



Holland Board of Public Works

Sustainable Return on Investment (SROI) Analysis Results

HDR Inc.
August 8, 2012



Agenda

- Introduction
- Electric Generation Resource Options & Scenario Overview
- SROI Overview
- SROI Results





Holland Board of Public Works

Electric Generation Resource
Options & Scenario Overview



James R. Connell P.E.
Sr. Vice President
Director of Power, HDR Engineering, Inc.

Work Flow:

- New Generation Options Analysis
 - a. Conceptual designs of electric generation options
 - b. Calculation of thermodynamic and emissions performance
 - c. Estimated Capital and Fixed & Variable O&M costs
 - d. Inputs to Ventyx Strategist Model
 - e. Defined Electric Resource Scenarios (CEP+)

- Ventyx Integrated Resource Planning & Production Cost model
 - a. HBPW Electric Load Forecast
 - b. Ventyx Reference Case for 25 year Energy Cost Forecasts
 - c. Electric Resource Scenario Strategist Runs
 - d. Sensitivity Runs – High/Low Natural Gas Cost Forecasts

- HDR Decision Economics Analysis
 - a. Financial Return On Investment (FROI)
 - b. Sustainable Return On Investment (SROI)

James De Young Station



- Unit 3 Retired in all cases
- Snowmelt system currently fed by U3/U4
- 46 MW Combined Capacity U4+U5
- No Capital Investment – Retire U4 & U5 by 2016 per the CEP
- Invest \$28M Air Pollution Control Equipment , U4 Retires 2027, U5 Retires 2033 (Base Case)

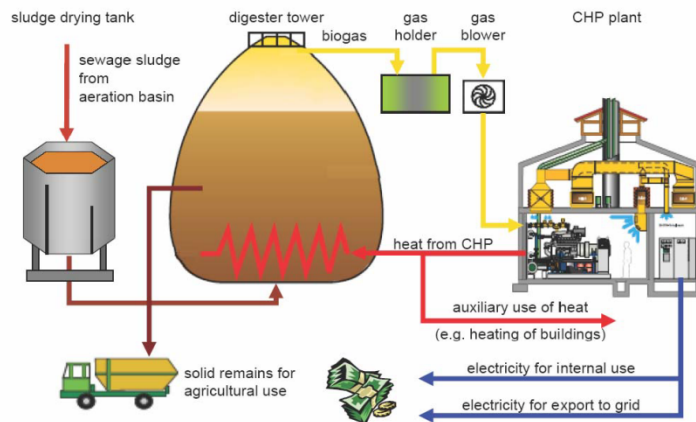
Renewable Generation Options



20MW Wind Farm



8MW Solar Photovoltaic



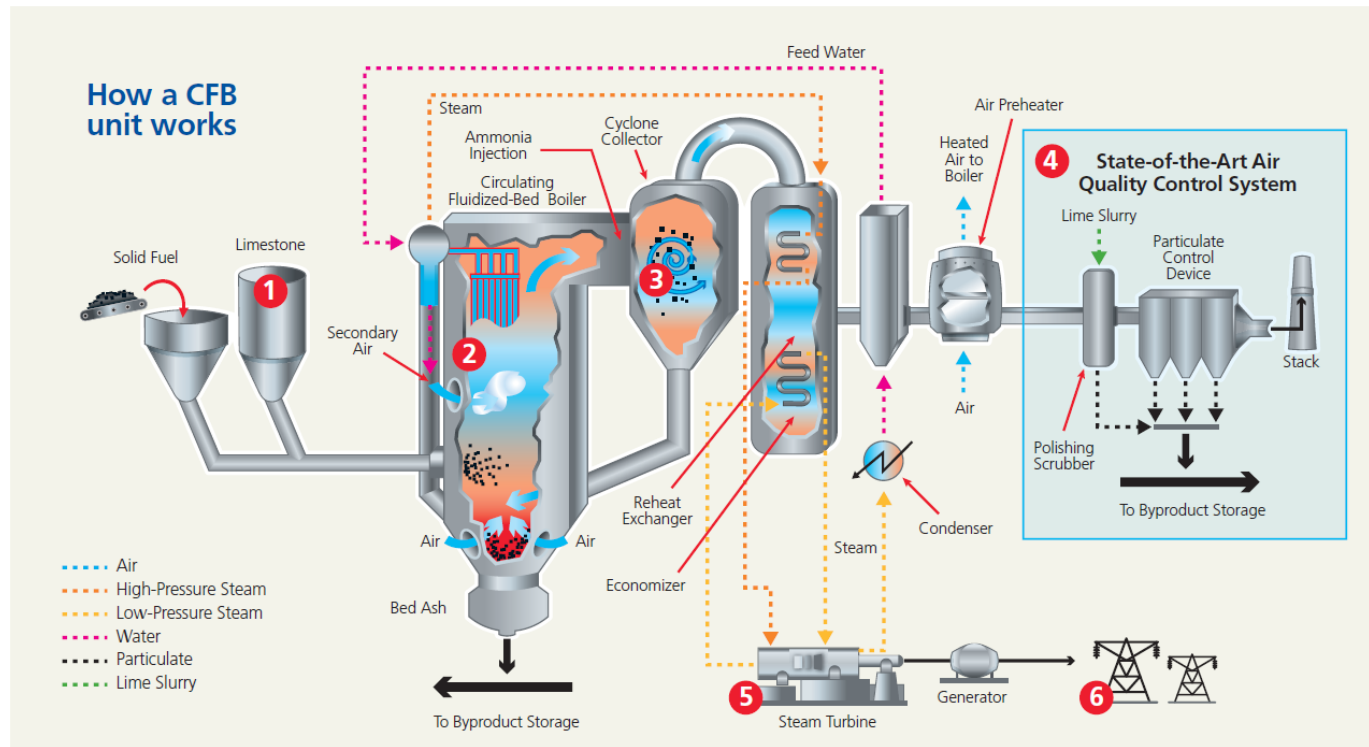
4MW Digester Gas CHP



22MW Biomass Conversion JDY - U5

New Solid Fueled Unit 10 at JDY

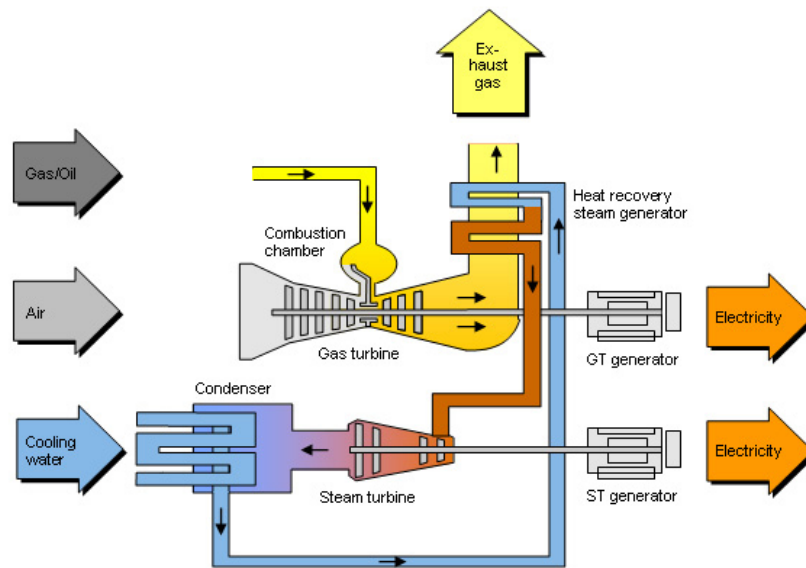
Circulating Fluidized-Bed (CFB) Boiler



70 MW Capacity

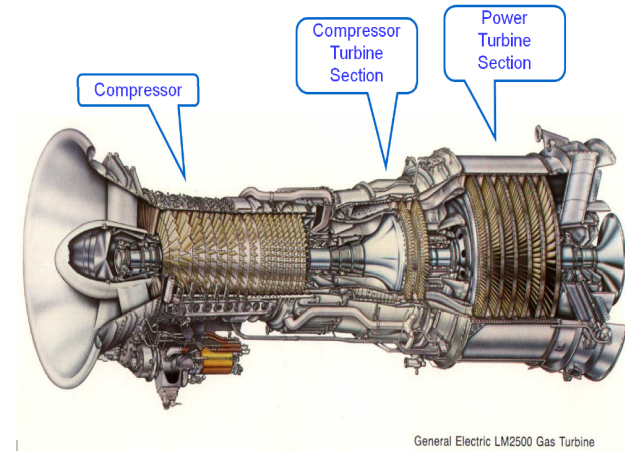
- 50% Petroleum Coke
- 30% Biomass
- 20% PRB Coal

Natural Gas Fired Combined Cycle



2x1 LM2500 - 78MW
2x1 LM6000 - 114MW

GE LM2500 Aero-derivative Gas Turbine



General Electric LM2500 Gas Turbine

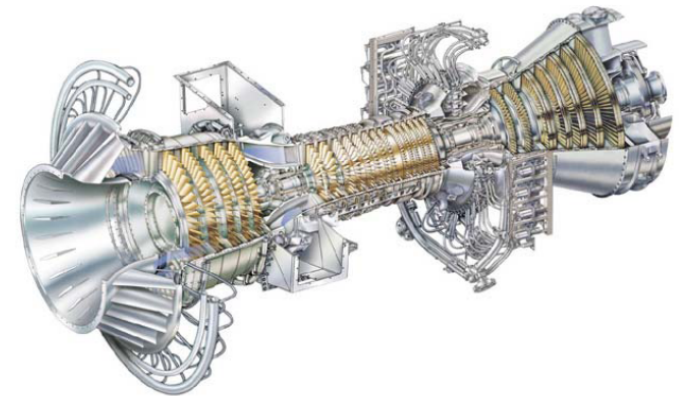
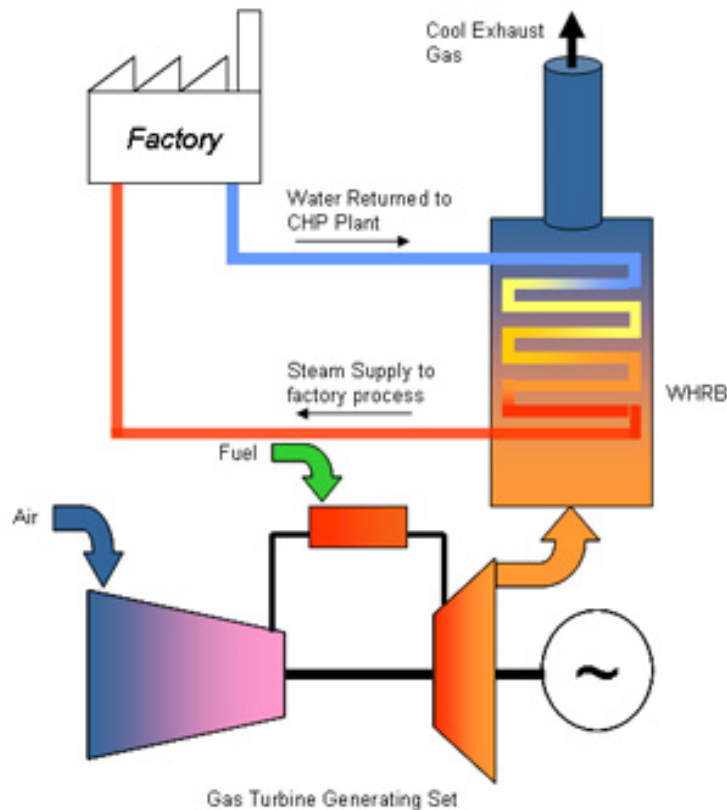


Fig. 13. The GE LM6000 (aero-derivative of the CF6-80C2). (Source: GE Power Systems)

Natural Gas Fired Combined Heat and Power (CHP)



The Gas Turbine based Combined Heat & Power Cycle

Combined Heat & Power is the simultaneous production of Power and Heat from a single fuel source.

The Gas Turbine generates electricity to power the plant.

The hot exhaust gases are passed through a Waste Heat Recovery Boiler*

The hot gases heat water which is supplied either as hot water or steam to the factory/facility processes.

* Waste Heat Recovery Boilers are also known as Heat Recovery Steam Generators (HRSG)

LM2500 CHP – 30.5MW

| Base Case Scenario | | | | |
|-------------------------------------|-------------------|----------------------------------|------------------------------|--|
| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | now | \$28,440 | Capital cost includes new bag house, DSI system, and SNCR system for both JDY Units 4 and 5. Assume maximum 65 year operating life for both units (Unit 4 will retire in 2027 and Unit 5 will retire in 2033). |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| JDY Unit 10 (CFB) | 70.1 | 2017 | \$329,080 | Fuel mixture of 50% PetCoke, 30% biomass, and 20% PRB coal. |

Scenario A

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|---|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. CEP states that all existing JDY units will be offline by 2016. |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| 2x1 LM2500 Combined Cycle Facility | 78.6 | 2015 | \$147,235 | Per CEP, facility will be located at the existing JDY site. |
| LM2500 CHP Plant | 30.5 | 2015 | \$60,986 | CHP facility will be located at/near the Industrial Park. |

Scenario B

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|--|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. CEP states that all existing JDY units will be offline by 2016. |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| 2x1 LM2500 Combined Cycle Facility | 78.6 | 2015 | \$147,235 | Per CEP, facility will be located at the existing JDY site. |
| LM2500 CHP Plant | 30.5 | 2015 | \$60,986 | CHP facility will be located at/near the Industrial Park. |
| Wind Generation (HBPW Asset) | 6.8 | 2014 | \$46,649 | HBPW developing wind farm based on 20 MW of installed capacity (2014 commercial operation). Net output based on an annual capacity factor of 34%. |
| Solar Pv | 1.3 | 2030 | \$59,056 | Capital cost based on 8 MW of installed capacity per CEP (net output based on 16.13% annual capacity factor). CEP calls for 24 MW of installed Pv capacity however Ventyx run ends at 2036 (6 years after initial installation phase). |
| JDY Biomass Generation | 21.8 | 2018 | \$66,004 | Capital cost based on converting JDY Unit 5 to burn woody biomass in 2018. Note that per CEP JDY Unit 5 will retire in 2016 (2018 operation date based on 26 month construction schedule). Assume maximum 65 year operating life for JDY Unit 5 (2033 retirement). |
| Digester Gas CHP | 4.0 | 2014 | \$35,212 | Capital cost includes power island (CTG, HRSG, etc.) and digester gas system (per Spart proposal). |

Scenario C

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|--|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. CEP states that all existing JDY units will be offline by 2016. |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| JDY Unit 10 (CFB) | 70.1 | 2017 | \$329,080 | Fuel mixture of 50% PetCoke, 30% biomass, and 20% PRB coal. |
| LM2500 CHP Plant | 30.5 | 2015 | \$60,986 | CHP facility will be located at/near the Industrial Park. |
| Wind Generation (HBPW Asset) | 6.8 | 2014 | \$46,649 | HBPW developing wind farm based on 20 MW of installed capacity (2014 commercial operation). Net output based on an annual capacity factor of 34%. |
| Solar Pv | 1.3 | 2030 | \$59,056 | Capital cost based on 8 MW of installed capacity per CEP (net output based on 16.13% annual capacity factor). CEP calls for 24 MW of installed Pv capacity however Ventyx run ends at 2036 (6 years after initial installation phase). |
| Digester Gas CHP | 4.0 | 2014 | \$35,212 | Capital cost includes power island (CTG, HRSG, etc.) and digester gas system (per Spart proposal). |

Scenario D

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|---|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. CEP states that all existing JDY units will be offline by 2016. |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| JDY Unit 10 (CFB) | 70.1 | 2017 | \$329,080 | Fuel mixture of 50% PetCoke, 30% biomass, and 20% PRB coal. |
| LM2500 CHP Plant | 30.5 | 2015 | \$60,986 | CHP facility will be located at/near the Industrial Park. |

Scenario E

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|--|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | now | \$28,440 | Capital cost includes new bag house, DSI system, and SNCR system for both JDY Units 4 and 5. Assume maximum 65 year operating life for both units (Unit 4 will retire in 2027 and Unit 5 will retire in 2033). |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| Market Purchase | - | - | - | Assume all new electric generation resources will be purchased from market. |

Scenario F

| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|---|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. Assume JDY Units 4 and 5 will be retired in 2016 (per CEP). |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
| Distillate Peaking CTG (Unit 6) | 18.0 | now | - | 18 MW output corresponds to summer operation (22 MW corresponds to ISO conditions). |
| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| Market Purchase | - | - | - | Assume all new electric generation resources will be purchased from market. |

Scenario G

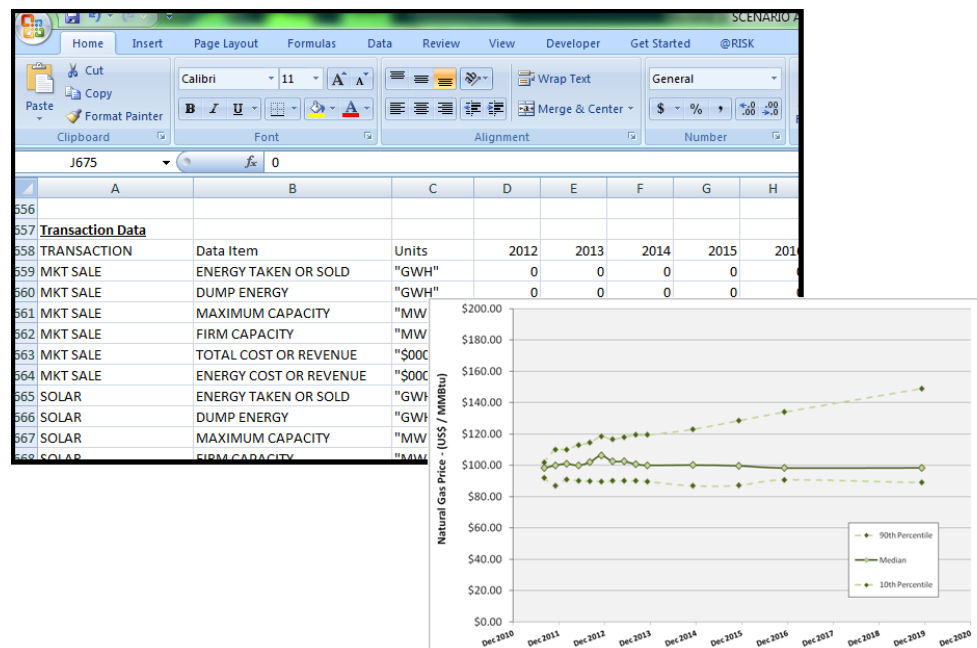
| | Net Output | Commercial Operation Date | Capital Cost (2012\$) | Comments |
|-------------------------------------|------------|---------------------------|-----------------------|---|
| | MW | yr. | \$1,000 | |
| Existing Electric Resources | | | | |
| JDY Units 4 & 5 | 46.0 | in operation until 2016 | - | No AQCS capital costs included. Assume JDY Units 4 and 5 will be retired in 2016 (per CEP). |
| NG Peaking CTGs (Units 7, 8, and 9) | 147.0 | now | - | |
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| Campbell / Belle River Generation | 46.0 | now | - | |
| Landfill Gas (PPA w/ Granger/NANR) | 10.0 | now | - | |
| Grayling Biomass (PPA) | 1.0 | now | - | |
| New Electric Resources | | | | |
| 2x1 LM6000 Combined Cycle Facility | 114.3 | 2015 | \$182,189 | Facility capital cost based on installation adjacent to existing JDY site. |



Ventyx

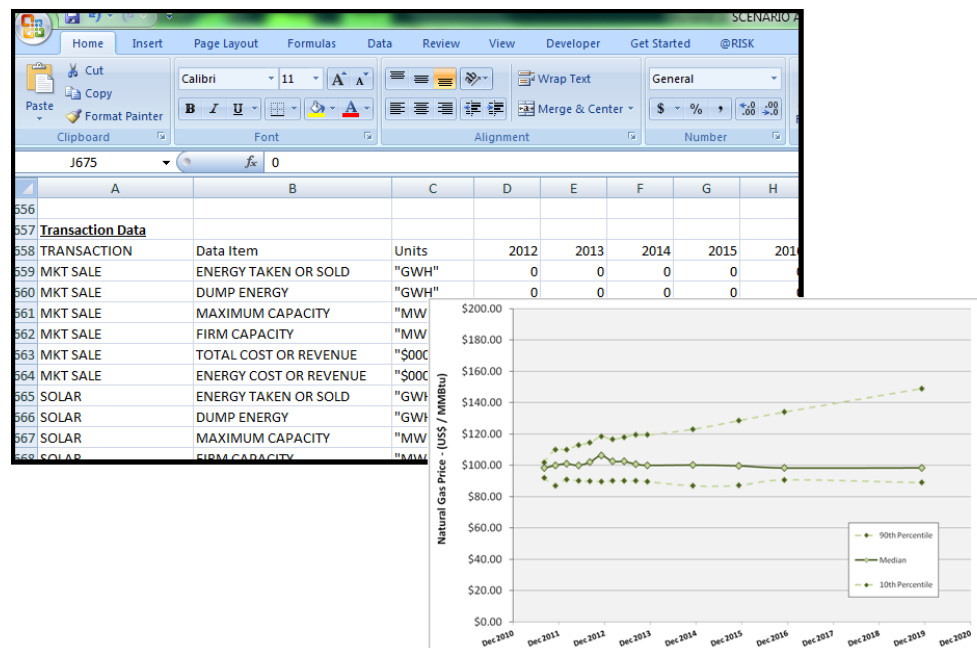
Ventyx Dispatch Model

- HBPW engaged Ventyx to conduct operational modeling
- Ventyx's model considers the available resources in each scenario and forecasts how the resources would be dispatched based on economic variables internal and external to HBPW
- The Ventyx forecasts feed directly into the SROI model



Ventyx Dispatch Model

- Ventyx also provides forecasts of external energy market conditions
- Some of these forecasts were also used directly in the SROI model





Questions?



SROI Overview

Dennis Bruce & Andrew Luison
HDR Engineering Inc.

Traditional Business Case Analysis

Life-Cycle Cost Analysis involves the analysis of the costs of a system or a component over its entire life span

Financial Analysis involves evaluation of cash flow impacts to determine investment suitability

Traditional models often fall short:

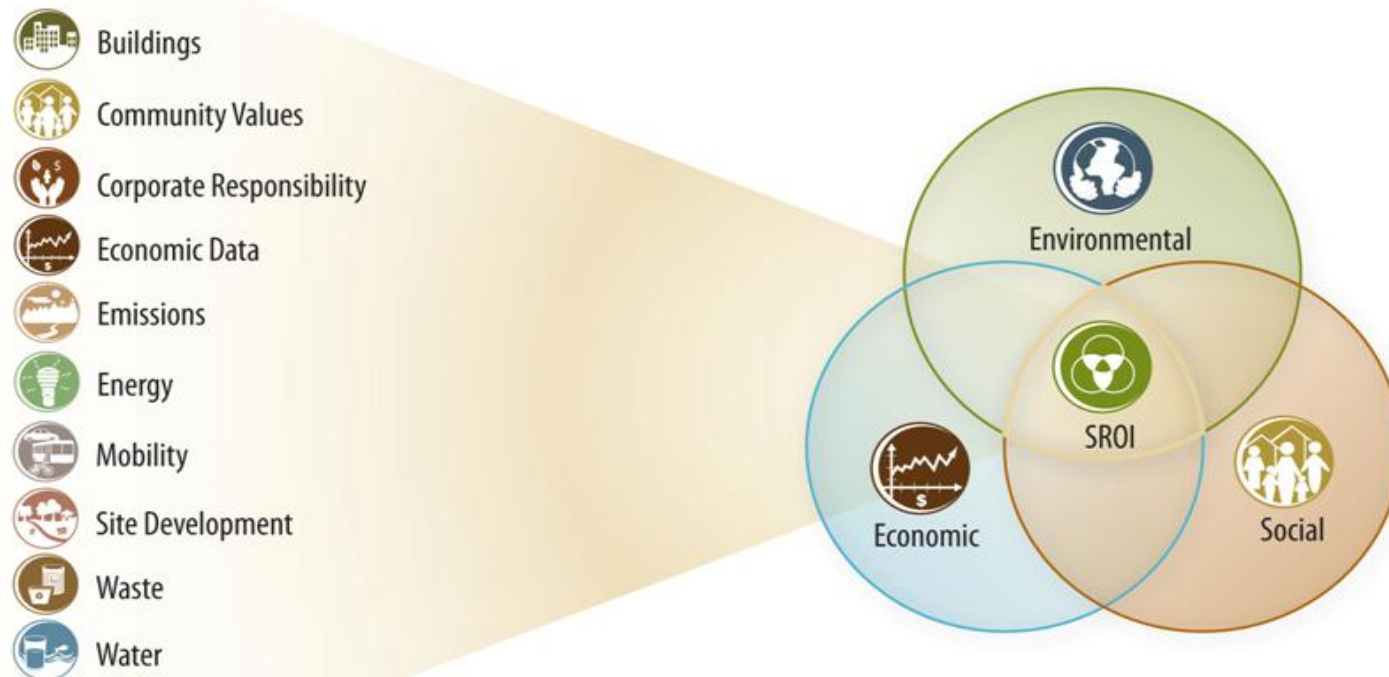
- Only consider cash impacts
- Do not account for uncertainty
- Lack transparency

What is SROI?

Triple Bottom Line Decision Making Framework

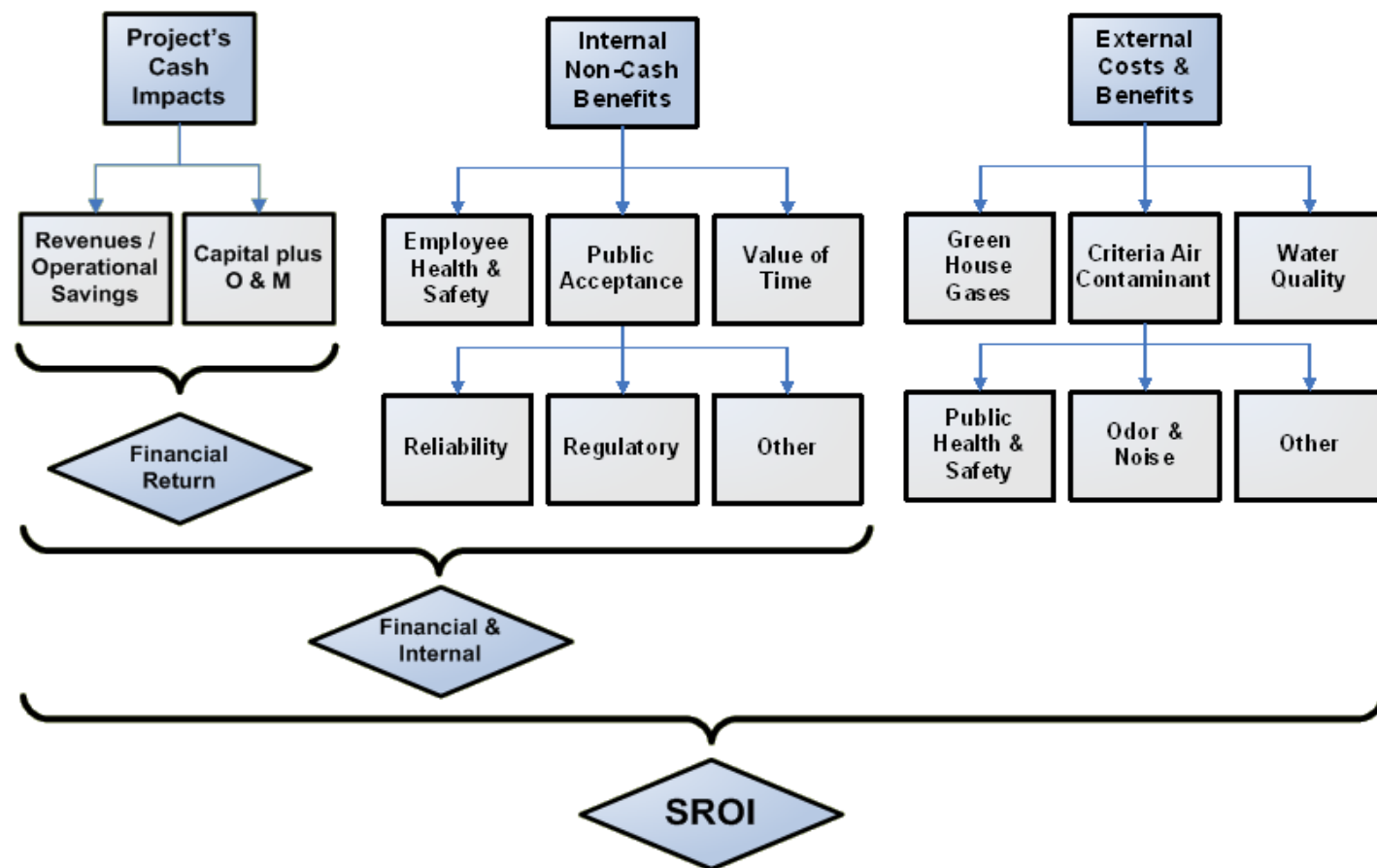
It's best practice in Cost-Benefit Analysis and Financial Analysis over a project's entire life-cycle, augmented by:

- Accounting for uncertainty using state-of-the-art risk analysis techniques
- Engaging stakeholders directly to generate consensus and transparency



The Triple-Bottom Line Framework

SROI adds to traditional financial analysis the monetized value of non-cash benefits and externalities



SROI Methodology

A Four-Step Process



“SROI reveals the hidden value in projects.”

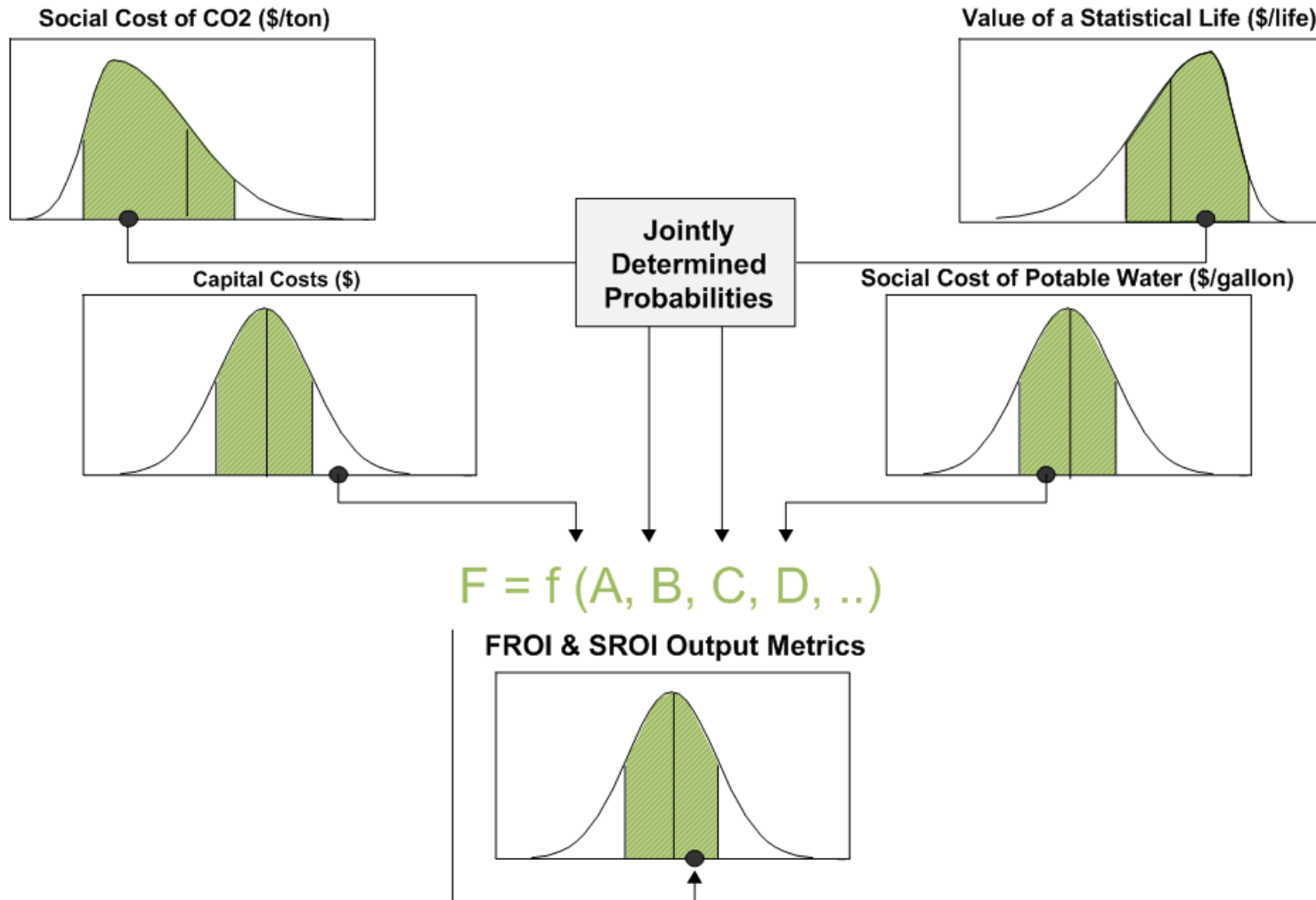
David Lewis, PhD

Former Principal Economist at the US Congressional Budget Office

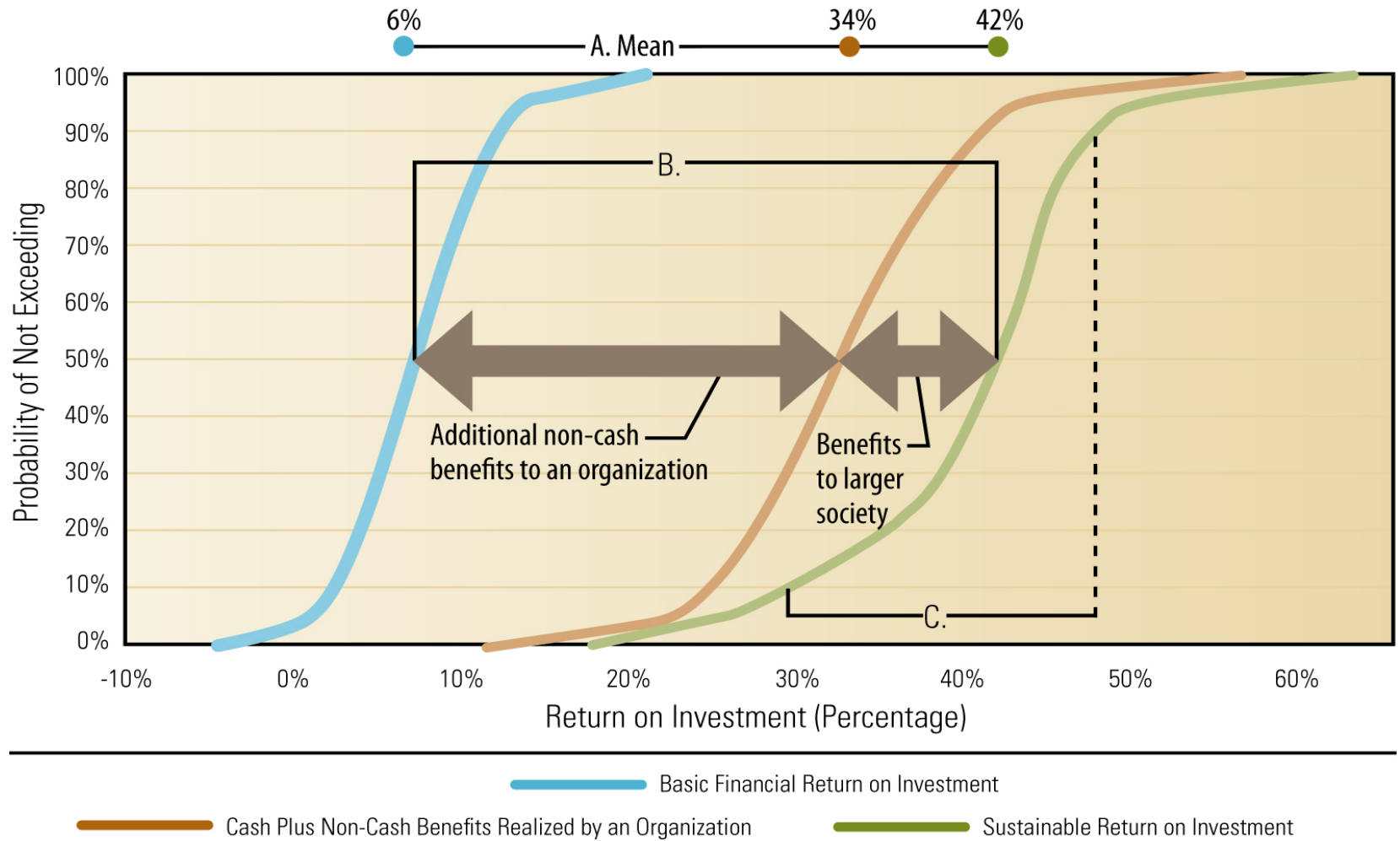
Author “*Policy and Planning as a Public Choice: Mass Transit in the United States*”

Today: End of Step 4

Run the Model and Produce Results



S-Curve Diagram



SROI Outcomes (\$NPV): Changing Decision Making Processes

| | Technology X | Technology Y (Tech X plus Renewable) |
|--|--------------|--|
| Traditional (FROI) | \$188 | \$126 |
| Environmental and Community Impacts | \$234 | \$337 |
| Total Impact (SROI) | \$422 | \$463 |

- “X” would be selected from a fiscal perspective
- “Y” is the best option on a balanced SROI basis
 - \$62M investment, yields >\$100 in environmental benefits



SROI Process for
P21 Decision

SROI Process for P21

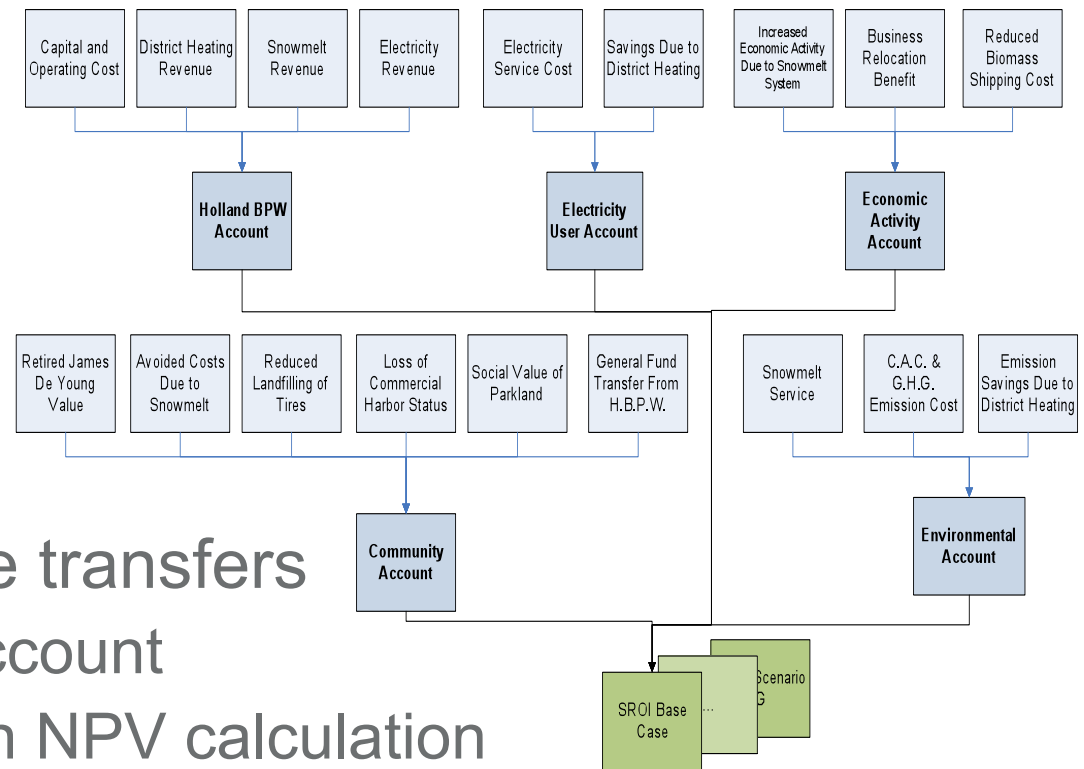
- 2 RAP sessions with stakeholders from HBPW, the Holland community, and HDR
 - Potential project costs and benefits identified
 - Preliminary and refined values discussed
- Additional research and interviews to refine assumptions and inputs
- Several refinements of technology options and costing inputs
- Development of SROI model
- Development of metrics and output reports
- Discussion of results (**today**)
- Impacts are incremental:
 - **relative to the “base case”**

The image features a complex abstract graphic design. It consists of several overlapping rectangular blocks. A large teal block on the left contains the text 'Benefit & Cost Categories'. To its right is a grey block, and further right is a taller teal block. A yellow-green block is positioned at the bottom right, partially overlapping the grey and teal blocks. A thin yellow-green horizontal line is at the top. A large grey block is at the bottom. The overall layout is clean and modern.

Benefit & Cost Categories

Benefit and Cost Impacts

- A range of impacts were identified by stakeholder group or “account”
- Key stakeholder accounts:
 - Holland BPW
 - Electricity User
 - Environmental
 - Economy
 - Community
- Some impacts are transfers
 - Quantified by account
 - But cancel out in NPV calculation



Holland BPW Account

- Capital, EPC, O&M, Fuel, and Fixed Costs
- Retail Electricity Sales
- Interchange Purchases & Sales
- District Heating Costs & Recovery
- Snowmelt Costs & Recovery
- Retired JDY Value
- Reduced Biosolids Treatment Cost
- Capacity Purchases & Sales
- Renewable Energy Credit Purchases & Sales
- Site Remediation Cost



Electricity User Account

- Savings Due to District Heating
- Electricity Service Cost



Environmental Account

- Criteria Air Contaminant Emissions
- Greenhouse Gas Emissions
- Additional Emission Savings Due to District Heating



Economic Activity Account

- Business Relocation Benefit
- Reduced Biomass Shipping Costs



Community Account

- General Fund Transfer from HBPW
- Loss of Commercial Harbor Status
- Social Value of Parkland
- Landfilling of Tires
- Retired James De Young Land Value
- Snowmelt Service Cost





Results &
Outcomes

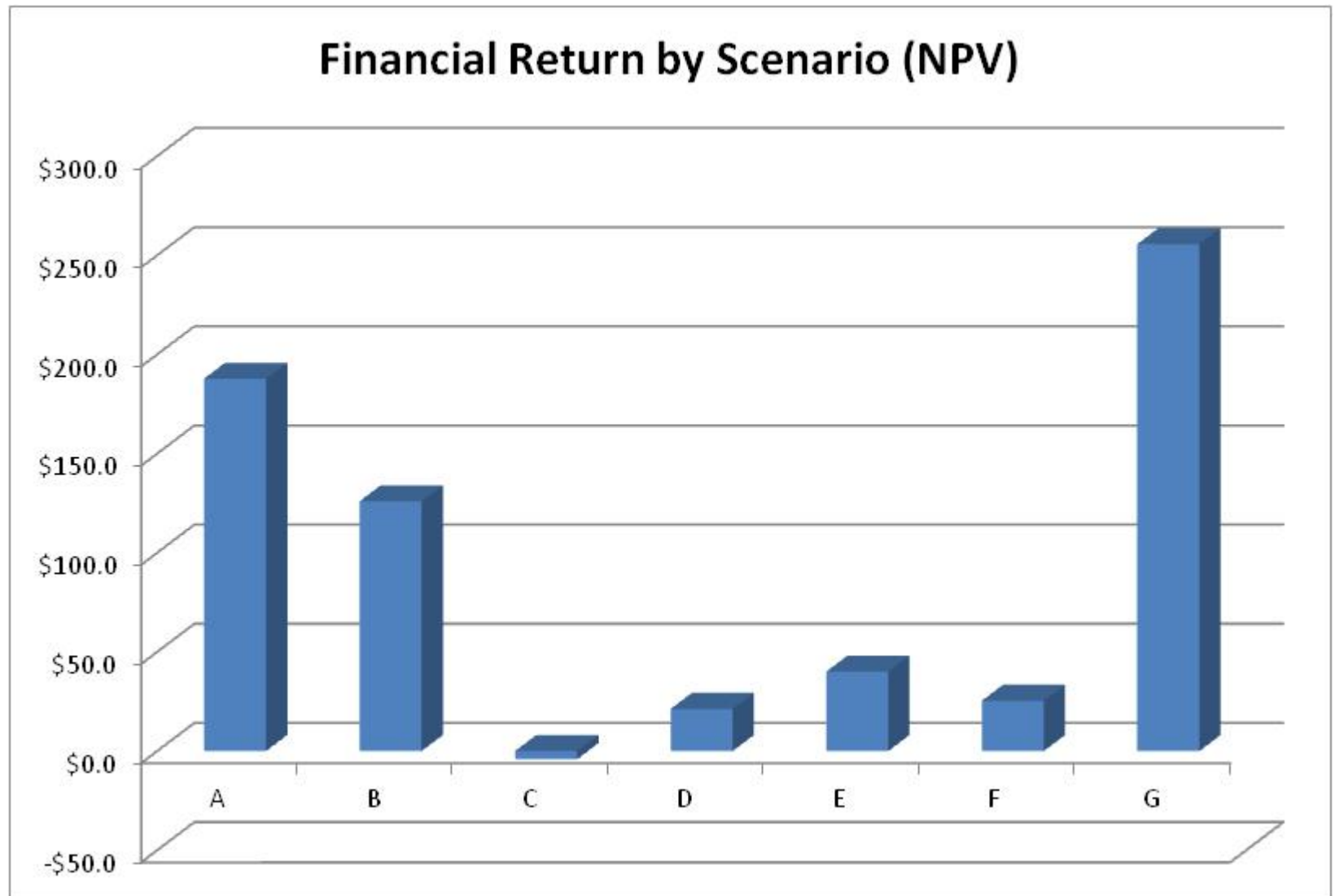
High-Level Outcomes:

- All but one scenario provides a positive SROI relative to the base case
- Impacts span all stakeholder accounts
- Two individual impacts dominate the overall results:
 - Value of electricity service cost reduction
 - Value of emissions reductions
- The 3 scenarios with natural gas (e.g., A, B, G) provide the highest SROI
 - The largest benefit is reduced emissions
 - Electricity cost reductions significant too (>\$100M)

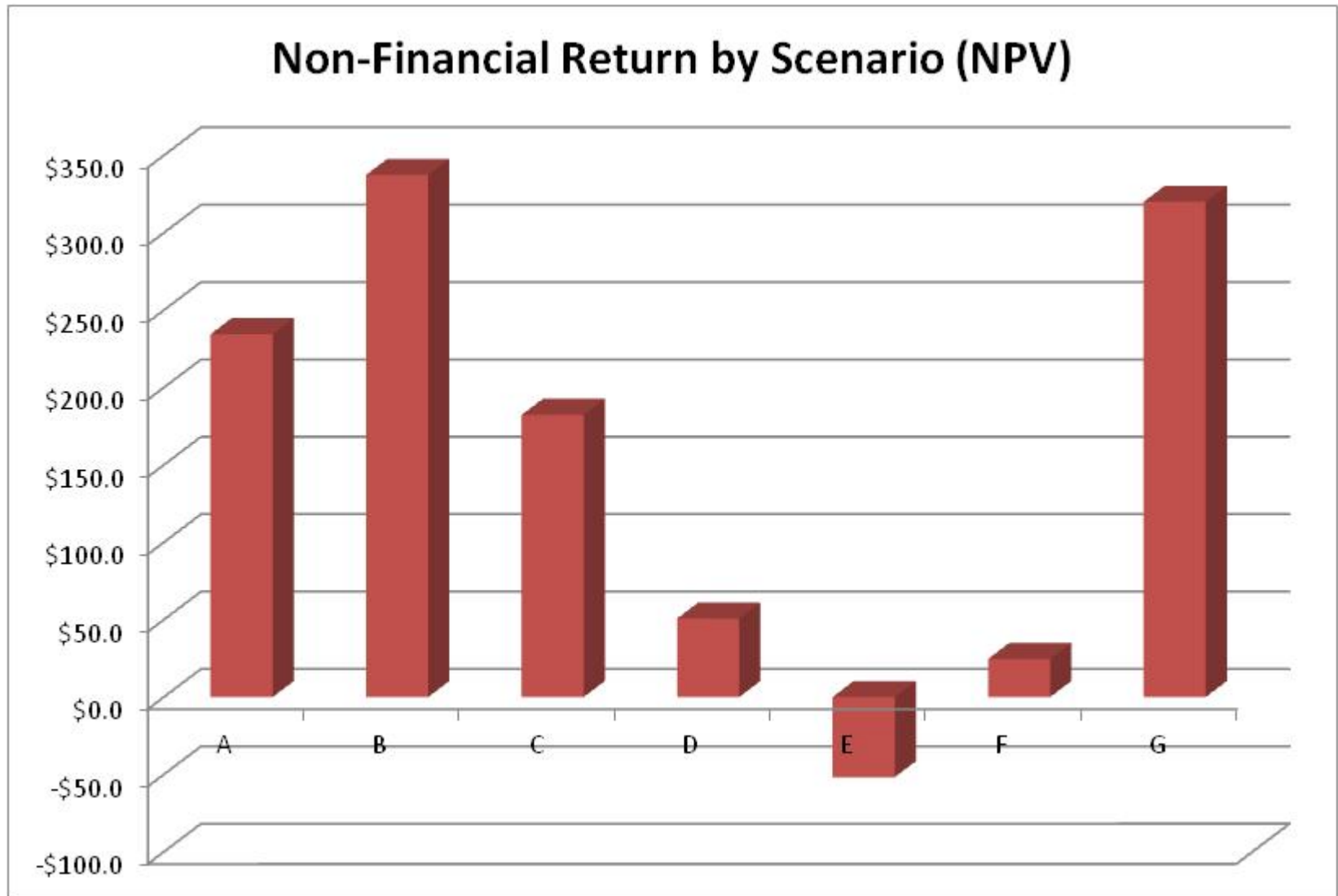
High-Level Outcomes (cont'd):

- The scenario providing the greatest incremental value (at the mean) from both an FROI and SROI perspective relative to the base case is Scenario G
 - FROI ~\$250M
 - SROI ~\$575M
 - Range from about \$300M to \$800M
 - Range includes low, medium and high gas price
- Scenario G:
 - reduces both electricity costs and emissions
 - Increases Holland's competitiveness
 - Provides district heating and snowmelt benefits

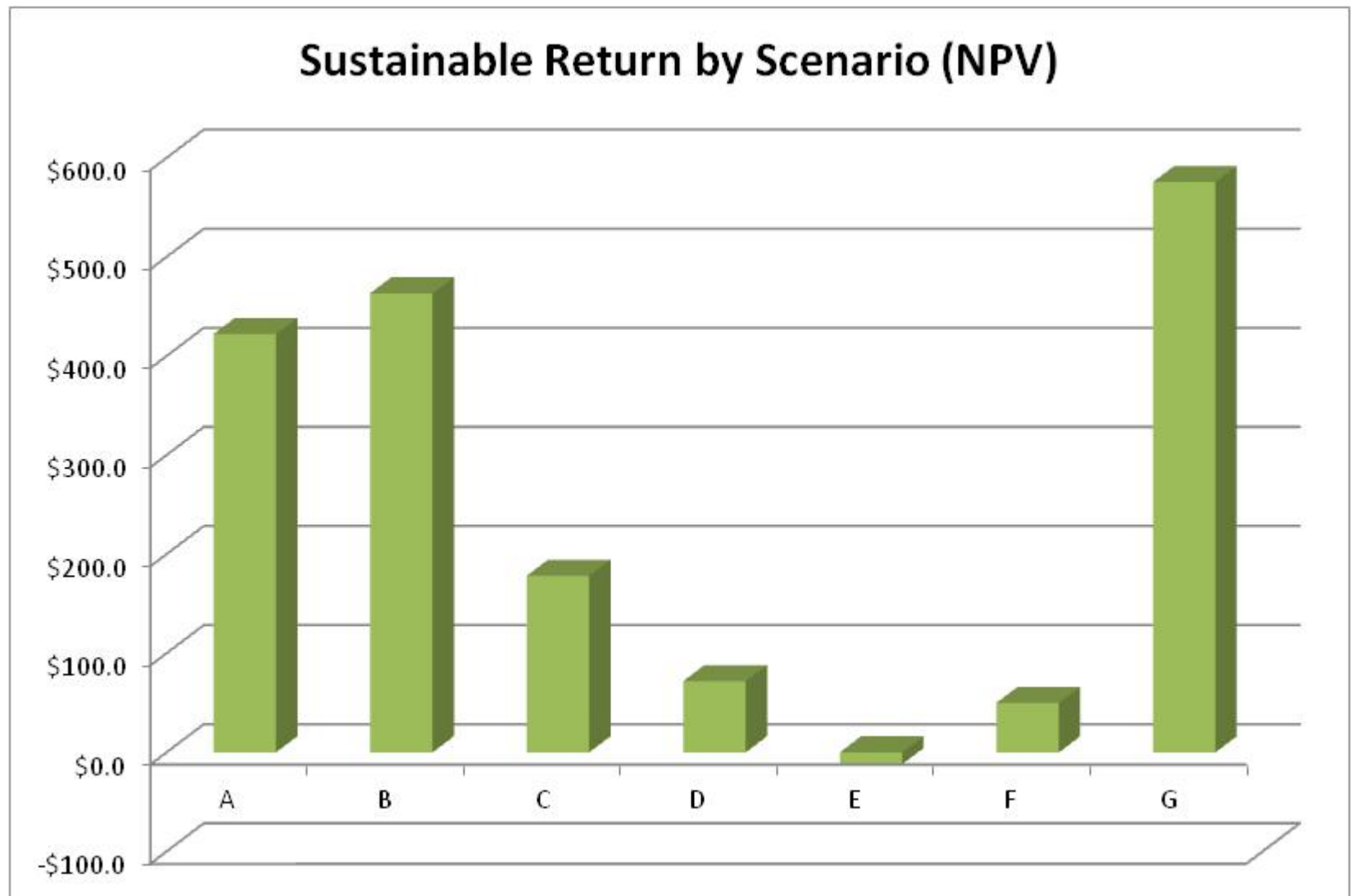
Financial Return on Investment (\$M)



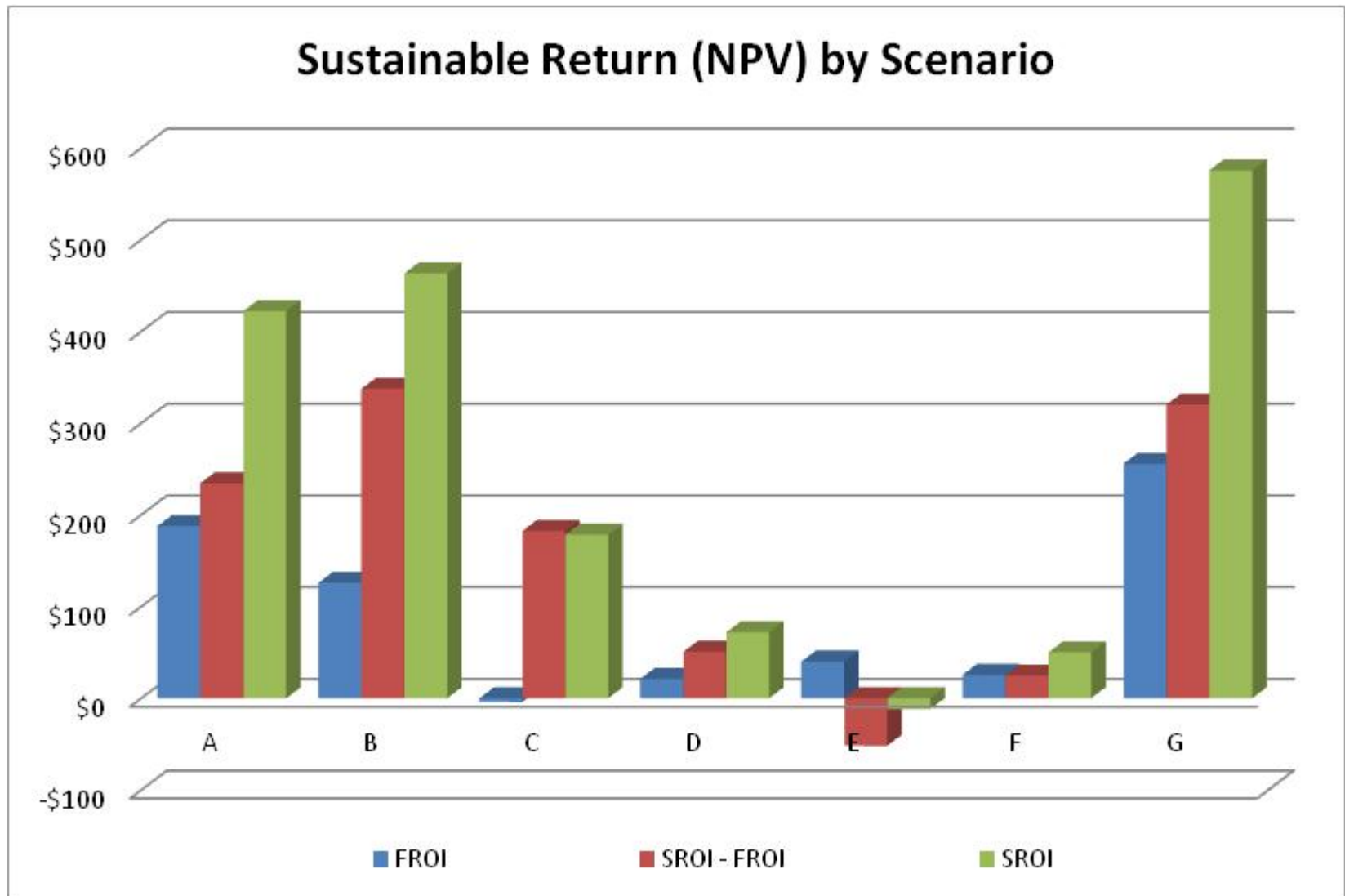
Non-Financial Return on Investment (\$M)



Sustainable Return on Investment (\$M)



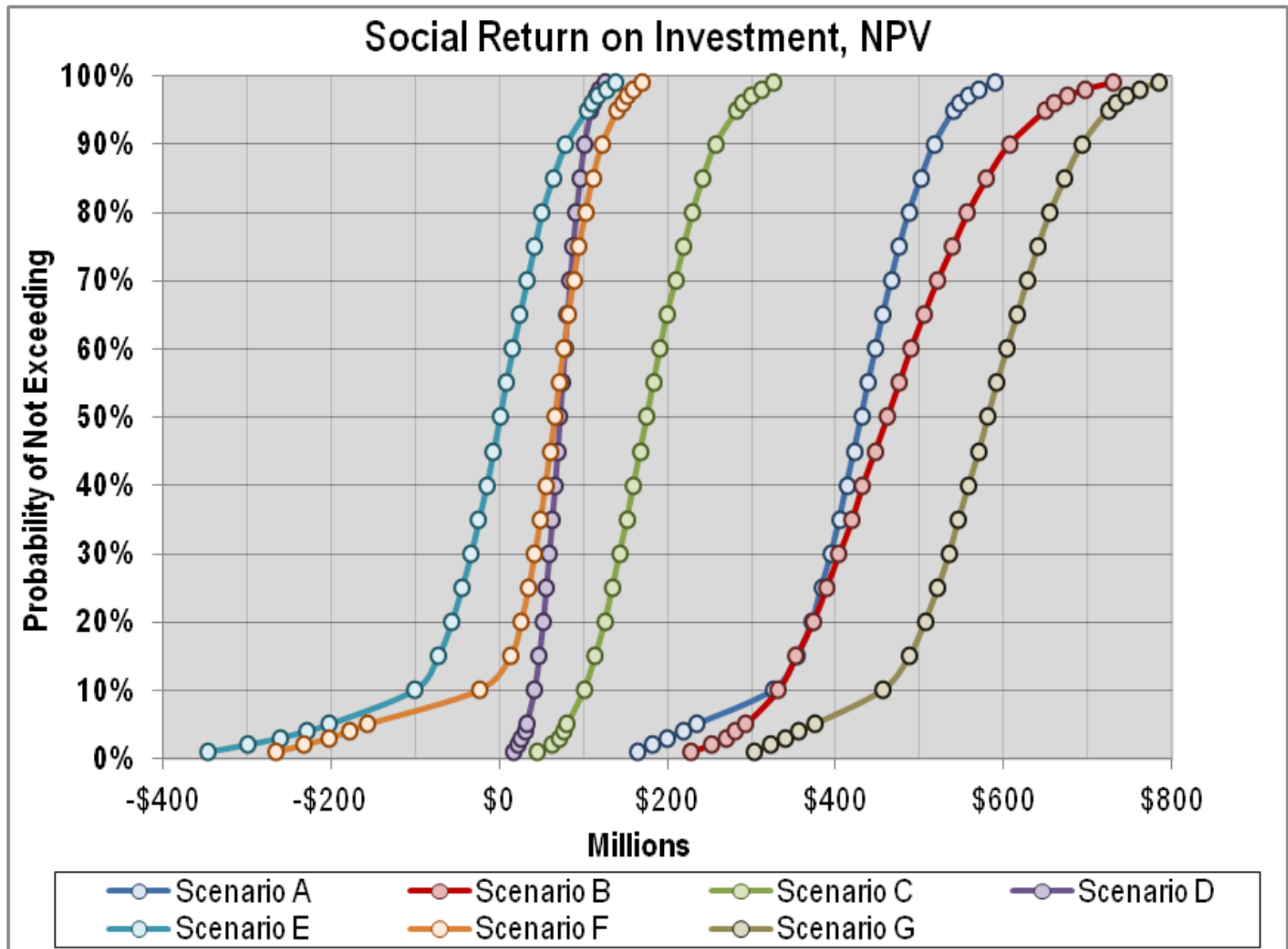
Sustainable Return on Investment (\$M)



Contributions to NPV by Scenario

| | A | B | C | D | E | F | G |
|------------------------------------|--------------|--------------|--------------|-------------|--------------|-------------|--------------|
| Net Present Value | \$422 | \$465 | \$178 | \$72 | -\$12 | \$50 | \$576 |
| Electricity Service Cost | \$185.0 | \$116.0 | -\$26.1 | \$2.0 | \$56.9 | \$67.0 | \$283.4 |
| Criteria Air Contaminant Emissions | \$118.8 | \$185.5 | \$107.9 | \$21.6 | -\$75.9 | -\$32.1 | \$176.1 |
| Greenhouse Gas Emissions | \$104.0 | \$164.3 | \$80.6 | \$25.0 | \$16.8 | \$33.7 | \$113.8 |
| Business Relocation | \$41.7 | \$19.6 | -\$5.8 | \$4.6 | \$36.2 | \$52.7 | \$60.0 |
| Savings due to District Heating | \$17.6 | \$20.8 | \$20.6 | \$17.5 | \$0.0 | \$0.0 | \$2.2 |
| Snow Melt Service | \$1.1 | \$1.1 | \$1.7 | \$1.7 | -\$7.7 | -\$25.8 | \$1.0 |
| Loss of Commercial Harbor Status | -\$4.4 | -\$4.4 | \$0.0 | \$0.0 | -\$0.5 | -\$4.4 | -\$4.4 |
| Reduced Landfilling of Tires | -\$28.6 | -\$28.6 | \$0.0 | \$0.0 | -\$28.6 | -\$28.6 | -\$28.6 |
| Other | -\$13.0 | -\$8.9 | -\$0.8 | -\$0.4 | -\$8.8 | -\$12.7 | -\$27.9 |

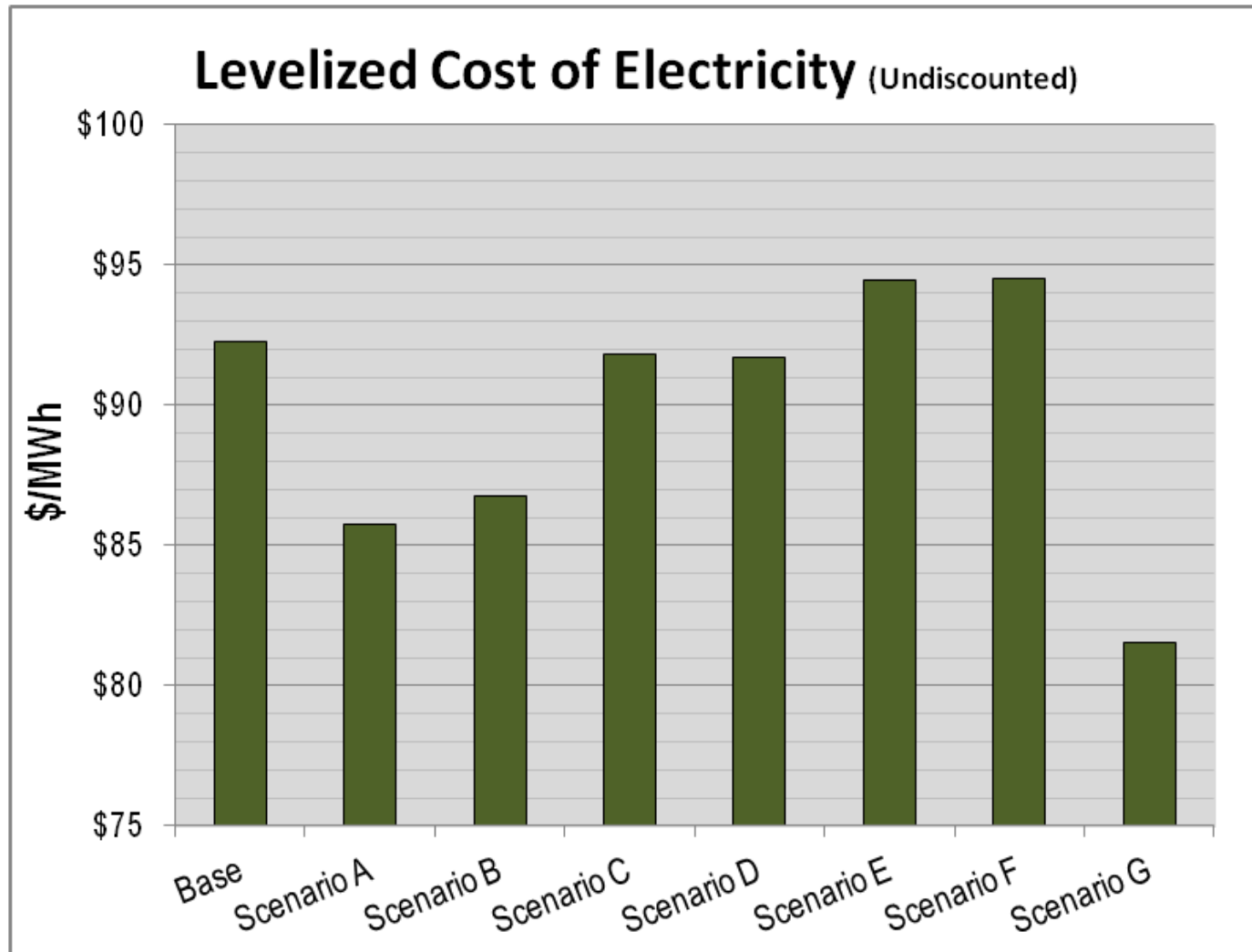
Sustainable Return on Investment (SROI)



Results & Conclusions



Levelized Cost of Electricity





Scenario
Summaries

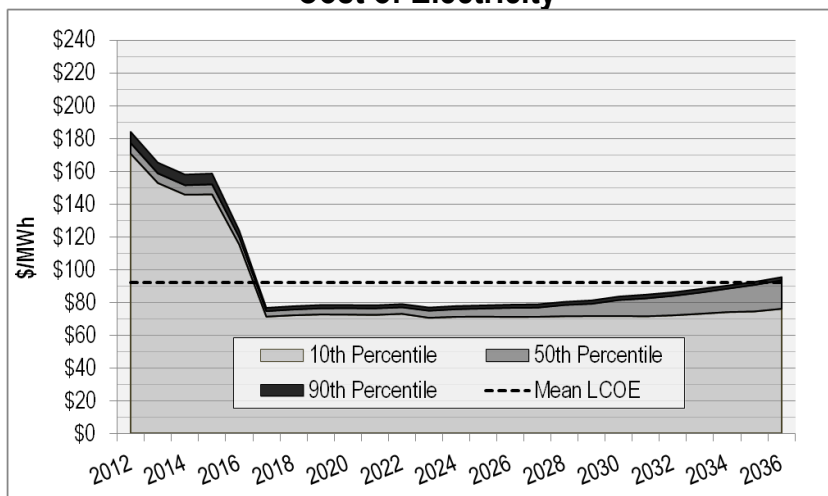
BASE CASE

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| ✓ | | | | | | | | ✓ |

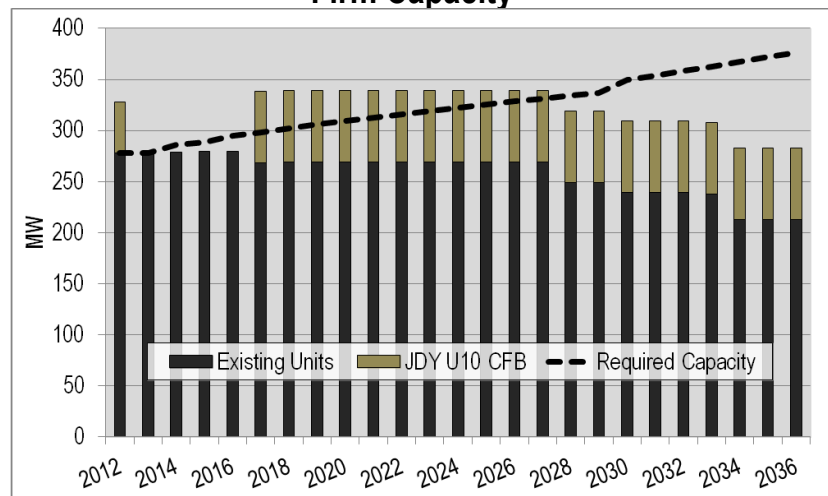
◆ JDY Units 4 and 5 continue to operate, each with a new bag house with DSI (for SO₂ mitigation) and an SNCR system (for NO_x mitigation)

◆ Circulating fluidized bed boiler and steam turbine facility beginning operation in 2017 and located at the existing JDY site

Cost of Electricity



Firm Capacity

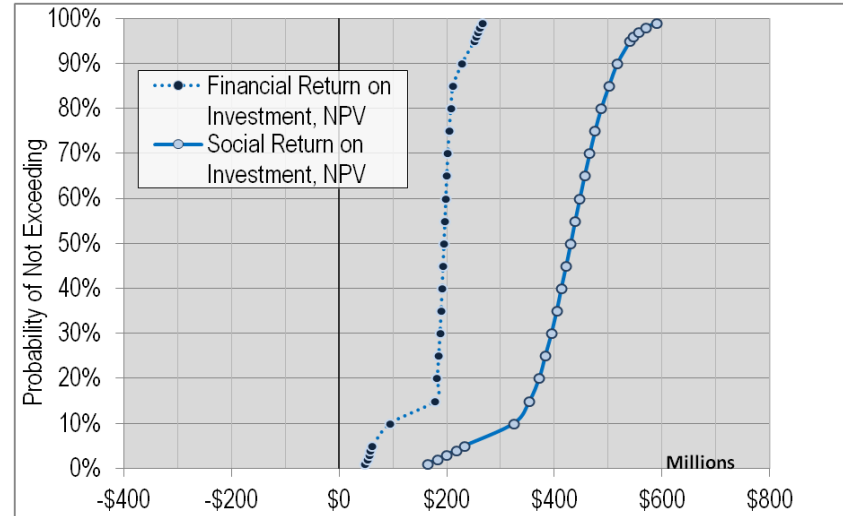


SCENARIO A

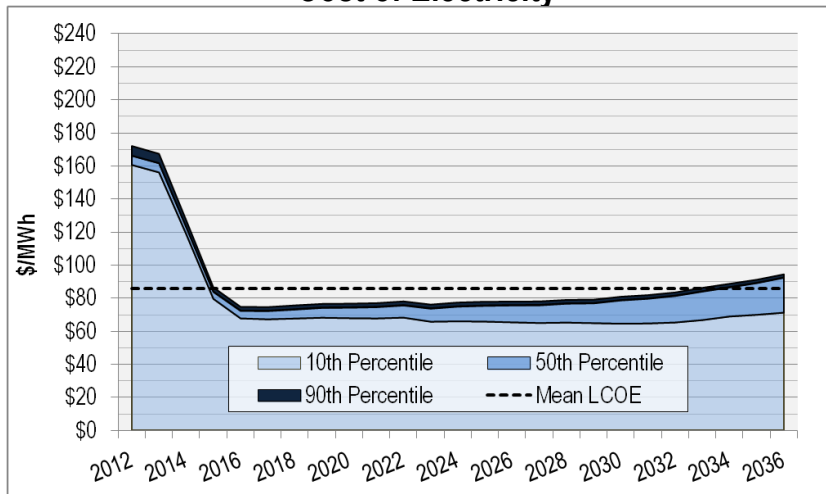
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | ✓ | ✓ | | | | | | |

- ◆ All existing JDY units offline by 2016
- ◆ Gas turbine (LM2500) combined heat and power plant beginning operation in 2015 and located at or near the Industrial Park
- ◆ Gas turbine (LM2500) combined cycle facility beginning operation in 2015 and located at the existing JDY site

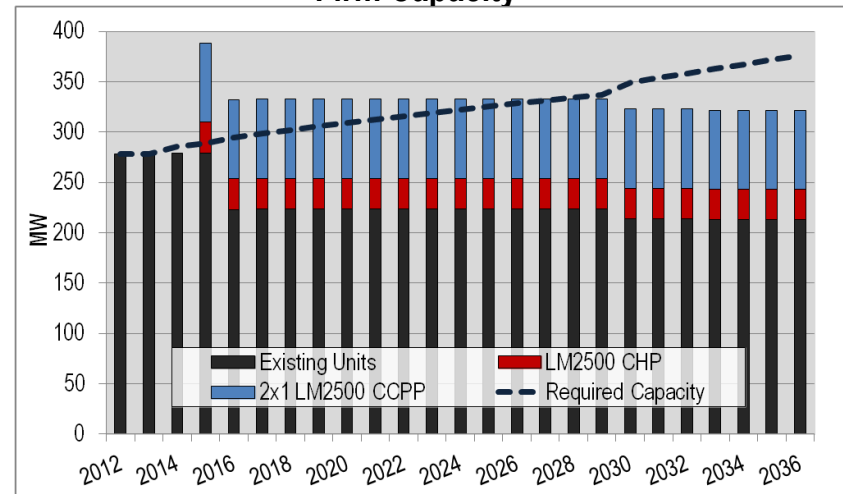
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO A

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCBP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | ✓ | ✓ | | | | | | |

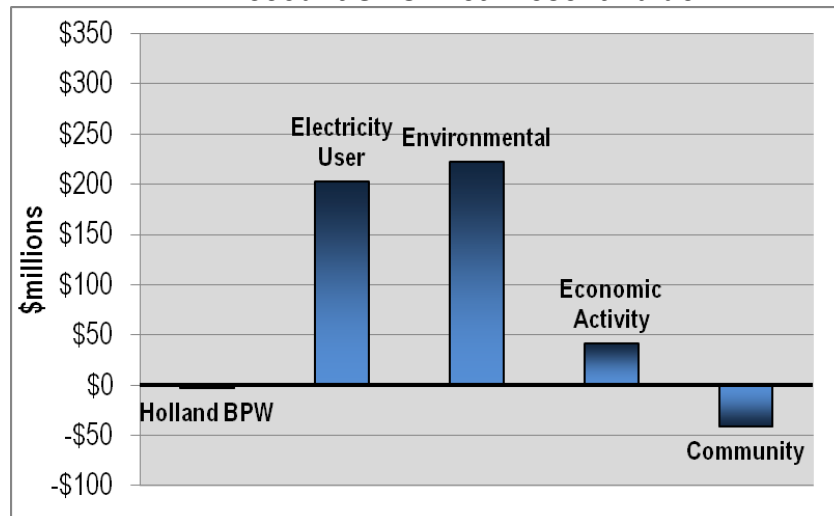
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|--|------------------------------|----------|----------|----------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (3) | \$17.63 | \$13.18 | \$17.94 | \$21.13 |
| % savings (4) | 58.2% | 48.3% | 59.3% | 66.6% |
| Electricity Service Cost Savings (2) | \$184.97 | \$150.55 | \$192.52 | \$232.73 |
| Emission Savings (3) | \$222.81 | \$147.60 | \$218.26 | \$304.13 |
| Business Relocation Benefit (3) | \$41.72 | \$31.20 | \$42.09 | \$50.52 |
| Reduced Biomass Shipping Costs (5) | -\$0.01 | -\$0.01 | -\$0.01 | -\$0.01 |
| Reduced Landfilling of Tires (4) | -\$28.64 | -\$30.67 | -\$28.68 | -\$26.60 |
| Avoided Loss of Commercial Harbor (8) | -\$4.41 | -\$4.77 | -\$4.40 | -\$4.06 |
| Reduced Snow Melt Service Cost (4) | \$1.08 | \$0.57 | \$0.68 | \$3.05 |

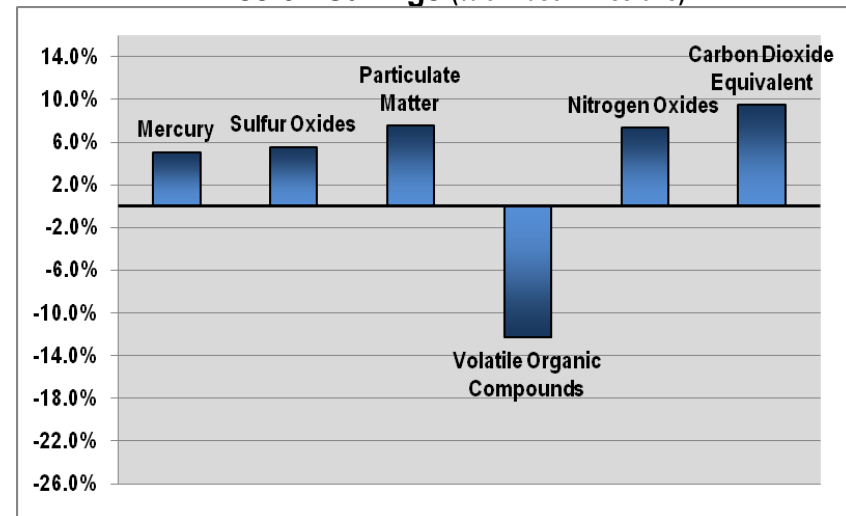
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (4) | lbs | 31 |
| Sulfur Oxides (4) | tons | 4,867 |
| Particulate Matter (4) | tons | 258 |
| Volatile Organic Compounds (6) | tons | -79 |
| Mono-Nitrogen Oxides (3) | tons | 3,841 |
| Carbon Dioxide Equivalent (3) | tons | 3,214,147 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

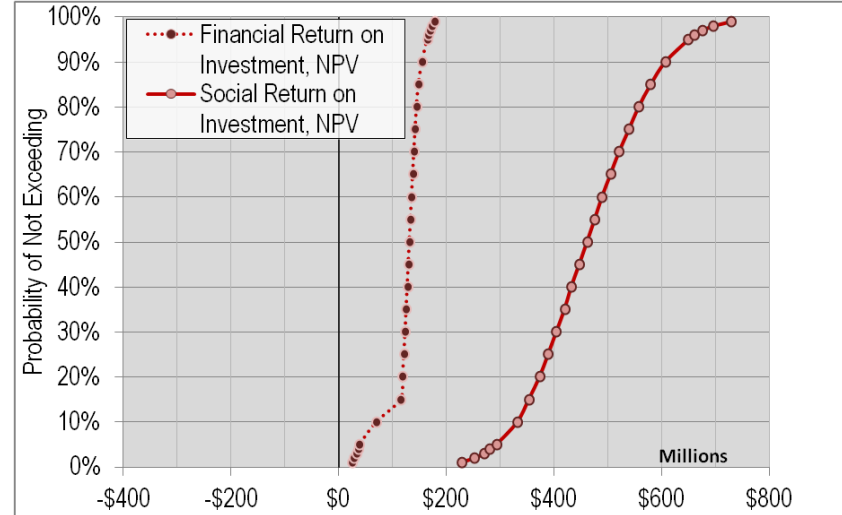


SCENARIO B

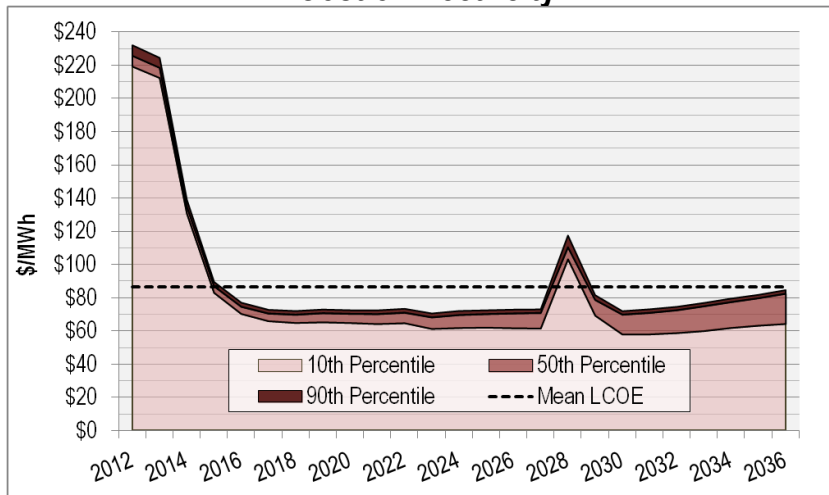
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |

- ◆ All existing JDY units offline by 2016
- ◆ Gas turbine (LM2500) combined heat and power plant beginning operation in 2015 and located at or near the Industrial Park
- ◆ Gas turbine (LM2500) combined cycle facility beginning operation in 2015 and located at the existing JDY site
- ◆ JDY Unit 5 retrofitted to burn woody biomass in 2018
- ◆ 8 MW of solar capacity beginning operation in 2030
- ◆ 20 MW of wind capacity beginning operation in 2016
- ◆ Digester gas combined heat and power plant beginning operation in 2014, and located at the existing JDY site or the wastewater treatment facility

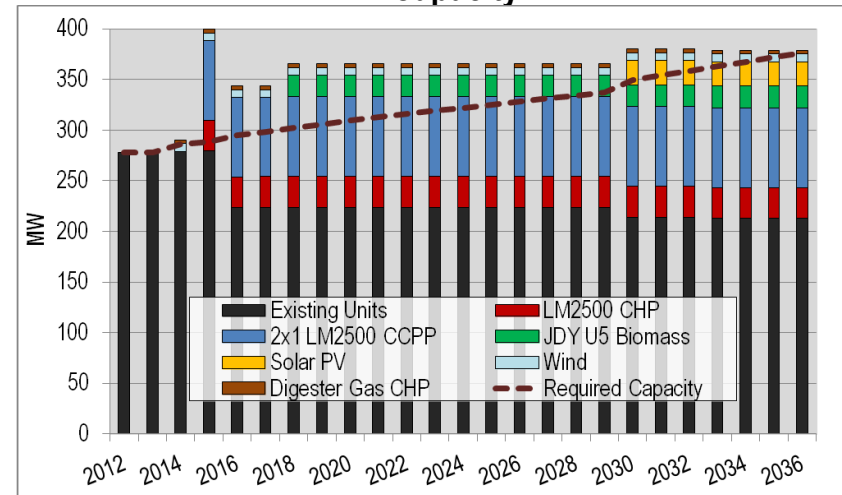
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO B

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|----------------|---------------|--------------------|-------------------|----------|------|---------------------|------------|------------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |

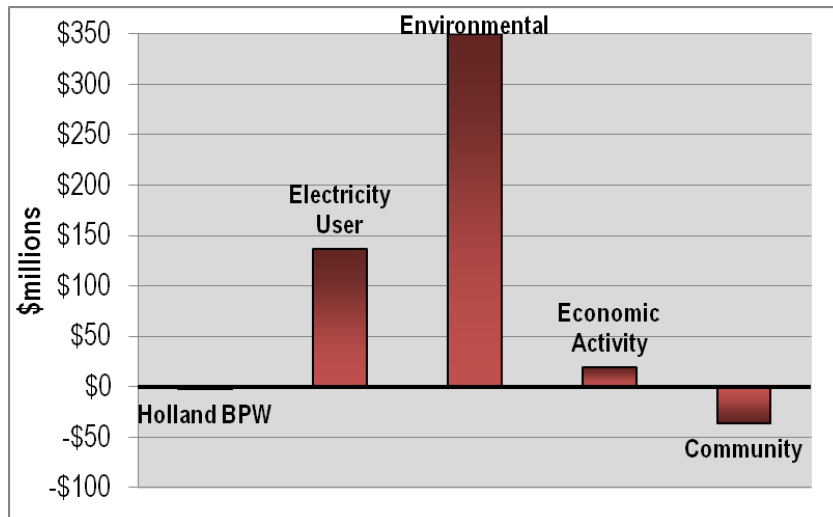
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|---------------------------------------|------------------------------|----------|----------|----------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (1) | \$20.75 | \$15.62 | \$21.17 | \$24.89 |
| % savings (3) | 59.2% | 49.6% | 60.2% | 67.3% |
| Electricity Service Cost Savings (3) | \$116.01 | \$83.63 | \$121.88 | \$148.86 |
| Emission Savings (1) | \$349.81 | \$227.46 | \$340.03 | \$484.30 |
| Business Relocation Benefit (5) | \$19.56 | \$13.72 | \$19.95 | \$24.63 |
| Reduced Biomass Shipping Costs (4) | -\$0.00 | -\$0.00 | -\$0.00 | -\$0.00 |
| Reduced Landfilling of Tires (4) | -\$28.64 | -\$30.68 | -\$28.65 | -\$26.55 |
| Avoided Loss of Commercial Harbor (7) | -\$4.41 | -\$4.77 | -\$4.40 | -\$4.07 |
| Reduced Snow Melt Service Cost (3) | \$1.14 | \$0.62 | \$0.74 | \$3.17 |

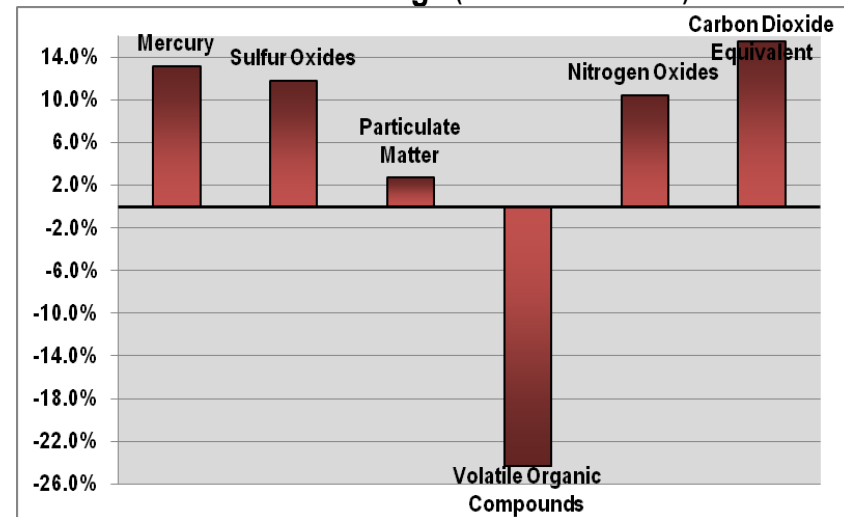
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (1) | lbs | 81 |
| Sulfur Oxides (1) | tons | 10,392 |
| Particulate Matter (5) | tons | 92 |
| Volatile Organic Compounds (8) | tons | -156 |
| Mono-Nitrogen Oxides (1) | tons | 5,464 |
| Carbon Dioxide Equivalent (1) | tons | 5,229,384 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

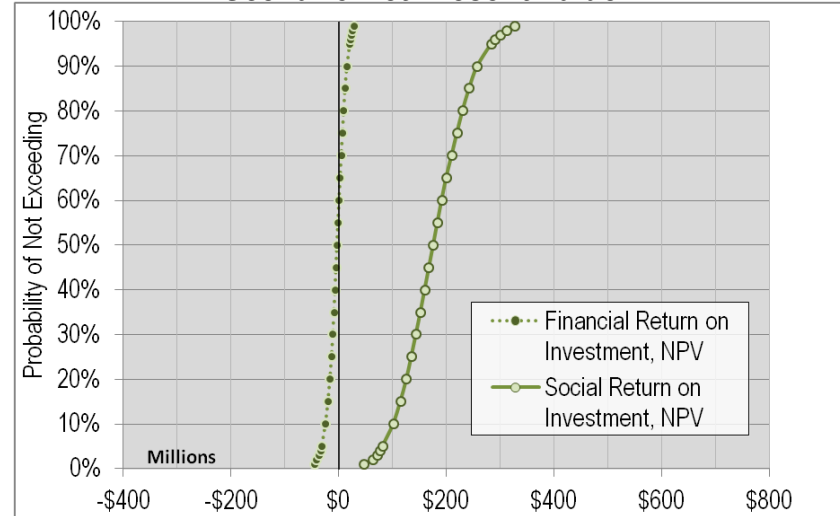


SCENARIO C

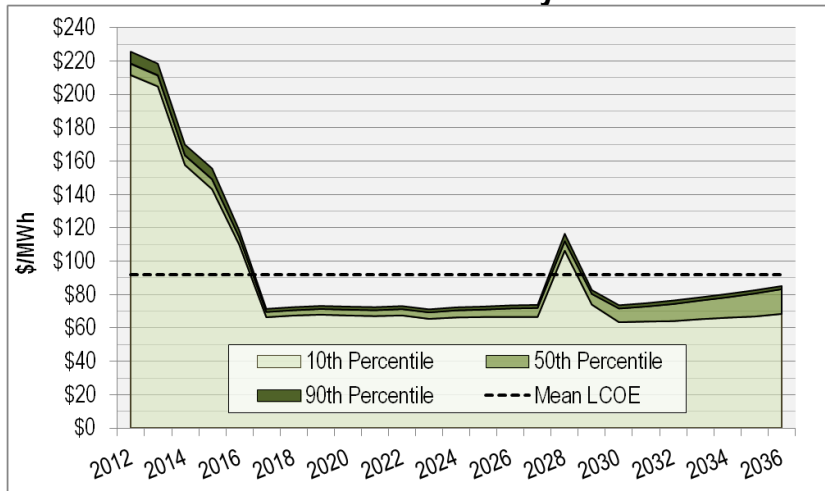
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCBP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| ✓ | ✓ | | | ✓ | ✓ | ✓ | | |

- ◆ All existing JDY units offline by 2016
- ◆ Circulating fluidized bed boiler and steam turbine facility beginning operation in 2017 and located at the existing JDY site
- ◆ Gas turbine (LM2500) combined heat and power plant beginning operation in 2015 and located at or near the Industrial Park
- ◆ 8 MW of solar capacity beginning operation in 2030
- ◆ 20 MW of wind capacity beginning operation in 2016
- ◆ Digester gas combined heat and power plant beginning operation in 2014, and located at the existing JDY site or the wastewater treatment facility in 2014

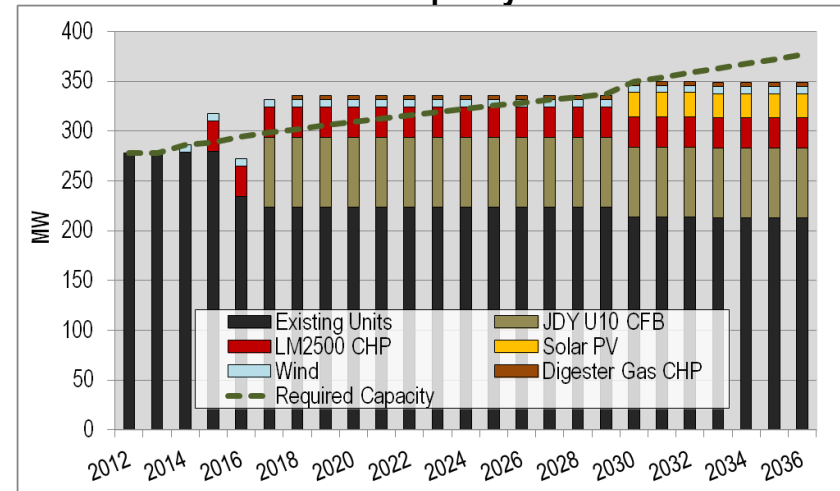
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO C

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| ✓ | ✓ | | | ✓ | ✓ | ✓ | | |

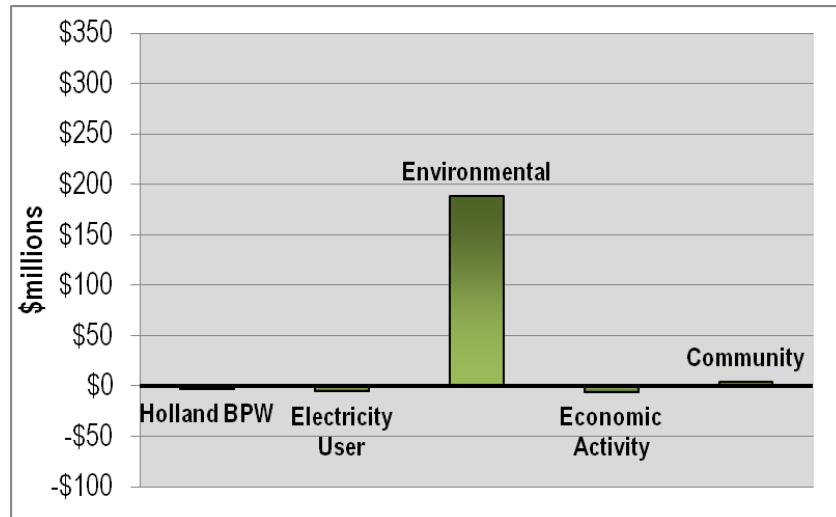
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|--|------------------------------|-----------------|-----------------|----------------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (2) | \$20.61 | \$15.69 | \$20.97 | \$24.56 |
| % savings (1) | 61.4% | 52.1% | 62.3% | 69.2% |
| Electricity Service Cost Savings (8) | -\$26.15 | -\$45.83 | -\$25.81 | -\$7.55 |
| Emission Savings (4) | \$188.51 | \$119.40 | \$184.62 | \$262.38 |
| Business Relocation Benefit (8) | -\$5.77 | -\$13.05 | -\$5.42 | \$1.21 |
| Reduced Biomass Shipping Costs (3) | -\$0.00 | -\$0.00 | -\$0.00 | -\$0.00 |
| Reduced Landfilling of Tires (3) | \$0.00 | -\$0.91 | -\$0.01 | \$0.92 |
| Avoided Loss of Commercial Harbor (1) | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| Reduced Snow Melt Service Cost (1) | \$1.71 | \$1.13 | \$1.28 | \$3.92 |

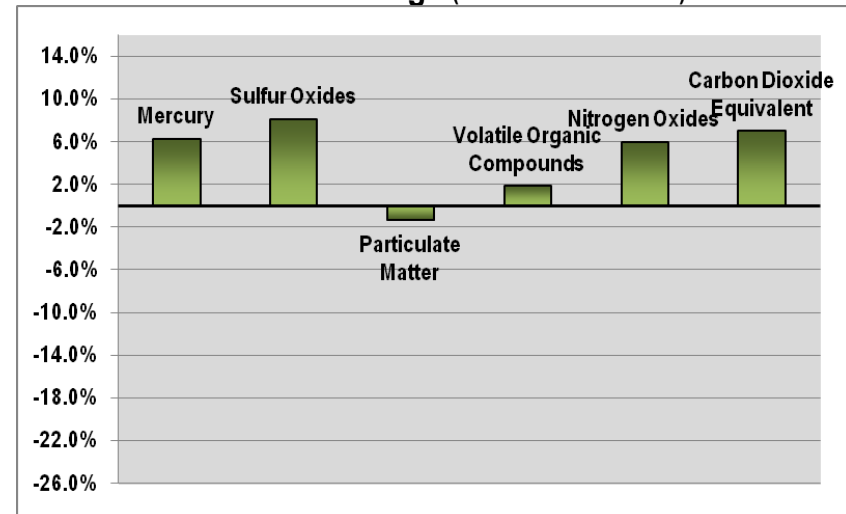
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (3) | lbs | 39 |
| Sulfur Oxides (3) | tons | 7,142 |
| Particulate Matter (8) | tons | -47 |
| Volatile Organic Compounds (3) | tons | 12 |
| Mono-Nitrogen Oxides (4) | tons | 3,109 |
| Carbon Dioxide Equivalent (4) | tons | 2,387,894 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

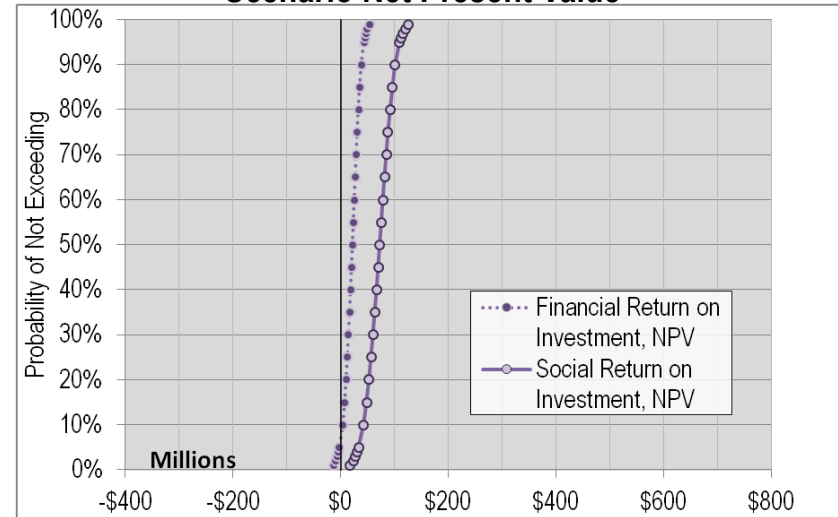


SCENARIO D

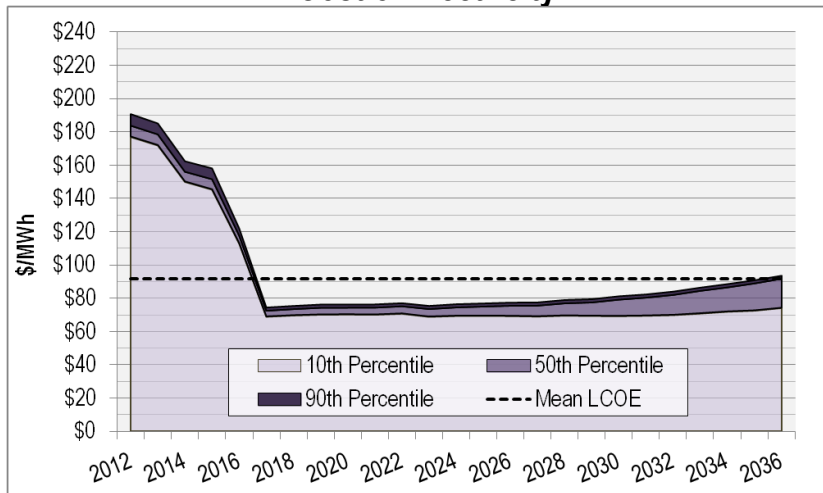
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| ✓ | ✓ | | | | | | | |

- ◆ All existing JDY units offline by 2016
- ◆ Circulating fluidized bed boiler and steam turbine facility beginning operation in 2017 and located at the existing JDY site
- ◆ Gas turbine (LM2500) combined heat and power plant beginning operation in 2015 and located at or near the Industrial Park

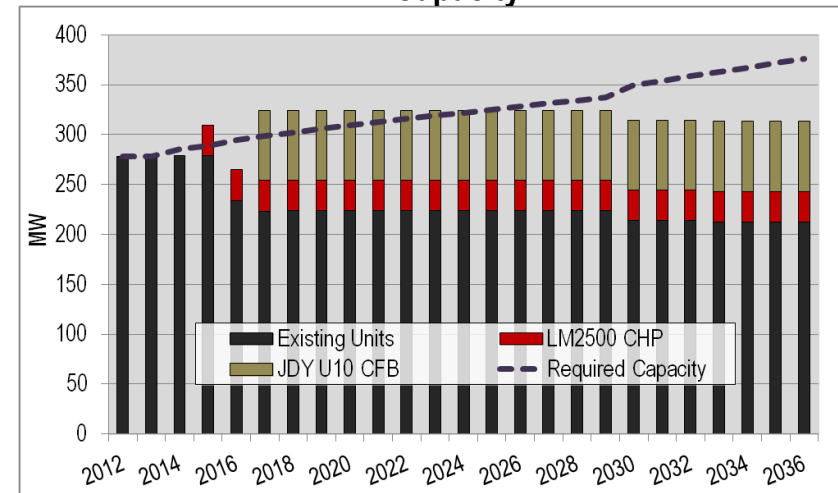
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO D

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCBP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| ✓ | ✓ | | | | | | | |

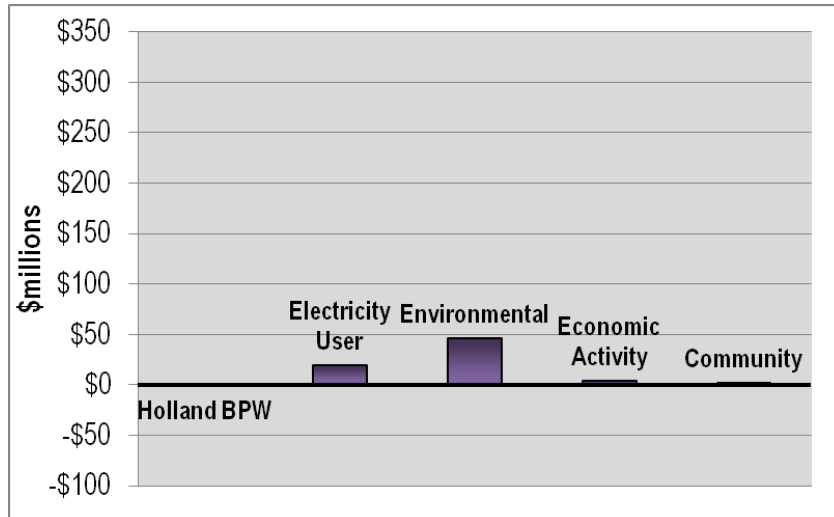
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|--|------------------------------|-----------------|---------|---------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (4) | \$17.48 | \$13.35 | \$17.81 | \$20.89 |
| % savings (2) | 60.6% | 51.4% | 61.7% | 68.6% |
| Electricity Service Cost Savings (6) | \$1.96 | -\$16.92 | \$2.81 | \$20.07 |
| Emission Savings (5) | \$46.66 | \$26.90 | \$45.38 | \$67.35 |
| Business Relocation Benefit (6) | \$4.56 | \$0.08 | \$4.63 | \$8.98 |
| Reduced Biomass Shipping Costs (1) | \$0.00 | -\$0.00 | \$0.00 | \$0.00 |
| Reduced Landfilling of Tires (2) | \$0.00 | -\$0.92 | \$0.00 | \$0.90 |
| Avoided Loss of Commercial Harbor (1) | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| Reduced Snow Melt Service Cost (2) | \$1.70 | \$1.12 | \$1.27 | \$3.85 |

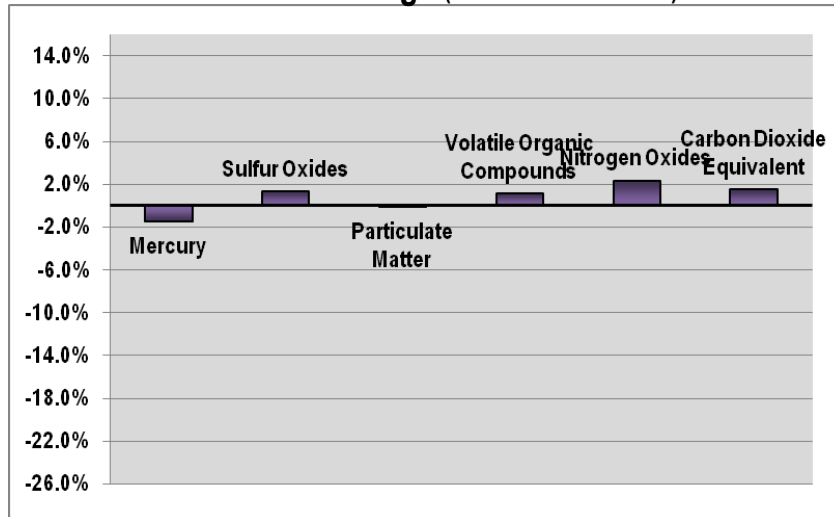
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (6) | lbs | -9 |
| Sulfur Oxides (5) | tons | 1,145 |
| Particulate Matter (7) | tons | -5 |
| Volatile Organic Compounds (4) | tons | 7 |
| Mono-Nitrogen Oxides (5) | tons | 1,229 |
| Carbon Dioxide Equivalent (7) | tons | 531,303 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)



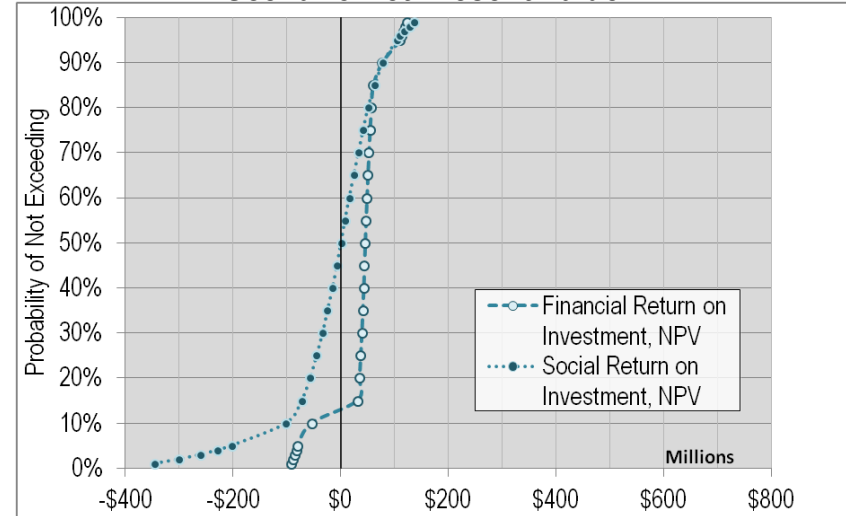
SCENARIO E

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCBP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | | ✓ |

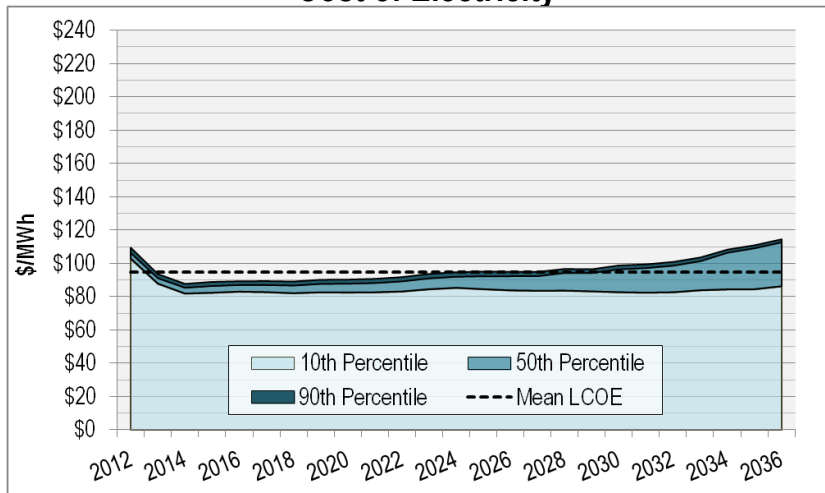
◆ JDY Units 4 and 5 continue to operate, each with a new bag house with DSI (for SO₂ mitigation) and an SNCR system (for NO_x mitigation) Y Units 4 and 5 continue to operate with new bag house, DSI system, and SNCR system

◆ Increased electricity demand satisfied by market purchases

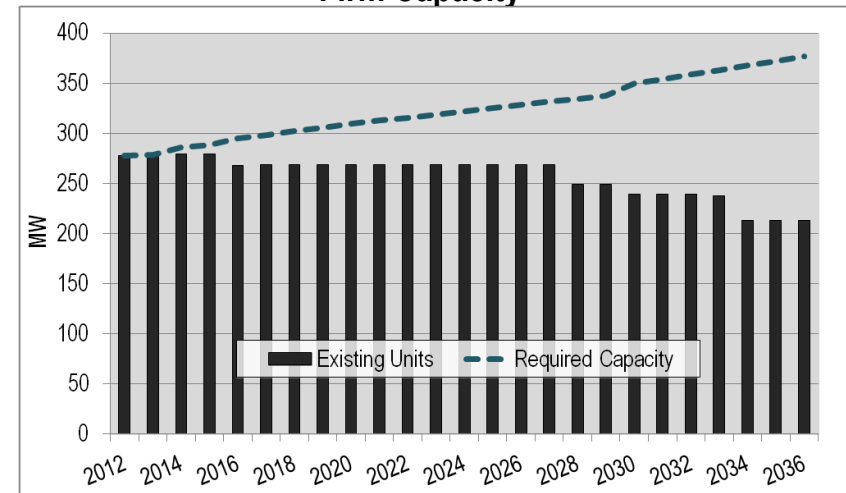
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO E

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCBP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | | ✓ |

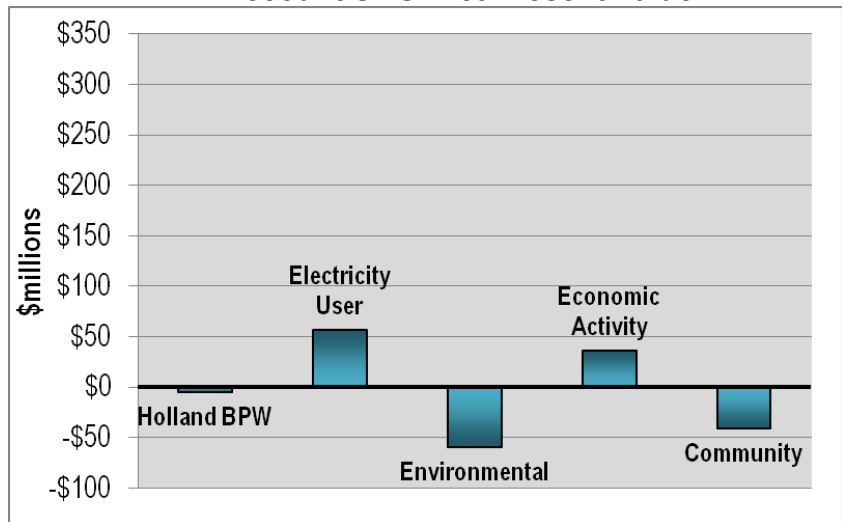
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|---------------------------------------|------------------------------|-----------|----------|----------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (6) | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| % savings (6) | #N/A | #N/A | #N/A | #N/A |
| Electricity Service Cost Savings (5) | \$56.88 | \$33.68 | \$63.00 | \$103.90 |
| Emission Savings (8) | -\$59.15 | -\$124.71 | -\$52.15 | \$1.18 |
| Business Relocation Benefit (4) | \$36.17 | \$25.11 | \$36.64 | \$44.93 |
| Reduced Biomass Shipping Costs (5) | -\$0.01 | -\$0.01 | -\$0.01 | -\$0.01 |
| Reduced Landfilling of Tires (4) | -\$28.64 | -\$30.66 | -\$28.68 | -\$26.56 |
| Avoided Loss of Commercial Harbor (4) | -\$0.51 | -\$0.61 | -\$0.50 | -\$0.41 |
| Reduced Snow Melt Service Cost (7) | -\$7.66 | -\$11.21 | -\$7.15 | -\$5.58 |

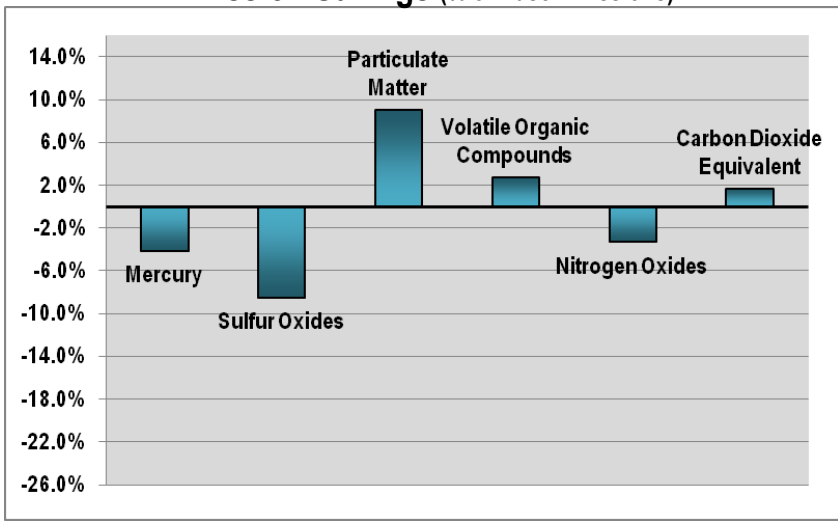
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (7) | lbs | -26 |
| Sulfur Oxides (8) | tons | -7,502 |
| Particulate Matter (1) | tons | 309 |
| Volatile Organic Compounds (2) | tons | 18 |
| Mono-Nitrogen Oxides (8) | tons | -1,728 |
| Carbon Dioxide Equivalent (6) | tons | 570,564 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

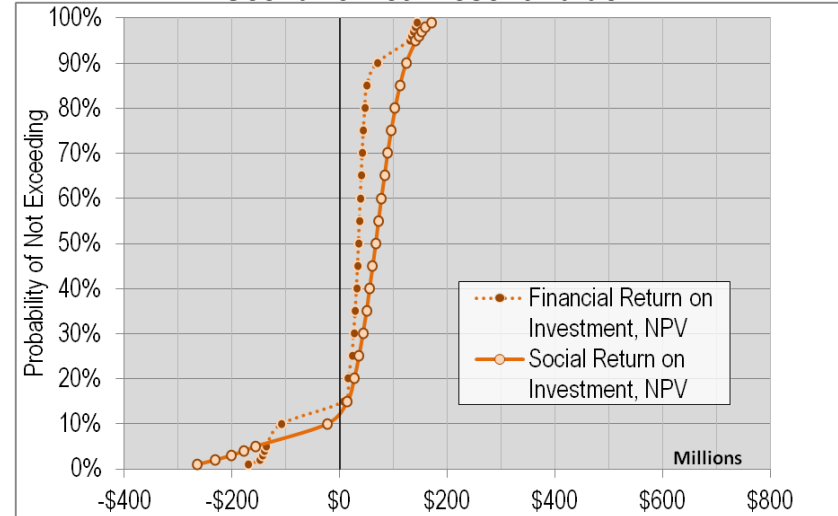


SCENARIO F

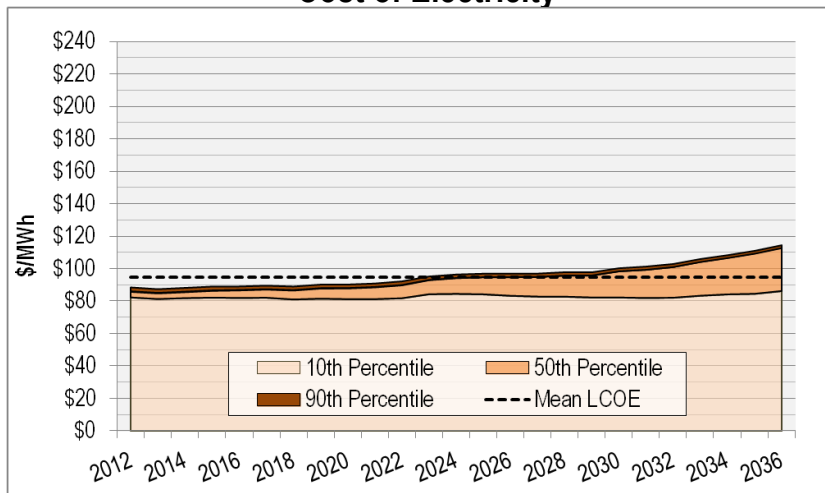
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | | |

- ◆ All existing JDY units offline by 2016
- ◆ Increased electricity demand satisfied by market purchases

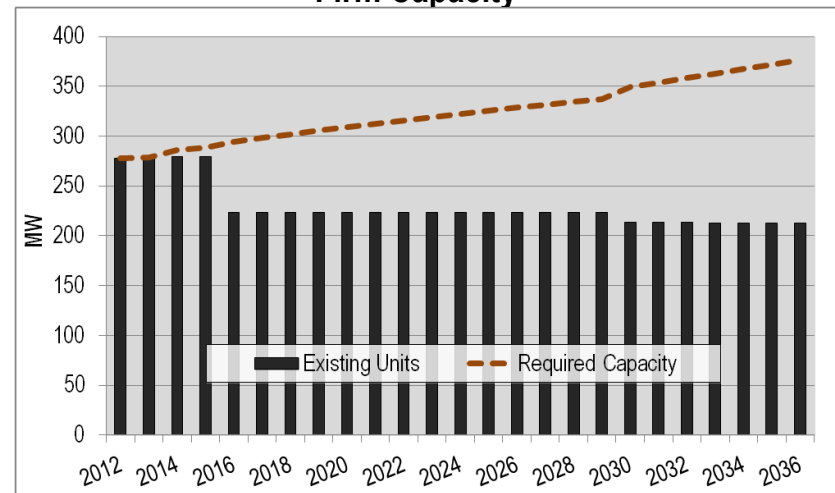
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO F

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | | |

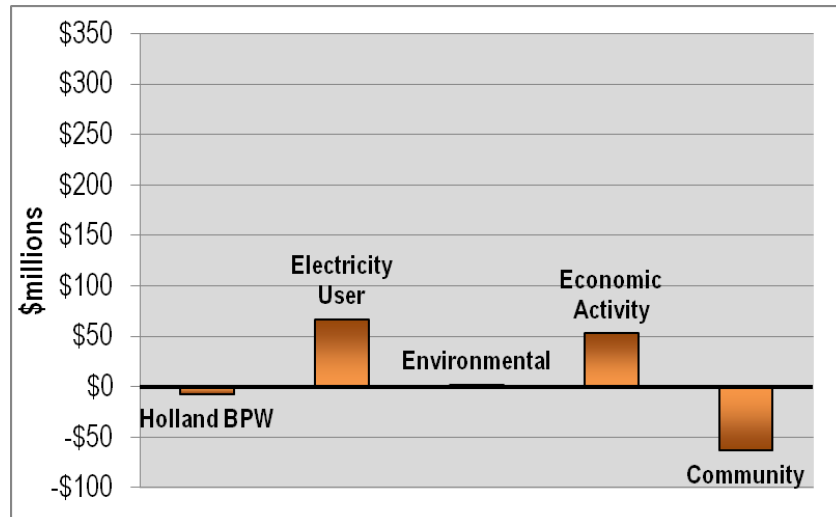
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|--|------------------------------|----------|----------|----------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (6) | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| % savings (6) | #N/A | #N/A | #N/A | #N/A |
| Electricity Service Cost Savings (4) | \$67.02 | \$46.16 | \$74.94 | \$148.16 |
| Emission Savings (6) | \$1.64 | -\$45.35 | \$4.09 | \$48.50 |
| Business Relocation Benefit (2) | \$52.74 | \$40.84 | \$53.05 | \$62.74 |
| Reduced Biomass Shipping Costs (5) | -\$0.01 | -\$0.01 | -\$0.01 | -\$0.01 |
| Reduced Landfilling of Tires (4) | -\$28.64 | -\$30.64 | -\$28.68 | -\$26.53 |
| Avoided Loss of Commercial Harbor (6) | -\$4.41 | -\$4.77 | -\$4.40 | -\$4.07 |
| Reduced Snow Melt Service Cost (8) | -\$25.80 | -\$50.19 | -\$21.73 | -\$18.50 |

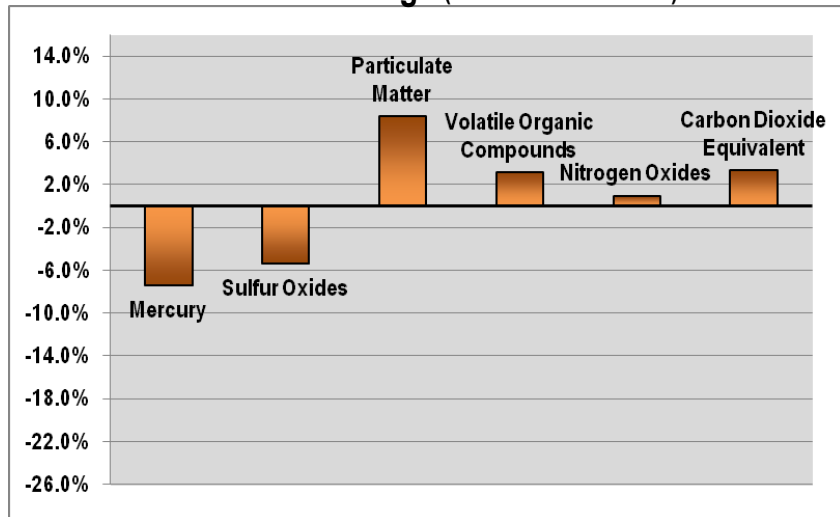
Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (8) | lbs | -46 |
| Sulfur Oxides (7) | tons | -4,744 |
| Particulate Matter (2) | tons | 288 |
| Volatile Organic Compounds (1) | tons | 21 |
| Mono-Nitrogen Oxides (6) | tons | 507 |
| Carbon Dioxide Equivalent (5) | tons | 1,151,404 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

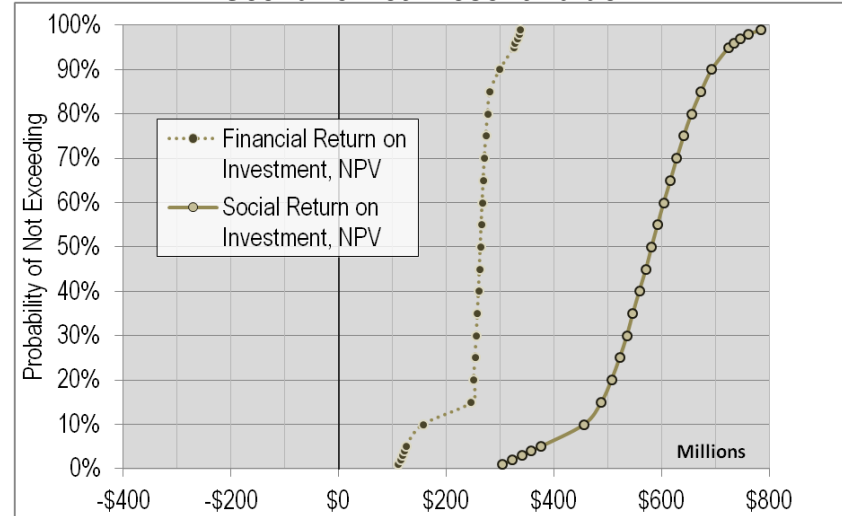


SCENARIO G

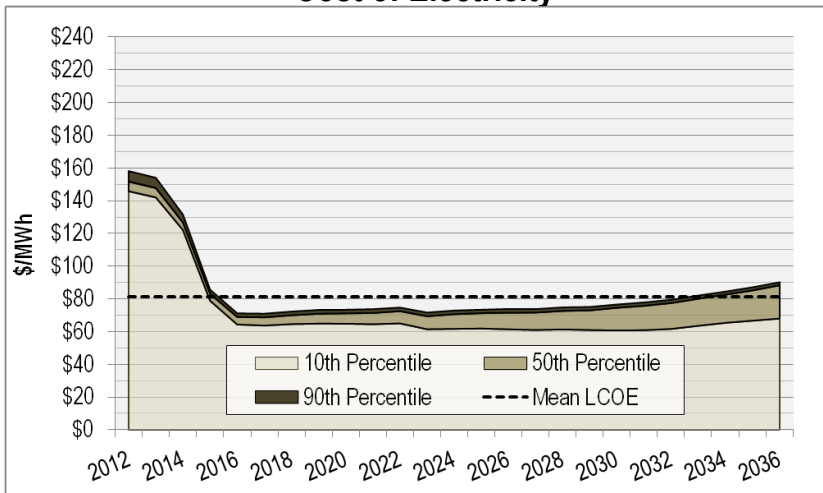
| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | ✓ | |

- ◆ All existing JDY units offline by 2016
- ◆ Gas turbine (LM6000) combined cycle facility beginning operation in 2015 and located adjacent to the existing JDY site

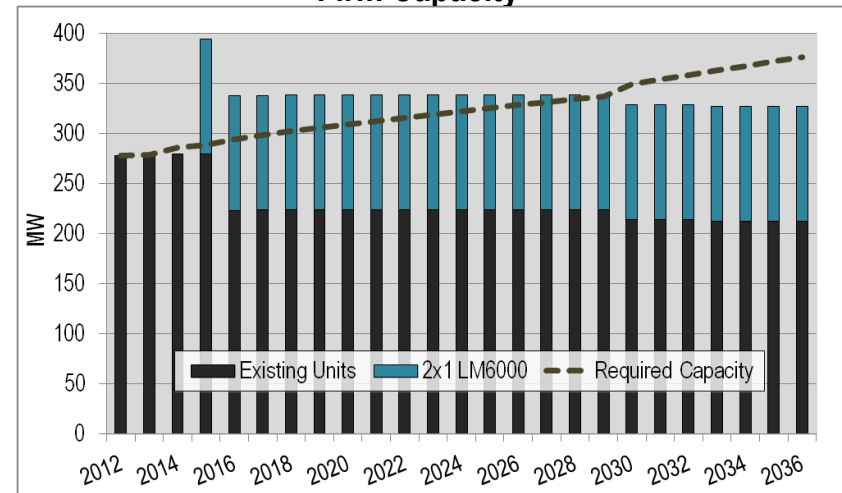
Scenario Net Present Value



Cost of Electricity



Firm Capacity



SCENARIO G

| JDY U10 CFB | LM2500 CHP | 2x1 LM2500 CCPP | JDY U5 Biomass | Solar PV | Wind | Digester Gas CHP | 2x1 LM6000 | AQCS Retrofit |
|-------------|------------|-----------------|----------------|----------|------|------------------|------------|---------------|
| Solid Fuel | Gas | Gas | Biomass | Solar | Wind | Dig. Gas | Gas | Coal |
| | | | | | | | ✓ | |

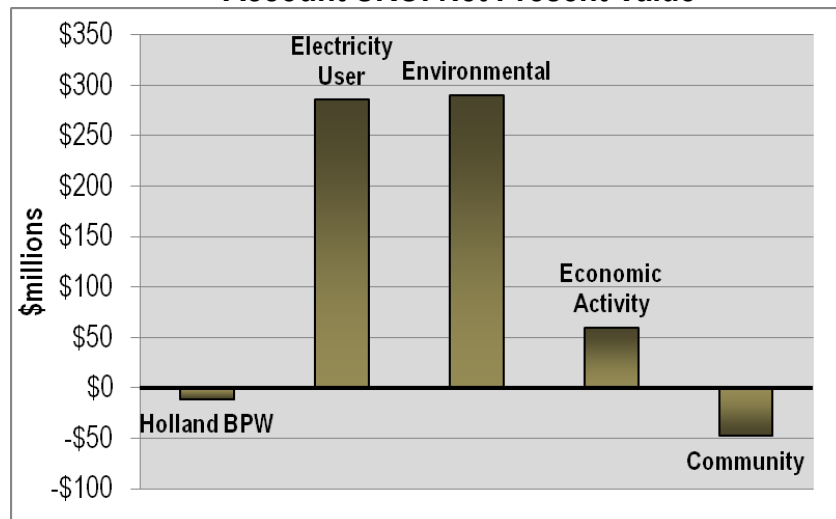
Major Public Benefits

| Account (Mean Rank) | Net Present Value (millions) | | | |
|--|------------------------------|----------|----------|----------|
| | Mean | 10% | 50% | 90% |
| Savings due to District Heating (5) | \$2.20 | \$0.00 | \$2.36 | \$4.03 |
| % savings (5) | 23.1% | 5.9% | 24.8% | 38.0% |
| Electricity Service Cost Savings (1) | \$283.40 | \$254.49 | \$291.26 | \$328.07 |
| Emission Savings (2) | \$289.92 | \$192.78 | \$285.68 | \$394.18 |
| Business Relocation Benefit (1) | \$60.03 | \$46.72 | \$60.18 | \$71.79 |
| Reduced Biomass Shipping Costs (5) | -\$0.01 | -\$0.01 | -\$0.01 | -\$0.01 |
| Reduced Landfilling of Tires (4) | -\$28.64 | -\$30.65 | -\$28.68 | -\$26.57 |
| Avoided Loss of Commercial Harbor (5) | -\$4.41 | -\$4.77 | -\$4.40 | -\$4.07 |
| Reduced Snow Melt Service Cost (5) | \$1.04 | \$0.53 | \$0.63 | \$3.03 |

Emission Savings

| Emission | Unit | Mean Savings |
|--------------------------------|------|--------------|
| Mercury (2) | lbs | 61 |
| Sulfur Oxides (2) | tons | 8,417 |
| Particulate Matter (3) | tons | 286 |
| Volatile Organic Compounds (7) | tons | -85 |
| Mono-Nitrogen Oxides (2) | tons | 5,036 |
| Carbon Dioxide Equivalent (2) | tons | 3,771,269 |

Account SROI Net Present Value



Emission Savings (% of Base Emissions)

