2006 Wire Workshop

Session IV – Road to Commercialization

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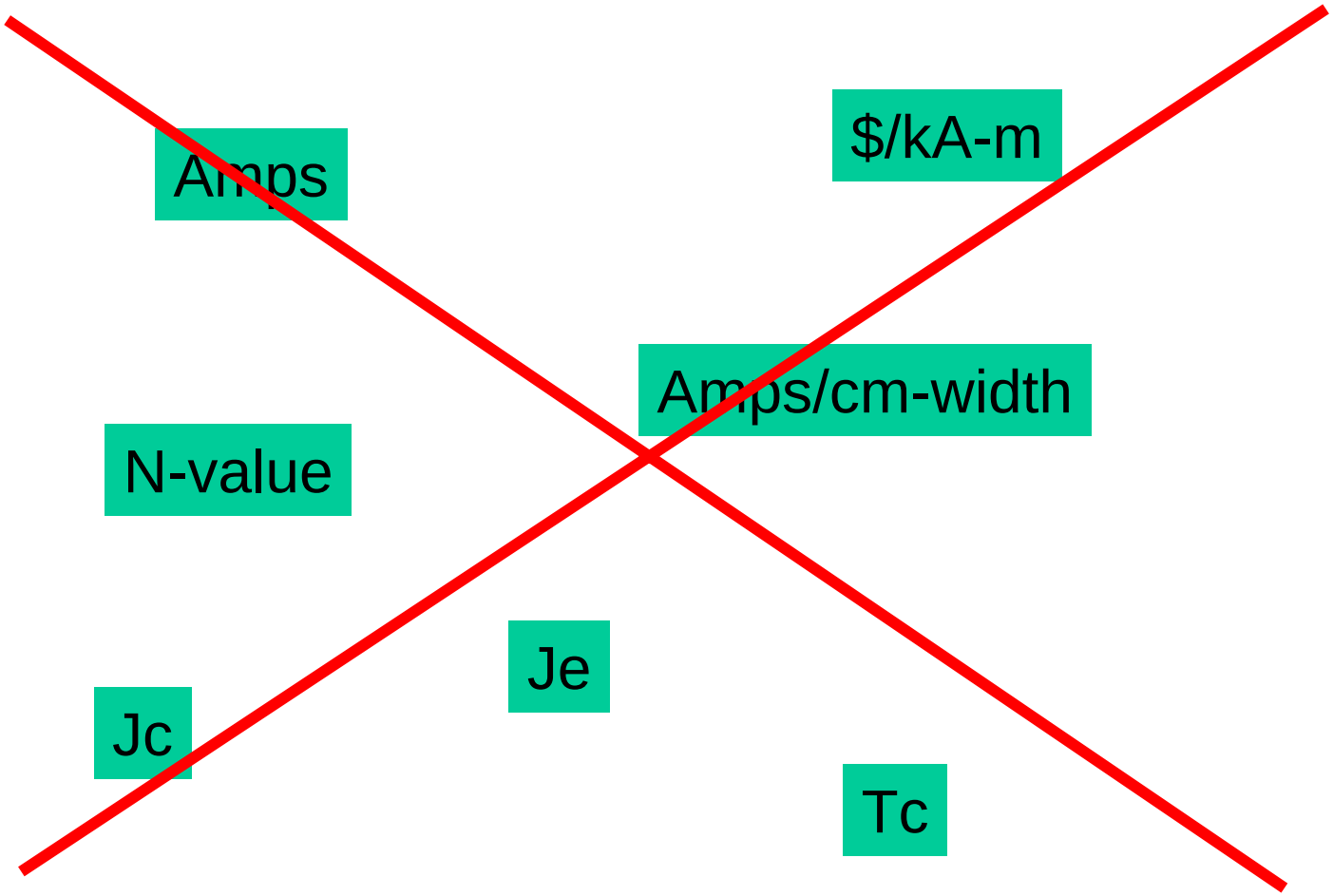
I was asked to discuss

“Getting the Metrics Right”

What are the old metrics? Are they wrong?

How should we best measure performance of HTS wires to quantify benefits to the end user?

Old/Traditional Metrics



New Metrics

One word = **VALUE**

There must be favorable cost/benefit result to end user for HTS equipment to be installed in T&D network.

HTS community must come to grips with the economic realities of the markets we are trying to penetrate.

Our products must provide a tangible value to the end user. We must convince not only the engineers, but also asset management the there exists a cost-benefit to the product.

'The Economics Must Work'

Example = Cables

(VERY Rough Numbers)

- North American UG cables market in 2005 for MV, HV, EHV was approx $1B (installed system)
  - HTS cables only address a portion of this total market – targeted at dense urban areas with high power consumption and space constraints.
  - Assume $700m addressable HTS cables market
- General rule of thumb:
  - Cable = 20%
  - Other materials = 10%
  - Cable/Acess. Install = 20%
  - Civil works = 50%

HTS vs Cu

Can HTS compete on a meter-to-meter basis with conventional cables?

Not really!

COMEX Cu trading spot price approx 2.23 $/lb. This is 50-60% increase in last 12 months.

Economics for HTS at today's wire prices still don't work if comparing meter-to-meter costs!

HTS vs. Cu

HTS advantage is at higher ampacity circuits – must take advantage of higher current densities.

"*Average*" HV XLPE cable costs 40-65 $/m/phase

- 120-195 $/m (3 phases)

What is benefit to justify cost??

Today's HTS cables cost 3500-6000 $/m (3 phases)

- before 500 $/m cryostat cost
- Haven't even *begun* to consider cryogenic costs

Cryogenics

- Cryogenics costs is extremely important component.
- Wire AC-Loss has direct effect on cryo system size.
- 1 km cable can easily need 8-10 kW cooling capacity
  - Improved AC Loss if cable/wire can reduce by 30%

How to Justify?

- What applications justify these costs?
- What is benefit to customer?

- Applications:
  - Transmission – backbone of Long Island
  - Distribution – dense urban areas where space for cables and substations is extremely limited

- Benefits
  - Space reductions. Substation footprints
  - Relocate transformers to out-lying areas
  - RoW, permitting, retro-fit existing ducts
  - Tie substations together on LV side of transformer
  - Load Flow?

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These benefits must be quantified by the end user to show value. Only then can they be reasons to justify increase in costs.

Virtually impossible to do with 10x cost premium

Wire costs MUST come down!

Life Cycle Costs

Not just first cost is consideration…..

- Maintenance and repair of cryogenics system must be factored into equation
  - Cryo system O&M
  - Cryostat maintenance and re-pumping

- HTS cable system will have ongoing costs….

So… what is best metric?

1. Must include material cost
   - wire, cryostat, accessories
2. Must include cryogenics costs
3. Must include ongoing O&M costs
4. Must include power (MVA) delivered by system
   - transformers, substation footprint, efficiency, etc.
5. Must be easily measured against Cu XLPE cable which is competition

Metric

$/system-MVA/meter/30yr life

Must be Judged vs. Copper XLPE cost

Engineers at utility will ALWAYS find alternative solutions to solve problems.