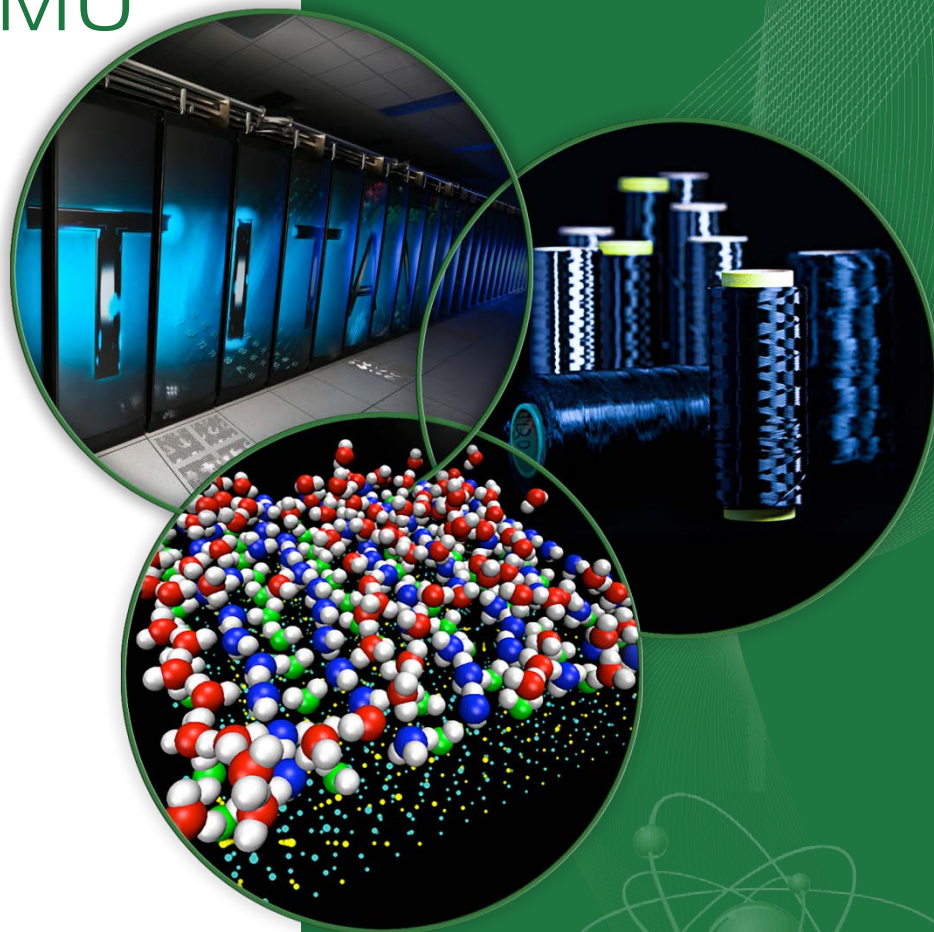


Factors Affecting PMU Installation Costs

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NASPI Work Group Meeting
Houston, TX
October 22-23, 2014



Overview

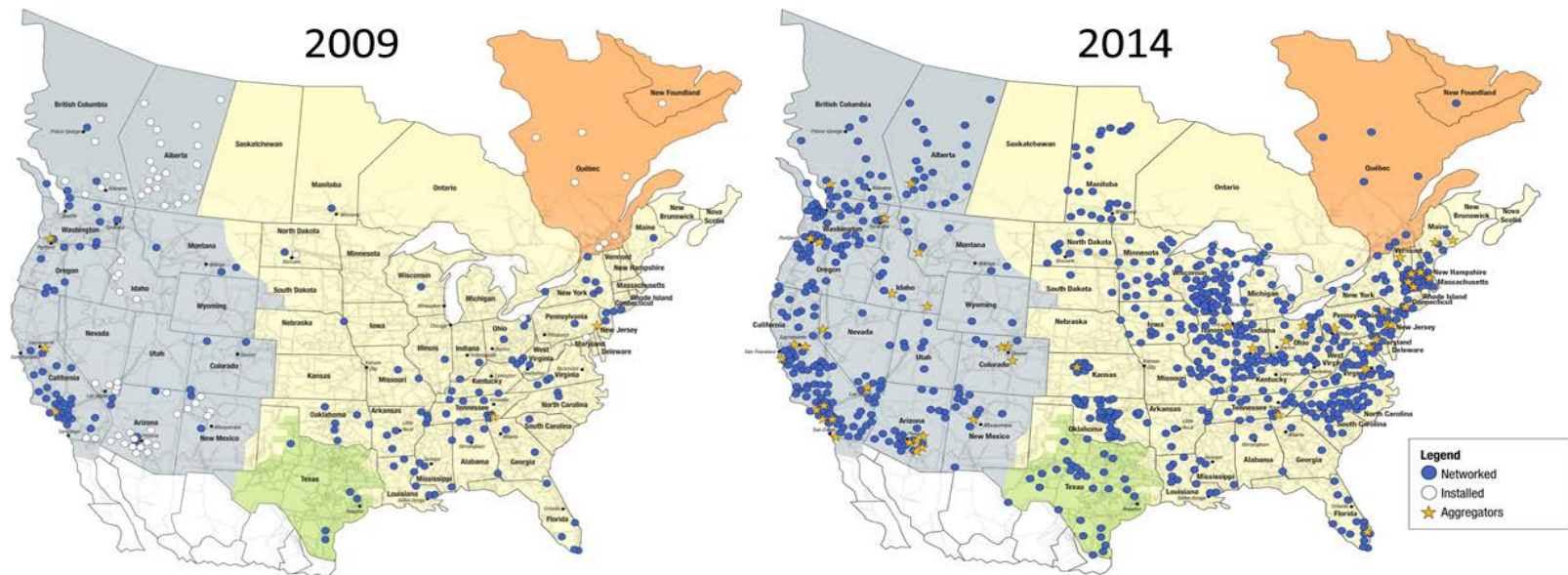
Installing synchrophasor systems involves a number of strategic and tactical decisions.

- Applications and design choices have cost implications for the synchrophasor system.
- There is little empirical data about the detailed cost implications of different system design choices.
- ORNL performed a DOE-sponsored study to explore high level requirements and cost impacts.
- Participants -- Nine transmission owners and reliability coordinators that were part of the SGIG/SGDP projects

This study focused on PMU acquisition and installation costs.

American Recovery & Reinvestment Act

- Smart Grid Investment Grants (SGIG) and Smart Grid Demonstration Projects (SGDP)
- Public funds matched by private investment
- Managed by the U.S. Department of Energy – Office of Electricity Delivery and Energy Reliability (DOE-OE)



Source: North American Synchrophasor Initiative (NASPI)

Approximately 1,500 PMUs Installed from 2009 to 2014

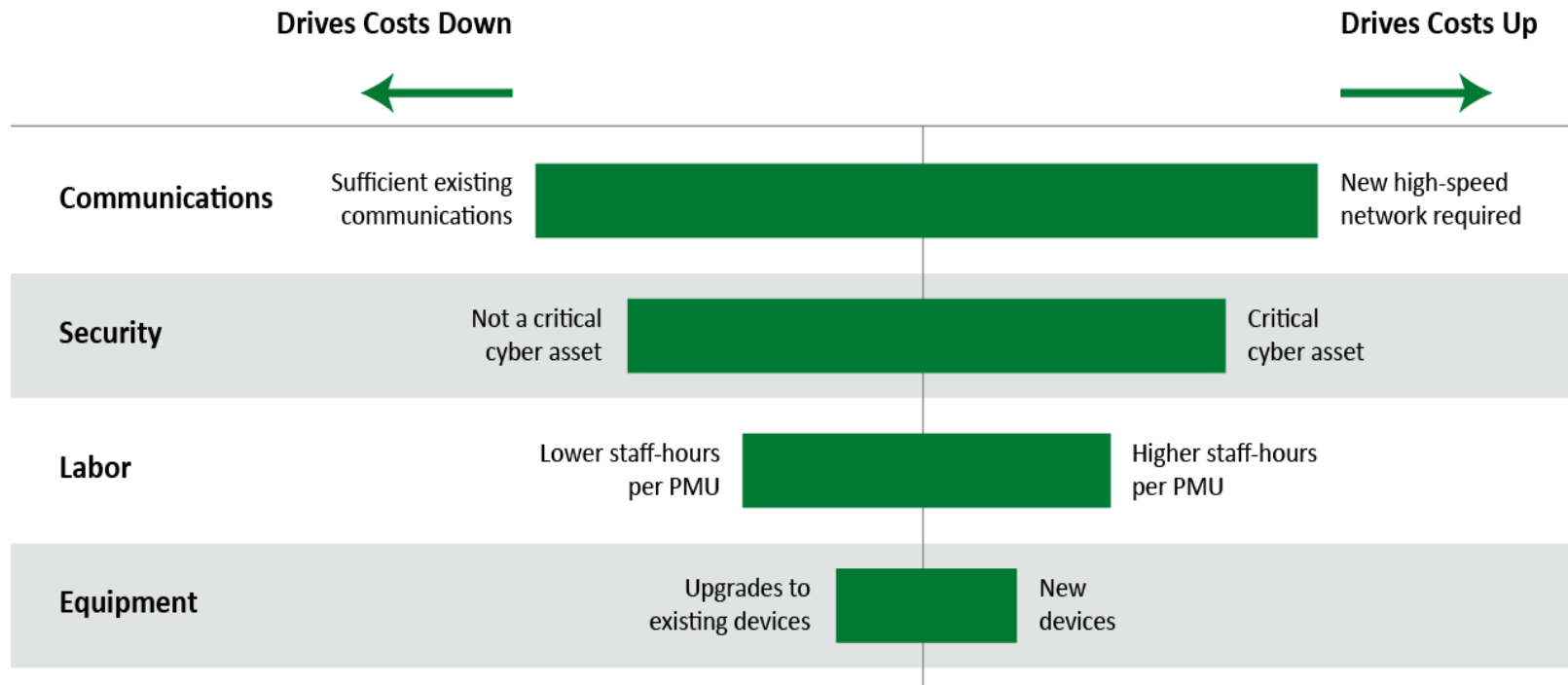
Participants

- 8 TOs and 1 ISO
- Consisted of prime and indirect recipients
- Participation through interviews and document review

NERC Region	Entity
WECC	BPA
	Idaho Power
	PG&E
SERC	Duke Entergy
Midwest Reliability, Reliability First	MISO
	ATC
	Manitoba Hydro
Texas Reliability Entity	Oncor

Historically, many of these participants have shared their experiences in the NASPI community

Key Cost Drivers

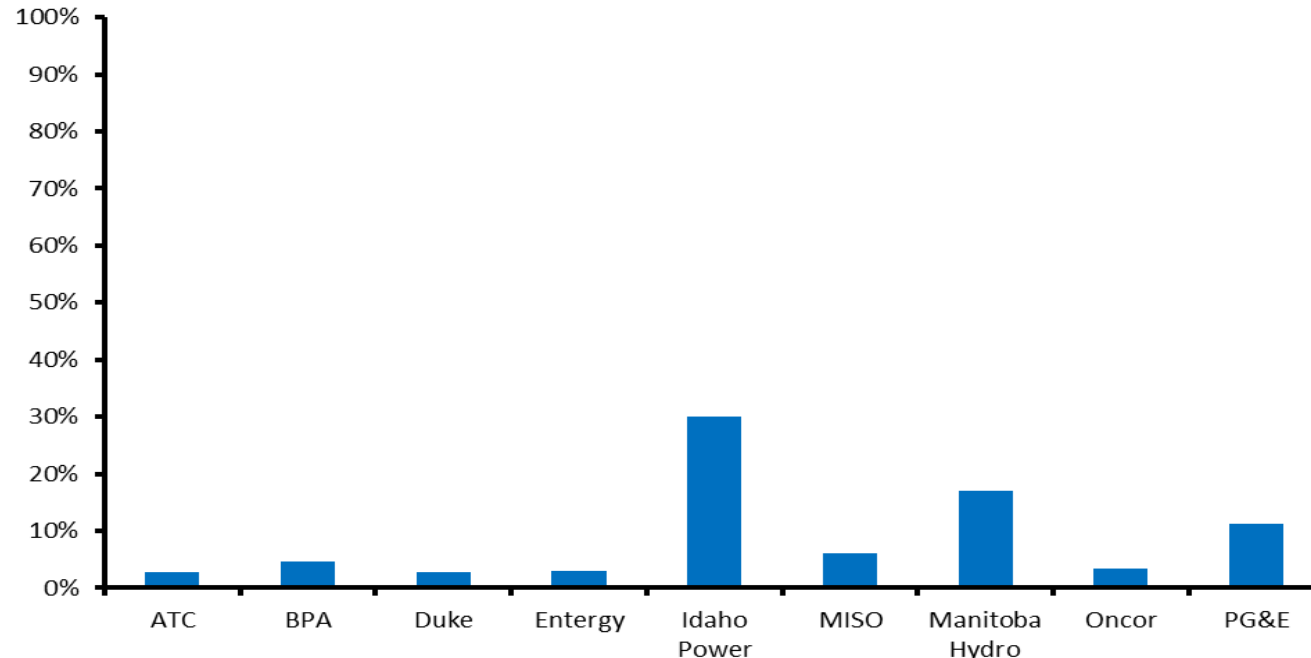


Ranges are illustrative.

The availability of communications was the single largest driver of the total costs.

Average PMU Device Cost

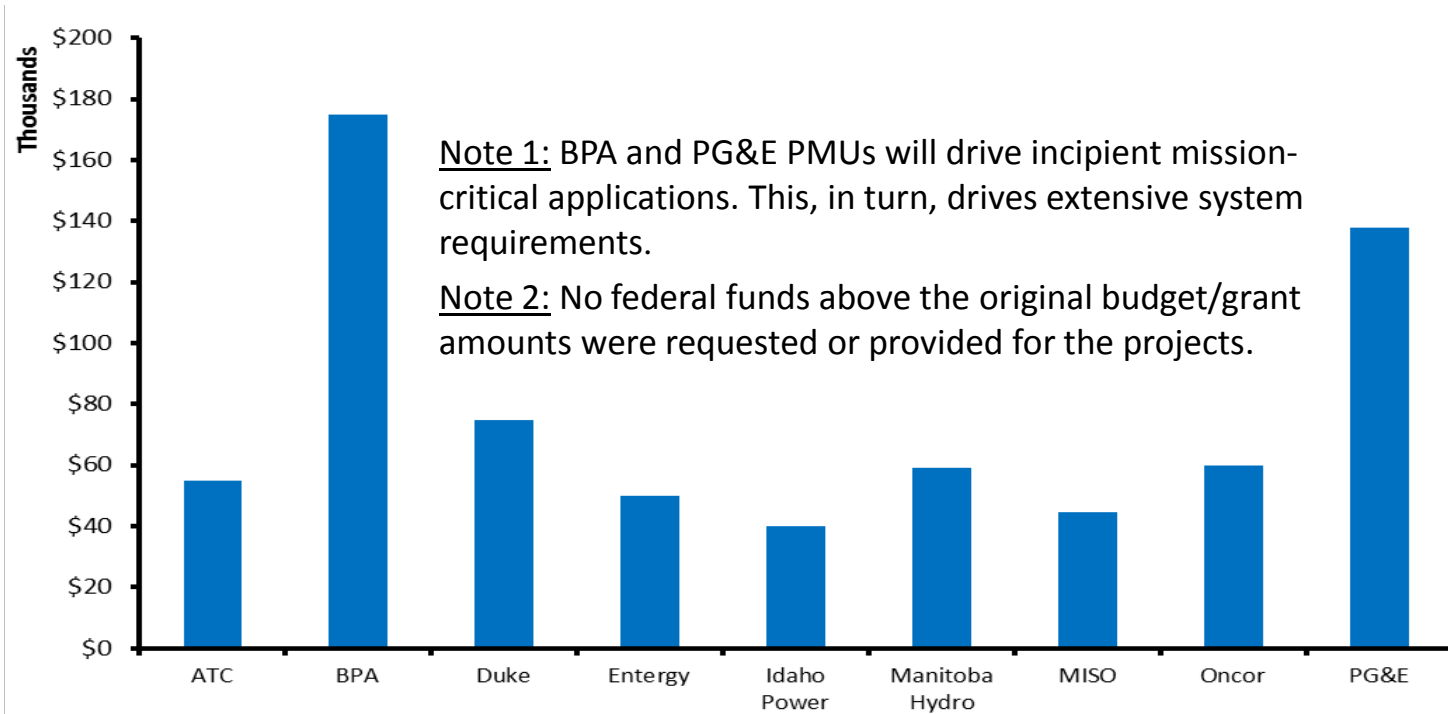
- The study compared the average PMU device cost to the average overall installed cost for each participant.



- The cost of PMU devices was typically less than 10% of the overall cost.
- PMU device cost higher in cases where overall costs were comparatively low.

Average Overall Cost per PMU

The averages include cost of communications, security, labor and other factors that each participant allocated to their PMUs.



The overall costs are primarily driven by the intended use (both present and future) of the synchrophasor system.

Summary

Four key cost drivers emerged

- Communications and security are the factors that drive the largest cost impacts.
- Labor is highest in some cases. Specialized vs. decentralized work crews and size of project's geographic footprint.
- Cost of PMU devices are an extremely small driver of the overall project cost.
 - Some of the study participants activated PMU functionality within existing devices rather than purchase new PMUs.

Each company's plan for synchrophasor use drove their requirements, and thus the costs.

Find the report on: www.smartgrid.gov

https://www.smartgrid.gov/sites/default/files/doc/files/PMU_cost_study_Final_09232014.pdf

The screenshot displays the SMARTGRID.GOV website. At the top, a navigation bar includes links for 'What is the Smart Grid?', 'Recovery Act Smart Grid Programs', 'Federal Smart Grid Initiatives', and 'Smart Grid Resource Center'. Below this, a search bar and a 'Search' button are present. The main content area features a large green banner for 'Recovery Act Smart Grid Investments'. To the left, there are sections for 'What is the Smart Grid?', 'Other Federal Smart Grid Initiatives', and 'Smart Grid Resource Center'. A red circle highlights the 'Access key program results' link in the top navigation bar, with an arrow pointing to it and the text 'click "Access key program results"'. Below the banner, there are sections for 'RECENT PUBLICATIONS' and 'NEWS AND UPDATES'. The 'RECENT PUBLICATIONS' section lists several reports, including 'Customer Participation in the Smart Grid - Lessons Learned' and 'Experience from the Consumer Behavior Studies on Engaging Customers'. The 'NEWS AND UPDATES' section lists news items, including 'USDA Announces Major Investments to Modernize Service, Improve the Reliability of Rural Electric Systems' and 'USDA Announces \$23 Million for Smart Grid Improvements'. A red circle highlights the 'Synchronphasor Applications in Transmission Systems' link in the 'Smart Grid Investment Grants' section, with an arrow pointing to it and the text 'click "Synchronphasor Applications in Transmission Systems"'. The 'Smart Grid Investment Grants' section includes a link to 'Impact Analysis' and a list of grants, such as 'Peak Demand and Electricity Consumption', 'Operational Improvements from Advanced Metering Infrastructure (AMI)', 'Operational and Maintenance Improvements in Distribution Systems', 'Reliability Improvements in Distribution Systems', 'Energy Efficiency Improvements in Distribution Systems', and 'Synchronphasor Applications in Transmission Systems'. The 'Smart Grid Demonstration Projects' section includes a link to 'Technology Performance' and a list of projects, such as 'Regional Demonstration Projects' and 'Energy Storage Demonstration Projects'. The 'ANALYTICAL APPROACH' section describes the DOE's approach to providing an objective assessment of the benefits of the Smart Grid.

click "Access key program results"

click "Synchronphasor Applications in Transmission Systems"