LG

Ahead of the Expected

Strategic Comparison of Air-cooled and Water-cooled Chillers:

A Guide to Optimal System Selection

WHITE PAPER

Strategic Comparison of Air-cooled and Water-cooled Chillers

01
Introduction:
The Strategic Importance of Chiller Selection

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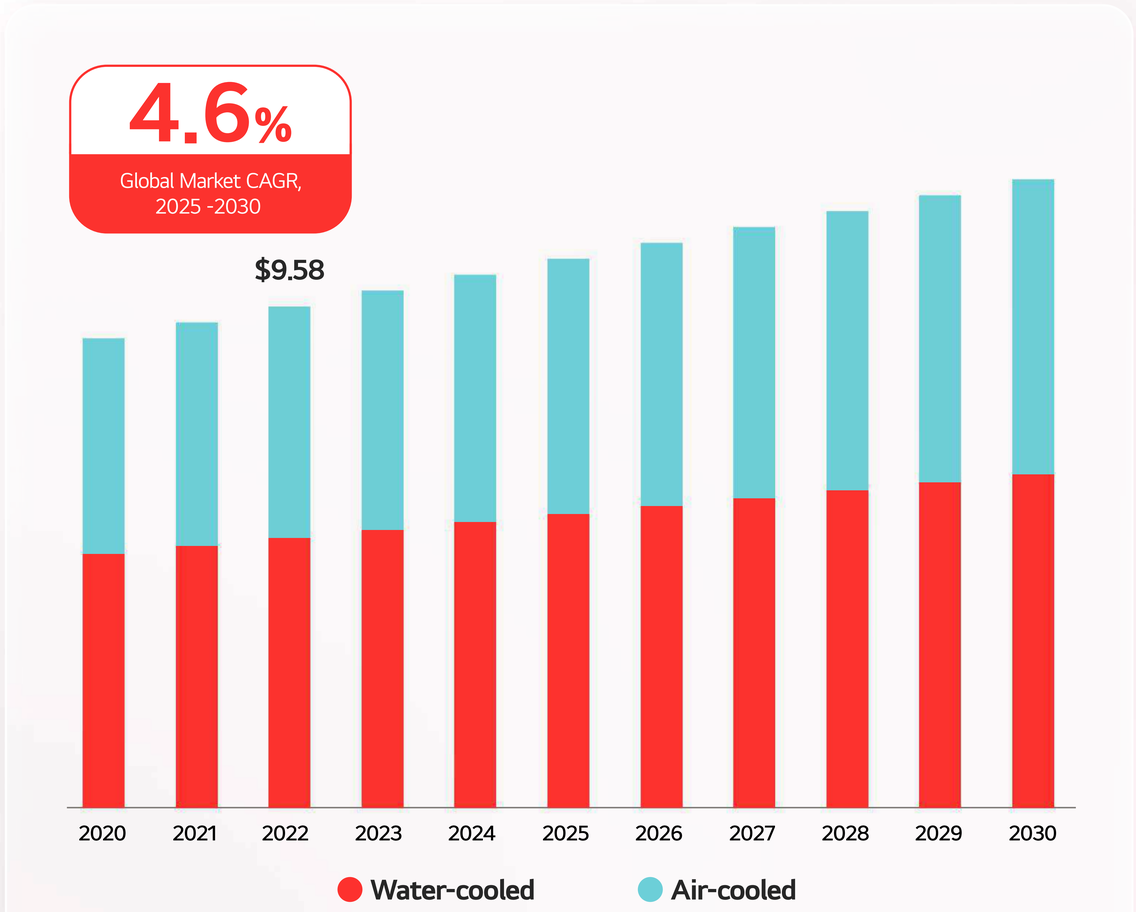


Chillers market size by product, 2020 – 2030(USD Billion)

In today's rapidly evolving industrial and commercial landscape, the demand for effective and efficient cooling systems has never been greater. Sectors such as data centers, manufacturing facilities, and commercial real estate increasingly recognize cooling not as a supplementary utility, but as essential infrastructure crucial to operational stability, energy management, and even business continuity.

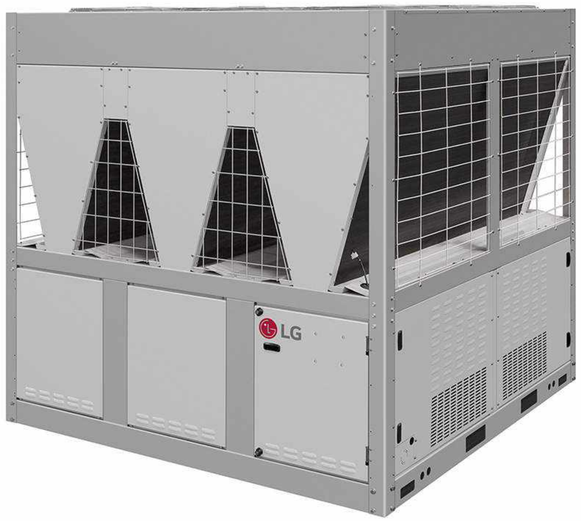
Traditionally, cooling solutions heavily depended on direct-expansion systems utilizing refrigerants. However, recent technological and environmental trends have shifted the focus toward water-based cooling systems. These systems are increasingly valued for improved energy efficiency, regulatory compliance, and lower environmental impact, aligning with global movements toward carbon neutrality.

https://www.grandviewresearch.com/industry-analysis/chillers-market

Introduction:
The Strategic Importance of Chiller Selection

At the heart of cooling infrastructure lies the chiller system, with air-cooled chillers and water-cooled chillers standing out as two principal options. Each type offers distinct technical characteristics and advantages depending on specific project environments.

This white paper provides a comprehensive comparison of air-cooled and water-cooled chillers across key decision-making factors and explores how LG's advanced technologies can meet evolving project requirements.



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Overview of Chiller Systems and Operating Principles

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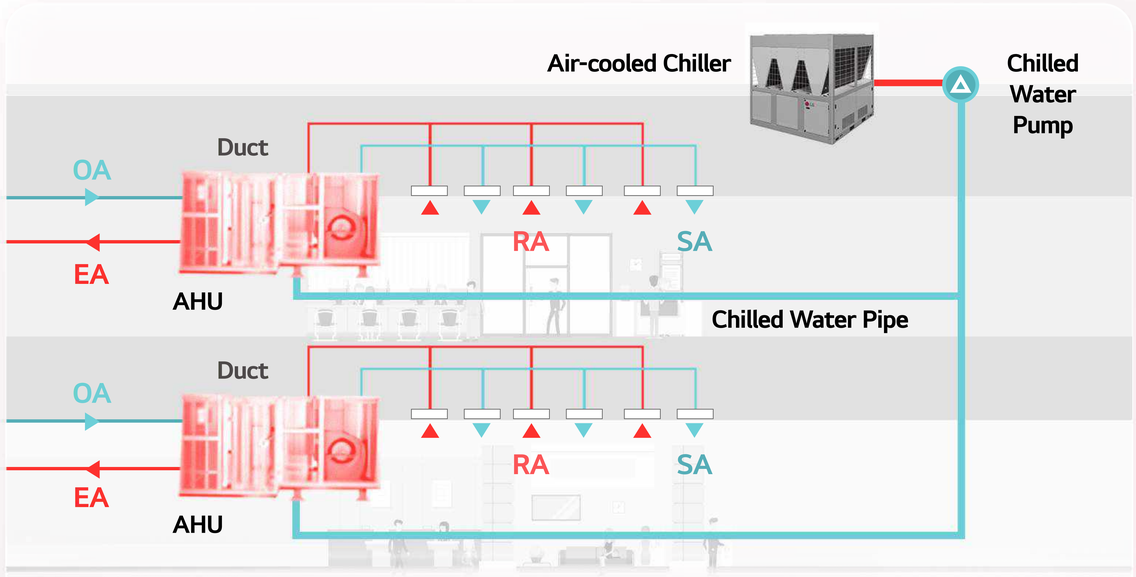
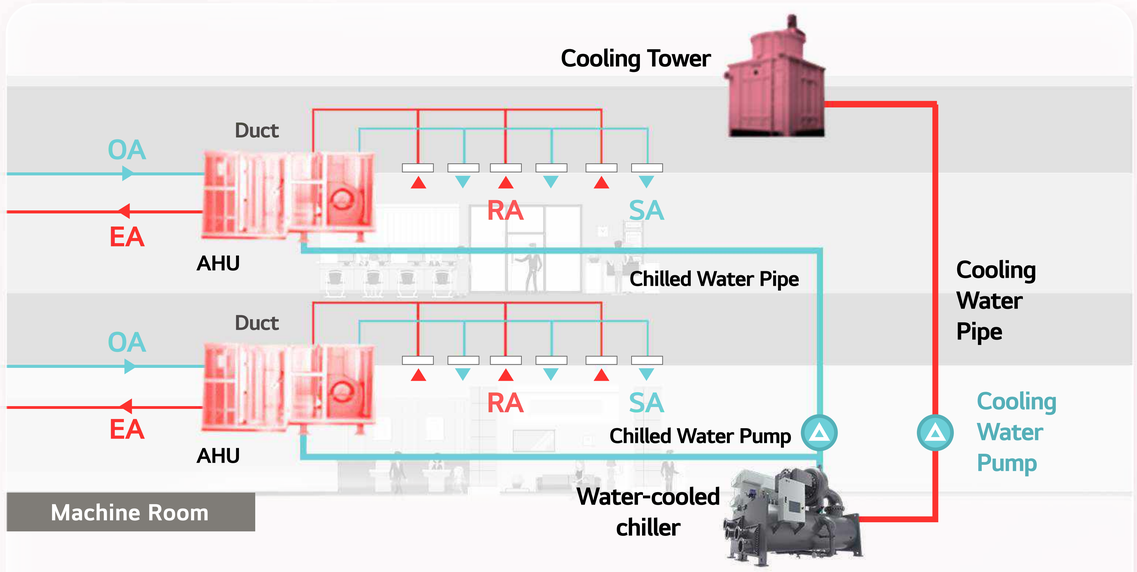


[Figure 1] Air-cooled System



[Figure 2] Water-cooled System

Chillers are central to modern cooling systems, functioning as the primary source of chilled water for air conditioning and process cooling applications in buildings and industrial environments. By producing chilled water and circulating it through heat exchangers, chillers absorb unwanted heat from interior spaces or equipment, maintaining thermal control across a wide range of environments.

While all chillers operate on similar thermodynamic principles, they differ significantly in how they reject heat—primarily through air (air-cooled) or water (water-cooled)—a distinction that influences efficiency, installation, and maintenance strategies.[Figure 1, 2]

Air-cooled chillers expel heat directly to the atmosphere using fans and ambient air, offering simpler installation without the need for cooling towers. They are compact and often preferred for retrofits or projects with space or water constraints.

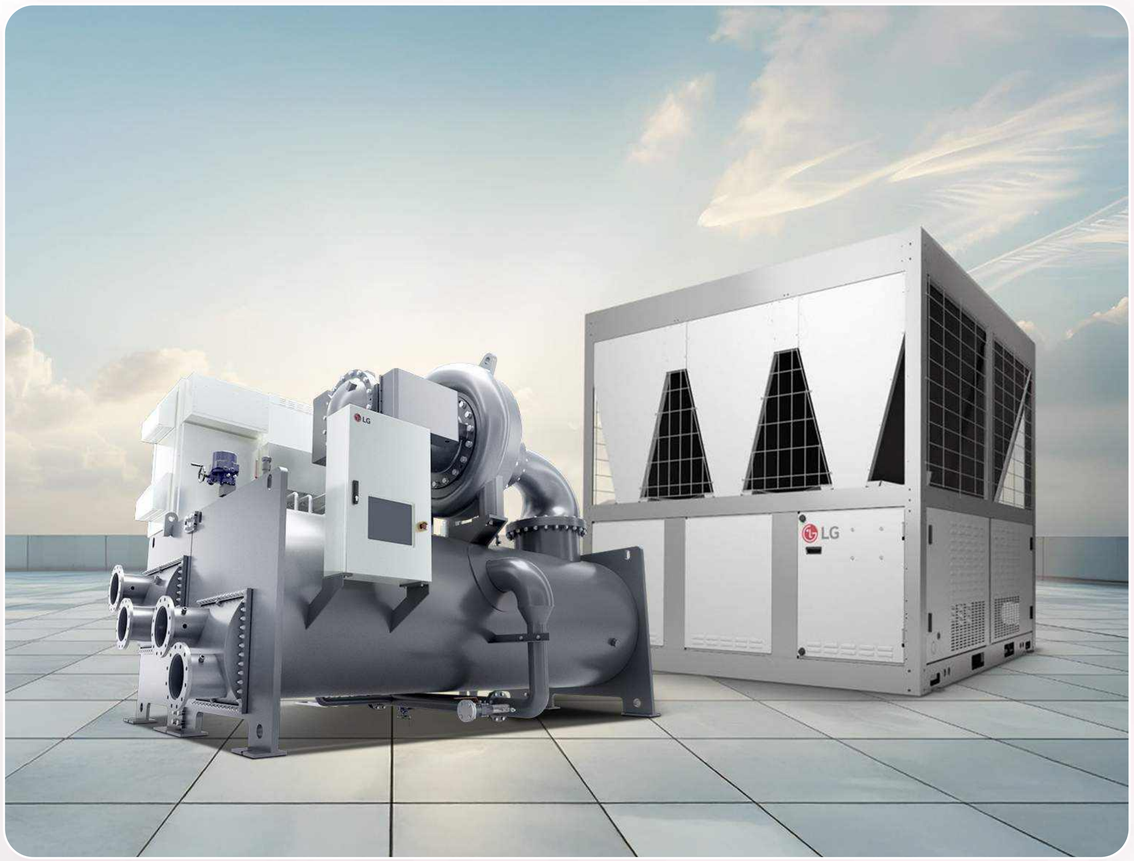
In contrast, water-cooled chillers transfer heat to a secondary water loop, which is then cooled via an external cooling tower. While this setup involves more infrastructure, it delivers greater energy efficiency and stable performance, especially under heavy or continuous cooling loads.

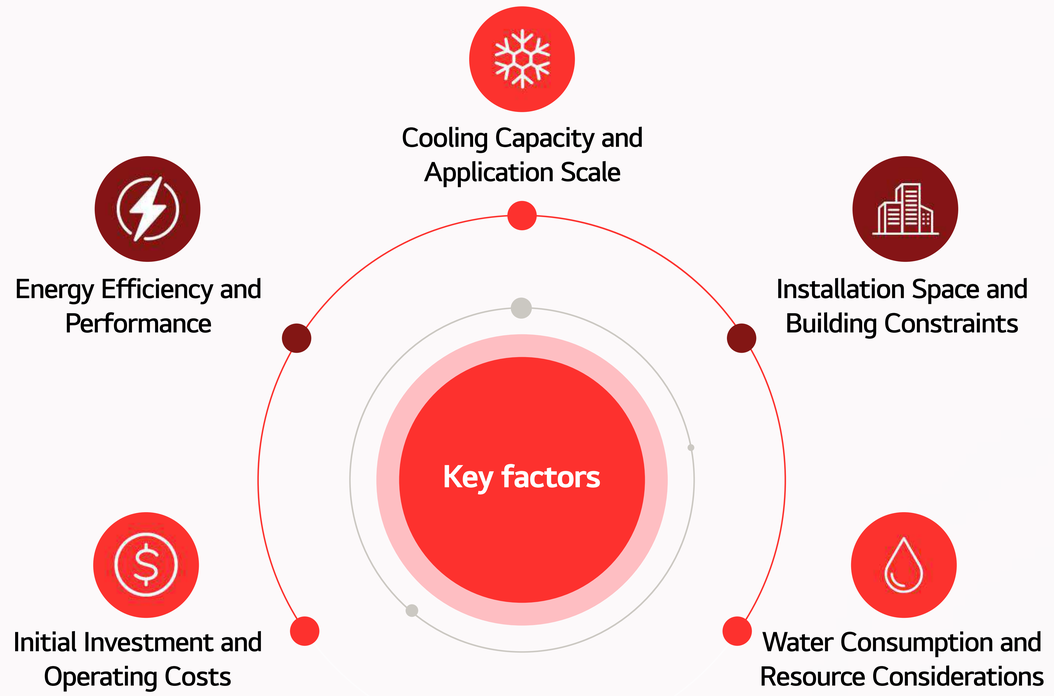
03

Air-cooled vs Water-cooled Chillers:

Key Comparison and Application Strategies

Air-cooled vs Water-cooled Chillers:
Key Comparison and Application Strategies





Choosing the appropriate chiller type is a critical decision that directly influences a project's energy efficiency, installation feasibility, operational costs, and long-term sustainability. This section provides a comprehensive comparison of the two systems across key factors essential for decision-making.

Cooling Capacity and Application Scale

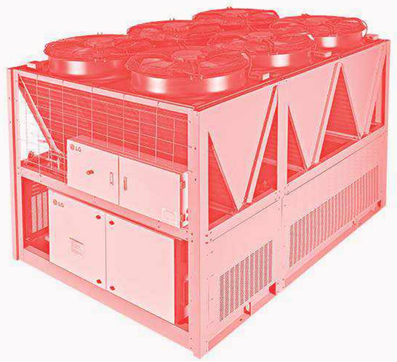
[Figure 3] Cooling capacity and application scale

Air-cooled chillers typically offer a cooling capacity range of 20 to 600 RT, making them well-suited for small to medium-sized installations such as educational institutions, mid-sized office buildings, and localized data centers. Their compact design and straightforward installation process allow them to effectively serve facilities with moderate loads and limited space.

In contrast, water-cooled chillers can accommodate a significantly broader range of cooling requirements, handling loads from 200 RT to well beyond 3,000 RT. They are engineered for large-scale applications that require continuous, high-volume cooling—such as massive data centers, manufacturing complexes, and huge shopping malls. [Figure 3]

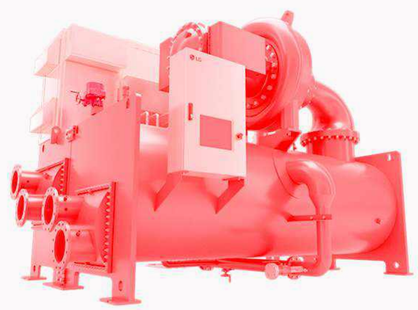
Energy Efficiency and Performance

Air-cooled Screw Chiller



IPLV 5.07

Water-cooled Oil-Free Centrifugal Chiller



IPLV 10.45

[Figure 4] Comparison of LG chiller models with the same capacity (1,058 kW)*

Energy efficiency is a decisive factor in chiller selection, affecting both environmental impact and total cost of ownership. Air-cooled chillers, while efficient under moderate conditions, may see reduced efficiency under high ambient temperature conditions, particularly during peak summer periods or in hot climates.

Water-cooled chillers generally offer more stable performance in high-load conditions, as the use of a cooling tower facilitates effective heat dissipation even during elevated outdoor temperatures. This design can contribute to improved seasonal performance under typical operating environments. [Figure 4]

As such, water-cooled chillers are generally more energy efficient than air-cooled systems across a range of operating conditions, including both full and partial loads.

*Based on LG internal test of model RCAW030VA2C and RCWFLAP at AHRI temperature condition

Installation Space and Building Constraints

Physical space availability is another crucial determinant in chiller selection. Air-cooled chillers are advantageous in projects with limited site area because they can be installed outdoors, such as on rooftops or in open courtyards, without the need for a cooling tower or extensive mechanical rooms.

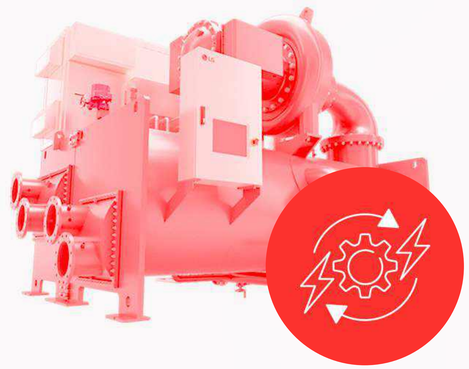
On the other hand, water-cooled chillers require dedicated indoor plant rooms for the chiller units themselves, as well as additional space for cooling towers, cooling water pumps and piping infrastructure. As such, they are best suited for facilities where ample mechanical space is incorporated into the initial building design.

Initial Investment and Operating Costs

In terms of initial capital expenditure, air-cooled chillers generally offer a 10% to 15% lower upfront cost compared to water-cooled systems. Their simplified design and lack of ancillary components such as cooling towers and condenser water pumps also contribute to reduced maintenance requirements.

While water-cooled chillers involve higher initial investments, they provide substantial operational cost savings over time, primarily due to their higher energy efficiency. When the payback period is within three years, water-cooled chillers are generally the more advantageous option. It is also important to note that accurate payback analysis should account for water-related operational costs, which can vary significantly depending on regional conditions and utility pricing.

Low initial investments



Low operational cost

Water Consumption and Resource Considerations

Water usage is also a key differentiator between air-cooled and water-cooled chillers, particularly in the context of operating cost management and infrastructure availability. Air-cooled chillers do not need a cooling tower or cooling water loop, which means they consume no process water during operation. This makes them especially well-suited for regions with water scarcity or where access to utility water is limited or unreliable.

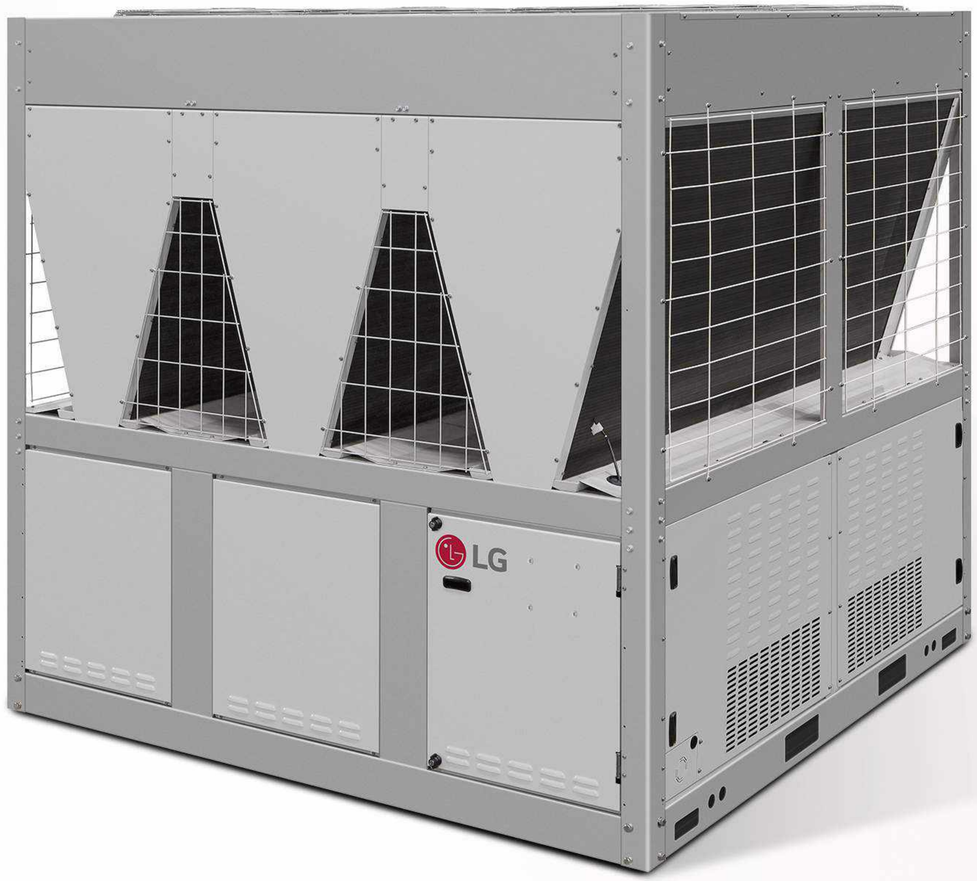
Water-cooled chillers, on the other hand, rely on continuous water circulation and evaporative cooling via a cooling tower. They incur ongoing water consumption and treatment costs, which can be substantial depending on site conditions. In arid regions, where securing a stable water supply is costly or technically challenging, water-cooled chillers may be less feasible. Therefore, for such environments, water availability should be a key consideration when selecting the appropriate chiller system.

Selection Factor	Air-cooled Chiller	Water-cooled Chiller
Cooling Capacity	Best for small to medium-sized facilities (20–600 RT)	Suitable for large-scale facilities (200–3,000+ RT)
Energy Efficiency	Good part-load performance, affected by high ambient temperatures	Superior full- and part-load efficiency, stable in all conditions
Space Requirements	Rooftop or open space installation possible, no cooling tower required	Space needed for cooling towers, mechanical room, and cooling water piping
Water Consumption	None (air-cooled)	High (continuous cooling water usage)
Maintenance Needs	Lower; fewer components	Higher; includes water treatment, tower maintenance

04
Chiller Selection Guide

Chiller Selection Guide:
Air-cooled Chillers Perspective

When evaluating air-cooled chillers, it is essential to assess more than just headline efficiency figures. Project-specific factors such as operational patterns, spatial constraints, and environmental objectives must all be considered to ensure the selected system delivers maximum value across its full lifecycle. This section explores the key decision factors and how LG's solutions support informed and future-ready choices.



Energy Efficiency Under Partial Load Conditions

In real-world operations, chillers rarely operate at full load. Instead, most facilities experience fluctuating demands throughout the year, making part-load efficiency a critical performance indicator. LG's air-cooled inverter scroll chillers leverage inverter-driven scroll compressors and active valve control to dynamically adjust output based on demand. When operating at partial capacity, the system maintains superior efficiency, helping facilities to lower annual energy consumption and reduce operational costs. Performance benchmarks include:*

LG Inverter Scroll Chiller performance

10.92

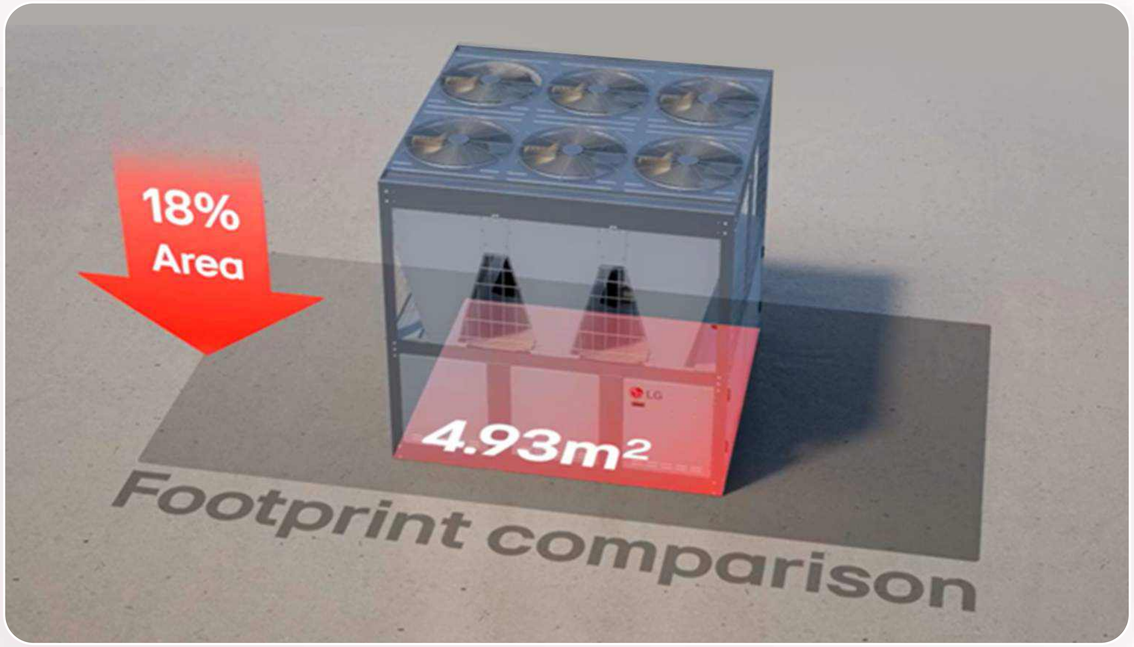
EER (Energy Efficiency Ratio)

20.13

IPLV (Integrated Part Load Value)

Unit: Btu/Wh

Installation Flexibility



Air-cooled chillers are typically installed on rooftops, terraces, or adjacent open spaces, making them particularly well-suited for environments with limited available land or constrained building footprints. In dense urban projects, the small footprint of air-cooled chillers can be a decisive advantage.

LG's air-cooled inverter scroll chillers further enhance this benefit with a compact design. They have a footprint that is 18% smaller** than other solutions for 60RT installations, allowing for simple and flexible installation even in highly space-constrained sites.

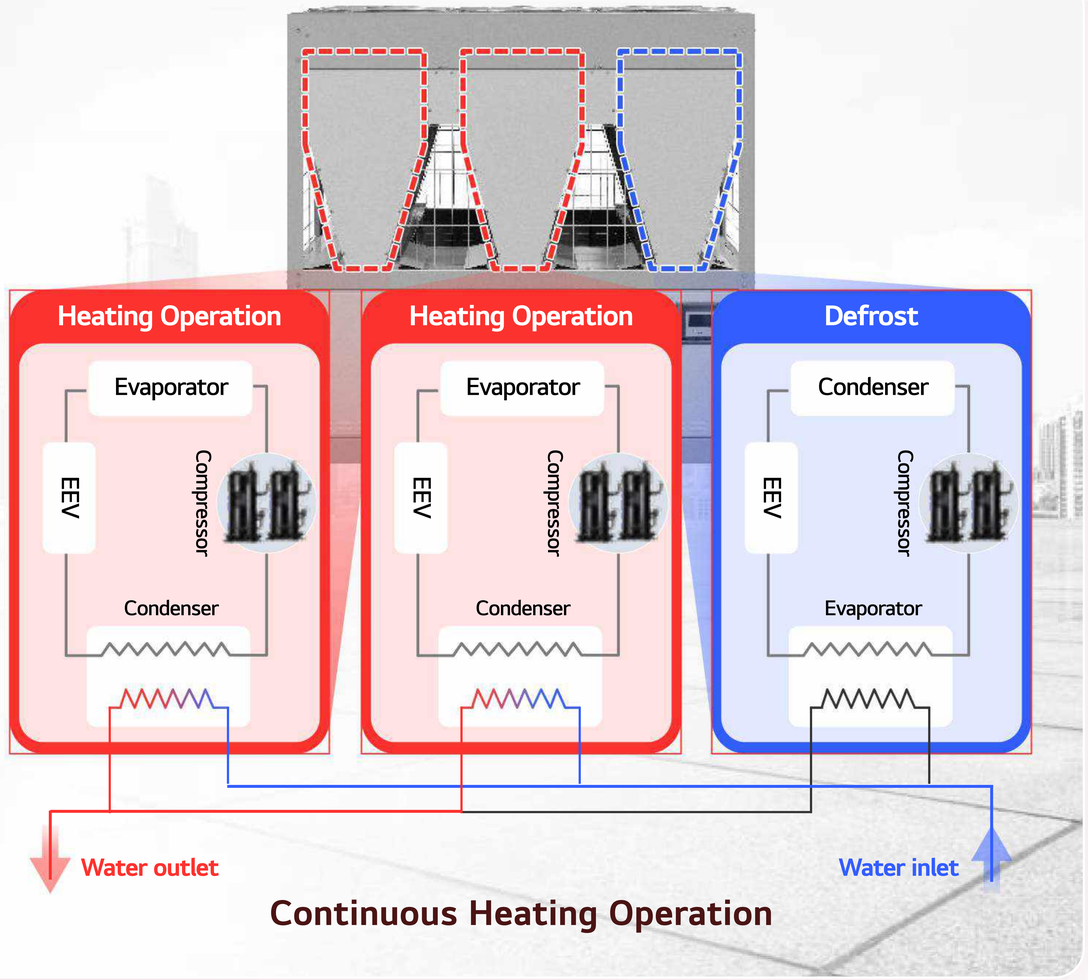
*Based on LG Air-Cooled Inverter Scroll Chiller 50RT model at AHRI temperature condition

**The footprint comparison of the LG INVERTER SCROLL CHILLER series is made against C company's 30RC series model and Y company's YLAA series model, based on an equivalent capacity range of 60RT.

Environmental Sustainability

Environmental responsibility has moved to the forefront of facility planning, with building owners and operators seeking to minimize carbon emissions. LG's air-cooled inverter scroll chillers help achieve these goals by using R32 refrigerant, which has a low Global Warming Potential (GWP) compared to traditional refrigerants like R410A.

Reliability and Maintenance



Continuous Heating Operation

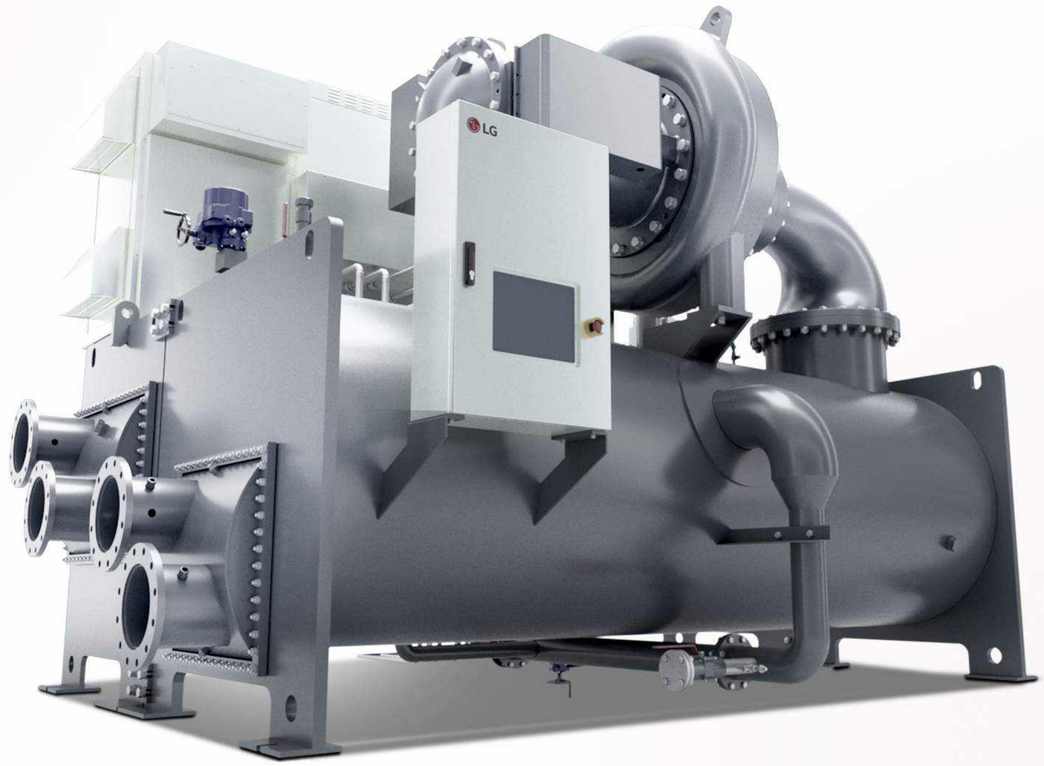
Operational reliability is crucial, particularly for mission-critical facilities that cannot afford heating and cooling interruptions. LG's air-cooled inverter scroll chillers are engineered with multiple features that reinforce system stability and reduce maintenance burdens:

- **Continuous heating functionality** during defrost cycles—a critical requirement when chillers are used as heat pumps—prevents service disruptions in colder seasons.
- **Wide operating ranges** enable reliable year-round performance
  - Cooling from -15°C to 52°C
  - Heating from -30°C to 35°C
  - Water outlet temperatures ranging from 4°C to 25°C (chilled)*
  - Water outlet temperatures ranging from 30°C to 60°C (hot)*
- **Corrosion-resistant Black Fin heat exchangers** enhance system durability—a feature for air-cooled chillers typically installed outdoors and exposed to harsh, polluted, or coastal environments.

*Based on internal test of LG Inverter Scroll Chiller 50RT model

Chiller Selection Guide:
Water-cooled Chillers Perspective

Selecting a water-cooled chiller involves a more complex decision-making process compared to air-cooled systems. Water-cooled chillers offer exceptional energy efficiency and scalability but require careful consideration of infrastructure, maintenance planning, and long-term operational goals. This section explains the key evaluation factors and how LG's solutions are designed to meet these high-demand requirements.



Energy Efficiency for High-demand Facilities

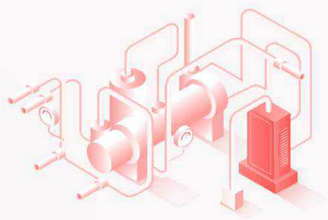
Energy consumption is a major operational cost in facilities with large, continuous cooling needs, such as data centers, hospitals, shopping complex, and manufacturing plants. For these projects, energy efficiency over the full operating spectrum is essential, not just peak efficiency under ideal conditions. LG's water-cooled oil-free inverter centrifugal chiller delivers significant improvements in energy performance:

- Up to 75% increase* in part-load efficiency (NPLV) compared to constant speed compressors.
- Up to 40% reduction* in annual operating energy costs compared to constant speed compressors.

By minimizing energy waste during both full-load and part-load operations, LG's systems support facilities in achieving aggressive cost control targets.

Infrastructure Requirements and Spatial Considerations

A mechanical room for housing chiller units



Cooling water piping and associated pumping systems.

Cooling towers for heat rejection

[Figure 5]Mechanical components of a Water-cooled Chiller

Water-cooled chillers necessitate a more complex mechanical setup than air-cooled systems. [Figure 5]
Thus, they are most suitable for new construction projects or major retrofits where mechanical spaces can be designed to accommodate these systems from the outset. Although the initial infrastructure investment is higher, the long-term operational savings and scalability make water-cooled chillers a strategic choice for high-capacity, mission-critical installations.

*Based on internal test of LG Oil-Free Inverter Centrifugal Chiller 500RT model, chilled water 12/7℃, cooling water 32/37℃. Actual result may vary according to environment.

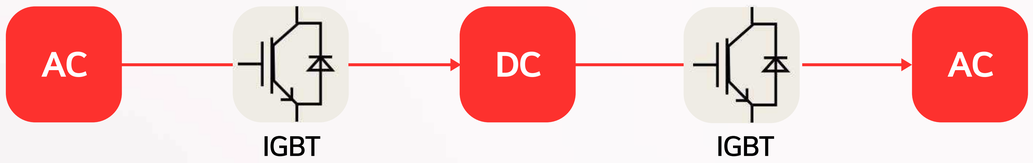
Environmental Sustainability

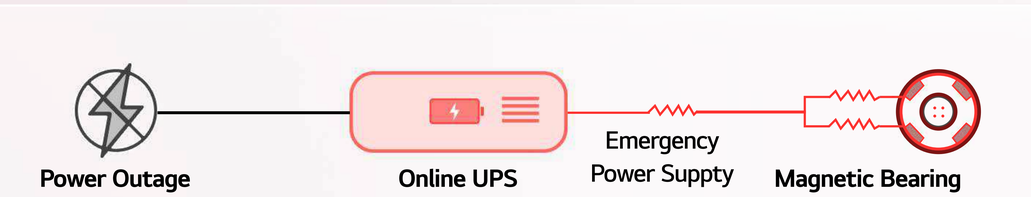
Modern building projects increasingly prioritize sustainability as well as regulatory compliance. Water-cooled chillers contribute significantly to environmental performance goals by:

- Reducing overall carbon emissions by utilizing low GWP refrigerants. LG offers water-cooled chillers that use refrigerants with low GWP such as R1233zd.
- May contribute to LEED certification, where HVAC system performance is a major evaluation criteria. Relevant chiller characteristics such as energy efficiency and refrigerant charge volume can support credit acquisition. Many LG water-cooled chillers are designed to meet the ≤1.3 kg/RT refrigerant threshold, aligning with commonly referenced LEED guidelines.

Operational Reliability and Maintenance Capabilities

In facilities where downtime is not an option, cooling system reliability is paramount. LG's water-cooled oil-free inverter centrifugal chillers address this through multiple layers of advanced technology:





- **Utilizing advanced TDDI inverter technology**, which minimizes electrical harmonic distortion and enhances system-wide energy quality.
- **Bearing protection systems (Online UPS)** safeguard critical compressor components during emergency shutdowns.
- **AI-based surge prevention algorithms,** built on virtual modeling and machine learning, predict load fluctuations and adjust operating parameters in real time to reduce the risk of instability.

*No need to install harmonic filter

05
Conclusion

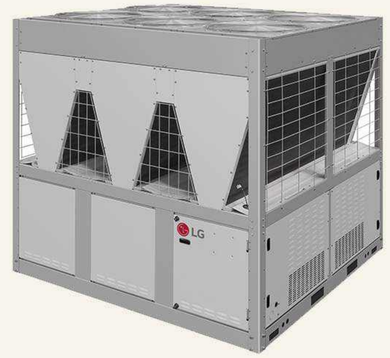
Selecting the right chiller system is a strategic decision with lasting impacts on operational efficiency, cost management, and environmental performance. Rather than focusing solely on initial investment, project planners must consider installation conditions, cooling demand patterns, long-term energy optimization, and sustainability goals.

Air-cooled chillers are ideal for projects requiring installation simplicity, limited site space, offering quick deployment and cost-effective cooling. Water-cooled chillers, on the other hand, excel in large-scale, high-demand facilities, delivering superior energy efficiency.

LG's advanced air-cooled and water-cooled chiller solutions combine inverter technology, low-GWP refrigerants, and smart connectivity to deliver resilient and energy-efficient performance, helping facilities meet today’s demands and prepare for tomorrow’s challenges.

06 Lineup

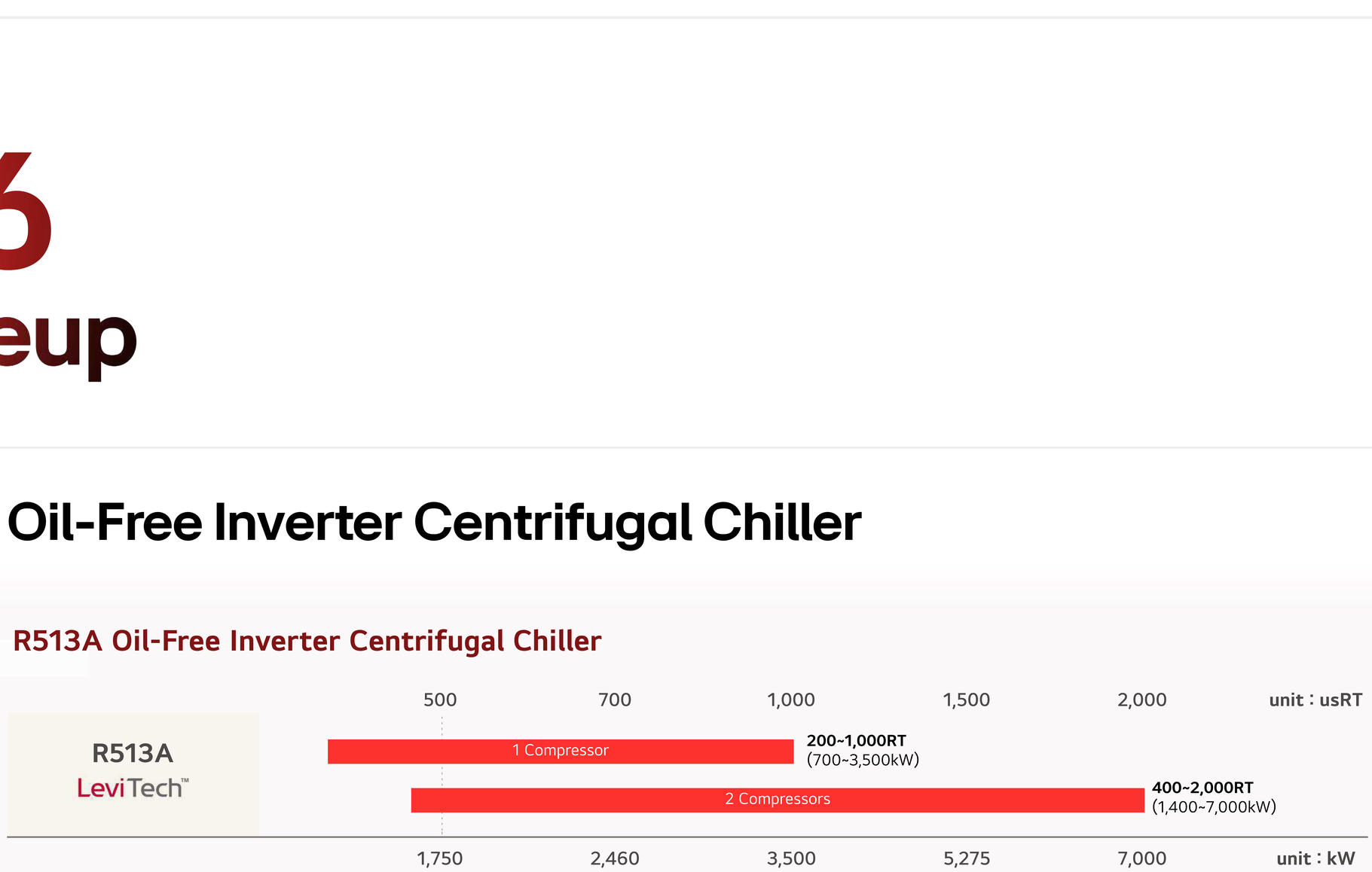
LG Air-cooled Inverter Scroll Chiller

		RT	17 ~ 23		33 ~ 45			50 ~ 67		
Unit										
Capacity (kW)	Cooling		57	65	74	114	130	148	171	195	222
	Heating		60	70	82	120	140	164	180	210	246

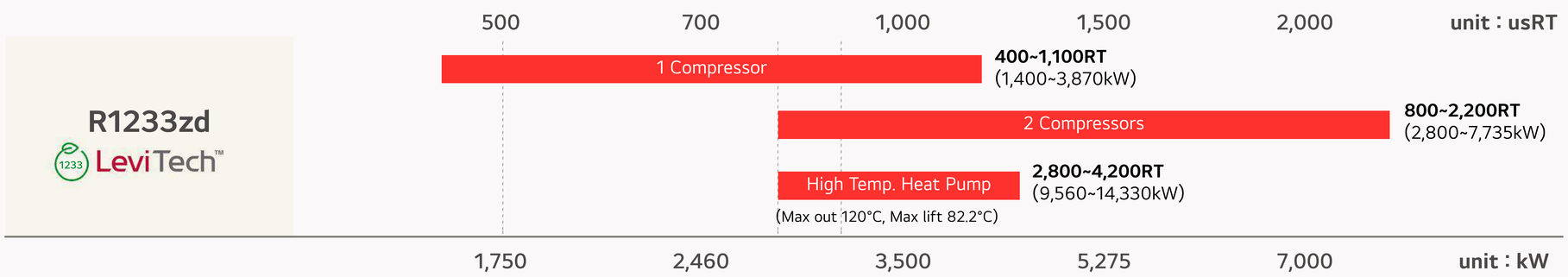
06 Lineup

LG Oil-Free Inverter Centrifugal Chiller

R513A Oil-Free Inverter Centrifugal Chiller



R1233zd Oil-Free Inverter Centrifugal Chiller



*The R1233zd two compressor model is under development and its launch timing is subject to change.

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by Tae Jin Kang, Technical Expert