High-Efficiency Transformers as a Viable Energy Conservation Measure

Greater Boston Energy Efficient Hotels Conference

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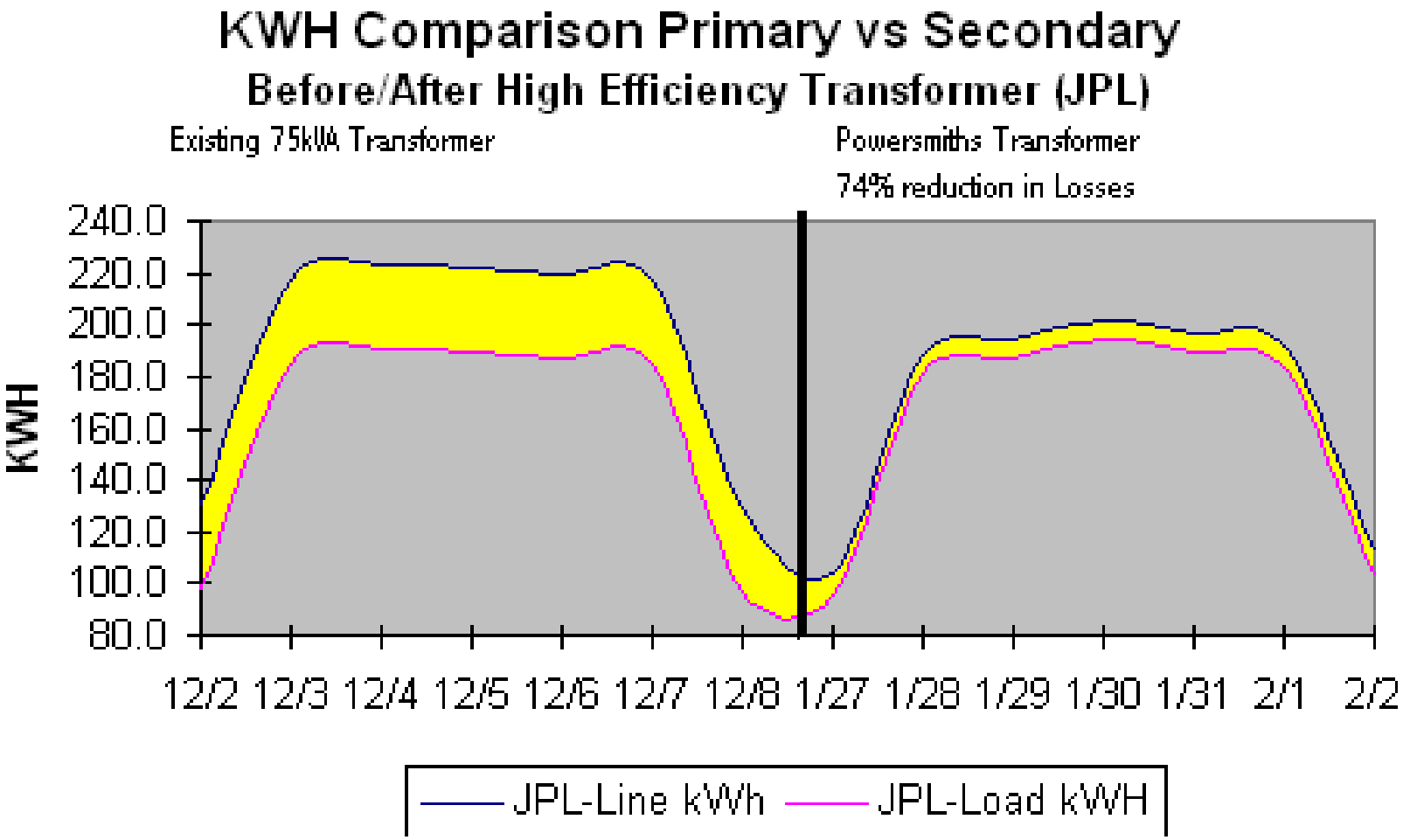
Chris Wheeler

UTSA Case Study: 74% Reduction in Losses –

NOTE: Peak Demand Savings as well as kWh



300 Room Boston Hotel

Standard Transformers

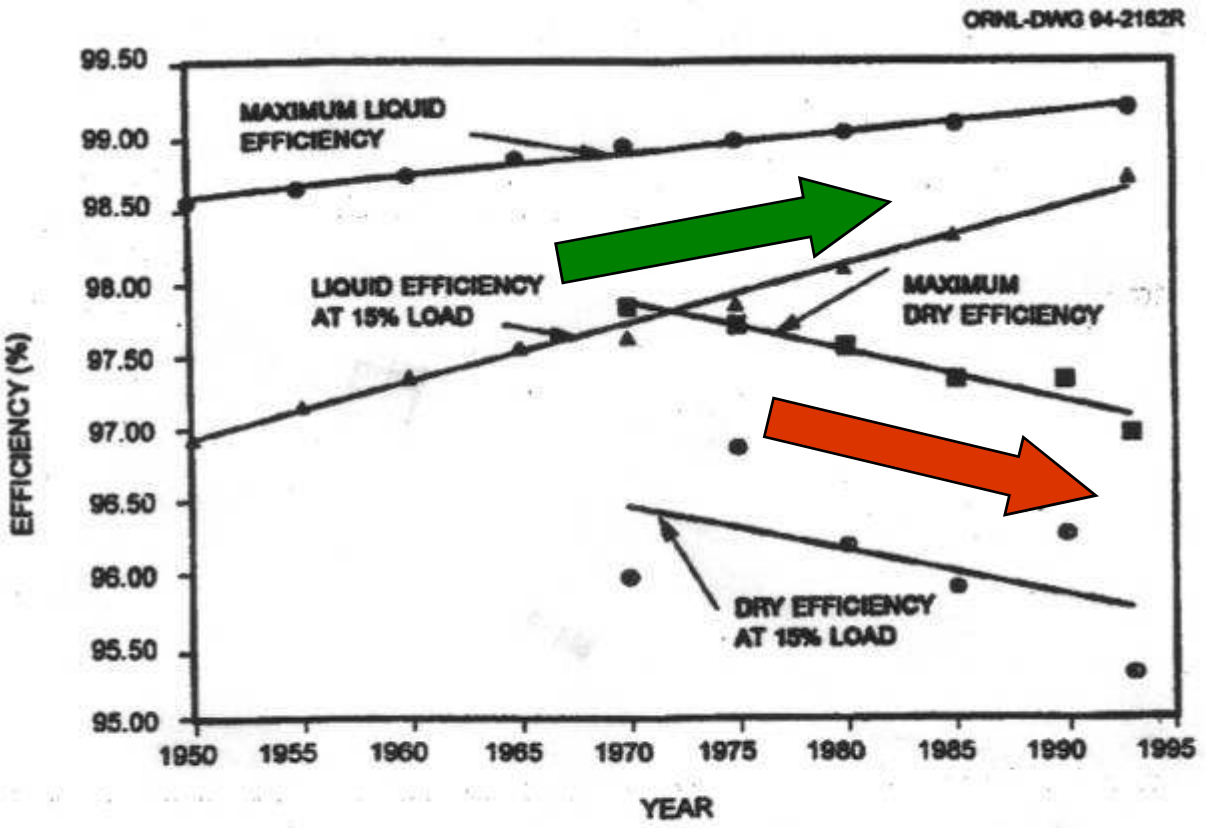
- 15 Existing Standard Efficiency Transformers
- Annual Losses
  - 189,571 kWh
  - 25.3 Peak kW
- Electricity Cost to Operate Transformers $37,988

Ultra-Efficient Transformers

- 80% Reduction in electric losses
- Annual Losses
  - 37,627 kWh
  - 4.9 Peak kW
- Electricity Cost to Operate Transformers $7,504
- Annual Savings = $30,484

Dry-type transformer efficiency – A race to the bottom

Utility **Life Cycle** purchases have driven up utility transformer efficiency



Commercial **First Cost** purchases have driven down efficiency of low voltage transformers

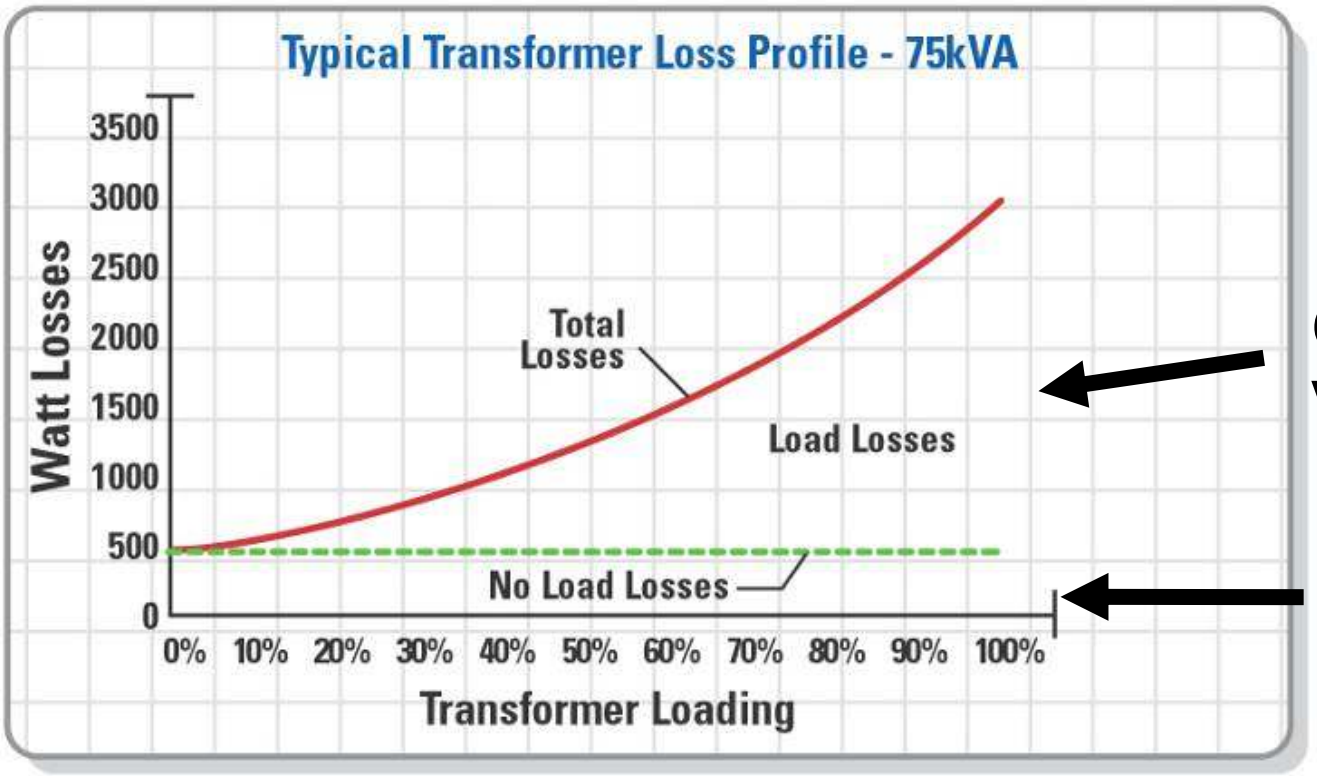
Fig. 1. Distribution transformer efficiencies over the years for 75-kVA, three-phase units. *Sources:* Barnes, P. R., et al. 1995. *The Feasibility of Replacing or Upgrading Utility Distribution During Routine Maintenance*, ORNL-6804/R1, Martin Marietta Energy Systems, Oak Ridge Natl. Lab. Also, transformer manufacturers' data.

Transformer Replacement: The Opportunity

According to US Dept. of Energy Study

- Est. 40 million dry-type transformers in North America
- In every building – across all vertical markets
- Mean time to failure is 32 years
- 50% of transformers are over 30 years old
- Environmental Impact
  - 145 Million tons of coal burned
- Energy Impact
  - 60-80 Billion kWh losses annually
- Financial Impact
  - At $0.10/kWh, losses amount to $6-8 Billion annually

Origin of Transformer Losses



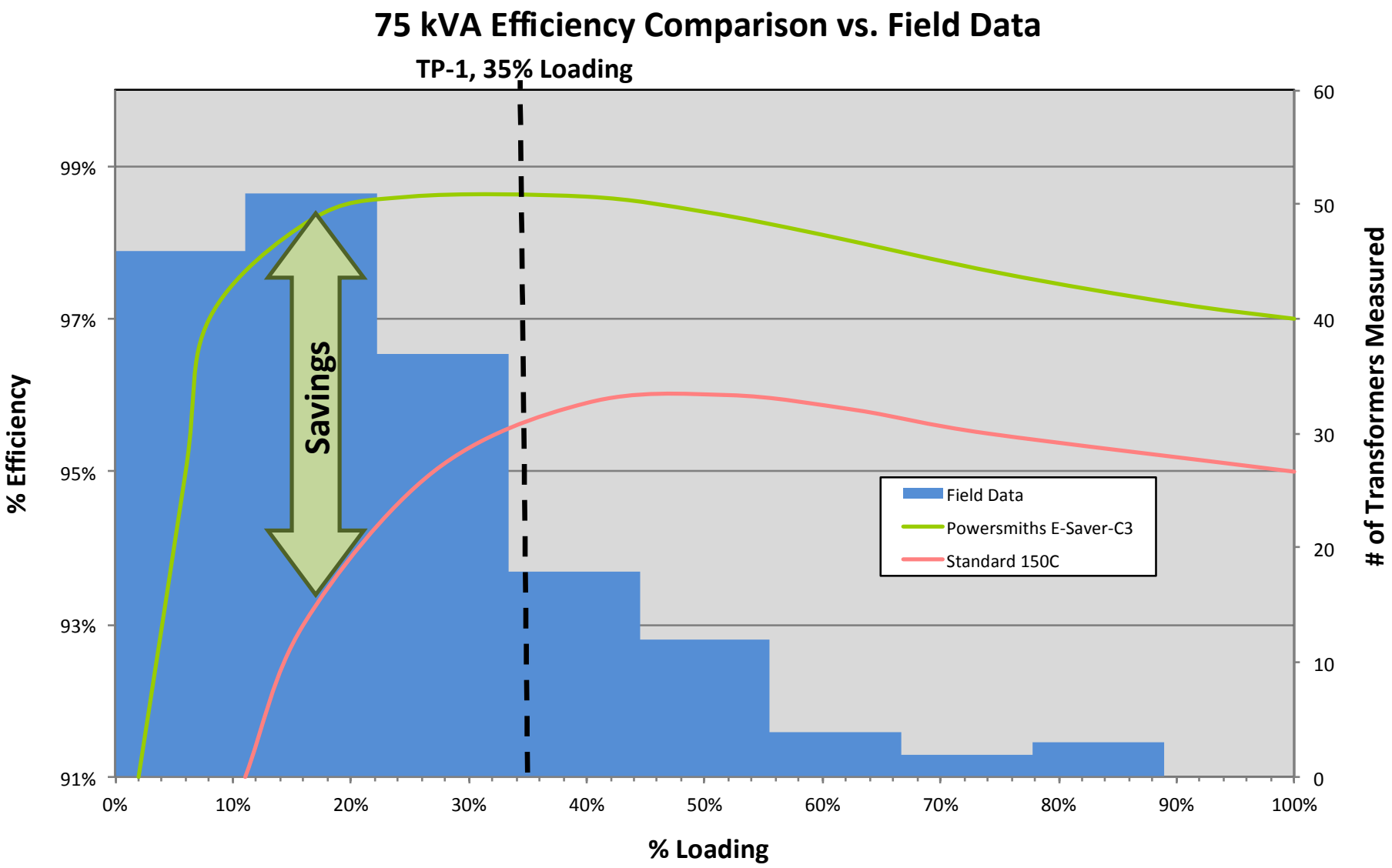
COIL LOSSES
Vary with load

CORE LOSSES
24hrs/day

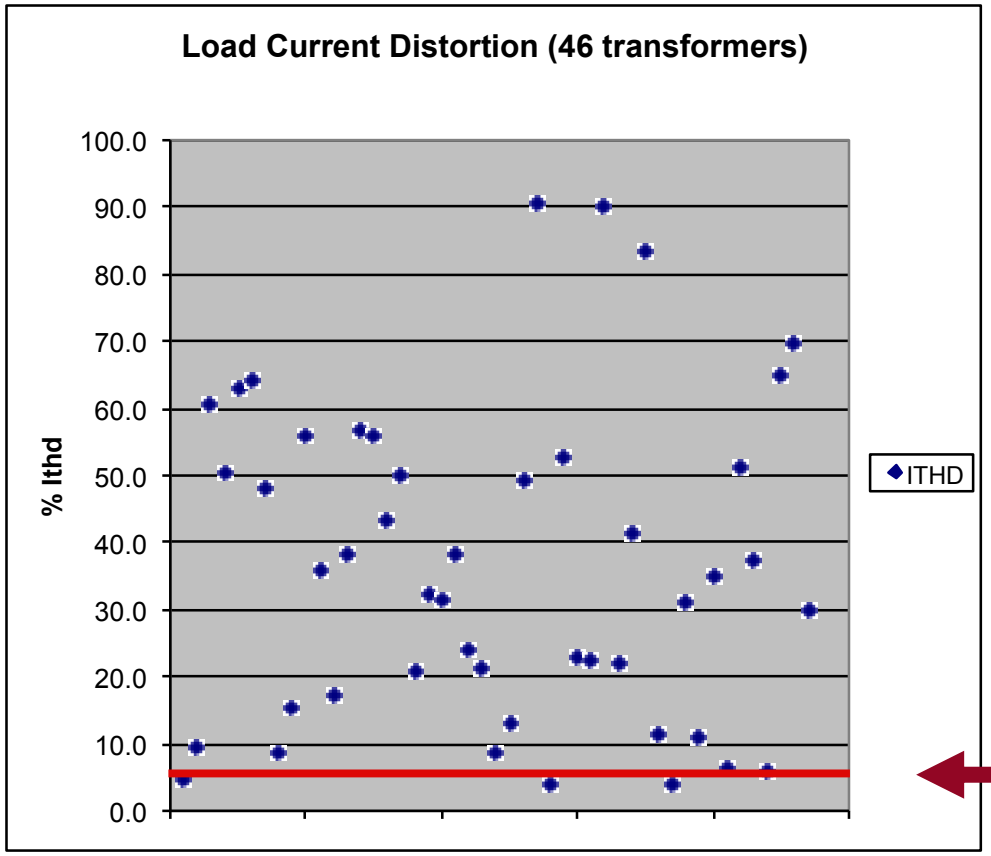
Transformer Retrofit Challenges

- No industry standard footprint or terminal configuration
- Hundreds of makes/models
- Accurate assessment of loss reduction opportunity
- Effective Measurement & Verification of before/after losses

Efficiency vs. Load Distribution



General purpose transformers are not UL Listed to feed today's loads



Engineering Liability

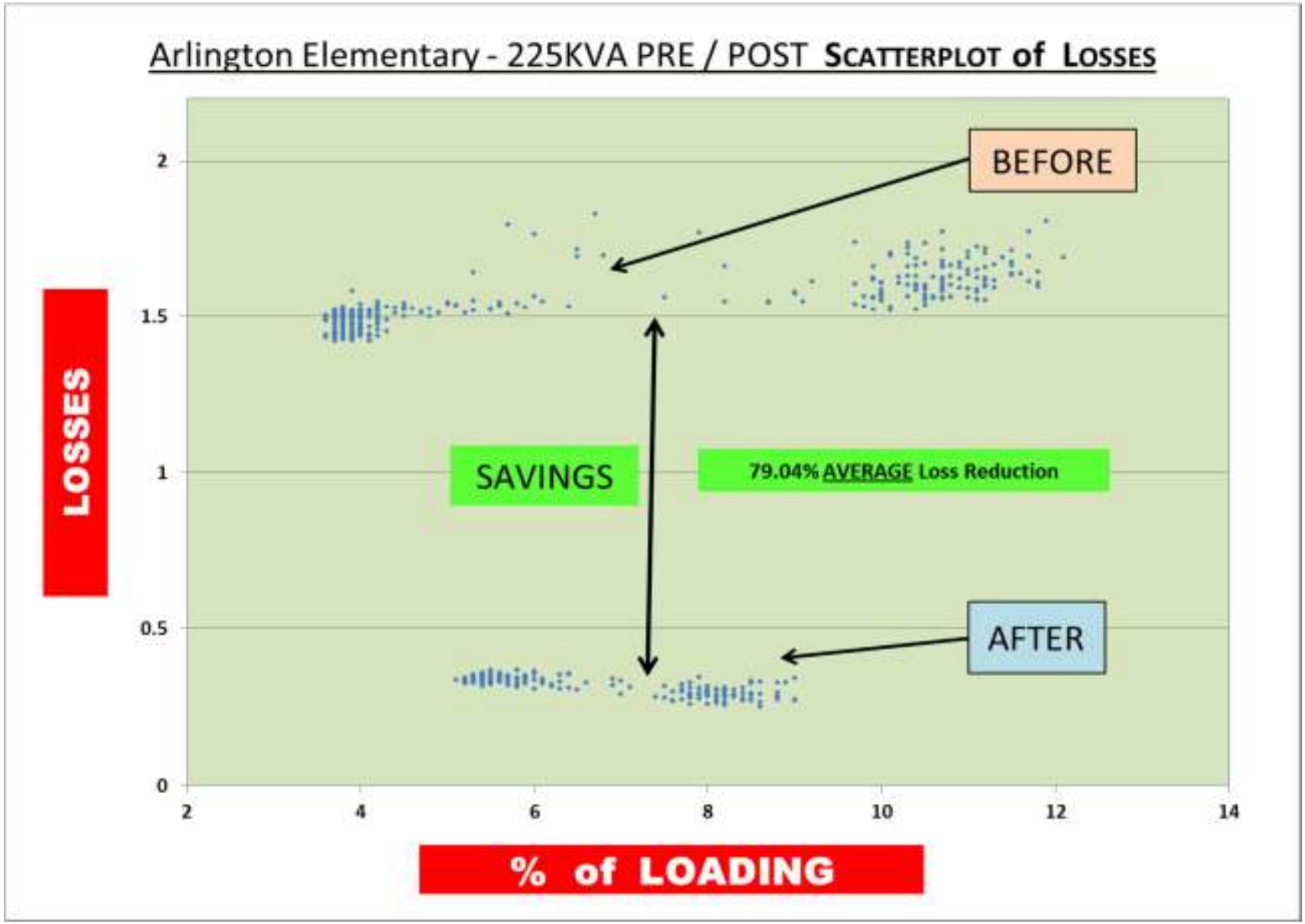
Non-linear loads can increase heat in a transformer without operating its overcurrent protection device

5% limit C57.12.01 for general purpose transformer

- Current THD as measured vs. C57.12.01 limit

Inefficiency = Heat

Heat = Additional Cooling


Arlington Elementary - 225KVA PRE / POST SCATTERPLOT of LOSSES
BEFORE
AFTER
SAVINGS
79.04% AVERAGE Loss Reduction
LOSSES
% of LOADING
0
0.5
1
1.5
2
2
4
6
8
10
12
14

Retrofit Opportunity & Benefits

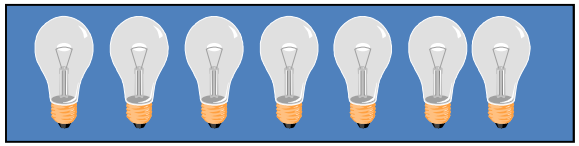
- kWh & Demand Savings
- Embedded for 30+ years
- Passive – no controls or user behavior change
- No efficiency degradation over installed life
- Refresh of key piece of electrical infrastructure – feeds all plug power
- General Purpose transformers are not UL Listed to serve today's electronic equipment load profile

Simpler Than Turning Off the Lights

Standard 75 kVA
K4 Rated Transformer
(Installed prior to 2007)
855W no load losses

Candidate Standard Level 3 (CSL-3)
75 kVA K4 Rated Transformer
155W no load losses

No Load Savings: 700W



For each transformer:
No load savings = turning off 7 - 100W light bulbs 24hr/day

What this means:
$18,000 over 3 yrs in a typical facility…. Embedded for 30-40 years.

Then add the savings when the transformer is loaded !

Questions?

Thank You!

Chris Wheeler

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(603) 686-9773
chris.wheeler@powersmiths.com