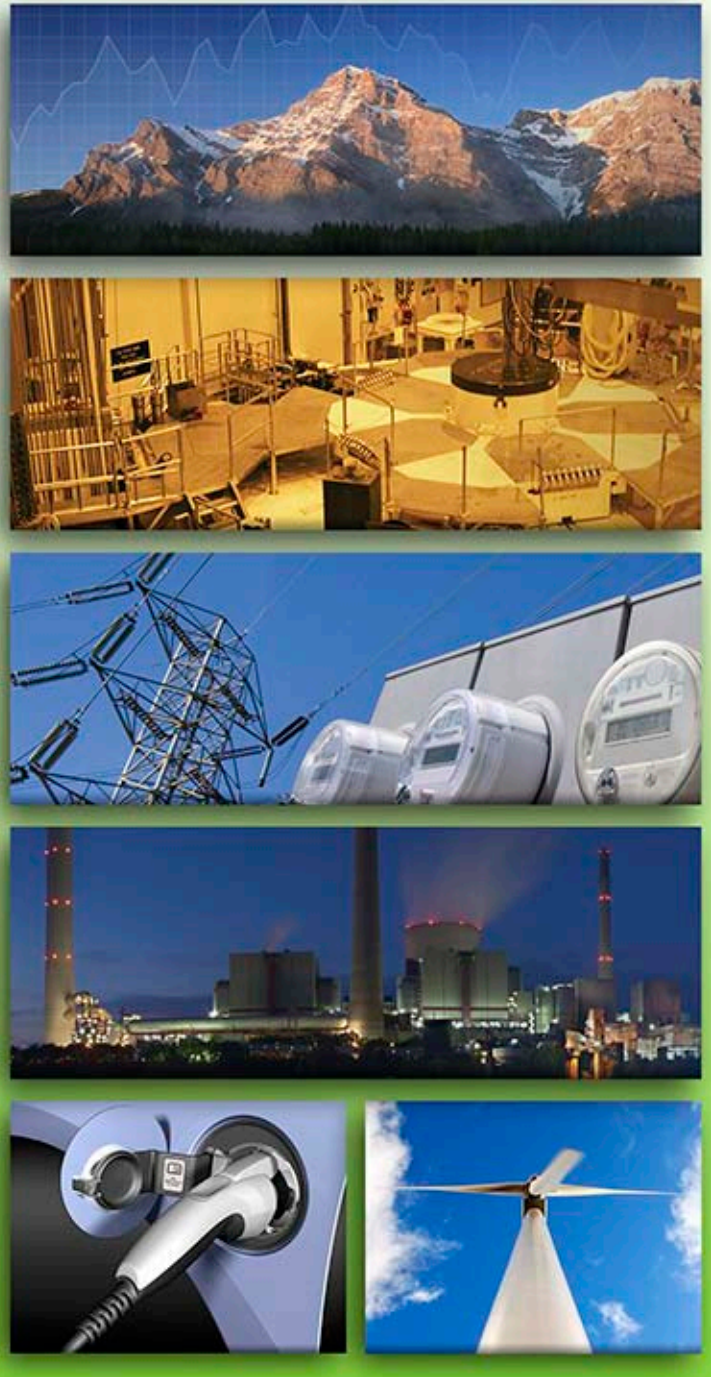

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Small Scale Distributed Generation

Perspectives on Markets and Challenges and Opportunities

ARPA-E Workshop
June 1-2, 2011

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Electric Power Research Institute

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Discussion Topics

- Current Status of Small DG in the US
  - Markets and Opportunities
  - Technology Platforms / innovations
- Pros and Cons of Available and Emerging Technology
  - Lessons Learned from Past Deployments
- What will it take to increase market penetration and mass adoption?
  - Technology Considerations
  - Business Models
  - Regulatory Framework
- Why is not DG adopted now?
- How would high efficiency DG change the landscape?
- What is the value proposition to electric utilities?

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Summary and Key Take Aways

- The Market / Opportunity is Large for Distributed Generation
- There are many natural gas-based technology platforms:
  - ICE most mature; followed by micro turbine; fuel cells; and stirling engines
  - High efficiency, low cost maintenance and high reliability are key factors
- Mass market penetration will need a key "driver": customer "pain"; energy services business model; regulatory driver e.g. CHP=energy efficiency
- Mass market will require " appliance like device"
- Value proposition for electric utilities: avoided new central generation; less T&D investment infrastructure; management of customer "summer peak loads"; customer retention (if they can be a participant in the energy services solution).

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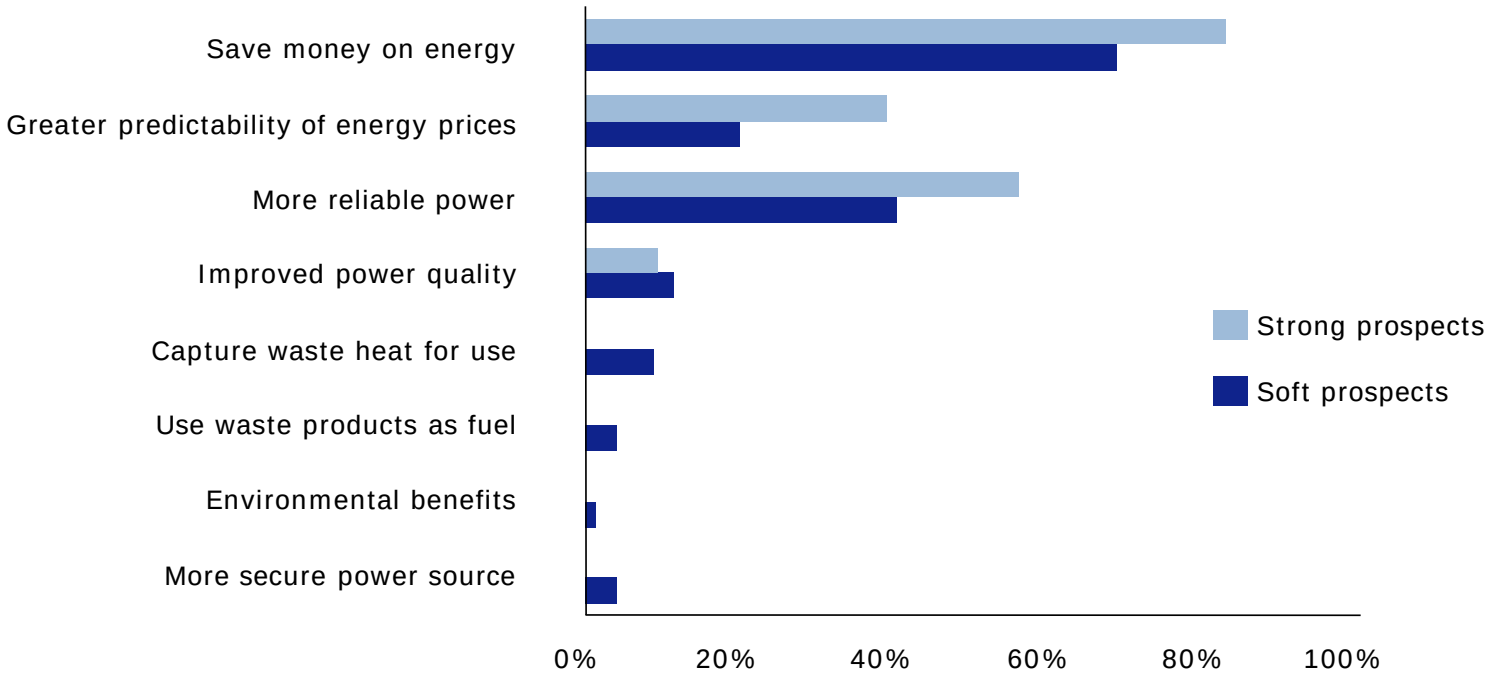
Market Research: Drivers for DER Distributed Energy Resources



Source: EPRI / Primen

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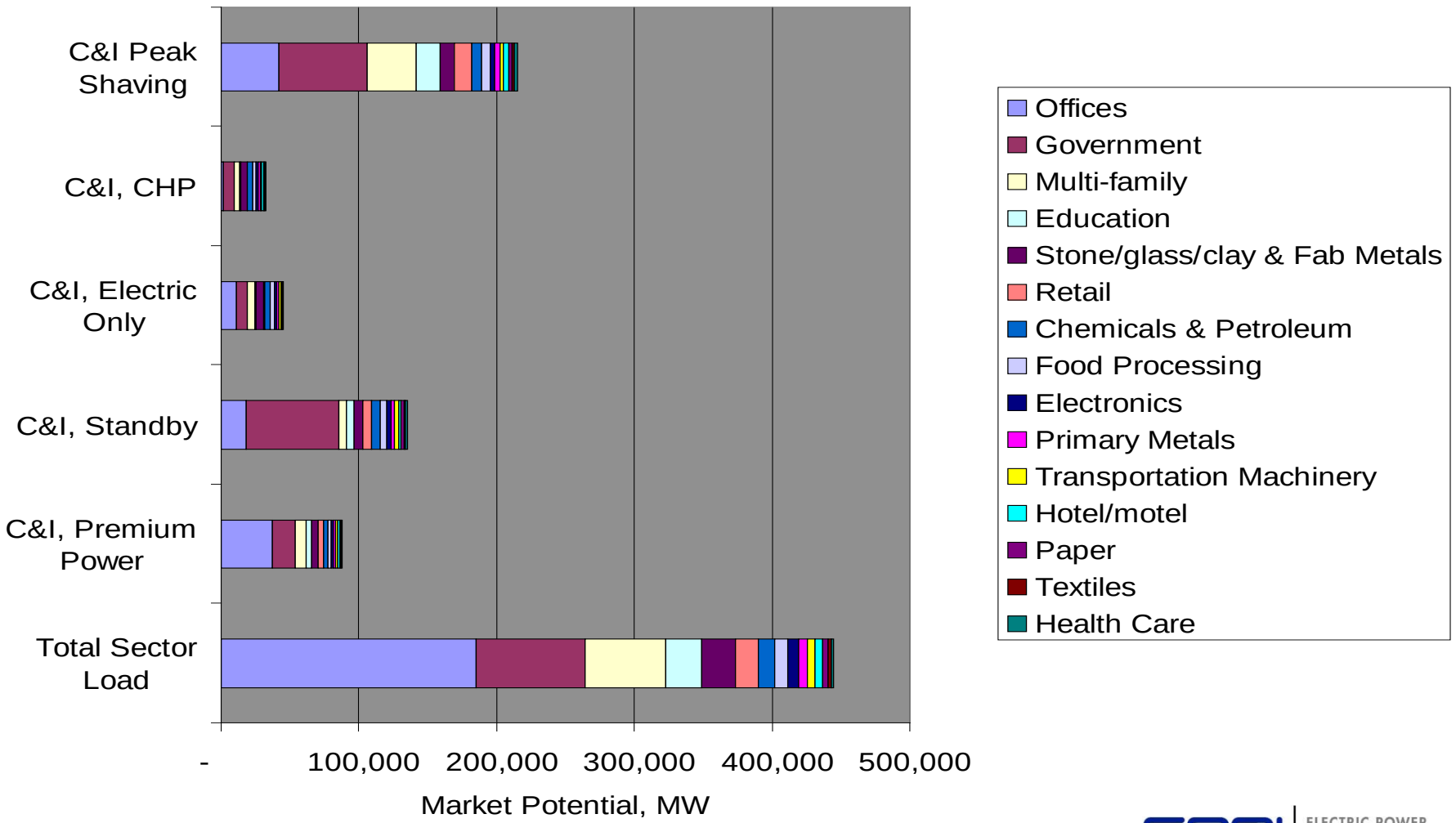
DG Market Potential Based on Customers' Stated Needs



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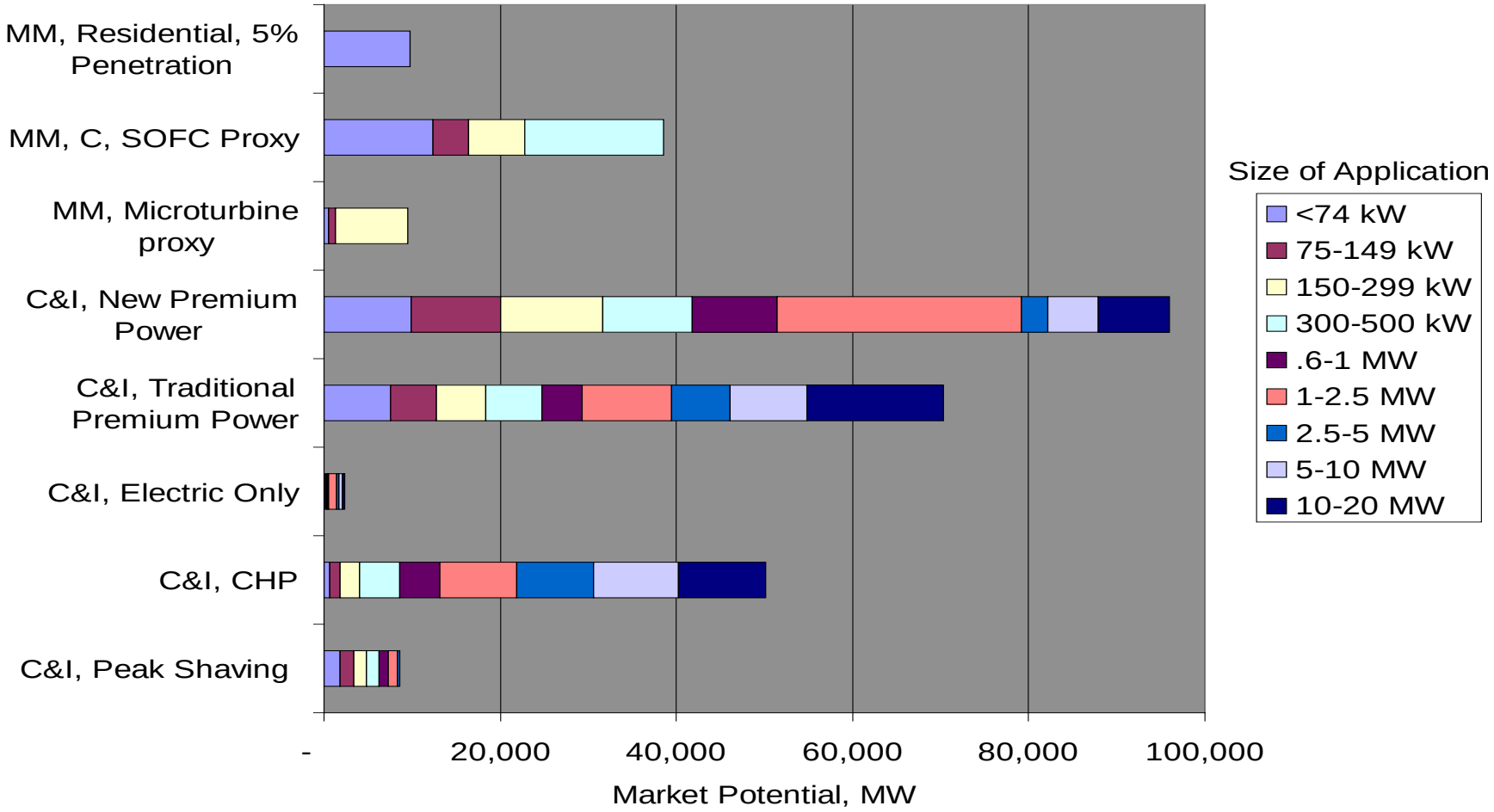
DG Market Potential Based on Customer Economics



MM= mass market; C= Commercial sector

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Markets and Opportunity by Size of DG in kW

Sector/	DR Size Range (kW)									
Operation Mode	30-74	75-149	150-299	300-599	600-999	1000-2499	2500-4999	5000-9999	10-20 MW	Total
Commercial										
Electric Only	440	696	465	392	55	437	11	1	0	2,497
Cogeneration	854	481	309	203	137	180	7	0	0	2,171
Peaking Power	35,206	13,503	6,591	3,120	1,378	527	100	0	0	60,425
Total Commercial	36,500	14,680	7,365	3,715	1,570	1,144	118	1	0	65,093
Industrial										
Electric Only	31	31	25	25	75	76	61	48	16	388
Cogeneration	10,605	9,997	9,746	9,822	5,687	4,811	2,327	1,285	657	54,937
Total Industrial	10,636	10,028	9,771	9,847	5,762	4,887	2,388	1,333	673	55,325
Total	47,136	24,708	17,136	13,562	7,332	6,031	2,506	1,334	673	120,418

Number of US Establishments where DG could be competitive with retail rates

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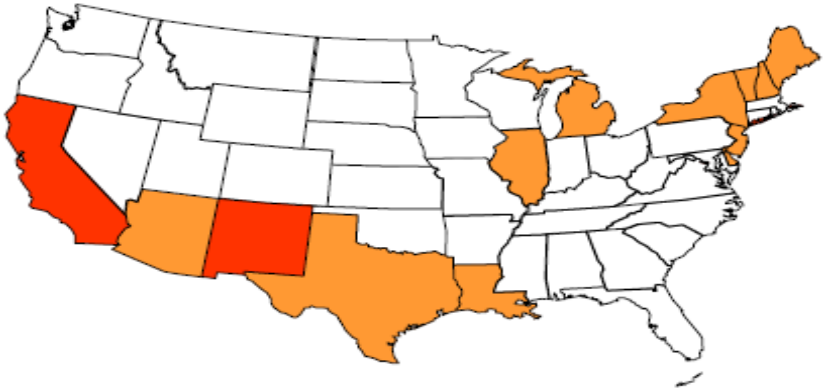
Potential Regional Markets for DER

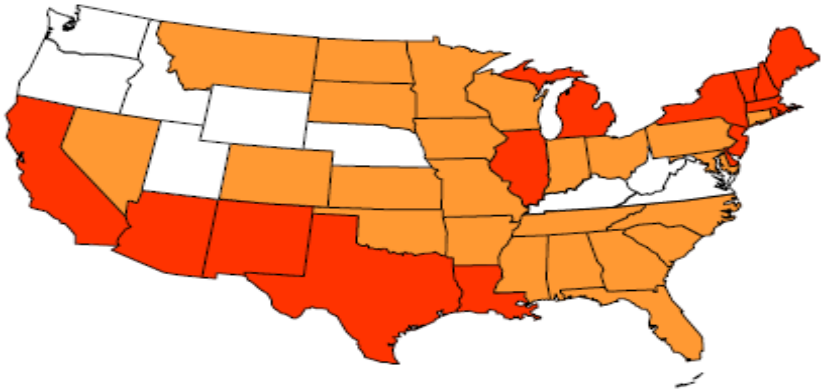
EPRI TR-114274

2010 Low Power Price

(EIA Reference)



2010 High Power Price



High Spreads

Medium Spreads

Low Spreads

Figure ES-1
State Spark Spread Rankings (Actual 1999 and Projected 2010)

Spark Spread has been a Traditional Driver

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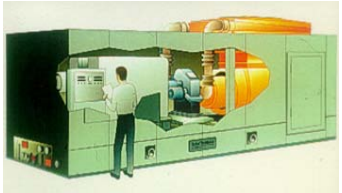
Technology Platforms for Distributed Generation

Current Options

Aero-derivative CT's

- 25-60 MW
- 40+ % Eff.
- Modular



Small CT's

- 1-5 MW
- ~ 40% Eff

Diesel and IC Engines

- 0.3-2 MW
- 36% Eff.
- efficiency increasing

Emerging Trends

Microturbines

- 30-300 kW
- 25-30% Eff
- efficiency increasing

Fuel Cells

- 1 - 300 kW
- 30-50 % Eff
- Many on-site markets

Hybrids?

- DG + Storage

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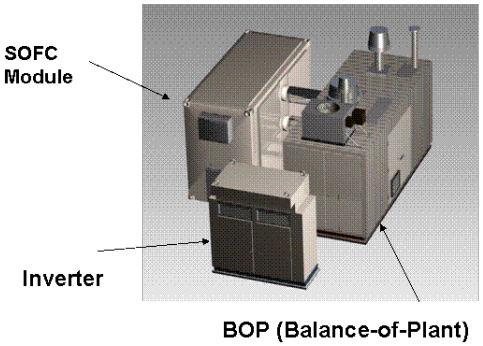
Technology Platforms

UTC Power PureCell 400 kW

Capstone 100 kW

Bloom Energy 100 kW Energy Server



VersaPower

ClearEdge Power 5 kW

CFCL 2 kW

Sunverge 2 kW Li-ion

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Technology Platform's: ICE

Photo Courtesy Honda

1.2 – 2.5 kW Honda Micro CHP

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Microturbines

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Technology Platform – Fuel Cells

Matsushita City Gas

Ebara City Gas

Sanyo LPG

Sanyo City Gas

ToshibaFCP City Gas

ToshibaFCP LPG

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Technology Platform- Fuel Cells
CFCL 2 kW Micro chp unit

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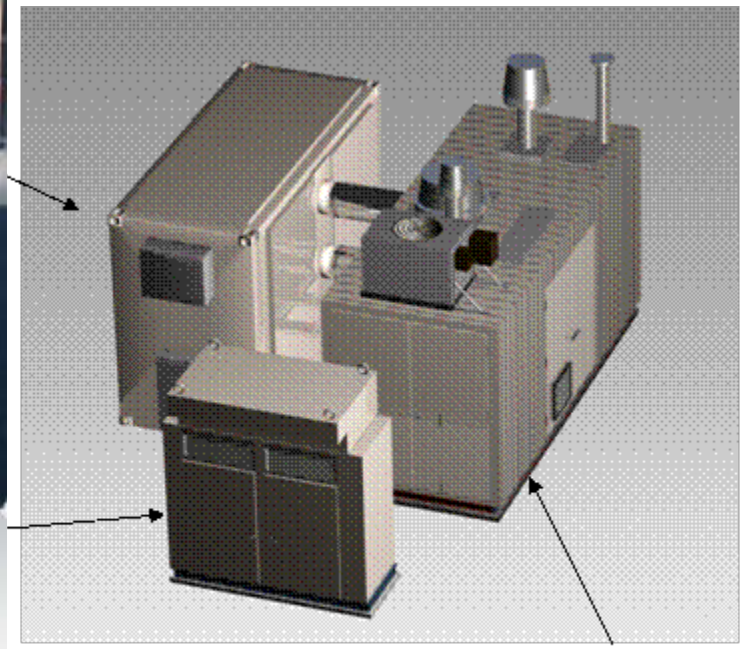
Technology Platform- SOFC Fuel Cells - Innovation 100-250 kW - ~ 60% electric eff. LHV



BOP (Balance-of-Plant)

Bloom Energy

Versa Power

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Technology Platforms: Stirling Engines

Photo Courtsey WhisperGen

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Solar-Thermal – Stirling Engine
Photo courtesy : Cool Energy

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Pros and Cons of Technology Options

- ICE
  - Pro: Low cost
  - Con: maintenance
- Micro Turbines
  - Pro: potential high reliability
  - Con: Low electrical efficiency
- Fuel Cells
  - Pro: High Efficiency; low emissions
  - Con: High cost; limited life
- Stirling Engine
  - Pro: Potential high reliability
  - Con: High cost, low electrical efficiency

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What will it take to increase mass market penetration of DG

- **Reliable and low maintenance DG**
  - Low reliabilty and high maintenance have impacted earlier initiatives
- **High customer "pain point" on energy costs**
  - High cost of electricity and heat; reliability may be a driver in C&I segment but not residential
- **Energy Service Business Models**
  - "Sell the Services not the DG box"
- **A Regulatory Driver for electric utilities to be involved.**
  - Many utilities can not own or rate base DG
  - DG bundled as a Smart Grid investment
  - DG = Energy Efficiency

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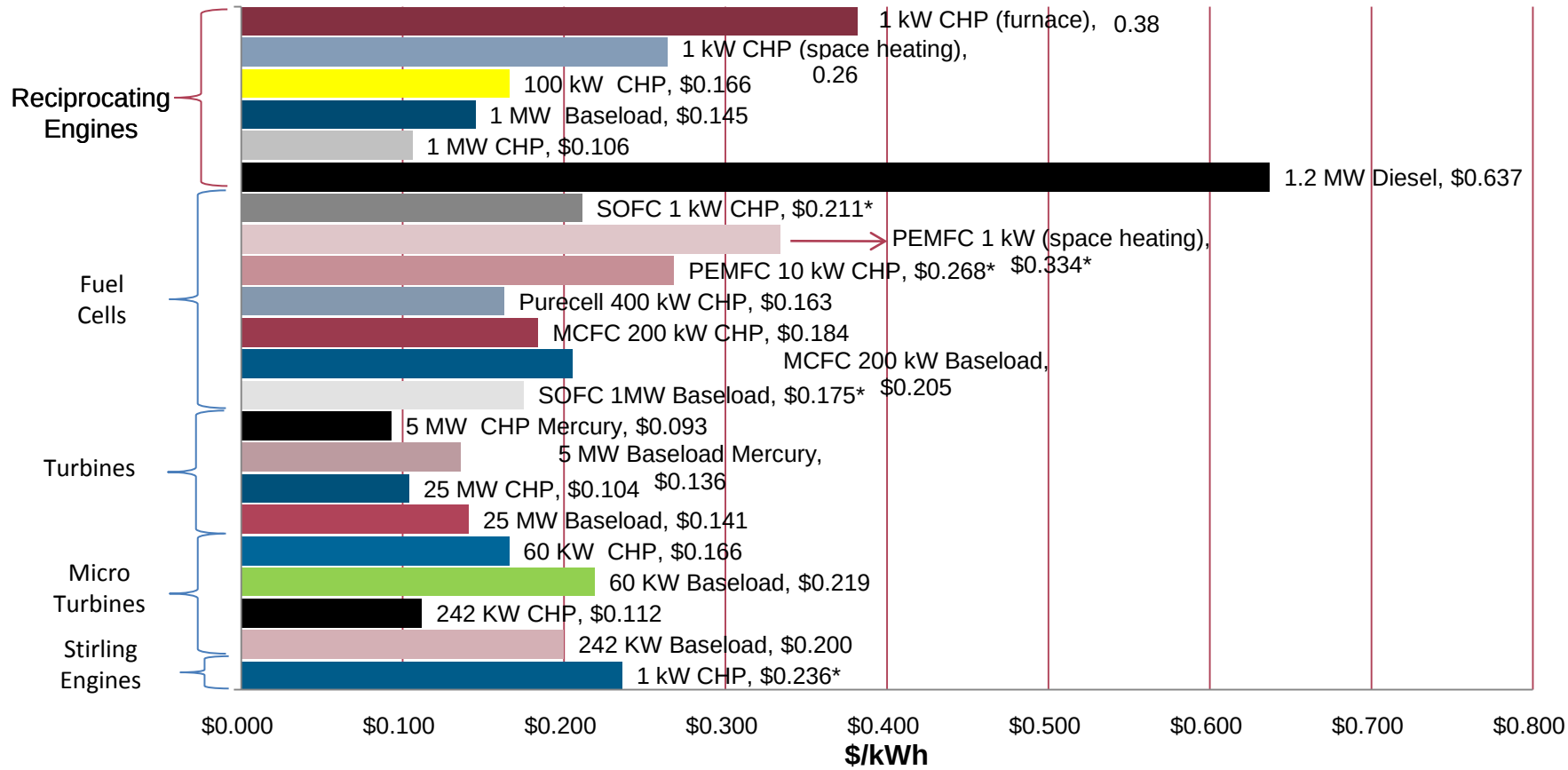
Summary – Cost of Electricity ($/kWh)

Natural Gas at $ 12 / MMBtu

DG Applications - Cost to Generate

Figure S-1



*Non-commercialized products. Cost and performance numbers based on expected values for commercialized product, expected in 2-4 years.

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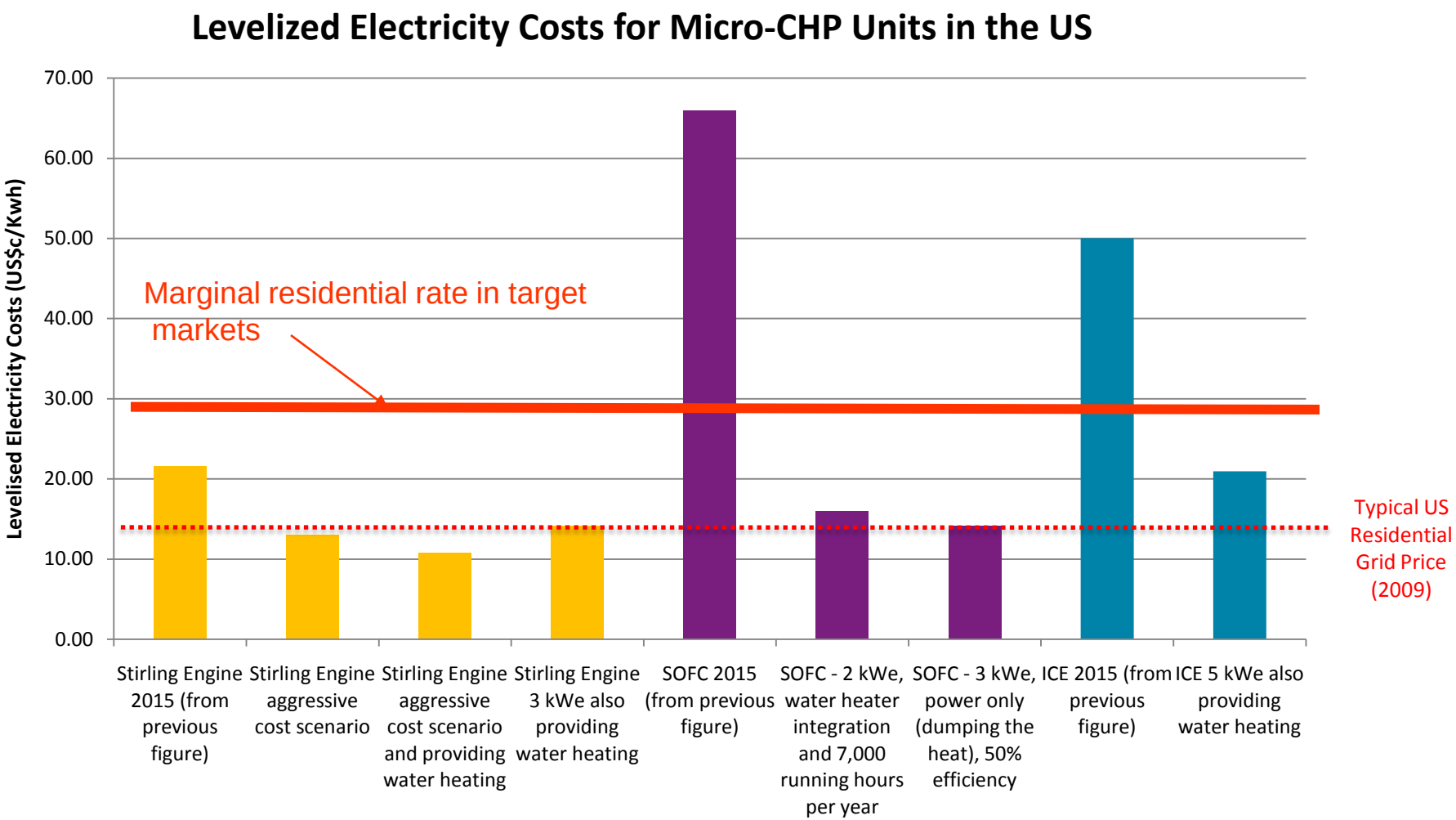
Aggressive Technology Cost Reduction Scenarios for US Market



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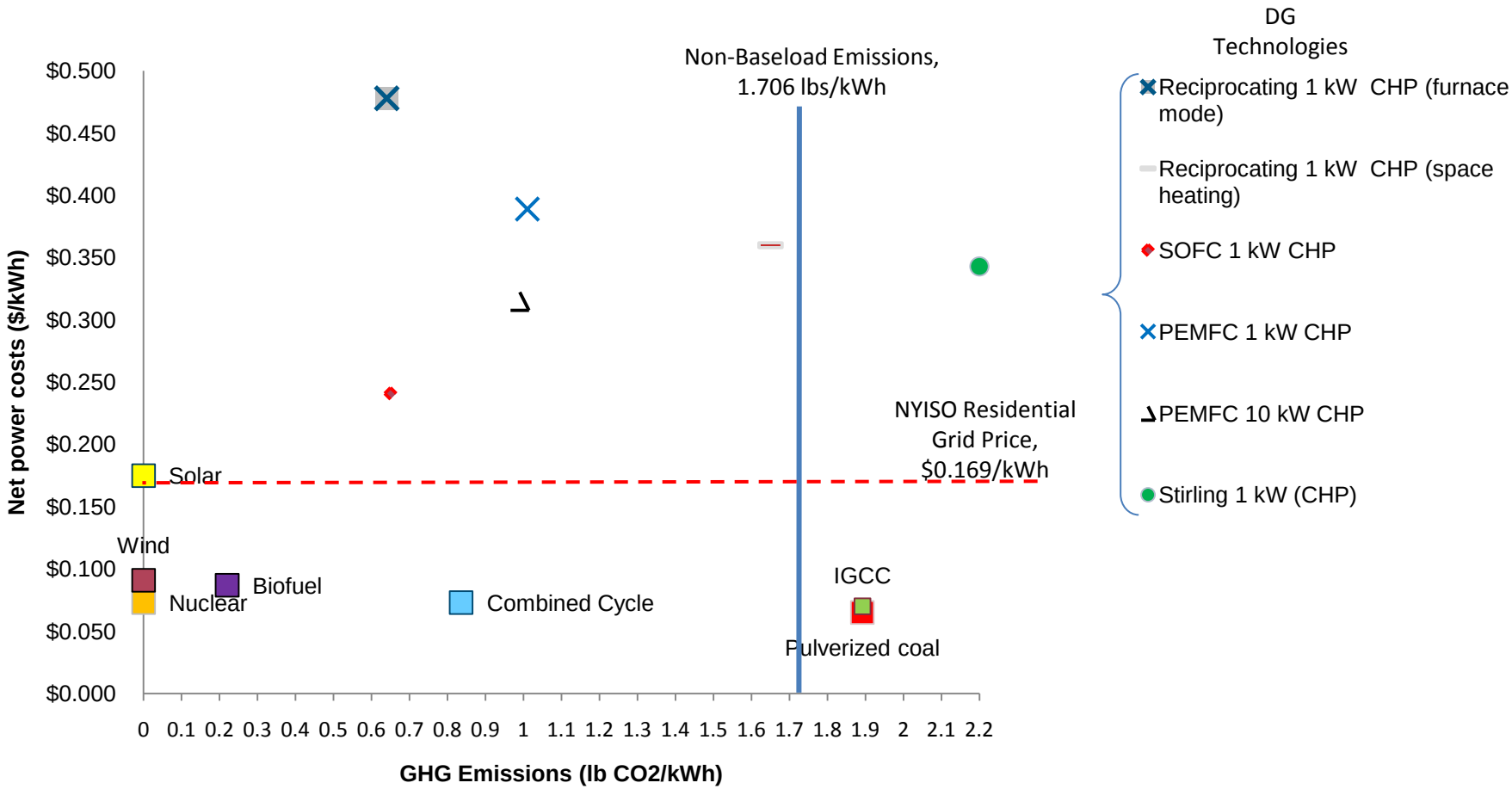
Comparison – DG vs. Grid NYISO Region



NYISO - Residential Case

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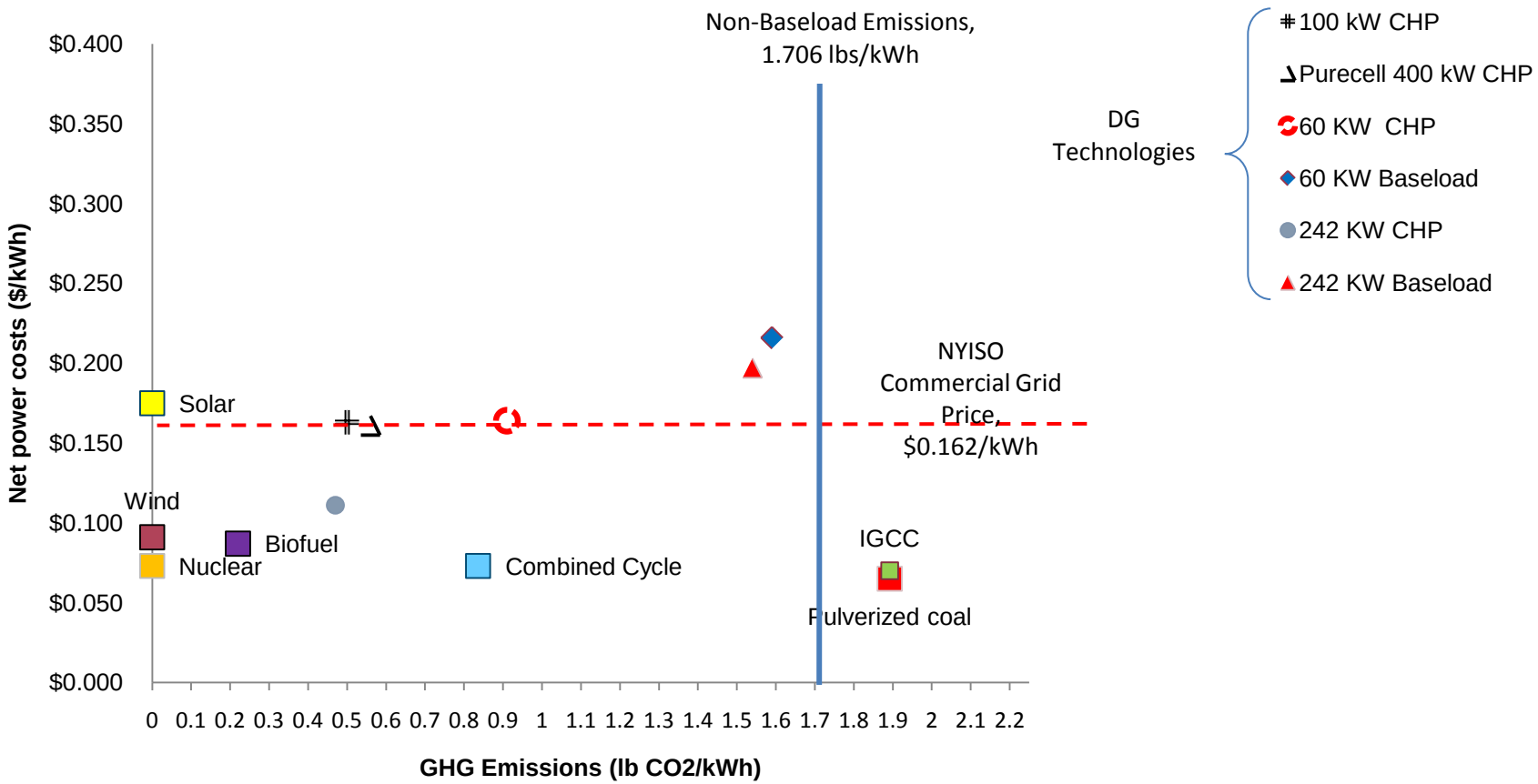
Comparison – DG vs. Grid NYISO Region



NYISO - Commercial Case

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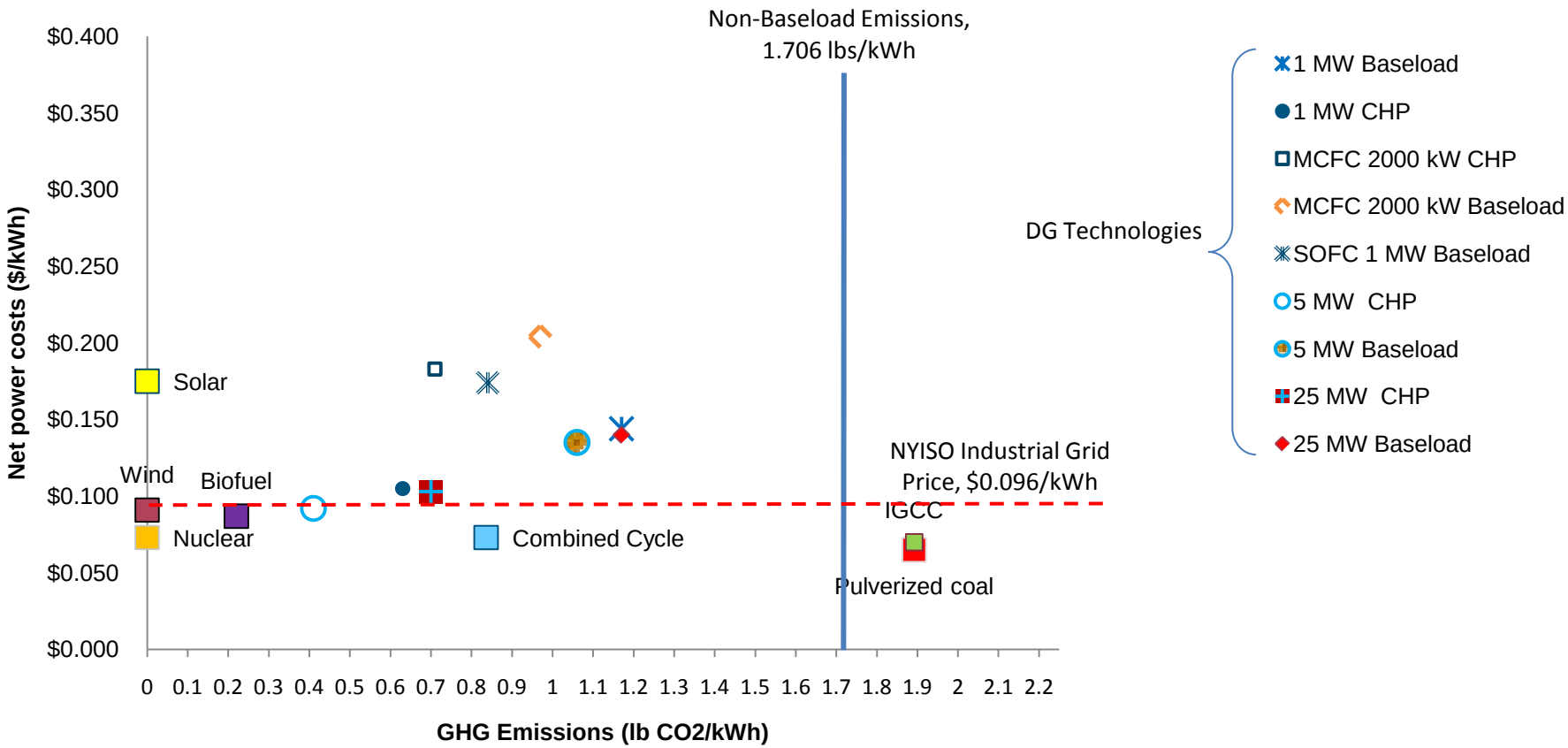
Comparison – DG vs. Grid NYISO Region



NYISO - Industrial Case

* 1.2 MW Diesel = $0.64/kWh and 1.6 lb CO2e/kWh

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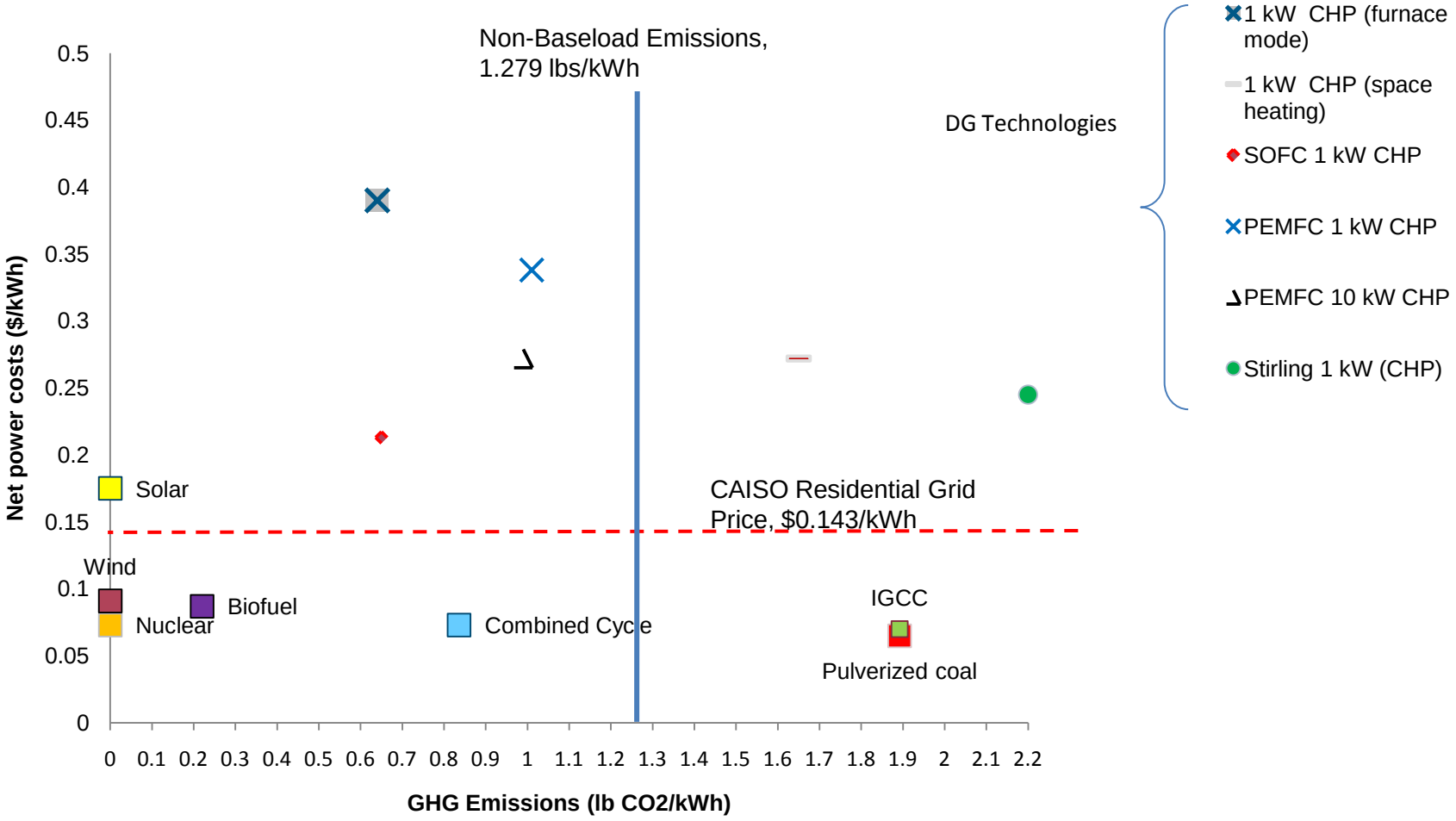
Comparison – DG vs. Grid CAISO Region



CAISO - Residential Case

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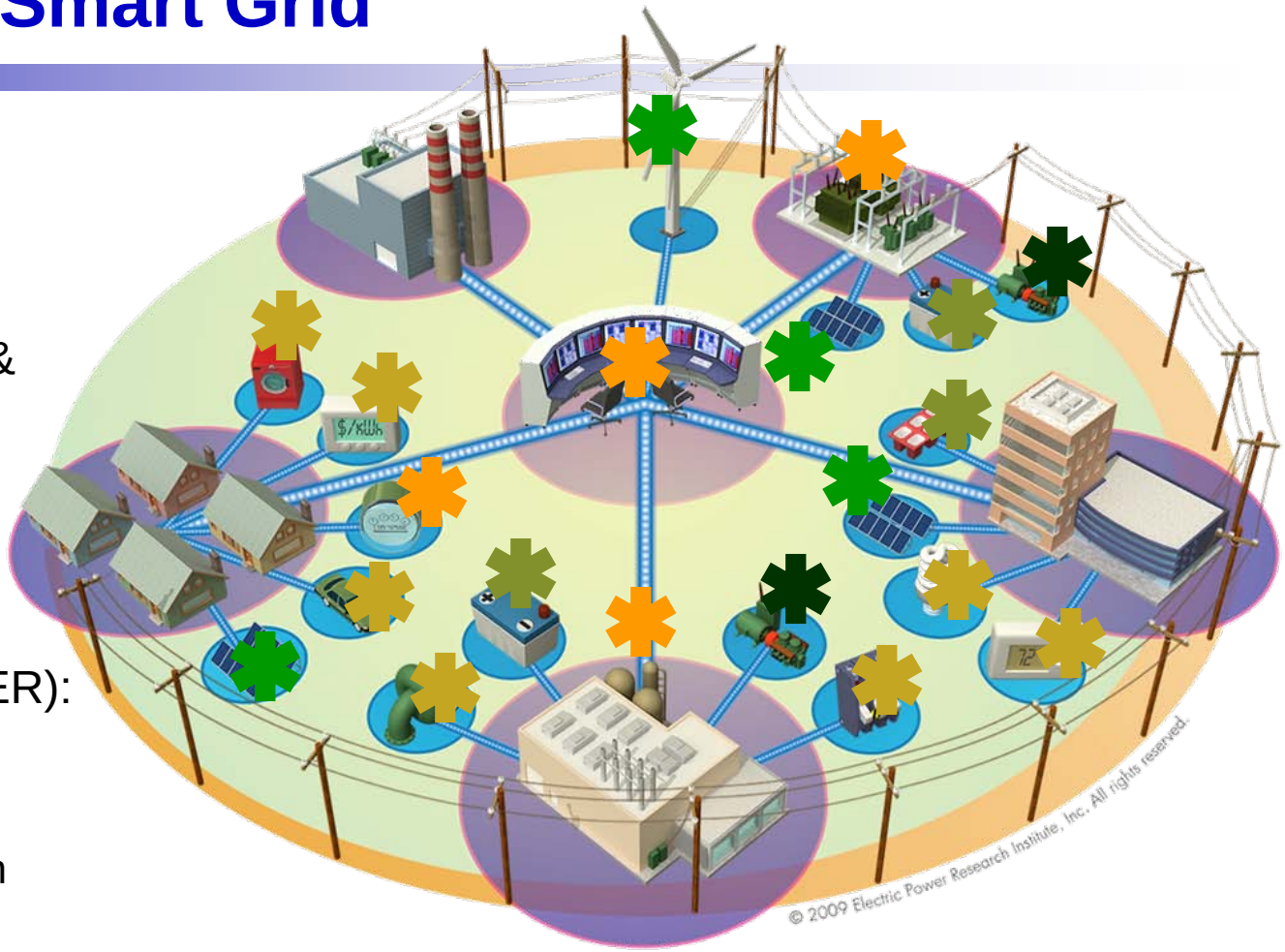
Utility Value Proposition link to Valuation of DG Asset in Smart Grid

- Virtual Power Plant
- Integration and Interoperability
- Leverage information & Communication Technologies
- Integration of Multiple Types of Distributed Energy Resources (DER):



- Distributed Generation
- Renewable Generation
- Storage
- Demand Response

Multiple Levels of Integration - Interoperability

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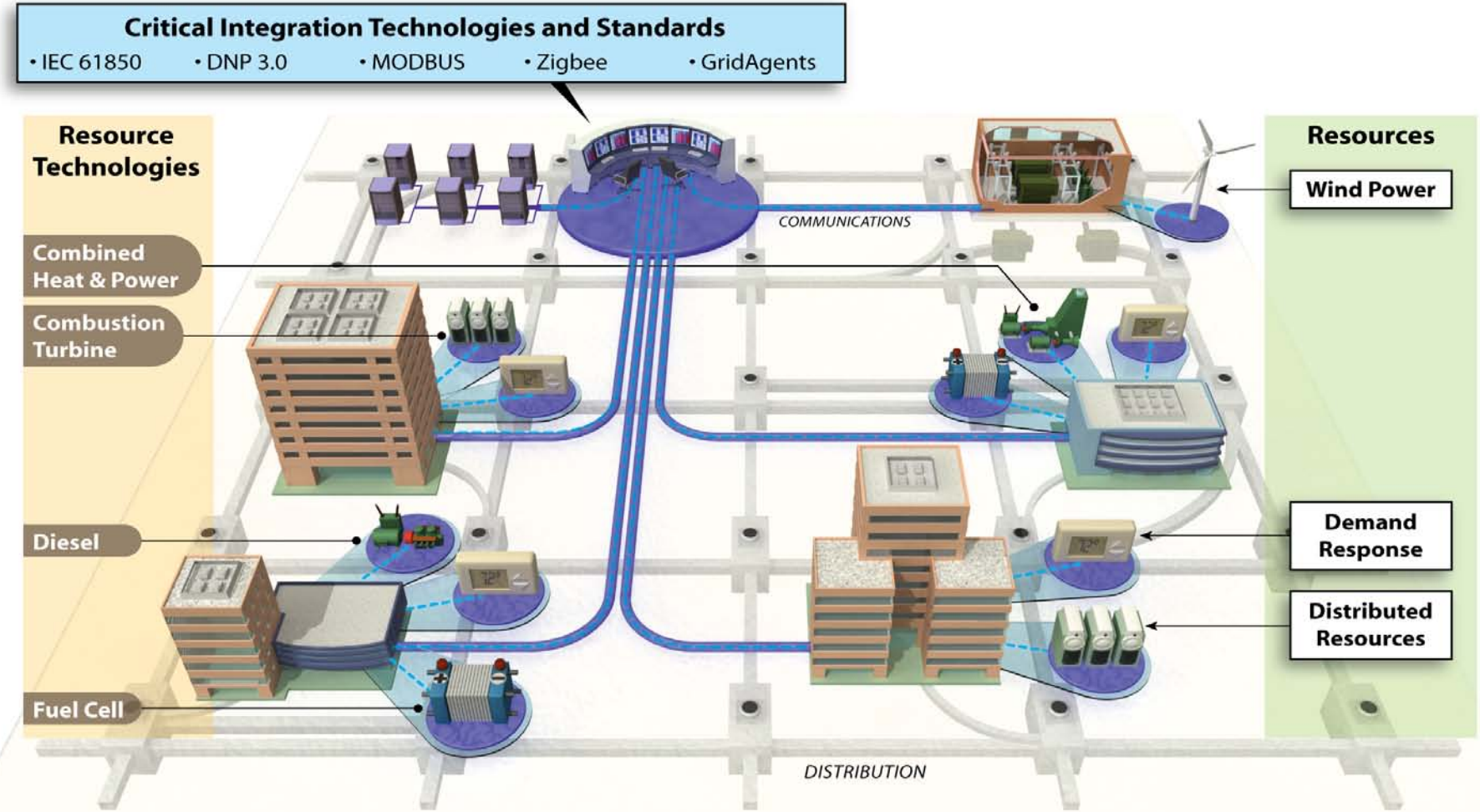
Utility Value Proposition - Example
Con Edison – Smart Grid Demo
Interoperability of Demand Response Resources



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conEdison

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Utility / Societal Value Proposition

Utility	Societal	Comments
Procure less Wholesale power	Avoided Central Gen	Least Cost? Reliable?
Less T&D Investment in Infrastructure CapEx Deferral	Least Cost plan	markets set plan
New Business	Jobs	Regulatory Treatment
Reduced GHG	Support RPS	Regulatory Treatment

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Recommendations

- Comprehensive Study needed of DG, DER, Storage in Smart Grid: Central vs DG Pardigm
  - Tool and Model>> support policy
- Accelerate development / deployment of “highest electrical” efficiency options
- Accelerate “plug & play” features of DG appliances
- Conduct Pilot deployment to demonstrate value proposition and costs / benefits to grid / society
- Advanced Technology Development – Impact?

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