Interconnecting Distributed Generators: Technical & Business Impacts

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Agenda

- Forces Behind Renewed Interest in DG
- Technologies & Applications
- Why Is Interconnection Such a Concern?
- How is Interconnection a Potential Barrier to DG?
- Emerging Regulatory Treatment of DG
- Interconnection Standards Development: Status Report
- Business Impacts of Interconnection
- A Glimpse of the Future for DG

What is Distributed Generation (DG)?

- Power generation from 30 -15,000 kW
  - Reciprocating engines
  - Microturbines and industrial turbines
  - Fuel cells
  - Renewables
- Distributed within transmission and distribution system
- Sited close to load

Distributed Generation Isn’t New!

- “Reappearing” After a Long Absence
- Existed in Various Forms Before Today
  - “Total Energy” experiment in the 1960s
  - Packaged cogeneration of the 1980s

What’s the DG Buzz About?

- Restructuring Promises Opportunities for DG Solutions
  - Price spikes cause concern
  - Numerous applications are cited, including grid support
- Many DG Technologies in Marketplace
  - New technologies being commercialized
  - Ambitious improvements slated for old standbys
- Interconnection Debate Continues

What's the DG Buzz About? (cont.)

- Environmental Restrictions Add Complexity
  - High price regions overlap with non-attainment areas
  - NOx control cost burdens smaller units
- Availability and Price of Natural Gas
- Increasing Sensitivity of Electrical Equipment and Concern for Power Quality
- Heightened Reliability Awareness
- New Savings Opportunity for Business & Industry

Technologies and Applications

Distributed Generation Technologies

The Non-Renewable Technologies

- Reciprocating Engines
- Turbines
- Microturbines
- Fuel Cells

Distributed Generation Technologies

Generally, non-renewable DG falls in the range of 30kW to 15MW, varying by technology

Technology	Size Range
Microturbines	30-200kW
Miniturbines	200-1000kW
Small Turbines	1000-15,000kW
Reciprocating Engines	30-15,000+kW
Fuel Cells	30-1000kW
Fuel Cell Hybrids	200-1000+kW

DG Applications

Application	Description
Continuous Power	Requires power on a nearly continuous basis, typically at least 6,000 hours per year.
Combined Heat and Power (CHP)	Applications utilize waste heat as useful thermal output, and typically operate 6,000+ hours annually.
Peak Shaving	Units typically operate 200-3000 hours per year during periods when high demand charges apply.
Standby/ Emergency Generation	Applications typically driven by the reliability (perceived or real) of the grid, or code requirements.
Mechanical Drive	Units drive shaft-driven equipment such as gas compressors, air compressors, refrigeration units, chillers, and pumps.
Grid Support	Applications may use DG to defer transmission or distribution system upgrades, reduce transmission losses, or provide voltage support.
Emerging Applications	Premium power, "green" power or DC applications.

DG Cost and Performance

Technology	Engine: Diesel	Engine: NG	Microturbine	Turbine	Fuel Cell
Size	30kW – 10+MW	50kW – 6+MW	30-200kW	.5 – 10+MW	100-3000kW
Installed Cost ($/kW)[1]	300-500	500-800	500-900	400-700	900-3300
Elec. Efficiency (LHV)	36-43%	28-42%	18-32%	21-40%	40-57%
Overall Efficiency[2]	~80-85%	~80-85%	~80-85%	~80-90%	~80-85%
Variable O&M ($/kWh)	0.005 - 0.015	0.007-0.020	0.004-0.01	0.003-0.008	0.0019-0.0153
Footprint (sqft/kW)	.22-.31	.28-.37	.15-.35	.02-.61	.9
Emissions (gm / bhp-hr unless otherwise noted)	NO_x: 7-9 CO: 0.3-0.7	NO_x: 0.7-13 CO: 1-2	NO_x: 9-50ppm CO: 9-50ppm	NO_x: <9-50ppm CO:<15-50ppm	NO_x: <0.02 CO: <0.01

[1] Cost varies significantly based on siting and interconnection requirements, as well as unit size and configuration.
[2] Assuming CHP

The Technology Push

- Reciprocating Engines Claim Dominant Share of Small Power Generation Market
- Microturbines Making a Big Splash
  - Building on Aviation & Automotive Applications
  - Promising Cost and Performance
- Fuel Cell Technology Still Evolving

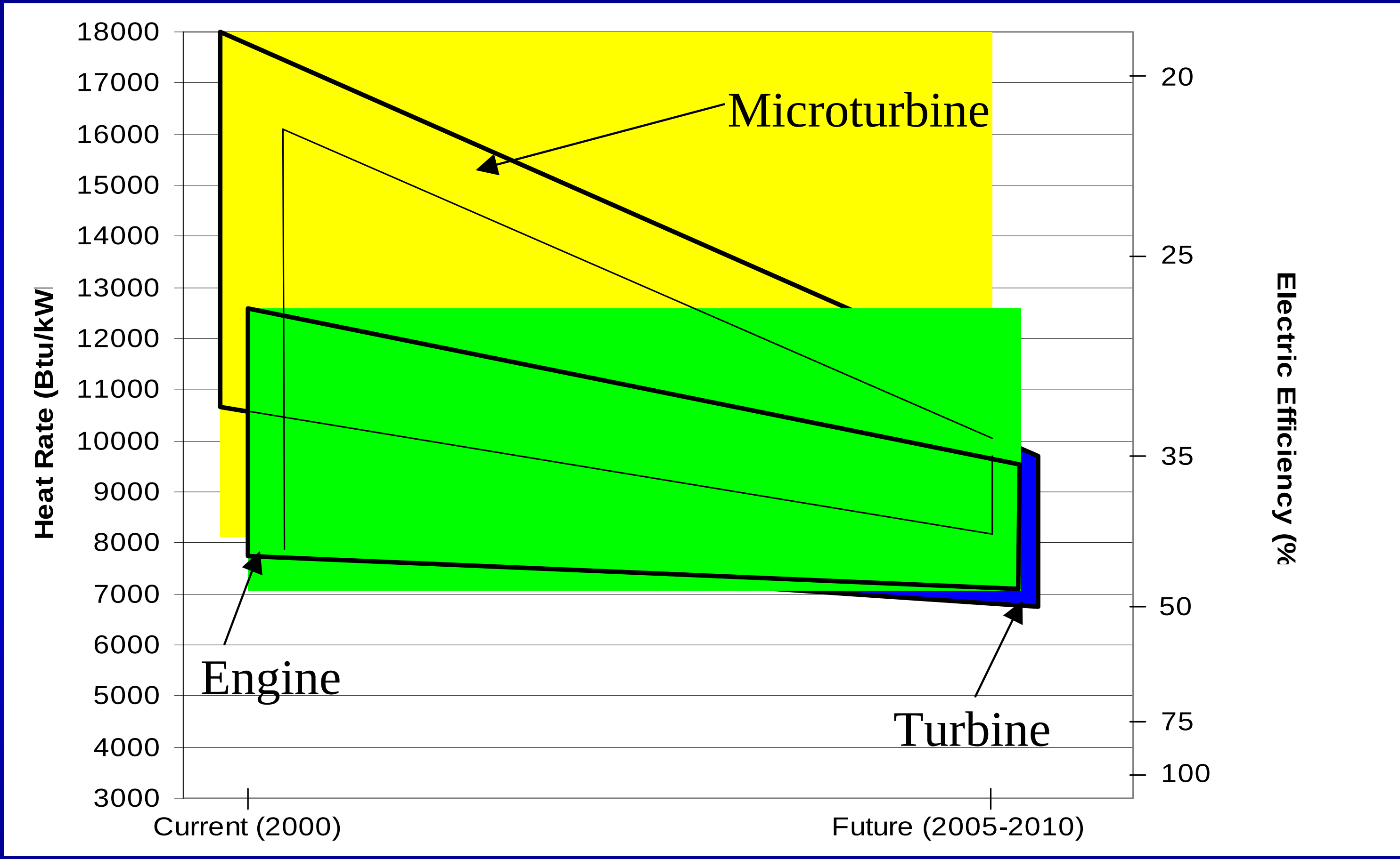
Critical Price and Performance Issues

- Installed Costs
  - Engines typically have advantage
  - Interconnection and permitting can be a major adder
  - Add on emissions controls can kill projects
- Efficiency
  - Fuel cells typically have highest efficiency, followed by engines
  - Better efficiency leads to lower fuel cost and CO_2 emissions

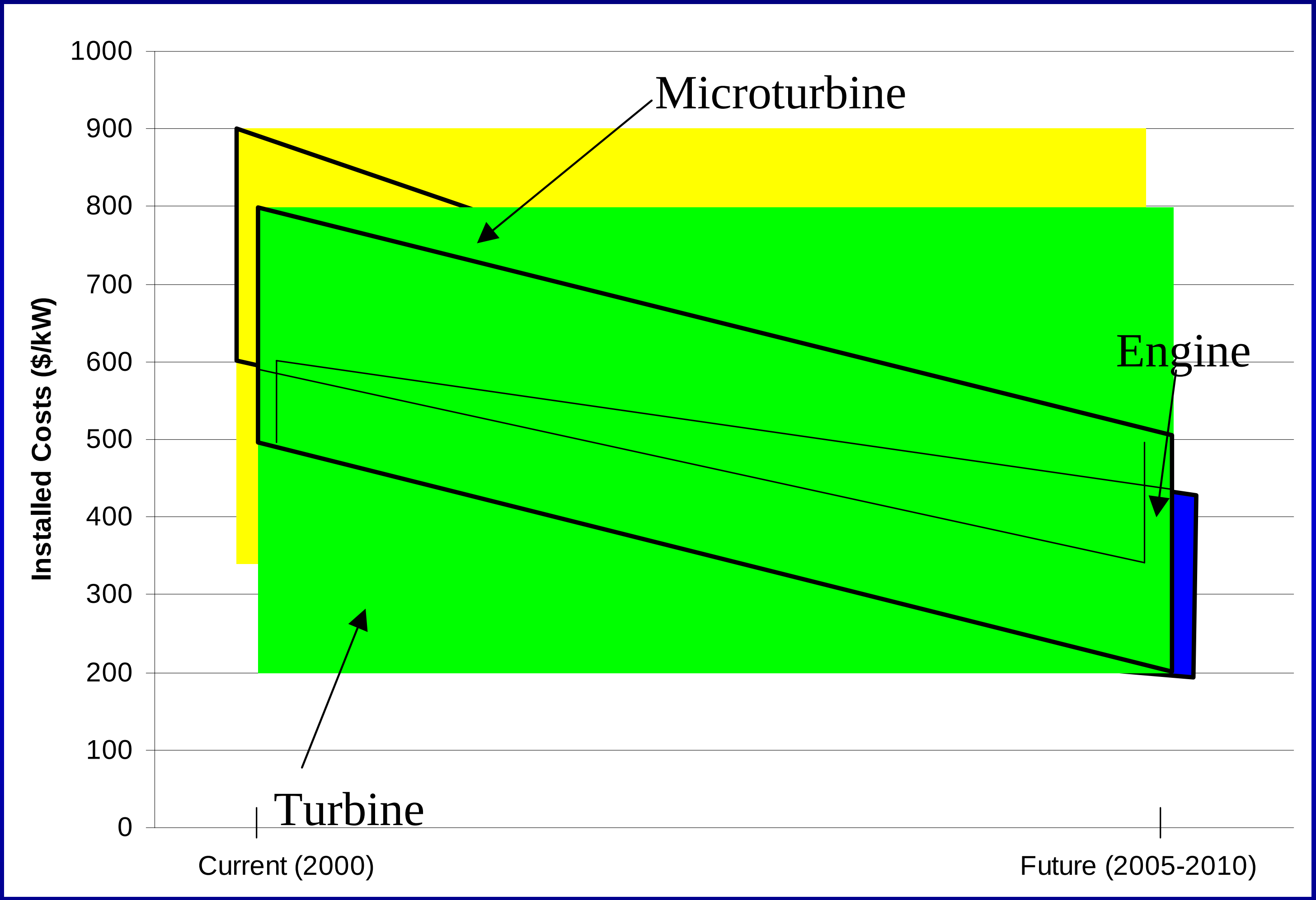
Critical Price and Performance Issues (cont.)

- Emissions
  - Engines, especially diesel, have high emissions of NOx, CO, and particulates and may be difficult to site
  - Fuel cells have virtually no emissions due to the lack of combustion process, though minor emissions from fuel reformer
- Useful Thermal Output
  - Turbines and fuel cells produce higher quality heat than engines and are better suited for cogeneration applications, especially where steam is required

Projected Efficiency Improvements



Projected Cost Reductions



How Does DG Change The Way Electricity is Delivered Now?

- Electric Power Systems Not Designed for Distributed Power Resources
- Utility Circuits Typically Radial, Designed for “1-Way” Operation
- Personnel Safety and Grid Stability Are Dominant Concerns of Utilities With “Reverse” Power Flow

As a result, interconnection has become a high-priority issue!

Utility Approach to Interconnection

- Maintain Grid Stability and Reliability
- Minimize Problems from Uncontrolled Customer Generation
- Obtain Protective Relaying to Protect the Grid
- Discourage Customer Generation
  - Discount Retail Rates
  - Discredit Customer Cogen Proposals
  - Take a Position in Development of Project

Emerging Regulatory Treatment of DG Interconnection

- Combination of State, National and Federal Interest and Oversight
- Selected States “Impatient” to Establish Interconnection Regulatory and Technical Requirements
- Consideration of Federal Mandate for Interconnection - FERC Emergency Authority for Transmission as Example

Customer Interconnection Concerns

- Utility Interconnection Costs Can Be a "Deal Breaker" for Smaller-Sized Projects
- Some Requirements Not Understood by Customer, and May Appear Unreasonable
- Manufacturer, Customer and Utility DG Activities are Frequently Not Coordinated
- Interconnection Requirements Are Far From Standard

Factors Driving Customer Choice

- High Energy Bills
- Reliability and Power Quality Problems
- Need to Control Operating Costs
- Early Adopters of Technology
- Dissatisfaction With Current Equipment
- Need for HVAC/Infrastructure Upgrade
- Thermal Process Needs

Distributed Generation Advantages to Customer

- Size for Baseload Capacity to Meet Minimum Constant Loads
- Capture Intermittent and Peaking Loads
- Increased Energy Efficiency
- Improved Reliability
- Expanded Power Supply Options

Barriers to Customer Implementation of DG

- Belief That Energy Costs are Fixed
- Expect Deregulation to Result in Lower Costs
- Focus on Core Business Only
- Managerial Time Constraints
- Reluctance to Take Chance of “New” Technology

The Reality of These Barriers

Perceived Barrier	Reality
Belief That Energy Costs are Fixed	Far From Fixed
Expect Deregulation to Result in Lower Costs	Pilot & Restructuring Experience Showing Bill Decreasing 5% or Less
Focus on Core Business Only	Benefits to Core Business, Including Reliability
Managerial Time Constraints	Can Be Turnkey Process, Including O&M
Reluctance to Take Chance of "New" Technology	Utility Backup, Service Warranty and Performance Guarantee Available

DG Technology Status

DG Technology/DG Suppliers	Pros	Cons
Gas Turbines (GT) • Solar Turbines • Allison • Turbomeca • Kawasaki • AlliedSignal • GE • Dresser-Rand	• Available and proven in wide range of sizes over 1 MW • Applicable to baseload, intermediate and peaking applications • Quick start-up capabilities • Superior for cogeneration	• Average-to-high costs • Low power efficiency (but improving) • Poor-to-average part load performance • May require add-on emission controls
Reciprocating Engines (RE) • Caterpillar • Cummins • Detroit Diesel • Jenbacher • Wartsila • Waukesha	• Widest range of unit sizes • Applicable to baseload, intermediate and peaking applications • Quick start-up capabilities • Highest efficiency of commercial technologies • Good part load performance	• Average-to-high capital costs • Limited-to-lower temperature cogenerator applications • Higher Q&M costs • Likely to require add-on emission controls
Microturbines (MT) • AlliedSignal • Capstone • Elliott/GE • NREC	• Small, compact size • Potentially low capital cost • Applicable to baseload, intermediate and peaking applications	• Not a proven technology, capital cost a major question • Low, power-only efficiency • Limited cogeneration applications
Fuel Cells (FC) • ONSI • Energy Research • M-C Power • Siemens Westinghouse • Ballard • Plug Power • IFC	• Superior emissions performance • High power efficiency • Good part load performance	• Not a proven technology, capital cost a major question • Limited to baseload, intermediate applications (slow cold, start-up time) • Limited cogeneration applications

DG Project Economics and Markets

DG Markets Today

- Primary Power Markets
  - Electric Only
  - Cogeneration (Heating and/or Absorption Chilling)
- Other Markets
  - Backup/Emergency
  - Peak Shaving
  - Shaft Drive
- New Niche Markets

DG Serving Primary Power Markets: What Makes it Work?

- High Competing Grid Electricity Prices
- Low Natural Gas Prices
- “Good” Regulatory Climate
- “Amenable” Load Profile
- Able to Meet Price/Efficiency Goals
- Typically Good Cogeneration Potential

DG Serving Other Power Markets: What Makes it Work?

- Backup/Peak Shaving Market
  - Low Capital Cost
  - Opportunity for “Light Duty” Lower Cost Units
  - Start-Up Time/Reliability a Concern (Microturbines)
- Shaft Drive Market
  - Low Gas/High Electric Prices Key
  - HVAC, Air Compression, Pumping, Gas Compression

New Niche Markets

- Premium Power
- Green Power
- Remote Power
- Alleviate T&D Constraints
- Hedge by Power Marketers
- Utilize “Free” Fuel

Transactional Considerations

Transactional Considerations Driven by Who is Making the Deal

- Utility
- Power Marketer
- End User/Customer
- Vendor
- Third Party

Some Utility Transactional Considerations

- Regulated vs. Unregulated Entity
- Utility Business Role
  - Information Source
  - Cheerleader
  - Technical Support
  - Project Manager
  - Lease Financing
  - Project Developer

Some Utility Transactional Considerations (cont.)

- Financial Participation Options
  - Equity Investor
  - Lessor
  - Debt Provider
- Possible Ongoing Role in Operation and Maintenance
- DR May Allow "Wires" Company to Enter Generation Business
- Vendor Alliances Emerging

Other Market Participant Considerations

- Power Marketers Viewing DR as Way to Offer Electricity & Gas
- Vendors Forming Marketing and Service Alliances
- ESCO's Now Providing Service Contracts, in Future Service & Fuel
- Finance Organizations Specializing in DR

Potential Benefits from Distributed Generation

- Lower Operating Costs
- Improved Power Quality
- Improved Supply Reliability
- Expanded Range of Power Supply Options

Lower Operating Costs

- Utilize Standby Generation Equipment During Periods of High Electricity Cost
- Become Aware of the Price Differential Between Gas and Electricity
- Consider Potential Savings From On-Site Power Generation
- Identify Energy-Intensive Business Operations

Improve Power Quality & Supply Reliability

- Identify Mission-Critical Operations
- Review Performance of Existing Static UPS Equipment
- Identify Impact of Power Outages on Business Operations
- Estimate Outage Cost

Expanded Range of Power Supply Options

- Lessen Dependence on Utility-Supplied Power
- Open Door to Potential New Revenue Stream
- Increase Business Flexibility
- Gain Ability to Operate During System Outages

The Bottom Line for DG

- Deregulation and Increasing Reliability Concerns Will Accelerate Interest
- Meeting Technology Challenges Still a Wild Card
- Need Other Applications (e.g., transportation) to Build Volume and Establish Service Infrastructure
- Need to Offer Light Duty/Heavy Duty Technology Options

What Might the Future Hold?

- A Proliferation of DG Installations, Driven by Manufacturers, Power Marketers & Retail Companies -- “Wires” Companies Also Players
- Very Small Point Emission Sources Essentially Escaping Regulation -- And Then Re-Regulation!
- Material and Design Advances Enhancing Performance
- Standardization of Design and Maintenance Practices (including Interconnection)
- Gradual User Acceptance of DG

Questions & Discussion