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Summary of Survey Findings: NASPI SynchroPhasor Technology Training

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Pacific Northwest
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Executive Summary

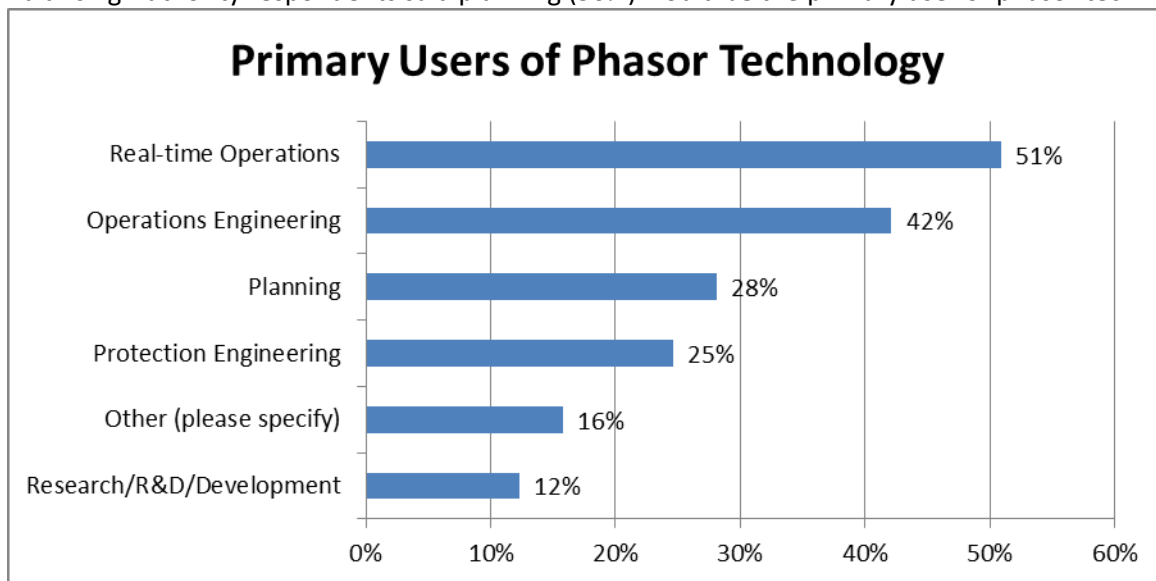
An anonymous survey was sent to members of the Smart Grid community to identify future synchrophasor technology training needs. The survey generated an 11% response rate.

28% of respondents said their company does not use nor plan to use phasor technology. Respondents represented companies with a wide variety of primary functions. Some of these functions such as vendors may not use synchrophasor technology in their work.

Respondents most likely to say they currently use phasor technology are affiliated with companies whose primary functions are:

- Generation Owner/Operator (90%)
- Transmission Owner/Coordinator (89%)
- Balancing Authority (70%)
- Reliability Coordinator (50%)

Overall, operations staff appear to be the primary users of phasor technology. Respondents said real-time operations (51%) and operations engineering (42%) would be primary users. In addition more than 55% of respondents said these two groups would benefit from phasor technology training. However Transmission Owner/Coordinator respondents said protection engineering (86%) and planning (75%) would be primary users followed by operations engineering (67%) and real-time operations (55%). Balancing Authority respondents said planning (50%) would be the primary user of phasor technology.



73% of respondents who said they currently use or plan to use phasor technology provided information about PMU deployments:

- 60% said they have installed or plan to install 50 or fewer PMUs.
- 73% said they have deployed or plan to deploy PMUs within the next three years.
- Respondents have deployed or plan to deploy PMUs on a wide variety of Kv transmission voltages. The top three voltages include:
 - 230 (38%)
 - 500 (38%)
 - 345 (25%)
- 52% said they have installed or plan to install PMUs on 50% or more of their high voltage substations.

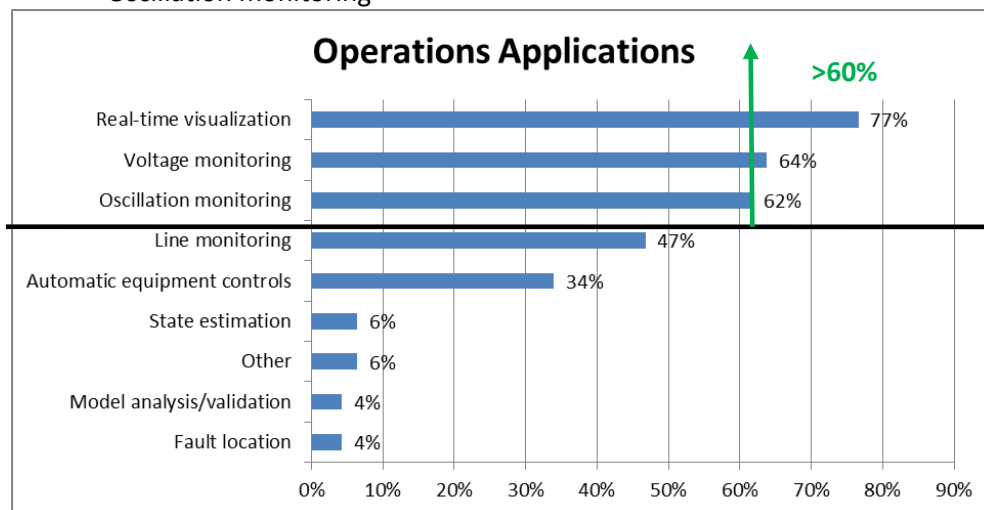
83% of respondents said their phasor data is currently integrated into other applications or systems or that their long term plan is to integrate it. 23% of respondents said they have or would develop custom systems to integrate phasor data. Respondents also said they use a wide variety of vendor systems to integrate phasor data and while no vendor emerged as a leader, the two most popular among were Alstom (18%) and OSIsoft (14%).

18% of respondents said they use a variety of stand-alone phasor data systems and systems are used by equal numbers of respondents.

60% of respondents said their company does not have a phasor technology business case for operations while 93% of respondents said they use or plan to use phasor technology for operations or for both operations and planning applications. This suggests a possible training need.

Three operations applications were selected by 60% or more of respondents as ones that they do or will use. 56% of respondents said they do not offer training to staff on applications that use synchrophasor data. In addition three respondents identified applications as a training gap they would like to address with their staff. These appear to be high value training options to address.

- Real-time visualization
- Voltage monitoring
- Oscillation monitoring



50% of respondents said they currently share phasor data with others such as neighboring utilities and another 29% said they have plans to share their data.

More than 50% of respondents said they use three planning applications:

- System load modeling
- Generator modeling
- Contingency analysis

In addition more than 50% of respondents who identified their company's primary function as Reliability Coordinator, Transmission Owner/Coordinator, Generator Owner/Operator and Balancing Authority said their Planning Group would benefit from phasor technology training.

55% of respondents said they do not provide phasor technology equipment training to their staff. 56% of respondents said they do not provide training to staff on applications that use synchrophasor data. 47% of respondents said their staff have not started a training program. These data suggest that there may be a need for equipment and application training or that a program to develop in-house trainers may be beneficial.

45% of respondents said they do provide phasor technology equipment training and 60% of this group said they use in-house developed classroom training, taught by internal staff or a consultant. 44% of respondents said they do provide training to staff on applications that use synchrophasor data and 60% said they provide it through in-house developed classroom training, taught by internal staff or a consultant. For those that currently offer training, classroom instruction appears to be the preferred training style.

PMU data quality was identified by respondents as the top training gap in synchrophasor technology. The table below shows, by a company primary function, training gaps that were identified by 50% or more of respondents. Standards and calibration training also appear to be important gaps for some company types.

		1: What is your company's primary function? (Select all that apply.)						
		Reliability Coordinator	Transmission Owner/Coordinator	Generation Owner/Operator	Balancing Authority	Consultant	Vendor	Other (please specify)
PMU data quality	Count	4	12	5	7	5	1	5
	% by Col	66.7%	70.6%	71.4%	87.5%	71.4%	25.0%	71.4%
Calibration	Count	1	9	4	4	1	0	2
	% by Col	16.7%	52.9%	57.1%	50.0%	14.3%	0.0%	28.6%
Installation	Count	1	8	3	3	1	0	1
	% by Col	16.7%	47.1%	42.9%	37.5%	14.3%	0.0%	14.3%
Standards	Count	2	9	3	5	3	0	4
	% by Col	33.3%	52.9%	42.9%	62.5%	42.9%	0.0%	57.1%
Other (please specify)	Count	0	2	0	0	2	0	3
	% by Col	0.0%	11.8%	0.0%	0.0%	28.6%	0.0%	42.9%

Background

An anonymous survey was sent to members of the Smart Grid community to identify future synchrophasor training technology training needs. An invitation was sent to the NASPI list serve address on September 10, 2012 and a reminder was sent September 17. The survey closed September 23.

Methodology

Standard survey techniques:

- Population (survey size): 750
- Sample size (total responses): 83
 - 52 completed
 - 31 started and not completed
- Response rate: 11%

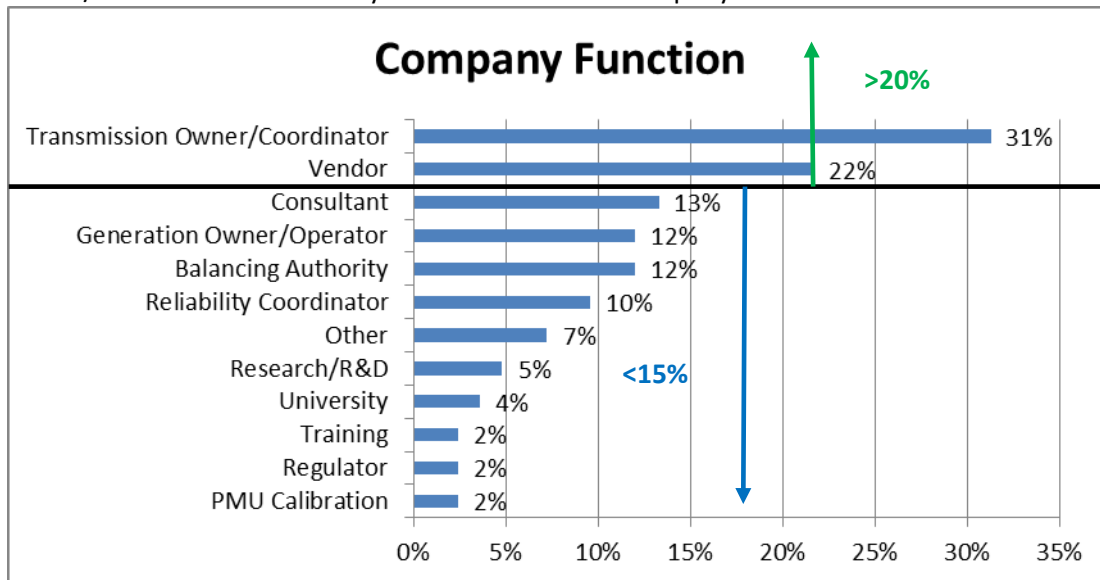
Findings

1: What is your company's primary function?

Respondents were asked identify their company's primary function and were encouraged to select one or more options from a list that included the opportunity to specify a function. The table below ranks in order of frequency the functions identified by respondents including a breakout of functions specified more than once under "Other."

Company Function	Frequency	Count
Transmission Owner/Coordinator	31%	26
Vendor	22%	18
Consultant	13%	11
Balancing Authority	12%	10
Generation Owner/Operator	12%	10
Reliability Coordinator	10%	8
Other	7%	6
Research/R&D	5%	4
University	4%	3
PMU Calibration	2%	2
Regulator	2%	2
Training	2%	2

The chart below shows that 31% of respondents said their company was a transmission owner/coordinator followed by 22% who said their company was a vendor.



1: What is your company's primary function? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
Reliability Coordinator		9.6%	8
Transmission Owner/Coordinator		31.3%	26
Generation Owner/Operator		12.0%	10
Balancing Authority		12.0%	10
Consultant		13.3%	11
Vendor		21.7%	18
Other (please specify)		22.9%	19
		Valid Responses	83
		Total Responses	83

1: What is your company's primary function? (Other, please specify.)

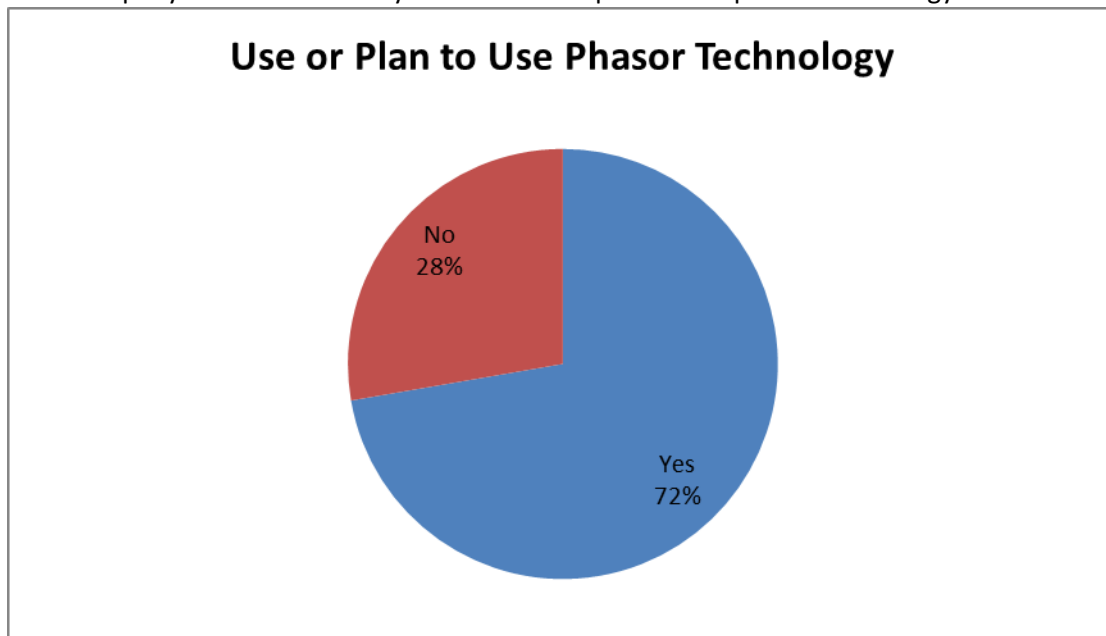
19 respondents specified other primary functions. Several functions were specified by more than one respondent:

Company Function	Percent	Count
Research/R&D	5%	4
University	4%	3
PMU Calibration	2%	2
Regulator	2%	2
Training	2%	2
All others	7%	6
Total	23%	19

Responses: What is your company's primary function?		
Regional Entity		
University		
Research		
Research & Development		
University		
Research		
PMU calibration system development		
Regulatory agency		
Simulation		
Training		
Training Supplier		
Electric Utility		
Regulator		
University		
Conformity assessment		
PMU Calibration system		
R&D (EPRI)		
SDO		
Testing & Certification, R&D, Third Party Inspection		
		Responses
		19

2: Does your company use or is it planning to deploy and use phasor technology?

72% of respondents said their company uses or plans to deploy and use phasor technology and 28% said their company does not currently use nor does it plan to use phasor technology.



2: Does your company use or is it planning to deploy and use phasor technology?
(Respondents could only choose a **single** response)

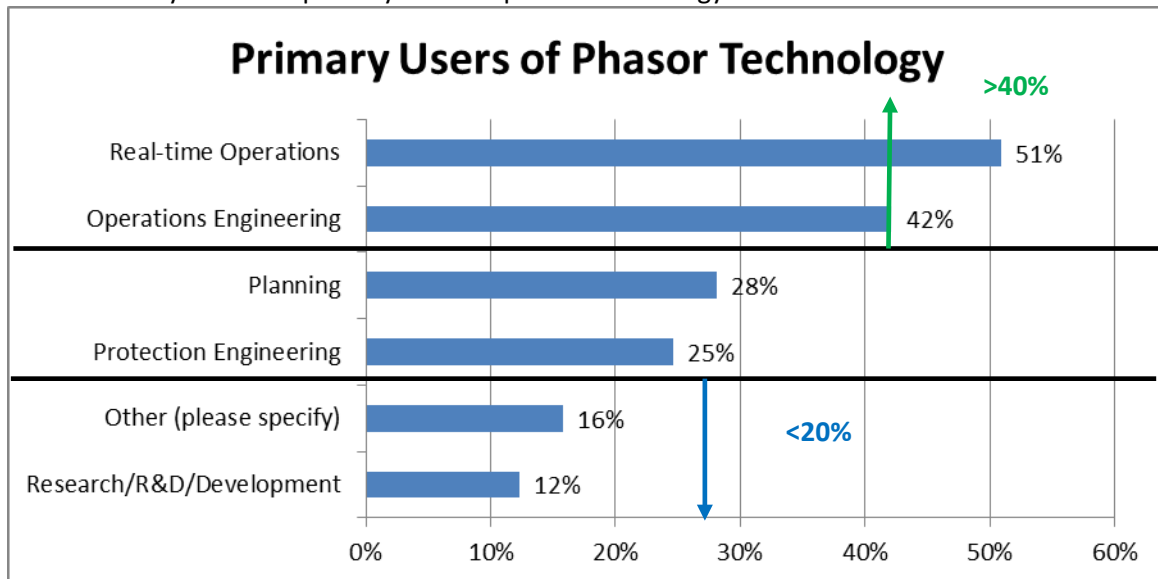
Response	Chart	Frequency	Count
Yes, we currently use phasor technology		56.6%	43
Yes, we plan to deploy and use phasor technology		15.8%	12
No, don't currently use or plan to use phasor technology		27.6%	21
Not Answered			7
	Mean		1.711
	Standard Deviation		0.877
	Valid Responses		76
	Total Responses		83

3: Who are or will be the primary users of phasor technology in your organization?

Respondents were asked identify the primary users of phasor technology in their organization and were encouraged to select one or more options from a list that included the opportunity to specify a user. The table below ranks in order of frequency the functions identified by respondents including a breakout of Research/R&D/Development that was specified seven times under “Other.”






Primary Users	Percent	Count
Real-time Operations	51%	29
Operations Engineering	42%	24
Planning	28%	16
Protection Engineering	25%	14
Other (please specify)	16%	8
Research/R&D/Development	12%	7

51% of respondents said that Real-time operations and 42% said Operations Engineering are or will be the primary users of phasor technology in their organization suggesting that operations organizations are most likely to be the primary users of phasor technology.



3: Who are or will be the primary users of phasor technology in your organization?
 (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
Protection Engineering		24.6%	14
Planning		28.1%	16
Real-time Operations		50.9%	29
Operations Engineering		42.1%	24
Other (please specify)		28.1%	16
		Valid Responses	57
		Total Responses	57

3: Who are or will be the primary users of phasor technology in your organization? (Other, please specify.)

15 respondents specified primary users of phasor technology not provided in the choice list. Research, R&D, or Development was specified by 7 respondents.

Responses: Who are or will be the primary users of phasor technology in your organization?		
Research		
R&D		
Betterment of Wide Area Monitoring		
Real-time operations is the market area we are serving		
System Awareness		
R&D		
Generator Integration projects		
All of the above		
Research		
Not sure		
Computer applications		
The regional ISO.		
Research and Development		
Development engineers		
Development & Test team		
	Responses	15

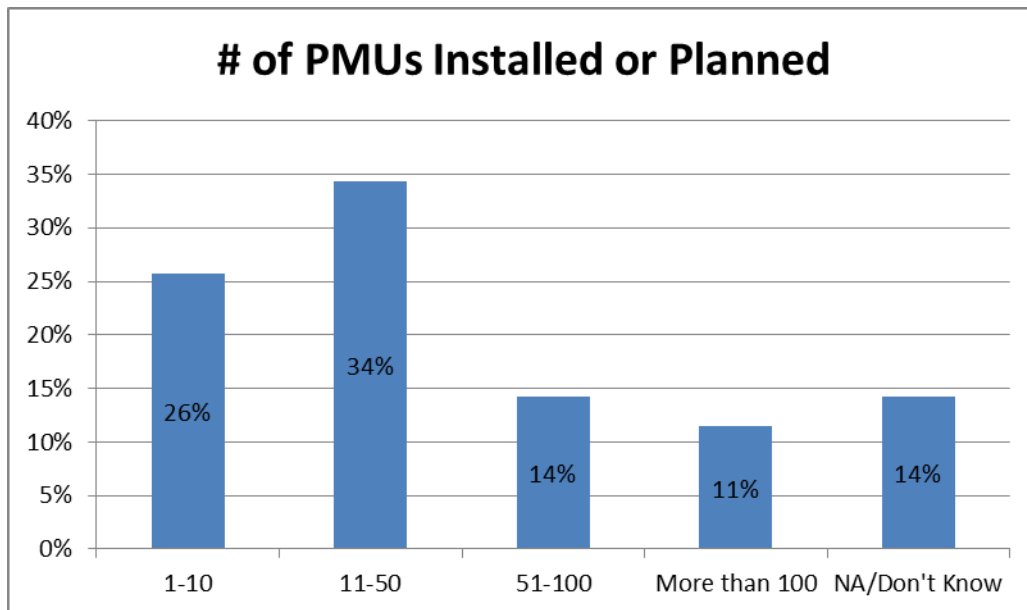
4: Please provide the following information on your current or planned PMU deployment.

Respondents were asked to complete fill-in-the-blank questions about the number of PMUs that are installed or plan to be installed, timeframe for PMU deployment, the transmission voltage of PMU installations, and the percent of high voltage substations that will have PMUs. Respondents provided numeric, qualitative and mixed responses in the fill in the blank fields. The analysis in this section attempts to quantify responses, if possible, and provide a roll-up of those responses.

Number of PMUs installed and/or planned to be installed

Respondents were asked to provide the number of PMUs installed or planned. While most respondents provided numerical information, some provided qualitative responses and others were mixed. A list of the responses are provided later in this section and notes for some responses indicate how they were handled in the roll-up below.

# of PMUs Installed or Planned	Count	Percent
1-10	9	26%
11-50	12	34%
51-100	5	14%
More than 100	4	11%
NA/Don't Know/No numerical data	5	14%
Totals	35	100%



4: Please provide the following information on your current or planned PMU deployment. (Number of PMUs installed and/or planned to be installed)

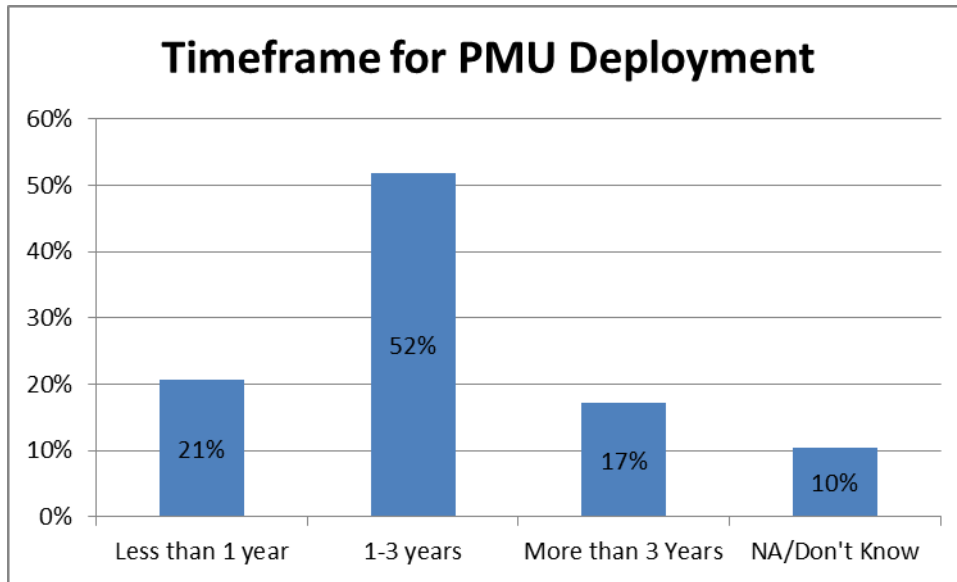
Responses: Number of PMUs installed and/or planned to be installed
16
80
120
10
4
6
2
14
24 and 40 [Note: these quantities were combined for analysis]
n/a, vendor
40ish different locations
2 present in lab
30
0 - we receive data only [Note: counted as NA for analysis purposes]
40 substations
50
300
80
All projects, solar, wind, geothermal [Note: counted as NA/Don't Know since no quantity is provided.]
120
42
4
Not known
20
40
250

Responses: Number of PMUs installed and/or planned to be installed		
6		
96		
70		
50		
7-10		
5		
10's of units [Note: counted as 20 for analysis purposes]		
NA		
11		
	Responses	35

Timeframe for PMU deployment (number of years)

73% of respondents said they have deployed or plan to deploy PMUs within the next three years.

Deployment Yrs.	Count	Percent
Less than 1 year	6	21%
1-3 years	15	52%
More than 3 Years	5	17%
NA/Don't Know	3	10%
Totals	29	100%



4: Please provide the following information on your current or planned PMU deployment. (Timeframe for PMU deployment (number of years))

Responses Timeframe for PMU deployment (number of years)
2-3
2
3
0
0.5
3
2013 [Note: counted as 1 year for analysis purposes]
2
1

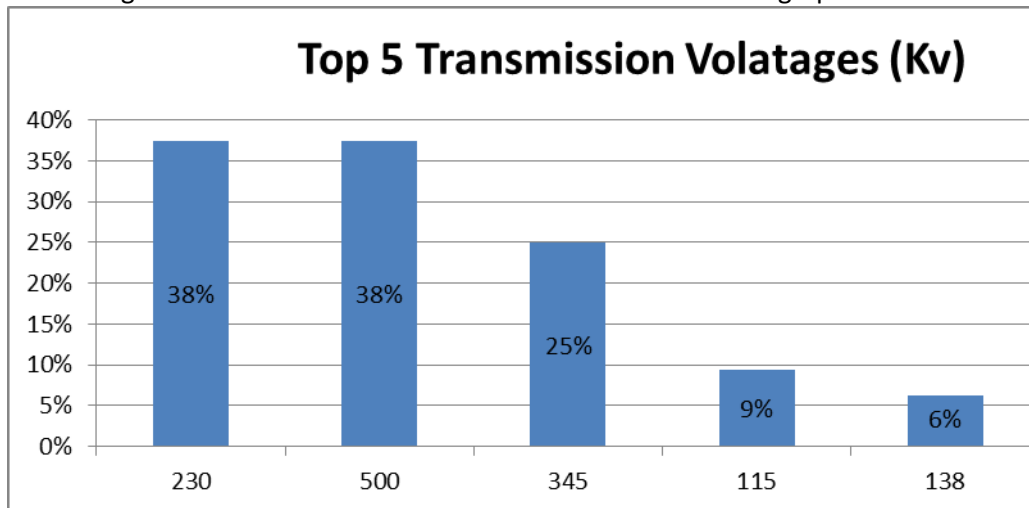
Responses Timeframe for PMU deployment (number of years)		
0 - we receive data only [Note: counted as NA for analysis purposes]		
by end of 2012 [Note: counted as less than one year for analysis purposes]		
1		
3		
15		
3		
2-3		
3		
Not known		
5		
1		
1		
10		
1		
10		
10		
0		
Now [Note: counted as less than 1 year for analysis purposes]		
NA		
0		
	Responses	29

Transmission voltage of installations (Kv)

Respondents provided 32 responses and provided one or more transmission voltages or other comments. Voltages were analyzed individually and the table below shows how many respondents provided each value.

Transmission Voltages	Count	Percent
230	12	38%
500	12	38%
345	8	25%
Don't Know/NA	6	19%
115	3	9%
138	2	6%
735	1	3%
400	1	3%
110	1	3%
0	1	3%
100	1	3%
239	1	3%
765	1	3%
275	1	3%

Five voltages were named more than once and are shown in the graph below.



4: Please provide the following information on your current or planned PMU deployment. **(Transmission voltage of installations (Kv))**
 32 respondents provided answers to this question and they are listed in the table below.

Responses: Transmission voltage of installations (Kv)
500, 345, 230, 138
345
500 + 230
0 [Note: this response was categorized as NA for analysis]
Lab. Deployment [Note: this response was categorized as NA for analysis]
138 and 345
230
345
230 and 500
500 and critical 230
230
0 - we receive data only [Note: this response was categorized as NA for analysis]
35-345 kV, 5-115 kV
500
500/230/115
230 & 500
500, 230, select 100
500
345 KV & 115 kV
not know
735kV
230, 345
500
400
230 and 500

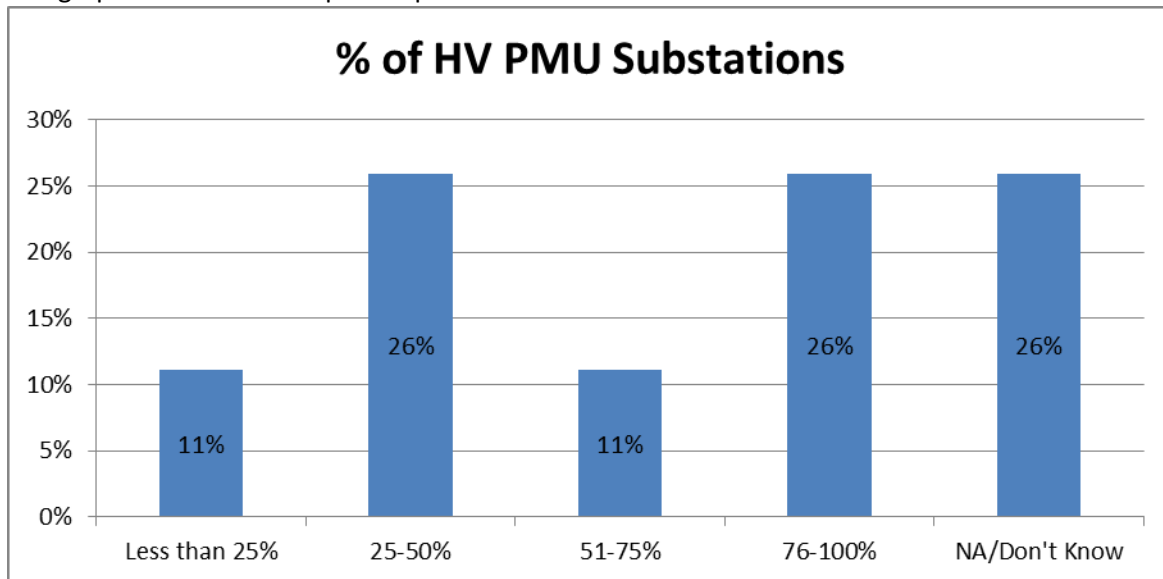
Responses: Transmission voltage of installations (Kv)		
500 /230		
275		
Lab [Note: this response was categorized as NA for analysis]		
0 [Note: this response was categorized as NA for analysis]		
.110		
NA		
765, 345, 239		
	Responses	32

Percent of HV (≥230 Kv) substations that will have PMUs (%)

Respondents provided percentages that ranged from 0-100%. The table shows a roll-up of responses.

% of HV PMU Substations	Count	Percent
Less than 25%	3	11%
25-50%	7	26%
51-75%	3	11%
76-100%	7	26%
NA/Don't Know	7	26%
Totals	27	100%

The graph shows the roll-up of respondent answers.



4: Please provide the following information on your current or planned PMU deployment. **(Percent of HV (≥230 Kv) substations that will have PMUs (%))**
 27 respondents provided an answer to this question and their responses are provided in the following table.

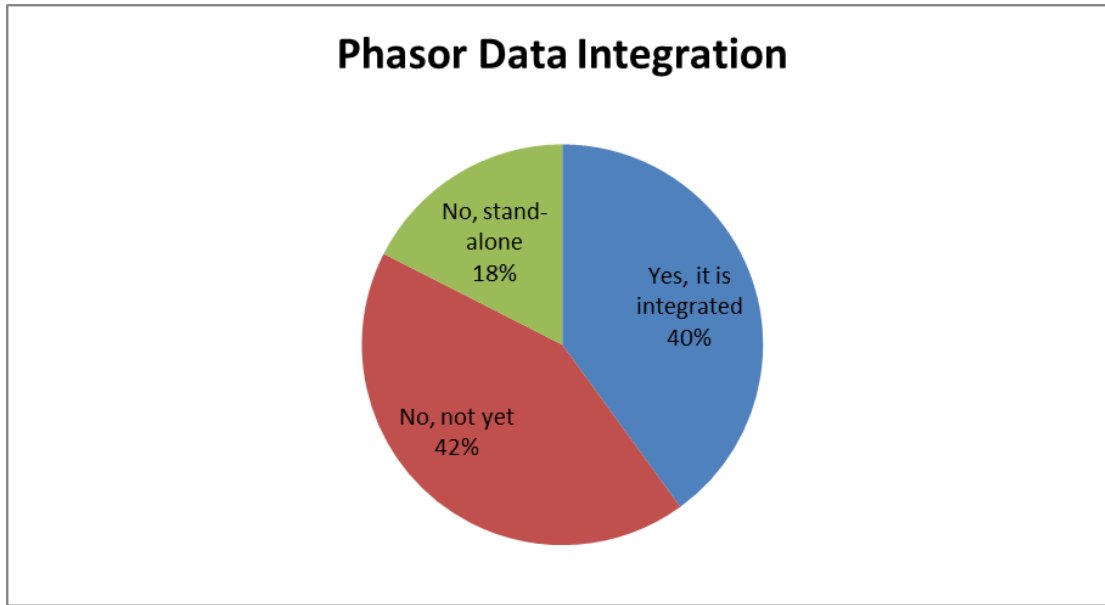
Responses: Percent of HV (≥230 Kv) substations that will have PMUs (%)
99%
75
100
0 [Note: this response was categorized as NA for analysis]
Lab. Deployment [Note: this response was categorized as NA for analysis]
66

Responses: Percent of HV (≥ 230 Kv) substations that will have PMUs (%)		
5		
100		
~50%		
25		
0 - we receive data only [Note: this response was categorized as NA for analysis]		
40%		
50		
100		
100		
15		
100		
Not known		
50		
25		
1		
75		
85		
50		
0 [Note: this response was categorized as NA for analysis]		
N/A		
NA		
	Responses	27

5: Is your phasor data currently integrated into other applications or systems (e.g., PI, EMS)?

40% of respondents said phasor data is currently integrated into other applications or systems, 42% said that phasor data isn't yet integrated but that is the long term plan, and 18% said phasor data is stand-alone rather than integrated.

It is noteworthy that 17 respondents (30% of total respondents) did not answer this question. This suggests that there may have been some confusion about the wording or some respondents did not know the answer.



5: Is your phasor data currently integrated into other applications or systems (e.g., PI, EMS)?

(Respondents could only choose a **single** response)

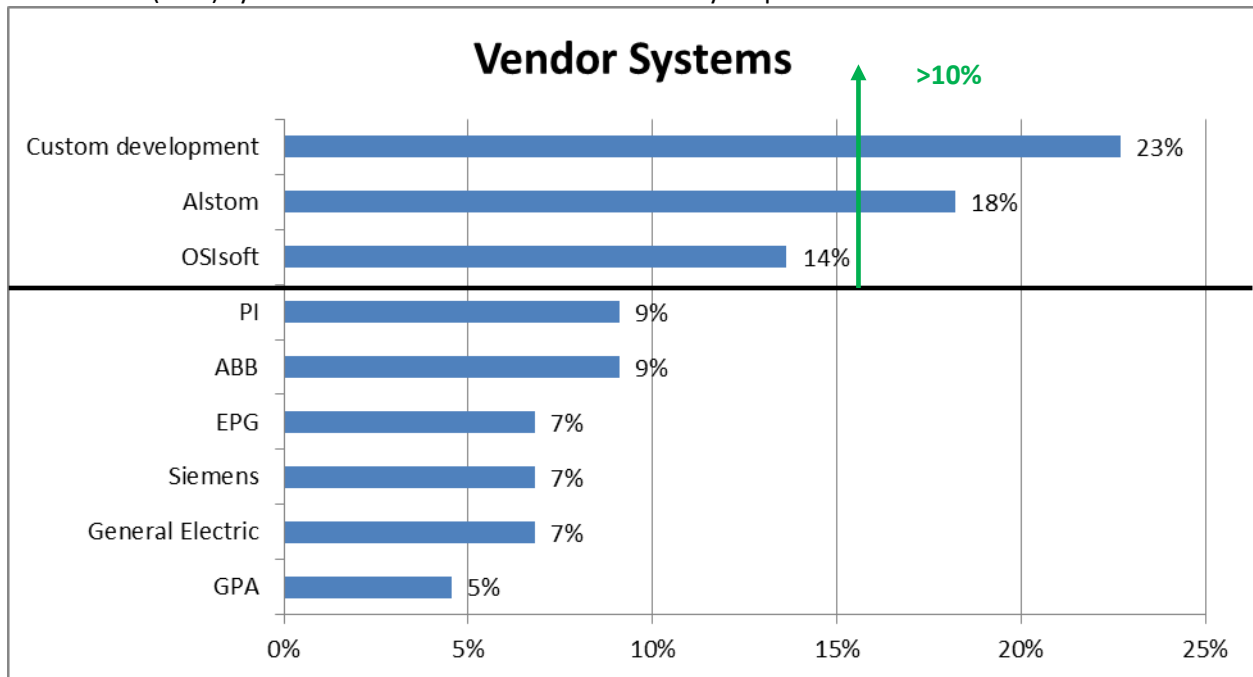
Response	Chart	Frequency	Count
Yes, it is integrated		40.0%	16
No, it isn't integrated yet, but that is the long term plan		42.5%	17
No, it is stand-alone		17.5%	7
Not Answered			17
		Mean	1.775
		Standard Deviation	0.733
		Valid Responses	40
		Total Responses	57

6: Which vendors' systems have you or will you integrate the phasor data into?

44 respondents provided answers about vendor systems they integrate phasor data into. 41% specified other responses and those were analyzed and are included in the following table.







Vendor Systems	Percent	Count
Custom development	23%	10
Alstom	18%	8
OSIsoft	14%	6
ABB	9%	4
PI	9%	4
NA	9%	4
Other	9%	4
General Electric	7%	3
Siemens	7%	3
EPG	7%	3
GPA	5%	2

23% of respondents said they will integrate phasor data into custom developed systems. Alstom (18%) and OSIsoft (14%) systems were ranked second and third by respondents.



6: Which vendors' systems have you or will you integrate the phasor data into? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
Alstom		18.2%	8
General Electric		6.8%	3
ABB		9.1%	4
Siemens		6.8%	3
Custom development		22.7%	10
Other		40.9%	18
		Valid Responses	44
		Total Responses	44

6: Which vendors' systems have you or will you integrate the phasor data into? (Other, please specify.)






Responses: Which vendors' systems have you or will you integrate the phasor data into
Not sure at this point [Note: this response was categorized as NA for analysis]
PI, EPG, GPA
OpenPDC/OpenPG/SIEGate
OSI [Note: this response was categorized as OSIsoft for analysis]
N/A, vendor
PI
OSIsoft
OSIsoft
EPG
OSII [Note: this response was categorized as OSIsoft for analysis]
BAs choice
We are vendor independent [Note: this response was categorized as NA for analysis]
PI, EPG, GPA
SEL
OSIsoft (PI) [Note: this response was categorized as OSIsoft for analysis]

Responses: Which vendors' systems have you or will you integrate the phasor data into		
Not yet decided [Note: this response was categorized as NA for analysis]		
PI Historian		
PI now, EMS (TBD) in future		
Stream Reader		
	Responses	19

7: Which phasor products are you feeding the phasor data to?

A small number of respondents said their phasor data is stand alone. Four products were selected equally by respondents.

7: Which phasor products are you feeding the phasor data to? (Select all that apply.)
 (Respondents were allowed to choose **multiple** responses)

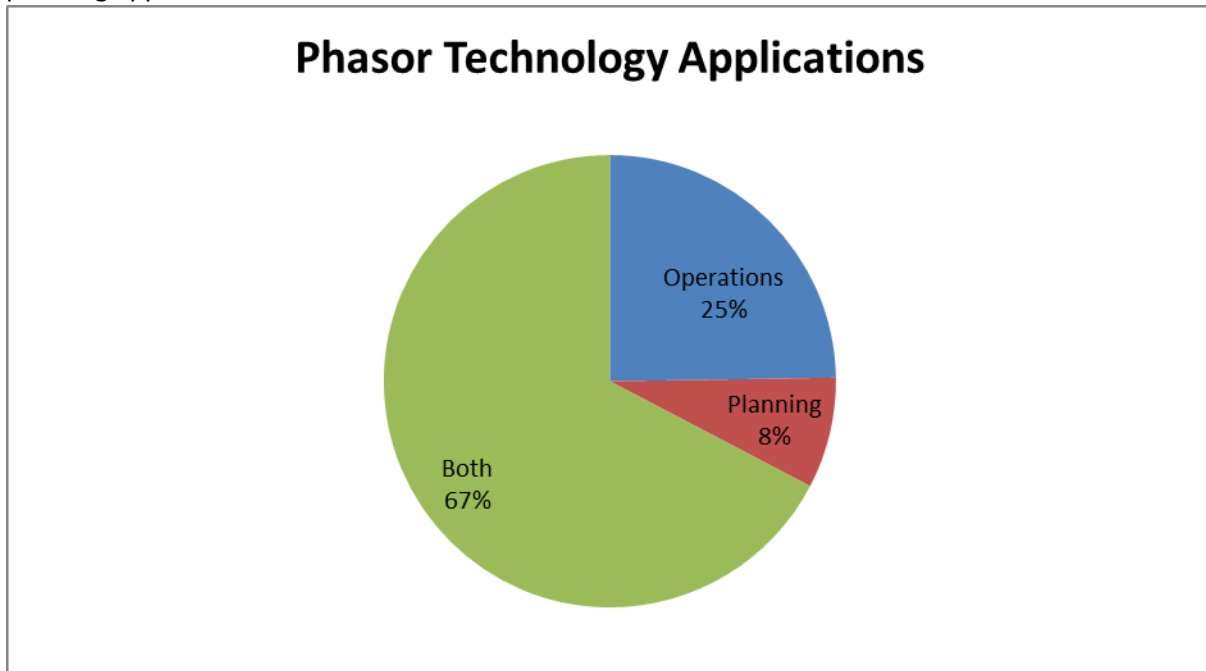
Response	Chart	Frequency	Count
RTDMS		25.0%	2
PhasorPoint		25.0%	2
SEL's SynchroWAVE Central		25.0%	2
Custom development		12.5%	1
Other (OpenPDC)		25.0%	2
		Valid Responses	8
		Total Responses	8

7: Which phasor products are you feeding the phasor data to? (Other, please specify.)

Response	Valid Responses
OpenPDC	
OpenPDC	
	2

8: Does your company use or plan to use phasor technology for operations applications and/or planning applications?

67% of respondents said their company uses or plans to use phasor technology for both operations and planning applications.



8: Does your company use or plan to use phasor technology for operations applications and/or planning applications?

(Respondents could only choose a **single** response)

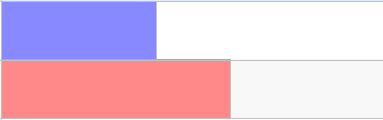
Response	Chart	Frequency	Count
Operations		25.0%	10
Planning		7.5%	3
Both		67.5%	27
Not Answered			10
		Mean	2.425
		Standard Deviation	0.874
		Valid Responses	40
		Total Responses	50

9: Does your company have a phasor technology business case for operations?

60% of respondents said their company does not have a phasor technology business case for operations. Only respondents who said they use phasor technology for operations or for both operations and planning were asked to answer this question.

It is noteworthy that 12 respondents (26% of total respondents) did not answer this question.

9: Does your company have a phasor technology business case for operations?
(Respondents could only choose a **single** response)

Response	Chart	Frequency	Count
Yes		40.0%	14
No		60.0%	21
Not Answered			12
		Mean	1.600
		Standard Deviation	0.497
		Valid Responses	35
		Total Responses	47

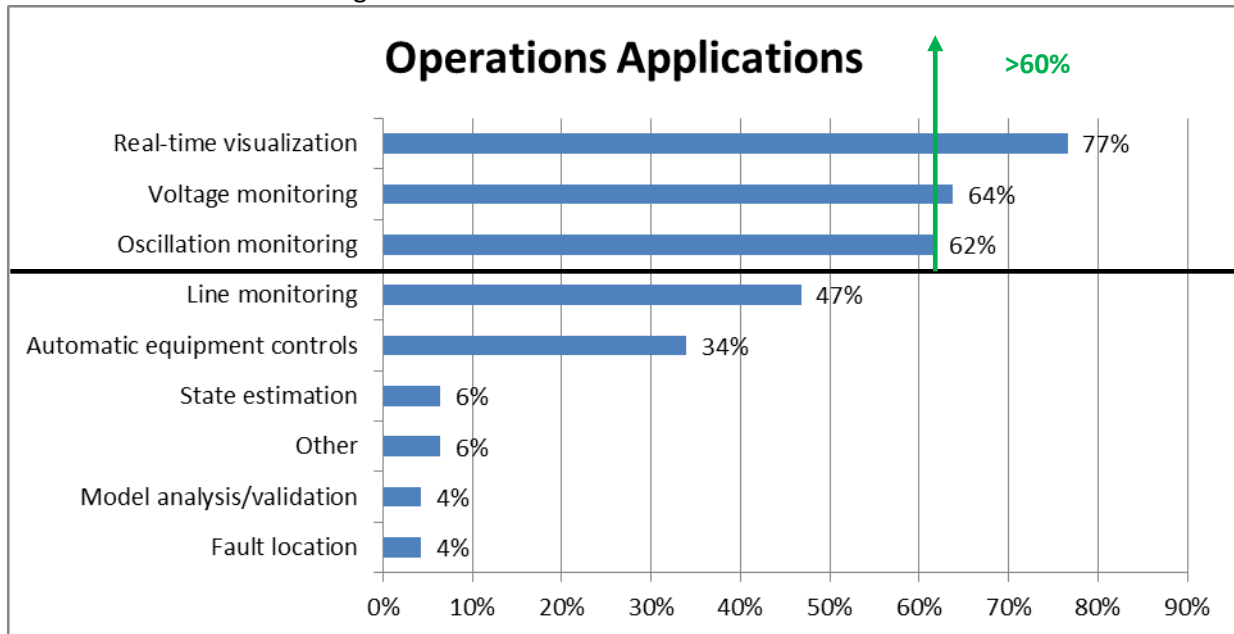
10: Which of these operations' applications do you or will you use?

The table below summarizes both the applications selected by participants from the choice list and applications specified in other.

Operations Applications	Percent	Count
Real-time visualization	77%	36
Voltage monitoring	64%	30
Oscillation monitoring	62%	29
Line monitoring	47%	22
Automatic equipment controls	34%	16
Other	6%	3
State estimation	6%	3
Fault location	4%	2
Model analysis/validation	4%	2

Three operations applications were selected by more than 60% of respondents:

- Real-time visualization
- Voltage monitoring
- Oscillation monitoring



10: Which of these operations' applications do you or will you use? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
Real-time visualization		76.6%	36
Line monitoring		46.8%	22
Oscillation monitoring		61.7%	29
Voltage monitoring		63.8%	30
Automatic equipment controls		34.0%	16
Other (please specify)		17.0%	8
		Valid Responses	47
		Total Responses	47

10: Which of these operations' applications do you or will you use? (Other, please specify.)

8 respondents specified other operation applications that they do or will use. Three applications were specified by two or more respondents:

- State estimation
- Fault location
- Model analysis/validation

Responses: Which of these operations' applications do you or will you use?		
State Estimation, Fault location		
Data mining		
State estimation		
Modal Analysis		
Commissioning SVCs		
All of the above		
Enhanced State Estimator, Fault Location		
System stability, model validation		
		Responses
		8

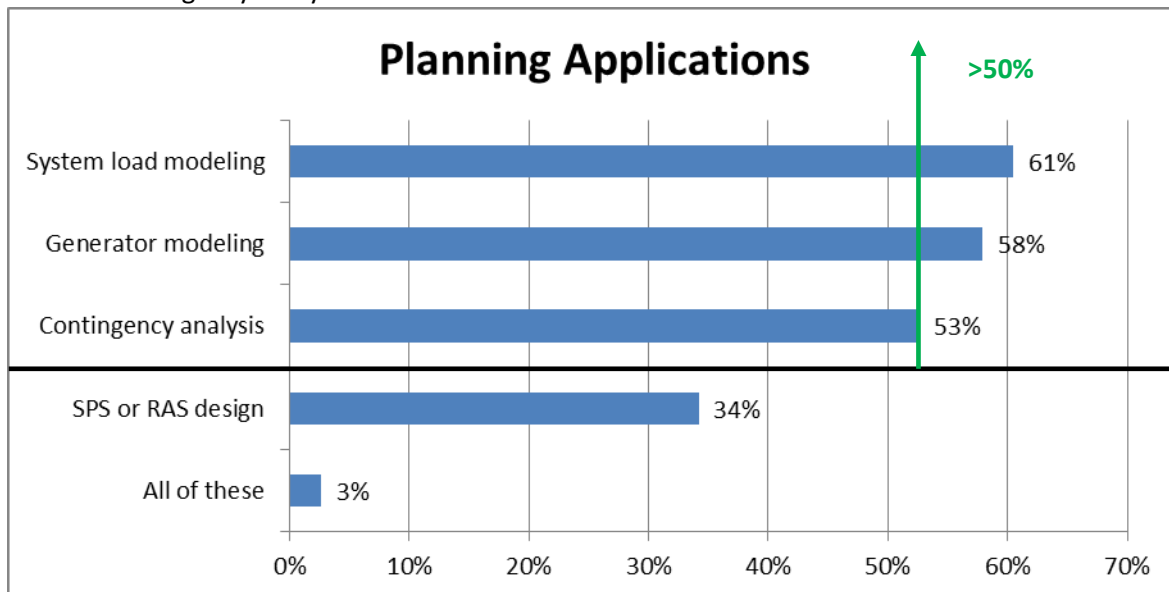
11: Which of these planning applications do you use?

The table below shows the percent of respondents who said they use each of the planning applications in the choice list. The table is sorted by response rate.

Planning Applications	Percent	Count
System load modeling	61%	23
Generator modeling	58%	22
Contingency analysis	53%	20
SPS or RAS design	34%	13
All of these	3%	1

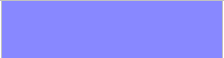



Three planning applications were selected by more than 50% of respondents as ones they use:

- System load modeling
- Generator modeling
- Contingency analysis



11: Which of these planning applications do you use? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

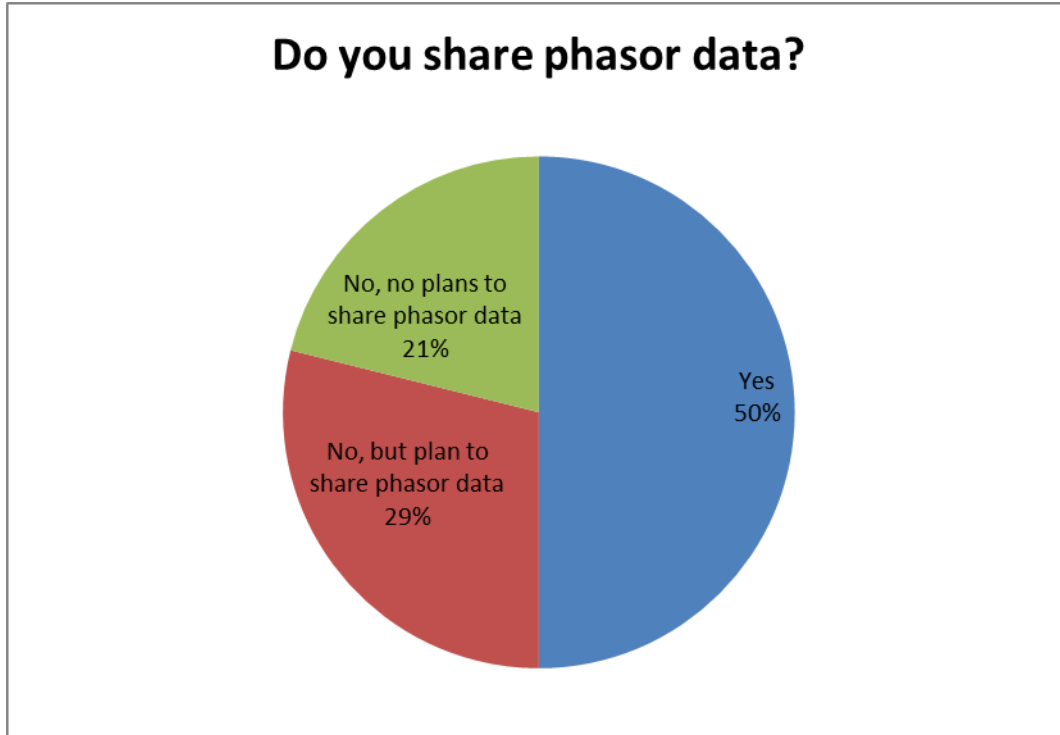
Response	Chart	Frequency	Count
Generator modeling		57.9%	22
System load modeling		60.5%	23
SPS or RAS design		34.2%	13
Contingency analysis		52.6%	20
Other (All of these)		2.6%	1
		Valid Responses	38
		Total Responses	38

11: Which of these planning applications do you use? (Other, please specify.)

Response	Responses
All of the above	1

12: Do you currently share phasor data with others such as neighboring utilities?

50% of respondents said they currently share phasor data and another 29% said they have plans to share. Just 21% said they do not share phasor data and have no plans to do so.



12: Do you currently share phasor data with others such as neighboring utilities?

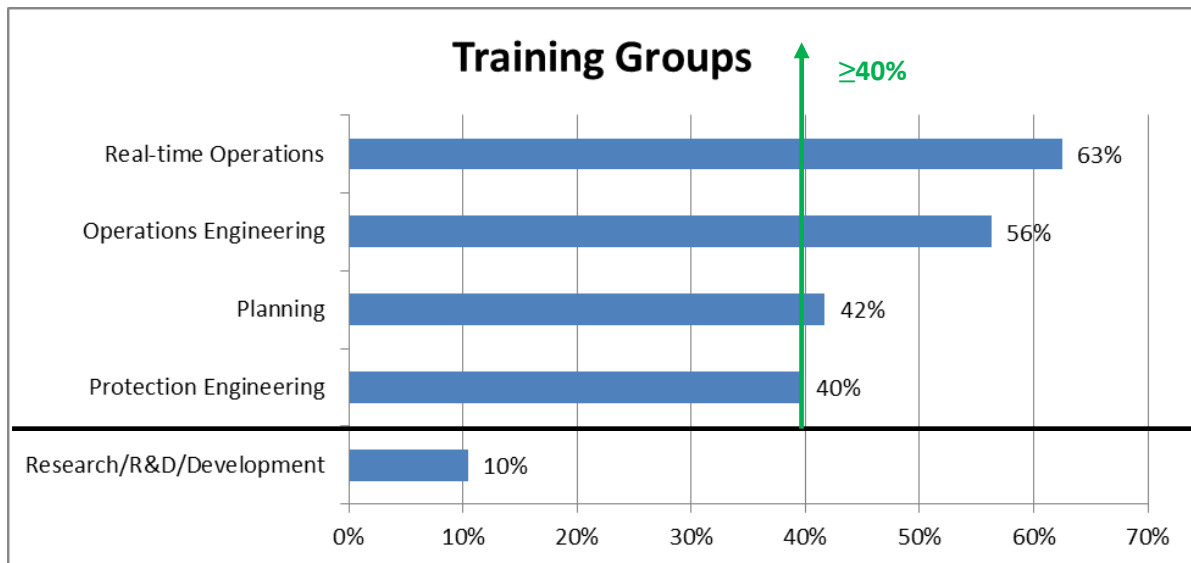
(Respondents could only choose a **single** response)

Response	Chart	Frequency	Count
Yes		50.0%	19
No, but we plan to share data when we deploy phasor technology		28.9%	11
No, we have no plans to share phasor data		21.1%	8
Not Answered			10
	Mean		1.711
	Standard Deviation		0.802
	Valid Responses		38
	Total Responses		48

13: What groups in your company would benefit from phasor technology training?

The table below shows the groups that would benefit from phasor training as ranked by respondent choices. Real-time Operations and Operations Engineering generated were selected by more than 50% of respondents.

Response	Percent	Count
Real-time Operations	63%	30
Operations Engineering	56%	27
Planning	42%	20
Protection Engineering	40%	19
Research/R&D/Development	10%	5
Other	13%	6



13: What groups in your company would benefit from phasor technology training? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
Protection Engineering		39.6%	19
Planning		41.7%	20
Real-time Operations		62.5%	30
Operations Engineering		56.3%	27
Other (please specify)		22.9%	11
		Valid Responses	48
		Total Responses	48

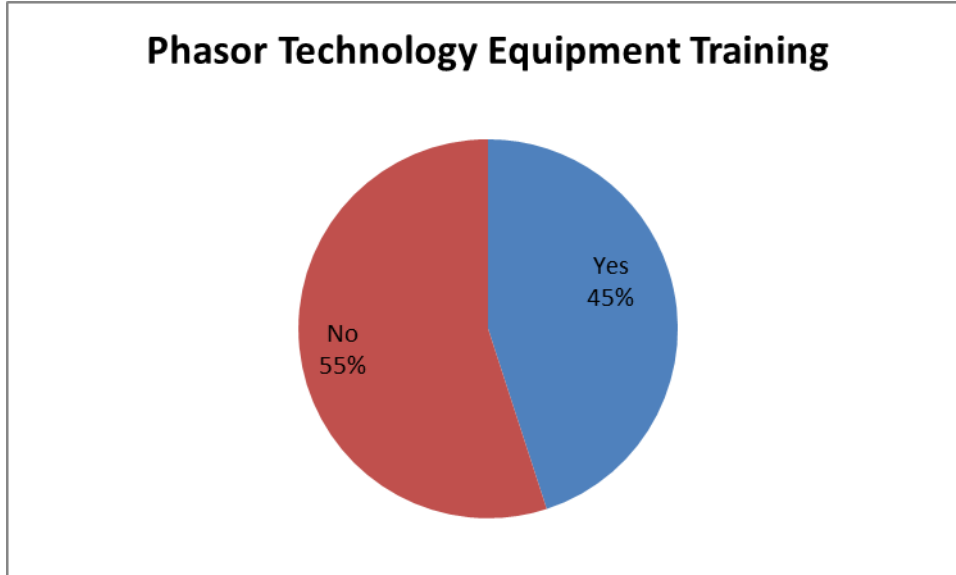
13: What groups in your company would benefit from phasor technology training? (Other, please specify.)

11 respondents specified groups in their company that would benefit from phasor technology training and 5 respondents identified research and/or development groups as candidates for training.

Response	
Research	
Systems engineering	
Advanced Technology	
All of the above	
Research	
Test	
Telecommunications, IT	
Lab/Engineering staff	
R&D	
R&D engineers	
Development teams	
	Valid Responses
	11

14: Do you provide phasor technology equipment training to your staff

55% of respondents said they do not provide phasor technology equipment training to their staff and 45% said they do.



14: Do you provide phasor technology equipment training to your staff (including communications)?

(Respondents could only choose a **single** response)

Response	Chart	Frequency	Count
Yes		45.0%	18
No		55.0%	22
Not Answered			8
		Mean	1.550
		Standard Deviation	0.504
		Valid Responses	40
		Total Responses	48

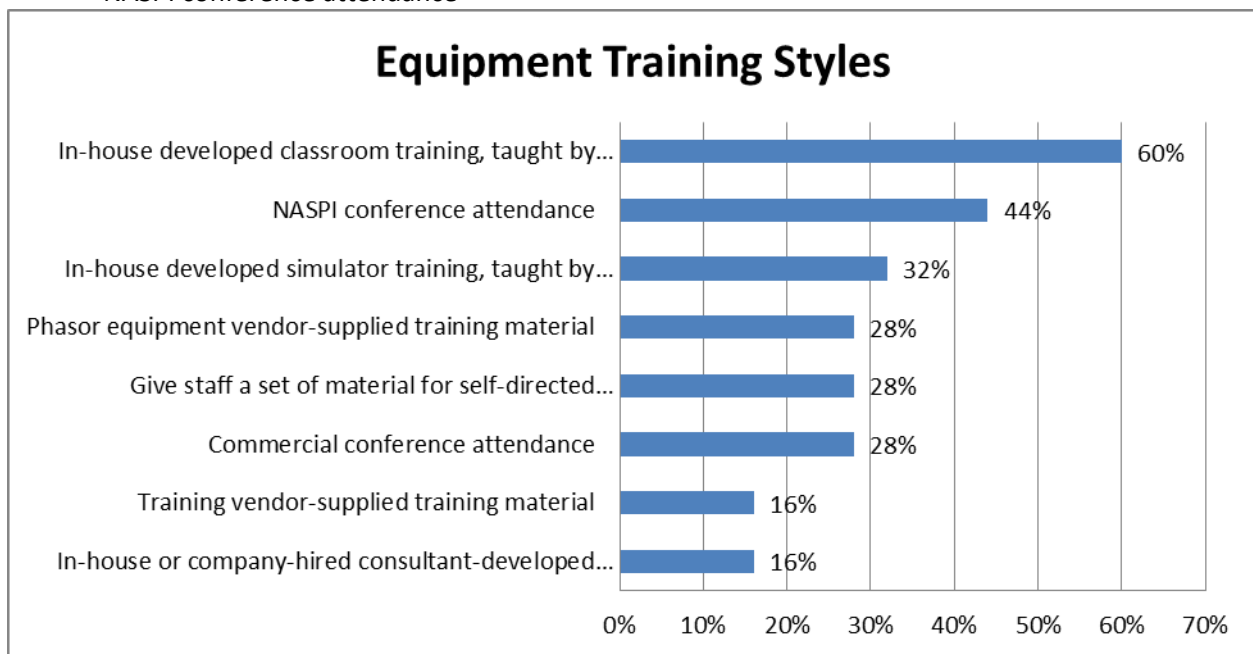
15: What styles of equipment training do you offer your staff?

The table below shows training styles selected by respondents in order of frequency.

Equipment Training Styles	Percent	Count
In-house developed classroom training, taught by internal staff or a consultant	60%	15
NASPI conference attendance	44%	11
In-house developed simulator training, taught by internal staff or a consultant	32%	8
Commercial conference attendance	28%	7
Give staff a set of material for self-directed research, including NASPI website material	28%	7
Phasor equipment vendor-supplied training material	28%	7
In-house or company-hired consultant-developed on-line training	16%	4
Training vendor-supplied training material	16%	4

Respondents said that a variety of training styles are used. The two most popular styles of equipment training are:

- In-house developed classroom training, taught by internal staff or a consultant
- NASPI conference attendance



15: What styles of equipment training do you offer your staff? (Select all that apply.)
 (Respondents were allowed to choose **multiple** responses)

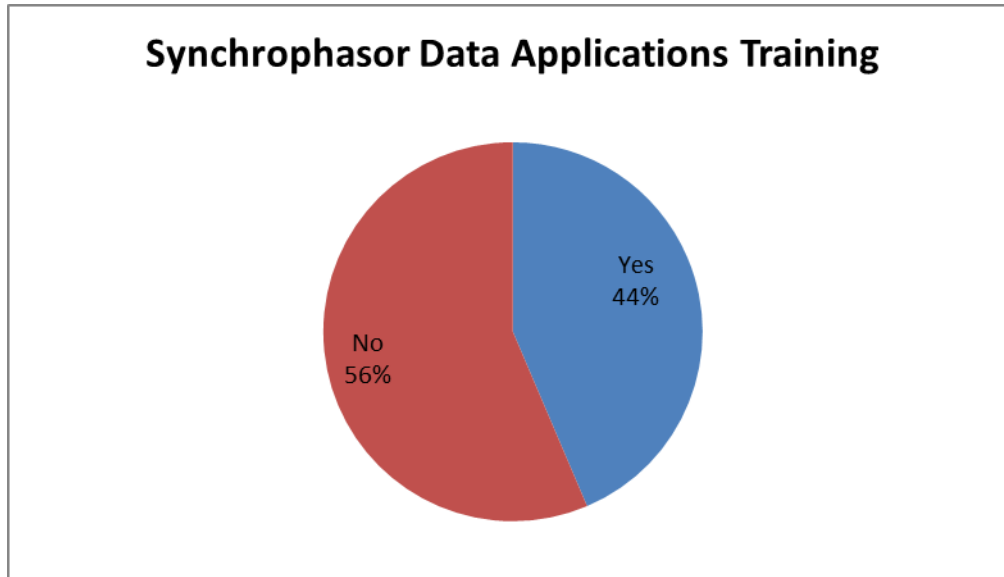
Response	Chart	Frequency	Count
In-house developed classroom training, taught by internal staff or a consultant		60.0%	15
In-house developed simulator training, taught by internal staff or a consultant		32.0%	8
In-house or company-hired consultant-developed on-line training		16.0%	4
Commercial conference attendance		28.0%	7
NASPI conference attendance		44.0%	11
Give staff a set of material for self-directed research, including NASPI website material		28.0%	7
Phasor equipment vendor-supplied training material		28.0%	7
Training vendor-supplied training material		16.0%	4
Other (please specify)		8.0%	2
		Valid Responses	25
		Total Responses	25

15: What styles of equipment training do you offer your staff? (Other, please specify)

Response	Responses
All of the above	
Hands on in the lab	
	2

16: Do you provide training to your staff on applications that use synchrophasor data (e.g., oscillation detection, voltage angle difference, etc.)?

56% of respondents said they do not provide training to staff on applications that use synchrophasor data.



16: Do you provide training to your staff on applications that use synchrophasor data (e.g., oscillation detection, voltage angle difference, etc.)?
(Respondents could only choose a **single** response)

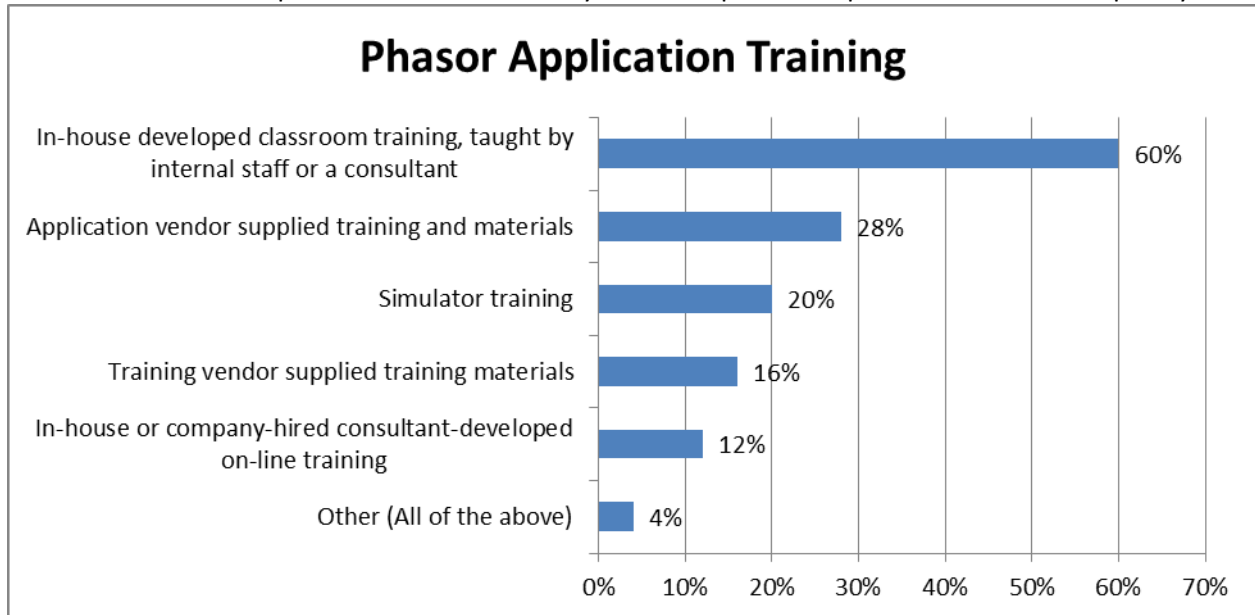
Response	Chart	Frequency	Count
Yes		43.6%	17
No		56.4%	22
Not Answered			7
		Mean	1.564
		Standard Deviation	0.502
		Valid Responses	39
		Total Responses	46

17: What kind of phasor application training do you provide to your staff?

The table below shows training options ranked by the frequency they were selected by respondents.



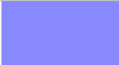



Phasor Application Training	Percent	Count
In-house developed classroom training, taught by internal staff or a consultant	60%	15
Application vendor supplied training and materials	28%	7
Simulator training	20%	5
Training vendor supplied training materials	16%	4
In-house or company-hired consultant-developed on-line training	12%	3
Other (All of the above)	4%	1

The graph shows that 60% of respondents said in-house developed classroom training taught by internal staff or a consultant is provided to staff. A variety of other options are provided with less frequency.



17: What kind of phasor application training do you provide to your staff? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

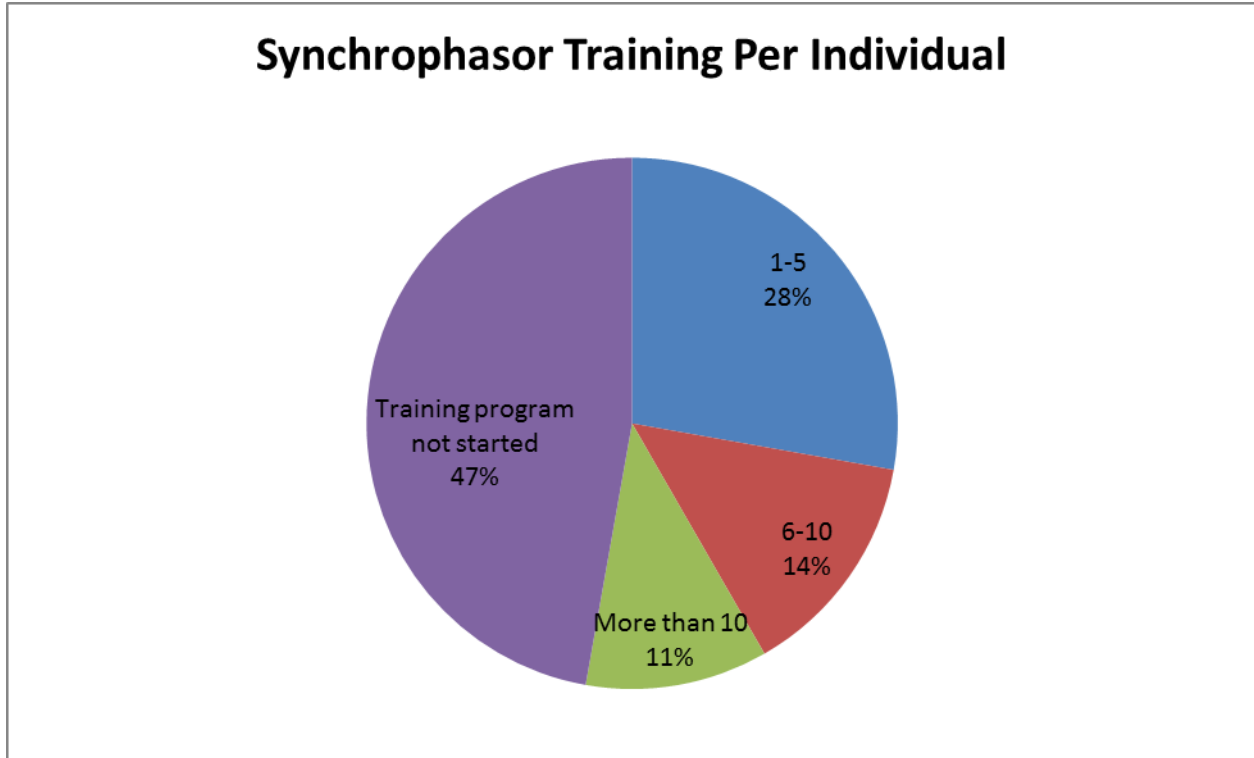
Response	Chart	Frequency	Count
In-house developed classroom training, taught by internal staff or a consultant		60.0%	15
In-house or company-hired consultant-developed on-line training		12.0%	3
Application vendor supplied training and materials		28.0%	7
Training vendor supplied training materials		16.0%	4
Simulator training		20.0%	5
Other (All of the above)		4.0%	1
		Valid Responses	25
		Total Responses	25

17: What kind of phasor application training do you provide to your staff? (Other, please specify.)

Response	Responses
All of the above	1

18: On average, how many hours of synchrophasor-related training did each of your staff receive in the last 12 months?

Almost half of respondents (47%) said that their staff have not started a training program. 28% said staff have received 1-5 hours of training and 25% said they have received 6 hours or more.



18: On average, how many hours of synchrophasor-related training did each of your staff receive in the last 12 months?

(Respondents could only choose a **single** response)

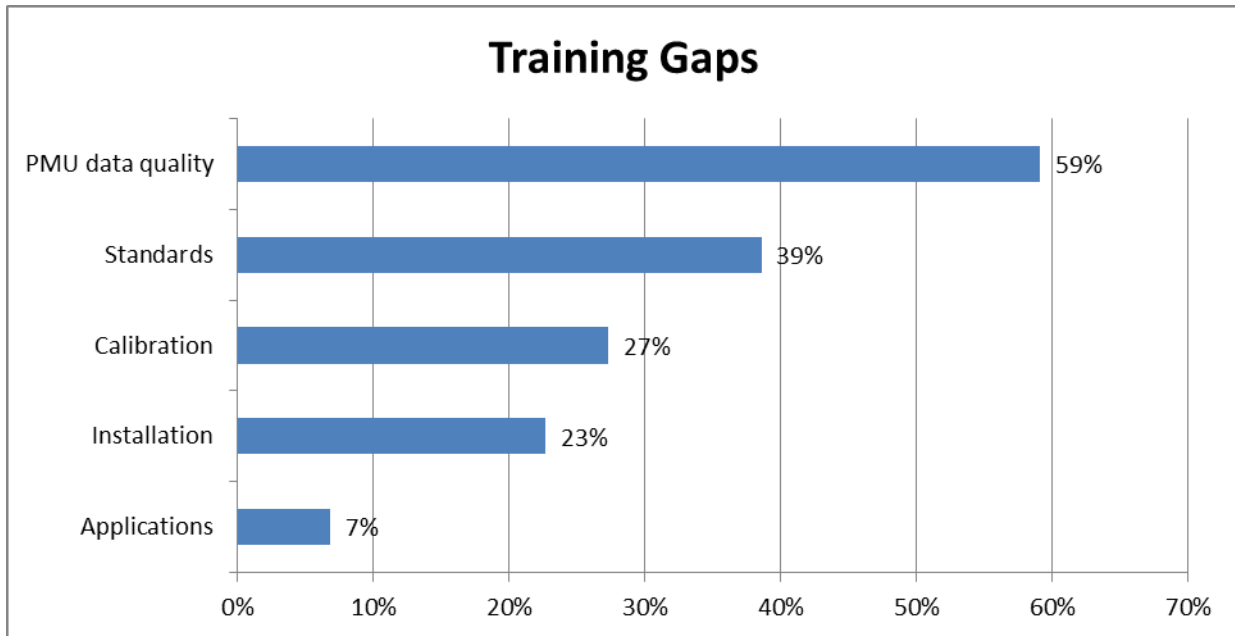
Response	Chart	Frequency	Count
1-5 hours per individual		27.8%	10
6-10 hours per individual		13.9%	5
More than 10 hours per individual		11.1%	4
Have not started training program		47.2%	17
Not Answered			8
		Mean	2.778
		Standard Deviation	1.312
		Valid Responses	36
		Total Responses	44

19: What training gaps in synchrophasor technology would you like to address with your staff?

The table below shows in order of responses the training gaps that respondents said they would like to address with their staff. Applications was specified by three respondents under “Other.”

Training Gaps	Percent	Count
PMU data quality	59%	26
Calibration	27%	12
Installation	23%	10
Standards	39%	17
Applications	7%	3
Other	9%	4

PMU data quality was identified by 59% of respondents as a training gap they would like to address. Standards ranked a distant second.



19: What training gaps in synchrophasor technology would you like to address with your staff? (Select all that apply.)

(Respondents were allowed to choose **multiple** responses)

Response	Chart	Frequency	Count
PMU data quality		59.1%	26
Calibration		27.3%	12
Installation		22.7%	10
Standards		38.6%	17
Other (please specify)		15.9%	7
		Valid Responses	44
		Total Responses	44



19: What training gaps in synchrophasor technology would you like to address with your staff? (Other, please specify.)

7 respondents specified other training gaps they would like to address with their staff. Three of the respondents identified applications as a gap.

Response	Responses
Application development	
Data interpretation and integration	
All of the above	
Application!	
Applications	
PMU data management	
Visualization software	
	7

20: Would you like a copy of these survey results?

(Respondents could only choose a **single** response)

Response	Chart	Frequency	Count
Yes [provide your email address]		72.5%	37
No		27.5%	14
Not Answered			4
	Mean		1.275
	Standard Deviation		0.451
	Valid Responses		51
	Total Responses		55



37 respondents said they would like a copy of the survey results and 30 provided an email address.

Survey Results Email Addresses
yardley@illinois.edu
luigiv@kth.se
snabors@me.com
esantos@huntpower.com
greg.hataway@powersouth.com
quigufrale@ieee.org
vmahesh009@gmail.com
dbrancaccio@bridgeenergygroup.com
maweekes@hydro.mb.ca
sam.chanoski@nerc.net
jay.giri@alstom.com
chris.leblanc@ni.com
tschorr@reflectionsoftware.com
mrfenimore@wecc.biz
farrokh.habibiashrafi@sce.com
mac@zglobal.biz
dnovosel@quanta-technology.com
panumpa1@illinois.edu
Megan.Vutsinas@duke-energy.com
tony.gomez@srpnet.com
martin@electricpowergroup.com
anthoony.napikoski@uinet.com
walkew@pjm.com
walter.sattinger@swissgrid.ch
kristin.kasschau@sce.com
sssternfeld@epri.com
aaron@enernex.com

Survey Results Email Addresses
bill_flerchinger@selinc.com
r.subramaniam@ieee.org
brent.blanchard@nypa.gov

21: Would you like to be contacted regarding synchrophasor training options?

(Respondents could only choose a **single** response)

Response	Chart	Frequency	Count
Yes [provide your email and phone number]		49.0%	24
No		51.0%	25
Not Answered			6
		Mean	1.510
		Standard Deviation	0.505
		Valid Responses	49
		Total Responses	55

24 respondents said they wanted to be contacted regarding synchrophasor training options and 19 provided contact information.

Synchrophasor Training Contact Information
yardley@illinois.edu
luigiv@kth.se
esantos@huntpower.com
aaron.fansler@ngc.com
greg.hataway@powersouth.com (334) 427-3281
vmahesh009@gmail.com
sam.chanoski@nerc.net
425-922-1072
chris.leblanc@ni.com
mrfenimore@wecc.biz 360-713-9028
farrokh.habibiashrafi@sce.com 714-934-0821
919 334 3010
217-819-9776
tony.gomez@srpnet.com 602 818-2398
714-659-3489
ssternfeld@epri.com 843-619-0050
aaron@enernex.com, 865.218.4600
r.subramaniam@ieee.org
brent.blanchard@nypa.gov

Conclusions

28% of respondents said their company neither uses nor does it plan to use phasor technology. Respondents represented companies with a wide variety of primary functions. Some of these functions such as vendors may not use synchrophasor technology in their work.

Respondents most likely to say they currently use phasor technology are affiliated with companies whose primary functions are:

- Generation Owner/Operator (90%)
- Transmission Owner/Coordinator (89%)
- Balancing Authority (70%)
- Reliability Coordinator (50%)

		1: What is your company's primary function? (Select all that apply.)							
		Reliability Coordinator	Transmission Owner/Coordinator	Generation Owner/Operator	Balancing Authority	Consultant	Vendor	Other	Total
Yes, we currently use phasor technology	Count	4	23	9	7	5	7	8	43
	% by Col	50.0%	88.5%	90.0%	70.0%	45.5%	41.2%	42.1%	42.6%
Yes, we plan to deploy and use phasor technology	Count	4	3	1	3	3	0	2	12
	% by Col	50.0%	11.5%	10.0%	30.0%	27.3%	0.0%	10.5%	11.9%
No, don't currently use or plan to use phasor technology	Count	0	0	0	0	3	10	9	21
	% by Col	0.0%	0.0%	0.0%	0.0%	27.3%	58.8%	47.4%	20.8%

Overall, operations staff appear to be the primary users of phasor technology. Respondents said real-time operations (51%) and operations engineering (42%) would be primary users. In addition more than 55% of respondents said these two groups would benefit from phasor technology training. However Transmission Owner/Coordinator respondents said protection engineering (86%) and planning (75%) would be primary users followed by operations engineering (67%) and real-time operations (55%). Balancing Authority respondents said planning (50%) would be the primary user of phasor technology.

		3: Who are or will be the primary users of phasor technology in your organization? (Select all that apply.)				
		Protection Engineering	Planning	Real-time Operations	Operations Engineering	Other (please specify)
Reliability Coordinator	Count	4	6	7	7	1
	% by Col	28.6%	37.5%	24.1%	29.2%	6.3%
Transmission Owner/Coordinator	Count	12	12	16	16	3
	% by Col	85.7%	75.0%	55.2%	66.7%	18.8%
Generation Owner/Operator	Count	5	6	7	8	1
	% by Col	35.7%	37.5%	24.1%	33.3%	6.3%
Balancing Authority	Count	5	8	7	9	2
	% by Col	35.7%	50.0%	24.1%	37.5%	12.5%
Consultant	Count	0	1	3	2	4
	% by Col	0.0%	6.3%	10.3%	8.3%	25.0%
Vendor	Count	0	0	2	0	3
	% by Col	0.0%	0.0%	6.9%	0.0%	18.8%
Other (please specify)	Count	2	1	5	3	5
	% by Col	14.3%	6.3%	17.2%	12.5%	31.3%

60% of respondents said they have installed or plan to install 50 or fewer PMUs.

73% of respondents said they have deployed or plan to deploy PMUs within the next three years.

Respondents have deployed or plan to deploy PMUs on a wide variety of Kv transmission voltages. The top three voltages include:

- 230 (38%)
- 500 (38%)
- 345 (25%)

52% of respondents said they have or plan to install PMUs on 50% or more of their high voltage substations.

83% of respondents said their phasor data is currently integrated into other applications or systems or that their long term plan is to integrate it. 23% of respondents said they have or would develop custom

systems to integrate phasor data. Respondents said they use a wide variety of vendor systems to integrate phasor data and while no vendor emerged as a leader, the two most popular were Alstom (18%) and OSIsoft (14%).

18% of respondents said they use a variety of stand-alone phasor data systems and systems are used by equal numbers of respondents.

60% of respondents said their company does not have a phasor technology business case for operations while 93% of respondents said they use or plan to use phasor technology for operations or for both operations and planning applications. This suggests a possible training need.

Three operations applications were selected by 60% or more of respondents as ones that they do or will use. 56% of respondents said they do not offer training to staff on applications that use synchrophasor data. In addition three respondents identified applications as a training gap they would like to address with their staff. These appear to be high value training options to address.

- Real-time visualization
- Voltage monitoring
- Oscillation monitoring

50% of respondents said they currently share phasor data and another 29% said they have plans to share their data.

More than 50% of respondents said they use three planning applications:

- System load modeling
- Generator modeling
- Contingency analysis

In addition more than 50% of respondents who identified their company's primary function as Reliability Coordinator, Transmission Owner/Coordinator, Generator Owner/Operator and Balancing Authority said planning would benefit from phasor technology training.

		1: What is your company's primary function? (Select all that apply.)						
		Reliability Coordinator	Transmission Owner/Coordinator	Generation Owner/Operator	Balancing Authority	Consultant	Vendor	Other (please specify)
Protection Engineering	Count	3	16	6	5	1	0	2
	% by Col	42.9%	76.2%	75.0%	55.6%	14.3%	0.0%	28.6%
Planning	Count	4	16	6	8	1	0	2
	% by Col	57.1%	76.2%	75.0%	88.9%	14.3%	0.0%	28.6%
Real-time Operations	Count	7	19	7	9	3	0	4
	% by Col	100.0%	90.5%	87.5%	100.0%	42.9%	0.0%	57.1%
Operations Engineering	Count	6	20	7	8	2	0	2
	% by Col	85.7%	95.2%	87.5%	88.9%	28.6%	0.0%	28.6%

55% of respondents said they do not provide phasor technology equipment training to their staff. 56% of respondents said they do not provide training to staff on applications that use synchrophasor data. 47% of respondents said their staff have not started a training program. These data suggest that there may be a need for training or a program to develop in-house trainers.

45% of respondents said they do provide phasor technology equipment training and 60% of this group said they use in-house developed classroom training, taught by internal staff or a consultant. 44% of respondents said they do provide training to staff on applications that use synchrophasor data and 60% said they provide it through in-house developed classroom training, taught by internal staff or a consultant. Classroom training appears to be the preferred training style.

PMU data quality was identified by respondents as the top training gap in synchrophasor technology. The table below shows by a company's primary function training gaps that were identified by 50% or more of respondents. Standards and calibration appear to be important gaps for some company types.

		1: What is your company's primary function? (Select all that apply.)						
		Reliability Coordinator	Transmission Owner/Coordinator	Generation Owner/Operator	Balancing Authority	Consultant	Vendor	Other (please specify)
PMU data quality	Count	4	12	5	7	5	1	5
	% by Col	66.7%	70.6%	71.4%	87.5%	71.4%	25.0%	71.4%
Calibration	Count	1	9	4	4	1	0	2
	% by Col	16.7%	52.9%	57.1%	50.0%	14.3%	0.0%	28.6%
Installation	Count	1	8	3	3	1	0	1
	% by Col	16.7%	47.1%	42.9%	37.5%	14.3%	0.0%	14.3%
Standards	Count	2	9	3	5	3	0	4
	% by Col	33.3%	52.9%	42.9%	62.5%	42.9%	0.0%	57.1%
Other (please specify)	Count	0	2	0	0	2	0	3
	% by Col	0.0%	11.8%	0.0%	0.0%	28.6%	0.0%	42.9%

Research, Research and Development, and Development (R&D) is a small audience but one that emerged repeatedly as a candidate for phasor technology training.

- 5% - Company's primary function
- 12% - primary users of phasor technology
- 10% - group that would benefit from phasor technology training

Recommendations

If this survey is repeated in the future or with another audience, some questions could be improved.

- Shorten the survey and ask fewer questions.
- Question 4: Fill in the blank questions – ask each question individually and provide respondents with a choice list.
- Question 5: Is your phasor data currently integrated into other applications or systems? – include an answer choice for “Don’t Know.”
- Question 9: Does your company have a phasor technology business case for operations? – include an answer choice for “Don’t Know.”

Target future surveys to audiences most likely to have phasor training needs.

Share survey results broadly and explain how findings will be used. This will encourage participation in other data gathering efforts as respondents and potential respondents understand the benefit they derive from answering the questions.

Training courses that could be offered that may appeal to a wide audience:

- Writing a phasor technology business case for operations
- PMU data quality
- Operations applications course to include:
 - Real-time visualization
 - Voltage monitoring
 - Oscillation monitoring
- Planning applications course to include:
 - System load modeling
 - Generator modeling
 - Contingency analysis
- Sharing phasor data

Most organizations that offer training do so classroom style. Consider offering a train-the-trainer course.

Follow-up with respondents who asked for survey results or asked to be contacted about training options.

Appendix 1 – Survey Questions

NASPI Synchrophasor Technology Training Survey

The objective of this survey is to identify existing and future synchrophasor technology training needs. You were selected to participate because of your membership in the Smart Grid community. Your answers are anonymous unless you explicitly provide your contact information and ask to be contacted regarding training options or to receive survey results. This survey should take 30 minutes to answer.

1. What is your company's primary function? (Select all that apply.)

- Reliability Coordinator
- Transmission Owner/Coordinator
- Generation Owner/Operator
- Balancing Authority
- Consultant
- Vendor
- Other (please specify) _____

2. Does your company use or is it planning to deploy and use phasor technology?

- Yes, we currently use phasor technology
- Yes, we plan to deploy and use phasor technology
- No, don't currently use or plan to use phasor technology >>>> Skip to Page 14: Would you like a copy of these survey results?

(End of Page 1)

3. Who are or will be the primary users of phasor technology in your organization? (Select all that apply.)

- Protection Engineering
- Planning
- Real-time Operations
- Operations Engineering
- Other (please specify) _____

4. Please provide the following information on your current or planned PMU deployment.

Number of PMUs installed and/or planned to be installed _____

Timeframe for PMU deployment (number of years) _____

Transmission voltage of installations (Kv) _____

Percent of HV (≥ 230 Kv) substations that will have PMUs (%) _____

5. Is your phasor data currently integrated into other applications or systems (e.g., PI, EMS)?

Yes, it is integrated >>>> Skip to Page 3: Which vendors' systems have you or will you integrate the phasor data into? (Select all that apply.)

No, it isn't integrated yet, but that is the long term plan >>>> Skip to Page 3: Which vendors' systems have you or will you integrate the phasor data into? (Select all that apply.)

No, it is stand-alone >>>> Skip to Page 4: Which phasor products are you feeding the phasor data to? (Select all that apply.)

(End of Page 2)

6. Which vendors' systems have you or will you integrate the phasor data into? (Select all that apply.)

- Alstom
- General Electric
- ABB
- Siemens
- Custom development
- Other _____

(End of Page 3)

7. Which phasor products are you feeding the phasor data to? (Select all that apply.)

- RTDMS
- PhasorPoint
- SEL's SynchroWAVE Central
- Custom development
- Other (please specify) _____

(End of Page 4)

8. Does your company use or plan to use phasor technology for operations applications and/or planning applications?

Operations >>>> Skip to Page 6: Does your company have a phasor technology business case for operations?

Planning >>>> Skip to Page 7: Which of these planning applications do you use? (Select all that apply.)

Both >>>> Skip to Page 6: Does your company have a phasor technology business case for operations?

(End of Page 5)

9. Does your company have a phasor technology business case for operations?

Yes

No

10. Which of these operations' applications do you or will you use? (Select all that apply.)

Real-time visualization

Line monitoring

Oscillation monitoring

Voltage monitoring

Automatic equipment controls

Other (please specify) _____

Advanced Branch: 8 Does your company use or plan to use phasor technology for operations application... = Operations; >>>> Skip to Page 8: Do you currently share phasor data with others such as neighboring utilities?

(End of Page 6)

11. Which of these planning applications do you use? (Select all that apply.)

- Generator modeling
- System load modeling
- SPS or RAS design
- Contingency analysis
- Other (please specify) _____

(End of Page 7)

12. Do you currently share phasor data with others such as neighboring utilities?

- Yes
- No, but we plan to share data when we deploy phasor technology
- No, we have no plans to share phasor data

(End of Page 8)

13. What groups in your company would benefit from phasor technology training? (Select all that apply.)

- Protection Engineering
- Planning
- Real-time Operations
- Operations Engineering
- Other (please specify) _____

14. Do you provide phasor technology equipment training to your staff (including communications)?

Yes >>>> Skip to Page 10: What styles of equipment training do you offer your staff? (Select all that apply.)

No >>>> Skip to Page 11: Do you provide training to your staff on applications that use synchrophasor data (e.g., oscillation detection, voltage angle difference, etc.)?

(End of Page 9)

15. What styles of equipment training do you offer your staff? (Select all that apply.)

- In-house developed classroom training, taught by internal staff or a consultant
- In-house developed simulator training, taught by internal staff or a consultant
- In-house or company-hired consultant-developed on-line training
- Commercial conference attendance
- NASPI conference attendance
- Give staff a set of material for self-directed research, including NASPI website material
- Phasor equipment vendor-supplied training material
- Training vendor-supplied training material
- Other (please specify) _____

(End of Page 10)

16. Do you provide training to your staff on applications that use synchrophasor data (e.g., oscillation detection, voltage angle difference, etc.)?

Yes >>>> Skip to Page 12: What kind of phasor application training do you provide to your staff? (Select all that apply.)

No >>>> Skip to Page 13: On average, how many hours of synchrophasor-related training did each of your staff receive in the last 12 months?

(End of Page 11)

17. What kind of phasor application training do you provide to your staff? (Select all that apply.)

In-house developed classroom training, taught by internal staff or a consultant

In-house or company-hired consultant-developed on-line training

Application vendor supplied training and materials

Training vendor supplied training materials

Simulator training

Other (please specify) _____

(End of Page 12)

18. On average, how many hours of synchrophasor-related training did each of your staff receive in the last 12 months?

- 1-5 hours per individual
- 6-10 hours per individual
- More than 10 hours per individual
- Have not started training program

19. What training gaps in synchrophasor technology would you like to address with your staff? (Select all that apply.)

- PMU data quality
- Calibration
- Installation
- Standards
- Other (please specify) _____

(End of Page 13)

20. Would you like a copy of these survey results?

- Yes [provide your email address] _____
- No

21. Would you like to be contacted regarding synchrophasor training options?

- Yes [provide your email and phone number] _____
- No

(End of Page 14)



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