FPL Experience with Alternative Water Sources

28th Annual Florida Chamber of Commerce Environmental Permitting Summer School

July 23, 2014

Steve Scroggs, Senior Director
Florida Power & Light Company
Discussion Topics

• Water and Electric Generation - Background
• Water Resource Options
  – Marine water
  – Cooling Ponds
  – Deep aquifer wells
  – Reclaimed Water
• Case Study - Turkey Point 6 & 7
  – Resource Options
  – Selection Process
  – Certified Design
    -- Reclaimed Water
    -- Radial Collector Wells
Water and Electric Generation
Water is a necessary part of the power generation process.

**Steam System**
- The “secondary” loop
- Water boils to steam and condenses back to water

**Reactor Coolant**
- The “primary” loop
- Water never boils

**Circulating Water**
- The “cooling fluid”
- Water removes heat from Steam System
- Exchanges heat with final heat sink

**“Make-up” Water**
- Replaces water that is evaporated in heat transfer (i.e. cooling tower), or
- Provides heat sink (i.e. water body)

---

**Diagram:***
- Reactor Coolant
- Steam System
- Reactor
- Steam Generator
- Turbine
- Final Heat Sink (Ex: Forced Draft Cooling Tower)
- Condenser
- Intake
- Discharge (1/3)
- Evaporation (2/3)
- Make-up Water

---

**Flow Diagram:**
- Water flows from Reactor to Steam Generator, then to Turbine, and finally to the Condenser.
- The circulating water removes heat from the Steam System and exchanges heat with the final heat sink.
- “Make-up” water is used to replace water lost to evaporation or as a heat sink.
Forced draft cooling towers are the most efficient technology for providing cooling while minimizing water use.

Cooling technology and make up water quality determine how much water is needed for cooling.

Cool Air In

Warm Water In

Warm Air and Water Vapor

Condensed Brine Out

Cool Water Out

Cool Air In

Warm Water In
Water Resource Options
Generation sites historically relied on large water bodies; during the 1970’s CWA began to significantly influence water sources

Before the 1970’s Florida plants were located on natural water bodies
- Coastal, lakes, rivers
Later power plants (1970’s and 1980’s) used cooling ponds or cooling canals
- Large land requirements

FPL service territory
- Once-through cooled
- Cooling ponds

Turkey Point cooling canal system

5 miles
St. Lucie Nuclear Units 1 and 2

Example of once-through cooling using intake and discharge pipes that go out into the Atlantic
Power generation and cooling water technological advances provide more flexibility in location of power generation and reduce water use.

**Next Generation Solar at FPL’s Martin Plant**

Three different generating technologies using a cooling pond as a water source and forced draft cooling towers as the cooling technology.
Current generation and cooling technologies require less water, allowing for more potential site locations

Newer power plants (1990’s to present)
- Combined Cycle requires less water
- Forced draft cooling towers further reduce requirements
Water Policy in Florida Today

• State water policy requires a proposed water use to be a “Reasonable-Beneficial Use”

• Strong competition exists for available surface and groundwater sources

• By regulation, the lowest quality water for the intended use must be used

• The State’s water management districts have specifically directed local governments to increase wastewater reuse

• It is stated public policy that use of water only once is not in the public interest
Case Study: Turkey Point 6 & 7
Case History: State Certification was granted for two new nuclear plants in May 2014

**Turkey Point Units 6 & 7**

- **2,200 MW two unit facility using Westinghouse AP1000**
- **Environmental benefits include:**
  - Avoids 267 million tons of CO2
    - FPL system produces ~40 million tons per year
  - Avoids consumption of over $60 billion in natural gas
  - Use 60 million gallons per day of reclaimed water
  - Marine water via Radial Collector wells will provide backup

Specifically designed to be integrated into the South Florida environment
Water is all around us, but just try to use some!

1. Marine
2. Ground Water
3. Reclaimed
4. Surface Canals
5. Onsite Canals
Water is all around us, but just try to go use some!

## Water Sources

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Intake Method</th>
<th>Additional Requirements</th>
<th>Volume (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine</td>
<td>Offshore Intakes</td>
<td>Tunneling</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>Canal Intakes</td>
<td>Fish screens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subsurface Intakes</td>
<td>Radial Collector Wells</td>
<td></td>
</tr>
<tr>
<td>Ground water</td>
<td>Biscayne</td>
<td>Well system</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Upper/Lower Floridan Boulder</td>
<td>Well system</td>
<td>~90</td>
</tr>
<tr>
<td></td>
<td>Zone</td>
<td></td>
<td>125</td>
</tr>
<tr>
<td>Reclaimed</td>
<td>Buried pipeline</td>
<td>On-site treatment</td>
<td>60</td>
</tr>
<tr>
<td>Surface water canals</td>
<td>Pumping system</td>
<td>On-site treatment</td>
<td>60-80</td>
</tr>
<tr>
<td>Surface water - onsite</td>
<td>Cooling Canal System</td>
<td>Expand system to provide capacity</td>
<td>&gt;125</td>
</tr>
</tbody>
</table>

1) Values estimated, vary with TDS content
Multiple screening studies result in a relative evaluation of the various sources and conveyance methods

**Resource Ranking**

- **Technical Factors**
  - Volume, reliability, quality, permittability, navigation, security

- **Environmental Factors**
  - Construction impacts, operational impacts, CERP consistency, permittability

- **Reclaimed emerged highly ranked, but with a reliability concern**
  - Municipal Water entity is a non-recourse supplier
  - Answer: Identify a backup source to balance reliability concern
  - Current Example: West County Energy Center
    -- Use of 21 MGD reclaimed water from Palm Beach County
    -- Retains original Floridan well system as a restricted backup
Project will use 59 MGD of reclaimed water as its primary source of cooling water

**Reclaimed Water**

- A cost-effective beneficial use of reclaimed municipal wastewater
- Does not use water targeted for Everglades restoration
- County will own/operate a 9 mile reclaimed water pipeline from South District Plant

Reclaimed water used by Turkey Point 6 & 7 will not compete with reclaimed water reserved for Everglades restoration
Proposed project includes a 44 acre Reclaimed Water Treatment Facility to remove nutrient and mineral content prior to use.
Conceptual Radial Collector Well (RCW) Design

- 4 onshore caissons each 1/3 capacity (one back-up)
- Caisson construction in upland areas
- Laterals approximately 25 to 40 ft below the substrate
- Laterals constructed from within caisson – no dredge and fill activities in Biscayne Bay
Pumping Activities At Equilibrium

Fort Thompson Formation

Turkey Point 6 & 7 Radial Collector Well - Conceptual Layout

Not To Scale - For Illustrative Purposes Only
RCW Drawdown (ft) within the Pumped Layer
Questions?