“Dedicated to objective analysis of energy issues and the promotion of intelligent decision making and energy technology development.”

A Project of the

University of Southern California

2012
The University of Southern California Global Energy Center is well positioned to provide leadership supporting a balanced, objective approach to the energy challenges facing our world. USC scholars have focused on all elements of energy including technology, public policy, workforce development, finance, and economics for decades.

The university’s scholars have conducted in-depth research in nearly all aspects of energy technology including renewables, geothermal, and nuclear with many developing patents that are now being used in industry. It is important to note that USC is the only research university in the western United States with a significant petroleum engineering program. The university has also undertaken a variety of energy research projects on a national and global basis.

The Global Energy Center leadership is devoted to taking a comprehensive approach to energy. The GEC is a unique center with a multidisciplinary program that plans to involve the following at USC:

- Viterbi School of Engineering
- Price School of Public Policy
- Marshall School of Business
- Energy Institute

The project will also involve various centers within these and other schools. The Communications Institute (TCI), an internationally respected nonprofit center that has developed extensive academically based educational programs and outreach will work with the USC community to develop and implement the project. TCI leadership have worked with USC since 1976 on a variety of projects and programs.

The following are key elements of the GEC planning for the future:

- **Energy Issues**
- **Research** (partial list)
  - Reservoir Monitoring Consortium (rmc.usc.edu)
  - Center for Geothermal Studies (cgs.usc.edu)
- **Education and Outreach**
The Global Energy Center (GEC) and its partnering institutions and other USC Centers would address critical energy issues including:

- **Smart Grid** – Smart Grid power and infrastructure and systems
- **Oil and Gas**
  - Enhanced oil and gas recovery systems
  - Intelligent oil and gas field systems (CISOFT)
  - Reservoir Monitoring (RMC)
  - New resource development technologies for oil and gas
- **Renewables** – Alternative such as solar energy plus geothermal energy production systems
- **Nuclear Energy** – Reviewing the long term use of nuclear energy and new technologies
- **Efficiency** - Energy efficiency and cost reduction systems
- **Fuel Cell and other new technologies** – Focus on fuel cells and other new developing technologies.
- **Climate Change** - Carbon management and climate change adaptation
- **Energy Use** - RESTOR: Recoverable Energy Storage Through Oil/gas/geothermal-well Reuse

Analysis of energy issues conducted by the Center will be not being conducted for the sake for academic research purposes but will be integrated into comprehensive education/outreach programs for policy makers, media, plus leaders in government and the private sector.

**Evaluating Energy Issues for Industry**

The GEC is particularly committed to supporting the vital work of industry in addressing both internal and external issues. These could include the following:

- **Assessing Long Term Needs of the Energy Industry**
  - Technology needs
  - Manpower needs
  - Capital investment and operating cost trends
  - Energy Price Forecasts
  - Impacts of government and regulatory policies

- **Developing Strategy**
  - Expand understanding of the status of various energy technologies
  - Supply and Demand and economic realities of energy development
  - Political Realities
  - Environmental Issues
  - Economic and Financial Trends
The Global Energy Center will also facilitate research studies on critical topics that can be sponsored by either the private sector or government. The research will include research focused on energy technology however; the center would also focus in econometric research. For example, USC cosponsored the 2011 *Powering California* forum which included presentation of economic analysis of viability of a variety of options in determining the state’s energy future. The real economic impact of energy decisions has often been lacking. This must also be related to the costs for the infrastructure required to produce energy.

The research of Center will therefore involve science, engineering, business, economics and public policy analysis. Examples include, but not limited to some ongoing and proposed projects:

- Oil and gas extraction technologies
- Energy, Economics, and Public Policy
- Intelligent oil field systems
- Optimum process control for refineries
- Geothermal Center of Excellence
- Future generation solar
- Cyber security for energy infrastructures
- Green data centers development
- Shale gas resource development
- Energy data processing/mining

The Center will bring together other research programs at USC focused on energy. The work of the center will be based on objective analysis involving science, engineering, economics, business, and law. The following are summaries of the work of two programs that are focuses on geothermal energy and the monitoring of underground fossil fuel energy sources.

This prospectus includes examples of two ongoing programs that would be part of the work of the Global Energy Center. These include:

- **Reservoir Monitoring Consortium (rmc.usc.edu)**
- **Center for Geothermal Studies (cgs.usc.edu)**
Research by respected public and private institutions project establishes the fact that the world will require significantly more energy in the future. While these needs are clear, there is increasing regulation on energy producers to protect the environment. For decades, policy makers at all levels of government and leaders in the private sector have dealt with question of how to access fossil fuel sources while protecting the environment. Increasingly, more energy development projects are killed because of the potential of the environmental damage they could cause.

Fortunately, technology now exists to monitor the underground production of natural resources. These include:

- Conventional
- Carbonate
- Shale gas
- High Pressure/High Temperature

The USC Reservoir Monitoring Consortium (RMC) works with industry to develop technology and processes to monitor underground reservoirs while production is underway that can identify any problems or changes. This technology monitors existing reservoirs and see how they are handling impact underground as we are producing.

**Objective** - The objective of Reservoir Monitoring Consortium (RMC) is to develop new methods for dynamic reservoir monitoring. The Consortium carries out a number of focused applied research projects in reservoir monitoring that are directly pertinent to the current and future needs of industry and government. The Consortium will develop specific workflows for different types of reservoirs. This will include the conventional reservoirs (e.g. carbonate, clastic, deep waters) and the unconventional reservoirs (shales, tight sands, heavy oils, and geothermal).

This will be preceded by the identification of the key technology gaps with input from the project sponsors. This USC center focuses on major issues such as integration of disciplines, data, information, and expertise. It will maintain a balance between short and long term, high impact research goals and the immediate and foreseen industry needs. One key distinguishing edge of RMC compared to other academic consortia is its focus on multi—disciplinary aspect of reservoir monitoring and its application to real time problems.

**Communications/Outreach** - Another goal of RMC will be to promote greater understanding of how technology can be used to permit the production of energy in an environmentally responsible approach. Based upon the research and work with industry, the Consortium will launch an aggressive public education effort to make policy makers, private sector leaders and others more familiar with the technology. We will also serve as a source of information for media.
**USC Center for Geothermal Studies (CGS)**

Geothermal energy can make a significant contribution to providing energy as a renewable source. The USC Center for Geothermal Studies (CGS) promotes excellence in research and development with practical focus and multi-disciplinary education for geothermal energy. The work of the center spans different technical and operational challenges associated with geothermal energy from exploration and production to its usage and transmission in a safe and cost effective manner.

The USC work on geothermal technology is extensive. It has received millions of dollars in research including US Department of Energy. For example, The U.S. Agency for International Development (USAID) has selected the USC Viterbi School of Engineering to work with a top Indonesian university to train experts in geothermal power.

**Center’s Goal** - The center’s aim includes developing new research programs and initiatives as well as courses and workshops and help transferring new technologies to the industry. We facilitate multi-disciplinary research in collaboration with other institutes and departments at USC where we can identify potential applications to geothermal energy. To ensure relevance and high level technical content of the program we have established a Strategic Advisory Board (SAB) and Technical Advisory Board (TAB).

CGS intends to use existing ongoing R&D programs as a platform to extend to other important related topics. This will include developing collaborative and synergistic R&D projects with other USC entities. Among them are, USC Energy Institute, USC petroleum Engineering program and Material Science, CiSOFT, the Earth Sciences department including its affiliated Southern California Earthquake Center, Information Science Institute (ISI), the Electrical Engineering department, Computer Sciences department and System Engineering Architecture department. Our multidisciplinary programs will provide the necessary synergy to ensure technical excellence to meet the grand challenges for Enhanced Geothermal Systems (EGS) and geothermal related issues.

Finally, CGS has formed alliances with other academic institutions with complimentary technical capabilities, different DOE National Laboratories, and major geothermal energy producers to further broaden the depth and breadth of our programs and making them more relevant.

The Center will hold regularly scheduled seminars, workshops we will work in close co-operation with the industry and academic experts to focus on the current and relevant problems and help transfer technologies from many other fields such as fossil oil, intelligent systems, material science, power engineering, smart grids and others to geothermal related applications. The information developed through extensive research at this center is provided to individuals, organizations or companies interested through our publications and other outreach activities to policy makers and media.

“Geothermal energy may be the most prolific renewable fuel source that most people have never heard of. Although the supply is virtually limitless, the massive upfront costs required to extract it have long rendered geothermal a novelty. But that’s changing fast as this old-line industry buzzes with activity after decades of stagnation.”

Los Angeles Times

Center Director Fred Aminzadeh (right) at Sacramento geothermal energy conference
Education and Outreach are core elements of the Global Energy Center. The educational elements strengthen the core role of the center with in USC as institution of higher education. However, the center is also dedicated to outreach to professionals, leaders, the media and the public. It is also dedicated to outreach to key constituencies by applying objective research and analysis to the critical issues facing society.

There is a great deal of misinformation about energy technology and economics. For many years USC, working with organizations such as Caltech and The Communications Institute, has developed programs to expand the knowledge of key constituencies on energy. We are committed not only to energy science and technology but also to economics and finance. So often practical solutions do not include a focus on financial and economic realities. Through previous work with the USC Price School of Public Policy, educational outreach will be a major part of the work of the Center.

In 2011 the Price School joined with the Viterbi School of Engineering, Sandia National Laboratories and The Communications Institute to conduct a leadership forum on California’s energy future Powering California. This forum is consistent with type of high quality educational programs the Center would conduct in the future with our partners.

The GEC outreach focus will include the following:

- **Energy information access and analysis**
  - Forums, seminars, conferences
  - Customized programs

- **Continuing Education Programs**
  - Industry
  - Policy makers and media
  - Leaders

- **Manpower Development** – USC curriculum development for the next generation Industry experts.

- **Mentoring on energy issues**
  - Technology
  - Policy
  - Startups
  - General consulting platform

- **Energy curriculum**
  - Universities in the NOCs
  - In-house training

The Center would conduct research and produce research papers on critical issues and technology and conduct a vigorous communications program with the release of each paper. Also, the educational programs presented above will often be based upon the research studies of the Center and its partners.
With the vital importance of energy in economy, it is important that leaders in all fields have a comprehensive understanding of energy. GEC is committed to developing Continuing Education Programs that will achieve this goal. These programs could include 4-5 day executive educational programs for industry or a two hour workshop for policy makers.

Executive Education – A good example of the type of high quality program the Center would offer is the Executive Petroleum Program: Economics, Exploration and Production now offered by the Viterbi School of Engineering. The program is a forum for industry executives to discuss and explore solutions through a four day Executive Petroleum Program.

The oil and gas industry is constantly evolving and it is imperative that executives are aware of the industry's current issues, challenges and evolving technologies. The Executive Petroleum Program (EPP) provides a high-level technical overview of the upstream oil and gas industry to executives with a limited, or very specialized, background in engineering or petroleum technologies.

The sessions are led by top industry experts and are designed to give participants an understanding of the current issues and challenges in the upstream oil and gas industry - specifically in the areas of Geology, Geophysics, Drilling/Completion/Stimulation/Formation Evaluation, and Production/Reservoir Management.

Upon completion of this course, participants will have the knowledge to assess the potential application of new technology and make informed purchasing decisions across all areas of the upstream oil and gas industry.

Workforce Development - The Center will also work with appropriate schools to produce the next generation of engineers, scientists, and business leaders who will develop these sources in future decades. This is a critical role academic institutions such as USC must fulfill. We envision the center focus on the following workforce development points:

- Crew change
- Professional training to address “middle-gap” in the workforce
- Professional training for specific groups:
  - Professional petroleum program (PPP)
    - Executive petroleum program (EPP)
    - Smart oil field certificate program
    - Custom made training programs for member companies
- Executive energy program (EEP)

Customized Education - Custom Courses can be designed to harness the expertise of USC Faculty for the specific needs of an organization. The USC Viterbi School of Engineering Professional Programs team will assess the organization's needs and identify a faculty member with specialized knowledge in the desired area of education. If the customized course involved public policy issues and economics, the Price School and other appropriate schools at USC will be enlisted.

GEC will also involve experts from partnering institution. Throughout the development process, the Professional Programs team will work closely with an organization to ensure that the course curriculum and method of delivery are in line with the organization's goals.
The University of Southern California views the center as a vehicle to promote expanded partnerships between industry and the academic research community devoted not to political or ideological goals but rather to objective analysis. It is also committed to developing real answers and not engaging in solely more academic research devoid of its application.

Goals - The following are key goals of the center:
- A partnership between USC and member companies (MC)
- A consortium to assess and address long term issues and needs of energy and related industries
- A platform for energy leaders to interact with peers and top scholars in energy
- A catalyst to help innovation on energy
- A workforce development and training function to fulfill professional training needs in all levels
- A Think Tank as “go to” place for information and analysis of energy related issues
- A portfolio of multi-disciplinary sponsored energy research programs

A Networking Platform
A key goal of the center is create a networking platform for leaders in all sectors devoted to a constructive dialogue and efforts to create real solutions to our the nation’s energy challenges.

- **National Oil Companies**
  - Addressing common issues on
    - Licensing terms
    - Energy technology R&D
    - Ongoing government (including DOE) sponsored programs
  - Joint venture and farm-in opportunities

- **Multi-National Companies**
  - Common public policy issues
  - Joint R&D investment on non-competing matters
    - Energy technology R&D
    - Workforce development and professional societies
    - Carbon management and energy efficiency

- **Independents and Small Producers**
  - Low Cost R&D, technology Transfer

- **Service Companies**

- **Networking, technology Transfer, training**
Global Energy Center Structure

The GEC is establishing a solid structure to achieve its mission involving the best scholars from not only USC but other major academic/research institutions plus the experts/leaders from the private sector and government. The structure will include:

- **Advisory Boards**
  - Strategic Advisory Board - Selected Key Industry Leaders from Member Companies and top academic leaders.
  - Technical Advisory Board - Selected Academic Leaders from USC and other Universities plus technology experts from industry and government including National Energy Laboratories.
  - Policy Advisory Board - Selected Local, State and Federal Government Representatives plus experts from private and public sectors.

- **Program Council**
  - General Program
    - Member Company Representatives
  - Specialized Programs For Sub-Groups or Individual Companies
    - Customized Programs for Individual or subset of member Companies

- **Leadership/Administration**
  - USC Advisory Council (Provost, DP, RH, YY & other Deans, KG & IE)
  - Managing Director (FA)
  - Industry Relations / Business Development Manager (TBD)
  - Communications and Outreach Programs Director – partnering institution: The Communications Institute

Advisory Boards Membership

The Center advisory boards will include top leaders in industry. These could include (Partial list):

- SEMPRA/Southern California Gas
- Edison International
- BP America
- Chevron
- Anadarko
- ExxonMobil
- General Motors
- Apache
- Schlumberger
- ION
- Ford Motor Company
- Honda

The Center would also attract industry leaders in biofuels, and other renewable energy sources who are committed to an objective assessment of the world’s long term energy future.
Funding

The goal of the GEC is to secure a broad base of funders who are committed to the objective, analytical approach of the center. This will include grant support plus a membership program that will include the following:

- Founding Member
- Platinum Membership
- Gold Membership
- Silver Membership
- Member

GEC Operations

The Global Energy Center will budget funding for research on critical energy issues but will also include a major commitment of the deployment of that research into society to develop better policies and practices in the use of energy.

GEC Scholars - The center will employ several scholars to oversee the content of the center’s program. GEC scholars will be placed in each of the key schools of the university.

GEC Program Development – The GEC program development staff will be devoted to the deployment of research and information emanating from the center to key constituencies. The staff will include top professionals with expertise in organizational management, public affairs, and communications.

The center will also develop partnerships with other universities and the National Energy Laboratories with a goal of the expanding coverage of the important research by these other institutions.
USC Strategic Vision and the USC Global Energy Center

The University of Southern California is one of the world’s fine academic institutions. It has distinguished itself for its outstanding curriculum and faculty but also is a leading research university. Over the years the university has operated with a strategic plan. USC has launched a new strategic vision that outlines the leading role the university will play in what it calls “the Age of the Pacific - an environment that is far more global, urban and integrated than ever before.”

With the development of the Global Energy Center it is important that it be consistent with this new USC Strategic Vision. A clear presentation of this vision has been presented by the President’s office:

“The strategic vision charts high-level aspirations for USC via three broad pathways: transforming education for a rapidly changing world, creating scholarship with consequences and connecting the individual to the world. Within these themes, key areas of expansion or improvement include transformational faculty, cross-disciplinary collaboration, translational research that addresses societal challenges, access to education, and global and local engagement.”

While the vision statement has many vital elements, in developing the center it would be important to note its relevance to following priorities set forth in the Vision:

- **Academic Excellence** – “Fields of study will have the greatest impact on society and require attention from preeminent universities in the 21st Century” notes the Vision Statement. The partnering USC schools are each leaders in their fields and bringing them together in one center designed to focus objectively of the greatest challenges facing mankind, energy, is critical. The Center will contribute to this critical goal. The Center can also impact not only curriculum but expanding the horizons for students while also distinguishing the great research capacity of the university. Our programs on workforce development also address these elements of the Vision statement.

- **Translational Research, Creative Work and Practice** – “Converting research to practical and sometimes entrepreneurial applications will play a pivotal role in creating the future” declares the Vision statement. There is a great need for the development of new, practical technologies that can meet the world’s energy needs in the future with a sustainable but realistic approach. At the same time, there needs to be a bridge “transitioning” to the future well into the second half and beyond of this century. There are no short term fixes. USC has the capacity to provide great leadership since it is the only university in western United States to have any expertise in nearly all energy sources from renewable sources such as geothermal to nuclear to petroleum.

- **Creating Conditions for Success** – “Future success in addressing complex problems depends upon collaboration on a massive scale.” The goal of Center of integrating the USC Schools of Engineering, Public Policy, and Business into one center will implement this important element of the vision.

- **Global and Local Engagement** – “USC has the talent, resources and will to become a global model of the engaged research university.” The vision statement notes the unique positioning of USC in such a diverse city as Los Angeles and environs beyond. No university is located in an area surrounded by the most ethnically diverse community in the world but also with large agricultural areas, mountains, deserts, and a wonderful marine environment. Southern California has been the center of energy development for more than a century.
Energy is the currency of the world. Energy supply and demand continue to shape the world politically and economically. After experiencing a dramatic spike in the price of oil, Americans recently once again were reminded of the importance of abundant, low cost energy to our economy. The outflow of dollars to pay for this oil has undermined the financial stability of the U.S. economy. At the same time, global politics have an immense impact on energy. From the uncertain future of Middle East oil to the apparent attempt to reestablish the Russian Empire to the events in Europe and other parts of the world, energy is a global challenge.

At the same time, during the past four decades concerns about the negative impact of energy development use could have on the environment. These concerns resulted in the creation of the environmental lobby which has pushed for more regulation, conservation, and other steps to produce more energy efficient products and particularly a new generation of automobiles. The reality is that the action to conserve energy has created greater efficiencies and has created cleaner air and an overall environment.

The University of Southern California is committed to expanding the work of the Global Energy Center to develop a consortium of the best scholars in the world to tackle these vital issues that will support the efforts of government and the private sector.

**The Environment, the Economy and Energy**

On July 9, 1970, noting increase concerns over environmental protection and conservation, President Richard Nixon by executive order created the Environmental Protection Agency as a single, independent agency from a number of smaller arms of different federal agencies.

Prior to the establishment of the EPA, the federal government was not structured to comprehensively regulate environmental pollutants. That changed dramatically with the formation of the Environmental Protection Agency in 1971. This one act particularly changed how energy was produced and used promulgating the value of environment protection and enhancement in energy policy decisions.

Three years after the formation of EPA, the nation found itself in the midst of what was dubbed “The Energy Crisis.” This was highlighted by a shortage of refined gasoline and long lines at gas pumps. It had a major economic impact on Americans and demonstrated our dependence on a reliable supply of energy.
Risk and the Environment

The public became increasingly risk adverse with major news coverage of environmental issues and the expansion of regulations from EPA. However, other news events expanded public concern about risks to the public’s health and safety posed by energy development. In 1979 a core meltdown in the Three Mile Island Nuclear Generating Station in Pennsylvania compounded public fears. There was a small release from the plant. According to the American Nuclear Society, “The average radiation dose to people living within ten miles of the plant was ....equal to a chest X-ray,” or about “about a third of the average background level of radiation received by US residents in a year." The real risk to the public was insignificant. The President’s Commission on the Accident at Three Mile Island evaluated the crisis and noted that one of the biggest problems was the inability of governmental and business officials to clearly explain the issues. This failure created an environment that exasperated public environmental fears and effectively ended nuclear plant construction in the United States.

Global Warming

Four years prior to the accident at Three Mile Island, in 1975 the journal Science published a paper by Wally Broecker Professor in the Department of Earth and Environmental Sciences entitled "Are we on the brink of a pronounced global warming?" This was the beginning of the effort to control man made carbon dioxide emissions to supposedly reduce the general warming of the planet. The “global climate change movement” contended that large-scale consumption of carbon intensive energy resources is undermining the long-term viability of the planet to sustain human civilization.

As a result, many policy makers have called for developing new energy technologies to reduced carbon emissions and reinvigorate economic growth and promote environmental sustainability.

The United States Government to state and local governments has enacted strict laws to reduce carbon emissions, promote conservation, and other initiatives to achieve these policy goals. These government actions have significant economic and technological ramifications often not understood by policy makers. For example, As Rich Little, Price School Senior Fellow on Infrastructure, has noted there is little attention to infrastructure required to meet our world’s energy needs to achieve the emission reductions advocated by policy makers.

Too often there limited discussion of the economics of the technological and related policy decisions and the cost-benefit trade-offs. Policy makers, government officials, business leaders, the media, and the public are all trying to make intelligent decisions about critical energy issues based upon the issues involved with the environment and sustainability. As important as these goals are, too often there is limited understanding of the economic and technological disciplines through which leaders can enhance their ability to make intelligent decisions and to project the ramifications of various policy changes.
Confronting Global Energy Demand and Issues

While government research and institutions are important in providing solutions for the long term energy challenges facing our world, the ultimate solutions and new technologies will be developed through private industry and the research capacity of academic research institutions. This is particularly important with the dramatic increased energy demand in the world.

Global Energy Demand - The Energy Information Administration Energy Outlook projects that world marketed energy consumption will grow by 53 percent from 2008 to 2035. Total world energy use rises from 505 quadrillion British thermal units (Btu) in 2008 to 619 quadrillion Btu in 2020 and 770 quadrillion Btu in 2035 (Figure 1).

Therefore, the energy choices made in the next decade will shape the entire supply picture between now and 2035 and beyond. The world will need all existing sources of energy along with new energy technologies including renewables.

Technological Development

The University of Southern California is committed to the idea that the private sector is the best hope for the solutions to resolve our worldwide energy demand. We are committed also looking all sources of energy and want to include those that can provide scalable amounts of energy today and the consideration of new technologies that can be major contributors to our energy supply tomorrow.

There are many new technology options, including developing unconventional domestic oil and natural gas, clean coal technology, nuclear, renewable energy resources, conservation, and energy efficiency improvements. Policy makers and opinion leaders need to know the costs and environmental impacts of these options. Too often their positions are not based on sound economics and science.

FOR MORE INFORMATION

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