Integrating a Proposed Hydro Project into a 3 (5) City System
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**SEAPA Area - 2010 Municipal Loads**

- **Total Load + Distribution Losses**
  - Jan: 18,000
  - Feb: 16,000
  - Mar: 14,000
  - Apr: 12,000
  - May: 10,000
  - Jun: 8,000
  - Jul: 6,000
  - Aug: 4,000
  - Sep: 2,000
  - Oct: 0
  - Nov: 0
  - Dec: 0

**Blind Slough**
- 1.1 MW

**KPU Diesel**
- 12 MW

**KPU Hydro**
- 6.1 MW

**KTN**
- 1.5 MW

**Swan Lake**
- 0 MW

**Tyee Lake**
- 13.5 MW

**SEAPA Generation**

**Map Details**

- Petersburg Substation
- Wrangell Substation
- Swan Lake Hydro Site
- Tyee Lake Hydro Site

- **Legend**
  - Blue nodes: Power generation sites
  - Purple lines: Transmission lines
  - Red nodes: Load centers
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**Power**
1-100 Watt bulb

**Energy**
100 Watts for 24 hrs = 2400 Wh - energy
100 Watts for 24 hrs = 2.4 kWh (kiloWatt hours)
100 Watts for 24 hours = .0024 MWh (MegaWatt hr)

**Power**
10,000 bulbs = 1 MW

**Energy**
10,000 bulbs for 24 hours = 24 MWh
or
417 100 W bulbs for 24 hrs = 1 MWh
1 Tyee Turbine = 12.5 MW
Tyee Plant (2 turbines) ≈ 6 Locomotives

1 Locomotive = 6000 hp or 4.4 MW
3 Locomotives = 13.2 MW

In Ketchikan 1 MW can serve 800 homes using 900 kWh/month flat demand rate. In the winter 1 MW can meet the peak demands of approximately 650 homes. In summer 1 MW can serve approximately 1000 homes.
PSG – WRG – KTN Daily Loads - how they vary hour by hour
The morning peak was 43 MW for the hour 8am to 9am
The total load for the day is the area under the curve (MW x hr) = 936 MWh
\[ \sum_{365 \text{days}} \]

If you add up the area under each days curve, and sum all the days of the year, this is the regions total energy demand in MWh.

<table>
<thead>
<tr>
<th>Date</th>
<th>Energy (MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Jan</td>
<td>795.6</td>
</tr>
<tr>
<td>1-May</td>
<td>400</td>
</tr>
<tr>
<td>9-Aug</td>
<td>600</td>
</tr>
<tr>
<td>20-Dec</td>
<td>936</td>
</tr>
<tr>
<td>31-Dec</td>
<td>912</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>252,737</strong></td>
</tr>
</tbody>
</table>
2010 Actual Load and Resource Values

<table>
<thead>
<tr>
<th>Table of PSG-WRG-KTN Loads and Resources</th>
<th>MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSG + WRG + KTN Load + Distribution Losses</td>
<td>252,737</td>
</tr>
<tr>
<td>Transmission Losses</td>
<td>5,406</td>
</tr>
<tr>
<td>Total Load</td>
<td>258,143</td>
</tr>
<tr>
<td>Tyee spilled energy</td>
<td>42,800</td>
</tr>
<tr>
<td>Swan Lake Spilled Energy</td>
<td>6,500</td>
</tr>
<tr>
<td>Total Spilled Energy</td>
<td>49,300</td>
</tr>
<tr>
<td>Total Hydro Capability for 2010</td>
<td>307,443</td>
</tr>
</tbody>
</table>

Region is long by nearly 50,000 MW-hr; Tyee spilled for 5 months! Swan Lake spilled for 1 month

All hydro and diesel generation inside the brown region, diesel in 2010 was limited to maintenance efforts

Load Resource Balance for 2010

![Load Resource Balance Chart]
Too big a water year is problematic!

The majority of spilled energy of 2010 occurred from late October through November. While SEAPA allows for storage increases to occur at Swan Lake and Tyee during this period, we don’t assume extremely high events will occur. These events are problematic for two other reasons.

1) Loads decrease because of the warm weather, and loads decrease because these strong storms cause outages. It’s hard to ramp up hydro units to avoid spill if your line is out.

2) Our member utilities dislike spill just as much as we do. Their generation increases which further reduces loads to SEAPA.
That’s right, in one year we go from way long to significantly short. In SE Alaska a 100% hydro system is feast or famine. As we discuss resource balance today, KPU’s Bailey Plant is generating with diesel engines! February loads were an astounding 46% above February 2010 Loads, Jan, March and April were also significantly above our projections which included provisions for the boiler conversion program. Cold weather has reduced inflows to near zero, storage is seriously depleted. Diesel generation (9-14 MW) is expected to last for 2-4 weeks depending on what else?.......WEATHER.
Huge annual fluctuations in fuel lead to large fluctuations in hydro output.
Swan Elevations 2010 and Present
Spill at 330.0 ft; Minimum at 271.5 ft
Tyee Elevations 2010 and Present
Spill (nominal) at 1390 ft; Minimum at 1250 ft, Ops Plan first warning, May 10th, elevation 1305 ft.
This is exactly why we are here today, a short year after completion of a new project makes you think of planning! What is the long term load and resource balance for the Region?

Kake-PSG-WRG-KTN Resource Load Balance - All Hydro

- Total Annual Energy (MWh)

- Hydro Resources
- 1% Growth after 2012
2012 to 2015- use historical average hydro generation
2015 Whitman 800 KW, next near full project complete
2018 Kake Intertie commissioned, Metlakatla on a future analysis
2020 Project A commissioned
Before Project A can be estimated as a reliable contribution, the FERC application is reviewed. As the majority provider to our member communities we have a responsibility to verify the proposed project will be financially viable.

Are you sure that project will integrate into the system and provide the stated energy?

1) Verify hydrology
2) Verify hydraulics
3) Plant operation proposal consistent with system operation?, will it integrate well or will significant inefficiencies result
Verify basin hydrology
- Basin productivity reasonable- cfs/sq. mi consistent with like basins?
- Stream gage information available? Data intact or sporadic? If sporadic what were correcting assumptions?
- Stream gage corrected back to reservoir using appropriate methods for elevation change and tributary areas

Verify project hydraulics
- Flow rates and net head consistent, tunnels, penstock sized appropriately?
- Is there daily, weekly, monthly or seasonal storage?
- Plant output restricted by ramp rates?
- Plant output restricted by reservoir limits or reservoir rate change limits?
- How were annual and monthly capacity and energy values derived?
  - Never Average inflow, you won’t get average generation
  - See tail end of presentation for details
A word concerning Storage

<table>
<thead>
<tr>
<th>Project</th>
<th>Storage Ac ft</th>
<th>Plant Pwr Cap MW</th>
<th>Plant Hydr Cap cfs</th>
<th># days storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>KPU Ktn Lks</td>
<td>13,600</td>
<td>4.2</td>
<td>127</td>
<td>54</td>
</tr>
<tr>
<td>KPU Silvis</td>
<td>38,000</td>
<td>2.5</td>
<td>80</td>
<td>241</td>
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<tr>
<td>KPU BVR Falls</td>
<td>8,052</td>
<td>7</td>
<td>87</td>
<td>47</td>
</tr>
<tr>
<td>SEAPA Swan lake</td>
<td>86,000</td>
<td>22</td>
<td>921</td>
<td>64</td>
</tr>
<tr>
<td>SEAPA Tyee</td>
<td>52,400</td>
<td>24</td>
<td>200</td>
<td>132</td>
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<tr>
<td>PMP&amp;L Blind Sl.</td>
<td>4,875</td>
<td>2</td>
<td>16</td>
<td>152</td>
</tr>
<tr>
<td>Mahoney Lake</td>
<td>4,000</td>
<td>9.6</td>
<td>58</td>
<td>35</td>
</tr>
<tr>
<td>Cascade Swan Lake</td>
<td>3,474</td>
<td>70</td>
<td>670</td>
<td>3</td>
</tr>
<tr>
<td>Ruth</td>
<td>2,200</td>
<td>20.1</td>
<td>152</td>
<td>7</td>
</tr>
<tr>
<td>Ruth with Dam</td>
<td>3,900</td>
<td>40</td>
<td>305</td>
<td>6</td>
</tr>
</tbody>
</table>

High altitude reservoirs require storage to assist with winter loads! High altitude reservoirs with little storage are prone to spill in summer when loads are low.
Which project do you think will waste less water?

52,400 Ac-ft

3500
Ramp rate restrictions add more burden to hourly load following efforts!
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**Inputs**
- Add new plant to existing system
- Hourly Loads
- Daily Avg. Inflow sequence for a year
- Reservoir Start
- Spin Reserve Reqs.
- Buss limitations
- Reservoir limits

**Outputs**
- System
- Diesel Gen
- Hydro Gen by plant
- Spill by plant
- End Reservoir Levels

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**SEAPSA Hourly Optimization Model**

**Buss Diagram**

- Hydro Gen
- Thermal Gen
- Load
- 2% Loss
- Capacity Limit
- Continuity Point

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SEIRP Technical Conference
Proposed Project
70,000 MWh, $110 M

Actual Expectation
50,000 MWh, $140 M

Project as proposed as stand alone benefit in FERC Application

Actual dispatched energy to system and updated costs. This project gets evaluated in Dave’s Finance Model
Now you can add the 50,000 MWh of system generation, you have high confidence it will be produced when needed and sold to help pay the bankers!

**Kake-PSG-WRG-KTN Resource Load Balance - All Hydro**

- **Load Forecast Risk!**

Legend:
- Blue bars: Hydro Resources
- Red line: 1% Growth after 2012
- Green line: 2% Growth after 2012
Summary

• This is a process, not a one-off solution, IRPs are repeated every 2-3 years
• Any solution will include diesel, SE AK is too volatile
  Unless the project is way over-sized (Tyee), those days are over
• Demand Side management hasn’t been discussed, but is a real consideration
• Diesel costs could be lowered through use of pooling the reservoirs, buying bulk
  and employing a hedge manager
• Hard to Hide a mistake (Kevin Harper), another words our small populations
  can’t support an expensive under-utilized project diesel costs
Why you can’t average river gages to get average generation

\[ X \approx \mu \]

Median
If you replace the last large inflow with a really large inflow, the average must move, but the median stays the same. Plants with small to moderate storage sized for average spill. If you make the plant large enough to generate the average you will not recapture your investment...ever.
Tyee 26 years of October Inflows

Inflow to Tyee Lake (cfs)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

Municipal Loads and Generation Losses

PTG Load
WRG Load
KTN Load

Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec
Historical Inflows: Tyee Reservoir