Off-grid energy data collection: Lessons learned and best practices

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Outline

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3. Measurement and conversions
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5. Data management and processing
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Background

- Off-grid electricity supply serves many people and is expected to grow rapidly
- A lot of data exists, but it is scattered and not systematically measured
- Many autoproducers, including households and public services
- Large numbers of small plants

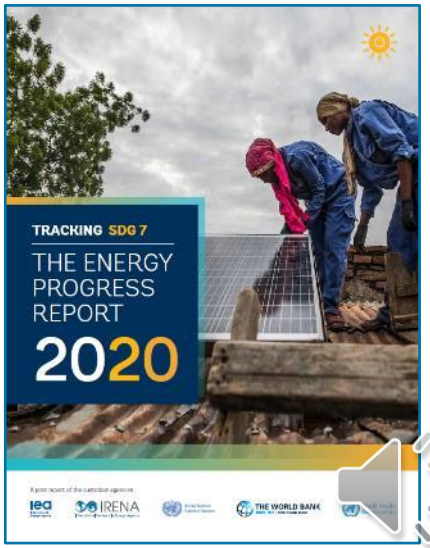
Objectives

Scope:

- Off-grid solar, hydro, biogas in developing countries (only biogas in China)

Purpose:

- Expand/refine our data for off-grid plants
- Separate on and off-grid plants in our DB
- Check the validity of off-grid estimates
- Standardise measurement and estimations
- Identify end-uses as far as possible
- Measure/estimate numbers of beneficiaries
- Examine linkages to other SDGs



Data sources

"Bottom-up" data collection

- Multiple data sources:
  - National databases and statistics
  - Trade and sales data
  - Projects and suppliers (websites, emails)
- Country and year
- Product (technology):
  - Electricity: hydro, biogas and solar PV (mini-grids, solar lights ,SHS, other uses)
  - Biogas
- Flow:
  - Capacity
  - Production and consumption (end-use)
  - Number of beneficiaries and access level

Measurement and conversions

A lot of raw data is "number of units" and needs to be converted to standard units of flow (capacity, production and number of beneficiaries)

- Biogas digesters:
  - Number of units, digester size (m^3), total capacity (m^3)
  - Annual production (m^3) [can also be converted to MJ]
- Electricity (including biogas generators):
  - Number of units, unit size (W), total capacity (kW)
  - Annual generation (MWh) [capacity x 8,760 x utilisation factor]
- Number of beneficiaries:
  - Number of households and number of people
  - Need to check "real" number of connections!
  - Electricity access "Tiers" based on annual supply per household

Estimations and assumptions

Biogas production estimates



- Daily gas production (small-scale):
  - Floating drum, dome: = capacity / 3
  - Bag digesters: = capacity / 4

- Industrial-scale digesters (electricity):
  - Daily gas production is highly variable
  - One m^3 of biogas generates 2kWh
  - Estimate biogas production from electricity generation if possible (or vice-versa), or estimate using an assumed generator capacity utilisation (usually 40-50%)


e.g. covered lagoon (20,000 m^3) with 300kW generator:
= 300 x 24 x 0.5 = 3,600 kWh/day (50% capacity)
= 1,800 m^3/day biogas (9% digester capacity)

Estimations and assumptions

Solar power capacity

- Lights, lighting kits, SHS: estimated from pictures or descriptions of the devices or end-uses

Portable light <1W (0.7W)

Portable light 1<3W (3.4W)

Lighting kit 3<11W (5+10W)

Home system 11W+ (20W)

- Other types of off-grid solar: estimated from pictures or end-uses (one full-sized solar cell = 5W)

Solar water pump
2-4kW for irrigation
(9x4x5x4 = 720W shown)

Communication mast
1-6kW depending on use
(180x24 = 4,320W shown)

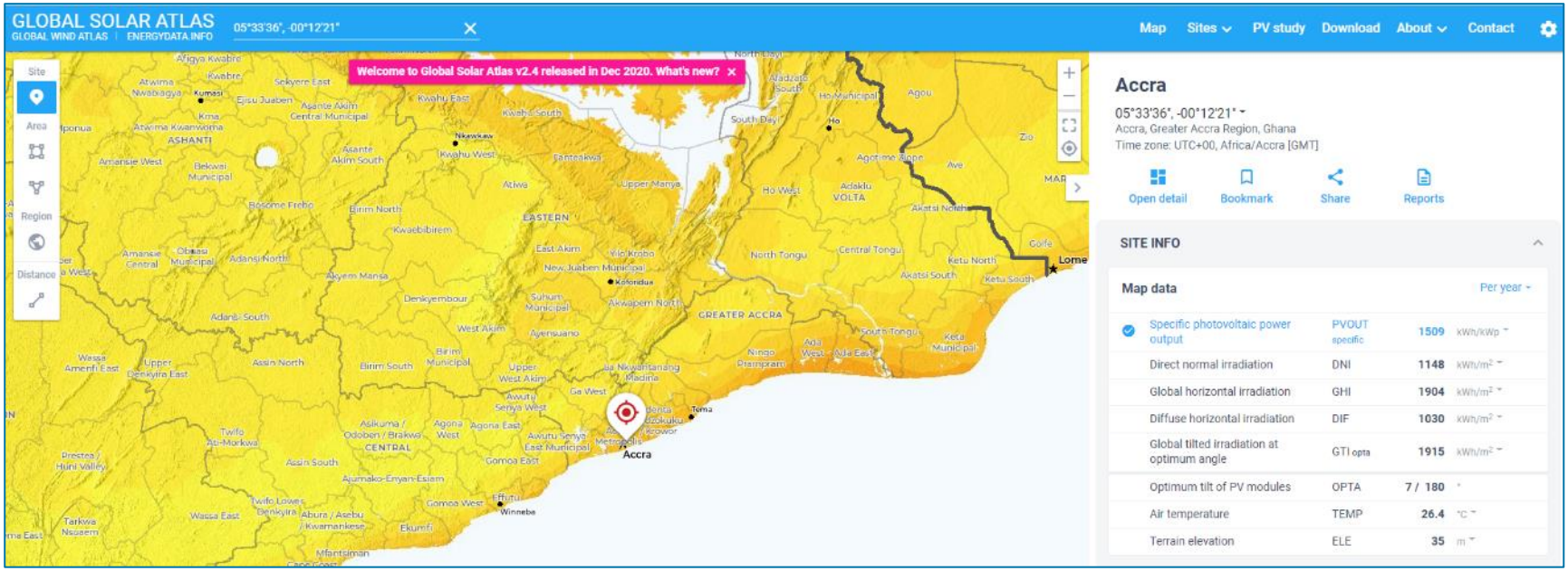
Solar street lights
100-200W for minor roads
(360x2 = 720W shown)

Note: solar panel capacity is 3-4 times the power rating of the lightbulbs used

Estimations and assumptions

Solar power generation

- Use Global Solar Atlas default values (kWh/yr per kW)



Hydro power generation

- Use capacity utilisation factor from on-grid in the country or an assumed consumption per capita

Estimations and assumptions

Decommissioning and losses (non-use)

- Small-scale biogas: declining use by 5-year period (e.g. India: 95%/85%/65%/45%/10%, 1-5yrs/6-10yrs/etc.)
- Large-scale biogas: assumed to still operate
- Solar lights and lighting kits (<11W): 3 years
- Solar home systems (11W+): 5 years
- Distribution losses 3% and repeat sales of lights 10%
- Some solar home systems assumed to still operate (e.g. where provided by utilities or government)
- Other solar and hydro: assumed to still operate

Estimations and assumptions

Number of beneficiaries and level of access

- Number of households and people both recorded (based on average rural/national household size)

  <u>For mini-grids:</u>

- Validity checks to make sure numbers quoted represent likely number of connections
- Use connection figures (HH/kW) from other plants in a country or assume supply of 5-10HH/kW
- Level of electricity access is based on average household supply
  (Tier 1: 4.5 kWh/HH/yr Tier 2: 73 kWh/HH/yr)

Data management

Metadata:

- Data table: 22 fields
  - Location, plant name, source, product, year (8 fields)
  - Capacity; production; end-use; beneficiaries; tiers (8 fields)
  - Other notes (6 fields)

Product classification:

- Energy source (solar PV, hydro, biogas - 3 separate files)
- Solar PV divided by technology type:
  - Solar lights (<11W), small SHS (11-50W), large SHS (>50W)
  - Solar mini-grids
  - Solar pumps (agriculture; public water supply; other)
  - Other PV (street lights; phone towers; clinics; schools; etc.)

Data processing

Calendar:

- Data collected throughout the year, compiled, validated and published at the end of the year.

Conversion to annual time-series:

- Pivot tables convert plant records into gross annual additions (capacity, beneficiaries, biogas production)
- Final tables produced by aggregating gross annual additions, taking into account decommissioning

Use in other IRENA statistics:

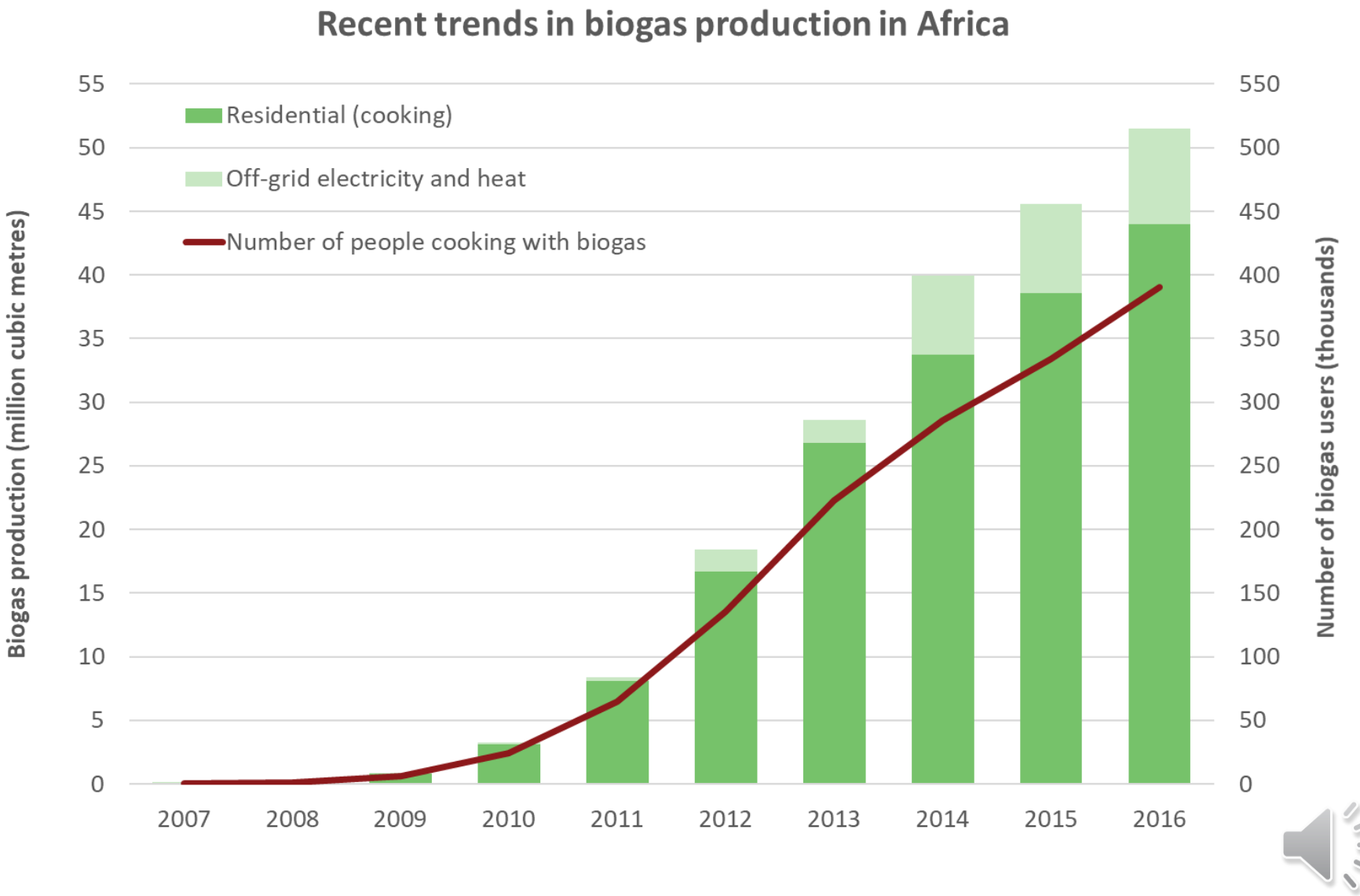
- Added to IRENA questionnaires as supplemental sheet for validation of national data and estimates

Results

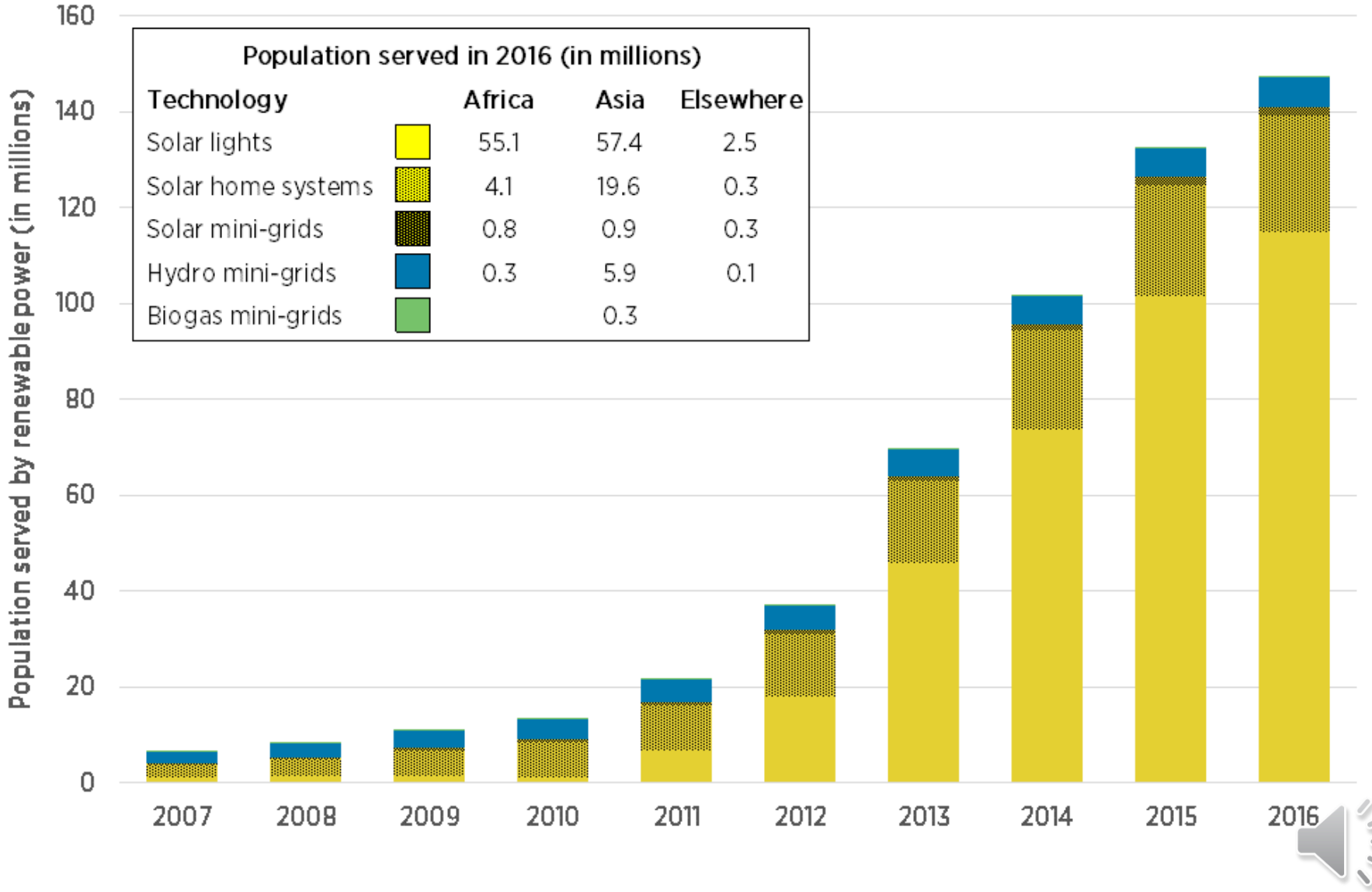
Number of plants in the database (to end-2019):

Product (technology)	Number of records	Number of plants
Biogas digesters	532	41,894,459
Biogas generators	91	558
Hydropower	721	38,884
Solar lights, SHS	894	69,615,233
Solar mini-grids	342	9,471
Solar water pumps	627	233,020
Other PV	686	1,019,571

Results


Recent trends in biogas production in Africa
Residential (cooking)
Off-grid electricity and heat
Number of people cooking with biogas
Biogas production (million cubic metres)
Number of biogas users (thousands)
0
5
10
15
20
25
30
35
40
45
50
55
0
50
100
150
200
250
300
350
400
450
500
550
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

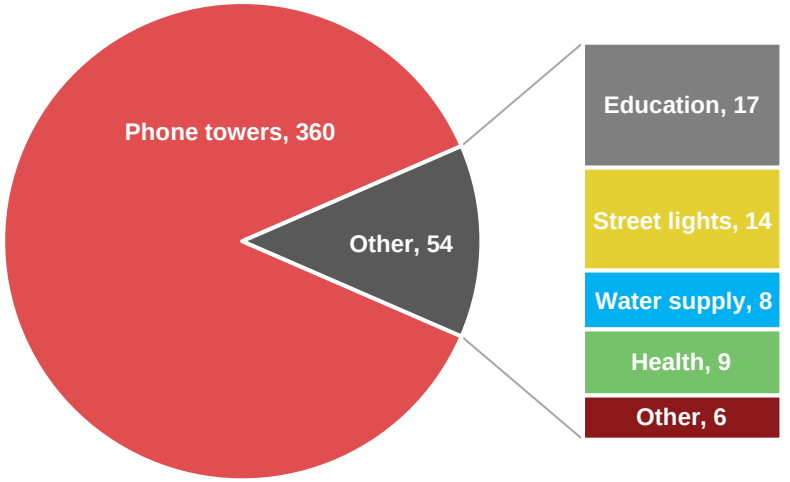
Results


Population served in 2016 (in millions)
Technology
Africa
Asia
Elsewhere
Solar lights
55.1
57.4
2.5
Solar home systems
4.1
19.6
0.3
Solar mini-grids
0.8
0.9
0.3
Hydro mini-grids
0.3
5.9
0.1
Biogas mini-grids
0.3
Population served by renewable power (in millions)
160
140
120
100
80
60
40
20
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

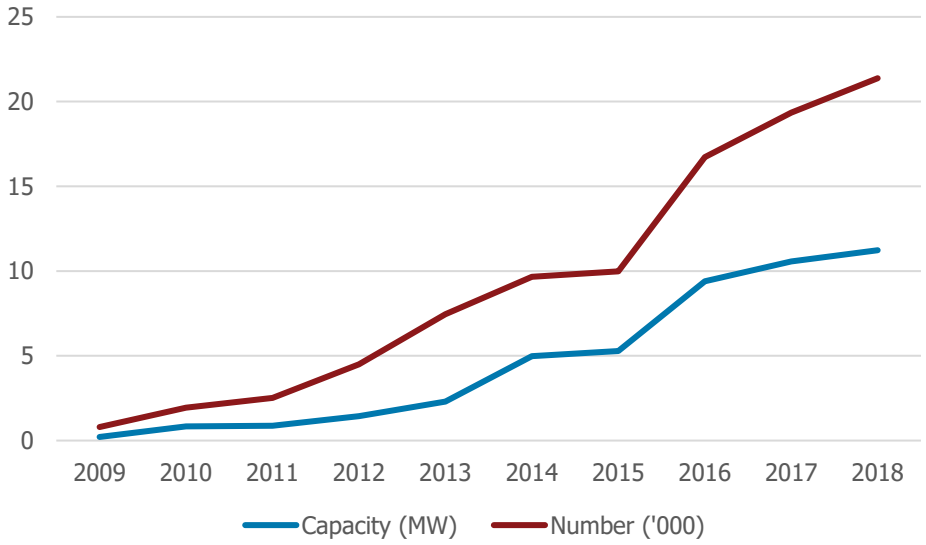
Results

Solar PV is becoming the power source of choice for pumping, phone towers, street lighting, rural clinics (including fridges) and other remote locations

Commercial and public uses of solar PV (total = 414 MW)



Growth in the use of solar PV in health care



Solar PV improves the delivery of health care for millions of people and varies in scale from small portable devices to major plants powering small hospitals

Lessons learned

- A considerable amount of data does exist and can be used, but data needs to go beyond “number of plants”.
- Basic level of good statistical practice is required (metadata, classification, measurement units).
- Reporting of number of beneficiaries needs improving (and could be expanded to other types of benefit).
- Decommissioning has to be considered. Gross additions can not simply be aggregated indefinitely.
- Many countries will need to include off-grid data in their statistics if current trends continue, including from non-traditional suppliers and operators.

IRENA

International Renewable Energy Agency