American Transmission Company
Smart Grid Investment Grant Update

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Project Participant Information

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Legacy Project Map
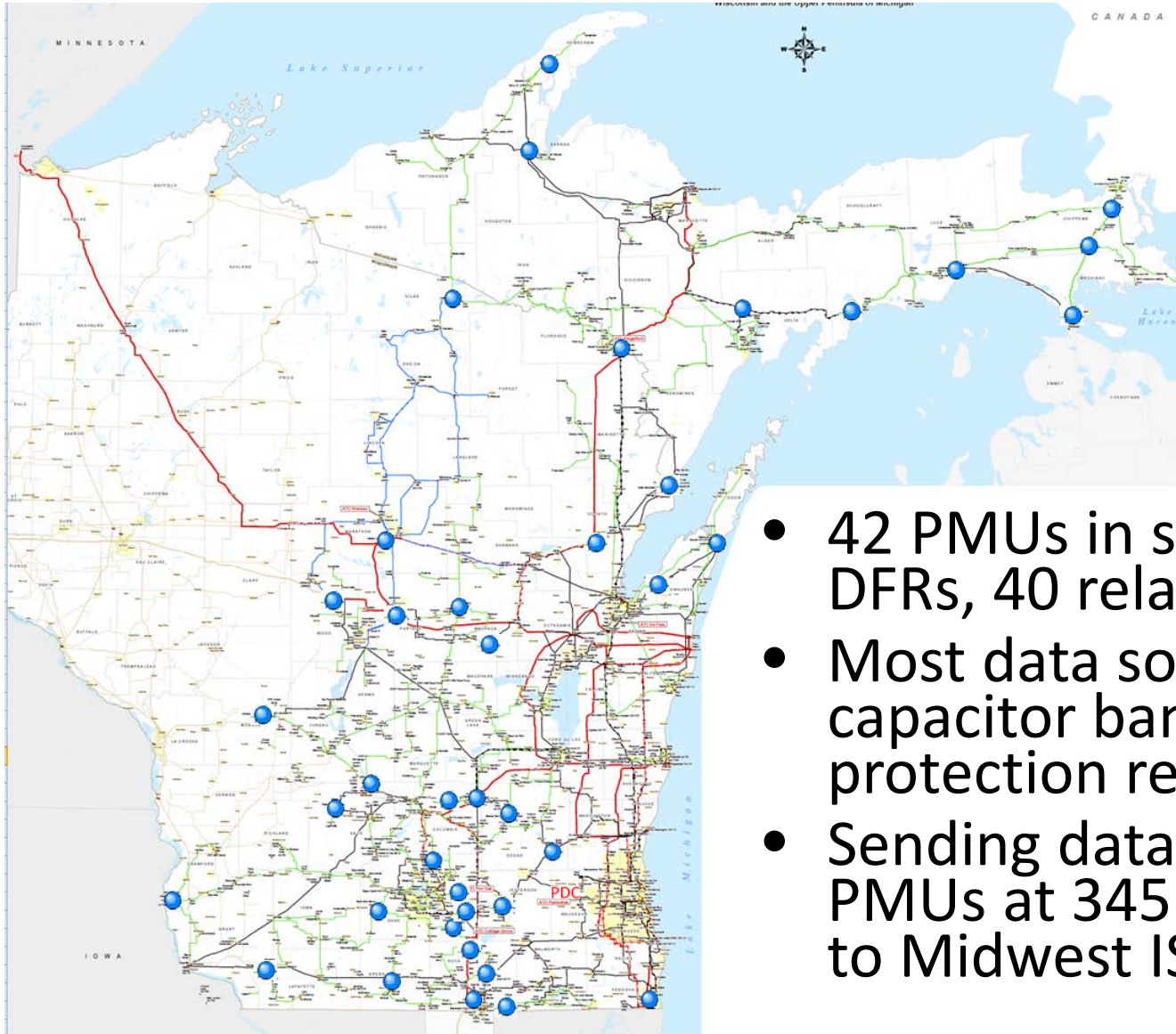
- 42 PMUs in service (2 DFRs, 40 relays)
- Most data sourced from capacitor bank protection relays
- Sending data from 5 PMUs at 345 Kv stations to Midwest ISO.

Combined DOE and Legacy Project Map

Legend:
- In service PMU (blue)
- Planned PMU (green)
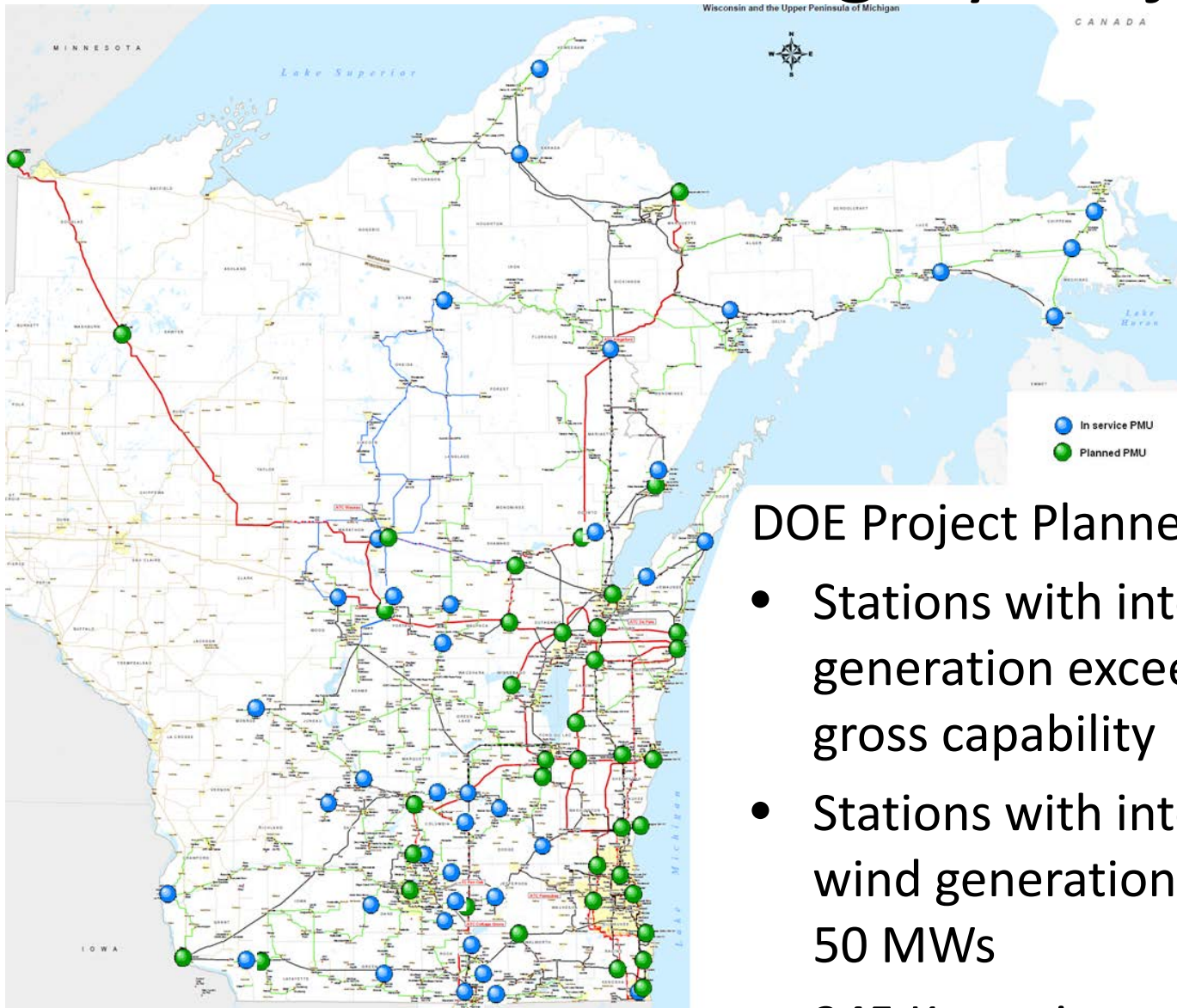
DOE Project Planned Installations

- Stations with interconnected generation exceeding 200 MW gross capability

- Stations with interconnected wind generation greater than 50 MWs

- 345 Kv stations

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Project Timeline – PMU Installs

We will begin PMU installations in December 2011. The sanitized schedule is shown below:

Activity Description	Orig Dur	Rem Dur	Early Start	Early Finish	Late Start	Late Finish	Total Float	% Comp
Install/Commission @ C	1	1	13DEC11	13DEC11	26JAN12	26JAN12	26d	0
Install/Commission @ R	1	1	15DEC11	15DEC11	30JAN12	30JAN12	26d	0
Install/Commission @ R	1	1	20DEC11	20DEC11	02FEB12	02FEB12	26d	0
Install/Commission @ T	1	1	22DEC11	22DEC11	06FEB12	06FEB12	26d	0
Install/Commission @ C	1	1	03JAN12	03JAN12	08FEB12	08FEB12	26d	0
Install/Commission @ B	1	1	05JAN12	05JAN12	10FEB12	10FEB12	26d	0
Install/Commission @ P	1	1	09JAN12	09JAN12	14FEB12	14FEB12	26d	0
Install/Commission @ G	1	1	11JAN12	11JAN12	16FEB12	16FEB12	26d	0
Install/Commission @ A	1	1	13JAN12	13JAN12	20FEB12	20FEB12	26d	0
Install/Commission @ R	1	1	17JAN12	17JAN12	22FEB12	22FEB12	26d	0
Install/Commission @ F	1	1	19JAN12	19JAN12	24FEB12	24FEB12	26d	0
Install/Commission @ N	1	1	23JAN12	23JAN12	28FEB12	28FEB12	26d	0
Install/Commission @ S	1	1	25JAN12	25JAN12	01MAR12	01MAR12	26d	0
Install/Commission @ S	1	1	27JAN12	27JAN12	05MAR12	05MAR12	26d	0
Install/Commission @ F	1	1	31JAN12	31JAN12	07MAR12	07MAR12	26d	0
Install/Commission @ N	1	1	02FEB12	02FEB12	09MAR12	09MAR12	26d	0
Install/Commission @ G	1	1	06FEB12	06FEB12	13MAR12	13MAR12	26d	0
Install/Commission @ C	1	1	08FEB12	08FEB12	15MAR12	15MAR12	26d	0
Install/Commission @ D	1	1	10FEB12	10FEB12	19MAR12	19MAR12	26d	0
Install/Commission @ P	1	1	14FEB12	14FEB12	21MAR12	21MAR12	26d	0
Install/Commission @ W	1	1	16FEB12	16FEB12	23MAR12	23MAR12	26d	0
Install/Commission @ D	1	1	20FEB12	20FEB12	27MAR12	27MAR12	26d	0
Install/Commission @ H	1	1	21FEB12	21FEB12	28MAR12	28MAR12	26d	0
Install/Commission @ W	1	1	23FEB12	23FEB12	30MAR12	30MAR12	26d	0
Install/Commission @ N	1	1	24FEB12	24FEB12	02APR12	02APR12	26d	0
Install/Commission @ W	1	1	28FEB12	28FEB12	04APR12	04APR12	26d	0
Install/Commission @ W	1	1	01MAR12	01MAR12	06APR12	06APR12	26d	0
Install/Commission @ G	1	1	05MAR12	05MAR12	10APR12	10APR12	26d	0
Install/Commission @ N	1	1	07MAR12	07MAR12	12APR12	12APR12	26d	0
Install/Commission @ M	1	1	08MAR12	08MAR12	13APR12	13APR12	26d	0
Install/Commission @ P	1	1	09MAR12	09MAR12	16APR12	16APR12	26d	0
Install/Commission @ C	1	1	13MAR12	13MAR12	18APR12	18APR12	26d	0
Install/Commission @ C	1	1	15MAR12	15MAR12	20APR12	20APR12	26d	0
Install/Commission @ S	1	1	19MAR12	19MAR12	24APR12	24APR12	26d	0
Install/Commission @ F	1	1	21MAR12	21MAR12	26APR12	26APR12	26d	0
Install/Commission @ F	1	1	23MAR12	23MAR12	30APR12	30APR12	26d	0
Install/Commission @ U	1	1	27MAR12	27MAR12	02MAY12	02MAY12	26d	0
Install/Commission @ B	1	1	17APR12	17APR12	04MAY12	04MAY12	13d	0
Install/Commission @ A	1	1	08MAY12	08MAY12	08MAY12	08MAY12	0	0
Install/Commission @ C	1	1	10MAY12	10MAY12	10MAY12	10MAY12	0	0
Install/Commission @ E	1	1	14MAY12	14MAY12	14MAY12	14MAY12	0	0
Install/Commission @ P	1	1	16MAY12	16MAY12	16MAY12	16MAY12	0	0
Install/Commission @ C	1	1	18MAY12	18MAY12	18MAY12	18MAY12 *	0	0
Install/Commission @ P	1	1	29OCT12	29OCT12	20DEC12	20DEC12	37d	0
Install/Commission @ K	1	1	02NOV12	02NOV12	28DEC12	28DEC12	37d	0

Project Timeline – Other

- We have two legacy PDCs in service and operational. We will transition to newer PDCs when technical issues have been addressed. (Planning for Q2 2012)

- Existing communications allow us to implement now. Our SCADA enhancement project will extend our fiber optic network to improve reliability and performance of the communications network.

- Some applications already developed in house using our OSI Soft – PI tools. Looking at other applications when more data is available 4Q 2012.

PMU Installation Statistics

- We are the sole transmission owner involved in this project and will be installing a total of 45 PMUs

- Elements monitored by PMUs Today (legacy plus DOE)
  - 5 stations operated at 345 Kv (0 from DOE project)
  - 37 stations operated between 69 Kv and 230 Kv (0 from DOE project)
  - 36 capacitor banks / 1 transformer tertiary / 5 - 345 Kv lines / 0 generators monitored

- 8% of our system substations (those operated at or above 69 Kv) are now monitored by PMUs (42 substations with PMUs). We expect to see that increase to close to 25% at project completion.

PMU Installation Statistics (cont'd)

- Minimum PMU sampling rate will be 30 samples/second
- PMU installation rate
  - 42 units have been installed as of 9/30/2011 over a 3 year period. 2 of these were DFR upgrades. The remainder were new installations where the PMU data was made available from a dual function relay/PMU.
  - We expect to have 4 DOE installs completed between now and year end. This will be a mix of stand alone PMUs and DFR upgrades
  - We expect to have all 45 DOE projects completed by year end 2012. Approximately half of these projects involve new installations of stand alone PMUs. The remaining units involve upgrades of existing Digital Fault Recorders
  - Any installations in 2013 will be done as part of our legacy project. We do not have any specific plans at this time.

PDCs and Communications

When our project is complete we will have the following in service equipment:

- PDCs
  - One redundant PDC pair at our offices in southeastern Wisconsin
  - One cold standby PDC at our offices in south central Wisconsin
    The above reflects MISO PDC expectations and is beyond what we anticipated when we originally scoped our project
  - Archive/database status
    - Currently Storing ~4 GBytes per day to our PI Historian database
    - All data is available since we began scanning (no compression)
    - We will store all data until such time that we determine what data we do not need

- Communications system
  - Communication link to MISO – highly available and redundant
  - Retired our link to TVA – MISO now providing that data
  - No direct links to other TOs anticipated at this time. We envision MISO as our "PMU data hub" if we need data from others in our region

Major operational applications using phasor data

- We will be making all our PMU data available to MISO. We do not envision any direct connects to other TOs to share data at this time.

- Wide-area situational awareness
  - ALSTOM eterraVision in development for overall wide area view. Looking at ways to leverage those capabilities with our non-standard PMU data configuration to enable use of PMU data.
  - Also looking at RTDMS and PGDA applications from Electric Power Group. Need to figure out how our project fits with the MISO project
  - PI ProcessBook prototype displays already created. Need to get Operations buy in and further direction.

- State estimation
  - ALSTOM EMS already has capability to use phase angle data as an input.
  - We are already feeding angle data to our EMS at 1 sample/second rate from our legacy sites but it is not used as an input to SE.
  - Plan to test SE once we have the majority of our 345 Kv sites in service. Currently that puts us out to 4Q 2012 / 1Q 2013

# Challenges and lessons learned

- Execution challenges
  - We are still struggling with buy in from Operations to make this a real time decision making tool. Some forward movement but we haven't been able to get what we've developed to be considered "screen worthy" by Operations
  - We have completed all site visits and have specified installation work to be done but have yet to install one PMU under the project
  - Longer lead times from some of our vendors than expected causing installation delays
  - Review cycle for drawing updates taking longer than planned
  - Problems getting the work scheduled on this non-standard project. We don't normally have projects that span many stations scattered across our footprint like this project

- Other challenges
  - PMU performance has been good but we have yet to determine acceptable downtime
  - Managing our data archives as we grow our PMU network will require that we get smarter about what data we need to keep and for how long

Other things we should know about your project?

- Already using the PMU data we have to help with post event analysis - 5/10/2011 event example
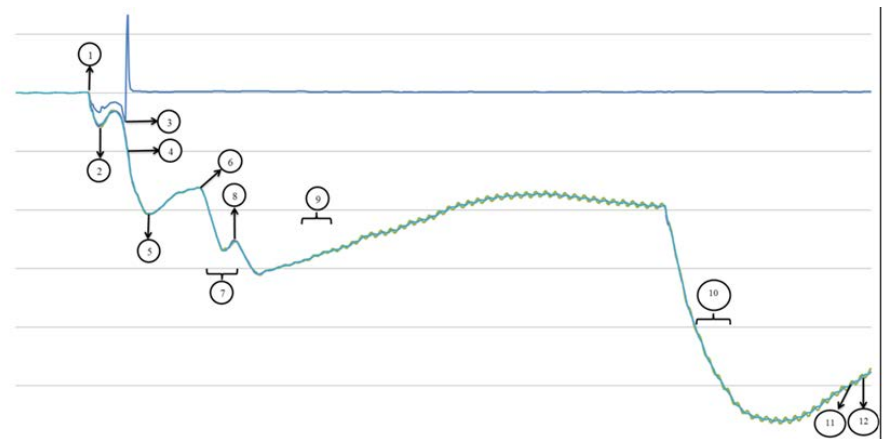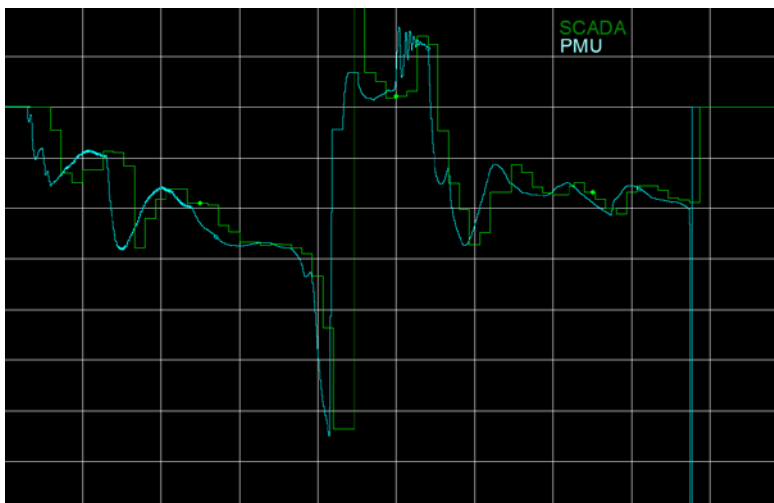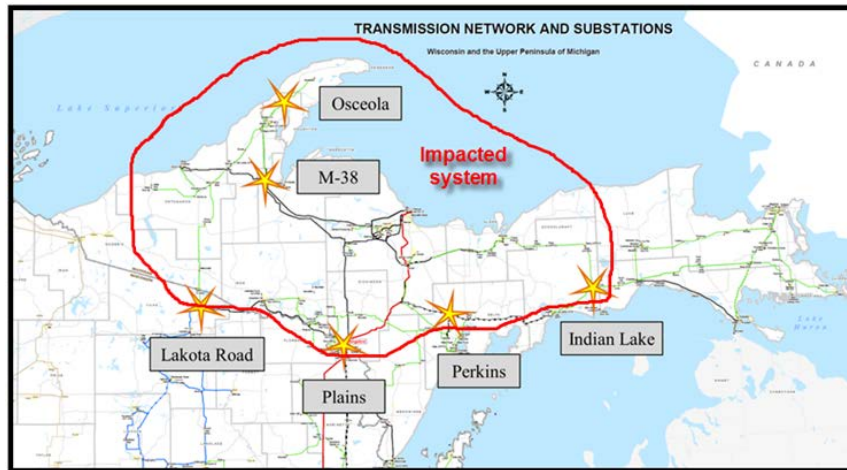
Other things we should know about your project? (cont'd)

- System protection requesting data to assist in post event fault analysis especially in areas where older electromechanical relays are used

- Operations requesting data periodically to address operational questions (Did you see any voltage spikes on the transmission system at this time, etc…

- Using the data to validate generator models in isolated areas where events have occurred.

Questions?