

Science Center of Sinaloa

**“Amount of Electric Energy Savings By
Using Mega Park’s Panels.”**

Energy Saving Program Technical Report

Culiacan, Rosales, Sinaloa. Nov 2003.

Mr. Engineer Alberto Coppel
MegaPark General Manager
P R E S E N T

Engineer:

By this mean, i give you the results on the project called: Amount of Electric Energy Saving By Using MegaPark Panels, as well as an Executive Resume, Technical Report, Methodology, and the results obtained.

In this study different building materials were analyzed, and they were compared against those building materials used by Mega Park. A same room model was used for all materials.

Model	Wall	Roof	Heat Gain
A	Brick	Concrete	12,204 W
B	Brick	Bovedilla	10,889 W
C	Block	Concrete	9,140 W
D	Block	Bovedilla	7,825 W
MegaPark	MegaPark (R11)	MegaPark (R19)	1,404 W

*Considering an External Temperature of 100°F, and an Internal Temperature of 72°F.

Model	Wall	Roof	Refrigeration Tons
A	Brick	Concrete	3.47
B	Brick	Bovedilla	3.1
C	Block	Concrete	2.6
D	Block	Bovedilla	2.2
MegaPark	MegaPark (R11)	MegaPark (R19)	0.4

Model	Wall	Roof	Electric Consumption
A	Brick	Concrete	1,500 KWh
B	Brick	Bovedilla	1,340 KWh
C	Block	Concrete	1,123 KWh
D	Block	Bovedilla	950 KWh
MegaPark	MegaPark (R11)	MegaPark (R19)	173 KWh

*Considering a temporary space of 12 hours.

Model	Wall	Roof	Energy Cost
A	Brick	Concrete	\$2,700 pesos a Month (\$255.56 USD)
B	Brick	Bovedilla	\$2,412 pesos a Month (\$228.30 USD)
C	Block	Concrete	\$2,022 pesos a Month (\$191.38 USD)
D	Block	Bovedilla	\$1,711 pesos a Month (\$161.95 USD)
MegaPark	MegaPark (R11)	MegaPark (R19)	\$311 pesos a Month (\$29.44 USD)

*Considering a rate without subsidy of \$0.17 USD per KWh in summer rate.

Best Regards,
Culiacan, Rosales, Sinaloa November 28th, 2003
"A Window to Energetic Culture"

MC Mario Alberto Siordia Grave
Responsible of The Energy Saving Program

Technical Report

Target: To account the electric power saved by using Megapark Panels in respect to houses that use block or brick as walls and concrete and bovedilla as ceiling.

Methodology

In every case, the same dimensions of the house are being considered

Volume of the home: $8\text{m} \times 8\text{m} \times 6\text{m} = 384\text{m}^3$

Temperatures.

A comfort temperature of 22°C indoors has been considered (TINT)

An outdoors temperature of 38°C has been considered (TEXT)

Home Location

The outside walls were located by the south, east and west have the same weather characteristics, therefore, they have accumulated the same amounts of heat.

For the wall located by the north, which is generally by the shades, a temperature decrease of 5°C was considered in respect to the TEXT.

Wind speed

An average wind speed of $v=2.3$ m/s for the outdoors wind, and a quiet drift indoors, was considered for the determination of the coefficients of convection among the air and the building surfaces.

Convection Coefficient for the exterior surface (h_o)

$$h_o = 5.8 + 4.1 v$$

$$h_o = 5.8 + 4.1 v = 5.8 + 4.1 (2.3) = 15.2 \text{ W/m}^2 \text{ }^\circ\text{C}$$

Convection Coefficient for the Interior Surface (h_i)

$$h_i = 9.36 \text{ W/m}^2 \text{ }^\circ\text{C}$$

4.- General Equation for Heat Gain (Q)

$$Q = U \cdot A \cdot \Delta T$$

Where:

Q = Heat Gain (W)

U = Total Heat Transfer Coefficient (W/m²°C)

A = Heat Transfer Area (m²)

ΔT = Temperature Difference

ΔT = T_{EXT} - T_{INT}

5.-Obtention of U.

The coefficient of heat transfer (conductiveness) will be equal to the opposite of the Total Heat Resistance (R):

$$U = 1 / R$$

For elements built for various materials, the sum of the individual resistances of each material should be made.

$$R = R_1 + R_2 + \dots + R_n$$

Each resistance (R_i) will be equal to the material's thickness and to the material conductivity.

$$R_i = X_i (m) / K_i (W/m^2°C)$$

Calculating only U in function of the heat transference for conduction and convection.

$$U = 1 / R$$

Where R:

$$R = 1/h_i + X_1 / K_1 + X_2 / K_2 + X_3 / K_3 + 1/h_o$$

6.- Total Heat Gain of the House (QTOTAL)

This will be the sum of the heat gained for each of the four walls, plus the heat gained by the roof.

$$Q_{TOTAL} = Q_i = Q_1 + Q_2 + Q_3 + Q_4 + Q_5$$

Obtention of Results

Case C: Block-Concrete
Calculation of the heat gains of the walls.

Area of each wall; $A=8m \times 6m = 48m^2$

Materiales of the walls: enjarre (mortero), Block and Plaster.

Properties of the Wall's Materials

Material	X_i (m)	K_i (W/m°C)
Cement-Sand	0.01	0.63
Block (mild concrete)	0.14	0.51
Plaster	0.01	0.46

$$h_o = 15.2 \text{ W/m}^2 \text{ } ^\circ\text{C}.$$

$$h_i = 9.36 \text{ W/m}^2 \text{ } ^\circ\text{C}$$

Substituting Values in R:

$$R = 1/h_i + X_1 / K_1 + X_2/K_2 + X_3/K_3 + 1/ h_o$$

$$R = 0.4846 \text{ (m}^2 \text{ } ^\circ\text{C /W)}$$

$$U = 1 / R = 1 / 0.4846 \text{ (m}^2 \text{ } ^\circ\text{C /W)} = 2.063 \text{ (W/ m}^2 \text{ } ^\circ\text{C)}$$

Calculating the heat gain for the south wall (Q1)

$$Q1 = U A \Delta T = 2.063 \text{ (W/ m}^2 \text{ }^\circ\text{C)} \cdot 48 \text{ m}^2 \cdot (38^\circ\text{C} - 22^\circ\text{C})$$

$$Q1 = 1584.384 \text{ W}$$

$$Q1 = Q2 = Q3 ; \text{ South, East and West Walls}$$

Calculating the heat gain for the North Wall (the one that has more shadow)

$$Q4 = 2.063 \text{ (W/ m}^2 \text{ }^\circ\text{C)} \cdot 48 \text{ m}^2 \cdot (33^\circ\text{C} - 22^\circ\text{C}) = 1089.264 \text{ W}$$

Calculating the heat gain for the four walls

$$Q_{\text{WALLS}} = Q1 + Q2 + Q3 + Q4$$

$$Q_{\text{WALLS}} = 5842.416 \text{ W}$$

Calculation of the heat gains for the roof

Roof area; $A = 8\text{ m} \times 8\text{ m} = 64 \text{ m}^2$

Roof Materials = Hard concrete, enjarre (mortero), and plaster.

Properties of the roof materials

Material	X_i (m)	K_i (W/m $^\circ\text{C}$)
Hard Concrete	0.01	1.40
Cement-Sand	0.14	0.63
Plaster	0.01	0.46

$$h_o = 15.2 \text{ W/m}^2\text{ }^\circ\text{C}$$

$$h_i = 9.36 \text{ W/m}^2\text{ }^\circ\text{C}$$

$$\Delta T = 38^\circ\text{C} - 22^\circ\text{C} = 16^\circ\text{C}$$

By applying the equations for R, U and Q, we get:

$$R = 0.3101 \text{ (m}^2 \text{ }^\circ\text{C /W)}$$

$$U = 3.22 \text{ (W/m}^2 \text{ }^\circ\text{C)}$$

$$Q_{\text{ROOF}} = 3297.28 \text{ W}$$



Calculating the total heat of the house:

$$Q_{TOTAL} = Q_i = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 = Q_{WALLS} + Q_{ROOF}$$

$$Q_{TOTAL} = 5842.416 \text{ W} + 3297.28 \text{ W} = 9139.693 \text{ W}$$

Let's remember That:

$$1 \text{ KW} = 0.284333 \text{ Tons of Refrigeration}$$

To balance the heat gain of 9.139 KW it takes:

$$(9.139 \text{ KW}) (0.284333 \text{ TR/KW}) = 2.599 \text{ TR} \quad 2.6 \text{ Ton}$$

Considering that a high efficiency one-ton air conditioner that works 12 hours a day, consumes around of 432 Kwh a month, so:

$$\text{Electric Consumption} = (2.6 \text{ Ton}) (432 \text{ KWh} / 1 \text{ Ton}) = 1123.2 \text{ KWh/Mont}$$

Considering a rate without subsidy of \$1.8/KWh (\$0.17 USD/KWh) during the summer, the energetic cost would be:

$$\text{Energetic Cost} = 1123.2 \text{ KWh/Month}$$

$$\$1.8/ \text{KWh} (\$0.17 \text{ USD/KWh}) = \$2,022 \text{ pesos a Month} // \$191.21 \text{ USD a month}$$

QTOTAL	2.60 Ton
Electric Consumption	1 123 KWh per Month
Energetic Cost	\$2 022 a Month

Case A: Brick-Concrete

Calculation of heat gains of the walls

Area of each wall: $A = 8\text{m} \times 6\text{m} = 48\text{m}^2$

Materials of the walls: brick, mortar and plaster.

Properties of these materials

Material	X_i (m)	K_i (W/m $^{\circ}\text{C}$)
(Cement-Sand)	0.01	0.63
Brick	0.14	1.3
Plaster	0.01	0.46

$h_o = 15.2 \text{ W/m}^2\text{C}$

$h_i = 9.36 \text{ W/m}^2\text{C}$

$R = 0.3179 \text{ (m}^2\text{C/W)}$

$U = 3.145 \text{ (W/m}^2 \text{ }^{\circ}\text{C)}$

Calculating the heat gain for the south wall (Q_1)

$$Q_1 = U \cdot A \cdot \Delta T = 3.145 \text{ (W/m}^2 \text{ }^{\circ}\text{C)} \cdot 48\text{m}^2 \cdot (38^{\circ}\text{C} - 22^{\circ}\text{C})$$

$$Q_1 = 2415.36 \text{ W}$$

$$Q_1 = Q_2 = Q_3$$

Calculating the heat gain for the North Wall (the one that gets less sun)

$$Q^4 = 3.145 \text{ (W/m}^2\text{C)} \cdot 48\text{m}^2 \cdot (33^{\circ}\text{C} - 22^{\circ}\text{C}) = 1660.56 \text{ W}$$

$$\mathbf{Q_{WALLS}} = 8906.64 \text{ W}$$

Calculation of the heat gain for the roof

Roof area; $A = 8\text{m} \times 8\text{m} = 64 \text{ m}^2$

Roof Materials: strained thick concrete, mortar and plaster.
Properties of the roof materials

Material	X_i (m)	K_i (W/m $^{\circ}$ C)
Strained thick concrete	0.14	1.40
Cement- Sand	0.01	0.63
Plaster	0.01	0.46

$h_o = 15.2$ W/m 2 $^{\circ}$ C.

$h_i = 9.36$ W/m 2 $^{\circ}$ C

$\Delta T = 38^{\circ}\text{C} - 22^{\circ}\text{C} = 16^{\circ}\text{C}$

Applying the equations for R, U and Q, we get:

$R = 0.31.01$ (m 2 $^{\circ}$ C / W)

$U = 3.22$ (W/m 2 $^{\circ}$ C)

$Q_{\text{ROOF}} = 3297.28$ W

Calculating the total heat of the house:

$Q_{\text{TOTAL}} = Q_i = Q_1 + Q_2 + Q_3 + Q_4 + Q_5 = Q_{\text{WALLS}} + Q_{\text{ROOF}}$

$Q_{\text{TOTAL}} = 8906.64$ W + 3297.28 W = $12,203.92$ W

(12.204 KW) (0.284333 TR/KW) = 3.4699 TR = 3.47 Ton.

Considering that a high efficiency 1-ton air conditioning system that works 12 house consumes an estimate of 432 KWh a month, so:

Electric Consumption = (3.47 Ton) (432 KWh / 1 Ton) = $1,499$ KWh / a Month

Considering a rate without subsidy of (CONVERTIR A DÓLARES) $\$1.8$ /KWh in summer rate, the energetic cost would be:

Energetic Cost = $1,499$ KWh/a Month $\$0.17$ USD/KWh = $\$257.05$ / A month (CONV. DÓLARES).

Q_{TOTAL} 3.47 Ton
Electric Consumption $1,500$ KWh a Month
Energetic Cost $\$257.24$ USD a Month

Case B: Brick-Small Vault

Calculation of heat gains of the walls.

Area of each wall; $A=8\text{m} \times 6\text{m} = 48 \text{ m}^2$ (157.48 Sq. Ft.)

Materials on the walls: Brick, mortar and plaster.

Properties of the materials walls were built with

Material	X_i (m)	K_i (W/m ² °C)
Cement-Sand	0.01	0.63
Brick	0.14	1.3
Plaster	0.01	0.46

$Q_{\text{WALLS}} = 8906.64 \text{ W}$

Calculation of the heat gain of the small vault roof and concrete beams.

Roof area; $A= 8\text{m} \times 8\text{m} = 64 \text{ m}^2$ (209.97 Sq.Ft.)

Polystyrene area; $A_p = 53.58 \text{ m}^2$ (175.79 Sq. Ft.)

Beam Area; $A_v = 10.42 \text{ m}^2$ (34.19 Sq. Ft.)

Roof materials: strained thick concrete, Polystyrene (mortar) and plaster.

Properties of the roof materials:

Material	X_i (m)	K_i (W/m ² °C)
Strained thick concrete	0.05	1.40
Polystyrene	0.15	0.467
Cement-Sand	0.01	0.63
Plaster	0.01	0.46
Concrete Beams	0.20	

11 Beams

c	o	n	c	r	e	t	e				
p	o	l	y	e	s	t	i	r	e	n	e
Mortar											
Plaster											

$Q = 1,510.405 \text{ W}$. This is the heat that comes in through concrete, polystyrene, mortar and plaster.

$Q = 471.82 \text{ W}$. This is the heat that comes in through beams, mortar and plaster.

$$Q_{\text{ROOF}} = 1,982.225 \text{ W}$$

$$Q_{\text{TOTAL}} = Q_{\text{WALLS}} + Q_{\text{ROOF}}$$

$$Q_{\text{TOTAL}} = 8906.64 \text{ W} + 1982.225 \text{ W} = 10,888.86 \text{ W}$$

$$\text{Ton} = 10.888 \text{ KW} (0.284333 \text{ TR/KW}) = 3.096 \text{ TR}$$

$$\text{Electric Consumption} = 3.1 \text{ TR} (432 \text{ KWh} / 1 \text{ Ton}) = 1339.2 \text{ KWh}$$

$$\text{Energetic Cost} = 1340 \text{ KWh} \quad \$1.8/ \text{KWh} = \$229.80 \text{ USD}$$

QTOTAL	3.1 Ton
Electric Consumption	1,340 KWh/ a Month
Energetic Cost	\$229.80 USD A Month

Case D: Block-Small Vault

Heat gain of block walls

Area of each wall; $A = 8\text{m} \times 6\text{m} = 48\text{m}^2$

Materials on walls: mortar, block and plaster.

$$Q_{\text{WALLS}} = 5842.416 \text{ W}$$

$$Q_{\text{TOTAL}} = Q_{\text{WALLS}} + Q_{\text{ROOF}}$$

$$Q_{\text{TOTAL}} = 5,842.416 \text{ W} + 1,982.225 \text{ W} = 7,824.641 \text{ W}$$

$$\text{Ton} = 7.824 \text{ KW} (0.284333 \text{ TR/KW}) = 2.2 \text{ TR}$$

$$\text{Electric Consumption} = 2.2 \text{ TR} (432 \text{ KWh} / 1 \text{ Ton}) = 950.4 \text{ KWh}$$

$$\text{Energetic Cost} = 950 \text{ KWh} \quad \$0.17 \text{ USD/KWh} = \$163.014 \text{ USD}$$

QTOTAL	2.2 Ton
Electric Consumption	950 KWh/a month
Energetic Cost	\$163.014 USD a month

Case: MegaPark- MegaPark

The most important materials are considered

Calculation of heat gains through the walls.

Area of each wall; $A = 8\text{m} \times 6\text{m} = 48\text{m}^2$ (157.48 Sq. Ft)

Materials of the walls: mortar, plaster, R11 glass fiber and plaster.

Properties of the materials on the walls

Material	X_i (m)	K_i (W/m°C)
Cement-Sand	0.01	0.63
R11 Glass Fiber	0.0889	0.040
Plaster	0.01	0.46

$$Q_{\text{WALLS}} = 1,148.376 \text{ W}$$

Calculation of the heat gain for the roof.

Roof Area; $A = 8\text{m} \times 8\text{m} = 64 \text{m}^2$ (209.97 Sq. Ft)

Materials of the roof: plaster, galvanized plate, glass fiber and plaster.

Properties of the materials on the roof

Material	X_i (m)	K_i (W/m°C)
Plaster	0.0127	0.46
Galvanized Plate	0.000429	36.33
R19 Glass Fiber	0.1524	0.040
Plaster	0.0127	0.46

$$Q_{\text{TOTAL}} = 1,148.376 \text{ W} + 256 \text{ W} = 1,404.376 \text{ W} = 1.404 \text{ KW}$$

$$\text{Ton} = 1.404 \text{ KW} (0.284333 \text{ TR} / \text{KW}) = 0.3993 \text{ TR} = 0.4 \text{ TR}$$

$$\text{Electric Consumption} = 0.4 \text{ TR} (432 \text{ KWh} / 1 \text{ Ton}) = 172.8 \text{ KWh}$$

$$\text{Energetic Cost} = 172.8 \text{ KWh} \ \$0.17 \text{ USD/KWh} = \$29.63 \text{ USD CONVERSIONES!!}$$

Q_{TOTAL} 0.4 Ton
Electric Consumption 173 KWh a Month
Energetic Cost \$29.63 USD a Month