



**Rooftop Solar Potential Assessment:
CSTEP's High Resolution Imagery & Geospatial Approach**

Rooftop Solar Conclave: Ahmedabad, Gujarat

16-12-2023

About CSTEP



- Not-for-Profit Organisation (Section 25)
 - Offices in Bengaluru and Noida
- **Essence:** We work with governments and Institutions to develop solutions using science & technology
- **Vision:** To be the foremost institution for policy analysis in India
- **Mission:** To enrich policymaking with innovative approaches using science & technology for a sustainable, secure, and inclusive society

CSTEP's Focus Areas



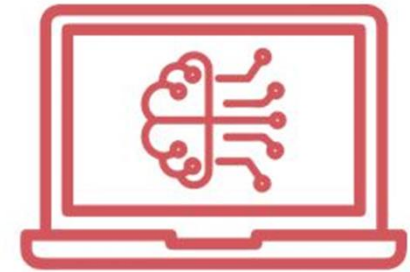
Secure &
Sustainable
Future



India's Clean
Energy
Transition

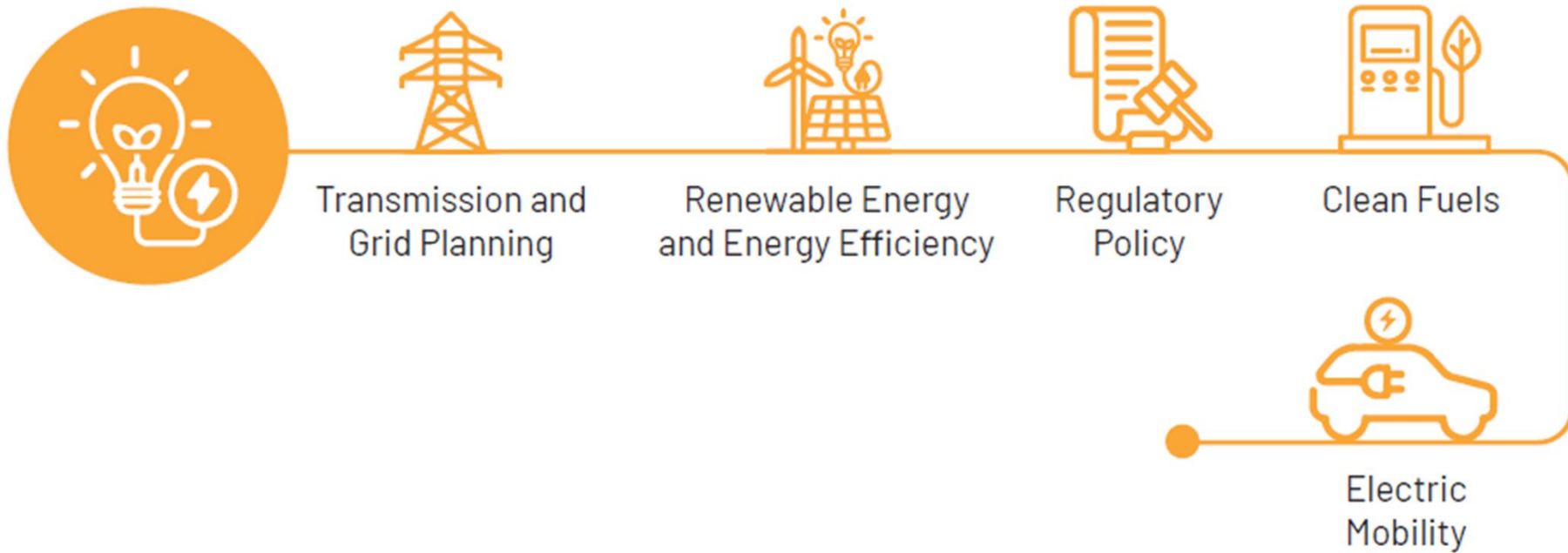


Clean Air for All



Digital
Transformation

India's Clean Energy Transition



Background – CSTEP RTPV Work

☐ Light Detection and Ranging (LiDAR) work in Bengaluru (2017-20)

- *1st of its kind project in India for RTPV potential assessment*
- *1,076 sq. km. covered - 2.8 GW potential on 8.2 lakh rooftops*
- *~12 MW installed using CSTEP's DPRs on govt. buildings and BMTC depots*
- *MoU and NDA signed with BESCO; Technical and knowledge partner for BESCO's RTPV implementation program*

☐ Drone-based aerial imagery work (2020-present)

Madhya Pradesh:

- *Bhopal, Sanchi, Indore, Gwalior and Jabalpur (~600 sq. km.) – 3.5 GW potential on 5.5 lakh rooftops*
- *MoU and NDA signed with MPPMCL*

Chhattisgarh:

- *Raipur, Naya Raipur, Bilaspur, Durg-Bhilai, Korba and Raigarh (~400 sq. km.) – 3 GW potential on 4.5 lakh rooftops*
- *MoU signed with CSPDCL*

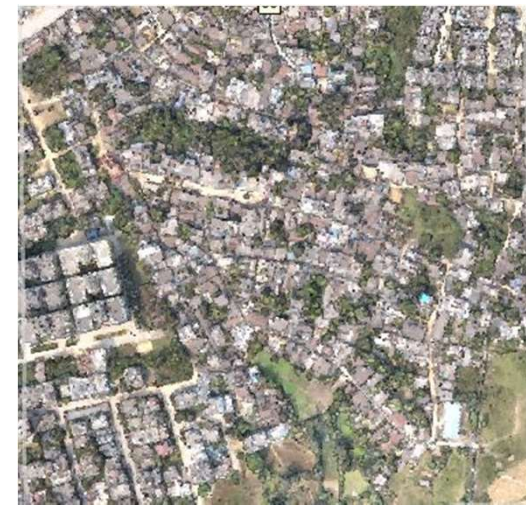
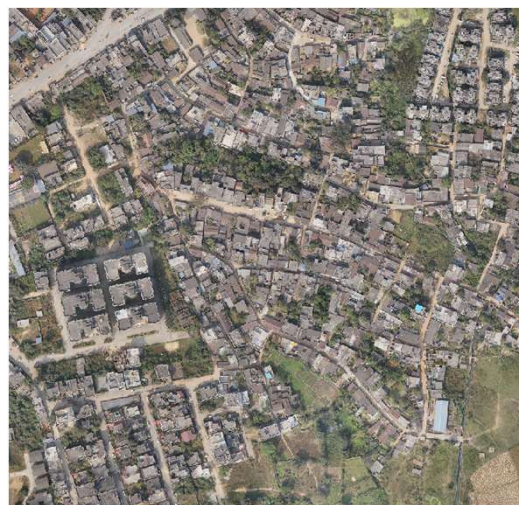
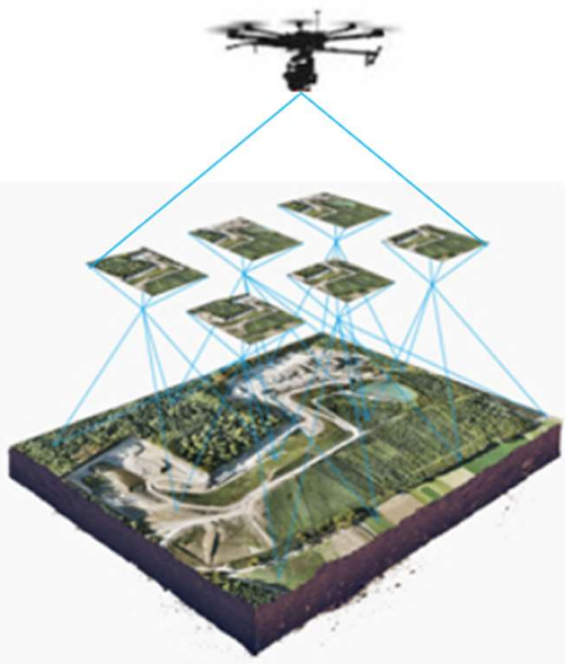
Others:

- *Initiated work in Chennai, Kozhikode, Guwahati and Salt Lake*

Aerial Data Collection and preprocessing

- **High resolution true-ortho (5 cm GSD)** for digitisation & identification of rooftop area
- **DSM (digital surface model)** of rooftop and surrounding area for
 - Slope
 - Aspect
 - Shading analysis
 - Roof top solar potential analysis
- **Point cloud for 3d model generation of building for visualisation**

Aerial Data Collection and preprocessing



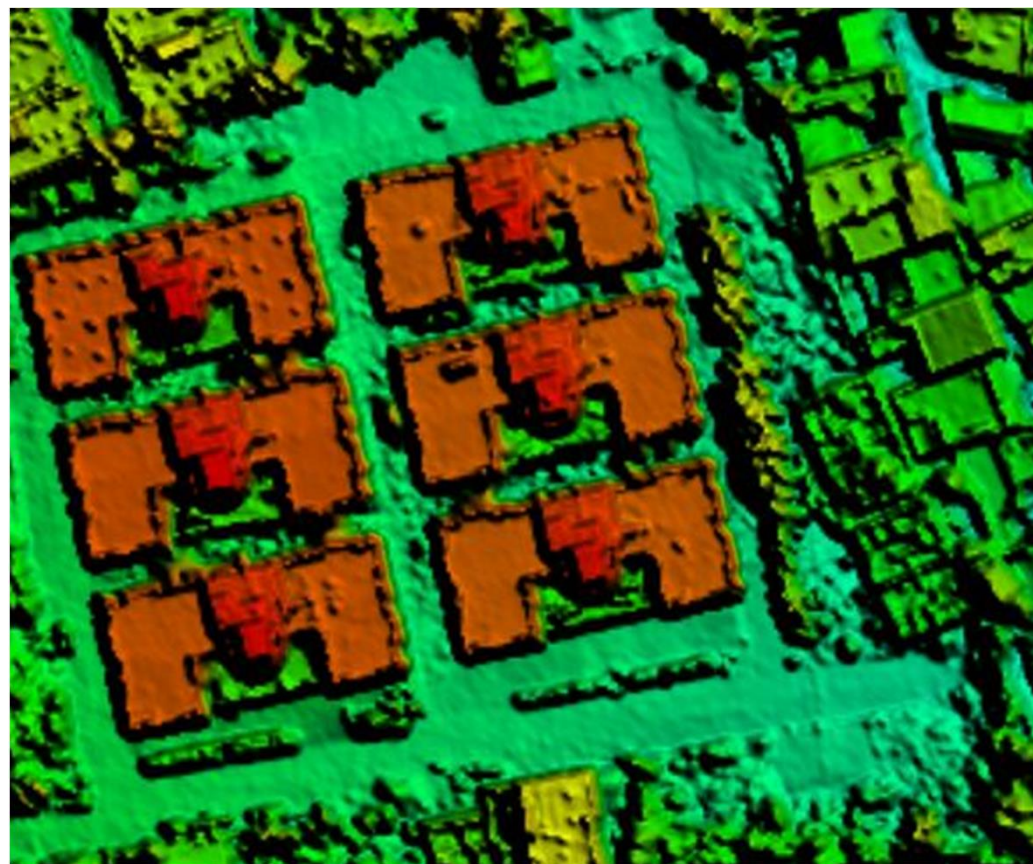
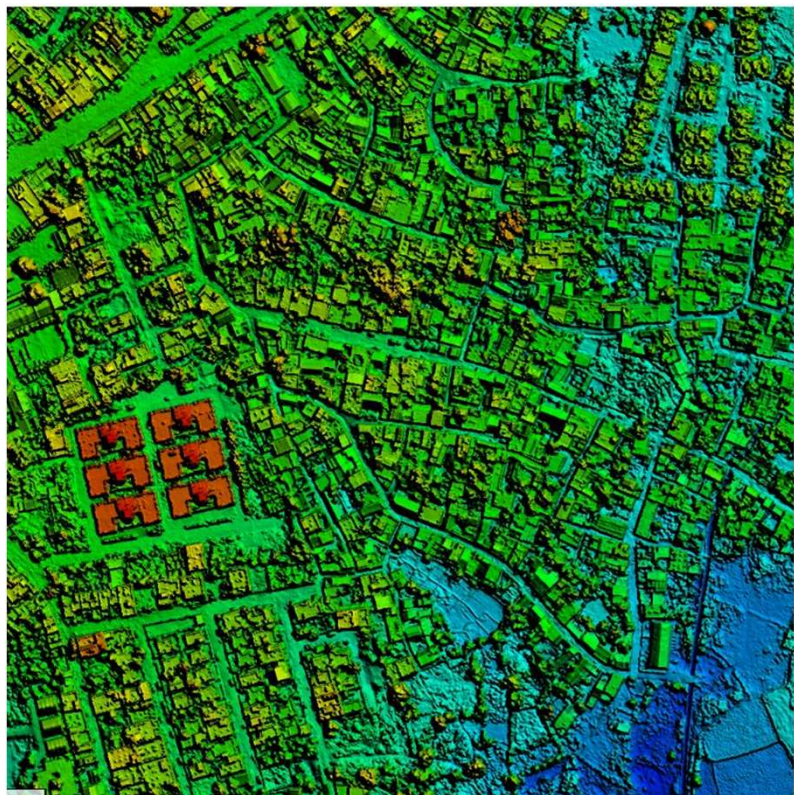
High resolution 20 MP JPEG Image



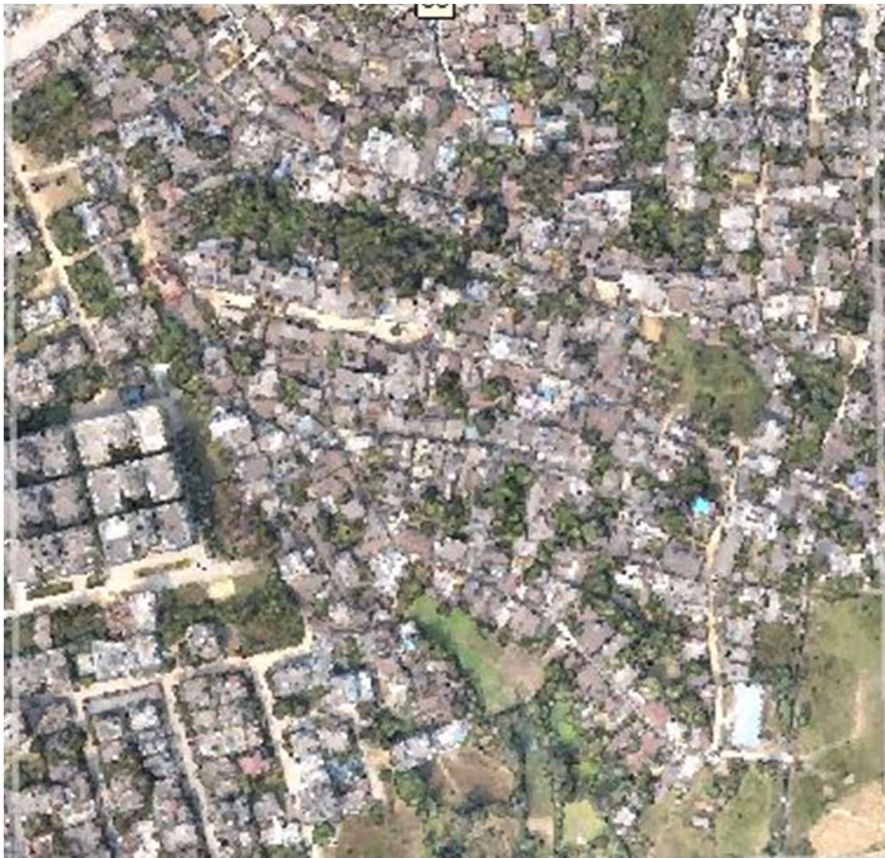
True Ortho 3-5 cm GSD



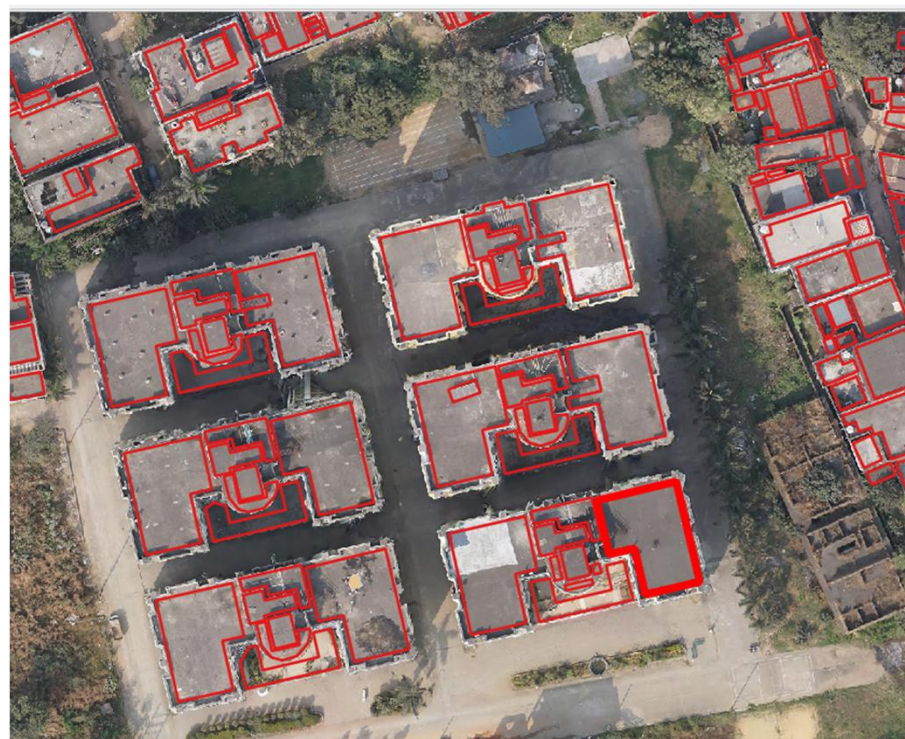
DSM



Point Cloud



Rooftop Digitization



Identify Results

Feature	Value
▼ 50_Slope_Aspect	
▼ Build_ID	50_14
▶ (Derived)	
▶ (Actions)	
Tile_ID	50
Build_ID	50_14
Poly_ID	50_14_9
Slope	0.036
Aspect	0.534

Rooftop Solar Potential



RTSE - Objective

- **Consumer**
 - Accurate information regarding system size, techno-economics, shadow-free area on roof
 - Marketplace to choose reliable developers and financing option
 - Assist in go/no-go decision making

- **DISCOMs & Developers**
 - Data room for demand aggregation
 - Customer acquisition

- **Web-based portal for Consumers, DISCOMs and developers**
 - Align with MNRE's national rooftop portal

RTSE – Outputs



○ Consumer Report (customizable)

- Existing
 - System size, placement on roof
 - Cost & techno-economics (payback and IRR)
 - Technical performance (generation and CUF)
- Proposed
 - Choice of vendors with costing and offerings
 - Choice of financing options with offerings
 - Integration with MNRE national rooftop portal and DISCOM portals

○ DISCOMs and Developers

- Subdivision-wise data room
- DPRs of all suitable rooftops in the ranges <3 kW, 3-10 kW, 10-50 kW, >50 kW

Unlock Rooftop Solar Potential of Your City

Get started

Microsoft Teams classic

Potential Assessment Results – Aerial Imagery



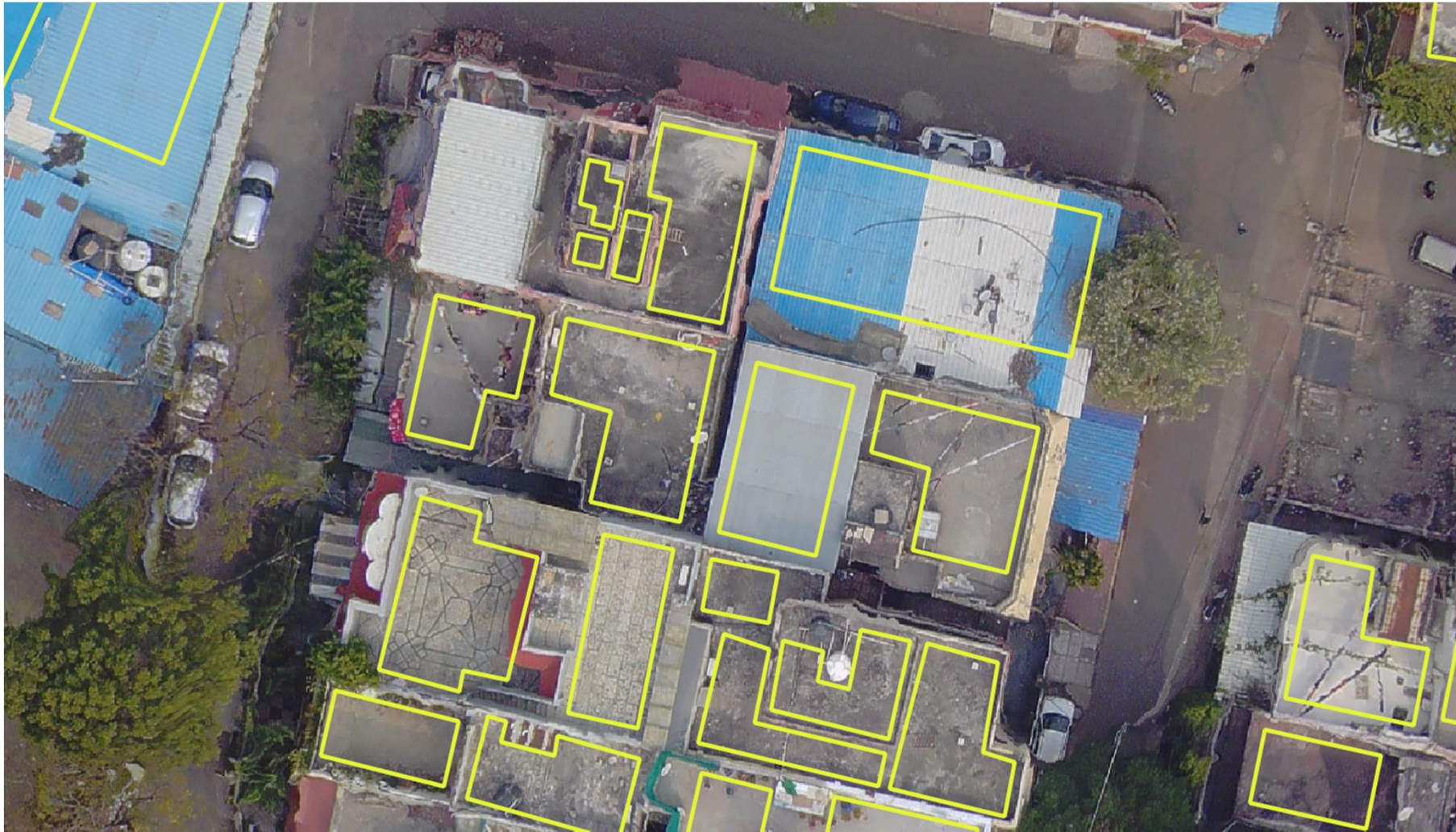
Bangalore			Bhopal			Indore			Gwalior			Jabalpur		
System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)
kW ≤ 3	675986	765	kW ≤ 3	104531	202	kW ≤ 3	84081	171	kW ≤ 3	62785	118	kW ≤ 3	22261	45
3 < kW ≤ 10	149267	763	3 < kW ≤ 10	78980	428	3 < kW ≤ 10	83425	453	3 < kW ≤ 10	42328	229	3 < kW ≤ 10	25456	144
10 < kW ≤ 50	40953	790	10 < kW ≤ 50	18988	354	10 < kW ≤ 50	23639	462	10 < kW ≤ 50	9040	159	10 < kW ≤ 50	5847	98
kW > 50	4538	481	kW > 50	1662	144	kW > 50	3640	362	kW > 50	546	45	kW > 50	241	21
	870744	2799		204161	1128		194785	1449		114699	550		53805	307
Raipur			Durg			Bilaspur			Korba			Raigarh		
System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)	System Size	No. of Polygons	Capacity (MW)
kW ≤ 3	68301	135	kW ≤ 3	52245	104	kW ≤ 3	33986	66	kW ≤ 3	22794	44	kW ≤ 3	9625	19
3 < kW ≤ 10	77923	448	3 < kW ≤ 10	55543	322	3 < kW ≤ 10	39417	232	3 < kW ≤ 10	17569	99	3 < kW ≤ 10	10767	63
10 < kW ≤ 50	24677	449	10 < kW ≤ 50	16232	277	10 < kW ≤ 50	11549	198	10 < kW ≤ 50	5113	88	10 < kW ≤ 50	3888	67
kW > 50	2184	202	kW > 50	1120	113	kW > 50	649	59	kW > 50	269	25	kW > 50	174	15
	173085	1234		125140	816		85601	555		45745	256		24454	164

Taxonomy – Morphological Settlement Zones (MSZ)

01	MSZ, open spaces, low vegetation surfaces NDVI ≤ 0.3
02	MSZ, open spaces, medium vegetation surfaces $0.3 < \text{NDVI} \leq 0.5$
03	MSZ, open spaces, high vegetation surfaces NDVI > 0.5
04	MSZ, open spaces, water surfaces LAND < 0.5
05	MSZ, open spaces, road surfaces
11	MSZ, built spaces, residential, building height $\leq 3\text{m}$
12	MSZ, built spaces, residential, $3\text{m} < \text{building height} \leq 6\text{m}$
13	MSZ, built spaces, residential, $6\text{m} < \text{building height} \leq 15\text{m}$
14	MSZ, built spaces, residential, $15\text{m} < \text{building height} \leq 30\text{m}$
15	MSZ, built spaces, residential, building height $> 30\text{m}$
21	MSZ, built spaces, non-residential, building height $\leq 3\text{m}$
22	MSZ, built spaces, non-residential, $3\text{m} < \text{building height} \leq 6\text{m}$
23	MSZ, built spaces, non-residential, $6\text{m} < \text{building height} \leq 15\text{m}$
24	MSZ, built spaces, non-residential, $15\text{m} < \text{building height} \leq 30\text{m}$
25	MSZ, built spaces, non-residential, building height $> 30\text{m}$

European Commission, **GHSL Data Package 2023**, Publications Office of the European Union, Luxembourg, 2023
10 m resolution data

Taxonomy – Building Polygons (LiDAR/UAV)



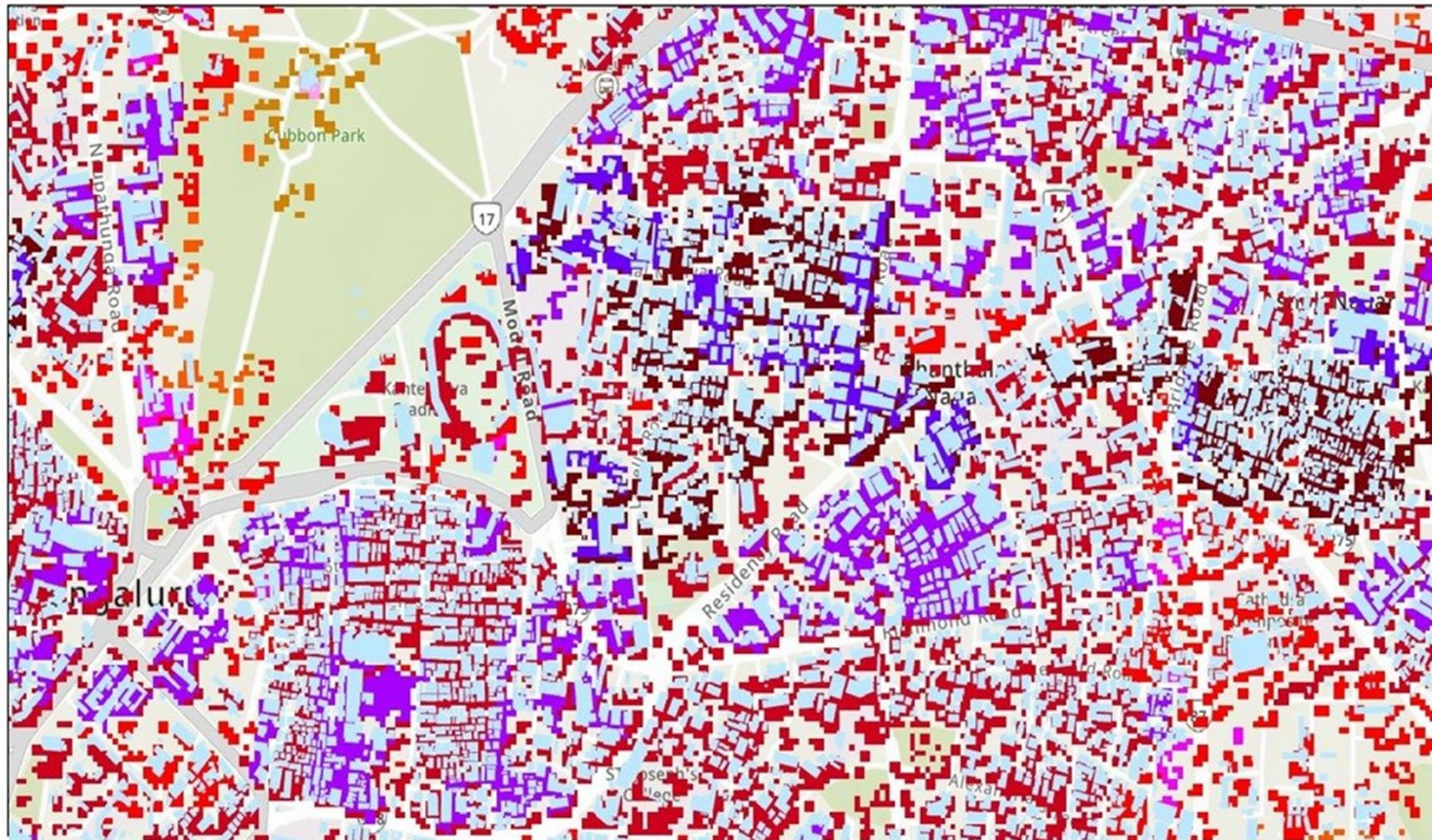
- 5 cm res. 3D data
- 50 cm DSM
- **11 cities**
 - Bengaluru
 - Bhopal
 - Indore
 - Gwalior
 - Jabalpur
 - Sanchi
 - Durg-Bhilai
 - Raipur
 - Raigarh
 - Korba
 - Bilaspur

Taxonomy – Microsoft Global Building Footprints



- 30-200 cm res. 2D data
- ~84 million buildings

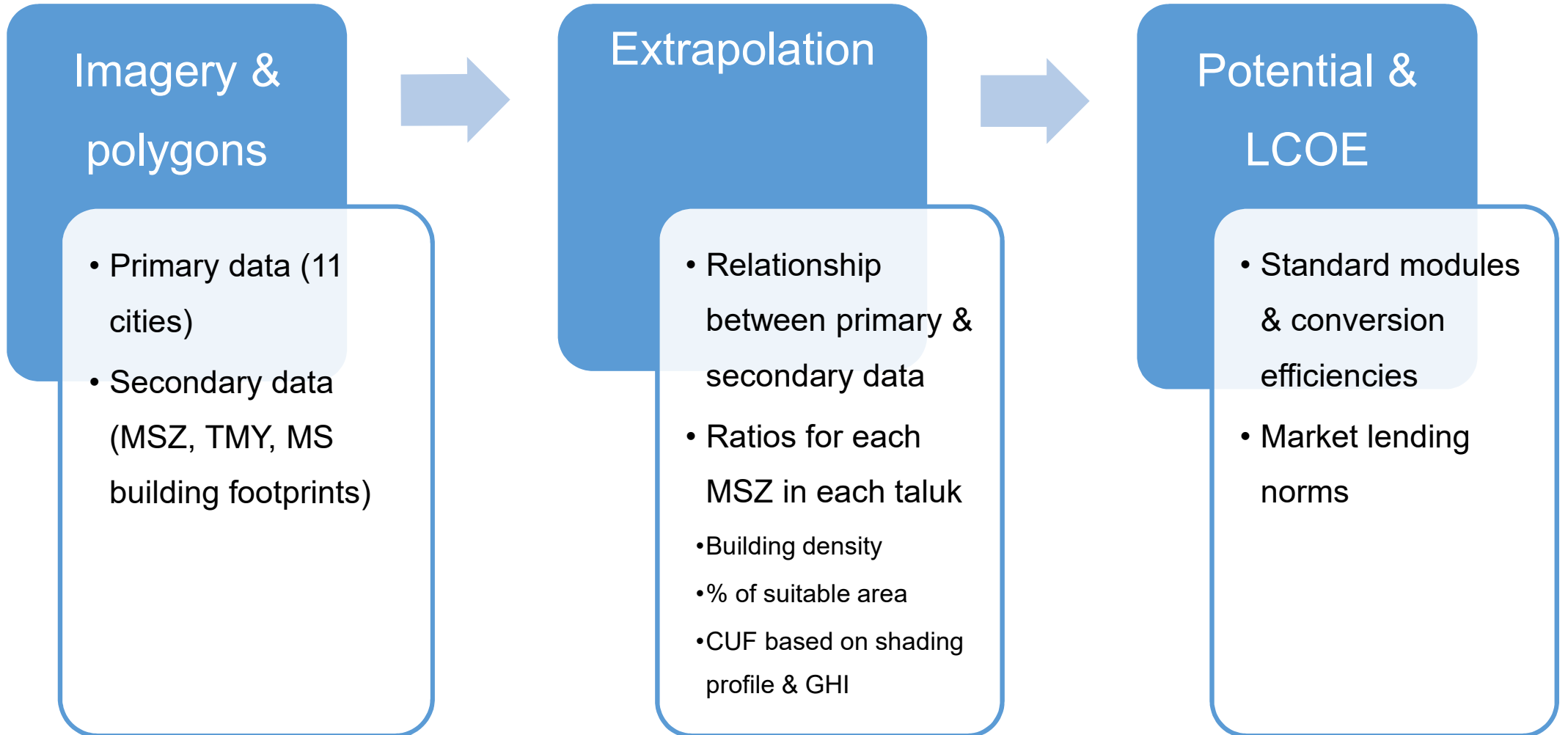
Methodology



Legend

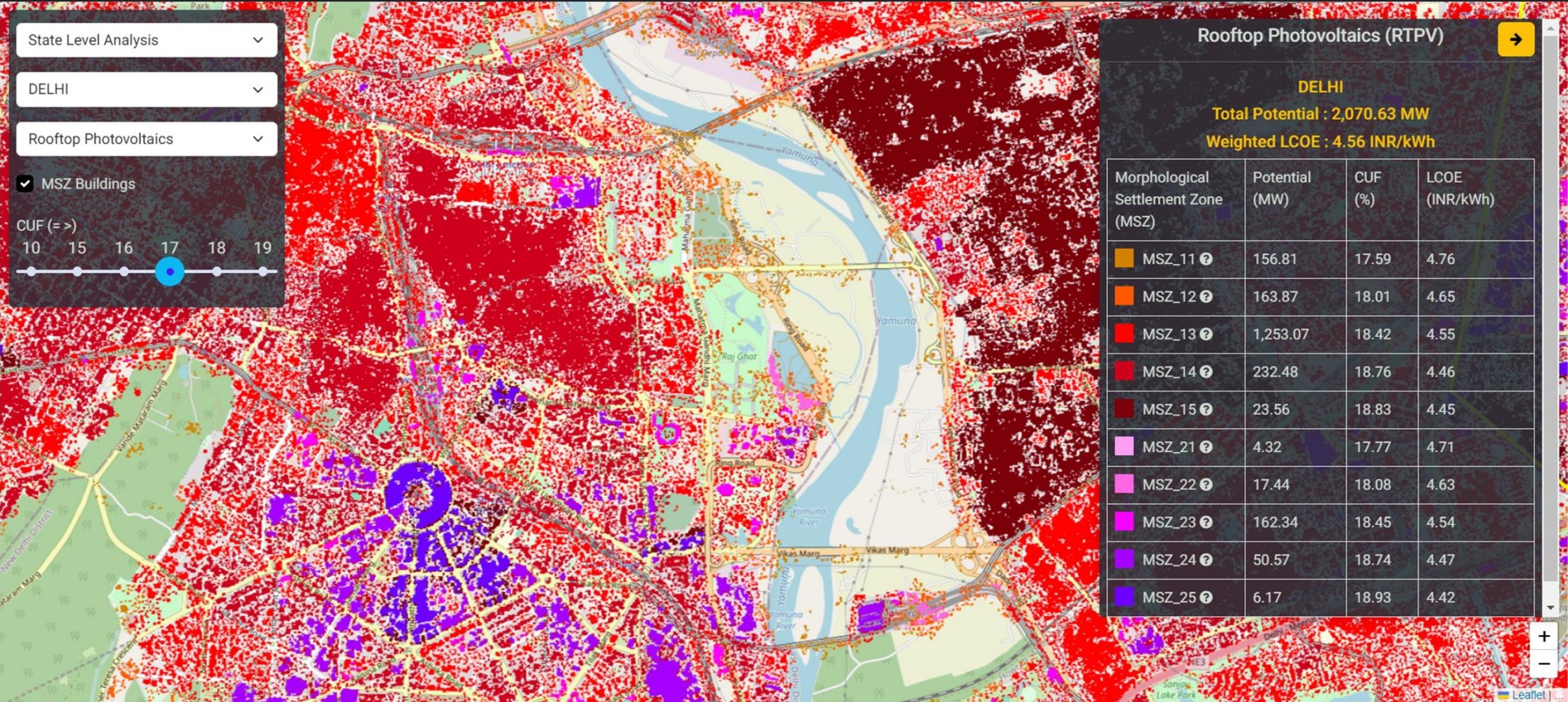
 MSZ 11	 MSZ 12	 MSZ 13	 MSZ 14	 MSZ 15
 MSZ 21	 MSZ 22	 MSZ 23	 MSZ 24	 MSZ 25
 Building Footprints				

Methodology



Methodology – Results

MNRE Decentralised Solar Atlas



<https://beta.cstep.in/mnredev/>

www.cstep.in

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Thank You!

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saptakg@cstep.in