
Introduction to Commercial Building Audits

Course No. ENRG 50

Introduction to Commercial Building Audits

Outline

A. Introduction to concept of commercial building energy auditing

1. Why energy efficiency (EE) is important
2. Energy use and waste in commercial building operations
3. Prioritizing energy efficiency over renewable energy generation

B. Ordinances, policies and standards governing commercial building audits

1. San Francisco Existing Commercial Buildings Performance Ordinance
2. State of California energy goals
3. ASHRAE standards, including Building Energy Assessment Professional (BEAP)
4. Other audit standards

C. Three ASHRAE audit levels

1. Preliminary energy use analysis
2. Level 1, Walk-through analysis
3. Level 2, Intermediate, energy survey and energy analysis
4. Level 3, Detailed analysis of capital-intensive modifications

D. Developing the scope of work in a commercial building audit

1. Objectives of the audit, including needed data and

resources

2. Assessment management
3. Responsibilities of audit team members

E. Elements in preliminary analysis of building performance data

1. Engineering and architectural document review
2. Geographical and climatic review
3. Review and analysis of current energy use and costs
4. Benchmarking procedures

F. Factors in on-site building assessment

1. Common safety hazards and field safety techniques
2. Occupant interviews and assessment of building operations
3. Building envelope
4. Electrical systems
5. HVAC&R systems
6. Lighting systems and use
7. Miscellaneous other energy use systems
8. Domestic water systems and use
9. Indoor environmental quality

G. Analysis of data collected

1. Identify opportunities for efficiency improvement
2. Calculate value of efficiency improvements and return on investment
3. Prioritize options based on client criteria

H. Audit completion activities

1. Prepare and present written report
2. Assist with development of implementation plan

B. Ordinances, policies and standards governing commercial building audits

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SF Existing Commercial Buildings Performance Ordinance

Requirements:

- **Benchmark energy use each year**, so one can compare with others and track progress
- **Get an energy audit every five years**, which identifies cost-effective opportunities to improve



SF Existing Commercial Buildings Performance Ordinance

Who shall participate?

- Owners of commercial buildings over 10,000 sf
- Buildings >50,000 sf required to report benchmarking by Oct. 2011

Why participate?

- Saving energy saves money.
- Benchmarking to ensure owners/users don't use more energy than competitors.
- Get recognized for leadership in energy management.
- The policy was written with extensive input from commercial stakeholders
- The ordinance gives SF environment the authority to impose fines of up to \$100 per day.

Benchmarking

Why benchmark?

- Assess energy performance baselines and set goals for improvement.
- Track and report on energy performance, costs, and environmental impact over time, for individual buildings and entire portfolios
- Comply with California Assembly Bill 1103, which requires disclosure of benchmarking data for real estate transactions
- Comply with the new San Francisco Ordinance that requires benchmarking of buildings $\geq 10,000$ sf in 2011
- Receive a prestigious ENERGY STAR label with scores above 75.
- Earn points toward LEED ® certification.

PG&E's free Automated Benchmark Service:

<http://www.pge.com/benchmarking/>



Benchmarking



Required data for benchmarking?

- Portfolio Manager username and password.
- The building street address, year built, and contact information.
- The building gross floor area and key operating characteristics for each major space type.
- 12 consecutive months of utility bills for all fuel types used in the building.

Data Collection Worksheet:

http://www.energystar.gov/ia/business/downloads/PM_Data_Collection_Worksheet.doc

Portfolio Manager Quick Reference Guide:

http://www.energystar.gov/ia/business/downloads/PM_QuickRefGuide.pdf?cff0-e2dd

We will talk about the benchmarking procedures in Chapter E

Energy Auditing

Requirements:

Building size	Minimum Level of Effort
50,000 sf and larger	ASHRAE Level II – An “intermediate” survey and energy analysis
10,000 to 49,999 sf	ASHRAE Level I – A basic energy analysis

Except buildings:

- Having had a qualifying audit or retrocommissioning since 2008
- Earning LEED for Existing Buildings certification
- Getting the ENERGY STAR label regularly (score \geq 75)
- Residential, less than five years old, smaller than 10,000sf, or under financial distress are also exempt

SF Ordinance Energy Efficiency Auditor Qualifications

- Licensed Professional Engineer and one of the following:
 - At least 2 years experience performing energy efficiency audits or commissioning of existing buildings; or
 - ASHRAE Commissioning Process Management Professional Certification; or
 - Similar qualifications in energy efficiency analysis or commissioning.
- Association of Energy Engineers Certified Energy Manager (CEM);
- At least 10 years experience as a building operating engineer, or at least 5 years experience as a chief operating engineer and one of the following:
 - BOC International Building Operator Certification; or
 - International Union of Operating Engineers Certified Energy Specialist; or
- Equivalent professional qualifications to manage, maintain, or evaluate systems, as well as specialized training in energy efficiency audits and maintenance of systems, as determined by the Director.

Energy Efficiency audit report shall include:

- (1) The date(s) that the audit was performed;
- (2) A list of all retro-commissioning and retrofit measures available to the owner;
- (3) An estimate of the approximate energy savings, avoided energy cost, and costs to implement each measure; and
- (4) One of the following:
 - A list of all retro-commissioning and retrofit measures available to the owner with a simple payback of not more than 5 years; or
 - A list of all retro-commissioning and retrofit measures available to the owner with a positive net present value; or
 - An integrated package of retro-commissioning and retrofit measures that in combination will equal or exceed the total combined reduction in energy consumption of implementing all retrofit and retro-commissioning measures with a simple payback of not more than 5 years.

B. Ordinances, policies and standards governing commercial building audits

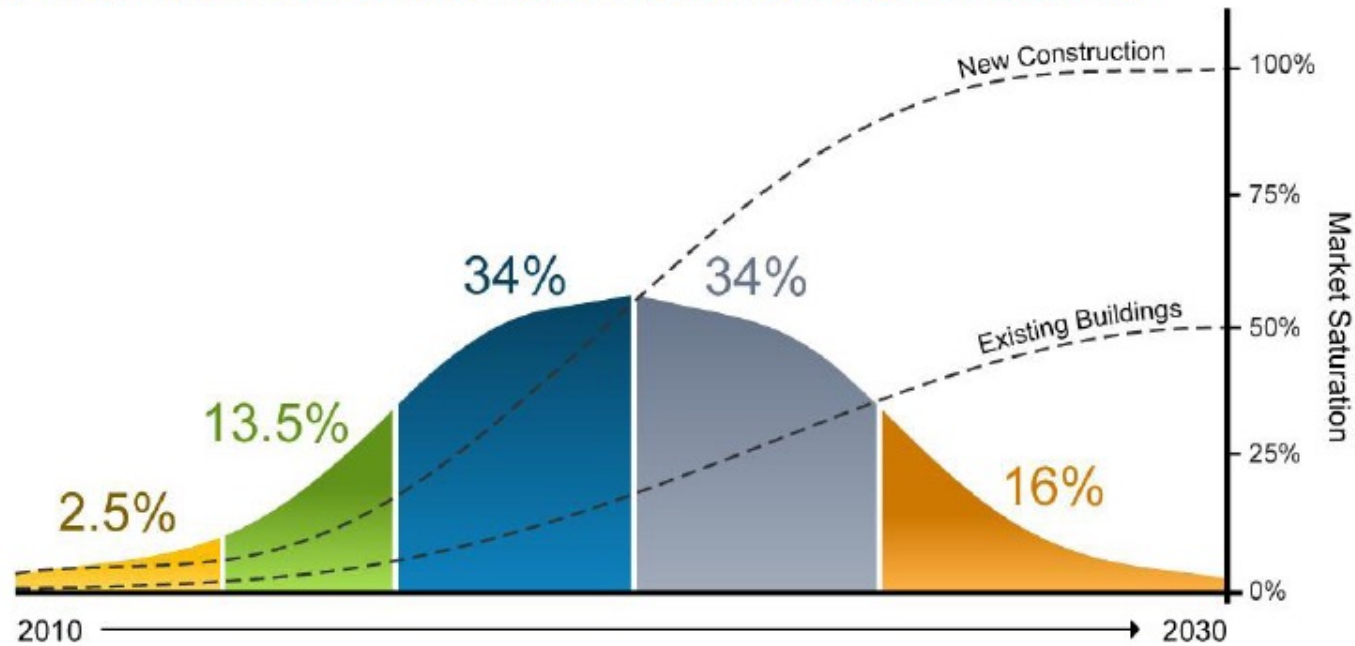
1. San Francisco Existing Commercial Buildings Performance Ordinance
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CA Strategic Plan by CPUC

- ZNE – Zero Net Energy
- All NEW residential construction will be ZNE by 2020
- All NEW commercial construction will be ZNE by 2030.
- information source:
<http://www.cpuc.ca.gov/NR/rdonlyres/6C2310FE-AFE0-48E4-AF03-530A99D28FCE/0/ZNEActionPlanFINAL83110.pdf>

CA Strategic Plan by CPUC

CONCEPTUAL MARKET DIFFUSION FOR ZERO NET ENERGY TARGETS



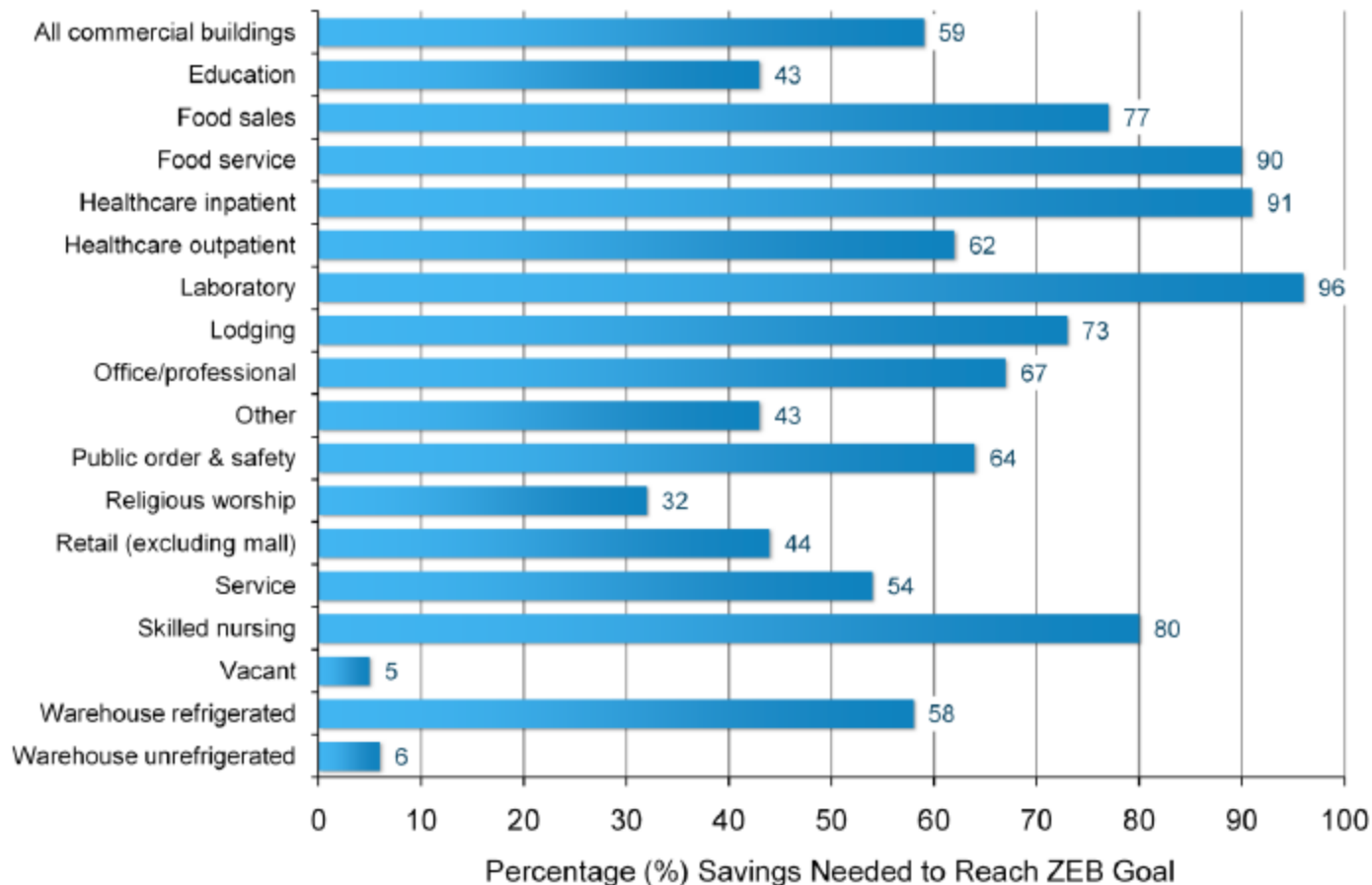
Innovators	Early Adopters	Early Majority	Late Majority	Laggards
1-4/1-5: Innovative Finance Tools & Incentives	1-3: Path to Zero/ZNE Pilots 1-6: Integrated Design 2-6: Existing Building Finance Tools 2-8: Plug Loads	2-1: Lead by Example 2-4: Benchmarking 2-5: Business case 2-7: Integrated Energy Management	2-2: Codes for Existing Buildings	1-1: ZNE Codes 1-2: T24 and T20 2-3: Code Compliance

Information source:

<http://www.cpuc.ca.gov/NR/rdonlyres/6C2310FE-AFE0-48E4-AF03-530A99D28FCE/0/ZNEActionPlanFINAL83110.pdf>

CA Strategic Plan by CPUC

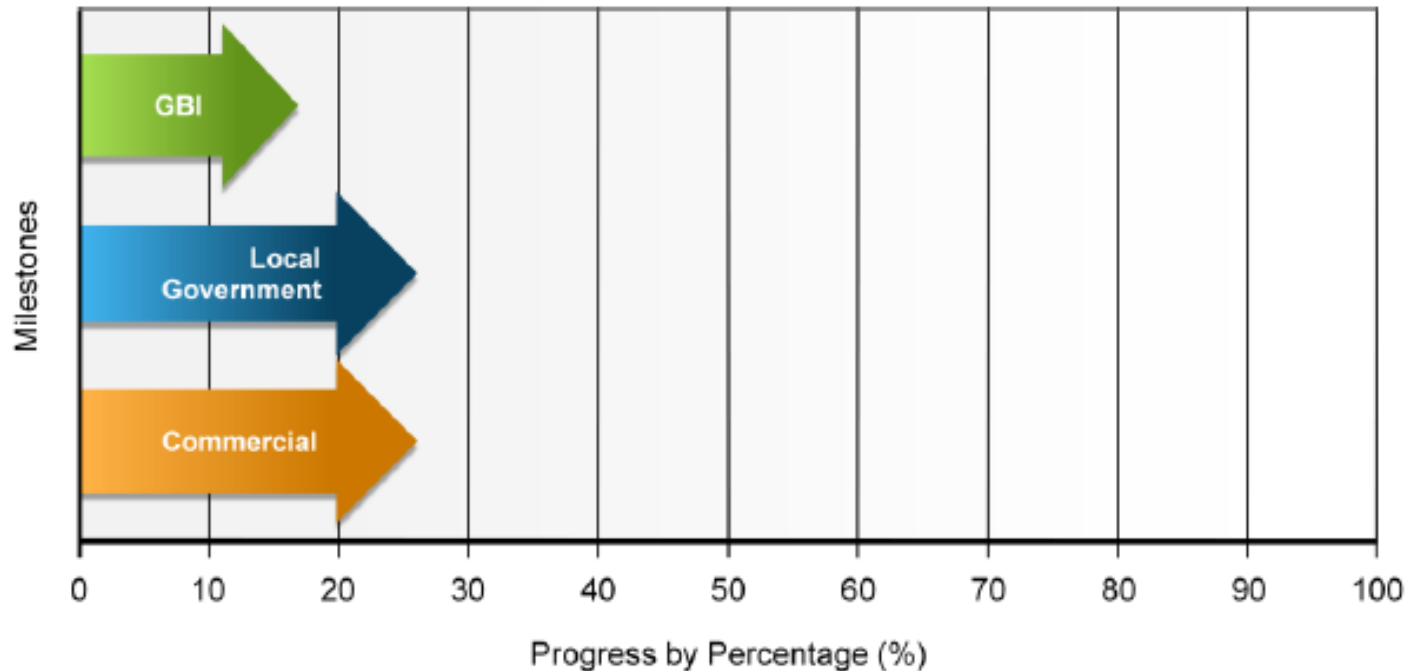
NEED 60% TO 70% DECREASE IN ENERGY CONSUMPTION OF COMMERCIAL BUILDINGS



Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/6C2310FE-AFE0-48E4-AF03-530A99D28FCE/0/ZNEActionPlanFINAL83110.pdf>

CA Strategic Plan by CPUC

PROGRESS TO DATE (2010-2012)



Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/6C2310FE-AFE0-48E4-AF03-530A99D28FCE/0/ZNEActionPlanFINAL83110.pdf>

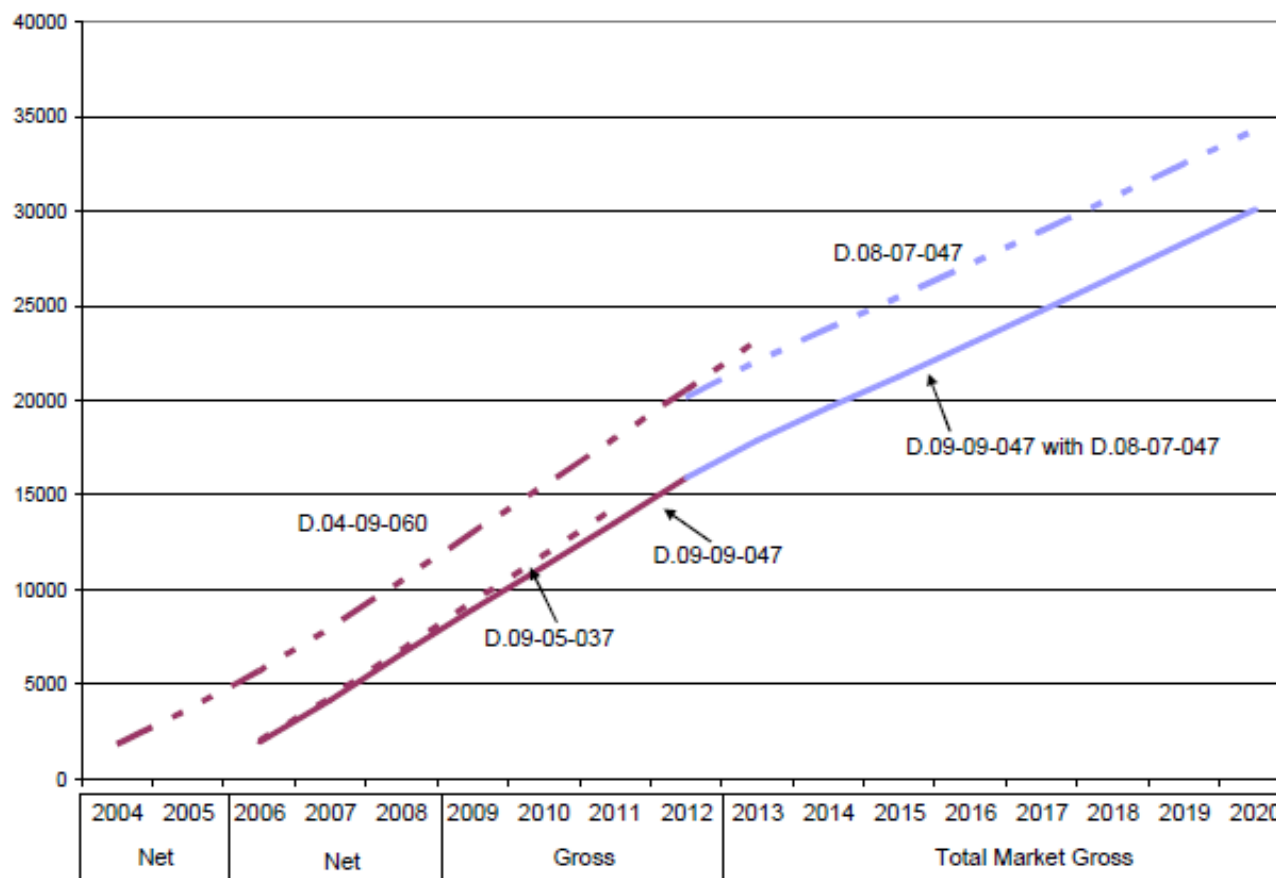
History of CPUC Utility Goals for EE

Yr of decision	Desicions	Goals	File sources
Sep. 2004	Original Goals Decision	D. 04-09-060	http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/40212.pdf
Sep. 2007	Incentive Mechanism	D. 07-09-043	http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/73172.PDF
Oct. 2007	Interim Opinion on Issues Relating the Future Savings Goals	D. 07-10-032	http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/74107.PDF
Jul. 2008	2008 Goals Decision	D. 08-07-047	http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/85995.PDF
May 2009	May 2009 Decision	D. 09-05-037	http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/101543.PDF
Sep. 2009	Sep. 2009 Decision	D. 09-09-047	http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/107829.PDF
Oct. 2010	Oct. 2010 Decision	D. 10-10-033	http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/125983.pdf

Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/E1E38C4A-5E56-4ACB-B0C9-AFD69656BFA0/0/goalsdecisionssummary.pdf>

History of CPUC Utility Goals for EE

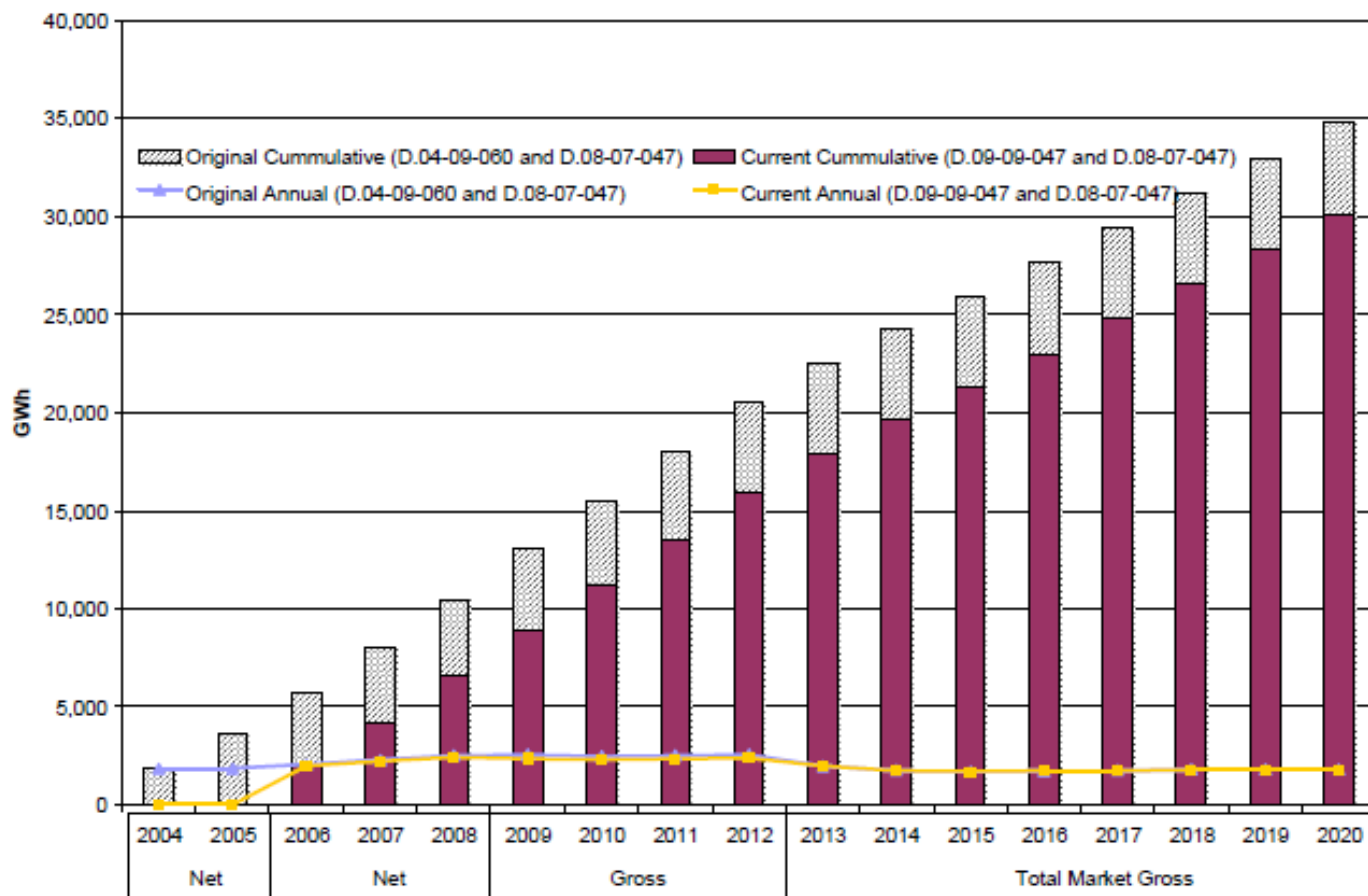
The affect on the CPUC adopted goals as a result of decision since D.04-09-060



Information source: <http://www.cpuc.ca.gov/NR/ronlyres/E1E38C4A-5E56-4ACB-B0C9-AFD69656BFA0/0/goalsdecisionssummary.pdf>

History of CPUC Utility Goals for EE

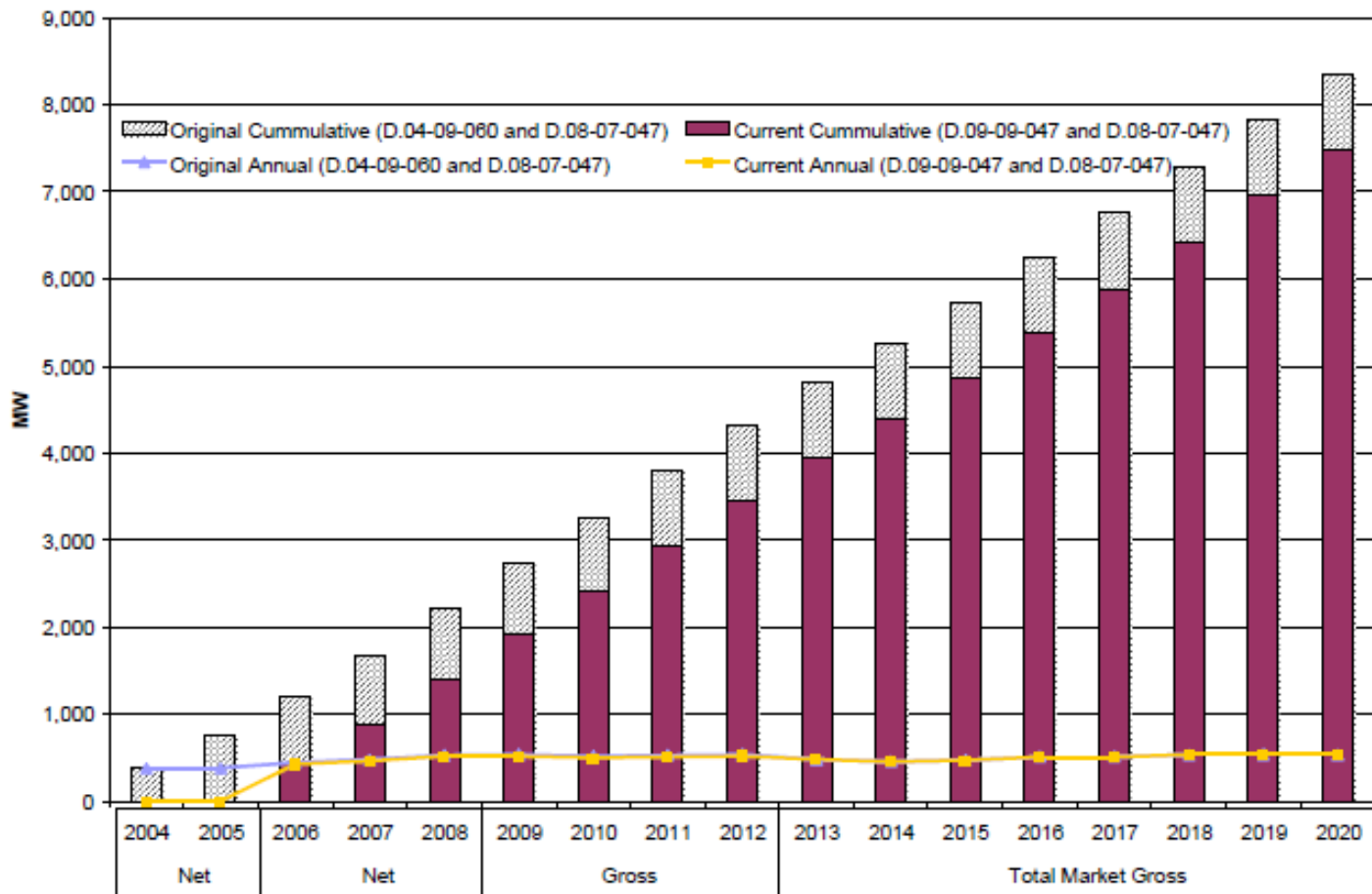
GWh saving goals



Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/E1E38C4A-5E56-4ACB-B0C9-AFD69656BFA0/0/goalsdecisionssummary.pdf>

History of CPUC Utility Goals for EE

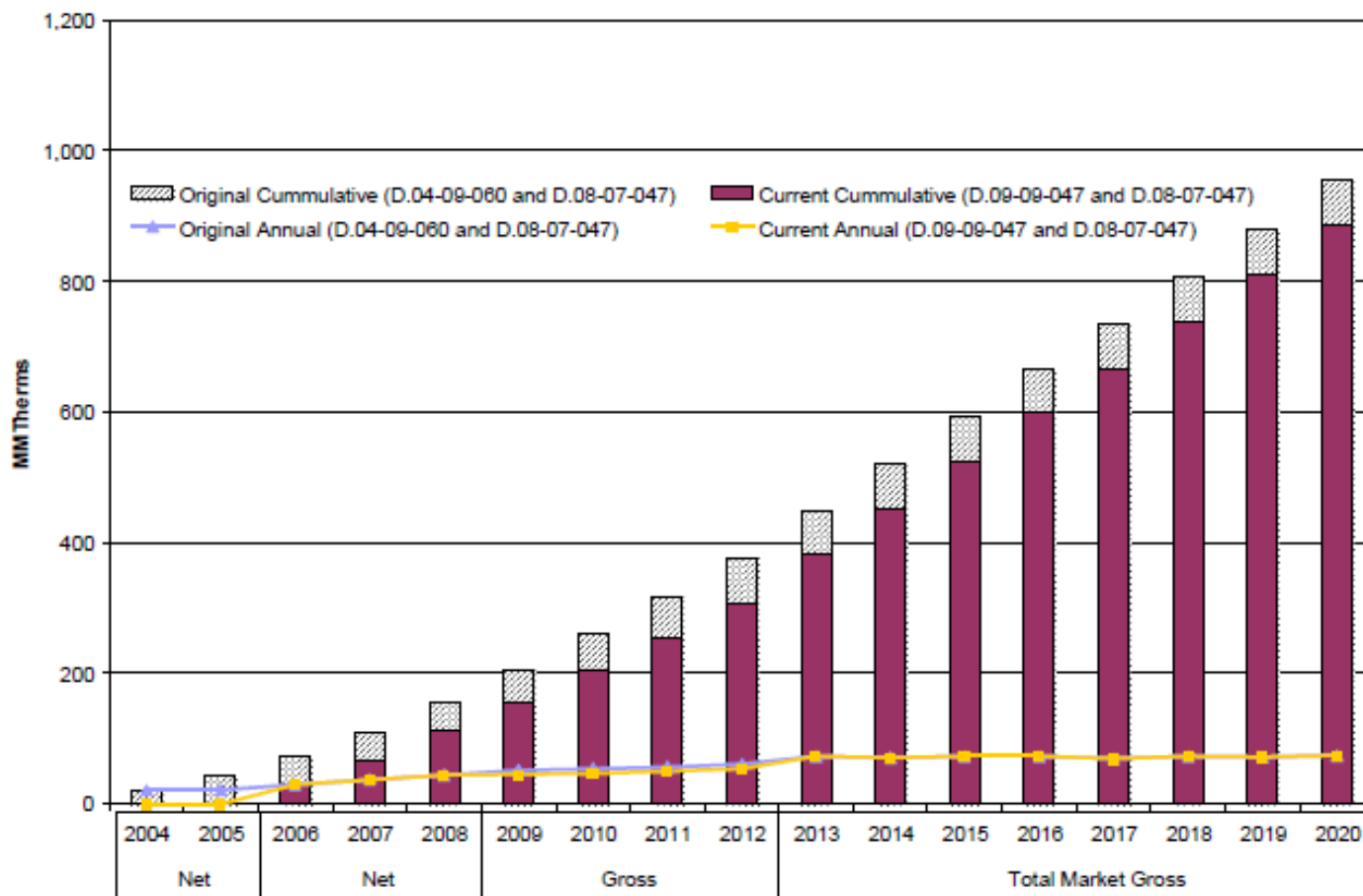
MW saving goals



Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/E1E38C4A-5E56-4ACB-B0C9-AFD69656BFA0/0/goalsdecisionssummary.pdf>

History of CPUC Utility Goals for EE

Therm saving goals



Information source: <http://www.cpuc.ca.gov/NR/ronlyres/E1E38C4A-5E56-4ACB-B0C9-AFD69656BFA0/0/goalsdecisionssummary.pdf>

Energy Efficiency Evaluation Report 2010-2011



California Public Utilities Commission

2010 – 2011 Energy Efficiency Annual Progress Evaluation Report

September 2012

Information source: <http://www.cpuc.ca.gov/NR/ronlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf>

Energy Efficiency Evaluation Report 2010-2011

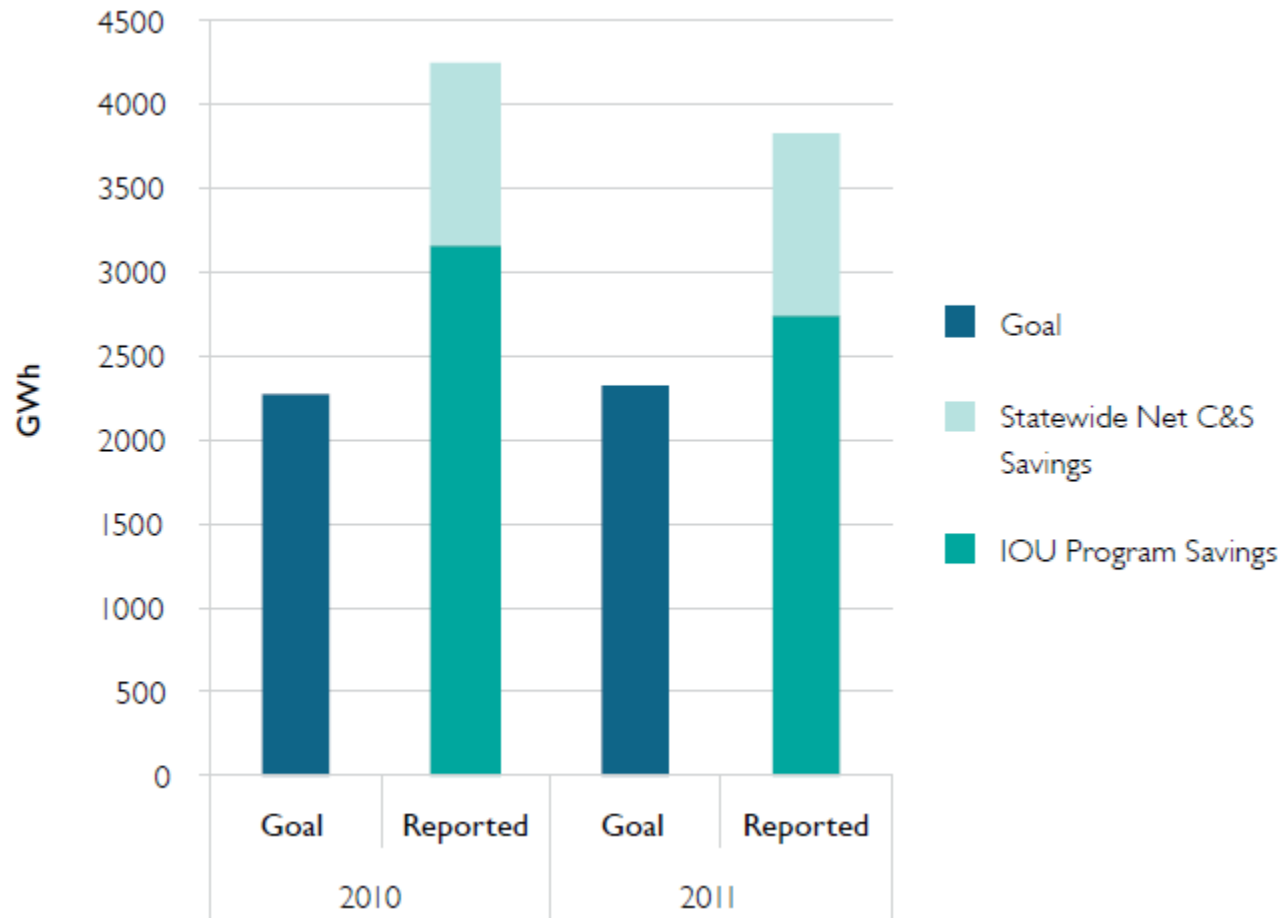
	Peak Demand	Electricity	Natural Gas	CO ₂	C/E
	MW	GWh	Mtherms	Tons	TRC
Statewide Reported through 2011	1,069	5,736	84	3,729,445	2.02
Projected through 2012	1,635	8,121	171	N/A	n/a
Codes and Standards* through 2012	364	2,178	30	n/a	n/a
Commission Adopted Goal 2010 – 2011	1,014	4,601	98	n/a	n/a

Source: ReportWorkbook_20120627_jst; IOU quarterly data filed June 1, 2012

* Codes and Standards are net savings expected.

Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf>

Estimated Savings and Performance Towards Goals



Information source: <http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf>

Energy Efficiency Evaluation

Figure 2a: California IOU Annual Energy Savings Evaluated (2006-2009), Reported (2010)

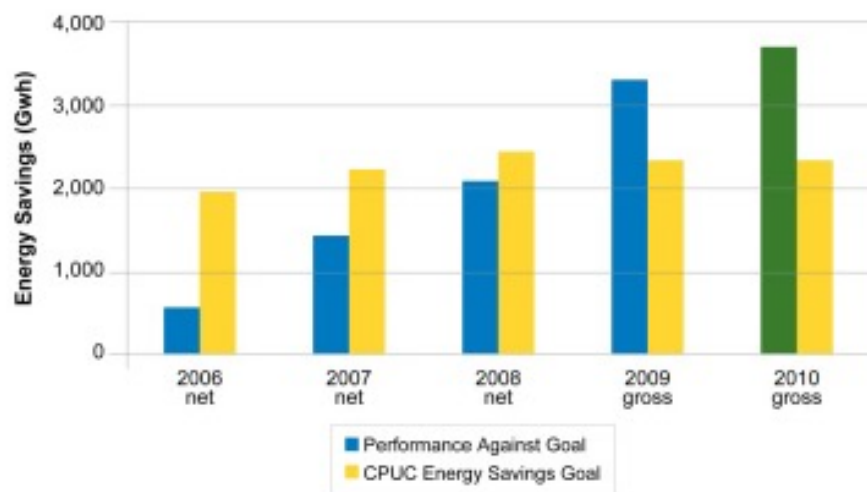
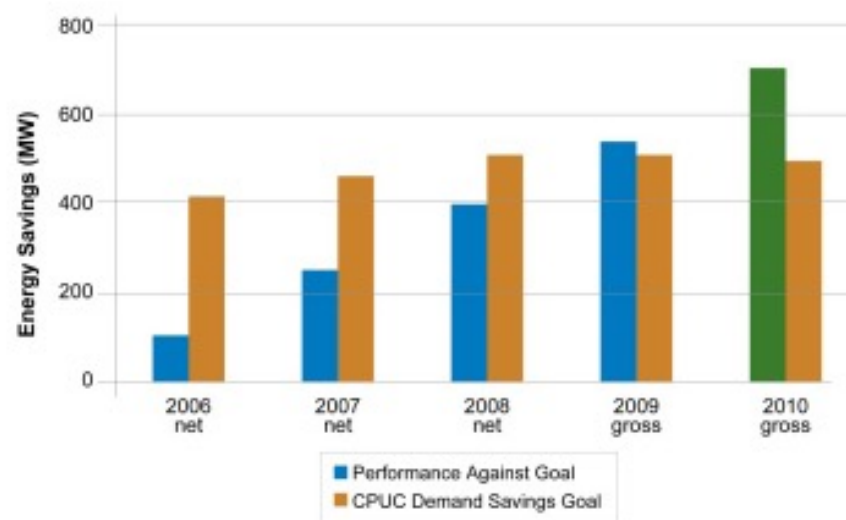


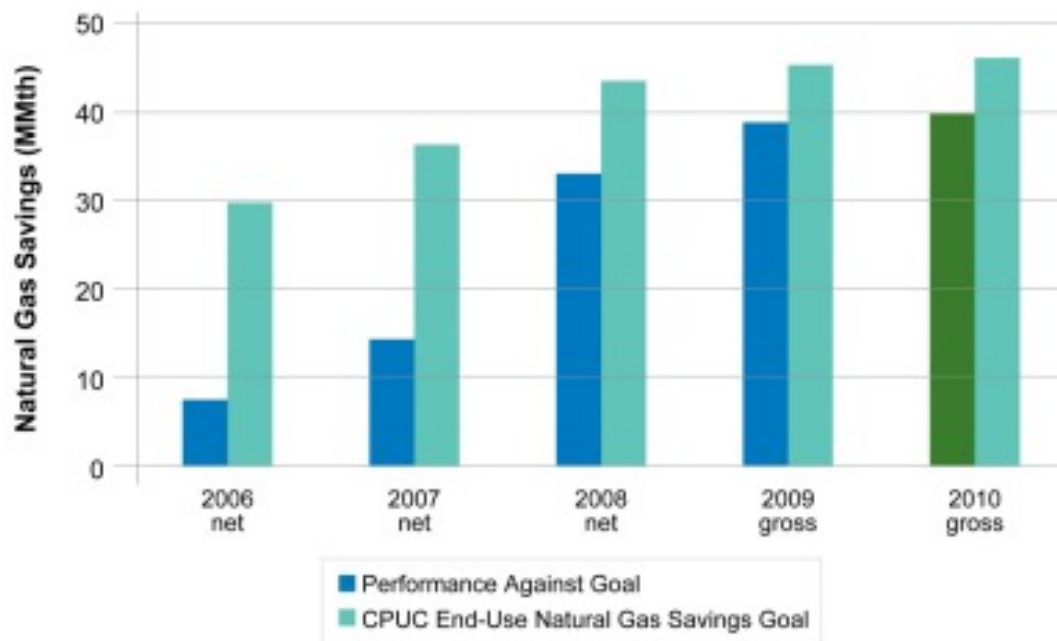
Figure 2b: California IOU Annual Peak Savings Evaluated (2006-2009), Reported (2010)



Information source: <http://www.cacleanenergyfuture.org/documents/EnergyEfficiency.pdf>

Energy Efficiency Evaluation

Figure 2c: California IOU Annual Natural Gas Savings Evaluated (2006-2009), Reported (2010)

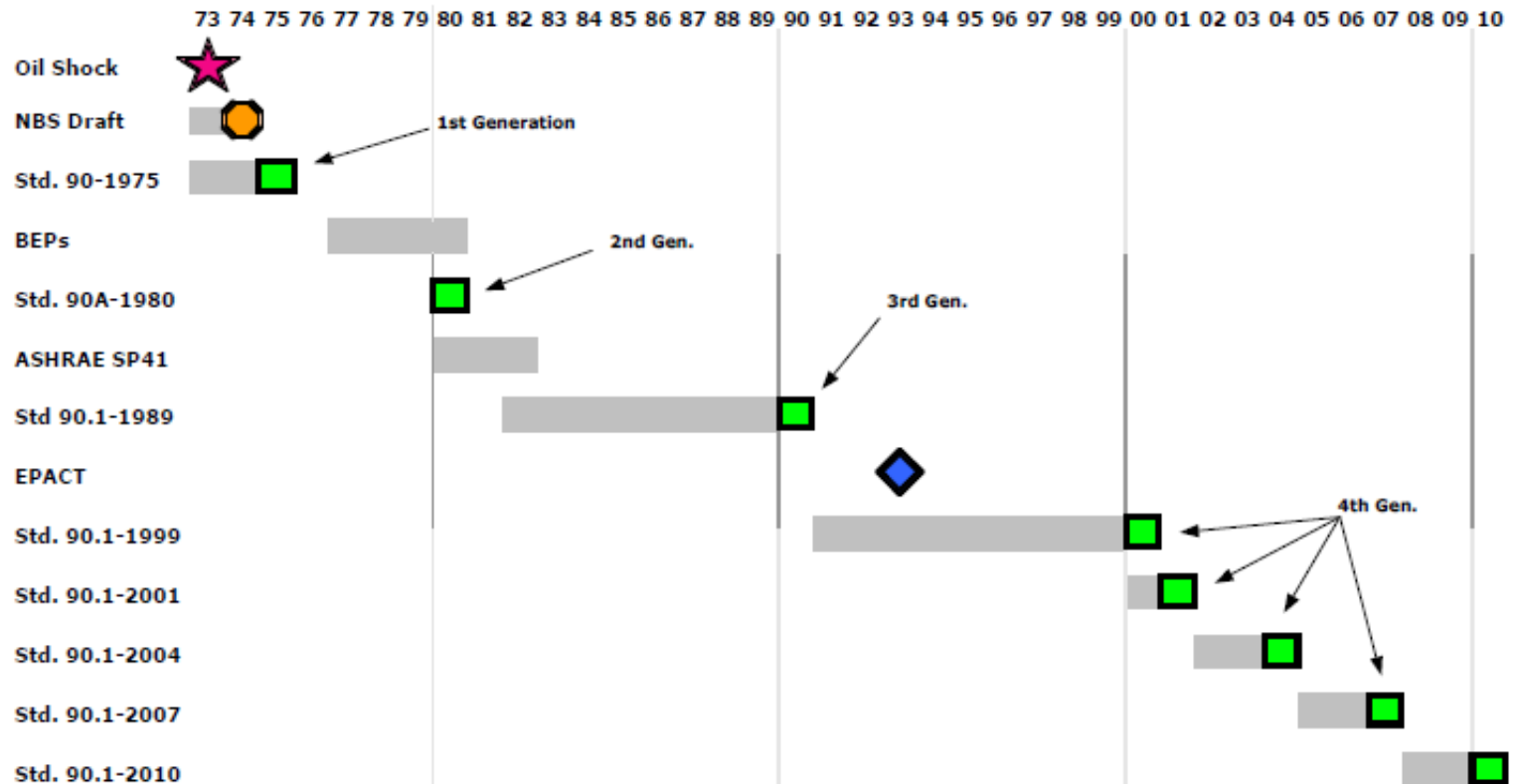


Information source: <http://www.cacleanenergyfuture.org/documents/EnergyEfficiency.pdf>

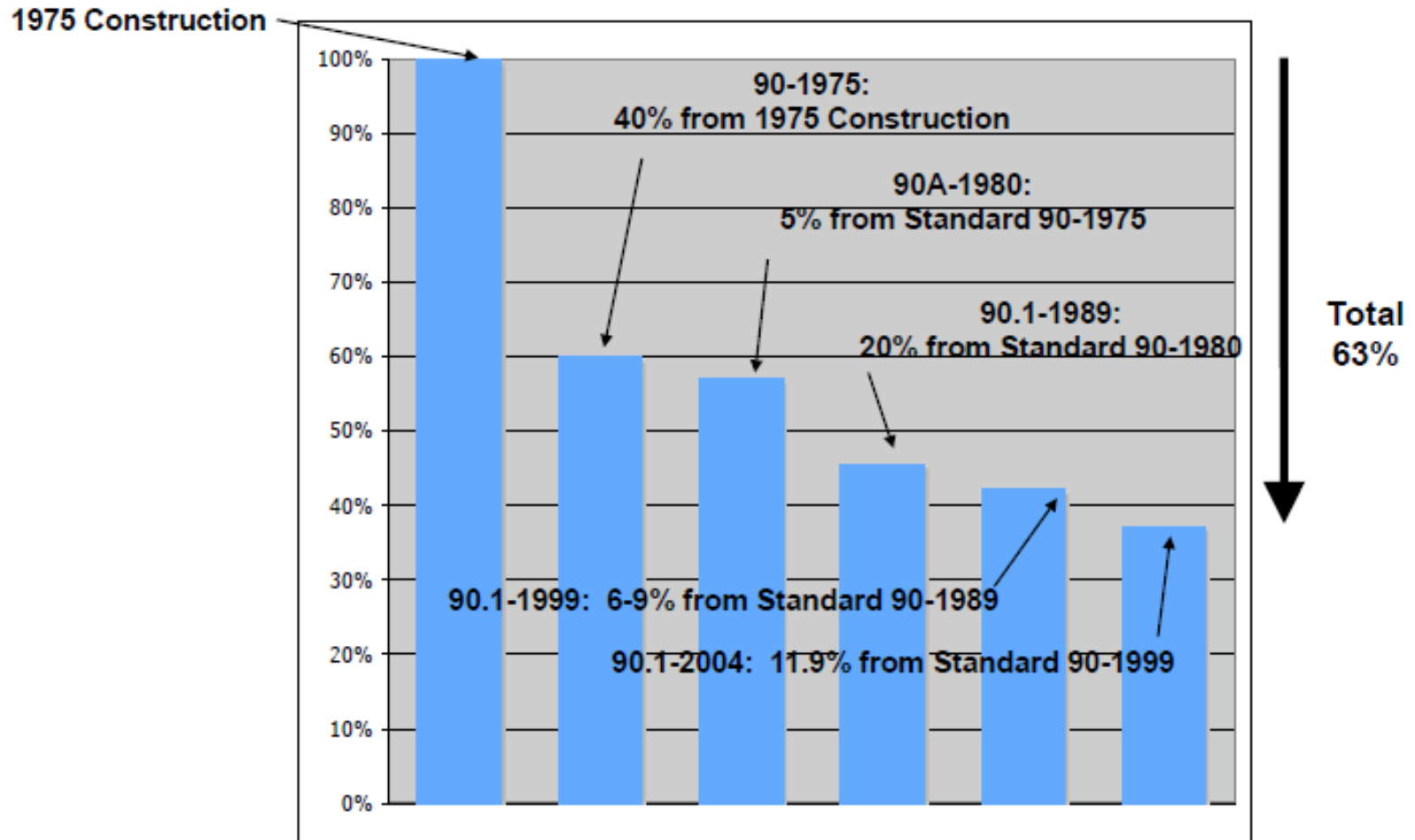
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35 Years of Standard ASHRAE 90.1



Standard ASHRAE 90.1 savings- Estimates for 4 Generations



http://ali.ashrae.biz/2012winterconferencecourses/std90-1envelope/Complying_90-1-2010_Env_Ltg_Chicago_2012_Final_Slides.pdf

Standard ASHRAE 90.1 – 2004 vs. 1999

TABLE 1—MODELED ENERGY USE INTENSITY BY BUILDING TYPE—1999 EDITION

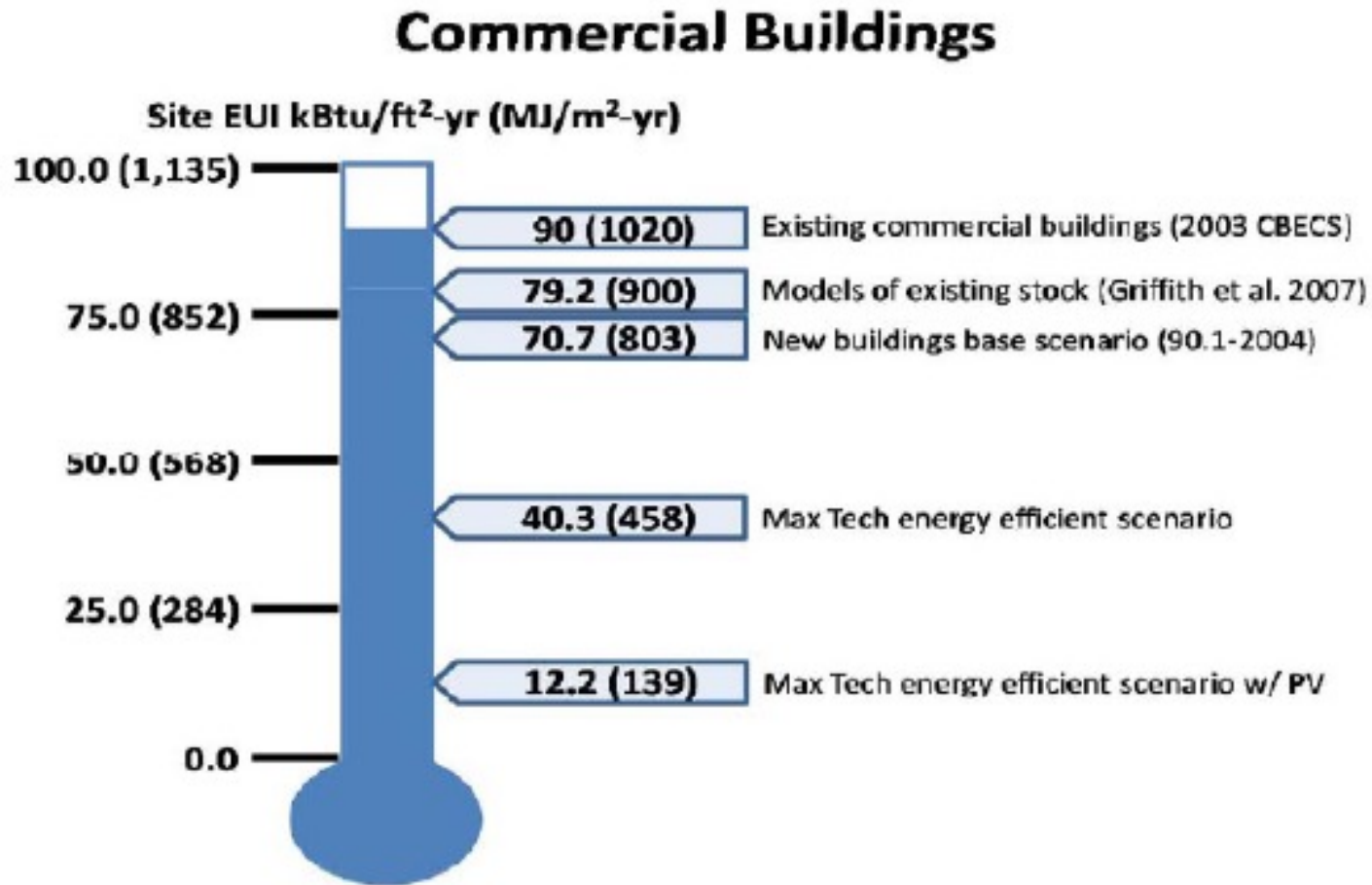
Building type	Building type floor area weight	Whole building EUI data for building population (kBtu/sf-yr or \$/sf-yr)				
		Electric EUI	Gas EUI	Site EUI	Source EUI	\$UI
Assembly	0.061	54.68	27.39	82.08	203.23	1.62
Education	0.155	31.33	16.85	48.18	117.72	0.96
Food Service	0.035	97.40	28.32	125.72	339.25	2.68
Lodging	0.091	40.93	11.53	52.46	142.16	1.14
Office	0.189	42.66	4.89	47.55	140.25	1.11
Retail	0.277	46.07	3.56	49.63	149.54	1.18
Warehouse	0.191	18.63	8.65	27.29	68.49	0.56
National		39.75	9.89	49.64	136.59	1.09

TABLE 2—MODELED ENERGY USE INTENSITY BY BUILDING TYPE—2004 EDITION

Building type	Building type floor area weight	Whole building EUI data for building population (kBtu/sf-yr or \$/sf-yr)				
		Electric EUI	Gas EUI	Site EUI	Source EUI	\$UI
Assembly	0.061	47.13	28.18	75.32	180.24	1.45
Education	0.155	27.12	16.94	44.06	104.52	0.86
Food Service	0.035	89.33	28.99	118.32	314.51	2.49
Lodging	0.091	31.82	13.33	45.15	115.97	0.93
Office	0.189	37.49	4.88	42.37	123.90	0.98
Retail	0.277	38.71	3.57	42.28	126.30	1.00
Warehouse	0.191	14.30	8.29	22.59	54.40	0.45
National		33.67	10.07	43.75	117.60	0.94

http://ali.ashrae.biz/2012winterconferencecourses/std90-1envelope/Complying_90-1-2010_Env_Ltg_Chicago_2012_Final_Slides.pdf

Future goals for ASHRAE codes



http://ali.ashrae.biz/2012winterconferencecourses/std90-1envelope/Complying_90-1-2010_Env_Ltg_Chicago_2012_Final_Slides.pdf

ASHRAE currently offers 6 certification programs

1. Building Energy Assessment Professional (BEAP)
2. Building Energy Modeling Professional (BEMP)
3. Commissioning Process Management Professional (CPMP)
4. Healthcare Facility Design Professional (HFDP)
5. High-Performance Building Design Professional (HBDP)
6. Operations & Performance Management Professional (OPMP)



Building Energy Assessment Professional Certification (BEAP)

- Was developed in close collaboration with representatives from:
 - ASHRAE's Building Energy Quotient (bEQ) program
 - Illuminating Engineering Society (IES)
 - National Institute of Building Sciences (NIBS)
 - Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - Testing, Adjusting and Balancing Bureau (TABB)

BEAP Eligibility Requirements

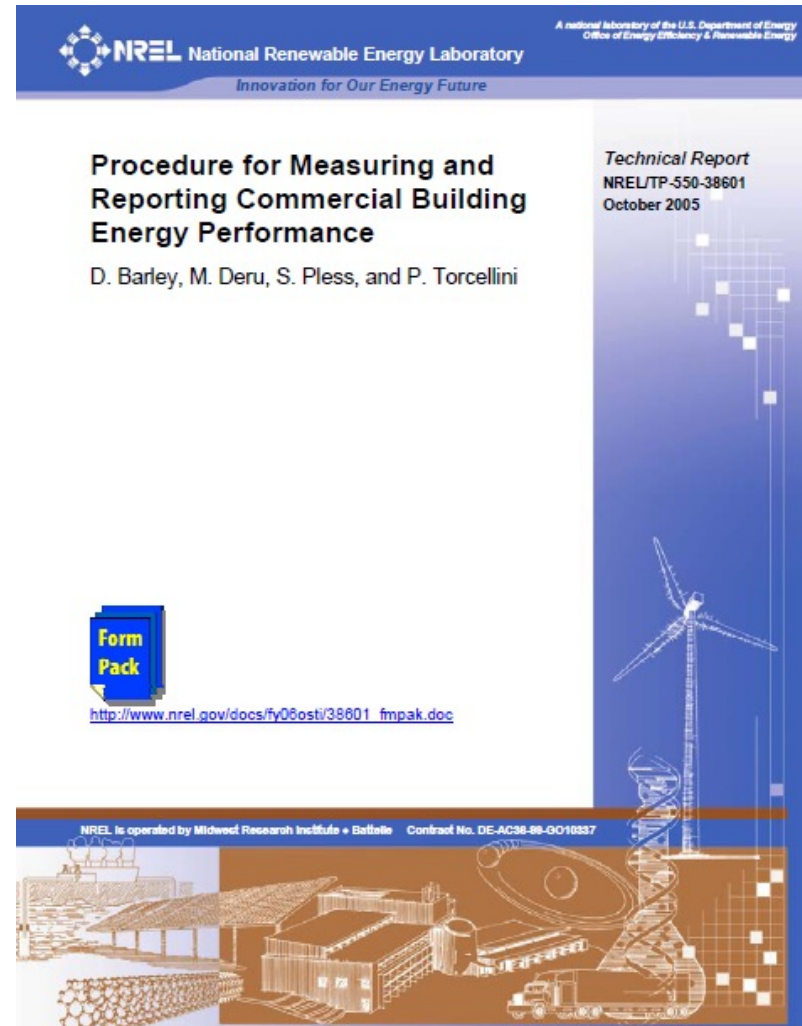
- Meet **ONE** of the following criteria and > 2 yrs' building energy assessment experience, will be eligible to take exam:
 - Government-issued/recognized license as a professional engineer, architect, or building contractor; or
 - Minimum of Bachelor's degree in engineering or related field, and > 3 yrs' energy-related HVAC, architecture, lighting, envelope, or renewable energy experience; or
 - Associate's degree or Technical degree, > 5 yrs related experience; or
 - High School diploma, and >8 yrs related experience

B. Ordinances, policies and standards governing commercial building audits

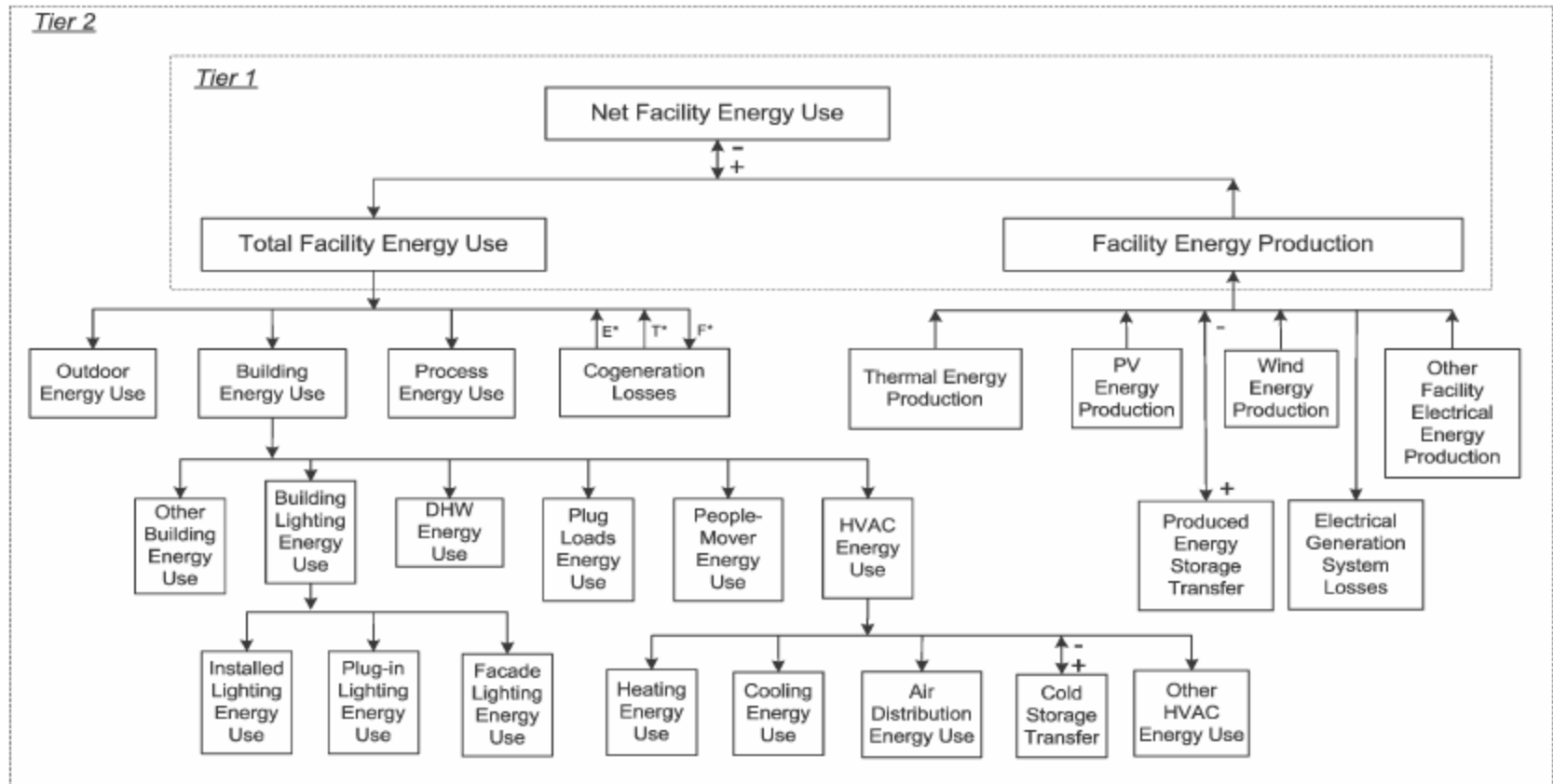
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Other audit standards

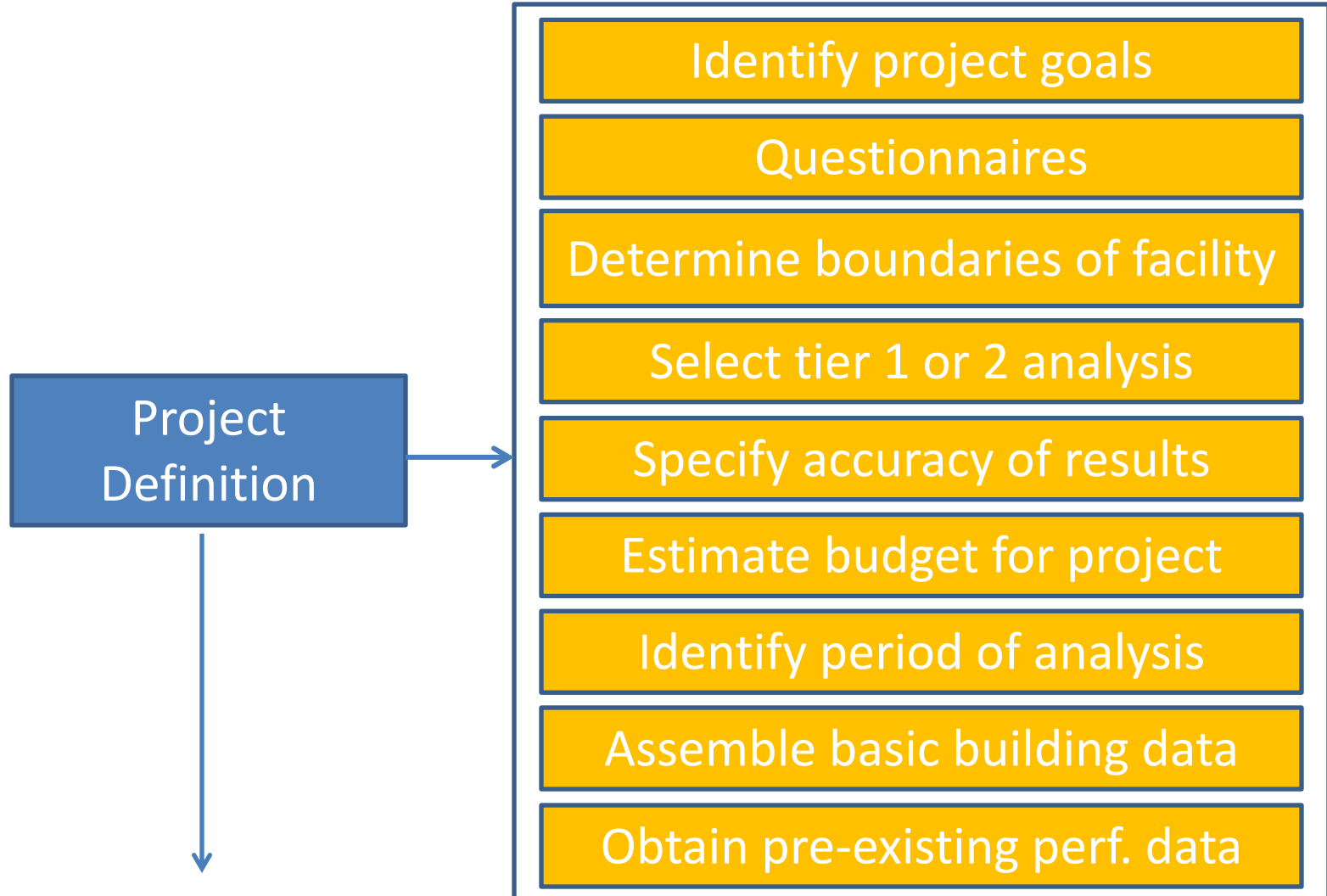
- NREL procedure
- <http://www.nrel.gov/docs/fy06osti/38601.pdf>



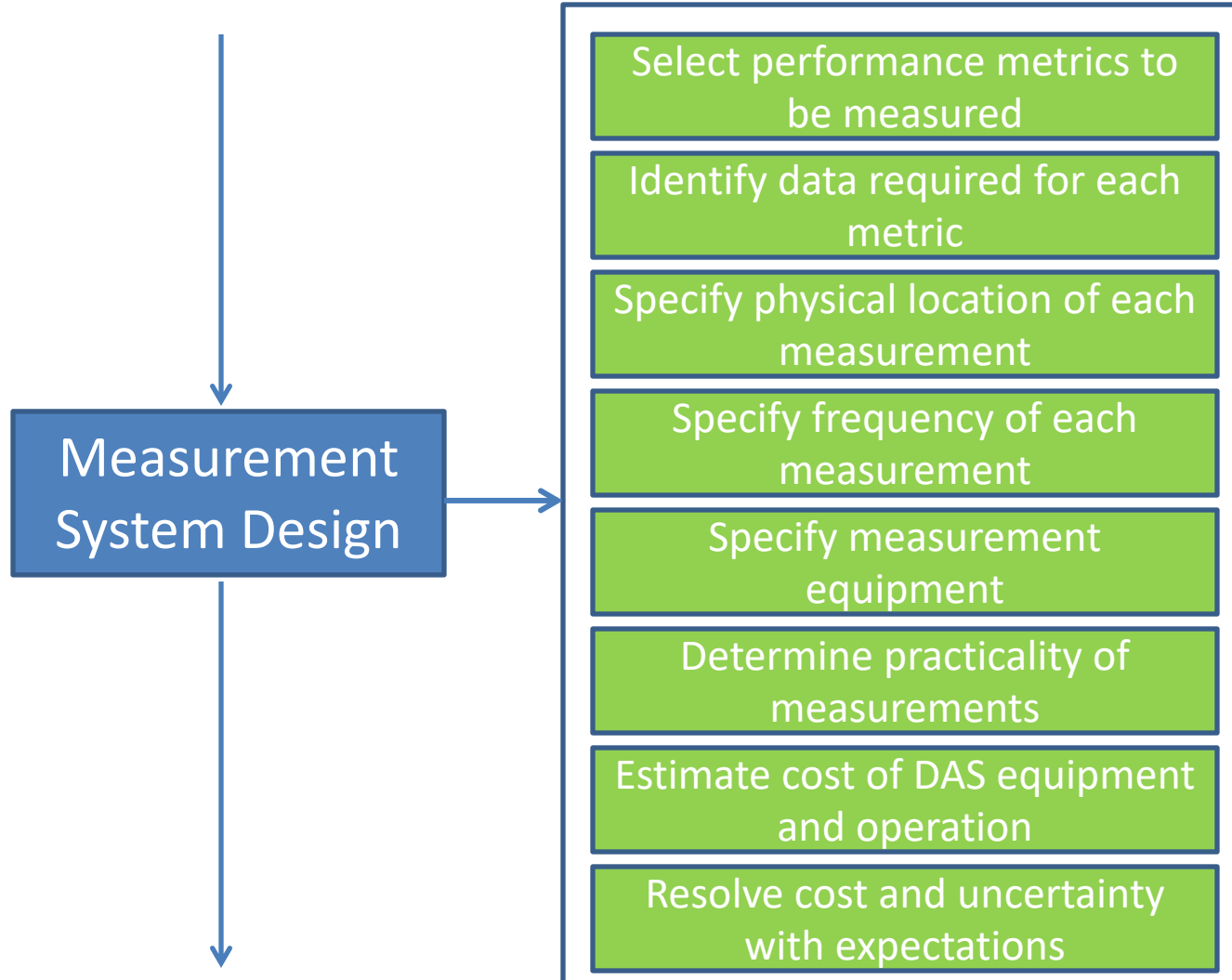
NREL procedure



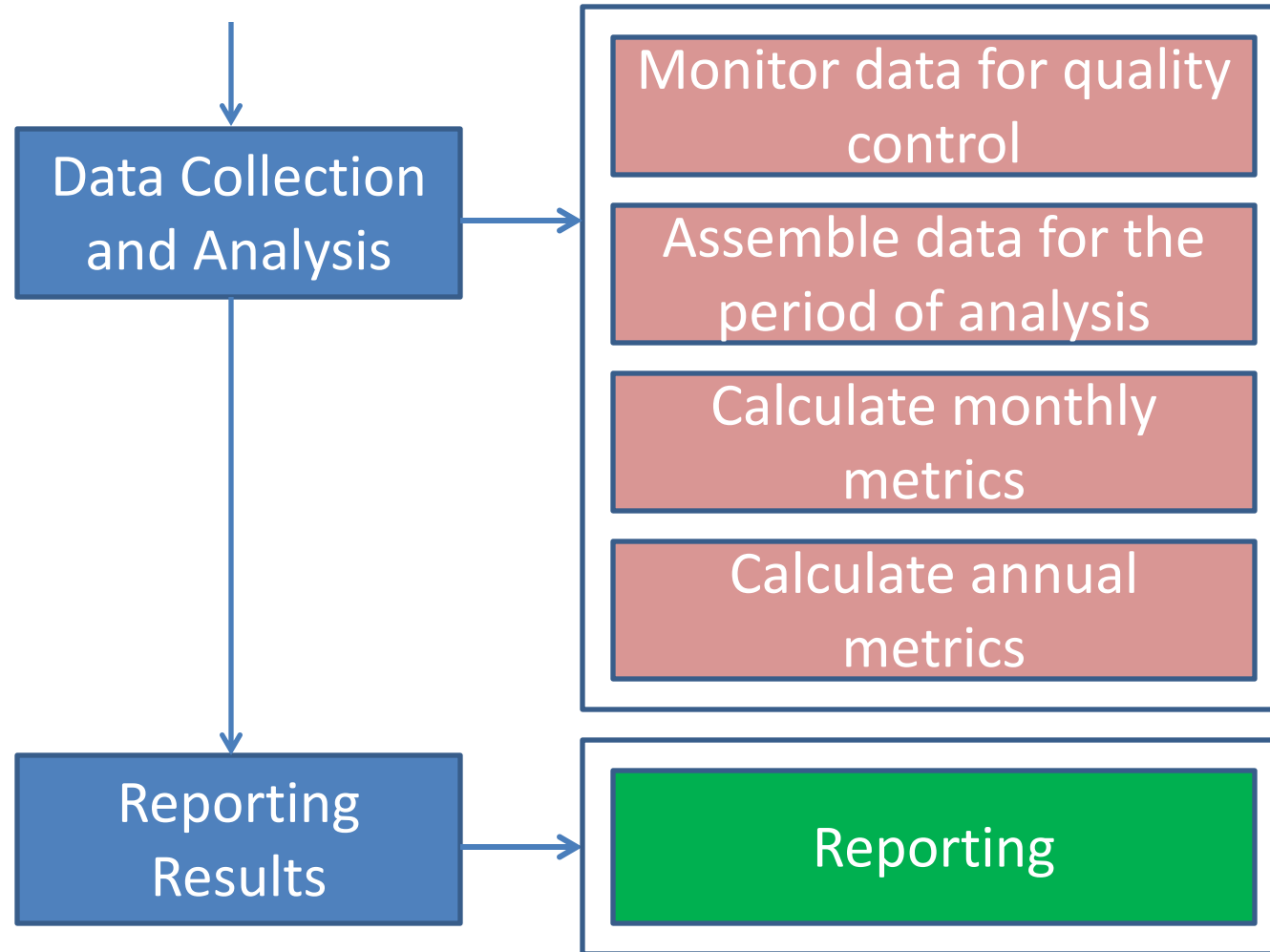
NREL procedure outline



NREL procedure outline

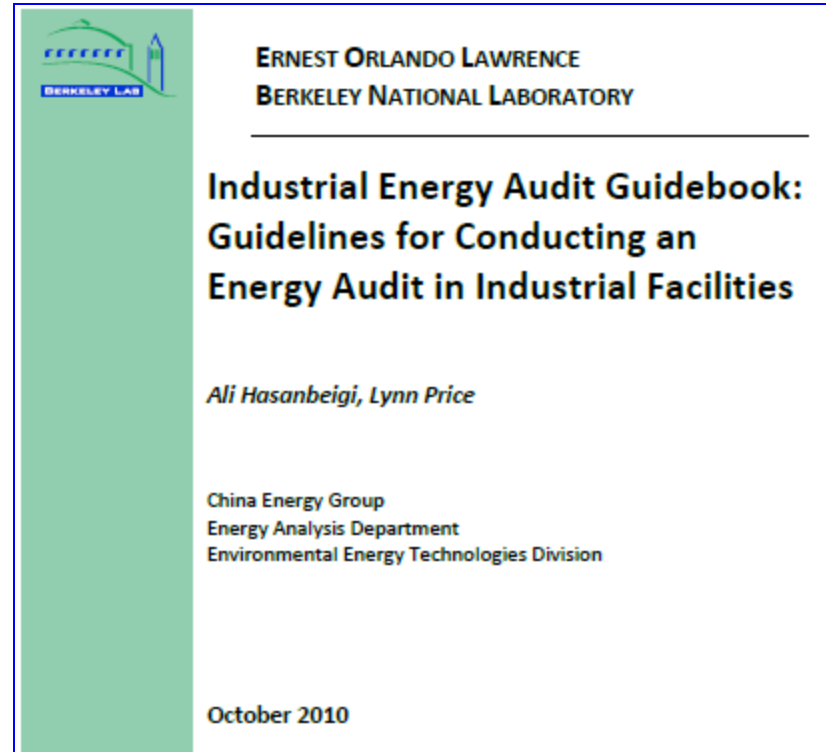


NREL procedure outline



Other audit standards

- LBNL Industrial Energy Audit Guidebook
 - http://minotaur.lbl.gov/china.lbl.gov/sites/china.lbl.gov/files/LBNL-3991E.Industrial%20Energy%20Audit%20Guidebook_0.pdf



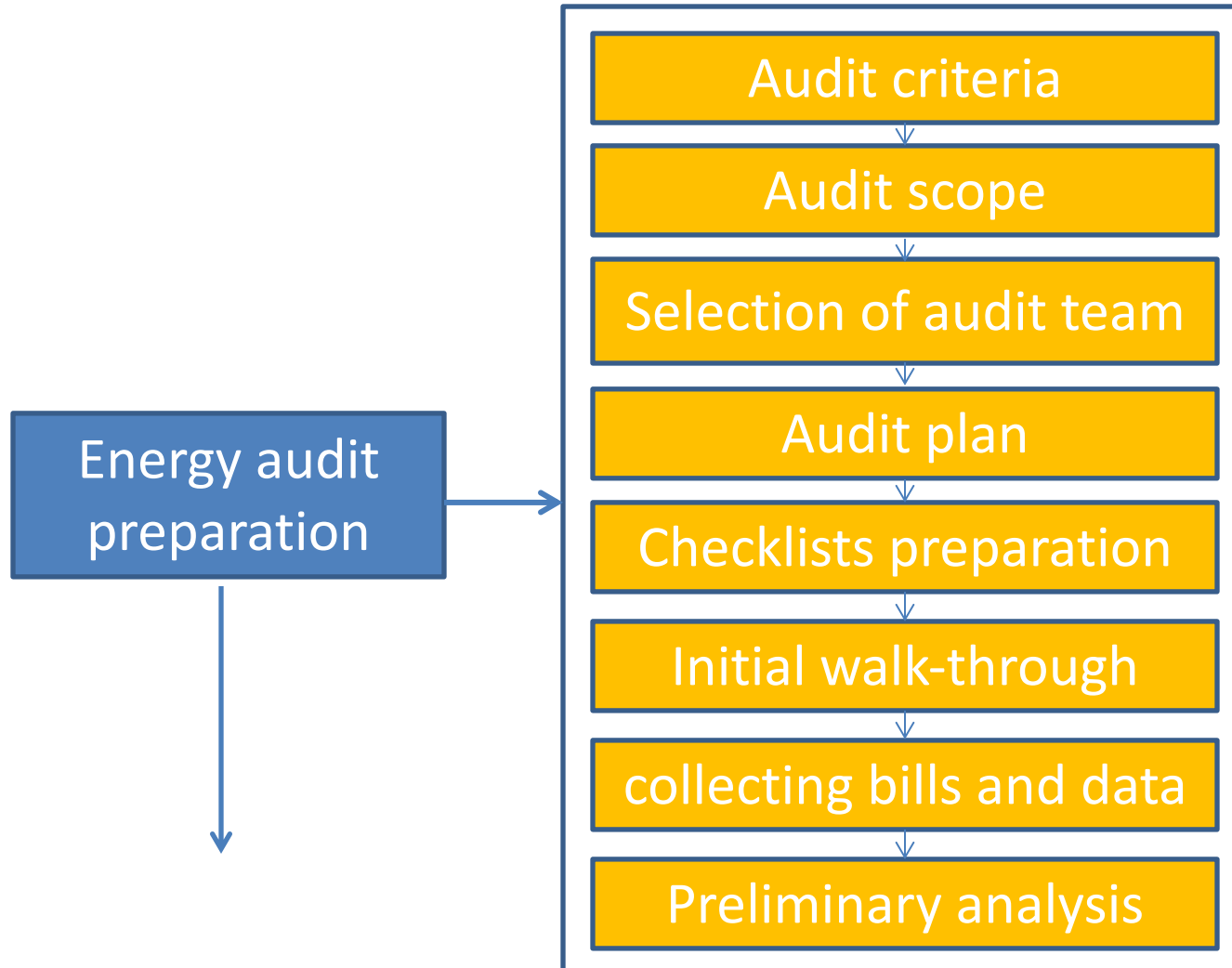
LBNL Industrial Energy Audit Guidebook

- Typical steps:
 - preparation and planning
 - data collection and review
 - plant surveys and system measurements
 - observation and review of operating practices
 - data documentation and analysis
 - reporting of the results and recommendations

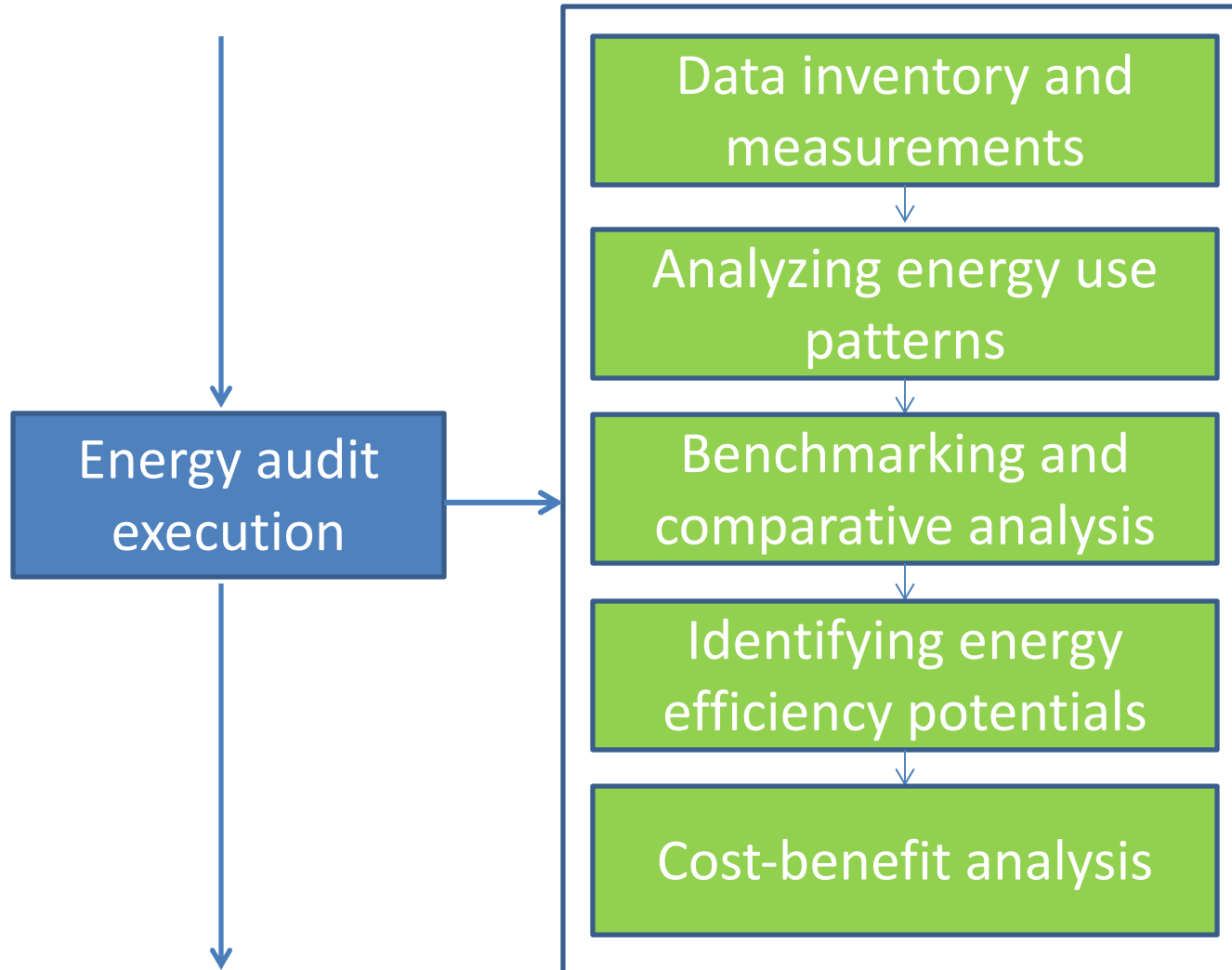
LBNL Industrial Energy Audit Guidebook

- Types of energy audits:
 - preliminary audit (walk-through audit)
 - detailed audit (diagnostic audit)
- Procedures:
 - energy audit preparation
 - energy audit execution
 - energy audit reporting
 - post-audit activities

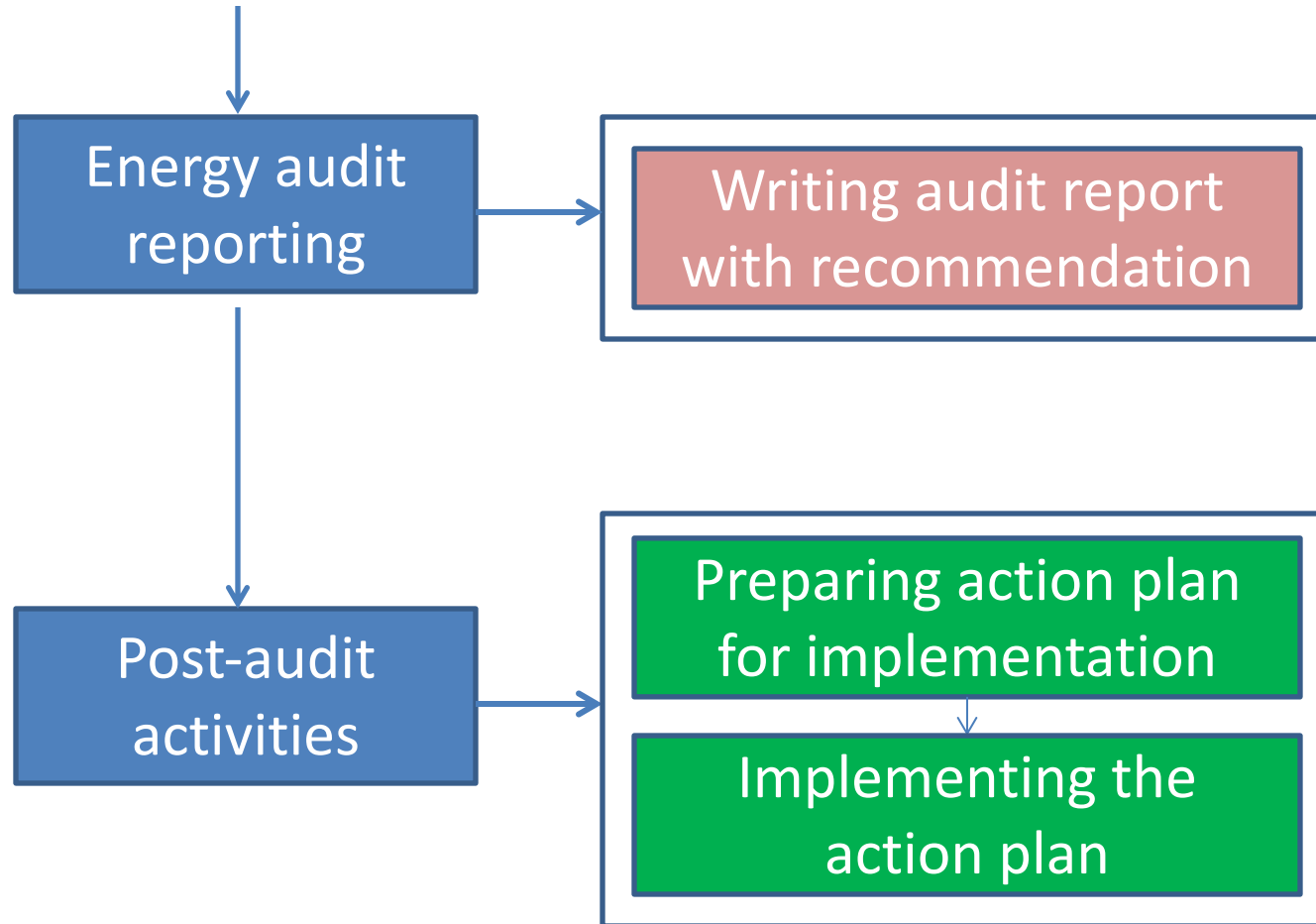
LBNL Industrial Energy Audit Guidebook



LBNL Industrial Energy Audit Guidebook



LBNL Industrial Energy Audit Guidebook



BEST Center Curricula, Resources & Recordings

Academic Programs

Georgia Piedmont Technical College - Building Automation Systems

Milwaukee Area Technical College - Sustainable Facilities Operations

Laney College - Commercial HVAC Systems

City College San Francisco - Commercial Building Energy Analysis & Audits

Professional Development Materials, Presentations & Videos

National Institutes

Building Automation Systems Instructor Workshops

Webinars (e.g., BEST Talks)

Faculty Profile Videos

Reports & Case Studies

Marketing Resources

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