

# **Gas Research Institute Power Generation Program**

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## **Abstract**

The Gas Research Institute (GRI) Power Generation Business Unit leads a research development and commercialization program whose objective is to establish a significant role for natural gas in modular and central-station power generation and cogeneration that provides value for the gas consumer as well as the natural gas industry. The overall power generation program consists of two main program areas, Bulk Generation and Modular Generation.

The GRI Bulk Generation program focuses primarily on the utilization of natural gas via cofiring and reburning in coal-fired power plants to improve their competitive dispatch and reduce pollutant emissions. Cofiring with natural gas can give electric utilities a competitive edge by maintaining or increasing boiler capacity and improving performance. Reburning with natural gas can offer electric utilities and manufacturers a flexible, cost-competitive option in meeting emissions regulations targeting large-scale boilers.

The GRI Modular Generation program focuses on both technology and product development of gas reciprocating engines, industrial gas turbines, microturbines, and fuel cells as well as the creation of information products intended to accelerate and facilitate the utilization of modular gas-fueled generation in distributed generation applications. Strategic thrusts include pollution prevention gas turbine products that provide a least cost emission compliance option, advanced generation systems that provide lower cost and high quality electricity service, capital cost reduction of gas reciprocating engines, distributed generation application/market assessment and evaluation tools, and natural gas distribution issues pertinent to modular power generation.

# GRI Power Generation Program

DOE Advanced Turbine Systems Annual Review

October 28, 1997

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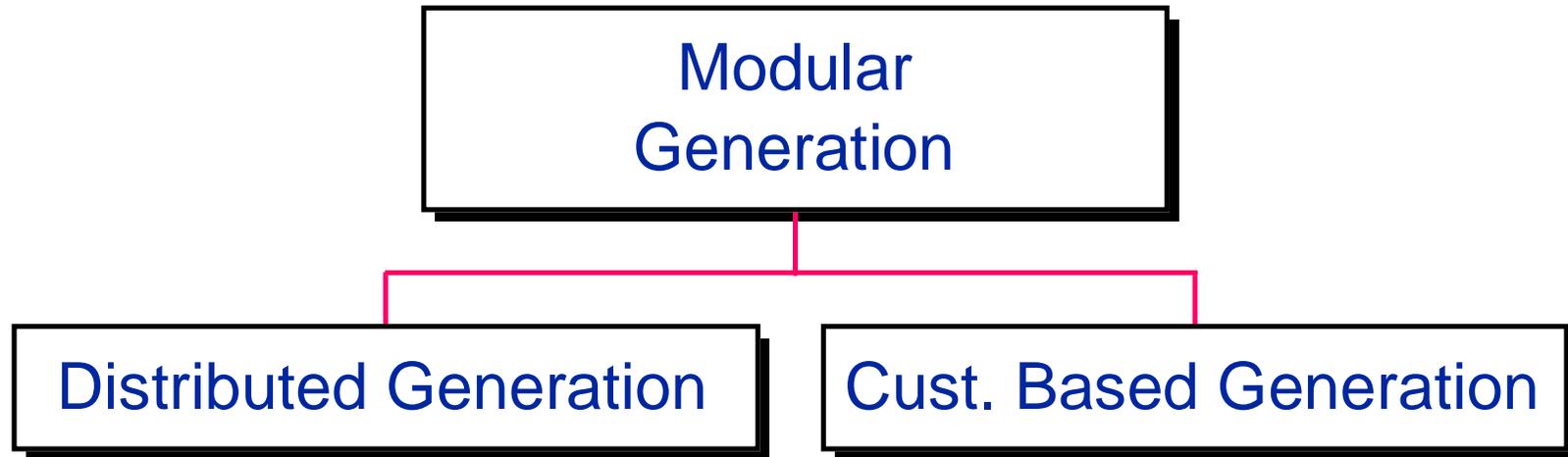
Gas Research Institute

# GRI Power Generation Program

<b>Power Generation</b>			
<b>Modular Generation</b>		<b>Bulk Power Generation</b>	
<b>Distributed Generation</b>	<b>Cust.Based Generation</b>	<b>Competitive Dispatch</b>	<b>Gas Based Emission Control</b>

*Program is market-based rather than technology-based*

# GRI Modular Generation Programs

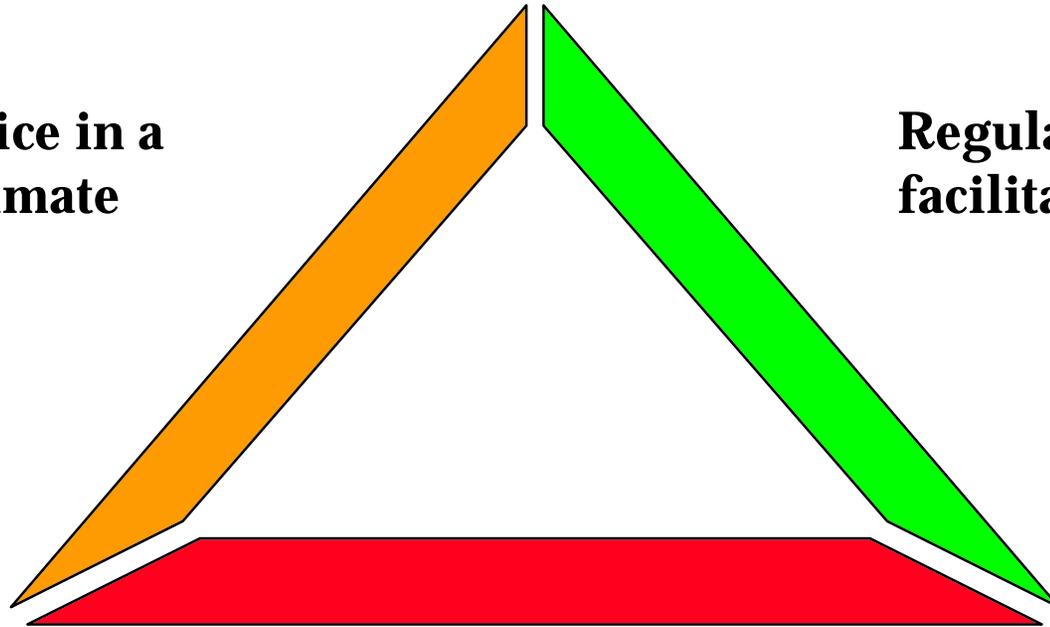


***Both market segments utilize the same natural gas-fueled modular technologies - reciprocating engines, gas turbines, and fuel cells. All hardware development is included under CBGT. DG focuses on market, institutional, and application issues specific to distributed generation.***

# Changing Structure of Energy Business

**Customer Choice in a competitive climate**

**Regulatory Change facilitates competition**



**Product Portfolio enables customer & provider choices**

***The basis of the new business is providing value with customer solutions***

# Stakeholders and Motivations

<b>Energy Customers:</b>	<b>Low Cost Energy Solution; Power Reliability And Quality</b>
<b>Electric Utilities: (Discos/ Retailcos)</b>	<b>Avoided Transmission and Distribution Capital Expenditures; Minimize Revenue Requirements. Customer Retention; DG As an Additional Energy Service</b>
<b>Energy Service Companies:</b>	<b>Emerging Business Opportunity; Provide a Product-Service “Package” to Customers</b>
<b>Gas Companies:</b>	<b>Increased Gas Load; Improved Gas System Utilization</b>
<b>Equipment Suppliers:</b>	<b>An Additional Market; Interested in Increasing Unit Sales</b>

**DISTRIBUTED GENERATION**  
**Smaller Facilities, Connected to The**  
**Distribution, Sub-Transmission System, Located**  
**Near or at Load Centers**

**T&D System Management**

**On-Site Generation**

**-Peaking load, T&D system support**

**-Primary benefit is avoided T&D costs, T&D asset management**

**-Higher capacity factor, power reliability/quality**

**-Primary benefit is lower energy costs and profits**

***Gas Industry has a stake in Distributed Generation***

# Distributed Generation Outlook

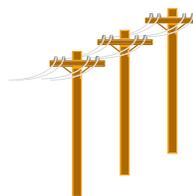
- Significant Source of Generation
  - Initially Driven by Customer Energy Service Demands
  - Industrial Sized (>3 MW) Base load
  - Commercial/Institutional (<3 MW) Intermediate/Peaking
- Provided by ESCO's, Utilities, Vendors, Marketers, or Alliances/Partnership
- Pursued by Electric Utilities and Unregulated Affiliates
  - Customers Retention
  - Market Growth
  - Least Cost Power Delivery Strategy
- Technology Available Today
- Product Improvements are Needed to Maximize Market Opportunities

# DG in the Utility Context



## Economic

- Defer T&D Investments
- Reduce T&D Losses
- Meet load growth at Least Cost



## Operational

- Grid Stability
- Power Quality
- Service Reliability



## Strategic

- Customer Retention
- Avoid Transmission Siting Constraints
- Maximize Asset Utilization

***Utility focus on DG is generally centered on cost management with the exception of Customer Retention. Only utility knows and can leverage cost management opportunities. These may be small compared to customer value.***

# Gas Industry Opportunities

- Traditional Businesses
  - LDC Participation in Power Generation
  - Capacity and Transport Sales
  - System Asset Utilization and Load Balancing
  - Storage
- “Non-Traditional” Gas Businesses
  - Non-Regulated Energy Products and Services
  - Strategic Alliances with Retail Energy Products and Services Companies

***Identifying “win-win” with other stakeholders will increase opportunities***

# Factors Influencing Growth of DG

- Regulatory Uncertainty
  - Price of Electricity
  - Creation of Incentives
  - True “Retail Access”
  - Opportunity or Threat to Electric Utilities
- Siteability
  - Integration with Electric Grid
  - Access to Existing Natural Gas Distribution Grid
  - Project Development/Permitting Costs
- Lack of Information About Distributed Generation
  - Evaluation of Benefits for All Stakeholders
  - Awareness and Inclusion of DG in Evolving Regulatory Debates
  - Documented Success Stories

# Gas-Fueled Modular Generation Options

<b>Type</b>	<b>Size</b>	<b>Efficiency</b>	<b>Application</b>
Recip. Engine	5 kW - 2 MW	33-39 %	Peakshaving; commercial cogeneration
Gas Turbines	1 MW - 20 MW	29-37 %	Industrial cogeneration; T&D support
Fuel Cells	200 kW - 1 MW	40 %	Commercial cogeneration; premium power
Microturbines	24 kW - 200 kW	20-30 %	Commercial cogeneration; premium power

# Gas Generation Options

Reciprocating Engines	\$600-800/kW
Gas Turbines	\$600-900/kW
Fuel Cells	\$2000-3000/kW
Microturbines	\$500-2000/kW

- *Portfolio of products available today*
- *Recip. engines and gas turbines very cost competitive*
- *Available in continuum of sizes*
- *Attractive option where reliability, power quality, and thermal energy have value*

# Forget About a Silver Bullet

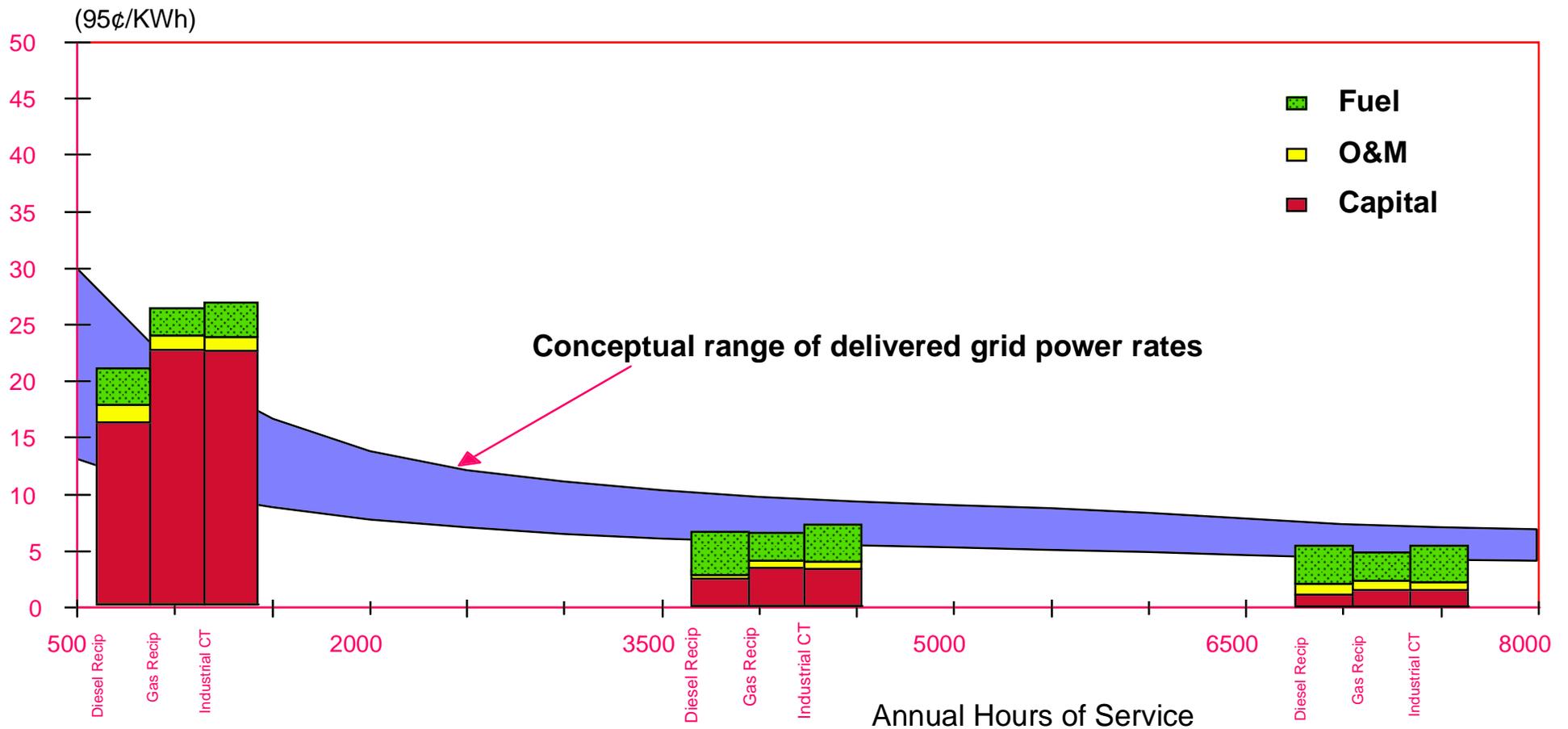
- Temptation: Shoehorn products into compliant customer systems; Sell them what you have



- Solution: Configure product to meet customer needs (stated and unstated); Upfront effort will result in a more secure payoff

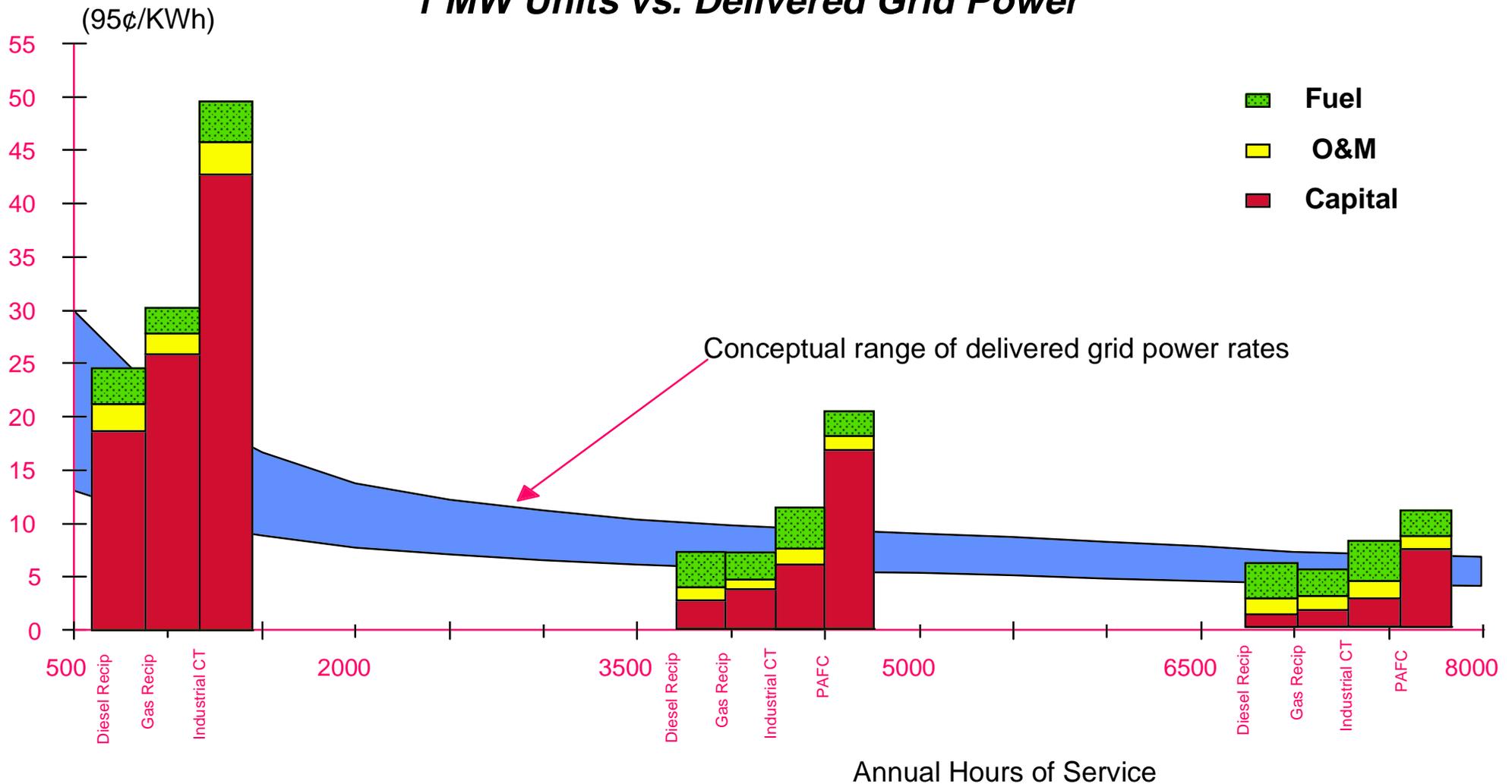
# Competitiveness of Retail Power Generation Options

## 3 to 5 MW Units vs. Delivered Grid Power



# Competitiveness of Retail Power Generation Options

## 1 MW Units vs. Delivered Grid Power



# Gas Fueled DG Technology/Product Development Needs

- Lower Capital Costs to Improve Economics
- Defined and Established Product Distribution Channel
- Reduced Maintenance Requirements
- Lower Emissions
- Higher Efficiency
- High Level of Reliability
- Remote Monitoring and Dispatch
- Compatibility with Gas and Electric Grids
- Standardization of Permitting/Project Development
- Documented Success Stories

# GRI DG Program

- **Product**: *a knowledge base of information consisting of market assessments, evaluation tools, guidebooks, system integration analysis, case studies, and field validation of benefits to energy customers and providers intended to accelerate and facilitate the utilization of modular gas-fueled generation in distributed generation applications*
  - Onsite Power as an Energy Service
  - Utility System Management
- **Target**: Customers and offerers of distributed generation
  - Development of Higher Capacity Factor Applications
- **Time Frame**: 1997 - 2003
- Complement Technology/Hardware Development in CBGT

# GRI CBG Program

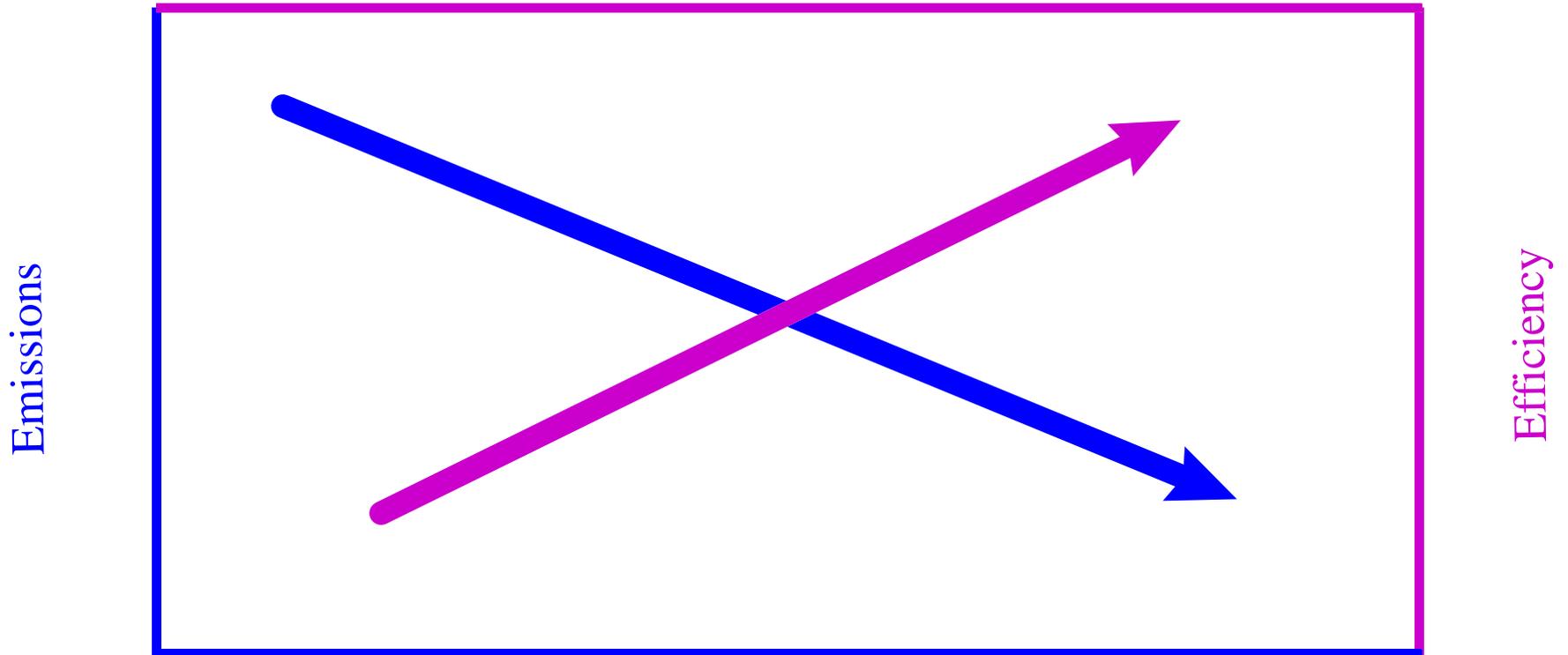
- Base Load Markets (>3 MW)
  - Primarily Gas Turbine Focus
  - Gas Turbine Emissions Compliance at Lowest Cost
  - Advanced Turbine-Based Systems that provide Lower Cost and Higher Quality Electricity Service
  - Gas Pressure and Gas Quality Issues
- Intermediate Load Markets (< 3 MW)
  - Primarily Gas Reciprocating Engine Focus
  - Lower the Capital Cost
  - Reduce Maintenance Requirements
  - Microturbine (70 kW)

# Gas Turbine Attributes

- Low Capital Costs
- Low Emissions
- High Efficiency
- Short Lead Times
- High Availability and Reliability
- Wide Range of Applications

*Gas Turbines have become the technology of choice for electric power generation*

# Technology Trends



*Direction of technology development has been to improved environmental acceptability and increased efficiency*

# Least Cost Emissions Compliance

- Dry Low NO<sub>x</sub> Combustors
  - Allison
    - 501K 25 ppm In-Line Combustor (LE IV)
  - GE
    - LM1600 25 ppm DLE
    - MS3002-JR 25 ppm Retrofit
  - Solar
    - SoLoNO<sub>x</sub> 25 ppm for Centaur, Taurus, Mars Models
- Fuel Composition Effects on Lean Pre-Mix Comb.
  - GE Power Systems and CR&D
- Catalytic Combustion
  - SRI Thermal Shock Resistance of Metal Monolith

# Advanced Turbine-Based Systems

- Industrial-Size ATS
  - Performance and Emissions Emphasis
    - Allison 701K Catalytic System
- Collaborative Advanced Gas Turbine
  - ICAD
  - High Simple Cycle Intermediate Duty

# MicroTurbogenerator

- NREC
  - Subsidiary of Ingersoll-Rand
- 70 and 200kW
- System Based on Truck Turbochargers and Novel Recuperator
- Four Applications
  - Cogeneration
  - Chiller
  - Refrigeration
  - Air Compressor
- SoCal Gas, NYGas Group

# Fuel Gas Booster

- Some Modular Generation equipment require onsite fuel compression
- Needs
  - High Reliability
  - Infrequent Maintenance
  - Long Life
  - Low Cost in Modest Volume Production
  - Easy Installation
  - Rapid Certification
- IGT Evaluation

# GRI-Supported Power Gen Products

<u><i>Power Output</i></u>	<u><i>Name</i></u>	<u><i>Manufacturer</i></u>
<i>70 &amp; 200 kW</i>	<i>PowerWorks MicroTurbine</i>	<i>NREC</i>
<i>350 kW</i>	<i>QSK19G Recip</i>	<i>Cummins</i>
<i>700 - 1800 kW</i>	<i>3500 Recips</i>	<i>Caterpillar</i>
<i>1100 - 3000 kW</i>	<i>Superior 2400</i>	<i>Cooper</i>
<i>4000 kW</i>	<i>501K DLN</i>	<i>Allison</i>
<i>4000 - 10,000 kW</i>	<i>Centaur, Mars, Taurus</i>	<i>SolarTurbines</i>
<i>13,500 kW</i>	<i>LM 1600 DLE</i>	<i>GE</i>
<i>6,000 - 14,000 kW</i>	<i>701K Catalytic Combustor</i>	<i>Allison</i>

# Additional Market Issues Impacting Modular Generation

Electricity Prices

Competition for Customers

Convergence

Environmental Issues

Customized Services

Need for Peaking

Excess Baseload Capacity

Transmission Pricing

Investment Risk

Non-Generation Alternatives

Stranded Costs Recovery

