Increasing Backup Generation Capacity and System Reliability by Selling Electricity during Periods of Peak Demand
Reliability and backup generators

- The US grid experiences outages of approx. 2 – 3 hours/year
- Estimated that there are approx. 12 million backup units in the US with 200 GW of capacity
- Approximately, 1.3 GW of backup generation is installed in New York City and 500 MW in Long Island
- Represents a large amount of under-utilized, installed, distributed, localized capacity
- Could reduce electricity prices, installed capacity (ICAP) market payments and increase reserve margins
Meeting peak demand

- NYISO uses the generators in *emergencies* for electricity (EDRP) and capacity (SCR-ICAP)
- The capital costs of the generators are already attributed to reliability!
- Diesel generators are excluded due to concerns about air quality and human health
- Using a full cost approach, emission control technologies, specifically diesel particulate filters (DPF) significantly reduces the air quality and human health effect.
Problem Statement

1. Are there sufficient profits to encourage a single generator to participate in the market?
2. Are there sufficient profits to promote additional backup capacity?
3. What happens if all the generators enter the market?
4. Are there system benefits with respect to cost and reliability?

- Case study in NYC and LONGLI using market prices from 2005 - 2006
Value of reliability

- value of lost load = the cost of self-generation

\[ VOLL = FC + MC \]

\[ FC = \left( \frac{CC \cdot CRF}{HY} \right) + \left( \frac{FOM}{HY} \right) \]

\[ MC = VOM + FUEL \]

- Where
  - CC is the overnight capital cost (in $/kW)
  - CRF is the capital recovery factor for interest and depreciation (~ 15%)
  - FOM is the fixed operating and maintenance (O&M) ($/kW-yr)
  - FUEL is the fuel cost ($/kWh)
  - HY is the number of hours the plant generates electricity (hours/year)
  - VOM is the variable O&M ($/kWh)
At 3.3 hours of outage per year
VOLL (this work) = 25.90 $/kWh
VOLL (literature) ≈ 10 $/kWh
Calculating profits

- For one backup generator,

\[
\text{Profits ($/kW-yr)} = \sum_{n=1}^{\text{ICAP}} (MCP_n - MC_{backup}) + \sum ICAP - \text{Retrofits}
\]

- Where \( MCP \) is the hourly market clearing in the DAM (in $/kWh)
- \( MC \) is the marginal cost of the backup generator (in $/kWh)
- \( n \) is the number of hours per year where \( MCP > MC \)
- ICAP is the monthly clearing price for capacity (in $/kW-month)
- Retrofits is the cost of the interconnections (~ $30/kW-yr) and diesel particulate filter, DPF (~ $6/kW-yr) at a 15% discount rate

- Assumptions:
  - An opportunity cost of zero for the generators to be ready to operate in the ICAP market
  - The additional costs of participation are negligible
Profits

Profits (in $/kW-year)

- Reliability
- Gen w/o DPF
- Gen w DPF

New York City

- Electricity
- ICAP
- TOTAL (minus retrofits)

Long Island
Backup Generator Capacity

- Profits reduce the ‘implicit’ cost of reliability (VOLL) to ~1 – 15 $/kWh

- Assume an elasticity of reliability: a 10% decrease in price would increase capacity by 1 to 4%

**Estimated Increases in Capacity (in MW)**

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<th>NYC</th>
<th>LONGLI</th>
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<tbody>
<tr>
<td>w/o DPF</td>
<td>200</td>
<td>50</td>
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<tr>
<td>w DPF</td>
<td>300</td>
<td>70</td>
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Simultaneity Problem

- If all the existing and additional generators enter the market, they may become the marginal plant.

- To evaluate the opportunities for arbitrage:
  - How many generators (in MW) operate at marginal costs higher than that of backup generators in the electricity market?
  - How would adding low cost capacity effect the ICAP market?
Electricity market

- MC = Heat Rate (mmBTU/MWh) x Fuel cost ($/mmBTU)
- MC for a diesel w DPF ~ 180 $/MWh (~ 2.20 $/gal)
- Using data from eGRID (2006) on plant characteristics

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<tr>
<td>Total Generators</td>
<td>1,600</td>
<td>570</td>
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<tr>
<td>Capacity with MC &gt; 180 $/MWh (MW)</td>
<td>163</td>
<td>640</td>
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<tr>
<td>Operation (h/yr)</td>
<td>50</td>
<td>1000</td>
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Installed Capacity

ICAP demand curve for NYC, summer 2006

Price (in $/kW-month)

Unforced Capacity (in MW)

0 2000 4000 6000 8000 10000 12000

0 5 10 15 20 25

0 2000 4000 6000 8000 10000 12000
Conclusions & Future work

- The profits in the electricity and ICAP markets reduces the VOLL, sufficient to cover the interconnections & environmental retrofits

- If all the existing generators enter the market, there are no profits in the electricity market, but ICAP?

- There can be substantial savings and reliability benefits for consumers and for the system