Amber Kinetics, Inc.

| utility scale flywheel energy storage |

Funded in part by the Energy Storage Systems Program of the U.S. Department Of Energy through National Energy Technology Laboratory

Edward Chiao | co-founder & CEO | nov 2010

Smart Grid Demonstration Program

Sub-Area: 2.5 Demonstration of Promising Energy Storage Technologies
problem

intermittent wind & solar generation

= unstable electric grid
solution

energy storage: balances supply & demand

= smarter electric grid
# Utility Scale Energy Storage

A demanding set of requirements

<table>
<thead>
<tr>
<th>Metric</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>&lt; $1,500 / kW (4 hr duration)</td>
</tr>
<tr>
<td>Installed Size</td>
<td>1-20 MW</td>
</tr>
<tr>
<td>Discharge Time</td>
<td>0 - 4 hours</td>
</tr>
<tr>
<td>Storage Efficiency</td>
<td>80%+</td>
</tr>
<tr>
<td>Cycle Life</td>
<td>150,000 deep cycles</td>
</tr>
<tr>
<td>Calendar Life</td>
<td>25+ years</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>Zero Emissions</td>
</tr>
<tr>
<td>Degradation</td>
<td>None</td>
</tr>
</tbody>
</table>
Smart Grid Demonstration Program

Sub-Area: 2.5 Demonstration of Promising Energy Storage Technologies

flywheels: kinetic energy storage

- 48 month project (3 phases)

- Engineering & Commercial prototypes

- Grid-connected demonstration (Phase 3)
Flywheel Energy Storage Architecture

- Hub
- Steel wire
- Rotor
- Motor-gen
- Magnetic bearing
Next Steps
Demonstrate Low-Cost Material

Prototype to demonstrate cheap, high strength steel rotor performance

High Strength
- Metalworking process to achieve high strength
- Very low cost, simplified MFG process

Demonstrate: 15x lower $ / kWh rotor cost

Longevity
- 25 year operating life
- 150,000 deep cycles
- Abundant material, scalable architecture
Technology Development Plan

3-Phase Development

Phase One: Engineering Prototype System
- Demonstrate flywheel system, rotor performance
- Demonstrate low-loss bearings & motor

Phase Two: Commercial-Scale Prototype System
- 100 kWh flywheel energy storage system
- Scale up & cost down

Phase Three: Grid-connected Demonstration
- MWh size grid-connected demonstration
- Demonstrate performance & cycle life
thank you

questions | comments | partnership opportunities

ed@amberkinetics.com