Analyzing American Energy Market - Case study

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Context

The American Energy Market Regulator (AEMR) is responsible for ensuring that America's energy network remains reliable with minimal disruptions, which are known as outages. There are four key types of outages: (1) Consequential, (2) Forced, (3) Opportunistic, (4) Planned. Of the four outage types, the only one the AEMR penalizes is a forced outage, as this will threaten the reliability of the network which is what the AEMR wishes to avoid.

The management at the AEMR has been increasingly aware of a large number of energy providers that submitted outages over the 2016 and 2017 calendar years. The management team has expressed a desire to have the following two areas of concern addressed: 1) Energy stability and market Outages, 2) Energy Losses and Market Reliability

Objective:

This case study aims at analyzing energy stability and reliability as measured by outages, energy loss and duration of outages.

Data source: AEMR CSV file dataset (2016 - 2017)

With 70% (2886 counts) of all outage events and 60% (152K MW) of total energy loss in 2016 - 2017, indicating that forced outage type as a major factor causing outages and energy loss while scheduled (planned) outage events tend to have the longest average duration of about 5 days in 2016 - 2017.

Executive Summary

Outage events:

Segmentation of outage events by type reveals that forced outages are the most common types of outages accounting for 70% (2,886 outages) of all approved outages (4,102 outages) in 2016 - 2017, forced outages remained a growing concern causing instability in the energy market .

Outage duration:

With an average duration of about 5 days, scheduled (planned) outage events tend to have the longest duration over the period of 2016 -2017 contrasted to a much lower duration of about 1 day of all other outage types (forced, consequential, opportunistic) added together.

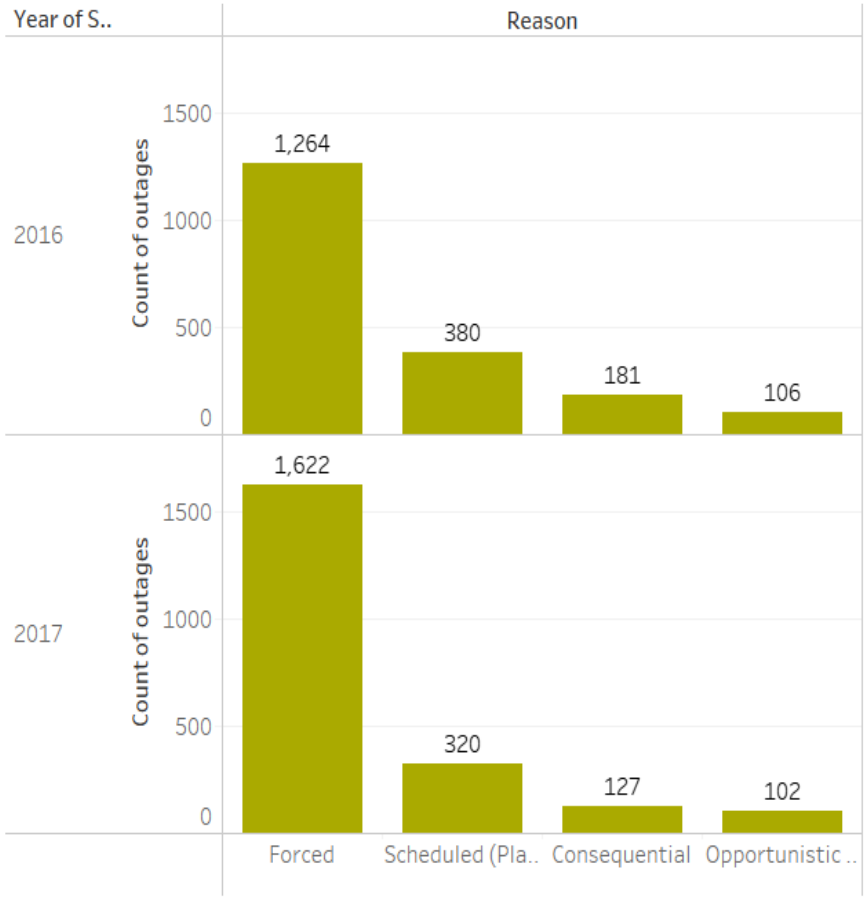
Energy loss:

Forced outage events account for more than 60% (152K MW) of total energy loss in 2016 - 2017 and saw an increase of more than 10,000MW in 2017, indicating that forced outages remained a growing concern causing instability in the energy market.

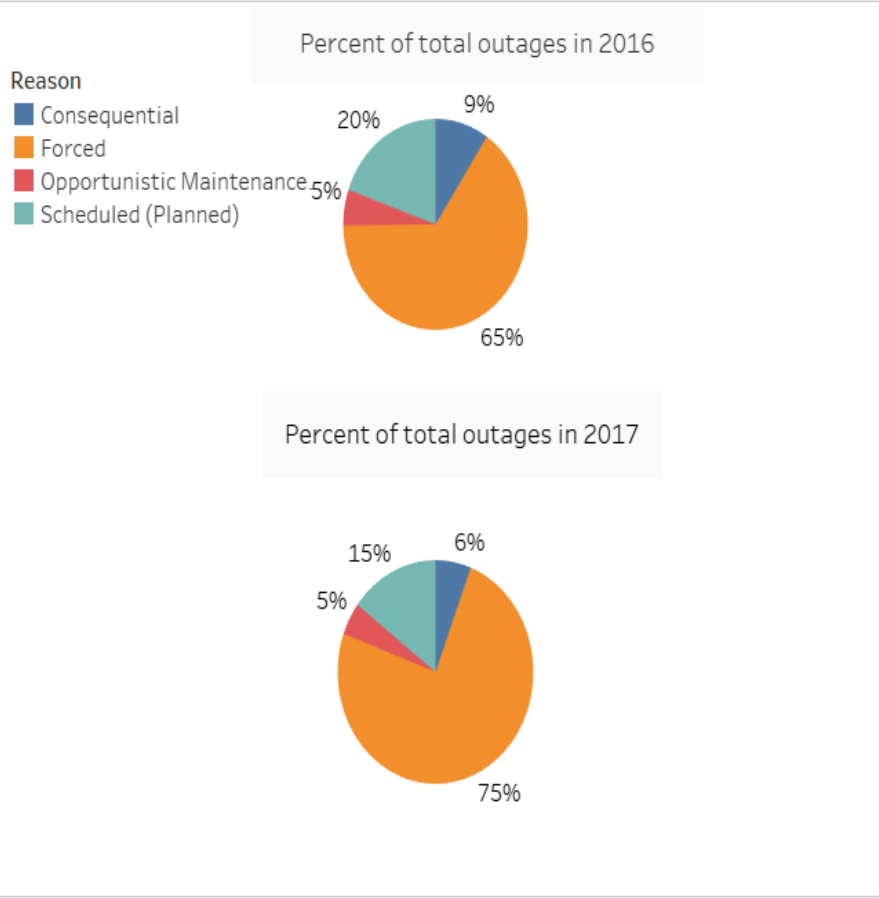
Segmentation of outage events by type reveals that forced outages are the most common type of outage accounting for 65% of all outages in 2016 and 75% of all outages in 2017, causing instability in the energy market.

- Opportunistic maintenance (planned) type of outage occured the least (5%) in both 2016 and 2017
- Forced outage events increased from 1,264 in 2016 to 1622 in 2017 with all other outage types showing a decline

Number of approved outage events by reason and year



Percent of total count of all approved outages events by reason and year



Further disaggregation of outage events by energy providers shows that of the total of all approved outage events (4102), AURICON has seen the highest number of outages (875, 21%) followed by GW (672, 16%) and MELK (536, 13%) - all three together accounting for 51% of total outages.

- Looking at only forced outages, theses energy providers account for about 55% of the total forced outages
- AURICON has seen its forced outages more than doubled from 208 in 2016 to 490 outages in 2017, sugesting that it is the most unreliable provider.

Number of all approved outage events by participants

Count of outages
4 577

	Start Time		
Particip..	2016	2017	Grand Total
AURICON	298	577	875
GW	402	270	672
MELK	273	263	536
AUXC	209	122	331
PJRH	142	146	288
TRMOS	71	176	247
PUG	47	149	196
KORL	87	108	195
PMC	107	61	168
ENRG	69	54	123
COLLGAR	53	64	117
TSLA_MGT	55	55	110
STHRNCRS	35	35	70
MUND	30	31	61
EUCT	28	17	45
DNHR	12	13	25
MCG	4	18	22
WGUTD	9	12	21
Grand Total	1,931	2,171	4,102

Number of forced outage events by participants

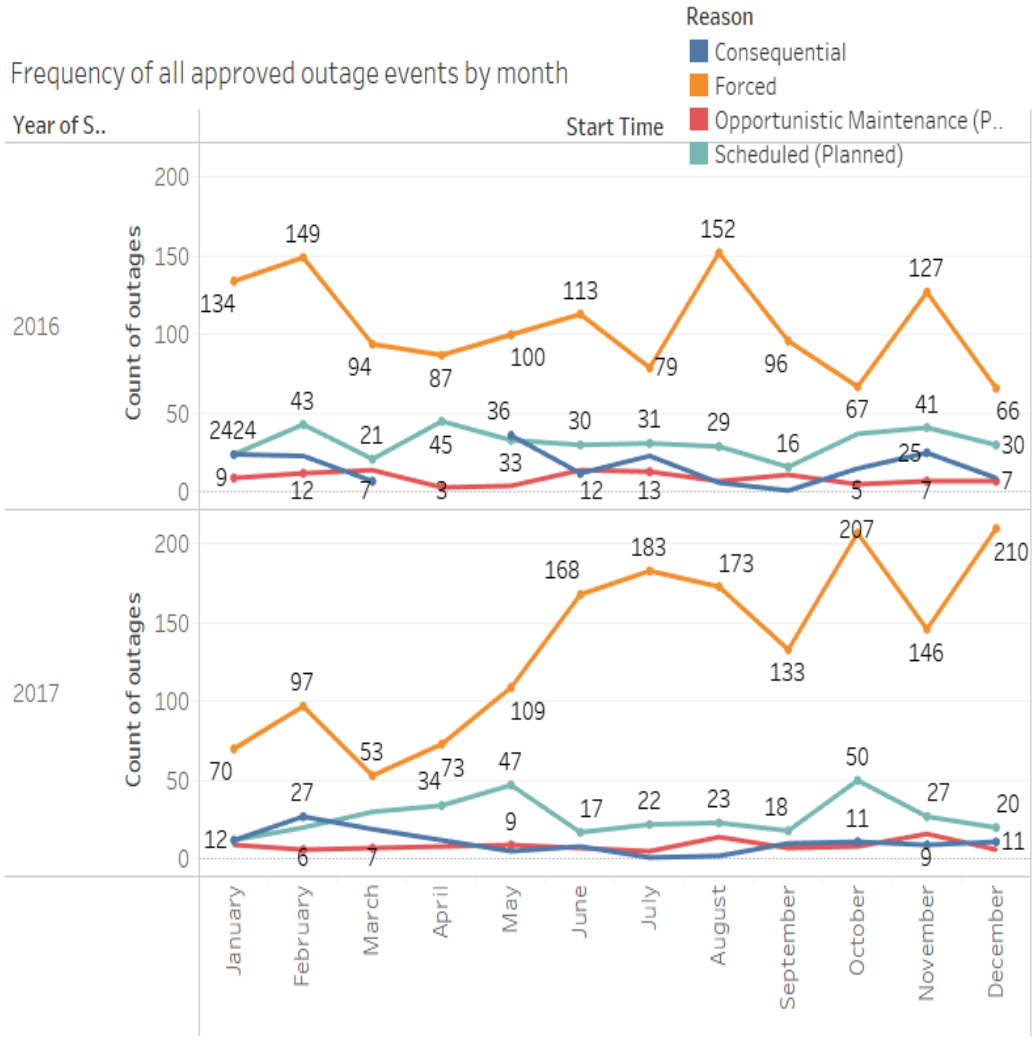
Count of forced autages
1 490

	Start Time		
Particip..	2016	2017	Grand Total
AURICON	208	490	698
GW	317	227	544
MELK	157	177	334
AUXC	206	120	326
TRMOS	65	172	237
PUG	24	135	159
PJRH	81	72	153
KORL	53	76	129
PMC	69	40	109
COLLGAR	29	45	74
STHRNCRS	13	18	31
ENRG	21	7	28
MUND	4	15	19
EUCT	11	3	14
MCG	1	12	13
WGUTD	2	8	10
TSLA_MGT	2	4	6
DNHR	1	1	2
Grand Total	1,264	1,622	2,886

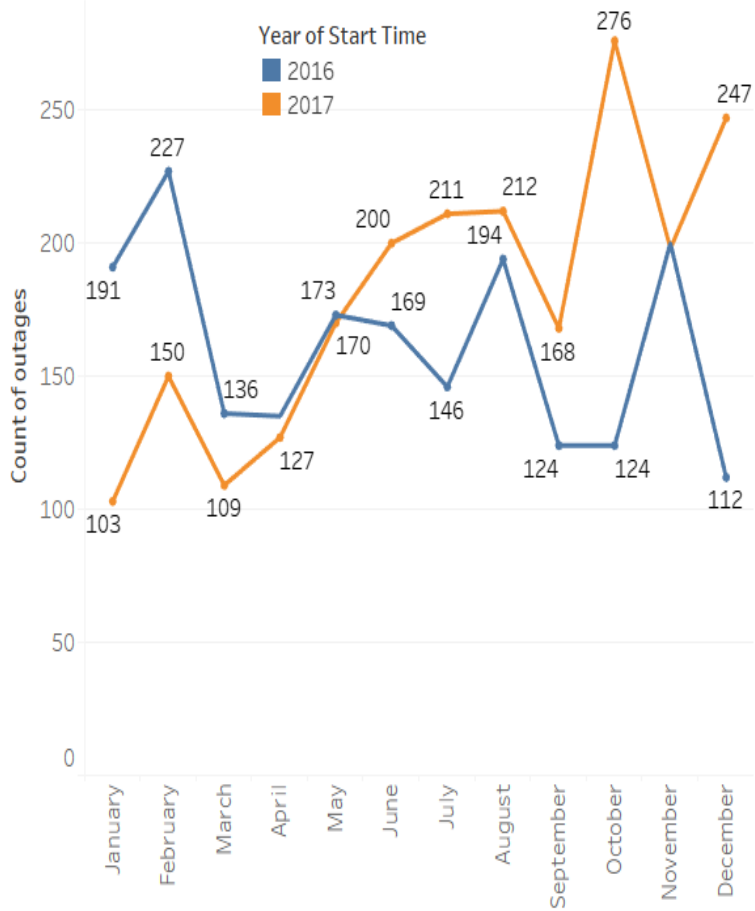
Breaking down outage events by month indicates that while total outage events remained fairly stable in 2016, they sharply increased in 2017, peaking in October 2017 to 276 outages - a 167% increase from January.

- Forced outages remained substantially higher in both years with their number dramatically increasing, peaking from 70 outage events in Janaury 2017 to 210 outage evetns in December of of the same year - an increase of 200%.

Frequency of all approved outage events by month



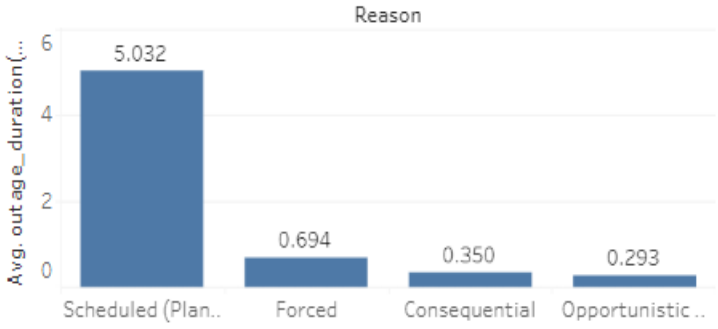
Total number of all approved outage events by month



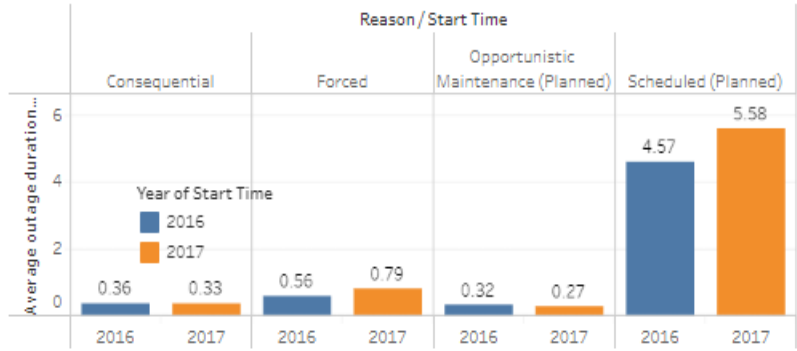
With an average duration of about 5 days, scheduled (planned) outage events tend to have the longest duration over the period of 2016 -2017 contrasted to a much lower duration of about 1 day of all other outage types (forced, consequential, opportunistic) added together.

- Scheduled and forced outages have seen an increase of 1 day and 0.23 day, respectively in 2017 while consequential and opportunistic outage duration decreased.
- Furtherther segmentation of outage duration by providers reveals that ENRG, MELK and EUCT with average outage duration of 6.84, 3.97 and 2.62 days respectively are the top three energy providers causing instability in the energy market in 2016 - 2017.

Average outage duration (days) by reason



Average duration (days) of all approved outage events by reason



Average outage duration (days) by participants

Avg. Outage_duration(days) 0.09 — 7.16

Partici..	Start Time: 2016	2017	Grand Total
ENRG	7.16	6.42	6.84
MELK	2.19	5.82	3.97
EUCT	4.04	0.27	2.62
COLLGAR	1.59	3.09	2.41
PJRH	1.91	1.85	1.88
KORL	2.12	1.49	1.77
WGUTD	1.29	1.28	1.29
MUND	1.65	0.52	1.08
GW	0.97	1.02	0.99
TSLA_MGT	0.64	0.79	0.71
PUG	1.61	0.34	0.64
PMC	0.56	0.40	0.50
STHRNCRS	0.40	0.37	0.38
MCG	0.81	0.17	0.28
AURICON	0.32	0.24	0.27
TRMOS	0.70	0.09	0.26
DNHR	0.25	0.26	0.26
AUXC	0.09	0.30	0.17
Grand Total	1.32	1.45	1.39

Average forced outage duration (days) by participants

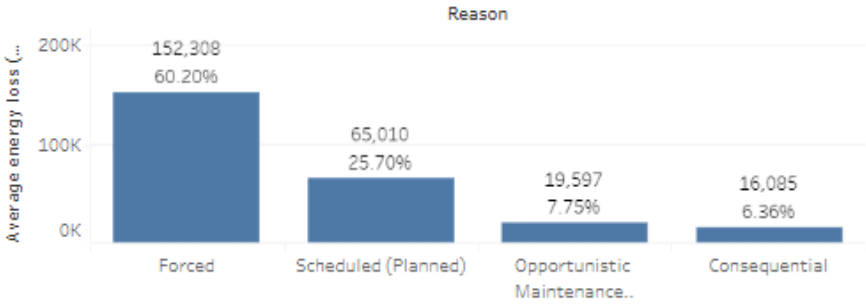
Avg. out_duration(day... 0.01 — 15.71

Partici..	Start Time: 2016	2017	Grand Total
ENRG	15.71	4.19	12.83
EUCT	9.75	0.03	7.67
MELK	0.28	4.82	2.69
COLLGAR	0.40	0.98	0.76
GW	0.26	0.88	0.52
WGUTD	0.02	0.58	0.47
KORL	0.34	0.55	0.47
DNHR	0.40	0.48	0.44
PJRH	0.31	0.44	0.37
MCG	1.29	0.23	0.31
PUG	0.92	0.18	0.29
TSLA_MGT	0.25	0.31	0.29
STHRNCRS	0.33	0.21	0.26
MUND	0.49	0.19	0.25
PMC	0.32	0.03	0.22
TRMOS	0.18	0.04	0.08
AURICON	0.07	0.08	0.08
AUXC	0.08	0.01	0.05
Grand Total	0.56	0.79	0.69

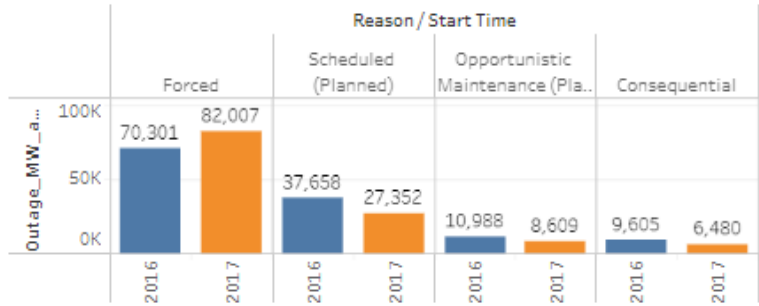
Forced outage events account for more than 60% (152K MW) of total energy loss in 2016 - 2017 and saw an increase of more than 10,000MW in 2017, indicating that forced outages remained a growing concern causing instability in the energy market.

- Drilling down to a provider level, GW, AURICON and MELK together account for 60% of all energy loss from forced outages each accounting for 23%, 21% and 16%, respectively.

Total energy loss (MW) by reason



Total energy loss(MW) by reason and year



Total energy loss (MW) due to forced outage events by participants

Outage_forced: 1 – 21,640

Partici..	Start Time 2016	2017	Grand Total
GW	15,751	19,327	35,078
AURICON	10,696	21,640	32,336
MELK	13,771	10,285	24,056
PMC	9,093	5,648	14,742
PJRH	5,882	4,839	10,721
KORL	4,040	4,680	8,720
COLLGAR	4,321	2,787	7,108
TRMOS	1,232	5,017	6,249
PUG	815	4,112	4,928
AUXC	2,734	1,769	4,503
ENRG	1,183	192	1,375
MCG	55	563	618
STHRNCRS	299	293	592
MUND	147	399	546
TSLA_MGT	160	170	330
WGUTD	54	221	275
EUCT	65	65	130
DNHR	1	1	3
Grand Total	70,301	82,007	152,308

Average energy loss (MW) due to forced outage events by participants

Avg. Outage_forced: 1.4 – 149.0

Partici..	Start Time 2016	2017	Grand Total
PMC	131.8	141.2	135.2
COLLGAR	149.0	61.9	96.1
MELK	87.7	58.1	72.0
PJRH	72.6	67.2	70.1
KORL	76.2	61.6	67.6
GW	49.7	85.1	64.5
TSLA_MGT	80.0	42.5	55.0
ENRG	56.3	27.4	49.1
MCG	55.0	46.9	47.6
AURICON	51.4	44.2	46.3
PUG	34.0	30.5	31.0
MUND	36.8	26.6	28.7
WGUTD	27.0	27.7	27.5
TRMOS	19.0	29.2	26.4
STHRNCRS	23.0	16.3	19.1
AUXC	13.3	14.7	13.8
EUCT	5.9	21.6	9.3
DNHR	1.4	1.4	1.4
Grand Total	55.6	50.6	52.8

Recommendations

- To decrease forced outages and shorten outage duration, AEMR should implement planned maitenance regularly.

- AEMR should reconsider services from AURICON, GW and MELK as they are the most unreliable providers causing instability in the energy network and encourage providers contributing towards less energy loss and outage events.

- AEMR should conduct further investigation on factors causing outages and energy loss in the energy network.

Thank you!