TECHNICAL INFORMATION: **ENERGY SAVINGS**

EP Warmfloor Heating System

Calculations based on results obtained from the test house. (See factors under Efficiency in Radiant Floor Systems section.)

Heat loss from:

Infiltration: 10200 ft3 x 0.018 Btu/ft3h x oF diff. x 0.7 = 128.52 x oF diff. [Btu/h]

Transmission: 760 x 0.5 + 800 + 1452 + 114 + 24 = 198.33 x oF diff. [Btu/h]
24 26 16 2.5 1.56

H EP warmfloor = (128.52 + 198.33) x 24 x (6387 x 0.7) x 0.75 = 26,303,645 Btu
1

This corresponds to the measured annual consumption of:

7635 kWh x 3412 = 26,050,620 Btu
~ 26 x 106 Btu

Conventional Heating Systems

In comparison, a typical home heating system shows the following heat load.

Heat loss from:

Infiltration: 10200 ft3 x 0.018 Btu/ft3h x oF diff. x 1.0 = 183.60 x oF diff. [Btu/h]

Transmission: 760 + 800 + 1452 + 114 + 24 = 214.17 x oF diff. [Btu/h]
24 26 16 2.5 1.56

H conventional = (183.60 + 214.17) x 24 x 6387 = 67,747,186 Btu
0.9

~ 68 x 106 Btu

Energy savings with EP Warmfloor

(H conventional - H EP warmfloor x 100) = 61 %

H conventional 5.1cm 1.3cm

Floor area covered by cables:

6m long x 0.06m dia/0.68m^2 x 100%

= **3.6%** covering

Floor area covered by element:

2 x 1m x 0,34m wide/ 0.68m^2 x 100%

= **68%** covering

Thin heating cables need more power to be able to warm a floor due to the **small area** they cover.

EP Warmfloor covers a much l**arger area,** thereby warming evenly the floor with a lower temperature.

Heating distribution – overall savings 15%

Heat loss through the subfloor:

1m^2 x 1/20 (50-10)C^0 = **7W**

50^0 10^0 Temperature difference between the hot water tubing and the ground gives considerable heat loss but Temperature difference between EP Warmfloor and the ground is minimal, giving less heat loss

Heat loss through the subflc

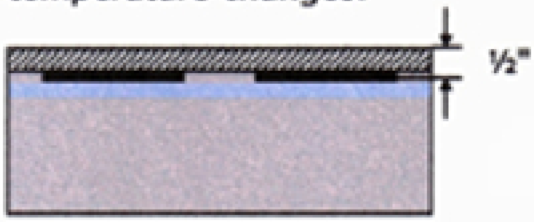
1m^2 x 1/20 (29-10)C^0 = **5W**

Temperature loss to the ground – overall saving 7%

Overall savings with EP Warmfloor

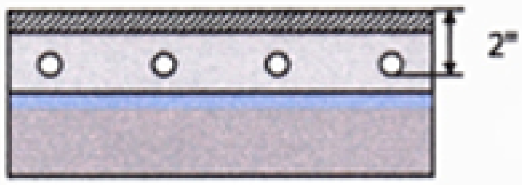
1. Reaction to temperature fluctuations – overall savings 15%

EP Warmfloor is installed right under the floor covering and reacts fast to temperature changes.



Self-regulating elements act as a floor sensor, supplying more wattage when cold and less wattage as they warm up.

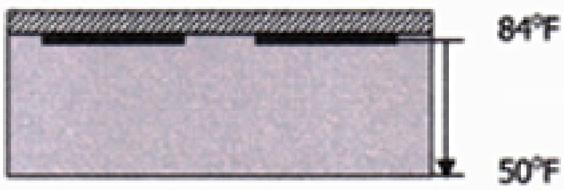
A hot water system needs to heat a thermal mass which takes a long time to heat up and to cool off.



Hot water systems require 4 times more energy or 4 times more time for the heat to reach the surface.

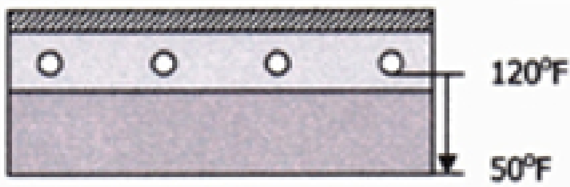
2. Temperature loss to the ground – overall saving 7%

The temperature difference between EP Warmfloor and the ground is minimal, giving less heat loss.



Heat loss through the subfl...
10sqft x 1/20 (84-50)°F = **5 W**

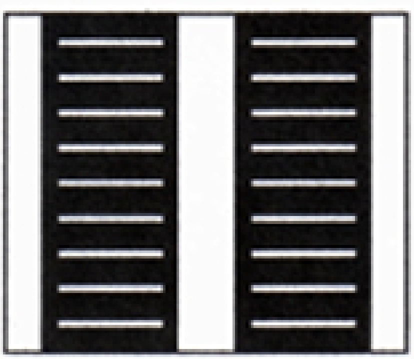
The temperature difference between the hot water tubing and the ground gives considerable heat loss.



Heat loss through the subfloor:
10sqft x 1/20 (120-50)°F = **10 W**

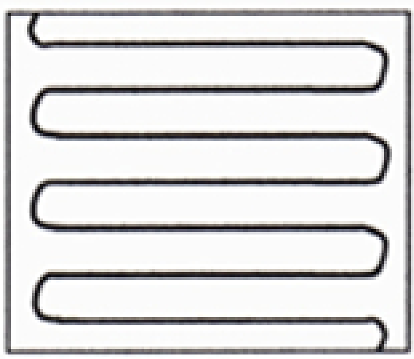
3. Heat distribution – overall savings 15%

EP Warmfloor covers a much larger area, thereby warming evenly the floor with a lower temperature.



Floor area covered by elements:
2 x 3ft long x 1ft wide/10sqft x 100%
= **60%** coverage

Thin heating cables need more power to be able to warm a floor due to the small area they cover.



Floor area covered by cables:
20ft long x 0.01ft dia./10sqft x 100%
= **2%** coverage

While a **Water Tubing** system would require:

$0.186m^2/0.0893m^2$ = **2.08 time more wattage** which would be $50W/m^2 \times 2.08$ = **$104W/m^2$**

To give the same heat output, an **Electric Cable** system would require:

$0.186m^2/0.0736m^2$ = **2.5 times more wattage** witch would be $50W/m^2 \times 2.5$ = **$125W/m^2$**

A typical total heating installation with the EP Warmfloor system requires: $50W/m^2$

NOTE: Since k is constant we may assume $k = 1W \cdot {}^{0}C^{-1} \cdot m^{-2}$, leaving the above values of A_2 to be $0.186m^2$, $0.0736m^2$ and 0.0893 respectively

$0.0077m^2 \cdot 2^0C \cdot W^{-1}(24^0C - 40^0C)$
$= A_2 \cdot k(21^0C - 24^0C) \approx A^2 \cdot k = \mathbf{0.0893m^2}$

$A_1 = 0.61m \cdot 0.0127m = 0.0077m^2$
$^T{}_1 = 40^0C$ (water temperature)

Water Tubing

Diameter = 12,7mm Length 0.61m,
15cm spacing

- **Where:**
- ***k*** **is thermal conductivity (constant)**
- **R_1 is thermal resistance of floor**
- **T_1 is temperature of heating element**
- **T_2 is temperature of floor surface**
- **T_a is the ambient temperature**
- **A_1 is the surface area of heating element**
- **A_2 is the surface of heat generated**
- **Consider typical values for heating a $0.093m^2$ with $R_1 = 2^0C \cdot m^2 \cdot W^{-1}$, $T_2 = 24^0C$ and $T_a = 21^0C$**

$0.0024m^2 \cdot 2^2 \cdot m^2 \cdot W^{-1}(24^0C - 70^0C)$
$= A_2 \cdot k(21^0C - 24^0C) \approx A_2 \cdot k = \mathbf{0.0736m^2}$

$A_1 = 1.2m \cdot 0.002m = 0.0024m^2$
$^T{}_1 = 70^0C$

EP Warmfloor Flat element

$0.093m^2$

Electric Cable

Diameter = 2 mm
Length = 1.2m (double-wire 7,5 cm spacing

$0.093m^2 \cdot m^2 \cdot W^{-1}(24^0C - 27^0C)$
$= A_2 \cdot k(21^0C - 24^0C) \approx A_2 \cdot k = \mathbf{0186m^2}$

$A_1 = 0.093m^2$
$T_1 = 27^0C$

Fig.1 shows a cross sectional area of a floor with a cable or tubing and EP Warmfloor flat element According to Newton`s law the rate of heat transfer to the surrounding air is proportional to the floor exposed area (A) and to the difference between the floor temperature and the air temperature. For the conservation of energy, the heat transfer for conduction equals the heat for convection, and in simplified equation:

It is scientifically proven that EP Warmfloor is approx **3 time** more efficient then heating cable. According to recent study EP Warmfloor was measured to be significantly more efficient then other heating system.

University study done compeered the heat transmission from EP Warmfloor self-regulating heating element with electric heating cable and water tubing system.

Why EP Warmfloor Is More Efficient

Now, it is scientifically proven that EP Warmfloor is approx. **2.5 times** more efficient than heating cables.

According to a recent study EP Warmfloor was measured to be significantly more efficient than other heating systems.

Francesco Schiavone, PhD, (PhD, BEng (Mech) – University of Florence, Italy, Senior Research Associate – Royal Melbourne Institute of Technology, Australia) compared the heat transmission from EP Warmfloor self-regulating heating element with electric cable systems and water tubing systems.

FIG. 1

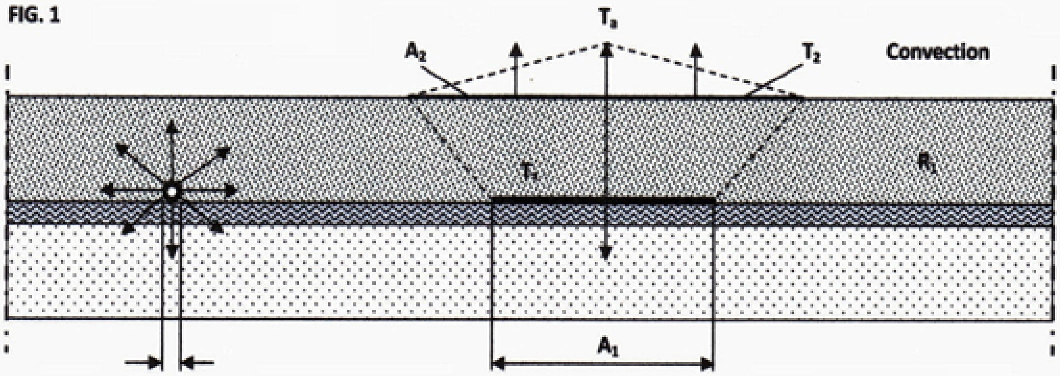


Fig. 1 shows a cross sectional area of a floor with a cable or tubing and EP Warmfloor flat element.

According to Newton's law, the rate of heat transfer to the surrounding air is proportional to the floor exposed area (A) and to the difference between the floor temperature and the air temperature. For the conservation of energy, the heat transfer for conduction equals the heat for convection, and in a simplified equation:

$$Q \propto A_1 \cdot R_1(T_2 - T_1) = A_2 \cdot k(T_a - T_2)$$

Where:

- k is the thermal conductivity (constant)
- R_1 is thermal resistance of floor
- T_1 is the temperature of heating element
- T_2 is the temperature of floor surface
- T_a is the ambient temperature
- A_1 is the surface area of heating element
- A_2 is the surface area of heat generated from heating element

Consider typical values for heating a square foot (0.093 m^2) with $R_1 = 2\,°\mathrm{C} \cdot \mathrm{m}^2 \cdot \mathrm{W}^{-1}$, $T_2 = 24\,°\mathrm{C}$ and $T_a = 21\,°\mathrm{C}$.

EP Warmfloor Flat Element Width = 30.5 cm Length = 30.5 cm	**Electric Cable** Diameter = 2 mm Length = 1.2 m (double-wire, 7.5 cm spacing)	**Water Tubing** Diameter = 12.7 mm Length = 0.61 m (15 cm spacing)
$A_1 = 0.305\ \mathrm{m} \cdot 0.305\ \mathrm{m} = 0.093\ \mathrm{m}^2$ $T_1 = 27\,°\mathrm{C}$	$A_1 = 1.2\ \mathrm{m} \cdot 0.002\ \mathrm{m} = 0.0024\ \mathrm{m}^2$ $T_1 = 70\,°\mathrm{C}$	$A_1 = 0.61\ \mathrm{m} \cdot 0.0127\ \mathrm{m} = 0.0077\ \mathrm{m}^2$ $T_1 = 40\,°\mathrm{C}$ (water temperature)
$0.093\ \mathrm{m}^2 \cdot 2\,°\mathrm{C} \cdot \mathrm{m}^2 \cdot \mathrm{W}^{-1}(24\,°\mathrm{C} - 27\,°\mathrm{C})$ $= A_2 \cdot k(21\,°\mathrm{C} - 24\,°\mathrm{C})$ $\therefore \boldsymbol{A_2 \cdot k = 0.186\ \mathrm{m}^2}$	$0.0024\ \mathrm{m}^2 \cdot 2\,°\mathrm{C} \cdot \mathrm{m}^2 \cdot \mathrm{W}^{-1}(24\,°\mathrm{C} - 70\,°\mathrm{C})$ $= A_2 \cdot k(21\,°\mathrm{C} - 24\,°\mathrm{C})$ $\therefore \boldsymbol{A_2 \cdot k = 0.0736\ \mathrm{m}^2}$	$0.0077\ \mathrm{m}^2 \cdot 2\,°\mathrm{C} \cdot \mathrm{m}^2 \cdot \mathrm{W}^{-1}(24\,°\mathrm{C} - 40\,°\mathrm{C})$ $= A_2 \cdot k(21\,°\mathrm{C} - 24\,°\mathrm{C})$ $\therefore \boldsymbol{A_2 \cdot k = 0.0893\ \mathrm{m}^2}$

Note: Since k is constant, we may assume $k = 1\ \mathrm{W} \cdot °\mathrm{C}^{-1} \cdot \mathrm{m}^{-2}$, leaving the above values of A_2 to be 0.186 m^2, 0.0736 m^2 and 0.0893 m^2 respectively.

A typical total heating installation with the **EP Warmfloor** system requires: **50 W/m^2**

To give the same heat output, an **Electric Cable** system would require:
0.186 m^2 / 0.0736 m^2 = <u>2.5 times more wattage</u>; which would be 50 W/m^2 x 2.5 = **125 W/m^2**

While a **Water Tubing** system would require:
0.186 m^2 / 0.0893 m^2 = <u>2.08 times more wattage</u>; which would be 50 W/m^2 x 2.08 = **104 W/m^2**