CABRAS #1 & #2 PERFORMANCE

CCU Working Session
Guam Power Authority
November 08, 2011

CABRAS #1 AND CABRAS #2

- Cabras #1 and #2 were installed in 1974 and 1975 respectively (37 and 36 years old respectively)
- Two 66 MW reheat units fired with RFO No. 6
- TEMES: Plant Performance Management Contractor since 2003
- TEMES: Contract requires performance testing every two years
- Overhauls: Most Recent & Next Planned
  - Cabras #1 July 2010; July 01 – July 30, 2012
  - Cabras #2 April 2009; January 08 – February 16, 2012
- Contract requirements
  - Effective Availability Factor at 90% minimum
  - Gross Heat Rate
    - 1st contract year: Within +2% of baseline (baseline from 2005 performance test)
    - 2nd – 5th contract year: ±1% of baseline
      - For 2nd and 3rd year baseline was from 1st year performance testing
      - For 4th and 5th year baseline was from 3rd year performance testing

MCHALE REPORT

- McHale and Associates, Inc. - hired to conduct performance testing on the units to gauge efficiency and provide a roadmap and benchmark for improvements
- Timeline
  - Testing: May 21 – June 02, 2011
  - Preliminary Report to TEMES: July 18, 2011
  - General Comments submitted by TEMES to McHale: August 16, 2011
  - Final Report submitted to TEMES by McHale: October 26, 2011
  - Report submitted to GPA with Comments: October 29, 2011
- GPA has not completed review or submitted comments

MAJOR RECOMMENDATIONS BASED ON MCHALE REPORT

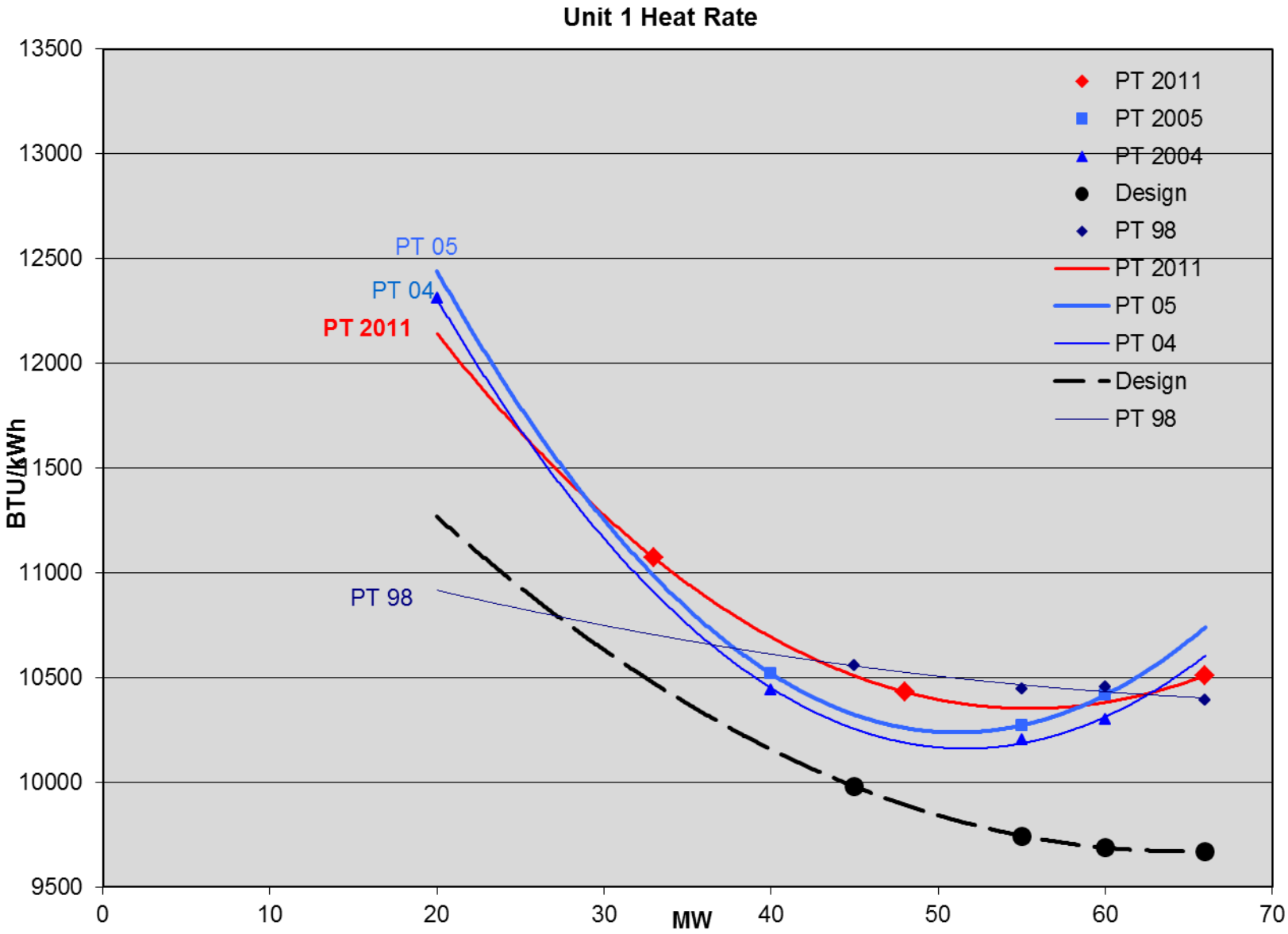
- Add O2 analyzer and CO analyzer system - 2010 Bond Funds
- Implement fully integrated Distributed Control System (DCS) combined with CO and O2 control ability and Boiler Management System (BMS) –Bond Funds
- Vary levels on feedwater heaters to produce the lowest DCA (Drain Cooler Approach). If values do not improve, repair drain cooler section of the feedwater heater – O&M
- Check lift on CWP – O&M (CWP 1B Completed)
- Check back wash valve on the condenser water box divider plates – O&M (Unit #2 Completed)
- Check vacuum system – O&M (Completed and no leaks found)
- Maintain and wash air heater regularly, consider using double seals – O&M

- Clean condenser tubes by high pressure jet with brush - O&M
- Operate the Cabras units between 48MW and 54MW
- Consider separate waste oil treatment facility apart from the Cabras units – CIP 2010 Bond Funds
- Reduce station power consumption rates by operating the units at higher levels, and invest in high efficiency motors and a variable frequency drives – O&M and CIP (SAIC Initiative)

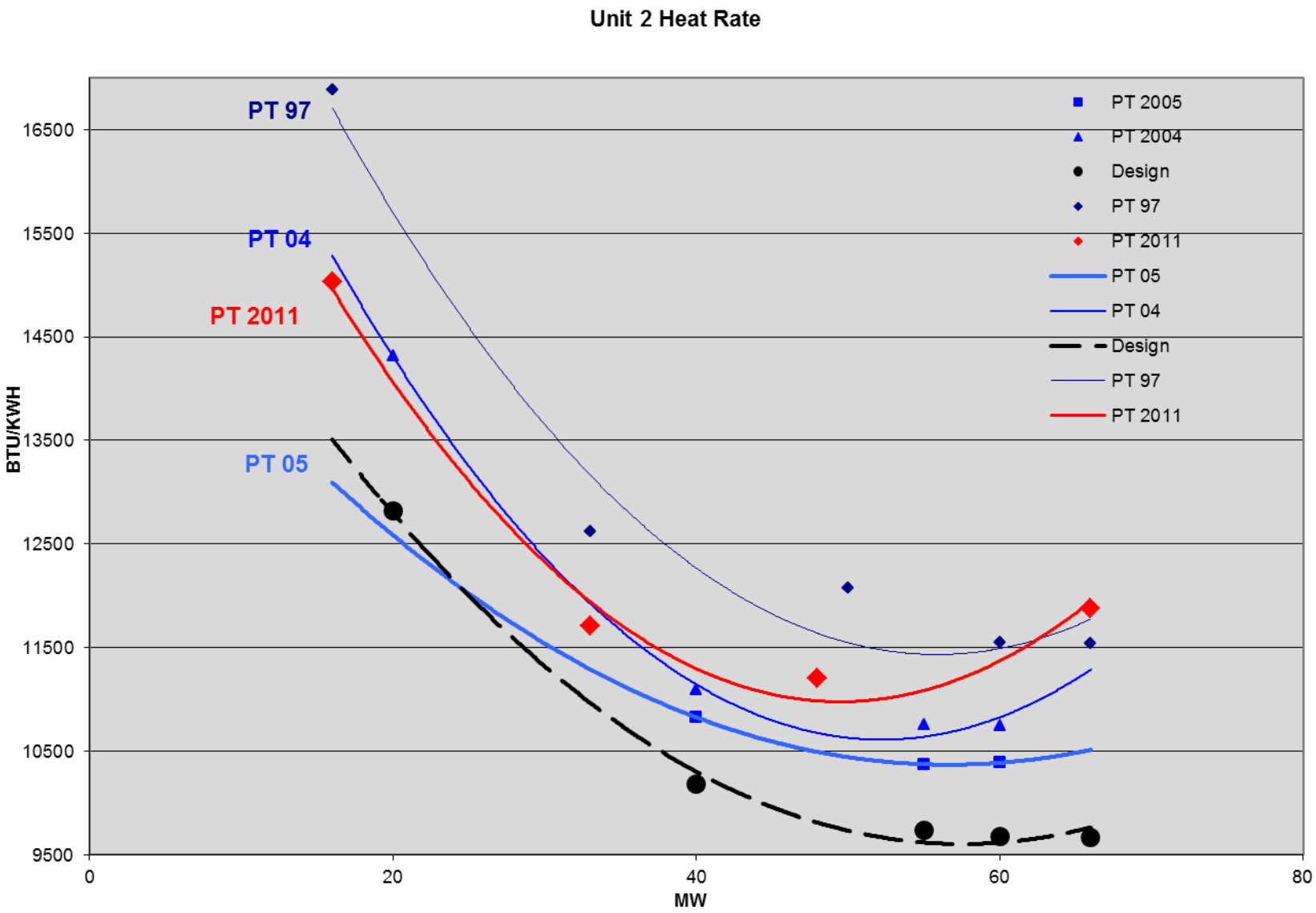
DO INEFFICIENCIES CAUSE RATEPAYERS $19 MILLION DOLLARS ANNUALLY?

- Design curve represents ideal condition
- 1974/1975 design values will always exceed actual performance test values
- There is an impact when fuel consumption increases for the same MW output.
- There is natural degradation of performance as the units age
- GPA works to maintain performance levels near latest performance test values, and to balance reliability and efficiency investments to maximize customer benefits

CABRAS #1 HEAT RATE



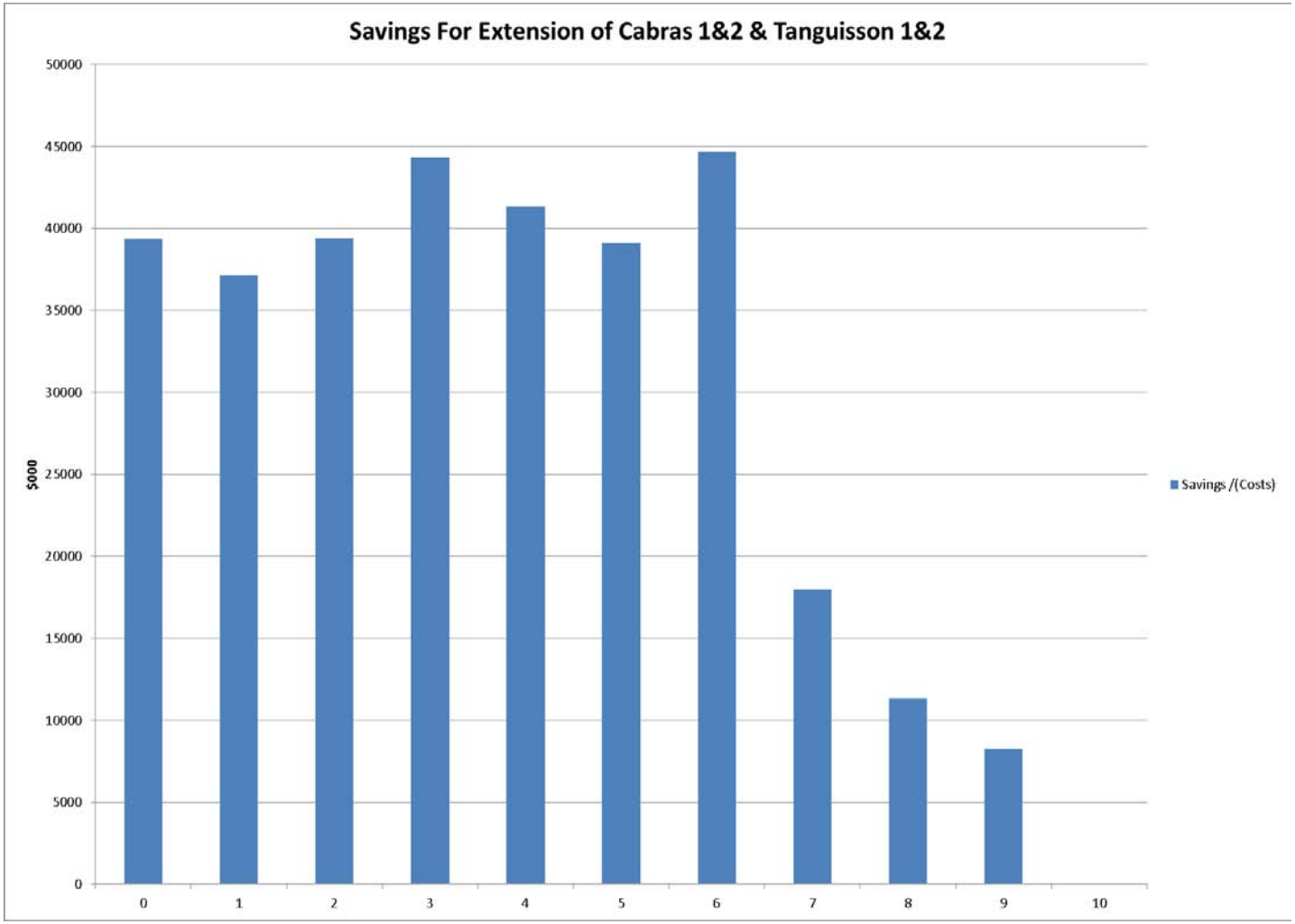
CABRAS #2 HEAT RATE



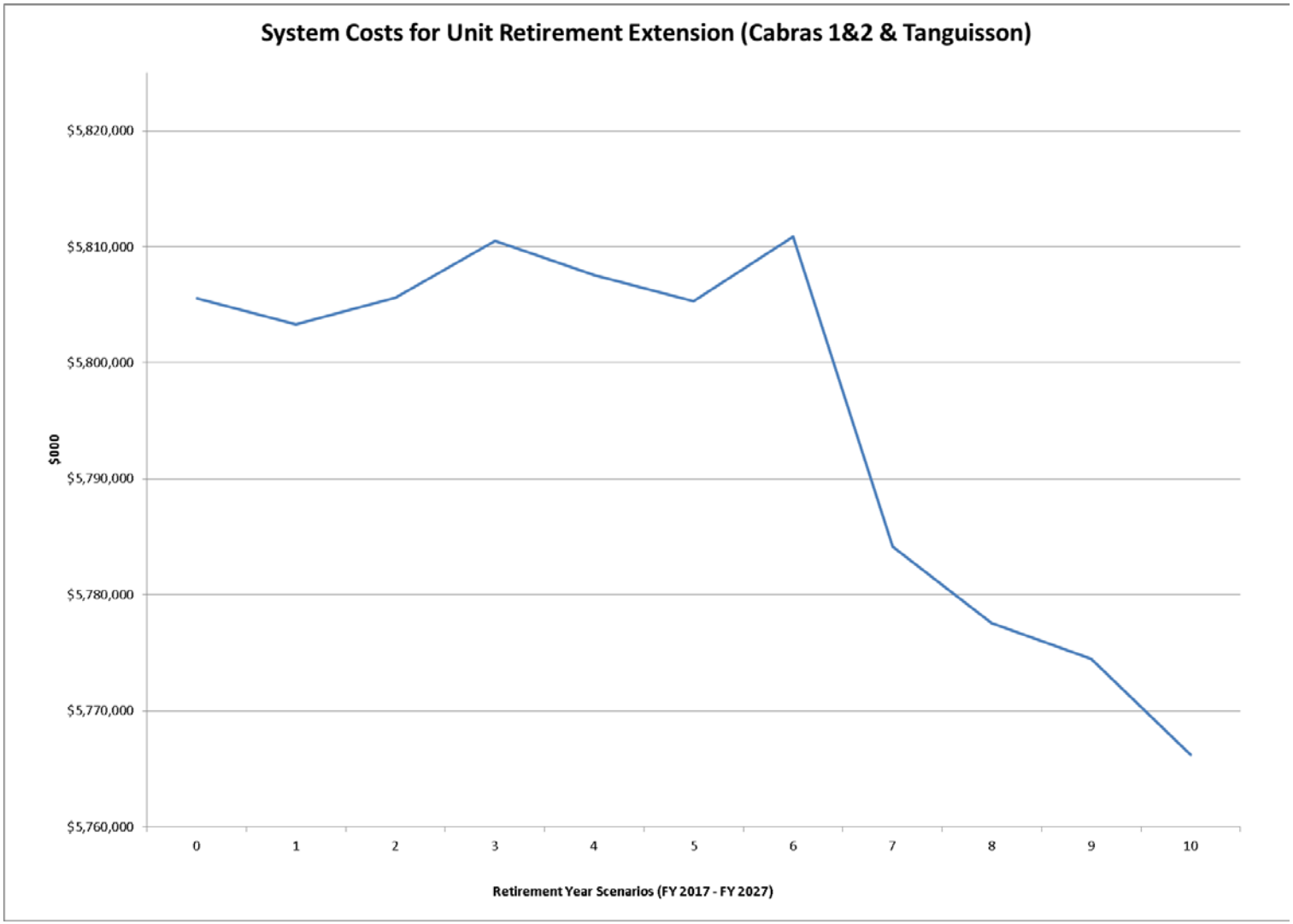
INVEST IN CABRAS #1 & #2 OR BUILD NEW BASELOADS?

- 2008 IRP
  - Original retirement for Cabras #1 & #2 was 2018/2019
  - Evaluation was conducted on deferring units' retirement every year until 2035
  - 2027 is recommended retirement year
  - IRP is currently being updated
  - Plant assessment is necessary to determine true needs for life extension

CABRAS PLANT RETIREMENT VS. LIFE EXTENSION COMPARISON

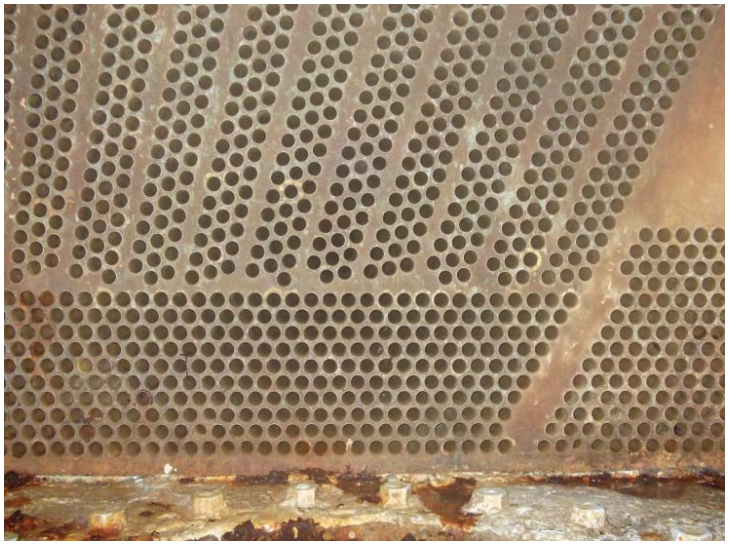


CABRAS PLANT RETIREMENT VS. LIFE EXTENSION COMPARISON



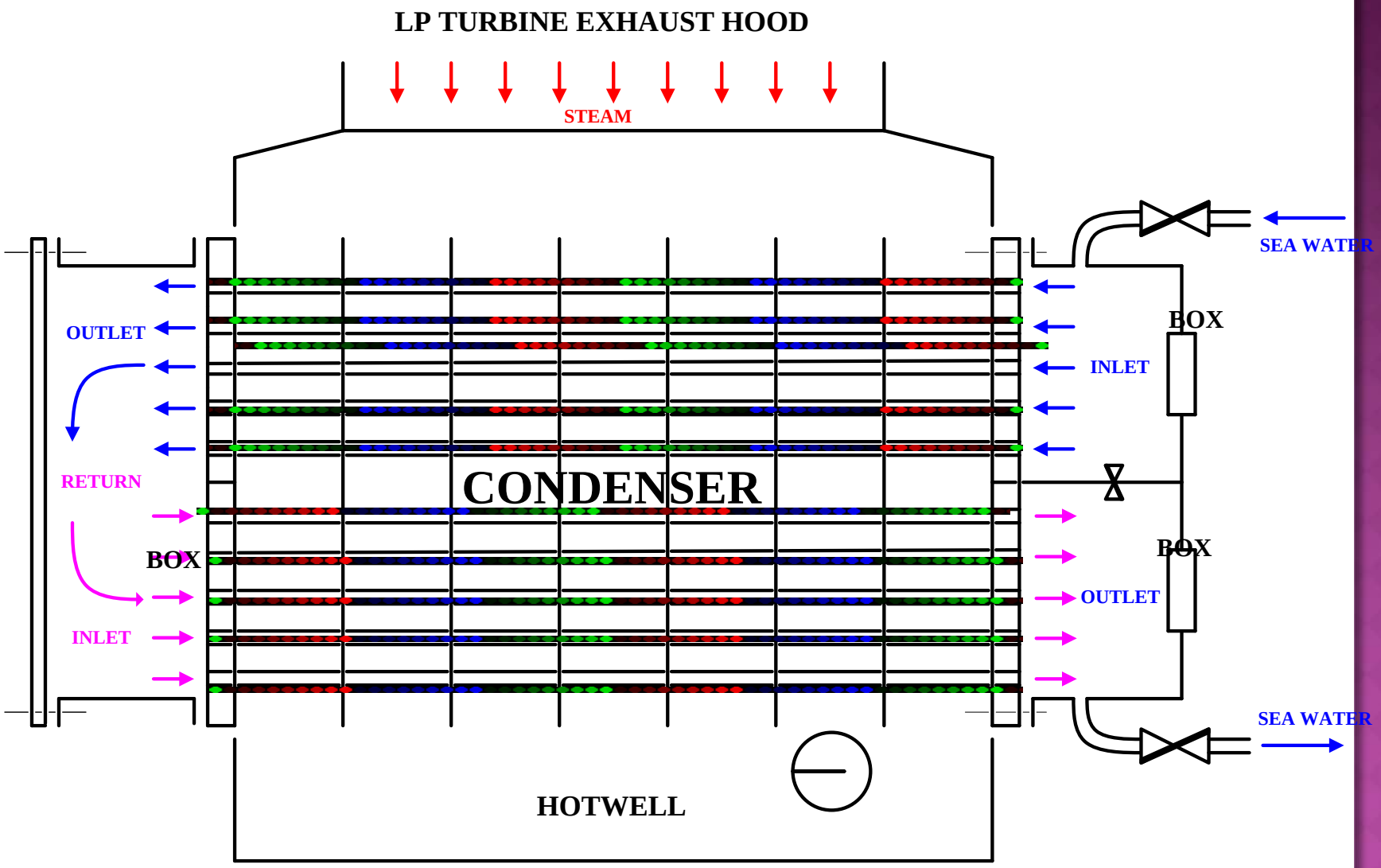
CONDENSER TUBES

Condenser Water Box



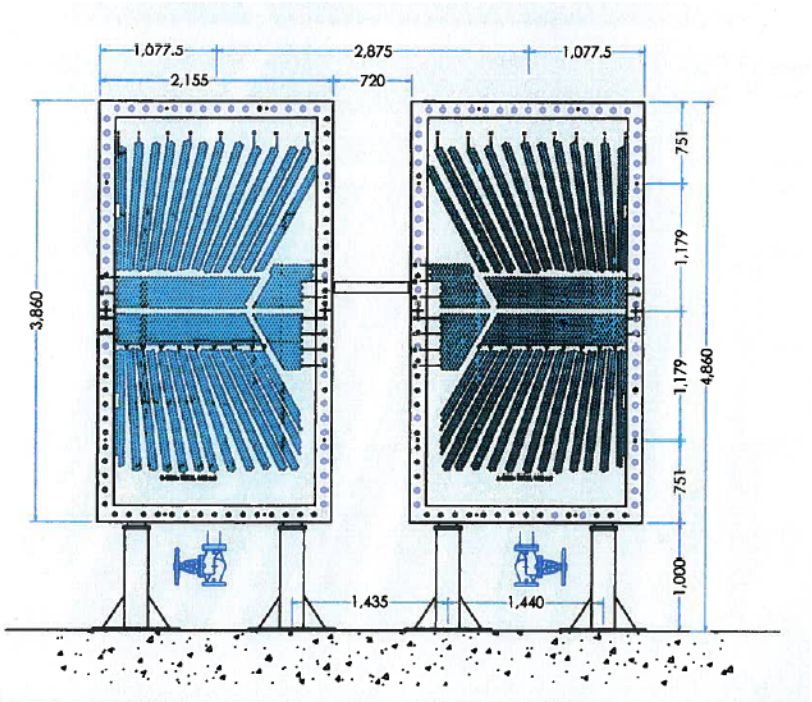
# of tubes = 8,224

SCHEMATIC OF CONDENSER



CONDENSER TUBES

Elevation View of Condenser



Condenser tubes stand 12’8” tall

CONDENSER TUBE CLEANING IS A SHUTDOWN NECESSARY?

- When unit is online, condenser tubes are surrounded by steam from turbine
  - Temperature of 105˚-110˚
  - Safety concern – 10 min. limit for maintenance workers in confined high heat box
- High pressure jet hose and pressure washer with brush attachment used for cleaning.
- Chlorine dioxide for continuous condenser cleaning
  - Previously ruled out by EPA

CABRAS FORCED OUTAGES BOILER TUBE LEAKS

2003-2007

- 14 sections of tube failures
  - Most failures at high heat flux of arch way tubes (8) and side wall tubes (5),
  - Caused by water-side corrosion or blisters due to deposits.
  - Resolution: (1) New water treatment facility (RO+EDI) commissioned (2) chemical cleaning performed (3) material attenuation examination used on critical areas (high heat flux of arch way and water wall tubes)
- 75% of high heat flux tubes replaced

2008 - Present

- 12 sections of tube failures
  - Most failures located on burner zones of front wall, lower panel of sidewall next to the inlet header, corner of water wall and reheater tubes

CABRAS #1 & #2 WASTE OIL ISSUE

- Cabras 1&2 burns waste oil for the island
- Waste oil
  - 2 types - processed and unprocessed
  - 3% to 7% of total fuel consumed by the plant (1 – 3 million gallons annually)
  - Unprocessed waste oil creates heavy deposits on the outer walls of boiler tubes
  - Affects good heat transfer
  - Damages boiler tubes
- Established new procedure for processing of waste oil to minimize damage

TEMES IMPROVEMENT ACTIVITIES

- Performed boiler tube material attenuation examination test - More than 100 sections of tubes replaced
- New water treatment facility, RO+EDI established in 2009
- Unit 1 cold end and hot end air heater baskets replaced in 2010
- Established new procedure for waste oil transferring
- Major maintenance outages reduced from 49 days to 35 days - better planning and use of cold stand by days

TEMES IMPROVEMENT ACTIVITIES

- Unit 1 blasting of turbine blades, cleaning and replacing turbine buckets
- Units 1 & 2 regular cleaning of condenser tubes
- All Units 1 & 2 feed water heaters placed in service
- Units 1 & 2 increased combustion air flow by 10%
- Unit 2 leakage rate of air heater minimized
- Unit 2 water consumption minimized
  - Increased the security of the starting air ejector
  - Replaced leaking boiler tubes
  - Boiler continuous blow down(BCBD) of valves

CABRAS #1 & #2 O&M EXPENDITURES

	Expenses (2010-2011)	Amount
1	Services	$855,981.66
2	Maintenance	$2,714,724.09
3	Parts/Supplies	$1,652,683.29
4	Training	$91,688.47
5	Admin	$27,414.97
	TOTAL	$5,342,492.48

Training activities for GPA employees include:

1) Plant Preventive Maintenance
2) Control Operations
3) Mechanical Maintenance
4) Leadership Management

CABRAS #1 & #2 CIP INVESTMENTS

	CALENDAR YEAR	AMOUNT
1	2005	$2,976,719.98
2	2006-2007	$3,987,559.96
3	2008-2009	$5,365,320.65
4	2010	$754,119.58
	TOTAL	$13,083,720.17

CABRAS #1 & #2 COMPLETED PROJECTS (2005)

	Work Description	Project Cost	Purpose	
1	Unit 1 Condenser retubing	$1,049,486.96	Reliability & Efficiency	Addresses McHale recommendation
2	Replace attemperator System	$448,059.11	Reliability	Addresses McHale recommendation
3	#5 HTR tube bundle replacement	$353,636.07	Reliability & Efficiency	Addresses McHale recommendation
4	Unit 1 Service water pipe renovation	$597,506.00	Reliability	
5	Arch tube replacement	$201,311.56	Reliability	
6	Replace one set of CWP & motor	$55,500.02	Reliability	
7	Replace butterfly valve on CWP system	$113,625.02	Reliability	
8	Boiler refractory renewal	$11,450.35	Reliability	
9	Economizer replacement	$146,144.89	Reliability	
	TOTAL	**$ 2,976,719.98**		

CABRAS #1 & #2 COMPLETED PROJECTS (2006-2007)

	Work Description	Project Cost	Purpose	
1	Unit 1 upgrde air preheater basket hot-cold	$184,248.52	Reliability & Efficiency	Address McHale recommendation
2	Unit 2 preheat and heat treatment	$28,679.80	Reliability	
3	Economizer HDR replacement	$15,422.76	Reliability	
4	Upgrade control valve	$153,714.50	Reliability	
5	Replace reheater & S.H. tubes	$323,374.19	Reliability & Efficiency	
6	Arch tube material replacement	$201,913.79	Reliability & Efficiency	
7	Boiler casing and refractory renewal	$670,708.85	Reliability	
8	Unit 2 generator rotor rewinding	$1,475,045.40	Reliability	
9	Unit 2 condenser retubing	$934,452.15	Reliability & Efficiency	Address McHale recommendation
	TOTAL	**$ 3,987,559.96**		

CABRAS #1 & #2 COMPLETED PROJECTS (2008 - 2009)

	Work Description	Project Cost	Purpose	
1	Unit 2 service water cooler retubing	$408,246.27	Reliability	
2	#2 boiler chemical cleaning (Acid)	$293,531.30	Reliability & Efficiency	
3	Install water treatment facility RO+EDI	$1,356,766.88	Reliability	
4	Arch tube replacement	$506,716.09	Reliability & Efficiency	
5	Replace rear wall & side wall rupture tubes	$992,222.49	Reliability & Efficiency	
6	Unit 2 replace air preheater basket	$232,716.23	Reliability & Efficiency	Address McHale recommendation
7	Turbine generator overhaul	$1,575,121.39	Reliability & Efficiency	Address McHale recommendation
	TOTAL	**$ 5,365,320.65**		

CABRAS #1 & #2 COMPLETED PROJECTS (2010)

	Work Description	Project Cost	Purpose	
1	Unit 1 smoke stack insulation refurbishment	$437,748.80	Reliability	
2	Unit 2 NDE boiler tube testing and inspection	$57,233.18	Reliability	
3	Replace air preheater cold end basket	$211,478.22	Reliability	Address McHale recommendation
4	Unit 1 RH tube replacement	$47,659.38	Reliability & Efficiency	
	TOTAL	**$754,119.58**		

CABRAS #1 & #2 PLANNED INVESTMENTS

	Work Description	Project Cost	Purpose	
1	Replace reheater tubes 35 panels	$1,113,000.00	Reliability, Efficiency	
3	Unit 2 heater drain pump replacement	$83,222.00	Reliability	
4	Unit 2 BFP motor replacement & fuel oil pump replacement	$240,631.00	Reliability	
5	DCS/BMS System	$5,000,000.00	McHale Recommendations	CIP Bond Funds
6	Waste oil treatment system	$150,000.00	Reliability, Efficiency	
7	Unit 2 instrument air compressor and dryer replacement	$129,856.00	Reliability	
	TOTAL	**$ 6,716,709.00**		

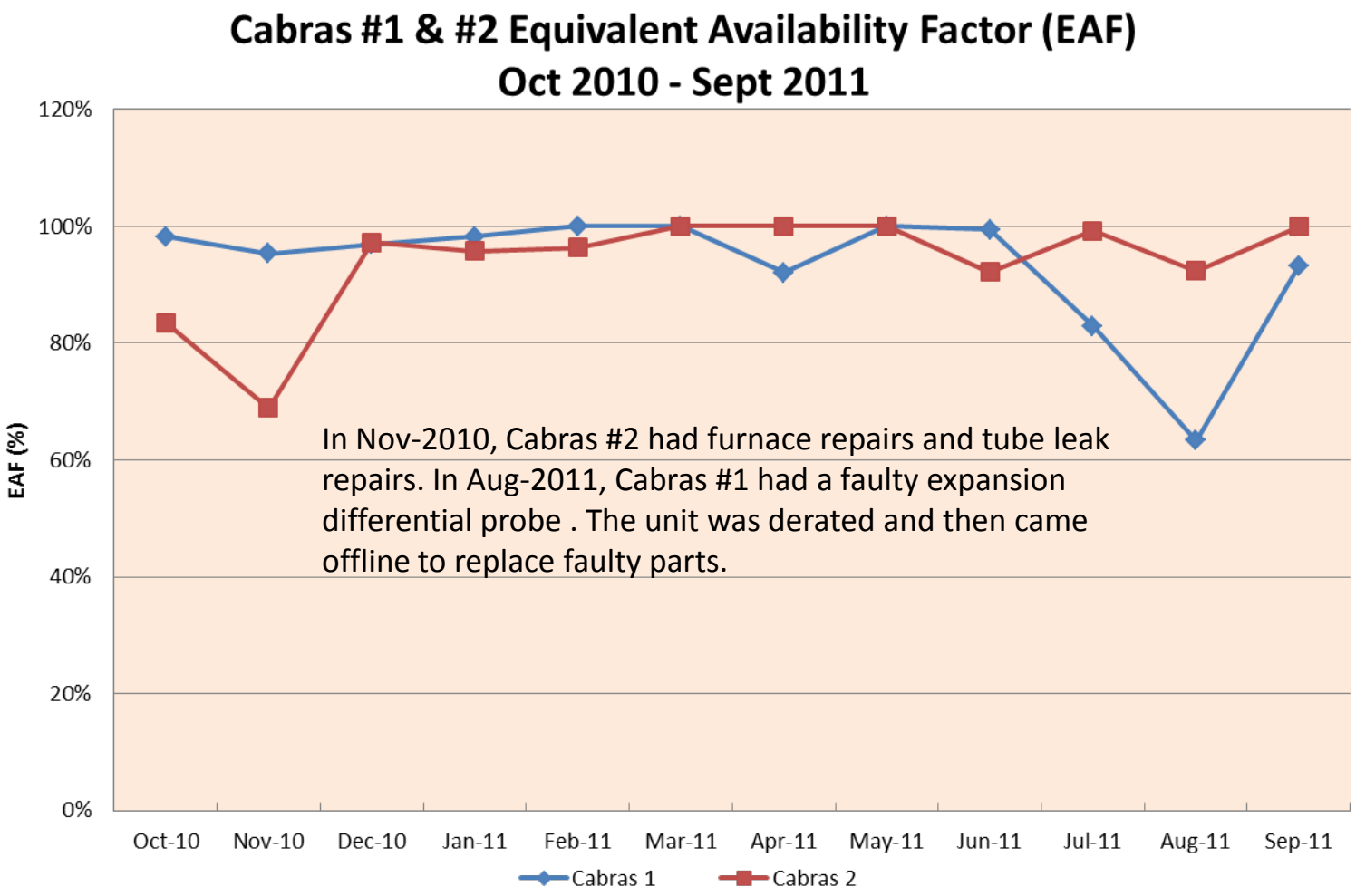
CABRAS #1 & #2 NEW BOND FUNDED PROJECTS

	Project Name	Project Cost	Purpose	
1	Facility Improvements	$1,288,000	Address safety/insurance concern and reliability	
2	Fire Protection for Transformers and Fire Detection System for Boiler Burner Area	$1,400,000	Address safety/insurance concern and reliability	
3	Replace Cabras Unit #2 Hydrogen and CO2 piping	$ 75,000		
4	Replace Existing Yard Fire Hydrant System	$420,000	Address safety/insurance concern and reliability	
5	Install Generator On-Line Monitoring System for Unit 1&2 and Provide Electrical Testing and Measuring Equipment	$ 228,000	Reliability	
6	Waste Oil Facility Improvements	$150,000	Reliability, Efficiency	Addresses McHale recommendation
7	Cabras #2 Reheater Tubes Replacement	$1,113,000	Reliability	
8	Replace Cabras Unit #1 Feedwater Heater #2 and Unit #2 FWH #4	$1,090,000	Reliability, Efficiency	Addresses McHale recommendation
9	Replace Cabras Unit #1 Instrument Air Compressor 1B & Cabras Unit #2 Service Air Compressor	$265,000	Reliability	
10	Cabras Unit #2 Heater Drain Pump & Motor Replacement	$240,000	Reliability	
11	Replace one Boiler feed Pump Motor for Cabras Unit #1	$275,000	Reliability	
12	Replace One Forced Draft Fan Motor for Cabras Unit #1	$275,000	Reliability, Efficiency	
13	Replace Service Water Cooler for Cabras Unit #1	$500,000	Reliability, Efficiency	
14	Replace Unit #1 Auxiliary Transformer - Cabras 1&2	$500,000	Reliability	
15	**Total**	**$7,819,000**		

CABRAS #1 & #2 PLANNED OVERHAUL ACTIVITIES

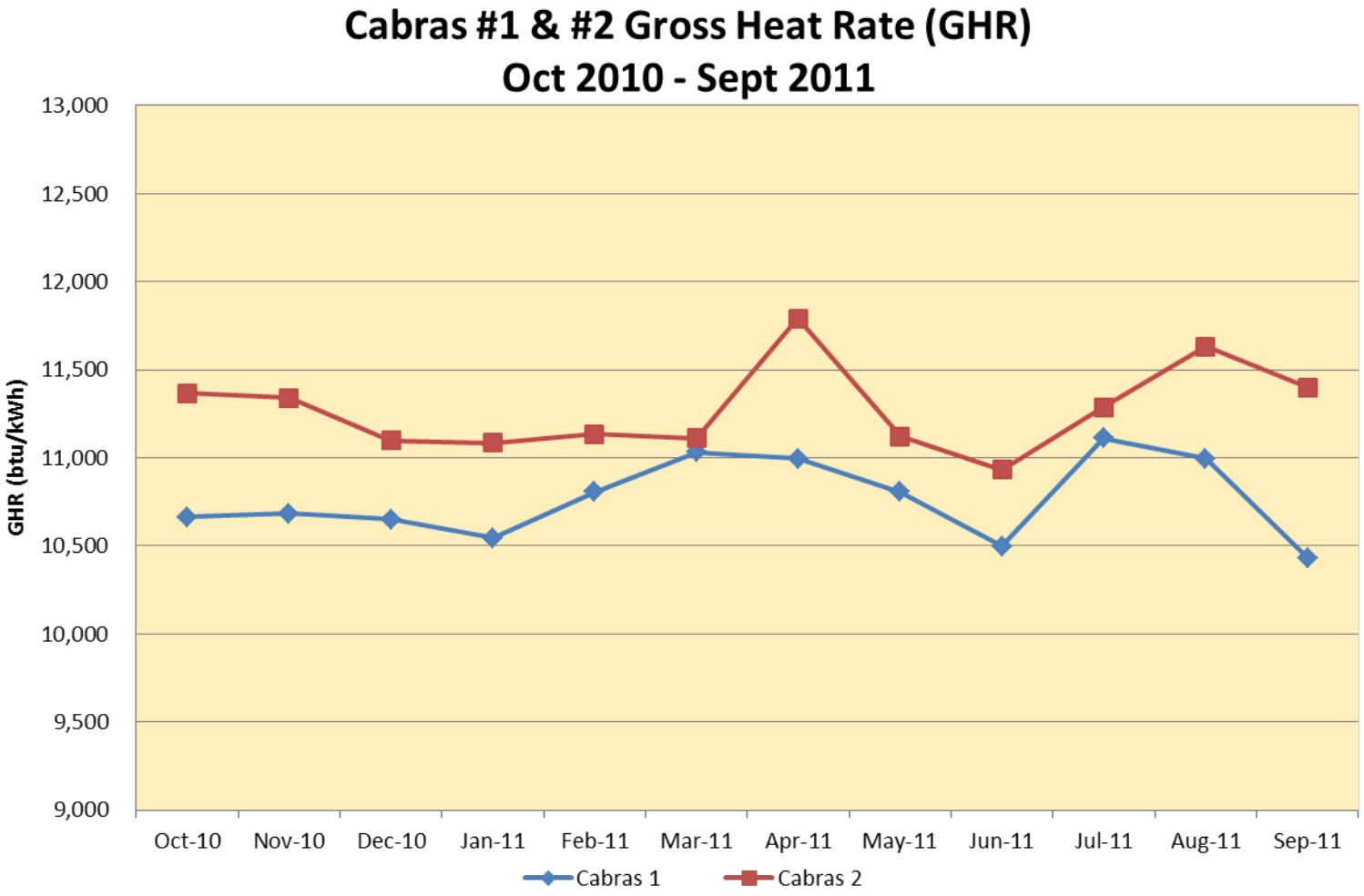
	Work Description	Cost	Purpose	
*1	Replace Unit front Wall Tubes and Lower Hopper Header	$870,000.00	Reliability, Efficiency	
*2	Unit 1 boiler feed pump repair	$92,073.09	Reliability	
3	Unit 2 boiler water wall tubes replacement	$740,317.00	Reliability	
*4	Unit 2 boiler tubes NDE/Attenuation measurement	$108,296.00	Reliability	
*5	Unit 2 BFP motor replacement	$197,683.00	Reliability	
6	Air preheater basket replacement	$174,392.00	Reliability	Addresses Mchale recommendation
7	Vibration adjustment for unit 1 generator #4 bearing	$23,083.39	Reliability	
*8	Replace traveling screen wash pump/motor	$74,570.00	Reliability	
9	Main condenser tube cleaning	$10,000.00	Efficiency	Addresses McHale recommendation
10	Air preheater basket cleaning	$10,000.00	Efficiency	Addresses McHale recommendation
11	Replace deaerator pegging steam control.	$15,000.00	Reliability	Addresses McHale recommendation
12	Adjust feedwater heater operating level and reduce drain cooler approaching temperature		Efficiency	Addresses Mchale recommendation
18	Repair temperature control for RH steam and main steam		Reliability, Efficiency	Addresses McHale recommendation
	TOTAL COST	**$2,315,414.48**		
	***Financed Overhaul Activities**	**$1,342,622.09**		

EQUIVALENT AVAILABILITY FACTOR (EAF)



PUC Target: Minimum 87%

GROSS HEAT RATE (GHR)

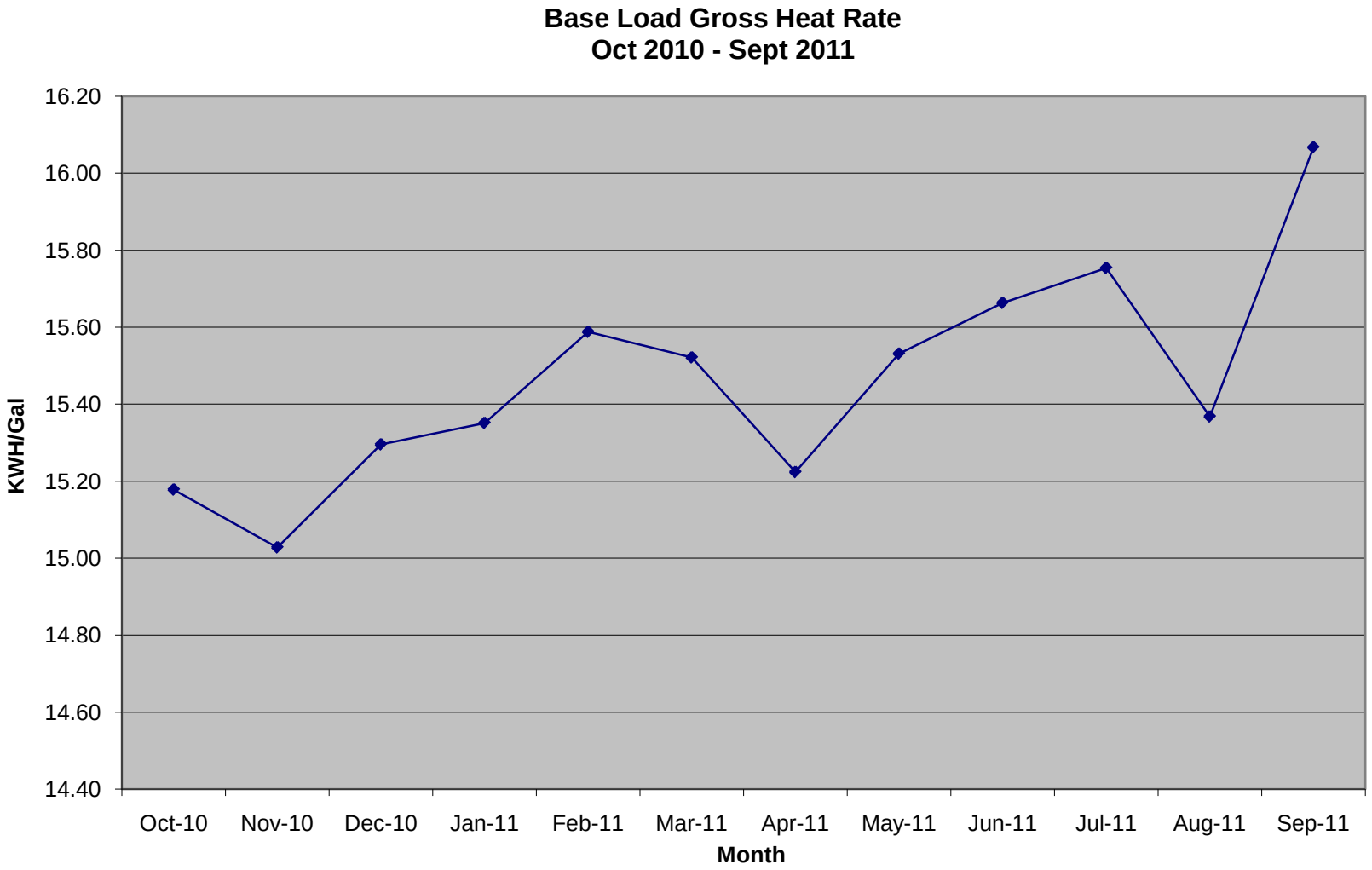


ECONOMIC DISPATCHING IMPROVEMENTS

- GPA's dispatching efficiencies
  - One Cabras Unit placed on Cold Standby
  - Reduced spinning reserve
  - Reduced reliance on peaking units
  - More stable generation production
  - Reduced Daily Fuel Costs

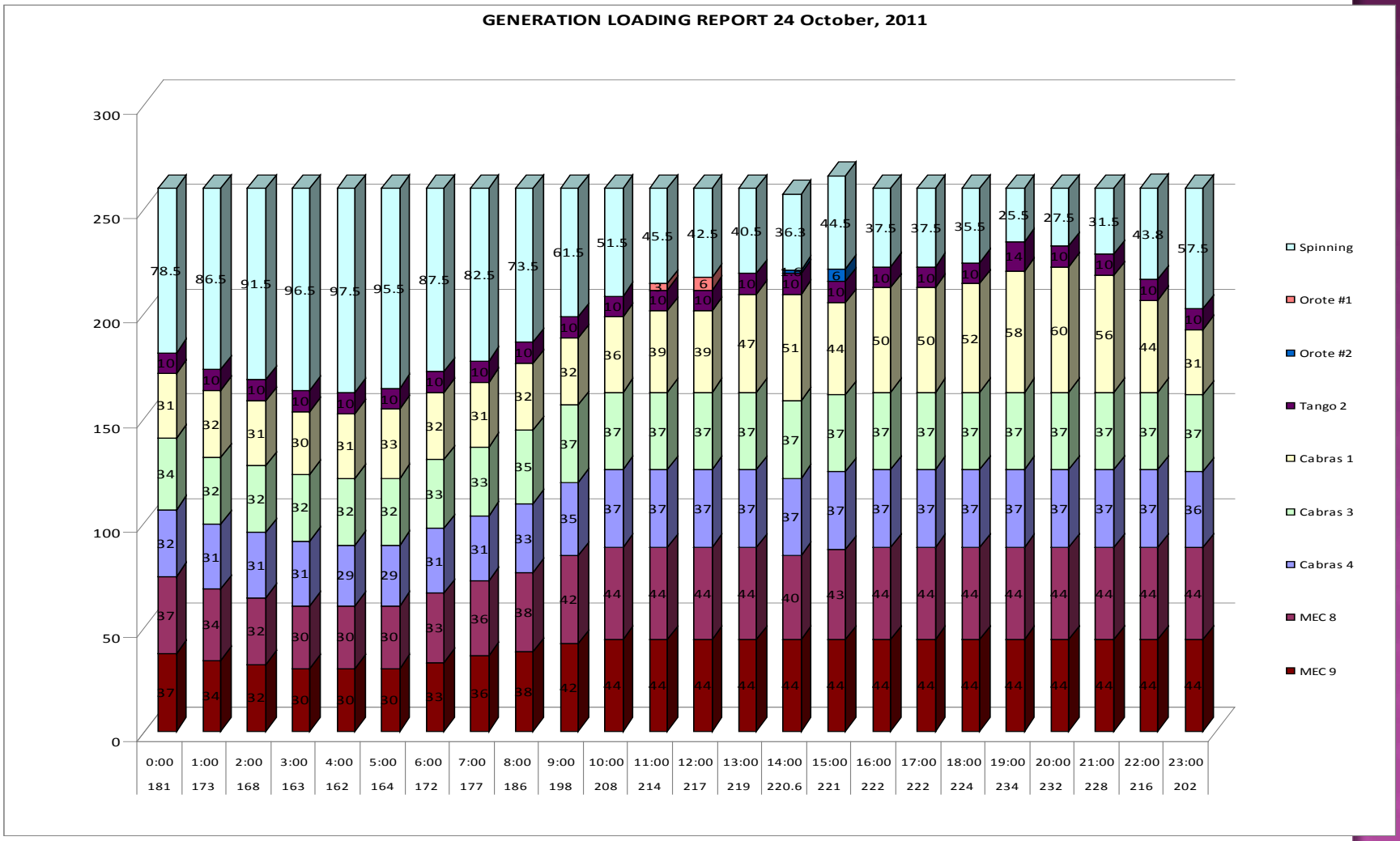
CURRENT PERFORMANCE

FY 2011 HEAT RATE (KWH/GAL)



GENERATION LOADING

System Efficiency = 16.02 kwh/gal



UNIT EFFICIENCIES FOR OCT 2011 (UP TO OCT 30)

Whenever a baseload unit is unavailable, GPA will need to use Diesel Units to compensate for loss of capacity

- Tenjo, MDI and Talofofo units are Peaking Units, used for Peak Hour Demands
- To compensate for Cabras 1&2 loss, GPA would need to run YCT, MCT and TEMES
- **Diff. in efficiency = 2 to 5 kwh/gal**

GENERATING UNIT	MAX. CAP.	EFFICIENCY	GROSS HEAT RATE
		kwh/gal	btu/kwh
MEC (Piti #9)	44	**17.70**	8,205
MEC (Piti #8)	44	**17.66**	8,222
Cabras #3	39	**16.88**	8,602
Cabras #4	39	**16.37**	8,871
Cabras #1	66	**14.16**	**10,260**
Cabras #2	66	**13.33**	**10,898**
Pruvient (Tanguisson #1)	27	**11.13**	**13,049**
Pruvient (Tanguisson #2)	27	**10.91**	**13,309**
Tenjo #1	4	**14.38**	9,605
Tenjo #2	4	**13.92**	9,917
Tenjo #3	4	**14.20**	9,722
Tenjo #4	4	**14.64**	9,430
Tenjo #5	4	**14.54**	9,497
Tenjo #6	4	**13.45**	10,269
MDI 1	5	**14.59**	9,467
MDI 2	5	**14.62**	9,446
Talofofo 1	4	**13.23**	10,440
Talofofo 2	4	**14.85**	9,302
Dededo DSL 1	3	**12.50**	11,048
Dededo DSL 2	3		
Dededo DSL 3	3	**12.50**	11,048
Dededo DSL 4	3		
YCT	22	**11.21**	12,313
MCT	22	**10.22**	13,513
TEMES	40	**6.57**	**21,026**
DCT 1	23		
DCT 2	22		
Marbo	16		

DAILY ECONOMIC DISPATCHING ANALYSIS IMPROVEMENTS

- 3 scenarios
  1. Cabras #1 online with Cabras #2 on reserve shutdown (RS)
  2. Cabras #1 and #2 online
  3. Cabras #1 and #2 offline

	1 - Cabras #1 online Cabras #2 on RS	2 - Cabras #1 & #2 Online	3 - Cabras #1 & #2 Offline
Peak Load	241 MW	241 MW	241 MW
Spinning Reserve	26 MW - 58 MW	85 MW - 157 MW	30 MW - 51 MW
Fuel Cost	$796,802.66	$811,511.70	$870,419.48
Savings / (Costs)		**$(14,709.04)**	**$(58,907.78)**

CURRENT PERFORMANCE

OCTOBER 2011 – BASELOAD PERFORMANCE

DATE	GROSS GENERATION	FUEL CONSUMPTION	NET FUEL EFFICIENCY	*Cost per KWH*	*% of Generation from Baseloads*	*GROSS HEAT RATE*
	kWh	(Gallons)	kwh/gal			btu/kWh
1-Oct-11	4,679,700	295,670	***15.83***	***$ 0.1607***	100.00%	9,176
2-Oct-11	4,251,900	258,264	***16.46***	***$ 0.1538***	92.13%	8,822
3-Oct-11	4,500,900	284,171	***15.84***	***$ 0.1598***	92.22%	9,170
4-Oct-11	4,610,700	292,088	***15.79***	***$ 0.1599***	97.27%	9,201
5-Oct-11	4,696,800	297,305	***15.80***	***$ 0.1596***	100.00%	9,193
6-Oct-11	4,795,500	305,174	***15.71***	***$ 0.1615***	100.00%	9,243
7-Oct-11	5,042,700	326,878	***15.43***	***$ 0.1634***	100.00%	9,415
8-Oct-11	4,931,900	318,979	***15.46***	***$ 0.1630***	100.00%	9,394
9-Oct-11	4,871,800	302,368	***16.11***	***$ 0.1564***	100.00%	9,014
10-Oct-11	4,934,500	310,118	***15.91***	***$ 0.1584***	100.00%	9,128
11-Oct-11	4,841,300	299,678	***16.16***	***$ 0.1570***	99.78%	8,990
12-Oct-11	4,491,900	285,807	***15.72***	***$ 0.1639***	96.70%	9,241
13-Oct-11	4,625,600	295,006	***15.68***	***$ 0.1608***	95.73%	9,263
14-Oct-11	4,534,500	283,896	***15.97***	***$ 0.1594***	95.76%	9,093
15-Oct-11	4,667,500	289,744	***16.11***	***$ 0.1581***	100.00%	9,016
16-Oct-11	4,536,900	279,379	***16.24***	***$ 0.1580***	100.00%	8,944
17-Oct-11	4,585,900	285,238	***16.08***	***$ 0.1601***	100.00%	9,034
18-Oct-11	4,704,800	292,467	***16.09***	***$ 0.1567***	100.00%	9,029
19-Oct-11	4,822,000	302,517	***15.94***	***$ 0.1585***	100.00%	9,112
20-Oct-11	4,748,600	297,090	***15.98***	***$ 0.1577***	100.00%	9,087
21-Oct-11	4,472,500	277,252	***16.13***	***$ 0.1577***	100.00%	9,003
22-Oct-11	4,438,600	280,334	***15.83***	***$ 0.1601***	100.00%	9,173
23-Oct-11	4,479,200	282,191	***15.87***	***$ 0.1603***	100.00%	9,150
24-Oct-11	4,809,900	299,845	***16.04***	***$ 0.1597***	99.64%	9,054
25-Oct-11	4,734,500	296,050	***15.99***	***$ 0.1602***	99.66%	9,082

TARGETS

Net Fuel Efficiency
15.1 kWh/gal

% Generation from Base Load
90% Min

Gross Heat Rate
9600 btu/kWh

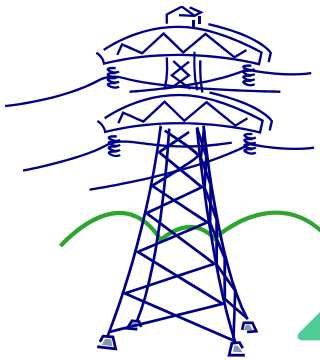
GENERATION SUMMARY

- Major Decisions on Horizon
  - (Impacts future use of Cabras and Tanguisson Units)
- Alternate fuel source such as LNG
  - Study initiated June 2011; Study completion by January 2012
  - Conversion estimated to take 5 years
  - Cleaner fuel source therefore new plants easier to permit
  - Higher efficiency machines; lower O&M cost
- Alternate fuel source of small modular reactors (SMR)
  - Package modules under development and commercially marketed within 10 years
- Demand side management program to reduce consumer consumption
- Integrated resource plan update in 2012
- Evaluates role of the older Tanguisson and Cabras units
- Substantial work in progress to reduce consumer rates

SYSTEM RELIABILITY & EFFICIENCY
KEEPING THE CUSTOMER FIRST

Generation

- Adequate Generation
- Preventive Maintenance
- Efficient Dispatching
- Base Loads before Peaking Units
- Generator Tuning
- Automatic Generation Control

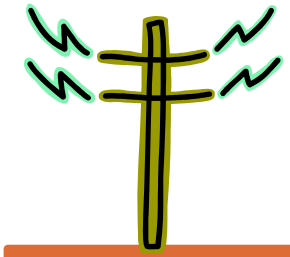


Transmission

- Preventive Maintenance
- Line Inspection
- Tree Trimming
- Splice Replacement
- Hardware Corrosion

Substation

- Preventive Maintenance
- Protective Relaying
- N-1 Contingency

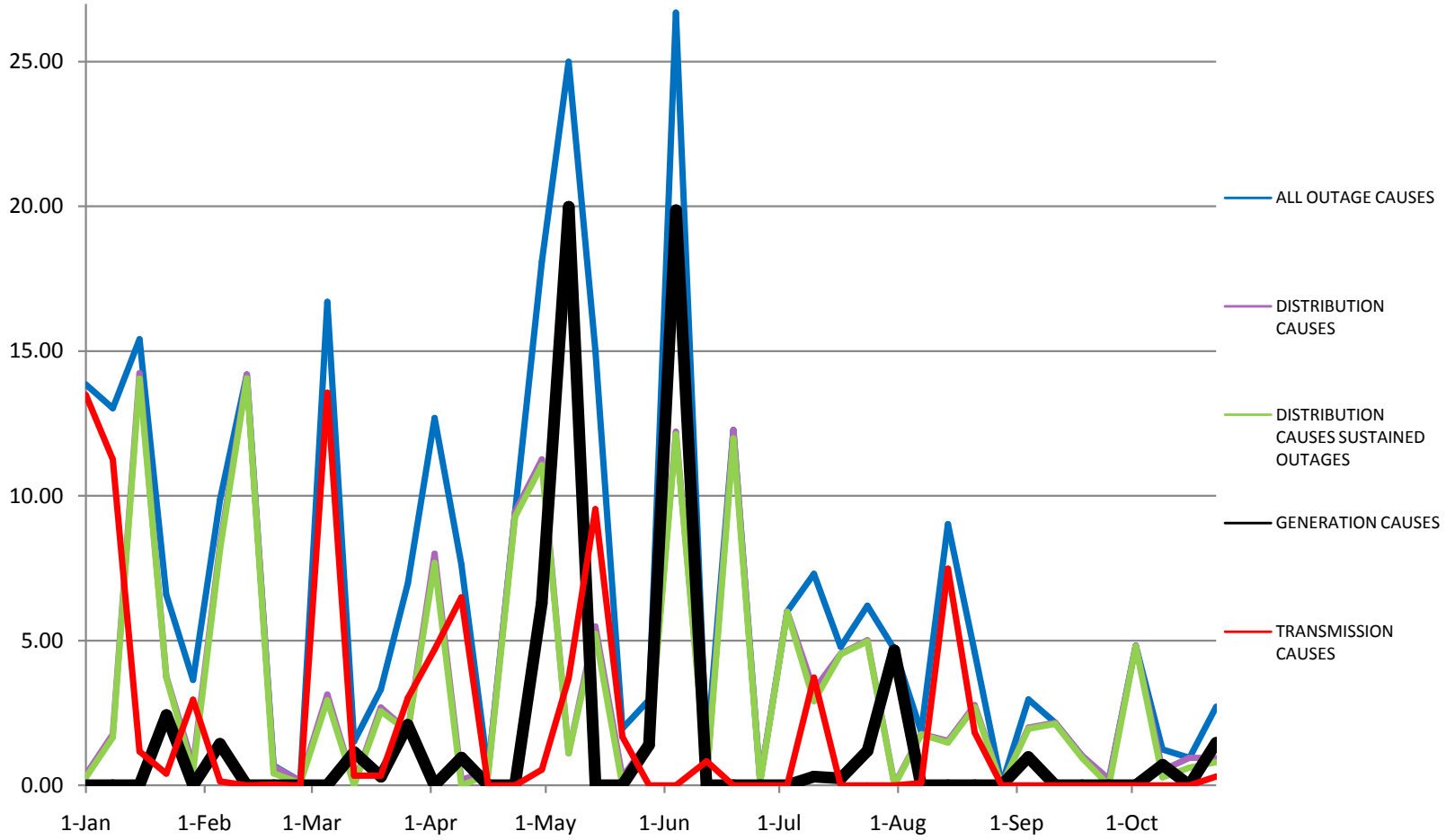


Distribution

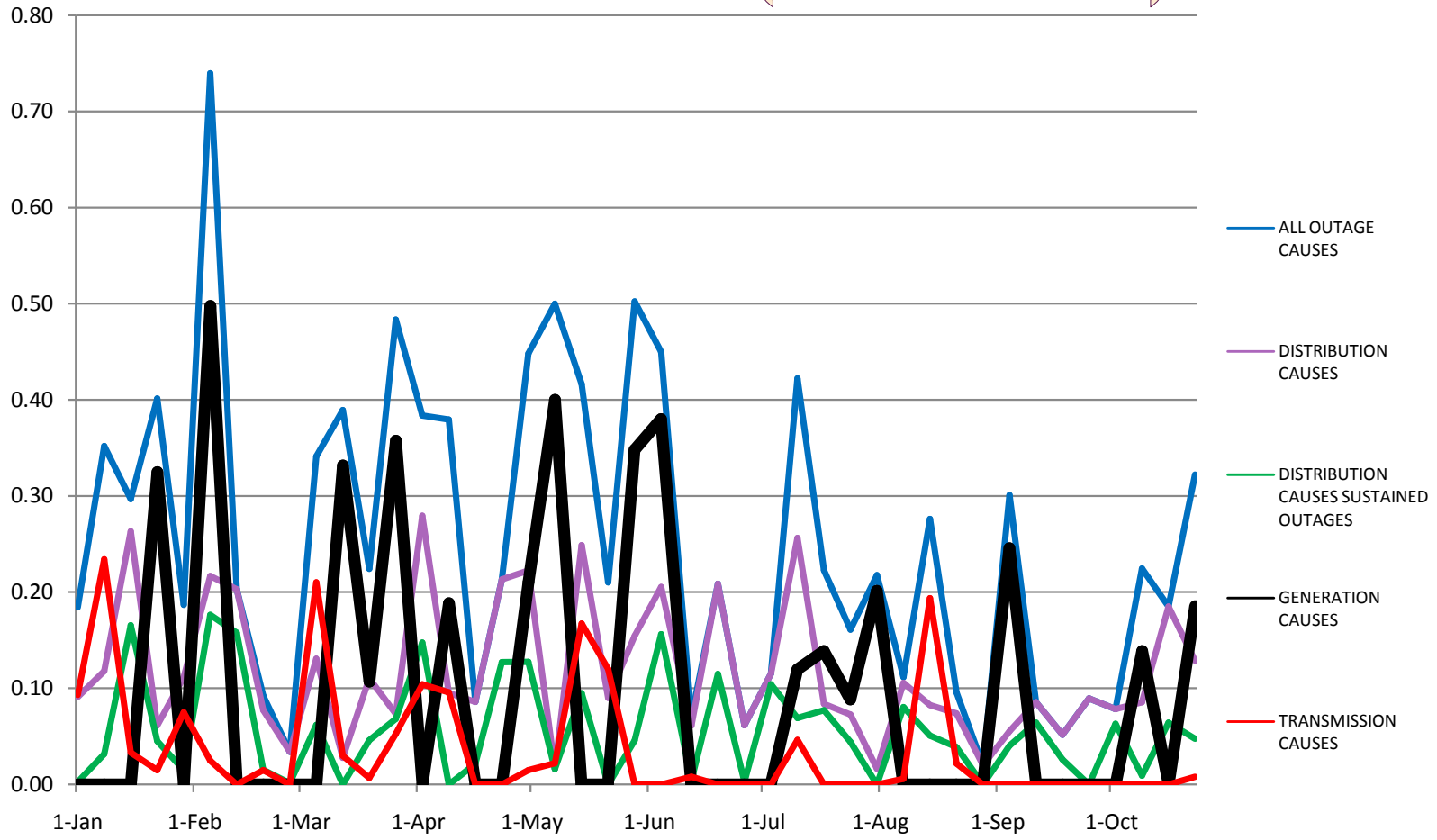
- Preventive Maintenance
- Line Inspection
- Tree Trimming
- Splice Replacement
- Hardware Corrosion

INVESTMENTS AT ALL LEVELS OF DELIVERY

AVERAGE OUTAGE DURATION SAIDI 2011 (MONTHLY)



AVERAGE OUTAGE FREQUENCY SAIFI 2011 (MONTHLY)



T&D MAINTENANCE

CCU Working Session
Guam Power Authority
November 08, 2011

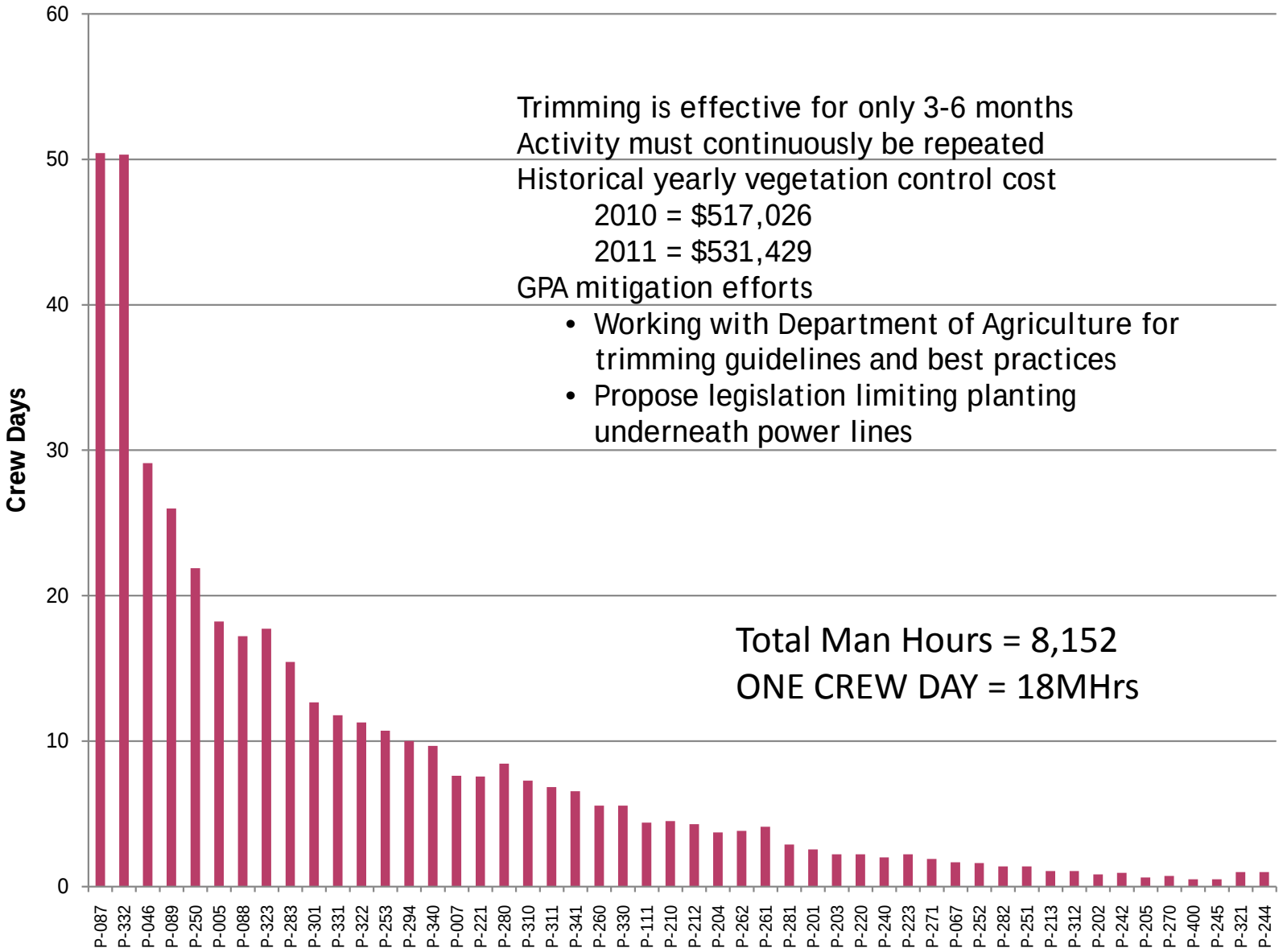
T&D OVERHEAD SYSTEM MAINTENANCE

- Top 3 known outage causes
  - Vegetation
  - Snakes
  - Lightning arrester (hardware failure)
- Outage reduction plan included Engineering and T&D assessment July 2011
- Dec 2012 – Target to address assessment findings
  - Use in-house and contract resources
- Major types of maintenance activities
  - Vegetation (8,152 man hours)
  - Splices / Hardware to include reconductoring (29,186 man hours)
  - Pole change out (4,447 man hours)
- ONE CREW DAY = 18 MAN HOURS

SNAKE MITIGATION

- U.S. Department of Agriculture Animal & Plant Health Inspection Wildlife Services
- $100,000 + annual contract
- Snake traps, toxicant devices, inspection services
- Over 10,000 snakes captured

VEGETATION CONTROL

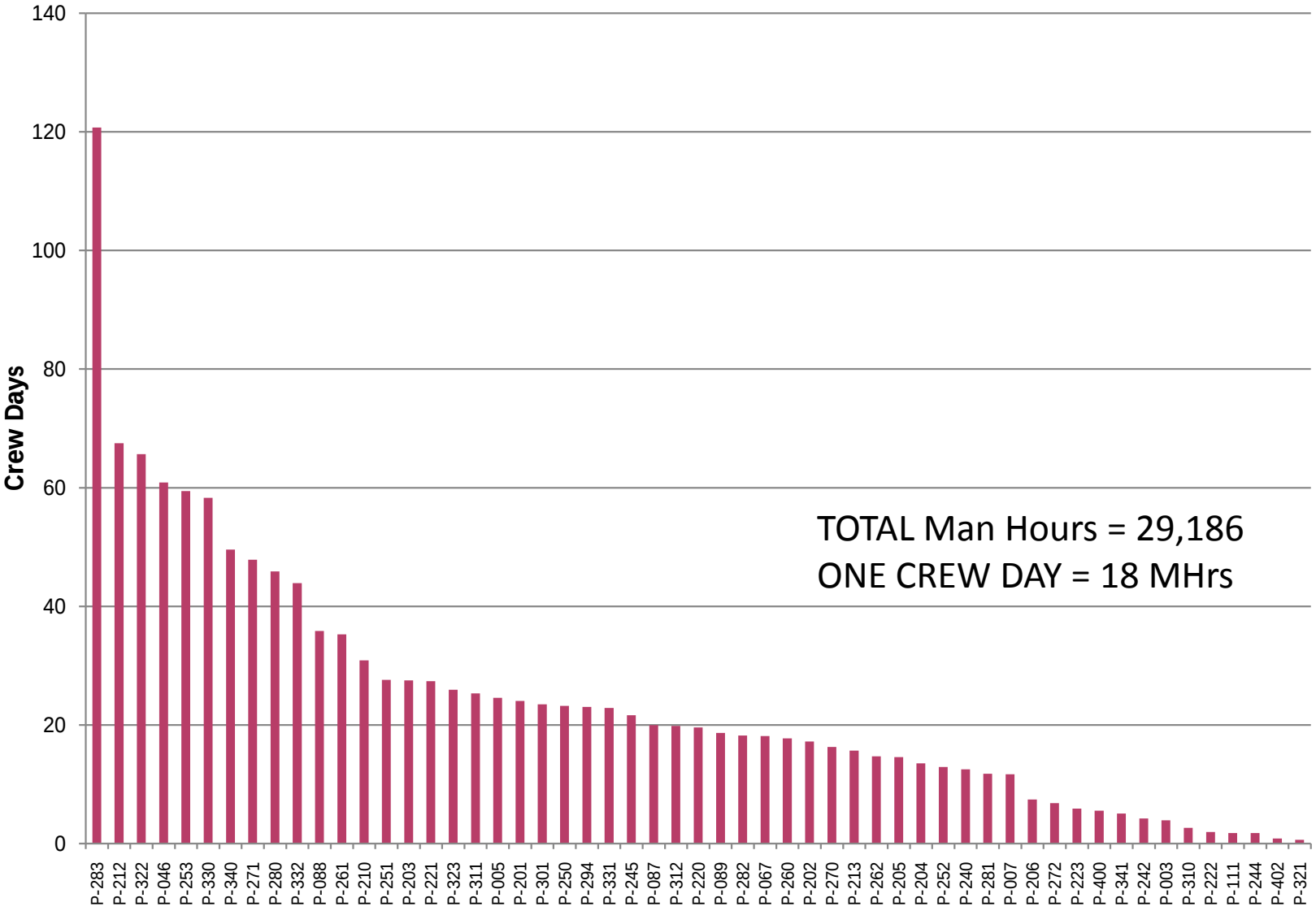


Trimming is effective for only 3-6 months
Activity must continuously be repeated
Historical yearly vegetation control cost
2010 = $517,026
2011 = $531,429
GPA mitigation efforts

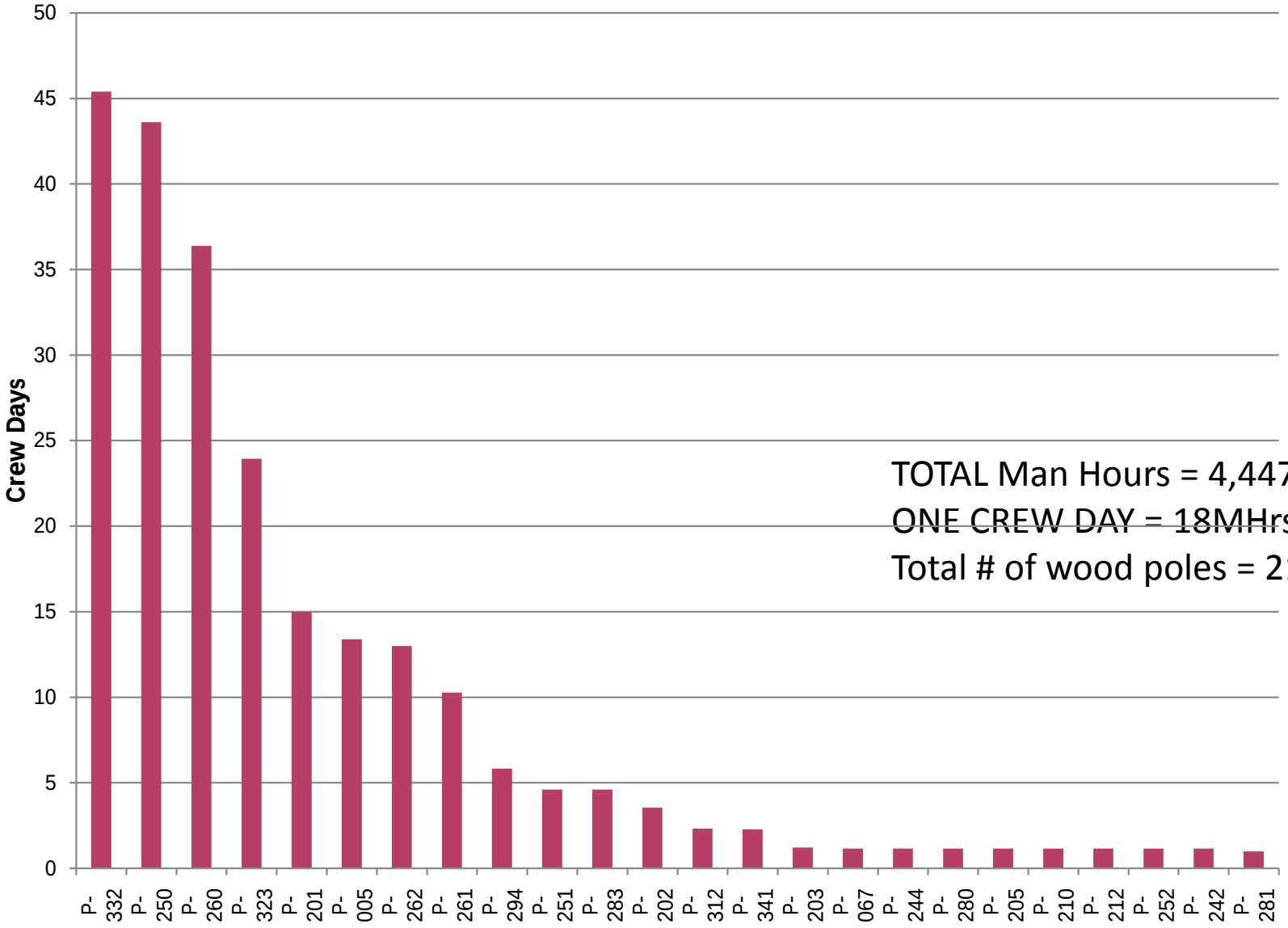
- Working with Department of Agriculture for trimming guidelines and best practices
- Propose legislation limiting planting underneath power lines

Total Man Hours = 8,152
ONE CREW DAY = 18MHrs

SPLICE & HARDWARE REPLACEMENT



WOOD POLE REPLACEMENT



TOTAL Man Hours = 4,447

ONE CREW DAY = 18MHrs

Total # of wood poles = 216

SUMMARY

- Continuous Efforts on Outage Reduction
- T&D System Investments
- Generation tuning project underway
  - Conducting necessary plant upgrades
  - Final tuning in first quarter CY 2012
  - Will reduce outages due to loss of generation
  - Will reduce risk of blackouts
- Automatic generation control
  - Project awarded
  - Completion in CY2012
  - Allows for the real time economic dispatching of units
- T&D Outages
  - Tree trimming efforts underway
  - Defective line hardware Replacements
  - Mitigation of snake related outages
  - Investments being made with 2010 bonds

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QUESTIONS?