

**REGENERATIVE
WORKOUT MACHINE
FEASIBILITY STUDY**

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CHBE 573

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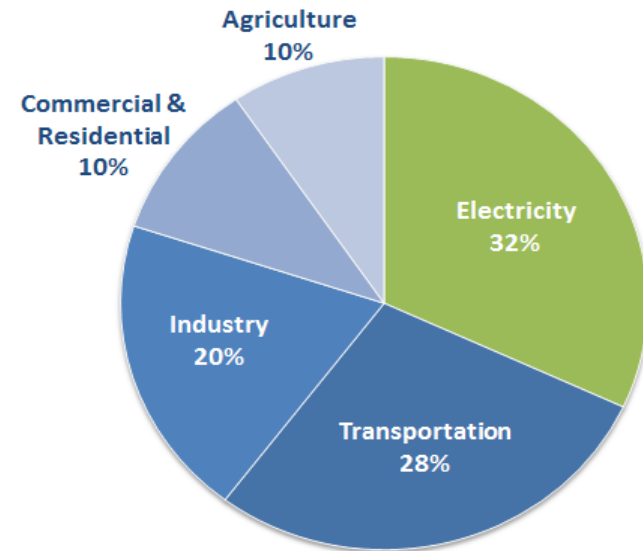
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Green House Gas Emissions in 2014

- Total Emissions:
 - 6,526 Million Metric Tones
- Electricity Sector: 32%
 - 11% increase from 1990
- Present Energy Source:
 - Fossil Fuels
- Alternative Energy Sources:
 - Nuclear Power
 - Solar Thermal Power



Micro Renewable Energy Systems

- Energy Generated: <5 kWh
- Individual or Community Owned
- Reduce dependence on Commercial Energy Sources



Power Generating Gym Equipment

- Kinetic Energy: Dissipated as Heat
- 30 minute workout: 50 Wh
- Charge 6 cellphones or 1 laptop for an hour
- 10 machines:
 - Average 8 hours/day: 8 kWh or 240 laptops for an hour.



Products Investigated



ReRev
Precor EFX546i
Elliptical



Woodway
Ecomill Treadmill



SportsArt
Fitness C531u



Power

- 100W/machine

Installation cost

- \$1000/machine

Additional costs

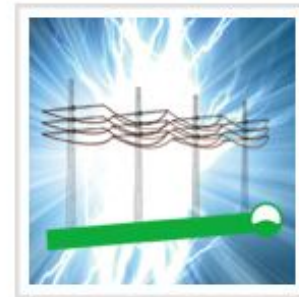
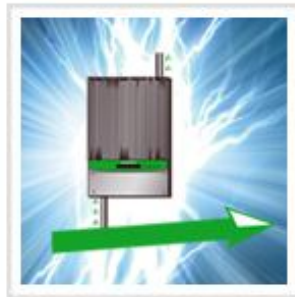
- \$14000/site

Pros

- Uses existing equipment
- Flexibility

Cons

- Warranty



SportsArt FITNESS



Power

- 160W/machine

Equipment Costs

- \$7714/machine

Installation Costs

- \$225/machine

Pros

- No additional equipment
- Warranty

Cons

- Machine durability (?)

For The Long Run®
WOODWAY®

Power:

- ?W/machine

Equipment Cost:

- \$5500/machine

Pros:

- Replaces machines consuming ~2600W
- Extensive warranty
- ReRev compatible

Cons:

- Small power production



Equipment Summary

| | SportsArt | ReRev | Woodway |
|------------------|----------------------|-------|----------------------|
| Compatibility | - | Most | ReRev |
| Power | 160W | 100W | 2600W |
| Additional equip | No | Yes | Yes (ReRev) |
| Equipment (\$) | 7714 | 0 | 5500 |
| Install (\$) | 225 | 1000 | 1000 |
| Additional (\$) | 0 | 14000 | 14000 |
| Longevity | Questionable | high | High |
| Warranty | 5 years on all parts | N/A | 5 years on all parts |

ReRev Retrofit Calculations

| Workout (hours) per day /machine | Percentage of daily usage % | No. of Machines | Total no. Of Days (Usage)/ year | Energy Savings (Wh)/yr | Energy Savings (kWh)/yr |
|----------------------------------|-----------------------------|-----------------|---------------------------------|------------------------|-------------------------|
| 0.5 | 2.08 | 1 | 1 | 50 | 0.05 |
| 1 | 4.17 | 1 | 100 | 10000 | 10 |
| 2 | 8.33 | 1 | 100 | 20000 | 20 |
| 3 | 12.50 | 1 | 100 | 30000 | 30 |
| 4 | 16.67 | 1 | 100 | 40000 | 40 |
| 5 | 20.83 | 1 | 100 | 50000 | 50 |
| 10 | 41.67 | 10 | 100 | 1000000 | 1000 |

Note: The red colored portion shows the ReRev basis taken from their website.

Retrofit CO₂ and Cost Savings Estimate

| Energy Production (kWH) | CO ₂ Released (kg) |
|-------------------------|-------------------------------|
| 1000000 | 25000 |
| 1 | 0.025 |
| 2 | 0.05 |
| 3 | 0.075 |
| 4 | 0.1 |
| 5 | 0.125 |
| 6 | 0.15 |
| 7 | 0.175 |
| 8 | 0.2 |
| 9 | 0.225 |
| 10 | 0.25 |

Current Electricity Charges:

First 14800 kwh – \$0.10605

Additional kwh – \$0.05103

| Energy Savings (kWh)/yr | CO ₂ SAVED (kg)/yr | Cost Savings (\$)/yr |
|-------------------------|-------------------------------|----------------------|
| 0.05 | 0.00125 | 0.00785 |
| 10 | 0.25 | 1.57 |
| 20 | 0.5 | 3.14 |
| 30 | 0.75 | 4.71 |
| 40 | 1 | 6.28 |
| 50 | 1.25 | 7.85 |
| 1000 | 25 | 157 |

**Assumption made Charges per kWh:
\$0.157/kwh**

Note: BC Hydro Basis

SportsArt Install Energy Savings Calc.

| Workout (hours) per day/machine | Percentage of daily usage % | Number of Machines | No. Of Days (usage)/yr | Energy Savings (Wh)/yr | Energy Savings (kWh/yr) |
|---------------------------------|-----------------------------|--------------------|------------------------|------------------------|-------------------------|
| 1 | 4.17 | 1 | 1 | 160 | 0.16 |
| 2 | 8.33 | 1 | 100 | 32000 | 32 |
| 3 | 12.50 | 1 | 100 | 48000 | 48 |
| 4 | 16.67 | 1 | 100 | 64000 | 64 |
| 5 | 20.83 | 1 | 100 | 80000 | 80 |
| 6 | 25.00 | 1 | 100 | 96000 | 96 |
| 7 | 29.17 | 1 | 100 | 112000 | 112 |
| 10 | 41.67 | 10 | 100 | 1600000 | 1600 |

SportsArt CO₂ and Cost Savings Estimate

| Energy Savings (kWh)/yr | CO ₂ SAVED (kg)/yr | Cost Savings (\$/yr) |
|----------------------------|----------------------------------|-------------------------|
| 0.16 | 0.004 | 0.02512 |
| 32 | 0.8 | 5.024 |
| 48 | 1.2 | 7.536 |
| 64 | 1.6 | 10.048 |
| 80 | 2 | 12.56 |
| 96 | 2.4 | 15.072 |
| 112 | 2.8 | 17.584 |
| 1600 | 40 | 251.2 |

Note: BC Hydro Basis

Woodway Install Energy Savings Calc.

| Workout (hours) per day/ machine | Percentage of daily usage % | Number of Machines | No. of Days per year | Energy Savings (Wh)/yr | Energy Savings (kWh)/yr |
|----------------------------------|-----------------------------|--------------------|----------------------|------------------------|-------------------------|
| 1 | 4.17 | 1 | 1 | 2600 | 2.6 |
| 2 | 8.33 | 1 | 100 | 520000 | 520 |
| 3 | 12.50 | 1 | 100 | 7800000 | 7800 |
| 4 | 16.67 | 1 | 100 | 1040000 | 1040 |
| 5 | 20.83 | 1 | 100 | 1300000 | 1300 |
| 6 | 25.00 | 1 | 100 | 1560000 | 1560 |
| 7 | 29.17 | 1 | 100 | 1820000 | 1820 |
| 10 | 41.67 | 10 | 100 | 26000000 | 26000 |

Woodway CO₂ and Cost Savings Estimate

| Energy Savings (kWh)/yr | CO ₂ Saved (kg)/yr | Cost Savings (\$)/yr |
|----------------------------|----------------------------------|-------------------------|
| 2.6 | 0.065 | 0.4082 |
| 520 | 13 | 81.64 |
| 7800 | 195 | 1224.6 |
| 1040 | 26 | 163.28 |
| 1300 | 32.5 | 204.1 |
| 1560 | 39 | 244.92 |
| 1820 | 45.5 | 285.74 |
| 26000 | 650 | 4082.00 |

Note: BC Hydro Basis

Payback Time Period

| Product | Total Installation Cost (\$) | Energy savings (kWh/day) | Daily cost savings (\$/day) | Energy Savings (kWh/yr) | Total cost savings per year (\$/yr) | Payback time (years) |
|-----------|------------------------------|--------------------------|-----------------------------|-------------------------|-------------------------------------|----------------------|
| ReRev | 24000 | 10 | 1.57 | 1000 | 157 | 152.87 |
| Woodway | 79000 | 260 | 40.82 | 26000 | 4082 | 19.35 |
| SportsArt | 79400 | 16 | 2.512 | 1600 | 251.2 | 316.08 |

Note: Basis Taken

No. of machines : 10

Usage of 10 hours(each) per day, 100 days(in total) per year

Implementation

- Since return on investment is low, need to maximize usage of regenerative machines
- University of Kentucky increased ReRev elliptical usage by 13% with the *Burn to Earn* Program
- Recommend similar program at UBC to increase elliptical usage
- Offset initial cost via grants like the AMS Sustainability Project Fund



Conclusions & Recommendations

- Human Energy Harvesting is among the most green and renewable energy
- Harvesting green energy while engaging in healthy activities
- Great opportunity to promote sustainability at UBC
- Profit generated from the energy-harvesting devices will have a catalytic effect
- Improving LEED points for the BirdCoop Fitness Center
- Improving enrolment rates at the BirdCoop Fitness Center
- Creating a noteworthy display of environmental responsibility

Future Work

- Evaluating different ways of harvesting human power
- Producing new ideas for the utilization of existing technologies and methods of capturing energy
- Other ways to improve efficiency of BirdCoop Fitness Centre
- Making the BirdCoop Fitness Centre more environmentally friendly

Questions/ Comments