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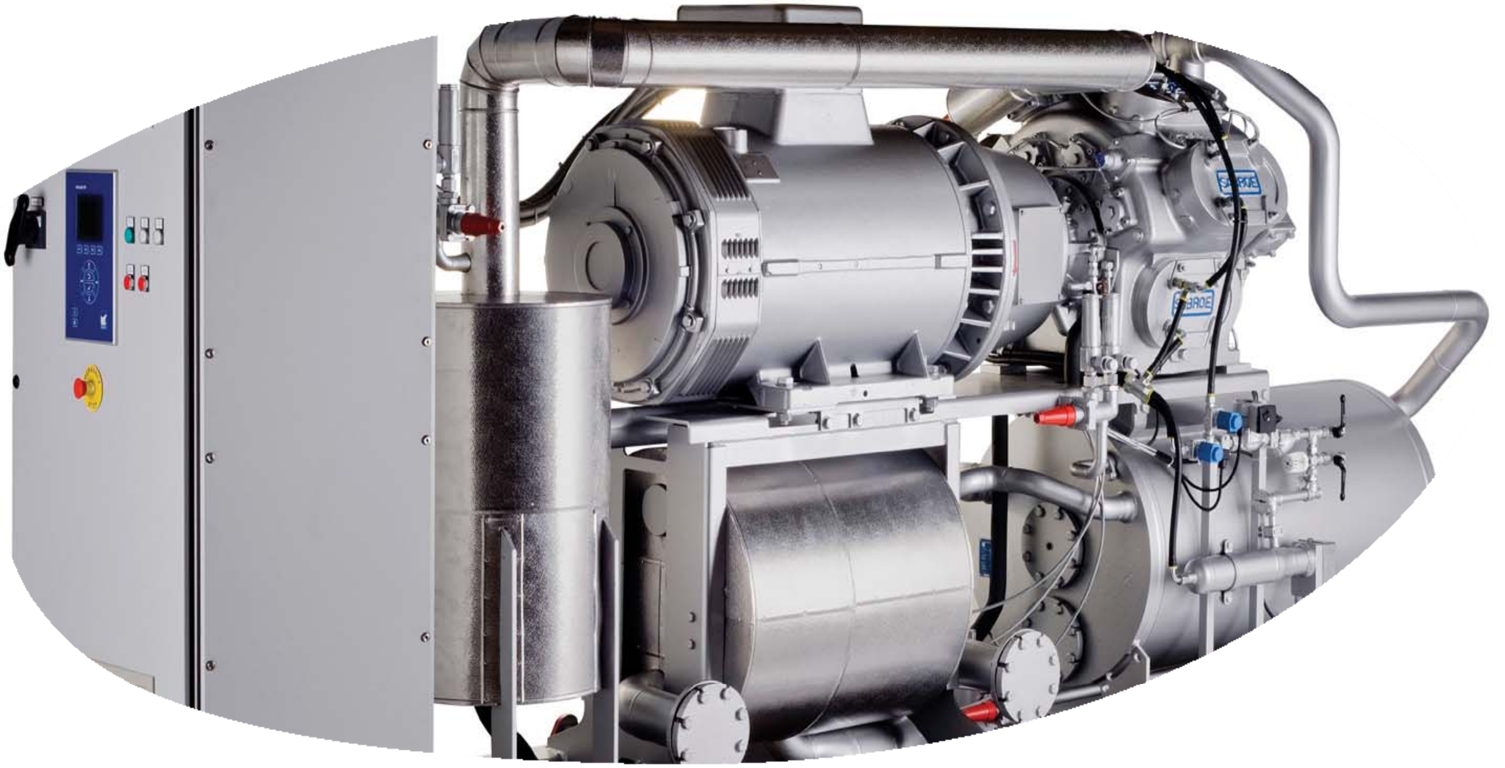
# Packaged ammonia heat pumps



Johnson Controls

# What is a HeatPAC?

A standardized industrial one stage-heat pump

Waste heat from process or condensing heat from existing cooling equipment

+40°C

996 kW

+35°C

Single-stage 8-cylinder compressor heat pump

**COP = 6.4**

Electrical power 185 kW

Hot water for cleaning, or heating purposes

+60°C

1181 kW

+70°C



Johnson Controls

# HeatPAC applications examples

Hot water production for cleaning and heating within the food industry

Condenser heat reclaim from refrigeration systems

Upgrading of industrial waste heat for use in industrial processes, district heating, individual buildings, etc.

Special applications such as wood seasoning, fish drying, exhaust gas cooling in power plants, etc.

Heating in ice rinks or other sporting arenas

Fruit and vegetable, greenhouse heating.

Hot water for baths and swimming pools.

Drying processes

# HeatPAC data

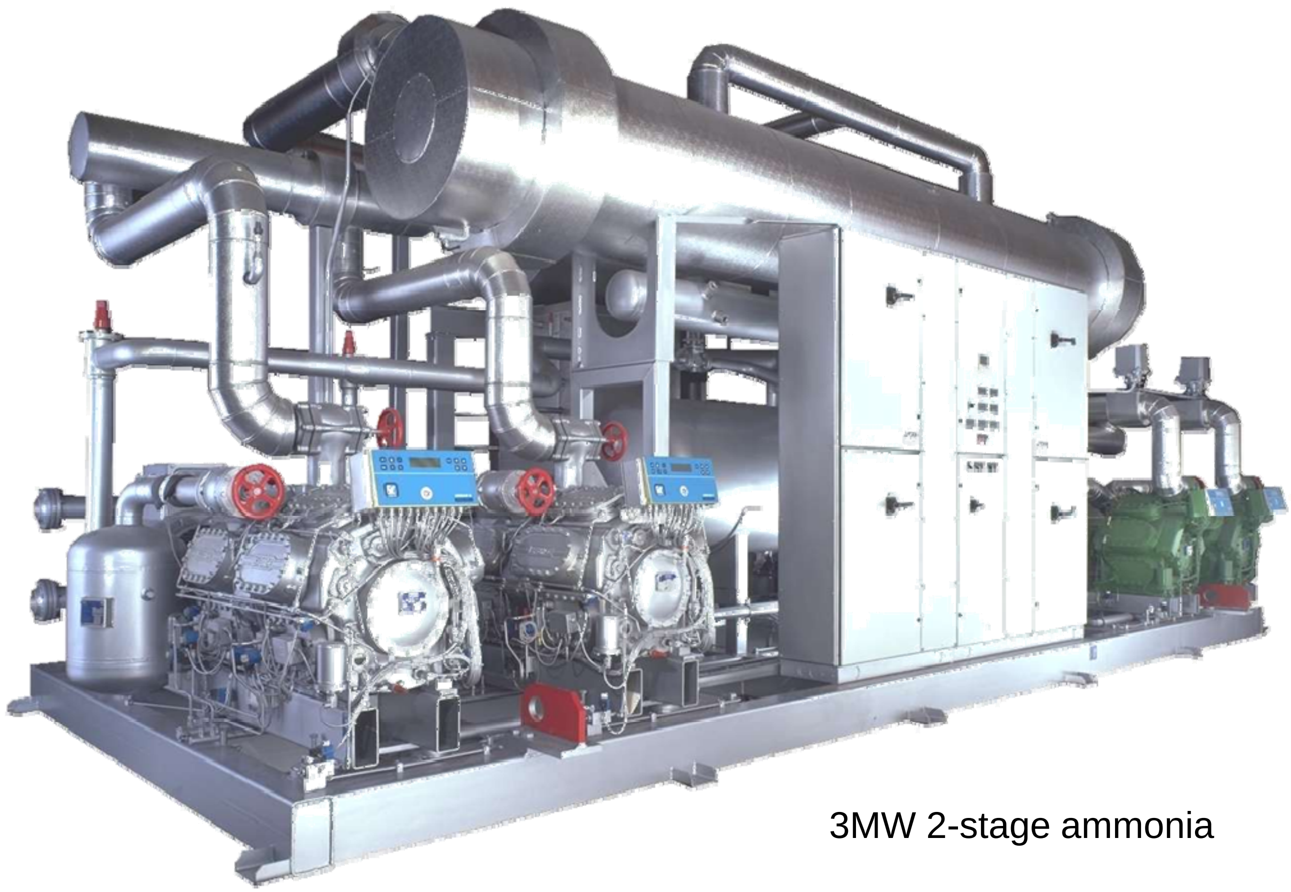
## HeatPAC packaged ammonia heat pumps

Condenser water inlet +64°C, outlet +70°C

Evaporator water inlet +39°C, outlet +34°C

| Type | Heating capacity kW | Cooling capacity kW | Power consumption kW | E-motor size kW | R717 charge kg |
|---|---|---|---|---|---|
| HPAC 24-W | 240 | 202 | 38 | 45 | 20 |
| HPAC 26-W | 359 | 302 | 57 | 75 | 23 |
| HPAC 28-W | 484 | 408 | 77 | 90 | 25 |
| HPAC 104-W | 570 | 478 | 93 | 110 | 28 |
| HPAC 106-W | 852 | 715 | 138 | 160 | 37 |
| HPAC 108-W | 1149 | 965 | 186 | 250 | 48 |

# Two-stage Heat pumps



3MW 2-stage ammonia

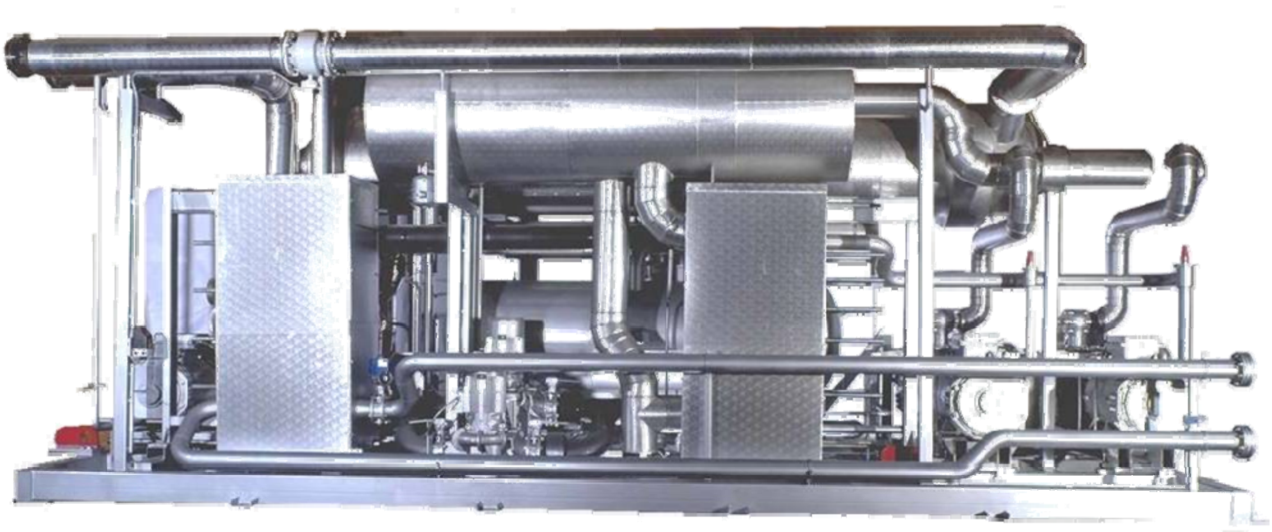
# Two-stage heat pumps

Advantages :

To be used for heating <u>and</u> air conditioning purposes

Ambient air can be a heat source – cooling towers etc.

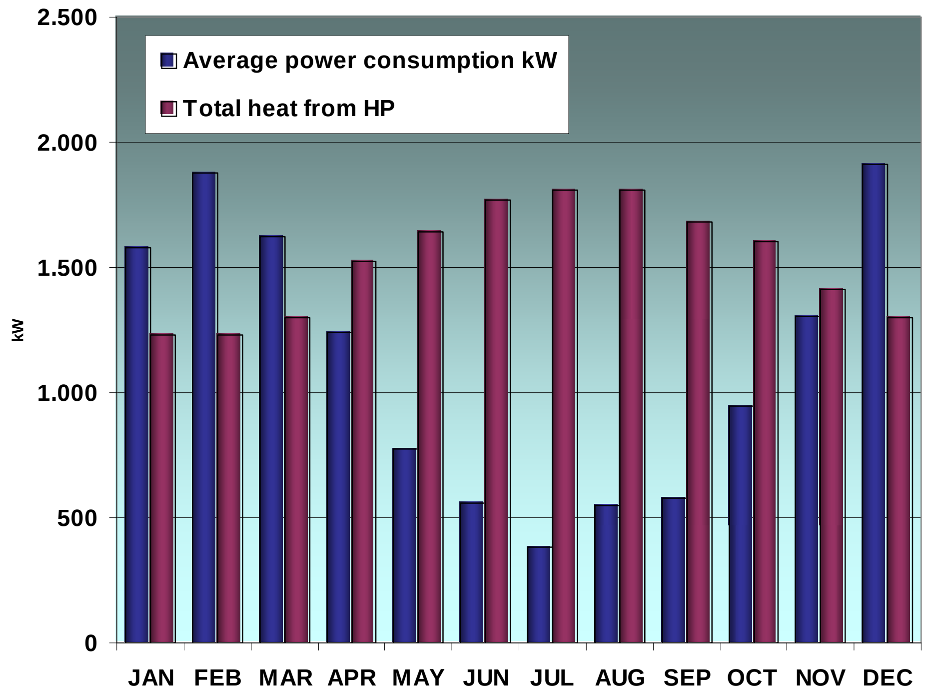
Applications where both heating and cooling are required



# Combine the heat pump with a traditional boiler

The boiler costs are 1/10 of the price of a two-stage heat pump, but the running cost are much higher

The combination is attractive and offers ultimate reliability. It requires careful planning



# Boiler vs. Heat Pump – real considerations

| | | | | | |
|---|---|---|---|---|---|
| Your country | Ukraine | | | Input | output |
| Gas price | 0.028 | €/kWh | | Heat capacity [kWh/m3]: | |
| Heat capacity | 10 | kWh/m3 | | DK | 12 |
| | | | | Russia | 10 |
| | | | | variations | 8.4 to 13 |
| Price of Electric power | 0.10 | €/kWh | | | |
| | Winter | | | Summer | |
| | 100% | | | 75% | |
| Boiler capacity | 1252 | kW | | 715.43 | kW |
| Gas concumption | 125.20 | m3/h | | 71.54 | m3/h |
| Running cost | 34.46 | €/h | | 19.69 | €/h |
| Heat pump capacity | 1252 | kW | COP | 6.71 | - |
| Electricity consumption | 186.5 | kW | Alt. Cap. | 106.57 | kW |
| Running cost | 18.84 | €/h | Alt. Cost | 10.76 | €/h |
| Yearly activity | 5040 | Hours | | 3600 | Hours |
| Saving | 78 754.04 | €/year | | 32 144.51 | €/year |
| Price of heat pump | 150 000.00 | € | | 150 000.00 | € |
| Simple pay back | 1.9 | Years | | 4.7 | Years |
| | | | Combined | 110 898.55 | €/Year |
| | | | | 1.4 | Years |

| | | |
|---|---|---|
| | District heating | |
| | Sales price Summer | |
| | 23.196 | €/Gcal |
| | Sales price Winter | |
| | 55.021 | €/Gcal |
| | Winter months | |
| | 7 | |
| | Summer months | |
| | 5 | |
| | Total | |
| | 12 | |
| 8640 | Hours/year (max 8760) | |
| 5 | Days for Service | |
| | Heat pump price | Installation price |
| | 125 000.00 | 25 000.00 |
| | Cost of installation | Service/year (Apx) |
| | 150 000.00 | 6 000.00 |

# Heat pumps potential of reducing other costs

| | | | | | | |
|---|---|---|---|---|---|---|
| Total | 8 885 623 | kWh per year | Heat Pump | | Boiler | |
| | Sales of heat | | Runing cost | | Runing Cost | |
| | 358 212 | €/year | 139 685 | €/year | 244 584 | €/year |
| | | | Netto earning | | Netto earning | |
| | | | 218 527 | €/year | 113 628 | €/year |
| | | | Payback on investment | 1.46 | Years | |

# Reductions on the low stage

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Total | 8 885 623 | kWh per year | | Heat Pump | | | Boiler | | |
| | Sales of heat | | | Runing cost | | | Runing Cost | | |
| | 358 212 | €/year | | 139 685 | €/year | | 244 584 | €/year | |
| | | | | Netto earning | | | Netto earning | | |
| | | | | 218 527 | €/year | | 113 628 | €/year | |
| | | | | Payback on investment | | 1.46 | Years | | |
| A simple estimate: | | | | | | | | | |
| Savings on the "cold" side | | | | | | | | | |
| | Lower condensing temperature | | | | | | | | |
| | 5 | °C | | | | | Coolinh load | 1000 | kW |
| | Normal power input | | | | | | Condensing load | 1200 | kW |
| | 1200 | kW | 121.2 | €/h | 1 047 168 | €/year | | | |
| | New power input | | | | | | | | |
| | 1020 | kW | 103.02 | €/h | 890 093 | €/year | | | |
| | | | | | 157 075 | €/year | | | |
| | Total savings in runing cost per year | | | 267 973.75 | € | | | | |
| | Payback time | | | 0.6 | Years | | | | |

# Water is an expensive resource

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Total | 8 885 623 | kWh per year | Heat Pump | | | Boiler | |
| | Sales of heat | | Runing cost | | | Runing Cost | |
| | 358 212 | €/year | 139 685 | €/year | | 244 584 | €/year |
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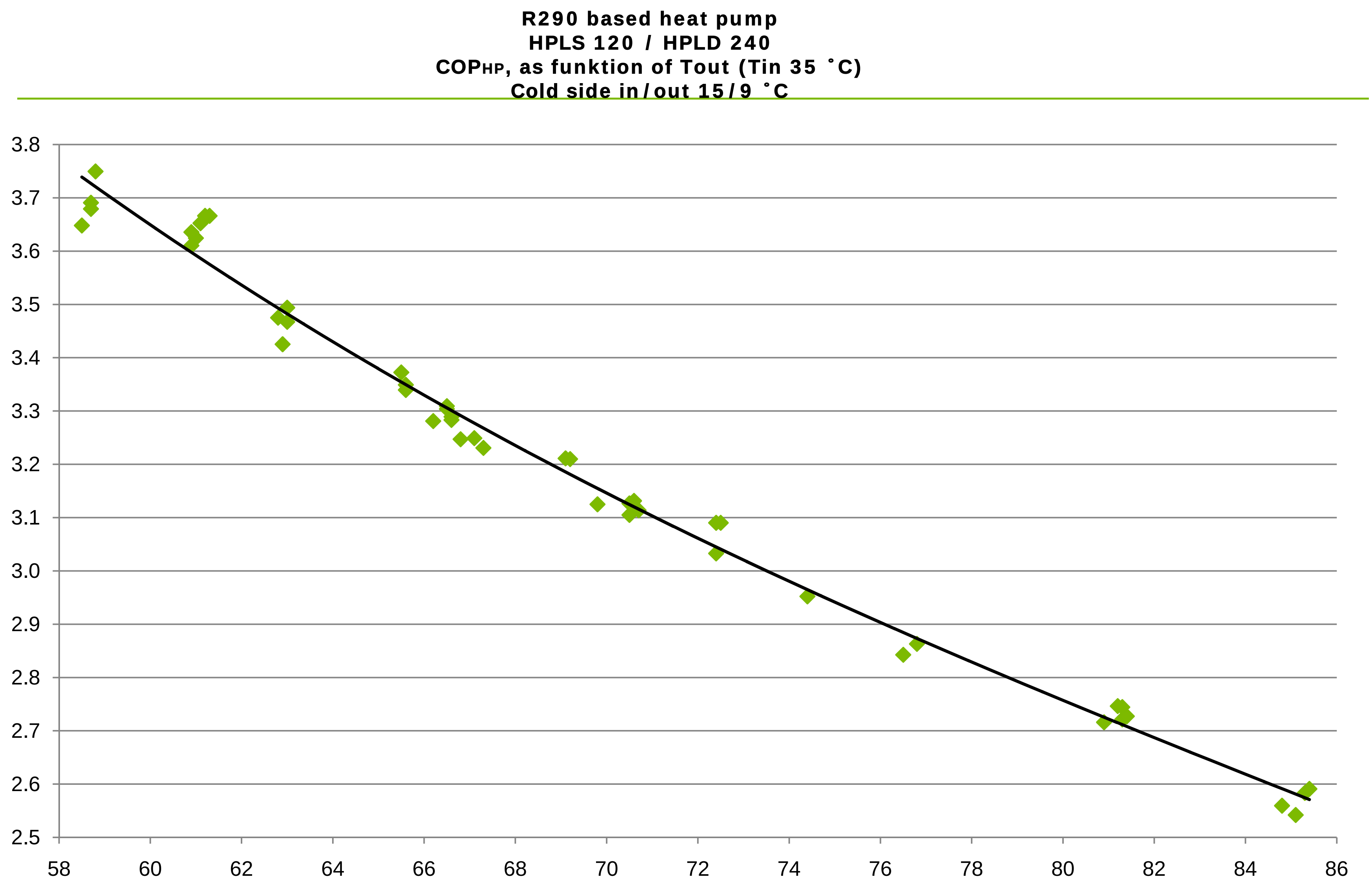
| | Total savings in runing cost per year | | 267 973.75 | € | | | | |
| | Payback time | | 0.6 | Years | | | | |

| | | |
|---|---|---|
| Water consum | 20 000 | m3/year |
| New Water | 19 400 | m3/year |
| Savings | 600 | m3/year |
| Savings Water | 1 200 | €/year |

# Latest data from the lab – Ammonia heat pump

| Heat Source | | | | Medium heated | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Entering temperature | Out going temperature | Cooling effekt | | Entering temperature | Out going temperature | Effect in media | Eletrical effect used | COP heat pump |
| | [°C] | [°C] | [kW] | | [°C] | [°C] | [kW] | [kW] | |
| Water | 40 | 36 | 1175,5 | Water | 40 | 85 | 1511,2 | 335,7 | 4,5 |
| Water | 30 | 26,9 | 911,1 | Water | 40 | 85 | 1233,0 | 321,9 | 3,8 |
| Water | 20 | 17,8 | 680,9 | Water | 40 | 85 | 977,0 | 296,1 | 3,3 |
| Water | 10 | 8,4 | 497,0 | Water | 40 | 85 | 773,1 | 276,1 | 2,8 |


R290 based heat pump
HPLS 120 / HPLD 240
COPHP, as funktion of Tout (Tin 35 ˚C)
Cold side in/out 15/9 ˚C
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
58
60
62
64
66
68
70
72
74
76
78
80
82
84
86

## What are some of the barriers for $NH_3$ heat pumps?

- The general mis-information about ammonia
- The smallest part of the people in the industry work with ammonia
- 90% of the engineers and technicians don't understand the systems
- Consultants and their knowledge about $NH_3$ is the biggest hurdle in many countries
- The opposition use all opportunities to scare customers away from $NH_3$
- $NH_3$ is seen as threat to many in the industry instead of learning it
- Seen as being to expensive
- "The business is too good to be true"

## Challenges

Insufficient level of heat pump technology awareness, even in the refrigeration industry.

Financing is difficult

Political issues

Can be difficult to market without government support

There are no significant technical problems which work against an increased use of ammonia heat pumps.

# Thank you for your attention