Microgrid Institute

Smart grids, smart microgrids

Plotting the trajectory of power market disintermediation

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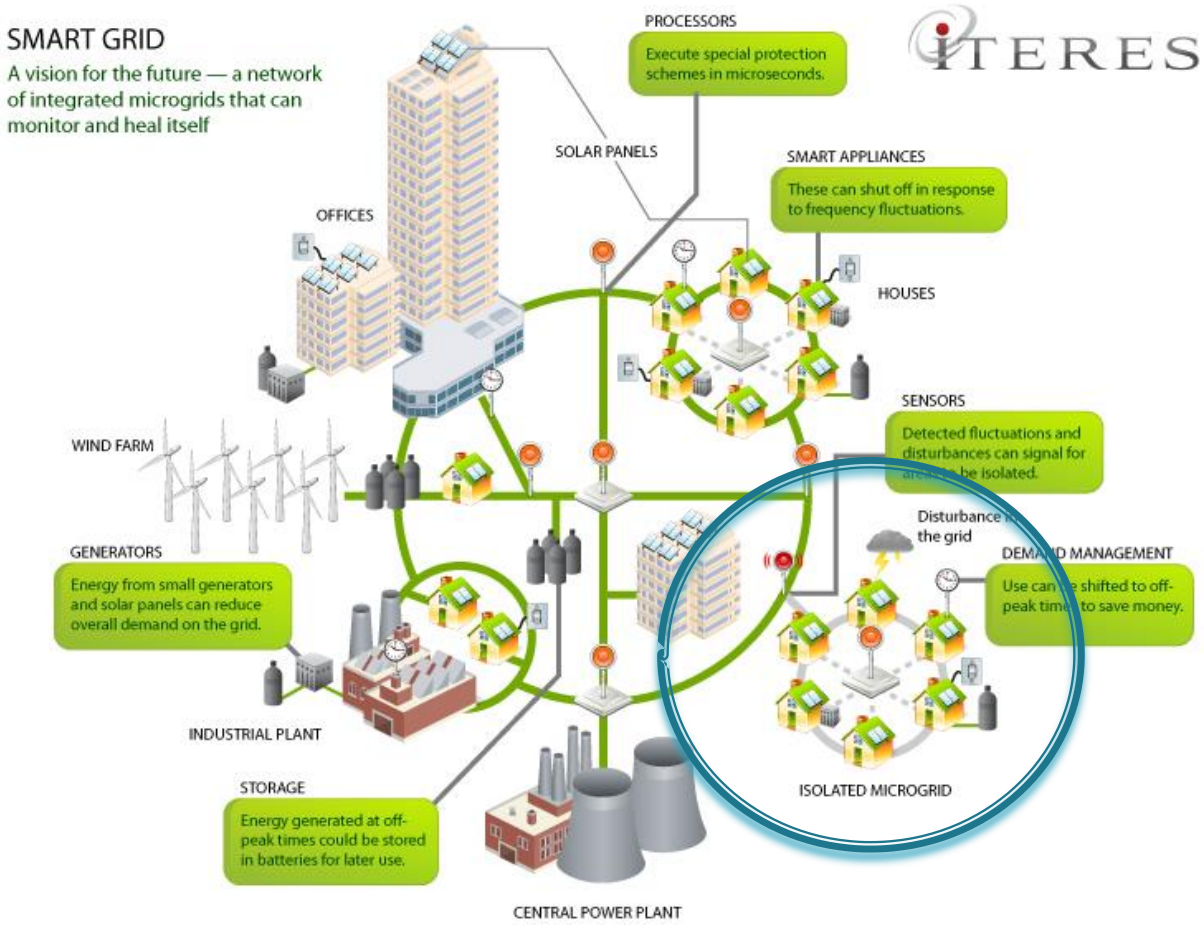
ABA-ACORE workshop / July 17, 2011

Smart grids and microgrids

A smart grid is an energy system characterized by two-way communications and distributed sensors, automation, and supervisory control systems.

A microgrid can be part of an optimized smart grid, and a microgrid itself also can be considered a tiny smart grid.



definition:*

Microgrid

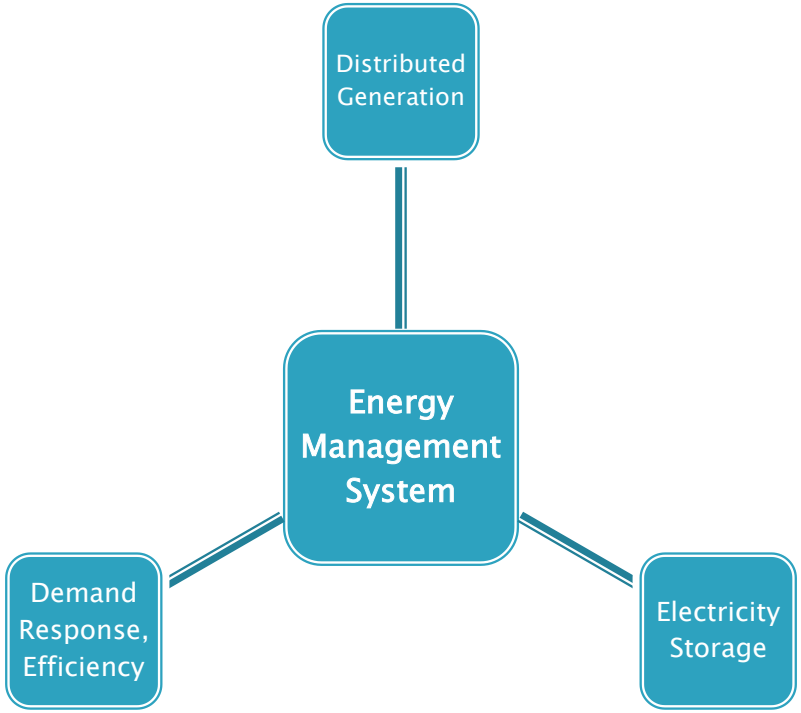
A local energy system capable of balancing captive supply and demand resources to maintain stable service within a defined boundary.

Microgrids are **defined by their function**, not their size.

Microgrids combine various distributed energy resources (DER) to form a whole system that's greater than its parts.

Most microgrids can be further described by one of three categories:

- **Isolated microgrids,** including those on **islands** and at **remote inland sites**, *not connected* to a local utility.
- **Islandable microgrids** that are fully interconnected and capable of both consuming and supplying grid power, but can also maintain some level of service during a utility outage.
- **Asynchronous microgrids** are connected to utility power supplies, but they aren't *inter*connected or synchronized to the grid. Such non-synchronized microgrids are capable of consuming power from the grid, but they aren't capable of supplying it.



*Source: Microgrid Institute
www.microgridinstitute.org

Microgrids can use almost any form of energy supply.

The key to making a microgrid work is the ability to **balance demand against available supply in real time** and thereby maintain service that's adequately stable and sufficient *for the host's purposes.*

Not all microgrids must provide service levels equivalent to modern utility service.
In fact *most will not.*

Microgrid Technologies and Resources

- Gas or diesel cogeneration
- Fuel cells and microturbines
- Photovoltaic (PV) modules
- Wind, biomass, small hydro

- Efficiency, conservation, and demand response capabilities

- Electricity storage

- **Energy management and automation systems**

Microgrid Drivers in Industrialized Markets

► **"Supply Surety"**†
especially at mission-critical and outage-sensitive facilities

- Military and government installations
- Institutional campuses (universities, hospitals, prisons)
- C&I sites (data centers, corporate campuses, factories, processing plants)
- Communities that repeatedly endure extended outages (NE, Florida, etc.)

† Government agencies and laboratories in the U.S. use the terms "surety" and "assurance" in describing energy supply priorities. Related engineering and regulatory concepts involve resilience, reliability, and power quality.

► **Social Policy**
Environmental liability, jobs/economic development in various jurisdictions – states, cities, and economic development zones

- Renewable mandates
- Environmental constraints
- Sustainable/domestic fuel preferences
- Local self-reliance

► **Transmission congestion**
Siting challenges, load pockets, least-cost regional planning

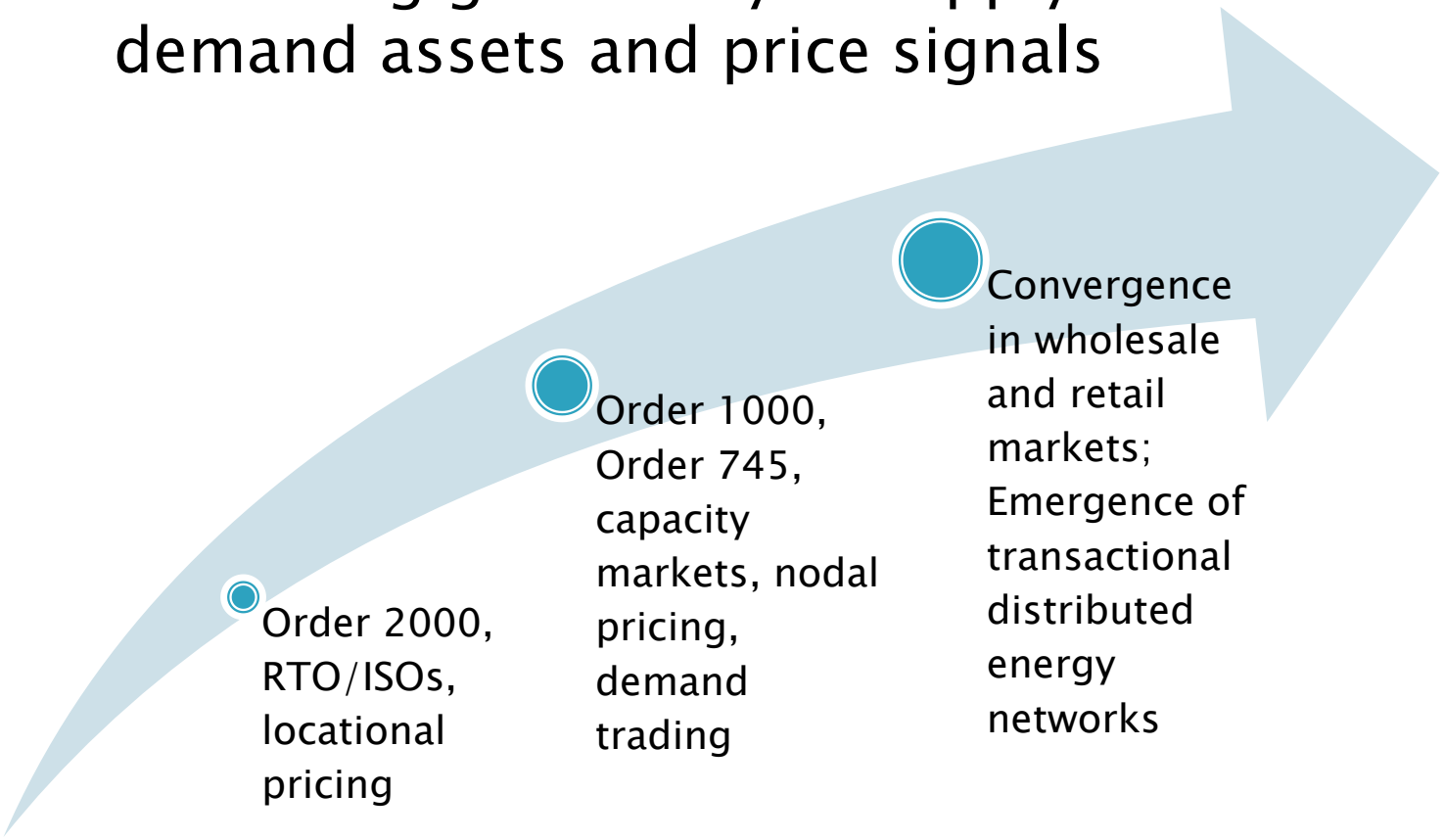
► **Economic competitiveness**
vs. high-cost utility power. Where DG is near grid parity, microgrids can optimize capacity and add value.

Distributed Energy Resources Trajectory

~Timeframe:	1980s–Present	2000s–Present	2010–Present	Present–2020+	2015+
	Self-Generation	**Demand Response**	**Distributed Generation**	**Microgrids**	**Transactional Energy**
Technology	Aeroderivative turbines, cogeneration/CHP, diesel gensets, etc.	DR energy management systems, submetering, distributed controls, smart metering/ smart grid integration	Rooftop PV, microturbines, fuel cells, energy storage, smart inverters, smart grid integration	DR & DG technology, energy management software, distributed sensors and controls	Advanced smart grid, distributed sensors and controls, Big Data analytics
Policy	PURPA, State IRP, etc.	EPAct 2005, FERC Order 2000 & 745, IRP & efficiency/ conservation policies	PURPA, EPAct, ARRA	In progress (FERC Order 1000 policy on non-transmission alternatives (NTA), ARRA, state policies)	None yet!
Contracting	Turnkey EPC, power purchase agreements (PPA)	Energy service contracting, aggregation, conservation service agreements,	DG PPAs, leasing	Microgrid service agreements	(Aggregation, energy service contracting)
Market Settlement	Bilateral trading, regional wholesale market settlement for energy and capacity	Regional market settlement	None (possibly regional market settlement for DR functionality)	None (possibly regional market settlement for DR and DG)	(Retail and wholesale market settlement)
Pricing & Tariffs	Interruptible rates, standby rates, and sometimes deferral rates to discourage self-generation	Dynamic rates, conservation/ efficiency incentives, locational marginal pricing (LMP)	Net-metering tariffs, standby rates, DG interconnection fees, and sometimes fixed-cost charges	In progress (derived from IPP, DR, and DG tariffs, plus FERC incentive tariffs for NTAs?)	None yet!

Market Trajectory:

Increasing granularity in supply and demand assets and price signals



DG Technology Trajectory

Manufacturing scale economics vs. network scale economics

Aeroengines, diesel gensets, and backup generators

Small-scale wind chargers, PV modules, and battery storage for remote sites, office-scale UPS

Gas-fired engines, packaged cogen

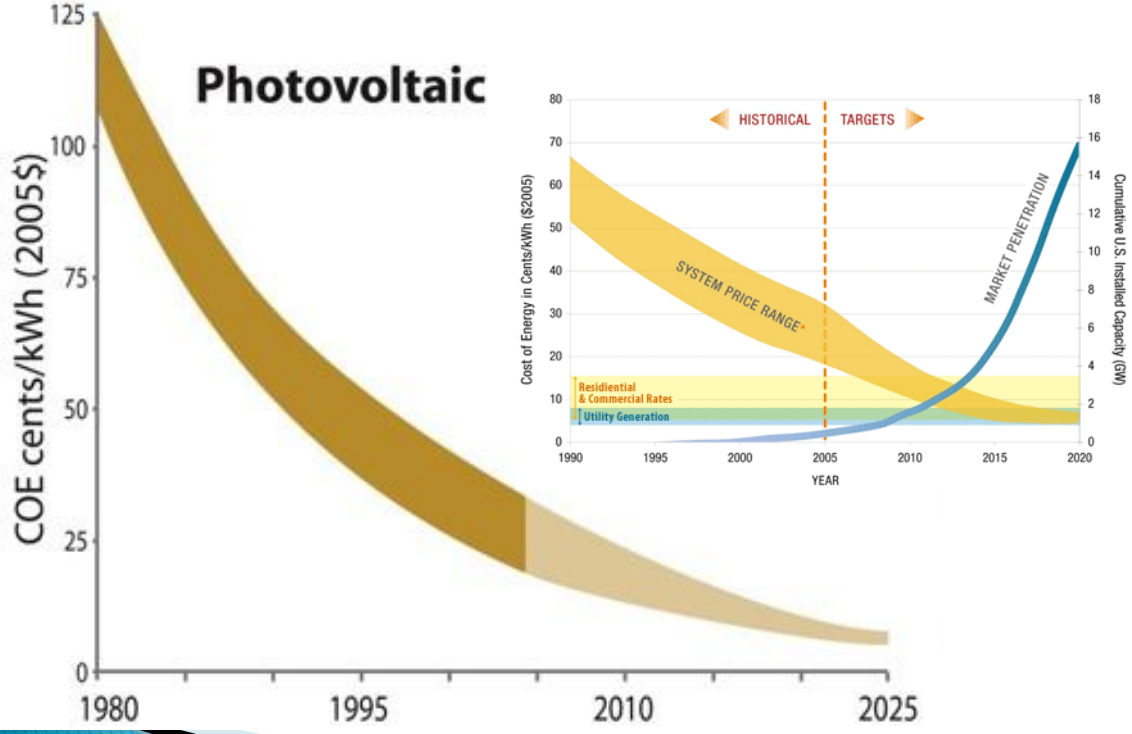
Rooftop PV

Battery storage, EV smart charging

Fuel cells, microturbines, V2G

DG Technology Trajectory:
Black Swans emerging

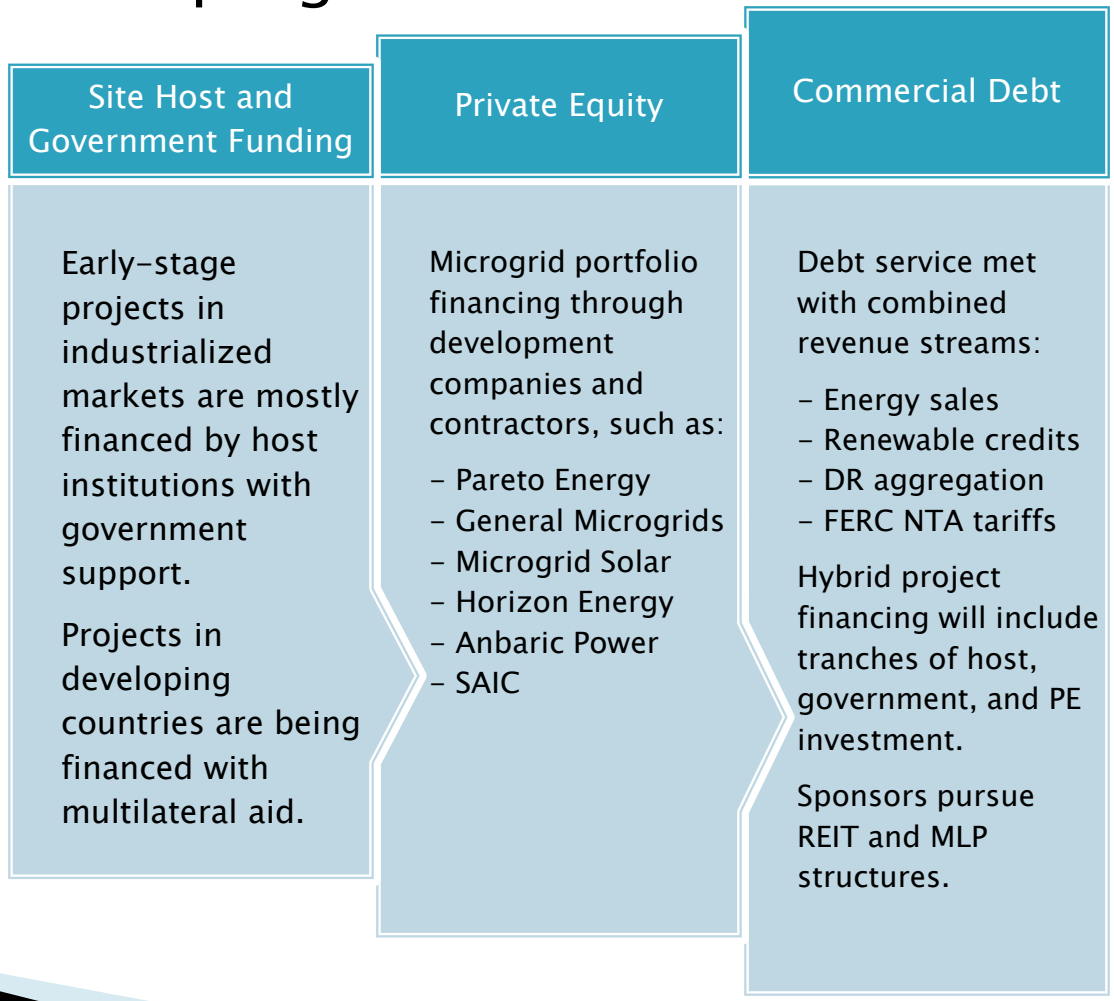
Exponential advances in nanotechnology bring cheap photovoltaics and battery storage.



"[T]hreats … from disruptive forces, particularly distributed resources, have serious long-term implications for the traditional electric utility business model and investor opportunities."

~Peter Kind, Energy Infrastructure Advocates, in January 2013 **EEI Report**

Microgrid Financing:
A work in progress



Microgrid Regulation:
A work in progress

Net-metering tariffs

- Pressure rising to reduce net-metered energy payments and restrain growth of DER
- Interconnection policies and fees increasingly onerous and costly

Demand response policy

- Volumetric pricing and rate-base regulation discourages conservation and load shifting
- DR tariffs and ISO/RTO policies shifting to prohibit DR sales that are enabled by DG

Microgrid Regulation:
A work in progress (continued …)

Retail franchise / service territory laws

- Franchised utilities challenge behind-the-meter energy transactions
- Microgrids seeking to serve multiple customers or even multiple premises face lawsuits and potential regulation as public utilities
- Energy development zones and community energy projects are nascent and their regulatory frameworks are still evolving

FERC 1000 NTA rules

- FERC Order 1000 opens the door to transmission incentive rates for microgrids and other non-transmission alternatives (NTA)
- No regulatory pathways currently exist for development, planning, and financing of NTAs

Industry Trajectory: 2020+

Distributed intelligence + distributed resources = disintermediation in energy markets

- Networked smart grid technology
- Cheap gas, PV, energy storage, fuel cells
- Advanced energy management systems

Plus growing demand for:

- Reliability, resilience, energy assurance / supply surety
- Sustainability, green energy, local self-reliance
- Least-cost alternatives to long-distance electric transmission

Industry Trajectory:
Disintermediation and transformation

Convergence of networked distributed intelligence, cheap distributed energy resources, and increasingly sophisticated data analytics and energy management technologies creates inevitable pressure on legacy regulatory structures and business models.

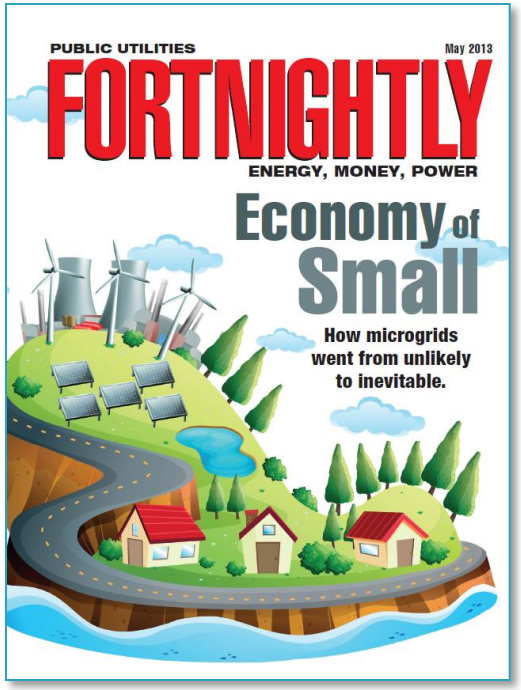
The watchword for the next 10 years is “disintermediation,” as increasingly affordable and effective microgrids and other DERs create competitive alternatives to the central utility service model.

Utilities have recognized this and are taking steps to prepare for the transition. Some are working to slow it down, and some are pursuing investment opportunities.

Utility tariff structures, interconnection policies and fees, and standby rates all are evolving to accommodate and/or restrain the distributed energy trend.

For more information …

"**Economy of Small**: How DG and Microgrids Change the Game for Utilities,"
by Michael T. Burr, *Public Utilities Fortnightly,* May 2013
http://ow.ly/mZczd



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