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De - central and central HEAT PUMPS for buildings

Still with or without HFC´s?

Menno van der Hoff

1988 First ground source private heat pump

1995 VRF systems

1999 Air to Water heat pumps

2001 CALORIS Water sourced heat pump WRF system

2002 European Patent on decentral + central heat pump

2005 Adiabatic industrial cooling system

2009 Propene natural refrigerant WSHP unit (HFC-free) HP awards

2010 Phase Change Material completion + EIA approval

2013 New method for heating and cooling a building

MENNO VAN DER HOFF

International product manager HVAC

Lives in	Nijmegen – NL
Born;	20 jan 1963
Member	NVKL and KNVvK
Chairman of	NVKL - KANS
Several	papers / patents
	intern. Honours / awards

Specialties:

- Design & application green low energy climate systems,
- building environment energy saving systems
- Electrical heat pump – air and water sourced
- Thermal energy storage
- Sustainability, near to zero energy buildings
- Future trends

More : see

nl.linkedin.com/in/mennovanderhoff/

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OUR HVAC challenge:

Large buildings with Triple A Energy label

• *use Trias ENERGETICA*

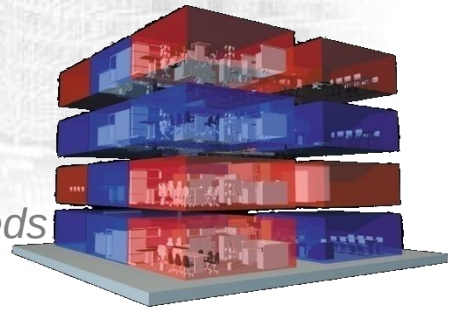
• *use Sustainable energy ONLY….*

The solution: Heat Pump

• *near to zero energy building designs*

result: Heating load decreases but
Cooling load may TRIPLE

HINT: Transfer & Store thermal energy freely around in place AND in time



• *Users have different climate needs*
• *mutual heating and cooling*

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2011 EU SALES VRF Systems

121600 outdoors & > 1 mio. Indoors

Source: JARN 2012 Tokyo

	2011	2010	2009
Italien	16.000	17.000	10.500
Türkei	15.000	9.000	7.900
Frankreich	14.000	13.000	11.400
Großritannien	12.500	14.000	14.000
Russland	12.300	8.500	4.700
Spanien	10.000	14.000	18.000
Deutschland	10.000	8.700	9.000
Griechenland	4.000	4.000	4.400
Summe	93.800	88.200	79.900

Tabelle: Die stärksten europäischen VRF-Klima-Nationen in den Jahren 2009 bis 2011. Die Zahlen für die Jahre 2009 und 2010 basieren auf den von der Redaktion von cci Zeitung analysierten Jarn-Statistiken der Vorjahre. Leider enthält der Jarn-Report 2011 keine Verkaufszahlen für VRF-Außengeräte in Spanien, Deutschland und Griechenland. Diese wurden von der Redaktion von cci Zeitung geschätzt.

BOOMING 8 % annual growth

The Asian VRF invasion

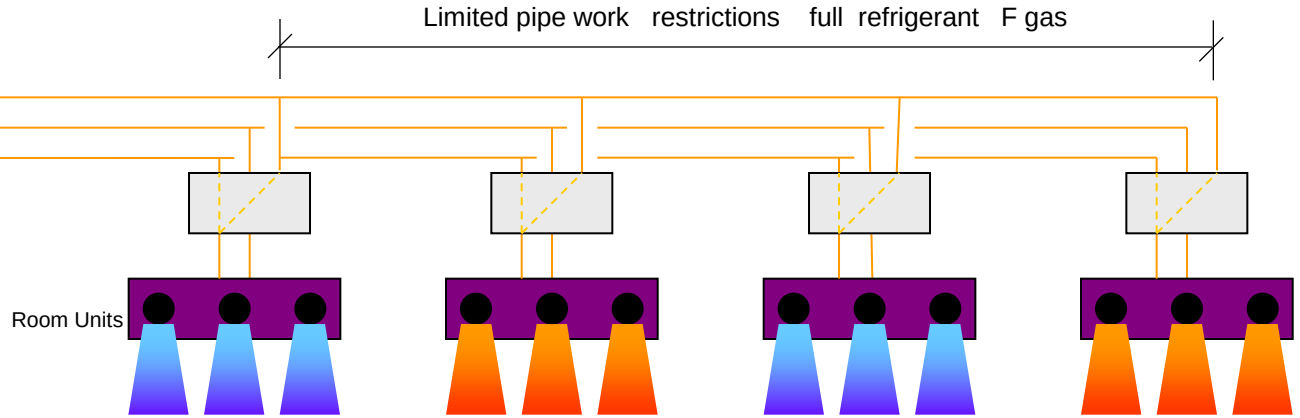
Advantages

Simple design – one supplier

One system for heating and cooling / 64 indoor units

Accepted technology

Heat reclaim - only if simultanuous heating & cooling present



Disadvantages

Installation of pipework & units in building => Risk of leaks

Refrigerant over full pipework and system => Higher charges

Restrictions on length of pipework - **leak** detection to EN 378

Small site leaks hard to trace -> ignored?

Refrigerant (R 410A) high G W P

Training & high qualification staff

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These VRF refrigerant options also have a problem:

1. R410A GWP 1710 class A1 risk of phase down / BAN / **phase out after 2020** ?
2. R32 GWP 675 class A2/A2L mildly **FLAMMABLE** refrigerant
3. R290 GWP 3 class A3 propane high **FLAMMABLE** not suitable for VRF
   indoor: only small (split) systems
4. HFO GWP < 10 class A2/A2L mildly **FLAMMABLE** environmental / safety concerns
   (2012 Kauffeld et al) (Toyota / Daimler)
5. CO_2 GWP 1 **lower EER & COP** safety risk when leaking inside building (suffocation)
6. L41 GWP 461 class A2/A2L mildly **FLAMMABLE** (68% R32 / 29% R1234ze / 3% R600)
7. HYBRID : any of the above & water for local transport of energy ; **EXERGY LOSSES**
8. **? ? ? ? Does anyone in the audience has the ideal answer ? H a n d s u p !**

-> VRF into trouble .....?

-> Need for alternative heat pump solutions

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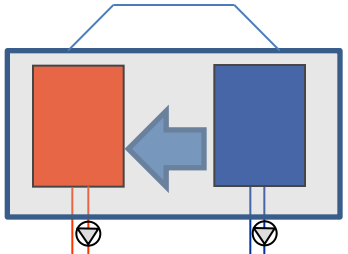
CENTRAL heat pump systems:

Back to Fan Coils ?

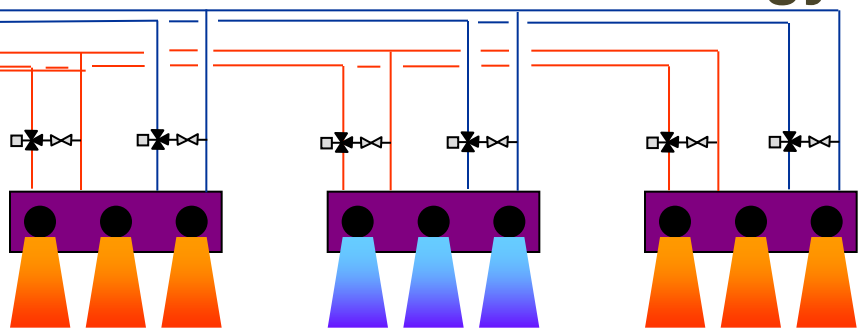
4 Pipe System

indirect heating / cooling



HFC or natural?

It is smart to transfer HP energy



Disadvantages

Installation cost of pipework - still 4 pipes to be insulated

No heat reclaim standard , but can be option

Often separate generation of thermal energy – thermal losses

Advantages

Proven technology + **OPTION for Natural Refrigerant**

Variable capacity control – efficiency improves in part load

Well known and applied - low refrigerant charges

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HC central units are widely available (also for NH_3 and CO_2)

DK > 1000 units 40kW - 400kW.

Low gas charge (5 ~ 25 kg propane)

SABROE BY JOHNSON CONTROLS

Johnson Controls

GEOCLIMA PROFESSIONAL AIR CONDITIONING

tricoolthermal

COFELY GDF SUEZ

EMICON AIR CONDITIONING AND INDUSTRIAL APPLICATION

SORRY: this list is incomplete, many more manufacturers come in!

GEA

Bundgaard

EK EUROKLIMAT®

Danfoss

SRS part of the Frigadon group

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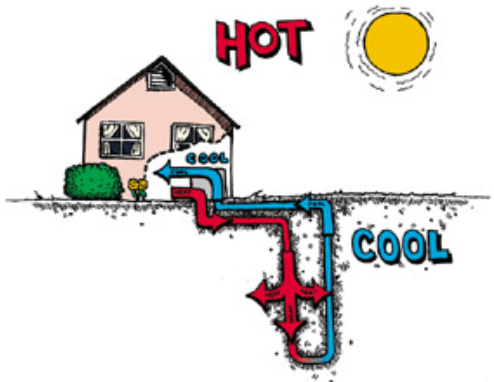
DECENTRAL Heat Pumps

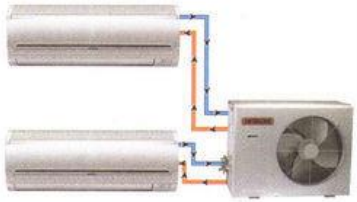
(most on HFC, a Growing share for Natural refrigerants)

Ground source HP

Thermal mass helps performance



Split - HP

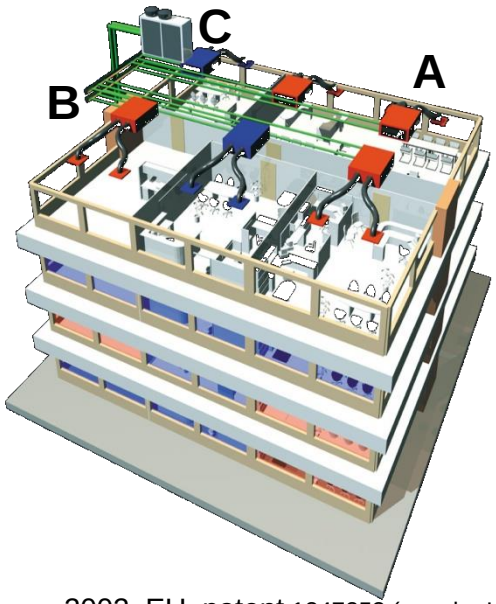


WSHP - system

A: Local Heat pumps in all rooms
(**W**ater **S**ourced **H**eat **P**ump)

B: 2 pipe **water** loop + BUFFER
(between 16 ~ 28 'C)

C: Central heat pump
(air to water)



2002 EU patent 1347253 (van der Hoff)

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HVAC-market needs a new solution

Suitable for - natural refrigerant
- large buildings

• 2020 says Energy-Zero:	Near to zero Watts of local energy consumption
• COP / EER demands rise:	New development of central hydraulic heat pump design
• HFC = phased out ?	Central units suitable for larger capacities & heat pumps
• F-gas proposal	2020: high GWP F-gas banned in HVAC products …?
• SEER / SCOP values rise	Hydraulics will do better – added with local thermal storage
• Local Energy storage is inevitable	store in the central HP and/or large thermal Ground source
• Ground source is growing trend	Combine air sourced and ground sourced -JOIN this trend!
• But comfort has to increase:	silent, unnoticeable and modulating heat pump operation
• Profit, margin and risk of failure	plug and play design – no commissioning – idiot proof
• Higher heat transfer – lowèst charge	Invest in superb design of components
• Combine known technologies smarter	Interested?

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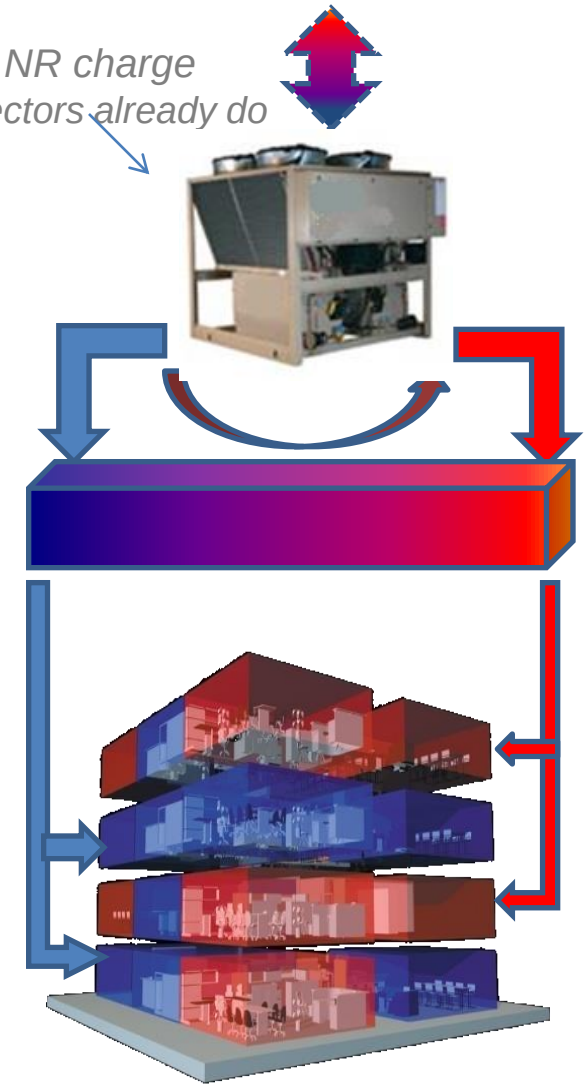
the natural HVAC alternative:

For large buildings aiming for A +++ label

Central Heat Pump small NR charge
forget HFC –> as all other sectors already do

Transfer & Store thermal energy in place AND time



Chilled water

Heated water

Thermal storage

Water hydraulic piping

Cooled rooms

Heated rooms

Heating and cooling load differs in time and place

SUMMARY AND CONCLUSIONS

- Large buildings need mutual cooling & heating / Cooling demand triples !
- VRF 8% annual growth , but facing a refrigerant image
- BANS are coming – problem for HVAC / VRF
- Decentral NR heat pumps OK for small systems. Not for large multisplits
- Large and small HVAC units are widely available on natural refrigerants.
- High SEER and SCOP requires a smart HP design and more thermal storage
- Water is a safe and natural high thermal capacity fluid to heat and cool
- Reuse energy from both sides of the HP process just doubles your COP
- Internal storage for a mismatch in local time / load patters
- THE full NATURAL solution for building HEAT PUMPS IS NOT IMPOSSIBLE !

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Thank you very much!