Lesson 3-1 – Costs and Cost Estimating

Lesson 3-1 Learning Objectives

- Define and determine fixed, variable, marginal and average revenues and costs
- Understand why each are important and determine which is an appropriate measure for a given question
- Understand the difference between cash costs and book costs and know when to apply each
- Apply simple revenue and cost models to determine profitability and loss

Engineering Costs

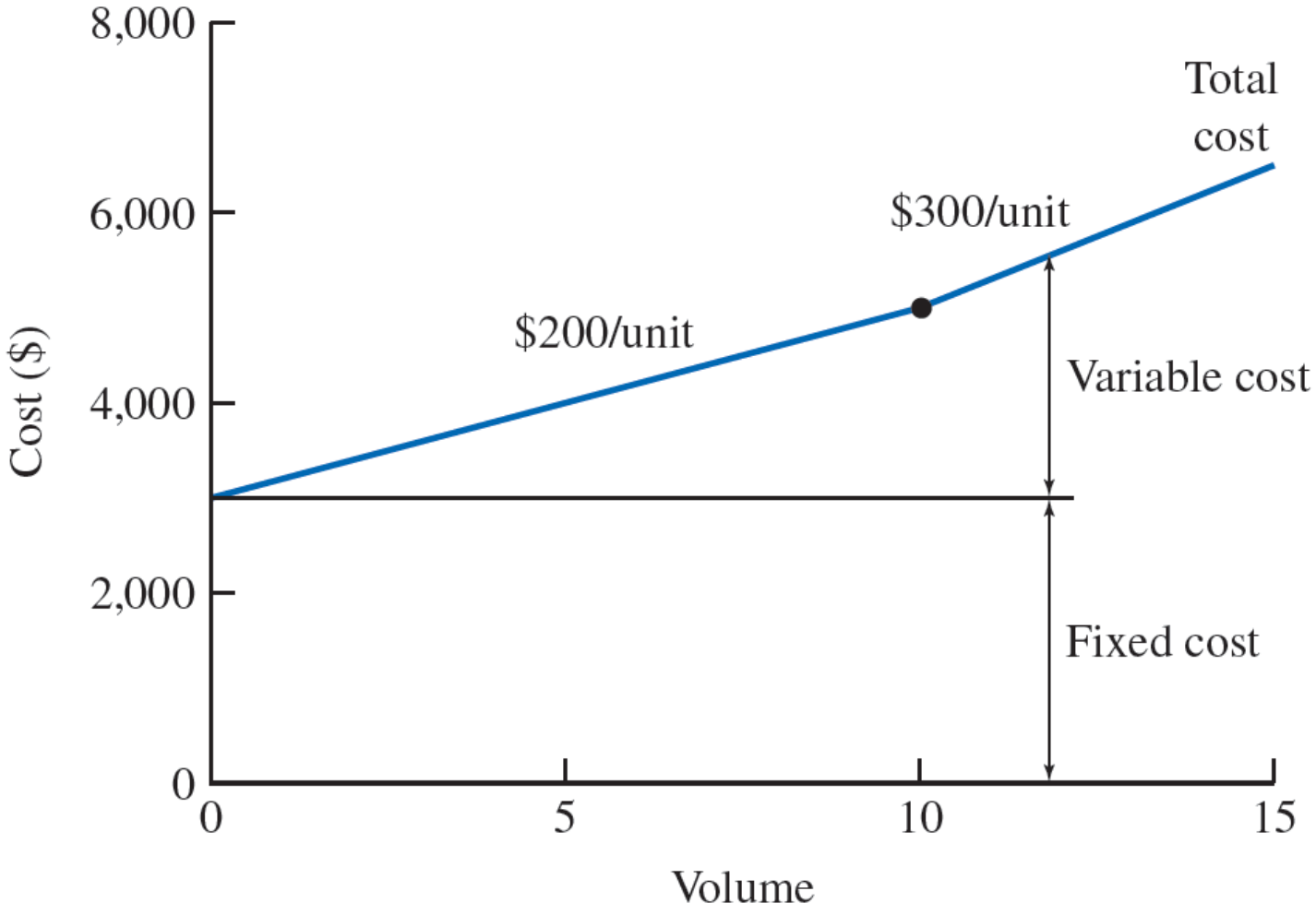
- Costs: the economic value of the resources used in the production of goods and services.
  - Land, labour, capital, resources and skills
  - Initial investment, wages and salaries, material purchases, utilities
  - Social costs (externalities)

Classification of Costs

- Fixed: constant and unchanging
  - Rent on a building is constant regardless of how much space is utilized.
- Variable: depends on level of output or activity level
  - Can be linearly proportional or non-linear
    - Amount of raw material used depends on how many units are made.
- Total cost = Fixed cost + Variable cost

$$\frac{\text{Rent} + \text{Materials} + \cdots}{\#\text{ of units}}$$

Figure of Classification of Costs



Total Cost = total fixed cost + total variable cost

Classification of Costs

- Marginal cost: variable cost for one more unit.

- Average cost: Total cost divided by the number of units

Revenues

- Same terms and definitions can be applied
  - Fixed
  - Variable
  - Average
  - Marginal
- Revenues are just costs without the negative sign in front
- And when their powers combine…..

Profit and Loss Terms

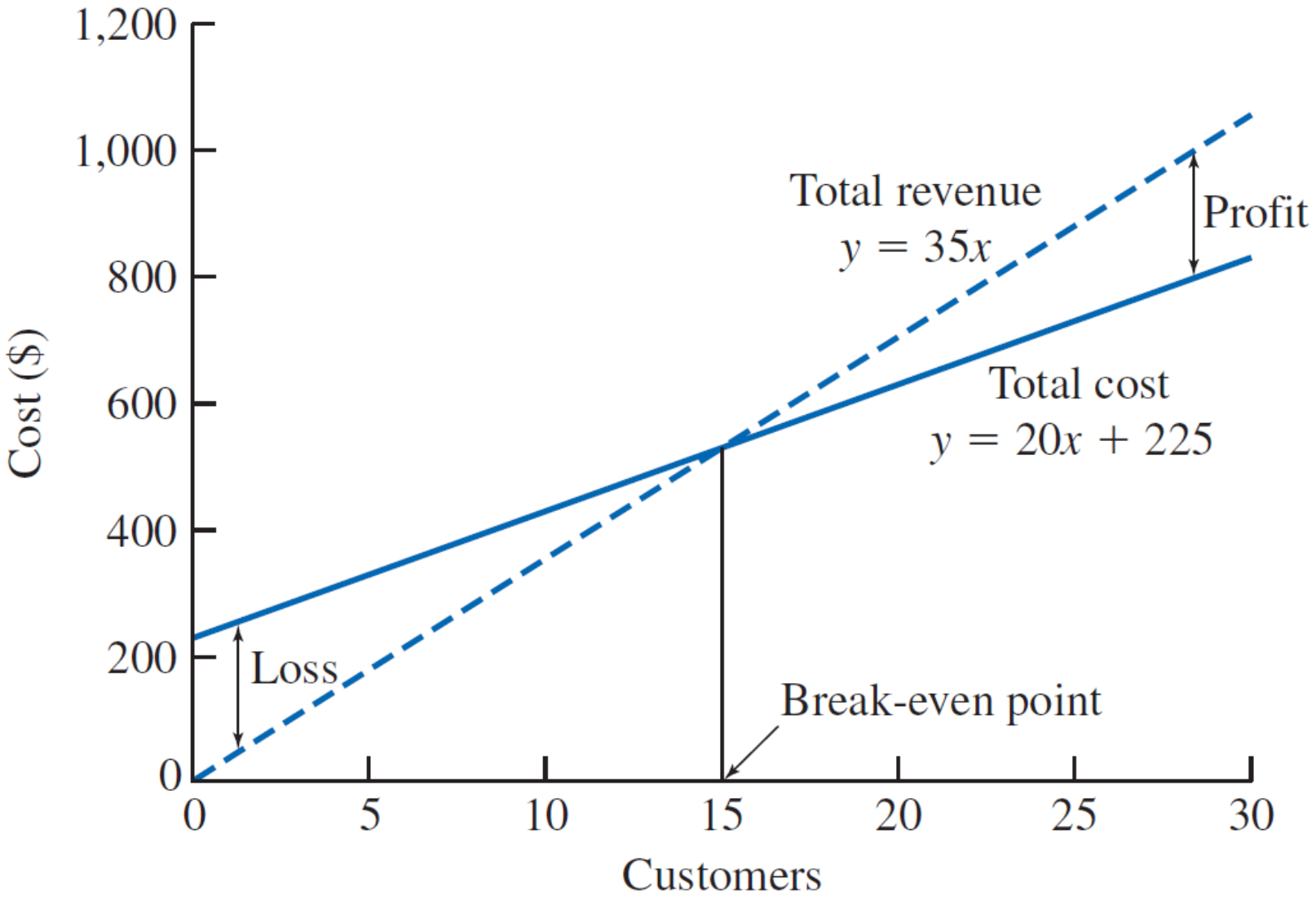
- Revenue = money coming in
  - Total revenue (often) = Unit price $\times$ units sold
- Costs = money going out

- Breakeven is when: total revenue = total costs
- Profit is made when: total revenue > total costs
- Losses occur when: total revenue < total costs
  - Going into debt or using up savings
  - Require additional investment
- Can create models or equations to represent these.

Profit and Loss Terms Explained

- Break-even point: The level of activity at which the total cost of providing the product, good, or service is *equal to* the revenue (or savings) generated.
- Profit region: Values of the variable *x* greater than the break-even point, where total revenue is greater than total costs.
- Loss region: Values of the variable *x* less than the break-even point, where total cost is greater than total revenue.

Figure of Profit and Loss Terms



Break-Even, Profit, and Loss: Problem

Ballard manufactures fuel cell stacks at a branch plant with the following data

Sale price per stack	$100
P&L cost per stack	$65
Lease/utilities etc	$50,000 per year
Capacity per year	2,000 stacks

a) How many stacks need to be sold to break even?
b) What is the profit when running full out?
c) An extra shift can be added that doubles capacity, but increases fixed costs by $40,000 and P&L by $20 per stack for any stacks over the first 2,000. Break even point?

Break-Even, Profit, and Loss: Solution

a) To breakeven: Total costs = Total revenue

$50{,}000 + 65x = 100x$

$x = 50{,}000/ (100 – 65) = 1{,}429$ stacks

b) Full capacity

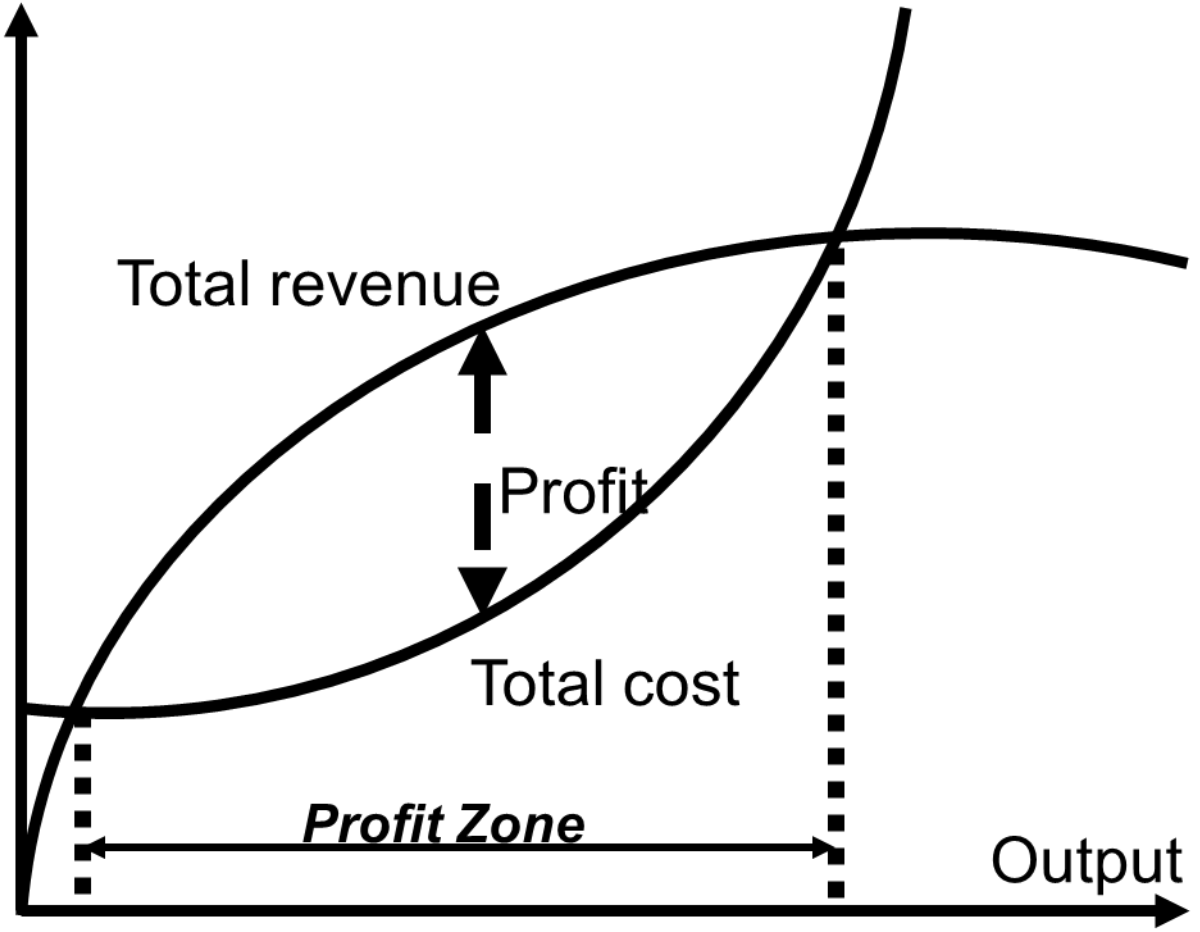
$2000(100\text{-}65) – 50{,}000 = 20{,}000$

c) Total costs = total revenue

$(50{,}000+30{,}000) + 2000(65) + x(85) = 100(x+2000)$

$x = (80{,}000+130{,}000\text{-}200000)/15 = 1{,}334$ additional stacks

Profit and Loss
(Non-Linear Revenue and Cost)



Past and Future Costs

- Sunk Cost: Money already spent due to a past decision
  - Should be disregarded in engineering economic analysis
  - Nothing can be done at this point to change the cost
  - Example: the amount paid to buy a car 2 years ago
- Opportunity Costs: The costs associated with a resource being used for an alternate task
  - What could we be doing with these resources instead?

Cost Types

- Recurring Cost: A cost that reoccurs at regular intervals
  - Example: Purchasing wages; Paying Rent
- Non-recurring Cost: One-of-a-kind cost recurring at irregular intervals
  - Example: Illness; Accident. Capital expenditure
  - Note: Sometimes we attempt to plan for large non-recurring costs by buying insurance. The periodic insurance premium then becomes a recurring expense/cost.

Incremental Costs

- Incremental Cost: Cost differences between alternatives

Land Rover LR4	Base Model	HSE Luxury	Incremental Price
Down Payment	$6,500	$7,680	$1,180
Monthly Payments	$585	$690	$105
Annual Insurance	$2,000	$2,200	$200
Annual Fuel	$1,850	$1,850	$0
Annual Maintenanc	$2,500	$2,500	$0
Resale Value	$25,000	$32,000	($7,000)

Cash Costs versus Book Costs

- Cash costs require a cash transaction (cash flow), which is the movement of money from one owner to another
  - Example: Monthly payment on an auto loan
- Book costs are recorded but are not transactions
  - Do not represent cash flows, are accounting entries
  - Do not always enter into engineering economic analysis, but can play in certain situations (e.g. taxes and depreciation)
  - Example – taxes, recording cheques

Life-Cycle Costs

- Life-cycle: all the time from conception to termination or retirement of a product or process.
- Life-cycle costs: the sum total of all the costs incurred during the life-cycle.
- Life-cycle costing: designing with an understanding of all the costs associated with a product during its life-cycle.

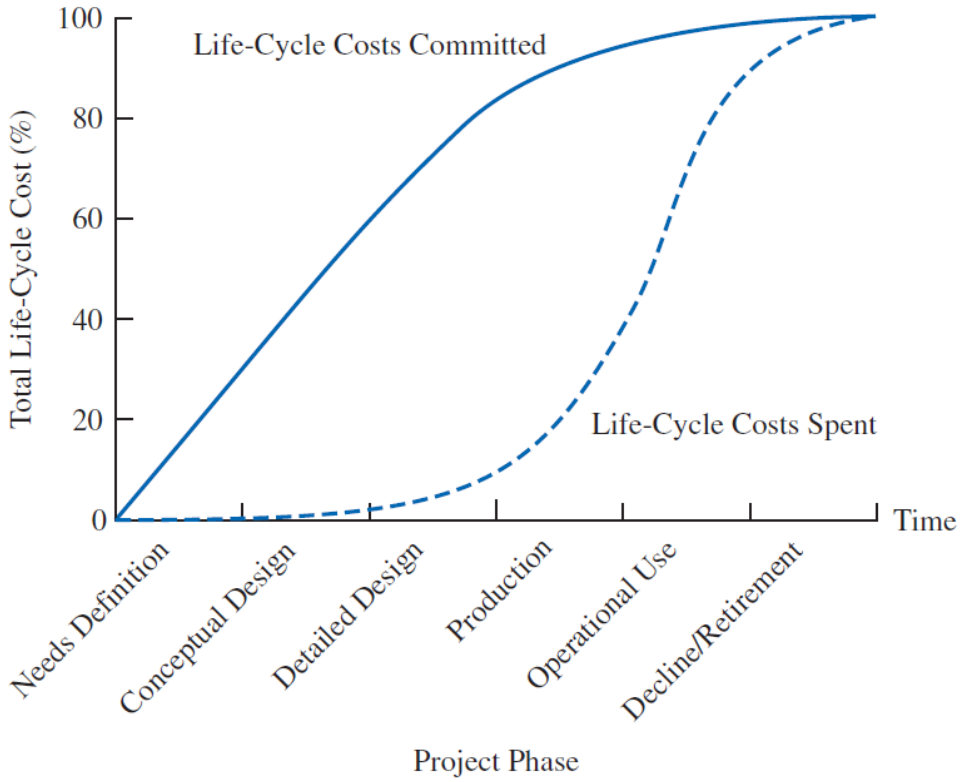
Phases of Life-Cycle Costs

1. Needs assessment and justification
2. Conceptual or preliminary design
3. Detailed design
4. Production or construction
5. Operational use
6. Decline and retirement (recycling/reuse/disposal)

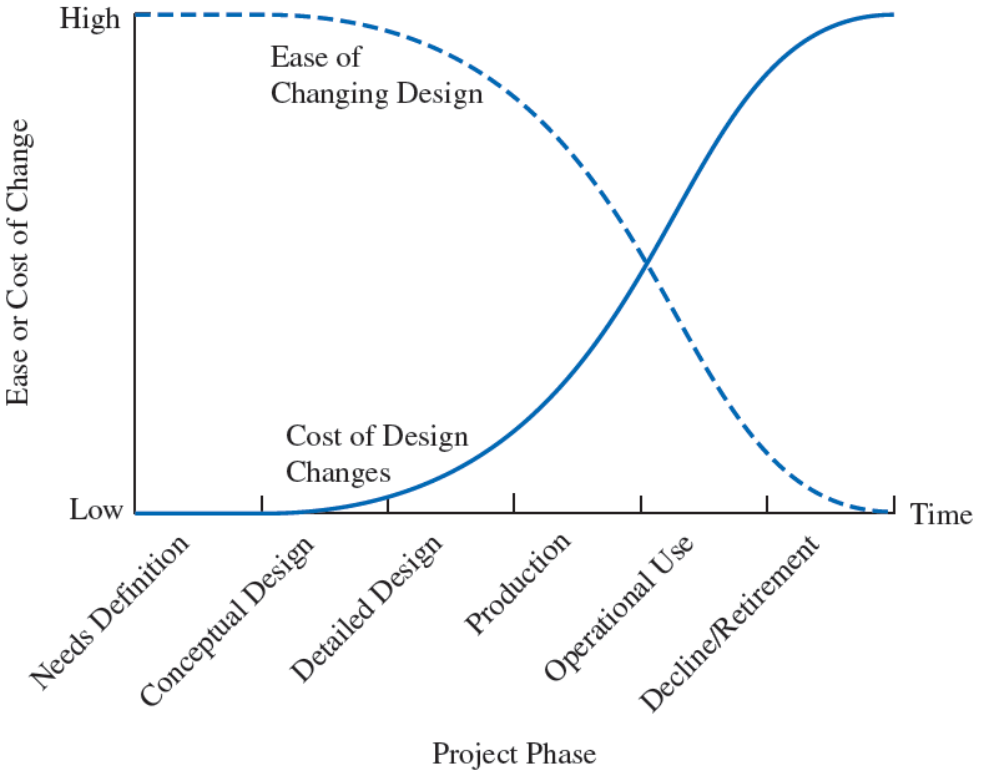
Life-Cycle Costing

- In general, the later a product design change is made, the higher the cost.
  - Earlier changes are easier and less costly.
  - Decisions made early in the life-cycle tend to ‘lock-in’ cost that will be incurred.
- About 70% to 90% of all costs are committed during the design phases.
- Only 10% to 30% of cumulative life-cycle costs have been spent by the end of the design phase.

Figures: Life-Cycle Costs



Cumulative life-cycle costs committed and dollars spent

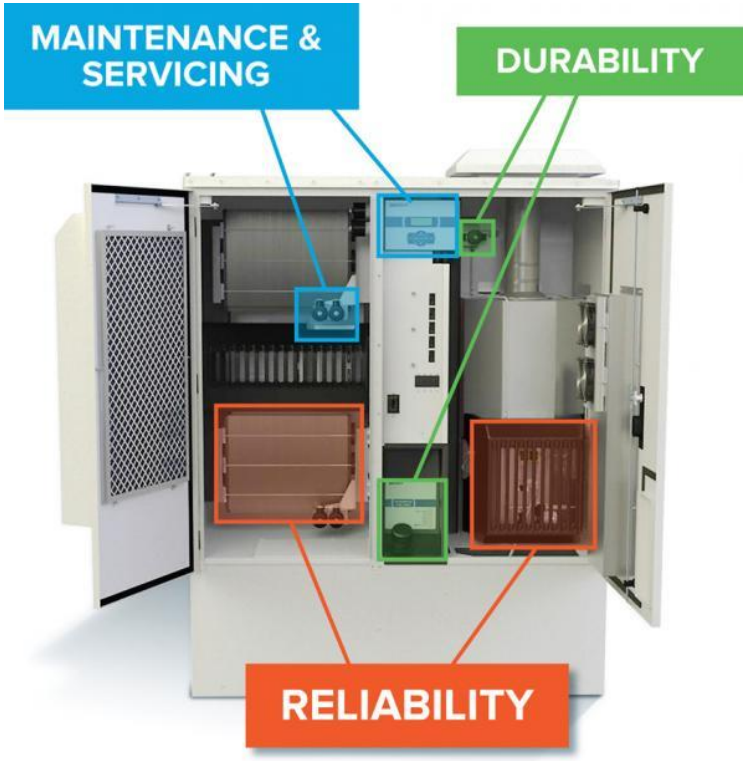


Life-cycle design change costs and ease of change

Life Cycle Costing

- Life Cycle Cost analysis incorporates all these phases into the assessment.
- Frequently see this in the news regarding government procurement.
- F-35 Fighter Aircraft
  - 65 aircraft for $9 billion (~$140 million per aircraft)
  - Total program cost: $65 billion

- Fuel cell backup power systems
  - Higher up front capital costs relative to diesel
  - Lower life cycle costs due to lower maintenance requirements



ElectraGen™-ME system - areas of advancement