Alternatives to improve electricity access in Colombia

Sebastian Zapata, PhD
Estéfany Garcés Arango, PhD(c)
Mónica Castañeda, PhD
Carlos Jaime Franco PhD
Isaac Dyner Rezonzew,PhD

Universidad Nacional de Colombia
Universidad Jorge Tadeo Lozano
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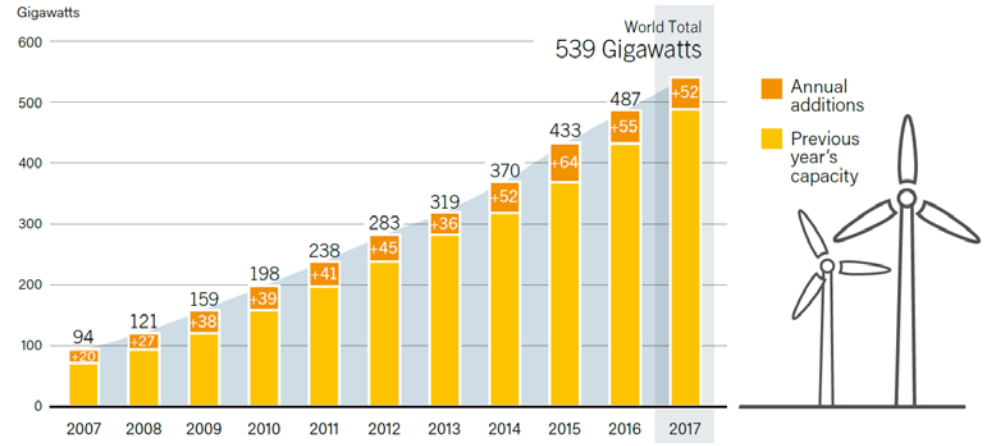
Agenda

1. Background
2. Renewable challenges
3. Electricity access in Colombia
4. Alternatives to ease electricity access

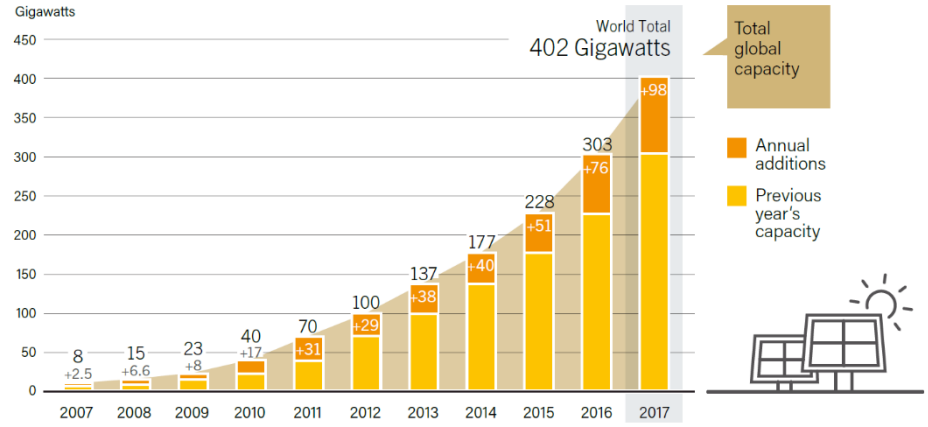
Background: a worldwide trend to renewables



Wind power installed capacity (Ren21, 2018)

The growth was 19% between 2007 to 2017, totaling 539 GW.

Investment in new renewable power capacity was more than twice that new fossil fuel and nuclear power capacity combined



Solar power installed capacity (Ren21, 2018)

Annual growth was 48% between 2007 to 2017 reaching a total of 402 GW.

…. Some signals

- Renewable energy cost are steadily falling - PV Grid parity (Haas et al, 2016; Bayod-Rújula, 2009).

- Evolution of renewable installed capacity (BP, 2014; GWEC, 2015)

- Renewables are no longer limited to developed economies (IEA, 2017).

Renewable challenges

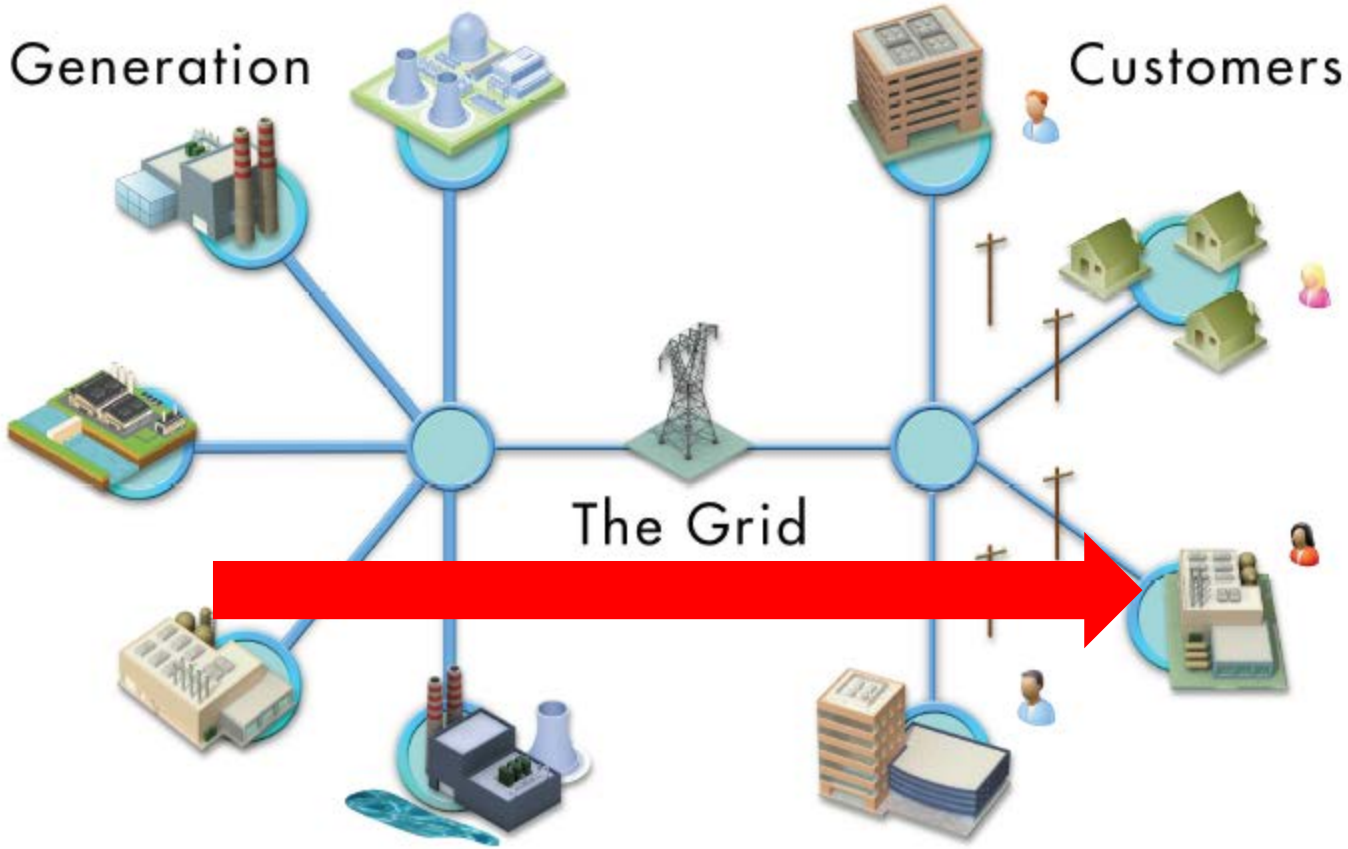
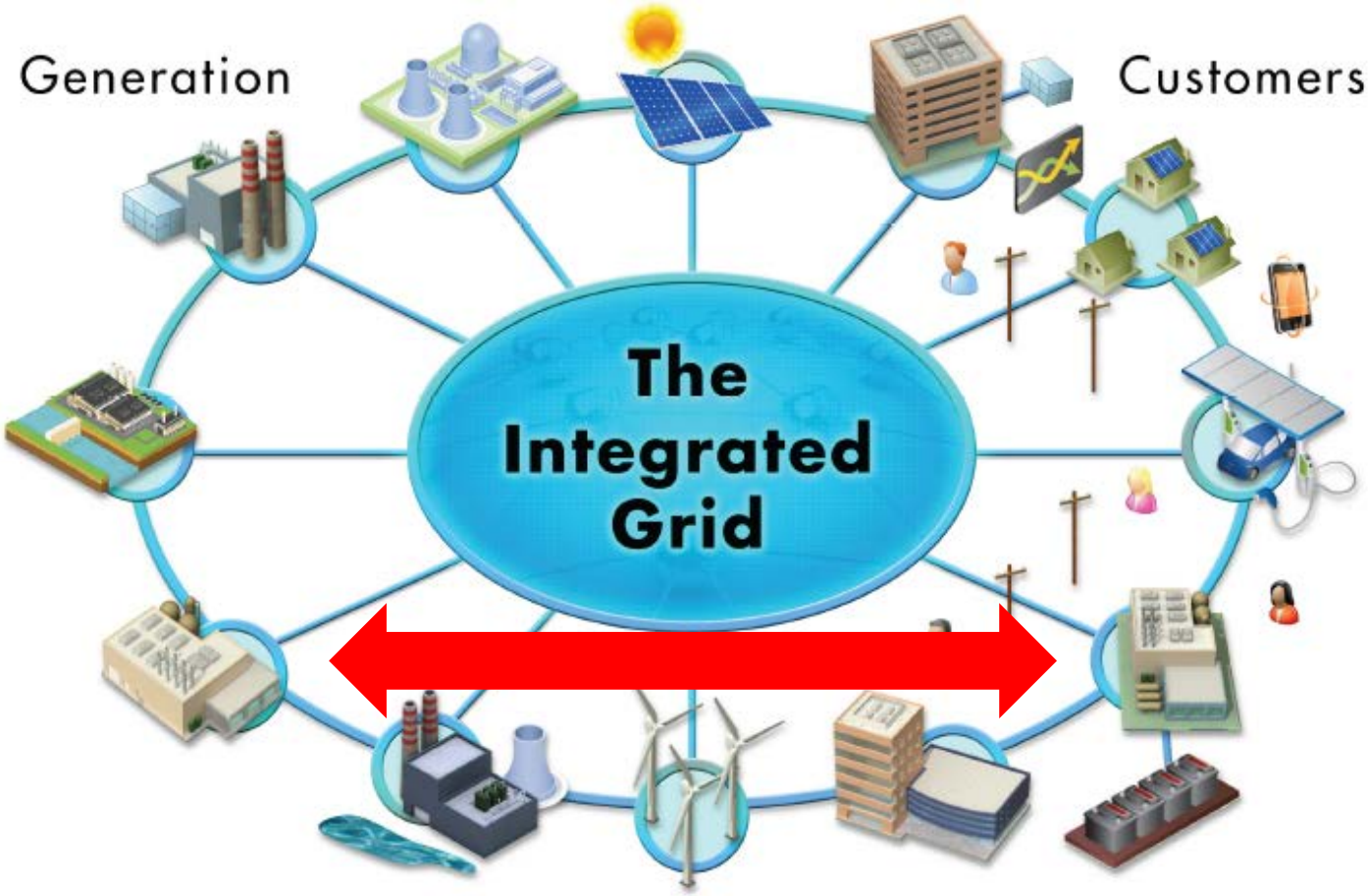


Figure 1. **Today's Power System** Characterized by Central Generation of Electricity, Transmission, and Distribution to End-Use Consumers (EPRI, 2014)

So, what if instead of…



We had a large number of generation facilities…..DER bi-directional …???
smoother transition …

Figure 2. Creating an Architecture with Multi-Level Cotroller (EPRI, 2014; Richter, 2013)

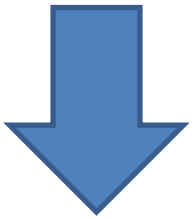
NEXT

Germany: price, power quality, reliability..

The lack of coordinated planning and deploying DER (Distributed Energy Resources) leads to challenges:

- Local over-voltage or loading issues on distribution
- System instability
- Resource variability and uncertainty
- Voltage fluctuation/Intermittency
- **Regulatory challenge:**
  - **Remuneration of distribution business**
  - **Definition roles and business boundaries**
  - **Distribution tariffs (free-riding, subsidies …)**

. Challenges PORC

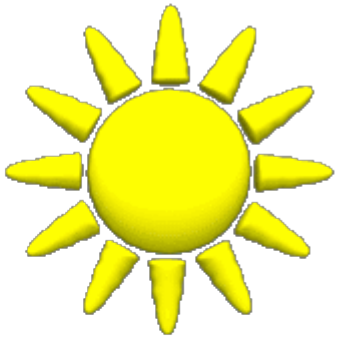


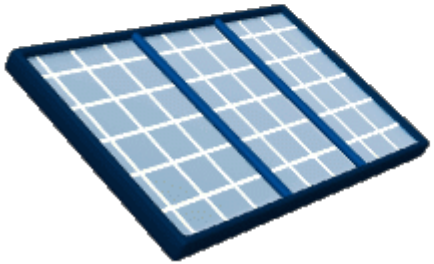
Requires

The right regulation and market design!!

(Perez Arriaga, 2013; EPRI, 2014; Anzalchi 2017; Agüero, 2017; Picciariello, 2015)

Some research results about the effect of high solar PV investment





To offset 100% of the average energy consumption for a household, a 2-kW system is enough in some developing countries.

An oversized PV system of 3KW is the worst scenario!!!

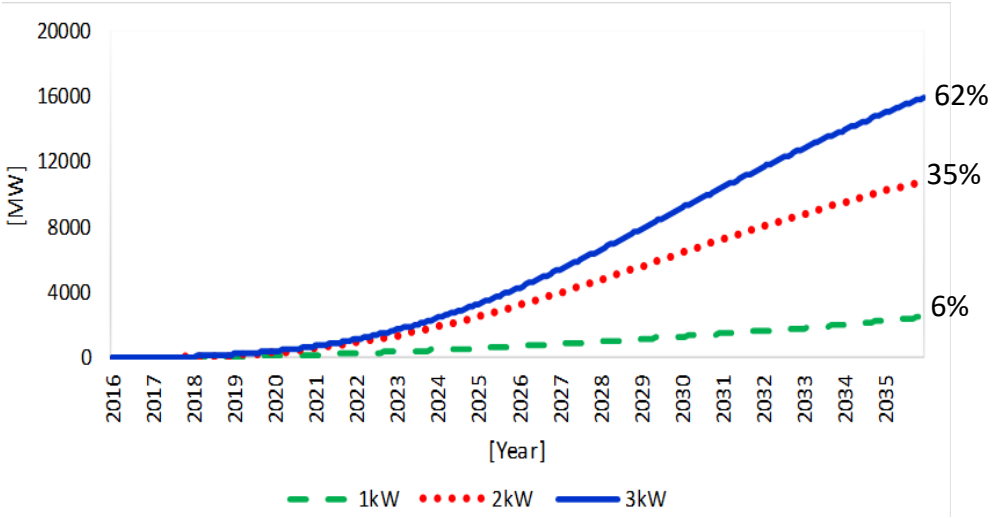


Figure 3. Solar PV cumulative installed capacity and percent of cumulative installed capacity

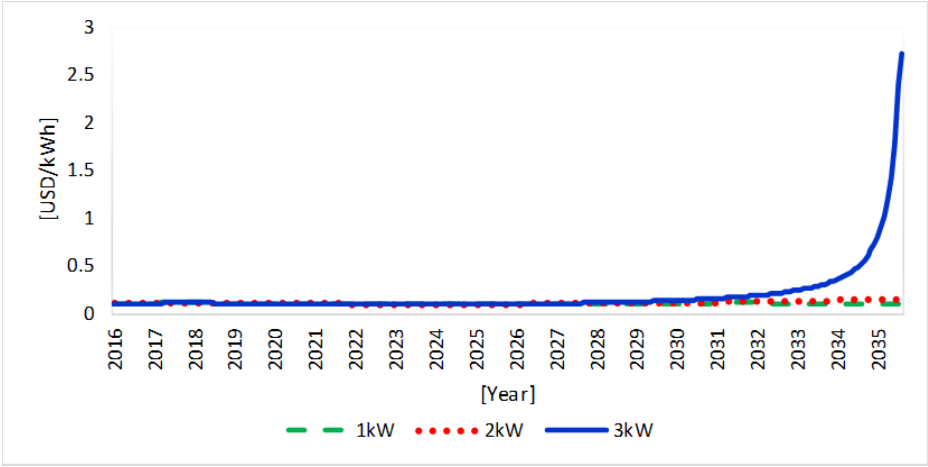


Figure 4. Final tariff for residential sector

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What are the long-term effects on customers?

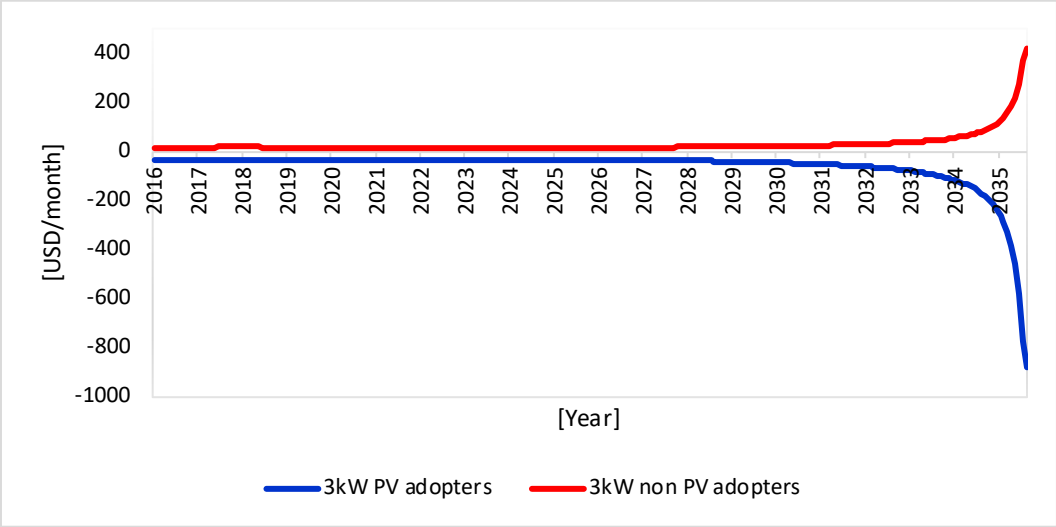
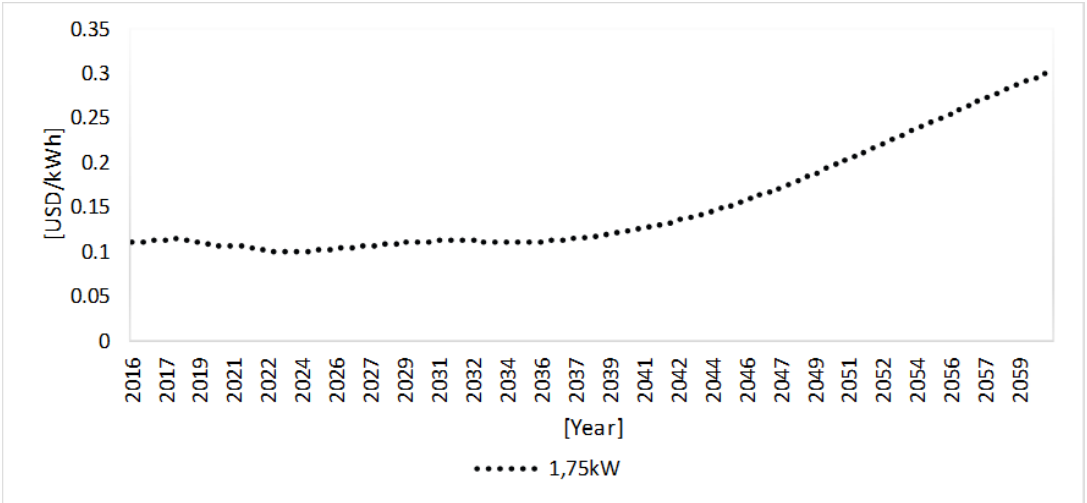


Figure 5. Energy bill for customers under oversized PV systems (3kW)

Revenue losses of utilities coincide with the high expenses of non-PV adopters and high revenues of PV adopters

Figure 6. Residential tariff for 1.7kW PV panel size and a longer timeframe

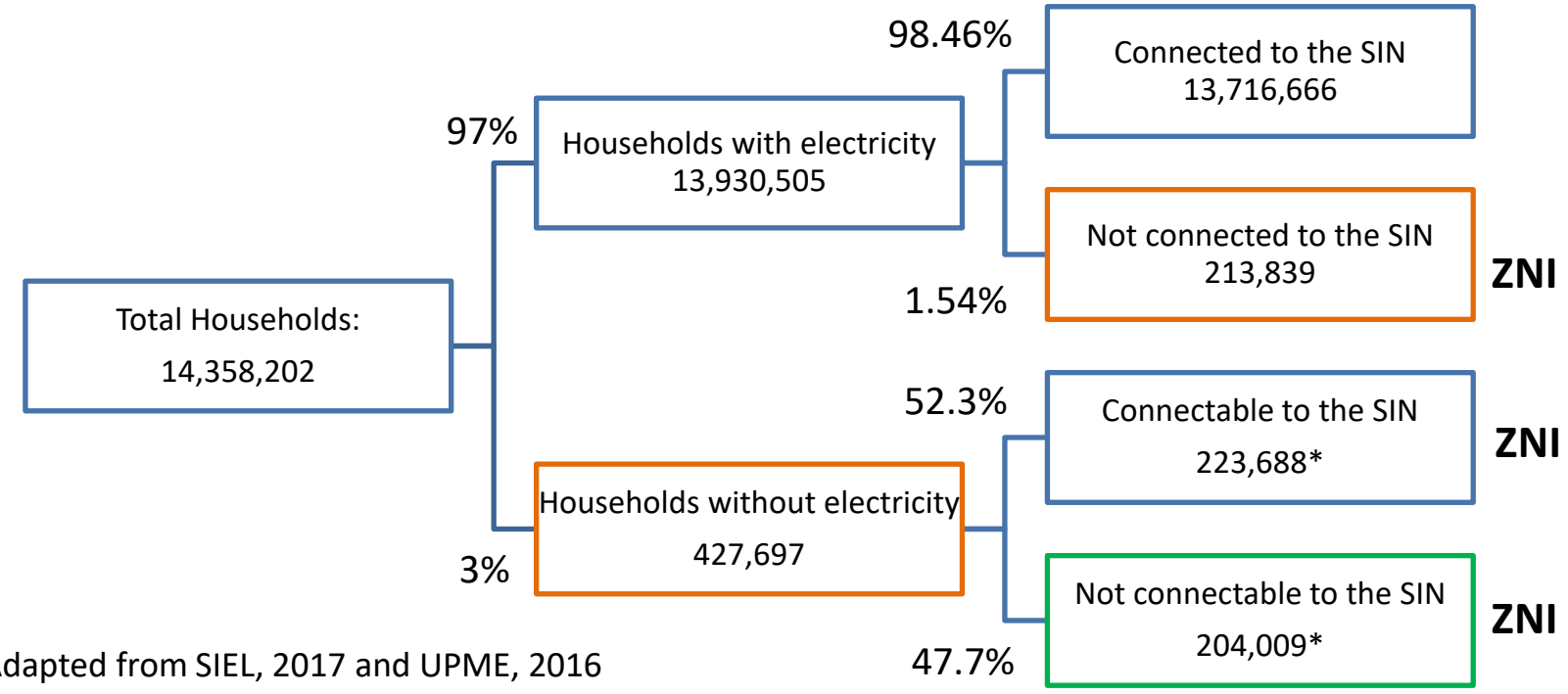


Electricity access in Colombia

SOURCE: IEA, Energy Access Outlook 2017

Electricity Access in Central and South America

	Rate of access						Population without access (million)
	National				Urban	Rural	
	2000	2005	2010	2016	2016	2016	2016
Central and South America	87%	91%	94%	97%	98%	86%	17
Colombia	81%	88%	97%	98%	100%	87%	1

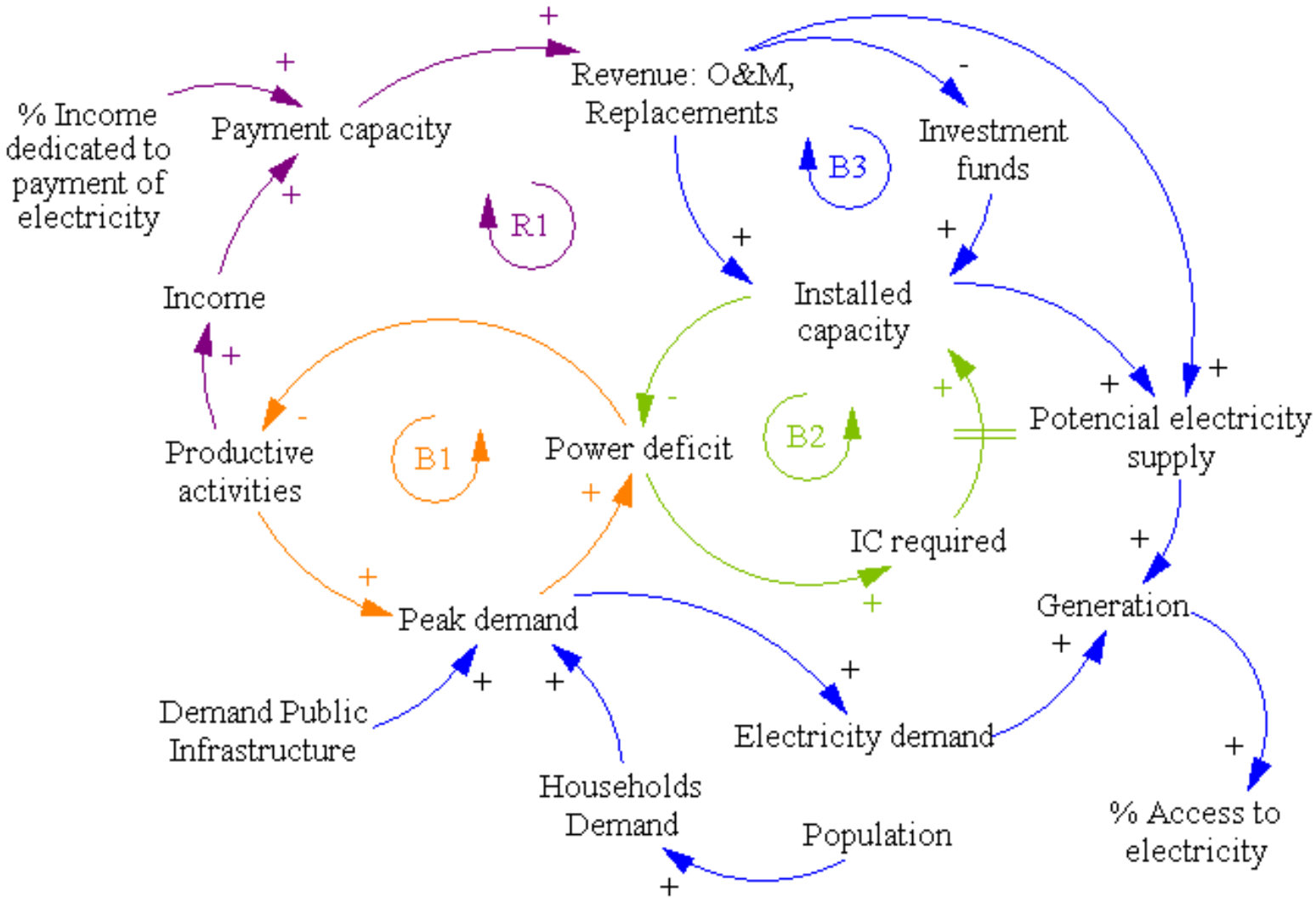


Source: Adapted from SIEL, 2017 and UPME, 2016

* Estimation made from the general results PIEC 2016-2020 (UPME, 2016, pág. 40)

Interconected and Off-grid regions (ZNI)

System dynamics: hypothesis



Preliminary results: diesel + solar, subsidy only

Initial conditions

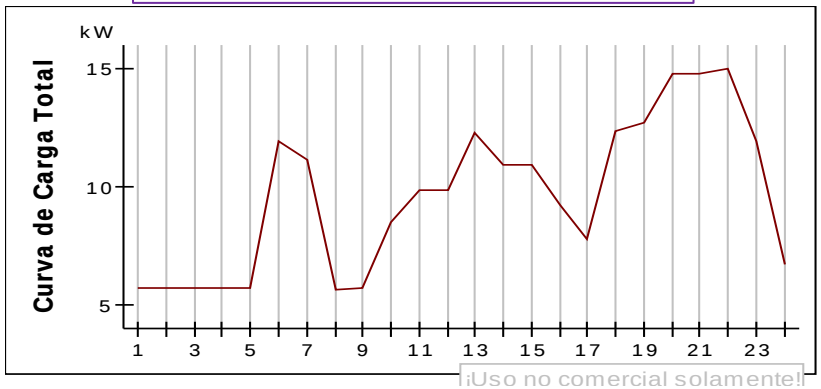
- Residential demand: 100 households
- Demand - public infrastructure: Street lighting, 1 school, 1 health center, 1 community center
- Demand - productive activities: small store with a refrigerator
- Microgrid of 100 kW initial installed capacity (diesel)

Simulation

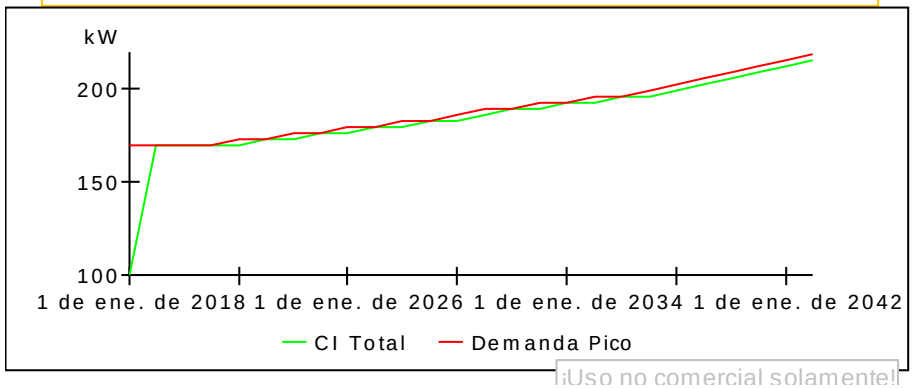
- Simulation period of 25 years (2018 – 2043)
- If additional capacity is required, this is with solar energy (without positive power margin)
- Always money available for installation of new installed capacity
- AOM money is subsidized, the community does not make payments
- Ensure that the revenue for AOM and battery replacements is never less than zero

Preliminary results

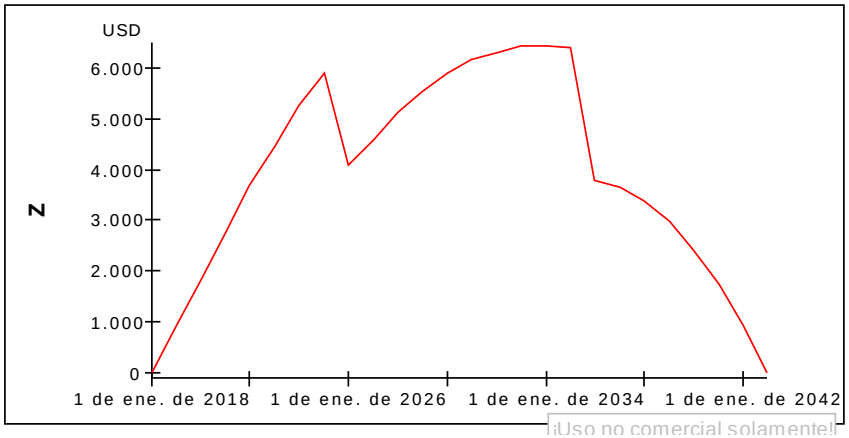
ELECTRICITY DEMAND



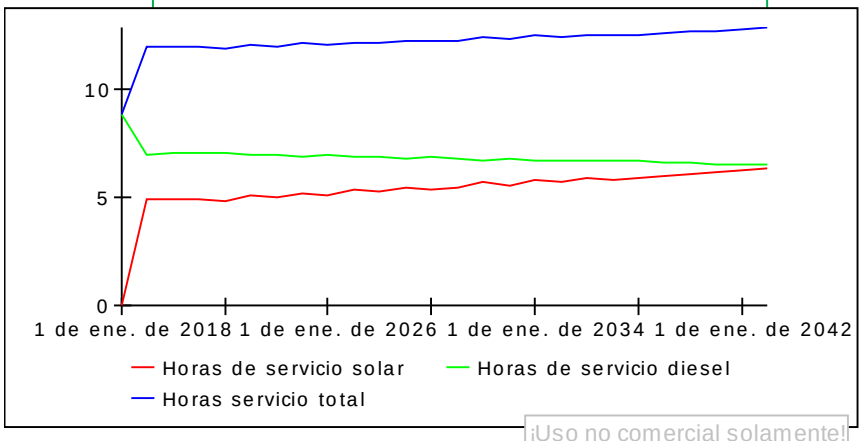
INSTALLED CAPACITY VS. DEMAND



REVENUE

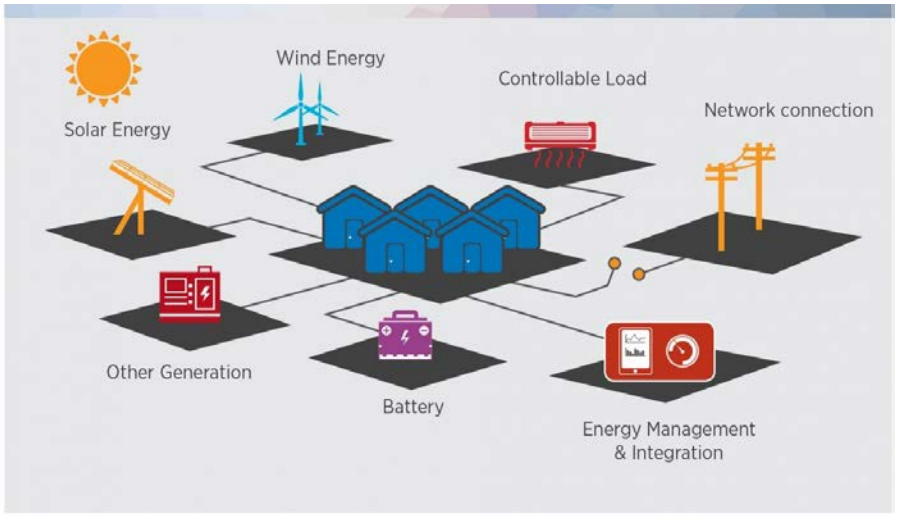


GENERATION



Alternatives to ease electricity access

Microgrids



Smart meters to prepaid energy

New business models as crowdfunding

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