MEASUREMENT & VERIFICATION

“Improving the Process”

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INTRODUCTION

PRESENTATION OVERVIEW

Measurement & Verification (M&V)

- Definitions
- Design Phase
- Construction Phase
- M&V Period
- Summary
- Open Discussion

DEFINITIONS

DEFINITIONS

MEASUREMENT & VERIFICATION

- NC GS 143-135.37(e) requires building performance verification for “major projects”
- Compares actual energy usage to an energy model (projected energy reductions based on ASHRAE 90.1-2004*)
- M&V process helps assess the true value of energy conservation measures (ECM)

DEFINITIONS

SB 668 M&V

- “Major projects”
  - ✓ New construction (larger than 20,000 SF)
  - ✓ Renovation (project cost > 50% of insurance value AND area > 20,000 SF)
- Meters required for:
  - ✓ Electricity
  - ✓ Natural gas
  - ✓ Fuel oil
  - ✓ Water
- Sub-metering recommended

DEFINITIONS

SB 668 M&V

- 12-month M&V period
- Collect and validate actual energy and water use data
- Compare data with energy model results and assumptions
- If usage exceeds model projections by 15% or more:
  - ✓ Owner will further investigate
  - ✓ Resolve issues found
  - ✓ Recommend further corrections
- Report data to SCO annually by August 1st

DEFINITIONS

LEED M&V (version 3)

- Only required if you choose to pursue the M&V credit
- M&V Plan (IPMVP – International Performance M&V Protocol)
  - ✓ Option B or
  - ✓ Option D
- M&V period: 12-months or more
- Corrective actions required if results indicate energy savings are not being achieved
- Pursuing this credit typically requires additional design fee

M&V COMPARISON

	SB668	LEED
When Used	New: > 20,000 SF Renovation: > 20,000 SF AND cost > 50% building value	Voluntary
Performance Period	1 year	1 year or more
Metering Requirements	Water utilities, natural gas, fuel oil, electricity (sub-metering recommended)	Electricity and district energy systems (sub-metering as necessary)
Metering Application	Whole building level	ECM level or whole building level
Trigger for Corrective Action	15% variance	10% variance (IPMVP v3)
Reporting	State Construction Office	None, but projects now required to input actual energy usage into EPA Portfolio Manager

DESIGN PHASE

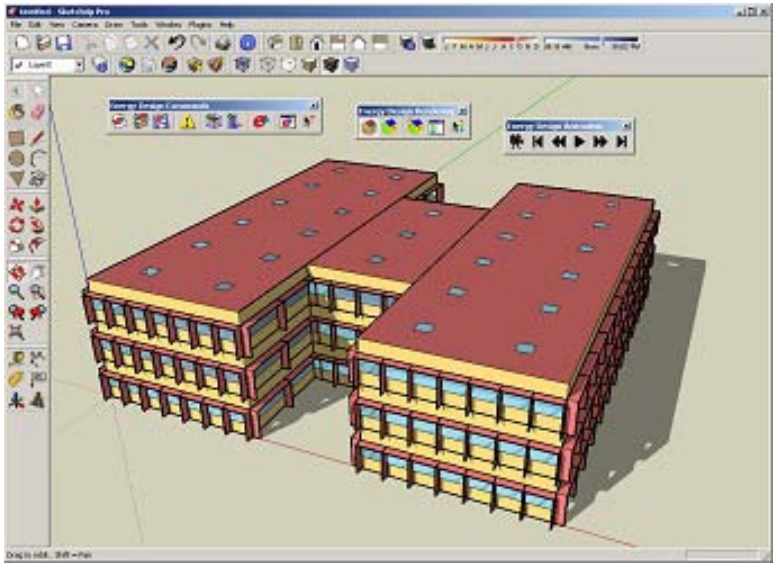
DESIGN PHASE

OVERVIEW

- Energy Simulation
- Metering Design
- Commissioning Agent Interface
- Measurement & Verification Plan

DESIGN PHASE

ENERGY SIMULATION



- Begin early in design process
- Stakeholder meeting
  - ✓ Owner participation is critical
- Document input data
  - ✓ Review & verify
- Accurate inputs are IMPORTANT, here are some reasons why …

DESIGN PHASE

ENERGY SIMULATION

- Based on NCSU classroom-office building energy simulation:

Item	Input	Energy Impact
Schedule	1 hour of building operation	3%
Occupancy	10% sway in people count	3%
Temperature	1 degree difference in thermostat set-point	1%

METERING DESIGN

- Coordinate with owner
- Establish utilities to be metered
- Evaluate the value & need for sub-metering
- Meter types
  - ✓ Review quality, cost, owner preference
- Meter readings
  - ✓ Is owner prepared to monitor meters on a routine basis?

DESIGN PHASE

COMMISSIONING AGENT INTERFACE

- Selected during advance planning
- On-board during schematic design
- Helps prepare Owner's Project Requirements (OPR)
  - ✓ Coordinate with design team
  - ✓ Include key info: set-points, schedules, etc.
- Reviews design documents and design intent (BOD)
- Reviews M&V plan
- Final check of metering design & controls integration

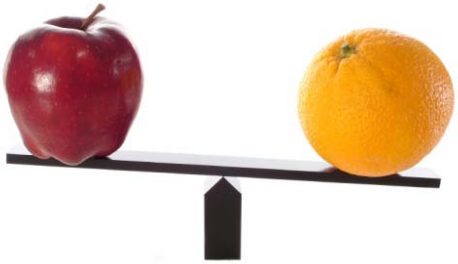
DESIGN PHASE

MEASUREMENT & VERIFICATION PLAN

- A report document prepared by the designer
- Plan is initiated during DD phase
- M&V plan identifies the following:
  - ✓ What gets metered
  - ✓ How it's metered
  - ✓ Who reads the meters
  - ✓ Who compiles the meter data
  - ✓ Points to be trended by control system
  - ✓ Reconciliation

DESIGN PHASE

M&V PLAN COMPARISON



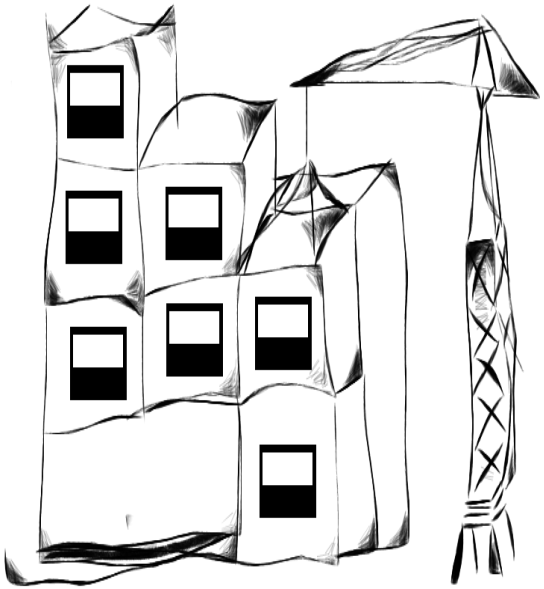
	SB668	LEED
Standard	Building Performance Verification (prepared by NC SCO)	International Performance Measurement & Verification Protocol (IPMVP) Version 3
What Gets Metered	Water utilities, natural gas, fuel oil, electricity (sub-metering recommended)	Electricity and district energy systems (sub-metering as necessary)
How It's Metered	Local system meters read by owner	Local metering read through DDC system with integrated trend logging
Who Compiles Meter Data	Building Owner	Collaboration between building owner and design engineer
Reconciliation	Building owner provides written explanation of deviation and proposed corrective measures	Design engineer performs calibrated energy model

CONSTRUCTION PHASE

CONSTRUCTION PHASE

IMPACTING THE MODEL

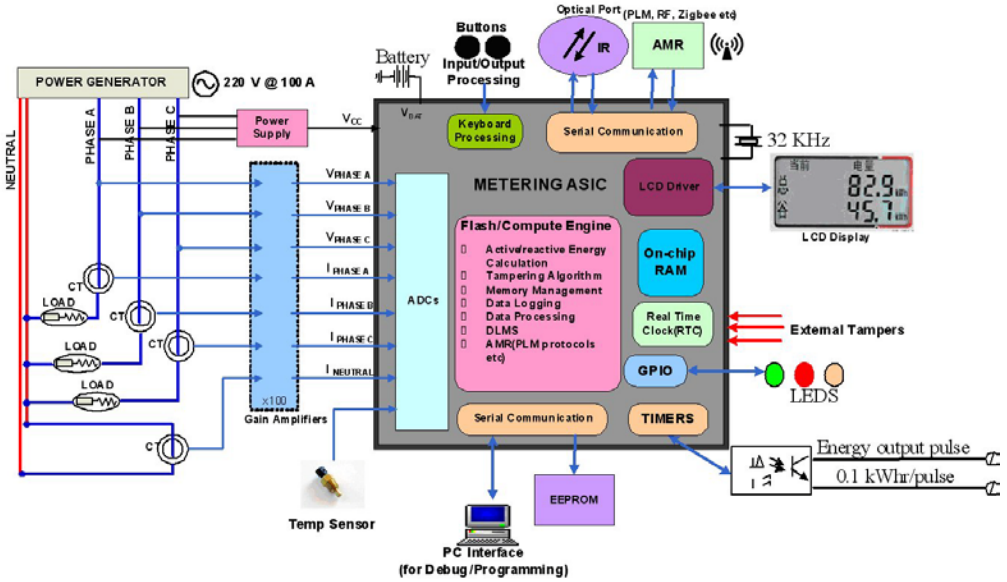
- “Design Freeze” (immediately after bid)
  - ✓ Understand Building Use
  - ✓ Occupancy Schedules Basis
  - ✓ User Characteristics
  - ✓ Revisit the Energy Model
- Document and Evaluate Changes
- Revisit the Energy Model again
  - ✓ Did enough change to re-run the model?



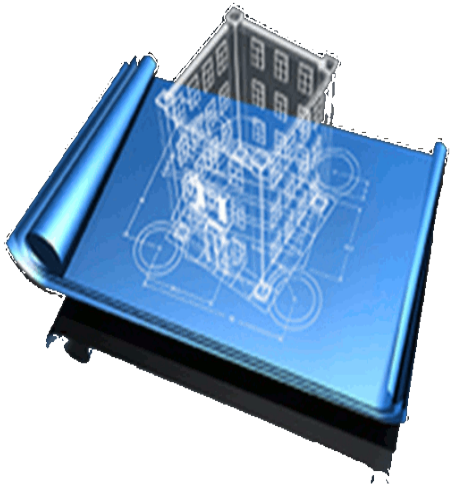
CONSTRUCTION PHASE

ENERGY METERS

- Submittal Reviews
- Installation Verification
- Accurate Calibration
- Integration: Building Automation System

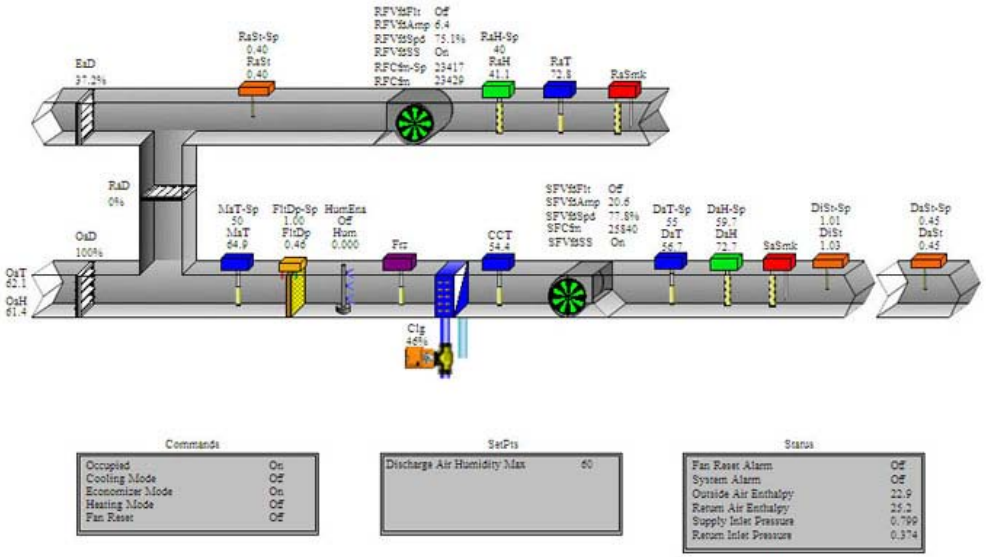


CONSTRUCTION PHASE



UNDERSTANDING AS-BUILT CONDITIONS

- Construction imperfections and implications
- Building controls operation and calibration
- Develop occupant and O&M staff behavior and understanding



12 MONTH M&V PERIOD

12-MONTH M&V PERIOD

WHEN DOES THE CLOCK START?

- Legislation: Beneficial Occupancy
- More realistic:
  - ✓ Commissioning complete
  - ✓ Full Occupancy
  - ✓ Measuring systems proven
  - ✓ “Burn in” period
  - ✓ Consensus and notification of M&V start date

12-MONTH M&V PERIOD

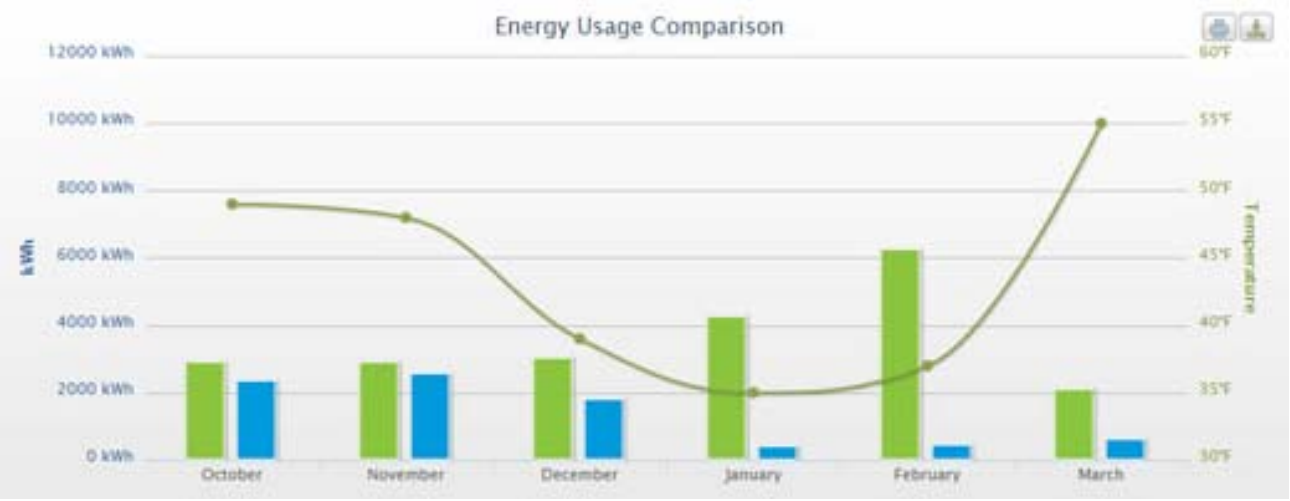
DATA COLLECTION

- Preferred: Monthly
- Practical: Quarterly
- Required: 12-months, post Beneficial Occupancy

12-MONTH M&V PERIOD

DATA SUBMITTAL

- Actual utility consumption and cost data per month (12 months)
- Gap analysis compared to energy model
- Data useful benchmarking tool for energy use



SUMMARY

SUMMARY

WHAT HAVE WE LEARNED?

- M&V Requirements — *SB 668 vs. LEED*
- Energy Modeling — *Inputs are critical and require collaboration*
- Meters, Meters, Meters — *You cannot manage what you do not measure*
- As-Built conditions — *Take a look at the model before M&V start*
- M&V Period — *Trend data monthly to identify potential issues*

OPEN DISCUSSION