Design and technical challenges of nZEB

Delivering Commercial nZEB Conference 2019
6th March 2019
Agenda

- Case Study – student accommodation (NUIG and DCU)
- Team approach
- Wider design considerations
- Guiding principles for energy conservation
- Detail consideration
- How does nZEB impact?
Team approach

• Multiple stakeholders
  • PM
  • QS
  • Planning and environmental
  • Landscape Architect
  • C&S Engineer
  • **MEP Engineer**
  • Fire Consultant
  • PSDP
  • Archaeological
  • Acoustic
  • **Energy**

• Early engagement workshops
  • Cost
  • Ecology
  • Planning
  • Energy approach
  • Input from FM team
Guiding Principles of energy conservation

- Starts with the client brief
- Energy Hierarchy
- “Fabric first” approach
- Sensible use of renewables
Construction details

- Early Design Approach
- Forms of Construction – robust solutions
- Verification / Tools – incl. Thermal Bridging
- Quality control during construction

Window - Inboard of Insulation

Window - In line w Insulation

Thermal Bridge & Condensation Risk
Case study – NUIG Student Accommodation

- 17,000 Students – need to expand existing accommodation at Corrib Village
- 674 student bed spaces
- Green field site – adjacent woodland corridor and River Corrib SAC and Annex 1 natural habitat
- 4-6 bedrooms per apartment
- 2-3 apartments per core
- 4-8 storey in height

Design Team:
- Aecom
- FCBS / COADY
- Punch Consulting Engineers
- JV Tierney & Co
- Mitchel & Associates
- Jeremy Gardiner & Associates
- Linesight
- Alegro
- Aegis
Site location
Site Context Analysis

- **Annex 1 Habitat**
  (refer to ecology report for further details)
- **Partially Constrained Areas**
  (refer to ecology report for further details)
- **Cashel (Stone Fort)**
- **Proposed Masterplan Route**
- **Connection to Newcastle Road**

The design team have collaborated with McCarthy Keville O'Sullivan Ecology in review of site parameters and to establish opportunities and constraints in relation to the existing landscape. Refer to Ecology and Landscape proposals for further information.
Massing studies

The initial envisaged site boundary can be seen to extend right up to the boundary of the adjacent carpark and its associated access road.

Following feedback from McCarthy Keeney O'Sullivan and MUG the site was reduced to take into account the surrounding Annex 1 Habitat and woodland landscape and future masterplan route.

With a reduced site area a typical 3-4 apartment core arrangement was seen to be significantly reducing the quality of external spaces and building arrangements for users.

As a result a new form was explored that began with maximising the passive security potential whereby buildings form the perimeter and enclose a private courtyard space.

The form was then split to create a semi public realm that engaged with the landscape toward the river with the potential of linking the development to the river Corrib walk.

Increasing sunlight to spaces and views toward the river landscape is achieved by opening the rear building of the courtyard space and splaying the linear block.

The courtyard block is set back to provide breakout space leading visitors to the external plaza of the site as well as creating space for coach pickup/drop off.

A glazed ground floor storey is introduced to permit views in/out the private courtyard, increase day lighting and diminish the massing without compromising the secure boundary.
Massing study development

### Option 13 (Options 91 & 62 Hybrid)

<table>
<thead>
<tr>
<th>Compliance check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density Yes</td>
</tr>
<tr>
<td>Phasing Yes</td>
</tr>
<tr>
<td>Daylighting No</td>
</tr>
</tbody>
</table>

Other information
- Hybrid option with increased density.
- Poor daylighting and consequently poor environment to block C/D courtyard.

<table>
<thead>
<tr>
<th>Level 0 (Grounds)</th>
<th>Level 1-3 (Typical)</th>
<th>Level 4-5</th>
<th>Level 6+</th>
<th>Block Height</th>
<th>Units per Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A</td>
<td>0</td>
<td>84</td>
<td>56</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Block B</td>
<td>13</td>
<td>48</td>
<td>32</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Block C</td>
<td>20</td>
<td>168</td>
<td>56</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Block D</td>
<td>23</td>
<td>90</td>
<td>64</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>84</td>
<td>56</td>
<td>6</td>
<td>140</td>
</tr>
</tbody>
</table>

### Option 62b (Lower Density Option)

<table>
<thead>
<tr>
<th>Compliance check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density Yes</td>
</tr>
<tr>
<td>Phasing Yes</td>
</tr>
<tr>
<td>Daylighting Yes</td>
</tr>
</tbody>
</table>

Other information
- Larger Courtyards.
- Retention of Street aspect.

<table>
<thead>
<tr>
<th>Level 0 (Grounds)</th>
<th>Level 1-3 (Typical)</th>
<th>Level 4-5</th>
<th>Level 6+</th>
<th>Block Height</th>
<th>Units per Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A</td>
<td>0</td>
<td>84</td>
<td>20</td>
<td>-</td>
<td>4.5</td>
</tr>
<tr>
<td>Block B</td>
<td>18</td>
<td>96</td>
<td>64</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Block C</td>
<td>20</td>
<td>168</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Block D</td>
<td>30</td>
<td>90</td>
<td>64</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>84</td>
<td>20</td>
<td>6</td>
<td>104</td>
</tr>
</tbody>
</table>

COADY Architects
Energy analysis

- Daylight and overheating report
- Building fabric
- Target
  - EPC 0.9
  - 10% RER
- Renewables
  - CHP proposed
  - PV Cells

Table:

<table>
<thead>
<tr>
<th>Element</th>
<th>U-Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall</td>
<td>0.18 W/m2.K</td>
</tr>
<tr>
<td>Floor</td>
<td>0.12 W/m2.K</td>
</tr>
<tr>
<td>Flat Roof</td>
<td>0.14 W/m2.K</td>
</tr>
<tr>
<td>Doors</td>
<td>1.3 W/m2.K</td>
</tr>
<tr>
<td>Glazing</td>
<td>1.3 W/m2.K</td>
</tr>
<tr>
<td>G-Value</td>
<td>0.4</td>
</tr>
<tr>
<td>Spandrel Panel</td>
<td>1.4 W/(m2.K)</td>
</tr>
<tr>
<td>Air Permeability</td>
<td>&lt;2.5(m3/(m2/h))</td>
</tr>
</tbody>
</table>
Site plan considerations

Detailed studies on:
- Density
- Apartment clusters
- Shared amenity
- Public Realm
- Security + Access
- Phasing + infrastructure
- Bicycle parking
- Refuse collection
- Universal design
- Materiality
- Daylight analysis
Typical floorplan
Typical cluster
Design proposals

- Central district heating – gas fired
  - Heat exchange units within each apartment

- Ventilation
  - protect air quality + building fabric
  - Demand controlled – no heat recovery
  - Local to avoid ducting and compromising the fire strategy

- EPC = 0.90
- CPC = 0.90
- RER = 0.29
  - 100m2 PV Cells – providing 17kWh/m2/yr
  - CHP – 29kWh/m2/yr – providing 12kWh/m2/yr renewables
Elevational treatment and materiality

1. Parapet with railing behind
2. Brick - Stacked soldier course band
3. Large windows to kitchen/living/dining areas
4. Metal spandrel panel
5. Eroded corner
6. Brick - Vertical running bond panel
7. Standard bedroom window: Consists of large glazed fixed panel with adjacent glazed inward opening panel in front of a fixed perforated metal panel to permit ventilation.
8. Brick - Stacked soldier course band
9. Brick - Ribbed brick alternating at GF storey
10. Brick - Reeded vertical running bond panel
11. Protuding metal surround
12. White buff brick type 03
13. Fixed perforated metal panel
14. Brick - Hit & miss ribbed alternating at GF level to plant room.
Elevational treatment and materiality

- Parapet with railing behind
- Brick - Stacked soldier course band
- Large windows to kitchen, living, dining areas
- Metal spandrel panel
- Protruding metal surround
- Beige buff brick type 02
- Brick - Stacked soldier course band
- Covered entrance to reception
- Curtain wall glazing
- Protruding metal clad stair feature
- Full height glazing to stairs
- Brick - Vertical running bond panel
- Windows to core
- Brick - Ribbed brick alternating courses to GF storey
- Core entrance

COADY ARCHITECTS
Visualisation from street
Case Study – DCU Student Accommodation

- Site and need identified within earlier masterplan studies
- 6 bedrooms per apartment
- 2-3 apartments per core
- 4-6 storey in height – with taller elements at nodal points

Design Team:
- FCBS / COADY
- Punch Consulting Engineers
- EDC – with Geraghty Energy Consultant
- Turner & Townsend
- BSM Landscape Architects
- Jeremy Gardiner & Associates
- i3PT
- Linesight
- nZEBRA
2016 Development Control Plan context
Typical floorplan and apartment cluster
Design proposals

- Central district heating – gas fired
  - Heat exchange units within each apartment

- Ventilation
  - protect air quality + building fabric
  - Centralised MHRV

- EPC = 0.78
- CPC = 0.78
- RER = 0.20

- PV Cells – providing 4kWh/m²/yr
- CHP – 18kWh/m²/yr – providing 8kWh/m²/yr renewables

Comparison with NUIG

- Central district heating – gas fired

- Ventilation – demand controlled local extract
  - No heat recovery

- EPC = 0.90
- CPC = 0.90
- RER = 0.29

- 100m² PV Cells – providing 17kWh/m²/yr
- CHP – 29kWh/m²/yr – providing 12kWh/m²/yr renewables
Typical cluster – space and water heating

• Central services core

• Heat exchange unit within communal room

• Standard radiators in rooms
Typical cluster – ventilation study

Centralised MHRV

**PROS**
- Improved air quality for well being of occupants and internal finishes
- Fewer façade openings
- More airtight construction
- Air is filtered
- Qualifies scheme for HPI
- Energy Efficient
- Reduced load on building heating system in winter, as waste heat is recovered

**CONS**
- Higher capital expenditure compared to LEV.
- Cupboard/ceiling space required for MVHR unit
- Acoustics between rooms needs to be considered for privacy.
- Fire strategy needs to be clear
- Annual maintenance of filters
Typical cluster – ventilation study

Localised demand controlled extract

**PROS**
- Simple system
- No cupboard space required for central fan unit
- Low capital cost
- No cross talk concerns
- Local control by occupants

**CONS**
- Façade openings for extract points and natural intake points
- Energy penalty due to increased uncontrolled infiltration/cold air exchange (during heating season)
- Unfiltered replacement air
- Ventilation rates dependent on external conditions i.e. buoyancy & pressure
- Multiple or zonal fans required
LIFE CYCLE COSTING LEV vs MVHR

5 bed cluster

<table>
<thead>
<tr>
<th></th>
<th>Capital Cost (€)</th>
<th>Annual Maintenance Cost (€)</th>
<th>Annual Electrical Savings (kWh)</th>
<th>Annual Thermal Savings (kWh)</th>
<th>Annual Running Cost Savings (€)</th>
<th>Payback Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVHR</td>
<td>5680</td>
<td>50</td>
<td>0</td>
<td>4628</td>
<td>244</td>
<td>15</td>
</tr>
<tr>
<td>LEV</td>
<td>1880</td>
<td>0</td>
<td>1646</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Elevational treatment
Proposed scheme
Proposed scheme
## How does nZEB impact?

<table>
<thead>
<tr>
<th>M&amp;E Engineer</th>
<th>Architect</th>
<th>Contractor</th>
<th>Client</th>
</tr>
</thead>
<tbody>
<tr>
<td>More stringent specifications for HVAC systems</td>
<td>Increased requirements for building fabric and air tightness</td>
<td>Construction quality around insulation air tightness</td>
<td>Increased cost</td>
</tr>
<tr>
<td>More in depth building calculations (incl NEAP)</td>
<td>Mandatory calculations for thermal bridges</td>
<td>Quality control for thermal bridging</td>
<td>Higher specification building services &amp; controls systems</td>
</tr>
<tr>
<td><strong>More collaboration from project outset (pre planning) and throughout the project life cycle</strong></td>
<td></td>
<td>Mandatory air tightness testing</td>
<td>Reduced running costs</td>
</tr>
<tr>
<td>Increased focus on site inspections &amp; construction quality</td>
<td></td>
<td>More emphasis during commissioning</td>
<td>More certainty on quality of building product</td>
</tr>
</tbody>
</table>

Manufacturers are vital for providing the innovative products that will shape the design solutions

CONTRIBUTING TO A BETTER ENVIRONMENT AND A SUSTAINABLE FUTURE!