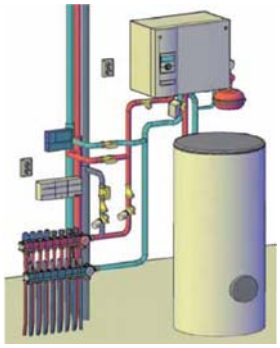
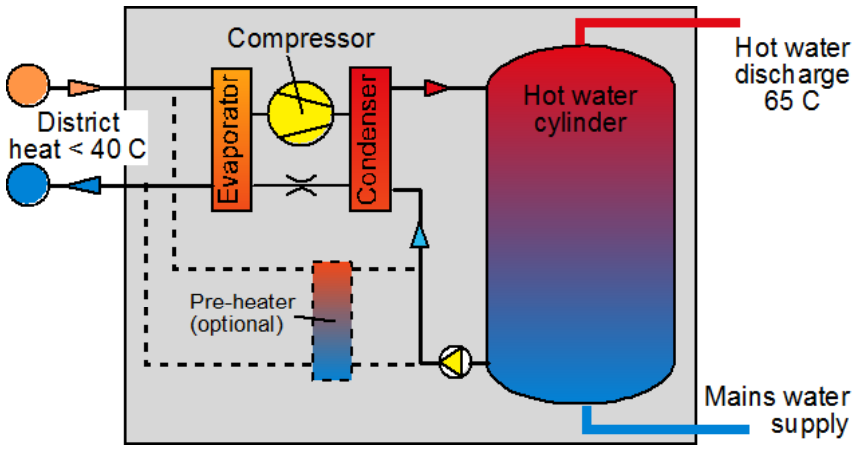
Booster Heat Pump



Annex 46 Meeting, February 11, 2016

Netherlands Enterprise Agency / Entry Technology Support BV

Schematic



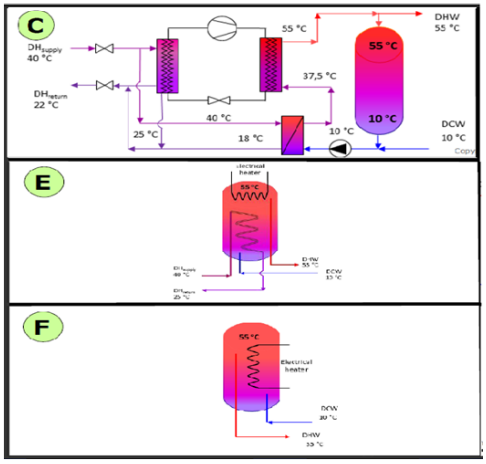
Drivers Booster Heat Pump

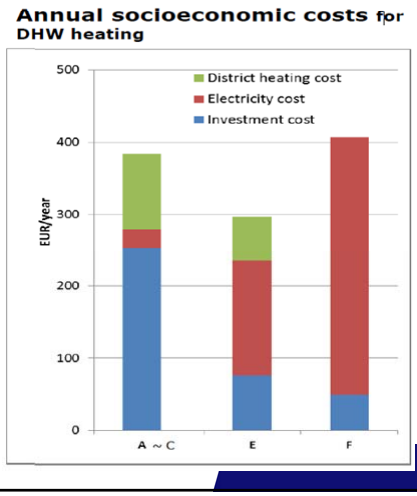
Drivers:

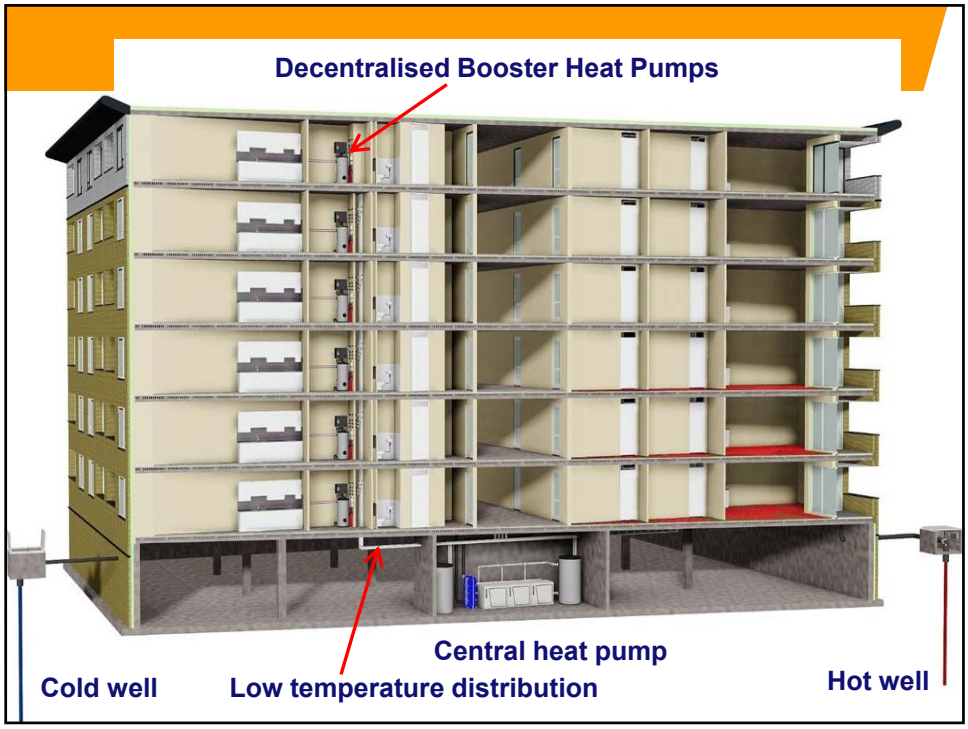
1. On the spot DHW preparation, reduction of distribution losses
2. 2nd law optimisation (dedicated heat pump operation, only for high (DHW) discharge temperatures)
3. Reduction of supply temperature, increased performance of source generator efficiency (e.g. Solar)
4. DHW preparation e.g. by space cooling

Reference: Alternatives Hot Water preparation

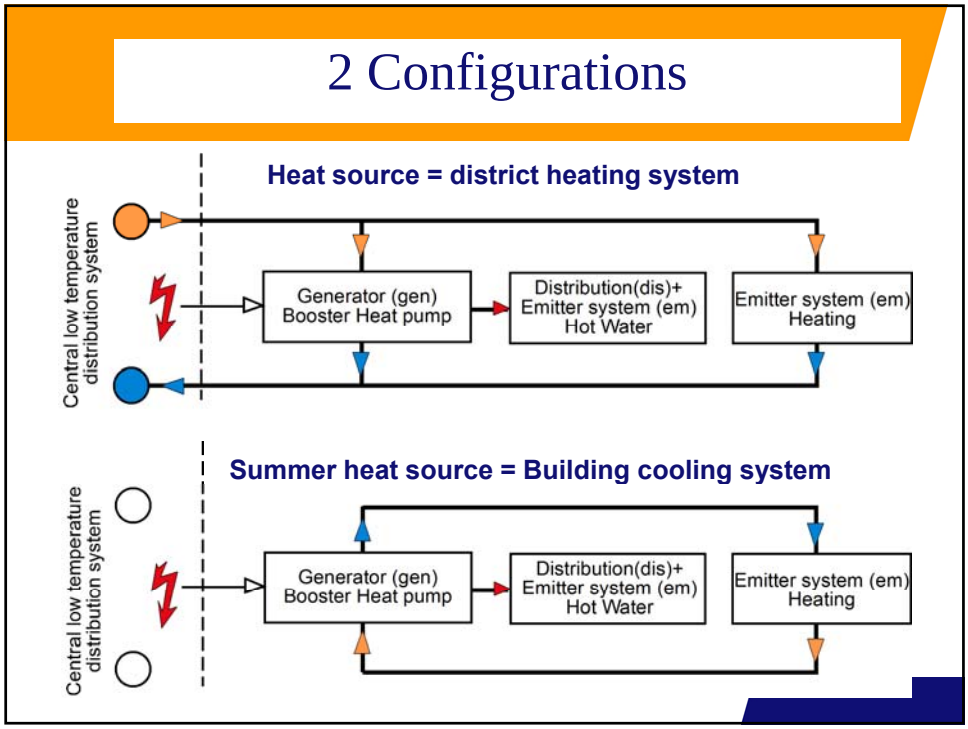
DANFOSS, LOW TEMPERATURE DISTRICT HEATING CONSUMER UNIT WITH MICRO HEAT PUMP FOR DOMESTIC HOT WATER PREPARATION, E.Zvingilaite et al.,







2 Configurations



Energy Performance Standard ?

Key parameter: Equivalent Generation Efficiency for Hot Water, including district energy infrastructure (dei):

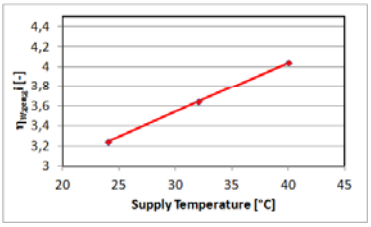
$\eta_{W;gen;equiv;tot}$

$$\eta_{W;gen;equiv} = \frac{\text{Total heat supplied @ Water heating system}}{\text{All primairy energy needed (electricity + heat, incl loss)}}$$

$$\eta_{W;gen;equiv} = \frac{\sum_{zi}\sum_{mi} Q_{W,dis,nren}}{E_{W;el} \; x \; f_{P;del';el} + E_{W;dh} \; x \; f_{P;del';dh} + E_{W;aux} \; x \; f_{P;del';el}}$$

Input:

1. Measured performance of Booster heat pump



2. Temperature level and generator efficiency of district heating system, including losses
3. Hot water demand
4. Optional: Cooling load of the building

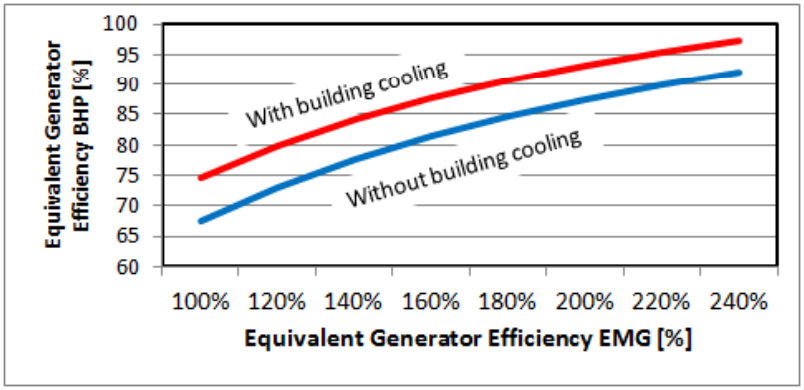
Spreadsheet

Residential Booster Heat Pump with Thermal Energy Supply from District Heating and Builing Cooling

			Month	JAN	MEI	JUN	JUL	AUG	SEP	DEC	
			Temperature [C]	2,6	13,3	16	17,4	17,4	14,6	4	sums
Usefull area	Ag;zi	150	Mseconds	2,6784	2,6784	2,592	2,6784	2,6784	2,592	2,6784	31,536
Building units	NW;zi	1	Mseconds	2,6784	2,6784	2,592	2,6784	2,6784	2,592	2,6784	31,536
Total DHW Heat Load (W)	QW;nd		[MJ/month]	727,45	727,45	703,99	727,45	727,45	703,99	727,45	
Emitter efficiency	ηW;em	1	[-]								
Distribution system efficiency	ηW;dis	0,742	[-]								
Total DHW Heat Load (W)	QW;dis;nren		[MJ/month]	980,40	980,40	948,77	980,40	980,40	948,77	980,40	1,15E+04
DH-supply Temperature	ϑdh;supp		[°C]	27,44	21,02	20,00	20,00	20,00	20,24	26,60	
COP Booster (incl ls, @ 14000 MJ)	ηW;gen		[-]	3,41	3,09	3,04	3,04	3,04	3,05	3,37	
COP Booster (excl ls, @ 14000 MJ)	ηW;gen			3,86	3,45	3,39	3,39	3,39	3,40	3,80	
COP Booster (incl ls, @ actual MJ)	ηW;gen			3,33	3,02	2,97	2,97	2,97	2,99	3,29	
Heat Load Booster (BHP thermal energy need)				686,01	656,17	629,85	650,85	650,85	631,08	682,43	7,84E+03
Summer Comfor Cooling ηC;gen;St	QC;nd;zi,mi		[MJ/month]	0,00	4,00	341,00	796,00	622,00	8,00	0,00	1,77E+03
Energy W (drawn from dh)	QW;dis;nren		[MJ]	686,01	652,17	288,85	0,00	28,85	623,08	682,43	6,21E+03
El. Booster	EW;gen;el		[Mje]	294,39	324,23	318,92	329,55	329,55	317,69	297,97	3,71E+03
Specific power circulation pump	PC;aux;ngen;spec	2	W/m2								
On-time circulation pump	tC;on;mi		[Ms]	0,00	0,00	0,23	0,43	0,41	0,01	0,00	1,08E+00
Auxiliary energy circulation pump:	WC;aux;ngen;mi			0,00	0,01	0,45	0,87	0,83	0,01	0,00	2,17E+00
Remaining Cooling load	QC;nd;zi,mi*		[MJ/month]	0,00	0,00	0,00	145,15	0,00	0,00	0,00	1,45E+02
EMG Equiv. Gen Eff. (H+W)	**ηH+W;gen;equiv;tot**	**150%**									
Etot,pr,el		9,49E+03	[MJ/an]								
Etot,pr,q		4,14E+03	[MJ/an]								
Equiv. Gen Eff. (H+W) BHP	**ηW;gen;equiv;tot**	**84,67%**									
Equiv. Gen Eff. Cooling	**ηC;gen;equiv**	**3660,28%**									

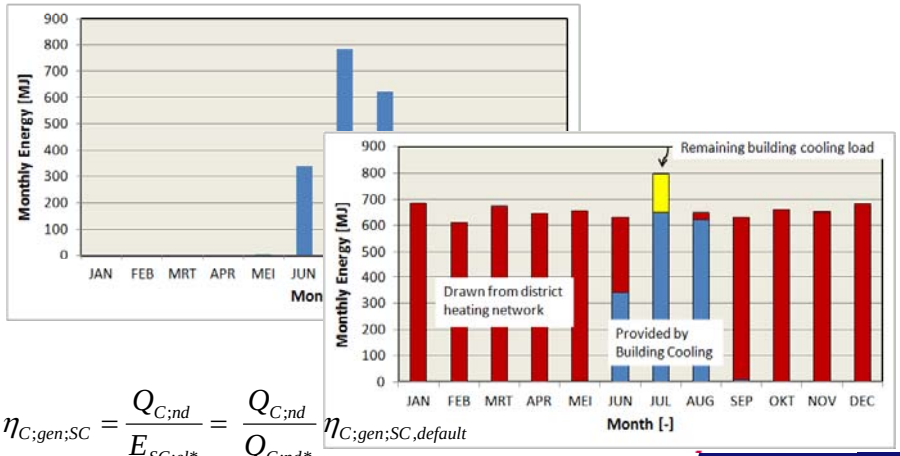
Testresults	
QW;dis;nren	14000
T [C]	COP
24	3,24
40	4,04
EW;el;ls;tst	15

Results



Booster heat pump efficiency, with and without building cooling, depending on district heating generation efficiency, for A_g=150 m^2, COP=4,04 @14000 MJ.

Optional bonus (Free cooling):



$$\eta_{C;gen;SC} = \frac{Q_{C;nd}}{E_{SC;el*}} = \frac{Q_{C;nd}}{Q_{C;nd*}} \eta_{C;gen;SC,default}$$

Conclusions:

1) Calculation procedure Booster heat Pump established & effectively standardised
2) Effect on Energy Performance identified
3) Including summer cooling
4) Booster Heat Pumps now on the market

Closure

With acknowledgment to:

Thanks for your attention

J. van Berkel,

Entry Technology Support BV

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