

# Market Potential for Microturbines: Industrial Applications in the U. S.

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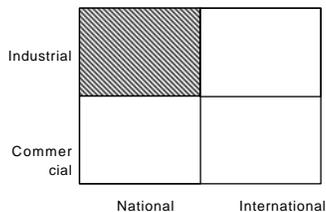


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## Project Focus

- “Micropower” (50 kW - 1 MW)
  - ✓ Reciprocating engines (50-1000kW)
  - ✓ Microturbines (50-200kW)
  - ✓ Miniturbines (200-1000kW)
  - ✓ Fuel cells (50-1000kW)
  - ✓ Hybrids (200-1000kW)
- Industrial Sector
- National



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## Microturbines

- Sizes range from 25 - 200 kW
- Basic technology: aircraft auxiliary power systems & diesel engine turbochargers
- Field testing of demo units underway
- Commercial deliveries expected in 1999



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## Microturbine Performance

- Low capital cost (\$350-\$800/kW)\*
- Competitive electrical efficiency with recuperators (up to 30% LHV)\*
- Low maintenance\*
- Small size and lightweight
- Low emissions and quiet operation
- Good fuel flexibility
- Cogeneration potential

\* If manufacturers' goals can be met



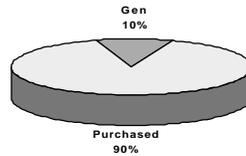
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## Industrial Sector Generation Applications

- Current self-generation: largely steam and gas turbines > 1 MW
- Applications driven by “waste” fuel or cogeneration
- Some reciprocating engines and PAFCs (50 kW - 1 MW sizes)



1996 Industrial Elec Use  
(923 Bill kWh)



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## 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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## **Serving Primary Power Markets: What Works?**

- 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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## **Serving Other Power Markets: What Works?**

- 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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## Preliminary Study Results

- Each technology will find a niche in the 50-1,000 kW size range
- When reciprocating engines/microturbines/fuel cells compete, each prevails for some end uses
- Depends on:
  - ✓ natural gas prices
  - ✓ electric load profile
  - ✓ thermal load profile
  - ✓ sizing of unit relative to peak demand
  - ✓ competing electricity price



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## Price and Performance Assumptions

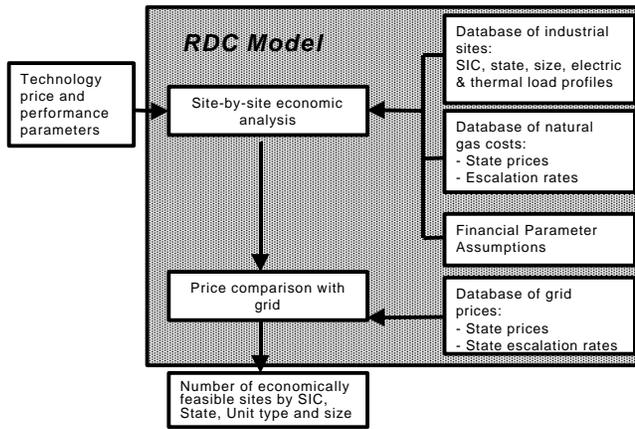
Size	50		100		200			500		
	Engine		Engine		Engine	ONSI		Engine	ONSI	
Cost	766	600	727	600	687	600	3310	636	600	3310
O&M	0.012	0.010	0.011	0.010	0.010	0.010	0.015	0.009	0.010	0.015
Eff.	31.0%	27.1%	31.7%	27.1%	32.5%	27.1%	39.6%	33.3%	27.1%	39.6%
Heat Rate	11,000	12,600	10,750	12,600	10,500	12,600	8,618	10,250	12,600	8,618
Therm. Out.	0.11	0.24	0.22	0.48	0.44	0.96	0.75	1.10	2.40	1.88
Overall Eff.	51.0%	65.2%	52.2%	65.2%	53.4%	65.2%	83.1%	54.8%	65.2%	83.1%



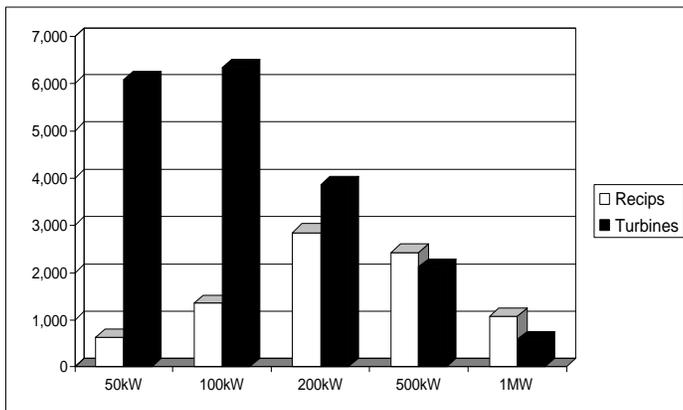
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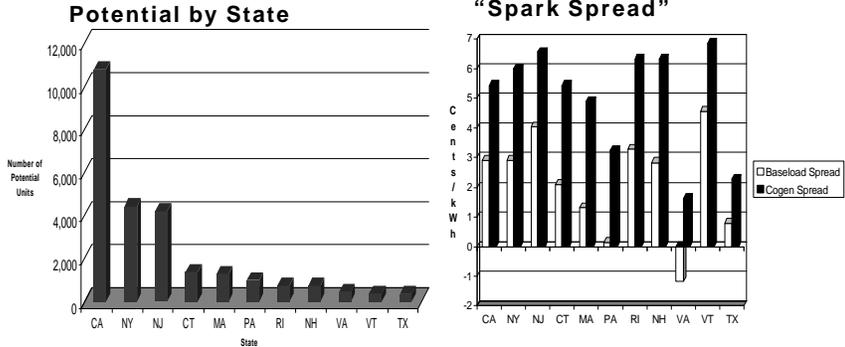
## Next Steps: Complete Analysis with Detailed Model



## Market Potential for Micropower



# Market Potential for Micropower *Geographic Concentrations* vs. "Spark Spread"



## Next Steps: Evaluate Scenarios

- Discount/Premium for Electricity (+/- 20%)
- Natural Gas Prices (+/- 10%)
- Future versus Current Unit Characteristics
  - ✓ Capital Cost (+/- 20%)
  - ✓ Efficiency (+/- 10%)
  - ✓ New Technologies (SOFC; SOFC/MT Hybrid)
- Expected Grid Electricity Price Escalation
- Thermal Utilization
- Interest Rate (+6%, -3%)
- O&M Expenses (+/- 20%)
- Backup Costs (+/- 20%)

