

# Defining & Measuring System/Intelligent Efficiency

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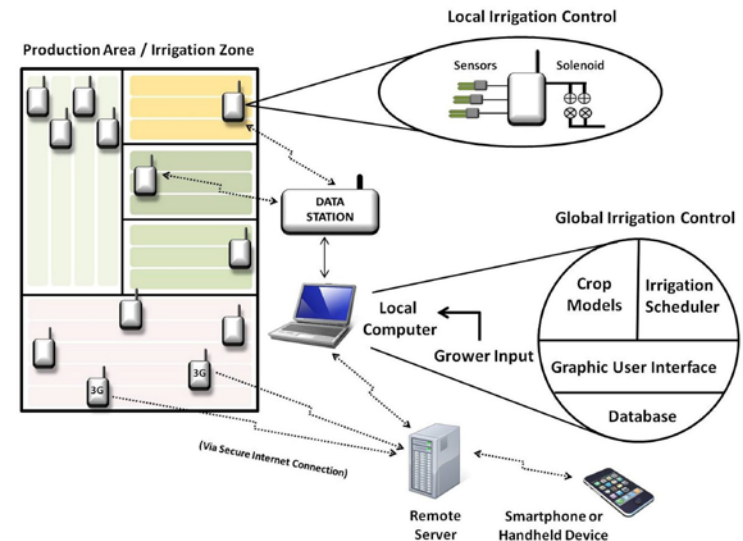
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# Intelligent Efficiency: Defining vs. Measuring

- ACEEE defines **intelligent efficiency** as “*a systems-based, holistic approach to energy savings, enabled by information and communication technology and user access to real-time information. Intelligent efficiency differs from component energy efficiency in that it is adaptive, anticipatory, and networked.*” (Neal Elliott)
- Some traditional metrics for energy efficiency:
  - Component/device-level efficiency (component energy inputs per service output) based on direct measurement
    - Examples: automobiles (liters per km), lighting (watts per lumen), servers (watts per computation)
  - System-level efficiency (system energy inputs per product/service/proxy output) based on direct measurement or aggregate data
    - Examples: buildings (kWh/m<sup>2</sup>), industry (MJ/ton)
  - Equipment or system proxies (characteristics correlated to efficiency)
    - Examples: on/off/sleep power limits, efficient components (e.g., power supplies)

# Some Measurement/Metric Challenges (1)

1. Component-level measurement does not capture system efficiencies
  - “Smart” systems effects are the goal
  - Components must be optimized to function as a system
  - Application space is enormous (here, water!)
2. Performance-based measurement is logical and direct
  - Requires retrospective analysis, quite similar to current energy measurement and verification (M&V) protocols
  - Performance drifting, optimization
  - Proliferation of protocols?
3. What is the denominator?
  - Example: energy inputs per unit of WHAT?
  - Many denominators for few components!
  - Too many? Fair and objective?



<http://www.smart-farms.net/>

## Some Measurement/Metric Challenges (2)

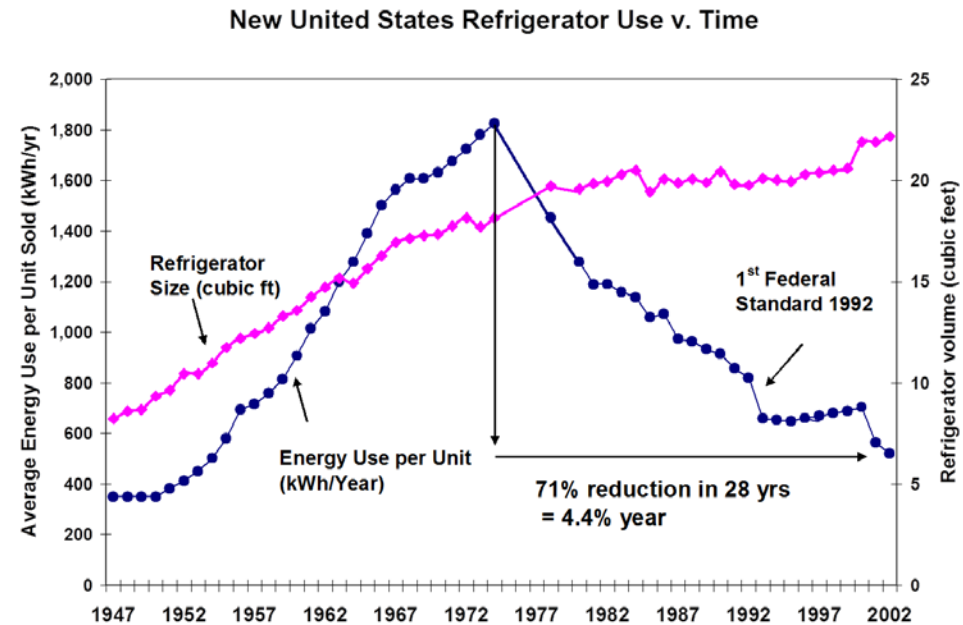
### 4. What is the baseline for establishing and tracking efficiency?

- Most data are relative (e.g., energy savings), not absolute!
- New capabilities = uncharted terrain? (water stress?)
- Poses challenges for metric design and protocols

### 5. Do prescriptive approaches make sense?

- Historical approaches: labels, standards, testing protocols before market
- Continuous “tightening”

### 6. Start with questions: Goals? Stakeholders? Applications? These drive metric design!



Source: Art Rosenfeld, David Goldstein

# Does IT component efficiency matter?

## Industrial motor systems

- Account for half of all electricity use in U.S. industry
- Efficient components, control, sensing and monitoring, and optimization lead to big energy savings
- Energy savings typically dwarf energy use of the installed system (operational and embodied)!*

