Singapore Changi Airport

Thermal Considerations for the Jewel Changi Airport

Background

- 67.7 million passengers in 2024 Making it the fourth busiest international airport in the world [1]
- Currently 4 terminals with a 5th under construction [2]
- Total floor area of 1,308,000 m^2 [3]
- A building complex so large it has its own rail network [4]

[1] “Busiest Airports in the World 2024 | OAG.” [Online]. Available: https://www.oag.com/busiest-airports-world-2024. [Accessed: 13-Mar-2025].
[2] R. Waite, “Heatherwick and KPF win Singapore mega-air terminal,” 12-Apr-2018. [Online]. Available: https://www.architectsjournal.co.uk/news/heatherwick-and-kpf-win-singapore-mega-air-terminal. [Accessed: 13-Mar-2025].
[3]“The Architecture And Design Of Jewel Changi Airport.” [Online]. Available: https://www.designandarchitecture.com/article/the-architecture-and-design-of-jewel-changi-airport.html. [Accessed: 13-Mar-2025].
[4] “Automated People Mover "Crystal Mover" for Singapore Changi International Airport” [Online]. Available: https://www.mhi.co.jp/technology/review/pdf/e442/e442010.pdf. [Accessed: 13-Mar-2025].

HVAC

- Carrier 23XRV series screw chillers [5]
  - Installed in 2013
  - Allow for part loading (variable speed drives)
- Electronically Commutated (EC) fans [6]
  - Retrofitted in 2020
  - Reducing energy consumption by 25%.
- MERV-14-rated Filters [7]
- Ultraviolet-C [7]

[5] Changi airport group, “CHAMP10NING SUSTAINABILITY, Sustainability Report 2018/19” [Online]. Available: https://www.changiairport.com/content/dam/cacorp/sustainability/sustainable-changi/sustainability-report/2018-19%20CAG%20Sustainability%20Report.pdf. [Accessed: 13-Mar-2025].
[6] Changi airport group, “FORGING A SUSTAINABLE CHANGI, Sustainability Report 2021/2022” [Online]. Available: https://www.changiairport.com/content/dam/cacorp/sustainability/sustainable-changi/sustainability-report/CAG%20Sustainability%20Report%20FY2122.pdf. [Accessed: 13-Mar-2025].
[7] International Airport Review, “Changi Airport deploys new technology for cleaner air in terminals.” [Online]. Available:

Sunlight

- Double glazed low-emissivity Solarban 70XL coated glass [8]
  - 62% of the sun's energy as visible light and only 33% of that energy as heat.
  - 9,000 triangles of double-glazed glass, with no more than two units shaped precisely the same way
- Frit-patterning, natural shading provided by trees and deploy-able shading [5, 9]
- Water cooled concrete in direct sunlight areas [5]

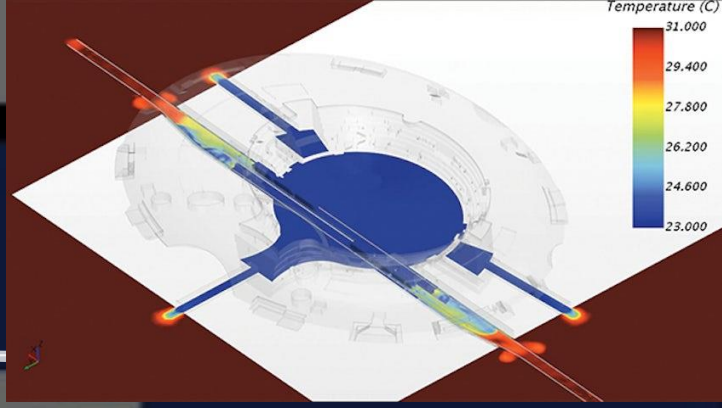
[5] Changi airport group, "CHAMP10NING SUSTAINABILITY, Sustainability Report 2018/19" [Online]. Available: https://www.changiairport.com/content/dam/cacorp/sustainability/sustainable-changi/sustainability-report/2018-19%20CAG%20Sustainability%20Report.pdf. [Accessed: 13-Mar-2025].
[8] "Vitro Glass makes Jewel Changi Airport in Singapore sparkle | Vitro Architectural Glass." [Online]. Available: https://www.vitroglazings.com/about/news/vitro-glass-makes-jewel-changi-airport-in-singapore-sparkle/. [Accessed: 13-Mar-2025].
[9] A. Smith, "Modelling the world's tallest indoor waterfall at Jewel Changi Airport," 25-Feb-2021. CIBSE [Online]. Available: https://www.cibsejournal.com/technical/modelling-the-worlds-highest-indoor-waterfall-at-jewel-changi-airport/. [Accessed: 13-Mar-2025].

Waterfall

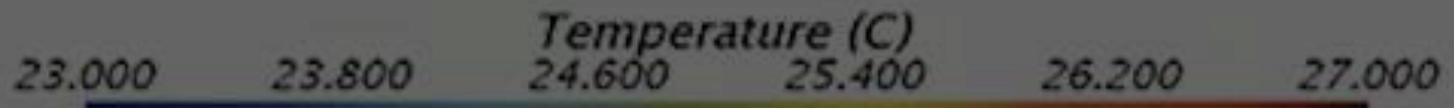
- Tallest indoor waterfall in the world, 40,000 liters/min of water falling 40m [9]
- Concerns over destratification of natural thermals [9, 10]
- Atelier Ten won a CIBSE Building Simulation Award for their work modelling the JCA [9]
- Ran simulations using Simcenter STAR-CCM+ on SIEMENS supercomputers validated by building practical mockups [9, 10]
- Verified adhernce to environmental and occupant comfort requirements before construction [10]

[9] A. Smith, “Modelling the world’s tallest indoor waterfall at Jewel Changi Airport,” 25-Feb-2021. CIBSE [Online]. Available: https://www.cibsejournal.com/technical/modelling-the-worlds-highest-indoor-waterfall-at-jewel-changi-airport/. [Accessed: 13-Mar-2025].
[10] H. Woon, “Using simulation to reduce the carbon footprint and provide more utility for users.” SIEMENS [Online]. Available: https://resources.sw.siemens.com/en-US/case-study-atelier-ten/. [Accessed: 13-Mar-2025].

Train

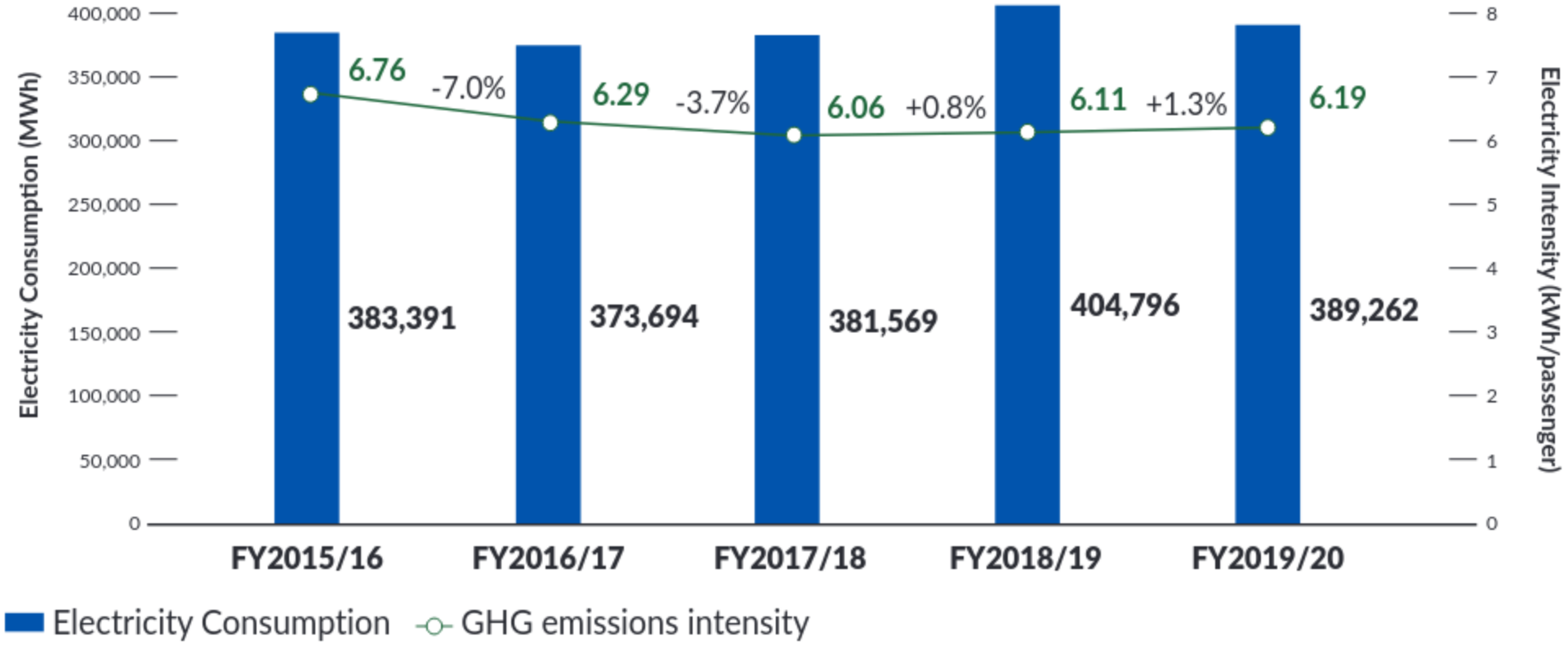


- The train was there first, the hole for the waterfall was made off center to accommodate for it [11]
- Singapore planning authorities imposed strict limits for allowable air leakage [10]
- The trains where originally to be sealed but the embodied carbon of the steel, concrete and glass where prohibitive [10]
- Alternatives such as air curtains were too loud and energy intensive [9]
- The solution was fast acting doors before and after the train [9, 11]



[9] A. Smith, “Modelling the world’s tallest indoor waterfall at Jewel Changi Airport,” 25-Feb-2021. CIBSE [Online]. Available: https://www.cibsejournal.com/technical/modelling-the-worlds-highest-indoor-waterfall-at-jewel-changi-airport/. [Accessed: 13-Mar-2025].
[10] H. Woon, “Using simulation to reduce the carbon footprint and provide more utility for users.” SIEMENS [Online]. Available: https://resources.sw.siemens.com/en-US/case-study-atelier-ten/. [Accessed: 13-Mar-2025].
[11] “Inside Jewel Changi Airport: An interactive special.” [Online]. Available: https://infographics.channelnewsasia.com/jewel-changi-airport/index.html. [Accessed: 13-Mar-2025].

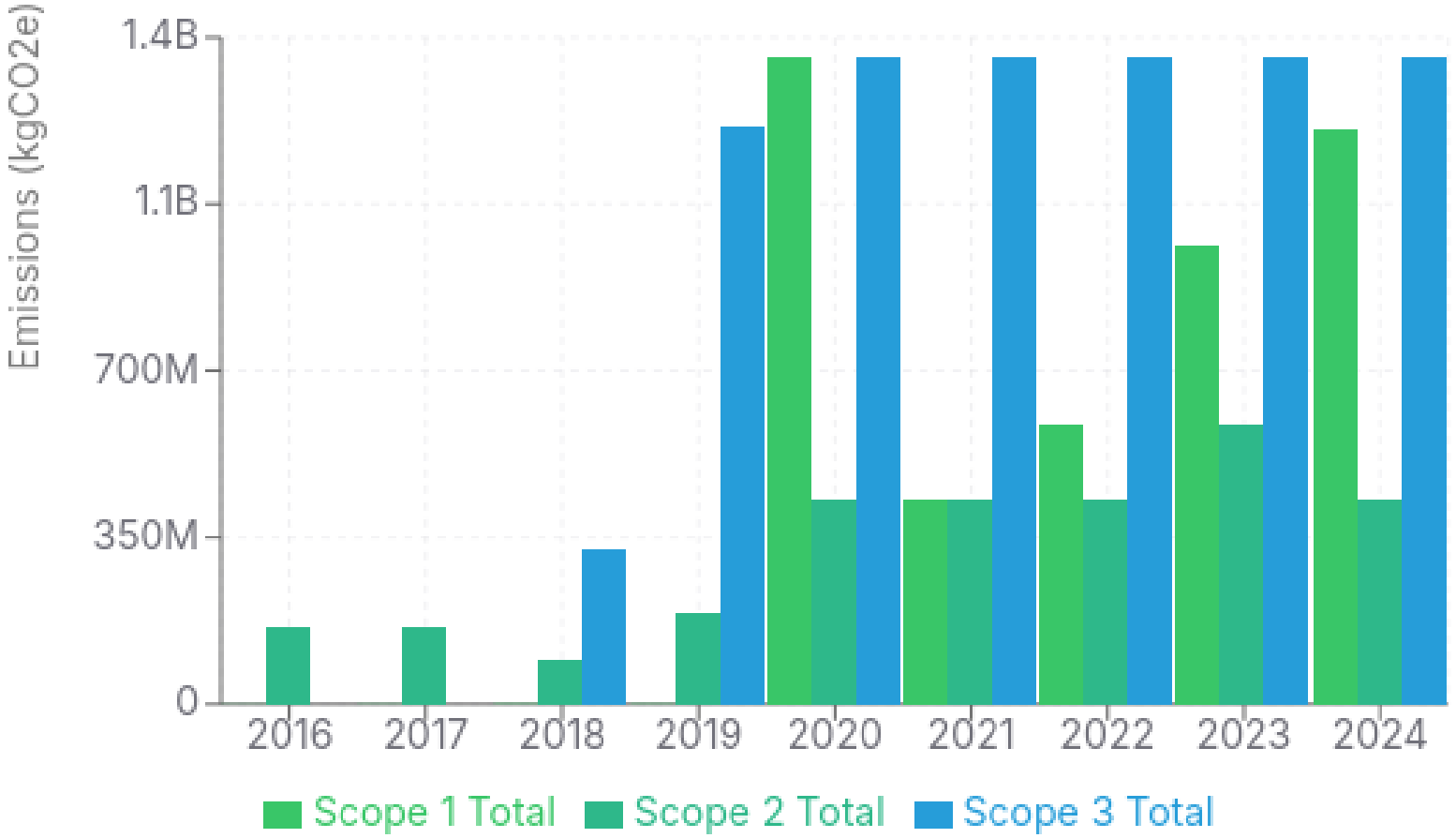
Energy Use



Note: More recent data is available from the 21/22 report but is not likely to be representative given COVID 19 pandemic.

[6] Changi airport group, "FORGING A SUSTAINABLE CHANGI, Sustainability Report 2021/2022" [Online]. Available: https://www.changiairport.com/content/dam/cacorp/sustainability/sustainable-changi/sustainability-report/CAG%20Sustainability%20Report%20FY2122.pdf. [Accessed: 13-Mar-

Carbon Emissions



- DitchCarbon Score of 20/100 [12]
- In the top 10% for the air transport industry [12]

[12] “Changi Airport Sustainability Report.” [Online]. Available: https://ditchcarbon.com/organizations/changi-airport. [Accessed: 13-Mar-2025].