

R290 Technology & Application Research & Development R290 技术和应用的研究与开发

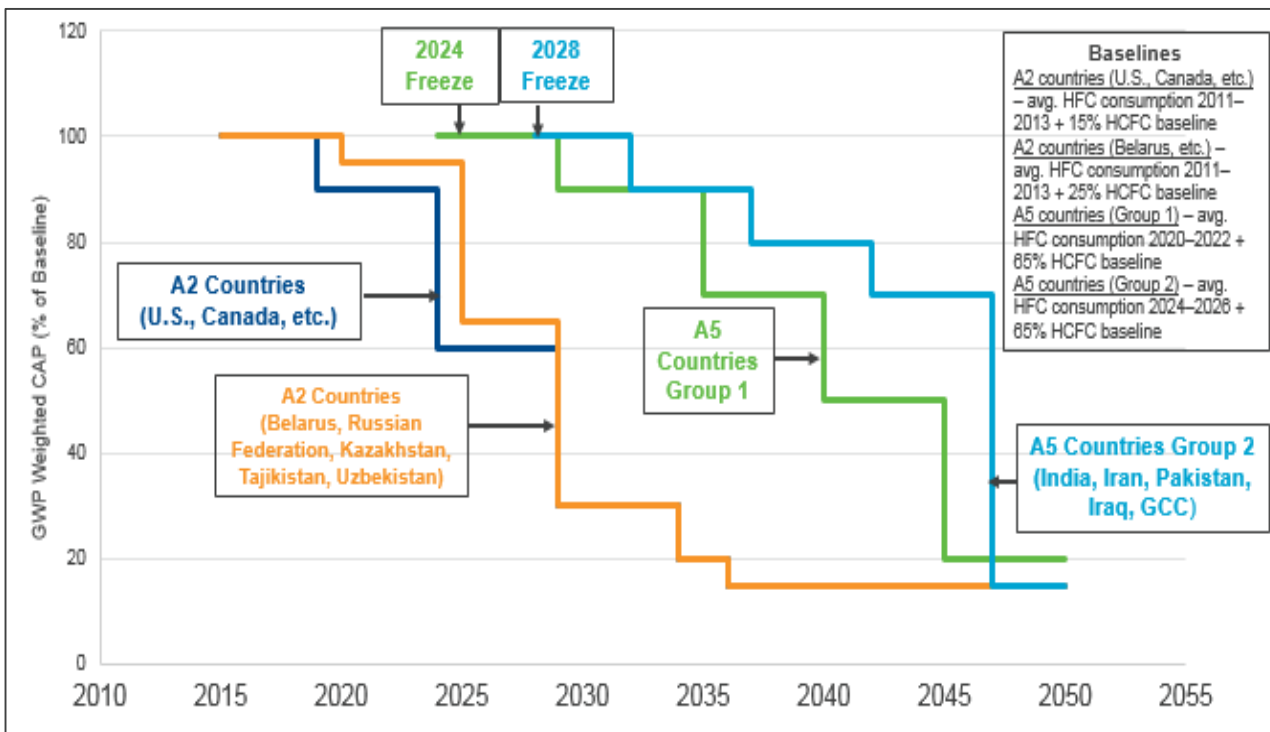
Warner Guo
过炜华

April 10th 2019
2019年 4 月10日



Kigali Amendment to Montreal Protocol

蒙特利尔协定基加利修订案



- Global agreement on HFC phase-down reached by 197 countries in Kigali, Rwanda “28th Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer”

<https://www.state.gov/e/oes/rls/remarks/2017/275874.htm>

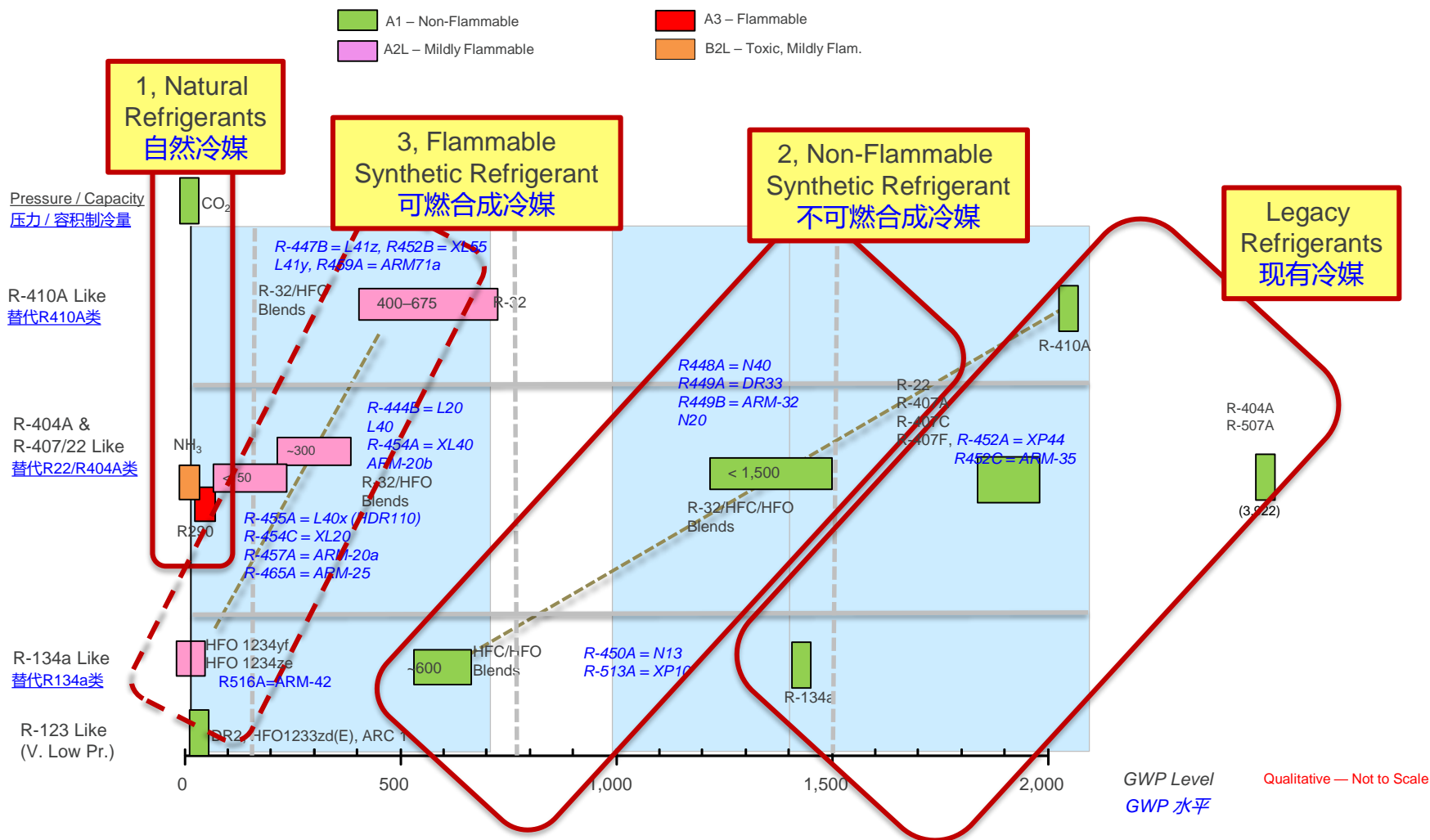
- 197个国家在第28届蒙特利尔协定成员国会议上达成了关于逐步减少HFC消耗的全球协议，即基加利修订案。

http://conf.montreal-protocol.org/meeting/mop/mop-28/final-report/English/Kigali_Amendment-English.pdf

Kigali Amendment Ratified by 69 Countries, Mar 26, 2019;
Went Into Effect Jan. 1, 2019
基加利修订案已于2019年1月1日正式生效
(2019年3月26日为止，已有69个国家批准了基加利修订案)**

New Refrigerants Alternatives

新型替代冷媒



Natural Refrigerant Inherently with Lower GWP
自然冷媒的超低GWP属性是减少HFC消耗的终极选项

Common Natural Refrigerants Comparison

常见自然冷媒比较

Refrigerant 冷媒	R290 (Propane) R290 (丙烷)	R744 (CO2) R744 (二氧化碳)	R717 (Ammonia) R717 (氨)
Critical Temperature 三相点温度	97°C	31°C	133°C
Pressure 压力	Medium-Low 中到低	Very High 非常高 50-70bar Sub-critical 亚临界50-70bar 120bar Trans-critical 超临界120bar	Medium-High 中到高
Volumetric Capacity 容积制冷量	Medium-Low 中到低	Very High 非常高	Medium-High 中到高
Discharge Temperature 排气温度	Low 低	High DLT Required by Trans-critical 跨临界应用需要高排气温度	Very High 非常高
GWP 全球变暖指数	3.3	1	0
ODP 臭氧波坏指数	0	0	0
Safety Code 安规编码	A3 Non-Toxic 无毒性 Highly-Flammable 易燃	A1 Non-Toxic 无毒性 Non-Flammable 不可燃	B2L Toxic 有毒性 Mildly Flammable 弱可燃

Due to Superior Refrigerant Performance, R290 is the Best Natural Option with Wide Coverage (A/C, Refrigeration and Heat Pump), Especially for Small Charge Direct Expansion and All Indirect Systems
R290作为冷媒的良好循环性能决定了它是自然冷媒工质中覆盖应用最广泛(空调, 冷冻, 热泵)的优选冷媒, 尤其适合小充注量的直接膨胀系统和间接系统的应用

State of Safety Standards and Codes On A3 Refrigerant

A3类冷媒的安全标准的现状

	Refrigerant Designation & Safety Classification 冷媒安全性分类	Generic Standard 通用标准	Product / Equipment Standards 产品/设备标准			
			Heating and Cooling Equipment 热泵&制冷设备	Commercial refrigerating appliances 商用冷冻设备	Refrigerating appliances, ice-cream appliances 冷冻设备	Compressor 压缩机
International 国际标准	ISO817 – 2014 Maintenance work	ISO5149 – 2014 adopted for A2L Ongoing Revision (Alignment w/ IEC60335-2-40)	IEC60335-2-40 • <u>A2L : Feb. 2018</u> • <u>A3: 2021</u>	IEC60335-2-89 <u>CDV March 2018</u> <u>Exp. Apr 2019</u>	IEC60335-2-24	EN60335-2-34:2016
China 中国标准	GB7778-2017 (Adopt ISO817) R290: A3	GB9237 – 2017 Aligned with ISO5149	GB4706.32-2012 Aligned With IEC R290: - RAC 0.99Kg - ATWHP: 4.94Kg - Chiller: No Limit(Ind.I) - Chiller 10Kg(Com.I)	GB4706.13 & 72 -2014 Aligned With IEC R290: - Showcase 2.5Kg	GB4706.13-2014 Aligned With IEC	GB4706.17-2010 Align w/ IEC
Japan 日本标准	ISO817	ISO5149	JIS C9335-2-40:2004	JIS C9335-2-89:2005	JIS C9335-2-24:2017	JIS C9335-2-34:2019
<div>Complete 已完成</div> <div>under revision 修订中</div>						

1. A3 Refrigerant Charge Limit Increase Under Assessment In International Organizations

国际组织正在评估提高A3类冷媒充注量限值

- IEC60335-2-89 (A3 Charge Increase) Final Vote at Apr 2019 , IEC60335-2-89中提高A3冷媒充注量的最终投票将在19年4月进行
- IEC60335-2-40 (A3 Charge Increase) Expected to be Approved in 2021 , IEC60335-2-40 中提高A3冷媒充注量的内容预计在21年将被批准

1. Asian Local Standards Align With International Standards/Regulations (ISO & IEC)

亚洲区域的国家标准与国际标准保持一致

R290(Propane) Characteristics & Application Introduction

R290(丙烷) 的属性及现有应用介绍

Characteristics / 属性

Property	Rating
Critical Temperature 临界温度	97°C Good for Most Applications 适用于大多数应用
Pressure 压力	Medium-Low 中到低 22.4bar at 65°C Saturated饱和 55% of R410A 89% of R22
Volumetric Capacity 容积制冷量	Medium-Low 中到低 60% of R410A, 85% of R22 Could be Compensated by High Speed Variable Speed Technology 可用高转速变频技术补偿
GWP	3.3
ODP	0
Safety Code 安全	A3 Non-Toxic, 无毒性 Flammable 可燃

Current Applications/现有应用

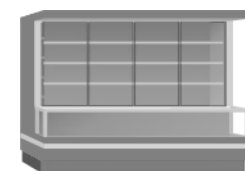
- Room A/C (500g Charge Limit)
房间空调器



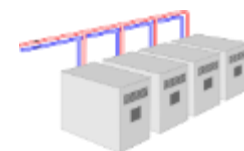
- Air To Water Heat Pump
空气源热泵热水器



- Commercial Reach-in
Showcase
商用展示柜



- Process Coolers & Chillers
工业冷却和冷水机组

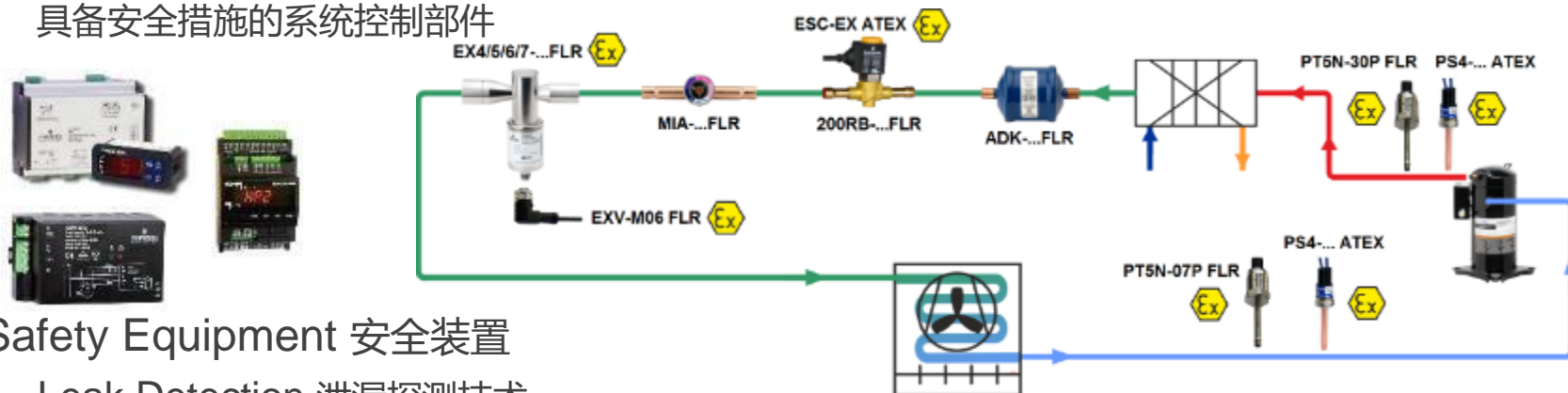


Good Refrigerant Properties and Wide Application Coverage for R290
R290具有良好的制冷循环属性和环境属性，因而具有广泛的应用前景

R290 Key Components Ready for Market

R290 制冷系统中的关键零部件已有成熟应用

- Compressor 压缩机
 - Full Lineup Compressor Availability
完备的R290压缩机系列
 - Lubrication Design to Solve Potential Wear
针对R290优化的润滑设计
- Controls & Line Components 控制&流体部件
 - System Control Combined With Safety Measures
具备安全措施的系统控制部件



- Safety Equipment 安全装置
 - Leak Detection 泄漏探测技术
 - Safety Valves 安全阀

System Components Demonstrated to be Efficient and Safe through Field Testing
系统关键零部件的高效率 and 安全性在现场测试中已得到证明

Compressor Performance Test Result Comparison

压缩机性能测试结果对比

Compressor 压缩机	GB25127 IPLV(H) (W/W)
4HP R410A Variable Speed Compressor 4HP R410A 变频压缩机	2.99 Base Line 基准
4HP R290 Variable Speed Compressor 4HP R290 变频压缩机	3.18 106%

Compressor 压缩机	GB25127 COP(H) (W/W)
5HP R410A Fixed Speed Compressor 5HP R410A 定速压缩机	2.47 Base Line 基准
5HP R290 Fixed Speed Compressor 5HP R290 定速压缩机	2.72 110%



R290 Compressor Test Stand
R290压缩机测试台

R290 Compressor Could Reach 6-10% Higher Efficiency Compared to R410A
R290压缩机和R410A压缩机对比，能效可以提高6%-10%

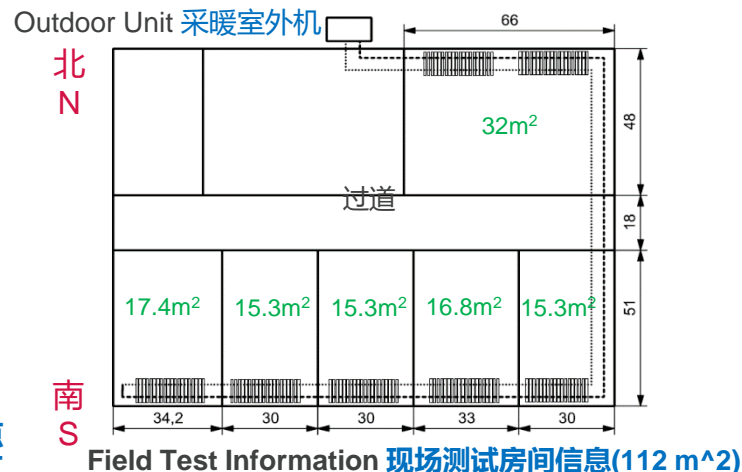
Emerson R290 Variable Speed Integrated Solution For HWHP

艾默生采暖用R290变频热泵热水机组整体解决方案

- Field Test 现场测试



Field Test Location : 现场测试地点
Miyun district, Beijing 北京市密云区



Emerson R290 Variable Speed Integrated Solution

艾默生R290变频整体解决方案



Safety Insurance

安全防护



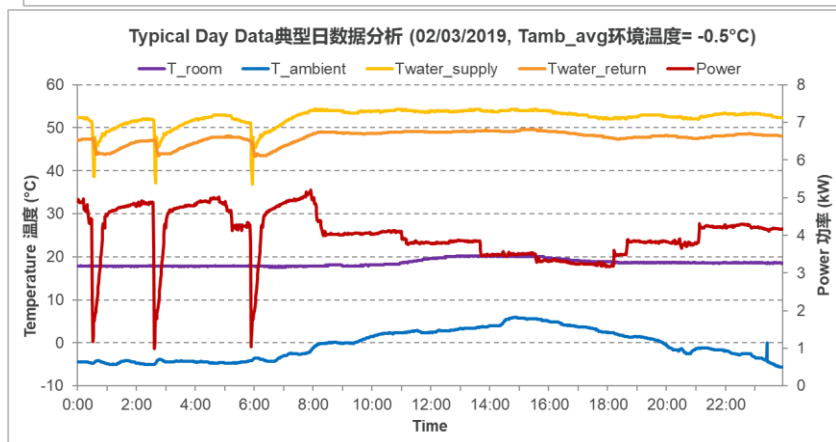
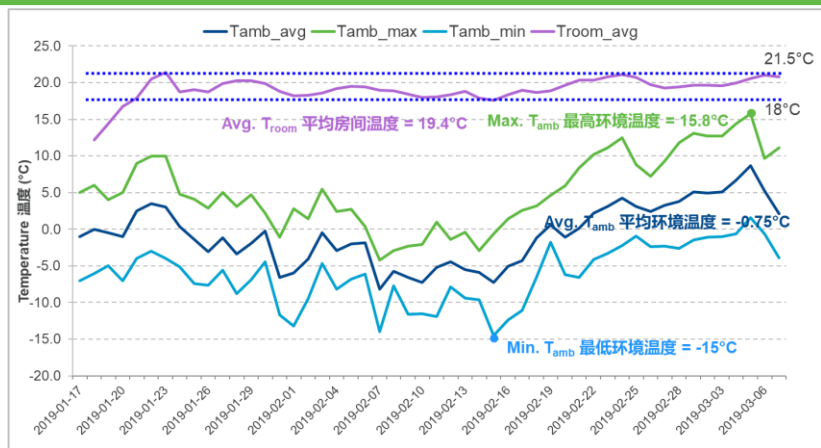
Emerson R290 Variable Speed Integrated Solution For HWHP

艾默生采暖用R290变频热泵热水机组整体解决方案

- Field Test Data Analysis 现场测试数据分析

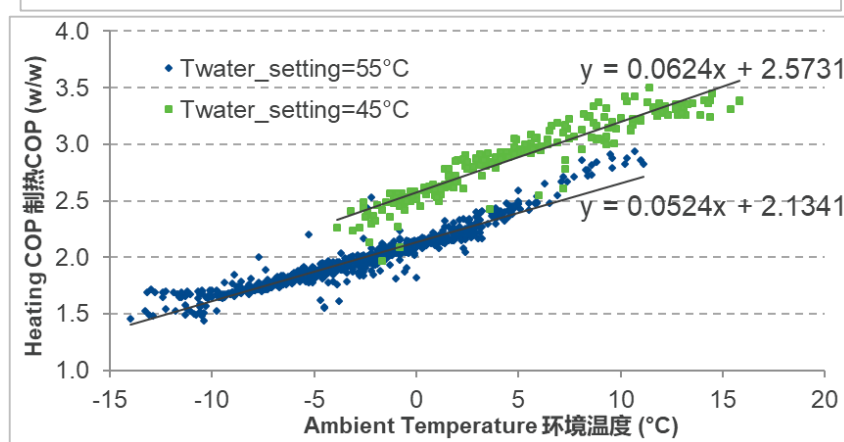
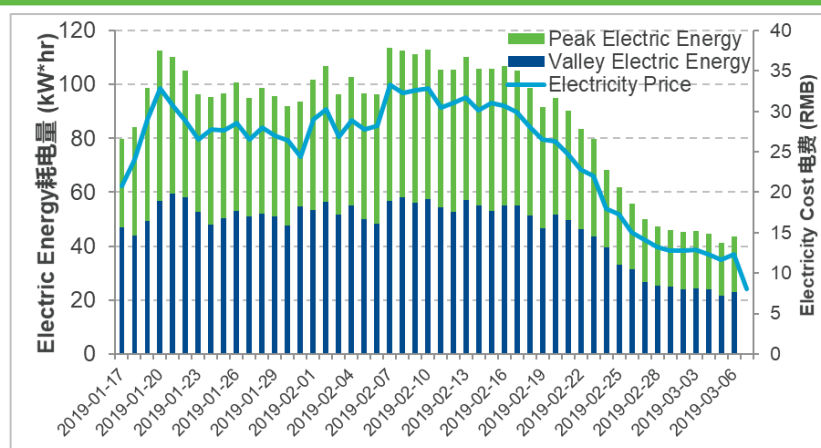
Stable & Comfortable Operation

稳定舒适运行状态



Operation Cost & System

运行费用及系统HCOP分析



- System stable runs for ~50 days w/ good system control and deliver comfortable room temp.
- 系统持续稳定运行50余天，通过良好系统控制提供舒适房间温度
- Average heating cop is 2.19 ($t_{water_out}=55^{\circ}C$ setting of most time), average running cost is 24.8 RMB/day
- 平均制热COP为2.19 (55°C 出水温度占据大部分时间)，平均运行费用为24.8元/天

Summary 总结

- Low GWP Requirement Diversified Refrigerant Options

低GWP冷媒的需求使冷媒的选择更多样化

- A1 Synthetic Refrigerants with Medium GWP

A1类合成冷媒具有中等水平GWP值

- A2L Synthetic Refrigerants with Medium and Low GWP (HFO & its Blends)

A2L类合成冷媒(包含HFO混合冷媒)具有中到低水平的GWP

- Natural Refrigerants with Low GWP

自然冷媒具有超低的GWP水平

- R290 Has Multiple Advantages over Other Natural Refrigerants

R290 和其他常见自然冷媒相比具更多项优势

- R290 Key Components Ready for Market

R290制冷系统的关键零部件已有成熟应用

- System Performance and Field Test Demonstrated Efficiency and Safety with Appropriate Application

制冷系统的性能测试以及现场测试证明R290在合适的应用中兼具高效性与安全性

Backup

2 艾默生空调应用产品型谱 - R32新冷媒系列

AC展区

UNEP展区

HP	App.	4	5	6	7	8	10	12	13	15	20	25	30	40
家用 型号	PAC/Cassette/ Duct	<div><div><div></div><div></div><div></div><div></div></div><div>63Fr Non-Injection</div></div>												
商用 型号	PAC/Chiller	<div><div><div><div></div><div></div><div></div><div></div></div><div></div><div><div></div><div></div><div></div></div></div><div>LI/VI Injection Qst /SMT Platform</div></div>												
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变频 型号	PAC/VRF	<div><div><div><div></div><div></div></div><div></div><div><div></div><div></div></div></div><div>LS 53Fr Injection / Non-Injection LS 63Fr Injection/Non-Injection</div></div>												
	VRF/Chiller	<div><div><div></div><div></div><div></div></div><div>LS 70Fr Non-Injection /Injection(80cc)</div></div>												



2014



2017



2019 ~ 2020