ICAO

ENVIRONMENT

The Eco Design of Airport Buildings

ECO AIRPORT TOOLKIT

Case Studies

The Eco-Design of Airport Buildings (Case Studies)

COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)
AIRPORTS AND OPERATIONS WORKING GROUP (WG2)

ECO AIRPORT TOOLKIT

Zurich Airport (ZRH)

Eco-design of Airport Buildings
A request for case studies

Description of Request

1.1 ICAO's Committee on Aviation Environmental Protection (CAEP) is currently developing an *ECO Airport Toolkit*, with the objective to provide supplementary information on selected topics included in the recently updated ICAO Doc 9184 *Airport Planning Manual, Part 2, Land Use and Environmental Management*. The "e-publications" are intended for use by airport operators, States and regional and local authorities that are planning or engaged in airport infrastructure projects, particularly in regions in which the aviation sector is developing strongly.

This request is for airport operators to use the below template to provide examples of case studies on the eco-design of their buildings, including aspects of planning, design, construction, operations, and maintenance. The case studies will be included as annexes to the ICAO e-publication "Eco-design of Airport Buildings"

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Emanuel Fleuti
Organization/Company	Zurich Airport
Job Title	Head of Environmental Protection
Email Address	emanuel.fleuti@zurich-airport.com
Telephone	+41-43-816 21 81
Airport *(Name and 3 Letter Code)*	Zurich Airport, ZRH

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title: The construction of pier E as part of the fifth expansion

Timeframe (e.g., start and end month/year if applicable): Construction (2000~2002); Operation (2003~)

Description:

Pier E of Zurich Airport was constructed as part of the fifth expansion of the airport. From the beginning, the pier was designed with special consideration to maximize energy efficiency and conserve natural resources. Such features enabled Zurich Airport to expand without increase in total energy consumption. During the construction phase from 2000 to 2002, measures were taken to minimize the adverse environmental effects, such as mandated use of particle filters and on-site concrete manufacturing. The location of the pier situated between runways allowed shorter taxiways for aircraft, thereby enabling emissions reduction, fuel savings, as well as more efficient ground traffic.

Thanks to the development of Pier E and other innovative initiatives, Zurich airport has reduced its own CO2 emissions from scopes 1 and 2 (emission sources owned and operated by Zurich airport and external electricity purchased) by more than 15,000 tonnes (31% reduction) since 1991, despite a 40%increase in infrastructure and a 65% increase in traffic units. The total energy consumption has been stabilized at the 1994 level. This has only been possible through efforts to maximize energy efficiency and conserve natural resources as did in the construction of pier E.

Aircraft Ground Energy Systems (AGES)
Specifically, Pier E aircraft stands are equipped with Aircraft Ground Energy Systems (AGES) that supply aircraft with electricity (400Hz) and Pre-Conditioned Air (PCA). This stationary system allows substantial reduction in fuel consumption and local air quality improvement.

Rainwater Collection
On the roof of pier E, rainwater is collected to be stored in two tanks in the underground. This water is later piped to the 160 toilets and 70 urinals in the building, resulting in about 12,000 m3 of drinking water per year (about one third of total water consumption of pier E) This rainwater collection facility also allows the retention of the precipitation water, limiting the chance of rainwater run offs.

Photovoltaic plant
The roof of Pier E serves a triple functionality: as a solar power plant; shading of the façade; and a design function. With about 5,000 solar modules in an area of 5,800 m2, a mean production of 290,000 kWh is achieved per annum by the roof. The success of this roof was widely recognized, evidenced by the Swiss solar prize award for its solar initiatives.

Glass façade as climate buffer
Pier E benefits from the double glass façades design that functions as climate buffers. The air inside two glass walls and inner-building air is hardly mixed, effectively working as an insulator and maintaining adequate temperature from extreme temperatures. The transparency of glass also allows the airport use natural daylight to a great extent.

Energy piles
Due to the instable soil, the pier was constructed on 441 piles. About 70% of these piles were equipped as energy piles, allowing a seasonal storage of energy. During the summer, excess heat is collected and stored through a system of heat exchange and ventilation, which can later be retrieved in winter. As a result, about two thirds of the cooling and heating demand is covered by this system. The success of this energy conservation was recognized through the Swiss Geothermal Award 2010 by the Swiss Geothermal Society.

Step 3: Have you considered getting a eco-design certification/rating system? Which one?
At the time of design and planning in 1995, eco-design certification or rating systems were not yet very well-known in Switzerland. At the same time, an airport pier didn't match any of the known systems at the time. To this end, Zurich airport decided not to pursue getting a certification.

Step 4: Are you certified by any sustainability rating system? Please identify.
No. However, the project has been awarded with a "Prix solaire" for its photovoltaic plant and with the "Swiss Geothermal-Prize 2010" for the outstanding achievement in using renewable energy.

Step 5: Please identify which area(s) the eco-design project has focused on
(X) Energy efficiency
(X) Emissions
(X) Waste
(X) Water
( ) None
( ) Other _____

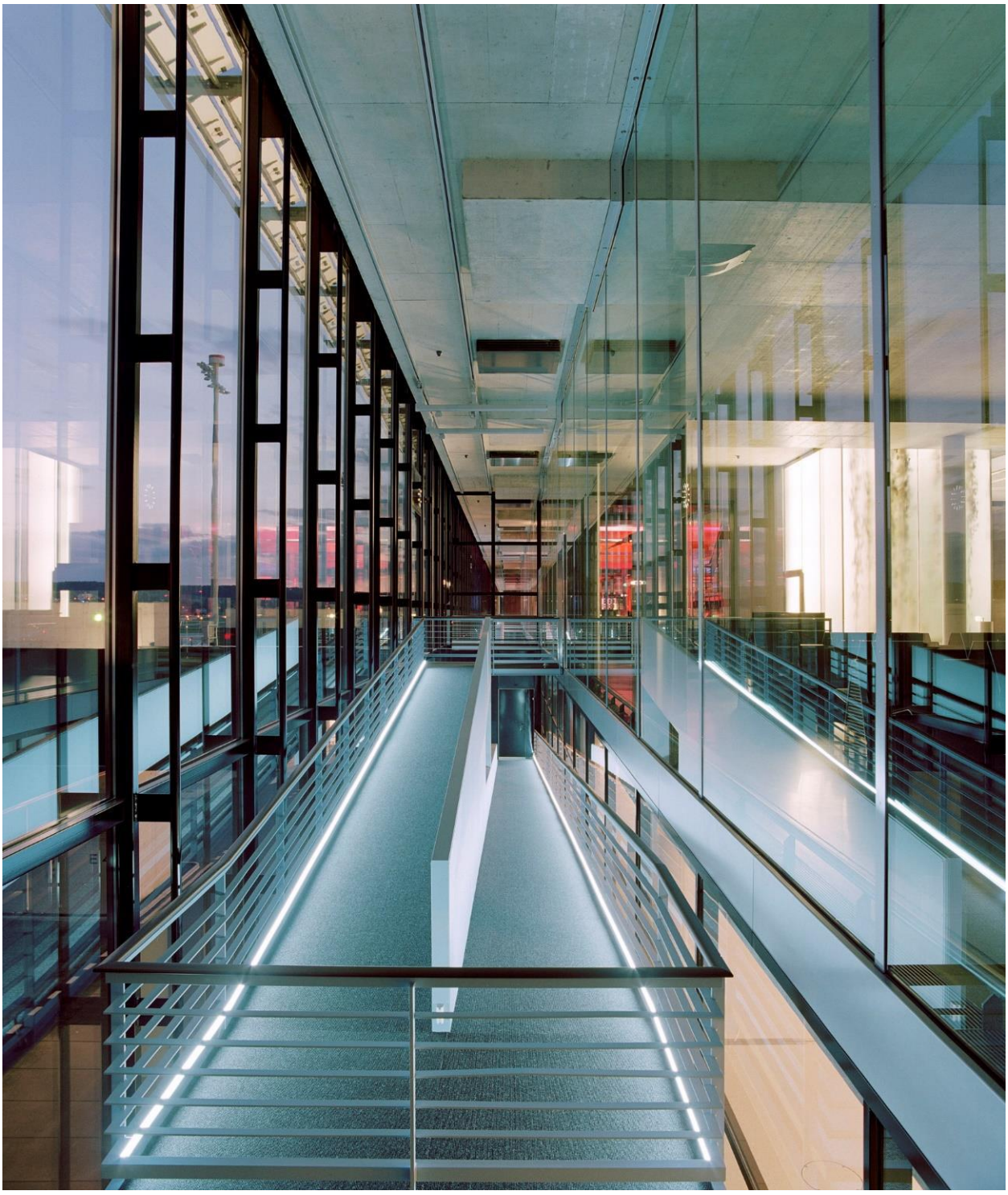
Step 6: Please identify and prioritize the driver(s) for the eco-design building project. Number 1-6, where 1 is a high priority and 6 is a low priority.
(2) Economic
(2) Environmental
(1) Political
(2) Social
( ) None
( ) Other _____

Step 7: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentive for the development of such programs? Any specific type of financing that was required? Can you describe it?
In the context of promoting public acceptance for the expansion project, the real estate company (at the time separate from the airport operator), asked for an environmentally outstanding new pier building in a planning and design competition. Accordingly, the evaluation criteria put a high emphasis on the environmental performance of the project. There were no special incentives or financing elements to it.

Step 8: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.
No.

Step 9: Which department is in charge and/or involved in the eco-design of airport buildings in your organization?
Real Estate Division

Step 10: Please insert Text and Images of your project/case study below here:




finnair

Lessons Learned:
It has proven essential to specify sustainability criteria in the beginning of the design competition as a leading element. As such, the project proposals were more efficient than if the criteria were to be added at a later stage.

COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)
AIRPORTS AND OPERATIONS WORKING GROUP (WG2)

ECO AIRPORT TOOLKIT

Amsterdam Airport Schiphol (AMS)

Eco-design of Airport Buildings
A request for case studies

Description of Request

ICAO's Committee on Aviation Environmental Protection (CAEP) is currently developing an *ECO Airport Toolkit*, with the objective to provide supplementary information on selected topics included in the recently updated ICAO Doc 9184 *Airport Planning Manual, Part 2, Land Use and Environmental Management*. The "e-publications" are intended for use by airport operators, States and regional and local authorities that are planning or engaged in airport infrastructure projects, particularly in regions in which the aviation sector is developing strongly.
This request is for airport operators to use the below template to provide examples of case studies on the eco-design of their buildings, including aspects of planning, design, construction, operations, and maintenance. The case studies will be included as annexes to the ICAO e-publication "Eco-design of Airport Buildings"

Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Denise Pronk
Organization/Company	Amsterdam Airport Schiphol
Job Title	Programme Manager Corporate Responsibility
Email Address	pronk_d@schiphol.nl
Telephone	0031653827742
Airport *(Name and 3 Letter Code)*	Amsterdam Schiphol (AMS)

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title:
1) New Pier (Pier A) – LEED V4 Gold certification;
2) Schiphol Morgue – BREEAM Excellent

Timeframe (e.g., start and end month/year if applicable): Pier A project to be delivered by late 2019; Morgue project ended in late 2017

Description:
In an effort to strengthen our competitive position and ensure that we can continue to offer our passengers and airlines a top-quality product, Amsterdam Airport Schiphol is making substantial infrastructural investments. To support and ensure Schiphol's continued growth, the airport's facilities will undergo extensive expansion and renewal in the years ahead. This will enable us to offer the required extra capacity, improve quality and further optimise processes in the long term.

Purpose

Step 3: Have you considered getting a eco-design certification/rating system? Which one?
Yes, LEED, BREEAM, and Dutch Energy Performance Certificates

Step 4: Are you certified by any sustainability rating system? Please identify.
Pier A – LEED V4 Gold certification; Energy Performance Certificate – to be determined.
Morgue – BREEAM Excellent; Energy Performance Certificate – Label A.

Step 5: Please identify which area(s) the eco-design project has focused on
(X) Energy efficiency
(X) Emissions
(X) Waste
(X) Water
( ) None
(X) Other Well-being and Materials _____

Step 6: Please identify and prioritize the driver(s) for the eco-design building project. Number 1-6, where 1 is a high priority and 6 is a low priority.
(1) Economic
(2) Environmental
( ) Political
( ) Social
( ) None
( ) Other _____

Step 7: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentive for the development of such programs? Any specific type of financing that was required? Can you describe it?

Sustainability is at the heart of Schiphol's strategy, therefore it is difficult to prioritize between the listed drivers. Yet, one requirement for any project by Schiphol is that there exists a sound business case. If it is not the case, non-financial benefits (environment and social impact) should be substantiated enough that the Management Board can weigh all priorities (i.e. besides economic and environment, safety and quality are important consideration as well)

One special consideration to be given to the Morgue Project was the short-planned life span of the building in the current location. The Morgue is expected to be functioning in the current location only for 15 years, with subsequent plan for relocation. Hence, the building had to be constructed with a clear consideration for disassembly.

Step 8: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

Amsterdam Airport Schiphol always engages with internal and external stakeholders and works in coordination with a number of stakeholders. In addition to the relevant trends and developments, Schiphol takes into account the values, interests and views of numerous stakeholders in the decision-making process.

Step 9: Which department is in charge and/or involved in the eco-design of airport buildings in your organization?
The Corporate Development department which is in charge of strategy is also in charge of sustainability. This team sets forth the requirements for new buildings, whereas the business areas are responsible for the execution and implementation of projects.

Step 10: Please insert Text and Images of your project/case study below here:

1) New Pier (Pier A) – LEED V4 Gold certification;

Our new pier is over 55,000m2 in size, equivalent to 11 football fields. The era of sitting in one of those black chairs and simply waiting until boarding time is almost over. The new pier will have comfortable lounge chairs for relaxation, high-top tables for working and last-minute shopping outlets. The pier's open layout means travellers can see the boarding process begin – even when they aren't waiting at the gate. There are trees, flowers and plants all over the new pier. The new pier is green in more ways than one. We have carefully considered various ways of reusing energy and using reusable or sustainable materials in the design of the new pier. The ceiling is made of reusable plastic, marble rubblework tiles and 5,000 m2 of solar panels. We flush the toilets using rainwater, and much of the floor is made of bamboo. Schiphol

Schiphol built this new facility according to the cradle-to-cradle principle. When a structure's lifespan has ended, the materials can be easily reused in a new project. It is the first 100% cradle-to-cradle building at and belonging to Schiphol.

2) Schiphol Morgue – BREEAM Excellent

Amsterdam Airport Schiphol opened a new morgue late last year which achieved a BREEAM rating of Excellent. This construction standard was achieved through insulating and energy-generating applications, such as the climate resilient circular water system that drains away waste water more slowly and filters it – rain water is captured to flush toilets. Electricity is supplied by solar panels and the building is lit by LED lighting. The building uses a heat pump so no natural gas is needed. Furthermore, there is an ecological plan for the morgue. It has a 'Green' roof and designated area for bees. Bees are an essential part of our ecosystem, and we want to support them because bee populations are dwindling. ENS technology captures particulate matter, thereby ensuring a healthier general environment and working environment. The architect designed the building according to the Fibonacci Sequence. By doing so, he used the principles of nature what makes that whether one is alone in the mortuary or with a big group; that way, the building always feels respectful and comfortable. This was the main objective when the building was designed.

Decision-Making Process:

Estimated Cost and Financial mechanisms available:

n/a

Images:

Lessons Learned:

Schiphol's suggestion for other airports to consider in eco-design project can be explained in one key word, the 'integration'; incorporating sustainability requirements from the very beginning of any project.

From the initial stage in exploring the right contractors to design the buildings, it is crucial to ensure project personnel are knowledgeable and experienced with the sustainability requirements. This step is essential as ambitious goals would not be achieved without sustainable design. Once the project is rolled out for implementation, sustainability officer should continuously corroborate with the architect and construction project manager that sustainability requirements are appropriately translated into the design and construction along with other safety and financial constraints set by the airport. Furthermore, contract managers should practice continuous oversight to ensure that the highest standards set forth for health, safety, environment, and quality compliances are maintained throughout the process, and every practice is carried out in accordance with the agreed terms.

COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION
(CAEP) AIRPORTS AND OPERATIONS WORKING GROUP (WG2)

ECO AIRPORT TOOLKIT

Carrasco International Airport (MVD). Uruguay

Eco-design of Airport Buildings

A request for case studies

Description of Request

1.2 ICAO's Committee on Aviation Environmental Protection (CAEP) is currently developing an *ECO Airport Toolkit*, with the objective to provide supplementary information on selected topics included in the recently updated ICAO Doc 9184 *Airport Planning Manual, Part 2, Land Use and Environmental Management*. The "epublications" are intended for use by airport operators, States and regional and local authorities that are planning or engaged in airport infrastructure projects, particularly in regions in which the aviation sector is developing strongly.

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Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	Jorge Navarro Pastorino
Organization/Company	Corporación América Uruguay
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Email Address	Jorge.navarro@aeropuertodecarrasco.com.uy
Telephone	+59826040329 ext. 1615
Airport *(Name and 3 Letter Code)*	Aeropuerto de Carrasco - MVD

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title:

Aeropuerto de Carrasco Energéticamente Eficiente

Timeframe (e.g., start and end month/year if applicable): 2015 to 2018

Description:

Aeropuerto de Carrasco's commitment to an environmentally friendly, sustainable operation.

A strong commitment for sustainability is at the heart of Corporación América, which has consistently been striving to mitigate the environmental impact of its operations, aiming to transform Aeropuerto de Carrasco into a "green airport".

In this regard, the company implemented a Residue Management Plan, along with an Energy Management System, aimed at the removal of fossil fuel usage, to be achieved by reducing heating consumption by 40%, and cooling consumption by 20%; increasing performance by 400% and avoiding the annual consumption of 122,400 m3 of natural gas.

The success of these measures, which in the year 2016 earned the Ministry of Industry, Energy and Mining's recognition through the National Energy Efficiency Prize, involved modifying the airport's Air Conditioning System. The company replaced the natural gas heating units with more efficient, electricity powered units.

The terminal area's air conditioning units include an air routing system which allow them to either process return or exterior air (free cooling). Along with the glass surface of the structure, which improves thermal insulation and reduces energy expense, free cooling has been optimized, further increasing the building's efficiency.

Adding to these measures, a new Photovoltaic Solar Power Plant was set up on a one hectare field in the airport's premises, and is made up of 1540 photovoltaic panels placed along seven rows, from north to south. Using next generation solar tracking technology, it is able to produce 25% more energy than traditional mobile panels.

This solar plant is meant to allow for 10% of the terminal's yearly power consumption to be covered by renewable energy, which constitutes a reduction of 352 tons of CO2 released into the atmosphere per year.

This year (2018) we are in the process of replacing conventional luminaires with new lamps with LED technology

Purpose

Step 3: Have you considered getting a eco-design certification/rating system? Which one?

The successful application of its Sustainability Plan, carried out through all of these measures, enabled Aeropuerto de Carrasco to complete its level 1 Airport Carbon Accreditation (ACA), awarded by the Airports Council International (ACI), in virtue of the low carbon emissions. This award allows Uruguay to be included in a list of eight Latin American countries with low environmental impact airport operations. Additionally, the airport terminal is a permanent member of the ACI's Latin America Environmental Committee, and is ISO 14064-1 certified, which is an international standard for the quantification and reporting of greenhouse gas emissions.

Corporación América is committed to continuous growth and investment into innovation for the lowering of its carbon footprint, while remaining faithful to the best quality and safety standards.

Step 4: Are you certified by any sustainability rating system? Please identify.

Step 5: Please identify which area(s) the eco-design project has focused on

(x) Energy efficiency

(x) Emissions

( ) Waste

( ) Water

( ) None

( ) Other _____

Step 6: Please identify and prioritize the driver(s) for the eco-design building project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(3) Economic

(2) Environmental

(1) Political

(4) Social

( ) None

( ) Other _____

Step 7: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentive for the development of such programs? Any specific type of financing that was required? Can you describe it?

Previously, there was no legal framework for the generation of power for self-consumption. The Airport worked alongside the Ministry of Industry, Energy and Mining, in order to enable the project, after which the Ministry issued the Decree 043/15, which enabled all Large Consumers to generate power using renewable sources, for selfconsumption, without the possibility of routing surplus power into the main grid.

The project was financed by the company itself.

In Uruguay, there is an Investment Law, which promotes investments which have a positive impact in the environment or employment. We were granted a corporate tax (IRAE) exemption of 30%.

Step 8: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

We worked with the Uruguayan Ministry of Industry, Energy and Mining, the National Directorate of Civil Aviation and Aeronautic Infrastructure (DINACIA), and with the state owned national electric power company.

Step 9: Which department is in charge and/or involved in the eco-design of airport buildings in your organization?

The department of Maintenance and Infrastructure.

Step 10: Please insert Text and Images of your project/case study below here:

Decision-Making Process:

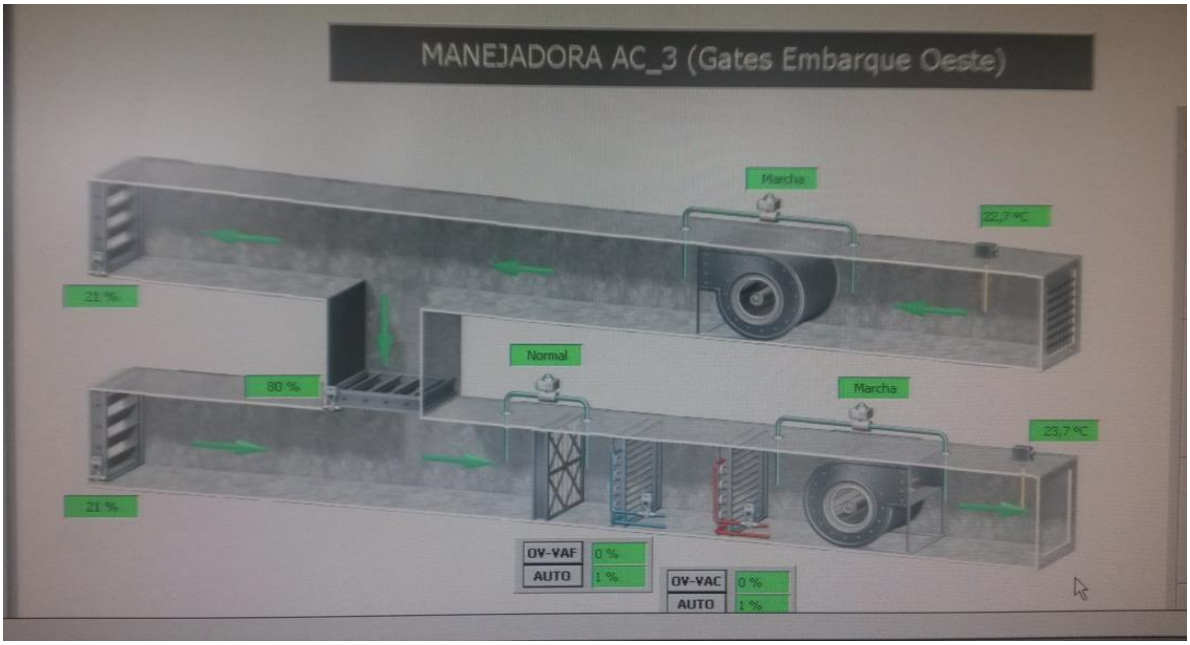
Estimated Cost and Financial mechanisms available:

Proyecto	Cost (USD)	Saving (USD/year)	Reduction of emissions of CO2 (tCO2 / year)
Heat pumps	600000	150000	346
Free Cooling	75000	52000	85
Solar photovoltaic generation	900000	110000	352
Lamps LED	700000	50000	146
Total	**2.275.000**	**362.000**	**929**

Images:

Heat Pumps

Free Cooling



Solar Photovoltaic Plant

LED ERCO brand lamps - Germany

Lessons Learned:

Having successfully completed this ambitious company has made us at the company and the workforce proud. We are now a regional example of good environmental practices.

This kind of projects are generally regarded as important, with a very long term return of investment, however after carrying out various financial analyses, we have concluded that in addition to being environmentally positive projects, they are economically viable as well.

COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION
(CAEP) AIRPORTS AND OPERATIONS WORKING GROUP (WG2)

ECO AIRPORT TOOLKIT

Midfield Terminal Building, Abu Dhabi, United Arab Emirates

Eco-design of Airport Buildings

A request for case studies

Description of Request

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Step 1: Please provide your contact details in case further information is needed.

	Respondent
Name	**Christine Eid**
Organization/Company	**Abu Dhabi Airports (ADAC)**
Job Title	**Senior Sustainability Manager**
Email Address	**ceid@adac.ae**
Telephone	**+97125056223**
Airport *(Name and 3 Letter Code)*	**Midfield Terminal Building (not yet in operation)**

Step 2: Please provide the following basic information of your Project/Case Study:

Project/Case Study Title:

Midfield Terminal Building (MTB) – Climate Responsive Design

Timeframe (e.g., start and end month/year if applicable):

Design Stage

Description:

A Climate responsive design takes into account the specific local climatic parameters which have direct influence mainly on indoor thermal comfort and energy consumption in a building.

This is achieved through a combination of Passive and Active design measures

Purpose:

- to provide and moderate the adequate indoor environment;
- to allow for a greater degree of control over the internal climate and to further enhance human comfort;
- and subsequently, reduce energy consumption.

Step 3: Have you considered getting a eco-design certification/rating system? Which one?

Yes, the MTB design has achieved the 3 Pearl rating for Estidama; as such, the MTB is the largest single building to be ever rated globally, and is the highest rated airport terminal in the region. The MTB is now pursuing the Estidama construction rating.

Step 4: Are you certified by any sustainability rating system? Please identify.

Yes; the MTB is currently certified 3 Pearl under the Estidama Pearl Rating System.

Estidama is a building design methodology for constructing and operating buildings and communities more sustainably. The program is a key aspect of the "Abu Dhabi Vision 2030" drive to build the Abu Dhabi Emirate according to innovative green standards. "Estidama" is the Arabic word for sustainability. The program is not itself a green building rating system like LEED or BREEAM, but rather a collection of ideals that are imposed in an elective building code type of format.

Within Estidama, however is a green building rating system called the Pearl Rating System that is utilized to evaluate sustainable building development practices in Abu Dhabi.

Step 5: Please identify which area(s) the eco-design project has focused on

(X) Energy efficiency

( ) Emissions

( ) Waste

( ) Water

( ) None

( ) Other _____

Step 6: Please identify and prioritize the driver(s) for the eco-design building project. Number 1-6, where 1 is a high priority and 6 is a low priority.

(**3**) Economic

(1) Environmental

( ) Political

(2) Social

( ) None

( ) Other _____

Step 7: Please give more details on the driver(s) chosen in the previous question. For instance, was there any available incentive for the development of such programs? Any specific type of financing that was required? Can you describe it?

The Estidama program is mandatory in Abu Dhabi, United Arab Emirates - all buildings must achieve a minimum 1 Pearl Rating, and all government-funded buildings must achieve a minimum 2 Pearl Rating (5 Pearl rating being the maximum).

During the design stage of the MTB, ADAC have identified greater opportunities for design optimisation which would result in greater O&M savings; and so ADAC decided to go for a higher rating than the minimum mandatory 2 Pearl. The MTB is currently certified 3 Pearl under the Estidama Pearl Rating System, and is pursuing the same level for the construction rating.

There are no other incentives for the implementing Estidama into the airport projects.

Step 8: Did you engage with internal and external stakeholders? If so, please identify which stakeholders you engaged with.

Extensive engagement with internal and external stakeholders was undertaken throughout the design stage and decision making process.

Internal stakeholders:

- Project Board – for decision making and approval;
- Operations & FM – for O&M requirements or constraints;
- Projects Program Controls – for cost analysis and program controls;
- Procurement & Contracts – for market readiness assessment and contract inclusion. External stakeholders:
- Airlines;
- Concessionaires;
- Department of Urban Planning and Municipalities;
- Utilities providers (energy, water and sewerage);
- Department of Transport;
- The Environment Agency.

Step 9: Which department is in charge and/or involved in the eco-design of airport buildings in your organization?

ADAC CP&C (Capital Projects & Construction) division is responsible for the development and delivery of the capital expenditure programme for ADAC airports, and so also in charge of the design and construction process – including eco-design and eco-construction – of all the airport projects.

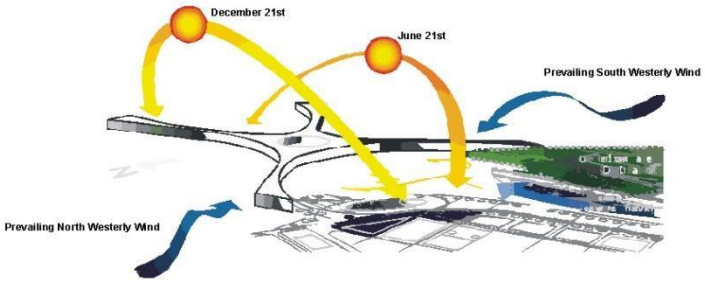
Step 10: Please insert Text and Images of your project/case study below here:

MIDFIELD TERMINAL BUILDING

PASSIVE & ACTIVE DESIGN

A Climate responsive design takes into account the specific local climatic parameters which have direct influence mainly on indoor thermal comfort and energy consumption in a building.

This is achieved through a combination of Passive and Active design measures;



- **Passive Design** considers its specific site planning and takes advantage of the local climate enabling the structure to naturally assist the building in its ability to provide and moderate the adequate indoor environment.
- **Active Design** supports and complements the passive features to allow for a greater degree of control over the internal climate and to further enhance human comfort.

PASSIVE DESIGN

CLIMATE RESPONSIVE

The central processor roof of the MTB spans above main passenger spaces of the terminal building articulated as a tent-like undulating surface suspended over 52m high, 180m large span arches.

It represents a wave like profile to the front of the building cantilevering out at an average of 15m beyond the processor façade, self-shading the entire front porch of the terminal.

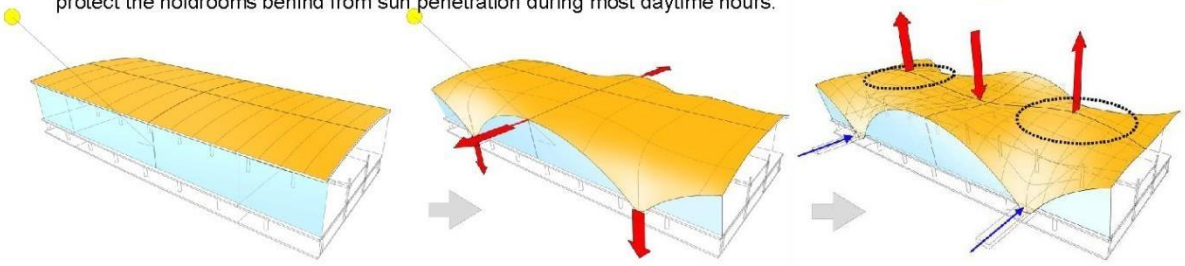
The roof is perforated by skylights along the spine of the building offering a daylight path inviting passengers and guiding them through to the center of building.

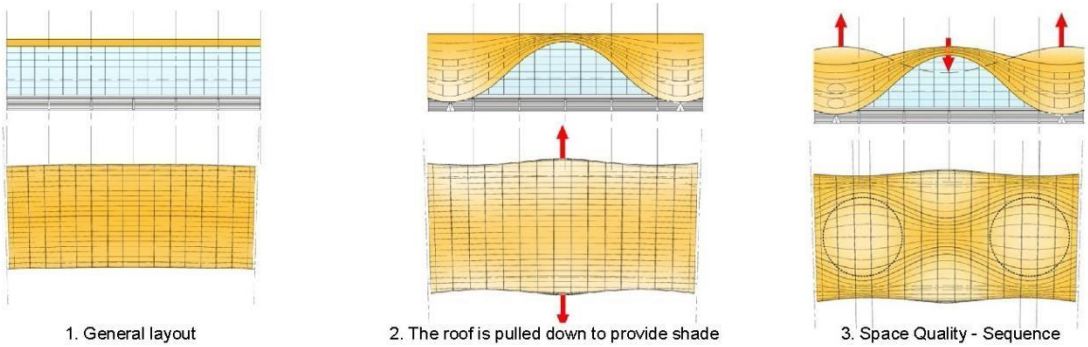
PASSIVE DESIGN

MASSING & ORIENTATION

The arch shaped roof geometry of the piers with the roof surface being pulled down at each segment protects the building from the sun and at the same time creates a continuous undulating form echoing the desert dunes of the Emirates.

The glazed parts of the undulating pier façades are canted 14.75° towards the outside, to protect the holdrooms behind from sun penetration during most daytime hours.





1. General layout

2. The roof is pulled down to provide shade

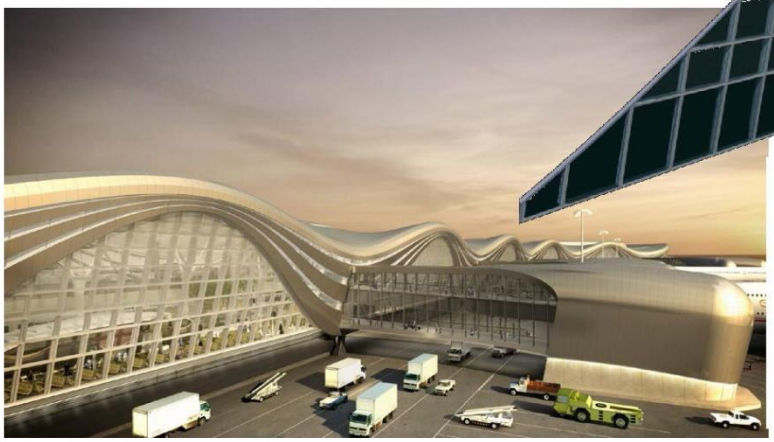
3. Space Quality - Sequence

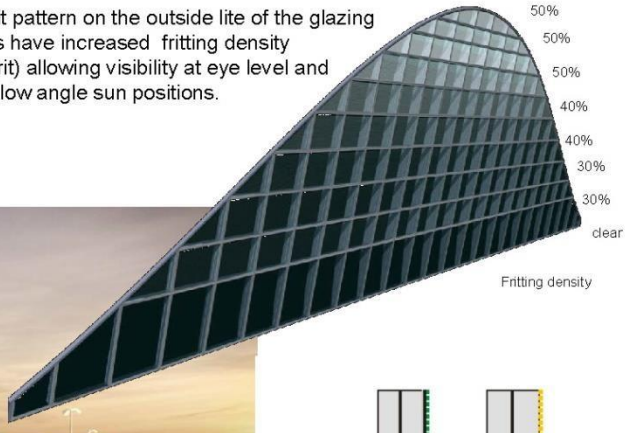
PASSIVE DESIGN

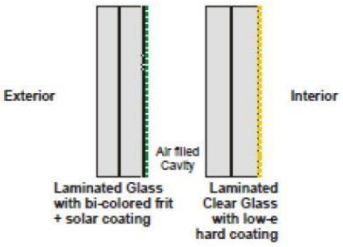
HIGH PERFORMANCE SELF-SHADING FACADES

The insulated double glazing facade is equipped with high performance selective coatings to efficiently filter daylight from unwanted non visual solar radiation wavelengths to reduce solar gains allowing 34% of the sunlight through the clear glass to pass but let only 21% of the solar heat gain enter the building.

In addition to that, the façade glazing have a ceramic frit pattern on the outside lite of the glazing assembly that blocks the suns radiation. These patterns have increased fritting density from bottom (no frit = clear glass) to top (50% opaque frit) allowing visibility at eye level and effectively reducing the solar radiation entering even at low angle sun positions.







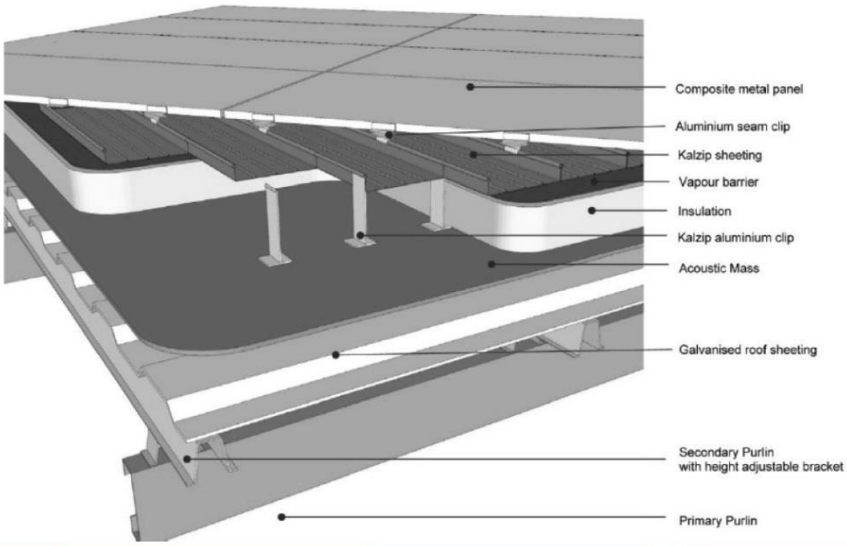
PASSIVE DESIGN

DOUBLE SKIN ROOF

The building envelope is equipped with a ventilated secondary skin to reduce heat transmission through opaque surfaces. The cavity between the internal and external roof skin layers is ventilated to the outside to reduce heat accumulation within the envelope.

The whole envelope and all openings are highly sealed against unwanted air infiltration from the outside as the extremely high humidity levels of the ambient air could lead to condensation issues at internal surfaces and increase dehumidification loads of the building.

The improved infiltration rate contributes to the reduction in the overall energy demand by 5.8%.

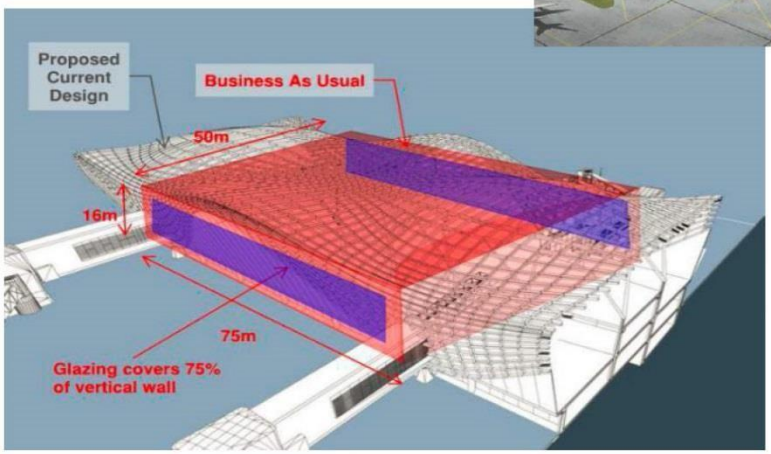


PASSIVE DESIGN

PASSIVE DESIGN – CASE STUDY

A life cycle cost benefit study was undertaken in order to assess the MTB building envelope and form design taking into consideration initial investment costs towards passive strategies and its eventual financial benefits.

This study was primarily undertaken to inform effective long-term decisions about both the building design and construction, as well as the building operation in order to maximize efficiency over the whole life cycle of the development.



The study resulted in the demonstration the current MTB enveloped design, for the area size of 75m x 50m, encompassing the proposed passive design strategies will result in the following:

- Total energy saving: 445,000 kWh/annum
- Total utility cost saved: 48,505 AED/Annum

ACTIVE DESIGN

MECHANICAL SYSTEM OPTIMIZATION

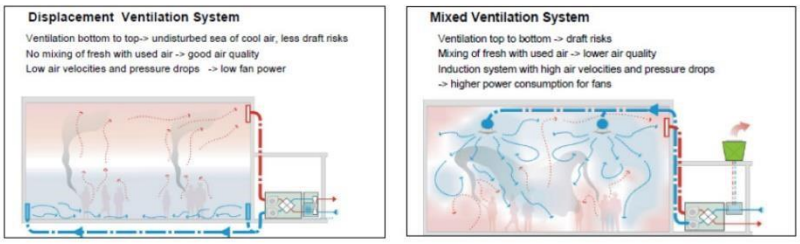
Occupancy controlled Ventilation

Passenger flows and occupancy profiles show a great variety of occupation density within the building. Peak times are around midnight and in the morning hours, while during other times of the day occupancy drops down as far as 20 – 40% of the peak occupancy. Therefore outdoor air supply will be controlled depending on actual occupancy of a space implementing CO_2 sensors in the return air system to control air flow based on demand.

Additionally, Temperature sensors installed throughout the terminal are linked to the AODB (Airline Operation Data Base) where temperature is controlled during occupied periods and permitted to drift up during unoccupied periods.

These measures significantly reduce the outdoor air loads and ventilation temperatures required for sensible cooling and dehumidification.

Displacement Ventilation System



By displacement ventilation system, the air is supplied near the floor to a distance of 10-15m and exhausted near the ceiling. This requires lower air volume movement rates, leading to lower fresh air intake rates and less electricity required to drive the fan for both air exhaust and supply.

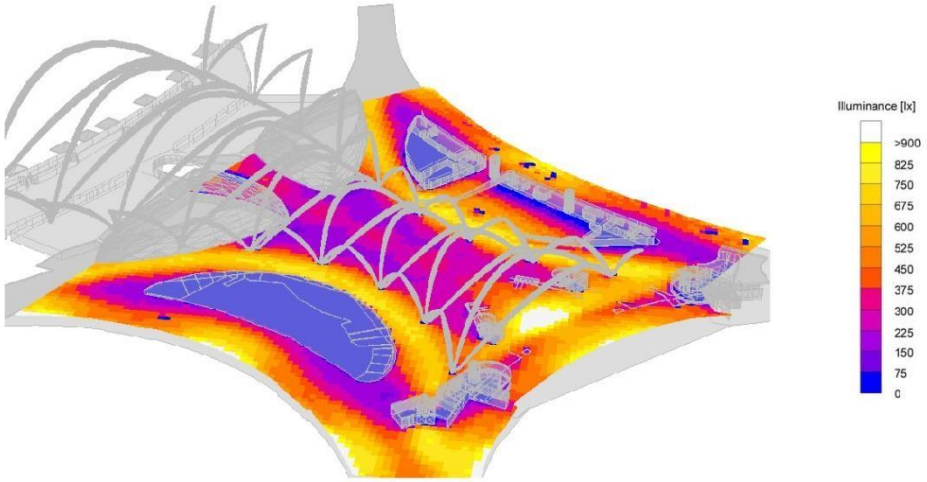
The air flowing in one direction (bottom to top) reduces drafts risk and prevents the mixing of fresh air with the used air. This results in a significant increase in thermal comfort for the passengers.

ACTIVE DESIGN

INTELLIGENT LIGHTING CONTROL SYSTEM

According to daylight simulations, more than 75% of publicly-occupied spaces will have a minimum of 250 lux daylight illuminance under clear skies at equinox and summer solstice. A daylight simulation for overcast conditions was also performed indicating adequate daylight in all public areas except Baggage Claim, which has very limited exterior exposure and requires artificial lighting under all circumstances.

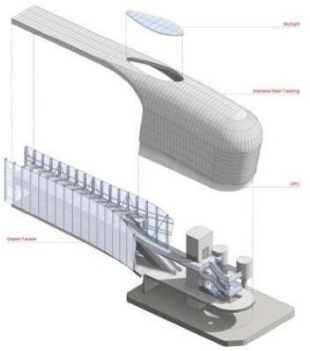
Photocell controllers are installed to provide daylight sensitive switching to designated lighting channels and scenes only when needed and dimming artificial lighting to the minimum when not needed – during off-peak hours. As a result, Lighting Loads were reduced by 24.1%.



ACTIVE DESIGN

ENERGY EFFICIENT FIXTURES & EQUIPMENT

PCAs are installed in the basement of the bridges resulting in a 20% reduction in energy consumption over traditional exposed location.



Efficient baggage handling System conveyor section is independently controlled and features a unique start/stop function which intelligently powers-off sections immediately when not in use. This advanced technology not only reduces total energy consumption by 60%, compared to a conventional conveyor system, but also reduces maintenance costs.

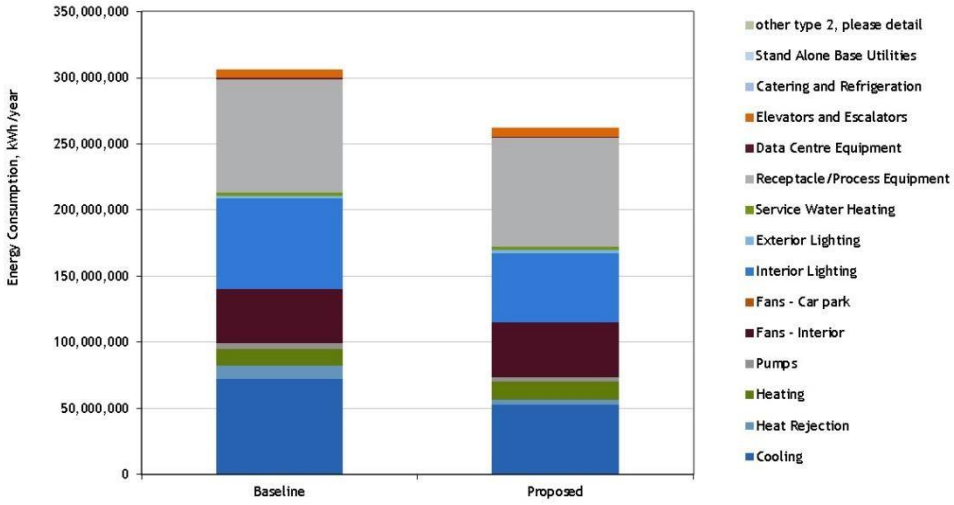
Selection of energy efficient equipment and appliances
All appliances (FIDS, ad screens, computers, etc…), office equipment and transportation devices such as elevators (159 no.), escalators (122 no.) and moving walkways (58) are certified energy efficient.

ENERGY MODELING

REDUCED DEMAND & SYSTEMS OPTIMIZATION

Extensive energy modeling demonstrated **14.5% overall energy use reduction**

- Lighting Loads were reduced by **24.1%** through careful design of lighting levels and day-lighting controls.
- Cooling Loads were reduced by **27.1%** through the design of displacement ventilation, energy wheels, series chillers in the central utility plant and demand based ventilation using CO2 and temperature sensors.
- Pump Loads were reduced in the proposed building design by **22.1%** as a result of the reduced cooling loads.
- the Baggage Handling System operational load was reduced by **60%** compared to a traditional system.



Decision-Making Process:

Each feature of the eco-design was evaluated from a capital cost and construction time impact perspective; it was also evaluated from an Operational perspective in terms of challenges or constraints. A market readiness assessment was also undertaken for products and material availability. The design team have also compared the proposed design to a baseline (as per code) case, highlighting the energy reduction benefits of the eco-design.

Then a report including all the above findings was raised to the project board for decision-making and final approval.

Estimated Cost and Financial mechanisms available:

We've shared in the slides above a brief summary of a cost benefit analysis undertaken on a small portion of the building considering only the passive design elements. Please refer to slide 7. More information is available if needed.

The combination of passive and active design elements were evaluated from an energy efficiency perspective only through energy modeling where a reduction of 14.5% on the overall annual energy consumption over a baseline was achieved. This would equate to a considerable saving on the utility cost.

Lessons Learned:

1. Start early in the design stage;
2. Set minimum expected levels of efficiency and targets for energy consumption reduction;
3. Include requirements for dynamic energy simulation (energy modeling) to be done at a stage where the design can still be influenced by its results and can be modified accordingly;
4. Prioritise the passive design strategies as those are the most effective solutions to reducing a building cooling demand;
5. Model the passive design strategies separately and determine the cost savings resulting from them as those savings will be continuous and stable throughout the life cycle of the building.

— END —