10.
UTILITIES
DATA & ANALYSIS

I. Introduction

The Utilities Element includes goals, objectives and policies that apply to the University's main campus as well as the University's satellite properties. This element focuses on the University's existing utilities and procedures for improving deficiencies, while providing guidance on future additions and improvements. Sub-elements included within this element are Chilled Water/Steam, Electric Power, and Telecommunications. The Physical Plant Division (PPD) is the entity primarily responsible for permitting, maintenance and expansion of all distributed utilities on the main campus. The utilities at the satellite properties of TREEO Center, Lake Wauburg, Eastside Campus, WRUF, WUFT, and Remote Library are handled individually by the Physical Plant Division, while the IFAS research properties of Austin Cary, Beef Research Unit, Dairy Research Unit, Millhopper Unit, Santa Fe River Ranch and Wall Farm are handled by IFAS.

II. Steam and Chilled Water Sub-Element

A. Chilled Water Production

Chilled Water Plants. The University operates and maintains ten chilled water production plants that produce chilled water for the distribution systems located on the campus and 15 plants that serve single buildings on and off main campus. The plant chillers range in age from 37 years to two new chillers installed in fall of 2014. As of September 2014 overall average plant efficiency for all the distributed chilled water plants combined was .832 kW/Ton. Table 1 is an assessment of current available plant capacity vs future master plan demands by plant. The column "Future Available Tons" are tonnage values that do not reflect future demand shifting or plant additions required to compensate for those demands. The actions required to satisfy those demands are described in the summaries for the individual plants. As well, a list of chillers associated with single buildings is shown. Only buildings with future demands are assessed for capacity vs future demand for the second group.

Table 1

Chilled Water Plants - serve multiple buildings	Plant Capacity in Tons	Peak Demand 2013	Peak Demand 2014	Current Available Tons	Projected Increase Tons	Future Available Tons
Weil Plant #1	6,800	4,720	4,900	1,900	1,267	633
Rabon Plant #2	11,152	7,393	7,700	3,452	1,689	1,763
Walker Plant#3	5,000	2,973	3,270	1,730	617	1,113
Southwest Plant #4	2,550	1,056	1,000	1,494	653	841
McCarty Plant #5	7,200	4,119	4,001	3,081	3,016	65
West Plant #6	1,458	633	649	809	1,303	-494
Holland Law Plant #7	1,650	548	575	1,075	0	1,075
Southest Plant #9	4,800	3,242	2,900	1,558	277	1,281
Pathogens Plant #10	3,600	2,058	2,000	1,542	450	1,092
Veternary Medicine Plant	4,300		3,225	1,075	210	865
	48,510	26,742	30,220	17,716	9,482	8,234

Chilled Water Plants - serve single buildings	Plant Capacity in Tons	Peak Demand 2014	Current Available	Projected Increase	Future Available
Orthopaedics	525	350	175	182	-7
North End Zone	650	Not in service			
Library West	200	Not in service			
Progress Center	1,510				
Human Resources	140				
Johnny Walker	162				
East Campus Data Center	700	350	350		
East Campus Office Building	373				
Elmore Hall	56				
Nanoscale Research	60				
Cancer Genetics	4,350				
Deriso Hall	60				
Racing Laboratory	60				
Clinical Trials	70				

Weil Plant #1

The demands of the O'Connell Center Renovation and the new Office of Student Life in 2015 will total around 189 tons and leave around 1,711 tons available, which is a single chiller redundancy limit PPD normally tries to hold in reserve for each plant. The Nuclear Science Building Renovation and Addition (Nexus) slated for completion in 2017 will put the plant below single unit redundancy. Since this plant cannot be expanded economically, to relieve some of this new demand, a few of the buildings on the interconnected distribution chilled water system that are currently served by the Weil Plant (namely Bryant Hall, Williamson Hall and the HUB) could be resupplied by the McCarty Plant. These total approximately 780 tons at peak conditions and would then leave 1,363 tons available sometime beyond 2020 at Weil Plant which, although below single unit redundancy of 1,700 tons, may be acceptable. It may be prudent to investigate replacing the old decommissioned 600 ton R-11 chiller that once served the North End Zone during times of high demand. This small chiller plant has the basic pumping, piping and electrical systems for reactivation but would require chiller replacement, cooling tower installation and reconditioning of the other plant equipment. The distribution piping from this small plant is piped into the existing 8" main that is served by the Weil Plant and could be used to feed the North End Zone area and/or the Florida Gym. Another scheme that should be investigated is Thermal Energy Storage whereby a chilled water storage tank would be constructed and filled during off-peak periods. This tank could be located just south of the Weil Plant cooling towers.

Rabon Plant #2

The Rabon Plant will see an increase of approximately 1,998 tons, leaving 1,454 tons available. This does not meet single unit redundancy if the existing 2400 ton chiller in Rabon were to fail. As such, demand shifting will likely be required, as well as chiller replacement to keep or gain plant thermal capacity. The Rabon Plant has a few of the oldest chillers on campus, which need to be replaced. Chillers 4 and 5 are 37 years old, chiller 6 and 7 are 26 years old. Although chiller replacements will gain some capacity, the plant is really not capable of adding additional machines, due to hydronic limitations of the plant primary piping system. A demand shifting scenario to relieve demand from Rabon would be to shift Larsen, Benton and Aerospace Engineering from Rabon's distribution supply loop #2 (SL-2) to the 18" piping system east of Center Drive currently supplied from McCarty Plant. However, in the future this could be supplied by the proposed "Chiller Plant #11", or possibly by the Southeast Plant (see McCarty Plant summary). This would relieve Rabon of approximately 360 tons of peak demand. Further load shifting from Rabon to the new proposed Plant #11 (or the Southeast Plant) could be accomplished by working down from the Benton/ Larsen buildings to Chemical Engineering (bldg.#723), New Engineering #33, Black Hall #724 and Particle Science #746. In considering chiller replacements at Rabon, it should be noted that prior studies have shown the energy consumption cost reductions available by installation of a steam turbine powered chiller could yield significant savings (contingent on favorable steam pricing). An area in the plant that once housed a 2,400 ton steam chiller could still be utilized for such a use, as some of the necessary piping is still in place to allow connection to the primary plant piping.

Walker Plant #3
Walker Plant will see an increase of approximately 617 tons leaving 1,113 tons available that is possibly within tolerance of meeting single unit redundancy for the plant. Investigation will be required on the 10" north distribution loop as it will likely exceed recommended velocity value with added demands and will likely require upsizing.

Southwest Plant #4
All planned future demands yield will leave approximately 841 tons available, which is above single unit redundancy of 650 tons. The FLMNH Powell Hall expansion in 2020 with a demand of around 580 tons cannot be supplied by the existing distribution system, so it may be wise to consider a separate chiller for this facility and utilize remaining capacity at Plant #4 for future projects within the existing distribution system network.

McCarty Plant #5
The additional demands of Chemistry/Chemical Biology, Newell Hall Renovation, and the Public Safety Building all in 2016, along with the 780 ton load shift as noted in the Weil Plant summary (required to allow for the Nuclear Science Building Renovation and Addition/Nexus in 2016) will reduce overall available capacity to 996 tons, which is below the single unit redundancy of 1,200 tons. Consequently, one of the recommendations would be to construct a new chiller plant "Chiller Plant #11" in the area immediately south of the CLAS site (Center Drive & Museum Road) with an initial capacity of one or two 1,200 ton chillers within a 4 chiller footprint building. This plant would be connected to the McCarty Plant south loop at the 18" piping in manhole #7 to relieve thermal demand on the McCarty plant and allow for future long term demands placed on that plant. The other alternative would be to expand the Southeast Plant with a building shell addition to house 4 chillers and include the installation of a single 1,200 ton chiller and associated pumps and tower. To get this new capacity into the distribution system the 18" piping system adjacent to Nanotechnology would need to be extended to the Southeast Plant distribution system.

West Plant #6
The TRIP building and the IFAS Academic building will add minimal demand to this plant, but with the addition of around 368 tons for the IFAS Natural Resources building in 2020, a plant addition will be required. The original plant was designed to double in capacity adding two more 600 ton chillers in a new building addition to the plant. The 8" distribution piping will be inadequate for the Natural Resources building as well as any expansion to the SW Recreation Center and a new piping system originating from the plant would have to be constructed.

Holland Plant #7
No master plan demands are shown for this area; 1,075 tons remains available.

Southeast Plant #9
The only planned demand increase for this plant is the Harrell Center which will leave the plant with available capacity of around 1,281 tons, which meets the plant redundancy requirement. Any further demand from Shands Teaching Hospital, although none have been currently identified, will need to come from this plant in the form of a plant expansion. The plant was designed to double in capacity from 4,800 tons to 9,600 tons. See the McCarty Plant summary for potential demand shifts requiring an expansion to this plant.

Pathogens Plant #10
The Environmental Health and Sciences Building slated for 2020 will require a fourth 1200 ton chiller and associated equipment added to Plant #10 to maintain chiller redundancy.

Veterinary Medicine Plant
Future planned demands for this area will fall beneath the plant redundancy limit.

Chilled Water Distribution. The campus chilled water plants distribute chilled water from the plants to the individual buildings through an extensive supply and return piping system, which supplies chilled water at an average temperature range between 42 and 45 degrees. In the north area of campus currently five of the plant's (Weil Plant #1, Rabon Plant #2, McCarty Plant #5, SE Plant#9 and Walker Plant #3) distribution systems are interconnected to allow greater reliability in case of individual plant failure. Piping sizes range from 4" to 24" and have the approximate age for lengths listed below:

11,000 feet of pipe 1-10 years old
33,000 feet of pipe 15-30 years old
51,000 feet of pipe 30-45 years old
39,000 feet of pipe 45-60 years old

Northeast Area. The northeast area of campus is supplied mainly by three plants (Weil Plant #1, Walker Plant #3, and McCarty Plant #5). The distribution systems for these plants are interconnected, as discussed previously, to eliminate the need for a redundant chiller at each of the plants if necessary. Although Rabon Plant #2 is also interconnected to the distribution system of the three above mentioned plants, its participation in relieving the anticipated future demands in the northeast part of campus is somewhat restricted, due to piping distribution and valving limitations. Probably the single most helpful distribution extension would be to complete the 18" piping from Nanotechnology down to the Southeast Plant allowing load shifting described in the early plant summaries for McCarty and Southeast Plant. The distribution system of the Rabon Plant #2 that supplies chilled water to the Health Center complex is also interconnected to the Southeast Plant #9 distribution system; although under normal operation, the valving is closed to prevent this interconnection and is only open for emergency conditions. A recently completed piping interconnection of SL-1 with SL-2 has allowed the Pathogens Plant #10 to greatly contribute to the Rabon Plant demands when necessary, but is limited due to pressure concerns. These concerns are due to the SL-1 distribution piping system consisting of old transite pipe that is not easily repaired if damaged. This system should be replaced to allow better service of SL-1 to SL-2. The area of the Shands Teaching Hospital and the J. Hillis Miller Health Science Center is served by three chiller plants - Rabon Plant #2, a 3-1350 ton chiller plant owned and operated by Shands within the footprint of

Rabon Plant #2, and the Southeast Plant #9. Distribution piping in this area appears sufficient for the master planned projects.

Northwest Area. This area of campus is served by Holland Law Plant #7 with a 10" system supplying the Law complex and a 6" system which supplies the Springs Residence complex. Since no master plan demands are shown for this area the distribution piping should be sufficient.

Southwest Quadrant. This area of campus is served by two plants; West Plant #6 and the Southwest Plant #4. The West Plant has two distribution loops - a western 8" loop that serves SW Recreation and an 18" eastern loop that transitions to 8" that serves Microbiology Cell Science. The future TRIP building can be adequately served by the western loop, as well as the future IFAS facilities proposed to the east of the plant that would be served by the eastern loop. With the construction of the Phase IV SW Recreation facility, the capacity of the 8" loop will likely exceed capacity necessitating the construction of an addition western loop from the plant.

South Area. The Veterinary Medicine complex located in the south area of campus has a central chilled water system with a distribution piping system that serves a variety of buildings. The 30,000 gsf Vet Med Integrated Lab building will require distribution piping from the central plant if DX equipment is not selected. This distribution system from the Vet Med plant is not connected to any other University chilled water system.

West Area. With the construction of the new ENT facility (UF-591) the existing chiller plant in Orthopeadics will be expanded and a new distribution loop extended to the facility

Chilled Water Plant Optimization – During the past several years, initiatives have been in progress to optimize and better integrate the campus district chilled water system. The system produces approximately 113 million ton-hours of chilled water in support of approximately 13M GSF. A significant amount of energy is required to produce and distribute chilled water. A variety of measures can be employed to improve the efficiency of chillers, plants as well as the distribution system. In addition, efficient utilization of the chilled water by the served facilities can induce additional improvements in overall efficiency. Traditionally, when energy consuming equipment reaches the end of its useful life, it has been replaced with the most efficient and cost effective equipment available. Overall system efficiency is not determined strictly by the sum of the individual components however. Understanding the integration and control of the various chillers, pumps, and valves is critical to an understanding the physical configuration, thermodynamic principles and hydraulic pumping. Direct digital control has enabled real time management of the systems via programmable algorithms. PPD has been managing plants to a limited extent in this manner for many years. The steady increase in energy costs in recent years combined with UF's desire to reduce its carbon footprint, have elevated the importance of fully maximizing plant and distribution efficiency. A 2009 UF Presidential directive to radically reduce campus energy consumption was issued. As a result of this directive, University funding was redirected in support of this initiative. Some of these funds were applied to a PPD chiller plant energy reduction initiative. A program was subsequently implemented to evaluate and make modifications on a plant by plant basis. Any viable plant modification with a simple payback of 3 years or less was considered. Currently accepted engineering practices suggested plant modifications for energy reduction including integration and controlling of the various chillers, pumps, valves through an understanding of the physical configuration, thermodynamic principles and hydraulic pumping. Some significant mechanical alterations and upgrades were necessary prior to control implementation. Although not complete, this initiative has already resulted in a 12% improvement in plant efficiency

($1M+/yr). Substantial additional savings are anticipated as controls systems are fully installed and refined.

A variety of strategies for optimization are listed below, which will continue to be implemented and augmented:

Condenser Water Reset - Domestic water based cooling towers use a system of fill media, water spray nozzles, and fans as a system heat removal process. Chiller efficiencies can be gained by optimizing the speed of the fan and controlling "condenser" water volume/temperature circulating through the chiller to achieve the most efficient chiller operation. This optimization of the condenser water is known as "condenser water reset".

Replace motor starters for most plant electric motors with variable frequency drives (VFDs) – A well-known energy efficiency industry standard to match motor speed with equipment need.

Remove all flow restriction devices from the internal piping system to reduce required pumping horsepower.

Evaluate and implement "variable flow" or "demand flow" pumping where warranted for primary and secondary piping loops to help control what is known in the industry as "low ΔT (as in low difference in temperature) syndrome". This is a common problem usually originating from older poorly controlled HVAC building systems where cold supply chilled water delivered from the plant is not adequately utilized in the building and is returned to the plant at an abnormally low temperature. Chiller plants designed to optimally perform at a supply and return water temperature difference of 12° (44 ° supply and 56 ° return) will perform very inefficiently if supply and return temperatures have a difference below the plant design (i.e. 44 ° supply and 48 ° return or 4 ° Δ T). By varying the chilled water flow through the chillers some compensation for poor building return temperatures can be made to increase efficiency.

Replace obsolete chiller controls with updated controllers and evaluate and implement best "chiller plant sequencing" to control chiller start/stop and chiller loading/unloading.

Calculate, test and implement best chilled water "system pressure". Although not an energy efficiency strategy, lowering the system pressure will increase distribution piping life.

Replace old pneumatic plant controls with "Direct Digital Controls" (DDC). Electric DDC controls are current industry standard for a universally accepted variety of reasons and should be implemented wherever practical.

Evaluation and modification of chilled water" bypass" piping. Chiller plants generally require a properly sized and operating bypass pipe connecting the supply with the return chilled water piping within the plant for healthy and efficient chiller optimization.

Compilation and creation of a chiller plant "Systems Manual" composed of up to date "as-built", operation and maintenance (O&M) information, and equipment manuals to form a comprehensive, editable, digital format of all relevant plant information required for plant operation and future engineering considerations. Using the as built and O&M materials create a Piping and Instrumentation Diagram (P&ID) for entire plant.

Chiller plant "Graphics Package" - A software based graphical representation of chiller plant (all major plant equipment - chillers, pumps, cooling towers etc.), distribution loop piping diagram, and loop buildings chilled water entering/leaving pressure and temperature conditions. Package has full monitoring and real time operational capabilities. Prior to 2011 full plant graphics for all plants were spotty (or nonexistent), and dissimilarly formatted. In 2011 the first comprehensive model plant graphics template format was created for campus wide chiller plant implementation. Benefits are real time monitoring, alarming and control with specific view to healthy energy-efficient plant operation. Graphics also depict chilled water supply and return temperatures as well as flow status for each building receiving chilled water from a given plant thus allowing plant operators to quickly diagnose flow and temperature anomalies on all parts of the distribution system

Thermal Energy Storage

Thermal Storage is a simple technology and has many benefits. This technology gained popularity in the 1980's, when the country's energy crisis was at its peak, and has proven itself to be an essential component of premier chilled water plants worldwide. The obvious benefit of this type of system is that Time of Use (TOU) pricing can be utilized, dramatically decreasing monthly electric bills during both the summer and winter periods.

The benefits of both thermal energy storage concepts are enumerated below:

<u>Reduction or elimination of demand charges and a reduction in kWh pricing during the off-peak period -</u> This occurs because of the "shift" in the time of day that the large chiller equipment will operate. This also translates into monthly power bill savings due to supplier's peak period and TOU pricing.

<u>Less frequent equipment maintenance -</u> By running the Cooling Plant equipment at lower ambient temperature and a point of best efficiency or full load, the service life of the equipment is extended.

<u>Provides redundancy with respect to the loss of cooling to the campus -</u> In an on-demand type cooling system, the chillers are called upon to operate during occupied times and produce chilled water on an as-needed basis. If the chillers experience downtime, chilled water cannot be produced to immediately satisfy the chilled water requirement of the facility. With a TES system, the chilled water production is independent of the building load and will provide a buffer time to get the chillers back online after any interruptions.

The most significant benefit of a CHW Storage system is that the CHW TES system simply takes less energy to produce the same amount of cooling than a conventional system. This occurs because the equipment can be operated within its most efficient performance range along with the ambient relief associated with running the chillers at night versus the middle of the day. This results in decreased power consumption of core mechanical plant components for the CHW TES. Recharging of the storage will occur daily starting in the evening at 21:15 hours and continue until the tank is fully charged or until 11:45 the next day. This period corresponds with the off-peak period with a 15-minute buffer at the beginning and end. The chillers can easily meet the cooling requirements of the building during off peak hours while simultaneously charging the TES tank. The recharge can be easily satisfied within the 15 off-peak hours of operation. The optimal time for recharge is from 12 midnight to 6 am, which is easily accomplished with the CHW TES.

B. Steam Production

Steam for the main campus is provided by a combined heat and power (CHP) Cogeneration Plant constructed in 1993 by Florida Power Corp (now Duke Energy) that uses natural gas to produce electricity and steam. Located off Mowry Road, the plant is currently owned and operated by Duke Energy.

The combustion gas turbine generator (CGT) is a General Electric Aero derivative LM 6000PC Sprint fired with natural gas only with an ISO rating of 47.2 MW. The plant was originally constructed with a LM6000 PA combustion turbine with an original ISO rating of 41 MW. The unit was installed in 1994 with steam injection for NOx emission control, and was manufactured prior to the development of dual fuel dry low NOx emission control systems. The LM6000 PA originally installed was subsequently upgraded to a LM6000 PC Sprint around the year 2000. The Sprint upgrade enabled the electrical output to be increased to 47 MW by injecting water to the inlet of the combustion turbine. Although newer variants of the LM6000 such as the PF have been introduced with dry low NOx technology, the UF combustion turbine has retained the steam injection technology as originally configured. The combustion turbine core was replaced with a completely new unit in March 2013. The new LM 6000PC engine is designated by General Electric as engine # 151-749. The CTG is currently maintained by General Electric under a long term service agreement with Duke Energy. As such, the CTG core has major and minor overhauls conducted at regular intervals of 3 and 9 years, respectively. The current engine has less than 6,000 operating hours, so is expected to not require a major overhaul until it reaches 75,000 operating hours or another 8 years. The PC variant of the GE LM6000 combustion turbine uses 31,000-35,000 pph of steam for NOx control. Steam injection is required for this PC model of the LM6000 to meet current Florida air quality regulations and the Title V operating permit for this facility

Steam is generated by a gas fired combustion turbine exhausting into a heat recovery steam generator (HRSG). The heat recovery boiler or HRSG is a Deltak multi pressure water tube boiler with superheater sections and duct burner. The HRSG and CTG system does not include any post combustion emission control (such as SCR or CO Catalyst). The HRSG has high pressure (HP) sections including two (2) superheaters, evaporator and three (3) economizers and is rated for 248,000 lb/hr at 750 psig/720 F. The intermediate pressure (IP) sections consist of superheater, evaporator and economizer and are rated for 16,000 lb/hr at 94 psig/461 F. The low pressure (LP) section consists of an evaporator and integral deaerator and is rated at 35 psig. The natural gas only fired duct burner is rated at a heat input of 190.2 MMbtu/hr. The steam injection for NOx control requires 720 psig steam. The balance of the plant equipment includes the feed water pumps, water treatment equipment, air compressors, chemical feed and process cooling. The cogeneration plant uses large quantities of water for CTG steam injection, CTG Sprint power augmentation, condensate make-up, evaporative air cooler and blowdown. Reclaimed water from the UF waste water treatment plant is used to supply the majority of the plant's water requirements. As such, a large portion of the balance of plant equipment is dedicated to water treatment. The water treatment process consists of media filters, softeners, reverse osmosis and deionization.

The Cogeneration Plant steam production may also be supplemented by two (boiler #4 and #5) dual fueled (natural gas or fuel oil) fired boilers owned by UF and operated and maintained by Duke Energy. The boilers are housed in the Rabon Plant #2 located immediately east of the Cogeneration Plant. Boiler

#4 was replaced in November 2014 with a new Cleaver Brooks 250 psi water tube boiler with a capacity of 80,000 pph. Boiler #5 manufactured by Babcock and Wilcox (D style) 250 psi, has a nameplate capacity of 120,000 pph, and was installed in 1977. It has a de-rated capacity of 105,000 pph according to Duke Energy and is recommended for replacement. These boilers are capable of delivering an additional 185,000 pph of steam to the campus system.

The historical peak steam demand for campus is around 210,000 pph and occurred in 2010. The chart below depicts 2011 steam demand and typifies the campus yearly demand curve.

Steam Distribution - North Area. This area of campus, north of Archer Road and east of Lake Alice, is served by an aging piping distribution system originating from Rabon Plant #2 as well as Weil Plant #1. The Duke Cogeneration Plant as well as the UF boilers #4 and #5 supply 250 psi steam to Rabon Plant and Weil Plant #1 which then reduced to 70 psi through either a 1 mW 1948 Elliot steam turbine generator at Rabon Plant#2 or pressure reducing valves at both Weil and Rabon and then serve campus through a 70 psi supply and a gravity piped condensate return system. Supply piping sizes range from 2” to 12” and have the approximate age for lengths listed below:

24,000 feet of pipe 1-10 years old
25,000 feet of pipe 15-30 years old
37,000 feet of pipe 30-45 years old
45,000 feet of pipe 45-60 years old
10,000 feet of pipe > 60 years old
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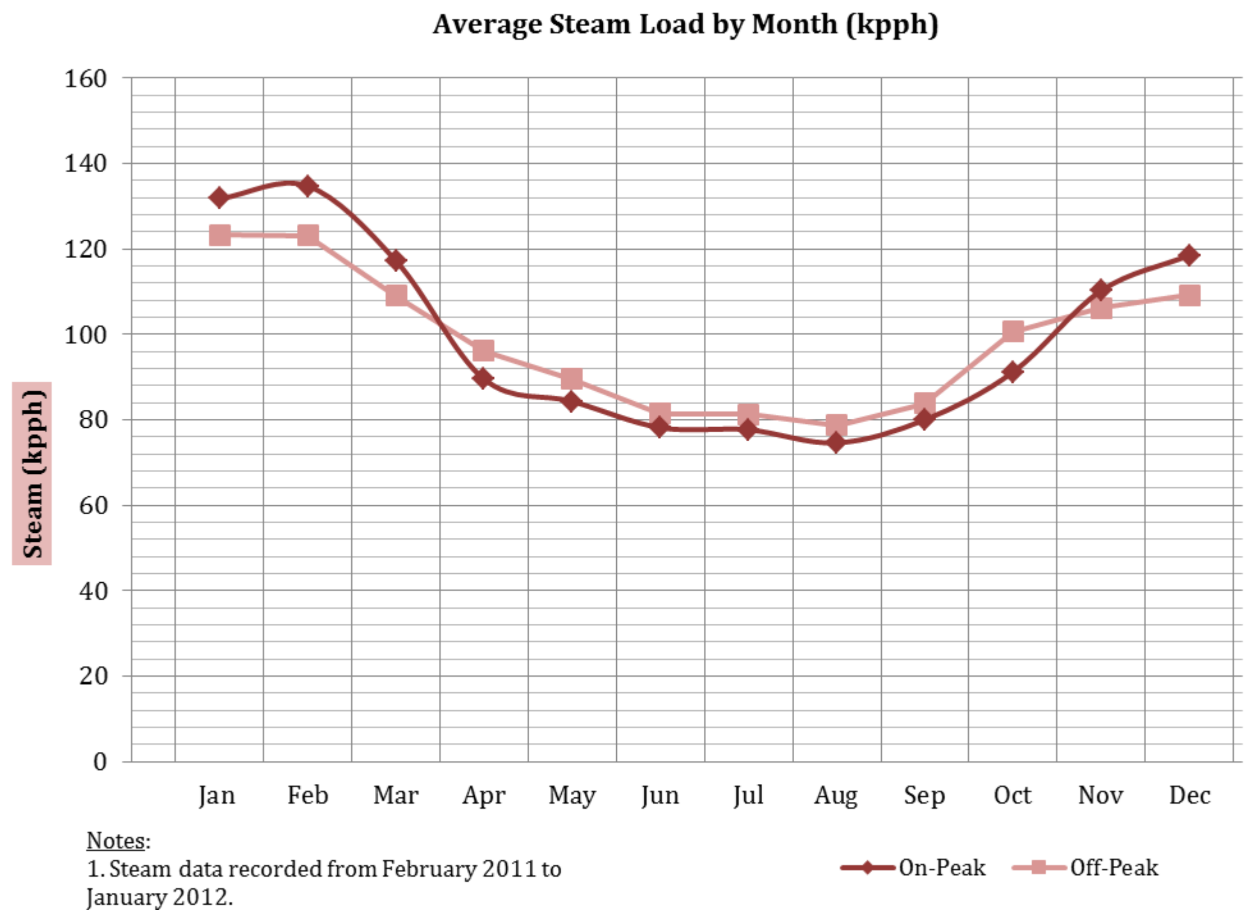
South Area. The campus area south of Archer Road is occupied mainly by the Veterinary Medicine complex. The Veterinary Medicine building has a central boiler system providing steam and hot water for various needs within the complex. This system is not connected to the central campus steam distribution. Planned development requires limited additional boiler capacity but may require additions to the existing boiler system.

West Area. None of the facilities in this area of campus are connected to the central campus system, but employ individual hot water heaters or steam boilers. Replacement and additions to the building boilers will be evaluated on a case by case basis.


Average Steam Load by Month (kpph)
Steam (kpph)
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Notes:
1. Steam data recorded from February 2011 to January 2012.
On-Peak
Off-Peak

III. Electrical Power and Other Fuels Sub-Element

The University of Florida campus is supplied electricity by three 69 kV Duke Energy substations: UF Substation (located adjacent to the Cogeneration Plant), Hull Road Substation (located in the west area of campus), and the Gainesville Substation (located west of Gainesville Fire Station #2 on Archer Road near the intersection of SW 16th Ave.). The UF Substations has a total of three 33.6 mVA transformers providing 23 kV service via 7 underground feeders to main campus. The Gainesville Substation has one 33.6 mVA transformer (with provisions for a second transformer) which provides 23 kV service via three feeders that terminate at three switches in the UF Substation yard. These switches provide the point of service for two campus feeders (#8 and #9) which also supply 23 kV power to campus. The Hull Road Substation consists of two 10.5 m VA transformers providing 12.47 kV service to the west area of campus. The 23kV service feeders supply electricity to 16 UF owned substations which reduce the transmission voltage from 23kV to 4.16 kV, 13.8 kV or 12.47 kV. The University of Florida East Campus is fed by GRU via NW 23rd Avenue feeder as well as a feeder from Waldo Road.

A. Existing Capacity vs. 10 Year Plan – Surplus or Deficiencies

In 2014 the UF Substation with the Gainesville Substation recorded a combined peak demand of 65.6 MWs (non-coincidental peak, worst case, is 75.3 MWs) versus a capacity of 134.4 MVA. The Hull Road Substation recorded a peak demand of 8.1 MWs (non-coincidental peak, worst case, is 11.1 MWs) versus a capacity of 20.5 MVA.

Substations - The University of Florida has a policy of providing redundancy by having double ended substations and loading the transformers to below 50% of their maximum capacity to enable them to pick up the other transformer's load in case of a single unit failure. The analysis below looks at existing as well as proposed substation and feeder demands in that light. Table 3 depicts the estimated kW for each future project. Table 4 depicts current and future available capacity for each Substation circuit and main, as well as the overall effect to the 23 kV feeders that supply the pertinent substations. It should be noted that the historical peak demand values were taken from the all-time high substation electronic relays' peak recording, which most likely was a reading taken when nonstandard field switching was in play due to planned or unplanned outages. Another policy that plays into the management of large demands placed on the system is to attempt to place any new demand that exceeds 1000kW directly on the 23 kV feeder backbone; not on the individual substation circuits. This will become evident in some of the following substation summaries.

Weil Substation #1

A major impact to this substation will occur with the addition of the O'Connell Center Renovation. An increase of around 500 kW will increase the net estimated peak demand for this facility to around 1500 kW and will necessitate removing this building from Weil Substation #1 and placing it directly on the 23 kV system. With the new projected demands, two of the three main breakers will be loaded just above the 50% mark prompting the need to monitor the mounting demands closely over the next 10 years.

Rabon Substation #2

Future demands may load individual breakers #2-3 beyond 50% but the main breakers will remain below 50%.

Auditorium Substation #3

Individual substation breakers #3-1, #3-2, #3-7 may see demands that will put the individual circuits beyond 50% but the three main breakers should be below 50%

Centrex Substation #4
Circuits #4-1 and #4-3 appear to have significant existing demands; future demands may push the demand well past the 50% limit and should be monitored. Main #1 may slightly exceed 50%, but Main #2 and #3 appear to be within limits.

Lake Alice #5
The 3 mains will be below 50%; circuit #5-2 will be significantly above 50% and demand may need to be shifted to a more lightly loaded circuit.

Heliport Pad Substation #6
All mains and individual circuits will remain below 50%

Walker Substation #7
This substation serves the Walker chiller plant and will not see demand above 50% of capacity

Heat Plant Substations #9
This substation serves the Weil chiller plant. There is a project underway to replace chiller #4 and rework some of the electrical. No excessive demands are anticipated.

Performing Arts Substation #10
In the summer of 2014, this substation had a catastrophic failure which rendered Main #1 circuit's 1 through 6 inoperable. The substation is being rebuilt, with breaker readings to be available once the project is complete. Circuit # 10-8 has an excessively high existing peak reading which appears to be in error.

Hull Road – Duke Power Substation
All four circuits are well below 50% capacity.

McCarty Substation #12
This substation serves the McCarty chiller plant and is projected to stay within the 50% limit.

Southeast Plant Substation #13
This substation serves the Southeast chiller plant and is projected to stay within the 50% limit even with future expansion of the plant.

Pathogens Substation #14
All circuits will remain below 50% limit

23 kV Circuits #1 through #10
Future anticipated demands from the individual substations that ultimately are transmitted to the 23 kV system will not increase the system circuits loading to beyond the 50% limit.

Metering
Utility metering is essential to obtain accurate consumption measurement and is of increased interest for many university stakeholders with sustainability initiatives around campus. Utility metering information helps support managerial and operational decisions including location of new construction, energy

conservation opportunities, LEED certifications, external/internal reporting consistencies, and billing the appropriate entity the appropriate amount. As mentioned previously, there was an organizational restructure at PPD, which allowed the metering group to align talents and efforts to be more accurate and efficient. This management change led to better database management, with a more analytical perspective, as well as providing dedicated metering calibration/repair/technical personnel.

Process Improvements
The metering process from obtaining the reads and ensuring accuracy of 1,365 physical meters have been reduced from 14 business days to 2 business days which allows more time for efficiency improvements and meeting our customers' needs. This has allowed the development of many new initiatives to benefit university energy stakeholders. In addition, the average physical meters that needed to be estimated each month have reduced from 79 (6.1%) to 22 per month (1.6%). This provides the university again with increased accuracy and energy transparency.

System Loss Improvement
System Loss referred in this document is the amount of utility units purchased and produced less the amount of units billed out for generating revenue. Some variables that can produce system loss includes administrative issues (not metering/billing utility units serviced to customers), utility theft, operational standards (breakdown of utility energy from high voltage/pressure to building level capability), and infrastructure issues (corroded pipes and lines).

AMR Implementation
Electric System Efficiency Improvements have made a significant impact to the university's entities utility expenses. Starting back in the FYE 07 timeframe, a decision was made to implement the AMR (Automatic Metering Reading) project for the 762 electric meters of UF/PPD's utility metering. These meters measures close to 20 million GSF for 971 buildings, plus street lighting, athletic fields, traffic signals and other non-GSF infrastructure that require electric. There are many benefits and opportunities that come along with this AMR implementation. The technology automatically collects consumption, diagnostic, and status data that transfers to a central database for analyzing. The consumption is collected in 15 minute interval data within typically the day after (24 hours). This information analyzed allows Utility Services and customers (E&G/HSC and other entities on campus) to better control the electric usage at the buildings, chiller plants, and the sewage plant. With the AMR implementation, all meters were changed out over a 3-year period. This process allowed meters that have been installed (with some to 50 years) to be replaced and properly installed. By ensuring the PT/CT ratio, multiplier, and all 3 phases are set up appropriately and working, this reduced the system loss by 7%. The 7% system loss reduction allows more appropriate billing of energy and the transparency of customers' usage for determining opportunities of improvements for the university. This efficiency improvement in excess of $3.1 million has allowed PPD Utility Services electric rate not be impacted as much from the risen energy rates.

B. Other Fuels.
Natural Gas - Natural gas is supplied to UF through a piping distribution system owned, operated and maintained by Gainesville Regional Utilities. Facilities are individually metered and billed accordingly. As new demands are identified, GRU is notified of these demands and piping extensions, upgrades, or modifications are made to accommodate the new demands. It is anticipated that with the proper modifications to the distribution system there will be adequate supply for all new building projects in the next 10 years.

Fuel Oil - Fuel oil is required for many of the emergency generators on campus and is generally stored at the generators. It is anticipated that fuel oil will be commercially available for any new demands.

IV. Telecommunications Sub-Element

Communication technologies are a critical element in the design of virtually all new and renovation building projects. These technologies include voice, data and video transmission, wireless connectivity, distributed antenna systems, security and fire alarm systems, audio/visual systems, or other communication technologies.

A Structured Cabling Plant is a key concept in enabling Information Technology for the University. In order to maximize network functionality, and to minimize labor and materials costs, a common set of network codes and standards is followed. To accomplish this, the University has adopted a policy in which these codes and standards are managed and administered centrally. The UF Information Technology Office (UFIT) is charged with this responsibility.

UF's communications systems follow the codes and standards set forth in the following: NEC 2002, NESC, NFPA, ANSI/TIA/EIA Telecommunications Infrastructure Standards, FCC, IEEE and BICSI'S Telecommunications Distribution Methods Manual. These codes and standards are to be used as references when designing telecommunications systems. UFIT promotes the use of widely accepted industry standards in deploying the University telecommunications infrastructure. Employees of the university, consultants and contractors working on behalf of the university should have a working knowledge of these standards prior to performing work for the university and should follow the university preferred standards and practices while deploying telecommunications infrastructure. University employees, consultants and contractors should contact UFIT for clarification and interpretation of these standards. The following standards are practiced at the University of Florida:

- ANSI/TIA/EIA Commercial Building Telecommunications Cabling Standard (568-C.1-2009 & A1:2012)
- ANSI/TIA/EIA Commercial Building Standard for Telecommunications Pathways and Spaces (569-C-2012)
- ANSI/TIA/EIA 606B-2012 Administration Standard for the Telecommunications Infrastructure. See Appendix 1 of the UF Telecommunications Standards for the current UF Labeling standard based on ANSI/TIA/EIA.
- ANSI/TIA/EIA Commercial Building Grounding and Bonding Requirements for Telecommunications (607-B-2013)
- ANSI/TIA/EIA Customer-Owned Outside Plant Telecommunications Cabling Standard (758-B-2012)

These standards can be obtained through BISCI at www.bicsi.com as well as www.tiaonline.org.

Pathways should be reinforced in capacity to serve present and 10-year Plan requirements, expanded to serve 10-year Plan and/or to replace old aerial and direct buried installations. Several hub improvements are underway currently or planned in the 10-year horizon.

WiFi – Wireless - The University of Florida has established WiFi or wireless access for faculty, staff and students in most of the heavily populated areas of campus. UFIT – Network Services is primarily responsible for the maintenance and continued expansion; however some local units exist and are maintained internally. Figure 10 – 1 illustrates the University's wireless coverage area as of January 2014.

Distributed Antenna System (DAS): The University of Florida has established an extensive array consisting of a neutral-host Distributed Antenna System (DAS) to support the increasing load and capacity for wireless service providers on campus. Construction projects and major renovations should take this system into account as it continues to expand its service across campus. A new DAS headend building is under construction and plans are to provide a similar support building at the Eastside Campus location.