



HYBRIDIZED VARIABLE SPEED CHILLED WATER PUMPING USING CONSTANT SPEED PUMPS

Case Study: Abbott Northwestern Hospital, Minneapolis, MN
Joe Witchger, Vice President & Brendan Huss, Mechanical Engineer
HGA Architects & Engineers- Energy & Infrastructure Group

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Abbott Northwestern Hospital (ANWH) Minneapolis, MN



System Summary

MAIN PLANT

- ▶ Peak Load: 2,500 Tons
- ▶ 6 million Ton-hrs/year
- ▶ 3,000 Tons N+1 Capacity
- ▶ Inefficient Operation:
 - ▶ Plant Average: 0.9 kW/ton

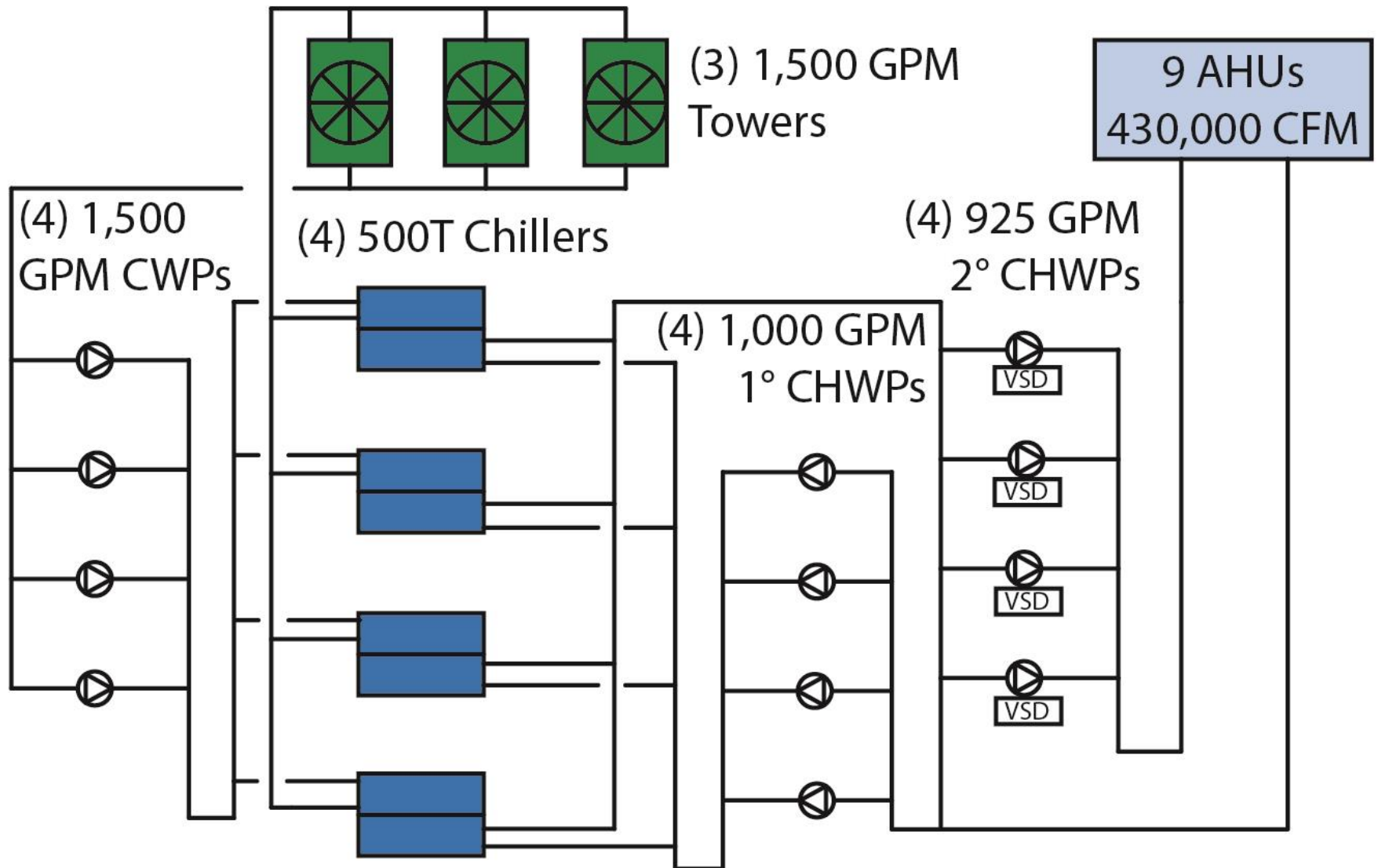
HEART HOSPITAL

- ▶ Peak Load: 1,450 Tons
- ▶ 2.9 million Ton-hrs/year
- ▶ 1,500 Tons N+1 Capacity
- ▶ System appeared to have insufficient capacity

How did we get here?

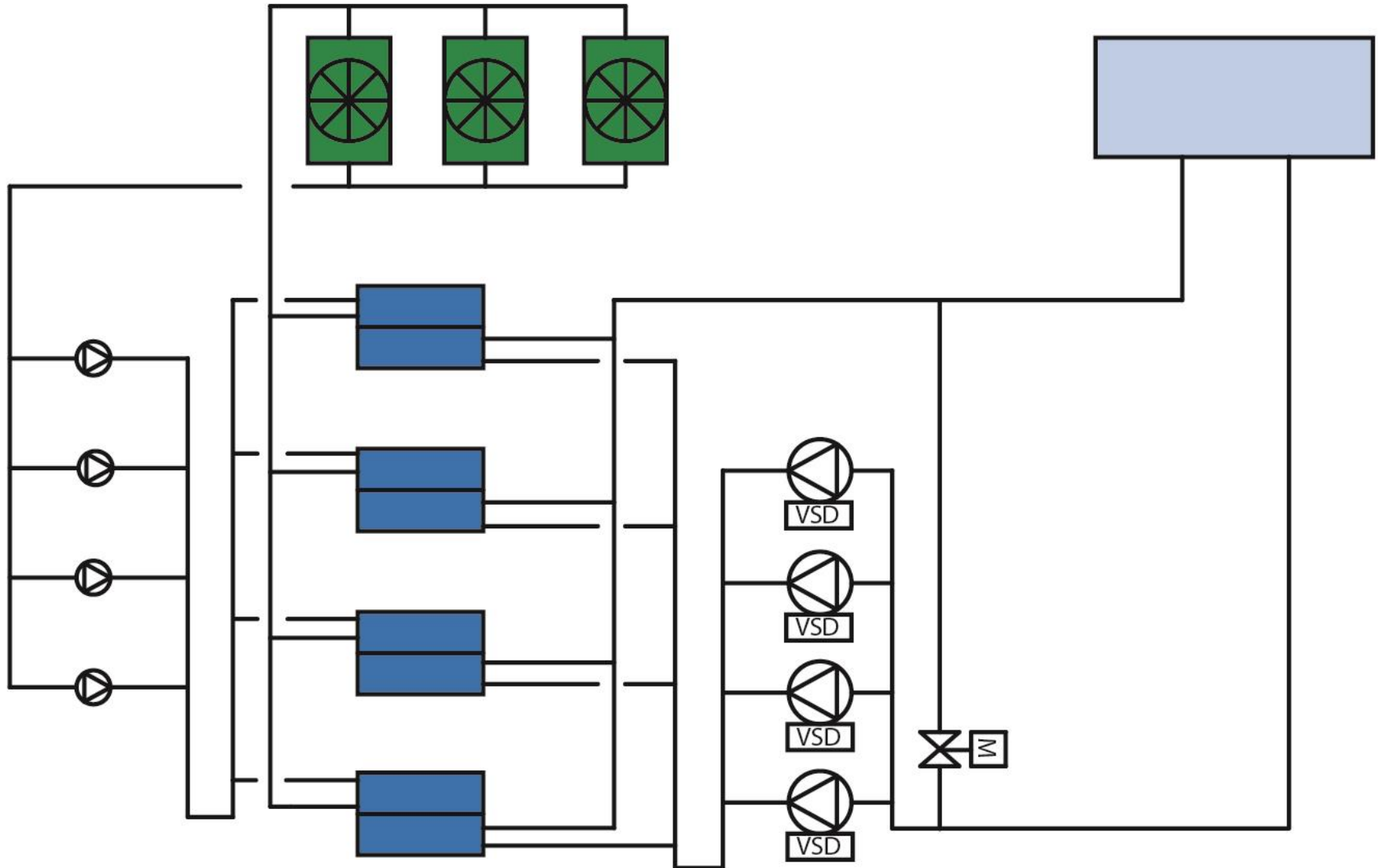
- ▶ Contracted to Improve Efficiency and Operation of Chiller Plants
- ▶ Evaluating Pumping Options
- ▶ Working within owner's budget
- ▶ Focusing on Short Term Projects with long term implications

Heart Hospital Existing Configuration



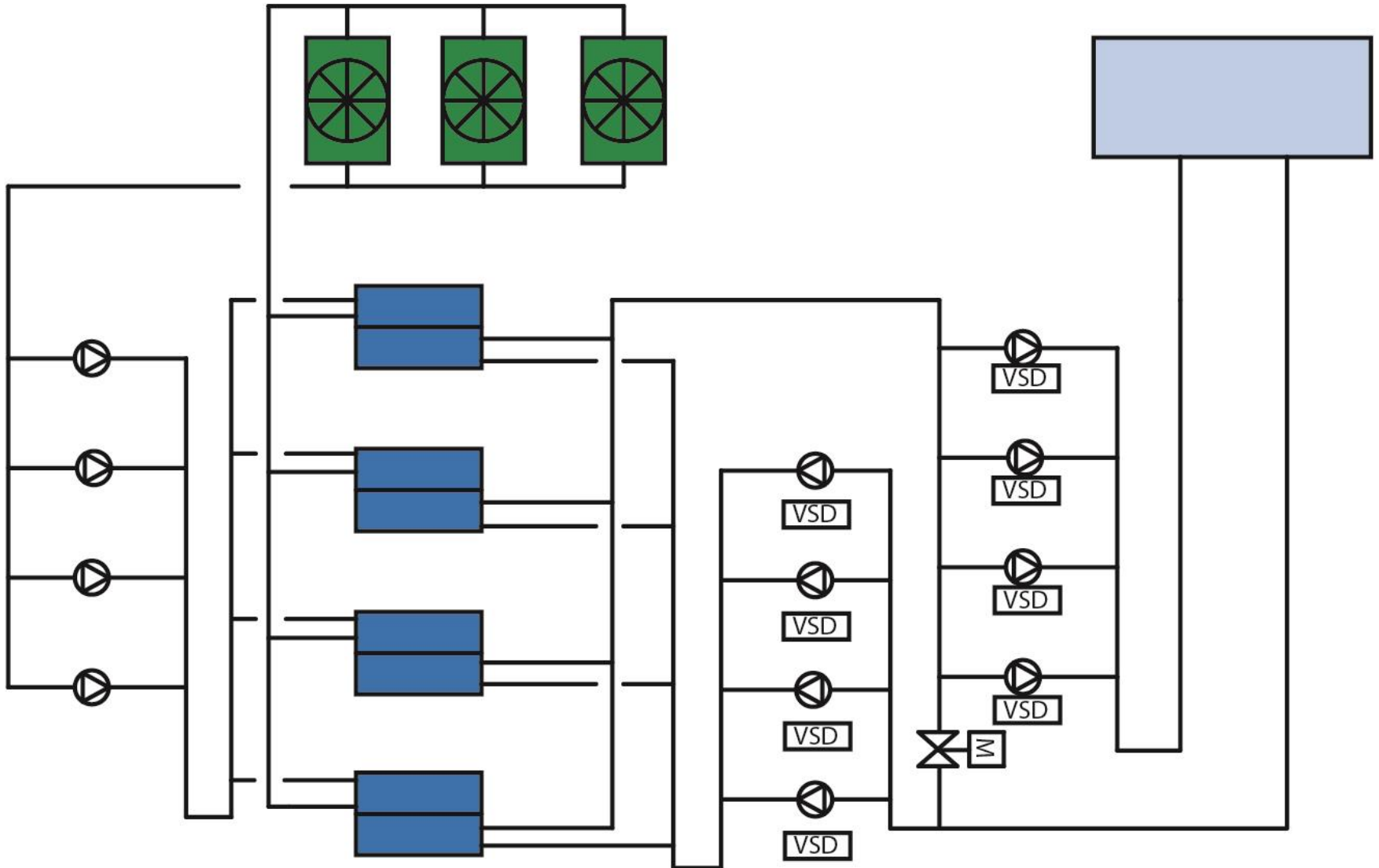
Heart Hospital – Option 1

Variable-Primary System

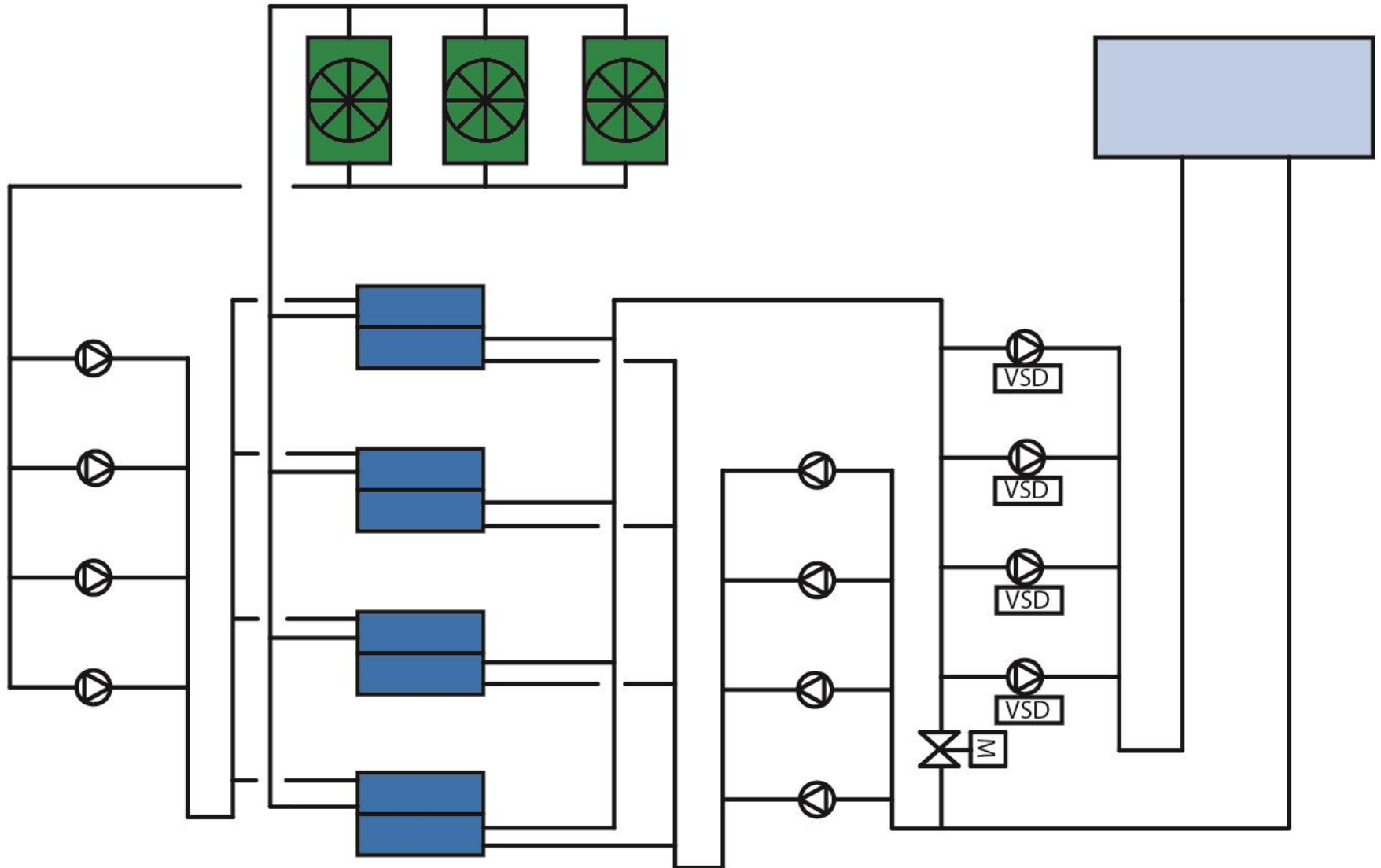


Heart Hospital – Option 2

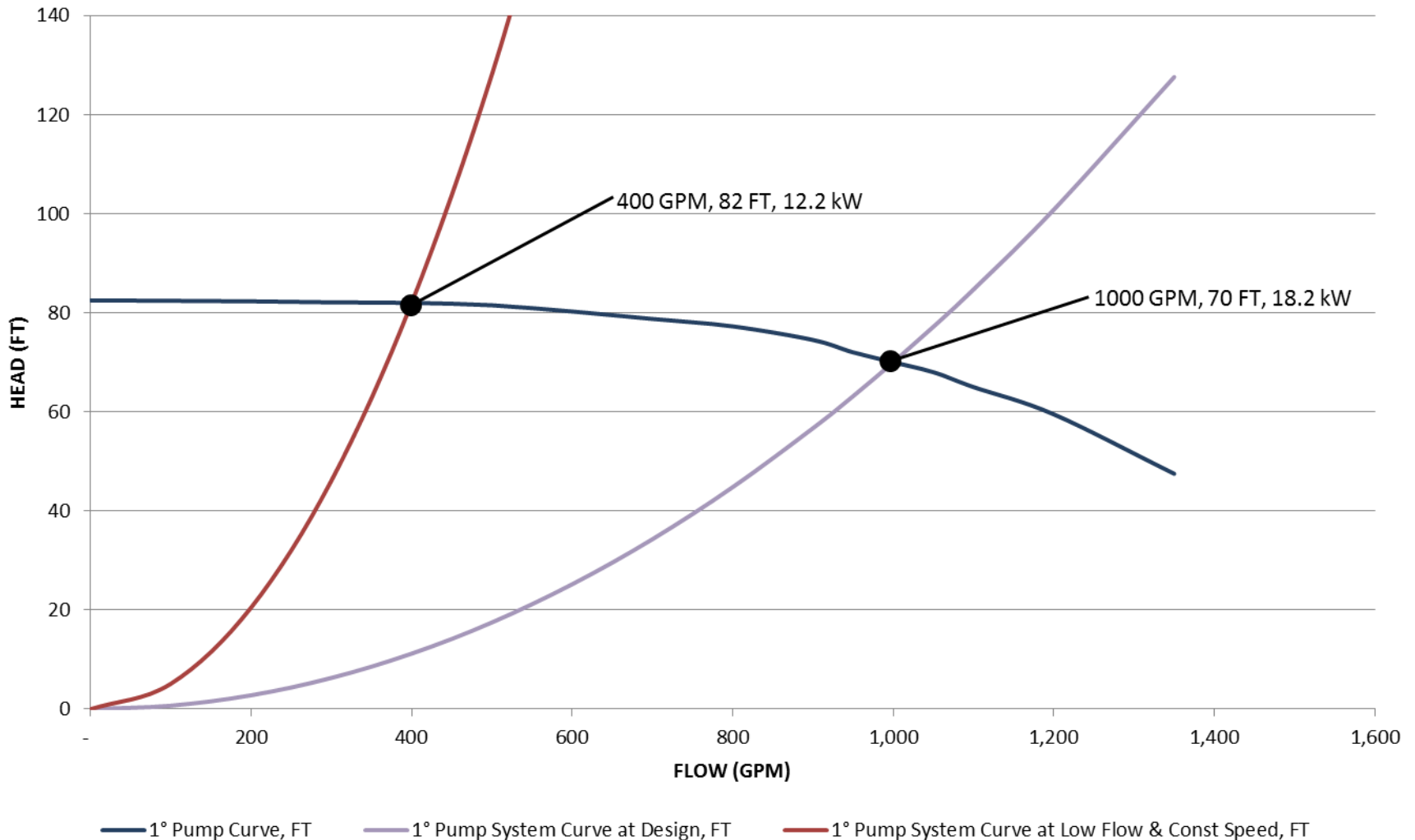
Add VSDs to Primary Pumps



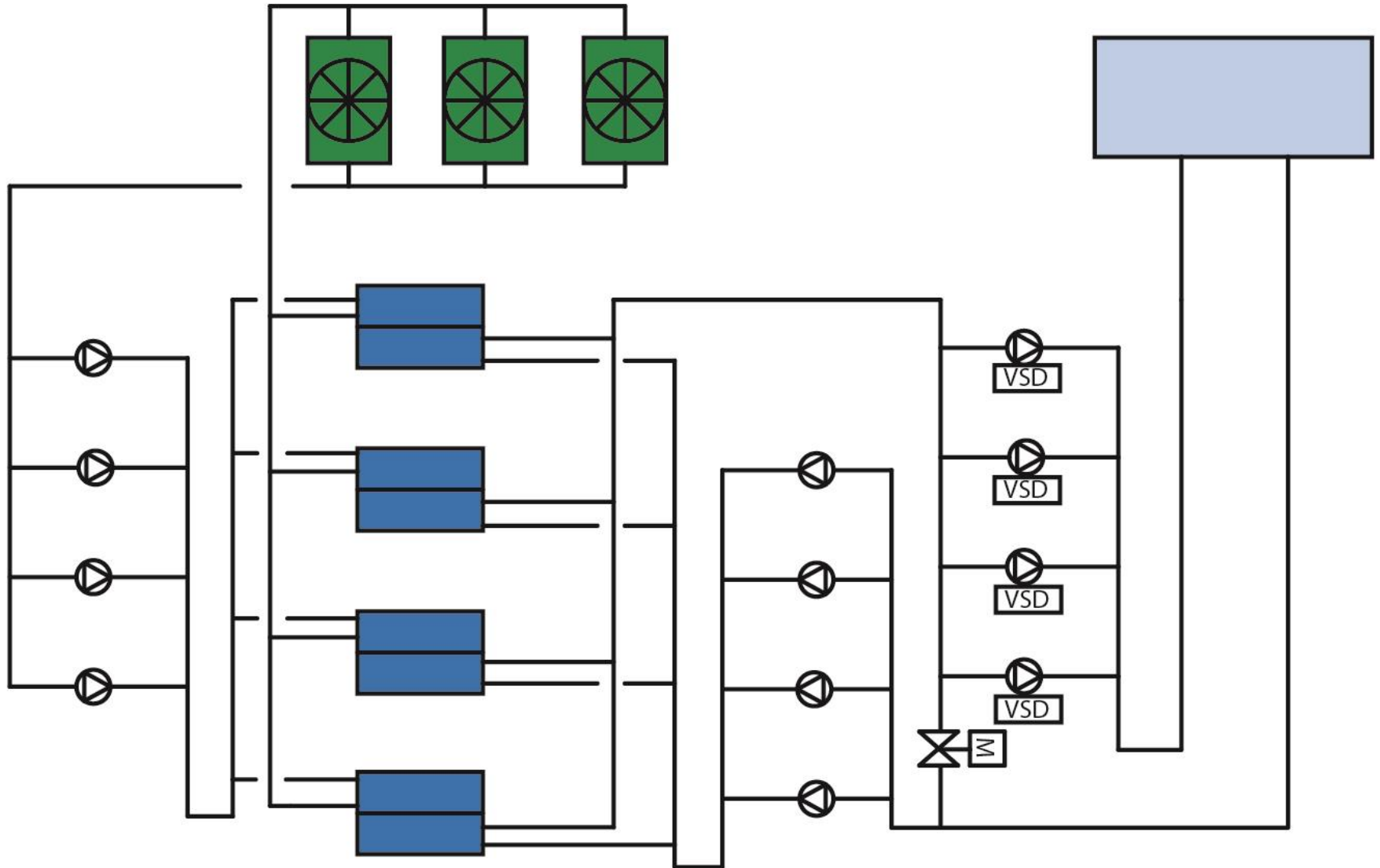
Heart Hospital Hybrid System



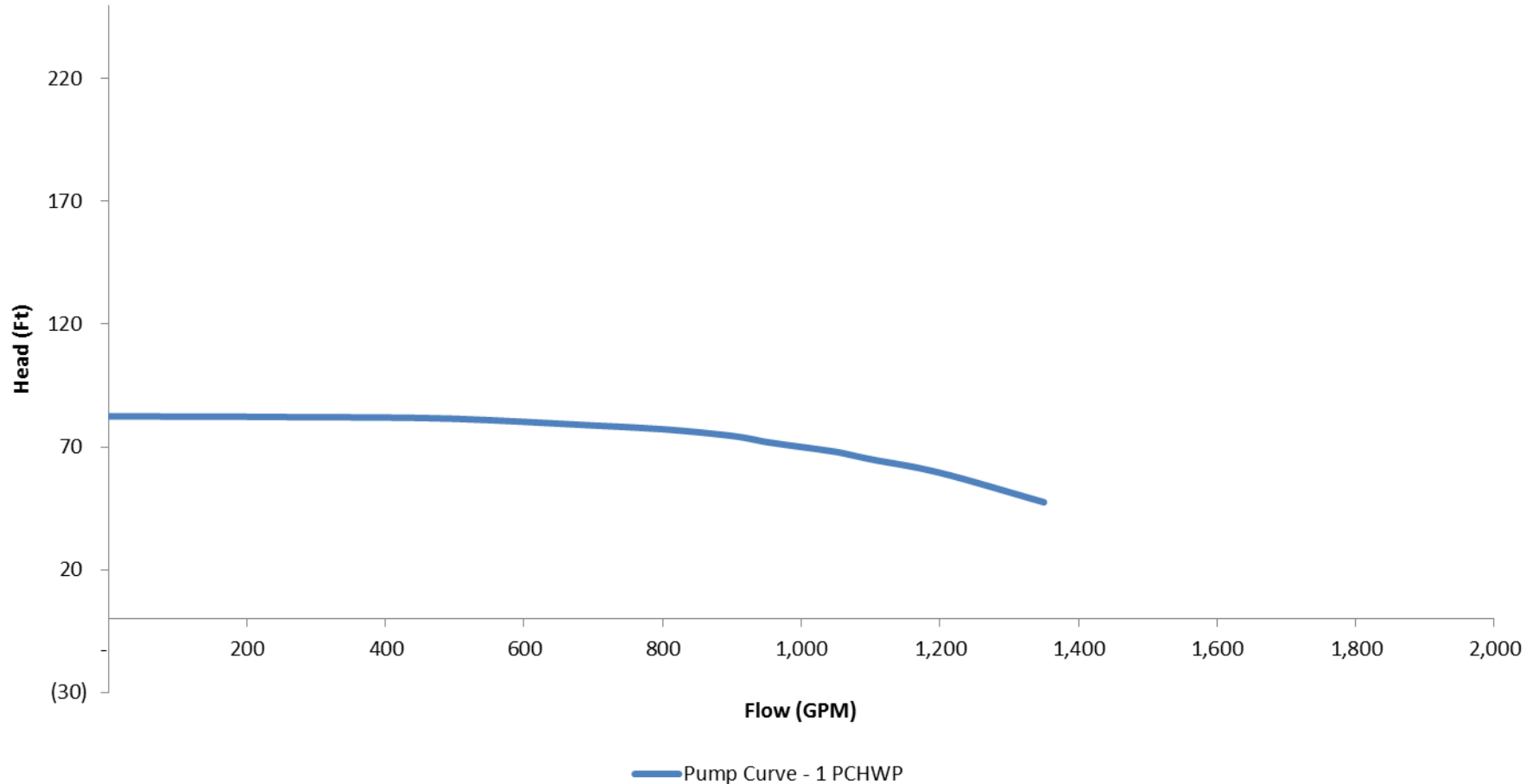
Allow Pumps to “Ride the Curve”



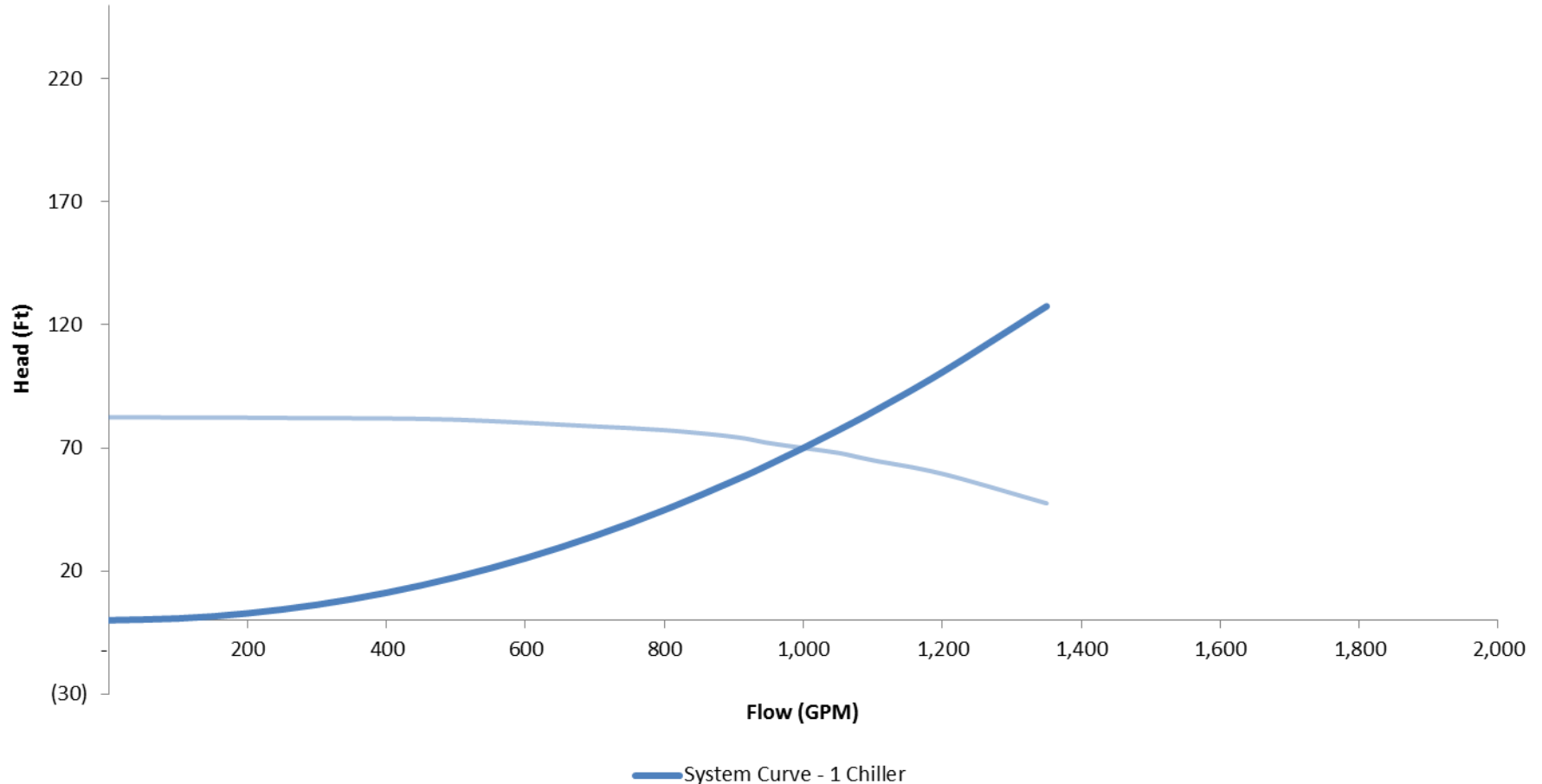
Heart Hospital Hybrid System



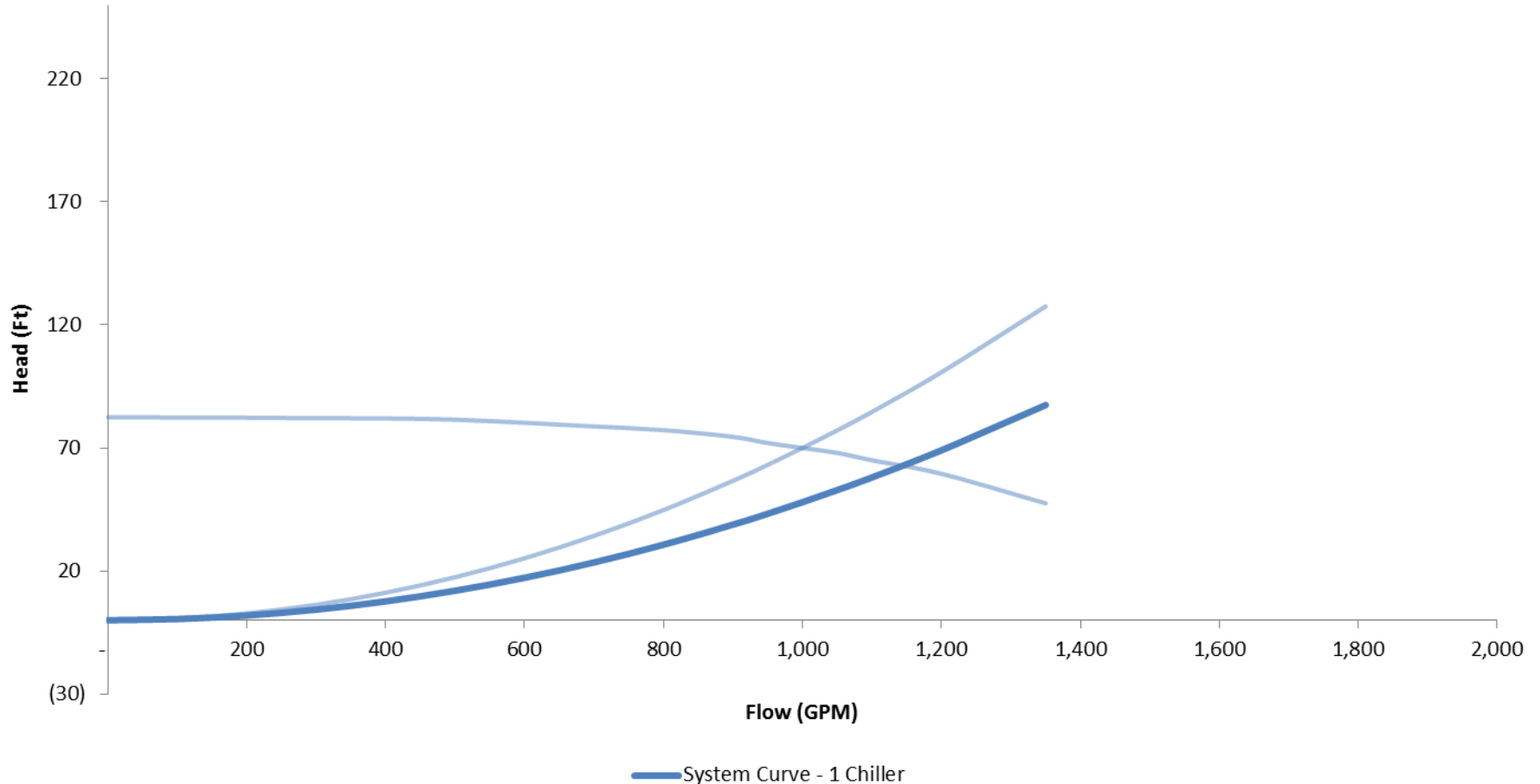
Heart Hospital Primary CHW Pump Curve



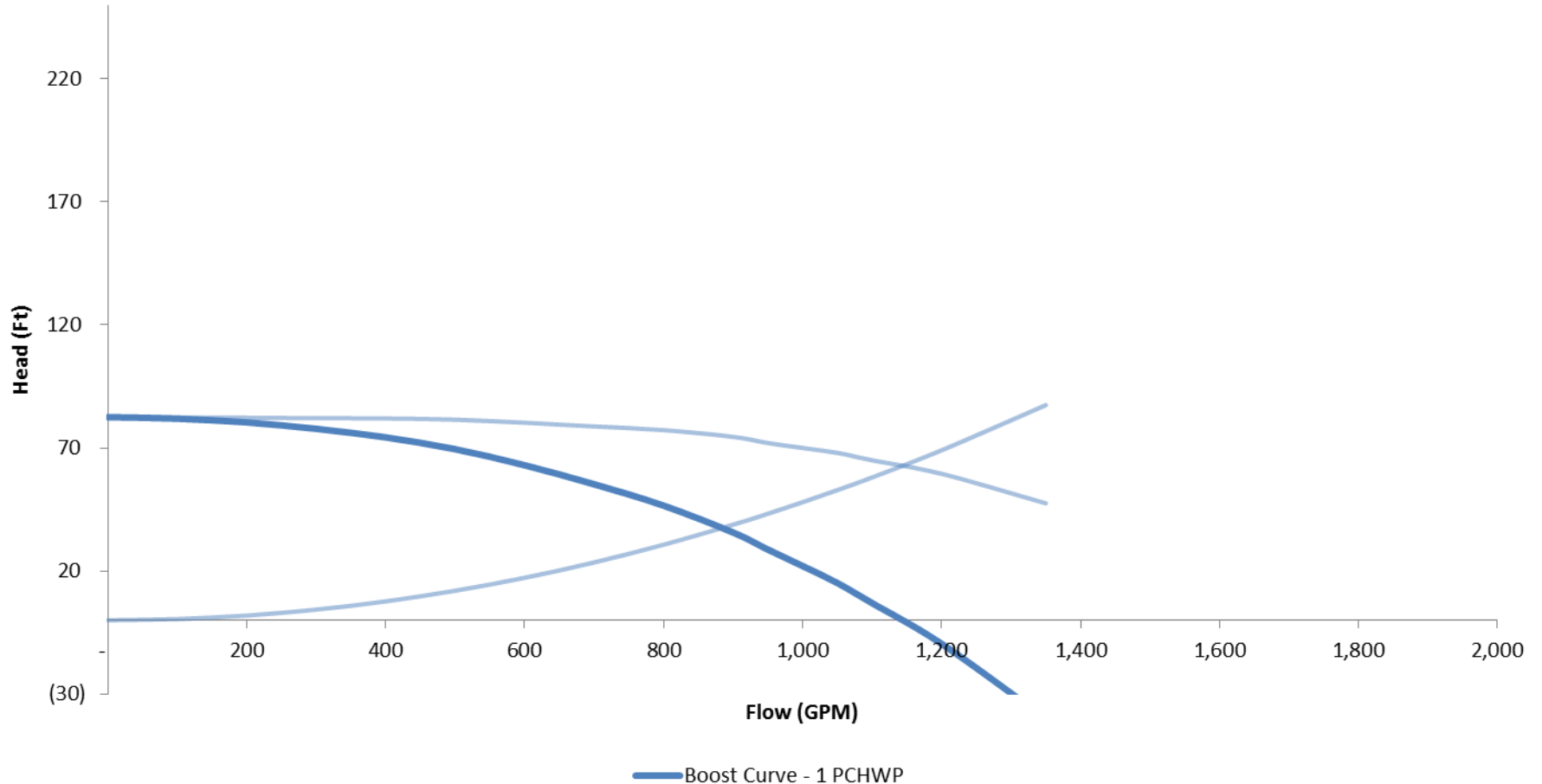
Heart Hospital System Curve: Balanced System



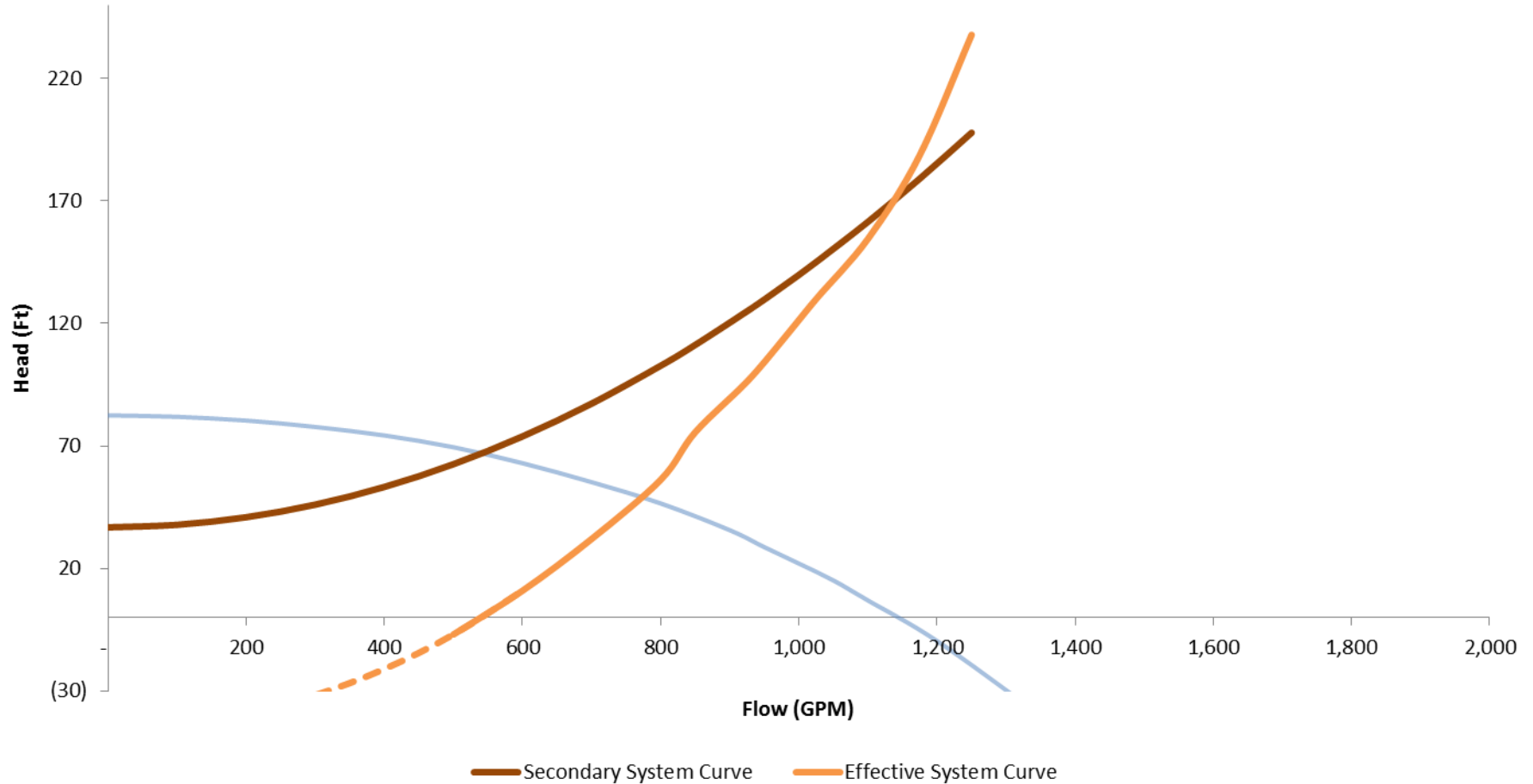
Heart Hospital System Curve: Open TDV



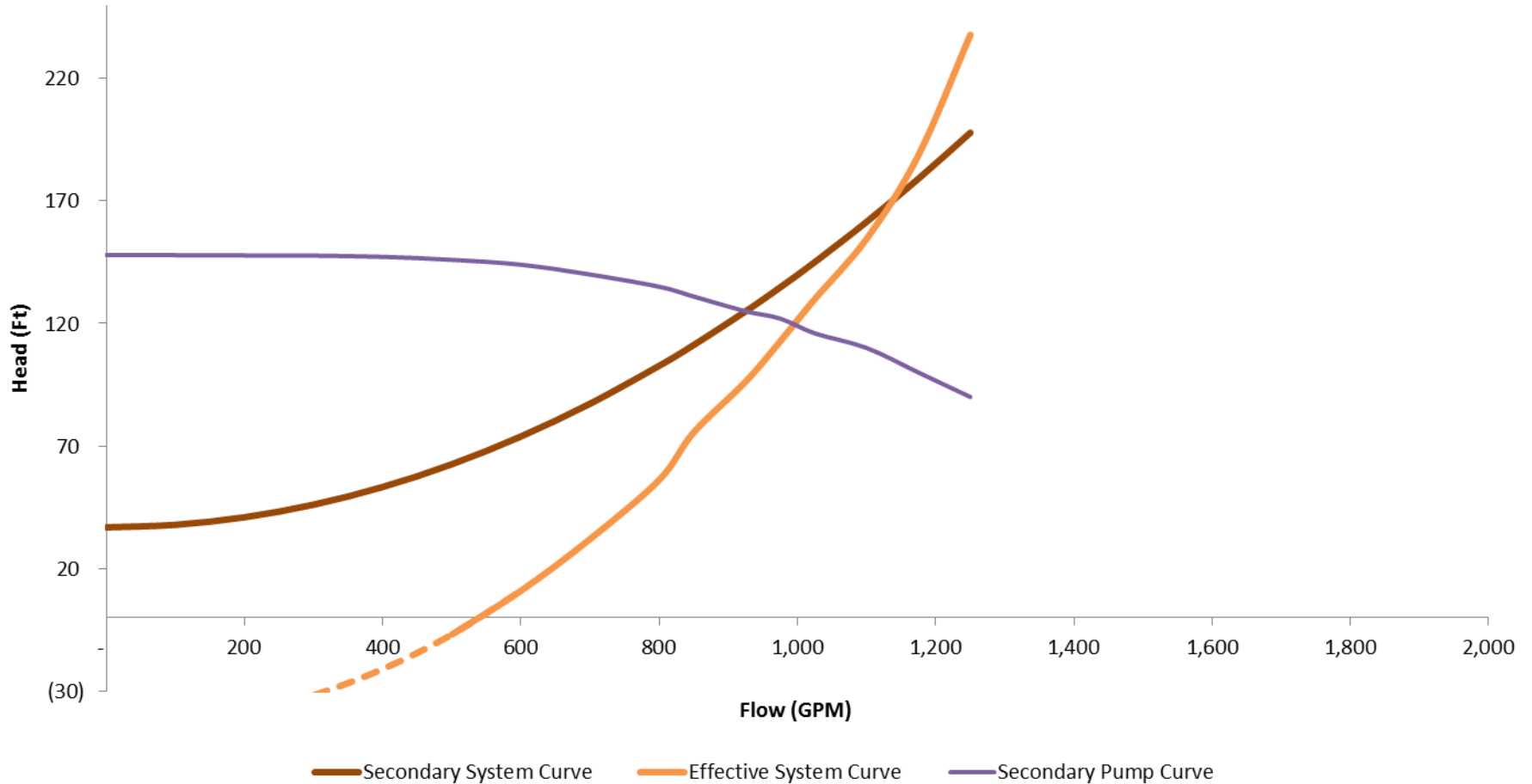
Heart Hospital Boost Curve



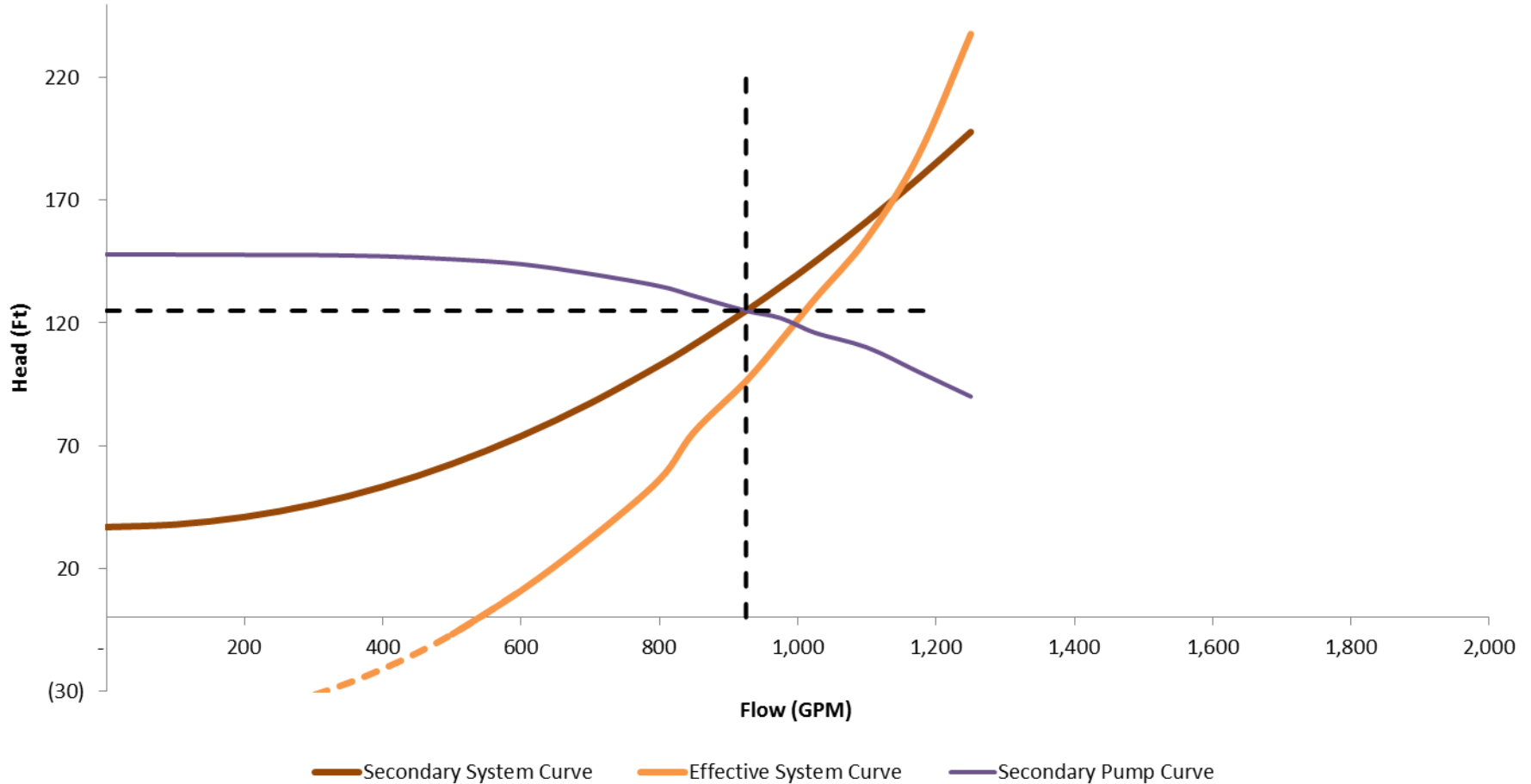
Heart Hospital Effective 2° System Curve



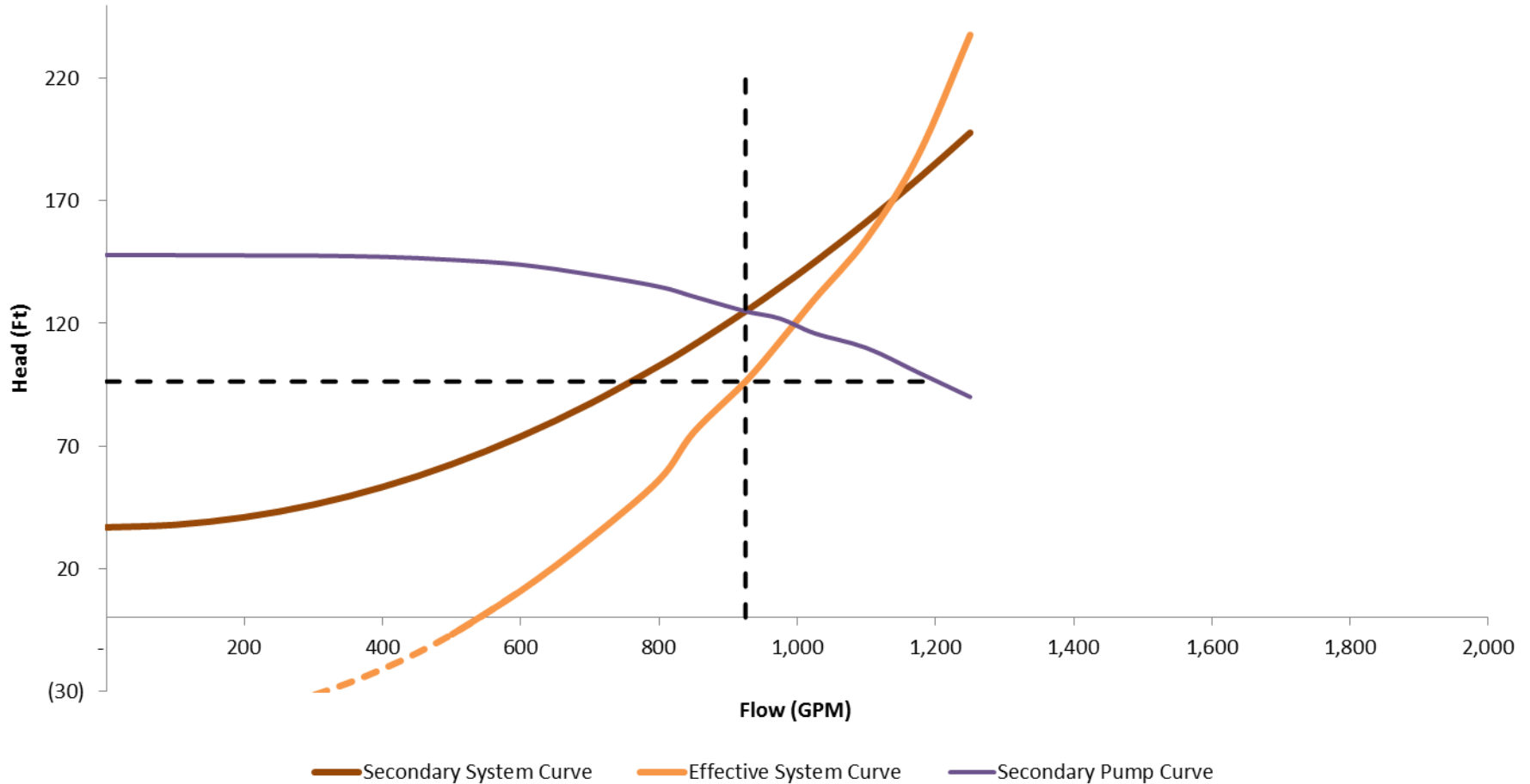
Heart Hospital Effective 2° System Curve



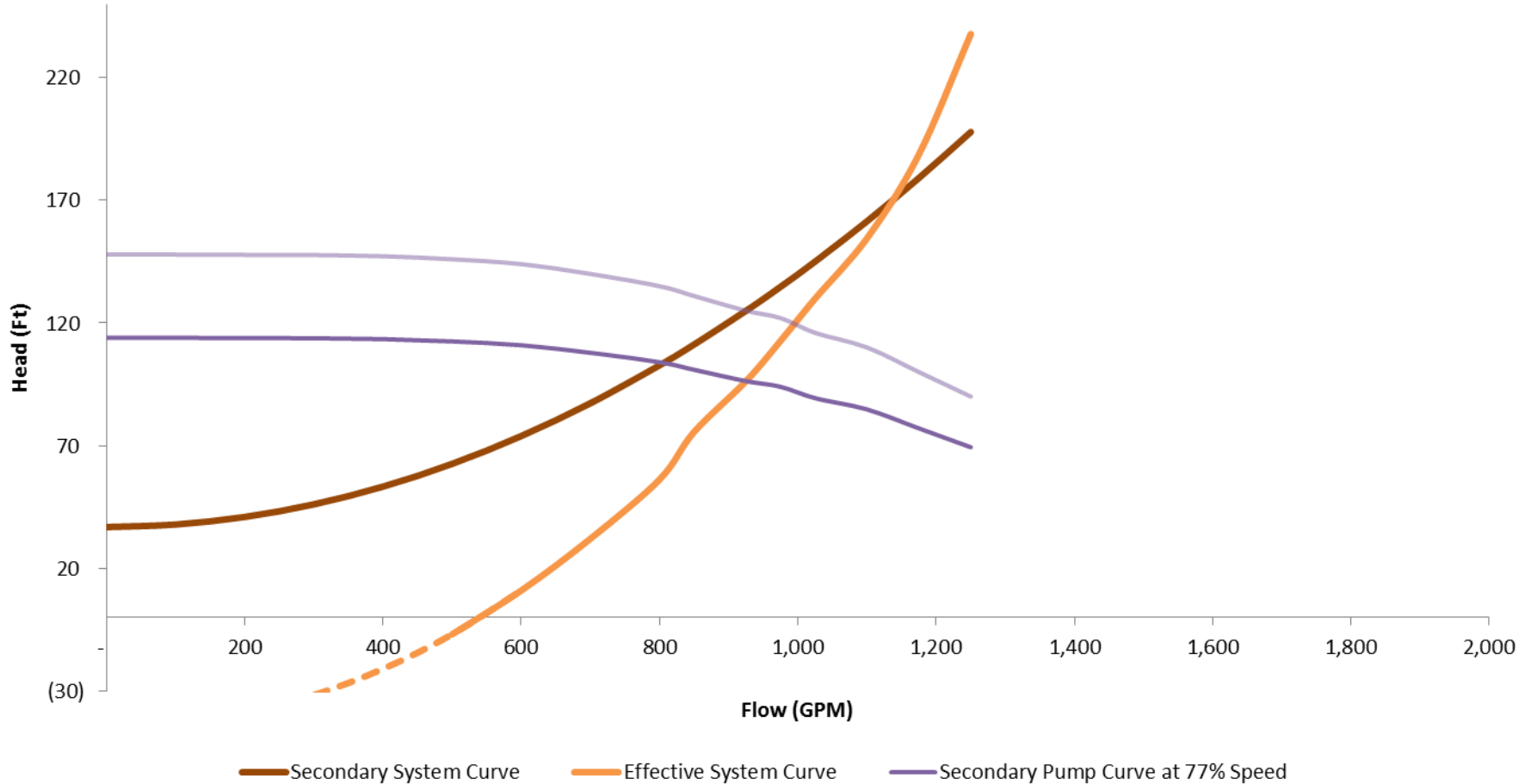
Heart Hospital Effective 2° System Curve



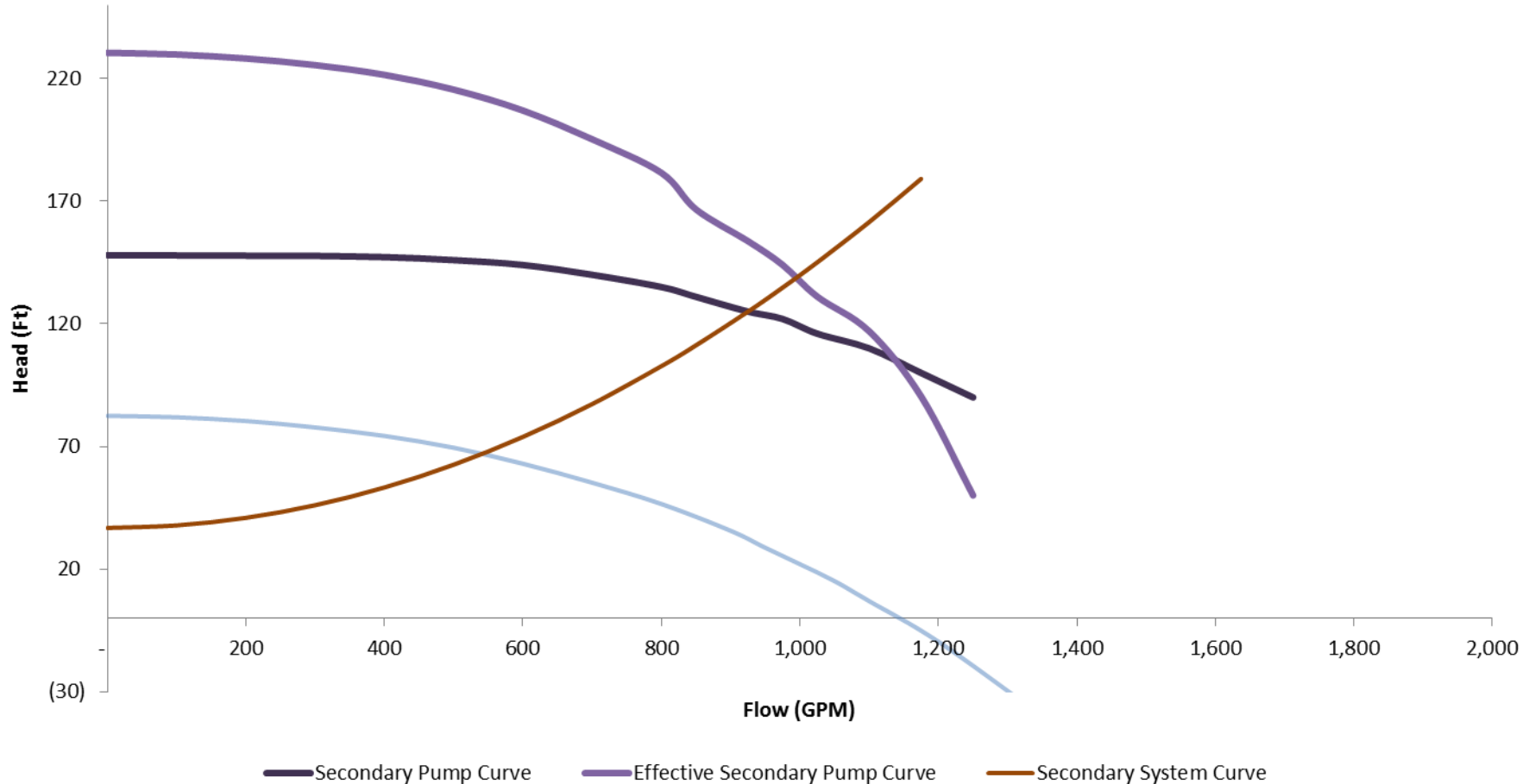
Heart Hospital Effective 2° System Curve



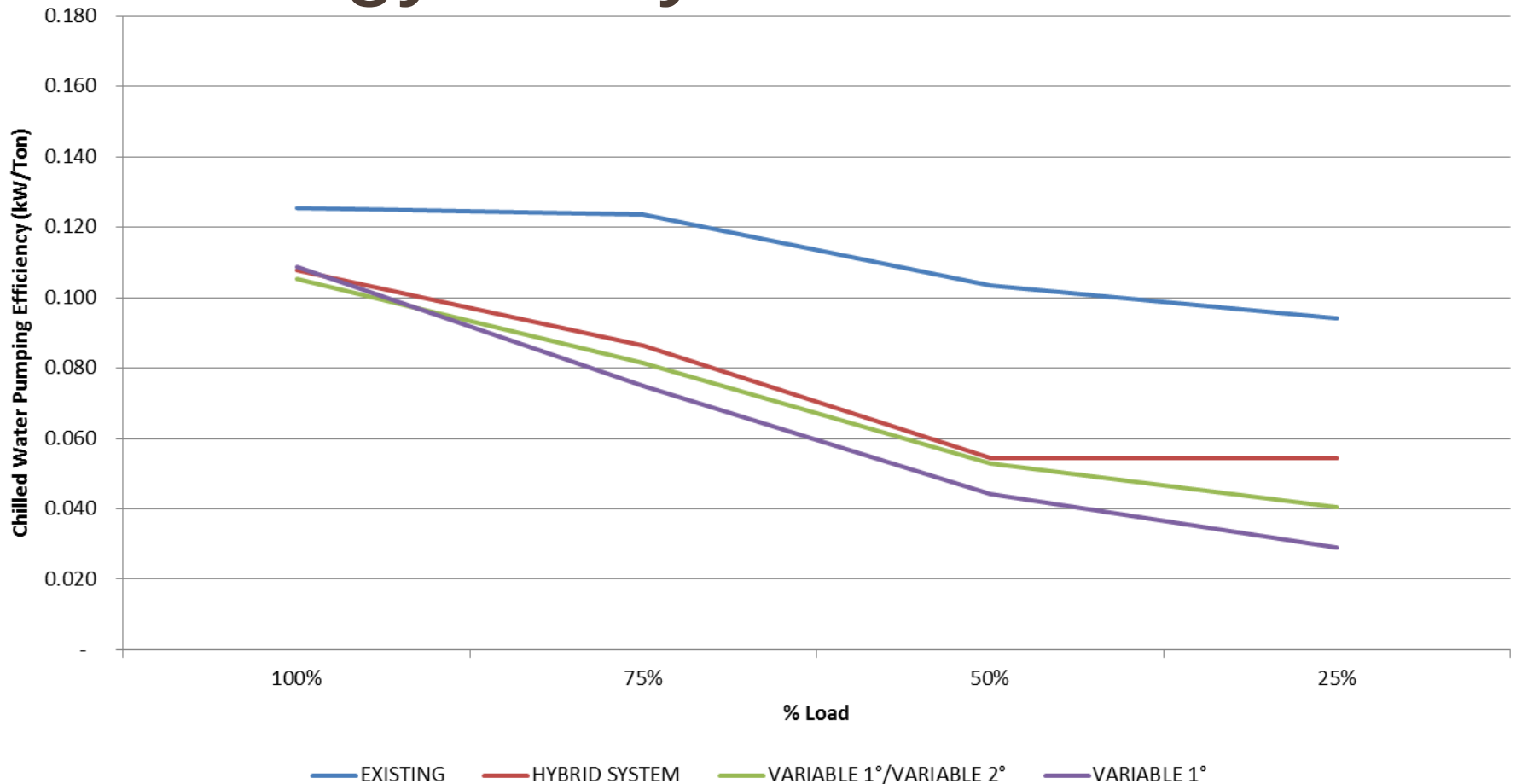
Heart Hospital Effective 2° System Curve



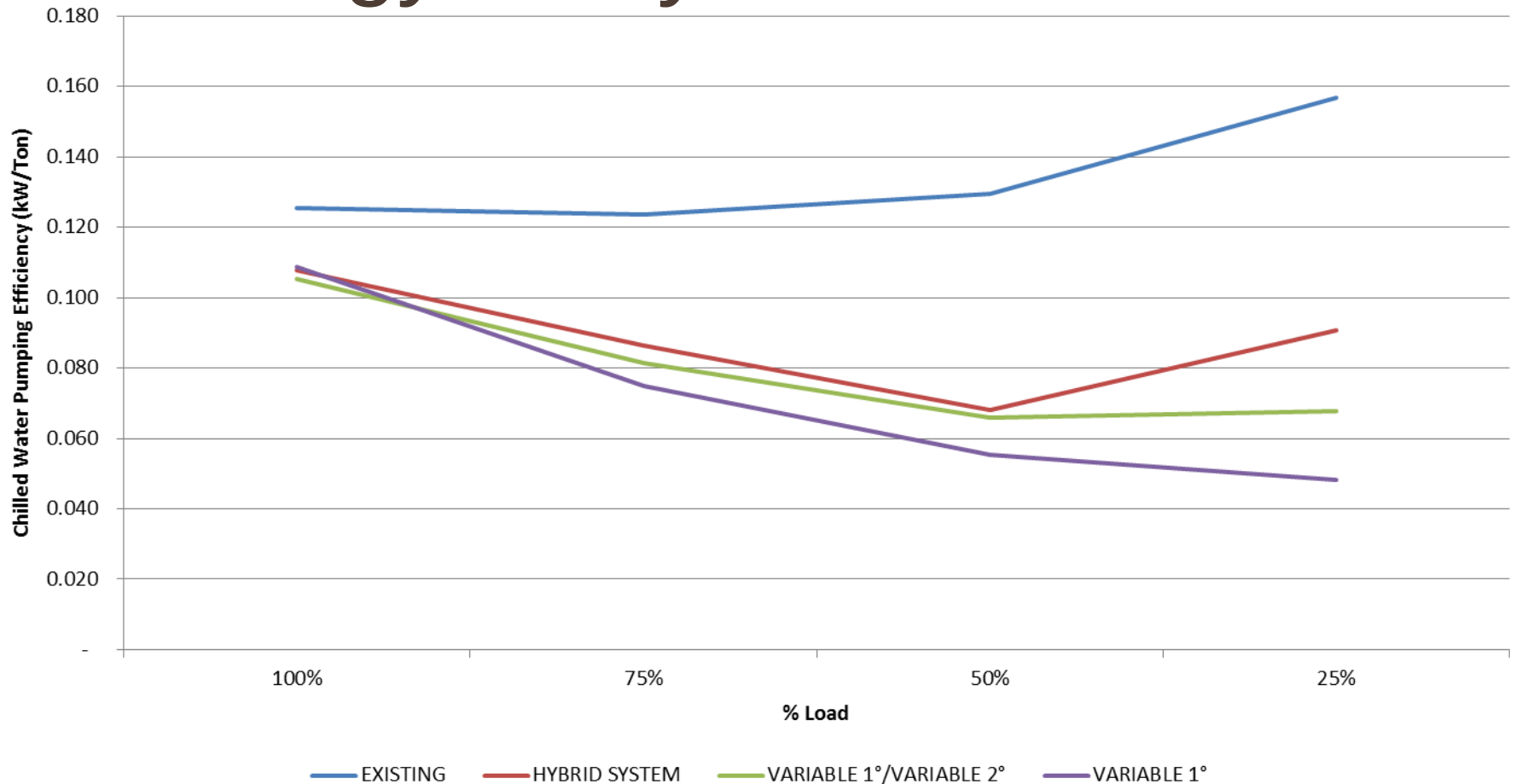
Heart Hospital Effective 2° Pump Curve



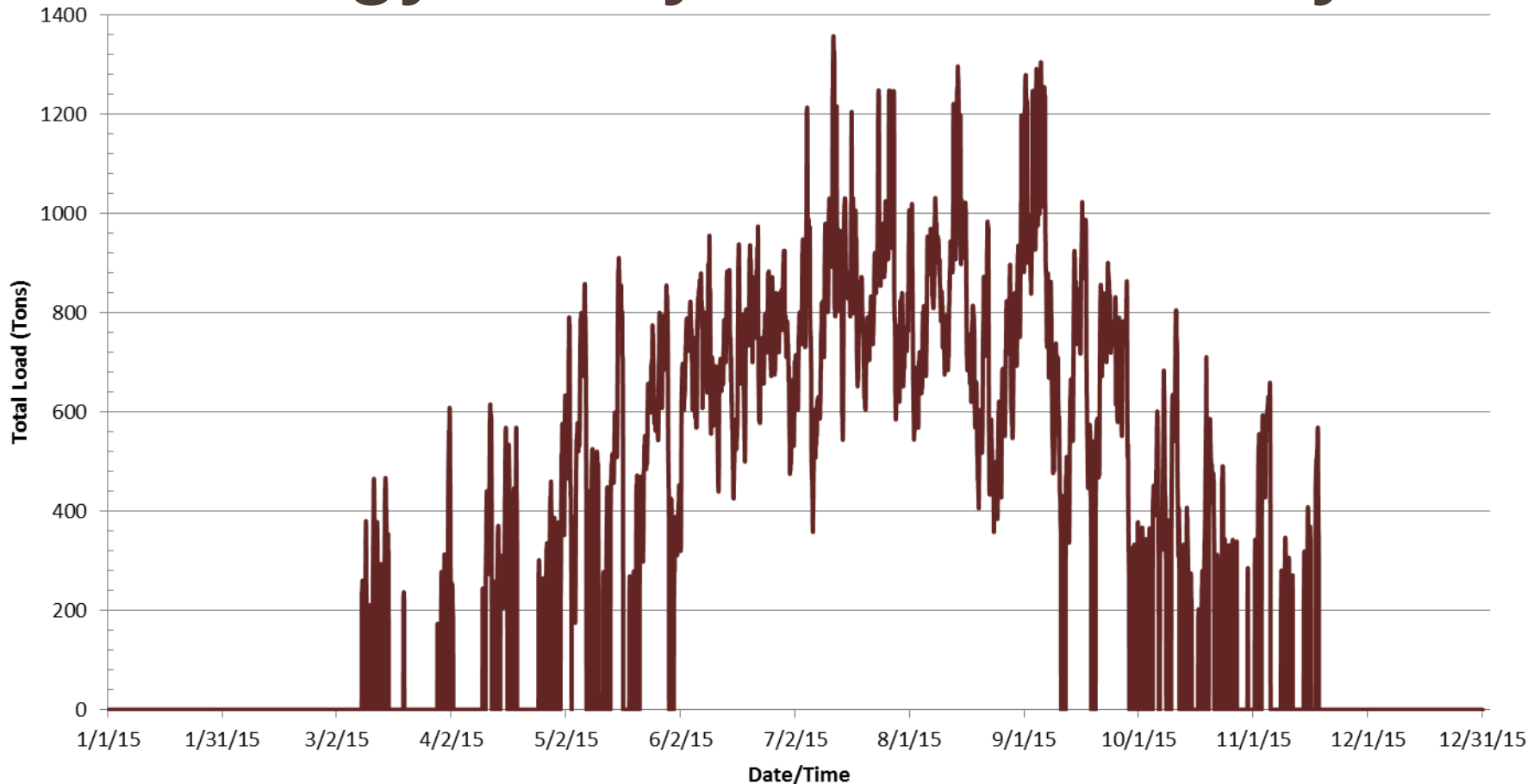
Heart Hospital Energy Analysis



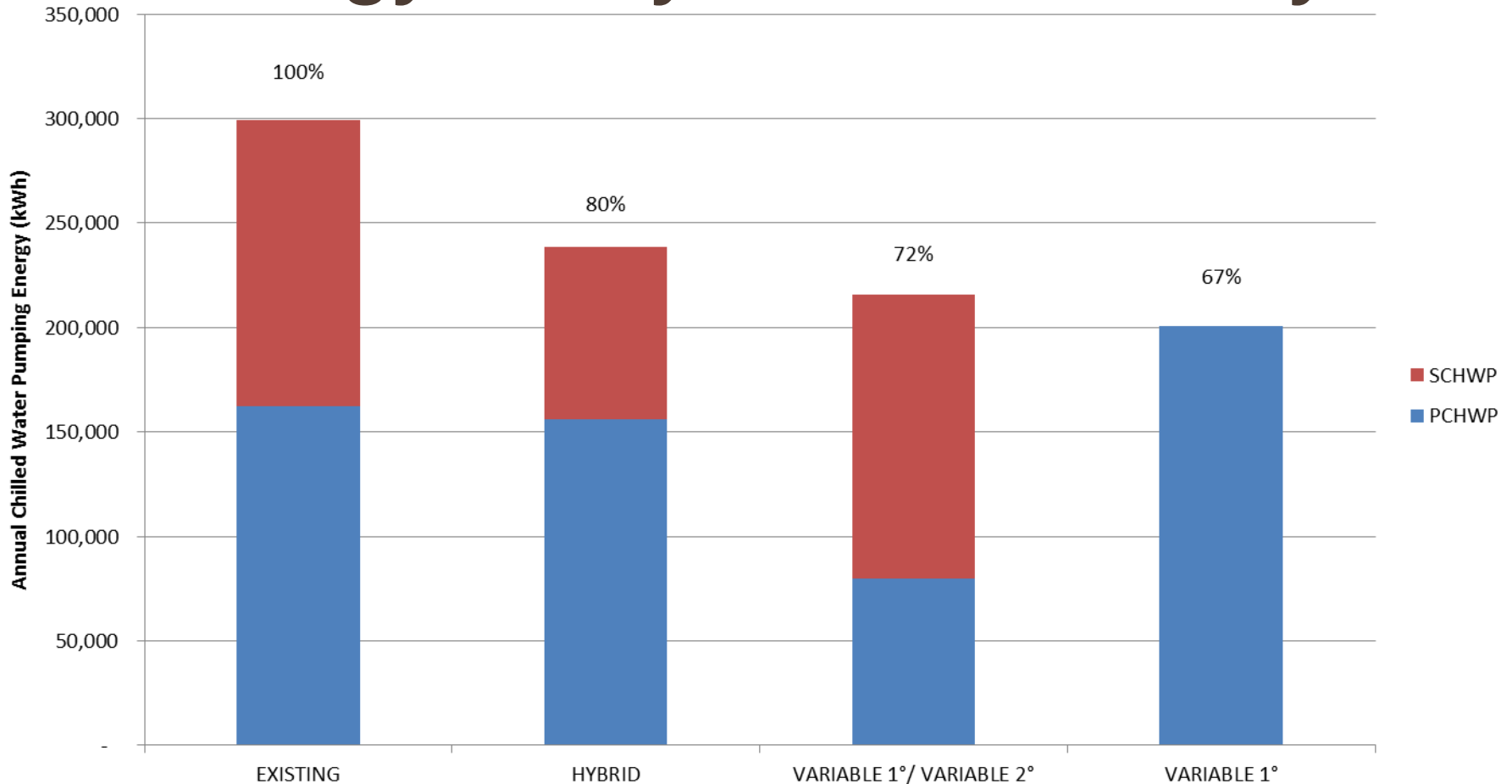
Heart Hospital Energy Analysis



Heart Hospital Energy Analysis: 8760 Analysis

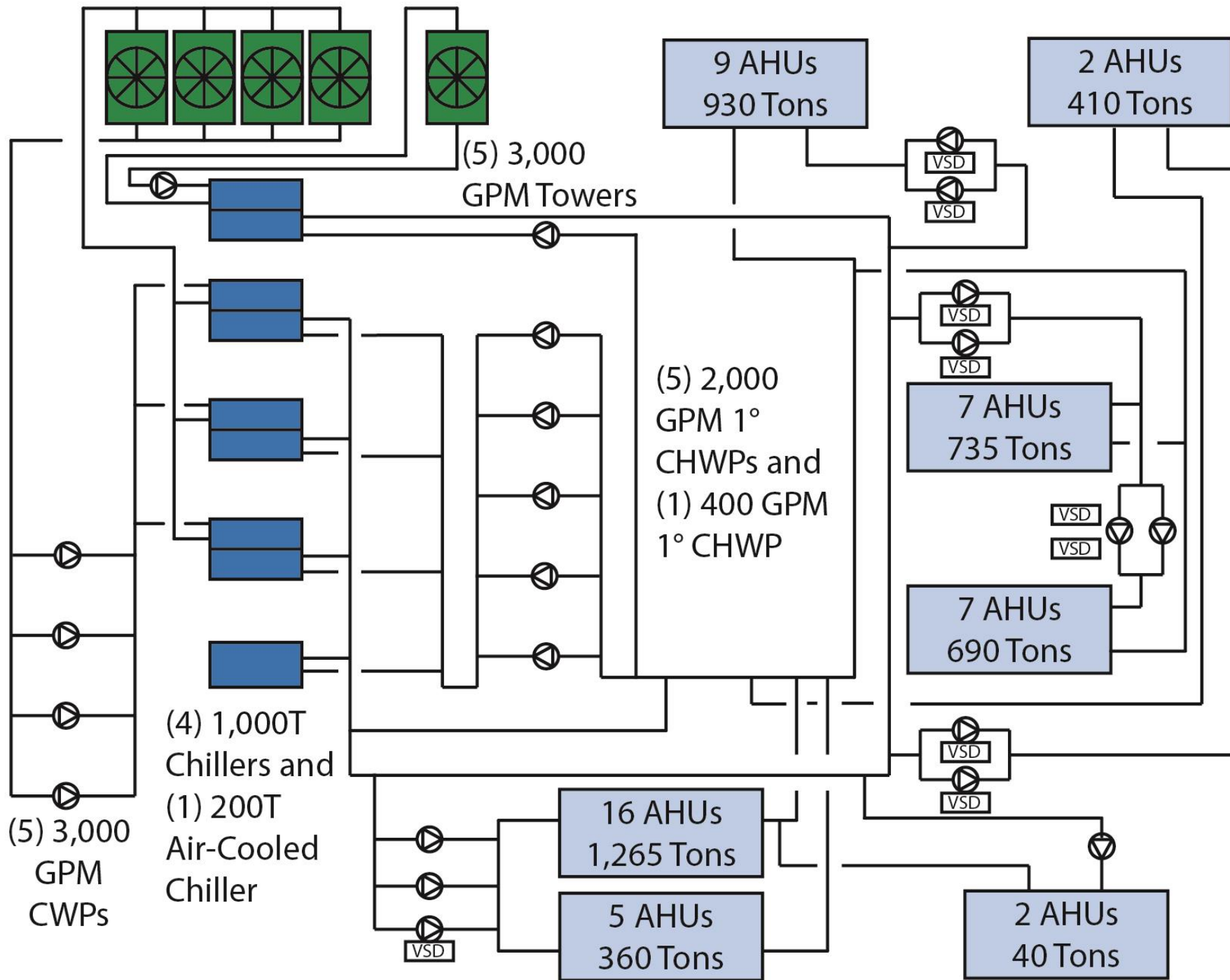


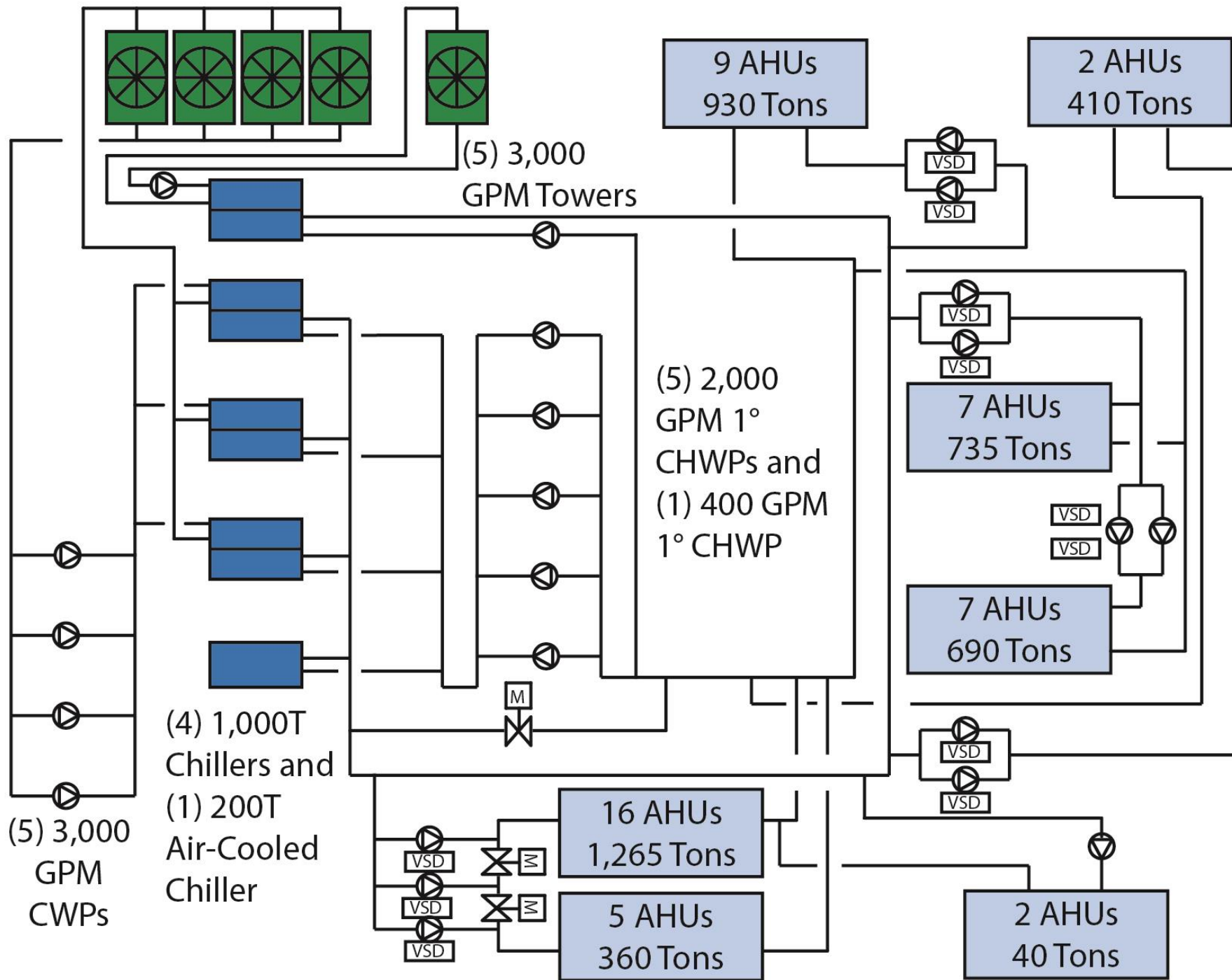
Heart Hospital Energy Analysis: 8760 Analysis



Heart Hospital Cost Comparison

Option	Price	Annual Savings
1: Larger Pumps with VSDs	\$288,000	\$7,413
2: VSDs on Primary Pumps	\$30,000	\$6,260
3: Alter Bypass	\$15,000	\$4,581





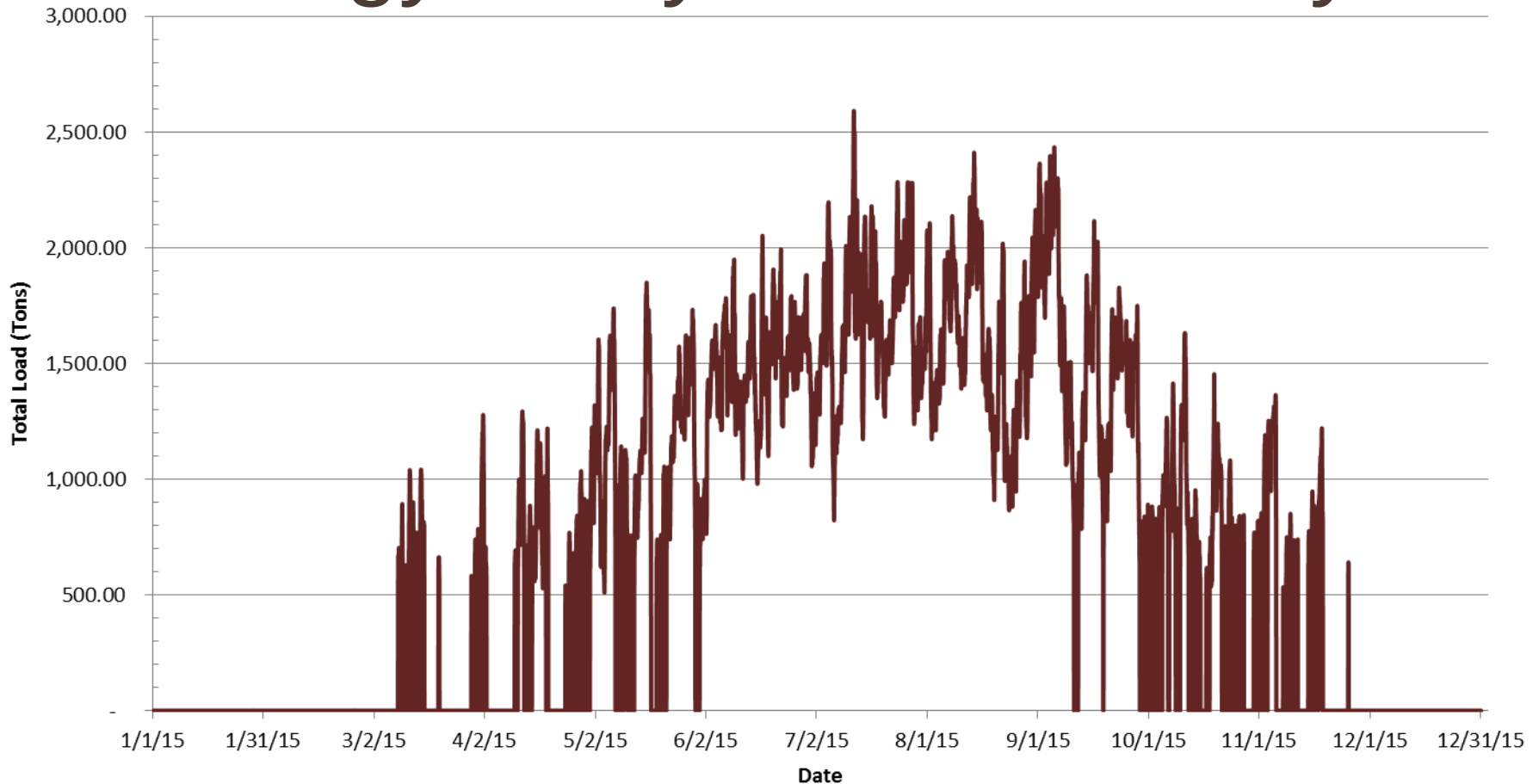
Main Plant Hydraulic Analysis

Existing Configuration										
		Primary Loop	SCHWP-3A,3B	SCHWP-4,5	SCHWP-6	SCHWP-7,8	TCHWP-9,10	P-HWB	SCHWP-13,14	Total 2° Flow
Pump Design	Flow (GPM)	2000	2600	1450	1450	1200	1100	100	1650	8450
	Head (Ft)	60	160	170	170	150	110	50	135	
	No. of Pumps	4	2	2	1	2	2	1	2	
Connected Load	Flow (GPM)	6924	2322	2132	712	2090	819	76	984	8316
	Head (Ft)	65	242	86	81	274	48	65	151	
	Pumps Operating	4	2	1	1	2	1	1	1	
75% Flow	Flow (GPM)	6893	1742	1599	534	1569	614	57	738	6239
	Head (Ft)	65	152	54	51	161	32	67	100	
	Pumps Operating	4	1	1	1	2	1	1	1	
60% Flow	Flow (GPM)	7681	1393	1279	427	1254	491	46	590	4989
	Head (Ft)	47	99	73	34	117	21	68	71	
	Pumps Operating	3	1	1	1	1	1	1	1	
50% Flow	Flow (GPM)	5279	1161	1066	356	1045	410	38	492	4158
	Head (Ft)	65	73	54	27	86	32	69	57	
	Pumps Operating	3	1	1	1	1	1	1	1	
40% Flow	Flow (GPM)	3794	929	853	285	836	328	30	394	3327
	Head (Ft)	62	48	37	18	56	11	69.5	42	
	Pumps Operating	2	1	1	1	1	1	1	1	
25% Flow	Flow (GPM)	3772	581	533	178	522	205	19	246	2079
	Head (Ft)	62	22	18	12	26	11	70	24	
	Pumps Operating	2	1	1	1	1	1	1	1	

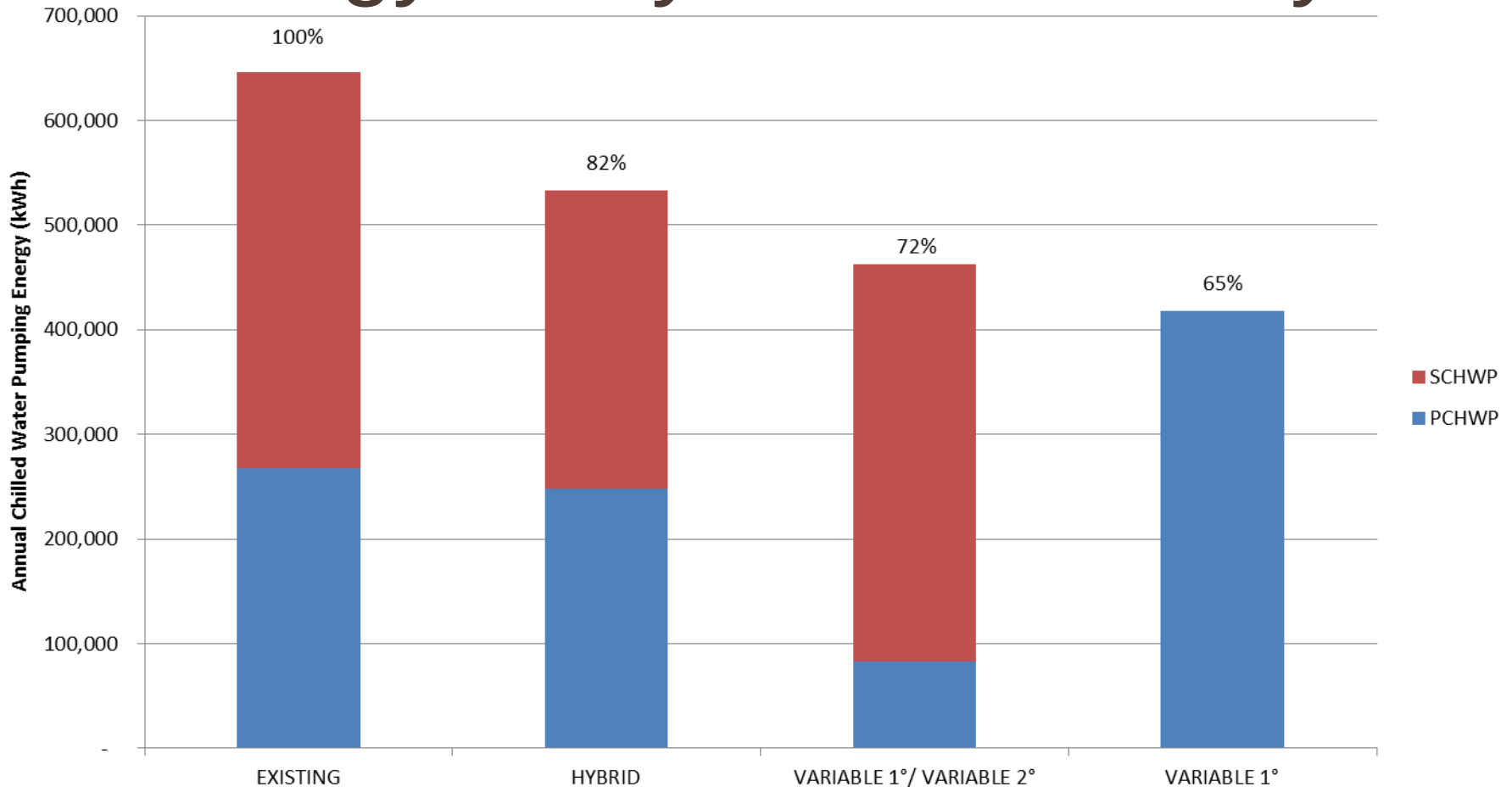
Main Plant Hydraulic Analysis

New Configuration										
		Primary Loop	SCHWP-3A,3B	SCHWP-4,5	SCHWP-6	SCHWP-7,8	TCHWP-9,10	P-HWB	SCHWP-13,14	Total 2° Flow
Pump Design	Flow (GPM)	2000	2600	1450	1450	1200	1100	100	1650	8450
	Head (Ft)	60	160	170	170	150	110	50	135	
	No. of Pumps	4	2	2	1	2	2	1	2	
Connected Load	Flow (GPM)	8316	2322	2132	712	2090	819	76	984	8316
	Head (Ft)	59	228	72	67	260	48	65	137	
	Pumps Operating	4	2	1	1	2	1	1	1	
75% Flow	Flow (GPM)	6239	1742	1599	534	1569	614	57	738	6239
	Head (Ft)	58	127	43	26	137	32	67	75	
	Pumps Operating	3	1	1	1	2	1	1	1	
60% Flow	Flow (GPM)	4989	1393	1279	427	1254	491	46	590	4989
	Head (Ft)	66	80	32	0	77	0	68	30	
	Pumps Operating	3	1	1	0	1	0	1	1	
50% Flow	Flow (GPM)	4158	1161	1066	356	1045	410	38	492	4158
	Head (Ft)	58	62	0	0	57	0	69	28	
	Pumps Operating	2	1	0	0	1	0	1	1	
40% Flow	Flow (GPM)	3327	929	853	285	836	328	30	394	3327
	Head (Ft)	66	16	0	0	14	0	69.5	0	
	Pumps Operating	2	1	0	0	1	0	1	0	
25% Flow	Flow (GPM)	2079	581	533	178	522	205	19	246	2079
	Head (Ft)	58	0	0	0	0	0	70	0	
	Pumps Operating	1	0	0	0	0	0	1	0	

Main Plant Energy Analysis: 8760 Analysis



Main Plant Energy Analysis: 8760 Analysis



Main Plant Cost Comparison

Option	Price	Annual Savings
1: Larger Pumps with VSDs	\$633,600	\$17,137
2: VSDs on Primary Pumps	\$55,000	\$13,818
3: Alter Bypass	\$25,000	\$8,500

Conclusions

- ▶ Cost effectively modify a Primary/Secondary system with or without using VSDs on the primary pumps.
- ▶ Using the decoupler as a low-flow bypass, the pumps are in series, reducing the complexity of trying to match primary and secondary loop flows.
 - ▶ Also allows for generating boost head.
- ▶ Significant cost of retrofitting a primary secondary to a variable primary system without a comparable payback
- ▶ Control strategy must avoid unstable operating points and maintain flow within limits

Questions?