Life-Cycle Cost Analysis:

Making Sense of the “Alphabet Soup”

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OUTLINE

• LCCA Overview
• Terms, Definition, Uses
• Payback Example
• NPV & IRR Examples
• LCOE
• Resources

Nothing happens until somebody SELLS something.
<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback</td>
<td>Initial investment / annual savings</td>
</tr>
<tr>
<td>Discounted Payback</td>
<td>Initial investment / discounted sav.</td>
</tr>
<tr>
<td>LCCA – Life-Cycle Cost Analysis</td>
<td>PV of Lifetime Costs &amp; Savings</td>
</tr>
<tr>
<td>NPV – Net Present Value</td>
<td>Investment Value in today’s $</td>
</tr>
<tr>
<td>NPW (PV) – Net Present Worth</td>
<td>&lt;ditto&gt;</td>
</tr>
<tr>
<td>DCF – Discounted Cash Flow</td>
<td>&lt;ditto&gt;</td>
</tr>
<tr>
<td>IRR – Internal Rate of Return</td>
<td>Equiv Rate of Ret. from Investmnt</td>
</tr>
<tr>
<td>LCOE – Levelized Cost of Energy</td>
<td>Level Cost of Providing Energy</td>
</tr>
<tr>
<td>ROI – Return on Investment</td>
<td>(Gain-Cost)/Cost, Net Earn/Investmt</td>
</tr>
<tr>
<td>ROE – Return on Equity</td>
<td>(Gain-Equity)/Eq, Net Earn/SH Eq</td>
</tr>
</tbody>
</table>
Pros & Cons

<table>
<thead>
<tr>
<th>Payback</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
| LCCA     | Intuitive, Simple | Ignores Savings>
|Disc. Payback | Time Value of $ | Paybk Date <ditto> |
| NPV      | “Gold Standard” | Many Inputs, Less Intuitive |
| NPW (PV) | Intuitive, Commonly Used | Hidden Pitfalls |
| DCF      | Intuitive, “Market-Based” | More Complex Calcs |
| IRR      |            |           |
| LCOE     |            |           |
| ROI      |            |           |
| ROE      |            |           |

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How are they Applied?

**Decision Rule**

- **Payback**
  - Payback < target => “Accept”

- **Disc. Payback**
  - Payback < target => “Accept”

- **LCCA**
  - Stand-alone projects => “Accept” if NPV is (+)
  - Comparing projects => “Accept” higher NPV

- **NPV**

- **NPW (PV)**

- **DCF**

- **IRR**
  - If IRR > target => “Accept”

- **LCOE**
  - If LCOE is market-competitive => “Accept”

- **ROI**

- **ROE**
Payback & Cash Flow

Discounted Payback

Discount Rate = 12%

Payback & Cash Flow
<table>
<thead>
<tr>
<th></th>
<th>Tesla S 75 (RWD)</th>
<th>BMW 540i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Price:</td>
<td>$ (85,000)</td>
<td>$ (65,000)</td>
</tr>
<tr>
<td>Sales Tx &amp; Regist.</td>
<td>$ (2,050)</td>
<td>$ (1,450)</td>
</tr>
<tr>
<td>Extended warranty</td>
<td>$ (2,400)</td>
<td>$ (2,100)</td>
</tr>
<tr>
<td>Tax credit:</td>
<td>$ 7,500</td>
<td>$ -</td>
</tr>
<tr>
<td>Salvage Value:</td>
<td>$ 33,000</td>
<td>$ 19,500</td>
</tr>
<tr>
<td>Economic Life (yrs):</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Inflation:</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Discount Rate:</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Annual Costs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miles Driven/yr:</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Energy Cost:</td>
<td>$ 0.11 /kWh</td>
<td>$2.80 /gal</td>
</tr>
<tr>
<td>Mileage:</td>
<td>3.09 mi/kWh</td>
<td>25.0 mi/gal</td>
</tr>
<tr>
<td>Fuel Costs/yr:</td>
<td>$ (711)</td>
<td>$ (2,240)</td>
</tr>
<tr>
<td>Non-fuel O&amp;M:</td>
<td>$ (1,250)</td>
<td>$ (1,250)</td>
</tr>
</tbody>
</table>
NPV & IRR

$ Tesla vs BMW

- Investment
- Insurance
- Non-Fuel O&M
- Salvage Value
- Fuel Costs
- Cumulative Cash Flow

$ BMW vs Tesla

- Investment
- Insurance
- Non-Fuel O&M
- Salvage Value
- Fuel Costs
- Cumulative Cash Flow

4,754

10.8%

4,754

-10.8%

4,754

-30,000

30,000

0

-30,000

30,000

-10,000

10,000

0

-20,000

20,000

-15.0%

15.0%

0.0%

10.0%

5.0%

-5.0%

-10.0%

-15.0%

0.0%

10.0%

5.0%

-5.0%

-10.0%

-15.0%
NPV & IRR

Discount Rate = 12%

Investment
Discounted Cash Flow
Cum. Discounted Cash Flow
NPV
IRR

Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5
---|---|---|---|---|---
-450,000 | 450,000 | -130,000 | -20,000 | 0 | 0

NPV: $1,000,000
IRR: 13.9%

$
LCOE - Levelized Cost of Energy (miles)

5 years @ 20,000 miles/yr = 100,000 miles

(NPV) => $67,005 / 100,000 = $0.67/mile
LCOE - Levelized Cost of Energy

Total Facility Capital Cost ($): 11,458,250
Net Electrical Capacity (kWe): 3,750
Capacity Factor (%): 90%
Fuel Cost ($/GJ): 6.35
Labor Cost ($/y): 150,000
Maintenance Cost ($/y): 380,000
Income from heat sales ($/y): 764,815
General Inflation (%/y): 2.10%
Interest Rate on Debt (%/y): 4.50%
Economic Life (y): 20

Level Cost of Electricity: $0.073 /kWh (in constant $)
Sensitivity Analysis

Cost of Electricity ($/kWh, Constant $)

Levelized grid power cost (delivered)

Annual savings cash flow: $1,058,000 /yr

Capital Cost: $11,458,000

Fuel/Electric Eff.: 36%

Gas: $6.35/GJ (incl CO2 tax)

Debt Interest Rate: 4.5%

Value of heat delivered: $8.00/GJ

Capacity factor: 90%

Capital Cost: $11,458,000

Fuel/Electric Eff.: 36%

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References of Interest:

Formulas, definitions, examples:
✓ https://accountingexplained.com/managerial/capital-budgeting

Levelized Cost of Energy Excel Templates:
California Biomass Collaborative
✓ https://biomass.ucdavis.edu/tools/energy-cost-calculator/

Danish Energy Agency “District Heating Assessment Tool”
Questions / Comments?

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