PART 3

NUMBER OF UNITS TARGETING
-AREA TARGETING &
COST TARGETING
(SUPERTARGETING)

MINIMUM NUMBER OF UNITS

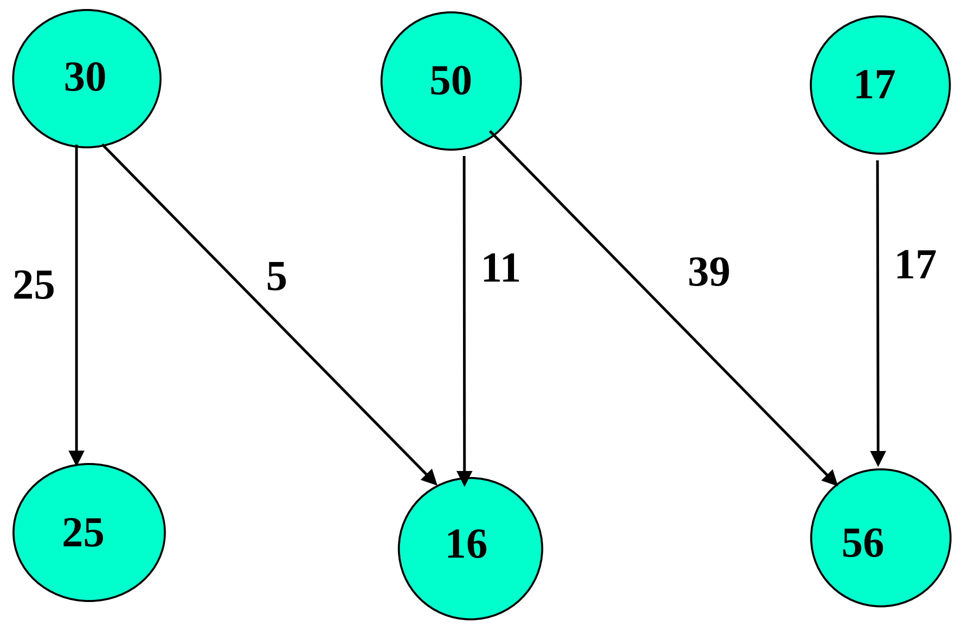
We use an example.

Consider the following 3 hot streams and 3 cold streams. Assume that all heat transfer is possible: What is the minimum number of exchangers needed?

Hot Streams	30	50	17
Cold Streams	25	16	56

MINIMUM NUMBER OF UNITS

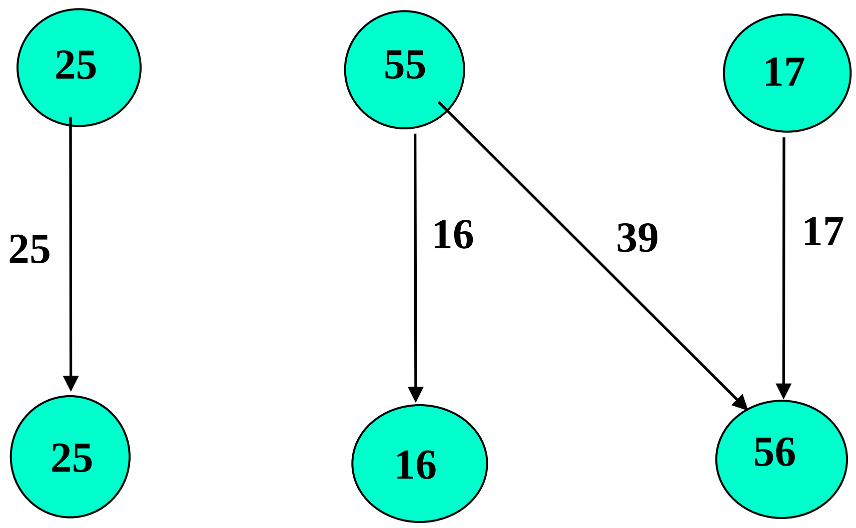
Five heat exchangers are needed, possibly less in some other cases. Here is how you solve the problem specifically.



The general answer is N=S-1 . When does one need less?

MINIMUM NUMBER OF UNITS

When there is an exact balance between two streams or a subset of streams.



The general answer is N=S-P. P is the number of independent subsystems. (Two in this case)

GENERAL FORMULA FOR UNIT TARGETING

$$N_{min} = (S-P)_{\text{above pinch}} + (S-P)_{\text{below pinch}}$$

We need to consider systems where the heat transfer is possible.

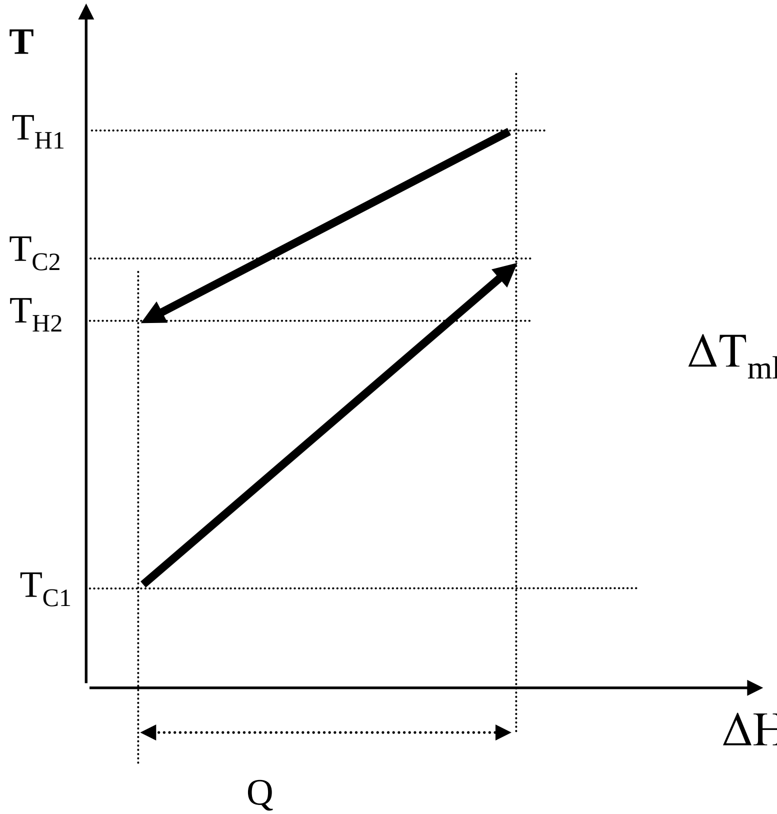
If we do not consider two separate problems, above and below the pinch we can get misleading results.

TOTAL AREA TARGETING

In this part we will explore ways to predict the total area of a network without the need to explore specific designs.

TOTAL AREA TARGETING

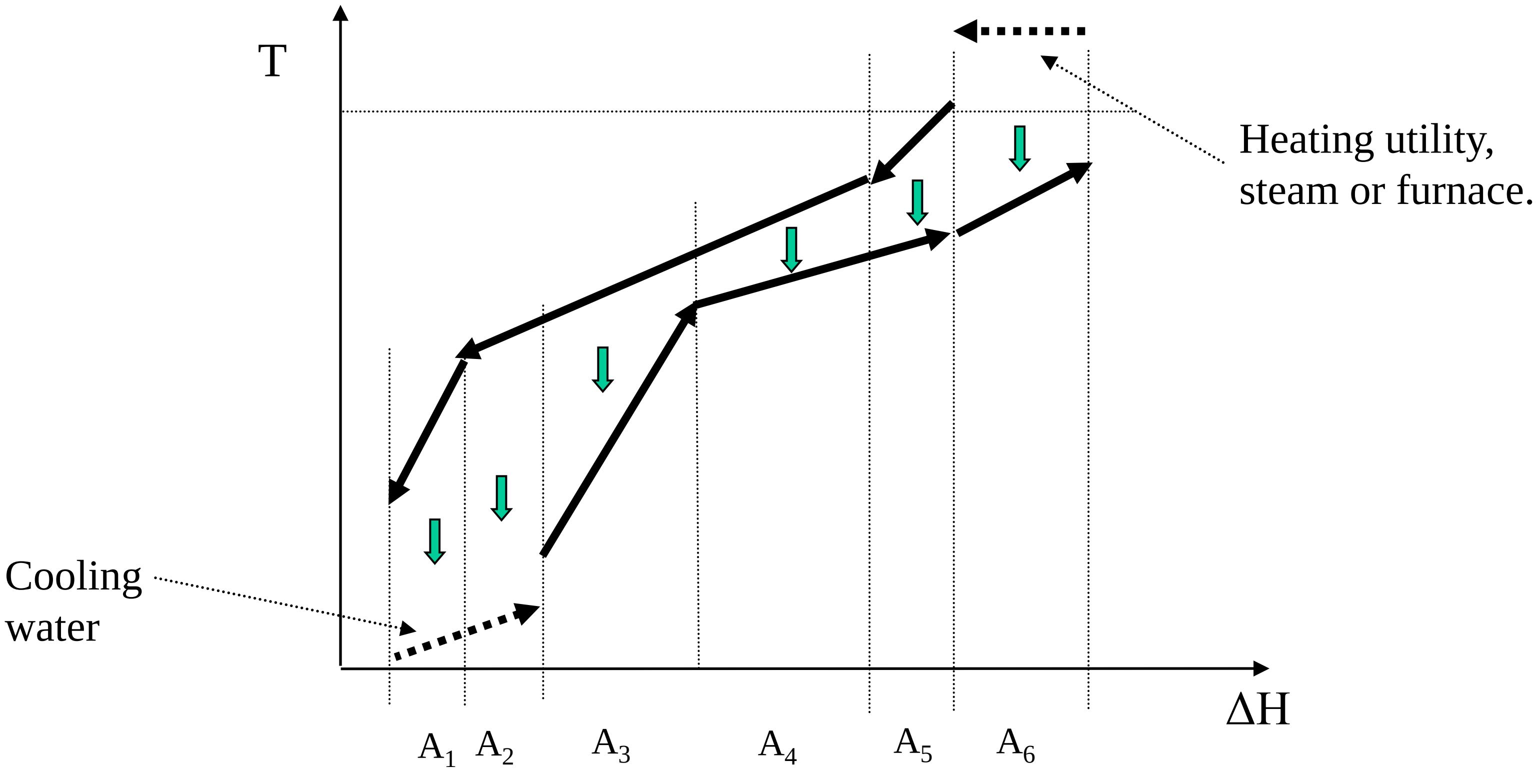
Because $A=Q/(U*\Delta T_{ml})$, one can calculate the area easily in the following situation.



$$\Delta T_{ml}=\frac{(T_{H1}-T_{C2})-(T_{H2}-T_{C1})}{\ln\dfrac{(T_{H1}-T_{C2})}{(T_{H2}-T_{C1})}}$$

TOTAL AREA TARGETING

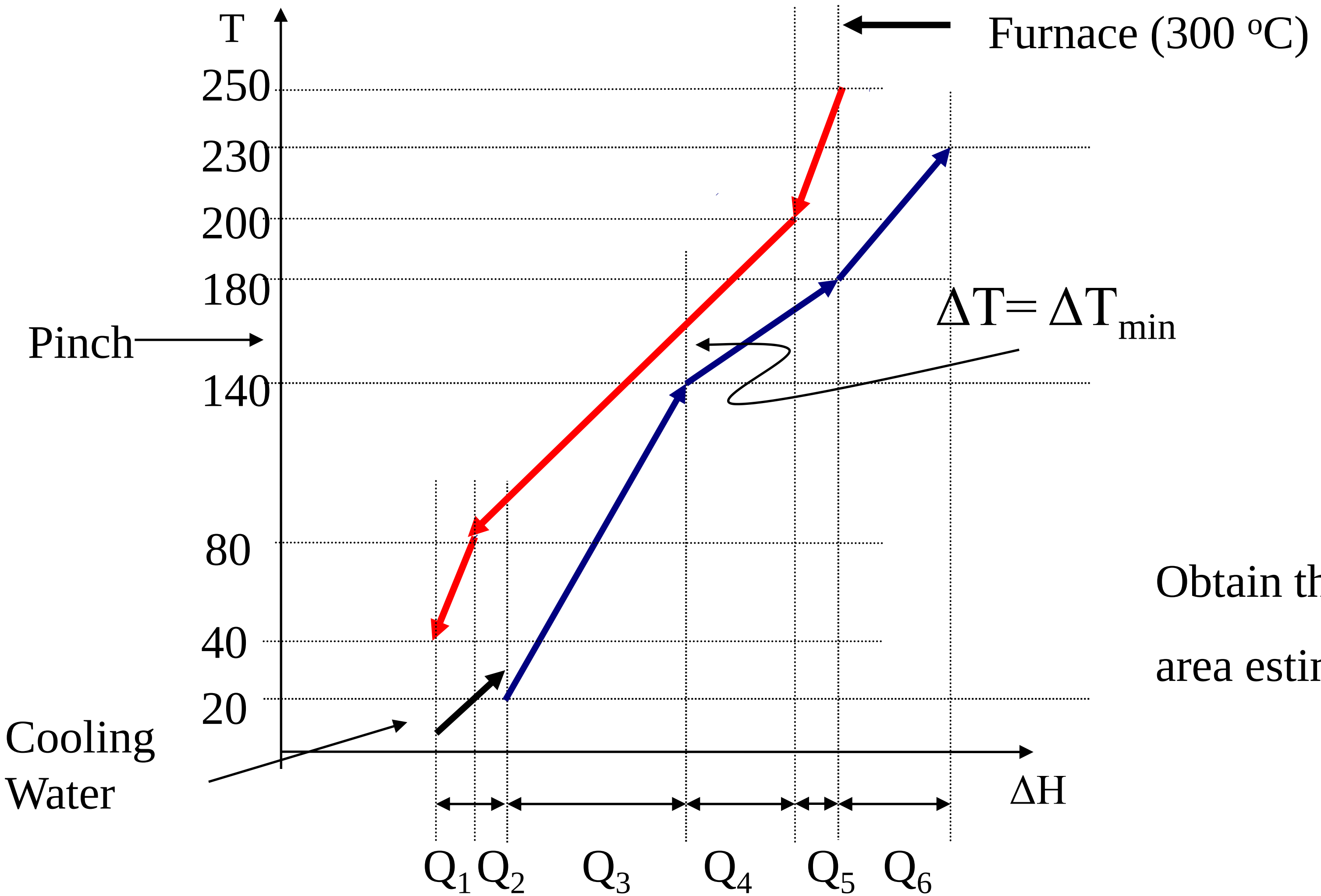
Since area=Q/(U ΔT_{ml}), the composite curve diagram provides one way of estimating the total area involved. Isolate all regions with a pair of straight line sections and calculate the area for each.



The above scheme of heat transfer is called VERTICAL HEAT TRANSFER

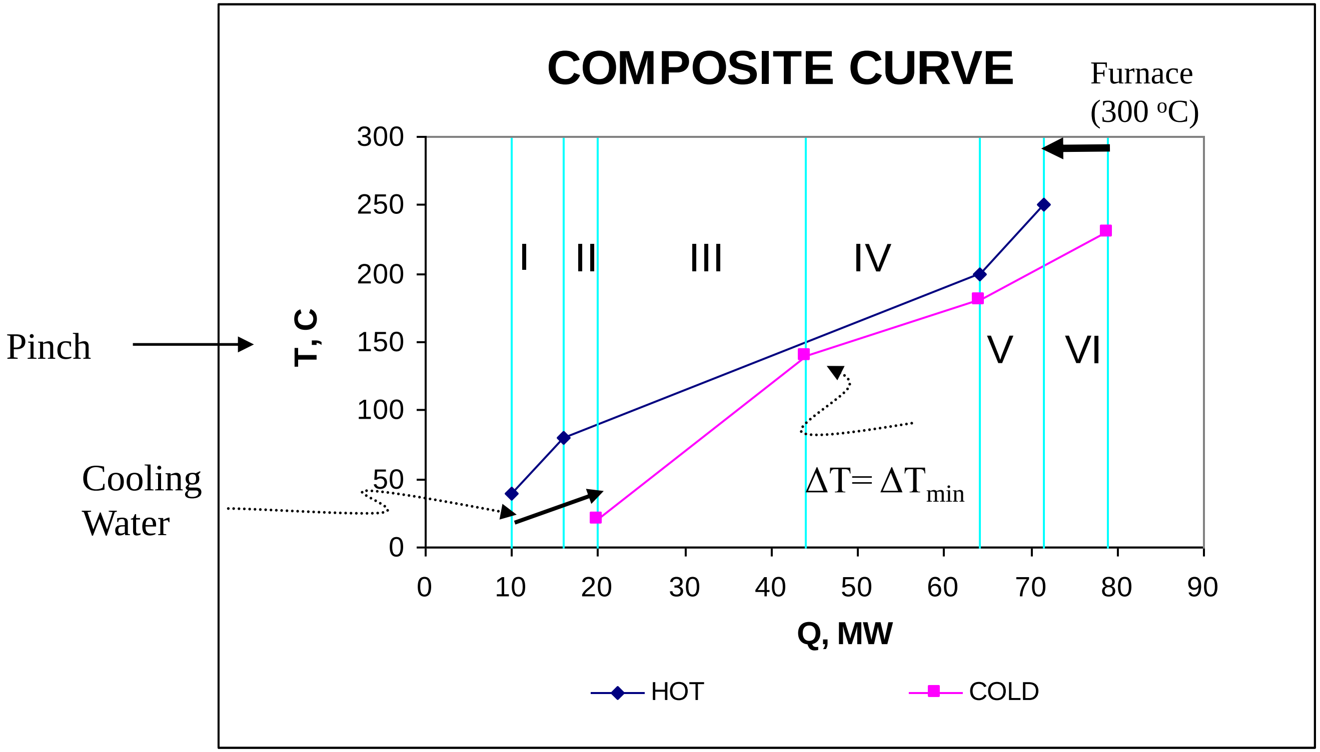
EXAMPLE

We now calculate the values of Q in each interval and estimate the corresponding area. Use U= 0.001 MW m^{-2} ^oC



Obtain the total area estimate

EXAMPLE



Units:

Q= MW

T= °C

A= m²

Interval	*Q*	T_{H1}	T_{H2}	T_{C1}	T_{C2}
I	6	80	40	15	20
II	4	90	80	20	30
III	24	150	90	20	140
IV	20	200	150	140	180
V	7.5	250	200	180	205
VI	7.5	300	250	205	230

EXAMPLE

Interval	Q	T_{H1}	T_{H2}	T_{C1}	T_{C2}	ΔT_{ml}	A
I	6	80	40	15	20	40.0	150.1
II	4	90	80	20	30	60.0	66.7
III	24	150	90	20	140	30.8	778.4
IV	20	200	150	140	180	14.4	1386.3
V	7.5	250	200	180	205	30.8	243.3
VI	7.5	300	250	205	230	81.9	91.6
					Total Area		2716.3

Units: $Q = MW$ $T = {}^{o}C$, $A = m^2$

$U = 0.001$ MW m^{-2} ${}^{o}C$

ANSWERS

- ***Is the total area predicted this way, realistic? That is, is it close enough to a value that one would obtain from a final design?***

YES, Within 10-15%

ANSWERS

- ***Is the estimate, realistic or not, conservative? That is, is it larger than the one expected from a final design?***

The area obtained is actually the minimum area needed to perform the heat transfer.

ANSWERS

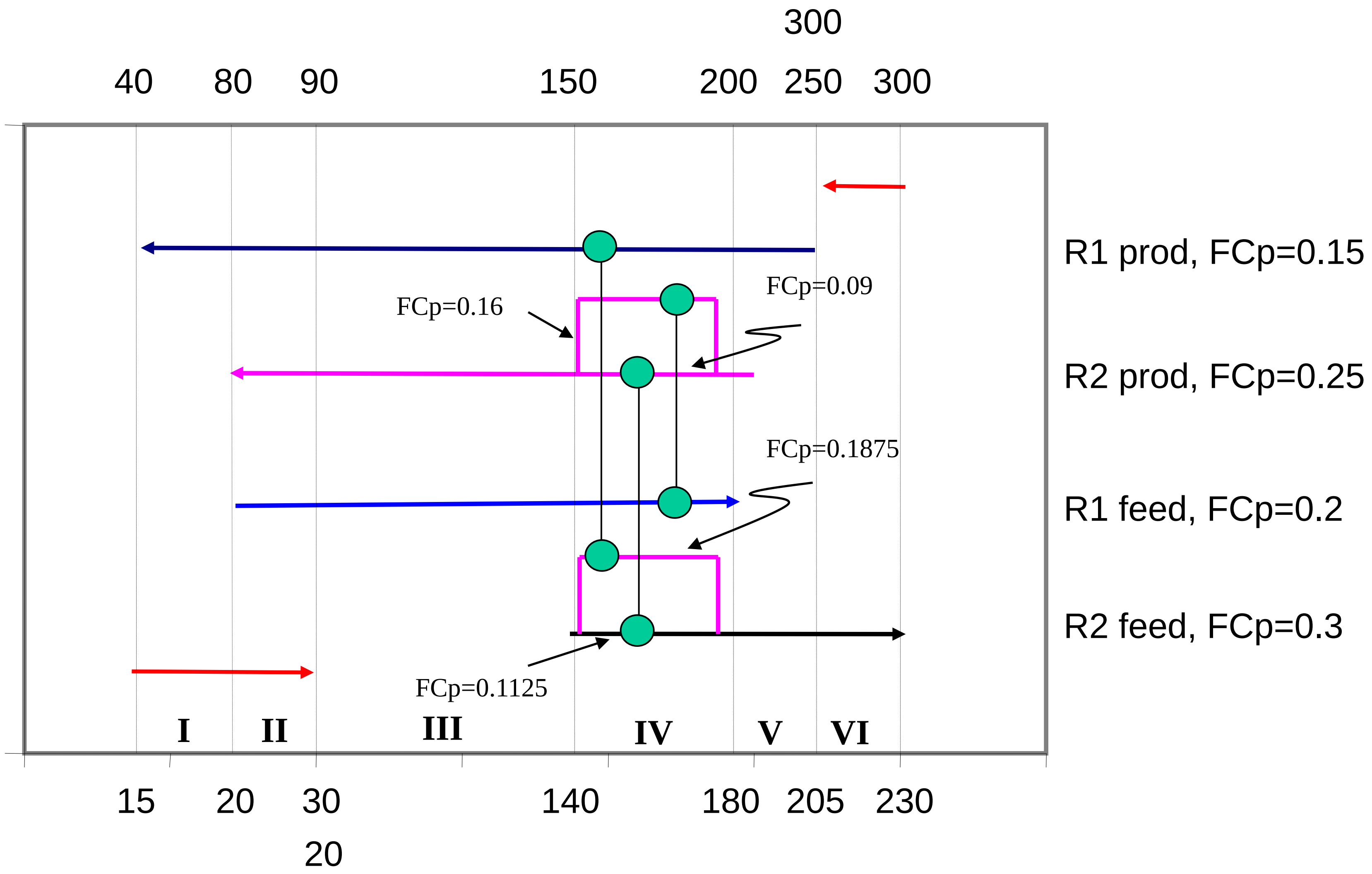
- ***How complex is a design built using the vertical transfer?***

Very Complex. Take for example interval 4. There are four streams in this interval.

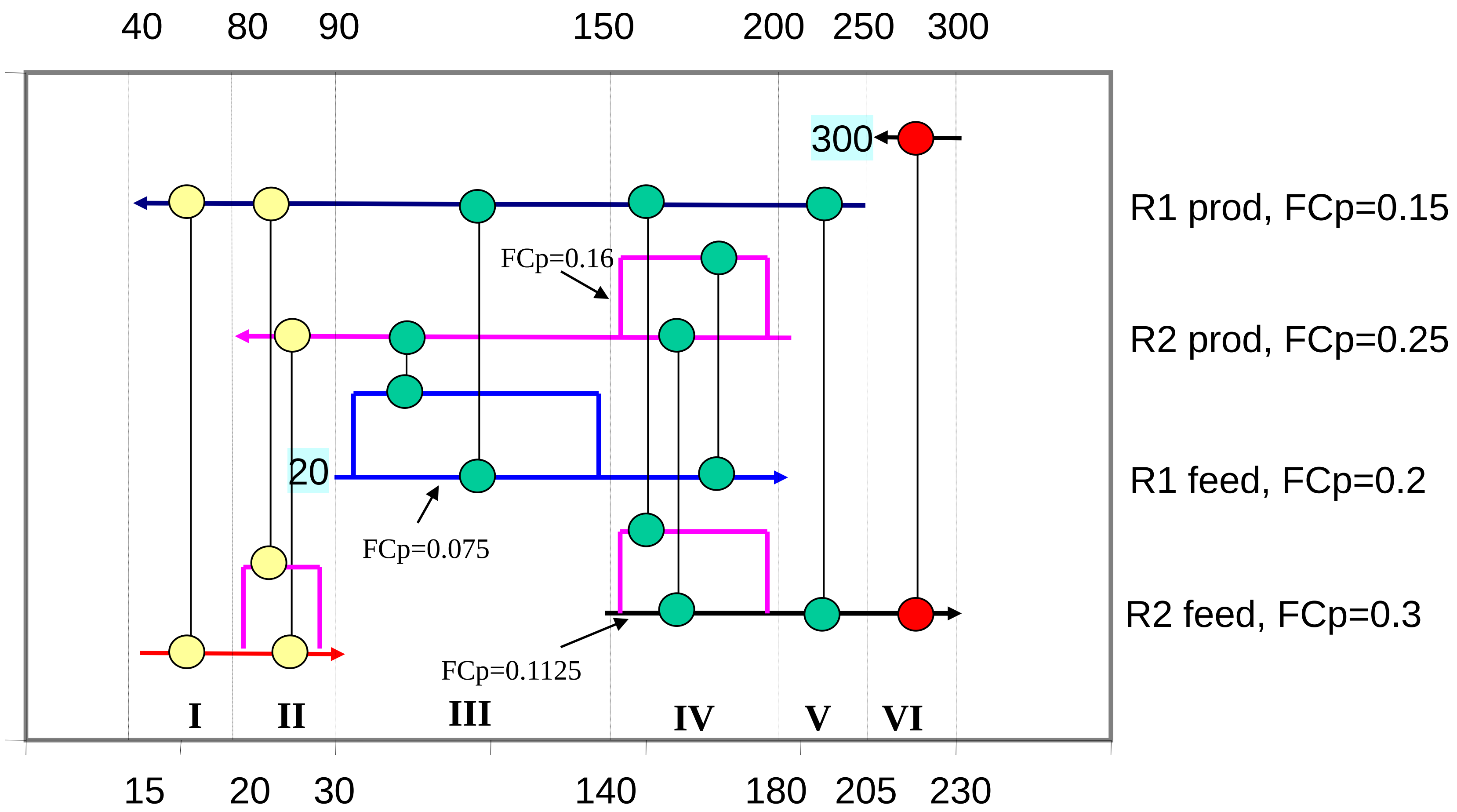
Stream	Type	Supply T (^oC)	Target T (^oC)	ΔH (MW)	F*Cp ($MW\ ^oC^{-1}$)
Reactor 1 feed	Cold	140	180	8.0	0.2
Reactor 1 product	Hot	200	150	-7.5	0.15
Reactor 2 feed	Cold	140	180	12.0	0.3
Reactor 2 product	Hot	200	150	-12.5	0.25

This implies at least three heat exchangers, just in this interval.

HEAT EXCHANGER NETWORK



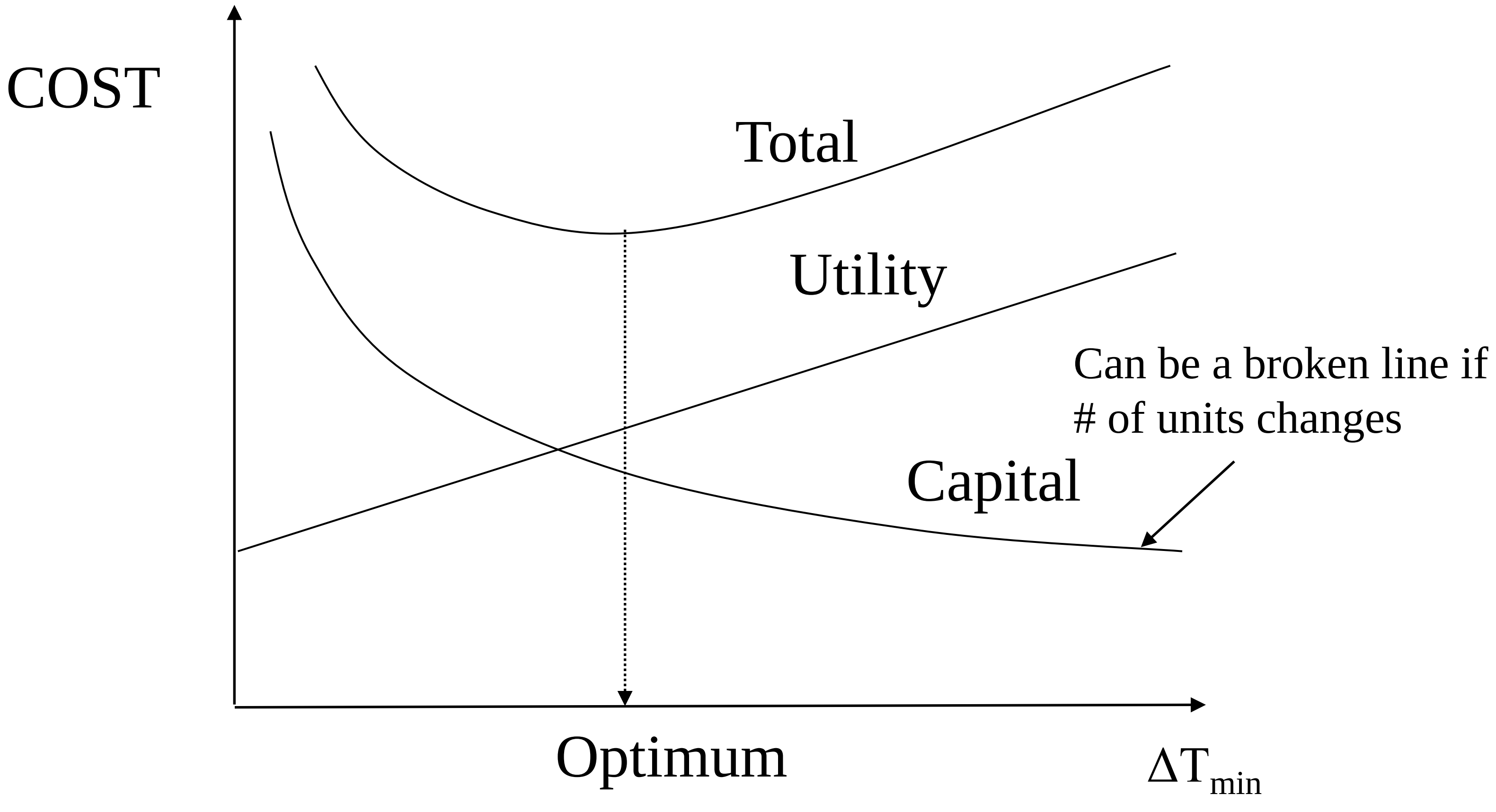
HEAT EXCHANGER NETWORK



TOTAL= 10 Exchangers

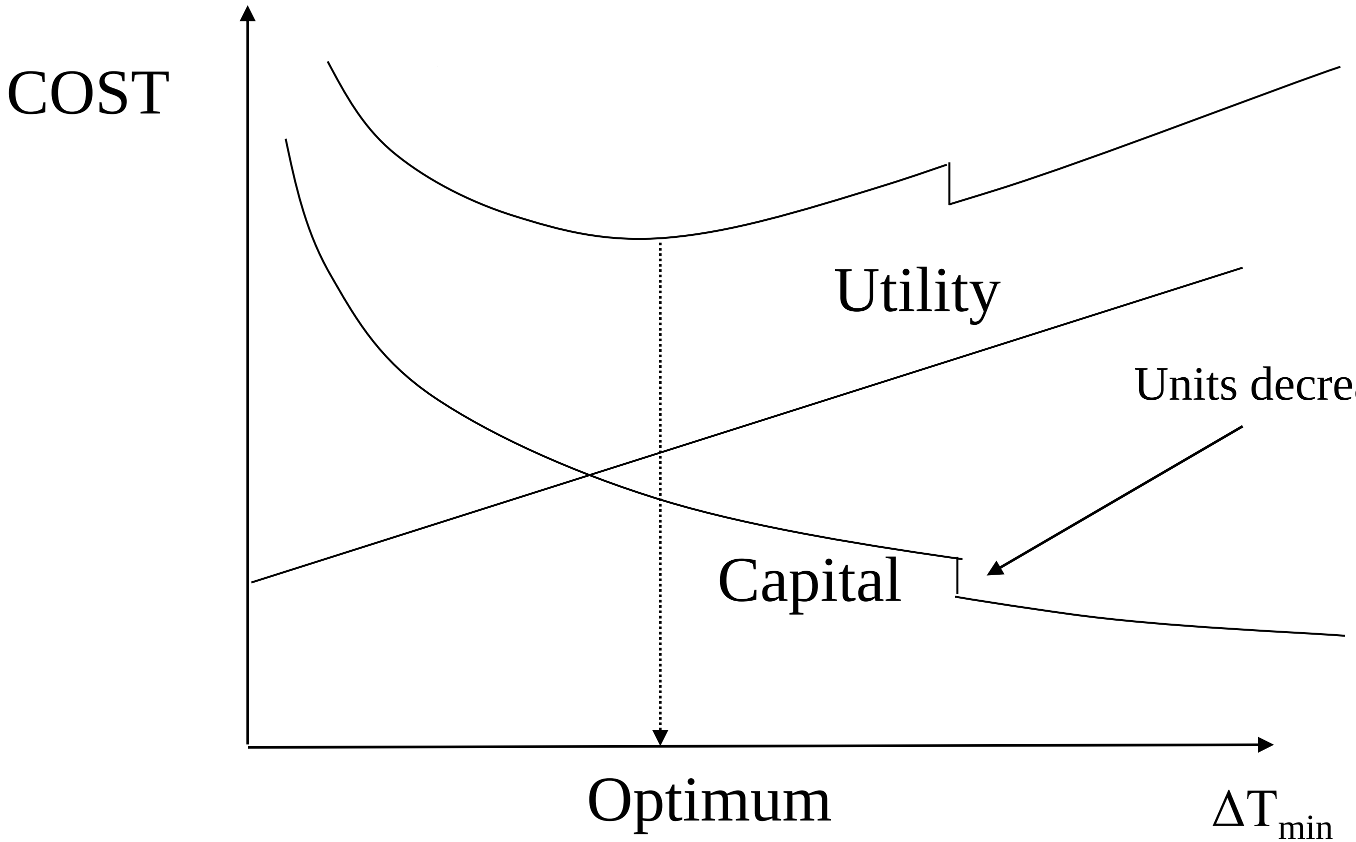
SUPERTARGETING

- Economy of the system is dependent on ΔT_{min}



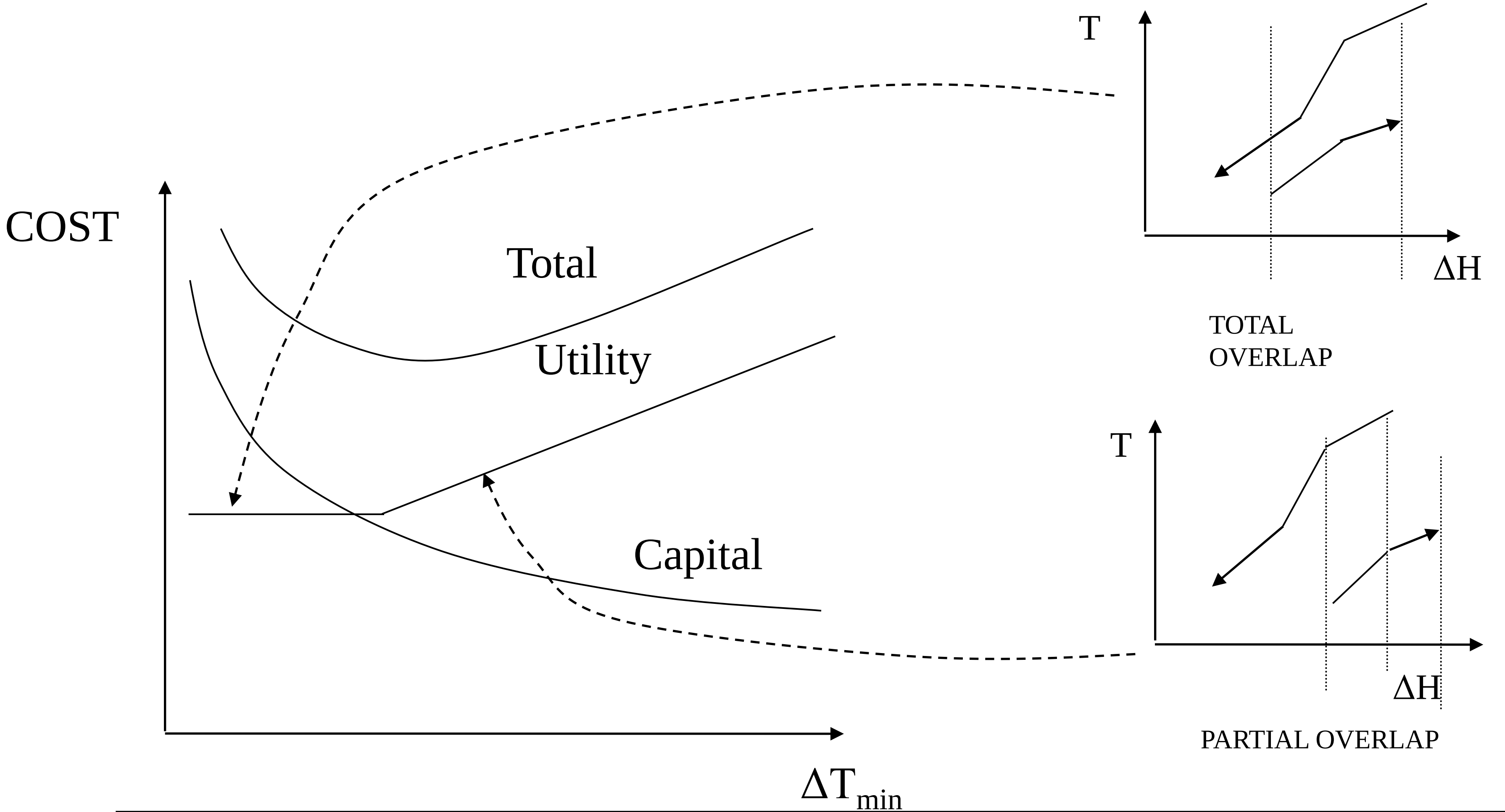
SUPERTARGETING

- Economy of the system is dependent on ΔT_{min}



SPECIAL CASES

- There is total overlap for some values of ΔT_{min}



Note: There is a particular overlap that requires only cooling utility