



HYDROVOLTS, INC. BUSINESS PLAN

Sustainability Section Excerpt

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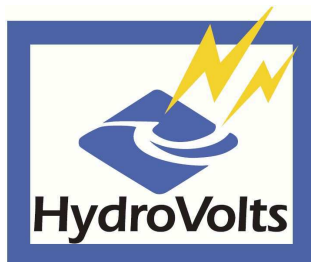
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1. The Opportunity

For over three thousand years people have tried to make renewable energy from fast water currents in rivers and canals, building large paddlewheels driven by the current to make energy or power machinery. Paddlewheels have largely disappeared because they are big, complex and so costly and inefficient that they generally cannot compete with other power sources. Now Hydrovolts, Inc. has invented a better way to tap the power of the world's fast currents using an ingenious new paddlewheel that spins underwater. The Hydrovolts turbine will make renewable energy in millions of sites never before feasible.

The patent-pending turbine resembles a car axle with wheels that floats in the current. Paddle blades are attached to the axle, and anchor lines are attached to the wheels. The anchor lines are attached to the shore or channel bottom and they prevent the wheels from turning; instead the water pushes the paddle blades and thus spins the shaft between the wheels which spins a generator to make electricity. A unique hinge mechanism for the blades reduces drag on one side of the shaft so there is a strong differential of power across the shaft to create rotation and generate power. This hinge mechanism gives the turbine its name, the Flipwing turbine. The Flipwing is being initially developed at a single size with dimensions approximately 1m x 1m x 2m which has the broadest application to the greatest number of sites. It will generate between 1-10kW, depending on water speed. Later two incrementally larger versions will be developed to expand the number of sites that can be economically tapped; these will generate up to 25kW or more in faster currents. The fully capitalized cost of energy for all unit sizes is expected to be less than 2 cents per kilowatt-hour (c/kWh), considerably less expensive and more reliable than solar or wind power. This turbine creates the opportunity to make renewable energy from millions of water channels and currents.

The Hydrovolts business model is equally innovative. The market opportunity for hydrokinetic energy generation is not in rivers or tidal channels—it is in constructed waterways such as irrigation canals, water diversion channels, discharge channels for wastewater, cooling water and large hydropower projects. These waterways generally have steady, predictable currents, little or no debris, no endangered species, and easy access by road. They are maintained by large engineering organizations that know how to install and maintain machinery. Hydrovolts will sell turbines for installation in these ideal sites where they will provide reliable renewable electricity. In future, Hydrovolts can address significant future market segments of enormous potential after attaining technological and commercial validation in manmade watercourses, including remote ocean sensors, tidal flows, ocean currents, and rivers and streams throughout the world, especially in areas not currently well-served by a grid or other generation.

The irrigation districts of the western US are the primary market opportunity for the new Hydrovolts technology. The company estimates that 88,000 units, with average price of ~\$21,000 each, can be installed in just the districts supplied by big water canals from federal dams and diversion projects. These accessible and motivated customers will enable Hydrovolts to grow at a rapid pace and scale up production of the technology. The company will then start providing its new portable hydropower turbines to the rest of the world. Millions of people living along rivers, canals and tidal channels will one day benefit from this new clean energy breakthrough.

Sustainability

Organizational Overview

The ultimate sustainability of any organization depends on its fundamental management systems and employment culture. Hydrovolts CEO Burt Hamner has been a consultant to business and government on sustainable management systems since 1991. His articles on sustainable industry have been published in books, academic journals and trade magazines. The Hydrovolts organization reflects his 18 years of consulting, research and publication on cleaner production and sustainable industry. More information and his publications are available at www.cleanerproduction.com.

The guiding framework for Hydrovolts organization performance management is the *Criteria for Performance Excellence* of the Malcolm Baldrige National Quality Award. The *Criteria* explicitly include extensive sustainability goals. Since 1987 the *Criteria* has been the definitive and internationally recognized standard for high-performance organizations, used by thousands of companies and organizations who share their best practices. As a professor in Peru, Burt developed a guideline for the national pension fund showing how the Baldrige criteria can be explicitly linked, element by element, to sustainable performance.¹ Hydrovolts will compete every year for the Baldrige award and actively participate in the best practices networks.

For managing and reporting on sustainability Hydrovolts will follow the *Sustainability Reporting Guidelines* of the Global Reporting Initiative (GRI) which outlines a comprehensive approach to track and measure accountability internally and externally to stakeholders. Among the many different standards proposed, the GRI has the most substantive structure and membership, detailed technical criteria, and extensive supporting network. As a consultant to the City of Spokane, Washington, Burt designed pro forma financial statements (income statement and balance sheet) that integrate most of the criteria used for the GRI Guidelines. This enables Hydrovolts management to show sustainable performance indicators right in their accounting system.

For operational control, Hydrovolts will implement a Total Quality Management (TQM) system based on the Toyota model. Since 2002 Burt has been teaching how to use Lean Manufacturing to reduce pollution and increase sustainability. Hydrovolts will explicitly follow guidance from the EPA's publication, *Lean and Environment Toolkit*. The *Toolkit* focuses on the identification and how to pursue environmental end points in production processes through Kaizen Events, 6S (5S + Safety); and Value Stream Mapping. The TQM and lean approach is consistent with the ISO 14001 Environmental Management Systems standard, which Hydrovolts will also follow.

For additional control Hydrovolts will use Activity-Based Costing (ABC) for its management accounting. ABC is ideal for batch manufacturing of products with several models. It is process-based and complementary to value stream mapping and life cycle analysis. With an ABC system all costs of waste and emissions are assigned to the responsible process and product/component, where they can be effectively managed. For example if use of one chemical product triggers regulatory compliance requirements, then the entire cost of compliance is added to the purchase price of that chemical and the cost of that production step. This highly motivates managers to find alternative products that don't have regulatory costs.

Industry Organizations and Sustainability Standards

There are two hydropower sustainability organizations with whom Hydrovolts will partner. The Low Impact Hydropower Institute (LIHI) publishes criteria and certifies traditional dam hydropower projects as "Low Impact." It does not yet include micro-hydro or hydrokinetic in-stream project certification,

¹ *Integrating Market-Based Sustainability Indicators and Performance Management Systems*. Universidad del Pacifico, 2006. <http://cleanerproduction.com/Pubs/pubs/Hamner%20-%20Market%20CSR%20Indicators%20and%20Quality%20Systems.doc>

however, these topics are under consideration. Hydrovolts has proposed helping LIHI develop sustainability criteria for turbine installation in natural rivers and streams, a key future segment.

The International Hydropower Association (IHA) has developed three key sustainability tools to guide sustainable planning, implementation and operation of hydropower, including *Guidelines*, *Assessment Protocol* and *Sustainability Assessment Forum*. Hydrovolts will join IHA and become expert in using the tools and participating in the *Forum*. From this position Hydrovolts will educate elected officials and customers about the sustainability guidelines and how its turbines advance sustainability objectives.

Hydrovolts will become an active member of the American Council on Renewable Energy and the US National Hydropower Association. It will help its customers benefit from the resources they provide to become more sustainable. Hydrovolts will be an active member of the Better Business Bureau, an important credential for a new company selling complex equipment to irrigation districts and other rural organizations. It also provides good network building opportunities with local companies.

Product Sustainability

Impact: Hydrovolts turbines provide clean renewable electrical energy to replace that from fossil fuel combustion. Replacing fossil fuel reduces emissions, resource depletion, environmental degradation, and negative worker impacts. In the western US which has substantial hydropower on its grid, Hydrovolts generators reduce the need for more traditional hydropower which blocks rivers, submerges ecosystems and generates a large carbon footprint from major construction activities. In places with no electricity at all, Hydrovolts turbines would help launch new local sustainable economies. In such places electric light often replaces fires used inside at night, which generate GHG. Electricity would improve local health and reduce GHG emissions and forest depletion. There is little impact in turbine operation, especially in the primary irrigation canal market where the flows are controlled and have few if any fish.

The main social impact of Hydrovolts turbines is in its secondary markets, providing electricity in places that have never had it reliably before. In the developing world a Hydrovolts turbine would light a school, power telephone infrastructure, or keep vaccines cold—it would have a powerfully positive impact on the lives of an entire village; in the aggregate it is a force for social betterment worldwide.

Quantitative Analysis: Carbon emissions from small-scale hydroelectric power have been calculated at 6g of carbon dioxide equivalents (CO₂e) per kWh, the lowest of all power generation alternatives². Hydrovolts turbines displace CO₂e that would have been emitted using other sources; the amount depends on the fuel and location. Coal produces ~200g of CO₂e for each kWh generated; thus a small Hydrovolts turbine with 95% capacity factor over its 15-year nominal lifetime displaces more than 60 kilotonnes of CO₂e if replacing electricity from coal. A diesel generator produces about 1kg of CO₂e for each kWh generated; substituting a Hydrovolts turbine would displace more than 310 kilotonnes of CO₂e over its lifetime. These figures are just for burning the fuel; extraction, preparation/refining and transporting the fuel emit more CO₂e. For customers dependent on diesel or biofuel generators the Hydrovolts alternative is vastly preferable for resource conservation.

Process Sustainability

Impact: Hydrovolts turbines consist principally of a rotor, a generator, power electronics, and a frame/housing. Most of the rotor and housing are fabricated from steel and aluminum. The generator is also steel in part, and has copper wire windings and neodymium magnets. The power electronics are electronic circuit boards and components of typical composition. The turbine will likely have trace amounts of other materials, including other metals, rubber and plastic. Along with energy, these are the primary inputs. Various packaging materials will also be used in transporting components and the finished turbines, including wood and paper products. Outputs in manufacture include heat and emissions at all stages, metal refining by-products, wastewater, and toxic residues from the electronic component manufacturing process.

² European Commission, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=SEC:2008:2872:FIN:EN:PDF>

Quantitative Analysis: Hydrovolts uses an Economic Input-Output Life Cycle Assessment (EIO-LCA) tool based on the approach of Nobel economist Wassily Leontief.³ It provides an analysis of cradle-to-grave impacts of the entire supply chain and manufacturing process per dollar output of turbine and turbine generator set units manufacturing (NAICS 333661), and specifically includes hydro turbines. A small Hydrovolts turbine uses 64.9GJ of energy, and emits 5.3 tonnes of CO₂e and 13.2kg of toxic discharges in its full lifecycle, almost all of it during manufacturing and transportation. The embodied energy of a small Hydrovolts turbine is 208kJ/kWh. This is about 4 times higher than for conventional hydro⁴, a result likely due to both scale and expected operating lifetime, but is substantially smaller than traditional (fuel-based) alternatives that Hydrovolts intends to displace.

There are three stages in a net energy analysis: construction, operation, and decommissioning. Operational and decommissioning impacts are minor—98% of the energy use and 99% of the toxic residues occur in the construction phase. CO₂e emissions are divided 89% in the construction phase and 11% in the decommissioning phase, primarily from transportation. Impacts from the top 5 sectors are:

Sector	Energy Use (GJ)	CO ₂ e Emissions (tonnes)	Toxics (kg)
Metal mining & processing	17	1.3	11
Power generation & supply	20	1.7	0.37
Transportation	5.3	0.53	0.00
Waste & remediation	0.54	0.22	0.12
Turbine manufacture	0.85	0.40	0.35
Other	11	1.1	1.3

Mitigation: The biggest impacts are in metal mining & processing, energy use and transportation, (especially in construction) and most require a supply chain management solution. Hydrovolts will choose materials with reduced environmental impact and high recycled content wherever possible. Hydrovolts will minimize the length of the supply chain which will reduce transportation impacts. As Hydrovolts becomes a more important customer to its vendors it will initiate environmental and social assessments of vendors and work with them to improve their sustainability, including ensuring healthy conditions and a living wage for workers. This will be particularly important for production of generators, power electronic components, and local metal parts fabricators. A sustainability assessment—economic, environmental and social—will be a standard part of bid requests and supplier selection criteria.

Turbines will be built with modular parts for easy part replacement, refurbishment, decommissioning and disassembly using common tools, extending useful equipment life. Design will also emphasize durability; a 15 year turbine warranty encourages appropriate maintenance and repair. No hydrocarbons are used for lubrication; turbines require minimal maintenance: hand cleaning and tuning without chemicals or other supplies. Product shipment will employ only reusable containers and renewable packaging (wooden crates and cardboard) to the minimal extent necessary.

Hydrovolts will implement a cradle-to-cradle take back program to recover, reuse and repurpose all components and materials of its turbine product, greatly reducing the 3 top impacts. Metals will be re-used and generators will be rebuilt. The turbines will be designed for disassembly and component recovery, significantly reducing manufacturing impacts. Instructions will be provided at purchase and available on the web detailing specific steps for disposal of turbines and replaced parts. Hydrovolts will facilitate this “de-supply chain” by maintaining a database of local parts suppliers, recyclers, and

³ Carnegie Mellon University Green Design Institute. (2009) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 1997 Industry Benchmark model [Internet], Available from:<http://www.eiolca.net> Accessed 8/22/09.

⁴ <http://pubs.acs.org/doi/abs/10.1021/es900125e>

reclamation centers and providing incentives to have customers ship back certain parts of the turbines for refurbishment and reclamation, reducing impacts by reusing where possible.

Customer Sustainability: Many Hydrovolts customers will buy turbines because they want to be more sustainable. To help them achieve this goal Hydrovolts will, when feasible, help its customers with community development projects. In these efforts Hydrovolts will follow guidance in the report by the International Finance Corporation (IFC), *Investing in People, Sustaining Communities through Improved Business Practice: A Community Development Guide for Companies*. This is a manual of best practices compiled by IFC staff from developing countries around the world. Hydrovolts efforts will naturally focus on sustainable energy generation, but this will be done in the context of helping the communities become more sustainable in general. For example, an irrigation district may want to explore all its renewable energy options, not just hydropower, and Hydrovolts can help them develop a community-based approach for bringing together all the people in the district who are interested in energy projects of any kind. Hydrovolts will specifically train its distributors who work regionally on ways to help communities be more sustainable.

International Development: Hydrovolts will initially concentrate on its primary market of irrigation canals in the western US; meanwhile interest in the technology will certainly increase around the world. Hydrovolts anticipates international expansion by 2011, and will partner with governments and international development agencies that provide grant funding and community development support. Working through experienced international aid programs will have more sustainable outcomes than simply selling turbines to individual customers, and will make the technology more accessible to the four billion people “at the bottom of the pyramid”. Hydrovolts CEO Burt Hamner has over 15 years experience as a clean technology consultant to USAID and the UN.

Pitch Sustainability

Transparency and Disclosure: Hydrovolts will conform as much as possible to the Low Impact Criteria of the LIHI and the Sustainability Guidelines of the IHA. The company will apply for micro-hydropower or hydrokinetic power certifications as they are developed. Hydrovolts will produce an annual Sustainability Report that is in conformance with the Global Reporting Initiative *Guidelines* and audited independently according to the AA 1000 standard. It will implement ISO 14001-compliant EMS for its manufacturing facilities and publish annual performance reports for facilities. These reports will be featured in press releases, on the web site, and in communications to investors, customers and other stakeholders. In regional markets Hydrovolts will obtain external certification dependent on the requirements of customers and regulators. Hydrovolts will acquire a B Corporations report and comply with all applicable standards, including ROHS and WEEE, and expects to adopt the recommendations of ISO 26000 when it is published in 2010.

Employees: Job descriptions, hiring criteria and performance reviews will explicitly include sustainability criteria developed specifically for the job. Hydrovolts will use Open-Book Management so employees know how the company makes and spends its money and are motivated to improve cash flow. All employees are eligible for the company’s Stock Incentive Plan. Communication includes reviews twice a year, regular informal lunches with management, and an open door policy that encourages and rewards innovation, debate, and constructive criticism. Hydrovolts uses family-friendly personnel practices such as telecommuting, flex-hours, leaves of absence, and job sharing. Knowledge is at the heart of sustainability, and all employees will receive training at least yearly in operations and in sustainability. To put knowledge into practice, employees are allowed two days per month for independent projects to improve the product and operations. Manufacturing employees will be cross-trained, and sales and management employees will spend at least one week per year working in the manufacturing line. Manufacturing managers will spend at least one week per year visiting customers. They also must spend at least one day per month participating in leadership roles in community sustainability activities. Hydrovolts will also sponsor sustainability training for its distributors who are indirect employees.

Investors: Financial reporting for sustainability is now addressed in two seminal reports. The IFA has published its *Sustainability Framework*, a web-based tool for professional accountants to learn how to integrate and present sustainability information into standard accounts and financial reports. Hydrovolts will follow the *Sustainability Framework* and implement environmental accounting practices. Separately the Prince of Wales has sponsored the *Accounting for Sustainability* project and the *Connected Reporting Framework (CRF)*. The *CRF* is a reporting model which presents key sustainability information alongside more conventional financial information to give a more rounded and balanced picture of the organization's overall performance. Hydrovolts will use the *CRF* as a benchmark for presenting financial and sustainability information to investors.

Social Equity and Community Responsibility: All employees will receive at least a living wage. Hydrovolts will emphasize hiring within the communities in which it operates, seeking a workforce that reflects as much as possible the local demographics, including disadvantaged and handicapped individuals. Hydrovolts will manufacture its turbines regionally, creating jobs, wealth and economic opportunity. The manufacturing facilities will be demonstrations of clean and lean manufacturing and the facility managers will actively mentor other companies in their region to become more sustainable. Remote communities that buy Hydrovolts turbines will create electricity where it was previously sporadic or unavailable, facilitating broader economic development to the betterment of their residents.