Microgrid And Smart Grid Activities At SMUD

Presented by

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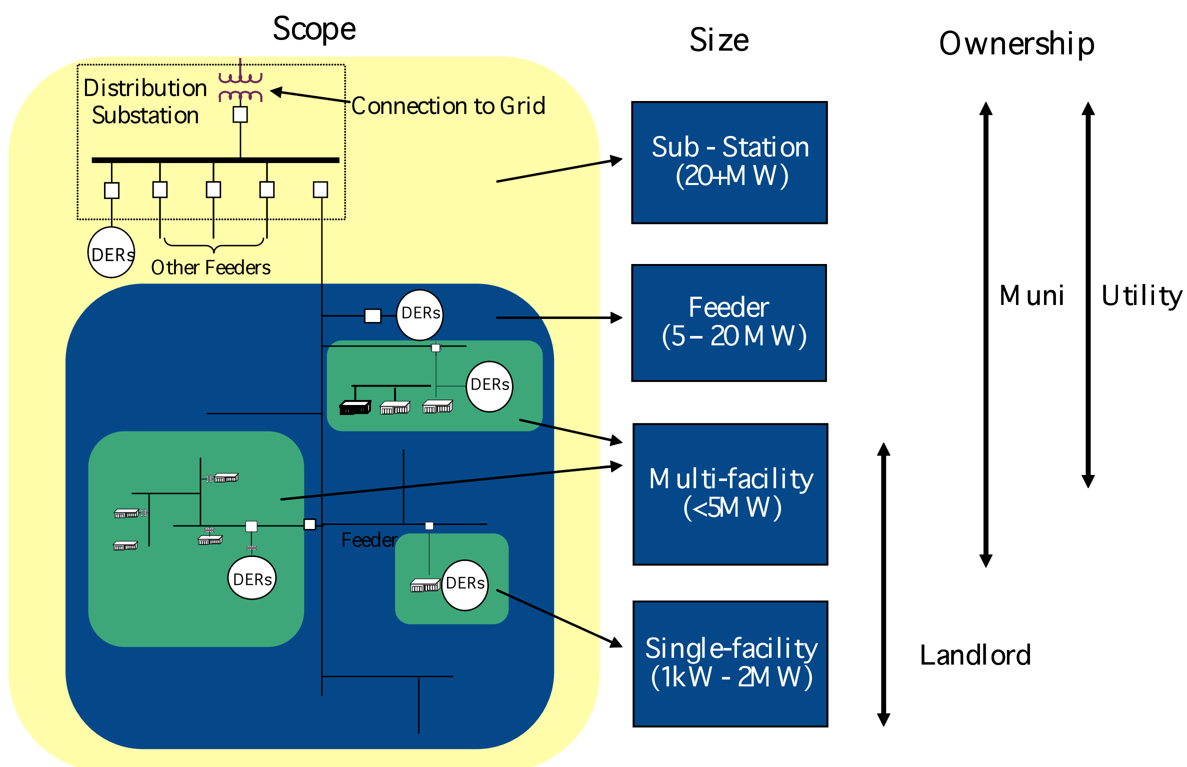
SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.SM

Presentation Topics

- SMUD Microgrid Definition
- Drivers For Project
- Project Overview
- Demonstration Site Features
- Modes of Operation
- Major Equipment
- Customer Economic Feasibility
- Schedule Going Forward
- Future Additions

SMUD's Microgrid Definition

- A Smart Grid concept
- "Integrated energy system consisting of interconnected loads and distributed energy resources which as an integrated system can operate in parallel with the grid or in an intentional island mode"
- Microgrids can vary in scope, size, and ownership



Source: US DOE/CEC Microgrids Research Assessment, Navigant Consulting Inc., May 2006

SMUD project will demonstrate multi-facility scale microgrid.

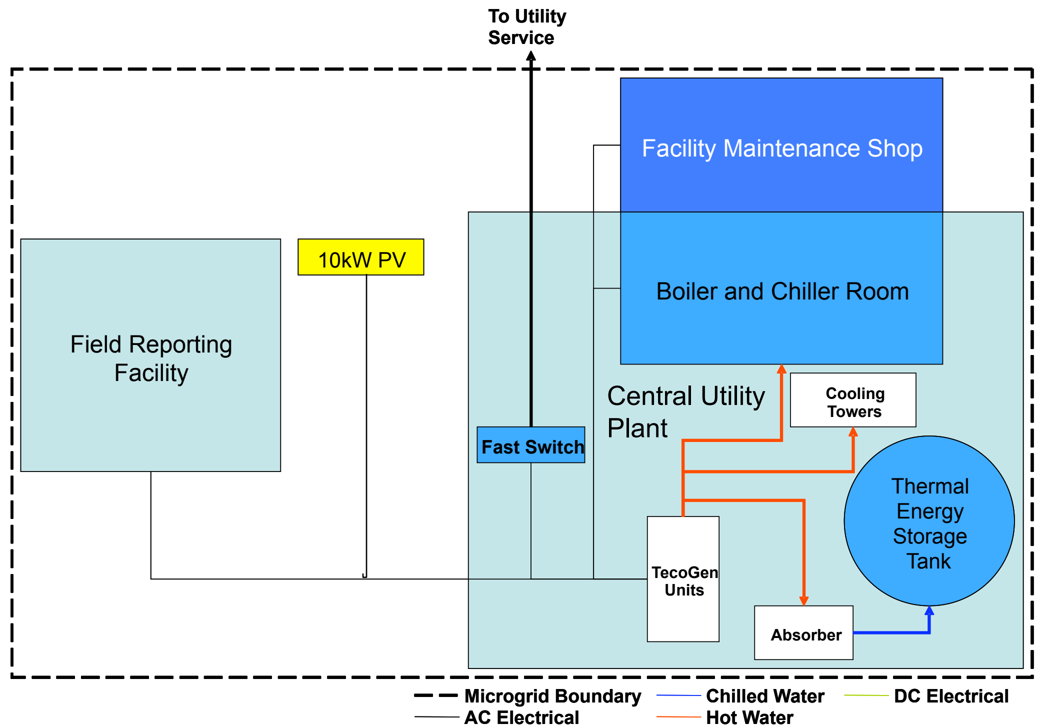
Board Policy and Customer Drivers For Microgrid Demonstration

- Supports Board strategic directives
  - SD-4 Reliability
  - SD-7 Environmental Protection
  - SD-9 Resource Planning
  - SD-10 Research and Development
- Invests in R&D to:
  - Improve customer and system reliability at reduced cost
  - Reduce peak load
  - Reduce Ghg through more efficient use of NG
  - Develop and deploy cost effective, clean distributed generation

SMUD Microgrid Project Overview

310kW demo of CEC/DOE/CERTS Microgrid concept
for our central utility plant

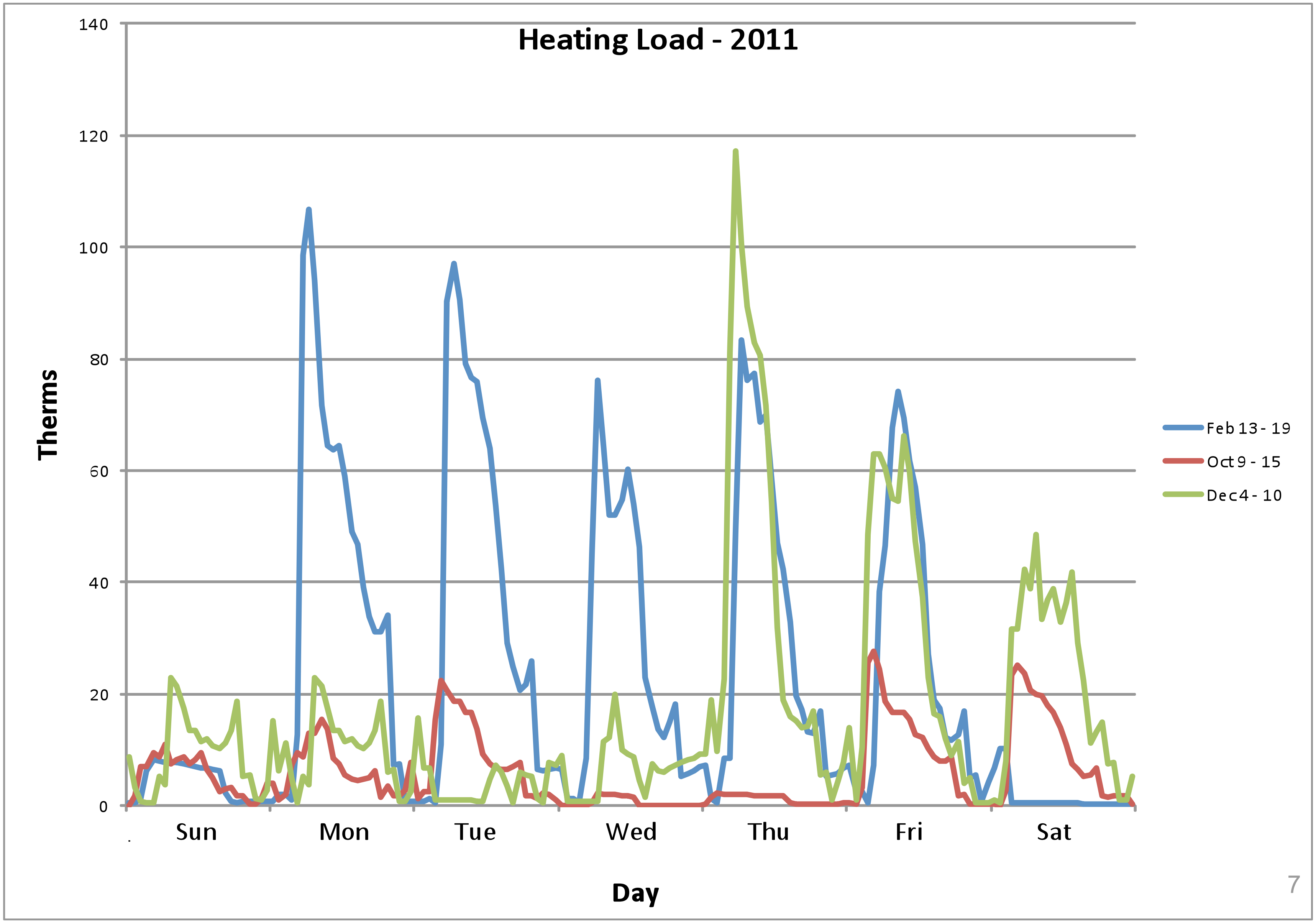
- California Energy Commissioned funded project - $2.9M over 3 years
- Partners include DE Solutions, TecoGen, NREL, CERTs, Univ. of Wisconsin
- Real world performance
- Integration and interoperability with demand responsive load control, advanced reciprocating engines, PV, and thermal energy storage
- Seamless separation and isolation from utility grid and resynchronization
- Feeder peak load reduction
- Economic value to customers and utility
- Technical and operational distribution system implications of exporting power from a microgrid



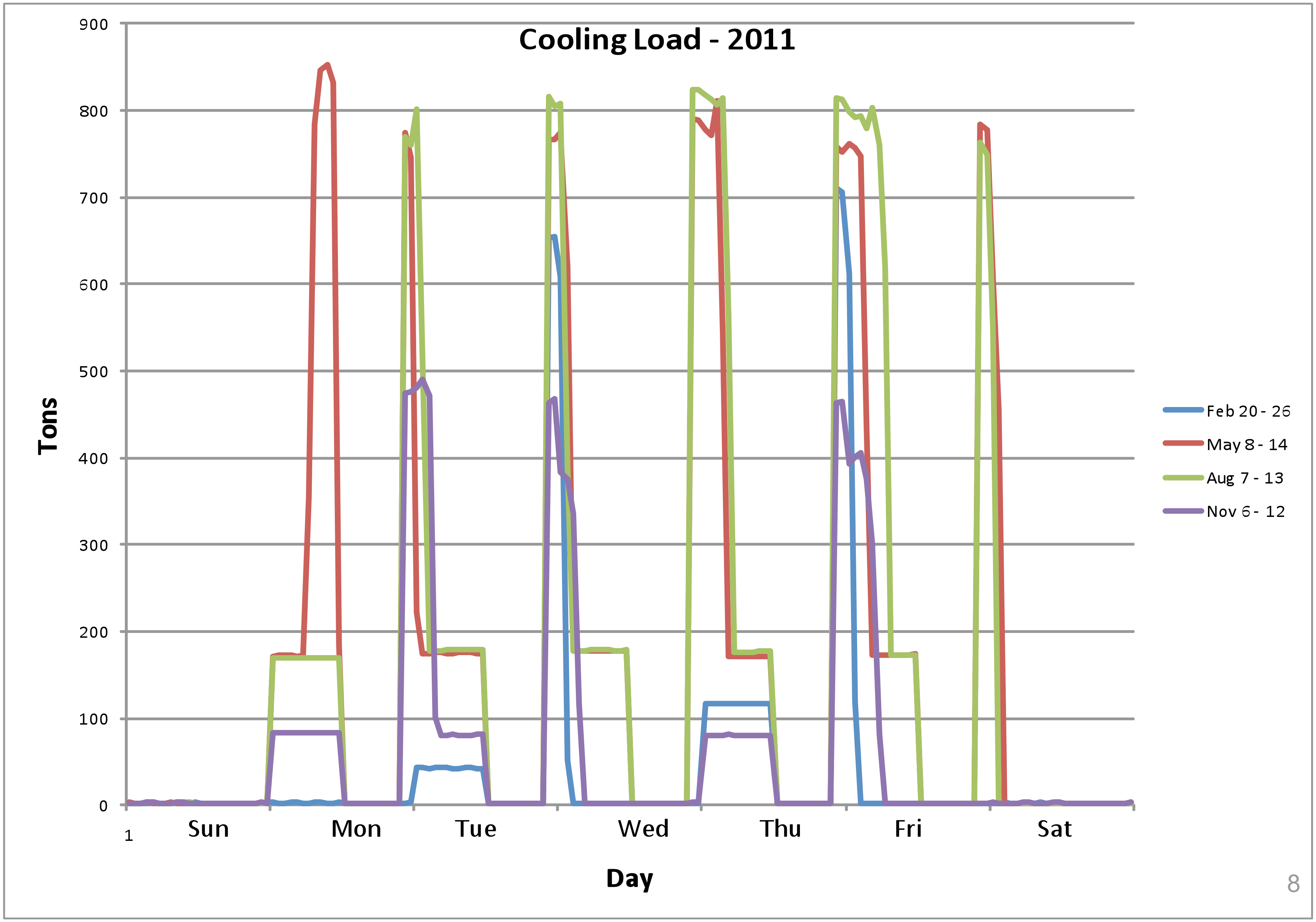
Existing Central Utility Plant

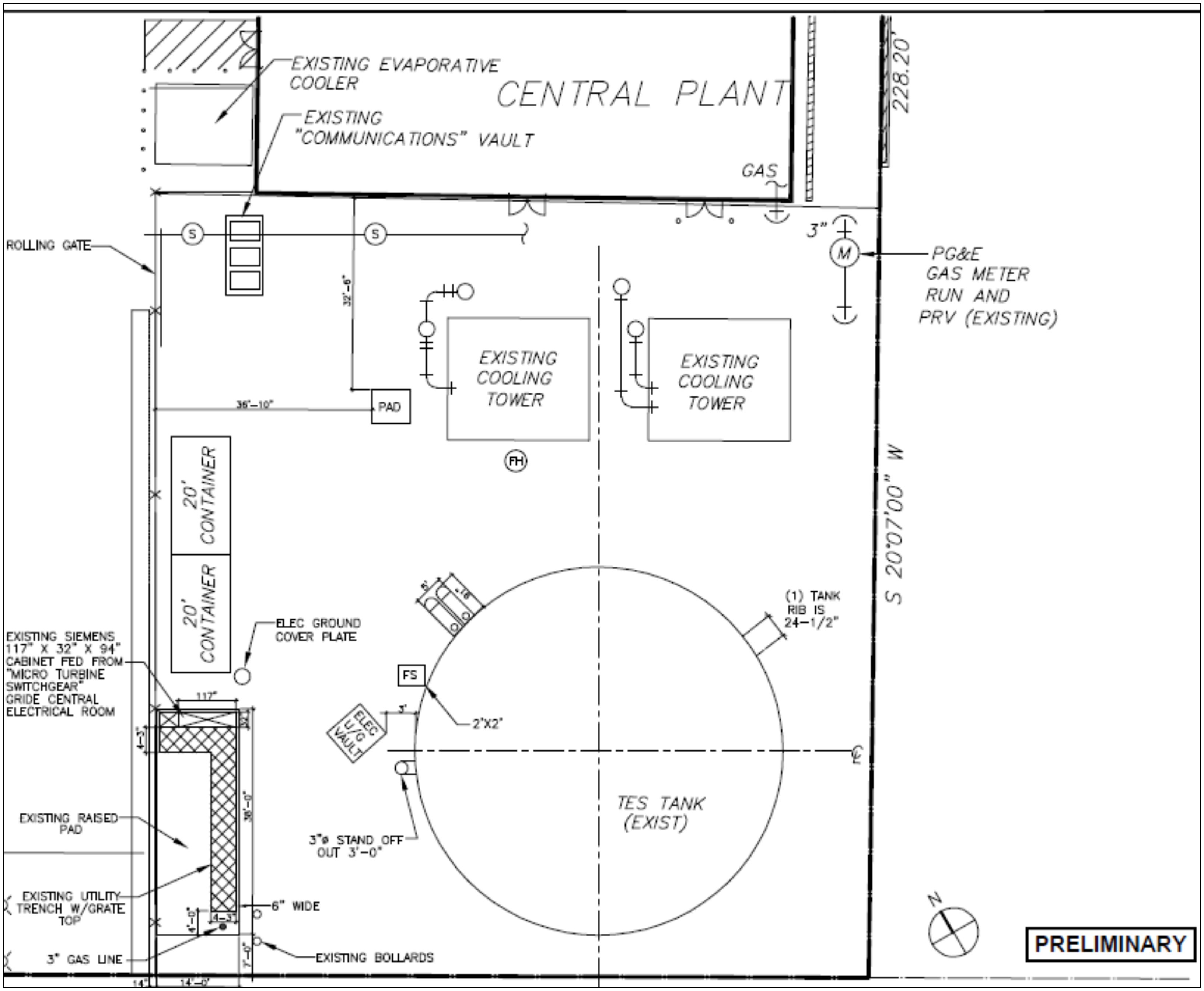
- Serves HQ buildings with chilled and hot water for space conditioning
- Equipment
  - Two centrifugal chillers
    - 600 tons and 200 tons
    - Efficiency 0.7 kW/ton
  - Two boilers
    - Two 5 MMBTUh hot water heaters
    - Two 1 MMBTUh hot water heaters
    - 80% efficiency
  - 760,000 gallon (15,000 ton-hr) Thermal Energy Storage (TES)

Thermal Loads



Cooling Loads





EXISTING EVAPORATIVE COOLER
CENTRAL PLANT
EXISTING "COMMUNICATIONS" VAULT
228.20'
GAS
3"
ROLLING GATE
PG&E GAS METER RUN AND PRV (EXISTING)
32'-6"
36'-10"
PAD
EXISTING COOLING TOWER
EXISTING COOLING TOWER
FH
20' CONTAINER
20' CONTAINER
S 20°07'00" W
(1) TANK RIB IS 24-1/2"
ELEC GROUND COVER PLATE
EXISTING SIEMENS 117" X 32" X 94" CABINET FED FROM "MICRO TURBINE SWITCHGEAR" GRIDE CENTRAL ELECTRICAL ROOM
117"
FS
2'X2'
3'
ELEC U/G VAULT
TES TANK (EXIST)
EXISTING RAISED PAD
3"ø STAND OFF OUT 3'-0"
38'-0"
EXISTING UTILITY TRENCH W/GRATE TOP
6" WIDE
3" GAS LINE
EXISTING BOLLARDS
14'-0"
N
PRELIMINARY

Grid Connected Operation

- Connected to 21 kV Feeder supplying loads in the CUP and FRF
- Excess electricity exported back to grid
- Priority thermal given to space heating and cooling will be secondary
  - Existing heating system is shut off between May and September
- When cooling, CHP system absorption chiller will charge TES tank
  - Absent heating load, absorber dispatched 24/7 for this purpose
- Tecogen INV-100 units will conservatively have a 92 % availability factor
- Absorption chiller sized to operate off recovered heat from two or all three INV-100 units
  - Should only one INV-100 be in operation, the absorption chiller will not be designed to operate
- System will include dump radiator to enable full-load CHP system operation regardless of the demand for heat

Islanded Operation

- Microgrid CHP system will “seamlessly” transition to islanding mode during grid disturbance
  - Non-critical loads in the CUP/FRF will be tripped
  - Noncritical loads include electric chillers and yet to be determined select air conditioning loads in FRF
- Remaining sensitive and critical loads will be prioritized and tripped off line as required (load shedding)
  - Must be tripped instantaneously to avoid under frequency tripping of INV-100s
  - Load shedding not likely needed unless one or two engines are down
  - Load shedding details are to be determined
- CUP will be served from three INV-100 units through a 480 volt bus
- 480v to 12 kV step-up transformer used to power FRF
- Recovered heat used in like-fashion to grid connected mode
- Smart Switch will automatically resynchronize microgrid when feeder is reenergized

TecoGen CHP Systems

- First engine driven product with UL certification for “utility safe” interconnection
- First product to commercially offer CERTs controls algorithms for microgrid operation (Droop control)
- Features:
  - Low emission NG engine
  - Water-cooled permanent magnet generator
  - Operated over wide speed range to optimize fuel efficiency
  - Power electronics converts variable frequency to 60 Hz
  - 700,000 BTUh recoverable heat
  - 82.4% (LHV) overall efficiency
  - Provides 230°F hot water

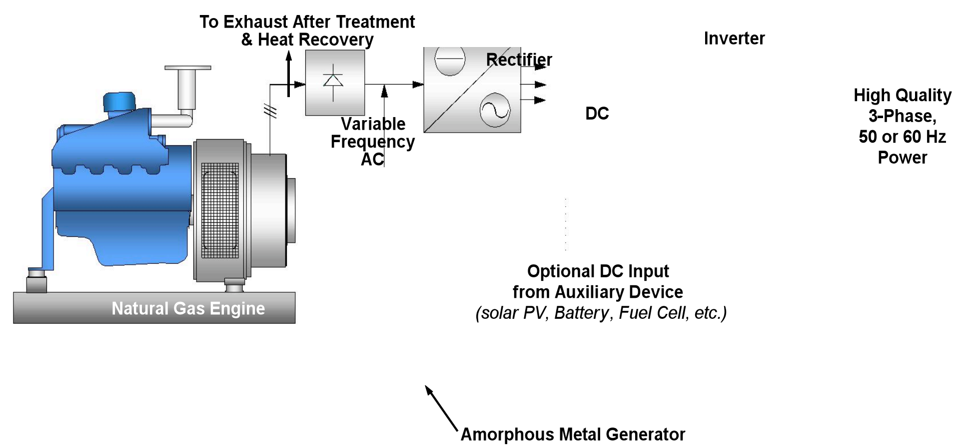
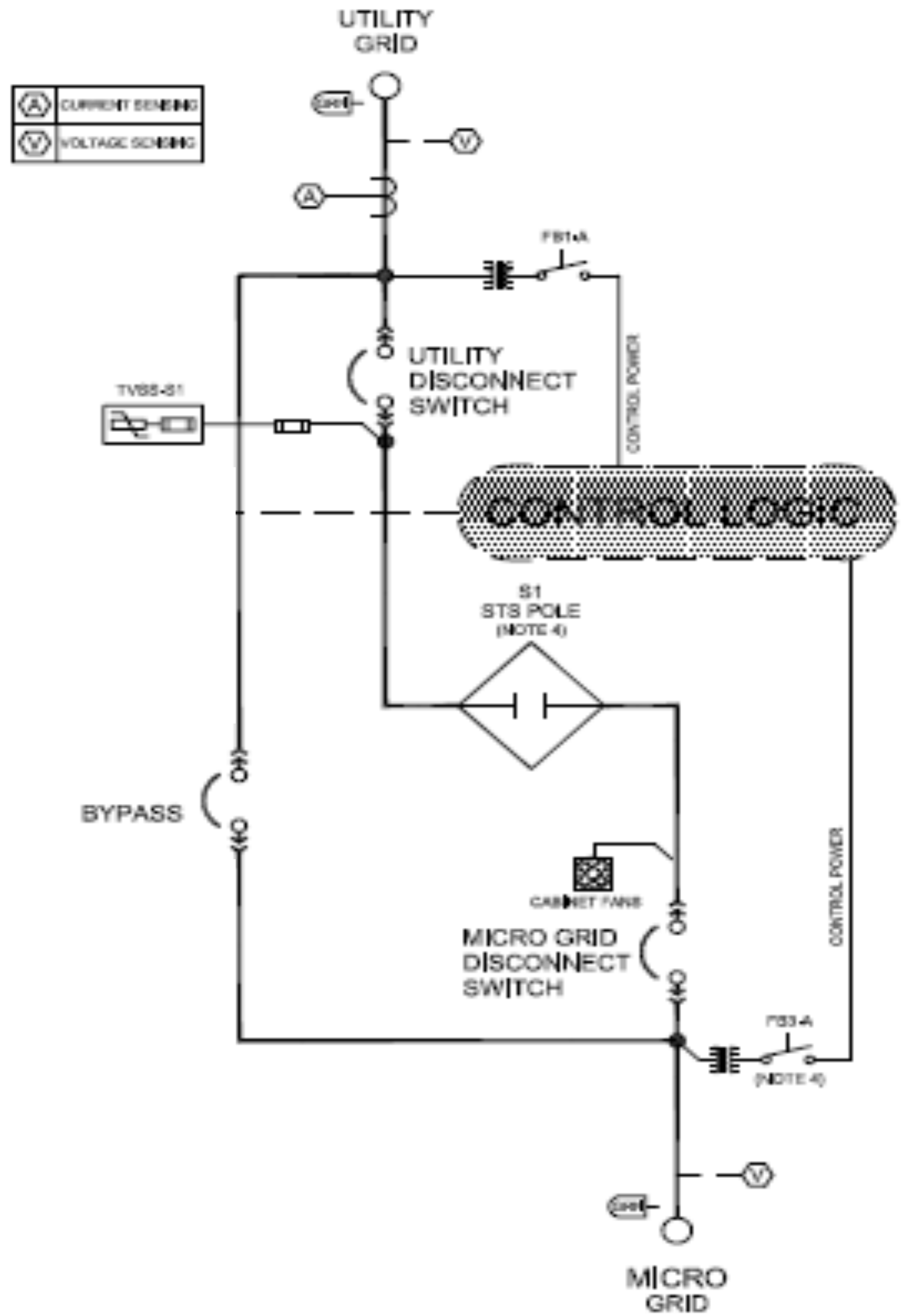


Figure 2 – The INV-100 Advanced Power Generation Technology

Thomas & Betts Cyberex Smart Switch

- SuperSwitch$_3$ by Cyberex
- Digital Power Static Transfer Switch
- Features:
  - 600 Amps
  - 480 V, 3-Phase, 3 wire + gnd, 60 Hz
  - 1 Bypass Switch
  - 100 kA withstand
  - Hockey Puck Style SCR (Type – II)
  - Comprehensive metering, monitoring, control and alarms
  - Color LCD Display
  - Remote and Local Control, and Bypass
  - Incorporates proprietary CERTs Smart Switch controls

Thomas & Betts Cyberex Smart Switch (cont'd)



Absorber

- Specification for bids completed but equipment not yet selected
  - Broad, Carrier/Sanyo, Century/Cention, JCI/York, Trane/Thermax, Yazaki
- Features:
  - Single-stage low temperature hot water absorption chiller
  - 120 tons cooling capacity
  - 2,100 MBH total energy input
  - 210°F hot water input
  - 180°F hot water output
  - 52°F chilled water input
  - 42°F chilled water output
  - Automatically controlled with alarming

Project Economics

Commercial type application would be favorable given high heat utilization factor

EIA Gas Price Projection and Electric Price Escatation

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Fuel Costs	($140,505.13)	($149,782.02)	($154,872.44)	($158,242.81)	($165,796.22)	($174,156.03)	($183,848.88)	($193,880.48)	($204,931.41)	($218,156.78)
Electric Revenues	$223,948.65	$225,768.45	$231,148.32	$234,965.56	$238,935.49	$241,266.66	$245,499.15	$249,931.20	$254,409.14	$259,199.51
Thermal Savings	$37,086.47	$39,203.83	$40,340.81	$41,241.82	$43,044.11	$45,169.81	$47,454.55	$49,811.94	$52,415.20	$55,472.02
Total Savings	$120,529.99	$115,190.26	$116,616.69	$117,964.57	$116,183.38	$112,280.44	$109,104.82	$105,862.66	$101,892.93	$96,514.75
Capacity Factor	75.9%	75.2%	75.9%	75.9%	75.9%	75.2%	75.2%	75.2%	75.2%	75.2%

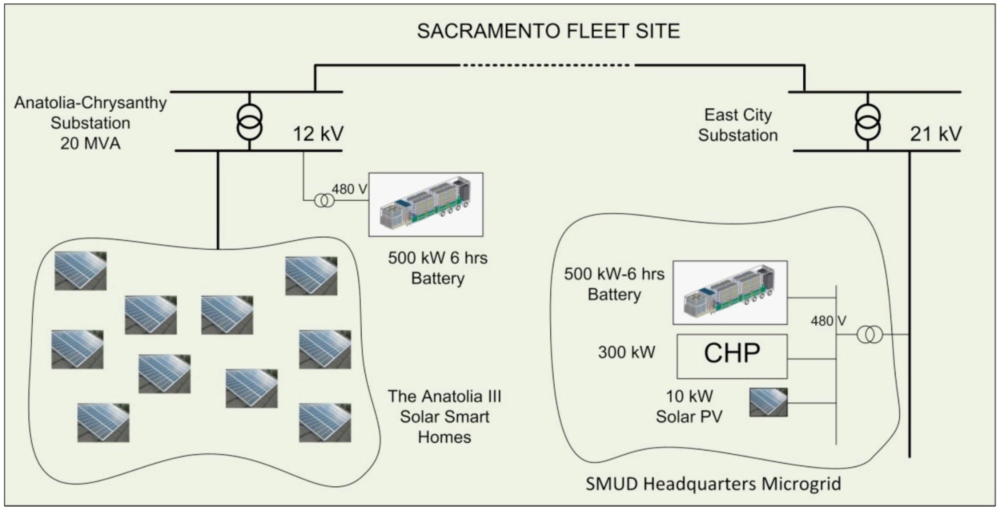
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Fuel Costs	($231,296.11)	($242,928.73)	($253,609.11)	($255,339.37)	($262,871.88)	($266,635.07)	($277,556.17)	($293,036.55)	($312,117.24)	($324,552.97)
Electric Revenues	$262,356.08	$265,771.89	$272,853.41	$280,134.22	$286,183.52	$292,402.64	$298,710.83	$305,104.61	$311,922.79	$316,877.13
Thermal Savings	$58,580.91	$61,651.19	$63,837.69	$64,406.00	$66,220.59	$67,242.80	$69,840.64	$73,457.58	$77,827.80	$80,865.48
Total Savings	$89,640.88	$84,494.35	$83,081.99	$89,200.85	$89,532.23	$93,010.37	$90,995.30	$85,525.64	$77,633.35	$73,189.64
Capacity Factor	74.5%	73.9%	74.5%	75.1%	75.2%	75.2%	75.2%	75.2%	75.2%	74.5%

NPV @ 6%	**$1,180,561.27**
Total Cash	**$1,968,445.09**

Schedule

• Detailed Design	August 2010
• Smart Switch Pre-commissioning	Q4 2010
• Construction	Q1 2011
• Commissioning	Q1 2011
• Demonstration	Q2 2011 – Q3 2012
• Final Reporting	Q4 2012

Future Additions
ARRA FOA 36 Topic 2.3: Regional Smart Grid Demonstrations



Benefit	Metric	Sacramento Fleet
Peak load reduction	Peak Load	5-10%
T&D loss reduction	T&D Losses	2%
Reduced cost of power interruption	CAIDI/SAIDI/SAIFI improvements	10%
Reduced damages as a result of lower GHG/carbon emissions	MWh served by renewable sources	TBD
Reduced cost to serve peak energy (energy arbitrage)	Hourly marginal cost data	70%

- Partners include Premium Power, National Grid, SAIC, NREL, Syracuse University
- Will firm renewables, reduce peak load and cost to serve peak, and improve reliability
- Installing two 500kW – 6 hours systems
- Operating as a fleet of distribution assets
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD