# Developing a Financial and Strategic Analysis for Toxics Use Reduction Projects

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WPI

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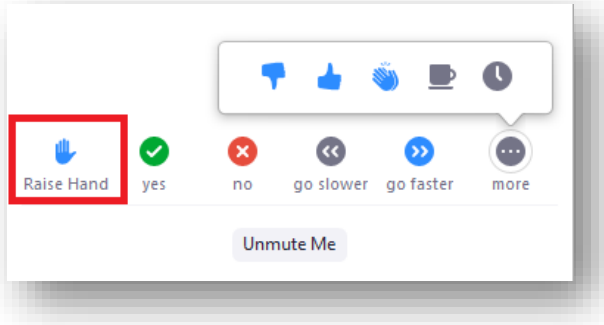


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# Introducing Joe Sarkis

Joseph Sarkis is a Professor of Management and Sustainability within the Foisie Business School at Worcester Polytechnic Institute. He earned his Ph.D. from the University of Buffalo. His research and teaching interests include Sustainability, Technology, Operations and Supply Chain Management. He has authored over 450 publications and is a highly cited researcher. He is an Industrial Ecology Fellow and has served as research scholar at universities throughout the world. He is a program coordinator for the Greening of Industry Networks. He is currently Editor-in-Chief of *IEEE Engineering Management Review* and Associate Editor for the journal *Resources Conservation and Recycling* on the topic of sustainable supply chains

# Agenda

- Purpose and Goal
- Making the Business Case – Financial
  - Cash Flows
  - Financial Appraisal Techniques
    - Payback
    - ROI
    - NPV
  - Non-Financial Factors and Measures
  - Integrating Financial and Non-Financial Measures
- Conclusion

# Purpose and Goals

- Discuss how projects can be evaluated for organizations.
- Provide insights into models, tools, and considerations for this evaluation.
- Discuss how to make the ‘Business Case’ for a decision.
- Emphasize alternative processes and substitutions to reduce environmental damage.

# Economic Infeasibility “Off-Ramp”

**50.46: Technical Evaluation of Toxics Use Reduction Techniques**

2) Toxics users need not complete the evaluation of a particular TUR option if, during the evaluation, the toxics user determines that the TUR option being evaluated is not appropriate for any of the following reasons:

   b) the technique is ***clearly*** economically infeasible, as determined pursuant to 310 CMR 50.46A;

   c) implementation of the technology, procedure, or training program is ***not likely to result in a decrease*** in the amount of toxics used per unit of product or the amount of toxics generated as byproduct per unit of product.

# 50.46A: Economic Evaluation of Potential TUR Techniques

1. Toxics users shall evaluate the economic feasibility of each TUR option identified as technically feasible ***as compared to the current operations involving the toxic***. The following items must be considered if relevant:
   a) indirect and direct **labor and materials costs**;
   b) purchase or manufacturing **cost of the toxic and its alternative** chemical;
   **c) capital and equipment costs**;
   **d) storage, accumulation, treatment, disposal, and handling costs** associated with toxics and byproducts;
   e) costs associated with **activities required to comply with local, state, or federal laws or regulations,** (e.g., fees, taxes, and costs associated with treatment, disposal, reporting and labeling);
   **f) worker health or safety costs** associated with the toxic and its alternative chemical (e.g., protective equipment, and lost employee time due to accidents or routine exposure to the toxic);
   **g) insurance**;
   **h) potential liability costs**; and
   **i) loss of community goodwill and product sales lost** to competing non-toxic products.

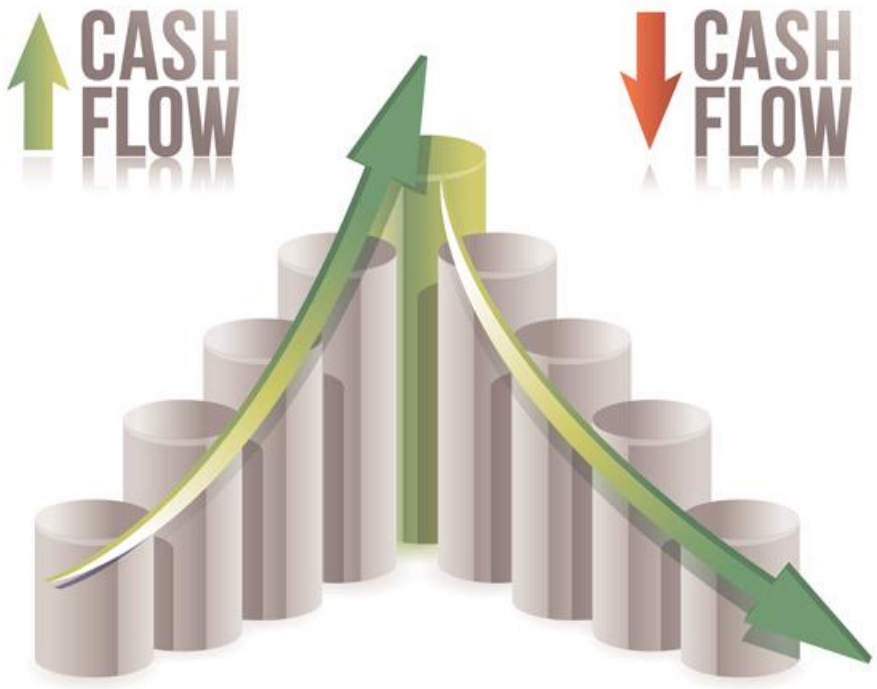
Understand how companies make financial appraisals and capital budgeting is first step.


# Financial Appraisal and Capital Budgeting

- In organizations the first question usually is: How much will this cost us?  What are our cash flows?
- This is a financial decision.
- So how to do an analysis that an organization will accept?
- Not only evaluation – but it is about selling the whole package – you begin with price; it need not end there.

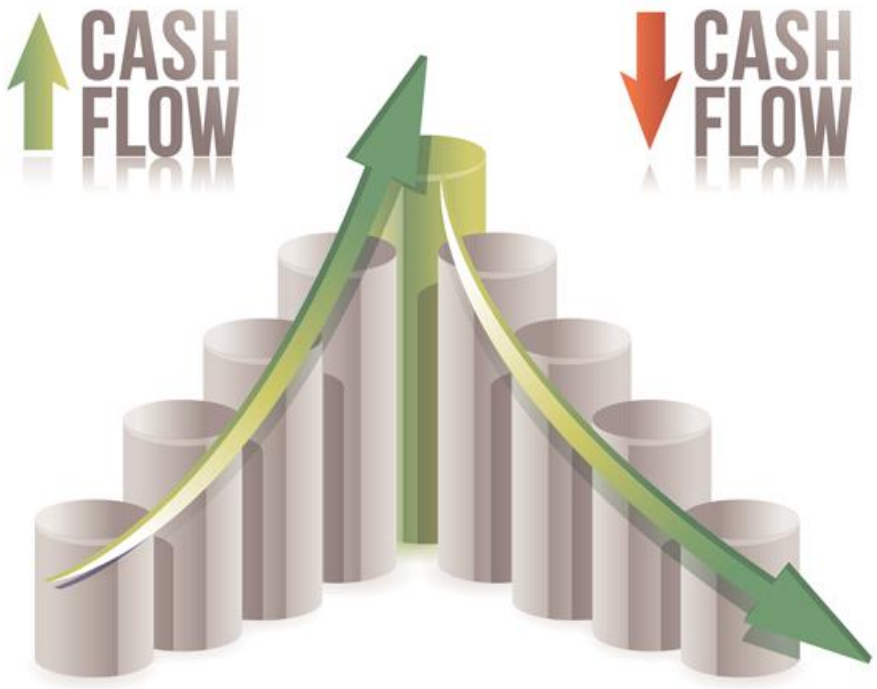
# Cash Flows

- How much money a company has paid out or received (Accounting field is focused on this)
- Three Types
  - Operational
  - Investment Cash Flows  (Buying and Selling)
  - Financing Cash Flows
- We will consider Operational and Investment – A very high level
- A short video
  - https://www.youtube.com/watch?v=hISdzmjNO5w



# Cash flows

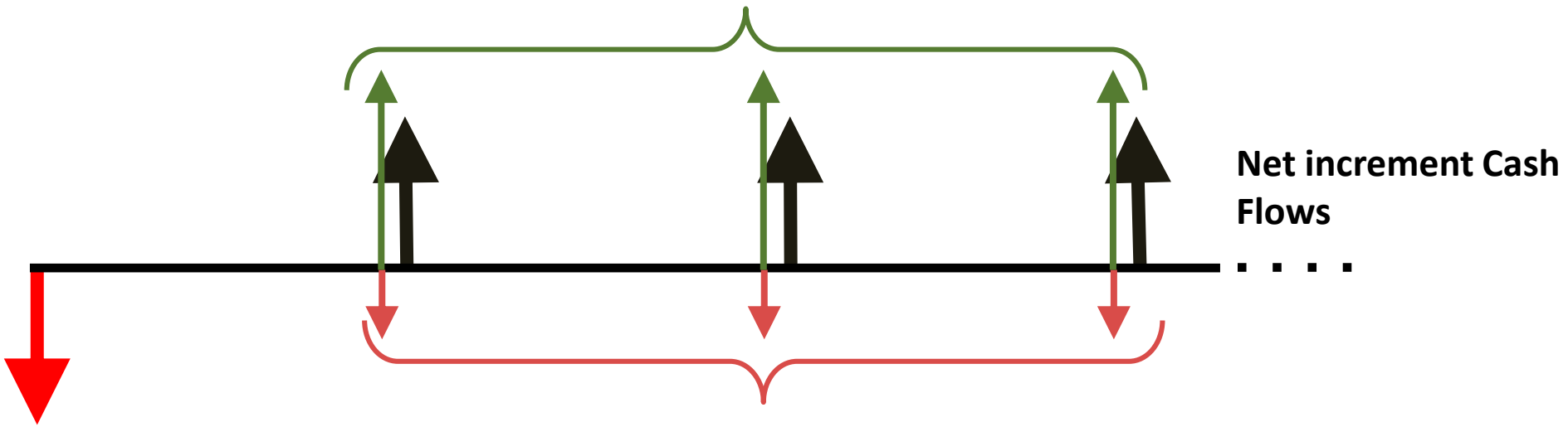
- You need to determine how much cash or benefit will flow over multiple time periods.
- Can be represented in many ways.



# Cash Flow Timeline

Inflows (savings):

- Increased production
- Avoided compliance costs
- Reduced waste & scrap
- Avoided treatment & disposal
- Reduced insurance




Purchase, Installation

Outflows (costs):

- Utilities
- Operation & Maintenance
- Raw materials

# Cash Flow Example

## A Simple Example – Purchasing a Solvent Recovery Unit


| End of Year | Incremental Savings (G) | Incremental Operating Costs [C] | Borrowed Money Receipts [B] | Principal [P] | Interest [I] | Tax Depreciation [D] | Capital Investment [K] | Salvage [L] | Other | Net Cash Flow [X] | Cumulative [NCF] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | $ 2,000 | | | $ (2,000) | $ (2,000) |
| 1 | $ 3,000 | $ 1,500 | | | | $ 500 | | | | $ 1,000 | $ (1,000) |
| 2 | $ 2,600 | $ 1,500 | | | | $ 500 | | | | $ 800 | $ (200) |
| 3 | $ 2,200 | $ 1,500 | | | | $ 500 | | | | $ 600 | $ 400 |
| 4 | $ 1,400 | $ 1,500 | | | | $ 500 | | | | $ 200 | $ 600 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | Tax Rate | 0.5 | | | | | | | | | |
| | Hurdle Rate | 0.12 | | | | | | | | | |

# General Formula for Cash Flows

The Net Cash Flow =

Incremental Savings – Incremental Operating Cost - *Taxes on Profit* – Capital Investment + Salvage Value

Taxes on Profit = (Incremental Savings – Incremental Operating Cost – Capital Investment – Depreciation) * Tax Rate


# Breakout Discussion (10 min)

We have seen an example of a potential cash flow statement.

Cash flows are needed for financial appraisal.

- To whom and where would you go to gather cost and benefit information?
- What “other” cost or benefit categories might exist?

# Potential Costs to Consider

| MATERIALS | LABOR | EQUIPMENT | OTHER |
|---|---|---|---|
| Raw materials | Production | Production | Depreciation |
| Solvents | Material handling | Cleaning | Maintenance |
| Cleaners | Inspection | Degreasing | Waste disposal |
| Process water | Recordkeeping | Material handling | Insurance |
| Cleaning water | Reporting | Storage | Taxes |
| Office supplies | Monitoring | Waste treatment | Utilities |
| Training materials | Labeling | Water treatment | Regulatory fees |
| Safety materials | Manifesting | Air pollution control | Lab fees |
| Parts | Stocking | Painting | Health & Safety |
| | Training | Protective | Liability |
| | | Safety | |


# Financial Appraisal – Capital Budgeting Methods

# Payback Period

**Payback Period Formula** =

$$\frac{\text{Initial Investment Made}}{\text{Net Annual Cash Inflow}}$$

# Simple Payback Example

| | Year (t) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Project A | Net cash flow | (2,000) | 1,000 | 800 | 600 | 200 |
| | Cumulative NCF | (2,000) | (1,000) | (200) | 400 | 600 |
| Project B | Net cash flow | (2,000) | 200 | 600 | 800 | 1,200 |
| | Cumulative NCF | (2,000) | (1,800) | (1,200) | (400) | 800 |

$$\text{payback period} = \text{full years until recovery} + \frac{\text{unrecovered cost at the beginning of last year}}{\text{cash flow during the last year}}$$

$$\text{payback period A} = 2 + \frac{200}{600} = 2.33 \text{ years}$$

$$\text{payback period B} = 3 + \frac{400}{1200} = 3.33 \text{ years}$$

# Payback Advantages and Limitations

- Payback period is simple and considers cash flows.
- It is ‘myopic’ – very short-term results oriented
- Payback period does not take into account the opportunity cost of money (also mentioned as the time value of money)
- It does not consider cash flows beyond the payback period, which means terminal or salvage value wouldn’t be considered.
- Payback period is not a useful measure of profitability.

# Return on Investment (ROI)

Return (Benefit)

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Investment (Cost)

= ROI

# Return on Investment

| | Year (t) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Project A | Net cash flow | (2,000) | 1,000 | 800 | 600 | 200 |
| | Cumulative NCF | (2,000) | (1,000) | (200) | 400 | 600 |
| Project B | Net cash flow | (2,000) | 200 | 600 | 800 | 1,200 |
| | Cumulative NCF | (2,000) | (1,800) | (1,200) | (400) | 800 |

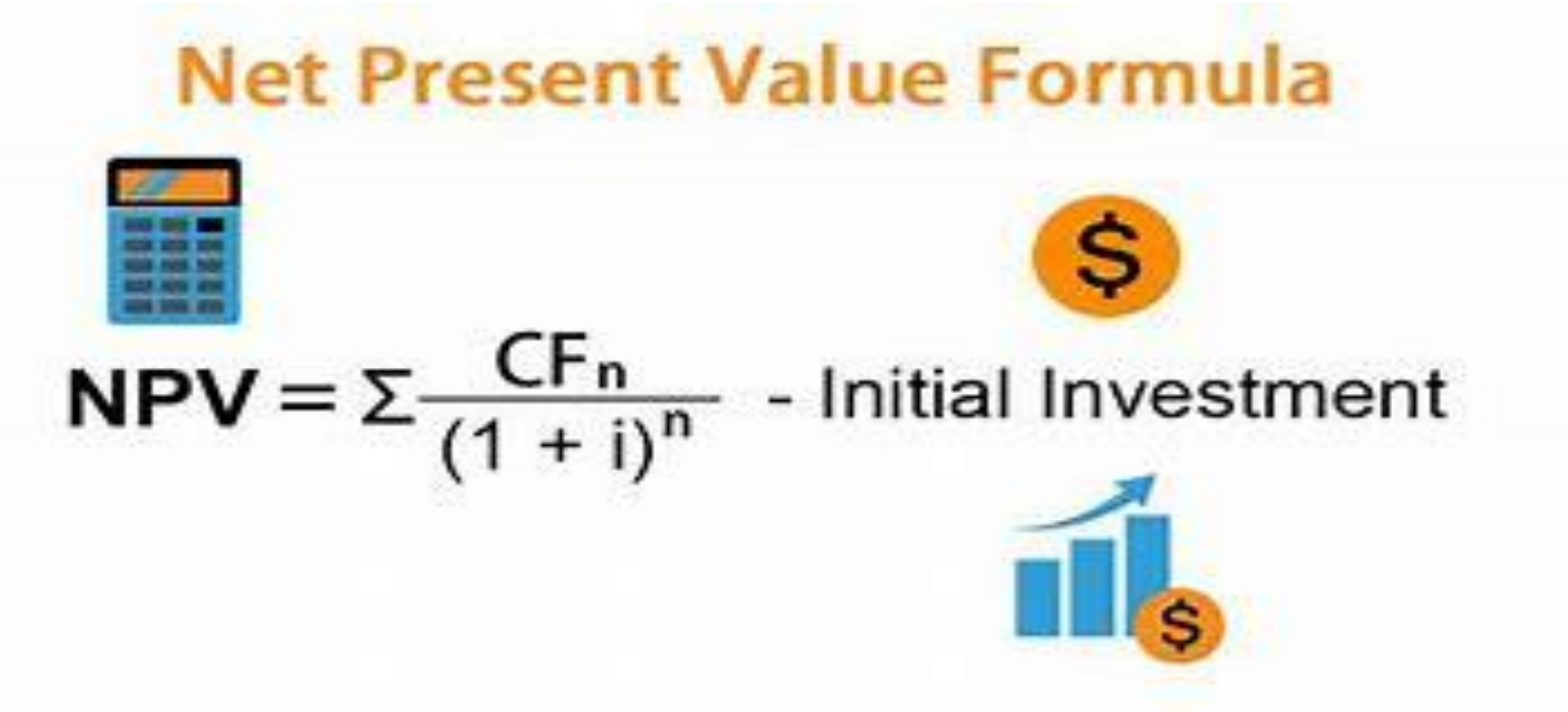
$$\text{ROI for Project A} = \frac{\text{Total Benefit Over 4 years} - \text{Total Investment}}{\text{Total Investment}} = \frac{1000 + 800 + 600 + 200 - 2000}{2000} = .30 = 30\%$$

$$\text{ROI for Project B} = \frac{\text{Total Benefit Over 4 years} - \text{Total Investment}}{\text{Total Investment}} = \frac{200 + 600 + 800 + 1000 - 2000}{2000} = .30 = 30\%$$

# ROI Advantages and Limitations

- ROI is simple and considers cash flows.
- ROI considers profitability – but is usually sole focus.
- It can consider cash flows beyond the payback period
- It is ‘myopic’ – very short-term results oriented – strategic concerns ignored
- ROI may not take into account the opportunity cost of money

# Net Present Value

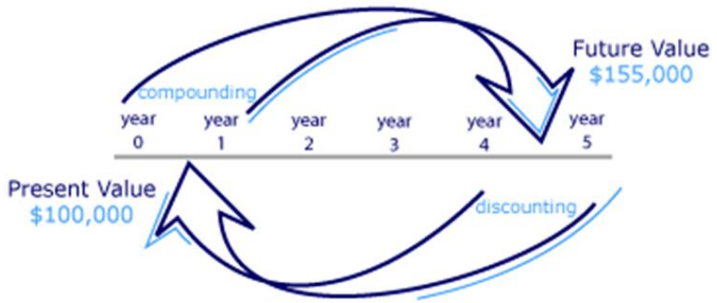



$CF_n$= Net Cash Flow in Time period n (same as NCF in our original notation and t is time in our original notation).

# Net Present Value (NPV)

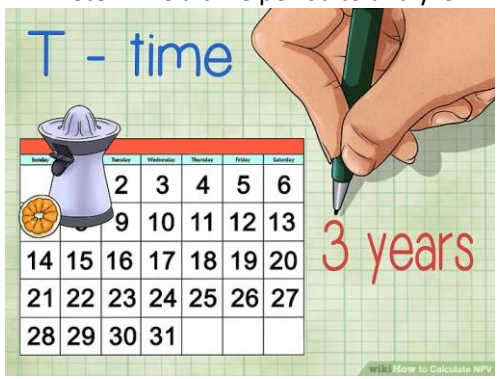
https://www.wikihow.com/Calculate-NPV

The time value of money




1. Determine your initial investment.

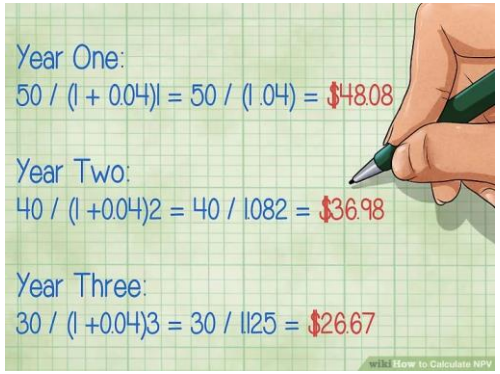

2. Determine a time period to analyze



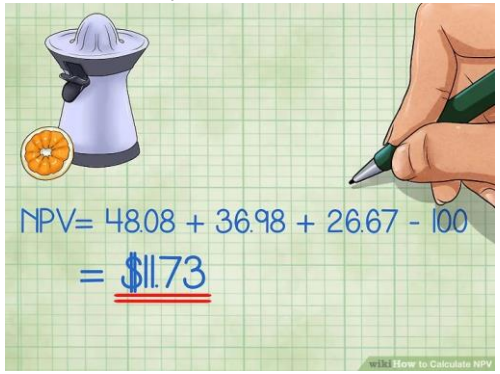

3. Estimate your cash inflow for each time period.


4. Determine the appropriate discount rate.

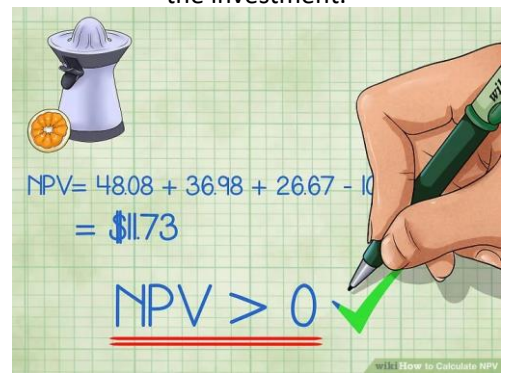

5. Discount your cash inflows.




6. Sum your discounted cash flows and subtract your initial investment.




7. Determine whether or not to make the investment.



# Net Present Value for Example

| | Year (t) | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| Project A | Net cash flow | (2,000) | 1,000 | 800 | 600 | 200 |
| | Cumulative NCF | (2,000) | (1,000) | (200) | 400 | 600 |
| Project B | Net cash flow | (2,000) | 200 | 600 | 800 | 1,200 |
| | Cumulative NCF | (2,000) | (1,800) | (1,200) | (400) | 800 |

Note that the discount rate or hurdle rate (we assume the same for this case) is 12% or 0.12

$$NPV_{Project\ A} = \frac{\$1{,}000}{(1+0.12)^1} + \frac{\$800}{(1+0.12)^2} + \frac{\$600}{(1+0.12)^3} + \frac{\$200}{(1+0.12)^4} - \$2000 = \$84.78$$

$$NPV_{Project\ B} = \frac{\$200}{(1+0.12)^1} + \frac{\$600}{(1+0.12)^2} + \frac{\$800}{(1+0.12)^3} + \frac{\$1{,}200}{(1+0.12)^4} - \$2000 = \$(11.07)$$

# NPV Advantages and Limitations

- NPV takes into account the opportunity cost of money (hurdle rate/discount rate/rate of return)
- NPV considers cash flows.
- NPV considers profitability – and is usually sole focus.
- It is less ‘myopic’ – but short-term financial results are included – strategic concerns ignored
- It is a little more difficult to calculate – harder for management to manipulate (managers don’t like this).
- Not always clear how discount/hurdle rate determined

## Summary of Financial Measures

| | Project A | Project B |
|---|---|---|
| Payback | 2.33 years | 3.33 years |
| ROI | 30% | 30% |
| NPV | $84.78 | ($11.07) |

- Which project would you select?
- What is wrong with this analysis?
- Other tools not covered here
  - Internal Rate of Return (IRR)
  - Accounting Rate of Return (ARR)

You can find many tutorials on YouTube. Here is one: https://www.youtube.com/watch?v=19n-4yf9jlE

# Poll #1 – Metrics


- Which technique would best convey information to financial people about opportunity costs associated with a TUR option?
  - Cash flows
  - Payback
  - Return on Investment (ROI)
  - Net Present Value

# Making the Business Case

- We have the financial measures.  If that is all, we are done – but it is not all.
- Issues to consider:
  - Which technique?
  - Are the numbers correct?
    - Sensitivity analysis will help get around uncertainty in costs and numbers
  - Should you select one of these projects or not do anything?
  - What other factors could/should be considered?


# Breakout Discussion (10 min)

Brainstorm factors that are not necessarily financial (or tangible) but can influence whether a project is selected.

Consider what would inform you on how to weigh various factors.


# Breakout Session

- What other factors exist?

# Possible business strategic priorities

Increased profit = reduced costs + increased revenue

Increased market share

Greater operational efficiency

Faster time-to-market

Good neighbor

Breakthrough products or services

Leadership in…

- Price
- Quality
- Technology
- Customer response

Parent company goals

GHG reduction

Energy efficiency

# Other Measures – Quantitative and Business Factors

- Productivity
- Product Quality
- Market Share
- Employee Health and Safety
- Stakeholder Relations
- Public Image
- Criminal Liability
- Financial Liability
  - Storage and Disposal
  - Real Property Damage
  - Civil Actions/ Toxic Tort Suits
  - Fines and Penalties

# Example Categories and Types of Measures and Metrics

**Financial Quantitative**
NPV
Payback
ROI

**Quantitative**
Lead Waste
Hazardous Chemicals
Throughput Time
Consumer Responses (market share)
Percentage of Recycled Materials

**Qualitative**
Corporate Reputation
Strategic Fit
Community Goodwill
Employee Safety

# How might you integrate Financial and Non-Financial Measures together?

- Use a Narrative – tell a story with numbers where needed - Qualitative
  - Identify the Problem
  - Identify the Alternatives for solving problem
    - Link it to strategy of the organization
    - Link it to business performance metrics
    - Present the Financial Results
  - Present your recommendations

# A Quantitative Approach to Integrate?

- **A Simple Scoring Approach**

  - Determine factors
  - Determine relative importance of factors
  - Weight the factor importance

  - Determine how well each alternative (option) performs on each factor
  - Score or weight the performance of each factor
  - Normalize factors performance scores
  - Multiply the importance weight of each factor by the performance of each alternative on a factor
  - Sum up the products

# A Weighted Factor Scoring Approach

**Example Calculation:**

NPV Factor Relative Importance weight is 0.20

NPV for Option A is scored a 5

NPV Weighted Score for Option A is 0.20 x 5 = 1.00

| | Relative Factor Importance | Option A Factor Performance | Option B Factor Performance | Option A Weighted Score | Option B Weighted Score |
|---|---|---|---|---|---|
| **Financial Quantitative** | | | | | |
| NPV | ***0.20*** | ***5*** | 0 | ***1.00*** | 0.00 |
| Payback | 0.05 | 3 | 2 | 0.15 | 0.10 |
| ROI | 0.05 | 3 | 3 | 0.15 | 0.15 |
| | | | | | |
| **Quantitative** | | | | | |
| Lead Waste | 0.05 | 6 | 6 | 0.30 | 0.30 |
| Hazardous Chemicals | 0.10 | 5 | 7 | 0.50 | 0.70 |
| Throughput Time | 0.05 | 3 | 3 | 0.15 | 0.15 |
| Consumer Responses (market share) | 0.05 | 8 | 8 | 0.40 | 0.40 |
| Percentage of Recycled Materials | 0.10 | 8 | 8 | 0.80 | 0.80 |
| | | | | | |
| **Qualitative** | | | | | |
| Corporate Reputation | 0.15 | 4 | 3 | 0.60 | 0.45 |
| Strategic Fit | 0.05 | 6 | 5 | 0.30 | 0.25 |
| Community Goodwill | 0.05 | 6 | 6 | 0.30 | 0.30 |
| Employee Safety | 0.10 | 8 | 8 | 0.80 | 0.80 |
| | | | | | |
| Summation | **1.00** | | | **5.45** | **4.40** |

# Poll #2

Who would you ask for information related to weighing the value of maintaining your company's reputation

- Senior Manager
- Equipment operator
- Vendor
- Regulators
- Community groups
- Other

# Poll #3

- Who would you ask for information related to weighing the cost associated with toxicity of material choices
  - Senior Manager
  - Environmental Health and Safety
  - TURA program (e.g., TURI, OTA, DEP)
  - Vendor
  - Online resources
  - Other

| Alternative 1 | Utility Functions | | | | Values | | Calculations | |
|---|---|---|---|---|---|---|---|---|
| Metrics | Target | Upper | Lower | Type (I, D, P) | Estimated Value | Normalized Value | Weight | **Strategic Metric Total** |
| **Financial Quantitative** | | | | | | | | |
| NPV | >= 0 | 5000 | 0 | I | 991 | 1.0 | 0.32 | 0.3 |
| Payback | 0 | 2 | 0 | D | 3.3 | 0.0 | 0.04 | 0.0 |
| ROI (per year) | >= 0.2 | 0.7 | 0.1 | I | 0.11 | 0.8 | 0.04 | 0.0 |
| **Quantitative** | | | | | | | | |
| Lead waste (tons/yr) | 0 | 150 | 0 | D | 30 | 4.0 | 0.06 | 0.2 |
| Hazardous chemical waste (savings gal/mon) | 1000 | 1000 | 0 | I | 900 | 4.5 | 0.16 | 0.7 |
| PCB board throughput time | 0 | 12 | 6 | D | 6.5 | 4.6 | 0.08 | 0.4 |
| Consumer responses (% increase market share) | 100% | 10% | 0% | I | 5% | 2.5 | 0.04 | 0.1 |
| % use of recycled materials and products | 100% | 40% | 0 | I | 35% | 4.4 | 0.07 | 0.3 |
| **Qualitative** | | | | | | | | |
| Employee relations | 5 | 5 | 0 | I | 4 | 4.0 | 0.02 | 0.1 |
| Community goodwill | 5 | 5 | 0 | I | 5 | 5.0 | 0.08 | 0.4 |
| Corporate image | 5 | 5 | 0 | I | 5 | 5.0 | 0.11 | 0.6 |
| | | | | | | | | |
| | | | | | | **Total** | | **3.1** |

# “Selling” TUR – Make the Business Case

Get to the right decision makers

LISTEN – understand ***business*** goals, not just environmental goals

Communicate the right message the right way

# Some additional thoughts

- Numbers can be manipulated – be ready to justify or have justified.
- There will be differences in opinion on some factors – be ready to reconcile
- Numbers are can be inaccurate and fuzzy – sensitivity analyses
  - Alter values and see what happens to solution – Is it robust?
- Be honest and transparent

# Conclusion