SDG&E's Accomplishments and Future Plans

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San Diego Gas & Electric®

NASPI North American SynchroPhasor Initiative

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San Diego Gas & Electric ®

SDG&E® is a regulated public utility that provides energy service to 3.6 million people through 1.4 million electric meters and 873,000 natural gas meters in San Diego and southern Orange counties. Our service area spans 4,100 square miles.

Named “Best in the West” for electric reliability for twelve years in a row.

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Main Efforts Over The Years

- Early efforts before 2010
  - Initial installation of relays with PMU functions started in 2005
  - Worked with PG&E and Virginia Tech on synchrophasor applications
  - Initiated the installation a Fiber Optic network (SONET) in all critical BES substations for PMU and protection communication in 2006
  - Successfully conducted a CEC/CIEE R&D project on State Estimation using PMU measurement between 2006 and 2008

- Participated in DOE co-funded projects
  - Western Interconnect Synchrophasor Program (WISP) from 2010 to 2014 for sharing data with Peak RC and CAISO
  - Peak Reliability Synchrophasor Program (PRSP)
  - Advanced Synchrophasor Protocol (ASP) development and demonstration project

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Main Efforts Over The Years (2)

- Control room Wide-Area Situational Awareness (WASA) system deployment
  - Phase 1 started in 2014 and completed in 2016
  - Phase 2 in the procurement stage for an advanced visualization system
- Initiated the application of PMUs in distribution system
  - Developed use case development and conducted pilot implementations and testing
- PMU installation
  - Over 140 PMUs installed in transmission grid
  - Over 70 PMUs installed in distribution network

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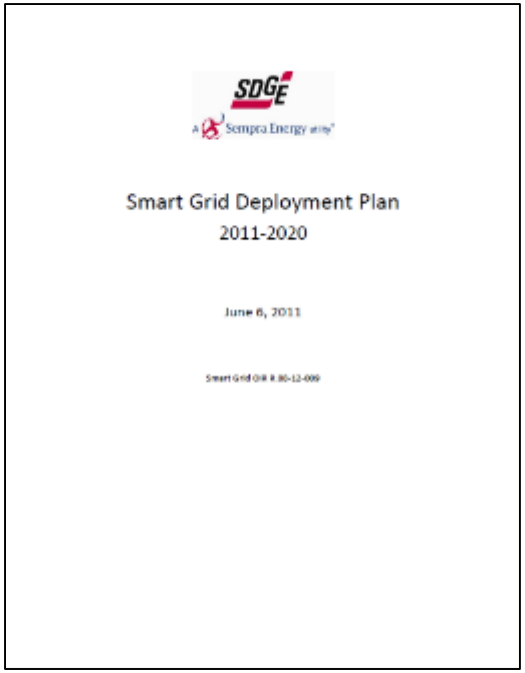
Objectives and Plan (2010)

- Objectives of SGD&E synchrophasor project which is part of SDG&E's Smart Grid Deployment Plan
  - Integrate Synchrophasor Technology into SDG&E's electrical grid, improve system performance and coordination with ISO and neighboring utilities, and participate in the Smart Grid Initiative

- Goals
  - Integrate Synchrophasor Technology into SDG&E's Bulk Power Electric System
  - Develop Applications to Aid in System Operations and System Protection
  - Share Data with CAISO, Peak RC, and Neighboring Systems
  - Meet NERC Requirements for Oscillography and Disturbance Monitoring


Smart Grid Deployment Plan
2011-2020

June 6, 2011

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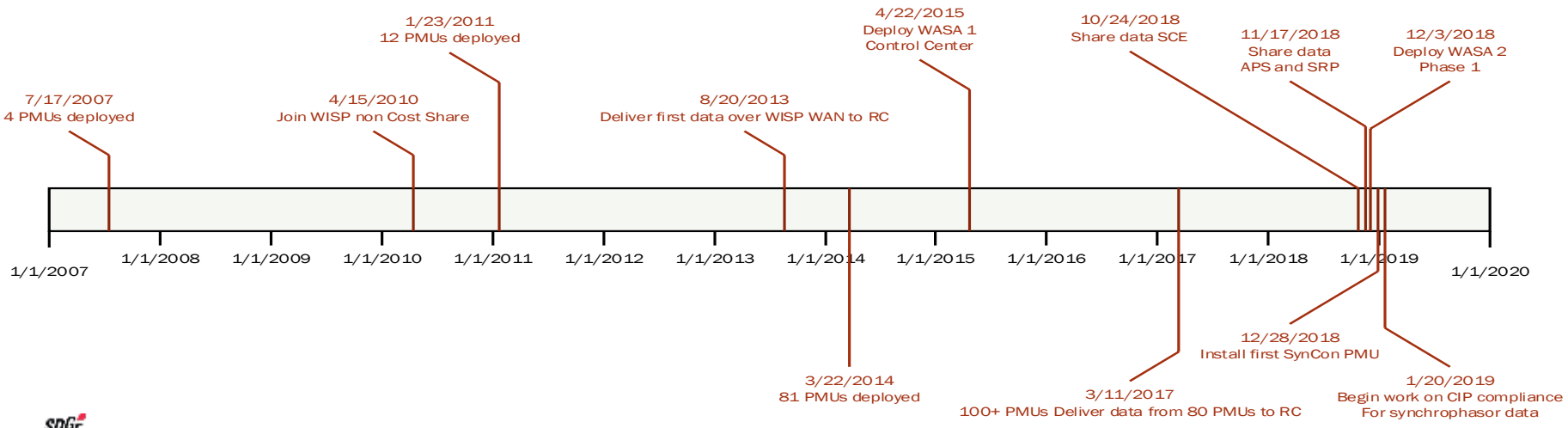
SDG&E®'s Approach

- Make a continued effort towards the objective and goals with an understanding that the followings will take time to realize
  - Install sufficient number of PMUs
  - Deployment of vendor supported application products
  - Setup required communication network
  - Comply with CIP requirements
  - Accomplish data sharing with neighboring utilities



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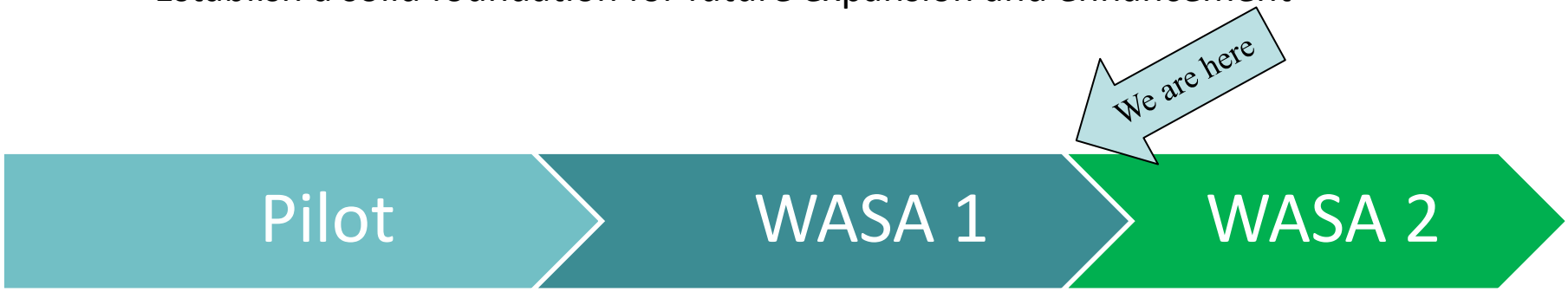
Phased WASA System Deployment

- **Pilot** – Evaluate application software for operation use
- **WASA system Phase 1 (WASA 1)** – Bring the technology into control room for operation use
  - Deploy best-in-the-class commercial off-the-shelf products at the time
  - Enable the use of the synchrophasor data in real-time and non-real-time operations
  - Provide operators with something useful and quickly first – capabilities that EMS /SCADA does not have
- **WASA system Phase 2 (WASA 2)** – Provide advanced WASA capabilities for supporting real-time decision making
  - Deploy a WASA system that fully meets SDG&E business requirements
  - Establish a solid foundation for future expansion and enhancement



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WASA System Deployment Key Success Factors

- Never assume “Build it and they will use”
- Get Operators involved early in the process
- Communicate well with all involved
- Coordination efforts among different departments
- Get help from SMEs with domain expertise
- Develop policies and procedures along with new applications

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WASA System Phase 1

- Deployment status
  - RFQ process completed in 2014
  - Deployment completed 2016
  - Ready for control room use after CIP compliance and operation procedures are in place

- Operators are ready to use the system for real-time operation decision making

  - High-resolution trending
  - Three-phase information and the detailed fault information
  - Oscillation condition visualization

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WASA System Phase 2

- WASA2 procurement and deployment approach
  - Core visualization software system will be procured and deployed first
  - Advanced analytical applications will be procured and deployed separately
- Visualization software platform
  - Provide single information visualization HMI for operators
  - Serve as the system integration platform for external system and data sources, as well as third party applications
- Advanced analytical applications
  - Linear state estimator or hybrid state estimator
  - Oscillation detection
  - Voltage instability assessment
  - Online line impedance measurement
  - Real-time disturbance detection and alarming
  - Back-up SCADA

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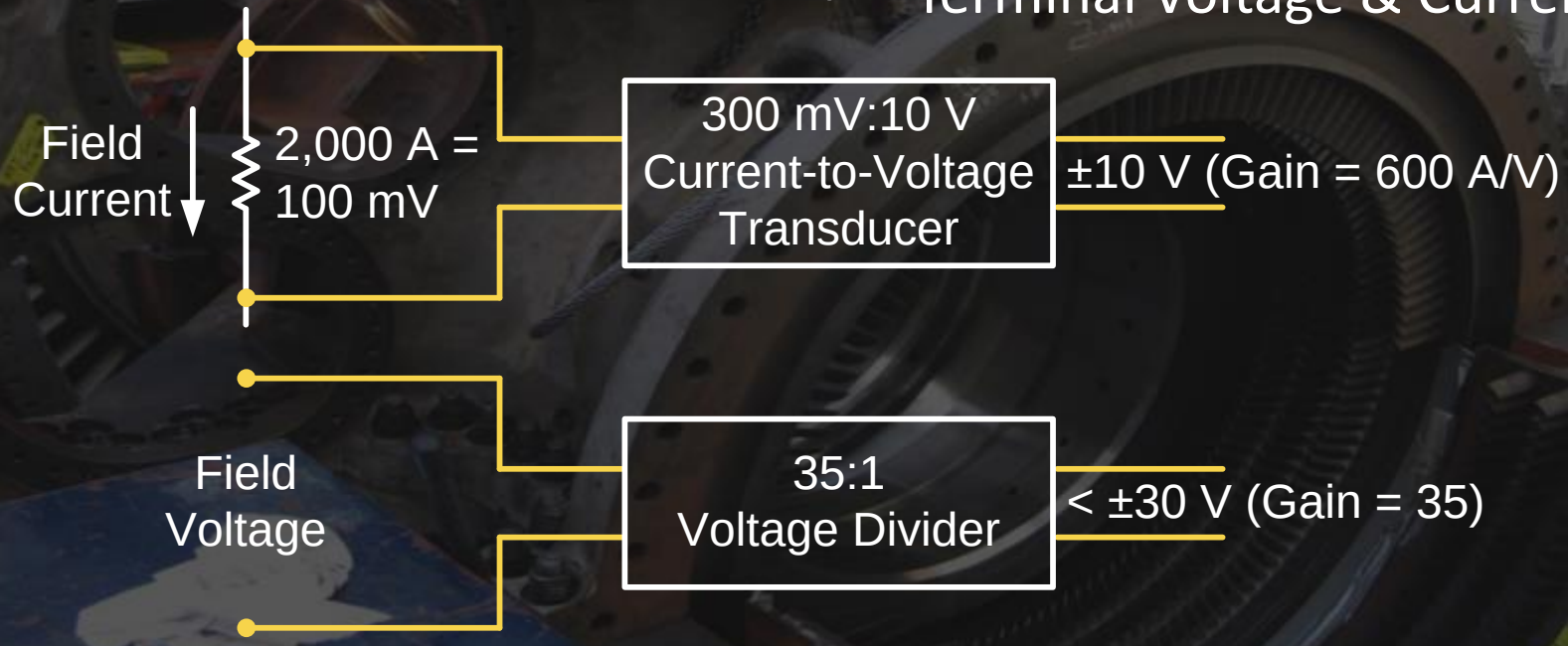
1st in The Industry

740MW Combined Cycle(2CT+1HRST) Generator monitoring (In-service 2014)

- Generator rotor angle
- Field voltage
- Field current
- Terminal Voltage & Current



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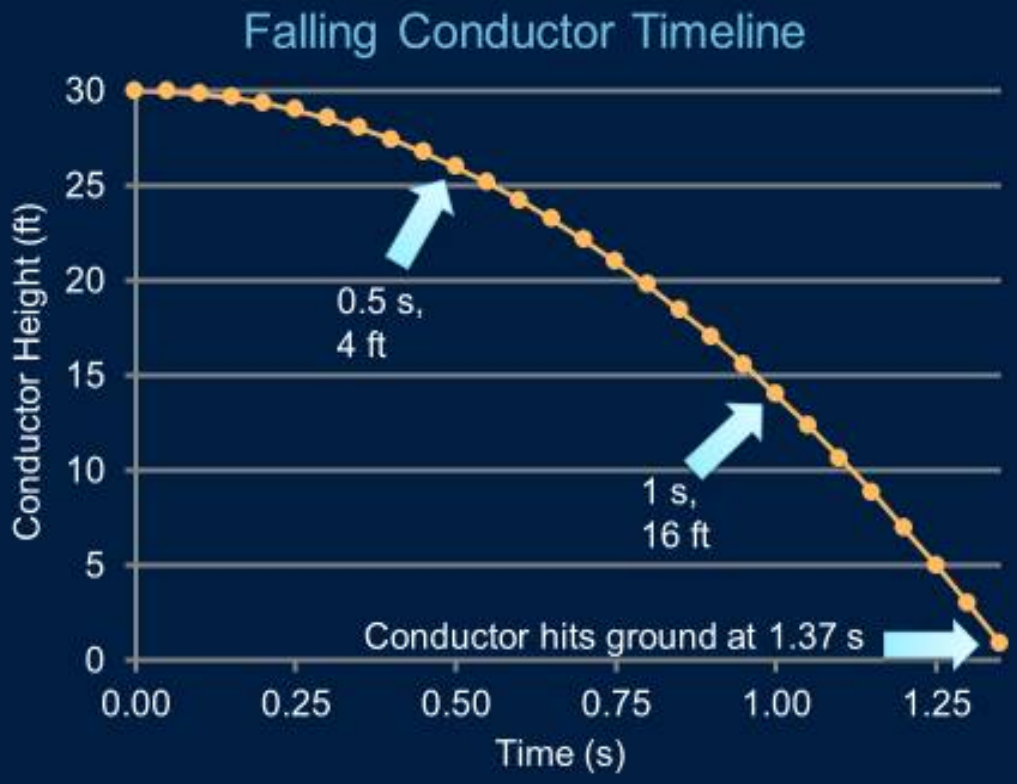
1st in The Industry

Detect Broken Conductor and Trip Circuit Before Line Hits the Ground?



$$d = \frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2d}{g}}$$

$$t = \sqrt{\frac{2(30)}{32.2}}$$

$$\text{time} \approx 1.37\,\text{s}$$

2016

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1st in The Industry

225 MVA Synchronous Condenser Monitoring (In service 12/2018)

- Generator rotor angle
- Field voltage
- Field current
- Terminal Voltage & Current
- Aux Transformer (V&I)

Power:	225 MVA
Voltage:	17.5 kV ± 10%
Power Factor:	cosϕ =0.001
Speed:	3600 rpm
Frequency:	60 Hz
Rated Current	7423A
Cooling	DAC (Direct Air Cooling)

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Future Plans

- Control Room WASA System
  - CIP Compliance
  - Advanced Analytical software
  - Unified alarm management
  - Operating procedures and processes
  - Wide Area Situational Awareness of Western Interconnection
- Increase observability of the entire SDG&E system
  - Install PMU at 69 and 138kV
  - Install PMU at key distribution stations
- Wide Area Protection And Control
  - Back-up protection
  - Controlled Islanding

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Concluding Remarks

- Realizing the benefits of the technology requires careful planning, sustained efforts, and be practical
- Understand what is needed and what it will take to get there is a critical success factor
- Technology is evolving and there are very few proven off the shelf products
- Take a phased approach
- Long-term vision and commitment from the management
- New systems must reverse the trend of operator displays becoming even more complex

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