The Solutions Network

Rochester, New York

Performance Metrics

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Overview

- Whats and Whys of Performance Metrics
- How to Select Performance Metrics
- Sources of Building Performance Metrics
- Interactive Session

Performance Metrics?

- A Performance Metric is a standard of measurement of a function or operation
  - a.k.a. Performance Indicator
    - Usually reserved for high level metrics

How Performance Metrics are Used

- Measure progress toward a goal
  - Reduce Energy consumption by 40%
- Standardized comparisons
  - Benchmark performance
  - Track long-term performance
  - Compare with other buildings
- Used from the design to the end of life

Need for Standard Metrics

- "Weights and measures may be ranked among the necessaries of life …"
  John Quincy Adams, 1821
- Standard units of measure provide a common language for commerce, science, laws, and other aspects of everyday life.

History of English Length Measurement

- At one time measurement of length was not standardized – much like sustainability metrics today.
- Inch was based on the thumb then later standardized as three barleycorns
- Foot was based on the human foot then standardized as 13 inches, and finally King Henry I (1100-1135) established the foot as 12 inches
- The inch and foot are now defined from the yard, which is 0.9144 meters

Why are Standardized Performance Metrics Important?

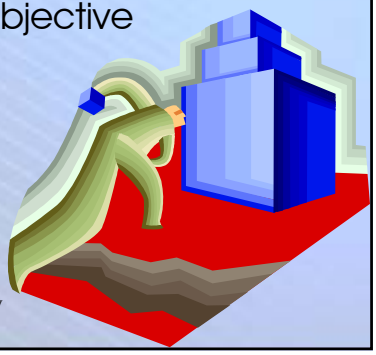
- Common language and benchmarks
- Consistent treatment of measurements → Repeatable & Comparable
- Greater confidence in results
  - Better confidence leads to better market acceptance
- Better understanding of real performance

Issues with Building Performance Metrics

- Energy Use Intensity = Energy/Area
  - Energy
    - What is and what is not included?
    - How is it measured?
    - How are energy types combined? (elec., gas, steam, on-site production, etc.)
  - Area
    - Include walls?
    - Parking garages?
    - Unconditioned spaces?

Attributes of Good Performance Metrics

- Clear definition
- Measurable
- Standardized
- Shows a clear relationship to the desired goal or objective
  - Measures and communicates progress toward the goal



Selecting Building Performance Metrics – I

- What do we mean by "Building Performance"?
  - Broad term and difficult to measure
- Divide the "Performance" in to topic areas and subtopic areas until you get to something that is measurable.
- Your values and society values help determine the topic and subtopic areas

Selecting Building Performance Metrics – II

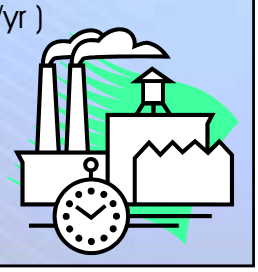
- Example Building Performance Topic Areas (high level metrics)
  - Environmental
  - Social
  - Economic
  - Service Quality

Selecting Building Performance Metrics – III

- Examples of Subtopic Areas – Environmental (mid level metrics)
  - Energy consumption for operations
  - Water
  - Material
- Difficult to aggregate performance across topic and subtopic areas
  - Cost is sometimes used

Selecting Building Performance Metrics – IV

- Start with a clearly defined goal
  - Reduce annual CO_2 production from building operations by 20% compared to CO_2 production in 1990
- Possible metric
  - Facility annual GHG emissions intensity, CO_2 equivalent (kg $CO_2/ft^2/yr$)

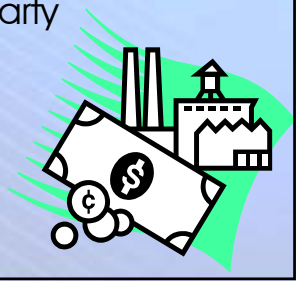


Selecting Building Performance Metrics – V

- Define Data Required
  - Building area
  - Primary energy consumption by fuel type
  - GHG emissions for energy conversion processes
  - Other sources of GHG emissions
    - Refrigeration system leakage
    - Industrial processes

Selecting Building Performance Metrics – VI

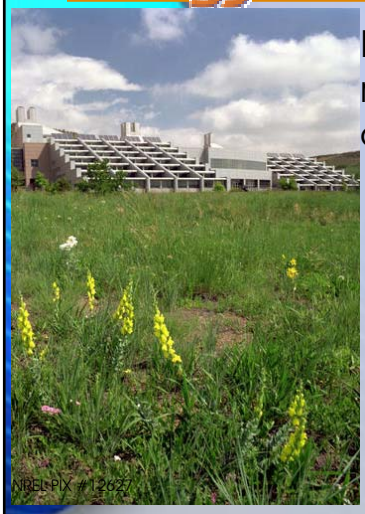
- Define data sources
  - Reliability
  - Uncertainty
  - Cost
- Define data archiving methods
- Assign a responsible party



Sources of Building Performance Metrics

- DOE/NREL Performance Metrics Project
- DOE High Performance Buildings Database
- USGBC – LEED
- CBECS (Commercial Building Energy Consumption Survey)
- EPA EnergyStar
- ASHRAE Standard 105 (under revision)
- International Green Building Challenge (GBC)

DOE/NREL Performance Metrics Project (PMP)



Multiyear effort to standardize the measurement & characterization of building energy performance

- Clearly defined Performance Metrics
- Standard methods for collecting, analyzing, and reporting data

http://www.highperformancebuildings.gov
Click on "performance metrics"

DOE High-Performance Building Database

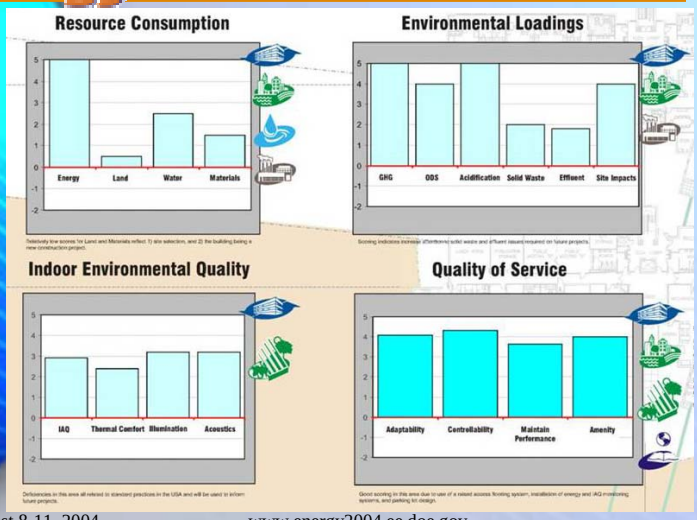
- Showcase for sustainable buildings
- Contains measured performance data
- Projects can be entered by anyone
- Accessible to everyone
- Can be used to motivate future builders on what is possible.

http://highperformancebuildings.gov
Click on "Enter the database"

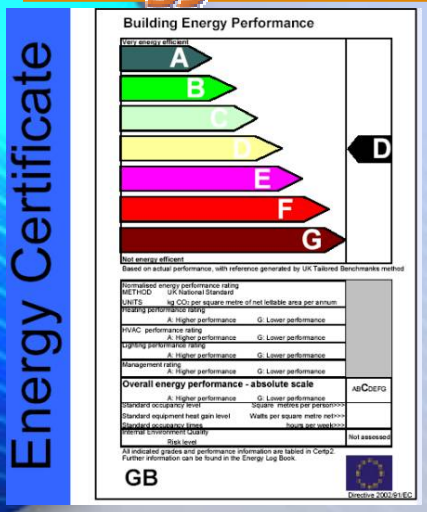
Green Building Challenge 2002 Performance Metrics

	Selected Environmental Sustainability Indicators for the Design	per m^2 only	by area & by occupancy	
ESI-1	Total net consumption of primary embodied energy, GJ	1.7	8.6	(MJ/m2) / (kaph/m2)
ESI-2	Net annualized consumption of primary embodied energy, MJ	23	114	(MJ/m2) / (kaph/m2)
ESI-3	Net annual consumption of primary energy for building operations, MJ	357	1815	(MJ/m2) / (kaph/m2)
ESI-4	Net annual consumption of primary non-renewable energy for building operations, MJ	316	1607	(MJ/m2) / (kaph/m2)
ESI-5	Net annualized primary embodied energy and annual operating primary energy, MJ	339	1721	(MJ/m2) / (kaph/m2)
ESI-6	Net area of land consumed for building and related works, m^2	0.3	4.9	m^2 / occupant
ESI-7	Net annual consumption of potable water for building operations, m^3	14	49	m^3 / (aph/m^2) *yr
ESI-8	Annual use of grey water and rainwater for building operations, m^3	2	9	m^3 / (aph/m^2) *yr
ESI-9	Net annual GHG emissions from building operations, kg. CO_2 equivalent	38	195	(Kg. eCO_2 / m^2) / (kaph / m^2)
ESI-10	Predicted CFC-11 equivalent leakage per year in gm.	0.000417	0.002121	(gm CFC-11 equiv / m2) / (kaph * m2) * yr
ESI-11	Total weight of materials re-used in Design from on-site or off-site uses, kg.	933	4741	kg / (aph/m^2) *yr
ESI-12	Total weight of new materials used in Design from off-site uses, kg.	430	2186	kg / (aph/m^2) *yr

GBC Assessment Tool – GBTool



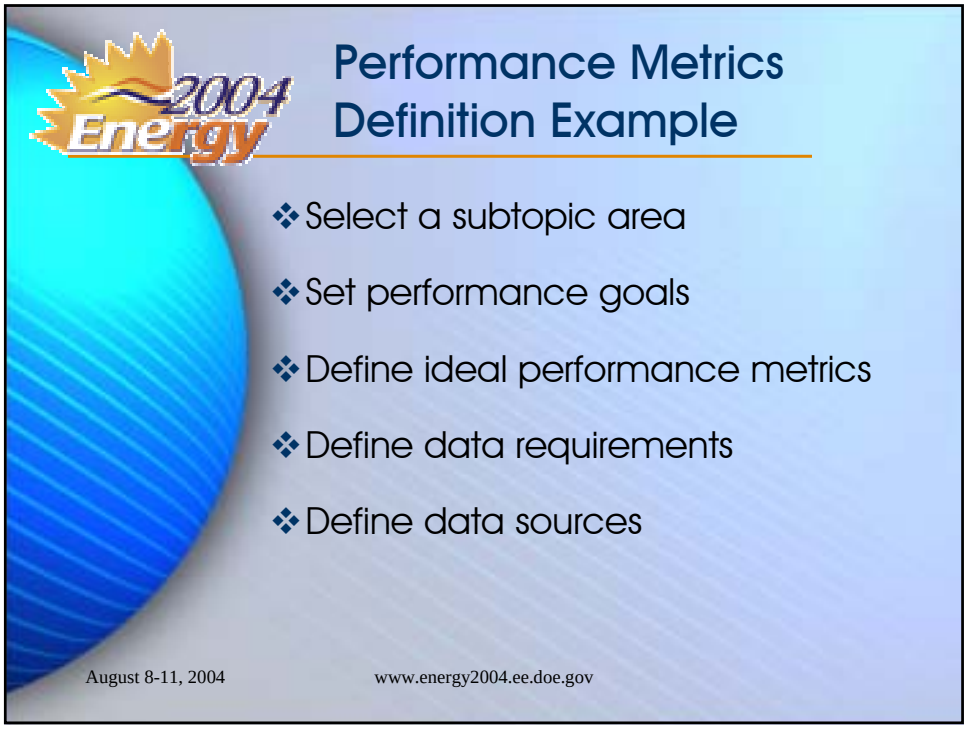
International Efforts in Building Performance – I



- European Union
  - EU plans to require certification of energy performance starting in 2005
  - Metrics: kg CO_2/m^2
    - Rates performance on greenhouse gas potential

International Efforts in Building Performance – II

- BREEAM – UK (First system - 1990)
  http://products.bre.co.uk.breeam
- Green Star/ABGR – Australia
  http://www.gbcaus.org.greenstar
- CRISP – Database of European efforts
  http://crisp.cstb.fr
- ISO – new standards for sustainability of buildings being developed


2004 Energy
Performance Metrics Definition Example
Select a subtopic area
Set performance goals
Define ideal performance metrics
Define data requirements
Define data sources
August 8-11, 2004
www.energy2004.ee.doe.gov