Charting New Territory in Passive House
Clayton Community Centre

Melissa Higgs, Principal, HCMA Architecture + Design
Zina Berrada, Sustainability Coordinator, HCMA Architecture + Design
Joe Quad, Project Manager, Integral Group
Thomas Bamber, Senior Mechanical Designer, Integral Group
Project team

City of Surrey
Client

HCMA Architecture + Design
Architecture

Integral Group Consulting
Mechanical

RJC Engineering
Structural

AES Engineering LTD
Electrical

EllisDon
Construction Manager

Turnbull Construction
Project Manager

Morrison Hershfield
Building Envelope

HAPA Collaborative
Landscape

Aplin & Martin Consultants
Civil

MEAD Energy + Architectural Design LDT
Passive House Certifier

PEEL Passive House
Passive House Consultants
Develop a new community hub in Clayton that integrates...
We challenged the team to take a new approach…
…where the community of Clayton, staff, arts, library, recreation, and the outdoors come together to **play, read, and make** in an integrated facility
Architectural considerations
Spatial Layout

Fitness

Gymnasium

Commons

Magic Box

Collections

Music Box
Optimized Orientation

Library

Gymnasium

Fitness Centre

Rehearsal Hall

Visual Arts
Ground Floor

Gymnasium

Service Area

Preschool

Art Centre
Architectural process
Architectural Process

Collaborative Process

Project schedule
SD DD CD Construction Completion
## Occupancy Schedule

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**ENERGY DATA SHEET**

**Project Name:** Community Health Center

**Energy Model:** Morningstar

**Date Last Revised:** December 2020

**DESIGN CONDITIONS**

- Temperature Setpoints:
  - Morning: 78°F (26°C)
  - Afternoon: 74°F (23°C)

- Humidity Control Setpoint: 60%

**LIGHTING & PLUG LOADS**

- Lighting Power Density: 8.0 W/sf (11.6 W/m²)
- Plug Load Density: 3.0 W/sf (4.6 W/m²)

**EQUIPMENT**

Please list any space-specific equipment to be provided, indicate power requirements (W) for each item of equipment.

Additional items include: HVAC equipment, lighting, appliances, power distribution, etc.

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INTEGRAL GROUP

HCM Architecture + Design
## Electrical Loads

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### Total Load by Time of Day

- **Peak Load:** 13.0 kW
- **Off-Peak Load:** 10.0 kW

### Total Load by Day of Week

- **Monday:** 12.0 kW
- **Tuesday:** 11.0 kW
- **Wednesday:** 13.0 kW
- **Thursday:** 14.0 kW
- **Friday:** 15.0 kW
- **Saturday:** 12.0 kW
- **Sunday:** 10.0 kW
Results of Schematic Design

PER
140 kWh/m².a

Equipment 11%
Fans 16%
Ext. Light 3%
Lighting 44%
Heating 7%
Cooling 6%
Cooking 4%
DHW 7%
Elevator 2%

Cooling loads
79 kWh/m².a

ENERGY LOSSES
- Ventilation Losses
- Transmission Losses
- Internal Heat Gains

ENERGY GAINS
- Solar Heat Gains
1 - Reducing the PER
Primary Energy Comparison

Primary Energy Consumption (kWh/m².a)

Average for Arts, Entertainment, Recreation: 824 kWh/m².a
West Vancouver Community Centre 2010: 296 kWh/m².a
Clayton Community Centre (early stage): 139.7 kWh/m².a
Primary Energy Breakdown

“Other Electricity” loads breakdown

- Heating / Cooling: 18%
- DHW generation: 37%
- Other Electricity: 44%

Primary Energy Breakdown:

- PER Demand
- Passive House Requirement
- Office Equipment
- Lighting

140.0 kWh/m².a
Electrical Loads

Energy Consumption (Wh/m².a)

- Lobby and social space
- Gymnasium
- Laundry / Janitor
- Changing Room
- Staff Area
- Café
- Reception
- Rehearsal Hall
- Control Room
- Dressing Room
- Theatre / WC
- Recording AV
- Music Studio
- Music Studio
- Studio
- Workshop
- Multipurpose Room
- Community Kitchen
- Preschool
- Library
- Workroom
- Welcome Desk
- Learning
- Workshop
- Multipurpose Room
- Fitness
- Studio
- Fitness Centre
- Spin Studio
- Elevator
## Electrical Loads

<table>
<thead>
<tr>
<th>Location</th>
<th>Equipment</th>
<th>Category</th>
<th>Quantity</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>116 Workshop</td>
<td>Mitre Saw</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1800</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Band Saw</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>220</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Table Saw</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>2900</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Drill Press</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1540</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Disc/Belt Sander</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>220</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Planer</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>3000</td>
</tr>
<tr>
<td>116 Workshop</td>
<td>Jointer</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1540</td>
</tr>
<tr>
<td>118 Café</td>
<td>Coffee Machine</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>4500</td>
</tr>
<tr>
<td>118 Café</td>
<td>Display Chiller</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>2810</td>
</tr>
<tr>
<td>118 Café</td>
<td>Warming Oven</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1500</td>
</tr>
<tr>
<td>118 Café</td>
<td>Panini Grill</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1800</td>
</tr>
<tr>
<td>118 Café</td>
<td>Microwave</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1500</td>
</tr>
<tr>
<td>118 Café</td>
<td>Dishwasher</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1.1 kWh/use</td>
</tr>
<tr>
<td>118 Café</td>
<td>Fridge/Freezer</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>1 kWh/day</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>TV</td>
<td>Office Equipment</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>AV System</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>240</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>Treadmill (Active)</td>
<td>Kitchen/Aux Electricity</td>
<td>8</td>
<td>369</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>Treadmill (Standby)</td>
<td>Kitchen/Aux Electricity</td>
<td>8</td>
<td>48</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>Stair Mill (Active)</td>
<td>Kitchen/Aux Electricity</td>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>227A Fitness Centre</td>
<td>Stair Mill (Standby)</td>
<td>Kitchen/Aux Electricity</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>227B Spin Studio</td>
<td>Disco Ball</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>227B Spin Studio</td>
<td>Projector</td>
<td>Kitchen/Aux Electricity</td>
<td>1</td>
<td>207</td>
</tr>
</tbody>
</table>
Electrical Loads

10 units = 23% of total equipment use

0 kWh/yr
Woodway Curve Treadmill
## Lighting Loads

<table>
<thead>
<tr>
<th>Area</th>
<th>Lighting Power LPD</th>
<th>IESNA recommended min levels</th>
<th>AES engineering comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>W</td>
<td>lux</td>
<td>W/m^2*100lux</td>
</tr>
<tr>
<td>m^2</td>
<td>W</td>
<td>W/m^2</td>
<td></td>
</tr>
<tr>
<td>Main Social Space / Lobby</td>
<td>836.86</td>
<td>11,596</td>
<td>13.86 200 W/m^2*100lux</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Due to double heightied space, more lights are required to achieve the lighting level on the floor. The lightings in the space are controlled such that they automatically turn on based on scheduled time in the morning to only 50% of the connected power.</td>
</tr>
<tr>
<td>Changing Room</td>
<td>110.52</td>
<td>1,855</td>
<td>16.78 200 W/m^2*100lux</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Typical lighting design for change/washrooms is to have one downlight shared between two stalls but the chang/washrooms in this building have individual full height partitions, where we would need to provide a dedicated downlight in each individual stalls, which increased the LPD.</td>
</tr>
<tr>
<td>Mechanical/Storage (Comb.)</td>
<td>651.52</td>
<td>3,217</td>
<td>4.94 100 W/m^2*100lux</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Due to double heightied space, more lights are required to achieve the lighting level on the floor. The lightings in the space are controlled such that they automatically turn on based on scheduled time in the morning to only 50% of the connected power.</td>
</tr>
<tr>
<td>Circulation</td>
<td>536.33</td>
<td>7,520</td>
<td>14.02 300 W/m^2*100lux</td>
</tr>
</tbody>
</table>

**INTGRAL GROUP**

**HCMA** Architecture Design
Lighting Loads
Current PER

Primary Energy Consumption (kWh/m².a)

- Average for Arts, Entertainment, Recreation: 824 kWh/m².a
- West Vancouver Community Centre 2010: 296 kWh/m².a
- Clayton Community Centre (early stage): 139.7 kWh/m².a
- Clayton Community Centre (currently): 125.8 kWh/m².a
2- Reducing the cooling loads
Internal Heat Gains

Clayton Community Centre

Total: 38,915W = 6.73 W/m²
(-evaporation, cold water)

23,046 W 15,709 W 13,520 W

Multi-units Passive House (10)

Total: 4,786W = 2.01 W/m²
(-evaporation, cold water)

3,222 W 4,974 W 349 W

Residential x3
Energy Balance

- Less insulation
- More air movement
- Less occupants
- Less equipment
- Less light
- Less solar heat gains

Energy Losses
- Transmission Losses
- Ventilation Losses

Energy Gains
- Internal Heat Gains
- Solar Heat Gains

Less occupants
- Less equipment
- Less light
- Less solar heat gains
Transmission Losses

Less Insulation
Reducing Solar Heat Gains

Glazing & Shading
Sun Exposure

100%

73.5%

61%
Sun Exposure

100%
Without shading

73.5%
With shading
Sun Exposure

Additional reduction factor values highlighted informed using specialist solar analysis of Level 02 solar shading to East, South & West elevations. Due to the complex shading geometry, this was regarded as a more accurate method of determining additional reduction factors.

See supporting documentation for analysis methodology and findings.
Transmission Losses

Reducing sun exposure

Heating Demand
Cooling and dehum. Demand
Transmission Losses
Reducing sun exposure
ENVELOPE 7 + SOLAR SHADING

BASELINE
ENVELOPE 1
ENVELOPE 2
ENVELOPE 3
ENVELOPE 4
ENVELOPE 5
ENVELOPE 6
ENVELOPE 7

Cooling and dehum. Demand
Heating Demand
Passive House requirement
Ventilation Losses

Natural Ventilation
Ventilation Losses

Natural Ventilation

Window ventilation air change rate: 4.00 1/h

Effective air change rate

2017/10/25
Air change rate value obtained from zonal natural ventilation analysis modelling carried out by Integral Group.
Natural Ventilation

Architectural implications

Operable windows
Ventilation Losses

Natural Ventilation

Heating/Cooling Demand (kWh/m².a)

- Passive House requirement
- Passive House requirement

Cooling and dehum. Demand
- Heating Demand
- Heating Demand

1 kWh/m².a Heating
7 kWh/m².a Cooling

ENVELOPE 7 + SOLAR SHADING + NAT. VENTILATION
ENVELOPE 7 + SOLAR SHADING + NAT. VENTILATION
ENVELOPE 5 + SOLAR SHADING + NAT. VENTILATION
Mechanical considerations
Radiant Ceiling
Cooling Loads

Heating Demand

Cooling and dehum. Demand

Passive House requirement

BASELINE

ENVELOPE 1

ENVELOPE 2

ENVELOPE 3

ENVELOPE 4

ENVELOPE 5

ENVELOPE 6

ENVELOPE 7

ENVELOPE 7 + SOLAR SHADING

Cooling Loads
Natural Ventilation
First Floor

Fitness Centre

Library
Natural Ventilation

Basis of Design
Natural Ventilation
Alternate Dynamic Modelling
Natural Ventilation
Alternate Dynamic Modelling
Natural Ventilation

Compliance

The limits of thermal comfort: avoiding overheating in European buildings

CIBSE

Overheating criteria – CIBSE TM52:

6.1.2 Criteria for defining overheating in free-running buildings

The following three criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three criteria is classed as overheating.

1. The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1 May to 30 September).

2. The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.

3. The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.
Natural Ventilation

Compliance

![Graph showing temperature variation over days]

- **Library temperature**
- **External temperature**

 DAY 181  |  DAY 182  |  DAY 183  |  DAY 184  |  DAY 185
Natural Ventilation

MECHANICAL COOLING ONLY
21.5 kWh/m².yr

MIXED MODE (MECH + NAT VENT)
7 kWh/m².yr

~65% REDUCTION in Cooling Energy
Natural Ventilation

Fitness Room 18°C (64°F) Cooling Setpoint

~64% REDUCTION in Cooling Energy

MECHANICAL COOLING ONLY
129.2 kWh/m².yr

MIXED MODE (MECH + NAT VENT)
46.2 kWh/m².yr

~64% REDUCTION in Cooling Energy
Natural Ventilation

Fitness Room 22°C (72°F) Cooling Setpoint

~87% REDUCTION in Cooling Energy

MECHANICAL COOLING ONLY
35.1 kWh/m2.yr

MIXED MODE (MECH + NAT VENT)
16.7 kWh/m2.yr

~87% REDUCTION in Cooling Energy
Controls
Ventilation Losses

Natural Ventilation

Heating Demand
Cooling and dehum. Demand

Passive House requirement

1 kWh/m².a Heating
7 kWh/m².a Cooling

Cooling and dehum. Demand
Heating Demand

BASELINE ENVELOPE 1 ENVELOPE 2 ENVELOPE 3 ENVELOPE 4 ENVELOPE 5 ENVELOPE 6 ENVELOPE 7 ENVELOPE 7 + SOLAR SHADING ENVELOPE 7 + SOLAR SHADING + NAT. VENTILATION ENVELOPE 5 + SOLAR SHADING + NAT. VENTILATION
Takeaways

1- Passive House calls for Holistic Solutions
2- Natural Ventilation has potential for significant savings
3- Include Nat Vent early in design
4- Dynamic modelling provides alternative insight
Thank you