SKY CELL

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Transforming Reverse Logistics:

A Comparative CO_2 Analysis of Net ZERO Reverse and Traditional Pharma Container Solutions

Abstract

This case study aims to analyze CO_2 emissions in pharmaceutical logistics and evaluate the effectiveness of the 1500X hybrid container combined with Net ZERO Reverse compared to RAP and RKN (active temperature-controlled) containers.

The results show that using the 1500X container in combination with ocean freight reverse transports can lead to a reduction of over 90% compared to the equivalent Leg 3 journey via air freight. This has significant implications for sustainability, operational efficiency, and cost-effectiveness in pharmaceutical supply chain

1. Industry Challenges & Net ZERO Reverse

1.1 CHALLENGES IN PHARMACEUTICAL LOGISTICS

Pharmaceutical products are one of the most logistically demanding products shipped on a global scale. Many pharmaceuticals such as vaccines and biologics require strict temperature control to ensure efficacy and compliance with regulatory standards. As a result, these are mostly shipped via air freight due to speed and reliability.

However, this heavy reliance on carbon-intensive air freight has a huge environmental impact with 71%[1] of the healthcare industry's emissions primarily derived from its supply chain. Transportation logistics contribute significantly to these emissions. Optimizing methods and routes, such as switching from air freight to ocean freight for returning empty containers, can lower the overall transport emissions by up to 67% compared to active RKN solutions.

Ocean freight, while slower, reduces carbon emissions per tonne-kilometer by more than 90% compared to air freight, based on a comparison using standard emission factors[2]. Choosing a hybrid container designed for ocean freight returns helps reduce our carbon footprint while maintaining the benefits of reusable containers.

>90%

compared to the equivalent Leg 3 journey via air freight

[1] Health Care Without Harm. (2019). Health care's climate footprint: How the health sector contributes to the global climate crisis and opportunities for action. https://global.noharm.org/sites/default/files/documents-files/5961/HealthCaresClimateFootprint_092319.pdf

[2] GLEC Framework V3.1, 2024; Mobitool Faktoren V3.0, 2023; UK Department of Energy Security and Net Zero Conversion Factors, 2023.

1.2 INTRODUCING NET ZERO REVERSE

SkyCell's Net ZERO Reverse, in combination with the 1500X hybrid container, is designed to tackle this challenge. By eliminating the need for air-based reverse logistics and replacing it with ocean freight, Net ZERO Reverse slashes emissions while reducing operational costs. The 1500X hybrid container, engineered for performance, reliability, and sustainability, plays a central role.

With Net ZERO Reverse, pharmaceutical products are transported via air freight in SkyCell's hybrid containers, ensuring precision temperature control and compliance. Once the shipment arrives at the destination, **the empty containers are returned via ocean freight in collaboration with our freight forwarder partners**.

Even though ocean freight emits considerably less emissions compared to air freight, some emissions remain. These residual carbon emissions are permanently removed through **high-quality removal projects** like biochar production via pyrolysis, which actively extract carbon from the atmosphere.

This study compares the CO_2 emissions associated with transporting pharmaceutical products using three container types:

SkyCell's 1500X, RAP, and RKN containers.

The goal is to quantify the environmental impact of each configuration, with particular focus on reverse logistics.

2. Methodology

2.1 STUDY DESIGN

Two major lanes were selected for analysis:

- **Chicago** (ORD) to **Sydney** (SYD)
- **Amsterdam** (AMS) to **São Paulo** (GRU)

Each route includes both the outbound leg (loaded) and the return leg (empty container repositioning).

The following assumptions were applied consistently across all scenarios:

- Aircraft type: Boeing 787-8 belly cargo
- Pharma product weight per pallet: 150 kg
- Pharma product volume per pallet: 1 m^3
- Radiative Forcing Index (RFI): 2

Container configurations included:

- 1500X: 1 pallet per unit; reverse logistics by ocean freight
- RAP: 4 pallets per unit; reverse by air freight
- RKN: 1 pallet per unit; reverse by air freight

This structure allows for a direct comparison of emissions performance between the 1500X with ocean-based reverse logistics and active containers using air returns.

2.1 CO_2 EMISSION CALCULATIONS

To accurately assess the potential transport emissions of the two chosen scenarios, we used SkyCell's carbon accounting tool DECARBONIZE, which is based on MIT's Centre for Transport and Logistics[3] most recent study on pharmaceutical cold chain logistics and the data available from the Network for Transport Measures (NTM).

Considering the standard set by the study, the calculations included **the volumetric weight approach for air freight**. This means that the weight of the pharma product and the packaging is considered and compared to the volumetric weight of the pharma container. The tool then calculates the emissions with the greater of the two factors. In addition, the secondary climate effects of air travel are also included, describing the global warming effect due to other effects that CO_2, mostly due to cloud formation.
The before mentioned MIT study recommends a value for this Radiative Foreign Index of 2. IATA currently uses a factor of 1, whereas other studies recommend a factor of 3[4].

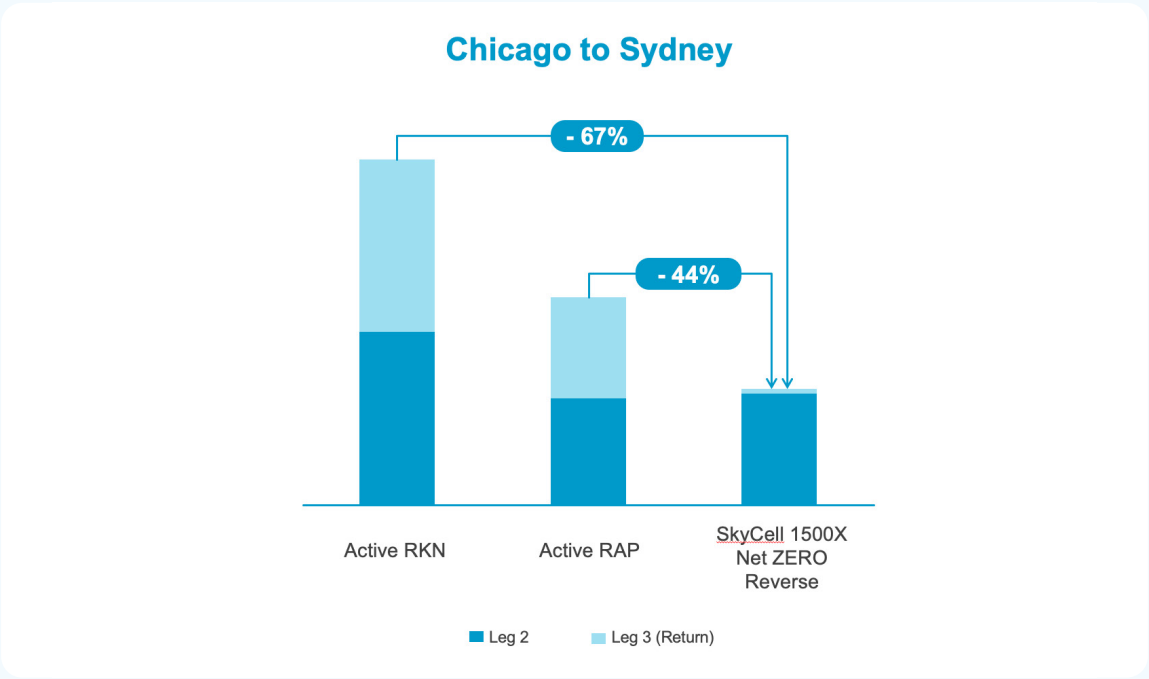
To facilitate comparison **the same origin and destination location** were assumed for all container types, and no layover air transport was considered. In addition, the final values are adjusted to comparable unit of 1 pallet of pharma product transported, with a volume of 1m^3.

For the outbound transport the container was loaded with one pallet of pharma product for active RKN and hybrid solutions, and in the case of active RAP 4 pallets, each with 150 kg of pharma product weight. In relation to the reverse, it was assumed that **all the active solutions are transported back via air freight while the hybrid is reversed with ocean freight.**

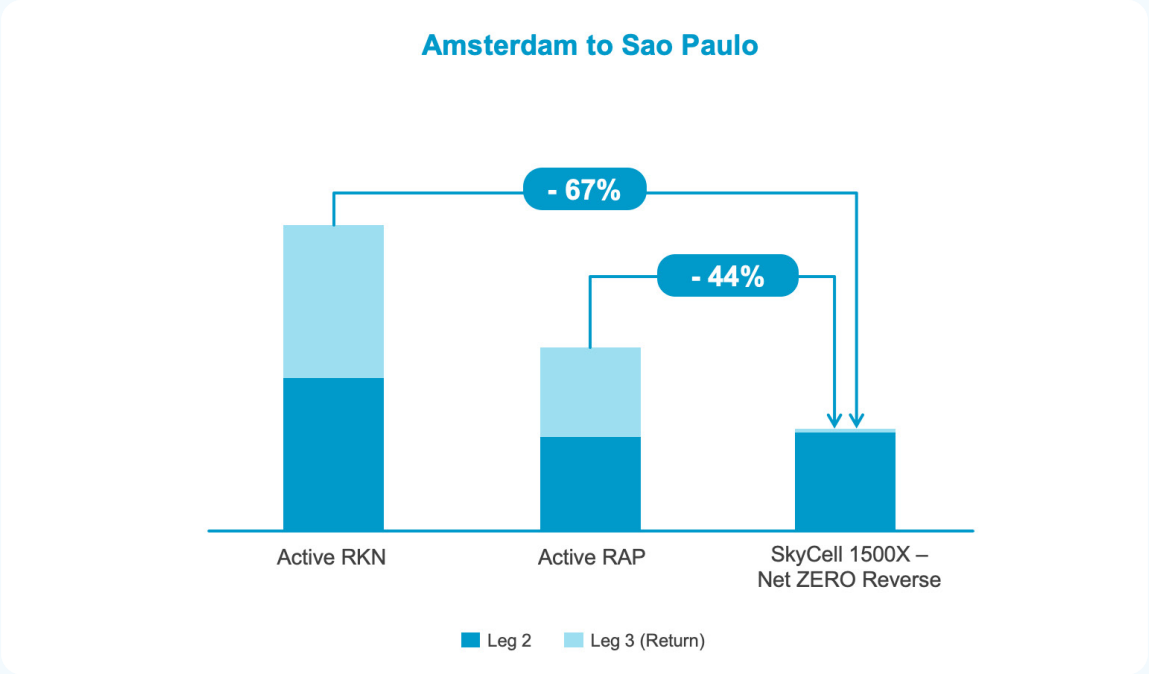
[3] MIT CTL - Reducing CO_2 Emissions in Cold-Chain Pharma Logistics - August 2023[6].pdf
[4] Lee et al., (2021). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmospheric Environment, 244, 117834

3. Data & Findings

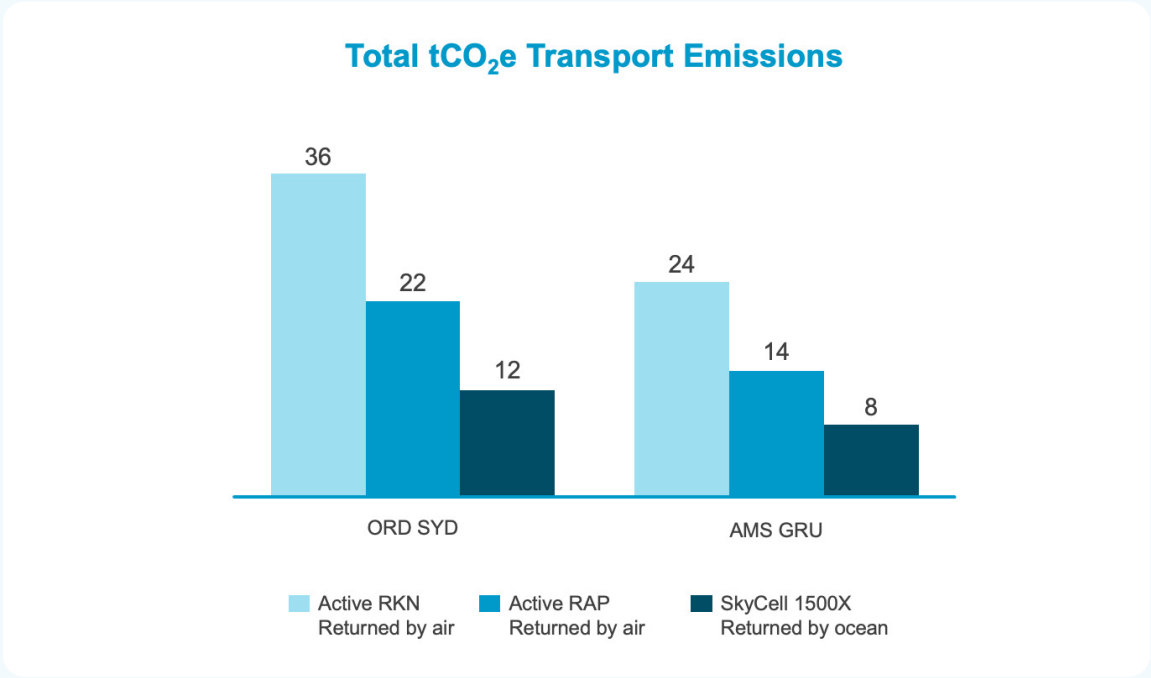
3.1 CO_2 EMISSIONS PER TRANSPORT LEG



Potential carbon emissions for lane Chicago (ORD) to Sydney (SYD), value in tCO_2e per pallet.



Potential carbon emissions lane Amsterdam (AMS) to Sao Paulo (GRU), value in tCO_2e per pallet.



Total transport emissions for 2 transport scenarios

3.2 TOTAL CO_2 REDUCTION WITH NET ZERO REVERSE

Compared to traditional containers, Net ZERO Reverse delivers the following emission savings across Leg 2 and Leg 3:

- **ORD to SYD**
  - 1500X vs. RAP: 10 tCO_2e saved
  - 1500X vs. RKN: 24 tCO_2e saved
- **AMS to GRU**
  - 1500X vs. RAP: 6tCO_2e saved
  - 1500X vs. RKN: 16 tCO_2e saved

By shifting reverse logistics from air to ocean freight, Net ZERO Reverse achieves up to 67% CO_2 reduction in the overall transport emissions compared to RKN and around 40% compared to RAP, yielding major overall emissions reductions.

4. Results Analysis

Across both routes, the 1500X consistently outperforms the RAP and RKN containers due to the ocean-based reverse strategy. Notably, emissions from Leg 3 (the return leg) are nearly eliminated for the 1500X (<0.1 tCO2e) compared to double the emissions for air-based returns.

4.1 WHY NET ZERO REVERSE + 1500X OUTPERFORMS RAP & RKN

The combination of SkyCell's 1500X hybrid containers with its Net ZERO Reverse services helps reduce emissions in several ways.

Optimized design

The 1500X has an optimized volume to weight ratio that maximizes payload capacity while reducing weight. Compared to active containers like the RAP or RKN, there are no electrical parts adding weight or bulk. This translates to more products shipped per container and reduced air cargo weight, helping reduce emissions with every shipment.

Reduced waste

With an independently assessed temperature excursion rate of less than 0.05%, the 1500X eliminates product loss. This means less weight, less replacement shipments, and overall improved efficiency. The container is designed for longevity, it can be reused for dozens of shipments, plus it can be maintained and repaired via SKyCells global service station network ensuring the efficiency of the circularity approach, the reusability of the container helps spread emissions across a long lifecycle.

Integration of ocean freight

By reducing reliance on air freight and shifting reverse logistics to ocean freight, Net ZERO Reverse significantly reduces the CO_2 footprint of every shipment.

4.2 KEY TAKEAWAYS & SUSTAINABILITY IMPACT

1. Net ZERO Reverse cuts emissions **by over 90%** on the return leg—delivering a total reduction of up to 24 tCO_2e per container on global routes.
2. The 1500X container maintains <0.05% temperature excursions and 0% product loss rate, ensuring **uncompromised quality and compliance.**
3. At scale, this model could eliminate **hundreds of thousands of tons of CO_2 emissions** annually from pharmaceutical supply chains.
4. Adoption of Net ZERO Reverse can help pharma companies achieve **regulatory compliance & corporate sustainability goals.**

5. References

1. HealthCaresClimateFootprint_092319.pdf
2. GLEC Framework V 3.1, 2024, Mobitool Factors, 2023, UK Department of Energy Security and Net Zero Conversion Factors, 2023.
3. MIT CTL - Reducing CO_2 Emissions in Cold-Chain Pharma Logistics - August 2023[6].pdf
4. Lee et al., (2021). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018. Atmospheric Environment, 244, 117834

Net ZERO Reverse, in combination with the 1500X hybrid container, offers a breakthrough in sustainable pharmaceutical logistics.

By eliminating the need for reverse air freight and integrating efficient ocean freight solutions, SkyCell delivers:

- Over 90% CO_2 reduction potential in emissions for reverse logistics and up to 67% reduction overall compared to RKN solutions.
- Permanent removal of residual emissions from returns
- A scalable, quality-assured model for future-ready pharma transport.

SKYCELL

Ready to reverse the impact?

Contact our experts today and join the Net ZERO revolution.

CONTACT US