EE379K/EE394V Smart Grids: Smart Distribution Applications

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Spring 2019

Outline

- Components of Distribution Systems
- Distribution Automation System
- Application Functions
- Illustrations

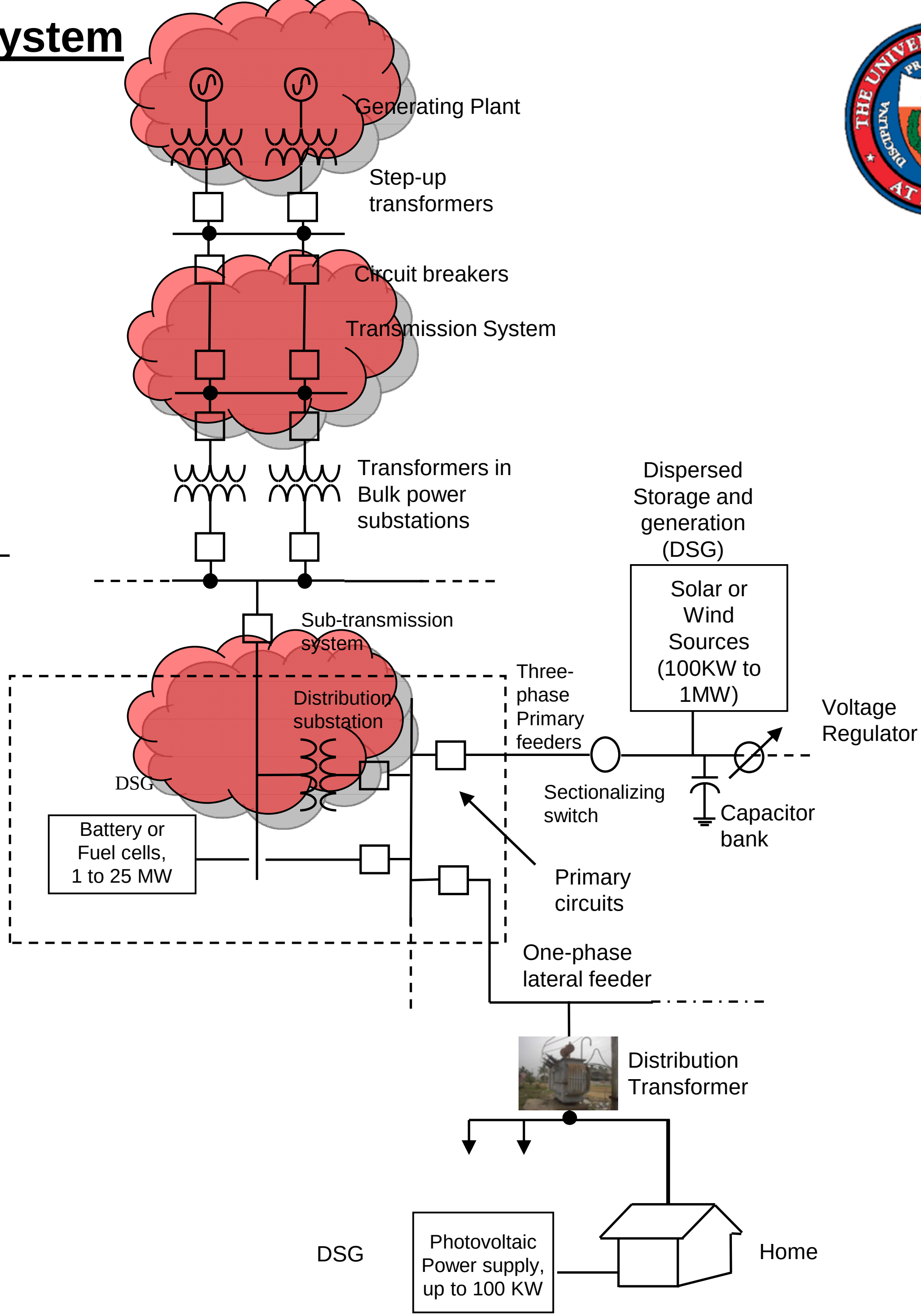
Typical Power System

Generation System

Transmission System

Distribution System

- substations
- transformers
- circuit breakers
- feeders
- sectionalizing switches
- capacitor banks
- voltage regulators
- DSGs
- customers
  - HT customers
  - LT customers



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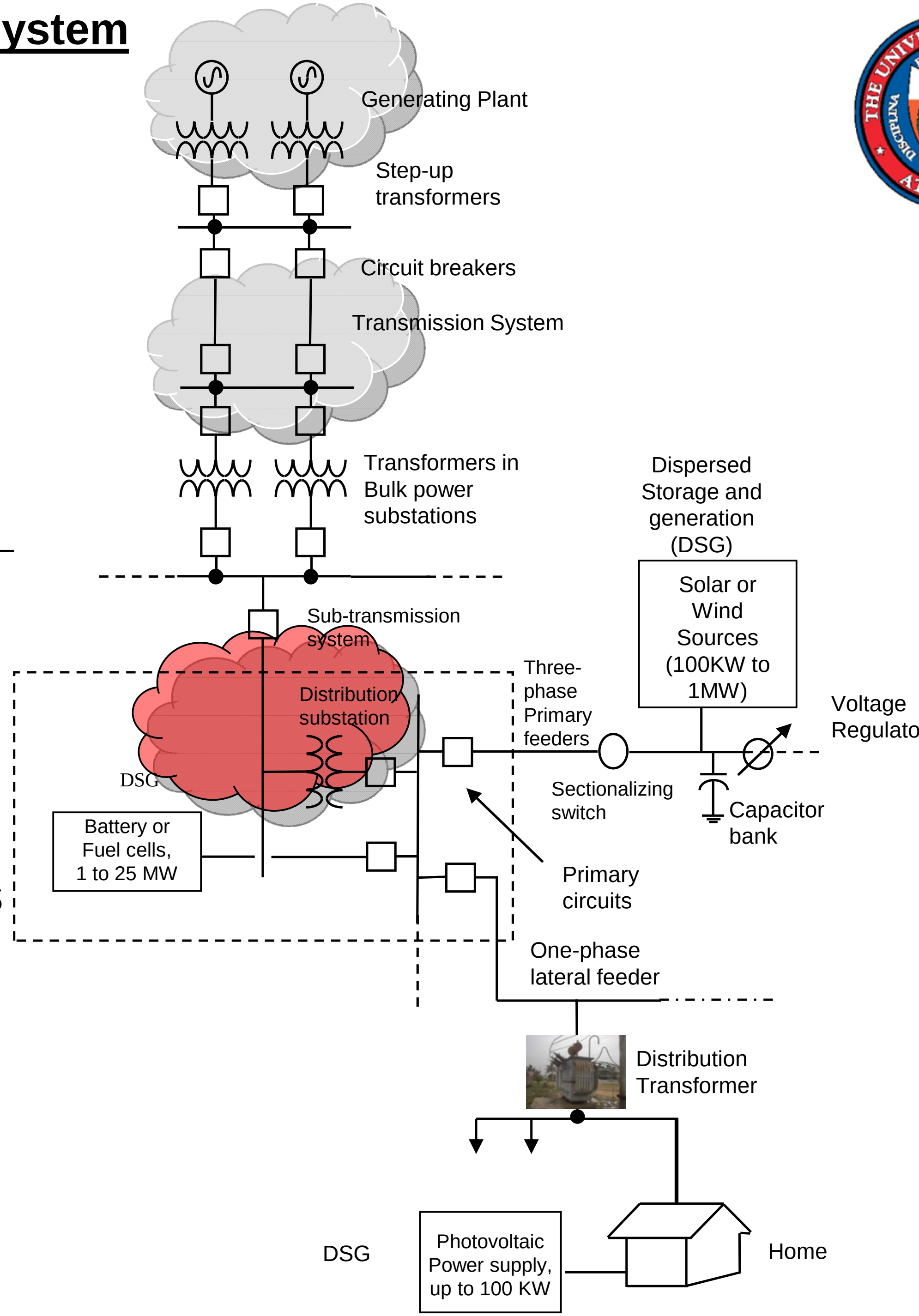


Sub-Station Transformer

Incoming feeders

Outgoing feeders

Distribution Transformers

Distribution Transformer (1-Ph) Location

Capacitor Banks

Voltage Regulators

Courtesy: College Station Utilities

Courtesy: College Station Utilities

Courtesy: College Station Utilities

Voltage Regulators

Voltage Regulators

Transformers:
- step down from 25 kV to 12.5 kV.

Voltage Regulators

Switch at a Distribution Transformer

Switch on a feeder

Switch on a feeder

Switch on a feeder

Protective Devices

Fuse cutout

a **fuse cutout** or **cut-out fuse** is a combination of a fuse and a switch, used in primary overhead feeder lines and taps to protect distribution transformers from current surges and overloads. An overcurrent caused by a fault in the transformer or customer circuit will cause the fuse to melt, disconnecting the transformer from the line. It can also be opened manually by utility linemen standing on the ground and using a long insulating stick called a ‘hot stick’.

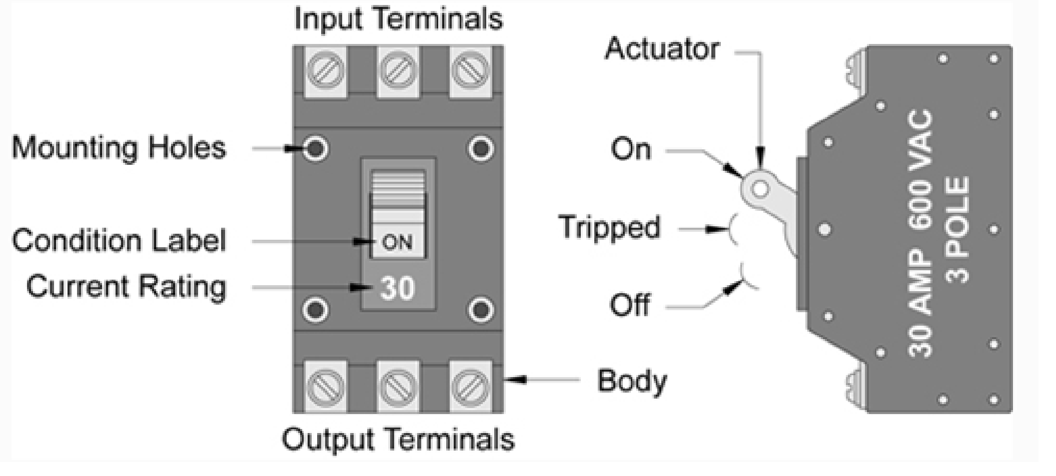
Protective Devices

Fuses

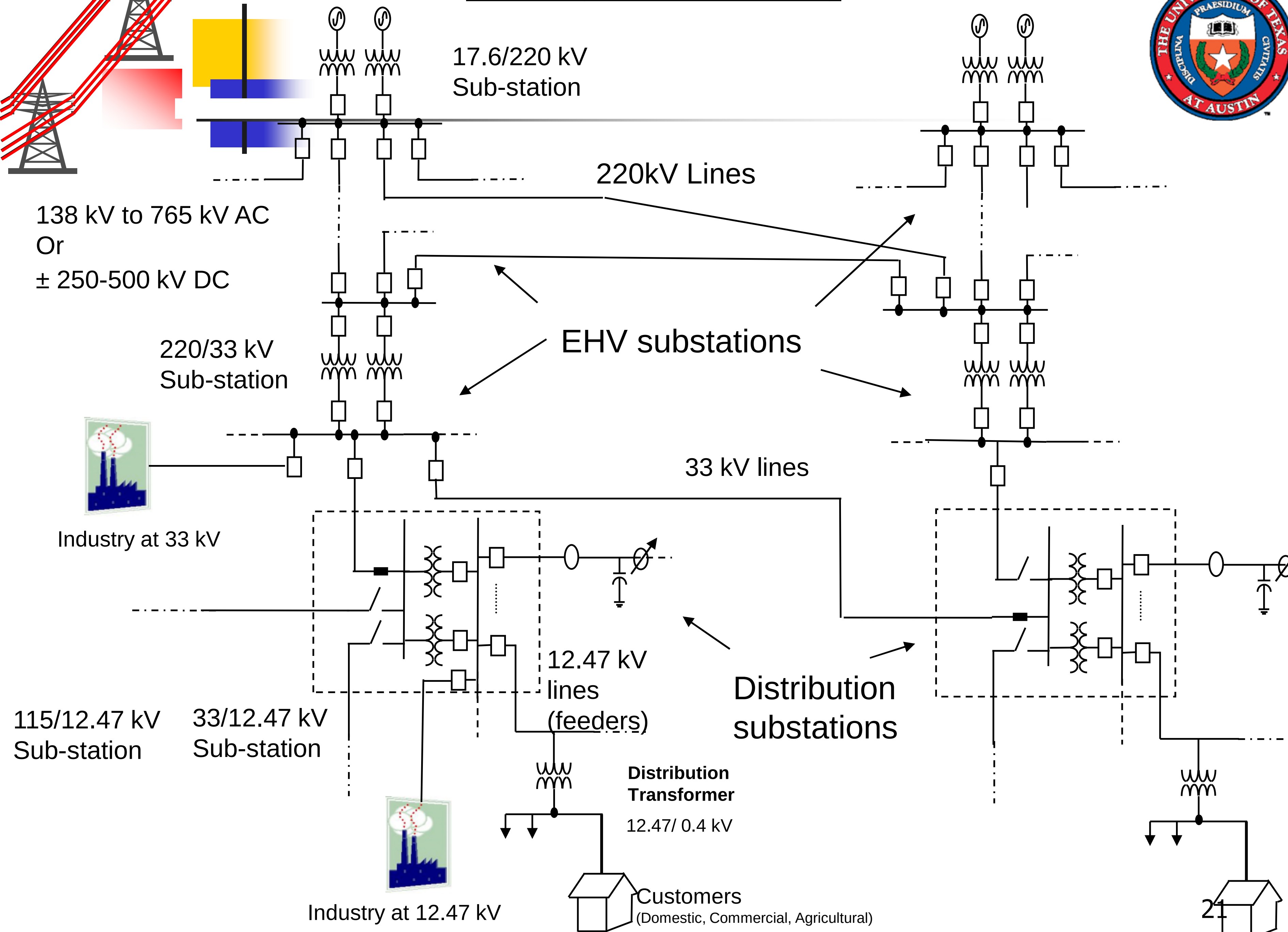
Fuses contain a narrow strip of metal which is designed to melt (safely) when the current exceeds the rated value, thereby interrupting the power to the circuit.

Circuit Breakers

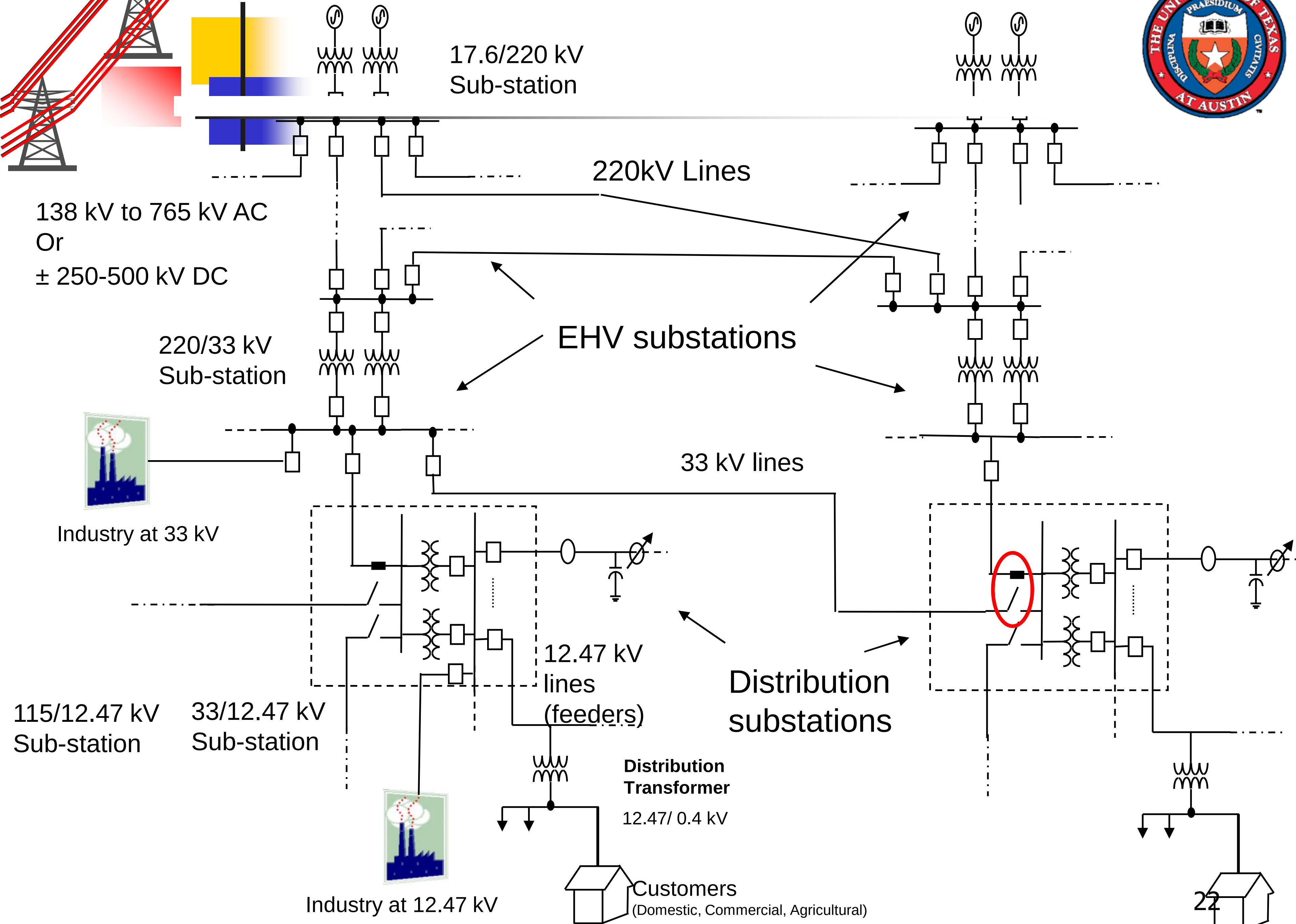
CBs trip (Open) when the current exceeds the rated value, thereby interrupting the power to the circuit. In most cases they can double as a power disconnect.



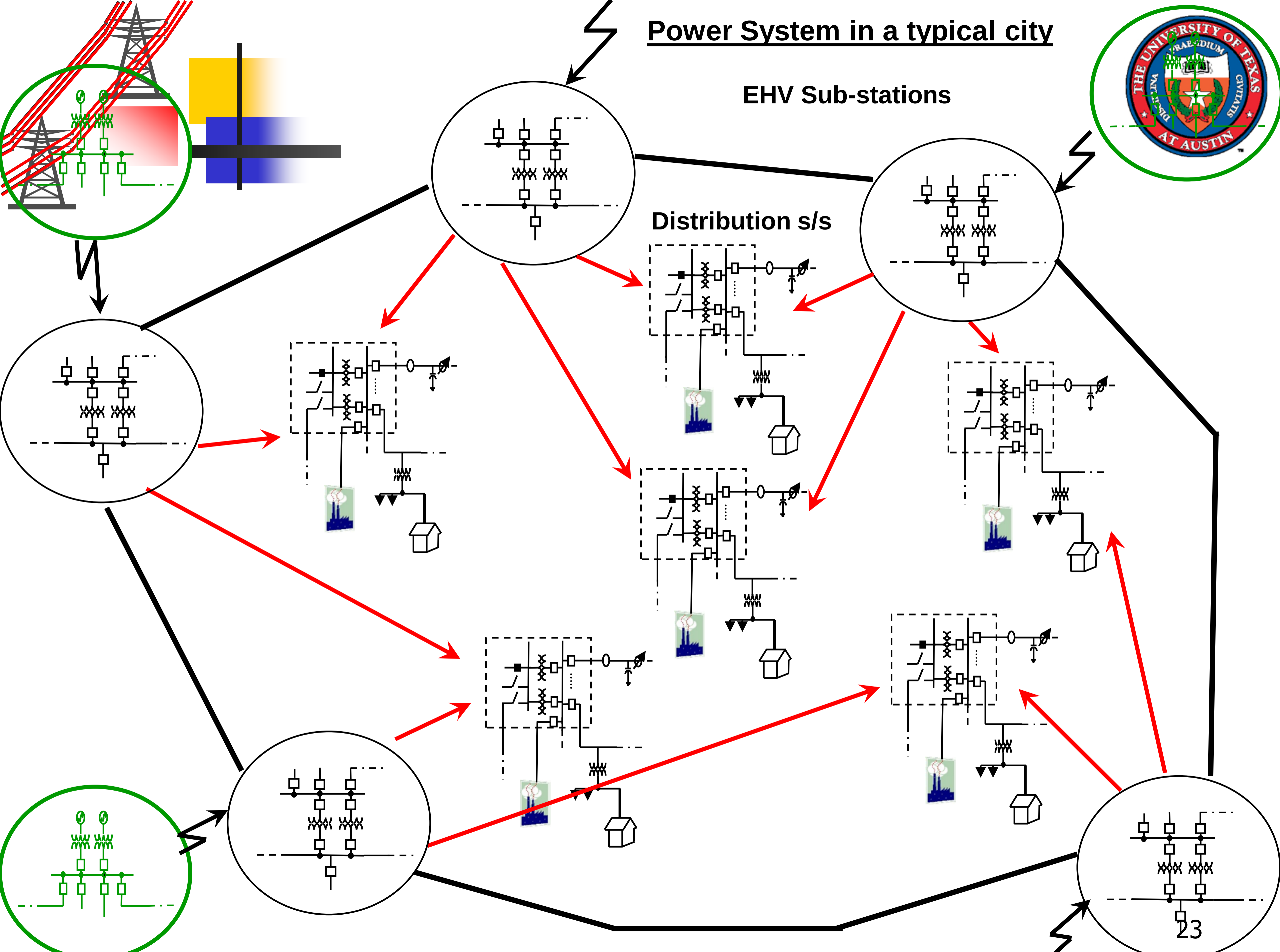
Power System connectivity



Power System connectivity



Power System in a typical city



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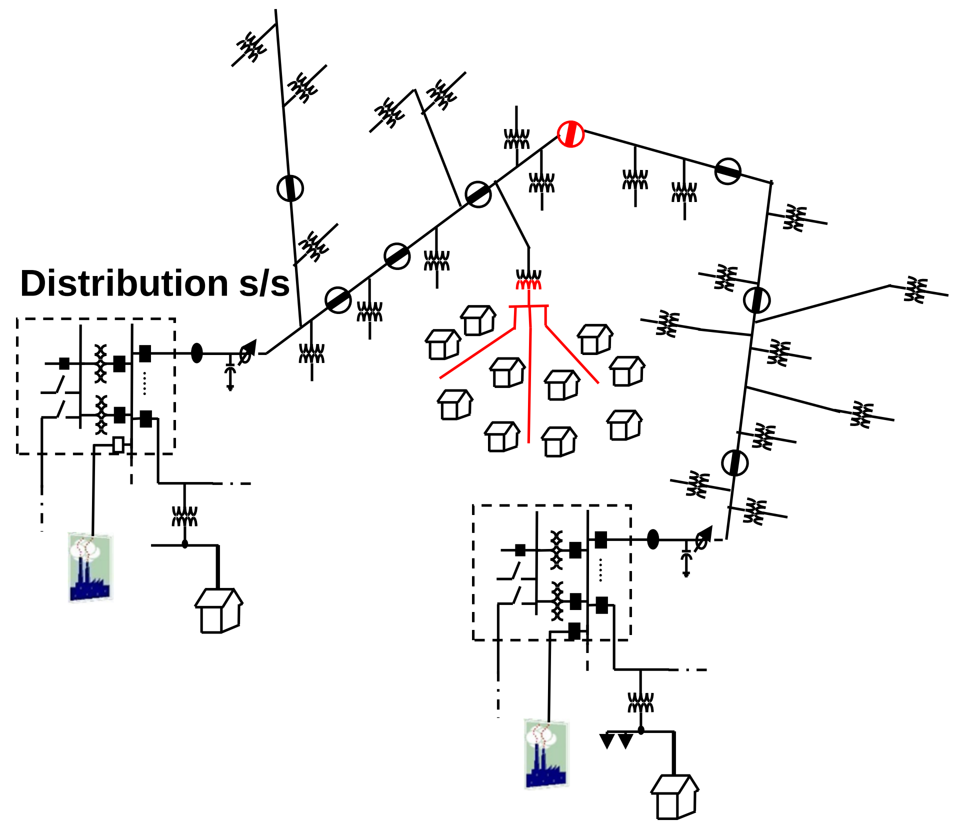

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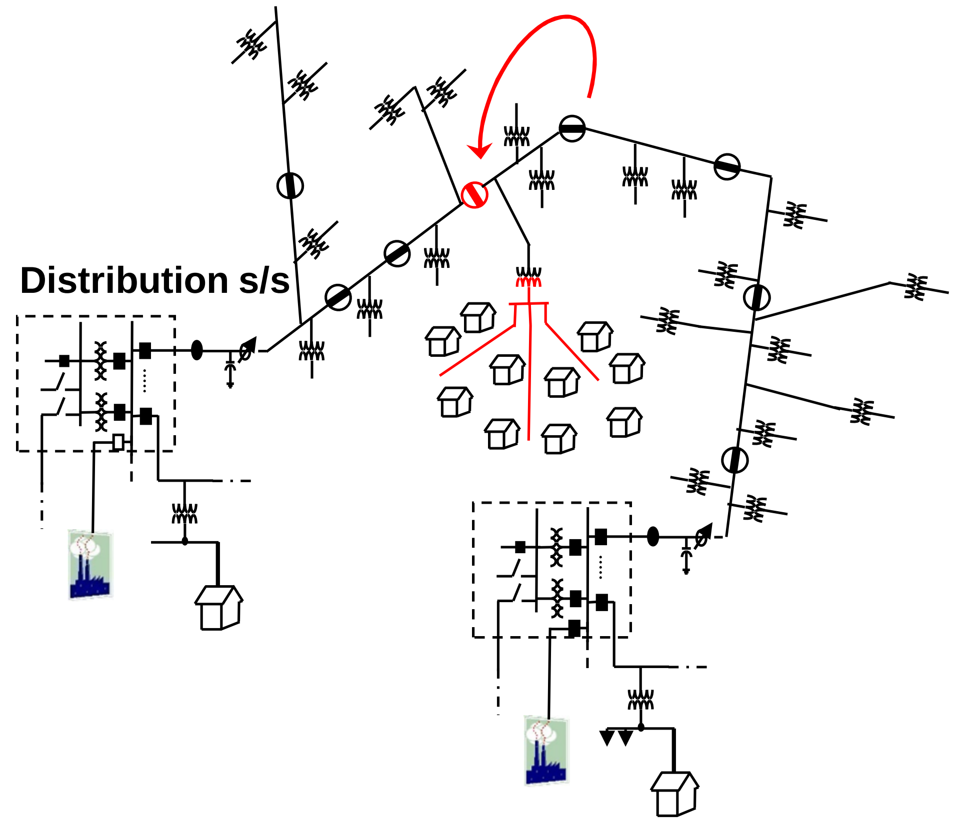
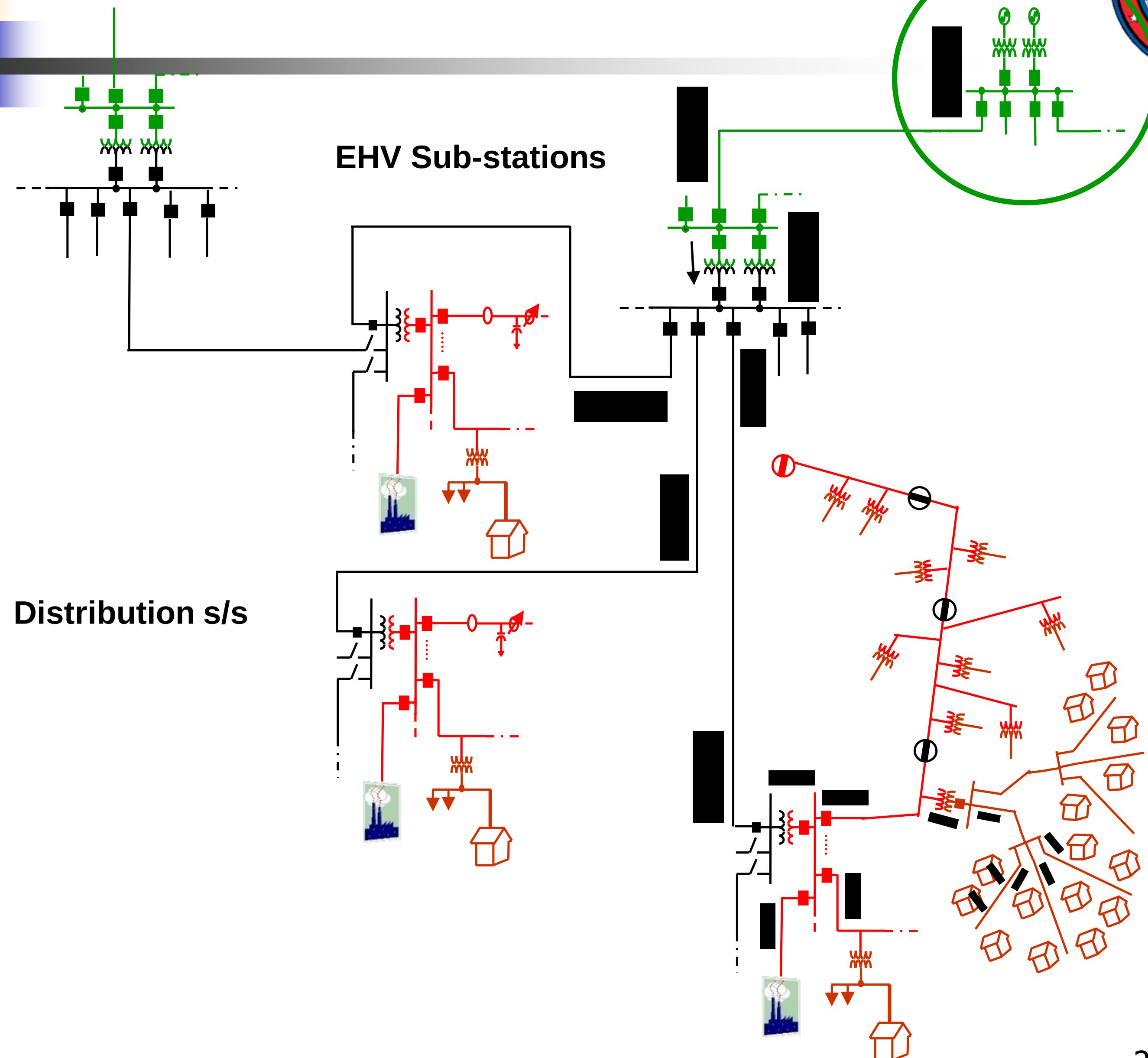
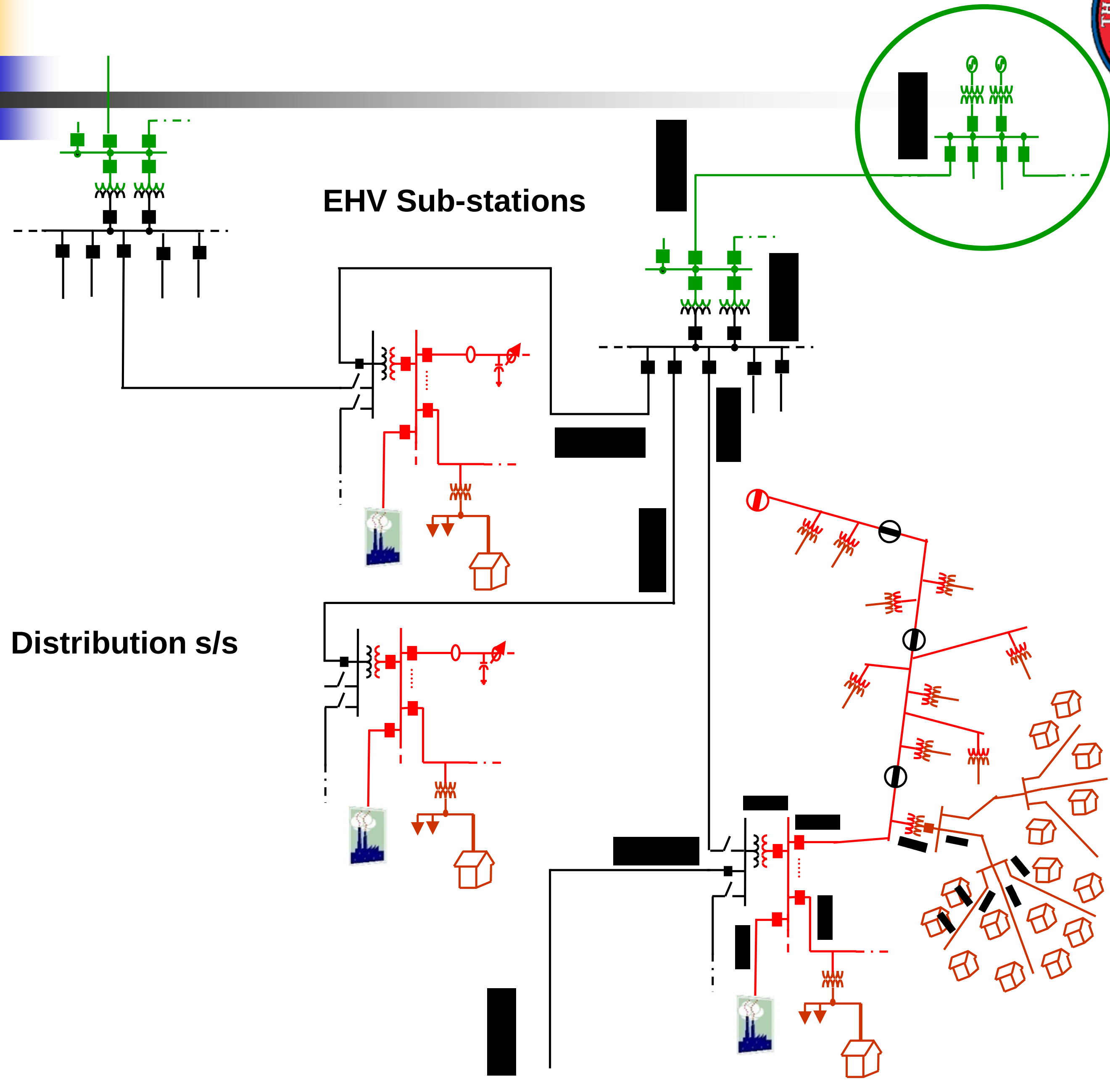


Energy Flow



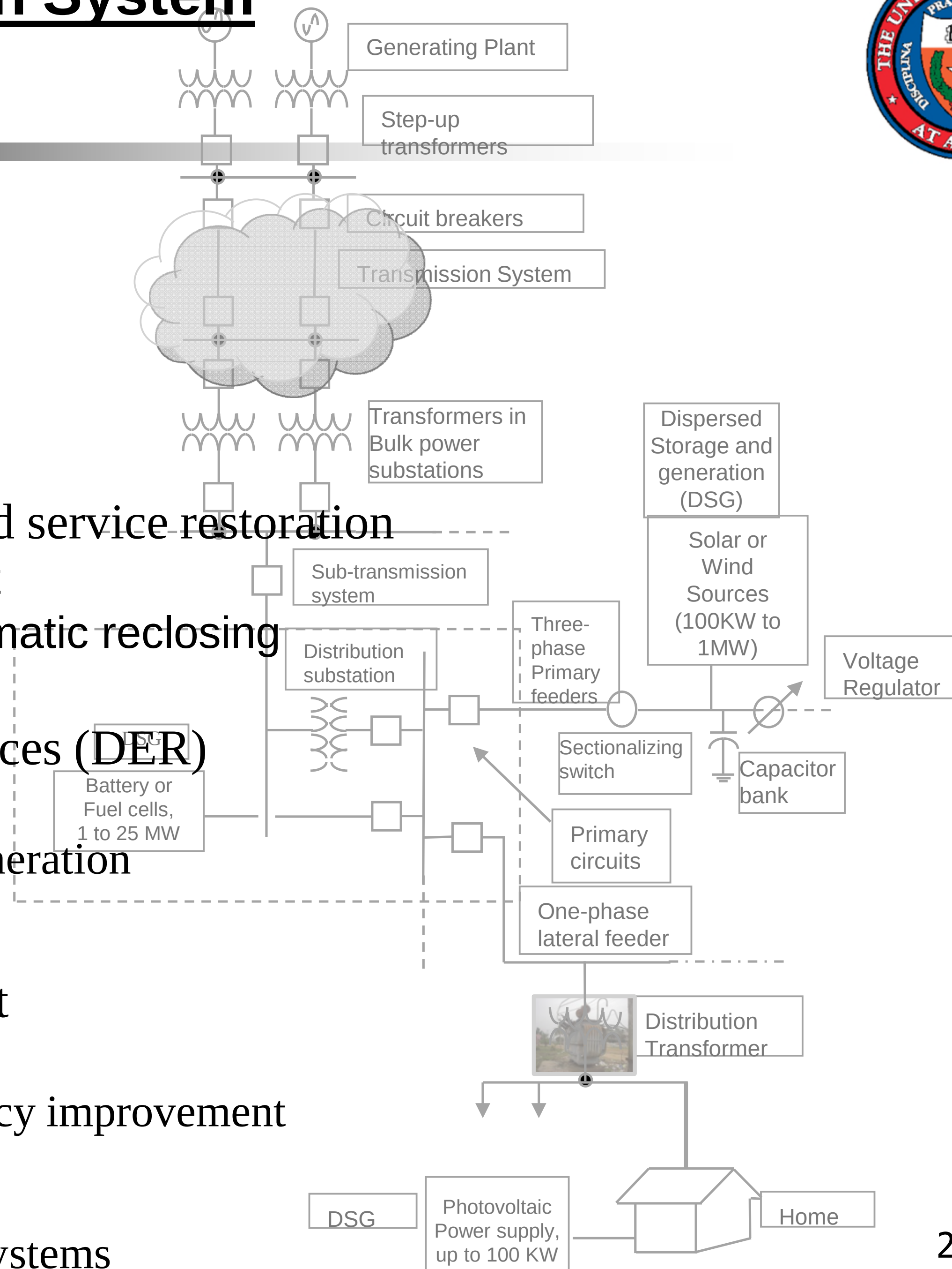
Energy Flow



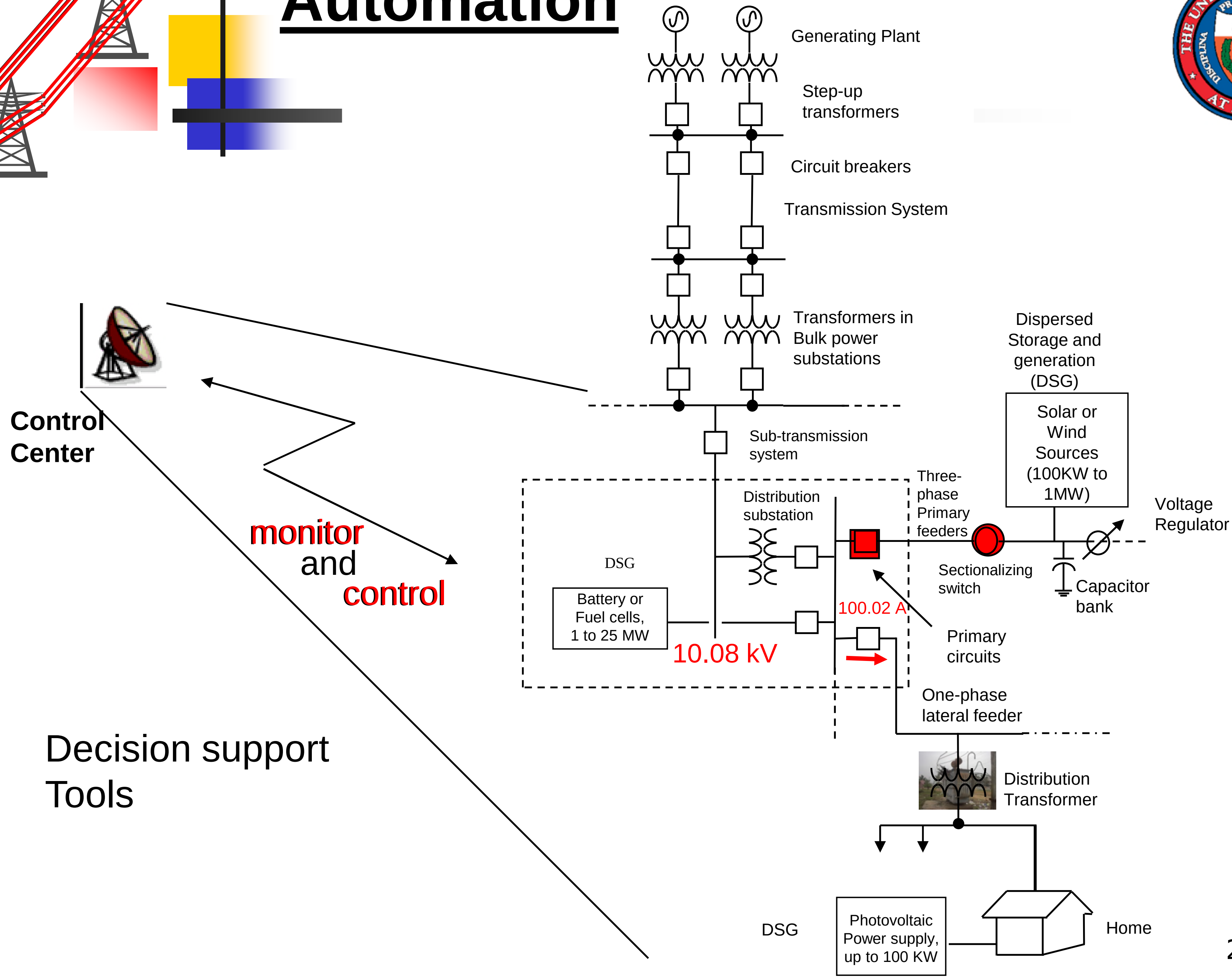
Distribution System

Operational Details:

- Protection
  - Coordination
  - Mostly Radial operation
- Fault location, isolation and service restoration
  - Vegetation Management
  - Quick restoration - automatic reclosing
- Distributed Energy Resources (DER)
  - Smaller power Sources
  - Storage and renewable generation
  - Voltage Regulation
- Demand Side Management
  - Demand Response
  - Conservation and Efficiency improvement
- Smart Grid
  - Distribution Automation Systems

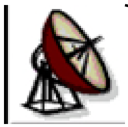


Automation



Decision support Tools

Distribution Automation System



Distribution Control Center

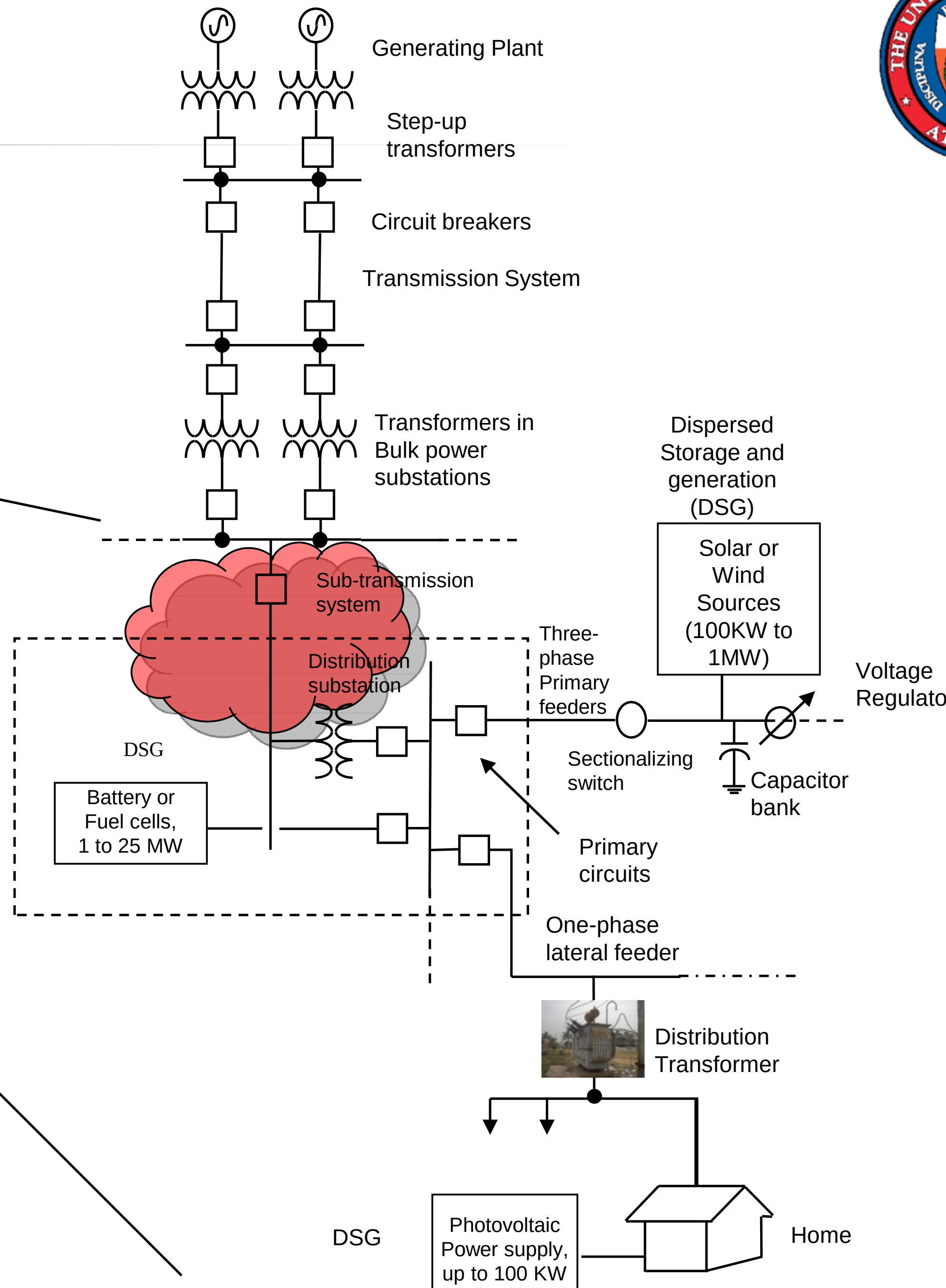
(monitor and Control)

SCADA

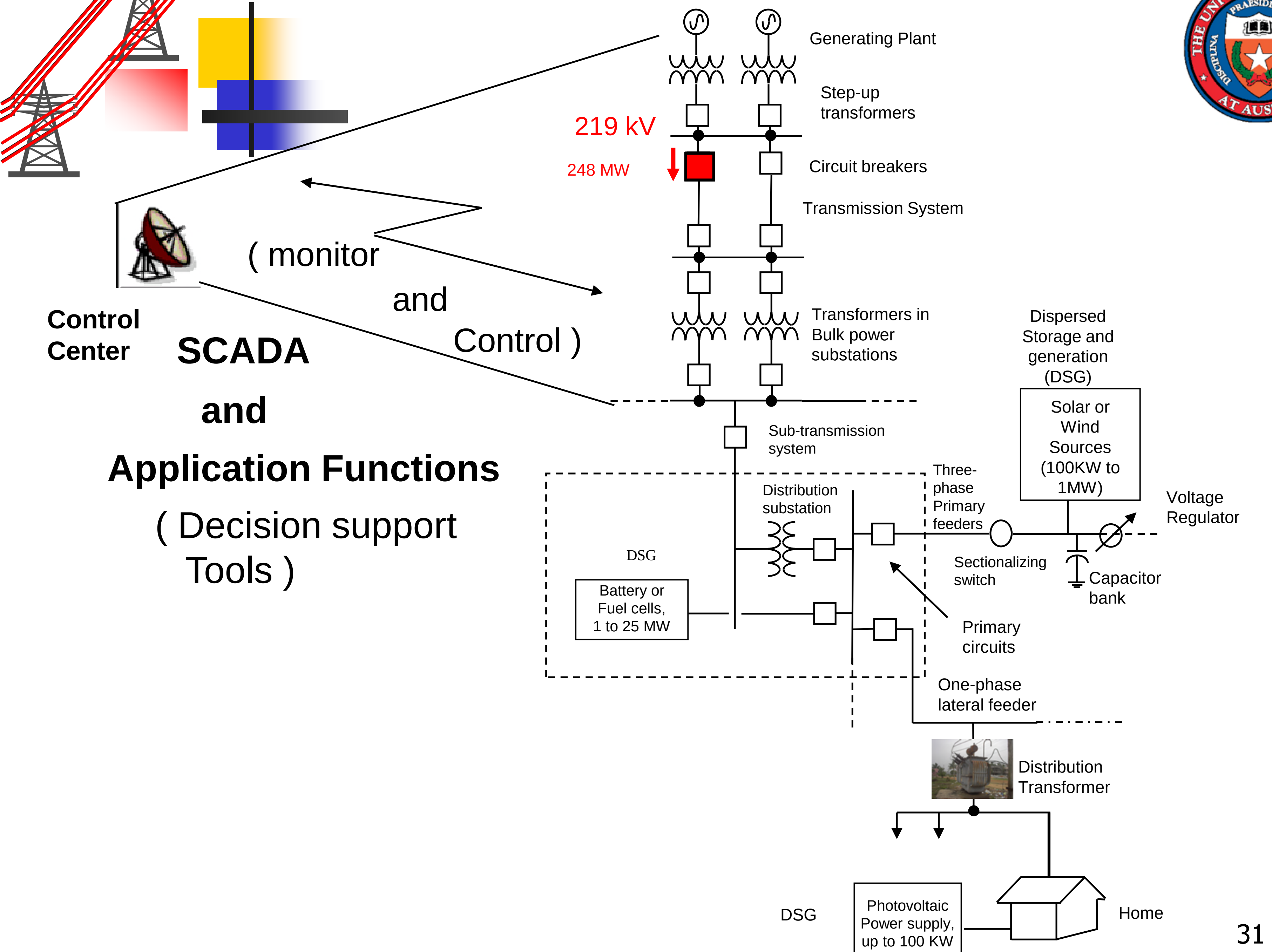
and

Application Functions

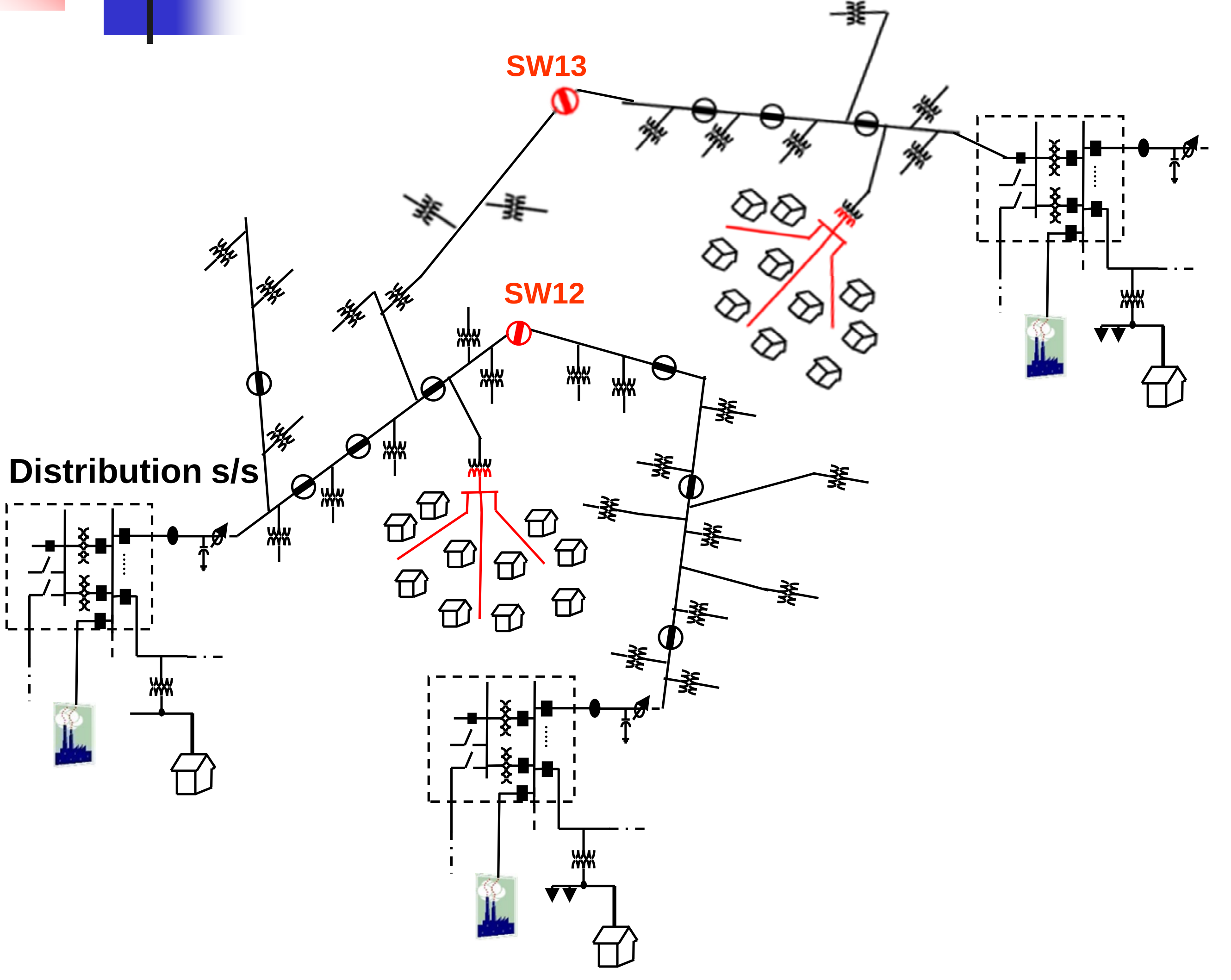
(Decision support Tools)



Energy Management System



Decision support tool for the operator



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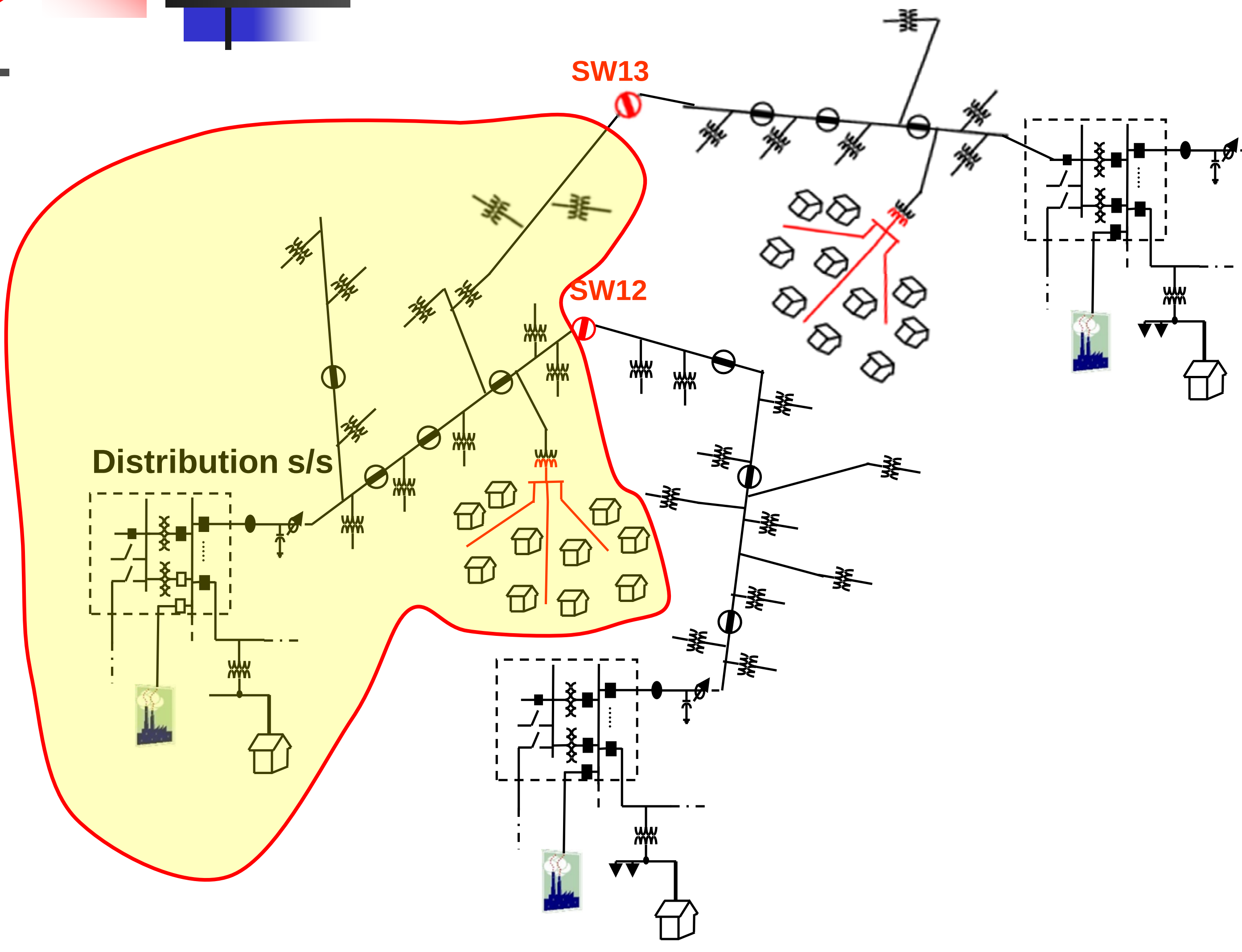

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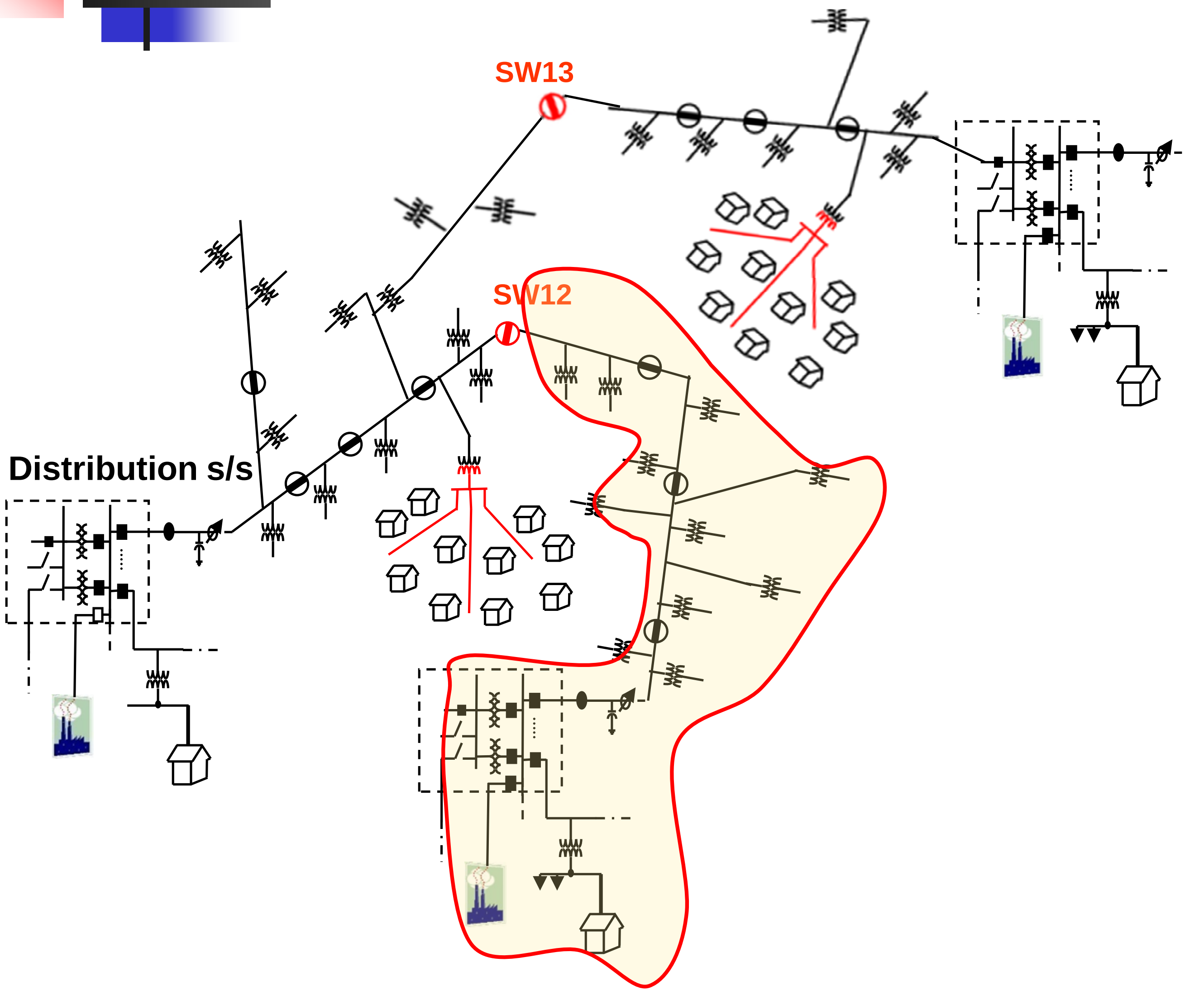

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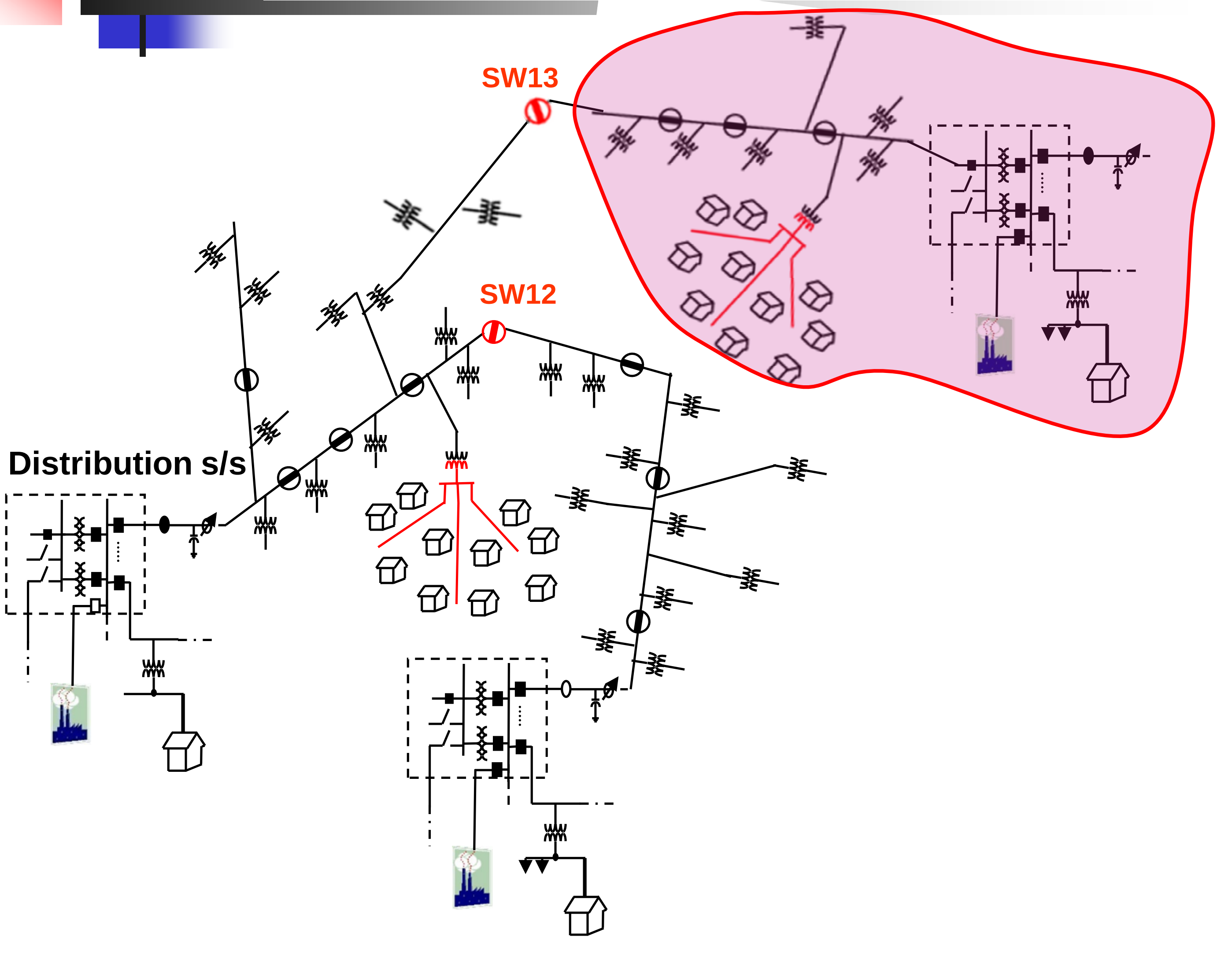

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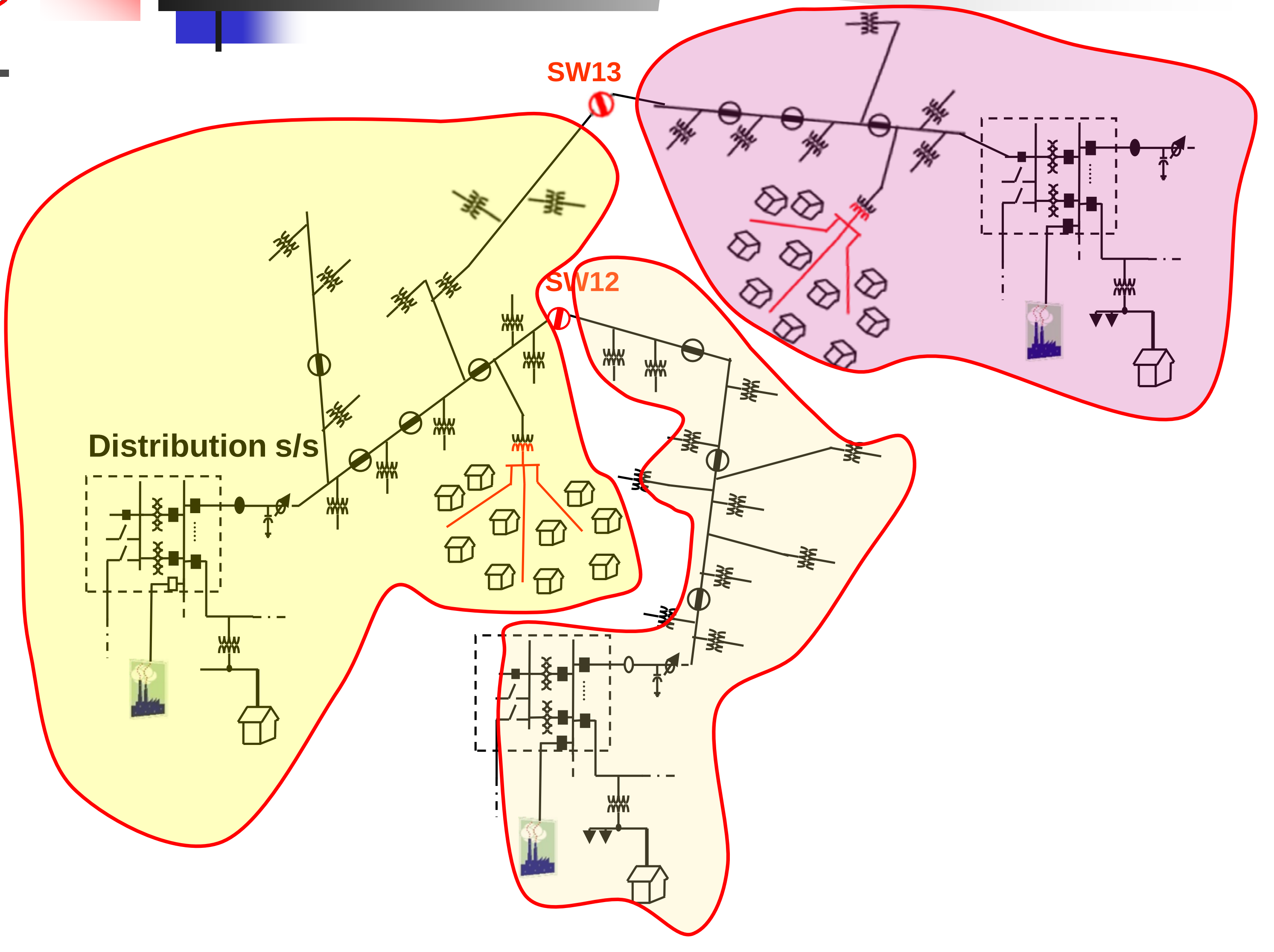

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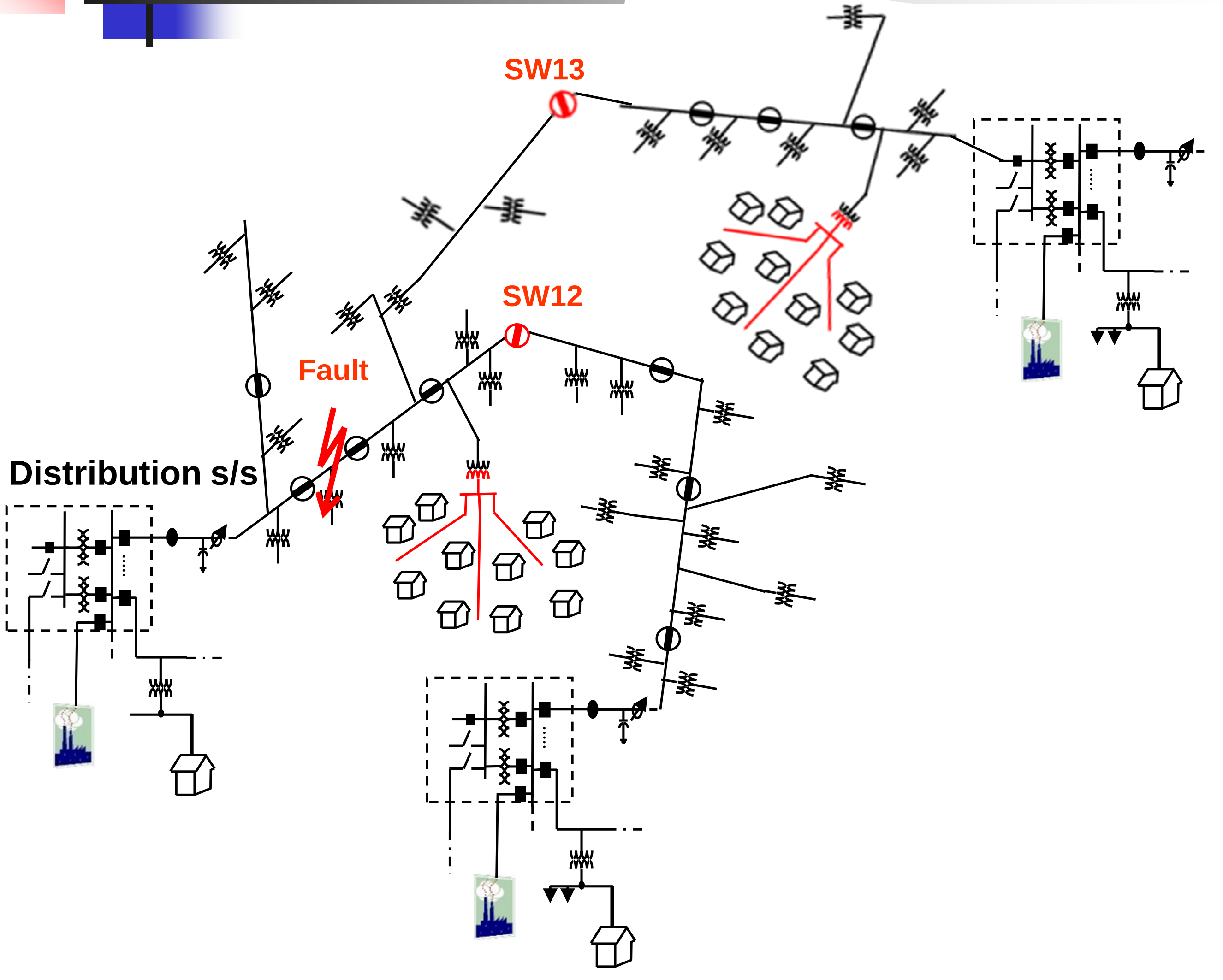

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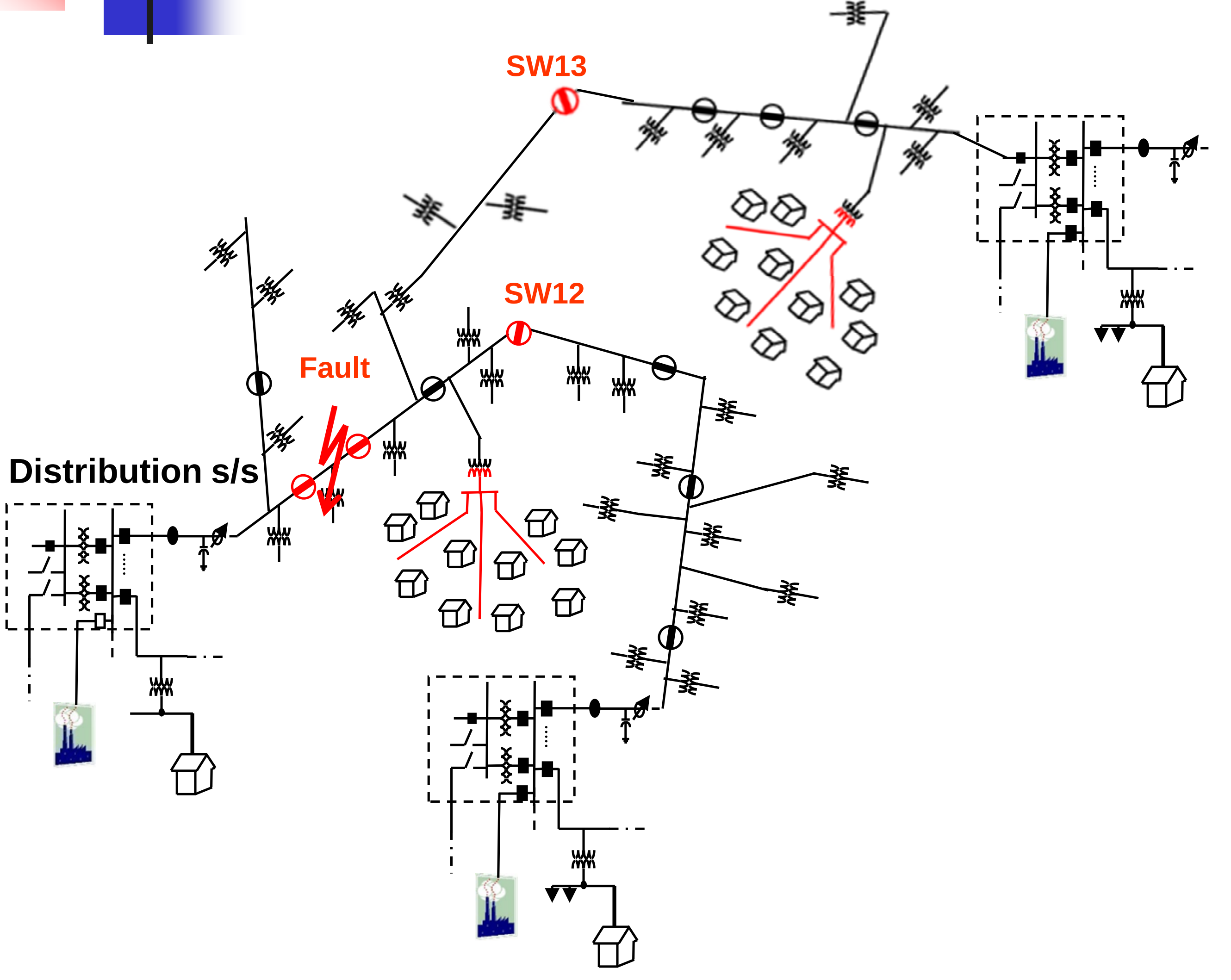

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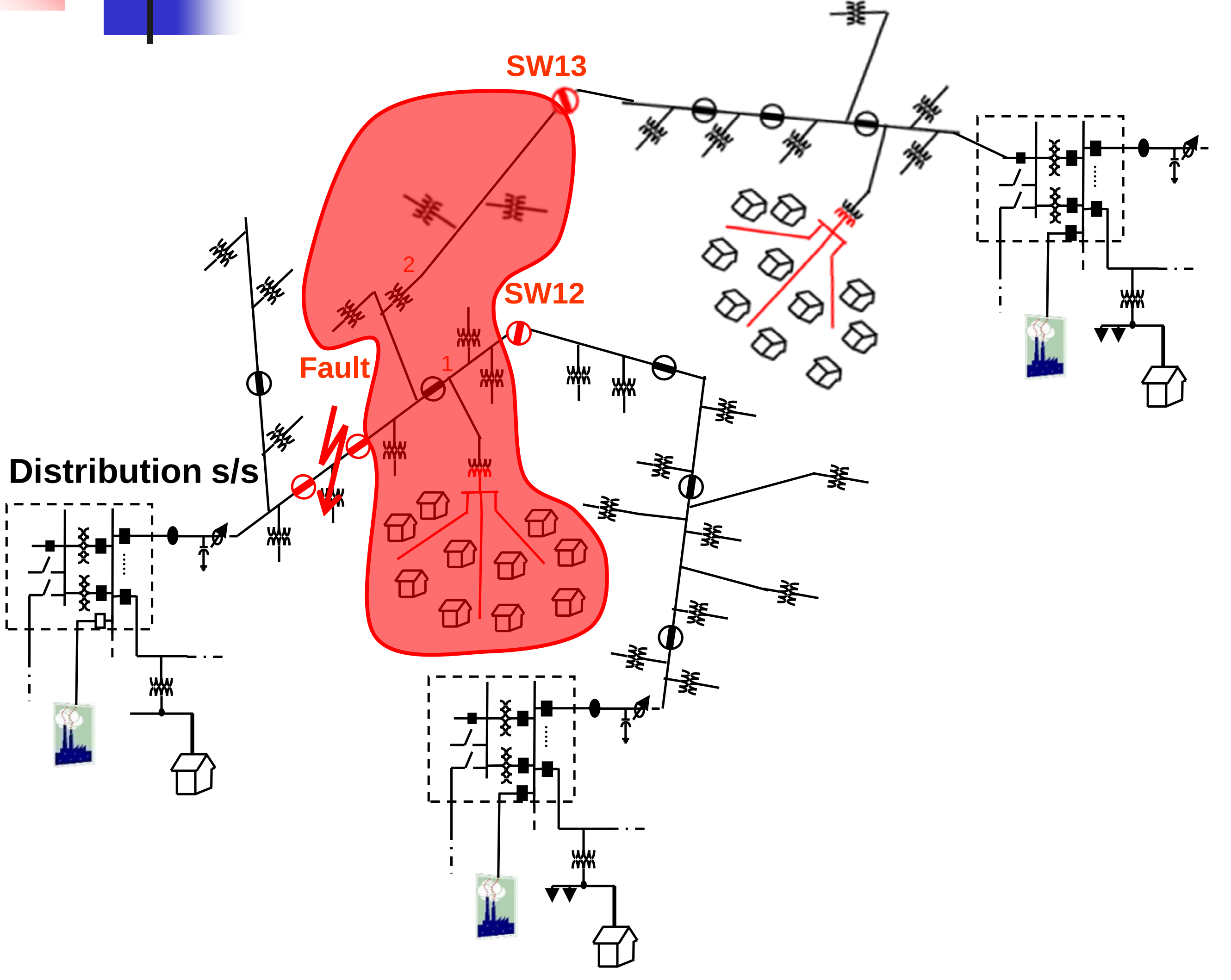
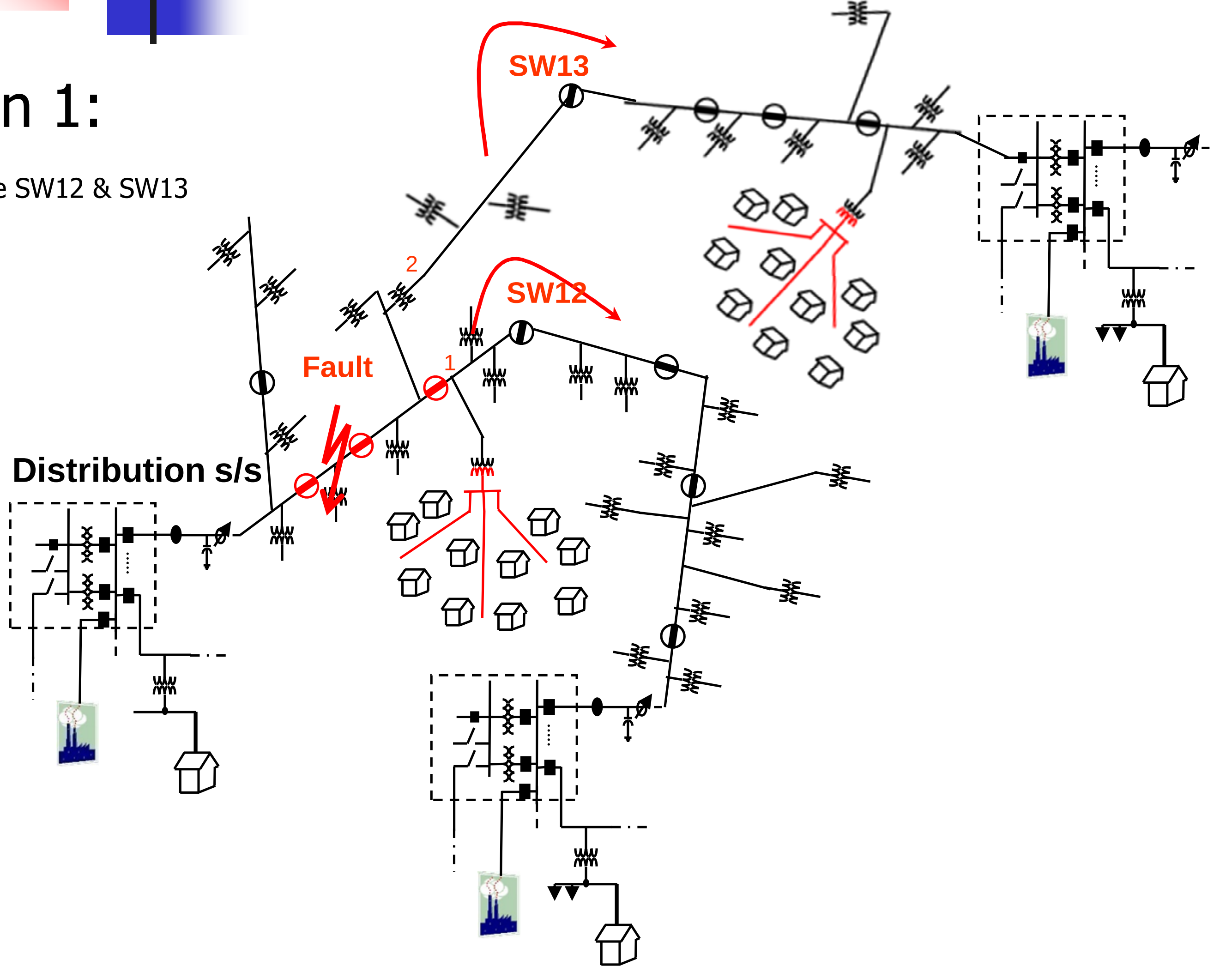


Decision support tool for the operator

Option 1:

- Close SW12 & SW13



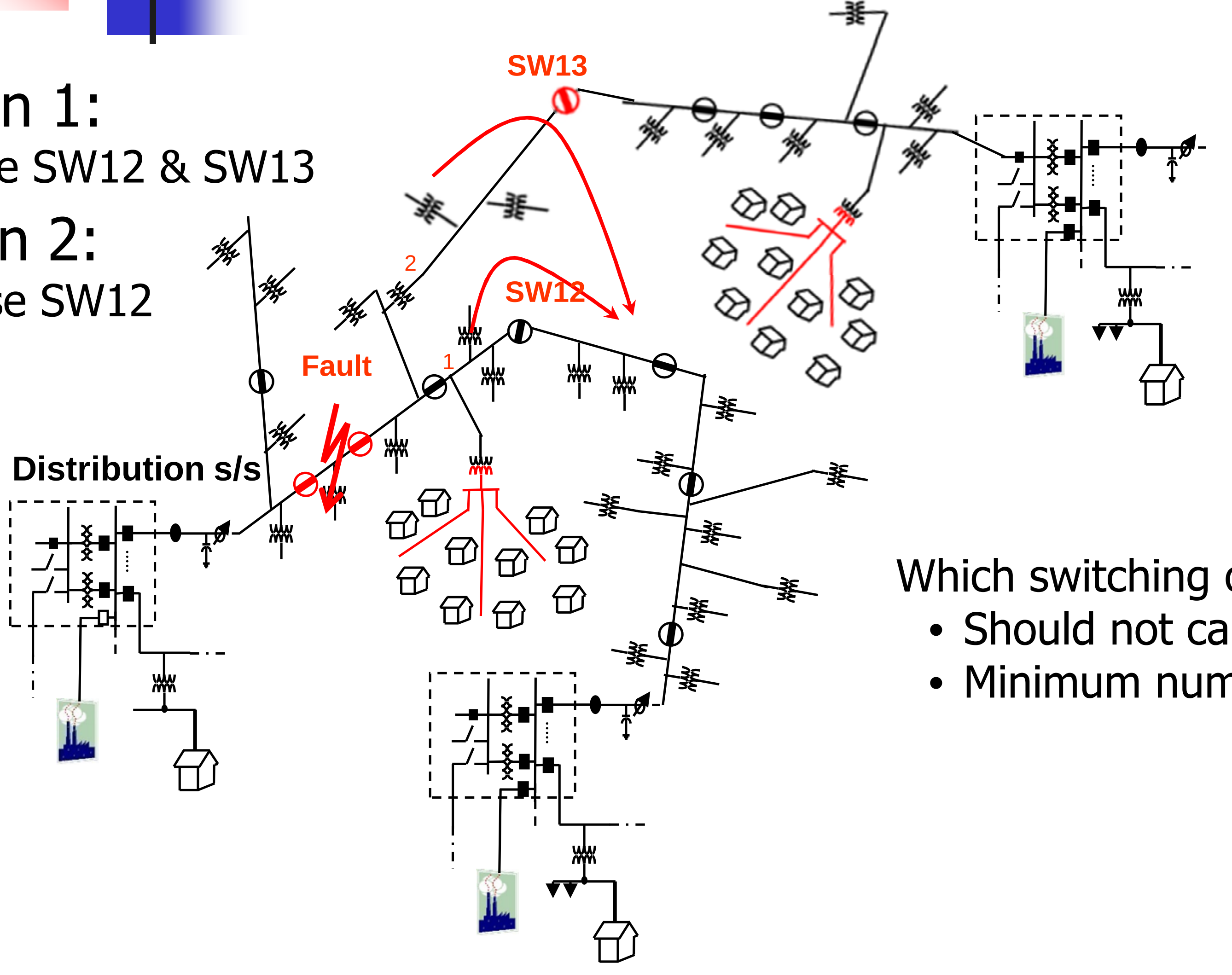
Decision support tool for the operator

Option 1:

- Close SW12 & SW13

Option 2:

- Close SW12



Which switching option ?

- Should not cause violations
- Minimum number of switchings

Typical Distribution Control Room Environment

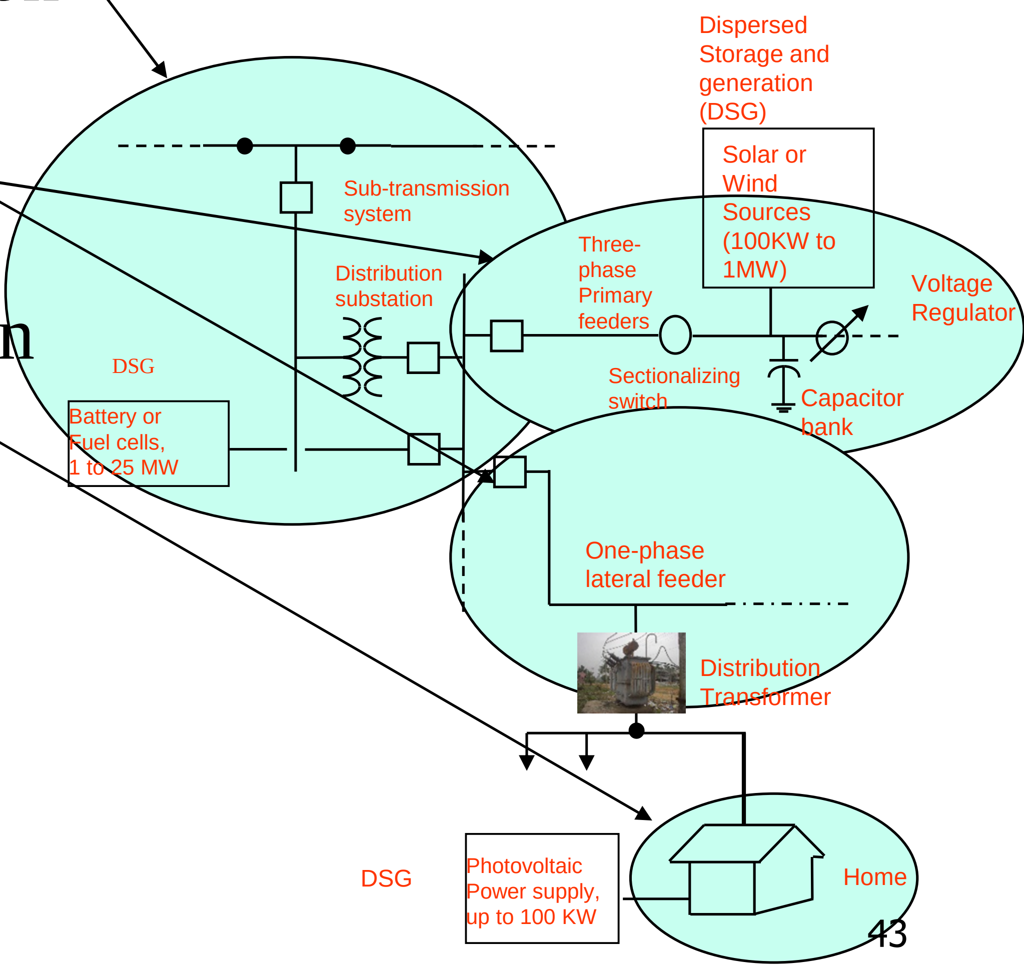
Source: http://tdworld.com/site-files/tdworld.com/files/uploads/2015/12/PDDCfinal_0.jpg

Levels of Automation

Substation Level Automation

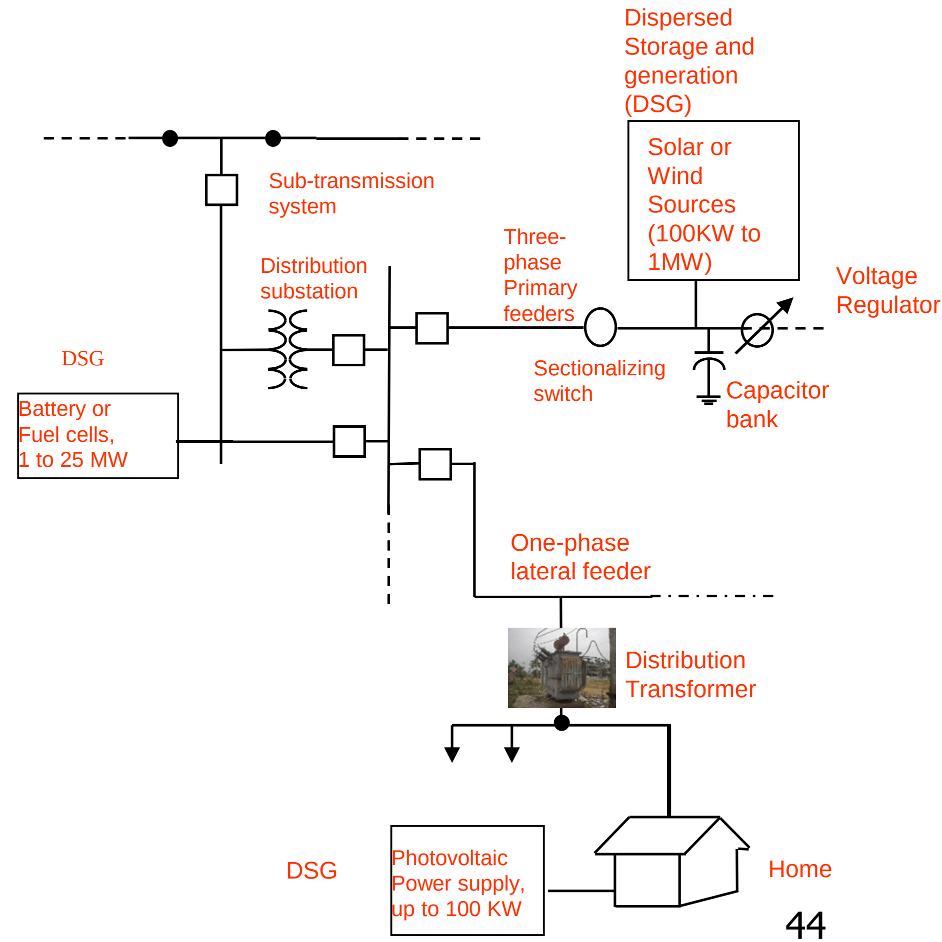
Feeder Level Automation

Customer Level Automation



SCADA – Software Components

Control



SCADA – Software Components

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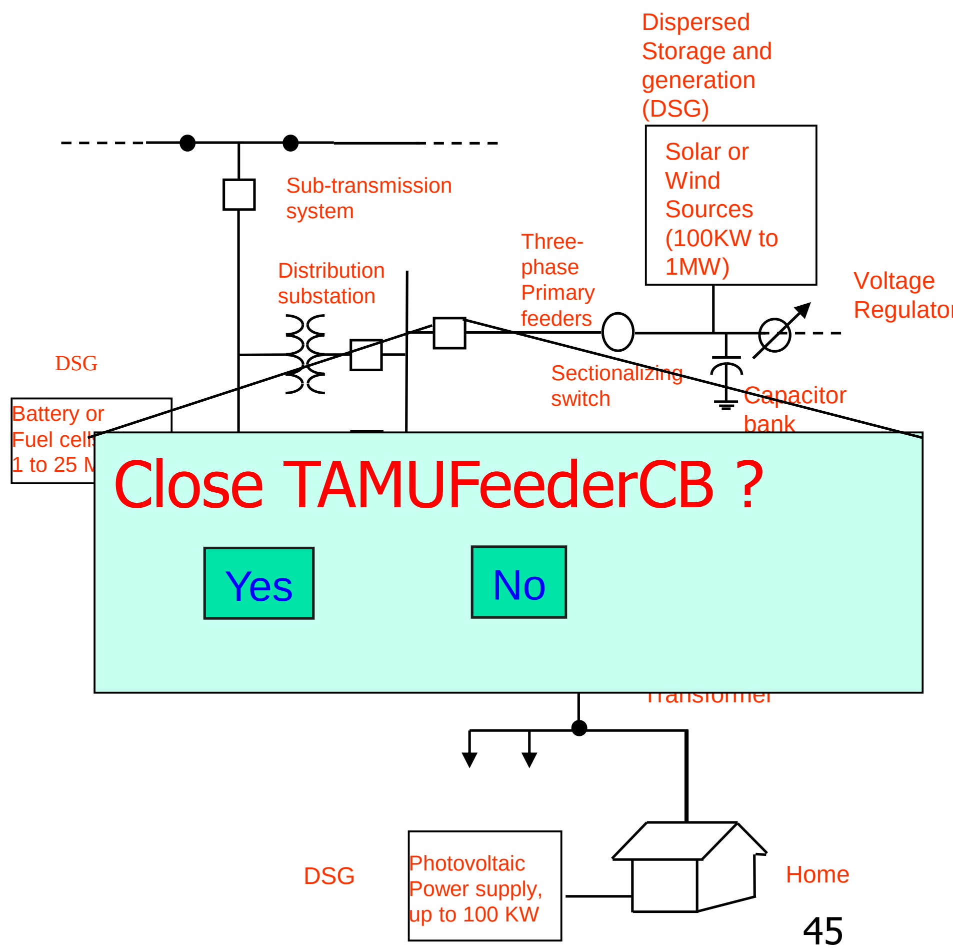

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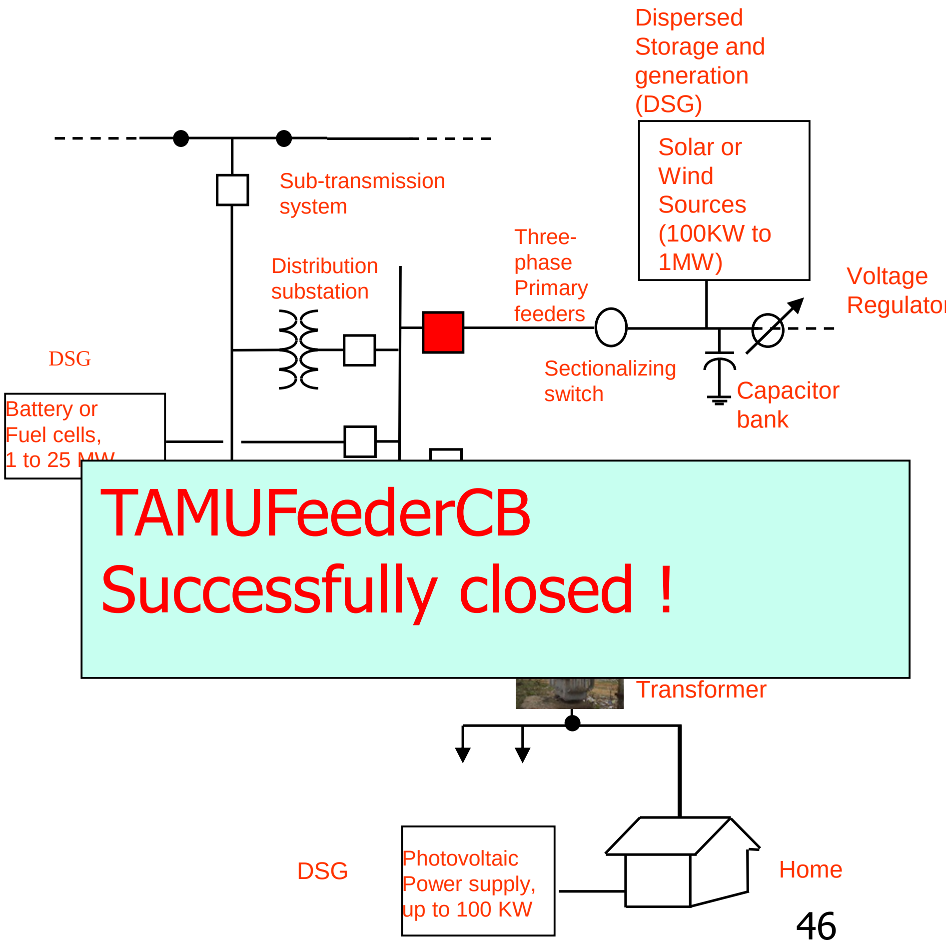
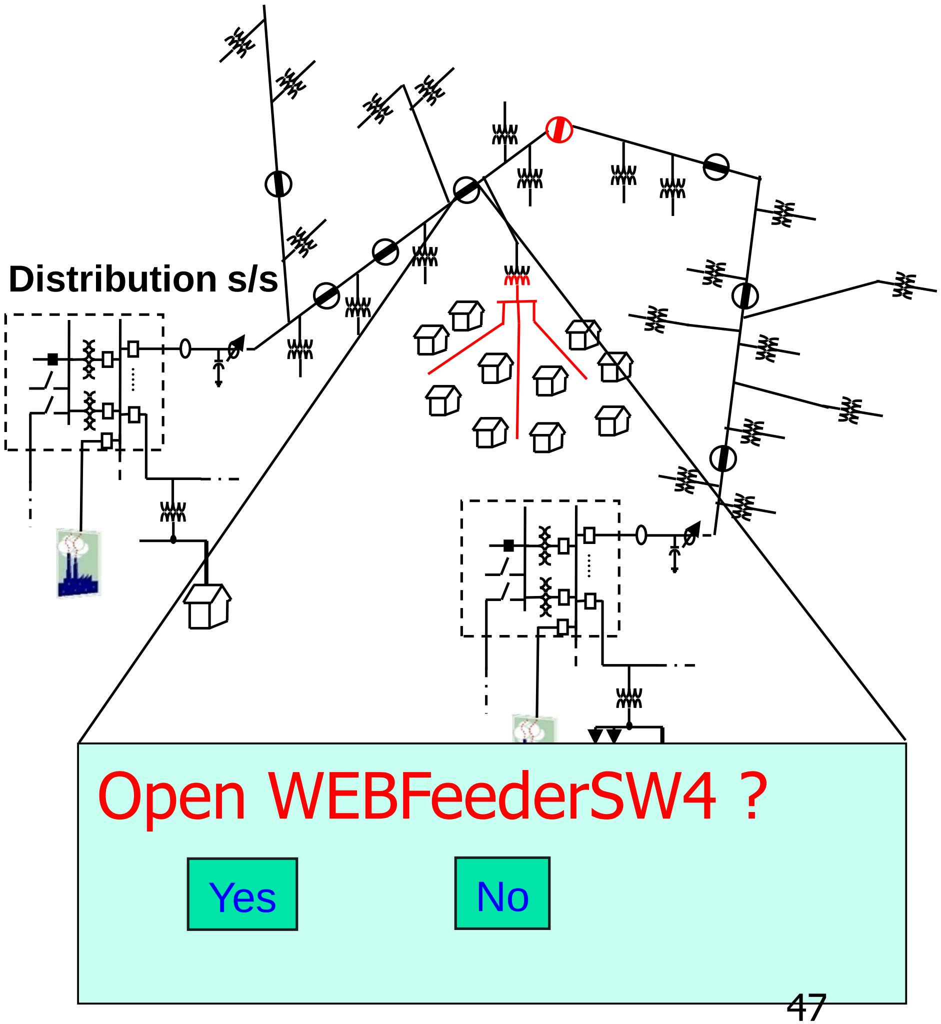

Dispersed
Storage and
generation
(DSG)
Solar or
Wind
Sources
(100KW to
1MW)
Sub-transmission
system
Distribution
substation
Three-
phase
Primary
feeders
Voltage
Regulator
DSG
Battery or
Fuel cells,
1 to 25 MW
Sectionalizing
switch
Capacitor
bank
TAMUFeederCB
Successfully closed !
Transformer
DSG
Photovoltaic
Power supply,
up to 100 KW
Home

Control



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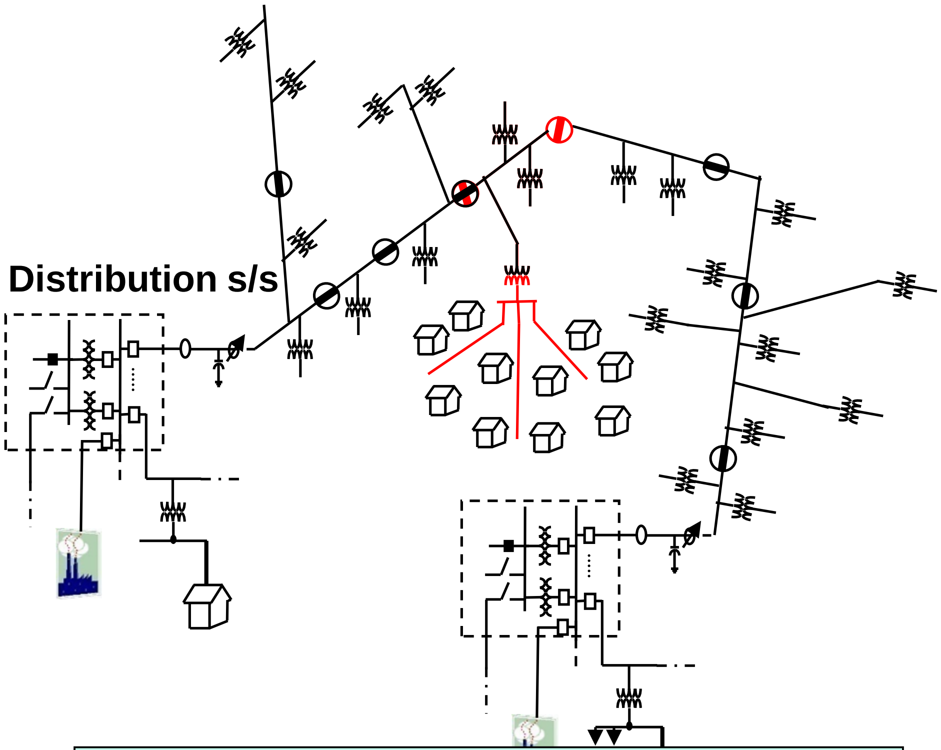


WEBFeederSW4
Successfully opened !

SCADA – Software Components

Graphical User Interface

Real Time display

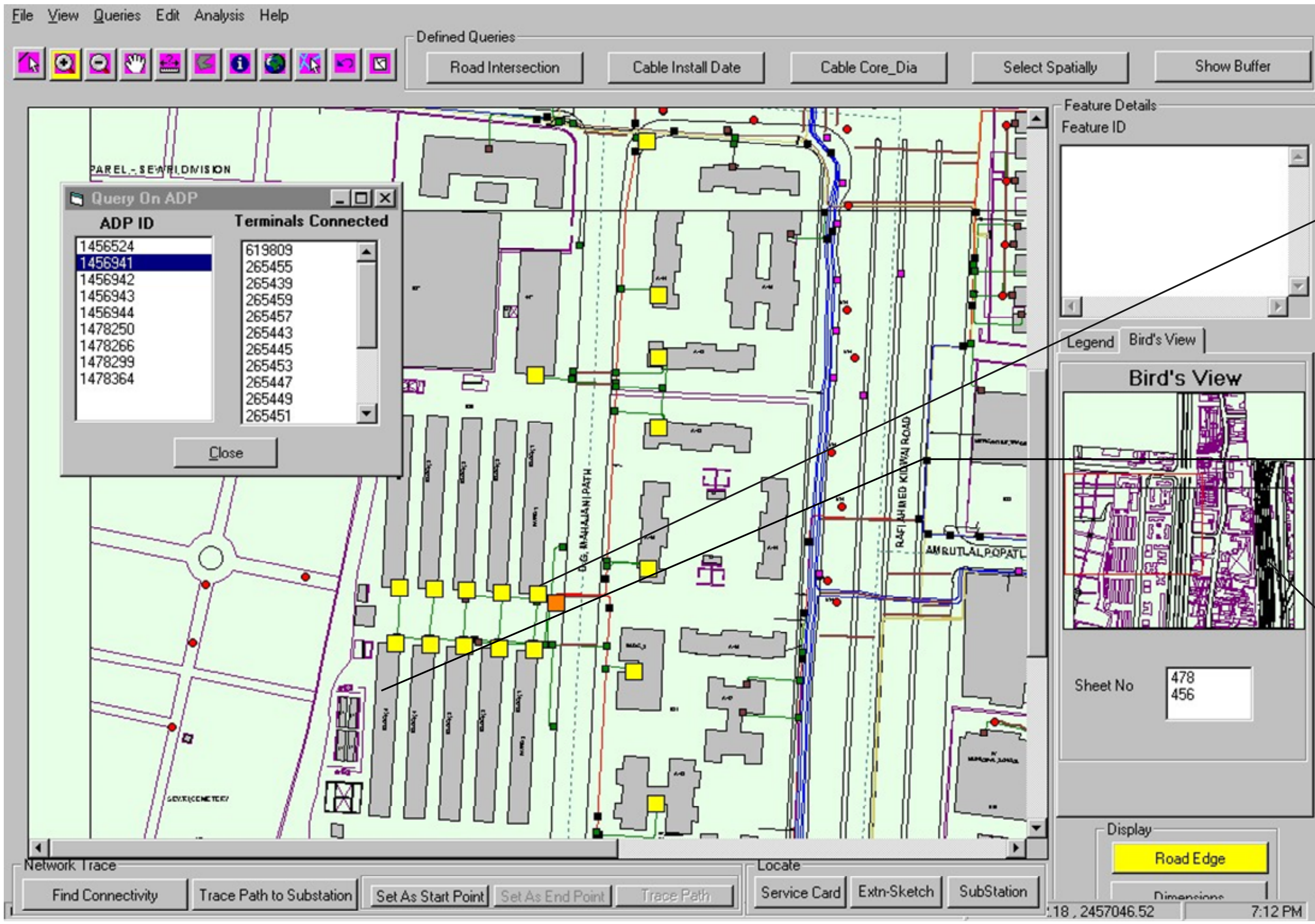
Single Line Diagrams,Graphics,Maps

Trends; Real-time and Historic

Alarms; current and Historic

Interface to control field devices

GIS Application Interface



Consumers associated with a ADP (Auxiliary Distribution Pillar)

Building Footprints

Bird's view of project area

Source: web

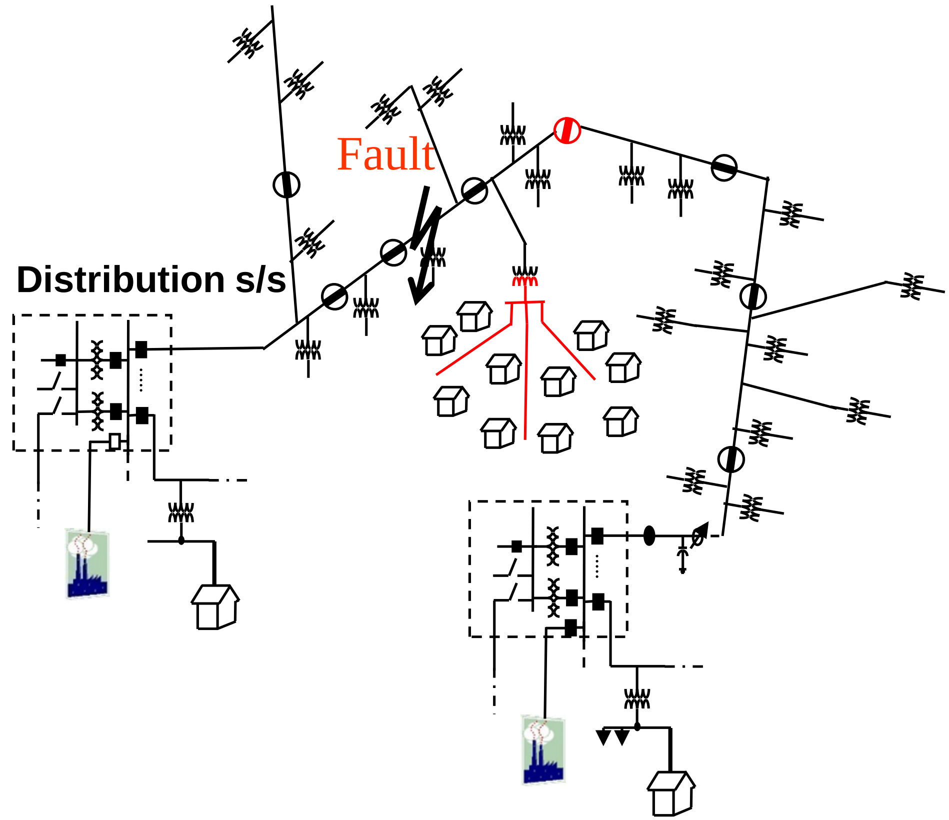
Distribution Automation Application Functions

- Feeder Reconfiguration for Service Restoration
- Feeder Reconfiguration for Load Balancing
- Feeder Reconfiguration for loss minimization
- Integrated volt-var control
- Outage Management
- Load Management/Demand Response
- ………

Remotely controllable switch on a feeder

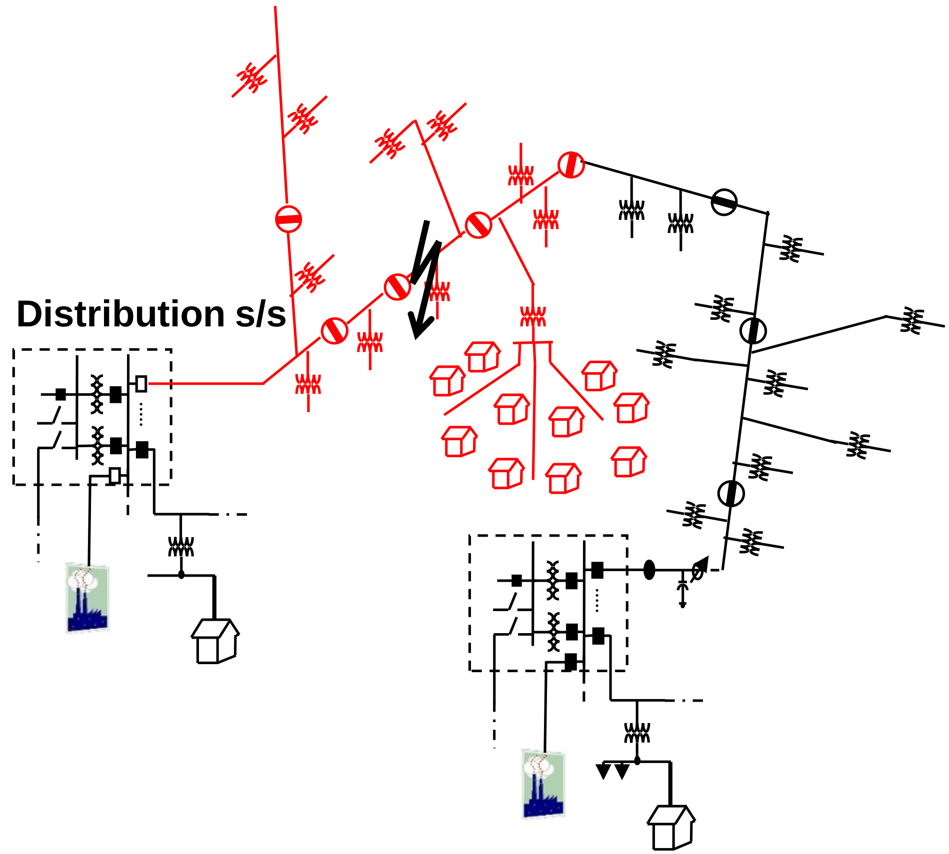
Network Reconfiguration - Fault Localization

- Fault Location, Isolation, and Service Restoration (FLISR) and Automated Feeder Switching*

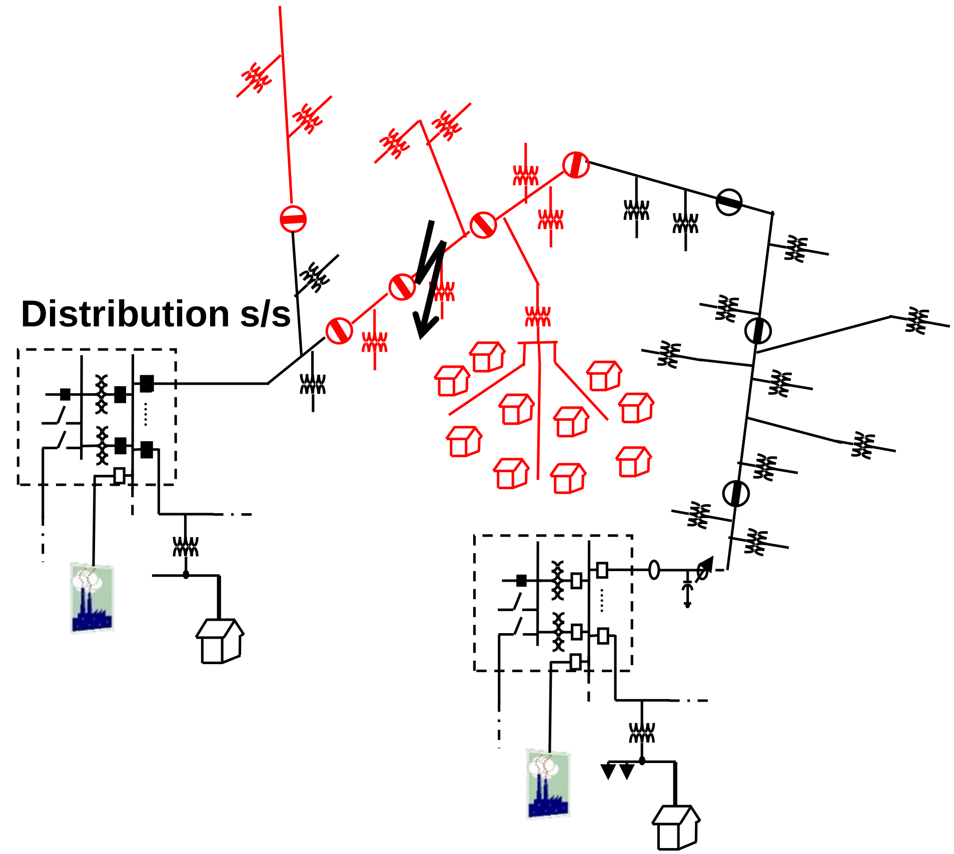


*https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

Network Reconfiguration - Fault Localization



Network Reconfiguration - Fault Localization



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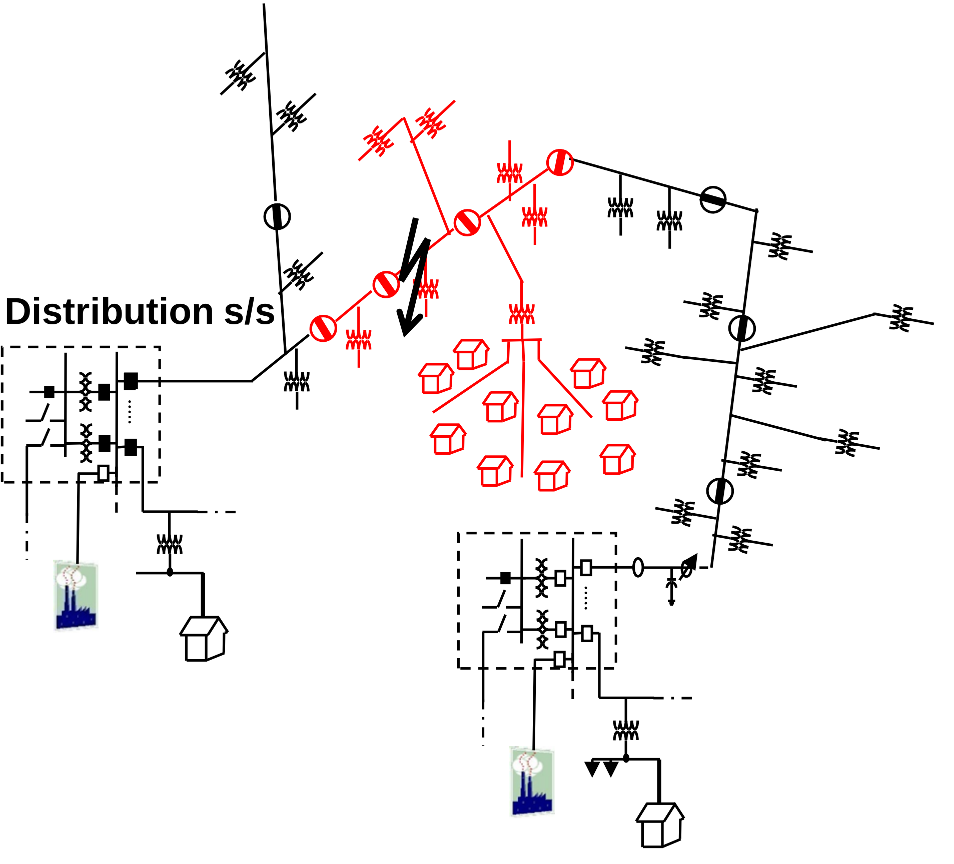

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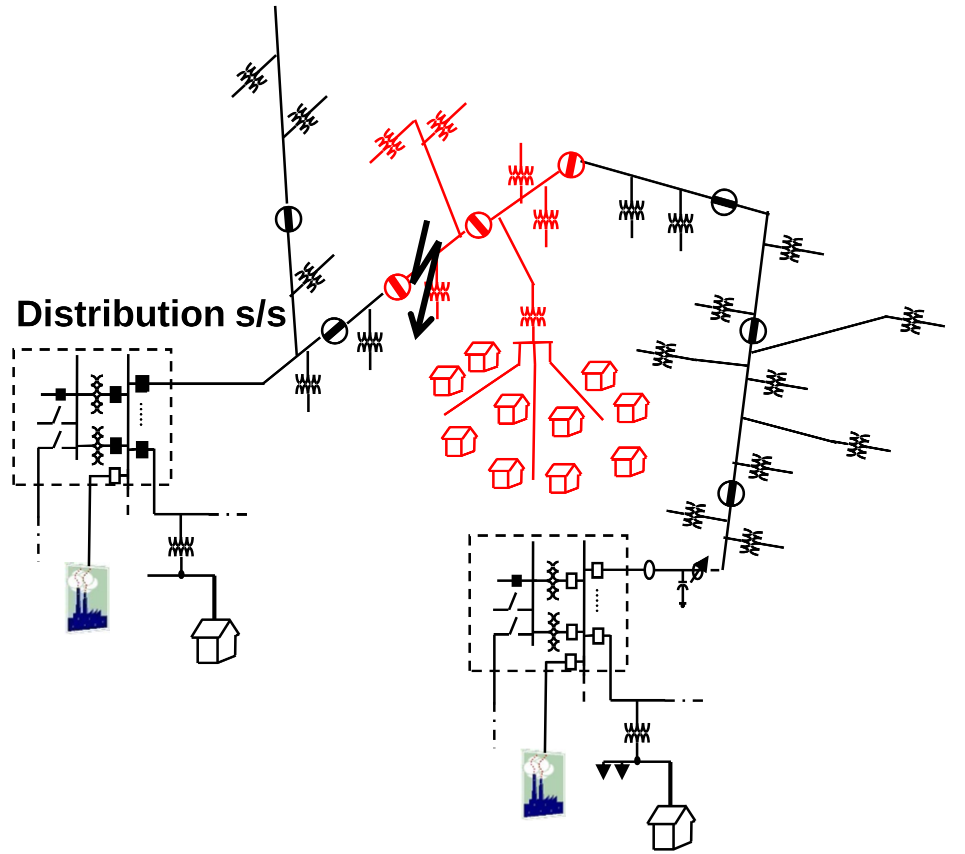

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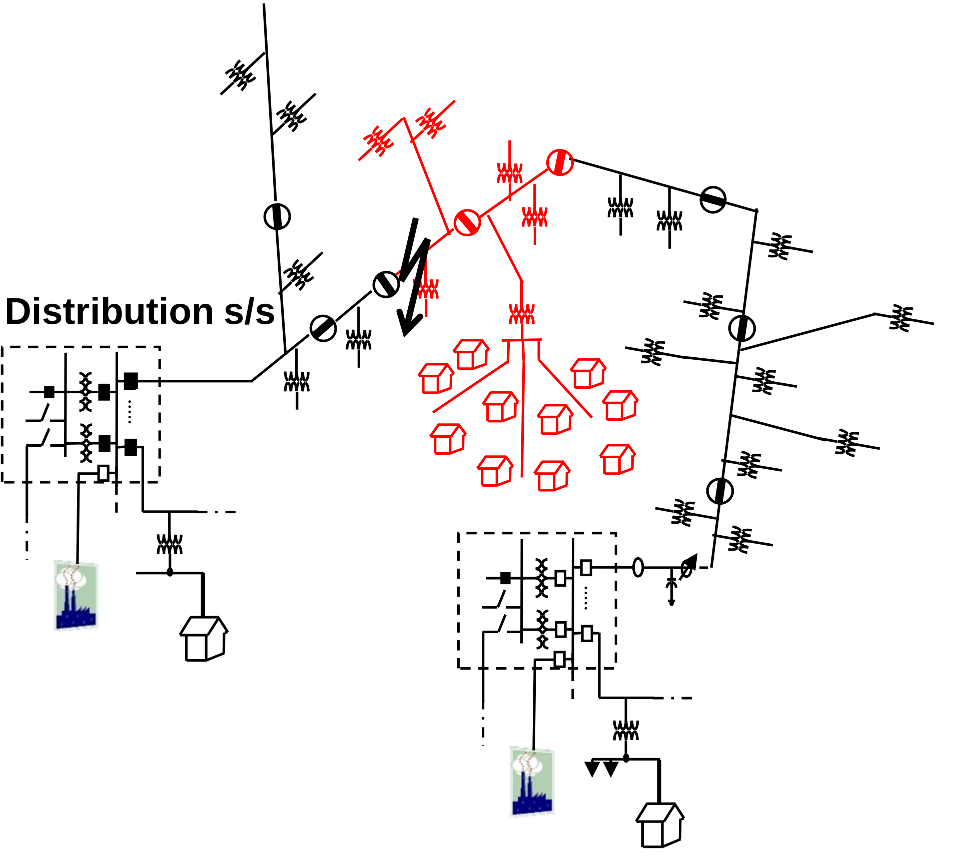

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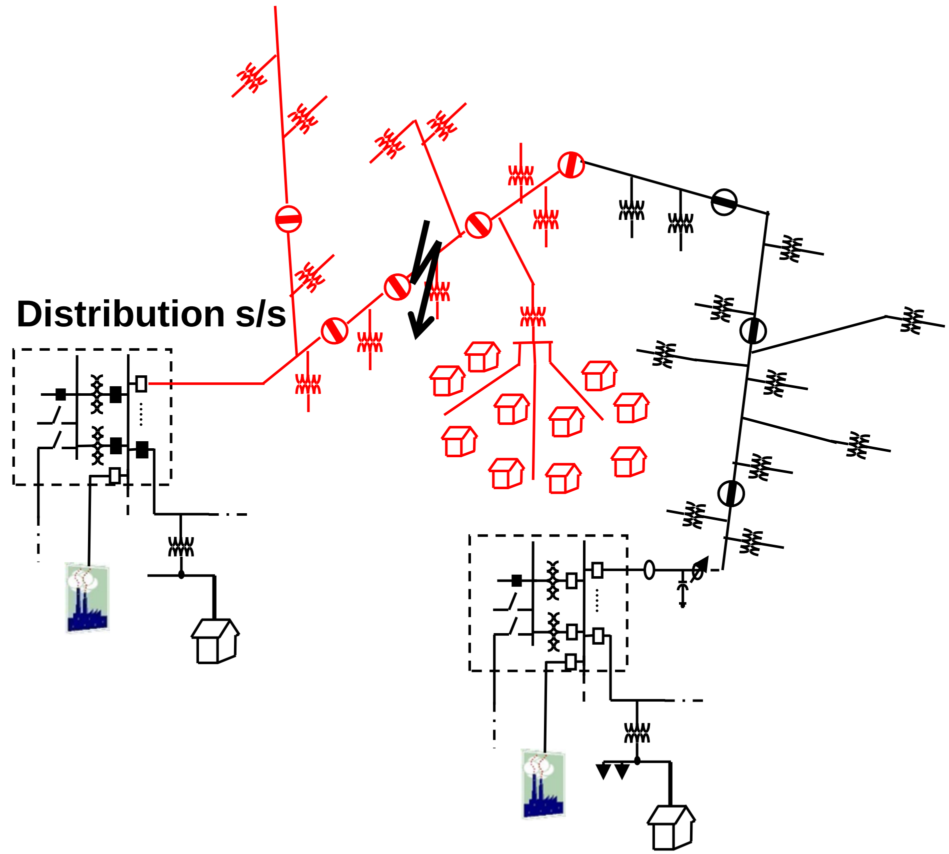
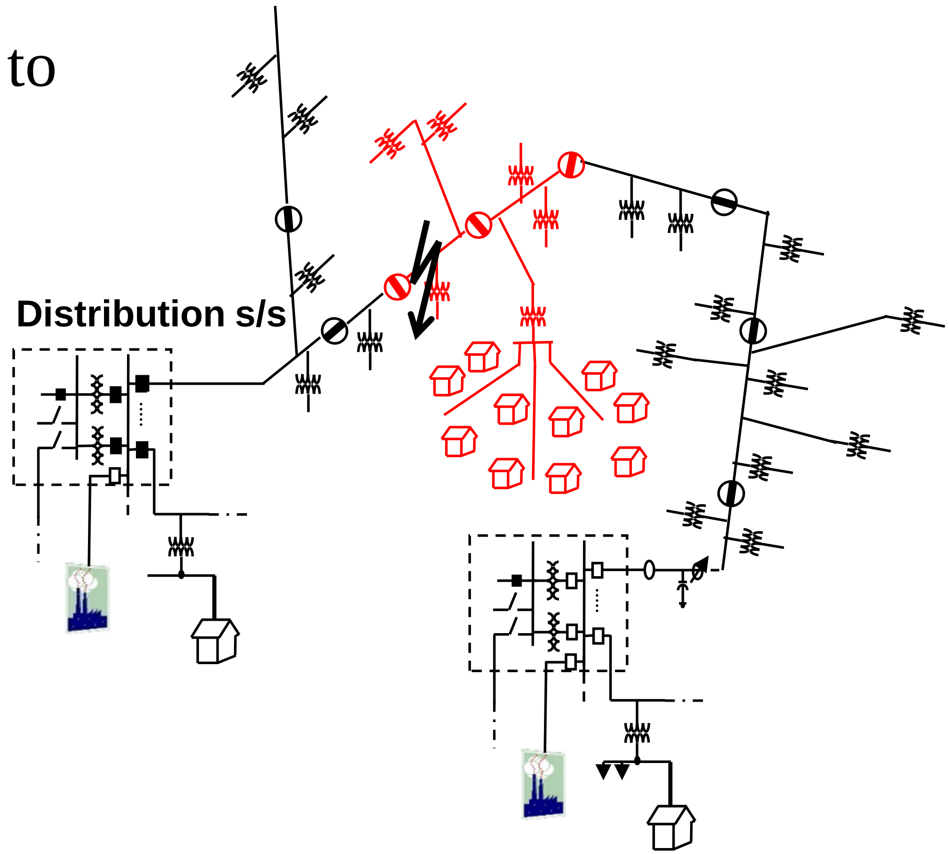


Network Reconfiguration - Fault Localization

- Localization is faster compared to manual determination of faulty section

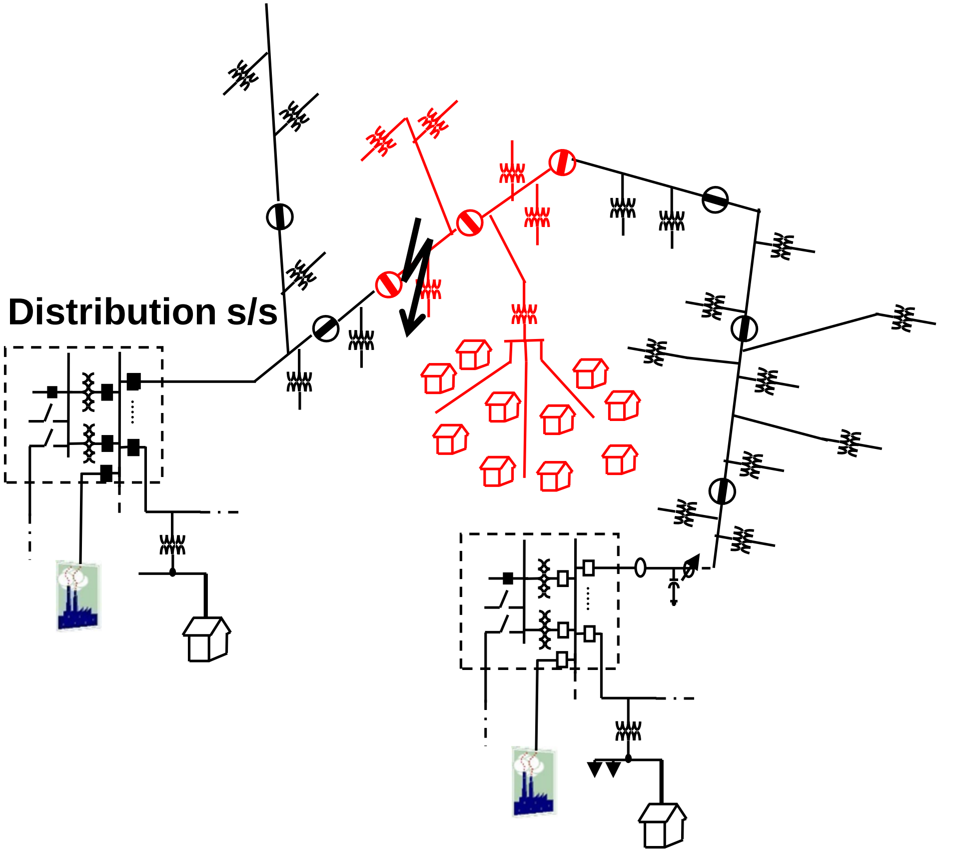


Network Reconfiguration - Fault Localization

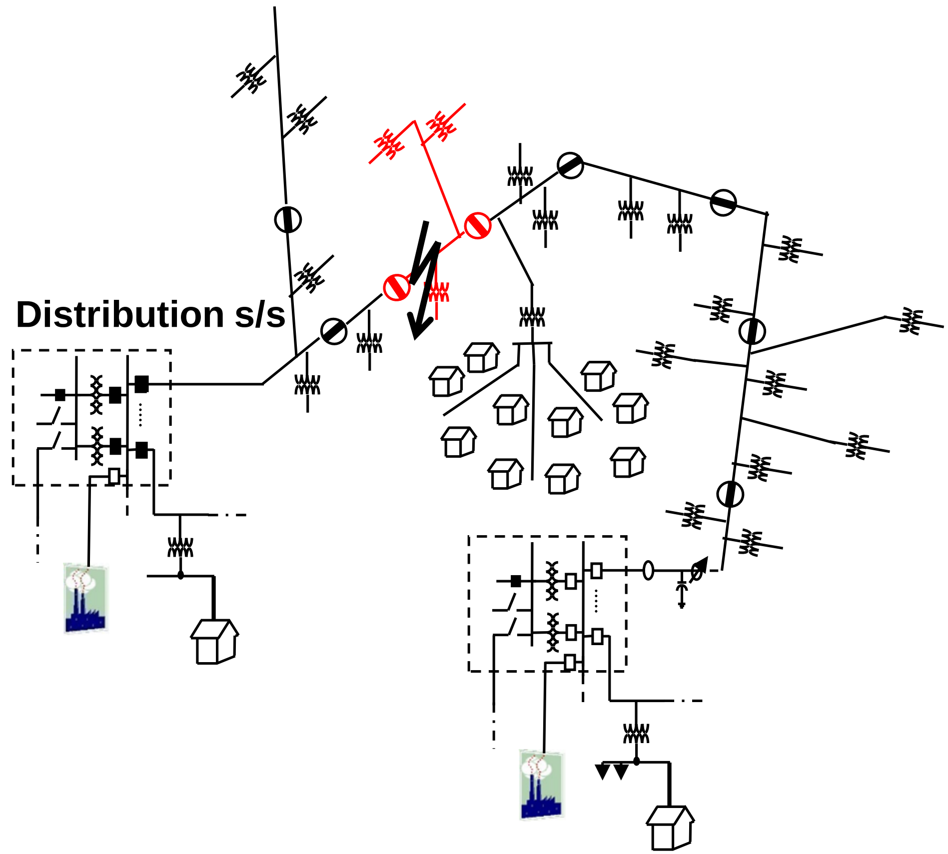
- Restores service to non-faulty feeder sections by reconfiguration
- Considerations

  * Presence of alternate paths
  * Operation of LB switches
  * Need to have remotely controllable switches
  * Restoration based on
    - satisfaction of current and voltage constraints
    - minimum switches
    - minimum losses

Network Reconfiguration – Service Restoration



Network Reconfiguration – Service Restoration



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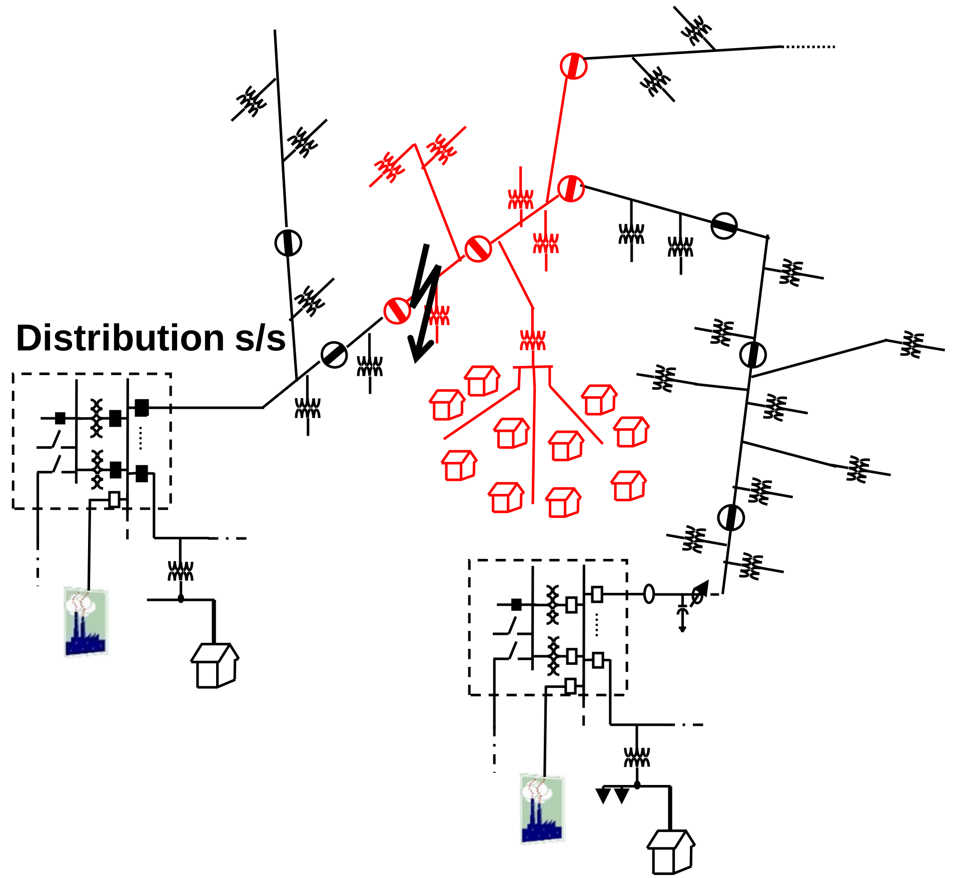

Network Reconfiguration – Service Restoration

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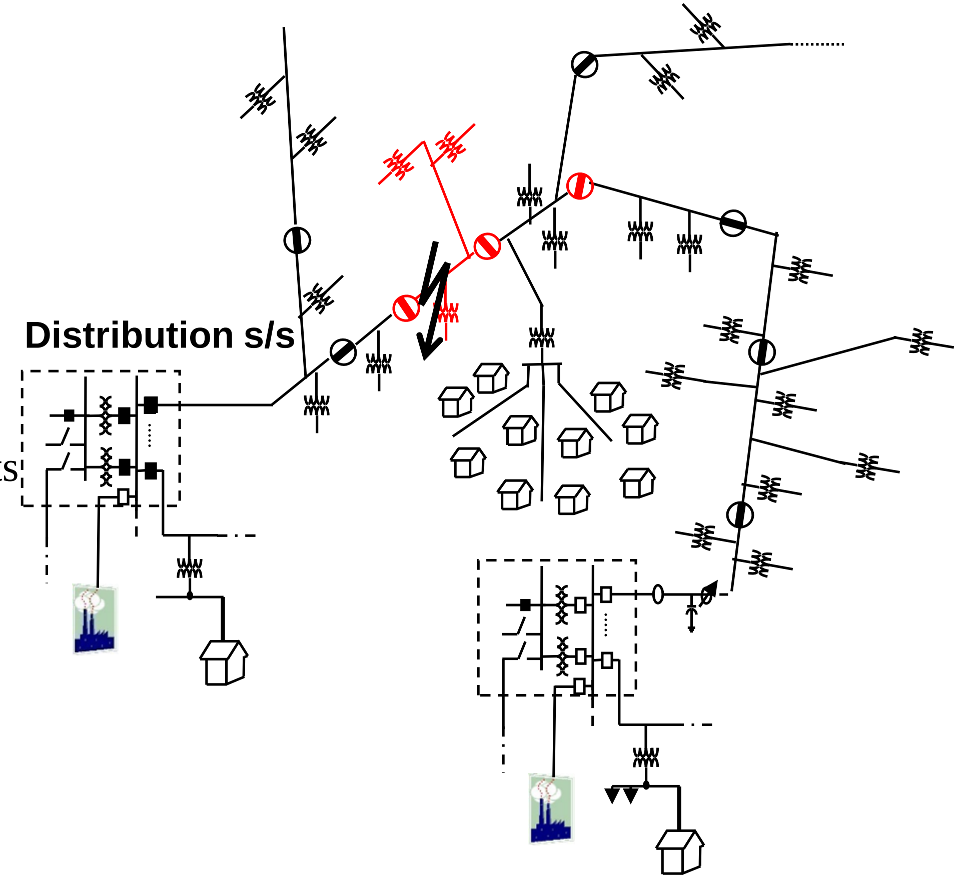

Network Reconfiguration – Service Restoration

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  * Operation of LB
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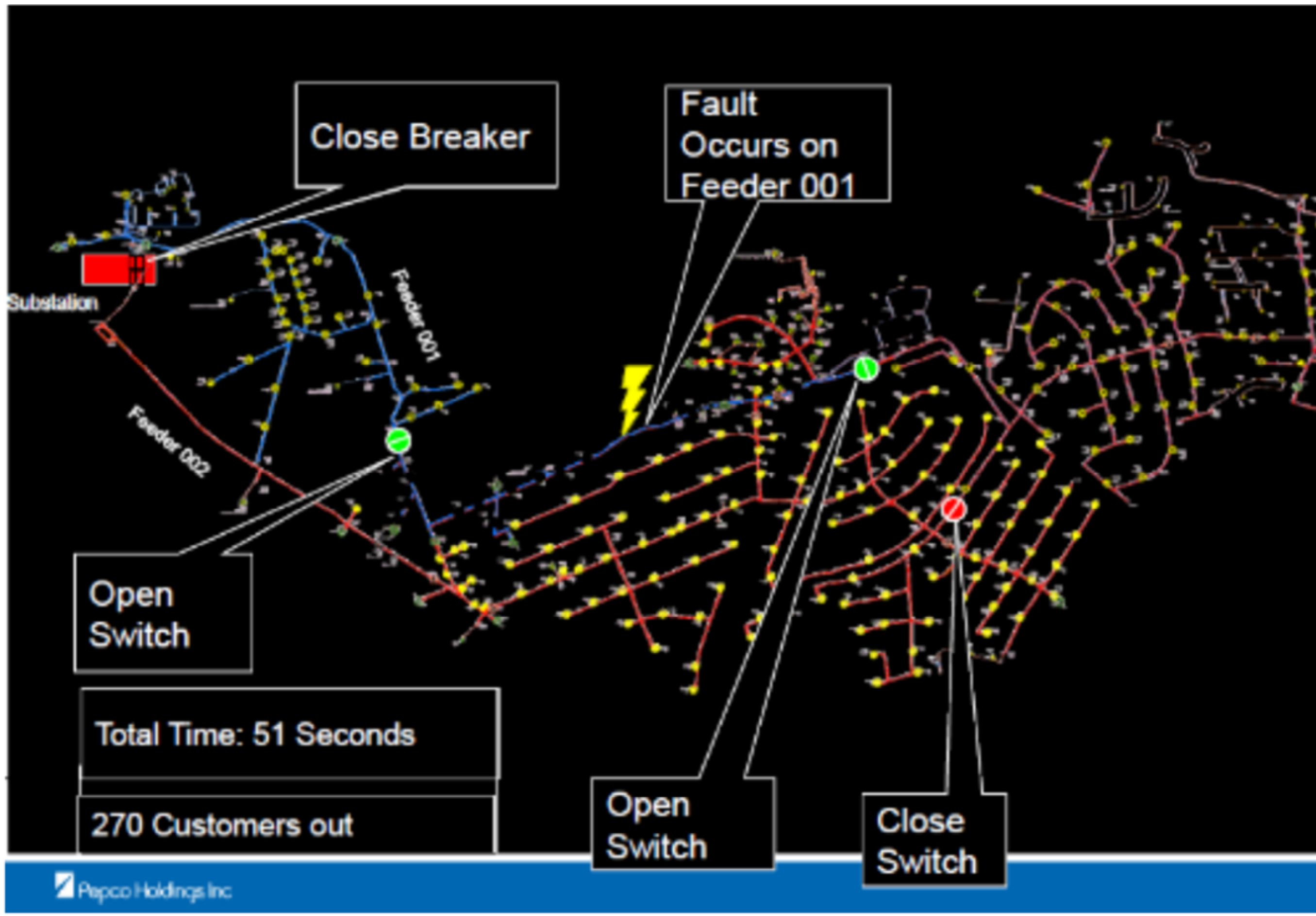
  * Restoration basec
    - satisfaction of
    - minimum swi
    - minimum loss

Screenshot of Pepco's Demonstration of FLISR Operations



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Network Reconfiguration – Service Restoration

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2 Major Findings: Reliability and Outage Management

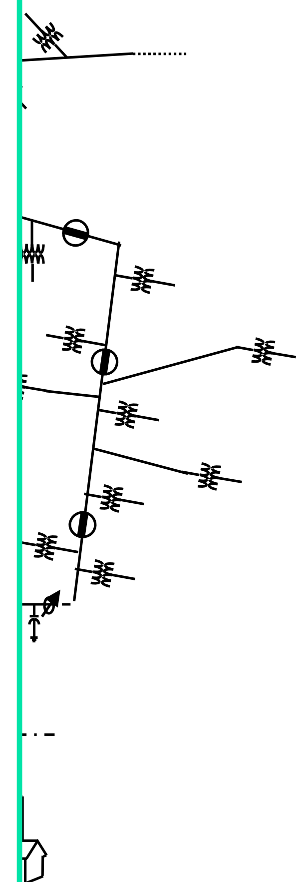
Improving grid reliability can reduce economic losses and customer inconveniences from sustained power interruptions, which are estimated to cost the economy almost $80 billion annually.[15] Table 4 summarizes select results from the 46 SGIG DA utilities that applied DA for reliability and outage management.

Table 4. Reliability and Outage Management Results from DA Investments

Primary Aim	• Fewer and shorter power disruptions for customers • Improved reliability performance, as measured by standard reliability indices (such as SAIFI and SAIDI)—which may be tied to utility performance standards			
Smart Grid Function	**Remote fault location and diagnostics**	**Fault location, isolation, and service restoration (FLISR) and automated feeder switching**	**Outage status monitoring and customers notifications**	**Optimized restoration dispatch**
Description	Without DA, utilities rely primarily on customer calls to identify outages. With DA, operators receive field telemetry from fault indicators, line monitors, and smart meters to rapidly pinpoint and diagnose issues.	FLISR operations quickly reconfigure the flow of electricity and can restore power to many customers who would otherwise have experienced sustained outages.	DA provides operators with comprehensive and real-time outage information, and alerts customers with more timely and accurate information about restoration.	By integrating distribution, outage management, and geographic information systems, utilities can precisely dispatch repair crews and accelerate restoration.
Key Impacts and Benefits	• Overall reduced customer minutes of interruption (CMI) • Shorter outage events with fewer affected customers • Lower or avoided restoration costs • Faster response, dispatch of repair crews, and prioritization of repairs	16 utilities reported reductions of about **146 million customer minutes of interruption** over three years For an outage event, FLISR operations showed: • Up to **45% reduction in number of customers interrupted** • Up to **51% reduction in customer minutes of interruption** About **270,000 fewer customers experienced sustained interruptions** (of >5 minutes) compared to estimated outcomes without FLISR One utility reported repair crews spent approximately 560 fewer hours annually assessing outages		

[15] Lawrence Berkeley National Laboratory, Cost of Power Interruptions to Electricity Consumers in the United States, LBNL-58164, (LBNL, 2006).

20 Distribution Automation: Results from the SGIG Program



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Distribution Automation Application Functions

- Feeder Reconfiguration for Service Restoration
- Feeder Reconfiguration for Load Balancing
- Feeder Reconfiguration for loss minimization
- Integrated volt-var control
- Outage Management
- Load Management/Demand Response
- ………

Distribution Automation Application Functions

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Capacitor Banks

Distribution Automation Application Functions

- Feeder Reconfiguration for
- Feeder Reconfiguration for
- Feeder Reconfiguration for
- **Integrated volt-var control**
- Outage Management
- Load Management/Demand
- ………

Table 14. Voltage and Reactive Power Management Results from DA Investments

Primary Aim	• Reduced wear and tear on capital assets • Lower capital and operating costs to keep rates affordable for consumers • Protect sensitive electronic equipment—in utility and customer systems—from voltage and other power quality issues that can damage or limit equipment performance			
Smart Grid Function	**Integrated volt/volt-ampere reactive controls (IVVC)**	**Automated voltage regulation**	**Conservation voltage reduction (CVR)**	**Automated power factor correction**
Description	IVVC enables automated and greater control of voltages and reactive power levels to improve feeder power factors and reduce line losses.	Enables utilities to monitor voltages, determine optimal control signals, and use manual or automated controls to regulate voltage levels on particular feeders	Monitoring and automated controls enable utilities to reduce feeder voltage levels to reduce electricity use, primarily during peak periods.	By monitoring voltages and using automated capacitor banks, utilities accomplish power factor corrections to improve energy efficiency and reduce energy requirements for electricity delivery
Key Impacts & Benefits	• Reduced line losses to improve energy efficiency and capacity management • Reduced peak demand • Improved reliability and reduced outage costs • Energy savings to reduce emissions and customer bills • Improved voltage management capabilities and power system measurement • Reduced reactive power consumption • Generation fuel supply and cost savings • Reduced damage to customer-side electronic equipment		38 utilities employed conservation voltage reduction to **reduce peak demands by 1%–3%** on average per event. One utility reduced annual system energy losses by an estimated 4,500 MWh, resulting in: • $0.34 million in **annual energy savings** • **Reduced CO_2 emissions** by about 340 metric tons Several utilities **improved power factors to near unity** (where power factors equal 1). One utility in particular: • **Reduced reactive power requirements by about 10%–13%** over a one-year test period • **Increased power factors by 1%–2%**	

U.S. DEPARTMENT OF ENERGY | Office of Electricity Delivery and Energy Reliability

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*https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

Capacitor Banks

Illustration of Distribution Automation System

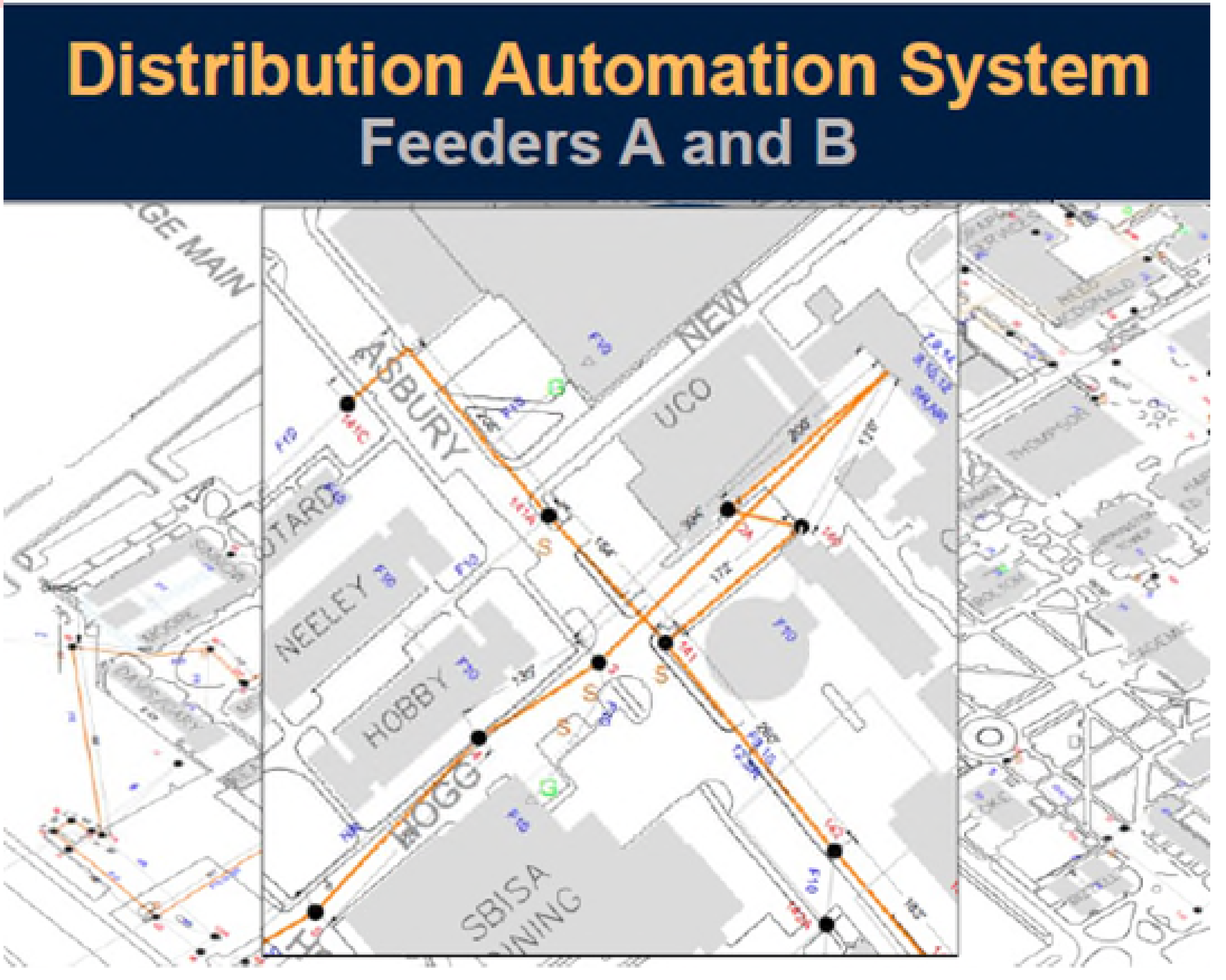
University Implements Distribution Automation to Enhance System Reliability and Optimize Operations

Tyler J. Hjorth
Texas A&M University

Payal Gupta and Ashok Balasubramanian
Schweitzer Engineering Laboratories, Inc.

Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System



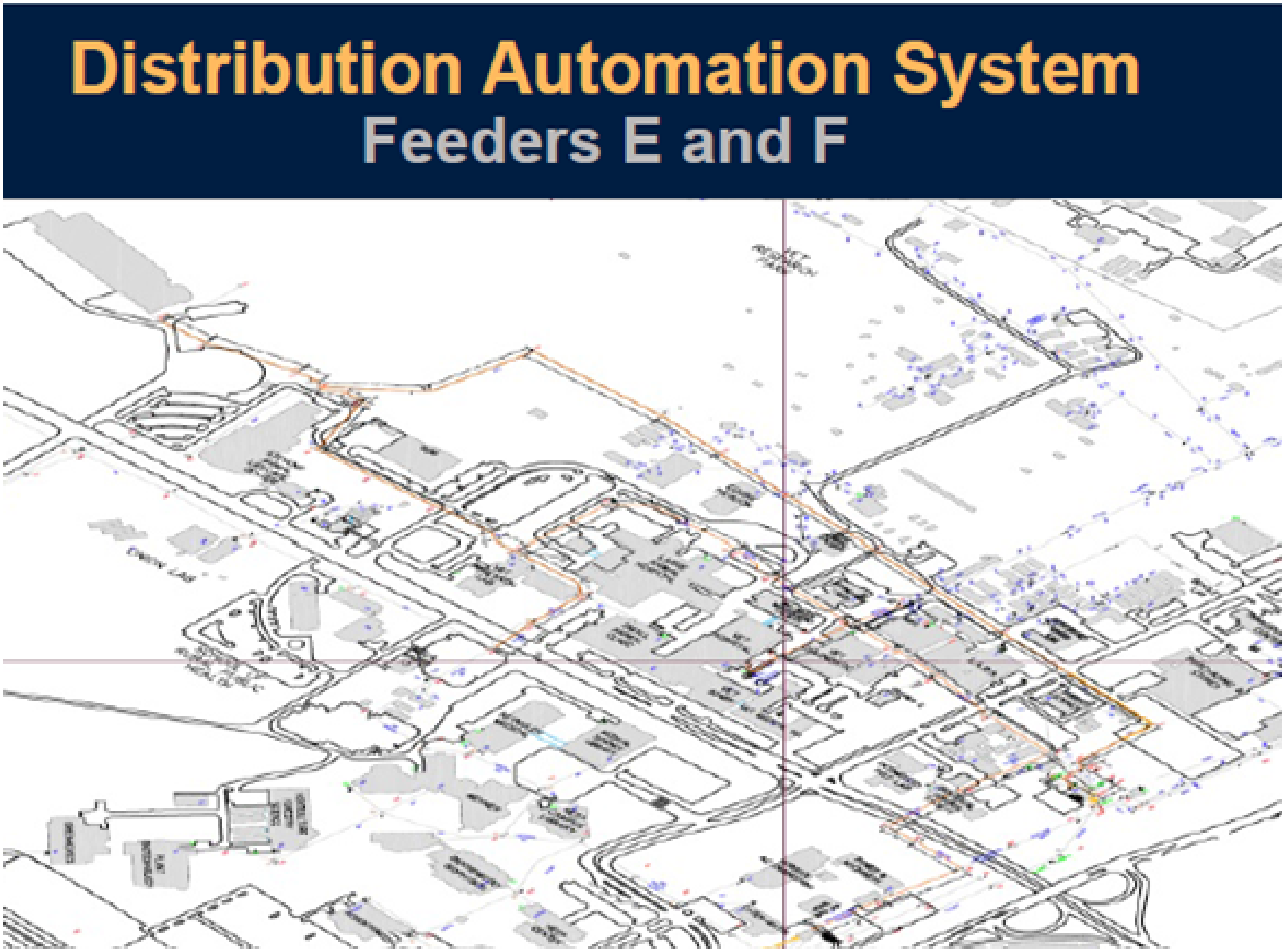
Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System

Distribution Automation System
Feeders C and D

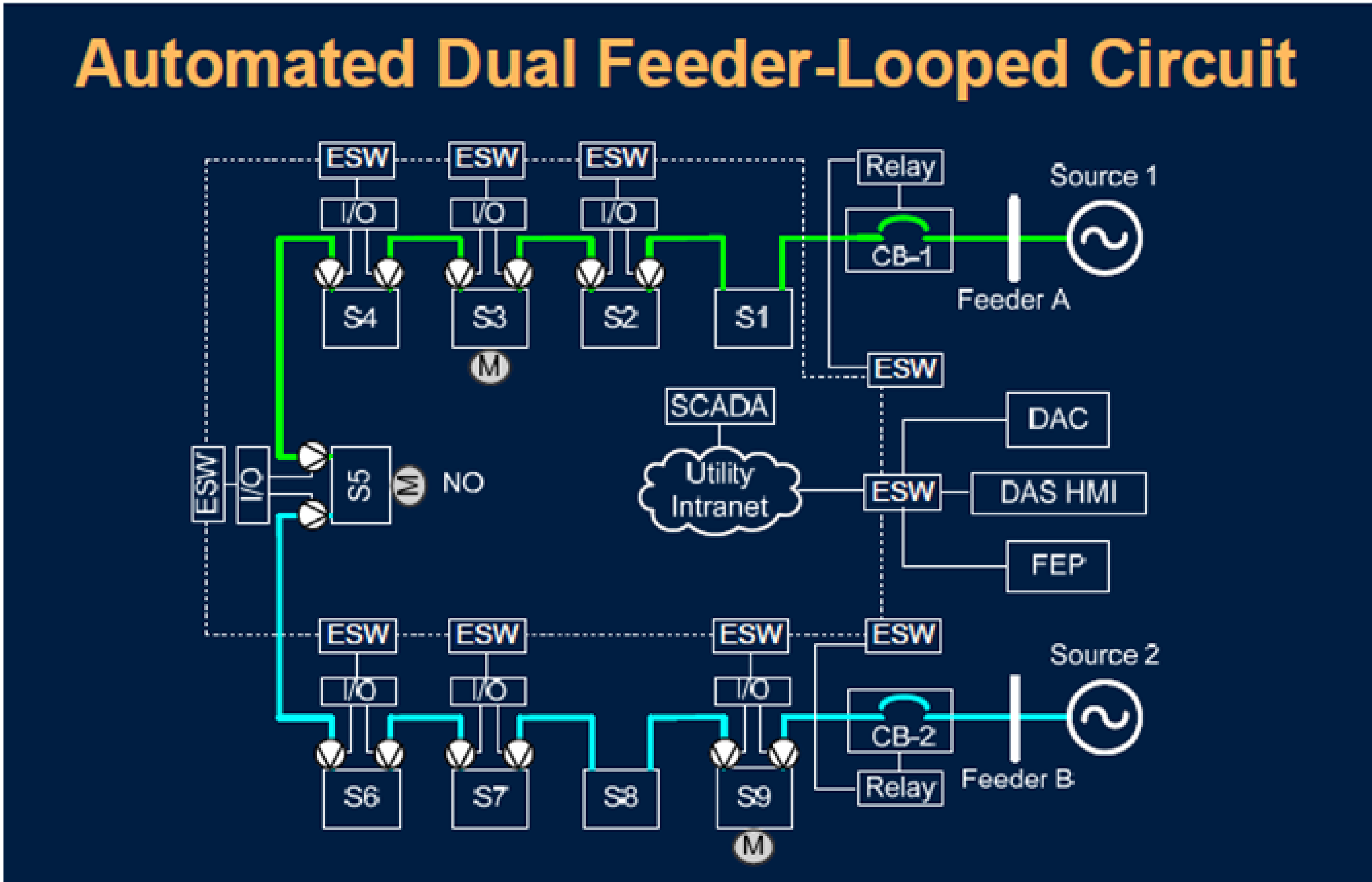
Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System



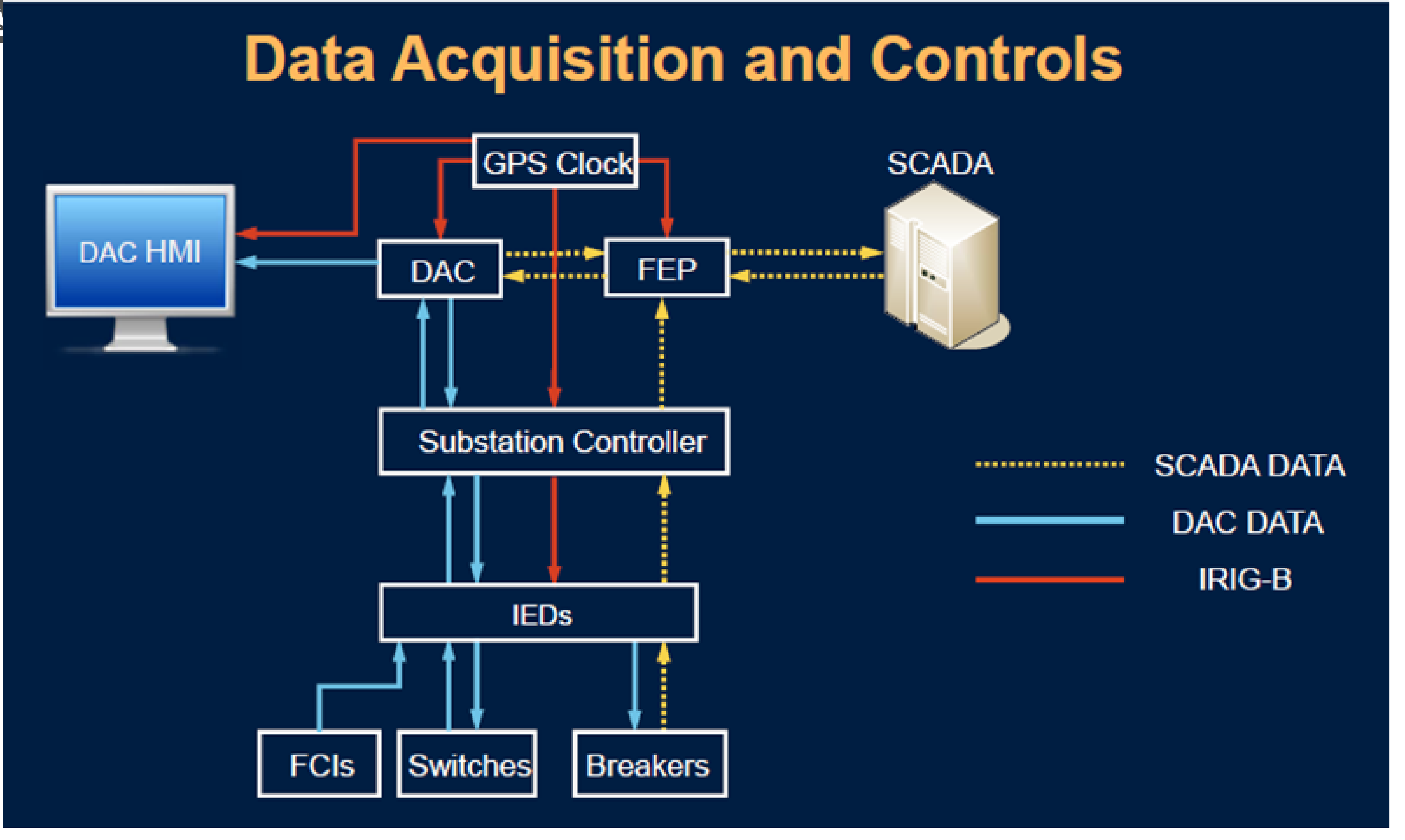
Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System



Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System



Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System

Distribution Automation System (DAS)

- Fault detection and isolation
- Automatic service restoration
- Automatic source transfer on loss of substation source
- System abnormal condition monitoring
- Response to multiple simultaneous faults
- Automated return-to-normal sequence

Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

Illustration of Distribution Automation System

Benefits of DAS

- Determines fault location
- Executes automatic network reconfiguration
- Improves system reliability with reduced outage time
- Increases system operational efficiency
- Reduces operating cost
- Allows easy system expansion with modular and scalable design

Ref: 69th Annual Conference for Protective Relay Engineers, April 4-7, 2016, Texas A&M University,

New Trends in Distribution System Operations

- New Paradigm : Smart Grids
- Integration of renewables
- Distributed Energy Resources (DER)
- Integration of renewables
- Protection challenges
- Incipient Fault Identification
- Micro-grids
- Distribution State Estimation
- ……….

References

- IEEE Smart Distribution Working Group
- P1854/D004 Draft Guide for Smart Distribution Applications, 2017

P1854™/D004
Draft Guide for
Smart Distribution Applications

Sponsor

Transmission and Distribution
of the
IEEE Power and Energy Society

Approved <Date Approved>

IEEE-SA Standards Board

P1854/D004, January 2017
Draft Guide for Smart Distribution Applications

Participants

At the time this draft guide was completed, the following members of the Smart Distribution Working Group had contributed to this Guide:

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References

January 9, 2019 CONTACT

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Jan. 8-11, 2019 Las Vegas

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The ten largest U.S. smart grid projects

SEPTEMBER 6, 2011

In 2009, the American Recovery & Reinvestment Act (ARRA) set aside $11 billion for smart grid investment. The U.S. Department of Energy (DoE) began distributing $3.4 billion of these ARRA funds in 2009 in the form of government grants, which were to be matched by $4.7 billion in private investment, according to the DoE. These grants were to be used for over 100 projects in 49 of 50 states, and the DoE immediately distributed $47 million to eight ongoing projects.

In 2009, the American Recovery & Reinvestment Act (ARRA) set aside $11 billion for smart grid investment. The U.S. Department of Energy (DoE) began distributing $3.4 billion of these ARRA funds in 2009 in the form of government grants, which were to be matched by $4.7 billion in private investment, according to the DoE. These grants were to be used for over 100 projects in 49 of 50 states, and the DoE immediately distributed $47 million to eight ongoing projects.

Grants given by the government are to cover up to 50% of the cost of a given smart grid project. About 25% of SGIG funding went toward smaller projects ($300K to $20 million in cost), while the remaining 75% went to larger projects ($20-200 million in cost).

Below is a list of the top ten largest smart grid projects in the United States based on cost.

Source: *Smart Grid Information Clearinghouse (www.SGIclearinghouse.org)*

FEATURED EVENTS

There are no upcoming events.

Tweets by @TelecomEngine

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Bill Rollender
@Bill_Rollender

Source: https://www.telecomengine.com/the-ten-largest-u-s-smart-grid-projects/

References

Top ten largest Smart Grid Projects in US based on Cost

1. Charlotte, NC – Duke Energy Business Services LLC Smart Grid Project

This project is a comprehensive grid modernization for Duke Energy's Midwest electric system, which encompasses Ohio, Indiana, and Kentucky. The project includes open, interoperable, two-way communications networks, smart meters for 1.4 million customers, automated advanced distribution applications, developing dynamic pricing programs, and supporting the plug-in electric vehicles.

ARRA FUNDING -$200,000,000

TOTAL FUNDING -$851,700,000

2. Houston, Texas – CenterPoint Energy Smart Grid Project

This project includes the installation of 2.2 million smart meters and more than 550 sensors and automated switches that will help protect against system disturbances such as natural disasters.

ARRA FUNDING – $200 000 000

TOTAL FUNDING – $639 187 435

3. Miami, Florida – Florida Power & Light Company Smart Grid Project

Energy Smart Florida is a comprehensive project installing over 2.6 million smart meters, 9,000 intelligent distribution devices, 45 phasors, and advanced monitoring equipment in over 270 substations.

ARRA FUNDING – $200 000 000

TOTAL FUNDING – $578 347 232

Source: https://www.telecomengine.com/the-ten-largest-u-s-smart-grid-projects/

References

Top ten largest Smart Grid Projects in US based on Cost

4. Raleigh N.C. -Progress Energy Service Company, LLC Smart Grid Project

Through this project, Progress Energy Service Company, LLC, is building a green Smart Grid virtual power plant that will provide conservation, efficiency and advanced load shaping technologies, including installation of over 160,000 meters across its multi-state service area.

ARRA FUNDING – $200,000,000

TOTAL FUNDING – $520,000,000

5. Baltimore Maryland – Baltimore Gas and Electric Company Smart Grid Project

This project is deploying a smart meter network and advanced customer control system for 1.1 million residential customers, enabling dynamic electricity pricing. Baltimore Gas and Electric Company is expanding the utility's direct load control program, enhancing reliability and reducing congestion.

ARRA FUNDING – $200,000,000

TOTAL FUNDING – $451,814,234

6. Philadelphia, PA. – PECO Energy Company Smart Grid Project

This project is deploying smart meters to all 600,000 customers, upgrading communication infrastructure to support a smart meter network, installing 7 "intelligent" substations, and accelerating deployment of more reliable/secure technologies that will reduce peak energy load and increase cost savings.

ARRA FUNDING – $200,000,000

TOTAL FUNDING – $422,570,000

Source: https://www.telecomengine.com/the-ten-largest-u-s-smart-grid-projects/

References

Top ten largest Smart Grid Projects in US based on Cost

7. Birmingham, Alabama – Southern Company Services, Inc. Smart Grid Project

Southern Company Services, Inc. is deploying five integrated smart grid technology systems that enhance energy efficiency, cyber security, distribution and transmission line automation, and smart power substations. This project will benefit customers in Florida, Georgia, Mississippi, North Carolina and South Carolina.

APPA FUNDING – $164,527,160

TOTAL FUNDING – $330,130,432

8. Sacramento, California – Sacramento Municipal Utility District Smart Grid Project

Through this project, Sacramento Municipal Utility District is installing a comprehensive regional smart grid system that includes 600,000 smart meters, 100 electric vehicle charging stations and 50,000 demand response controls including programmable thermostats and home energy management systems.

ARRA FUNDING – $127,506,261

TOTAL FUNDING – $307,737,084

9. Las Vegas, Nevada- NV Energy, Inc. Smart Grid Project

NV Energy, Inc is integrating smart grid technologies, including dynamic pricing, customer communications and in-home networks, grid monitoring, distribution automation, distributed renewables, and electric vehicles, including the installation of a network of 1,300,000 smart meters.

ARRA FUNDING – $138,000,000

TOTAL FUNDING – $298,000,000

Source: https://www.telecomengine.com/the-ten-largest-u-s-smart-grid-projects/

References

Top ten largest Smart Grid Projects in US based on Cost

10. New York, New York- Consolidated Edison Company of New York, Inc Smart Grid Project

This project is deploying technologies, including automation, monitoring and two way communications to make the electric grid function two-communications, more efficiently and enable integration of renewable resources. Also benefits customers in NJ.

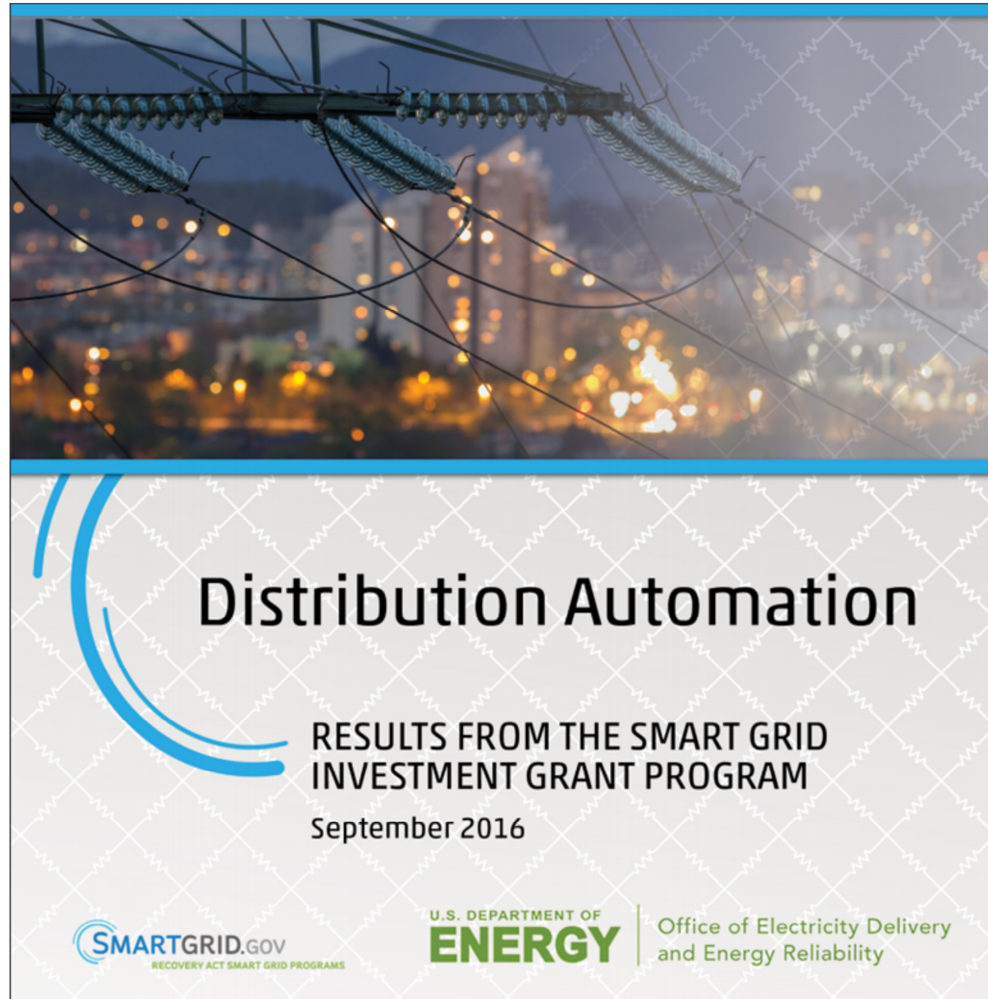
ARRA FUNDING – $136,170,899

TOTAL FUNDING – $272,341,798

Source: https://www.telecomengine.com/the-ten-largest-u-s-smart-grid-projects/

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016



Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: **NORTHERN VIRGINIA ELECTRIC COOPERATIVE (NOVEC)**

Electric Cooperative

Virginia

143,196 Customers

Distribution Circuits Impacted:	105 (of 235)	Distribution Substations Impacted:	37 (of 53)

DA Communication Network: IP-based communication links

Total Cost of DA Implementation under SGIG: $10,000,000

Distribution Automation Devices Deployed					
Automated Feeder Switches	✓	14	Remote Fault Indicators	✗	
Automated Capacitors	✓	164	Transformer Monitors	✓	56
Automated Regulators	✓	340	Smart Relays	✓	25
Feeder Monitors	✗		Fault Limiters	✗	
Automated Reclosers	✓	117	Smart Reclosers	✓	19
Substation Battery Bank Monitors	✓	33			

DA Improved Reliability from Five-Year Benchmarks: NOVEC reported reliability improvements on the 41 feeders installed with electronic vacuum reclosers and motor-operated air break switches. NOVEC analysis compared 2011-2013 data from 41 feeders for the major reliability indices with pre-deployment, five-year benchmarks and showed improvements across the board, as shown in Table 10.

Table 10. NOVEC Reliability Analysis, 2011-2013.

Analysis Period	SAIFI	SAIDI	CAIDI	MAIFI
Summer Benchmark	0.62	54.49	88.50	0.39
Summer 2011	0.66	38.32	57.93	0.21
Summer 2012	0.37	27.71	74.20	0.20
Summer 2013	0.40	22.53	70.63	0.15
Winter Benchmark	0.48	36.08	74.93	0.39
Winter 2011	0.27	21.63	68.55	0.40
Winter 2012	0.28	16.03	71.09	0.13

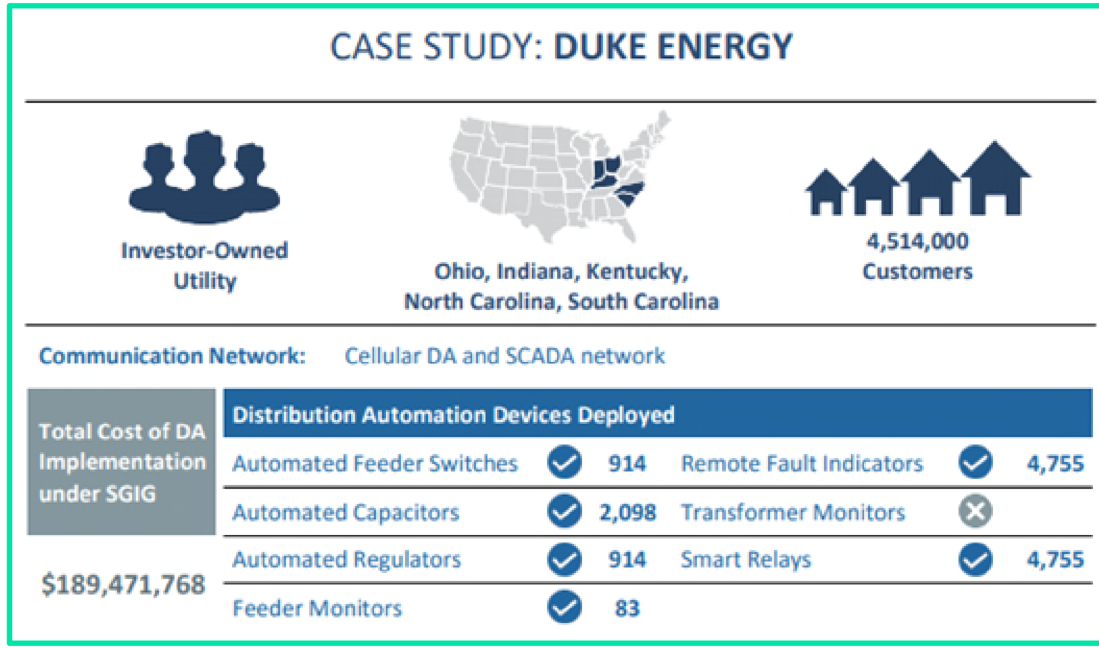
Improved Efficiencies Reduce Truck Rolls and Fleet Miles: NOVEC reduced truck rolls and fleet vehicle miles from improved efficiencies from a variety of automated field activities. Table 11 provides a summary of the savings.

34 Distribution Automation: Results from the SGIG Program

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016



CASE STUDY: **DUKE ENERGY**

Investor-Owned Utility

Ohio, Indiana, Kentucky, North Carolina, South Carolina

4,514,000 Customers

Communication Network: Cellular DA and SCADA network

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$189,471,768	Automated Feeder Switches	✓	914	Remote Fault Indicators	✓	4,755
	Automated Capacitors	✓	2,098	Transformer Monitors	✗	
	Automated Regulators	✓	914	Smart Relays	✓	4,755
	Feeder Monitors	✓	83			

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: CONSOLIDATED EDISON (CON EDISON)

Investor-Owned Utility

New York, New Jersey

3,578,188 Customers

Distribution Circuits Impacted: 840 (of 2,297)

DA Communication Network: Master radio sites to upgrade SCADA and wireless

Total Cost of DA Implementation under SGIG

$272,341,798

Distribution Automation Devices Deployed					
Automated Feeder Switches	✓	797	Remote Fault Indicators	✓	1,851
Automated Capacitors	✓	449	Transformer Monitors	✓	17,401
Automated Regulators	✓	111	Smart Relays	✓	205
Feeder Monitors	✓	617	Recloser Controls		307
Remote Battery Monitors	✓	17			

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: **CENTERPOINT ENERGY**

Investor-Owned Utility

Houston, TX

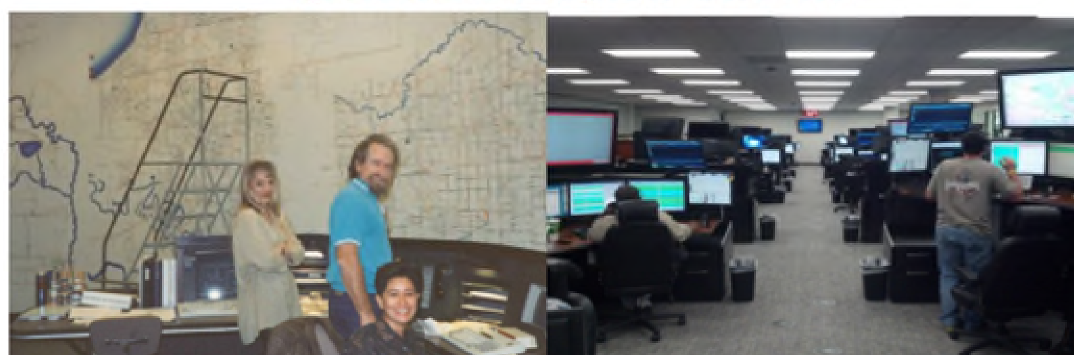
2,320,156 Customers

Distribution Circuits Impacted:	188 (of 1,516)	Distribution Substations Impacted:	31 (of 240)

DA Communication Network: RF, WiMAX, and cellular technologies

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$120,604,288	Automated Feeder Switches	✓	567	Remote Fault Indicators	✗	
	Automated Capacitors	✗		Transformer Monitors	✗	
	Automated Regulators	✗		Smart Relays	✓	171
	Feeder Monitors	✗				

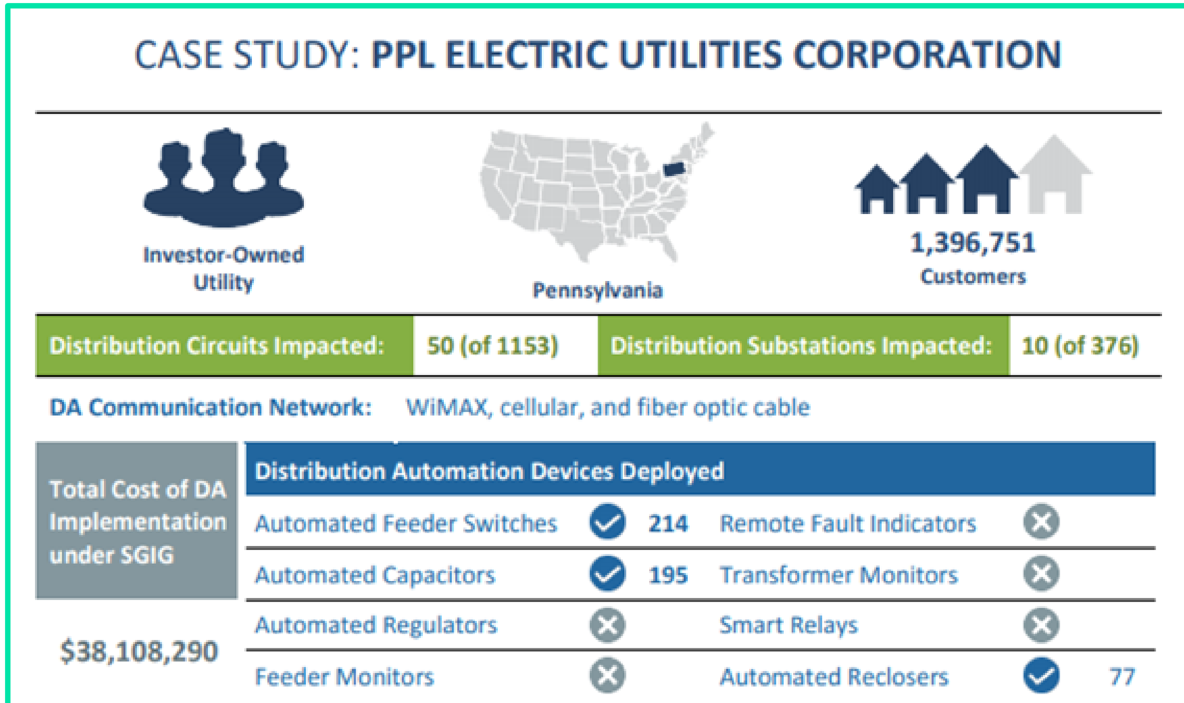
Figure 22. CenterPoint Energy's DMS – 1993 and 2014



Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016



CASE STUDY: **PPL ELECTRIC UTILITIES CORPORATION**

Investor-Owned Utility

Pennsylvania

1,396,751 Customers

Distribution Circuits Impacted:	50 (of 1153)	Distribution Substations Impacted:	10 (of 376)

DA Communication Network: WiMAX, cellular, and fiber optic cable

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$38,108,290	Automated Feeder Switches	✓	214	Remote Fault Indicators	✗	
	Automated Capacitors	✓	195	Transformer Monitors	✗	
	Automated Regulators	✗		Smart Relays	✗	
	Feeder Monitors	✗		Automated Reclosers	✓	77

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: **PEPCO - DC**

Investor-Owned Utility

Washington, DC

249,059 Customers

Distribution Circuits Impacted: 19 (of 779)

DA Communication Network: Wireless mesh

Total Cost of DA Implementation under SGIG

$8,308,800

Distribution Automation Devices Deployed					
Automated Feeder Switches	✓	42	Remote Fault Indicators	✗	
Automated Capacitors	✗		Transformer Monitors	✓	41
Automated Regulators	✗		Smart Relays	✓	306
Feeder Monitors	✗		Substation DRTUs	✓	6
Transformer Health Sensors	✓	14	Automated Circuit Reclosers/Switches	✓	64

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: **SOUTHERN COMPANY**

Investor-Owned Utility

Alabama, Florida, Georgia, and Mississippi

4,395,000 Customers

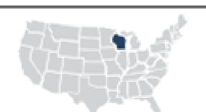
Distribution Circuits Impacted:	2,081 (of 4,706)	Distribution Substations Impacted:	359 (of 3,325)

DA Communication Network: Radio communications via SCADA platform

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$207,274,827	Automated Feeder Switches	✓	2,193	Remote Fault Indicators	✓	263
	Automated Capacitors	✓	1,869	Transformer Monitors	✗	
	Automated Regulators	✓	3,339	Smart Relays	✓	848
	Feeder Monitors	✗		Capacitor Monitors	✓	7,876

CASE STUDY: **WISCONSIN POWER AND LIGHT COMPANY (WPL)**

Investor-Owned Utility



Wisconsin

453,573 Customers

Distribution Circuits Impacted:	298 (of 906)

Communication Network: Capacitor control radios, take out radios, routers, hopper radios

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed				
$6,306,738	Automated Feeder Switches	✗		Remote Fault Indicators	✗
	Automated Capacitors	✓	576	Transformer Monitors	✗
	Automated Regulators	✗		Smart Relays	✗
	Feeder Monitors	✗			

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

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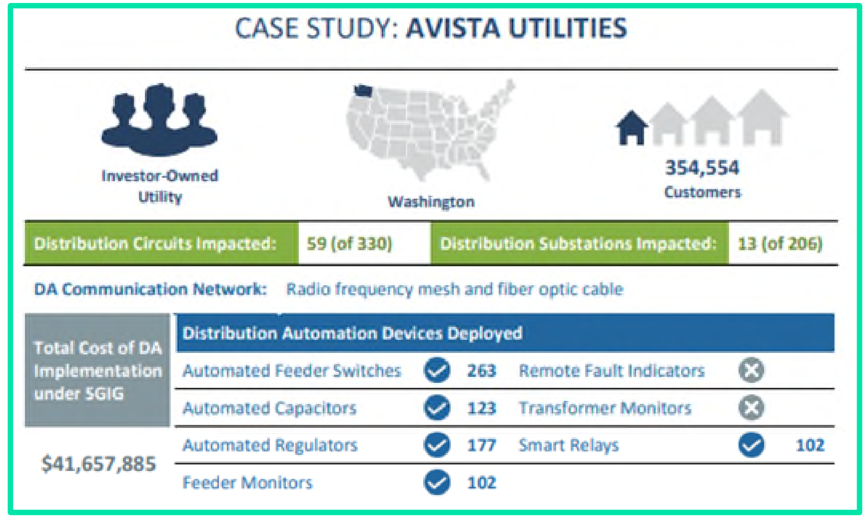

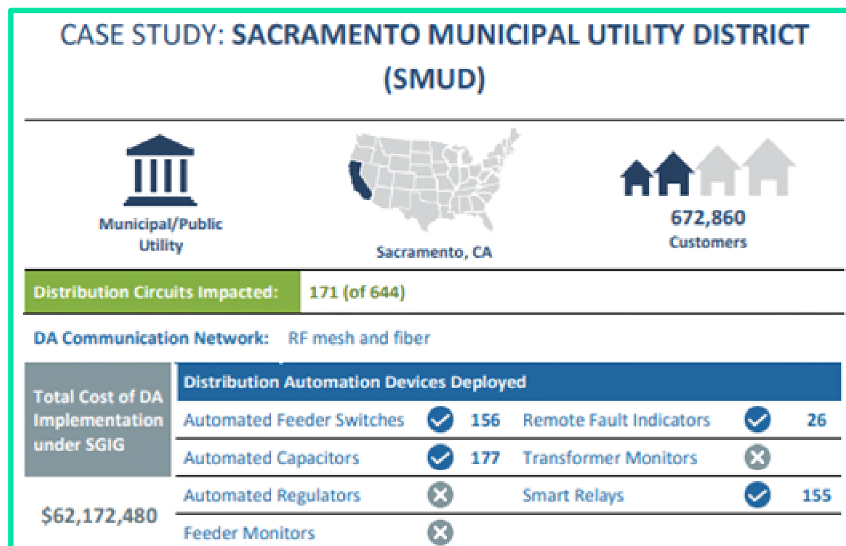

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

Distribution Automation: Results from the Smart Grid Investment Grant Program, Sept 2016

CASE STUDY: **CENTRAL LINCOLN PEOPLE'S UTILITY DISTRICT**

Municipal/Public Utility | Oregon | 38,465 Customers

Communication Network: Fiber optic cable and high-speed wireless

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$2,561,406	Automated Feeder Switches	✓	17	Remote Fault Indicators	✗	
	Automated Capacitors	✗		Transformer Monitors	✗	
	Automated Regulators	✓	2	Smart Relays	✗	
	Feeder Monitors	✓	14			

CASE STUDY: **FLORIDA POWER & LIGHT COMPANY (FPL)**

Investor-Owned Utility | Florida | 4,524,000 Customers

Distribution Circuits Impacted: 476 (of 3,124)

DA Communication Network: Wireless mesh network

Total Cost of DA Implementation under SGIG	Distribution Automation Devices Deployed					
$84,667,288	Automated Feeder Switches	✓	285	Remote Fault Indicators	✓	3,879
	Automated Capacitors	✓	1,403	Transformer Monitors	✓	2,716
	Automated Regulators	✓	1,806	Smart Relays	✓	1,084
	Feeder Monitors	✓	1,014	Throw-over Sensors	✓	745

Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

Re

Distribution Automation: Result from the Smart Gri Investment Grant Program, Sept 201

A.4. DA Project Case Studies

Case Studies	Project Performer	Date
A Smarter Electric Circuit: Electric Power Board of Chattanooga Makes the Switch	EPB	May-11
Bright Lights, Big City: A Smarter Grid in New York	Con Edison	May-11
At the Forefront of the Smart Grid: Empowering Consumers in Naperville, Illinois	City of Naperville	Sep-11
Vermont Pursues a Statewide Smart Grid Strategy	eEnergy Vermont	Nov-11
Building a Smarter Distribution System in Pennsylvania	PPL	Dec-11
A "Model-Centric" Approach to Smarter Electric Distribution Systems	ORU	Dec-11
Glendale, California Municipal Invests in Smart Grid to Enhance Customer Services and Improve Operational Efficiencies	GWP	Feb-12
CenterPoint Energy's Smart Grid Solutions Improve Operating Efficiency and Customer Participation	CenterPoint	Feb-12
Smart Grid Solutions Strengthen Electric Reliability and Customer Services in Florida	FPL	Jun-12
Using Smart Grid Technologies to Modernize Distribution Infrastructure in New York	Con Edison	Jul-14
Integrated Smart Grid Provides Wide Range of Benefits in Ohio and the Carolinas	Duke Energy	Aug-14
Smart Grid Technologies Cut Emissions and Costs in Ohio	AEP Ohio	Oct-15
Renovating the Grid and Revitalizing a Neighborhood	KCP&L	Oct-15

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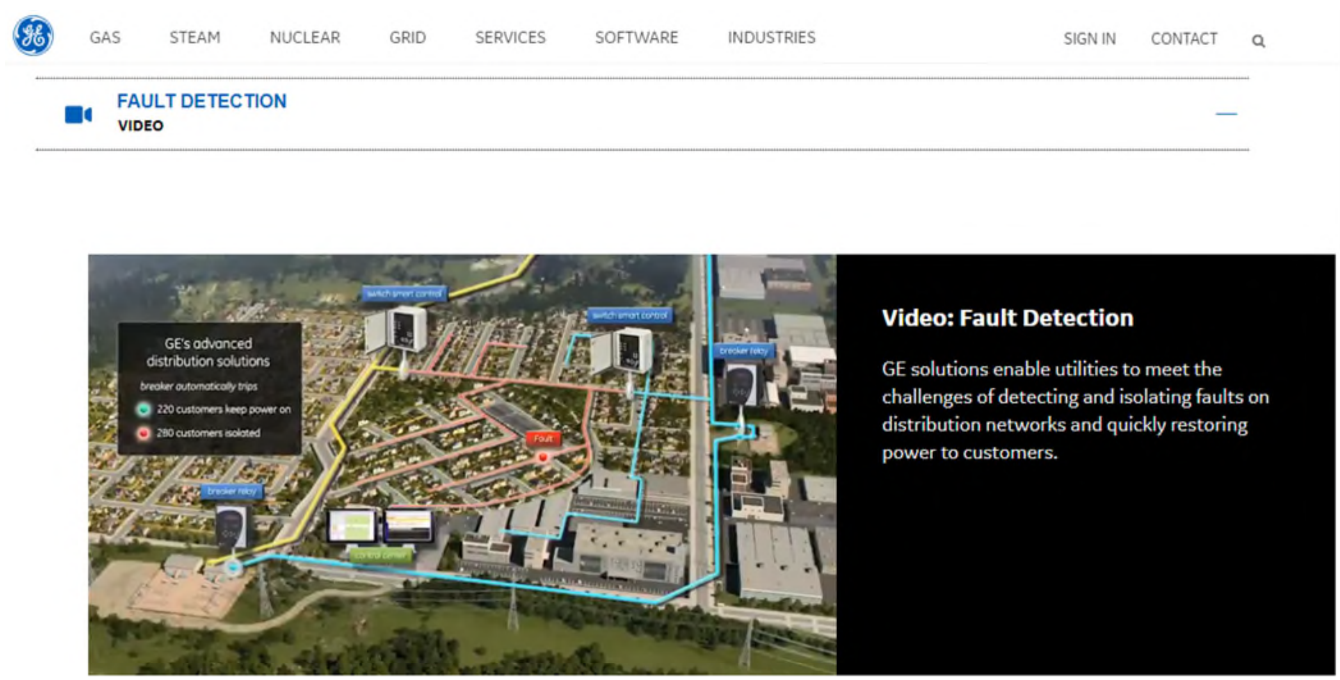
Source: https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf

References

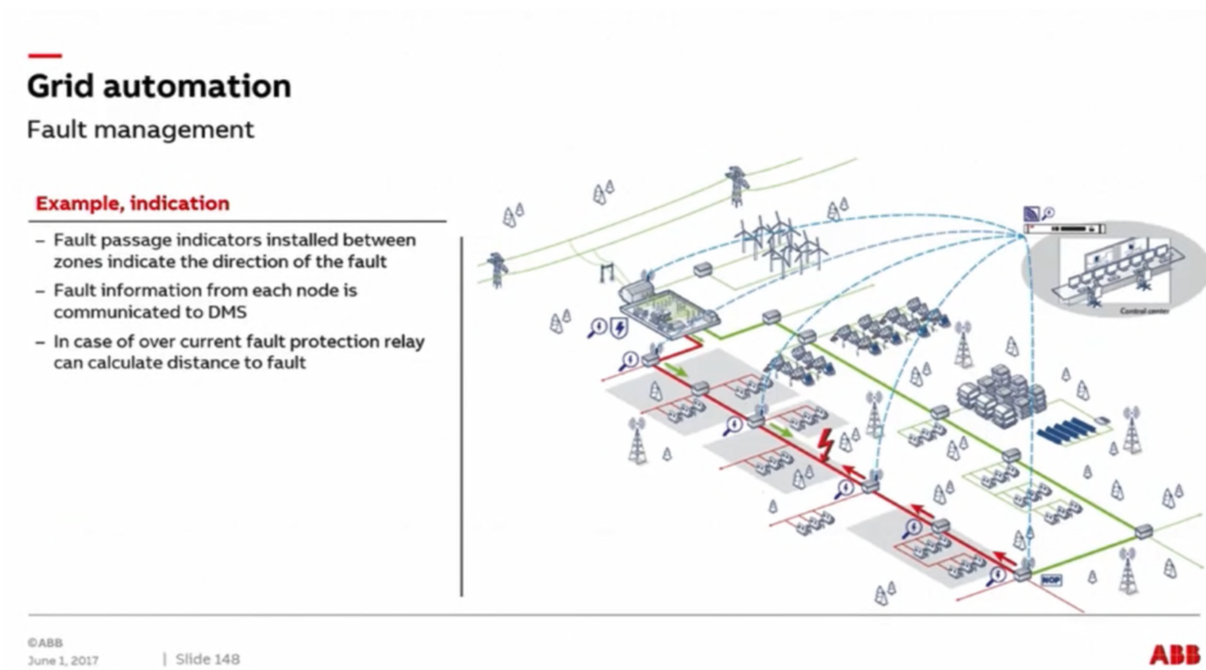
GE Advanced Distribution Management Solutions:



Source: https://www.ge.com/power/software/advanced-distribution-management-solutions

References

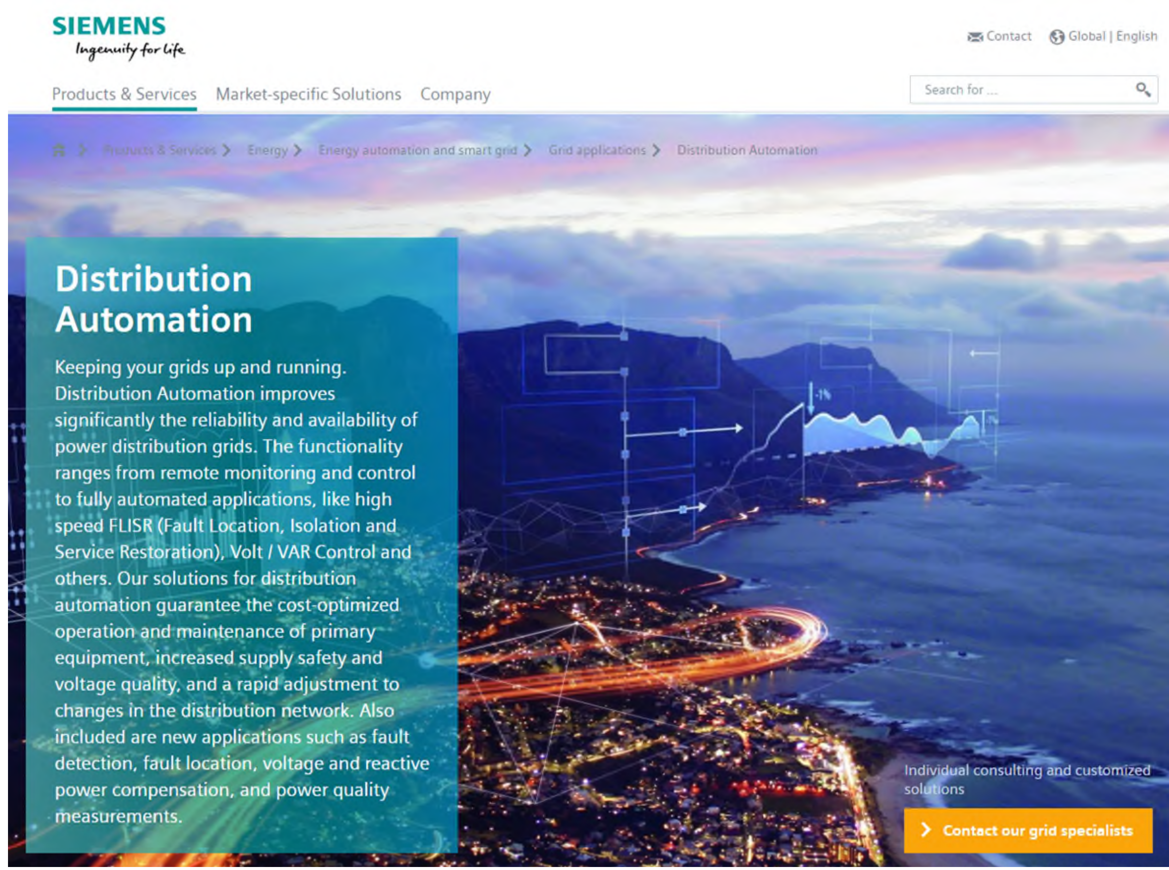
ABB : Advanced Fault Management System



Source: https://new.abb.com/medium-voltage/distribution-automation/campaigns/distribution-automation-application-solutions/advanced-fault-management

References

Siemens: Distribution Automation



Source: https://new.siemens.com/global/en/products/energy/energy-automation-and-smart-grid/grid-applications/distribution-automation.html

Summary

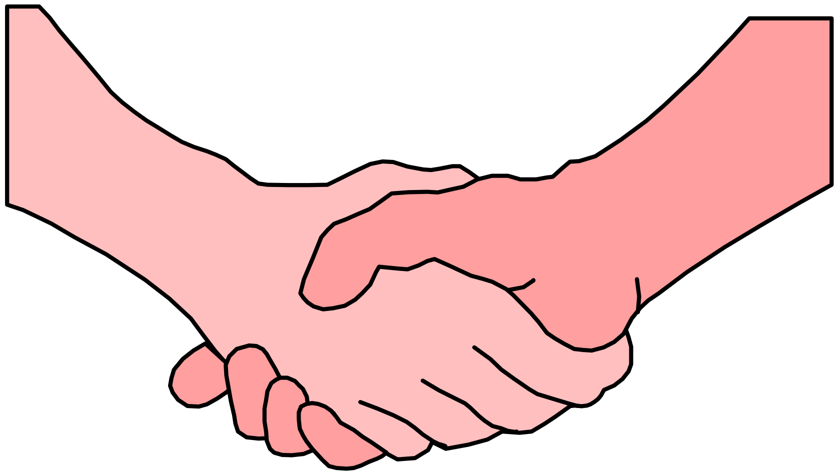
- Components of Distribution Systems
- What is SCADA ?
- Decision Support Tools

Summary

- Components of Distribution Systems
- What is SCADA ?
- Application Functions
- Some case studies of DAS

QUESTIONS

? ?



Thank U !!

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