U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

Comprehensive Energy and Water Evaluations

T03-S03, August 5th, 2025

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

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Director of Energy Services

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Agenda

- Legal Requirements for conducting Comprehensive Energy and Water Evaluations (CEWEs)
- Auditor Requirements and Training
- Audit Reports and Supporting Documentation
- Life Cycle Cost Analysis
- Los Alamos National Lab's Life Cycle Cost Analysis Tool Demo
- Conclusion and Q&A

Session Learning Outcomes

1. Recognize EISA and EA 2020 legal requirements for CEWEs
2. Develop a Covered Facilities evaluation plan as defined under EISA and EA 2020
3. Identify the level of audit required by law as described by ASHRAE Standard 211-2018
4. Identify training resources for completing CEWEs
5. Identify parts of an audit report, documentation for preservation, and calculations required for completing the CEWEs

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Resource Efficiency Manager III, Army Organic Industrial Base

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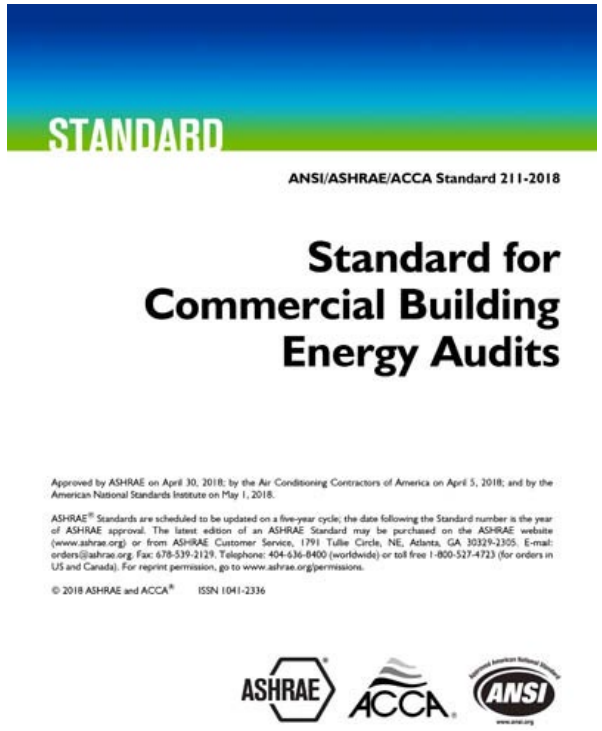
Objectives

- Learn about the legal requirements for conducting evaluations
- Define Energy Manager
- Understand the qualifications for conducting evaluations
- Learn where to get training and support
- Starting the CEWE

Legal Requirements

Energy Independence and Security Act (EISA) of 2007, Section 432

- Conduct a CEWE of every “Covered Facility” at least once every 4 years
  - Requirement can be met with Energy Savings Performance Contract (ESPC)/Utility Energy Savings Contract (UESC) audit (preferred)
  - Investment grade audits (IGA)
  - Contractor led audits
  - In-house audits
- Evaluations must meet requirements of an ASHRAE Level I or II audit
- Evaluations must include:
  - Energy and Water Saving Measures
  - Commissioning – Initial, Recommissioning, Retrocommissioning
  - Life Cycle Cost Analysis – Cost effectiveness
  - Payback Period



Legal Requirements

Energy Act of 2020 (EA 2020), Section 1002

- Expanded inclusion of water in conservation measures
- Amended implementation guidance
  - Implement measures within 2 years
  - Utilize performance contracting for 50% of measures
- Expanded web-based compliance tracking
  - Total implementation cost
  - Estimated annual savings
  - Count of potential measures by specific technology or technology category
  - Evaluation completion date

What defines an Energy Manager?

Legal Requirement from 42 USC

Energy Manager definition

The individual who is responsible for ensuring compliance with legal requirements by the facility and reducing energy use at the facility.

Contractor of a facility, part-time employee of a facility, and an individual who is responsible for multiple facilities

Subsection 8262 Definitions

Facility Energy Supervisor

Trained Energy Manager

What does ASHRAE have to say?

According ASHRAE 211-2018 only a Qualified Energy Auditor may complete audits.

Experience:

- Completed 5 commercial (nonresidential) building energy audits in the last 3 years; or
- Cumulative completion of 10 or more commercial building energy audits
- Contractor of a facility, part-time employee of a facility, and an individual who is responsible for multiple facilities

Qualifications:

- Holds a certification from a credentialing program approved by the DOE Better Building Workforce Guidelines for Building Energy Auditors or Managers
- Is a licensed professional engineer or licensed contractor specifically approved by the authority having jurisdiction (AHJ)
- Approved as qualified by the AHJ

What Programs are Credentialed?

Building Energy Auditor

- ASHRAE Building Energy Assessment Professional (BEAP)
- Association of Energy Engineers Certified Energy Auditor (CEA)

Building Energy Manager

- Association of Energy Engineers Certified Energy Manager (CEM)
- Energy Management Association Energy Management Professional (EMP)

Where can I get Help?

FEMP Website

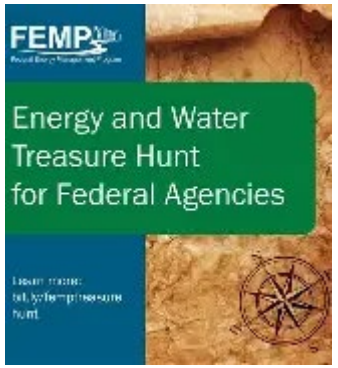
FEMP Treasure Hunt

- On site training
- Hands on auditing tool training
- Walk through audit with team presentations

DOE Better Plants

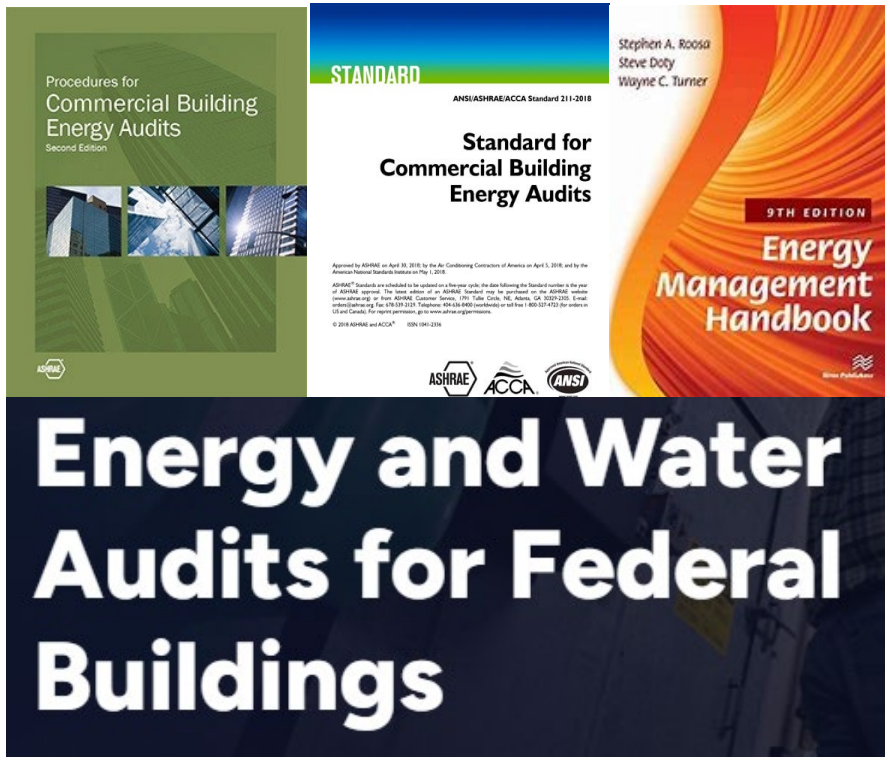
- Treasure Hunts
- Energy Boot Camp
- In-Plant Training – on site and virtual

DOE Better Buildings



Research your CEWE Format

Your Department or Agency is responsible for developing a CEWE format.
42 USC § 8253, (f)(6)(A)



Places to find guidance on how to format a CEWE

- ASHRAE Standard 211-2018, Appendix D
- ASHRAE Procedures for Commercial Building Energy Assessments (PCBEA) Second Edition
- FEMP Energy and Water Audits for Federal Buildings
- Energy Management Handbook, 9th Edition

Start your CEWE Plan

Desktop Audit/Preliminary Energy Use Analysis (Benchmarking)

Develop the Covered Facilities List

Definition 42 USC § 8253, (f)(2)(B)

Federal facilities that constitute at least 75% of facility energy or water use

Minimum requirement to evaluate 25% of “Covered Facilities” Annually

Ensures facility evaluations is completed not less frequently than every 4 years

Methods:

Calculate per building using master meter consumption and dividing by square footage (EUI), then multiplying by each facility’s square footage

Calculate per building using plug and system loads

Calculate per building using facility level metering

Benjamin Prichett, PE

Technical Lead for Energy Solutions at Jacobs

Objectives

- Learn about different approaches for executing required comprehensive evaluations (i.e. audits)
- Be familiar with options for implementing energy projects as a result of audits
- Understand the importance of tailoring audits to meet specific energy goals
- Learn how to create energy audit reports and deliverables to achieve project goals

Energy Project Framework

"The goal of the EISA process is to promote **continuous improvement** to ensure persistence of savings of implemented projects and provide a structure for ongoing **evaluation** of facilities, **implementation** of energy and water saving projects, and reporting of project and performance impacts."

Identifying Project Goals & Needs

- What are the **goals** of this project? (EUI reduction, LCC, resilience, operational efficiency, etc)
- What **laws** and/or **EO's** are the driving force behind this project? (EPACT 2005, EISA 2007, etc.)
- What **codes** need to be adhered to for this project(ASHRAE, UFC, local codes and standards, etc.)
- How will the **results** of this audit be used? Will project implementation require funding strategies?(SRM, MILCON, ESPC, etc.)

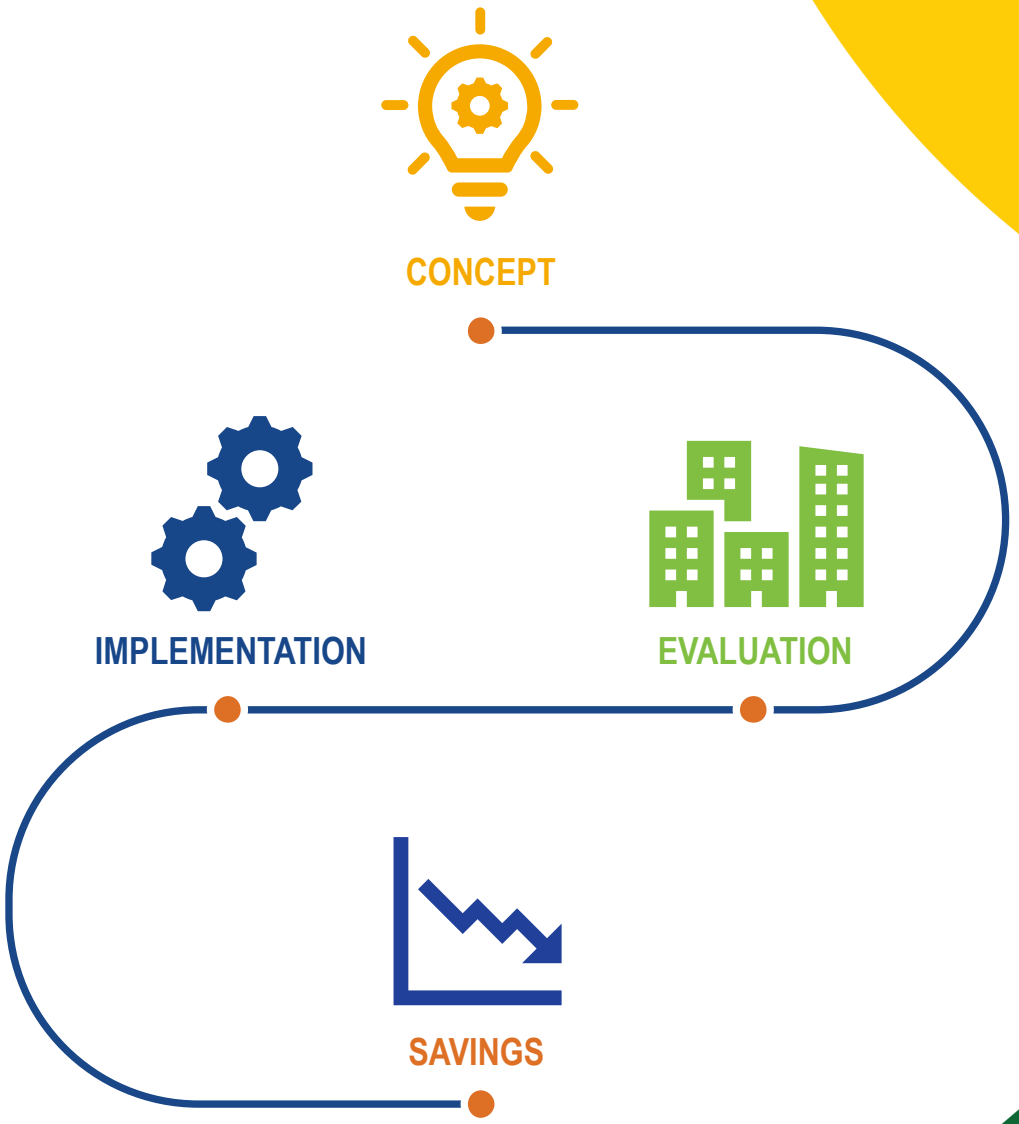
Calculations, Modeling, and Cost Estimates

Calculation and modeling **inputs/outputs** should align with **audit level**

- **ASHRAE Level 1:** “Walk-through” survey of facility
  Simple box energy model
  Parametric cost estimates($/sqft)
  High level energy calculations(low hanging fruit, parametric, etc.)
- **ASHRAE Level 2:** Detailed building survey
  In-depth energy model using observable inputs
  Line-item ROM cost estimates
  More detailed energy calculations(quantities, system types, etc.)
- **ASHRAE Level 3:** Long term building analysis
  Calibration of energy model through trended data and other more advanced metrics
  Design level cost estimates
  High accuracy level energy calculations(system sizing, operation parameters, etc.)

Transforming Audit Results into Energy Projects

- **Prioritize ECMs** based on life cycle cost and/or ability to meet goals
- **Bundle ECMs** of varying paybacks together to more cost-effectively accomplish multiple goals such as introducing more renewable generation and implementing resiliency strategies
- **Package into Projects** tailored for selected Funding Source



Prioritization and Bundling

- **Prioritization** should focus on key metrics such as LCC, SPB, cost, feasibility, resilience, etc.

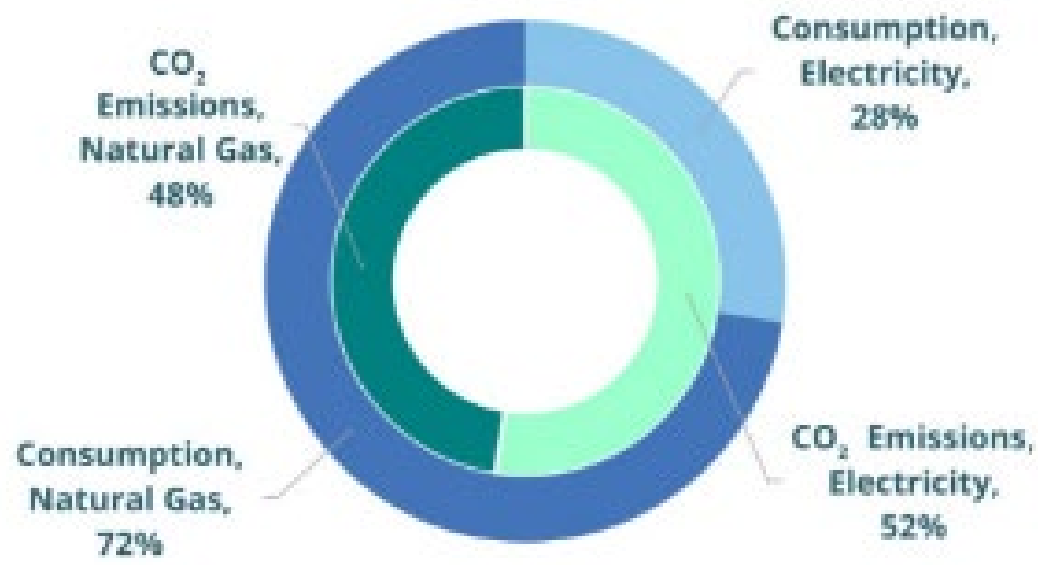
Proposed Solution	Prescribed by ASHRAE 90.1 2016	Industry Best Practice	Stretch - Progressive Solution	Technology Maturity	Capital Cost Impact	Energy Efficiency Impact	Water Impact	Feasibility	GHG Emission Impact	O&M Cost	Durability / Reliability	Climate/Locale Restraints	Space Requirements	Future Adaptation	Score	Recommended
4-Pipe VAV System	X	X		3	2	1	1	3	1	2	3	3	1	2	9.3	
RTU Gas Heat	X	X		3	3	3	3	3	1	3	2	3	3	1	12.2	
RTU Heat Pumps	X	X		3	3	3	3	3	3	3	2	3	3	1	13.2	X
WSHP System	X	X		3	2	3	2	3	2	1	3	2	1	3	11.3	

- **Bundling** by building can utilize cost effective ECMs to improve overall energy savings and maximize EUI reduction. **Bundling** by ECM type reduces the impact of project overhead and startup costs.

Energy Audit Reporting (Executive Summary)

The **executive summary** needs to contain:

- Project scope/details
- Purpose and objectives
- Baseline energy profile
- Identified opportunities summary
- Conclusions and recommendations



Energy Audit Reporting (Report Structure)

A comprehensive **Energy Audit Report** should include:

- Executive Summary that can be used as a stand-alone document
- Detail of project scope
- Summary of baseline conditions (energy consumption, metering, controls, etc.)
- Calculation and modeling methodologies
- In-depth description of energy conservation measures (ECMs) and/or projects
- Include documentation of **ALL** evaluated ECMs (both viable and non-viable)
- Appendices that will provide value to creating real projects from data gathered and results

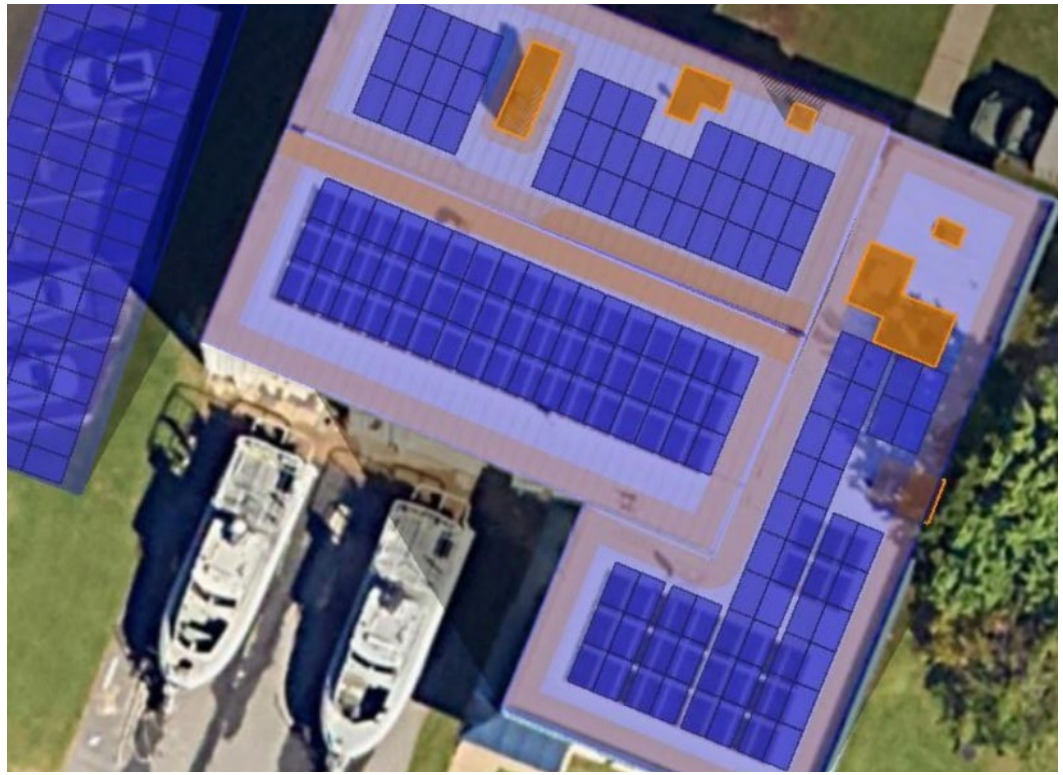
Energy Audit Reporting (Report Structure)

Contents

Energy Audit Reporting (Appendices)

Examples of key **Energy Audit Report** appendices:

- Existing building and system summaries
- Calibrated baseline modeling summary
- Prioritization and/or bundling matrix
- Energy calculations & cost estimates
- Additional supporting documentation, such as
    - Solar/renewable energy calculations and layouts
    - Funding documentation
    - Water and wastewater modeling
    - Etc.



Closing Thoughts

- Begin with the end in mind
- Select energy audit level to match project goals
- Define deliverables to support project development/implementation
- Use current energy plan/budget to guide execution of energy projects

Dalinda Bangert

Sustainable Buildings Coordinator

Los Alamos National Laboratory

Life-Cycle Cost Analysis

Topics:

- What is it?
- What it is not?
- Why should we use it?
- Examples of types of metrics
- What information is needed to complete it?
- Steps in completing a LCCA
- Example of a tool developed by Los Alamos National Laboratory

Life-Cycle Cost Analysis: Defined

What is it?

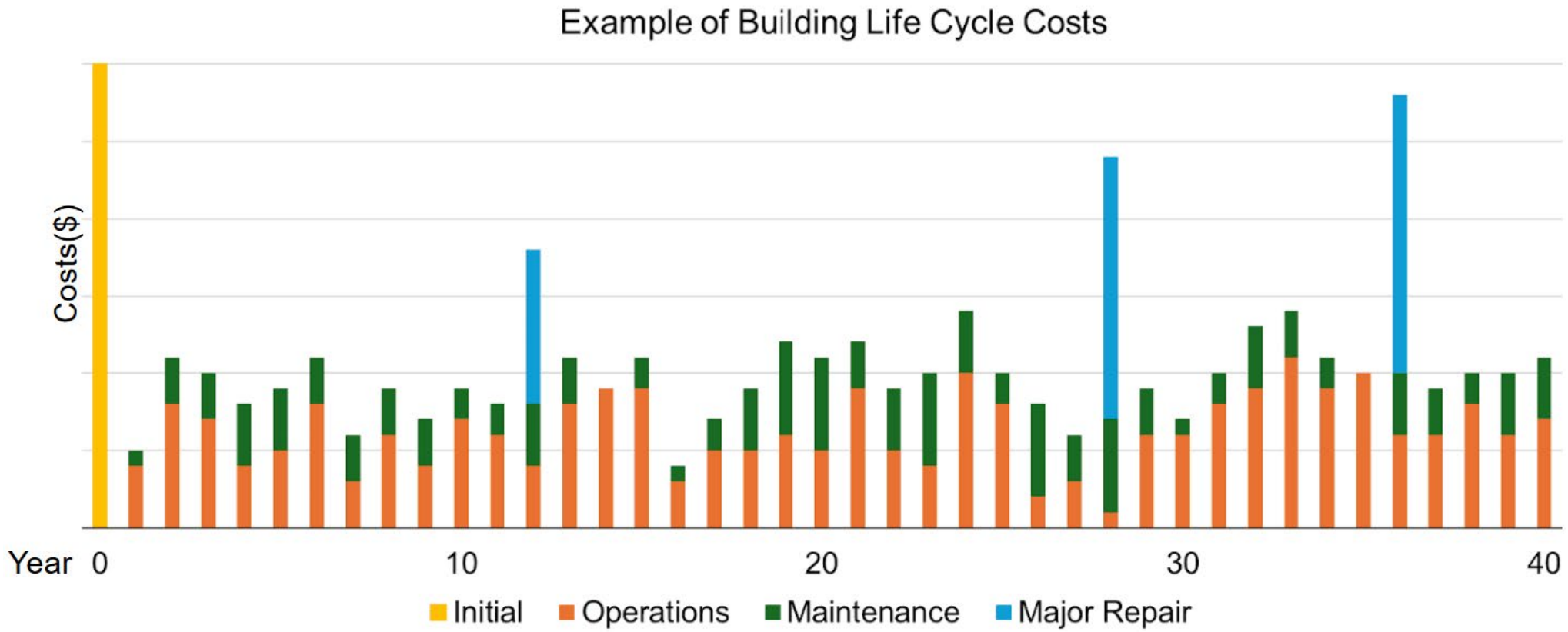
A method to evaluate the total cost of ownership of a product or building throughout its life.

A method to compare the total cost of ownership of one or more alternatives or a method to determine cost-effectiveness of one alternative.

10 CFR 436, Subpart A defines the process for Federal projects.

Smart business and the sensible use of taxpayer money.

Life-Cycle Cost Analysis: Defined



Life-Cycle Cost Analysis: Defined

What it is NOT?

It is **not value engineering**, which is a team approach to analysis with the goal of achieving the required functions at the lowest cost of ownership.

However, LCCA and Value Engineering are companions throughout planning and design phases.

It is **not a life-cycle assessment** which evaluates the environmental costs associated with a product, process, structure or activity.

Life-Cycle Cost Analysis: Why?

- Why do we use life-cycle cost analysis?
  - Required by 

Code of Federal Regulations
A point in time eCFR system

    - 10 CFR 436, Subpart A, 10 CFR 433, Subpart A, 10 CFR 435, Subpart E
    - 42 USC § 8253, (f)(1)(D), 42 USC § 8253, (f)(4)(A), 42 USC §8254
  - Type of decisions it may help an agency or company make:
    - Project acceptance or rejection
    - Optimal energy efficiency, system selections, or designs
    - Optimal combination of interdependent systems or projects

Life-Cycle Cost Analysis: Common Metrics

Life cycle costs: Used to evaluate alternative new building designs. This metric compares the total costs of ownership over time of the alternatives.

Net savings: Used to evaluate both new and retrofit projects. It is the difference between the life-cycle cost *with* and the life-cycle costs *without* an alternative.

Savings-to-Investment Ratio (SIR): The ratio of the savings to the costs of an energy or water conservation measure. If the savings/costs = 1 or more, it is considered cost-effective.

Adjusted Internal Rate of Return (IRR): It is calculated by subtracting 1 from the nth root of the ratio of the terminal value of savings to the present value of costs, where n is the number of years in the study period. To be considered cost-effective the IRR must be greater than the discount rate as set by DOE.

Simple Payback Period: The number of years required for the savings to equal the costs of the retrofit, ***without consideration of discount rates***. Used as a “rough measure” to determine if a conservation retrofit will be cost-effective. An alternative is likely to be cost-effective if payback time is *significantly* less than the useful life of that system, and of the Federal building in which it is to be installed.

Life-Cycle Cost Analysis: Steps

1. Define the scope
2. Define the timeframe
3. Establish Costs
4. Discount future costs to present value
5. Compare results
6. Select optimal solution

Life-Cycle Cost Analysis: Steps

1. Define Scope
   - Decide which alternatives to include
   - Alternatives may be alternative combinations since some selections may affect others.
2. Define the timeframe
   - Study period may vary depending on the type of project, but never more than 40 years.
3. Establish Costs
   - Initial costs: design & construction
   - Annually Recurring Costs: Energy and Water Usage, Maintenance,
   - Non-recurring Costs: Repair and replacement of systems and equipment, Periodic maintenance, Residual value/cost of disposal

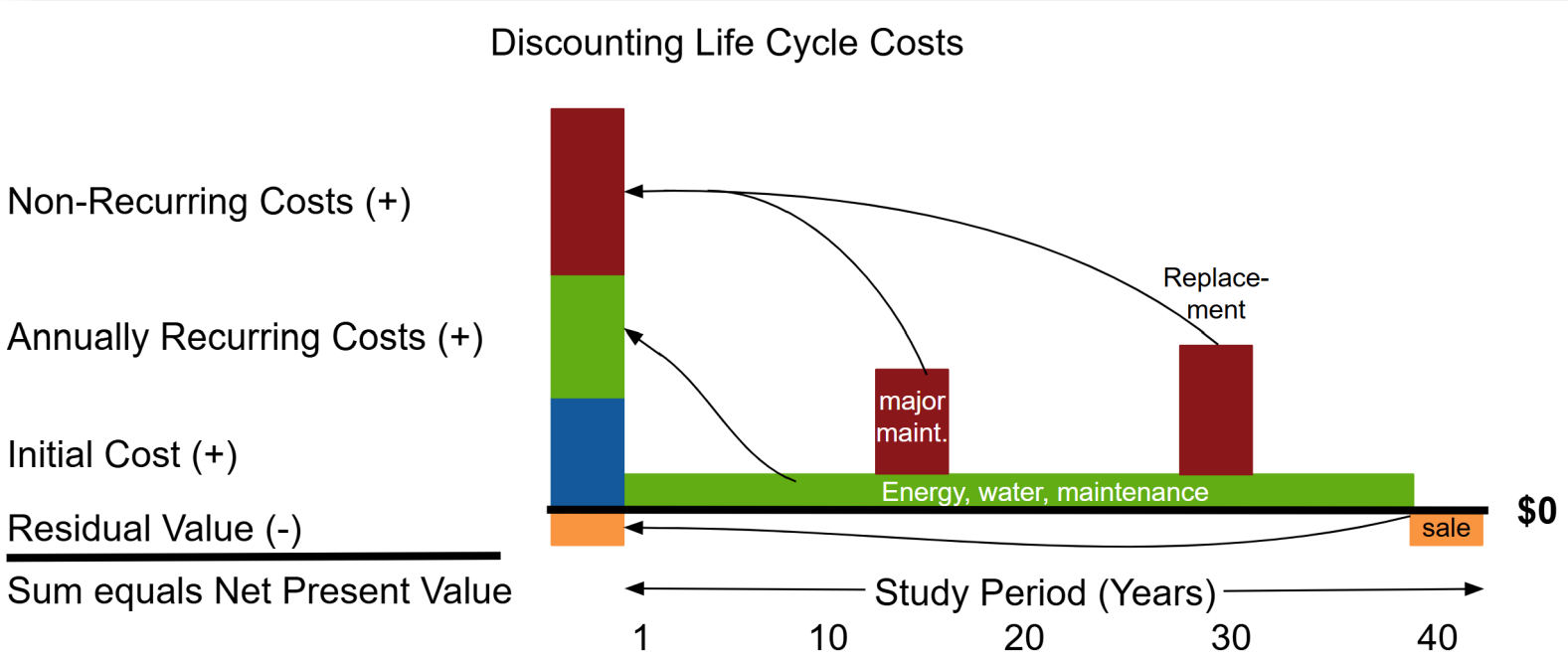
Life-Cycle Cost Analysis: Steps

4

Discount future costs to Net Present Value (NPV)

- Discount Rate which is the Real Interest Rate: Nominal Interest Rate – Inflation

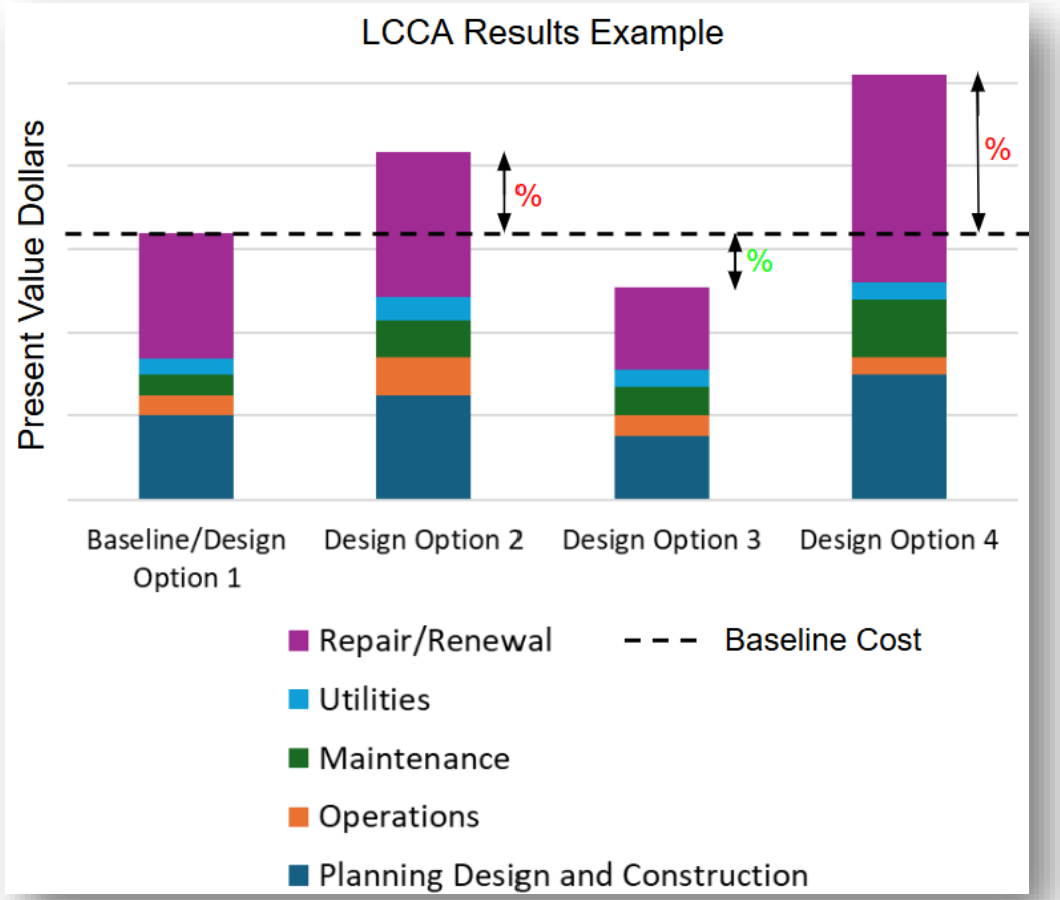
  1+Inflation



Life-Cycle Cost Analysis: Steps

5 Compare results

6 Select Optimal Solution



Resources
NIST Handbook 135 Life Cycle Costing Manual
https://nvlpubs.nist.gov/nistpubs/hb/2020/NIST.HB.135-2020.pdf
Annual Supplement to the NIST Handbook
https://www.energy.gov/femp/articles/annual-supplement-nist-handbook-135

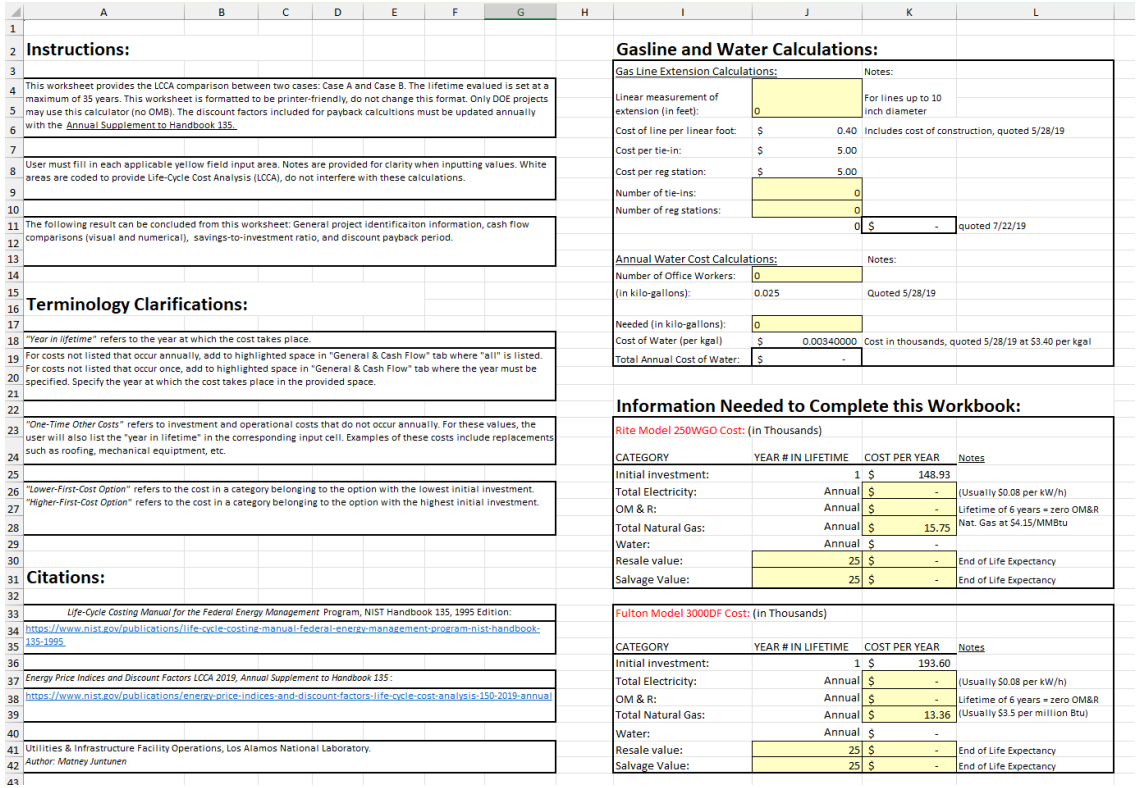
Life-Cycle Cost Analysis

Los Alamos National Lab originally developed its own LCCA tool.

It was not very user friendly.

New version allows for visualization of the data.

The National Institute of Standards and Technology (NIST) developed the Building Life Cycle Cost (BLCC) Programs to provide computational support for the analysis of capital investments in buildings. https://www.energy.gov/femp/building-life-cycle-cost-programs



Instructions:

This worksheet provides the LCCA comparison between two cases: Case A and Case B. The lifetime evaluted is set at a maximum of 35 years. This worksheet is formatted to be printer-friendly, do not change this format. Only DOE projects may use this calculator (no OMB). The discount factors included for payback calcultions must be updated annually with the Annual Supplement to Handbook 135.

User must fill in each applicable yellow field input area. Notes are provided for clarity when inputting values. White areas are coded to provide Life-Cycle Cost Analysis (LCCA), do not interfere with these calculations.

The following result can be concluded from this worksheet: General project identificaiton information, cash flow comparisons (visual and numerical), savings-to-investment ratio, and discount payback period.

Terminology Clarifications:

"Year in lifetime" refers to the year at which the cost takes place.

For costs not listed that occur annually, add to highlighted space in "General & Cash Flow" tab where "all" is listed. For costs not listed that occur once, add to highlighted space in "General & Cash Flow" tab where the year must be specified. Specify the year at which the cost takes place in the provided space.

"One-Time Other Costs" refers to investment and operational costs that do not occur annually. For these values, the user will also list the "year in lifetime" in the corresponding input cell. Examples of these costs include replacements such as roofing, mechanical equiptment, etc.

"Lower-First-Cost Option" refers to the cost in a category belonging to the option with the lowest initial investment.
"Higher-First-Cost Option" refers to the cost in a category belonging to the option with the highest initial investment.

Citations:

Life-Cycle Costing Manual for the Federal Energy Management Program, NIST Handbook 135, 1995 Edition:
https://www.nist.gov/publications/life-cycle-costing-manual-federal-energy-management-program-nist-handbook-135-1995

Energy Price Indices and Discount Factors LCCA 2019, Annual Supplement to Handbook 135:
https://www.nist.gov/publications/energy-price-indices-and-discount-factors-life-cycle-cost-analysis-150-2019-annual

Utilities & Infrastructure Facility Operations, Los Alamos National Laboratory.
Author: Matney Juntunen

Gasline and Water Calculations:

Gas Line Extension Calculations:		Notes:
Linear measurement of extension (in feet):	0	For lines up to 10 inch diameter
Cost of line per linear foot:	$ 0.40	Includes cost of construction, quoted 5/28/19
Cost per tie-in:	$ 5.00	
Cost per reg station:	$ 5.00	
Number of tie-ins:	0	
Number of reg stations:	0	
	0	$ - quoted 7/22/19

Annual Water Cost Calculations:		Notes:
Number of Office Workers:	0	
(in kilo-gallons):	0.025	Quoted 5/28/19
Needed (in kilo-gallons):	0	
Cost of Water (per kgal)	$ 0.00340000	Cost in thousands, quoted 5/28/19 at $3.40 per kgal
Total Annual Cost of Water:	$ -	

Information Needed to Complete this Workbook:

Rite Model 250WGO Cost: (in Thousands)

CATEGORY	YEAR # IN LIFETIME	COST PER YEAR	Notes
Initial investment:	1	$ 148.93	
Total Electricity:	Annual	$ -	(Usually $0.08 per kW/h)
OM & R:	Annual	$ -	Lifetime of 6 years = zero OM&R
Total Natural Gas:	Annual	$ 15.75	Nat. Gas at $4.15/MMBtu
Water:	Annual	$ -	
Resale value:	25	$ -	End of Life Expectancy
Salvage Value:	25	$ -	End of Life Expectancy

Fulton Model 3000DF Cost: (in Thousands)

CATEGORY	YEAR # IN LIFETIME	COST PER YEAR	Notes
Initial investment:	1	$ 193.60	
Total Electricity:	Annual	$ -	(Usually $0.08 per kW/h)
OM & R:	Annual	$ -	Lifetime of 6 years = zero OM&R
Total Natural Gas:	Annual	$ 13.36	(Usually $3.5 per million Btu)
Water:	Annual	$ -	
Resale value:	25	$ -	End of Life Expectancy
Salvage Value:	25	$ -	End of Life Expectancy

Laura McCall

Data Analyst

Los Alamos National Laboratory

Closing Thoughts

- Your Department or Agency is responsible to adopt CEWE report standards, required documentation, and ensure the reports and implementation is occurring.
- Your Department or Agency is responsible for deciding the training requirements for a Trained Energy Manager.
- A CEWE is more than an ASHRAE Level I, but less than a Level II
- The CEWE purpose is to find any/all ECM/WCM within every building and document them
- The DOE MEASUR tool may assist with calculations and ECM/WCM development

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FEMP Summer Workshops

This Training Is Accredited

How to obtain your CEUs:

1. Log in to https://edu.wbdg.org/ using your WBDG credentials
   - The assessment and evaluation will be made available to attendees at 8:00am ET on Monday, August 11th
   - The assessment and evaluation will close on September 22nd
2. In the list of trainings you attended, click on the Visit link by the course you wish to complete
   - If the course you're looking for is not listed, click on My Account in the top right menu
   - If you still can't find your course, contact the WBDG support team to check your eligibility
3. Complete the assessment with a score of 80% or above
4. Upon passing the assessment, click the Post-Evaluation Survey button
5. Complete and submit the evaluation
6. Click Download Your Certificate to generate your certificate of completion, which can be downloaded for your records

Questions or issues? Contact WBDG Support at wbdg@nibs.org.

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A continuing education unit (CEU) from the International Association for Continuing Education and Training (IACET) equals 10 hours of learning in an approved program for licensed or certified professionals.

Thank You

U.S. DEPARTMENT of ENERGY | Federal Energy Management Program

FEMP Summer CAMP (Courses Aligned with Mission Priorities)

Links

Search for 42 USC CHAPTER 91, SUBCHAPTER III, Part B: Federal Energy Management

Federal Energy Management Program Energy and Water Audits for Federal Buildings

https://www.energy.gov/femp/energy-and-water-audits-federal-buildings

Better Plants

https://betterbuildingssolutioncenter.energy.gov/better-plants

Better Buildings

https://betterbuildingssolutioncenter.energy.gov/

ASHRAE Standard 211 Mandated Forms

https://www.ashrae.org/technical-resources/bookstore/supplemental-files/mandatory-reporting-requirements-for-level-1-and-level-2-energy-audits

National Institute of Building Sciences, Better Buildings Workforce Guidelines, Job Task Analysis

https://nibs.org/fmoc/bbwg_jtamat/