Studio London
101 Goswell Road
London EC1V 7EZ
T +44 20 7253 5147
F +44 20 7251 8322

mail@zaha-hadid.com
www.zaha-hadid.com

**Le Schuylkill**
Monaco

Environmental Statement

Zaha Hadid Architects

The Schuylkill tower was completed in 1963 and has arrived at a life cycle milestone. Although the tower has been well maintained, it is no longer adapted to current living standards, codes regulations nor to environmental imperatives.

A detailed feasibility study demonstrated that renovating the existing building was preferable from both a financial and environmental stance.

**Batiments Durable Mediterraneen de Monaco (BD2M) certification**

After careful consideration, the client opted to pursue the BD2M environmental accreditation scheme, given it is well adapted to the Mediterranean climate. The BD2M certification assesses the project through 7 major themes: territory and site, materials, energy, water, comfort and health, social and economics, and project management.

The Schuylkill project excels (scoring 75/80 points) across all 7 themes and respects the baseline prerequisites for a Silver score target for the following categories: overall cost analysis, site analysis, bioclimatic approach, adapted vegetation and exterior spaces treatment, use of eco-performing materials, energetic performance, energy consumption monitoring, summer comfort analysis, environmental project development supervision and guidance, project management, , envelope air tightness and a “clean site” management.

The certification process requires 3 reviews to achieve the target level. The project reviews are at design stage, at the end of construction and after two years of operation. This approach ensures longer monitoring than an average certification and guarantees performance at all key phases of the project.

The BD2M design committee reviewed the project in late 2023 and awarded a Silver rating for the design stage evaluation, praising the sustainability approach and innovative character of the project.

**Carbon savings**

The Schuylkill building is considered a “decarbonized” building, removing oil-based energy supplies, and replacing them with renewable energy sources.

In addition to preserving the existing concrete structure, careful selection of materials, products, technical equipment and systems has contributed to lowering whole life carbon emissions. This selection process includes identification of the existing building components for off-site recycling, reuse and repurposing.

To confirm this, a whole life carbon assessment has been carried out, resulting in a global carbon impact of 623 kgCO2e/m².

In comparison, the current French threshold for new built residential building target is set at 750 kgCO2e/m² which will reduce to 650 kgCO2e/m² by 2025.

(RIBA 2030 Climate Challenge thresholds are 1200 kgCO2e/m² currently, reducing to 625 kgCO2e/m for 2030.)

**Water recycling**

Water use is a fundamental issue in the mediterranean environment, and it has been a key consideration throughout the design process.

Water recovery and reuse as well as reduced consumption are the key objectives. The main principles are:

- Reducing water pressure alongside the use of water saving and low consumption sanitaryware and fittings.

- The use of a greywater recovery system providing recycled water for the toilets, reducing the use of clean / drinking water by 6,000 $m^3$ per year and reducing the environmental impacts associated with clean water production.

- The use of a greywater heat exchanger to reduce energy used for hot water production, estimated at 90 MWh/yr.

- Implementation of a water leakage detection system connected to the potable water monitoring system.

- Rainwater harvesting for irrigation of the exterior green spaces. The increase of the external areas permeability and an efficient drainage system improves the recovered water volume, estimated at 30 $m^3$)

- Selection of drought tolerant plants for the exterior planting and the implementation of a low consumption water irrigation system.

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- The installation of a sea water cooling loop – see below.

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**Seawater cooling loop**

The existing building energy supply is oil based and will be dismantled and replaced with a sea water loop providing heating, cooling and hot water. The seawater loop is connected to heat pumps equipped with a refrigerant-reversing valve allowing it to operate in either heating or cooling mode.

During the past couple of years, Monaco has been implementing a seawater loop infrastructure to provide sea water air conditioning (SWAC) to new developments in the principality. Although the Monte Carlo neighbourhood is not connected with a seawater loop network, the client's motivation to promote renewable energies for the Schuylkill has resulted in an agreement the operator to create a new substation on the site.

The connection to the seawater loop as a renewable energy source provides 70% of the required energy for the production of heating, cooling and hot water.

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**Materials, recycling and reuse**

The recycling and reuse of existing building fabric components has been considered from the outset of the design process.

In the early design stages, extensive surveys of the building materials and components accompanied by a partial strip-out enabled detailed re-use assessments to identify appropriate off-site recycling outlets (specialist recycling centres, reclamation yards, etc)

The materials and components identified for off-site reuse, recycling or reclamation include; floor and walls finishes, doors, furniture, window frames, glazing, metal balustrades and technical equipment such as surveillance and fire safety systems, radiators, emergency generators.

Most of the existing concrete structure is preserved. Structural analysis and 4D monitoring of the existing structure allowed for targeted reinforcements to transfer the new loads and resist seismic forces in compliance with the current regulations. The structural analysis included the necessary information to treat affected areas.

Low carbon concrete is used for the new structures and foundations. The lightweight structure of the penthouse extension uses low carbon steel profiles (XCarb).

The choice of new materials and equipment has been carefully considered. When possible, new materials were selected for their extended life span and their reduced carbon impact. Eco-labelled materials and finishes have been specified (e.g., FSC certified wood and timber products, bio-based insulation with vegetal pith binders, A+ / low toxicity paint, recycled glass insulation, etc.).

In line with the BD2M certification requirements, all materials are specified with a bias for using local and regional supply chains.

All new technical equipment has been selected and specified considering extended lifespan, high efficiency, and reduced maintenance characteristics.

**Envelope design**

The new envelope targets 2 main objectives: architectural quality and an energy performance.

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The trunk of the tower is composed of an insulated terracotta rainscreen and double-glazed units. It is durable and sustainable, and well adapted to the aggressive marine environment. It also responds to current fire requirements for a high-rise building (IGH Immeuble Grande Hauteur)

This new envelope provides new acoustic and thermal insulation, airtightness, waterproofing and solar protection.

Thermal insulation is achieved using high-performance and eco-labelled insulation (average u value of 0.6 W/m².K) to the entire building envelope and roofs.

Acoustic insulation is performed by solid concrete and masonry walls backing the rainscreen and by the use of acoustic laminated glass.

All new glazed facades and windows integrate aluminium thermally broken frames, double glazing units and external blind systems.

The airtightness of the building is a major challenge for controlling energy consumption and the new envelope has a performance below 0.8 m³/h.m². As an additional measure, air leakage tests will be performed on all windows and curtain walls, rather than a partial sample testing to guarantee the performance is achieved.

**Solar protection**

Protection against solar radiation is a major challenge in the Mediterranean region. The building morphology with continuous horizontal balconies and terraces offers good and efficient passive protection to the facade during the hot summer season. A second layer of protection uses retractable and adjustable venetian blinds, positioned on the external face of the glazed units.

The façade solar radiation simulations have permitted to quantify the energy loads on the façade, to evaluate the efficiency of the balconies and to assess the different sun protection solutions required. Along with this simulation a UTCI model (Universal Thermal Climate Index) has been carried out to assess the user thermal comfort in the balcony and terrace areas and the efficiency of additional sun protection (retractable awnings)

The combination of external blinds and glazing has been specified to meet solar factor / light transmission needs, ensuring good solar protection while ensuring optimal natural light levels into interior spaces. The external light reflection is also restricted to 12% to avoid excessive glare and discomfort.

**Thermal performance**

A thermodynamic analysis has been conducted to assess the thermal behaviour of the building over a full year to validate the effectiveness of passive cooling devices. The analysis has been conducted under 2 meteorological scenarios: the current average meteorological data from the Monaco station and a forecast into year 2050 as per the GIEC meteorological scenario prediction.

The excellent performance of the new envelope is confirmed under the current average meteorological scenario where 99% of the living areas achieve an ‘adaptive’ thermal comfort without the use of cooling systems. This performance represents a BD2M Gold medal rating.

Under a predictive 2050 meteorological scenario, a light cooling system contribution is needed to maintain discomfort below an 8% threshold.

**Optimised performance of new services**

Low energy consumption lighting fixtures with a self-restricted lighting power supply limited to 7W/m$^2$.

All new services are compliant with the eco design Eup/ErP certification.

Low energy consumption lift systems with optimized traffic planning by vertical transportation specialists and manufacture’s simulations.

Ventilation in all living spaces is done using a double flow controlled mechanical ventilation system (CMV) to reduce heat loss due to ventilation. The exchangers, which are located on the roof, have a 90%+ efficiency.

Heating, cooling and hot water production is a centralized production unit using heat pumps connected the seawater loop and using a refrigerant-reversing valve allowing it to operate in either heating or cooling mode.

All hot water columns are distributed across the floor plates and run vertically, close to the terminal points and not through the cores. This prevents horizontal runs on the floor building up with the consequent thermal loss and unwanted heating of floors in communal areas.

Energy consumption is permanently monitored and displayed at each individual apartment and the data is accessible to the user and operators. The services can be also remotely controlled by the occupants.

A Building Management System (BMS) controls the building's services including the sun protection devices to provide optimised thermal comfort to the occupants, facilitate the operation of technical equipment and to optimize the energy consumption of the building. It also facilitates maintenance.

**Energy consumption**

The operational energy performance of the building has been drastically improved with energy consumption being more than halved. The current existing building consumes 195 KWh/$m^2$/yr whilst the renewed building will consume 82 KWh/m2/yr, which represents a gain of 58%.

**Comfort**

The Schuylkill is a project designed for the comfort of its users. Numerous microclimate studies were undertaken to make architectural design choices. These were done at different building scales and with different levels of detail.

They include wind comfort analysis for the external areas, terraces and balconies by dynamic flow modelling, urban heat island studies to strengthen landscape design, thermo-dynamic simulation to improve summertime thermal comfort in indoor spaces, acoustic studies for private areas, natural light assessments to guarantee satisfactory levels of natural light for all living areas, sun radiation simulations to assess façade protection strategies, UTCI comfort simulation for the balcony and terrace areas, etc.

The common denominator of all these studies was to accompany the project design towards an architecture, landscape and building technology adapted to the user, its environment, and today's needs, while guaranteeing the continuity of this comfort in the face of GIEC projections on climate change (rising temperatures, declining water resources, increasing scarcity of resources, etc.).