
CampusEnergy2021
BRIDGE TO THE FUTURE
Feb. 16-18 | CONNECTING VIRTUALLY
WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

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Thermal Energy Storage Couples Savings with Flexibility at NCSU Centennial Campus

Bill Ferrell - NCSU

Jonathan Eveleth, PE - RMF Engineering, Inc.

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INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Q&A Will Not Be Answered Live

Please submit questions in the Q&A box.
The presenters will respond to questions off-line.

NORTH CAROLINA STATE UNIVERSITY

- Founded in 1887 in Raleigh, North Carolina
- 36,000 Students
- 8,800 Faculty and Staff
- 12 colleges representing all major academic fields

CENTENNIAL CAMPUS

- Public-Private research campus
- 70+ corporate, government and nonprofits
- 70+ research and academic units
- Home to College of Engineering, College of Textiles and Institute for Emerging Issues

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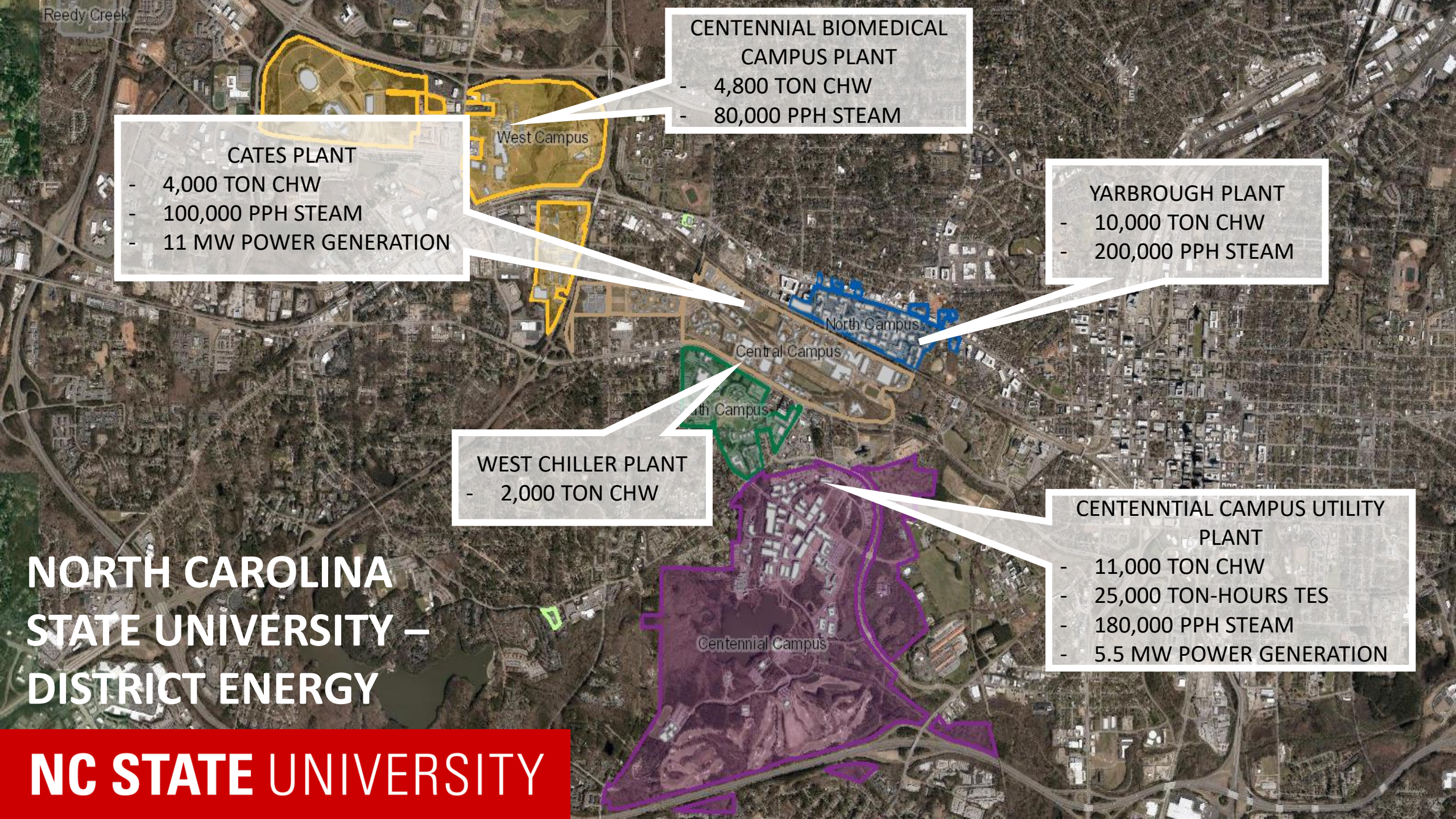

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Problem: Growth on Centennial Campus

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CENTENNIAL CAMPUS UTILITY PLANT - CHILLED WATER

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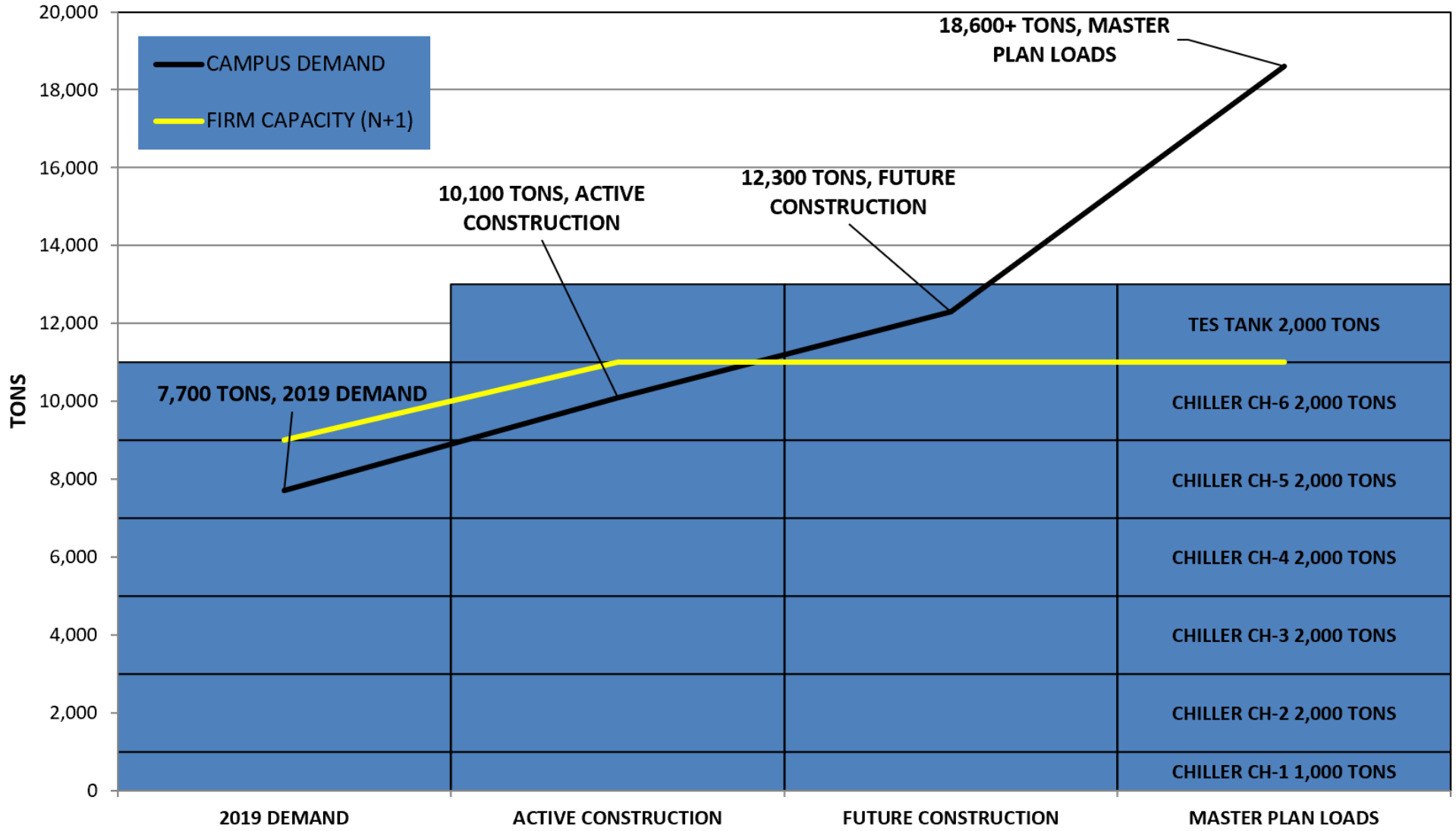

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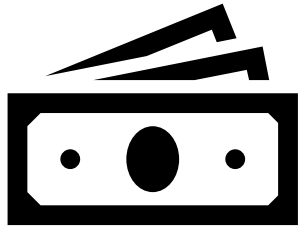
Utility Cost Savings – Time of Use

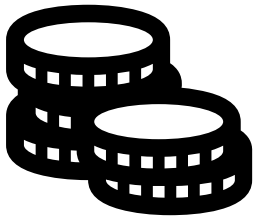
On-Peak Cost

- $19.29/kW Summer Demand Charge
- $14.15/kW Winter Demand Charge
- $0.054 per kWh Energy Charge



Off-Peak Cost

- $0.89/kW Demand Charge
- $0.049/kWh Energy Charge



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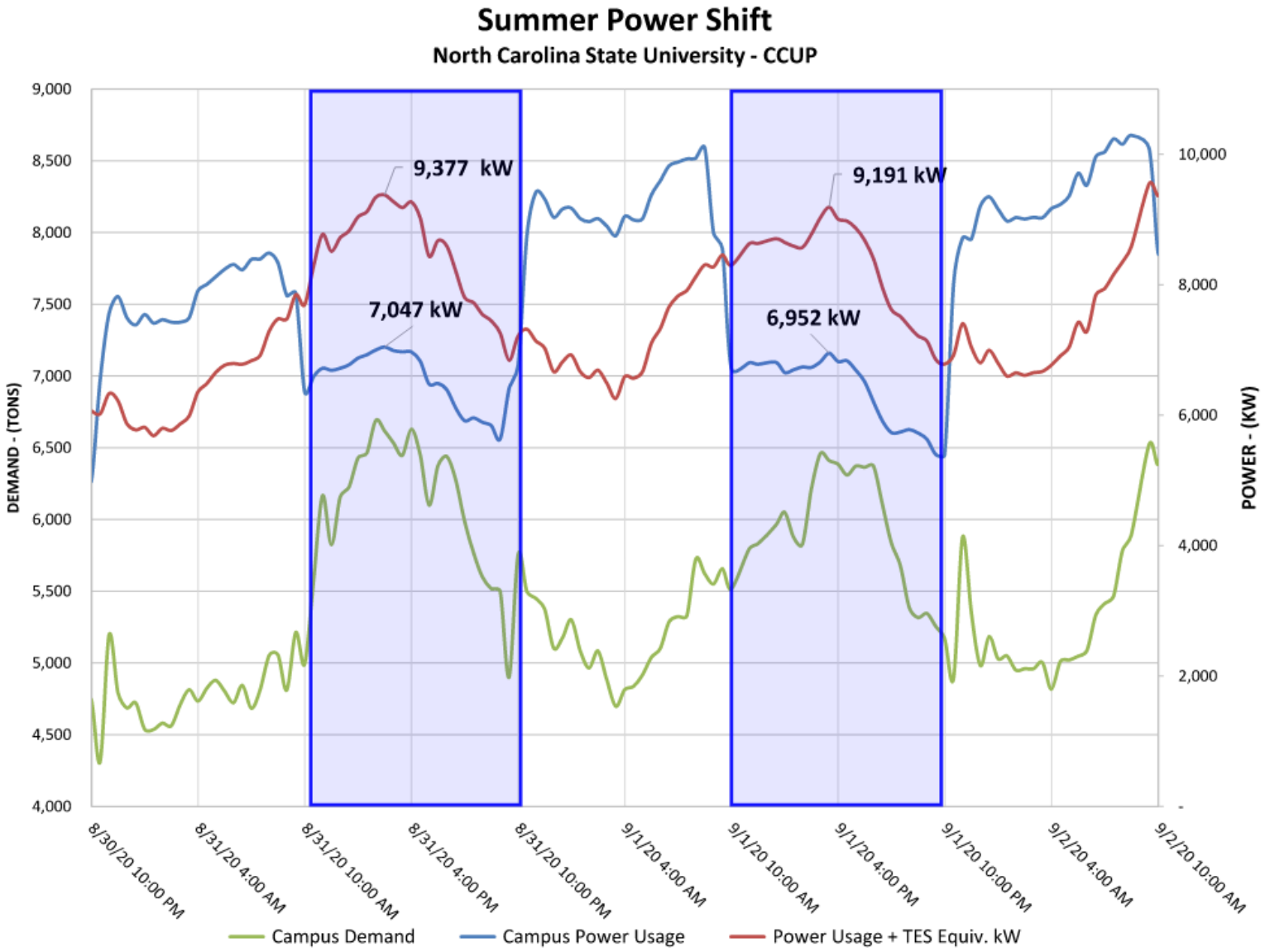

Average Monthly Demand Charge Savings:
2,000 kW per month

Estimated Annual Savings
$290,000+/year

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Connectivity

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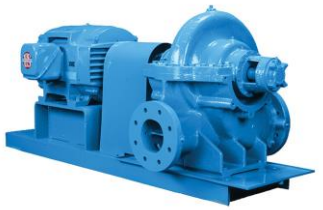
Connectivity: Discharge



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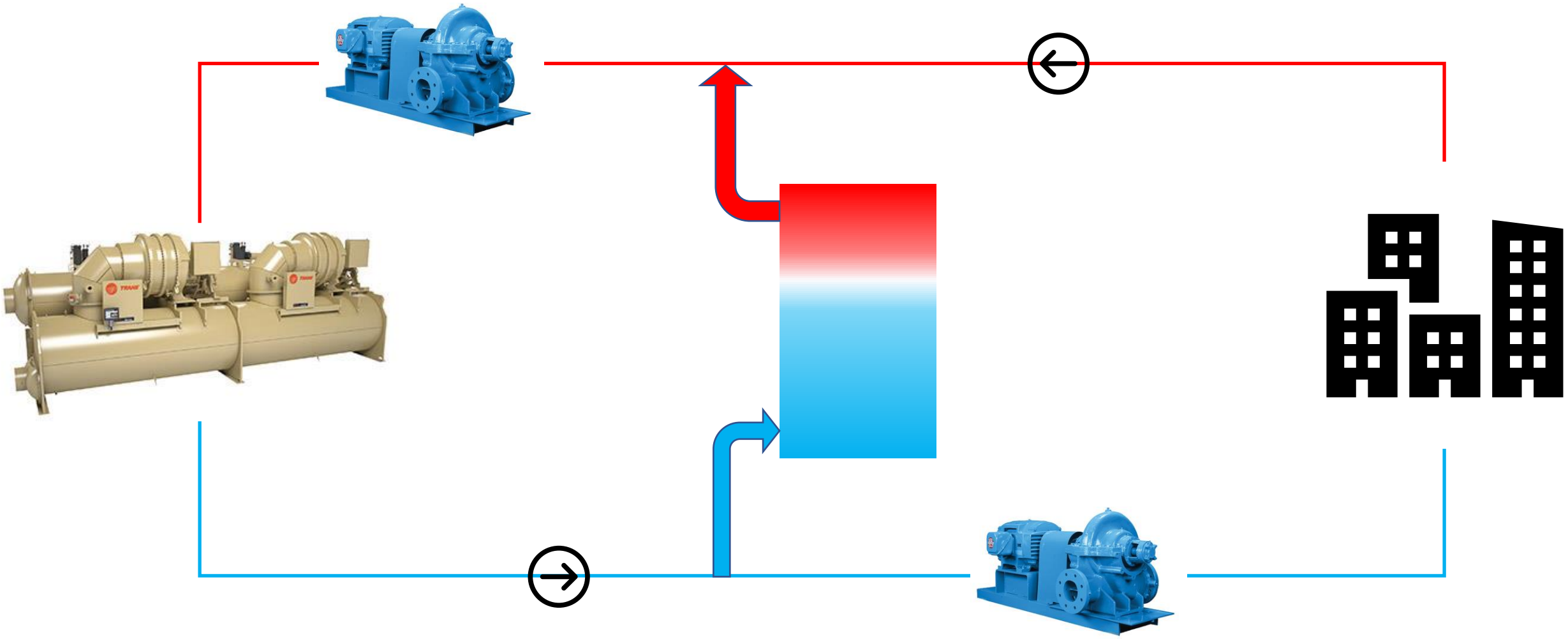
Connectivity: Charge



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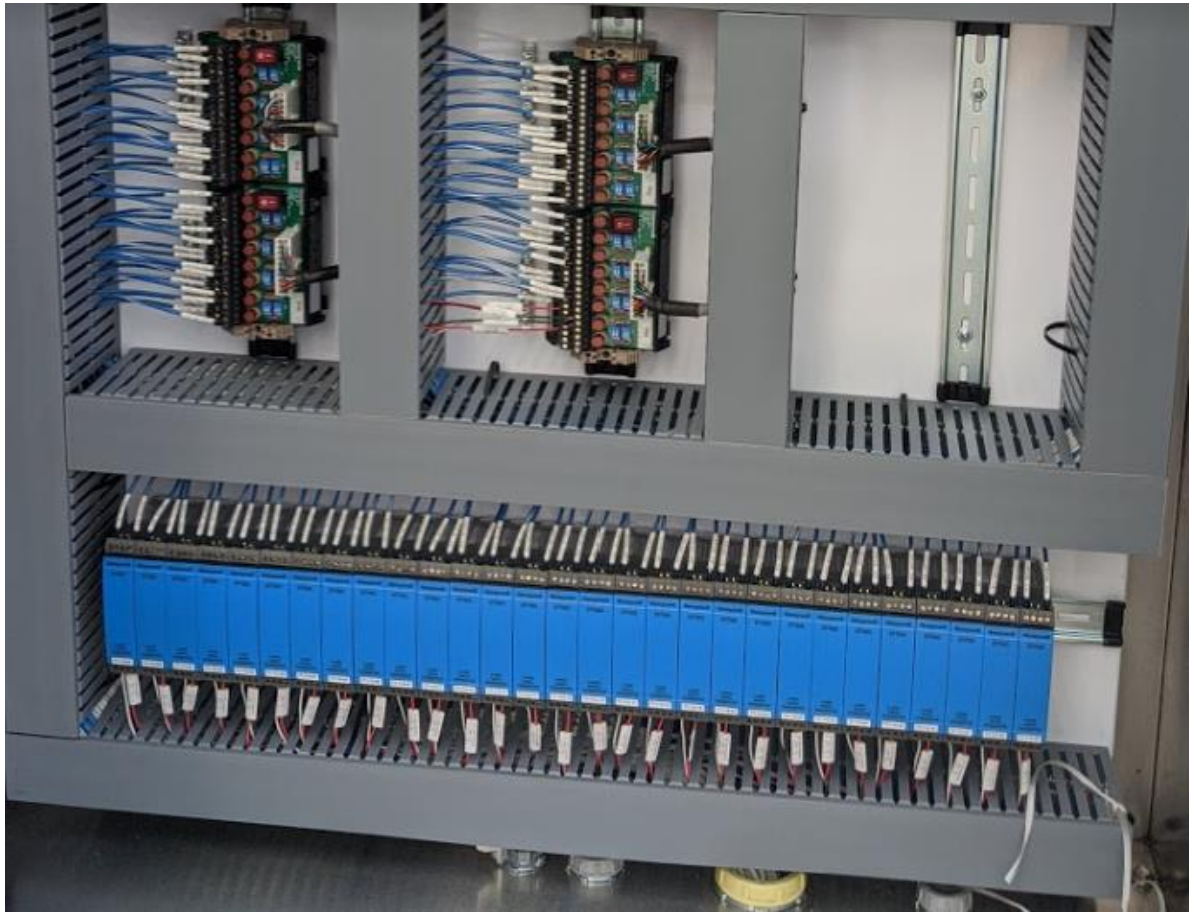
Challenge: Operation and Control

- PLC Based Control System
- Desired Automatic Dispatching
- Capital Project Limitations
- Predictive Weather Data
- Operator Control



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CENTENNIAL CHILLER PLANT - TES WEATHER DATA

Monday, March 16, 2020 16:28:55

OUTSIDE AIR

TEMP	67.5 °F
WET BULB	50.7 °F
HUMIDITY	29.1 %
ENTHALPY	20.7 BTU/LB

CHILLED WATER

CONDENSER WATER

COOLING TOWERS

TES TANK

WEATHER DATA

BUTTON 6

BUTTON 7

TRENDS

ALARMS

LOGIN

ACK ALM

FORECAST DATA

TIME		TEMP (°F)	HUMIDITY (%)	PRESSURE (mb)	ENTHALPY (BTU/LB)	ESTIMATED TONS
16:00		59.6	46	1027.7	19.6	1218
17:00		60.7	45	1026.7	20.0	1267
18:00		61.7	44	1026.5	20.3	1318
19:00		61.5	46	1026.8	20.5	1342
20:00		59.8	51	1026.8	20.3	1314
21:00		58.6	56	1026.9	20.3	1317
22:00		57.2	61	1026.8	20.2	1301
23:00		56.1	64	1026.6	20.0	1268
24:00		55.2	69	1026.4	20.1	1283
1:00		54.5	74	1025.8	20.2	1299
2:00		53.7	77	1025.2	20.1	1285
3:00		53.5	79	1024.8	20.2	1296
4:00		53.4	80	1024.5	20.2	1305

FORECAST DATA

TIME		TEMP (°F)	HUMIDITY (%)	PRESSURE (mb)	ENTHALPY (BTU/LB)	ESTIMATED TONS
5:00		53.3	81	1024.0	20.3	1312
6:00		52.1	83	1023.9	19.8	1245
7:00		51.4	84	1023.9	19.5	1205
8:00		51.2	84	1024.0	19.5	1192
9:00		51.8	84	1024.1	19.7	1234
10:00		52.7	84	1024.2	20.2	1304
11:00		53.6	85	1024.2	20.8	1396
12:00		55.1	81	1024.1	21.2	1465
13:00		57.8	77	1023.8	22.3	1639
14:00		60.2	75	1023.5	23.4	1842
15:00		62.6	71	1022.8	24.2	2013
16:00		64.6	69	1022.1	25.1	2196

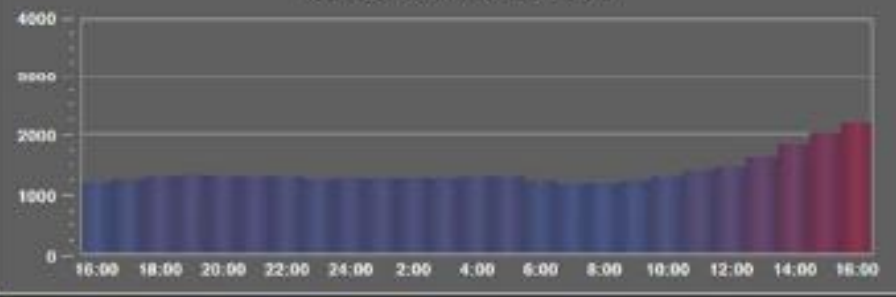
PLANT

PRODUCTION	1419 TONS
	0.731 kW/TON
RLA AVG	74.3 %

STAGING

CURRENT STAGE	1
STAGE LOGIC	ENABLED

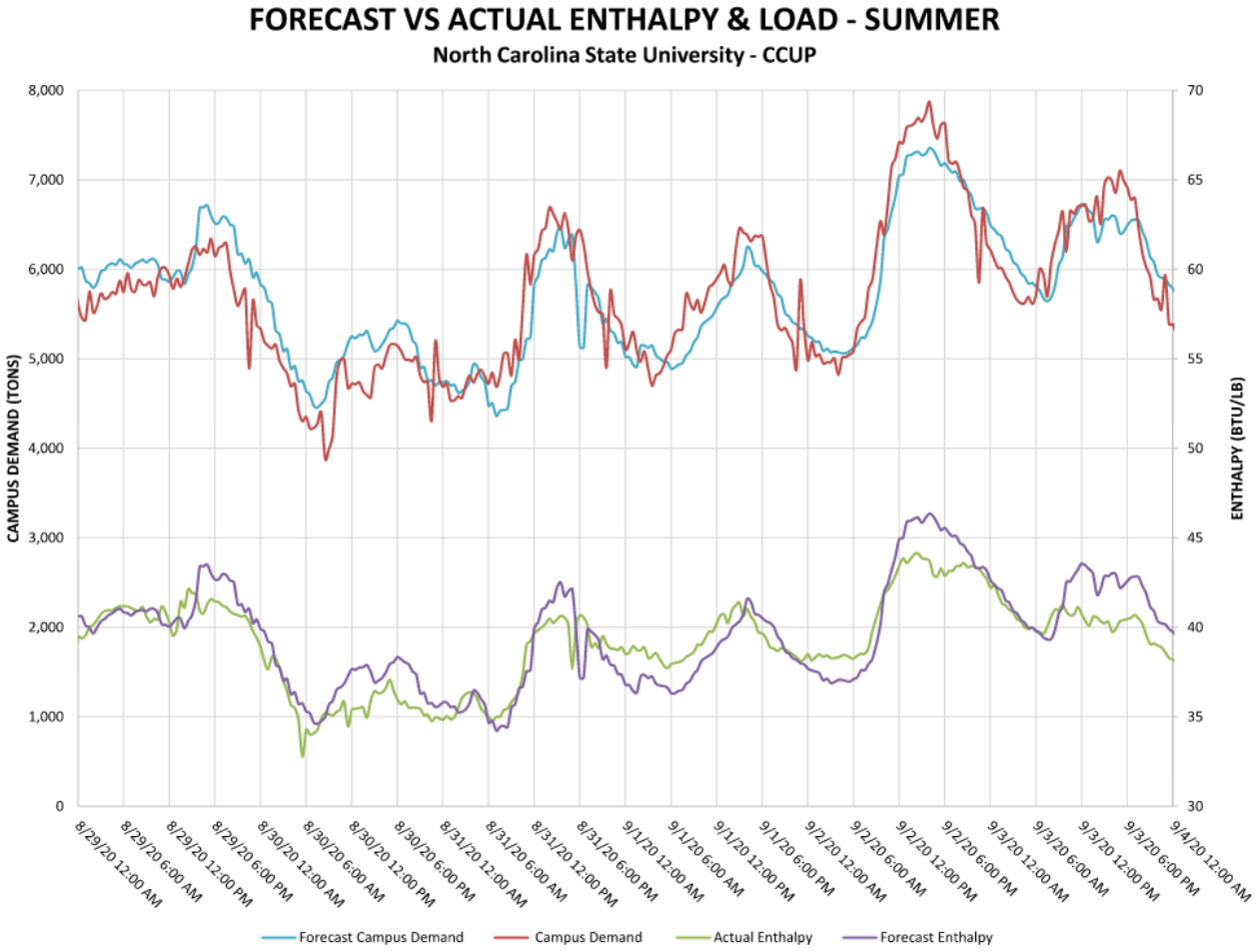
HOURLY ESTIMATED TONS

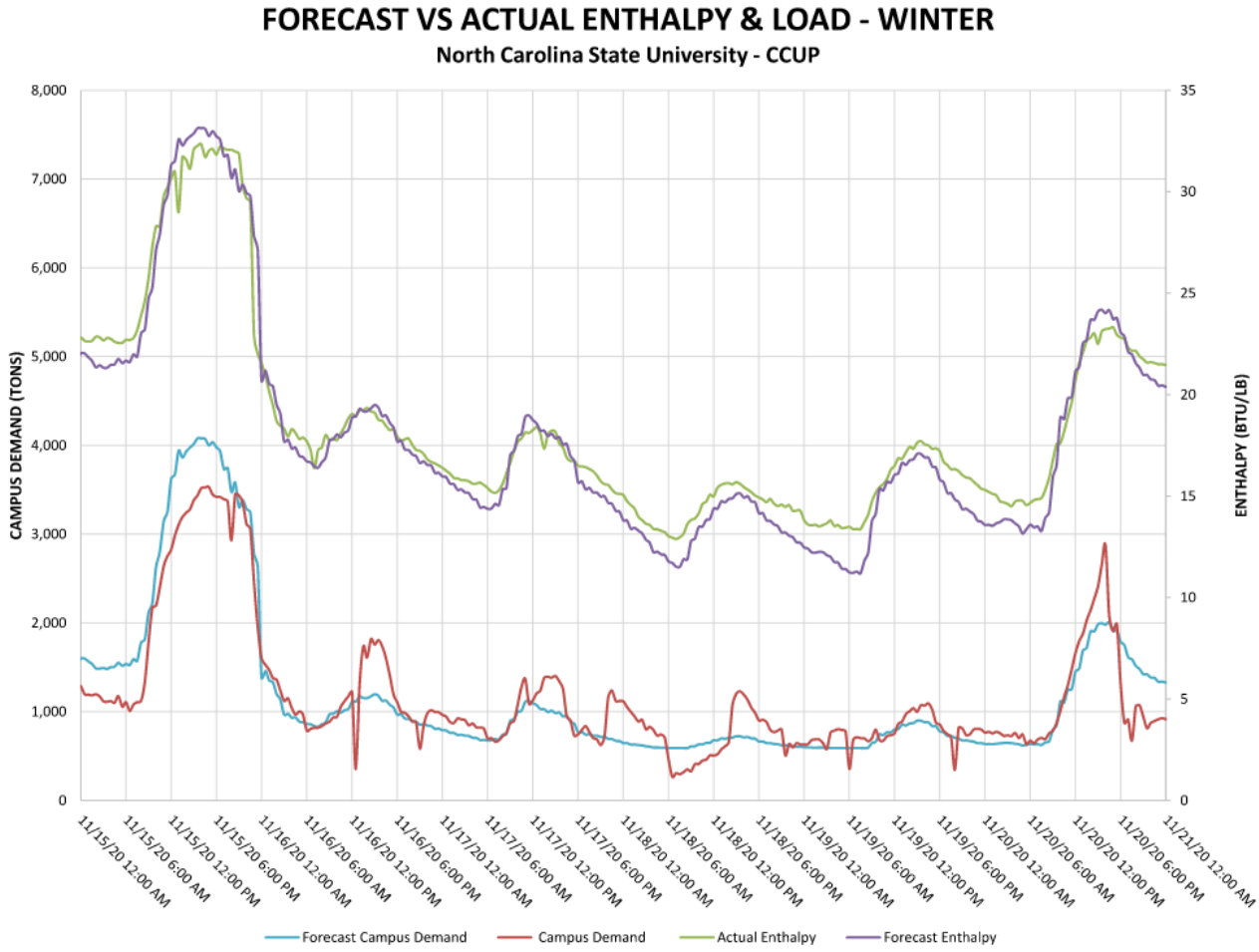


Weather Powered by Dark Sky

11:40:48 AM 3/16/2020 CCUP CH2_STRT_FAIL CCUP CHILLER 2 NOT RUNNING WHEN COMMANDED TO START 1 Digital

Forecast Accuracy





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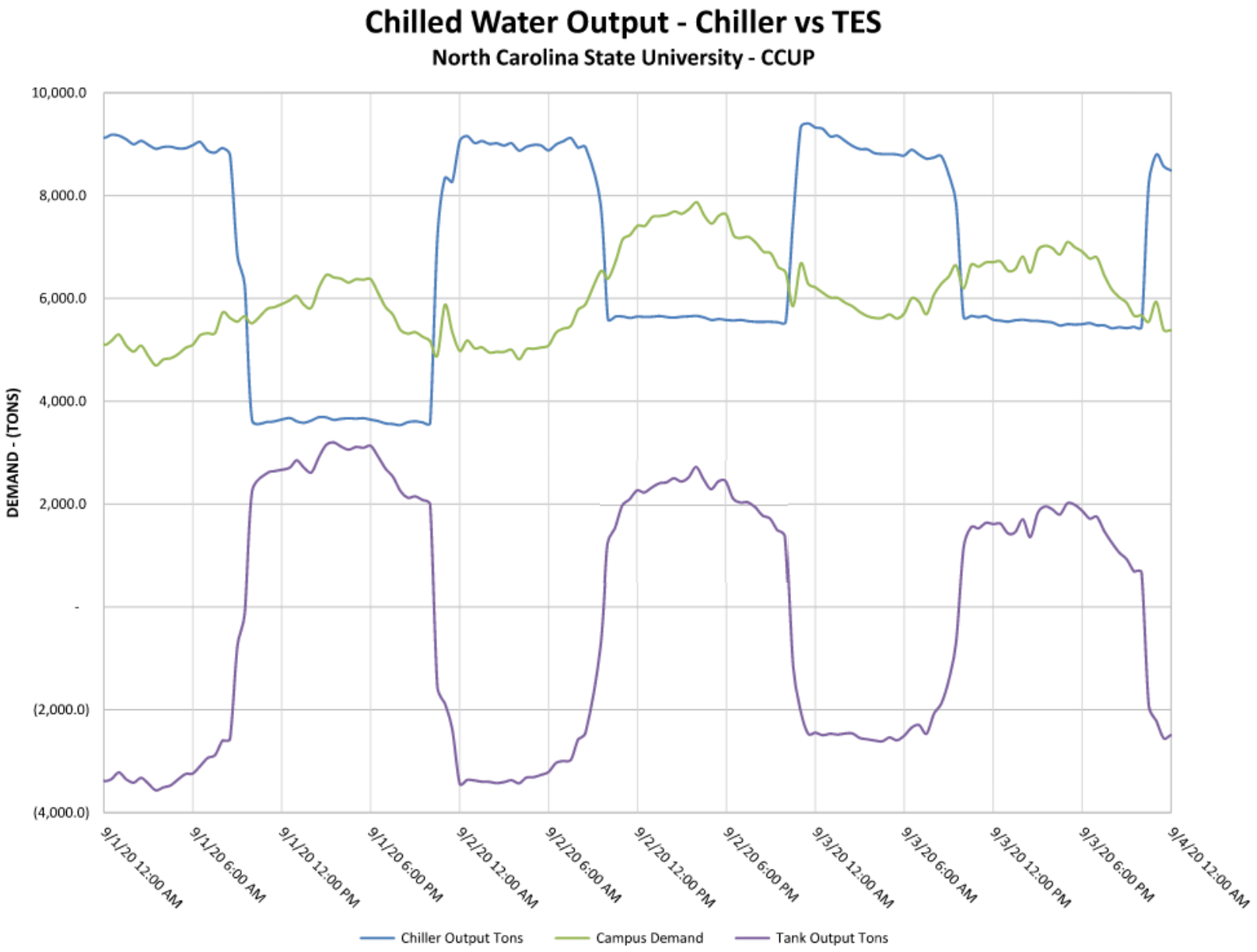
Sequencing

- Forecast ton-hours
- Tank capacity
- Available chillers



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CENTENNIAL CHILLER PLANT - TES TANK

Tuesday, January 05, 2021 14:58:56

OUTSIDE AIR
TEMP 53.1 °F
WET BULB 45.4 °F
HUMIDITY 55.4 %
ENTHALPY 17.9 BTU/LB

SEASON	PREP START	DEMAND START	DEMAND END	TES STAGE	TANK AVAILABLE (TONS)	DEMAND ESTIMATE (TONS)	DEMAND REMAINING (TONS)	TES CHLR STAGE	CHILLER BIAS	CHILLERS					
WINTER	5:30	5:45	21:15	DEMAND	12499	11575	5345	0	NO BIAS	CH 1	CH 2	CH 3	CH 4	CH 5	CH 6

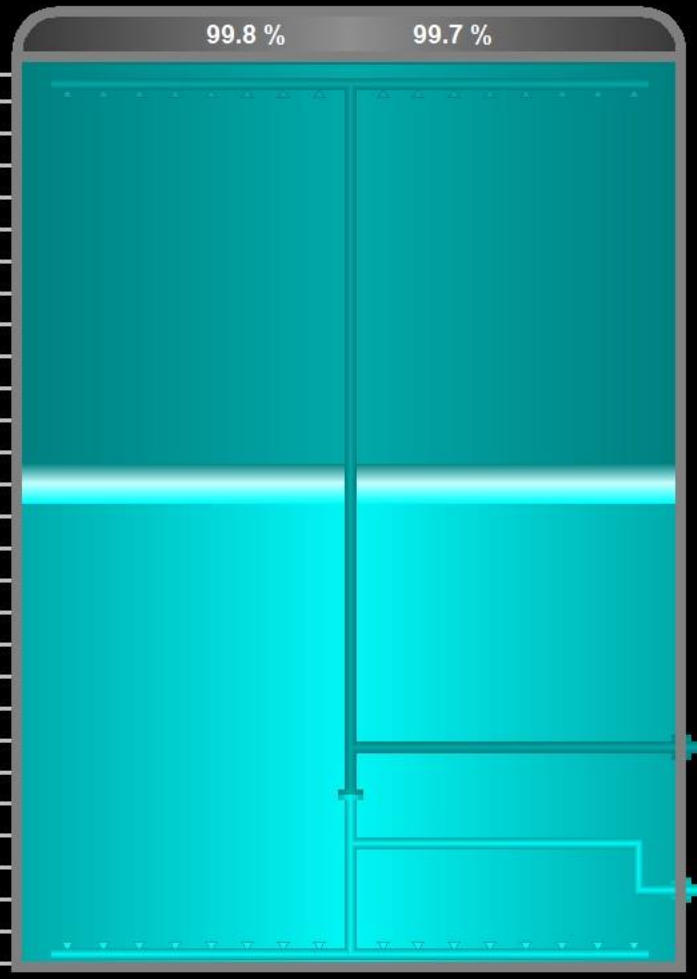
PEAK kW IMPORT	kW IMPORT	DELTA kW
3836	3497	339

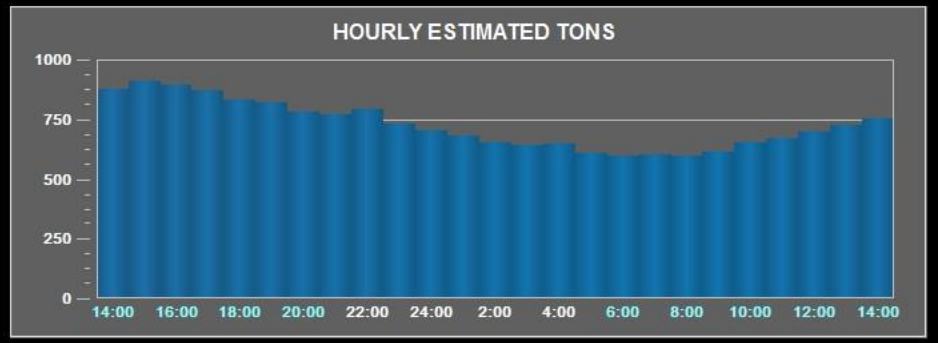
PLANT
PRODUCTION 785 TONS
0.016 kW/TON
RLA AVG 0.0 %

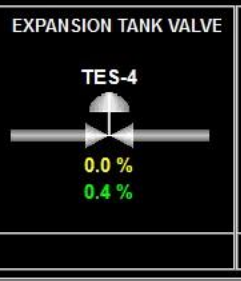
STAGING
CURRENT STAGE 0
STAGE LOGIC DISABLED

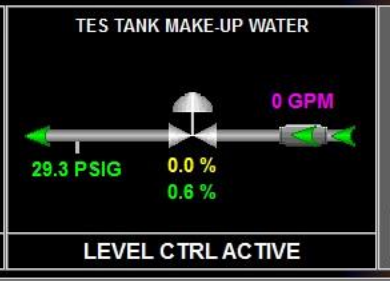
TES FLOW
500 GPM/ACTIVE
ACTIVE

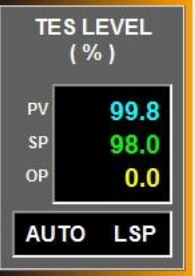
CHILLED WATER
CONDENSER WATER
COOLING TOWERS
TES TANK
WEATHER DATA
DETAILS
TRENDS
ALARMS
LOGIN
ACK ALM





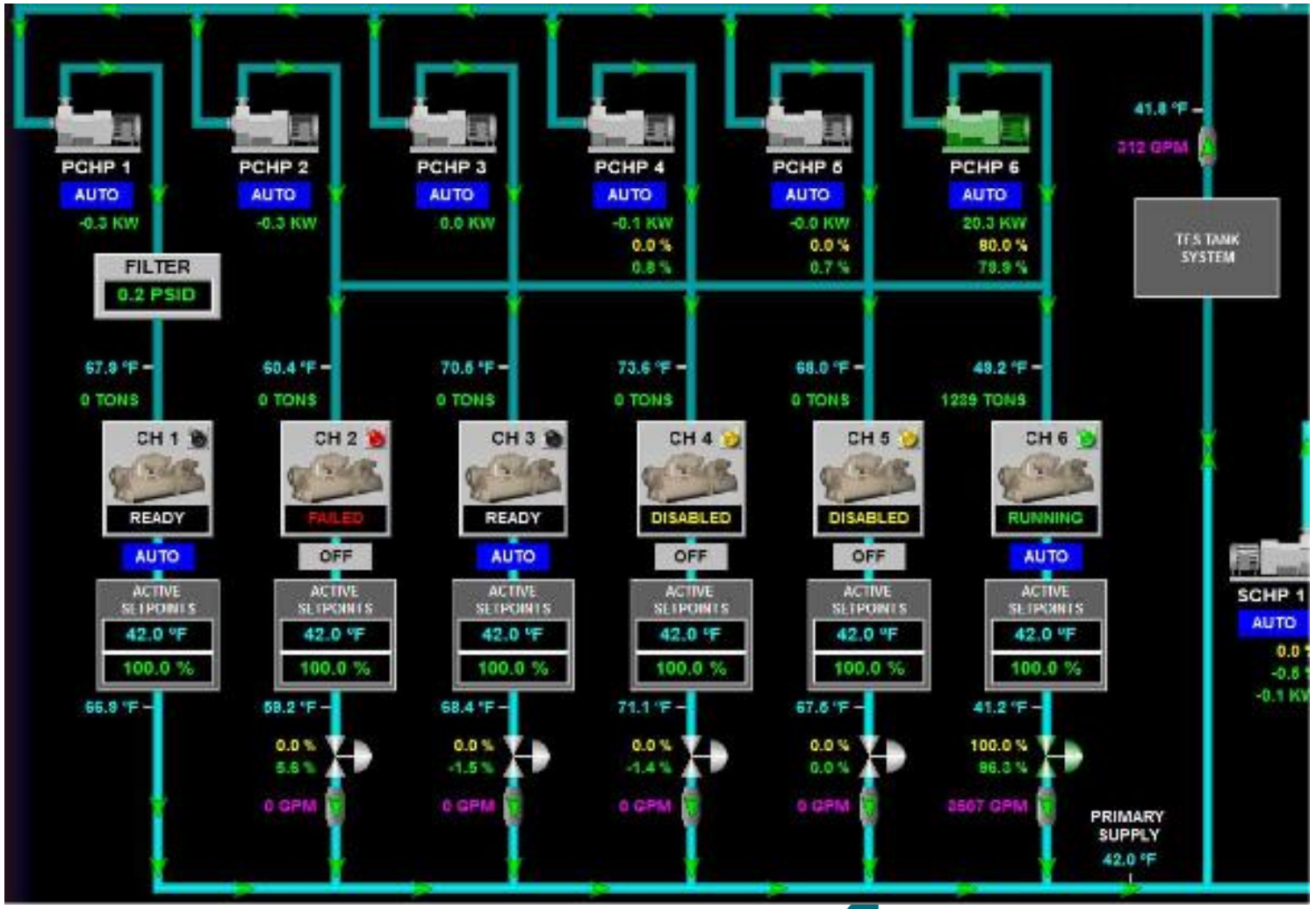






Alarms & Operator Control

- Alarms
- Operational Chiller Selection



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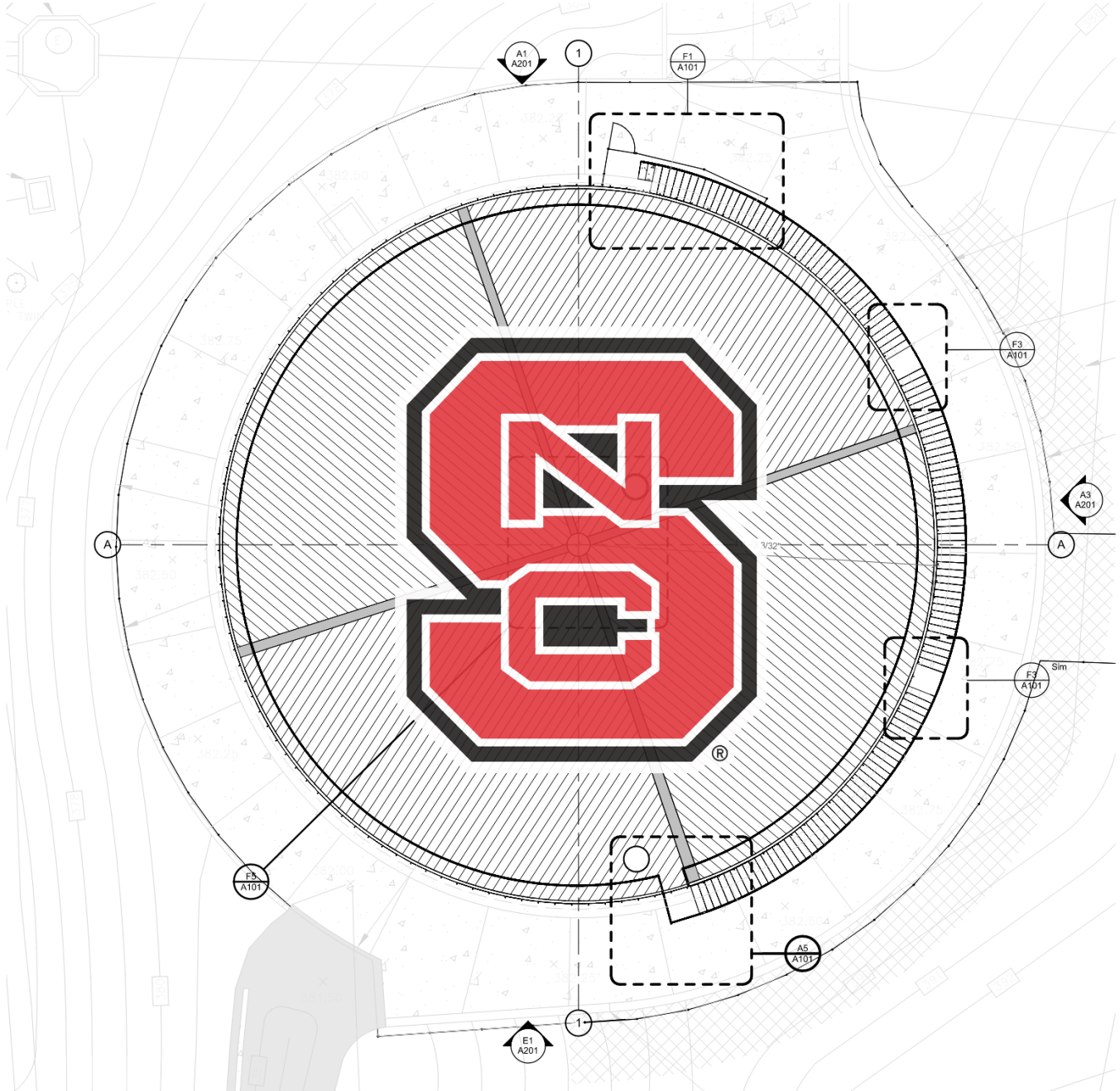
Design Decisions

- Foundation System
- Stairs vs Ladder
- Thermowells vs string temperature sensors
- Dual level transmitters
- Façade & Roof



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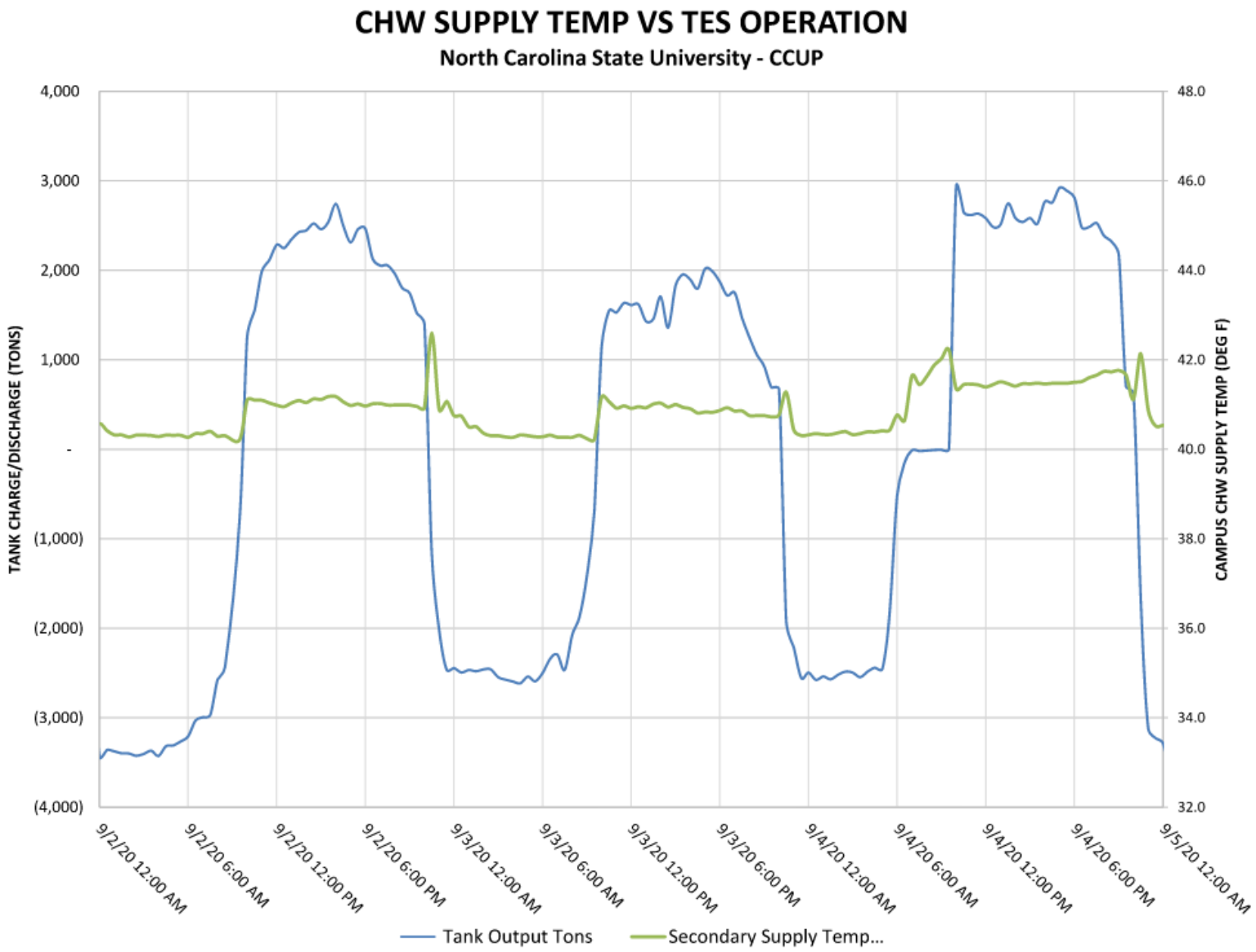
Lessons Learned

- Chiller Maintenance Routine
- Building Controls – Predictable temperature spikes at chiller startup
- Construction collaboration is critical!



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