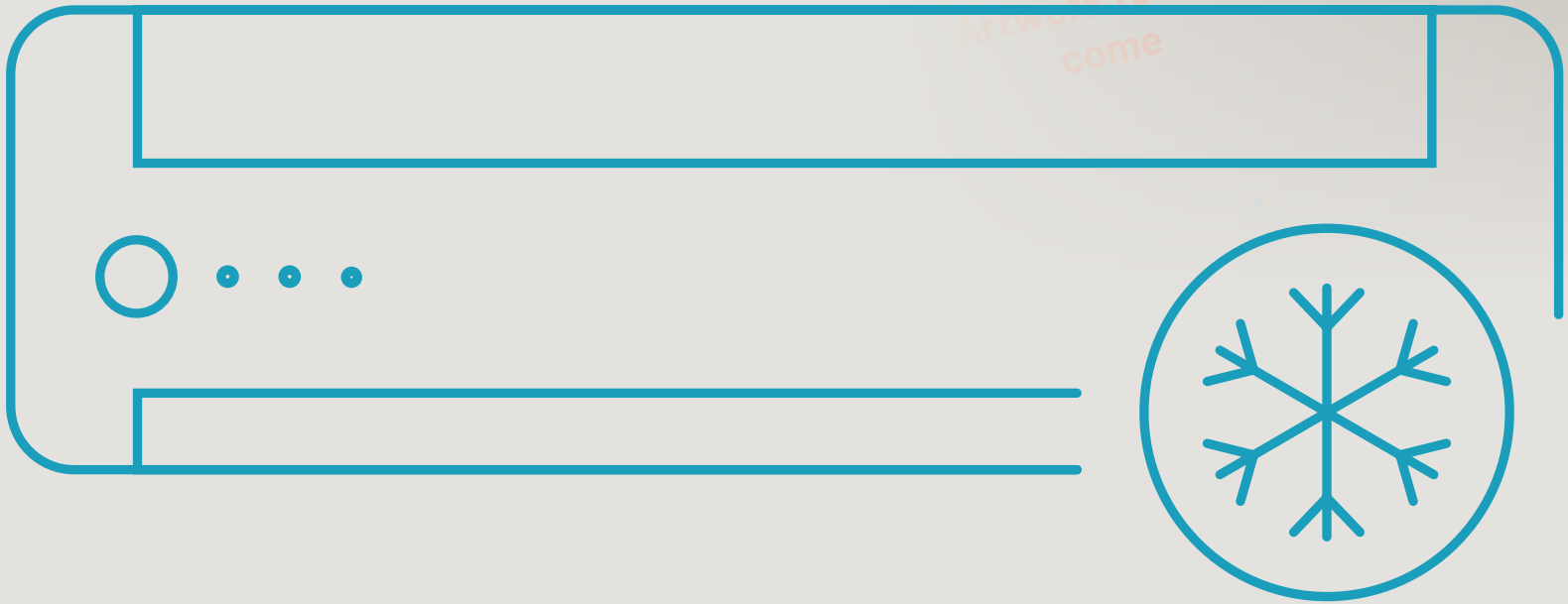
Cool Up

Recommended ✓✓
sustainable cooling solutions for

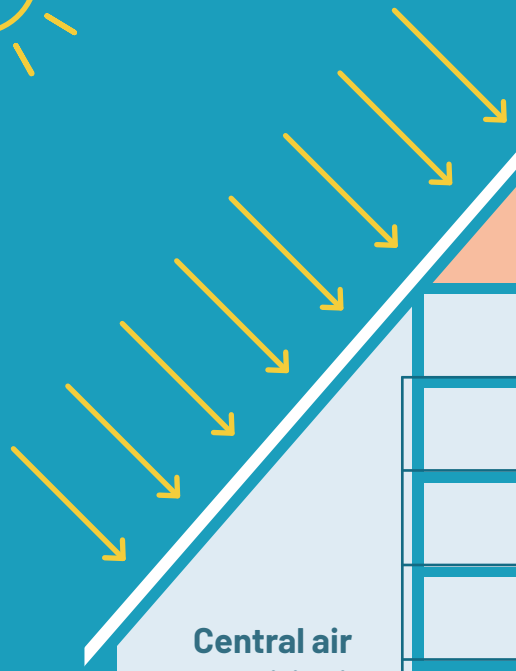
Air conditioning

in **Egypt, Jordan, Lebanon and Türkiye**



Options for sustainable AIR CONDITIONING





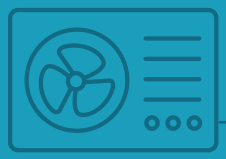
Cooling technology	Natural refrigerants				Building types					
	R744 Carbon dioxide	**R290** Propane & other HC	**R717** Ammonia	**R718** Water	Hotels	Large commercial buildings	Data centres	New districts / compounds	Smaller offices & buildings	Residential & small buildings
Central air conditioning systems										
Sorption chillers			R717	R718						
Water cooled chillers	R744	R290	R717	R718						
Air cooled chillers	R744	R290	R717	R718						
DX / roof systems		R290								
Multi-split / VRF systems	R744	R290								
Stand alone AC systems										
Single split units	R744	R290								
Window / wall units	R744	R290								
Thermal sources										
District cooling	R744	R290	R717	R718						
Geothermal / waterbody				R718						
Energy saving										
Passive cooling										
Monitoring & optimization										

Yellow
Opportunity for the future

Icon
Technology is available

Green
Ready for implementation

Sustainable cooling options for **air conditioning**



Solutions ready for implementation

Technology & applications	Energy & climate	Safety & implementation	Market considerations	Recommended for locations
HOTELS OR LARGER COMMERCIAL BUILDINGS				
Central hydrocarbon (HC) chiller Replacement of HFC and HCFC based chillers with hydrocarbon based natural refrigerant systems such as R290 (propane), R1270 and R600a. Due to flammability concerns, it is recommended that the refrigerant should not be circulated inside a building and roof-mounted or remote from building set-ups should be used which pipes water/glycol mix to the air handling units.	✗ Large energy savings ✓ Energy efficient technology ✓ Low GWP refrigerant ✓ Renewable integration	✗ Technician friendly tech ✗ No safety risks or measures ✗ Non-flammable refrigerant ✓ Non-toxic refrigerant	✓ Market ready products ✗ Low-cost solution — Wide consumer acceptance ✓ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
Monitoring solutions Using monitoring sensors coupled with centralised data collection for key parameters (such as energy use, cooling performance, maintenance information, leakage etc.) can help to identify issues and potential ways to optimise system efficiency. This data can also help outside the building, as a comparison dataset for other systems, cities and regions.	— Large energy savings ✓ Energy efficient technology NA Low GWP refrigerant NA Renewable integration	✓ Technician friendly tech ✓ No safety risks or measures ✓ Non-flammable refrigerant ✓ Non-toxic refrigerant	— Market ready products ✓ Low-cost solution ✓ Wide consumer acceptance ✓ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
Passive cooling There are wide range of techniques to cool buildings and occupants without the use of air conditioning. Some of the most effective measures reduce solar heat gain through use of strategic shading, insulation and ensuring roofs and façades use certain reflective paints/bright colours. Controlled ventilation, reducing heat loads internally and simple fans are also essential.	✓ Large energy savings ✓ Energy efficient technology NA Low GWP refrigerant NA Renewable integration	✓ Technician friendly tech ✓ No safety risks or measures ✓ Non-flammable refrigerant ✓ Non-toxic refrigerant	✓ Market ready products ✓ Low-cost solution ✓ Wide consumer acceptance ✓ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
CONSTRUCTION OF NEW DISTRICTS				
Sustainable district cooling District cooling can be economically attractive for new districts/compounds. The high additional investment in the network and piping is more than offset by higher efficiencies and cost reductions from optimised operation of a centralized plant. To be sustainable, natural refrigerants, such as R717 (ammonia), should be used with the system powered by renewable energy.	✓ Large energy savings ✓ Energy efficient technology ✓ Low GWP refrigerant ✓ Renewable integration	✗ Technician friendly tech ✗ No safety risks or measures — Non-flammable refrigerant — Non-toxic refrigerant	✓ Market ready products ✗ Low-cost solution — Wide consumer acceptance ✗ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye

Opportunities for future implementation

Technology & applications	Energy & climate	Safety & implementation	Market considerations	Recommended for locations
HOTELS OR LARGER COMMERCIAL BUILDINGS				
Central ammonia chiller (R717) Minor energy savings are possible using this natural refrigerant in modern equipment. Safety can be ensured by positioning the chiller outdoors and circulating a chilled water/glycol mix to the indoor air handling units. Challenges include higher potential costs, lack of qualified technicians and overall market acceptance related to use of this toxic refrigerant.	✗ Large energy savings ✓ Energy efficient technology ✓ Low GWP refrigerant ✓ Renewable integration	✗ Technician friendly tech ✗ No safety risks or measures ✓ Non-flammable refrigerant ✗ Non-toxic refrigerant	✓ Market ready products ✗ Low-cost solution – Wide consumer acceptance ✓ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
Central absorption chiller Absorption chillers work via extracting energy from a heat source instead of using electricity. Compared to electrical chillers, efficiency is low, so are only preferable when large waste heat streams can be utilised. These flexible systems allow for thermal storage on both hot/cold sides and the higher the temperatures and volumes of the heat source, the better the performance.	– Large energy savings ✓ Energy efficient technology ✓ Low GWP refrigerant NA Renewable integration	✗ Technician friendly tech ✓ No safety risks or measures ✓ Non-flammable refrigerant ✓ Non-toxic refrigerant	✓ Market ready products ✗ Low-cost solution – Wide consumer acceptance ✗ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
RESIDENTIAL & SMALLER COMMERCIAL BUILDINGS				
Hydrocarbon based split AC units (R290 propane) HFC and HCFC split air conditioner units are commonplace and rapid growth is expected with a shift towards using R32 systems. Shifting to R290 instead would result in significant direct emissions savings. However, market acceptance, servicing and handling barriers linked to flammability would need to be overcome (although they also currently exist for HFC R32).	✗ Large energy savings ✓ Energy efficient technology ✓ Low GWP refrigerant ✓ Renewable integration	✗ Technician friendly tech ✗ No safety risks or measures ✗ Non-flammable refrigerant ✓ Non-toxic refrigerant	✓ Market ready products – Low-cost solution – Wide consumer acceptance ✓ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye
DATA CENTRES				
Central water chiller (R718) Data centres are ideal candidates for water based chillers as the purpose is to prevent overheating. Water is highly efficient at removing heat generated in dense server racks and can maintain temperatures within a narrow range for optimal operating conditions, leading to improved reliability and longevity of electrical equipment and reduced energy and operational costs.	✗ Large energy savings – Energy efficient technology ✓ Low GWP refrigerant ✓ Renewable integration	✓ Technician friendly tech ✓ No safety risks or measures ✓ Non-flammable refrigerant ✓ Non-toxic refrigerant	✓ Market ready products – Low-cost solution – Wide consumer acceptance ✗ Large expansion possible	✓ Egypt ✓ Jordan ✓ Lebanon ✓ Türkiye

Pros and cons of using natural refrigerants

Natural refrigerants

Are non-synthetic substances found in nature with negligible ozone depletion & global warming effects. The refrigerants below have good market development perspective while satisfying F-gas regulations.

Benefits

Mature tech & widely available | Energy efficient | Cost effective | Suitable for warmer climates | Non-flammable | Non-toxic

Challenges

New tech with limited availability | High pressure operation | Safety issues & measures | Trained personnel required | Large volume of space required | Limited temperature lift

Natural refrigerants	Benefits	Challenges
R744 **Carbon dioxide** Trans-critical operation under high pressure	CO_2 is a safe, cheap and environmentally friendly substance with good thermal conductivity and heat capacity. Trans-critical operation is widely used in cooler climates.	CO_2 changes from gas to liquid at around 32°C, operating above this requires very high pressures, quality components and specialized technicians. Less suitable in warmer climates.
R744 **Carbon dioxide** Sub-critical operation in a cascade system with a secondary refrigerant	Operating below the critical temperature and pressure point, CO_2 can follow the standard boiling and condensation process, making it simpler and cheaper to install and operate.	Warmer climates require a secondary system for sub-critical operation. Safety and trained technicians are required when using flammable refrigerants for 2nd system. Asphxiant gas.
R290, R1270, R600a **Hydrocarbons** Propane, propylene, isobutane	Hydrocarbon refrigerants are simple, environmentally friendly, efficient and cost-effective. They have been in use for decades and design standards exist for most products.	Flammability is the most significant challenge. Following standard IEC 60335-2-40, careful design is required, with installation & maintenance by trained technicians.
R717 **Ammonia**	Being employed in refrigeration for over a century, ammonia is widely available, cost-effective, ozone and climate friendly refrigerant with highly efficient thermodynamic properties.	Rated B2L, safety is a factor. Ammonia is toxic to humans, flammable under certain conditions and corrosive to some metals, requiring safety measures and trained personnel.
R718 **Water**	Abundant and essential to life, water avoids all safety, cost and environmental concerns. Water has a high heat capacity & is usually more energy efficient than standard refrigerants.	Early stage technology with few products commercially available so far. Requires more space due to gas expansion & has operational limitations. Can lead to corrosion & scaling.

Overcoming barriers to action

Key barriers blocking implementation

Market resistance

There is a reluctance and a degree of push back from leading manufacturers on shifting to sustainable AC technologies. Some have an economic interest in promoting synthetic refrigerants, while others are hesitant to shift as the demand is currently comparably low.

Lack of familiarity

Amongst the wider market there is a lack of experience and understanding of sustainable AC products. This dynamic is especially important with installers, who play a key role in what technologies are promoted and selected by customers.

Skills deficit

The increased safety risks for some natural refrigerants, especially flammable hydrocarbons such as R290, requires a higher level of skill and know-how when performing installation, maintenance, repair and servicing of sustainable AC units.

Higher upfront costs

Costs for installing sustainable cooling technologies are typically higher. This is largely due to the technologies being less mature, being lower down the technology learning curve, with lower mass-production capacities and low market competition.

Stand out projects - leading the way to sustainable cooling

EGYPT

1. EGYPRA Project
2. Bahareya Village
3. Smart Village District Cooling*
4. AUC New Cairo Campus*
5. Western desert gas complex (Gasco)*
6. Katameya Sporting Club (Petrosport)*
7. District cooling by Shaker group*
8. District cooling by Gas Chill company*
9. Eastern Company West Building*
10. AL Galala Resort DC plant*

JORDAN

1. Industry & commerce solar cooling
2. Abdali AURD district cooling
3. Al Salam Supermarket
4. Hashemite University Solar PV
5. Mutah University CSP trigeneration
6. HCST geothermal heating & cooling
7. Dead Sea Spa REACT solar thermal
8. Aqaba Residence Energy Efficiency
9. MAIA-TAQA solar thermal
10. SEED school & health centres

LEBANON

1. LEED residential VRF HVAC**
2. Ice bank cold storage**
3. Baabda high efficiency HVAC**
4. Halat RE & biomass absorption
5. Zouk Mosbeh waste heat chiller**
6. Geothermal cooling (Beriut)
7. Lemantec R600a & R290 products

TÜRKIYE

1. First transcritical CO_2 test unit 2006
2. Sub-critical CO_2 cascade
3. Carrefour CO_2 trans-critical system
4. Small trans-critical CO_2 systems
5. Supermarket refurbishment demo
6. CO_2/NH_3 cold room cascade
7. R290 monoblock cooling units (Iskid)

In summary, various activities can already be observed regarding sustainable cooling. While the above lists are far from complete with new project coming online, there are still limited sustainable cooling activities utilizing natural refrigerants.

* These projects are partly sustainable as while they utilise natural refrigerants, the energy source is supplied by fossil gas.

** These projects are partly sustainable as while they increase efficiency and/or are ready for the implementation of renewable energy, they currently do not use natural refrigerants.



More information

Full reports

This snapshot is based on the 2022 series of reports entitled:

Catalogue of Technical Solutions for Sustainable Cooling in:

- **Egypt**
- **Jordan**
- **Lebanon**
- **Türkiye**

AC technologies

- **Domestic air conditioning:** cooltechnologies.org/sector/domestic-air-conditioning
- **Commercial / industrial air conditioning:** cooltechnologies.org/sector/commercial-industrial-air-conditioning
- **Hydrocarbon technologies database:** hydrocarbons21.com

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