ECO°COOL

Sichere Lösungen für
temperatursensible Logistik.

THERMAL BLANKET PORTFOLIO FOR PHARMACEUTICAL AIR- AND SEA-FREIGHT

www.ecocool.de

TYPICAL TEMPERATURE-CONTROL RISKS IN AIR-FREIGHT

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- Temperature-control risks in Air-Freight
  - Tarmac Time: During loading procedures, pallets are being placed on the Tarmac for hours, exposure to ambient temperature conditions (hot & cold) but most critically exposure to direct sunlight
  - Placement of pallets behind jet engines may cause short lived but extreme heat spikes
  - Placement next to heating exausts inside the freight compartment may also lead to (local) temperature excursions

- Essential characteristics of Thermal Blankets for Air-Freight:
  - Reflective outer surface key to mitigate sunlight exposure
  - Relative importance of thickness of insulation dependent on thermal mass of goods, in some instances, thick insulation may lead to adverse results (low mass of goods, low reflectivity, heat build-up under blanket)
  - Low emissivity inner coating reduces heat transfer from blanket to goods

TYPICAL TEMPERATURE-CONTROL RISKS IN SEA-FREIGHT

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- Temperature-control risks in temperature controlled Sea-Freight:
  - Biggest challenge: Times in which reefers remain unplugged from external power and exposed to ambient conditions. These durations can be of extended periods of time.
  - Short lived excursions during loading procedures and customs examination
- Essential characteristics of Thermal Blankets for Sea-Freight:
  - Insulation more important than in Air-Freight, however, low mass of typical pallets with pharmaceutical products pose challenge for temperature control
  - Low emissivity inner coating reduces heat transfer from blanket to goods
  - Reflective outer surface still useful against radiative (infra-red) heat gain, however, of lesser importance than in air-freight

HOW WE WORK

- Production made in Germany
  - Short lead-times for all European sites
  - Experience in global distribution
  - ECOCOOL operates consignment warehouses close to customer location if required (implemented for customer in France)
- No restriction on „standard“ formats
  - All Blankets are manufactured according to customer specifications
  - All formats possible (single pallets, ULD-pallets, drums, air-line containers, etc.)
- Special requests can almost always be met, e.g.
  - Customer labels
  - Serial numbers or even printable data loggers/tags
  - Bespoke closures available (velcro, tape, etc.)
- All covers are reusable
  - However, the logistical effort and CO_2 footprint of reverse logistics may render this economically and environmentally disadvantageous
- Assembly instructions and on-site training available

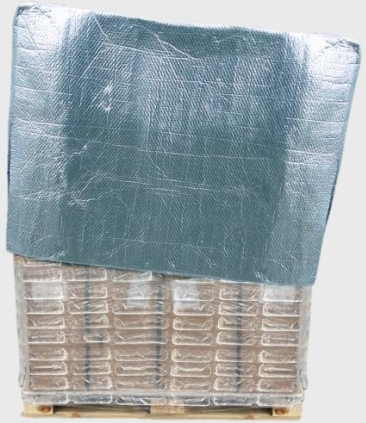
PORTFOLIO OF THERMAL BLANKET SOLUTIONS

ECO-LIGHT

ECO-BREATH

ECO-SAFE

ECO-SAFE+



ECO-XTREME(+)

ECO-LIGHT

- Reflectiv entry level cover
  - Single layer bubble wrap, coated with aluminium foil on the outside, HDPE-film on the inside for easy handling and robustness

- Applications:
  - Entry-level air-freight cover
  - Secondary protection e.g. for pallet shippers, passive shippers etc.
  - Primary protection for less sensitive products (e.g. 2-30°C), consumer care products

- Advantages:
  - Most economical solution
  - Easy handling

ECO-BREATH

- Breathable, reflective cover
  - Breathable skin-type cover with microperforations (aluminium foil on nonwoven-PP substrate)
  - Aluminium foil on both sides: Reflectivity on outside and low-emissivity on inside
- Applications:
  - Similar as for ECO-LIGHT but with slightly better thermal performance, especially for low-mass air-freight
- Advantages:
  - Most economical shipping and storage
  - Easy handling
  - Extremely robust and easy to clean, therefore reusable
  - Less plastic content

ECO-SAFE

- Reflective (standard) pharma solution:
  - Double layer bubble wrap with aluminium foil on both sides (reflectivity on outside, low emissivity on inside)
  - Available as sewn (standard) thermal blanket as well as laminated cardboard variant

- Applications:
  - Standard air-freight solution of many pharmacuetical customers for CRT products (e.g. 2-25/15-25˚C)
  - Short-term solution for 2-8˚C products (with sufficient stability data)

- Best compromise of protection, handling, robustness and pricing

ECO-SAFE+

- Innovative Pharma Solution with excellent thermal properties
  - Standard ECO-SAFE Blanket combined with 5 gel-filled mats („WaterBlankets“)
  - Increased thermal mass (~30kg/plt) adds significant amount of protection (more efficient than „thicker“ blankets with lower U-value) but no added freight costs if volumetric weight is charged
  - Best use case: Relative low-mass pallets (e.g. < 250 kg)

ECO-SAFE+

- Applications
  - Extremely safe 15-25°C Thermal Blanket solution (air- and sea-freight), qualified and used by global pharmaceutical manufacturers since 2017 with no major excursions!
  - Reliable for 2-8°C sea-freight (qualified and used by leading pharmaceutical manufacturers)
  - Short-term protection for 2-8°C air-freight

- Advantages
  - Unrivaled temperature control/cost ratio

ECO-XTREME

- Reflective Thermal Blanket with increased insulation layer (2.5 cm)
  - Reflective outer and low-emissivity innser surfaces
  - Highly insulating rPET insulation fleece (2.5cm, U-value: 1.4 [W/Km^2])
  - Eco-Friendly due to usage of insulation fleece made out of 80% recycled PET (17.5 old PET bottles per kg of product or ~ 40 old bottles per blanket)

ECO-XTREME

- Applications
  - Similar performance and areas of application as ECO-SAFE+ but more bulky
  - ECO-XTREME is advantageous for heavier pallets
  - ECO-SAFE+ is preferable (in terms of temperature control) for lighter pallets
  - Often used as effective ULD cover where usage of WaterBlankets is impractical
  - ECO-XTREME+ (ECO-XTREME Blanket + WaterBlankets) further improves temperature control

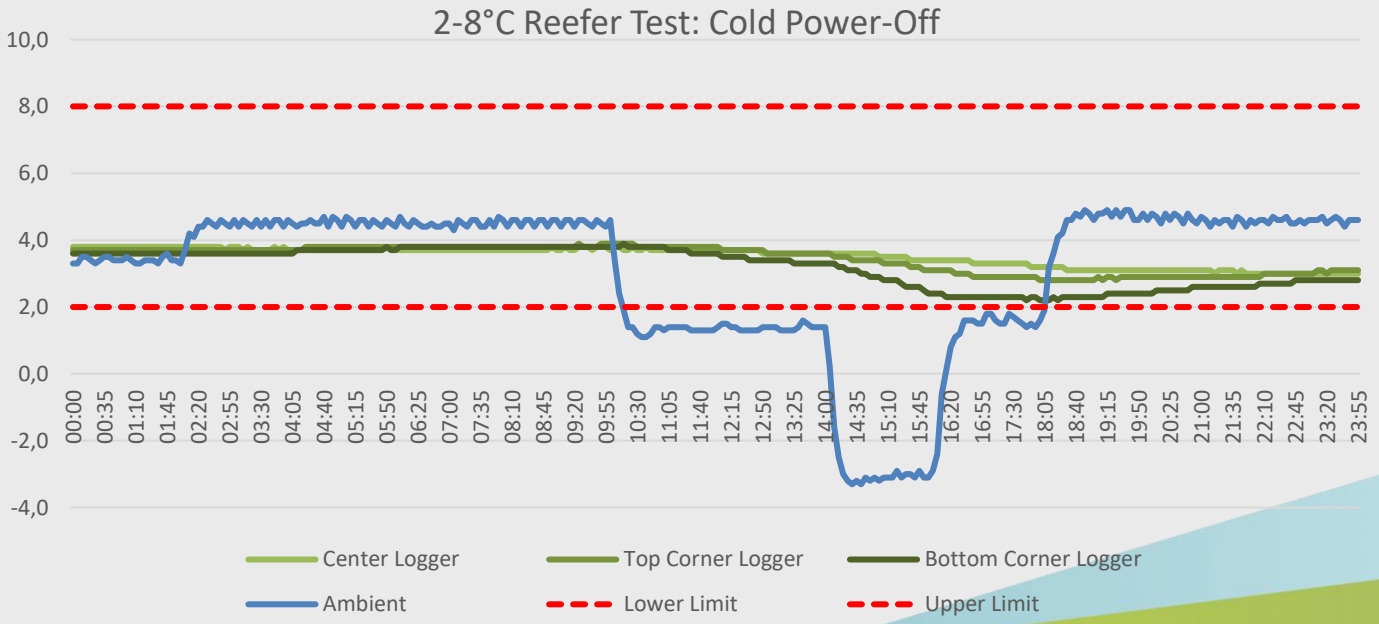
- Advantages
  - High performance Thermal Blanket, especially for high mass pallets
  - Use of high content of recycled raw material

THERMAL BENCHMARKING

- Qualification case study: ECO-SAFE+ for 2-8°C Sea-Freight
- Climate chamber hot +45°C
- Climate chamber cold -5°C
- Outdoor field test
- All tests (except sea freight qualification) conducted with 100L water as thermal dummy load (approx. 9% filling)

QUALIFICATION DATA FOR 2-8°C SEA-FREIGHT

- Data drawn from a qualification for a pharmaceutical manufacturer; Ambient temperature is temperature inside container ≠ outside ambient temperature
- Solution tested: **ECO-SAFE+**
- Minimal payload mass: 40kg, distributed over 40 boxes on EUR-pallet (dims: 120x80x110 cm)
- Ambient temperature out of range for 8 hours, no excursions detected



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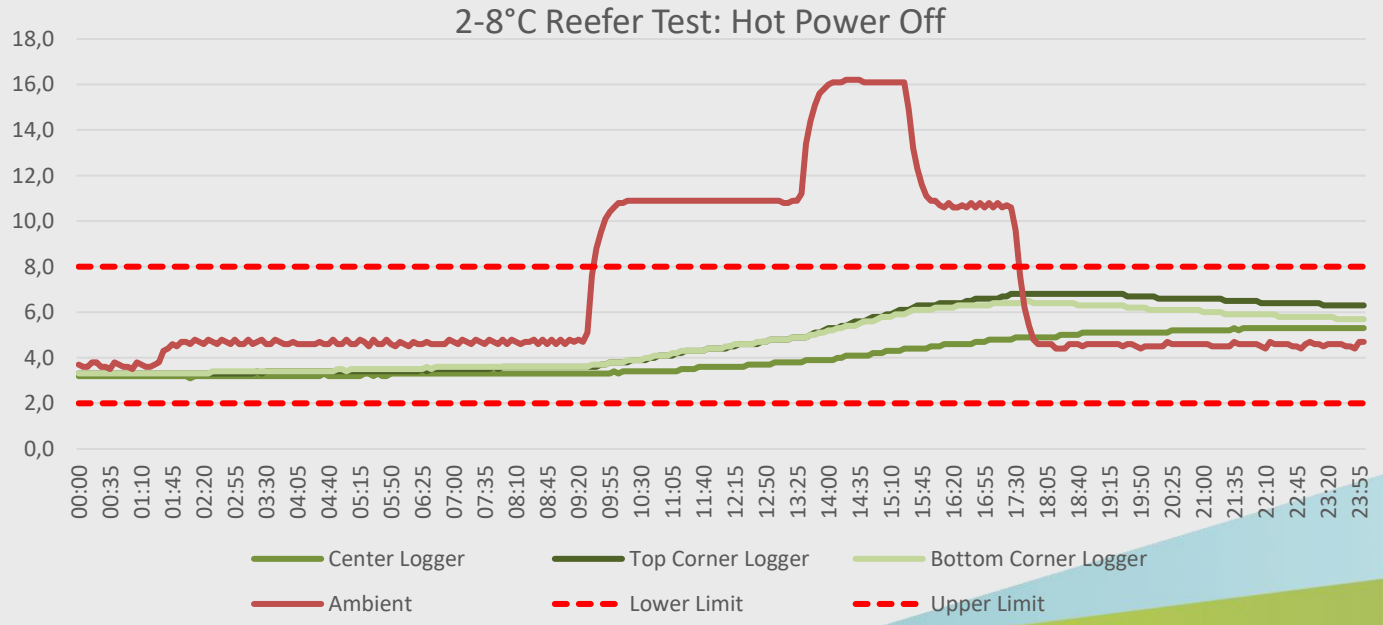


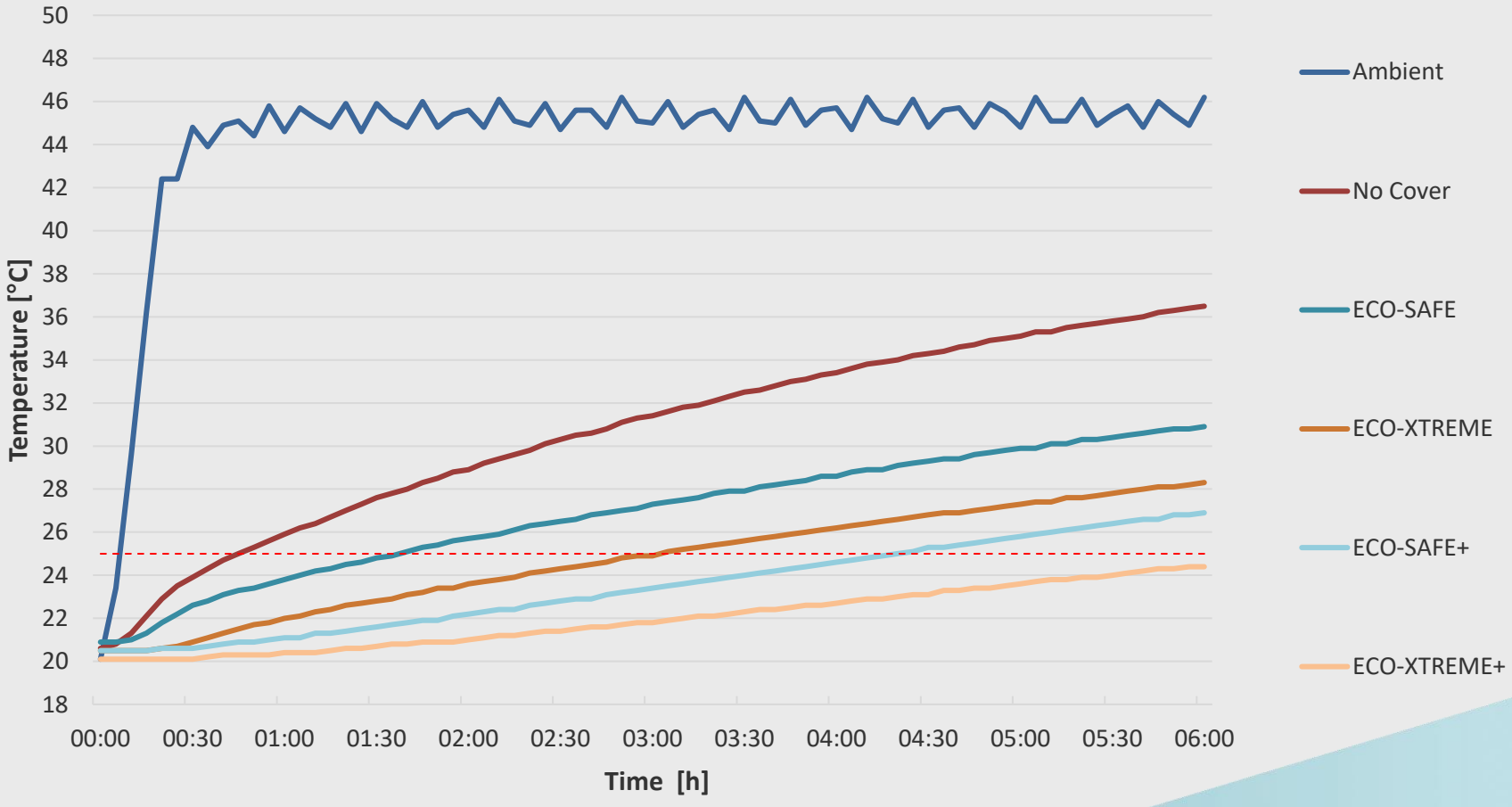
REAL LIFE EXPERIENCES FOR 2-8°C SEA-FREIGHT

- Live-shipments with customer since 2021
- No excursions reported
- Practical application:
  - Customer ships temp controlled to sea-freight 3PL
  - 3PL orders packaging material on behalf of customer directly at ECOCOOL and applies packaging before stowing of container
- **Integration into SmartCAE happening at the moment, therefore, virtual lane risk assessment possible!**

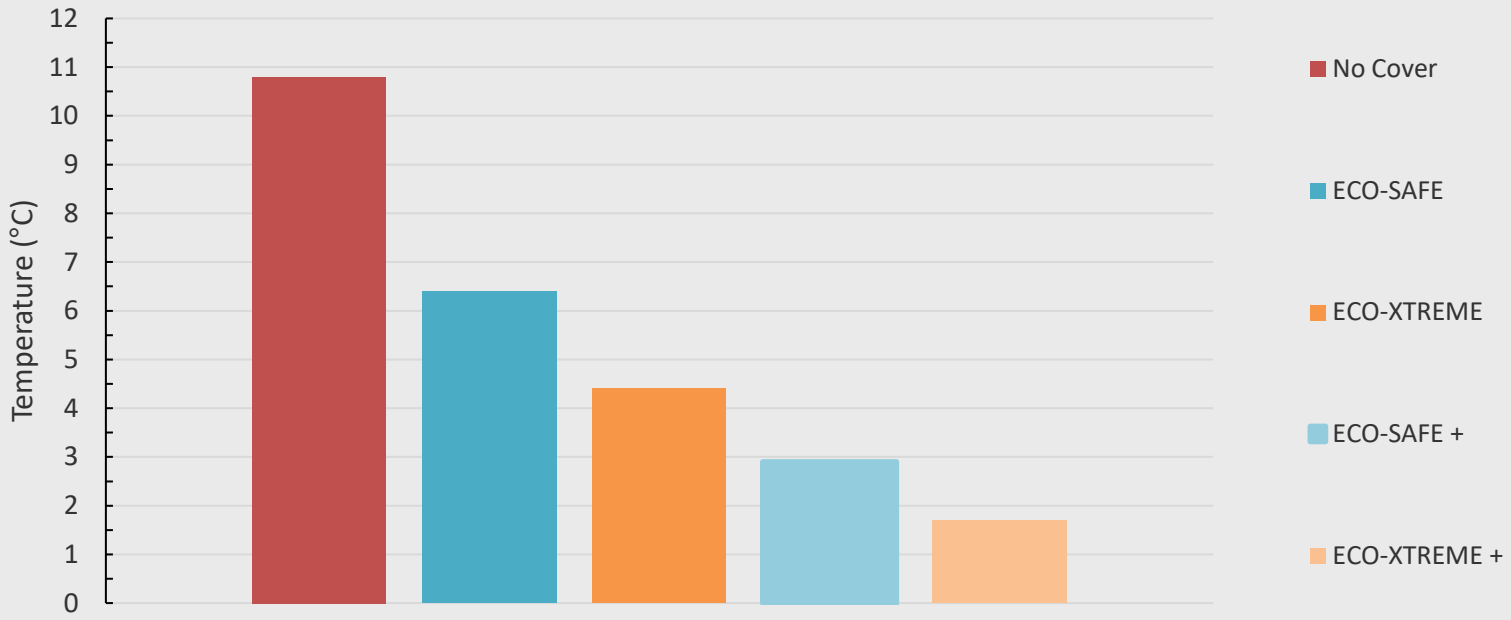
THERMAL BENCHMARKING

- Climate chamber hot +45°C
- 3 Logger positions (top & bottom corner, center)
- All datapoints only show most critical logger (upper product corner)
- All tests assumed 15-25°C product, relative order of results remains the same with 5°C start temperature
- Focus on ECO-SAFE, ECO-SAFE+, ECO-XTREME and ECO-XTREME+ as most relevant product solutions (all other results available upon request, 2-8°C test results also available shortly)

CLIMATE CHAMBER HOT TEST – TOP CORNER LOGGERS (INSIDE BOX)



HEAT GAIN AFTER 3 HOURS @ 45°C

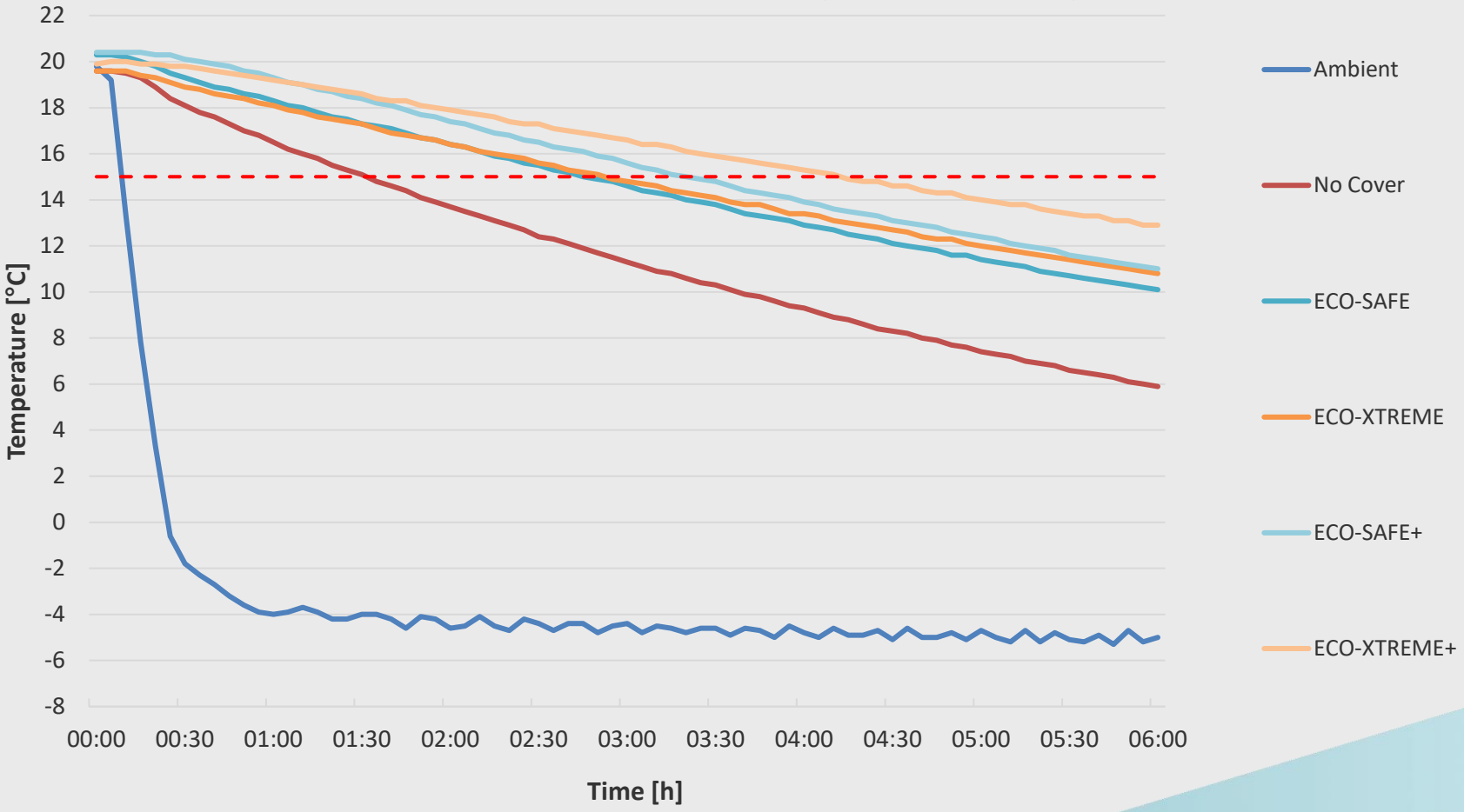


Solution	Heat Gain after 3hrs @45°C
No cover	+ 10.8 °C
ECO-SAFE	+ 6.4 °C
ECO-SAFE+	+ 2.9 °C
ECO-XTREME	+ 4.4 °C
ECO-XTREME+	+ 1.7 °C

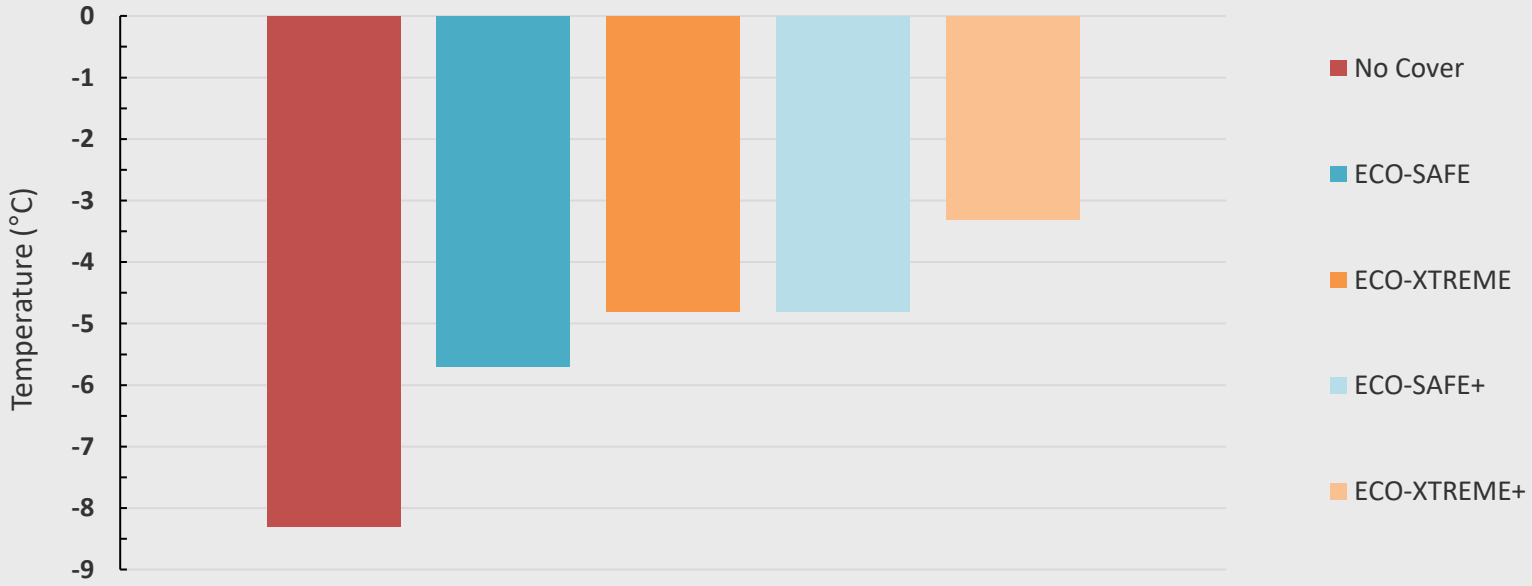
THERMAL BENCHMARKING

- Climate chamber cold -5°C
- 3 Logger positions (top & bottom corner, center)
- All datapoints most critical logger (bottom product corner)
- No pallet bottoms used, hence differences between solutions are less pronounced as results are driven by cold air from below the pallet (same for all solutions)

CLIMATE CHAMBER COLD TEST – BOTTOM CORNER LOGGERS (INSIDE BOX)



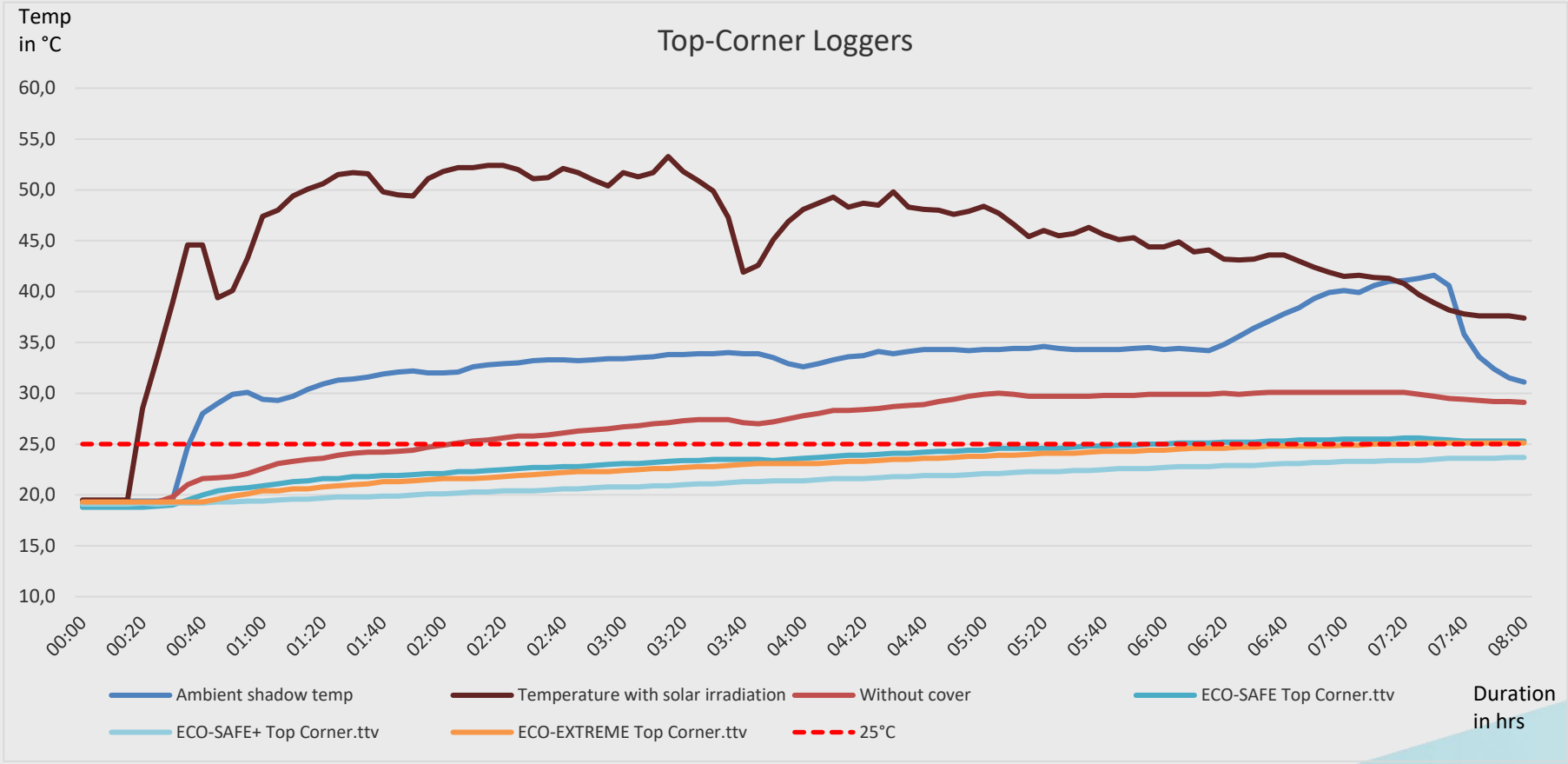
TEMPERATURE LOSS AFTER 3 HOURS @-5˚C



Solution	Temp loss after 3hrs @-5°C
No cover	- 8.3 °C
ECO-SAFE	- 5.7 °C
ECO-SAFE+	- 4.8 °C
ECO-XTREME	- 4.8 °C
ECO-XTREME+	- 3.3 °C

OUTDOOR TEST – IMPACT OF DIRECT SUNLIGHT

OUTDOOR TEST



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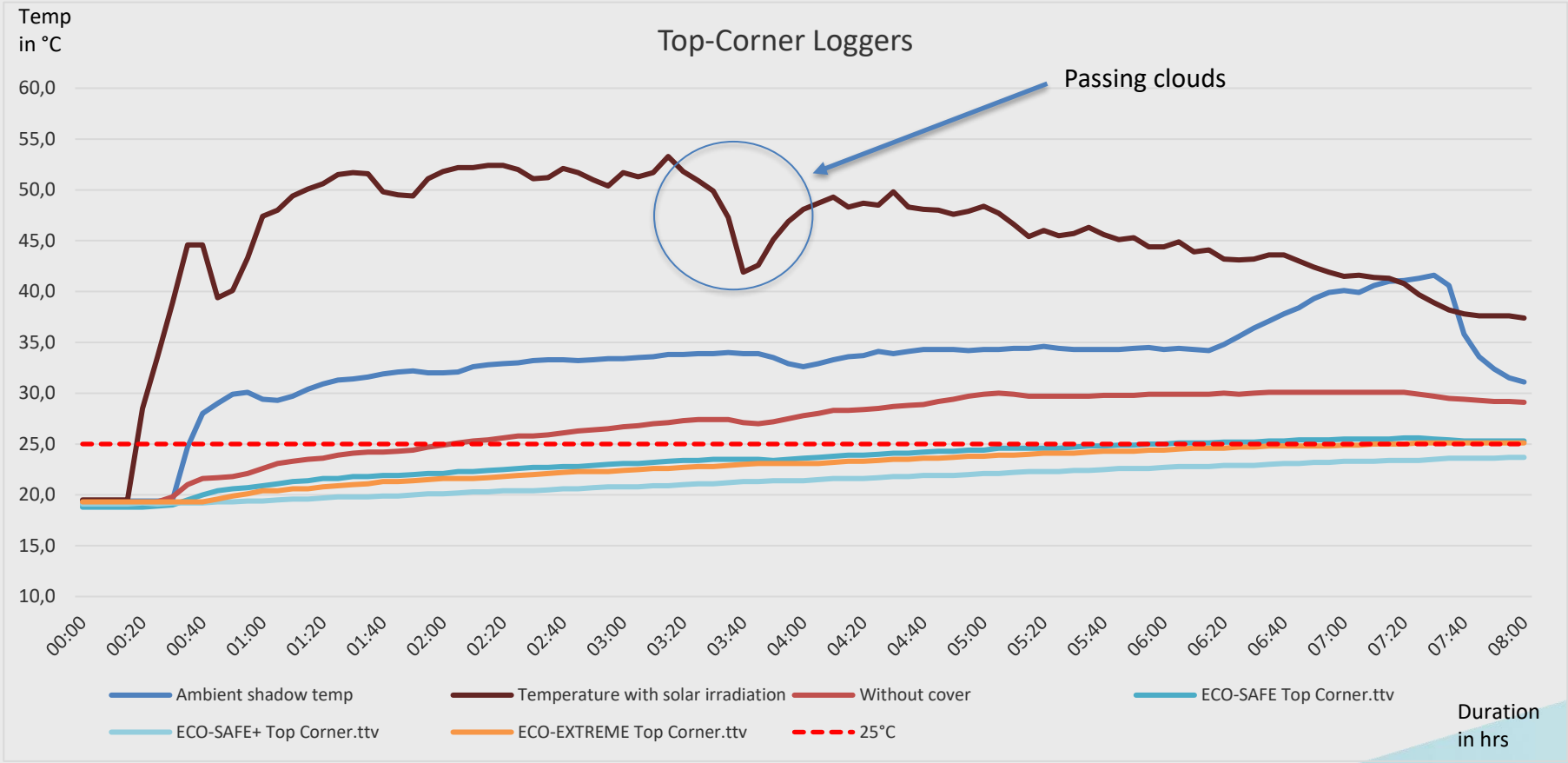

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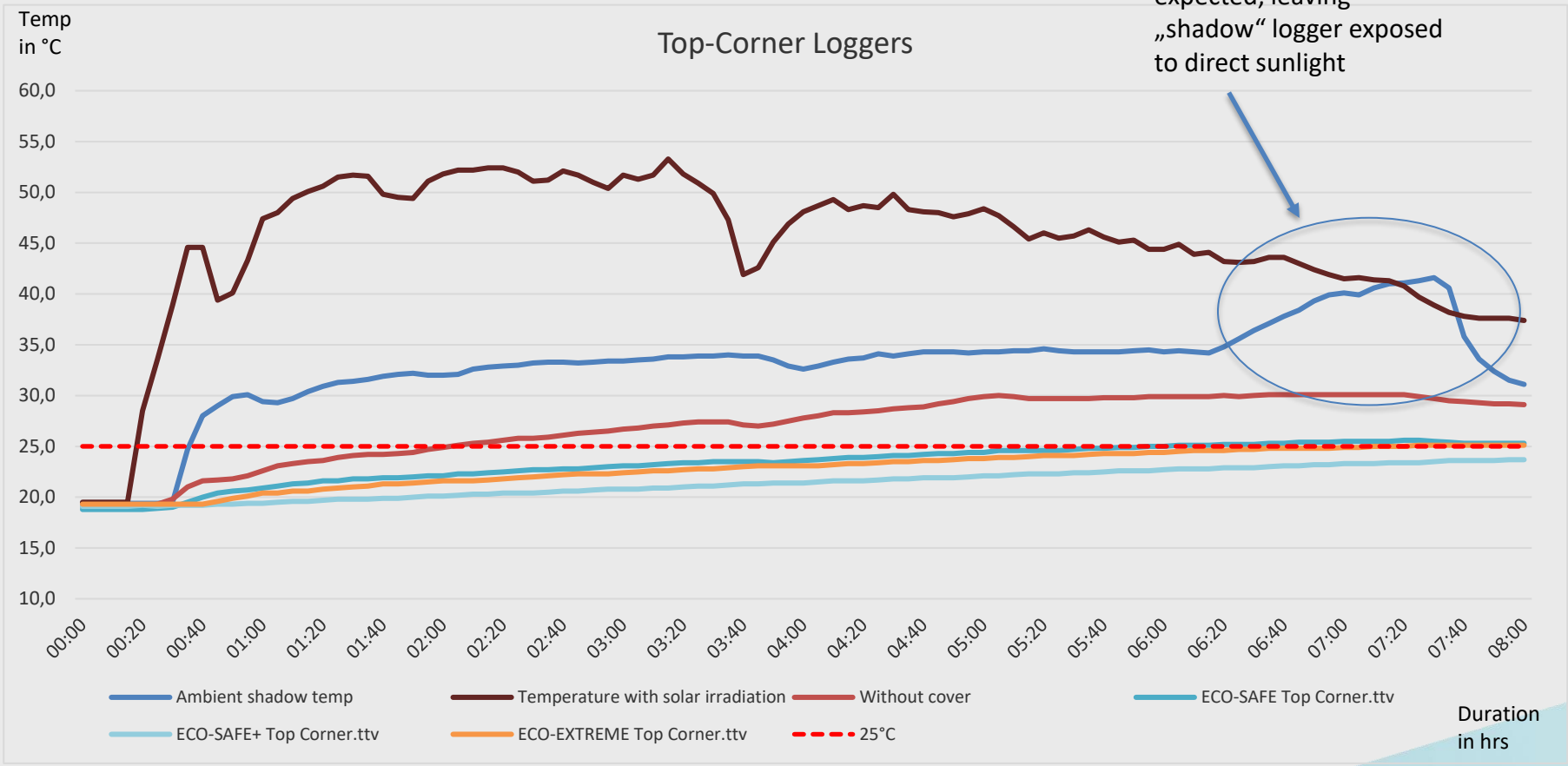

OUTDOOR TEST – SUMMARY

Solution	TIME < 25°C	PERFORMANCE RELATIVE TO NO PROTECTION		MAX. TEMP	TIME OUT OF RANGE
		Ø Temperature Difference	Duration < 25°C		
NONE	2:05 h	NA	NA	30.1°C	> 16 h
ECO-SAFE	6:05 h	-3.9°C	292%	25.6°C	2:30 h
ECO-SAFE+	NA	-6.0°C	NA	24.1°C	0:00 h
ECO-XTREME	7:25 h	-4.5°C	356%	25.1°C	1:00 h

OUTDOOR TEST CONCLUSIONS

- Results (especially relative ordering) carries over from climate chamber tests
  - ECO-SAFE+ > ECO-XTREME > ECO-SAFE
- Differences are less pronounced than in climate chamber test
  - Root cause: Ambient 45°C is more challenging than 32°C + sunlight as the sunlight affects mostly the top of the pallet whilst the sides may radiate away excess heat
  - Reflectivity is more important than insulation thickness. As all blankets have reflective surfaces, they mitigate effect of sun in a similar way
- Advantages of ECO-SAFE+ clearly visible:
  - Added latency through thermal mass results in slower heat gain and only solution that remained < 25°C for the entire duration of the test

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