TransGrid

TransGrid Revenue Proposal
2018/19 – 2022/23

Appendix M

UMS Group:

Benchmarking (ITOMS)

Overview

Data Revision Date: 28th Jan 2016

Charting Sheet Revision Date: 28th Jan 2016

Analysis Sheet Revision Date: 28th Jan 2016

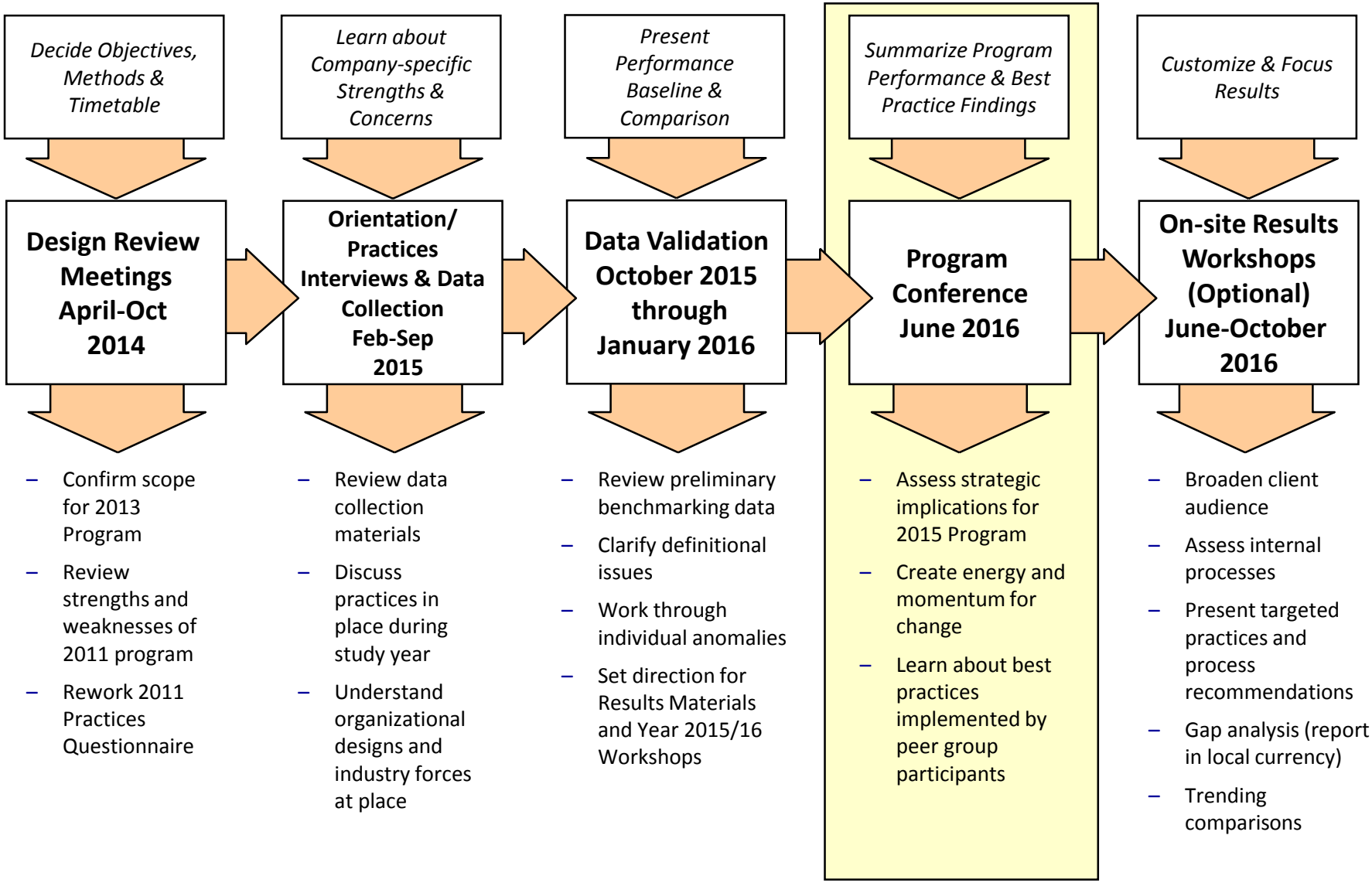
ITOMS Program Confidentiality Terms

- To protect the interests of UMS and other participating companies, each participating company shall treat as confidential all project information that is expressly marked as such, not to be distributed beyond the participating company's managers and employees who are bound by comparable confidentiality and nondisclosure agreements. In addition, all data collection materials, including but not limited to data questionnaires, practices questionnaires, process surveys, and documents describing UMS methodologies and processes are proprietary to UMS Group. Client agrees not to copy or distribute this material without prior written permission from UMS. Client also agrees to support UMS' confidentiality commitment by ensuring that participant codes are not shared or distributed in written, verbal, electronic, or any other form.
- All company data, reports, documents and any other materials received from each participating company that are agreed upon by the Executive Steering Committee and expressly marked as non-confidential may be used for open analysis that can be shared among member companies. If necessary, this non-confidential data can be made available by your company for public or regulatory review with prior written permission from UMS.

The ITOMS Consortium

The International Transmission Operations & Maintenance Study (ITOMS) was initiated in 1994 as a consortium of interested international transmission companies as a means of comparing performance and practices within the transmission industry worldwide. The consortium requested that UMS Group facilitate and provide program management and analysis expertise to conduct the study. The program has enabled in-depth comparisons to be made in this area, and has facilitated the exchange of information and ideas on performance improvements and innovative working practices. As a result of these mutually beneficial exchanges, the participants have a developing understanding of the best practices in their field.

This Meeting Is One in a Series of Individual and Group Workshops



The ITOMS Program Is Predicated On The Collection And Analysis Of Valid And Defensible Data

- The project was managed by UMS group for the consortium. UMS Group is a management consultancy whose expertise lies in performance measurement of the electric utility industry. UMS has led the ITOMS Program previously in 2013, 2011, 2009, 2007, 2005, 2003, 2001, 1999, 1997, 1995 and 1994.
- The ITOMS project was developed by a 4 member Steering Group, made up of employees of organizations representing each of the global regions involved. The Steering Group plays a significant role in creating and approves the final project scope, schedule, and data collection materials. The Steering Group members provided direction and oversight for the program and worked closely with UMS to resolve data validation and collection issues.
- All data was collected via the new data collection data pack approach as directed by the Steering Group
- Data collection was scheduled over a 5 month period. Historically, this has allowed participants sufficient time to collect data and, if they preferred, to use the most relevant financial year (as opposed to a strict calendar year).
- The ITOMS 2015 Program continued to employ (and enhance) a stringent QA/QC process developed during the 2001 program year. This process involves the Steering Group and external audits of UMS materials, and documented ITOMS process guides. All data submittals were documented for receipt and data versions were tracked using an automated document control format.
- During the Data Validation Process which was revised for the 2015 program, the Steering Group and UMS assessed the validity of the data submitted during the data collection period. This Validation Process involved conference calls with all participants to discuss a prepared list of concerns. Participants addressed all data validation concerns following the Validation process, prior to publishing final results.

The Global Reach of the ITOMS Membership

North America/ South America

TRS	Transelec
TVA	Tennessee Valley Authority
ISAC	ISA Colombia
ISAP	ISA Peru
CTP	CTEEP

Europe/Scandinavia

EGN	Energinet dk	NG	National Grid
FIN	Fingrid Oyj	REE	Red Eléctrica de España
LAN	Landsnet	REN	Rede Eléctrica Nacional, S.A.
TEN	Tennet		
SSE	SSE plc	TER	Terna S.p.A.
SVK	Svenska Kraftnat	AMP	Amprion
		ELE	ELES

Asia /Middle East/ Africa

ESK	ESKOM	SIC	Sichuan Power
TCO	TRANSCO	SHA	Shandong Power
EGA	EGAT	OET	OETC
PGI	PowerGrid India	GCC	GCCIA
TNB	Tenaga Nasional Berhad		

Australia/New Zealand

ECT	Electranet SA
PLQ	Powerlink Queensland
TAS	TasNetworks
TGD	TransGrid
WEP	Western Power

ITOMS Company Characteristics

Company	Market Supply System	Service Territory (km^2)	GWHr Transmitted
GCC	Independent System Operator – Energy Market	2,673,123	1,993
CTP	Independent System Operator – Energy Market	248,223	135,889
ELE	Nationalized Grid with Energy Market Pool	20,273	12,226
SVK	Nationalized Grid with Energy Market Pool	450,000	116,600
FIN	Independent System Operator – Energy Market	338,440	67,157
TEN	Privatized Generation and Transmission Systems	163,831	128,694
PGI	Nationalized Grid with Energy Market Pool	3,287,263	1,163,674
TER	Others	301,338	310,535
TVA	Others	207,199	169,051
EGA	Nationalized Generation and Transmission	513,120	177,580
OET	Others	228,000	26,790
WEP	Independent System Operator – Energy Market	255,064	18,197
EGN	Nationalized Grid with Energy Market Pool	43,094	43,317
REN	Privatized Generation and Transmission Systems	89,349	50,198
LAN	Nationalized Grid with Energy Market Pool	103	17,123
ISAP	Privatized Generation and Transmission Systems	877,163	37,924
SSE	Privatized Generation and Transmission Systems	55,167	5,670
TAS	Nationalized Generation and Transmission	64,519	10,210
NG	Independent System Operator – Energy Market	151,189	264,868
TNB	Nationalized Grid with Energy Market Pool	663	116,068
TRS	Independent System Operator – Energy Market	0	66,550
REE	Independent System Operator – Energy Market	504,645	266,853
TGD	Independent System Operator – Energy Market	802,986	64,000
PLQ	Nationalized Grid with Energy Market Pool	332,000	46,783
ISAC	Independent System Operator – Energy Market	611,196	45,030
ESK	Nationalized Grid with Energy Market Pool	1,221,037	234,092
ECT	Independent System Operator – Energy Market	200,000	11,952
TCO	Privatized Generation and Transmission Systems	108,035	62,441
SIC	Nationalized Grid with Energy Market Pool	486,000	204,600
SHA	Nationalized Grid with Energy Market Pool	157,800	386,256
AMP	Others	73,100	191,000

ITOMS Asset Characteristics

Company	Overhead Line Transmission Structures	Overhead Line Transmission Circuit Km	Circuit Ends	Substation & Switching Stations	3 Phase Equivalent Transformers	Breakers
GCC	1,744	1,724	56	8	6	83
CTP	29,959	18,797	1,401	169	269	1,709
ELE	7,184	2,884	298	34	27	322
SVK	50,296	15,049	480	154	22	722
FIN	47,924	14,495	1,057	113	72	1,100
TEN	24,753	18,328	2,266	432	285	2,688
PGI	206,635	116,041	3,221	228	457	4,717
TER	179,489	61,733	5,977	684	659	4,887
TVA	104,748	26,358	1,937	511	216	2,944
EGA	56,287	31,734	2,660	318	582	3,330
OET	7,644	5,088	459	75	152	631
WEP	32,007	7,443	946	155	334	991
EGN	6,439	2,545	655	173	189	815
REN	18,005	8,528	1,346	99	199	1,383
LAN	17,055	3,274	336	75	25	336
ISAP	17,135	10,512	434	89	78	541
SSE	11,251	4,787	524	117	201	404
TAS	7,726	3,540	354	67	114	353
NG	21,579	14,099	2,969	474	794	2,519
TNB	32,201	21,621	4,076	623	1,178	4,497
TRS	22,282	9,836	505	474	77	521
REE	77,302	39,936	4,753	625	158	5,050
TGD	37,631	13,174	1,268	110	201	1,508
PLQ	24,539	15,041	1,128	169	193	1,302
ISAC	15,867	10,249	440	68	58	493
ESK	79,695	29,896	2,512	248	478	3,138
ECT	13,659	5,588	495	88	158	476
TCO	8,333	6,284	1,094	144	407	1,770
SIC	18,712	11,118	773	44	83	1,101
SHA	11,919	5,966	736	33	69	899
AMP	18,273	10,644	1,250	205	280	1,294

The ITOMS Framework Provides Comprehensive And Understandable Measures Of Performance Across Cost And Service Level In Several Key Sub-Areas Of Your Transmission Business To Give An Accurate And Detailed Assessment Of Performance

Measurement Framework: Transmission Maintenance

Activity	Productivity Measures	Service Level Measure
Overhead Line Maintenance 60-99kV	• Overhead Line Maintenance Spending 60-99kV Per Circuit Km • Overhead Line Maintenance Spending 60-99kV Per Equivalent Circuit Km* • Overhead Line Maintenance Spending 60-99kV Spending Per Structure • Overhead Line Maintenance Spending 60-99kV Spending Per Equivalent Structure	• 60-99kV Overhead Line Forced and Fault Outages Per 60-99kV Circuit Km* • 60-99kV Overhead Line Forced and Fault Outages Per 60-99kV Structure
Overhead Line Maintenance 100-199kV	• Overhead Line Maintenance Spending 100-199kV Per Circuit Km • Overhead Line Maintenance Spending 100-199kV Per Equivalent Circuit Km* • Overhead Line Maintenance Spending 100-199kV Spending Per Structure • Overhead Line Maintenance Spending 100-199kV Spending Per Equivalent Structure	• 100-199kV Overhead Line Forced and Fault Outages Per 100-199kV Circuit Km* • 100-199kV Overhead Line Forced and Fault Outages Per 100-199kV Structure
Overhead Line Maintenance 200-399kV	• Overhead Line Maintenance Spending 200-399kV Per Circuit Km • Overhead Line Maintenance Spending 200-399kV Per Equivalent Circuit Km* • Overhead Line Maintenance Spending 200-399kV Spending Per Structure • Overhead Line Maintenance Spending 200-399kV Spending Per Equivalent Structure	• 200-399kV Overhead Line Forced and Fault Outages Per 200-399kV Circuit Km* • 200-399kV Overhead Line Forced and Fault Outages Per 200-399kV Structure *
Overhead Line Maintenance +400kV	• Overhead Line Maintenance Spending +400kV Per Circuit Km • Overhead Line Maintenance Spending +400kV Per Equivalent Circuit Km* • Overhead Line Maintenance Spending +400kV Spending Per Structure • Overhead Line Maintenance Spending +400kV Spending Per Equivalent Structure	• +400kV Overhead Line Forced and Fault Outages Per +400kV Circuit Km* • +400kV Overhead Line Forced and Fault Outages Per +400kV Structure *

ITOMS Framework Continued

Measurement Framework: Transmission Maintenance Continued

Activity	Productivity Measures	Service Level Measure
Patrol & Inspection 60-99kV	• Patrol & Inspection Spending 60-99kV Per Circuit Km • Patrol & Inspection Spending 60-99kV Per Equivalent Circuit Km* • Patrol & Inspection Spending 60-99kV Spending Per Structure • Patrol & Inspection Spending 60-99kV Spending Per Equivalent Structure	• 60-99kV Overhead Line Forced and Fault Outages Per 60-99kV Circuit Km* • 60-99kV Overhead Line Forced and Fault Outages Per 60-99kV Structure
Patrol & Inspection 100-199kV	• Patrol & Inspection Spending 100-199kV Per Circuit Km • Patrol & Inspection Spending 100-199kV Per Equivalent Circuit Km* • Patrol & Inspection Spending 100-199kV Spending Per Structure • Patrol & Inspection Spending 100-199kV Spending Per Equivalent Structure	• 100-199kV Overhead Line Forced and Fault Outages Per 100-199kV Circuit Km* • 100-199kV Overhead Line Forced and Fault Outages Per 100-199kV Structure
Patrol & Inspection 200-399kV	• Patrol & Inspection Spending 200-399kV Per Circuit Km • Patrol & Inspection Spending 200-399kV Per Equivalent Circuit Km* • Patrol & Inspection Spending 200-399kV Spending Per Structure • Patrol & Inspection Spending 200-399kV Spending Per Equivalent Structure	• 200-399kV Overhead Line Forced and Fault Outages Per 200-399kV Circuit Km* • 200-399kV Overhead Line Forced and Fault Outages Per 200-399kV Structure *
Patrol & Inspection +400kV	• Patrol & Inspection Spending +400kV Per Circuit Km • Patrol & Inspection Spending +400kV Per Equivalent Circuit Km* • Patrol & Inspection Spending +400kV Spending Per Structure • Patrol & Inspection Spending +400kV Spending Per Equivalent Structure	• +400kV Overhead Line Forced and Fault Outages Per +400kV Circuit Km* • +400kV Overhead Line Forced and Fault Outages Per +400kV Structure *

ITOMS Framework Continued

Measurement Framework: Transmission Maintenance Continued

Activity	Productivity Measures	Service Level Measure
Vegetation Maintenance	• Vegetation Maintenance Spending Per Vegetation Exposed Hectare • Vegetation Maintenance Spending Per Equivalent Vegetation Exposed Hectare • Vegetation Maintenance Spending Per Vegetation Maintained Hectare • Vegetation Maintenance Spending Per Equivalent Vegetation Maintained Hectare	• Vegetation Caused Forced and Fault Outages Per Vegetation Exposed Hectare • Vegetation Caused Forced and Fault Outages Per Vegetation Maintained Hectare

Measurement Framework: Substation Operations and Maintenance

Activity	Productivity Measures	Service Level Measure
Protection Maintenance	• Protection Maintenance Spending Per Scheme • Protection Maintenance Spending Per Equivalent Scheme	• Protection Related Forced and Fault Outages Per Scheme*
Circuit Breaker Maintenance – 60-99kV	• Circuit Breaker Maintenance Spending 60-99kV Per Breaker • Circuit Breaker Maintenance Spending 60-99kV Per Equivalent Breaker	• 60-99kV Circuit Breaker Forced and Fault Outages Per 60-99kV Breaker*
Circuit Breaker Maintenance – 100-199kV	• Circuit Breaker Maintenance Spending 100-199kV Per Breaker • Circuit Breaker Maintenance Spending 100-199kV Per Equivalent Breaker	• 100-199kV Circuit Breaker Forced and Fault Outages Per 100-199kV Breaker*
Circuit Breaker Maintenance – 200-399kV	• Circuit Breaker Maintenance Spending 200-399kV Per Breaker • Circuit Breaker Maintenance Spending 200-399kV Per Equivalent Breaker	• 200-399kV Circuit Breaker Forced and Fault Outages Per 200-399kV Breaker*
Circuit Breaker Maintenance – +400kV	• Circuit Breaker Maintenance Spending +400kV Per Breaker • Circuit Breaker Maintenance Spending +400kV Per Equivalent Breaker	• +400kV Circuit Breaker Forced and Fault Outages Per +400kV Breaker*

ITOMS Framework Continued

Measurement Framework: Substation Operations and Maintenance Continued

Activity	Productivity Measures	Service Level Measure
Transformer Maintenance – 60-99kV	• Transformer Maintenance Spending 60-99kV Per Transformer • Transformer Maintenance Spending 60-99kV Per Equivalent Transformer	• 60-99kV Transformer Forced and Fault Outages Per 60-99kV Transformer*
Transformer Maintenance – 100-199kV	• Transformer Maintenance Spending 100-199kV Per Transformer • Transformer Maintenance Spending 100-199kV Per Equivalent Transformer	• 100-199kV Transformer Forced and Fault Outages Per 100-199kV Transformer*
Transformer Maintenance – 200-399kV	• Transformer Maintenance Spending 200-399kV Per Transformer • Transformer Maintenance Spending 200-399kV Per Equivalent Transformer	• 200-399kV Transformer Forced and Fault Outages Per 200-399kV Transformer*
Transformer Maintenance – +400kV	• Transformer Maintenance Spending +400kV Per Transformer • Transformer Maintenance Spending +400kV Per Equivalent Transformer	• +400kV Transformer Forced and Fault Outages Per +400kV Transformer*
Instrument Transformer Maintenance	• Instrument Transformer Maintenance Spending Per Instrument Transformer • Instrument Transformer Maintenance Spending Per Equivalent Instrument Transformer	• Instrument Transformer Related Forced and Fault Outages Per Instrument Transformer *
Compensation Equipment Maintenance	• Compensation Equipment Maintenance Spending Per Compensation Device • Compensation Equipment Maintenance Spending Per Equivalent Compensation Device	• Compensation Equipment Related Forced and Fault Outages Per Compensation Device*
Switches Maintenance	• Switches Maintenance Spending Per Switch • Switches Maintenance Spending Per Equivalent Switch	• Switches Related Forced and Fault Outages Per Switch*
Substation Site and Auxiliary Equipment Maintenance	• Substation Site Maintenance Spending Per Circuit End • Auxiliary Equipment Maintenance Spending Per Circuit End	• Auxiliary Equipment Forced and Fault Outages Per Circuit End* • Auxiliary Equipment Forced and Fault Outages Per Substation and Switching Station

Description of Outliers

- "Outliers" are data points on a chart that are outside the peer group range. An outlier may be a high or low outlier. Being marked as an outlier does not mean that the data is suspect, but rather that it is either so high or so low that it skews the average.
- The criteria for determining whether a data point is an outlier is if the one data point can significantly alter the average, will extend the chart such that it is difficult to read the majority of the data points which end up squeezed together, or that are more than two standard deviations from the average.

Composite Benchmark Methodology

Each company's composite benchmark position is derived by calculating a composite cost score (ranging from 0 to 2, where a 2 is indicative of high cost) and a composite service level score (ranging from 0 to 2, where 2 is indicative of strong service level performance).

Calculating the Composite Cost Score for each sub-function:

For each sub-functional area included in the scatter (e.g. the Overhead Transmission Line Maintenance composite benchmark includes Overhead Line Patrol & Inspection 60-99 kV, 100-199 kV, 200-399 kV +400 kV, Overhead Line Maintenance 60-99 kV, 100-199 kV, 200-399 kV and +400 kV, and Vegetation Maintenance), the cost per unit for that sub-function is converted into a 0 to 2 score. The relative 0 to 2 score is calculated by comparing the company's cost per unit metric against the metrics of the rest of the peer group. The highest cost per unit company will receive a 2 score and the lowest cost per unit company will receive a 0 score. All other companies will be spread out on the scale between this 0 and 2 range.

Calculating the Composite Service Level Score for each sub-function:

Similar to the composite cost calculation, a composite service level score is calculated for each sub-functional area included in the composite benchmark scatter (e.g. the Overhead Transmission Line Maintenance composite benchmark includes Overhead Line Patrol & Inspection 60-99kV, 100-199 kV and 200+ kV, Overhead Line Maintenance 60-99kV, 100-199 kV and 200+ kV, and Right-of-Way Maintenance). The service level metric for each sub-function is converted into a relative score on a 0 to 2 scale, where 2 indicates strong service level performance. Again, this relative 0 to 2 score is calculated by comparing the company's service level performance for a particular sub-function vs. the performance of the rest of the peer group. The company with the strongest service level performance will receive a 2 score and the company with the worst service level performance will receive a 0 score. All other companies will be spread out on the scale between this 0 and 2 range.

Composite Benchmark Methodology – Continued

Calculating the Overall Composite Cost Score for each company:

Once a 0 to 2 cost score is calculated for each sub-function , an overall composite score (again on a 0 to 2 scale) is calculated by weighting each individual cost composite score by that sub-function's relative importance, based on percentage of total cost. (Please note: if a company has some costs for a sub-function, but does not have a cost per unit score (indicating that workload was not reported), this sub-function will not be weighted in the calculation). The 2005 program added a second view of the composite that takes a straight average (non-weighted) of each individual cost composite score.

This is an Overall Relative comparison based upon each company's spend for their assets. There is not a specific dollar value gap between each value, it is a relative position.

There is no linear relationship between values. This is a topographical mapping of a relationship relative to the rankings, not the data.

Calculating the Overall Composite Service Level Score for each company:

Once a 0 to 2 service level score is calculated for each sub-function , an overall composite score (again on a 0 to 2 scale) is calculated by weighting each individual service level composite score by that sub-function's relative importance, based on percentage of total cost. (Please note: if a company has some costs for a sub-function, but does not have a service level score (indicating that workload was not reported), this sub-function will not be weighted in the calculation). The 2005 program added a second view of the composite that takes a straight average (non-weighted) of each individual service level composite score.

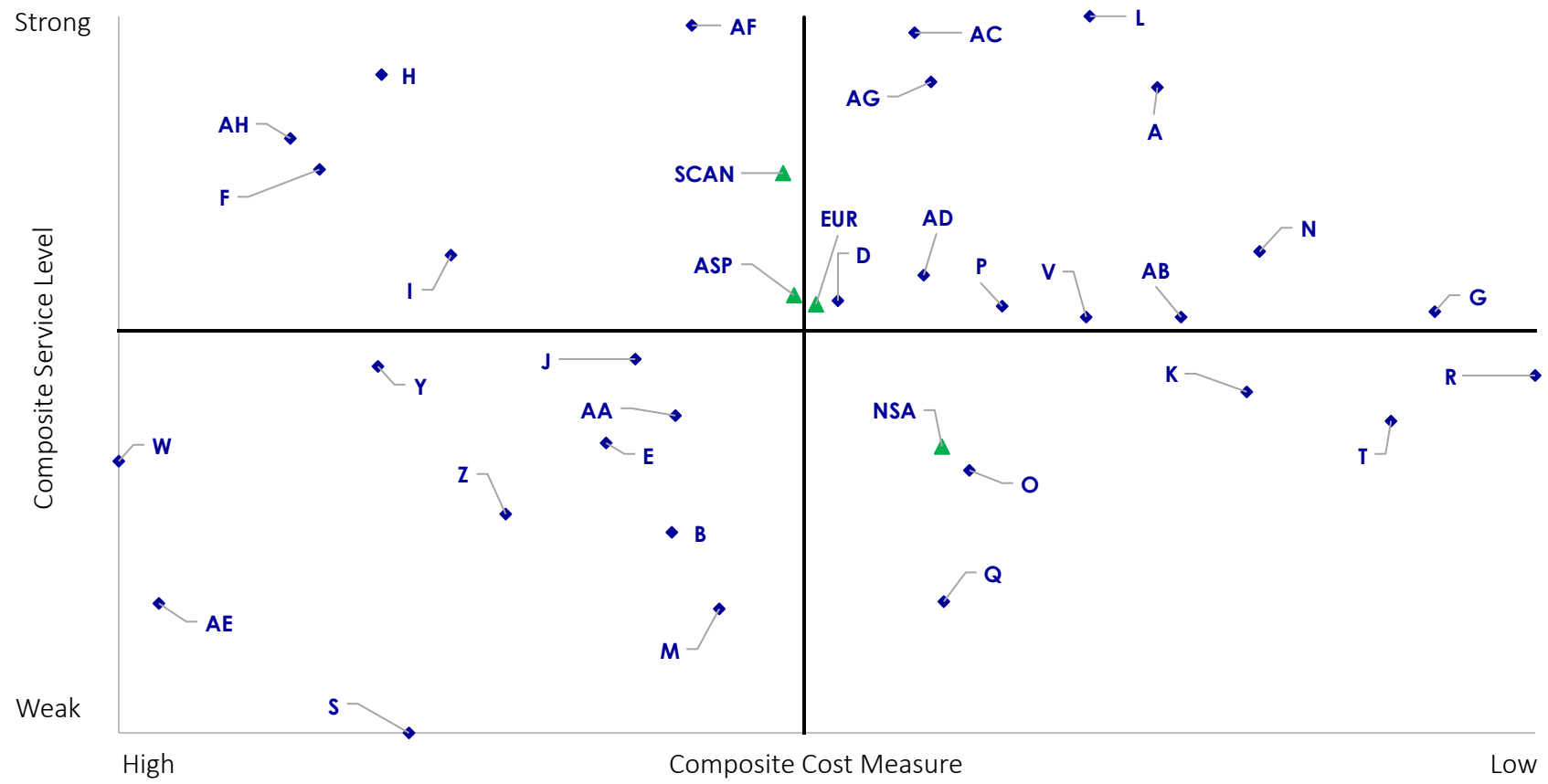
This is an Overall Relative comparison based upon each company's spend for their assets. There is not a specific dollar value gap between each value, it is a relative position.

There is no linear relationship between values. This is a topographical mapping of a relationship relative to the rankings, not the data.

Transmission Line Maintenance Composite Benchmark – Weighted Average**

**Weighted average indicates that each sub-function component score was weighted by the % spend in that sub-function. See methodology in Overview pages 14-15.

Overhead Transmission Line Maintenance Composite Performance Scatter Plot*

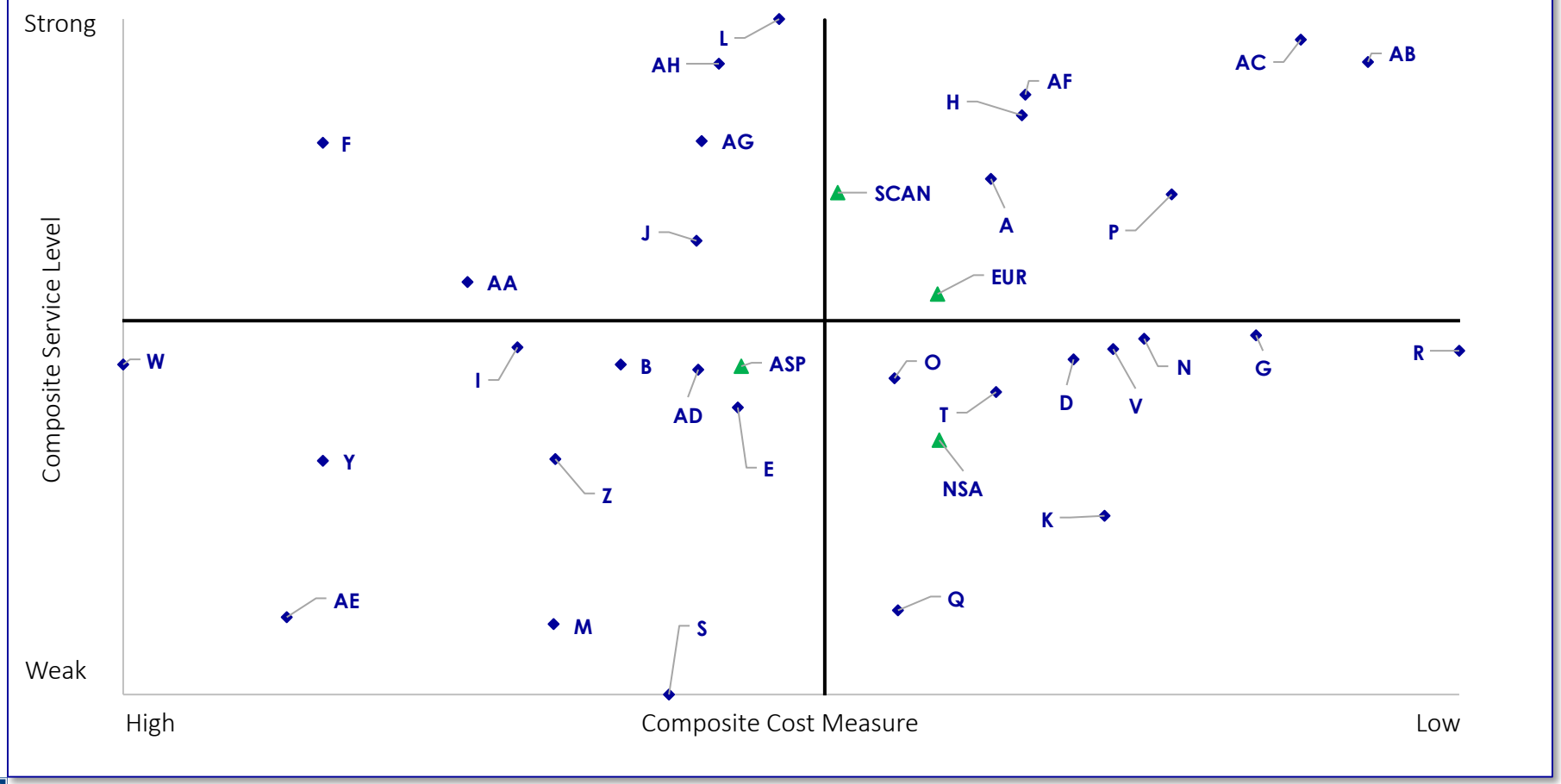


*Includes Overhead Line Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV, 200-399kV and +400kV and Vegetation Management

Transmission Line Maintenance Composite Benchmark – Non-Weighted Average**

**Non-weighted average indicates that a straight average was taken of each sub-function component score. See methodology in Overview pages 14-15.

Overhead Transmission Line Maintenance Composite Performance Scatter Plot*

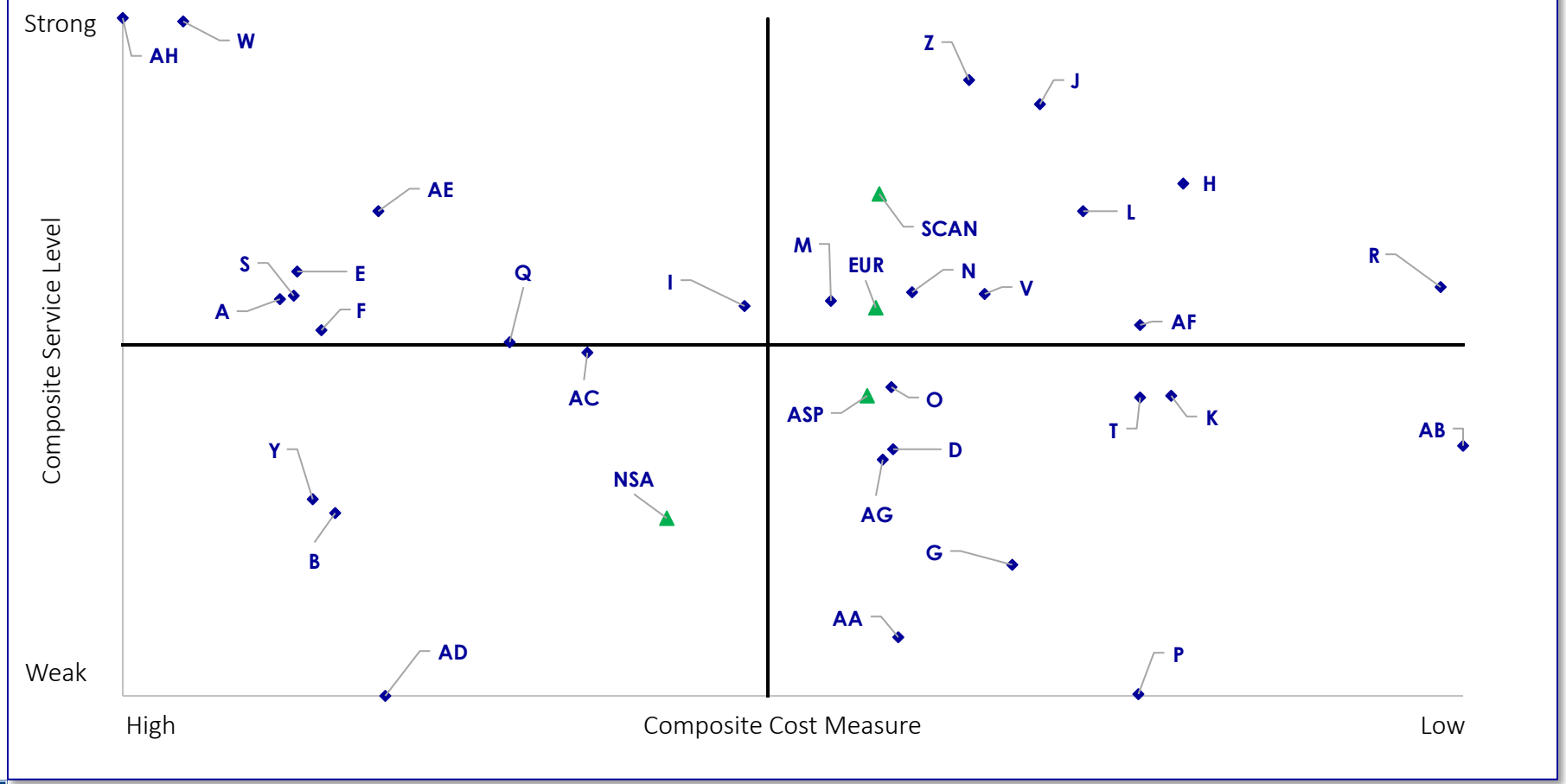


*Includes Overhead Line Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV, 200-399kV and +400kV and Vegetation Management

Substation Maintenance Composite Benchmark – Weighted Average**

**Weighted average indicates that each sub-function component score was weighted by the % spend in that sub-function. See methodology in Overview pages 14-15.

Substation Maintenance Composite Performance Scatter Plot*

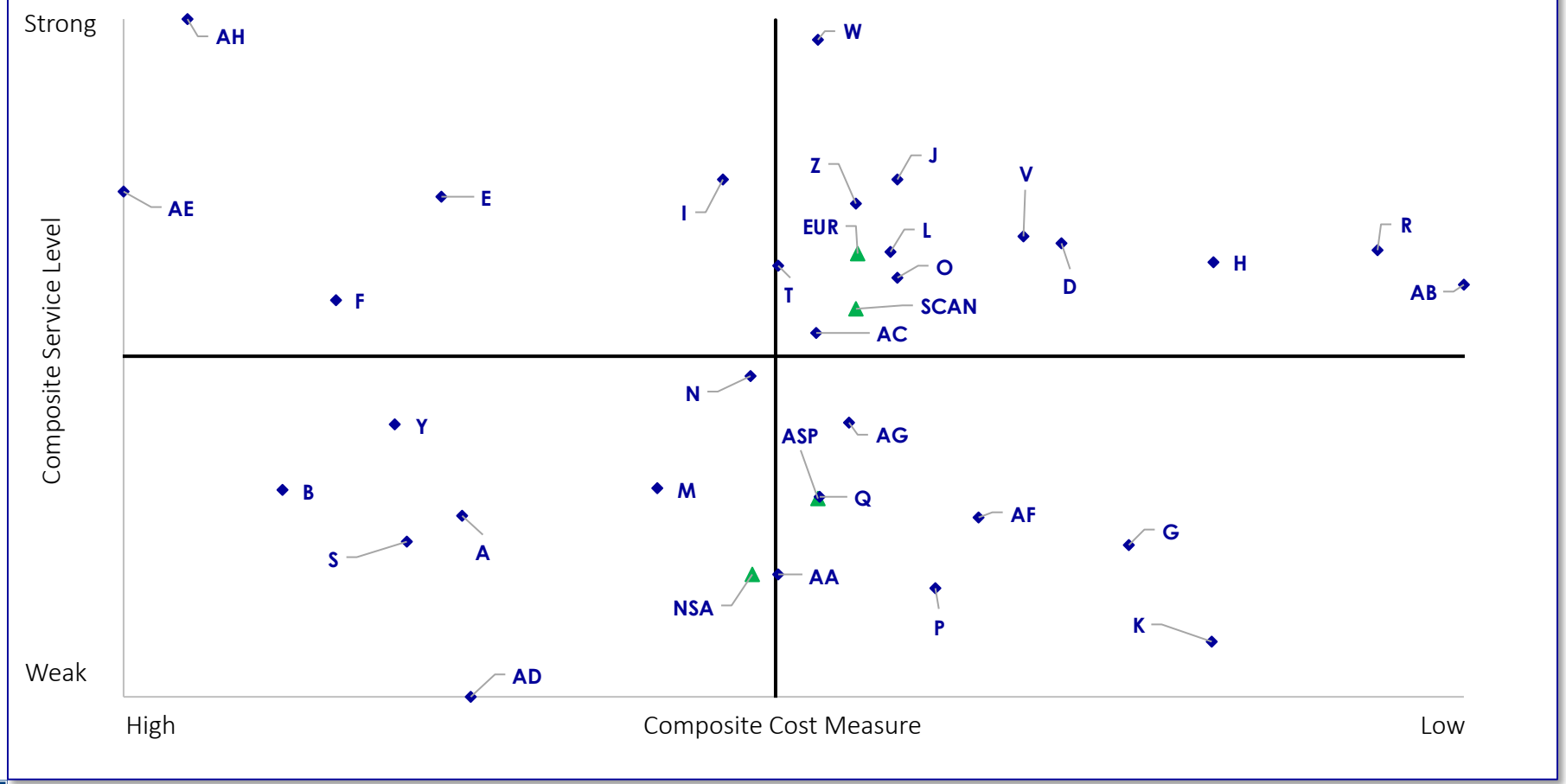


*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Substation Maintenance Composite Benchmark – Non-Weighted Average**

**Non-weighted average indicates that a straight average was taken of each sub-function component score. See methodology in Overview pages 14-15.

Substation Maintenance Composite Performance Scatter Plot*

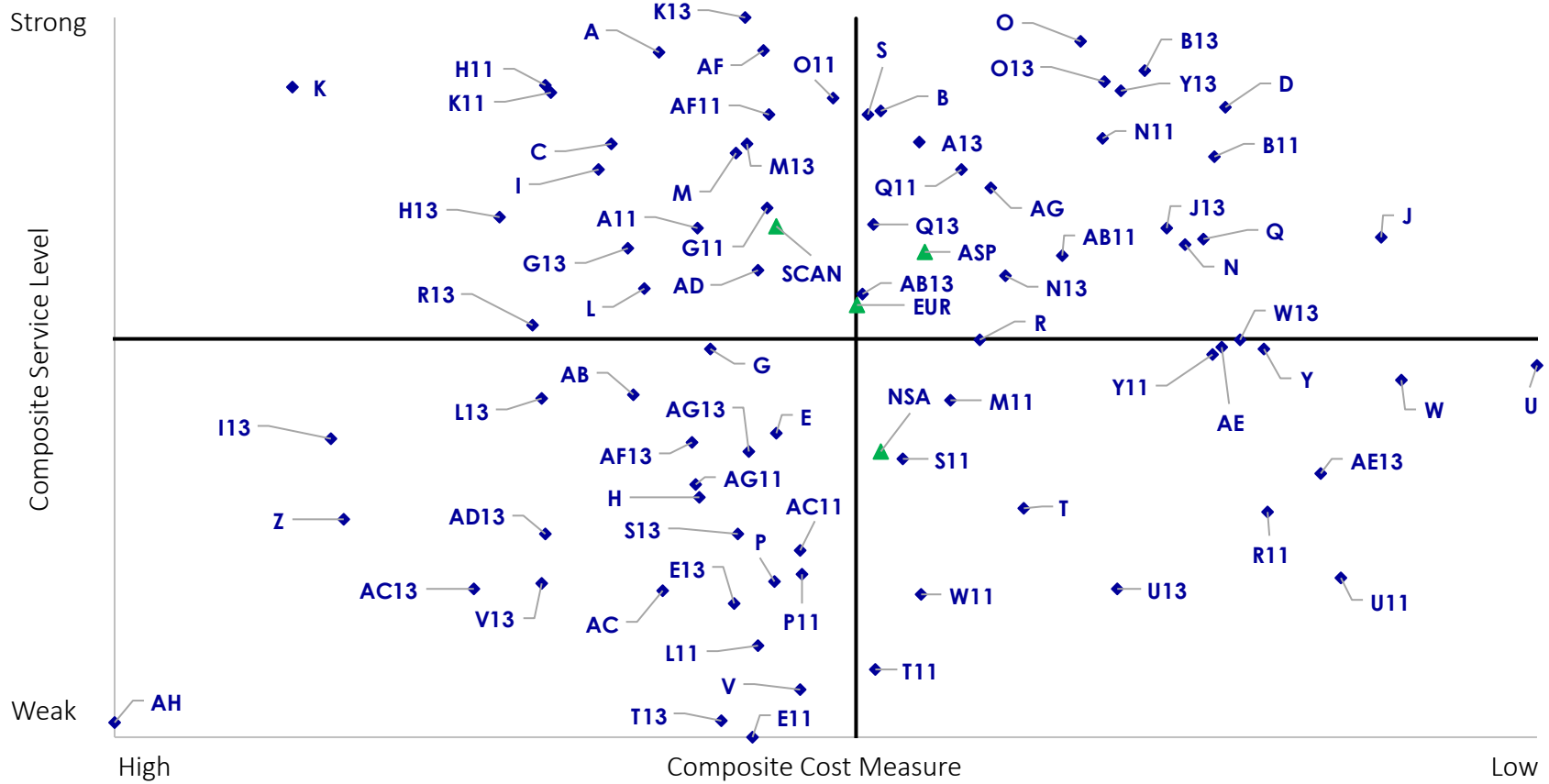


*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Transmission Line Trend – Weighted Average**

Data points with no year reference code represent the current study year
**Weighted average indicates that each sub-function component score was weighted by the % spend in that sub-function. See methodology in Overview pages 14-15 and sample calculation in Appendix page 5.

Overhead Transmission Line Maintenance Trend Composite Performance Scatter Plot*



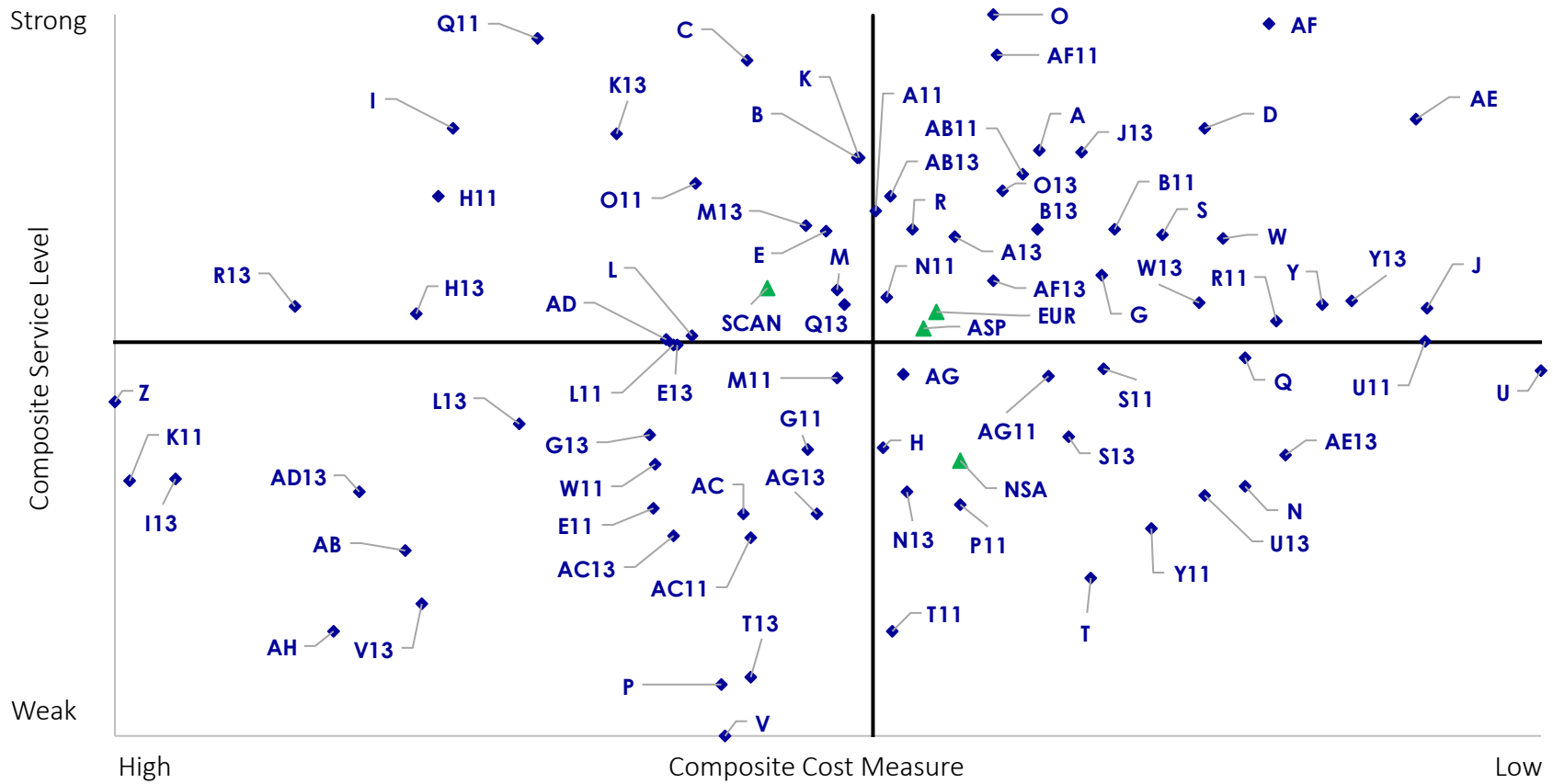
Note: Relative performance for each year recalculated using original data and current program measurement protocols.

*Includes Overhead Line Maintenance 60-99kV, 100-199kV and +200kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV and +200kV and Vegetation Management

Transmission Line Trend – Non-Weighted Average**

Data points with no year reference code represent the current study year
**Non-weighted average indicates that a straight average was taken of each sub-function component score. See methodology in Overview pages 14-15.

Overhead Transmission Line Maintenance Trend Composite Performance Scatter Plot*



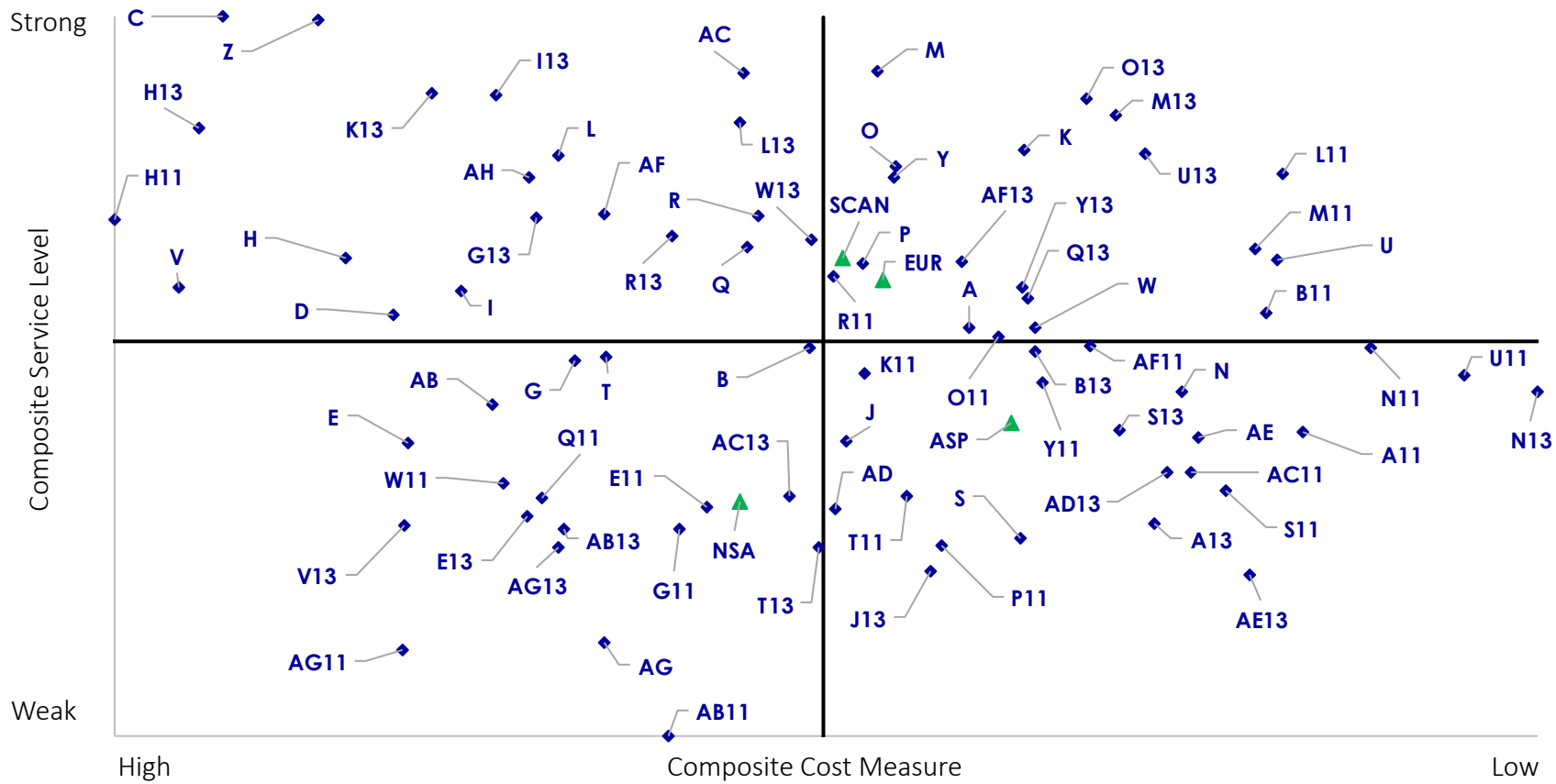
Note: Relative performance for each year recalculated using original data and current program measurement protocols.

*Includes Overhead Line Maintenance 60-99kV, 100-199kV and +200kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV and +200kV and Vegetation Management

Substation Trend – Weighted Average**

Data points with no year reference code represent the current study year
**Weighted average indicates that each sub-function component score was weighted by the % spend in that sub-function. See methodology in Overview pages 14-15 and sample calculation in Appendix page 5.

Substation Maintenance Trend Composite Performance Scatter Plot*



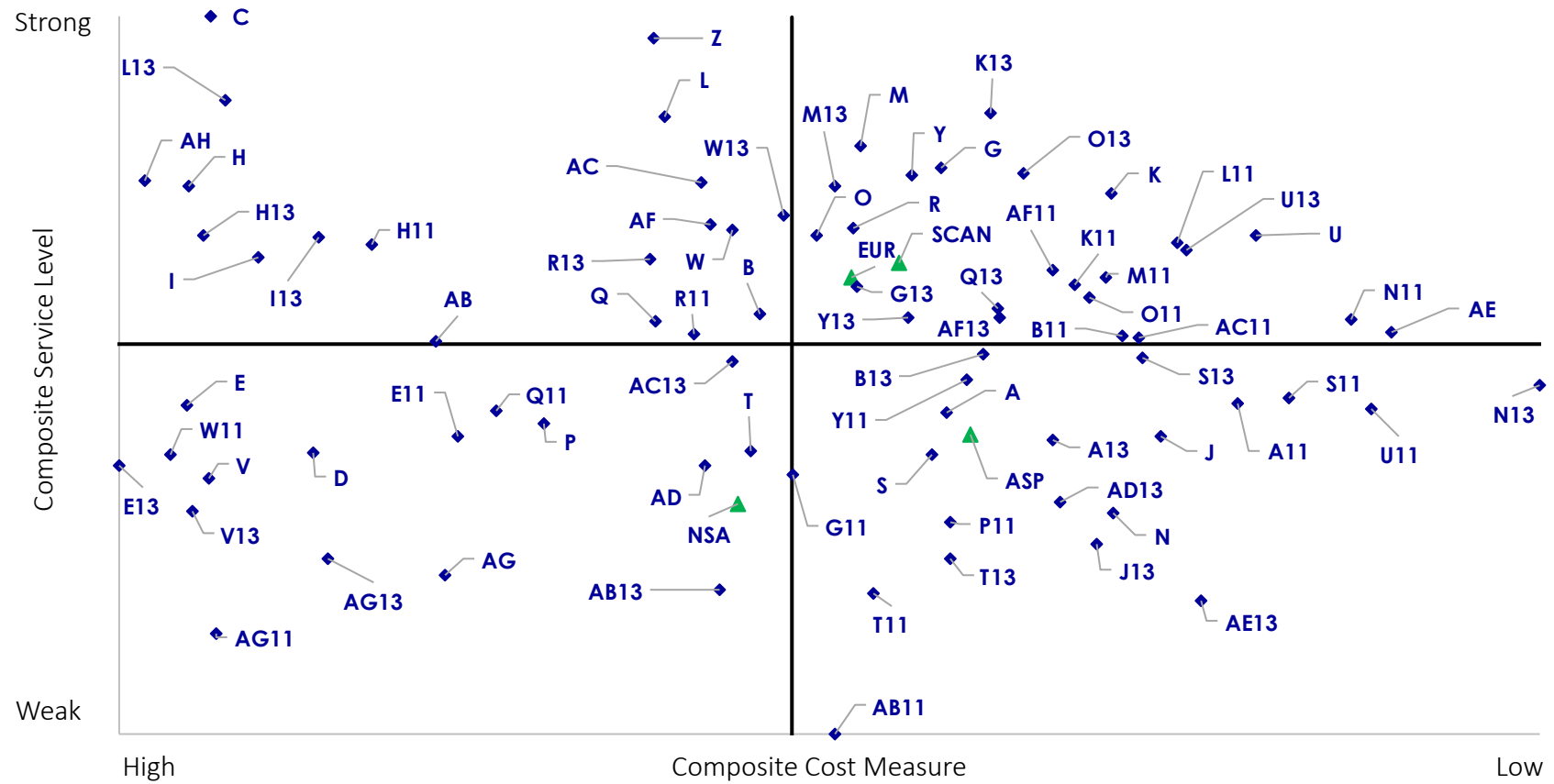
Note: Relative performance for each year recalculated using original data and current program measurement protocols.

*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV and +200kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Substation Trend – Non-Weighted Average**

Data points with no year reference code represent the current study year
**Non-weighted average indicates that a straight average was taken of each sub-function component score. See methodology in Overview pages 14-15.

Substation Maintenance Trend Composite Performance Scatter Plot*



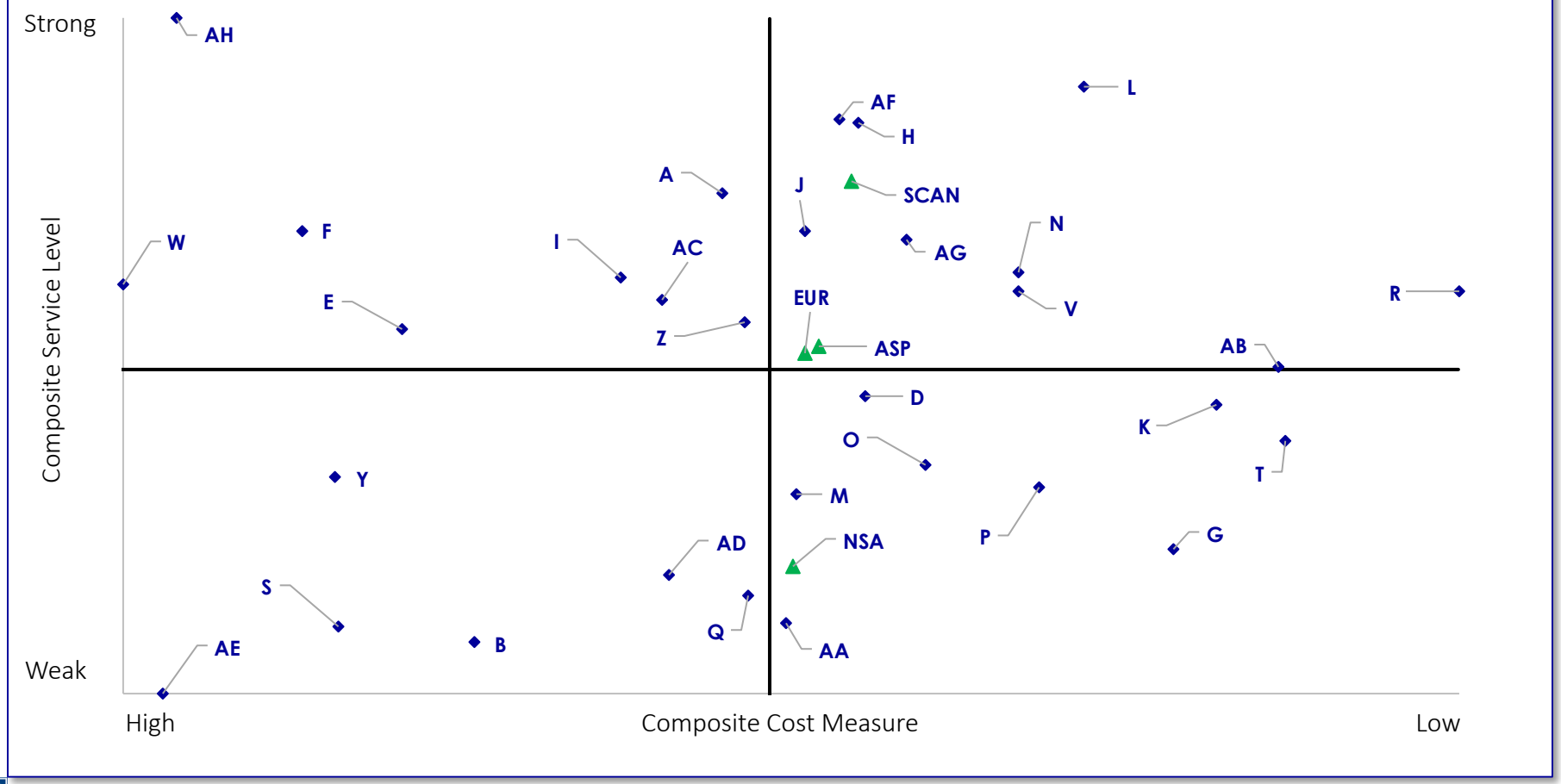
Note: Relative performance for each year recalculated using original data and current program measurement protocols.

*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV and +200kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Overall Composite Benchmark – Weighted Average**

**Weighted average indicates that each sub-function component score was weighted by the % spend in that sub-function. See methodology in Overview pages 14-15 and sample calculation in Appendix page 5.

Overall Composite Performance Scatter Plot*

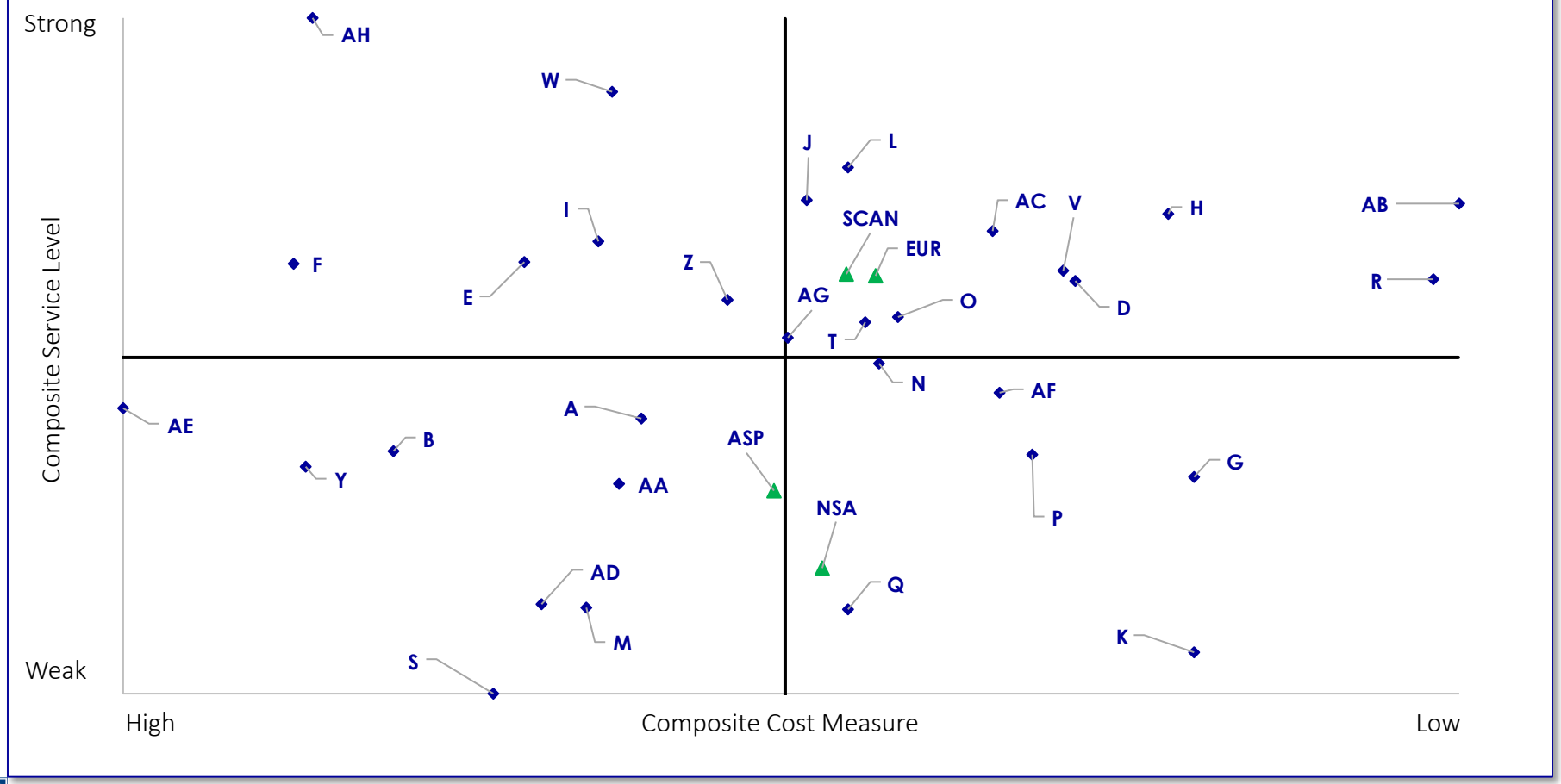


*Includes Vegetation Management, Protection Maintenance, OHL Maintenance, OHL Patrol and Inspection, Breaker and Transformer Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Overall Composite Benchmark– Non-Weighted Average**

**Non-weighted average indicates that a straight average was taken of each sub-function component score. See methodology in Overview pages 14-15.

Overall Composite Performance Scatter Plot*



*Includes Vegetation Management, Protection Maintenance, OHL Maintenance, OHL Patrol and Inspection, Breaker and Transformer Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Transmission Line – Overall Top Performing Companies

Tennessee Valley Authority, Energinet, & Transgrid

Patrol & Inspect Top Performers

P & I Overall
- Scottish & Southern
- Tennessee Valley Authority

+ 400 KV
- Transgrid
- Scottish & Southern
- Fingrid
- Svenska Kraftnet

200 to 399 KV
- Tennessee Valley Authority
- Energinet
- Scottish & Southern

100 to 199 KV
- Energinet
- Transgrid
- Tennessee Valley Authority

60 to 99 KV
- ESKOM
- Tennessee Valley Authority

Vegetation Management Top Performers
- Electranet
- Fingrid
- REN
- Shandong Power
- Svenska Kraftnet

Tower Painting Low Cost Performer
- Tennet
- Shandong Power
- Sichuan Power

Line Maintenance Top Performers

OHLM Overall
- Fingrid
- Transgrid

+ 400 KV
- Transgrid
- Fingrid
- National Grid

200 to 399 KV
- Scottish & Southern
- Tennessee Valley Authority
- Fingrid
- National Grid

100 to 199 KV
- Energinet
- Transgrid
- Fingrid

60 to 99 KV
- Tennessee Valley Authority
- ESKOM
- Power Grid India

Substation – Overall Top Performing Companies

TRANSCO, TERNA, Amprion, & Tennessee Valley Authority

Circuit Breaker Top Performers

CB Overall
- TRANSCO
- AMPRION
- Sichuan Power

+ 400 KV
- TRANSCO
- Fingrid
- ISAP
- Sichuan Power

200 to 399 KV
- TRANSCO
- AMPRION
- Sichuan Power

100 to 199 KV
- TRANSCO
- ISAC
- AMPRION

60 to 99 KV
- Electranet
- CTEEP
- Tennessee Valley Authority

Protection Maintenance Top Performers
- TERNA
- REE
- Shandong Power

Instrument Transformer Top Performers
- TERNA
- EGAT
- TRANSCO

Switch Top Performers
- TRANSCO
- Landsnet
- Sichuan Power

Compensation Equipment Top Performers
- Tennessee Valley Authority
- Energinet
- Power Link Queensland

Substation Top Performers

Site
- Fingrid
- Western Power

Auxiliary Equipment
- TERNA
- TRANSELEC
- TASNetworks

Power Transformer Top Performers

Transformers Overall
- REN
- EGAT

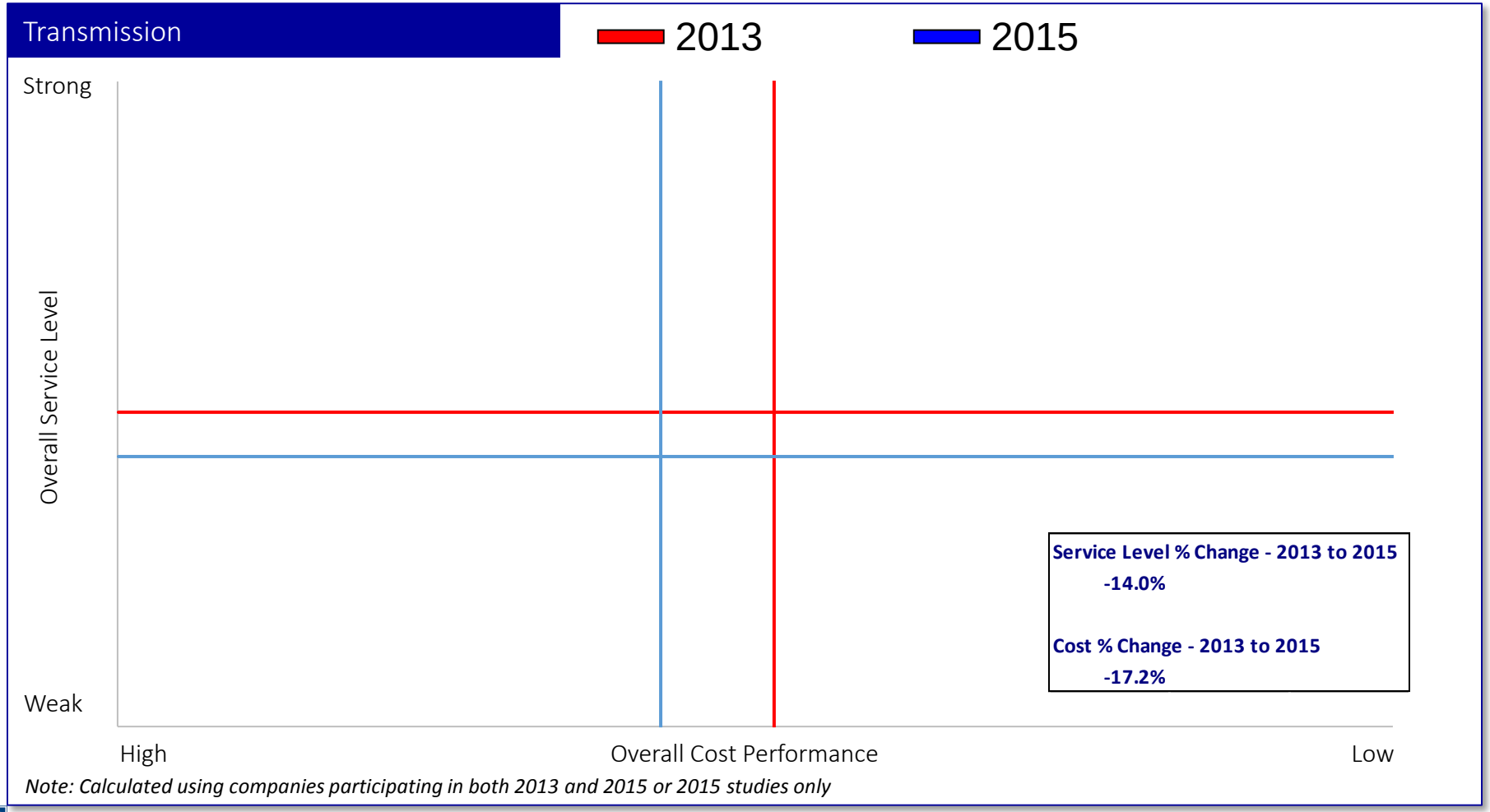
+ 400 KV
- Scottish & Southern
- CTEEP
- Energinet
- TRANSELEC
- EGAT

200 to 399 KV
- TERNA
- REN
- Tennessee Valley Authority
- Fingrid
- EGAT

100 to 199 KV
- AMPRION
- LANDSNET
- REN

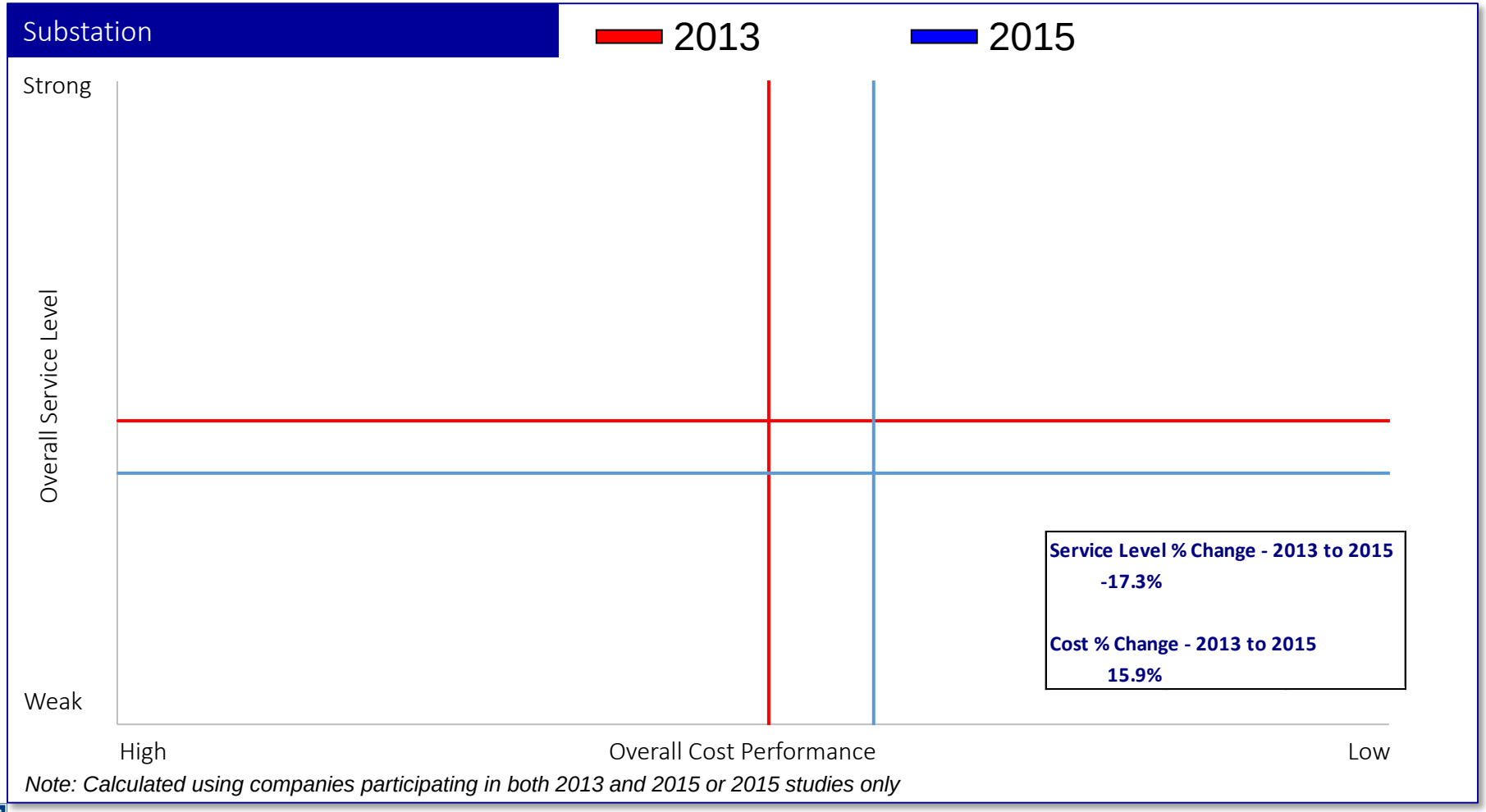
60 to 99 KV
- TRANSELEC
- REE
- Tennessee Valley Authority
- Transgrid

Average Comparisons – 2015 vs 2013 (Lines)



Note: Calculated using companies participating in both 2013 and 2015 or 2015 studies only

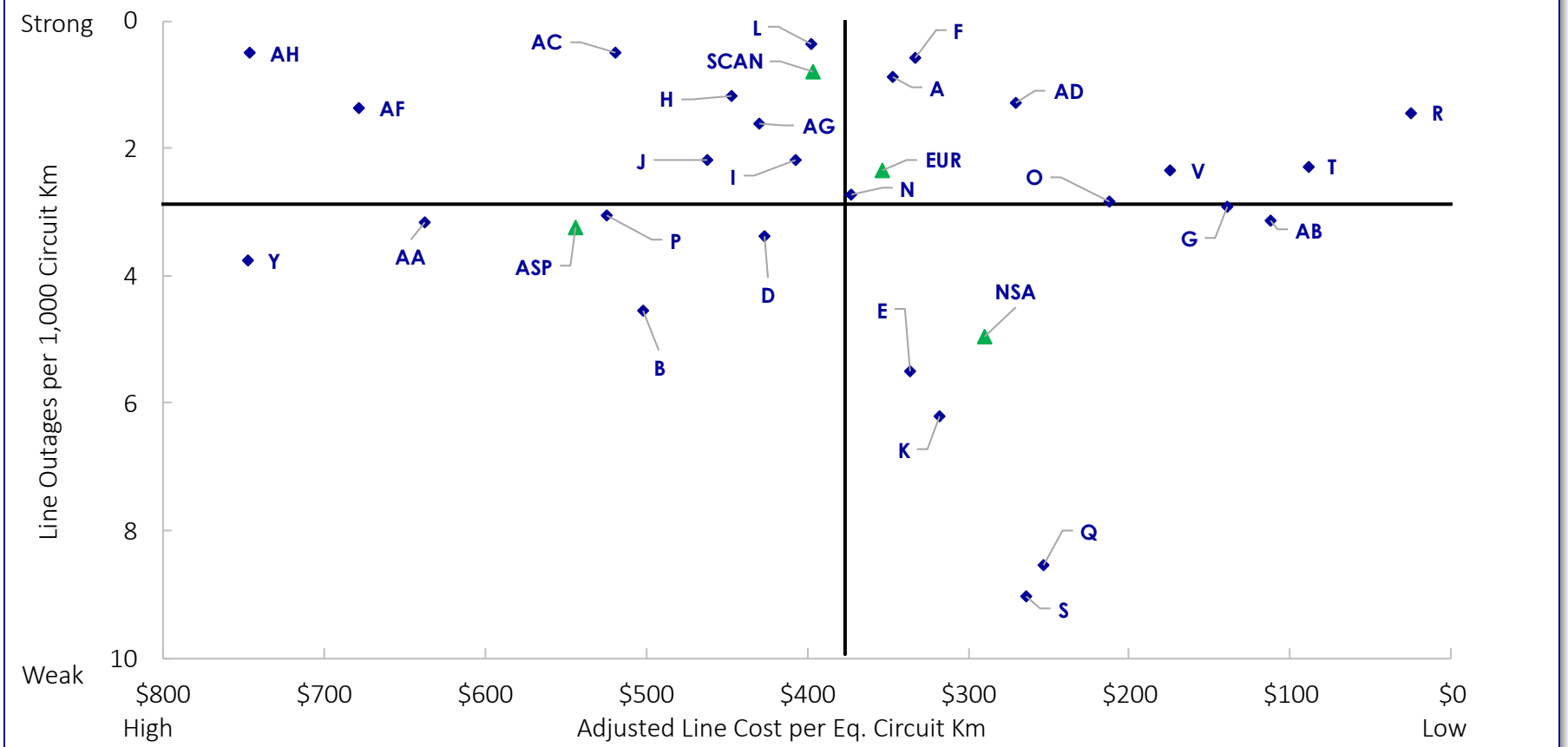
Average Comparisons – 2015 vs 2013 (Substations)



Note: Calculated using companies participating in both 2013 and 2015 or 2015 studies only

Overall Cost and Faults Comparison – Lines

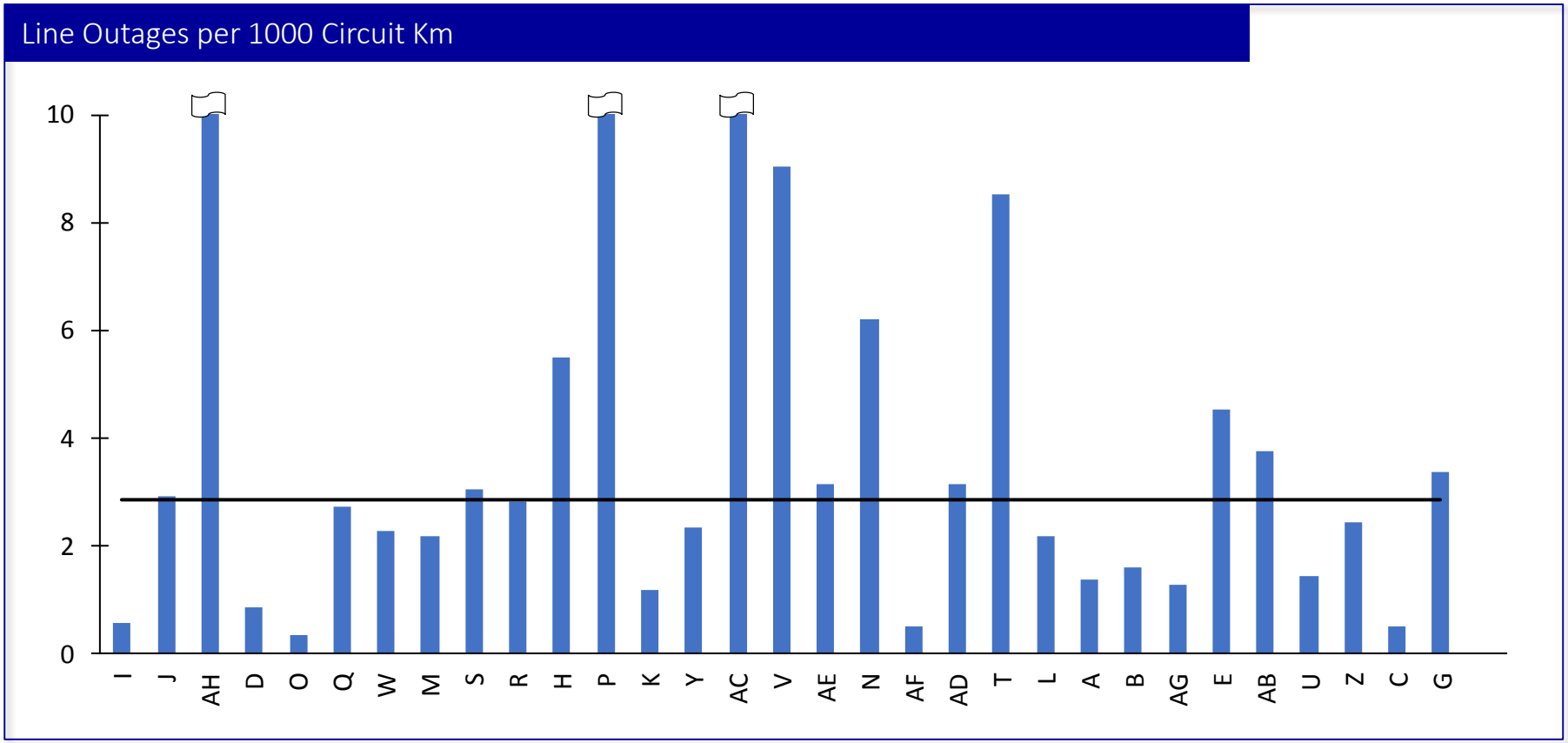
Lines Overall Chart



Cost Outlier: AH, Z; SL Outlier: AH, P, C

*Includes Overhead Line Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV, 200-399kV and +400kV, Tower Painting and Vegetation Management

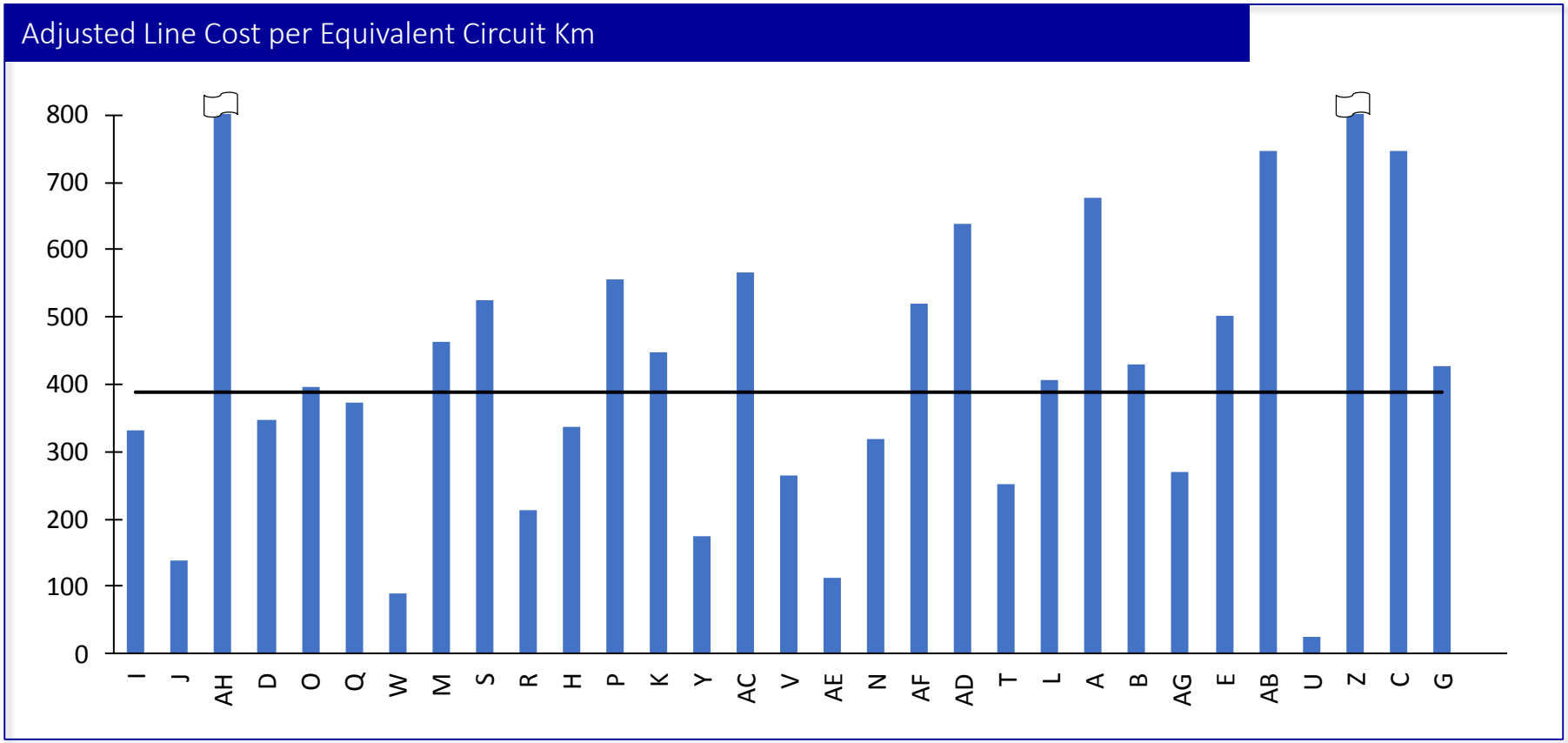
Overall Cost and Faults Comparison – Lines



AH	P	AC
12.83	18.14	14.05

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Lines

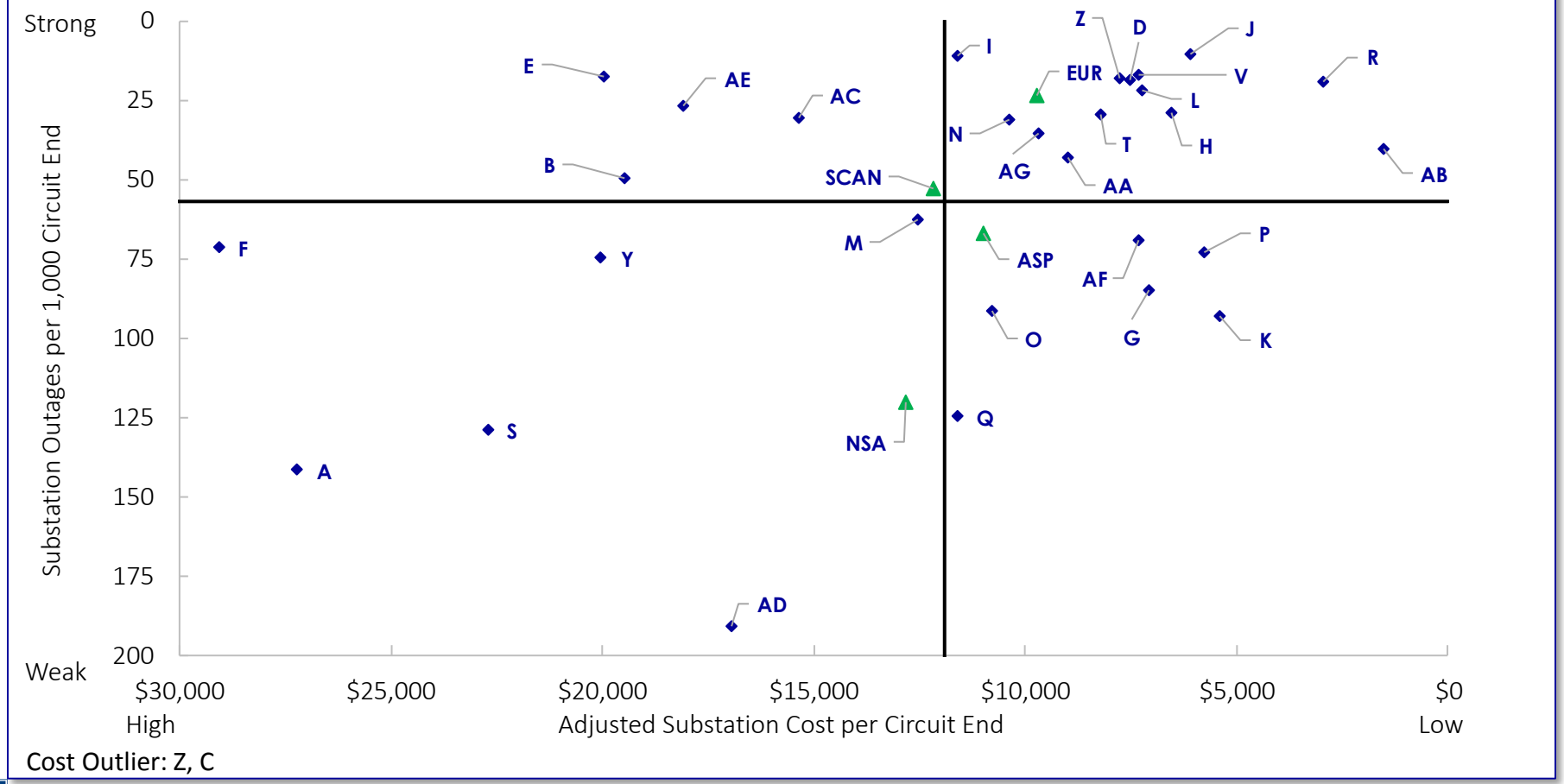


AH	Z
$ 3,165	$ 1,358

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Substations

Substations Overall Chart

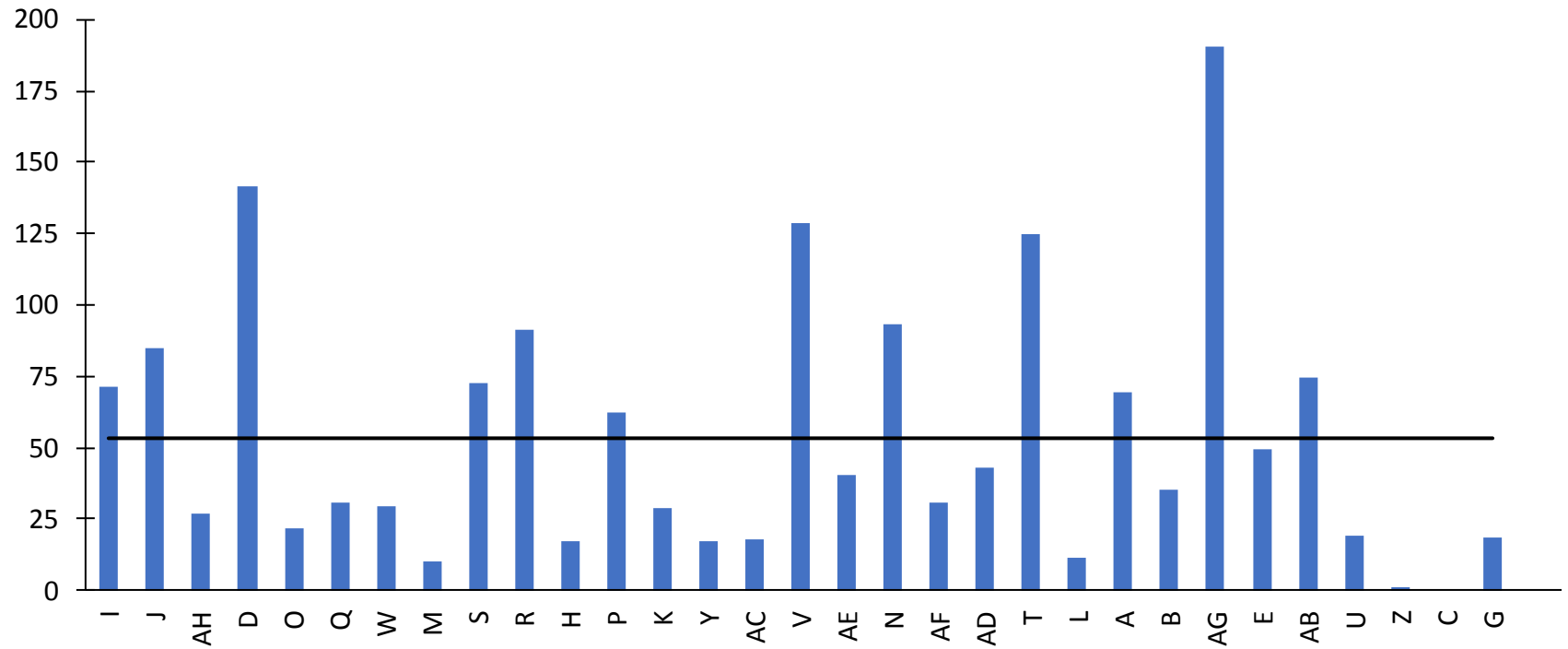


Cost Outlier: Z, C

*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV, 200-399kV and +400kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Overall Cost and Faults Comparison – Substations

Substation Outages per 1000 Circuit End

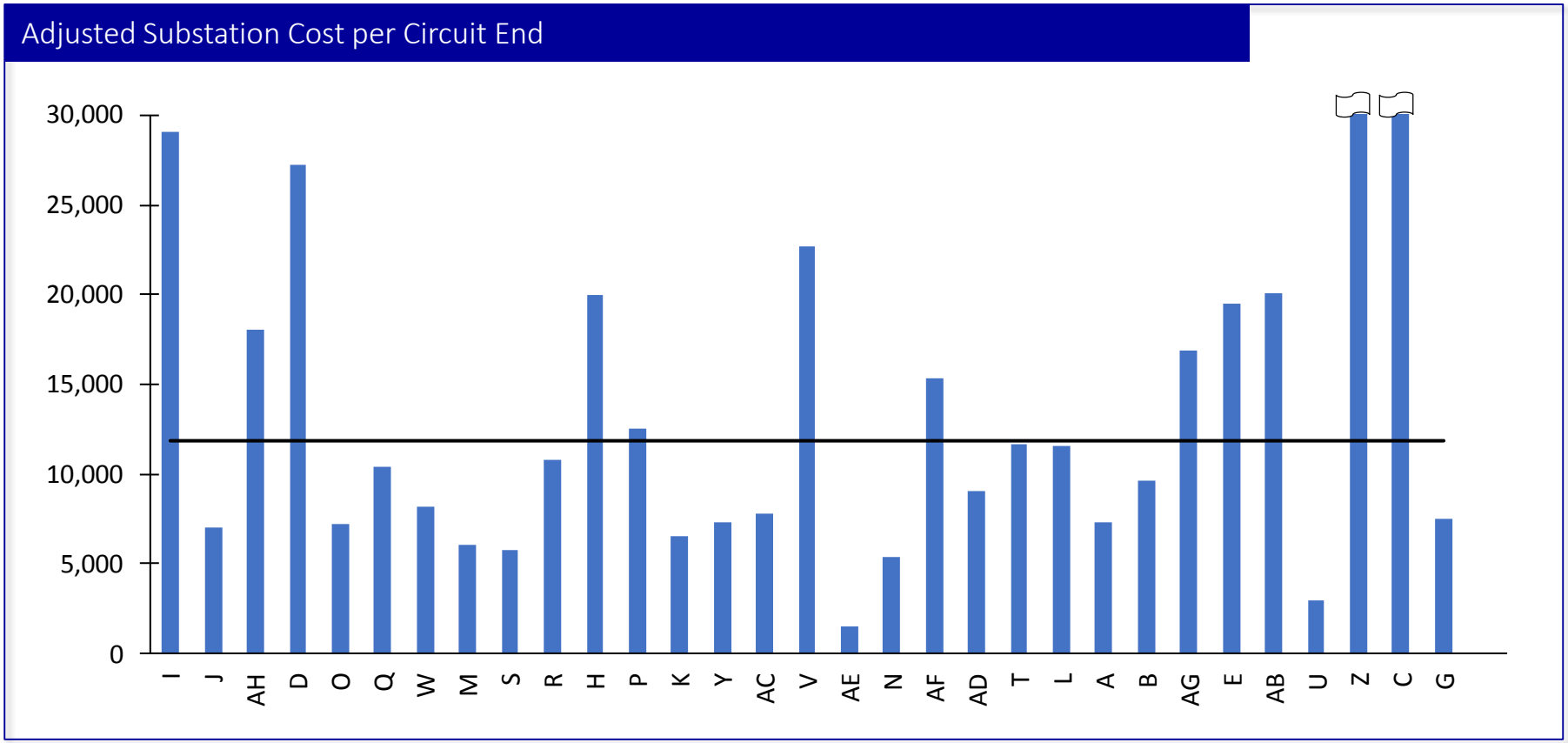


0 Outages: C

Z
1.29

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Substations

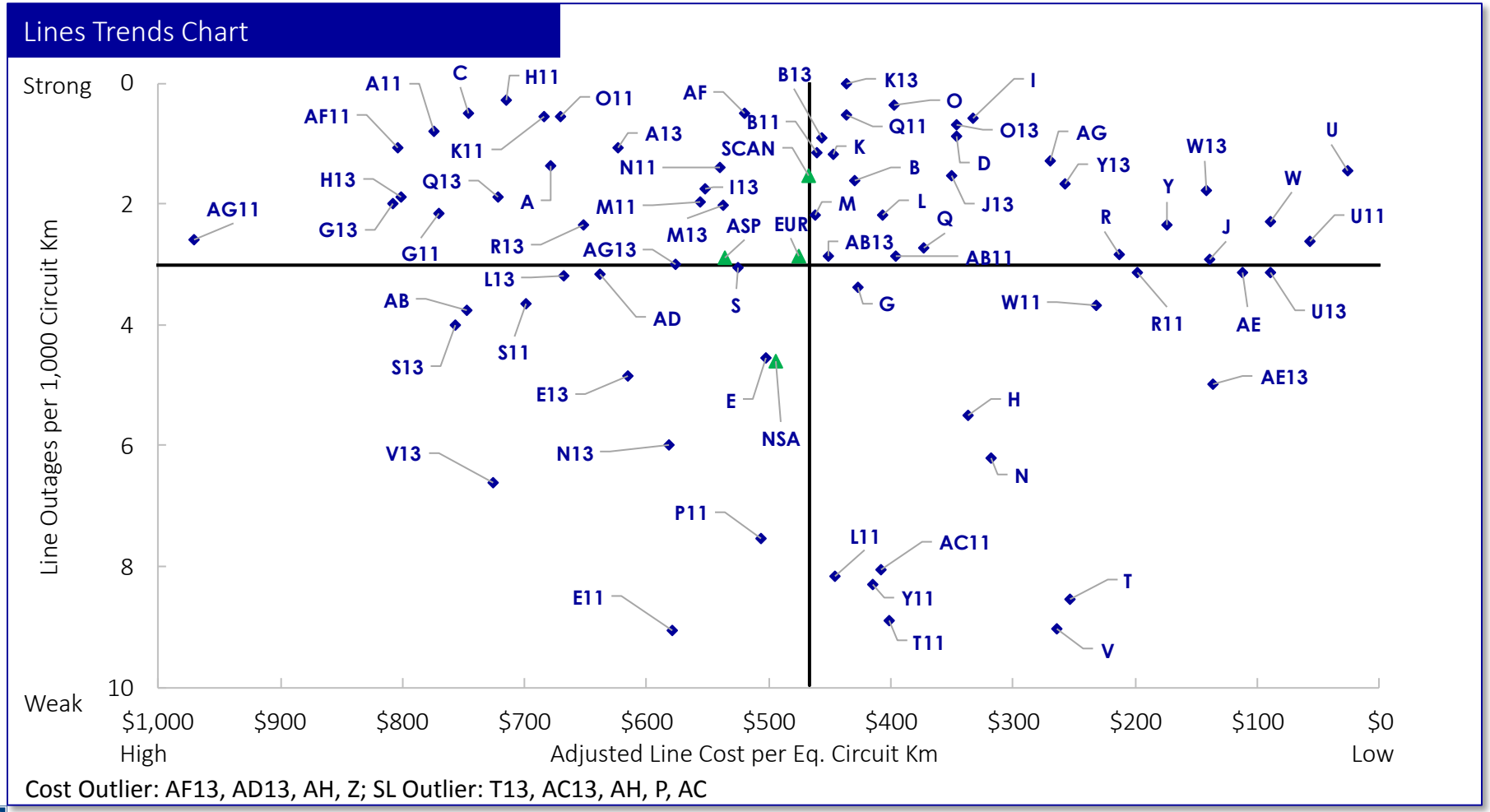


Z	C
$ 41,744	$ 46,810

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Lines (Trend)

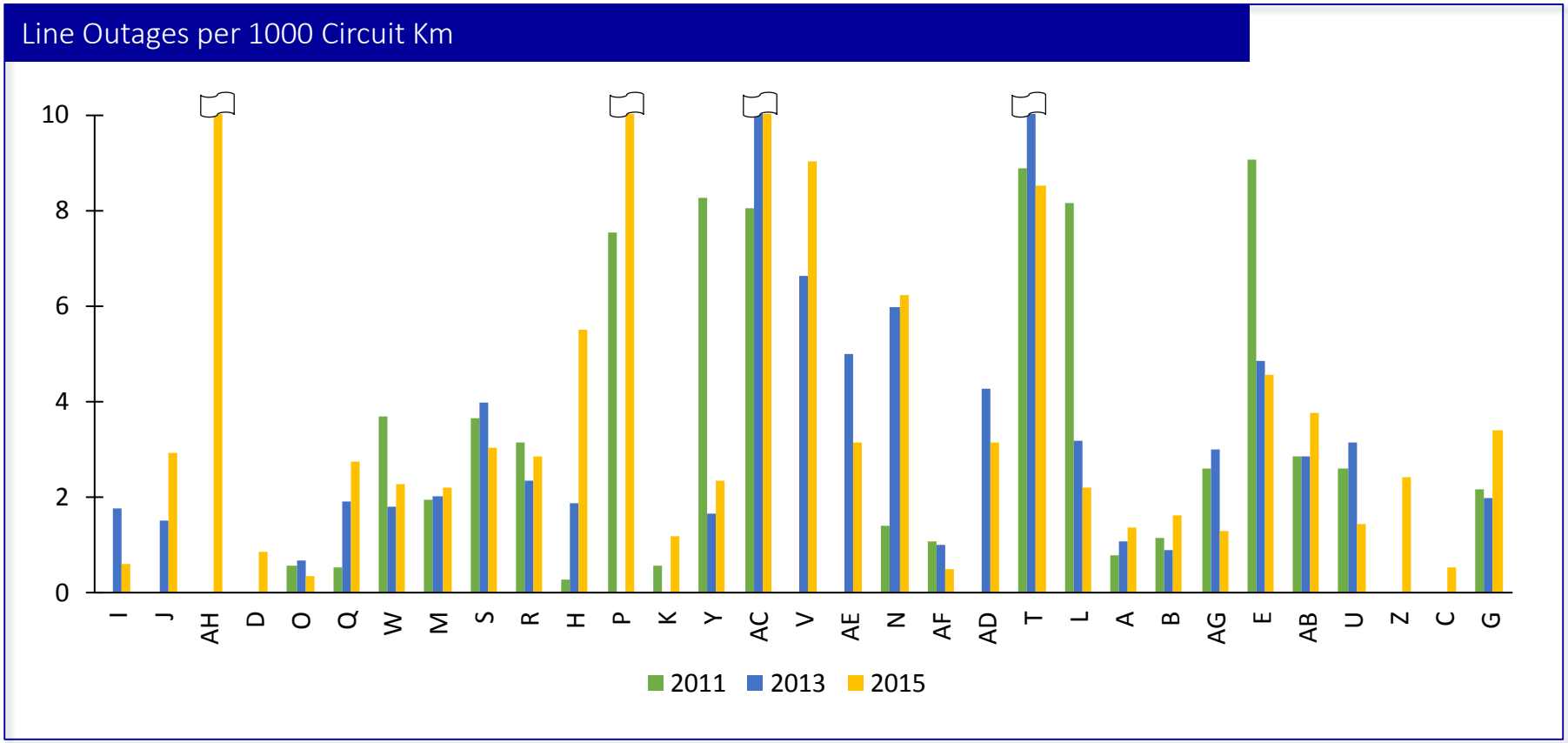
Data points with no year reference code represent the current study year



Cost Outlier: AF13, AD13, AH, Z; SL Outlier: T13, AC13, AH, P, AC

*Includes Overhead Line Maintenance 60-99kV, 100-199kV and +200kV, Overhead Line Patrol and Inspection 60-99kV, 100-199kV and +200kV and Vegetation Management

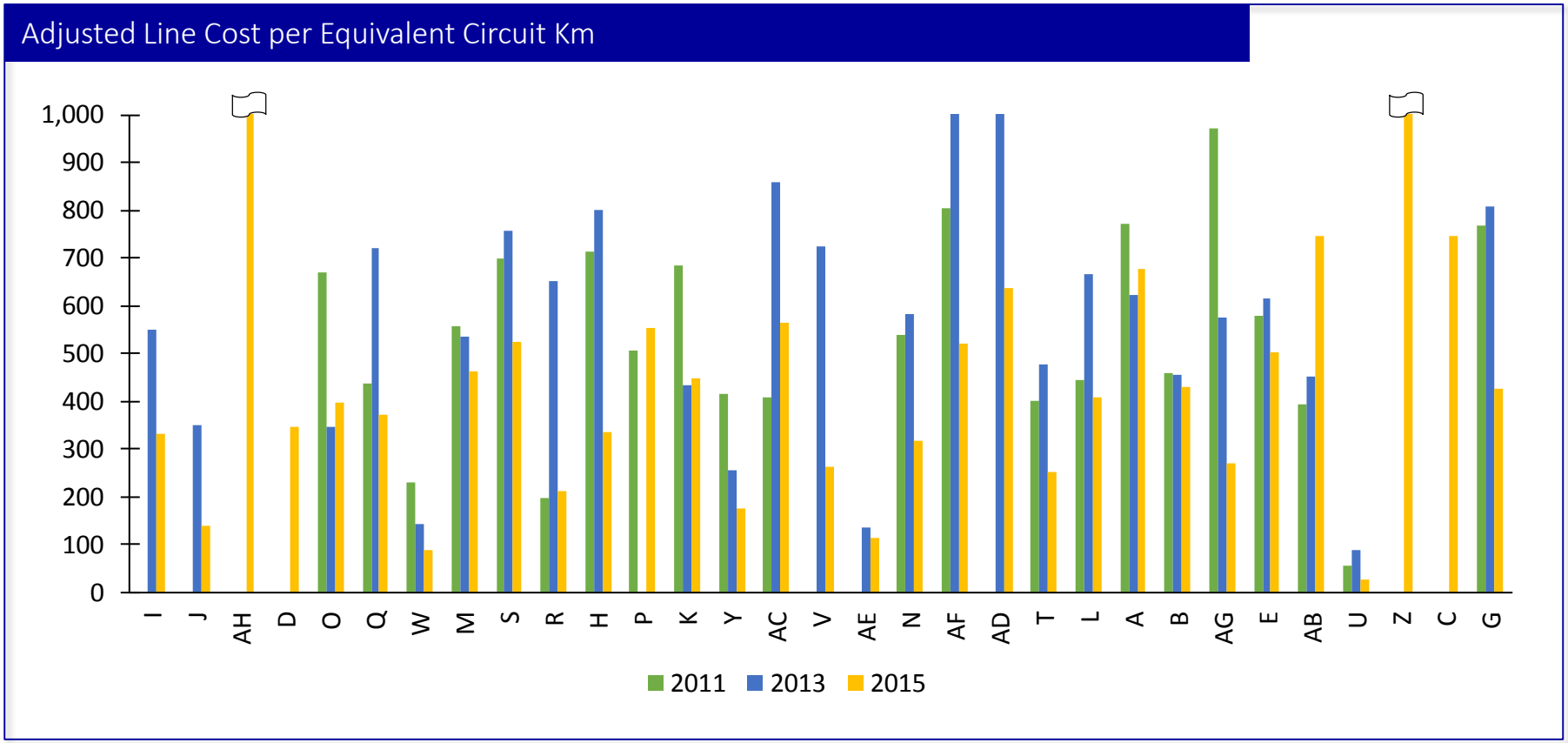
Overall Cost and Faults Comparison – Lines (Trend)



T13	AC13	AH15	P15	AC15
13.65	16.36	12.83	18.14	14.05

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Lines (Trend)



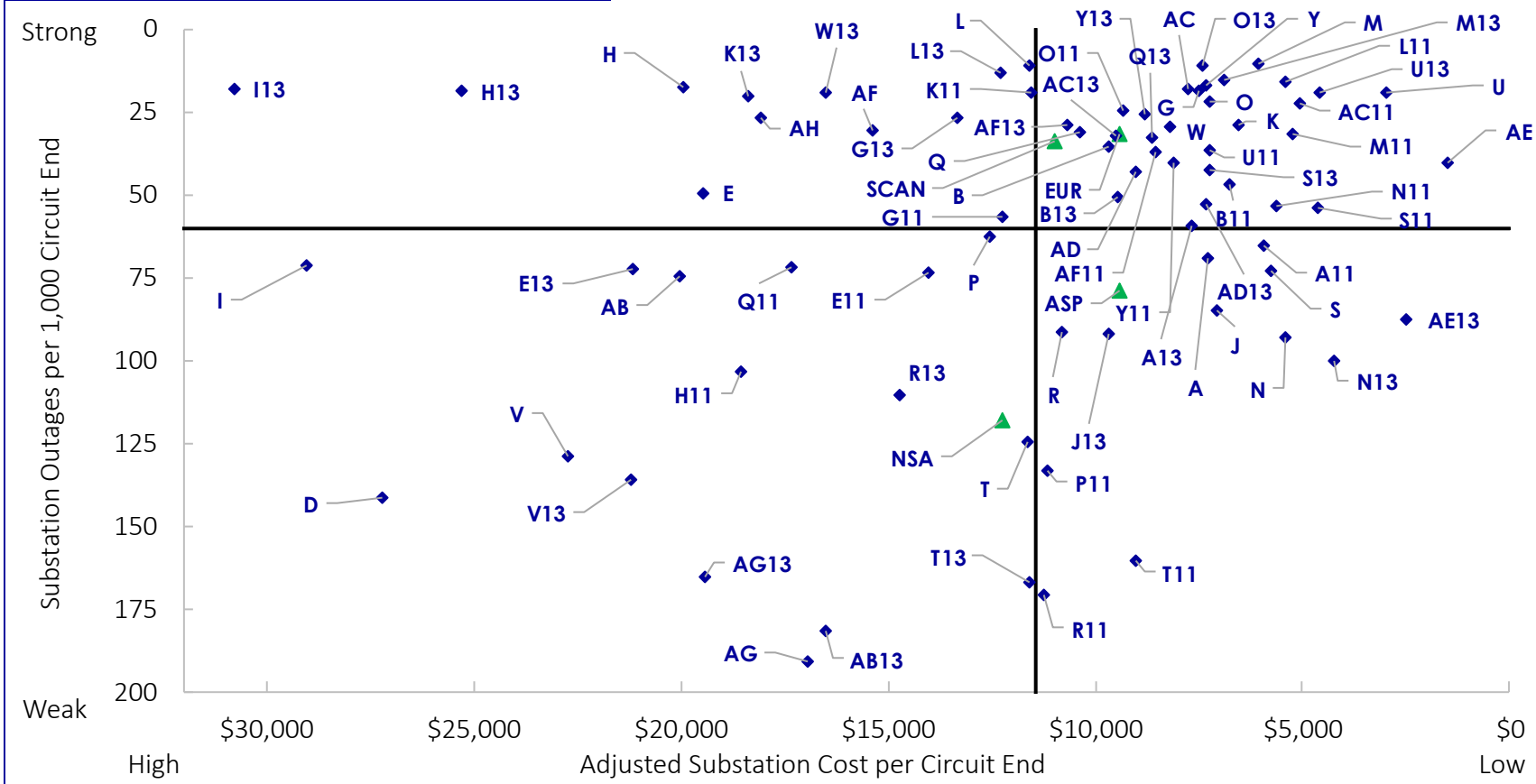
AF13	AD13	AH15	Z15
$ 1,152	$ 1,169	$ 3,165	$ 1,358

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Substations (Trend)

Data points with no year reference code represent the current study year

Substations Trend Chart

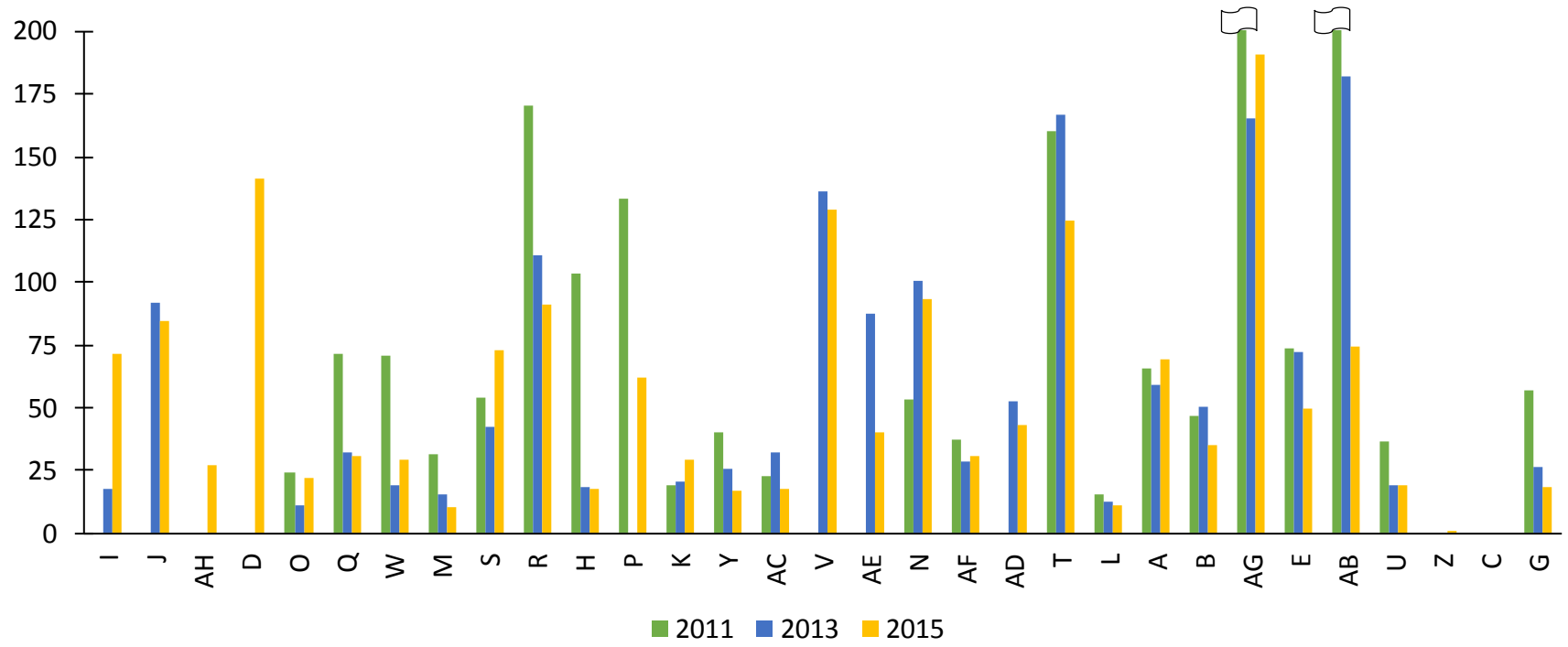


Cost Outlier: W11, AG11, Z, C; SL Outlier: AB11, AG11

*Includes Protection Maintenance, Breaker and Transformer Maintenance 60-99kV, 100-199kV and +200kV, Switch Maintenance, Compensation Equipment Maintenance, Instrument Transformer Maintenance, Substation Site and Auxiliary Equipment Maintenance

Overall Cost and Faults Comparison – Substations (Trend)

Substation Outages per Circuit End

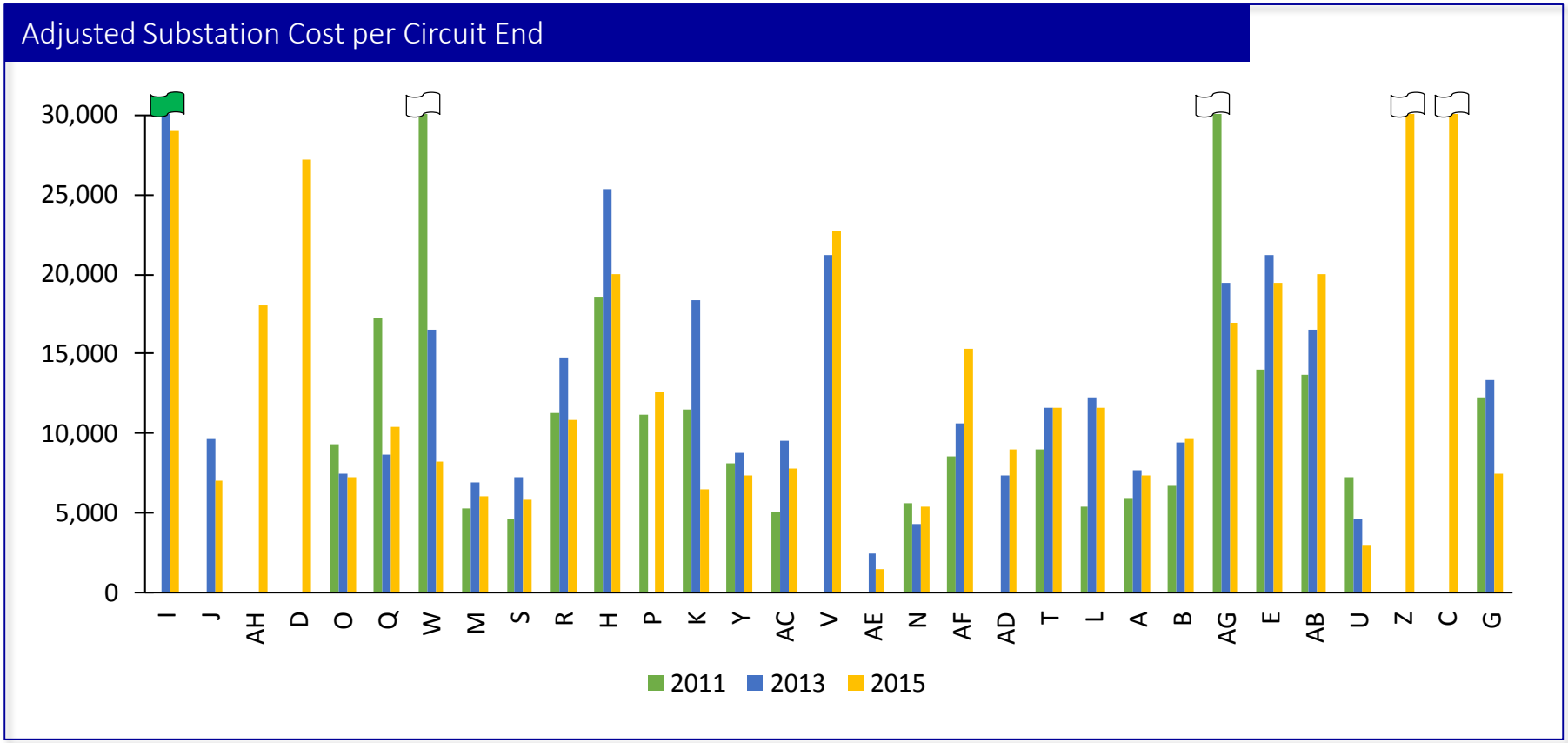


0 Outages: C

AB11	AG11	Z15
264.77	763.44	1.29

Value Identification Scaled Break Outlier Data

Overall Cost and Faults Comparison – Substations (Trend)



W11	AG11	I13	Z15	C15
$ 42,213	$ 64,976	$ 30,784	$ 41,744	$ 46,810

Value Identification Scaled Break Outlier Data

Data Version Control

Company	Data Last Revised	Revisions Made
I	11-Oct-15	2
J	12-Dec-15	2
AH	28-Nov-15	2
D	17-Dec-15	5
O	9-Oct-15	4
Q	1-Dec-15	2
W	13-Nov-15	4
M	26-Nov-15	2
S	29-Dec-15	3
R	28-Nov-15	2
H	23-Nov-15	2
P	12-Nov-15	2
K	20-Nov-15	3
Y	18-Nov-15	3
AC	27-Nov-15	3
V	20-Nov-15	2
AE	12-Dec-15	2
N	15-Nov-15	2
AF	28-Nov-15	2
AD	23-Dec-15	3
T	20-Nov-15	2
L	11-Nov-15	2
A	6-Nov-15	2
B	30-Nov-15	5
AG	28-Nov-15	2
E	9-Oct-15	2
AB	10-Dec-15	3
U	16-Dec-15	3
Z	12-Jan-16	3
C	12-Jan-16	3
G	1-Dec-15	1

Report Revision

Revision Number	Revision Date	Revision Description	Revision made by
1	12th May 15	Re-created the charts; Added 2 new charts	A. Chow
2	15th Jan 16	Updated report with 2015 ITOMS data	PJ Julongbayan
3	20th Jan 16	Updated report with internal Audit comments	PJ Julongbayan
4	28th Jan 16	Updated report with internal review comments	PJ Julongbayan
5	4th Feb 16	Updated report based on the result of 2nd Internal audit	PJ Julongbayan
6	16th Feb 16	Updated report based on the external audit	PJ Julongbayan

Report Version

Version Number	Version Date	Version Description
1	26th Feb 16	Issued on Feb