

# Cold Chain Energy Week

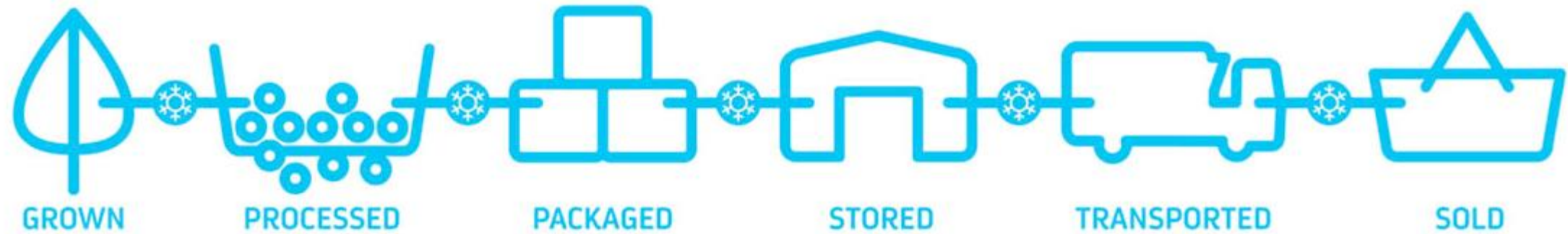
## Day 2

**Dave Pearson**  
**Star Renewable Energy**

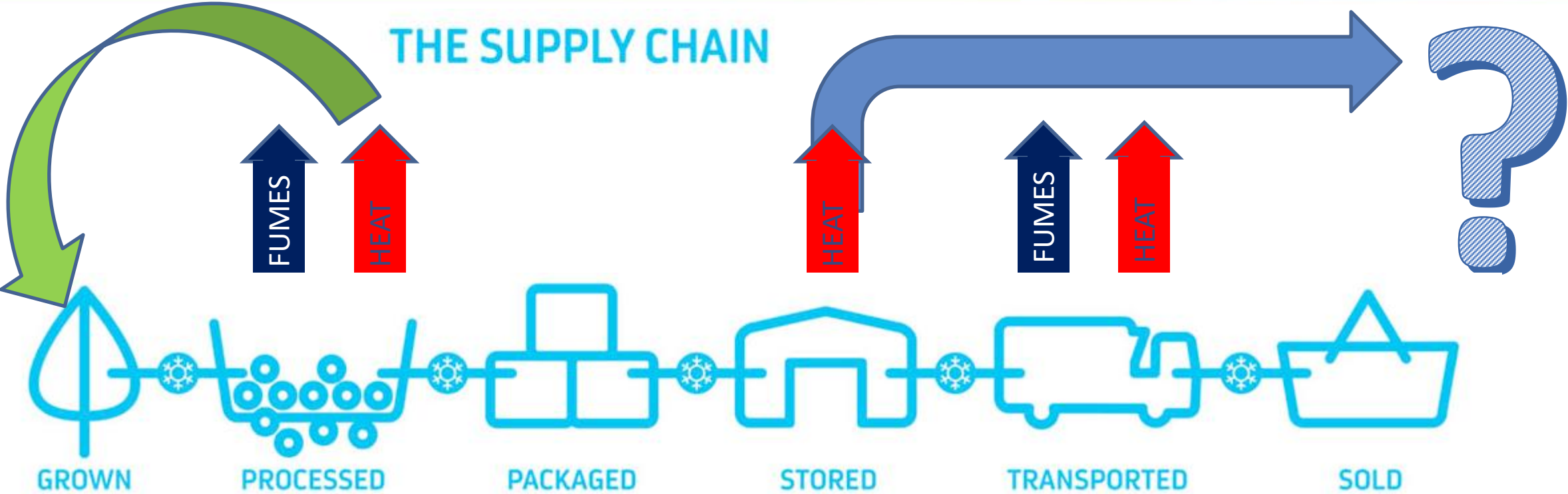


# What is this all about ?

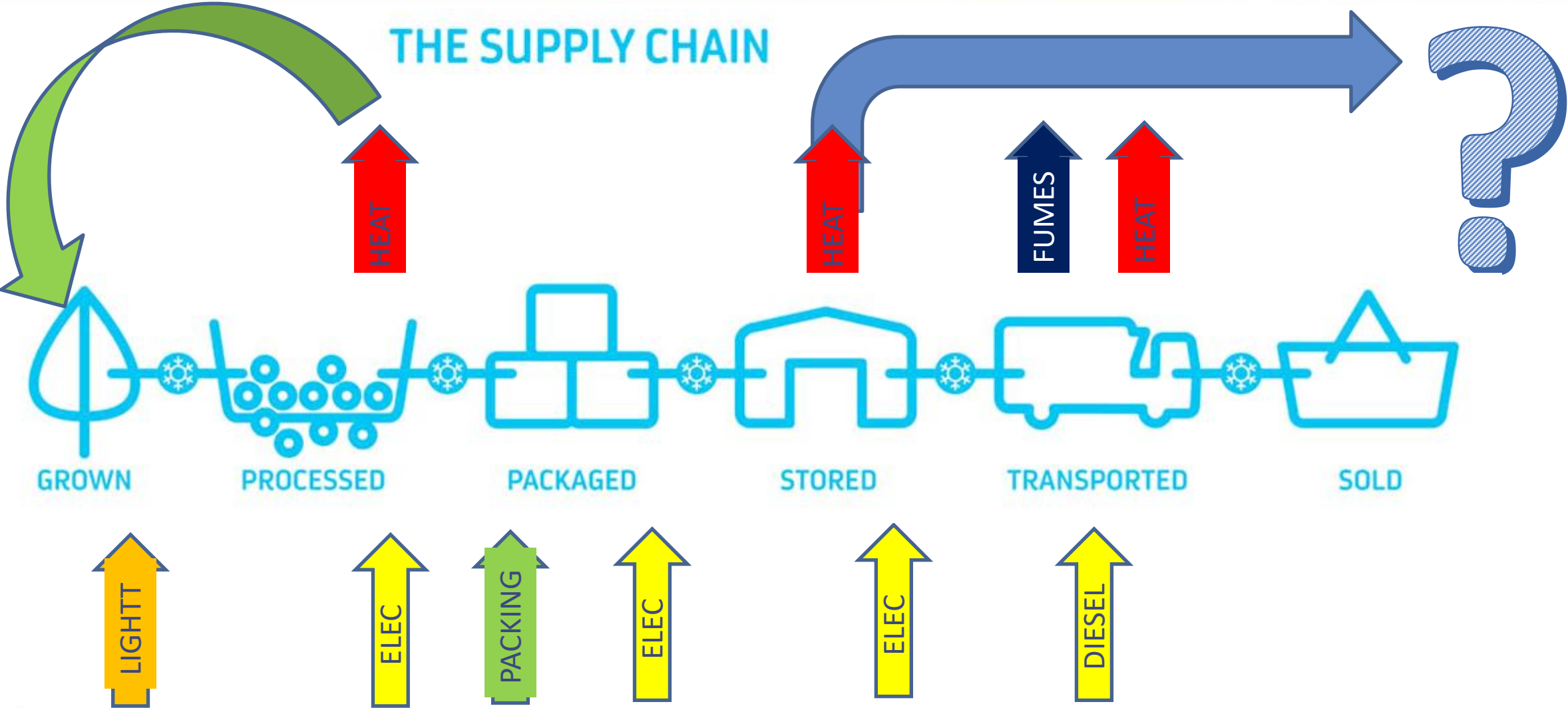
## THE SUPPLY CHAIN



# What is this all about ?



# What is this all about ?



## 4 d Map of (for heating and cooling):

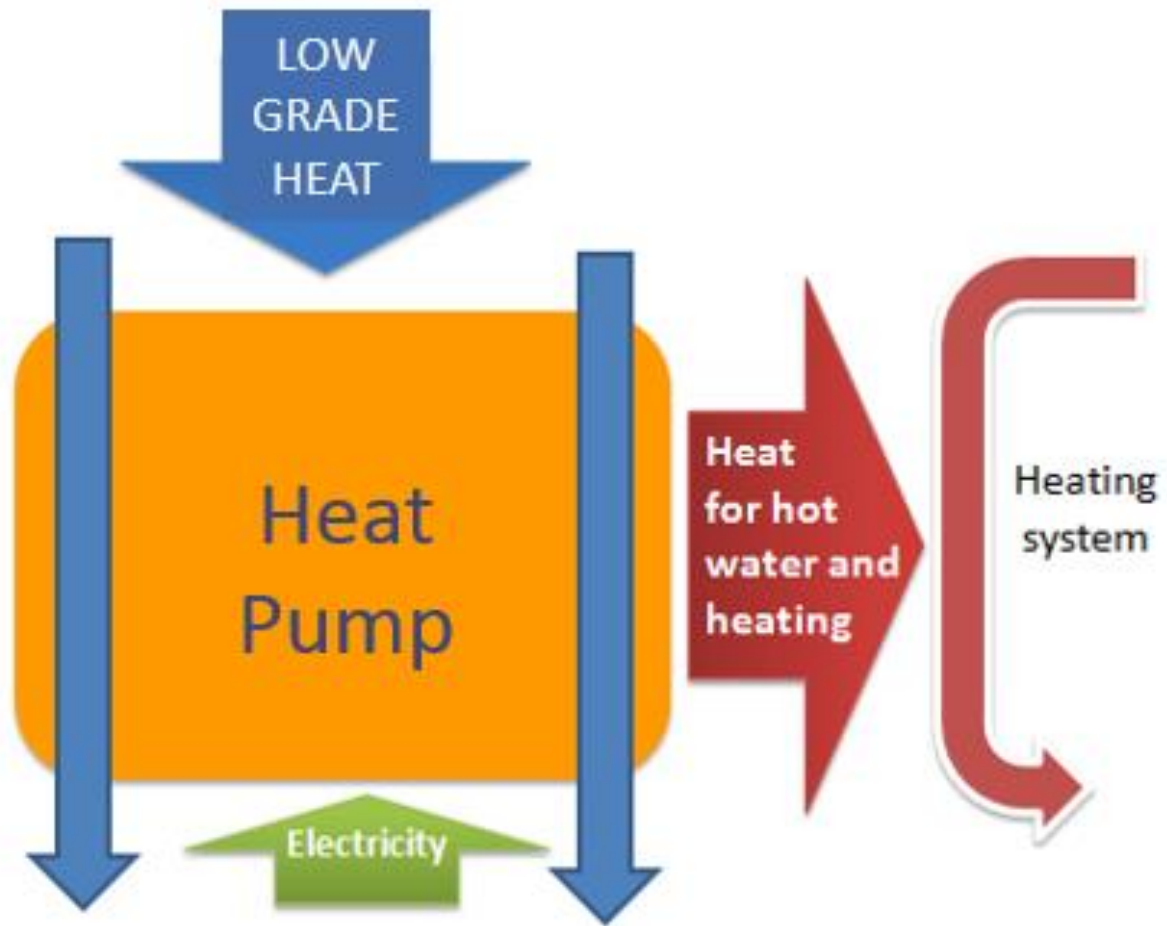


- Location
- Grade
- Time available
- Quantity

## 4 d Map of (for heating and cooling):

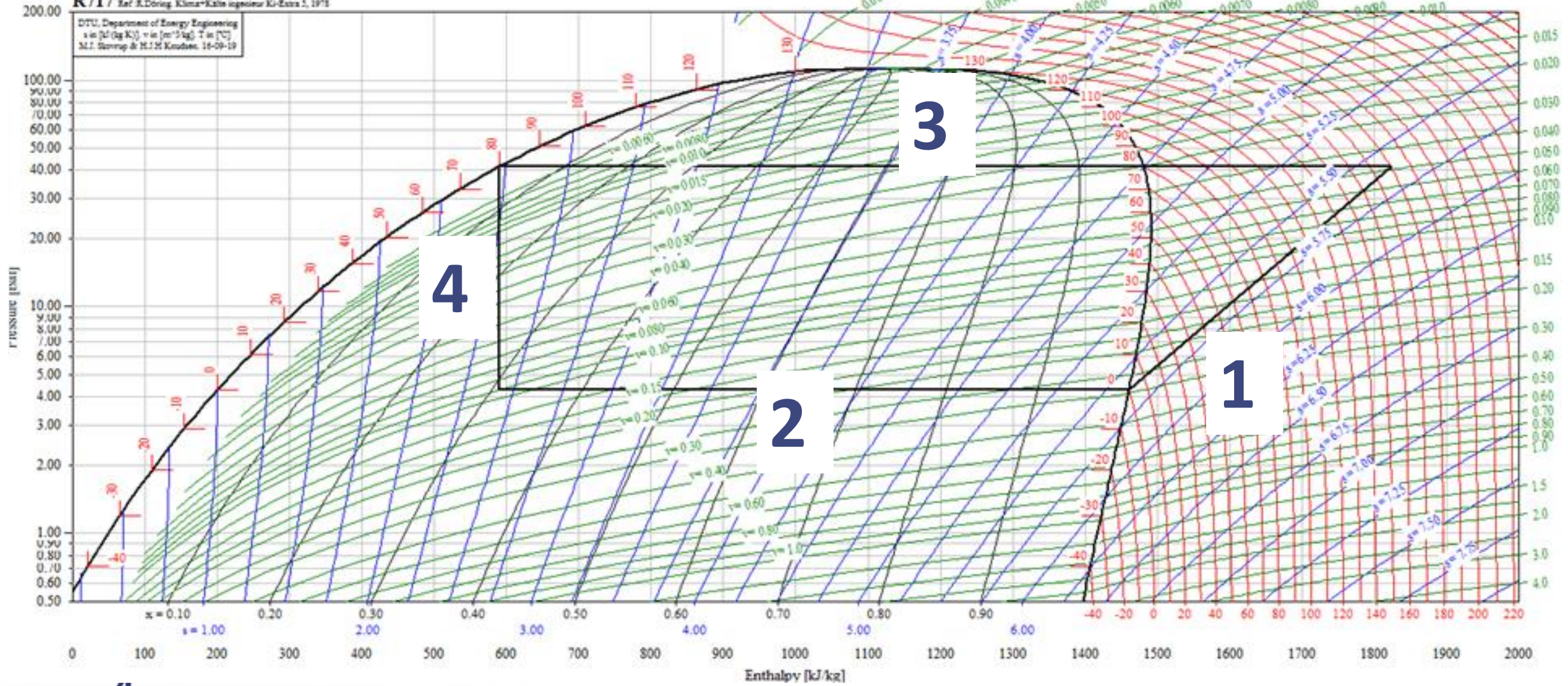


- Location
- Grade
- Time available
- Quantity
- **Match up heating and cooling?**



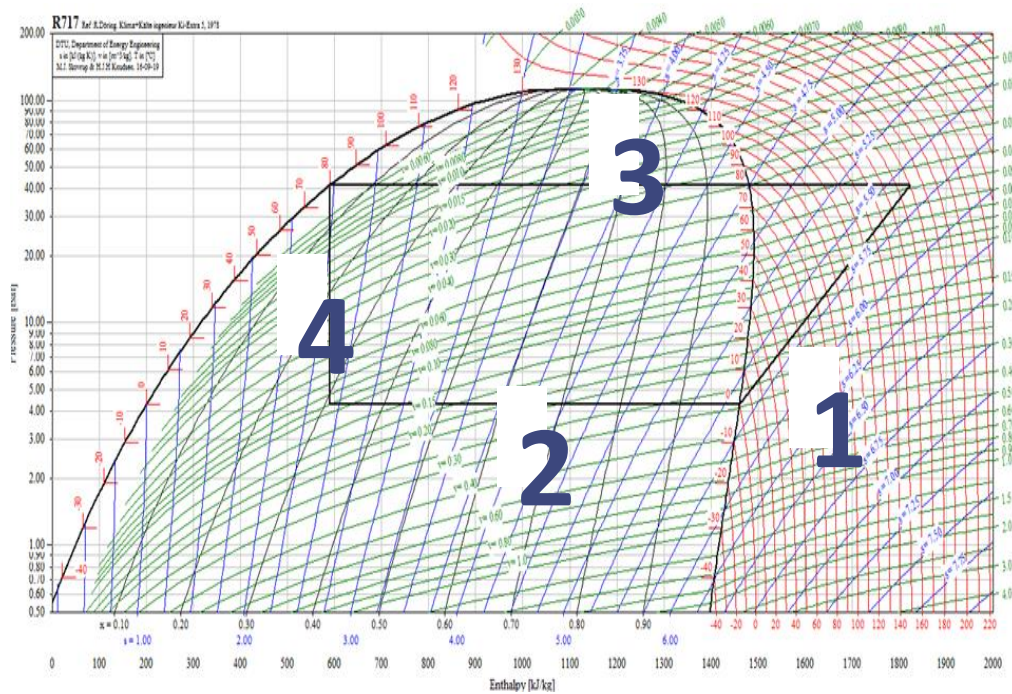
R717 Ref. S.Döring, Klima+Kälte ingenieur Ki-Eutra 2, 1978

DTU, Department of Energy Engineering  
 $\alpha$  in [kJ/(kg K)],  $\nu$  in [m<sup>3</sup>/kg],  $T$  in [°C]  
M.T. Støvring & M.J.M. Knudsen, 16-09-19





# How do we describe efficiency?



## Cooling

- Cooling effect (2) / Work (1) = COP<sub>c</sub>
- (typical chiller will be better)

## Heating

- All cooling PLUS work = Heating
- So heating = cooling + work
- Heating effect (3) / Work (1) = COP<sub>h</sub>

# How do we describe efficiency?

## Cooling (4C to 35C)

COP<sub>c</sub> = 6.08

## Cooling (4C to 20C)

COP<sub>c</sub> = 10.28

Ambient Conditions Condition 1 +

Oil Cooling : Liquid

Flash Economized

Speed

Evap Temperature 4 °C Cond/Inter Temperature 35 °C

Suction Line Loss 0.18 bar Discharge Line Loss 0.5 bar

Superheat (Non-Useful) 0 K Subcooling At Cond 0 K

Superheat (Useful) 0 K

Condition	ET °C	CT °C	% Cap	Capacity kW	Power kW	Qo/Pe	Vi	OCHR (100%) kW	OCHR (Min) kW
1	4	35	100	936.5	154.1	6.08	2.2	25.2	41.5

Ambient Conditions Condition 1 +

Oil Cooling : Liquid

Flash Economized

Speed

Evap Temperature 4 °C Cond/Inter Temperature 20 °C

Suction Line Loss 0.18 bar Discharge Line Loss 0.5 bar

Superheat (Non-Useful) 0 K Subcooling At Cond 0 K

Superheat (Useful) 0 K

Condition	ET °C	CT °C	% Cap	Capacity kW	Power kW	Qo/Pe	Vi	OCHR (100%) kW	OCHR (Min) kW
1	4	20	100	961	93.5	10.28	1.8	0.1	19.6

# How do we describe efficiency?

## Cooling (4C to 35C)

COP<sub>c</sub> = 6.08

154kW<sub>e</sub> = 1090kW<sub>th</sub> (@35C)

Ambient Conditions Condition 1 +

Oil Cooling : Liquid

Flash Economized

Speed

Evap Temperature 4 °C Cond/Inter Temperature 35 °C

Suction Line Loss 0.18 bar Discharge Line Loss 0.5 bar

Superheat (Non-Useful) 0 K Subcooling At Cond 0 K

Superheat (Useful) 0 K

Condition	ET °C	CT °C	% Cap	Capacity kW	Power kW	Qo/Pe	Vi	OCHR (100%) kW	OCHR (Min) kW
1	4	35	100	936.5	154.1	6.08	2.2	25.2	41

## Cooling (4C to 75C)

COP<sub>c</sub> = 1.96

430kW<sub>e</sub> = 1273kW<sub>th</sub> (@75C)

368kW<sub>e</sub> = 1090kW<sub>th</sub> (@35C)

So an extra 214kW gains 1090kW<sub>th</sub> **USEFUL**

COP<sub>hi</sub> = 5.09

Ambient Conditions Condition 1 +

Oil Cooling : Liquid

Flash Economized

Speed

Evap Temperature 4 °C Cond/Inter Temperature 75 °C

Suction Line Loss 0.18 bar Discharge Line Loss 0.5 bar

Superheat (Non-Useful) 0 K Subcooling At Cond 0 K

Superheat (Useful) 0 K

Condition	ET °C	CT °C	% Cap	Capacity kW	Power kW	Qo/Pe	Vi	OCHR (100%) kW	OCHR (Min) kW
1	4	75	100	843.4	430.6	1.96	4.8	294.2	177.8



# How do we describe efficiency?

## Cooling (4C to 75C)

$COP_c = 1.96$

430kWe = 1273kWth (@75C)

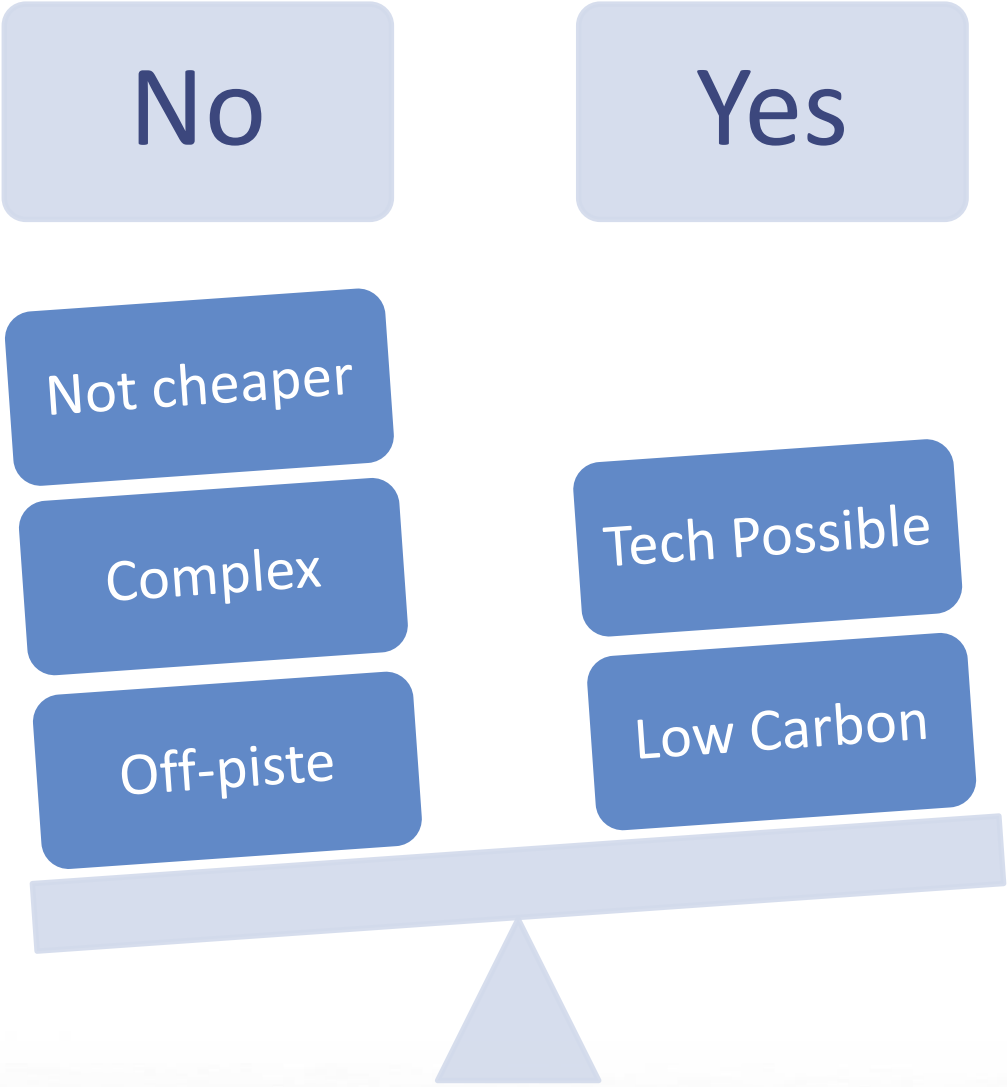
368kWe = 1090kWth (@35C)

So an extra 214kW gains 1090kWth USEFUL

$COP_{\phi} = 5.09$

**HOWEVER..... In winter  
The  $COP_{\phi}$  is 3.26**

# Conclusion- Is heat recovery a good idea.....



But do your homework and gather the data

## 4 d Map of (for heating and cooling):



- Location
- Grade
- Time available
- Quantity

# Questions ??

**Dave Pearson**

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