Distributed Cogeneration for Commercial Buildings: Can We Make The Economics Work?

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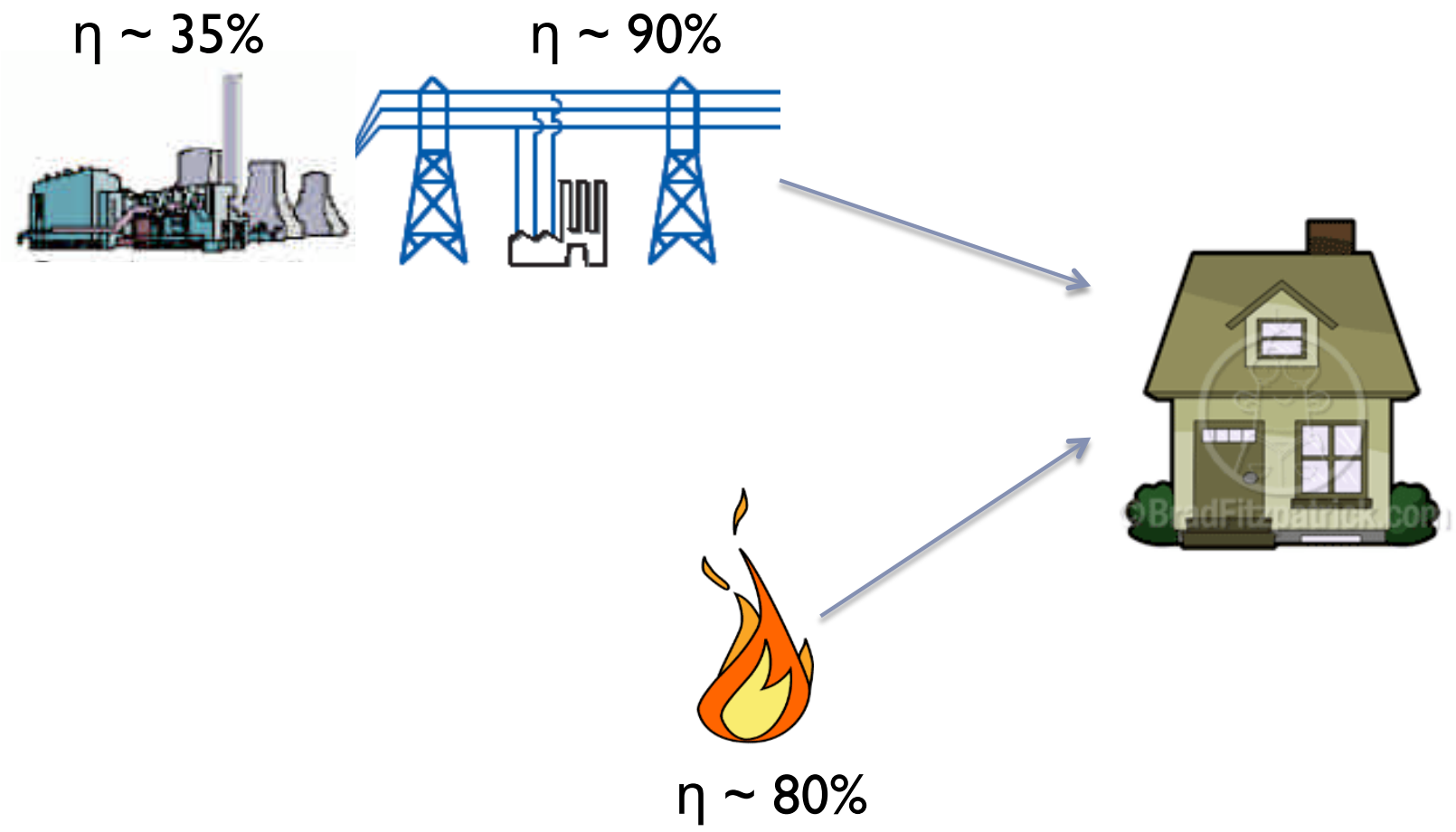
The Current System…



Cogeneration is ~40% More Efficient

$\eta_{electrical} \sim 35\%$

$\eta_{thermal} \sim 45\%$

Slow Adoption of Small-Scale Cogeneration

- ~7% of US generation capacity is cogeneration[1,2]
  - Well below levels demonstrated in other countries
  - Concentrated in large industrial projects[2]
  - Below estimates of economic and technical potential[3,4]

[1] Energy and Environmental Analysis, Inc., 2010. Combined heat and power installation database.
[2] US Environmental Protection Agency, 2007. Emissions and generation resource integrated database (eGRID), Version 1.1 (2005 data).
[3] Lemar, P., 2002. Integrated Energy Systems (IES) for Buildings: A Market Assessment, Prepared by Resource Dynamic Corporation for Oak Ridge National Laboratory.
[4] Resource Dynamics Corporation (RDC), 2003. Cooling, Heating, and Power for Industry: A Market Assessment. Prepared for US Department of Energy.

Slow Adoption of Small-Scale Cogeneration

- Cogeneration is a high risk, low return investment.
  - Large capital expense
  - Huge uncertainties in future fuel and electricity prices

Case Study: Hospital In Newark, NJ

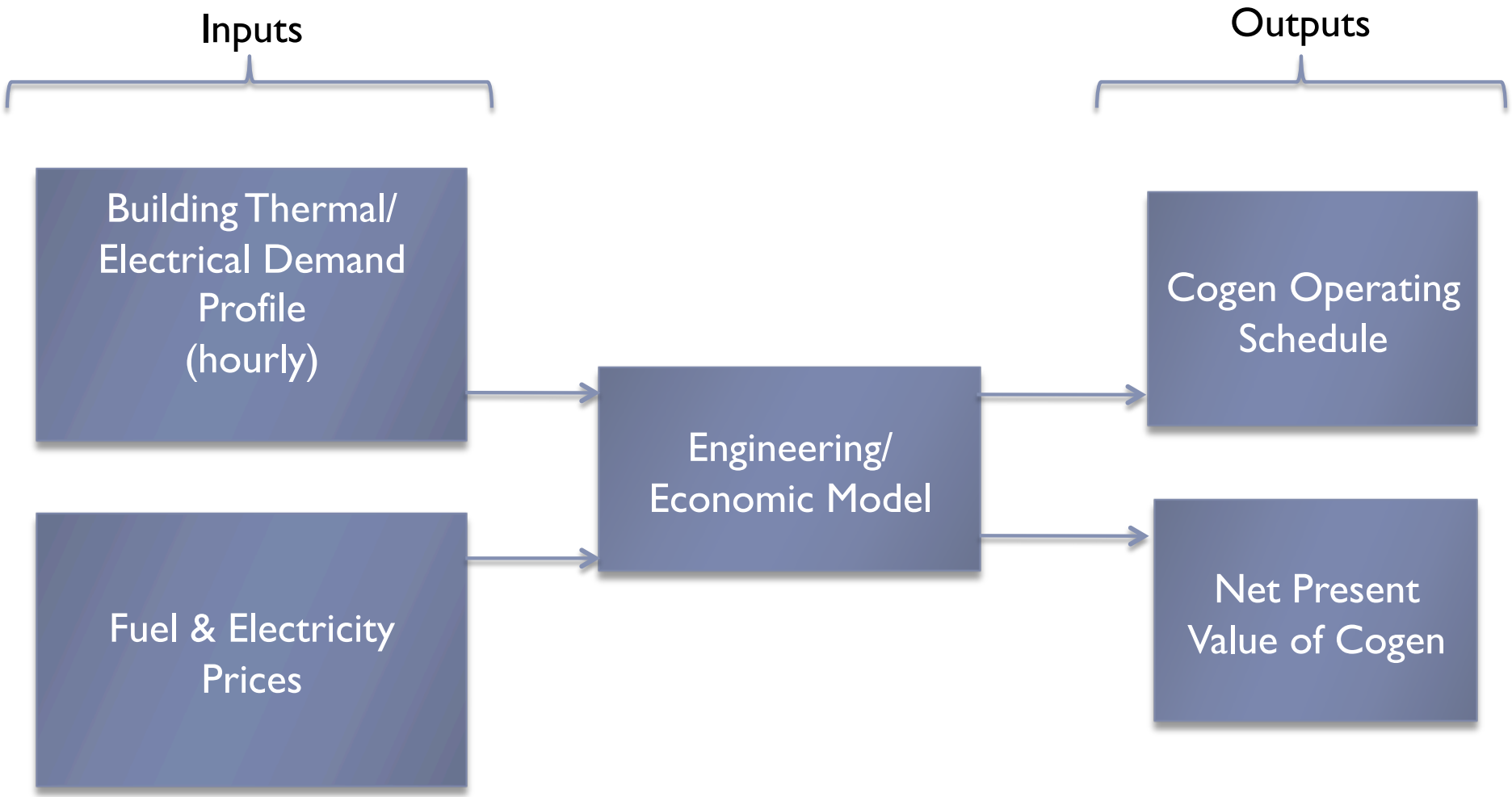
Case Study Building

- 150,000 sq. ft. hospital
- $850,000 annually for heating and electricity

Cogeneration Unit

- 300 kW_e reciprocating engine (natural gas-fired)
- Capital Cost: $600,000
- Net Efficiency=79%

Model Overview



Model Overview

- Minimize hourly operating cost

$$min \quad C_{total} = C_{cogen} + C_{utility-supplied\ energy}$$

- Optimize by checking "corner points"
  - Cogen is off
  - Cogen is on full power
  - Cogen is on such that thermal output of generator equals thermal demand of building
  - Cogen is on such that electrical output of generator equals electrical demand of building

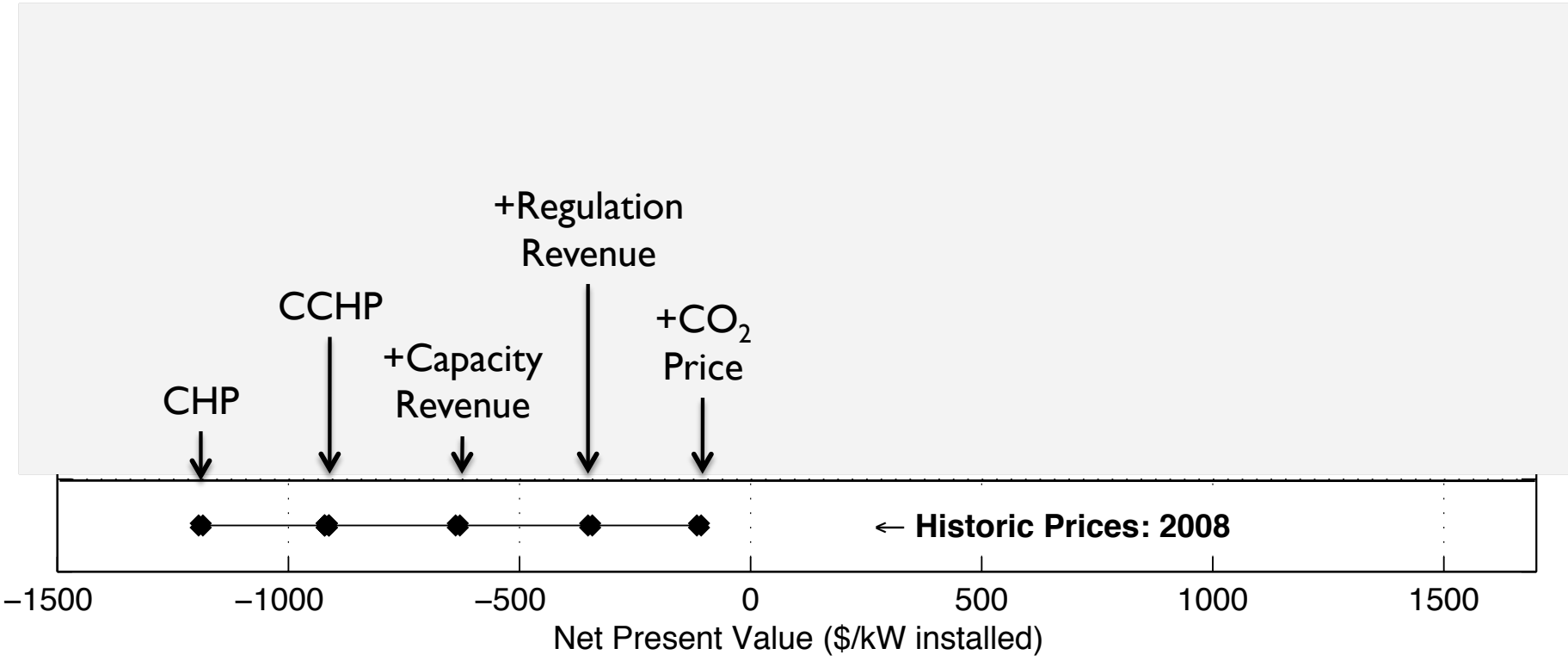
Input Assumptions

- Assumptions for discount rate
  - 80% debt-financed at 10% interest rate
  - 20% equity-financed with 35% return expected
  - 15 year lifetime
- Discount rate = 15%

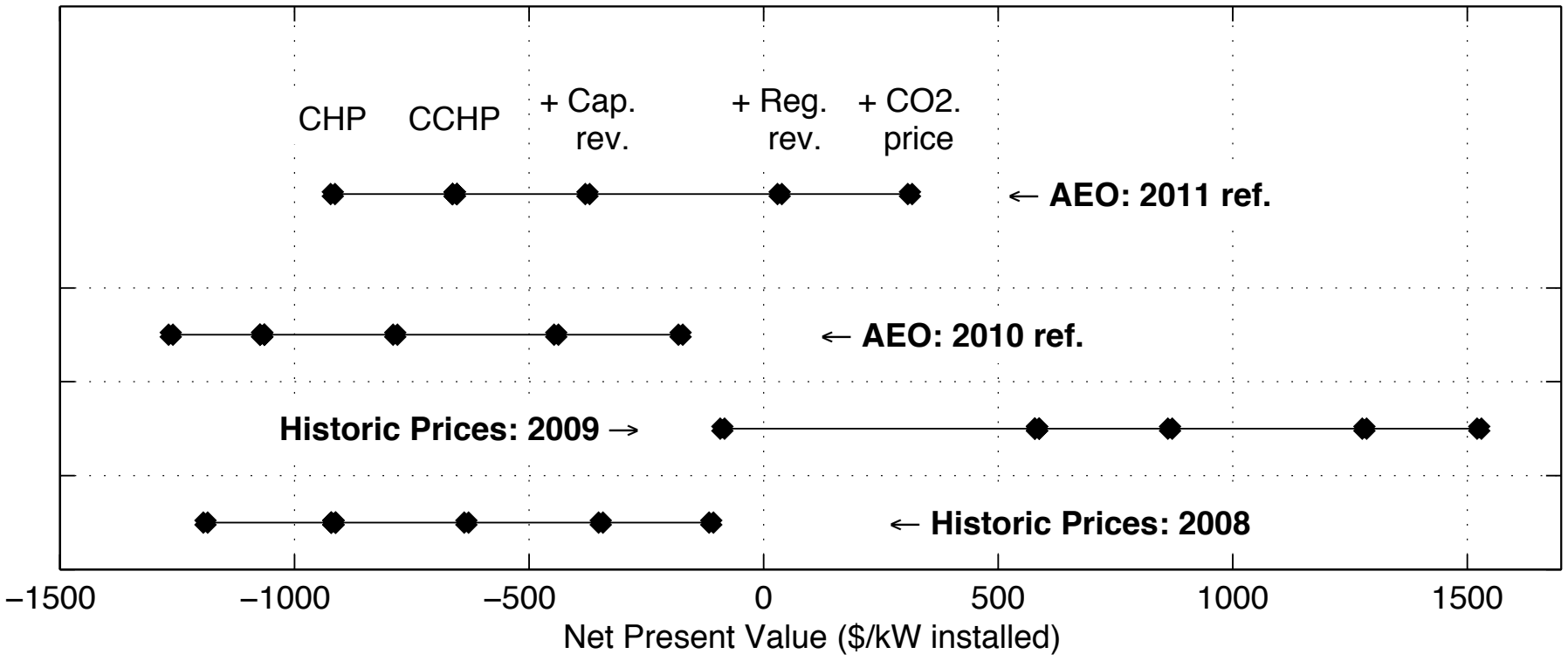
Results

- Assuming 2008 fuel and electricity prices repeat for the next 15 years…
  - NPV = -1,200 $/kW installed
- Assuming 2009 fuel and electricity prices repeat for the next 15 years…
  - NPV = -90 $/kW installed

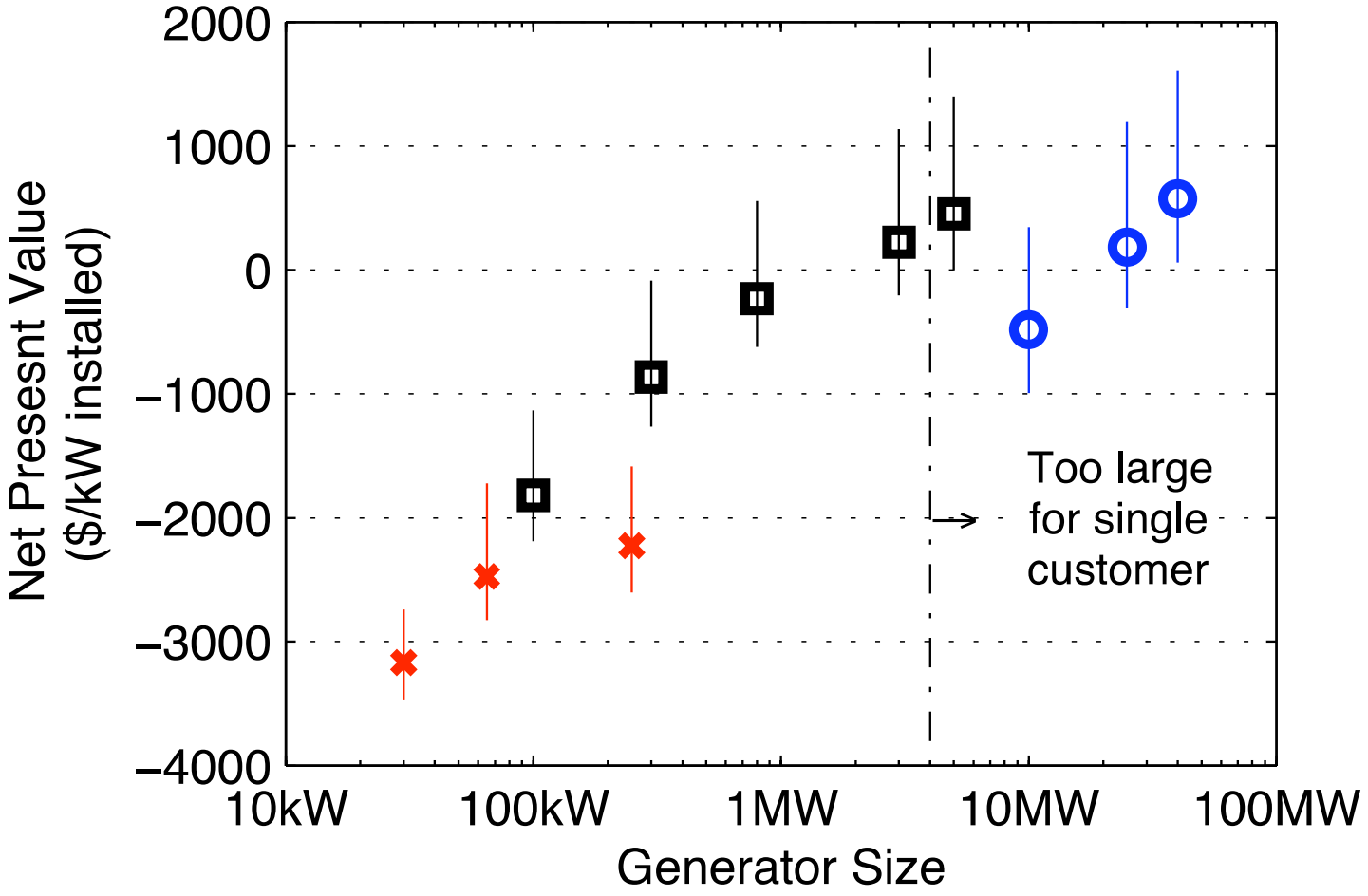
Increasing Revenue to Cogen



Increasing Revenue to Cogen



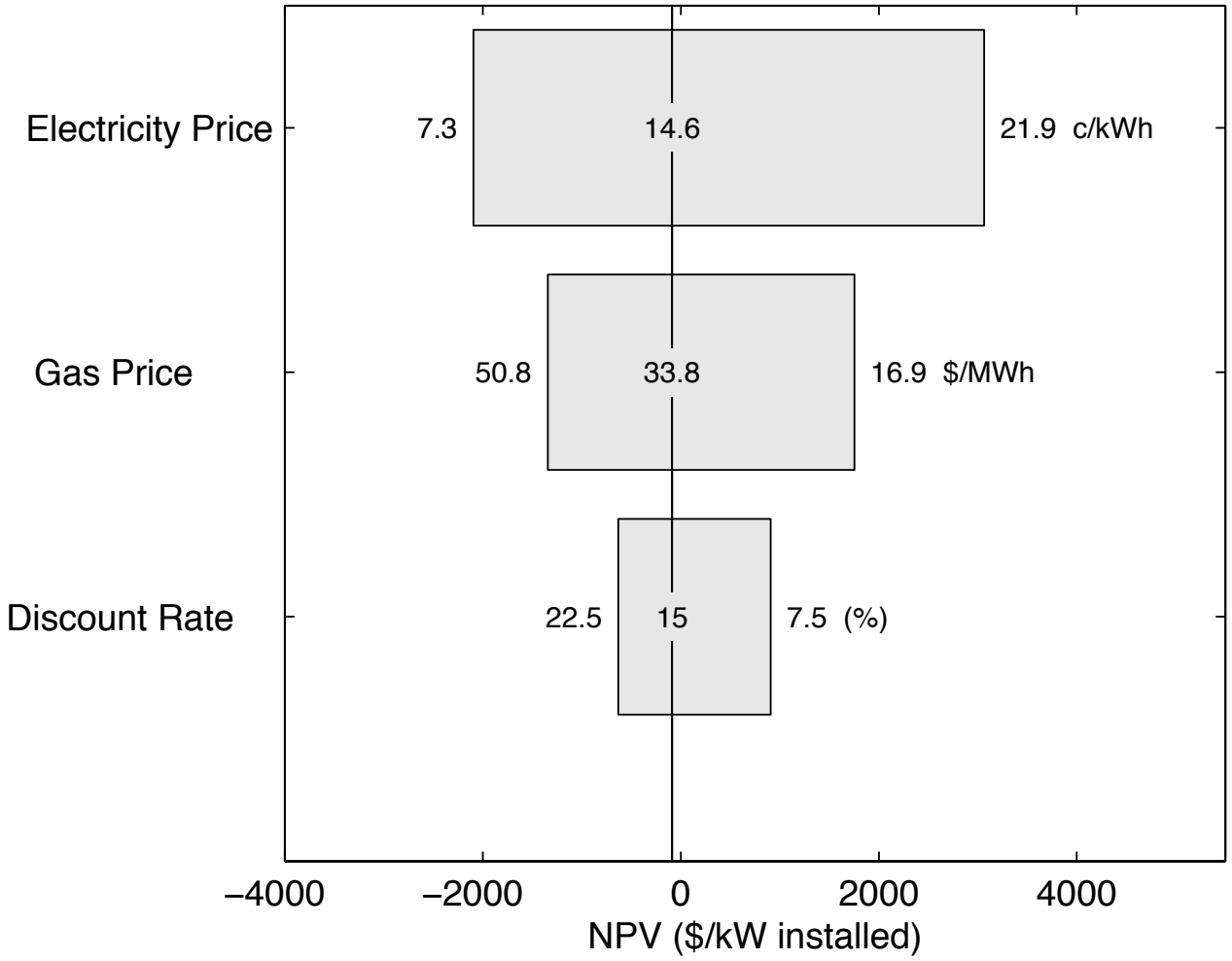
Economies of Scale



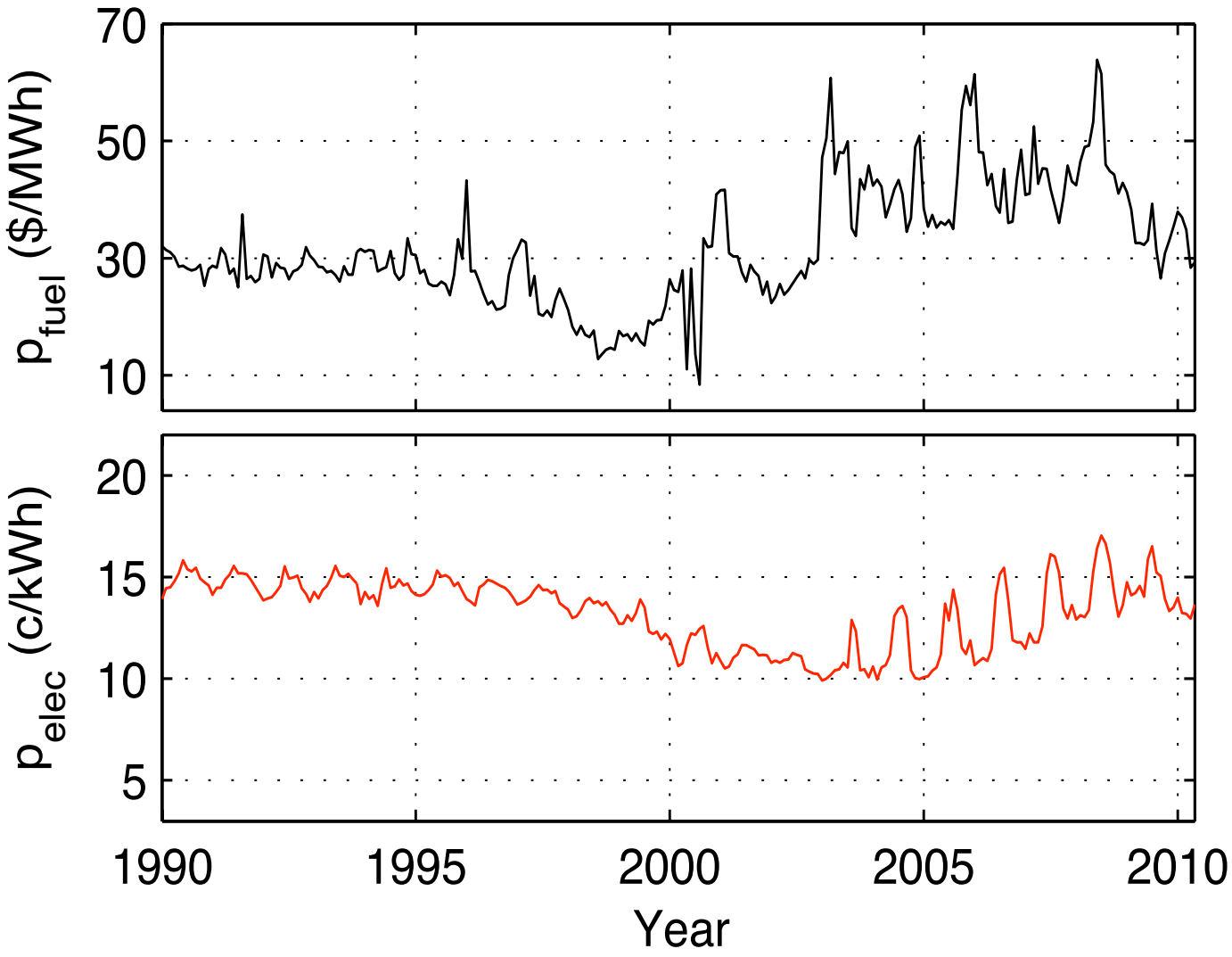
Economies of Scale

- Generators larger than a few megawatts are too large for most end users
- With a microgrid, a single generator would serve a small aggregate of end users
  - The legal status of microgrids is ambiguous, creating a significant barrier to their development

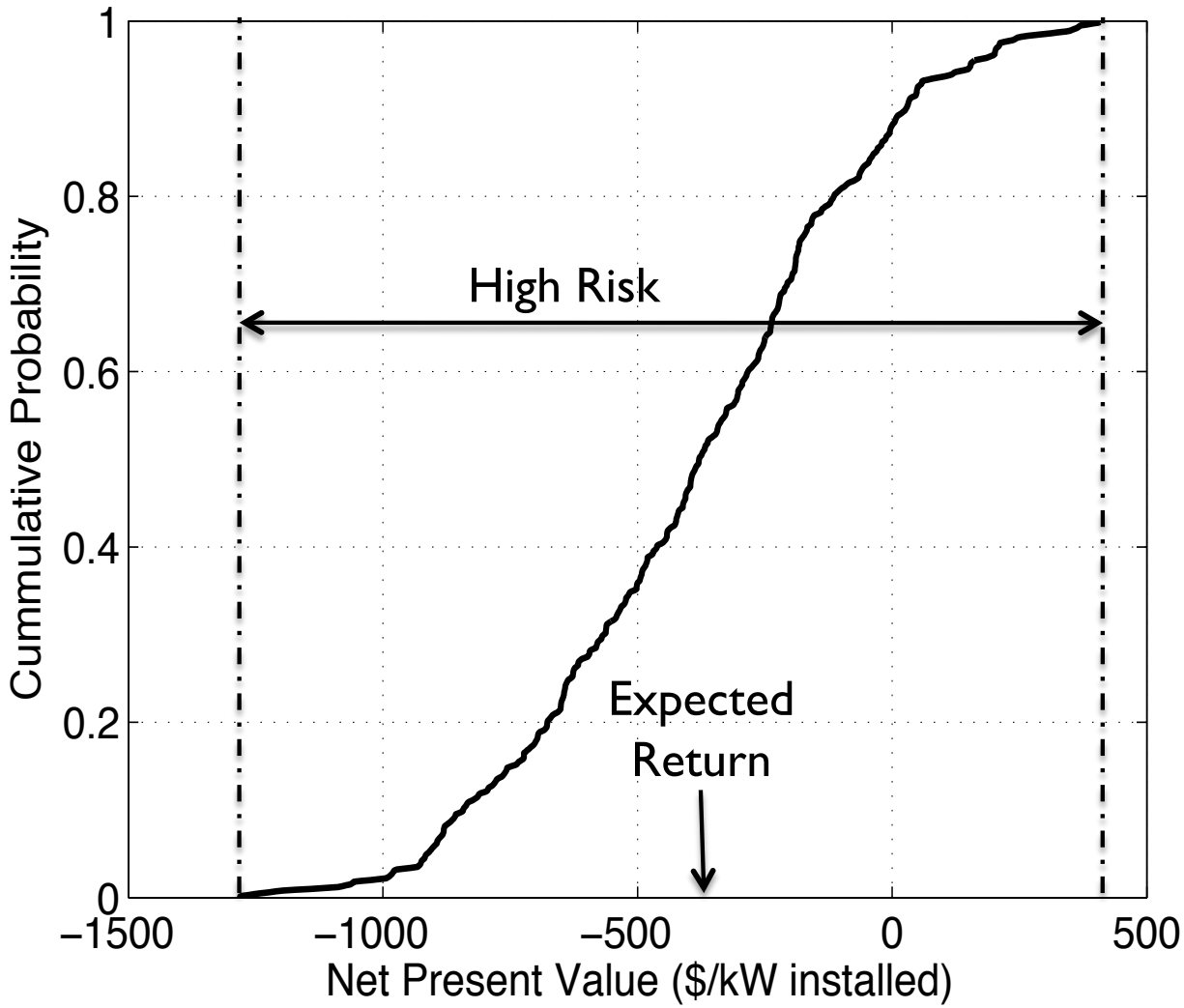
Sensitivity



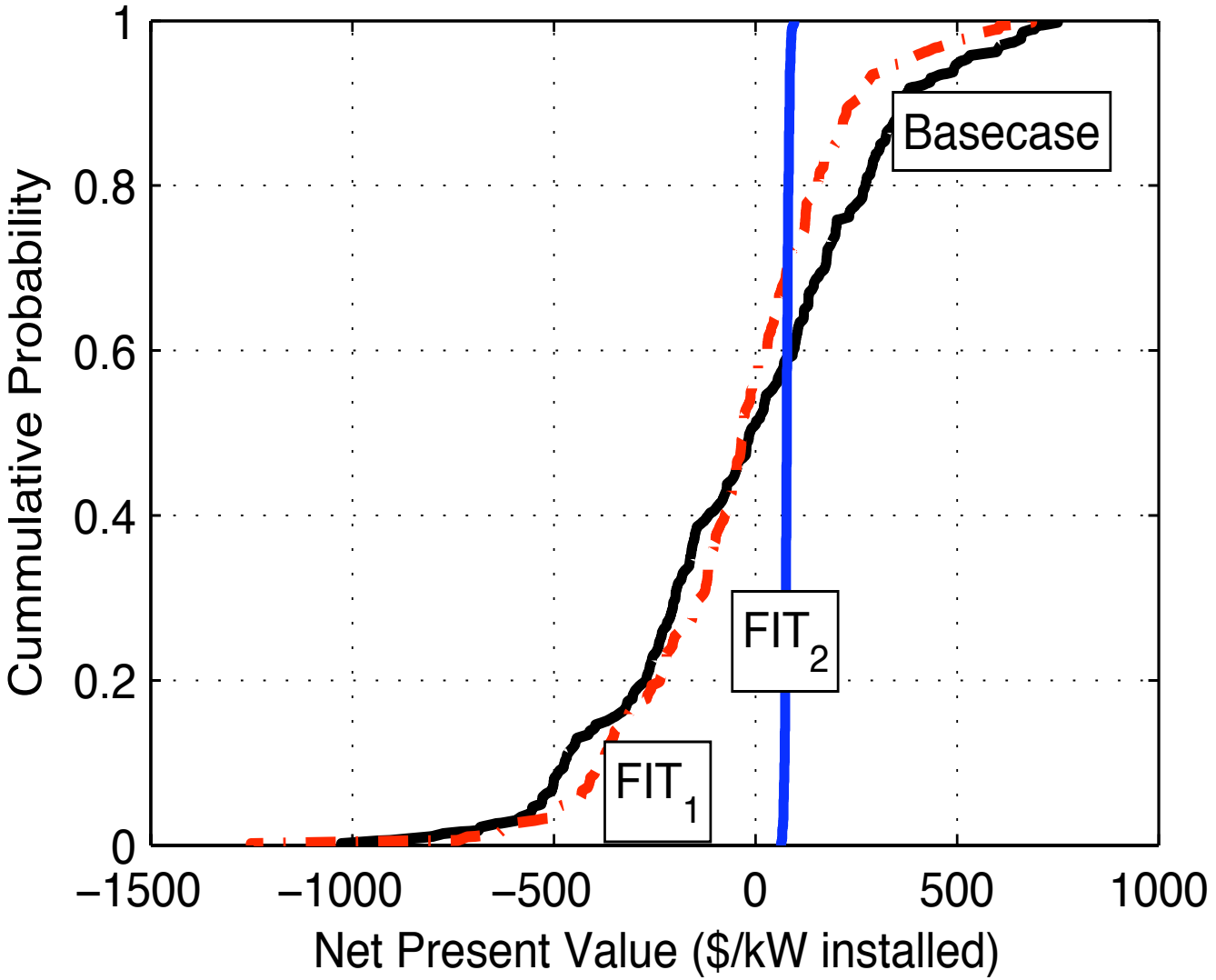
Historic Natural Gas & Electricity Prices



Cogen: High Risk, Low Return



Decreasing risks



Insights/Conclusions

- Be skeptical of any economic analysis based on a single sample year

- We can design mechanisms to increase the revenue to cogen projects
  - However, many of these mechanisms do not currently exist:
    - Capacity & regulation markets
    - CO_2 tax or cap-and-trade

Insights/Conclusions

- Cogen benefits from economies of scale. Microgrids may increase market for larger cogen projects
  - The legal status of microgrids is ambiguous, creating a significant barrier to development
- Feed-in tariffs, if property designed, can reduce the risks to a cogen project
  - However, excessively generous feed-in tariffs may encourage the adoption of low-efficiency projects

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Thank You

Questions?