Distribution PMU
A scoping study

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Distribution PMU

- Reports same data as transmission PMU

$$x(t) = (X)\cos\{(\omega)t + (\varphi)\}$$

plus something called ROCOF

Differences because:

- More cost constrained
- Distances shorter
- Lines smaller

Situation changing because:

- Not much monitored at present
- Expecting DER and EV

Distribution PMU: different requirements

Accuracy

- Smaller dimensions – smaller φ
- Regulations on voltage quite strict

- Altogether not so easy!

Distribution PMU: Applications

Distribution Automation List

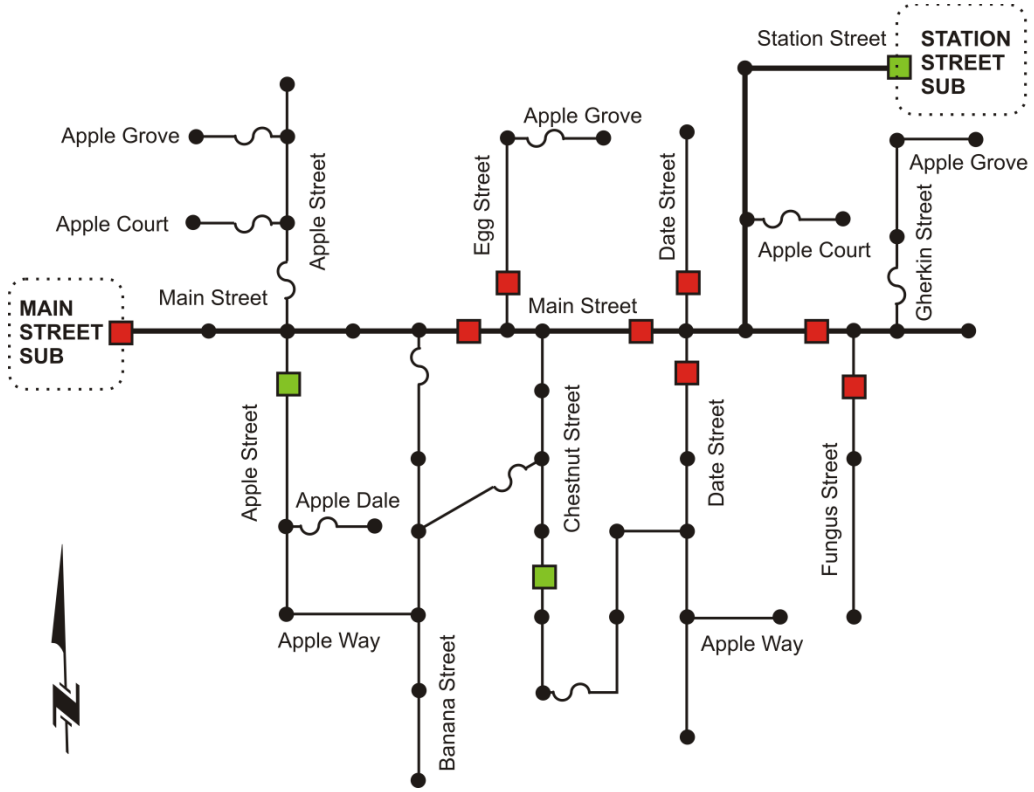
- System Operation
- System Operation (faulted)
- Diagnostics and Modeling
- Planning

Distribution system largely “passive” at present

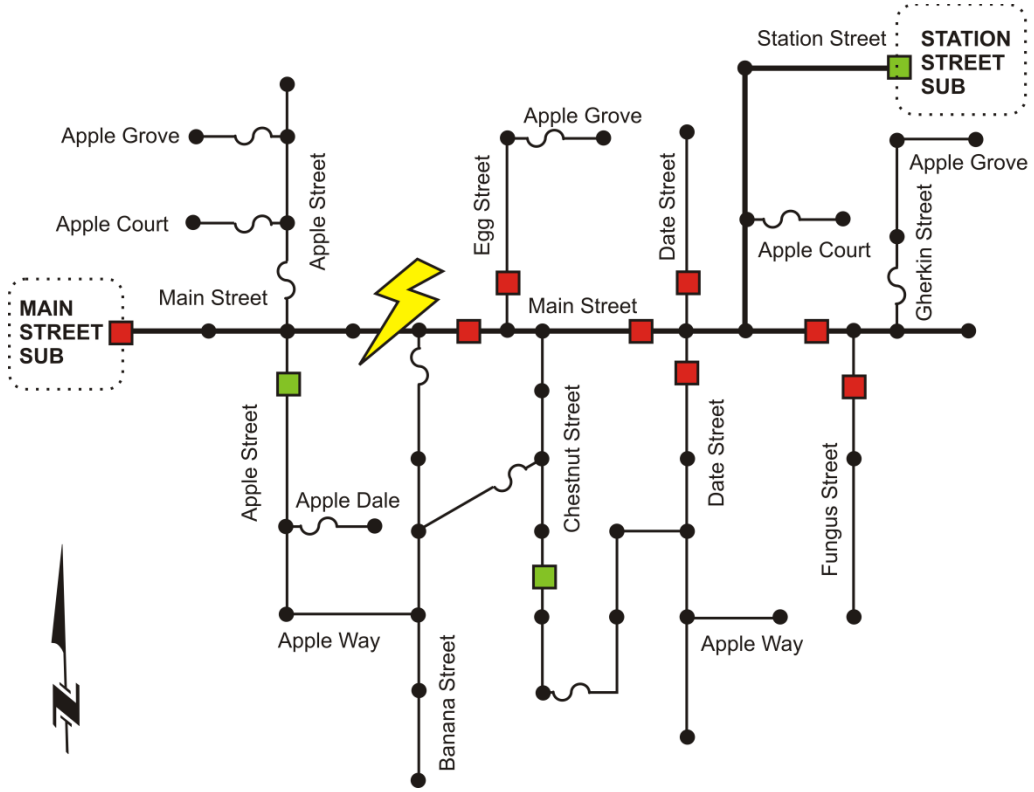
Study group is

1. Examining functions for value
2. Explaining why things are not being done
3. Checking to see if PMU is a solution

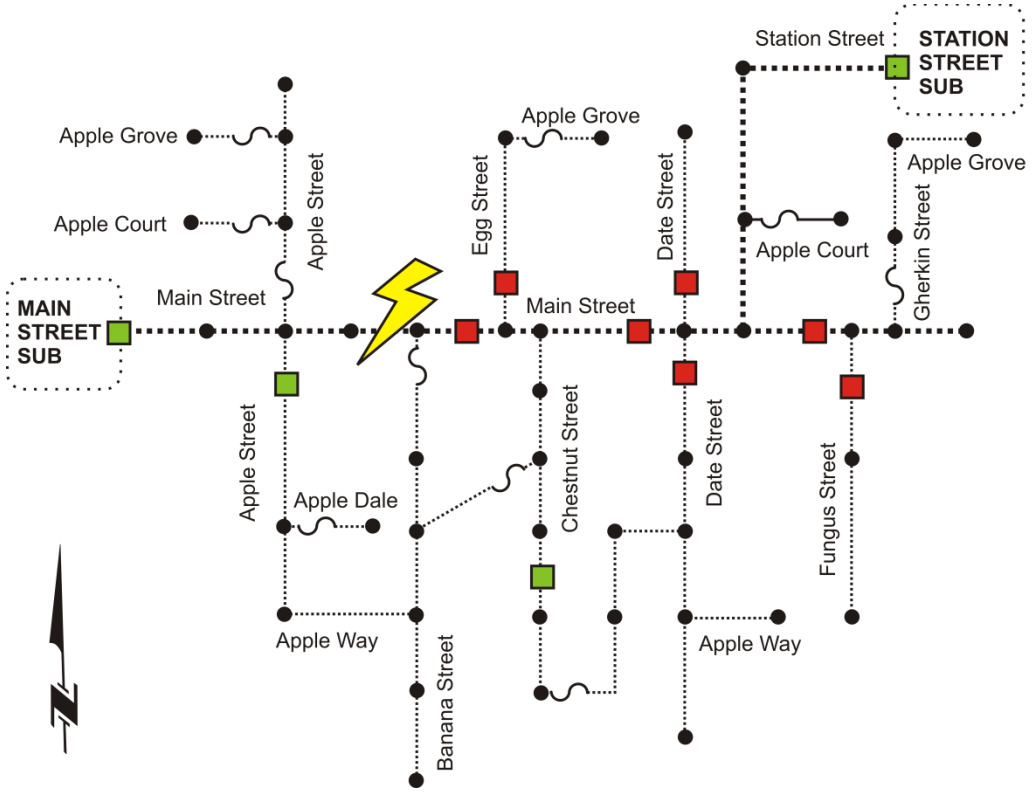
A reconfiguration example:



Add a fault:


Station Street
STATION STREET SUB
Apple Grove
Apple Court
Apple Street
Egg Street
Apple Grove
Date Street
Apple Court
Apple Grove
Gherkin Street
MAIN STREET SUB
Main Street
Main Street
Apple Street
Apple Dale
Chestnut Street
Date Street
Fungus Street
Apple Way
Banana Street
Apple Way

Trip feeder: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Date Street
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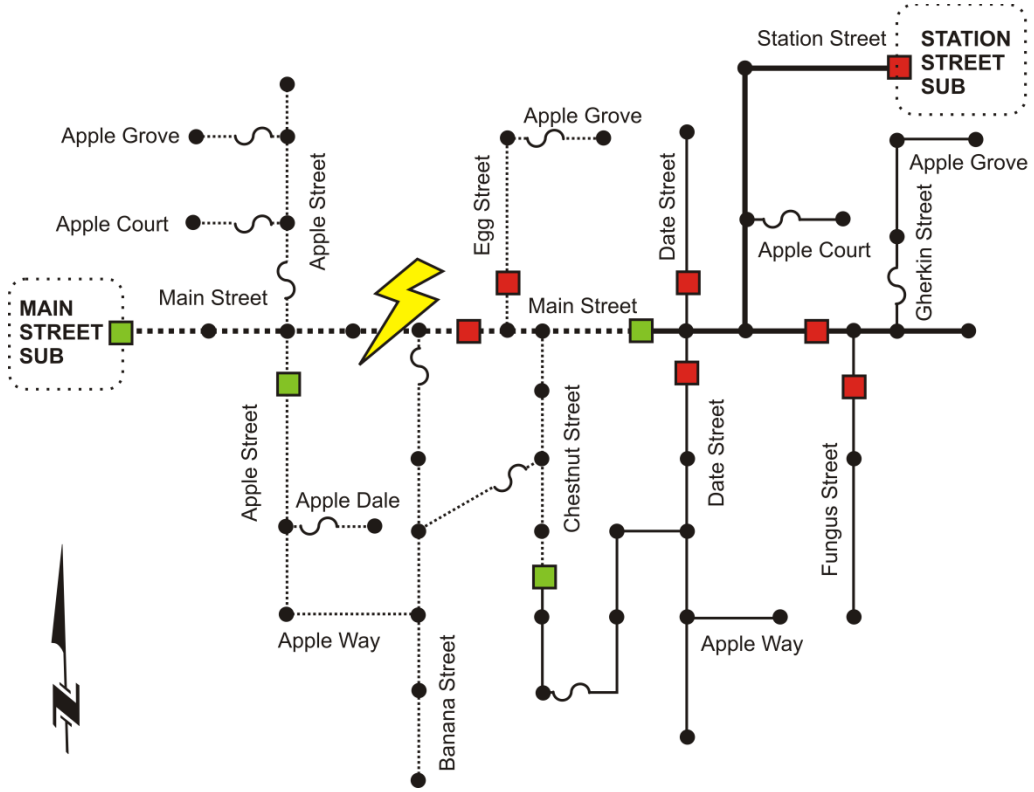
Apple Way
Apple Way
Banana Street

Backfeed: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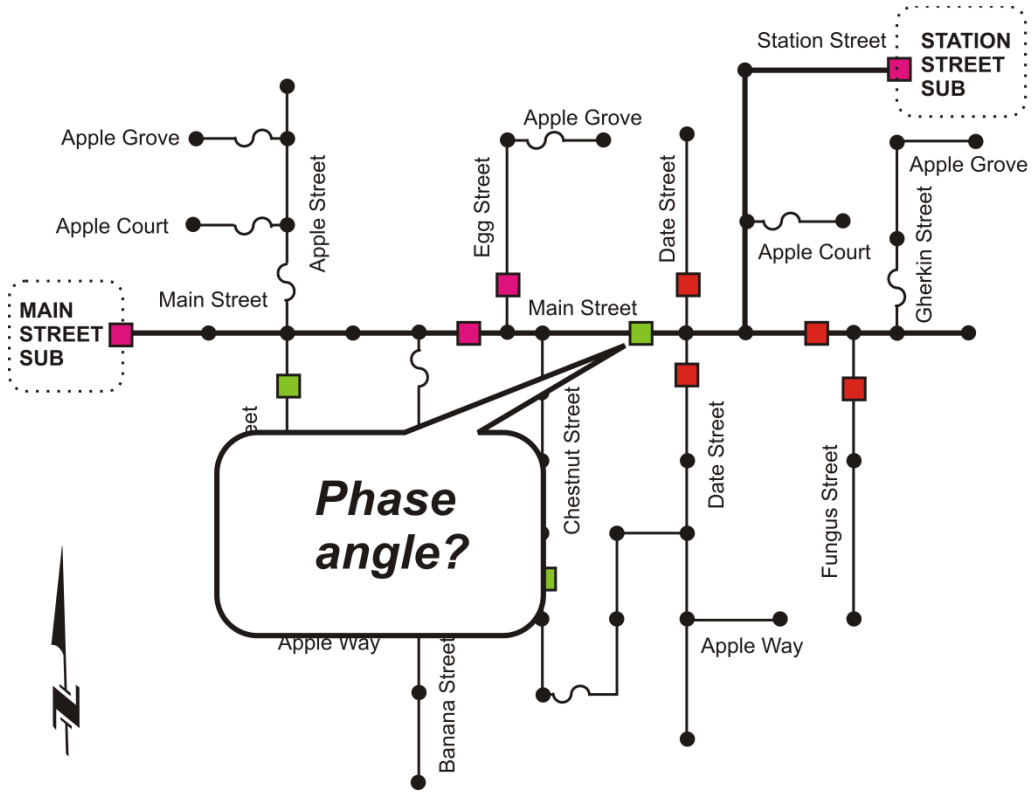
Restoration:



Can breaker be closed?

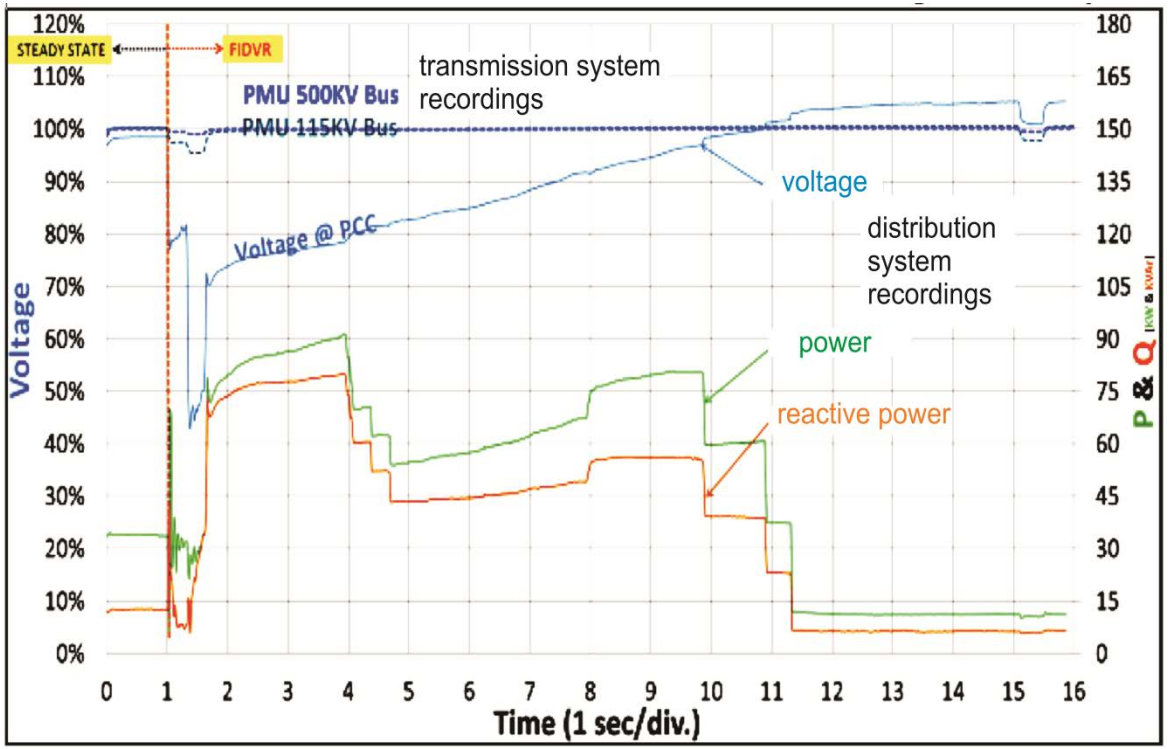
Non-faulted Reconfiguration:

Pennsylvania Power and Light collected time-of day load data in 1984 and 1985 at 15-minute intervals. Together with Westinghouse, they studied reconfiguration

- They estimated a loss reduction of over 14%
- That turned out to be 2500 MWh for 26 feeders
- That turned out to be an increase in efficiency of 0.2%, to 98.95%

Think of that on a national basis!

FIDVR example:



SCADA not fast enough for this!

What is study group finding?

Some (but not all) Distribution Automation functions aided by PMU

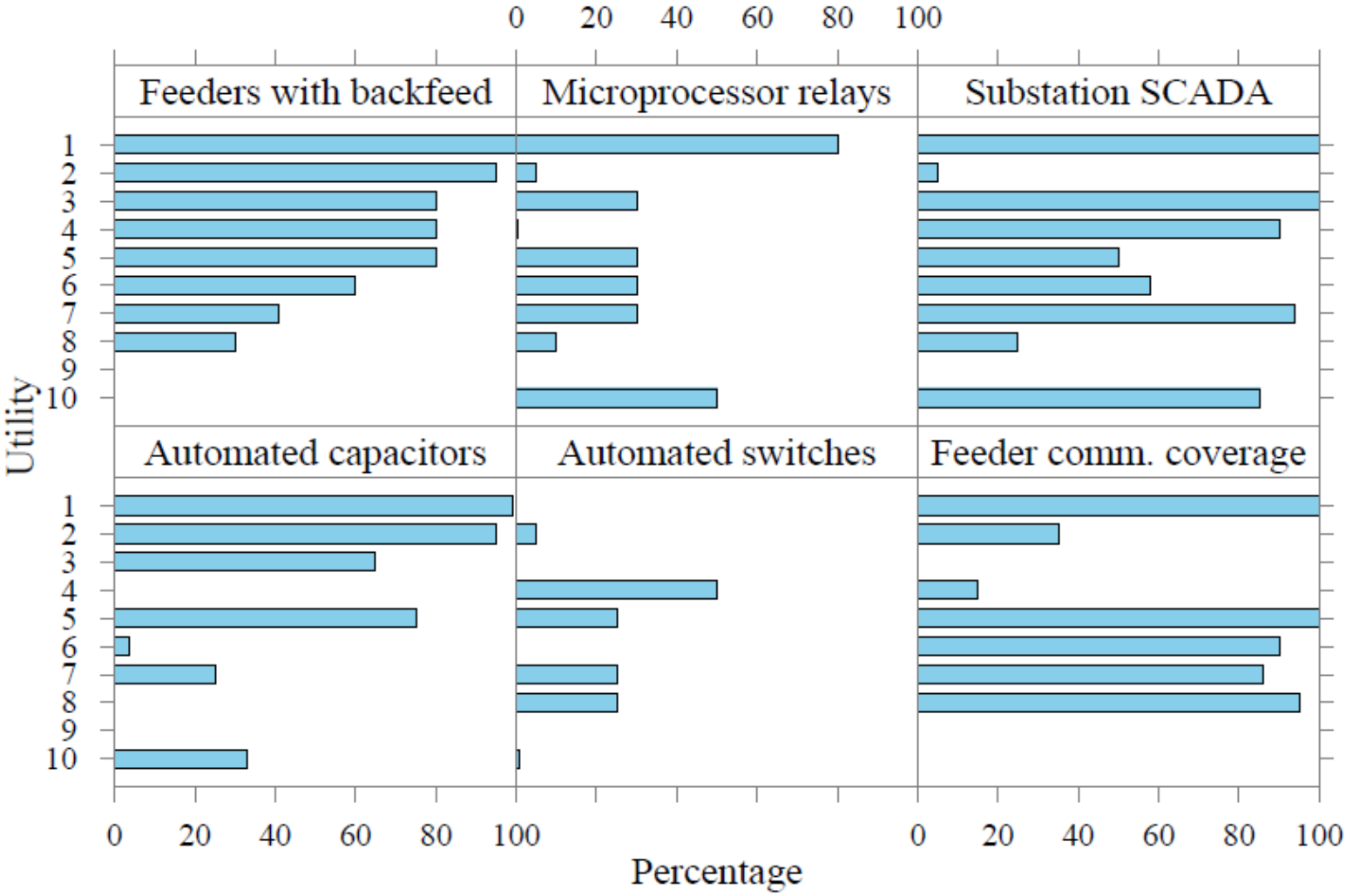
Many functions cost effective

If the PMU is installed, other functions become *enabled*

These can take particular advantage of PMU information

Function	Benefit	Value to Utility
Feeder Automation	Restoration Management Isolate faults Redistribute load	Reduce outage time, lost revenue Reduce outage area Reduce losses, defer system improvements
Load Management	Reduce system peaks Control loading in distribution system	Lower generation costs Customer satisfaction Better system performance in emergencies Reduce losses
Substation Automation	Higher substation reliability Higher equipment loading	Reduce spares, O&M costs Defer replacement
Volt/VAr control	Local VAr supplies Improved voltage control Load control	Reduce losses Customer satisfaction Better system performance in emergencies
Cogeneration/DSG Control	Reduce system peaks Control loading in distribution system	Lower generation costs Defer generation addition Defer system improvements Reduce losses

Utilities are not all the same



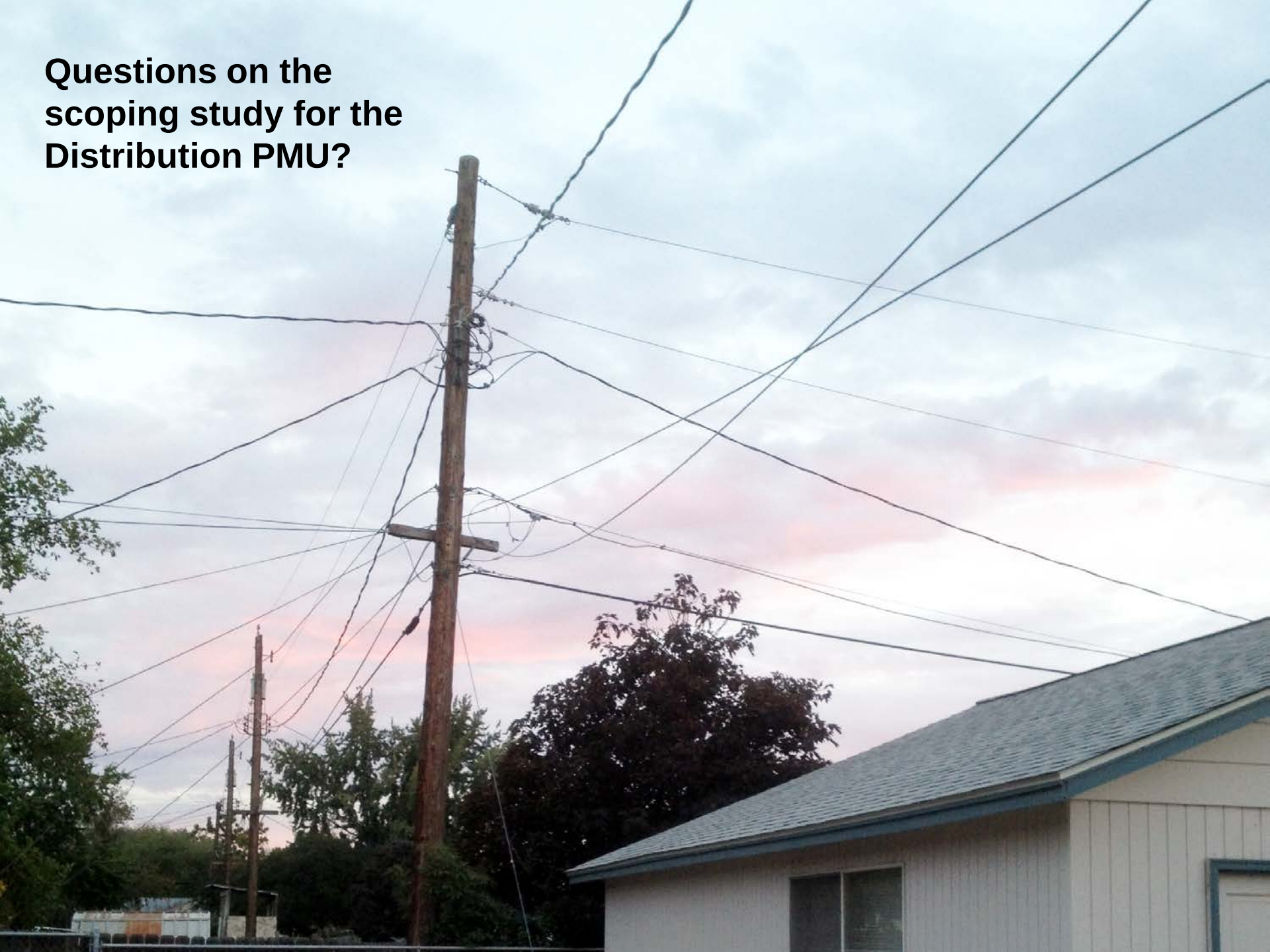
EPRI data

Infrastructure!

Why should DOE care about the distribution PMU?

The potential benefit to the nation is *enormous!*

DOE can see the national advantage to kick-starting


Questions on the scoping study for the Distribution PMU?