



# Business Case for Natural Refrigerants

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**11-12/04/2018 – Beijing**



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# **R290 Heat Pump Under China Coal-Electricity Policy**

Dr. Qiang Gao

Dr. LinJie Huang

Evelyne Jiang

Sanhua Holding Group

## Qiang Gao

### R&D Director, Sanhua Microchannel



Qiang Gao is a specialist in the field of heat transfer, with over 13 years experience in the heat exchangers. He graduated from Xi'an Jiaotong University and got Ph. D in Power Engineering and Engineering Thermophysics.

Qiang is the major drafter of Chinese industrial standard of micro channel heat exchanger JB/T 11967 — 2014, and one of the drafters of Technology Development Report of Chinese HVAC Industry. Qiang is now also deputy director member of China Energy conservation and environmental protection technology and Information Committee.

Qiang worked for the shell & tube, and the fin & tube heat exchanger during the Postdoc in Guandong Jirong, and worked for automotive heat exchanger in Delphi for 2 years. Since 2009, Qiang works for Sanhua on the micro channel heat exchanger for almost 9 years.

Qiang leads the research and development activities of Sanhua micro channel heat exchanger (sanhuamc®), launched first micro channel evaporator and heat pump in the HVAC market.

# Energy Revolution in Northern China



## Coal to Clean Energy for Heating

Coal to Gas (C-G)

Coal to Electricity (C-E)

Potential huge market:  
**26 million units**

Northern China Region	Population			Clean Energy Unit (planned)		
	Rural	Urban	Total Residents (k)	Rural	Urban	Total (10k units)
Beijing	94	641	735	66	58	123
Tianjin	64	302	366	44	27	72
Hebei	999	1040	2039	599	94	693
Shandong	1204	1806	3010	722	135	858
Shanxi	397	486	883	194	36	231
Henan	4842	4560	9402	547	103	650

Clean Energy Heating Coverage		By 2019	By 2021
Northern China	Overall Target	50%	70%
2+26 Cities (Beijing, Tianjin etc)	Urban	+90%	100%
	In-between	+70%	+80%
	Rural	+40%	+60%
Other Cities	Urban	+60%	+80%
	In-between	+50%	+70%
	Rural	+20%	+40%



Coal-gas:  
Boiler



Coal-electricity:  
Heat pump fan coil



Coal-electricity:  
Heat pump distributed heating (country)



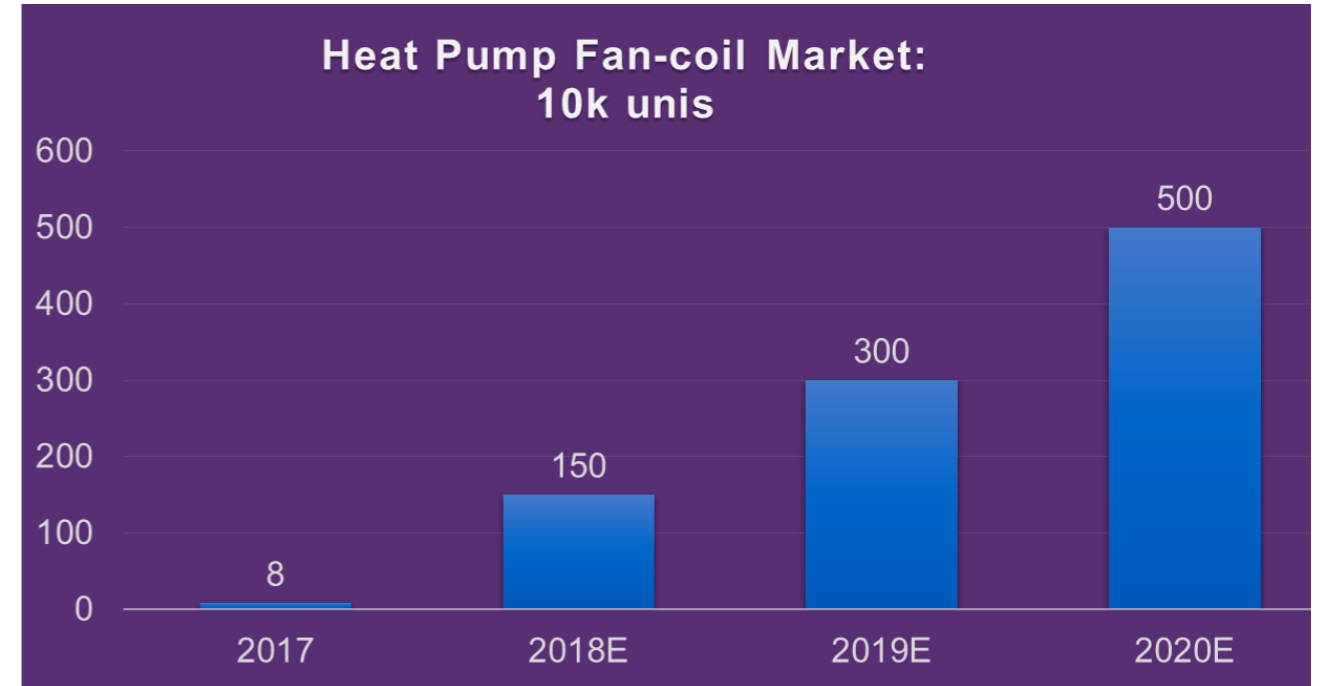
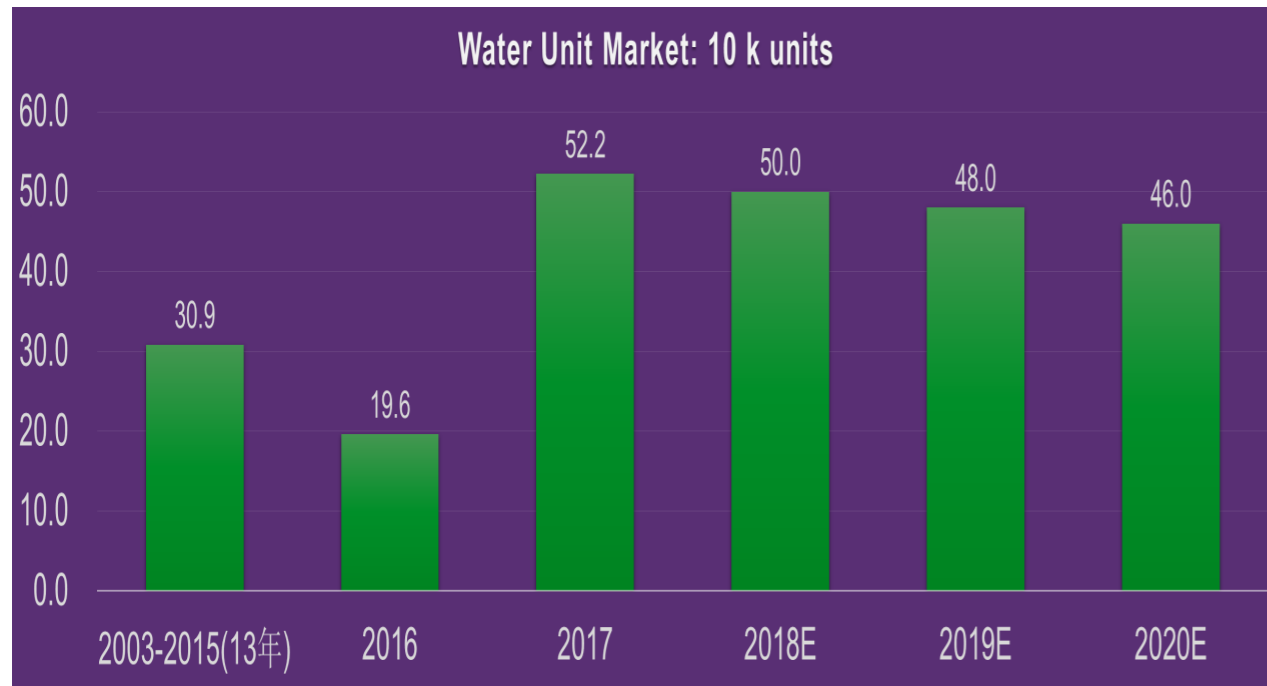
Coal-electricity:  
Heat pump centralized heating (town)



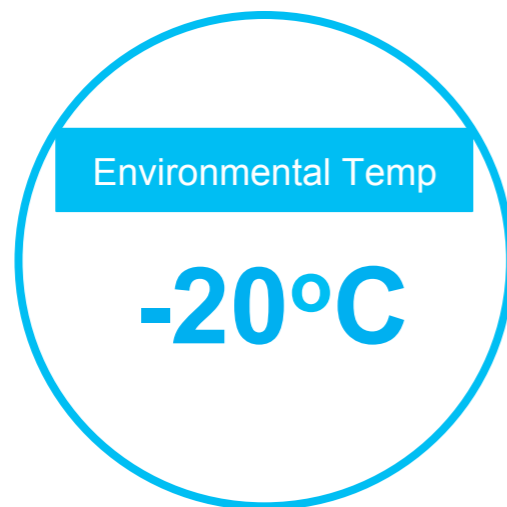
Coal-electricity: Heat  
Storage boiler

**By 2021, the clean energy heating will hit up to 70% of the overall heat energy heating**

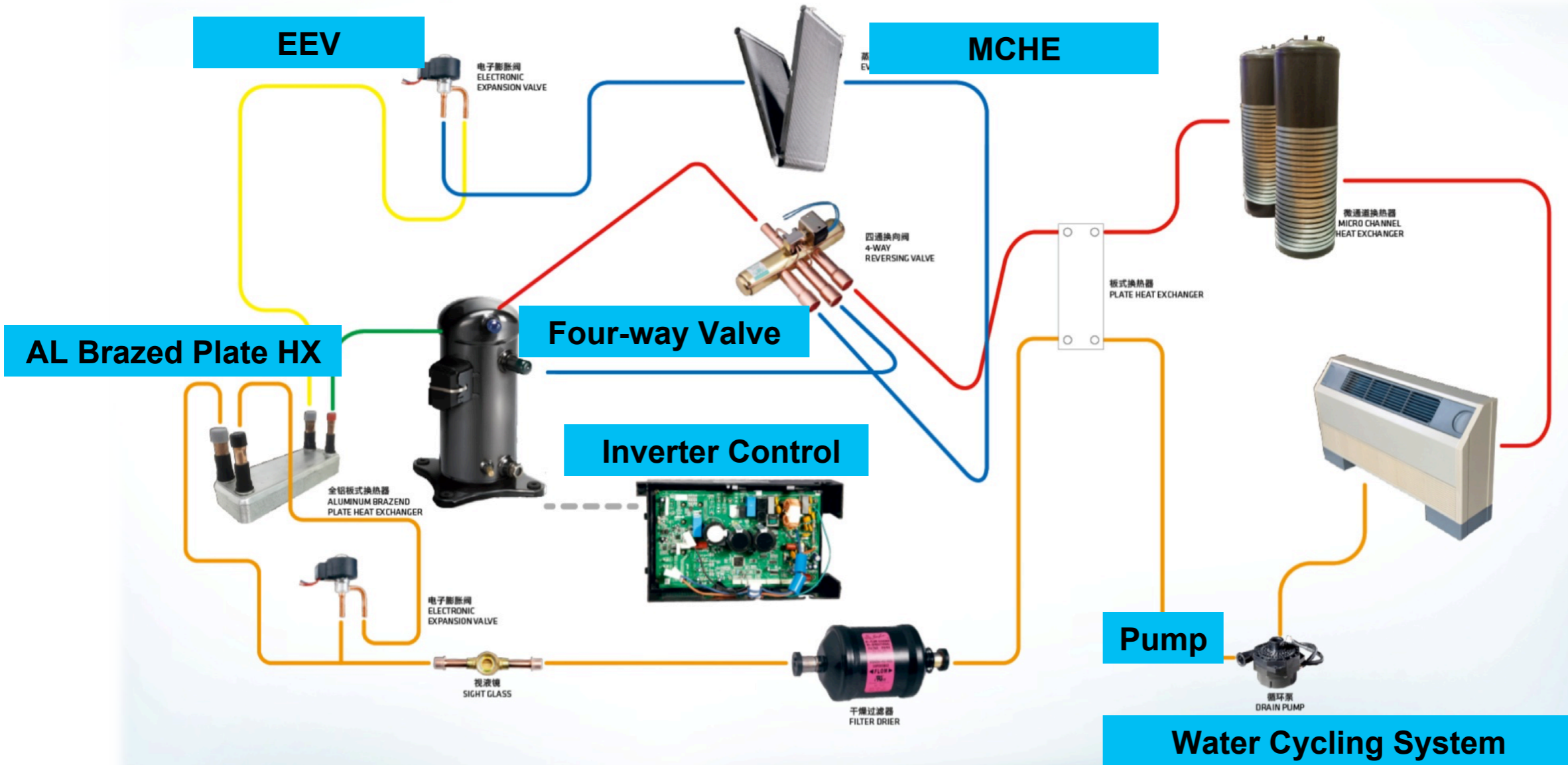
# Coal-Electricity in Northern China



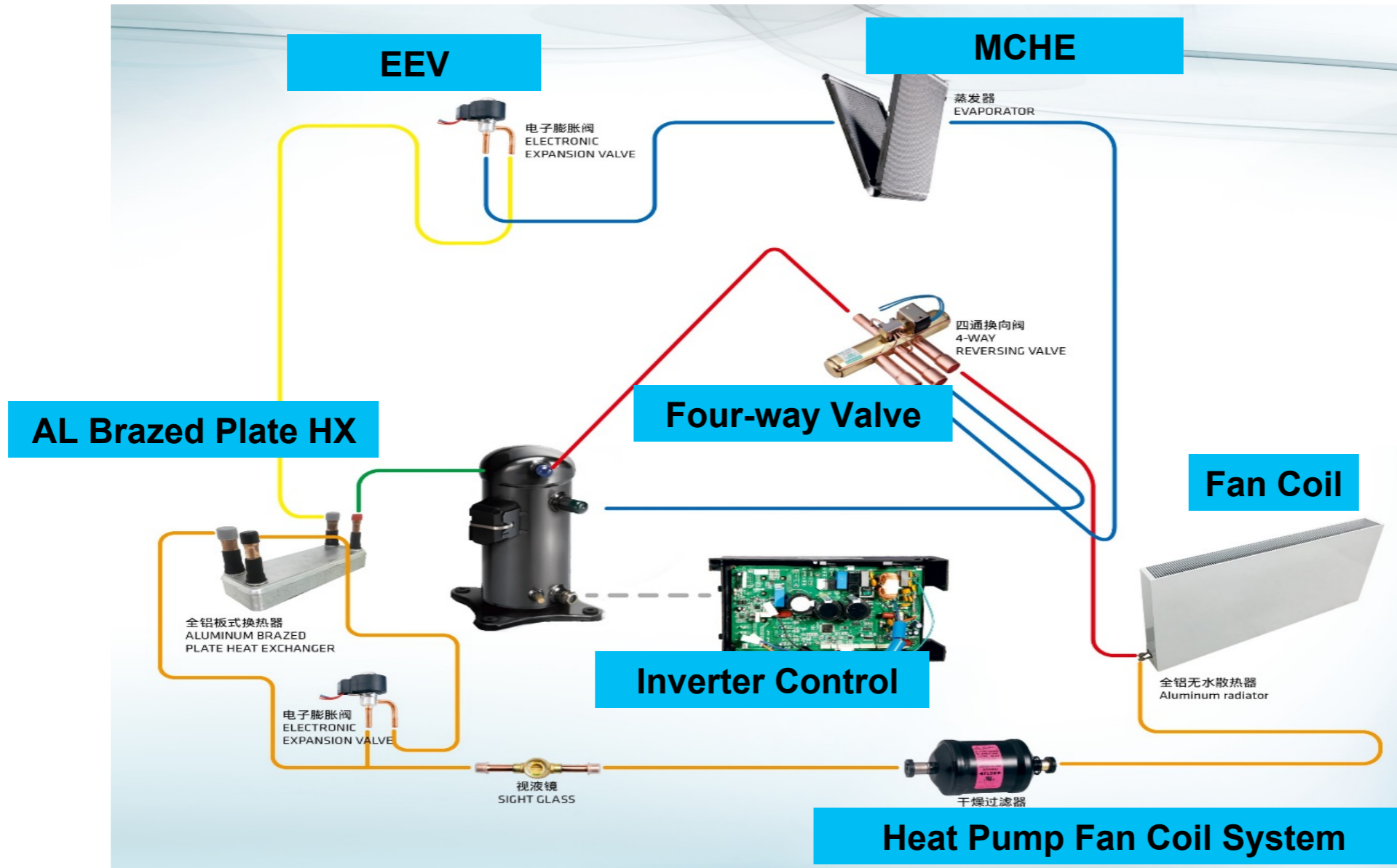
Coal to electricity shows the government **Decision** to improve the environment



**Heat pump at low environmental temperature is becoming the focus of the industry**



## Air-cooled Heat Pump Chiller: Sanhua Core Components



## Heat Pump Fan Coil: Sanhua Core Components



# Sanhua MCHE for Coal-Electricity



HT effectiveness



Ref charge



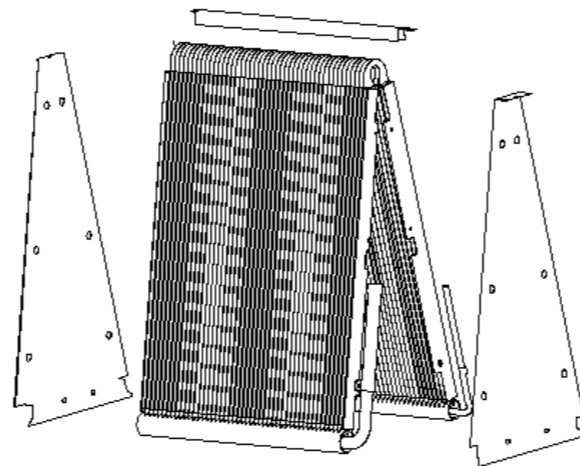
HX weight



Recycling



Condenser



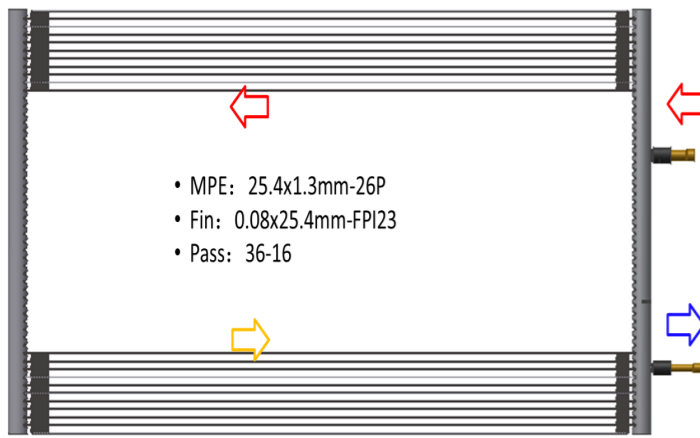
Evaporator



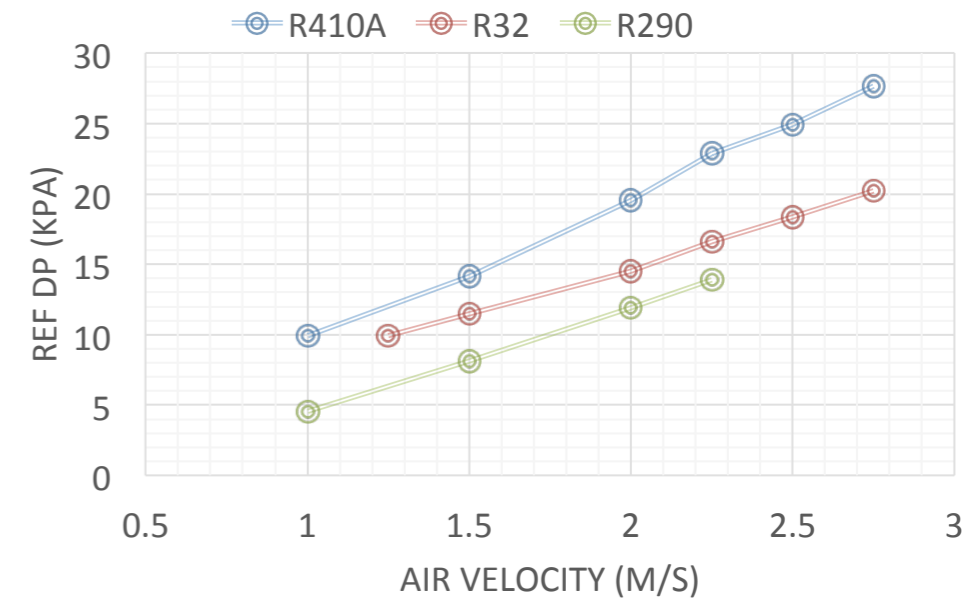
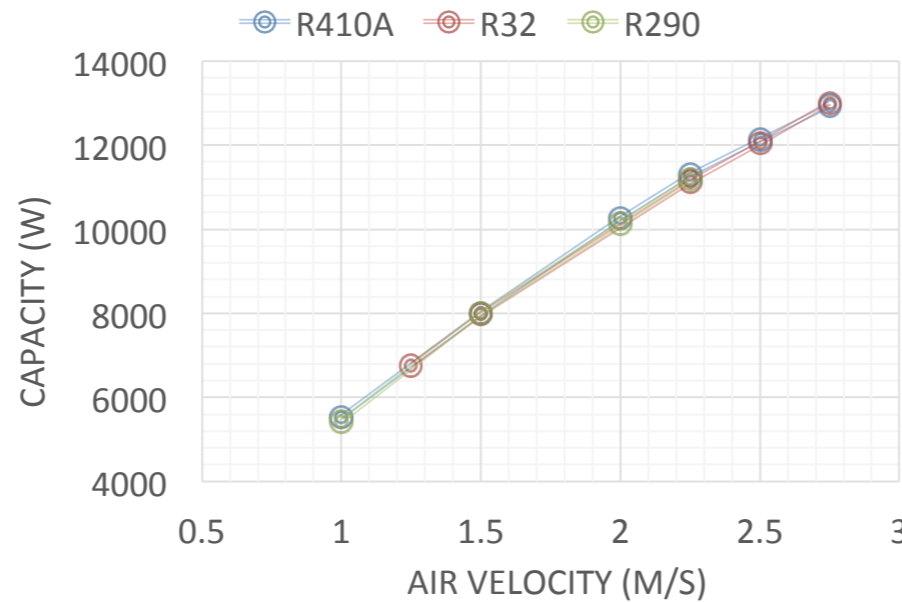
Heat pump

**SANHUAMC<sup>®</sup>** is the **best** HX solution to A2 & A3 refrigerants that needs minimum refrigerant charge

# Sanhua MCHE for R290 System

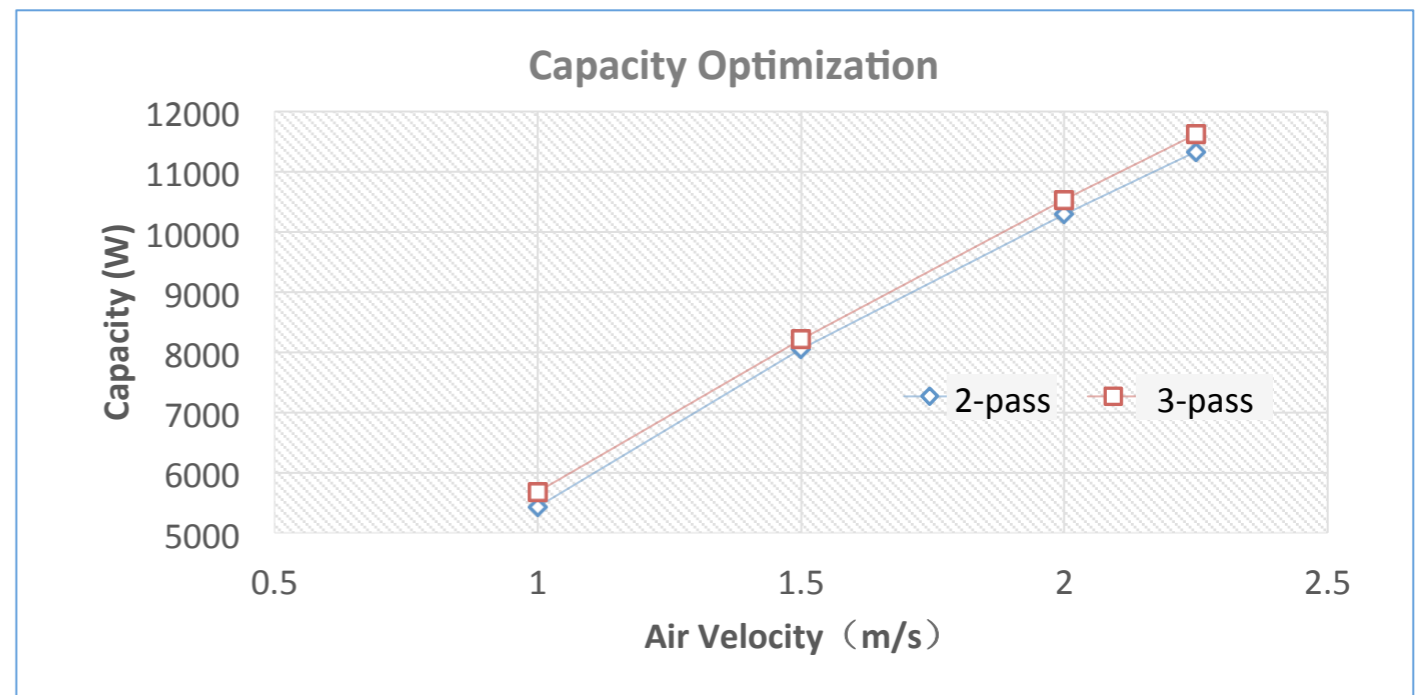


Condition: 35°C/24°C



## Heat transfer & capacity as condenser

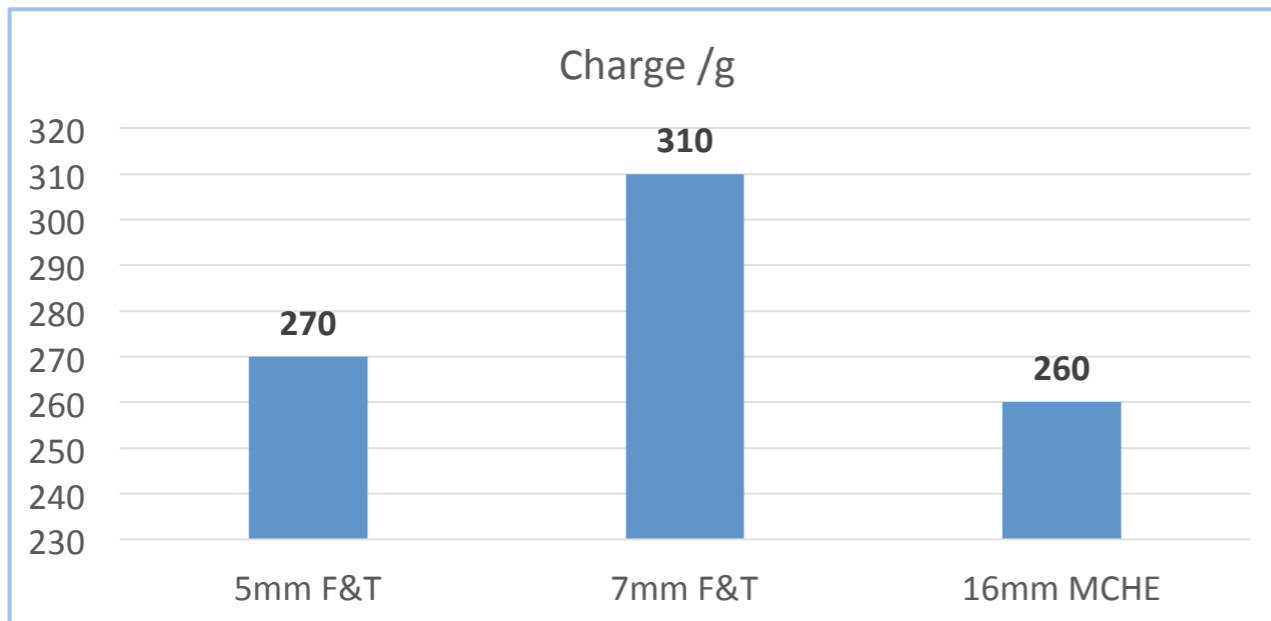
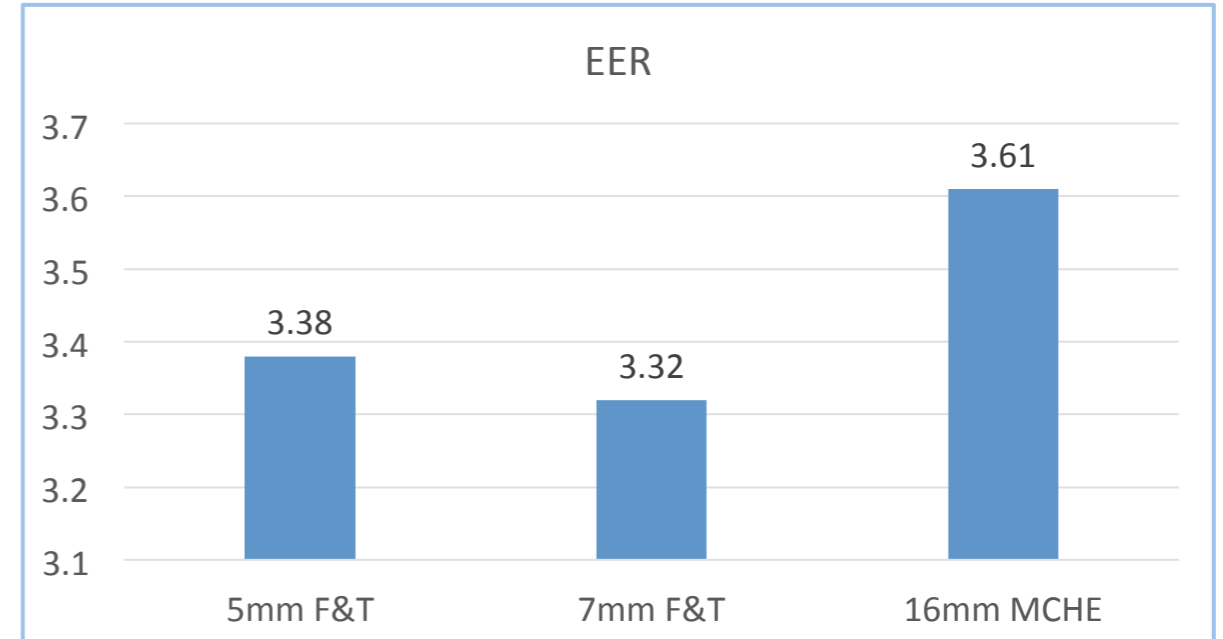
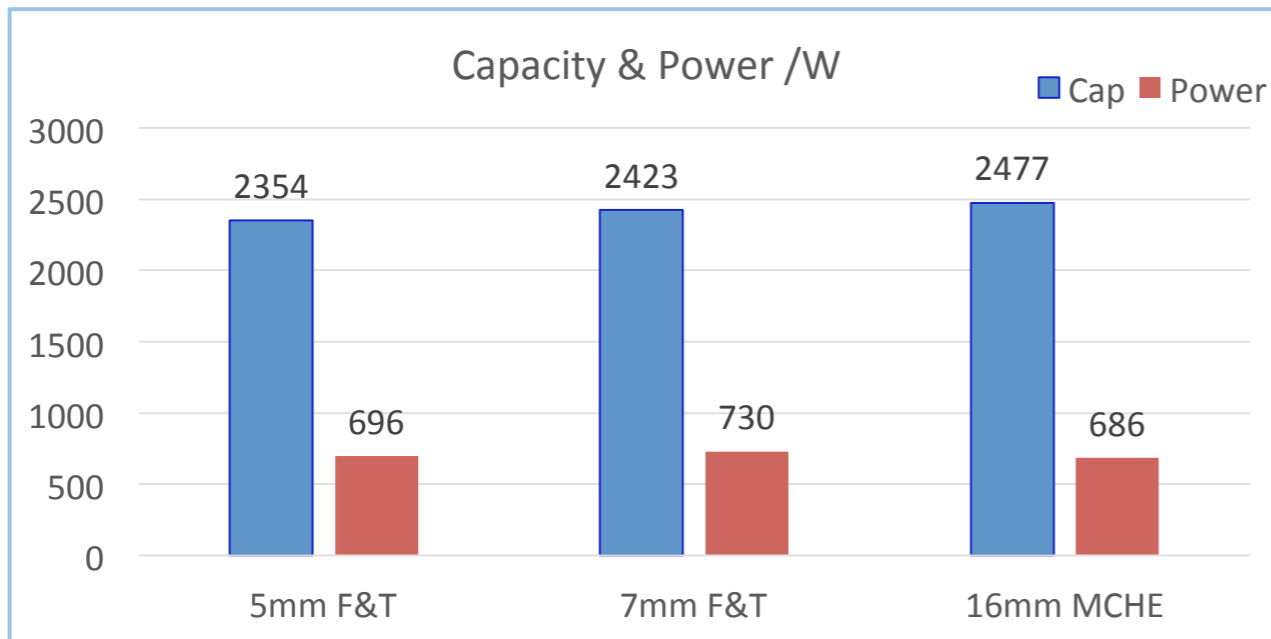
- By changing to R290, MCHE coil has the same capacity but lower pressure drop than R410A & R32
- By further optimizing the configuration of MCHE, the capacity can increase by 2~4%



# Sanhua MCHE for R290 System

System Performance as condenser

Demo — MCHE Condenser in 1hp mini-split AC



By applying MCHE in the 1hp R290 AC

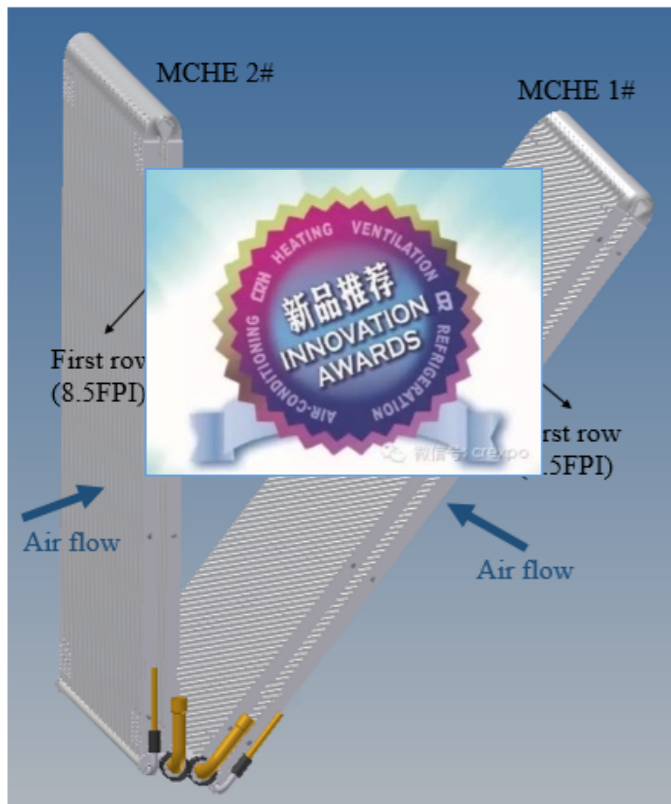
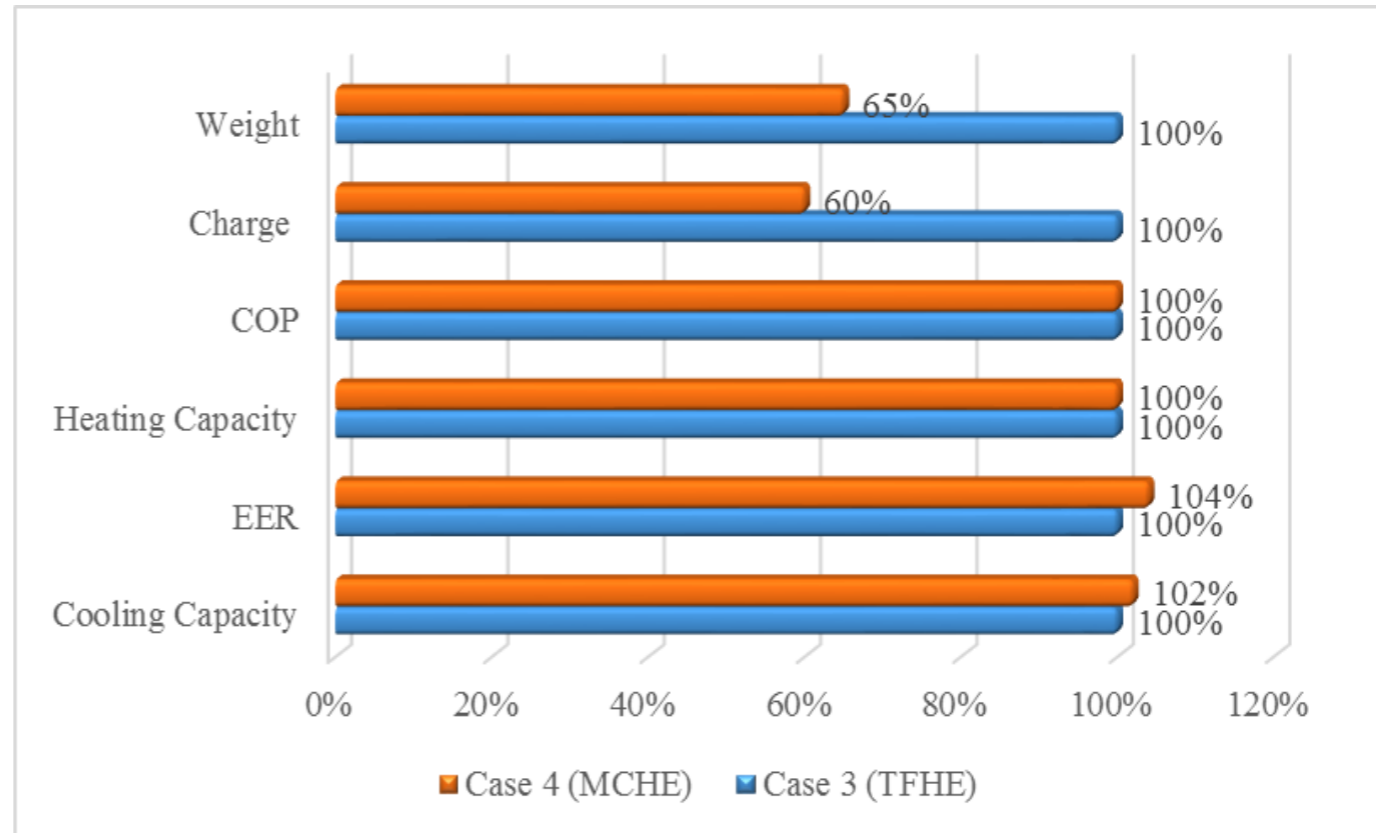
- The system **charge can be 4% less** than 5mm F&T
- The **EER is higher** than 5mm F&T by **6%**

# Sanhua MCHE for Heat Pump Chiller



65kW modular heat pump unit

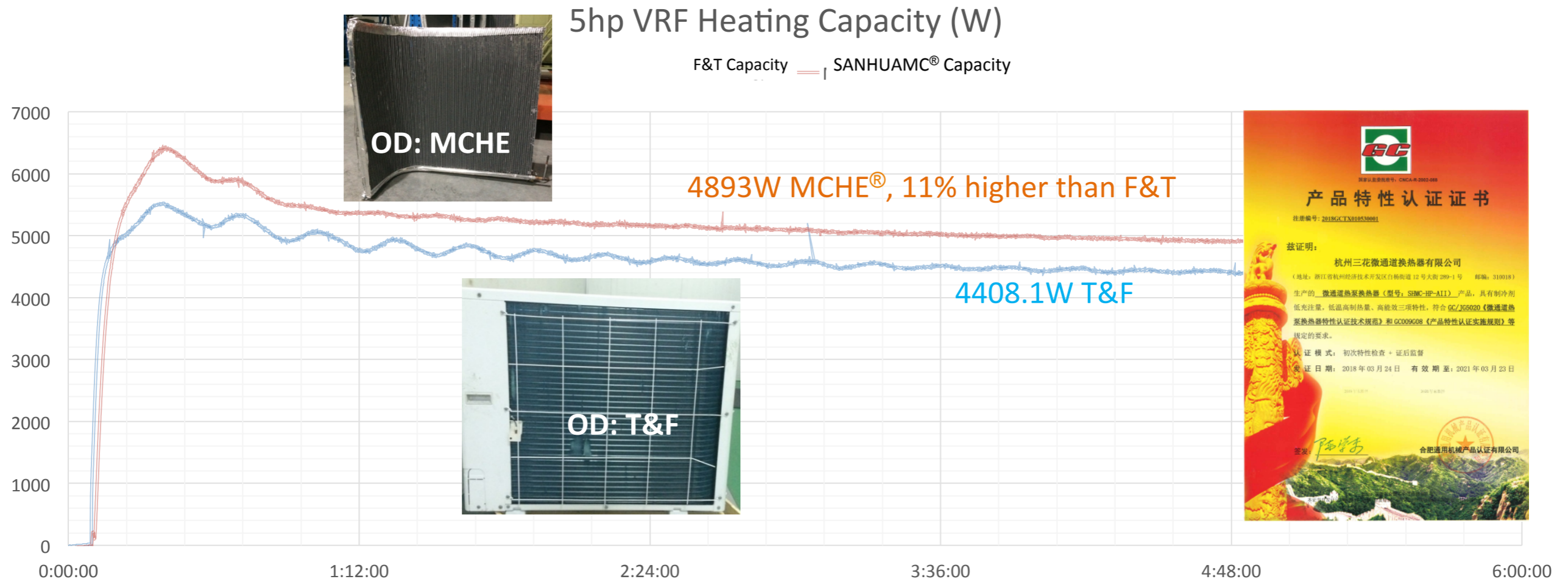
## Heat pump chiller is option for Electricity-Coal



SANHUAMC®

Design	F&T	2G32 MCHE®		2-row 2G20 MCHE®	
Cooling Cap (kW)	57.2	56.2	OK	57.3	OK
EER	3.01	3.04	OK	2.96	OK
Heating Cap (kW)	60.6	61.6	OK	59.8	OK
COP	3.06	3.24	OK	3.11	OK
Frosting/Defrosting	No frost after 3hrs	Defrosting after 1~2hrs	NG	No frost after 3hrs	OK
Oil Return	OK	OK		OK	

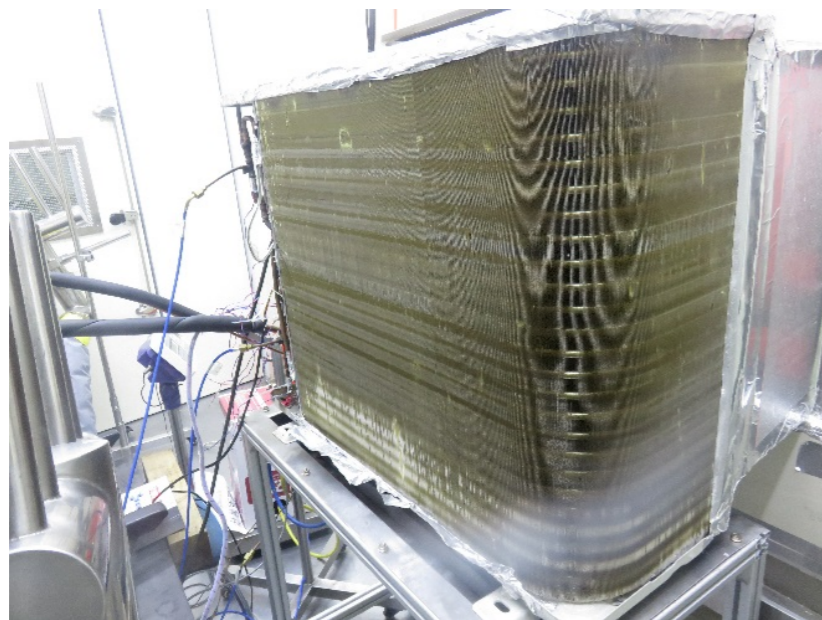
## -20°C Heating Condition – typical condition for Electricity-Coal



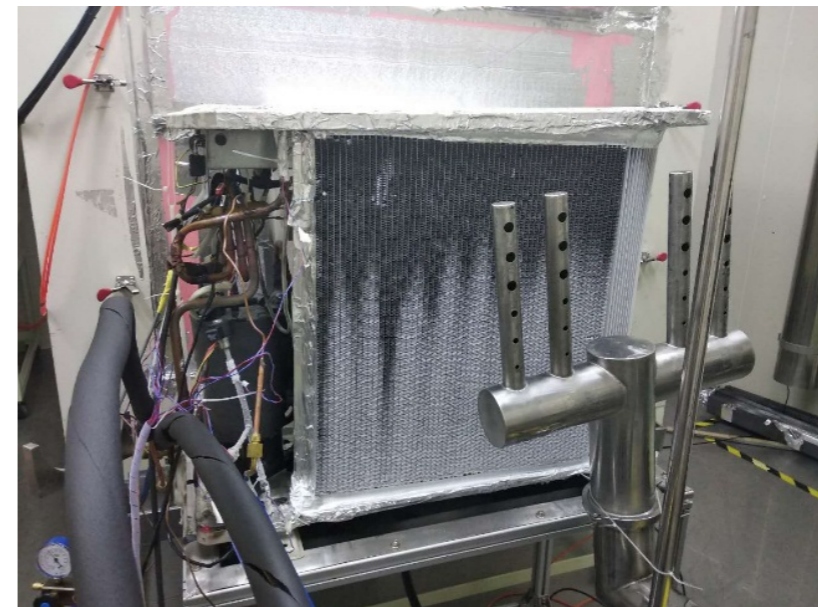
	Max Capacity (W)	Min Capacity (W)	Cap loss	COP @min capacity
T&F	5524.5	4408.1	20.2%	1.101
SANHUAMC®	6419.8	4893	23.8%	1.211

MCHE system is **10% higher** than F&T on both COP & capacity at -20 °C low temperature condition

## 3hp Mini-split Heat Pump with R410A, Drop-in by R290



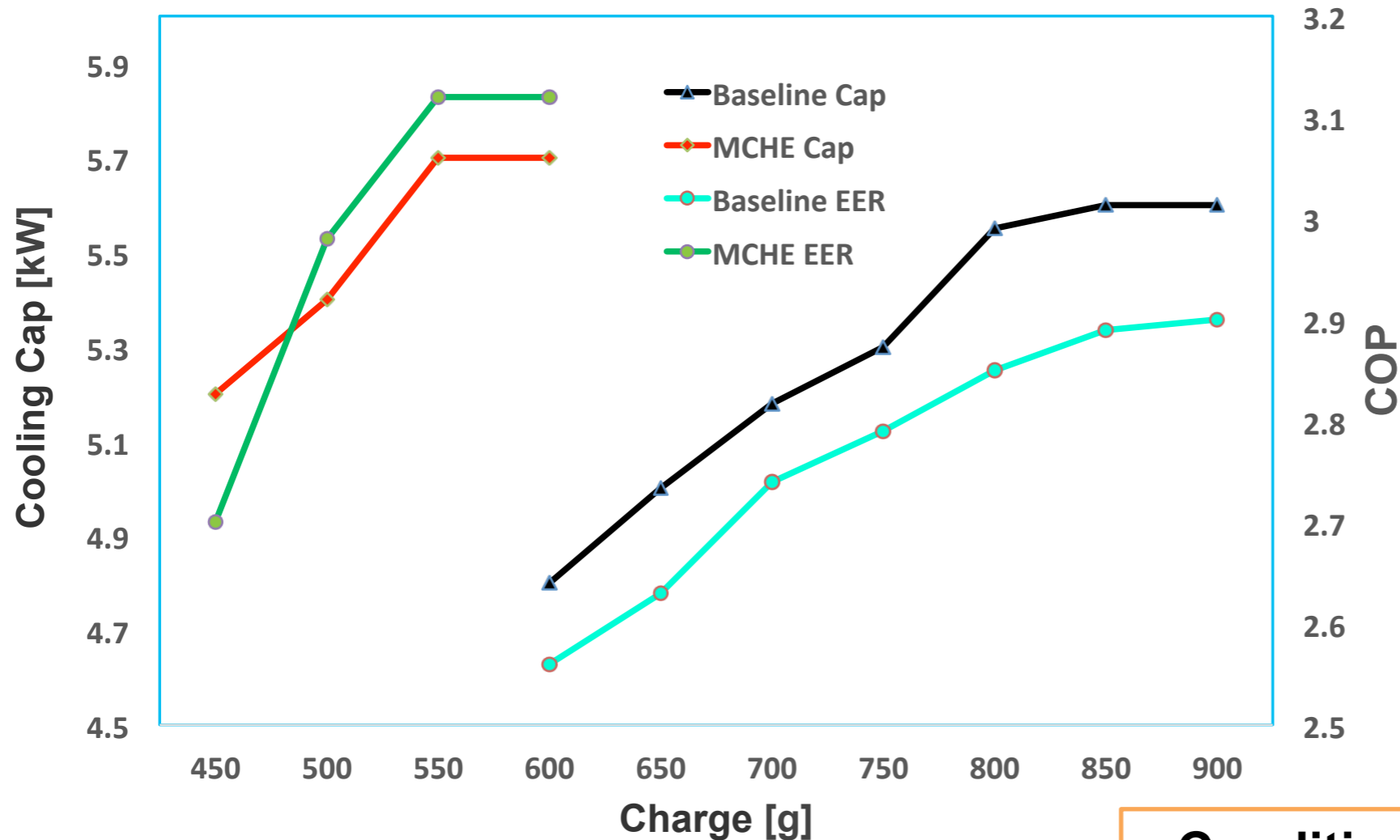
Baseline: F&T OD + F&T ID



New Platform: MCHE OD + F&T ID

HX Type	Size	Rows	Geometry	Tube Pitch (mm)	Fin	Fin Pitch(mm)	FPI
T&F - OD	726×630	1.5	φ9.52	25×22	Plate fin	1.1	23
MCHE - OD	726×630	1 row	20.6	9.4	Louvered fin	1.6	16
T&F - ID	520×660	2	φ9.52	25×22	Louvered fin	1.4	18

# R290 Heat Pump with Sanhua MCHE



Condition	ID DB/WB (°C)	OD DB/WB (°C)	Frequency (HZ)
A (Max Cooling)	27/19	35/24	84
B (Rated Cooling)			60
C (Free Cooling)			82
H1 (Rated Heating)	20/15	7/6	69
H2 (Free Heating)			79
H3 (Low-temp Heating)	20/15	2/1	84

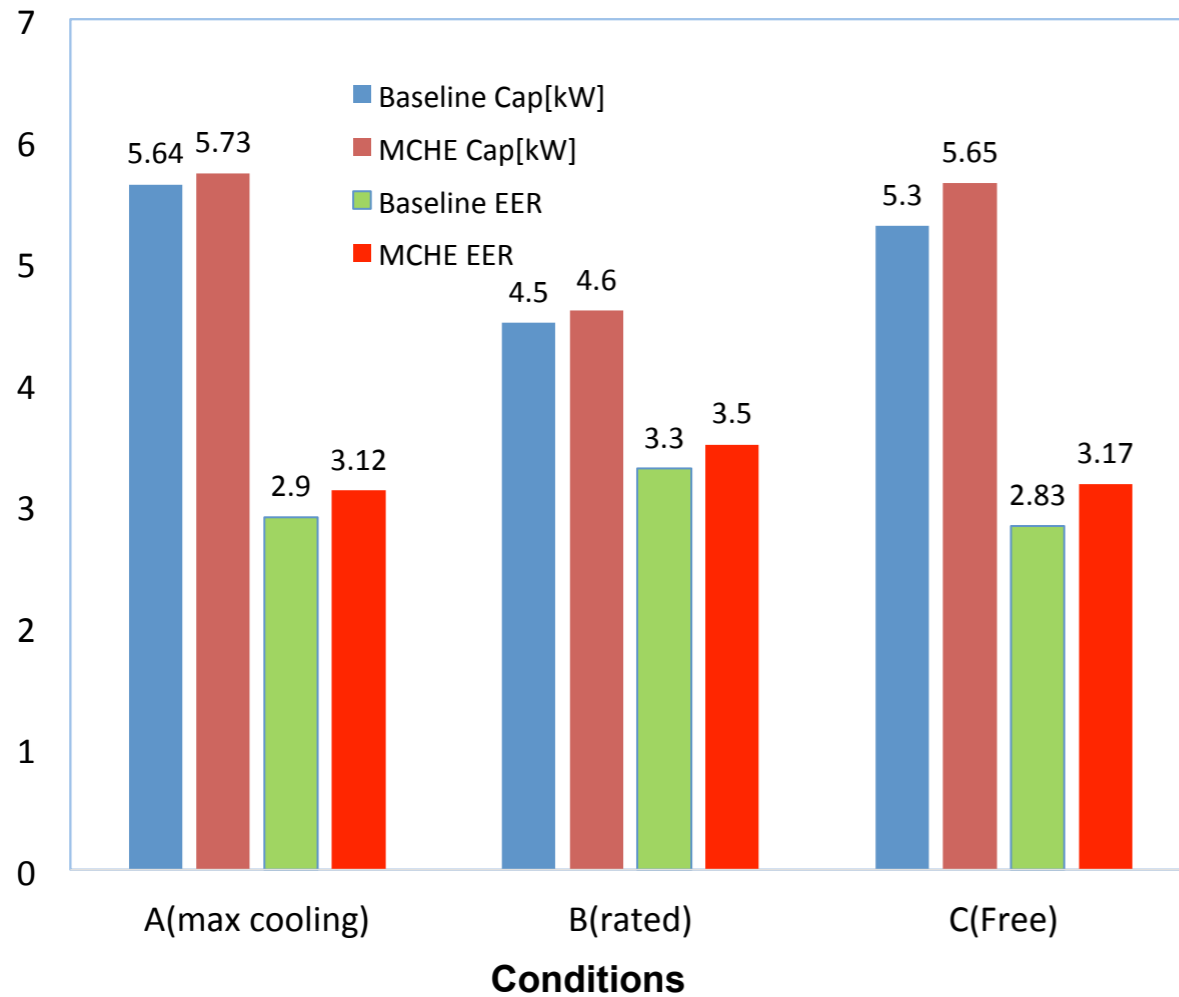
## Condition-A (max cooling)

MCHE system has

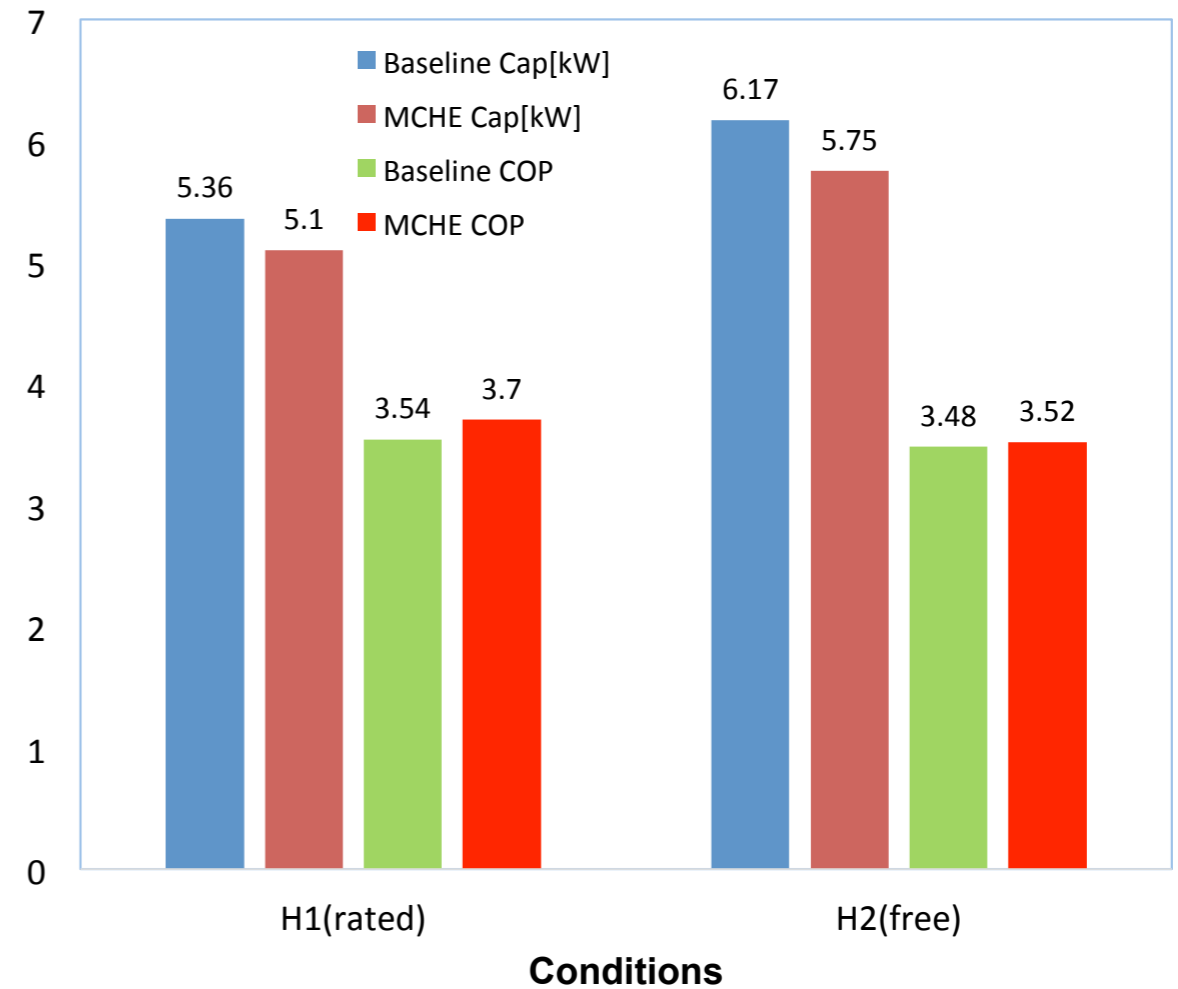
- **33% less charge**
- **7% higher EER**

Configuration	Charge (g)	Cooling Capacity (kW)	EER
Baseline	900	5.6	2.9
MCHE OD	610	5.7	3.12

### Cooling Performance



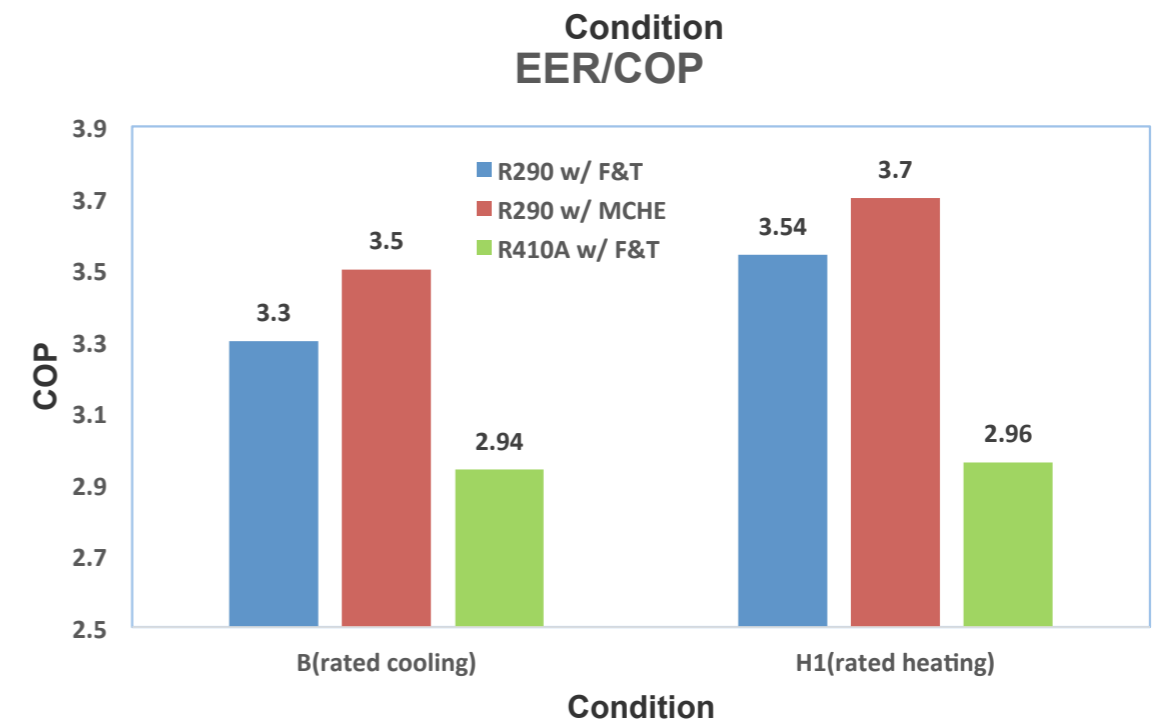
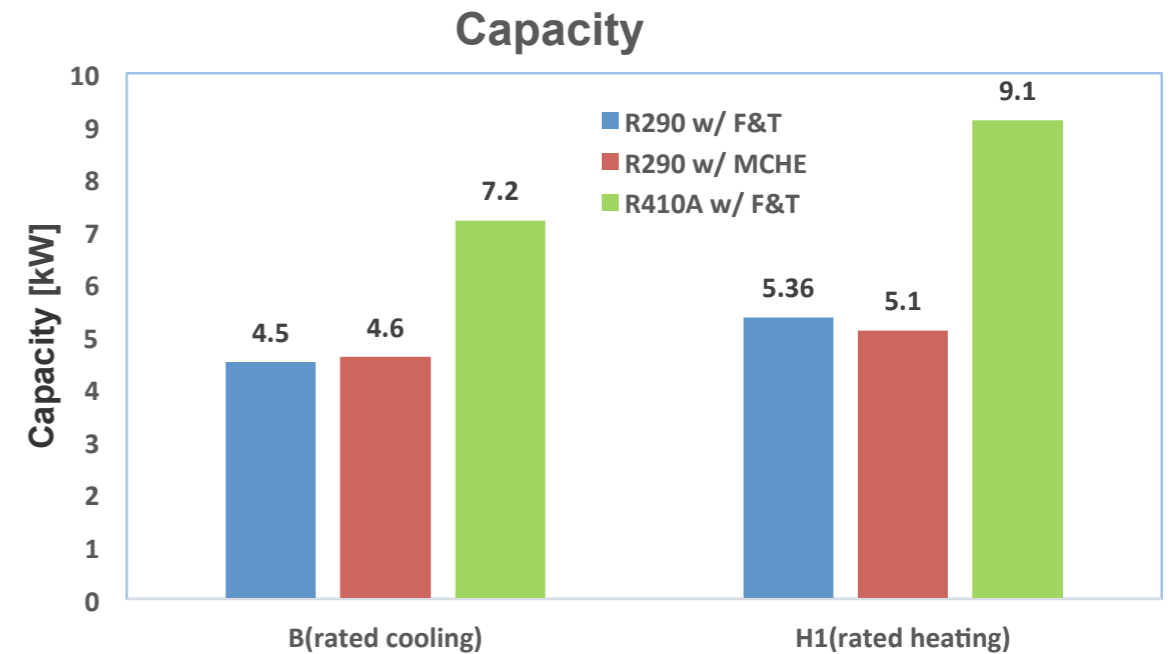
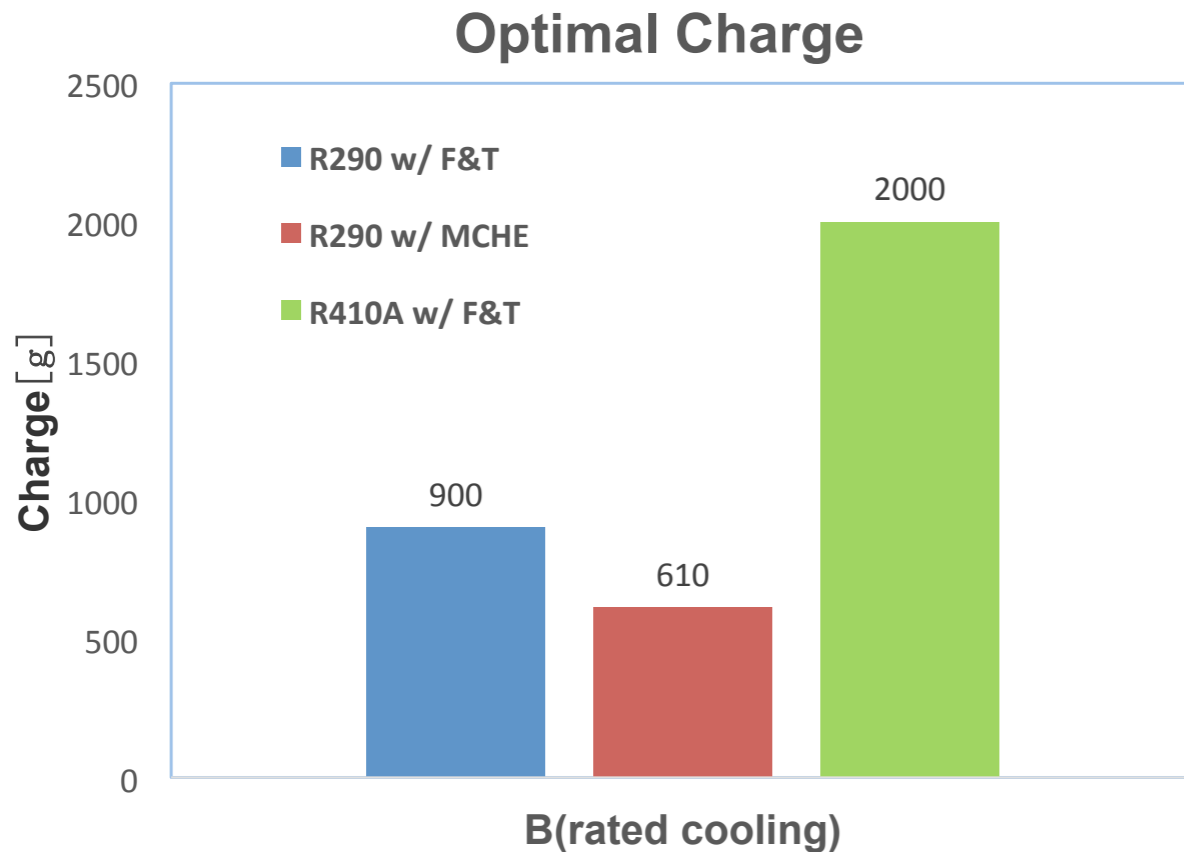
### Heating Performance



MCHE system has **better EER & COP** on both the cooling and heating conditions compared to F&T system while using R290

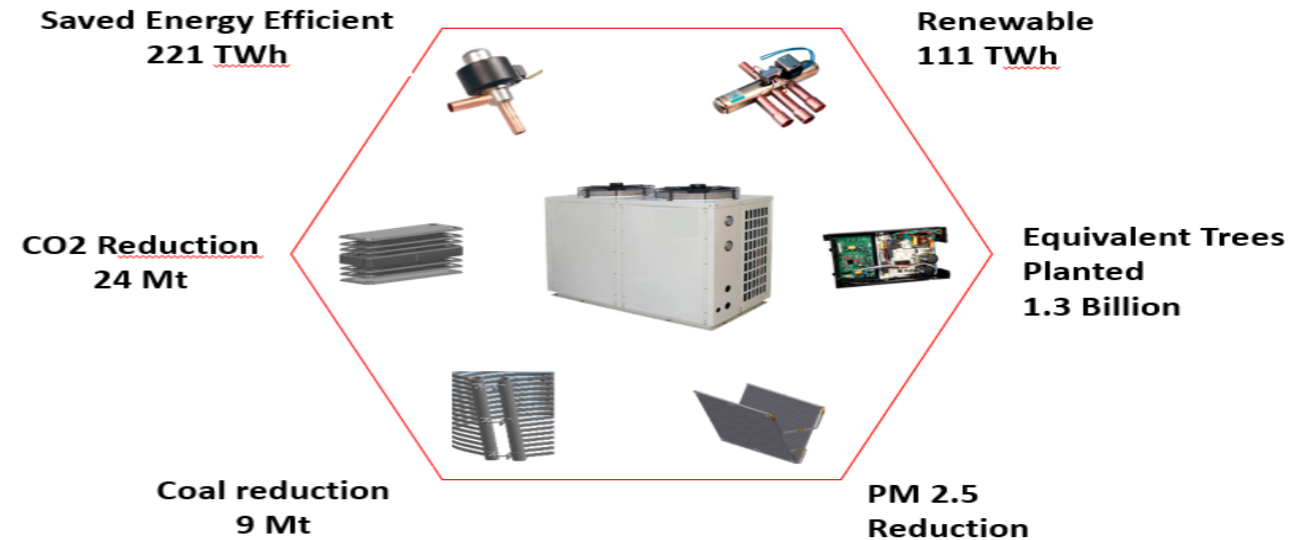
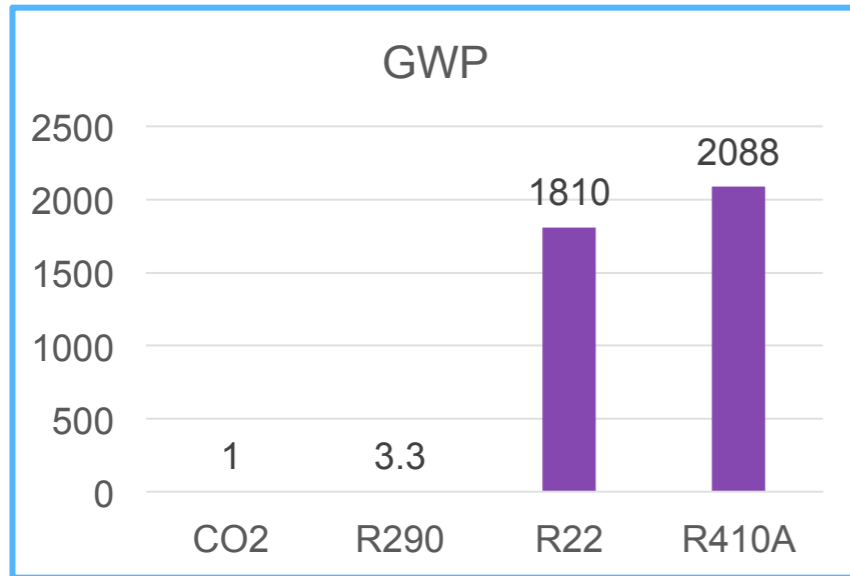


# R290 Heat Pump with Sanhua MCHE



- MCHE can **reduce R290 charge by 30%** with **higher system efficiency**
- R290 system capacity is 60% of R410A system due to the direct drop-in and lower mass flow rate of R290

# Sanhua Efforts to Green Environment



**2,5 m units**  
by 2020, air-sourced heat pump

Technology	R22 + T&F	Proposal
R290	13.7 MT CO2	0.2 MT CO2
MCHE+R290		0.1 MT CO2

**降低CO2年排放量 37.7 MT**

\*Estimated installed stock of 2.47 million HP units by 2020

\*MCHE™ is higher in efficiency and over 50% less in refrigerant charge

**By applying both R290 and MCHE to the heat pump for Coal-Electricity, CO2 can be reduced 37.7MT**



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Thank you very much!

