Solar Mini-Grids in Rural Burundi

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- Gigawatt Global Coöperatief U.A. is a multinational renewable energy company focused on the development and management of *utility-scale solar fields* in emerging markets**.**

> "A for-profit company with a non-profit's soul"

- Completed: Rwanda, Georgia, USA
- In Progress: Nigeria, Kenya, West Bank, South Sudan, Benin, Burundi, **Mini-grids in Burundi**

Main Questions

a. How to **organize, regulate, finance, and implement** microgrids to create affordable, sustainable energy production and use in developing economies (Burundi).

b. What are the **tariff and financial structure**, **technology ownership and management**, and **system organization** alternatives to enable **scalability** (for modular growth or connection to larger grid systems), **financial feasibility** (sustainability and returns to all stakeholders), and **highest impacts** (deliver low cost, clean energy to users).

Burundi Country Report

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Economic Indicators

GDP (current US $)	$ 3.09 billion (2015)
GDP growth	-2.5% (2015)
Total Population	11.18 million (2015)
GDP per capita (current US $)	$ 276.0 (2015)

Energy Indicators

Electricity Access Total	7% (2015)
Average household consumption	23 kWh/year/hh (African average of 150 kWh/year)
Electricity Access in Rural Areas	1% (2015)
Percentage of Burundi Living in Rural Areas	88%

Source: World Bank and SE4All Power Africa Energy Hub

Power Stations and Transmission Grid for Burundi

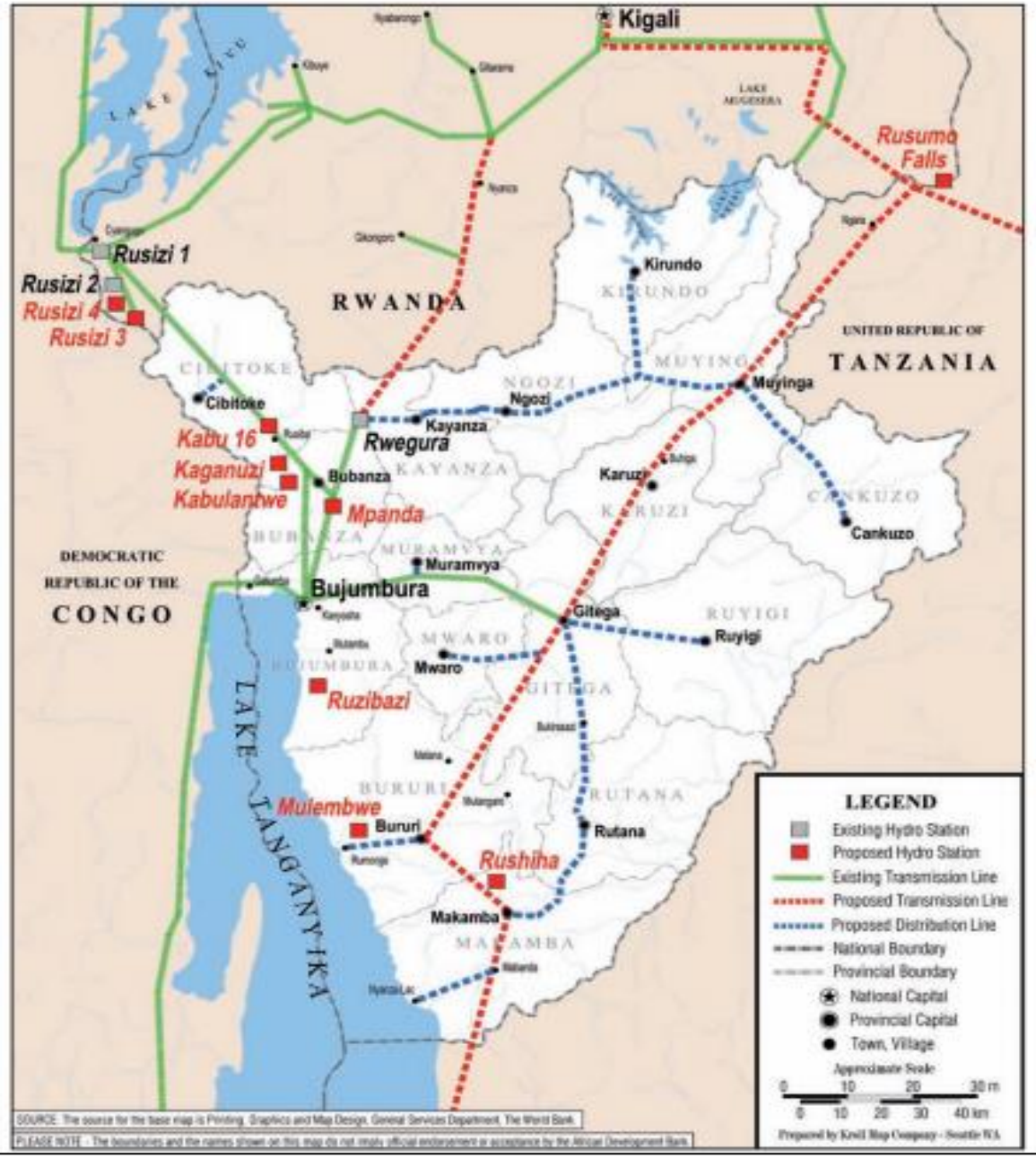
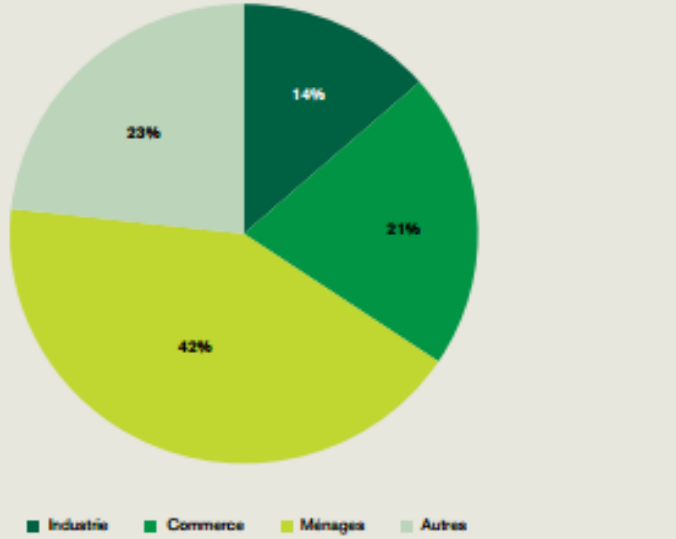
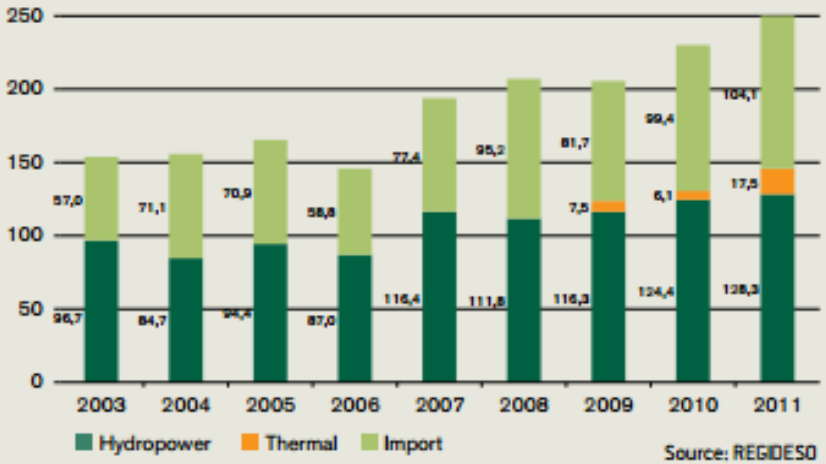


Diagram 5 Distribution of REGIDESO clients in 2011



Source: REGIDESO

Diagram 6 Production sources REGIDESO (2003-2011)



Source: REGIDESO

The Mini-Grid Solution

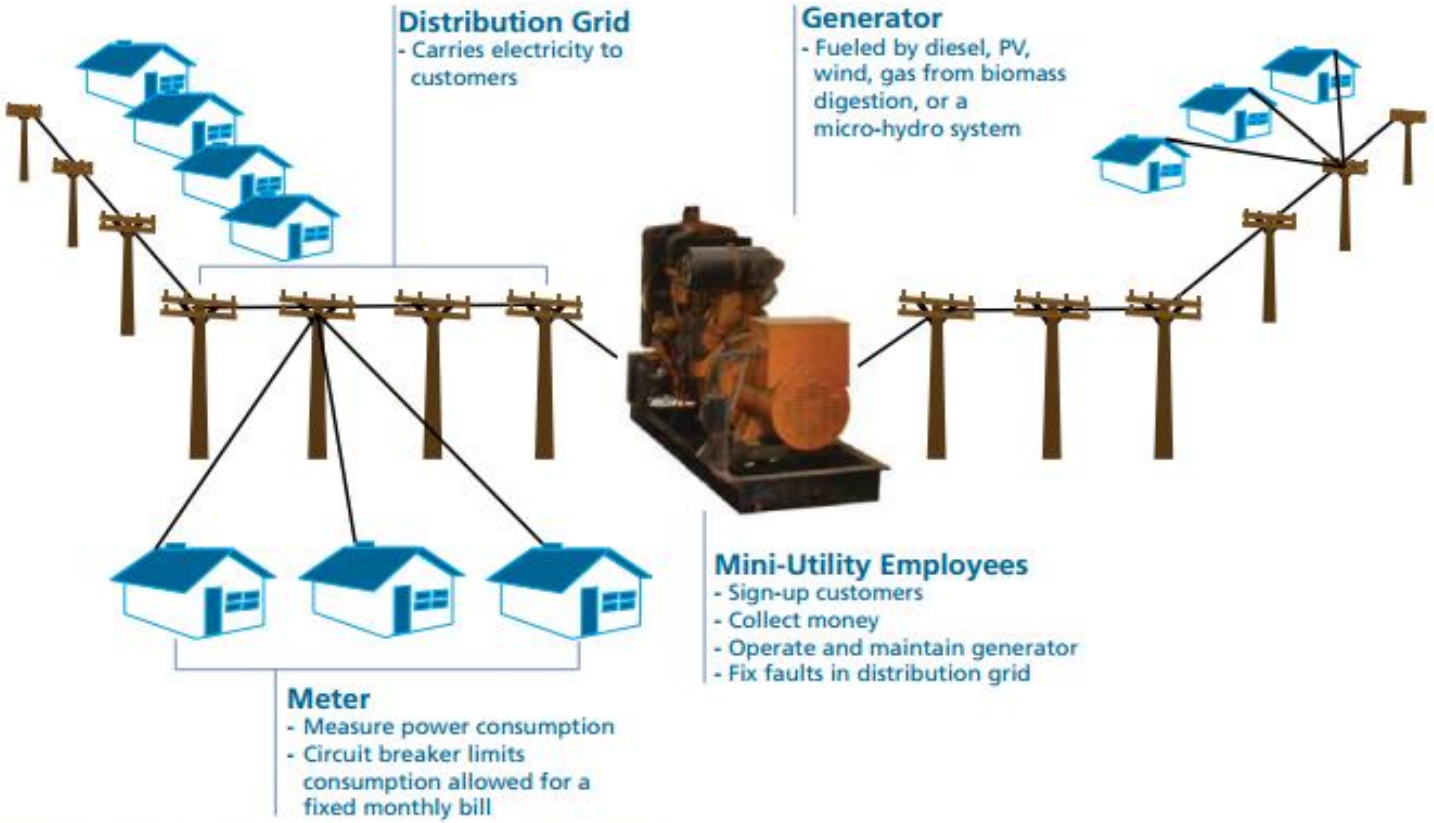


FIGURE 3.15: Generalized mini-utility operating model
Source: IFC analysis.

Why Are Mini-Grids Not Used More In Africa?

- “The major hurdles in the success of mini-grids are not technology-related. There are no significant technology barriers that hinder mini-grids whether they are powered by diesel generators, renewable energy or a combination of both (hybrid systems). Rather, since supply to remote villages with low income is not economically viable, **financial sustainability** is the key challenging factor. Compounding the problem is the fact that there is no “one-size-fits-all” solution.” (SE4ALL Energy Access Committee, OFID 2014)

Two Part Pilot Project In Off-grid Burundi

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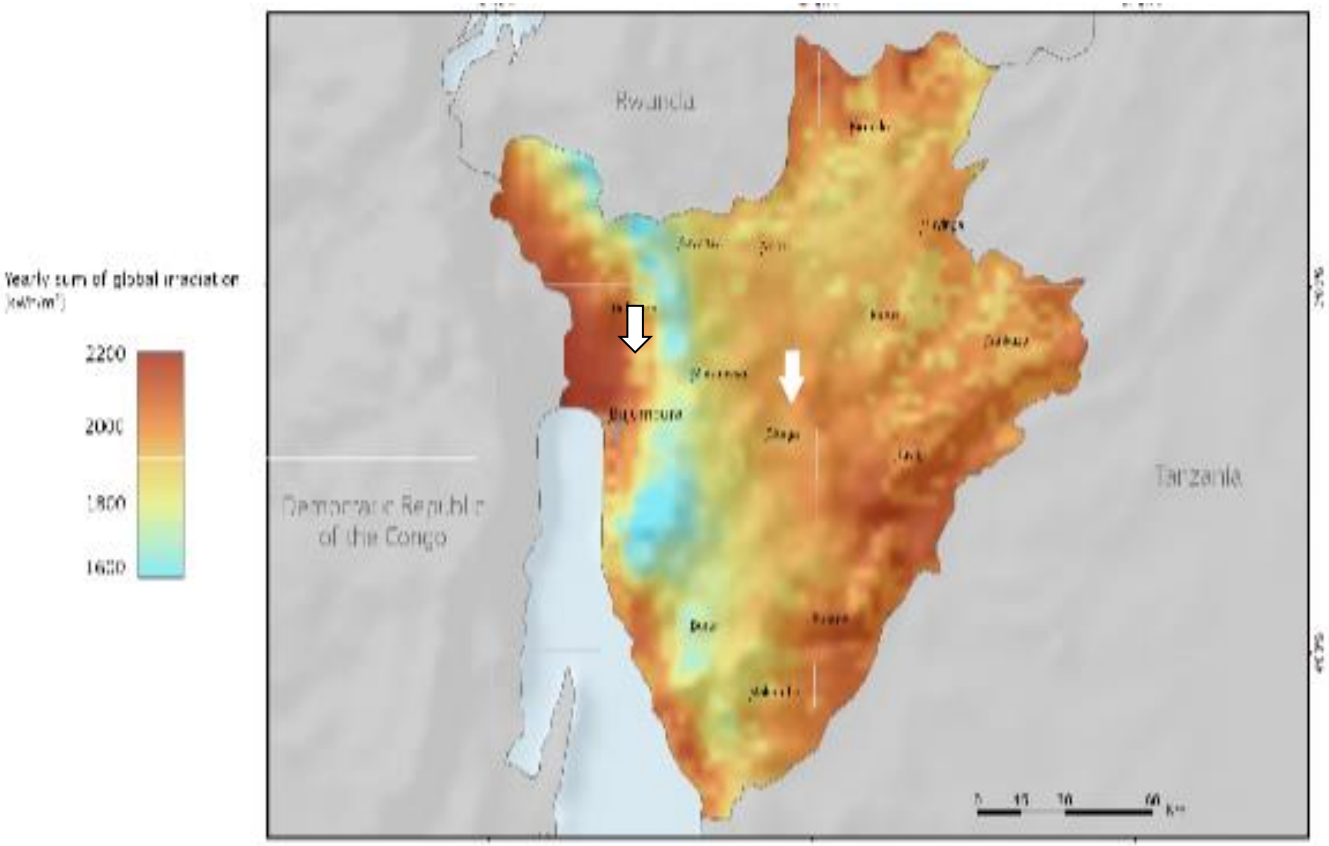
- Street lighting mini-grid
- Community mini-grid
  - Anchor-Based Consumer Model
  - Phase 2: connect school and medical clinic
  - Additional SHS component
- Long-term goal: create a replicable model to ultimately reach 1 million Burundians



Joint Research Center/ PVGIS

Five Key Challenges

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- Matching supply & demand
- Community involvement
- Cheap & reliable fuel source
- Managing monetary risk
- Tariff formation

→ Case studies of best practices in scalable mini-grids

→ Two detailed feasibility study “game plans”

Demand Analysis: Community Mini-grid

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Name	Type of Business	Appliance 1	Appliance 1 Power Rating (kilowatt)	Hours per day of use of Appliance 1	Time of use Appliance 1 (day/Night)	Appliance 2	Appliance 2 Power Rating (kilowatt)	Hours per day of use of Appliance 2	Time of use 2	Energy useage per day (kWh)
Gilbert NKURUNZIZA	Mill	Mill	2	12	Day	Rice Huller	2.25	6	Day	37.5
Mathias NTIRABAMPA	Mill, Rice Huller	Mill	2	12	Day	Rice Huller	2.25	6	Day	37.5
Juma	Mill, Rice Huller	Mill	2	12	Day	Rice Huller	2.25	6	Day	37.5
Gervais NSHIMIRIMANA	Mill	Mill	2	12	Day					24
Jean NYANTOBERWA	Mill	Mill	2	12	Day					24
Nicolas NYANTOBERWA	Food shop, mill, décortiquese	Mill	2	12	Day					24
Gerard Bukuru	Mill	Mill	2	12	Day					24
Average			**2**	**12**			**2.25**	**6**		**29.78571429**
Sum										**208.5**

Liters of Diesel used per day Appliance 1	Liters of Diesel used per day Appliance 2	Cost of diesel per liter	Expenditures on fuel per day	Cost per kWh	Income Frequency (per day, per week)	Average income per day	Percentage of Income spent on Diesel	Signed Agreement (Y/N)
8	5	$ 1.00	$ 13.00	$ 0.35	Per day	$ 60.00	21.67%	
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8		$ 1.00	$ 8.00	$ 0.33	Per day	$ 60.00	13.33%	
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8		$ 1.00	$ 8.00	$ 0.33	Per day	$ 60.00	13.33%	
8	**5**	**1**	**$ 10.14**	**$ 0.34**		**60**	**17%**	
56	**15**	**7**	**$ 71.00**	**$ 2.37**				

Tariff Structure

- Consumption-based tariff by kWh
  - vs. Capacity-based by monthly fee, Pre-Device Tariff, Energy as a service, etc.
- Tiered by customer type
- Time of Use

Customer	Tariff	Weightage	Weighted Average
Commercial	$ 0.40	40%	$ 0.160
Industrial	$ 0.38	50%	$ 0.190
Residential	$ 0.35	0%	$ -
Night (battery)	$ 0.50	10%	$ 0.050
TOTAL		**100%**	**$ 0.400**

Billing Structure

- Pay-as-you-go (vs. Fixed monthly payment)
  - Scratch cards
  - Lumeter, Sparkmeter, SteamaCo

Financial Model

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kWh * tariff

Revenue leveraged from the grant (modeled on next slide)

Burundi Micro Grid Financial Summary

	Year	0	1	2	3	4	5	6	7	8	9	10
5	**Revenue**	$ -	$ 22,710	$ 23,137	$ 23,571	$ 24,012	$ 24,460	$ 24,916	$ 25,379	$ 25,850	$ 26,329	$ 26,815
6	Cap Ex	$ -118,961	0	0	0	0	0	0	0	0	0	0
7	Op Ex		$ -4,327	$ -4,434	$ -4,543	$ -4,655	$ -4,770	$ -4,888	$ -5,009	$ -5,132	$ -5,259	$ -5,388
8	**EBIDTA**		$ 18,383	$ 18,703	$ 19,028	$ 19,357	$ 19,690	$ 20,028	$ 20,371	$ 20,718	$ 21,070	$ 21,427
10	Less Depreciation		$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896	$ -11,896
11	Less Tax		$ -1,946	$ -2,042	$ -2,139	$ -2,238	$ -2,338	$ -2,440	$ -2,542	$ -2,647	$ -2,752	$ -2,859
12	**NOPAT**		$ 4,541	$ 4,765	$ 4,992	$ 5,222	$ 5,456	$ 5,692	$ 5,932	$ 6,175	$ 6,422	$ 6,671
14	**Cash Available for Debt Service**		$ 16,437	$ 16,661	$ 16,888	$ 17,118	$ 17,352	$ 17,589	$ 17,828	$ 18,072	$ 18,318	$ 18,568
15	Principal		$ -5,748	$ -6,208	$ -6,705	$ -7,241	$ -7,820	$ -8,446	$ -9,122	$ -9,852	$ -10,640	$ -11,491
16	Interest (8%)		$ -6,662	$ -6,202	$ -5,705	$ -5,169	$ -4,590	$ -3,964	$ -3,288	$ -2,559	$ -1,770	$ -919
17	*Debt Ratio*	*70%*										
18	**Loan Balance Outstanding**	$ -83,273	$ -77,524	$ -71,316	$ -64,611	$ -57,370	$ -49,550	$ -41,104	$ -31,982	$ -22,130	$ -11,491	$ -0
19	DSCR		1.32	1.34	1.36	1.38	1.40	1.42	1.44	1.46	1.48	1.50
21	Depreciation Add Back		$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896	$ 11,896
22	Tax Shield on Interest		$ 1,999	$ 1,861	$ 1,712	$ 1,551	$ 1,377	$ 1,189	$ 986	$ 768	$ 531	$ 276
23	*Equity Ratio*	*30%*										
24	**Net Income to Equity**	$ -35,688	$ 6,026	$ 6,112	$ 6,190	$ 6,259	$ 6,319	$ 6,368	$ 6,405	$ 6,429	$ 6,439	$ 6,433
25	Equity IRR	11.76%										
26	Equity Payback Period	5.75	Years									

Expansion Scenarios: Leverage Grant by Reinvesting Profit into 30% Equity of New, Identical Mini-Grids Every Two Years

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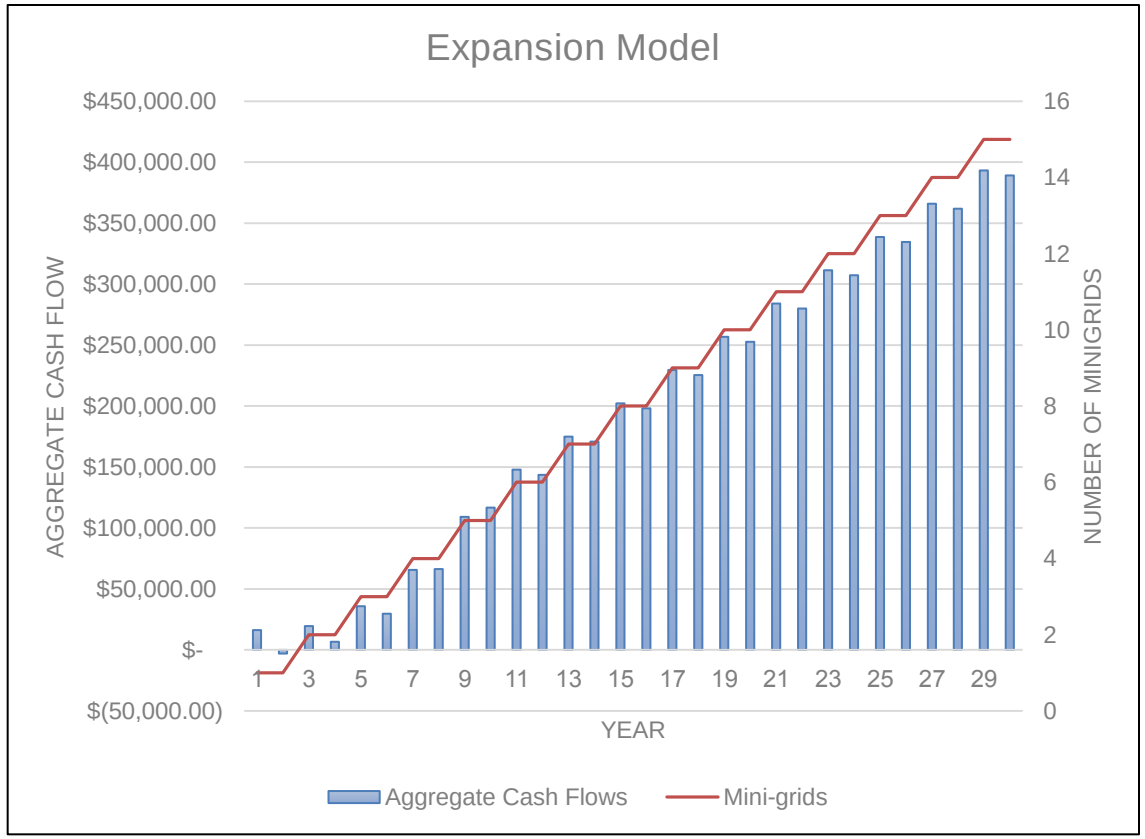
One MG every two years: steady, upward linear trend.



As many MGs every two years as our cash flow allows: exponential growth