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Holland BPW - RAP Workbook

RAP SESSION I

September 28, 2011

HDR Corporation
Decision Economics

Risk Analysis · Investment and Finance
Economics and Policy

BPW

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September 28, 2011

Prepared By:

HDR

This workbook was provided to participants at the R.A.P. session to review preliminary costs and benefit categories. Participants were asked to add to, change, and comment on the proposed categories, and their structure and logic.

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List of Figures and Tables

Risk Analysis Process (RAP) Session Holland BPW – September 28th 2011

DoubleTree Hotel – 650 East 24th Street, Holland MI

Note: proceedings will be recorded as an aid to our note taking.

Topic	Purpose	Facilitation	Time (Minutes)	Start and End Times
Introductions and Review of Agenda	Welcome and self-introduction of panelists; rules of engagement; role of panelists, opportunities for public input and questions during the day.	John Parker	30	9:00am-9:30am
Overview of the options Under Consideration	Project background; opportunities for public input and questions after today; describe 8 options at a high-level.	Holland BPW – To be determined.	30	9:30am-10:00am
Overview of the RAP Process	Explanation of RAP objectives and process, and: role of panelists: role of observers: role of facilitator.	HDR Presentation by John Parker	20	10:00am-10:20am
Questions from panel on RAP session	Clarification of RAP Session.	Panel Questions and HDR Answers.	10	10:20am-10:30am
RAP Session #1 - Structure and Logic of the Business Case Model	Panel review and modification of business case model structure and logic for costs of options.	HDR facilitation (Ewa Tomaszewska) of panel review, analysis and modification of model.	45	10:30am-11:15am
Morning Break			**15**	**11:15am-11:30am**
RAP Session #1 – Continued (Costs)	Panel review and modification of business case model structure and logic for costs of options.	HDR facilitation (Ewa Tomaszewska) of panel review, analysis and modification of model.	45	11:30am-12:15pm
Observers Questions and Answers	Solicit Questions from Observers.	John Parker	15	12:15pm-12:30pm

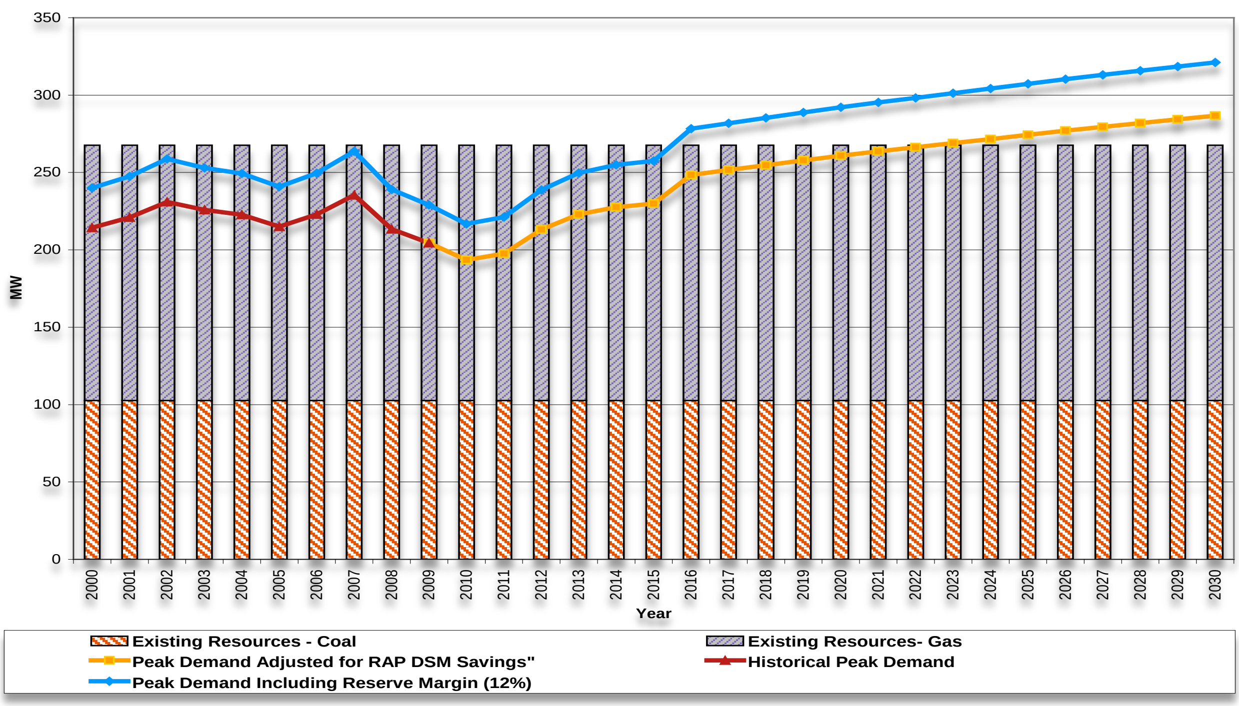
Lunch Break	**Opportunity for observers to talk with panelists.**		**60**	**12:30pm-1:30pm**
RAP Session #1 – Continued (Benefits)	Panel review and modification of business case model structure and logic for benefits.	HDR facilitation (John Parker) of panel review, analysis and modification of model.	60	1:30pm-2:30pm
Afternoon Break			**30**	**2:30pm-3:00pm**
RAP Session #1 – Continued (Benefits)	Panel review and modification of business case model structure and logic for benefits.	HDR facilitation (John Parker) of panel review, analysis and modification of model.	45	3:00pm-3:45pm
Wrap-Up	Plans for next RAP session and panel observations or comments.	John Parker	15	3:45pm-4:00pm
Observers Questions and Answers	Solicit Questions from Observers.	John Parker	30	4:00pm-4:30pm
			~6.5 hours	

Introduction

This Risk Assessment Process (RAP) workbook provides an overview of the sustainable return on investment (SROI) framework for assessing the costs and benefits of the proposed changes to the Holland BPW power generation system. The workbook provides an overview of the options, and the costs and benefits that result from each option. The methodology used to calculate costs and benefits is then displayed visually in a series of structure and logic (S&L) diagrams.

Energy consumption has steadily risen in Holland in the past thirty years, and this trend is expected to continue despite demand-side management efforts. Figure 1 shows that Holland BPW's current electric load capacity of 277 megawatts (MW) will be inadequate in the upcoming years.

Figure 1 - Holland BPW Peak Electricity Capacity



> "The recession our country experienced over the past decade slowed our need for further expansion, but it didn't reverse it. In spite of the recession Holland continued to grow, including the recent addition of two large investments in our community by LG Chem and Johnson Controls. These two facilities alone will require more energy than is currently used by all our residential customers combined."[1]

[1] http://p21decision.com/p21-start-thinking/whats-the-problem/ - "On July 21, 2011 the maximum hourly Peak Demand was 225 MW. With a 12% reserve margin, that puts required capacity at 252 MW, putting current

In addition to increases in forecasted energy load, Holland BPW acknowledges that:

> *"The greater Holland community is at a crossroads in determining how best to meet its future power needs. Factors at work are long-term growth in power demand, regulatory requirements for the use of renewable energy sources, rising demand for power world wide and the cost and difficulty of maintaining the aging equipment at the De Young plant, which currently produces a significant portion of the community's electricity."*[2]

In order to stay abreast of these future conditions, Holland BPW has proposed several options to replace and augment its generation portfolio.

The options under consideration are:

1. **James DeYoung Circulating Fluidized Bed Solid Fuel Plant**
2. **LM2500+ (G4) Combined Heat and Power Plant**
3. **2 x 1 LM2500+ Combined Cycle Plant**
4. **James DeYoung Unit 5 Repowering with 1 x 6FA Combustion Turbine Generator**
5. **James DeYoung Unit 5 Biomass Retrofit**
6. **Solar Photovoltaic**
7. **Wind Generation**
8. **Digester Gas Combined Heat and Power Plant**

These options will be described in further detail in the following section. Each option will be assessed individually in terms of its costs, benefits, and risks. The options will then be combined into portfolios of generation options. These portfolios will reflect the scenarios considered in the Community Energy Efficiency and Conservation Strategy Plan. The scenarios will be evaluated using HDR's Sustainable Return on Investment (SROI) methodology.

SROI is an approach to determine the public value of a project or initiative and to determine if the project is worthwhile. It answers the question of whether a project provides benefits (net of its costs) and therefore should be undertaken:

- Is the public value sufficient to justify the money required to develop the project?
- Which option provides greatest return relative to the project cost?

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generation capacity close to maximum. Holland's electric usage is growing: A single new industry like LG Chem adds approximately 20 MW of demand."

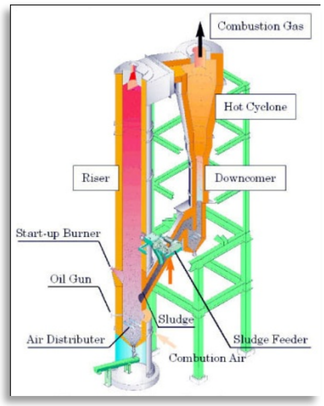
[2] Holland BPW Press Release: "Air Quality Permit Allows Holland Board of Public Works to Move Ahead with Power Options Evaluation" February 11, 2011.

This public value includes not just the financial or net “cash” benefits of each option, but also incorporates the value of broader social and environmental impacts that may be in some stakeholders’ opinion, the primary reason for undertaking the project.

Options

1. **<u>James DeYoung Circulating Fluidized Bed Solid Fuel Plant</u>**

This option involves installing a circulating fluidized bed (CFB) solid fuel plant at the existing James DeYoung (JDY) site. The fuel used to generate power will be a mixture of petroleum coke, biomass, tire-derived fuel, and biosolids. The plant will produce approximately 70 megawatts (MW) of power. In the base generation case, the plant will also send hot, circulating, water to the snow melt system. The base generation case does not provide process steam for district heating.



<u>Additional options include:</u>

- Installing a heat pump on the back end of the snow melt system to extract additional energy out of the circulating water for district heating.
- Extracting steam off of the steam turbine for district heating.

2. **<u>LM2500+ (G4) Combined Heat and Power Plant</u>**

Option 2 is to install a combined heat and power (CHP) plant. The plant would utilize a LM2500+ (G4) combined gas turbine to generate power. A single-pressure heat recovery steam generator (HRSG) will be installed in the city's industrial park, making use of the exhaust produced by the gas turbine. The CHP plant will produce approximately 30 MW of power. The steam produced by the turbine will be used for district heating in the base generation case. The base generation case does not provide water to the snow melt system.

<u>Additional options include:</u>

- Installing a Heat Recovery Steam Generator (HRSG) stack water heater, to add to the district heating and/or snow melt systems. If both district heating and snow melt were provided, a heat pump would be required.

3. **<u>2 x 1 LM2500+ Combined Cycle Plant</u>**

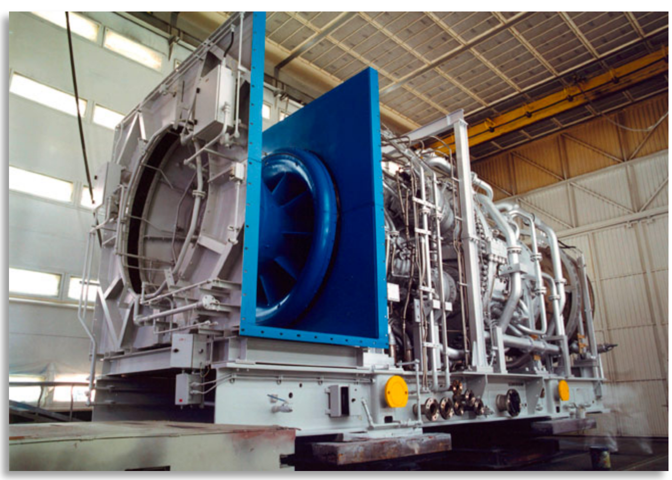
Here, two LM2500+ combined gas turbines will be installed in a 2 x 1 combined cycle plant. Additionally, two triple-pressure HRSGs will be installed at the existing JDY site. The plant will produce approximately 77 MW of power. In the base generation case, hot circulating water will be sent to the snow melt system. No process steam for district heating will be provided in the base generation case.

Additional options include:

- Additional energy could be extracted from the circulating water by installing a heat pump. The pump would be installed to the back-end of the snow melt system, and the additional energy would be used for district heating.
- Extracting steam off of the ST for district heating.

Installation of Snowmelt on 8th Street at Marketplace

4. James DeYoung Unit 5 Repowering with 1 x 6FA Combustion Turbine Generator



Unit 5 at the JDY site will be repowered with one 6FA combustion turbine generator, and will utilize the existing steam turbine and condenser. This option will produce approximately 100 MW of power, netting 75 MW after loss of existing power is factored in. This new power rating falls in line with options 1 and 3. In the base case, hot circulating water will be sent to the snow melt system and no steam will be processed for district heating.

Additional options include:

- Installing a heat pump on the back end of the snow melt system to extract additional energy out of the circulating water. This energy would be used for district heating.
- Installing an HRSG stack water heater for the district heating and/or snow melt systems. Providing heat to both systems would require a heat pump.
- Extracting steam off of the ST for district heating.

5. **James DeYoung Unit 5 Biomass Retrofit**

The existing Unit 5 boiler at the JDY site will be retrofitted to burn woody biomass. This option will produce approximately 24 MW of power. In the base generation case, hot circulating water will be sent to the snow melt system and process steam will not be provided for district heating.

Additional options include:

- Installing a heat pump on the back end of the snow melt system to extract additional energy out of the circulating water. This energy would be used for district heating.

6. **Solar Photovoltaic**

24 MW of solar energy will be harnessed by installing photovoltaic (PV) panels.

7. **Wind Generation**

Erecting wind turbines will result in 37 MW of wind capacity.

8. **Digester Gas Combined Heat and Power Plant**

A digester gas combustion turbine generator and single-pressure HRSG will be installed at either the waste treatment facility or existing JDY site. The sites are relatively close to one another. This option will produce approximately 4 MW of power and steam for district heating in the base generation case. The base generation option does not provide water to the snow melt system.

Additional options include:

- Installing an HRSG stack water heater for the district heating and/or snow melt systems. Providing heat to both systems would require a heat pump.

Cost and Benefit Categories

Table 1 below provides the proposed cost and benefit categories for assessing the eight generation options. The specific impacts are based on consultation with the project team and other stakeholders, best-practices, and feedback from today's RAP session.

The cost and benefit categories have been separated into two categories – financial and social. Financial costs and benefits calculate actual cash flows accruing to Holland BPW or the community of Holland.[3] These revenues and financial costs are the basis of a traditional return on investment (ROI) analysis. Social costs and benefits are externalities that are not usually captured in ROI analyses, and do not have a price set by a market. An example is the benefit of a snow melt system. The Unit 3 electric generator waste heat goes into the condenser water used to cool the unit. In the winter, this water with excess waste heat is directed to the snow melt system before being discharged into Lake Macatawa. The benefit to the community has no price but the benefits include no salting, no plowing, no slipping or sliding, no track-in to store carpeting, and the sidewalk bricks are not prone to frost heave throughout the winter months.

Adding these non-cash costs and benefits allows us to evaluate how each option will impact society at large, and reveal the "hidden" value of the option. Social benefits and costs that do not involve actual cash flows will be monetized so they may be evaluated alongside the financial cost and benefits. Together, the net financial and social costs and benefits give the option's SROI.

These costs and benefits are listed and described in Table 1. Structure and logic diagrams show how each of these items are calculated, and are provided on Page 15.

[3] We propose calculating the benefits to both Holland BPW and its clients and owners, the Holland community. In the aggregate analysis, the costs and benefits will net out since the costs to one group are revenue to another (for example higher costs of generation result in higher electricity rates).

Table 1 - Cost Benefit Analysis Cost and Benefit Categories

Name	Impact Type	Description	Category
Renewable Energy Credit	Benefit	Those options that are eligible to receive RECs will generate revenue through the sale of the credits. Options that are not classified as renewable will require credits to be purchased.	Financial
Energy Market Revenue	Benefit	Revenue Holland BPW receives from selling generated energy	Financial
Capacity Market Revenue	Benefit	The plant's capacity may potentially be contracted out. This represents an option value which has financial worth.	Financial
Ancillary Market Revenue	Benefit	Some options may be able to provide ancillary services such as reserves, regulation, and black start capability. Revenue is generated when these services are provided.	Financial
Incentive Tax Credits	Benefit	Some generation modes are eligible for Federal and State financial incentives. Applicable grants and/or credits are calculated in this benefit.	Financial
District Heating Revenue	Benefit	Quantifies the increase in revenue attributed to increased district heating service.	Financial
Water Quality Improvements	Benefit	Some options will reduce the amount of thermal discharge into the lake, which is expected to improve water quality. Improved water quality is a social benefit, and can be monetized.	Social
Generation Reliability	Benefit	By increasing generation capacity on the grid, the likelihood of power outages decreases. Power outages are a cost on society, and reducing the number of outages brings about a social cost-savings.	Social
District Heating Social Benefit	Benefit	By channeling heat into the district heating system, the additional energy that would have otherwise been generated to produce this heat is no longer required. The reduction in generation also brings about a reduction in emissions, which will be monetized. Furthermore, there is a reduction in heating costs to those who receive the service.	Social
Snow Melting	Benefit	Heat produced by the plant can be used to heat sidewalks downtown, and melt snow. The social benefit gained through this system is monetized.	Social
Fixed Costs	Cost	Fixed costs are those financial costs that do not fluctuate with equipment usage.	Financial
Variable Costs	Cost	Represent equipment maintenance costs that are primarily dependent upon the hours the equipment are operating.	Financial

Consumable Costs	Cost	Consumables refer to the cost of delivered materials consumed, disposal of byproducts produced, startup fuel, and spare parts.	Financial
Renewable Energy Credits	Cost	Similar to the REC benefit, only some options are not eligible to receive credit, and RECs must be purchased to meet Michigan renewable portfolio standards.	Financial
Other Costs	Cost	Additional financial costs that are not captured in the other cost categories fall under “Other Costs.”	Financial
Water Consumption	Cost	Water has value above and beyond what is charged by a utility. The social cost of water is applied to the volume consumed in each option.	Social
Emissions	Cost	Different methods of generating electricity produce pollutants at different rates. Emissions produced may be quantified and monetized.	Social

Not all benefits are applicable to each option. For example, wind and solar power do not produce heat that can be used in the snow melt or district heating systems. Figure 2 maps the benefits to each proposed option. A ☑ means that the row’s option has the *ability* to produce the benefit in the corresponding column.

Figure 2 - Option-Benefit Matrix

		RECs	Energy Market Revenue	Capacity Market Revenue	Ancillary Market Revenue	Incentive Tax Credits	District Heating Revenue	Water Quality Improvement	Increased Generation Reliability	Emission Savings from Heating	Fuel Flexibility	Snow Melting	Energy Security
1	JDY Unit 10 CFB		✓	✓			✓	✓	✓	✓	✓	✓	✓
2	LM25000 CHP		✓	✓	✓		✓		✓	✓		✓	✓
3	2x1 LM2500		✓	✓	✓		✓	✓	✓	✓		✓	✓
4	Unit 5 Repower w/ 6FA		✓	✓	✓		✓	✓	✓	✓		✓	✓
5	Unit 5 Biomass Retrofit	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
6	23MW Solar PV	✓	✓	✓		✓			✓				✓
7	37MW Wind Farm	✓	✓	✓		✓			✓				✓
8	4MW Digester Gas		✓	✓			✓		✓	✓		✓	✓

Financial

External

The options will be combined into scenarios similar to the Holland Community Energy Efficiency and Conservation Strategy Plan. These are reproduced below in Table 2.

Table 2 - Investment Scenarios

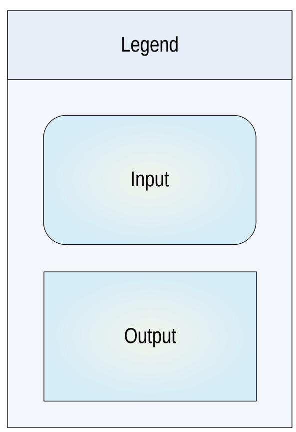
Item	Base Case $M	Scenario A $M	Scenario B $M	Scenario C $M	Scenario D $M
70 MW Solid Fuel	$270			$270	$270
20 MW Industrial CHP		$40	$40	$40	$40
55 MW CCGT		$90	$90		
Industrial DH Network		$10	$10	$10	$10
Downtown DH Network		$10	$10	$10	$10
SFH Retrofit - Toal Investment		$125	$125	$125	$125
SFH Retrofit Owner Share		-$63	-$63	-$63	-$63
Refrigerator Incentives	$0	$1	$1	$1	$1
AC Buyback (7,500)	$0	$2	$2	$2	$2
Industrial Efficiency		$0	$0	$0	$0
Solar PV (8 of 24MW)			$32	$32	
37 MW_{nom} Wind			$111	$111	
Additional Snow-Melt					
Total 2030 Investment	**$270**	**$215**	**$358**	**$538**	**$395**
Total Additional Capacity	**70MW**	**55MW**	**100MW**	**170MW**	**125MW**
Investment / Capacity	**$3.86/MW**	**$3.91/MW**	**$3.58/MW**	**$3.16/MW**	**$3.16/MW**

Structure and Logic Diagrams

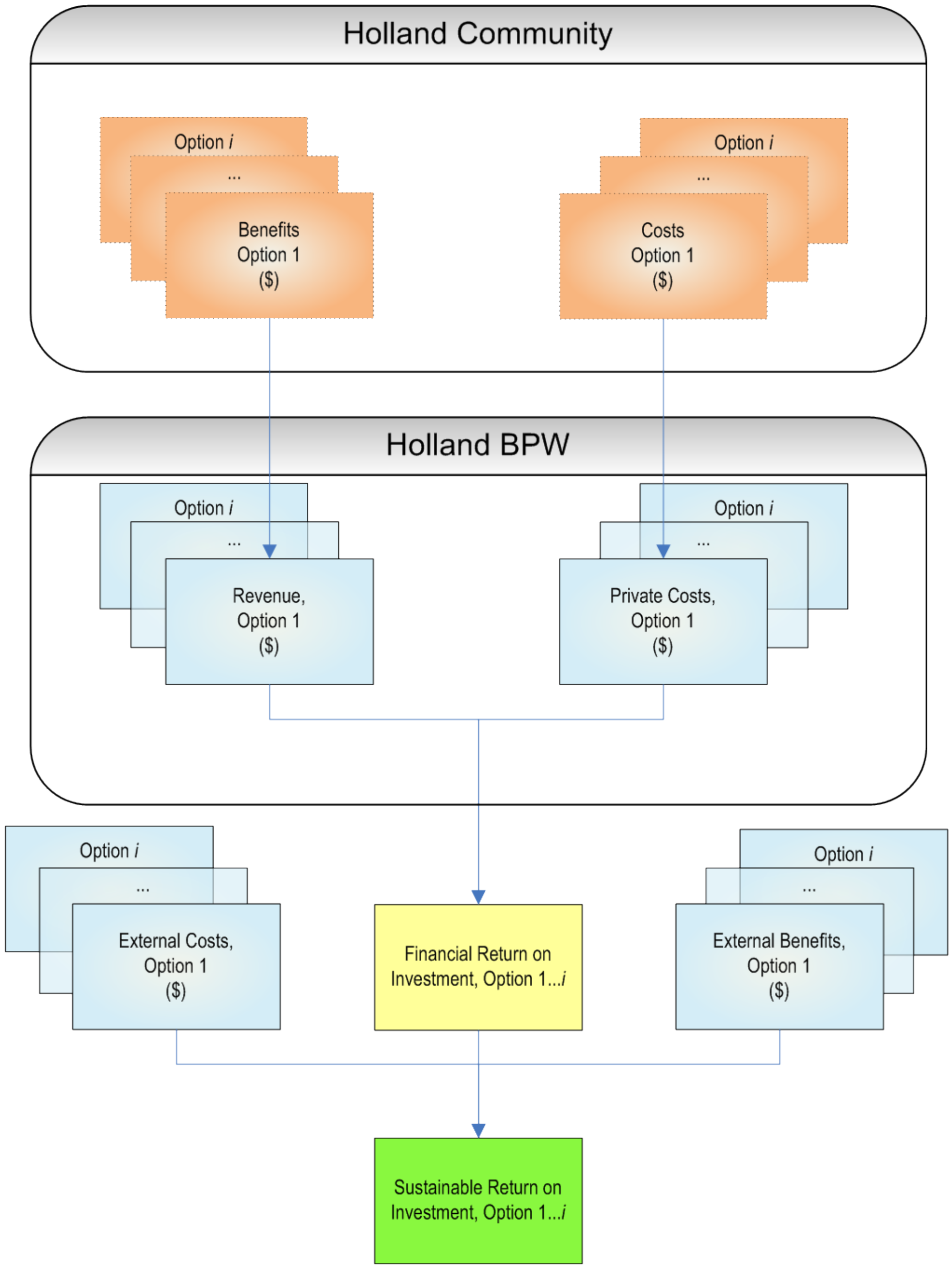
Structure and logic (S&L) diagrams illustrate how an impact is quantified. S&L diagrams are the graphical representation of an equation, where each box is a variable (input, intermediate output, output) and the links between boxes are operations (add, multiply, divide, etc.). S&L diagrams differ from a flowchart, influence diagram, or decision tree, as they provide us with the framework to understand and calculate the potential impacts to be evaluated.

S&L diagrams allow the project team to think through a problem. They provide the ability to communicate with and seek feedback from others on the project team and peer reviewers. In this section, S&L diagrams have been included for all the costs and benefits listed in Table 1.

The following legend applies to all the S&Ls presented in this section. Those elements contained in rounded-boxes are exogenous variables inserted into the model. Their values may be the result of research, expert opinion, and other external sources. Elements contained in squared-boxes are calculated endogenously within the model.

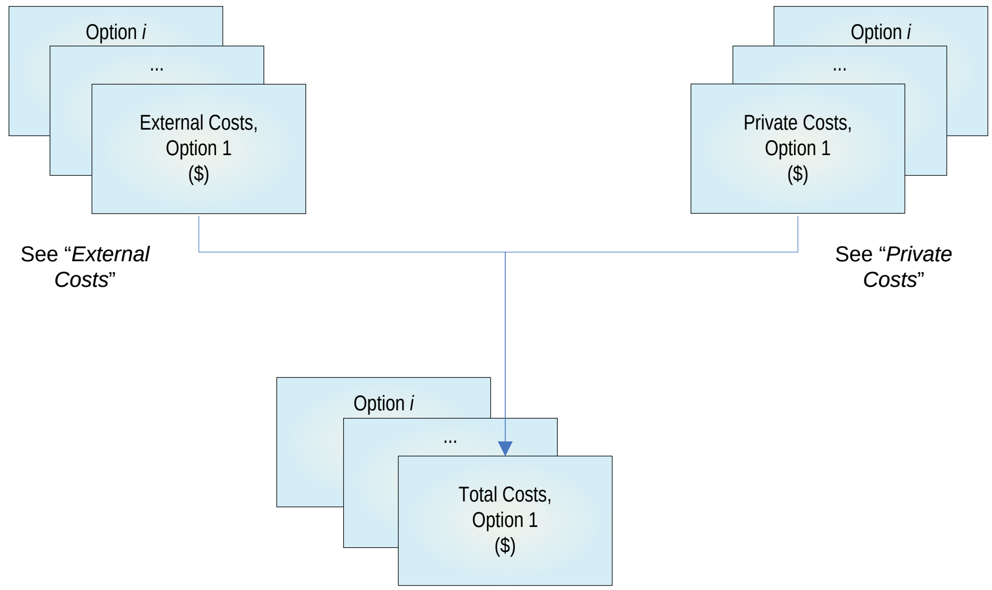


Overview

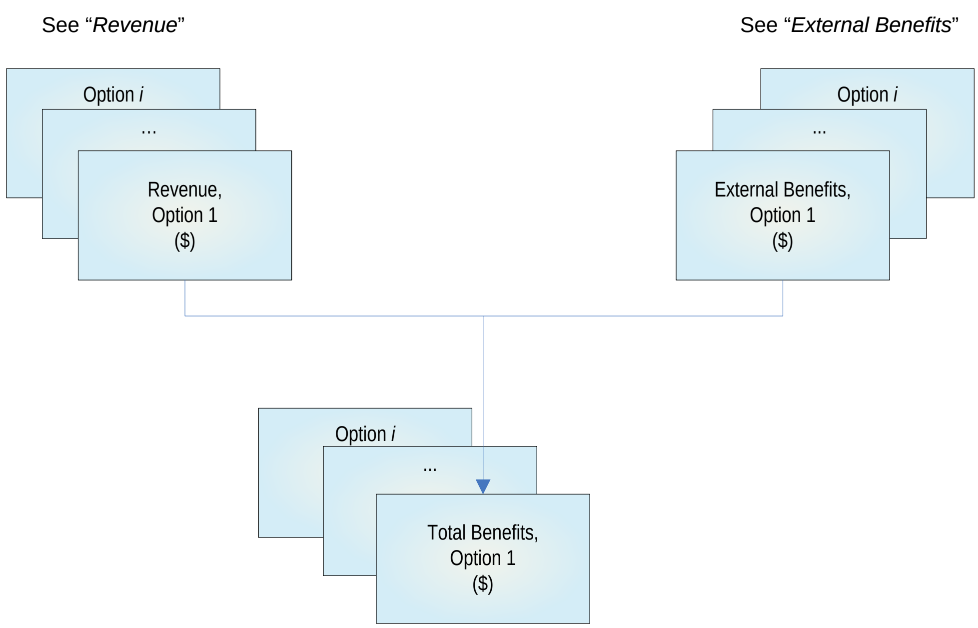


Holland Community
Option *i*
...
Benefits
Option 1
($)
Option *i*
...
Costs
Option 1
($)
Holland BPW
Option *i*
...
Revenue,
Option 1
($)
Option *i*
...
Private Costs,
Option 1
($)
Option *i*
...
External Costs,
Option 1
($)
Financial Return on
Investment, Option 1...*i*
Option *i*
...
External Benefits,
Option 1
($)
Sustainable Return on
Investment, Option 1...*i*

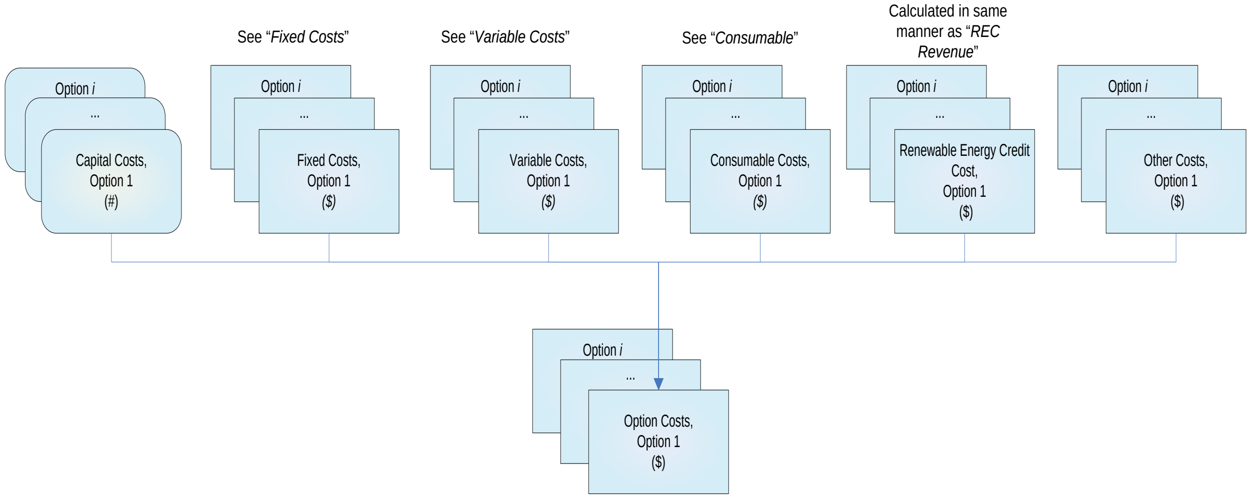
Costs



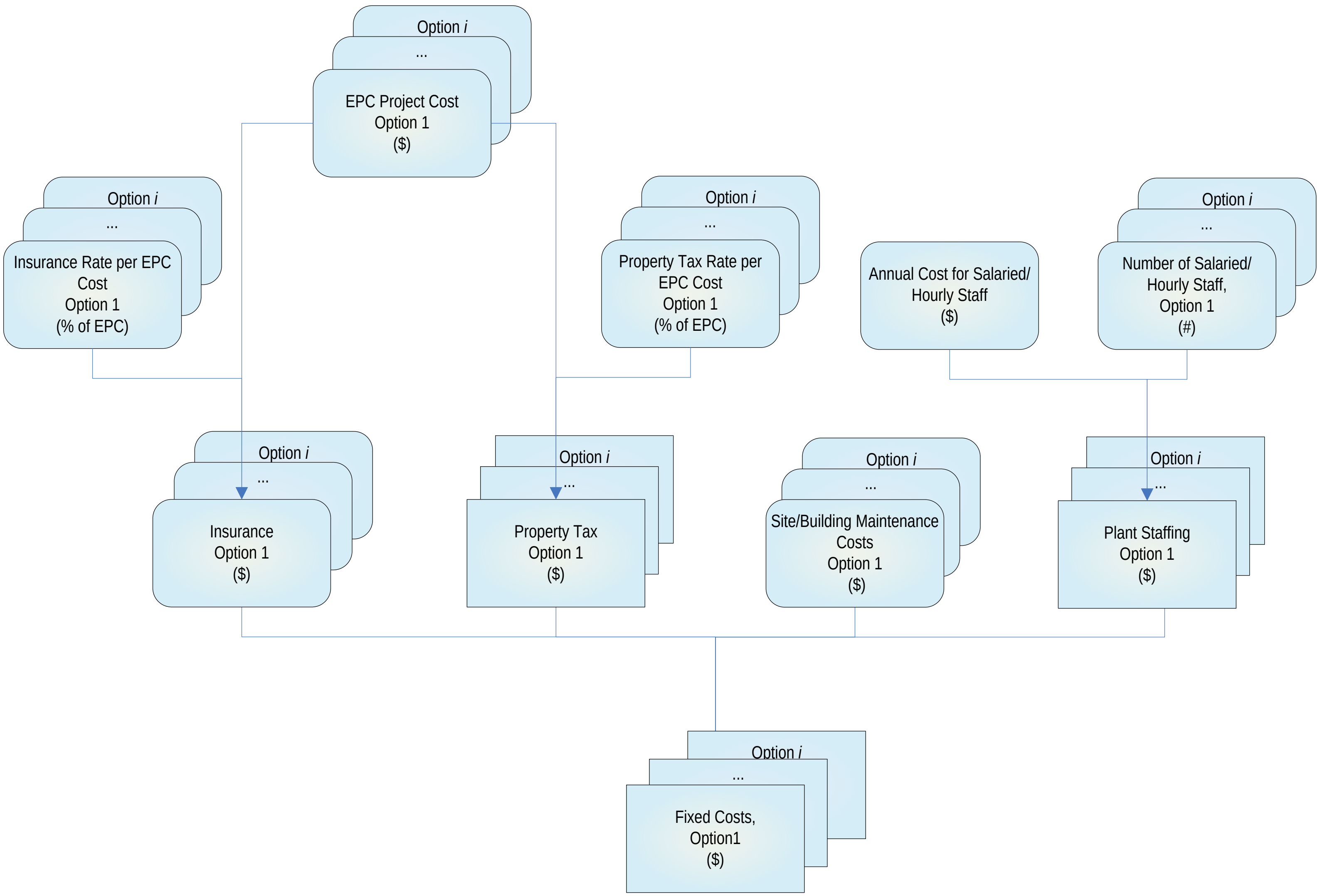
Benefits



Private Costs

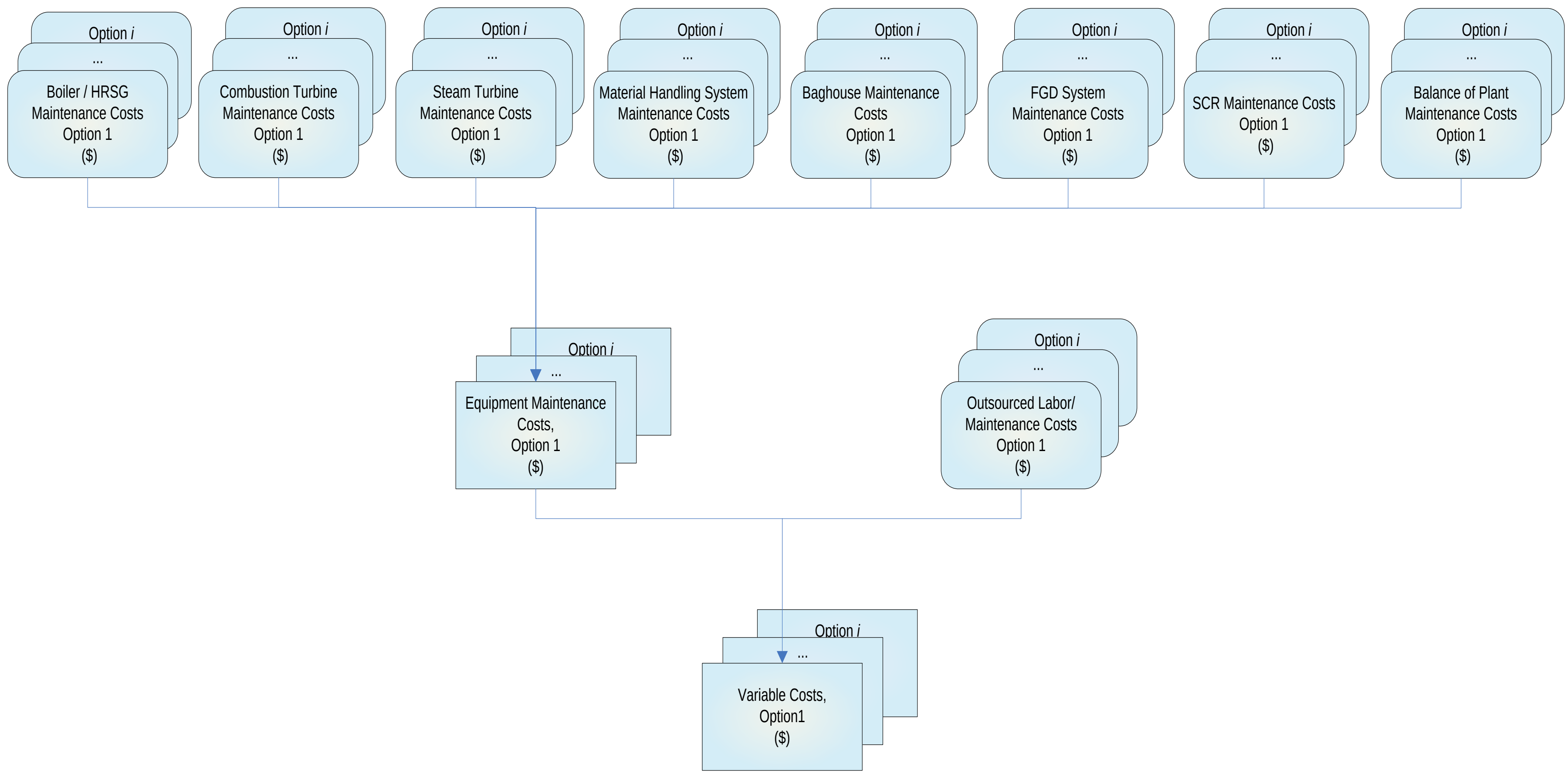


Fixed Costs

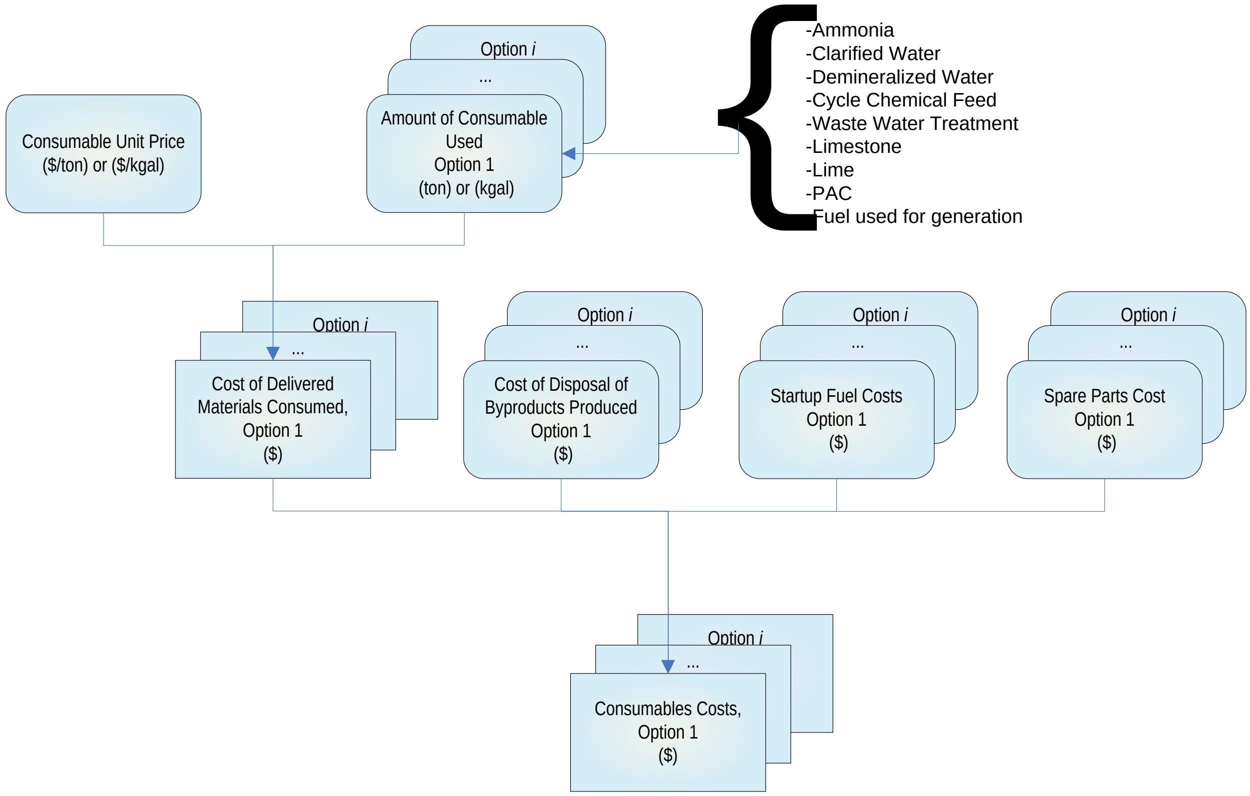


Option *i*
...
EPC Project Cost
Option 1
($)
Option *i*
...
Insurance Rate per EPC Cost
Option 1
(% of EPC)
Option *i*
...
Property Tax Rate per EPC Cost
Option 1
(% of EPC)
Annual Cost for Salaried/ Hourly Staff
($)
Option *i*
...
Number of Salaried/ Hourly Staff,
Option 1
(#)
Option *i*
...
Insurance
Option 1
($)
Option *i*
...
Property Tax
Option 1
($)
Option *i*
...
Site/Building Maintenance Costs
Option 1
($)
Option *i*
...
Plant Staffing
Option 1
($)
Option *i*
...
Fixed Costs,
Option1
($)

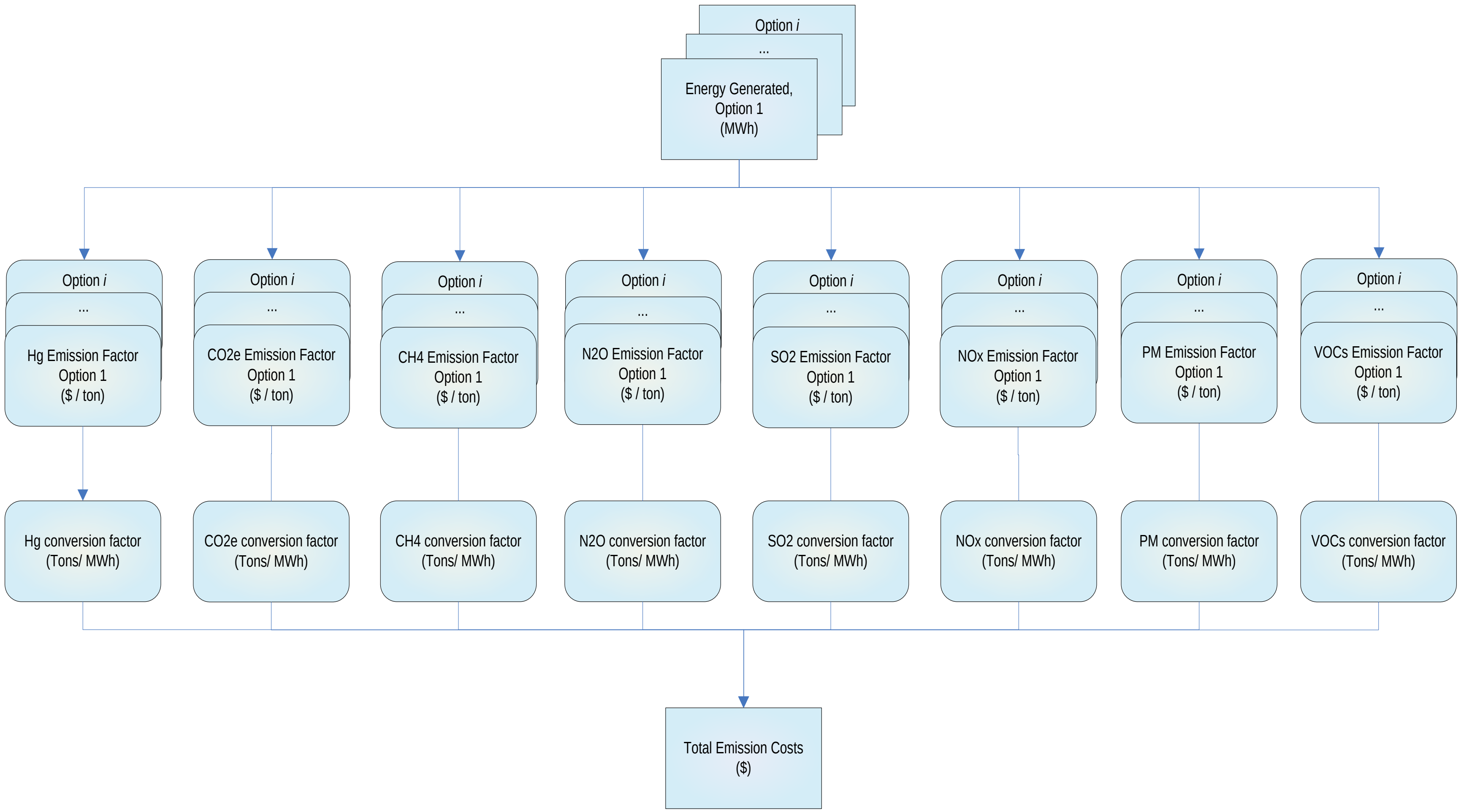
Variable Costs



Consumables

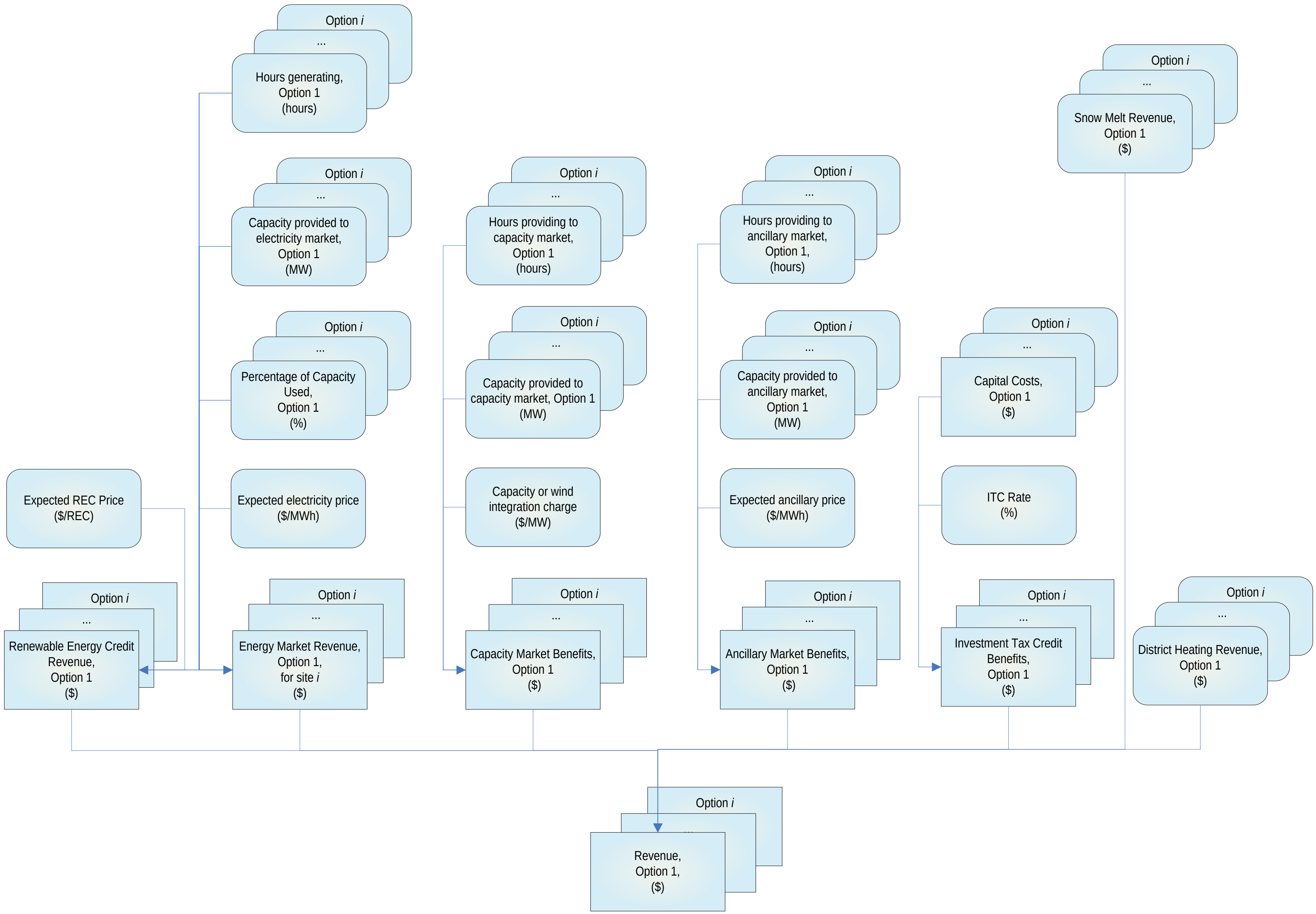


Emissions



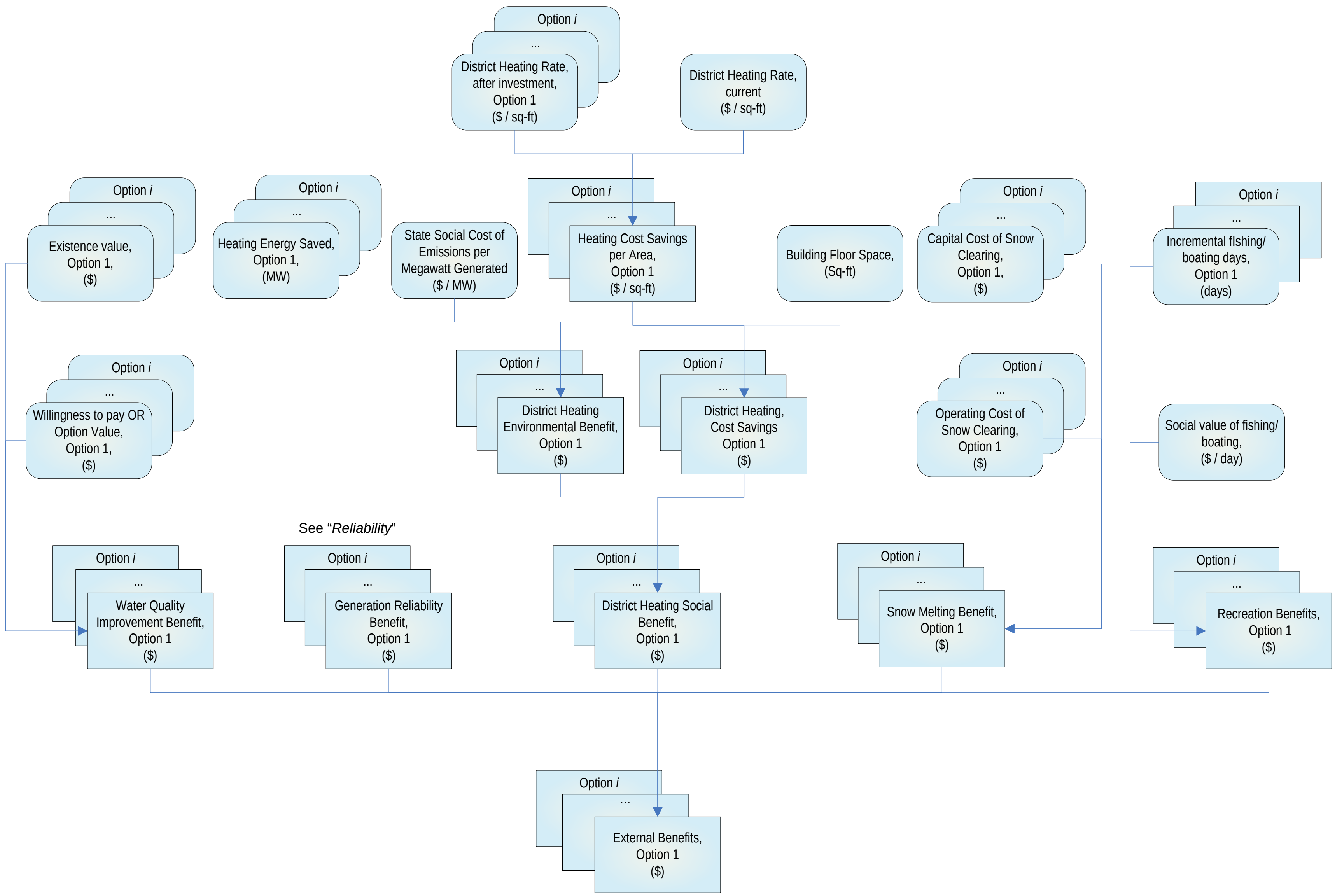
Option *i*
...
Energy Generated, Option 1 (MWh)
Option *i*
...
Hg Emission Factor Option 1 ($ / ton)
Option *i*
...
CO2e Emission Factor Option 1 ($ / ton)
Option *i*
...
CH4 Emission Factor Option 1 ($ / ton)
Option *i*
...
N2O Emission Factor Option 1 ($ / ton)
Option *i*
...
SO2 Emission Factor Option 1 ($ / ton)
Option *i*
...
NOx Emission Factor Option 1 ($ / ton)
Option *i*
...
PM Emission Factor Option 1 ($ / ton)
Option *i*
...
VOCs Emission Factor Option 1 ($ / ton)
Hg conversion factor (Tons/ MWh)
CO2e conversion factor (Tons/ MWh)
CH4 conversion factor (Tons/ MWh)
N2O conversion factor (Tons/ MWh)
SO2 conversion factor (Tons/ MWh)
NOx conversion factor (Tons/ MWh)
PM conversion factor (Tons/ MWh)
VOCs conversion factor (Tons/ MWh)
Total Emission Costs ($)

Revenue

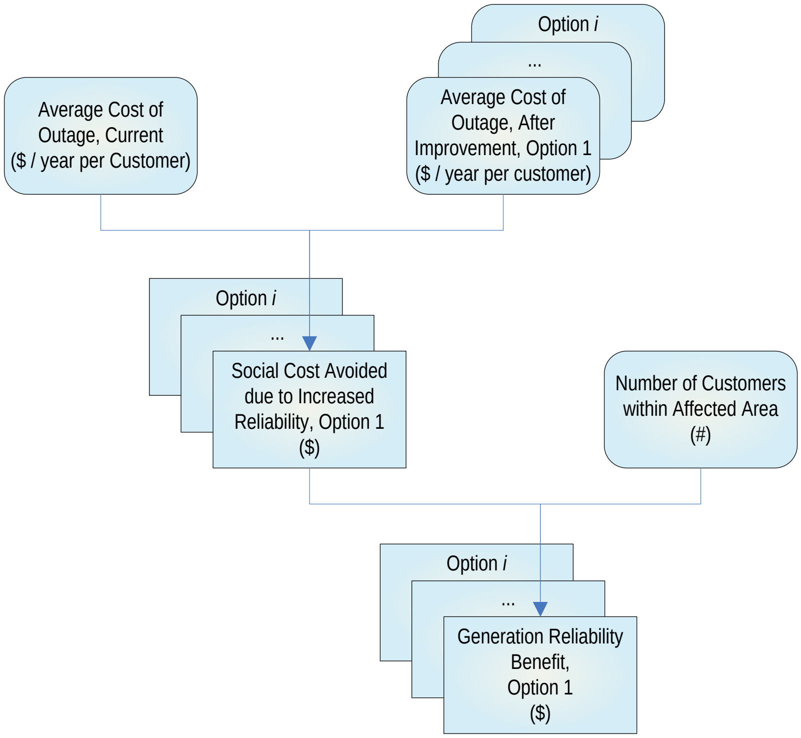


Option i
...
Hours generating, Option 1 (hours)
Option i
...
Capacity provided to electricity market, Option 1 (MW)
Option i
...
Percentage of Capacity Used, Option 1 (%)
Expected electricity price ($/MWh)
Option i
...
Hours providing to capacity market, Option 1 (hours)
Option i
...
Capacity provided to capacity market, Option 1 (MW)
Capacity or wind integration charge ($/MW)
Option i
...
Hours providing to ancillary market, Option 1, (hours)
Option i
...
Capacity provided to ancillary market, Option 1 (MW)
Expected ancillary price ($/MWh)
Option i
...
Snow Melt Revenue, Option 1 ($)
Option i
...
Capital Costs, Option 1 ($)
ITC Rate (%)
Expected REC Price ($/REC)
Option i
...
Renewable Energy Credit Revenue, Option 1 ($)
Option i
...
Energy Market Revenue, Option 1, for site i ($)
Option i
...
Capacity Market Benefits, Option 1 ($)
Option i
...
Ancillary Market Benefits, Option 1 ($)
Option i
...
Investment Tax Credit Benefits, Option 1 ($)
Option i
...
District Heating Revenue, Option 1 ($)
Option i
...
Revenue, Option 1, ($)

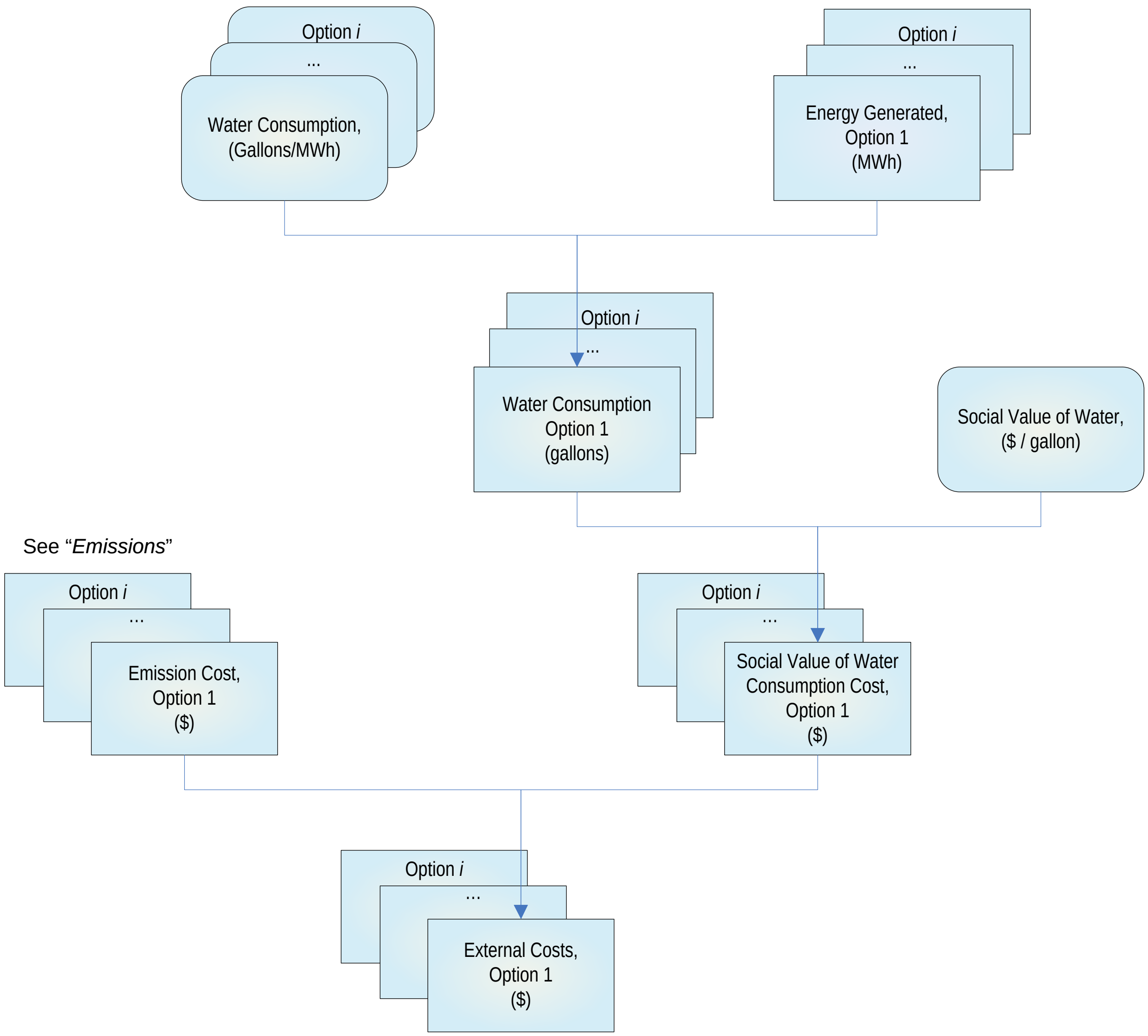
External Benefits



Reliability



External Costs



Some costs and benefits were considered by HDR, but were deemed unrealistic or their monetized value would be a double-count of other costs or benefits. As such, they will not be included in the SROI analysis. A preliminary version of the omitted elements is shown in Table 3.

Table 3 - Omitted Costs & Benefits

Name	Impact Type	Description
Fuel Flexibility	Benefit	Measures the benefit of being able to use many different types of fuels when conditions are suitable to each
Energy Security	Benefit	---
Cost of Delay	Cost	The cost incurred because of schedule delays in project construction

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