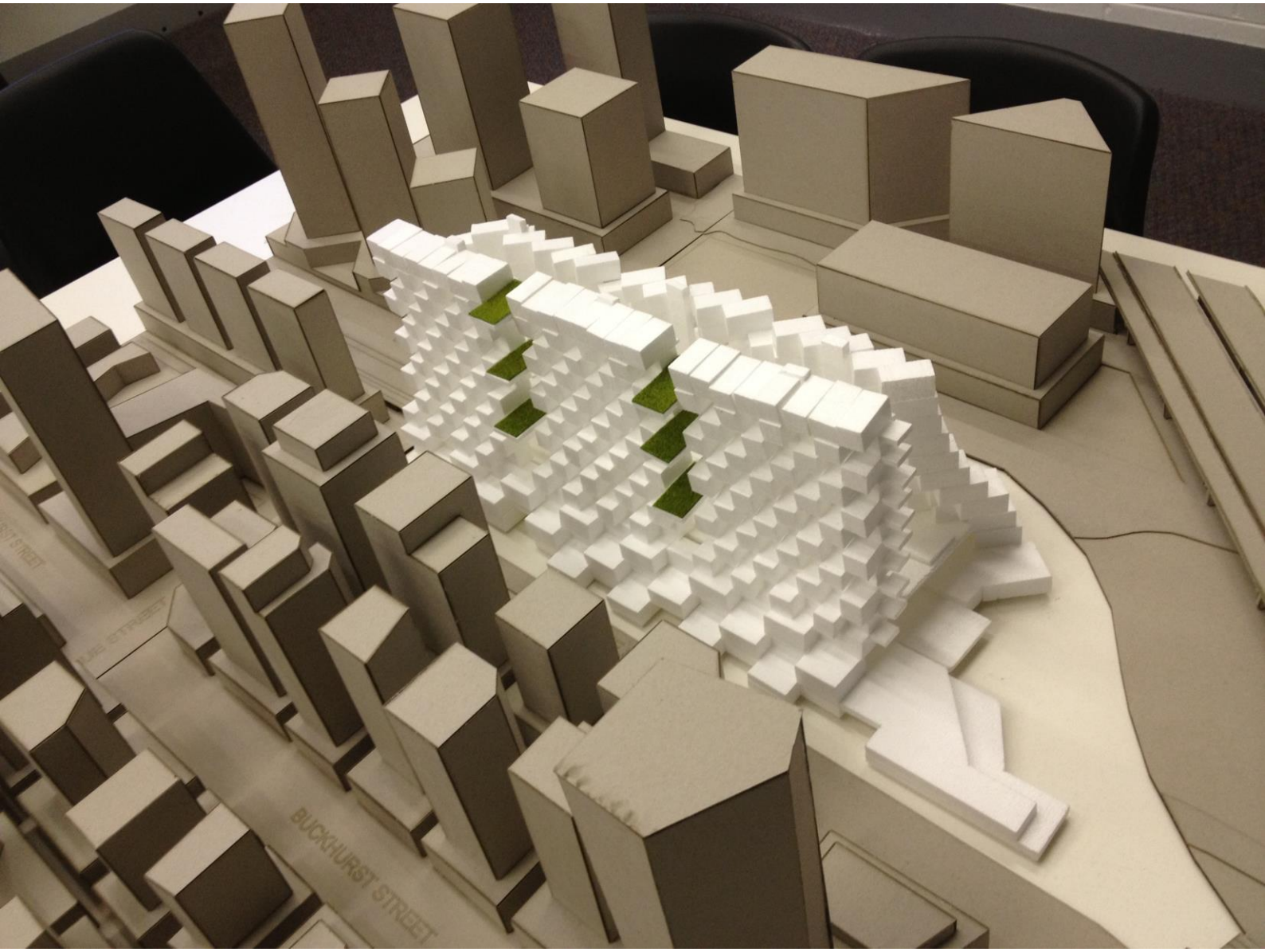


PROJECT BRIEF

Team Leader: **Van Anh Hoang**_502886
University of Melbourne
Project's site name: Montague Precinct
Melbourne, Australia

I. INTRODUCTION

Montague precinct is planned by the Government as the new high density residential area for Extended Melbourne CBD. Since Melbourne population is expecting to steadily grow to more than 5 million by 2025 and 6.5 million by 2050, Government opts for a density of 300 dwellings per hectare for the area. Within the 4ha site, the proposition creates a live-connect-work urban community that addresses the challenge of creating higher and denser living community while providing more desirable housing typologies that accommodate more outdoor settings and open green spaces.

With integrated public transportation system, the development permits higher use of existing infrastructure. The concept also promotes the idea of a sustainable community through the proposal of environmentally sustainable design strategies, both passive and active in the consideration of energy efficiency, rain water harvesting and utilization of solar energy and wind power.

II. MAIN CONCEPT

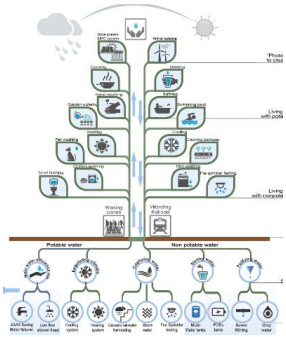
Australia is the driest continent, yet the second highest water consumer of the world. While persistent drought as a consequence of climate change is facing the country, Metropolitan Melbourne used approximately 560GL of drinking water for non-drinking purposes. Besides, deforestation in the urge of urbanization contribute to the threat of Water scarcity facing Australian cities nowadays. Design for Scarcity including Design for Water Scarcity, Energy & Food Scarcity and Human Well being are three most hot-button issues for Australia to achieve its sustainable development vision. Our ambition is seeking for a solution that can reverse the negative effects of **urbanization process. The concept of "Each building is a smart tree" brings Melbourne towards a Resilient Forest which responses to the problem of water scarcity through the efficient water** conservation strategies. The concept adopts the environmental benefits of trees in water management, selects the most appropriate characteristics such as using water efficiently, moderating climate, capturing water, storing water and purifying water and implement them in the design to create a Water Smart Building.

Integrated approach

The design demonstrates the integrated sustainability approach in which passive and active design strategies are implemented efficiently to create a comprehensive sustainable design. Sustainability is not about the environment, but also about the well-being and comfort of the occupants and promotion of their lifestyles and culture. The design is expected to achieve 104/147 points of GreenStar Rating, (equipvalent to 6 Stars) of GBCA.

III. STRATEGIES AND FEATURES

1. Water Smart Building



Learning from nature, the design select 5 environmental benefits of trees in water management, including using water efficiently, ability to capture and storing water in harsh conditions, moderating climate by evaporative cooling and ability to clean water and soils of some aquatic plants. These beneficial characteristics are imitated and interpreted in five design strategies that create a comprehensive Water Smart Design that responds to the current problems of scarcity in Australian cities.

Including five water conservation measurements:

2.1 *Water Efficiencies*

All fixtures are to be installed with minimum 4A rating fittings such as low-flow dual flush, flow regulated taps, low flow showerheads, sensor activated (infra-red) taps (in office and retail stores)This is expected to save the building up to 30% of mains water supply.

2.2 *Moderating Climate*

Cooling & Heating System
Integrated with small pumping and controlling system in each block to control the hot and cold water flowing in floors, ceilings and walls. The system substitutes 100% air conditioning.
Shower Tower & Spray Rings
The cooling tower charging of PCMs will occur 63% of the year time. The ring on top will spray water to mix with air blowing through shower tower from top to bottom. The heat will be rejected. This charging will occur at night to ensure that the chillers are operating as efficiently as possible. It is expected to up to 70% electricity for air conditioning
Filtered fresh air supplied to office, retails
All the air supplied by mechanical fans to the open office and retails spaces will be 100% cooled fresh air drawn from roof top level, supplied through shower towers and mechanical fan.
Chilled ceilings: Chilled ceiling panels absorb radiated heat from equipment and occupants. Occupants experience "coolth" by radiating heat to chilled panel integrated with walls and ceilings over head.
Heating floors: At night time or in winter, hot water will be pumped to tube underneath floors to heat up the indoor air.
Exhaust :High level ceiling exhaust ensures complete emptying of warm air in ceiling spaces.
Healthy air
100% outside air supply via vertical ducts deliver air floor by floor to sealed access floor plenum.

2.3 *Capturing Water*

Cascade rain water harvesting
The building form is designed to maximize rain water capture by curving facade with terraced rain gardens. The water harvested is

used for non-potable purposes such as irrigation, toilet flushing, basin, cooling and heating system. With the average rainfall of 55mm/month in Melbourne, the 30,000 m2 total area for rain water harvesting is expected to harvest 1140kL/month (36m3 of water/day)

2.4 Storing water

Mains water is stored in the water tanks in basement and pumped to roof top for human usage. Rain water and Grey water are treated by water treatment plant for non-potable usage.
Sky gardens also capture rainwater for cascade irrigation before flowing to water treatment plant to recycle, together with water in swimming pool and sprinkler system.

2.5 Purifying water

Sewer Mining system
Innovation in Sewer Mining technology is also utilized to find additional water source for non-potable water usage activities. Grey water, storm water and black water from public sewer is treated through central water treatment plant which provides 100% of non-potable water usage of the building and significantly reduces pressure to public sewer system.
Irrigation water flowing naturally from upper garden to lower garden is collected and recycled for the next round.

3 Energy Smart Building

The building promotes both passive and active energy strategies to achieve an integrated sustainable design

3.1 Passive Strategies:

Melbourne weather is characterized by high diurnal range between daytime and night-time, summer and winter. This climate characteristic suggests passive design strategies of using temperature exchange devices such as PCMs, shower tower, thermal mass and generate radiant cooling, heating, evaporative cooling and night purging.

Natural ventilation by night purge: The design utilizes the high diurnal range of temperature in Melbourne to support passive cooling and heating process.

- North Facade design: Big glass window is recessed to reduce heat gain in summer and get more daylight in Winter.
- By using DaySim analysis program, the simulation of Insolation on Facade measures solar heat gain on various directions of building facades. Calculation from DaySim program shows that West facade gains highest heat from the sun, followed by North side. On the contrary, South and East Side gains less solar radiation. The simulation results support the facade design of building. West facade is designed with small window and thick wall, North facade with large sunken windows to reduce heat from high sun angle (Summer) and receive more heat from low sun angle (Winter), both South and East facade is designed with full height windows.

3.2 Active Strategies:

- Wind turbines: Wind turbines are located in strategic positions (8 installed under the sky bridges, and 12 installed in the roof), utilizing

the abundant resource of wind power in Melbourne. The electricity created is used to operating the pumping system.

- Identify locations to install wind turbines: Locations to install Wind turbines will be base on wind speed of different locations on the building. Stable wind speed of more than 5m/s is considered suitable for wind turbines to generate electricity effectively, such as Roof top and under bridge 1&4. Wind speed under bridge 2&5 sometimes is lower than 5m/s but still acceptable. However, wind speed under bridge 3&6 is not strong enough for wind turbine operation. Total energy generation of 476MWh is supposed to full fill all electricity consumption by pumping system
- Solar panels: 1536 m2 PV facing North, arrays on the roof with a capacity of 137 kWp, producing upto 208.6MWh of electrical power each year.
- Solar hot water panels: ETC system and heat pumps produce all ot water needed, provide upto 20.000litres per day which save 700KWh of electrical power daily.
- Harvesting energy from Vibrating Railroad Tracks: A device to harvest vibrating energy has a conversion efficiency of over 70% and can generate about 250 watts of power depending on the amount of vibration in the track. Walking panels to be installed to harvest energy from pedestrians. 1 walking panels`500X500 mm can generate 1.95 kWh
- Pumping system

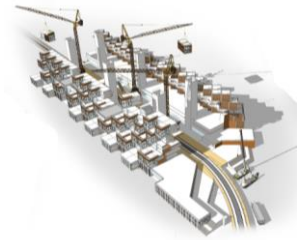
The pumping system located in basement level to manage water flow in the building. 100% electricity for pumping taken from Wind Turbine, Solar panel and Tram Vibrating Railroad Tracks. From 6 main cores, water will be distributed to each blocks, including mains water, recycled water, fire sprinkler water. After using, waste water is collected to grey water treatment plant in the basement.

4 Micro-Farming

City is losing its "Green", citizens have dreamed for Rural Houses with garden, place to walk a dog, family barbecues, sunbathing, children playing on the trees, catching buterfilies and birds...The notion of bringing suburbia into the city is addressed through the design of private and public multi-functional sky terraces. A vibrant central open-air communal space offers inhabitants a variety of experiences. The terraces are accessible from individual dwellings, providing a variety of amenities such as jacuzzi, pools, barbeques pits, sunbathing, family party. Gardens could be changed to micro-farming, home could be transformed to office.

15% of the world's food comes from the micro farmer. An intelligent water distribution system in the building is automated, robotic, efficient, use less energy and totally controlled by Computer Center of the Building. The integrated technology allows all residents to convert their garden into a Micro-Farm at any time to produce food for their needs. The Micro-Farm brings a life of suburb to CBD with open yards full of vegetables and animals which is losing rapidly in Australian Cities.

5 Replicability_Each building is a tree in the forest



By "planting" buildings that function as trees in terms of management and energy self-sufficiency, the design aims to "Greening" Melbourne into a forest, reverse negative effects of urbanization and industrialization. The modular design of environmental systems and typologies permit this paradigm to be easily replicated and implemented in other projects.

4 Adaptability & Flexibility

The proposition creates a live-connect-work urban community that opts to a density of 300 dwellings per hectare. The notion of AGILITY is addressed through the design of a range of housing typologies from 8.1x8.1m prefabricated modular system that support flexibility and diversity adaptable to different lifestyles and demographic change. The typologies are also supplemented by multi-functional sky terraces accessible from individual dwellings. The terraces provide a range of private outdoor spaces in the sky and are adapted to suit many purposes such as Jacuzzi, pools, barbeques pits, sunbathing, family party, vegetable gardens.

5 Local Material and Sourcing

In the attempt to reduce carbon footprint, the design promote the use of local materials and resources.

-100% local materials and resources: The design used Modscape as Melbourne local supplier. Modscape is one of the largest company in Australia on Prefabricated Building with Sustainable Strategies which is just 9km to the site. Using local steel material that was developed especially for modular construction, the frame is extremely strong in both horizontal, vertical and also very lightweight. The carbon footprint is 60% lower than comparable products. Low Embodied Energy & Recycled materials are also applied to minimize Carbon emission.

- Using Recycled Timber
The use of recycled timber greatly reduce carbon footprint to 30% when compared with the case using natural timber

6 Urban landscape

A vibrant central open-air communal space serves as a link that connect the urban green corridor to the building landscape, providing a variety of amenities (swimming pools, barbeques, spa, promenade garden…) and offer inhabitants a variety of experiences. The proposition contributes to the urban landscapes with it planted facades, balconies and sky gardens. The building is planted on every horizontal surface, create almost 100% of landscape ratio.

9. Design for Diversity

The prefabricated 8.1m x 8.1m modular systems allows the composition for a variety of desirable housing typologies The different combination of prefabricated modules results in 2160 different housing typologies which will allow the building to be adaptable to suit different cultures, lifestyles, preferences and demographic change.

10. Cultural enhancement

Sustainable living wasn't about changing your lifestyles, reducing the water used, turning off the lights, turning down the heat to adapt to the age of depleting resources. Sustainability is about creating more desirable living typologies. Sustainability is not only about the environment, but also about the well being and comfort of the occupants and the promotion of their lifestyles and culture.

IV. CONCLUSION:

1. Economic effect

The prefabricated modular design is more cost efficient than its conventional construction method. Significant savings are made through the effectiveness of construction, operation and reduction of wastage. The sustainable features cost approximately 15% extra to the initial building investment. However, the energy saving up to 72% and water saving up to 75.5% is expected to return the investment cost in 10 years. The integrated tram station also ensure the effective use of this means of transportation in the future.

2. Environment effect

With the vision of "Greening" Melbourne into a forest by "planting" buildings that function as trees, the design aims to reverse negative effects of urbanization and industrialization, helping Melbourne to achieve its sustainable vision. The building is expected to reduce 65% carbon footprint and 85% waste water to the environment. With integrated public tram system, the development permits higher use of existing infrastructure in the future, which also means reduction of carbon emission.

3. Community effect

The notion of AGILITY is addressed through the design of housing typologies from 8.1x8.1m prefabricated modular system that supports flexibility and diversity adaptable to different lifestyles and demographic change. The proposition creates a live-connect-work urban community that promotes Australian life style in many ways. Through the design of flexible typologies, balconies, sky gardens and communal spaces, the design offers inhabitants their desirable and balanced living by encouraging outdoor activities, communication between neighbors, community events and diversity of cultures

APPENDIX

1. Green Star Assessment

GREENSTAR ASSESSEMENT

Greenstar - Multi Unit Residential v1 2009

CATEGORY	TITLE	CREDIT NO.	POINTS AVAILABLE	POINTS AWARDED
Management				
	Green Star Accredited Professional	Man-1	2	2
	Commissioning Clauses	Man-2	2	2
	Building Tuning	Man-3	1	1
	Independent Commissioning Agent	Man-4	1	0
	Building Users' Guide	Man-5	1	1
	Evironmental Management	Man-6	3	1
	Waste Management	Man-7	2	1
	Metering	Man-16	6	4
		TOTAL	**18**	**12**
Indoor Environment Quality				
	Daylight	IEQ-4	2	1
	Thermal Comfort	IEQ-5	2	1
	Harzadous Materials	IEQ-6	1	1
	Internal Noise Levels	IEQ-7	2	2
	Volatile Organic Compounds	IEQ-8	4	2
	Formaldehyde Minimisation	IEQ-9	1	1
	Electric Lighting Levels	IEQ-13	1	1
	Private External Space	IEQ-20	1	1
	Dwelling Ventilation	IEQ-21	3	3
	Natural Ventilation	IEQ-22	3	1
		TOTAL	**20**	**14**
Energy				
	Conditional Requirement	Ene-	0	0
	Greenhouse Gas Emissions	Ene-1	20	12
	Unoccupied Areas	Ene-7	2	1
	Energy Efficiency Appliances	Ene-11	2	2
	Peak Electricity Demand Reduction	Ene-12	2	2
		TOTAL	**26**	**17**
Transport				
	Provision of Car Parking	Tra-1	2	2
	Fuel-Efficient Transport	Tra-2	2	2

	Cyclist Facilities	Tra-3	3	1
	Commuting Mass Transport	Tra-4	5	5
	Trip Reduction - Mixed Use	Tra-5	2	1
		TOTAL	**14**	**11**
Water				
	Occupant Amenity Water	Wat-1	5	4
	Landscape Irrigation	Wat-3	1	1
	Heat Rejection Water	Wat-4	2	2
	Fire System Water	Wat-5	1	1
	Water Efficiency Appliances	Wat-7	1	1
	Swimming Pool/Spa Water Efficiency	Wat-8	2	2
		TOTAL	**12**	**11**
Materials				
	Recycling Waste Storage	Mat-1	2	2
	Building Re-use	Mat-2	6	3
	Recycled Content & Re-used Products and Materials	Mat-3	1	0
	Concrete	Mat-4	3	2
	Steel	Mat-5	2	1
	PVC Minimisation	Mat-6	2	1
	Sustainable Timber	Mat-7	2	2
	Design for Disassembly	Mat-8	1	1
	Dematerialisation	Mat-9	2	1
	Flooring	Mat-11	1	1
	Joinery	Mat-12	1	1
	Internal Walls	Mat-14	2	2
	Universal Design	Mat-15	1	1
		TOTAL	**26**	**18**
Land Use & Ecology				
	Conditional Requirement	Eco-	0	0
	Topsoil	Eco-1	1	0
	Re-use of Land	Eco-2	1	0
	Reclaimed Contaminated Land	Eco-3	2	1
	Change of Ecology Value	Eco-4	4	3
	Outdoor Communal Facilities	Eco-5	3	3
		TOTAL	**11**	**7**
Emissions				
	Refrigerant ODP	Emi-1	1	1
	Refrigerant GWP	Emi-2	2	1
	Refrigerant Leaks	Emi-3	1	1

	Insulant ODP	Emi-4	1	0
	Watercourse Pollution	Emi-5	3	2
	Discharge to Sewer	Emi-6	5	4
	Light Pollution	Emi-7	1	1
	Legionella	Emi-8	1	0
		TOTAL	**15**	**10**
Innovation				
	Innovative Strategies and Technologies	Inn-1	2	2
	Exceeding Green Star Benchmarks	Inn-2	2	1
	Environmnental Design Initiatives	Inn-3	1	1
		TOTAL	**5**	**4**
		TOTAL	**147**	**104**

2. Calculation

CALCULATION

CATEGORY	TITLE	%	NUMBER	UNIT	NOTES
Building Fact					
	Density		300.00	house/ha	
			600.00	pp / ha	
			2,400.00	pp/ 4ha	
	Number of Dwellings		1,346.00	blocks	
	Number of People		2,692.00		
	Single Block		8.1 * 8.1 * 4	m	
			65.61	m2	
	Double Block		8.1 * 8.1 *2	m	
			131.22	m2	
	Residentials		1346 * 65.61	m2	
Area					
	GFA Residentials	45%	88,311.06	m2	
	GFA Garden	2%	3,084.94	m2	
	GFA Commercial	24%	48,262.00	m2	
	GFA Office	29%	57,692.00	m2	
	Total GFA		**197,350.00**	m2	
	Site area		40,000.00	m2	
	FAR		**4.93**		
	Roof area		5,120.00	m2	

	Solar panels area	30%	1,536.00	m2
	Evacuated Tube collector ETC	20%	1,024.00	m2

Water

Rainfall in Melbourne	55.00	mm/month	
Roof area (South side)	2,880.00	m2	
Roof area (North side)	2,240.00	m2	
Total Rood Area	**5,120.00**	m2	
Total Garden Area for rain water harvesting	30,000.00	m2	70 percent capture
Total rain water harvested (month)	1,140.00	kL/month	
Total rain water harvested (week)	285.00	kL/week	
Total rain water harvested (year)	13,680,000.00	L/year	
Total water saving by harvesting rain water	9.34	%	
Water tank with a capacity for one's week capture	8x10x4	1 tank	2 tank
Water consumption (2011-2012)	149.00	L / person /day	25% saving in water use compare to 2004
Water consumption (2004)	423.00	L / person /day	
Total Water consumption of building (day)	**401,108.00**	L/day	

	Total Water consumption of building (year)	**146,404,420.00**	L/year
	Total main water saving		
	Main saving by using water efficient fixtures	30.00	%
	Total water saving by using water efficient fixtures	4.50	%
	Non-potable water are met by other water substitution (Rain harvesting, water recycling, sewer mining)	100.00	%
	Total main water saving by using water substitution (Rain harvesting, water recycling, sewer mining)	85.00	%
	Total main water saving (%)	**89.50**	**%**
	Total main water consumption		
	Total main water saving (L) (day)	**358,991.66**	**L**
	Total main water saving (L) (year)	**131,031,955.90**	
	NEW WATER CONSUMPTION	**44.50**	**L**

Energy		**Global formula :**	**E = A * r * H * PR**	
	E = Energy (kWh)		277,200.00	kWh/an
	A = Total solar panel Area (m^2)		1,120.00	m^2
	r = solar panel yield (%)		0.15	

H = Annual average irradiation on tilted panels (shadings not included)*	1,650.00	kWh/m².an
PR = Performance ratio, coefficient for losses (range between 0.9 and 0.5, default value = 0.75)	1.00	
Total power of the system	**168.00**	**kWp**

References

1. **Othman, M., Jayasuriya, N.**: Water Conservation within an ecological sustainable development (ESD) framework, 2004
2. **Goodbun, J.; Till, J.; Iossifova, D.**: Scarcity: Architectural Design (AD), Architecture in an Age of Depleting Resources Architectural Design, July 2012
3. **Kishnani, N.:** Greening Asia, Emerging Principles for Sustainable Architecture, 2012
4. **Building Code Australia (BCA)**: Class 2 to Class 9 Buildings, volumn 1, Section J, Energy Efficiency, 2010
5. **Green Building Council Australia**: Technical manual green star multi unit residential, 2009
6. **Bureau of Meteorology, Australia Government**: http://www.bom.gov.au/vic/?ref=hdr, accessed October 2013
7. **Australian Bureau of Statistics:** Environment, http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/1301.0~2012~Main%20Features~Water~279, accessed in October 2013
8. **Department of Environment, Australia Government**: Australia's water resources and use, http://www.environment.gov.au/node/22961
9. **Modscape**: http://modscape.com.au/, accessed November 2013, accessed in October 2013
10. **Photovotaic Calculation**: http://photovoltaic-software.com/PV-solar-energy-calculation.php, accessed November 2013
11. **Melbourne Water**: http://www.melbournewater.com.au/waterdata/wateruse/Pages/default.aspx, accessed November 2013
12. **The City of Port Phillip:** Montague Precinct Structure Plan, http://www.portphillip.vic.gov.au/Report_1_Att_1_Structure_Plan_Consultation_Draft_-_Part_1.pdf, June 2012
13. **Kiniry, L.**: 6 Ways to Harness the Wasted Energy of Trains (and Their Passengers), http://www.popularmechanics.com/science/energy/efficiency/6-ways-to-harness-wasted-transit-energy#slide-2, accessed October 2013
14. **City of Melbourne**: Water sensitive urban Design guidelines, http://www.melbourne.vic.gov.au/Sustainability/SavingWater/Documents/WSUD_Guidelines.PDF, accessed October 2013
15. **Tan Su, F**: CH2 6 stars, but how does it work?, http://architectureau.com/articles/practice-15/, accessed October 2013
16. **Johanson, S.**: Architect eyes on Montague, http://www.smh.com.au/business/architect-eyes-on-montague-20130319-2gdak.html, March 20, 2013
17. **TV News VIC**, Tallest building in southern hemisphere approved, http://www.abc.net.au/news/2013-03-18/melbourne27s-tallest-building-plan-gets-green-light/4578666, Mar 2013