In

their ongoing search for ways to meet the rising expectations of shareholders, the leaders of global energy utilities and their suppliers are asking us about the bundle of technologies kown as Distributed Generation (DG).

Distributed Generation offers the promise of providing electricity in a fundamentally different way-, dispersed fleet of small-scale electric generators providing power to the grid, rather than a large centralized power station. Mostly fueled by natural gas, liquid fuels, or renewables (solar, wind), these dispersed generation resources could bypass major portions of the electric transmission and distribution system.

Arthur D. Little believes that Distributed Generation has the potential to transform the industry. You'll find information at the website to explain why, and what companies will need to do to profit from Distributed Generation. We'll also tell you about the technologies and products that comprise Distributed Generation, and the regulatory issues around it.

Executives at utilities, energy companies and equipment suppliers are beginning to face critical decisions about how distributed generation (DG) will impact their company's future.
In addition, DG is quickly finding its way onto regulatory and legislative agendas in many states and the federal government.
Arthur D. Little is working on a Multi-Client Study that addresses many of the more urgent issues that will educate policy makers on DG.
Arthur D. Little's Multi-Client DG Study has brought together like-minded companies, and provided them with a solid, authoritative, and credible factual

foundation, as well as the means to communicate these facts.
Our reputation has been built on our innovation, insight, and objectivity.

Arthur D. Little is working with leading power generation companies and OEMs to blaze trails in Distributed Generation. Our work encompasses every aspect of DG, from technology and market assessments, to development and implementation of business strategies, to development of new technologies and products. Although the assignments may vary, the objective is consistent: help our clients capitalize on the tremendous potential for growth and value creation from Distributed Generation.

The markets for Distributed Generation-and the technologies themselves-hold enormous potential. Although it might be difficult for DG technologies to compete in supplying commodity energy right now, the potential performance trajectory is steep. Successive generations of the technology will deliver substantially greater performance benefits than the incremental upticks of established generation technologies.
The winners will follow the technologies that underpin DG and the products that are changing the competitive landscape in power generation.

The potential for Distributed Generation to be a "disruptive"1 technology has major consequences in terms of the market potential for DG products and services.

ATTRIBUTES OF EVOLUTIONARY TECHNOLOGY

Established firms have inherent advantages

Modest improvements

Established trajectories of product performance improvement

The structure of the industry (its value network) is not altered

Predominant firms establish the pace of growth

ATTRIBUTES OF DISRUPTIVE TECHNOLOGY

Distinctly different package of attributes

Difficult to apply initially in traditional established markets

"True" value in the marketplace is difficult to establish

Rapid learning curve

Value network is reshaped

Totally new players enter - established competitors forced to exit the business

Customers do not drive initial creation

Easier, cheaper, faster

The following are at different stages on the pathway to commercialization.

DG Product	Description	Status
Microturbines	Small (<250 kW) microturbines were initially developed for hybrid electric vehicles, but now the focus is on power gen Projected to be low capital cost, low maintenance cost, low emissions, low noise, and moderate efficiency	Early commercial
Fuel Cells	Fuel cell-based energy systems can provide electricity and thermal services to both residential and commercial buildings Proton Exchange Membrane (PEM) fuel cells are also being developed for hybrid electric vehicle applications	Alpha/beta testing (residential scale)
IC Engines	Diesel or gas IC engines packaged for power generation Used widely for standby, baseload, cogen, and peaking Drawbacks: emissions, noise, and high maintenance cost	Mature
Solar Photovoltaic (PV)	Semiconductor-based panels convert sunlight into power Ideally suited and cost-effective for many off-grid applications Still rely on government subsidies for grid-connected use, but prices are steadily dropping	Early commercial
Uninterruptible Power Supply (UPS)	Protects against temporary power interruptions	

Rapid growth has followed the computer and telecommunications industries

System consists of power electronics and energy storage

Early commercial

UPS systems use energy storage devices (typically batteries) to provide electric power when primary electric supply is unavailable.

Uninterruptible Power Supply (UPS) Systems

Description

Uninterruptible Power Supply (UPS) systems provide ride-through power for essential or sensitive equipment in the case of a temporary grid outage or sag

Conventional sizes - in the past, ranged from <1 kVA[watts] for personal computers to over 1,000 kVA [watts] for large industrial equipment

In general, both competitive intensity and product volume increase with smaller sized units

The required rectifying-storing-inverting cycle (AC to DC, DC stored to DC recovered from storage,

then DC to AC sinewave power) required with conventional systems accumulate high combined

efficiency losses to achieve the desired AC power in / AC power out, systems have significant losses (typically >65%) .

Main Components -	**MDG Benefits**
Power conditioning equipment -	MDG Low/cost utility grade [100 percent PURE SINEWAVE] *Automatic Power Conditioning*
Inverters -	NOT REQUIRED WITH MDG
Surge protectors -	NOT REQUIRED WITH MDG
Filters and regulators -	NOT REQUIRED WITH MDG
Energy storage (usually batteries) -	MDG - ULTRA HIGH PERFORMANCE DESIGN (over 92% efficient), REBUILDABLE ADVANCED HYBRID LITHIUM-ION PB
Software -	Thousands of less required micro-electronic components per Hyper-conductor (not semi-conductor based) system. *Quick and easy replacement circuit boards
Remote controll -	REMOTE (wireless), PC controled CHARGE / DISCHARGE, system monotoring, load – Generation “dispatchable” Spinning reserve type Instantly available reserve power to run loads

	Instant connect / disconnect to accumulate and dispatch power to load site or to high voltage power grid
Semi-conductor based - operates	**HYPERCONDUCTOR** based technology
	system at COOL TEMPERATURES, with lower resistance and therefore more total efficiency
Power Capacity - (low)	1, 5, 10, 50, 250, 1,000 kilowatt each - -- combined 5GWh+
Overall efficiency (max. 38%)	MDG AC Battery Power Plant/Intertie - Minimum 81%

Distributed Generation is getting a lot of attention these days in both industry trade publications and main-stream press. There are a host of policy and regulatory issues which change frequently and a rising tide of business implications that is starting to capture the attention of the media. It's almost too much to keep up with.

This page will provide you access to sources with the latest and ***most relevant*** DG regulatory and business issues.

Investigation Into Distributed Resources in Texas Project #20363

Description / View

The Commission's investigation into distributed resources in Texas is ***focused on the interconnection of distributed generation*** ***and the development of standard contracting approaches for distributed resources.*** An informal e-mail list is maintained to facilitate communication on these and related matters. If you would like to add your name to the e-mail list, contact nat.treadway@puc.state.tx.us(5/4/99) Public Notice of July 21, 1999 Workshop (07/07/99)

Arthur D. Little is working with leading power generation companies and OEMs to ***blaze trails*** **in Distributed Generation**. Our work encompasses every aspect of DG, from technology and market assessments, to development and implementation of business strategies, to development of new technologies and products. Although the assignments may vary, the objective is consistent: help our clients capitalize on the tremendous potential for growth and value creation from Distributed Generation.