



Webinar Series - Episode 2

Innovation in renewable & sustainable cooling



Dr. Ahmed Rezk
Aston University



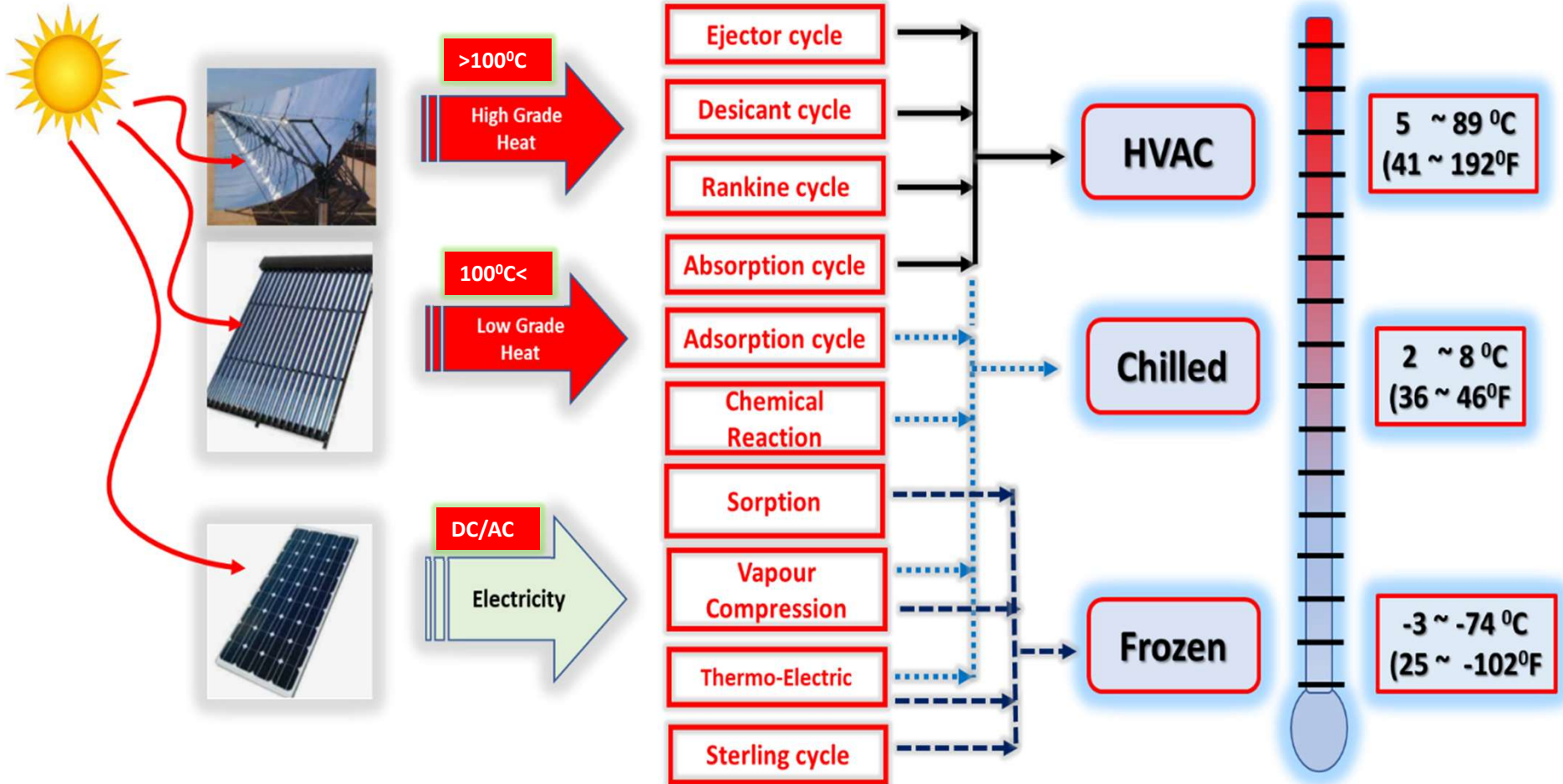
Dr. Catarina Marques
London South Bank University



Mr. Zafer Ure
PCM Products Ltd



Solar Refrigeration Options

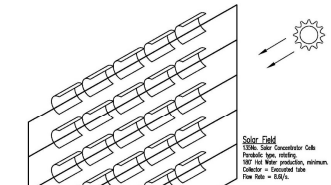


Refrigerant : WATER

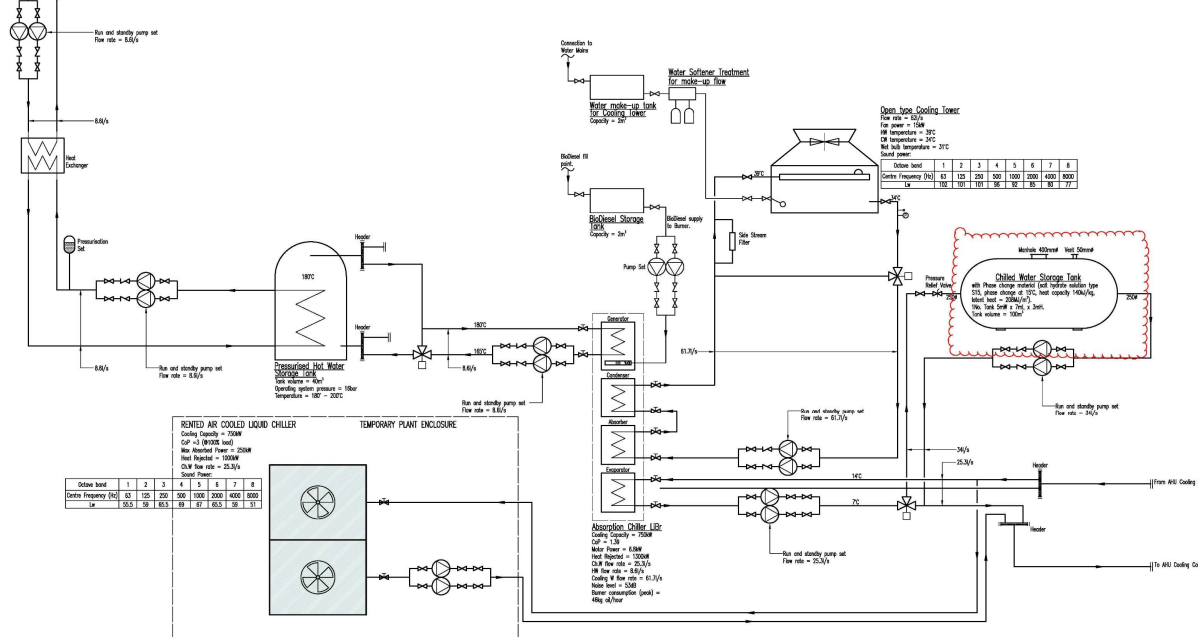
Absorbent : Li-Br

Application : Min. +7C

SOLAR DRIVEN COOLING EXAMPLE

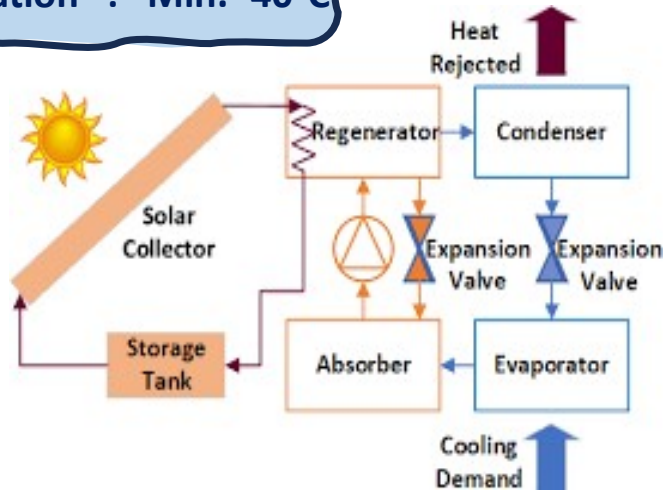


100 m³ Tank
+15C / (59F) PCM
5 MWh (1,420 RT-h)



THERMALLY DRIVEN REFRIGERATION

Refrigerant : **Ammonia**
 Absorbent : **Water**
 Application : **Min. -40°C**



Domestic

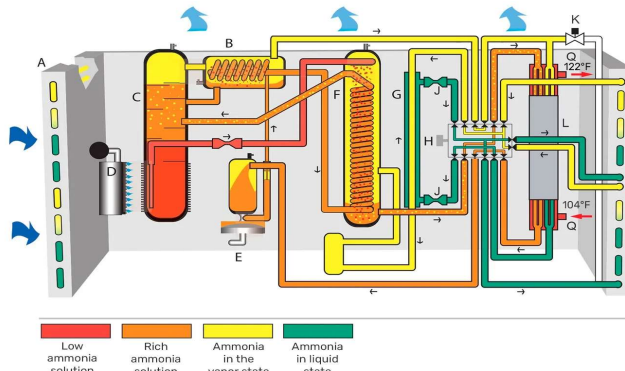


Industrial



Industrial heat pumps, replacing the use of fossil fuels in La Penilla, Spain, saving 1 750 tonnes of CO₂e, and in Konolfingen and Orbe in Switzerland, saving 1 000 tonnes of CO₂e each per year.

Commercial



<https://www.robur.com/en-us/media/inside-the-thermodynamic-cycle>



<https://colibri-bv.com/>

Cold Logistics

a) **2~8°C Shipments;**

b) +4°C ice for very high end medical applications.

b) **Ambient 20~24°C;**

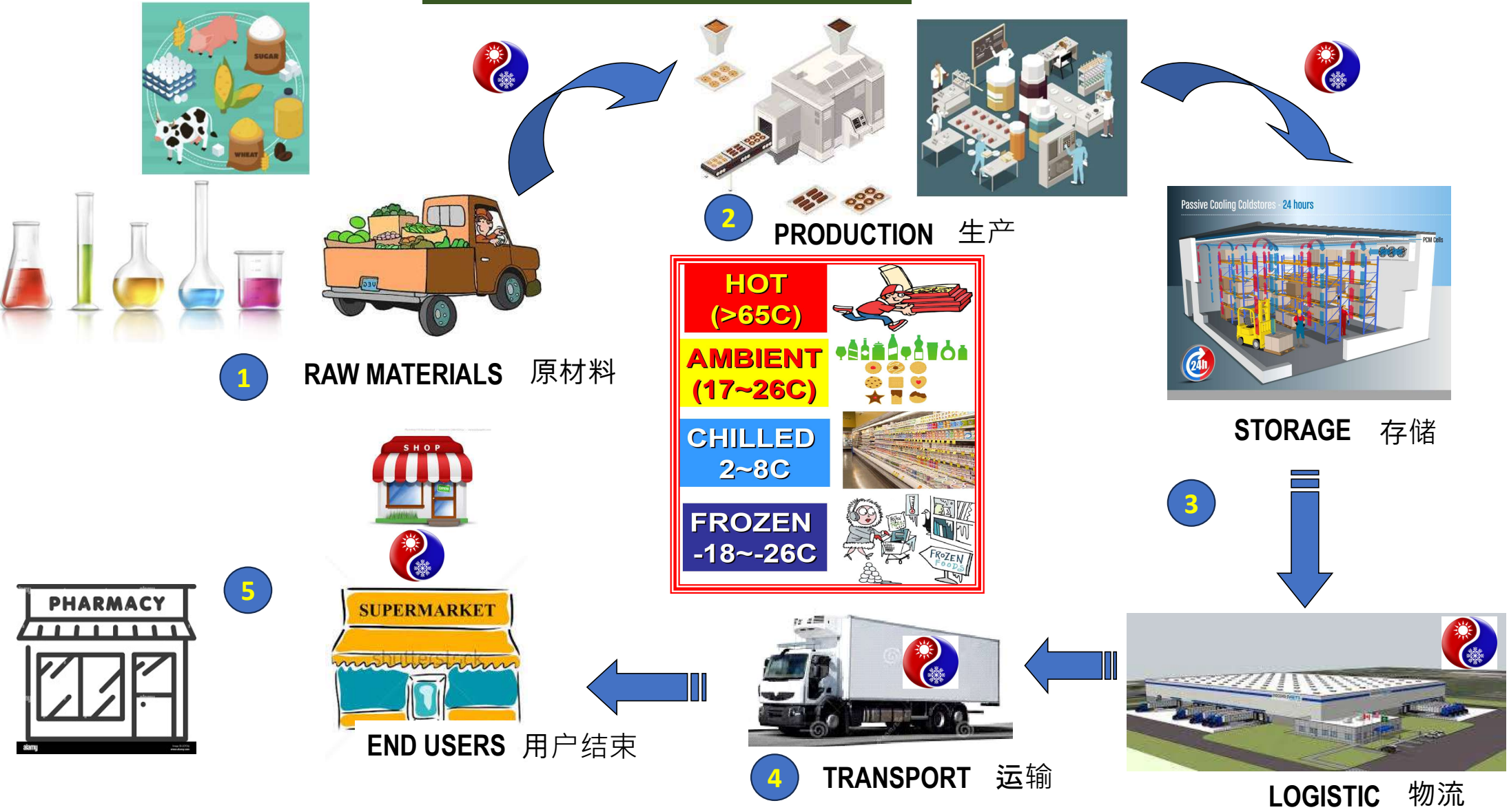
18~24°C we can keep the ambient products under control

c) **Frozen -3 ~-34°C Shipments;** Frozen applications

d) **Dry Ice replacement -65°C ~ -78°C Applications;**

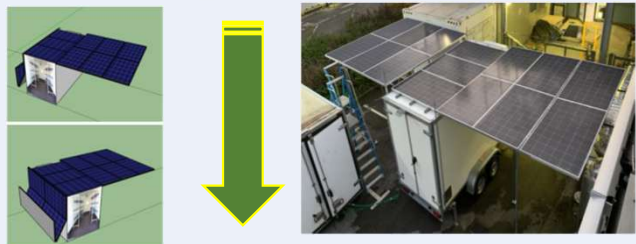
ice packs filled with this cold ice to replace the dry ice usage

TEMPERATURE CONTROLLED LOGISTIC

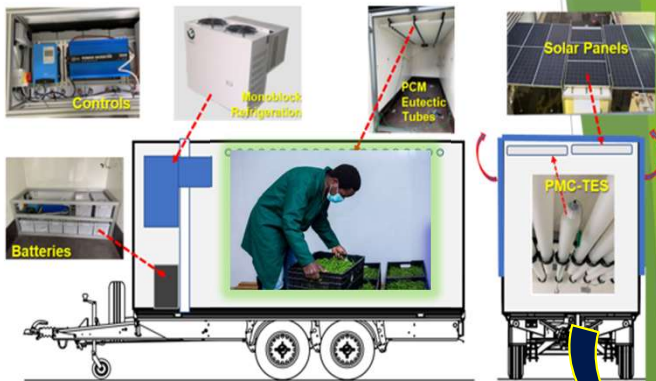


SOLAR DRIVEN FARM TO FORK COOL LOGISTIC

Food Harvesting



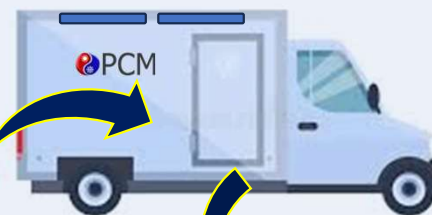
Solar driven mobile refrigeration unit



Solar Driven On-Site Cooling



Eutectic Plate Cool Delivery / Logistic



Solar Driven Static Cold Store



Consumption



Shops



Consumer

BRIDGING THE GAP

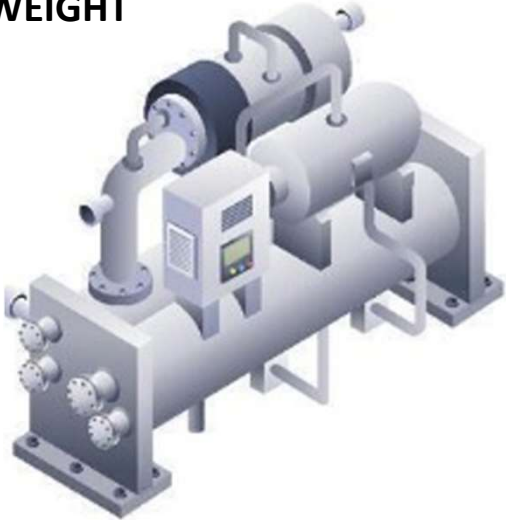
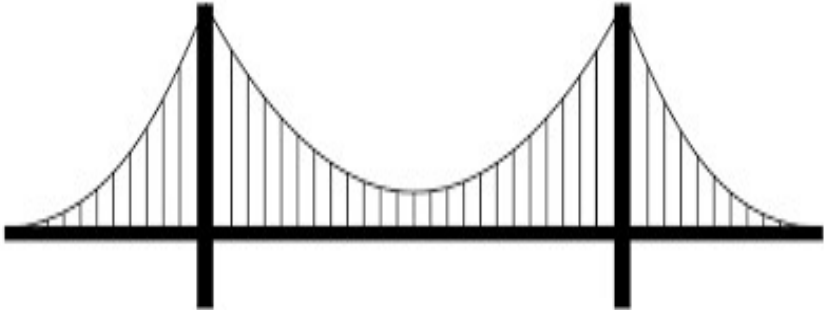
SALT + WATER



- ENVIRONMENT
- LIFE
- COST
- WEIGHT

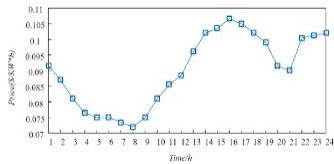


RENEWABLE ENERGY



ENERGY USE

- **Thermal Energy Storage (TES) Benefits**



- **Lower ambient over-night**

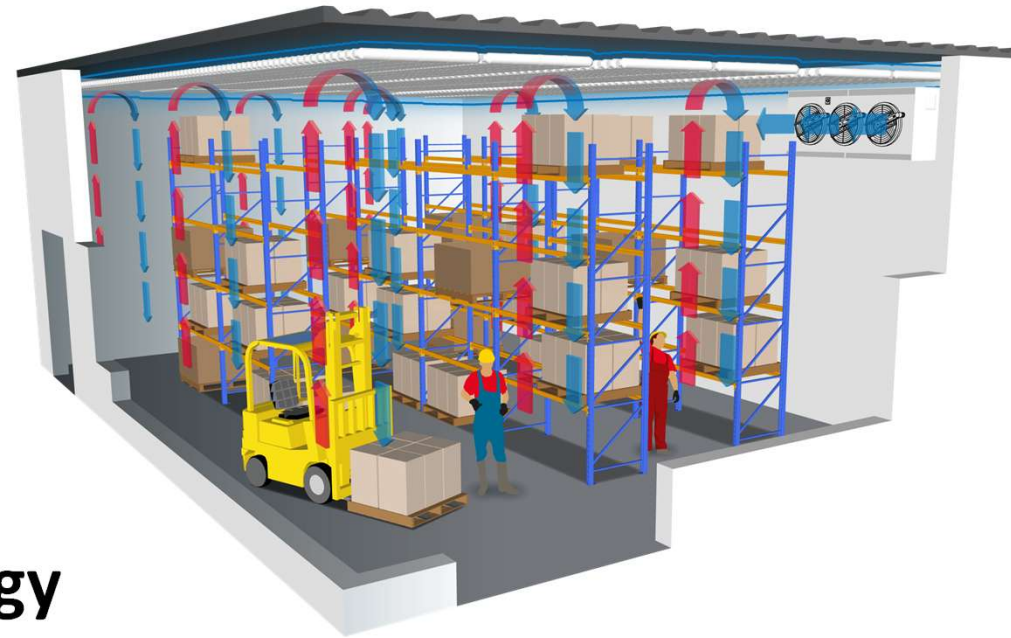
- **Lower electricity rates**

- **Free solar energy**

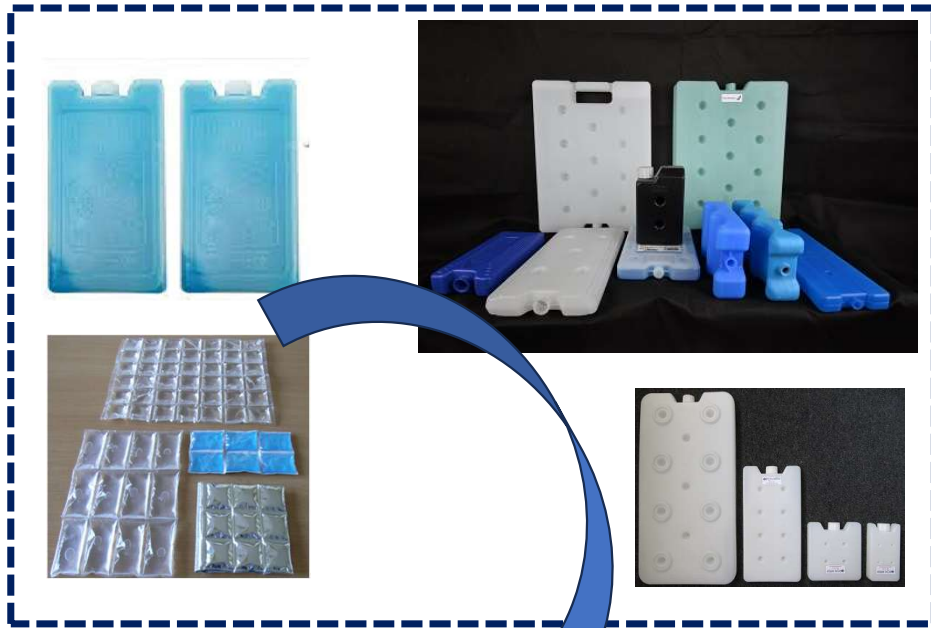
- **Free wind power energy**

- **Stand-by Capability**

- **Mechanical failures**
- **Power cuts**



IcePACKS



COOL BOX



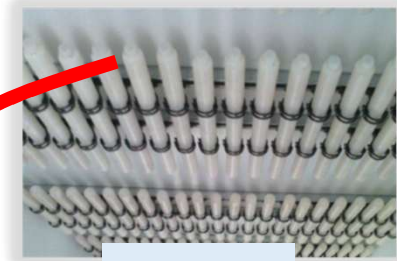
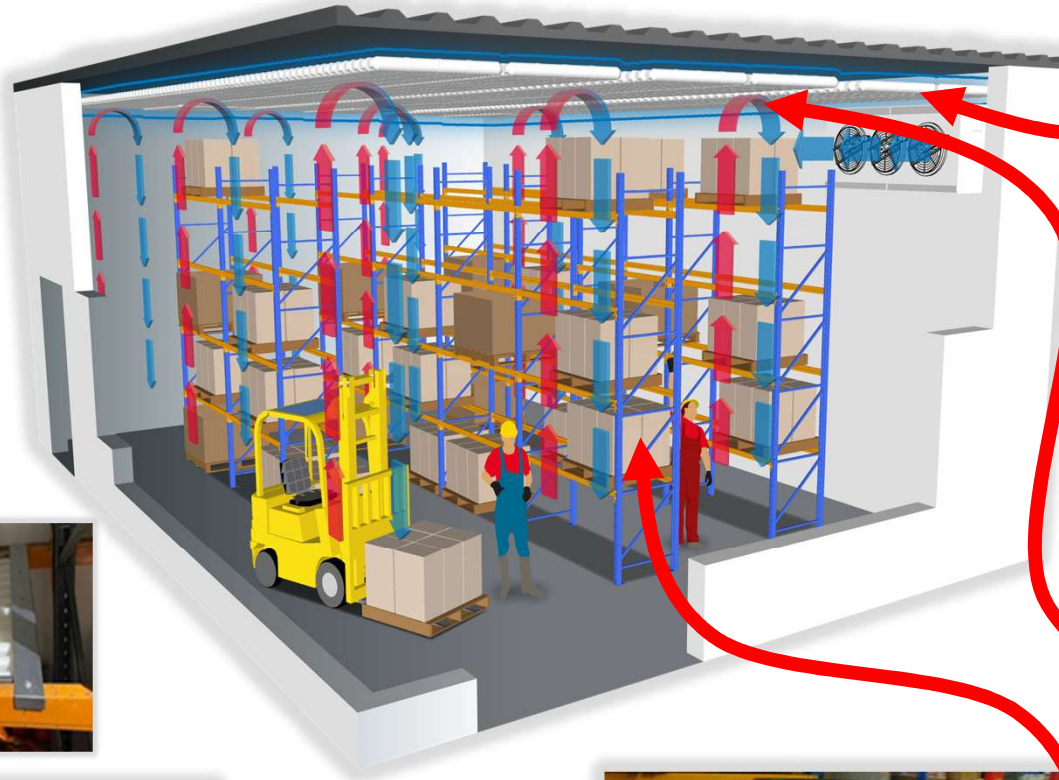
PCM Modules



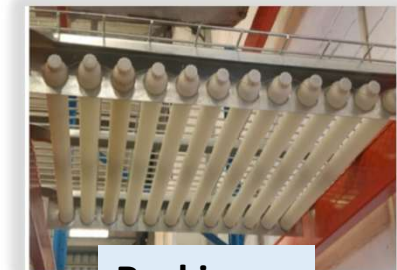
COLD STORAGE



COLD STORE



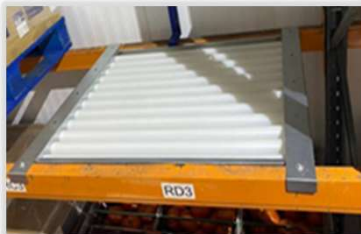
Ceiling



Racking

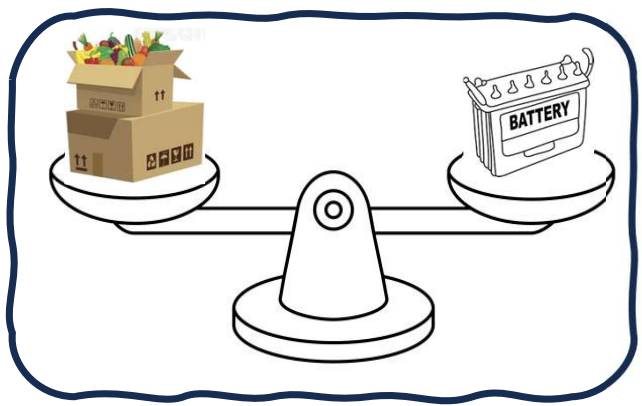







Pallet

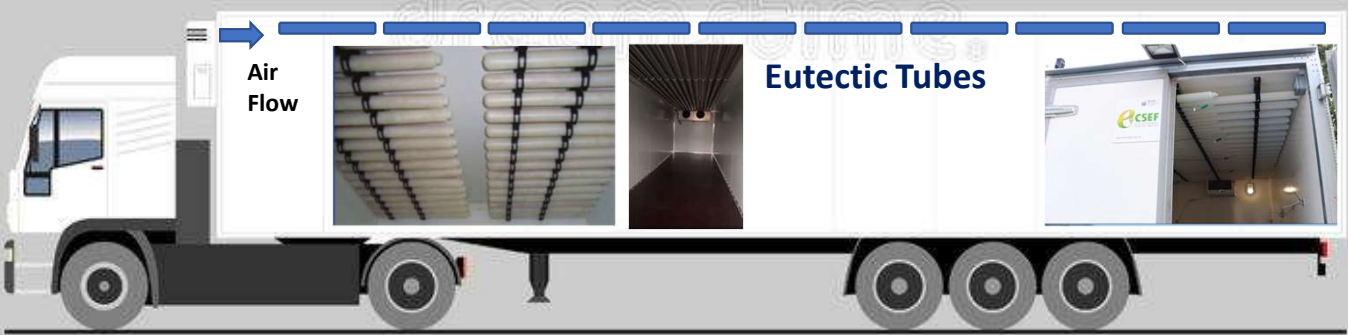
























Electrified Transport

Goods vs. Range



-  **3.5 Ton**
-  **7.5 Ton**
-  **18 Ton**
-  **25 Ton**
-  **26 Ton**

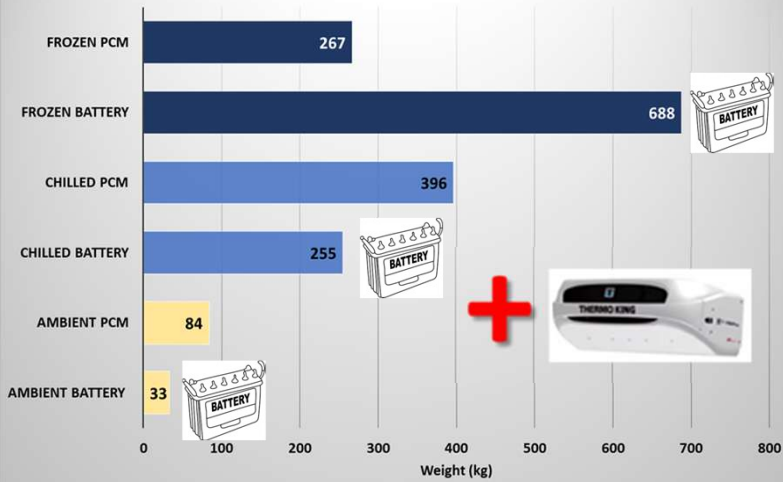


Recommended Description		Identifier	UK Maximum Gross Weight (tonnes)	Shape	
LORRIES	LIGHT GOODS VEHICLES	2 axles	3.5	no rear side windows 	
	SMALLER 2-AXLE LORRIES	2 axles	Over 3.5 7.5	 	
	BIGGER 2-AXLE LORRIES	2 axles	Over 7.5 18		
	HEAVY GOODS	MULTI-VEHICLES	3 axles rigid	25 26*	
			3 axles artic.	26	
	VEHICLES over 7.5 tonnes gross require a Heavy Goods Vehicle Driver's Licence)	MULTI-VEHICLES	4 axles rigid	30 32*	
			4 axles artic.	36 38*	
		AXLE	Vehicle and draw-bar trailer 4 axles	30 36**	 
			5 axles or more artic. See note (a)	40	
		LORRIES	Vehicle and draw-bar trailer 5 axles See note (a)	40**	 
			6 axles artic. See note (b)	41*	
			6 axles draw-bar See note (b)	41* and **	 
5 or 6 axles artic. See notes (b) and (c)			44* and ***		
	6 axles draw-bar	44* ** and ***	 		
	6 axles artic. See note (b) and (d)	44*			
	6 axles draw-bar See note (b) and (d)	44* and **	 		

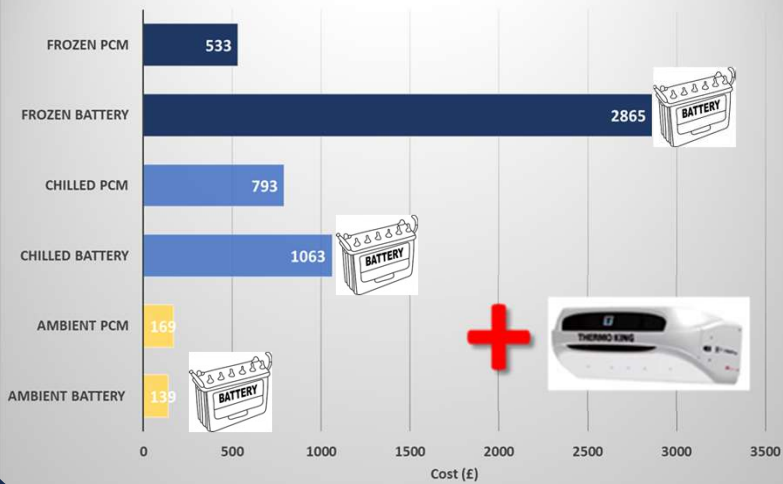
Mobile Cooling for Transport

20' Container Size

20ft size cold room operation

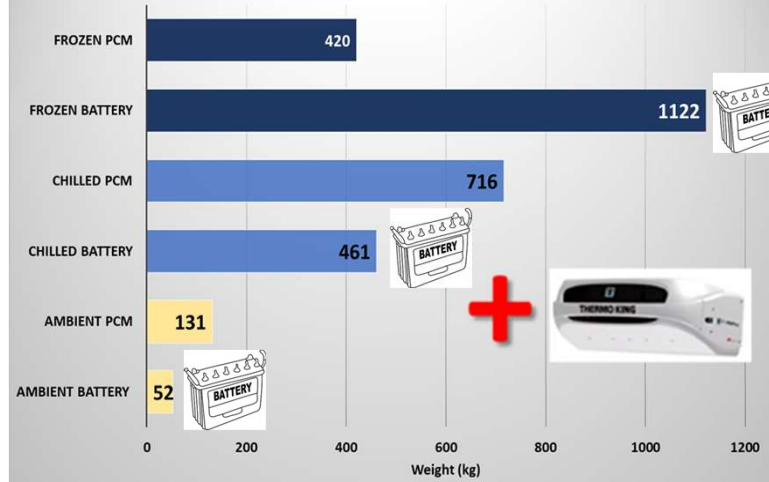


20ft Container Cost Comparison Battery vs. PCM

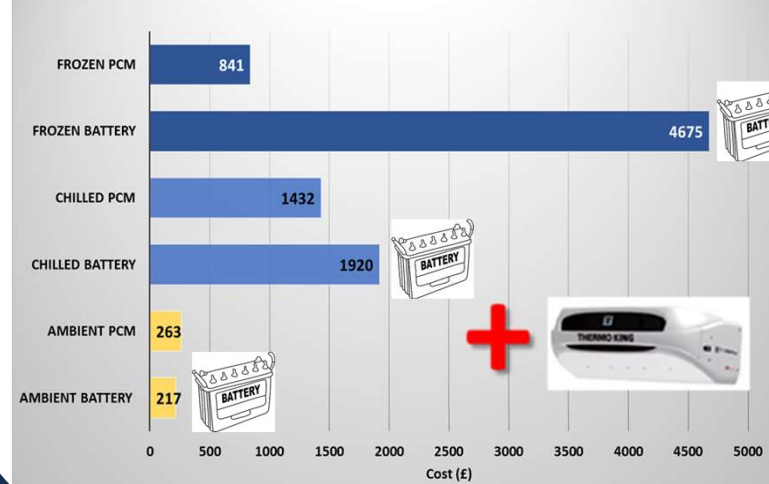


40' Container Size

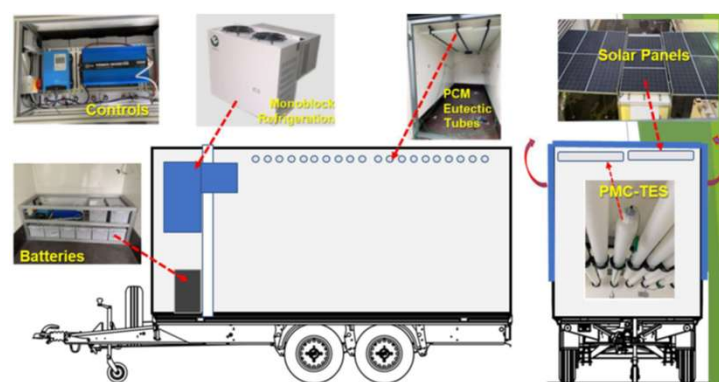
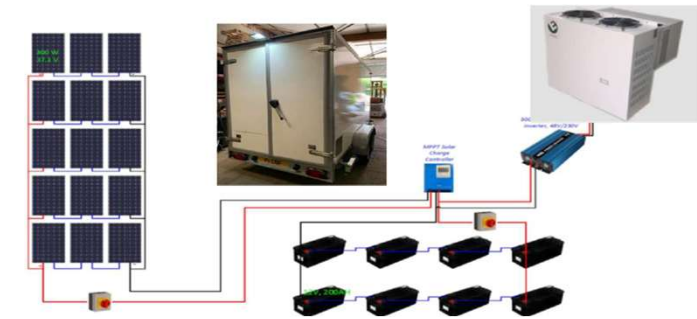
40ft container size cold room operation



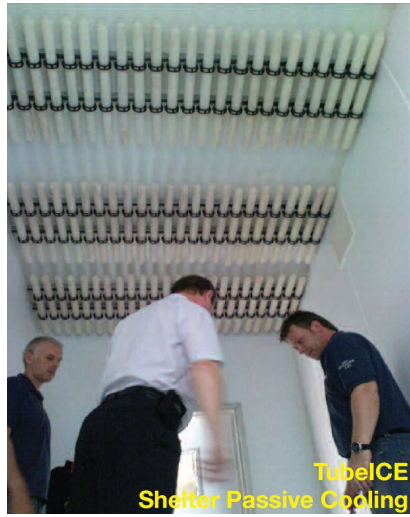
40ft Container Cost Comparison Battery vs. PCM



SOLAR MOBILE COOLING



SOLAR COOLING



PCM Modules



CONCLUSION

- **Heat driven system for larger installation**
- **PV driven systems for smaller installation**
- **TES is a vital part of any solar refrigeration**
- **Battery vs TES balance**
- **Insulation Quality**

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Useful Publications

[**https://ior.org.uk/events/ICCC2022/iccc2022-programme**](https://ior.org.uk/events/ICCC2022/iccc2022-programme)

[**https://iifiir.org/en/fridoc/solar-cooling-2020-40-lt-sup-gt-th-lt-sup-gt-informatory-note-on-143007**](https://iifiir.org/en/fridoc/solar-cooling-2020-40-lt-sup-gt-th-lt-sup-gt-informatory-note-on-143007)