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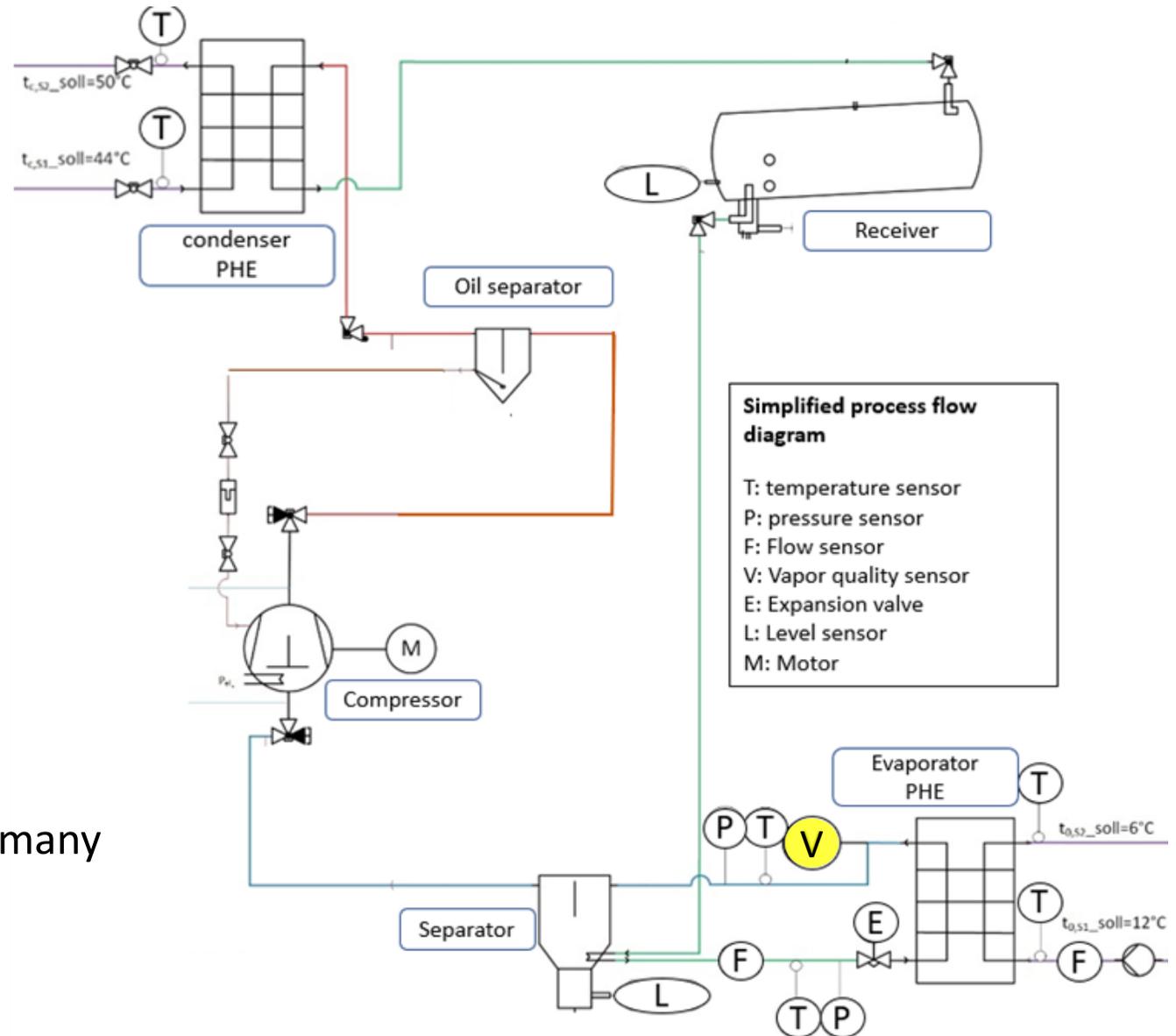
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**Large SEPR and COP  
improvement obtained by  
controlling an ultra-low-  
charge DX chiller using a  
vapor quality sensor**



# Simplified diagram

- Equipped with both
  - Superheat control
  - Vapor quality control
- 100 kW chiller 7/12°C
- 4 kg Ammonia
- Tested at Hochschule Karlsruhe, Germany
- Designed by Fischer Kälte, Germany



# ECOdesign and SEPR requirements

(Seasonal Energy Performance Ratio)

## ECOdesign

(EC directive)

SEPR process chillers

SEER comfort chillers

SCOP heat pumps

High temperature process chillers	From 01/2018	From 01/2021
	SEPR 12/7"	SEPR 12/7"
Air cooled < 400 kW	4,5	5,00
Air cooled 400 to 2000 kW	5,00	5,50
Water cooled < 400 kW	6,50	7,00
Water cooled 400 to 1500 kW	7,50	8,00
Water cooled 1500 to 2000 kW	8,00	8,5

Measured values for ammonia-based chiller					
	SEPR	Full load COP	Part load COP	Unit	Yearly energy consumption
Superheat 8K control	5.6	3.9	6.9	kW/kW	91.086 kWh
Vapor Quality control	8.2	4.7	10.5	kW/kW	63.140 kWh
Improvement	46	21	51	%	27.946 kWh

# SEPR improvement on DX chiller

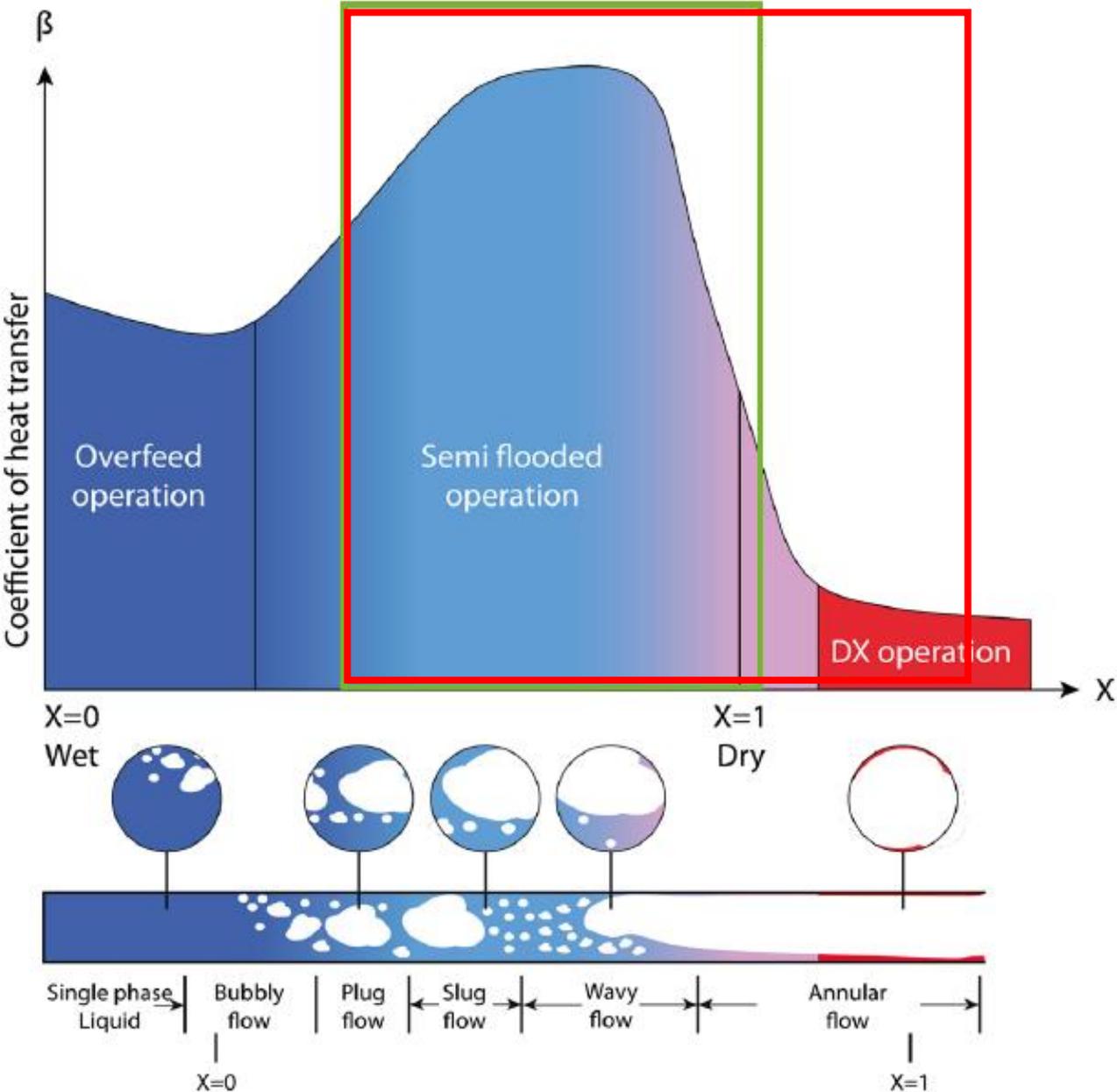
(Seasonal Energy Performance Ratio)

	SEPR	Point A	Point B	Point C	Point D
<b>Outdoor temp °C</b>		<b>30</b>	<b>23</b>	<b>16</b>	<b>9</b>
<b>Load %</b>		<b>100</b>	<b>93</b>	<b>87</b>	<b>80</b>
<b>Cooling capacity Superheat 8K control</b>		<b>76</b>	<b>72</b>	<b>66</b>	<b>61</b>
<b>Power consumption Superheat 8K control</b>		<b>20</b>	<b>15</b>	<b>11</b>	<b>9</b>
<b>COP Superheat 8K control</b>	<b>5.6</b>	<b>3.9</b>	<b>4.7</b>	<b>5.9</b>	<b>6.9</b>
<b>Cooling capacity Vapor Quality control</b>		<b>79</b>	<b>65</b>	<b>61</b>	<b>56</b>
<b>Power consumption Vapor Quality control</b>		<b>17</b>	<b>11</b>	<b>8</b>	<b>6</b>
<b>COP Vapor Quality control</b>	<b>8.2</b>	<b>4.7</b>	<b>6.1</b>	<b>8.2</b>	<b>10.5</b>
<b>Improvement</b>	<b>46</b>	<b>21</b>	<b>30</b>	<b>39</b>	<b>51</b>

i	W <sub>i</sub>	W <sub>i</sub> <sup>2</sup>
1	-19	0.88
2	-18	0.91
3	-17	0.85
4	-16	1.05
5	-15	1.24
6	-14	2.88
7	-13	1.29
8	-12	3.89
9	-11	0.99
10	-10	11.00
11	-9	17.29
12	-8	20.00
13	-7	28.79
14	-6	38.79
15	-5	50.00
16	-4	76.36
17	-3	106.00
18	-2	153.23
19	-1	205.41
20	0	247.00
21	1	287.00
22	2	325.61
23	3	360.81
24	4	393.79
25	5	424.48
26	6	452.88
27	7	479.09
28	8	503.21
29	9	525.63
30	10	547.00
31	11	567.61
32	12	586.88
33	13	605.09
34	14	622.48
35	15	639.00
36	16	654.76
37	17	669.81
38	18	684.36
39	19	698.49
40	20	712.00
41	21	725.09
42	22	737.84
43	23	750.25
44	24	762.36
45	25	774.00
46	26	785.36
47	27	796.49
48	28	807.36
49	29	818.00
50	30	828.49
51	31	838.81
52	32	848.96
53	33	858.89
54	34	868.64
55	35	878.25
56	36	887.76
57	37	897.09
58	38	906.24
59	39	915.21
60	40	924.00

# Heat transfer optimization

Superheat control  
Vapor quality control



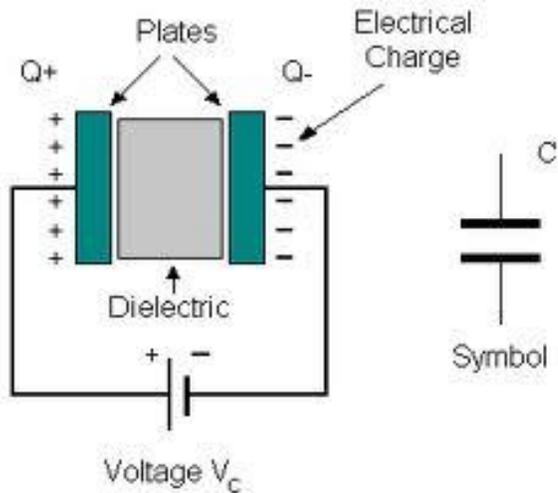
1/29/2020



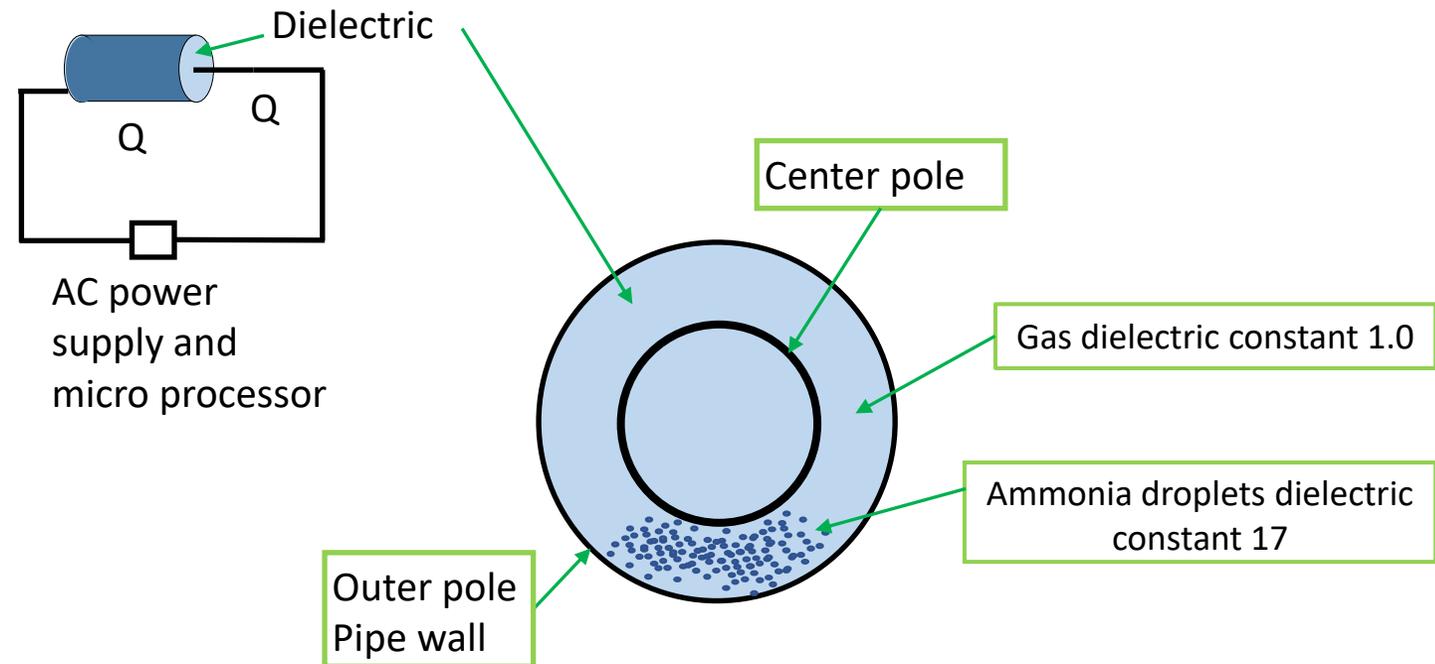
WE INCREASE UPTIME, SAFETY AND EFFICIENCY

# Vapor quality measurement principle

## Capacitor

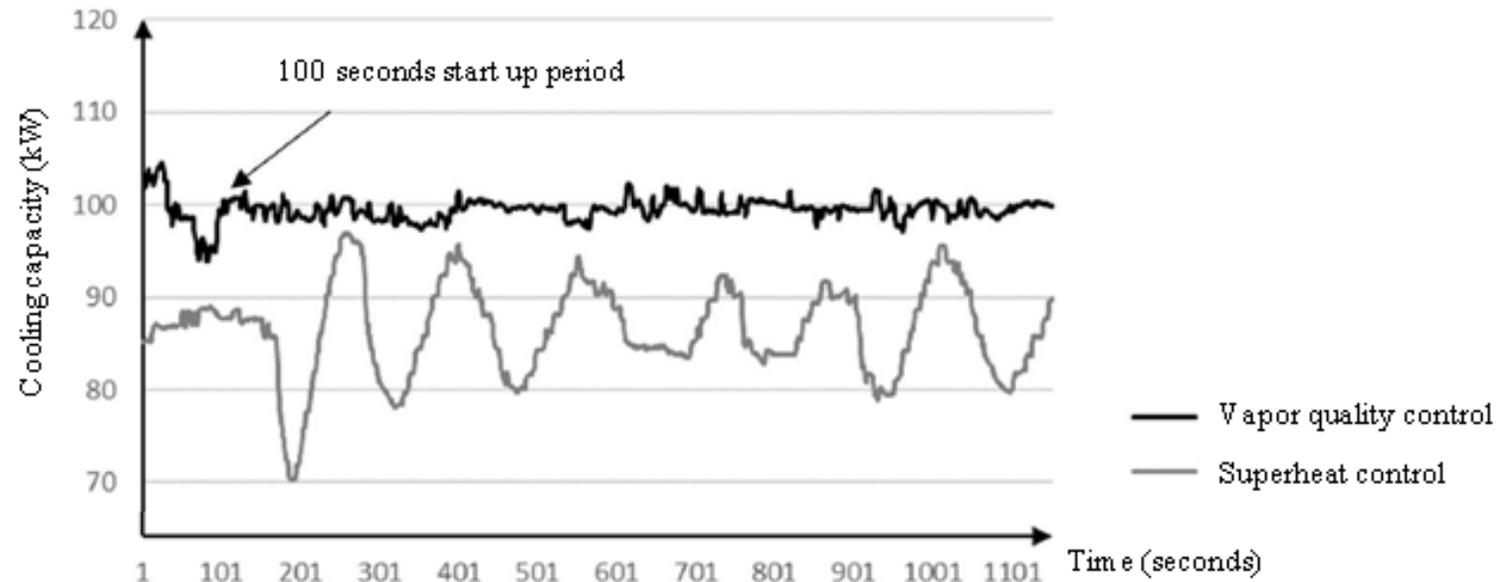
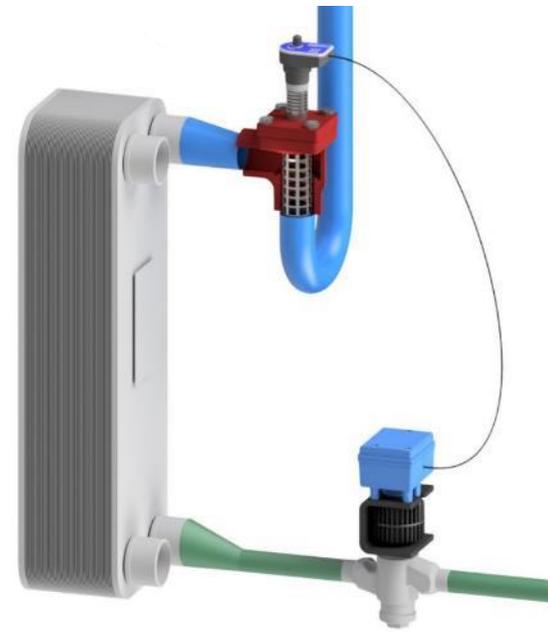


## Sensor



# Why is vapor quality control better?

- Faster control loop compared to superheat control
- Superheat is reduced to a minimum
- Increased evaporator capacity
- Reduced pressure loss



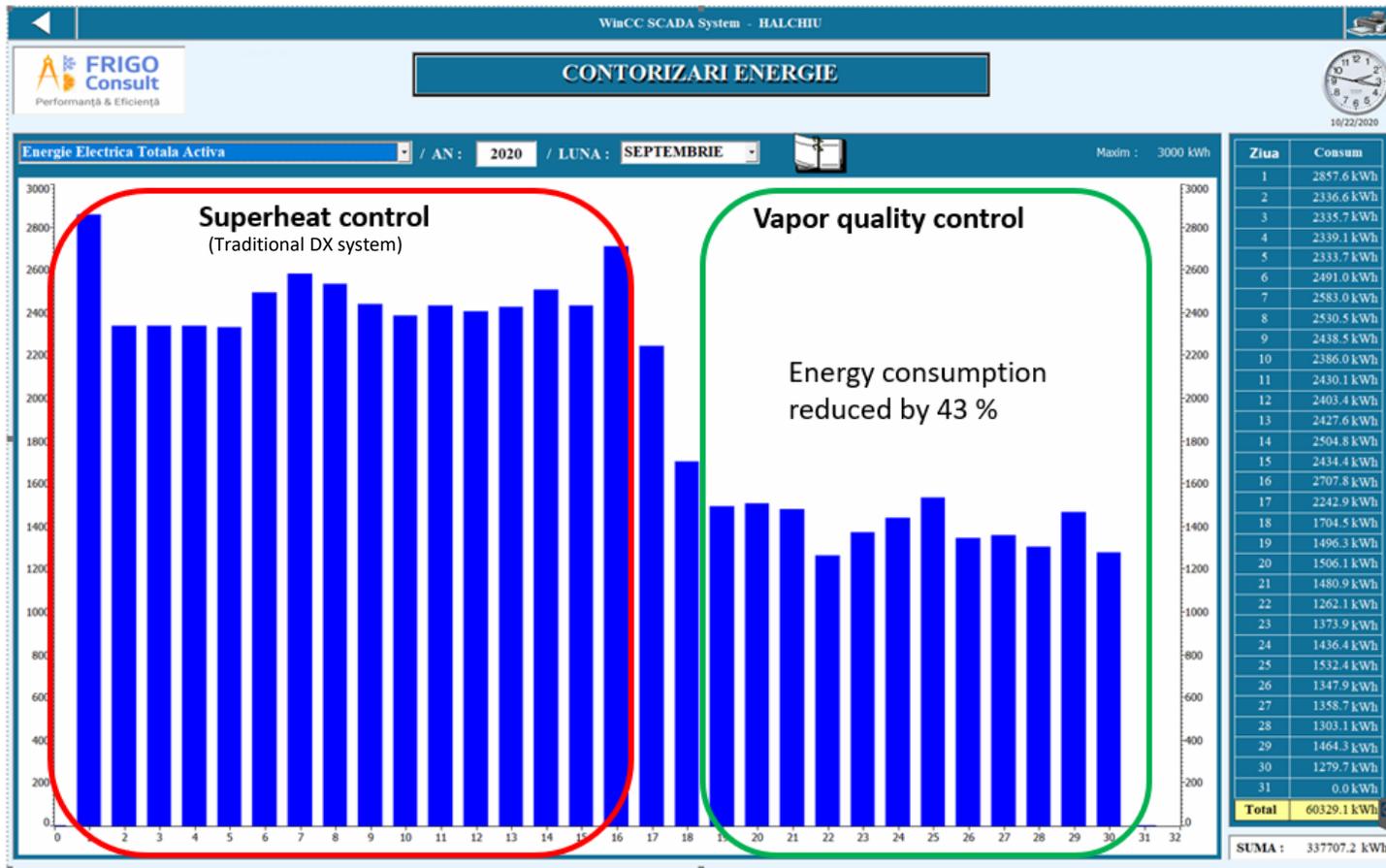
# Cost saving and CO2 reduction

- Considerable annual electricity cost saving
- CO2 saving will depend on the energy source used for electricity generation

	Annual energy consumption	Annual electricity cost EU	Annual CO2 emission EU
Superheat 8K control	91,086 kWh	10,930€	27 tons
Vapor Quality control	63,140 kWh	7,577€	19 tons
Improvement	27,946 kWh	3,353€	8 tons



# Similar savings in complete cold store



- The bar graph shows the daily energy consumption of the Halchiu plant in Romania.
- Here vapor quality control, replaced superheat control in September 2020.
- The total energy consumption for the refrigeration system was reduced by 43%.
- Annual saving 383 MWh and 110 T CO<sub>2</sub>

Thank you for your attention

The test unit will now be installed in Aarhus Denmark, where it will be used for demonstration and further test

More information is available on [www.hbproducts.dk](http://www.hbproducts.dk)  
Questions can be sent to [hk@hbproduct.dk](mailto:hk@hbproduct.dk)

