

STATE OF THE MINI GRID MARKET GLOBALLY

Mini Grids for Half a Billion People



WORLD BANK GROUP
Energy & Extractives

**5th Mini Grid Action Learning
Event and Summit**
*Global Technical Conference on
Mini Grids*
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Global Summary of Installed and Planned Mini Grids

Totals calculated	Number of mini grids	Number of connections (Millions)	Number of people (Millions)	Number of developers identified	Median capital cost (US \$/kW)	Total capacity (MW)	Total investment (Mil. US \$)
Global totals: installed	19,163	10.0	46.9	5,690	4,410	6,481	28,302
Global totals: planned	7,507	8.1	39.1	323	4,444	2,646	12,365
Grand total	26,670	18.1	86.1	6,013	4,420	9,126	40,667

Sources: ESMAP research and analysis; Navigant Research; Bloomberg New Energy Finance (BNEF); World Bank surveys; Infinergia; Club-ER. See Annex slides for a full list of sources and detailed methodology.

Notes:

- (1) Data from 138 countries and territories.
- (2) Data likely underestimate the total number of mini grids globally due to the large number of small-scale diesel and hydro powered mini grids for which no data exists (yet), particularly in Asia, the Middle East, and North Africa.

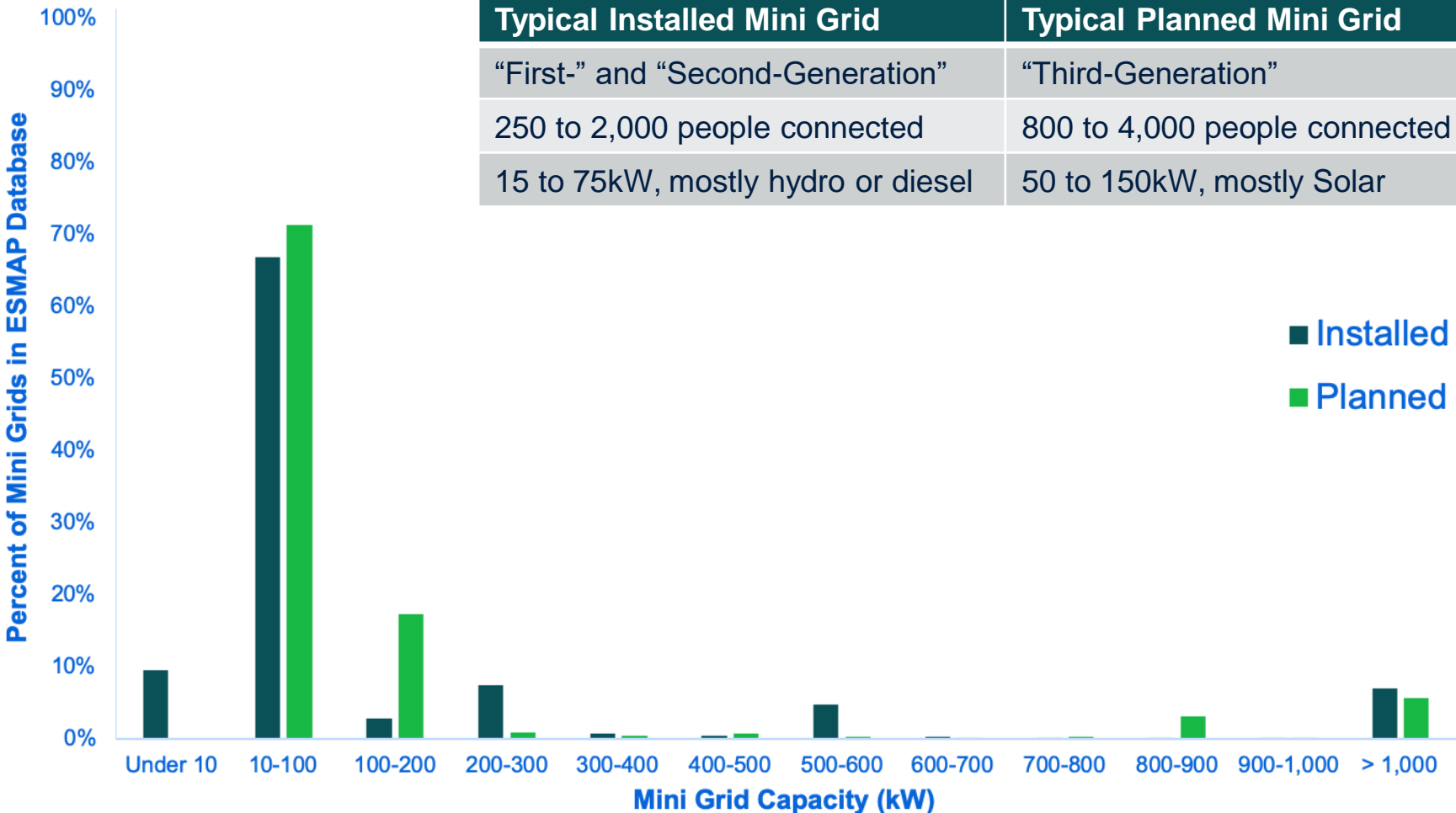
Data Availability and Sources

	Number of Installed Mini Grids with Data	% All Installed	Number of Planned Mini Grids with Data	% All Planned
Total Mini Grids	19,163	100%	7,507	100%
Total Capacity	17,761	93%	6,012	80%
Companies Involved	12,892	67%	3,108	41%
Cost per kW	11,147	58%	1,476	20%
Capacity by Technology	10,164	53%	2,810	37%
Number of Connections	7,902	41%	4,001	53%
Number of People	7,579	40%	3,610	48%
Year Operational	3,568	19%	441	6%

Main Data Sources

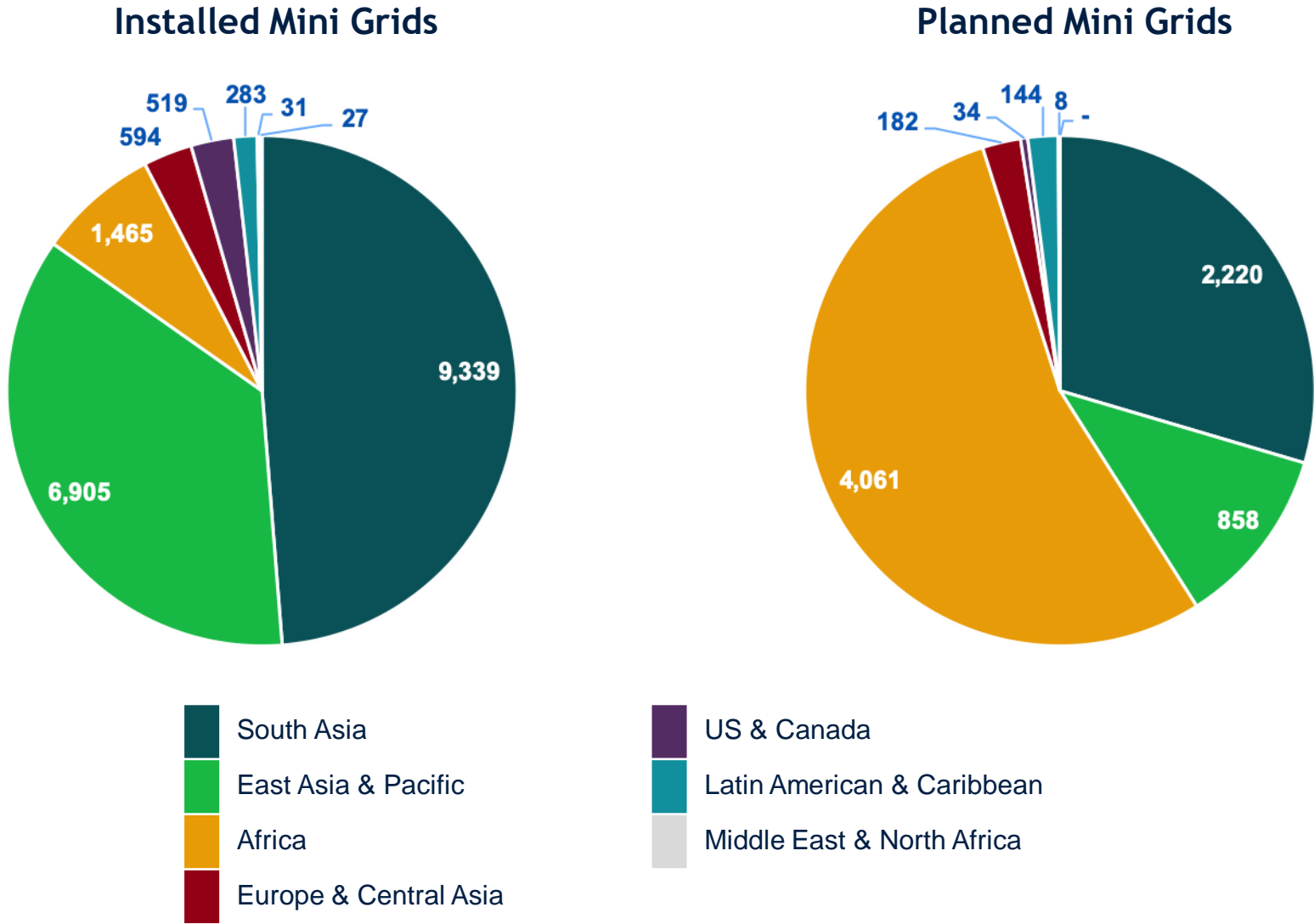
- Proprietary and open-access databases from Navigant Research, Bloomberg New Energy Finance, and the Green Mini Grid Market Development Program
- World Bank surveys of mini grid operators in Myanmar, Nepal, and Cambodia
- Interviews and desk research conducted by Navigant and ESMAP for more than 50 countries
- Reports from Infinergia, ECREEE, and IRENA

Mini Grid Characteristics



Typical Installed Mini Grid	Typical Planned Mini Grid
“First-” and “Second-Generation”	“Third-Generation”
250 to 2,000 people connected	800 to 4,000 people connected
15 to 75kW, mostly hydro or diesel	50 to 150kW, mostly Solar

Comparison of Installed and Planned Mini Grids by Region



Regional Summary of Installed Mini Grids

Region	Number of mini grids	Number of connections (millions)	Number of people (millions)	Number of developers identified	Median capital cost (\$/kW)	Total capacity (MW)	Total investment (million \$)
South Asia	9,339	2.9	16.2	537	1,850	298	632
East Asia and Pacific	6,905	2.9	12.1	4,158	4,379	1,721	8,236
Africa	1,465	3.0	14.9	479	6,668	783	3,966
Europe and Central Asia	594	0.1	0.3	56	5,015	1,007	5,050
United States and Canada	519	0.2	0.6	246	3,973	2,152	8,551
Latin America and Caribbean	283	0.7	2.7	188	3,800	456	1,632
Middle East and North Africa	31	0.1	0.1	17	3,387	32	110
Other Island Territories	27	> 0.1	> 0.1	9	3,986	31	125
Global total	19,163	10.1	46.9	5,690	4,410	6,481	28,302

Note: Data remain scarce for the Europe and Central Asia, Latin America and Caribbean, and Middle East and North Africa regions, where there are likely to be significantly more mini grids than what is captured in the table above.

Top Ten Lists for Installed Mini Grids

Rank	Number of mini grids	Millions of people (% population)
1	Afghanistan: 4,980	Afghanistan: 7.5 (21%)
2	Myanmar: 3,988	Philippines: 7.3 (7%)
3	India: 2,800	India: 6.2 (<1%)
4	Nepal: 1,519	Madagascar: 3.6 (14%)
5	China: 1,184	Tanzania: 3.0 (5%)
6	Philippines: 896	DRC: 2.6 (3%)
7	Indonesia: 583	Nepal: 1.7 (6%)
8	Russia: 501	Myanmar: 1.4 (3%)
9	United States: 391	Peru: 0.9 (3%)
10	Senegal: 272	China: 0.8 (<1%)
Total (% global)	17,114 (89%)	35.0 (75%)

Top Ten Lists for Installed Mini Grids

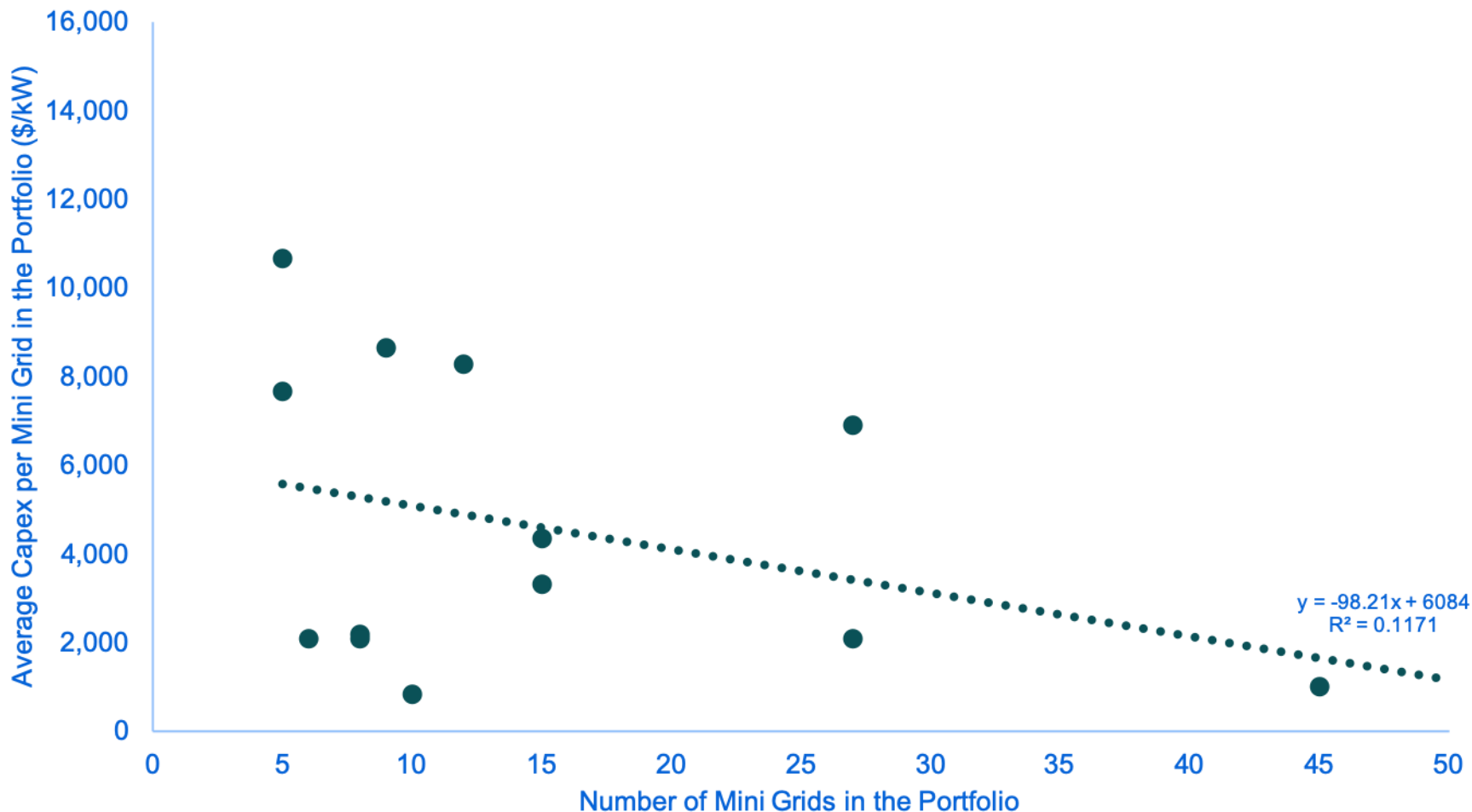
Rank	Median Capex (US\$/kW)	Total capacity (MW)	Total investment (million US\$)
1	Mexico: \$1,456	United States: 1,594	United States: \$6,332
2	Chile: \$1,667	Russia: 671	Russia: \$3,364
3	Afghanistan: \$1,850	Canada: 558	Canada: \$2,219
4	Kenya: \$2,102	China: 472	China: \$2,068
5	DRC: \$2,320	Philippines: 397	Philippines: \$2,035
6	Uganda: \$2,435	Australia: 287	Madagascar: \$1,167
7	Tanzania: \$2,680	Japan: 219	Australia: \$1,092
8	Myanmar: \$2,707	Madagascar: 175	South Korea: \$1,072
9	Cambodia: \$2,986	Tanzania: 158	Japan: \$958
10	Indonesia: \$3,000	India: 138	Spain: \$487
Total (% global)	n.a.	4,668 (72%)	\$20,794 (73%)

Top Ten Lists for Installed Mini Grids

Rank	Number of developers	Developer portfolios (MGs per portfolio, country)
1	Myanmar: 3,986	NPC-SPUG: (750, Philippines)
2	Nepal: 440	UN Habitat: (646, Afghanistan)
3	United States: 217	Aga Khan Dev. Ntwrk.: (551, Afghanistan)
4	Mali: 124	CARE International: (543, Afghanistan)
5	Peru: 96	RAO Energy: (500, Russian Fed.)
6	Burkina Faso: 93	BRAC: (422, Afghanistan)
7	Cambodia: 50	Afghan Aid: (344, Afghanistan)
8	Tanzania: 47	Int'l Rescue Committee: (344, Afghanistan)
9	Afghanistan: 42	Swed. Cmte. for Afgh.: (312, Afghanistan)
10	Haiti: 36	People in Need: (221, Afghanistan)
Total (% global)	5,131 (90%)	4,633 mini grids (24%)

Insights from the Data

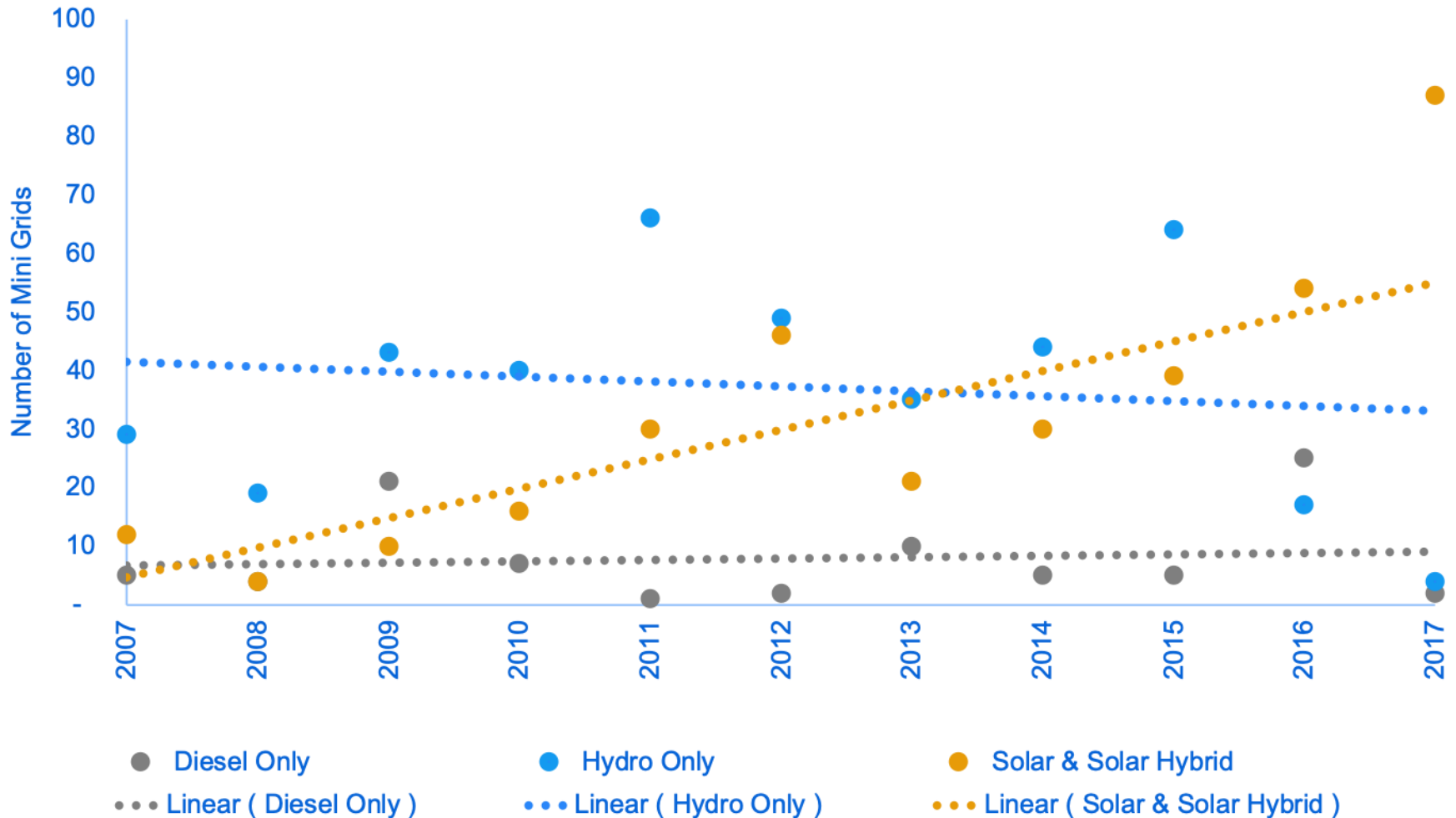
A portfolio approach to mini grid development can reduce capital costs by almost \$100/kW.



Note: Includes only portfolios of 5 or more mini grids for which capital cost data were available.

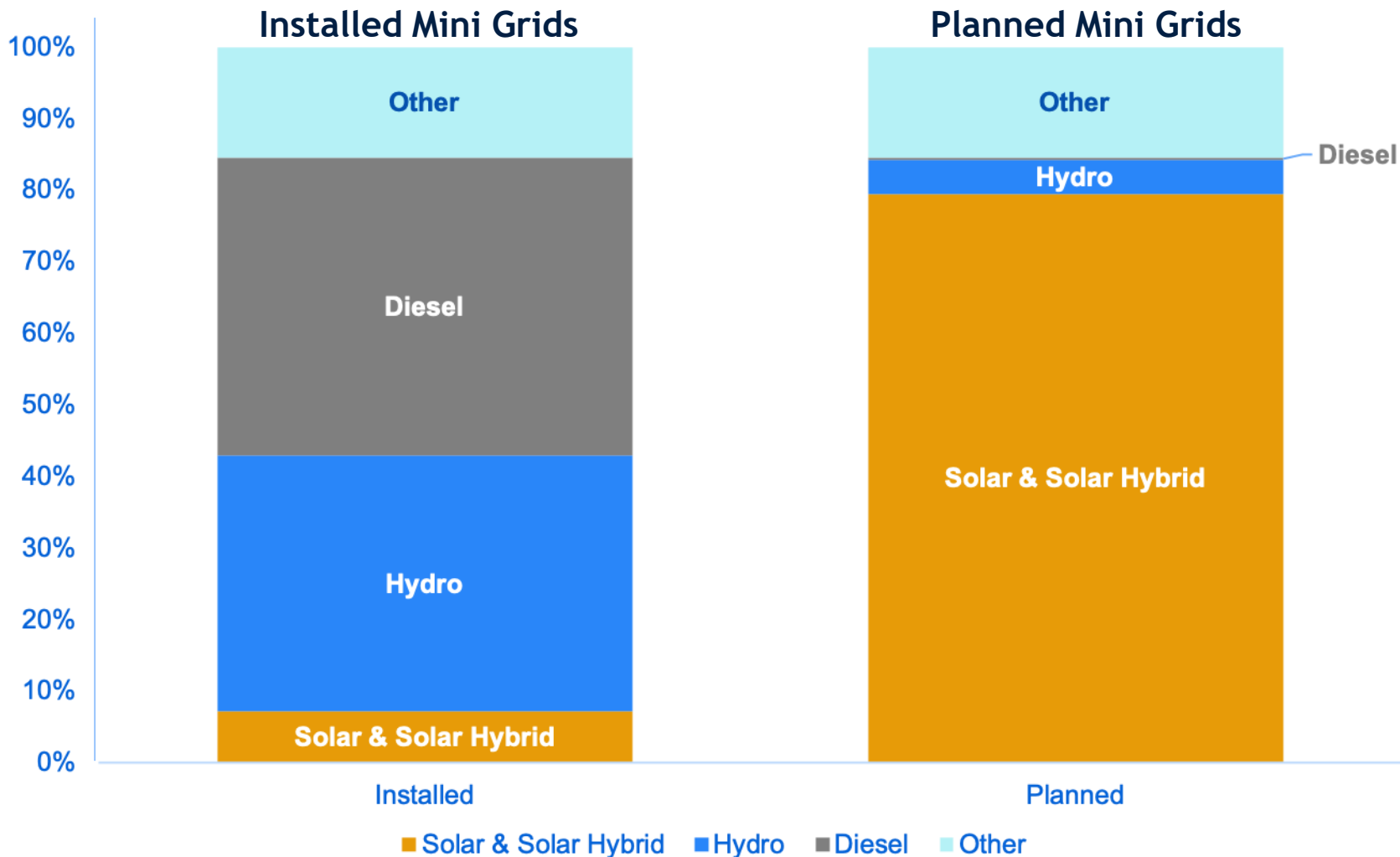
Insights from the Data

The number of solar and solar-hybrid mini grids installed each year has been increasing...

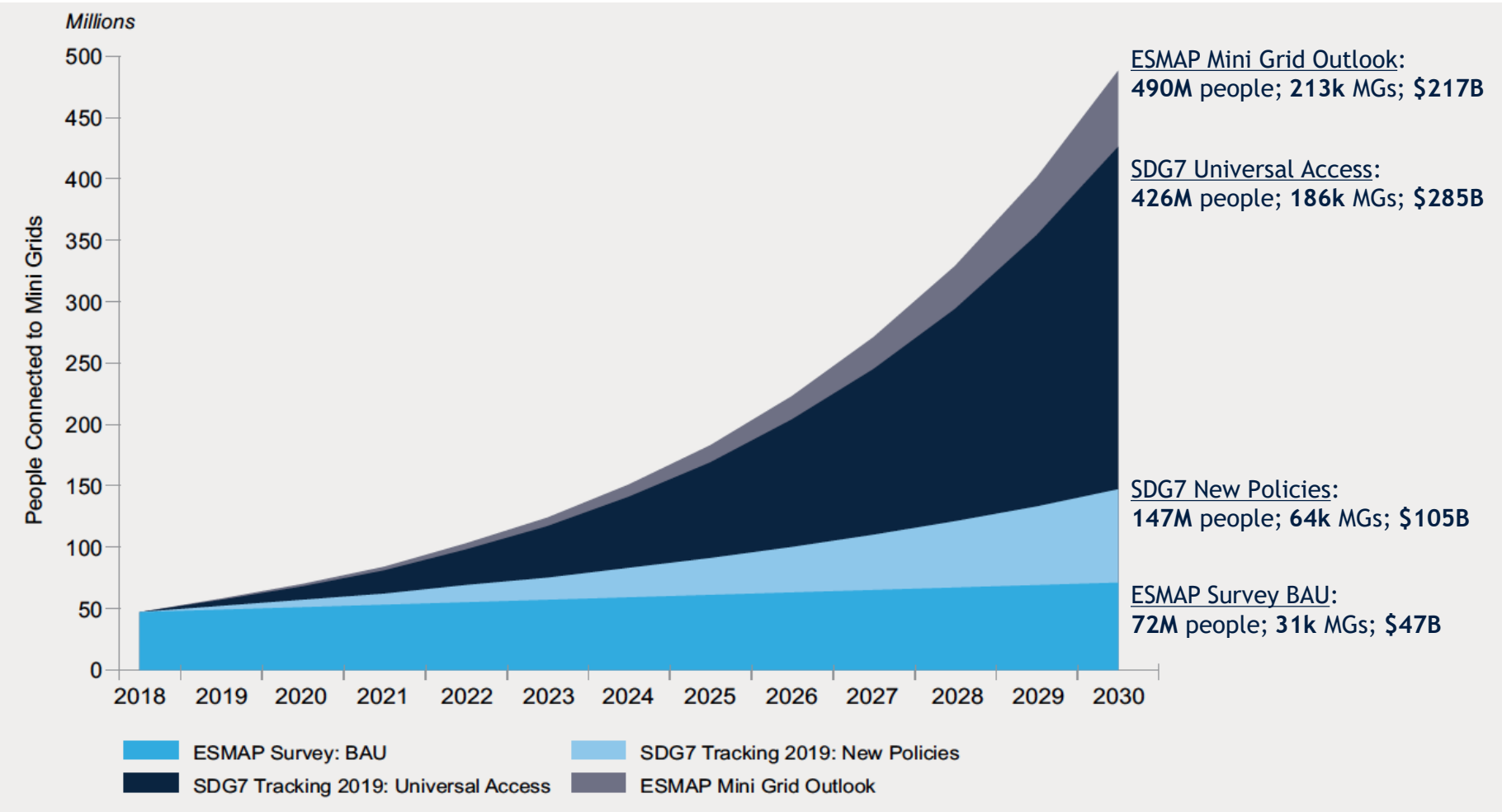


Insights from the Data

...and solar and solar-hybrid mini grids are the dominant technology for planned mini grids.



Market Outlook to 2030

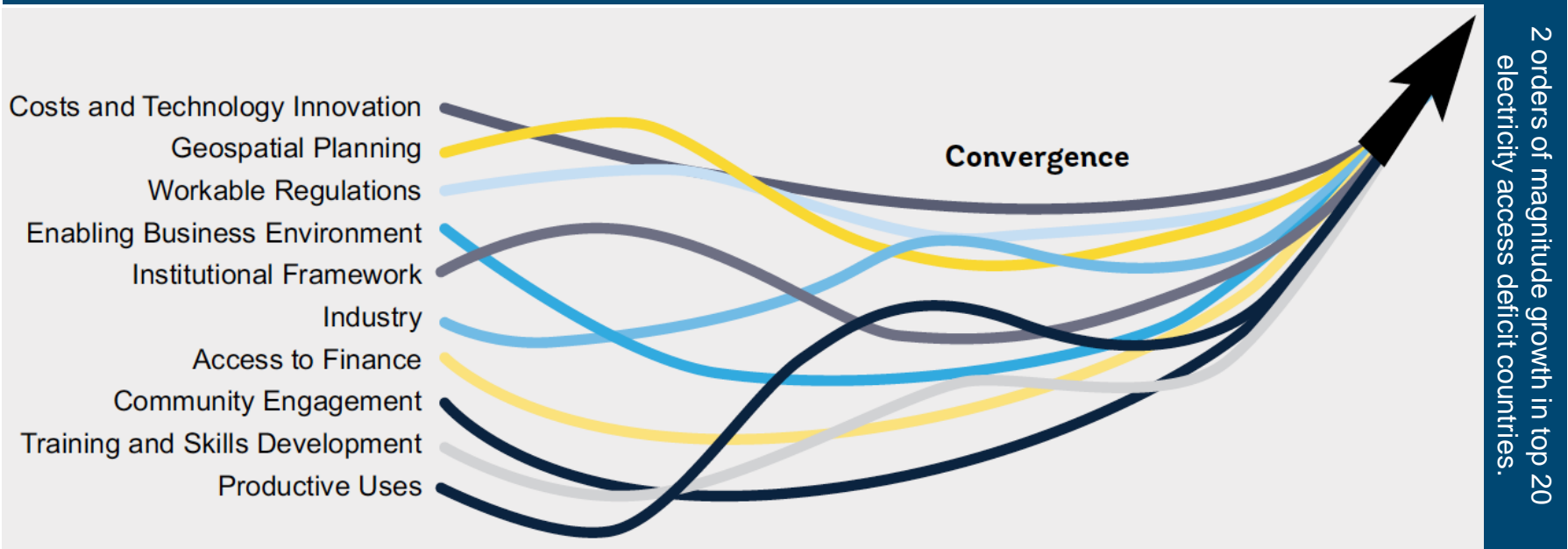


ESMAP Mini Grid Outlook: \$444 investment per person; mini grids provide 40% of all new connections to achieve SDG7.
SDG7 Universal Access: \$669 investment per person; mini grids provide 35% of all new connections to achieve SDG7 (IEA 2017).
SDG7 New Policies: \$713 investment per person; mini grids provide 26% of all new connections to achieve 92% global electrification.
ESMAP BAU: Number of mini grids, investment, and people connected grow linearly following 2007-2017 trajectory.

Conclusion

Where We Want to Be to Reach Universal Access by 2030

490 million people served at least cost by **210,000 mini grids**, mostly solar-hybrids, requiring an investment of **\$220 billion**.



Where We Are Today

47 million people connected to **19,000 mini grids**, mostly hydro and diesel-powered, at an investment cost of **\$28 billion**. *Plus: 7,500 mini grids planned, mostly in Africa, mostly solar-hybrid, connecting more than 27 million people at an investment cost of \$12 billion.*

CONTACT

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Thank you.

Annex

Data Sources

The ESMAP mini grid database consists of projects and project data from many sources. The main sources that provided data for mini grids in multiple countries are as follows:

- **Interviews and desk research** conducted by Navigant and ESMAP for more than 50 countries
- **Navigant Research proprietary database** of renewable energy microgrid projects globally;
- **Bloomberg New Energy Finance proprietary database** of renewable energy microgrid projects globally with a capacity greater than 100 kW;
- **A proprietary research report by Infinergia** published in 2018 entitled Mini-grid for Village Electrification: Industry and African & Asian Markets;
- **A 2016 survey report of mini grids in West Africa by ECREEE** (ECOWAS Centre for Renewable Energy and Energy Efficiency) entitled Mapping & Assessment of Existing Clean Energy Mini-Grid Experiences in West Africa, available online:
http://www.ecreee.org/sites/default/files/mapping_and_assessment_of_existing_clean_energy_mini-grid_experiences_in_west_africa_ecreee.pdf;
- **An open-access database of around 2,000 mini grid projects from CLUB-ER** (African Association for Rural Electrification), available online: <http://club-er.org/library/techno-economic-databases-324.html>;
- **A 2015 report from IRENA** (International Renewable Energy Agency) entitled Off-Grid Renewable Energy Systems: Status and Methodological Issues, available online: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_Off-grid_Renewable_Systems_WP_2015.pdf;
- **World Bank surveys of mini grid operators** in Myanmar, Nepal, and Cambodia;

Methods

Modeling to Fill Data Gaps

In general, median values were used instead of averages to avoid skewing effects of very large or very small mini grids. When carrying out the modeling, the following four-step cascading process was applied:

1. Whenever possible, and particularly for countries with relatively few projects, real-time desk research was conducted to try to find missing data, particularly on costs and number of connections or people.
2. If information specific to that mini grid could not be found, median values from other mini grids in the same country were used to minimize the impact of variations across countries, so long as a sufficient number of projects in that country had data for that metric.
3. In the absence of a sufficient number of data points for other mini grids in that same country, median values for mini grids in the same region were used.
4. In the rare case where no data existed at the regional level, median values at the global level were used.

Indicator	Formula for Estimation	Rationale
Number of mini grids	None—all data are from known projects and/or country totals from reputable sources	This approach resulted in a high degree of confidence that at least “X” number of installed and planned mini grids exist in the world today.
Number of connections	Median capacity per connection of other projects in that country or at the regional level, times total capacity	Using this formula instead of median capacity per mini grid x number of mini grids results in estimations less likely to be skewed by large single mini grids with many customers.
Number of people	Number of connections, times average household size for that country	While imperfect because it does not capture people at certain connections like schools or community centers, this method is both efficient and tailored to each country’s household demographics.
Median capital cost	Based on available data for total project cost/total capacity or existing cost-per-capacity data	Cost data are not readily available for most projects, so whatever cost data were available, either total upfront project cost or cost per capacity, were collected.

Mini Grid Characteristics

Totals calculated	Mini grids per portfolio	People per mini grid	Connections per mini grid	Capacity per connection (watts)	Capacity per mini grid (kW)
Global totals: installed (excluding Afghanistan)					
Median	4	539	117	223	50
Average	16	2,034	490	1,656	1,349
Number of Observations (N)	146 portfolios	2,836 MGs	3,159 MGs	3,113 MGs	13,845 MGs
Global totals: planned					
Median	32	1,000	200	150	30
Average	122	1,966	403	567	565
N	22	3,611	4,002	3,091	6,013
Grand total					
Median	5	1,000	174	135	23
Average	48	1,472	285	629	613
N	202	11,190	11,904	9,908	23,774

Top Ten Lists for Planned Mini Grids

Rank	Number of mini grids	Millions of people (% population)
1	India: 1,905	Philippines: 11.6 (11%)
2	Senegal: 1,217	India: 7.8 (<1%)
3	Nigeria: 879	Angola: 5.0 (17%)
4	Indonesia: 506	D. R. Congo: 3.1 (4%)
5	Tanzania: 301	Nigeria: 2.0 (1%)
6	Rwanda: 236	Tanzania: 1.5 (3%)
7	Kenya: 228	Indonesia: 1.3 (<1%)
8	Bangladesh: 215	Cameroon: 1.3 (5%)
9	Mali: 184	Senegal: 0.8 (6%)
10	Russia: 180	Mauritania: 0.6 (14%)
Total (% global)	5,636 (75%)	35,065,716 (90%)

Top Ten Lists for Planned Mini Grids

Rank	Median Capex (US\$/kW)	Total capacity (MW)	Total investment (million US\$)
1	Kenya: \$2,320	Philippines: 641	Philippines: \$3,554
2	Russia: \$2,397	Tanzania: 457	Tanzania: \$1,982
3	United States: \$3,696	Angola: 299	Angola: \$1,296
4	Mali: \$4,116	India: 174	India: \$821
5	Malawi: \$4,279	Russia: 147	D. R. Congo: \$613
6	Nigeria: \$4,400	D. R. Congo: 141	Nigeria: \$492
7	Argentina: \$4,444	Nigeria: 112	Russia: \$353
8	Bangladesh: \$4,725	Cameroon: 64	Australia: \$326
9	Australia: \$5,543	Australia: 59	Cameroon: \$275
10	Niger: \$8,357	Rwanda: 53	Rwanda: \$231
Total (% global)	n.a.	2,146 (81%)	\$9,943 (80%)

Top Ten Lists for Planned Mini Grids

Rank	Number of developers	Developer portfolios (MGs per portfolio, country)
1	Myanmar: 171	OMC: (996, India)
2	Burkina Faso: 18	PLN: (500, Indonesia)
3	Bangladesh: 15	Tiger Power: (500, India)
4	Haiti: 10	RAO Energy: (178, Russia)
5	Tanzania: 9	Husk Power Systems: (175, India)
6	India, US, Indon.: 7	AT2ER: (108, Togo)
7	Madagascar: 6	Eskom: (100, South Africa)
8	Cameroon: 5	Henri Frasier Fils & Cie: (100, Madagascar)
9	Austral., Maurita., Niger: 4	Powerhive: (100, Kenya)
10	Malawi: 3	Freyr Energy: (50, India)
Total (% global)	270 (84%)	2,807 mini grids (37% of all planned MGs)