Metrics for High Performance Buildings

Stephen Turner, P.E.
Managing Director
Northeast Region
401 524 4798
sturner@ctgenergetics.com

CTG Energetics, Inc.

Inland Empire Utility Agency

Ford / Premier Automotive Group

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Learning Objectives

- How metrics *may* help boost building performance
- What metrics help project teams meet Owners' needs
- When traditional metrics defeat LCC
- Why are some metrics more relevant
- Future trends: carbon metrics, etc.

Beyond commissioning: Measure performance (“Px”)

- To-date, *completion* more important than *Px*.
  - The LEED plaque is the end point of the process!?!
  - <5% of LEED projects earn the M&V credit
- Yet savings are a primary rationale:
  - Energy, water, emissions, travel, etc.
- Many organizations do not measure impacts of the built environment on humans
  - Many owner organizations fear the results…

Change: Levels of "Environmental Actualization"

with apologies to Abraham Maslow…

How metrics *may* help boost building performance

- The good…
  - Energy modeling algorithms - *Wonderfully accurate when assessing options parametrically*
- The bad…
  - Increased ventilation rates - *Do not guarantee improved Indoor Air Quality (IAQ)*
- The ugly…
  - Meeting codes – *Anything less is illegal*

Criteria & Source	*XXX*
Mechanical ventilation rate - Connecticut Mechanical Code (IMC 2003)	15 cfm/p in BOD; room tables from engineer
Mechanical ventilation rate - ANSI/ASHRAE 62.1-2004	Additive calculation & multiple provisions; no analysis provided
Natural ventilation provisions - Connecticut Mechanical Code	NA? (HVAC system present)
Natural ventilation provisions - ANSI/ASHRAE 62.1-2004	within 25' of window, 4% etc. as above
Thermal Comfort PMV-PPD - ANSI/ASHRAE 55-2004 Section 5.2	No requirement expressed
Thermal Comfort Natural ventilation only mode - ANSI/ASHRAE 55-2004 Section 5.3	80% predicted satisfied shoulder season
Operative temperature & RH, summer - ANSI/ASHRAE 55-2004 Section 5.2	76 ± 4°F, 30-70%RH
Operative temperature & RH, winter - ANSI/ASHRAE 55-2004 Section 5.2	70 ± 4°F, 30-70%RH
Visual Environment - IESNA Recommended Practice Guides	Room tables from engineer
Daylighting - LEED NC v2.2 (Other?)	LEED NC v2.2 Eqc
Electric lighting footcandle levels - IESNA Handbook & Yale Design Guidelines	Room tables from engineer
Electric lighting Color Temperature - Design Guidelines	16511; tubes = 3500°F, CF = 2700-3000
Electric lighting Color Rendering Index	No requirement expressed
Electric lighting Spectral Power Distribution	No requirement expressed
Acoustics RC Criteria with windows closed - Basis of Design Document	No requirement expressed
Acoustics NC Criteria with windows closed - Basis of Design Document	40, Auditorium 30
Acoustics RC or NC Criteria with windows open	No requirement
Acoustics speech privacy criteria	No requirement expressed
Occupant controllability of dry bulb setpoint	± 6°F per spec
Occupant controllability of sash	Manually operable by occupants
Occupant controllability of daylight	Operable manual treatments
Occupant controllability of electric lighting	By space, plus occupancy sensors & daylight dimming

What metrics help project teams meet Owners' needs

- Additional metrics can be developed during planning, design & construction that pertain to operations
  - Operations & maintenance costs
    - Required if LCC actually performed
  - What will the meters read?
    - NOT what did the energy model "predict"
  - What will surveys say?
    - e.g., www.cbesurvey.org

ELECTRIC	Electric-ity for lighting	Electricity for ventilation (fans)	Electricity for in-building pumps[1]	Electric-ity for plug loads	Elect-ricity for unident ified loads[2]	Total electric-ity
Design load (W/gsf)	0.52	0.50	0.60	0.97	-	2.60
Peak demand (W/gsf)	0.42	0.50	0.42	0.73	0.00016	2.07
Peak demand (kW) (Projected sub-metered peak)	71	85	72	124	20	372
Annual consumption (kWh/yr) (Projected sub-metered reading)	218,154	346,598	191,245	891,503	175,200	1,823,000
Annual Use Index (kWh/gsf/yr) Goal	1.28	2.04	1.12	5.24	1.03	10.72
Annual Use Index (Site BTU/gsf/yr) Goal	4,378	6,956	3,838	17,893	3,516	36,583
Annual Use Index (kWh/gsf/yr) LABS21	2.51 to 3.32	4.48 to 6.88	included elsewhere	4.39 to 5.67	NA	14.74 to 17.91
Annual Use Index (Site BTU/gsf/yr) LABS21	8,564	15,286	-	14,979	-	50,293 to 61,109

When traditional metrics defeat high performance or LCC

- HVAC dollars per ton installed
  - Standing column well for heat pump may cost > $3,000 per ton just for the well
- Energy Use Intensity
  - Compare Greenhouse Gas emissions from building at 180,000 BTU/sf/year
    - 70% electric, 30% oil on Block Island
    - 70% electric, 30% gas in Boston
    - All gas with cogen
- Watts per sf for lighting
  - Who cares what peak W/sf is after project is built?

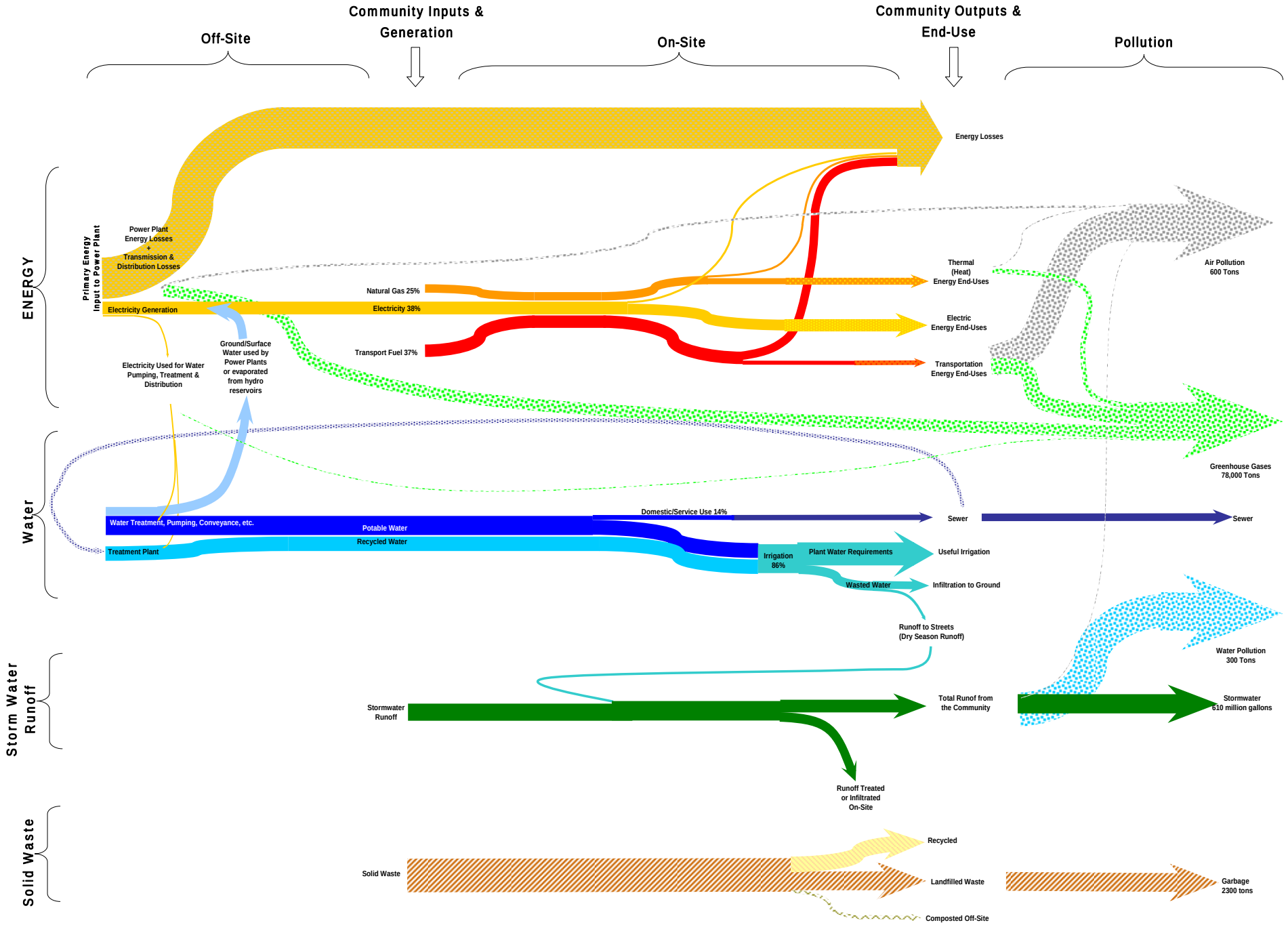
Why are some metrics more relevant

- Metrics are used when they are “in the world” for Owners
- “In the world” is an industrial design phrase meaning intuitively usable
- Examples:
  - What will the meters read?
  - What will the bills be?
  - How much will my energy costs per widget be?
    - Energy $ per diploma
  - How much will my service contract cost
    - How many O&M staff will I require?

- Avoid metrics that are confusing for non-technical Owners and Operators
- Avoid using metrics in ways that are not relevant to Owners & Operators
  - Design density, e.g. W/sf plug load
  - Modeled loads, e.g. W/sf/year

Future trends

- Environmental flow diagrams
- Carbon metrics
  - GHG per widget
  - GHG per square foot
- $/net square foot to build
- $/net square foot O&M
- Tons of material per usable square foot
- Adaptive reusability
- Deconstruction cost



Thanks!

Please contact me at:

Stephen Turner, P.E.
Managing Director, NE

CTG Energetics, Inc.
Providence, RI

sturner@ctgenergetics.com
401 524 4798