



SIEMENS

# Siemens Wind Power / UCF College of Sciences: Wind Analytics Contest 2017



Siemens D3 platform – 3.0-MW direct drive wind turbines

Reduced complexity,  
increased profitability

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During operation, wind turbines automatically generate event information, warnings, and faults

Some cause the turbine to shut down and require intervention before restart



## Optimizing how wind turbines work with machine learning

October 14, 2014 by Ulrich Kreutzer

Wind parks produce their own air circulation dynamics. First row turbines get more wind than those in the middle. They also produce vortices that affect the performance of downstream turbines. Learning software can reduce these effects by optimizing rotor speeds and blade angles.

Wind turbines are maintained by technicians, who visit the turbines when some action is needed. Visits are always performed by teams of at least two, and travel time between the maintenance building and turbines can be as much as 30 minutes or more.





A manual switch is located at the base of every turbine, and upon arriving at the turbine, the technician must switch this from remote to local operation.

This signal indicates the turbine was visited, is used to track Park operations with regards to the frequency with which they personally visit a turbine.

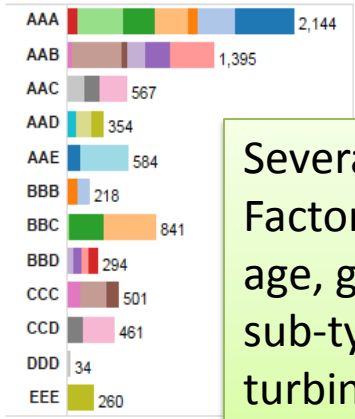
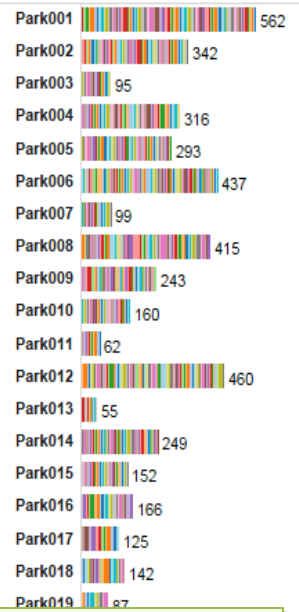
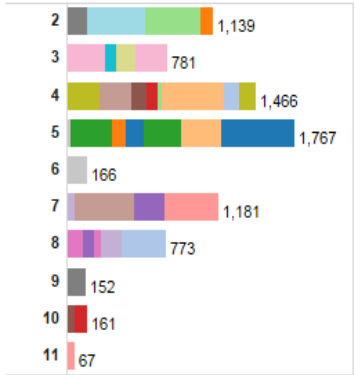
# DATASET PROVIDED

Information Log prior to one subset of Visits (visits < 30 mins)

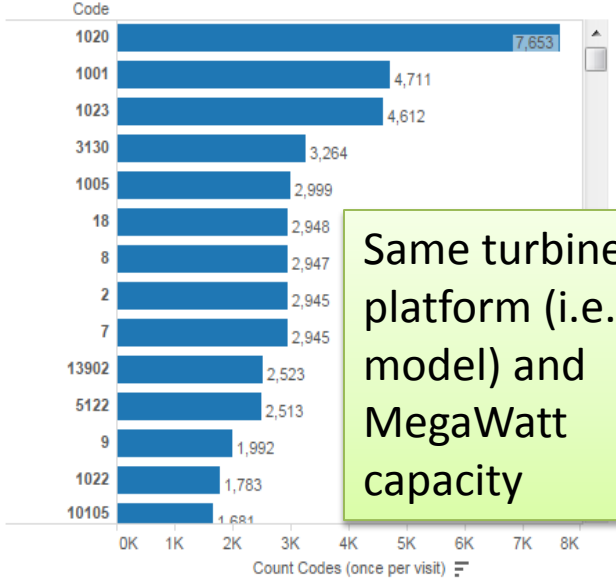
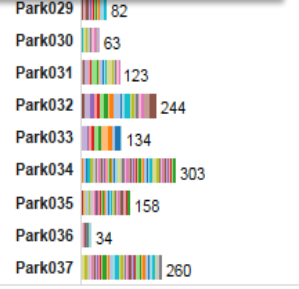
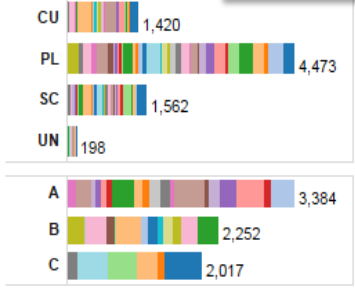


- 1 year's worth of visits
- 172,000 records
- 37 wind parks

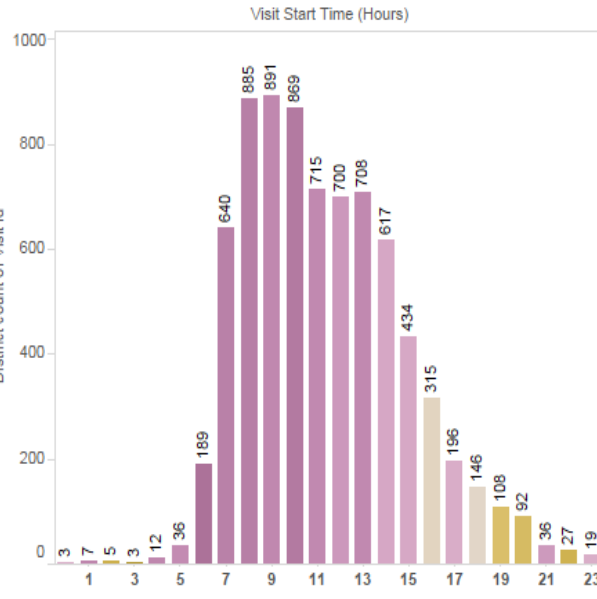
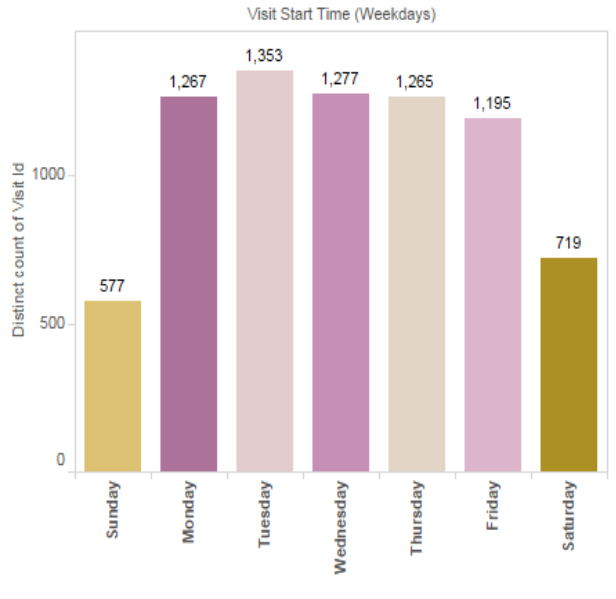
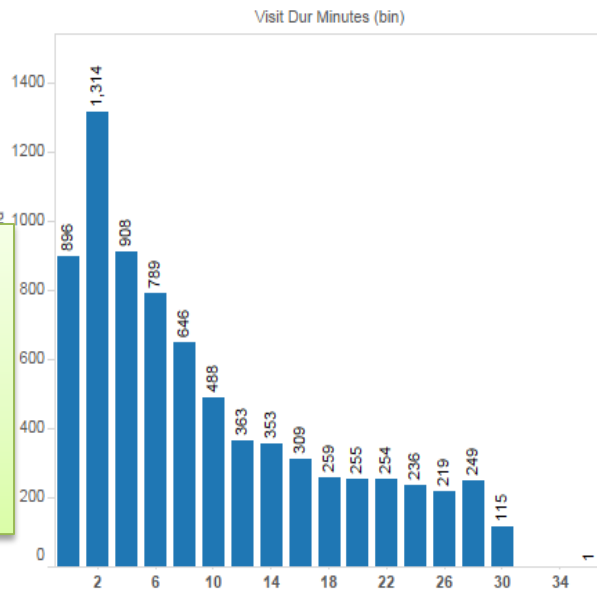
total visit count **7,653**



Several anonymous Factors (could be age, geographic, sub-types of turbines...)



Same turbine platform (i.e. model) and MegaWatt capacity



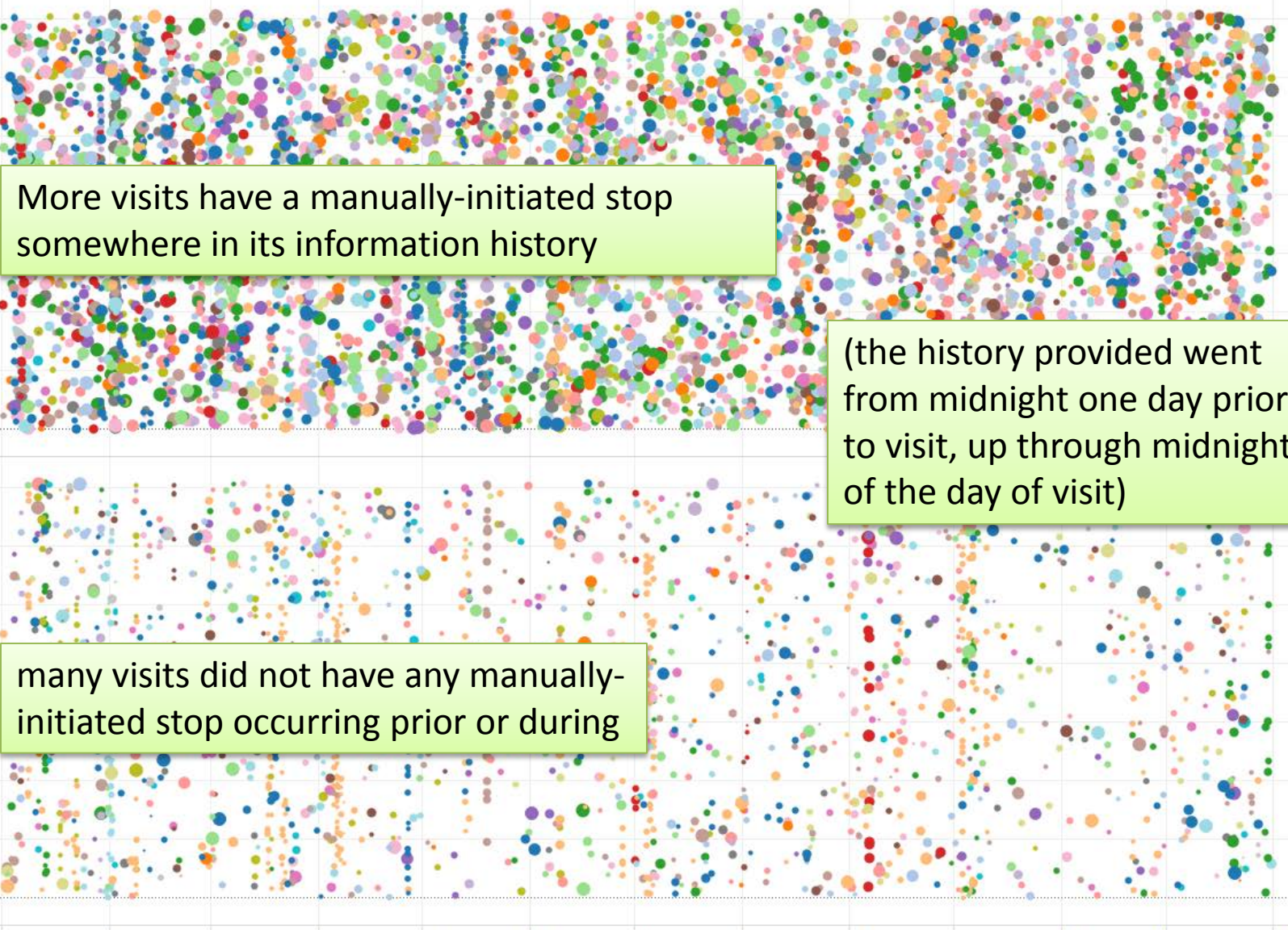
Each dot represents a visit; size of dot corresponds to length of visit (from 2 minutes to 30 minutes).

Visits vs time (shows patterns) - X axis time; Y axis just separates simultaneous points for better viewing

ManualStop during Visit

- Visit Type
- (All)
  - CU
  - PL
  - SC
  - UN
- Cancel Apply

manual stop



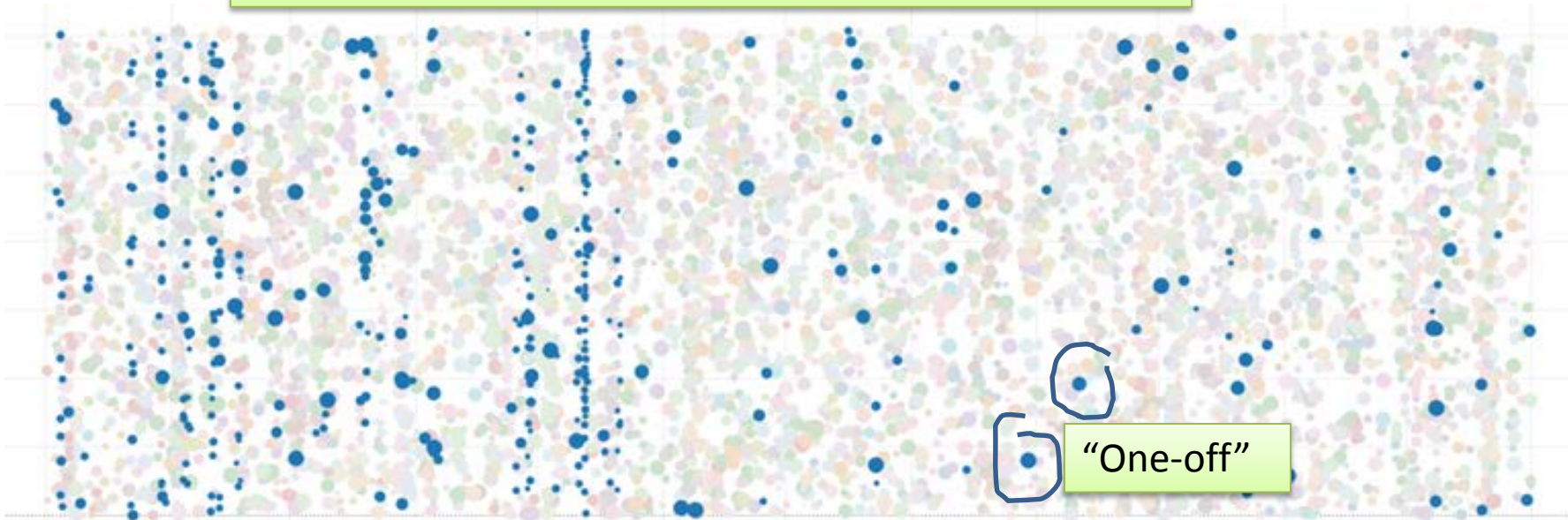
More visits have a manually-initiated stop somewhere in its information history

(the history provided went from midnight one day prior to visit, up through midnight of the day of visit)

many visits did not have any manually-initiated stop occurring prior or during

no manual stop

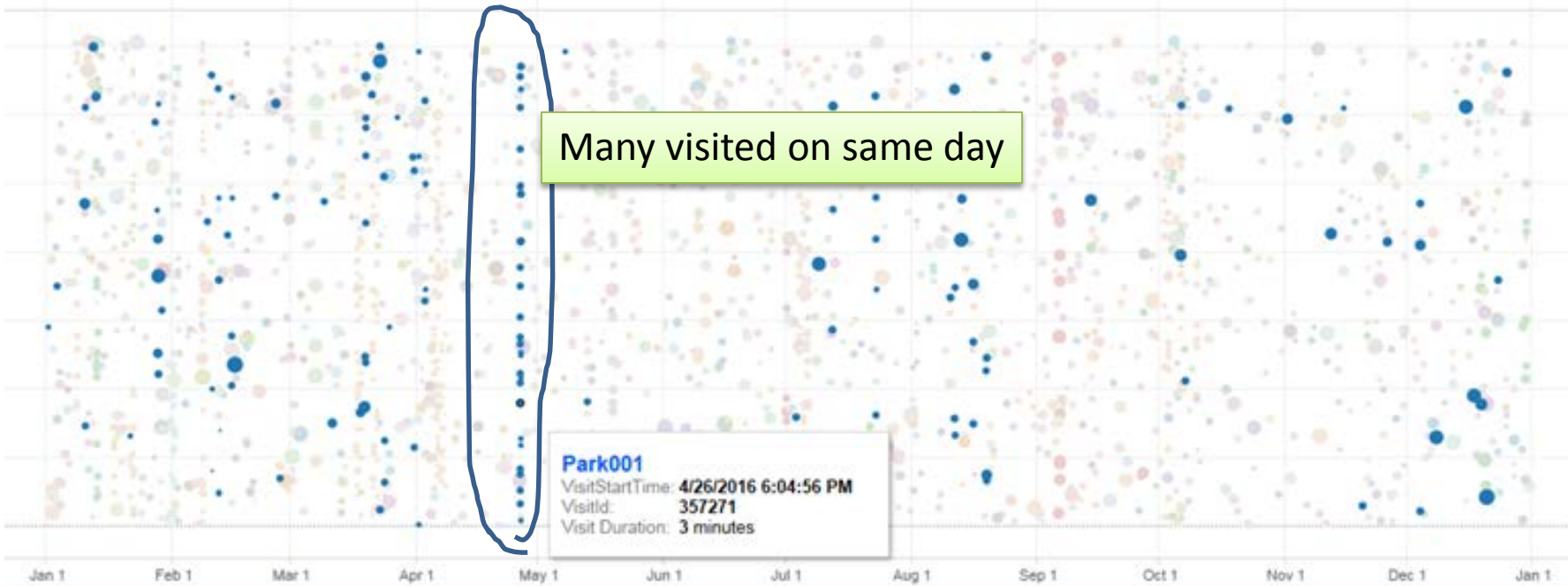
Some parks exhibit MANY visits on the same day, along with seemingly random 'one-off' visits



“One-off”

Many visited on same day

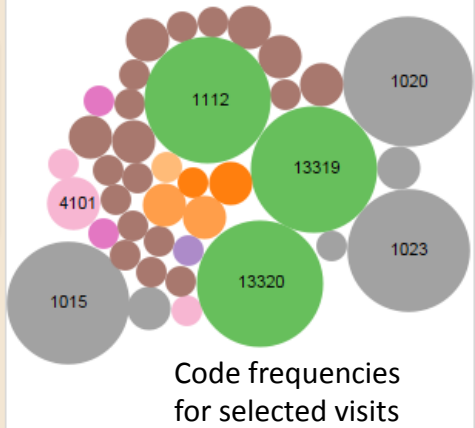
**Park001**  
VisitStartTime: 4/26/2016 6:04:56 PM  
VisitId: 357271  
Visit Duration: 3 minutes





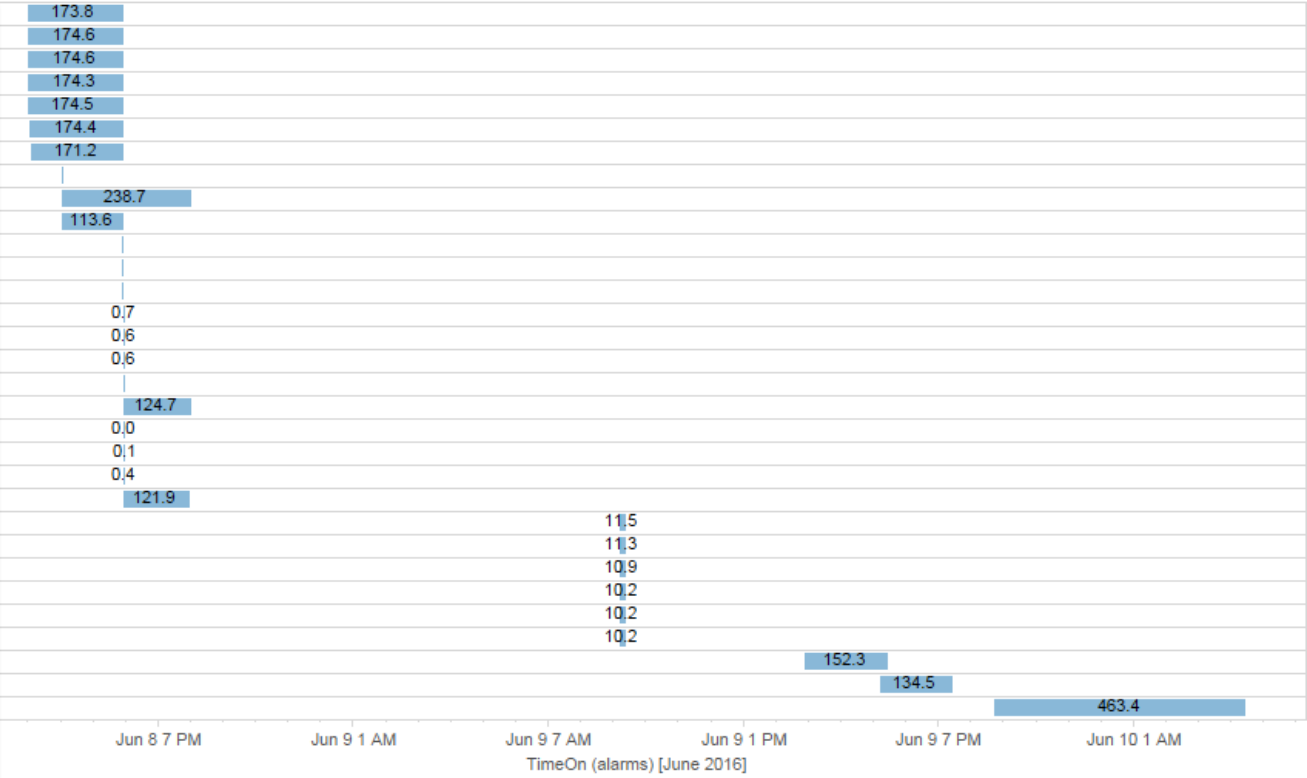
Station ID	Visit Id	Min. V.	Visit Start Time	code sequence (repeats removed)
10836	304603	12	6/9/2016 9:11:53 AM	5122-5110-5104-1018-5111-5112-5113-9-63003-1020
10848	1028789	5	6/13/2016 6:48:44 AM	
10856	856090	10	6/11/2016 11:24:20 AM	
10870	121365	12	6/11/2016 11:58:15 AM	
10872	343473	10	6/11/2016 12:14:02 PM	
10874	988579	11	6/11/2016 12:28:40 PM	
10876	642077	11	6/11/2016 12:42:28 PM	
10878	483300	10	6/11/2016 1:48:27 PM	
10880	685919	13	6/11/2016 2:01:41 PM	
10882	198245	11	6/11/2016 2:19:14 PM	
10884	807743	12	6/11/2016 2:33:57 PM	
10888	26228	9	6/11/2016 3:49:52 PM	
10900	562553	8	6/11/2016 4:34:22 PM	
10902	550148	8	6/11/2016 4:23:55 PM	

Sequences and frequencies of codes can be generated from this historical log



Visit Id	Code	Alarm Description
304603	5122	
	5104	
	5110	
	1018	
	5111	
	5112	
	5113	
	9	
	1020	
	63003	
	2	
	7	
	18	
	13902	
	14001	
	15001	
	8	
	1023	
	14001	
	15001	
	1001	
	1025	
	1020	
	1023	
	1112	
	13319	
	13320	
	4101	
	4102	
	4101	

Data file of information log history, provided, shows the sequence, pattern, and length of event codes, warning codes, and fault codes prior to the Visit



# ANALYSIS TASKS

- Investigate the codes leading up to the visit for patterns in seeing either particular codes or a specific pattern of code sequence
- Investigate patterns or commonalities by various factors
- Consider segmenting code occurrences or sequences into those occurring BEFORE, DURING, and AFTER the visit to look for associations or patterns
- Take special note of many turbines at a Park being visited on the same day vs. “one-off” visits