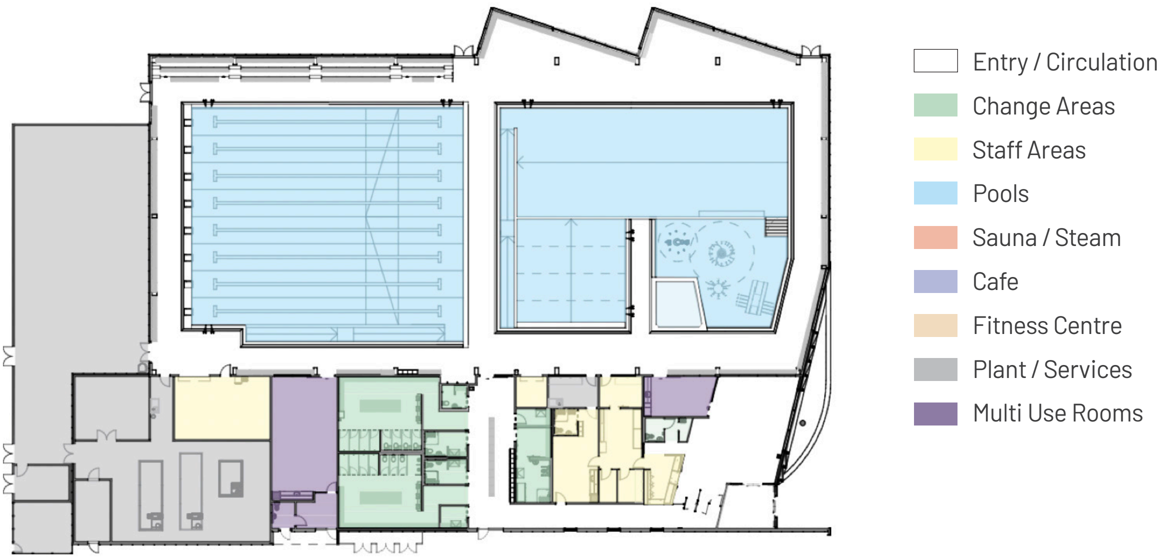
3.3
Typical Community Aquatic Centre



This case study uses a recently completed aquatic centre to allow calculation of the following:

- The carbon emissions profile of a typical community sized aquatic facility.
- The relative contribution of different building elements to the embodied carbon.

This case study demonstrates the relative benefit of upgrades to existing building fabric for an older facility, as well as the reduction in operational carbon expected from changing the heating source from a gas boiler to an electric heat pump.

An aquatic facility was modelled based on the Stratford Aquatic Centre as representative of a medium-scale community aquatic facility. It was modelled with weather from the Lower North Island and a fresh air dehumidification system to be representative of the most common HVAC configuration.

Construction Value:

Approx. $24M

Features:

- 25 m, 8-lane pool
- Learners' pool
- Programmes pool
- Toddler pool

Key Metrics:

Floor Area: 2,700 m^2

Water surface area: 1,000 m^2

Occupants: 600

Insulation R values (m2K/W):

Windows	0.31
Walls	5.1
Roofs	4.4
Energy Use Intensity (EUI)	600-700 kWh/m^2 yr
Temperature settings	Main Pool water: 27.5°C Programmes/ Learners/Leisure Pools: 31°C Pool hall air temp. : 24°C Relative humidity 65 %

Key Information

The below table indicates the carbon emissions impact of a typical community aquatic centre over its life time (assumed to be 50 years).

Life Cycle Stage	$kgCO_2e / m^2$
A1-A3 Materials	774
A4 Transport	11
A5 Construction	64
B1 Use phase	526
B4-B5 Replacement	173
B6 Energy	3,244
C1-C4 End of Life	15
Total	**4807**

The carbon emissions from operating the building (3244 $kgCO_2e /m^2$) account for 67% of the total emissions over the 50-year building life, assuming the use of an electric heat pump.

For a new build facility, modelling was undertaken to understand the difference in life cycle carbon between a gas boiler and a heat pump central energy system over a 50-year design life. The life cycle carbon for a gas boiler system was modelled at 14,610 $kgCO_2e /m^2$, compared with 4,807 $kgCO_2e /m^2$ for a heat pump system as given above. A significant proportion of the carbon emissions relating to a gas boiler lies in the operation of the facility - 13,531 $kgCO_2e /m^2$ for the gas boiler, compared with 3,244 $kgCO_2e /m^2$ for the heat pump.

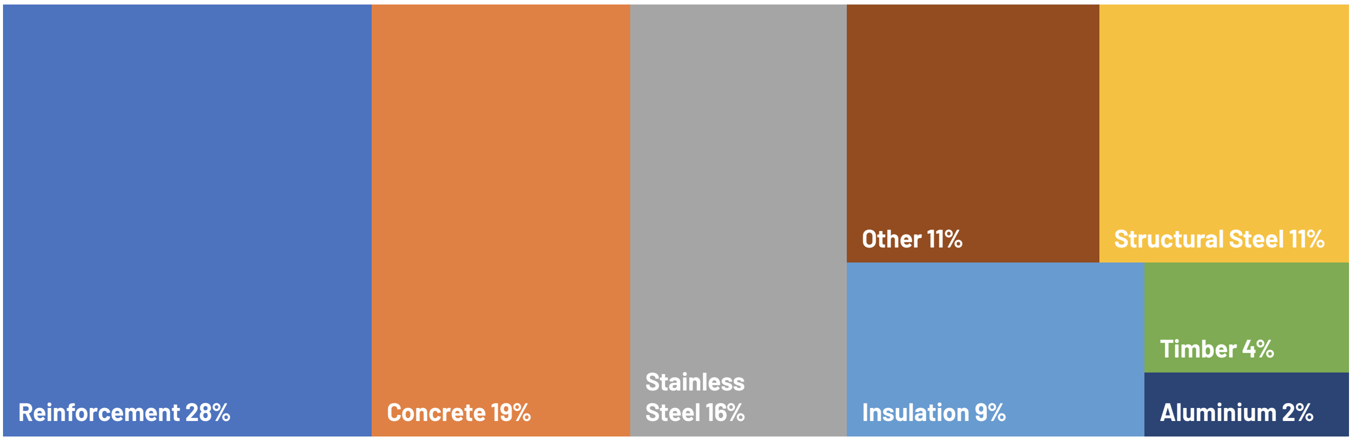
The carbon payback period for a heat pump system (i.e., the length of time required to pay back the embodied carbon associated with the change in system with the operational carbon savings it offers) is estimated to be **2.79 years.**

Older aquatic facilities (25+ years old) typically employed a foil vapour barrier and insulation batts for the roof and wall construction. The insulation values associated with this construction are significantly lower than what is obtained by the insulated panel construction more commonly used in modern aquatic centres (approximately R1.8 for foil and batts compared with R5 for insulated panels). The carbon payback period for replacing an old roof and wall fabric with new is modelled at **16.66 years**.

For owners and operators of existing facilities who are looking to improve the performance and/or carbon profile of their facility, the easy sustainability win is therefore to replace gas boilers with a heat pump system.

With older facilities (25+ years), it is likely that other factors such as the seismic resilience and condition of the primary structure, and how well the facility is meeting existing needs will affect decisions on whether to upgrade or build new. An upgrade to a heat pump energy system is likely to be considerably less intrusive than the replacement of building fabric.

The diagram below provides a breakdown of the upfront embodied within a new facility by material type.



A significant proportion (58%) of the upfront embodied carbon is associated with the primary structure (concrete, structural steel and reinforcement). The modelling assumes the base build has structural steel portals for the primary structure.

Reductions in upfront embodied carbon are therefore best targeted at primary structure, where significant savings can be made:

- **20% reduction** in upfront embodied carbon, associated with procurement of steel reinforcement from suppliers who use electric arc furnaces instead of gas boilers.
- **4% reduction** in the upfront embodied carbon associated with primary steel are achieved in the same way as reinforcing steel, by carefully considered procurement.
- **10% reduction** in upfront embodied carbon offered by the replacement of structural steel with mass timber structure. While there is a small cost premium to go to glue laminated primary structure, the Whole of Life cost is less due to the reduced maintenance requirements of timber in an aquatic environment.
- **3% reduction** in upfront embodied carbon offered by the use of low carbon concrete.

Modelling and Assumptions

- Life cycle modelling has been undertaken using One Click Life Cycle Assessment software.
- Emissions factors for materials and elements have been taken from the One Click LCA database. Where available, NZ-specific environmental product declaration (EPD) data has been used. In the absence of NZ-specific data, generic global data has been used which has been regionalized to NZ.
- Product and element service life times (that is, replacement cycles) have used One Click LCA built-in assumptions.
- Emissions factors for purchased electricity and building gas usage have been taken from 2022 Ministry for the Environment published guidelines.
- No allowance for future decarbonisation of the grid has been included.
- Refrigerant emissions are highly variable between sites. For the comparative modelling above, a high-level assumption was made for gas boiler systems as being ~20% of the refrigerant emissions from an equivalent heat pump system, to allow for equipment required to condition gym and office spaces.
- Building electricity consumption (beyond pool heating/HVAC) has been assumed to be 1.5GWh/yr. Although expected to be typical for a community aquatic facility, it is likely to vary between sites depending on design decisions.
- A coefficient of performance of 3.0 was assumed for the air source heat pumps, and an efficiency of 0.85 for a gas boiler. These are likely to be slightly conservative assumptions.
- The carbon figures and findings presented above have been calculated using specific past project examples and should not be taken to be predictive of any future project performance.