Depreciation Analysis for Power Generation

Power Generation Division

February 2016

Topics

- **Combined Cycle (CC) Industry Data**
- **CC FPL Experiences – Putnam**
  - Unavailability
  - Heat Rate
  - Emissions
- **Steam Units**

The design life, along with other factors, must be considered when determining the operating life of a Combined Cycle Plant

Combined Cycle Plant Design Life

- **Typical design lifetimes of Combined Cycle Plants are 30 to 40 years[1]**
- **Plant components can be replaced or upgraded to keep the plant commercially viable and to continue operation**
- **The decision to continue to replace components and extend the plant's life has to be weighed against:**
  - Overall plant reliability/availability
  - Availability of more efficient technology
  - Environmental regulation changes

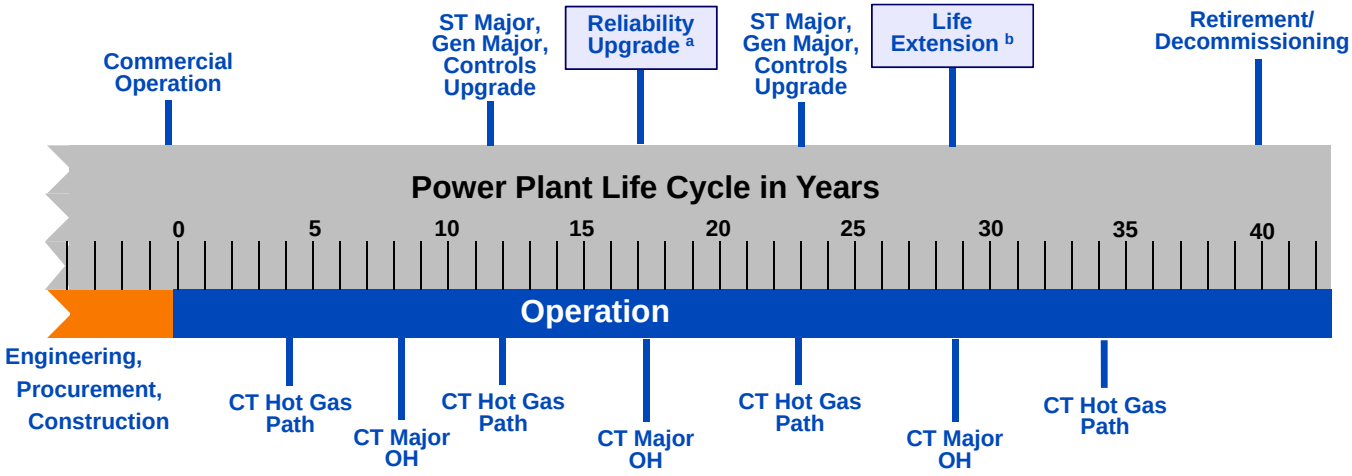
Reliability, economic and environmental issues need to be considered in the decision to continue to operate a plant

1. Source: Combined Cycle Journal "Life Extension, Maximizing the productive lifetimes of gas-turbine assets"

FPL

According to industry sources, the typical plant operating period may average approximately 40 years

Typical Power Plant Life Cycle[2] Timeline



a. Reliability Upgrade – Typically OEM durability and performance upgrades
b. Life Extension – Turbine rotor, HRSG tube bundles

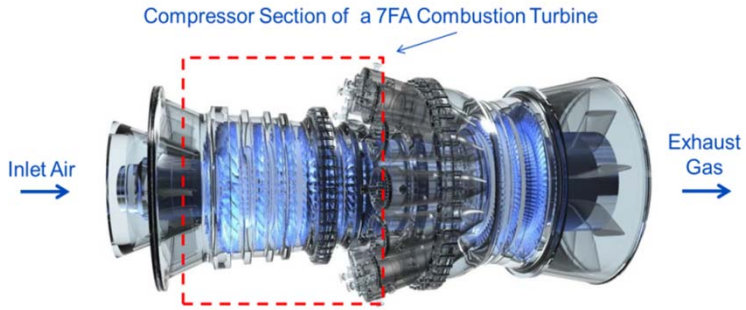
During a power plant's operating life, reliability upgrades and life extension projects are expected to occur to meet the expected design life

2. Based on Black & Veatch "Plant Improvement Engineering Services" product literature.

As an example, reliability upgrades during a plant's operating life is dependent on the OEM's continued development and improvement to the product line

GE 7F .05 Compressor Upgrade

- **FPL has embarked on system reliability upgrades for GE 7FA Combustion Turbine (CT) fleet**
- **The .05 upgrade addresses past compressor issues, such as corrosion, and also provides improved power output and heat rate**



The system reliability upgrade in the "Typical Power Plant Life Cycle Timeline" and reflects FPL's experience

The Florida Power & Light (FPL) Putnam Plant Units 1 & 2 were retired at the end of 2014, after 37 years of operation

Comparable U.S. Combined Cycle (CC) Plants

- **CC plants selected for comparison have commercial operation dates before 1985, are 200 MW or larger and not cogeneration facilities**
- **Of the 13 comparable plants:**
  - 4 were retired at an average age of 34 years
  - 1 is planned to retire at in 2017 at an age of 42 years
  - 8 are available to operate at an average age of 38 years
- **Putnam Plant Units 1 & 2 age at retirement is within the expected design life and comparable retired units**

Putnam Plant data will be used as a benchmark for CC Plants to study factors that influenced the decision for depreciation life for FPL

Several factors need to be weighed when determining the depreciated life of a combined cycle plant

CC Plant Depreciated Life Summary

- **Industry Combined Cycle Data**
  - Plant design life is between 30 and 40 years
  - Retired and planned retired combined cycle plants average age is approximately 35 years
  - There are operating CC Plants over 38 years old
- **Unavailability**
  - There are practical limitations of managing unavailability as equipment ages
  - Putnam Plant's unavailability factor showed an overall increasing trend over the last five years of service
  - A plant's level of unavailability increases over time to a point where it's value as a dependable base or intermediate generation resource is diminished

Additional factors to be weighed when determining the depreciated life of a combined cycle plant

CC Plant Depreciated Life Summary (cont.)

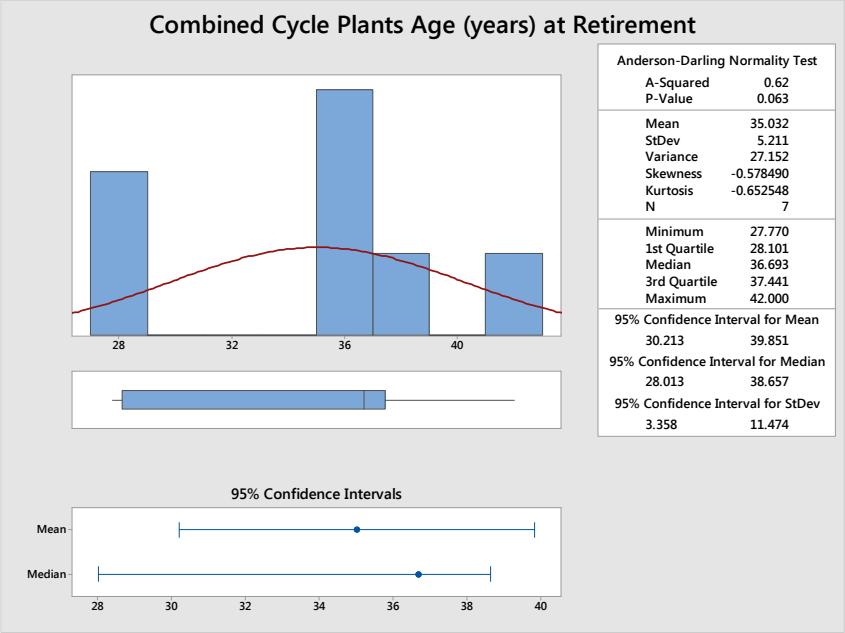
- **Heat Rate**
  - Newer plants provide a technology step change in heat rate improvement
  - Older plants move into a lower system dispatch order, but still provide value to the system
  - After Putnam Plant had been in operation for 25 years, more advanced plants began to be added to the fleet; it was eventually retired after 37 years
- **Environmental**
  - Combustion technology improvements continue to drive plant emissions lower

Based on industry design life and FPL and comparable CC units, recommend a depreciated life of a combined cycle plant to be 40 years

Actual CC plant retirements is in line with the industry expectation of 30 to 40 years

CC Plants

- **Retired and planned retired units**
  - Mean of 35 years
  - 95% confidence interval for the mean is 30 to 40 years



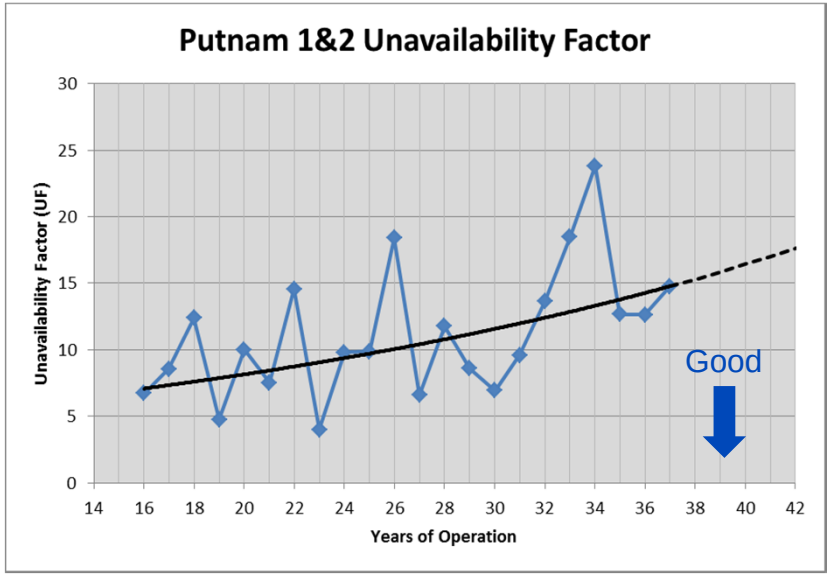
Topics

- Combined Cycle (CC) Industry Data
- **CC FPL Experiences – Putnam**
  - Unavailability
  - Heat Rate
  - Emissions
- Steam Units

CC Plants are designed to be dispatched as base or intermediate loaded units. To fulfill that role, the time the plant is unavailable to produce power should be low

Putnam Plant's Unavailability[3] Factor

- **Putnam Plant's Unavailability factor indicated an overall increasing trend**
- **This is expected since as a plant ages, additional plant work during outages is required to maintain an acceptable level of reliability**

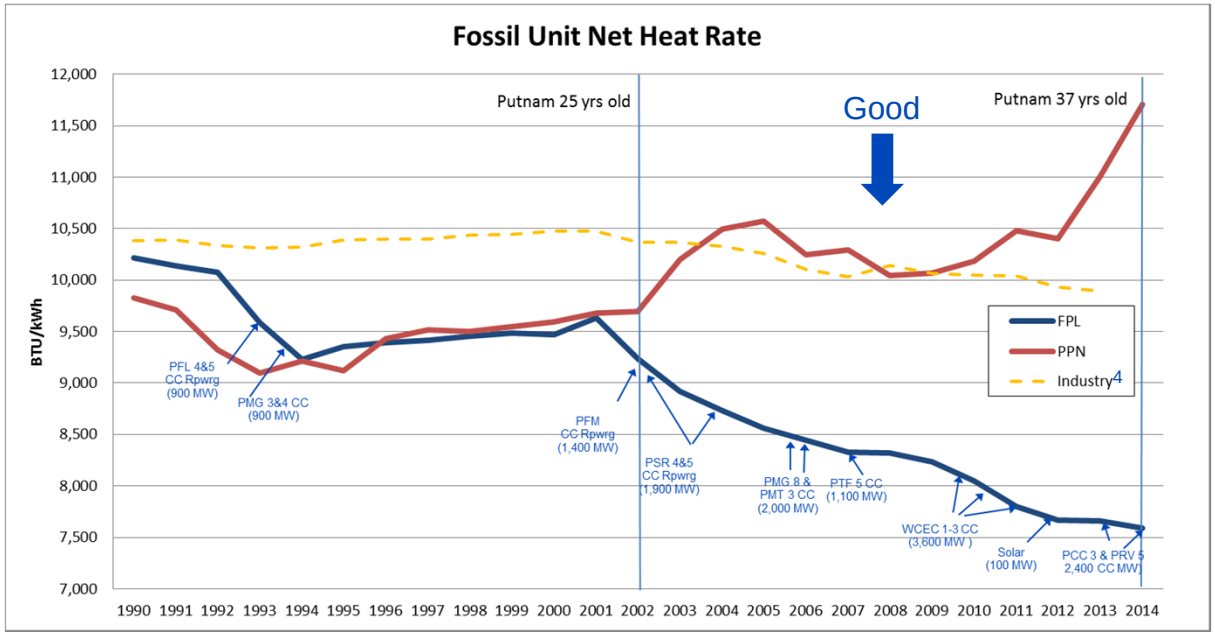


A plant's increasing level of unavailability is one of determining factors to consider when deciding if it is cost effective to continue to maintain

3. Unavailability Factor is the summation of Forced, Planned and Maintenance Outage Factors.

As more efficient plants are added to a fleet, older plants generate less which increases its net heat rate

Putnam Plant Heat Rate compared to FPL Fossil Fleet and Industry

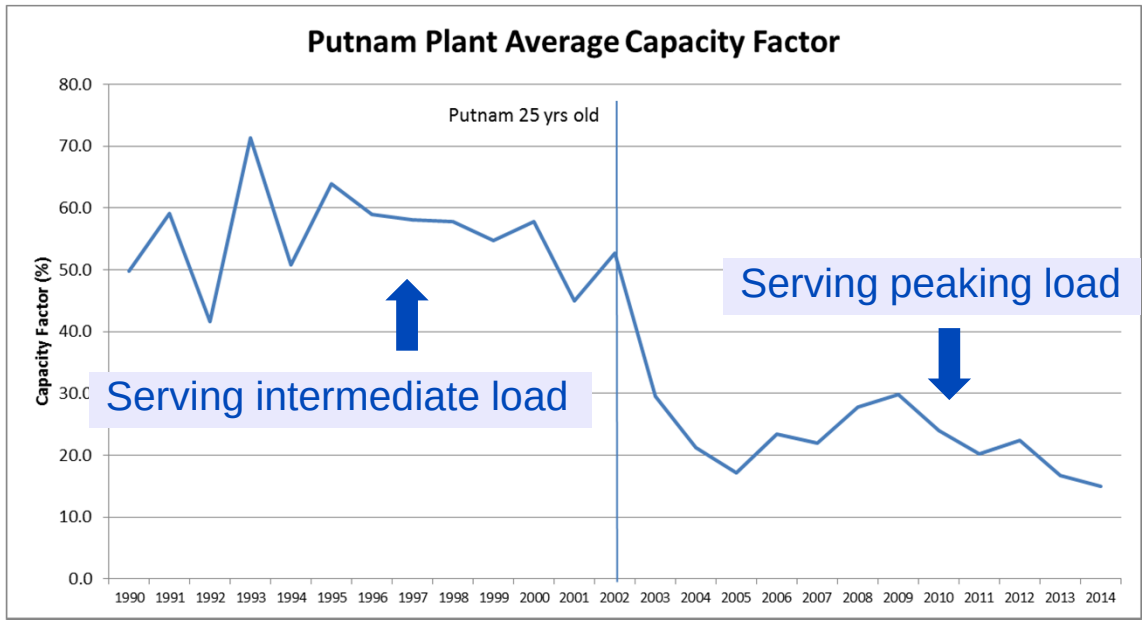


Newer plants provide a technology step change in heat rate improvement

4. Source: Platts / Ventyx - All representative non-FPL/NEE U.S. fossil plants reporting on FERC, EIA, & RUS forms. FPL NHR values based on FPSC Schedules A3 (incl. solar); FPL oil use from TYSP and A Schedules.

In the 25th year of Putnam Plant's operation, FPL began to modernize its fossil fleet with more advanced combined cycle plants which changed Putnam's operating profile

Putnam Plant's Average Capacity Factor

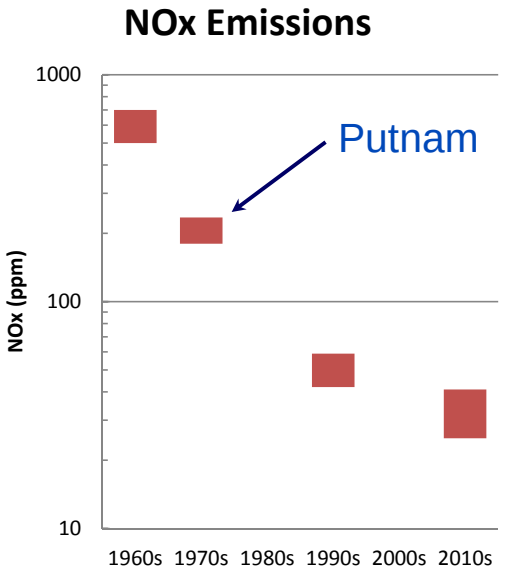


A plant's value as a base or intermediate load unit to a system fleet can be correlated to it's capacity factor

Putnam Plant's emissions were much higher than the newest technology Combined Cycle plants

Combined Cycle Plant Emissions

- Older conventional steam plants can have NOx emission levels of 125 to >500 ppm on fuel oil
- Putnam Plant vintage gas turbines have an emissions on natural gas of ~90 to 100 ppm
- FPL's newest gas turbines' (Cape Canaveral and Riviera) have NOx emissions of 25 ppm on natural gas. Equipped with SCRs in the HRSG, the stack emissions are 2 ppm



Combustion technology improvements continue to drive plant emissions lower

Topics

- Design Life
- Combined Cycle (CC) Industry Data
- CC FPL Experiences – Putnam
  - Unavailability
  - Heat Rate
  - Emissions
- **Steam Units**

Steam units have been evaluated to determine criticality of need, and estimated depreciation life

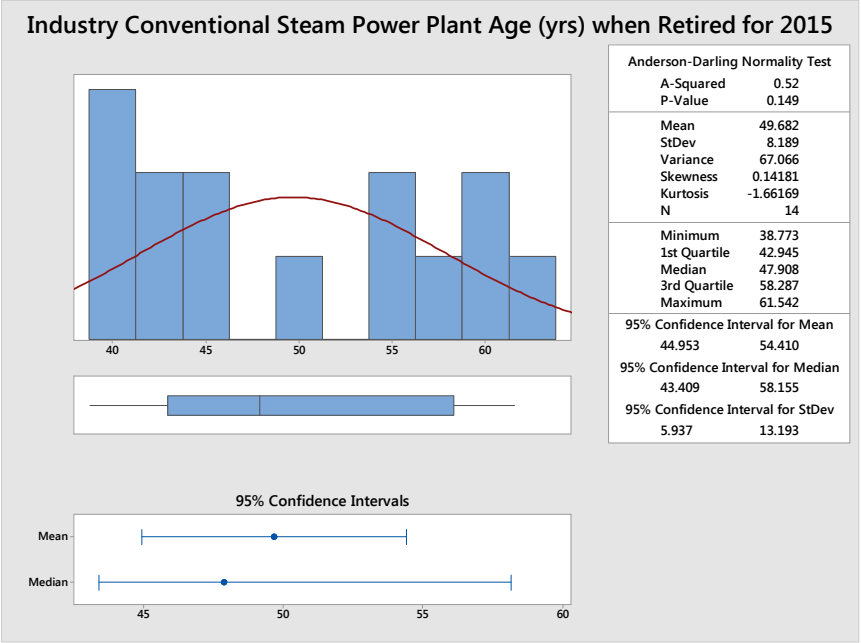
Steam Units Depreciation Life summary

- In 2015, the average age of gas fired conventional steam units in the industry removed from service was 50 years
- FPL conventional steam units removed from service also averaged 50 years
- Steam units operating on coal show average of 55 years

Steam units - evaluation of industry retirements in 2015

Steam Units – Gas

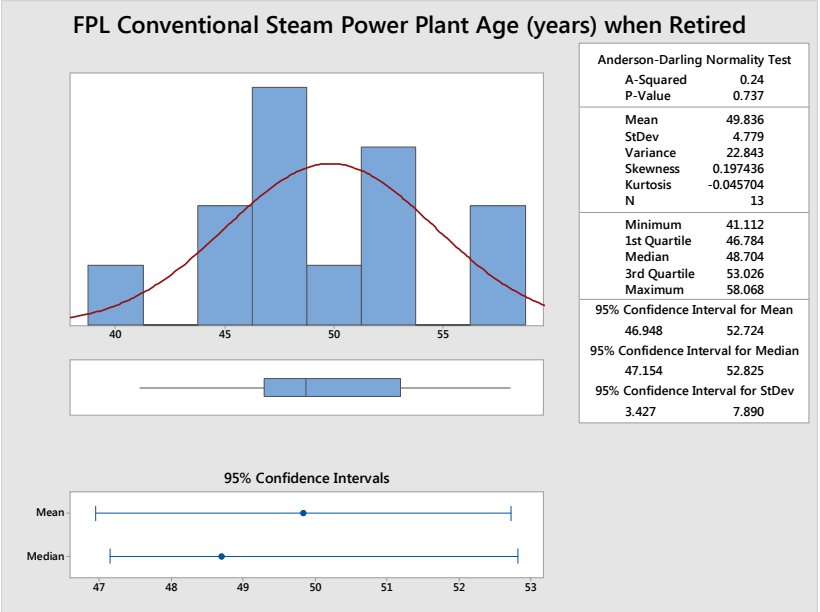
- **Steam Units with Gas as primary fuel**
  - Mean of 50 years
  - 95% confidence interval between 45 and 54 years



Steam units - evaluation of past FPL retirements

FPL Steam Units – Gas

- **FPL Steam Units with Gas as primary fuel**
  - Mean of 50 years
  - 95% confidence interval between 47 and 53 years



Based on both industry and FPL experience, a depreciated life of a gas fired conventional steam unit is recommended to be 50 years

FPL Fossil Fleet

FPL Conventional Steam (ST) and Combined Cycle (CC) Units

	Current Mo-Year		Aug-15		
Site	Unit	Type	Summer OCC	CO Date	Age (Yrs)
Turkey Point	1	ST	378	Apr-67	48
Manatee	1	ST	785	Oct-76	39
Manatee	2	ST	785	Dec-77	38
Lauderdale	4	CC	438	May-93	22
Lauderdale	5	CC	438	Jun-93	22
Martin	1	ST	799	Dec-80	35
Martin	2	ST	802	Jun-81	34
Sanford	5	CC	950	Jun-02	13
Martin	3	CC	431	Feb-93	23
Martin	4	CC	431	Apr-93	22
Sanford	4	CC	950	Oct-03	12
Ft Myers	2	CC	1349	Jun-02	13
Martin	8	CC	984	Jun-05	10
Manatee	3	CC	978	Jun-05	10
Turkey Point	5	CC	971	May-07	8
West County	1	CC	1116	Aug-09	6
West County	2	CC	1116	Nov-09	6
West County	3	CC	1116	May-11	4
Cape Canaveral	3	CC	1102	Apr-13	2
Riviera	5	CC	1104	Apr-14	1

Appendix

Putnam Plant and comparable Combined Cycle Plants used for this study

Combined Cycle Plants

OPERATING

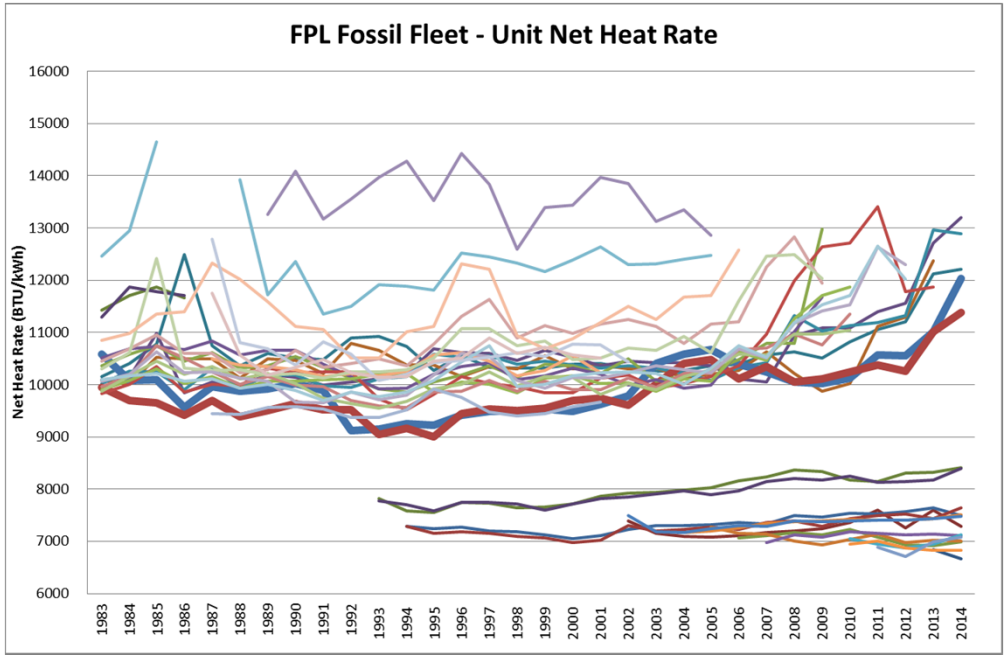
Company Name	Plant Name	Unit	Nameplate Capacity MW	Primary Fuel Code	Commercial Online Date	Unit Status	2014 Capacity Factor	Unit Age (Yrs as of 7/1/15)	Gas Turbine
American Electric Power Co Inc	Comanche (OK)	CC	290	NG	2/1/1974	Operating	20.6%	41	S/W 501B
NRG Energy Inc	T H Wharton (TX)	CC3	318	NG	8/1/1974	Operating	4.7%	41	
NRG Energy Inc	T H Wharton (TX)	CC4	329	NG	8/1/1974	Operating	4.7%	41	
Entergy Corp	Sterlington (LA)	CC7	226	NG	9/1/1974	Operating	0.6%	41	
NRG Energy Inc	Gilbert (NJ)	CC	351	NG	5/1/1977	Operating	2.4%	38	S/W 501B
Portland General Electric Co	Beaver (OR)	CC	586	NG	11/1/1977	Operating	4.7%	38	
Mass. Municipal Wholesale Electric Co	Stony Brook (MA)	CC1	318	NG	11/1/1981	Operating	6.1%	34	
Chugach Electric Association Inc	Beluga (AK)	CC	215	NG	9/1/1982	Operating	50.9%	33	
							Average Age	**38**	

RETIRED / PLANNED RETIREMENT

Company Name	Plant Name	Unit	Nameplate Capacity MW	Primary Fuel Code	Commercial Online Date	Unit Status	Retirement Date	Age at Retirement (Yrs)	Gas Turbine
NRG Energy Inc	Long Beach Generation LLC	CC1	332	NG	12/1/1976	Retired	12/31/2004	28	
NRG Energy Inc	Long Beach Generation LLC	CC2	255	NG	4/1/1977	Retired	12/31/2004	28	
NextEra Energy Inc	Putnam (FL)	CC2	290	NG	8/1/1977	Retired	12/31/2014	37	S/W 501B
NextEra Energy Inc	Putnam (FL)	CC1	290	NG	4/1/1978	Retired	12/31/2014	37	S/W 501B
NRG Energy Inc	Coolwater Generating Station	CC3	290	NG	5/1/1978	Retired	12/31/2014	37	S/W 501B
NRG Energy Inc	Coolwater Generating Station	CC4	290	NG	8/1/1978	Retired	12/31/2014	36	S/W 501B
El Paso Electric Co	Newman	CC4	290	NG	8/1/1975	Operating	12/31/2017	42	S/W 501B
							Average Age	**35**	
							Average Age w/o Putnam	**34**	

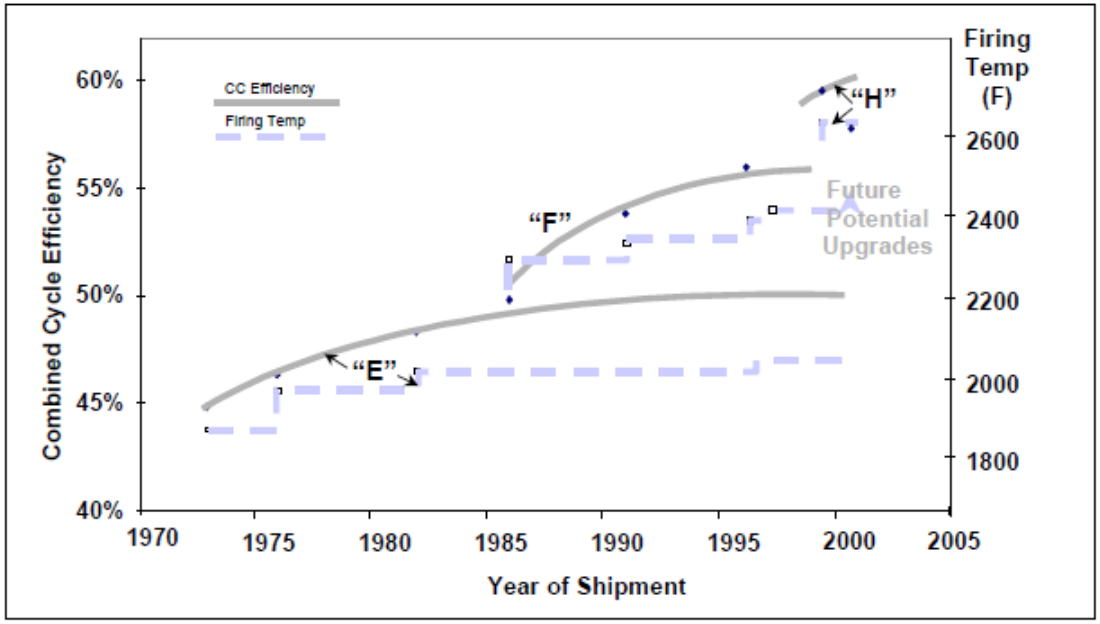
Putnam Plant's heat rate lagging behind the FPL fossil fleet

Putnam Heat Rate Compared to FPL Fossil Fleet



Combustion Turbines have experienced periodic step changes technology

Combustion Turbine Advances[1]



Performance step changes have occurred about every 13 to 15 years

1. GE publication "Continuing Evolution of the Gas Turbine"

FPL

Industry 2015 retired conventional steam units used for this study

Retired Industry Steam Units

Company Name	Plant Name	Unit	Nameplate Capacity (MW)	Primary Fuel Code	Comercial Online Date	Unit Status	Retirement Date	Age at Retirement (Yrs)
White Pine Electric Power LLC	White Pine Electric Power (MI)	GEN2	18	NG	Dec-54	Retired	Apr-15	60.4
City of Vero Beach - (FL)	Vero Beach Municipal Power Plant (FL)	4	56	NG	Aug-76	Retired	May-15	38.8
Louisiana Energy & Power Authority	Morgan City (LA)	3	18	NG	May-70	Retired	Jun-15	45.1
Louisiana Energy & Power Authority	Morgan City (LA)	4	33	NG	May-70	Retired	Jun-15	45.1
Louisiana Energy & Power Authority	Plaquemine (LA)	1	17.5	NG	Dec-71	Retired	Jun-15	43.5
Louisiana Energy & Power Authority	Plaquemine (LA)	2	20.4	NG	Jan-76	Retired	Jun-15	39.4
Stillwater Utilities Authority	Boomer Lake Station (OK)	1	11.5	NG	Sep-56	Retired	Jun-15	58.8
Mississippi Power Co	Jack Watson (MS)	1	76	NG	Jun-57	Retired	Jul-15	58.1
Mississippi Power Co	Jack Watson (MS)	2	76	NG	May-60	Retired	Jul-15	55.2
Georgia Power Co	Kraft (GA)	4	115	NG	Mar-72	Retired	Oct-15	43.6
City of Vero Beach - (FL)	Vero Beach Municipal Power Plant (FL)	1	13	NG	Nov-61	Retired	Nov-15	54.0
Los Angeles Department of Water & Power	Scattergood (CA)	3	445	NG	Oct-74	Retired	Dec-15	41.2
NRG El Segundo Operations Inc	El Segundo Power (CA)	4	335	NG	Apr-65	Retired	Dec-15	50.7
Public Service Co of Colorado	Zuni (CO)	2	60	NG	Jun-54	Retired	Dec-15	61.5
							Average Age	**49.7**

FPL retired conventional steam units used for this study

Retired FPL Steam Units

Site	Unit	Nameplate Capacity	CO Date	Retired Date	Age at Retirement (Yrs)
Cape Canaveral	1	402	Apr-65	Jun-10	45
Cape Canaveral	2	402	May-69	Jun-10	41
Cutler	5	75	Nov-54	Nov-12	58
Cutler	6	162	Jul-55	Nov-12	57
Port Everglades	1	248	Jun-60	Nov-12	52
Port Everglades	2	248	Apr-61	Nov-12	52
Port Everglades	3	402	Jul-64	Jan-13	49
Port Everglades	4	402	Apr-65	Jan-13	48
Riviera	1	310	Jun-62	Feb-11	49
Riviera	2	310	Mar-63	Feb-11	48
Sanford	3	156	May-59	Nov-12	54
Turkey Point	1	402	Apr-67	Oct-16*	50
Turkey Point	2	402	Apr-68	Dec-13	46
				Average Age	**50**

* Planned