P3 Final Report

Renewable Energy for the RiverSphere

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submitted April 2005

Summary of Phase I

1. Background and problem definition

Carefully considered designs for renewable energy would directly benefit our region in several ways. First, technology change provides job options for an area that is very heavily reliant on fossil-fuel extraction as its main industry. The resulting economic diversification would also reduce costly greenhouse gas emissions. Second, regional prosperity could be increased with income from a system that requires minimal maintenance, as long as there is extra energy that could be sold to surrounding markets. In 1990, the state of Louisiana contributed almost 200 million metric tons of CO_2 to the atmosphere, which amounts to approximately 1% of the global total. The purpose of our project is to develop a system that can be used as a model for reducing the dependence on oil, gas, and coal to provide energy, and create an infrastructure for long-term, sustainable solutions that would be significantly less damaging to the local ecology. A study of all the options for renewable energy in southern Louisiana would be pertinent to a region that has thus far been static in acting towards these new technologies and provide a bridge between various disciplines to work towards a common goal.

As the developing world advances, its energy requirements are going to grow, and if the sector remains unchanged, the impact on the environment could be devastating. The findings of the project help to provide information as to the possibilities that can be provided to these underdeveloped countries for energy production, which is crucial to their intellectual and physical advancement, but in a manner that will not prove destructive in the long-run. The natural capital of the developing countries can be maintained, therefore protecting the tourism economy, while adding possibilities for the development of intellectual capital, investment capital, and physical capital by helping to provide pollution-free energy.

This project was conducted by a team of four undergraduate students, with the help of many advisors in and out of the university. The most important educational experience that was gained by the Renewable Energy for the RiverSphere team was the ability to coordinate and consult with advisors from every dimension of the project, including legal, scientific, engineering, economic and environmental. The holistic understanding of the project and its requirements helped to enlighten the team members as to the larger difficulties that could arise during the implementation of a project, such as access to information and expertise, as well as to the smaller but no less problematic difficulties, such as the agreement on common units to be used for calculations and comparisons.

The educational benefits to the greater community resulting from the implementation renewable energy at the RiverSphere, and environmental education and research center planned for downtown New Orleans, will be more varied than the disciplines required for its implementation. The education that will occur at the RiverSphere, as well as that which will take place from the implementation of the project, may ultimately include the establishment of a precedent for energy production from run-of-river facilities, technical development of low-head, low-velocity, high-variability run-of-river turbines, and social understanding of the connection between humans, society, water, and energy to name only a few.

2. Purpose, objectives, scope

The group was comprised of four students, all juniors and seniors in the field of environmental studies. We met weekly in order to compare research on details related to the specifications of types of renewable technology. Our guiding purpose was the creation of the matrix to discern information on economic costs, environmental benefits, regulatory concerns, applicability to New Orleans and the RiverSphere site, among other information. Field visits were an integral part of our data collection method, as we found that those intimately involved with the process at sites were able to give more relevant information than that published. Also, within the context of southern Louisiana, some of these sites are not recognized as "renewable" and are simply seen as ways to take advantage of natural forces.

In conducting our research, we sought out many contacts in many fields of renewable energy in Louisiana. We met with many renewable energy and environmental policy experts, specifically in photovoltaics and river cooling, making contacts in regulatory fields like the USACE, and becoming part of the RiverSphere design process in order to understand developing needs of the building. As interest grew on behalf of project managers and directors for the RiverSphere, our objective became to develop realistic data and background work in regulatory requirements in order to facilitate implementation at the site. We selected passive solar and energy efficiency construction, river cooling, photovoltaic, and river turbines as the most promising renewable energy systems for the RiverSphere site. We took a field visit to the Vidalia Hydroelectric Facility run by Louisiana Hydroelectric, which takes advantage of USACE river control structures to divert water from the Mississippi River, making up for low head differential to generate power creatively based on Mississippi conditions. We also learned about plans for wind energy utilizing offshore oil platforms in Louisiana state waters. Both of these technologies are not applicable to the RiverSphere site, but the knowledge helped us understand the climate of renewable industry in getting projects initiated.

Therefore, the scope of the project was realistically two-fold. While the objectives were closely concentrated around a specific site and built project within the New Orleans urban fabric, and our research was meant to guide this project, we never lost sight of the goal that we might be able to expand whichever technology best fit to develop other sites. The scope of the project could eventually encompass the region, specifically other sites along the Mississippi, encouraging the utilization of the power of the River in the same way. We are looking at our research now as being a case study for other projects interested in applying similar technologies in the future.

3. Data, results, findings

Baseline Energy Use Prediction

In order to determine which renewable technology might be appropriate for the RiverSphere project, and to what extent, we felt it was necessary to obtain a baseline building energy use estimation for the project. With the amount of design information that was available in the early stages of research, we were able to obtain building energy analysis software, called eQuest. This DOE-2 program was originally designed in collaboration with the Lawrence Berkeley National Laboratory with funding from the Department of Energy. It allows the user to predict building energy use and cost using a description of building layout, construction type, area usage, lighting strategy, and HVAC conditioning systems.

The RiverSphere facility is located in an existing building which Tulane intends to completely renovate and make additions to in several phases. The main functions of the building will occur in a 2-story building totaling 150,000 square feet located on the existing casino footprint on site. This square footage was broken down by eQuest into percentage function, allocated as follows:

Convention/Meeting Area	50%
Conference Space	20%
Auditorium	10%
Laboratory	5%
Classroom/Lecture	8%

Net window area was entered at 18.7% of floor-ceiling wall area, with conventional glazing, no sunshades or overhangs, and completely inoperable. This meant no strategy to combat solar gain, and no attitude toward obtaining cross-ventilation to reduce cooling loads.The HVAC system in the estimation utilizes Chilled Water for Cooling, Hot Water Coils and Electric Resistance for Heating, all in a standard Variable Air Volume (VAV) system. The predictions were based on an entirely electric system, without heating through natural gas, so that direct comparisons could be made to the renewable systems which would be used to power the building.

Hours of operation were estimated 7 am – 9pm Monday – Saturday. The HVAC operation was set to occur one hour before and after building opening. Weather data for New Orleans metropolitan area was input for accurate cooling and heating degree days. We used local utility rates (Entergy Corporation) obtained from the Green Project, our contact for photovoltaics in the area, to estimate costs of total energy.

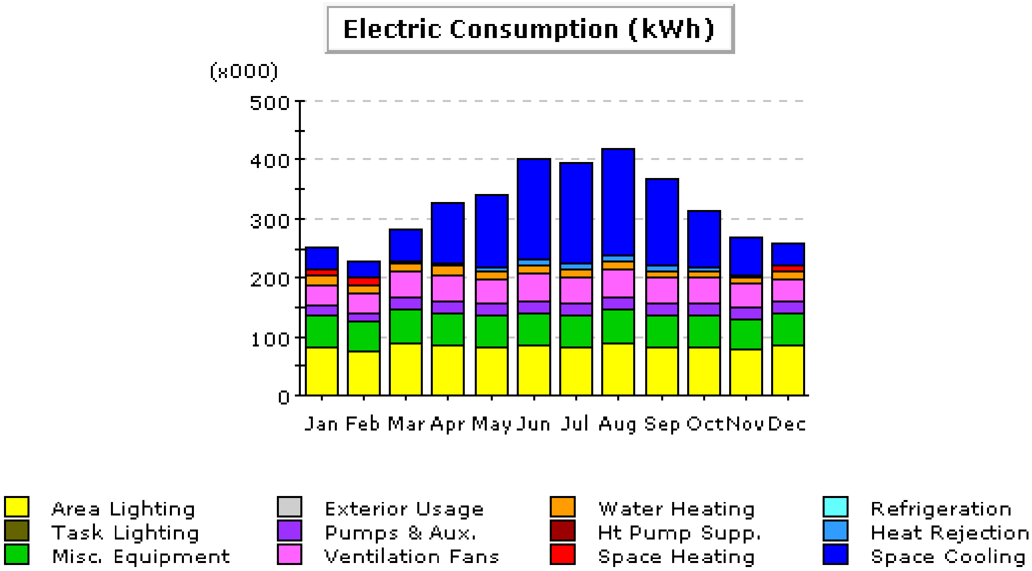

Figure 1: Energy consumption characteristics of proposed RiverSphere facility.

The estimate for total consumption returned by the software was 3,850,700 kWh per year. Over one third (31.4%) of the total needs were dedicated to space cooling, and one quarter (25.7%) of electricity needs went to task lighting. The other main consumers are Equipment and Ventilation Fans, presumably due to the large convention spaces and the demanding laboratory equipment specified in the program. In comparison, our campus recreation center, which operates long hours every day and heats a swimming pool, is 150,000 square feet as well and uses 4,170,000 kWh (based on 2003 data).

Passive Solar and Environmental Design Strategies

A secondary prediction was run using eQuest factoring in considerable passive solar design strategies. This would be a situation in which the building would be designed from the schematic phase with environmental considerations in place. Extensive use of materials, equipment, and climate strategies would be employed to make the building function as a sustainable whole. The design team and Tulane have pledged to make the RiverSphere project a LEED platinum building, so a building with these energy reductions is very possible given the design climate.

With the software, we were able to run a variant on the baseline analysis to recalculate energy use. All windows in the building were modified to be operable low-e glazing. Also, we added sunshades to all facades, with a depth of 3’ from building face on the North and West and 10’ on the South and East. Skylights were added in both the core and perimeter zones, reducing the load on lighting within the building. Interior lighting would include photosensors to turn off and on depending on room use and natural lighting conditions. HVAC default settings were modified to reach more moderate heating and cooling temperatures, since often buildings in New Orleans are overcooled in the summer and overheated in the winter due to lack of sophistication with systems control.

Additional insulation was added to wall construction and a reflective roof surface was added to reduce overall heat gain through construction.

eQuest found that with these changes made, the annual energy use of the building could be reduced to 1,600,000 kWh/year, a savings of 2,250,700, over 50%. Building with passive solar and environmental design strategies could save 1452 tons of greenhouse gas emissions annually (CO2 emissions are estimated using EIA U.S. National Average emission figures for 1998-2000 of 1.29 lbs/kWh. It should be noted that our utility, Entergy, has a lower than national average CO2 emission rate, due to its use of natural gas and nuclear power). Beyond complying with building codes for the City of New Orleans, no additional regulations or permits need to be considered with regard to passive lighting and cooling.

River Cooling

Using water from the Mississippi River as part of a cooling strategy to reduce energy use by a building's cooling system has been employed in limited locations in New Orleans, but has been done very successfully.

The system brings water from the river into a traditional system of chillers instead of utilizing cooling towers to reduce the temperature of domestic water. At Ochsner Hospital, several miles upstream from the RiverSphere site, water from the Mississippi is taken from a level far enough below the surface to reach an appropriate temperature (over 30' below the surface) and pumped through a single large pipe into the complex's physical plant at a rate of 8000 gal/min. It is then run through a series of chillers where the low temperature helps to condense the system refrigerant from liquid to gas phase. The refrigerant is then cycled to cooling units throughout the hospital in a traditional system. The river water is fed through another single pipe back into the river. In a conventional cooling system water from the municipal water system is pumped into cooling towers, where electricity is used to bring it to a low enough temperature where it can be used to condense the refrigerant. This water, already treated to be drinking water quality, also needs to be chemically treated to prevent corrosion of the cooling towers

Energy considerations make this system incredibly sensible for a location so close to the river. A single 480volt motor is used in a pump to bring river water to the chillers. By contrast, 9 of these motors are used to power each of the cooling towers necessary for the same capacity system. Our contacts at Ochsner Hospital are currently working on estimates of the potential energy savings of their river cooling systems; figures should be available shortly. Even though we cannot quantify the savings at this time, since our estimates show that space cooling will use over one third of the RiverSphere's energy consumption, a river cooling system could significantly reduce the building's energy use and resulting greenhouse gas emissions.

An auxiliary environmental benefit of this approach is that it saves the chemicals needed to treat the water for the cooling tower system, and saves the energy and chemicals used to improve water to drinking water quality. River cooling also saves huge quantities of fresh water. The environmental cost of a river cooling system is also relatively low.

Wildlife are not in danger due to screens on the intake and return pipes. The river water is returned at a temperature 5 degrees lower than what it is taken from. The EPA does regulate acceptable levels of thermal pollution such as this, and the given system meets the standards. The water returns with no additional chemicals or byproducts.

The important regulations to be considered with regard to cooling the building with river water are building permits, EPA permits, and Louisiana Department of Environmental Quality. Building permits are the same, as before, electrical and mechanical inspections are required by the City of New Orleans. In order to be in accordance with EPA regulations, the water temperature of the returning water needs to monitored and reported to the EPA on a quarterly basis for analysis. The LDEQ requires that the project be in accordance with section 404 for the Clean Water Act, which monitors the discharge of material into the water through an Army Corps permit. The river cooling system at Ochsner Hospital is also subject to the jurisdiction of the Jefferson Levee Board, but this is because the intake and return pipes travel through the river levee and therefore pose issues to the infrastructure of river control. At the RiverSphere site, the building is situated between the levee and the river, so no such issues would arise.

Photovoltaic

New Orleans has an annual average of 4.93 hours of peak sunlight a day, compared with a national average of 4.81 hours of peak sunlight a day. Due to the climate of New Orleans (hot summers and mild winters), the seasonal energy consumption patterns line up reasonably well with solar power production patterns. Solar cells are guaranteed to last for 25 years, and require virtually no maintenance (although there may occasionally be minor problems with the inverters). The current largest operating photovoltaic system in Louisiana is at The Green Project in New Orleans consists of 72 modules. We used their experiences to form conjectures about applying photovoltaics to the RiverSphere site.

The two key factors in determining what percentage of the RiverSphere's energy consumption can be covered through solar energy are annual energy demand and roof area. The Green Project's annual load is approximately 42,000 kWh/year, and the RiverSphere's estimated energy load is approximately 3,800,000 kWh/year. The roof area they used for 72 modules was 3174 square feet, and the RiverSphere site will have approximately 150,000 square feet to work with. As an estimate, if we used 40% (1360 modules) of the RiverSphere's roof area for solar energy, 158,000 kWh would be produced in a year; if 70% (2380 modules) were used, 277,000 kWh would be produced in a year. A cost estimate (based on $340/module, plus inverters and estimated installation costs) for the smaller system (40% roof space) is $615,000 and $1,080,000 for the larger system (70% roof space).

The regulatory issues relevant to installing a large roof-top photovoltaic system in New Orleans have been addressed and should not be a barrier to installing solar panels at the RiverSphere. Building codes are the key regulation that needs to be considered for the installation of photovoltaic devices on the roof the building. The electrical inspection here is extremely important to ensure the devices are current with electric code. Also important are Net Metering rules and regulations, which allow electricity from private systems to be put into the utility grid, with the utility reimbursing the electricity producer for the electricity added into the system. The Louisiana Public Service Commission is currently drafting the rules and regulations for Net Energy Metering in Louisiana. In the meantime, it appears possible to connect a photovoltaic system to the utility grid in New Orleans, as long as it is not putting an excess amount of electricity back into the grid each month.

River Turbines

The most abundant source of energy at the RiverSphere site appeared to be the Mississippi River. The hydroelectric capabilities associated with the location of implementation appeared to be not only the most convenient, but the most efficient form of electricity production available. In order to confirm these assumptions, we first investigated the characteristics of the river relevant to the implementation of a hydroelectric source of energy. These included the depth of the river, the flow velocity of the water, and the variability in the amount of water which flowed by the site, as well as the composition of the water itself. One indicator of the variability in the amount of water in the river is its "stage," which is the height of the river relative to a fixed point, based on a standard measurement devised by the Army Corps of Engineers, the standard being feet NGVD. We found high stage variability in the Mississippi, depicted in Figure 3. This posed a design challenge in that the turbine would have to readily adapt to different water depths, as well as to be efficient at varying speeds in order to achieve constantly beneficial energy output. The stage of the river is also indicative of the flow velocity of the river water, as can be seen in Figure 4. For the purposes of rough estimation, the average stage height could be assumed to be 7-8 feet NGVD. This means that at the deepest part of the river (where the water flow is fastest) the water flow velocity would be 3-4 feet per second, or approximately equal to 1.1 meters per second (appendix 1c).

Since our site is limited by the navigational requirements of the river, we assumed that construction would have to be within 50 meters of the bank. Our site, being located on the inside curve of a bend near the mouth of the river, is located in one of the slowest sections of the river (Figure 2). We obtained data from researchers in Tulane's Earth and Environmental Sciences department for a site with similar morphology and bathymetry as ours. The data provided by their Acoustic Doppler Current Profiler suggested a water flow velocity of 0.2-0.4 meters per second near the river's edge along the RiverSphere site.

The characteristics mentioned above (low water flow velocity, shallow water depth, and high stage variability) were crucial in the determination of the type of turbine which was believed would be most advantageous. Therefore, turbines were only considered if they had high efficiency, small individual unit size, and high adaptability to changing river stage. Of the models whose technical specifications were accessible, few turbine models possessed the qualities necessary. The "Davis" (appendix 2b. and c.) and the "Gorlov" (appendix 2d.) were the two turbines who appeared most fitting of the needed characteristics for the following reasons. Both turbines were highly efficient, and highly variable in their arrangement configuration, which minimizes the impact on the environment, as well as to maximize the energy derived from the river. We were not able to determine the potential output of these turbines in the water speeds of our site.

The installation of a turbine in the Mississippi river in order to generate power for the building will require accordance with many local and federal regulations. First, there are the basic building inspections that need to be done to comply with New Orleans City building regulations. Next, an Environmental Assessment must be done for state level administrative purposes to ensure that installing a turbine will not have any negative environmental impacts. The Army Corps of Engineers ("Corps") has a Coastal Use Permit (CUP) that must be obtained to document the development of Louisiana's coastal zone and ensure sustainable development. This permit also considers § 10 of the Rivers and Harbors Act that deals with the hindrance of navigable waterways. The CUP also has a 30-day comment period that allows for public response to the potential development. Lastly, the Louisiana Department of Natural Resources' Coastal Management Division has a Coastal Zoning permit that is required whenever there is development in their jurisdiction. Their permitting process can be done in phases. First there is a solicitation of views, which will decide if the project is in the Coastal Zone and if there are specific features of the design that will negatively impact the permitting process. Next there is a Request for Determination that will determine if there is a need for a CUP permit for the particular activity. The third phase allows for the applicant to jointly apply for their CUP with the Corps. Any dredging that is done to install the turbines might require a § 404 dredge-and-fill permit. So far it seems that the Riversphere site does not need to worry about FERC regulations, as it will be operating under the 5 Megawatt power limit. The Net Metering rules & regulations, described above and currently being written by the Public Service Commission, would also applies to river turbines.

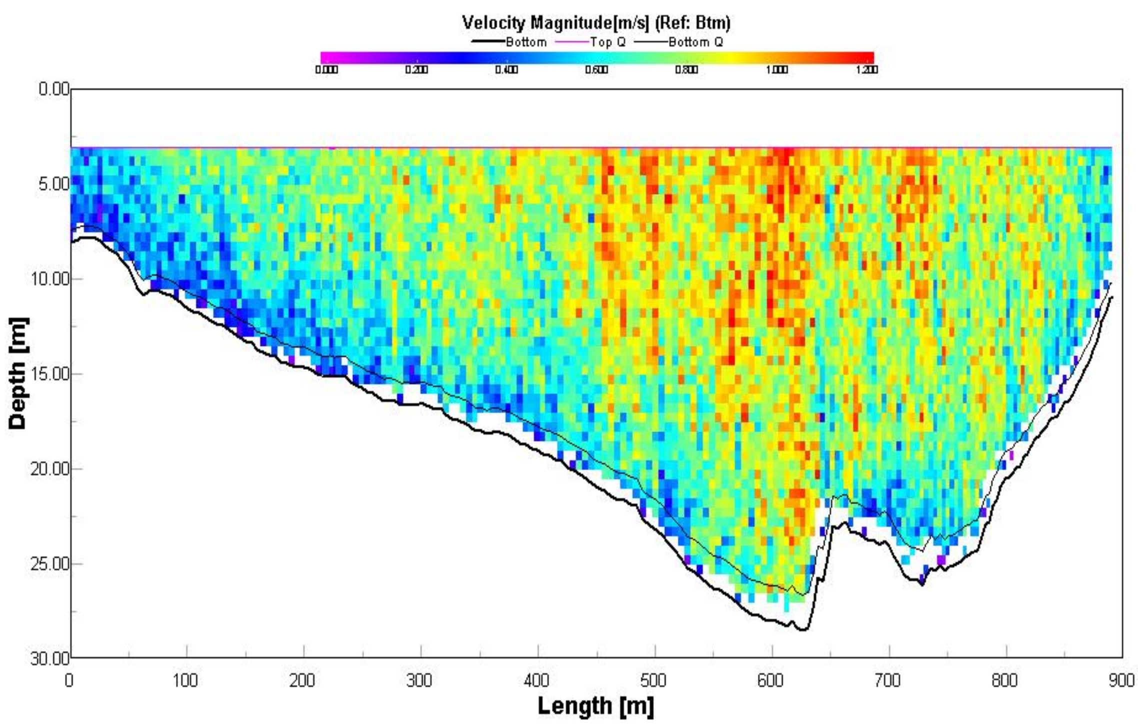

Figure 2: Acoustic Doppler Current Profiler cross section velocity data at site equivalent to RiverSphere (Mike Stewart, Tulane Environmental and Earth Sciences).

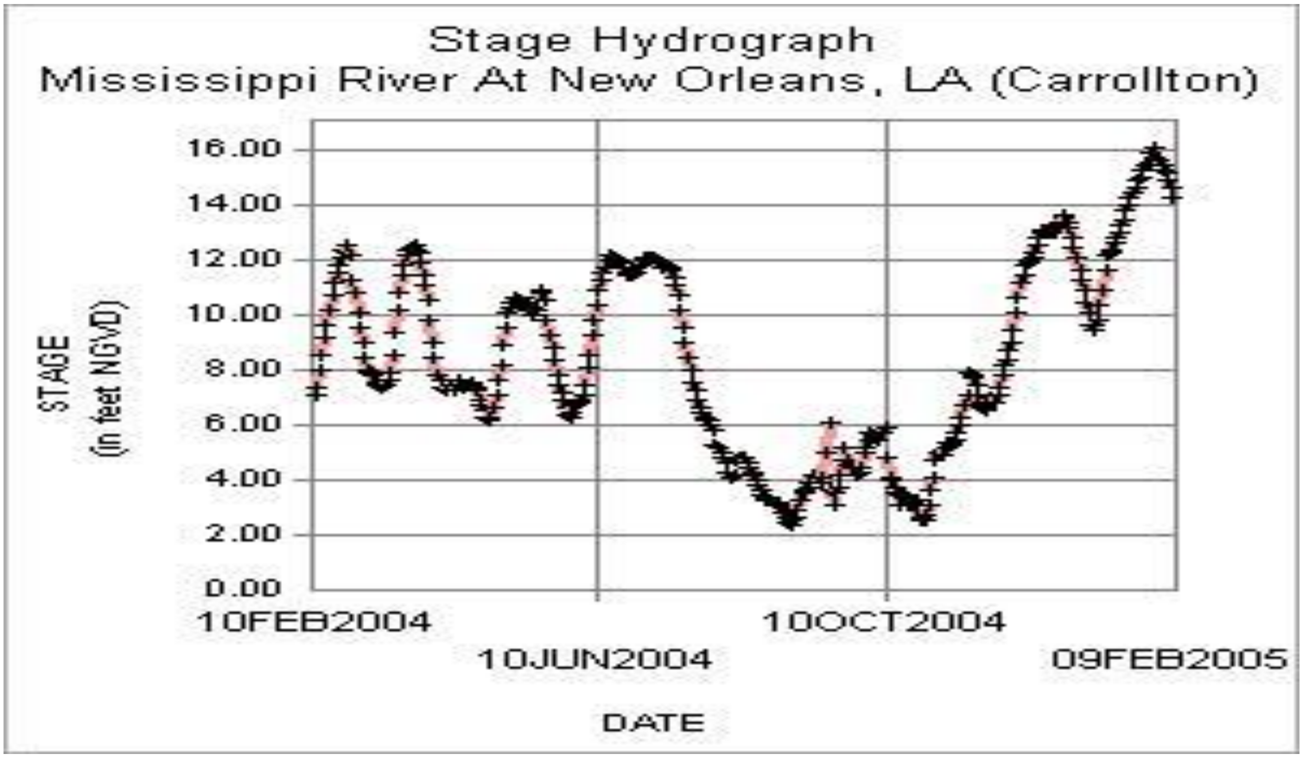

Figure 3: 2004 Mississippi River stage Hydrograph measured near the RiverSphere site (US Army Corps of Engineers; http://www.mvn.usace.army.mil/eng/Edhd/Wcontrol/opfiles/051804.asp).

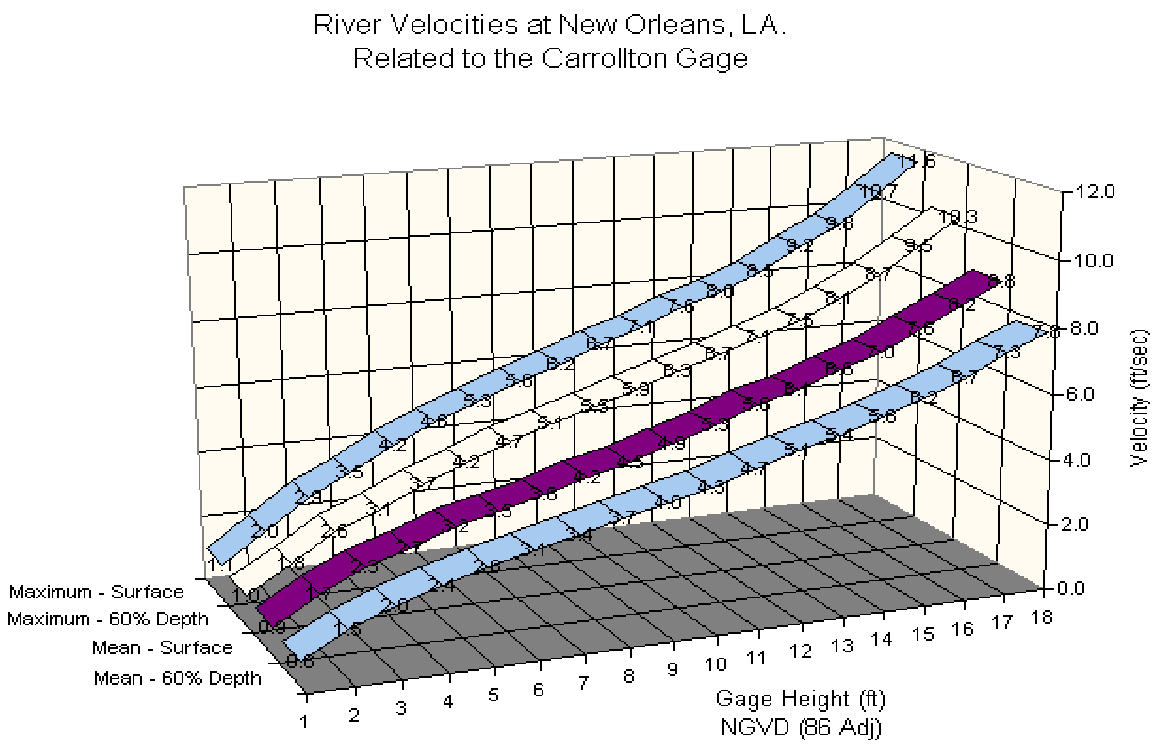

Figure 4: River velocities measured relevant to stage (source same as Fig. 3).

4. Discussion, Conclusions, Recommendations

While the RiverSphere site will be an academic research center, it can also provide information in another, important way: by providing a functioning example of incorporated renewable energy solutions. The best way to promote a technology is to prove that it works. Therefore, the success of the RiverSphere site will encourage others to try renewable energy approaches in their own facilities. Based on this principle, the ideal outcome of this team's research will be to determine the maximum number of renewable technologies that can be implemented at our site depending on cost-benefit analysis, and provide information about the logistics of incorporating each element. One building can make a difference in reducing greenhouse gas emissions; but if that one building provides information for how all structures can reduce greenhouse gas emissions, the possible benefits have great potential.

I Did the project balance the elements of people, prosperity and the planet?

From the beginning, the creation of the RiverSphere has been a community-oriented goal. We found that the elements people, prosperity, and the planet were all considered in our project because they are all interwoven in the future of New Orleans. To begin with, the design of the RiverSphere incorporates existing Louisiana infrastructure and takes advantage of local resources; for example, using the river as a source of cooling and power, and using our above-average peak sunlight hours through photovoltaics. Approaching this project from a local perspective made this an environmentally cooperative measure, as opposed to an exploitative one.

Louisiana has a problem commonly referred to as "brain drain," meaning that our most intelligent and enthusiastic people leave the area to pursue success elsewhere. We want to see Louisiana as the place people come to in order to fulfill their ambitions, instead of the place people leave due to lack of opportunity. Creating a unique research site will draw intellectual minds back to New Orleans, and help bring academic and business opportunities to the area. It will open up lines of communication between many different interests, including academic institutions, project developers, and USACE.

In addition to just being a research center, the renewable energy features incorporated into the building will provide direction for Louisiana after the oil industry's decline. Off-shore oil platforms are already being considered for conversion into sites for wind power; the RiverSphere will help bring this progression from non-renewable energy to renewable energy inland. Developing a baseline for various renewable energy sources will serve as an example for people interested in incorporating renewable energy into their own projects. Also, extra energy for the area may be provided through net metering.

While this project has the obvious benefits of reducing demand for carbon/fossil fuels and creating an example for renewable energy systems, the RiverSphere will hopefully have another important impact on the environment. Due to our rapidly disappearing wetlands, Louisiana is in a major ecological crisis; developing a unique environmental research center in the area will help bring more attention to our specific and immediate environmental concerns.

II

Our project was successful in that we developed the basic background information needed to implement various technologies at the RiverSphere site. The scope of researching all applicable renewable energy technologies was quite extensive, however, we succeeded in making estimations about our designs' reduction of greenhouse gas emissions. We have also succeeded in making contacts and partnerships with key players for phase II, particularly with the design team and the USACE. We did not, however, design a turbine system in itself.

The biggest barrier we had to overcome was simply a lack of background information for our project; because there is no precedence for a system incorporating so many different technologies, we had to spend more time on groundwork and information hunting than we originally anticipated. It was also difficult to obtain specifications on turbines, and all our river data were about other parts of the river. Our partnership with electrical and mechanical engineering was limited, and we had trouble with some Louisiana authorities who were not forthcoming with information. We had difficulty coordinating with engineers capable of designing that technology, and we also lack the site-specific data necessary to make accurate predictions about turbine performance. Our team also lacks the knowledge of how to do cost-benefit analysis for this system, so finding resources for this aspect will be done for phase II.

In terms of things we would do differently, our biggest change would involve scheduling. Establishing contacts for obtaining data would have been the best first move, as that is a time-intensive part of the project as well as our most critical issue. We also would have tried to have a larger team with more background from the very beginning, in order to sidestep the lack-of-information issues we had.

III

The disciplines represented by the students in our team included Architecture, Environmental Studies, Environmental Engineering, Political Science, Business, and Electrical Engineering. However, our Electrical Engineer was able to work with the project for only a short amount of time, so their contribution was less helpful than anticipated. With the exception of that particular discipline, we found that the various academic backgrounds within our team supplemented our project by providing different, yet applicable, viewpoints. Our team member who is a faculty member with the Center for Bioenvironmental Research was able to contribute specifically by accessing information from departments within and adjacent to the CBR. The RiverSphere Project coordinators overseeing our research were also able to help with project specifics.

IV

This project definitely has the potential to bring about positive impacts in the movement towards sustainability. When it comes to technological breakthroughs, renewable energy is just like any other development: the hardest step to success is the first one. When doing research for our project, we went to visit The Green Project to learn about their photovoltaics system. Being able to learn from their experiences instead of starting completely from scratch was invaluable. The RiverSphere will be that kind of example to any facility looking to incorporate renewable energy. Once people understand how effective renewable solutions are, and have seen examples of successful renewable systems, they will be more inclined to use those technologies. Society is eventually going to have to move away from fossil fuels, and the sooner we can provide a basis for renewable energy, the better off our society will be; the RiverSphere site will be one of the first parts of this breakthrough. Technological breakthroughs in LA have historically been very destructive, so the development of renewable technologies is an incredible turnaround. The fact that the RiverSphere is in a visible setting, and will have opportunities for tourism and educational, will make this impact even more significant.

V

The technologies we researched were significant first to the RiverSphere site itself; we can confidently say that due to our suggestions, the greenhouse gas emissions caused by the building will be greatly reduced. As the RiverSphere will be producing energy, the issue of net metering will be brought to attention in the near future. Once regulations in renewable standard portfolios are determined, there will be a precedent for other facilities to attempt to produce their own power as well. Hopefully, the RiverSphere will also help draw attention to the need for establishing emissions credit systems.

On a broader scale, the variety of technologies implemented in the RiverSphere's design mean that almost any architectural project could benefit from using one or more components we researched. We found that passive energy designs taking into account natural lighting and ventilation were able to reduce the RiverSphere's energy demand by almost two thirds, making the fundamental architectural approach key to energy reduction even without involving extra renewable systems. Our technologies are obviously applicable in the developed world, but even for developing countries, efficient architectural designs can make a big difference in the feasibility of energy requirements. While turbine systems and photovoltaic cells can be very expensive to developing areas, the river cooling technology is less complex; when considering that many highly populated areas of the world are close to water sources, this technology could be particularly useful when building in underdeveloped regions.

VI
For our project, we established contacts with many different groups and organizations. Ochsner Hospital, Louisiana Hydroelectric, and The Green Project all gave us information about their renewable energy systems and tours of their sites. We also received input from various departments in Tulane University, including electrical engineering, civil and environmental engineering, earth and environmental sciences, the Center for Bioenvironmental Research, the Office of Environmental Affairs, and the Tulane Law school. The USACE was also very helpful in informing us about permit issues. Finally, we are associated with the RiverSphere Design Consortium itself, specifically Bruce Mau Design, Eskew+Dumez+Ripple, Hargraeves Associates, and Transsolar.

VII
At this point in our project, we have begun to quantify some of the benefits. While our results are still estimates, and we have insufficient data to complete quantitative analysis for turbines and river cooling, we feel the emerging pattern justifies further investigation of all renewable energy strategies. The table below shows energy savings relative to the figures shown for regular construction.

Method	**Kwh/year**	**CO2 emissions/year (tons)**
Regular construction	3,850,700	
Passive solar and energy efficient design	-2,250,700	-1,452
Photovoltaic (small)	-158,000	-102
Photovoltaic (large)	-277,000	-179

VIII
The renewable energy technologies we researched for this project already exist, but for many of them there was a major lack of current information. Therefore, while the ideas did already exist in some capacity, the innovation of our project occurred in finding current data and exploring regulations. Using a river turbine in the Mississippi is an original proposition, and incorporating many different technologies into one system is also an approach that thus far appears to be unique.

Proposal for Phase II

1. P3 Phase II Project Description

Challenge Definition and Relationship to Phase I

In Phase II of our project, we will work with the RiverSphere design team to develop a plan for integrating renewable energy systems into the design of the facility. This phase will entail three main tasks. First, we will hold several symposia to present our findings in Phase I to the design team, to bring additional faculty and students into the project, and to discuss results, possible designs, and data needs. Second, we will do further analysis of the applicability of different systems to the site, including collecting data for a velocity profile of the Mississippi at the RiverSphere site. Finally, we will design educational exhibits on renewable energy for the RiverSphere itself, build small mobile exhibits, and try to capture our experience in the project in a syllabus and proposal for an undergraduate course in renewable energy.

Symposia with RiverSphere Design Team

In Phase II we will have several half-day symposia between our group and the RiverSphere's design team. The first will be held at the beginning of the academic year, in September 2006. Interested faculty members, students and community stakeholders will be invited. One of the goals of the first symposium will be to recruit additional faculty members and students to work on Phase II of our project through class projects, honors theses, and internships.

The primary goal of the symposium will be to foster a discussion of how to select and design the renewable energy system for the RiverSphere site. At the first symposium, we will present the design team with our findings to date. From their questions and comments, we will be able to identify additional data needs, and ultimately help the design team begin to decide which systems to incorporate into the site. The first symposium will help us define our work program for the fall semester.

In the two subsequent symposia, we will present the design team with updates on our research, and will participate in developing a plan for the integration of renewable energy systems into the design of the building. This work could entail identifying potential vendors, and working with the design team to write specifications and perhaps the RFP for a renewable energy system.

Further investigation of potential of river turbines: Velocity Profile

Preliminary research conducted on the technical and regulatory application of river turbines for the RiverSphere site in Phase 1 of our project laid strong foundations for moving towards the actual implementation of this technology. The next step in moving towards this goal involves the collection of more specific data relating to physical characteristics of the Mississippi River at the site.

The main physical attributes of the river we identified in our report as being crucial to determining turbine effectiveness are stage and velocity. In Phase 2 of our project we will partner with Tulane University's Earth and Environmental Sciences (EES) department to collect this information at an appropriate level of detail. Such detail will allow us to accurately calculate a turbine's energy output over a period of one year (taking into account the river's seasonal variations).

The EES department uses an Acoustic Doppler Current Profiler (ADCP) to establish the cross sectional velocity of the river at a specific place and time (see figure 2 in Phase 1 report). Our partners within the department will use the ADCP to profile river velocity at the RiverSphere site. In order to establish how velocity changes with change in river stage we will collect this data at regular intervals over the course of an entire year. This time frame allows for the consideration of river characteristics at high, low, rising and falling stages. The information collected in this process will allow our team to gain an understanding of the energy production potential of RiverSphere.

Other Physical river considerations

There are a number of more general considerations we feel require further investigation for a complete turbine suitability analysis for the RiverSphere. Water quality, or more specifically, identifying the potentially corrosive materials in the river that will affect the turbine materials & maintenance schedule, is something we need to establish. We will consult the available data sources for this information. Also important is to establish a risk assessment procedure associated with placing turbines in a very busy navigation channel. Once again we will consult available data to answer this question.

Cost and economic impact studies

Though we found some general comparisons of the costs per kW of these systems, we were not able to estimate the cost of installing each system at the RiverSphere site. By working with the design team and identifying potential vendors, we will be able to better estimate the potential costs of each of these systems.

While we give some general assessments of the potential economic impact of each system on our local economy, we would like to enlist students in the A.B. Freeman School of Business to help us assess this in more detail. For example, when we visited the Sidney A. Murray, Jr. Hydroelectric Station, we learned that the power plant had been built at the Avondale Shipyards, just upriver of New Orleans, and then floated upstream on the Mississippi River to its site. Over three thousand people worked on its construction. Economic impact studies could help us better assess which of these system would have the greatest economic impact, not just in energy potential, but in construction and maintenance jobs, attraction of creative people, etc. We will do this through an existing Service Learning program in the A.B. Freeman School of Business at Tulane that assigns teams of students to nominated projects.

Innovation and Technical Merit

A number of the systems that we considered this year are now operating in the New Orleans area. The Green Project will unveil its phovoltaic system on April 22, while Oschner Hospital relies on river water in its cooling system. In working with these systems, our project's innovation will be to integrate them into the facility in a way that minimizes costs, maximizes available resources, and also maximizes the educational benefits about renewable energy to visitors to the RiverSphere.

If selected and pursued, design of a river turbine specifically adapted to the conditions and requirements of the RiverSphere location, will be a novel design and installation in our region. From visiting other renewable projects, we learned how useful a successful pilot project can be. It was invaluable to be able to speak with a local manager who had already worked through the purchasing, installation, regulatory and maintenance issues. In investigating the possibility of a run of river renewable energy site in the navigable stream in the Mississippi, applying existing technology to a new condition, we are doing data collection, regulatory investigation, relationship building that others may draw upon in harnessing the energy of the Mississippi River.

P3 (Sustainability)

All of the types of renewable energy that we have studied will be beneficial to the environment of the region by decreasing the dependence on fossil fuels and other wasteful technologies. Louisiana has much to lose from climate change, and reducing the greenhouse gas emissions of the state would do much to help the future of the communities in the region. As a result of climate change, southern Louisiana suffers an increasing frequency of hurricanes and more significant erosion with each storm. This could destroy or critically damage many coastal communities. Also, drinking water supplies in the area become threatened with saltwater intrusion. All of these effects could be reduced if climate change was controlled by a reduction in the use of fossil fuels, and studying which renewable energies will provide the best substitute. The ultimate product will function as the beginnings of a system that could reduce the dependence of future generations on oil, gas, and coal, to an alternate option that would support the region in many more ways.

Carefully considered designs for renewable energy would directly benefit the local and regional economies. Firstly, new technologies provide job options for an area that is directly reliant on fossil-fuel extraction as its main industry. Louisiana is a very poor state which would have a lot to gain from investing in emerging technologies, especially renewable technologies, since the oil and gas industry will eventually no longer be able to support an already failing economy. The resulting economic diversification would also reduce costly greenhouse gas emissions. Secondly, regional prosperity could be increased with income from the system as long as there is extra energy that could be sold to surrounding markets.

It is essential that Louisiana discover a way to reduce these emissions, since the state is affected so greatly by the consequences. In 1990, the state of Louisiana contributed almost 200 million metric tons of CO_2 to the atmosphere, which amounts to approximately 1% of the global total. The purpose of our project is to develop a design that can move the energy consumption of the gulf coast region to renewable energies such as solar, wind, biomass or waterpower. All of these options reduce the need for oil, gas, and coal use and create an infrastructure for sustainable solutions. The options to be studied are all low impact in terms of infrastructure and implementation, and occur within the locality. There would be no transference of ecological degradation to another community. Any of the proposed systems would be significantly less damaging to the local ecology than the present oil and natural gas extraction processes. A study of all the options for renewable energy in southern Louisiana would be pertinent to a region that has thus far been static in acting towards these new technologies. The environment of the region is failing in part because of global climate change, a phenomenon to which we are a significant contributor. The economy is extremely susceptible to extreme fluctuations because of its dependence on the fossil-fuel industry, mainly oil, and the communities are suffering because the welfare of their future is in jeopardy. Researching and implementing an effective sustainable option for a renewable technology alternative will educate the region on the possible direction to take towards a sustainable future.

Measurable Results, Evaluation Method, and Implementation Strategy

The goal of this project is to research the design and implementation of a renewable energy that is to be integrated into a larger environmental education project. Our first major product will be the completion of a study that isolates the most feasible technology based on cost-benefit, efficiency, energy production, and environmental savings. Our second major product, completed in collaboration with the RiverSphere design team, will be a plan for a building energy system that integrates efficiency and several renewable energy systems. This product may be ultimately expressed as specifications or a draft RFP for the energy system. Our third major product will be the design of educational exhibits for both the RiverSphere site and mobile exhibits. Our final major project will be the completion of a Renewable Energy course proposal and syllabus, that shares our experiences and learning with future Tulane undergraduates.

Other measurable results would include the amount of energy produced. Success would be defined by designing a system that would produce enough energy for the complex in which it is located to offset the total cost (economic and environmental) and impact of having that energy provided by a non-renewable resource. The adaptability of design will be an important result, as, ideally, this research could be used to provide a solution to developing countries rich in natural capital but with no method of transforming those resources into tradable economic value.

Phase 1 was implemented by a team of 4 students, some volunteer, some earning course credit and some earning a small consulting wage from the RiverSphere, who met weekly with faculty and staff advisors. Through the symposium that would commence Phase I, we will recruit additional faculty and student collaborators. The students collaborating on Phase II will be doing so through internships in the RiverSphere.

Educational Tool

After a renewable energy system has been selected for the RiverSphere (most likely several integrated systems), our job will be to use our research to design educational exhibits for the center. Drawing on the process The Alliance for Affordable Energy, a local energy and environmental non-profit, has agreed to advise us. They have many years of experience communicating energy concepts to the general public. These exhibits will bring together models, graphics, and the creation of spaces that allow the public to interact with the systems. The final product will be drawings of these educational exhibits. As the construction of the RiverSphere will take several years, we will also make mobile educational exhibits about the use of renewable energy on the site that can be taken to schools, community meetings, etc.

Finally, we will use our experience in this project do draft a sample syllabus and proposal for an undergraduate course on Renewable Energy for upper class engineers, architects, and environmental studies majors. Currently the only course at Tulane that addresses renewable energy is a law school course in Energy policy & law, and it is only offered every two years. We envision a course that will approach renewable energy from business, environmental, technical and architectural perspective, just as we have done during this project. It could be taught by a faculty team, and students would visit many of the sites we visited during this project.

Program Implementation Schedule 2005/06

September

- Continue river cruises to collect velocity and stage data (this will happen each month for a period of one year).
- Start drafting schedule and list of participants for initial design symposium.
- Execute first symposium at the end of the month.

October – December

- Identify the full team for the Phase 2 project in response to new recruits from the symposium.
- Table all suggestions raised in the symposium for further development of Phase 1 findings.
- Begin work with A.B. Freeman School of Business Service Learning Project on economic impact study.

January-February

- Start drafting schedule and list of participants for second design symposium. This includes a briefing on the research conducted on priorities identified in the first symposium.
- Host second symposium at the end of the January.
- Again respond to design directions specified in symposium and further refine RiverSphere's renewable energy strategy.
- Start working with The Alliance for Affordable Energy on educational materials.
- Drafting specifications, or an RFP, for the construction of the proposed system.

March

- Present draft specifications, or RFP, to the design team in the last symposium for final refinement and approval.
- Work with selected faculty on the collation of the entire P3 experience into an ongoing undergraduate renewable energy course.

April

- Write final report including the detailed proposal for the construction of a renewable energy system for RiverSphere.