



Case Western Reserve Survian Technologies LLC

TEAM: Brett A Hoover, James Knight Jr.
ADVISOR(S): Edward Caner

What is your product or service? Survian Technologies will conduct wildlife bird & bat surveys for Wind Power Developers using an innovative surveillance system called BIRDS: Birds Eye Remote Dimensional Software. A valuable pre construction survey will be offered to Wind Power Developers as mandated by the State Siting boards as well as a post-construction survey service necessary to minimize turbine inactivity during periods of high bird/bat activity. The latter results in a significant increase in overall wind farm efficiency.

What is the underlying technology and what does it do? Survian's surveillance approach will comprise novel object identification and segmentation software coupled with high-definition image acquisition hardware designed to identify and monitor birds and bats in flight.

How is the technology unique? Current solutions, such as manual observation, have convoluted protocols, are inaccurate, inconsistent, and in need of standardization. Alternatively, advanced radar and RFID tracking systems have proven to be cost prohibitive and still must be supplemented with manual surveillance for species-specific identification. Survian is taking a completely automated and digital approach, which significantly improves upon each of the competitors' shortcomings. Accurate and reliable surveillance data translates to more effectively placed wind farms and more efficiently harvested wind energy.

How is the product innovative? Survian's technology is fully automated and digital. It can also identify, and adapt to, previously undefined objects (birds/bats), by recognizing new Adaptive Feature Metrics (AFM) and adding these to an existing AFM library. This improves the system's accuracy in real-time. The product launch strategy relies on our ability to cater the technology to both wind energy developers and federal and state wildlife agencies to provide a comprehensive and superior surveillance service. By consolidating new and existing algorithms into a novel software system and uniting this with high-resolution imaging hardware, we can easily meet the surveillance needs of wind energy developers with the speed, ease, and cost-effectiveness necessary to make wind energy a viable mainstream solution for our country's energy needs. Eliminating inefficiencies associated with poorly located wind farms and extended periods of turbine inactivity will significantly increase the net energy extracted from a given farm per unit time.

Who will buy it? In the wind energy industry, our target

customer group, wind farm developers need a reliable, cost-effective way to monitor wildlife to meet federal and state wildlife regulations. For example, during the pre- and post-construction phases, developers manually survey bird/bat activity to predict the effects turbines will have on local wildlife and to forecast how often and when the turbines will need to be shutdown. Other possible industries, such as air traffic control and nuclear energy have equally challenging applications that would be ideal for automated surveillance technology.

Why will they buy it? Manual surveillance is cost, labor, and time-intensive. In addition, the resulting data is often inconsistent and unreliable. Wind energy developers rely on this data to strategically place turbines to minimize their negative impact on local wildlife. This lack of quality data can lead to poor turbine placement, resulting in long periods of inactivity. Our technology will save wind energy developers time, money, and will improve wind farm efficiency by enabling more effective turbine placement and minimizing periods of turbine inactivity.

What is the size of the market? In 2003, total wind energy revenues were \$2.5B and in 2008 topped \$18.7B. By 2013, the market is forecasted to reach \$52.7B, a compound annual growth rate of 40.6% (2006-2013). Wildlife surveillance represents 0.5-2% of the installed cost of wind turbines. This represents a significant amount of the wind energy market. As the market expands, the demand for our technology will follow.

How will you protect your intellectual property? Preliminary IP research shows good potential for patent filing to cover the technology (software and hardware) and its novel application to wildlife. Survian is actively pursuing this patent application and in conjunction with the University and its strategic partners.

Clark Atlanta Univ. / Morehouse College Apex Plastics

TEAM: Yemaya Stallworth-Bordain, Kamal Sewell
ADVISOR(S): Donald Hylton

What is your product? The Apex Plastics prototype 1 (AP1) is an instrument for characterizing the application and performance properties of synthetic materials and the impact that their use could have on the environment. It is a product that enables plastic manufacturers to reduce waste, minimize inefficiencies (e.g. energy usage), reduce cost and streamline development and introduction of new products.

What is the underlying technology and what does it do? The AP1 instrument measures the viscous (flow) and elastic (flow resistance) properties of synthetic plastic materials



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in a deformation mode similar to the manner observed in thermoforming, blow molding and other post-extrusion stretching applications. This is accomplished by applying a carefully controlled inflation medium to a heated sample. A dedicated software package conducts the test and automatically calculates and categorizes the results.

How is the technology unique? To date there is no method for evaluating commercial thermoplastics before running the process. Hence, the AP1 solves the thermoformer's and blow molder's problem of not being able to control the quality of the raw materials being processed and thus, the final product. Most competing technologies for testing these materials require considerably more time and complexity on expensive instrumentation. The resultant data is indirect and is so complex that expertoften costly interpretation is required. Conversely, in production control environments, AP1 operators will require minimal training and data interpretation.

How is the product innovative? Two key innovative characteristics of the AP1 are its simplicity and its attractive price. The costs of competing instrumentation are a major factor in preventing widespread applicability. The software package developed for the AP1 operates the instrument, collects data, makes calculations and in simple terms appraises the operator of the expected behavior of the test material. The operator then uses this knowledge to determine whether the material is suitable for the desired application. By combining a direct manufacturing simulation that mirrors the processing method with easy, userfriendly accompanying software, one can test materials with a speed and ease not yet seen in the industry.

Who will buy it? Thermoforming and blow molding manufacturers and thermoplastic sheet suppliers will buy the AP1. The AP1 is a valuable tool for commercially producing more sustainable, hence "greener," plastic products.

Why will they buy it? The current methods for evaluating thermoforming and blow molded products, even though informative, are cost prohibitive. Thermoformers and blow molders can spend between 25-45% of their cost of goods sold on evaluating thermoformability of commercial plastics. The current methods and machines of evaluating thermoformability of materials are very expensive because they are tuned to correct errors while the machine is running, i.e. the process will continue to turn out products of unacceptable quality until proper specifications or conditions are met. For example, in a web-fed operation, running five parts across the web and continuously discarding a single row of parts is unaffordable. That single row may have been rejected on the basis of quality, but it represents 20% of production, which could be equivalent to that product's profit yield.

What is the size of the market? In 1998, approximately 2.9 million metric tons of plastics were thermoformed in North America. This is a sustained annual growth rate of about 10% over nearly four decades. An additional 4.55 million metric tons are thermoformed worldwide. The total world market is estimated to have a value of about US \$35 billion.

How will you protect the intellectual property? The AP1 has been invented and developed at Clark Atlanta University. Of the three inventors, including Dr. Costel D. Denson, Mr. Donald Hylton and Ms. Yemaya Stallworth-Bordain, the latter two are currently employed by Clark Atlanta. The invention rights to this technology have been assigned to Clark Atlanta University through its Office of Research and Sponsored Programs (ORSP) that manages Clark Atlanta patents.

Duke University CPS Biofuels

TEAM: Jacqueline Coates. Lauren Knish, Hosoon Lim, and Takayuki Yamazaki

ADVISOR(S): Guerry Grune

What is your product? Purified glycerol can be converted into glycerol ethers (GTBE) that can be added to gasoline blends to increase the efficiency of traditional gasoline. Unlike past and current fuel additives that have been proven to have a negative effect on the environment, GTBE is environmentally friendly and more effective than similar products. This product can be created from natural organic feedstock and can be implemented using the existing U.S. energy infrastructure.

What is the underlying technology and what does it do? CPS Biofuels has developed a method of producing a glycerol based biomass source, glycerol tertiary butyl ether (GTBE) that can be used to improve the efficiency of blended ethanol, specifically E10 and E85. The process creates GTBE by first purifying glycerin to form glycerol and then creating a reaction between the glycerol and C2-8 olefins to form glycerol ethers. The GTBE can then be used in several applications. It can be used in gasoline as a combustion boosting fuel oxygenates to increase productivity. It can also be used in kerosene-type jet fuels as a fuel system icing inhibitor.

How is the technology unique? Our new technology is unique because the GTBE production process uses glycerol instead of methanol. The product is produced via catalytic conversion and fractional distillation. The GTBE produced can have as few as one or as many as three ether linkages. This process creates salt by-products that will be removed, most likely through a filtering and flushing process.



Team Submissions



How is the product innovative? GTBE is a new product that will increase ethanol efficiency while overcoming many of the problems of tradition petroleum. The product is renewable, can be produced domestically, and utilizes the current energy infrastructure of the U.S. The product will help cut gasoline expenses and is extremely environmentally friendly and is even believed to have medicinal purposes.

Who will buy it? There are several different approaches CPS Biofuels can take to market GTBE. The first potential market is as an over the counter fuel additive, which customers can buy to increase gas mileage and make their cars more environmentally friendly. A second potential market is the United States Air Force, because GTBE is an efficient system icing inhibitor in jet fuel that is more environmentally friendly than the current product PRIST. The third option is to market the product to ethanol producers to increase the efficiency of their blended products. Under this scenario GTBE will take the place of MTBE, which is currently outlawed in many states because of its' environmental impacts.

Why will they buy it? Purchasing GTBE has many incentives. Customers will buy the product because it will increase ethanol efficiency, which is important as gasoline prices fluctuate. GTBE also offers a more environmentally friendly alternative than its' various competitors. Many people and companies are working to become more environmentally aware, and GTBE will help.

What is the size of the market? The market for this product is huge as the ethanol market in the U.S. is expanding. As an ethanol additive, the market for GTBE will expand comparatively. The US currently has the capacity to produce over 10 million gallons of MTBE, a competing product, per day. CPS Biofuels believes it can capture at least 10% of this market, creating a tremendous value proposition.

How will you protect your intellectual property? CPS Biofuels possesses the intellectual property for the blending of biofuel additives and for biogasoline, which is a large part of the company's value. CPS currently has one patent granted and five patents pending that relate to the company's immediate and near-term plans to develop biofuel related products. The granted biodiesel fuel patent (US 5,578,090) teaches a fuel additive composition and an alternate fuel composition as well as the method for preparing the fuel additive. The five pending patents and associated application numbers are as follows: Alternative Fuel and Fuel Additive Compositions (US20090013591A1), Production of Gasoline from Fermentable Feedstock (WO2008156651A1), Biodiesel Process (WO2008123925A2), Alternative Fuel and Fuel Additive Compositions

(WO2007061903A1), and Improved Biodiesel Fuel, Additives, and Lubricants (WO2007027669A1).

Lund University, Sweden Series Tech

TEAM: Oskar Bjarnasen, Erdal Kocoglu and Sahnaz Tavsanoglu

ADVISOR(S): Hans-Henrik Lidgard

What is your product? The invention is a type of electrically magnetized synchronous machine (EMSM) which can be used in engines for hybrid vehicles in order to replace the permanent magnet synchronous machine (PMSM) which is most commonly used in hybrid vehicles today. This specific type of EMSM is a series magnetized synchronous machine (SMSM) and differs mainly in that the rotor is connected in series with the stators. This eliminates the need for separate control and rectifier for the rotor which reduces the number of components required and negates the need for permanent magnets.

What is the underlying technology and what does it do? The SMSM is a type of EMSM, and therefore has all the benefits of an EMSM when compared to the PMSM. Instead of using permanent magnets, an EMSM uses an electric current to create magnetism to the rotor. In traditional EMSMs, the current is supplied separately to the rotor and the stators, requiring separate control components. With the SMSM, the rotor is connected in series with the stators, and is therefore supplied by the same current. The SMSM uses the same control circuit for the rotor as for the stators. A rectifier is used to switch to direct current for the rotor from the alternating current used for the stators. The rectifier is an inexpensive component, and the only additional part required in order to obtain the additional gains which the SMSM offers in comparison to the EMSM.

How is the technology unique and innovative? As the SMSM is a type of EMSM, it has all the benefits compared to the PMSM such as higher peak torque which is especially relevant in a stop-and-go situation and higher degree of efficiency during the continuous operation. Compared to the traditional EMSM, the SMSM provides important additional benefits. The main advantages of the SMSM lie in that it requires less wiring and fewer components than the traditional EMSM, which reduces the efficiency loss due to heat generation in the wiring. This also makes the SMSM cheaper than the traditional EMSM, both in component cost and in that it requires less space in the motor.

Who will buy it? SMSM technology has several applications such as for an automotive starter motor, automotive generator, industrial robot and air conditioning equipment. Because of its great commercial value and advantageous timing, the company intends to begin with launching the



technology for the hybrid car industry. Therefore, hybrid car manufacturers including both the ones producing hybrid cars and the ones which do not have a hybrid model but plan to produce in near future constitute the target customer group.

Why will they buy it? The type of motor most commonly used in hybrid vehicles today contains a permanent magnet (PM) rotor. Permanent magnets are made of the extremely expensive rare earth material (REM). Mostly due to the growth of the hybrid market, demand for PM is soaring and is expected to greatly exceed the supply in the near future. On the supply side, China dominates the market, supplying around 97% of the world's consumption of the material. China has recently announced a reduction in the exports of REM's in order to protect its national commercial interests. This decision will reduce the supply for buyers outside of China considerably, while world demand is still rising. Prices of PM's are expected to continue to rise dramatically. Due to this significant increase in demand and decrease in supply the situation for hybrid vehicle producers is highly uncertain. Some companies, even if they would be willing to pay high prices, may risk not getting the material at all. It is an obvious and unacceptable strategic drawback for automobile manufacturers to be dependent on such a material. These extremely expensive magnets create a need for hybrid car manufacturers to find a cheaper technology which secures the supply line of hybrid cars in the future. These two factors, the large potential of the hybrid market and the increase in prices for permanent magnets, create a situation where companies could save millions by switching to an alternative technology. The technology presented here, the SMSM, essentially makes the rotor in electric motors less expensive, easier to assemble and secures the chain of supply.

What is the size of the market? Today, hybrid cars represent a minor part in the automobile sector; in 2005 they represented only 0.2 percent of the total sales of new cars, globally. This, however, is changing rapidly and in 2012, hybrids cars are expected to account for 6 percent of sales of the combined U.S., Japanese and European markets. By taking into account the trends in technological development and gasoline prices, the hybrid car market in terms of units sold is forecasted to be 2.2 million in 2012.

How will you protect your IP? The invention is protected through a patent, which has been granted in Sweden. Patents have also been applied for in several other countries such as EU, US and Japan. In near future, file patent applications will also be filed in China, South Korea, Singapore and India. The patent strategy has been to focus on the countries where the world's main car manufacturing industries are located.

Missouri University of Science & Technology *Interdisciplinary Design Collaborative*

TEAM: RJ Miller, Michael Orlando, Chris Wright and Jordan Wright

ADVISOR(S): Rob Stone

What is the product? The field of Energy Monitoring and Targeting (M&T) is an emerging technique that aids building occupants/managers in reducing the energy costs associated with the structure. By measuring many aspects of a system, an analysis can be made which results in knowing the easiest, most inexpensive or otherwise optimized methods for reducing wasted energy. Energy Conscience is aimed at improving behavior in order to become more energy efficient and reducing waste through automatic control of devices based on environmental inputs and forecasted energy availability.

What is the underlying technology and what does it do? The proposed innovation is to develop a system of low-cost, modular nodes with connectivity over a variety of mediums, primarily utilizing commercial, off-the-shelf (COTS) wireless technology. These sensors will network with a primary information collection and control device. This device will assemble, analyze and distribute the data to be viewed. The nodes will be designed to use a common radio transceiver interface, able to work with a variety of sensors or devices. The radio ability will allow for installation without wires, while innovative sensor types will allow for installation with minimal cost and service interruption. This technology will gather energy consumption data and use this information to save energy by making automated recommendations to users and actively adjusting outputs to automatically ensure energy efficient behavior. Integration into OEM devices is emphasized.

How is the product unique? Existing systems which collect data on energy usage are fundamentally limited in a few ways. A predominant percentage of M&T systems only account for electrical usage and lack the ability to control settings based on energy usage and other factors. These are also prohibitively expensive and lack proper expansion capabilities.

How is the product innovative? The proposed innovation focuses on making these systems economical by using common components to accommodate inexpensive parts. In addition, by ensuring compatibility with networks which already exist, another attempt to cut costs will be made by utilizing existing infrastructures. Also, ease of installation is imperative for market success. By utilizing innovative methods of sensor installation, downtime and installation cost can be minimized. User interaction with the systems



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must be carefully designed to provide the right amount of information, at the correct time, based on simple (or absent) inputs from the user. Lastly, interoperability is very important and will allow many devices to communicate using a common language that was built with detailed logical communication paths. Device to device communication, without setup, will be orchestrated through the central data collection mechanism and controller. Attached nodes will affect the behavior of devices based on a number of factors, all without extensive programming. By creating modular nodes and associated architecture, each subsystem of the entire product range will be replaceable with alternate parts or future upgrades.

Who will buy the product? Energy Conscience has a clear business case for any industry using a significant amount of energy in the course of their operations. From steel mills to automakers, every company with an interest in reducing waste and greenhouse gasses can benefit. Potential customers may include anyone ranging from small customers that want one sensor to large corporations seeking to capture usage information at multiple structures or geographic sites.

Why will they buy the product? The technology can be used to reduce energy consumption by showing present and historical usage, thus increasing energy usage awareness. By allowing the system to be configured in any size, it is suitable for both new construction and retrofitting. Automated energy management can provide for active manipulation of an environment based on any measurable factor or combination thereof. "Intelligent" devices could change their behavior based on available energy, types of energy, expected future energy, or any other measurable characteristic. A model of the building being input into the system would allow it to understand the flow of energy in different forms, enabling the ability for automated suggestions on how to best conserve energy based on usage patterns and expected energy availability. Data from the products in various installations can be used to show highly accurate trends in energy usage for interpretation by industry. With automatic collection and dissemination of data through participating users, the data can be analyzed to provide conclusive historical information and statistics. Finally, low cost, remote sensors can be used for a variety of specialized applications such as monitoring compliance in industry applications. With the ability to configure the nodes to use any type of sensor, the technology could be easily installed in factories around the nation for fast and reliable monitoring; also reducing regular costs associated with federal compliance programs.

What is the size of the market? The US Energy Information Administration estimates that in 1998, the combined manufacturing industries consumed 23,796 Trillion BTU

of energy. Initial estimates suggest that with full product implementation, savings of 10% to 20% could be realized. Thus, an expedited return on investment for all industries implementing the technology is expected to lead to a high acceptance rate.

How will you protect your IP? Protection of Intellectual Property will be pursued in the form of patents in coordination with the university's Technology Transfer office. As many of the components are available separately, the primary focus will be on protecting the developed software and algorithms. These portions of the systems will also be closed-source and a strict license will be written in order to utilize the published API (Application Programming Interface) which accommodates third party developers to incorporate their components into Energy Conscience.

Purdue University *SiMetal*

TEAM: Jimmy Cruse, Carlos Kemeny and Isaac Wildeson
ADVISOR(S): Timothy Sands

What is your product? Our product is GaN-on-Silicon LED chips, using a novel fabrication method, which will reduce the cost of LED chips by 25-50% through reduced material, equipment, and production cost. The novel process will also increase reliability of LED chips.

What is the underlying technology and what does it do? We have developed a method to eliminate the detrimental characteristics of silicon by "metallizing" the silicon substrate with a built-in back-contact/reflective layer of zirconium nitride. The presence of a reflective layer will recover light that is directed towards substrate and would normally be lost. This process enables the usage of silicon substrates for LED chips, which in turn will make affordable LEDs for high brightness LED fixtures.

How is the technology unique? LED chip fabrication processes are extremely valuable in an extremely litigious space. As sapphire and SiC LED chips have dominated the market, GaN-on-Silicon LED chips are the next step. The development of a novel process using silicon is the next critical step to achieving cost reductions for the wide-scale adoption of LED lighting. We solve the problem of high cost fabrication of LED chips through a method that uses silicon wafers, rather than sapphire or SiC.

How is the product innovative? With our novel process, fabrication of LED chips on 12" wafers of silicon will scale up and improve reliability. Scalability to this degree is not possible using smaller 6" sapphire wafers, nor feasible with SiC which is very expensive. Additionally, critical to the manufacturability of chips are two processes; lift off and dicing. Both processes are simplified with our technology,



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further reducing costs. Our process also requires less gallium nitride ($<1\ \mu\text{m}$) to achieve smooth, thin films than what is generally required with a sapphire wafer ($\sim 5\ \mu\text{m}$), further decreasing input costs and process time. The larger wafer size, requiring fewer wafers for product generation, coupled with process improvements and less GaN yield significant cost reductions.

Who will buy it? These GaN-on-Silicon chips will be sold directly to packaged LED companies, such as Cree and Lumileds. They will be offered superior chips, at lower cost and higher reliability than they currently produce. The largest companies producing packaged LEDs create their own chips; however, they will be attracted to our offerings. With our low cost and quality performance, we will offer a product that can assist packaged LED companies to be true competitors in the packaged LED market.

Why will they buy it? The industry players are all concerned about LED chip cost. Cost is linked to materials and production; the LED market cannot expand until LED chip cost is reduced. The high brightness LED space is waiting for advanced methods which will reduce manufacturing costs. Today, with sapphire, the manufacturers produce chips on 6" wafers. By converting to silicon, they will be able to produce on 12" wafers, allowing them to scale up their production. As a matter of reference, an estimated 18,000 1mm x 1mm LED chips can be produced on a 6" wafer, whereas an estimated 70,000 1mm x 1mm LED chips could be produced on a 12" wafer. In addition, the infrastructure for silicon processing is already established and more advanced than that of sapphire. We anticipate the cost reduction to be from 25-50%.

What is the size of the market? In 2006, the LED chip market was an estimated \$205MM. By 2011, the LED chip market is expected to increase to \$985MM. Of this \$205M in 2006 revenues, approximately \$100MM to \$150MM was sapphire-based LED chips. Most of the remaining \$50M was silicon carbide-based LED chips.

How will you protect your intellectual property? The University has a patent application pending with international options on the fabrication method. Furthermore, a cross-platform IP strategy will be employed through continued optimization of this method. Future patentable research will include eliminating the "green gap", which refers to the current inability to fabricate efficient green LEDs.

South Dakota State University *ProFrac*

TEAM: Chenchaiyah Marella and Barnabas Sugutt
ADIVSOR(S): William Gibbons and Kasiviswanathan Muthukumarappan

What is your product? Our product is a membrane separation and concentration process that separates nutritionally and functionally high value proteins from cheese whey. This process utilizes a novel membrane separation technology, coupled with an improved process design, to reduce costs and energy consumption.

What is underlying technology and what does it do? MembraneFractionation selectively targets specific protein fractions and separates them from a mixture of proteins and other components. By combining microfiltration, wide pore ultrafiltration and ultrafiltration, under innovative process conditions, our system sequentially removes impurities, then fractionates and concentrates specific proteins.

How is the technology unique? MembraneFractionation is unique in that our process manipulates the size and shape of protein molecules by precisely adjusting temperature and pH between each separation stage. This allows us to selectively remove specific components at a lower cost and energy consumption than processes currently in use.

How is the product innovative? Our process uses a sequence of microfiltration, wide pore ultrafiltration, and ultrafiltration steps, coupled with precise pH and temperature control to manipulate protein size and shape. This combination results in more efficient separation at lower pressures, and this also reduces membrane fouling. The most innovative aspects of this system include the wide pore ultrafiltration process, and the control of protein shape and size via temperature and pH.

Who will buy it? The U.S. has ~200 dairy processing plants which handle 40 million tons of whey/yr. Worldwide, whey production is 177 million tons/yr, and these companies also represent a market for our technology. Currently, whey processors use a conventional microfiltration/ultrafiltration process to simply concentrate whey proteins that produces a low value product. This industry is actively seeking novel and cost effective processes to produce pure/enriched whey protein products.

Why will they buy it? Industry currently processes whey into commodity products with a price of \$1.8-22/kg, depending on protein quality and quantity. In contrast, pure and enriched protein products are priced at \$44-350/kg, however, processes currently used to manufacture these enriched protein products are costly and energy intensive. Our technology utilizes a novel combination of process



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conditions and membrane separation technology to purify and enrich whey proteins at a lower cost and energy consumption. This will improve the profitability of producing these higher-value, enriched protein products. We anticipate that whey processors will readily purchase the technology we develop.

What is the size of the market? The demand for α -Lactalbumin enriched protein is ~ 400 tons/year while the demand for Lactoferrin is ~20-30 tons/year. The functional foods and infant foods segments use pure/enriched whey proteins as ingredients. The functional foods market in the US is estimated to be \$18-19 billion with a 10% annual growth. The infant foods market is about \$7.8 billion. In addition to the present 200 odd dairy processing plants, we anticipate that more processing plants will be established in the near future.

How will you protect your intellectual property? We are in the process of filing invention disclosure with our university technology transfer office. We will evaluate intellectual property protection by either patents or trade secrets.

University of Memphis Poros

TEAM: William Ganus, Samuel Tekobo and Zachary Thomas
ADVISOR(S): Eugene Pinkhassik

What is your product? Chemical industries increasingly use catalysts to make the chemical manufacturing process more energy-efficient. Homogeneous catalysis, in which the catalyst is mixed into the reaction, is considerably more efficient than heterogeneous catalysis, in which the catalyst is immobilized on the surface of a solid material. Unfortunately, an energy-demanding separation process is required to remove homogeneous catalysts from the final product. Our products are porous nanocapsules which entrap homogenous catalysts. The catalyst is contained within the nanocapsule, which can easily be removed from a reaction mixture, thus optimizing the energy efficiency of homogeneous catalysis while minimizing the energy requirements of physical separation.

What is the underlying technology and what does it do? Our group has developed a scalable method for creating nanocapsules that have pores distributed throughout the surface. These pores allow starting material to quickly enter the capsule and react with the catalyst, and the final product will freely exit the capsule. The catalyst, being larger than the pores, will remain entrapped in the capsule. The pore size is tunable such that a large variety of reactions can be accommodated with the same underlying technology.

How is the technology unique? By harnessing a natural,

nanoscale self-assembly process, our group has developed a nanocapsule synthesis which functionalizes the thinnest membrane in the world. This ultrathin shell allows molecules to enter the nanocapsule, interact with the catalyst, and leave as a product with unprecedented ultrafast speeds. This efficiency can lead to superior cost and energy savings in industrial applications.

How is the product innovative? Alternative microencapsulation technologies do not offer equally efficient retention of catalysts combined with ultrafast mass transfer of starting materials and products. Another traditional catalyst immobilization method involves attaching catalysts to a solid support. This solves the separation issue, but makes the catalytic process less efficient, requiring more costly catalyst to achieve the same output. Our technology of entrapping catalysts in porous nanocapsules is enabled by a new method for creating nanoscale materials. The ability to control the structure of polymer membrane with precision that was previously impossible allowed us to reduce the membrane thickness down to single nanometer.

Who will buy it? Our primary customers will be those chemical and pharmaceutical manufacturers who use enzymes and organometallic catalysts in the production of fine chemicals and pharmaceuticals.

Why will they buy it? Typically, application of catalytic reactions is a compromise between efficiency of catalytic conversion and ease of catalyst separation from the product. Highly efficient homogenous catalysts require either a costly and energy-demanding separation step or an immobilization method that reduces the catalyst efficiency. Our product will eliminate the need for the separation step while preserving high efficiency of the catalytic reaction. In other words, it will help reduce manufacturing costs without significant changes in the production cycle. In addition to direct savings, our product will reduce emission of hazardous materials and carbon footprints of production plants.

What is the size of the market? The Fredonia Group reports that the world catalyst industry comprises a \$13 billion market. This market is predicted to expand 6 percent annually through 2012. The fastest growing materials are enzymes and organometallic catalysts, the focus of our technology, with combined annual revenues of \$4.9 billion annually. We will focus on catalysts for fine chemicals, pharmaceuticals and environmental applications, which constitute a \$2.3 billion segment. We aim at 2% market penetration by the end of year 5, or \$58 million in annual sales, assuming continued 6% annual market growth.

How will you protect your intellectual property? The University has a patent application pending on the underlying technology from which this product was developed.



Team Submissions



We will obtain an exclusive license for the use of nanoporous capsules in the catalysis field. We will work with the University and collaborating partners on protecting further intellectual property and improvements to this technology.

University of North Carolina, Charlotte *Integrated Luminous Control for Zero Carbon Buildings*

TEAM: Benjamin Futrell, Rhonda Lowe, April Spivack, and Mathew A. Parker

ADIVSOR(S): Professor Dale A. Brentrup

What is your product or service? Forty percent of energy demands and seventy-six percent of carbon production in the U.S. is attributed to commercial/institutional sector lighting. Control systems for integrating luminance sources within the corporate environment provide the greatest potential toward achieving a carbon neutral workplace. The operative applications of systems currently in use exhibit failures due to unsupported installation, lack of user knowledge, and the inability to assess the luminous environment as it affects human visual comfort. These factors have limited the use and efficacy of control systems. Unlike the predecessors, ICØ (Integrated Luminous Control for Zero Carbon Buildings) is a real-time control apparatus which specifically addresses the occupant's visual comfort, taking full advantage of energy saving, daylighting and electric lighting integration, while accurately maintaining appropriate light levels at the work plane.

What is the underlying technology and what does it do? High Dynamic Range Imaging provides an accurate measurement of spatial luminance at any point within a captured scene. ICØ controls glare and visual comfort, as well as task based lighting levels at the work plane, as measured from a selected field of view. Basic functions entail automating the image captures of a work setting, computational mapping of the interior luminous environment, and outputting commands that optimize building systems. Through this method, both electrical lighting and fenestration shading systems are controlled in tandem as a cohesive, robust system, optimizing the field of view and thereby increasing energy savings and occupant productivity.

How is the product or service unique and/or innovative?

Current industry methods of controlling electric lighting and interior shade screens, for integration with available daylighting, rely solely on motion detectors, standard photocells, or radiometers, and are intended to merely quantify illuminance or radiation from the point of installation (most often at the ceiling or roof plane). Uniting occupant based, environmental photo metrics with existing lighting strategies allows environmental variables to be accounted

for in a case by case, discrete manner. ICØ provides a long overdue assessment and accommodation of the occupant's visual comfort and ability to perform tasks efficiently in the workplace.

Who will buy the product? The use of ICØ is not limited by the type of light source and lighting sales are driven by the end user, indicating that the potential consumer ranges from residential projects upward with few limitations. However, the current push toward energy efficient lighting in commercial and educational architecture is a fast moving product sector, having the greatest environmental impact and presenting sales opportunities across the lighting and building controls market sector. In 2003, More than forty manufacturers were actively involved in the U.S. lighting control market with most being privately held by larger parent companies involved in other segments of the lighting control industry.

Why will they buy it? The market is currently driven by advancements toward net zero carbon buildings and minimizing corporate expenditures through workplace productivity. The vast majority of lighting equipment purchases during 2008 were driven by the desire to achieve increased energy savings, or to comply with increasing mandatory energy benchmarks. The application of lighting controls is a great advantage in gaining LEED certification, and has become an exciting new design element in sustainable design projects. The use of ICØ in task based illumination dramatically lowers a building's energy-density, while the technology's accountability to user productivity aids in systems implementation that would otherwise be sacrificed due to under represented financial returns and misrepresented failures. ICØ drives incentives through increased productivity levels, the greater determining factor in owner and client value considerations. The methodology underlying ICØ increases user acceptance in maintaining the luminous surroundings, as well as an assurance of proper equipment operation and intended energy savings in both new construction and renovation projects globally, and ultimately the proliferation of environmental awareness.

What is the size of the market? The ACEEE (American Council for Energy Efficient Economy) has declared that a minimum of 0.03pkh can be saved by the judicious application of daylighting controls alone. In 2003, the total market for lighting sensors was \$154 million, growing at more than 11 percent annually. Frost & Sullivan predict that the portion of the lighting controls market that includes sensors, dimmers, and timers will exceed 62.9% with revenues crossing \$790 million of the total market by 2010, reporting. "Just looking at the trends in general, it seems that the sensor market is likely to witness more growth than any other product segment in the near future in view of



Team Submissions



energy code enforcements.”

How will you protect your intellectual property? This technology was disclosed to the Office of Technology Transfer at UNC Charlotte on January 30, 2009 and assigned UNCC invention report number 2009-020. The university is currently reviewing the disclosure to determine appropriate intellectual property protection options.

University of North Carolina, Charlotte Photovoltaic Power Engineering Co.

TEAM: Tanya Dias and Terence Goveas
ADVISOR(S): Michael Fiddy and M. A. Hasan

What is your product? Our product is a photovoltaic cell that tackles the main factor holding large-scale domestic utilization of solar energy, namely cost. For a given material system, the cost of ownership and payback-time are directly related to the cell efficiency and materials cost. High efficiency leads to less material and lower installation cost (small foot print). Our team has designed a process and a method that: 1. Enhances the spectral response of photovoltaic cells, 2. Maximizes light entrapment through optically designed surface without affecting the crystalline integrity of the cell material, 3. Maximizes the junction volume where electron-hole pairs are generated and driven by the built-in potential, 4. Utilizes processes that can be integrated with current fabrication methods without major additional cost. Theoretical calculations based only on enhancements in the spectral response (point 1 above) predict efficiencies higher than 49% for non-concentrated single-junction solar cells. We expect an overall \$ per Watt reduction in excess of 20%. Solar energy is the most ubiquitous and freely available source of energy. It has been well said that one hour of incident solar energy can power the planet for a whole year.

What is the underlying technology and what does it do? The efficiency of silicon solar cells is affected by: 1. Losses due to reflection from the cell surface, 2. Transmitted, non-absorbed light with energies smaller than the band gap (long wavelengths), 3. High-energy light that is generally absorbed near the cell surface leading to a low spectral response (wavelength dependent efficiency), and 4. Carrier recombination and trapping before reaching the cell's electrode. While our cell design may have a minimal impact on the last factor, it will affect all the others. Reflection from the surface can be minimized using optically designed so-called edge-illuminated waveguide holograms that can fill the inversely-etched cell surface. The concept behind an edge-illuminated hologram is that light incident at different angles and frequencies on the structure is brought by volume diffraction effects (i.e. with very high efficiency) to a specific location at the edge of

the waveguide. For transmitted low-energy light, up conversion is used by utilizing rare earth dopants. In this case, low-energy light is up-converted to a shorter wavelength (high energy) suitable for absorption by the cell (point 2). Similarly, short-wavelength light with low spectral response is down-converted to lower energies having higher spectral response. This can be carried out using phosphor nanoparticles.

How is the technology unique? The uniqueness of this technology lies in the large efficiency boost utilizing multiple approaches without taxing conventional production methods. Formation of the edge-illuminated hologram can be carried out by etching or imprinting the required patterns before application of the antireflection coating. Phosphor nanoparticles can be embedded in the antireflective layer during growth.

How is the product innovative? Our design provides desired benefits like improved efficiency, affordability and compatible manufacturing techniques, all using a new methodology that does not require rediscovery. It is simple, neat and easy to use!

Who will buy it? With the global concern about the environment and energy resources, there is much need to focus on the solar market and conversion efficiencies. Germany alone produces over 2 TWh of solar-electricity. It's investment of over \$5 billion has led to 35,000 new jobs and many countries world-wide are following the same path. Power companies in the United State have started major investments in renewable energy and people's awareness has prompted an intensive growth in household solar installation. With solar power, developing countries no longer need large infrastructure and long-haul transmission lines. Power can be delivered locally improving lifestyle and boosting the local economy.

Why will they buy it? It's affordable, easy to use and maintain, plus highly efficient! It has no moving parts, no waste, and pays for itself in less than 10 years (household modules). Just consider an airplane crashing into a solar farm and compare it to a crash in a nuclear plant! Silicon is the second most abundant element on earth and it will support all our needs. Since our design has minimal added costs and is adaptable using current manufacturing processes, maintenance and replacement is not a major issue.

What is the size of the market? The present market for solar cells is approximately \$15.6 billion with potential growth to \$70 billion by 2016. Presently, crystalline silicon solar cells account for 93% of this market. Our design exploits a single junction which is easier and cheaper to manufacture.

How will you protect your intellectual property? Our



Team Submissions



design will be safe-guarded by a patent application made through the university. The University may file both national and international patent applications.

University of South Florida

Flexible Organic Photovoltaic Energy Collector

TEAM: Barbara Bennington, Jason Lewis and Jaideep Rijput
ADVISOR(S): Mohamed Eddaoudi, Eric Eisenberg and Xiaomei Jiang

What is your product? The Flexible Organic Photovoltaic Energy Collector (FOPEC) is a new type of solar array based on environmentally friendly organic soft semiconductors built on a flexible substrate. FOPEC uses a semi-transparent solution-processable carbon-based film to collect sunlight and convert it to electricity. The FOPEC solar array is a low-cost, lightweight, flexible, and portable solution to many drawbacks and constraints of currently available solar power products.

What is the underlying technology and what does it do? FOPEC utilizes a vacuum free, solution based technology in contrast to the conventional high vacuum and high temperature based methods to produce solar cells. FOPEC starts with a solution of conducting polymers and “bucky-ball” carbon molecules dissolved in solvents. Thin films are formed from these solutions using existing large scale, low cost manufacturing methods such as inkjet, roll to roll and screen printing. This process creates a patterned solar array to generate DC power. Depending on the array configuration it can be tailored to achieve high voltage and/or high current.

How is the technology unique? FOPEC arrays rely on polymers that have the same electrical properties as silicon, but can be dissolved and printed or sprayed on any surface that is exposed to sunlight or artificial light. Most conventional solar cells are made of silicon wafers, a brittle substance that limits their usability. FOPEC array modules can be made flexible as well as semi-transparent. FOPEC technology allows the fabrication of solar arrays on cheap flexible substrate materials such as plastic and paper. This makes them lightweight, durable, and less expensive than silicon cells.

How is the product innovative? FOPEC provides a high power density which reduces the system requirements for space and weight. Our design is easily scalable for large applications such as rooftops, autonomous back up emergency power supplies, or smaller devices such as laptops, cell phones, and PDAs. The semi-transparent property of the array allows for applications on windows and windshields. FOPEC arrays are more efficient than silicon solar cells in artificial light environments. This significantly expands their use in indoor applications. Additionally, these

arrays can be integrated into soft fabric substances such as tents, military back-packs or combat uniforms, providing a highly portable renewable power supply for deployed military forces.

Who will buy it? Our primary target market is residential, commercial and industrial consumers of electricity. Other large markets will potentially include: State, and Local governments, and Federal government agencies such as the U.S. Department of Defense.

Why will they buy it? More energy from the sun strikes the Earth in one hour than all the energy consumed on the planet in one year, yet solar generated electricity accounts for less than 0.02% of all electricity produced worldwide. The enormous gap between the potential of solar energy and its use is due, in part, to the cost/conversion capacity. The current cost of \$4/W for silicon-based PV modules does not meet the U.S. Department of Energy’s cost goal of \$0.33/W. FOPEC provides a lower cost, low maintenance; emission free, sustainable source of renewable energy that overcomes many of the disadvantages of silicon based solar power systems. Government incentives such as tax credits and purchase subsidies for consumers who switch to solar electricity are already in place. These programs are expected to expand which will increase consumer demand.

What is the size of the market? US residential electric power customers total approximately 124 million according to a 2007 report from the Energy Information Administration. Monthly consumption rate per customer is 936 kWh, corresponding to 1.6 GW annually. According to the US Government’s National Energy Policy (2006); energy consumption is expected to increase 32% by 2020 which will require alternative renewable energy resources such as solar electricity to meet this demand. Consequently, the solar industry estimates that growth rates above 25% annually are possible, resulting in a \$27 billion market by 2020. In a 2005 report from The Material Research Society, organic solar cells are predicted to occupy more than 10% of the total solar PV products market within the next several years, and potentially more than 40% by 2015.

How will you protect your intellectual property? The University has a patent application pending on the development of this innovative solar power generation system.

University of Tennessee

Sequel Innovations Partnership

TEAM: John L. Batey III, Greg Compton and Carl D. Hill
ADVISOR(S): Pat Richardson and Glenn D. Swift

What is your product? Consumers and businesses rely on expanded polystyrene (EPS) as a versatile and cost



Team Submissions



effective solution for applications ranging from drinking cups to home insulation, automobile bumpers, and packing peanuts. However, the polystyrene expansion process is energy intensive. Rising energy costs have contributed to the erosion of profit margins within the EPS manufacturing industry, and the time-consuming production process requires manufacturers to hold bulky inventory in large facilities that increase energy requirements. Our novel EPS technology reduces EPS production time and energy usage to a fraction of the existing process.

What is the underlying technology and what does it do?

Our patented process incorporates specially formulated polystyrene beads with a unique microwave heating process to expand the beads to 40x their original size. The beads can be expanded within a mold to form any desired shape, or the beads can be expanded alone to produce loose fill EPS. After a brief cooling period, the final EPS product generating using our process is indistinguishable from products formed using the incumbent production process.

How is the technology unique? Existing EPS production processes use steam heat to expand polystyrene beads in a three-stage process. Census Bureau data reveals that the industry consumed over 2 billion kilowatt-hours in 2002. We estimate that our process can reduce net energy usage by as much as 20 percent, requiring only a fraction of the energy, a single piece of equipment, and producing a finished product in only 10 minutes. If our process were wholly adopted by the industry, the total annual energy savings would be roughly equivalent to the annual energy generation of one nuclear power plant.

How is the product innovative? Our process directly addresses several cost drivers of the EPS industry: energy, inventory, and capital investment. Our microwave technology is inherently more efficient than the most advanced boiler technologies. Furthermore, our patented production process virtually eliminates WIP and the need for finished goods inventory, freeing up valuable floor space. Also, our signature process dramatically lowers required operating capital, greatly reducing the production volume necessary for a manufacturer to be profitable. Our process is innovative because it is fundamentally different than any existing EPS manufacturing process.

Who will buy it? The EPS manufacturing industry is large and well developed. Few EPS manufacturers develop their own production systems. Most firms purchase off-the-shelf production systems from plastic machinery manufacturers. Thus, our target customers will be among the plastic machinery equipment suppliers. By doing so, we will be able to effectively reach a much larger customer base than if only EPS manufacturers were targeted.

Why will they buy it? EPS manufacturers compete primarily on cost and look to equipment suppliers for innovative production solutions to maximize efficiencies. To date, most plastic machinery innovations have focused on making steam generation equipment more efficient, however our process introduces an inherently more efficient process that eliminates the need for ancillary boiler infrastructure. Moreover, our special process has significantly lower initial costs and will reduce maintenance costs due to its simplicity. Our process is an attractive alternative for existing EPS manufacturers as well as new entrants.

What is the size of the market? There are over 600 establishments in the polystyrene foam product manufacturing market in the USA, of which approximately 80 percent employ less than 100 people. Industry revenue in 2008 topped out at \$8.7 billion and is expected to grow 2 percent to \$8.9 billion in 2009. According to Census Bureau data, the ratio of capital expenditures on machinery and equipment to revenues is 5.5 percent; therefore we estimate that capital machinery and equipment expenditures in 2009 will be nearly \$500 million. We estimate that the size of our target market will be 10 percent of the total market, or about \$50 million.

How will you protect your intellectual property? The University Research Foundation has a patent application pending with international options on the manufacturing process. Our organization has secured an option on the patent as well as future licensing rights.

University of Toledo Greenhouse Gas Guzzlers

TEAM: Jonathan Johnson, Emily Sack and Desikan Sundararajan

ADVISOR(S): Sonny Ariss, Abdul-Majeed Azad & Daniel Kory

What is your product? Our product is a novel catalytic process that stands to revolutionize energy arena and change the way we look at and treat greenhouse gases. It generates carbon monoxide from carbon dioxide and hydrogen from water vapor under very mild experimental conditions. Both H₂ and CO are the feed for solid oxide fuel cells (SOFCs). The process is also capable of converting a mixture of (CO₂+H₂O) into syngas (CO+H₂) - a precursor for the Fischer-Tropsch (F-T) synthesis of a variety of valuable chemicals and synthetic fuels. Catalyst is a major industrial solid waste (~19 MMT produced worldwide in 2006; ~15.5 MMT in the US alone by 2015) which in the process is converted into a major ferrite manufacturing component.

What is the underlying technology and what does it do? As we know, the ultimate chemical fate of the conventional fossil fuel combustion is always CO₂ and H₂O,



Team Submissions



well-known greenhouse gases responsible for contributing considerably to the global warming. In this technology CO₂ and H₂O are converted catalytically - individually or together - into carbon monoxide and hydrogen at one hand and into syngas on the other. All these products are suitable SOFC feeds for generating clean electric power. Syngas is an ideal F-T precursor for manufacturing scores of valuable organic compounds including synthetic fuels. The technology employs a nearly useless industrial solid waste for the above-mentioned conversion, which in the process is transformed into a valuable component from which soft magnets are manufactured. Thus, it creates precursors for clean energy generation and electronic device manufacturing while innovatively mitigating the environmental and industrial pollution.

How is the technology unique? The currently pursued various options (geological, oceanic and mineral) are mostly concerned with the sequestration of CO₂ alone; all of these are extremely energy intensive, elaborate in design, years away from achieving practical feasibility and above all, exorbitantly expensive. Other less popular options (catalytic methanation, photo-reduction, etc.) either require hydrogen or are least quantitative and hardly targeted to be of any practical implication. In comparison, our technology does not suffer from any of these flaws and shortcomings. The gaseous products (CO, H₂ and syngas) become SOFC or F-T feeds for electric power generation and organic synthesis, respectively. If so desired, CO can be converted into H₂ by water-gas-shift reaction and used as the PEM fuel cell feed. The catalyst (essentially an industrial waste) that mediates the conversion of carbon dioxide into carbon monoxide, water into hydrogen or the CO₂+H₂O mixture into syngas (CO+H₂) is in turn converted into an oxide with enhanced magnetic characteristics and can be used for the manufacturing of soft magnets used in a number of sophisticated motors, audio and video devices.

How is the product innovative? So far, no technology has offered a practical solution to the burgeoning problem of global warming. Our product is innovative because it uses the greenhouse gases to: (1) generate ready-to-use fuel for SOFCs and syngas for Fischer-Tropsch liquid synthesis, and (2) create value-added precursor for manufacturing soft magnets. This way, it addresses the issue of abating global warming decisively and, provides an effective and novel solution to the environmental and ecological problem of greenhouse gases. The technology is also of relevance to NASA's in-situ resource utilization (ISRU) program for MARS exploration since Martian atmosphere is ~ 96% CO₂ and CO could be transformed into H₂/CH₄ fuel.

Who will buy it? The technology and the product is potentially of interest to energy producers and suppliers, utility

chains, SOFC manufacturers and users, organic synthesis companies, soft magnet manufacturers and Mars human exploration missions. Army uses logistic fuels and could employ the CO₂-SOFC technology for many military field operations, including mobile forward base units, auxiliary field hospitals, field command posts, operational forays, and unmanned aerial vehicles.

Why will they buy it? Reliable scientific projections estimate that the average global temperature will rise between 1.4°C and 5.8°C by the year 2100. Government mandates, such as the RPS, are requiring electricity suppliers throughout the country to generate specified percentages of their output from renewable sources. Since our technology offers an environmentally benign path to combat the ever-increasing menace of global warming in an innovative way, the entire energy sector is expected to benefit, as it provides incentives for curbing the carbon footprints from fossil fuels during power generation. Utilization of waste as a catalyst helps the industry creating it find a rewarding remedy, as the waste becomes a valuable precursor for another industry making soft magnets.

What is the size of the market? It is predicted that global clean energy markets are going to quadruple in the next decade from \$55.4 billion in revenue in 2006 to more than \$226.5 billion by 2016. In 2007 the global level of CO₂ was 30 billion metric ton and is projected to be 43 billion metric ton by 2030. The United States contributes 22.2% of CO₂ emissions in the world, making it a prime market for this new technology. Existing level of the industrial waste could convert ~1.9 MMT of CO₂ into CO or 0.74 MMT of H₂O into H₂ annually. The approximate market size of this greenhouse gas mitigation is over \$1 billion.

How will you protect your intellectual property? The technology described in this proposal is patent pending. The University has submitted a patent application with international options on the process pertaining to conversion of CO₂ and H₂O into fuel and running SOFC. Furthermore, the patent position of the process is greatly enhanced by the University's ownership of a large portfolio of patents protecting the underlying processes from which the greenhouse gas mitigation technology was developed. The University feels that the technology presented in this proposal is securely protected.

University of Washington SmartFin

TEAM: Kishore Sundara-Rajan and Alexei Zyuzin
ADVISOR(S): Alexander V. Mamishev

Product. The proposed product is a sensor array and associated software that provides accurate measurement and control of moisture and additives at the wet end of paper



Team Submissions



machine. Installation of this technology enables dramatic energy savings in the paper manufacturing process through reduction of steam usage and loss due to off-spec product.

Underlying technology. This product relies on dielectric measurements in the extremely low frequency portion of electromagnetic spectrum, which allows greater discrimination of constituents in the pulp and control of the sensing volume through sensor head design. These measurements will enable tighter control of mechanical (non-evaporative) dewatering of paper web, so that less water needs to be evaporated using heat in the paper manufacturing process. A similar sensing approach has been successfully used for other applications, and in pilot trials for this application, but it has not been used commercially for wet end measurements.

Uniqueness. Our technology enables a new manufacturing process, in which accurate measurement of concentration of moisture and additives is coupled with novel fillers that replace free water at the wet end of the paper machine. Most of the measurements of paper properties during manufacturing are currently accomplished at the dry end of the paper machine, mainly because of shortcomings of the existing technology. By measuring the properties in the wet end, we enable the use of feed-forward control.

Innovativeness. The proposed project will achieve a higher rate of water removal using mechanical methods, thus saving energy and materials in the process of paper production. The central idea is that the sensors installed at the wet end of the paper machine will provide accurate information about the concentration and the distribution of fiber and fillers in the paper web. The novelty of this project lies in three aspects of the design of the measurement system: sensor heads, measurement electronics, and signal processing algorithms. A combination of monitoring and control capability for filler content in paper production, filler composition, and mechanical dewatering parameters will allow an unprecedented rate of moisture removal.

Our customers. The commercialization team's preliminary discussions with paper machine manufacturer Metso, who controls about 35% of the paper machine market worldwide, have been very positive. Other potential partners would include ABB and Honeywell. Less likely, but also possible partners are Voith, Albany, and Kraftfeld Paper. Direct users of this technology are paper mills, located throughout the United States and around the globe. Globalization and energy crisis are forcing paper mills pay much more attention to their energy expenditures. The product will also be marketed through the Industrial Assessment Centers.

Value for customers. The proposed moisture sensor would

enable mills to significantly reduce steam usage in the dryer section. With real time moisture data at the wet end, operators would be able to use the more energy efficient mechanical process to remove a higher percentage of moisture than is currently possible. Since the process of mechanical moisture removal is significantly more energy efficient than steam drying, the savings potential is very large. The commercialization team estimates that 2.3 million BTU/ton paper produced can be saved. At costs of \$7/ million BTU steam, the savings would amount to \$16.11/ ton of paper produced. At paper prices of \$500/ton, this savings would equate to 3.2% improvement in overall mill profitability.

Market. Payback periods of under 12 months are viewed as highly desirable in this industrial sector. The commercialization team believes that a moisture sensor system priced between \$140,000 for small paper mills, which would require few sensors, to \$200,000 for large mills, would enable mills across the entire size range to achieve payback in less than 10 months. We assume that OEM discounts on the order of 20% would be required to motivate our partners to strongly support product sales. We believe that revenues of \$1.6M could be achieved in 2012. These could grow to \$15M per year by 2022 with expected EBIT of \$4.8M.

Intellectual property protection. The team will rely initially on IP generated at the host university, where the original research is conducted. The team is already in contact with the Technology Transfer Office and is evaluating licensing terms expected by the university. The team members have previous experience with patent applications. Continuing work will result in new knowledge that will have to be protected. The main patenting areas are expected to be: 1) fringing field sensors for moisture and additives measurements, 2) parameter estimation algorithms, 3) control scheme implementations for mechanical water removal.

Western Virginia University WV Mountaineers

TEAM: Ruben Avagyan, Nishit Banuri & Subodh Chaudhari
ADVISOR(S): Bhaskaran Gopalakrishnan and Wafik Iskander

What is the product or service idea? EnergyExpert is a customized Decision Support System developed to help manufacturers in reducing their energy bills. The goal is to provide integrated Operations/Energy Management strategy to minimize energy cost per unit of product. This system has seven modules: Decision Making Unit (DMU), Production Planning/Operations Scheduling, Heating/Cooling, Energy Load Forecasting, CHP Control, Actual Load Monitoring, and Smart Grid Interconnection.



Team Submissions



What is underlying technology and what does it do? This innovative approach allows customers to develop Production Planning and Control (PPC) strategy for minimum energy/demand cost. This is achieved by the “low-energy” scheduling of the operations and continuous real-time “buy or make” game with the energy supplying utilities based on the time of the day, sell and buy prices of electricity on the Smart Grid. The on-site electricity and heat generation is enabled through the installation of Cogeneration or Tri-generation unit (CHP) and connection to Smart Grid. The “brain” of the system is DMU, where all the information from the other modules of the system is processed and control (or threshold) signals (decisions) are developed. The DMU is interfaced with the plant CHP system. The smart meters on the CHP system communicates with DMU about current fuel cost, operating efficiency and cost curve. Operations and CHP generation baseline schedules are calculated from the production plans, weather forecasts and current utility rates using Artificial Intelligence (AI) algorithms. Baseline schedules are continuously updated via the monitoring of the actual data. The reduction of the electric bills is achieved by the optimal operations scheduling, load spike management (switching/shedding) and the real-time electricity rate monitoring.

How is the technology unique? The current market products concentrate on controlling demand peaks and leave out the aspect of production power requirement. The control logic in some cases may not allow enough flexibility. The EnergyExpert is customized solutions based on production plans and have additional flexibility to improve profitability through buying electricity when it is cheapest and selling electricity when the bid price is higher to the Smart Grid. None of the products in the market employ Heuristics/Data processing based intelligent system to monitor demand or control demand/energy cost.

How is the product or service innovative? The current product manufacturers focus on Off-the-shelf type of product which will be generic to everybody. EnergyExpert

focuses on generic methodology but customizable solutions suited to business needs of specific customers. None of the current product manufacturers address need to suit their customers in the changing electricity distribution era, i.e. Smart Grid. No manufacturer provides service to integrate Operations Planning with energy/demand cost management. All the existing products may be characterized as “passive” Decision Support Tools (DST), while EnergyExpert is an active DST.

Who will buy it? The prospective customers include big electricity consumers who also have demand for heat. In manufacturing sector Primary & Fabricated Metal, Machinery, Wood Products, Printing, and Furniture industry are targeted since they have intermittent loads, CHP potential and also consume significant electricity. Commercial customers having high fluctuation in demands can also benefit from the service.

Why will they buy it? Electricity production is supposed to shift from coal to renewable and sustainable fuels. The new renewable and nuclear electricity plants will have higher energy as well as demand costs. Approximately demand constitutes 50% of electricity costs of a typical manufacturing plant. Significant reduction in the electricity cost is possible through EnergyExpert. Also, to gain genuine advantages of changing infrastructure (Smart Grid) one should really look at altering traditional peak control strategy. None of the current manufacturers offer these functionalities in their product.

What is the size of the market? The size of the target manufacturing sector industries is approximately \$894 Billion and they consume 294 Billion kWh annually which costs them \$13.7 Billion.

How will you protect the intellectual property? The team is working on Trade Mark / Service Mark proposal for this product / service. The team is researching US Patents database to apply for a patent.