WISIONS Webinar Series| Webinar 2 | 19.04.2018

What if the grid arrives?
How off-grid renewable energy projects have adapted to grid arrival

Moderator: Molly Hurley Depret

Panelists:

- **Chris Greacen**, Palang Thai
- **Rebecca Leaf**, Association of Rural Development Workers Benjamin Linder (ATDER-BL, Nicaragua)
- **Junaed Tazdik**, IDCOL Assistant Manager, SHS Program
- **Mafruda Rahman**, Green Climate Fund (GCF)
- **Carmen Dienst**, WISIONS coordinator, Wuppertal institute

What if the grid arrives?
Key questions to be addressed

When the national electricity grid reaches off-grid areas, communities, governments, and other stakeholders are left with major decisions to make and have concerns on:

- **What will become of stand-alone renewable energy systems or micro-grid solutions?**
- **Will they sustain and survive? Can and shall they become connected to the grid?**
- **What are preconditions and challenges?**
- **And how can communities with off-grid systems best plan and prepare for this possibility?**

WISIONS background

What is WISIONS initiative about?

www.wisions.net

- **WISIONS** **started in 2004** promoting sustainable energy solutions in developing regions (with support from “Stiftung ProEvolution”)
- Main objective of WISIONS is to **make clean energy a default solution** for basic energy needs in developing regions,
- by helping **local partners** to identify successes and bring them to scale through **demonstration, marketing and regional networks.**
- The initiative’s approach is **need-oriented** and aims to **empower local practitioners**

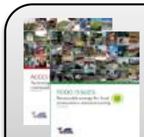
WISIONS structure

Wuppertal Institute Supervision

Coordination - Strategic reflection

Knowledge Sharing

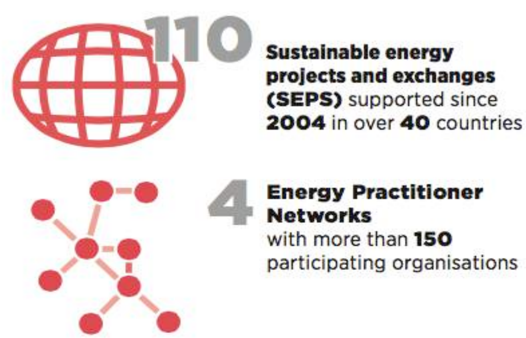
Dissemination & Advocacy

- **wisions.net** Blog & NL
- 
  Brochures Factsheet
- 
  Scien. papers & conf.
- Webinars

Supporting Tools & Grants

SEPS - Sustainable Energy Project Support

Exchanging experience & practical learning



Practitioner Networks' Support

Research

delivery models; outcomes/impacts

- Contribution to Sust. Dev.
- Post-Evaluations
- Understanding transformation

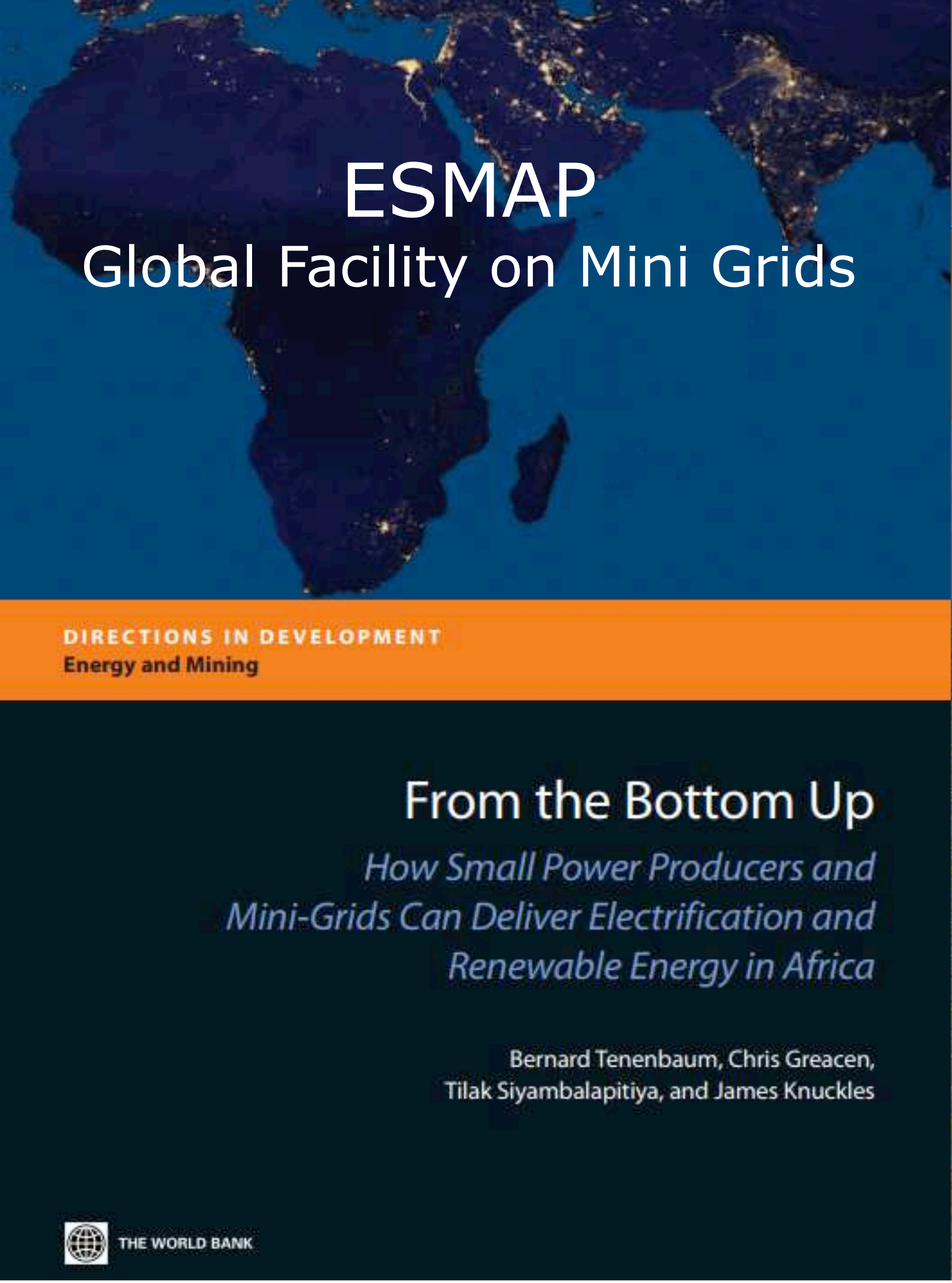
Mini-grids and the Arrival of the National Grid

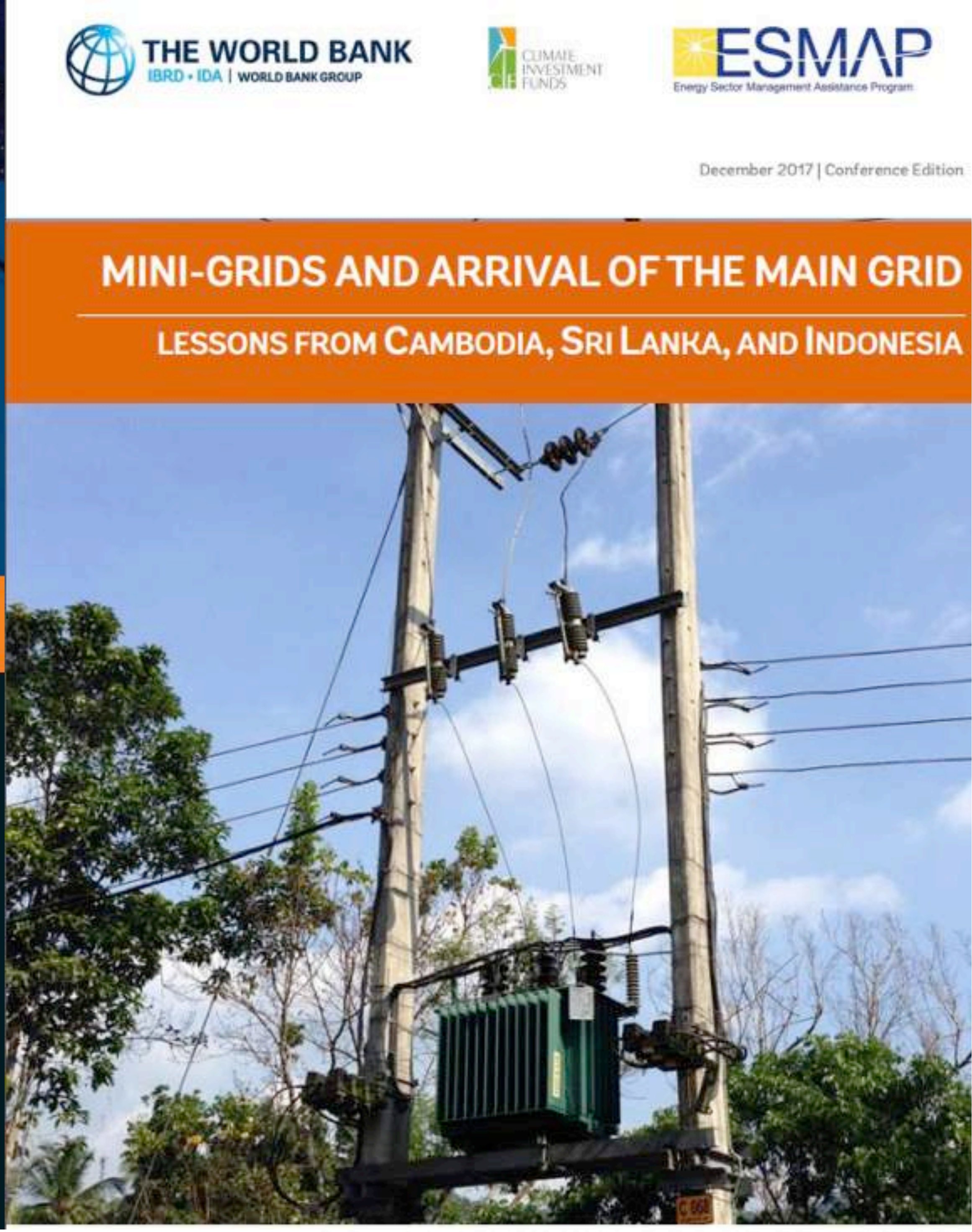
***Wisions Webinar**:*

What if the grid arrives?: How off-grid renewable energy projects have adapted to grid arrival

- **Chris Greacen**
- **19 April, 2018**

ESMAP
Global Facility on Mini Grids





http://tiny.cc/BottomUp

http://tiny.cc/gridarrival

Off-grid

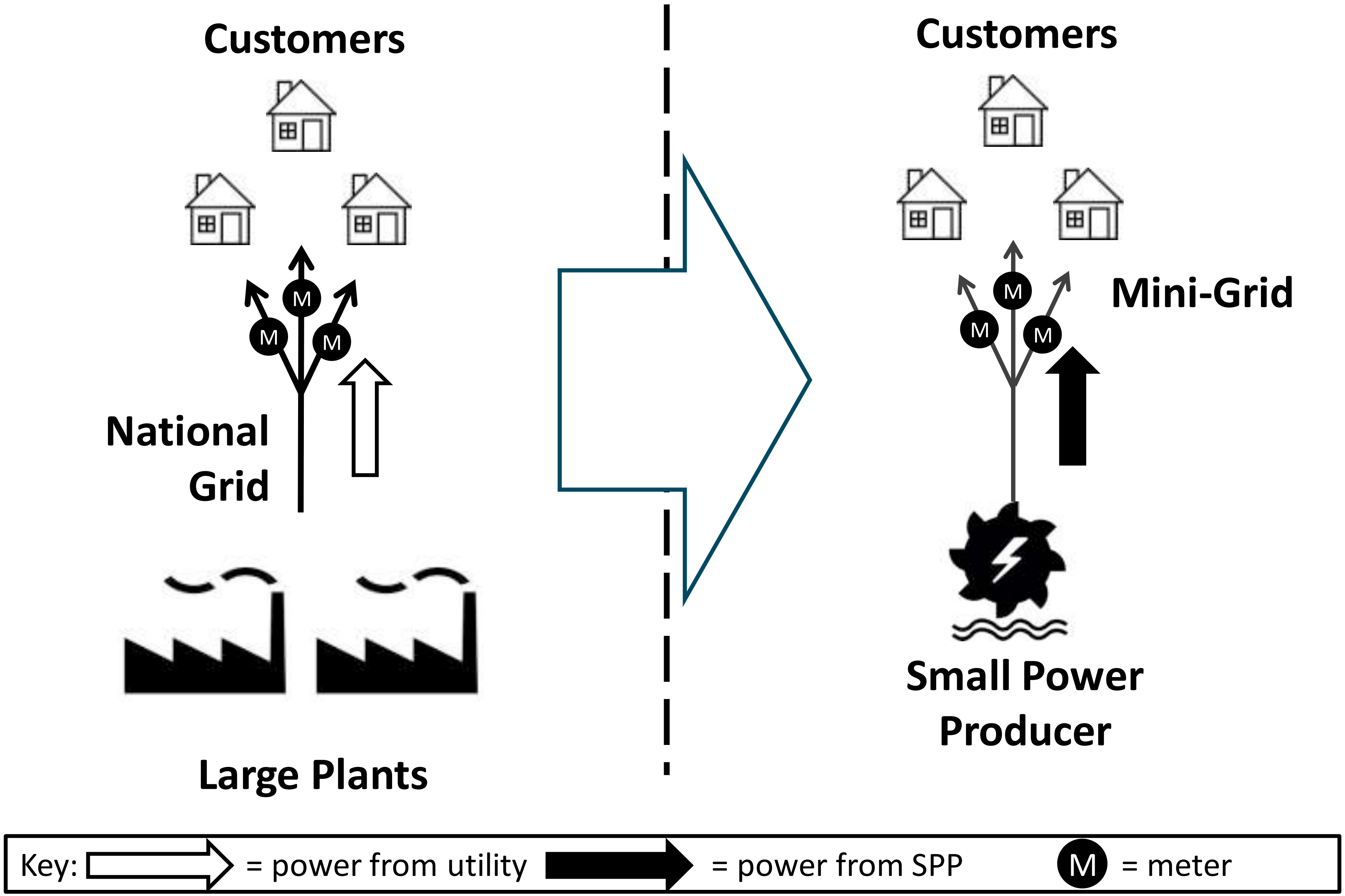
+ **Village scale – Mini grid**

+ **Household scale - SHS**

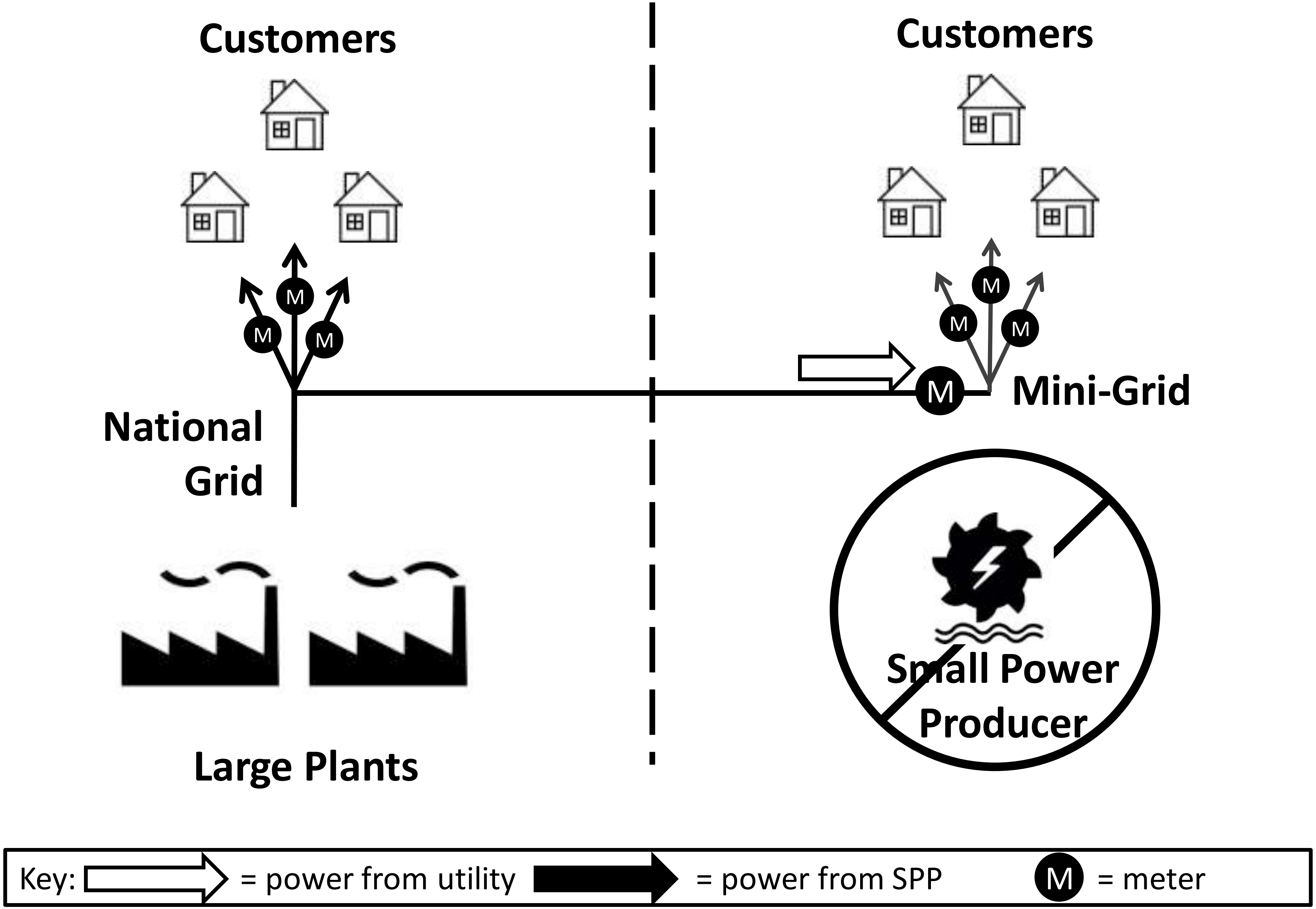
Mini grid options after arrival of the main grid

- Small Power Distributor (SPD)
- Small Power Producer (SPP)
- Both SPD and SPP
- Separate systems in the same village
- Assets abandoned
- Buyout by utility

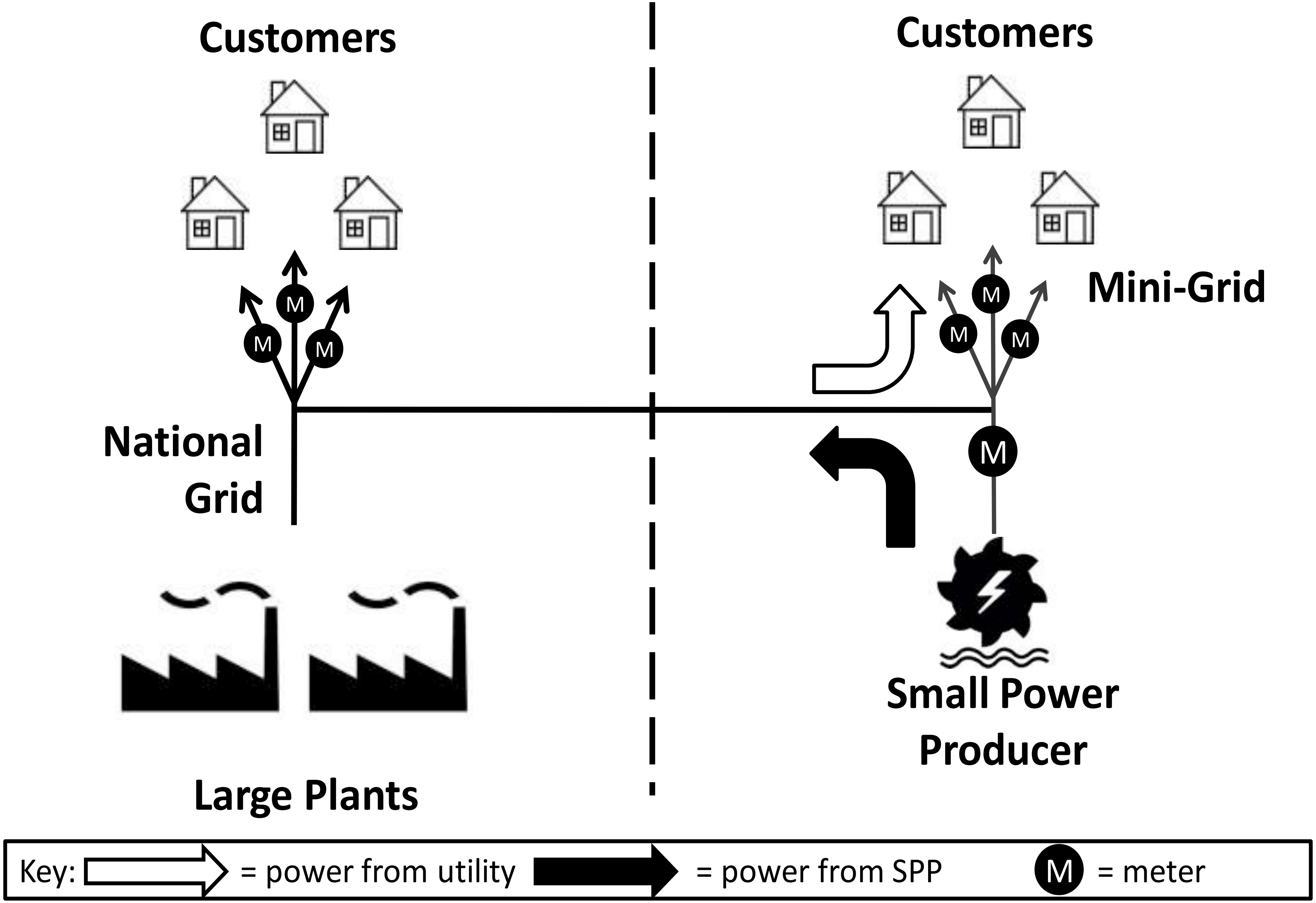
Arrival of the main grid



Small Power Distributor (SPD)



Small Power Producer (SPP)



A Guidebook on Grid Interconnection and Islanded Operation of Mini-Grid Power Systems Up to 200 kW

Chris Greacen

Richard Engel

Thomas Quetchenbach

Photo credit: Chris Greacen

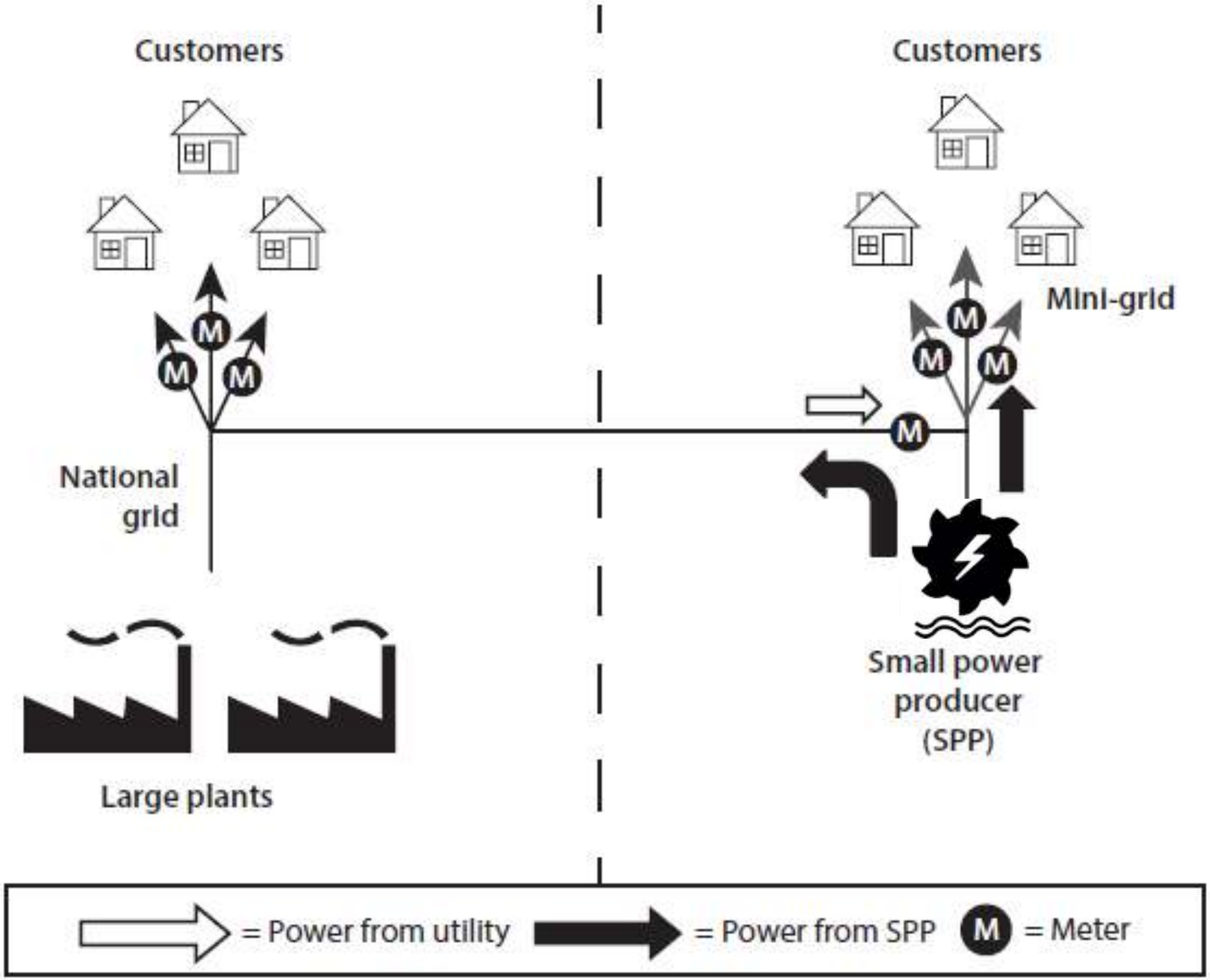
April 2013

BERKELEY LAB
Lawrence Berkeley National Laboratory

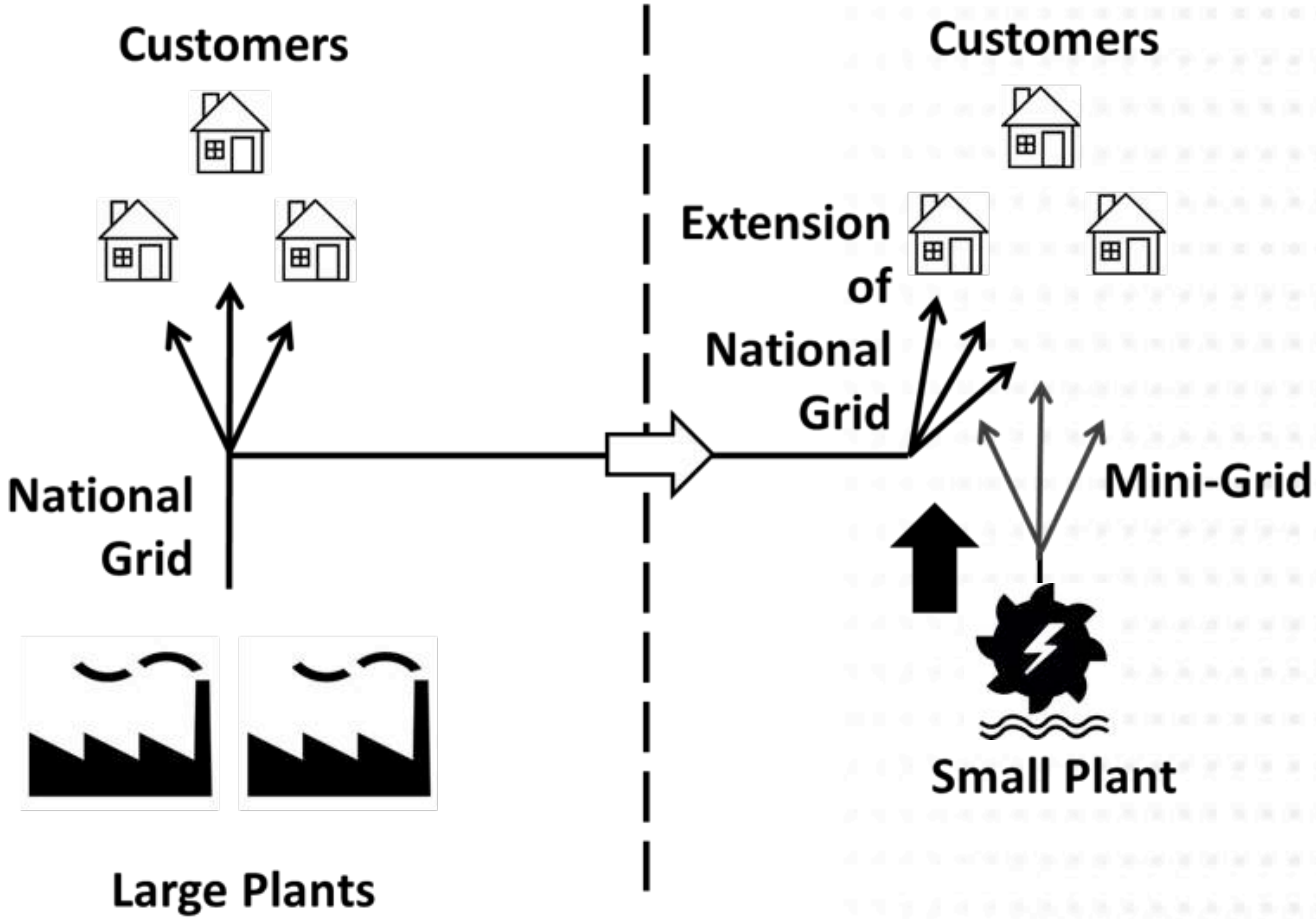
Schatz Energy Research Center
SERC
Schatz Energy Research Center

http://tiny.cc/GridInterconnectGuidebook

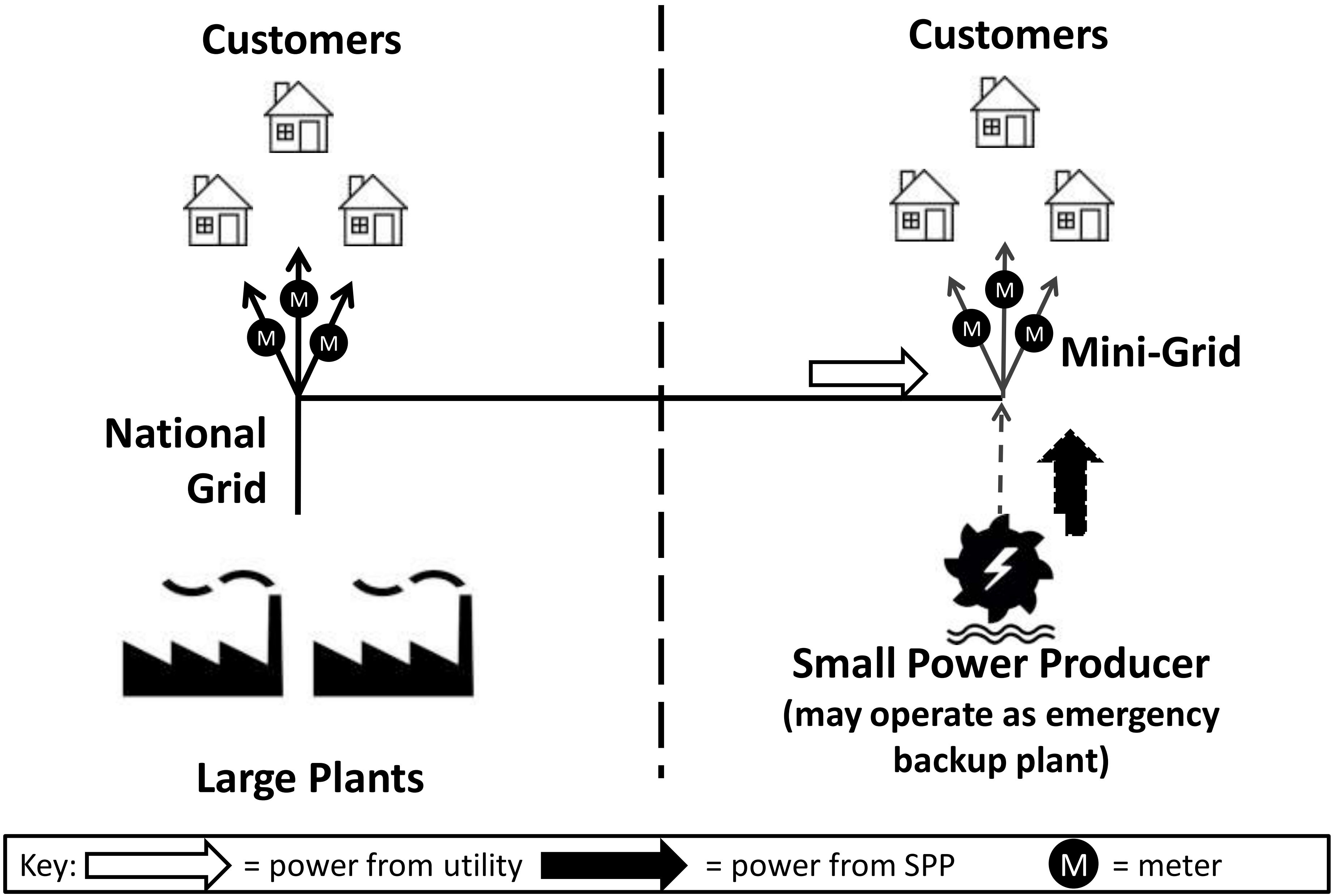
Both SPP and SPD



Co-existence

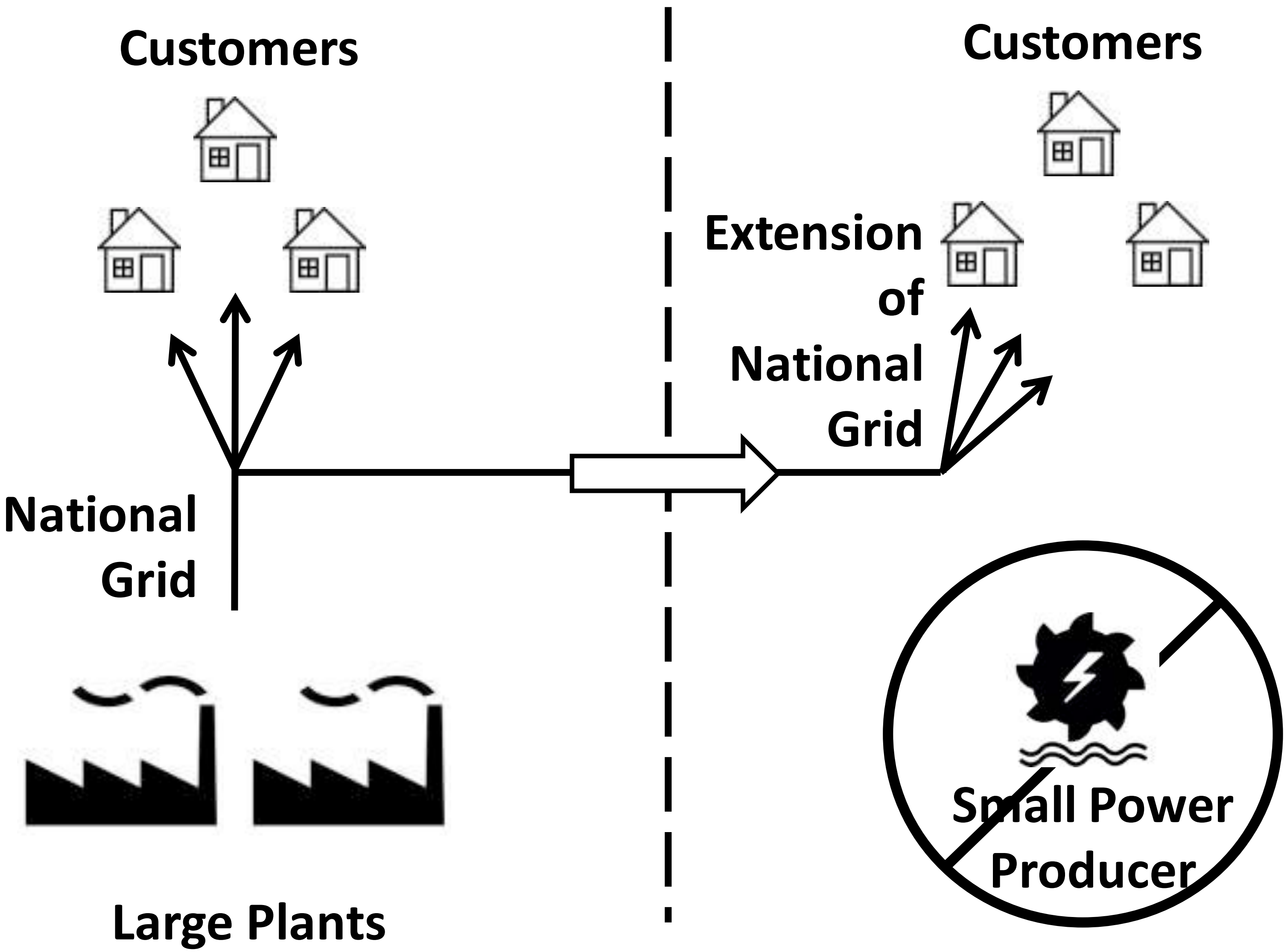


Buyout



Customers
M
M
M
National
Grid
Large Plants
Customers
M
M
M
Mini-Grid
Small Power Producer
(may operate as emergency
backup plant)
Key:
= power from utility
= power from SPP
M
= meter

Assets abandoned



Thank you

https://palangthai.wordpress.com/docs/

"What happens when the grid comes? Challenges faced by off-grid renewable energy projects"

Case Study of Bangladesh

April 19, 2018

Junaed Tazdik - Assistant Manager, SHS Program, Renewable Energy
Mafruda Rahman- Assistant Manager, Green Climate Fund (GCF)

An Overview of IDCOL

- A fully government owned financial institution
- Started operation in 1997
- Largest financier in private sector infrastructure projects in Bangladesh
- Market leader in renewable energy sector
- Funded by the government and multiple development partners i.e. the World Bank, ADB, JICA, IDB, KfW, GIZ, USAID, DFID and GPOBA.
- Total employees 362 (117 in head office and the remaining in the regional office)

Power

Solar Programs

Telecommunications

Biogas Programs

Port

ICS Programs

Renewable Energy Activities

Financed 4.1 Million SHS

Installed 44,500 Biogas Plants

8 Solar Mini grid Projects in Operation

602 Solar Irrigation Pumps in Operation

9 Biogas Based Power Projects in Operation

Financed 1 Biomass Based Power Projects

Energy Efficiency Initiatives

IDCOL Energy Efficiency program focuses on:

1. Green Brick Program
2. Industrial Energy Efficiency
3. Improved Cookstoves Program

Financed 6 energy efficient Auto-brick projects

Installed 960,000 ICS

Financed energy efficient equipment

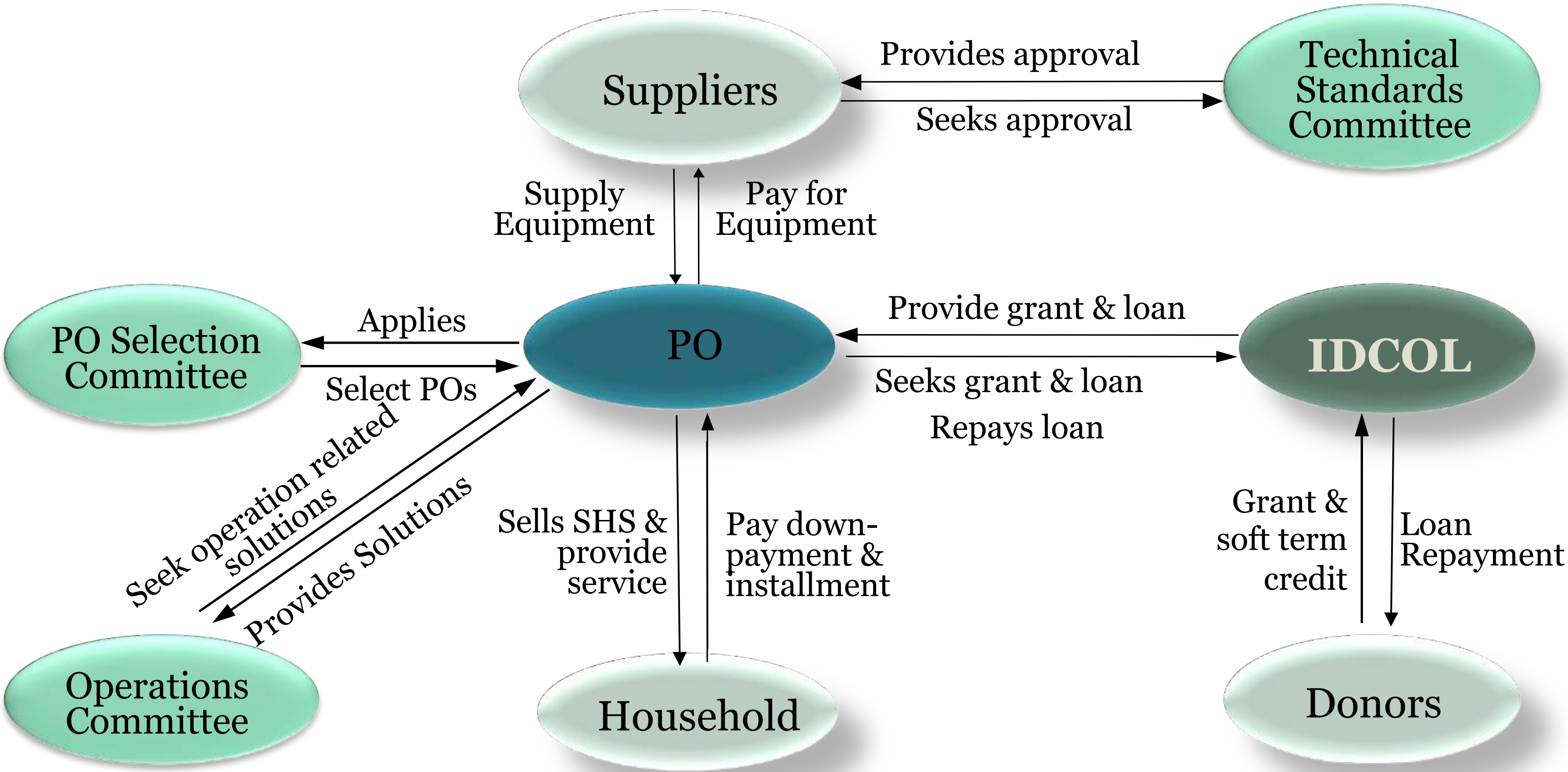
IDCOL's SHS Program

Program at a Glance

- **Target** : 6 million SHSs by 2021
- **Achievement** : 4.13 million
- **No. of beneficiaries** : 18 million, 12% population
- **Size of SHS** : 10 Wp to 130 Wp
- **Power generation** : 150 MW (approx.)
- **Fossil fuel saving** : 200,000 ton/year (USD 180 million/year)
- **Job creation** : 75,000 people
- **IDCOL investment** : USD 699 million

IDCOL
TOGETHER FOR TOMORROW

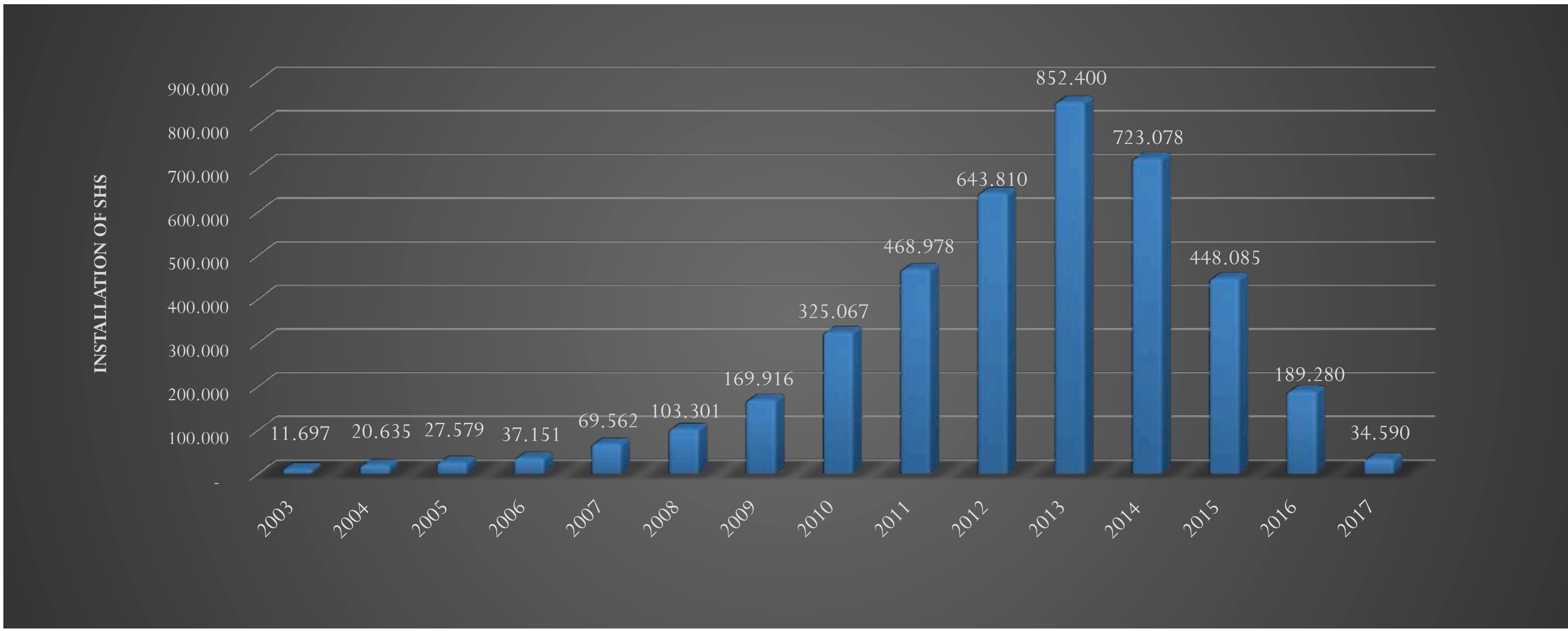
Program Structure



Success Factors

- Innovative financing structure - Ownership model
- Financial contribution of all parties
- Sustainable business model
- Cost-efficient standardized technical design
- Quality control and after sales service
- Development of local support industries
- Bangladesh’s micro-finance experience
- Support from the Government and different multilateral donors

Year-wise Installation of SHS



Current Challenges

- SHS market outside IDCOL program
- Free distribution of SHS under safety-net programs of the Government
- **Rapid expansion of REB grid which results in:**
  - Difficulty in attracting new customers;
  - Poor collection performance of the existing customers;
  - Lack of system maintenance which leads to inactive systems etc.

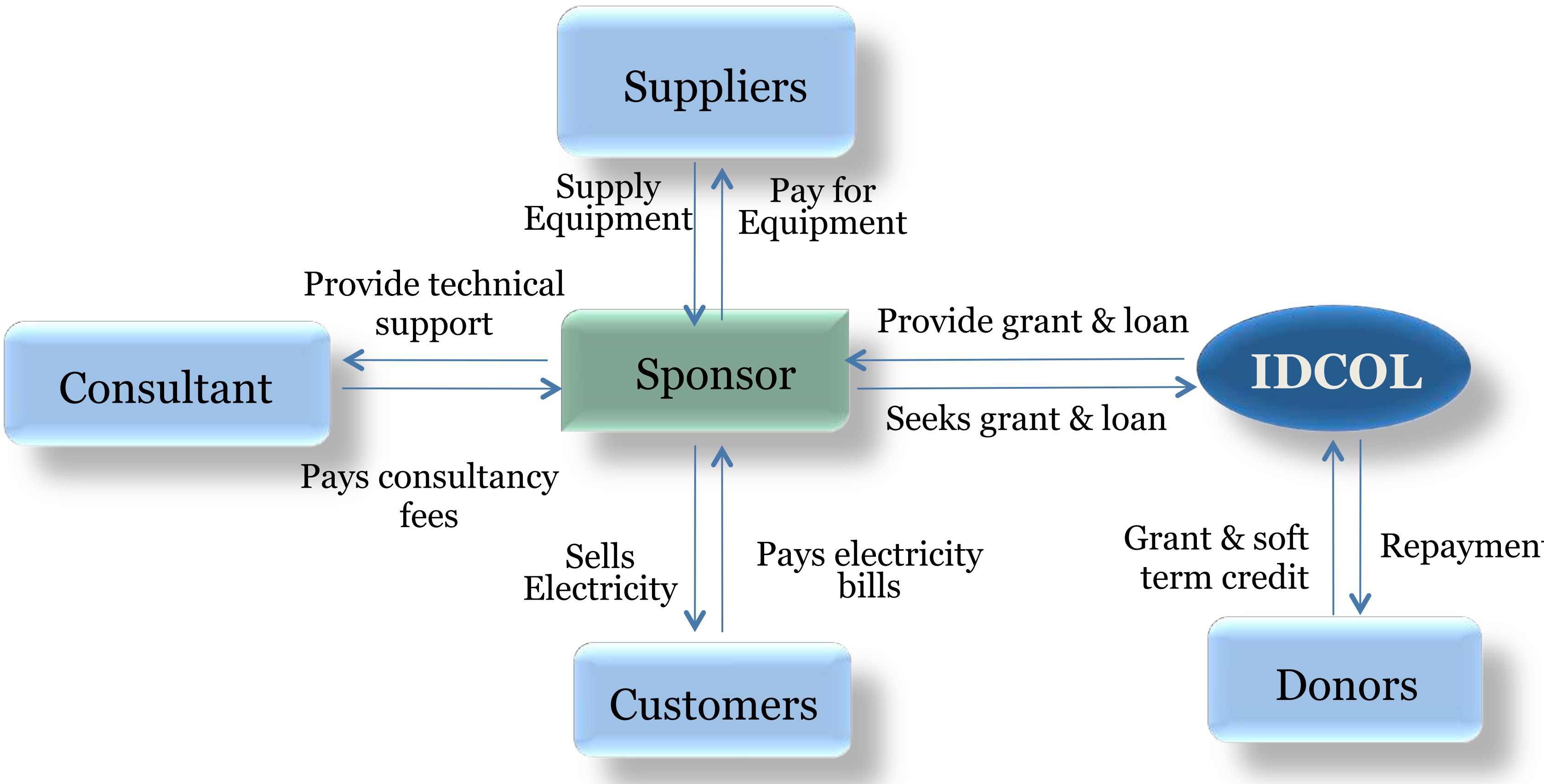
Mitigation Measures

- Engaging POs in safety-net programs of the Government
- Initiatives for Product/Business Diversification
- **Initiatives/actions taken in case of arrival of grid:**

- IDCOL POs are strictly advised not to install any system in locations with active grid connection and select their customers carefully. But, if the grid-connection is installed after 3(three) months from the installation date of SHS then the system is not considered grid-connected and POs are eligible for the financial support.
- IDCOL signed an MoU with Rural Electrification Board (REB) where it is ensured, before giving electricity connection to any existing SHS Customer of a PO, REB will ensure that the Palli Bidyut Samity (PBS) working under REB obtains a confirmation from that PO that the customer has already paid all the dues owed to that PO.
- Also, REB will not provide new electricity connection to a SHS Customer that has payment overdue as notified by the respective PO.

IDCOL's Solar Mini Grid Projects

Role of Partners: At a Glance



Challenges and Lesson Learned

- Lack of Adequate Technical Supports in the Private Sector
- Lack of Proven Technology
- Ensuring Adequate Financial Return
- Availability of Quality Equipment
- Possibility of Grid Extension

Policy on integration of mini grid with national grid

1. Based on economic feasibility analysis the Power Division has identified **<u>1,024 villages</u>** that will be under remote area power supply system. These off-grid areas will be those islands and hilly areas which are isolated from the national grid network and

- *Where electricity supply system does not exist , or*
- *The existing electricity supply system is inadequate and the coverage is very low*

An MoU was signed between Rural Electrification Board (REB) and SREDA

<u>THESE ARE THE POTENTIAL AREAS FOR SMGs</u>

Policy on integration of mini grid with national grid

2. According to paragraph 3.7 of the Guideline for the Implementation of the Solar Power Development program 2013 developed by Power Division :

> *if grid electricity reaches the project area after 5 years of construction of the plant, the Government will purchase electricity from the Project to ensure 15% return and the system may become connected to the grid to feed the grid with generated electricity or as per any other arrangement as agreed on between the sponsor and government.*

THANK YOU


A Rural Electrification Project with small hydroelectric plants

in northern NICARAGUA








ATDER-BL

atder.bl@gmail.com

April 2018

Location

Central America is a large isthmus that bridges between North Amercia (*see Mexico above*) and South America *(see Colombia below)*. Nicaragua is located in the center of the isthmus. Note the two large lakes of Nicaragua, and the location of Managua, the capital city, on the southern shore of the smaller lake. Our project area is indicated by red arrow.

Nicaragua – electricity infrastructure

This map of Nicaragua shows the administrative districts or provinces.

RAAN and RAAS are the northern and southern autonomous Atlantic regions. These are sparsely populated areas lacking roads and all types of infrastructure.

Recently large parts of the subtropical rain-forest have been logged, and land use has changed to raising cattle.

The symbols consisting of a tilde surrounded by a small circle, represent the large generating plants of the national electric system. It is immediately evident that electricity demand and supply are concentrated around the capital city of Managua, and in the northwest section of the country.

At the time we started our project, the national generating plants were one geothermal of 30 MW, two hydros of 25 MW each, and the rest were petroleum burning plants totalling approx. 500 MW.

Nicaragua – national transmission system

Diagram of the national electric transmission grid. The international intertie that permits purchase and sale of electricity between Nicaragua, Costa Rica and Honduras runs parallel to the Pacific coast. The transmission grid centers on Managua and Leon, with 3 branch lines that extend eastward and one that extends northward. The central and Altantic regions have sparse coverage

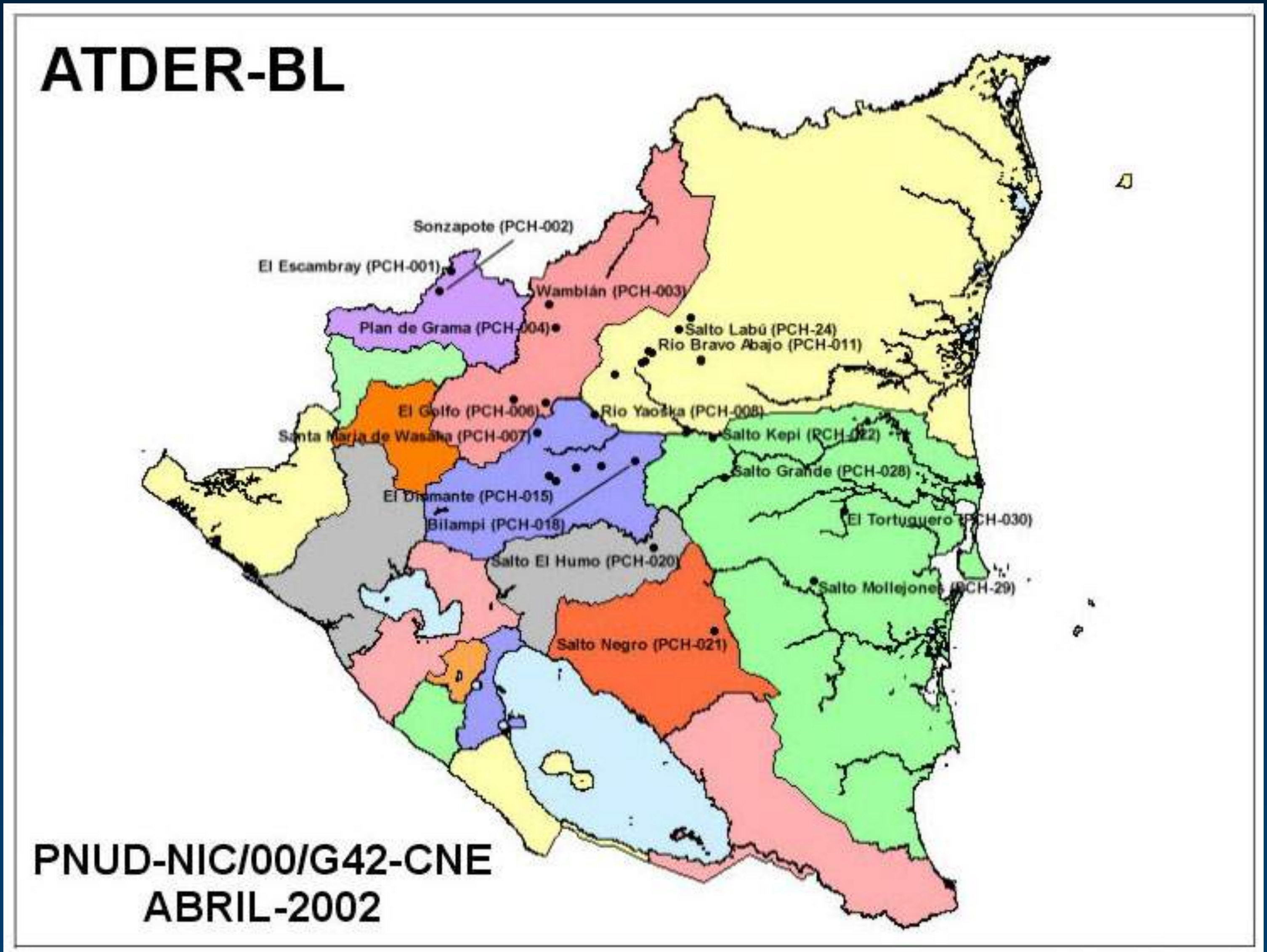
Potential of small hydroelectric plants for contributing to rural electrification in areas outside the reach of the national grid

There is a historical background in Nicaragua of small hydroelectric plants operating as isolated, independent systems.

Varios cities and towns including: Matagalpa, León, Diriamba, San Ramón, Boaco, Bonanza and Siuna were first electrified by small, isolated hydroelectric plants during the period from 1910 – 1940.

When the national grid was extended from Managua and reached these important populations centers in the 1950's and 1960's, the local distribution grids were absorbed into the national system and the hydro plants were abandonned, for three main reasons: (1) the frequency and voltage control systems of this first generation of small hydroelectric plants were primitive, and the technology was not readily available for converting them to synchronize with the national grid, (2) petroleum was very inexpensive, and (3) nobody was concerned about air pollution nor climate change at that time.

In 2001, the Nicaraguan government, with the help of the UNDP and donated funds from Switzerland and Norway, launched a new campaign to electrify remote areas of the country with small hydroelectric plants. Our organization was contracted to carry out the initial site identification survey and prefeasibility studies for each of the potential rural hydroelectrification projects.



25 sites were identified with sufficient hydro generation potential (150 - 500 kw) to serve local communities of 200 to 800 houses, in areas beyond the reach of the national distribution grid and outside the concession area of the national distribution company, DISNORTE-DISSUR. Eight of these projects were built by the Nicaraguan government with Swiss and Norweigan donations during the period from 2004-2014.

Disadvantages of the isolated small hydro system:

We had built our own small, isolated hydroelectric plant in the town of Bocay in the north of Jinoteg province in 1994.

Experience from operating our own small isolated hydro sysem, confirmed by the plants built by the government SHP (Small Hydro Plant) program was that it is possible for a community-oriented small hydro to sustain itself over the long term if the plant is well designed and built, and operated with care and prudence, but it can only be viable if built with 100%, or close to 100%, donated funding.

It will not be able to pay back a significant proportion of loan money, and it will always operate at high risk of not being able to repair itself in case of major damage to the plant from a flood, a landslide, failure of the generator, or other important damage. This is because the isolated system suffers from a small billing base, and also from under-usage of the installed capacity of the hydro plant. The initial investment is high, and the small number of customers plus low electricity consumption per capita, do not take full advantage of the high initial investment cost – the plant will not operate at full capacity in a poor rural community. If the demand grows over time, the system will have difficulty saving up enough money to pay for extensions of the electric grid, as most of the income each month is needed simply to pay the plant operator, the bill collector and the linesworker, and to pay the rudimentary ongoing operating costs.

Drawbacks of the isolated small hydro system:

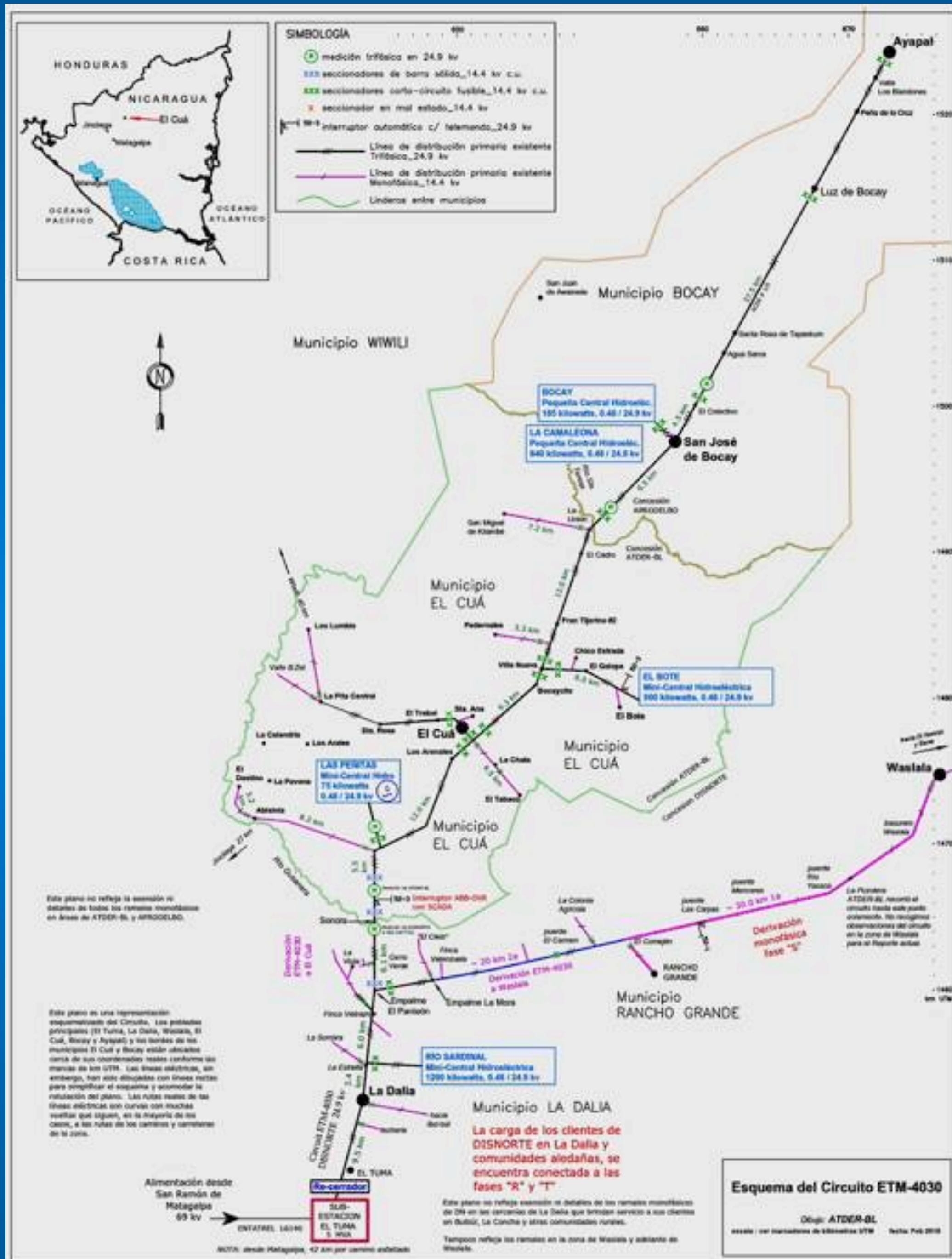
Also, in the tropics and subtropics, characterized by a pronounced rainy-season / dry season annual weather pattern, if the local demand grows over time, within a few years the system will stop providing satisfactory service to the people during the dry season due to lack of sufficient water flow in the stream during the driest months of the year.

Given these accumulated experiences, when we discovered a small river with one megawatt of hydro potential in the rural community of El Bote in 1999, we decided to try something different, **INTERTIE** this plant to the National Electric grid.

El Bote powerhouse

900 kw

two pelton turbines

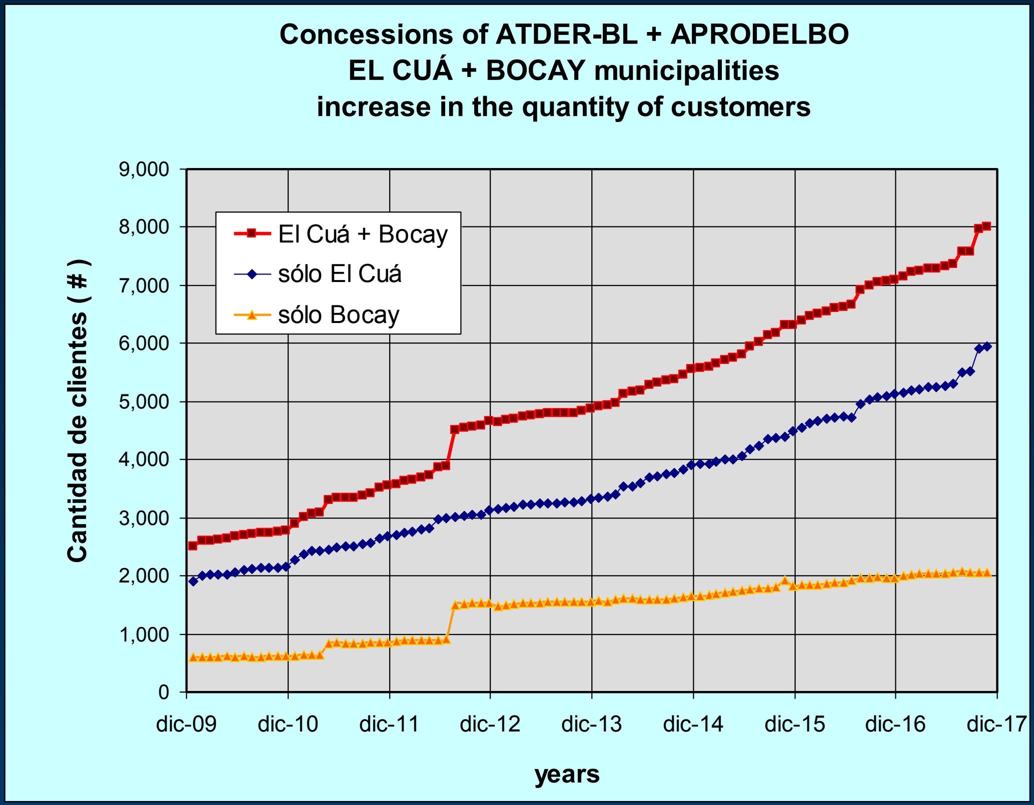


The rectangles with blue lettering are the local small hydroelectric plants.

The magenta square at the bottom of the diagram is the El Tuma substation, the closest substation to our area.

Black lines are 3-phase medium-voltage lines (24.9 kilovolts). Pink lines are single-phase medium voltage lines (14.4 kilovolts).

We built 57 km of 3-phase 24.9 kv line to connect the new El Bote hydro plant (900 kw) to the nearest point of the circuit of the National Distribution company at the point called “Empalme El Panteón”. We then built 21 additional kilometers of 3-phase line north to intertie our old hydro plant in Bocay to the grid, and added synchronization equipment to the Bocay control system.



The concept of intertying the small hydro plants has been successful.

The intertie gives us a second source of income, as the National Distribution company buys our excess hydro generation during the rainy season.

The interty also allows us to purchase any energy the people need that we are unable to generate during the dry season due to lack of water in the local rivers. This allows us to provide more reliable service to the people.

The graph above shows the growth of our system. From 2,600 customers in December 2009 to 8,000 customers in December 2017. An average annual growth rate of 16%.

We have repaid US$ 1 million on our loan. And we have enough funds to cover part of the costs of expansion of our grids, though we have also received donations and subsidies for grid expansions.

Our average tariff to the end users is US$ 0.16 / kwh. Average consumption per customer is 50 kwh/month.

E N D

follows an appendix about hydrology in tropical areas and the impact of the “dry season /rainy season” weather pattern on small hydro generation.

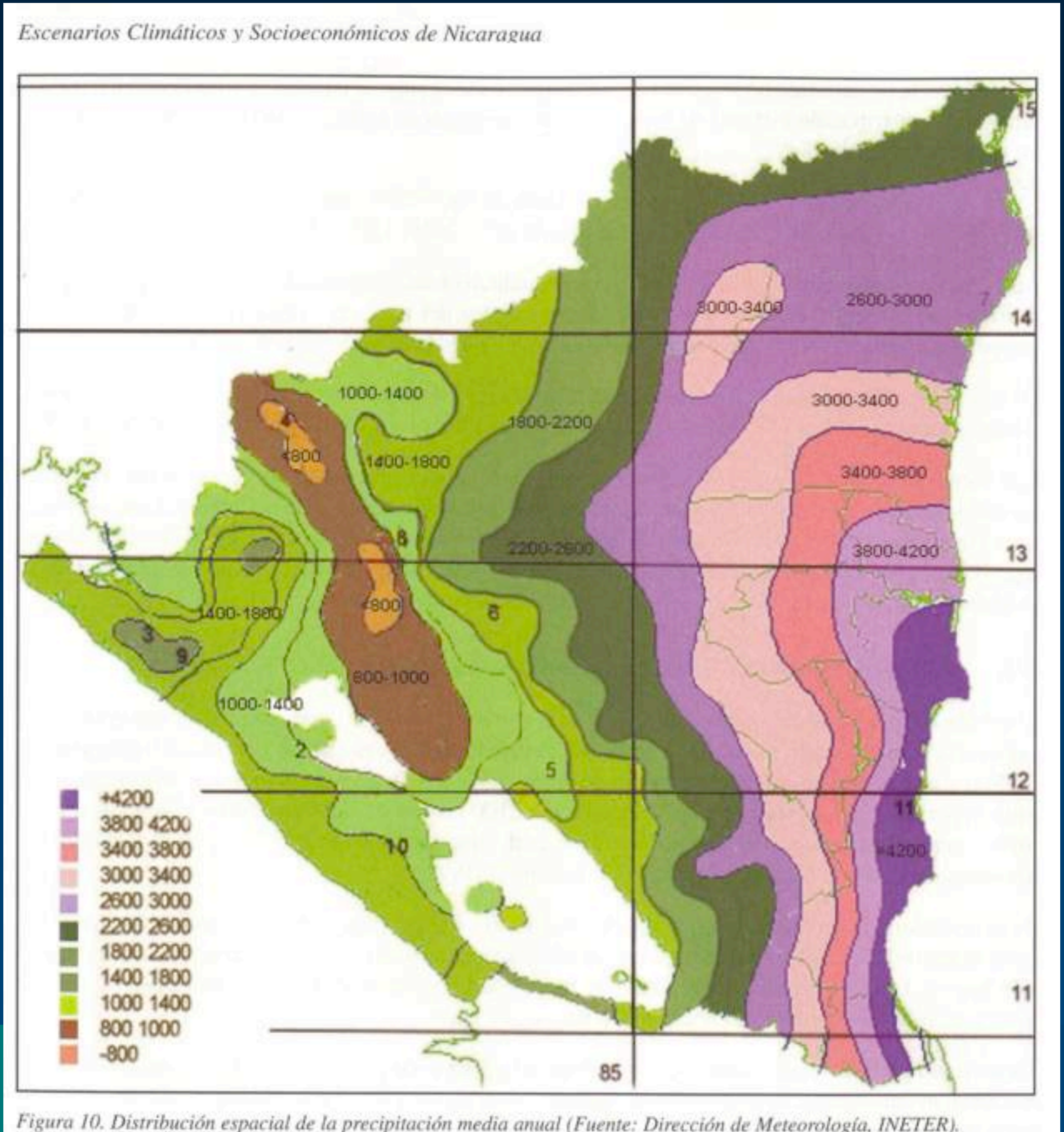


Figura 10. Distribución espacial de la precipitación media anual (Fuente: Dirección de Meteorología, INETER).

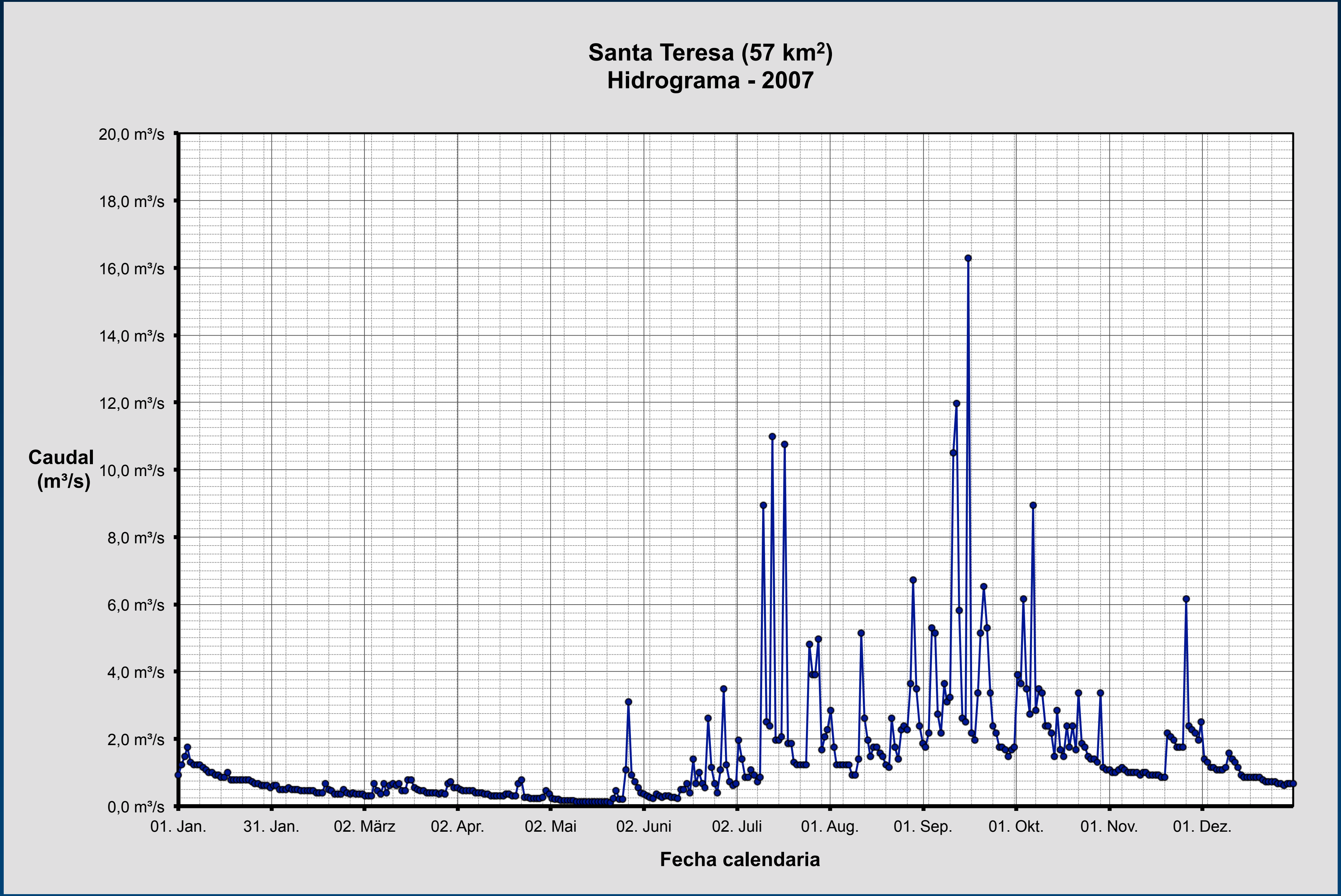
Isoyetas de precipitación pluvial sobre el ciclo anual

FACTOR 1: Distribución de caudales de los ríos, sobre el ciclo climático anual

En toda la Tierra, entre las latitudes del Trópico de Cancer y el Trópico de Capricornio, el clima se caracteriza por un ciclo de TEMPORADA LLUVIOSA / TEMPORADA SECA.

En el caso de Nicaragua, las lluvias comienzan en el mes de Mayo cada año, y finalizan en el mes de Noviembre o Diciembre. Durante la “Temporada Seca” o “Verano” de Enero a Abril, cae muy poca lluvia. Los ríos se secan durante estos meses.

HIDROGRAMA



Santa Teresa (57 km²)
Hidrograma - 2007
Caudal (m³/s)
20,0 m³/s
18,0 m³/s
16,0 m³/s
14,0 m³/s
12,0 m³/s
10,0 m³/s
8,0 m³/s
6,0 m³/s
4,0 m³/s
2,0 m³/s
0,0 m³/s
01. Jan.
31. Jan.
02. März
02. Apr.
02. Mai
02. Juni
02. Juli
01. Aug.
01. Sep.
01. Okt.
01. Nov.
01. Dez.
Fecha calendaria

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