POISED FOR PROFIT II:

PROSPECTS FOR THE SMART ENERGY SECTOR IN THE PACIFIC NORTHWEST

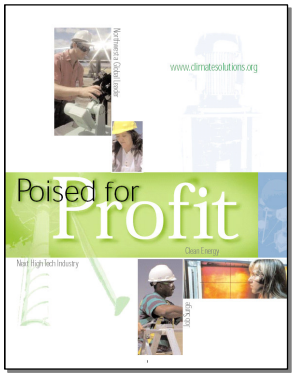
November 12, 2003

THE ATHENA INSTITUTE

TABLE OF CONTENTS

PREFACE

POISED FOR PROFIT: PROMOTING A NORTHWEST CLEAN ENERGY INDUSTRY



In 2001, eight economic development and energy agencies from Oregon, Washington, and British Columbia commissioned a study: *Poised for Profit: How Clean Energy Can Power the Next High-Tech Job Surge in the Northwest*. The resulting report revealed that the clean energy sector could be twice the size of the aircraft industry within 20 years. What's more, it could generate as many as 30,000 new jobs. That first report is available at www.climatesolutions.org.

A new partnership has come together to fund *Poised for Profit II,* follow-on research to support a world-class clean energy industry in the Northwest. Through the work of The Athena Institute, the project has produced a series of reports containing critical information for investors, entrepreneurs, and policymakers. These tools include:

- Research and analysis to pinpoint the largest and best opportunities
- Surveys of investor and utility plans
- Directories to research reports, related companies and helpful resources

This document is part of a research module called the Preliminary Analysis of Near-Term Opportunities. It reports on the market opportunities for Smart Energy technologies. Other documents in the module cover near-term prospects in wind, solar and fuel cells.

Turn to the Appendix for details on the project scope and methodology.

ABOUT THE PARTNERS

Poised for Profit II was jointly funded and guided by the following organizations and members of the Poised for Profit Steering Committee:

- **BC Hydro:** Karen Leach and Bruce Sampson
- **Bonneville Power Administration**: Mike Hoffman, Kevin O'Sullivan and Mike Weedall
- **City of Portland:** Jeff Cogen and Curt Nichols
- **NW Energy Technology Collaborative:** Lee Cheatham and Jeff Morris
- **Oregon Institute of Technology:** Howard Thurston
- **Oregon Office of Energy:** Mark Kendall
- **Leading Edge British Columbia:** Anton Kuipers

- **Pacific Northwest National Laboratory:** Mike Lawrence
- **Portland Business Alliance:** Molly Moore
- **Portland Development Commission:** Ann Griffin
- **Portland General Electric:** Joe Barra
- **Seattle Office of Economic Development:** Ben Wolters
- **Washington Office of Trade and Economic Development:** Tony Usibelli and Tim Stearns

About Climate Solutions

The *Poised for Profit* initiative is managed by Climate Solutions, a public interest group that works to make the Pacific Northwest a global warming solutions leader. Since 1998, the group has targeted development of a Northwest clean energy technology industry cluster as a globally significant contribution the Pacific Northwest can make to reduce greenhouse emissions. Climate Solutions generates leading-edge information and knowledge on clean energy technology and the economic opportunities it presents. The organization issues reports, organizes conferences and builds cross-cutting alliances to further the goal of rapid energy transition.

About The Athena Institute and The Center for Smart Energy

The Athena Institute is a research organization that helps executives and organizations find success in emerging markets. Its methodologies and insights have been implemented by many organizations, ranging from Fortune 1000 corporations to public policy agencies. Athena manages the **Center for Smart Energy** (www.centerforsmartenergy.com), the industry's guide to the value chain. The Center is dedicated to making North America the leader in Smart Energy innovation. The Center's research and acceleration programs help businesses and investors pursue their strongest opportunities in the Smart Energy sector.

Acknowledgements

The Athena Institute would like to recognize the following companies and individuals for their contributions to the *Poised for Profit* initiative in general and this report in particular.

For catalyzing the project and providing oversight, we acknowledge Climate Solutions, with special recognition to Rhys Roth.

For expert comments and research materials, we wish to thank:

- Peter Arias, Reed Global

- Clay Braziller, Canadian Institute for Market Intelligence
- Merwin Brown, SEC Consulting
- KC Golden and Patrick Mazza, Climate Solutions
- Steve Hauser, Utility Automation, Inc.
- Landis Kannenberg, Rob Pratt and Steve Widergren, Pacific Northwest National Laboratory
- Liz Thomas, Preston/Gates/Ellis
- Wal Van Lierop, Chrysalix Energy

We also acknowledge and thank the more than 135 individuals who gave of their time for discussions with Athena analysts during the course of this study. We are especially appreciative of the co-funders and members of the Steering Committee, who provided ongoing advice and assistance.

ABOUT THE RESEARCH INITIATIVE

The Athena Institute was tasked to identify near-term market opportunities for selected energy technologies. At the direction of the Steering Committee, we focused on opportunities that could see commercial success within five years, with emphasis on "cluster opportunities" that could have positive economic impact for Oregon, Washington and British Columbia. The Milken Institute defines clusters as "agglomerations of interrelated industries that foster wealth creation in a region." (For example, Washington's King County is known for its aerospace and software clusters.) This report relates to the prospects for regional cluster success. It does not address the prospects for individual companies or the economic benefits related to constructing and operating clean energy facilities such as job creation from wind farms or the economic benefits of spending less on imported energy. Please see the Appendix for more details on the project's scope and methodology.

Viewed through this filter, Smart Energy emerged as an area with significant near-term opportunities for the Northwest. Smart Energy is the application of digital technologies to the generation, delivery, and use of electric power. The use of the term "Smart" captures the fusing of intelligence into the existing system.

The challenge of the Smart Energy report was to create a coherent picture of an emerging sector not yet clearly defined. We first developed a way to organize and describe the sector. Then we uncovered those niches that represent the best opportunities for the Northwest. Because a taxonomy for this previously ill-defined industry has not yet been created, this Smart Energy sector report focuses at a broader level of analysis than the reports for fuel cells, solar, and wind.

INTRODUCTION

The world's electric power industry is in the early stages of an unstoppable change. A new wave of digital technology has arrived, promising to dramatically improve the generation, transport and use of electricity. Along the way will come enormous new opportunities, enormous new companies, and enormous new revenues.

The rewards will go to regions, companies and individuals that seize the chance. If the Pacific Northwest becomes one of those leaders, it can gain an industry of distinction to rival current mainstays such as aerospace, biotech, forest products and software.

This report outlines the sector, including its issues and market potential. It inventories the region, its assets and its challenges. And it reveals the opportunities -- the specific market niches that could bring near-term growth and revenue. It is divided into six areas:

- **Key Findings** -- an overview of the research results
- **Market Overview** -- an introduction to Smart Energy technologies and markets
- **Market Drivers** -- the factors promoting market growth
- **Market Barriers** -- the hurdles and obstacles
- **Market Potential** -- the segments with near-term growth potential around the world
- **Regional Potential** -- the Northwest's assets, challenges and specific opportunities, plus an overview of ways to accelerate progress

An appendix describes the project and its methodology.

KEY FINDINGS

The following section gives a quick scan of the research findings relevant to the Northwest. A more detailed executive summary of this report is available for download at www.centerforsmartenergy.com.

Smart Energy is currently a $15B business worldwide. Smart Energy, the application of digital technology to the electric power industry, represents a significant market opportunity. Growth is being driven by an aging infrastructure in need of upgrade, demand for premium power, the growing alternatives to centralized generation, new technologies now available, and by government support and market restructuring. Smart Energy will produce significant economic growth and export opportunities. The Pacific Northwest is ideally suited to build an industry of distinction that could be sustained for decades.

Northwest-Based companies are already doing $2B worth of business. Economic development is always easier when building on strengths and successes. The Northwest is already home to a significant Smart Energy industry. The Northwest has a number of additional assets including world-class research facilities, transmission and distribution experience, transferable private sector skills, environmental consciousness, and an ideal test bed environment.

The Northwest faces challenges with access to ideas, capital, markets, and with lack of geographical proximity. Examples include difficulties in getting ideas out of the laboratories, a shortage of energy-friendly venture capital, and eographic distance and regional rivalry. These hurdles must be overcome to build an economic cluster.

The Northwest has strong potential in several specific market niches. Our research has uncovered five market niches that have potential for near-term growth and a good match with our regional strengths. They are 1) Advanced Metering Technologies, 2) Utility Back-Office Software, 3) Grid Monitors and Controls, 4) Transmission/ Distribution/ Substation Automation, and 5) Power Electronics. We also found four additional opportunities with moderate potential: Energy Management Systems, Building Automation and Controls, Energy Management Service Companies, and Workforce Automation. *Our comments relate to the potential for an economic cluster, not to the prospects for individual companies, some of which will find success whether or not a cluster arises in the Northwest.*

The Northwest can accelerate the growth of a Smart Energy cluster. Several efforts could speed progress and strengthen the smart energy sector:

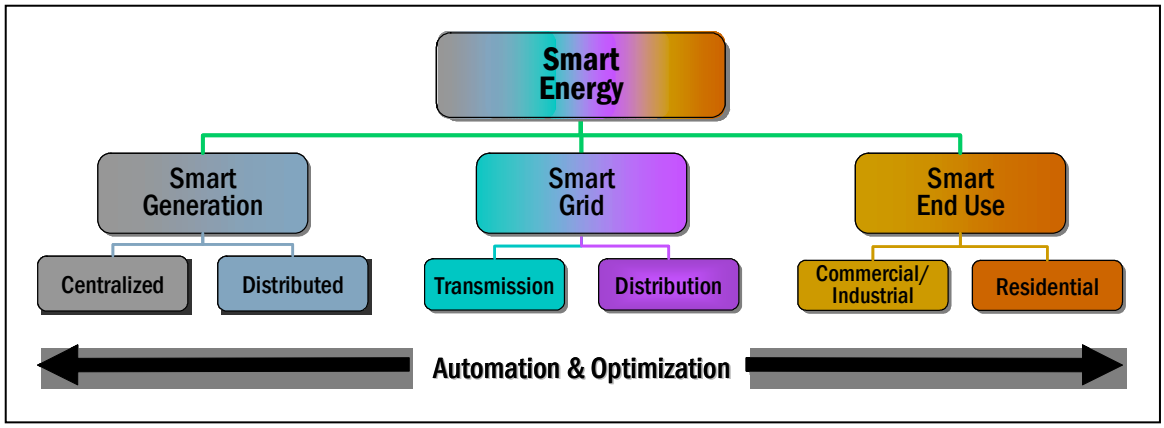
- **Advocacy of regulatory changes** to affect rates, regulations, policies and incentives to favor deployment
- **Standards and test beds** to use shared cost facilities and regional utility cooperation to test and certify products
- **Market transformation** activities to improve market access
- **Business assistance** such as trade associations, incubators and accelerators, and workforce training to provide resources for growth
- **Outreach and education** to investors and the business community to increase the awareness and interest in the sector
- **Pursuit of major research opportunities** to attract R&D dollars from government, foundations, and private companies

A coordinated plan that links initiatives together could move the region forward quickly. The Northwest is well positioned to become a world-class leader in this emerging Smart Energy sector.

A full treatment of each of these research results can be found in the sections that follow.

MARKET OVERVIEW:
DIGITAL TECHNOLOGY APPLIED TO ELECTRIC POWER

One of the challenges in Smart Energy is the lack of commonly accepted terms and definitions. Despite sales in the billions of dollars, the sector is poorly understood. Yet there *is* a unifying theme. In the simplest sense, Smart Energy is the application of digital technology to the electric power system. It spans the entire value chain, from creation (generation) to transport (grid) to consumption (end-use). (See Figure 1.)



Smart Energy is made up of three subsections:

1. **Smart Generation** involves the production of electricity in ways that are more efficient and more controllable. Smart Generation includes alternative energy sources. *This document does not cover Smart Generation.*
2. **Smart Grid** products help design, analyze, transform, control, condition, switch, monitor, protect and optimize electricity transmission (high-voltage) and distribution (medium voltage) with products such as intelligent switches, digital relays and advanced meters. *Many of the best near-term opportunities for the Northwest are in the Smart Grid area.*
3. **Smart End Use** includes products and services to increase efficiency and reduce peak loads. Energy management software and services, smart motors, intelligent load shedding and building automation systems are all examples of solutions that streamline operations while saving energy. *Some near-term opportunities for the Northwest are in (or partially in) the End Use area.*

Patrick Mazza, Research Director of Climate Solutions, defines Smart Energy as: "energy generation, delivery and use optimized by information technology for efficiency, economy and reliability." Clark Gellings, Vice President for Power Delivery and Markets at the Electric Power Research Institute (EPRI), puts it this

way: "The very thing that has transformed any number of industries is about to transform [the electric power] industry -- that is, computers and technology that involve communication and sensors. The combination will give us an opportunity to transform our power delivery system."

In an August, 2003 report titled "Electricity Sector Framework for the Future," EPRI advocates transforming the grid by:

- Replacing today's slow electromechanical switches with fast-acting electronic controls
- Integrating communications to monitor and manage the network remotely
- Transforming today's meters into two-way "energy portals" that allow information to flow back and forth
- Increasing efficiency so we can do more with less
- Integrating distributed resources into the grid to supplement centralized power

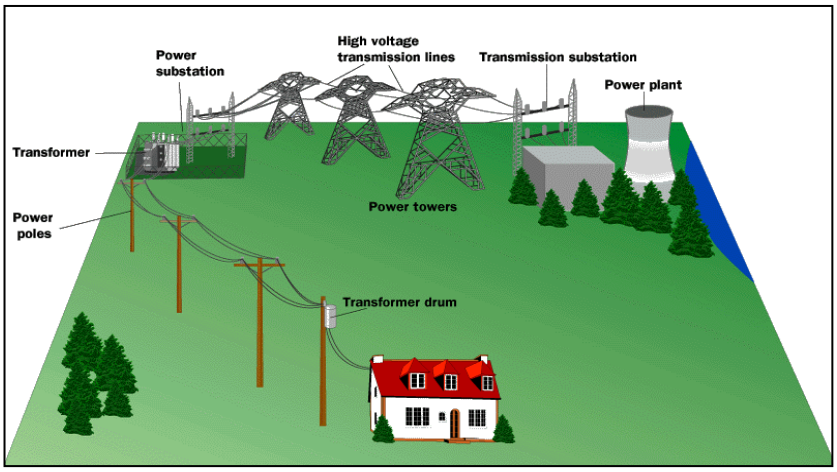
All of these things require Smart Energy products and services.

For the purposes of this report, we use Smart Energy to refer to technologies that a) relate to the generation, transport or use of electricity and b) include "embedded intelligence" in the form of software, hardware or both. Examples include:

- **Advanced meters** to collect usage data electronically and automatically, doing away with the need for a physical inspection by a meter reader
- **Monitors and sensors** for remote monitoring and control of functions ranging from generation to transmission to distribution to operation of electric devices
- **Tools for grid planning, design and operation** to simulate, plan and automate the complex transmission and distribution operations
- **Load management/demand response technologies** that help reduce peaks in electric demand and thereby reduce the need for standby power plants
- **Software for utilities** to automate accounting, billing, pricing, reporting, customer service, workforce management, outage restoration and similar functions
- **Smart devices** ranging from motors to HVAC systems to home appliances that use embedded intelligence to improve efficiency and/or allow remote operation

We will cover specific technologies and specific market opportunities later in this report.

Figure 2
Electric Power System Overview
Power originates in the power plant (upper right), then steps through transmission substations, high-voltage lines, substation transformers and power pole transformers on its way to the end user. Each step in this journey provides opportunities for new, "smart" devices.
Source: Schweitzer Engineering Labs



SMART ENERGY AFFECTS THE ENTIRE ELECTRICITY VALUE CHAIN

If Smart Energy affects the entire value chain, then it makes sense to understand how that value chain works. Figure 2 illustrates the process, from creation to delivery to consumption.

Generation

The value chain begins when electricity is generated. Generation embraces both big, centralized plants as well as new-generation "distributed generation." Distributed generation (DG) refers to replacing large, central power plants with smaller plants scattered throughout the grid. With DG, you can place the power much closer to the customer, minimizing the need for expensive high-voltage transmission. Indeed, some DG installations are on the customer's premises.

Increasingly, that distributed power comes from alternative sources, a trend known variously as "clean energy," "green power," "renewable energy," or "alternative energy." It is important to understand that alternative energy fits into a larger picture and that alternative energy requires Smart Energy technologies. Regardless of the type of generation -- centralized, distributed, or alternative -- it still requires digital technology to invert, convert, condition, control and monitor the electricity and to connect it safely to the grid. Likewise, utility software often helps to automate or optimize parts of the generation process, from resource planning to asset management.

(*NOTE:* This report does not specifically address the cluster prospects of the generation piece of the value chain. Other reports in the *Poised for Profit* series cover selected generation technologies.)

Grid - Transmission

The electric power industry subdivides the grid into two pieces: *transmission* and *distribution.* After generation, the electricity is stepped up by a transmission substation to a high voltage that can be transported efficiently over long distances. The North American transmission system comprises more than 700,000 miles of high voltage lines. It takes five to ten years to add a major line, due to the long process of obtaining right-of-ways, permits and environmental approvals. In theory, Smart Energy products can save billions of dollars by making better use of the existing transmission grid while simultaneously making it more reliable. Smart Energy products help to design, analyze, transform, control, condition, switch, monitor, protect, and optimize transmission.

Grid - Distribution

Traditionally, distribution starts at the substation and ends at the customer meter. Transformers inside power substations lower the voltages for safe distribution in populated areas. Distribution switchgear controls the amounts delivered. Relays, circuit breakers and surge arresters prevent hazards. Pole transformers step down the voltage further to a level suitable for end-users. Metering systems measure and record the power consumed.

The North American distribution system totals over 1M miles of lines according to "GridWise: the Benefits of a Transformed Energy System," a September 2003 report authored by Pacific Northwest National Laboratory (PNNL). The time required to add distribution assets is typically one to two years.

Many concepts and products that apply to transmission also apply to distribution. In fact, the electric power industry often refers to transmission and distribution together under the names "T&D" or "the grid." As with transmission, digital equipment can play an important role in distribution. For instance, more and more utilities are replacing mechanical meters (and human meter readers) with smart meters that transmit data electronically.

End Use

Many opportunities exist to communicate with, control and optimize electrical devices in use by commercial, industrial, and residential customers. For instance, customers can use the information from advanced meters to optimize energy usage with the help of special software. Smart motors and appliances can increase efficiency and reduce peak loads. There are literally hundreds of other ways that digital technology can automate and optimize the use of electricity.

This report *does* include smart devices for energy efficiency, but it does *not* cover passive materials or design. You will *not* find discussion of insulation, passive solar design, efficient light bulbs, building materials, and similar resources.

A SUBSET OF AN ENORMOUS MARKET

Smart Energy is part of one of the world's largest industries. North America has more than 3,000 electric utilities and more than 2,100 other power producers. The total asset value of the industry exceeds $800B, with approximately 60% invested in power plants, 30% in distribution facilities, and 10% in transmission facilities. The U.S. power industry serves 125M customers who pay $247B annually for electricity. (The global figure is an estimated $800B.)

Managing this flow of electrons is a Herculean task that creates many market opportunities. Some of the largest opportunities are related to the grid -- the infrastructure that transports electricity from the point of generation to the point of consumption. According to the Freedonia Group, the market for grid equipment amounts to $17B in the U.S. and $70B worldwide. Many end-use opportunities are substantial as well. For instance, electric motors represent $12.5B in annual sales worldwide, uninterruptible power supplies $3B and energy consulting and services $2.5B. Although the bulk of those sales still goes to analog and electromechanical devices, the transition to digital is well underway. Smart Energy products capture a higher percentage each year.

SIX CUSTOMER SEGMENTS LEAD THIS MARKET

Table 1 below summarizes the six major customer groups that represent the bulk of the spending in Smart Energy.

Table 1 -- Smart Energy Customer Segments and Representative Examples

Segment	Members of Segment	Applications	Comments
Utilities	Investor Owned Utilities (IOUs) Publicly Owned Utilities (Municipalities, Coops, Public Utility Districts)	Grid automation Workforce automation Advanced metering Load management/demand response Energy management systems	Utilities are under pressure to retain customers despite deregulation. Both investor-owned and public utilities are looking to reduce costs and increase reliability. Many offer their own energy efficiency/energy management advice to customers.
Independent Power Producers	Independent Power Producers (IPPs) who own part of the grid	Grid automation and controls Workforce automation	IPPs are growing and buying parts of the grid. Many will seek products similar to Transmission Organizations.

Segment	Members of Segment	Applications	Comments
Transmission Organizations	Independent System Operator (ISOs) Independent Scheduling Administrator (ISAs) Independent Transmission Company (ITC) Regional Transmission Organization (RTO)	Grid automation and controls Workforce automation	Transmission organizations seek to increase power capacity while reducing costs. They may have less of a bias toward construction than would a traditional vertically integrated utility.
Energy Service Providers	Transmission and Distribution Consultants Energy Service Companies (ESCOs)	Advanced metering Energy management systems Building automation and control Smart devices Workforce automation	ESCOs represent a major distributor/user of key end-use technologies.
Large Energy Users	Industrial Agricultural Marine Light Industrial Commercial Chains Hospitals/HC Networks University Systems Government & Military	Building automation and control Energy management systems Power electronics Smart devices Smart motors/adjustable speed drives	Industrial processes count for nearly 37% of total energy. The NW has local strengths in variable drives, industrial process controls. Many users implement their own energy management programs, even if the utility has a program available. The Northwest has national chains to aggregate, including financial institutions and retail chains.
Moderate Energy Users	Small Commercial Residential	Integrated end-use energy management software Power electronics	Growing emphasis on digital home by EPRI, Microsoft and other organizations could raise profile of home gateways.

Utilities are the most important category. They are the single-biggest customer for Smart Energy, as well as the single biggest distribution channel to other customers. Unhappily, the utility sector is in the midst of a long recession. A study by Newton-Evans on utility spending shows that capital spending in the utility sector has flattened since 2000. As this sector revives, increased spending will boost Smart Energy revenues to new levels.

Large energy users are also a key segment for many Smart Energy products. Large corporations can often save hundreds of thousands -- even millions -- of dollars with Smart Energy products and services. Equally important, they can use Smart Energy products to improve power quality and reliability. High quality, uninterrupted power has become essential to many businesses.

MARKET DRIVERS:
POWERFUL FORCES ARE CREATING MARKET GROWTH

Six powerful forces are driving the Smart Energy sector worldwide. Taken together, they will create strong growth between now and the end of the decade.

AGING INFRASTRUCTURE THAT MUST BE UPDATED

The nation's electricity infrastructure is falling behind, as underlined on August 14, 2003 when a blackout dropped power to 50M people in parts of the U.S. and Canada. The power grid must be upgraded. Many of those upgrades will be made with Smart Energy technologies, providing a powerful stimulus to the sector.

The existing electricity infrastructure was designed in the 1950s and installed in the 60s and 70s using electromechanical devices now outdated. The Department of Energy recently conducted a series of meetings and workshops to examine the condition of the national grid and set forth a roadmap for its improvement. A July 2003 document titled *Grid 2030* concluded that America's electricity system is "aging, inefficient, and congested, and incapable of meeting the future energy needs of the Information Economy."

Demand Is Outpacing Transmission Capacity

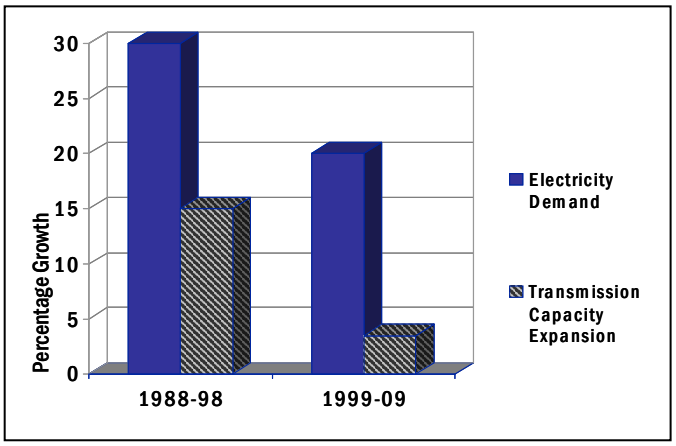
According to the *2002 National Transmission Grid Study*, electricity demand has increased 25% since 1990, yet construction of transmission facilities has *decreased* 30%. Annual transmission investment has declined steadily for the past 25 years. As Secretary of Energy Spencer Abraham said in his introduction to the study: "Our nation's transmission system over the next decade will fall short of the reliability standards our economy requires."

According to the Electric Power Research Institute (EPRI), the capital expenditures of the North American electric power industry during the 1990s were only 12% of revenues. That's less than half the historical average and the lowest ever except for the Great Depression. EPRI puts the annual investment deficit at $20B per year. That deferred investment is now coming due. Either the U.S. and Canada will pay to update the infrastructure, or they will experience continued degradation in power quality, reliability, and cost. Power outages already cost the two countries more than $100B per year, according to EPRI's calculations.

The Edison Electric Institute has similar findings. No major new transmission investments have occurred in the last 15 years. The majority of existing lines are over 20 years old. The Institute estimates the transmission system needs $56B worth of upgrades over the next decade -- yet less than 1/4 of that is planned.

(EPRI says the number is $100B over 10 years.) Whatever the exact amount, investment in new transmission is clearly lagging far behind growth in demand. (See Figure 3.)

Figure 3
The Growing Transmission Gap
For the 10 years from 1988 to 1998, U.S. transmission capacity grew at half the rate of electricity demand. Predictions are that the performance will be even worse over the next 10 years, dropping to less than one-fourth.
Source: Pacific Northwest National Laboratory



The Edison Electric Institute estimates that 94% of all outages are due to the transmission and distribution infrastructure. Congestion and bottlenecks are increasing and the grid is running closer and closer to the edge of sustainable power levels. One way to improve this situation is to build "traditional" power plants and transmission lines. That method would cost $450B between now and 2020, estimates Pacific Northwest National Laboratory (PNNL).

Another way to address this problem is to use Smart Energy concepts -- adding intelligence to the system to a) add more functionality, b) reduce costs, c) safely run the existing grid at higher capacity, and d) increase efficiency so we need less electricity. Such improvements would dramatically reduce the need for new power plants and new transmission lines. PNNL believes smart technologies could shave billions from the total bill, including $50B by deferring the need for some 200 power plants.

GROWING DEMAND FOR HIGH-QUALITY POWER

At the same time the infrastructure is deteriorating, the demand for electricity is rising, especially the demand for "premium power" -- electricity free of fluctuations and interruptions. Smart Energy products address this growing demand. First, they reduce demand through greater efficiency, reducing losses in transmission, distribution, and usage. Second, they also boost the reliability and the quality of electricity.

In 1970, electricity accounted for 8% of total U.S. energy use. In 2000, it accounted for 16%. The demand for electricity will nearly double in the next 20 years. (Energy Information Agency, 2001.) The demand for premium power is growing

even faster. High-powered computers, precision manufacturing operations, financial data centers, telecommunications centers, and server farms are just a few of the many applications that require premium power. Today's sophisticated medical, military, safety, air traffic and industrial electronics require uninterrupted and highly conditioned service. (See Table 2.)

Table 2 -- The Cost of Power Outages

Industry	Hourly Cost
Cellular Communications	$41,000
Telephone Ticket Sales	$72,000
Airline Reservations	$90,000
Semiconductor Manufacturing	$2,000,000
Credit Card Operations	$2,580,000
Brokerage Operations	$6,480,000

Source: American Power Conversion

"As society continues to find new, smart applications for electricity, it becomes ever more dependent upon a power flow that is characterized by security, quality, reliability, and availability," explains EPRI's Clark Gellings. "In 2001, the U.S. economy experienced an estimated $120B loss in productivity as a result of poor power quality and reliability." According to Gellings, the loss could reach as high as $500B by 2020.

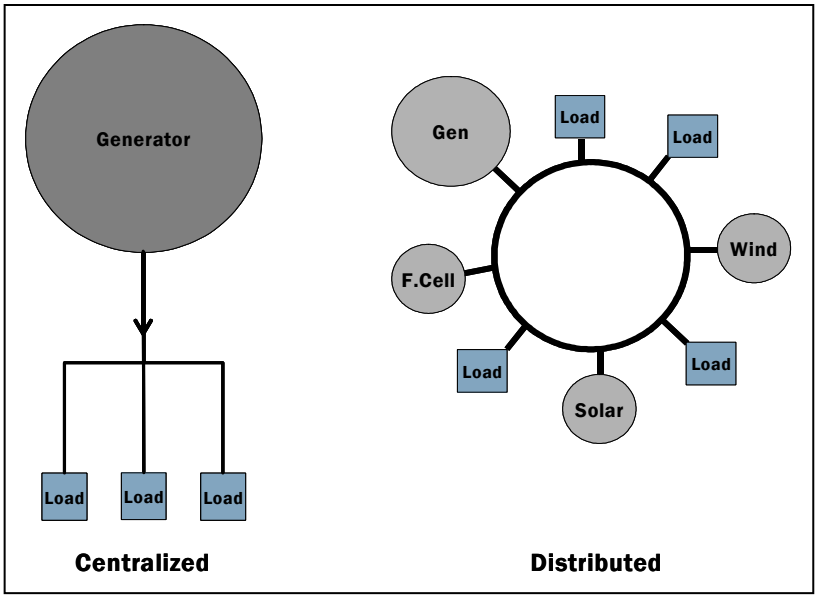
GROWING DEMAND FOR ALTERNATIVES TO CENTRALIZED GENERATION

Recent decades have seen a move away from traditional centralized power generation. One part of this trend is "distributed generation" (DG), which supplements centralized power plants with smaller facilities near the customer. (See Figure 4.) Smaller, scattered DG power plants would shorten construction times, cut capital requirements, reduce the need for high-voltage transmission and lessen the vulnerability to terrorism and system-wide blackouts. Some analysts estimate one fourth of all generation will be from distributed sources by the next decade.

Increasingly, that distributed power comes from alternative sources, a trend known variously as "clean energy," "green power," "renewable energy," or "alternative energy." At the same time, interest is growing in "demand management," the practice of briefly reducing consumption during peak times.

For instance, a device at the customer's premises may turn down a thermostat or briefly shut off a water heater in response to a signal.

Figure 4
Distributed Generation
Centralized generation (left) features a large central plant that ships power to distant customers. Distributed generation (right) scatters power plants throughout the system, locating them much closer to customers.
Adapted from NewERA



All three of these alternatives are gaining support around the globe. *None of them are possible without Smart Energy products.* Distributed generation requires monitoring, managing and connecting to the grid. Electricity from renewables must be inverted, conditioned, and controlled. Demand management requires smart meters and smart devices. The growing demand for these approaches simultaneously increases the demand for Smart Energy. (See Sidebar 1.)

Sidebar 1 -- Portland's Celerity Pioneers Distributed Generation Network

CELERITY ENERGY

Portland-based Celerity Energy is a different kind of energy management company. Through its Reliable Power subsidiary, it performs many typical ESCO functions. Reliable is a full-service provider of "power reliability" products and services -- standby generators, uninterruptible power supplies, and surge suppressors.

The parent company is pioneering a way to link those standby generators into a network that can be called on to generate electricity for peak power needs. Celerity's Networked Distributed Resource service aggregates seldom used standby generators, creating partnerships between utilities and the owners of on-site generation. The same techniques Celerity has developed to remotely monitor, control and dispatch today's diesel and gas generators could someday be used to network cleaner sources such as wind, solar and fuel cells.

RAPID TECHNOLOGY ADVANCES OPEN NEW HORIZONS

Today's power delivery system was designed in the 1950s and installed in the 60s and 70s, before the era of the microprocessor. Technical advances now make it possible to upgrade the system with digital reliability and responsiveness. These technical breakthroughs have set the stage for the growth of the Smart Energy

sector. The DOE's *Grid 2030* report confirms there are "promising technologies on the horizon that could help modernize and expand the Nation's electric delivery system." The report cited numerous Smart Energy examples, including "distributed intelligence and smart controls, power electronics devices for AC-DC conversion and other purposes, and distributed energy resources including on-site generation and demand management."

Many of the core concepts were pioneered and proven in business computing, telecommunications and the Internet. We now have cheap computing power and low-cost bandwidth for telecommunications. We now know how to use semiconductors to substitute for cumbersome electro-mechanical devices. We now know to use computer hardware and software to connect devices across vast distances, to manage large networks from a single console, and to make automatic decisions based on pre-defined rules. And we know how to communicate wirelessly, reducing the need for expensive wiring and making it easier to retrofit existing installations.

With much of the learning curve out of the way, it becomes relatively simple to apply those same technologies to the electric power industry. This transformation may be delayed by some of the barriers discussed below, but it will certainly not be stopped.

INCREASED GOVERNMENT SUPPORT

Governments around the world have greatly increased their attention to electric power issues. They are motivated by fear of blackouts, climate change, rising energy costs, dependence on foreign oil and vulnerability to terrorist attack.

Governments increasingly see digital technology as a way to make electric power cleaner, more reliable, and less at risk. For instance, a smart grid can be more responsive to grid problems that might otherwise cause a blackout. A smart grid can route around damaged areas, whether that damage is from a natural disaster or a terrorist attack. A smart grid also makes it easier to install distributed generation when and where needed. At the same time, smart technologies reduce energy use, lowering dependence on foreign oil and reducing emissions.

Digital technology also offers solutions to the growing concerns over pollutants and climate change. Emissions controls are becoming more stringent, making it harder to site power plants that derive power from fossil fuels. Concern over global warming is leading to new regulations at the state, national and international level. Given that many experts cite power plants as the single largest source of pollution, it is no wonder that attention is focused on reducing their environmental impact.

Because of these concerns and the growing perception that digital technologies provide a solution, governments are spending billions each year on incentives for clean energy and Smart Energy. The trend is clear. It is becoming more and more expensive -- in financial capital, in political capital and in good will -- to pollute. As a result, companies and consumers are turning to Smart Energy concepts to minimize the environmental impact of electric power.

Bonneville Power Administration (BPA), a federal agency, has a "non-wires alternatives" policy that considers ways to meet needs through efficiency and Smart Energy before it considers building new transmission lines. Likewise, the government of Canada has numerous agencies and programs in support of sustainability and renewable energy.

Meanwhile, dozens of state, provincial and city governments have also instituted incentives to spur the adoption of better energy solutions. Examples include tax credits, accelerated depreciation, rebates, and net metering. Although many of these incentives are targeted at renewable energy or energy efficiency, they often stimulate Smart Energy sales as well. For instance, connecting wind or solar to the grid involves power electronics and interconnection technologies. Likewise, many energy efficiency schemes have intelligent controls at the heart.

California, Texas, Connecticut, and Michigan are four examples of states mandating stricter standards, or adopting minimum green energy requirements for utilities, or using public funds to stimulate clean energy and Smart Energy companies, or all three. British Columbia has green power targets for utilities and plans to spend C$600M over the next 10 years to reduce demand through efficiency and energy technology. BC, Oregon, and Washington all provide incentives for the installation of renewable energy and programs to stimulate market demand for energy efficient products.

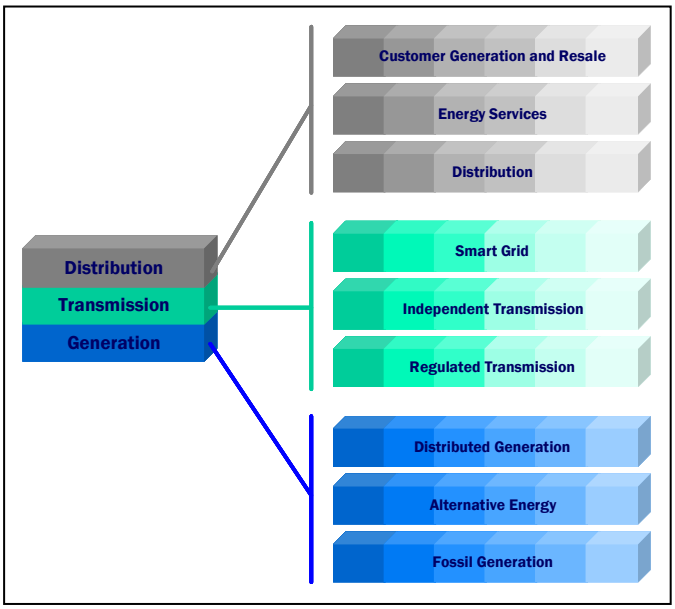
In most cases, governments are looking to private industry to supply the technology and the solutions. As the 2002 *National Transmission Grid Study* described, "The national transmission grid DOE envisions is based on the principles of free markets with clear rules, equal access, consumer safeguards, economic incentives and investment opportunities rather than federal ownership and operation." In mid-2003, the DOE established a new Office of Electric Transmission and Distribution. Meanwhile, the Federal Energy Regulatory Commission (FERC) is evaluating new proposals to further deregulate the grid. Through these and other agencies, the government will spend millions of dollars on research, development, pilot programs, and market incentives, many of them directly related to Smart Energy.

MARKET RESTRUCTURING

The electric power industry is restructuring in some parts of the world. Areas of the industry that were previously closed off to competition are now open, leading to new market opportunities and fast-growing new companies, many of them related to Smart Energy.

To be sure, restructuring has been marked by fits and starts. Deregulation, for example, was stalled by the California power crisis at the beginning of the decade and has now started to see gradual increase in some parts of the world. As restructuring continues, it will produce a gradual shift from vertical integration to horizontal disaggregation. In a vertically integrated industry, individual companies own all or most of the value chain from top to bottom. As disaggregation occurs, each segment splits into multiple sub-segments. Each sub-segment gains multiple competitors. (See Figure 5.)

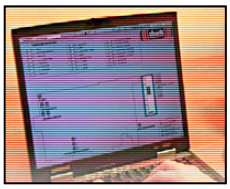
Figure 5
Disaggregation
This drawing is a simplified view of what happens as the power industry moves from vertical integration to horizontal disaggregation. As represented at left, the industry had been vertically integrated for more than a century. Utilities typically owned every aspect of the value chain. As shown at right, we are now entering an era where each segment has multiple sub-segments, each with multiple competitors.



The disaggregation of the computer industry led to the rise of giant companies such as Microsoft and Dell. The deregulation and disaggregation of the telecomm industry led to an explosion of new products and services -- cell phones, 800 numbers, 911 services, advanced PBXes and more. Over time, these same forces may bring about similar opportunities in the electric power industry -- if not in all countries, then at least in some parts of the world.

There is yet another reason to look to market restructuring as a driver of growth. Competitive environments cause utilities and other energy companies to look for ways to reduce head count and large capital investments. The automation and optimization of Smart Energy can often provide a solution to this need to do more with less.

Sidebar 2 -- Seattle's Powerit Solutions Reduces Energy Costs for Large Facilities



Seattle-based Powerit Solutions markets a Web-based tool that helps commercial and industrial sites reduce energy costs. Its Energy Director software monitors and controls equipment according to rules set by the customer. The company achieves typical savings of 10-15% on electricity bills by adjusting loads at times of peak demand.

The software typically manages equipment such as HVAC, materials processing, freezing, pumping, drying, conveyors and other equipment with high power needs. It monitors their energy usage and automatically reduces peak demand by prioritizing energy loads -- that is, by cutting back less-important loads during peak periods. Developed in Sweden, the system has been installed in over 250 facilities worldwide. Target customers are those with annual energy bills of $100,000 or more who have large power loads that can be interrupted or reduced.

MARKET BARRIERS: OBSTACLES COULD SLOW PROGRESS

Despite the powerful forces on the side of growth, the Smart Energy sector faces hurdles. We expect that digital technology will ultimately transform the electric power industry, ensuring its ability to serve the growing need for reliable, affordable, high-quality electricity. However, the pace at which this transformation takes place is uncertain, due to numerous challenges and roadblocks, the most significant of which are described below.

REGULATORY UNCERTAINTY INHIBITS INVESTMENT

The North American regulatory situation is literally too complex to cover in this report -- and that complexity is a big part of the problem. Regulatory confusion is the single greatest challenge to the growth of Smart Energy. Debates are raging on whether to:

- Create Regional Transmission Organizations in charge of the transmission grid.
- Mandate reliability standards.
- Impose a Standard Market Design.
- Reveal true pricing to customers.
- Allow construction of new high-voltage transmission.
- Allow utilities to recover the costs of new technology in their rates the way they recover the cost of new power plants.
- Reward utilities for implementing energy efficiency.
- Require utilities to include green power as part of their energy mix.
- Create credits and incentives for alternative energy and smart meters.
- Determine ways to address many other complex issues.

This is not the forum for a discussion of these problems, but it is important to flag them as the number one constraint on market growth. The Federal Energy Regulatory Commission, the Department of Energy, the U.S. Congress, the Canadian Parliament and various provinces and states are grappling with these issues now. If they make serious progress, 2004 and 2005 could see a substantial improvement in Smart Energy fortunes. If stabilization is delayed, market expansion could be delayed as well.

The Balkanized Regulatory Landscape Impedes Change

The U.S. is a confusing patchwork of overlapping federal, regional, state and municipal agencies. Creating a cohesive national plan requires "a degree of

intergovernmental cooperation that has been difficult to achieve," as the DOE's *Grid 2030* report says.

Canada also has multiple jurisdictions. Some provinces, such as Alberta, have deregulated. Others, such as British Columbia, have produced hybrid, partially deregulated systems. Still others retain a regulated structure.

The electric power industry finds itself in a twilight zone. It is neither fully regulated nor completely deregulated. Without clear rules, investors and entrepreneurs face enormous risks -- risks that, in most cases, cause them to hold back from investing in new concepts. "Unprecedented levels of risk and uncertainty about future conditions in the electric industry are causing many investors to pursue other opportunities," confirms the DOE's *Grid 2030* report. "Capital investment in new electric transmission and distribution facilities is at an all-time low."

Regulations Discourage Efficiency and Optimization

In addition to the restructuring issues mentioned above, current ratemaking structures make it difficult to roll out new technologies for energy efficiency and demand response.

Current regulations reward investor-owned utilities for building new power plants. In fact, that is typically the only way those utilities can earn returns for shareholders. Many experts believe that utilities should not have profits tied solely to the amount of power sold. They suggest that utilities should also have financial incentives to optimize service using the full range of technologies. Regulations should allow utilities to choose conservation, efficiency, or demand management when those options are preferable.

Unfortunately, the Balkanized nature of the North American electric industry means those changes must be made state-by-state or even district-by-district. The Northwest does have a few incentives in place or in the works. Certain utility efficiency improvements qualify for Oregon's 35% Business Energy Tax Credit. And some utilities qualify for partial reimbursement through BPA's conservation and renewables discount. As regulations are improved and modernized, they will unleash large new markets for Smart Energy technologies.

Regulations Can Unleash Markets Too

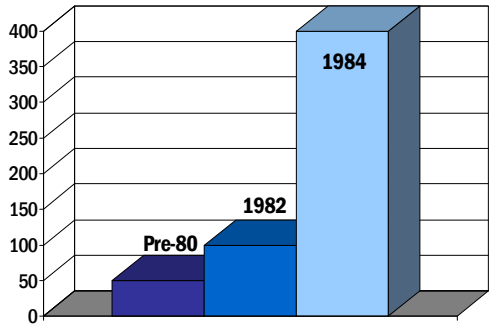


Figure 6: Venture investments in telecomm jumped eight-fold after the court ruling of 1982 and the market opening of 1984. Source: Utilipoint

Regulatory uncertainty is an obstacle, as discussed above. But it is important to note that it can be an opportunity as well. Removal of a regulatory obstacle can unleash a market. Figure 6 shows what happened to venture investments in the telecomm space when that industry deregulated in the early 80s. We could see similar results from events in the electric power industry. Changes with the potential to unleash investment include passage of national energy bills with significant incentives; deregulation or market restructuring in key states, provinces or countries; or passage of aggressive renewable portfolio standards.

LACK OF MARKET ACCESS HOLDS BACK NEW COMPANIES AND TECHNOLOGIES

Many Smart Energy companies -- including several in the Northwest -- are growing quickly. Market growth will be even more dramatic when better regulations, incentives and financial rewards make mainstream utilities more receptive to new technology. Observers claim that deserving Smart Energy technologies often can't get a fair hearing. They describe the extreme difficulty of selling to utilities. More than one venture capitalist reported shying away from companies that sell only to utilities, because it takes years to get those utilities to consider a new idea.

Utilities have historically been reluctant to try new technologies. When Utilipoint surveyed 300 utilities in early 2003, only 11% described themselves as early adopters -- those that innovate by using new technologies. Another 47% were conservative adopters -- those that use a technology once they have seen others do so successfully. The remaining 42% were followers -- those that run old technology because it is proven.

As the industry gradually transitions to a free market, many utilities find themselves without the interest, understanding, or skills to use new technologies. To be fair, utilities are not bad guys trying to block progress. Regulators, customers, and financial markets historically rewarded reliability, not risk-taking. Utility conservatism was entirely justified in the regulated world of the last century. Utilities are simply living by old rules that served them well for decades. But even if their attitudes are understandable, they pose a roadblock to full success. To find success, many Smart Energy products must be a) purchased by utilities, or b) offered by utilities to their customers.

To get a new technology to market, Smart Energy companies must undergo long sales cycles at bureaucratic utilities that have many reasons to be cautious and few reasons to be experimental. Utilities historically preferred to build their own rather than buy off the shelf, so there are few standards. Vendors must often reconfigure their products for each utility. And because many utilities suffer from "not-invented-here syndrome," vendors must often undergo lengthy test periods. Industry veterans talk about this problem as "pilotitis." Smart Energy companies can often convince the R&D head of a utility to participate in a small pilot. When it comes time to roll that pilot out to the entire utility, the company discovers that utility decisions impact many different departments, each with its own agenda. Converting a pilot to a sales win can take years -- if it can be done at all.

Sidebar 3 -- NxtPhase Closes $7M Private Financing

VANCOUVER, BC (July 9, 2003) – NxtPhase Corporation announced it has closed a convertible debt financing in the amount of US $7M. The company believes this most recent financing will carry it through to self-funding, self-sufficiency, projected to occur in 2004.

NxtPhase is a privately held corporation with headquarters in Vancouver, BC and development and manufacturing offices in Phoenix, Arizona and Winnipeg, Manitoba. It makes optical sensors and digital protection devices for monitoring and managing the electric grid. It is a successful hi-tech spin-off from the University of British Columbia (UBC).

The company believes it is well positioned for growth. Core development of its optical sensing products is now complete and the company has over 50 utility customers.

Market Dynamics Contribute to the Northwest's Market Access Challenges

Part of the problem lies with regulations that make it hard for utilities to get their money back, as mentioned above. Part of the problem lies with a lack of standards, forcing new companies to re-engineer and resubmit their products for each utility (including well over 3,000 utilities in North America alone). And part of the problem lies with the dynamics of this market.

It is difficult to capture the market dynamics of such a large and fragmented sector. Even so, a few generalities apply. On the grid side, sales are dominated by a few global giants such as General Electric, Siemens, and ABB, all with U.S. headquarters on the East Coast. They have long-standing relationships with the utilities and with a few key distributors.

All three groups -- suppliers, distributors, and utilities -- have been conditioned by a half-century of business in a regulated industry. They have many reasons to be cautious and few incentives to be experimental. Sales cycles are extremely long. Both suppliers and customers tend to be large, bureaucratic, and resistant to change. They tend to look to the East Coast and Europe for their partnerships.

They seldom acknowledge the Pacific Northwest as a source of electric power innovation or expertise. At the same time, there is a high degree of uncertainty about who is responsible for upgrading the grid, making it unclear who the customer is.

On the end-use side, most product sales go through large chains and large distributors. Again, it can be extremely difficult to gain access to those big players and their market clout. When it comes to energy services, few national players have emerged. Energy consultancies and energy service companies tend to be local or regional players, pointing to the difficulty of expanding a service model to national or international scale.

These market dynamics -- poor access to sales channels and long, difficult sales cycles -- stand as an additional roadblock to the expansion of Smart Energy.

SHORTAGE OF CAPITAL INHIBITS GROWTH AND STARTUPS

Like almost every other industry, Smart Energy suffers from today's difficult market for seed and venture capital and from today's challenging economic climate. But the energy sector also has its own special challenges.

For one, the regulatory and market access problems mentioned above have investors sitting on the sidelines until it becomes clear when, where and how they can safely invest. In some cases, they are waiting for tax credits or incentives, which have a history of coming and going. In most cases, though, they are waiting for clarification. This hiatus applies to venture capitalists, who don't know which markets will be allowed to grow; to project financiers, who don't know which technologies will get approvals and incentives; and to utilities, who don't know how or whether they can recover the costs of technology investments.

Even forward-thinking utilities often find themselves without the money for new technology, thanks to a series of financial catastrophes in the energy sector. One problem was the collapse of Enron, which saddled many utilities with unexpected debt and which tainted the entire sector. Another factor is the decline of the Dow Jones Utility Average dropped 28.7% in 2001 and another 26.8% in 2002 -- the steepest decline since the Depression.

Still another issue is the size of the debt load. In anticipation of a brave new deregulated world, power companies borrowed a collective $600B in the late 90s and early 00s. Starting in 2003 and continuing through 2006, some $90B must be repaid or renegotiated. As former energy executive Karl Miller recently told *Fortune Magazine*: "The debt bubble in this industry is massive."

Table 3: Venture Investments In Energy

Year	Energy Venture Investments	Percentage of Total
1998	$204,000,000	0.9%
1999	$442,000,000	0.7%
2000	$1,200,000,000	1.2%
2001	$774,000,000	1.9%
2002	$448,000,000	2.3%
Q1-03	$350,000,000	5.0%
2003	$1,800,000,000 (est)	>5.0% (est)

Source: Dr. Wal Van Lierop, President & CEO, Chrysalix Energy Ventures, based on data from Venture Economics, PricewaterhouseCoopers, NVCA, Money Tree, Nth Power, and Rockport Capital

The capital shortfall has other causes as well. Most venture capitalist and angel investors do not know about Smart Energy or understand its parallels to the software and semiconductor industries. They also have concerns about regulatory barriers; about longer times until payoff; and about the lack of standards that would permit a large market to grow exponentially. As a result, they rarely look at deals in the energy space.

To be fair, finding startup capital is difficult in any industry. And there are signs that clean energy and energy technology are finding increasing favor. Although overall VC investments have plunged dramatically since their dot-com highs, the percentage devoted to energy-related businesses has increased. (See Table 3.)

ADDITIONAL FACTORS CONSTRAIN THE SMART ENERGY SECTOR

In addition to the major barriers cited above, we note the following factors that also hinder market growth.

Technology commercialization issues. Although the fundamental concepts are in place, many technologies still require lots of work to get from concept to commercialization. In some cases, the technology is still at the prototype stage and requires market testing and large-scale manufacturing to reach critical mass. In other cases, the technology is mature, but the industry still has not settled on standards, making purchase, operation, and interconnection difficult.

Solutions include 1) national standards for interoperability and interconnection and 2) test bed and market access programs. The more of these we see, and the sooner we see them, the sooner the technologies will move into the mainstream.

Low electricity prices. The United States has some of the lowest electricity prices in the world. Other countries have stronger financial incentives to embrace power-saving Smart Energy solutions.

Lack of popular appeal. It may seem silly to talk about "sex appeal" in connection with technology markets. Nevertheless, certain technologies create a public fascination. A few years ago, the Internet fit that description. Today, fuel cells and the hydrogen economy have captured the imagination. Things such as energy efficiency and T&D improvements simply do not have the same allure.

Lack of a common terminology. Again, it may sound trivial to talk about vocabulary as a market constraint. Yet even industry veterans typically don't have names for the product categories they manufacture. A single phrase means four different things to four different energy professionals -- and means nothing to most customers. It's hard to sell something investors and customers can't understand.

Shortage of trained engineers. According to the Chair of the Electrical Engineering Department at the University of Washington, Dr. Chen-Ching Liu, the national shortage of power engineers will reach a crisis point in the next decade as the baby boom generation retires. Without highly trained workers and innovators, it is unclear how the country can bring about a dramatic shift to a more efficient, more reliable, less polluting energy infrastructure. Although Canada, China, and several European countries actively support workforce training in power-related topics, the U.S. has no such policy as of this writing.

Sidebar 4 -- Tacoma Power Explores Energy Management Services for End Users

Tacoma Power is one of the innovative utilities that could help make the Northwest a leader in Smart Energy. Like many utilities, it generates, transmits and distributes electricity. But it also provides telecommunications services, including cable TV and high-speed Internet access through its Click! Network, which runs over a 750 MHz two-way hybrid fiber/coax network.

Now the utility is exploring ways to use the network to provide advanced energy products and services. One residential gateway concept would turn meters into Internet devices for two-way dialog between consumers and the utility.

Tacoma Power is "interested in giving our customers the most control possible," explains gateway project manager John Athow, "There are two questions -- whether it's technically possible and whether it's of interest to customers. We are investigating both."

MARKET POTENTIAL:
SMART ENERGY WILL SEE MAJOR GROWTH

Up to this point, we've defined Smart Energy and looked at a broad overview of the industry. With this as a foundation, we can look at the opportunity areas within the value chain. This section outlines the worldwide potential for the Smart Energy market. It also includes some general estimates of market size and growth rate. A later section details those areas with particular promise for the Northwest.

NEAR-TERM MARKET OPPORTUNITIES WORLDWIDE

The *Poised for Profit* research has uncovered multiple opportunity areas that exhibit the potential for substantial near-term growth. Figure 7 below shows these opportunities and where they fit in the big picture. Many prospects span two, three or even four portions of the value chain. This section will examine each of these sub sectors in turn. (*Note:* This report does not cover Smart Generation or Smart Storage. Other documents in the *Poised for Profit* series cover selected generation technologies.)

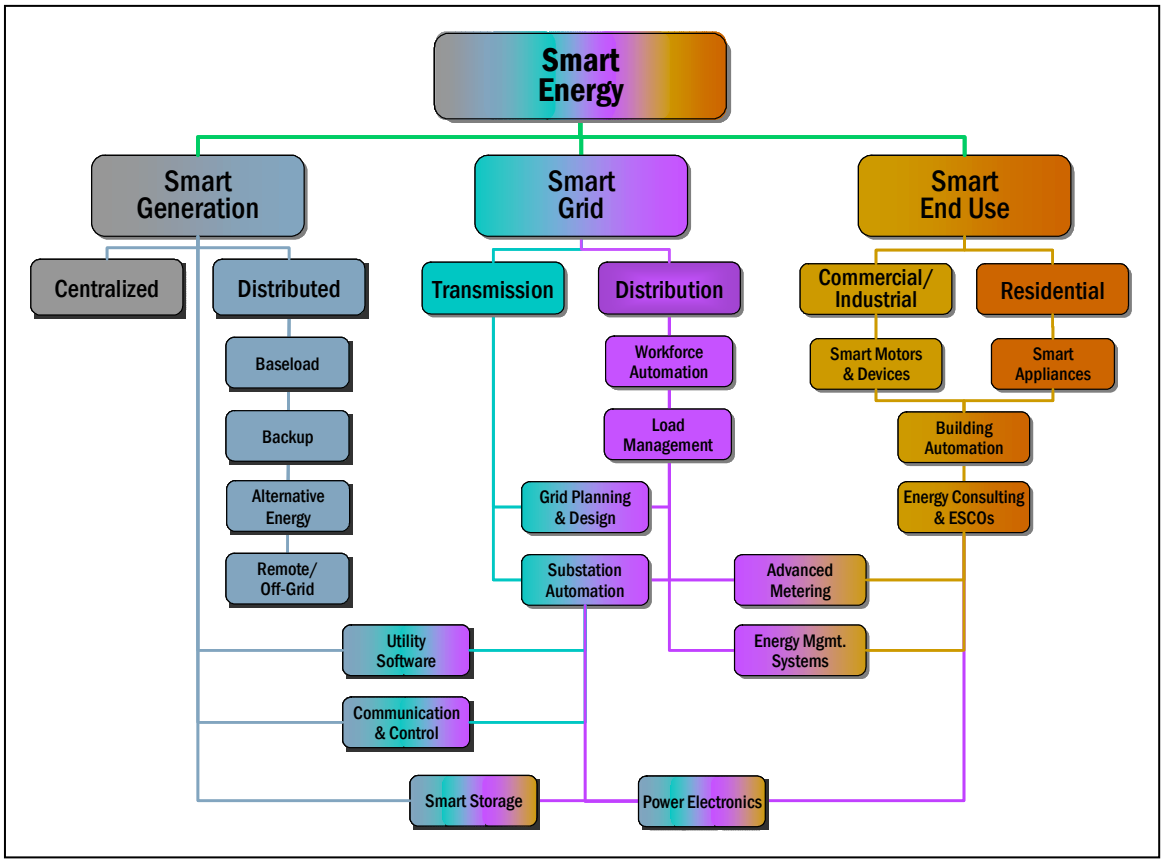


Figure 7: Smart Energy Opportunity Areas

A note about taxonomy: Smart Energy applications have been around for at least two decades (albeit in crude versions in the early days). Despite this long history, the segment has never become "self-aware." Instead, different industries claim different pieces. As a result, there is no generally accepted taxonomy. Various portions of the Smart Energy market go by different names -- "energy technologies," "power systems technologies," "energy efficiency," and others.

The important point is not the labeling. The important point is the identification of bona-fide market opportunities. We believe the taxonomy shown in Figure 7 is a useful way to picture the Smart Energy sector and its relationships. And we believe the niches shown there collectively represent a market worth at least $15B today.

Opportunity #1: Utility Back Office Software

The electric power industry is one of the last in the world to fully embrace computing. To grasp the size and scale of this market opportunity, you have only to realize that the global electric power industry a) is comprised of thousands of utilities serving billions of customers and b) has not yet fully embraced the computer hardware and software that is at the heart of virtually every other major industry today.

Many utilities still run their operations on ancient minicomputers with home-grown software. Until recently, utilities preferred to custom program their own applications, even complex back office systems. Today, more and more utilities are turning to industrial-strength packaged software, which can then be customized to meet the utility's special needs. This approach typically cuts costs while increasingly functionality. As utilities emerge from their current financial crisis, enterprise software should experience strong growth, as it did previously in many other industries.

This category has some overlap with workforce automation (see below). Some typical examples include:

- **Customer information and billing systems** track customers, services provided, amounts owed, payments, service history, etc.
- **Asset management systems** help utilities inventory, plan, track and optimize the use of their resources while maintaining regulatory compliance.
- **Engineering analysis systems (EA)** aid engineers as they specify, operate, or test power plant components or process equipment or evaluate energy alternatives.
- **Enterprise resource planning systems (ERP)** integrate traditional back office functions such as general ledger, accounts receivable, accounts payable, payroll, etc.

- **Graphical information systems (GIS)** display assets (generation, transmission, distribution, facilities) and customers on computer maps. Typically they are used in conjunction with other software categories including asset management, customer information, workforce management and outage management.

Other back-office systems include such things as interactive voice response (IVR) systems, and automated staking (electronically establishing locations and allocating inventory).

Conventional wisdom has it that the financial crisis of the past few years has left utilities unable to buy new software. But some analysts believe the events of the last few years will create a rebound market for utility back-office software. "You can only cut head count and reduce expenses for so long," explains Diane Borska, a leading power industry analyst and managing director of The Borska Group, Inc. "Utilities made it through the cost-cutting phase, now they have to look at ways to increase revenue. Many times that requires new, 'customer-facing' software. In addition, they find themselves forced to do more with less, and automation can provide a solution."

Sidebar 5 -- Alstom ESI Wins Energy Contracts in Romania

February 2003, Bellevue, WA. Alstom ESI, formerly known as Alstom Esca, will deliver systems to manage both the power transmission grid and the central market for Romania's newly deregulated electricity market. The contract embraces hardware and software, including servers, workstations and e-terra software modules.

Alstom is a global specialist in energy infrastructure, providing utilities with systems and solutions for small substations up to entire transmission grids. It employs approximately 300 people in Bellevue, WA.

The Bellevue office is part of Alstom's Energy Automation and Information division. Its e-terra solutions are designed to meet the changing needs imposed by the deregulation of the worldwide electric power industry. The company's software manages six of the eight regional hubs for electricity trading around the country.

Northwest companies with products and services in this category include Cayenta Canada, Eden Systems, Energration, Equarius, Microsoft, Utility Solutions and Alstom ESI. (See Sidebar 5.)

Opportunity #2: Grid Monitoring, Communications and Control

We use this designation to capture a wide range of technologies that span generation, transmission and distribution. Utilities are increasingly replacing electromechanical systems with digital technology to monitor and remotely manage the grid. In general, they involve a) the use of digital technology to remotely monitor various assets and b) software to collect and analyze the data.

Figure 9
EPRI Smart Power Vision
The Electric Power Research Institute believes communications and intelligent sensors will enable a self-healing power delivery system.
Source: EPRI

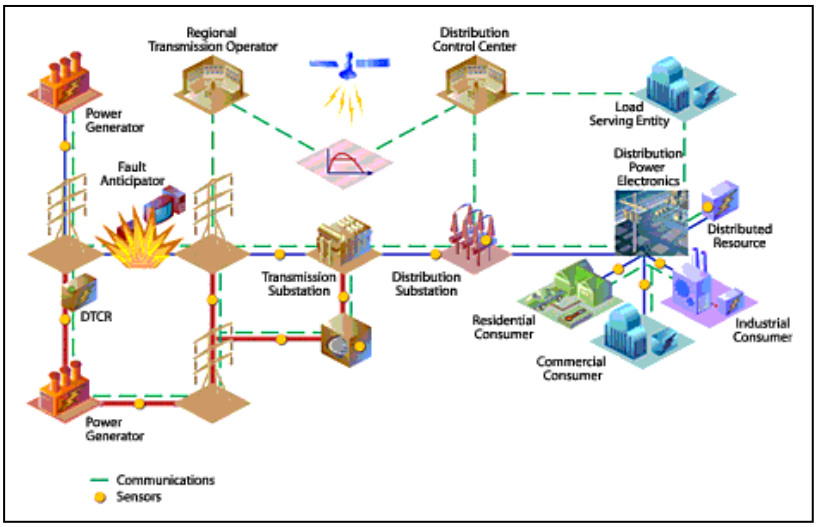


Figure 8 shows a vision of the smart grid created by EPRI. Notice that sensors and communications are a key aspect. Here are just a few of the different types:

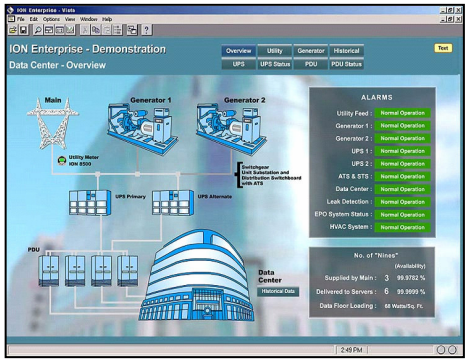
Power systems monitors observe and assess grid behavior. Digital devices collect signals (e.g. power flows, bus voltages, and alarms) and send them to a control console for analysis.

- **Power quality analyzers** evaluate power at the substation by measuring such things as sags and swells, voltage transients, and min/max volts.
- **Power systems controls** interpret data from the monitors to determine customer needs, operate the transmission networks, and regulate the flow of power. Common systems for the real-time management of grid assets include SCADA, EMS, DA, and DMS.
- **Condition monitoring systems** watch transmission/distribution equipment and track degradation over time, including transformers, battery banks, etc. They also support a utility's maintenance programs.

Venture capitalist David Berkowitz, Senior Vice-President of Vancouver, BC-based Ventures West, believes "Software for the grid is a major opportunity going forward." NxtPhase Corporation, also in Vancouver, operates in a subset of this market that it calls "smart measurement." NxtPhase estimates the current market just for that subset is $1B worldwide.

Northwest companies in this category include NxtPhase, Consolidated Electronics, GridSense, MCM Enterprise, Power Measurement (see Sidebar 6), Schweitzer Engineering Laboratories, Tantalus and Serveron (see Sidebar 7.)

Sidebar 6 -- Power Measurement Celebrates 20th Year



Now celebrating its 20th year, Saanichton, BC-based Power Measurement is a global provider of advanced meters and enterprise energy management systems with approximately 250 employees and roughly $50M in sales.

For utilities, Power Measurement supplies advanced meters and supporting software. The company's products can collect data from customers, but also from generating stations, substations and grid inter-ties.

For industrial and commercial users, Power Measurement promises to identify energy-intensive activities, pinpoint power problems and supervise facilities through a command-and-control center (see sample screen at left).

Sidebar 7 -- John Day Dam Adopts Smart Monitoring Equipment from Oregon Company

February 4, 2003, Hillsboro, OR. Serveron Corporation announced today that it has installed a dozen of its units at the John Day Dam to remotely monitor the hydropower facility's critically important large transformers.

Launched in February 2001, Serveron provides remote monitoring of transmission and distribution facilities using the Internet. Operating around the clock, 365 days per year, Serveron provides installation, monitoring, alert notification, and maintenance information. It also offers computer analysis of utility assets. As one of the country's first dedicated providers of next-generation, "Smart" equipment and services, Serveron stands as an example of the new business opportunities now arising.

Opportunity #3: Grid Planning and Design

The power grid is one of the most complex systems on earth. As it evolves, the complexity increases, thereby intensifying the need for computer tools.

- **Power system simulators** perform complex simulations to derive network limits, spot bottlenecks and forecast problems.
- **Distributed generation simulators** evaluate grid conditions and identify the impact of distributed generation at a particular site.
- **Engineering design and optimization tools** allow utility engineers to make a wide variety of drawings, calculations, and analyses for siting, estimating, designing, and constructing towers, lines, connections, substations and other facilities.

At the high end -- the modeling of regional and national grids -- the Northwest is already a world leader, with several important research efforts underway. Powertech Labs, PNNL, University of Washington, Washington State University, and Oregon State University are all working on concepts relevant to grid optimization. Itron subsidiary Linesoft is a category leader. "Grid simulation is

going to get hot," predicts Jon T. Brock, Chief Operating Officer of research consultancy Utilipoint International. In addition to simulation for planning and design, Brock believes the industry needs software for training the next generation of power engineers. "We need a 'Flight Simulator' for the grid." Indeed, the Dispatcher Training Simulator offered by Bellevue-based Alstom may be a step along that path.

Opportunity #4: Transmission/Distribution/Substation Automation

This category includes components that replace old-style electromechanical products with new digital technologies. Those technologies accomplish switching, monitoring, protection and control. Most experts predict high growth in this segment as utilities replace their aging infrastructure with new digital products. Solutions in this category include individual components such as intelligent switchgear, controllers, circuit switchers, circuit breakers, surge arresters, reclosers, power flow controls, automatic protection relays, and voltage regulators. It also incorporates software, consulting, and turnkey systems.

In many cases, digital products are less expensive than older, electromechanical devices even before calculating additional benefits such as remote monitoring and remote control. For instance, nearly 90% of all new relay unit purchases in the U.S. are digital, according to research firm Newton-Evans. Furthermore, export opportunities are significant. The same study found that international utilities outspend North American utilities 15 to 1 on new substation programs.

Bruce Sampson, Vice President of Sustainability for BC Hydro, predicts big growth in the transmission sector. "There is little incentive to build new transmission, yet there's growing pressure on the grid all over North America. Digital technology can make the existing grid more efficient, forestalling the need to build new transmission."

"Technology is the key in the current regulatory environment," confirmed research firm Freedonia Group in its most recent report on the $70B worldwide market for transmission and distribution equipment of all kinds. "The best opportunities will exist in power transformers and switchgear relays. Power transformers will benefit from continued gains in electricity production by non-utility generators. Relay increases will be driven by automation to improve efficiency."

Sidebar 8 -- University Spin-Out Rides Smart Grid Trend to Rapid Growth

Founded in 1982 as a "spin-out" from Washington State University, Schweitzer Engineering Labs (SEL) introduced the world's first micro-processor-based relays in 1984. (Relays switch large currents on or off automatically or from a distance.) A single SEL product can often replace an entire panel of electro-mechanical relays at one-third the price.

After years of steady progress, the Pullman, WA-based company has recently experienced rapid growth as Smart Grid concepts start to catch on. In 2002, the company exceeded $100M in revenues and added more than 100 employees to reach nearly 700 in total.

Today, SEL has more than two-dozen offices across the country and more than a dozen overseas. It is now expanding into related products and services for utilities and industrial customers.

There is some overlap between this category and the grid monitoring, command-and-control category described above. Northwest companies with a role in this area include Alstom Transformers (which has a Medford, OR branch and is separate from Bellevue's Alstom ESI), Cascade Controls, NxtPhase, PC Utilidata, Power Measurement and Schweitzer Engineering Laboratories. (See Sidebar 8.)

Opportunity #5: Load Management/Demand Response

Broadly speaking, products in this category allow a utility to remotely or automatically reduce the amount of power used by customers. They promise a less costly way to respond to peak loads than keeping a power plant running just in case. Typically, they allow a utility to reduce peak loads by decreasing the amount of electricity customers use until the peak has passed. Active demand products reduce voltages, curtail use or otherwise allow a utility to cut back the amount of power needed. Passive demand products create a scheduled time of use. Both methods can reduce the need for expensive stand-by generation.

Many analysts believe demand response will eventually see significant revenue growth, driven by utilities' needs to do peak load shaving. For instance, a McKinsey & Co. study in 2001 showed potential nationwide savings of $10-15B per year from demand response programs. All that's needed, some experts think, is a way to let the demand side bid into the market. Rather than bidding to supply additional power, aggregators could bid to reduce power by the same amount.

Several examples of this trend are occurring in the Pacific Northwest. For instance, as part of BC Hydro's plan to spend C$600M on load reduction, the utility is considering a partnership with a UK firm that aggregates demand from many different customers. Likewise, Bonneville Power Administration has embarked on an ambitious "Non-Construction Alternatives" program that carefully examines options for avoiding the need to build new transmission. In many cases, Smart Energy concepts are central to their non-construction efforts, as with the recent

test program to tie together backup generators using peak shaving technology from Portland's Celerity Energy.

At the moment, however, this market mechanism is often blocked by regulatory barriers. (See the "Market Barriers" section for a further discussion of this obstacle.) Many utilities are not allowed to recover the costs of installing technologies for demand response, even though they can recover the costs of a new power plant. What's more, utilities do not yet have the infrastructure to support load management or the in-house expertise to apply it properly. For these and other reasons, it may be several more years before this category begins to hit its full potential.

Northwest companies with offerings in this area include Celerity Energy, Legend Power Systems, Microplanet and PCS Utilidata. (See Sidebar 9.)

Sidebar 9 -- MicroPlanet and PCS UtiliData Target Voltage Control for Utilities

At least two Northwest firms are marketing energy-saving voltage control devices to utilities, according to the March 27, 2003 issue of the Con.Web newsletter. Conservation voltage regulation (CVR) allows utilities to lower line voltage, thereby saving electricity that is otherwise wasted.

National standards require utilities to operate between 114 and 126 volts. Most utilities err on the high side -- around 123 or 124 volts -- to allow for sags and line losses. This excess voltage results in higher energy bills and shortened lifespan for lights, motors and appliances.

CVR devices allow utilities to lower the delivered voltage while maintaining or even improving reliability. In January, 2003 the Northwest Energy Efficiency Alliance approved a $2.8M project to implement and test Conservation Voltage Regulation in the Pacific Northwest.

Edmonds, WA-based MicroPlanet makes a small CVR box that plugs into the customer's meter. The $1,000 programmable device stabilizes voltage at a lower level. Although MicroPlanet sells to conservation-minded end users and business owners, it hopes to open a channel to utilities. The company has set up a sales network in 30 states and 21 countries to market to utilities, homebuilders and local governments.

Spokane-based PCS UtiliData uses a different approach. Its Adaptive Voltage Control system operates at the substation level, regulating voltage to hundreds or thousands of homes at a time. In many cases, an AVC system can replace a noisy, polluting diesel generator. Instead of firing up a generator to increase power supply, a utility can use AVC to instantaneously reduce power demand.

Opportunity #6: Workforce Automation and Management

Products in this category help utilities automate and manage their key assets: their equipment, their workers, and their customers. Products in this category help utilities automate and manage their key assets: their equipment, their workers and their customers. Although this area often interfaces with utility software (see above), we believe it qualifies as a category of its own, especially since it includes hardware (e.g., wireless devices for trucks or handhelds for workers) as well as software (e.g., field force scheduling and dispatch). Examples include:

- **Workforce management** is a growing trend in many industries, including electric utilities. The greatest area of interest is in mobile workforce automation and scheduling, to make expensive repair and installation

technicians more cost-effective. These systems often tie central scheduling applications to wireless terminals, so technicians can get up-to-the-minute changes without calling or returning to the office.

- **Outage management solutions** use remote monitors, GIS information and computer software to more efficiently pinpoint outages and their likely causes.
- **GIS applications.** Graphical Information Systems create computer maps of widely dispersed equipment. Utilities can associate a database with the map, so clicking on a piece of equipment on the screen brings up technical and maintenance details. These applications also allow for more efficient repair and maintenance scheduling, equipment upgrades and troubleshooting. Advanced systems even interface with GPS units mounted on repair trucks to show where they are in real time.
- **Maintenance expert systems** provide "just-in-time" training to technicians. An electronic database contains expert repair, installation, and troubleshooting information. Technicians can call up the data as needed. Advanced wireless versions let technicians access this information in the field as they are working.

Automating and managing the workforce is likely to become a significant component of utilities' drive to manage costs and reliability. According to IDC, the worldwide market for wireless and mobile consulting, integration and management could reach $37B in four years. Wireless integrator Motorola estimates the utility segment of that market at $1B and growing at 15% a year. GIS, Global Positioning Systems (GPS), remote sensing and surveying grew in popularity over the last several years. According to ESRI, a leading GIS firm, the market for these technologies and services increased by 23% in 2002, with the biggest spenders being electric, gas and other utilities.

Northwest companies with interests in this space include Fieldsoft Technologies, Itron, Itronix (not related to Itron) and MDSI Mobile Data Solutions.

Opportunity #7: Advanced Metering

The United States alone has approximately 130M electric meters and 140M gas and water meters. Until recently, most were read manually once a month. Today, utilities are converting to advanced meters, which transmit data via phone, Internet or wireless connection. Advanced meters can show how much electricity is being used on an hour-by-hour basis.

The metering market seems poised for continued growth. Investment banking firm Delafield Hambrecht calls advanced metering "a significant untapped market." The firm estimates only 17% of the total market is equipped with advanced meters, far short of the 60-90% projected penetration rate. The Chartwell market research

firm also forecasts strong growth for advanced metering. Its April 2003 report predicts the market will grow 15-20% over the next five years.

Much of that growth may come from the software that piggybacks on the meters themselves. "The applications are the real big thing" says analyst Lynn Fryer Stein of Primen, an energy market research firm. "The meters and the connectivity are just how we collect the information and get it back and forth."

As of this writing, the U.S. Congress is considering an energy bill that includes incentives for advanced metering and programs to encourage federal buildings to adopt smart meters. Passage of the bill could provide an immediate boost to this sector.

The Northwest is home to Itron, the world's largest provider of advanced meters (see Sidebar 10), and to several other firms with offerings in this category, including Dent Instruments, E-Power Technology, Teldata, H.J. Arnett Industries, Power Measurement, Utility Systems & Applications and others.

Sidebar 10 -- Itron Reports Record Financial Results for 2002

Itron made its mark in automated meter reading -- including wireless, "drive-by" products as pictured -- where it is by far and away the market leader

July 16, 2003. Spokane, WA-based Itron today reported financial results for the quarter ended June 30, 2003. Second quarter revenues were $80.3M, up $7.8M, or 11% over second quarter 2002 revenues.

In summer 2003, Itron acquired Schlumberger Electricity Metering (SEM), which had revenues of $229M and EBITDA of $33M in 2002. It brings to Itron more than 1,000 new employees and more than 3,000 utility customers. Itron also acquired three companies in 2002 and announced plans to acquire a fourth.

The publicly traded company is headquartered in Spokane, WA with manufacturing facilities in Michigan and North Carolina. It has moved into many other areas beyond meters, including energy information management, demand-side response, workforce automation, and customer information systems.

Opportunity #8: Energy Management Systems

Energy management systems gather information about energy usage to create a single picture and a single control point. Utilities use them to manage thousands of customers. Large-end users employ them to manage campuses and factories, and high-rise buildings.

Utility-side products pull together data from thousands of advanced meters to provide load analysis, forecasting and planning. End-user products bring together information from meters, from sensors and from building controls to manage campuses, office parks, factories, apartments and high-rises. Large office towers can sometimes save hundreds of thousands per year through better energy

management. Regional companies in this space include Avista Advantage, Christenson Power Services, and Alstom.

Opportunity #9: Building Automation and Control

More and more switches, sensors, thermostats and controls come with embedded intelligence and the ability to communicate. They can be pulled together and managed through building management systems and building diagnostics. Once under control, they can be managed to improve energy efficiency.

Building automation and control, building management systems, and building diagnostics work to control energy use. The most straightforward application is to remotely control such things as lighting, heating and air conditioning. The next step is to use that same data and those same controls to improve efficiency (at which point there is overlap with end-user energy management systems, as described above).

The two driving trends in this subcategory are 1) a switch away from proprietary systems toward standards and 2) a move toward centralized control of multiple buildings via the Internet. The DOE has funded a significant amount of research in this area at PNNL. The Northwest also houses branch offices of Johnson Controls and Siemens Building Automation, two industry giants. It also has several "home-grown" companies including Control Contractors, Holaday-Parks Building Automation Systems, Regal Controls, and Alerton. (See Sidebar 11.)

Sidebar 11 -- UK Firm Buys Redmond, WA-Based Maker of Smart Building Controls

March 3, 2003. Novar plc of the United Kingdom has completed its acquisition of Redmond, WA-based Alerton Technologies, a maker of building automation and control systems.

Alerton is recognized as a pioneer in the building automation and controls industry. Its digital controls and computerized monitoring are in place in thousands of buildings, including Seattle's Bank of America building (see photo).

Building automation and control systems can provide major energy savings, along with many other benefits. Alerton was known for its leadership role in BACnet products. BACnet is an industry standard for interoperability that allows computer-based systems to manage controls and equipment from a wide range of manufacturers.

Alerton will remain in Redmond and become a subsidiary of Novar's Intelligent Building Systems division. Novar plc is a $2.3B corporation with interests and subsidiaries in several industries, including building management systems and energy management systems.

Opportunity #10: Smart Motors / Adjustable Speed Drives

Electric motors use a significant percentage of the nation's electricity (25% by some estimates). New designs increase efficiency through on-board intelligence and through the ability to adjust the speed to match the need.

Smart motors and adjustable speed drives are one piece of a worldwide market for electronic motor drives, which is slated to grow from $12.5B in 2000 to $19.1B in 2005, according to Drives Research Corporation. Northwest companies include Motors and Controls Corp and MagnaDrive, a Washington company that holds patents for a unique adjustable speed drive that could, in theory, revolutionize industrial motors. (See Sidebar 12.)

Sidebar 12 -- Seattle's MagnaDrive Signs International Distribution Agreement

Seattle, WA, February 19, 2003. MagnaDrive today announced it has signed an agreement for UK-based British Autogard to represent Magna-Drive products in Europe, Southern Africa, Australia and Asia. MagnaDrive produces innovative electric motors that use magnetic induction in place of physical connections, thereby reducing friction, vibration and energy use.

The company's technology was named a Technology of the Year for 2001 by *IndustryWeek Magazine.* It's adjustable speed drives (ASDs) offer energy savings of one-fourth to two-thirds over ordinary electric motors. Industrial motors consume approximately 25% of the nation's electricity.

This agreement adds to the company's existing distribution arrangements in Canada, Taiwan, Korea and Japan. Because electricity costs are higher overseas, analysts believe the international market for ASDs will be twice as large as the domestic market.

Opportunity #11: Smart Devices and Appliances

Just as building controls are becoming intelligent, so too are devices, equipment and appliances. This intelligence may allow remote monitoring and control. It may replace electromechanical systems with digital versions. Or it may increase energy efficiency.

Smart devices can encompass anything from industrial equipment to home appliances, as long as the unit includes communications and intelligence. There is some overlap with the building automation category described above. Building automation relates to lighting, heating, air conditioning, and related functions. The term Smart devices relates to individual products with embedded intelligence.

The Northwest has little commercial activity in this space. To some extent, Microsoft's smart home efforts relate to this category. And some of PNNL's research involves products that can sense the condition of the grid and reduce the power load as needed. (See Sidebar 13.)

Sidebar 13 -- PNNL Prototypes Smart, "Grid-Aware" Appliances

Energy research underway at Pacific Northwest National Laboratory is one of the assets that make the Northwest a natural candidate to lead the Smart Energy sector. For instance, PNNL researchers in Richland, WA, have a prototype device that senses grid conditions and then controls water heaters, air-conditioners, and other appliances to help avoid power outages.

If it senses a grid problem, the device automatically takes actions to reduce the electrical load. Examples include brief delays in starting a hot water heating cycle, slight postponements of defrost cycles, small reductions in voltage, minor dimming of lights, and so on. This type of "non-intrusive load management" could be one key to a smart, self-repairing grid.

By itself, a single device has little impact on grid conditions. But if thousands of such devices were attached to the grid, they would provide a brief but all-important cushion. If the grid can operate closer to the limit, utilities have less need for expensive spinning reserves -- power plants kept online "just in case."

Opportunity #12: Energy Consulting & ESCOs

Outsourcing is a growing trend in all technology areas, and energy is no exception.

Energy consultants provide a wide range of services to utilities and large end users, such as resource planning, consulting engineering, and strategic planning. Northwest examples include Acres International, Energy International and a long list of engineering firms.

Energy service companies (ESCOs) provide a wide range of services, including management consulting, engineering consulting, system integration, site assessments, financing, project installations, maintenance contracts, energy management and building control. Their primary targets are commercial and industrial customers. They typically prefer agreements that last five years or more. Many ESCOs work on performance guarantees while assuming some technical, operational, and financial risk. Some of them also receive a percentage of the energy savings they produce, although most have a flat fee as some portion of their compensation.

The energy services opportunity has slowed from its high expectations in the early 90s, but it is poised to experience resurgence. Growth will be driven by the overall trend toward outsourcing. This trend is affecting most industries. It is expected to have a large impact in the utility arena, which had traditionally been reluctant to outsource. In today's economic climate, utilities can no longer afford to do everything themselves when they can outsource to less expensive, more efficient specialists.

Sidebar 14 -- Facility IQ Manages Large Sites Over the Internet

A subsidiary of Spokane's Avista Utilities has found success as a service company that manages electric, water, waste, and phone bills for large companies. Originally spun out of Avista Utilities in 1995, Avista Advantage now boasts more than 200 clients around the country. Its flagship FacilityIQ product line helps these large companies manage expenses across more than 100,000 locations.

At heart, Facility IQ is a bill paying/bill management system for services such as electricity and telephone. For instance, a customer using the Utilities module has all its energy, water, and sewage bills sent to Facility IQ. The bills are audited, entered into a master database and presented online for payment approval. Once the bill-paying data is in the system, it can help to reduce usage and costs. Facility IQ provides instant online access to key data, reports and comparisons, allowing customers to find trouble spots and reduce consumption.

According to a 2002 study by the National Association of Energy Services Companies, ESCO revenues increased at a 24% annualized rate over the past decade, although growth has declined since 1996 to 9%. Current ESCO market activity ranges between $1.9B and $2.1B each year. An estimate by SAM Equity Partners Ltd puts the combined energy consulting and ESCO market at $2.5B, growing at 15-20% per year.

Northwest examples include Acres International, Energy International, Clark's Energy Service, Northwest Energy Services, and Quantum Engineering & Development.

Opportunity #13: Power Electronics

Power electronics come into play at the point of generation, the point of distribution and the point of consumption. Mossadiq Umedaly, Executive Chairman of Xantrex, a world leader in power electronics, puts the worldwide market at $3B and growing rapidly. He defines that market as:

A. Distributed power such as solar, wind and backup generators
B. Mobile power such as auxiliary power for trucks, ships, boats, RVs, military and campus fleets (such as airport tugs and warehouse forklifts)
C. Premium power for sophisticated, sensitive equipment in hospitals, financial service centers, telecommunications centers

Point of generation. At the point of generation, power electronics are often called "balance of system." They invert, convert, and condition electricity from sources such as diesel generators, wind turbines, PV panels, and fuel cells.

Point of distribution. At the point of distribution, power electronics control, condition and connect distributed energy sources to the grid. (See Figure 10.)

Distributed generation (DG) comes in many flavors -- mini-hydro, microturbines, fuel cells, wind, solar and others. Some DG projects connect to high-voltage

transmission lines. Other times, the power is produced closer to customers and the connection is made to the distribution grid. In still other cases, the power is generated on site and connected directly to customer systems. Issues can include:

- Conditioning the power so it is suitable for use
- Integrating safety features to prevent harm to customers and to line workers
- Making the physical connection
- Allowing for net metering (selling power back to the utility)
- Integrating batteries or other methods to overcome the intermittent nature of some renewable sources

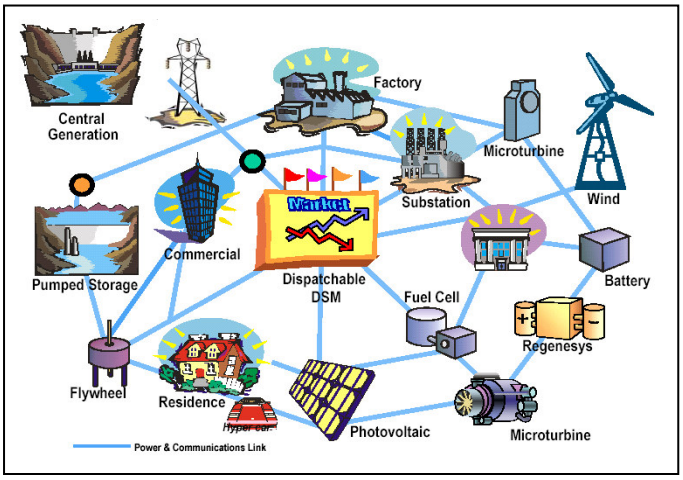


Figure 10
BPA's EnergyWeb
The Bonneville Power Administration is a world leader in understanding and advancing the concept of an intelligent, decentralized power system, as illustrated in this concept drawing. Such a system will require new products for connecting distributed power sources to the grid.
Source: BPA

Although still small, distributed generation may see rapid growth by the middle of this decade. The IEEE released standards for DG interconnection in 2003. As those standards gain acceptance they will make it easier and safer to buy and install DG. They will also create large-scale market opportunities. Companies will be able to create standard products that can be used virtually anywhere.

According to Allied Business Intelligence, global distributed generation (DG) capacity will increase from 20,000 MW to just shy of 300,000 MW by 2011. A report from Darnell shows the worldwide distributed and cogeneration (DCG) market growing from 53 GW in 2003 to 78 GW in 2008, creating a $30B opportunity by 2008, some fraction of which would be interconnection technologies.

Point of consumption. Power electronics find many uses at the point of consumption. Power factor correction devices adjust for characteristics of electric motors that cause them to draw more power than they actually need. Advanced power supplies use semiconductors to add new levels of control and efficiency to electrical devices. Uninterruptible power supplies protect against power dips, surges and outages. Other products convert or condition electricity for applications

that require premium power, such as computers, sensitive medical equipment, telecommunications centers, financial services centers, and so on.

The Northwest houses numerous companies that operate in this space, including Advanced Power Technology, Alpha Technologies and its BC subsidiary Argus Technologies, Denon Technologies, JATS Alternative Power, MTI Systems, New Path Renewables, Northern Technologies, Philtek Power, RBH Electronic Designs, Schott Applied Power, Sure Power Industries, Thomson Technology and Xantrex. (See Sidebar 15.)

Sidebar 15 -- Xantrex Becomes Power Electronics Leader

Based in Burnaby, BC, Xantrex is a maker of advanced power electronics. It is generally acknowledged as the world leader in inverters, which convert DC power into AC power for electronic and electrical equipment. Xantrex also markets backup power for homes and small businesses and power supplies for precision equipment.

Xantrex began in 1983 as a provider of programmable power supplies. In 2000, it acquired the Washington companies, Trace Engineering, Trace Technologies and Heart Interface. Although it has downsized those operations, it maintains facilities in Arlington, WA; Livermore, CA; Miamia, FL; Elkhart, IN; and Barcelona, Spain. It has more than 600 employees and revenues of approximately $135M.

REVENUE FROM SMART ENERGY

Establishing the worldwide Smart Energy market size is difficult. Only some Smart Energy categories are routinely tracked by analysts and market research firms. Our research has uncovered the following estimates of current worldwide sales in several categories that are all or partially composed of Smart Energy products:

- **Advanced meters:** $0.6B, growing 15-20% per year.
- **Electric motors:** Estimates put sales at $12.5B (smart motors are capturing a growing percentage).
- **Energy Consulting and Energy Service Companies:** $2.5B, growing 15-20% per year.
- **Power electronics:** Balance of system, $3B, growing 20-25% per year; Uninterruptible power supplies, $3B, growing 8% per year.
- **Transmission and distribution equipment:** $70B, growing 4-6% per year. (Only a percentage of this number is Smart Energy, the balance being wires, poles and electromechanical devices. However, the Smart Energy portion is growing much more rapidly on a percentage basis as digital devices replace analog versions.)
- **Utility back-office software:** CIS/CRM $1B growing 6% per year; energy trading $2.6B growing 10% per year.

- **Workforce automation:** Workforce automation software, $1.3B growing 15-20% per year; wireless systems for utilities, $1B, growing 15% per year.

Athena estimates that the Smart Energy segments discussed in this document represent at least $15B in revenues worldwide. By way of comparison, experts put the worldwide wind market at $7B, the solar market at $1.5B and the fuel cell market at $0.5B.

REGIONAL POTENTIAL: KEY ADVANTAGES BUT HURDLES AS WELL

In the previous section, we examined the global market for Smart Energy. In this section, we identify the assets that strengthen our region's prospects, the hurdles that block its path, the benefits from a successful cluster and the best ways to accelerate progress.

REGIONAL ASSETS

The Northwest has many of the assets necessary to establish a powerful Smart Energy cluster. The five most important are:

- Successful pioneers
- World-class research
- Transmission and distribution expertise
- Transferable skills
- Environmental consciousness

The Northwest Has Successful Pioneer Companies

Economic development research reveals that the number one factor for growth is the existence of several successful companies in close proximity. These companies play several roles. Their early success attracts venture capital. Their success also attracts employees, who typically look for regions with "thick" employment -- that is, where they have several options to continue their careers without leaving the area. These pioneers also act as an "executive university," creating a supply of people with the all-important combination of technical expertise and management skills. What's more, industry expansion occurs more easily through nurturing the growth of existing companies than encouraging startups or attracting companies from outside the region.

The Northwest is already a global leader in Smart Energy thanks to companies such as Alstom, Itron, Power Measurement, Schweitzer, Tantalus, Xantrex, and others. The *Poised for Profit* research has uncovered more than 225 Smart Energy-related businesses in the Northwest, doing over $2B annually. Many of these companies have found growth even in the midst of the economic downturn.

The success of this cluster has gone largely unnoticed by the press and by investors.

The Northwest Boasts World-Class Research Facilities

If having successful "pioneers" is the number one factor for economic growth, then research facilities is number two. The Northwest is blessed with one of the world's largest concentrations of Smart Energy research. Some of the fields where Northwest labs have made notable contributions include high-voltage transmission, grid simulation and design, grid monitoring and control, demand response technologies, and advanced motor design.

These institutions also make an important contribution to workforce training. According to the Institute of Electrical and Electronics Engineers, fewer than 15 universities nationwide offer PhD-level programs in power engineering. The U.S. currently awards about 500 undergraduate degrees in the field, compared to about 2,000 in the 1980s. As a result, many North American companies must look to Europe and Asia for power engineers. Fortunately, Washington State University and the University of Washington have graduate programs, and Gonzaga boasts a strong undergraduate program. Those programs provide a regional advantage, as the industry braces for the shortage of power engineers.

Below is a brief overview of several Northwest Smart Energy research assets.

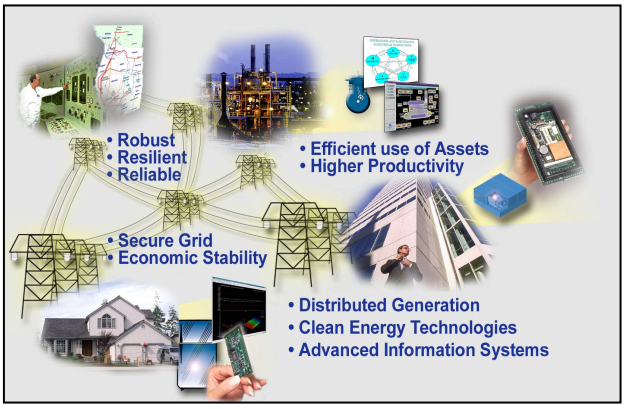
The Bonneville Power Administration has sponsored many important research projects and hosts the EnergyWeb project, a vision of a future Smart Grid that integrates "the utility electrical system, the telecommunications system, and the energy market." (See Figure 10.) In addition, BPA owns and operates significant transmission assets, and therefore represents a strong opportunity for companies to demonstrate the effectiveness of new technologies. BPA also works in cooperation with PNNL and regional universities to develop intellectual property and insights into transmission challenges. BPA is headquartered in Portland, OR.

The Oregon Institute of Technology hosts the Oregon Renewable Energy Center, which includes research into grid interconnection and other Smart Energy topics. In particular, OREC emphasizes the integration of technologies into energy systems of practical use to businesses and the public. OIT also has an incubator that can be used to accelerate the growth and commercialization of particular Smart Energy technologies. Recently OIT has established plans to launch a Smart Energy Research Laboratory, a joint effort between the Oregon Renewable Energy Center ant the Department of Mechanical Engineering Technology at OIT.

The Oregon State University's School of Electrical Engineering and Computer Science (EECS) features a research program in Energy Systems. It is also home to the Motor Systems Resource Facility, one of the country's top research and testing laboratories for motors, drives, power electronics and power quality. It also has an energy extension program in its College of Engineering that helps solve energy-

related problems for homes and businesses. In cooperation with BPA, the Energy Resources Research Laboratory (ERRL) collects and manages data from transmission line research (it also tracks data from BPA's wind energy resource studies). And OSU also hosts a regional Industrial Assessment Center for improving the energy efficiency of medium-sized businesses.

Pacific Northwest National Laboratory is one of the country's top Smart Energy research centers. PNNL has its headquarters in Richland, WA plus offices in Seattle, WA, Tacoma, WA, and Portland, OR. In response to the DOE's increasing emphasis on transmission and distribution, PNNL expects to significantly expand its research in that area. It also conducts research into building automation, fuel cells, energy efficiency, and other related subjects. One of the assets of a multiprogram national laboratory is the ability to deploy multidisciplinary teams. In that regard, PNNL's expertise in advanced materials, information science, national security, and environmental technology all have relevance to current and future Smart Energy research. (See Figure 11.)



Powertech Labs of Surrey, BC provides testing and research to the electric and natural gas industries. It provides complex, detailed testing on nearly all aspects of electric power. Powertech Labs is a spin-off and wholly owned subsidiary of BC Hydro, the principal electric utility in British Columbia. It has developed software to model power grid stability, including impact of distributed generation or demand response. It is also notable as the only Northwest facility that can conduct high-voltage testing. (The next nearest high voltage facilities are at places like PG&E in California and E2 in Oak Ridge, TN.)

Sidebar 16 -- Powertech Labs Offers Unique Testing Facilities

Powertech Labs of Surrey, BC operates one of the best equipped and most advanced testing facilities in North America. Its campus has 18 labs, including one of the few high voltage facilities in North America (see photo). It employs nearly 100 professional engineers, scientists and technologists.

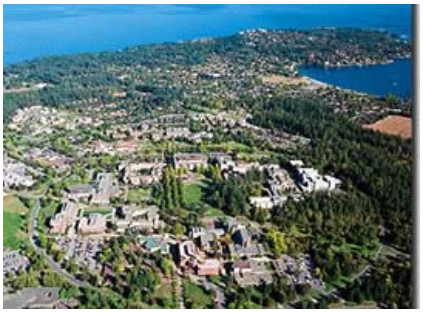
The company is organized around seven business units, several of which put Powertech squarely in the Smart Energy space. The seven are: Power System Studies; Electrical Technologies; Power Engineering Labs; Civil Infrastructures and Alternative Energy Technologies; Gas Systems Engineering; Materials Engineering and Applied Chemistry. Engineers in the Power System Studies Group have pioneered many advanced tools and techniques for power system analysis. The group has extensive international consulting experience in all aspects of power system stability and control

The University of British Columbia. Situated on the tip of Point Grey in Vancouver, BC, the University of British Columbia is one of Canada's leading educational institutions. It has 40,000 students enrolled in more that 500 academic programs. UBC researchers conduct more than 4,000 research projects and attract upwards of $150M in research funding annually from government, industry and non-profit foundations. The Department of Electrical and Computer Engineering offers undergraduate and graduate programs in power, control, and electromagnetics, including programs and research into power electronics.

The University of Washington has ten engineering programs with nearly 1,500 undergraduates and 1,200 graduate students. It has degree programs in power engineering that typically enroll about 50 students per year (roughly 20 graduate students). The university also encourages research on transmission optimization, automation, and power quality. Its power engineering program has partnerships with the Grainger Foundation, the Electric Energy Industrial Consortium and the Advanced Power Technologies Center. The Washington Technology Center is also located at the University, and supports firms developing and testing prototypes in many fields, including engineering fields. (Can we include the quote from one of the companies who said they locate here b/c of the engineering graduates?)

The University of Victoria is located in the capital of British Columbia, where it offers more than 100 programs to 18,000 students. UVic researchers were awarded $46.8 million in outside research grant and contract funding in 2002/03, up 40 percent over the past year. Equally important, UVic's Innovation and Development Corporation helps researchers develop the commercial potential of their ideas. In 2001, it assisted 18 UVic spin-off companies and filed patents for 45 new inventions based on UVic research. The university is widely recognized for its research programs and its interdisciplinary initiatives, including the Institute for Integrated Energy Systems. (See Sidebar 17.)

Sidebar 17 -- Institute for Integrated Energy Systems



The Institute for Integrated Energy Systems at the University of Victoria researches new technologies for sustainable energy.

Although known primarily for its work in fuel cells, IESVic also researches energy systems and energy policy. The former includes work with industrial partners to provide access to specialized knowledge and equipment as well as work on how to integrate alternative energy into the power grid. The latter includes work with government partners to support policy and decision making.

Research capabilities include product design and manufacturing; materials testing; engineering mechanics; market analysis; and socio-economic studies.

The Institute also promotes energy systems education at all levels, formally and informally, to convince the world of the critical need for new and sustainable energy systems.

Washington State University's energy and power systems program is one of the largest and strongest in the country, typically enrolling about 40 students per year, half at the undergraduate and half at the graduate level. (See Sidebar 18.) WSU is also a member of the Power Systems Engineering Research Center, which is funded through the National Science Foundation. In addition to its power engineering programs, WSU operates the Energy Program for the State of Washington. That program includes a library and clearinghouse services for energy professionals, plus numerous technology and consulting services, mostly geared to energy efficiency.

Sidebar 18-- WSU Power Engineering Program Spurs Business Opportunities

Power engineering at Washington State University remains one of the strongest and largest programs in the country. In addition to providing nationally-recognized academic programs, WSU's Energy and Power Systems program also acts as a leading research facility. The number of research projects is now at record levels and the program continues to be called on for research of national consequence.

One of the program's hallmarks is a public-private consortium called the Power Professorship. Private sector members include utilities, power vendors and consulting companies. Both faculty and students work closely with these industrial partners on technical projects of direct relevance.

The partnership is obviously working. Pullman graduates are heavily recruited within the industry. And Washington's Inland Empire has seen the rise of a growing cluster of energy-related businesses. Several of these companies were founded by, or rely heavily on, professors and graduates from WSU.

The Northwest Has Deep Transmission and Distribution Expertise

The Northwest heritage includes hydropower, long distances between metropolitan areas and shipping power back and forth to California. As a result, the region has a vast network of transmission lines and deep expertise in grid issues --

transmission modeling, design, planning, and installation. Bonneville Power Administration, to name just one example, oversees one of the largest transmission systems in the world. Many of our agencies and utilities have both the necessary experience and the necessary "mind-set" -- an interest in and openness to advancing technology.

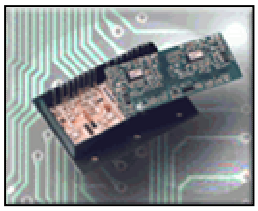
The Northwest Has Transferable Private Sector Skills

Of all the categories investigated during the *Poised for Profit* project, Smart Energy has the most immediate and obvious overlap with regional strengths such as:

Software engineering. The Northwest houses headquarters or significant branch offices of nationally known software organizations such as Adobe, Attachmate, Boeing Computer Services, Crystal Decisions, Microsoft, Pivotal, Timberline Software, and WRQ, not to mention hundreds of innovative small firms. Several regional universities host strong software engineering programs. For instance, Washington State has more than 45,000 people working in software (and another 24,000 in electronics and computer manufacturing).

Internet expertise. With firms such as Amazon, RealNetworks, Infospace and many others, the Northwest is a leading center of Internet expertise. (Some of it un- or under-employed due to the dot-com crash.) Since some people describe Smart Energy as a marriage of energy and Internet, this expertise is of value and significance.

Sidebar 19 -- Bend, OR-Based Advanced Power Technology Acquires Two Companies in 2002



Advanced Power Technology of Bend, OR acquired two companies in 2002 as it works towards its goal of becoming the world leader in power semiconductors for high-power and high-frequency applications. Power semiconductors are used in the conditioning and control of electrical power.

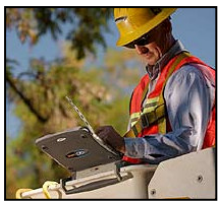
APT's specialty products are found in high-powered medical, industrial and aerospace devices. The company also makes a line of products for the burgeoning RF market, including radar and avionics.

Although people might not think of Bend as a high-tech hotspot, APT successfully competes with such high-tech heavyweights as Motorola, Philips and Fairchild. Its 2002 revenues of $43.4M represented a 17.8% increase over 2001, despite the current economic downturn.

Semiconductor design and manufacturing. Oregon's base of semiconductor expertise has direct relevance to the growing number of digital devices for the power industry. (See Sidebar 19.) Oregon currently employs more than 30,000 people in wafer and semiconductor manufacturing (and another 23,000 in electronics, computer and printer manufacture).

Wireless communications. Washington State boasts one of the largest wireless clusters in the nation, housing the U.S. headquarters of AT&T Wireless, T-Mobile, Western Wireless and other growing players. British Columbia also has deep wireless expertise (as does its neighbor Alberta). Utilities and power companies are increasingly interested in wireless methods of monitoring equipment and gathering data. (See Sidebar 20.)

Sidebar 20 -- Spokane Maker of Rugged, Wireless Laptops Finds Success in Utility Market



Spokane-based Itronix illustrates how the Smart Grid trend can provide opportunities in adjacent industries. As more utilities automate their mobile workforces, Itronix has found a ready market for its ultra-rugged laptops and handhelds.

The company's products feature rugged construction for demanding work environments, integrated wireless communications for mobile workers, and in-vehicle docking stations for recharging. In addition to utility companies, Itronix sells to the military, construction, telecoms and other industries that need highly reliable computers for indoor/outdoor use. (Itronix has no relation to Itron, the utility automation company also based in Spokane.)

The skills developed over the past 25 years in the industries mentioned above -- management skills, product development skills, sales skills -- can now be deployed in Smart Energy. In addition, regional organizations such as Intec (Spokane), South Sound Technology Alliance (Tacoma) and Oregon Institute of Technology (Klamath Falls) have programs underway to identify and supply the workforce training needs of the electric power industry.

The Northwest's Environmental Consciousness Is a Business Advantage

The Northwest has many government and industry programs in support of energy efficiency and energy technology. Organizations such as the Northwest Energy Efficiency Alliance and the Oregon Energy Trust spend tens of millions each year to deploy energy-saving technologies. What's more, it is home to many "enlightened" organizations (to quote one Canadian official). Bonneville Power Administration is a government-owned transmission operator whose mission includes support of new technologies. BC Hydro has an exemplary record of support for sustainable technologies of all types. Utilities such as PGE, Avista, PSE, Tacoma Power and others have been leaders in testing and trying new technologies.

The Northwest's environmental bias makes it easier to attract support and subsidies for emerging energy technologies. Our international reputation for a beautiful environment and an eco-friendly population also make it easier to attract skilled workers and top management from other regions.

The Northwest Is an Ideal Smart Energy Test-Bed

The assets described above make the Northwest an ideal test-bed for the Grid of the Future. The case is made even stronger by these additional factors that make the Northwest a great place to demonstrate new technologies:

- **Diverse climates and geographies.** The Northwest has four distinct seasons and a wide range of geographies, from desert to mountain to seacoast to urban.
- **Diverse mix of power sources.** We produce baseload power from centralized hydro, nuclear, coal and wind facilities. We also have pilot distributed generation facilities powered by fuel cells, solar and wind.
- **Diverse mix of transmission facilities.** We have thousands of miles of transmission lines and multiple voltages. Approximately 50% of the lines are owned by public utilities. And the region has lots of rural areas, which are excellent for distributed generation experimentation.
- **Diverse mix of commercial, industrial and high-tech giants.** Organizations such as Boeing, Weyerhauser, Starbucks, Microsoft and our regional ports are ideal candidates to pilot new technologies.
- **Diverse mix of utilities.** Our region includes federal, state, provincial, municipal, coop and investor-owned utilities.
- **History of utility cooperation.** Northwest utilities routinely work together on business, technology and policy matters. The BPA is a nexus for cooperative research and discussion. We have numerous organizations with a history of collaboration, including the Northwest Energy Efficiency Alliance, the Northwest Power Planning Council, the Electric League of the Pacific Northwest and several others.
- **Test bed efforts now underway.** The Northwest Energy Technology Collaborative is actively working to create test beds and demonstration projects. The Northwest Energy Efficiency Alliance, the Bonneville Power Administration and several of the larger utilities also sponsor demos and testing that often overlaps into the Smart Energy arena.

REGIONAL CHALLENGES

In simplest terms, companies need access to four essential ingredients to succeed: 1) ideas, 2) money, 3) talent, and 4) markets. If they want to enjoy the benefits of an economic cluster, they need access to a fifth ingredient: 5) each other. The Northwest has challenges in all of these areas.

Access to Ideas

The Northwest houses some of the world's premiere Smart Energy research efforts. Yet only a small fraction of that intellectual property is ever converted to business opportunities.

Part of the problem is the dreaded "commercialization chasm" -- the extraordinary difficulty of translating theoretical advances into practical products. This problem is not unique to the Northwest or to energy technology. Labs and universities everywhere struggle with commercialization. But even if we are not alone in this difficulty, it still could prevent us from harvesting the fruits of our top-notch research facilities.

Part of the problem lies with lack of proximity and parochial attitudes. Few Seattle entrepreneurs, for instance, have any idea of the rich resources embodied by institutions such as Powertech Labs (in Vancouver, BC), WSU (in Pullman, WA), PNNL (in Richland, WA), and BPA (in Portland, OR).

Finally, part of the problem comes from the capital and market issues described below, which make it even harder to transfer ideas out of the labs.

Access to Capital

To be sure, the capital shortage is acute in every geography and every industry. But the Northwest's Smart Energy companies face other significant hurdles. Of the major metropolitan areas, only Seattle has a reasonably large community of both venture capitalists and angel investors. Portland, Vancouver, Tacoma, Victoria, and Spokane have made progress, but still don't have great depth.

The situation is made worse because few regional investors have an understanding of or interest in energy. In many cases, Northwest Smart Energy startups are forced to look outside the region for capital -- a much harder prospect.

Access to Talent

On one hand, the Northwest is an attractive place to live. What's more, both Seattle and Portland have broad bases of high-tech management expertise, much of it under-employed due to the slowdowns in the software, semiconductor, and aerospace industries.

When it comes to energy technology expertise, however, the Northwest is far from existing talent pools. "There is a cluster of big energy technology companies in Pennsylvania and the East Coast," explains Andrea Johnston, CFO of Vancouver, BC-based NxtPhase, which builds grid monitors and controls. "Therefore there's a big pool of top management talent to draw from. It's much harder to recruit those top people to move across the continent, away from their roots and their business networks."

Access to Markets

The Northwest suffers from its lack of visibility. The world does not look to this region for leadership in energy, or recognize its strengths. And the Northwest's regional market isn't big enough to sustain startups and act as a steppingstone. Startup companies may get one or two local sales if they're lucky. Then they typically have to look 2,000 miles away for the next one -- a challenge for a young, cash-strapped company.

Ironically, the Northwest is also hampered by its low power prices. Most people would name low power costs as an advantage. When it comes to jump-starting the Smart Energy sector, however, low prices create less incentive to implement new ideas. In addition, virtually all Northwest power comes from baseload plants. Unlike regions such as California, there is very little gap between peak and off-peak prices. It is therefore difficult for Northwest utilities to implement time-of-day pricing and other demand management programs.

Access to Each Other

Michael Porter, the Harvard professor and economic development theorist, describes clusters as "critical masses in one location with unusual competitive success. Much of that success comes from the networking effects when companies are located near one another. Close proximity makes clusters easier to establish and maintain. Some economic development experts argue that clusters cannot arise unless companies are highly concentrated.

Northwest Smart Energy firms are scattered hundreds of miles apart. What's more, the regional Smart Energy industry is not yet "self-aware."

Twenty years ago the personal computer industry became "self-aware" and began to organize trade associations, conferences, joint marketing, and lobbying efforts. The Northwest took a lead in this effort, and became one of the world's top software centers. By contrast, most Northwest Smart Energy companies still don't see themselves as part of a sector. They fail to take advantage of the networking, policy advocacy and joint marketing that can give them great leverage. Without a serious and sustained effort to promote communication and cooperation, this lack of proximity could doom Northwest hopes of becoming a global leader. It is quite possible the next few years will see a repeat of the last few -- namely, isolated pockets of individual success, but few spin-off benefits.

REGIONAL OPPORTUNITIES

To this point, we've examined the global scene and our regional issues. With those discussions as background, we are ready to consider where and whether the Northwest has near-term opportunities in the Smart Energy space. After

examination of the opportunities, assets and barriers described above, we conclude that the Northwest has significant potential in at least five niches. These segments were selected for two qualities: 1) a promise of rapid near-term growth and 2) a close match with our regional strengths.

- **Advanced metering**, where we already house the worldwide market leader
- **Utility back office software**, where we are home to an industry leader and which meshes with our existing software expertise
- **Grid monitors and controls**, where we also have a category leader and several important startups
- **Transmission/distribution/substation automation,** where we have related companies and where we stand to gain from the expected up tick in grid spending
- **Power electronics,** where we have a world leader and several promising companies

In addition, at least four other niches offer moderate-to-strong potential:

- Energy management systems
- Building automation and controls
- Energy service companies (ESCOs)
- Workforce automation

The Northwest Has Significant Potential in Five Important Niches

At this early stage of the game, the Pacific Northwest could still gain a leading stake in the Smart Energy sector. Our research uncovered five areas that combine a) near-term growth prospects with b) regional strengths. Table 4 lists these opportunities along with their associated issues.

Advanced Metering. Advanced metering may be our region's single largest opportunity in terms of revenue and jobs, since the worldwide leader is Spokane-based Itron. With its recent acquisition of the Schlumberger metering subsidiary, Itron now has more than 60% of the market and does more than a half billion in sales each year.

The Northwest's strengths in wireless applications should prove useful as metering companies continue to look for wireless solutions. Tantalus Systems of Burnaby, BC is one of several regional companies beginning to build international reputations in this arena.

Table 4 -- Strong Opportunities for Northwest Smart Energy Growth

Opportunity	Assets	Challenges	Organizations
Advanced Metering	▪ Region already has market leaders in this area ▪ Builds on our wireless capabilities	▪ Will require education to inform software companies of the opportunities to augment this area	▪ Itron: Spokane, WA ▪ Teldata Solutions: Portland, OR
Utility Back-office Software	▪ Region has a world-leader and several promising upstarts	▪ Geographical distance from some of the best markets	▪ Alstom: Bellevue, WA ▪ Enegration: Vancouver, WA ▪ Utility Solutions: Bend, OR
Grid Monitors and Controls	▪ Regional IP from PNNL, Universities ▪ Regional strengths in sensors and control development	▪ Technology transfer difficult ▪ Sensor and control strengths are in industrial processes, not utilities	▪ Alstom: Bellevue, WA ▪ Micromonitors: Bend OR ▪ PNNL: Richland, WA
Transmission/ Distribution/ Substation Automation	▪ Regional strengths in digital relays ▪ Strong transmission presence with BPA. Area is net exporter of power ▪ Intec, OIT, and other academic programs could develop complementary training	▪ Hardware margins decreasing ▪ Service opportunities in this category difficult to export ▪ Category dominated by large players; start-ups may have challenges	▪ Alstom: Bellevue, WA ▪ Schweitzer: Pullman WA ▪ IST: Vancouver, WA
Power Electronics	▪ BC-based Xantrex is a category leader ▪ Numerous other companies in the sector ▪ Some synergies with existing electronics and semiconductor industries ▪ Related research at OSU, UBC, Simon Fraser and elsewhere ▪ Can sell to industrials and other commercial customers until utilities come around	▪ Geographical isolation can make it hard to find customers and recruit management ▪ Little experience with the operational issues of high-volume electronics manufacturing ▪ Utility resistance is a hurdle ▪ Lack of common standards is a hurdle	▪ Alpha Technologies ▪ Denon Technologies ▪ Northern Technologies ▪ Philtek Power ▪ Thomson Technology ▪ Xantrex ▪ UBC, Simon Fraser, OSU

In addition to sales of the meters and wireless systems to send and retrieve data, we foresee software sales as well. Although most analysts are not yet factoring meter-related software into their growth equations, we believe utilities will increasingly seek to make business use of the rich data they are now collecting. Our region's expertise in software development should help support growth in that area. As the

meter moves to become a gateway with which to offer other products and services, proximity to Microsoft and its digital home agenda could be strategic.

Grid Monitoring, Communications and Control. The Northwest should be able to play a central role in this category. Regionally, several groups are working to develop intellectual property around grid optimization, including PNNL, Powertech Labs, University of Washington, and WSU. As SCADA systems continue to move from UNIX towards Windows platforms, the region's proximity to Microsoft means regional Windows-based software companies could find this an appropriate area to explore. We have anecdotal evidence that companies in this category are influenced by the availability of power engineering graduates when selecting sites for offices and branches. WSU, UW, Gonzaga, OIT and OSU currently offer or are in a position to offer programs tailored to training power and electrical engineers.

This opportunity also builds on regional strengths in sensors and controls where there are dozens of niche opportunities. Micromonitors of Bend, OR is one example of a sensor company focused on this space. GridSense of Vancouver, BC is another. Power Measurement of Saanichton, BC is another. There are also service opportunities, since anywhere from one fourth to one half of the budget for these systems is spent on training and system integration.

Transmission/Distribution/Substation Automation. This segment represents an outstanding opportunity for the Northwest. As with the previous category, it builds on work being done on grid optimization. With the variety of transmission conditions in the Northwest, the region is an ideal place to test new technologies. We also have the beginnings of a cluster with companies such as Alstom, PCS Utilidata and Schweitzer Engineering Labs.

This segment embraces considerable export opportunities. Our geographic location would aid those who are trying to penetrate the Asian market, but does not preclude sales to Europe and Latin America. International utilities are more likely to purchase these products from a large supplier or system integrator, so it may be necessary for regional firms to partner with overseas integrators.

Utility Back-Office Software. The Northwest already has a large market player in Alstom ESI, which is one of the top six in the world. It also houses branch offices for other important players such as Indus, and for major systems integrators now becoming active in this space, such as EDS.

In addition to Alstom, the Northwest also boasts several startups, plus several consulting firms devoted to helping utilities with this challenge. Since the utility industry is following a path blazed by numerous other industries before it, we can expect the Northwest's strengths in enterprise software to come into play. In many

cases, it requires only modest changes to customize existing back office programs to the needs of utilities. Indeed, Microsoft recently formed a small group to pursue the utility vertical market.

Sidebar 21 -- Portland's FirstPoint Energy Corp. Builds Integrated Platform for Utilities

Portland-based FirstPoint Energy combines products from subsidiary and related companies to create energy information services for utilities and large businesses.

FirstPoint owns UtilityOne, a Bay Area provider of e-commerce software for utilities. It also has a relationship to Portland's Teldata Solutions, which provides advanced metering solutions for electric, gas and water utilities. The company's goal is to create a complete, end-to-end integrated energy platform. Current offerings include advanced metering, software for aquiring and managing meter feeds, and energy information software for Internet-based access to that data.

Power Electronics. Power electronics seems destined to grow 15-25% per year over the next few years, on a base of at least $3B in current sales. Power electronics is particularly attractive since it relates to almost all other forms of electricity. No matter which form of alternative energy takes off first -- solar, wind, tidal, biomass, fuel cells -- it will need power electronics. When and if automobiles make the transition to electric/hybrid or fuel cell engines, they will need power electronics. With category leader Xantrex, with numerous other related companies and with related industries such as electronics and semi-conductors, the Northwest has more opportunities to take a lead than perhaps any other region in the world.

The Northwest Has at Least Four Moderate to Strong Opportunities

Our research has uncovered at least four additional market segments with moderate to strong potential for near-term jobs and revenue growth in the Northwest. Table 5 lists and explains our findings.

Table 5 -- Moderate Opportunities for Northwest Smart Energy Growth

Opportunity	Assets	Challenges
Energy Management Systems	▪ Regional emphasis on software and enterprise computing should provide innovations and support ▪ Strong start with Itron-owned Silicon Energy providing versions of these systems	▪ Smaller local demand to support start-ups ▪ Requires building commercial go-to-market partnerships and channel relations with existing suppliers
Building Automation and Controls	▪ Significant DOE-funded research at PNNL ▪ Several small to medium startups ▪ Giants Johnson Controls and Siemens Building Technologies have significant regional presence	▪ Distance from major centers of building activity ▪ Category growth may be slowed by problems in the real estate and construction markets
Energy Service Companies (ESCOs)	▪ Regional strengths in energy conservation techniques with programs at WSU, elsewhere ▪ High quality labor available	▪ Difficult to export a service ▪ Competes with local utilities that deliver it for free ▪ State tax structure creates disincentives to locate headquarters here
Workforce Automation	▪ Wireless entrepreneurs and skilled software companies ▪ Major carrier presence ▪ GIS application development beginning	▪ Local area is more software heavy than device heavy ▪ Manufacturing components may go elsewhere

REGIONAL BENEFITS FROM A SMART ENERGY CLUSTER

The Pacific Northwest already obtains significant benefits from its existing Smart Energy businesses. Success in building a Smart Energy cluster would amplify the rewards in revenue, jobs, and exports.

Regional Revenue and Jobs from Smart Energy

It is relatively easy to assess the approximate number and revenue impact of Smart Energy companies in BC, Oregon, and Washington. Part of the *Poised for Profit* effort was to catalog regional Smart Energy companies. Based on the data collected for that directory, we estimate the sector encompasses more than 225 companies with revenues in excess of $1.9B, plus at least another $150M in research and development funding, for a total in excess of $2B.

Smart Energy brings with it high-paying jobs for scientists, researchers, engineers, professors, lab technicians and other knowledge workers. It also holds the

potential for family-wage jobs, including technicians, trainers, operators, and programmers along with field sales, installation, repair and support.

Estimating current employment figures is problematic. Many companies are only partially in the Smart Energy sector, so it is difficult to determine which employees to allocate where. A conservative approximation would put the number in excess of 6,000 in BC, Oregon, and Washington, counting research and development but excluding indirect spin-off jobs.

Exports from Smart Energy

The electric power industry is mature in most industrial countries, but deregulation, privatization, and liberalization are driving demand for Smart Energy solutions in some parts of the world. Deregulation has also increased the interest in more advanced products in energy trading and metering. This trend is affecting several regions of the United States, Canada, and Mexico, creating North American export opportunities. Market restructuring is also driving growth in parts of Latin America, Australasia, and Western Europe, particularly in the United Kingdom and the Scandinavian countries.

In developing countries, export opportunities derive less from deregulation and more from growing energy needs. Export opportunities include construction and upgrades of power T&D networks in these countries, plus demand for new power generation (including distributed generation). More than a dozen large international financial institutions (such as The World Bank) fund energy-related infrastructure projects in developing countries.

Because of their complexity and their high value-to-weight ratio, many Smart Energy products can be manufactured in the Northwest for export outside the region. (In fact, export must be a component of every company's strategy since so much of the opportunity is located beyond the Northwest.) In other words, as long as the products are valuable enough that labor costs are only a small portion of the price, we can hope to create and retain assembly and manufacturing jobs. This is particularly true for products that must continually be upgraded or calibrated during manufacture. For the rest, we can expect high-volume manufacturing to migrate to low-cost centers such as China; even then we can reasonably expect to keep some design, prototyping and fabrication jobs in this region.

Other Benefits

The focus of this report is on the economic benefits, which include hundreds of new products for export, thousand of new jobs and billions in new revenues. A thriving Smart Energy cluster would bring the Northwest other rewards as well. For instance, it will gain a strengthened electrical infrastructure as Smart Energy

products are applied regionally and as concepts such as demand management are applied:

- Fewer new high-voltage transmission lines
- Fewer new power plants
- More reliable power
- Cheaper power
- A significant reduction in emissions, greenhouse gases and health care costs

In addition, the Northwest will gain the intangible benefit of providing leadership towards a sustainable future.

ACCELERATING PROGRESS

The Northwest is fortunate to have a significant Smart Energy foundation in place. It should take every opportunity to expand its early lead, lest it lose out to other regions. Michigan, Texas, Connecticut, and California have multi-million dollar efforts in place to attract clean energy businesses of every kind, including Smart Energy firms. The Northeast has made progress in restructuring, leading to many market opportunities for new technologies. The Southeast has exceptional T&D expertise at Oak Ridge and the Tennessee Valley Authority, along with significant power to export. Europe is home to several industry giants.

There is another important reason to look for ways to accelerate the growth of Smart Energy. A reading of the most recent economic development research reveals that "force-feeding" sectors rarely results in significant economic growth. In the 80s and early 90s, many regions attempted to start new sectors from scratch. All but a few of those efforts failed, including efforts costing tens of millions in the Northeast, in Maryland and in Texas.

It is extremely difficult to command an industry to appear in a region. On the other hand, efforts built around existing strengths and existing concentrations often find success. It is quite achievable to find an early-stage cluster and fan that spark into a flame, as Phoenix illustrated in the last few years by successfully nurturing a nascent optics industry.

Below are six examples of initiatives that could meaningfully advance the prospects for a Smart Energy cluster in the Northwest.

Advocacy of Regulatory Changes

The region should work with regulators to adopt rates, regulations, policies, and incentives that favor the deployment of Smart Energy technologies. Aggressive

regional policies could create fertile market opportunities for homegrown companies.

To be sure, the regulatory issues are complex and entrenched. Even so, looking for achievable first steps and joining forces can make a real difference. Perhaps the most obvious and easy step is to join existing organizations. Regional examples include the Northwest Energy Technology Collaborative and the Smart Energy Business Alliance. National examples include the GridWise Alliance, EPRI's Electricity Sector Framework for the Future.

Access to early adopters is critical to the growth of a Smart Energy company. If the Northwest region could add Smart Energy-friendly regulations and incentives, we would strengthen our case as the ideal place to move products off the drawing board and into customers' hands.

Standards and Test Beds

Lack of market access is one of the major barriers to the growth of Smart Energy companies. It is extremely difficult to get utilities to accept new technologies. The Northwest could improve the prospects of its Smart Energy sector -- and enhance its attractiveness to companies looking to relocate -- by implementing market access programs such as test beds and certification.

Test beds are typically shared cost facilities that share test results with all the participants (and sometimes with the world at large). As of this writing, a regional consortium called the Northwest Energy Technology Collaborative is preparing a test bed initiative that could be an important first step in the right direction. In addition, organizations such as PNNL, BPA, NEEA, and the state energy offices are actively scouting for opportunities for demonstration projects that can also provide needed real-world results.

According to EPRI, the utility industry currently uses 152 different communications protocols. Several CEOs emphasized the power of creating regional standards and testing facilities for certification. Any such effort would need to include regional utilities to have validity. This move alone could dramatically improve the region's value as a leading center for Smart Energy companies.

Market Transformation

A concerted program to improve market access could make this region a magnet for Smart Energy companies. Regulatory change is one important step, since utilities must have incentives to try new technologies (today, they often have disincentives instead). Standards and test beds are another step. Market transformation is yet another.

The Northwest has an excellent record of market transformation, particularly in areas with environmental implications. The Northwest was one of the first regions to successfully implement recycling, for instance. Likewise, the Northwest Energy Efficiency Alliance is widely recognized for its success in accelerating market acceptance for products such as compact fluorescents and Energy Star appliances. These market transformation skills should now be applied to Smart Energy products. Government and military buying programs could also create early markets.

Business assistance

We can take several steps to help Smart Energy companies succeed. *Trade associations* supply all-important networking, outreach, joint marketing, and policy recommendations. *Incubators and accelerators* offer services, mentoring and facilities. *Workforce training programs* increase the number of skilled workers and managers.

A trade association is virtually a prerequisite for an industry cluster. It is even more important for the Northwest because a) our companies are not yet aware of themselves as a regional force and b) the lack of geographical proximity makes it essential to introduce companies to each other. As of this writing, a new regional trade association called the Smart Energy Business Alliance is in the formation stages.

The Northwest could greatly benefit from an "energy technology innovation center" to assist emerging clean energy ventures with the rapid commercialization of their products and services. Such centers -- and related organizations such as business incubators and business accelerators -- have found widespread success in many technology industries.

The U.S. now boasts at least 15 clean energy incubators, accelerators and technology centers. Canada, Europe, and Japan also have notable facilities. Despite its reputation for environmental friendliness and entrepreneurial activity, the Northwest has no such institution. To be sure, technology centers can cost in the millions. Even so, other regions and countries have found the money, through government, through public benefit funds or through public/private partnerships.

The Northwest should embark urgently on the preparation of a business and fundraising plan for a clean energy innovation center. We would expect this center to spend the bulk of its time on Smart Energy businesses (since Smart Energy represents the region's largest opportunity), but its services should be available for other clean energy categories as well.

The Northwest could also improve its Smart Energy prospects with a workforce training campaign. Such a campaign might include educational kits for high schools and junior colleges; additional graduate research programs at area universities; and workforce retraining for utility employees who must deal with new Smart Energy technologies.

Washington Senator Maria Cantwell has released a white paper calling for just such an effort and is pursuing funding opportunities in Congress. Spokane-based Intec has laid out a proposed training program. And the Northwest Public Power Association has established an 80-acre National Utility Training Services facility in Richland, WA, to provide state-of-the-art, performance-based, hands-on industry training.

Outreach and Education

The Northwest can benefit from outreach to investors and to the business community.

First, we can increase the flow of capital to deserving Smart Energy companies through research, publications and events devoted to helping investors understand the category. Access to capital is a formidable challenge for regional Smart Energy companies. Our region has neither large energy funds, nor clean energy VCs, nor public funds committed to clean energy investment. Indeed, most regional investors remain ignorant of Smart Energy as a sector and an opportunity.

Access to venture capital has improved dramatically in Washington and Oregon over the past decade. Even so, very little of that money goes to energy-related businesses of any kind, much less to Smart Energy companies. Regional angels and venture capitalists tend to focus on software and computer-related investments.

Ironically, Smart Energy has great overlap and synergy with those very areas. A short-term (18 months) program of investor education could change this and could establish Smart Energy as a legitimate place for venture investing. Typical examples include venture forums, energy conferences, and investor-oriented newsletters.

Second, we can attract entrepreneurs, service companies and relocations by letting let the world know of our region's advantages. Smart Energy is largely unknown as a standalone sector (even though it is many times larger than better-known segments such as fuel cells and solar). Likewise, the Northwest is unknown as a center for clean energy or Smart Energy.

A short-term promotion and publicity campaign could quickly raise our profile around the world. This effort would also help to solve some of the region's other challenges as well. For instance, venture capitalists are strongly attracted to emerging clusters that can show early success stories. Likewise, companies shopping for new branch locations prefer regions that can supply customers and skilled workers. Skilled workers, meanwhile, gravitate to "thick" employment markets -- regions with many companies and many jobs in the same sector.

Such promotional efforts do not need to be costly. It is far more effective -- and far less expensive -- to get positive articles in respected publications than to purchase advertisements or send delegations on expensive visits. Promotional campaigns undertaken by organizations such as Michigan's NextEnergy and Austin's Clean Energy Incubator can provide templates for success.

Pursuit of Major Research Opportunities

First, the Northwest needs to coordinate its homegrown research to avoid duplicating efforts. Second, it needs to attract even more R&D. Governments, foundations and private companies are pouring hundreds of millions of dollars into Smart Energy research. We need a concerted effort to bring more of those dollars to the Northwest.

The Northwest can raise its Smart Energy prospects by aggressively pursuing research opportunities. With the advent of the DOE's new Office of Electricity Transmission and Distribution, we can expect to see additional DOE research and demonstration projects devoted to Smart Energy. At the same time, several other initiatives are also pursuing major research agendas. Examples include the Consortium for Electric Infrastructure to Support a Digital Society (CEIDS) and the Consortium for Electric Reliability Technology Solutions (CERTS).

As noted earlier, the Northwest has a strong research base in Smart Energy. Nonetheless, much of the most recent energy research funding has gone to Tennessee, California, and New Mexico. The Pacific Northwest should compete aggressively for future awards. A coalition of regional universities and laboratories might be one vehicle for improving the region's prospects for gaining a larger share of these projects.

Conclusion

The ideal initiative, of course, would combine the six separate ideas above into a coordinated plan. That plan would build a regional market as a steppingstone to success nationally and internationally.

The Northwest already has the beginnings of a Smart Energy cluster. Through actions such as those described above we can add fuel to that flame. By helping this category grow into a full-fledged industry of distinction, we can bring thousands of new jobs and billions in new revenues while simultaneously reducing pollutants and greenhouse gases.

APPENDIX A:
PROJECT SCOPE, METHODOLOGY AND TEAM

This report is focused narrowly on near-term market opportunities. As used in this report, a "near-term opportunity" is a market niche that can generate thousands of high-quality local jobs and millions in new revenues within the next three to five years. In addition, that niche must create significant export opportunities, significant growth prospects for current companies and significant reasons for "latent entrepreneurs" to start up related businesses.

As you read through this report, please note that:

- **This report discusses regional cluster prospects.** This report does not relate to the prospects for success for individual companies, which may well prosper whether or not a cluster emerges.
- **This report focuses on near-term prospects.** A market niche with little short-term potential could still become a major opportunity later in the decade. The goal of this study was to find sectors that could see significant market growth within five years. Sectors with longer time horizons were not appropriate for inclusion.
- **This report focuses on cluster potential rather than clean energy potential.** Comments relative to alternative energy speak only to its cluster potential, not to its value as a cleaner way to generate power. Nor does it include the economic benefits related to constructing and operating clean energy facilities such as job creation from wind farms or the economic benefits of spending less on imported energy.
- **This report includes generally accepted consensus figures for market sizing. .** Our numbers represent generally accepted consensus figures of market sizes and growth, as reported by industry analysts and market research firms. The report does not include more detailed financial forecasts. (See Methodology section below for more explanation.)
- **This report series focuses on particular energy technologies.** The terms "clean energy," "alternative energy," "renewable energy," and "New Energy" embrace a wide range of technologies. At the beginning of the *Poised for Profit II* process, the Steering Committee made the decision to restrict the research to the areas of fuel cells, solar, wind and Smart Energy (this report). By design, neither this report nor the others in the series discuss such areas as superconductivity, electricity storage, tidal power, or biomass.

THE METHODOLOGY

Athena analysts are specialists in the growth of emerging markets. Athena's *Research + Action Regional Competitiveness Program* aids leaders in growing an industry in their region. The program combines emerging markets expertise with a systematic research methodology:

- Extensive review of secondary data and industry reports. Over the course of this project, Athena analysts located, obtained, read and reviewed more than 225 energy- and economic development-related research reports
- Multiple interviews, discussions and research roundtables with regional and national players, including energy companies, utilities, investors and policy/program leaders. Over the year-long project, Athena analysts directly interviewed more than 135 experts
- Attendance at key energy, grid and investment conferences. Athena analysts attended (and in many cases participated in) more than 105 individual sessions at three dozen different events
- In-house technical sessions with analysts to map information, generate market scenarios, and establish key findings
- Submission of draft reports to a review committee of advisors and industry experts

Market numbers are included in this report to provide the broadest sense of overall market potential. To size markets at this level, Athena serves as a meta-analyst, using a consensus approach:

- Identify top analysts covering each of the markets and secure their latest estimates
- Review the assumptions, models, and timing of projections through discussions with key analysts
- Explore areas of disagreement and reconciling the estimates against our own understanding of the marketplace to generate consensus figures

When commissioned specifically to provide market sizing or economic modeling for growth impacts on a community, Athena combines those broader perspectives with detailed modeling. In the case of market projections, we identify companies that are currently or will be top market makers; review market reports, SEC filings and other documentation; hold analyst briefings with key managers in those companies; conduct formal surveys with a representative group of additional companies, investors, and others attached to the market of focus; and build financial models. In the case of economic modeling for jobs and other growth impacts, Athena experts utilize modeling techniques standard and defensible in the research field. Those more exhaustive methodologies were not part of the funding or scope of this current project.

The Bibliography

Researchers and others interested in more details may request the bibliography as a separate document by sending email to smartenergy@theathenainstitute.com.

About The Athena Institute and The Center for Smart Energy

The Athena Institute is a research organization that helps executives and organizations find success in emerging markets. Its methodologies and insights have been implemented by many organizations, ranging from Fortune 1000 corporations to public policy agencies.

Athena Center for Smart Energy (www.centerforsmartenergy.com) is the industry's guide to the value chain. It is dedicated to making North America the leader in Smart Energy innovation. Center research and acceleration programs help investors and businesses pursue their strongest opportunities in the emerging Smart Energy sector.

About the Analysts

PS Reilly is a noted expert, researcher, and advisor on commercial success in emerging markets. Her insights and predictions are regularly featured in articles, columns, and keynotes. Most recently she was Vice President of Emerging Markets for Ziff Davis Media, where she provided strategic advice to leading technology companies, including IBM, Peoplesoft, and many others. She has designed and led numerous large-scale research projects, from analysis of a single market, to investigating the economic impact of regional policy and infrastructure changes.

Jesse Berst is an internationally known technology and business analyst. He has authored or co-authored more than a dozen books on technology topics, written hundreds of articles for leading publications and keynoted dozens of business events in the U.S. and abroad. He combines two decades of professional experience in emerging markets with a personal interest in environmental and energy issues. He has served on the Department of Energy National Grid Vision Planning Committee and is the Chairman of the Advisory Committee for Pacific Northwest National Laboratory's Energy Sciences and Technology Directorate.

Jeff Canin brings 20 years of experience in the financial services sector. As a stock analyst with Hambrecht & Quist, Montgomery Securities and Salomon Brothers in San Francisco, he provided in-depth high tech research coverage to institutional investors in North America and Europe. Since 1995, he has worked as a venture capitalist and consultant to emerging growth companies in the information technology and distributed energy fields.

David Amdal has a 25-year career heading international market research firms. He was formerly head of market research for BIS Strategic Decisions for the Asia-Pacific region, a $30M operation with ten offices in seven countries. (BIS has since become Giga Information Group.) He has conducted 300+ market entry evaluations, identifying the sectors, customers and communication with the strongest potential for success. Clients have included Apple, IBM, Canon, S.C. Johnson, Foremost, R. J. Reynolds, Heineken, Guinness, Bayer, BIC, Coca-Cola and Gillette, as well as regional development authorities.

Inquiries: PS Reilly, ps@psreilly.com, 858-603-0139.

To download an electronic copy of this study or its executive summary, visit www.centerforsmartenergy.com.