

# Distributed Generation: Technology Challenges and Needs

**Presented at  
American Power Conference  
Chicago  
April 7, 1999**

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**Distributed Generation:  
Technology Challenges and Needs**

# Industry Restructuring Transforming Delivery of Power & Energy Services

- Distributed Generation (DG)  
Technologies Receiving New Attention
  - Offer performance and flexibility
  - Ideal resources to help address regulatory, environmental and competitive challenges
- The Non-Renewable DG Technologies
  - Reciprocating Engines
  - Microturbines
  - Fuel Cells

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# The Return of Distributed Generation

- “Reappearing” After a Long Absence
- The Concept of Distributed Power is Not New
  - “Total Energy” Experiment in the 1960s
  - Packaged Cogeneration of the 1980s

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# Distributed Generation Advantages

- Size for Baseload Capacity to Meet Minimum Constant Loads
- Capture Intermittent and Peaking Loads in Residential and Commercial Cogeneration
- Increased Energy Efficiency
- Reduced Emissions

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# What is Driving Distributed Generation Today?

- Restructuring of the Electric Power Industry
- Advances in Technology
- Availability and Low Price of Natural Gas
- New Environmental Regulations
- Increasing Power Quality Concerns
- Heightened Reliability Awareness

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# 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

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# Reciprocating Engines

- Reciprocating Engines Claim Dominant Share of Small Power Generation Market
- Extensive Power Generation Applications Worldwide
- Leverage on Transportation Applications and Availability of Trained Mechanics
- Offer Efficiency, Reliability & Low Capital Cost

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# Fuel Cells

- Fuel Cell Technology Still Evolving
  - Developed in Aerospace and Other High Value Applications
  - Solid Oxide Units - Potentially Attractive Hybrid Applications with Microturbines
  - Phosphoric Acid Fuel Cells Commercially Available Today
  - Capital Cost a Big Issue
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# Microturbines

- Microturbines Making a Big Splash
  - Building on Aviation & Automotive Applications
  - Promising Cost and Performance
- Major Companies Taking a Stake in This Market
- The Promotion May Be Greater Than the Potential

# What Is A Microturbine?

- Essentially a Packaged Automotive Turbocharger Combined With Elements of Aircraft Auxiliary Power System
- Basic Components - Compressor, Combustor, Turbine & Generator
- Typically 30 kW to 200 kW in Size
- Primarily Designed for Electric Power Generation

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# Who Are the Microturbine Manufacturers?

- Allied-Signal
- Capstone
- Elliott Energy/GE Power Systems
- Northern Research & Engineering
- Others

# Key Design/Technology Issues

- Recuperator Technology
- Bearing Type
- Inverter
- Package Footprint and Size
- Turbine Inlet Temperature
- Fuel Flexibility

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# What Benefits Are Promised?

- Low Cost
- Efficiency Levels of Approximately 30%
- High Reliability
- Ease of Maintenance
- Relatively Low Emissions
- Short Lead Time & Siting Close to Load
- Recuperation and Cogeneration Options

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# *Can These Promises Be Kept?*

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# Promise # 1: Low Cost

- Cost goals \$250 to \$500/kW
- Costs may be approaching these goals, but have a way to go
- Current cost data not available
- At least one manufacturer suggest that production price estimates are “crazy”

## Promise # 2: 30% Efficiency

- Efficiency Goal Typically Based on Recuperative Design
- Currently Operating Units Either “Prototype” or “Test” Units
- Unconfirmed Field Feedback Reports Efficiency Levels of 15%-20%

# Promise # 3: High Reliability

- Reliability Data is Hard to Collect
- Some Potential Users Plan Multiple Units to Increase Reliability
- A Return to the “n+1” Rule?

## Promise # 4: Ease of Maintenance

- Maintenance Requirements Appear to Be Minimal
- Projecting 6,000 to 12,000 Hours Between Scheduled Maintenance
- “Building Engineer” Expertise May Not Be Sufficient
- Still Will Require Experience Level of At Least A Good Auto Mechanic

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# Promise # 5: Relatively Low Emissions

- Emissions Reported As Lower Than Reciprocating Engines
- Sample Emissions Reports From Manufacturers
  - 25 ppm NO<sub>x</sub> (75 kW, recuperated)
  - 9 ppm NO<sub>x</sub>, 145 ppm CO (45 kW, recuperated)

# Promise # 6: Short Lead Time

- 1 - 12 Week Lead Time Indicated
- Set Up in Matter of Hours
- Fairly Mobile
  - Carry in Trunk of Car - 30 kW Unit  
(3 ft cube, weigh 250 pounds)
  - Pick Up Truck - 200 kW Unit  
(4 ft cube, weigh 450 pounds)

# Promise # 7: Recuperation & Cogeneration Options

- Recuperation Required for Higher Efficiencies
- Recent RDC Study Identified 12,000 Applications Nationwide
  - Nearly 96% Cogeneration Opportunities
  - Evenly Distributed in 30 kW-100 kW Size Range
  - Office, Mercantile/Service and Education Sectors Show Highest Potential

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# DG Markets are Differentiated

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

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# New Niche Markets

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

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# 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

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# 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

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# The Markets for DG are Growing

- Recent RDC Study Focused on Microturbine and Fuel Cell Markets
- Market Opportunities are:
  - Real
  - Near Term

# Recent National Market Results (Microturbines and Fuel Cells Only)

- Over 54,000 MW Technical & Economic Market Potential
- Potential Multibillion Dollar Market
- Anticipated Penetration of 900 MW/Year
- \$600 Million Annual Sales

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# Selected Commercial Market Segments Offer the Greatest Potential

- Office
- Mercantile/Service
- Food Service
- Food Sales
- Education
- Health Care
- Lodging
- Public Assembly

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# Technology Challenges Need to be Addressed

- Ultimate Reliability of Equipment Rotating at High Speed
- Impact on Power Quality
- Feasibility of Relatively Unattended Operation
- Ability to Realistically Track Environmental Performance
- Dominance of Gaseous Fuel Option
- Use of Advanced, High-Temperature Materials

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# The Bottom Line for Microturbines Today

- Deregulation and Increasing Reliability Concerns May Accelerate Interest
- Limited Primary Power Market
- 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

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# What Might the Future Hold?

- A Proliferation of DG Installations, Driven by Power Marketers and “Wires” Companies
- 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 as a Power Supply Option

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