# Project Documentation – CARABANCHEL 34

## Abstract

### 1.1 Data of building

<table>
<thead>
<tr>
<th>Year of construction/</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>1368.50 m²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>U-value external wall 1</th>
<th>0.244 W/(m²K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-value external wall 2</td>
<td>0.273 W/(m²K)</td>
</tr>
<tr>
<td>U-value first floor</td>
<td>0.207 W/(m²K)</td>
</tr>
<tr>
<td>U-value roof</td>
<td>0.189 W/(m²K)</td>
</tr>
<tr>
<td>U-value window</td>
<td>1.08 W/(m²K)</td>
</tr>
<tr>
<td>Heat recovery</td>
<td>82 %</td>
</tr>
</tbody>
</table>

### Space heating

<table>
<thead>
<tr>
<th>9 kWh/(m²a)</th>
</tr>
</thead>
</table>

### Space cooling

<table>
<thead>
<tr>
<th>7 kWh/(m²a)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Primary Energy Renewable (PER)</th>
<th>107 kWh/(m²a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generation of renewable energy</td>
<td>9 kWh/(m²a)</td>
</tr>
<tr>
<td>Non-renewable Primary Energy (PE)</td>
<td>98 kWh/(m²a)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure test n₉₀</th>
<th>0.2 h⁻¹</th>
</tr>
</thead>
</table>

Special features: First Public dwelling block certified Passivhaus in Madrid

Source: (Lucia Gorostegui photographer)
1.2 Brief Description of the Project

Madrid’s Council Housing Department has developed the construction of this dwelling block located in the popular neighbourhood of Carabanchel. The building is designed by Ruiz-Larrea & Associates Architects and has obtained the Passivhaus Classic certification in sustainable building construction.

The aim of Ruiz-Larrea & Associates has been an energy efficient design, indoor air quality and high comfort standards of every housing unit. The project is developed with constructive systems conceived to achieve PassiveHaus standards (ETICS -External Thermal Insulation Composite Systems-, air insulated façade, high performance window framing…) and also minimizes heating and cooling demand by the carefully avoiding the many thermal bridges of an existing structure.

The adaptation of the structure to the standard’s requirements has led to a nearly zero-energy consuming building (NZEB) with a 60% reduction in energy demand and consumption. The main criteria to achieve the NZEB certificate are based in the so called Passivhaus construction standards.

Passivhaus is the most demanding certificate regarding comfort and energy efficiency. A Passivhaus building is basically defined as that in which the air gets heated or cooled to achieve an optimum ventilation of the indoor spaces.

The competition requirements asked for 25 dwellings of 1, 2 and 3 bedrooms and communal areas. Council’s main target with this development was to cover a lack of public housing rental.

Due to the architectural organization and layout, the air tightness tests are gained with only one thermal envelope and 5 tightness lines so one single test was carried out per storey. Thus, the reduction in number of tests to be carried out has had a positive impact on construction costs.

Besides, bioclimathic design criteria have been met as well as energy efficiency systems, eco construction standards, and indoor comfort solutions (air quality, allergen-free and VOC -free indoor spaces). These also applied to water management and consumption.
House typologies

The housing block is organized around the vertical staircase and lift shaft, which link to a distribution corridor facing north. This lay out allows all units to enjoy double orientation (north-south) on their façades, therefore improving natural ventilation.

The units lay out provide a clear separation of spaces. That means, there is a day-living area where the kitchen, utility room, eating area and living rooms are located and a different area (night-living) where bathroom and bedrooms are located staying as quiet as possible from the day-living area activities.

Facing south the window frames are vertical shaped while they turn horizontal at north façade. Parking facility was already designed in a preliminary phase and it is located in the second basement provided with a semi-automated parking system.

(Source: RLA)
Situation plan (Source: RLA)
1.3 Responsible project participants

Architect/ Entwürfsverfasser
RUIZ LARREA & ASOCIADOS (RLA) Architects
Implementation planning/ Ausführungsplanung
RUIZ LARREA & ASOCIADOS (RLA) Architects
Building systems/ Haustechnik
EDISON Engineering / Diego Martín Velez
Structural engineering/ Baustatik
BAC Engineering
Building physics/ Bauphysik
Antonio Gómez Gutiérrez/ Diego Martínez Vélez
Passive House project planning/ Passivhaus-Projektierung
Antonio Gómez Gutiérrez/ Diego Martínez Vélez
Construction management/ Bauleitung
MARCO INFRAESTRUCTURAS Y MEDIO AMBIENTE, S.A

Certifying body/ Zertifizierungsstelle
Nuria Díaz, VAND Arquitectura
www.vandarquitectura.info
Certification ID/ Zertifizierungs ID
Project-ID (www.passivehouse-database.org) Projekt-ID (www.passivehouse-database.org) 6342

Author of project documentation / Verfasser der Gebäude-Dokumentation
Antonio Gómez Gutiérrez RLA
Date, Signature/ Datum, Unterschrift
Madrid, 18th of June 2020
2 Pictures of the project

2.1 Exterior photographs

South view. Proteccion Solar up Source: (Lucia Gorostegui photographer)

South view. Proteccion Solar down. Source: (Lucia Gorostegui photographer)
2.2 Photographs of the inside

Inside view Source: (Lucia Gorostegui photographer)

External Distribuidor view Source: (Lucia Gorostegui photographer)
3 Plans

Airtightness envelope (blue line), thermal envelope (grey line) and TFA are shown in the following plans:
First floor (Source: RLA)
2nd, 3th, 4th and 5th floor (Source: RLA)
First floor (Source: RLA)
2nd, 3rd, 4th and 5th floor (Source: RLA)
Sections:

Desenes segons ubicació ser rematades amb pilastres de L.

BARRERA DE PROTECCIÓ
Segons arxiu 3, planta 3, j.
Tota la altura de barrera de protecció amb f1 i 3,5m.

Chapa ondulada mineralizada
FRECUENCIA 14 BIC AD
R10714 j, perforació 35 %
Parets de ventilació

Chapa ondulada mineralizada
FRECUENCIA 14 BIC AD

Horitzontal de remate de chapa con falso

Apilamiento

(Source: RLA)
Sections:
4 Technical details of the construction

4.1 Exterior walls

Wavy Sheet
Air Chamber
Substructure steel tube 50.50 galvanized
LR Insulation ($\lambda=0.035$ W/mK) 100 mm with Ejotherm H2 type thermal bridge rupture fixations with a $\psi = 0.001$ W/K Waterproof Mortar 10mm
Brick stonework 120 mm
Gypsum plasterboard 20 mm
Insulation ($\lambda=0.035$ W/mK) 50 mm
Panel 50 mm
Gypsum panel 15 mm

[INT] = [INTERIOR]
U-value = 0.273 W/(m$^2$K)

Plasterboard 10 mm
LR Insulation ($\lambda=0.035$ W/mK) 120 mm with Ejotherm H2 type thermal bridge rupture fixations with a $\psi = 0.001$ W/K Waterproof Mortar 10mm
Brick stonework 120 mm
Gypsum 20 mm
Insulation ($\lambda=0.035$ W/mK) 50 mm
Panel 50 mm
Gypsum plasterboard 15 mm

[INT] = [INTERIOR]
U-value = 0.273 W/(m$^2$K)
4.2 Basement 1st floor

- [EXT] = [OUTDOOR]
- Ceramic tile
- Lightweight concrete 80mm
- XPS Insulation ($\lambda=0.035$ W/mK) 50 mm
- Concrete 200+50 mm
- LR Insulation ($\lambda=0.035$ W/mK) 120 mm
- Air chamber
- Wavy Sheet False ceiling
- [INT] = [INTERIOR]

$U$-value = 0.207 /($m^2$K)

XPS thermal insulation with a half-wood machined edge, with a $\lambda = 0.036$ W / mK, and consisting of 2 plywood sheets with a thickness of 100 and 80 mm.

4.3 Flat roof

- [EXT] = [OUTDOOR]
- Lightweight concrete 100mm
- XPS Insulation ($\lambda=0.036$ W/mK) 100+80 mm
- Concrete 200+50 mm
- [INT] = [INTERIOR]

$U$-value = 0.189 W/($m^2$K)
4.4 Connection details

External wall-Flat roof (type 1)

Outside floor slab- floor slab
External wall-Anchor Ventilated Facade

Connected External wall- First floor.

4.5 Windows
4.5.1 Window Frame

WERU AFINO, PVC-frame with reinforcement inside the blind-frame. Pane thickness: 48 mm rebate depth: 19 mm, spacer: TGI-Spacer P. Certified Component warm, temperate climate Pvc de WERU AFINO D U w-value = 1.08 W/(m²K)

4.5.2 Glass

<table>
<thead>
<tr>
<th>Type</th>
<th>U-Value</th>
<th>g-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/12Ar/4/12Ar/4</td>
<td>0.7W/m²K</td>
<td>0.50</td>
</tr>
<tr>
<td>3+3/12Ar/4/12Ar/3+3</td>
<td>0.7W/m²K</td>
<td>0.50</td>
</tr>
</tbody>
</table>

4.5.3 Shadow elements

External blinds were incorporated to provide solar protection during the summer months Motorized system of roller blinds in drawer with electric drive with lateral zipper guiding (wind resistant). In the south orientation, the fabric is of the blackout trend light white type: transmission 76% / absorption 12% G tot 0.02 / opacity 100 in RAL 9010 color; and in the north orientation it is of the trend light anthracite type: transmission 7% / absorption 93% G tot 0.05 / opacity 100 in color RAL Anthracite 7016
4.5.4 Window installation detail

Top installation

SATE Facade

Ventilated Facade

Bottom installation

SATE Facade

Ventilated Facade
4.6 Construction phase
First Floor under and top insulation installation (Source: RLA)

Window installation (Source: RLA)
Shadow elements installation  (Source: RLA)
Ventilated Facade installation (Source: RLA)
5  Airtightness
5 airtight lines with a single Test per floor communicating with each of the homes present per floor. This reduces the number of Test. All this with the aim to achieve optimal costs of construction.

Hermeticidad – planificación y ejecución
5.1 **BlowerDoor test results**

### Planta 1 – 5 viviendas

<table>
<thead>
<tr>
<th></th>
<th>Despresurización</th>
<th>Presurización</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumen de aire filtrado, $V_{50}$</td>
<td>200 m³/h</td>
<td>176 m³/h</td>
<td>188 m³/h</td>
</tr>
<tr>
<td>Tasa de renovación, $n_{50}$</td>
<td>0.291/h</td>
<td>0.261/h</td>
<td><strong>0.281/h</strong></td>
</tr>
<tr>
<td>Coeficiente de flujo de aire, $C_{env}$</td>
<td>8.8 m³/(h·Pa°)</td>
<td>11.1 m³/(h·Pa°)</td>
<td>10.4 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Coeficiente de aire filtrado, CL</td>
<td>8.6 m³/(h·Pa°)</td>
<td>10.8 m³/(h·Pa°)</td>
<td>9.7 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Exponente de flujo de aire, n</td>
<td>0.805</td>
<td>0.713</td>
<td>0.763</td>
</tr>
<tr>
<td>Límite de confianza</td>
<td>0.99923</td>
<td>0.99742</td>
<td>0.99815</td>
</tr>
</tbody>
</table>

### Planta 2 – 5 viviendas

<table>
<thead>
<tr>
<th></th>
<th>Despresurización</th>
<th>Presurización</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumen de aire filtrado, $V_{50}$</td>
<td>172 m³/h</td>
<td>162 m³/h</td>
<td>167 m³/h</td>
</tr>
<tr>
<td>Tasa de renovación, $n_{50}$</td>
<td>0.251/h</td>
<td>0.241/h</td>
<td><strong>0.251/h</strong></td>
</tr>
<tr>
<td>Coeficiente de flujo de aire, $C_{env}$</td>
<td>12.6 m³/(h·Pa°)</td>
<td>10.2 m³/(h·Pa°)</td>
<td>11.4 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Coeficiente de aire filtrado, CL</td>
<td>12.2 m³/(h·Pa°)</td>
<td>10.0 m³/(h·Pa°)</td>
<td>11.1 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Exponente de flujo de aire, n</td>
<td>0.676</td>
<td>0.713</td>
<td>0.703</td>
</tr>
<tr>
<td>Límite de confianza</td>
<td>0.99314</td>
<td>0.99250</td>
<td>0.99383</td>
</tr>
</tbody>
</table>

### Planta 3 – 5 viviendas

<table>
<thead>
<tr>
<th></th>
<th>Despresurización</th>
<th>Presurización</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumen de aire filtrado, $V_{50}$</td>
<td>173 m³/h</td>
<td>173 m³/h</td>
<td>176 m³/h</td>
</tr>
<tr>
<td>Tasa de renovación, $n_{50}$</td>
<td>0.271/h</td>
<td>0.261/h</td>
<td><strong>0.261/h</strong></td>
</tr>
<tr>
<td>Coeficiente de flujo de aire, $C_{env}$</td>
<td>10.9 m³/(h·Pa°)</td>
<td>17.6 m³/(h·Pa°)</td>
<td>14.7 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Coeficiente de aire filtrado, CL</td>
<td>10.7 m³/(h·Pa°)</td>
<td>16.9 m³/(h·Pa°)</td>
<td>13.8 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Exponente de flujo de aire, n</td>
<td>0.721</td>
<td>0.593</td>
<td>0.653</td>
</tr>
<tr>
<td>Límite de confianza</td>
<td>0.99319</td>
<td>0.99550</td>
<td>0.99435</td>
</tr>
</tbody>
</table>

### Planta 4 – 5 viviendas

<table>
<thead>
<tr>
<th></th>
<th>Despresurización</th>
<th>Presurización</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumen de aire filtrado, $V_{50}$</td>
<td>170 m³/h</td>
<td>154 m³/h</td>
<td>162 m³/h</td>
</tr>
<tr>
<td>Tasa de renovación, $n_{50}$</td>
<td>0.251/h</td>
<td>0.241/h</td>
<td><strong>0.241/h</strong></td>
</tr>
<tr>
<td>Coeficiente de flujo de aire, $C_{env}$</td>
<td>10.1 m³/(h·Pa°)</td>
<td>6.2 m³/(h·Pa°)</td>
<td>8.7 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Coeficiente de aire filtrado, CL</td>
<td>9.8 m³/(h·Pa°)</td>
<td>6.1 m³/(h·Pa°)</td>
<td>8.0 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Exponente de flujo de aire, n</td>
<td>0.729</td>
<td>0.825</td>
<td>0.785</td>
</tr>
<tr>
<td>Límite de confianza</td>
<td>0.99354</td>
<td>0.99468</td>
<td>0.99438</td>
</tr>
</tbody>
</table>

### Planta 1 – 5 viviendas

<table>
<thead>
<tr>
<th></th>
<th>Despresurización</th>
<th>Presurización</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumen de aire filtrado, $V_{50}$</td>
<td>129 m³/h</td>
<td>122 m³/h</td>
<td>125 m³/h</td>
</tr>
<tr>
<td>Tasa de renovación, $n_{50}$</td>
<td>0.191/h</td>
<td>0.181/h</td>
<td><strong>0.181/h</strong></td>
</tr>
<tr>
<td>Coeficiente de flujo de aire, $C_{env}$</td>
<td>7.3 m³/(h·Pa°)</td>
<td>9.4 m³/(h·Pa°)</td>
<td>8.4 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Coeficiente de aire filtrado, CL</td>
<td>7.2 m³/(h·Pa°)</td>
<td>9.1 m³/(h·Pa°)</td>
<td>8.2 m³/(h·Pa°)</td>
</tr>
<tr>
<td>Exponente de flujo de aire, n</td>
<td>0.739</td>
<td>0.663</td>
<td>0.703</td>
</tr>
<tr>
<td>Límite de confianza</td>
<td>0.99405</td>
<td>0.99106</td>
<td>0.99215</td>
</tr>
</tbody>
</table>

The test has been carried out by: Hobeki

### 6 Ventilation

Project Documentation Page 29 of 39 06/2020
6.1 Ventilation planning

or comfort ventilation with high efficiency heat recovery, 21 Zehnder Comfoair 180 units and 4 Zehnder Comfoair 200 units have been used. The installation has been carried out vertically, integrating into kitchen furniture, with a flow range between 90-145 m3/h with F7 filters on intake and G4 on equipment return. In this way, fresh air is obtained that favors well-being, maximizes comfort, energy saving and the absence of mold and bacteria. The equipment with Passivhaus component certificate, obtain a heat recovery with an efficiency of 82% (>75%) and an electrical consumption of 0.27 W/h/m3.

Ventilation 1 D (Source: RLA)  Ventilation 3 D (Source: RLA)
6.2 Construction phase

(Source: RLA)
6.3 Ventilation unit

<table>
<thead>
<tr>
<th>Average air flow rate m$^3$/h</th>
<th>Average air change rate 1/h</th>
<th>Heat recovery efficiency</th>
<th>Effective heat recovery efficiency unit</th>
<th>Specific power input Wh/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-145 m$^3$/h</td>
<td>0.30 /h</td>
<td>82 %</td>
<td>80.7 %</td>
<td>0.27 Wh/m$^3$</td>
</tr>
</tbody>
</table>

Ventilation unit (Source: RLA)

7 Building Services
7.1 Heating/cooling

Energy-efficient heating and cooling air conditioning system consisting of an outdoor unit located on the roof and a Split-type indoor unit in the living room of the dwellings with a capacity of 3.5 kW of cooling and 3.7 kW of power of heating. Temperature control is carried out by means of a thermostat located in the main room. This system provides a high level of comfort with a minimum noise level, avoiding the aesthetic impact of air conditioning equipment. In heating, PHI recommends having an auxiliary heating supply and an electric heated towel rail with a power of 750 w is installed in bathrooms.

7.2 Domestic hot water
Centralized production of ACS outside of the thermal envelope, with condensing boiler, 60kW class 6 P= 67 Kw, Vaillant, support with renewable energy with a coil exchanger and two 1000l tanks.

Thermal energy panels are installed to fulfill the requirements of building standards. 8 solar panels have been installed in two rows, with an individual capacity area of 2.51 m² and a 9kW heat dissipater per row. It is backed up by condensing boiler, with a coil exchanger and two 1000l tanks.

Solar panels, tanks and Boiler (Source: RLA)
PHPP Results

8
Energy balance heating
Energy balance cooling