

11-IEP-1H

**DOCKET**

11-IEP-1G

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# **Distribution System Monitoring:**

## **Intelligence to manage variability and uncertainty**

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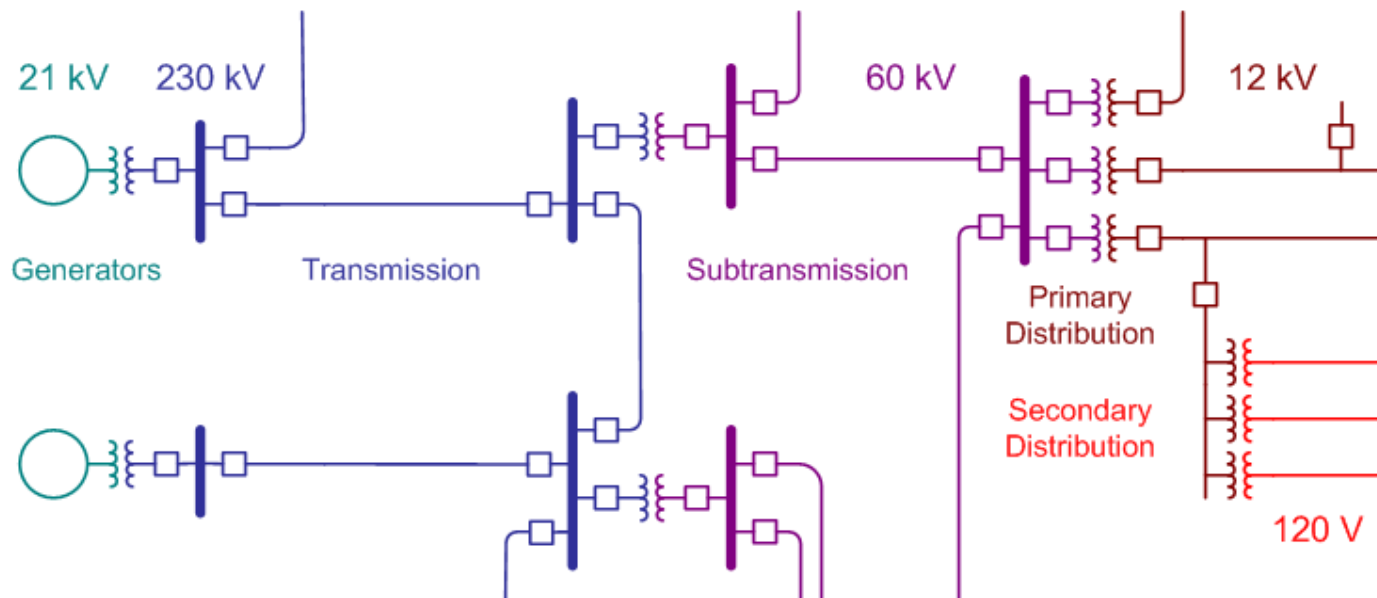
IEPR Committee Workshop

Distribution Infrastructure Challenges and Smart Grid Solutions  
to Advance 12 GW of Distributed Generation

June 22, 2011



## How distribution systems are different than transmission systems: Architecture, Diversity, Variation, Vulnerability, Opacity





## Some distribution feeder attributes:

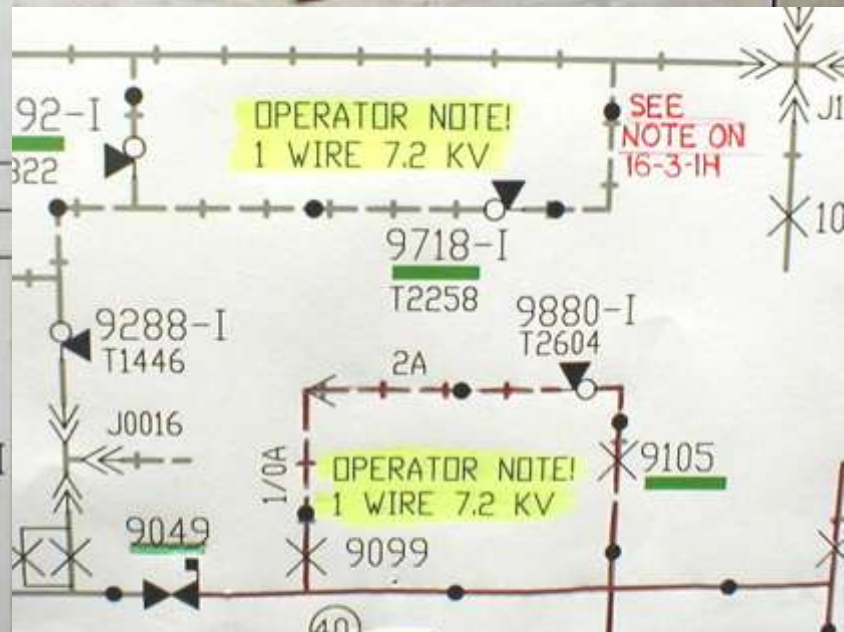
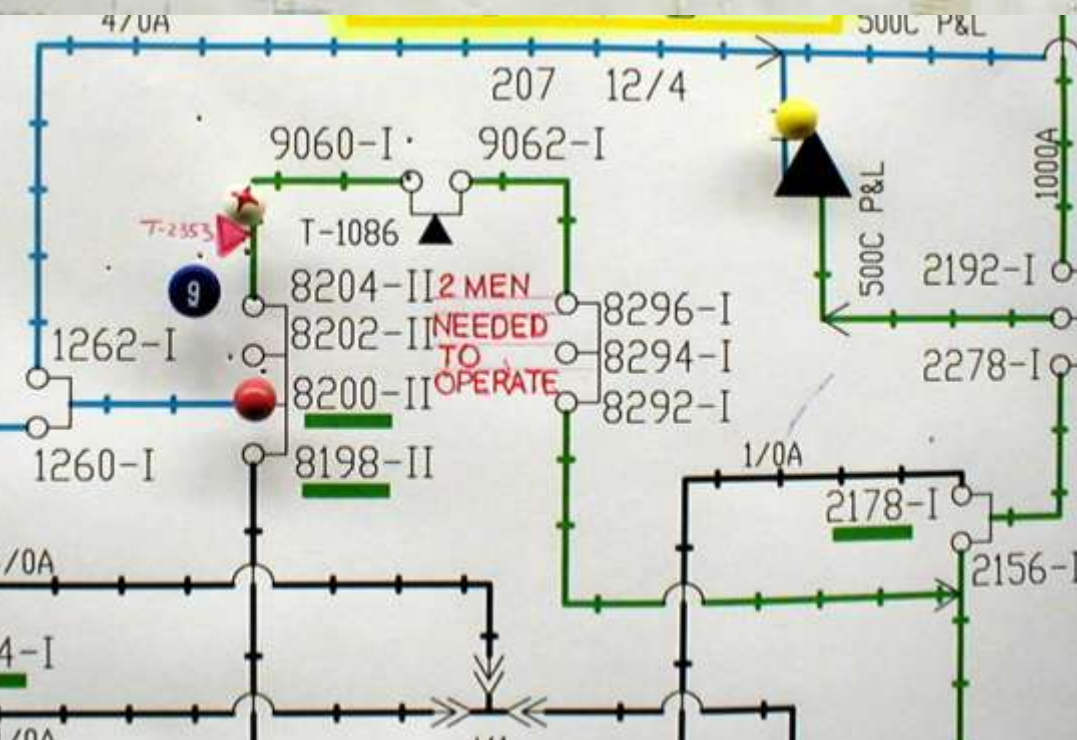
- underground vs. overhead
- voltage level
- topology (e.g. radial, loop, network), sectionalizing options
- circuit length, load density
- load characteristics (time profile, load factor, predictability)
- anticipated load growth, EV, DG
- sensitivity of loads to power quality
- phase imbalance
- extent of SCADA capabilities in place
- type of voltage regulation equipment in place
- type of protective equipment and protection scheme used
- exposure to environmental insults, susceptibility to tripping



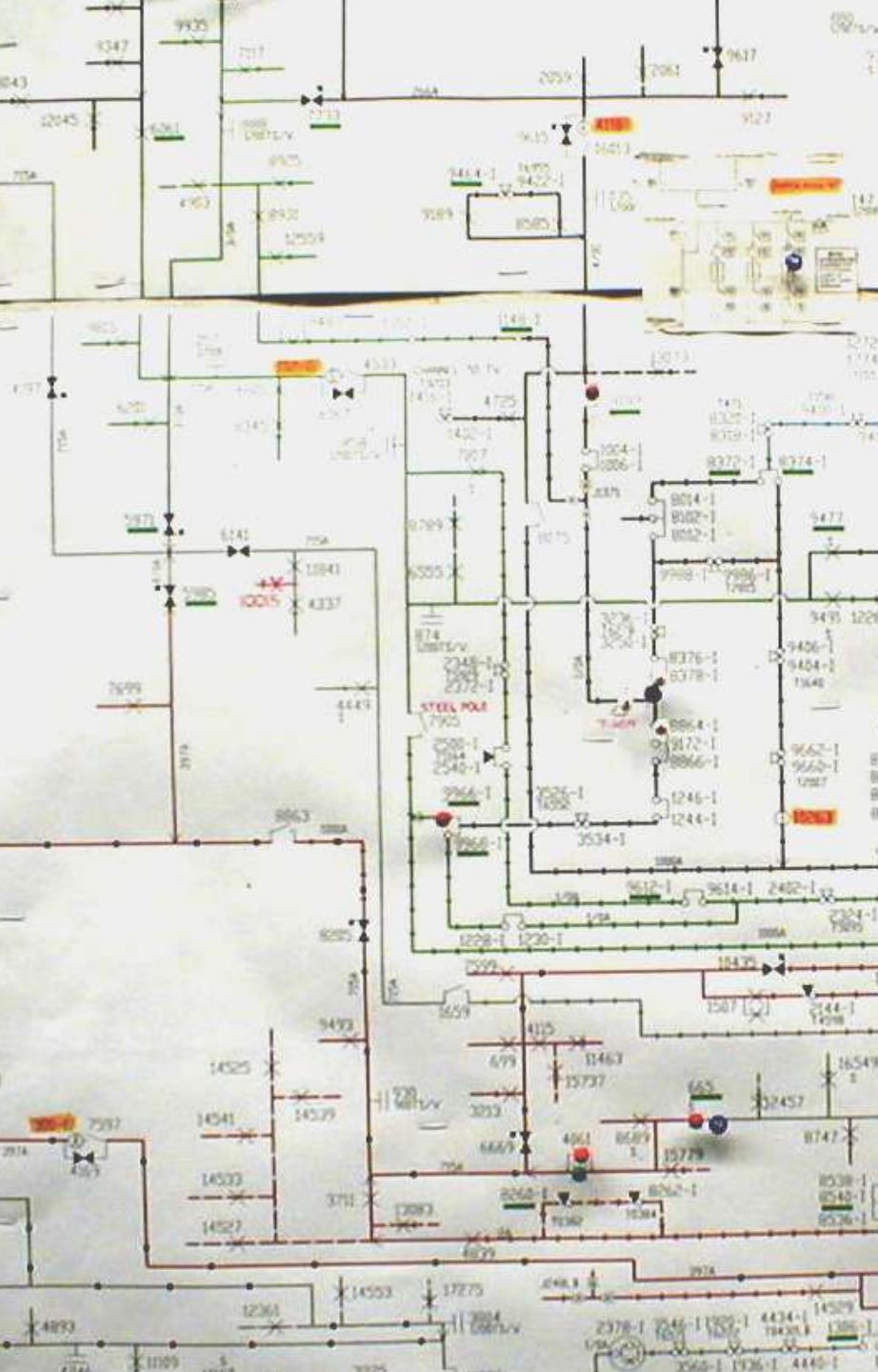
Illustration:  
Michael Sowa











→ Data richness, variation and vulnerability make it important to characterize distribution circuits in detail,

*but*

opacity makes it difficult to do so

## What can we see, and what would we like to see?

- **Direct measurement on distribution circuits**  
voltage, power flow, harmonics
- **Behavior of DG and loads**  
inverters, forecasting, adoption rates
- **Inference from observations**  
predictive & aggregate models



## Direct measurement on distribution circuits

**SCADA** gives power and voltage data at substation  
(where available)

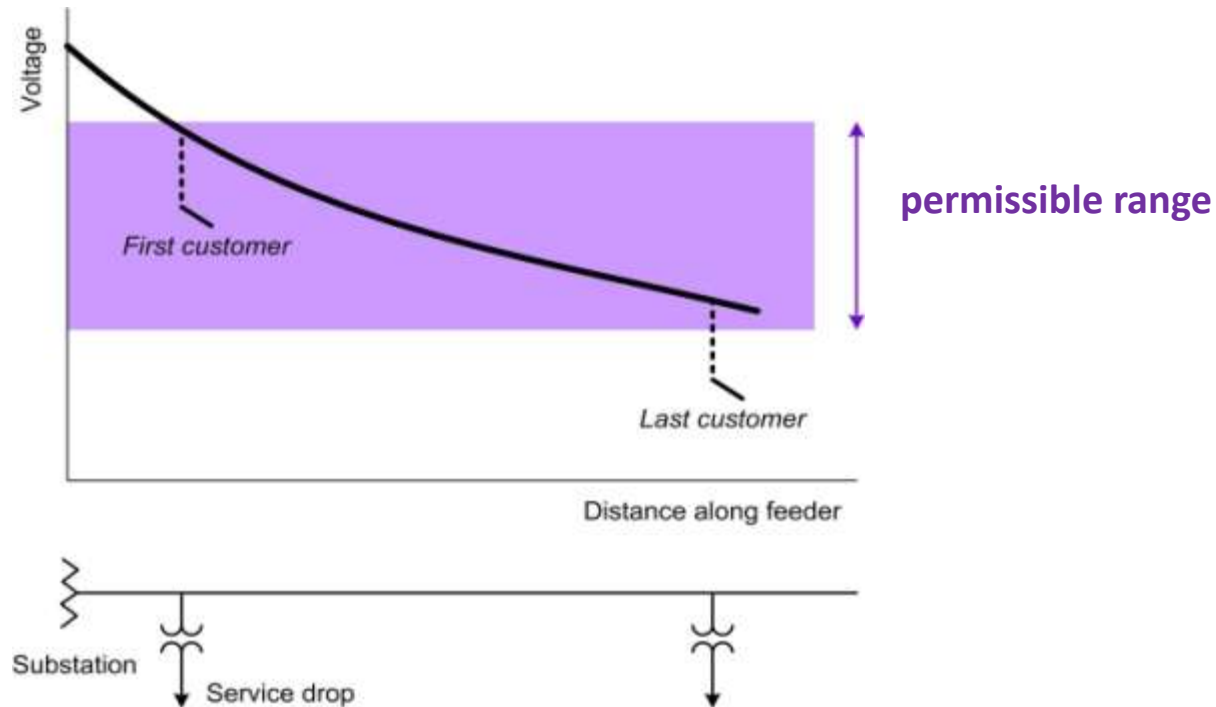
**Capacitor banks** give voltage reading along circuit  
(where available)

**AMI** customer meters can be enabled to give voltage  
reading (where available)

→ *need additional sensing and monitoring to evaluate  
and anticipate DG impacts*

# Additional sensing and monitoring

*How closely spaced? What sampling rate?*



## **PIER Transmission Research Program**

### **Policy and Technical Advisory Committees have agreed:**

- **Distribution systems harbor some of the greatest challenges for renewable resource integration today.**
- **Increased monitoring and characterization of distribution systems is a fundamental need in order to facilitate higher levels of DG integration.**
- **Existing work by utilities on distribution systems with high-penetration DG should be shared and knowledge gaps identified.**
- **Collaborative, coordinated efforts to monitor distribution circuits should provide compatible and complementary data.**



# Distribution Monitoring Research: Overview

1. **Characterization of sample feeders**
2. **Local DG impact assessment**
3. **Information sharing**
4. **Coordinated data analysis**
5. **Feeder modeling for future DG and EV impact predictions**
6. **Implementation of broader feeder monitoring where indicated**
7. **Distributed resource behavior specifications**

# Distribution Monitoring Research: Next Steps

1. **Characterization of sample feeders**
  - a. Individual studies: **Utilities are already conducting**
  - b. Coordinated, statewide effort:  
**Utilities perform, PIER helps coordinate**
2. **Local DG impact assessment**
  - a. Individual studies: **Utilities are already conducting**
  - b. Collective interpretation and gap analysis: **PIER funded**
3. **Information sharing**  
**Utilities participate, PIER helps coordinate**
4. **Coordinated data analysis**  
**PIER funds research**

*continued...*

## Distribution Monitoring Research: Next Steps

5. Feeder modeling for future DG and EV impact predictions

PIER funds research, utilities participate and advise

6. Implementation of more comprehensive feeder monitoring where indicated

TBD

7. Distributed resource behavior specifications

TBD



# Distribution Monitoring Research: Next Steps

## 1. Characterization of sample feeders

- a. Individual studies: **Utilities are already conducting**
- b. Coordinated, statewide effort

**Working group has been formed to determine scope, resolution and protocol for collecting compatible and complementary data**

- 2. Local DG impact assessment
- 3. Information sharing
- 4. Coordinated data analysis
- 5. Feeder modeling for future DG and EV impact predictions
- 6. Implementation of broader feeder monitoring where indicated
- 7. Distributed resource behavior specifications

## Desired Benefits of Distribution Monitoring Research

- Safe and reliable distribution system operation with increasing presence of distributed generation and EVs
- Visibility for transmission operators beyond the substation
- Informing DG specifications and interconnection standards
- Informing needs for strategic upgrades

*All of the above depend on good data.*