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

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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

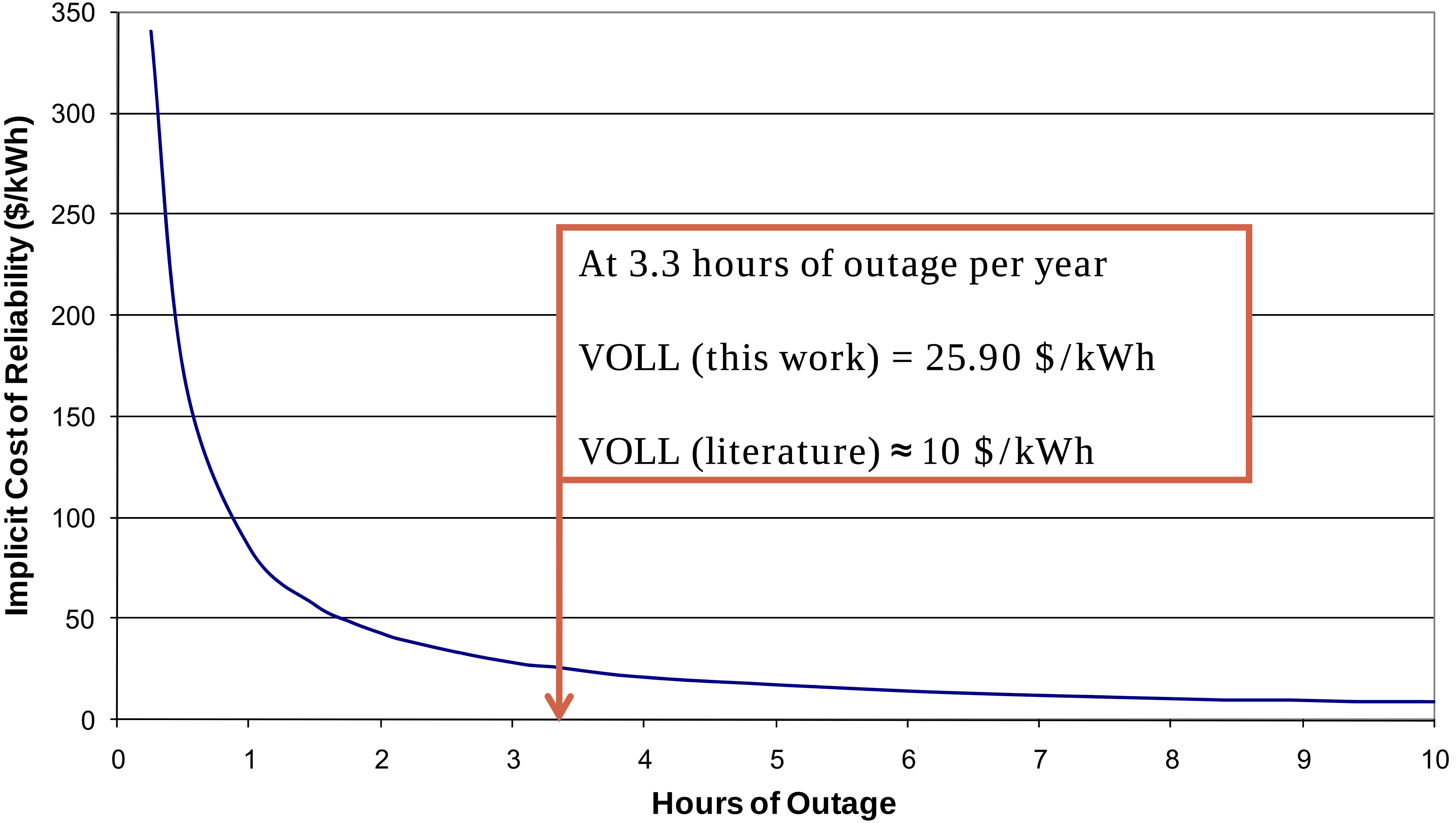
$$VOLL = FC + MC$$

$$FC = \frac{CC \cdot CRF}{HY} + \frac{FOM}{HY}$$

$$MC = VOM + FUEL$$

  - 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)

‘Implicit’ value of reliability



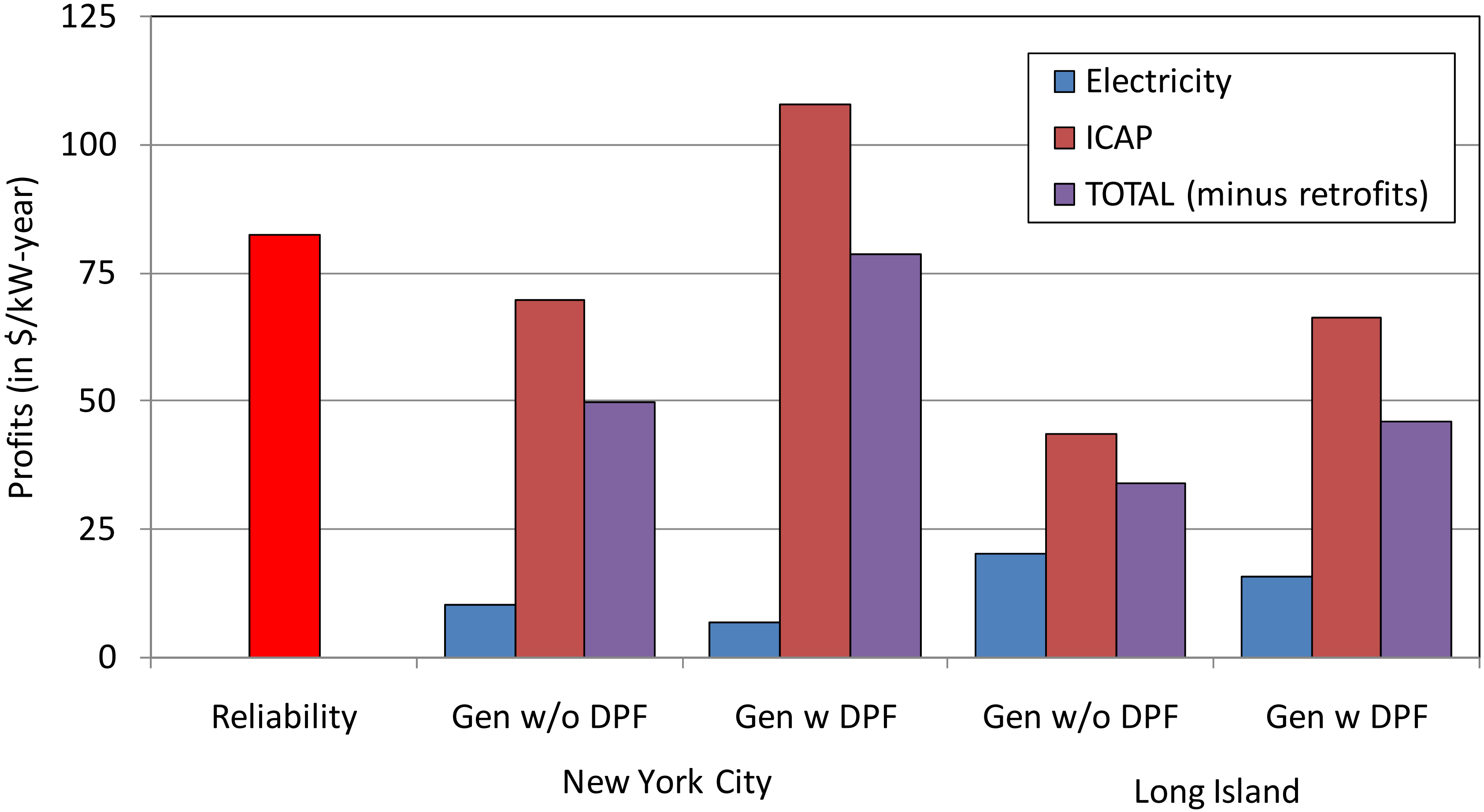
Calculating profits

- For one backup generator,

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

  - 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


125
100
75
50
25
0
Profits (in $/kW-year)
Electricity
ICAP
TOTAL (minus retrofits)
Reliability
Gen w/o DPF
Gen w DPF
Gen w/o DPF
Gen w DPF
New York City
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)

	NYC	LONGLI
w/0 DPF	200	50
w DPF	**300**	**70**

Simultaneity Problem

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

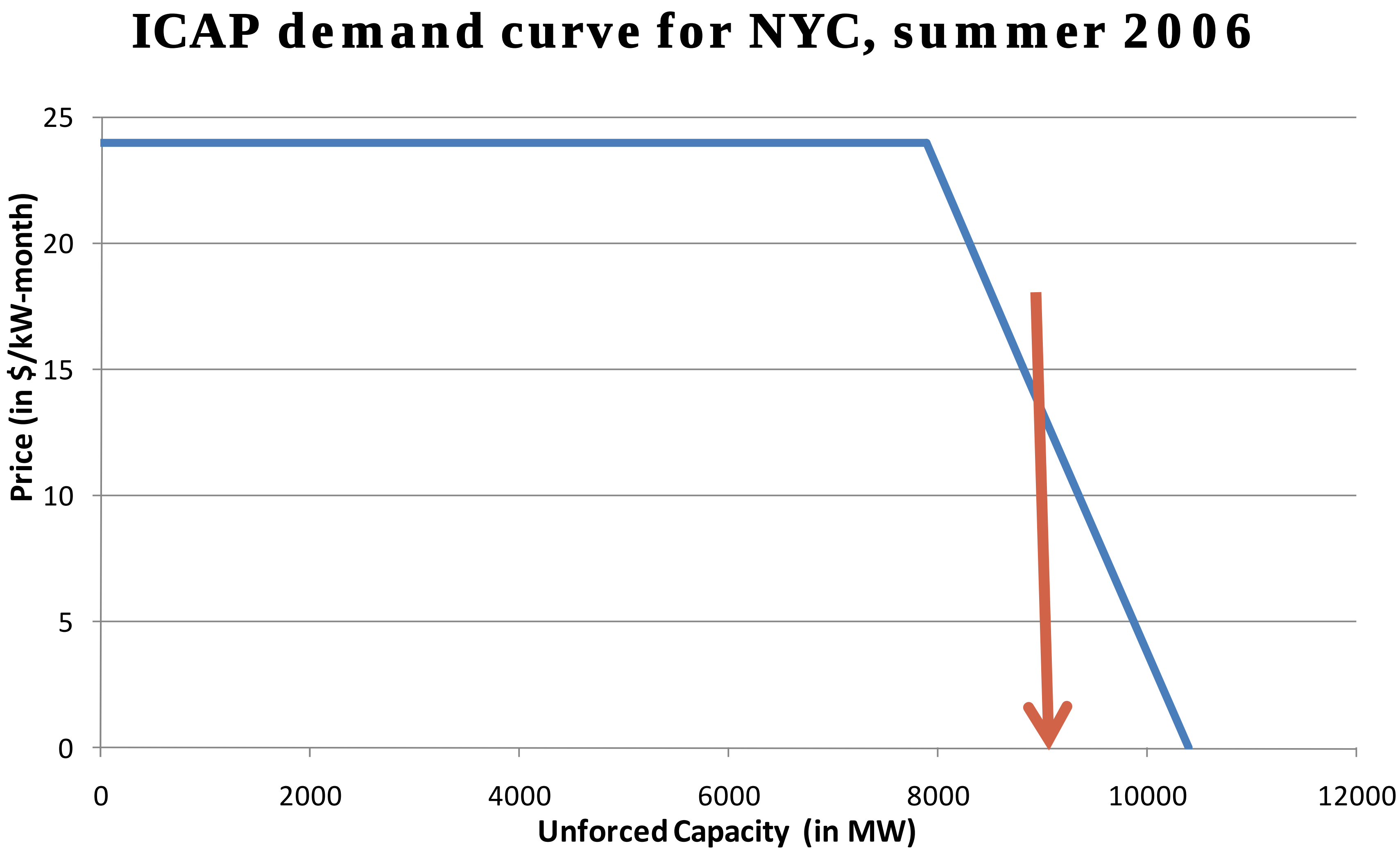
- To evaluate the opportunities for arbitrage:
  - How many generators (in MW) operate at marginal costs higher than that of backup generators in the electricity market?
  - How would adding low cost capacity effect the ICAP market?

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

	NYC	LONGLI
Total Generators	1,600	570
Capacity with MC > 180 $/MWh (MW)	163	640
Operation (h/yr)	50	1000

Installed Capacity



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