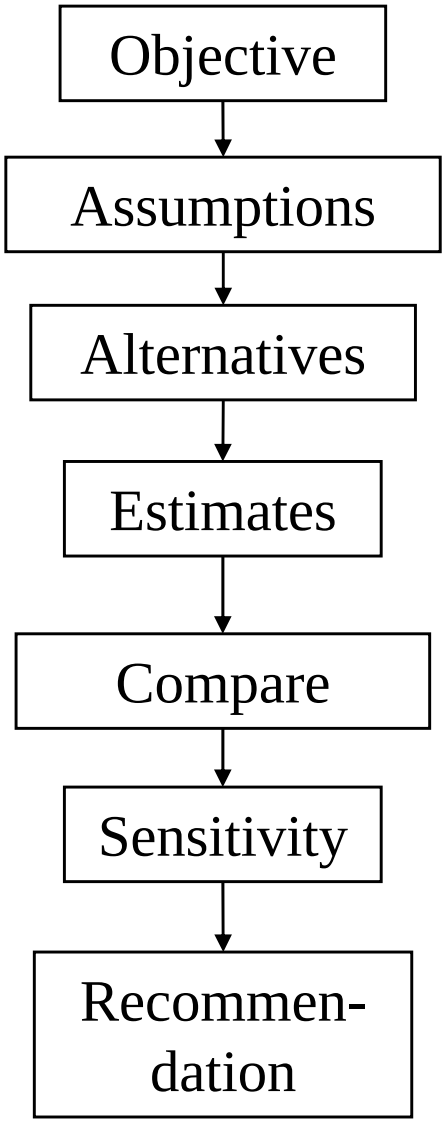
Economic Analysis

Limited resources

and competing needs

Note that this deck was built using data from Module 13 – Economic Analysis from the SCEA CostProf Modules

Agenda



- Review Economic Analysis Theory
  - Objective
  - Assumptions
  - Alternatives
  - Cost and Benefits Estimates
  - Compare Alternatives
  - Test Sensitivity
  - Formulate Recommendation
- While Reviewing Simple Example on How to Save the Earth

Economic Analysis – What Is It?

- Economic Analysis (EA) is an objective method for making rational decisions among alternatives
- Compares *time-phased*, *economically-adjusted* costs and benefits of solutions/alternatives for a defined problem/objective
- EA is sometimes referred to as a Cost Benefit Analysis (CBA)

- <u>Limited resources & competing needs!</u>

Economic Analysis – Why Do It?

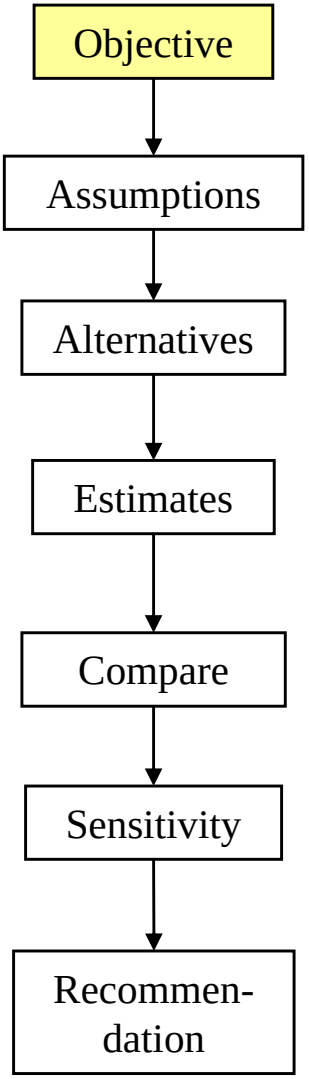
- Facilitates the identification and examination of all possible solutions to a given problem
- Allows for “smart” allocation of scarce or competing resources
- Provides an objective, defendable justification for executing an alternative
  - Provides information useful for budget submission and justification
- Offers a basis against which program execution and success can be measured
- Often required as part of the DoD Milestone Decision process
- Other agencies require EA as part of their program analysis process

Overview of EA Process

- Define the Objective
- Formulate and/or Examine Assumptions
- Identify and Examine Alternatives
- Develop Cost and Benefits Estimates
- Compare and Rank Alternatives
- Test Sensitivity of Alternative Rankings
- Formulate Recommendation

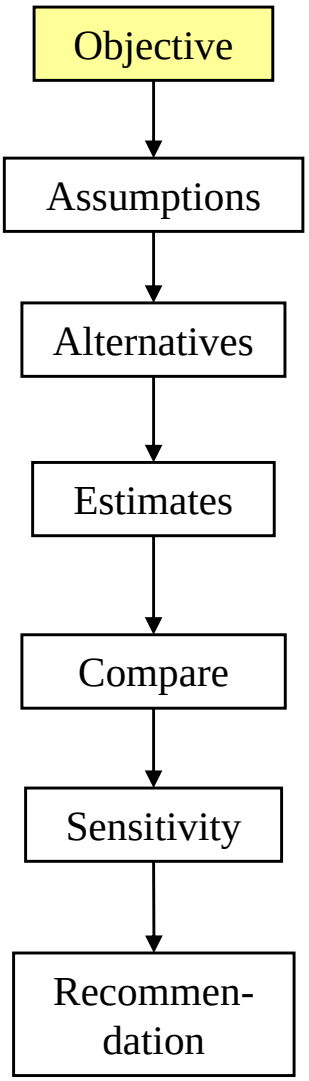
And, of course, **document as you go!**

Step 1: Objective



- Define the Objective
  - Define the problem
  - Select an objectives that is broad, yet relevant
  - Objective should:
    - Allow for multiple alternatives and not presuppose a solution
    - Address the problem versus addressing a symptom of the problem
- Objective is important for focusing and loosely bounding the analysis

Example – Save the Earth (starting yesterday)

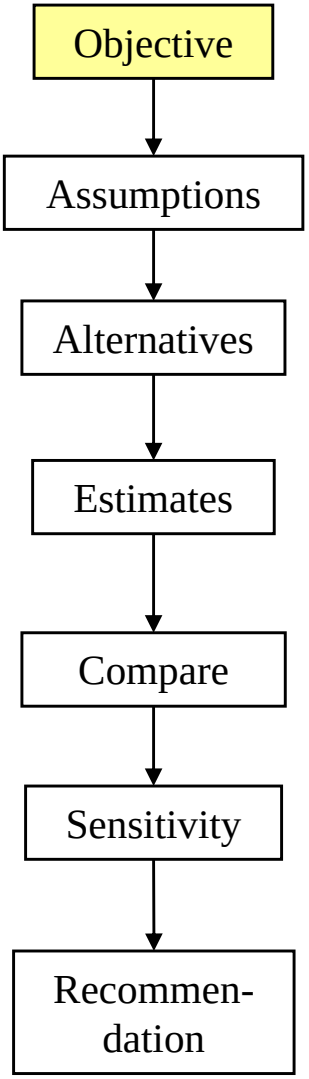


Problem: I want to become more environmentally friendly at home.

Candidate Objectives

1. Reduce environmental footprint of house
2. Reduce non-renewable energy reliance
3. Create less waste
4. Reuse & recycle
5. Feel ‘friendly’ or ‘green’
6. Fewer bad chemicals

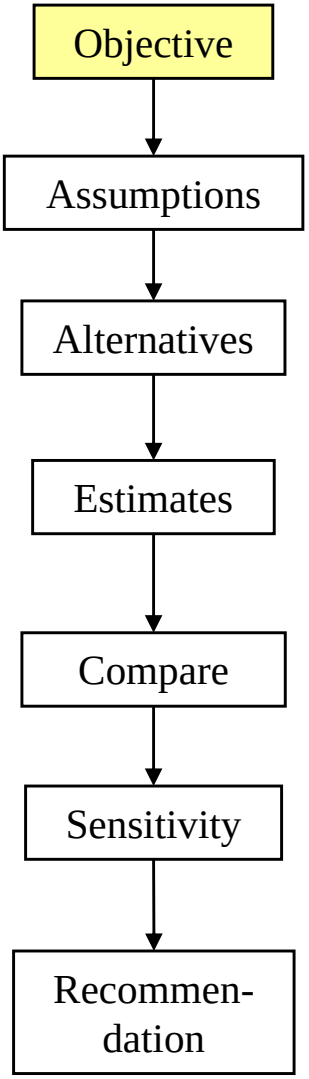
Save the Earth Example – Candidate Objectives



- Candidate Objectives

1. Reduce environmental footprint of house
   - Good objective though maybe a little too broad
   - Could reshape to focus on *improving efficiency of house*?
2. Reduce non-renewable energy reliance
   - Good objective – a little more broad
3. Create less waste
   - Too narrow – focuses solely on one aspect of greening
   - Also, focuses on symptom (waste), not problem (consumption or supply choices)
4. Reuse & recycle
   - Presupposes solution and a little narrow
5. Feel ‘friendly’ or ‘green’
   - Too broad
6. Less bad chemicals
   - Presupposed solution and a little narrow

Example – Objective

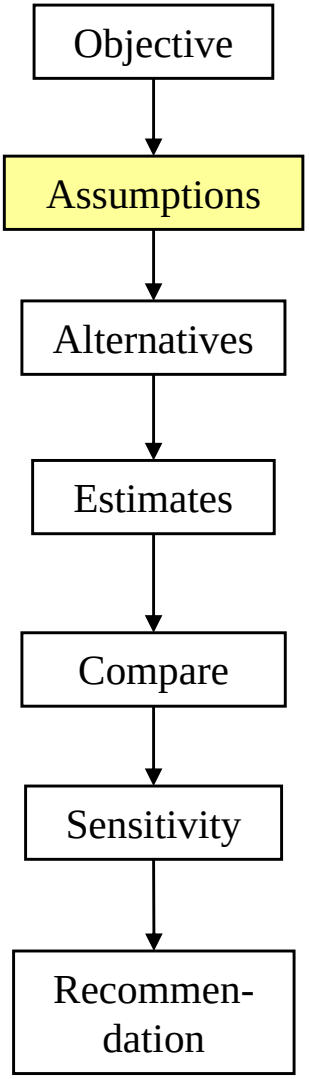


- Objective
  - Either #1 (revised) or #2 would be fine

    1. Improve efficiency of house
    2. Reduce non-renewable energy reliance

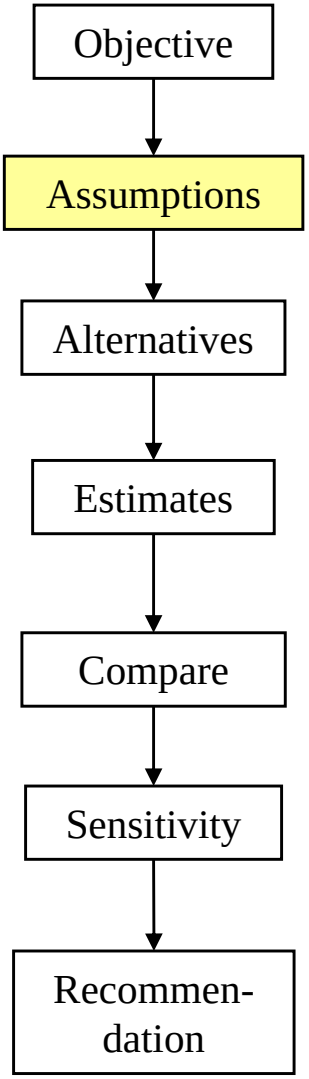
  - We select #2 for the purpose of continuing the example

Step 2: Assumptions



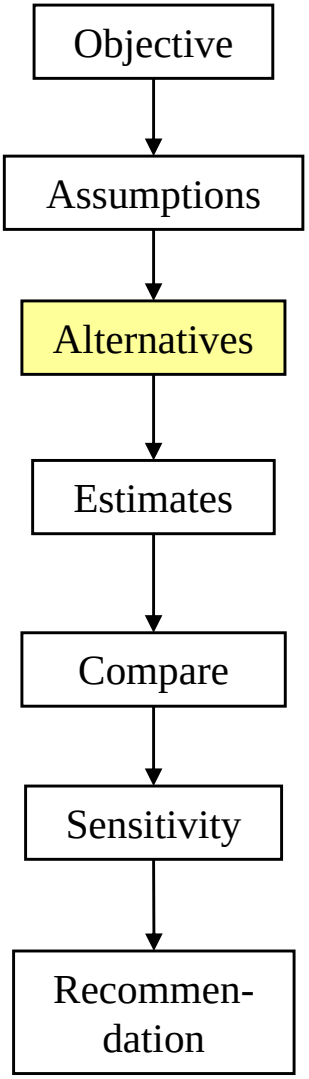
- Formulate and/or examine Assumptions
  - Examine problem thoroughly
  - Develop complete list of assumptions
    - Mathematical/Methodology assumptions
    - "Limits of analysis" assumptions based on problem characteristics
    - Address both strict constraints and assumptions of convenience; document type of assumption
  - Scrutinize assumptions for relevancy, necessity, and reasonableness
- Assumptions provide the groundwork for defining the alternatives and alternatives bound the analysis

Example – Assumptions



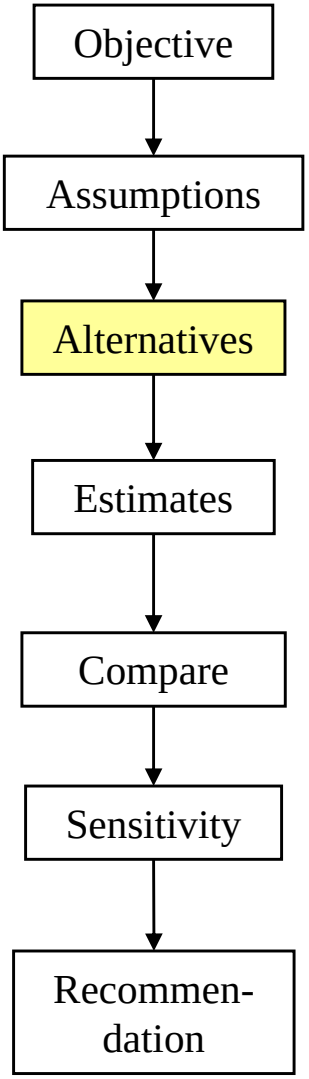
- Objective: Reduce non-renewable energy reliance
- Assumptions:
  - Focus on proven green energy replacement technologies
    - Excludes emerging, unproven, cost-prohibitive technologies
  - Focus on ‘reasonable’ technologies installed on property
    - Omit benefits from external alternative energy cooperatives
  - Won’t focus on reduction of non-renewable energy through Energy Star appliances
  - Won’t focus on reduction of non-renewable energy through conservation techniques (reduce use of exisiting systems)

Step 3: Alternatives



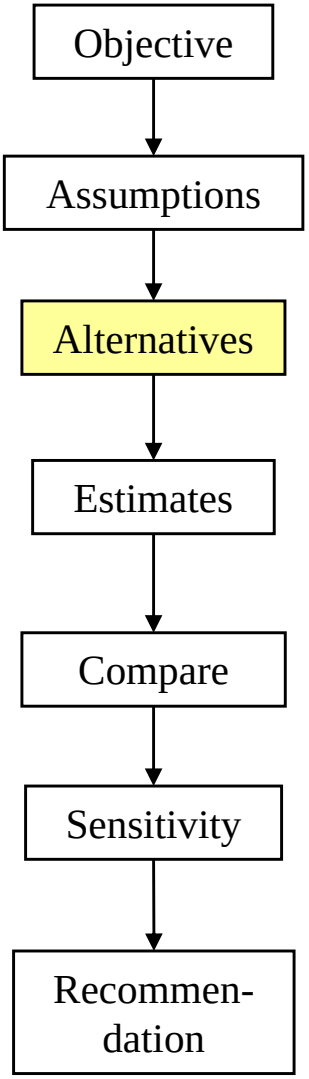
- Identify and examine alternatives
  - Examine problem with the assumptions to help identify possible solutions
  - Develop alternatives without boundaries
  - Examine alternatives for unfeasible options
    - Document reasons for eliminating alternatives in case circumstances change to cause an alternative to be viable again
  - Note that alternative list may change during analysis
- Alternatives are critical, as they inherently are the **first step** in the **decision-making** process – they define what actions *could* be taken

Number of Alternatives



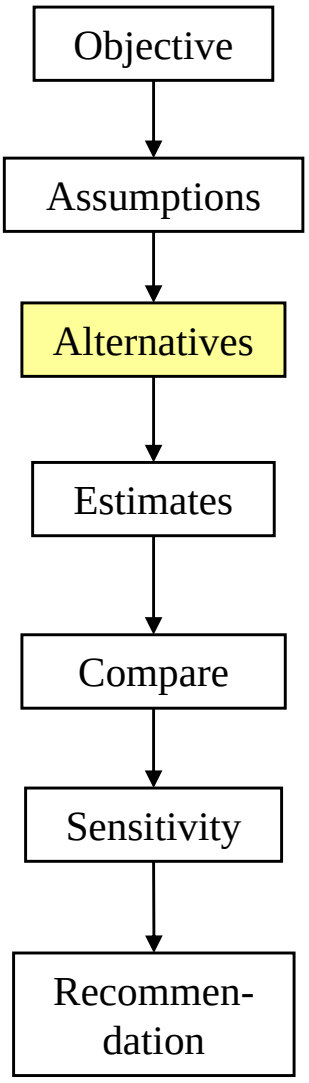
- Must have at least 2 alternatives
  - Status Quo:
    - Change nothing
    - Sometimes called “AS IS”
  - Alternative to Status Quo:
    - Includes desired capabilities
    - Sometimes called “TO BE”
- Typically consider four alternatives
  - Status quo
  - Modernize existing assets
  - Lease/privatization
  - New acquisition

Number of Alternatives



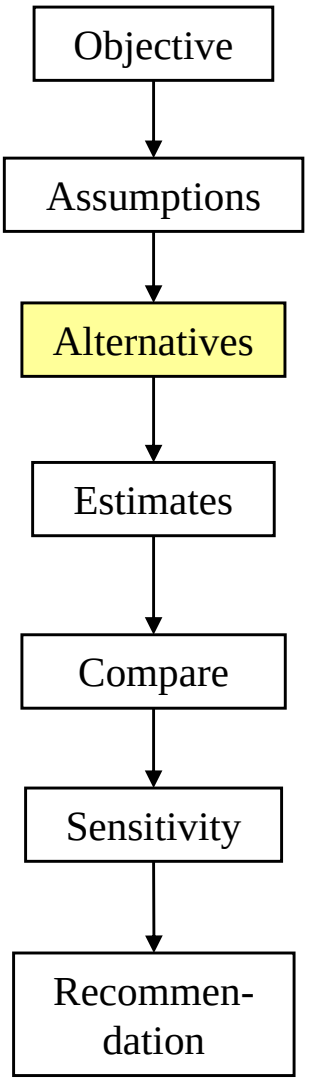
- Understand that you can have *many* alternatives
  - Often have more than one variant of “new acquisition” or “modernization”
  - As alternative quantity increases, so does time and effort required to develop cost and benefits
  - Important to consider everything, but consider factors for downselecting early if analysis proves to be cumbersome or too exhaustive
  - Be sure to document why you downselect early

Example – Alternatives



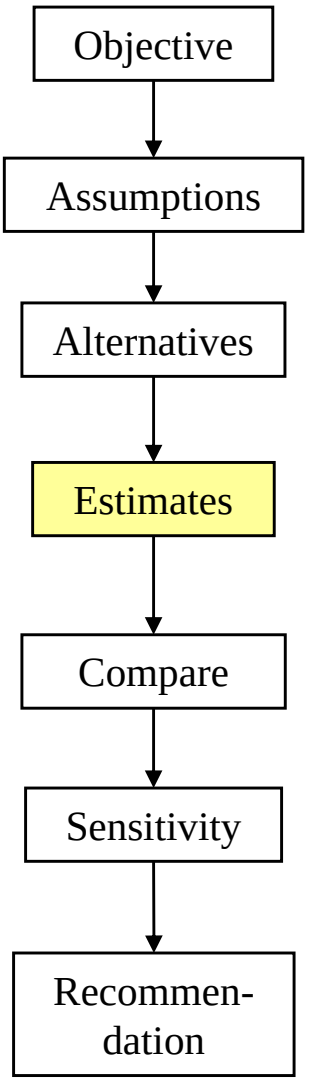
- Objective: Reduce non-renewable energy reliance
- Alternatives:
  - Status Quo – do nothing
  - Solar Panels for Photovoltaic Electricity
  - Combined Heat & Power Generation (CHP)
  - Solar Hot Water Heater
    - Not ideal since only addresses water heating energy
  - Wind Turbine Electricity
    - Not feasible because of trees on neighbors' lots
  - Micro Hydro Electricity
    - Not feasible because of lack of steady stream

Example – Assumptions Redux



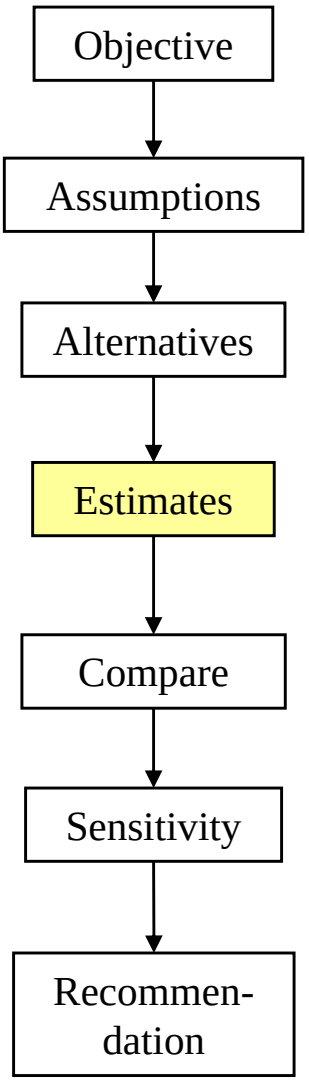
- Revisit Assumptions (back to step 2)
  - Focus on reducing non-renewable energy reliance
  - Will do this by exploring supplemental energy sources that are renewable
  - Will not focus on reduction of existing appliances / load

Step 4: Cost and Benefits Estimates



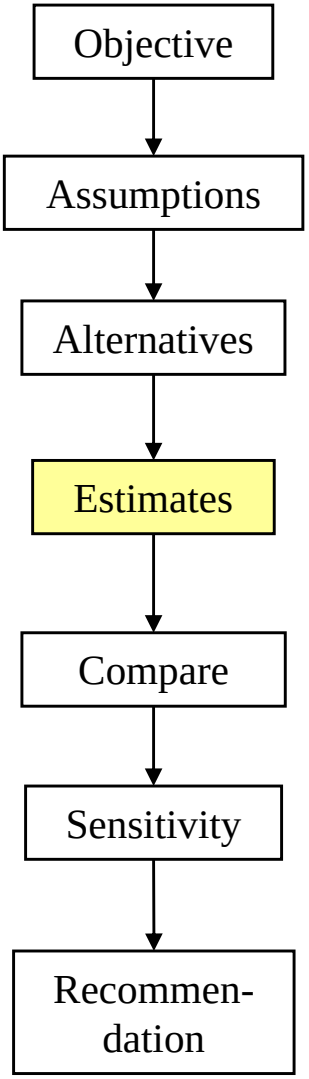
- Develop cost and benefits estimates:
  - Define Cost and Benefits Estimating parameters (or mathematical assumptions)
  - Develop comprehensive cost estimate for each alternative
  - Define and quantify benefits for each alternative
- Cost and Benefit Estimates are important as they serve as the **objective basis** for comparing alternatives
- Remember that benefits can be qualitative and quantitative – and can benefit from a structured collection framework

Estimating Parameters



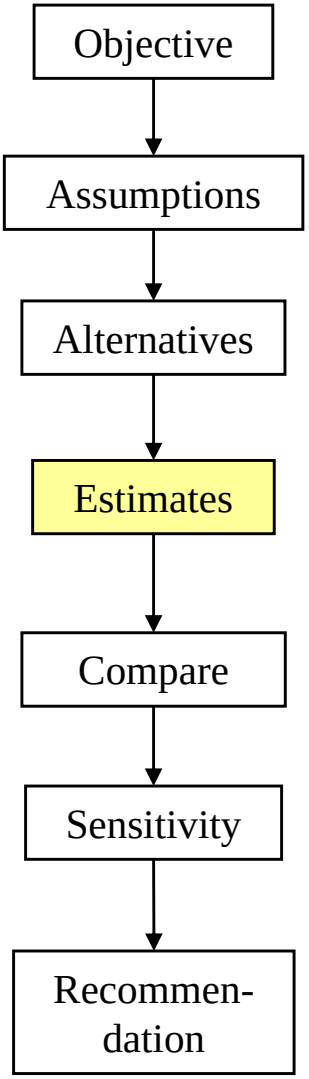
- Define Estimating parameters (mathematical assumptions)
  - Determine Economic Life Cycle for each alternative
    - Economic life cycle is period during which alternative provides benefits
    - Usually constrained by Physical life, Mission life, and/or Technological life
  - Determine Period of Analysis for each alternative
    - Period of Analysis is the time required to develop/ implement the alternative plus the economic life during which benefits accrue
  - Economic Life Cycles and Periods of Analysis can differ between alternatives
    - Maybe you think you'll move in about 10 years? 20 years? (Mission Life)
    - Maybe you know better replacement technology will be available in 25 years? (Technological Life)

Parameters – Base Year



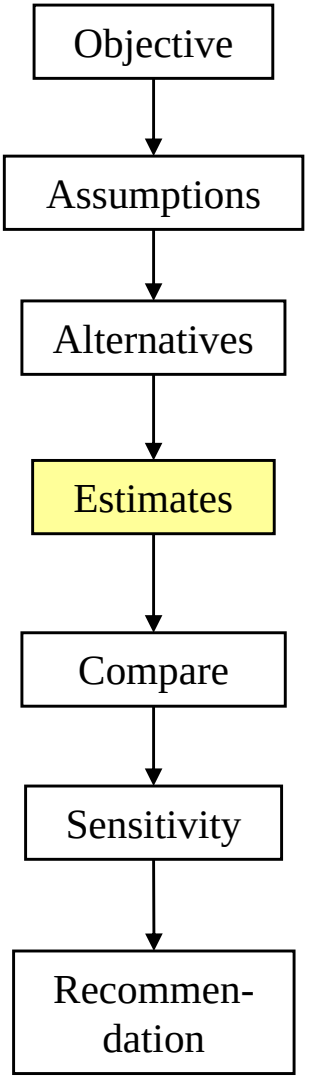
- Determine Base Year for analysis
  - Year to which estimates are adjusted both in terms of inflation (constant $ estimates) and discounting (both constant and current $ estimates)
    - More information on Discounting and Net Present Value (NPV) on upcoming slides
  - Usually the first fiscal year in which there is a difference in expenditures between alternatives

Example – Parameters



- Research results:
  - Status Quo
    - Current scenario could last indefinitely (assuming China doesn't buy up all the world's coal and oil)
  - Solar Panels
    - Time required to install PV panels is 1 week, so effectively 0 yrs of lead time for this analysis
    - Panels expected to last 20+ years
  - Combined Heat & Power (CHP) Generator
    - Time required to install CHP station is 2 weeks, so effectively 0 yrs of lead time for this analysis
    - A new CHP is expected to last 20 years

Example – Parameters

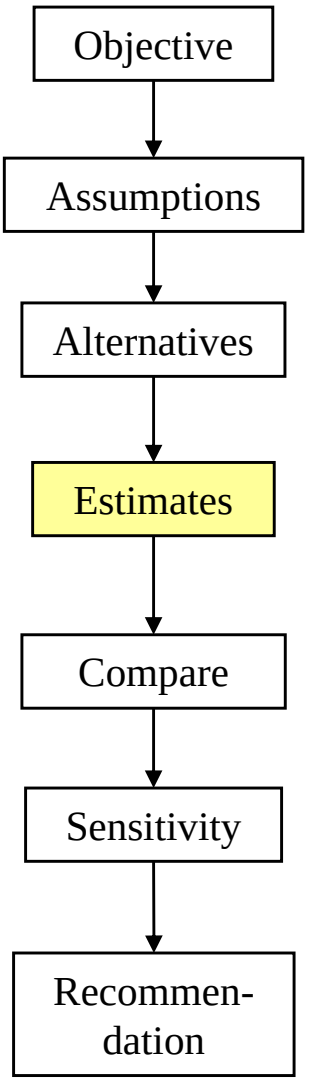


- Estimating Parameters
  - Using research results, Economic Life and Period of Analysis for each alternative is:

Alternative	Economic Life	Period of Analysis
Status Quo	50+ years	20 years
Solar Panels	20+ years	20 years
CHP System	20 years	20 years

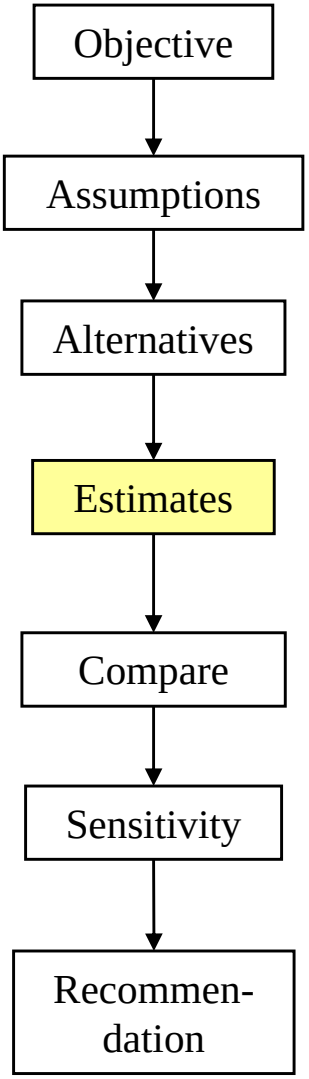
  - Move within 20 years? Mission life is 20 years.
  - Constant $ or Current $?
    - Data I have collected is in terms of this year's $
    - Estimate in **Constant FY09 $**
    - FY09 = this year will be my Base Year

Example – Assumptions Redux



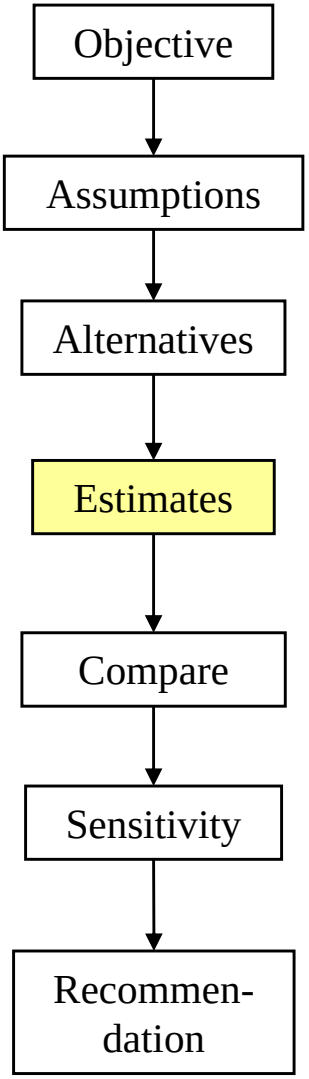
- Revisit Assumptions (back to step 2)
  - Focus on reducing non-renewable energy reliance
  - Will do this by exploring supplemental energy sources that are renewable
  - Will not focus on reduction of existing energy demand
  - Alternative Economic Life based on Mission Life (not Physical or Technological life)
  - EA Period of Analysis = 20 yrs, spanning FY09 through FY29
  - Use Constant FY09 $ for estimates

Cost Estimates



- Develop comprehensive cost estimate for each alternative
  - Define Work Breakdown Structure / Cost Element Structure to organize and capture all costs
  - Identify all applicable cost categories
    - EA Cost Estimate typically more extensive than Life Cycle Cost Estimate (LCCE)
    - Costs to include:
      - "Traditional" LCCE costs such as development, acquisition, operations, support, maintenance, disposal
      - Opportunity costs of existing assets/resources used if those assets/resources could be used elsewhere
      - "Imputed" costs, which are value of services provided without charge to a project (e.g., Base Operating Support)
      - Status Quo Phase-out costs for any Alternative that requires the Status Quo system to continue to operate while the Alternative is developed

Cost Estimates



- Develop comprehensive cost estimate for each alternative
  - Identify all applicable cost categories (continued)
    - Costs to exclude
      - Societal costs outside of the organization that are incidental to accomplishing the objective
      - Sunk (or realized) costs - however, these should be addressed as part of the assumptions
      - Costs captured under Benefits Estimate
    - "Optional" Costs
      - "Wash costs," which are costs that accrue equally by all alternatives
        - » Include if required to report total program costs
        - » Exclude if required to streamline decision making material

Life Cycle Cost Estimating
Identify Potential Cost Elements

I. Planning & Concept Exploration Phase

- ***Travel*** - Will travel be required to evaluate potential alternatives?
- ***Analysis*** - Will it be necessary to conduct extensive up-front analysis of the alternatives?

II. Implementation Phase

- ***Shipping*** - Will there be shipping cost system to reduce redundant tasks?
- ***Facility*** - Will the facility be altered in any way to accommodate the project?

III. Phase-Out

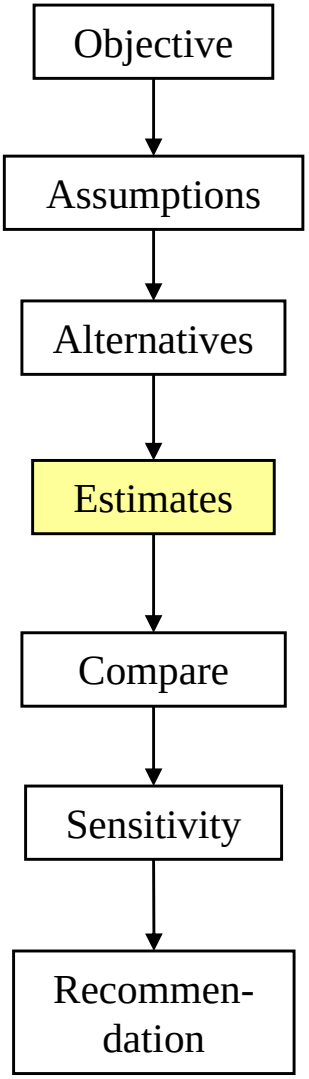
- ***Removal*** - Will there be costs associated with removing equipment or supplies?
- ***Facility*** - Will the facility be altered at the end of the project?

IV. On-Going Maintenance Phase

- ***Training*** - Will initial or continual training be required for the staff?
- ***Maintenance and Upgrades*** - Will maintenance and upgrades be needed before the end of the project's life?

Must also include 'traditional' LCCE phases like R&D, Acquisition, O&M and Disposal.

Example – WBS/CES



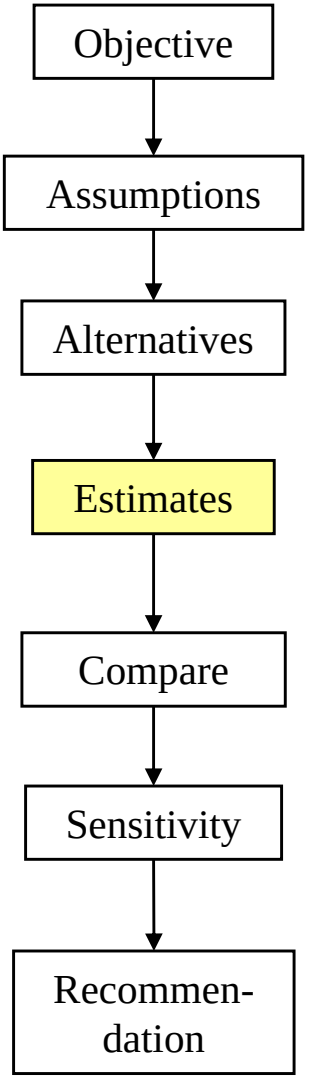
- Develop comprehensive cost estimate for each alternative
  - Develop WBS/CES

    1.0 Development/Acquisition
    - 1.1 Development / Installation Labor
    - 1.2 Material Acquisition

    2.0 Annual Maintenance/Operations
    - 2.1 Maintenance Labor
    - 2.2 Maintenance Parts & Supplies
    - 2.3 Operations Labor
    - 2.4 Operations Parts & Supplies

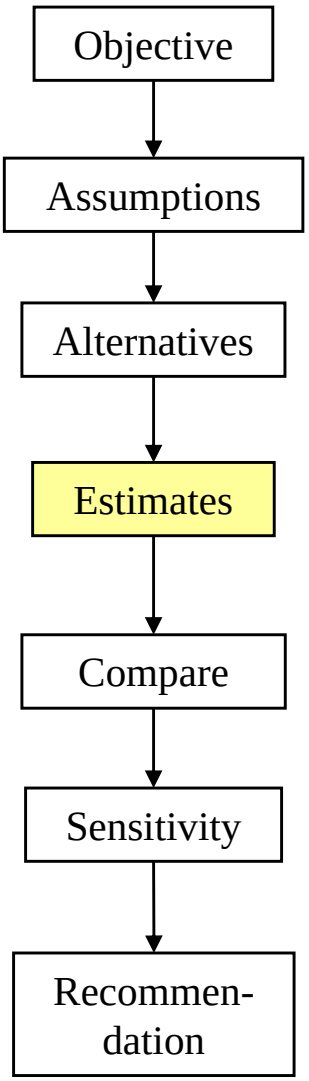
  - NOTE: WBS/CES used for example is *greatly* simplified and does not follow traditional format
  - See MIL-881 for WBS/CES guidance

Example – Data Collection



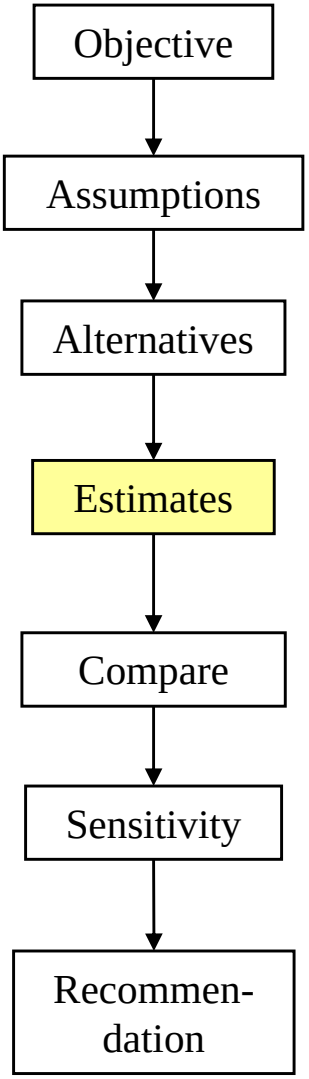
- Develop comprehensive cost estimate for each alternative
- Gather data - Performed research and came up with the following information:
  - Solar Panels Cost is $6,500 (for simplicity)
  - Solar Panel O&M = $75 annually
  - Solar Panel Etc Recurring = $150 annually
  - CHP System is $10,000 (again for simplicity)
  - CHP System O&M = $100 annually
  - CHP System Etc Recurring = $200 annually
  - + any etc costs, inflation rates & discount rates

Example – Assumptions Redux



- Revisit Assumptions (back to step 2)
  - Focus on reducing non-renewable energy reliance
  - Will do this by exploring supplemental energy sources that are renewable
  - Will not focus on reduction of existing energy demand
  - Alternative Economic Life based on Mission Life (not Physical or Technological life)
  - EA Period of Analysis = 20 yrs, spanning FY09 through FY29
  - Use Constant FY09 $ for estimates
  - No varying interest / discount rates
  - No varying O&M or recurring costs
  - No salvage value

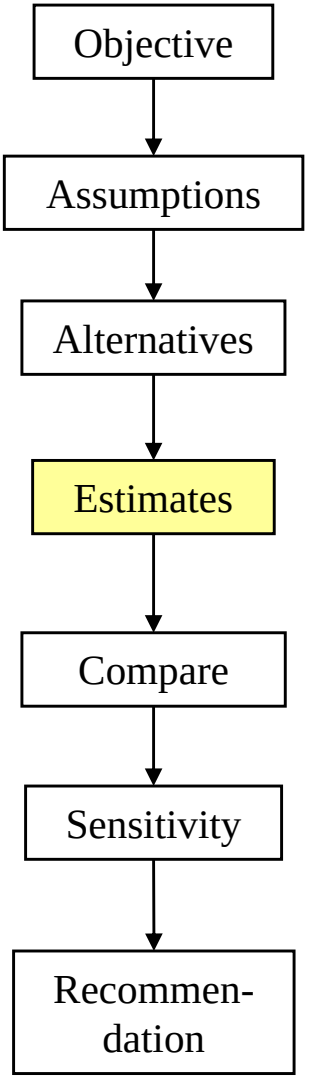
Benefits Estimate



- Define and quantify benefits for each alternative
  - Define alternative benefits
    - Develop comprehensive list
    - Downselect to avoid overlap between benefits and cost estimate
    - Categorized into:
      - Quantifiable, monetary
      - Quantifiable, non-monetary
      - Non-quantifiable (fuzzy)

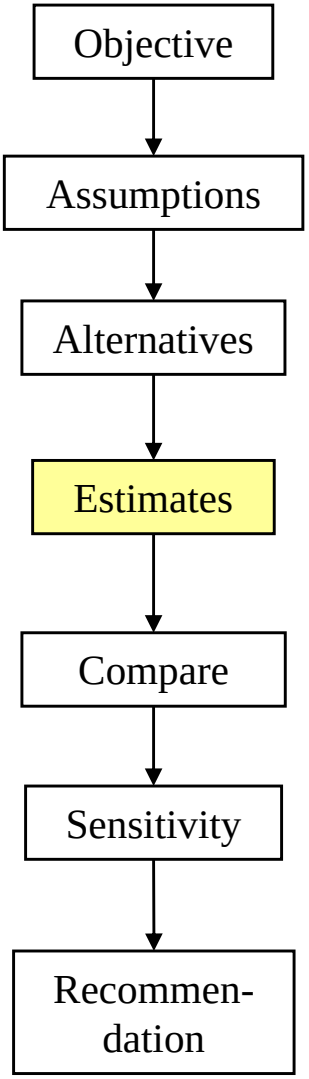
Best to quantify in terms of dollars if possible

Benefits Estimate



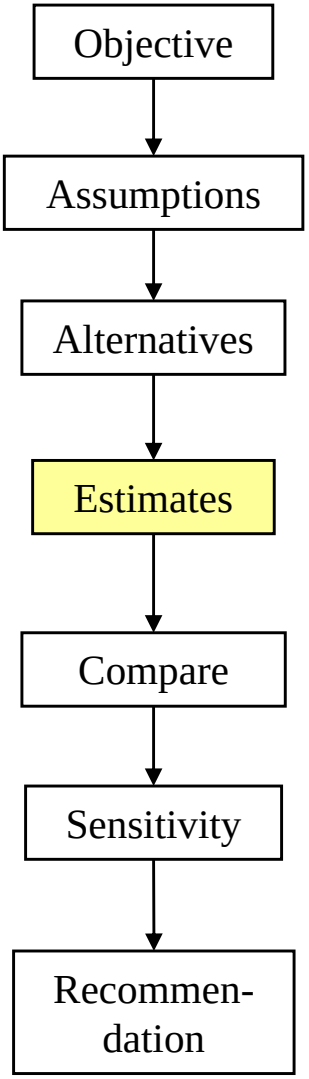
- Define and quantify benefits for each alternative
  - Define alternative benefits (continued)
    - Monetary Benefits can be categorized as:
      - Cost Savings - a reduction in current funding requirements
      - Cost Avoidance - a future cost savings or reduction in future resource requirements
      - Improved productivity – an improvement in ability, efficiency and/or quality of getting work done (does not result in reduction in funding requirements)
    - Include Monetary benefits in Cost Estimate or Benefits Estimate? Generally speaking…
      - Cost Savings should be addressed in Cost Estimate
      - Cost Avoidance can be addressed in either section
      - Improved productivity should be address in Benefits Estimate

Benefits Estimate



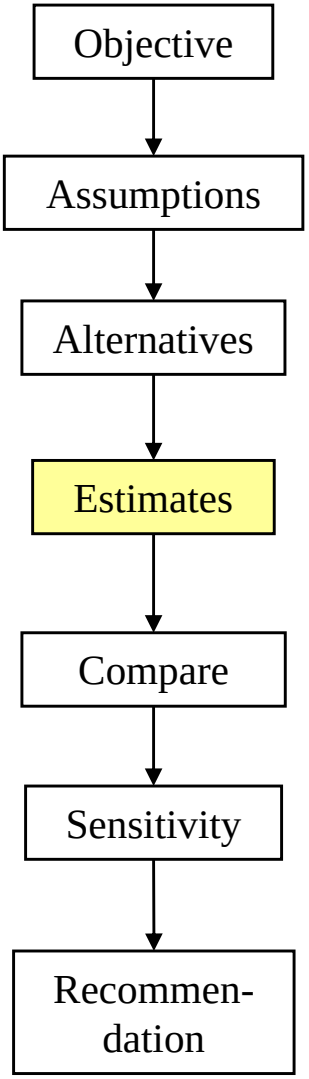
- Define and quantify benefits for each alternative
  - For non-quantifiable benefits
    - Address how to compare benefits between alternatives
    - Rank benefits or use weights (as with non-monetary but quantifiable benefits)
  - Phase benefits according to when they will be realized.
    - Phasing is critical for discounting and comparison reasons
    - Phasing of benefits should coincide with phasing of implementation of alternative system
    - Benefits should be phased through entire economic life

Example – Benefits Estimate



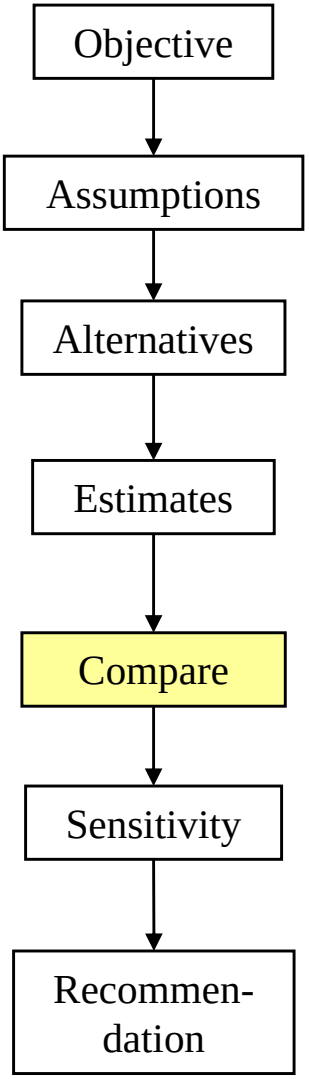
- Define and quantify benefits
  - Define candidate alternative benefits
  - Monetary:
    - Reduction in monthly electric bill (but already captured in cost estimate)
  - Non-monetary (for simplicity, none are quantifiable)
    - Fixed cost of electricity for 30 year life of system
    - Residual Values – technology could lead to faster home sale or possibly higher sale price
    - Investment in the future (reduced technology cost for future endeavors)
    - Free, renewable fuel & partial energy independence
    - Ecological benefits – reducing demand for greenhouse gas-producing electricity
    - Home security and stability during power outages
    - Clean and quiet power production

Example – Assumptions Redux



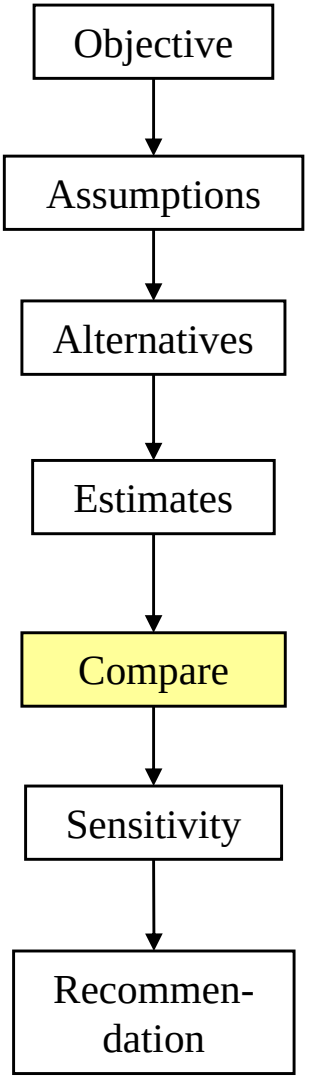
- Revisit Assumptions (back to step 2)
  - Focus on reducing non-renewable energy reliance
  - Will do this by exploring supplemental energy sources that are renewable
  - Will not focus on reduction of existing energy demand
  - Alternative Economic Life based on Mission Life (not Physical or Technological life)
  - EA Period of Analysis = 20 yrs, spanning FY09 through FY29
  - Use Constant FY09 $ for estimates
  - No varying interest / discount rates
  - No varying O&M or recurring costs
  - No salvage value
  - Non-monetary benefits are non-quantifiable (simplicity)

Step 5: Compare Alternatives



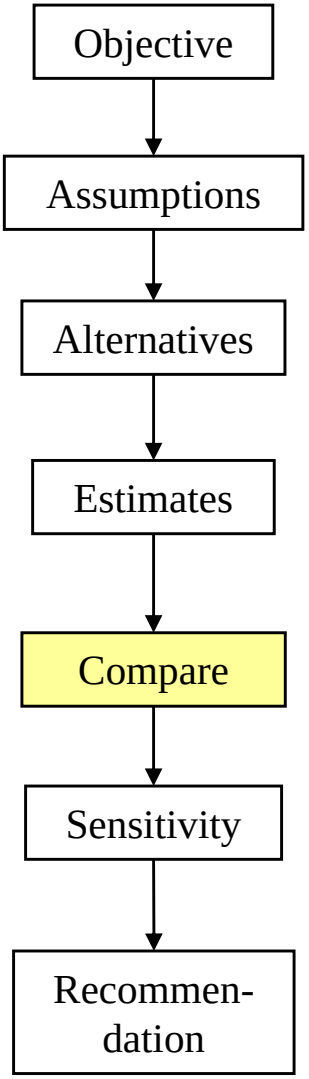
- Compare and rank alternatives
  - Phase costs and benefits by year
  - Adjust for inflation (if needed)
  - Discount costs and benefits
  - Select comparison technique that accommodates estimating assumptions (such as different economic lives)
- Comparing and ranking alternatives involves several non-trivial sub-steps
- Comparing Alternatives is important because it provides the first look at the concluding recommendation

Comparison – Time Phasing



- Phase costs and benefits by year
  - If not already done as part of the estimating step, identify what costs and benefits occur in each FY for every alternative
  - Inflationary and discounting adjustments are dependent on year in which costs/benefits occur
  - Accuracy of costs/benefits phasing could impact the recommendation
    - Any uncertainties should be identified as candidates for sensitivity analysis
  - For non-monetary but quantifiable and non-quantifiable benefits, phasing still critical for comparing relative benefits between alternatives

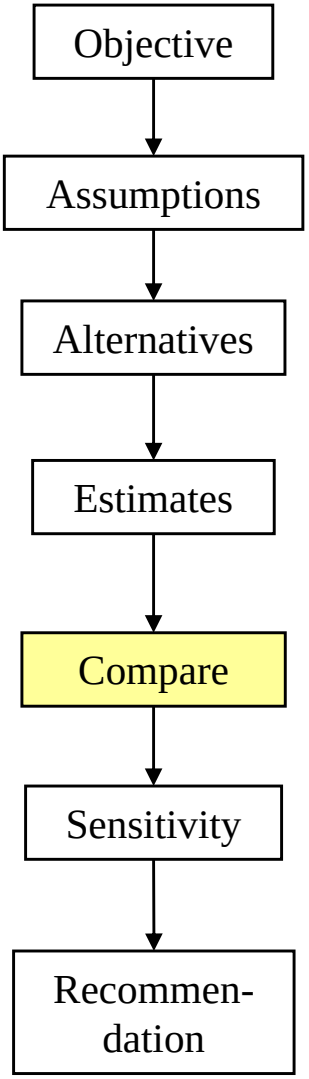
Comparison – Inflation



- Adjust for inflation
  - If needed, adjust costs and monetary benefits to
    - Constant $ using same Base Year; *or*
    - Current $

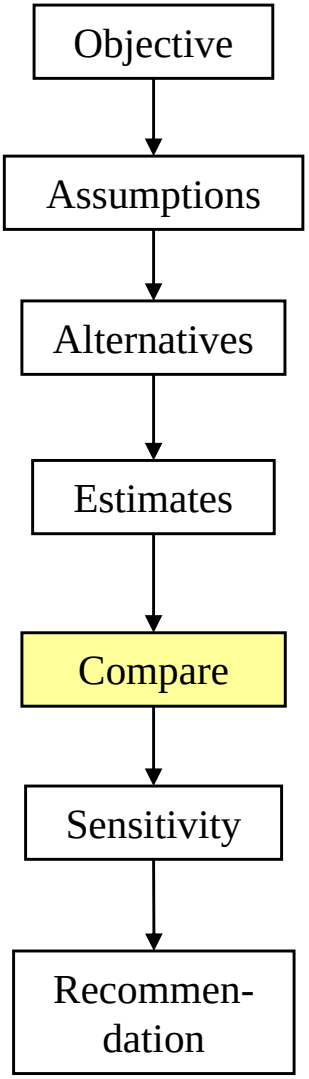
    depending on assumption made regarding use of constant/current $
  - Inflationary adjustments may be made during estimating step
  - Refer to Inflation module for further discussion on the application and reasons for inflationary adjustments

Comparison – Discounting



- Discount costs and benefits
  - To equitably compare alternatives, costs and monetary benefits must be discounted to reflect the "time value of money"
  - Discounting puts the "E" in "EA" because it adjusts estimates based on economics to allow for an "economics-free" comparison of alternatives
  - Discounting also sometimes referred to as Net Present Value (NPV) analysis

Example – Comparison



- Preliminary Recommendations
  - Based on Comparison of Costs and Benefits, the first cut of ranking of alternatives is B/C Ratio:

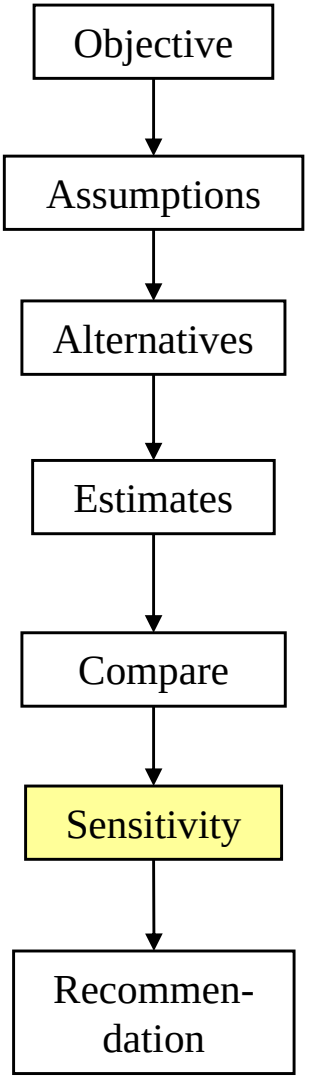
STATUS QUO	
PV COSTS	$36,756
PV BENEFITS	$6,500
NET PRESENT VALUE	-$30,256
B/C RATIO	0.18

SOLAR PANELS	
PV COSTS	$10,438.11
PV BENEFITS	$9,188.93
NET PRESENT VALUE	-$1,249.19
B/C RATIO	0.88

CHP SYSTEM	
PV COSTS	$15,250.81
PV BENEFITS	$16,540.07
NET PRESENT VALUE	$1,289.25
B/C RATIO	1.08

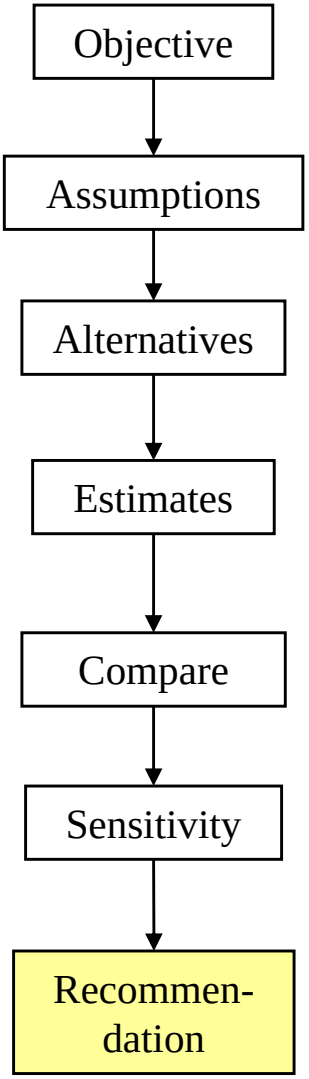
B/C RATIO	
STATUS QUO	0.18
SOLAR PANELS	0.88
CHP SYSTEM	1.08

Step 6: Test Sensitivity



- Test Sensitivity of Recommendations
  - List assumptions and constraints on which to perform sensitivity analysis
    - Most likely to change
    - Most uncertain / Least-understood
    - Significant Cost or Benefits drivers
    - Factors with key relationships to the analysis results
  - Recalculate analysis using discounted costs
  - Compare and rank alternatives using new data
- Sensitivity analysis is important because:
  - Highlights recommendation strengths/weaknesses
  - Could lead to further analysis on validity of assumptions

Step 7: Formulate Recommendations



- And finally…Formulate Recommendations
  - Synthesize *all* data
    - Baseline Cost/Benefit Comparisons
    - Sensitivity Analysis Results
    - Discussion on non-quantifiable benefits
  - Rank all alternatives
  - Select recommended course of action
  - Good to have justification material ready to support second and third place alternatives in case of questions
- Recommendations on the course of action or alternative to implement is ***the goal*** of the Economic Analysis