Italcementi Center for Research and Innovation

Bergamo, Italy

LEED-NC v2.1 EAc1

A. Project Narrative

Viridian Energy & Environmental LLC (Viridian) analyzed the energy use of the proposed Italcementi Center for Research and Innovation located in Bergamo, Italy. The proposed design is estimated to perform 58.2% better than the budget building based on the Energy Cost Budget Method of Section 11 of ASHRAE/IESNA Standard 90.1-1999 (ASHRAE 90.1-99) as prescribed in the LEED reference guide for LEED-NC v2.1. This earns ten (10) LEED points using the EAc1 Point Interpolation Tables as revised in September 2004. These tables interpolate energy savings and points available and can be applied to LEED-NC v2.0/2.1 projects.

The proposed building is a two-story structure with basement and sub-basement floors that encompasses 176,238 ft^2 (16,373m^2), including unconditioned spaces. The building includes offices, library spaces, laboratory spaces, control rooms, storage spaces, meeting rooms, an auditorium, board room, transition spaces, mechanical spaces and a parking garage.

Viridian used the computer software DOE-2.1E to model the building design and evaluate energy efficiency measures. DOE-2.1E is a computer program for detailed energy use analysis of residential and commercial buildings. It was developed by Lawrence Berkeley Laboratories, in collaboration with the U.S. Department of Energy and other research groups. DOE-2.1E calculates the hour-by-hour energy use of a building based on information on the building's location, construction, HVAC systems, central plant, occupancy, and operation. The energy model was developed for the sole purpose of calculating the LEED EAc1 points and should not be used for predicting the actual energy use of the building.

The utility rates used for both the budget building and the proposed design are based on ASM Brescia S.P.A tariffs for electricity and natural gas. The average electricity costs are €0.10/kWh (for detailed information, please refer to the Appendix). The average costs for natural gas are €1.56/therm.

The analysis was based on international climatic data for Milan, Italy (Table D-3 of ASHRAE 90.1-99) using a bin weather file for that location (IWEC TMY2 data). The budget building meets the requirements prescribed in Table B-14 of ASHRAE 90.1-99.

B. Building Energy Efficiency Measures

1. Building Envelope

The building has an insulating envelope comprising of insulated concrete panels, thermally broken curtain wall segments and a roof with increased insulation and high solar reflectance. The fenestration consists of argon-filled, low-e coated triple-pane or double-pane insulating glass. Exterior shades and roof overhangs provide shading.

2. Lighting and Lighting Controls

Lighting incorporates mostly fluorescent and compact fluorescent lighting fixtures resulting in a low overall lighting power density of 0.73 W/sqft (7.85 W/m^2), 34.8% lower than ASHRAE 90.1-99.

The proposed design also incorporates daylight dimming controls for most perimeter spaces and second-floor spaces with skylights (approx. 19% of total floor areas). The installation consists of a light sensor that is usually ceiling-mounted and calibrated to a desired footcandle level in the work area. A controller dims the ballasts of the lamps. As outdoor light increases in intensity, the daylight dimming device gradually reduces the electricity use of the lamps, to maintain a constant footcandle level.

Occupancy sensors are used in laboratories, private offices, control rooms, meeting rooms, the library, the board room and locker rooms. The installation includes approx. 39% of total floor area.

3. HVAC System

The design includes three ground-source heat pumps with cooling EER = 18.8 (140kW capacity, each) and heating COP=4.1 from (104 kW capacity, each). Additional cooling is provided by two water-cooled chillers, with 700 kW capacity each and EER = 19.85 at full load. Additional heating is provided by two condensing boilers, with 846 kW capacity each and a thermal efficiency of 93.7%.

Air distribution is provided by seven variable-air-volume air-handling units (AHUs). The relative humidity in offices, cafeteria, auditorium and board room is maintained at 50% (±15%). 60 snorkels and 16 VAV fume hoods are exhausting air from laboratories, which are served by 100% outside air units (AHU-1 and AHU-2). All seven AHUs are equipped with heat recovery units.

The proposed design incorporates carbon dioxide sensors for AHU-4 (auditorium), AHU-5 (cafeteria), AHU-6 (lobby) and AHU-7 (board room). CO_2 controls reduce energy use by reducing AHU operation and modulating outside air ventilation when occupancy levels are reduced during partially occupied hours.

4. Renewable Energy Generation

The Italcementi Center for Research and Innovation features a roof-mounted solar thermal system with an estimated hot water output of 300,000 Liters at 40°C (104°F) and a roof-mounted photovoltaic (PV) system with a capacity of 90.3 kW_{peak} and an

estimated annual electricity generation of 95,572 kWh. Solar thermal and PV systems combined, the on-site renewable energy generation is approximately 12.5% of the total regulated energy load. Supporting documentation is provided in the following two separate documents:
Italcementi_renewables-PV_9dec09.pdf / Italcementi_renewables-thermal_9dec09.pdf

C. Side-By-Side Comparison of Budget Building versus Proposed Design

LEED™	*Proposed Design*
Building Envelope (as per ASHRAE 90.1-99 Table B-14)	**Building Envelope**
Exterior wall construction	Exterior wall construction
Mass wall • U = 0.857 W/m²K	*Concrete Panel Wall* • U = 0.443 W/m²K • 100 mm concrete panel • 20 mm air space • 75 mm polystyrene insulation • Water proofing • 200 mm concrete wall • Plaster
Steel-framed wall • U = 0.704 W/m²K	*Spandrel Panel (Curtain Wall)* • U = 0.615 W/m²K • 25 mm insulating glass unit • 75 mm air space • 50 mm polystyrene insulation
Roof	Roof
Continuous insulation above deck • Solar reflectance of 30% • U = 0.358 W/m²K	*Continuous insulation above deck* • Solar reflectance of 83% (modeled at 45% as per ASHRAE 90.1-1999 Section 11.3.6) • U = 0.195 W/m²K • Sarnafil membrane • 120 mm polyisocyanurate insulation • 80 mm topping slab • 300 mm concrete slab
Building Shades	Building Shades
None	Permanently installed

LEED™	*Proposed Design*
Glazing	Glazing
Vertical fenestration 40.1-50.0% of gross wall area *Fixed glazing* • SC = 0.30; SC_{North} = 0.45 • VT = 0.60 • $U_{assembly}$ = 2.61 W/m²K	Supporting documentation regarding U-factor is provided in the following separate document: Italcementi_U-factor_9dec09.pdf) Vertical fenestration, 48.4% of gross wall area *Type 1A – triple pane, argon filled, low-e:* • Shading Coefficient (SC) = 0.29 • Visual Transmittance (VT) = 0.50 • U_{COG} = 0.8 W/m²K / $U_{assembly}$ = U = 1.24 W/m²K *Type 1 –triple pane, argon filled, low-e, 50% frit:* • SC = 0.29 • VT = 0.50 • U_{COG} = 0.8 W/m²K / $U_{assembly}$ = U = 1.15 W/m²K *Types 2, 2A 3 – double pane, argon filled, low-e:* • SC = 0.29 • VT = 0.50 • U_{COG} = 1.1 W/m²K / $U_{assembly}$ = U = 1.49 W/m²K
Doors/Operable Windows • SC = 0.30; SC_{North} = 0.45 • VT = 0.60 • $U_{assembly}$ = 2.67 W/m²K	*Doors/Operable Windows – double pane, argon filled, low-e:* • SC = 0.29 • VT = 0.50 • U_{COG} = 1.1 W/m²K / $U_{assembly}$ = U = 2.44 W/m²K (as per ASHRAE Handbook of Fundamentals 2001 Pages 30-8/9, because no manufacturer's data was available)
Skylights 5% of gross roof area *Skylights without curb (ASHRAE 90.1-1999 Table B-14)* • SC = 0.45 • VT = 0.60 • $U_{assembly}$ = 3.92 W/m²K	Skylights 16% of gross roof area *Type 1 (double pane, low-e)* • SC = 0.42 • VT = 0.59 • U_{COG} = 0.8 W/m²K / $U_{assembly}$ = 1.15 W/m²K *Skylight (OKASOLAR with integral sunshades)* • SC = 0.33 (maximum with open shades) SC = 0.09 (minimum with closed shades) • VT = 0.47 (maximum with open shades) VT = 0.01 (minimum with closed shades) • U_{COG} = 1.1 W/m²K / $U_{assembly}$ = 1.42 W/m²K

LEED™

Lighting (ASHRAE 90.1-99, Table 9.3.1.2)

- 12.03 W/m² Overall
  - 19.4 W/m² Laboratory
  - 14.0 W/m² Office - Open
  - 16.2 W/m² Office - Enclosed
  - 18.3 W/m² Library[1]
  - 15.1 W/m² Dining Area
  - 16.2 W/m² Conference/Meeting
  - 17.2 W/m² Lecture
  - 19.4 W/m² Lobby
  - 7.5 W/m² Transition/Corridor
  - 9.7 W/m² Stairs – Active
  - 11.8 W/m² Active Storage
  - 14.0 W/m² Mechanical/Electrical
  - 2.2 W/m² Parking

Lighting Controls

Occupancy sensors

None

Daylight dimming

None

[1] Assume 33% of area is Card File and Cataloging at 15.1 W/m², 33% of area is Stacks at 20.5 W/m² and 33% of area is Reading Area at 19.4 W/m²

Proposed Design

Lighting

- 7.85 W/m² Overall
  - 11.5 W/m² Laboratory
  - 10.8 W/m² Office - Open
  - 13.1 W/m² Office - Enclosed
  - 18.3 W/m² Library
  - 8.5 W/m² Cafeteria
  - 16.5 W/m² Board Room/Meeting
  - 19.3 W/m² Auditorium
  - 7.6 W/m² Lobby
  - 6.7 W/m² Transition/Corridor
  - 9.4 W/m² Stairs
  - 2.4 W/m² Storage
  - 2.4 W/m² Mechanical
  - 2.7 W/m² Parking

Lighting Controls

Occupancy sensors

Occupancy sensors in private offices, laboratories, board room, library, conference rooms and locker rooms (19% of total floor area) are assumed to save 30% during occupied hours[2]

Daylight dimming

Continuous daylight dimming controls in perimeter spaces and spaces with skylights (39% of total floor area), 18% minimum power fraction, 10% minimum light fraction. Visible transmittance (VT) of vertical fenestration is 50% and VT of skylights is 59% or between 1% and 47% for skylights with integrated shades (varies for closed and open shades).

[2] The contribution of occupancy sensors requires modification of lighting schedules in the energy model. As per ASHRAE 90.1-1999 Section 11 – The Energy Cost Budget Method, the effect of measures requiring schedule modifications is documented as a separate line item in the ECB Compliance Form.

HVAC Comparison of Budget Building (ASH99) versus Proposed Design (BaseC)

ASHRAE 90.1 Comparison: Systems				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
AHU-1 (Labs)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 0.89)	29,617 cfm	Air Flow Rate	23,543 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	79%	Outside Air Flow Rate	100%
	Supply Static Pressure	5.36”	Supply Static Pressure	5.47”
	Supply Efficiency[3]	78%	Supply Efficiency	79%
	Supply Fan Brake Power	0.80 W/cfm	Supply Fan Brake Power	0.82 W/cfm
	Return Static Pressure	3.22”	Return Static Pressure	3.22”
	Return Efficiency	79%	Return Efficiency	79%
	Return Fan Brake Power	0.48 W/cfm	Return Fan Brake Power	0.48 W/cfm
	No Heat Recovery (as per Section 6.3.6.1 (a): design has VAV fume hoods, which are also modeled in the LEED Baseline)		Heat Recovery Effectiveness	64%
AHU-2 (Labs)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 2.19)	25,873 cfm	Air Flow Rate	20,600 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	80%	Outside Air Flow Rate	100%
	Supply Static Pressure	5.48"	Supply Static Pressure	5.61"
	Supply Efficiency	77%	Supply Efficiency	77%
	Supply Fan Brake Power	0.84 W/cfm	Supply Fan Brake Power	0.86 W/cfm
	Return Static Pressure	3.12"	Return Static Pressure	3.12"
	Return Efficiency	77%	Return Efficiency	78%
	Return Fan Brake Power	0.48 W/cfm	Return Fan Brake Power	0.48 W/cfm
	No Heat Recovery (as per Section 6.3.6.1 (a): design has VAV fume hoods, which are also modeled in the LEED Baseline)		Heat Recovery Effectiveness	78%

[3] Efficiency refers to product of fan and motor efficiencies

ASHRAE 90.1 Comparison: Systems (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
AHU-3 (Offices)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 1.12)	10,594 cfm	Air Flow Rate	10,594 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	100%	Outside Air Flow Rate	100%
	Supply Static Pressure	4.37"	Supply Static Pressure	4.48"
	Supply Efficiency	76%	Supply Efficiency	77%
	Supply Fan Brake Power	0.68 W/cfm	Supply Fan Brake Power	0.69 W/cfm
	Return Static Pressure	2.10"	Return Static Pressure	2.10"
	Return Efficiency	74%	Return Efficiency	76%
	Return Fan Brake Power	0.33 W/cfm	Return Fan Brake Power	0.33 W/cfm
	Heat Recovery Effectiveness	50%	Heat Recovery Effectiveness	65%
AHU-4 (Auditorium)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 0.78)	7,583 cfm	Air Flow Rate	7,063 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	28%	Outside Air Flow Rate	30%
	Supply Static Pressure	4.24"	Supply Static Pressure	4.28"
	Supply Efficiency	70%	Supply Efficiency	70%
	Supply Fan Brake Power	0.72 W/cfm	Supply Fan Brake Power	0.72 W/cfm
	Return Static Pressure	3.08"	Return Static Pressure	3.08"
	Return Efficiency	62%	Return Efficiency	62%
	Return Fan Brake Power	0.58 W/cfm	Return Fan Brake Power	0.58 W/cfm
	Heat Recovery Effectiveness	50%	Heat Recovery Effectiveness	58%

ASHRAE 90.1 Comparison: Systems (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
AHU-5 (Cafeteria)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 1.27)	10,411 cfm	Air Flow Rate	9,417 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	27%	Outside Air Flow Rate	30%
	Supply Static Pressure	3.77"	Supply Static Pressure	3.82"
	Supply Efficiency	71%	Supply Efficiency	72%
	Supply Fan Brake Power	0.62 W/cfm	Supply Fan Brake Power	0.63 W/cfm
	Return Static Pressure	2.51"	Return Static Pressure	2.51"
	Return Efficiency	64%	Return Efficiency	64%
	Return Fan Brake Power	0.46 W/cfm	Return Fan Brake Power	0.46 W/cfm
	No heat recovery (Minimum Outside Air Supply = 30%)		Heat Recovery Effectiveness	61%
AHU-6 (Lobby)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 1.40)	2,096 cfm	Air Flow Rate	1,766 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	25%	Outside Air Flow Rate	30%
	Supply Static Pressure	3.72"	Supply Static Pressure	3.81"
	Supply Efficiency	46%	Supply Efficiency	46%
	Supply Fan Brake Power	0.95 W/cfm	Supply Fan Brake Power	0.97 W/cfm
	Return Static Pressure	2.40"	Return Static Pressure	2.40"
	Return Efficiency	54%	Return Efficiency	55%
	Return Fan Brake Power	0.52 W/cfm	Return Fan Brake Power	0.52 W/cfm
	No heat recovery (Minimum Outside Air Supply = 30%)	%	Heat Recovery Effectiveness	43%

ASHRAE 90.1 Comparison: Systems (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
AHU-7 (Board Room)	System 2: VAV with Reheat		VAV system with chilled water & reheat	
	Air Flow Rate (Sizing-Ratio = 2.16)	2,103 cfm	Air Flow Rate	1,413 cfm
	Minimum Air Flow	0.4 cfm/ft^2	Minimum Air Flow	0.3
	Outside Air Flow Rate	20%	Outside Air Flow Rate	30%
	Supply Static Pressure	4.10"	Supply Static Pressure	4.21"
	Supply Efficiency	52%	Supply Efficiency	53%
	Supply Fan Brake Power	0.93 W/cfm	Supply Fan Brake Power	0.96 W/cfm
	Return Static Pressure	2.15"	Return Static Pressure	2.15"
	Return Efficiency	54%	Return Efficiency	65%
	Return Fan Brake Power	0.47 W/cfm	Return Fan Brake Power	0.47 W/cfm
	No heat recovery (Minimum Outside Air Supply = 30%)		Heat Recovery Effectiveness	44%
Ventilation	Total fan power for exhaust fans (includes for general exhaust, parking and laboratory as designed) Note that the exhaust fan power was included in the Total Fan Power Limitation as per Section 11.4.3(i) and Table 6.3.3.1	7.17 kW	Total fan power for exhaust fans (includes for general exhaust, parking and laboratory as designed)	7.17 kW

ASHRAE 90.1 Comparison: Plant				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
Ground-source Heat Pumps	Cooling Capacity	140 kW	Cooling Capacity	140 kW
	EER	13.4	EER	18.7
	Heating Capacity	104 kW	Heating Capacity	104 kW
	COP	3.1	COP	4.1
	Geothermal Well Pumps:		Geothermal Well Pumps	
	Pump Head	200 kPa	Pump Head	200 kPa
	Impeller Efficiency	71%	Impeller Efficiency	71%
	Motor Efficiency	83%	Motor Efficiency	83%
	Pump Brake Power	21 W/gpm	Pump Brake Power	21 W/gpm

ASHRAE 90.1 Comparison: Plant (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999)		Proposed Design	
	Climate Zone B-14		Milan, Italy	
Service Hot Water Heaters	One electric hot water heater, no solar thermal system		One electric hot water heater, with connection to solar thermal system	
	Capacity	70 kW	Capacity	70 kW
Boilers	Two Gas-fired Boilers (S-R = 2.50)		Two Gas-fired Condensing Boilers	
	Heating capacity per boiler	5.04 MBtu	Heating capacity per boiler	2.89 MBtu (846kW)
	Thermal efficiency	80%	Thermal efficiency (100%)	93.7%
			Thermal efficiency (50%)	95.9%
Hot Water Pumps	As per Table 11.4.3A Footnote 6, pump system power for each pumping system shall be the same as the Proposed Design			
	Primary Pump Head	70 kPa	Primary Pump Head	70 kPa
	Impeller Efficiency	68%	Impeller Efficiency	68%
	Motor Efficiency	89.5%	Motor Efficiency	82.0%
	Primary Pump Brake Power	8 W/gpm	Primary Pump Brake Power	8 W/gpm
	Secondary Pump Head	187 kPa	Secondary Pump Head (average)	187 kPa
	Impeller Efficiency	72%	Impeller Efficiency (average)	72%
	Motor Efficiency	89.5%	Motor Efficiency (average)	86.5%
	Secondary Pump Brake Power	19 W/gpm	Secondary Pump Brake Power	19 W/gpm
	Supply Temperature	180°F	Supply Temperature	140°F (60°C)
	Return Temperature	130°F	Return Temperature	113°F (45°C)
	Temperature Drop	50°F	Temperature Drop	27°F (15°C)
	Variable Speed Controls		Variable Speed Controls	
	Minimum Flow Ratio	50%	Minimum Flow Ratio	30%
	Note: Hot Water Temperature Reset Controls not required as per ASHRAE 90.1-199 Section 6.3.4.3 Exception (b) that applies to systems with variable flow			

ASHRAE 90.1 Comparison: Plant (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
Chillers	Two Electric Centrifugal Chillers (S-R = 1.81)		Two Centrifugal Chillers, with high performance at part loads	
	Cooling Capacity	350 tons	Cooling Capacity	199 tons (700 kW)
	COP	6.1	COP at ARI conditions	6.0
			COP at operating conditions and 100% part load	5.8
			COP at operating conditions and 50% part load	9.8
Chilled Water Pumps	As per Table 11.4.3A Footnote 5, pump system power for each pumping system shall be the same as the Proposed Design			
	Pump Head	193 kPa	Pump Head (average)	193 kPa
	Impeller Efficiency	69%	Impeller Efficiency	69%
	Motor Efficiency	91.0%	Motor Efficiency	88.6%
	Pump Brake Power	20 W/gpm	Pump Brake Power	20 W/gpm
	Supply Temperature	44°F	Supply Temperature	44.6°F (7°C)
	Return Temperature	56°F	Return Temperature	53.6°F (12°C)
	Temperature Drop	12°F	Temperature Drop	9°F (5°C)
	Variable Speed Controls		Variable Speed Controls	
	Minimum Flow Ratio	50%	Minimum Flow Ratio	30%
	Note: Chilled Water Temperature Reset Controls not required as per ASHRAE 90.1-199 Section 6.3.4.3 Exception (b) that applies to systems with variable flow			
Cooling Tower	2 Axial-fan Towers (S-R = 1.98)		2 Centrifugal-fan Towers	
	Capacity	346 tons	Capacity	258 tons (908 kW)
	Efficiency (HP/gpm)	38.2	Efficiency (HP/gpm)	12.8
	Design Wetbulb Temperature	75°F	Design Wetbulb Temperature	77°F (25°C)
	Design Range	10°F	Design Range	9°F (5°C)
	Design Approach	10°F	Design Approach	9°F (5°C)
	Fixed setpoint control		Fixed setpoint control	
	Two-speed fan with low speed of 0.67 as per Section 6.3.5.2		Variable speed fan with minimum speed of 0.5	

ASHRAE 90.1 Comparison: Plant (cont.)				
Category	LEED Baseline (ASHRAE 90.1-1999) Climate Zone B-14		Proposed Design Milan, Italy	
Condenser Water Pumps	As per Table 11.4.3A Footnote 5, pump system power for each pumping system shall be the same as the Proposed Design			
	Primary Pump Head	120 kPa	Primary Pump Head	120 kPa
	Impeller Efficiency	80%	Impeller Efficiency	80%
	Motor Efficiency	89.5%	Motor Efficiency	90.3%
	Primary Pump Brake Power	10 W/gpm	Primary Pump Brake Power	10 W/gpm
	Secondary Pump Head	160 kPa	Secondary Pump Head (average)	160 kPa
	Impeller Efficiency	85%	Impeller Efficiency (average)	85%
	Motor Efficiency	89.5%	Motor Efficiency (average)	88.5%
	Secondary Pump Brake Power	13 W/gpm	Secondary Pump Brake Power	13 W/gpm
	Supply Temperature	85°F	Supply Temperature	86°F (30°C)
	Return Temperature	95°F	Return Temperature	95°F (35°C)
	Temperature Rise	10°F	Temperature Rise	9°F (5°C)
On-Site Energy Generation	None		Roof-mounted Photovoltaic System	
			Capacity	90.3 $kW_{DC,Peak}$
			Annual Electricity Generation	95,572 kWh_{AC}
			Roof-mounted Solar Thermal System	
			Annual Hot Water Generation (40°C)	79,252 gallons (300000 Liter)