



**Microgrid Evolution: New Paradigms
Drive New Architectures**

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Evolution of Microgrids

Type	Benefits	Target	Control
Cogeneration	Backup power savings (CHP)	Customer	Local
CERTS		Large facility	Local EMS
Perfect Power	Very high reliability	Large facility	Local + Utility
Customer driven*	Backup power Greening Lower cost	Distribution feeder	Autonomous

*NMSU-FSU research sponsored by NSF Grant ECCS-0702208



Drivers

- Public Policy
- Environmental Agencies
- Technology
- Utility Economics
- Customers
 - Reliability
 - Cost



The Customer

Large Individual Consumers

- Industrial consumers account for 27.3% of retail sales
- Will drive CoGen/CHP/Perfect Power

Smaller Customers

- Residential consumers account for 36.9%, commercial 35.5% retail sales
- Can consolidate and produce tremendous impact



The Customer-driven Paradigm

Customer concerns

- Cost
- Reliability
- Convenience

Utility concerns

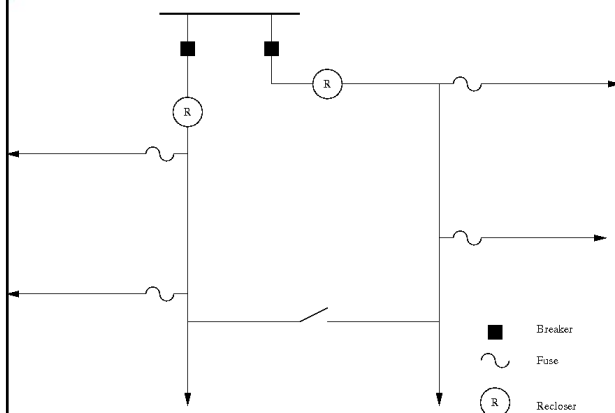
- Revenue
- Safety
- Infrastructure

Utility becomes an *enabler*

- Reliability management
- Network service
- Energy aggregation/marketing



Conventional Distribution Feeder



DG Concerns:

- ✓ IEEE 1547- Safe operation
- ✓ Adequacy of fault levels
- ✓ Resynchronization
- ✓ Protection/Coordination

DG Opportunities

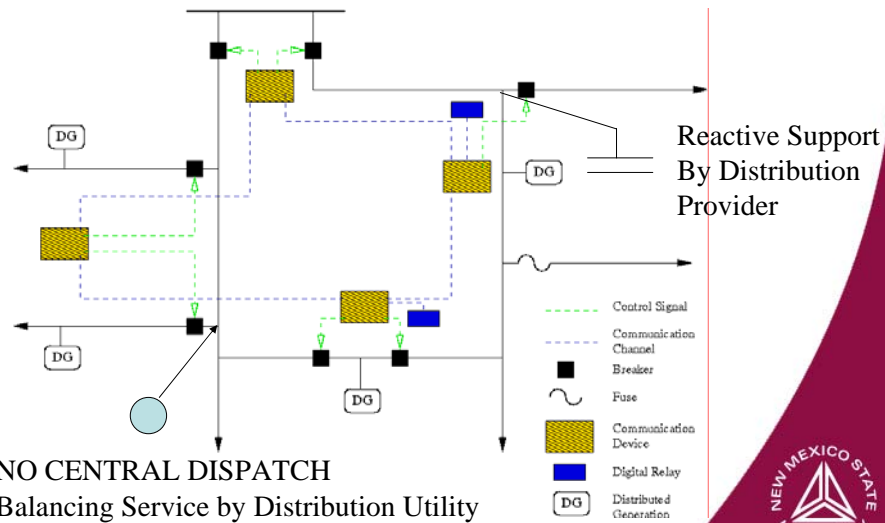
- ✓ Attractive buy-back rates
- ✓ Peak Demand Reduction
- ✓ Deferred Expansion
- ✓ Savings for customer

Showstoppers

- Technology Cost
- Standby Charges



Autonomous Microgrid



NO CENTRAL DISPATCH
Balancing Service by Distribution Utility
or Independent Provider Using Generation / Storage



Utility Services

- Advanced metering
 - Real-time prices
 - Minimal control of customer generation
- Network Architecture
 - Looped system
 - Reactive support
- Strategically located larger generation and Storage
 - Peak demand control
 - Balancing service if islanded
- Reliability Monitoring
 - Feeder sectionalizing allows Islanding

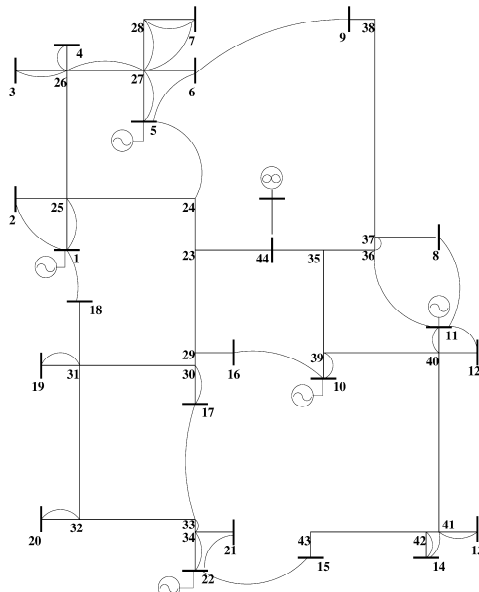


Evolution of Customer-driven Microgrids

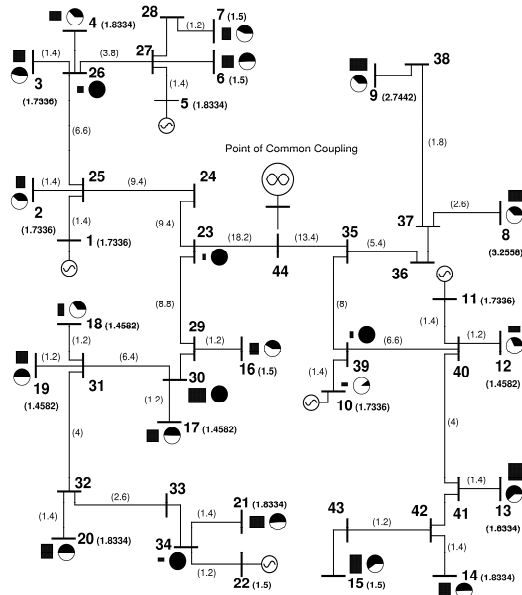
- Network planning
- Generation deployment for feeder support
- Reactive support in islands
- Autonomous control in islanded operation



Customer-driven Architectures I. Network Planning

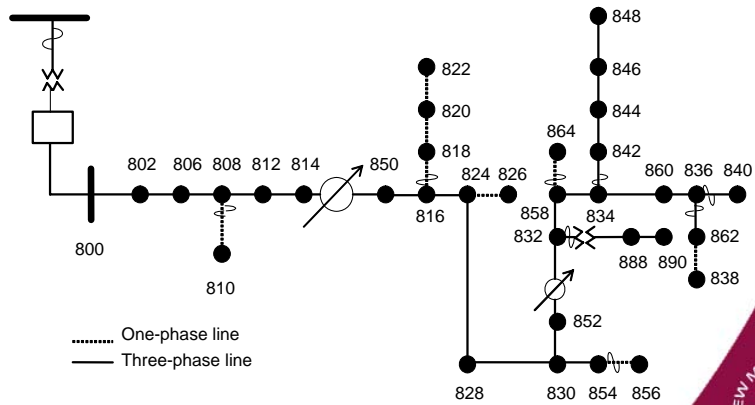


Customer-driven Architectures II. Generation Deployment



Customer-driven Architectures III. Reactive Power Support

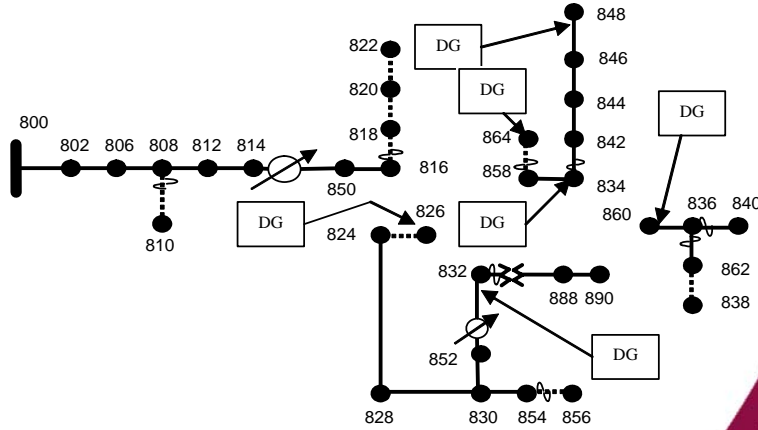
34 node feeder



Customer-driven Architectures

IV. Voltage Support in Islanded Mode

34 node feeder-multiple Islanding scenarios

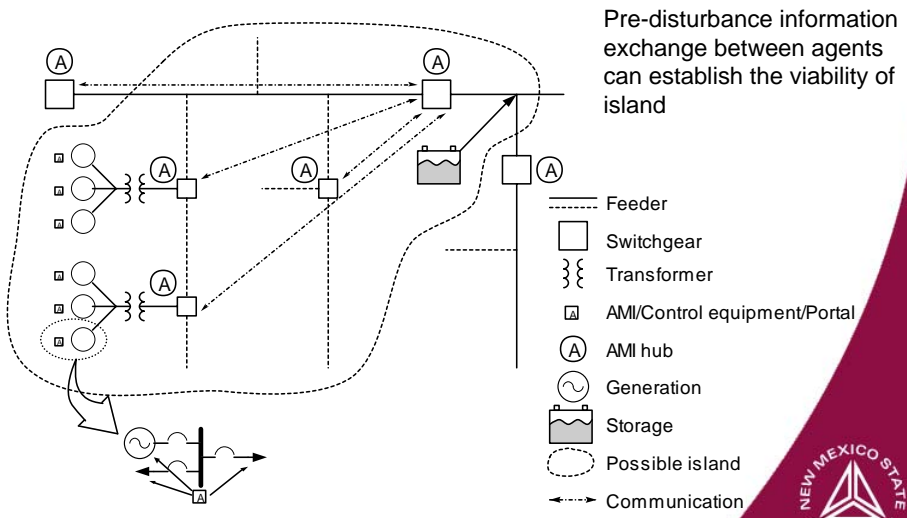


Is there a capacitor allocation that minimizes loss under normal conditions AND provides reactive support when islanded?



Customer-driven Architectures

V. Autonomous Islanding



Pre-disturbance information exchange between agents can establish the viability of island



Customer-driven Microgrid

- Feasible with today's technology
- Anarchic proliferation of DG possible
 - Lower cost of technology
 - Desire for backup power
 - “Greening”
- Utility business model changes
 - Avoid regressive ‘standby’ charges
 - Provide enhanced services



Questions? Comments?

