Texas A&M University

Energy Systems, Microgrids, and Sustainability

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UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

Overview of Texas A&M University

State's first public institution of higher education, was opened on Oct. 4, 1876 as the Agricultural and Mechanical College of Texas

Total undergraduate/graduate enrollment is over 52,000

Holds a rare federal land, sea, space grant university designation

TAMU is a Tier 1 research university with total research expenditures ($706 million in FY11)

Campus size is over 5,200 acres, more than 500 acres for the main campus in College Station, TX

Overview of Utilities & Energy Services (UES)

The university utility systems have operated with on-site power generation since 1893

Extensive network of electrical distribution and central thermal energy production and distribution for cooling and heating to meet university requirements for over 800 buildings totaling over 24M GSF (19M conditioned)

UES offers a highly reliable and cost-effective range of mission-critical services for over 60,000 customers consisting of students, faculty, staff, and visitors on campus

Energy Services Continuum

PROCUREMENT

Calculate and nominate campus electricity & NG requirements

Specify annual and monthly consumption quantities

Review and recommend payment of invoices

Serve on TAMU energy procurement and risk management committee

TRANSMISSION

TAMU owns:
- Domestic water transmission system

Atmos owns:
- HP (600 psi) NG transmission system to CHP facility

BTU owns:
- 138kV electrical transmission system (ERCOT)

UES coordinates closely with Atmos, ERCOT, and BTU

PRODUCTION

Management of:
- Four campus utility plants
- A&M System Building utility plant
- Solid Waste & Recycling Services
- 2 wastewater treatment facilities

Production of:
- Electricity
- Chilled water for cooling
- Hot water for heating
- Domestic cold & hot water
- Steam

DISTRIBUTION

TAMU owns and operates campus delivery systems:
- 12.5kV electrical
- Domestic water (hot & cold)
- Chilled Water
- Heating Hot Water
- Steam
- Sanitary Sewer
- Storm Drainage

Atmos owns:
- LP & IP natural gas distribution system

METERING & BILLING

2,500 revenue-quality meters in over 500 buildings

Manage utility rate model and rate setting

Direct customer invoicing and cost recovery
- Operating budget
- Capital upgrades
- Purchased energy

Energy management services

DEMAND-SIDE MANAGEMENT

First response to ensure customer comfort and environmental control

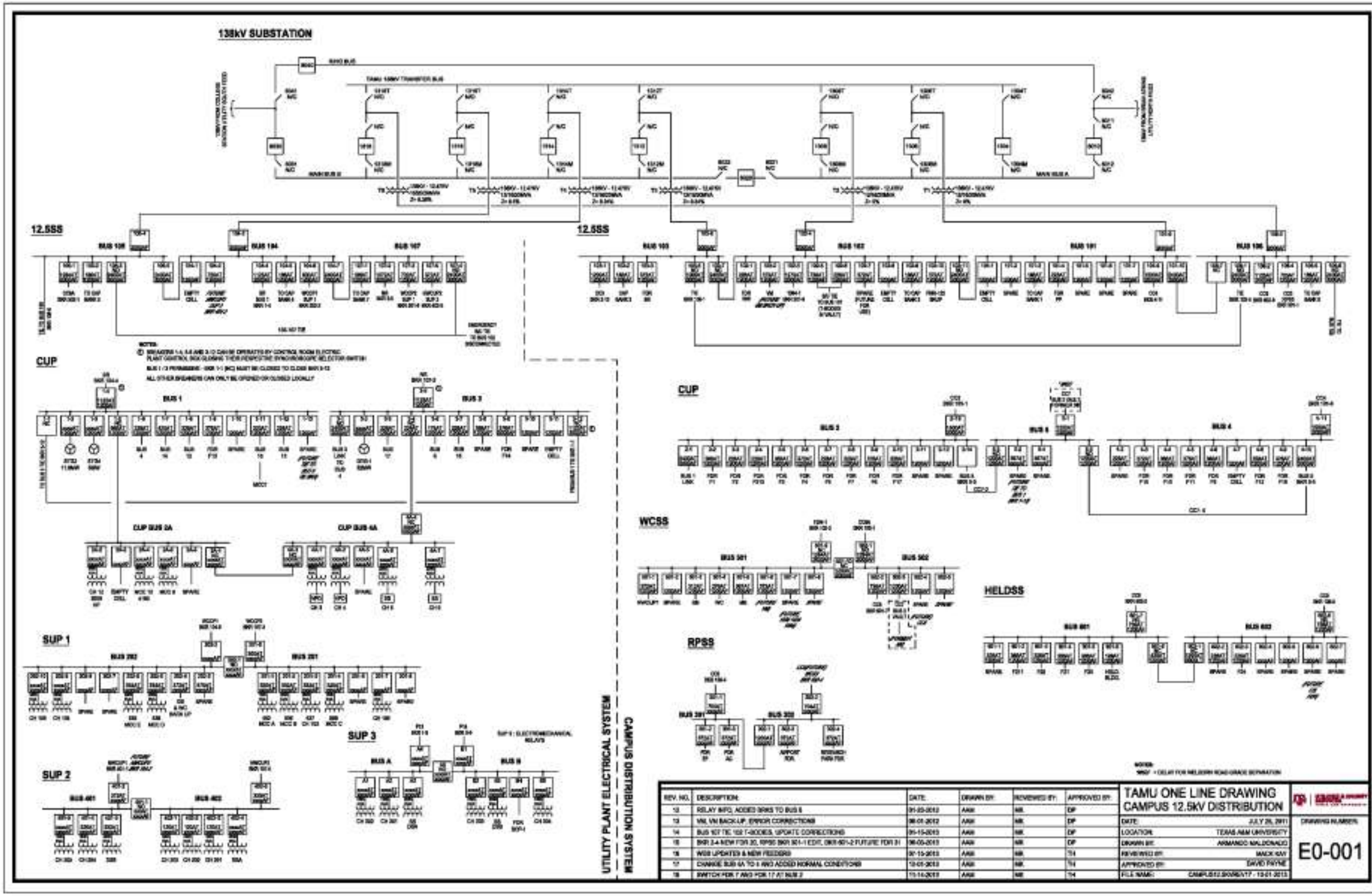
Building automation and HVAC operation

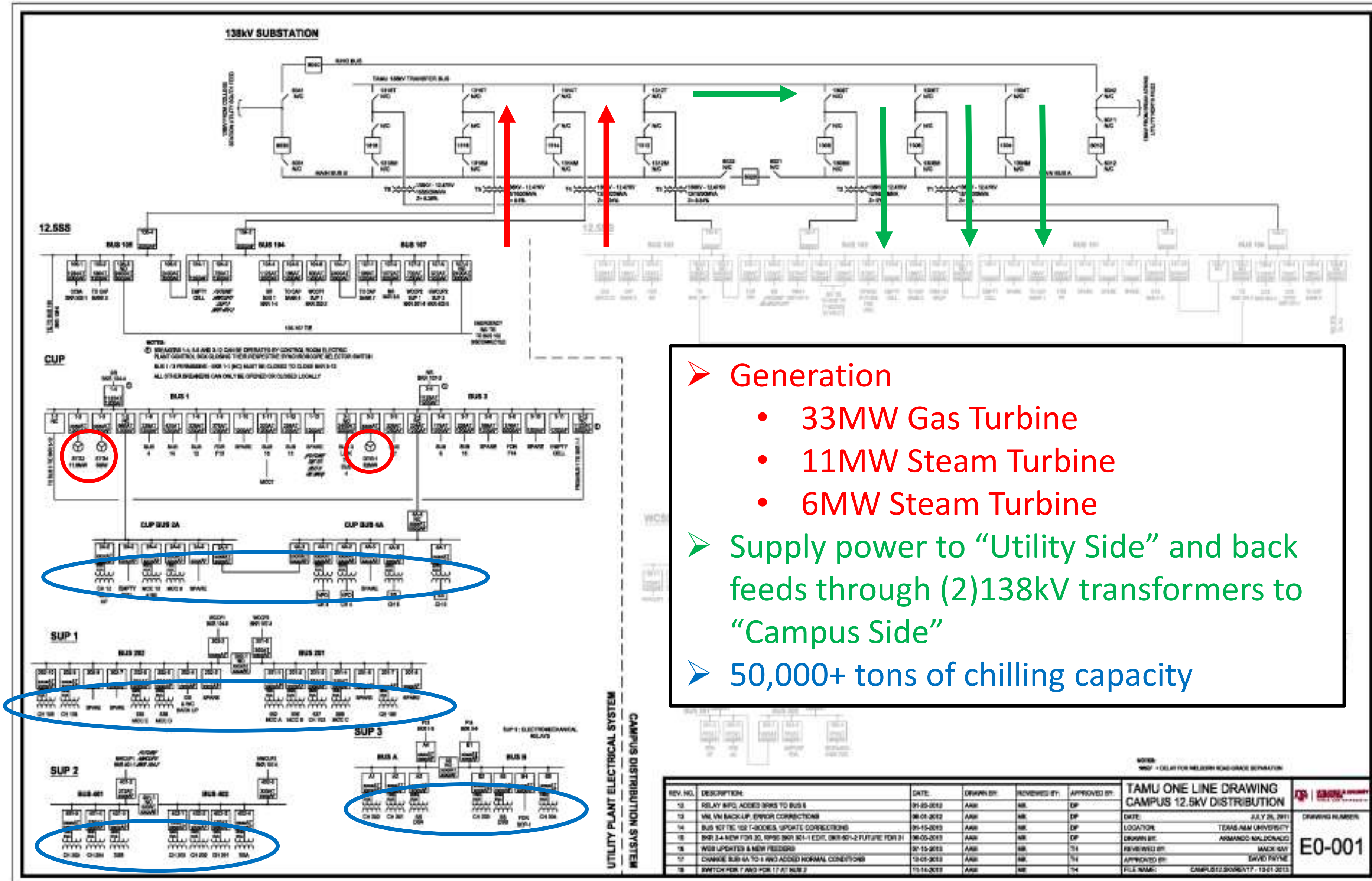
Energy stewardship & building system optimization

Design review and capital project coordination

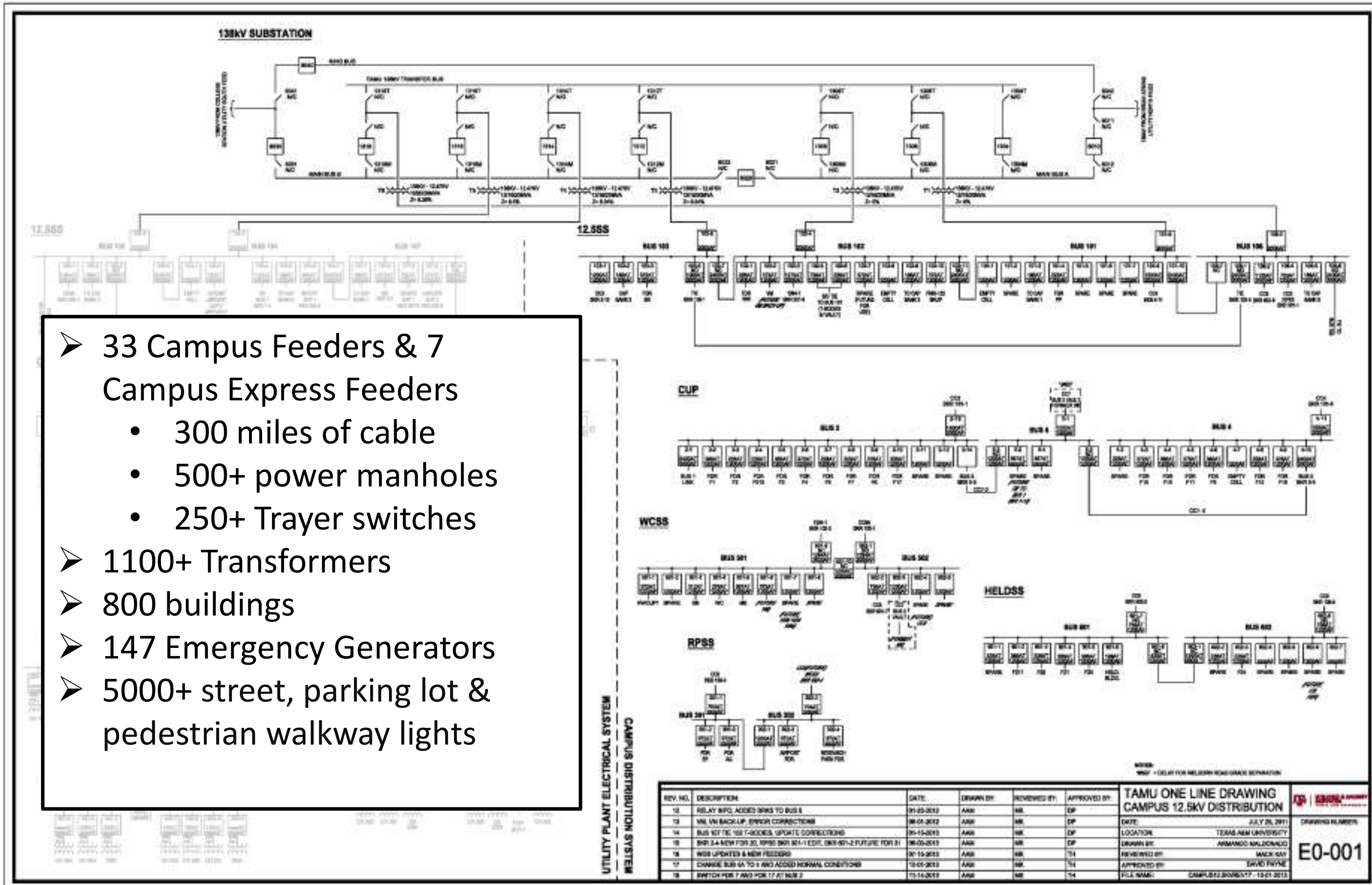
Customer requests thru AggieWorks Center

Capital renewal and upgrade


138kV SUBSTATION
12.5SS
12.5SS
CUP
CUP
CUP BUS 2A
CUP BUS 4A
WCSS
HELDSS
RPSS
SUP 1
SUP 2
SUP 3
UTILITY PLANT ELECTRICAL SYSTEM
CAMPUS DISTRIBUTION SYSTEM
TAMU ONE LINE DRAWING
CAMPUS 12.5kV DISTRIBUTION
E0-001



- Generation
  - 33MW Gas Turbine
  - 11MW Steam Turbine
  - 6MW Steam Turbine
- Supply power to “Utility Side” and back feeds through (2)138kV transformers to “Campus Side”
- 50,000+ tons of chilling capacity



- 33 Campus Feeders & 7 Campus Express Feeders
  - 300 miles of cable
  - 500+ power manholes
  - 250+ Trayer switches
- 1100+ Transformers
- 800 buildings
- 147 Emergency Generators
- 5000+ street, parking lot & pedestrian walkway lights

Utility Information Systems

Owlet Lighting Automation

ETAP

Schweitzer

Square D

Beckwith LTC

Emerson Ovation

Schneider

Siemens

TAMU UES Key Performance Indicators

UES is passionate about data and key performance indicators (KPI)

Primary KPI is Electrical Service Availability Index (ESAI) is based off square footage instead of customers or meters for greater resolution

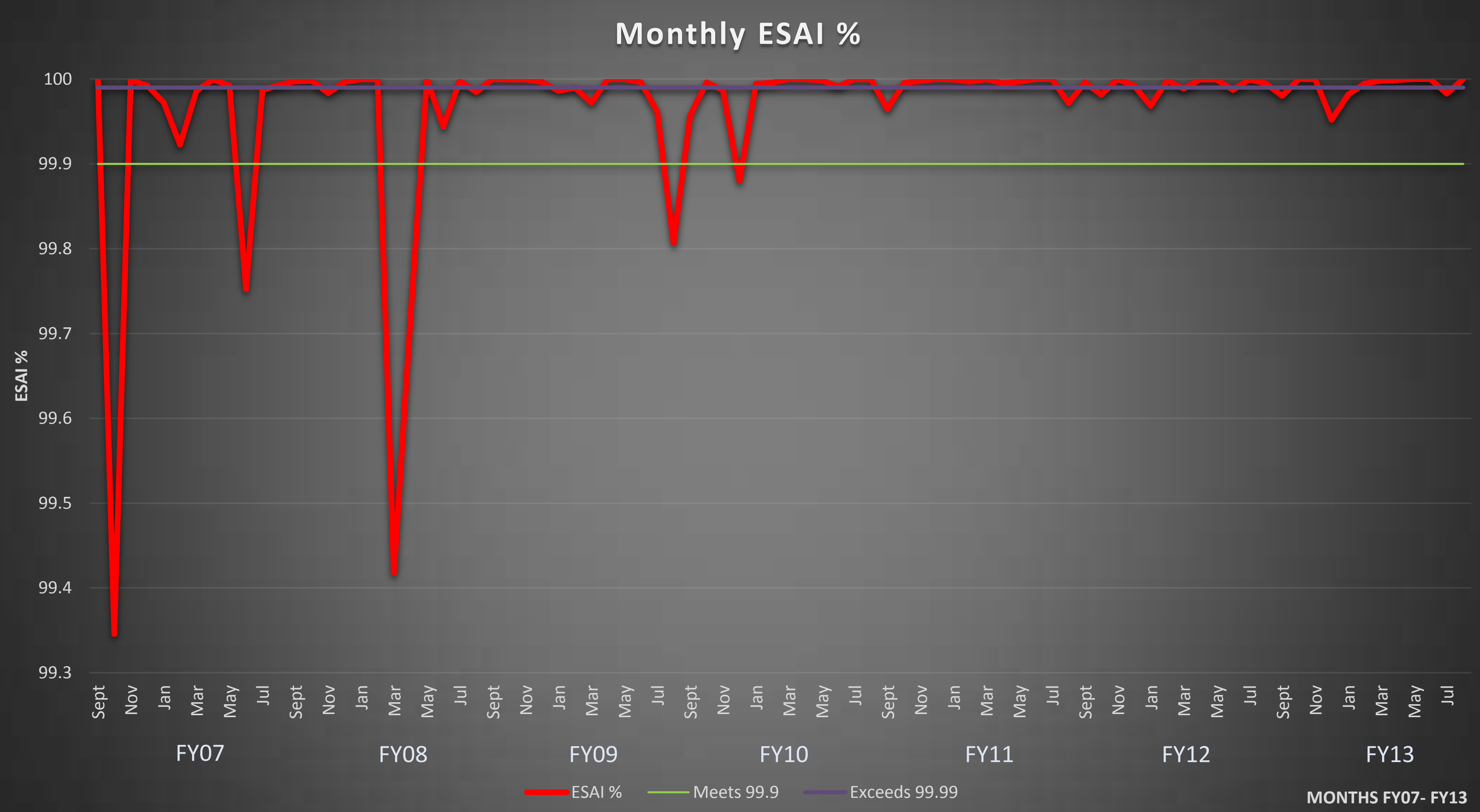
$$Hours\ in\ the\ Month\ * Total\ Gross\ Sq.Ft. = Total\ Gross\ SqFtHrs\ for\ Month$$
$$Outage\ Hours\ in\ the\ Month\ * Affected\ Gross\ Sq.Ft. = Total\ Affected\ Gross\ SqFtHrs\ for\ Month$$

$$\boldsymbol{Electrical\ Service\ Availability\ Index = \frac{(Total\ SqFtHrs - Total\ Affected\ SqFtHrs)}{Total\ SqFtHrs} * 100}$$

UES also tracks the following IEEE Reliability Indices:

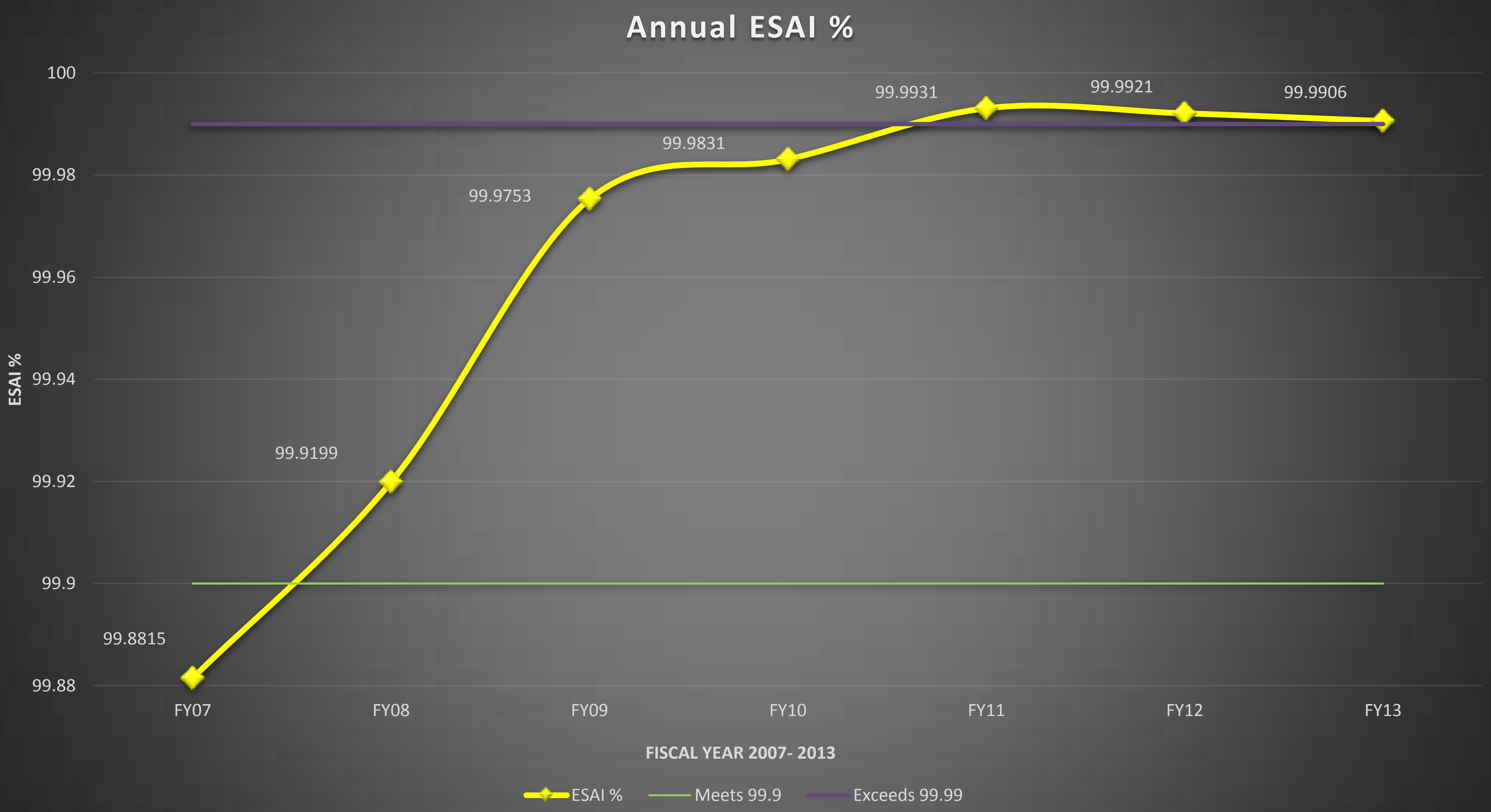
System Average Interruption Duration Index in minutes (SAIDI), Customer Average Interruption Duration Index in minutes (CAIDI) System Average Interruption Frequency Interruption Index (SAIFI), Customer Average Interruption Frequency Interruption Index (CAIFI), Customer Interrupted per Interruption Index (CIII). Average Service Availability Index (ASAI)

Electrical Service Availability Index (ESAI)



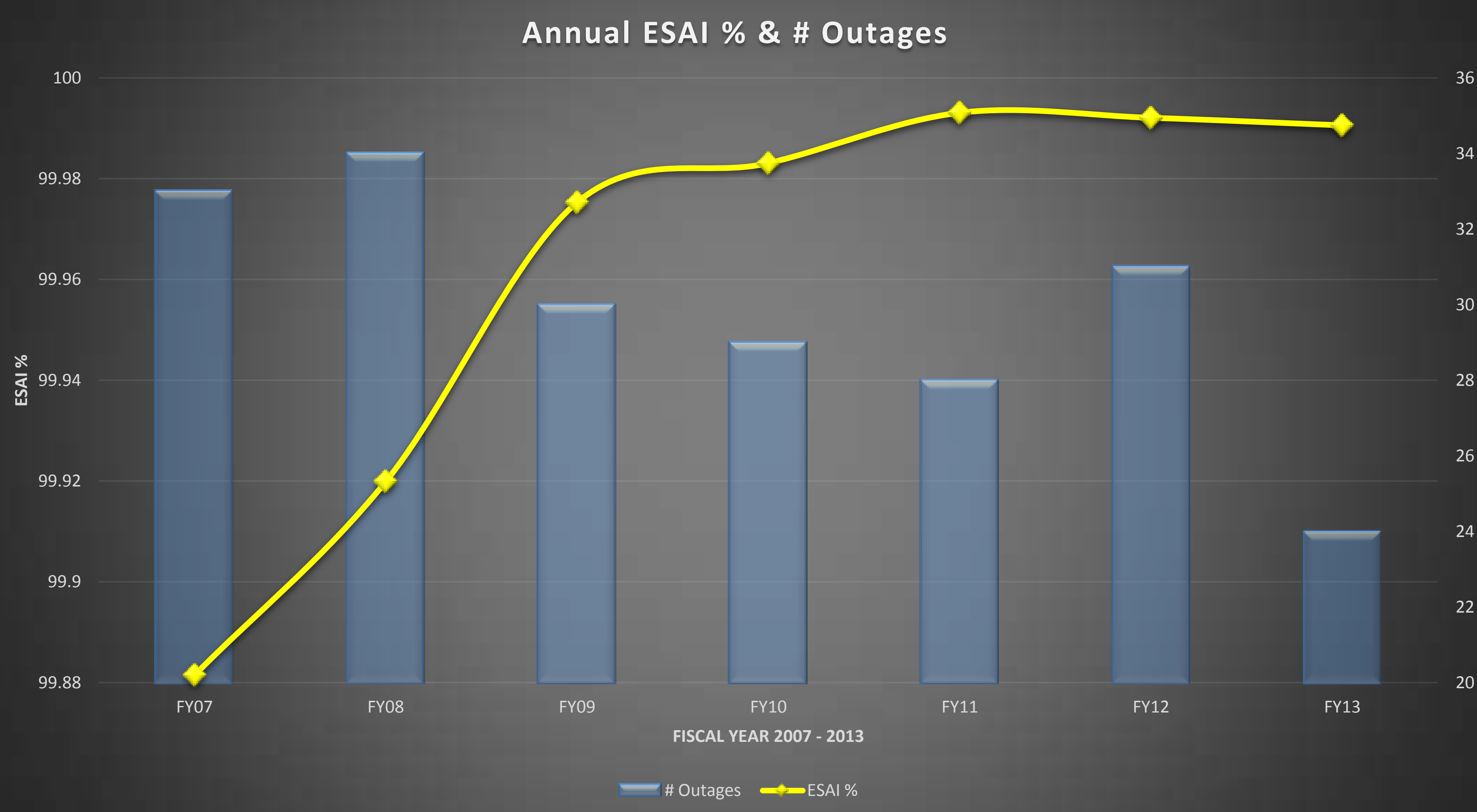
UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

Annual ESAI

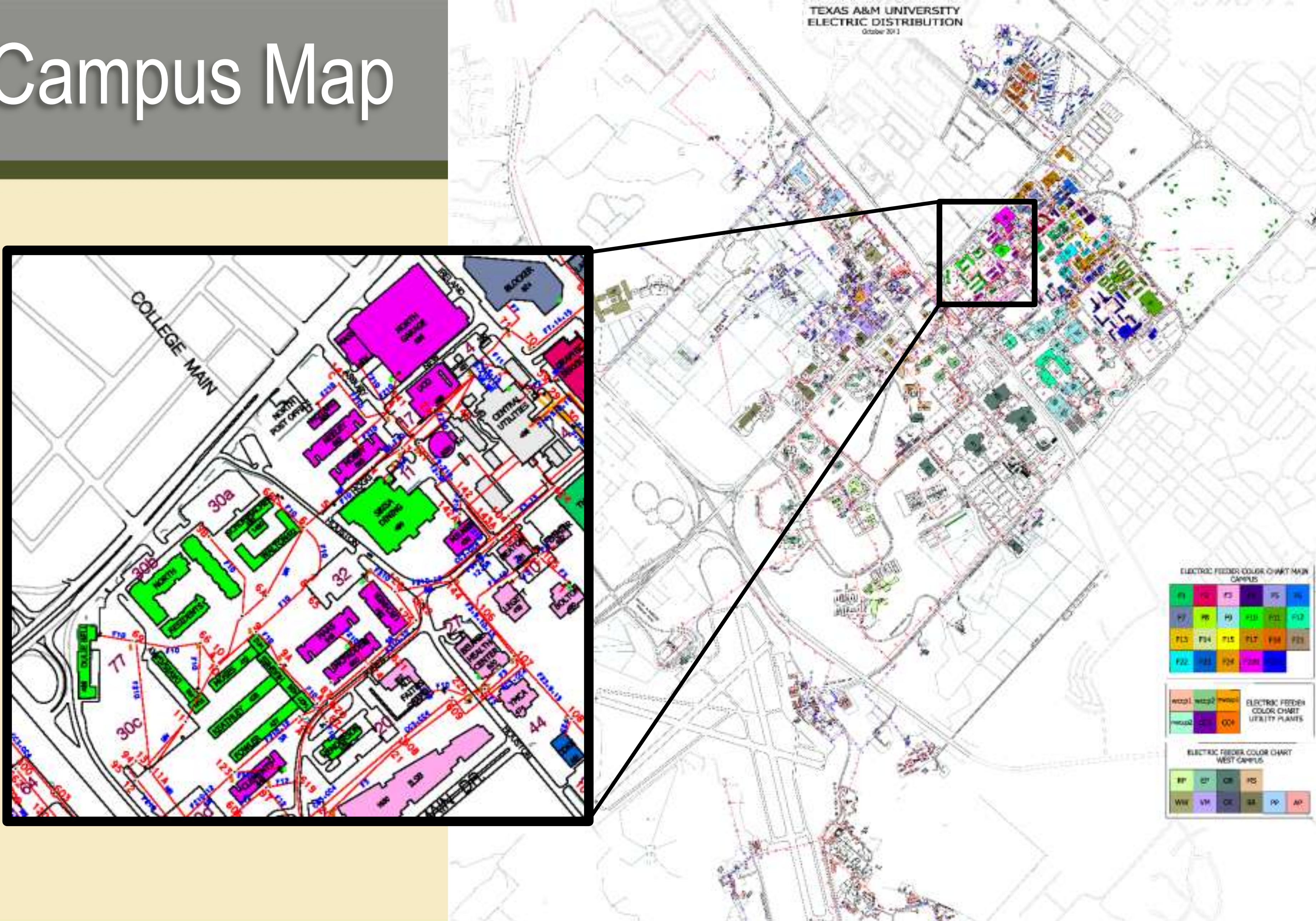


Annual ESAI %
100
99.98
99.96
99.94
99.92
99.9
99.88
ESAI %
99.8815
99.9199
99.9753
99.9831
99.9931
99.9921
99.9906
FY07
FY08
FY09
FY10
FY11
FY12
FY13
FISCAL YEAR 2007- 2013
ESAI %
Meets 99.9
Exceeds 99.99

Annual ESAI & Outages

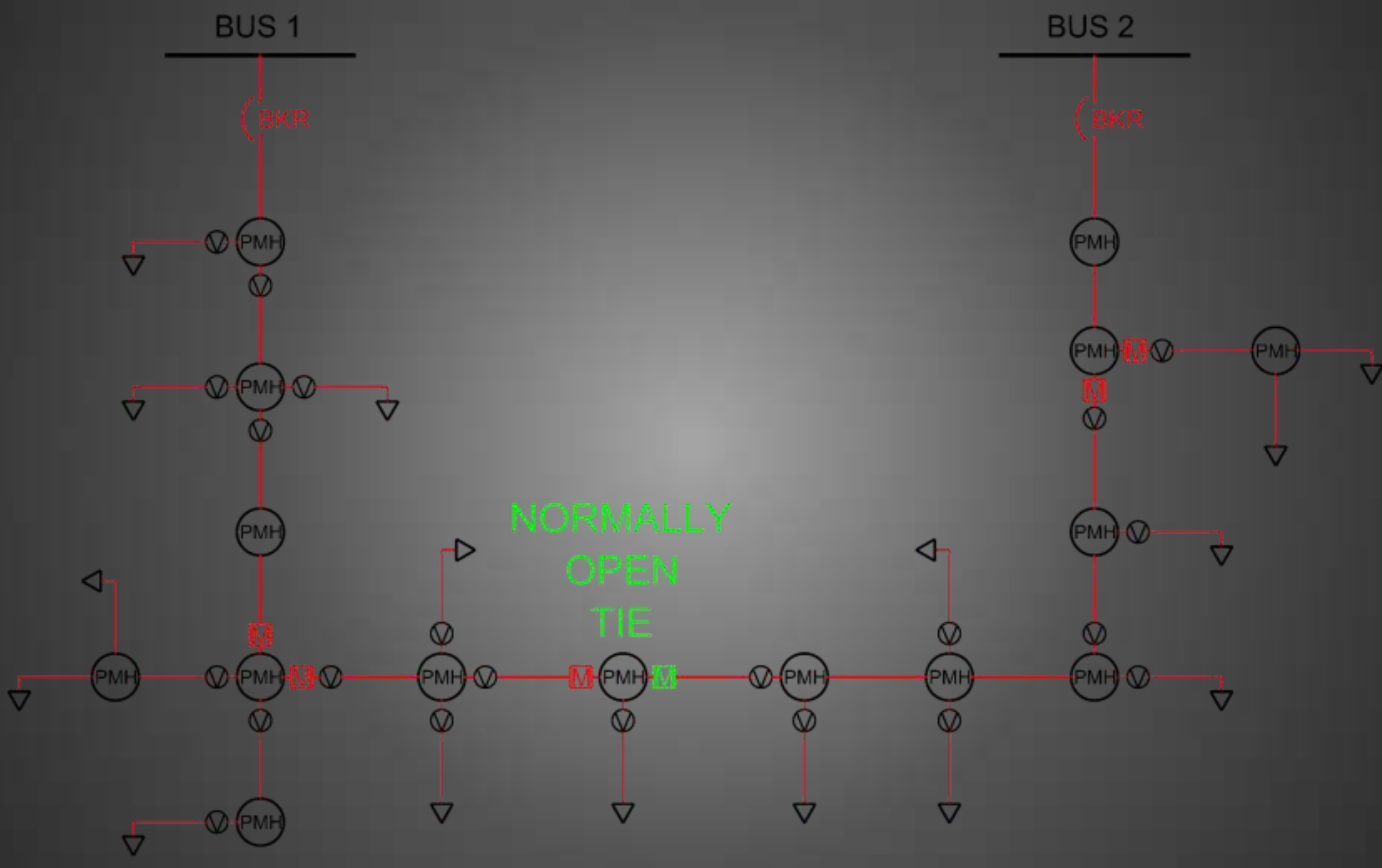


Campus Map

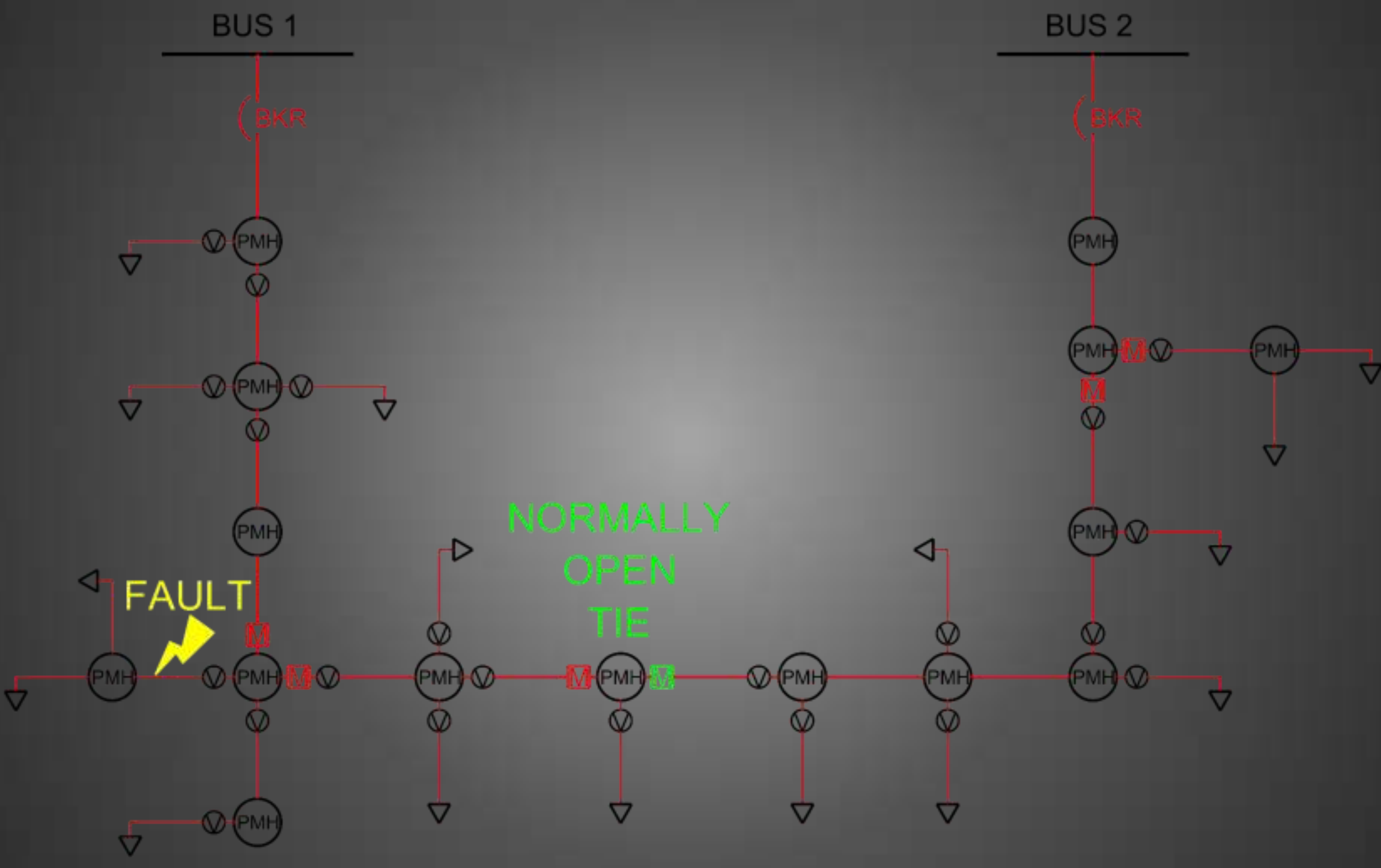


TEXAS A&M UNIVERSITY
ELECTRIC DISTRIBUTION
COLLEGE MAIN
NORTH POST OFFICE
CENTRAL UTILITIES
30a
30b
30c
32
77
44
NORTH
ELECTRIC FEEDER COLOR CHART MAIN CAMPUS
ELECTRIC FEEDER COLOR CHART UTILITY PLANTS
ELECTRIC FEEDER COLOR CHART WEST CAMPUS

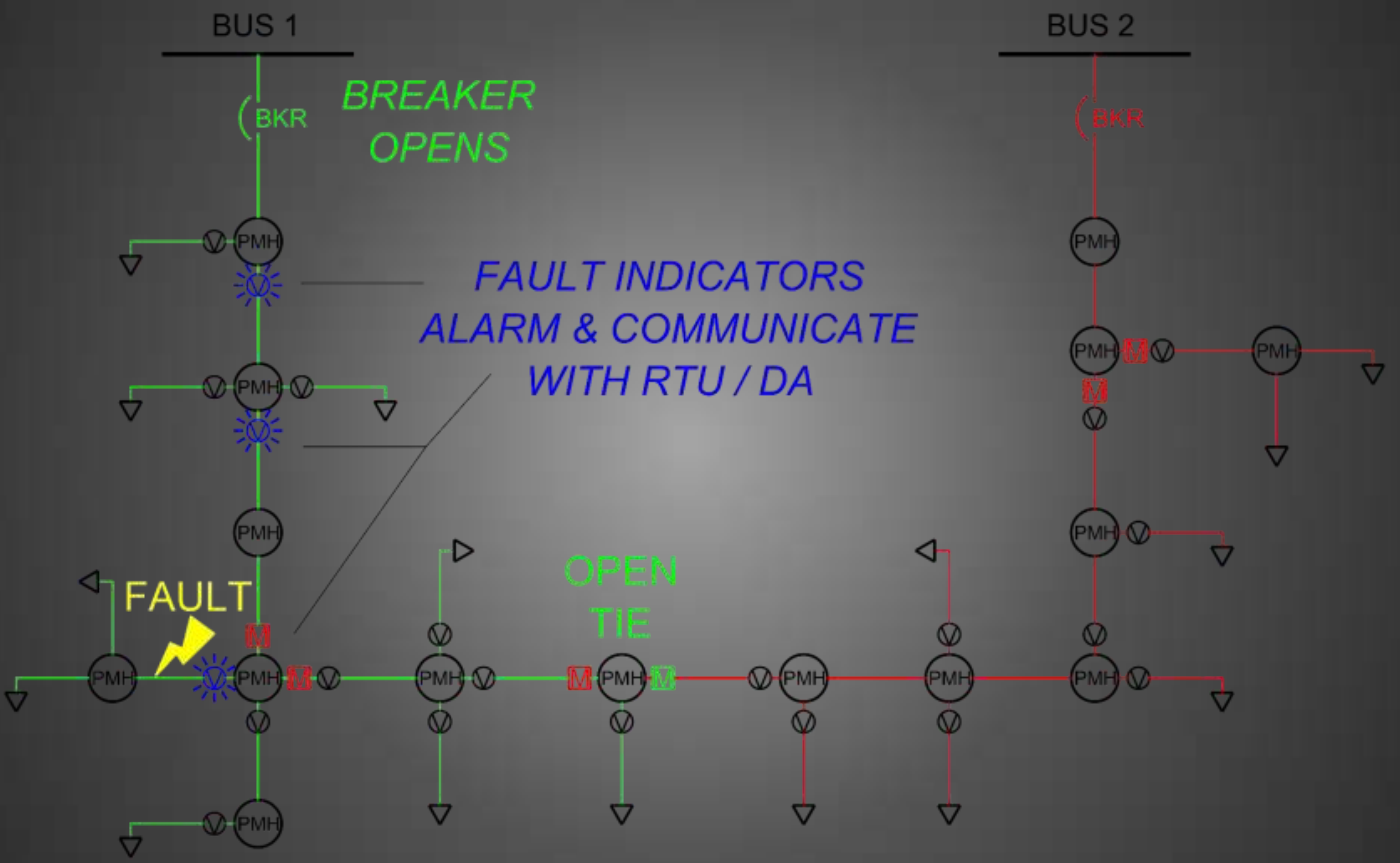
UES Distribution Automation



UES Distribution Automation



UES Distribution Automation



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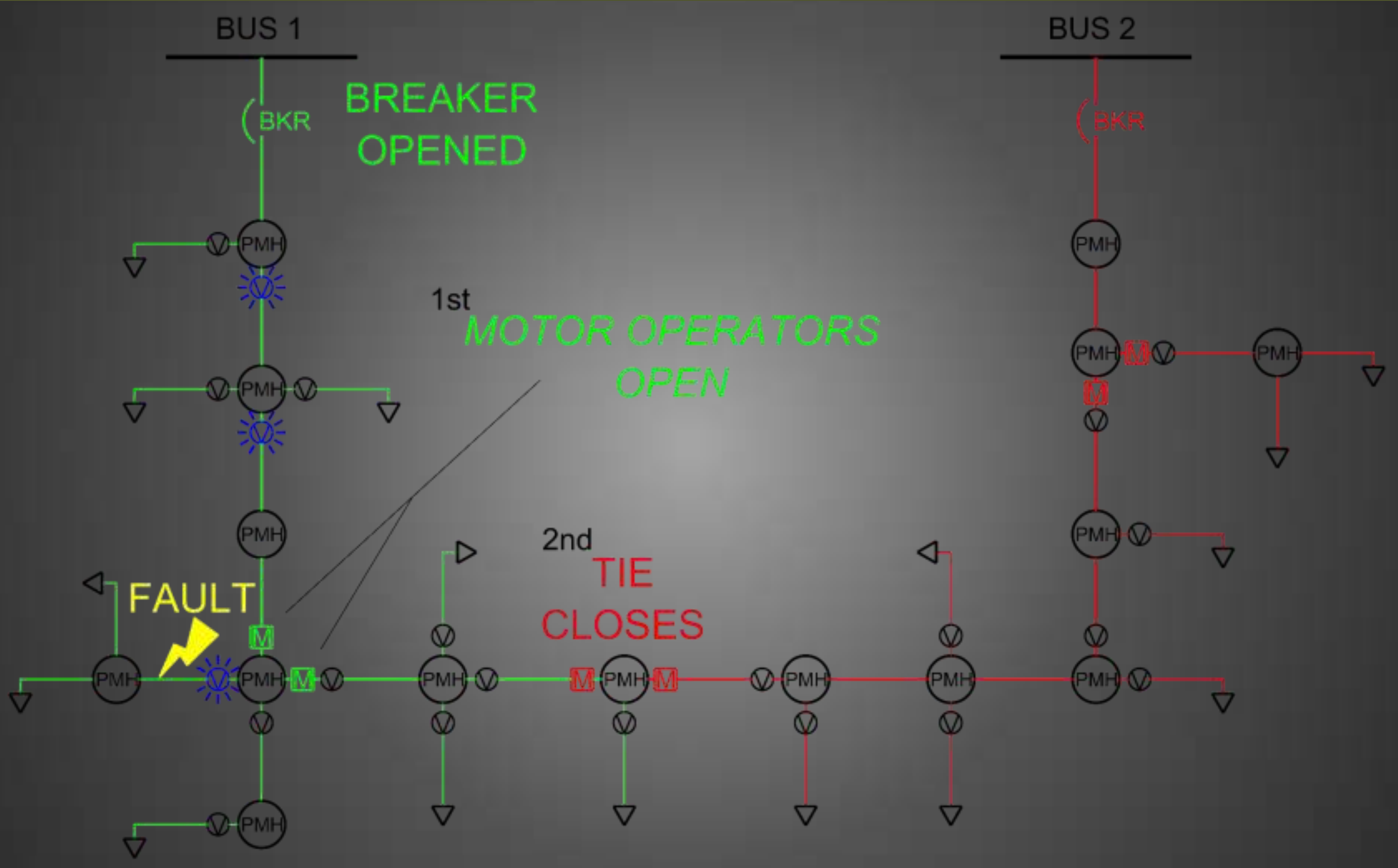
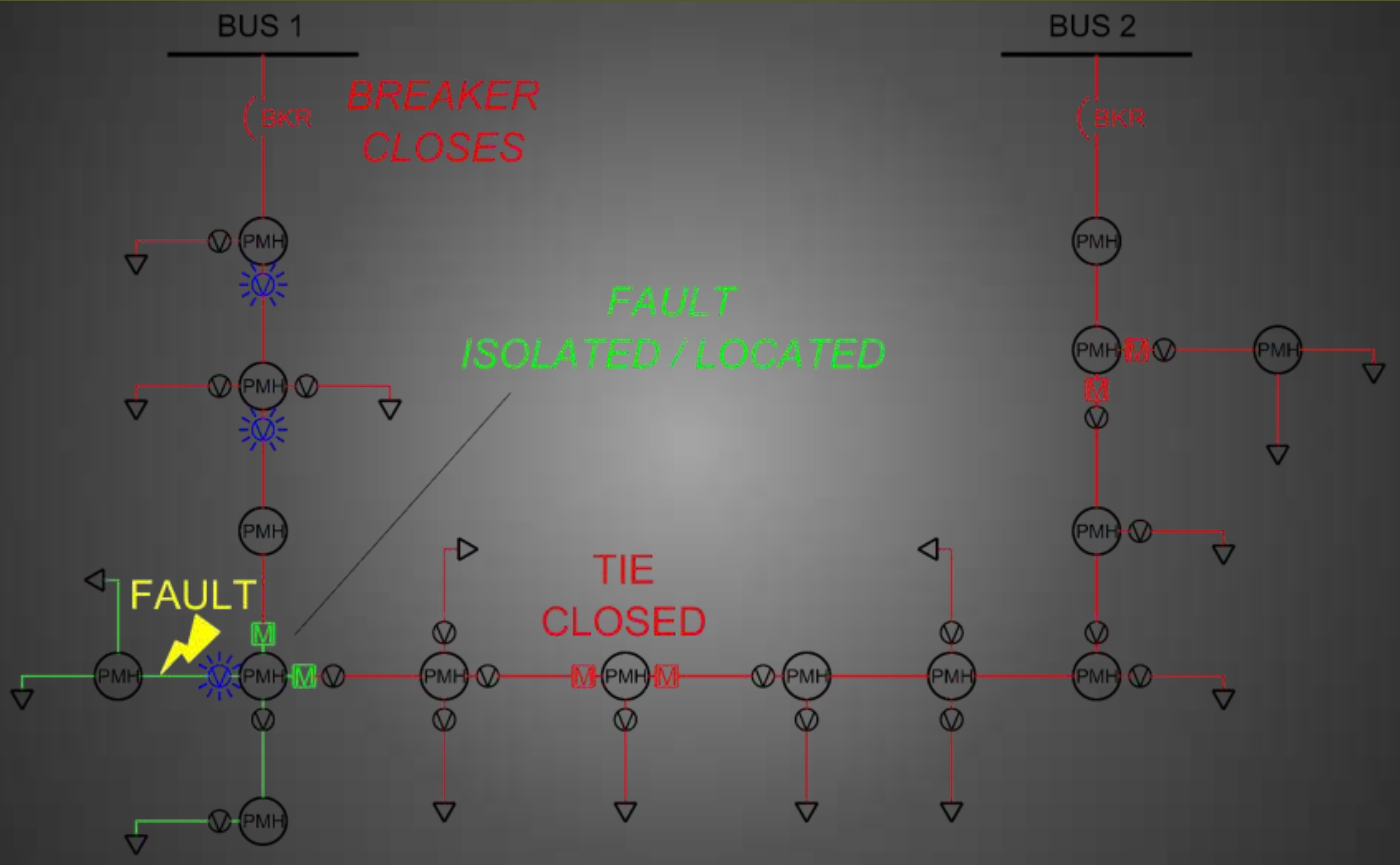


UES Distribution Automation



Typical vs DA Outage Response

Comparison using best/same response times

Typical	
Description	**Time (mins)**
Call out	5
Commute	30
Fault Type	30
Segmentation	30
Isolation	15
Fault Repair	30

Total	**140**
ESAI %	**99.8982**

*ESAI % 1 year for individual example feeder.

Distribution Automation	
Description	**Time (mins)**
Fault Type	0.25
Fault Location	0.25
Isolation	0.25
Back Up	0.25
Call Out/Commute	35
Repair	30

DA

Total	**66**
ESAI %	**99.9233**

Project Approach

Determine SCADA System Improvement Goals

Review Equipment Requirements to Meet Goals

- Retrofit Options For Existing Equipment
- Requirements For New Equipment

Identify the project team and partners

Identify budget constraints

Project Goals

Real-Time Electrical System Health & Status Monitoring from the TAMU 138kV Transmission to the campus buildings

- Fully Integrated Solution with UES Information Systems (Emerson Ovation, SEL, ETAP, Schneider Power Quality Enterprise, Owlet Lighting System, and Emergency Generator Monitoring)
- Improved Network Connectivity meeting NERC Standards
- System Automation & Remote Breaker Control
- System must be scalable for future growth
- Base System Budget of $1.75M

Project Team

Project Leadership, management, technical development, and installation by Texas A&M UES engineering and technical staff

Strategic Partnership with the following:

- Program Integrator – engineering consulting firm for project control and quality assurance
- Schweitzer Engineering Laboratories (SEL) – hardware provider and electrical engineering support
- Emerson Ovation – utility plant distributed control system/front end GUI
- Trayer Engineering – underground medium voltage switch retrofit
- S&C Electric – pad mounted above ground switch
- Nemaco – remote terminal unit enclosures
- Shermco – third party NETA testing and verification

Base System Components

Hardware to be installed:

- 2 SCADA Servers
- 35 remote terminal units (RTU's)
- 25 motors operators for 9 underground switches
- 30+ communication processors and logic controllers
- 440+ circuit fault indicators
- 30,000+ feet of relay control system cabling and fiber

Additional 25,000 system data points

30+ new graphical user interface screens

15kV Switching Stations

4 Switching Stations

1 Central Utility Plant

3 Satellite Utility Plants

26 - 15kV Buses
- 184 Breaker Cubicles
- SEL Relaying
- Ovation Monitoring

Remote Terminal Units

NEMA 6P Fully Submersible Enclosure

Nitrogen Humidity Control

24VDC Power Supply / Batteries

SEL-2440

- Fault Indicators
- Switch Position Status
- Motor Operator Status
- Temperature
- Water Level
- Sump Pump Status

SEL-751

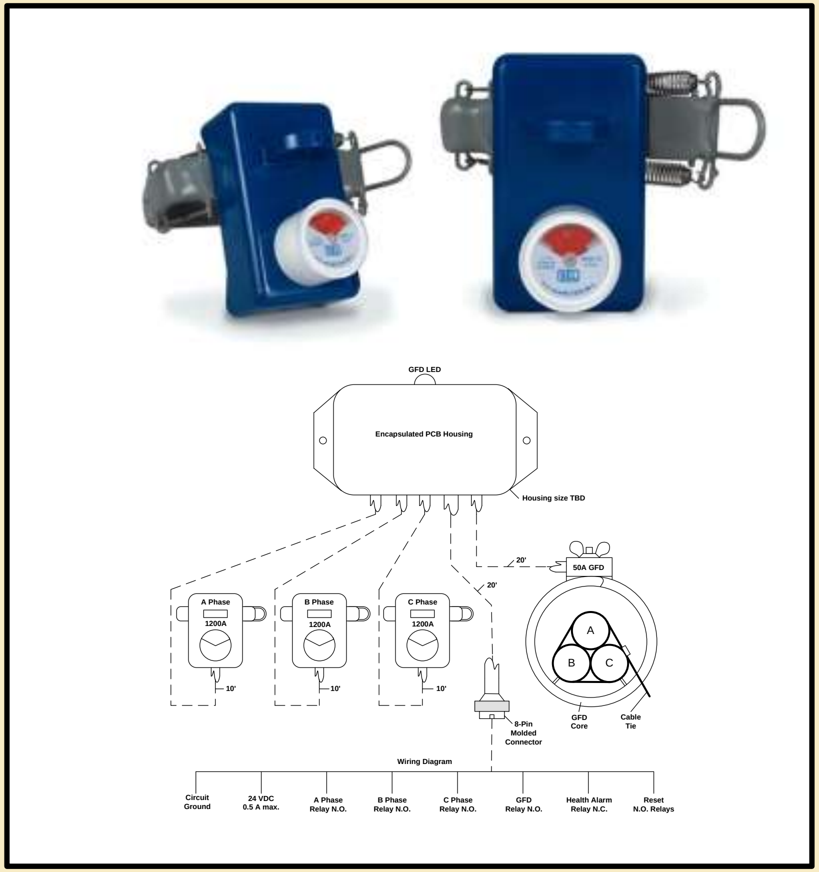
- Motor Operator Control
- CT Inputs (Future Use)

SEL-2730M

- Managed Switches
- Communication

Motor Operators & Fault Indicators

Motor Operators



Fault Indicators

Communication

RTUs contain SEL-2730M switch for communication

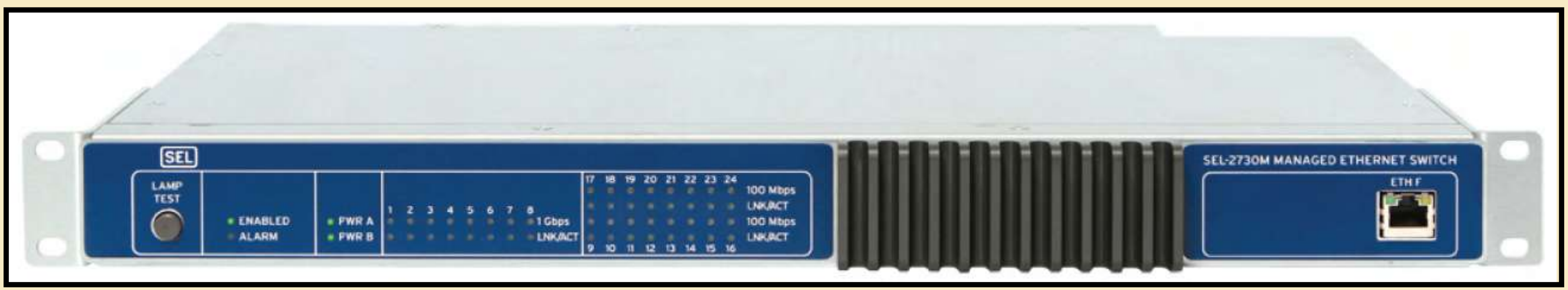
Network switches will be connected via Fiber

- 62.5u Multimode
- 9u Singlemode

Singlemode Backbone Fiber between main switching stations & plants

- Communication to SEL – RTACs for remote operation of 15kV breakers

Multimode Field Fiber for each DA loop connecting RTUs to main servers



Project Close Out

Project construction is currently underway with substantial completion by end of FY14

Utility Information systems will be fully integrated with dedicated fiber and meet NERC standards

Six campus feeders will be fully automated and all breakers will have remote operation capability

Personnel at each organizational level will access Real-time Electrical System Health & Status Monitoring

Scalable system that will include two additional feeders in FY15

Project remains on budget and will be completed for $1.75M

Capabilities & Features

- ✓ Real-time system status indication and event recording
- ✓ Real-time Load flow and System Capacity Monitoring
- ✓ Real-time System Fault Indication
- ✓ Distribution Automation allowing for 50% feeder restoration in < 1 minute
- ✓ Variable Relay Protection Scheme based on system configurations (Football Gameday Operations)
- ✓ Variable Load Shedding for loss of transmission grid or onsite generation
- ✓ Fully automated Black Start capability and re-synchronization to grid
- ✓ 138kV Substation transformer monitoring
- ✓ Automatic & Remote System Lockouts to prevent inadvertent and/or potentially unsafe operation
- ✓ Real-time system modeling from substation to each campus facility
- ✓ Demand Response and Smart load control from plant to buildings, e.g.
- ✓ Exterior lighting control system with full dimming and monitoring
- ✓ Automation of System Reactive Power Control using distribution system capacitor banks and generators
- ✓ Monitoring of tunnel and direct buried thermal commodities

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