Distributed Generation and Micro-Grids

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What’s a Micro-Grid and Where’s the Market?

• A micro-grid is an electrically isolated set of generators that supply all of the demand of a group of customers

• The Market:
  – Utilities that want to provide service where there is no utility grid
  – Energy service providers operating in a deregulated environment
Why Have a Micro-Grid?

• Disadvantages
  – Reduced generation diversity
  – Reduced demand diversity

• Advantages
  – Not burdened with the cost of the T&D system
  – Unaffected by the reliability of the T&D system
Example of a Micro-Grid

- Constant 100 kW load
- Outage probability of 1 day in 10 years
- Each fuel cell has a 5% forced outage rate and will last for 20 years
- Capital cost ($/kW) decreases with plant size
- O&M cost is 4.0¢/kWh
- 10% discount rate
System Capacity Increases with Plant Size

The required system capacity is the result of a binomial probability evaluation.
Plant Cost Decreases w/ Plant Size

Plant Size (kW)

Cost

Plant Cost ($/kW)

$2,500

$2,000

$1,500

$1,000

$500

$0
Tradeoff is Between Capacity and Cost

![Graph showing the tradeoff between plant size and system capacity with cost as the y-axis and plant size as the x-axis. The graph illustrates the cost curve and capacity curve, with the demand line at a constant level.](image-url)
Results

• Optimal design: 50 plants, 2.5 kW each
• Levelized cost is 7.1¢/kWh
• Levelized cost for single 100 kW grid-connected unit is 5.9¢/kWh
• Micro-grid alternative is preferred if cost of grid backup exceeds 1.2¢/kWh
**Conclusions and Future Work**

- There may be a market for micro-grids
- Photovoltaics could be part of micro-grids
- Allow loads and customers (number and type) to vary
- Add load control and other technologies
- Incorporate reliability levels and costs
- Create investment flexibility models