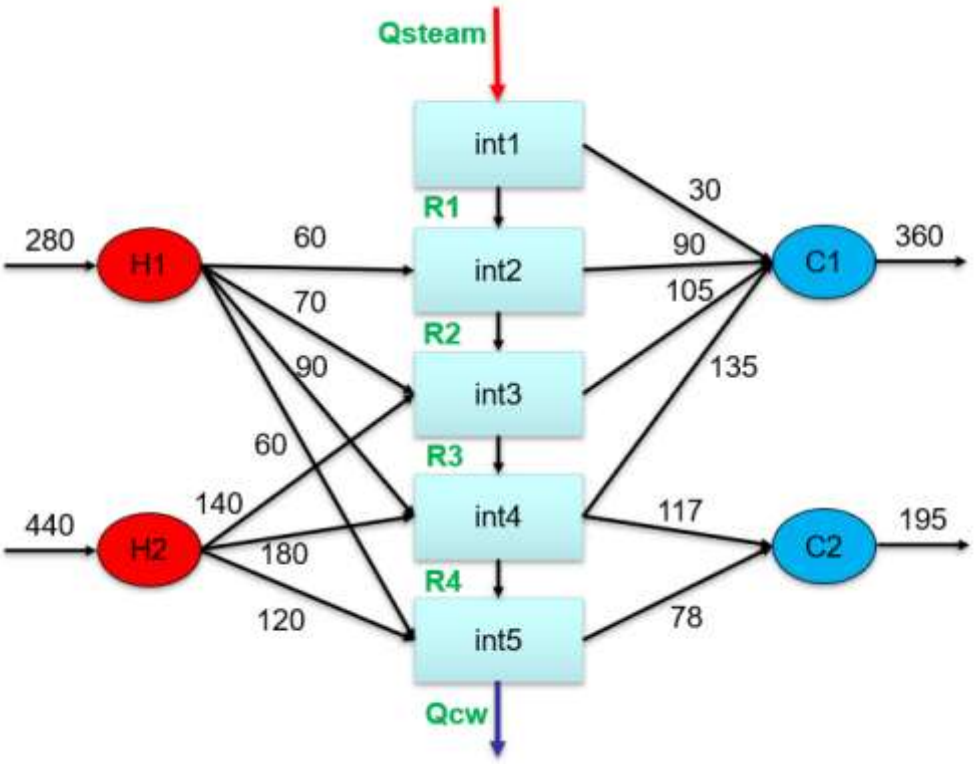
Determine the minimum utility consumption for the two hot and two cold streams given below:

	Fcp (MW/C)	Tin (°C)	Tout (°C)
H1	1	400	120
H2	2	340	120
C1	1,5	160	400
C2	1,3	100	250

Steam: 500 °C
Cooling water: 20-30 °C
Minimum recovery approach temperature: 20 C

En este caso, resolveremos el ejemplo utilizando el "Transhipment model", en el cual se plantean los balances alrededor de cada intervalo de temperaturas



In [ ]:
```
from pyomo.environ import *
model = ConcreteModel()
```

Variables

In [ ]:
```
Qsteam = model.Qsteam = Var(within = NonNegativeReals)
Qcw = model.Qcw = Var(within = NonNegativeReals)
R1 = model.R1 = Var(within = NonNegativeReals)
R2 = model.R2 = Var(within = NonNegativeReals)
R3 = model.R3 = Var(within = NonNegativeReals)
R4 = model.R4 = Var(within = NonNegativeReals)
```

Objective function

In [ ]:
```
model.util = Objective(expr = Qsteam + Qcw)
```

Constraints

In [ ]:
```
model.int1 = Constraint(expr = Qsteam - 30 - R1 == 0)
model.int2 = Constraint(expr = 60 + R1 - R2 - 90 == 0)
model.int3 = Constraint(expr = R2 + 70 + 140 - R3 - 105 == 0)
model.int4 = Constraint(expr = R3 + 90 + 180 - R4 - 117 -135 == 0)
model.int5 = Constraint(expr = R4 + 60 + 120 - 78 - Qcw == 0)
```

Solution

In [ ]:
```
results = SolverFactory('glpk').solve(model)
model.pprint()
results.write()
```

```
6 Var Declarations
    Qcw : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 : 225.0 :  None : False : False : NonNegativeReals
    Qsteam : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 :  60.0 :  None : False : False : NonNegativeReals
    R1 : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 :  30.0 :  None : False : False : NonNegativeReals
    R2 : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 :   0.0 :  None : False : False : NonNegativeReals
    R3 : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 : 105.0 :  None : False : False : NonNegativeReals
    R4 : Size=1, Index=None
        Key  : Lower : Value : Upper : Fixed : Stale : Domain
        None :     0 : 123.0 :  None : False : False : NonNegativeReals

1 Objective Declarations
    util : Size=1, Index=None, Active=True
        Key  : Active : Sense    : Expression
        None :   True : minimize : Qsteam + Qcw

5 Constraint Declarations
    int1 : Size=1, Index=None, Active=True
        Key  : Lower : Body             : Upper : Active
        None :   0.0 : Qsteam - 30 - R1 :   0.0 :   True
    int2 : Size=1, Index=None, Active=True
        Key  : Lower : Body              : Upper : Active
        None :   0.0 : 60 + R1 - R2 - 90 :   0.0 :   True
    int3 : Size=1, Index=None, Active=True
        Key  : Lower : Body                      : Upper : Active
        None :   0.0 : R2 + 70 + 140 - R3 - 105 :   0.0 :   True
    int4 : Size=1, Index=None, Active=True
        Key  : Lower : Body                              : Upper : Active
        None :   0.0 : R3 + 90 + 180 - R4 - 117 - 135 :   0.0 :   True
    int5 : Size=1, Index=None, Active=True
        Key  : Lower : Body                      : Upper : Active
        None :   0.0 : R4 + 60 + 120 - 78 - Qcw :   0.0 :   True
```

```
12 Declarations: Qsteam Qcw R1 R2 R3 R4 util int1 int2 int3 int4 int5
# ==========================================================
# = Solver Results                                         =
# ==========================================================
# ----------------------------------------------------------
#   Problem Information
# ----------------------------------------------------------
Problem:
- Name: unknown
  Lower bound: 285.0
  Upper bound: 285.0
  Number of objectives: 1
  Number of constraints: 6
  Number of variables: 7
  Number of nonzeros: 11
  Sense: minimize
# ----------------------------------------------------------
#   Solver Information
# ----------------------------------------------------------
Solver:
- Status: ok
  Termination condition: optimal
  Statistics:
    Branch and bound:
      Number of bounded subproblems: 0
      Number of created subproblems: 0
  Error rc: 0
  Time: 0.10663795471191406
# ----------------------------------------------------------
#   Solution Information
# ----------------------------------------------------------
Solution:
- number of solutions: 0
  number of solutions displayed: 0
```

In [ ]:

```
Qc = value(Qcw)
Qh = value(Qsteam)
print('Cold utility = {0:2.2f}, Hot utility = {1:2.2f}'.format(Qc, Qh))
```

```
Cold utility = 225.00, Hot utility = 60.00
```