American Energy Market Regulator Case Study

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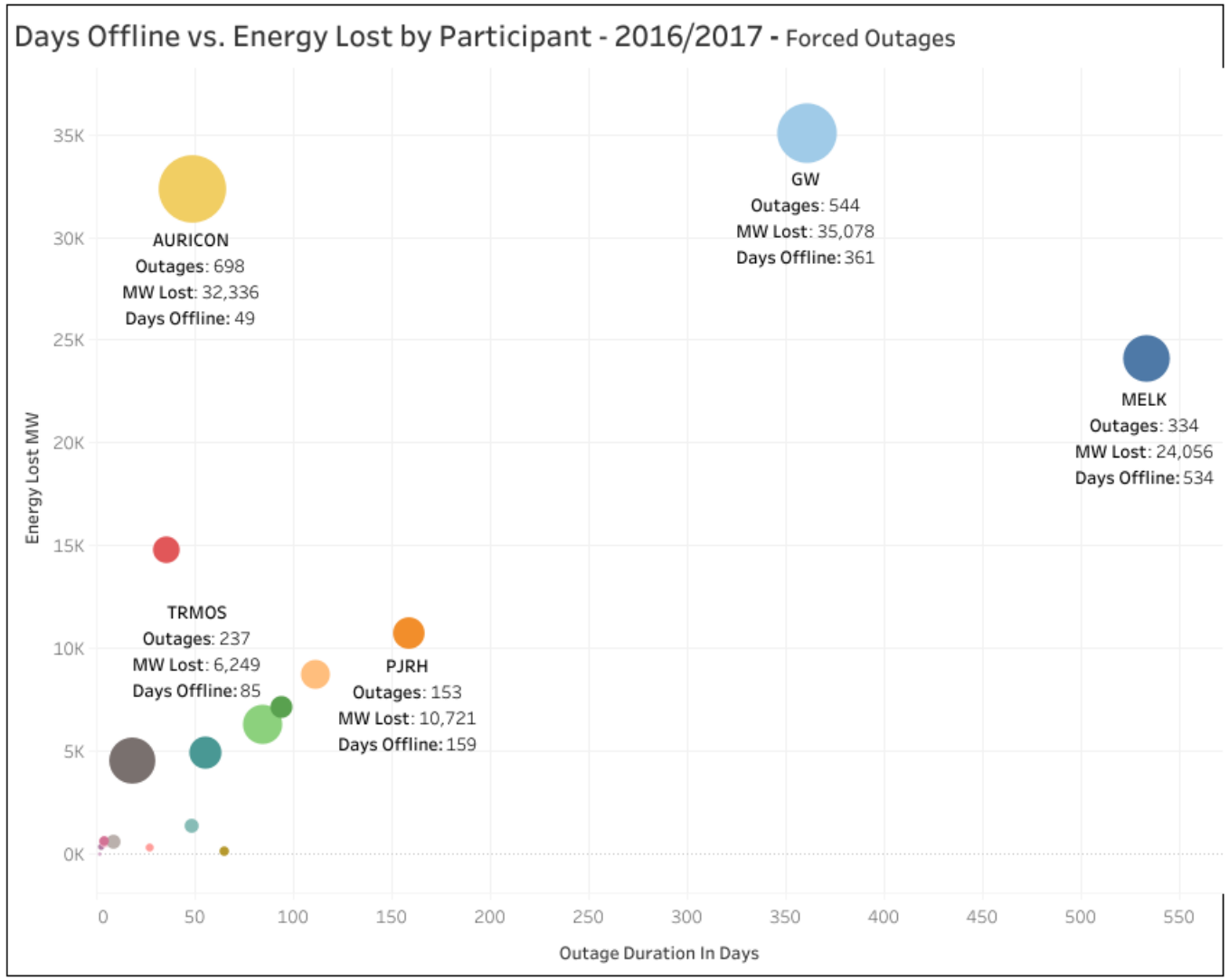
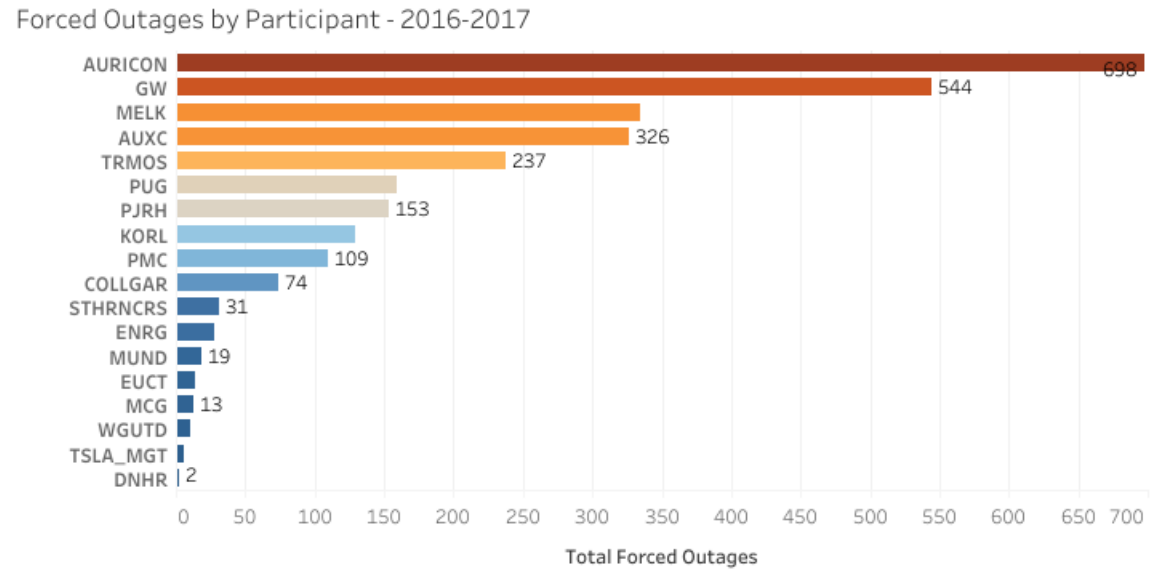
Three Participants accounted for over half of the Outages, Energy Lost and Days Offline.



Top 3 (Auricon, Melk and GW) vs. All Other Participants
Forced Outages in 2016 - 2017

	% Energy Lost MW	% Total Days Offline	% Total Forced Outages
All Other Participants	40%	43%	45%
AURICON, MELK, GW	60%	57%	55%



Key Findings:

(1) Auricon had the most number of outages at 698 AND and one of the lowest number of days offline.

(2) Auricon's 3 day outage December 17-22, 2017 accounted for over 20% of Auricon's 32,336 MW energy lost over both years.

(3)Melk had the most days offline at 534 days during 2016-2017.

(4)GW had the highest Energy Loss at 35,078 MW.

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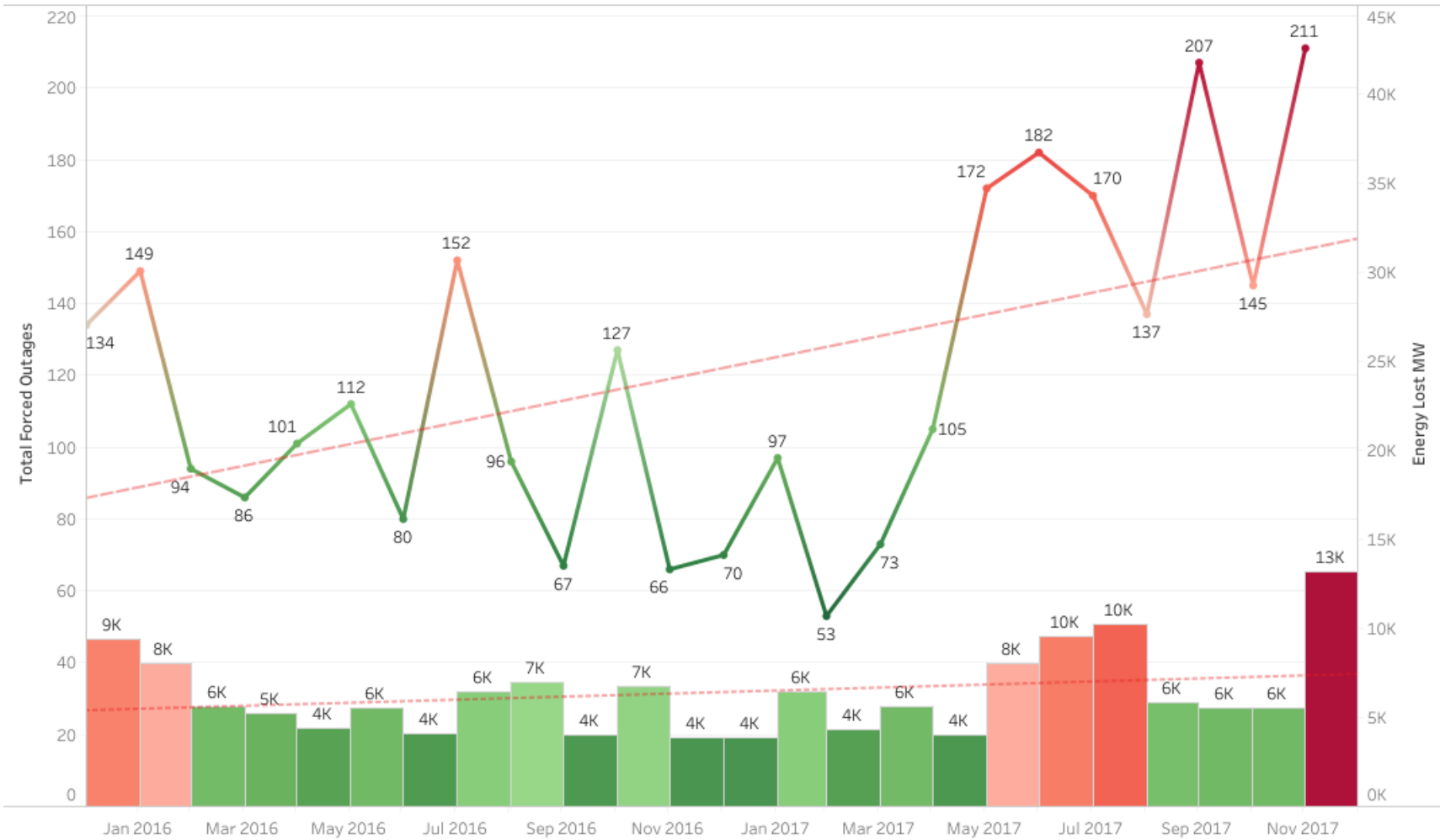
Outages are increasing at a higher rate than Energy Loss from 2016 to 2017

Forced Outages and Energy Loss by Month



Key Findings:

(1) Generally, an increase in Outages caused an increase in Energy Loss.

(2) The overall trend for outages has increased from January 2016 to December 2017.

(3) The largest Energy Loss (17,000 MW) occurred in December 2017 resulting from an outage at Auricon's facility.

(4) In August 2016, the number of outages was 152 (High) but the Energy Loss was only 6,000MW (Low).

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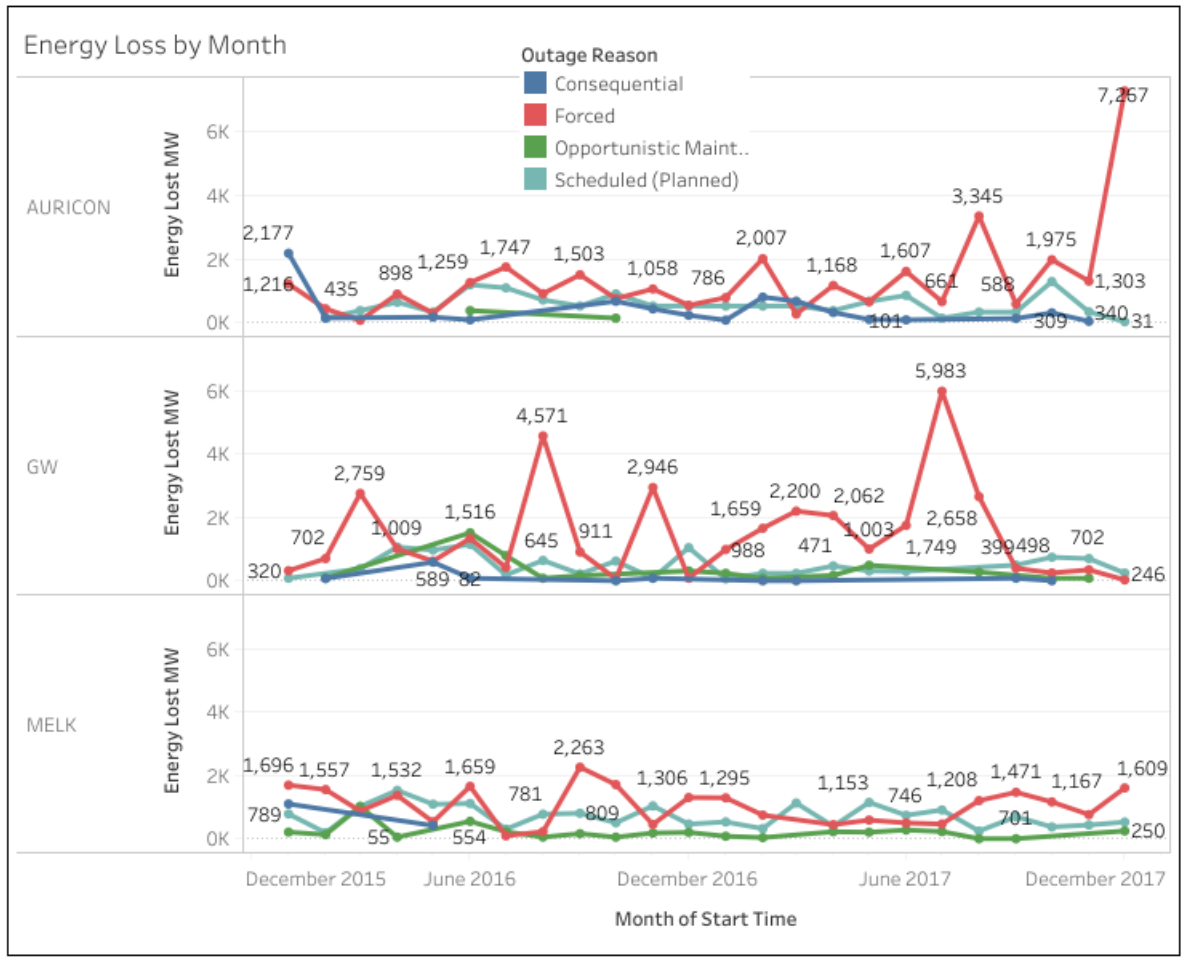
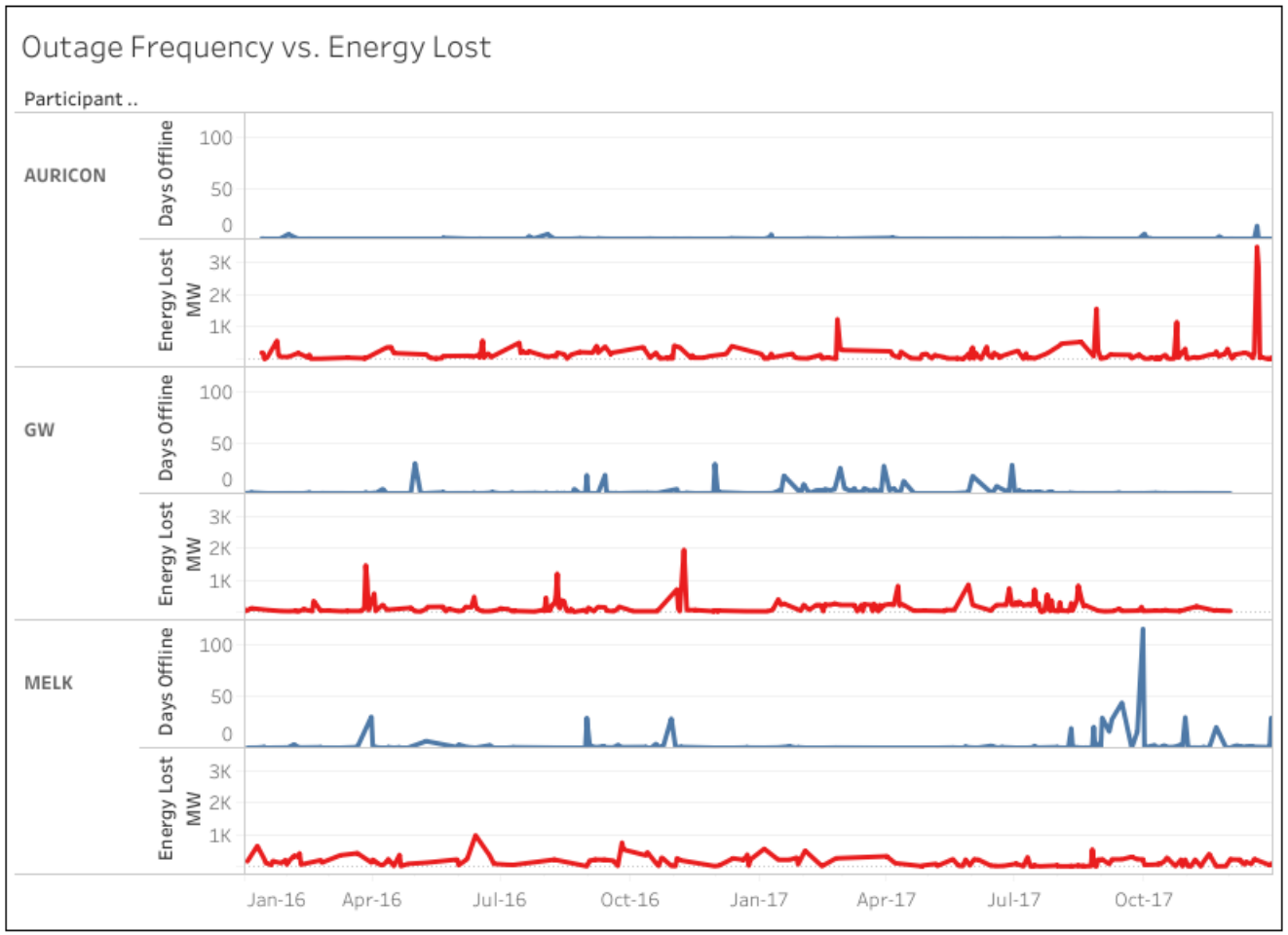
Top 3 Contributors to Energy Loss and Outages - Auricon, GW and Melk

Forced Outages cause the most disruption to Energy Output while consequential and Scheduled outages have relatively low impact on Energy Output.

Duration of an outage is not always correlated to Energy Loss from an outage. As shown in December 2017 for Auricon, the highest Energy Lost for any Participant was over 3 days in December 2017 - a relatively short outage. Melk at a very long outage > 100 days in October 2017, yet Energy Lost was < 1k MW.





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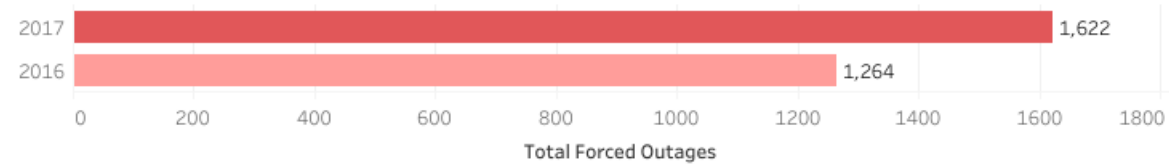
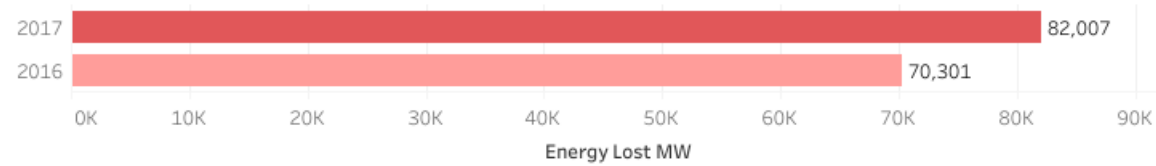
Forced Outages Increased by 28% YOY and Energy Loss Increased by 17%

Auricon contributed 60% of the increased Outages which was offset by Participants with reduced outages for a overall increase in Outages of 28% from 2016 to 2017. Auricon also contributed 57% of the Energy Loss which was offset by Participants with reduced Energy Loss for a total Increase in Energy Loss of 17% overall.

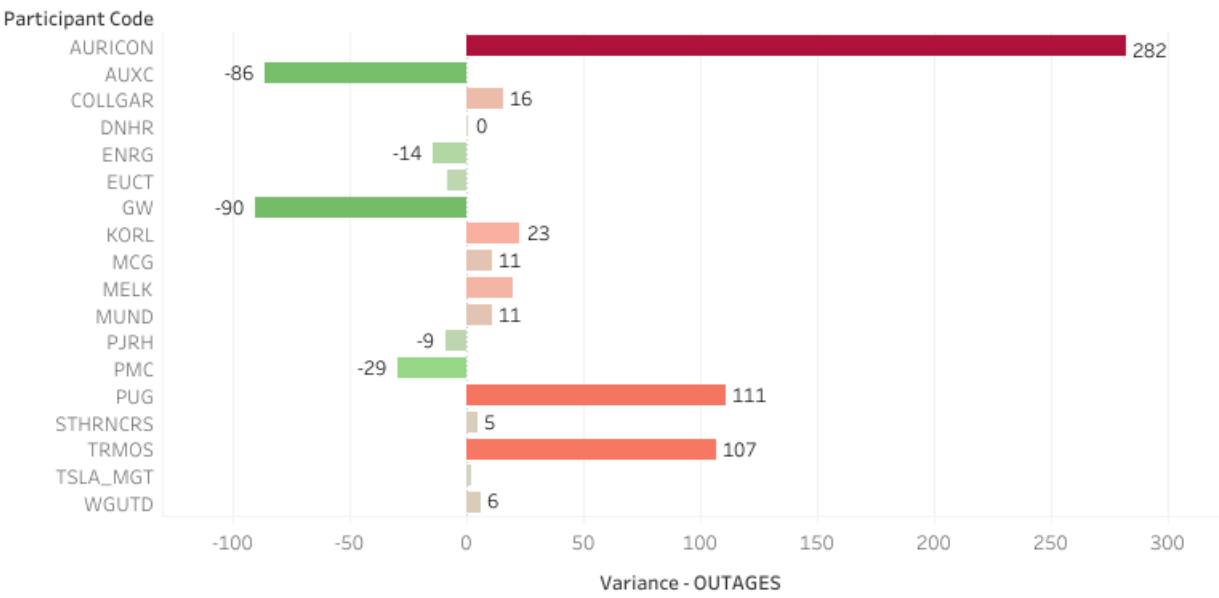
Total Forced Outages by Year



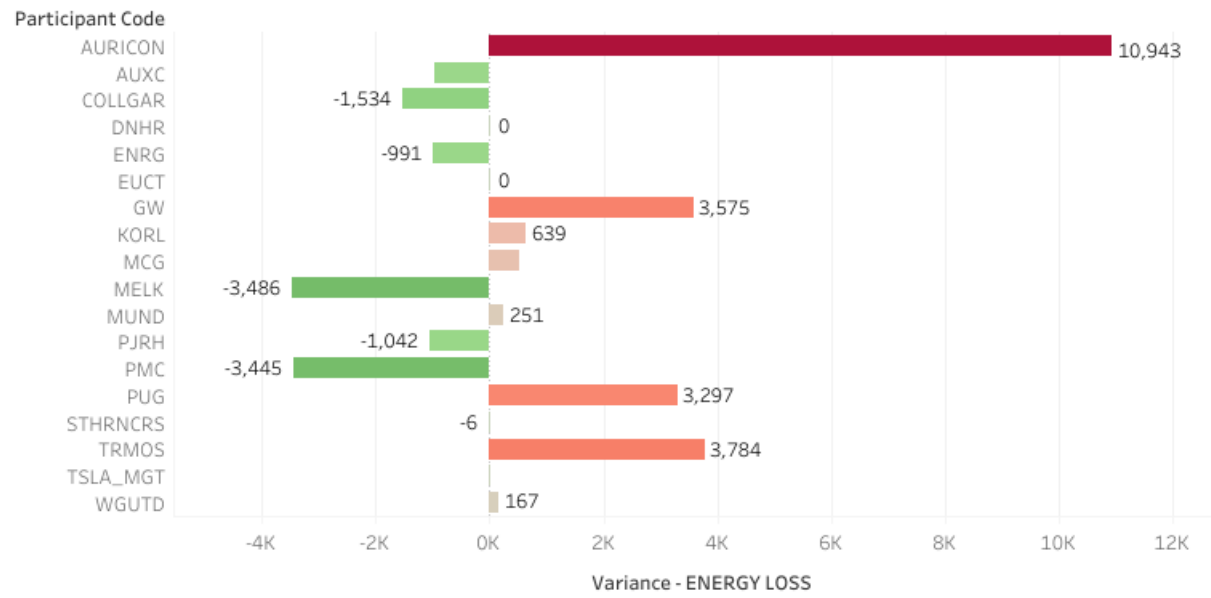
Total Energy Loss by Year (MW)



Change in Number of Forced Outages 2016 to 2017



Change in Energy Lost from Forced Outages 2016 to 2017



Generally, Year-Over-Year increase in Forced Outages equals an increase in Energy Lost. However, for Melk, the number of outages increased by 20 outages from 2016 to 2017, yet the Energy Loss for Melk actually decreased by 8,717 MW.

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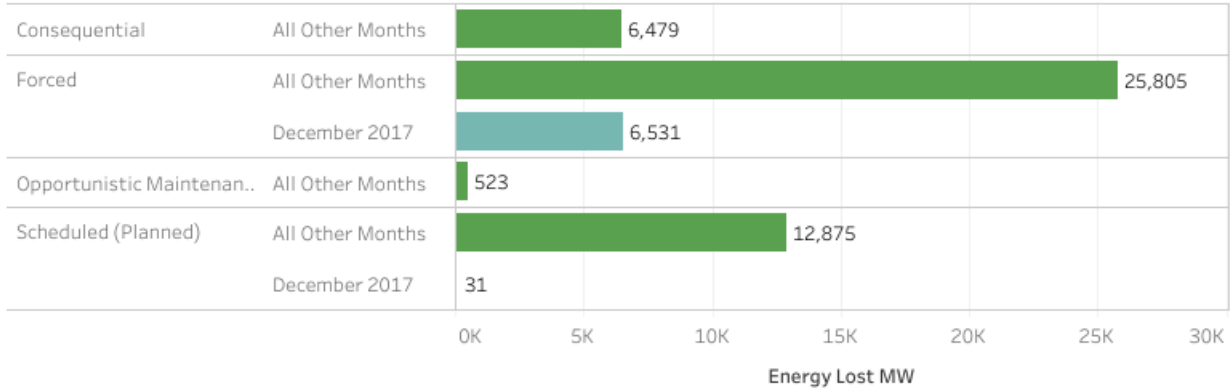
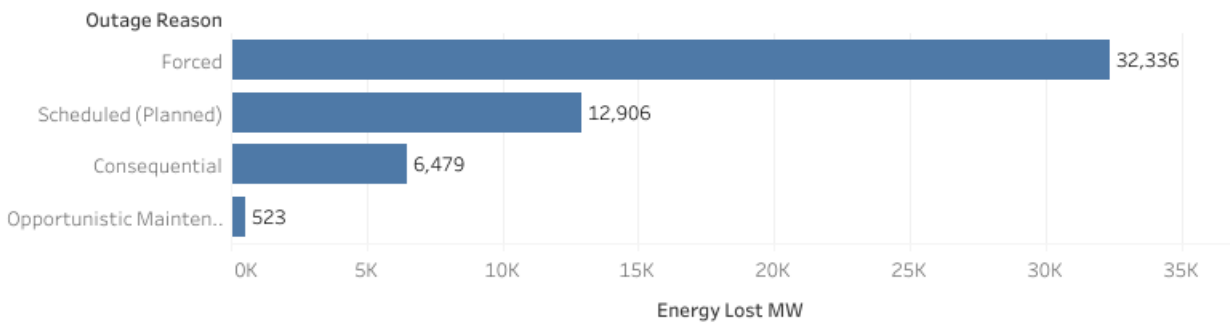
Auricon December 17, 2017 to December 22, 2017 Outage

This outage accounted for over 20% of total Energy Lost during 2016-2017 for Auricon. The outage lasted 3 days and the main incident was caused by a Full Unit Trip.

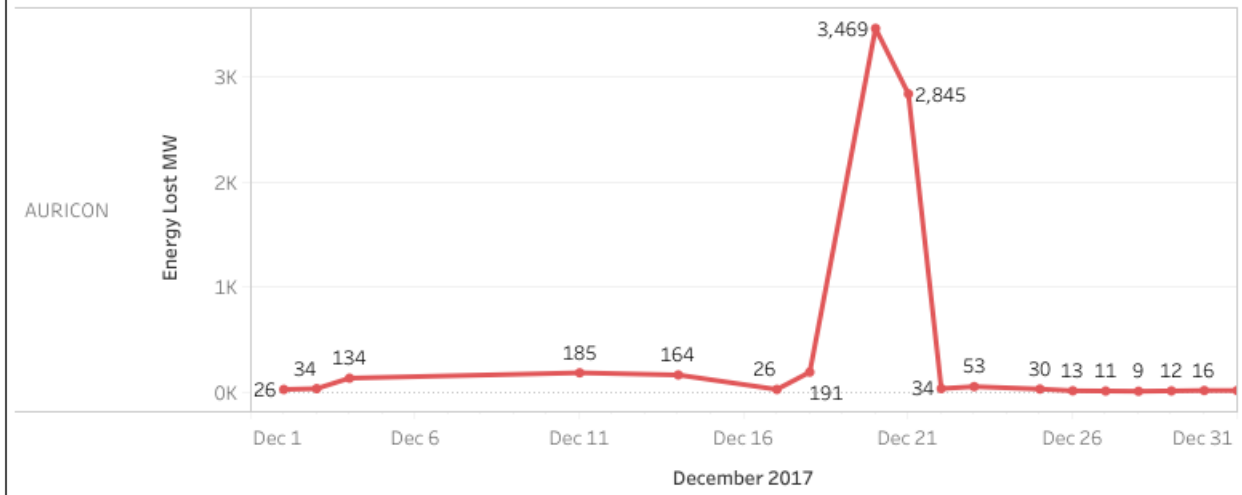
December 2017 Auricon outage compared to All Other Months - Energy Lost



Auricon Outages - All Years by Reason



Auricon - Energy Lost December 2017



Description of Outage & Energy Loss by Day

	Dec-17-2017	Dec-18-2017	Dec-20-2017	Dec-21-2017
Full unit trip			3,460	2,574
Output reduced due to ambient conditions			8	69
Reduced generation capability			1	
Slow to ramp up	26			
Unit slow to ramp up				202
Wind farm output limited		44		
Wind farm tripped		147		
Grand Total	**26**	**191**	**3,469**	**2,845**

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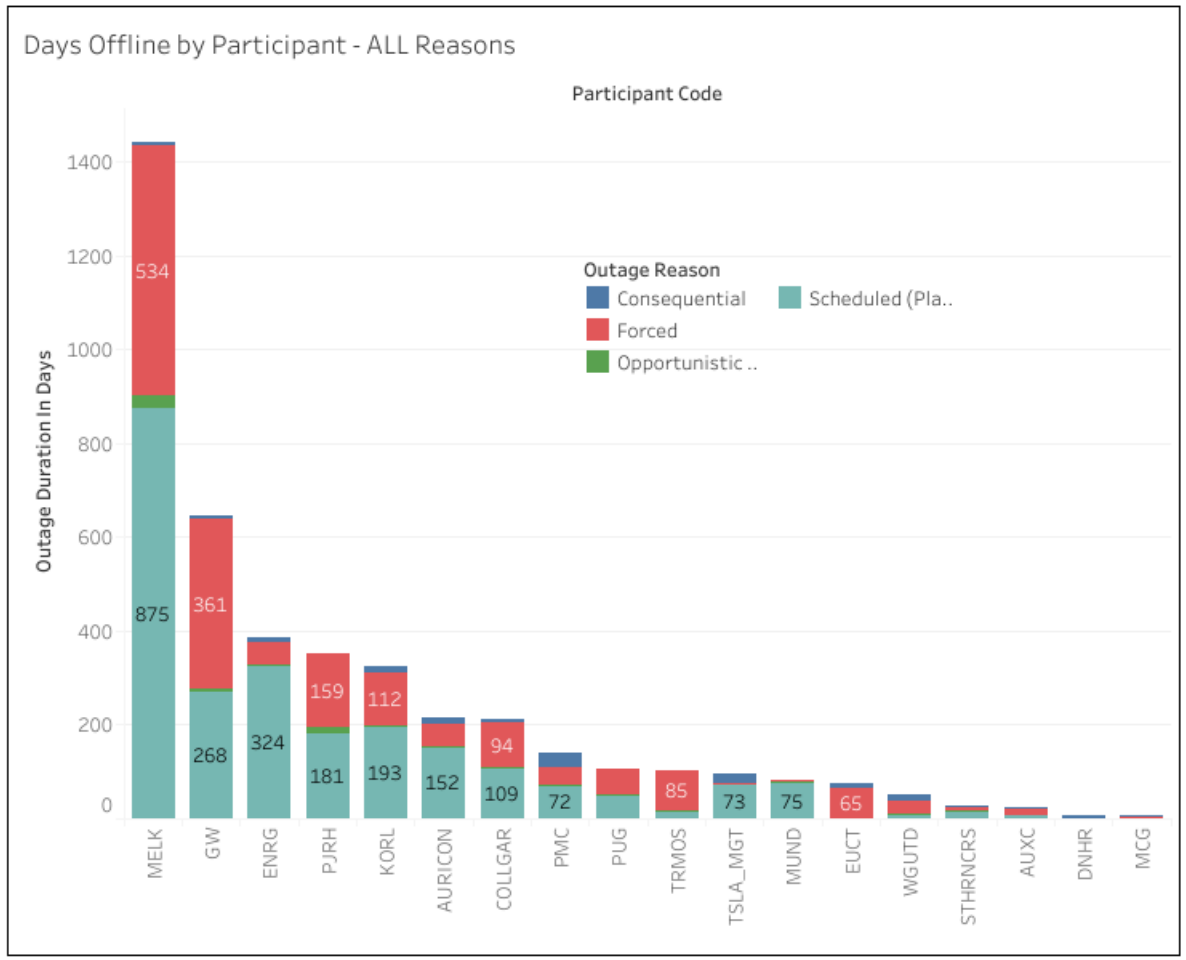
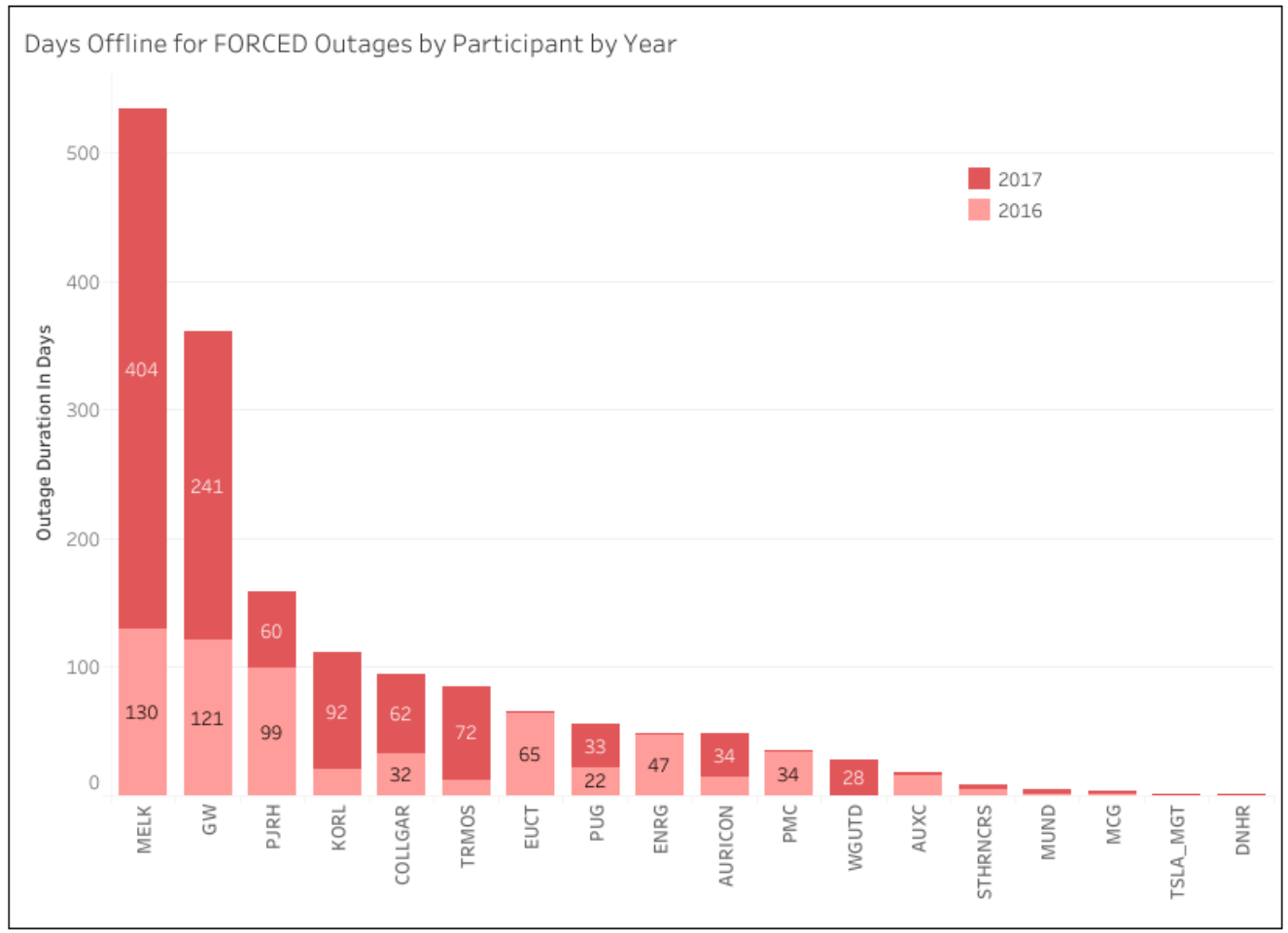
Days Offline increased 68% from 2016 to 2017.

Scheduled and Forced outages account for 95% of Days Offline. Forced Outages = 1,664 days offline and Scheduled Outages = 2,423 days offline.

Days Offline Increased 68% from 2016 (621 days) to 2017 (1,044 days). Melk contributed 44% to the increase (+274 days) and GW contributed 20% (+120 Days)





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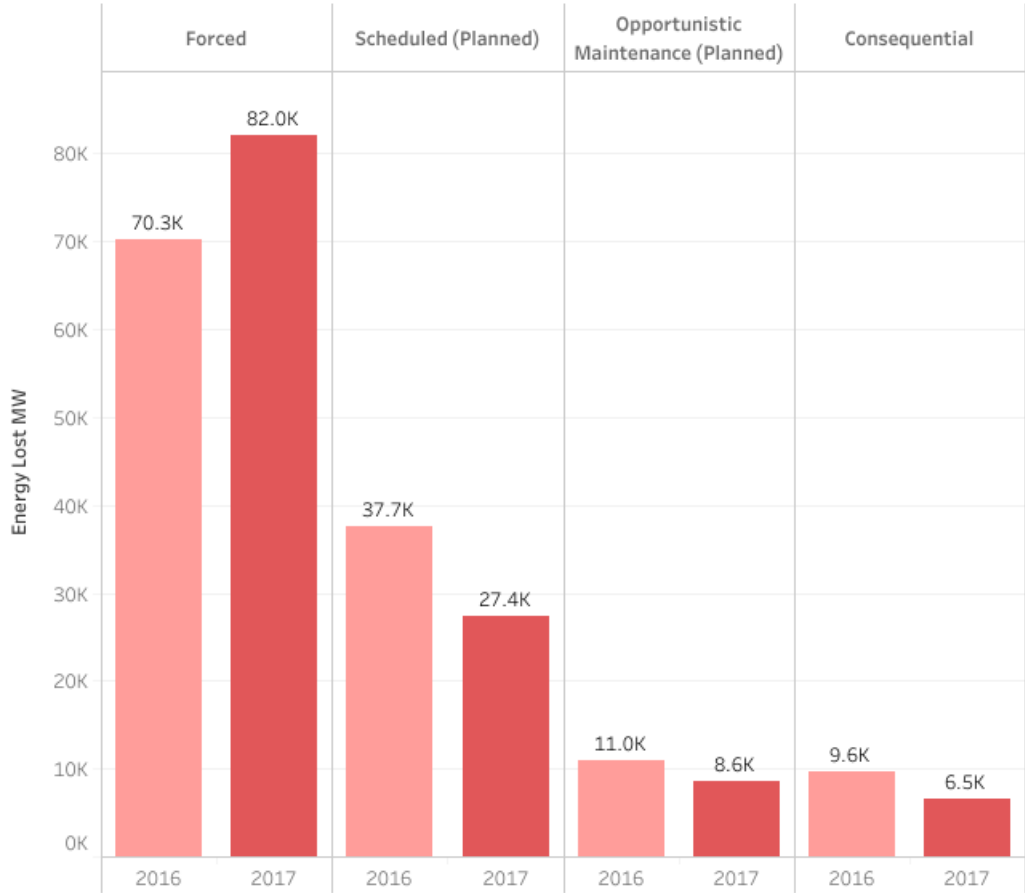
Overall Energy Loss decreased by 3% from 2016 to 2017 due to decreases in Energy Loss for Scheduled, Maintenance and Consequential Outages.

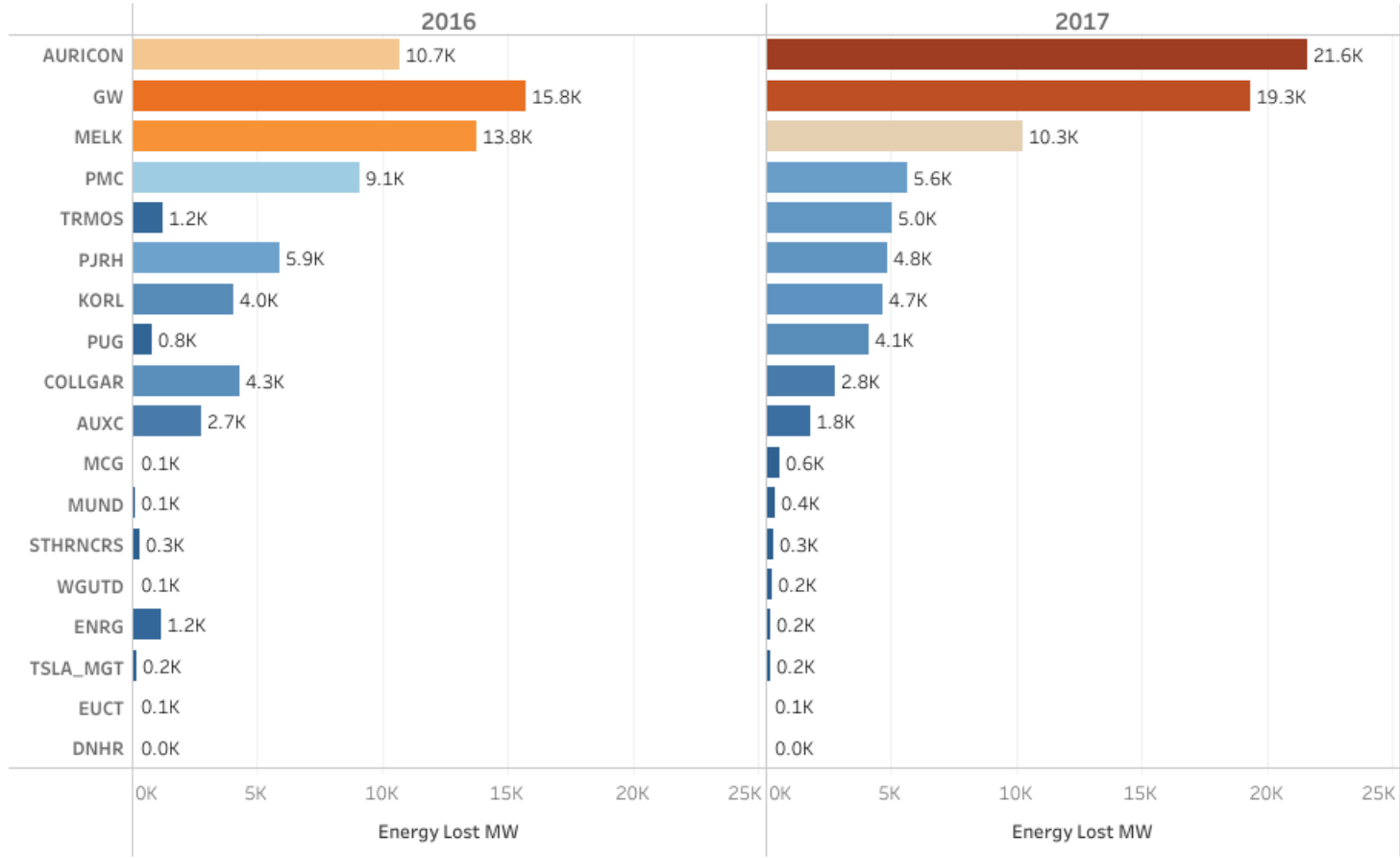
Scheduled and Forced outages account for 95% of all Energy Loss. Forced Outage Energy Loss increased by 17% from 2016 to 2017, but was offset by decreases in all other Outage Types for a total decrease from 2016 to 2017 of 3%.

Auricon and GW accounted for the largest increase in Energy Loss from 2016 to 2017. Auricon's Energy Loss increased by 100% (11,000MW to 22,000MW) and GW's Energy Loss increased by 20% (16,000MW to 19,000MW).

Energy Loss by Year and Outage Reason



Energy Loss by Market for Forced Outages



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Key Takeaways

1. Auricon, Melk and GW contributed the most to all outage metrics. Data provided did not indicate the energy actually produced by these entities and so a future analysis should consider Energy Produced vs. Energy Lost.

2. The trend for number of Forced Outages increased from 2016 to 2017. A review of causes of Forced Outages may identify some key improvements that can reduce this going forward.

3. Participants are increasing efficiency in how Planned and Scheduled outages are handled - decreases in Energy Loss and Duration Offline by these tasks offset increases in Forced Outages. Participants should continue to improve efficiencies in non-Forced outage events.

4. Auricon's December 2017 3-day outage had a significant impact on energy reliability due to a 'Full Unit Trip' incident. A detailed review should be done to understand how this could be prevented in the future.