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Macro Micro Studio: A Prototype Energy Autonomous Laboratory

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SUPPLEMENTARY INFORMATION

1.1. Concept Development

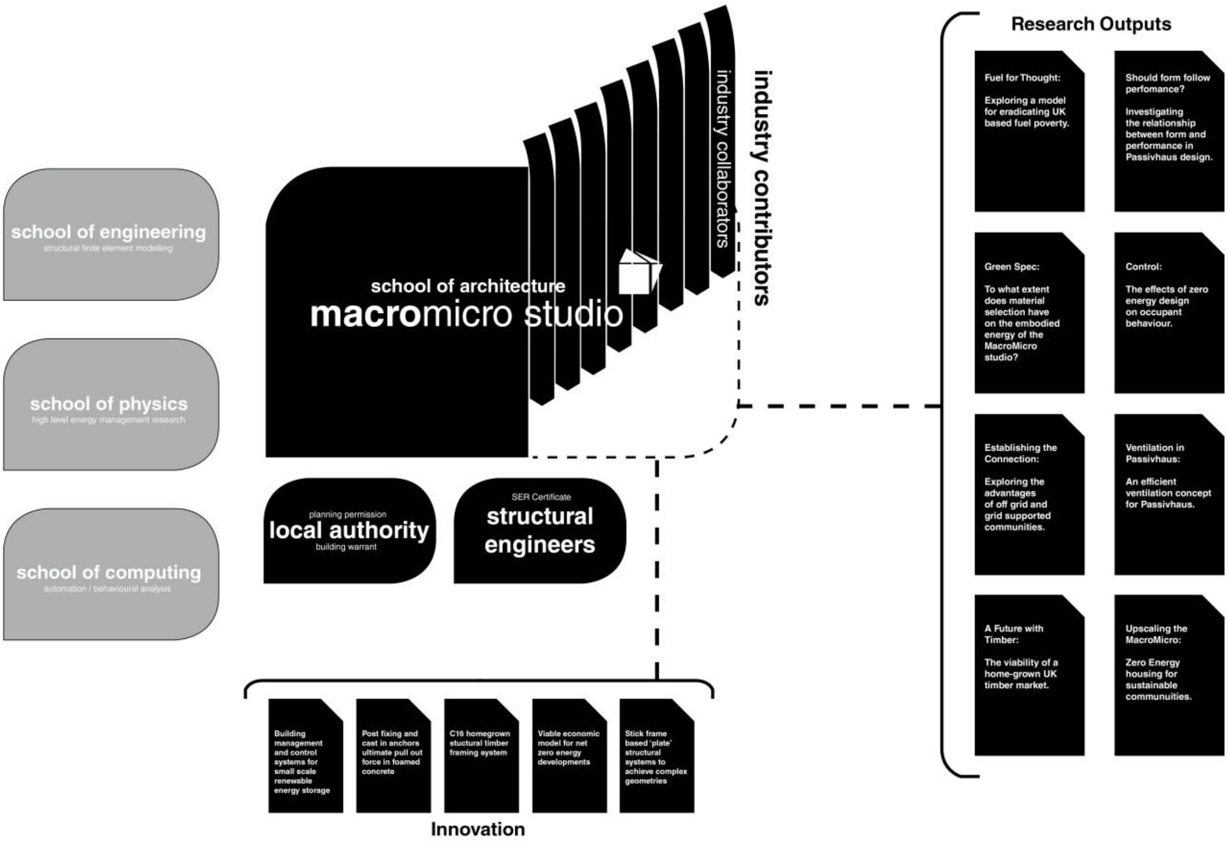

Figure 1. Project structure, organization and related student thesis studies

Figure 2. Project development at the end of the first academic year in 2011

1.2. Design Drawings

Figure 3. Site plan

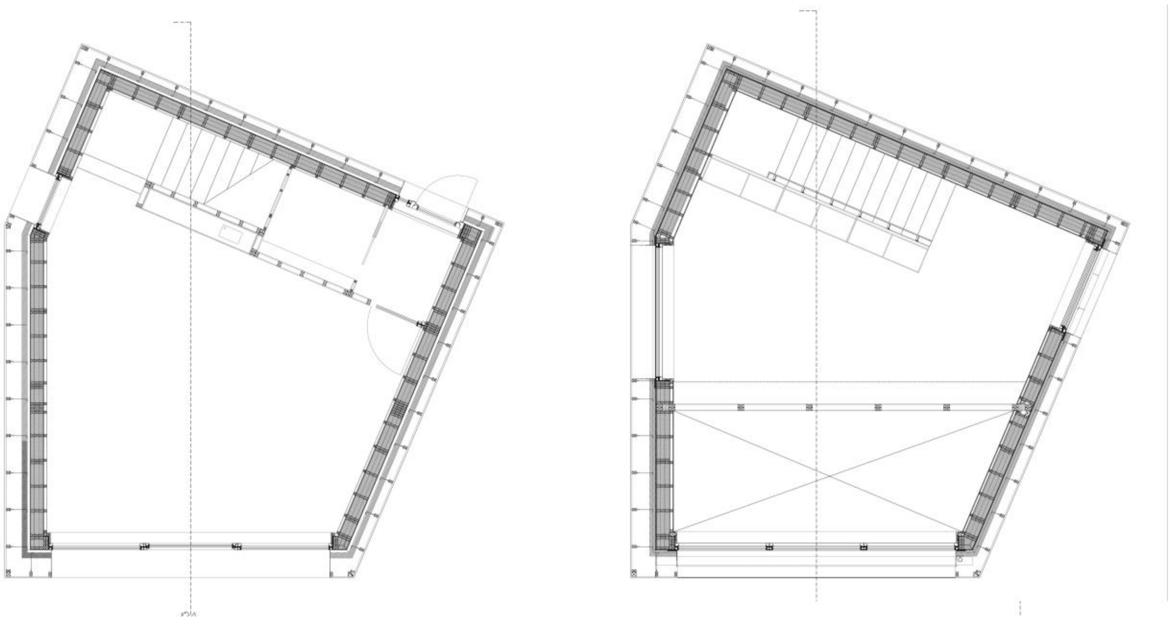

Figure 4. Ground and first floor plans

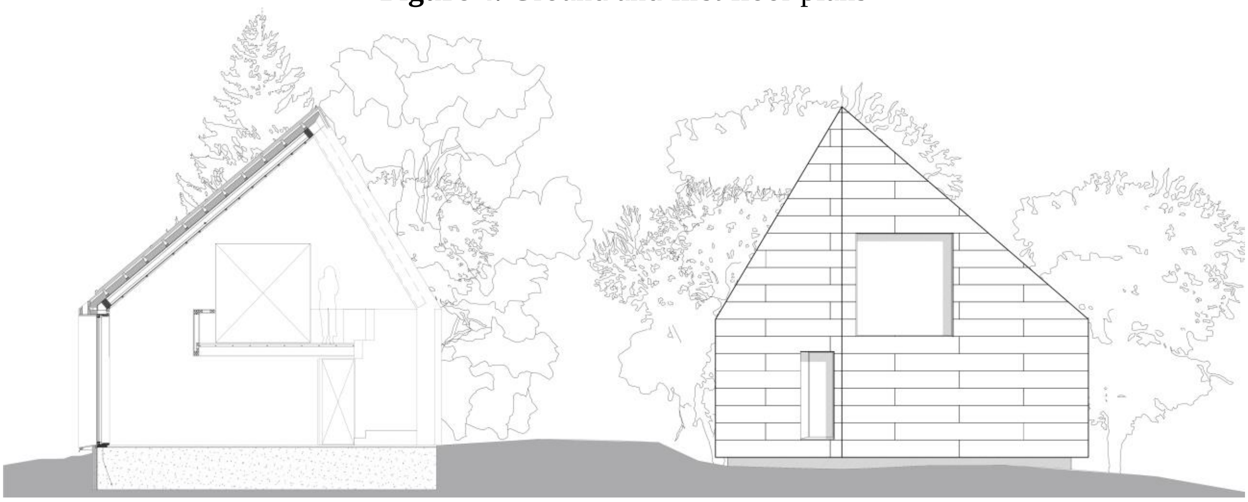

Figure 5. Principle section and west elevation

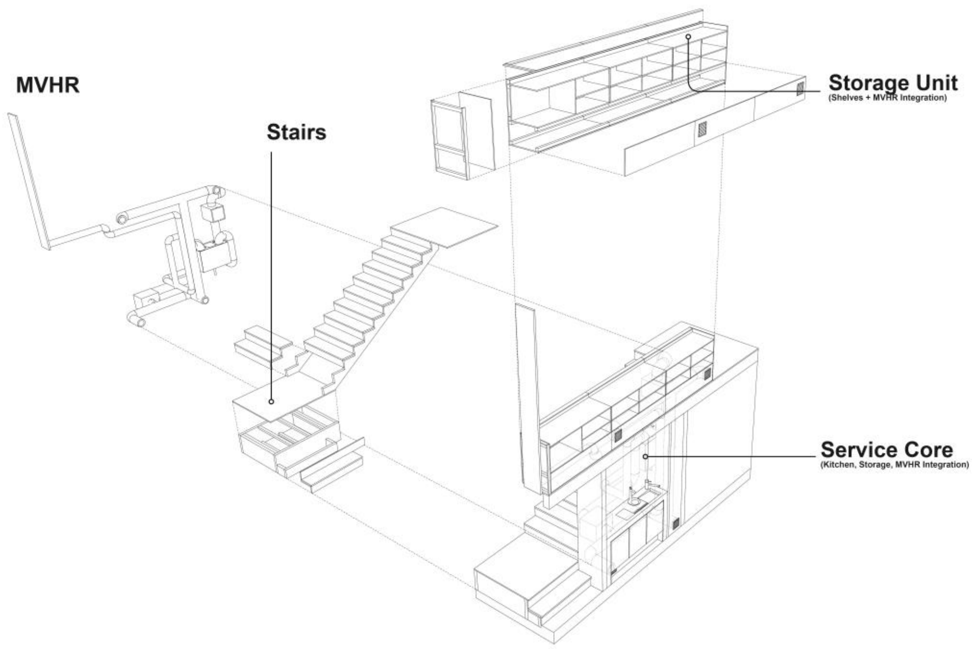

Figure 6. Service core and services integration

1.3. Shell Geometry

The Studio electricity demand and solar insolation defined the size of the south elevation and south roof area and pitch and these were assumed to be fixed in the model and were defined as: length of plan (a); angle of south roof (θ); area of south roof (S).

The relationship between these parameters is as follows:

$S = a \times \frac{a}{\cos\theta}$. with the length of the square defined as: $a = \sqrt[2]{s \times \cos\theta}$ (Figure 2.2a).

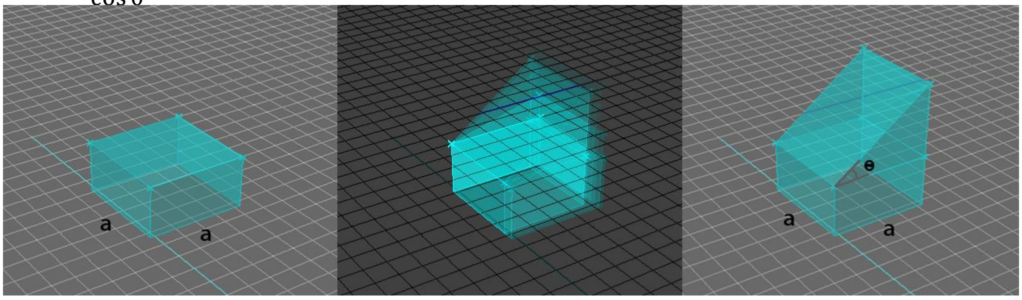

Figure 7. Relationship between side length of plan (a); angle of south roof (θ); area of south roof (S).

The ground plan is defined by two overlapping squares of different perimeter lengths, the larger of the squares rotated about a point on the south east corner of the smaller square. This provides more space for the circulation, stair and service zone without impeding on the functional space of the ground floor.

The ground floor plan area can be described as follows (Figure 2.2b):

$$S = \frac{1}{2}\left(\frac{ab\,(a+b)^2}{a^2+b^2} + ab\right) + a^2.$$

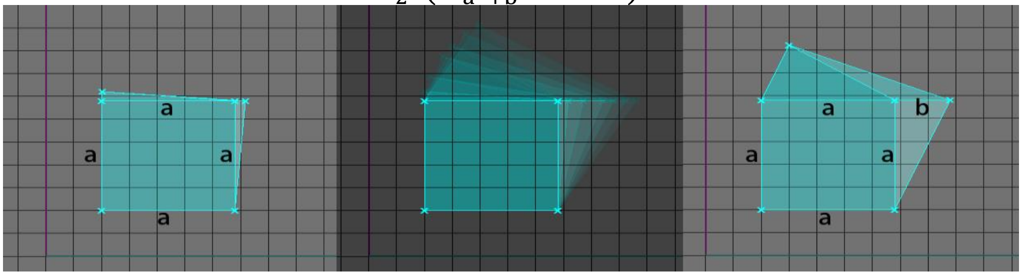

Figure 8. Relationship between south geometry and north geometry of the ground floor plan.

The mezzanine area is defined by the set-back distance (c) of the mezzanine front edge from the south elevation of the building. The mezzanine floor plan area can be described as follows (Figure 2.2c):

$$S` = S - \left(ac + \frac{bc^2}{2a} \right)$$

The gross floor area of the building is $50m^2$, which means the total ground floor area (S) plus mezzanine floor area (S`) = $50m^2$. These are then defined by the equation (Figure 9d):

$$\left(\frac{ab\,(a+b)^2}{a^2+b^2} + ab\right) + 2a^2 - \left(ac + \frac{bc^2}{2a}\right) = 50\ m^2$$

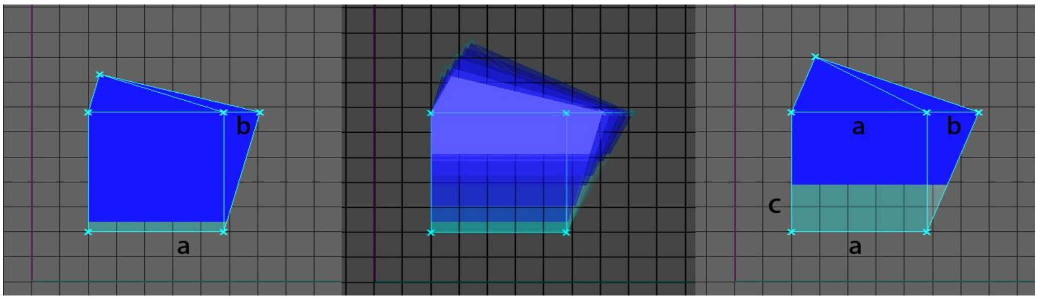

Figure 9. Relationship between south geometry and north geometry of the mezzanine plan.

The mezzanine floor location and the angle of rotation between the two squares are related, the rotation between them defined by the length (b), with the maximum width of the plan being defined by (a) + (b). (Figure 2.2d).

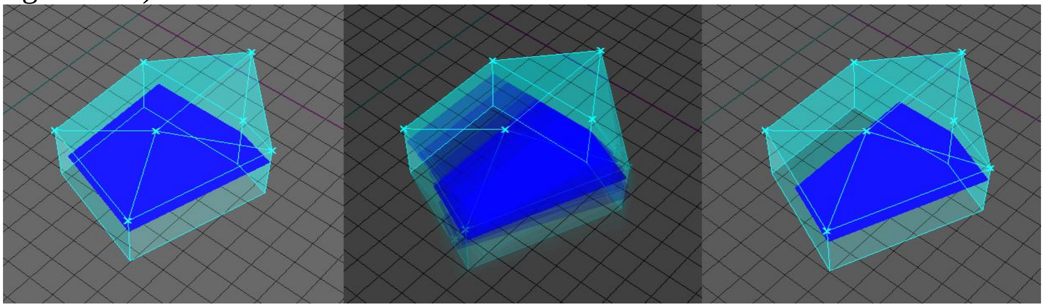

Figure 10. Defining the mezzanine floor relationship to the building form.

The digital model links together the various parameters to control the geometry allowing modification of the form to be tested by changing a number of key parameters. Generally when the solar panel area and south roof pitch are fixed, the front edge setback to the mezzanine (c) defines the angle factor (b) between the two square geometries eg if the mezzanine floor is pushed to the north, the entrance is rotated to the east (Figure 9e). The geometry can also be controlled by the parameters (S) and (θ). For example, the larger the angle (θ) results in the mezzanine being pushed forward and the smaller the angle (θ) results in the mezzanine being pushed backward in order to maintain optimum headroom at the mezzanine edge. The overall plan length and depth can also be varied giving elongated or narrowed plan forms. In the adopted geometry the mezzanine setback is determined by the ridge line of the shell allowing the mezzanine to occupy the higher volume below the ridge line of the roof. Further parameters were developed to control opening positions in relation to the surface geometry of the shell and internal programmatic arrangement.

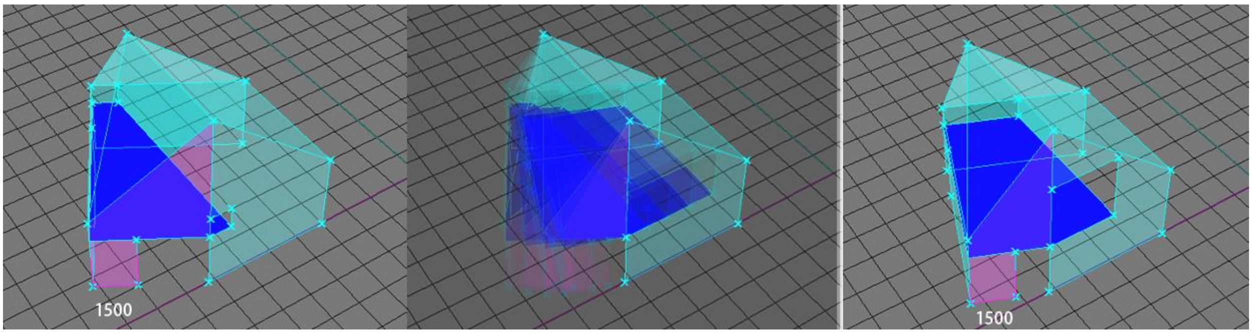

Figure 11. Defining opening positions within the shell.

1.4. Technical Data

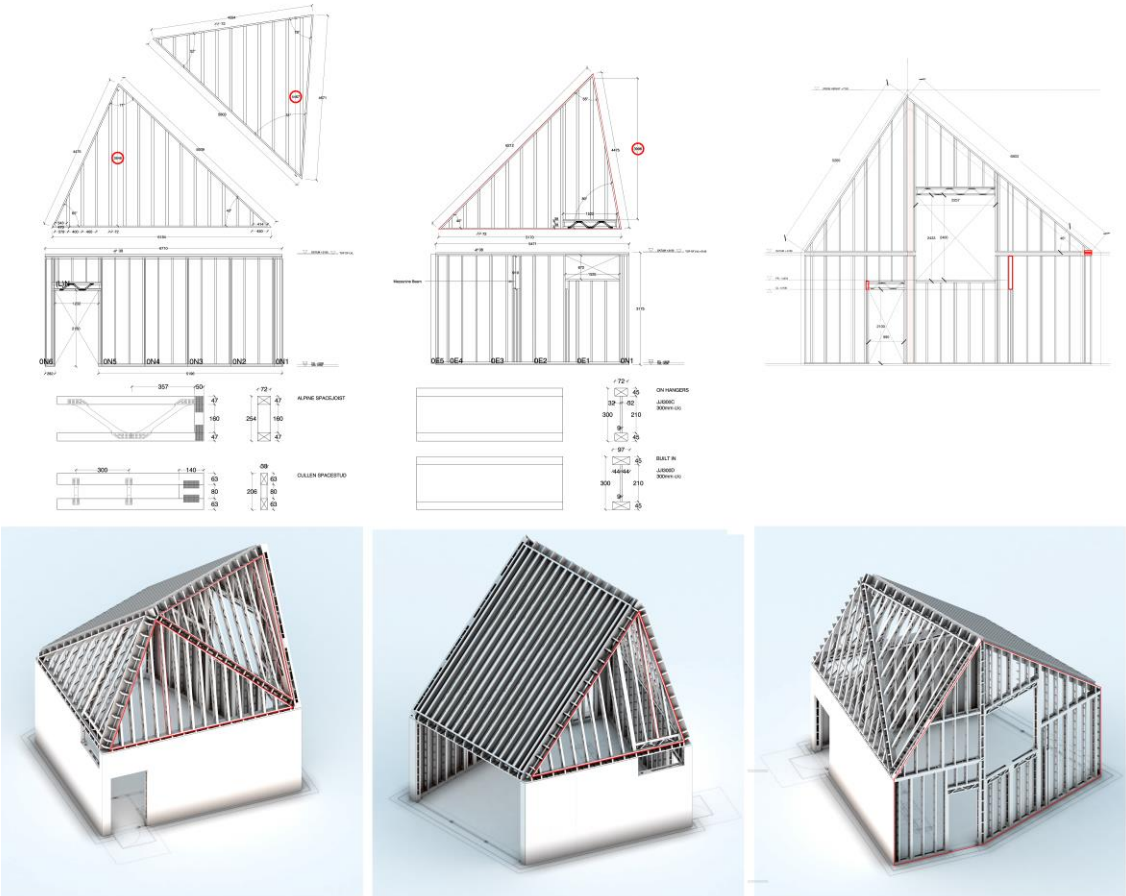

Figure 12. Timber frame design.

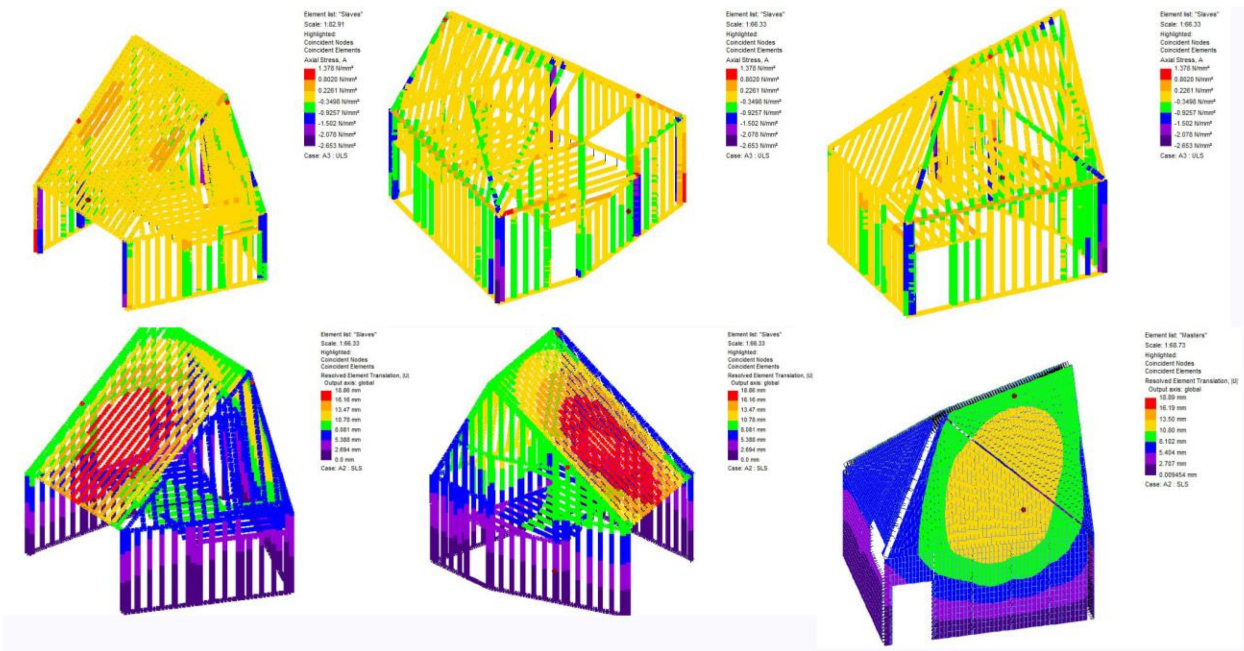

Figure 13. FEA analysis of building shell.

Lighting and Lighting Control Specification			
Type	***Electrical Specification***	***No.***	***Location***
IGuzzini Lazer Blade General LED Mono and Multi Optic Indoor Downlight (148x44x54mm)	10 W, 850 lm, Luminous efficacy (lm/W, real value): 54, 3000K CRI95 Optic: WF - Wide Flood 48° Control gear electronic dimmable DALI included	5 off	
IGuzzini Underscore LED Strip (5000x5x6mm)	9.6 W, 165 lm, Luminous efficacy (lm/W, real value): 17, 4000K CRI60 Optic: G - General lighting Control gear electronic	1 off	
IGuzzini iPro>BK11 wall Up/Down light (161x60x50mm)	2x1.5 W, 2x120 lm, Luminous efficacy (lm/W, real value): 24 Warm 3100K CRI80 Optic: VWF - Very Wide Flood 84° Adjustability: directional Control gear electronic	5off	
IGuzzini IPlan Pendant Rectangular LED up/down light (1200x300x26mm)	45 W, 7100 lm Luminous efficacy (lm/W, real value): 93 4000K CRI80 Control gear DALI included	2off	
IGuzzini Glim Cube Wall Up/Down Light LED (90x58x50mm)	2x1.2 W, 2x94 lm, Luminous efficacy (lm/W, real value): 28, 4200K CRI75 Optic: S - Spot 15° / 72° Adjustability: fixed Control gear electronic	2off	
IGuzzini IP53 Ellipse 709 ceiling down light LED (275x150x105mm)	8.7 W, 750 lm, Luminous efficacy (lm/W, real value): 43 Warm 3000K CRI80 Optic: D - Diffused light Adjustability: fixed Control gear electronic	1off	
IGuzzini Glim Cube >BA99Wall (164x68x70mm)	3.5 W, 270 lm Luminous efficacy (lm/W, real value): 33 4200K CRI75 Optic: Light blade Transformer electronic	2off	
Honeywell Ex-Or MS1500PF Standard Series LightSpot, ultrasonic movement detector.	230V – 50Hz, 10amps max. switch capacity 5-15 mins time delay – On/Off photocell adjustable 50-5000lux	1off	
Honeywell Ex-Or LS3100RF LightSpot Switching Sensor with Manual Override	230V – 50Hz, 10amps max. switch capacity 10m Macro / 7m Micro at 2.5m height Adjustable 10 to 1000 Lux Adjustable 10 secs to unlimited	1off	
Honeywell Ex-Or MR2500D Mid Range Regulating LightSpot, Switching Programmable Photocell	230V – 50Hz, 10amps max. switch capacity 20m range Passive/Active Regulating adjustable photocell 50-5000lux	1off	
Honeywell Ex-Or MSB1000DT BattenFit Sensor with Photocell	230V – 50Hz, 10amps max. switch capacity Passive Infrared presence detector	2off	

Figure 14. Lighting specification

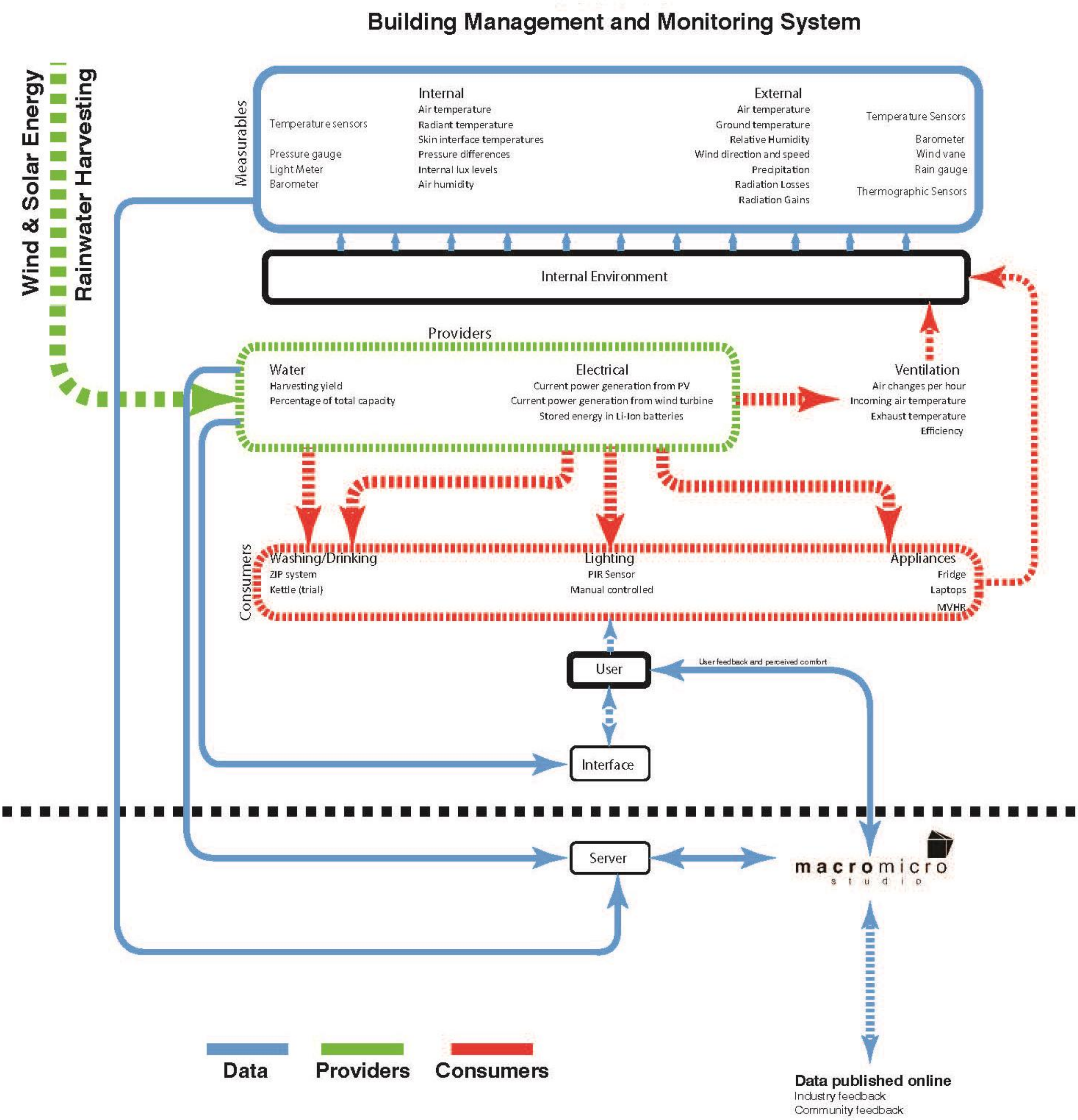

Figure 15. Schematic for proposed building management system