Tukwila Pool

Solar Thermal Information

Andrew Williamson | June 13, 2012

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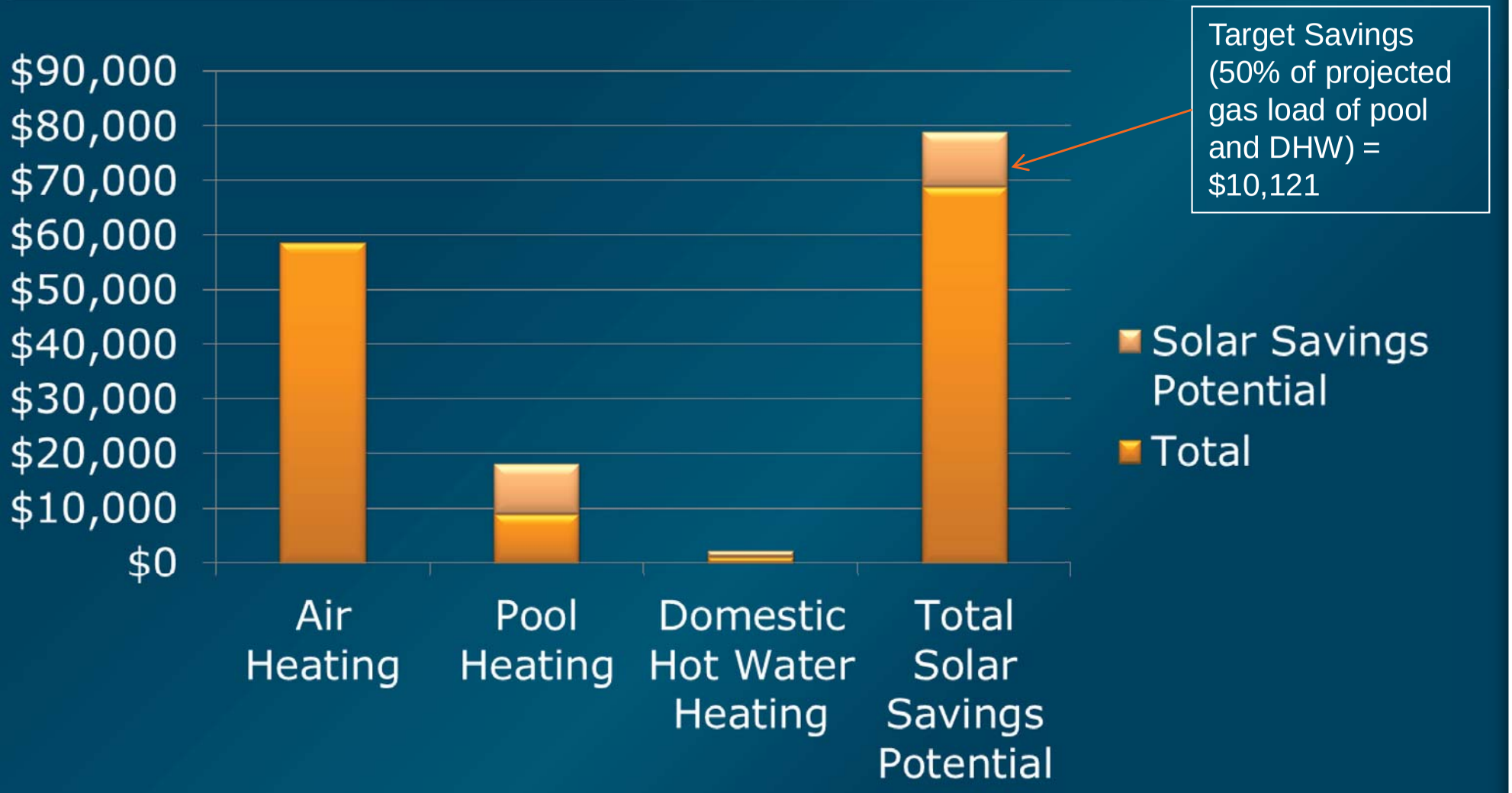
Discussion Points

- Solar Options at the Tukwila Pool
- What are the major economic drivers?
  - Savings
  - Construction Costs
  - Structural Considerations
  - Ongoing Maintenance
- Benchmarks from the Industry
- How Tukwila Pool compares to these benchmarks

Natural Gas Use Comparison

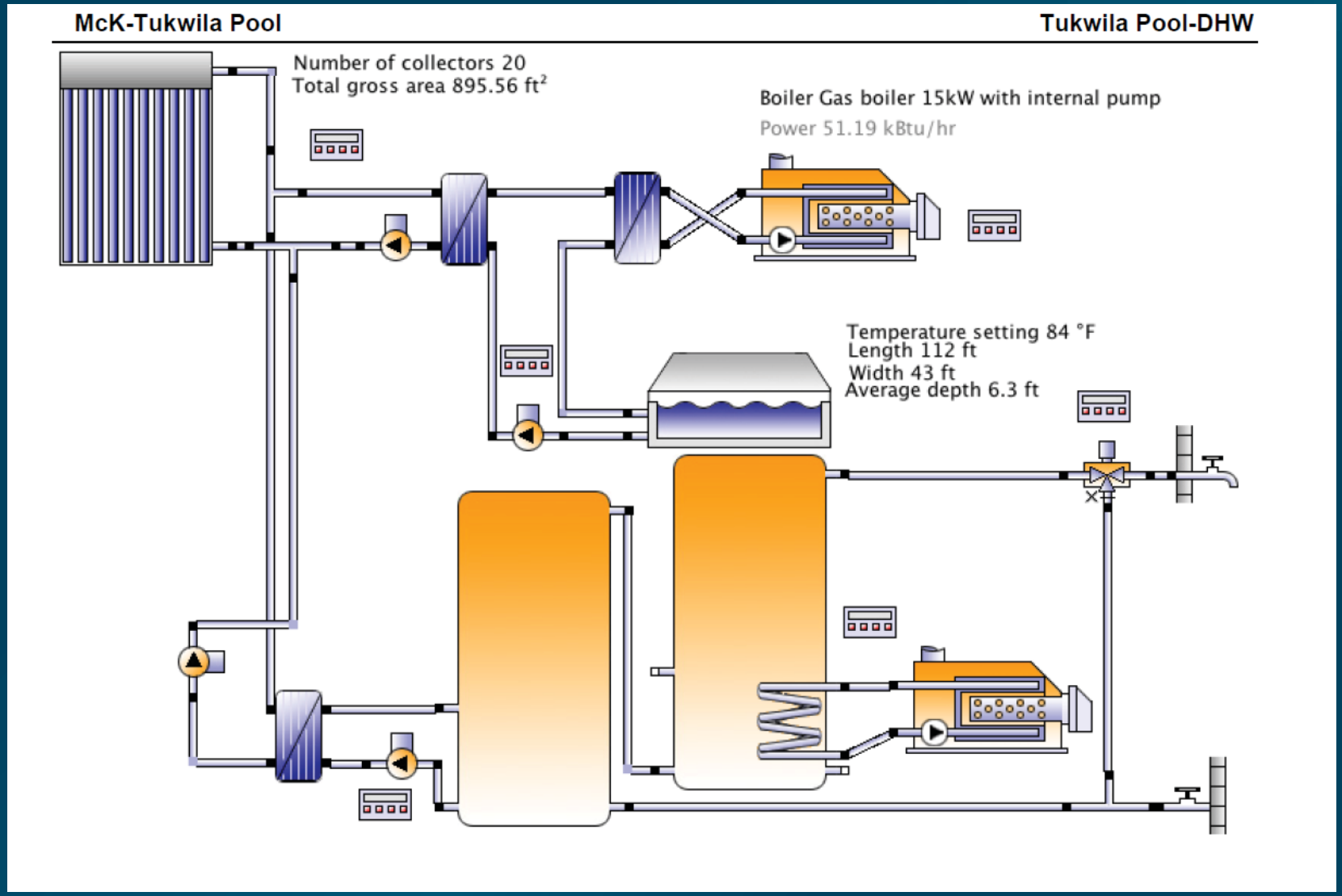


Solar Thermal: Heating Water vs. Air

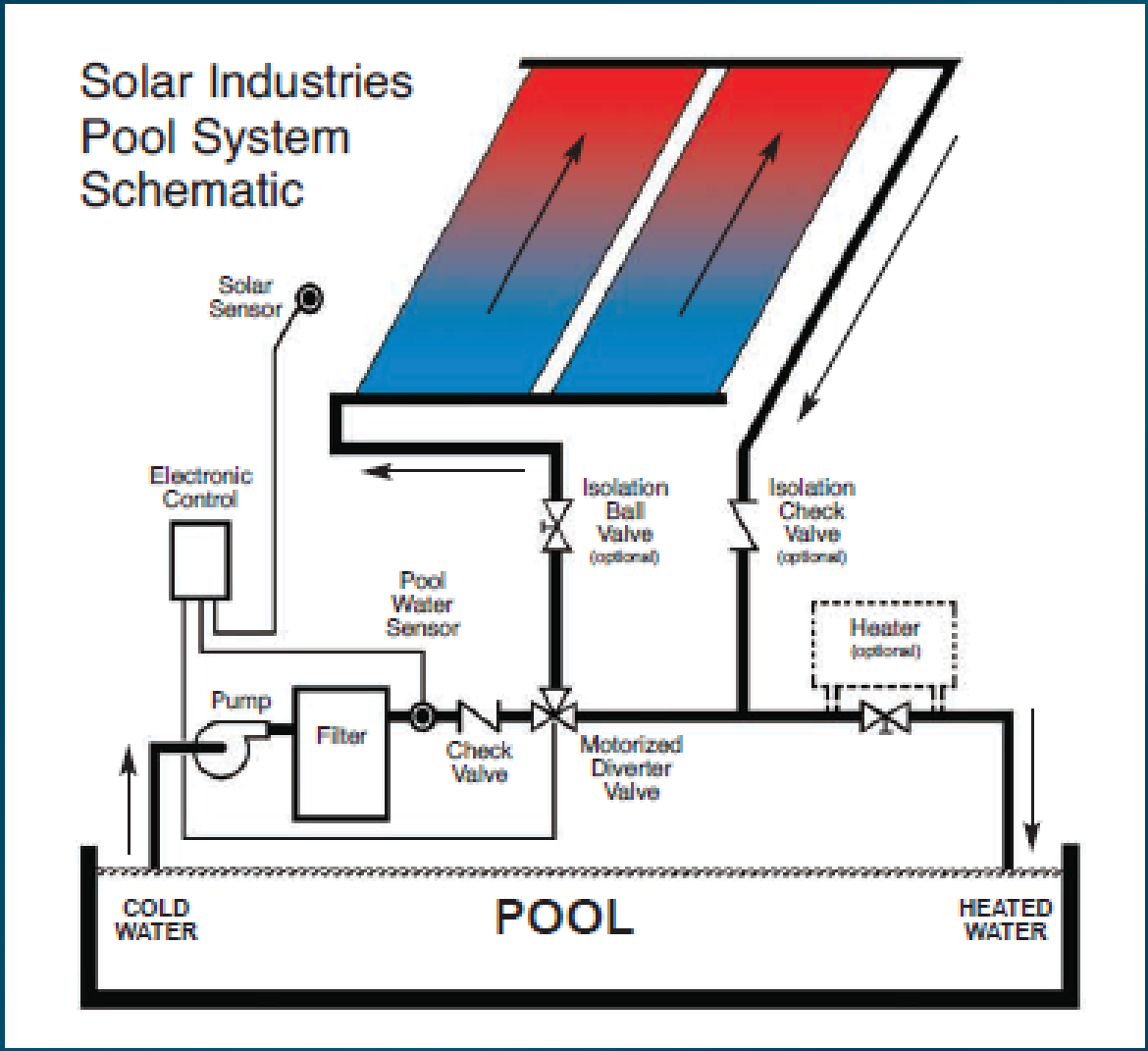
- To achieve higher temperatures needed for airside heating, the flow through the solar collect will need to be decreased.
- Lower output from solar collectors during winter months (more clouds), when airside heating load is greatest.
- Highest output from solar collectors during summer months, when airside heating load is lowest.
- More solar collectors increases initial cost, which takes away from other capital improvement items.
- Increasing winter and shoulder month production, results in a greater increase in over-production in the summer.
- To compensate for over-production, collectors would need to either be isolated (maintenance issue) or another source would be needed for heat rejection (exhaust air). Thermal energy cannot be sold back to the utility.
- Solar sizing software is designed to maximize output to meet water load (generally constant over year), without over-production.

- ADDING SOLAR COLLECTORS BEYOND PEAK SUMMER LOAD DECREASED THE RETURN ON INVESTMENT.

Evacuated Tube Schematic



Flat Panel Schematic



Vendor Comparison

System	Collector Area (ft^2)*	Collector Weight (lb)**	Annual Operation	Solar Fraction Total	Total Cost ($)	Annual Savings (Therms)	Annual Savings	Simple Payback (Years)
Flat Plate	4,096	5,300	May - Oct	53.0%	210K	6,808	$7,497	28
Evacuated Tube #1	1,527	7,900	All Year	53.9%	240K	2,802	$3,086	78
Evacuated Tube #2	896	4,600	All Year	61.3%	217K	1,993	$2,195	99

* Available Roof Area = 9,500 ft^2

**Mounting Weight Not Included in first cost – Structural upgrades could account for an additional TBD of cost

***It is assumed that all 3 options will require structural improvements to the existing roof

****McKinstry has solicited feedback from 3 vendors in the industry to provide this detail. The vendors referred to in the table above include: Apricus, Gen-con Solar and NW Mechanical

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Economic Drivers

- System Comparison
  - Flat Plate
    - Show better payback
    - Lower production per panel area
    - Drain-back system only operational in summer months
    - Better weight per sq ft – Will Still Impact Structural
    - Pool water circulated directly through solar collectors
  - Evacuated Tube
    - Longer payback
    - Better production per panel area
    - Operational all year – requires freeze protection (glycol solution)
    - More weight per sq ft – Bigger Structural Impact
    - Pool water isolated from collectors through heat exchangers

Economic Drivers

- Construction Costs
  - McKinstry takes into account ALL costs of the project.
    - Pricing is inclusive of all Audits, Site Evaluation, Construction Management, Site Supervision, Contingencies, Taxes and Measurement and Verification
- Structural Considerations
  - Due to the nature of the layout of the pre-stressed tendons, the joists are sensitive to incoming point loads and would require significant analysis to determine whether or not there is reserve capacity to support incoming loads
  - Option to support solar array from the load bearing walls. This would require a steel framed platform.
  - Added structure is not a part of the construction cost identified
- Ongoing maintenance needed to upkeep solar systems
  - Ongoing maintenance will be required for all additional pumps, heat exchangers and motors. Estimate for ongoing costs would not require significant day-to-day maintenance beyond quarterly cleaning of roof and exterior of tubes. Maintenance cost for heat exchangers typically run about $1,000 /year if evacuated tube technology is implemented.

Other Pools

- Snohomish Aquatics Center
  - New Construction Pool
    - Structural can be built in
    - Center Cost $21.3 million with lazy river, 10 lane swimming pool, water slide and shallow side, hot tub and a wave pool. This is a much larger pool and load.
- North Kitsap Community Pool
  - Installation cost similar to our project approximately $110,000
  - Payback range is close to 15 years (very similar to our numbers) without structural improvements
  - This is not inclusive of design, taxes, contingencies, etc. Tukwila numbers are “turn-key”.
- Bainbridge Aquatics Center
  - Project cost shared with public was for only equipment
  - Costs were not inclusive of design, audit, labor for installation and structural review.
  - Large amount of risk for structural considerations. Cost of material was $70,000

Exhibit D

Solar Thermal: Heating Water vs. Air

		Spring	Summer	Fall	Winter		Spring	Summer	Fall	Winter	
A	Collector Max Output (BTU / Day):	30,000	40,000	30,000	10,000		30,000	40,000	30,000	10,000	per Solar Rep
B	Cost per Collector:	$6,000					$4,500				Budget Price
C	Total Collectors:	35					70				Variable
D	Installed Cost:	$210,000					$315,000				= B x C
E	Solar Maximum Output (BTU / Day):	1,050,000	1,400,000	1,050,000	350,000		2,100,000	2,800,000	2,100,000	700,000	= A x C
F	Air Heating Load (BTU / Day):	902,691	325,327	890,358	1,332,518		902,691	325,327	890,358	1,332,518	Estimated
G	Water Heating Load (BTU / Day):	1,120,824	1,112,695	1,104,208	1,096,285		1,120,824	1,112,695	1,104,208	1,096,285	Estimated
H	Total Load (BTU / Day):	2,023,516	1,438,022	1,994,566	2,428,802		2,023,516	1,438,022	1,994,566	2,428,802	= F + G
I	Solar Contribution:	52%	97%	53%	14%		104%	195%	105%	29%	= E / H
J	Therms Saved:	958	1,278	958	319		1,023	1,015	1,008	639	Conversion
K	Annual Natural Gas Savings:	$3,869					$4,058				J * Gas Rate

- Air and water heating loads are approximated for daylight hours only to match solar production periods.
- Air heating would not be available during winter months in a drainback system (flat plate). Typical operation Nov - Apr.
- Additional annual maintenance costs (~$3,000): Cleaning roof & tubes - $2,000; Pumps & heat exchangers - $1,000.
- Additional panels requires more structural modifications. Depending on the size of the array, could be $25K - $75K.

In illustration above, doubling the system size results in less than 5% increase in energy savings. An additional investment of $105,000 gains $189 in savings.

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