



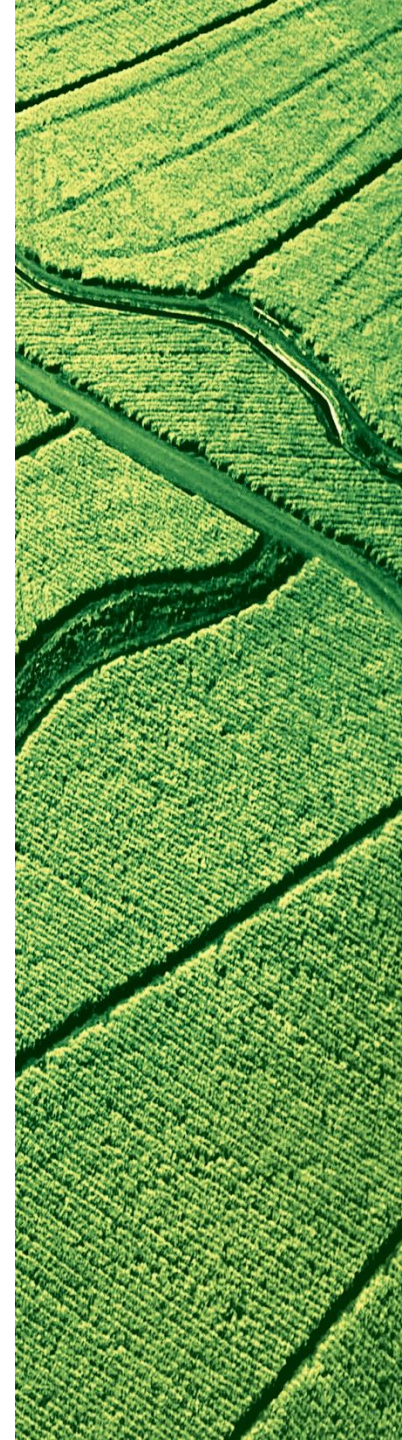
The 60th Meeting of the APEC Expert Group on
Energy Efficiency & Conservation (EGEE&C 60)

Energy Efficiency Enhancement through Technological Innovations in Chinese Taipei

March 15 , 2023

Directed:  經濟部能源局
Bureau of Energy,
Ministry of Economic Affairs

Administrated:  ITRI
Industrial Technology
Research Institute



The roadmap of 10-year technology development

No.	Goal	Technical Description	Future Development	TRL:1-5			TRL:6-8			TRL:9-11		
				2025-2027	2028-2030	2030-2034	2025-2027	2028-2030	2030-2034	2025-2027	2028-2030	2030-2034
1	Heat Pump	12%~30%Energy savings. Provide optimum cooling performance and mobility comfort.	Robotic Personal Comfort Device	[Progress bar]			[Progress bar]			[Progress bar]		
2		The traditional VHP heating COP reaches 1.4~1.6.	Alternative Gas-Fired Heat Pump Technologies	[Progress bar]			[Progress bar]			[Progress bar]		
3		COP>1, the unit energy saving rate is 40%.	Commercial Absorption Heat Pump Water Heater	[Progress bar]			[Progress bar]			[Progress bar]		
4	Refringent	Equipment efficiency (COP) keep stable after replacing the refrigerant.	Air conditioner compressor with natural refrigerant	[Progress bar]			[Progress bar]			[Progress bar]		
5		Refrigerant without GWP or ODP, non-toxic and non-flammable	Chiller with Water Refrigerant	[Progress bar]			[Progress bar]			[Progress bar]		
6	Heat Exchanger & Component	Improve 125% volumetric heat transfer rate. Increase 20~30% heat transfer efficiency. Reduce 20% weight.	Novel, Polymer-Based, Air-Cooled Heat Exchangers; Additive Manufacturing for Heat Exchangers	[Progress bar]			[Progress bar]			[Progress bar]		
7		The unit energy saving rate is 10%.	Integration of Piezoelectric Sensor-Actuators into Heat Exchanger Headers to Alleviate Flow Maldistribution in Real Time	[Progress bar]			[Progress bar]			[Progress bar]		
8		Without additional post-casting heat treatment for Aluminum cerium alloy. Reduce 30%~60% manufacturing costs.	Cast Heat Exchanger Using the Novel Al-Ce Alloy	[Progress bar]			[Progress bar]			[Progress bar]		

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TRL:1-5 TRL:6-8 TRL:9-11

No.	Goal	Technical Description	Future Development	2025-2027	2028-2030	2030-2034
9	Heat Exchanger & Component (Cont.)	Improve heat transfer efficiency UA of heat exchanger up to 400% and mechanical strength.	Low-Cost, High-Performance Polymer Composite Heat Exchangers Produced by Additive Manufacturing	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
10		Reduce refrigerant leakage. Improve equipment operation efficiency and reliability. Reduce equipment production costs.	Adhesive Bonding of Aluminum and Copper in HVAC&R Applications	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
11		The unit energy saving rate is 40%. Reduce 35% of refrigerant filling volume.	Novel Compact Flooded Evaporators for Commercial Sector Refrigeration	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
12		Improve air side heat transfer coefficient by 4 times.	Enhanced Air-Cooled Heat Exchanger	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
13	Air Conditioner Components (Motor, Compressor)	Efficiency keep stable after replacing rare earth (>IE4)	High-efficient motor without rare-earth magnet for HVAC application	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
14		36% energy saving by switching from isentropic to isothermal compression.	Oil-Less Compressor/Rapid-Cast, High-Speed Centrifugal Compressor Impeller	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		
15	Cooling for Heat Driven	The membrane air conditioning system can save energy by 54-89%, and the SEER can be greater than 30.	Membrane Cooling System	[Progress bar: TRL 1-5 (2025-2027), TRL 6-8 (2028-2030), TRL 9-11 (2030-2034)]		

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TRL:1-5 TRL:6-8 TRL:9-11

No.	Goal	Technical Description	Future Development	2025-2027	2028-2030	2030-2034
16	Other Device	The unit energy saving rate is 10%.	Wearable Devices for Personal Comfort			
17	Air Supply Device	The unit energy saving rate is 40%. Reduce 35% of refrigerant filling volume.	Electroactive Smart Air-Conditioner VEnt Registers (eSAVER)			
18	Prospective Research Magnetic cooling materials Thermoelectric materials Adsorption materials	The unit energy saving rate is 25%.	Electrocaloric Cooling System			
19		The unit energy saving rate is 40%.	Thermoelastic Cooling System			
20		The COP can reach 1.4 under refrigeration.	Thermoacoustic Cooling System			
21		About 12-40% energy saving effect in hot and humid areas.	Liquid Desiccant Cooling System			
22		Increase 3-5 times of the current vapor compression dehumidifier (required electricity is 1/5).	Mechanical Dehumidification Using High-Frequency Ultrasonic Vibration			

Technical innovation

Microchannel heat exchanger (MCHX)



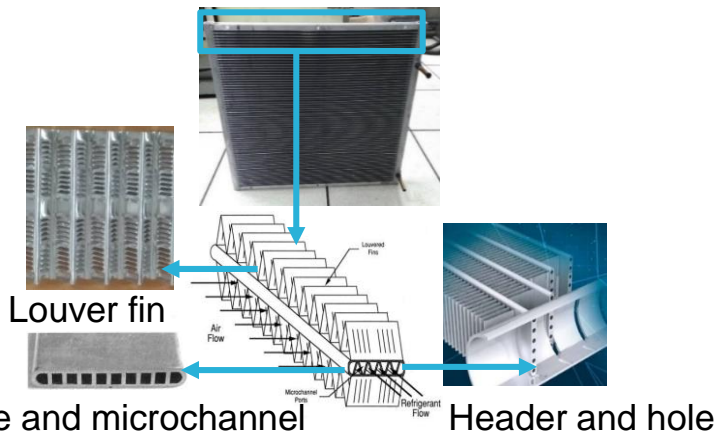
Core technical advantages

- **The unique and practical MCHX design software tool in Chinese Taipei** : With complete refrigerant database and the calculation capacity error within 5%.
- **Key technologies** : Combined low GWP refrigerant and MCHX commercial technologies used for VRF, 5G/6G data centers, electric vehicles applications, the system weight and volume can be reduced by 10% and 20%, meanwhile, the efficiency will increase by 10%.



Applications & Key products

MCHX and high static pressure fan



Max. static pressure 80 Pa

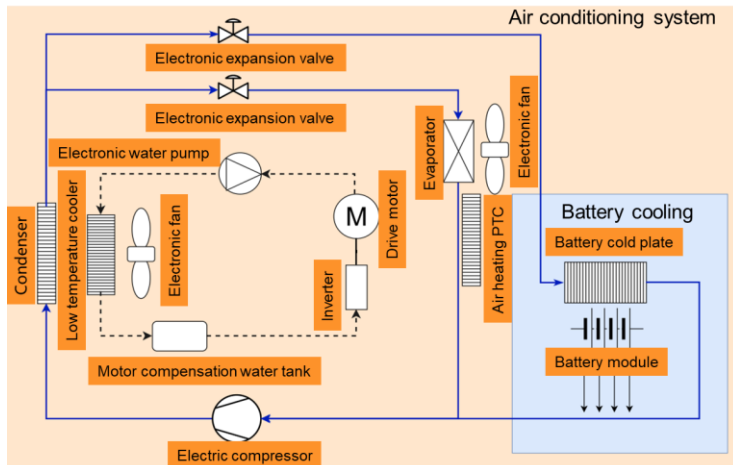
Electric-vehicles Thermal Management System

Core Technical Advantages

- **Key component localization production** : Horizontal-type inverter-fed scroll compressor module, Micro-channel heat exchangers (MCHXs), and Electronic commutation (EC) fan modules.
- **Intelligent thermal management system**: Integrate battery cooling, motor cooling, controller cooling, cabin air conditioning and other systems, saving 20% of electricity.

Applications & Key Products

Air conditioning and cooling modules for electric vehicles



Key components and modules

Intelligent control system



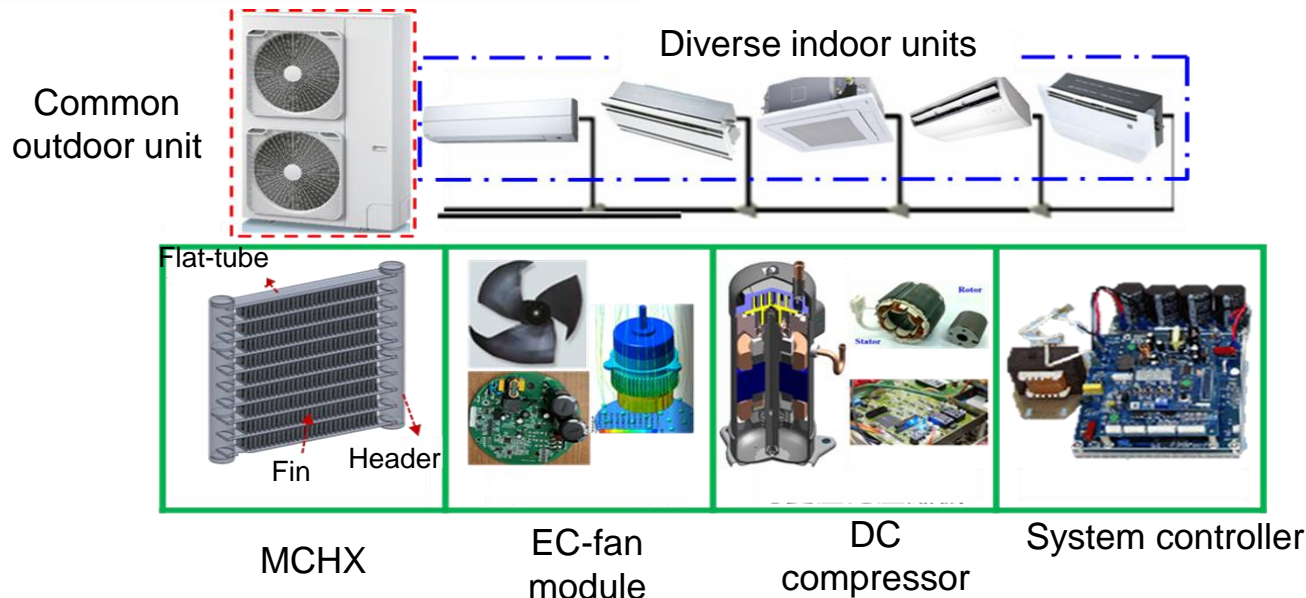
Variable Refrigerant Flow (VRF) System

Core Technical Advantages

- **World's first R32 common condensing unit:** Used for mini VRF and VRF series, the Cooling Seasonal Performance Factor(CSPF) is 30% better than Class I energy efficiency, the noise reduced 10dB
- **Key components localization:** Micro-channel heat exchanger, Anti-high static pressure EC fan, DC inverter-fed compressor, system controller, open source of VRF operating system.

Applications & Key Products

Common outdoor unit & open operating system



Organic Rankine Cycle (ORC) power generator

Core technical advantages

- **Organic Rankine Cycle system** : The total solution engineering system uses low boiling point organic working fluid to convert medium and low temperature heat energy into electricity. The heat source temperature is 85°C~130°C (unit inlet), the generator power output is 10KW~>300kW, and the unit system efficiency is $\geq 8\%$ (the higher the temperature, the higher the efficiency).

Applications & Key Services

It has been applied in more than ten different industrial fields such as chemical, pulp and paper, steel and geothermal, etc. Its investment recovery period is generally $\leq 4\sim 5$ years



Industry	Heat source	Unit capacity	Payback period
Chemical	82°C/200TPH Condensed water	200kWe	~ 3.6 years
Pulp and Paper	110°C/60TPH Hot water	125kWe	~ 3.5 years
Waste Disposing	165°C/4TPH Steam	255kWe	~ 3.8 years

Electronic Device & Data Center Cooling System

Core technical advantages

- **Heat Pipe Heat Exchangers(HPHX)** : Unique design to activate pulsation two-phase flow in three-dimensional operation. Heat dissipation capability is 60% higher than other HPHXs.
- **Immersion Cooling for Servers** : Total solution combining power, cooling, monitoring, maintenance, and server all-in-one. PUE<1.1, 40% less than traditional data center and 10% less than commercial immersion cooling facility. The best choice for edge computing data centers.

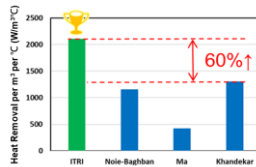
Applications & Key products



Heat Removal from Laser Projectors



High Performance HPHX



Performance Comparison



Heat Pump Dryers



10U Immersion Cooling Edge Computing Data Center

High Performance HPHX Technology and Applications

	Traditional A/C Cooling	Immersion Cooling Traditional Type	ITRI Innovative Immersion Cooling
PUE@30°C	1.6-2.0	1.2	<1.1
Energy Saving(%)	-	~30%	~40%
Water Loop	With	With	Without
Heat Transfer	Active	Active	Partially Passive(HP)
Heat Removal (kW/m ²)	10	15	16.7
Down Size	-	~30%	40% less than traditional data center and 10% less than commercially available one
Floor Area(m ²) (for 50kW IDC)	10	7.3	5
Setup Time	3-6 months	1~3 months	<4 hours

Thank You