



# Soluciones Energéticas Sostenibles

## Energy Simulation Results

### Rochester School



06/02/2013

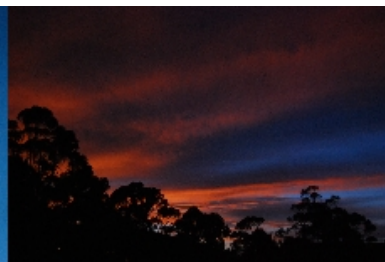
# INTRODUCTION

One of the aims within the scope of the Rochester School New Site Project is to get the LEED® for Schools v2009 certification. To achieve this goal is necessary to comply the prerequisite EAp2 and get as many points as possible on credit EAc1.

One of the alternatives that allow to accomplish the Prerequisite 2: Minimum Energy Performance and Credit 1: Optimize Energy Performance of the chapter Energy and Atmosphere within the LEED® certification process, consists in carrying on a computer based energy use simulation of two buildings, the baseline building design according to Appendix G of ANSI/ASHRAE/IESNA 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings (Performance Rating Method) and the proposed building design that incorporates technologies and alternatives, whose effect will be energy savings.

Finally it should be verified that the proposed design meet or exceed the saving goals required for the project certification.

This presentation shows the energy simulation results of the Rochester School New Site Project.

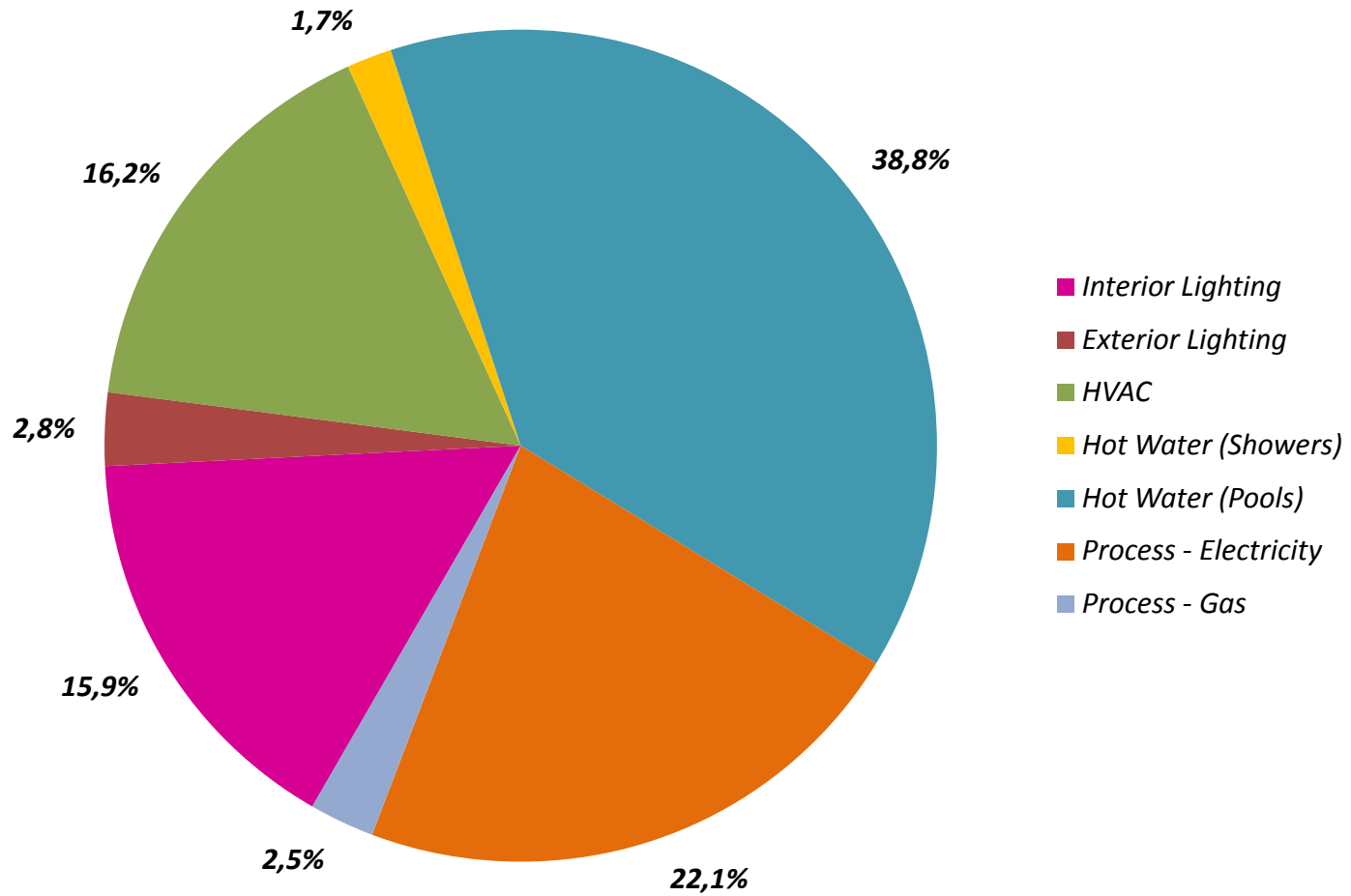


# BASELINE DESIGN

SYSTEM	Utility	BASELINE			
		kWh x 10 <sup>3</sup>	%	US\$	%
Interior Lighting	Electricity	322.3	15.5	56,773	15.9
Exterior Lighting	Electricity	57.6	2.8	10,140	2.8
HVAC	Electricity	327.9	15.7	57,765	16.2
Hot Water (Showers)	Electricity	35.4	1.7	6,244	1.7
Hot Water (Pools)	Electricity	787.5	37.8	138,736	38.8
Process - Electricity	Electricity	448.0	21.5	78,919	22.1
Process - Gas	Gas	103.7	5.0	9,024	2.5
<b>TOTAL</b>		<b>2,082.3</b>	<b>100.0</b>	<b>357,600</b>	<b>100.0</b>



# ENERGY COST DISTRIBUTION ACCORDING TO END USES

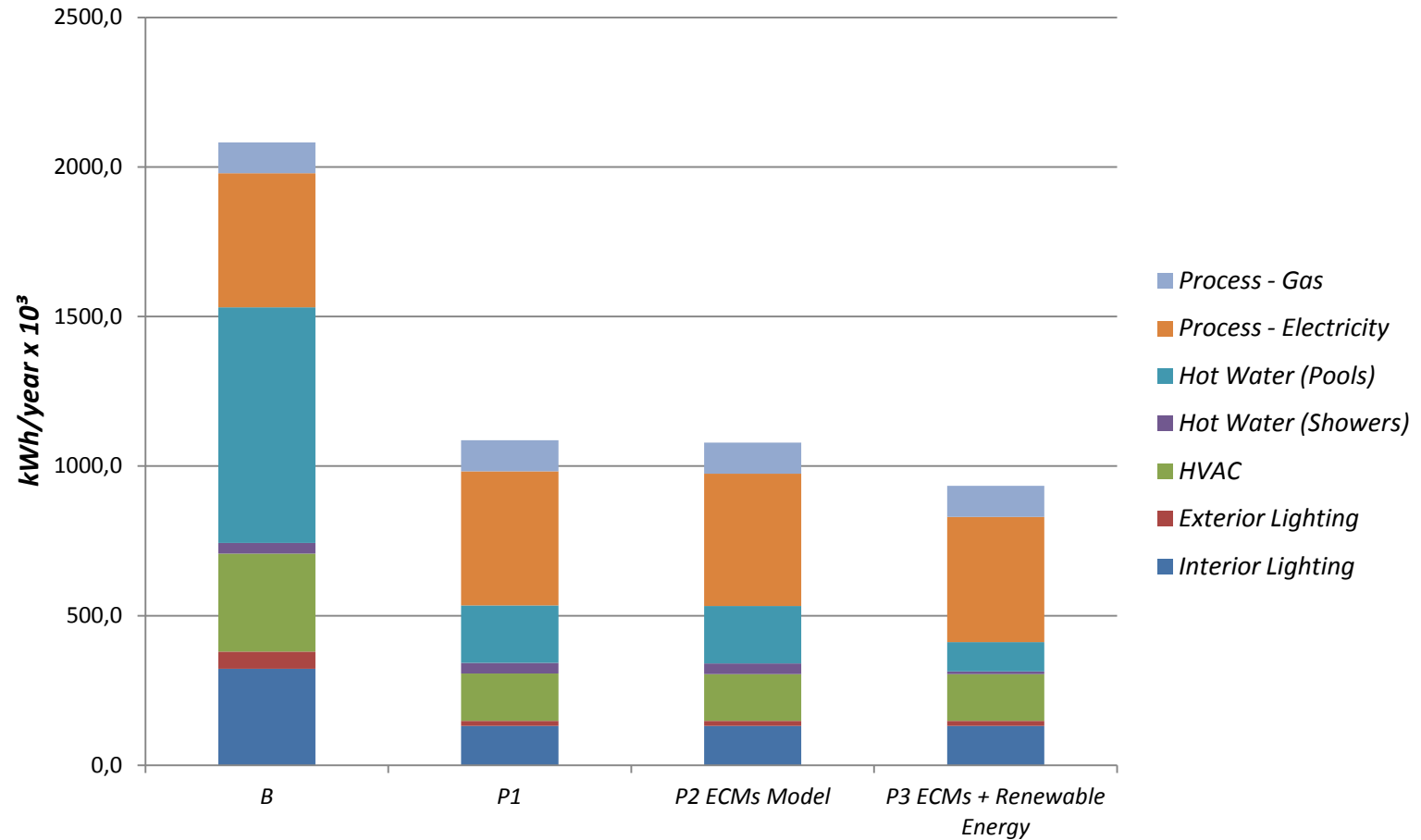


# BASELINE AND PROPOSED CASES

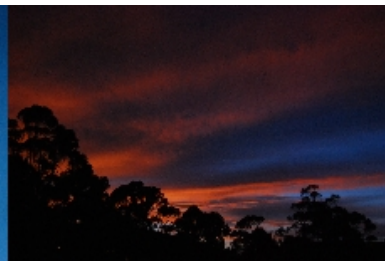
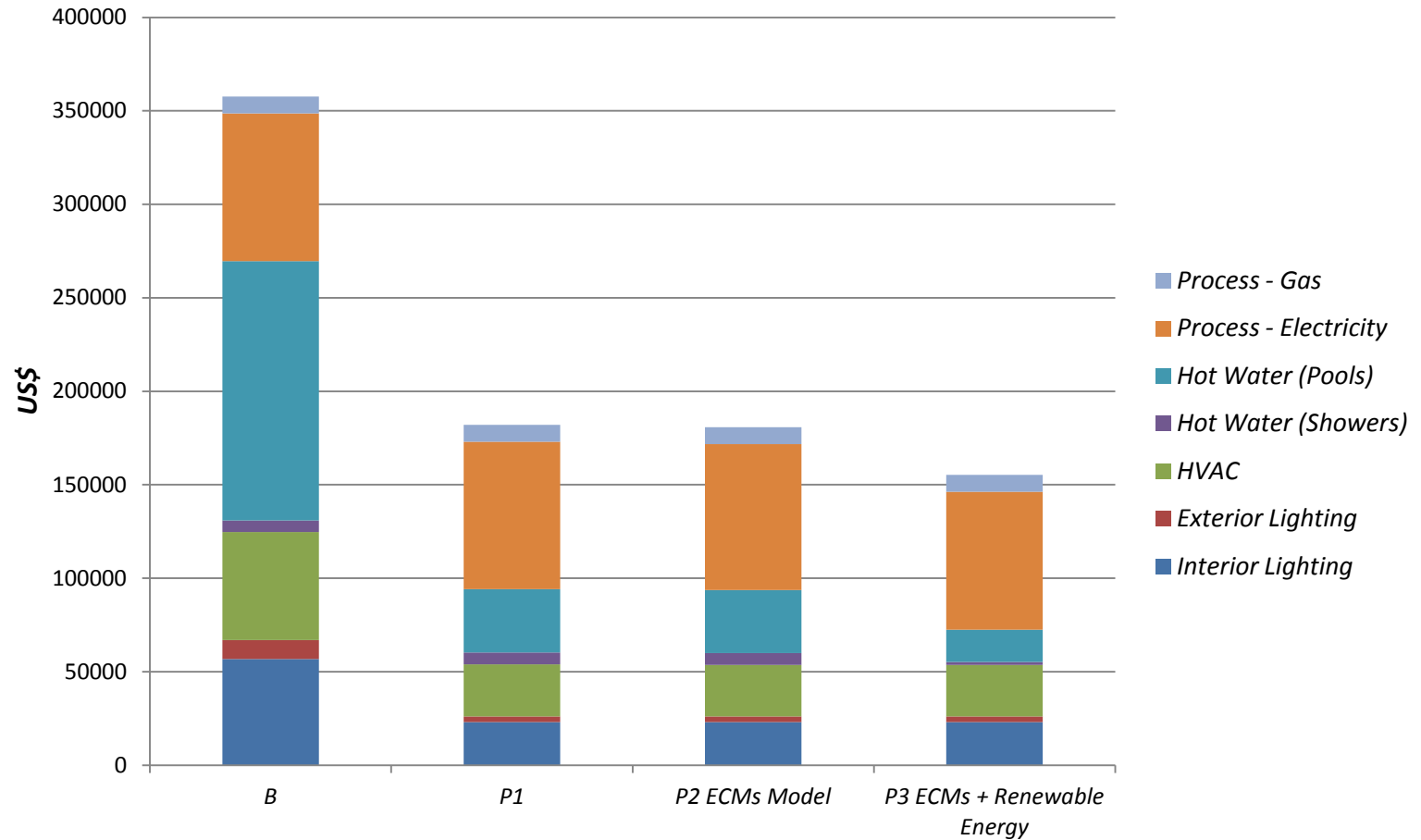
SYSTEM	Utility	B		P1		P2 ECMs Model		P3 ECMs + Renewable Energy	
		kWh x 10 <sup>3</sup>	US\$	kWh x 10 <sup>3</sup>	US\$	kWh x 10 <sup>3</sup>	US\$	kWh x 10 <sup>3</sup>	US\$
Interior Lighting	Electricity	322.3	56773	131.4	23153	131.4	23153	131.4	23153
Exterior Lighting	Electricity	57.6	10140	16.7	2935	16.7	2935	16.7	2935
HVAC	Electricity	327.9	57765	158.7	27956	156.5	27574	156.5	27574
Hot Water (Showers)	Electricity	35.4	6244	35.4	6244	35.4	6244	8.8	1552
Hot Water (Pools)	Electricity	787.5	138736	192.1	33838	192.1	33838	98.4	17341
Process - Electricity	Electricity	448.0	78919	448.0	78919	442.7	77988	418.4	73706
Process - Gas	Gas	103.7	9024	103.7	9024	103.7	9024	103.7	9024
<b>TOTAL</b>		<b>2,082.3</b>	<b>357,600</b>	<b>1,085.9</b>	<b>182,068</b>	<b>1,078.5</b>	<b>180,756</b>	<b>933.9</b>	<b>155,285</b>
SAVINGS	kWh x 10 <sup>3</sup>	-	-	996.3	175,532	1,003.8	176,844	1,148.4	202,315
	%	-	-	47.8	49.1	48.2	49.5	55.1	56.6



# ENERGY CONSUMPTION FOR THE DIFFERENT ALTERNATIVES (kWh/year x 10<sup>3</sup>)

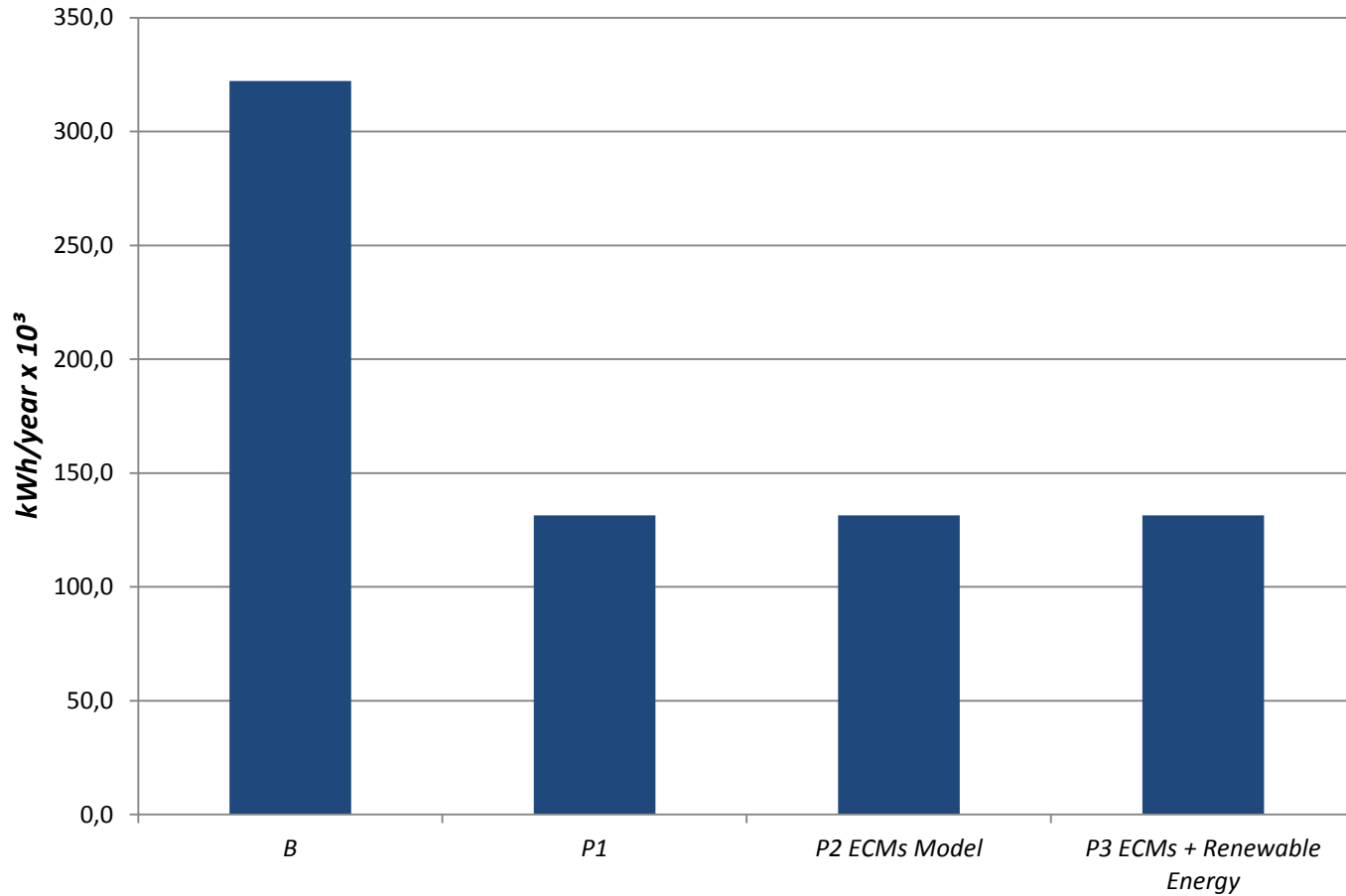


# ENERGY COST FOR THE DIFFERENT ALTERNATIVES (US\$)



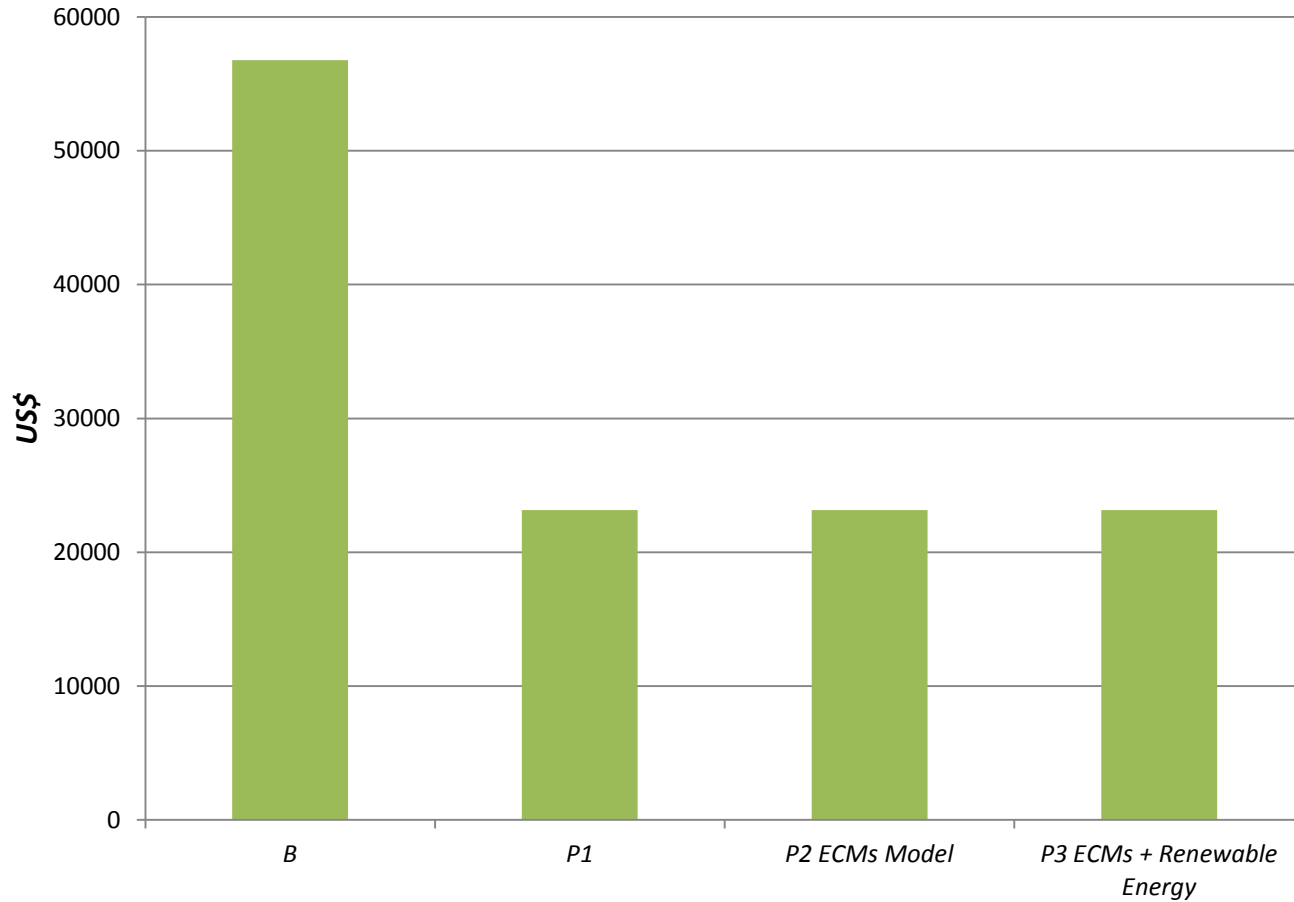
# INTERIOR LIGHTING

(kWh/year x 10<sup>3</sup>)





# INTERIOR LIGHTING (US\$)



# INTERIOR LIGHTING

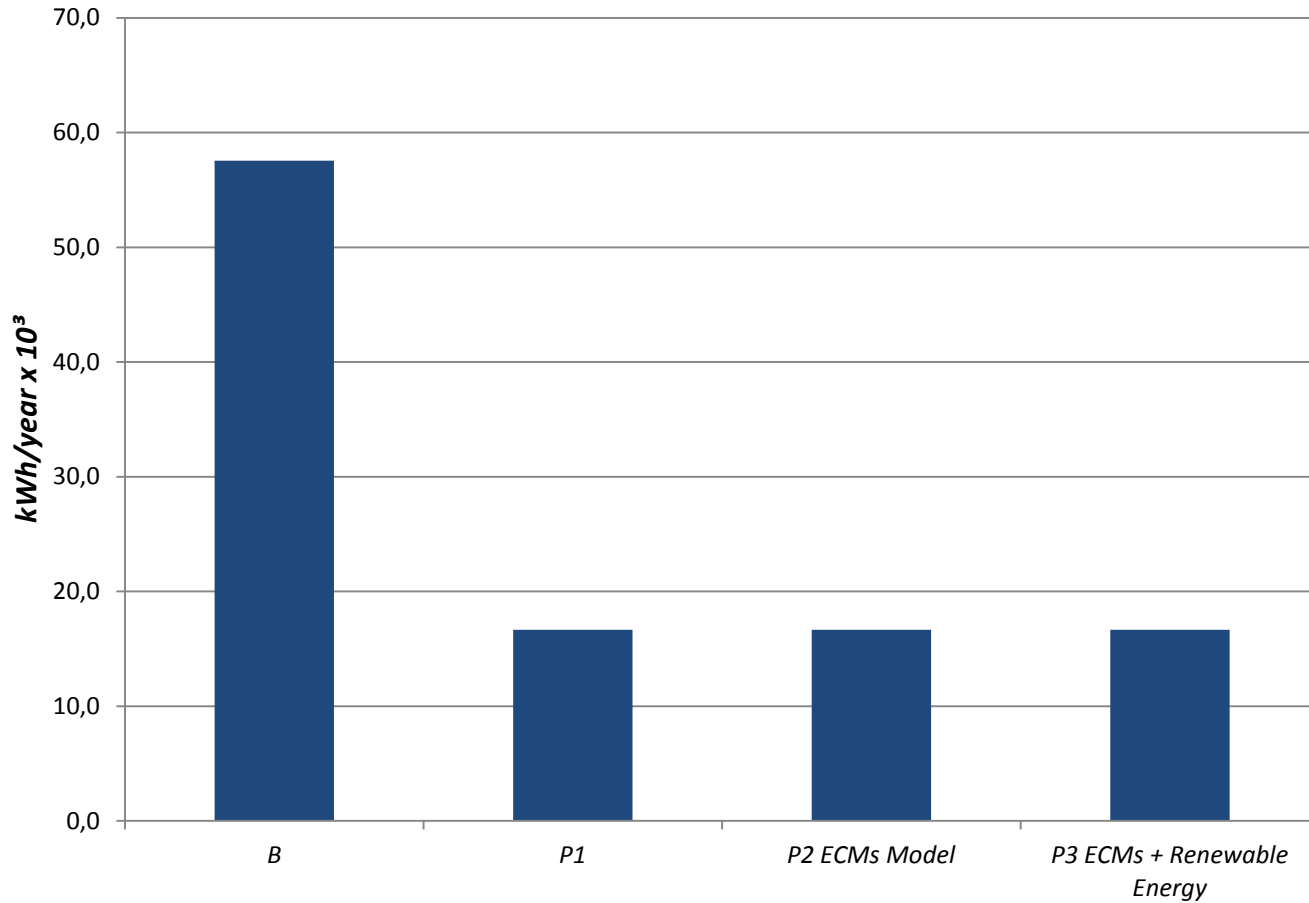
The energy conservation measures in the interior lighting system are:

- ✓ Lower interior lighting power installed in the proposed case (see table below)
- ✓ Lighting control by occupancy sensors and daylighting harvesting
- ✓ LED and fluorescent lamps

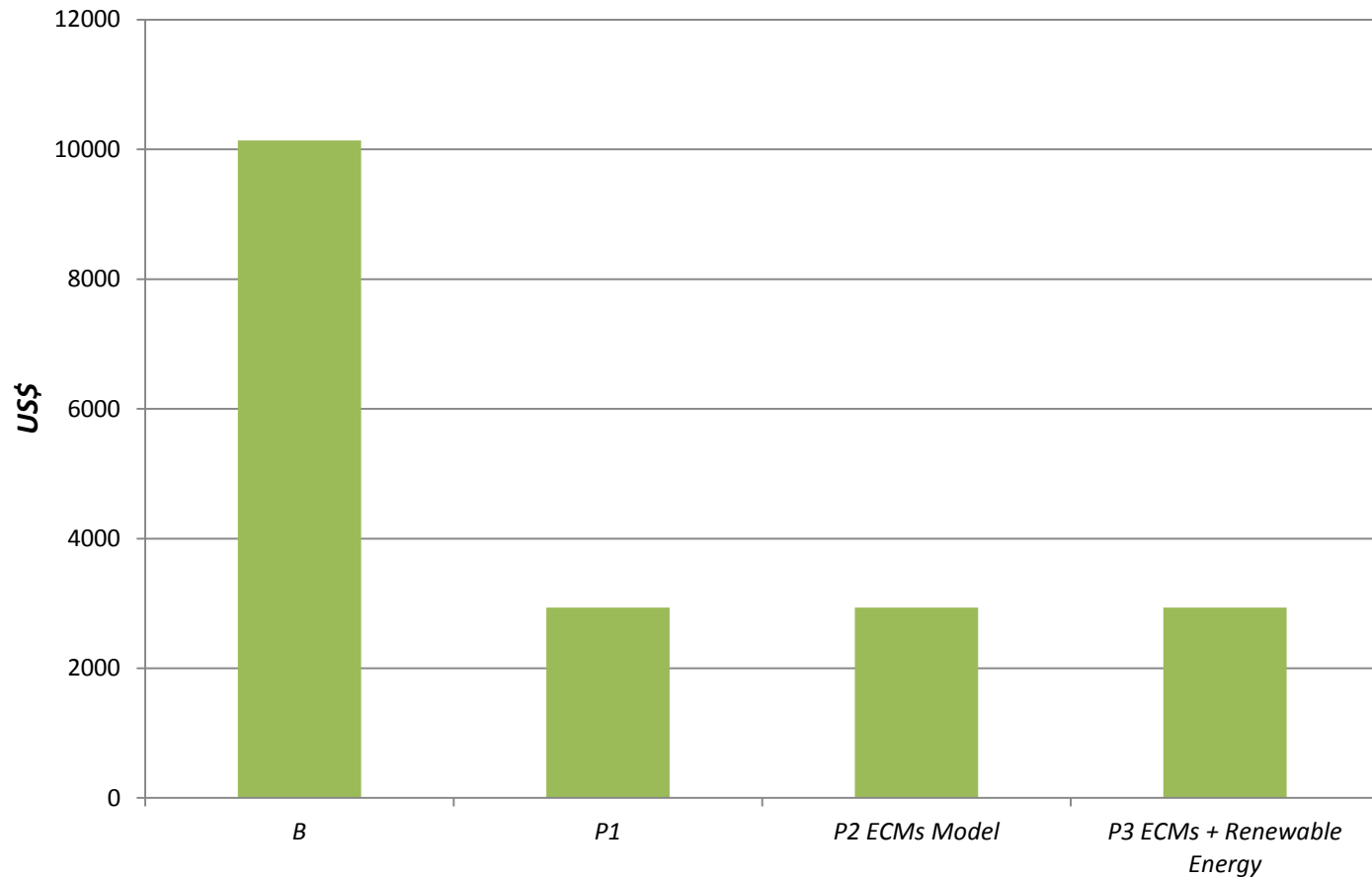
<b>BUILDING</b>	<b>LPD Average [W/ft<sup>2</sup>]</b>		
	<b>Baseline</b>	<b>Proposed</b>	<b>Proposed with control</b>
<i>H1 &amp; H2</i>	1.06	0.65	0.60
<i>H3</i>	1.12	0.58	0.54
<i>H4 &amp; H5</i>	1.11	0.57	0.53
<i>Audeteria</i>	0.87	0.48	0.45
<i>Aquatic Centre</i>	0.65	0.44	0.41



# EXTERIOR LIGHTING (kWh/año x 10<sup>3</sup>)



# EXTERIOR LIGHTING (US\$)



# EXTERIOR LIGHTING

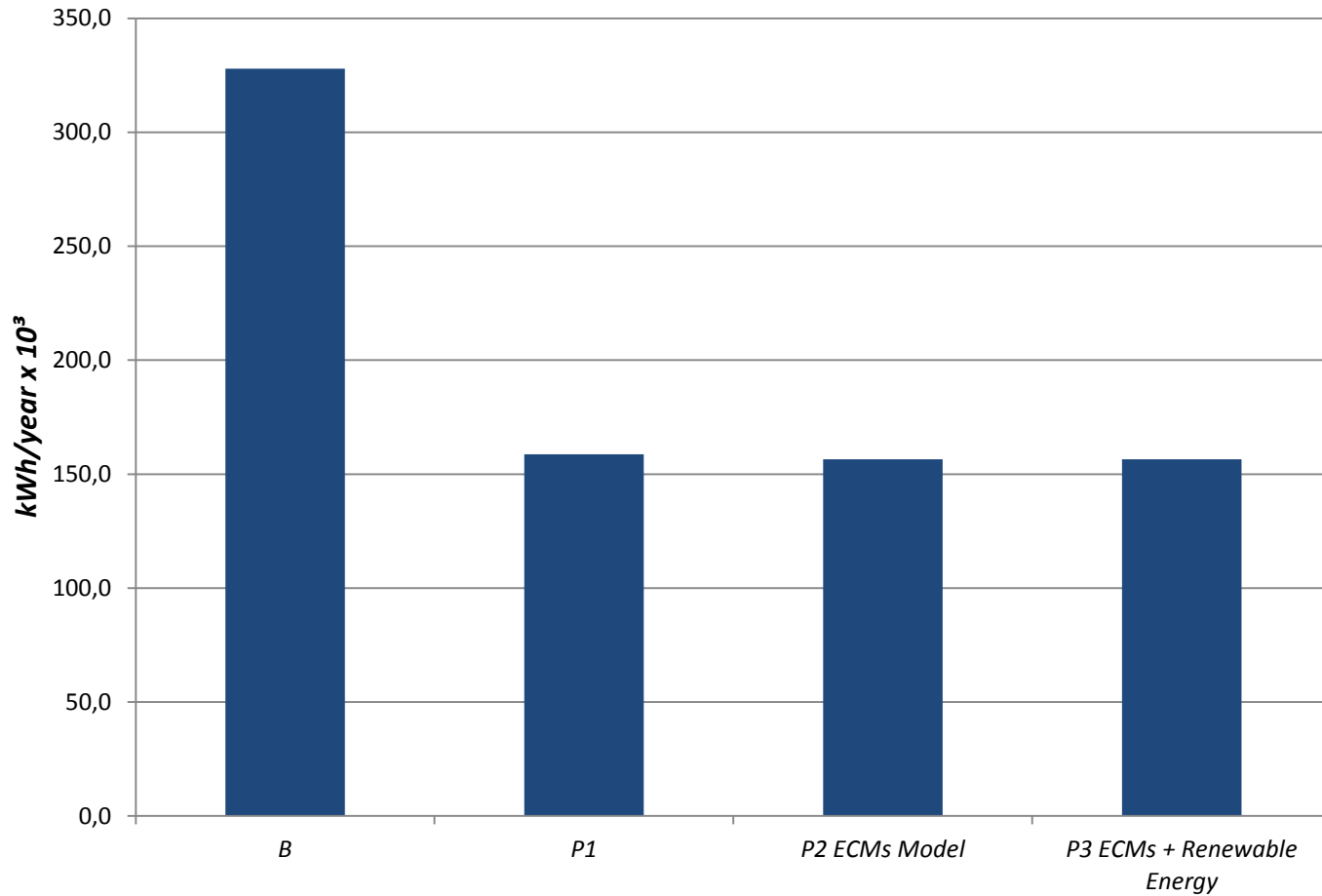
The energy conservation measures implemented in the exterior lighting system are:

- ✓ Lower exterior lighting power installed in the proposed case (see table below)
- ✓ LED and fluorescent lamps

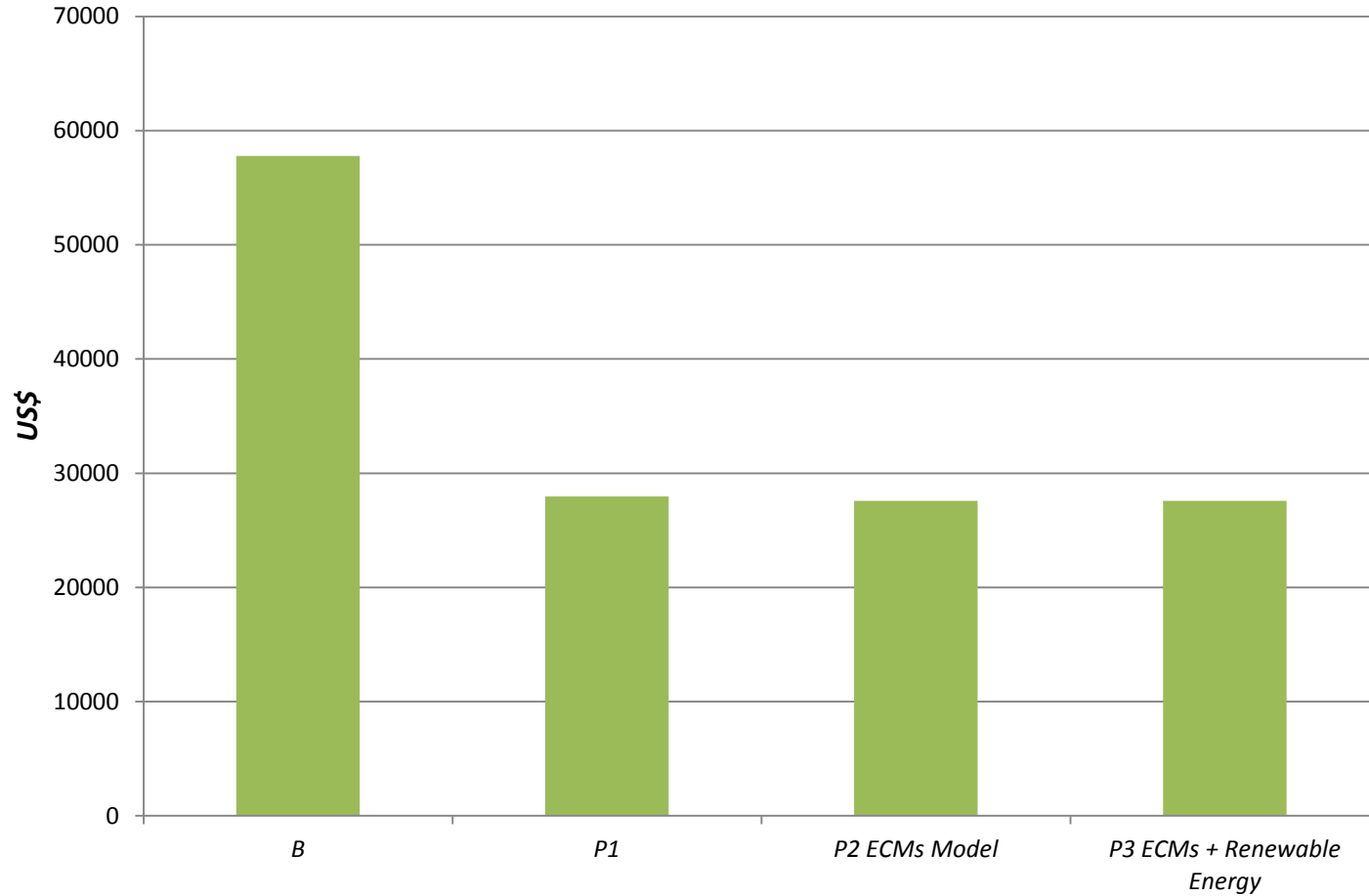
<i>Power Installed [W]</i>	
<i>Baseline</i>	<i>Proposed</i>
13,140	3,803



# HVAC (kWh/year x 10<sup>3</sup>)



# HVAC (US\$)



# HVAC

The energy conservation measures implemented in the HVAC system are:

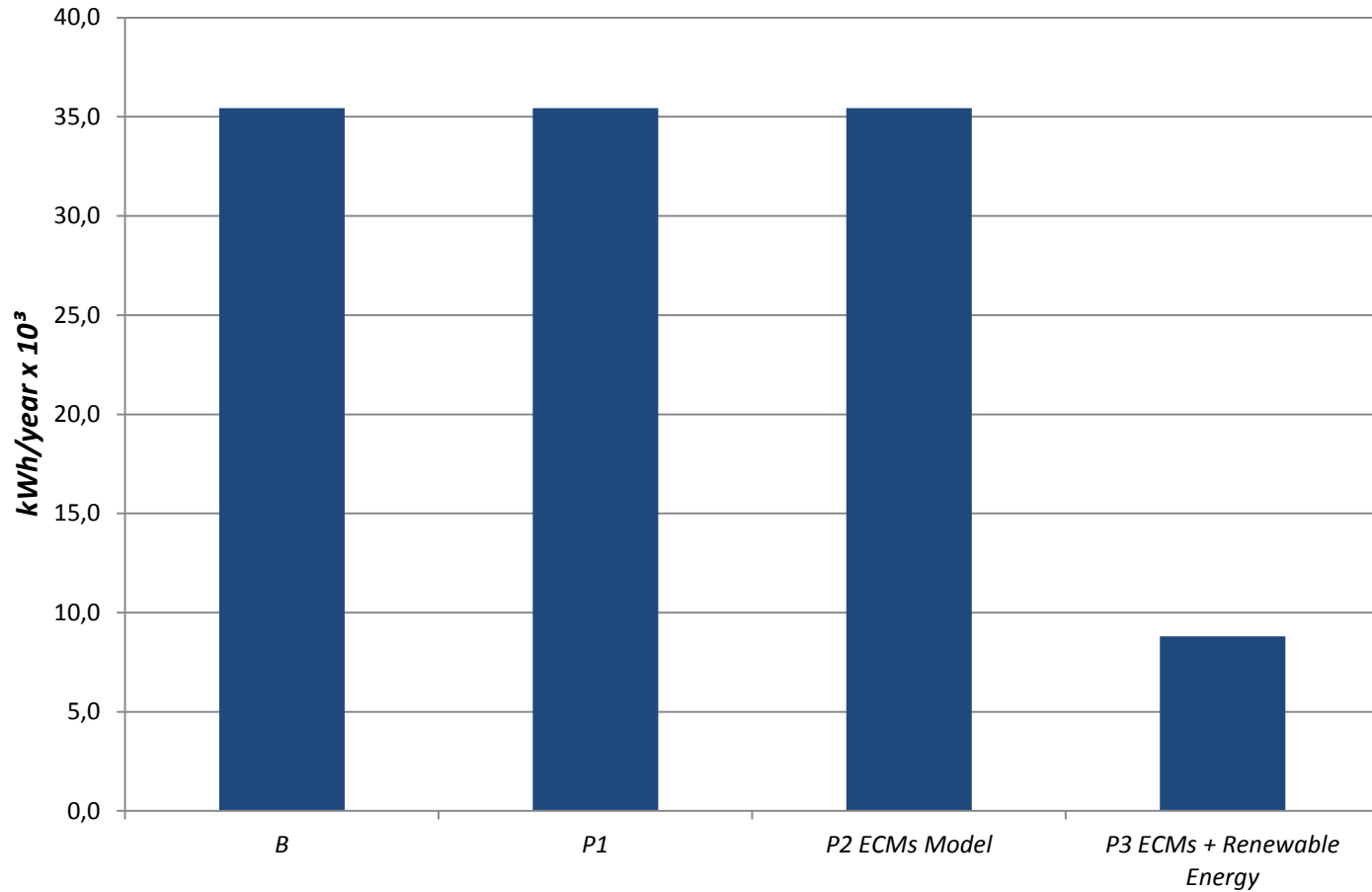
- ✓ Natural ventilation in Aquatic Centre
- ✓ Mechanical ventilation in conditioned spaces (100% outside air), controlled by thermostat in offices, and controlled by thermostat and CO<sub>2</sub> sensor in classrooms
- ✓ Demand control ventilation in classrooms



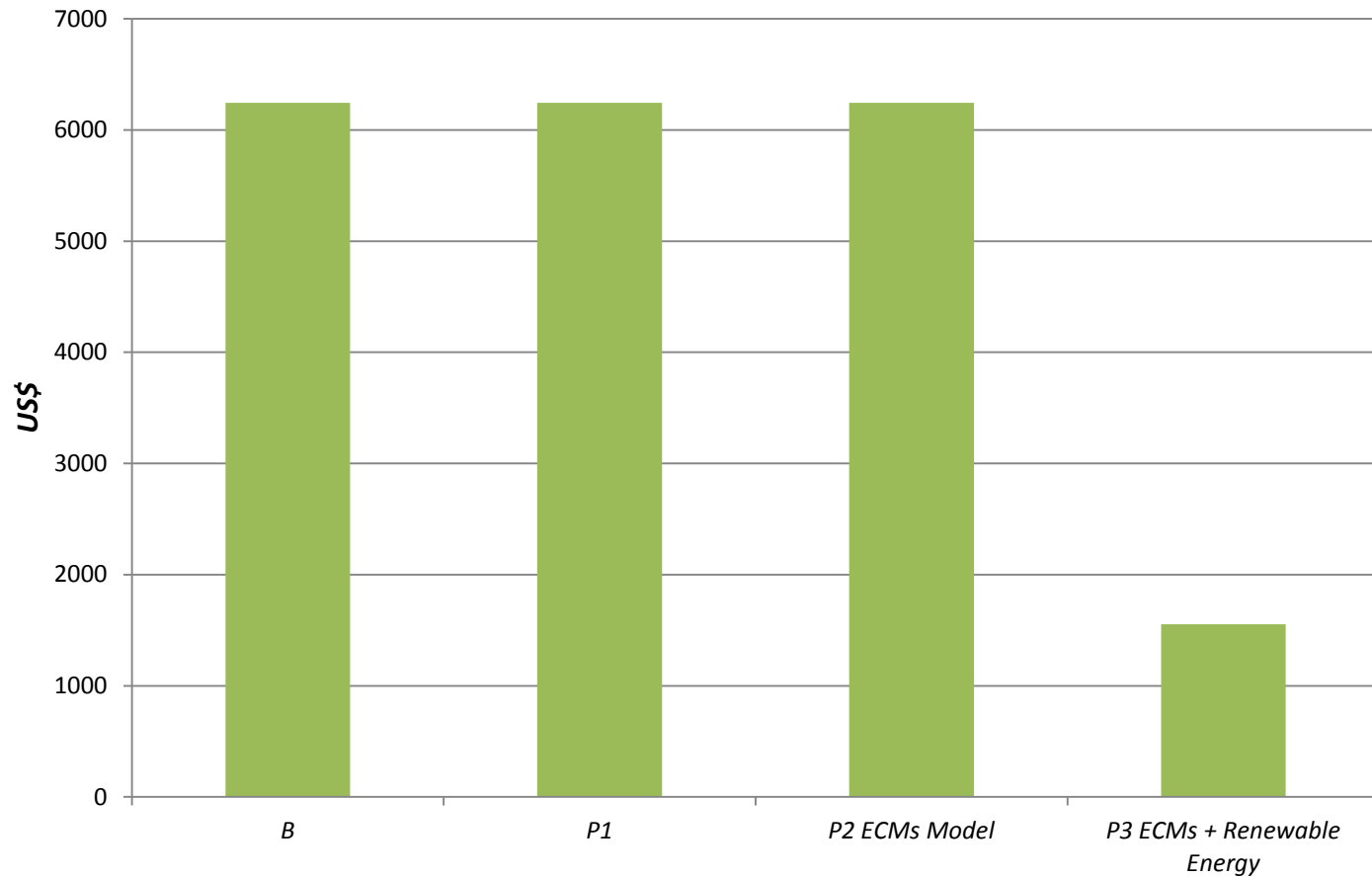


# HOT WATER (SHOWERS)

(kWh/year x 10<sup>3</sup>)



# HOT WATER (SHOWERS) (US\$)



# HOT WATER (SHOWERS)

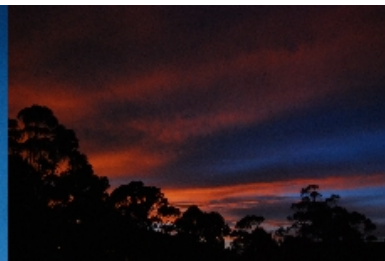
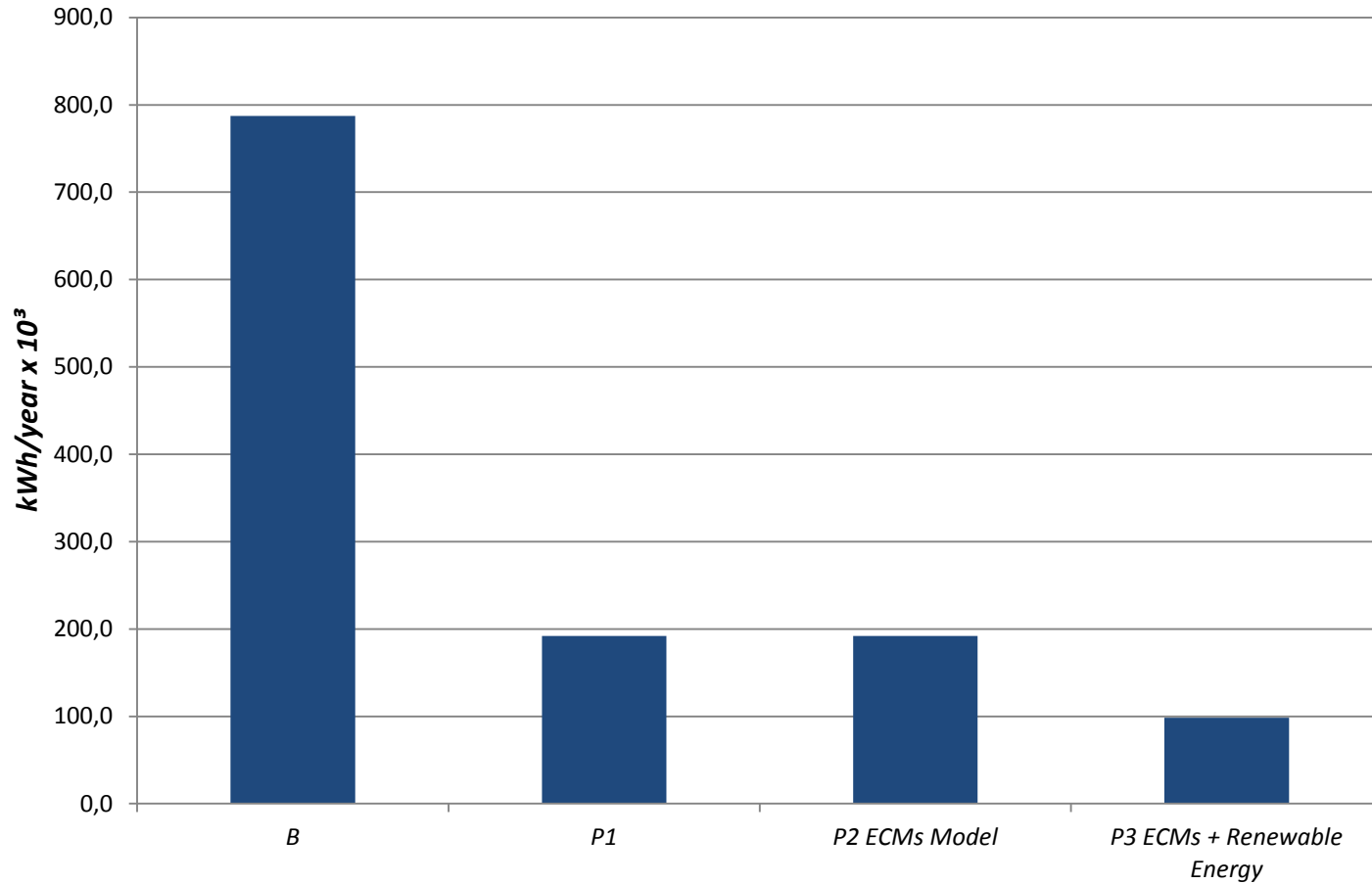
The energy conservation measure implemented for water heating (showers) system is:

✓ Audeteria, Aquatic Centre Hubs 1 & 2 have a service hot water system. All the energy needed for water heating of Aquatic Centre and Audeteria showers is supplied by solar collectors.

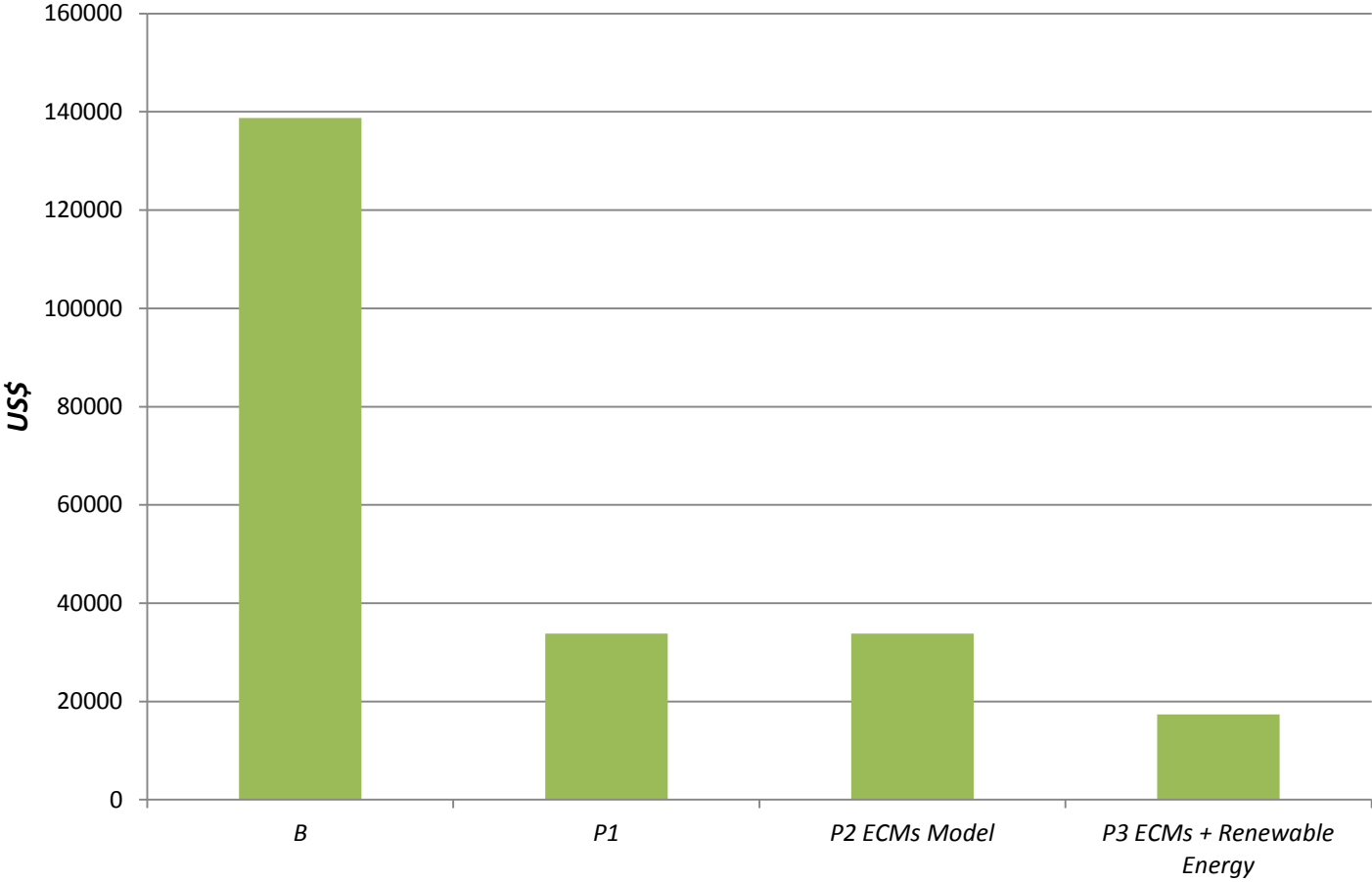


# HOT WATER (POOLS)

(kWh/year x 10<sup>3</sup>)



# HOT WATER (POOLS) (US\$)



# HOT WATER (POOLS)

The energy conservation measures implemented for water heating (pools) system are:

- ✓ 48.8% of the energy needed for water heating of Aquatic Centre pools is supplied by solar collectors.
- ✓ The remaining 51.2% of the energy is supplied by 4 heat pumps with a coefficient of performance of 4.1.

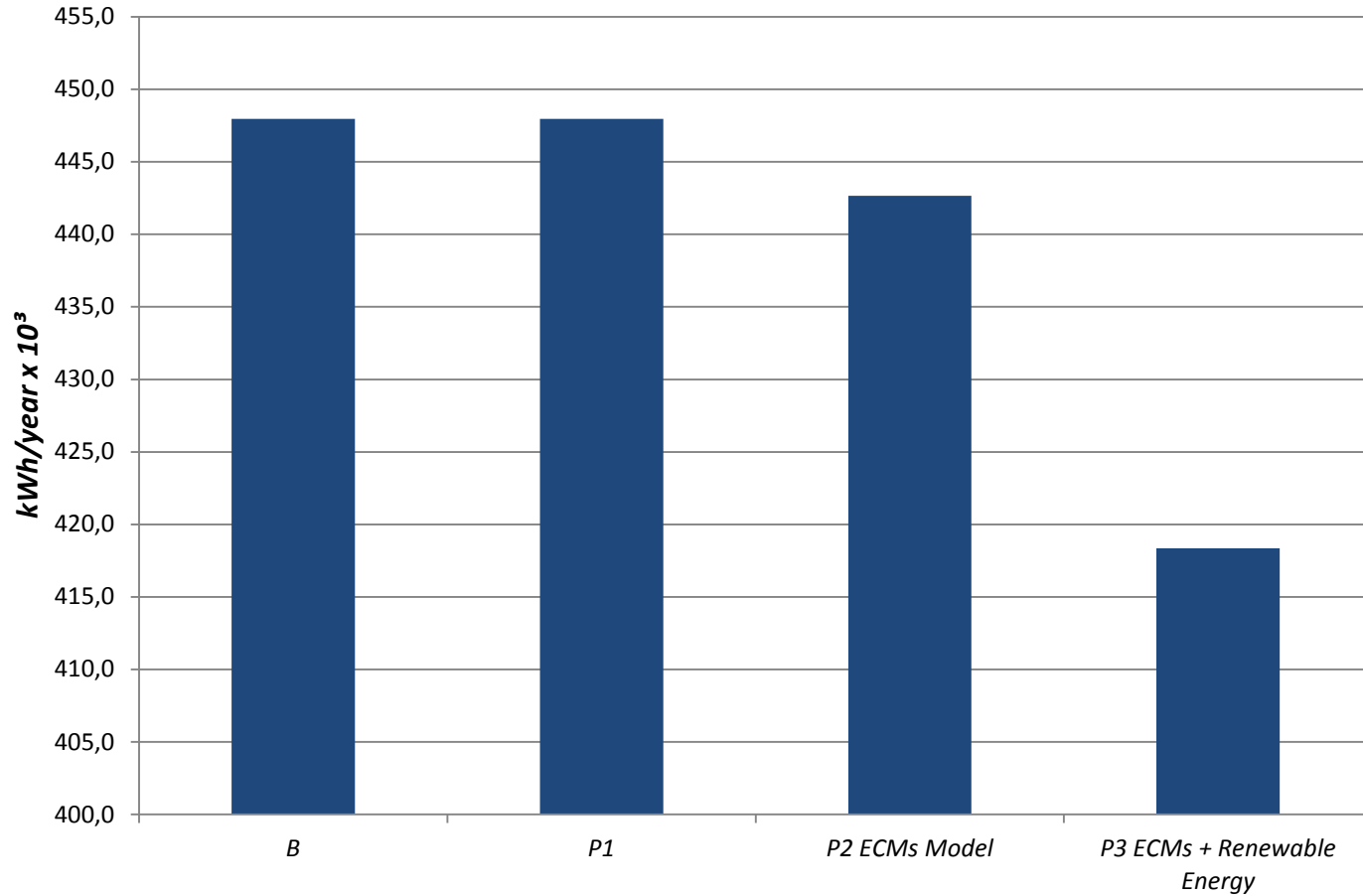
## MODELING METHODOLOGY

- ✓ If these two systems (solar collectors and heat pumps) are not enough two heat up, two gas heaters were installed.
- ✓ The back-up energy for the baseline case was simulated using electricity according to Table G3.1.11b. “... Where the energy source is electricity, the heating method shall be electrical resistance.” And because the two gas heaters represent 2.7% of the installed power for water heating.

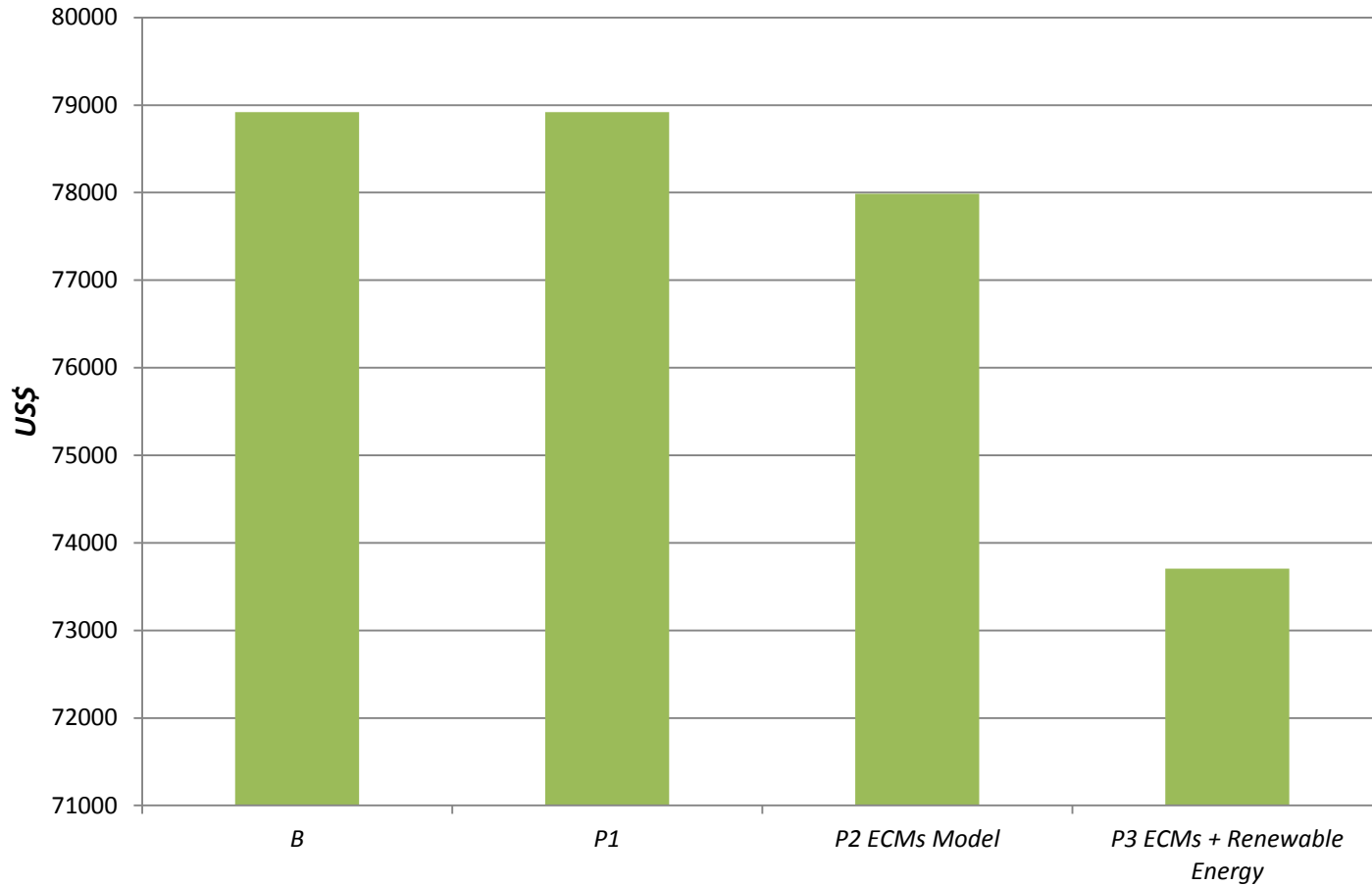


# PROCESS LOADS – ELECTRICITY

(kWh/year x 10<sup>3</sup>)



# PROCESS LOADS – ELECTRICITY (US\$)





# PROCESS LOADS – ELECTRICITY

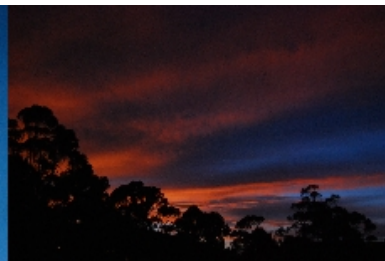
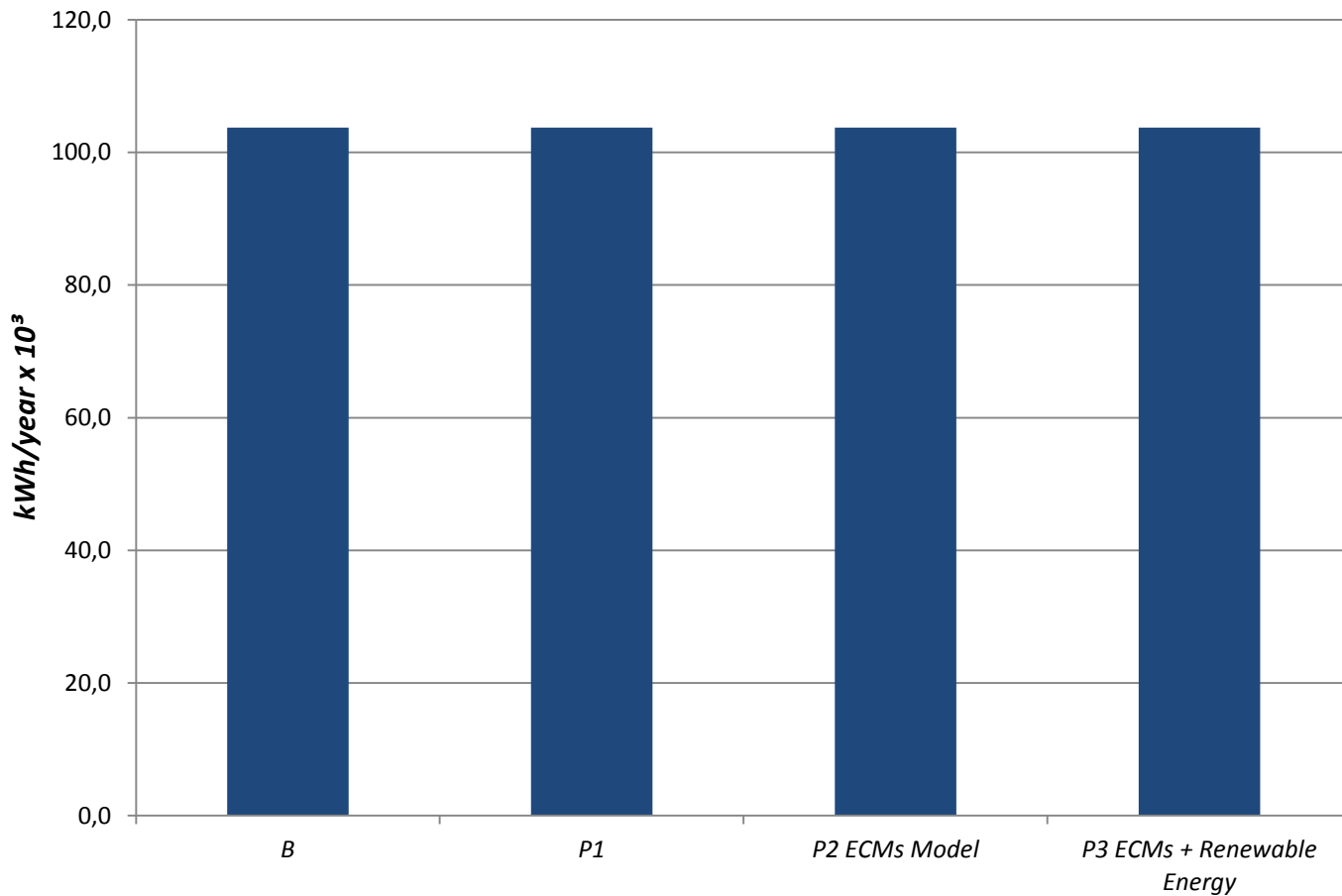
The energy conservation measures in the process loads - electricity system are:

- ✓ Lifts equipped with energy regeneration system.
- ✓ The photovoltaic panels of the project generate 24,305 kWh per year (2.25% of the total consumption of the project). This energy was assigned as savings in the process loads within the presentation. The savings by renewable energy are included in Section 1.8 On-site renewable energy of the LEED Online EAp2 Form.

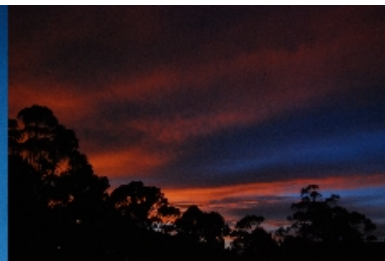
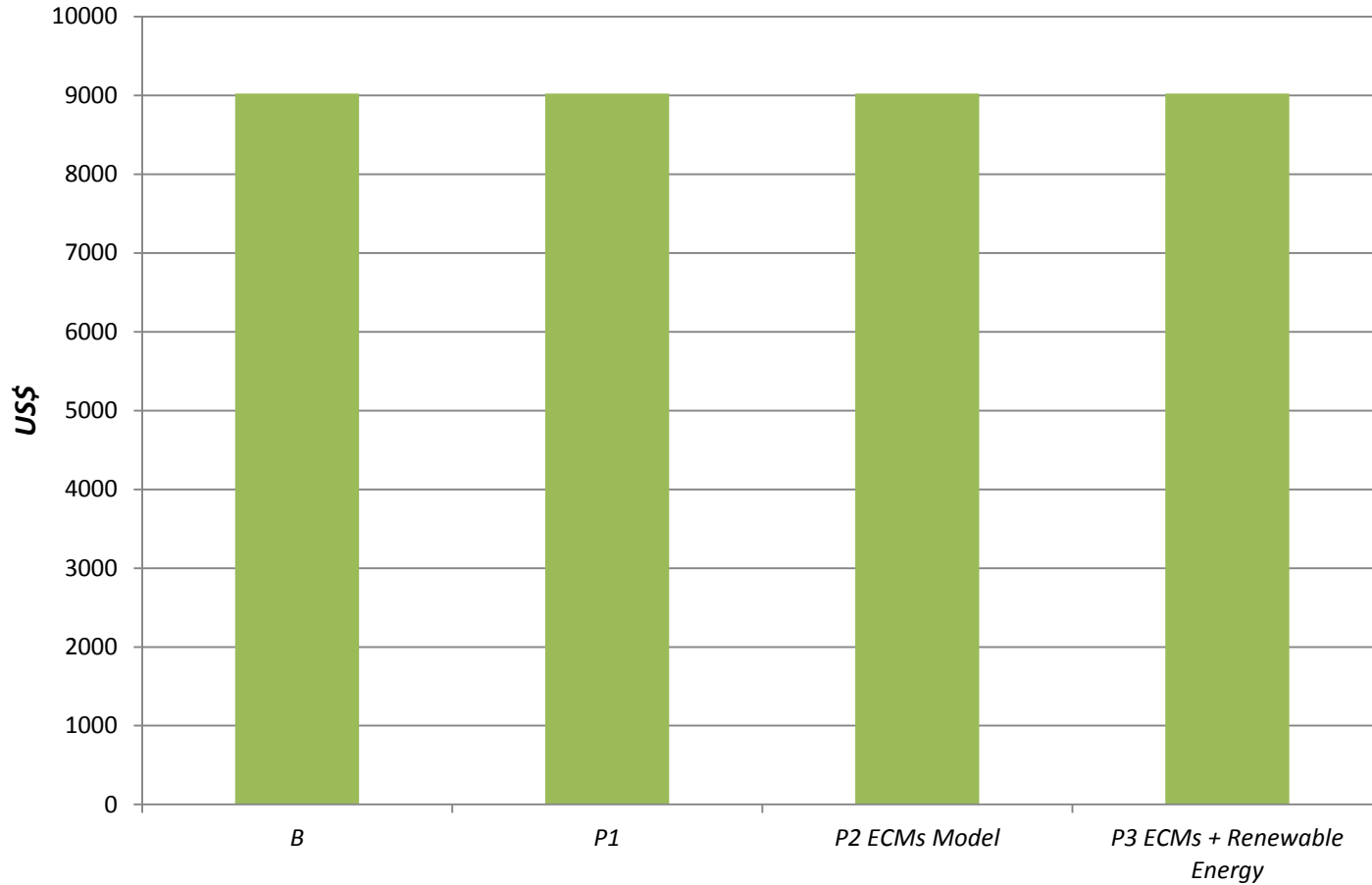


# PROCESS LOADS – GAS

(kWh/year x 10<sup>3</sup>)



# PROCESS LOADS – GAS (US\$)



# PROCESS LOADS – GAS

No saving measures were implemented in process loads – gas. All the alternatives have the same consumption of energy and the same cost.



# ENERGY CONSERVATION MEASURES SUMMARY

- ✓ Sun protection in building facades
- ✓ Lower installed interior and exterior lighting power
- ✓ Interior lighting control by occupancy sensors and daylighting harvesting
- ✓ Mechanical ventilation in conditioned spaces. Demand control ventilation in classrooms
- ✓ Natural ventilation in Aquatic Centre
- ✓ Lifts equipped with energy regeneration system
- ✓ All the energy needed for water heating of Aquatic Centre and Audeteria showers is supplied by solar collectors
- ✓ 48.8% of the energy needed for water heating of Aquatic Centre pools is supplied by solar collectors and the remaining 51.2% by heat pumps with a coefficient of performance of 4.1
- ✓ 24.305 kWh/year of electric energy generated by photovoltaic panels



# CONCLUSIONS

- ✓ The results presented are due to the sum of the five simulations performed in TRACE 700: Hubs 1 + 2, Hub 3, Hub 4 + 5, Audeteria and Aquatic Centre + Management + Lodge.
- ✓ The energy conservation measures implemented lead the Rochester School project to 55.1% of savings in energy terms and 56.6% in cost terms, compared to energy efficiency building defined in ASHRAE Standard 90.1-2007.
- ✓ Two exceptional calculation measures will be presented, concerning to natural ventilation in Aquatic Centre and the energy regenerative process of the project lifts; which will be accepted or rejected by a GBCI (*Green Building Certification Institute*) reviewer.

