

# All-Superconducting Substation

An HTS System Integration Concept

by  
CSAC

# General Concept

- Substation comprised of all superconducting power components
  - Transformer, FCL,  $\mu$ SMES, Cabling
  - (Turbine Generator Rotor)
- Single Cryostation Support
- "Full Quadrant" Power
- Uninterruptible Substation Power
  - The EPRI UPS Substation Project Extended

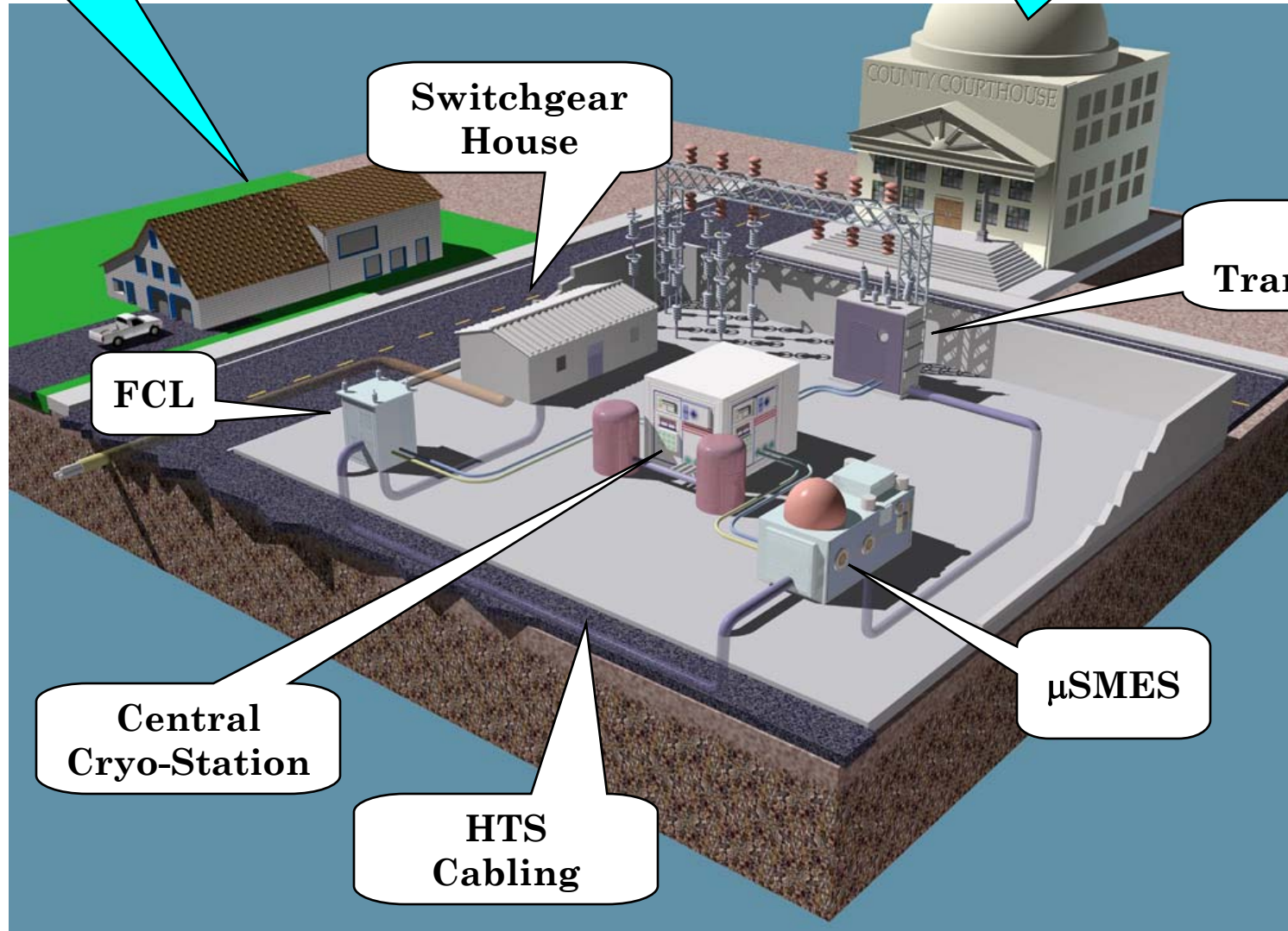
# Substation Specifications

<b>Power Capacity</b>	<b>100 MVA</b>
<b>Voltage</b>	<b>24 kV</b>
<b>Area</b>	<b>40 x 60 m<sup>2</sup></b>
<b>Transformer</b>	<b>100 MVA, 3<math>\phi</math></b>
<b>FCL</b>	<b>3 @ 30 MVA</b>
<b>SMES</b>	<b>3 @ 3 MJ (30 MVA)</b>
<b>Cabling</b>	<b>100 MVA, 3<math>\phi</math>, 500 m</b>

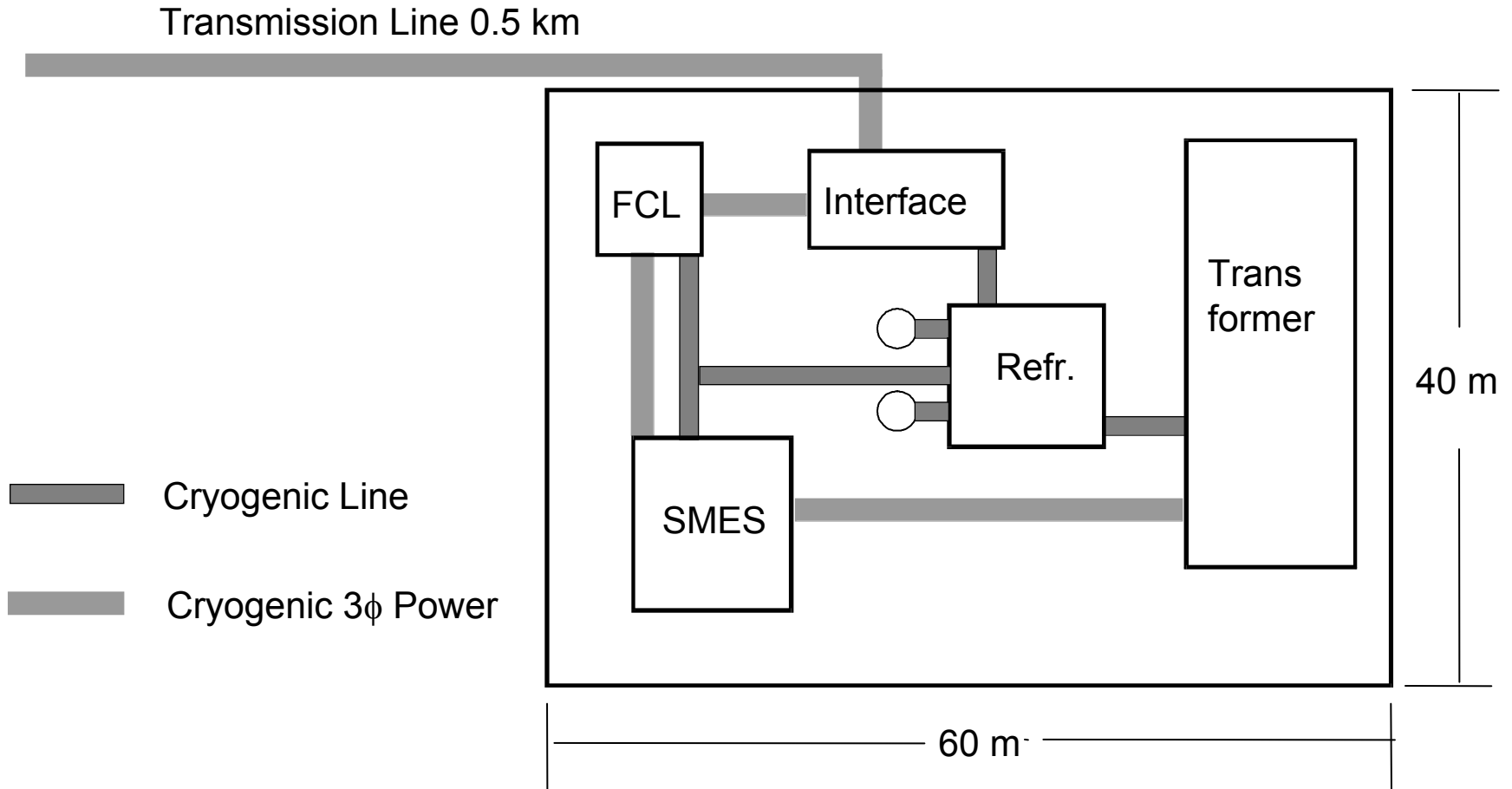
# Legend

Nice Family House

Courthouse where you can sue your local utility when the lights go off



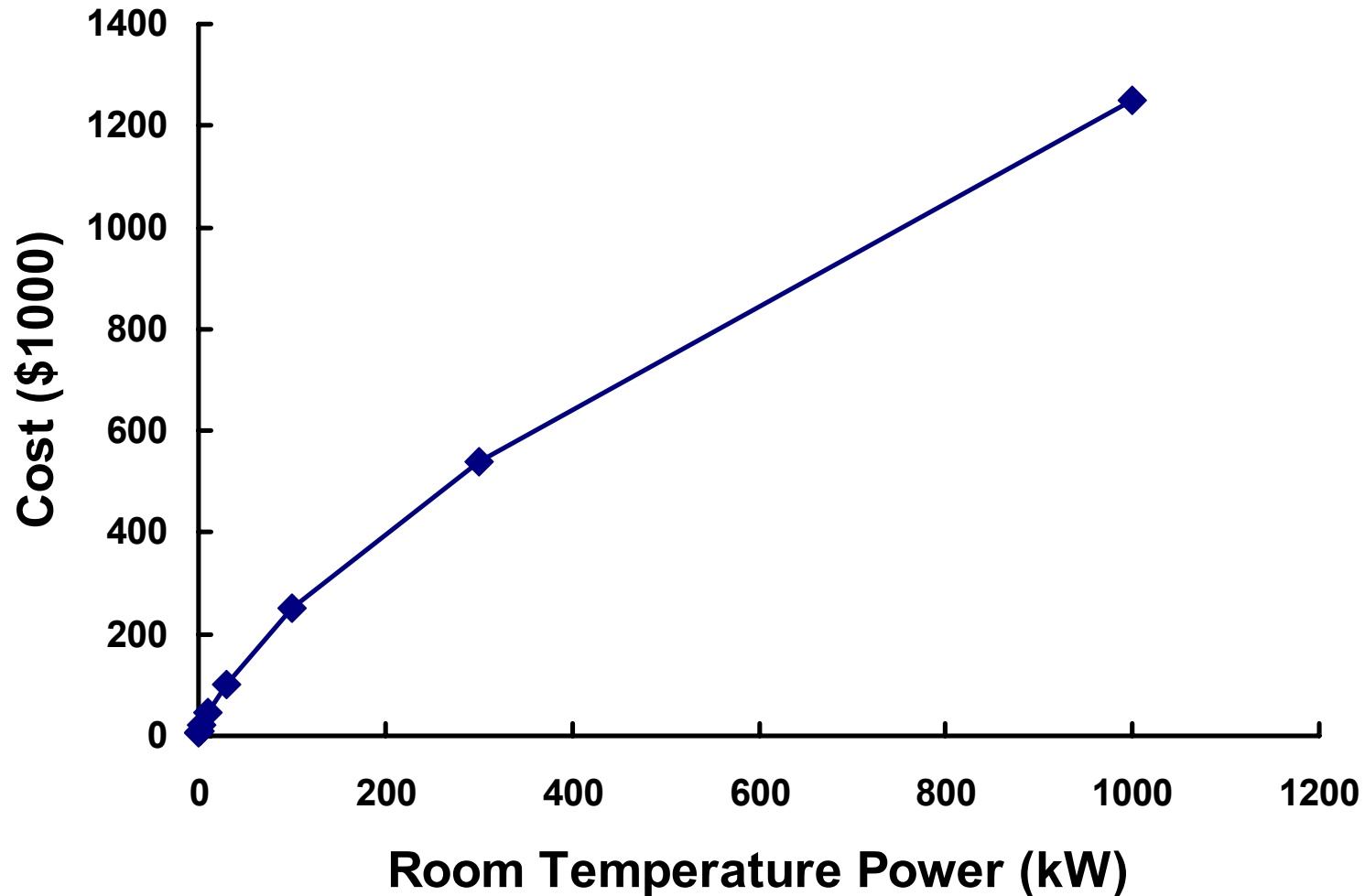
# Super-Sub Plan View Scale/Dimensions



# HTS Component Cryo-Budget

<b>Component</b>	<b>Heat Load Range</b>	<b>Heat Load Design</b>
<b><u>Transformer</u></b>		
30 K	150 - 400 W	250 W
77 K	500 - 800 W	600 W
<b><u>Fault Current Limiter</u></b>		
30 K	75 - 300 W	200 W
77 K	400 - 1000 W	700 W
<b><u>SMES</u></b>		
20 K	20 - 70 W	50 W
77 K	75 - 300 W	200 W
<b><u>Transmission Line</u></b>		
30 K	5 - 15 W/m	3000 W
77 K	5 - 10 W/m	3000 W

# Cryoplant Cost vs Power



# Net CryoPower/Cost

Component	300 K Cryopower	Cryo Cost
Transformer	240 kW	450 k\$
Fault Current Limiter	240 kW	450 k\$
SMES	12 kW	50 k\$
Transmission Line	260 kW	500 k\$
Total—Separate Refrigerators	752 kW	\$1450 k\$
Super-Sub single Refrigerator	700 kW	\$1000 k\$

P.M. Grant/W. Hassenzahl  
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**30 % !**



# Conclusions

- Tangible energy/cost savings accrue from systems matching and cryo-integration of individual components (e.g., eliminate 300 K terminations)
- Commercial HTS power components will be emerging from DOE SPI
- System integration of HTS could play key role in addressing the President's Critical Infrastructure Directive

# Proposal

- DOE SPES sponsor design study on integrated HTS power facility (e.g., "Super Substation")
- Two SPI teams solicited/selected competitively as additions to FY00/01
- \$500 K ea. (\$1M total), 1 Year

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