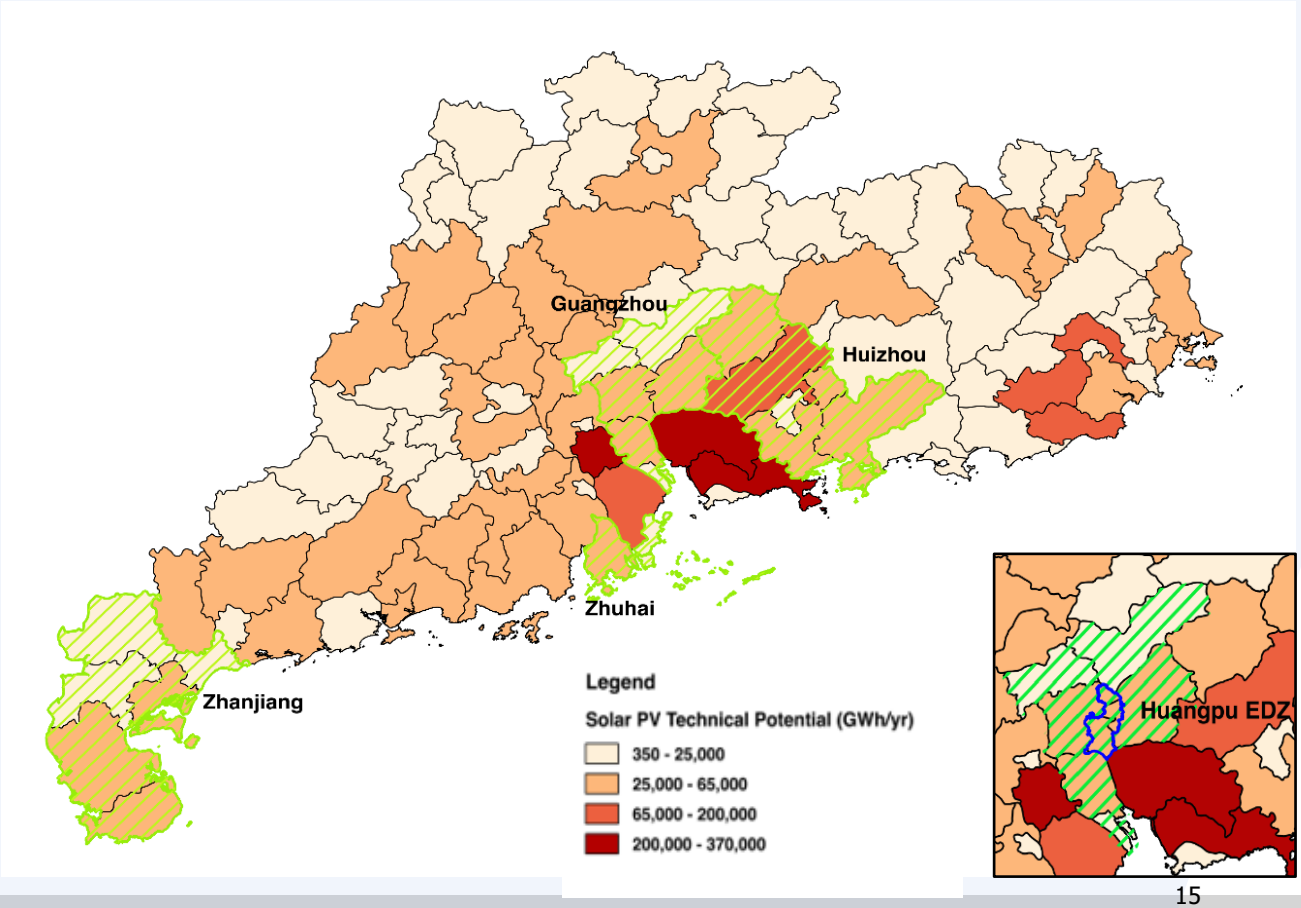
- Purple area are suitable to develop solar PV projects

Guangdong Province Solar Resource Assessment

Data Layer	Description/Notes	Source	URL
Administrative Boundaries	Guangdong Province Level 3	GADM database of Global Administrative Areas	http://www.gadm.org/
Land Cover	300-meter, 2015	European Space Agency Climate Change Initiative	https://www.esa-landcover-cci.org/
Land Slope	30-meter digital elevation model, 2000, Space Shuttle Radar Topography Mission	USGS Earth Explorer	https://earthexplorer.usgs.gov/
Protected and Sensitive Areas	Protected Area Profile for China from the World Database of Protected Areas, 2017	Protected Planet, UNEP-WCMC	https://protectedplanet.net/country/CHN
Solar Insolation	Global Tilted Irradiation (GTI): irradiation for optimally tilted surface (kWh/m^2)	Global Solar Atlas, The World Bank Group	http://globalsolaratlas.info/
Photovoltaic Power Potential	Amount of energy, converted by a PV system into electricity (kWh/kWp), based on local conditions	Global Solar Atlas, The World Bank Group	http://globalsolaratlas.info/

Selection of Target Area

Technical potential of every districts in Guangdong



Guangdong Province Solar PV Technical Potential and Location of EDZs

Step 2: Selection of RE technology application and sector

Renewable Energy Technology Multi Criteria Assessment Tool

- Quantitative Criteria:
  - Levelized Cost of Electricity (LCOE) ($US/kW)
  - Lifetime Production (MWh)
  - Annual GHG Reduction (tCO2e)
  - GHG Abatement Cost Effectiveness ($/tCO2e)

- Key inputs to the quantitative criteria analysis(solar PV as example)：
  - Capital and O&M Costs
  - Maximum Surface Area
  - Efficiency
  - Utilization Factor

- Qualitative Analysis
  - Alignment with NDC or Similar National Goal
  - Air Pollution Benefits
  - Government Financial Support
  - Other Environmental Benefits
  - GSP/Jobs
  - Energy Security

Renewable Energy Technology Multi Criteria Assessment Tool

Solar RE Technologie: Year for MCA Analysi 2017

3. Review and update the nominal ratings in the orange-colored input cells below. A nominal value of 0 indicates that implementation of the technology is not applicable to that criterion. A nominal value of 5 indicates that the criterion is applicable and could be significantly improved through implementation of the technology.

Sector	End Use Demand	Technology Tier 1	Technology Tier 2	Technology Tier 3	Technology Code	Alignment with NDC or Similar National Goal	Air Pollution Benefits	Gov't Financial Support	Other Env. Benefits	GSP/Jobs	Energy Security
Criteria Weights >						1	1	1	1	1	1
Residential	Electricity	PV	Rooftop	Fixed	R PV R F	5	3	5	2	2	3
Residential	Electricity	PV	Open Space	Fixed	R PV OS F	3	2	5	2	2	3
Residential	Electricity	PV	Open Space	One-axis Tracking	R PV OS 1T	5	3	5	3	5	3
Residential	Electricity	PV	Open Space	Dual-axis Tracking	R PV OS 2T	4	3	5	3	5	3
Commercial/Institutional	Electricity	PV	Rooftop	Fixed	C PV R F	4	3	5	2	2	3
Commercial/Institutional	Electricity	PV	Open Space	Fixed	C PV OS F	2	2	5	2	2	3
Commercial/Institutional	Electricity	PV	Rooftop (Slope<=10%)	One-axis Tracking	C PV R 1T	2	5	3	5	5	3
Commercial/Institutional	Electricity	PV	Rooftop (Slope<=10%)	Dual-axis Tracking	C PV R 2T	2	5	3	5	5	3
Commercial/Institutional	Electricity	PV	Open Space (Slope<=10%)	One-axis Tracking	C PV OS 1T	2	3	3	3	5	3
Commercial/Institutional	Electricity	PV	Open Space (Slope<=10%)	Dual-axis Tracking	C PV OS 2T	2	3	3	3	5	3
Industrial	Electricity	PV	Rooftop	Fixed	I PV R F	5	3	5	3	3	2
Industrial	Electricity	PV	Open Space	Fixed	I PV OS F	3	2	5	3	3	2
Industrial	Electricity	PV	Rooftop (Slope<=10%)	One-axis Tracking	I PV R 1T	0	5	0	5	2	2
Industrial	Electricity	PV	Open Space (Slope<=10%)	One-axis Tracking	I PV OS 1T	0	3	0	3	2	2
Industrial	Electricity	PV	Rooftop (Slope<=10%)	Dual-axis Tracking	I PV R 2T	0	5	0	5	2	2
Industrial	Electricity	PV	Open Space (Slope<=10%)	Dual-axis Tracking	I PV OS 2T	0	3	0	3	2	2
Industrial	Electricity	Concentrated Solar Power	Parabolic Trough	With Storage	I CSP PT	0	3	0	2	2	2
Industrial	Electricity	Concentrated Solar Power	Thermal Tower with Heliostats	With Storage	I CSP TT	0	3	0	2	2	2

headers).

	Capital Cost ($ US/kW)	Fixed O&M ($ US/kW/Year)	Efficiency (%)	Maximum Installed Capacity Potential (MW)	Capacity Factor (%)	Utilization Factor (%)	Lifetime (yrs)	Tech. Maturity (yrs)	Technically Feasible Grid Penetration (%)	Annual Production (MWh)	% of Demand Met (Annual)	Lifetime Production (MWh)	Annual GHG Reduction (tCO_2e)	LCOE ($ US/MWh)	GHG Abatement Cost Effectiveness ($/$tCO_2e$) - Undiscounted
Criteria Weights >	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	$ 2,640	$ 35.20	16.0%	130	10.2%	60%	20	20	45%	69,702	0.6%	1,394,041	30,036	610	152
	$ 3,135	$ 35.20	16.0%	0	10.2%	60%	20	20	40%	0	0.0%	0	0	714	NA
	$ 3,360	$ 40.00	16.0%	0	15.0%	65%	20	15	40%	0	0.0%	0	0	484	NA
	$ 3,600	$ 40.62	16.0%	0	19.0%	69%	20	10	40%	0	0.0%	0	0	383	NA
	$ 2,440	$ 32.80	16.0%	327	10.2%	60%	25	20	45%	175,886	1.4%	4,397,156	75,792	564	142
	$ 2,897	$ 32.80	16.0%	69	10.2%	60%	25	20	40%	36,890	0.3%	922,254	15,896	659	142
	$ 3,040	$ 37.60	16.0%	327	15.0%	65%	25	15	45%	279,280	2.2%	6,981,999	120,345	439	102
	$ 3,120	$ 38.40	16.0%	327	19.0%	69%	25	10	45%	375,524	3.0%	9,388,104	161,818	335	78
	$ 3,610	$ 37.60	16.0%	60	15.0%	65%	25	15	40%	51,138	0.4%	1,278,441	22,036	513	103
	$ 3,705	$ 38.40	16.0%	40	19.0%	69%	25	10	40%	46,084	0.4%	1,152,103	19,858	391	78
	$ 2,320	$ 31.20	16.0%	165	10.2%	60%	30	20	45%	88,964	0.7%	2,668,917	38,336	537	135
	$ 2,755	$ 31.20	16.0%	0	10.2%	100%	30	20	40%	0	0.0%	0	0	377	NA
	$ 2,840	$ 36.00	16.0%	165	15.0%	100%	30	15	45%	217,324	1.7%	6,519,730	93,648	267	64
	$ 3,372	$ 36.00	16.0%	0	15.0%	100%	30	15	40%	0	0.0%	0	0	312	NA
	$ 2,960	$ 36.80	16.0%	165	19.0%	100%	30	10	40%	275,277	2.2%	8,258,325	118,621	220	51
	$ 3,515	$ 36.80	16.0%	0	19.0%	100%	30	10	40%	0	0.0%	0	0	257	NA
	$ 5,000	$ 104.00	25.0%	0.00	70.0%	100%	35	20	70%	0	0.0%	0.00000	0.00000	107	NA
	$ 5,000	$ 104.00	125.0%	0.00	70.0%	100%	35	20	75%	0	0.0%	0	0	107	NA

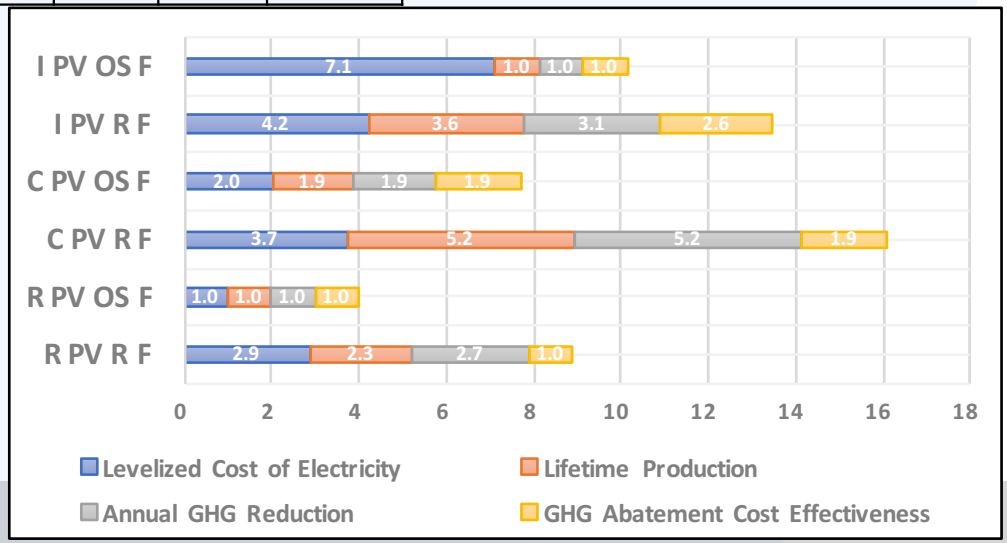
Renewable Energy Technology Multi Criteria Assessment Tool

Key inputs to the quantitative criteria analysis： Solar PV Application Performance and Cost Assumptions

Technology Code	Capital Cost ($ US/kW)	Fixed O&M ($ US/kW/year)	Efficiency (%)	Maximum Installed Capacity Potential (MW)	Capacity Factor (%)	Utilization Factor (%)	Lifetime (yrs)	Tech. Maturity (yrs)
R PV R F	$2,640	$35.20	16.0%	130	10.2%	60%	20	20
R PV OS F	$3,135	$35.20	16.0%	0	10.2%	60%	20	20
C PV R F	$2,440	$32.80	16.0%	327	10.2%	60%	25	20
C PV OS F	$2,897	$32.80	16.0%	69	10.2%	60%	25	20
I PV R F	$2,320	$31.20	16.0%	165	10.2%	60%	30	20
I PV OS F	$2,755	$31.20	16.0%	0	10.2%	100%	30	20

R: residential rooftop
C: commercial/institutional rooftop
I: industrial rooftop
PV: the solar PV technology
OS: open space
F: the fixed arrays

Technology Quantitative Multi-Criteria Ranking：

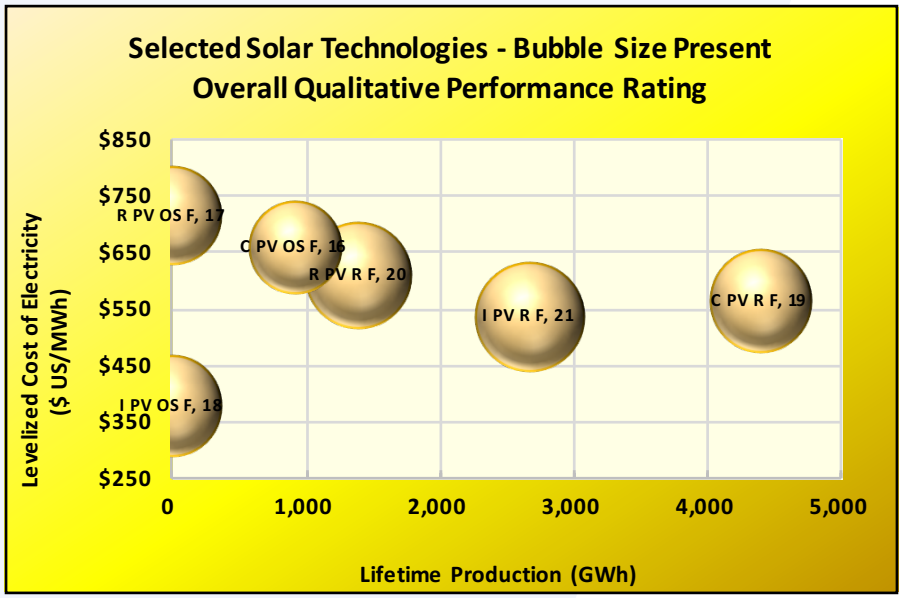


Renewable Energy Technology Multi Criteria Assessment Tool

- Initial Qualitative Ratings and Criterion Weights

Technology Code		Alignment with NDC or Similar National Goal	Air Pollution Benefits	Gov't Financial Support	Other Env. Benefits	GSP/Jobs	Energy Security
	Criteria Weights >	1	1	1	1	1	1
R PV R F		5	3	5	2	2	3
R PV OS F		3	2	5	2	2	3
C PV R F		4	3	5	2	2	3
C PV OS F		2	2	5	2	2	3
I PV R F		5	3	5	3	3	2
I PV OS F		3	2	5	3	3	2

- Combined Quantitative and Qualitative Analysis Results



The bubble chart indicates that, based on both quantitative criteria (x and y axes) and the total qualitative criteria score (bubble size), flat panel PV application on commercial rooftops (C PV R F) provides the best results overall. It has the greatest overall lifetime production (technical potential), it is mid-way in terms of implementation costs (LCOE), and it has a relatively high qualitative score (19). The next best opportunity appears to be flat panel PV systems installed on industrial rooftops (I PV R F).

MCA Screening Survey

Solar PV technology for example

MCA Rating for Solar PV Technologies

3. Please provide a rating for each of the criteria for each solar PV technology application listed below, based on the importance, status, and impacts of the technology on those criteria. *

	Solar Supply potential	Greenhouse gas reduction potential	Economic Development (GDP impacts, jobs, or sector-specific goals)	Financing potential and feasibility	Costs and savings (cost-effectiveness)
Residential - Rooftop	Medium	Low	-- Please Select --	Medium	Low
Residential - Open Space	High	Medium	Uncertain	Medium	Low
Commercial/Institutional - Rooftop	Medium	Medium	Medium	Medium	Uncertain
Commercial/Institutional - Open Space	High	Uncertain	Medium	High	High
Industrial - Rooftop	Low	High	Uncertain	Medium	Uncertain
Industrial - Open Space	Low	Medium	High	Uncertain	High

Back Next

- Screening Criteria
  - RE supply potential
  - Greenhouse gas reduction potential
  - Economic Development (could be GDP impacts, jobs, or sector-specific goals)
  - Financing potential and feasibility
  - Costs and savings
  - Energy diversity
  - Co-benefits of interest.
- There are four levels of rating in each criterion for each technology – High, Medium, Low, Uncertain.
- Analyze the results：For every criterion, score 3points for High, 2 points for Medium ,1 point for Low and 0 for Uncertain. Sum the total score of each technology and application model. The technology or application model that get the highest score will be selected as the preferred one.

Selection of Solar PV technology and application model

Screening the application model

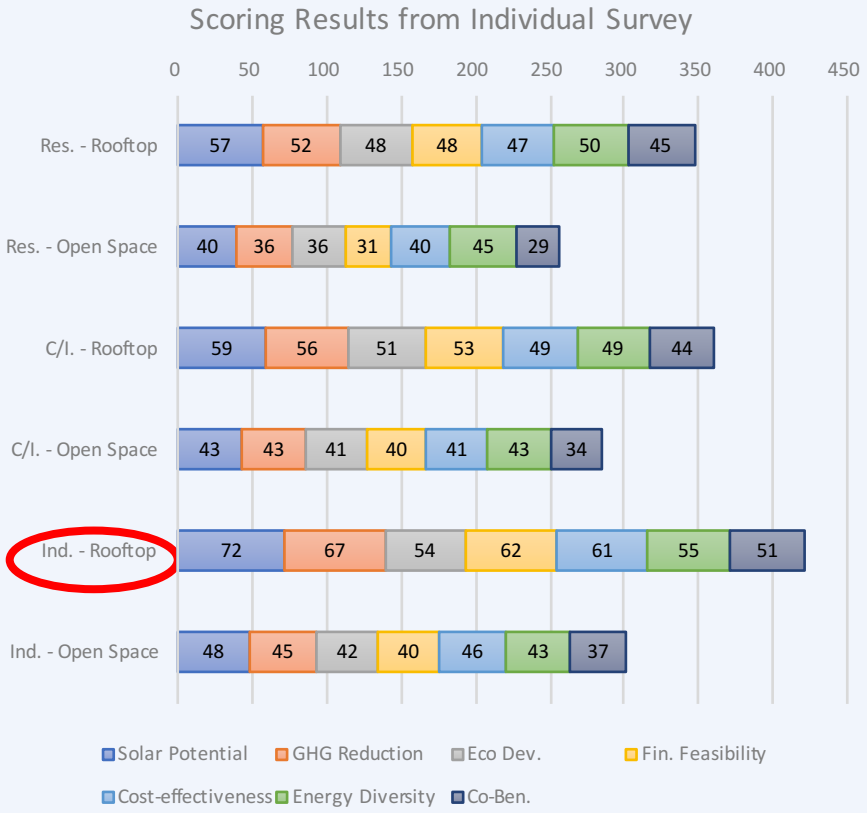
#	Sector	Technology	Install Location
1	Residential	PV	Rooftop
2	Residential	PV	Open Space
3	Commercial/Institutional	PV	Rooftop
4	Commercial/Institutional	PV	Open Space
5	Industrial	PV	Rooftop
6	Industrial	PV	Open Space

Technological Choses：

- Choosing the chemical material of the solar PV panel： Amorphous Silicon; Cadmium Telluride; Copper, Indium and Selenium; Monocrystalline Silicon; Polycrystalline Silicon; and Spherical silicon
- Choosing the installation structure：fixed arrays, arrays with single-axis tracking, or arrays with dual-axis tracking
- Whether we need storage(e.g. batteries) system or not(100 is strongly suggest that we need storage system， 0 is the opposite， 50 for no opinion)

Selection of Solar PV technology and application model

- Result: **Industrial Solar rooftop PV** is selected

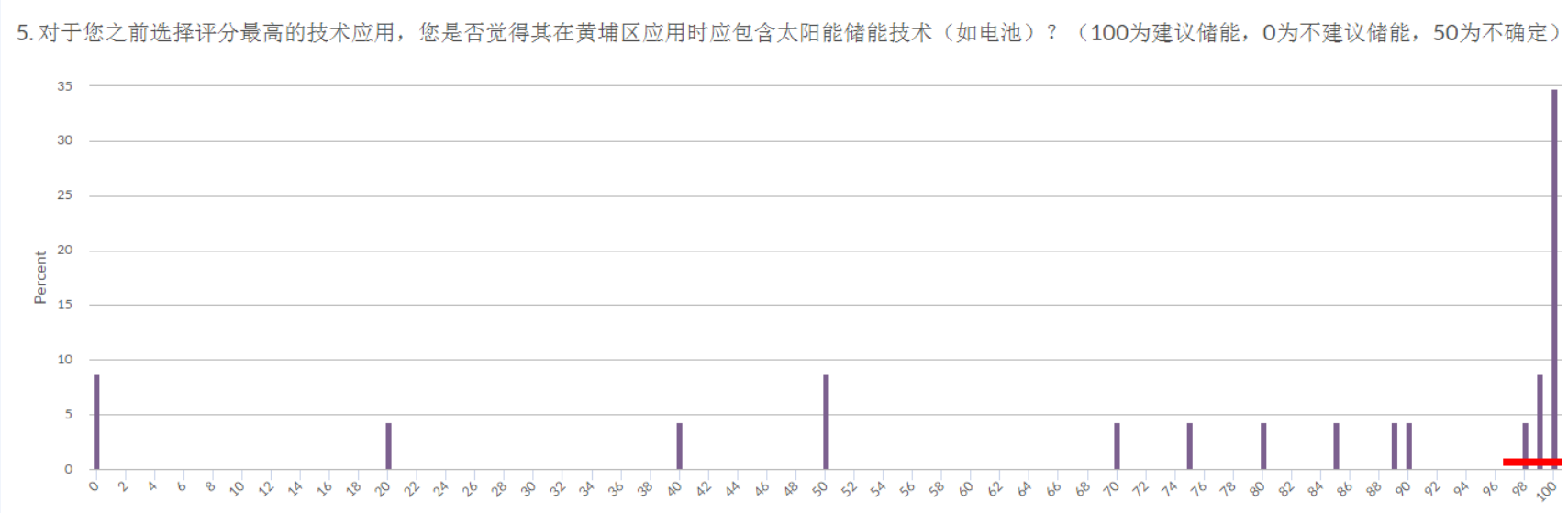


- RE Technology Application MCA Tool provides quantitative analysis for each technology applications for reference

推荐程度（1为不推荐，5为特别推荐，留空或0为不确定）

Fixed arrays	★★★★☆ Count: 23 Not Applicable: 0
单轴追踪	★★½☆☆ Count: 22 Not Applicable: 0
双轴追踪	★★☆☆☆ Count: 24 Not Applicable: 0

Selection of Solar PV technology and application model



- Need storage system

Step 3: Selection of Target Area

Pilot Guangzhou Case Overview

Pilot Project on RE Implementation

Industrial Rooftop PV

Guangzhou Technological and Economic Zone in Huangpu District (Huangpu EDZ)

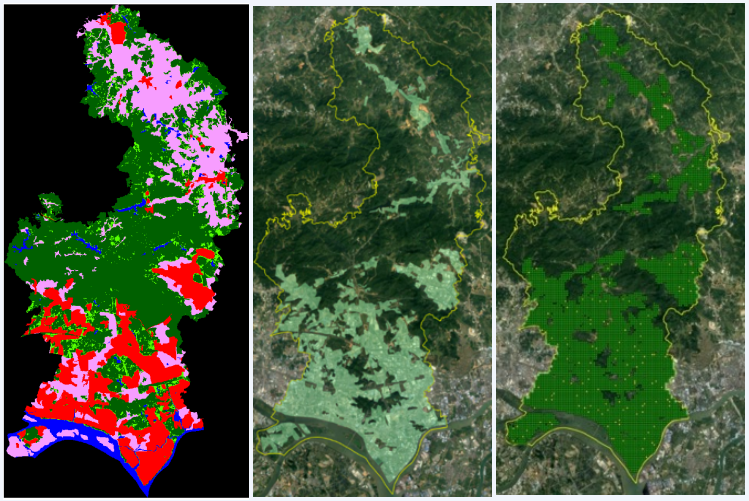
- Guangzhou Technological and Economic Development Zone in Huangpu District
  - 420MW Solar Power target by 2020 in Huangpu District
  - Huangpu district needs a detailed solar PV technology implementation planning.
  - Huangpu district administrative government has policy and financial support on the RE planning and RE development.
  - GIEC carried out to produce the low-carbon development plan and the thirteen five-years energy plan for the Huangpu EDZ and understanding it very well.

Pilot Guangzhou Case Overview

- In Huangpu pilot project, use QGIS to analyze the technical potential of solar resource
- Subsequent application of the MCA Scoping Tool
- and a survey of 25 local experts using the MCA Screening Survey Tool

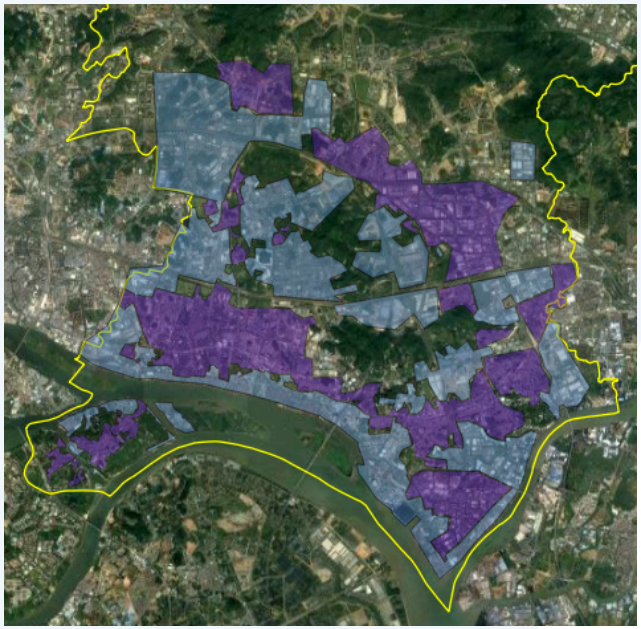
- the highest priority technology application should be solar PV systems applied to industrial rooftops
- The total size of the program is 320 MW of capacity
- Based on a nominal system size of 2.0 MW, the program will cover about 160 system installations.
- the business (or program implementation) model is summarized including the key phases, individual steps, actions, parties, mechanisms, performance requirements, and procedures required for program level implementation

Urban Land Analysis and Sector Zones Disaggregation

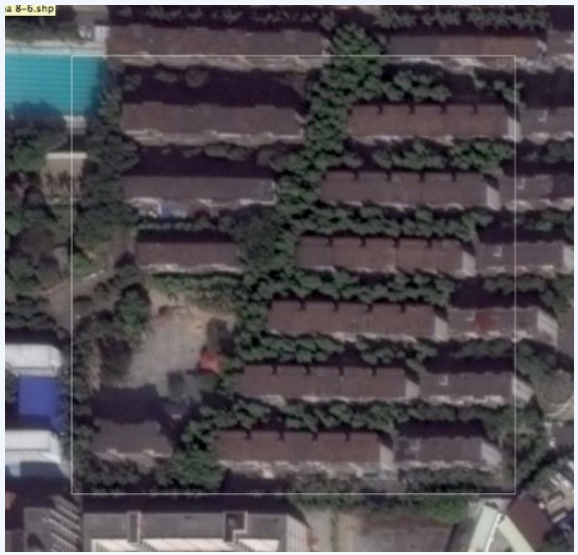


Panel 1: Land cover data, urban land shown in red.
Panel 2: Urban land cover manually corrected based on satellite image.
Panel 3: Grid squares created in urban area, yellow squares show random selection of grid squares.

Example Disaggregation of Urban Area into Sector Zones. Southern portion of Huangpu EDZ showing a separation of industrial (light purple) and residential/ commercial/ institutional zones (darker purple).



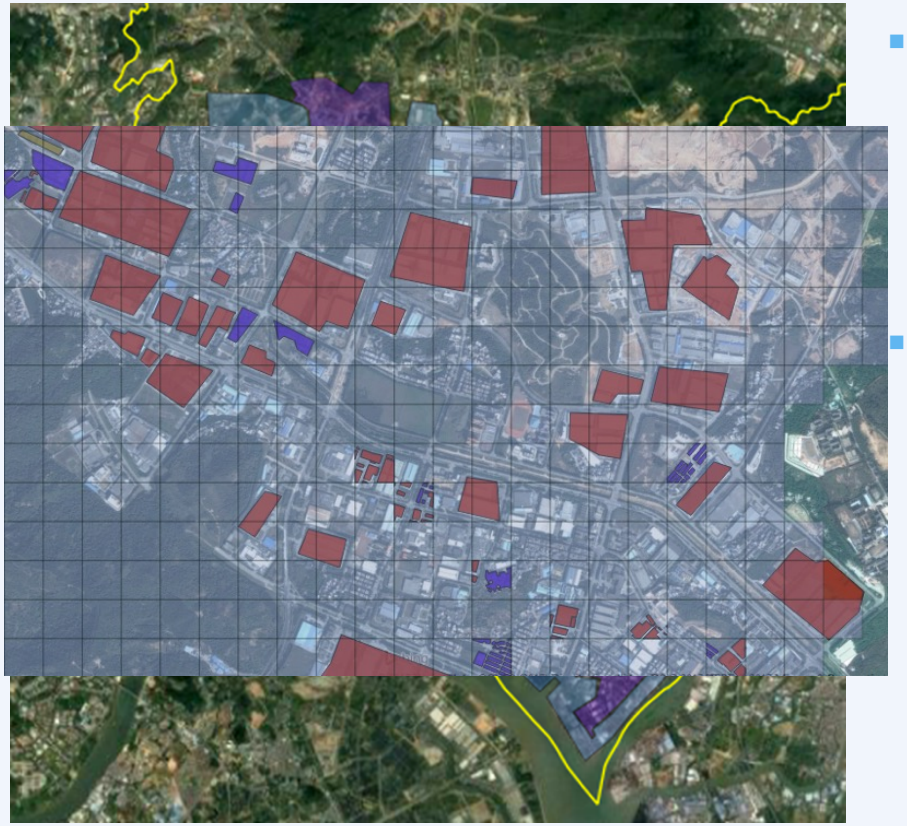
Digitizing Rooftops to Estimate Potential Installation Areas by Sectors



- For other REs:
  - Biomass: Areas of agricultural land by crop type or production of specific agricultural product, or livestock population, within a specified radius around a proposed location of a biomass generation unit;
  - Micro-hydro: Potential generation based on elevation change and streamflow characteristics along streams and rivers in a specific location;
  - Wind: Amount of area of suitable land cover, elevation, and wind speed within a specified distance of transmission infrastructure.

GIS Assessment and Spatial Analysis in Huangpu District

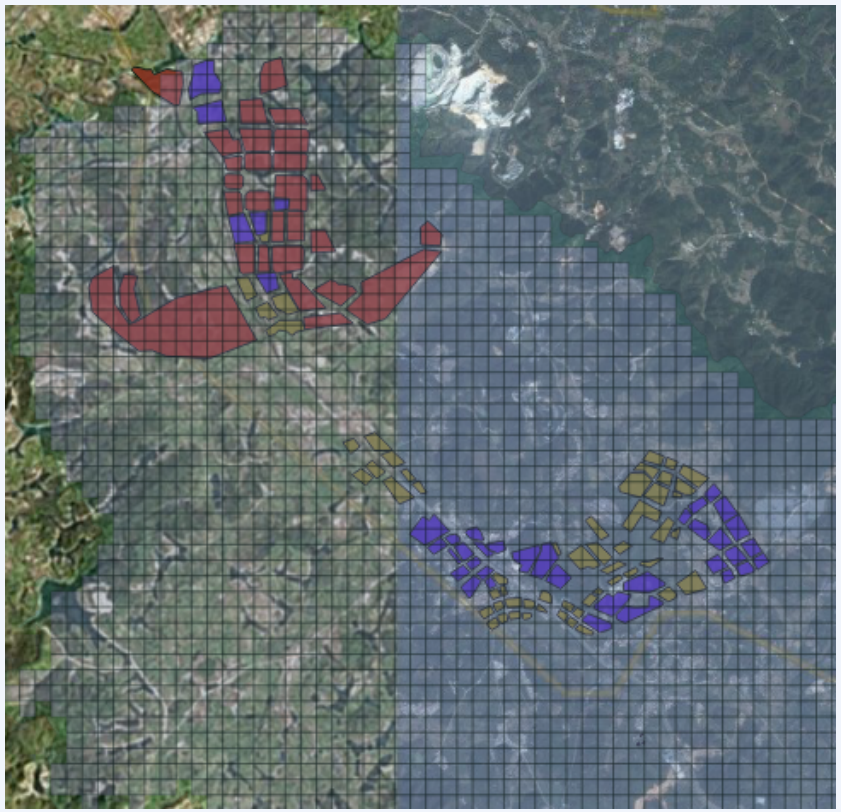
❖ Disaggregation of Developed Area



- Light color is industrial area, Purple is commercial and residential area
- Red = industrial buildings rooftop; Purple = Residential buildings rooftop; Yellow = commercial/institutional buildings rooftop

GIS Assessment and Spatial Analysis in Huangpu District

Disaggregation of Area under development



- Based on the Sino-Singapore Knowledge City planning, we divide it into 3 land use type and calculate their surface.

Red = industrial land use;
Purple = Residential land use;
Yellow =commercial/institutional land use

GIS Assessment results of Huangpu District Rooftop Area

Rooftop Area calculation

- Calculation of rooftop area in developing region：

  $S_p = S_{lu} * D$

  S_{lu}：Land use surface

  D：Building density

- Total surface that can install solar PV：

  St = (Sp + S) * 70% [1]

  Sp: Rooftop area in developing region

  S: Existing buildings rooftop surface

Rooftop Area results

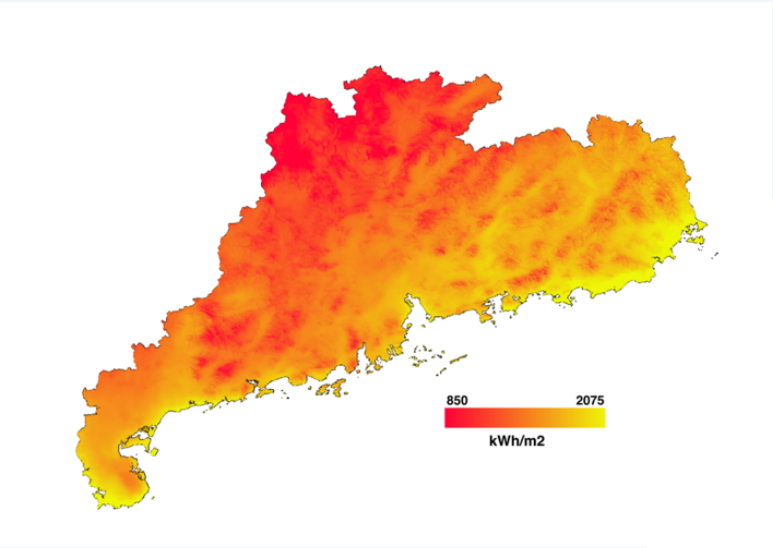
- Industrial Rooftop： 3.9 km2
  - Estimated rooftop area in planning region：1.47 km2
- Commercial/Institutional Rooftop：3.4 km2
  - Estimated rooftop area in planning region ： 0.63 km2
- Residential Rooftop：3.1 km2
  - Estimated rooftop area in planning region ： 0.55 km2

Technical Potential of Solar PV generation on Industrial Rooftop Area

- Industrial Rooftop Area：3.9km2

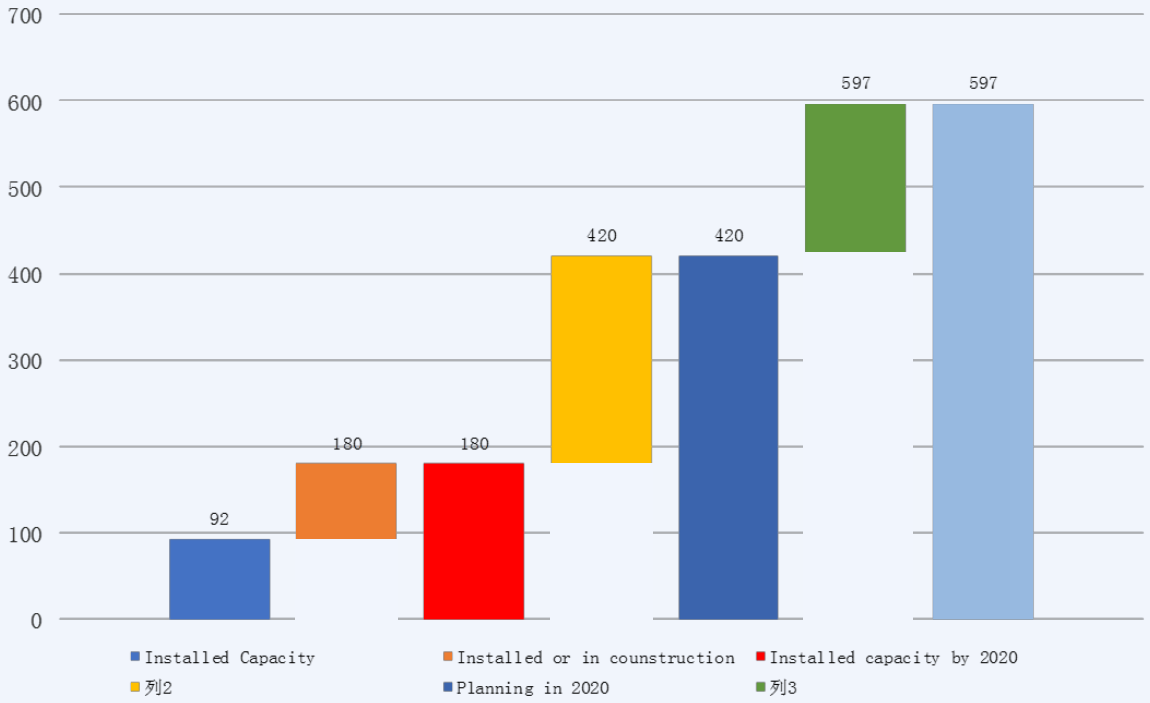
$$\frac{R * S * 16\%}{h}$$ 3

  - R: Solar Radiation of Guangzhou(kwh/m^2)
  - S:Solar PV surface(m^2)
  - 16%:Average efficiency of PV panels



- Technical Potential: 597MW
- Electricity generated: 683.1GWh
- 7.42% of the electricity demand in Huangpu district

Compare the current status and planning target of Solar PV development in Huangpu District



Project Goal

- Huangpu district has 597MW technical potential that can be developed
- Solar PV installed or in construction capacity by 2020： 180MW < 420MW
- The solar PV development in Huangpu district can't reach its planning target by 2020

1. Help Huangpu district achieve its RE target by 2020 to 420MW
2. Install 320 MW by 2020
   - Scale of the project : 130 solar PV systems (Each project 2.5MW)

Step 4: Implementation and Business Model For Industrial Rooftop

Implementation Model for Industrial Rooftop PV

- 7 Phases
- Parties include GIEC, Guangzhou Municipal Development and Reform Commission, Power supply bureau of the Huangpu district(China South Power Grid), industrial facility owners, Solar PV companies as project developers and Banks as lending institutes

Implementation Model for Industrial Rooftop PV

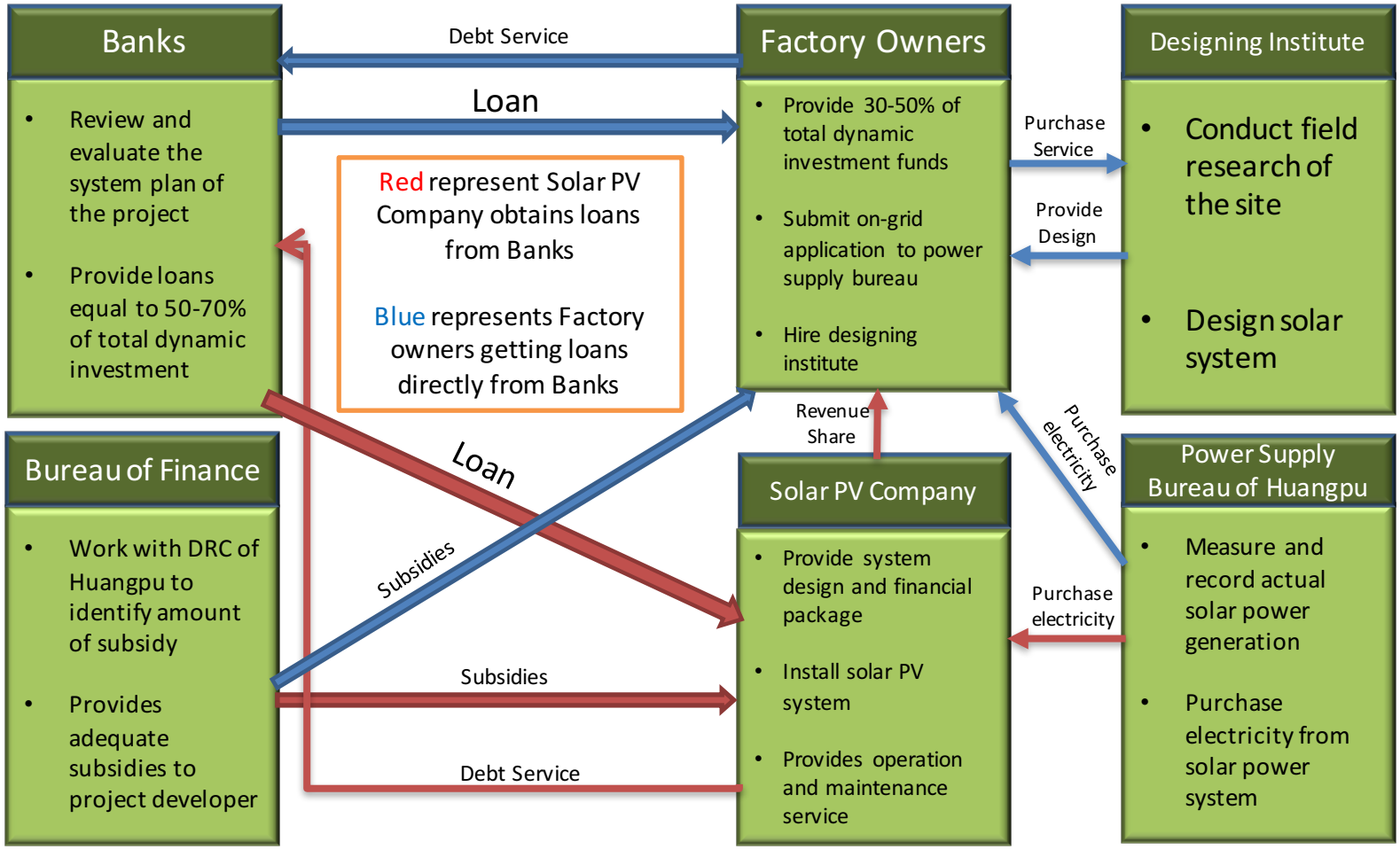
Phase	1	2	3	4
Phase Name	Complete Program Feasibility Assessment	Partner Assembly	Program Marketing	Define Projects
Parties Involved	GIEC Power Utility Power supply bureau of the Huangpu district	GIEC Industrial Facility Owners Solar PV Company, Bank Guangzhou DRC Power supply bureau of the Huangpu district	GIEC Solar PV Company Industrial Facility Owners	Solar PV Company Industrial Facility Owners GIEC
Steps: Legal, Policy, Administrative, and Financial Mechanisms	1. GIEC works with the Power supply bureau of the Huangpu district to assess technical feasibility of integrating the new distributed generation achieved by the program. 2. GIEC and Power supply bureau of the Huangpu district address any identified feasibility issues.	1. GIEC presents the Program and its expected impacts to each partner and gains their support for the program and agreement on their role, timing, etc. 2. Solar PV Company prepare a standard financing package(s) to facility owners.	1. Solar PV company conducts the marketing program to facility owners. 2. GIEC and Solar PV company provide support to interested facility owners to understand the benefits of the program.	1. Solar PV Company provide proposals to Facility Owners. 2. GIEC provides technical support to Facility Owners to evaluate proposals. 3. Facility Owners select a winning bidder among the proposals submitted (contingent on receipt of funding)
Analytical Requirements	GIEC: Detailed local industrial electricity demand and solar PV supply assessment Power supply bureau of the Huangpu district: Integration assessment of new solar power with the local grid	GIEC and Solar PV Company: Additional financial and other risk analyses for projects of different types of Industrial Owners (state-owned enterprise, listed companies or privates enterprises)and product(explosive or corruptive materials).	GIEC and Solar PV company develops a listing of industrial facility contacts for marketing the program	Solar PV Company develop preliminary design and cost estimates for use in their proposals to Facility Owners.

Implementation Model for Industrial Rooftop PV

Phase	5	6	7
Phase Name	Program Funding	Program Implementation	Program Scale-Up
Parties Involved	Bank Industrial Facility Owners Guangzhou DRC Solar PV Company	Industrial Facility Owners Solar PV Company Guangzhou DRC Power supply bureau of the Huangpu district	GIEC Guangdong DRC South China Power Grid Industrial Facility Owners Solar PV companies
Steps: Legal, Policy, Administrative, and Financial Mechanisms	1. Solar PV Company completes the financing package and sends it to Facility Owner. Solar PV Company provides support to Facility Owners to understand the package. 2. Facility Owner reviews and conducts any follow-up with Solar PV Company . 3. Facility Owner signs designing and business contract(s). 4. Lending Institution provides funds to Solar PV Company consistent with contract requirements. 5.Guangzhou DRC can apply the distributed PV power generation subsidy for the project.	1. Industrial Owners get approval of the China South Power Grid to build their solar PV installation 2. Solar PV Company install PV systems for Facility Owner. 3. Connect the solar system on the grid.	1.Contact and assemble the factory owner that listed in the Guangzhou Distributed Solar PV Generation Planning 2. Contact the power supply bureau of other districts. 3. Solar PV company and GIEC do the Phase 1- 6 in a city scale and even provincial scale in the future.
Analytical Requirements	Facility Owner reviews design and cost proposals from Facility Owner or GIEC complete standard financial analysis (e.g. using the Financing Tool) for inclusion in the financing package.	Guangzhou DRC do the project recording and information gathering of the project.	

Business Models for Industrial Rooftop PV

Fund Flow and Role of Partners



Subsidies Policy and Economic Benefit

National Subsidy	
Distributed	0,32RMB/kwh(20 years)
City level subsidy	
Investment subsidy	0,2RMB/W, maximum 2 million RMB for a single project
Generation subsidy	0,1RMB/kwh(10 years)

Power connection type	**Measured Power Generation Price(RMB/kwh)**	**Payback Period(years)**
All on-grid	1	10.05
For own use, sell the remaining power to the grid	1.2	8.38

- CO_2 Reduction：681,050 tons
- Emission reduction cost：682 RMB/tCO_2
- Equivalent to 840,000 tons standard coal
- National level subsidy：218 million RMB/yr
- Local investment subsidy：120 million RMB
- Local production subsidy：68,31 million RMB/yr
- The total preliminary investment is 8,7 billion RMB，Annual O&M cost is 117 million RMB
- Create 19701 jobs

Step 5: Pilot Results

Pilot Results and next steps

Pilot Results :

- Show list of analysis results for all key variables
  - Energy and Emissions Results
  - RE Technology Market Assessment
  - Program Financial Assessment
- Guangdong Solar Resource Assessment Whitepaper
- Technology Implementation Document

Next steps :

- Finalizing the Huangpu pilot project TPID
- Extend the toolkit and methodology to develop Solar PV technology implementation to Guangdong Province
- Develop Biomass technology implementation approaches for Guangdong Province

Biomass resources assessment of Guangdong Province

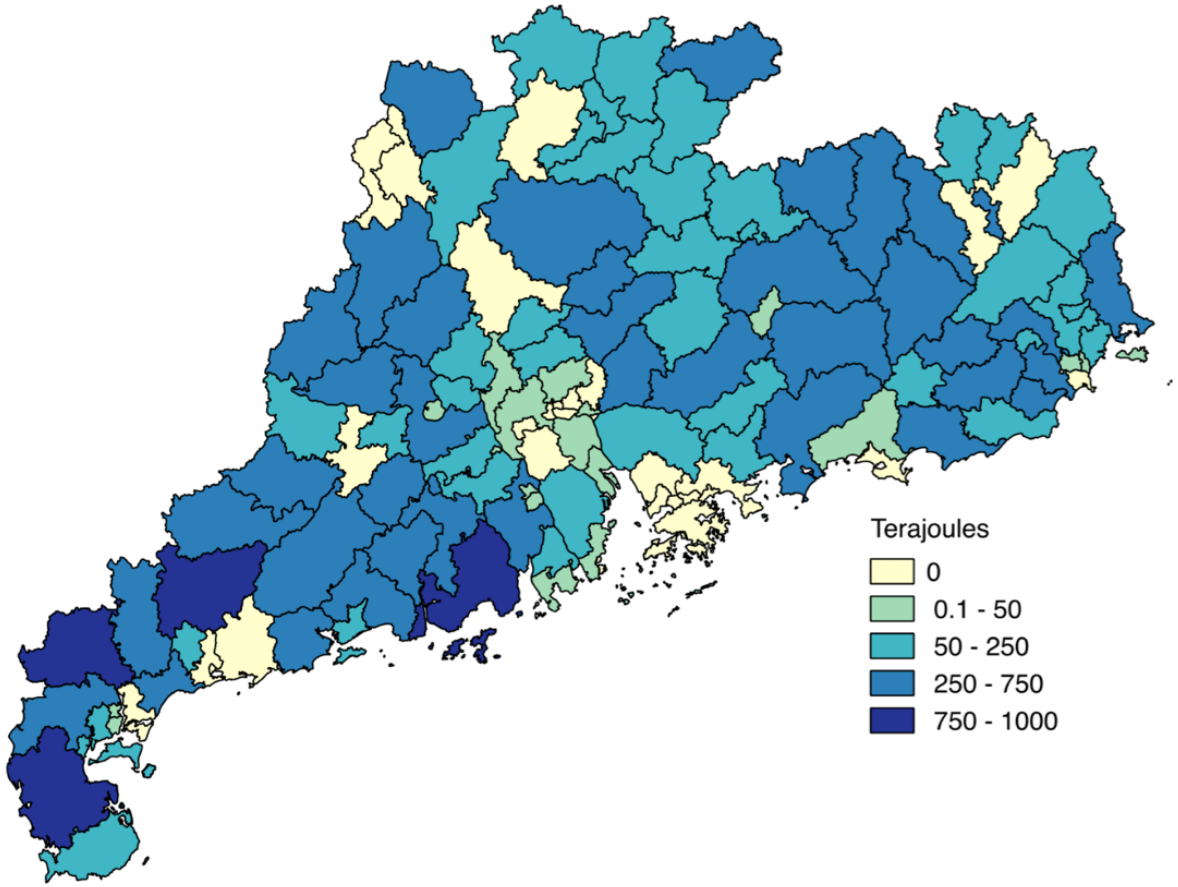
- Different approach compare to solar resource:
  - Sources of biomass are varied
  - Feedstocks' characteristic are different
  - Existing several kinds of biomass generation technologies
- 3 sectors of biomass resources: Agriculture, Forestry and Municipal Solid Waste
- Identify conversion technologies
  - Electricity:
  - Biogas conversion
  - Pellets/Briquettes:
  - Other:
- Calculate conversion to energy product – e.g.
  - GWh of power – for generate electricity
  - TJ of solid fuel

Major Data sources: Guangdong Statistical Yearbook 2017 and Guangdong Statistical Yearbook on Agriculture 2017

Biomass resources assessment of Guangdong Province

Agriculture:

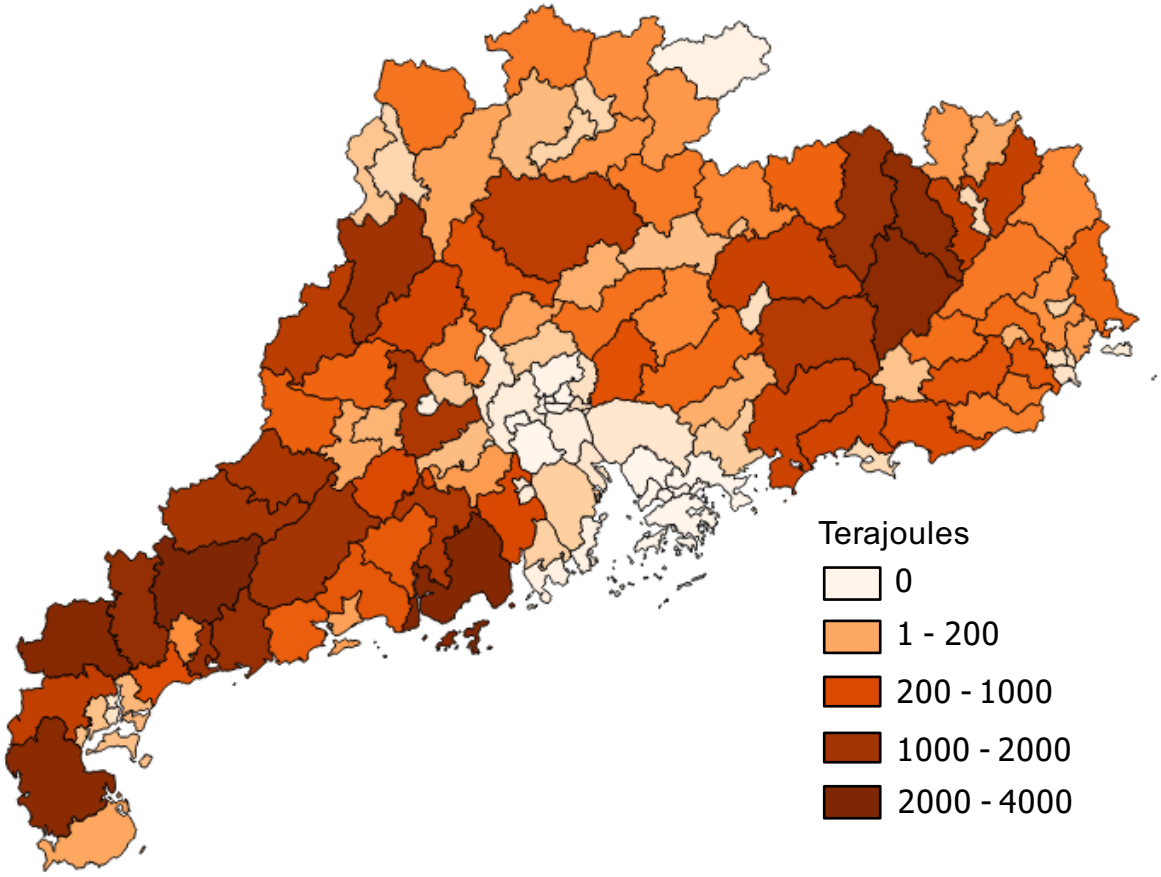
- Feedstock: Rice Husk
- Major distributed in the west part of Guangdong
- 2.81 million tons
- 29595 Tj of equivalent fuel
- Technical potential: 2961.5GWh



Biomass resources assessment of Guangdong Province

- Feedstock: Rice Straw
- Major distributed in the west part and north-east part of Guangdong

- 9.39 million tons
- 107394 Tj of energy
- Technical potential: 10180GWh

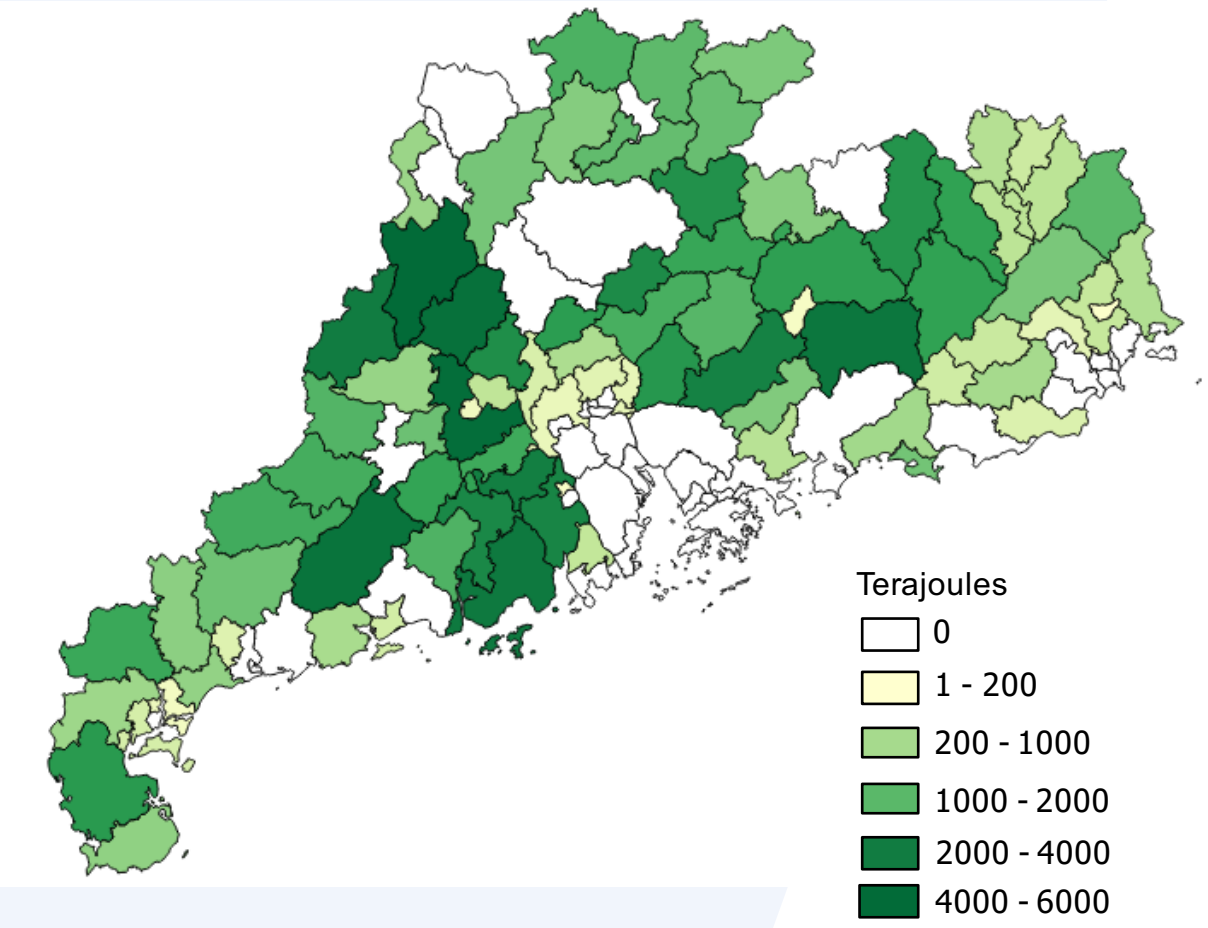


Biomass resources assessment of Guangdong Province

Forestry

- Feedstock: Wood products residues
- Major distributed in the north-west part of Guangdong

- 4.6 million tons
- 82839 Tj of energy
- Technical potential: 6024GWh



Biomass resources assessment of Guangdong Province

- Current Results:

Feedstock	1. Resource (tons)	1. Biomass Primary Thermal Energy (TJ)	1. Biogas Primary Thermal Energy (TJ)	2. Biomass Power (GWh)
All Feedstocks	46,582,951	530,996	105,881	13,506
All Feedstocks - BAU Consumption	46,123,971	522,505	105,881	13,021
Rice husk	2,818,905	29,595	3,221	2961
Rice straw	9,396,351	107,394	39,883	10180
Sugarcane crop residue	764,071	29,326	12,706	712
Sugarcane bagasse	3,056,284	7,010	791	3021
Urban green space residue	2,197,680	15,406	N/A	1,460
Forest harvest residue	1,907,672	34,338	N/A	2,160
Wood products residue	4,602,191	82,839	N/A	6,024
Bamboo products residue	132,786	2,390	N/A	165
Firewood (use by farmers)	458,980	8,491	N/A	484
Shrubland biomass accumulation	177,957	1,247	N/A	92
MSW Total Organics	15,875,974	116,823	-	1,868
MSW: paper/cardboard	12,576,450	89,939	-	1,442
MSW: wood waste	1,649,762	15,615	-	250
Municipal sewage sludge	7,569,735	112,789	49,279	1,658

Thank you for your attention!

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CHINESE ACADEMY OF SCIENCE
GUANGZHOU INSTITUTE OF ENERGY CONVERSION

Pharmaceutical factory
9400 t biomass/year

Aluminum melting
54000 t biomass/year

Food processing
10500 t biomass/year