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MEASURING THE SUSTAINABLE RETURN ON INVESTMENT (SROI) OF WASTE TO ENERGY

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ABSTRACT

Waste to Energy facilities serve their communities in a number of important ways. Our industry does a terrific job reducing volumes that would have otherwise been destined for landfills. Energy recovery is an important and positive byproduct of that process but not the only one. Beyond these two obvious attributes you seldom hear of anything else. This is unfortunate because there are significant social, environmental, and economic benefits associated with the technology. Industry "silence" can be attributed to an inability to describe those benefits in ways people understand or see a dollar value in. In other words, we have a tough time measuring the value of "Green."

This paper describes a framework through which we can make the case for sustainable benefits associated with Waste to Energy. It begins with discussion of why it is important to seek a connection with the "triple bottom line" including the social, environmental, and economic attributes of a given program/project/facility. It sheds light on the need to think beyond traditional life cycle cost analysis techniques that focus on direct cash benefits. It describes a process through which noncash and external costs and benefits can be calculated and presented in monetary terms, referred to as the Sustainable Return on Investment or SROI (direct cash + noncash + external costs and benefits = SROI). This paper should help readers make an aggressive case to reveal the FULL VALUE of Waste to Energy across the sustainability triple bottom line.

INTRODUCTION

We are living in a transformational period. Economic growth and consumption are down. Jobs are rapidly moving offshore. Consumer and government debt are at record levels. There is growing concern with regard to climate change. The long-term ramifications of this "perfect storm" of circumstances are staggering. They are also exciting, since together they open the door to action that could bring about change leading to a promising future. We are already seeing action. Congress passed ARRA 2009 in February of last year. Commonly known as Stimulus II, there is significant funding for programs that closely align with the waste management and Waste to Energy industry. In addition, funding for energy-related programs has been made available through the 2009 Omnibus Spending Bill and proposed in the President's budget for 2010. Looking further out, there are provisions in cap and trade legislation that could also support investments in waste management and Waste to Energy. Most political observers would agree that to a great degree, President Obama has staked his presidency on the success of his transformational vision, policy, and investments.

Jobs, Energy, and GHG Reductions

These investments have the potential to lead to large numbers of new "green" jobs linked to long-term growth of domestic industries that are difficult to move off shore. Further, they have the potential to create a new generation of energy-related programs that could increase efficiency, reduce demand, and shift emphasis away from fossil-fuel dependence to renewable energy and low-carbon solutions. The ability to make a credible and robust case for initiatives involving the combination of job creation, reduced dependency on fossil fuels, and reductions in greenhouse gas emissions can lead to favorable funding decisions by the federal government as well as state and local energy programs (generously funded via weatherization and Energy Efficiency and Conservation Block Grants).

Leverage, Transparency, and Specific Results

The up-side potential of recent government investments is significant; however, the down side is that even at current record spending levels, there may not be enough money set aside to jump-start a new, green economy. The administration is aware of the shortage and has taken significant steps to increase the odds of success. The White House is demanding results in exchange for federal funding as evidenced in the performance measurement, monitoring and reporting requirements accompanying the EECBG program. Communities that applied for grants are expected to make a compelling case including commitments achieving minimum leverage ratios of 5 local dollars to every grant dollar. Also, demands for transparency will help identify applicants who are most likely to be effective in their use of federal funds.

Additional evidence of the importance of making a case for specific results was provided on October 5, 2009 when the White House issued Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance, which took an unprecedented step by directing federal agencies to make a full accounting of the social and economic costs and benefits of their sustainability programs. The goal behind this mandate is to evaluate programs based on their sustainable performance beyond financial returns on investment to include results associated with the sustainability triple bottom line. According to the EO, programs that show positive results will be favored for additional funding. Those that do not will see funding reductions or terminations.

Waste management systems, specifically Waste to Energy, are excellent examples of outcomes of leverage, transparency, and documented results. Most of these systems/facilities involve some form of public /private/partnership, shared investment, risk, and results. They involve detailed service agreements describing performance expectations. Their permitting and performance monitoring requirements provide comprehensive information about facility input (including source and nature of the fuel feedstock and that portion that is biogenic) and output (including energy, emissions, recovered materials, and residuals). Further, municipal waste management programs keep track of material collection, shipping, and disposition data that can be useful in establishing and managing related GHG emissions (or avoided emissions).

Competition and Green Business Case

Competition for federal funding is intense and will continue to grow. For example, demand for $1.5 Billion in ARRA TIGER Grant funds topped $54 billion, which tells us there will be a few winners and many losers. Those "losers" will demand justification for decisions made, and transparency will grow in importance. It will not take long for applicants to refine the tactics needed to succeed in a competitive field. They will quickly learn they need to craft a "Green" Business Case around the total objective merit of a proposal to attain a score sufficient for a grant.

Successful applicants will pay careful attention to the policy objectives accompanying a grant program and the need to make a detailed case around projected results aligning with that policy. Waste management system and Waste to Energy facility operators are among many users with access to federal funding and will need to make a clear and compelling case for the environmental costs and benefits associated with investment in specific programs. As mentioned earlier, this field is full of ideal candidates for funding but short on specific examples of applicants making a detailed case.

How Will WTE Fare?

The Waste to Energy industry has traditionally been quiet regarding the performance metrics emerging federal policy is focused on: jobs, energy, reduced GHG emissions. Yet, compared to other renewable energy sources(aside from nuclear energy), no other alternatives come close to the scale, reliability, efficiency, and net GHG emissions benefits associated with Waste to Energy. The direct, indirect, and induced jobs involved in planning and developing new facilities, operating and maintaining existing plants, and retrofitting and expanding aging equipment involve significant and well-paid workers with knowledge and skill that cannot be furnished from a distant land. The energy produced in a typical facility surpasses the potential of many dozens of large-scale wind turbines that would have to operate 24/7/365 to match Waste to Energy performance. It would take thousands of solar PV cells and 24 hours of sun to produce comparable results.

These characteristics make Waste to Energy a good candidate to base-load electric power that cannot be provided by wind or solar sources. Approximately 60% of the post recycling municipal solid waste stream is biogenic and the source of low-carbon energy. The ability to generate 50+ megawatts of power continuously from a waste-material-based fuel stream can offset emissions from fossil-fueled facilities while avoiding emissions from long-haul waste transport and methane produced in MSW landfills. In addition, the record is clear that integrated waste management systems have higher recycling and material recovery rates and less dependence upon landfills that produce methane emissions. With all of these environmental benefits it is ironic that these systems are typically judged by one single number: the tipping fee, which hardly tells the story of environmental costs and benefits or the complete degree of “Green” contributed by these efforts.

Are We Prepared to Measure Green Value?

Waste to Energy is clearly associated with benefits that match the administration’s transformational objectives. But there is even more to the story. What is the full “Green” value of a Waste to Energy facility? How does it contribute to social, economic, and environmental costs and benefits? Are we measuring Waste to Energy’s *triple bottom line* to determine the direct cash, noncash and external costs and benefits of its social, environmental, and economic attributes? Are we finding ways to craft the Green Business Cases that could attract federal funding and a greater willingness to invest? Are we prepared to make our case when comparing this technology to the other choices available to public policy makers?

So far, the answer has been NO because the industry lacked a means to calculate its triple bottom line. Sustainable Return on Investment, or SROI, provides that means. It is a methodology and transparent framework through which Waste to Energy can be objectively evaluated with results reported in monetary and probabilistic terms.

MEASURING THE TRIPLE BOTOM LINE AT WASTE TO ENERGY FACILITIES

Recently, the SWANA Applied Research Foundation released a study entitled, “Waste-to-Energy as a Green Solid Waste Management Option for Non-Recycled Waste.” The December 2009 study (see http://swana.org) set out to “quantify the environmental benefits associated with the processing of non-recycled waste through WTE plants for electricity generation rather than disposing of this non-recycled waste in landfills." [Note: a co-author of this paper was among a group of SWANA ARF subscribers who provided funding for a series of applied research activities related to WTE].

The SWANA ARF effort used an environmental life cycle assessment approach to quantify and evaluate the environmental benefits and impacts, as well as sustainability characteristics associated with WTE as an alternative to landfilling non-recycled municipal solid waste and fossil-fuel-based energy production. The study assumed that aggressive measures are being taken with regard to material recovery and composting programs. It found that CO2 and other air emissions are significantly reduced when non-recycled waste is processed through WTE electricity generation rather than disposed of in MSW landfills. It stated that emissions reductions can be achieved as follows:

- Carbon dioxide – 728 pounds of CO2-E (Carbon dioxide equivalents) per ton of waste combusted;
- Carbon monoxide – 1.50 pounds per ton;
- Nitrogen oxides – 1.90 pounds per ton;
- Sulfur oxides – 6.52 pounds per ton; and
- Particulate matter – 1.47 pounds per ton.

The study goes on to report the following sustainable traits of WTE when used to process non-recycled materials (as opposed to landfilling and the use of fossil fuel based electricity generation):

- Results in waste stabilization;
- Avoids long-haul transport of waste for disposal;
- Provides long-term control over disposal capacity and pricing;
- Reduces reliance on fossil fuels;
- Provides a community with a base load renewable energy resource;
- Complements source separation recycling programs;
- Provides an opportunity for cogeneration;
- Is cleaner than coal or oil; and
- Minimizes landfill disposal.

These findings help in elevating the common understanding as to **environmental** benefits and impacts associated with WTE technology. There are additional benefits related to the social and economic implications that require analysis going beyond LCA to reveal the full value of the technology. The Sustainable Return on Investment (SROI) methodology, a framework for measuring the entire Sustainability Triple Bottom Line including the social, environmental, and economic costs and benefits associated with WTE and translating them into a common, monetary denominator is described below.

Policy makers and decision makers have shown a burgeoning interest in being able to make an objective case for sustainability based upon measurable economic, environmental and social benefits. The purpose of this document is to discuss HDR's SROI process and explain how it can be used to help promote sustainable investment strategies from an objective and transparent perspective that is linked to the triple bottom line of a project, both today and into the future.

<u>Comparison to Traditional Decision Tools</u>

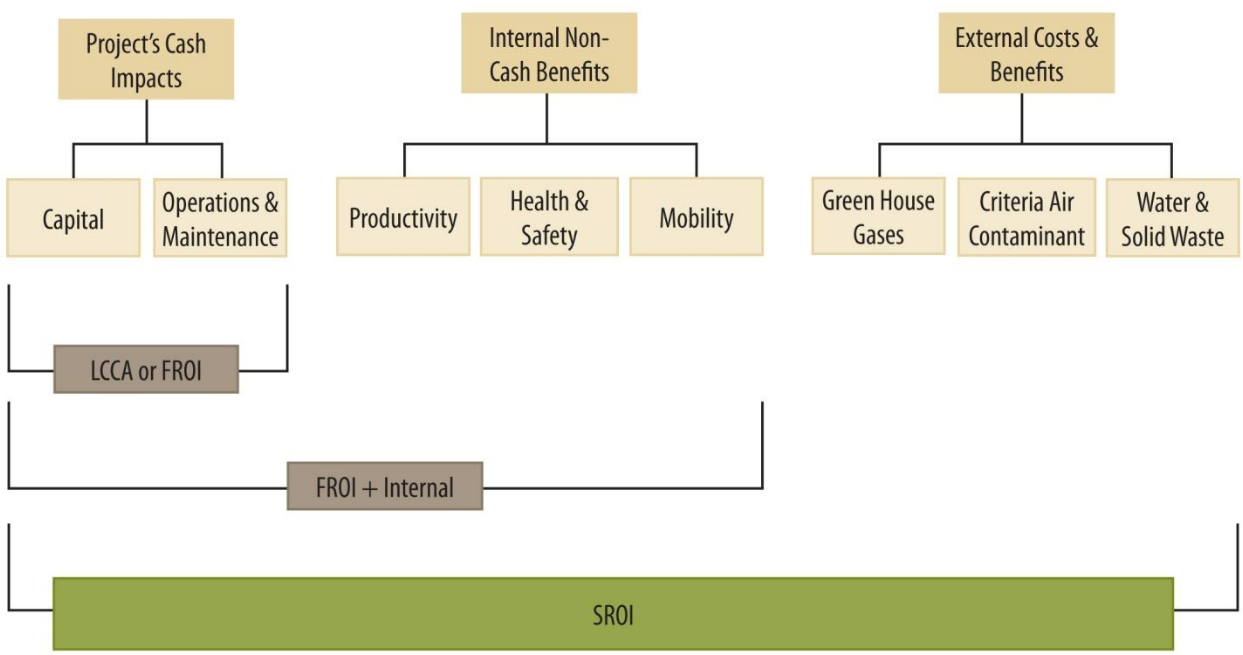
Traditional financial evaluation tools, such as Business Case Analysis or Life-Cycle Cost Analysis (LCCA), rely exclusively on financial impacts. In contrast to the broad-based analysis allowed through the SROI process, these traditional tools have two primary drawbacks:

1. An inability to accurately quantify the noncash benefits and costs accruing to both the organization in question and to society as a whole resulting from a specific investment; and
2. A failure to adequately incorporate the element of risk and uncertainty.

In contrast, the SROI process takes into account the entire scope of potential costs and benefits related to sustainability measures, while simultaneously incorporating a risk analysis component over the project's life-cycle. The process includes traditional input, such as savings on utility bills or reduced O&M costs, but also input data such as quantified environmental savings from reduced carbon emissions or the value of enhanced productivity from employees working in a green building (e.g., fewer sick days or performing a task more efficiently).

A key feature of SROI is that it converts to dollar terms (monetizes) the relevant social and environmental impacts of a project, yet still provides the equivalent of traditional financial metrics referred to as "Financial Return on Investment (FROI)". FROI accounts for internal (i.e., accruing to the organization) cash costs and benefits only, while SROI accounts for all internal and external costs and benefits. Figure 1 illustrates how traditional financial models differ from SROI.

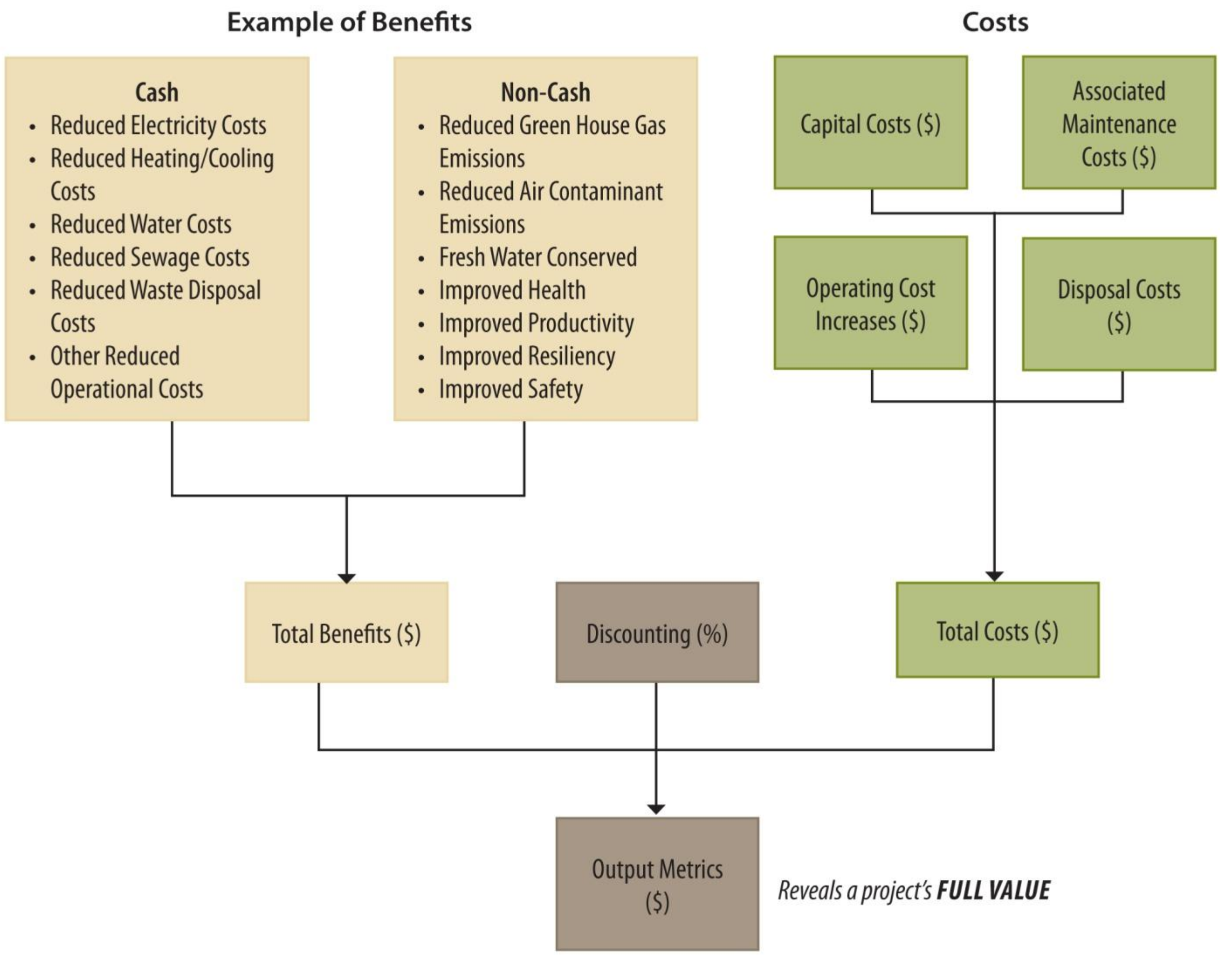
Figure 1: Comparison of SROI to Traditional Life-Cycle Costing



SROI Methodology

At the intersection of economics and sustainability lies the SROI process. The SROI framework provides comprehensive cost-benefit analysis, business-case analysis, economic impact assessment, risk analysis, consensus-based decision making for inputs, and a transparent and inclusive definition of environmental values. SROI incorporates economic treatment of environmental and social metrics while building consensus among stakeholders around measured values.

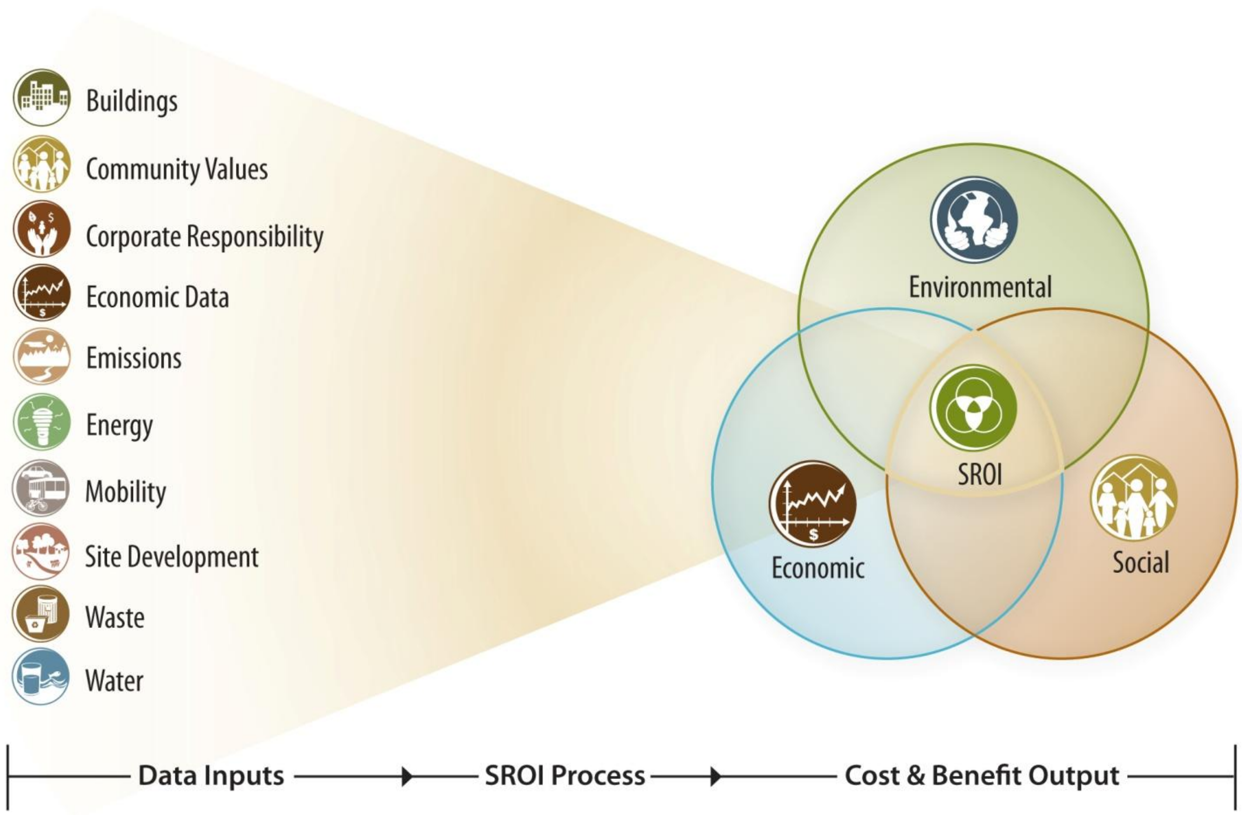
Figure 2: SROI Flow Diagram



The SROI Flow Diagram contains an overview of a wide variety of inputs that can be considered in the SROI model. Note that monetizing the non-cash inputs in the diagram below is what sets SROI apart from other methods. While non-cash inputs like improvement to community health, worker productivity, gallons of water conserved lack standard values, there is considerable peer reviewed research in each of these areas (and many others) to identify a range of potential values which can be refined to reflect specific geographic and/or market based factors. Prior to acceptance of any data input value into the SROI analysis, consensus among stakeholders and area experts as to the high, median and low value ranges is required.

The SROI process promotes transparency and accountability as entities seek to maximize the "triple bottom line" of economic, social and environmental value created by their activities (see Figure 3). The intent is to provide public agencies, NGOs and private corporations with a widely recognized and standardized process to model and prioritize projects to demonstrate the maximum and long-term return on their investment.

Figure 3: SROI Methodology Guides Your Decision Making Process



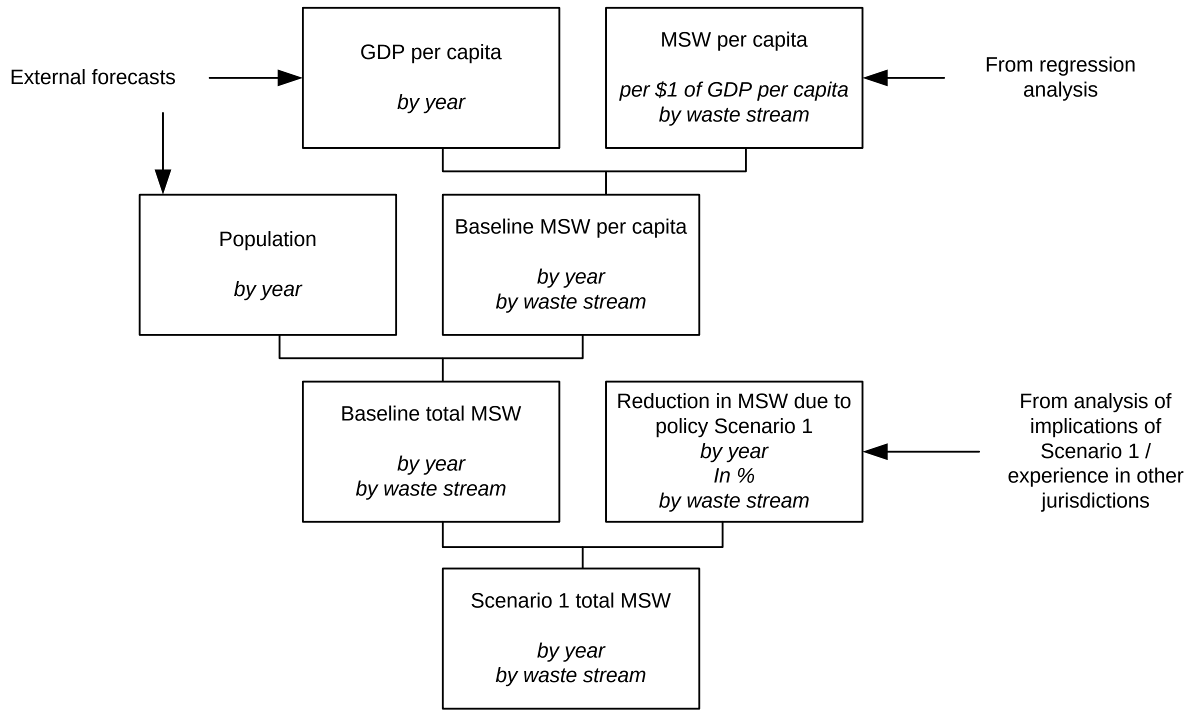
The SROI process involves four distinct steps:

1. Development of the structure and logic of costs and benefits over the project life cycle. This involves determining the costs and benefits that result from the proposed investment and a graphical depiction to quantify these values.
2. Quantification of input assumptions and assignment of risk/uncertainty. This step involves building the preliminary outline of the SROI model, populating the model with initial data assumptions and performing initial calculations for identified costs and benefits (financial, social and environmental).
3. Facilitation of a Risk Analysis Process (RAP) session. This is a meeting, similar to a one-day charrette, which brings together key stakeholders to reach consensus on input data values and calculations to be used in the model.
4. Simulation of outcomes and probabilistic analysis. The final step in the process is the generation of SROI metrics, including Net Present Value (NPV), Discounted Payback Period, Benefit-Cost Ratio and the Internal Rate of Re-turn, in addition to the traditional financial metrics. Financial metrics are included as a point of comparison and to transparently and comprehensively illustrate the relative merits of all potential investments being analyzed.

Step 1: Structure and Logic of the Cost and Benefits

A "structure and logic model" depicts the variables and cause and effect relationships that underpin the forecasting problem at-hand (see Figures 3 and 4). The structure and logic model is written mathematically to facilitate analysis and also depicted diagrammatically to permit stakeholder scrutiny and modification during Step 3.

Figure 4: Example of a Structure and Logic Diagram (Illustrative Example)

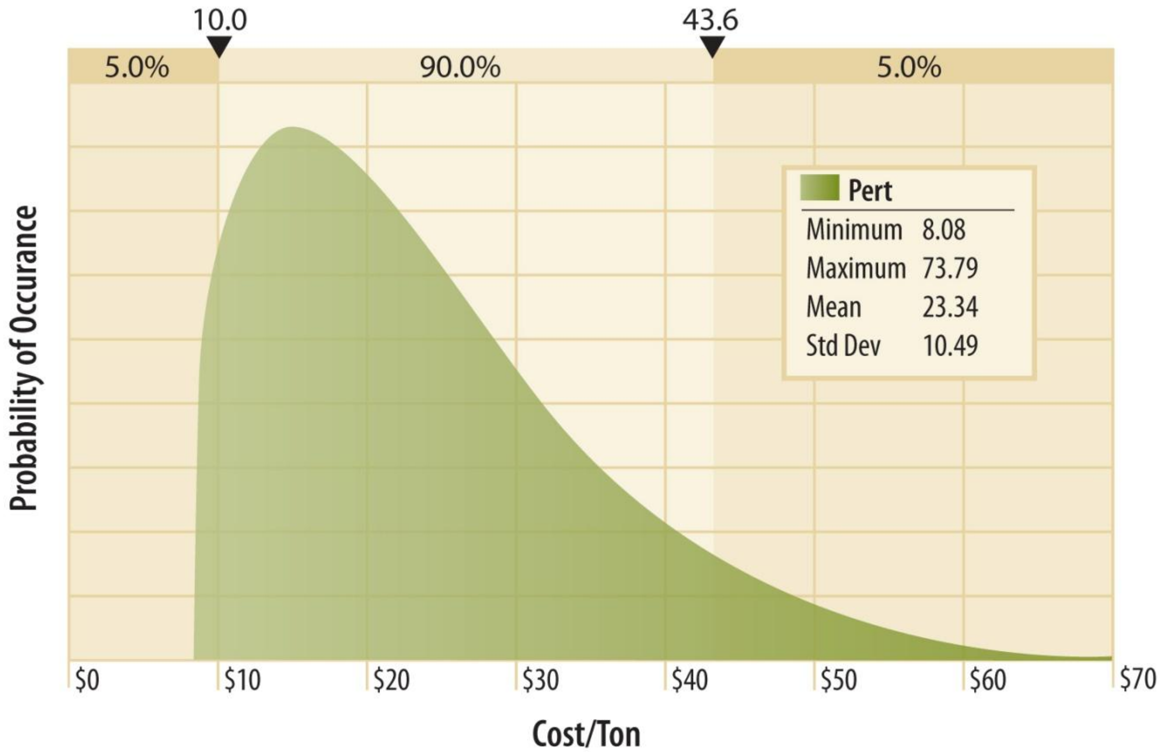


Step 2: Central Estimates and Probability Analysis

Risk analysis and Monte Carlo simulation techniques can be used to account for uncertainty in both the input values and model parameters. All projections and input values are expressed as probability distributions (a range of possible outcomes and the probability of each outcome), with a wider range of values provided for inputs exhibiting a greater degree of uncertainty. Of note, each element is converted into monetary values to estimate overall impacts in comparable financial terms and discounted to translate all values into present-value terms[1]. Specifying uncertainty ranges for key parameters entering the decision calculus allows the SROI framework to evaluate the full array of social costs and benefits of a project while illustrating the range of possible outcomes to fully inform decision-makers.

[1] Discounting all future monetary values to their present-day equivalents permits costs and benefits that arise over different periods to be compared on a common footing.

Figure 5: Probability Distribution for the Value of a Ton of CO_2



Each variable is assigned a central estimate and a range to represent the degree of uncertainty. Estimates are recorded on Excel-based data sheets (see Figure 6). The first column gives an initial median. The second and third columns define an uncertainty range representing a 90 percent confidence interval—the range within which there exists a 90 percent probability of finding the actual outcome. The greater the uncertainty associated with a forecast variable the wider the range.

Figure 6: Example of Data Input Sheet (Illustrative Example)

Market Price (Recycled Materials) $/tonne	Most Likely	Low	High
Paper	$79	$65	$90
Glass	$24	$15	$30
Ferrous Metals	$91	$80	$105
Aluminum	$1,180	$1,000	$1,300
Plastics	$6	$3	$10
Compost	$15	$10	$20

Probability ranges are established using both statistical analysis and subjective probability. Probability ranges do not have to be normal or symmetrical. In other words, there is no need to assume a bell-shaped normal probability curve. The bell curve assumes an equal likelihood of being too low and too high in forecasting a particular value. For example, if projected unit construction costs deviate from expectations, it is more likely that the costs will be higher than the median expected outcome than lower.

The risk analysis transforms the ranges depicted in Figure 6 into formal probability distributions (or “probability density functions”), helping stakeholders understand and participate in the process even without formal training in statistical analysis.

The central estimates and probability ranges for each assumption in the forecasting structure and logic framework come from three sources, as described below:

- The best available third party information from a variety of sources, including the Environmental Protection Agency, the Department of Energy, the Bureau of Labor Statistics, financial markets, universities, think tanks, etc.
- Historical analysis of statistical uncertainty in all variables and an error analysis of forecasting coefficients, which are numbers that represent the measured impact of one variable (say, the market price for recycled plastics) on another (such as the price of electricity). While these coefficients can only be known with uncertainty, statistical methods help uncover the level of uncertainty (using diagnostic statistics such as standard deviation, confidence intervals, and so on).
- Subjective probability. Obtaining subjective probabilities is the subject of Step 3.

Step 3: Expert Evaluation: The RAP© Session

The third step in the SROI process involves formation of an expert panel to hold a charette-like one- or two-day meeting called the Risk Analysis Process (RAP) session. It uses facilitation techniques to elicit risk and probability beliefs from participants about:

i. The structure of the forecasting framework
ii. Uncertainty attached to each input variable and forecasting coefficient in the framework.

In (i), experts are invited to add variables and hypothesized causal relationships that may be material, yet missing from the model. In (ii), panelists discuss a protocol where initial central estimates and ranges that were provided to panelists prior to the session are modified based on subjective expert beliefs.

Examples of typical RAP session participants include:

- **Client**
  - Project team
  - Technical specialists
  - Financial experts
- **HDR**
  - Facilitator
  - Economists
  - Technical

  - **Outside Experts**
  - **Public Agencies and Officials**
  - **Business Groups**

Step 4: Simulation of Outcomes and Probabilistic Analysis

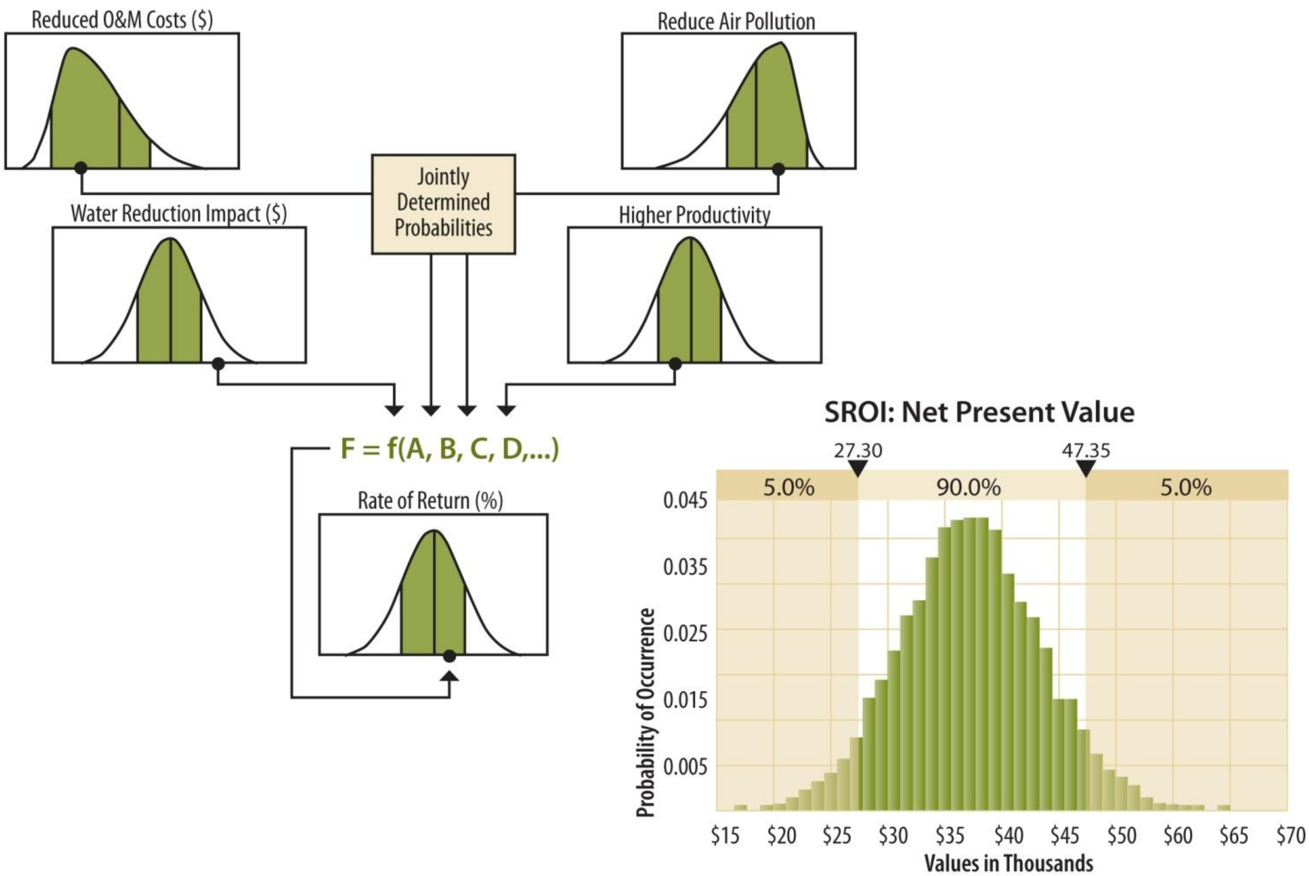
Traditional financial analysis takes the form of a single "expected outcome" supplemented with alternative scenarios. The limitation of a forecast with a single expected outcome is clear – while it may provide the single best statistical estimate, it offers no information about the range of other possible outcomes and their associated probabilities. The problem becomes acute when uncertainty surrounding the underlying assumptions of a forecast is material.

Another common approach to provide added perspective on reality is "sensitivity analysis." Key forecast assumptions are varied one at a time, in order, to assess their relative impact on the expected outcome. A concern with this approach is that assumptions are often varied by arbitrary amounts. A more serious concern with this approach is that, in the real world, assumptions do not veer from actual outcomes one at a time. Rather, the impact of simultaneous differences between assumptions and actual outcomes is needed to provide a realistic perspective on the riskiness of a forecast.

Risk analysis provides a way around the problems outlined above. It helps avoid the lack of perspective in "high" and "low" cases by measuring the probability or "odds" that an outcome will actually materialize. A risk-based approach allows all inputs to be varied simultaneously within their distributions, avoiding the problems inherent in conventional sensitivity analysis. Risk analysis also recognizes interrelationships between variables and their associated probability distributions.

In step four, final probability distributions are formulated by the risk analyst (Economist) and represent a combination of probability information drawn from Steps 2 and 3. These are combined using simulation techniques (called Monte Carlo analysis) that allow each variable and forecasting coefficient to vary simultaneously according to its associated probability distribution (Figure 7). The result is a forecast that includes estimates of the probability of achieving alternative outcomes given the uncertainty in underlying variables and coefficients.

Figure 7: Combining Probability Distributions (Illustrative Example)



SROI Outputs for Users

The SROI analysis produces results that address both financial and sustainable criteria using many popular financial/economic metrics. For example:

- **Net Present Value (NPV)**: The net value an investment or project adds to the value of the firm, calculated as the sum of the present value of future cash flows less the present value of the project's costs.
- **Return On Investment (ROI):** The ratio of the net value of an investment relative to the cost of the investment.
- **Discounted Payback Period (DPP):** The period of time required for the return on an investment to recover the sum of the original investment on a discounted cash flow basis.
- **Internal Rate of Return (IRR):** The discount rate at which the net present value of a project would be zero (represents the annualized effective compounded return rate which can be earned on the invested capital and is compared relative to the cost of capital.)
- **Benefit/Cost Ratio (B/C ratio):** The overall "value for money" of a project, expressed as the ratio of the benefits of a project relative to its costs, with both expressed in present-value monetary terms.

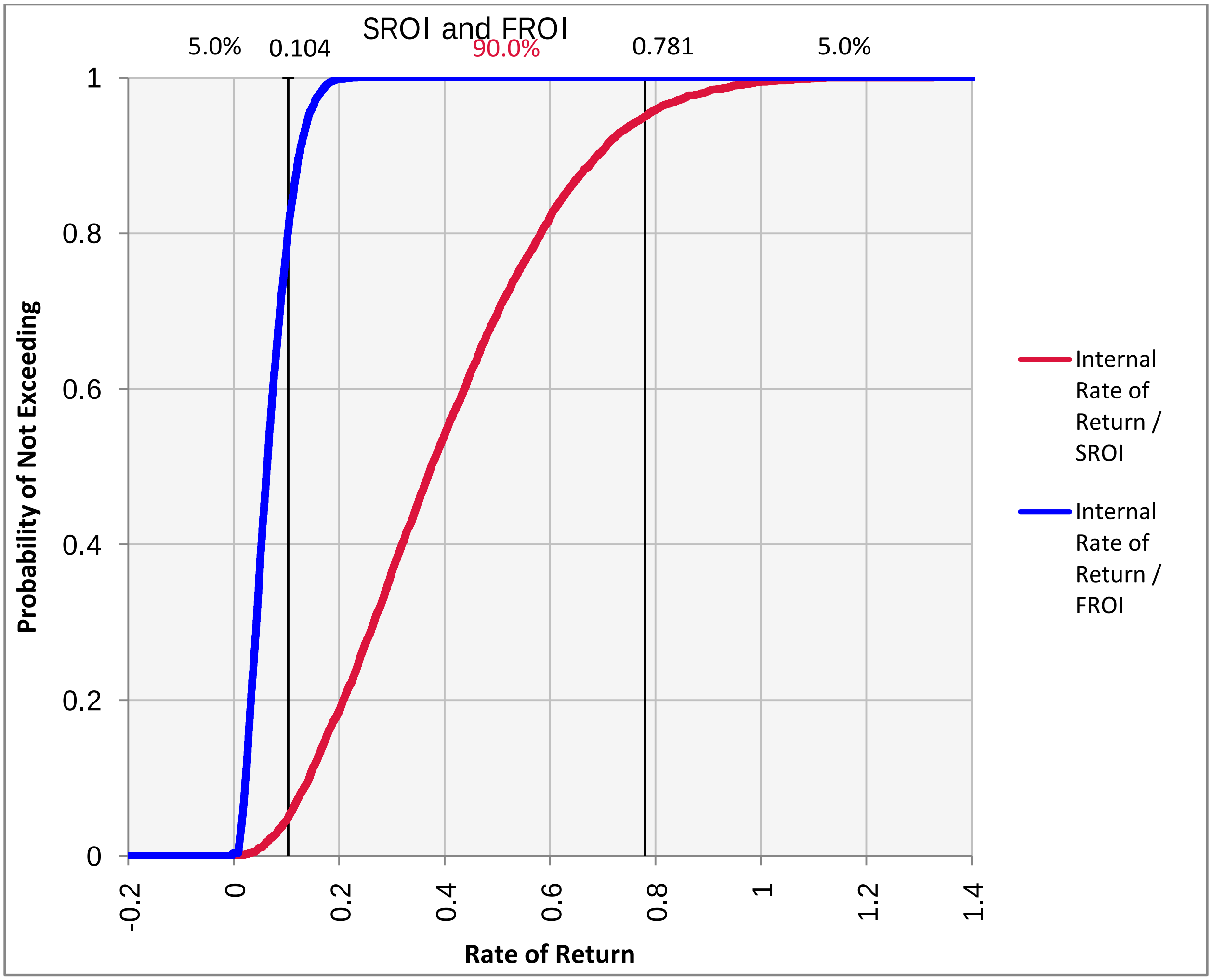
For example, suppose a municipality wanted to increase its recycling rate from 55% to 65% and at the same time produce energy from waste[2]. Comparing the full costs (social, environmental as well as private) costs and benefits and calculating the return on investment from this perspective gives the SROI. This can be compared with the more traditional FROI, which does not include these external costs and benefits (Figure 8).

Figure 8: Sample Comparison of the FROI and SROI for a Given Initiative

	Financial Return on Investment	**Sustainable Return on Investment**	**Notes**
Annual Benefits of Benefits $	$262,794	$9,322,181	Total value of benefits in first year
Net Present Value $, discounted at a 5% real rate	($19,045,781)	$203,325,513	PV of benefits less PV of costs
Internal Rate of Return %	6%	38%	Discount rate making NPV=0

[2] These results are from WasteDEC, a model that calculates the SROI, FROI and risk associated with several waste disposal technologies. The model uses ranges of values for inputs that are taken from industry experience and literature sources.

Figure 9: Sustainability "S" Curves Contrasting Rate of Return for a Waste to Energy Project



Using the SROI process allows decision-makers the ability to prioritize worthy—but competing—projects for funding based on the maximum financial and societal returns. In the example, a project's outcome metrics are synthesized into an intuitive risk analysis model based on return on investment.

A. Compare the financial return on investment and sustainable return on investment. In this example, the mean sustainable return on investment is more than six times the traditional return on investment.

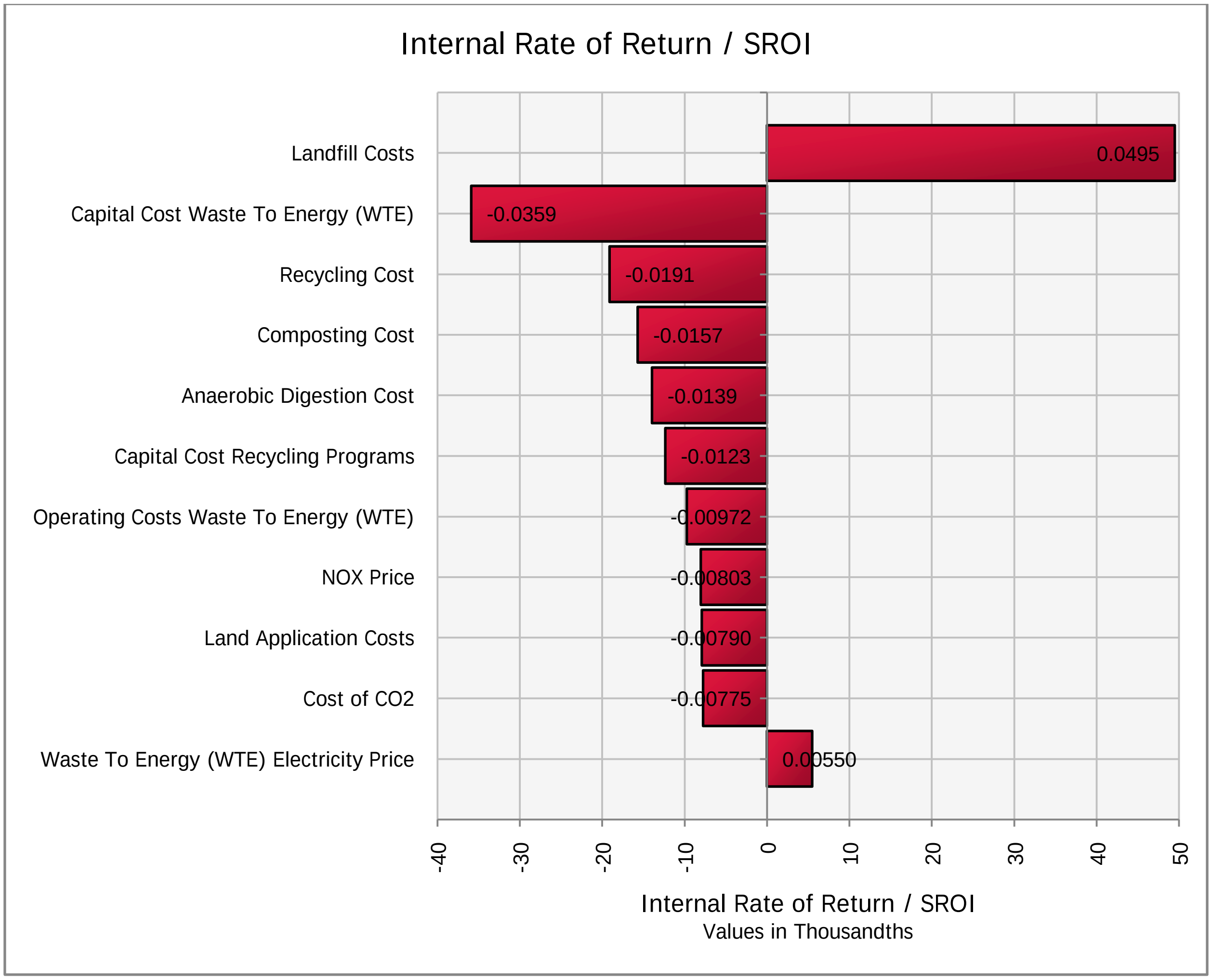
B. Evaluate noncash benefits, such as improvements in employee health and productivity, and the benefits to larger community.

C. Assess the statistical likelihood that return will fall within an 80% confidence interval. In this example, sustainable return on investment ranges from 10% to 78%.

This recycling and Waste-to-Energy project (Figure 9) for the municipality might have been rejected on traditional business case (FROI) criteria, a 6% rate of return might not have been deemed acceptable. Looking at external costs and benefits of the alternatives such as the true, social, costs of landfilling and benefits of Waste to Energy the SROI suggests that this project is a winner with a mean return (SROI) of 38%. Decision makers can also be sure that the risk has been accounted for and measured. If they are risk averse and want to be 90% sure, then they can count on an SROI of at least 10%.

An additional benefit of SROI risk-adjusted results is that risks are quantified and can be ranked so risk mitigation plans can be formulated. A tornado diagram (Figure 10) ranks the risk from biggest (at the top) to smallest (at the bottom).

Figure 10: Tornado Diagram Illustration of Risk Ranking Tool



CONCLUSION

While there is general agreement about the importance of social impacts, with the environment front and center, there is less of a consensus regarding how organizations can account for socially responsible actions. As a result, Waste to Energy proponents has many questions about how to incorporate and achieve sustainability in projects and programs: What external costs and benefits should be considered? How should these costs and benefits be measured? Which alternative provides the optimal triple bottom line payoff? What's the probability of breaking even?

The SROI framework addresses these questions by incorporating a transparent probabilistic methodology that adheres to well-established economic concepts. As such, the SROI framework can be used to determine which projects should be undertaken – from both a business case perspective and from a social perspective.