



T2+2™ Market Overview

Supercapacitors

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Supercapacitors, also known as ultracapacitors or electric/electrochemical double layer capacitors (EDLCs), are static electrical energy storage devices. Supercapacitors bridge the gap between traditional batteries and capacitors, as they have more power density than a battery and more energy density than a conventional capacitor.<sup>1</sup> Although they don't store as much energy as a battery, they can discharge their stored energy more quickly.<sup>2</sup> Supercapacitors are composed of two carbon-based electrodes, an electrolyte (aqueous or organic), and a separator that allows the transfer of ions while providing electronic insulation between the electrodes.<sup>3</sup> Their capability to produce quick, short-duration energy bursts has made supercapacitors ideal for peak power applications such as elevators, forklifts, consumer electronic gadgets and robotics.<sup>4</sup> While market sizes are difficult to estimate, we find the global market size to be approximately:

<i>Market Niche Size</i>			
<b><i>Market Size in Dollars</i></b>	<b><i>Growth Rate</i></b>	<b><i>Base Year</i></b>	<b><i>Detailed Basis for Estimate</i></b>
\$208 million (overall market)	27.1%	2008	According to a 2009 Lux Research report, the market for supercapacitors is expected to reach \$877 million in 2014, representing a compound annual growth rate (CAGR) of 27.1%. <sup>5</sup>
\$122 million (consumer electronics market)	28.5%	2008	Supercapacitor growth in the consumer electronics market is expected to reach over \$550 million by 2014, <sup>6</sup> a CAGR of 28.5%.
\$86 million (large storage applications)	24.48%	2008	The market for supercapacitors used in large storage applications is expected to grow to over \$320 million through 2014, <sup>7</sup> a CAGR of 24.48%.

The market for supercapacitors is primarily divided between large multinational firms targeting the electronics industry and dedicated capacitor firms focused on large energy storage applications.<sup>8</sup> The cost of supercapacitors in 2006 was \$0.01 per farad (which

<sup>1</sup> "Power and Charger Market for Material Handling Equipment." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>2</sup> LaMonica, Martin. "Ultracapacitors look to fit into energy storage." September 2009. CNET News web site. [http://news.cnet.com/8301-11128\\_3-10363496-54.html](http://news.cnet.com/8301-11128_3-10363496-54.html) (accessed December 9, 2009).

<sup>3</sup> Gebbia, Mark. "Supercapacitors Evolve to Meet Market Needs." Hearst Electronic Products web site. [http://www2.electronicproducts.com/Supercapacitors\\_evolve\\_to\\_meet\\_market\\_needs-article-fapo\\_illinoisCapacitor\\_dec2009-html.aspx](http://www2.electronicproducts.com/Supercapacitors_evolve_to_meet_market_needs-article-fapo_illinoisCapacitor_dec2009-html.aspx) (accessed December 9, 2009).

<sup>4</sup> "Global Ultracapacitors Market Analysis and Forecasts to 2015." October 2009. PRLog.com web site. <http://www.prlog.org/10394296-global-ultracapacitors-market-analysis-and-forecasts-to-2015.html> (accessed December 9, 2009).

<sup>5</sup> "Demand for Supercapacitors Expected to Surge." June 2009. Lux Research. Cloud Computing Journal web site. <http://au.sys-con.com/node/997023> (accessed December 9, 2009).

<sup>6</sup> Ibid.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

measures a capacitor's storage potential), or \$2.85 per kiloJoule.<sup>9</sup> Prices in 2008 have now reached below \$0.01 per farad, and they are expected to decline further in the medium-term.<sup>10</sup>

Market size and growth rate are a function of the number of people in the market and the anticipated rate of buying. As markets transition between emerging, growth, shakeout, mature, and declining, the basis for competition and the number of competitors usually changes, along with the factors influencing adoption of innovation. The number of and growth rate for customers suggests how many units might be sold.<sup>11</sup>

<i>Our Current View on the Phase of the Market</i>	
<b>Today</b>	<b>Trend</b>
Early Growth	Growth

Supercapacitors are still in the relatively early stages of commercialization.<sup>12</sup> However, the technology has begun to move into more mainstream applications, and many supercapacitor firms are displaying significant growth in sales volumes.<sup>13</sup> This is indicative of a market transitioning from an emerging phase to a growth phase. This trend is expected to continue in the medium-term, as a significant increase in demand is forecast, spurred primarily by the continued growth in the electric/hybrid electric vehicle and renewable energy markets.<sup>14</sup>

Markets can also be described in terms of the basis for competition (best technological performance, best value or the price/performance tradeoff that best matches the end-users' preferences, lowest cost, or best availability or the ability to get the product quickly). This dimension helps to define the context in which a commercialization strategy must be developed.

<i>Basis for Competition in the Arena</i>	
<b>Today</b>	<b>Trend</b>

<sup>9</sup> Ball, Richard. "Supercapacitors see growth as costs fall." March 2006. Electronics Weekly web site. <http://www.electronicsweekly.com/Articles/2006/03/03/37810/Supercapacitors-see-growth-as-costs-fall.htm> (accessed December 10, 2009).

<sup>10</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>11</sup> For a detailed discussion of the "innovativeness dimension," see Everett M. Rogers, *Diffusion of Innovations*, 4<sup>th</sup> ed. (New York: Free Press, 1995). For further readings related to market phases and innovation, see also James Utterback, *Mastering the Dynamics of Innovation* (Boston: Harvard Business School Press, 1996) and Vijay K. Jolly, *Commercializing New Technologies: Getting from Mind to Market* (Boston: Harvard Business School Press, 1997).

<sup>12</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>13</sup> Ball, Richard. "Supercapacitors see growth as costs fall." March 2006. Electronics Weekly web site. <http://www.electronicsweekly.com/Articles/2006/03/03/37810/Supercapacitors-see-growth-as-costs-fall.htm> (accessed December 10, 2009).

<sup>14</sup> "NanoMarkets Publishes Report on Batteries and Supercapacitors for Smart Grid." 2009. PR Newswire. HighBeam Research web site (subscription required). <http://www.highbeam.com> (accessed December 9, 2009).

Competition in the market for supercapacitors appears to be driven by cost, as low unit prices are one of the most important requirements supercapacitor manufacturers must meet in order to satisfy end-user needs.<sup>15</sup> Competition primarily based on cost is further evidenced by the growing commoditization of supercapacitors, which are relatively undifferentiated and are competing in highly price-sensitive markets.<sup>16</sup>

In each market there may be stakeholders and companies with significant market share that will influence the introduction of your technology. Some organizations or companies that will likely influence the introduction of this technology are the following:

<i>Examples of Major Competitors in the Arena</i>		
<b>Competitor</b>	<b>Relevance</b>	<b>Web site</b>
Panasonic	Panasonic is a leading international electronics company that manufactures a wide range of capacitors for high and low voltage applications. <sup>17</sup>	<a href="http://industrial.panasonic.com">http://industrial.panasonic.com</a>
Maxwell Technologies	Maxwell develops and manufactures ultracapacitors for a wide range of industrial, consumer, energy, and transportation applications. <sup>18</sup>	<a href="http://www.maxwell.com">http://www.maxwell.com</a>
NEC – Tokin	NEC – Tonkin is a Japan-based company that produces tantalum capacitors, electric double layer capacitors, and lithium ion rechargeable batteries. <sup>19</sup>	<a href="http://www.nec-tokin.com/english/">http://www.nec-tokin.com/english/</a>
NESSCAP Co. Ltd.	NESSCAP is involved in the research, development, manufacturing and sales of a number of ultracapacitor products. <sup>20</sup>	<a href="http://www.nesscap.com/companyinfo_aboutnesscap.htm">http://www.nesscap.com/companyinfo_aboutnesscap.htm</a>
ELNA Co., Ltd.	Elna specializes in a wide range of capacitor products including electric double layer capacitors. <sup>21</sup>	<a href="http://www.elna-america.com/">http://www.elna-america.com/</a>

<sup>15</sup> “The Ultracapacitor Competition Intensifies.” March 2009. New Energy and Fuel web site. <http://newenergyandfuel.com/http://newenergyandfuel.com/2009/03/20/the-ultracapacitor-competition-intensifies/> (accessed December 9, 2009).

<sup>16</sup> “Demand for Supercapacitors Expected to Surge.” June 2009. *Lux Research*. Cloud Computing Journal web site. <http://au.sys-con.com/node/997023> (accessed December 9, 2009).

<sup>17</sup> “Industrial Solutions.” Panasonic web site. [http://industrial.panasonic.com/ww/products\\_e/passive\\_electromech\\_e/passive\\_electromech\\_e.html#AB](http://industrial.panasonic.com/ww/products_e/passive_electromech_e/passive_electromech_e.html#AB) (accessed December 9, 2009).

<sup>18</sup> “Applications.” Maxwell Technologies web site. <http://www.maxwell.com/ultracapacitors/applications/industrial.asp> (accessed December 9, 2009).

<sup>19</sup> “Core Business.” NEC – Tonkin web site. <http://www.nec-tokin.com/english/info/jigyoku.html> (accessed December 9, 2009).

<sup>20</sup> “About NESSCAP.” NESSCAP web site. [http://www.nesscap.com/companyinfo\\_aboutnesscap.htm](http://www.nesscap.com/companyinfo_aboutnesscap.htm) (accessed December 9, 2009).

<sup>21</sup> “About Us.” ELNA America web site. <http://www.elna-america.com/aboutus.php> (accessed December 9, 2009).

Cap-XX Ltd	Cap-XX produces high power prismatic supercapacitors for wireless, consumer and commercial applications. <sup>22</sup>	<a href="http://www.cap-xx.com/">http://www.cap-xx.com/</a>
Nippon Chemi-Con Corporation	Nippon Chemi-Con manufactures a variety of electronic components including electronic double layer capacitors. <sup>23</sup>	<a href="http://www.chemi-con.co.jp/e/index.html">http://www.chemi-con.co.jp/e/index.html</a>
Ioxus Inc.	Ioxus produces ultracapacitors and hybrid capacitors for high performance applications. <sup>24</sup>	<a href="http://www.ioxus.com/">http://www.ioxus.com/</a>

<i>Examples of Key Stakeholders or Networking Channels with Contact Information</i>		
<b>Stakeholder</b>	<b>Relevance</b>	<b>Contact Information</b>
The Electronic Components Association (ECA)	The Electronic Components Association (ECA) represents the electronics industry sector, which comprises manufacturers and suppliers of passive and active electronic components, component arrays and assemblies, and commercial and industrial electronic equipment and supplies. <sup>25</sup>	2500 Wilson Boulevard Arlington, VA 22201  <a href="http://ec-central.org">http://ec-central.org</a>
International Electronics Manufacturing Initiative (iNEMI)	iNEMI is an industry-led consortium that seeks to advance technology and industry development, as well as to promote the dissemination of best business practices and the forming of industry-wide standards. <sup>26</sup>	2214 Rock Hill Road Room 1409 Cimic Tower Suite 110 800 Shang Cheng Road Herndon, VA 20170 Tel: 703-834-0330  <a href="http://www.inemi.org/cms/">http://www.inemi.org/cms/</a>
International Electrotechnical Commission (IEC)	The IEC is a leading electronics organization that promotes international development and cooperation; it helps form and publish standards for electrical, electronic and related technologies. <sup>27</sup>	3, rue de Varembé P.O. Box 131 CH - 1211 Geneva 20 Switzerland Tel: +41 22-919-02-11  <a href="http://www.iec.ch">http://www.iec.ch</a>
The Energy Storage Council (ESC)	The ESC was established to advance the research, development and deployment of energy storage technologies. <sup>28</sup>	3963 Flora Place 2nd Floor St. Louis, MO 63110 Tel: 314-363-4546

<sup>22</sup> Cap-XX web site. <http://www.cap-xx.com/> (accessed December 10, 2009).

<sup>23</sup> "Company Profile." Nippon Chemi-Con web site. <http://www.chemi-con.co.jp/e/company/index.html> (accessed December 10, 2009).

<sup>24</sup> Ioxus web site. <http://www.ioxus.com/> (accessed December 10, 2009).

<sup>25</sup> "About Us." Electronic Components Association web site. <http://ec-central.org/membership/index.cfm> (accessed December 9, 2009).

<sup>26</sup> "About iNEMI." International Electronics Manufacturing Initiative web site. <http://www.inemi.org/cms/about/> (accessed December 9, 2009).

<sup>27</sup> "Mission and Objectives." The International Electrotechnical Commission web site. <http://www.iec.ch/about/mission-e.htm> (accessed December 9, 2009).

<sup>28</sup> "About the ESC." The Energy Storage Council web site. <http://www.energystoragecouncil.org/index.html> (accessed December 9, 2009).

		<a href="http://www.energystoragecouncil.org/">http://www.energystoragecouncil.org/</a>
KiloFarad International	Kilofarad International (kFI) is an industry association established to promote the interests of the ultracapacitor community. <sup>29</sup>	2500 Wilson Blvd Suite 310 Arlington, VA 22201 Tel: 858-503-3335  <a href="http://www.kilofarad.org">http://www.kilofarad.org</a>
Electric Power Research Institute (EPRI)	The EPRI is involved in the research and development (R&D) of power generation, transmission and use for the betterment of the public. <sup>30</sup>	3420 Hillview Avenue Palo Alto, CA 94304 Tel: 800-313-3774  <a href="http://my.epri.com">http://my.epri.com</a>
The Consumer Electronics Association (CEA)	The CEA represents 2,000 companies within the consumer electronics industry, and it provides market research, training, and representation throughout the industry. <sup>31</sup>	1919 S. Eads St. Arlington, VA 22202 Tel: 703-907-7650  <a href="http://www.ce.org/">http://www.ce.org/</a>

Entry barriers are obstacles that remove customer segments from the market for some period of time. They limit the size of the addressable market in general or the market share that can be captured. These barriers must be overcome or avoided to have a successful market entry. Our work to date suggests the following entry barriers may prevent customer segments from buying this type of technology for some period of time.

<i>Market Entry Barriers</i>	
<i>Name of Barrier</i>	<i>Description/Why</i>
<b><i>Lack of Standardization</i></b>	Supercapacitors are available in a variety of form factors – with cylindrical and rectangular designs being the most common. Retrofitting supercapacitors into existing commercial applications requires special attention and development to be effective. Proper product standardization is necessary to increase the versatility and drive further commercialization of the technology. <sup>32</sup>
<b><i>Highly Competitive Marketplace</i></b>	The market is dominated by a select group of vendors, <sup>33</sup> and there is a great deal of competition among manufacturers. <sup>34</sup> Overall, market share is highly concentrated, with Panasonic, Maxwell, and NESSCAP controlling over 75% of the supercapacitor market. <sup>35</sup> Further competition is likely as the market transforms into a more commodity-based business. <sup>36</sup> This increased commoditization and competition will likely prove challenging to new firms

<sup>29</sup> “About Us.” KiloFarad International web site. <http://www.kilofarad.org/aboutus/overview.html> (accessed December 9, 2009).

<sup>30</sup> Electric Power Research Institute web site. <http://my.epri.com> (accessed December 9, 2009).

<sup>31</sup> “About CEA.” Consumer Electronics Association web site. <http://www.ce.org/AboutCEA/default.asp> (accessed December 9, 2009).

<sup>32</sup> “World Ultracapacitor Markets.” July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>33</sup> Ibid.

<sup>34</sup> Steve Eckroad (Energy Storage Project Manager, EPRI), 650-855-1066, in a telephone conversation with Krysten Oates on January 22, 2009.

<sup>35</sup> “World Ultracapacitor Markets.” July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>36</sup> Ball, Richard. “Supercapacitors see growth as costs fall.” March 2006. Electronics Weekly web site. <http://www.electronicseweekly.com/Articles/2006/03/03/37810/Supercapacitors-see-growth-as-costs-fall.htm> (accessed December 10, 2009).

	entering the market place.
<b>High Manufacturing and Capital Costs</b>	High capital and manufacturing costs have been a major impediment to the overall supercapacitor industry, with some estimating these costs to be about 50 times higher than those of batteries. <sup>37</sup> These high costs stem primarily from the use of proprietary raw materials such as activated carbon beds, nano-sized carbons, and doped substrate materials. These special materials have proven to be a major challenge to reducing the cost of manufacturing, <sup>38</sup> and may be prohibitively expensive for new or smaller, less well-capitalized firms.

Price remains a significant barrier to further market penetration and expansion of supercapacitors.<sup>39</sup> Economies of scale are seen to be the only factor that can successfully bring down the cost of supercapacitors, as raw material manufacturers currently have a strong bargaining position that has been utilized to keep cost per unit high.<sup>40</sup>

Market drivers are forces that strengthen or weaken the importance of end-user needs over time. Practice level drivers are micro-economic; they affect the end-user directly. They influence the selection of substitutable goods and thus affect market share. Arena level drivers affect the organizations and industrial sectors in which the end-users work. They influence the overall demand for goods like this technology and its substitutes. They affect when and how much of the total addressable market is actually going to be in the market and buying.

<i>Market Drivers</i>	
<b>Name of Driver</b>	<b>Why Significant</b>
<b>Cell Phone and Digital Camera Use Stimulates Demand</b>	Cell phones and digital cameras will likely drive further supercapacitor adoption in electronics. Multimedia cell phones and autofocus cameras both have high pulse power demands that batteries and conventional capacitors are poorly equipped to provide, and this issue is expected to spark supercapacitor growth in the sector. <sup>41</sup>
<b>Diverse Market Applications</b>	The number of applications for supercapacitors is growing. Stop-and-go applications such as aircraft door mechanisms, forklifts and cranes are creating new market opportunities for supercapacitor offerings. The technology has also generated significant interest in renewable energy markets, where they can be utilized as an uninterrupted power system (UPS) for wind turbines, <sup>42</sup> and as a

<sup>37</sup> "Global Ultracapacitors Market Analysis and Forecasts to 2015." October 2009. PRLog.com web site. <http://www.prlog.org/10394296-global-ultracapacitors-market-analysis-and-forecasts-to-2015.html> (accessed December 9, 2009).

<sup>38</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>39</sup> LaMonica, Martin. "Ultracapacitors look to fit into energy storage." September 2009. CNET News web site. [http://news.cnet.com/8301-11128\\_3-10363496-54.html](http://news.cnet.com/8301-11128_3-10363496-54.html) (accessed December 9, 2009).

<sup>40</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>41</sup> "Demand for Supercapacitors Expected to Surge." June 2009. *Lux Research*. Cloud Computing Journal web site. <http://au.sys-con.com/node/997023> (accessed December 9, 2009).

<sup>42</sup> Wang, Sibio, et al. "Supercapacitor Energy Storage Technology and its Application in Renewable Energy Power Generation System." *Proceedings of ISES World Congress 2007 (Vol. I – Vol. V)*. Springerlink web site. <http://www.springerlink.com/content/k23382u24w5485p4/> (accessed December 10, 2009).



	storage device for solar power systems. <sup>43</sup> These emerging applications are expected to drive demand in the long-term. <sup>44</sup>
<b><i>Growth in Demand from the Automotive Industry</i></b>	Hybrid and electric vehicles are augmenting demand for supercapacitors as regenerative braking and stop-and-go (ignition acceleration and starting) applications have gained significant industry interest. <sup>45</sup> However, it is important to note that the automotive sector is reorganizing due to current economic conditions and, as such, the demand for supercapacitors may not grow as robustly as previously expected. <sup>46</sup> This is likely to be a short-term challenge but, even so, the automotive industry is predicted to be one of the primary market drivers for supercapacitors in the long-term. <sup>47</sup>
<b><i>Increased Demand from Utility Markets</i></b>	Utilities are increasingly using advanced energy storage systems such as supercapacitors to maintain a continuous supply of power during the period between a blackout and the start of back-up power. Within the power grid, the deployment of supercapacitors is expected to gain momentum, especially with increased emphasis on smart grid initiatives in developed world economies. <sup>48</sup>

The automotive sector is expected to be the main driver of supercapacitor market in the long-term.<sup>49</sup> Current demand for supercapacitors is expected to increase significantly as interest in the transportation market accelerates.<sup>50</sup> Although it is expected that supercapacitors may never fully power a long-range electric vehicle, when strategically deployed they can greatly reduce the need for large battery packs and can significantly reduce the heat stress on battery systems, as they can effectively operate in a wide range of hot and cold temperatures.<sup>51</sup> In addition to the transportation sector, new applications in renewable energy production and distribution will likely also help drive demand for

<sup>43</sup> Daugherty, Mark. Leonard, Kevin. "Ultracapacitors for Renewable Energy Storage." Solrayo web site. [http://www.solrayo.com/SolRayo/Renewable\\_Energy\\_Slides\\_files/Ultracapacitors\\_for\\_Renewable\\_Energy\\_Storage\\_Webinar.pdf](http://www.solrayo.com/SolRayo/Renewable_Energy_Slides_files/Ultracapacitors_for_Renewable_Energy_Storage_Webinar.pdf) (accessed December 9, 2009).

<sup>44</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>45</sup> "Power and Charger Market for Material Handling Equipment." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>46</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>47</sup> Ball, Richard. "Supercapacitors see growth as costs fall." March 2006. Electronics Weekly web site. <http://www.electronicseweekly.com/Articles/2006/03/03/37810/Supercapacitors-see-growth-as-costs-fall.htm> (accessed December 10, 2009).

<sup>48</sup> "Global Ultracapacitors Market Analysis and Forecasts to 2015." October 2009. PRLog.com web site. <http://www.prlog.org/10394296-global-ultracapacitors-market-analysis-and-forecasts-to-2015.html> (accessed December 9, 2009).

<sup>49</sup> "Need for Reliable, High Quality Power Supply Drives the Global Ultracapacitors Industry." November 2009. Bharatbook.com. Online PR News web site. <http://www.onlineprnews.com/news/10479-1257315092-need-for-reliable-high-quality-power-supply-drives-the-global-ultracapacitors-industry.html> (accessed December 9, 2009).

<sup>50</sup> "World Ultracapacitor Markets." July 2009. Frost & Sullivan web site (subscription required). <http://www.frost.com> (accessed December 9, 2009).

<sup>51</sup> Motavalli, Jim. "Ultracapacitors: Maybe Not Miracle Workers, but Great EV Power Potential." November 2009. BNET web site. <http://industry.bnet.com/auto/10002905/ultracapacitors-maybe-not-miracle-workers-but-great-ev-power-potential/> (accessed December 9, 2009).



supercapacitors, as domestic and international goals for alternative energy deployment cannot be met without significant new storage capability installed in national grids.<sup>52</sup>

Here are some additional data and sources that can help you better understand the market.

<i>Name</i>	<i>Description</i>
Ultracapacitors.org	<p>This web site is a useful resource that provides new, data, research and product information regarding supercapacitor technology and business.</p> <p>For more information please see the following URL: <a href="http://www.ultracapacitors.org/">http://www.ultracapacitors.org/</a></p>
Global Spec: Products/Services for capacitor storage energy	<p>The products and services listing page for capacitors provides a detailed list of numerous manufacturers and suppliers of a wide range of capacitors with differing capacitance range, tolerance and voltage range.</p> <p>For more information please see the following URL: <a href="http://electronic-components.globalspec.com/Industrial-Directory/capacitor_storage_energy">http://electronic-components.globalspec.com/Industrial-Directory/capacitor_storage_energy</a></p>

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<sup>52</sup> “NanoMarkets Publishes Report on Batteries and Supercapacitors for Smart Grid.” 2009. *PR Newswire*. HighBeam Research web site (subscription required). <http://www.highbeam.com> (accessed December 9, 2009).