



#### Microgrids Co-existing with the Grid: Competition Beyond Access and Resiliency

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#### Why microgrids?

- In the US, in Africa, in India, in many island nations, in remote parts of West Australia, in island nations, mining towns, ... at the Microgrid Symposium, in Bucharest, 2018, microgrids are standalone, small (~ 5 to 20 MW) systems.
- India calls Solar Home Systems (SHS) of tens of kW size as mini-grids!
- Microgrids are viewed as complementary to the grid, for electricity *access;* provisioned where the grid cannot extend economically due to remoteness
- In the US, *resiliency* and *reliability* are reasons for promoting microgrids following Hurricane Sandy that affected NY, NJ, MD, CT, ...
- This is gross *under-selling* of the potential and prospects of microgrids.
- For this paper, a federation of microgrids is the preferred topology for electricity supply of the future, urban & rural
- Resilience, Reliability, Access are baseline expectations from any engineered system



#### Microgrid Symposium, Bucharest, September 2 - 5, 2018.

http://microgrid-symposiums.org/presentations-and-posters/



Even in 2018, focus on resiliency, reliability, access .... No work on federation of microgrids!



#### A federation -

An emerging world of urban, rural microgrid clusters

Each microgrid can work independently; with each other synergistically; and also with the traditional grid



# Startups, customers, incumbents enter the microgrid space

College campuses, malls, commercial buildings, residential communities, ... may deploy their own microgrids, say of 0.5 MW to 5 MW capacity each, like captive power plants today



#### **Microgrids comprise**

Multiple renewable generation sources - solar panels, wind turbines, battery storage, ... plus demand side management and sophisticated controllers for balancing among generation sources and storage to meet given load profiles



# A cluster of inter-working and complementary microgrids

Microgrids adjacent to each other.

A day-time peak load microgrid, say, a commercial building or college campus, may complement a neighboring evening peak load microgrid, a residential community or a shopping mall.



## The existing grid? Serves as insurance ... for a while

Backup power in the early years

As microgrids clusters become common place, and reliable, the traditional grid loses demand, therefore revenues

Microgrids represent a reduced emissions footprint

- socially desirable
- encouraged by public policy



## Industry structure obsolete -Basis of historical market design dead

- Barriers to entry have fallen; we are all in the electricity business
- Economies of scale do not matter; unit costs independent of size
- Traditional industry boundaries breached electricity? IT? Internet? EPB in Chattanooga, TN, an electric utility also in the ISP business



#### Industry structure obsolete - Implications

- Traditional regulations also dead rate of return, stranded cost recovery, public interest definition, ....
- Competition, market forces define next generation services
- "Local generation, local consumption, local autonomy" why do we need the network?
- "Grid" term usurped by the electricity industry!
- "Grid" dead? Mostly a local area electricity network

#### "Electricity LAN" called "Off grid" solutions



### **Economics favors microgrids - 1**

- Renewables-based, no burning
- Close to customers, no transmission
- No fuel costs
- No moving parts

Large electricity applications - steel making, ore smelting, cement plants, ... will continue to use the traditional grid ... whose role diminishes over time.



# A federation of microgrids, urban and rural, is the topology of the future grid

- Trading power and information among themselves
- A new area for research, prototype development
- Inherently clean, climate friendly
- Profound, unexplored business implications



#### **Economics favors microgrids - 2**





### **Evolution of microgrids**





#### **Microgrids - urban, rural no distinction**





#### **Microgrids: Federations in New Delhi**





# Microgrids within mini grids: Federation proposed by Siemens for Puerto Rico





#### **Microgrid federations in a neighborhood**

	Generate, Use, Buy, Sell	Shopping Mall	11	11	X	11	×						
	Generate, Use, Buy, Self	Home: Rooftop & Inside		1	1	1	1						
NO	Generale, Use, Buy Sell	High Rise Office Building	11	111	X	1	1						
CATI	C <mark>enerate,</mark> Use, Buy Sell	School Yard & Parking Lot; Inside	11	1	X	11	1						
ĽÕ	Generate, Use, Buy, Sell	High Rise Residential Building	1	111	<i>」 」 」 」</i>	1	J						
	Generate, Use, Buy, Sell	College Campus	11	11	1	11	11						
			Lighting	Energy Efficiency	Cooking	Air Conditioning & Heating	Hot Water						
	MARKET												



#### **Evolution of a federation of microgrids - Phase I**





#### **Evolution of a federation of microgrids - Phase 2**





#### **Evolution of a federation of microgrids - Phase 3**





### **Conclusion: Rise of competitive service\* providers**

Why? Microgrids challenge two industry structure foundations:

- economies of scale unnecessary for \$/kWh reduction
- barriers to entry in electricity business have gone
  - natural monopoly presumption is dead
  - regulatory price structuring is dead

\*Not necessarily **electricity** providers, an important point. They may provide lumens, cooling, heating, motion, charging, cooking, ....

See Walt Patterson, <u>What Electric Business?</u> 2019, Chatham House, Hoffman Center



# **Background slides**



# **Context: Industry at inflection point**

(peak use in 2007)





## Forces gutting demand, revenue





https://microgridknowledge.com/mini-grids-puerto-rico-siemens/

#### Siemens Offers Plan for Competitively Priced Minigrids in Puerto Rico

📩 July 25, 2018 By Elisa Wood 📄 Leave a Comment 🛛 🚔



Configuring Puerto Rico's electric system into 10 mini-grids could bring the island much-needed resiliency at a competitive price, according to a white paper issued by Siemens this week.



# My recent microgrids related articles

2018

Electricity - Perfect Product? EEnergy Informer, March 2018, Vol. 28, No. 3, ISSN: 1084-0419.

2017

<u>"Build Back Better" in Puerto Rico - Microgrids Treated Shoddily</u>, *Renewable Energy World*, December 28, 2017 <u>Puerto Rico - Pioneer in Microgrids</u>, *Microgrid Knowledge*, Dec 13, 2017.

Puerto Rico - Rebuild with Microgrids, Renewable Energy World, Oct 4, 2017

<u>Cooking Microgrids: The Case for Application-specific Power Networks</u>, *Renewable Energy World*, Jun 9, 2017 <u>The Microgrid Revolution: What Business Models Will Prevail on the New Grid?</u> *Microgrid Knowledge*, Apr 17, 2017

Diving into the solar microgrid revolution, GreenBiz, April 1, 2017

The compelling case for creating a nation of microgrids, GreenBiz, Mar 15, 2017

Microgrids for Clean Cooking and Internet, Renewable Energy World, Feb 27, 2017

2016

Linearly Extensive Electricity Businesses, Renewable Energy World, Dec 9, 2016

Microgrids and the Market Capitalization of Utilities, Renewable Energy World, Nov 30, 2016

Federation of Microgrids: A Moral and Business Necessity, Renewable Energy World, Oct 4, 2016

#### 2015

The mega wonders of microgrids, Business Standard, Jul 9, 2015

Why Microgrids are Essential in India's Electricity Generation Mix, Jul 8, 2015, Renewable Energy World.

Tesla E-motorcycles Complement SolarCity Microgrids, Renewable Energy World, May 20, 2015.

Microgrids as Fact and Metaphor, Renewable Energy World, Jan 22, 2015.





#### Praeger, October 2016

Amazon <a href="https://www.amazon.com/Microgrid-Revolution-Strategies-Next-Generation-Electricity/dp/144083315X">https://www.amazon.com/Microgrid-Revolution-Strategies-Next-Generation-Electricity/dp/144083315X</a>



#### About the author

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