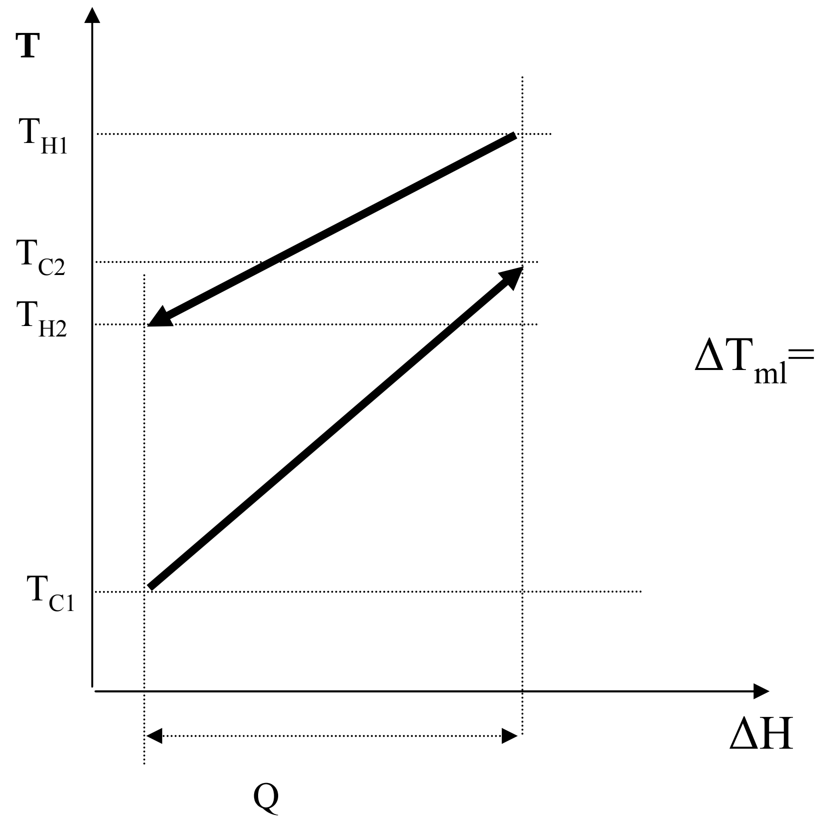
TOTAL AREA AND NUMBER OF UNITS TARGETING

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.

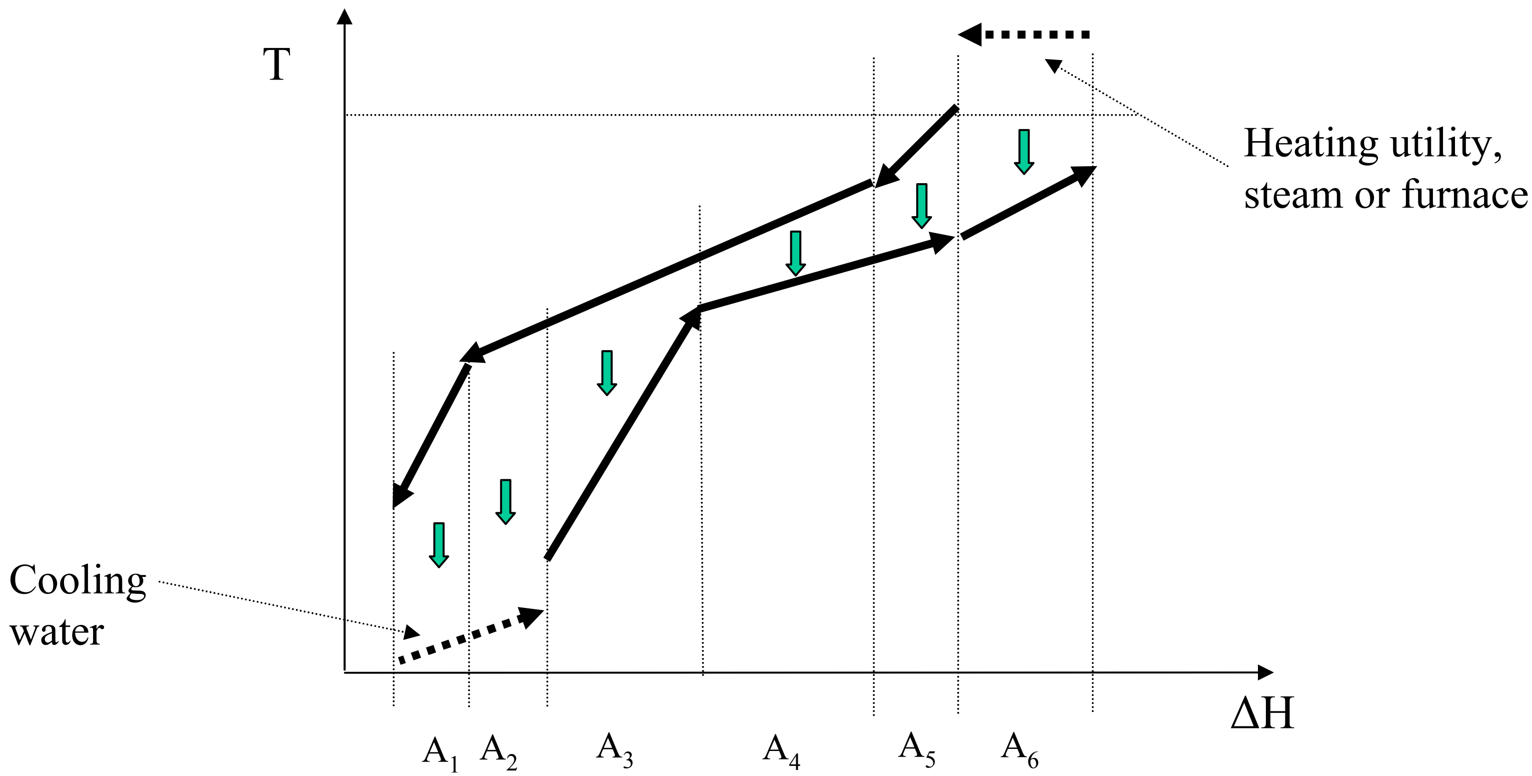
Because $A=Q/(U*\Delta T_{ml})$, one can calculate the area easily in the following situation.



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

TOTAL AREA TARGETING

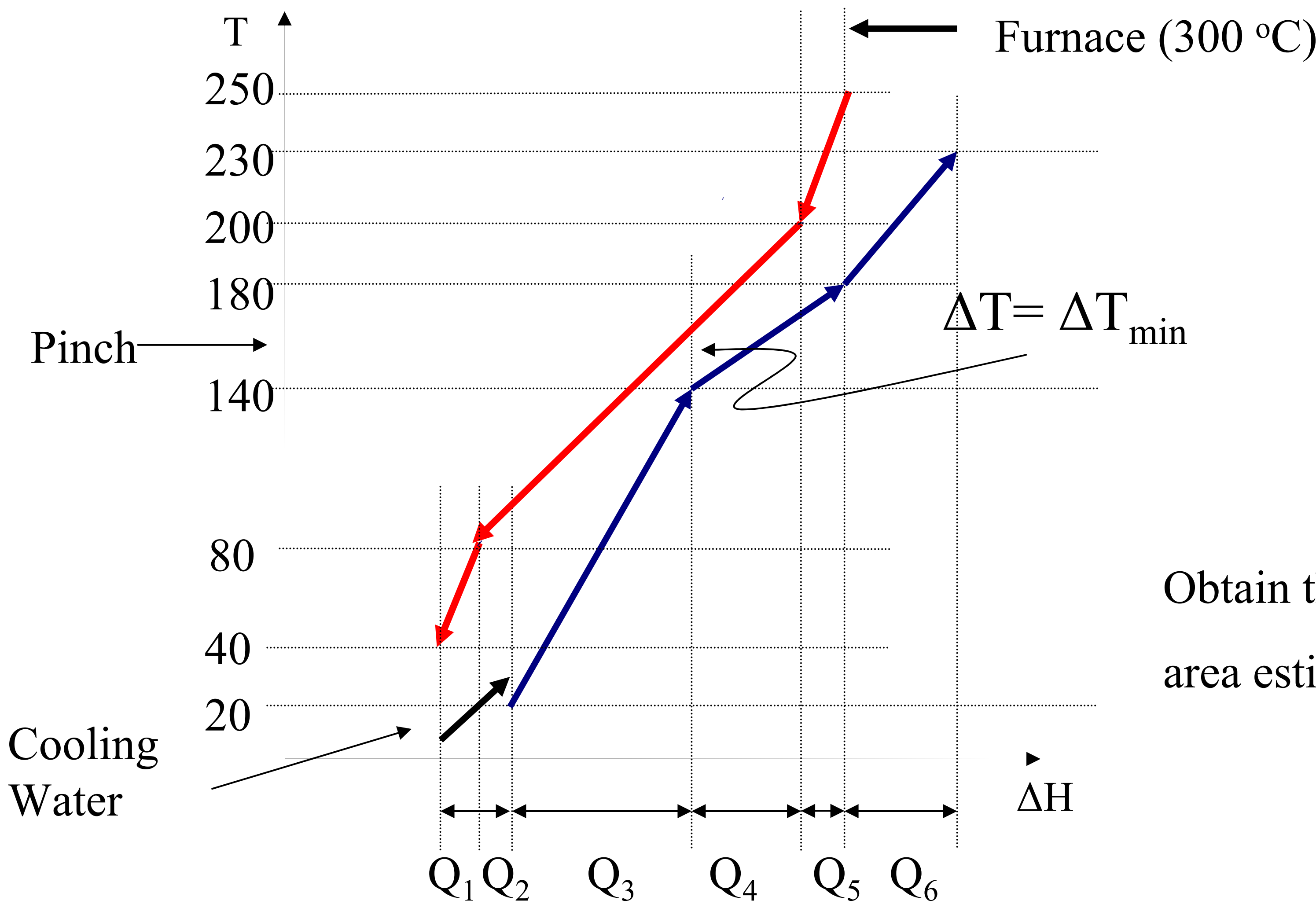
Since area=Q/(U ΔT_{ml}), the composite curve diagram provides one way of estimating the total area involved. Isolate all regions with a pair of straight line sections and calculate the area for each.



The above scheme of heat transfer is called VERTICAL HEAT TRANSFER

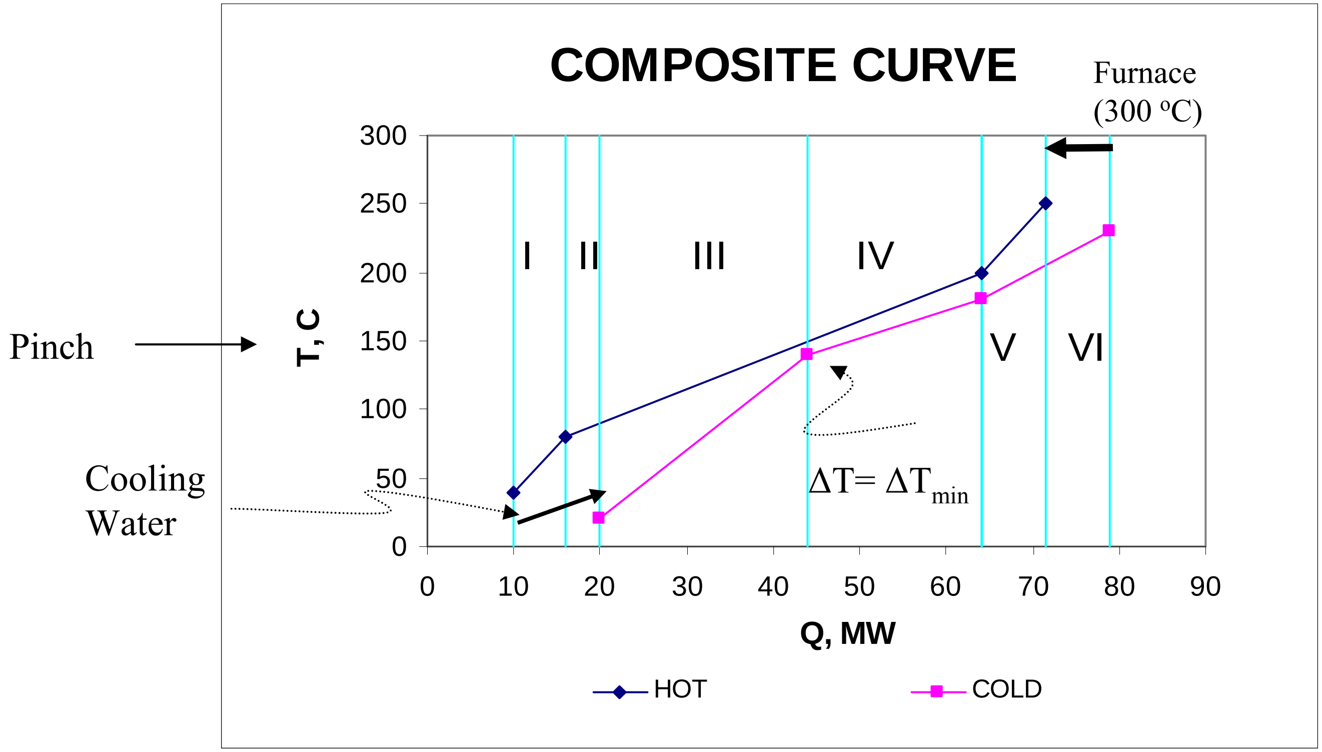
EXERCISE

Calculate the values of Q in each interval and estimate the corresponding area. Use U= 0.001 MW m^{-2} ^{o}C



Obtain the total area estimate

EXERCISE



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

EXERCISE

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 = °C , A = m^2

U = 0.001 MW m^{-2} °C

TOTAL AREA TARGETING

Drawbacks

- ***Fixed costs associated with the number of units are not considered.***

We will see later how the number of units can be calculated

QUESTIONS FOR DISCUSSION

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

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

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

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

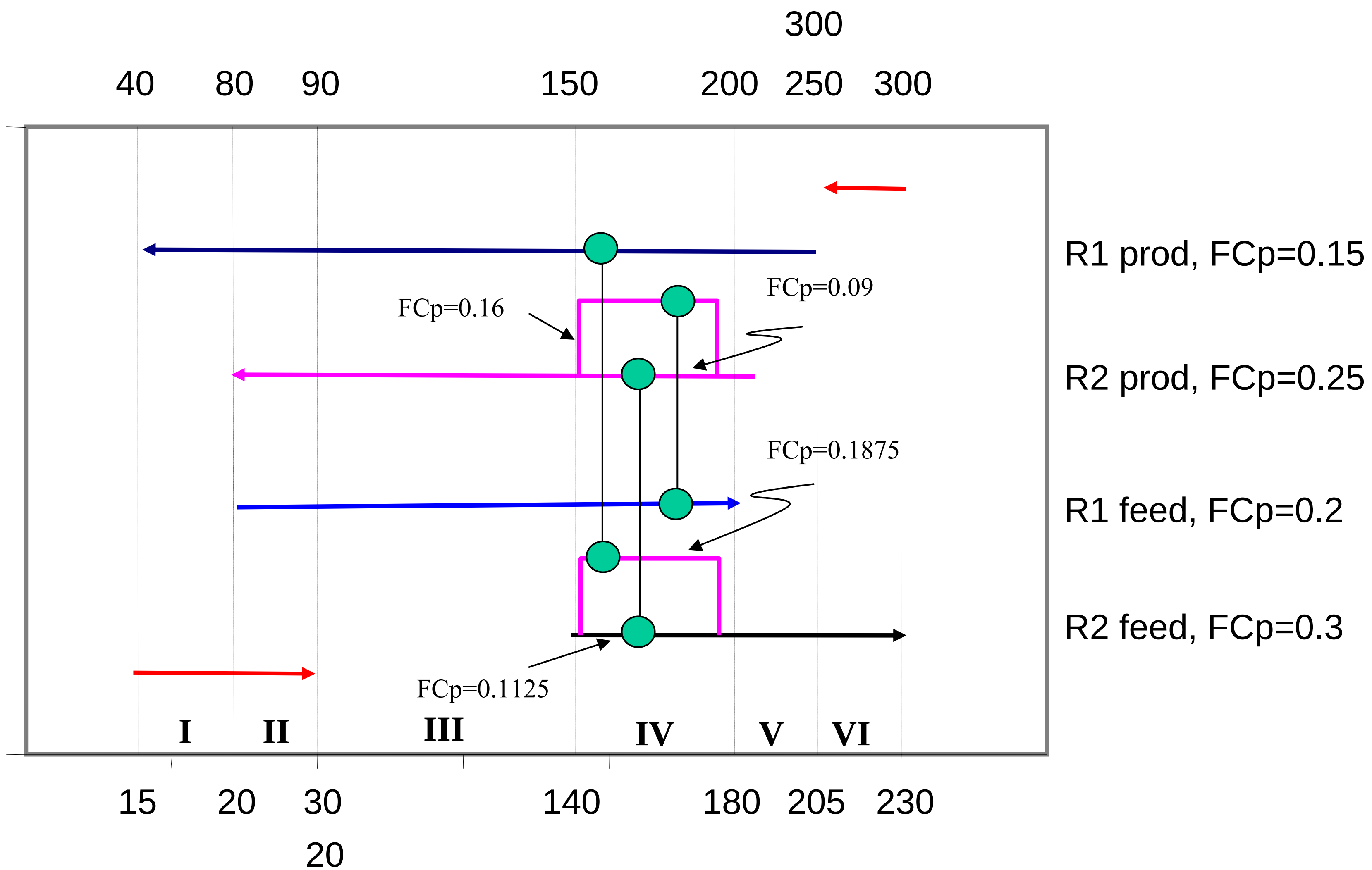
- ***How complex is a design built using the vertical transfer?***

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

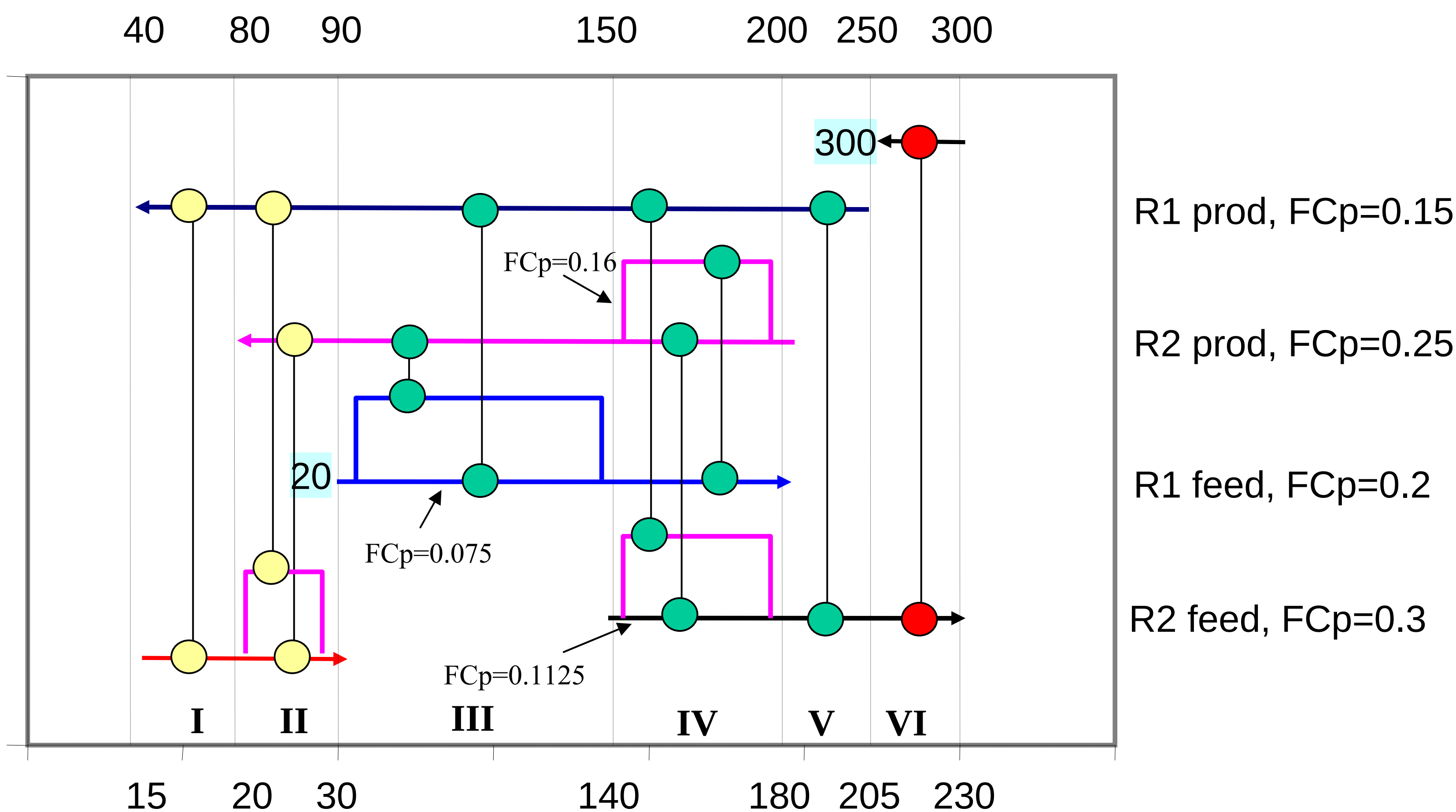
Stream	Type	Supply T (^oC)	Target T (^oC)	ΔH (MW)	F*Cp (MW $^oC^{-1}$)
Reactor 1 feed	Cold	140	180	8.0	0.2
Reactor 1 product	Hot	200	150	-7.5	0.15
Reactor 2 feed	Cold	140	180	12.0	0.3
Reactor 1 product	Hot	200	150	-12.5	0.25

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

HEAT EXCHANGER NETWORK



HEAT EXCHANGER NETWORK

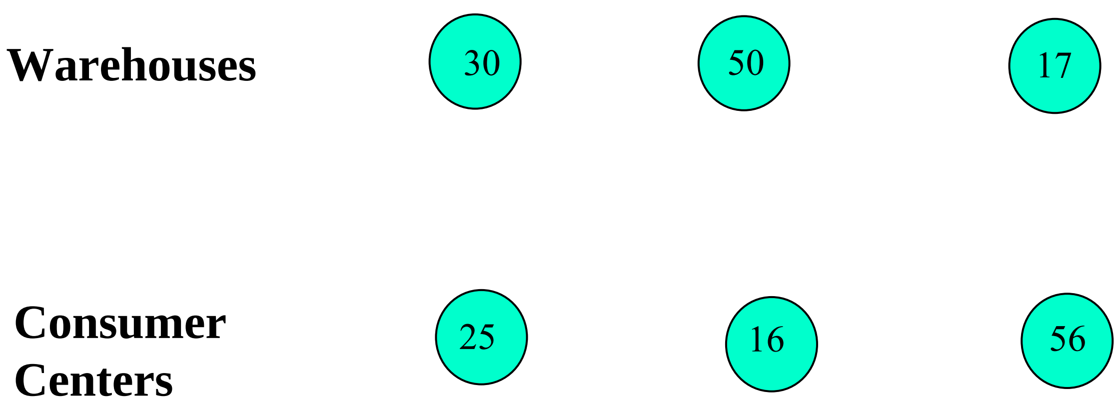


TOTAL= 10 Exchangers

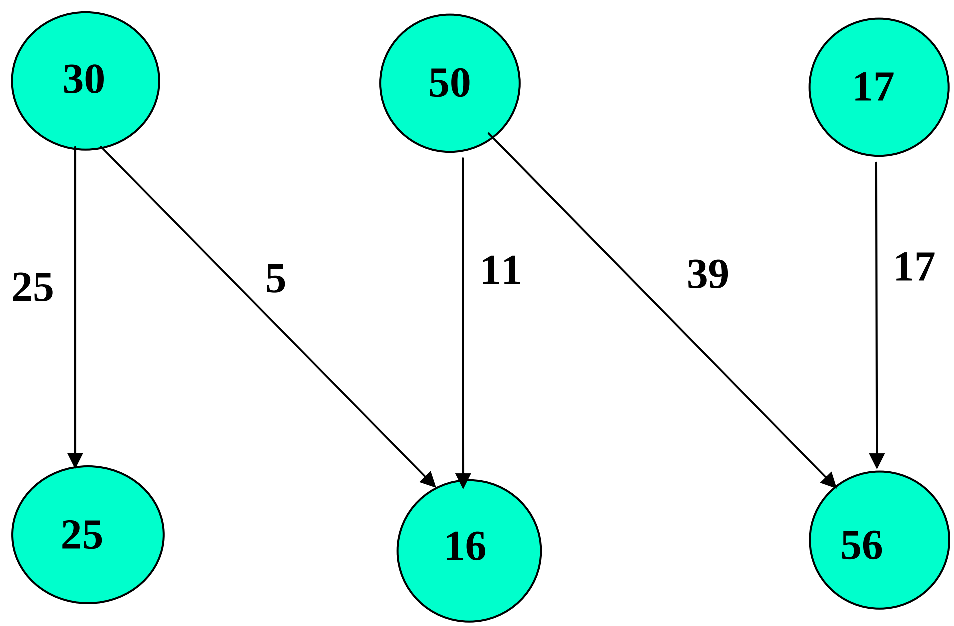
Minimum Number of UNITS

We can anticipate very simply how many exchangers we should have!!!

Consider the following warehouses, each containing some merchandise that needs to be delivered to the row of consumer centers. What is the minimum number of trucks needed?

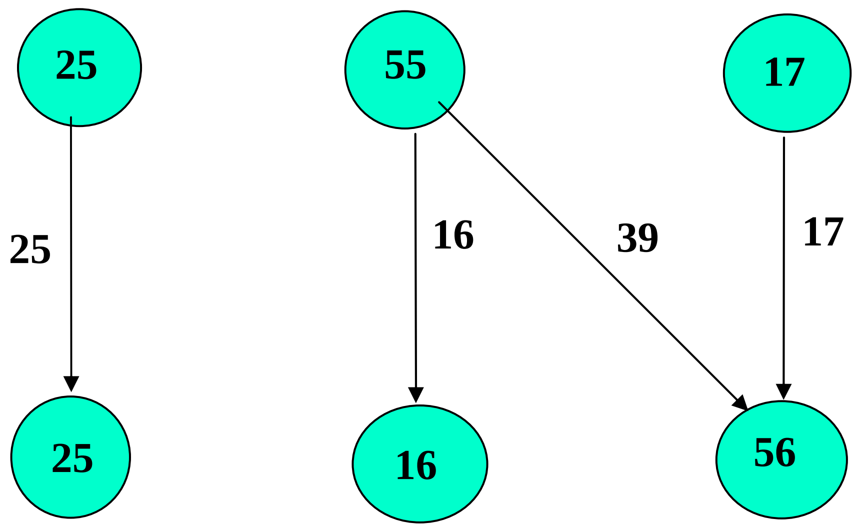


You need five trucks, possibly less in some other cases. Here is how you solve the problem specifically.



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

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)

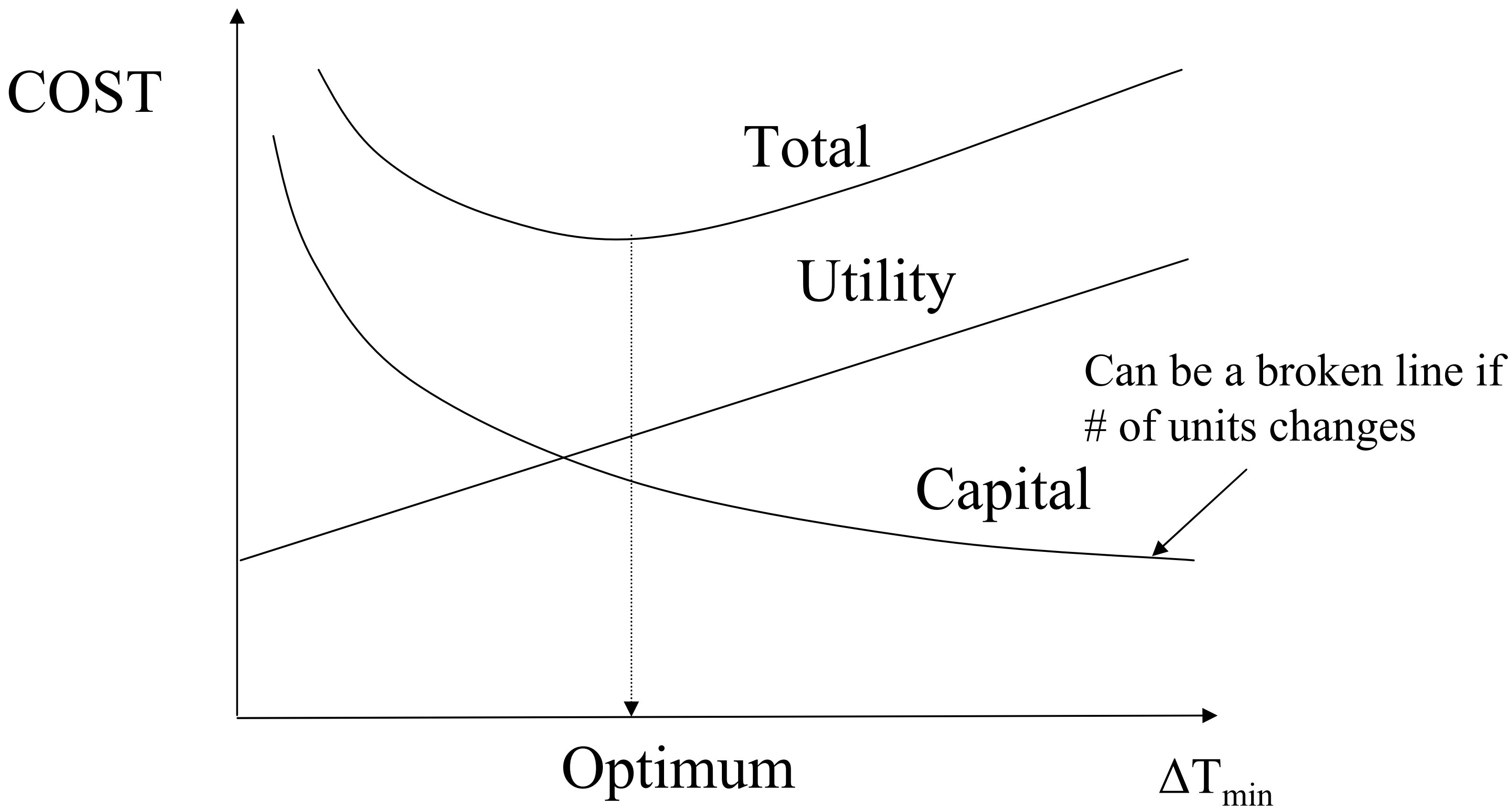
GENERAL FORMULA FOR UNIT TARGETING

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

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

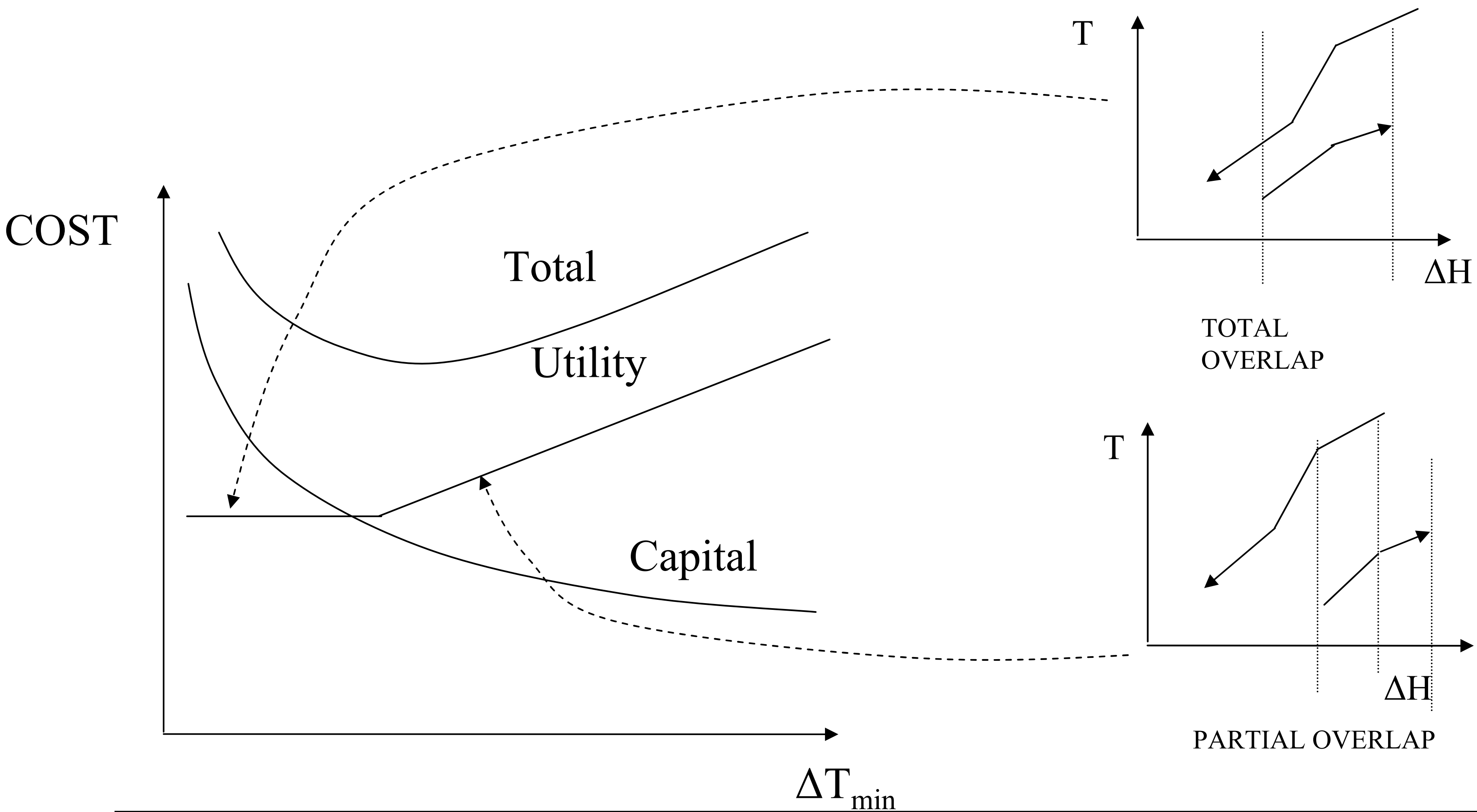
SUPERTARGETING

- 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