DTE Energy
Smart Grid Projects

MPSC Smart Grid Collaborative

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March 13, 2008

DTE Energy®

Agenda

- **Defining Smart Grid**
- **AMI Implementation**
- **DG as Distribution Capacity**
- **DG as Virtual Power Plant (DOE)**
- **GridApp Projects (DOE)**
- **PHEV Penetration Study (DOE) – DTE Energy, UofM, PNNL, GM & Ford**

Defining “Smart Grid”

Electricity delivery network modernized using latest digital/information technologies to meet key defining functions*

- Enabling active participation by consumers
- Accommodating all generation and storage options
- Enabling new products, services, and markets
- Optimizing assets and operating efficiently
- Anticipating and responding to system disturbances in a self-healing manner
- Operating resiliently against physical and cyber attack
- Providing power quality required by a digital economy

The evolution of a smart grid will be one of continuous improvement.

* *Identified through the Modern Grid Strategy development efforts led by the NETL project team*

OE Actions on Implementing Title XIII of the Energy Independence and Security Act of 2007

- **Establish a Smart Grid Advisory Committee (By 3/29/2008)**
- **Establish a Smart Grid Task Force (By 3/29/2008)**
- **Submit to Congress a report concerning the status of Smart Grid system deployments (Due 12/19/2008)**
- **Submit to Congress a study assessing laws and regulations affecting siting of privately owned electricity distribution wires on and across public rights-of-way (Due 12/19/2008)**
- **Carry out a program to research, develop, and demonstrate Smart Grid technologies (planned 1st Q-FY09 following development of RD&D plan)**
- **Establish a Smart Grid regional demonstration initiative showcasing advanced technologies (planned 1st Q-FY09, guided by RD&D plan)**
- **Establish a federal matching funds program (By 12/29/2008)**
- **Submit to Congress a quantitative assessment concerning the security implications of Smart Grid system deployments (Due 6/19/2009)**

Smart Grid Task Force

Functions

- Serves as Federal focal point on all things "smart grid"
- Coordinates and integrates intra- and inter-governmental activities
- Oversees report production for submission to Congress
- Oversees development of smart grid RD&D plan
- Guides smart grid regional demonstrations
- Advises on interoperability framework
- Guides establishment of the federal matching funds program
- Develops tech assistance plan to States and guides plan implementation
- Guides outreach and communications to build awareness and educate decision makers
- Collaborates with and supports FACA

Members

OE: leadership, RD&D, policy analysis, infrastructure protection

FERC: wholesale markets

NIST: interoperability standards

EERE: energy efficiency and renewables

DHS: homeland security

DoD: national security

EPA: climate change

Smart Grid Implementation Workshop

Planned for June 2008, with broad stakeholder engagement to reach consensus on and acceptance of:

- Key defining functions or “characteristics” of a smart grid
- Values associated with a smart grid
- Metrics for measuring progress toward a smart grid

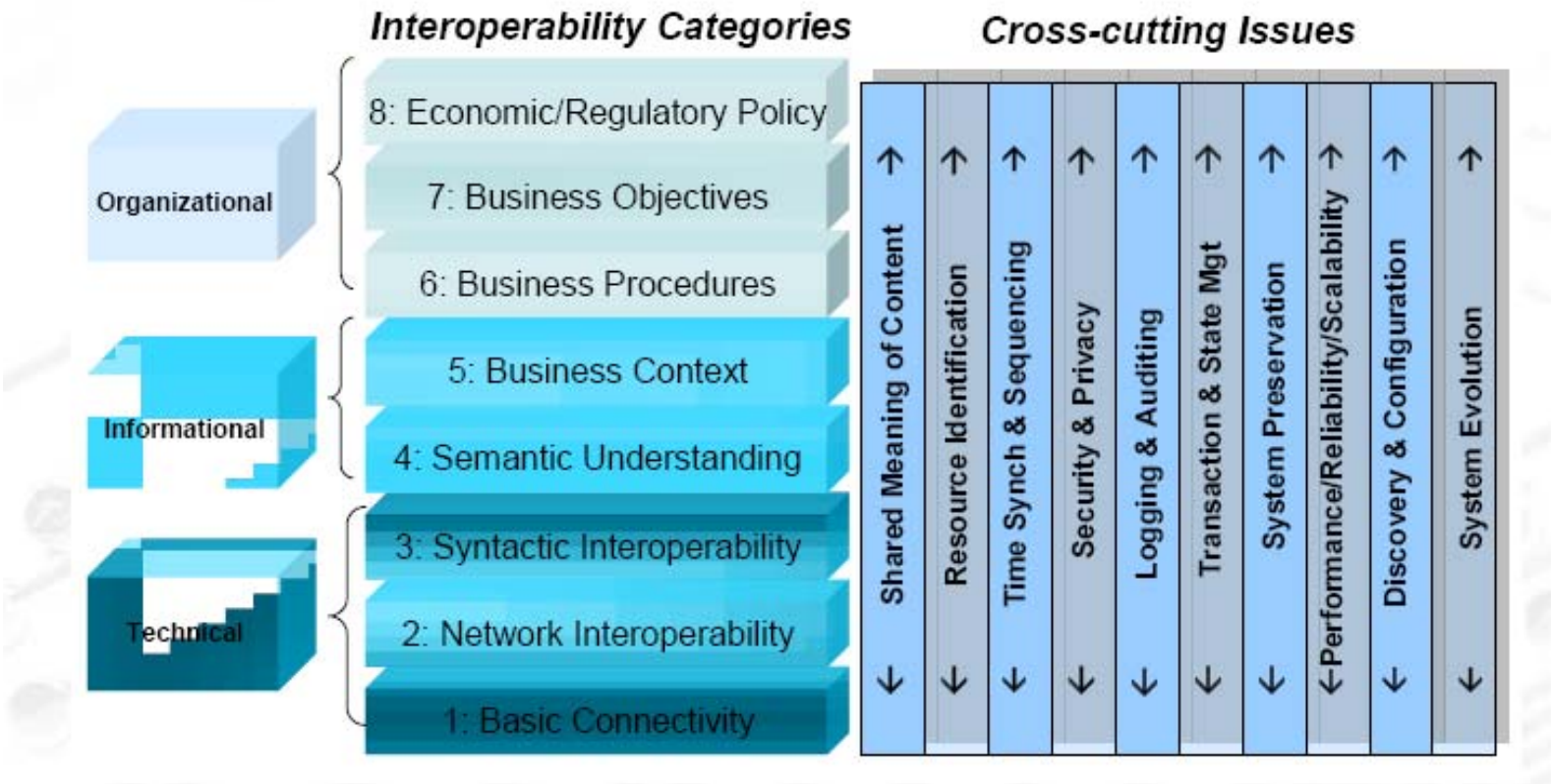
Input to:

- Smart Grid RD&D Plan development
- Soliciting and selecting smart grid regional demo activities

A Planning Committee comprising a broad representation of smart grid stakeholders is organizing the Workshop.

Interoperability Framework Development

GridWise Architecture Council (GWAC)



Framework Areas

Tech Assistance to States

- Modern Grid Strategy team working with State Regulators to formulate State strategies for modernization
  - •Promoting deployment of smart grid technologies
  - •Focus on business case model
  - •Providing feedback into State program direction and performance
  - •Suggesting regulatory action to address barrier
  - •Supporting, and supported by, WV and OH regulators

Input to:

Tech assistance plan to support States in developing and implementing smart grid pathways

Communications and Outreach for Public Awareness

National GridWeek 2007, April 2007 in DC

- Aligning and coordinating national agenda on grid modernization
- 634 participants, including federal/state/industry/Lab leaders
- Inaugural event organized and sponsored by OE

National GridWeek 2008, September 2008 in DC

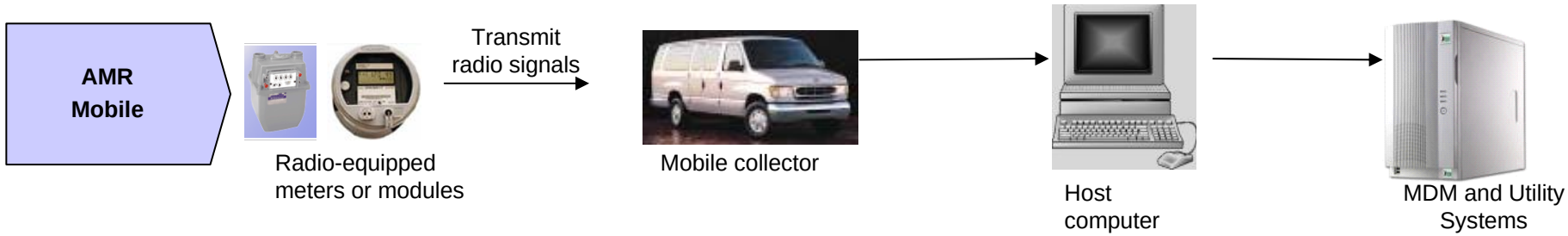
- GridWise Alliance as Lead Organizer; OE as major sponsor
- Becoming *the* national event on smart grid
    - technologies and practices
    - policies and regulations
    - lessons learned and success stories
    - business cases
    - education and outreach

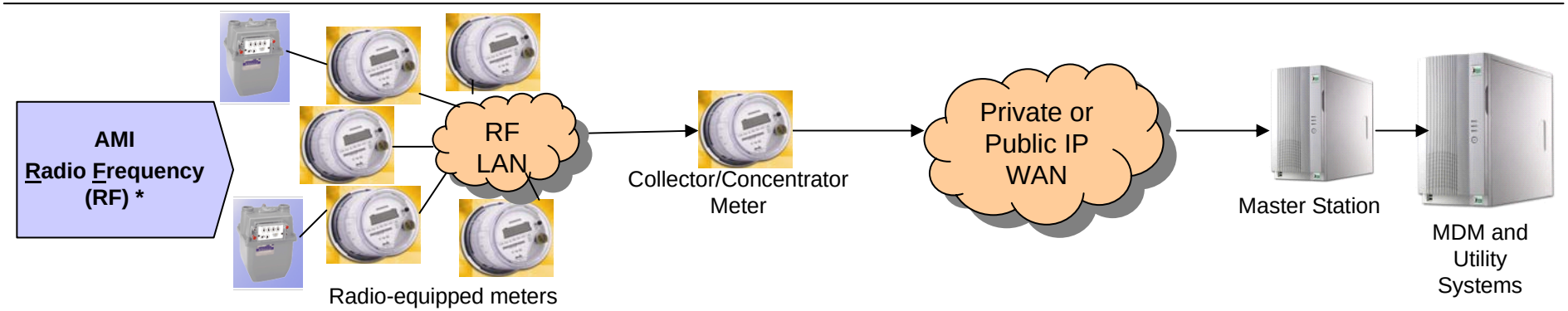
Smart Grid Newsletter

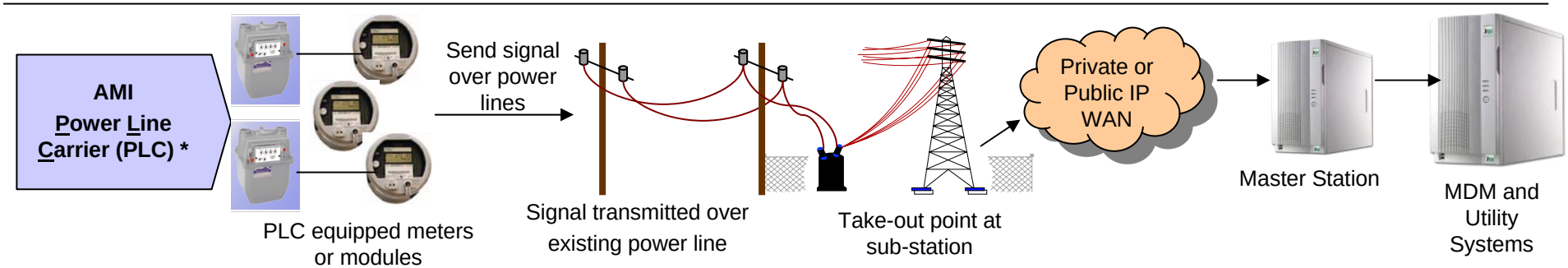
Monthly publication covering news, trends, research and marketplace information relevant to grid automation (http://www.smartgridnews.com/)

Overview of primary AMR / AMI technologies

DTE Energy





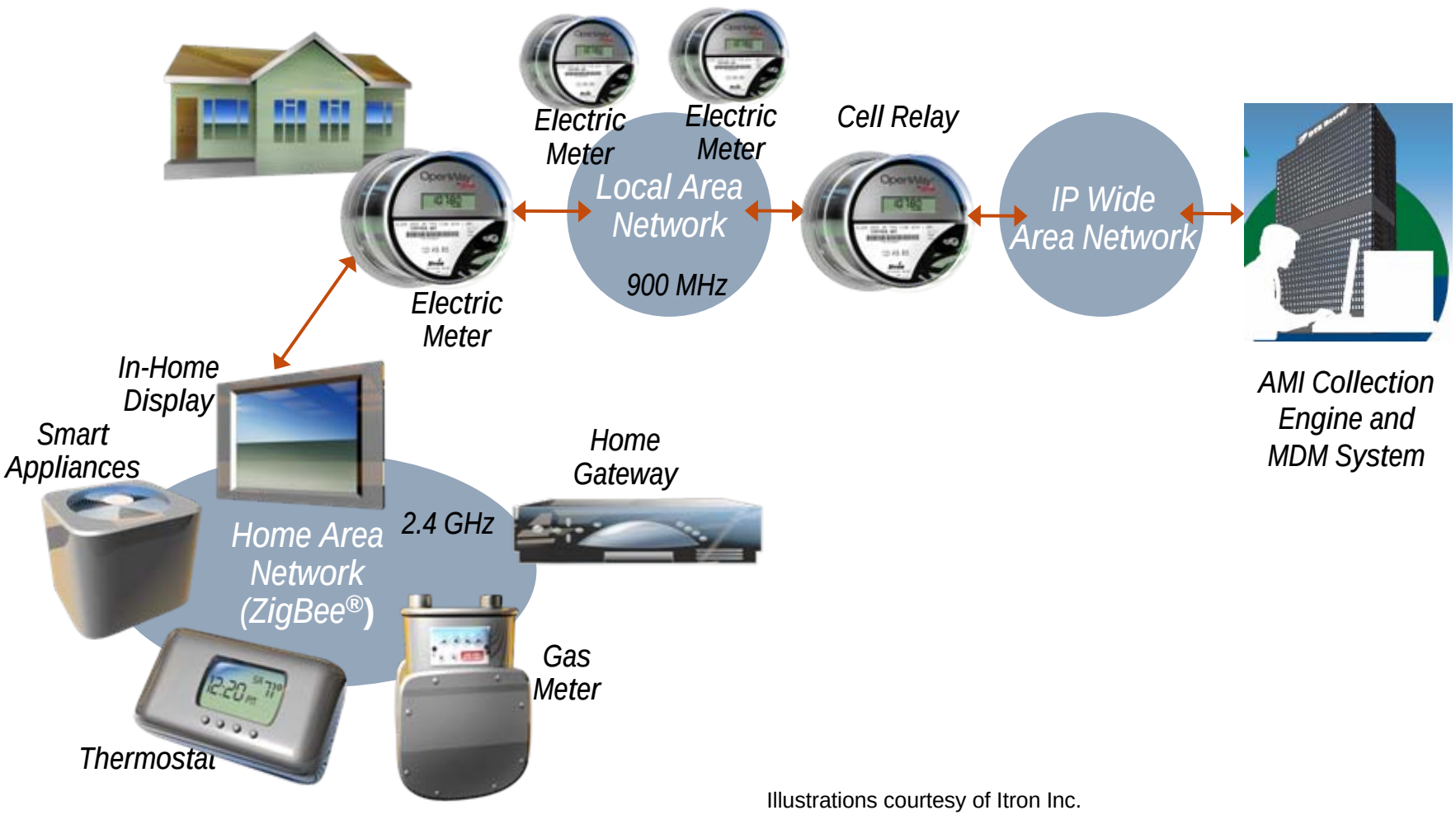


* Remote disconnect/ reconnect capabilities are available on RF and PLC network options and are not available with a mobile network

AMI – a platform to build on

DTE Energy

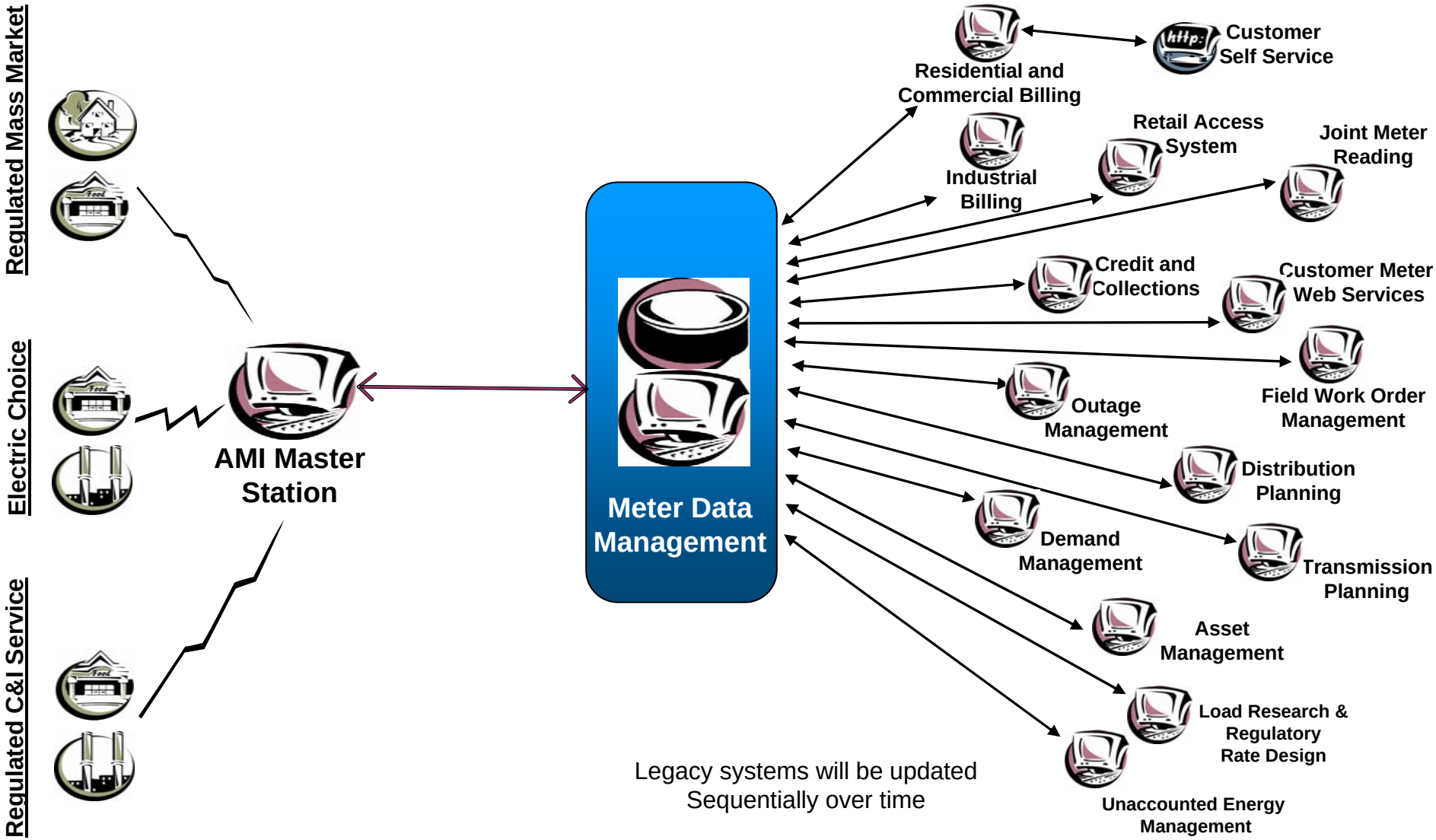
Advanced Metering Infrastructure



Illustrations courtesy of Itron Inc.

Numerous Legacy Systems at DTE Energy are affected

With MDM serving AMI



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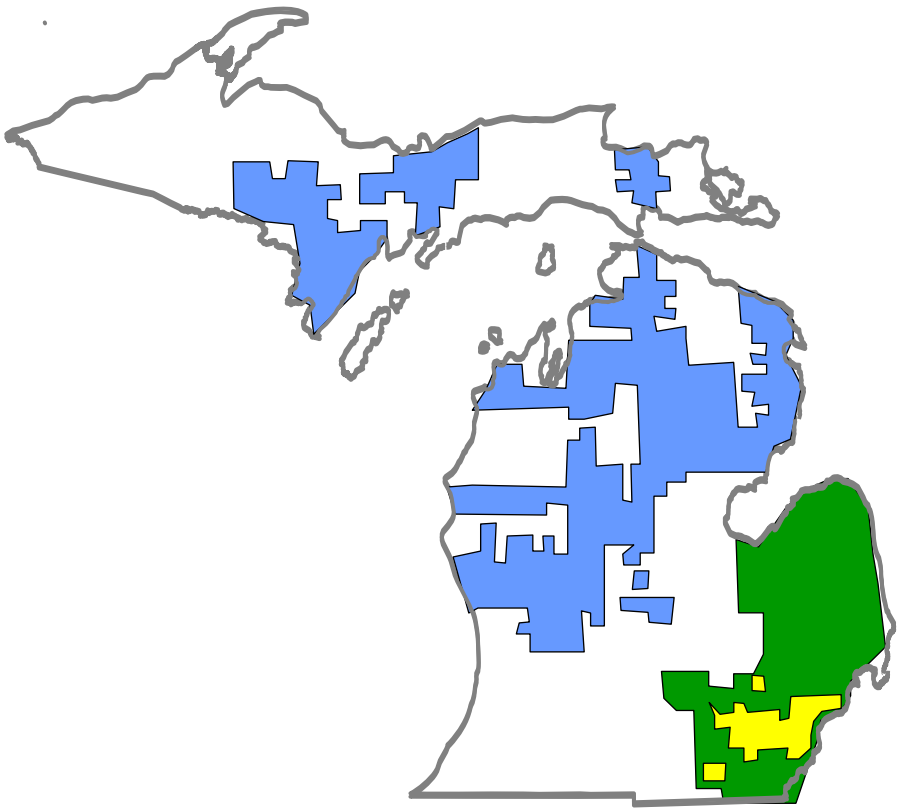
DTE Energy Service Area



Utility Service Territory

Detroit Edison MichCon

Overlap

Service Area: 7,600 Sq. Miles

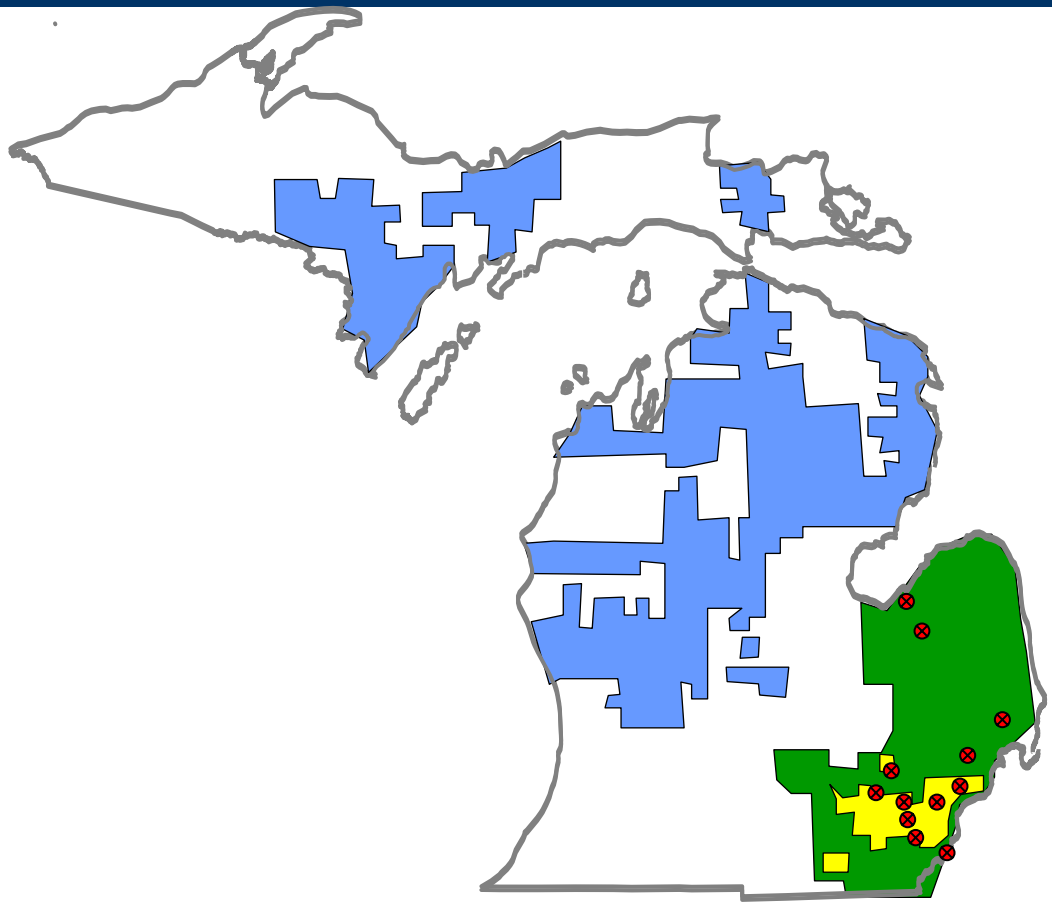
Customers: 2.2 million

System Peak Load: 12,762 MW
Annual Sales: 54,000 GWH

- 37% Commercial
- 29% Residential
- 29% Industrial
- 5% Wholesale & Interconnection

Distribution Substations	**662**
Distribution Circuits	**2,808**
	1,876 @ 4.8kV
	932 @ 13.2kV
Distribution Circuit Miles	**38,939**
	20,184 @ 4.8kV
	18,755 @ 13.2kV
Subtransmission	**802 @ 24 kV**
	2,743 @ 41.6kV

DG Distribution Solutions



Utility Service Territory

Detroit Edison

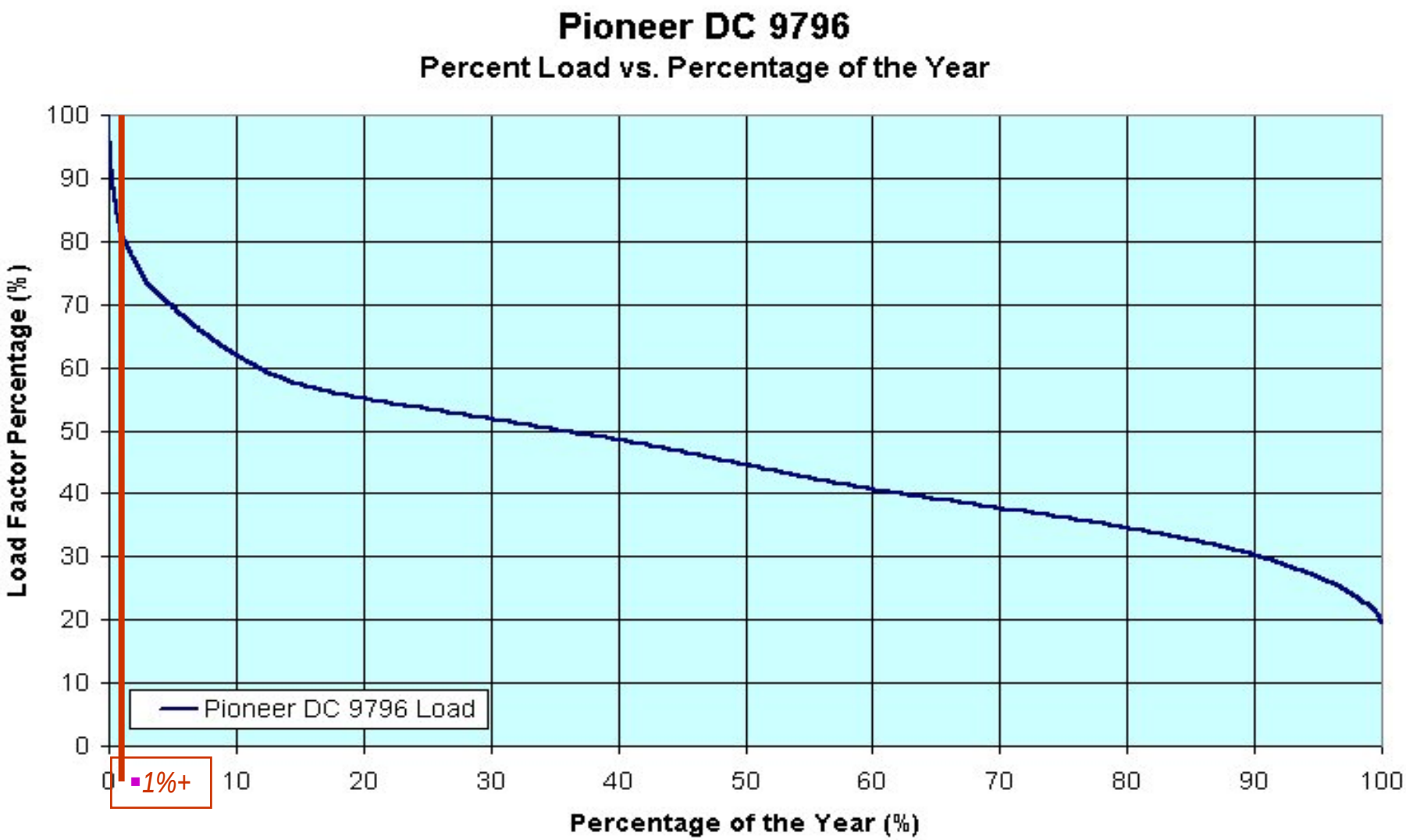
MichCon

Overlap

DG Circuit Installations

12 Different Installations
6 Operating DGs in 2007
2 New Installations in 2008
Intentional Islanding 4 times

Asset Utilization Opportunity



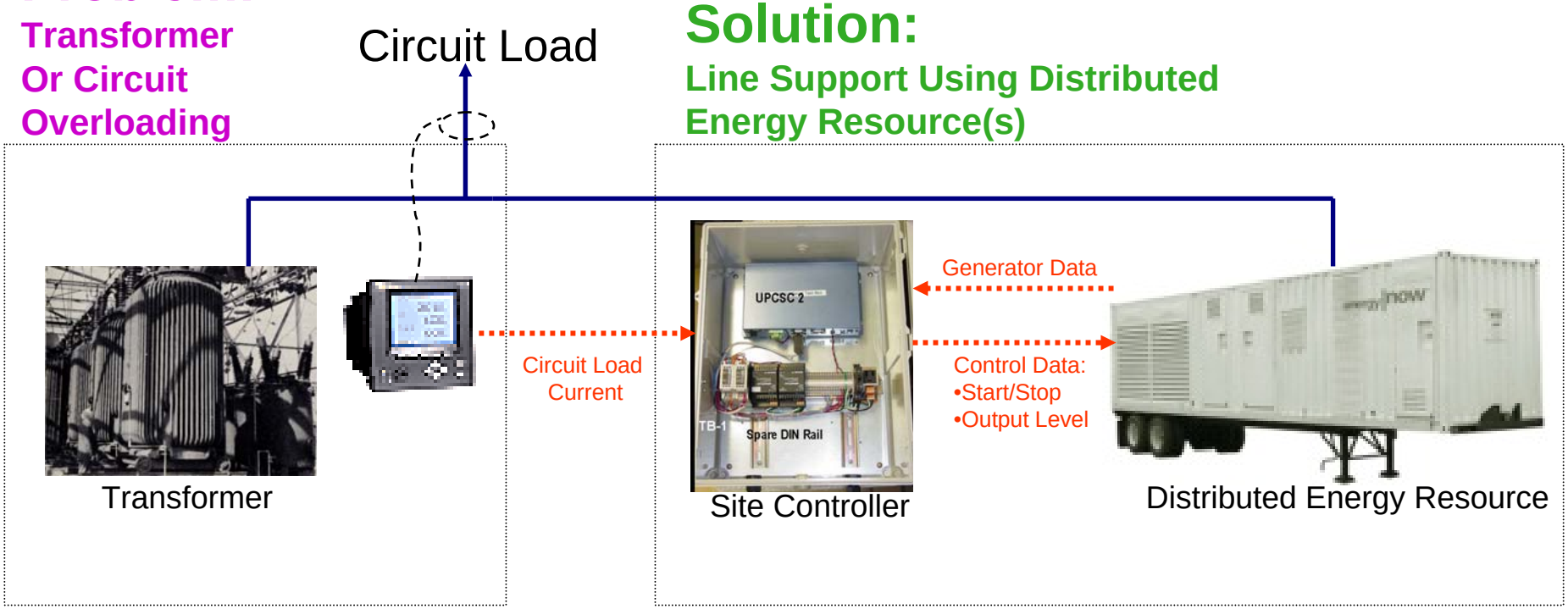
Internal to Distribution Circuit

Substation Applications

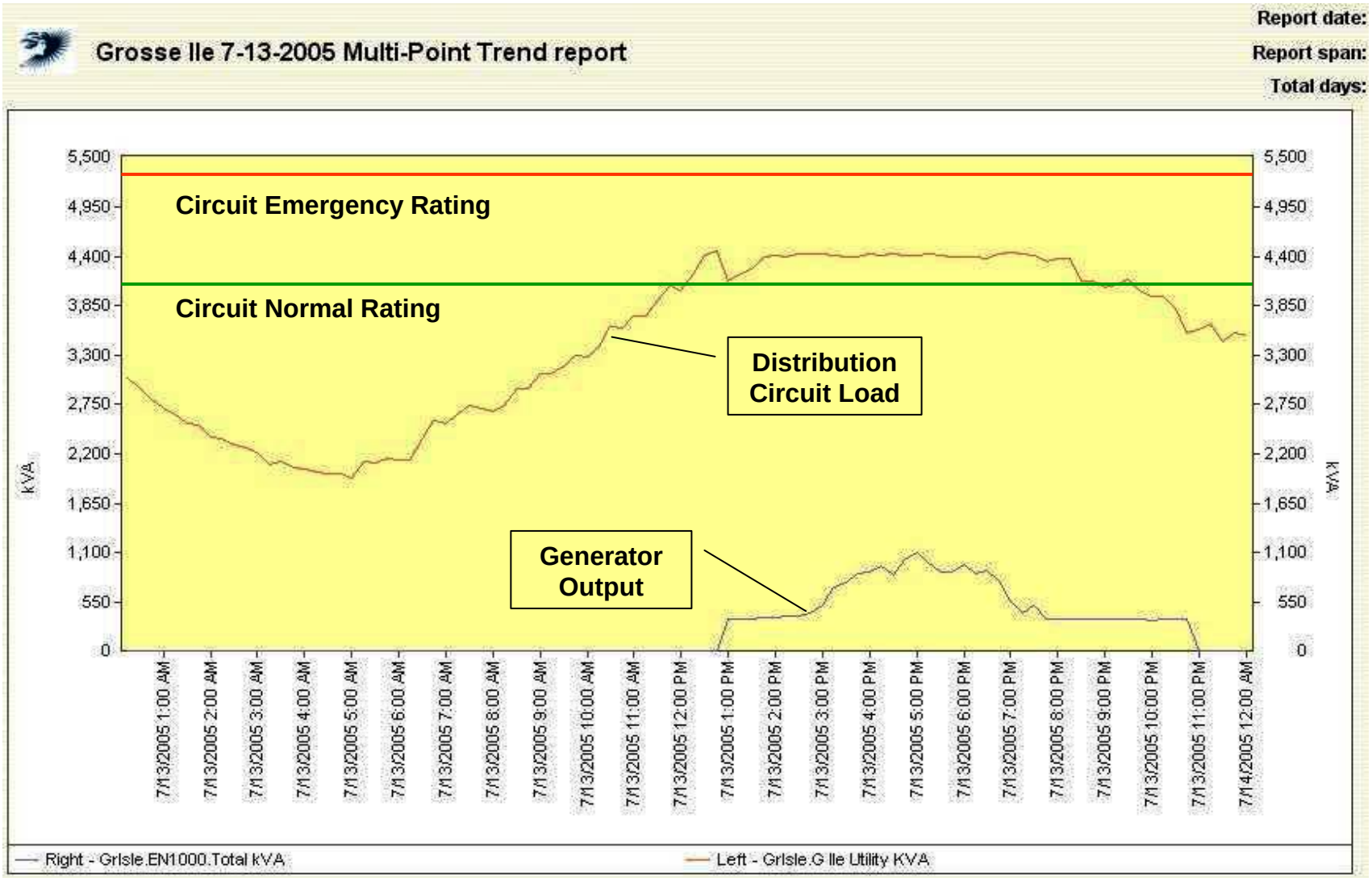
Peak Shaving Application

Problem:
Transformer Or Circuit Overloading

Solution:
Line Support Using Distributed Energy Resource(s)



Automatic Load Following



Past & Present DG Run Hours

DTE Energy

Circuit	D-D Rating	Peak Rating	2004 Run Hrs	2005 Run Hrs	2006 Run Hrs	2007 Run Hrs
IVNHO	**600 A**	**721 A**	**N/A**	**N/A**	**96**	**102**
GOLF	**406 A**	**630 A**	**N/A**	**N/A**	**64**	**59**
UNLAK	601 A	**746 A**	**188**	**410**	**Retired**	**Retired**
GRILE	490 A	**553 A**	**40**	**234**	**31**	**122**
SHORES	493 A	**553 A**	**41**	**122**	**82.5**	**35**
MILFD	590A	**726 A**	**32**	**58**	**12**	55
WEBST	360 A	**505 A**	**N/A**	**75**	**4**	0
90+ Degree Days	N/A	N/A	**3**	**20**	**12**	14


On-Board
Communication mast
1.5 MW, 4800V, 3ph, Direct Connect
Bi-Fueled Generator
Underground or overhead house
service
External
Fuel Fill
Fence Free Design
Bi-Fuel
Design for
extended
run time

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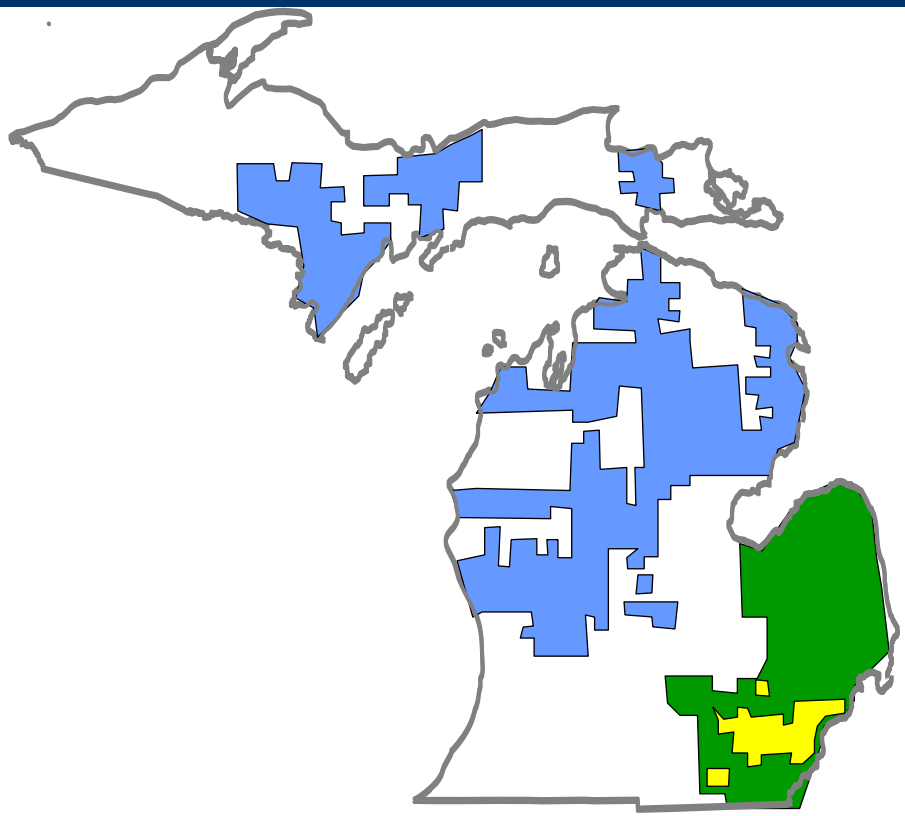
DOE Phase 1 & 2

Department of Energy DER Aggregation Communication, Control, and MISO Sale

Detroit Edison Service Area



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- **37% Commercial**
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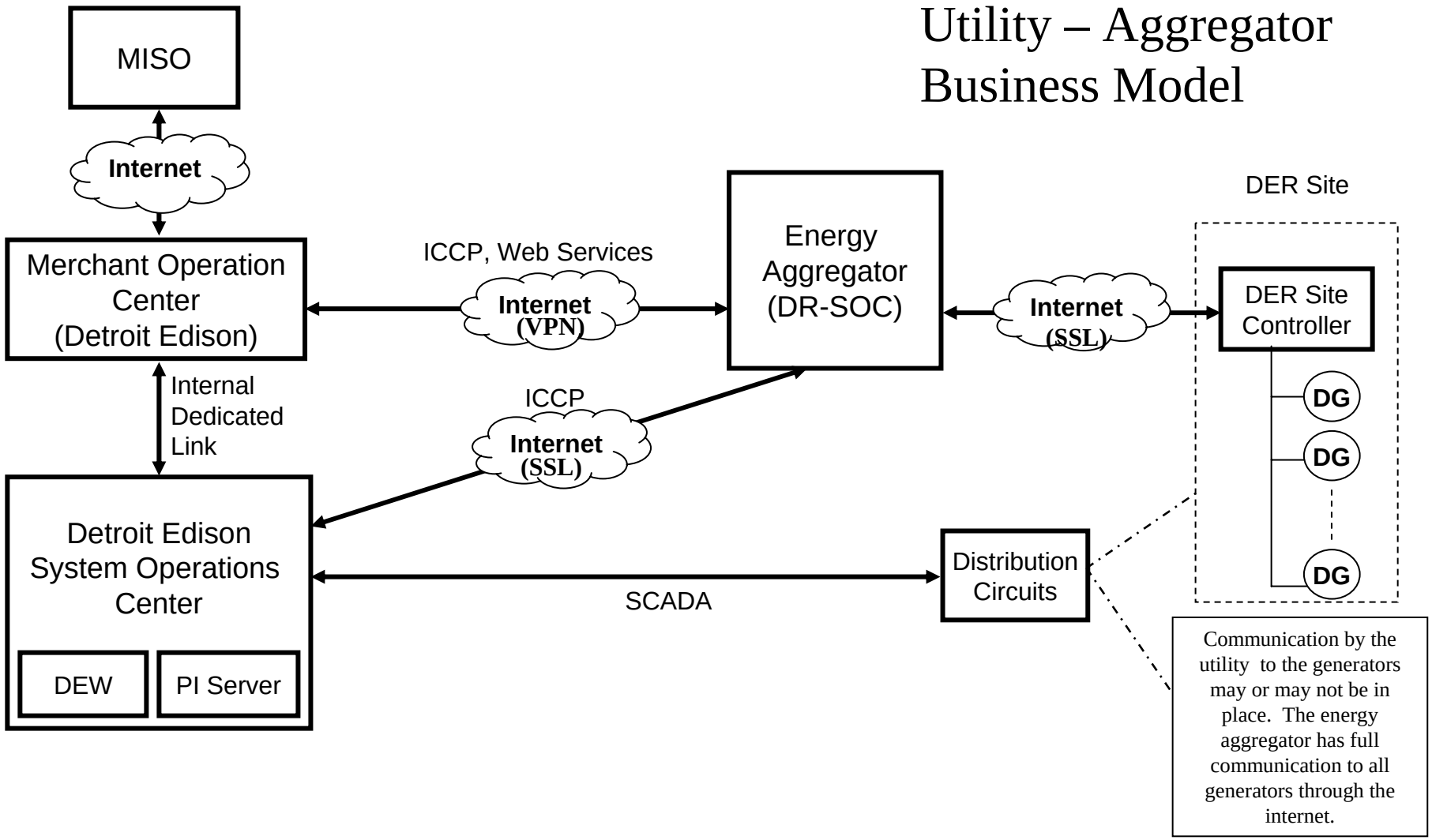
- **5% Wholesale & Interconnection**

Distributed Generation: 1.6 GW
or 12 % of Peak Load
(Includes > 100kW units)

Primary Service Database (approx unverified)

500kW > DG > 100kW	50MW
20MW > DG > 500kW	590MW

Communication Architecture in place from DOE 2 (No human intervention required)



DEW Modeling For DOE 2

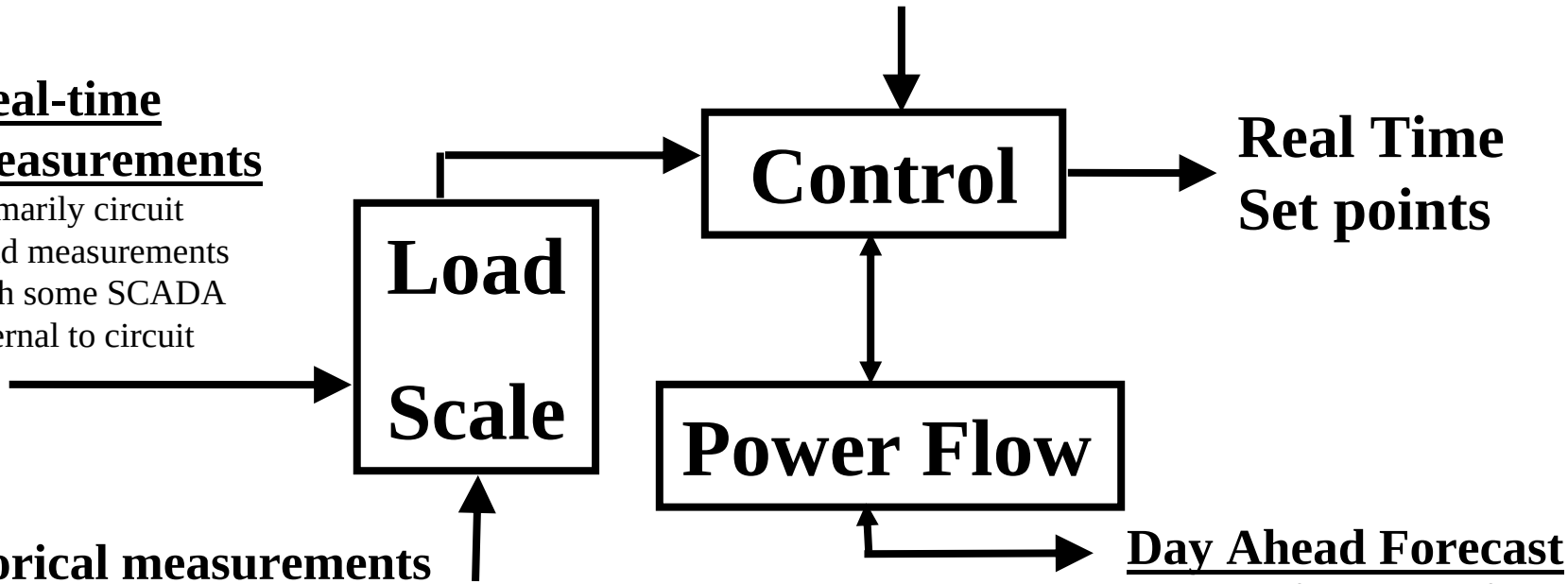
DTE Energy

Constraints

DG needed for Demand Management
Customer Hours DG not available
Total run hours not to exceed e.g. diesel air permit limits
Circuit Level Restrictions

Real-time measurements

Primarily circuit head measurements with some SCADA internal to circuit



Historical measurements

Customer meter info and sales

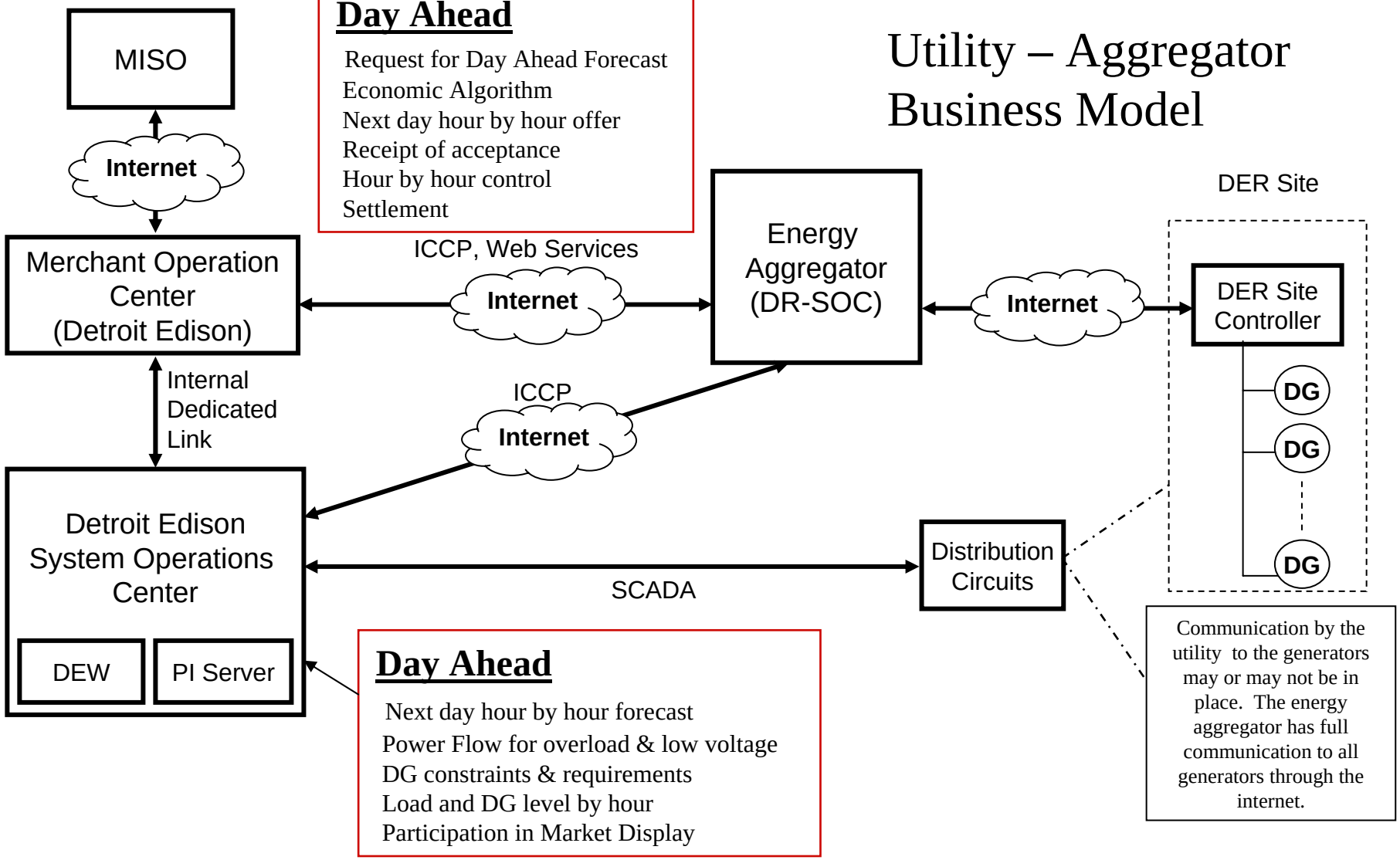
Day Ahead Forecast

Standby – 24 hrs of the Lesser of DER or Load
Sell back – 24hr of the DER includes Load following Control

DEW is a Freeware using open architecture database. All functionally developed in this project will be included in DEW.

Communication Architecture Aggregating for Day Ahead

DTE Energy



PI Process Book General Display

Real Time

Day Ahead

5/16/2006 11:23:16 AM

Peaker Morning Report

Contacts and SOP

Total DER KW = -0.09 KW

COMMUNICATION LINK

DTE SOC | DTECH

Total Generation	Circuit Avg. Load	DG Status Legend	DEW Suggested Action		Participating Legend
KW	Amps	- OFF - ON - BAD STATE	KW	KVAR	- NOT PARTICIPATING - PARTICIPATING - BAD STATE

Site #	CIRCUIT NAME - GENERATOR	Total Generation	Circuit Avg. Load	DG Status	DEW Suggested Action		Participating In Market
1	ANGOLA DC8862 - Lawrence Tech. U. 150+150KW NG	300 KW	263 Amps	0 KW	0 KW	0 KVAR	0 KW
2	BROOKS DC8081 - Meadowbrook Insurance 800KW D.	800 KW	204 Amps	0 KW	0 KW	0 KVAR	0 KW
3	CRESTWOOD DC8307 - S.Y.Systems 500KW Diesel	500 KW	252 Amps	0 KW	0 KW	0 KVAR	0 KW
4	DUVALL DC9455 - Karmann Manufacturing 1000KW D.	1000 KW	119 Amps	0 KW	0 KW	0 KVAR	0 KW
5	EMERICK DC2925 - Washtenaw County Bldg4 255K						
6	FARMINGTON DC8892 - Botsford 150KW Nat Ga						
7	FISHER DC8188 - ASC Global 2000KW Diesel						
8	FISHER DC8188 - Flat Rock Comm.Center. 500KW						
9	FRISBIE DC2125 - Metropolitan Baking 600KW D						
10	GOLF DC8518 - 2MW Diesel Generator						
11	GROSSE ILE DC 2841 - Grosse Ile Schools 1MW I						
12	IVANHOE DC1760 - 1.5.MW Bi-fuel Generato						
13	JOSLYN DC9182 - Alps Automotive 500KW Dies						
14	MEDINA DC8533 - Adell Comm. 600KW Diesel						
15	MILFORD DC8103 - Milford Junction-MCN 1MW N						
16	PIONEER DC8793 - Warde Labs 600KW Diesel						
17	SHELDON DC9508 - Arctic Colc Storage 750KW						
18	SHORES DC1770 - Greek Orthodox Church 1MW						
19	SOUTHFIELD DC9010 - Southfield 26KW Solar + 50K						
20	SPRUCE DC9874 - Washtenaw County Bldg3 200Kv						
21	SUNSET DC9016 - Farmington 85KW Nat Gas						
22	TIENKEN DC8850 - Beaumont Dialysis 150+150 I						
23	UNION LAKE DC1688 - Union Lake 2MW Diesel						
24	Webster DC371 - 500 KW Diesel						

	UNIT 1 ACT.	UNIT 2 ACT.	REC.
X AMPS	0	0	
Y AMPS	0	0	
Z AMPS	0	0	
TOTAL KW	0	0	Pt Created
TOTAL KVAR	0	0	Pt Created
TOTAL KVA	0	0	
TOTAL PF	1.00	1.00	
X-Y Volts	0	0	
Y-Z Volts	0	0	
Z-X Volts	0	0	

DG 1 DG 2

DG's Current

DG's Voltage

DG's Total KW

DG's Total KVAR

Contacts and SOP

Enable Control

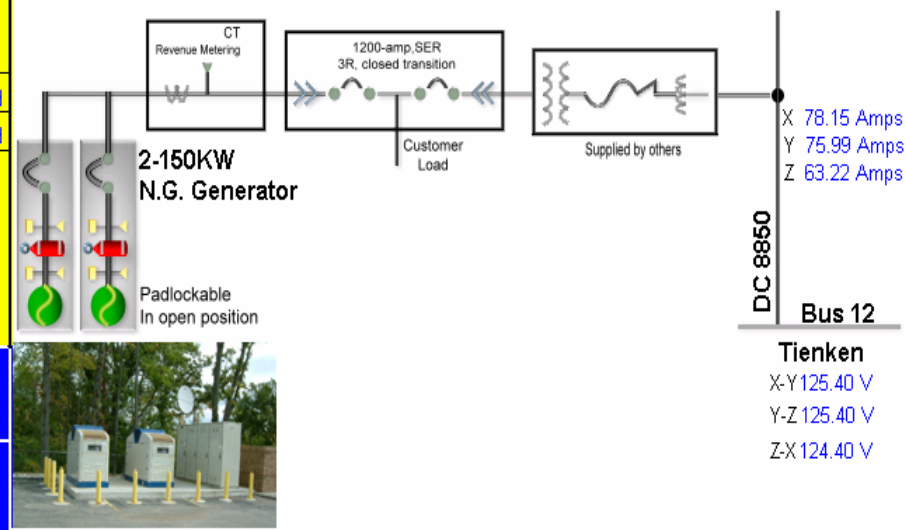
Check if Proceedure has been followed

Communication Link

DTE SOC | DTECH

Beaumont Dialysis

Tienken DC 8850



Override Setting 150

OFF ON

Current Status

Current Status

Override Setting 150

OFF ON

Status

Circuit phase currents

Circuit phase voltages

Total Generation 18,216 KW

DOE Phase 3 – System Study
DER Advanced Integration

DTE Energy

energy.gov
U.S. DEPARTMENT OF ENERGY

DTE Energy®
Detroit Edison

d.e.w. distribution engineering workstation

NEXTENERGY
Economic Security through Energy Diversity

Rolls-Royce Fuel Cell System

OSIsoft.

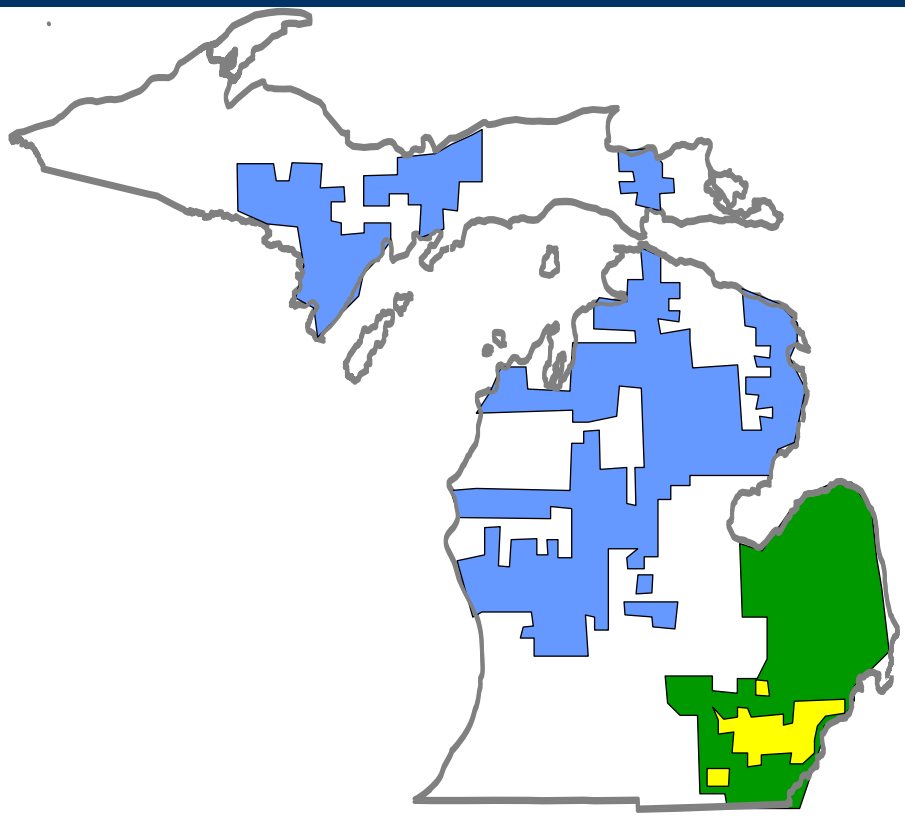
MTechnology, Inc.

DOE 3 Project Phases

Three Phases

- **System Study**
  - **Build Entire Detroit Edison Electrical System**
  - **Customer DER Survey**
  - **Quantifying the benefits of Customer DG on the electrical system for various levels of integration**
    - **Loss reduction & released capacity**
  - **Economic Analysis of Customer DG**
  - **System Reliability Analysis with Customer DG**
  - **Penetration Limits**
- **Development of 1 MW Inverter and fuel cell system at NextEnergy**
- **Intentional Islanding**
  - **Microgrid Demonstration**
  - **Circuit level Demonstration**
  - **System Islanding Study**

Virtual Power Plant – Dispatchable Customer Generation Program



Utility Service Territory

Detroit Edison **MichCon**

Overlap

- Create a 300 MW Virtual Power Plant over the next 10 years using customer generation
- Approximately 200 customers
- 20 MW in 2008
- 30 MW/year beginning in 2009
- Low cost peaking plant
- Provide maintenance, fuel cost, paralleling switchgear and monitoring

Total System Study

Potential Cost for various levels of DER integration

Level of Integration	KW Benefit	Cost Range
• Just interruptible	Min-Max Load offset	$ 0
• Standby with soft transfer (nicer for customer)	Min-Max Load offset	$ 0 - 75,000
• Parallel sellback (no transfer trip)	Sell back maybe limited	$ 0 - 125,000
• Parallel sellback (with installed transfer trip)	Max Sell back	$ 150,000+

- **Cost measures**
  - Cost per capacity added
  - Energy cost per hour
  - Additional Environmental Cost per customer will be analyzed

* Cost does not include distribution system upgrades that maybe required

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GridApp Consortium

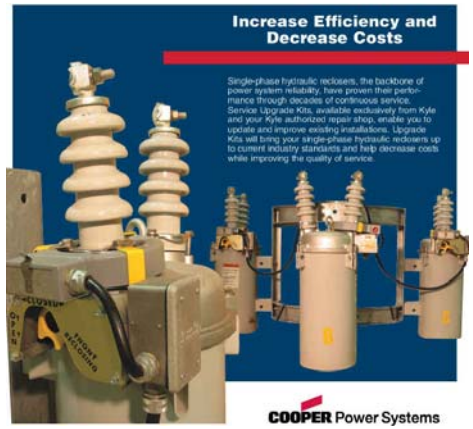
- **The Advanced Grid Applications Consortium (GridApp) is a consortium of utilities that join together to help modernize the U.S. electrical grid**
- **GridApp provides a fast-track process for engineering development, demonstration, and validation of selected High-Impact Technologies. Our mission is to transition best technologies and best practices into broader use by member utilities.**

GridApps Technology Testing

DTE Energy

Trip Save 1 shot
Recloser in a cutout

GridSense LineTracker
communicating meter
Load and fault current



Kyle Retrofit Communicates
load & fault current

Cooper Cap Control
with neutral sensing

Substation in a box

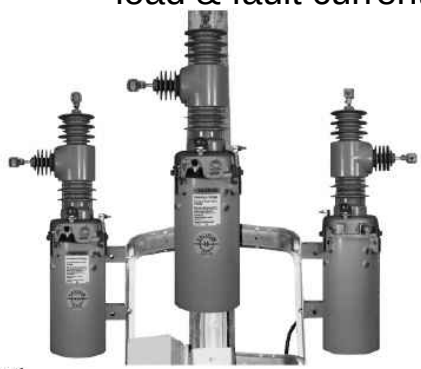


Figure 1.
Kyle® Type NOVA-TS Triple-Single, Electronically Controlled Recloser
Microprocessor-Based Recloser Control.

Cooper Triple Single

Autonomous Storm Detector
interactively modifying
relay trip settings

Radio
Communicating
Fault Indicators

GridApp Consortium

- **Completed Projects**
  - **Autonomous Storm Detector (ASD)- FirstEnergy**
  - **Distribution Center (DC) In a Box - Exelon**
  - **Synchronized Measurement Analysis in Real Time – SCE**
  - **GenOnSys Phase I - Portland General Electric**
- **Projects In Process**
  - **Advanced Capacitor Control System (ACCS) - Idaho Power**
  - **S&C TripSaver – DTE Energy**
  - **Dispatchable Energy Storage System - First Energy**
  - **Distribution Coordinated Control - DTE Energy**
  - **GenOnSys Phase II - Portland General Electric**
  - **GridSense LineTracker DataPAC Development – CTC/DTE/SCE**
  - **Substation Engineering Modeling Tool (SEMT) – SCE**
  - **Radio Communicating Fault Indicators – Exelon**

S&C TripSaver™ Project Overview

- **Receive ten (10) S&C TripSaver™ Dropout Recloser trial units from S&C.**
- **Perform electrical testing at the Warren Service Center high voltage test laboratory.**
- **Perform physical testing and handling at the Pontiac Service Center overhead lines test yard.**
- **Install six (6) trial units at locations on Wolfhill DC 8822 and Wolfhill DC 8838.**
- **Monitor the performance of the TripSaver™ using Gridsense™ LineTrackers with remote communication.**
- **Provide feedback to the GridApp™ Consortium and S&C.**

S&C TripSaver™ Dropout Recloser

- **Advantages of Using the S&C TripSaver™ Dropout Recloser**
  - **Improve the reliability of the electrical distribution system.**
  - **Ideal for long, heavily wooded single-phase laterals.**
  - **Reduce the number of customers affected by momentary outages using the traditional “fuse saving” methods. (i.e. fast curve on a recloser)**
  - **Reduce fuse blowing caused by temporary faults.**

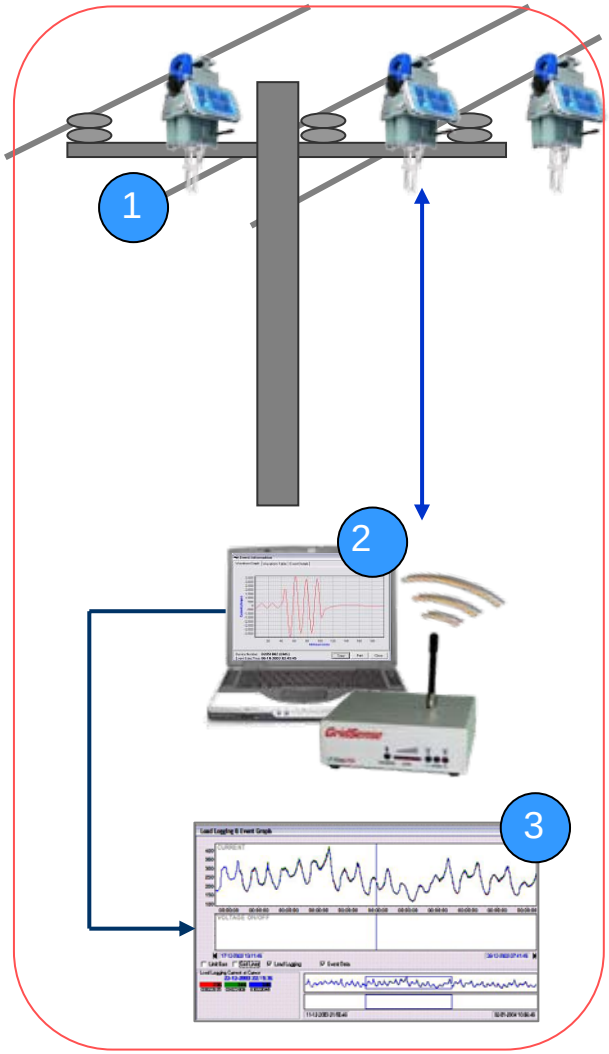
S&C TripSaver™ – Operating Sequence

- **Operating Sequence Open - 5s – Close – Open - Dropout**
- **After Dropout, 5 seconds - Close contacts (Resets)**
- **Lineperson now manually closes TripSaver**

TripSaver Closed

TripSaver Dropped Out

GridSense Line Tracker – Develop DNP Radio Communication



1. LineTracker Sensing & Detection

- Automatic Adaptive Event Recording
  - Fault Current
  - Protection Operation
  - Outages & Restorations
- Load Profiling from 1 – 60 minute averages

2. Onsite Wireless Communications

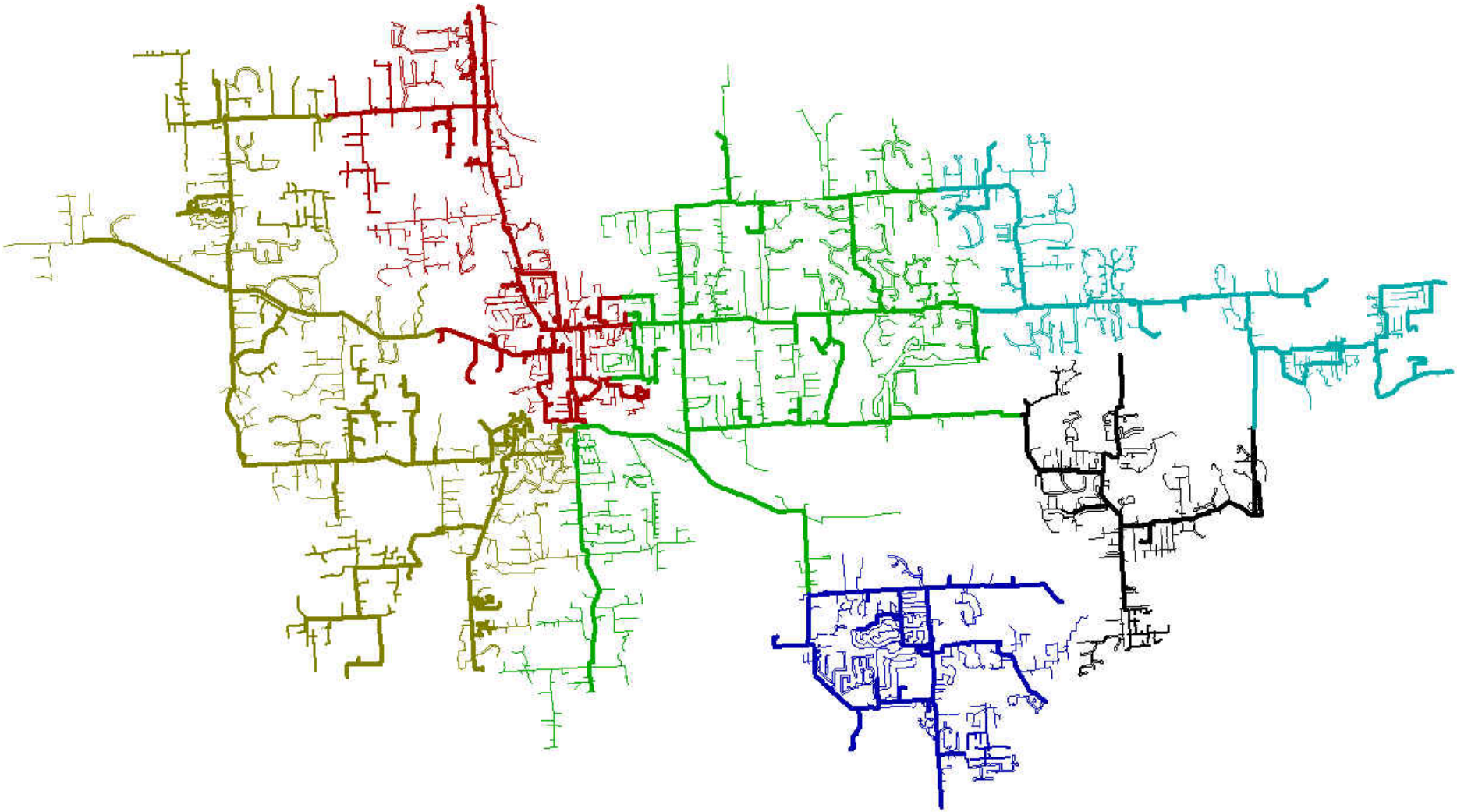
- LT-DataLink transceiver and LineMan software provide wireless:
  - Device Configuration
  - Data Download
  - Device upgrades

3. Installations

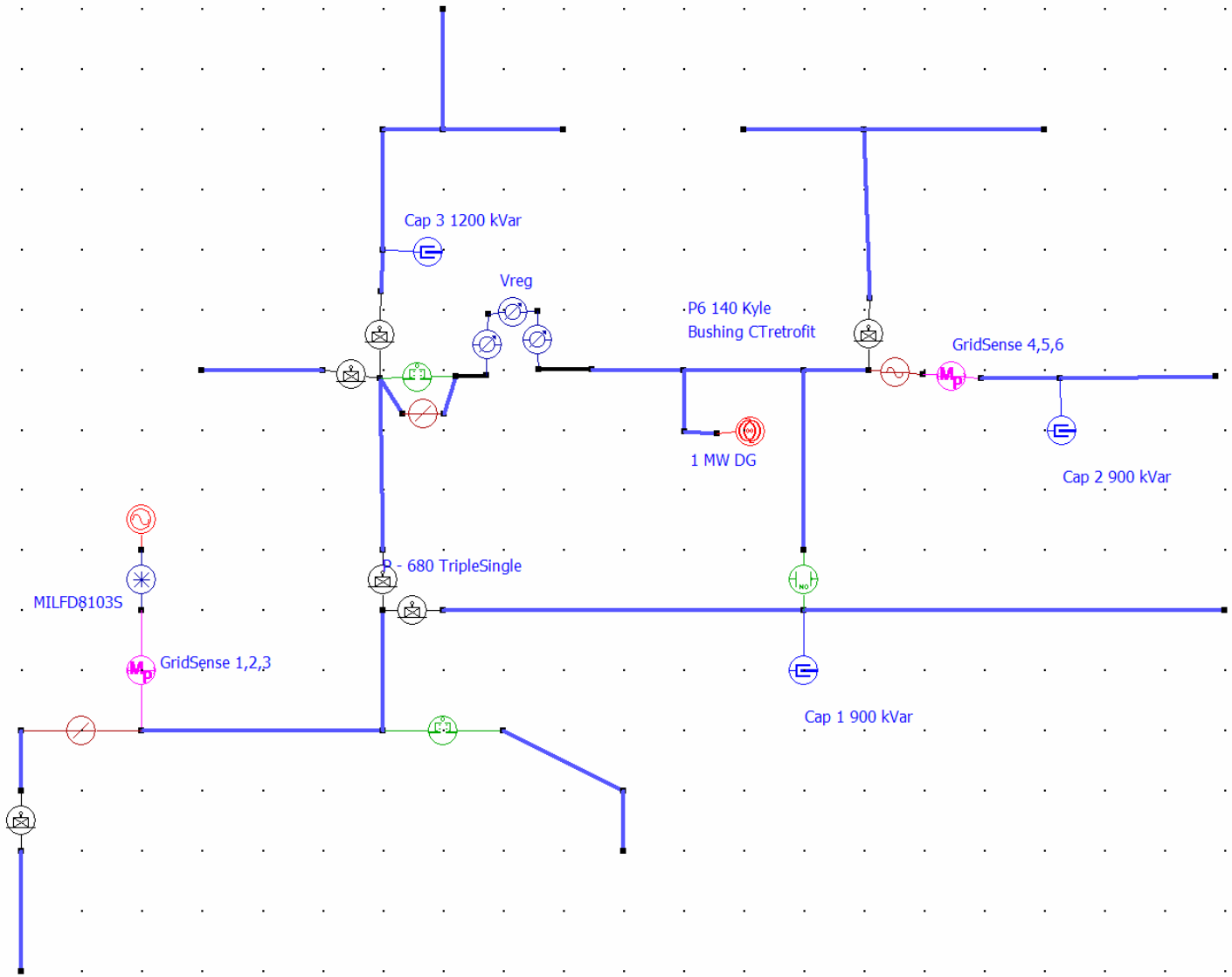
- Behind essential fuses
- Poor performing pockets
- Areas needing more model accuracy

Milford Coordinated Control Project (Model-Base Hieratical Control)

DTE Energy

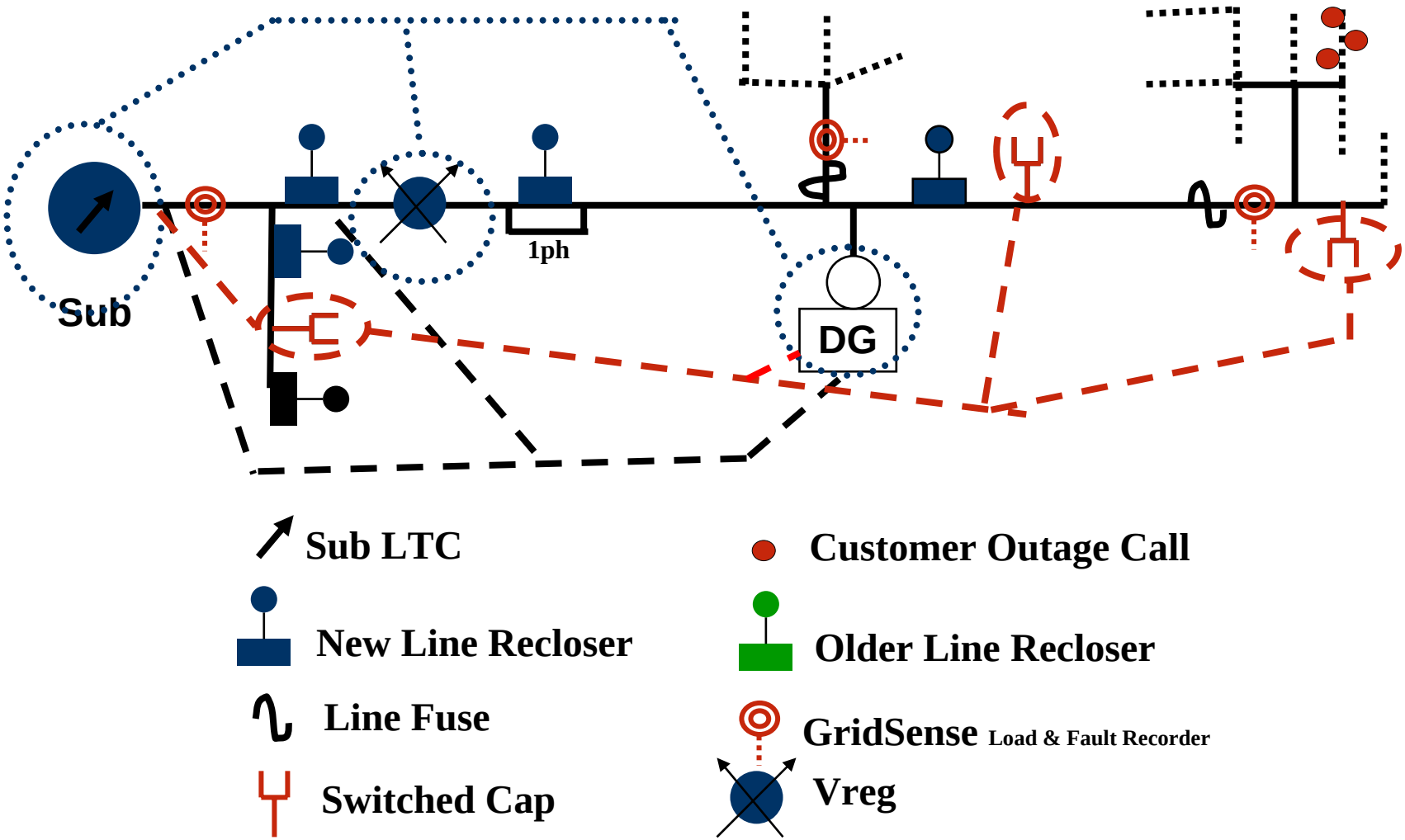


Milford Coordinated Control Project (Model-Base Hieratical Control)



Model-based, Hierarchal Control Coordinated Control All Algorithms

DTE Energy



Coordinated Control Optimization Algorithms

- **Capacity Constrained (only a few hours per year)**
  - **Mission is to Resolve the capacity shortfall regardless of losses**
  - **DG has air permit has max number of hours as a constraint**
- **System Normal (most of the year)**
  - **Mission is to minimize losses**
  - **Max number of switching operations is a constraint**
  - **Fail safe default setting for loss of communication**
- **Abnormal System (shutdowns and outages)**
  - **Capacity Constrained**
  - **Non Capacity Constrained**

DEW's Coordinated Control has two modes of operation:

- **Real time control of all active devises**
- **Planning Mode used to justify retrofitting legacy devices &/or targeting the adding of new devices and control**

Coordinated Control

Control – Overload, Voltage, Reactive, Losses

- **DG – Existing DG Operation & Control updated**
  - **Recloser switched between 3-phase and 1-phase**
  - **Defaults - Recloser will be 3-phase upon loss of communication**
- **Cap Control – Modify existing cap controls**
  - **Phase voltage and neutral current sensing**
  - **Defaults - Voltage over ride (normal range)**
  - **Cap tag out procedure tied to neutral current**
- **Voltage Control – Modify existing fixed voltage control**
  - **Defaults - Voltage over rides (normal range)**
- **Merge Controls – Combine all of the above into a coordinated control**

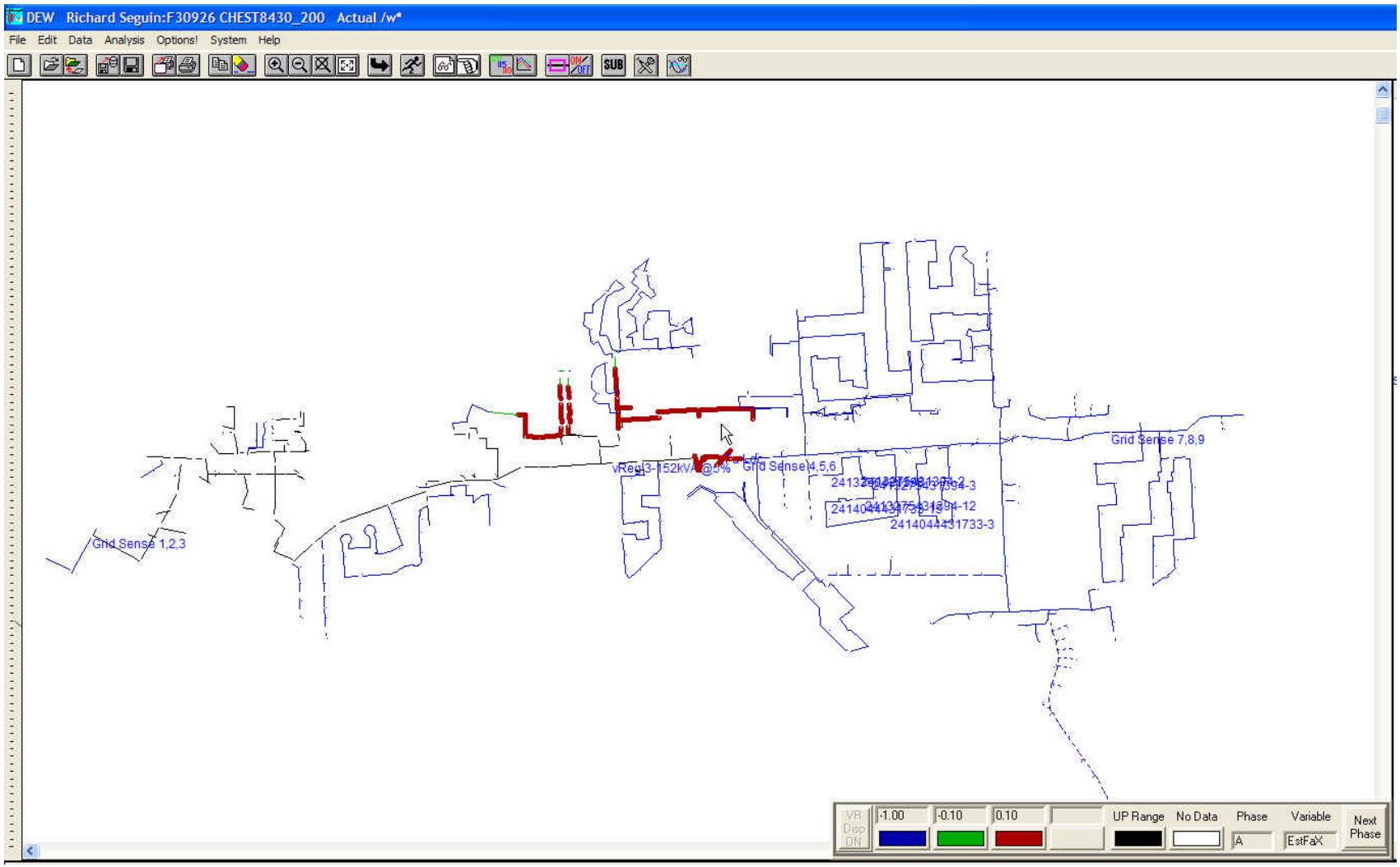
Monitored Data – used to validate model, assure control has been implemented enabling further control, detect configuration change and fault identification & location

Configuration Changes

- **Normal Configuration changes – Model updated and Sensitivity Matrix recalculated**
- **Outage Identification & Fault Location – Merge GridSense, recloser, and substation relay fault data with outage calls from Outage Management System**

Coordinated Control - Fault Location

Chesterfield Example of Possible Fault Location in DEW V7

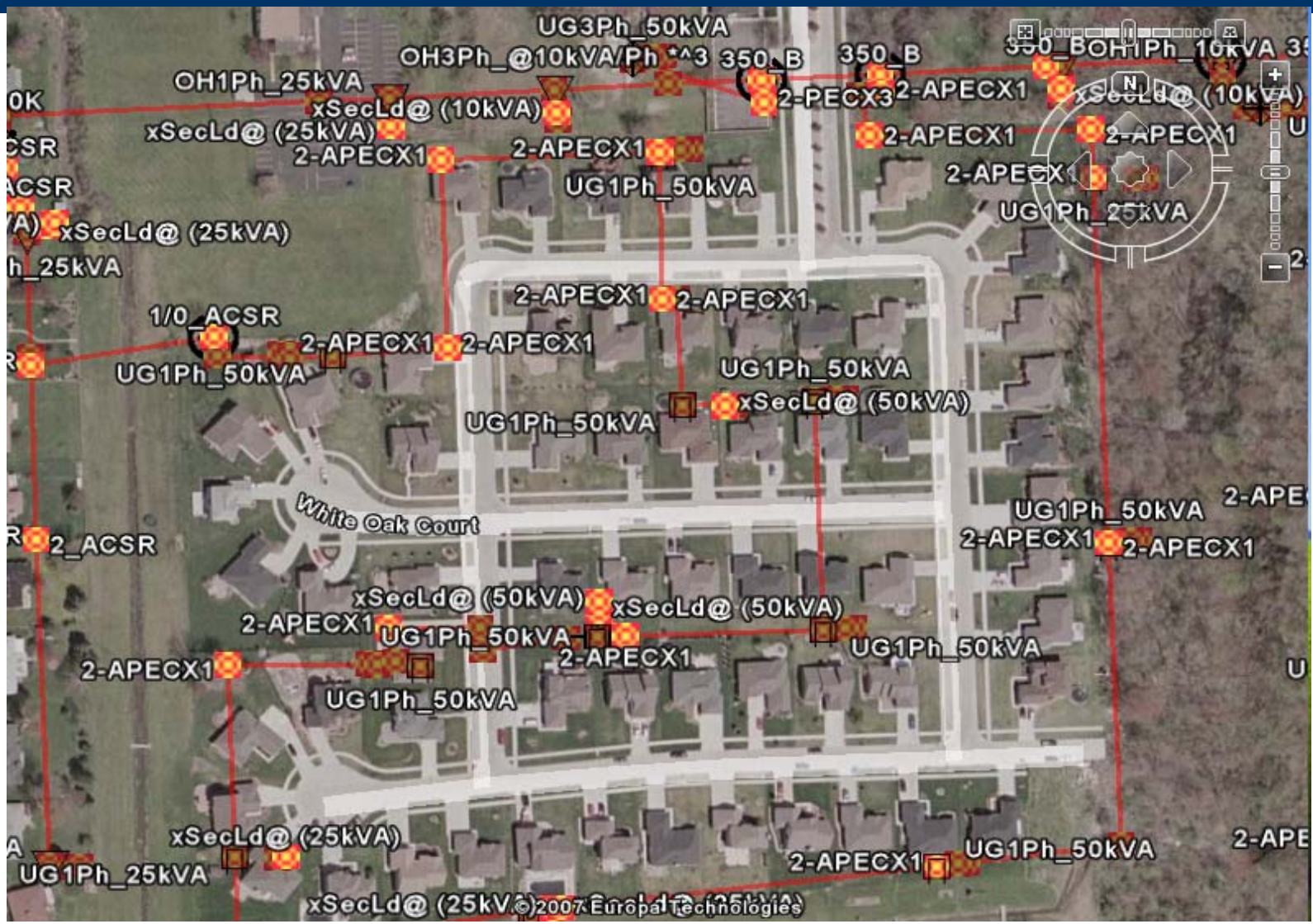


Coordinated Control - Fault Location

Possible fault location using DEW V7 Google Interface

Google Earth Rendering of Outage Area using DEW V7 Google Interface

DTE Energy



Agenda

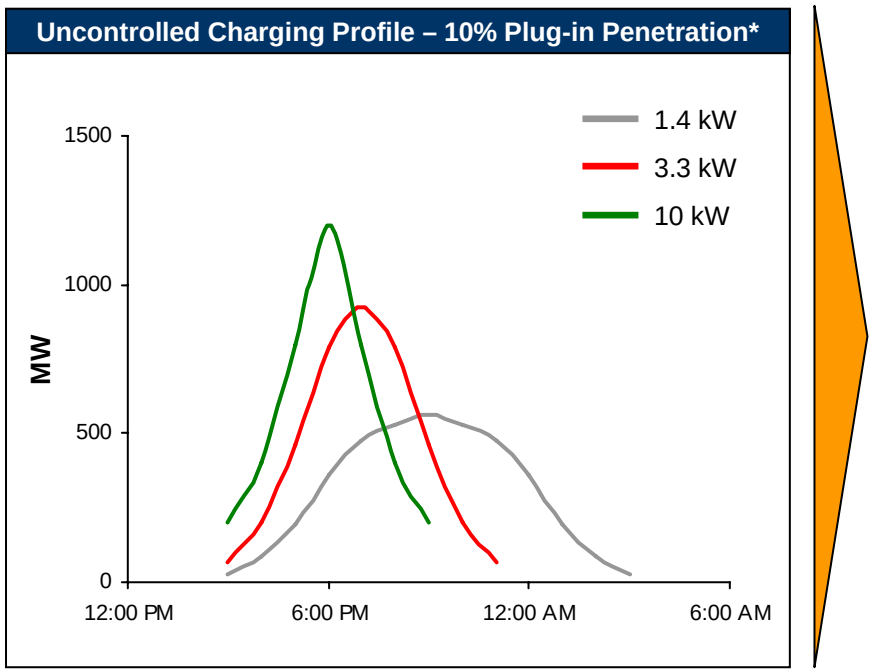
- **AMI Implementation**
- **DG as Distribution Capacity**
- **DG as Virtual Power Plant (DOE)**
- **GridApp Projects (DOE)**
- **PHEV Penetration Study (DOE) – DTE Energy, UofM, PNNL, GM & Ford**

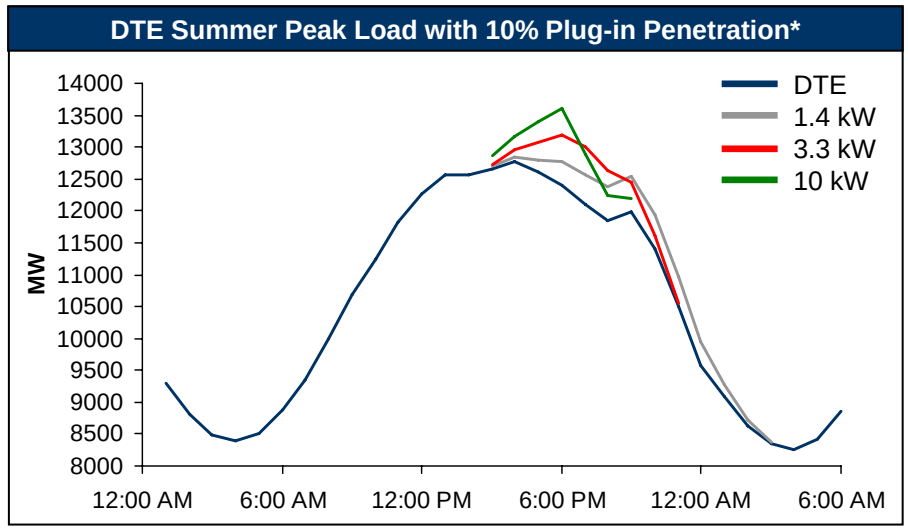
PHEV Study

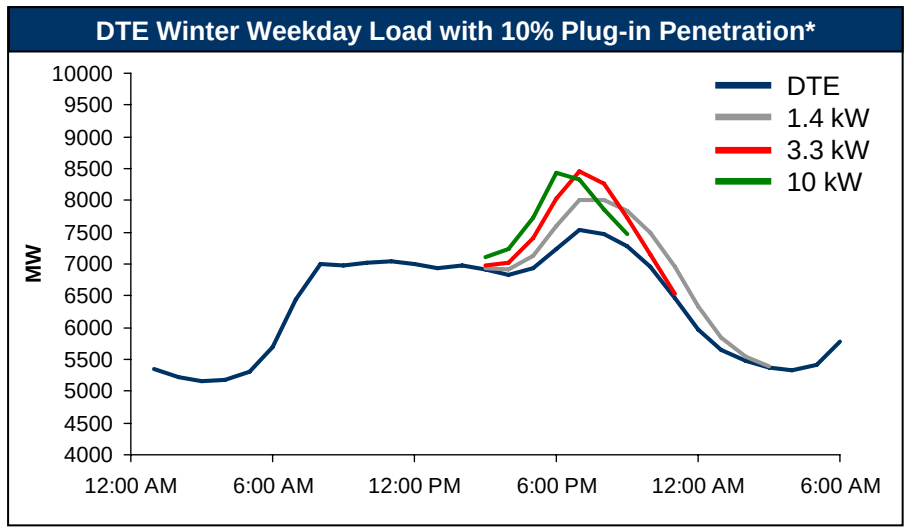
- **Task 1. Technological Barriers to Acceptable PHEV Performance and Cost**
- **Task 2. Consumer Attitudes and Behavior regarding Adoption of the PHEV**
- **Task 3. Impact of PHEVs on the Reliability of the Electric Grid**
- **Task 4. Impacts Assessments on the transmission and distribution system**
- **Task 5. Integrated analysis of PHEV on the future U.S. energy system**
- **Task 6. Impacts on the wholesale power markets**

What Impact Would Uncontrolled Charging Have on the Overall Electric Grid?

DTE Energy

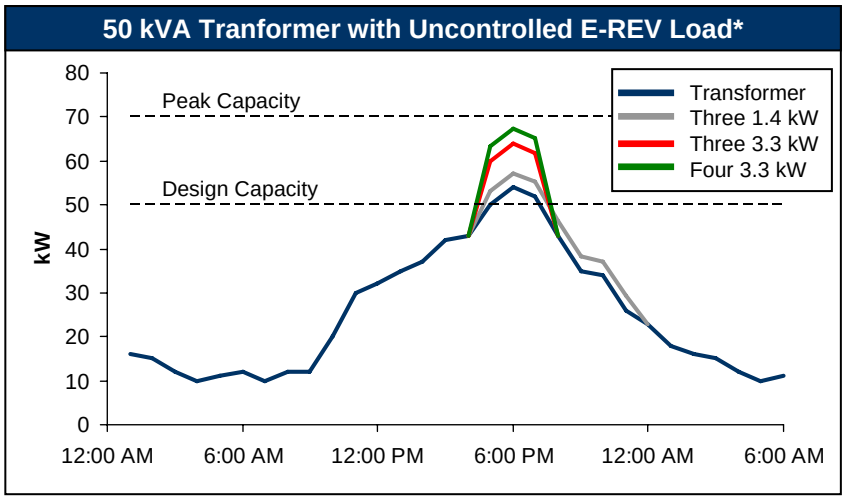


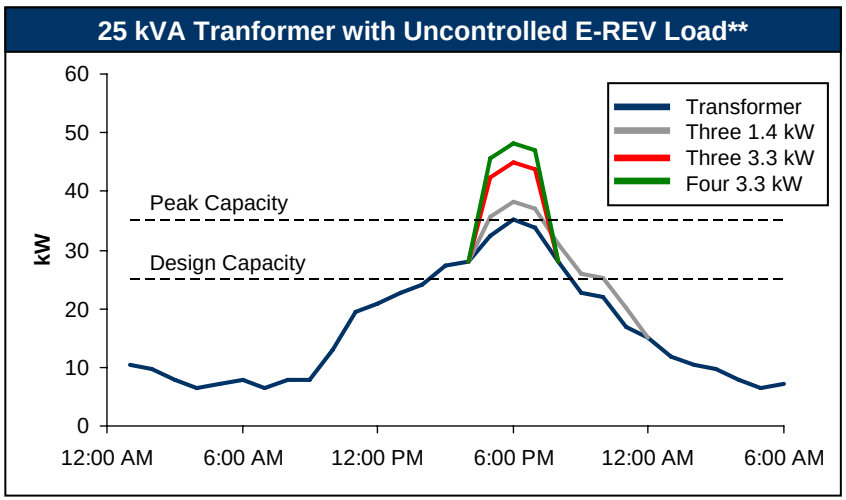




* Assumes all vehicles arrive home between 3 and 9pm and that arrival times are normally distributed

Uncontrolled Charging Would Lead to Localized Distribution Disruptions





- Transformers are rated to handle peak loads of approximately 140% design load (e.g., 70 kW for a 50 kVA transformer)
- Peak loads in excess of 140% or extended periods of time at peak loading can lead to localized electric service problems
  - Voltage dips (dimming lights, damage to expensive electronics)
  - Service interruption
  - Transformer failure
- Multiple vehicles charging on one transformer, even at relatively low charge rates, can lead to electric service problems/disruptions
- Measures can be taken to mitigate potential grid issues
  - On-vehicle charging control (time/date control)
  - Circuit inspection/troubleshooting by local utility as part of purchase process
  - SmartGrid technology will allow virtual real-time charging management and transformer troubleshooting

* Load shape for warm summer day. 6-10 homes per 50 kVA circuits in newer neighborhoods. 100% central AC penetration assumed. Current DTE planning standard.

** Load shape for warm summer day. 8-12 smaller, older homes per 25 kVA circuit. Most homes without central AC.

Questions