







### Supplement Material

**Table S1:** Problem Table Algorithm for Industrial Plant A.

1	2	3					4	5	6	7					
$T' (^{\circ}\text{C})$	$\Delta T (^{\circ}\text{C})$	$mCP \left(\frac{MW}{^{\circ}\text{C}}\right)$					$\sum mCP \left(\frac{MW}{^{\circ}\text{C}}\right)$	$\Delta H (MW)$	Initial Cascade	Single Utility Heat Cascade					
		0.00556	0.0682	0.2	0.035	0.15									
160									0	9.8225					
	20											0.05556	1.1112		
140														1.1112	10.9337
	30											0.12374	3.7122		
110														4.8234	14.6459
	30											-0.11126	-3.3378		
80														1.4856	11.3081
	5											-0.07626	-0.3813		
75														1.1043	10.9268
	5											-0.22626	-1.1313		
70														-0.027	9.7955
	25											-0.28182	-7.0455		
45														-7.0725	2.75
	5						-0.35	-1.75							
40									-8.8225	1					
	5						-0.2	-1							
35									-9.8225	0 (Pinch)					

**Table S2:** Problem Table Algorithm for Industrial Plant B

1	2	3						4	5	6	7		
		$mCP \left(\frac{MW}{^\circ C}\right)$										$\sum mCP \left(\frac{MW}{^\circ C}\right)$	$\Delta H (MW)$
		0.08333	0.0444	0.5	0.07675	0.02	0.0933						
195										0	4.2953		
	40							0.08333	3.3332				
155								-0.00997	-0.0997			3.3332	7.6285
	10											3.2335	7.5288
145								0.06678	1.3356				
	20											4.5691	8.8644
125								-0.43322	-4.3322				
	10											0.2369	4.5322
115								-0.45322	-4.5322				
	10											-4.2953	0 (Pinch)
105								0.00238	0.0595				
	25											-4.2358	0.0595
80								0.09568	0.4784				
	5											-3.7574	0.5379
75								0.09568	0.9568				
	10											-2.8006	1.4947
65								0.11568	3.4704				
	30											0.6698	4.9651
35								0.03893	0.7786				
	20					1.4484	5.7437						
15													






**Table S3:** Problem Table Algorithm for Industrial Plant C.

1 $T'$ (°C)	2 $\Delta T$ (°C)	3 $mCP$ ( $\frac{MW}{^\circ C}$ )												4 $\sum mCP$ ( $\frac{MW}{^\circ C}$ )	5 $\Delta H$ (MW)	6 Initial Cascade	7 Single Utility Heat Cascade
		5	10	35.1	0.59	2.58	0.24	2.2	0.14	50	0.85	7	0.05				
250																0	61
	40															-0.14	-5.6
210																-0.19	-19
	100															-1.04	-36.4
110																-1.04	-36.4
	35															1.38	6.9
75																1.38	6.9
	5															8.94	44.7
70																8.94	44.7
	5															10.93	54.65
65																10.93	54.65
	5															3.93	66.81
60																3.93	66.81
	17															11.17	33.51
43																11.17	33.51
	3															5.16	10.32
40																5.16	10.32
	2															-44.84	-134.52
38																-44.84	-134.52
	3															-12.05	-48.2
35																-12.05	-48.2
	4															-7.05	-7.05
31																-7.05	-7.05
	1															28.1	84.3
30																28.1	84.3
	3															28.1	84.3
28																28.1	84.3
																50.42	111.42

**Table S4:** Problem Table Algorithm for Industrial Plant D.

1	2	3		4	5	6	7
$T' (^{\circ}\text{C})$	$\Delta T (^{\circ}\text{C})$	$mCP \left(\frac{MW}{^{\circ}\text{C}}\right)$		$\sum mCP \left(\frac{MW}{^{\circ}\text{C}}\right)$	$\Delta H (MW)$	Initial Cascade	Single Utility Heat Cascade
		3.33	7.9231				
85		↑	↑			0	664.8515
	20			-7.9231	-158.462		
65						-158.462	506.3895
	45			-11.2531	-506.39		
20						-664.852	0

**Table S5:** Multiple Utility Problem Table Algorithm for Industrial Plant A.

1	2	3	4					5	6	7	8	9
$T'$ (°C)	$T''$ (°C)	$\Delta T$ (°C)	$mCP \left(\frac{MW}{^\circ C}\right)$					$\sum mCP \left(\frac{MW}{^\circ C}\right)$	$\Delta H$ (MW)	Multiple Utility Heat Cascade	Multiple consumed/generated	Heat Sink/Source
			0.00556	0.0682	0.2	0.035	0.15					
HPS	240									0		0
		80						0	0			
160	160								0			
		10						0.05556	0.5556			
LPS	150									<b>0.5556</b>		5.6634
		10						0.05556	0.5556			
140	140									1.1112		
		30						0.12374	3.7122			
110	110									4.8234		
		30						-0.11126	-3.3378			
80	80									1.4856		
		5						-0.07626	-0.3813			
75	75									1.1043		
		5						-0.22626	-1.1313		0.027	
70	70									0		
		20						-0.28182	-5.6364		5.6364	
HW	50									<b>0</b>		4.1591
		5						-0.28182	-1.4091		1.4091	
45	45									0		
		5						-0.35	-1.75		1.75	
40	40									0		
		5						-0.2	-1		1	
35	35									<b>0</b>		<b>Pinch</b>
		15						0	0			
CW	20									<b>0</b>		0



**Table S7:** Multiple Utility Problem Table Algorithm for Industrial Plant C

1 $T'$ (°C)	2 $T''$ (°C)	3 $\Delta T$ (°C)	4 $mCP$ ( $\frac{MW}{^\circ C}$ )											5 $\sum mCP$ ( $\frac{MW}{^\circ C}$ )	6 $\Delta H$ (MW)	7 Initial Cascade	8 Multiple consumed/ generated	9 Heat Sink/So urce	
			5	10	35.1	0.59	2.58	0.24	2.2	0.14	50	0.85	7						0.05
250	250																0		17
		10															-0.14	-1.4	1.4
HPS	240																0		
		30															-0.14	-4.2	4.2
210	210																0		
		60															-0.19	-11.4	11.4
LPS	150																0		44
		40															-0.19	-7.6	7.6
110	110																0		
		35															-1.04	-36.4	36.4
75	75																0		<b>Pinch</b>
		5															1.38	6.9	-6.9
70	70																0		
		5															8.94	44.7	-44.7
65	65																0		
		5															10.93	54.65	-49.07
60	60																-5.58		
		10															3.93	39.3	
HW	50																3.93	66.81	-44.88
		17																-111.69	
43	43																4.17	12.51	
		3																-124.2	
40	40																5.16	10.32	
		2															-44.84	-134.52	
38	38																0		
		3															7.95	39.75	-32.7
35	35																-7.05	-7.05	
		5															0		
31	31																28.1	84.3	-84.3
		1															0		
30	30																0		
		3															0		
28	28																0		
		8															0		
CW	20																0		-117

**Table S8:** Multiple Utility Problem Table Algorithm for Industrial Plant D

1	2	3	4		5	6	7	8	9	
$T'$ (°C)	$T''$ (°C)	$\Delta T$ (°C)	$mCP \left(\frac{MW}{^\circ C}\right)$		$\sum mCP \left(\frac{MW}{^\circ C}\right)$	$\Delta H$ (MW)	Initial Cascade	Multiple consumed/generated	Heat Sink/Source	
			3.33	7.9231						
LPS	150		↑	↑			0		327.2585	
		65				0	0			
85	85							0		
		20				-7.9231	-158.462		158.462	
65	65							0		
		15				-11.2531	-168.797		168.7965	
HW	50							0		337.593
		30				-11.2531	-337.593		337.593	
20	20							0		0
		0				0	0		0	
CW	20					0			<b>Pinch</b>	