Energy Performance Metrics for Public Water Systems

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Why do we care about energy?
Why do we care about metrics?
SLOWER TRAFFIC KEEP RIGHT
SPEED LIMIT 55
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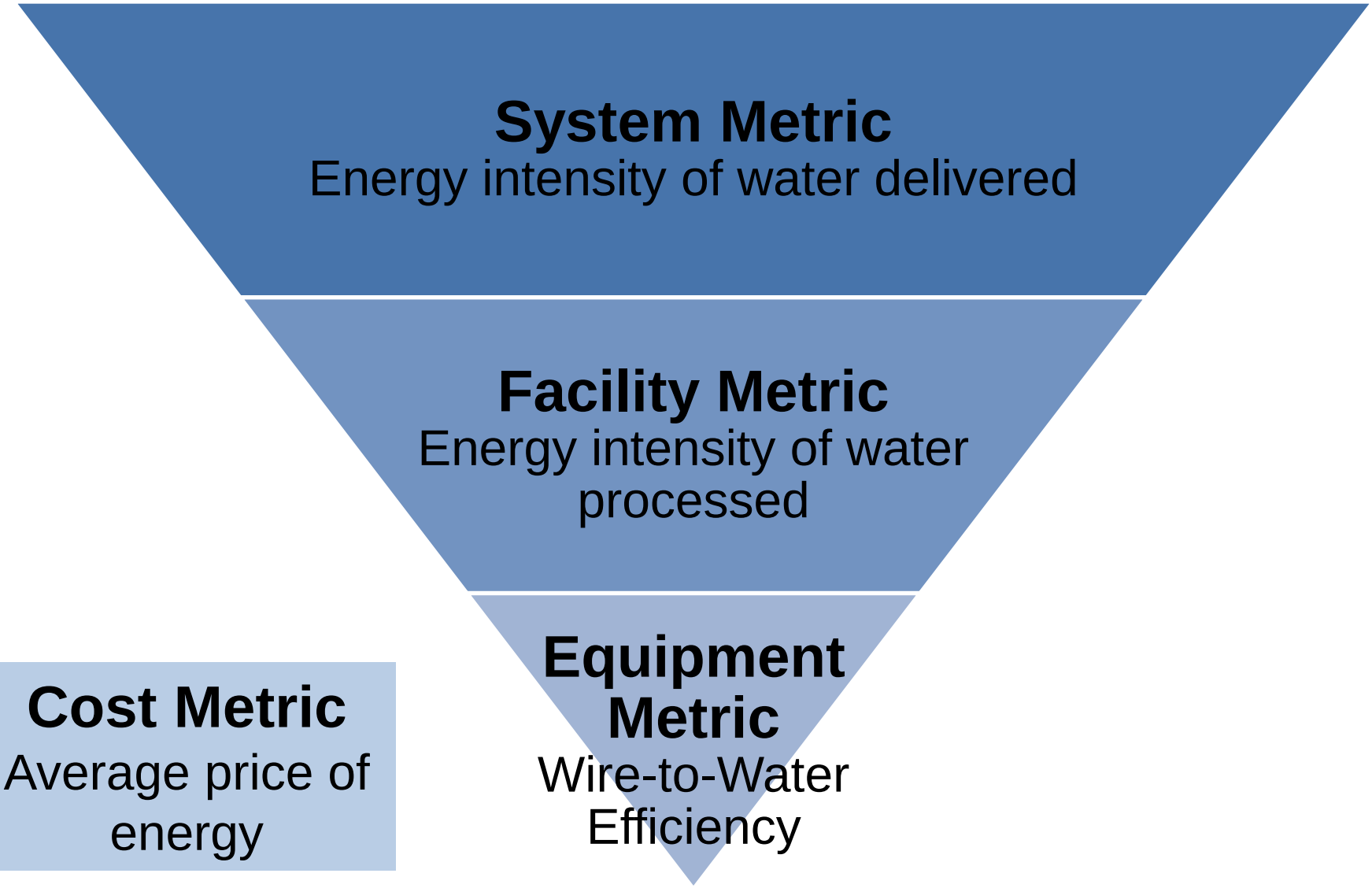

Cost Metric
Average price of energy

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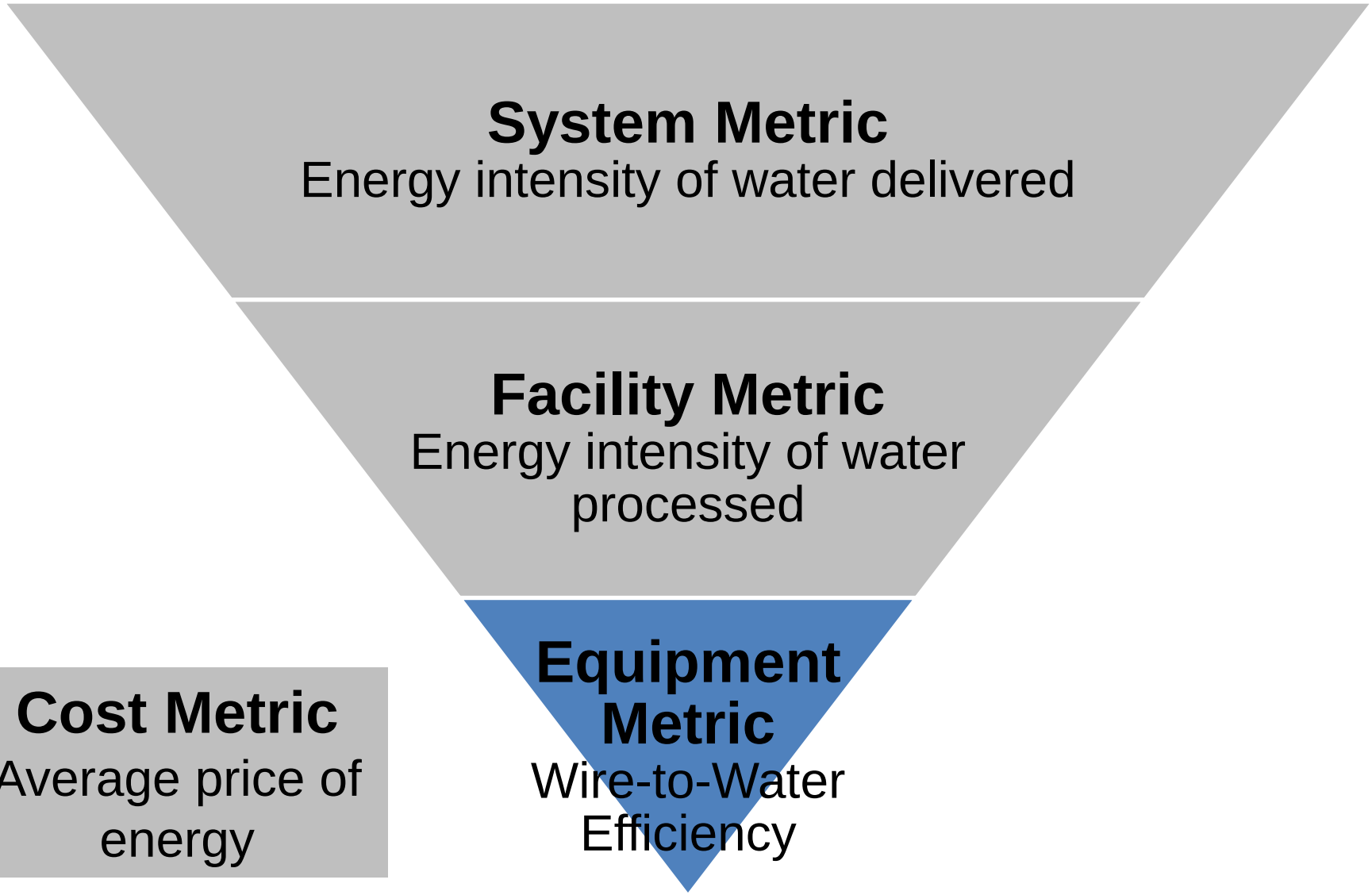

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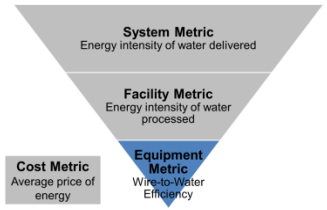
Definition

- Ratio of output to input (percentage)
- “How much of this equipment’s energy input is useful?”
- Range 0%–100%
- High value desirable



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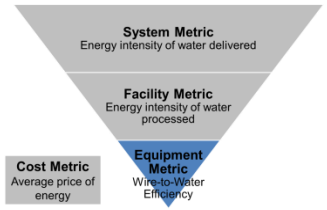
How to Calculate

- Q = Flow rate (gpm)
- h = Total dynamic head (ft)
- P = Power draw (kW)
  - SCADA
  - Multimeter
  - Trained electrician



$$\eta = \frac{Qh}{5280P}$$

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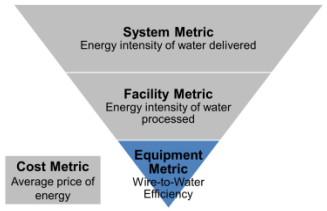
Example: Performing as Expected?

- Design: 79% wire-to-water efficiency
  - 84% pump efficiency
  - 94% motor efficiency
- Actual:
  - 1,000 gpm
  - 210 ft TDH
  - 75 kW

$$\eta = \frac{Qh}{5280P}$$

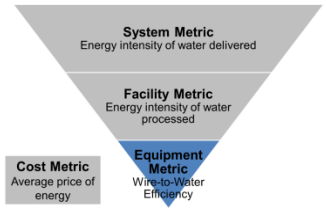
$$\eta = \frac{(1000)(210)}{5280(75)}$$

$$\boldsymbol{\eta = 53\%}$$



Limitations

- Need instantaneous measurements
- Only describes equipment for given conditions
- Cannot compare facilities
- Does not indicate necessity of energy use



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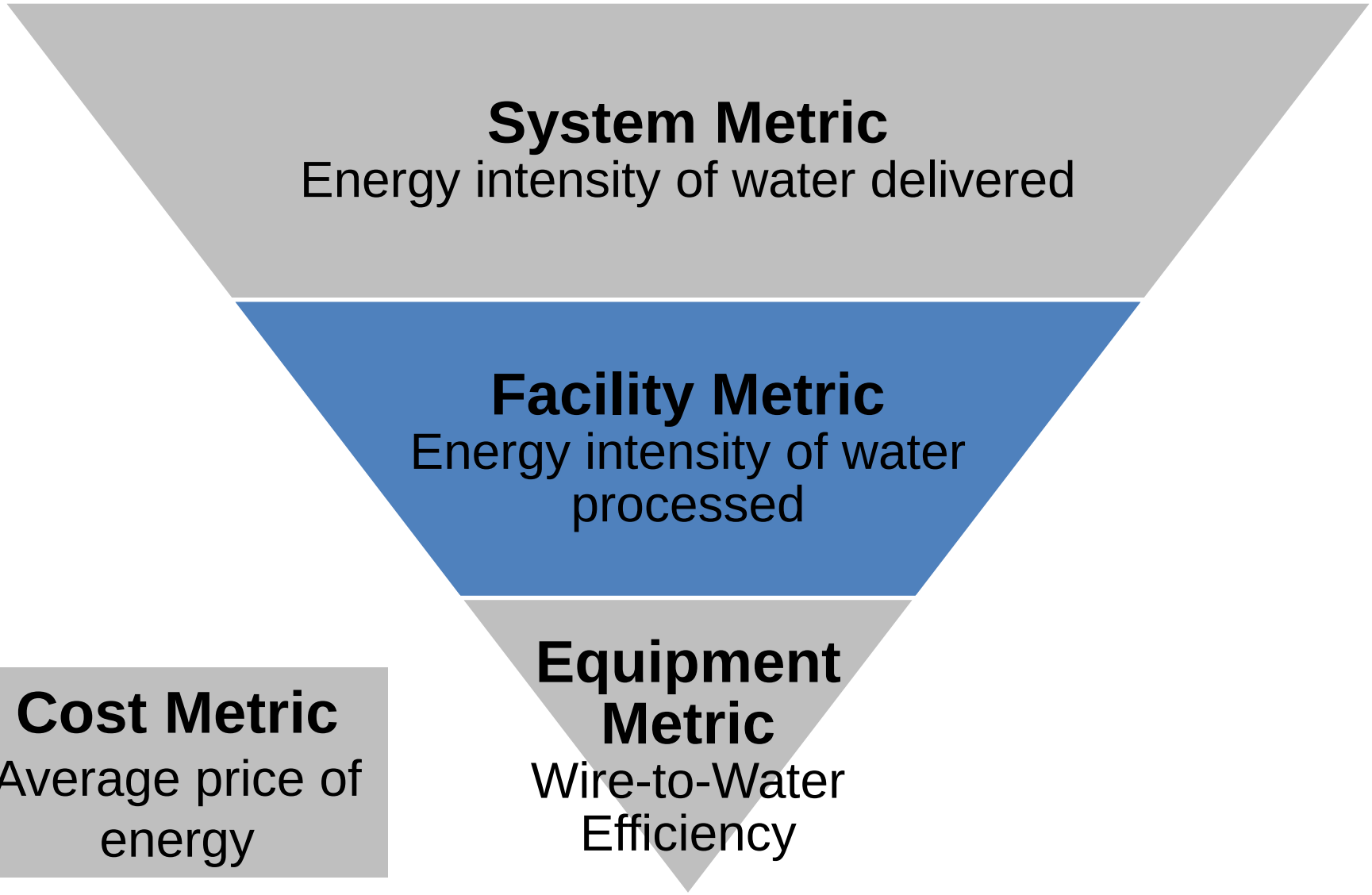

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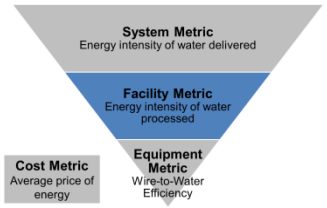
Definition

- Ratio of energy to water volume (kWh/MG)
- “How much energy does it take to process a unit of water at this facility?”
- Range 0–huge (20,000 kWh/MG)
- Low value is desirable



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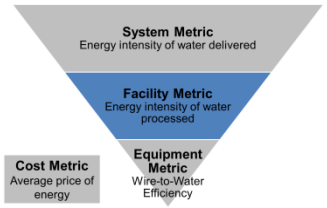
How to Calculate

- E_F = Energy used at facility (kWh)
- V_F = Water volume processed at facility (MG)
- Over same period of time

$$Y_F = \frac{E_F}{V_F}$$



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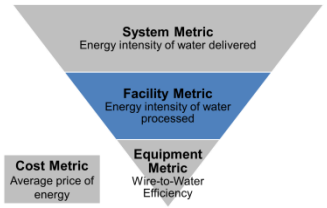
Example

Which water well will want what watts when working?

Well 1
750,000 kWh
300 MG

Well 2
345,000 kWh
230 MG

Well 3
252,000 kWh
120 MG



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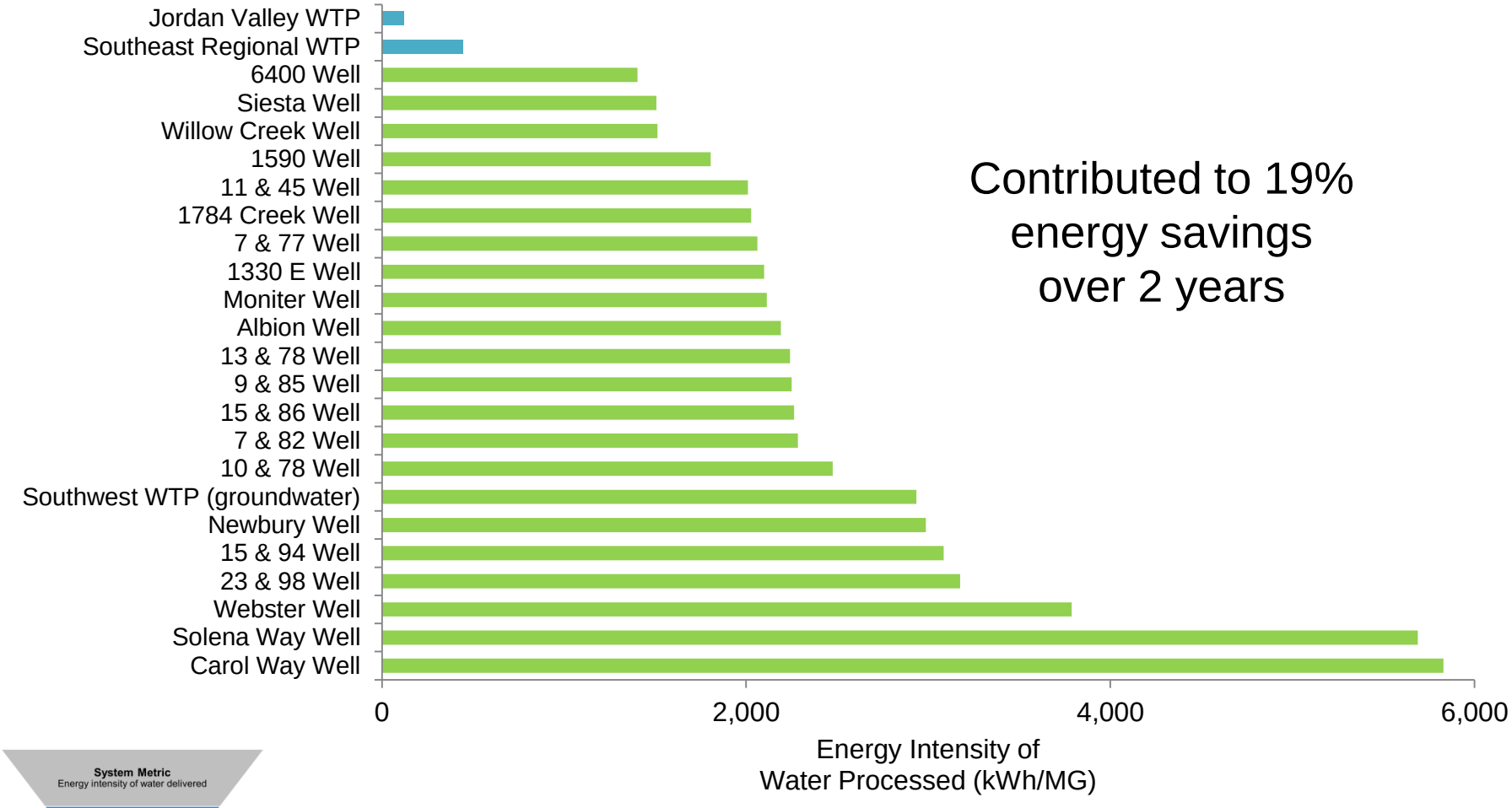
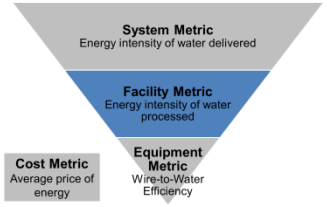
Example: Jordan Valley Water



Contributed to 19% energy savings over 2 years



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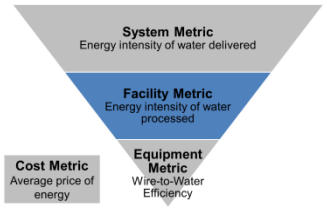
Limitations

- Billing period discrepancies (monthly vs. daily data)
- Changes over time
- Includes non-water electric loads
- Does not indicate whether equipment is efficient



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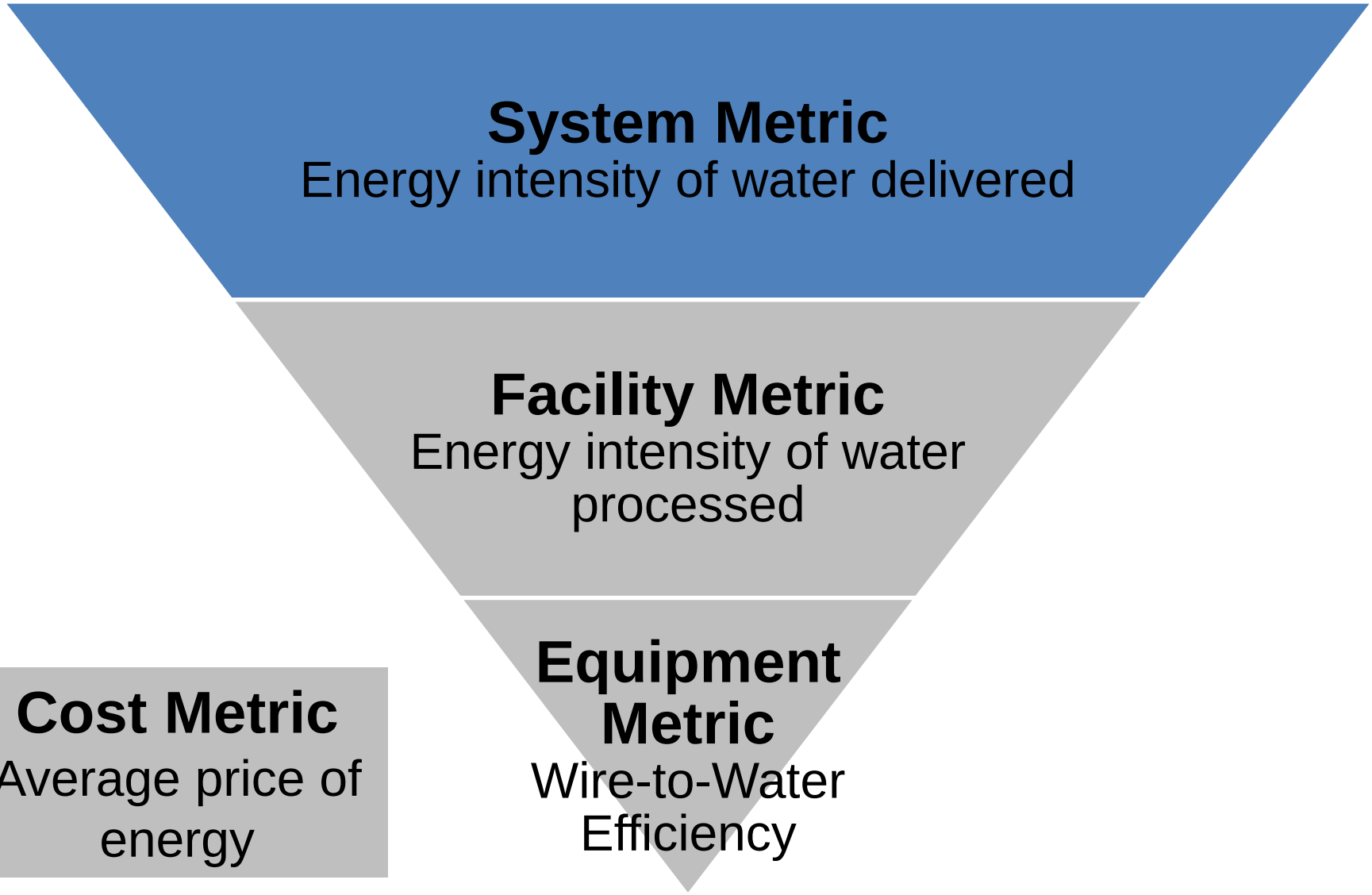

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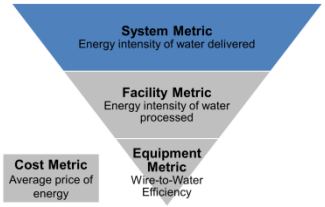
Definition

- Ratio of system-wide energy use to volume of water delivered (kWh/MG)
- “How much energy does the system take to deliver one unit of water to the end-user?”
- Range 0–15,000 kWh/MG
- Low value desirable



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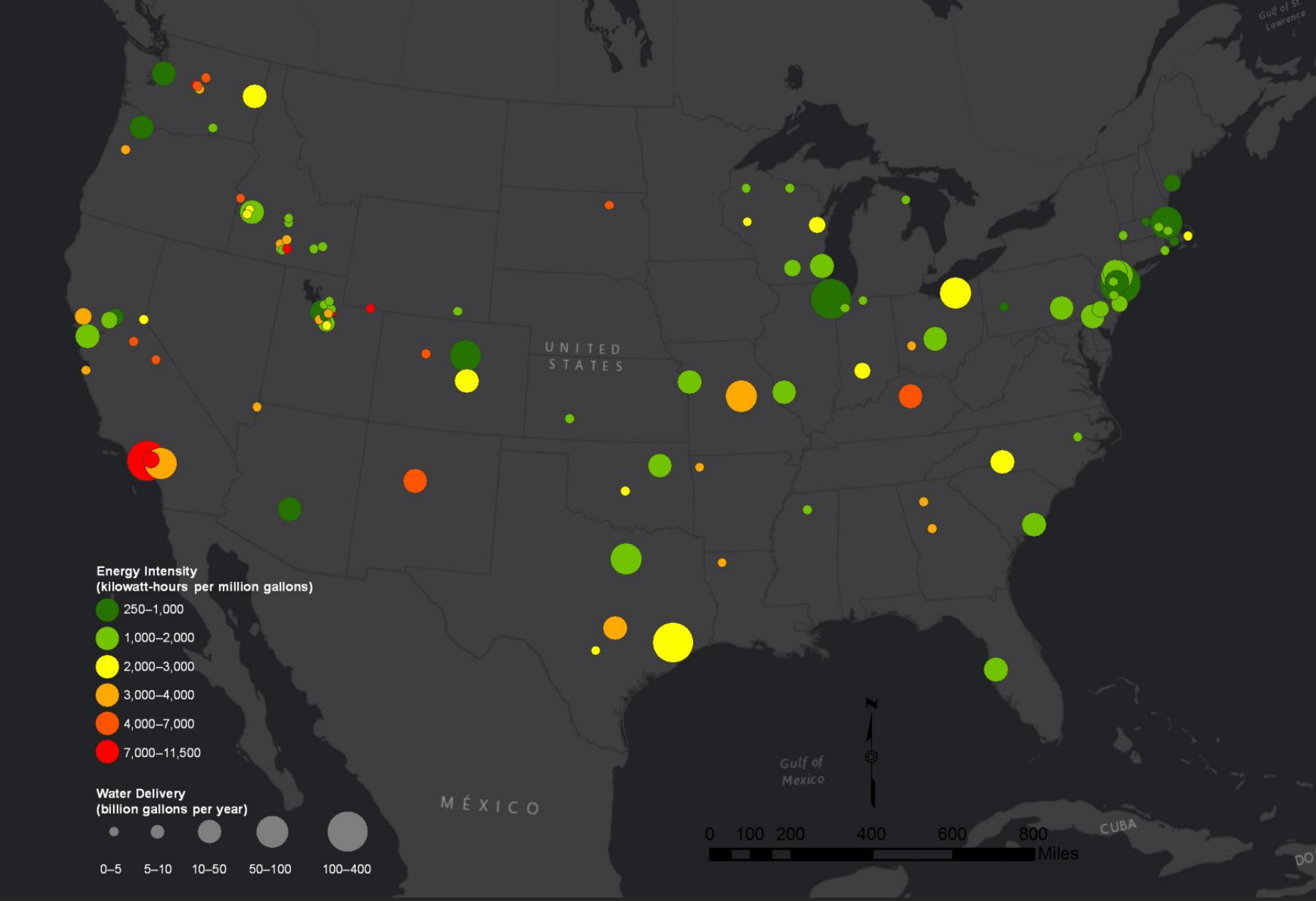

Sowby, Robert B., and Burian, Steven J., "Survey of Energy Requirements for Public Water Supply in the United States," *Journal AWWA*, July 2017

How to Calculate

- E_S = Total energy used in system (kWh)
- V_D = Total water volume **delivered** (MG)
- Over same period of time

$$Y_S = \frac{E_S}{V_D}$$

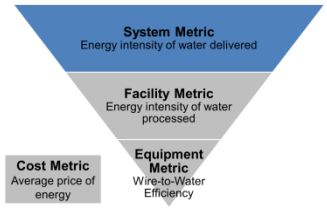

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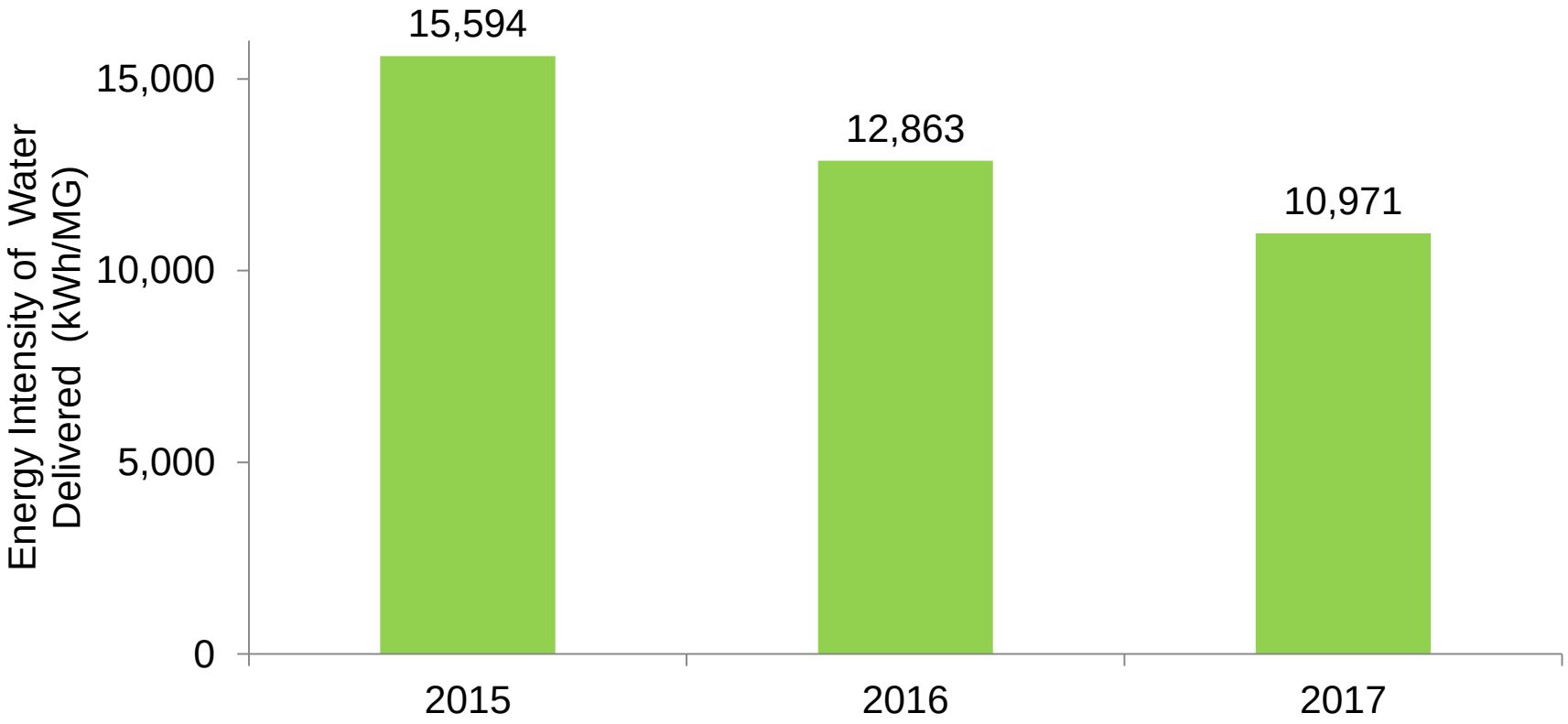
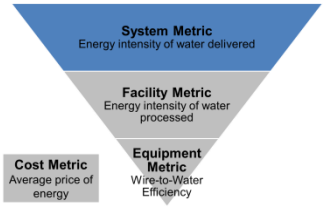
Photo courtesy of Harold Hargraves, City of Pocatello, Idaho, March 2018

Example: Parker Water District



Data courtesy of Jamie Langer, Parker Water & Sanitation District



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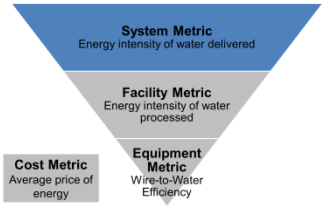
Limitations

- Difficult to compare systems
- Wide range of values
- Blurs differences within system



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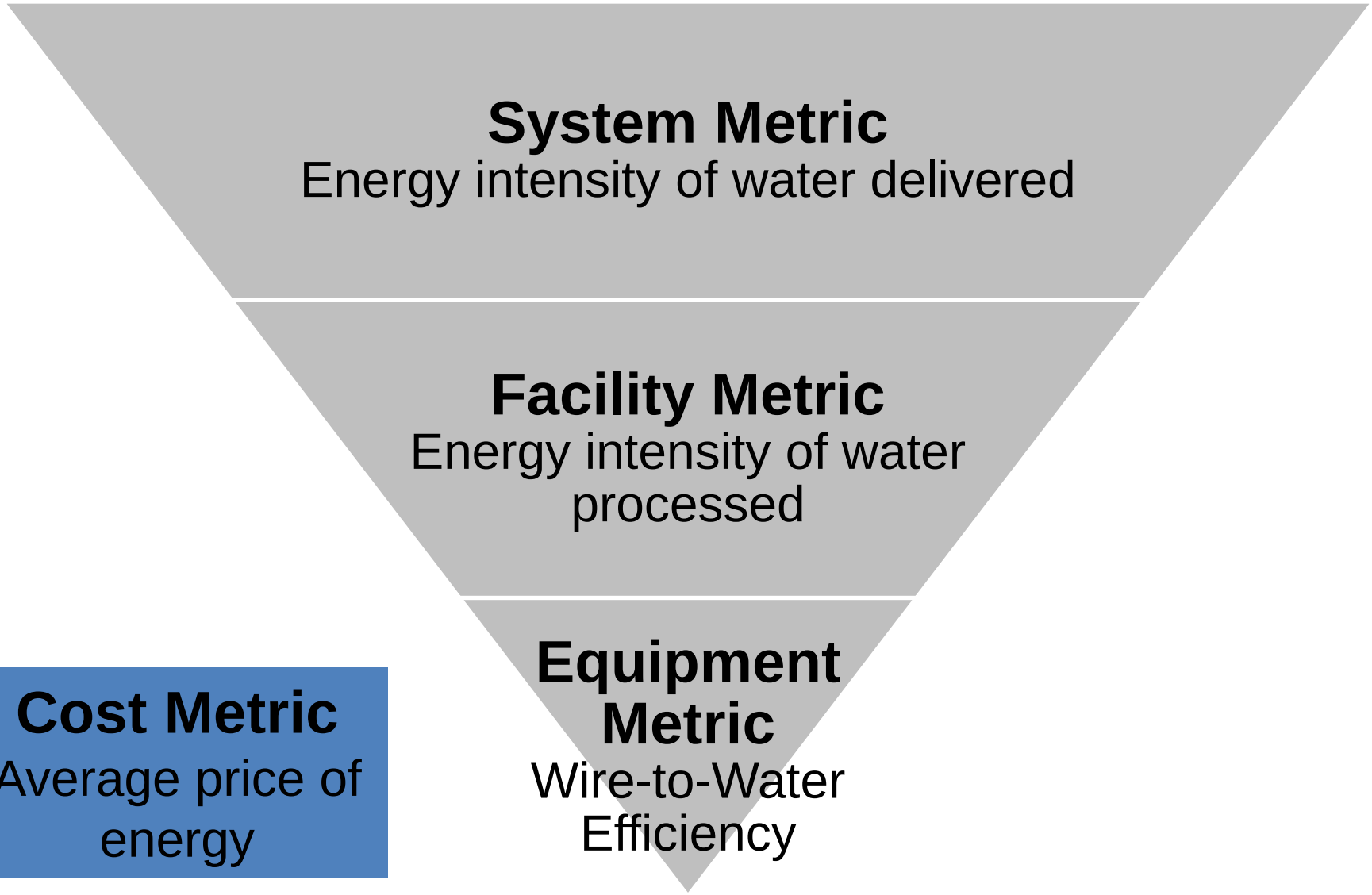

Cost Metric
Average price of energy

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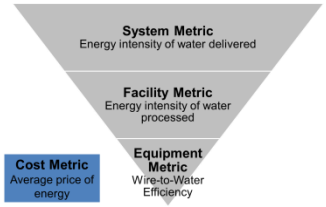
Definition

- Ratio of energy cost to energy used ($/kWh)
- “How much does every unit of energy cost after including all the other fees?”
- Range $0.03/kWh–$0.30/kWh
- Low value is desirable



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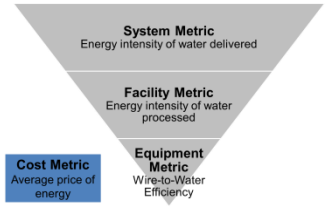
How to Calculate

- Total energy cost ($)
- Total energy use (kWh)
- Compute at facility or system
- Apply to energy intensity to get costs

$$A = \frac{Total\ Energy\ Cost\ (\$)}{Total\ Energy\ Use\ (\mathrm{kWh})}$$



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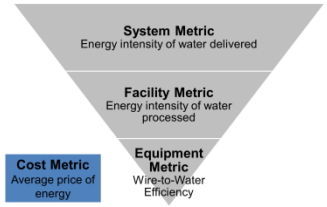
Example: WTP

- Switched one treatment train to off-peak operation and reduced the number of simultaneously running finished water pumps
- Before
  - 390,000 kWh
  - $31,200
- After
  - 485,000 kWh
  - $34,000

$$Before = \frac{\$31{,}200}{390{,}000\ \text{kWh}} = \mathbf{\$0.08/kWh}$$

$$After = \frac{\$34{,}000}{485{,}000\ \text{kWh}} = \mathbf{\$0.07/kWh}$$



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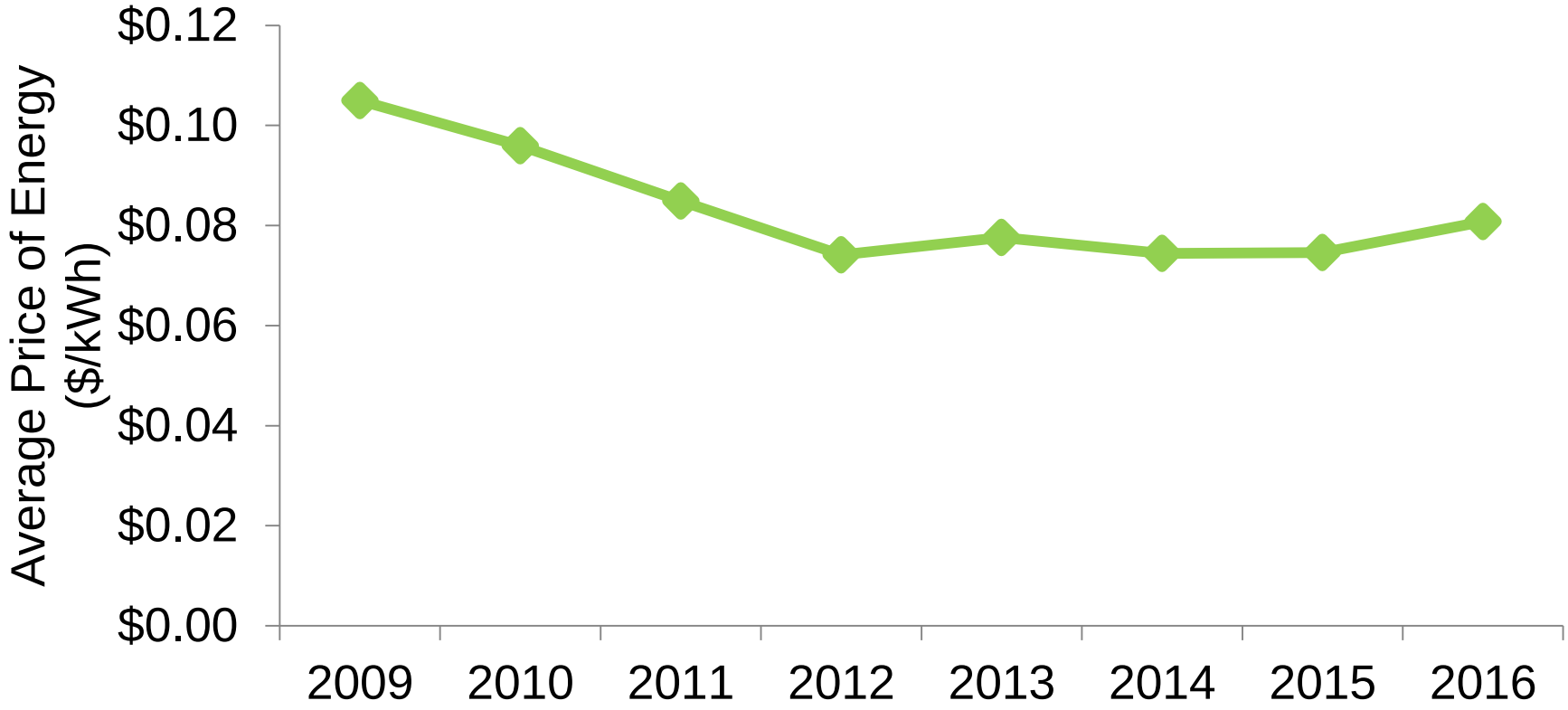
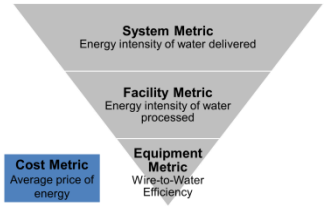
Example: Mountain Regional Water



Data courtesy of Doug Evans, Mountain Regional Water District



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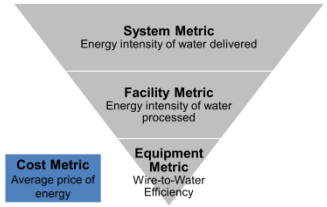
Limitations

- Changes to rate schedules
- Does not indicate necessity of energy use



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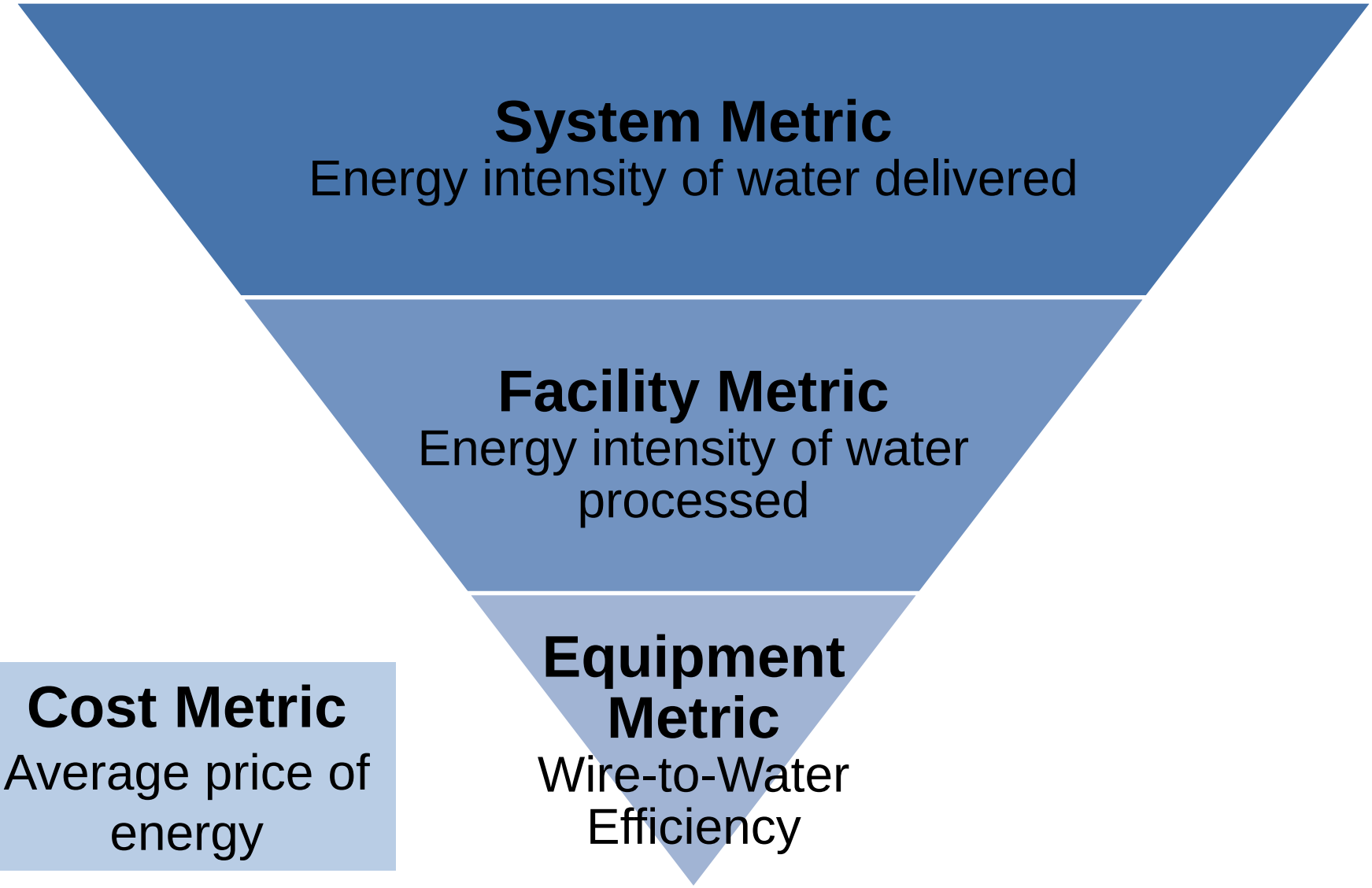

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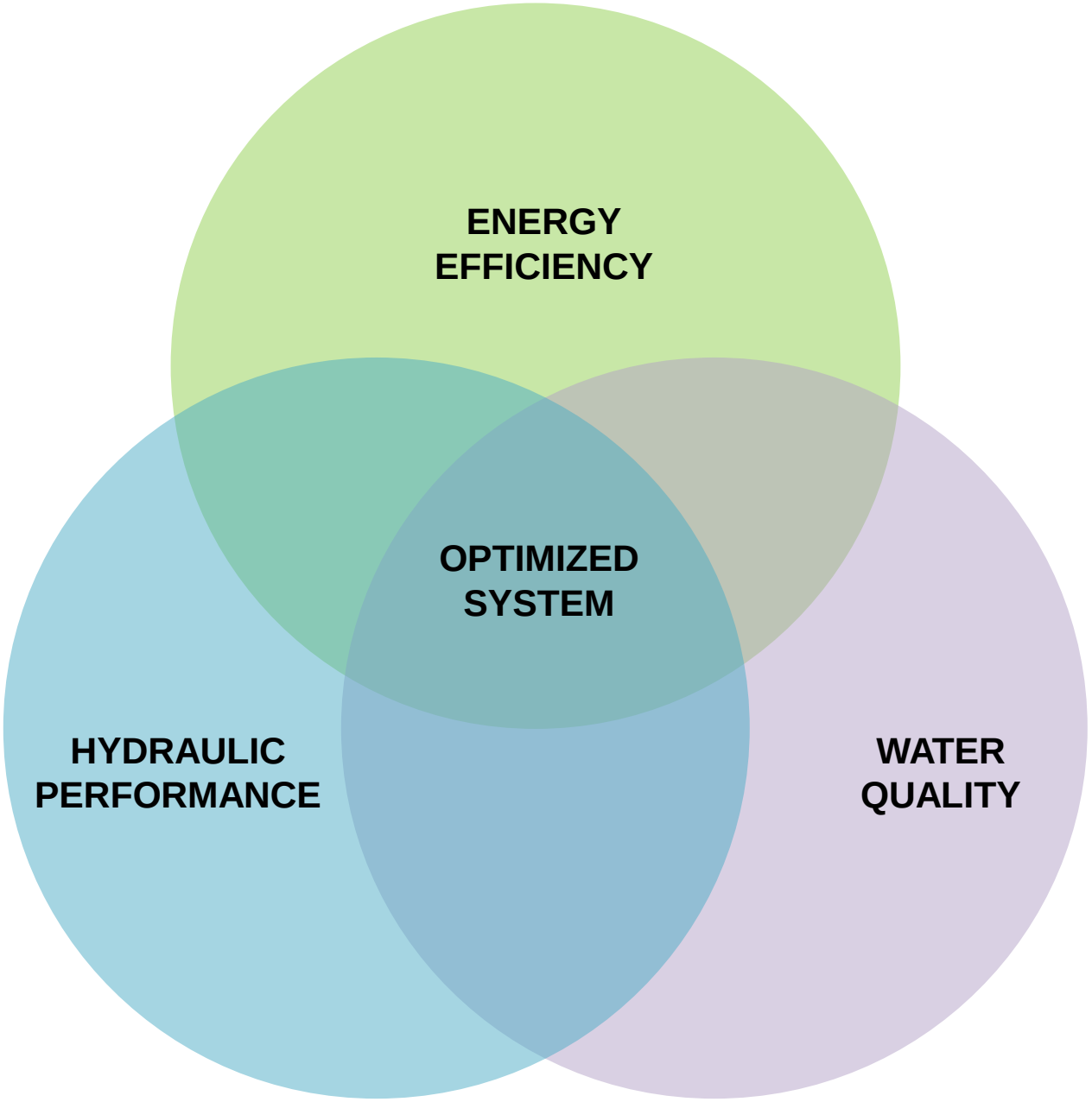

Jones, Steven C., and Sowby, Robert B., “Water System Optimization,” *Journal AWWA*, June 2014

Thank You

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