Kinetic Energy

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Picture Source: http://www.geekosystem.com/pavegen-sidewalk-tiles/
Picture Source: http://www.gizmag.com/velkess-flywheel-technology-large-scale-energy-storage/27088/pictures#1
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Kinetic Energy: Generation - How does it Work?

- There are multiple ways to harvest kinetic energy:
  - **Piezoelectricity**
    - When the material is compressed the atoms press together enough to change the configuration of the electrons. When the pressure is removed the electrons return to their previous place. If the piezoelectric compounds are fitted with an auxiliary circuit though, the returning electrons can be captured and used to create a micro circuit.
  - **Hydraulics**
    - When the series of hydraulic pistons are compressed they can force hydraulic liquid through the system creating pressure. That pressure is pushed through hydraulic lines and eventually stored in a pressure vessel known as an accumulator. The stored pressure is then ran through a motor or generator as needed producing electricity.
Kinetic Energy: Storage - How does it Work?

- To store electricity the flywheel’s electric motor generator absorbs the electrical energy and turns the electrical energy into mechanical by spinning the shaft of the devise. The electrical energy is now stored as momentum on the flywheel.

- To use the energy stored on the flywheel the generator uses the momentum the flywheel has built up to convert the momentum into electrical energy.

- Most flywheels operate within a vacuum utilizing magnets and carbon fiber. New flywheels though are using E-glass or electric grade glass which is not as strong as carbon fiber, but can store up to 20 times more energy per dollar. Flywheels are typically the size of a refrigerator.

Information and Video Source: [http://velkess.com/about.php](http://velkess.com/about.php)
Benefits of Using Kinetic Energy

- Emits no pollutants
- Generates no hazardous waste because most of the materials used can be recycled or repurposed
- Strong Adaptability
  - Energy generating slabs can be retrofit to existing buildings or specifically designed to meet the specifications of a new development
  - Flywheels can store electrical energy generated by almost any method
- Can store or harvest energy at any time
- Burns no fuel
- Extremely Efficient: new flywheel models only lose about 2% of the energy stored in a day to friction. Also the best flywheels in the world can hold up to 500 kW of power
- Very Durable
  - Energy generating slabs are built to withstand extreme conditions and high footfall
  - Flywheels are self stabilizing, their rotation keeps them fixed in place. Also most flywheels contain cooling systems to prevent overheating.

Source: [http://www.kinergy.com/about_kinergy_power.shtml](http://www.kinergy.com/about_kinergy_power.shtml)
Picture and Information Source: [www.pavegen.com](http://www.pavegen.com)
Challenges

**Kinetic Energy: Generation**

- Low amount of energy is produced during each step or movement of the slab
  - Roughly 1 to 6 watts are produced during each step
- Initial cost is extremely high
  - Eight pavegen slabs costs roughly $30,800 without shipping and instillation
- Uncertainty about economic life
  - Currently it is still unknown how long the slabs will last. Could by anywhere from 5 to 20 years

**Kinetic Energy: Storage**

- Size and Scale
  - Currently the magnets used in Velkess flywheels only use 25lbs magnets. To get the energy generation needed they need to get magnets that are 750lbs. As a result custom parts are required which drives up costs.
- Cost Efficiency
  - It is estimated that current flywheels only become cost effective over 20 to 30 years.
- Market Acceptance and Most Productive Use
  - Beacon, one of the leaders in flywheel technology went bankrupt in 2011. Mainly used the technology for frequency regulation.

Source: [http://www.slate.com/articles/health_and_science/alternative_energy/2013/03/energy_storage_technology_batteries_flywheels_compressed_air_rail_storage.html](http://www.slate.com/articles/health_and_science/alternative_energy/2013/03/energy_storage_technology_batteries_flywheels_compressed_air_rail_storage.html)
Where is Kinetic Energy: Generation Being Used?


Picture Source: http://www.kinergypowerusa.com/technical_synopsis.html

Picture Source: http://www.unchartedplay.com/new-products2/soccket

Picture Source: http://www.inc.com/ss/kinetic-energy-chargers4

Picture Source: http://www.pavegen.com/media/gallery

Picture Source: http://www6.cityu.edu.hk/see_mer/marine-energy-introduction.htm
Where is Kinetic Energy: Storage Being Used?

Storage devise for energy collected from wind and solar. These will likely be able to store 15kWh.

Used in a variety of vehicles, in particularly some formula 1 cars

Picture and Information Source: http://spinoff.nasa.gov/spinoff1996/32.html
Picture and Information Source: http://www.gizmag.com/velkess-flywheel-technology-large-scale-energy-storage/27088/
Picture Source: http://www.fortnightly.com/fortnightly/2012/05/energy-storage-solutions
Cost and Maintenance: Kinetic Energy Generation

**Initial Cost**
- Eight Pavegen titles initially costs $30,800 without shipping and installation
  - $3850 per tile
  - Future tiles will cost roughly $50
- Other personal kinetic energy devises cost anywhere from $100 to $500.

**Maintenance**
- Depending on your proximity to the vendor your cost of maintenance could be very high
  - Most of the products are built to be durable as vendors know how much of a beating the machines will take
- Disposal of these products is fairly inexpensive because most parts are recyclable.

Since each situation is different, with different costs associated with each vendor and location it is difficult to determine exact costs over the life of the product.

Source: [http://www.inc.com/ss/kinetic-energy-chargers#4](http://www.inc.com/ss/kinetic-energy-chargers#4)
Cost and Maintenance: Kinetic Energy Storage

Cost Comparison

- The diagram to the right is a life-cycle cost comparison between a VRLA battery with a life of 4 years and a low-rpm flywheel with a life of 20 years.

- Study conducted by the Federal Energy Management Program.

- The resulting PV life-cycle costs:
  - Battery: $248,129
  - Flywheel: $105,572

Source: http://smartenergy.illinois.edu/pdf/Archive/FlywheelEnergyStorage.pdf
Future of Kinetic Energy: Generation

- As prices fall and efficiency rises the use of energy generating devices from kinetic energy will rise. High density areas will be fitted with kinetic energy collecting sidewalks and hallways.

- With improved economies of scale kinetic energy devices should be common to you and I in the next 2 to 5 years.

- Eventually you will see something like this......

- The Strawscraper utilizes the same piezoelectric principles that many of the slabs and tiles use. Instead of using footfall the Strawscraper uses kinetic energy produced from the straws swaying in the wind and the motion of the building.

Source: Marvin Jones, Vice President of US National Business Development at Kinergy Power
Picture and Information Source: http://www.treehugger.com/urban-design/hairy-skyscraper-would-collect-energy-through-piezo-electric-straws.html
Future of Kinetic Energy: Storage

- Home use of flywheel energy storage is the next hurdle for this technology.
- For companies like Velkess they want this technology to store all the energy your home produces from wind and solar energy generation.
- The key moving forward will be reducing costs and improving efficiency
  - Future flywheels will be slightly larger and faster.
    - Doubling the size results in double the storage capacity, doubling the speed though quadruples the storage capacity.
- It is expected that energy storage will be a $31.5 billion dollar industry by 2017 so competition in this space will be on the rise.

Source: [http://www.economist.com/node/21540386](http://www.economist.com/node/21540386)
Thank you

Questions?
Vendors

Kinetic Energy Generation
- Pavegen
- Kinergy Power
- Energy Floor
- Pelamis Wave Power
- Uncharted Play
- RollerGen
- Bionic Power
- nPowerPEG

Kinetic Energy Storage
- Velkess
- Beacon
- Temporal
- Vycon
References

Kinetic Energy Generation

- **Pavegen:**
  - [http://www.pavegen.com/media/gallery](http://www.pavegen.com/media/gallery)

- **Kinergy Power:**
  - [http://www.kinergypowerusa.com/technical_synopsis.html](http://www.kinergypowerusa.com/technical_synopsis.html)
  - [Marvin Jones, Vice President of US National Business Development at Kinergy Power](http://www.kinergypowerusa.com/technical_synopsis.html)

- **Other:**
  - [http://www.ecopedia.com/energy/piezoelectricity-how-dance-floors-can-provide-energy/](http://www.ecopedia.com/energy/piezoelectricity-how-dance-floors-can-provide-energy/)
  - [http://www.inc.com/ss/kinetic-energy-chargers#4](http://www.inc.com/ss/kinetic-energy-chargers#4)
  - [http://www6.cityu.edu.hk/see_mer/marine-energy-introduction.htm](http://www6.cityu.edu.hk/see_mer/marine-energy-introduction.htm)
  - [http://www.treehugger.com/urban-design/hairy-skyscraper-would-collect-energy-through-piezo-electric-straws.html](http://www.treehugger.com/urban-design/hairy-skyscraper-would-collect-energy-through-piezo-electric-straws.html)

Kinetic Energy Storage

- **Velkess:**
  - [http://velkess.com/about.php](http://velkess.com/about.php)

- **Beacon:**
  - [http://www.slate.com/articles/health_and_science/alternative_energy/2013/03/energy-storage_technology_batteries_flywheels_compressed_air_rail_storage.html](http://www.slate.com/articles/health_and_science/alternative_energy/2013/03/energy-storage_technology_batteries_flywheels_compressed_air_rail_storage.html)

- **Temporal:**

- **Other:**
  - [http://smartenergy.illinois.edu/pdf/Archive/FlywheelEnergyStorage.pdf](http://smartenergy.illinois.edu/pdf/Archive/FlywheelEnergyStorage.pdf)
  - [http://www.economist.com/node/21540386](http://www.economist.com/node/21540386)