
# 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<br>Greening<br>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

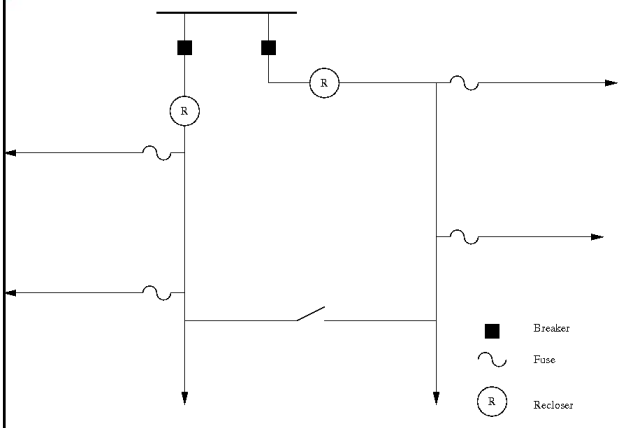
# The Customer-driven Paradigm

Customer concerns
- Cost
- Reliability
- Convenience

Utility concerns
- Revenue
- Safety
- Infrastructure

Utility becomes an *enabler*
- Reliability management
- Network service
- Energy aggregation/marketing

# Conventional Distribution Feeder

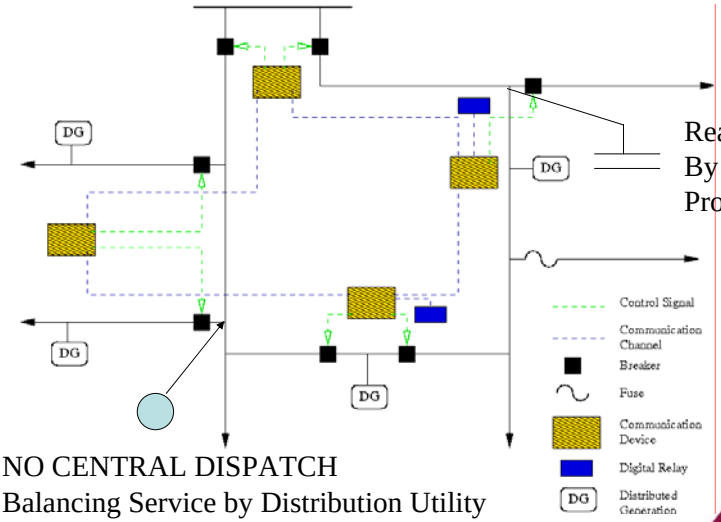



DG Concerns:
- ✓IEEE 1547- Safe operation
- ✓Adequacy of fault levels
- ✓Resynchronization
- ✓Protection/Coordination

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

Showstoppers
- Technology Cost
- Standby Charges

# Autonomous Microgrid




Reactive Support By Distribution Provider

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

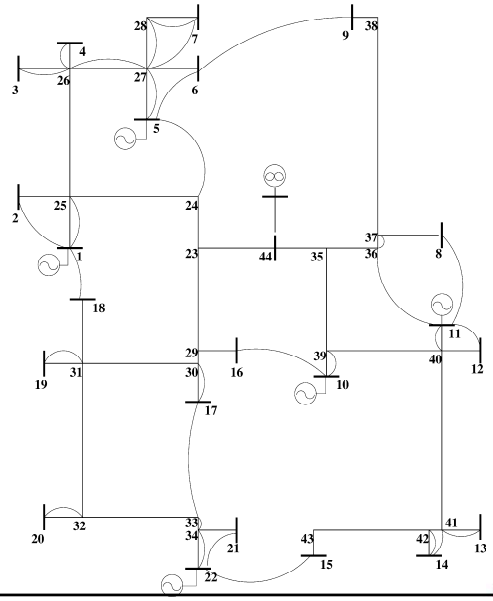
# Utility Services

- 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

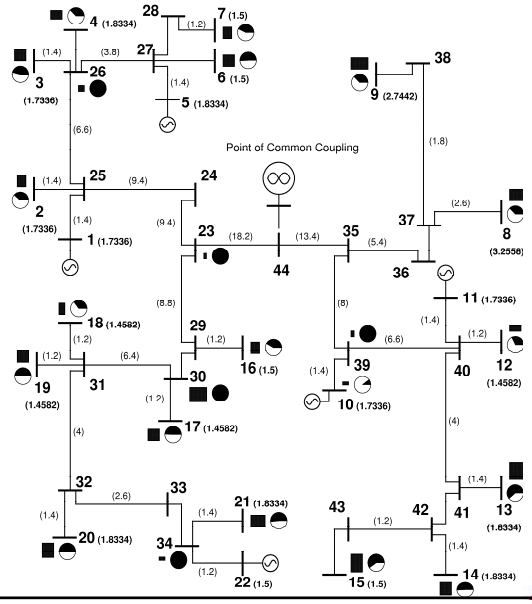
# Evolution of Customer-driven Microgrids

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

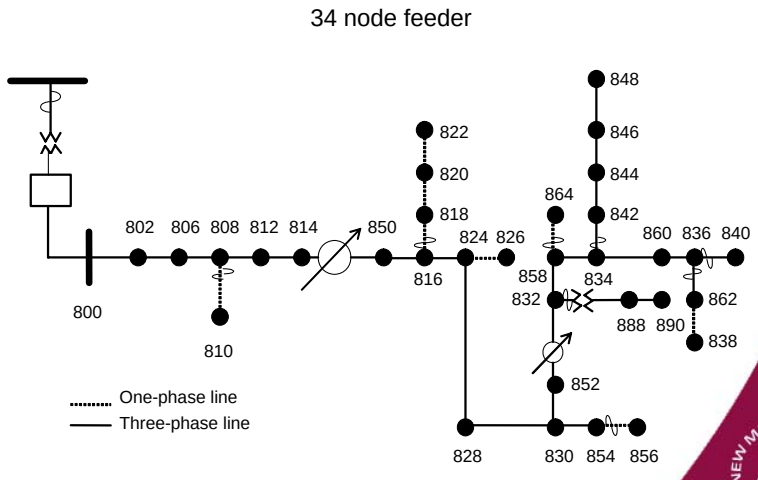
# Customer-driven Architectures I. Network Planning



# Customer-driven Architectures
# II. Generation Deployment

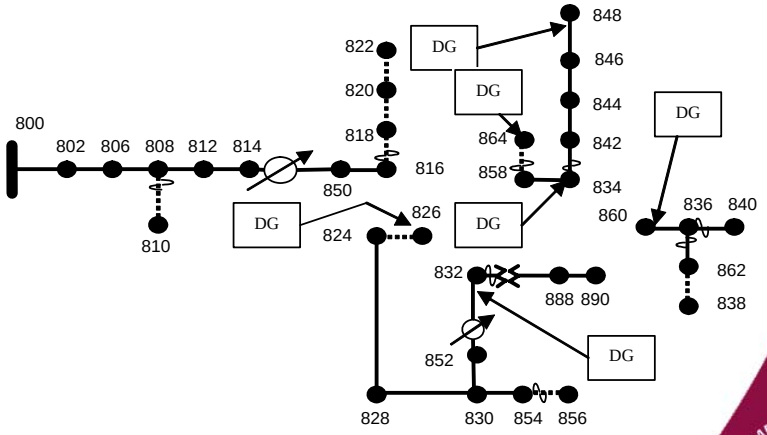



# Customer-driven Architectures
# III. Reactive Power Support



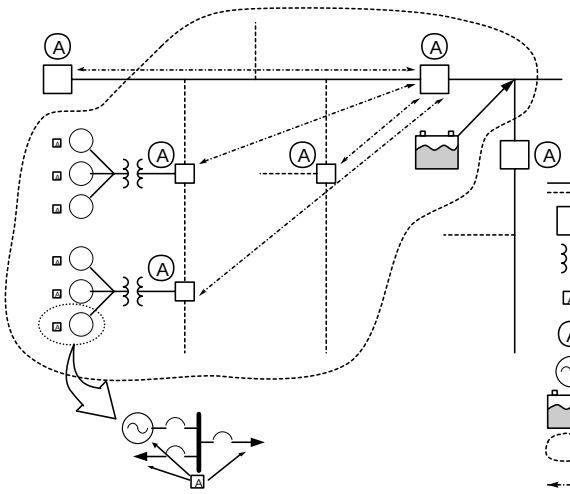
# Customer-driven Architectures
# IV. Voltage Support in Islanded Mode

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?