



## **Connecting the North Star with the Lone Star**

*A Pilot Study proposing the launch of*

**NorTex:**

**A Norway-Texas Energy and Biomedical  
Science & Technology Partnership**



**NORWEGIAN CONSULATE GENERAL**

*Houston*

*Commissioned by:*

*The Norwegian Consulate General in Houston to compliment the activities of  
Transatlantic Science Week in Houston (12-16 November, 2012)*

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## 1.1 Summary:

*This pilot study proposes the creation of a public private partnership between academic institutions in Texas and Norway including universities and companies in energy, biomedicine and healthcare technologies). This initiative would focus on bridging transatlantic partnerships through joint research projects and the joint development and commercialization of novel and disruptive multi-disciplinary technologies to solve some of the most challenging issues in Energy and Healthcare. The partnership, **NorTex** will build on some of the key discussions and outcomes of TSW12, which was especially designed to focus on some of the unique world-class multidisciplinary and innovative research based technologies in Texas that are of interest to Norway.*

*NorTex will encompass science and technology venture events, entrepreneurship programs, and exchange of students, scientists, health specialists, and engineers, as a means to delivering its goals. It is proposed that NorTex will be jointly funded by the Government (centrally, possibly also regionally) of Norway and commercial partners in Texas and Norway.*

## 1.2 Background:

In September 2012, with an earmarked grant from the Ministry of Foreign Affairs, the Norwegian Consulate General in Houston commissioned this pilot study to assess the feasibility of establishing a Texas-Norway Partnership covering science, technology, innovation, entrepreneurship, focused on energy and medicine/healthcare. This Partnership would build on the existing initiatives already carried out by the Consulate General, Innovation Norway, INTSOK, and the Norwegian-American Chamber of Commerce (NACC, Houston).

The recent visit of former **Norwegian Foreign Minister Jonas Gahr Støre** to Houston, in January 2012, was a key impetus for launching this study. In his [speech](#) he concluded with the following quote:

***“Thriving industry is based on the effective application of science and innovation – it all starts with ideas.”***

***“While energy, shipping and finance have been our strong suits in Houston I am pleased to note that this year’s Transatlantic Science Week – to be held here in Houston in November – will focus on energy as well as medicine/health and innovation. The purpose is to build new networks between American and Norwegian research and higher education institutions and knowledge-based businesses.”***

***“It is my hope that the successful collaboration developed between our two nations in the field of energy can be extended to the field of healthcare and medical technologies.”***

***“One idea – among many others – could be to establish a kind of a Transatlantic “committee” or “forum” with a view – particularly – to studying or evaluating strategic, long-term proposals for creating new knowledge-driven, innovative business initiatives in the fields of, for example, medical technology, information technology and energy. These would be collaborative initiatives between the United States and Norway. We could look at what kind of initiatives would need initial public–private seed funding. Well, I leave this up to you – for further discussions – and I suggest that the organisers of the forthcoming Transatlantic Science Week in Houston in November consider whether this issue should be put on their agenda in some way or another?”***

The minister also referenced the importance of Norway's long-standing relationship with Texas in an op-ed in [Stavanger Aftenblad and Bergens Tidende](#) (Norway), 5 January 2012

In suggesting that [TSW12](#) in Houston would be a suitable venue to bring this thinking further, many of the areas covered in this pilot study will in fact be discussed in workshops at TSW12.

The Pilot Study builds also upon the visits to Houston by other central representatives of Norwegian authorities during the last 24 months, including:

- The visit of **Norway’s Minister of Trade and Industry, Trond Giske**, in November 2010, who during his visit emphasized the formation of cooperation between Norway and Texas in the areas of innovation and entrepreneurship.
- The visit, by **Norway’s Minister of Research and Higher Education, Tora Aasland**, in October 2011, to Rice University, the University of Houston, Texas A&M, and Baylor College of Medicine.

- The visit by the **Norwegian Parliament's Standing Committee on Foreign Relations and Defense**, in October / November 2011, which included the Baker Institute at Rice University as well NASA-JSC.
- The visit by **Norway's Minister of Petroleum and Energy, Ola Borten Moe**, in June 2012, to the University of Texas in Austin, focusing on Norway-Texas research collaboration in geosciences and petroleum technology, with a special focus on the impact of [the recent R&D sponsorship by Statoil](#) at this world-class University.

Furthermore, this Pilot Study can also be seen in the context of various **existing MoUs which several Norwegian Universities have with Universities in Texas.**

## 2. Why Texas?

Houston is considered Norway's most important energy hub outside Norway; with close to 150 Norway-related companies present here, most of them in the energy and shipping sectors (including, Statoil, DNV, Aker Solutions, Kongsberg, Energy Ventures, DNB, and NOV). Houston has also developed into one of Norway's most important finance hubs, particularly in the energy sector. There is also a slice of Norway to be found in Texas. Estimates indicate that, between 8 – 10,000 Norwegian expats live in the Greater Houston region, making it the largest Norwegian expat community outside Scandinavia.

Times are changing. Houston, which is twinned with Stavanger, has become a gateway for the Norwegian business sector in the US, as Brooklyn was for emigrants from Norway in the 19th and 20th centuries. There are many differences between Texas and Norway, but also some striking similarities. Both are experiencing economic growth at a time when our neighbors are suffering setbacks. We are seeing considerable value creation in the oil, gas and shipping sectors. We are seeing that technological advances driven by the energy sector are having positive spin-off effects. Norwegian companies are also making their presence felt in Texas in the field of environmental technology and the pharmaceutical industry (Minister Støre's [op-ed](#), January, 2012).

### 2.1 Texas is Innovative:

From the development of the integrated circuit at Texas Instruments in the 1950s, that set the stage for today's information society, through the heart of the space race at NASA's Johnson Space Center, that landed a manned mission on the moon in

1996 and recently landed the Curiosity rover on Mars, to the discovery of the Buckyball at Rice in 1985, to the life-saving treatments and advanced diagnostics developed at Houston's MD Anderson Cancer Center, Texas has been home to cutting-edge ideas. **Today, Texas' workforce, talent, universities and business climate have made it a leader in high-tech innovation, research, development and commercialization.**

## **2.2 A 21<sup>st</sup> Century Houston: A booming high-tech energy and medicine metropolis:**

As the home for a high-tech industry ecosystem with over 5,000 companies supporting the energy industry, Houston is by many considered to be the “Energy Capital of the World.” What was traditionally a low-tech labor-intensive industry is today successful because of continuous high-tech innovation. The oil and gas industry, however, continues to drive the Houston economy and are today responsible for 50% of the jobs related to the export of goods and services around the Greater Houston area. While continuous innovation and aggressive adoption and use of information technology over the past 30 years has led to lowering the employment numbers, it has also helped create new companies that today are part of the Houston economy. Moreover, reliance on these industries as the nexus of Houston's economy has also changed significantly over the last three decades. ***The early 1980s crash in the Oil markets was the key driver to diversification of the state's economy.*** That diversification helped Houston emerge from the recent recession faster than any other large U.S. city. While the rest of the country plods along, Houston's \$384 billion, increasingly high-tech, economy boomed by a China-like 8.6% in 2011, best in the U.S., and is expected to expand 8.5% this year (*Forbes Magazine, 2012*). [In fact](#), if Houston were an independent nation, it would rank as the world's 30th largest economy. A little known fact, outside of Texas, is that it ranks as the first in the US for wind power installation. It is the first state to reach 10,000 MW wind energy installations (about 1/3 current US total, more than twice that of California).

Three of the four top medical research institutions in Texas are based in Houston. The [Texas Medical Center](#), a coalition of 52 public and private member institutions, employing 92,500 people, sees 7.1 million patients annually, has an annual budget of \$14 billion, a local economic impact of \$10 billion, is the largest medical center in the world and includes the renowned MD Anderson Cancer Center (No.1 cancer center world-wide).

The Port of Houston ranks first in the U.S. in foreign water born tonnage and first in U.S. imports, generating \$179 billion in annual statewide economic impact, according to [Forbes](#).

In his moon speech, delivered at Rice University in 1962, President Kennedy said *“We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.”* NASA and the Johnson Space Center (JSC) helped make Houston the world’s ‘space capital’, as well as an aerospace hub.

[In total](#), there are 68 publicly traded companies today, with more than \$1 billion in sales headquartered in Houston, second only to New York, with 83. Twelve - billionaires call Houston home, led by energy titan Richard Kinder, worth \$8.2 billion.

### 2.3 How Texas Measures up to the rest of the US Economy:

***Texas is ranked as the Number One business destination in the US for the seventh year in a row (CEO Magazine, 2011).***

#### [All figures are from 2011 resources](#)

- **38% of US net new jobs were created in Texas**
- **384,000 new jobs created, more than double than US state**
- **Employment grew 85% faster than CA, NY, FL, IL or PA**
- **No.1 exporting state in the US**
- **If Texas were a nation, it would have the 13<sup>th</sup> largest economy in the world (almost as large as Russia or Spain)**
- **Texas led the US states in recovering from the recession**

The powerhouse Texas economy created a staggering number of jobs in a five-year span from 2006 to 2011 – 451,000 of them – besting the next highest state almost eight times over. That explosion of job growth is set to continue, and the Texas population is projected to double from 25 million to 50 million over the next 50 years. In reality, this means an increase over 1,000 per day (the highest rate in the US)

[Data compiled between 2009-11](#) show that:

- **Texas accounts for 8% of the US population, ranking as 2<sup>nd</sup> Largest state (2011)**

<b>Texas</b>	<b>Residents</b>	<b>State Rank</b>
<b>Population, June 1, 2011</b>	25,145,561	2

Source: U.S. Census Bureau, 2010 Census Data

The state's Gross State Product hit an astounding \$1.3 trillion in 2011, more than 8 percent of the U.S. total and second only to California. **Texas is a global leader in numerous industry sectors, from aerospace and aviation to energy and renewables and life sciences, manufacturing and logistics.**

### **Unique Science and Innovation Opportunities in Texas, for Norway:**

Texas is a technology rich state, with about \$18 billion in total R&D funding (public & private), and **world-class science, engineering and medical research institutions.**

#### **2.4 Texas Ranks 4<sup>th</sup> in overall US R&D investment:**

<b>Source of R&amp;D Funding</b>	<b>Investment</b>	<b>State Rank</b>
Federal Government	\$4,461,000,000	8
Industry	\$12,830,000,000	3
Universities	\$711,000,000	3
<b>Total</b>	<b>\$18,002,000,000</b>	<b>4</b>

## **3. Key Science and Technology Sectors in Texas**

### **3.1 The Texas Medical Center:**

The Texas Medical Center (TMC) in Houston is the largest medical complex in the world, with 52 institutions, spread over 1,300 acres (over 5.25 square Kilometer). Key institutions are the University of Texas Health Science Center, Baylor College of Medicine, Texas Heart Institute, and the MD Anderson Cancer Center. The TMC as a whole has a total annual budget of \$14 billion, and member institutions received \$3.5 billion in grants for research. The TMC treats 7.1 million patients annually (16,000 international patients), employs 92,500 people and has an economic impact of \$10 Billion on the region. The uptake of new technologies into providing the best standards of Healthcare and efficient Healthcare management are some of the best in the world. Rice University, a top ranked private independent research university and member of the Texas Medical Center, recently invested over \$300 million in the

[Bioscience Research Collaborative](#) (BRC). The BRC, a state of the art research facility, was created as a catalyst for research collaboration and innovation supporting scientists and educators from Rice University and other Texas Medical Center institutions to perform leading research and accelerating this into practice to benefit medicine and healthcare.

There is a lot of best practice here to share with **Norway's medical institutions**, companies as well as government Healthcare officials that can be applied to increase innovation and efficiency in the **Norwegian Healthcare system**.

### **3.2 The convergence of Nanotechnology, Energy, IT, Space and Medicine:**

While Houston (and Texas in general) has gone 'under the radar' of those who fly over it to travel between the East and West Coast High Tech hubs in the US, those 'in the know' are aware of the unique opportunities offered by the Lone Star State. Texas is internationally recognized as the 'birthplace' of Nanotechnology, and with the vision of the late [Prof. Richard Smalley](#) of Rice, better known as the Grandfather of Nanotechnology, [developed world class Nanomedicine and Nanoenergy initiatives](#). As well as a base for NASA's Life science directorate, at the Johnson Space Center, along with some of the top Tier one Science and Engineering universities and Medical Schools in the US. [Rice University](#), [the University of Texas in Austin](#) (UT Austin), [Texas A&M](#) and the [University of Houston](#) are the top Tier one R&D institutions. In addition, Texas also has several other Tier One institutions ([Southern Methodist](#), [Baylor University](#), [Texas Christian](#), [UT Dallas](#) and [Texas Tech](#)).

In fact, Texas boasts two engineering departments that [rank](#) in the top 10 in the US for Petroleum Engineering. The University of Texas (1<sup>st</sup>) and Texas A&M (3<sup>rd</sup>).

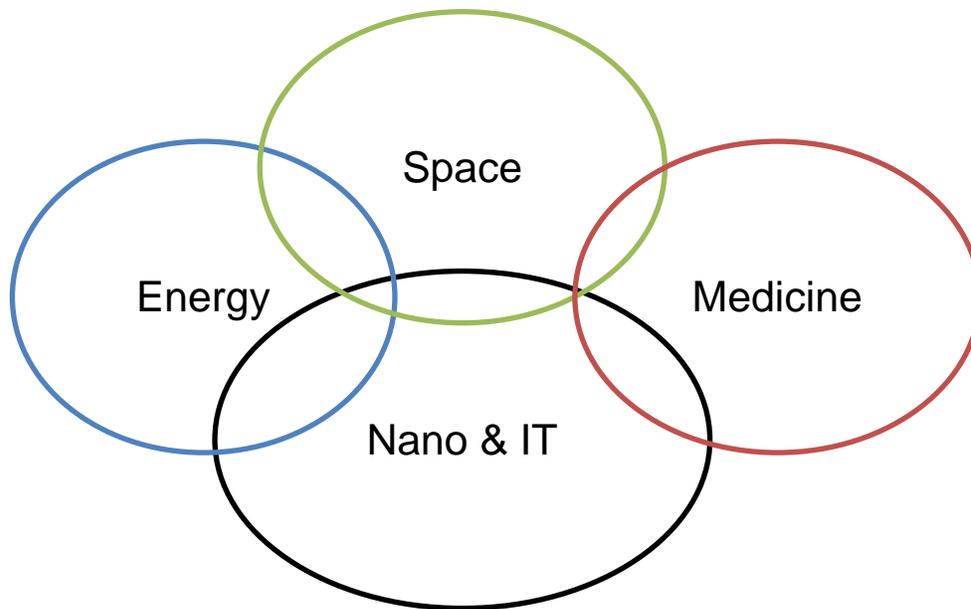
This expertise is widely recognized by the international leading energy companies and recently yielded a [\\$5MM investment by Statoil to the University of Texas](#) focused on the use of geology, geophysics and petroleum engineering expertise in tackling the challenges of shale gas and deep marine reservoirs, amongst others.

Texas universities also have some very highly ranked business schools and entrepreneurship programs such as the [Jones Business School](#) and the [Rice Alliance](#) at Rice University, the [McComb School of Business](#) and [the IC<sup>2</sup> Institute](#) at the University of Texas in Austin, the [Bauer College of Business](#) at the University of Houston and [the Mays Business School](#) at Texas A&M University.

Texas has world leading medical Schools in Houston at the Texas Medical Center, Dallas and Galveston as well as being the number 2 Cyberstate in the US, due to

the development of the IT and communication clusters in Austin, San Antonio and Dallas (named the Telecomm Corridor).

### 3.3 The Texas Convergence Nexus



*This diagram illustrates how Nano and IT technologies have supported the development of the Texas Convergence Nexus. It also illustrates how the presence of NASA in Houston has created synergies in both medicine and energy.*

This unique technology convergence, along with the innovative and entrepreneurial spirit of Texas and ‘can do’ attitude has led to the development of unique initiatives.

**3.3.1 Nano-Medicine: The [Texas Alliance for NanoHealth](#)** (ANH) is the first multi-disciplinary, multi-institutional collaborative research endeavour aimed solely at using nanotechnology to bridge the gaps between medicine, biology, materials science, computer technology and public policy. It is focused on developing diagnostic and therapeutic technologies in the areas of heart disease, cancer, diabetes, stroke, and infection. Texas has one of the greatest concentrations of nanotechnology research in the world with over 150 leading nanotechnology researchers, combined with the Texas Medical Center’s strength, this makes Houston the international center of nanohealth. The ANH is led by [Prof. Mauro Ferrari](#), one of the top Nanomedicine experts in the world and was founded in

Houston as one of the enduring legacies of the late Prof. Richard Smalley from Rice University.

**3.3.2 Space Medicine:** With the close science and technology ties between the NASA-JSC, Rice University, The University of Texas Medical Branch (UTMB) and institutions of the Texas Medical Center, the Houston-Galveston area has emerged as a world leader in space medicine. NASA's JSC provides virtual collaboration opportunities via its [Human Health and Performance Center](#) and the [National Space Biomedical Research Institute](#) is affiliated with Baylor College of Medicine and location at the Bioscience Research Collaborative. The cluster of NASA and these world-class medical institutions have developed Telemedicine significantly and the Texas Medical Center and several diagnostic devices developed for astronaut use are now mainstream in medical technologies (e.g. MRI, Dialysis machine). As a member of ESA, Norway is well positioned and both Norway and Texas and the US would benefit from enhanced coordination and collaboration.

**3.3.3 Nanotechnology and Energy:** Through the vision of the late Professor Richard Smalley (Nobel Prize Laureate, Rice University), the idea of [using nanoscience to advance research and applications in energy](#) and environment was born in Houston. The [Advanced Energy Consortium](#) was created to facilitate pre-competitive research in micro- and nanotechnology materials and sensors that have the potential to create a positive and disruptive change in the recovery of petroleum and gas from new and existing reservoirs. **There is a unique opportunity here for the Norwegian Energy Industry and academia to become partners in a unique consortium** which includes leading energy companies such as: Schlumberger, BP, Shell, Petrobras, ConocoPhillips, Total, BG Group and Halliburton. It includes the Tier One engineering schools in Texas (U. Texas, Texas A&M, Rice and U. Houston) as well as several Ivy League US institutions. There are also several initiatives in the same Texas universities using nano-sciences to advance clean energy (solar, storage, transmission, fuel cell) and environmental technologies.

**3.3.4 Information Technology (IT) in Energy and Medicine:** Computational Science, High Performance Computing and Information Technology innovations hold the secret for continued success in the energy exploration industry and some key advances in biomedical research, helping to improve patient care and outcome. Work emanating at Rice from the [Ken Kennedy Institute for Information Technology](#) is highly relevant in this context. Funded in 1986 by the late University Professor [Ken Kennedy](#), a visionary and world leading computer scientist who was instrumental in developing the field of high performance computing. In Austin, the University of Texas hosts [The Texas Advanced computing center](#), that has hosts some of the most powerful High Performance Computer clusters in the US and also

works closely with the energy and biomedical sectors as well as playing a key role in climate science.

There is considerable expertise in the Oil and Gas industry, both in Texas and Norway. The challenges that lie ahead, especially in ultra deep-water exploration, will not only require new imaging algorithms and computational methods and innovations but will also require advanced materials, robotics, sensors and other IT solutions to maintain safe and efficient operations at very deep offshore reservoirs, especially in subsea factories. The IT expertise within the Oil industry in Texas is very focused on applying IT to modernize and solve problems within the industry and increase the yields of oil and gas from new and existing reservoirs. ExxonMobil Shell, BP, Conoco and other oil majors each have IT divisions within them, with thousands of employees, that are larger than many IT companies. Rapidly emerging across the industry is the need to develop and accelerate use of computational science, high performance computing and visualization to advance subsurface imaging, increasingly critical to both exploration and production. The Ken Kennedy Institute at Rice has partnered with the industry and is annually convening a world-leading workshop on high performance computing focused on industry specific needs and challenges. In response to needs the institute is also hosting focused summer training programs in HPC and Big-Data.

**3.3.5 Space and Energy: Norway and Texas have led some of the most cutting edge initiatives in exploring the synergies between Oil and Gas exploration and space technologies.** In fact, a special workshop will be hosted at TSW12 entitled: '*Synergies Between Space and Offshore Exploration*'. The space industry and the oil and gas industry share similar challenges (power generation, communication, automation) both work at the leading edge of what is possible from technologies in extremely harsh environments. Advances of Space technologies in high-fidelity modeling, simulation and visualization, high-precision sensors, instruments, harsh-environment electronics, autonomous operations and on-board intelligence have enabled challenging recent robotic space missions. These technologies can be applied to oil and gas exploration for: a) undersea exploration, b) underwater inspection, maintenance and repair, c) automation of unmanned offshore platforms and d) autonomous drilling.

Robotics and automation are amongst the many technology innovations in space research that are highly sought after to access ultra deep-water sites and build fully automated subsea factories and also use the same technologies in extreme environments like the Arctic. In fact, there are ***two TSW12 workshops on the Arctic; one on sharing Environmental Data Across Boundaries in the Arctic and another on Norwegian - North American scientific collaboration, logistical coordination and resource sharing in the High North.*** Safety is also a key

concern, as well as the environment, in addition to the operational efficiency and maximizing the amounts of resources retrieved from existing and new drilling sites. Following the cancellation of the Shuttle program (and loss of 4000 NASA related jobs in the Greater Houston area) the energy industry have been aggressively recruiting engineers, program managers as well as ex-astronauts to accelerate the update and application of space exploration research, ideas and thinking for its exploration and upstream operations.

**Success story:**

*Robotic Drilling Systems AS, a Norwegian company developing a drilling rig that can think for itself, signed an information-sharing agreement with NASA to discover what it might learn from the rover Curiosity ([Bloomberg, Sept, 2012](#)). [Apache Corp. \(APA\)](#) and [National Oilwell Varco Inc. \(NOV\)](#), both Houston-based, along with [Norway's Statoil ASA \(STL\)](#) are among the companies working on technology to take humans out of the most repetitive, dangerous, and time-consuming parts of oil field work.*

## **4. Recommendations for the creation of NorTex:**

### **The Energy and Biomedical Science & Technology Partnership**

#### **4.1 Outline:**

To establish a Public Private Partnership (PPP) to support and run a multi-disciplinary transatlantic forum between Texas and Norway to accelerate collaboration, innovation and support entrepreneurship in the areas of Energy and Biomedicine / Health. This forum will serve to bring the brightest minds in Texas and Norway to work together on tackling the most challenging problems, thus enabling the exchange of cutting edge science and the spin out of new technologies through innovation and entrepreneurship. By creating new transatlantic collaborations and joint ventures, NorTex will help to accelerate far-reaching ideas into commercialization with transformative impact on the healthcare and energy sectors.

NorTex will move beyond facilitating workshops and short-term visits between academia and industry to explore new models for working together, building transatlantic bridging partnerships and an intellectual pipeline to support innovation and entrepreneurship. The program aims to accelerate the development of emerging disruptive technologies and to find solutions that will have a direct impact and provide solutions to the most important problems facing the healthcare and energy sectors. It will leverage the unique strengths that Texas has to offer, especially the use of space technologies, nanosciences and advanced information and

communication technologies with complimentary strengths of some of the most innovative companies and universities in Norway. The advanced programs in technology transfer; innovation and entrepreneurships developed at Rice University (Houston) and the University of Texas (Austin) will be cornerstones for this partnership forum.

#### **4.2 Expected outcomes:**

- Norwegian, Texan and US Universities and Technology Transfer Offices (TTOs) exchange best practice on entrepreneurship and innovative strategies accelerating commercialisation and technology transfer.
- New partnerships and joint ventures created between industry and academia. Perhaps spin off consortia will stand-alone in specific areas that prove to be successful and self-sustaining.
- Joint publications and joint patents and perhaps start-up companies between Norway and Texas.
- Increased use of innovative Biomedical technologies and Healthcare management to the benefit of Norway's Healthcare system.
- Create innovative solutions to key energy industry technology challenges via industry-academic multi-disciplinary research consortia, new joint ventures, joint patents and perhaps joint spin out companies.

#### **4.3 Key partners:**

The program will focus on initially engaging the top academic institutions in Texas (Rice, UT Austin, U. Houston, Texas A&M, The Texas Medical Center institutions, UT Southwestern Medical school (Dallas), UT Medical Branch in Galveston-UTMB, Texas Tech, UT Dallas and the University of North Texas). It should also aim to engage the Houston Technology Center and Austin Technology Incubators as well as the NASA Johnson Space Center. The Texas and Norway Energy industry, Venture capitalists, the Norwegian Ministries of: Health and Care Services, Education and Research, Petroleum and Energy, Trade and Industry as well as The Research Council of Norway will be essential partners. After an initial start-up period, partnership will be open to other tier one universities in the US.

#### **4.4 Funding and support:**

##### **4.4.1 Government seed funding and support:**

As can be seen in the case studies below, a relatively small amount of UK government funding, for the Texas-UK Bioscience collaborative, (\$6MM for 5 years, matched by \$3.5 MM of Texas University and foundation funding) yielded over \$17 MM in federal grants, a joint spin-off company and several patents and publications. An offshoot of this program, funded by \$100,000 from the Welsh government,

focused on Nano-Medicine, Innovation and Entrepreneurship, yielded collaborations, student exchanges and over \$37 MM funding for the University of Swansea.

***It will be essential to the success of the program to have seed funding and strong support from the Norwegian government in addition to private funding.***

The program could start in 2013 with initial funds of \$1million (6million NOK) (split 50/50 between public and private partners. Industry funding could either be on a workshop/event basis or an annual contribution to either the energy or medicine forums. Universities may not have funding to contribute to the program but should commit time of their staff to show buy in and ownership of the program.

In specific areas, foundations can be approached (e.g. Gates, Google, Mitchell)

The programs will be supported by the Norwegian Consulate General, essentially serving as the partnership secretariat, with the Norway House Institutions (Innovation Norway, INSTOK and the Norwegian-American Chamber of Commerce-NACC) but will also require program managers in Texas and Norway to run it effectively. There will be need for extra staffing at Norway House, Houston, most importantly someone dedicated to the Medical/Health Sector. This will need to be someone familiar with both Texas and Norway, so perhaps a Norwegian expat from Texas would be ideal. Alternatively, someone seconded by the Health Authorities in Norway.

#### **4.4.2 Industry Funding:**

There is considerably more private funding from interested Norway-related companies (Aker, Statoil, NOV, DNV, etc.) to co-fund an innovative NorTex energy consortium in collaboration with the government. However, a program in Healthcare technologies will require more funding from the Norwegian government considering the absence of large Norwegian Bio-pharm companies that would co-support a healthcare innovation PPP to the same extent as energy. There are also Norwegian Venture Capital and others who may be interested in portions of the program. The program needs to be focused on key technologies but inclusive enough to cover the essential industry players. Success of the program will depend on meeting the gaps in industry and therefore early engagement with industry is essential to shape the thematic areas.

#### **4.5 The Program content:**

##### **4.5.1 Exchange of best practice in Entrepreneurship:**

To engage the top Technology Transfer Offices (TTOs) of Norwegian Universities with those in Texas (especially Rice, U. Texas in Austin, MD Anderson and Baylor

College of Medicine). [The Rice Alliance for Technology and Entrepreneurship](#) (Rice Alliance) is Rice University's nationally recognized initiative devoted to the support of technology commercialization, entrepreneurship education, and the launch of technology companies. Rice University Business Plan Competition hosted by the Rice Alliance is the World's Richest and Largest, awarding more than \$1.3 million in prizes. Over 133 past competitors are in business today having raised in excess of \$394 million. Norwegian TTOs should also be encouraged to attend the annual US [AUTM](#) (Association of Technology Managers) meeting. There is a golden opportunity to do so as the [next annual meeting](#) will be held in San Antonio, Texas on 27 Feb 2013. This is an opportunity to also hold a Norway-Texas meeting on the side and visits to various Texas Universities. AUTM also runs special programs for training which Norwegian TTOs should take advantage of as well as working with Rice/UT to design special courses (similar to [The Norwegian Entrepreneurship program](#) for Gründerskolen students with Rice/Houston start-ups and other leading US entrepreneurship centers). Rice and UT both run extremely successful Business Plan Competitions. Sponsorship and inclusion of Norwegian Students to participate in these competitions is extremely important to grow the culture of the next generation of entrepreneurs. Two workshops in this area are included in TWS12: one on "**Emerging Technologies and Commercialization**", and another on "**Research-based Education: Keeping Pace with Innovation and Tec Transfer**"

#### **4.5.2 Technology Venture Forums:**

[The Rice Alliance for Technology and Entrepreneurship](#) runs an IT and web venture forum, a life science venture forum, and an energy and clean technology venture forum. Norwegian partners should be encouraged to participate and there is an opportunity there to emulate and create specific Norway-Texas forums built on this model and use these existing opportunities to include Norwegian Startups and Venture Capital investors as well as academics and post-graduate students. Sponsorship of the Rice Alliance at a level of \$10,000/year would ensure a seat on the board for the Norway and support a closer engagement with the center. The themes and content of the forums will depend on industry involved.

#### **4.5.3 Multidisciplinary Research Forums:**

These would be workshops attended by academia, industry and government that would include some of the unique opportunities in Texas that Norway would benefit from:

##### **4.5.3a Energy:**

Themes: special focus on ultra deep-water exploration (Gulf Coast, North Sea and Arctic), Shale/unconventionals. Renewable energy and Carbon Sequestration could also be added, depending on interest from industry.

## **The Nor-Tex Petroleum Cluster**

An initiative to establish a Petroleum Cluster consisting of universities and the petroleum industry in Texas and in Norway was proposed by Professor Arne Graue (Professor and Chairman Executive Board of Petroleum Research School of Norway) during the Transatlantic Science Week (TSW12). Establishing such a cluster may provide an important potential for coordinating the various petroleum related research activities reported during TSW12. The following important petroleum research relations between Texas and Norway have been identified:

1. MoU between UT Austin and Petroleum Research School of Norway
2. MoU between Rice University and Petroleum Research School of Norway
3. MoU between UiS and U. of Houston
4. MoU between NTNU and Texas A&M
5. Several research collaborations between universities in Norway and universities in Texas
6. Statoil's support of UT Austin, with possible expansion

Specifically, the existing research collaboration between UiB, Rice U., Texas A&M and UT Austin, has supported 15 individual exchange visits of researchers and students between US and Norway in 2012. This collaboration had around 40 PhD students present at TSW12 and had an experimental program at Texas A&M and at ConocoPhillips Research Center the weeks before and after TSW12 to take advantage of the presence of all the students in Texas during TSW12.

This collaboration has already proposed a CO<sub>2</sub> field pilot tests for EOR onshore in Texas, at significantly less costs than offshore Norway; the tests starts in December 2012 and would be of great interest to oil companies in Norway as well in Texas. It has also identified several individual researchers in the US and in Norway who would like to spend time in the counterpart country to facilitate joint research between the universities, with support from oil companies in Norway and USA. A Petroleum Cluster would be an important tool to also include and coordinate other research activities with other partners in Norway and Texas, to provide a consistent perspective of the opportunities available through all the collaborations.

The objective of a Nor-Tex Petroleum Cluster would hence be to strengthen and expand the educational and research collaboration between Norway and Texas. The Cluster could also assist in facilitating industry funding for adjunct and chair positions especially emphasizing the Nor-Tex collaboration. Several companies have already been identified and meetings are planned to explore the possibilities and take the initiative forward.

#### **4.5.3b Medicine:**

Themes: Cancer, Healthcare Innovation, Healthcare management (especially electronic records), Tele-Medicine, Global Health Technologies.

**4.5.4 Ph.D. and Post-Doctoral Exchange Programs:** establish PhD programs with co-supervisors from each side or formal exchange programs. This can only be done after faculty or students establish 'bottoms up' contact with each other and not via institutional top down pressure. The program could build on the existing Norwegian Entrepreneurship Program and use the opportunities presented at *TSW12 where, for the first time, a doctoral student program in Oil and Gas technologies* is included, involving some 60 Ph.D. levels students, 30 from Norway and 30 from the U.S.

#### **4.6 Governance Structure:**

- The program should have a governance committee of government (possibly a combination of both national and regional), academic and industrial partners on each side of the Atlantic.
- There should be two program managers to manage each side and quarterly meetings of the governance committees to ensure accountability, strategy and effective planning.
- Each partner should have a NorTex contact for their institution/company that will liaise between with committee (or be part of it) forum partners.
- The program should set *clear and measurable objectives and milestones* and prepare a quarterly report to all partners to ensure transparency and dissemination of information.
- The Norway House institutions, led by the Consulate General, to form a secretariat in Texas. The Research Council of Norway to serve as Secretariat in Norway.

### **Texas-UK case studies:**

#### **1-The Texas-UK Bioscience Collaboration**

*The British Consulate-General Science section in Houston worked with the top 10 Texas Universities, NASA-JSC and 30 UK universities and led a 5 year collaboration in Bioscience which led to \$17million in Federal funding grants, 4 patents issued and a Bio-Nano company spin off from the University of Houston and UCL (Endomagnetics) and industry-academia IPR agreements. The program was funded by the UK Government (\$6million), Texas Universities (\$1.5million), The Houston Foundation (\$1million) and Farish Foundation (\$1million). More recently, a biotech company from Imperial College London was awarded \$15million from Texas CPRIT funding to locate its operations in Texas (see Annex A for details)*

**2-The Swansea-Texas Nanomedicine Collaboration:** *A spin of TX-UK program was created by the Houston Consulate between Swansea University and Texas with \$100,000 Funding from the Welsh Assembly Government and yielded several MoUs, with Texas A&M (undergraduate) and the Methodist hospital (PhD) and over \$37million in funding for Swansea from UK federal research funds and EU funding. The funding was awarded to the Nanohealth Center in Swansea, established with the help of the Texas Alliance for Nanohealth. The most recent award from the EU (\$1.2mm) established a [‘Celtic Alliance for Nanohealth’](#) (CAN) with Ireland, which includes programs in innovation and entrepreneurship, jointly with Houston’s Rice Alliance for Entrepreneurship.*

## **5.0 Acknowledgments:**

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- **John C. Welch III**, *President, Norwegian-American Chamber of Commerce (NACC, Houston)*
- **Erik Wiik**, *Regional President North America, Aker Solutions, Houston*

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*The following Annexes were added to represent snapshots of key facts and figures and not meant to represent in depth sector reports:*

#### **List of Annexes:**

Annex A: Texas Biomedical Industry and Research

Annex B: Energy in Texas

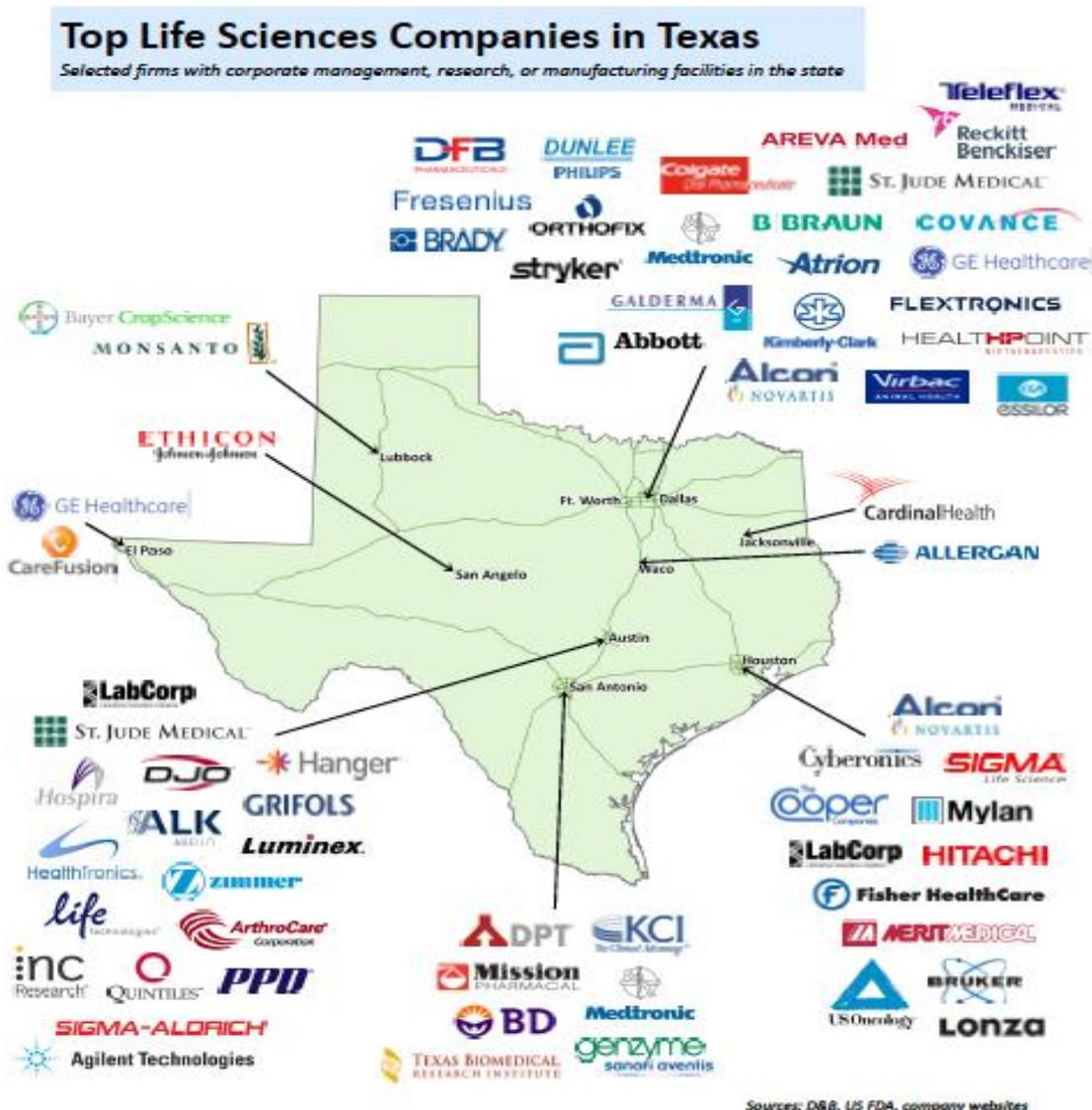
Annex C: Information Technology in Texas

Annex D: European FDI in Texas

## Annex A: Texas Biomedical Industry and Research

As home to over 3,400 biotechnology manufacturing and R&D firms, Texas is one of the leading biotech states in the country. More than 88,500 workers are employed in biotech-related sectors in Texas, and dozens of global biotech companies, such as Novartis, Abbott, and Medtronic, have major operations in the state. A concentration of highly trained biotech workers, multiple top-tier research institutions, and a top-ranked business climate all strengthen the state's status as a biotechnology leader.

Most data from this report has been compiled from the [Battelle/Bio State Bioscience Industry Development](#) and the [Texas Biotechnology Industry report](#). Both published in 2012.



The total economic impact of the biotechnology industry in Texas in 2009 was estimated at \$75 billion, according to the [Texas Healthcare & Bioscience Institute](#), an industry association. Additionally, for every biotechnology job created, another 2.3 jobs were created elsewhere in the Texas economy. Venture capital (VC) firms invested \$1.27 billion from 2006-2011 in 152 Texas biotech and medical device companies. (Source: PricewaterhouseCoopers)

## **State funded initiatives helped grow the Texas Biotech sector:**

### **Texas Enterprise Fund (TEF):**

In 2003, the Texas Legislature passed legislation authorizing the \$295 million TEF, a “deal closing” fund created to attract businesses and new jobs to Texas. The Legislature reauthorized the TEF most recently in 2011. As of April 2012, the TEF had awarded over \$98.1 million to biotechnology-related projects with commitments to create 11,451 jobs.

### **Texas Emerging Technology Fund (TETF):**

In 2005, Gov. Rick Perry and the Texas Legislature passed legislation authorizing the \$200 million Texas Emerging Technology Fund (TETF) to promote and finance technological innovations across multiple industries, including biotechnology. The TETF was reauthorized most recently in 2011. Seven Regional Centres of Innovation and Commercialization (RCICs) were created to help administer the TETF program. To date, \$233.58 million from the TETF have been awarded for biotechnology-related projects, with \$127.24 million going to commercialize start-up companies and \$106.34 million awarded to universities or university-related consortiums.

### **CPRIT**

In June 2007, Gov. Rick Perry signed a law creating the Cancer Prevention and Research Institute of Texas (CPRIT), which dedicated \$3 billion in state bond money to cancer research over ten years. CPRIT also received an appropriation of \$450 million from the Texas Legislature for fiscal years 2010-2011.

Since 2010, CPRIT has funded 387 awards worth over \$670 million for cancer research, commercialization, and prevention. Together with matching funds obligated by grant recipients, more than \$900 million has been invested in Texas' endeavour to change the face of cancer. CPRIT award recipients include Texas academic institutions, non-profit organizations, and private companies. CPRIT has become one of the nation's largest cancer grant providers, second only to the National Institutes of Health (NIH).

In March 2012, CPRIT awarded \$20 million for a Houston-area pre-commercialization centre to incubate promising oncology-focused technologies, as well as three “Scholar in Cancer Research” awards to attract top investigators in oncology research to Texas.

## **Key Biotech Industries in Texas**

### **Medical Devices:**

**Texas has a major medical device industry, and some of the biggest players in the business are here.** More than one dozen Fortune 500 medical device giants have manufacturing or major corporate operations in the state, including Abbott Laboratories, Johnson & Johnson, Medtronic, GE, Stryker, Cardinal Health, St. Jude Medical, Becton Dickinson, Thermo Fisher Scientific, and Agilent Technologies. These companies and many others have created a large medical device workforce in the state. Approximately 800 firms employ more than 15,200 workers in this sector, and as a result, Texas is one of the top 10 states in the nation for number of medical device workers. In the highly advanced subsector of electro-medical instrument manufacturing, employment in Texas increased nearly 11% from 2005-2011, despite the intervening recession.

### **Emerging Technology and Venture Capital Investments in Medical devices**

Since 2005, the Texas Emerging Technology Fund (TETF) has invested over \$70 million in medical device-related start-ups. Funded companies have developed a wide range of technologies, including implants, imaging equipment, and diagnostic tools.

Over the six-year period 2006-2011, venture capital (VC) firms invested approximately \$568 million in 96 Texas medical device and equipment companies, according to consulting firm PricewaterhouseCoopers. Fifteen of those investment deals occurred in 2011 alone, with a total of almost \$60 million invested in Texas medical device companies that year.

In 2010, the total value of Texas medical equipment shipments exceeded \$4.3 billion, with manufacturers making total capital investments of over \$100.3 million, according to the U.S. Census Bureau. Additionally, international exports of medical devices from Texas increased 10% in 2011 to \$2.2 billion.

The sectorial cluster of Medical Devices companies is as follows:

Sector	Key products	Main Cluster	Secondary Clusters
<b>Orthopaedics</b>	Spinal, extremity, bone/tissue implants	Austin	San Antonio, DFW
<b>Cardiology</b>	Catheters, surgical instruments, prosthetic heart valves	Houston	DFW, Austin
<b>Diagnostics</b>	Cell cultures, laboratory equipment, clinical chemicals	Austin	San Antonio, Houston, DFW
<b>Ophthalmic</b>	Contact lenses, lenses, ophthalmic surgical tools	DFW	
<b>Wound Care</b>	Electromedical wound equipment, mattress systems, skin dressings, bandages	DFW	San Antonio

Source: [Texas Biotechnology Industry Report 2012](#)

### Pharmaceutical:

While Texas is not a leading 'Big Pharma' cluster like the North East, Research Triangle Park or the West Coast, it ranks 2<sup>nd</sup> nationally for the number of clinical trials, reflecting the strength and size of the Texas Medical Centre in Houston and Medical Schools in Galveston and Dallas. Many of the leading Contract Research Organisations (CROs) have offices in Austin. This is a key area that the Texas Emerging fund and the CPRIT initiatives have tried to address. One of the most notable successes was the recent designation of Texas A&M University as one of the 3 National centres (the only one led by a public university) for developing and manufacturing medicine and vaccines [to respond to pandemic diseases and bioterror threats](#). This \$285.6 MM award includes \$176.6MM from the Federal Government, a \$40MM from the state's TEF fund and investments by 20 private companies. Texas was also awarded a major National Bio-containment Laboratory, [The Galveston National Lab](#) to develop vaccines, treatments and diagnostics for emerging infectious diseases, with support from state, private and philanthropic funding.

## Biomedical R&D:

Texas has a strong R&D pipeline, supplied in part by the state's vast network of public universities and health-related institutions, which invest heavily in R&D and intellectual property generation. In year 2010 alone, Texas public institutions of higher education expended over \$2.5 billion on medical and life sciences research, accounting for 61% of all higher education R&D expenditures in the state

<b>Biomedical R&amp;D at Texas Universities by 2010 Expenditures</b>		
<b>Institution</b>	<b>City</b>	<b>Total R&amp;D (Millions)</b>
<b>MD Anderson Cancer Center</b>	<b>Houston</b>	<b>\$547</b>
<b>Baylor College of Medicine</b>	<b>Houston</b>	<b>\$428.9</b>
<b>UT Southwestern Medical Center</b>	<b>Dallas</b>	<b>\$395.3</b>
<b>UT Health Science Center</b>	<b>Houston</b>	<b>\$240.7</b>
<b>UT Health Science Center</b>	<b>San Antonio</b>	<b>\$185.2</b>
<b>UT Medical Branch (UTMB)</b>	<b>Galveston</b>	<b>\$156.8</b>
<b>Texas A&amp;M Health Science Center</b>	<b>College Station</b>	<b>\$78.1</b>
<b>Texas Tech University</b>	<b>Lubbock</b>	<b>\$50.8</b>
<b>University of North Texas HSC</b>	<b>DFW</b>	<b>\$39.8</b>
<b>UT Health Center</b>	<b>Tyler</b>	<b>\$14.3</b>
<b>Total</b>		<b>\$2,137</b>

## Texas Universities and Innovation:

In 2010, the University of Texas (UT) ranked No. 2 nationally for the number of patents earned by a university, up from No. 5 in 2009, according to The Patent Board, an independent patent research firm. UT saw a 22% increase over the previous year, jumping ahead of Stanford University and the California Institute of Technology (Cal Tech).

## Funding for all R&D (2008):

<b>Source of R&amp;D Funding</b>	<b>Investment</b>	<b>State Rank</b>
<b>Federal Government</b>	<b>\$4,461,000,000</b>	<b>8</b>
<b>Industry</b>	<b>\$12,830,000,000</b>	<b>3</b>
<b>Universities</b>	<b>\$711,000,000</b>	<b>3</b>
<b>Total</b>	<b>\$18,002,000,000</b>	<b>4</b>

Source: National Science Foundation, [Science & Engineering Indicators](#), 2012

## Highlights of Key Biomedical Research Institutions in Texas:

### [MD Anderson Cancer Center:](#)

The University of Texas MD Anderson Cancer Centre (MDACC) is continuously ranked as the Number one cancer centre on a national and international level. It ranks first in the number of research grants awarded and total amount of grants given by the US [National Cancer Institute](#) (NCI). Total R&D grants are \$623 million and total operating revenue of \$3.78 billion (of which 75% is from net patient revenue).

### Key and specialized departments:

- [Division of Cancer Prevention and Population Sciences](#) - advances the fields of cancer prevention and population sciences and eliminate health disparities in cancer
- [Cancer Genomics Core Laboratory](#) - supports research to expand molecular therapeutics and diagnostics
- [Stem Cell Transplantation & Cellular Therapy Center](#) - stem cell transplants and public/volunteer cord blood bank; performs more than 600 procedures a year; also a specialized center for matched unrelated bone marrow donor transplants
- [Proton Therapy Center](#) – advanced radiation treatment
- [Prevention and Screening](#) –[chemoprevention](#) (pioneered at M. D. Anderson) use of drugs and natural substances for reversing pre-malignant lesions and preventing first or second primary cancers in individuals at high risk.

### **Baylor College of Medicine (BCM):**

BCM is a private medical school in the Texas Medical Centre in Houston. It is continuously ranked as one of the top 25 Medical schools in the US ([U.S. News & World Report](#)) and ranked 2<sup>nd</sup> in the US in federal funding for R&D expenditure in Biological Sciences and 1<sup>st</sup> in Texas for NIH funding (Ref: [NSF](#)). Located in the Texas Medical Center, BCM has affiliations with eight teaching hospitals, each known for medical excellence as well as an MBA program with Rice University.

The college has total research support of \$363 million, with \$280 million from federal sources, and more than 90 research and patient-care centers and units.

### Key Research Centers at BCM:

[The Cell and Gene Therapy Center \(CAGT\):](#) founded in 1998 as a collaborative project amongst Baylor College of Medicine (BCM), The [Methodist Hospital](#), and [Texas Children's Hospital](#) (the largest paediatric hospital in the US). The intent was to make available to clinical, translational, and basic science investigators at these institutions a series of core competencies and resources that would be valuable in

developing and exploiting these promising new gene therapy technologies. CAGT provides an infrastructure to rapidly translate novel cell and gene therapy protocols from the laboratory to the clinic and is therefore an attractive partner for Biotech and pharma company clinical trials and (GMP) manufacturing. It is ranked as one of the top gene therapy centres in the world. Patient facilities include the adult stem cell transplant unit at The Methodist Hospital and the Paediatric Stem Cell Transplant Unit in Texas Children's.

**BCM Technologies-BCMT**: BCM is one of the most successful medical schools in Texas in technology transfer and commercialisation. This is due to BCMT, which is a true "early-stage investor" that provides seed capital to perform value-creating proof-of-concept research and plays a major role in the structuring and development of BCM start up companies. The initial investment from BCMT is often made for the specific goal of validating the technology through highly focused research activities and initial investment frequently precedes recruitment of a management team. BCMT prefers to lead Seed and First rounds and will continue to co-invest in later rounds. As can be seen from BCMT's [portfolio](#) it has created some of the most successful Texas Biotechs.

**The Human Genome Sequencing Center**: The Baylor College of Medicine Human Genome Sequencing Center (BCM-HGSC) was established in 1996 when the [National Human Genome Research Institute \(NHGRI\)](#) designated Baylor College of Medicine as one of six pilot programs for the final phases of the [Human Genome Project](#)(HGP). Then in 1999, the Center was chosen as one of three sites from the pilot program to complete the HGP. The major activity of the BCM-HGSC is high-throughput DNA sequence generation and the accompanying analysis. The BCM-HGSC is also involved in developing the next generation of DNA sequencing and bioinformatics technologies that will allow greater scientific advances in the future. One of the current initiatives is [The Cancer Genome Atlas Project](#).

## **Rice University:**

### **Department of Bioengineering:**

Rice's bioengineering program is consistently ranked amongst the top 10 in the US. Its success can be attributed to the strength of material sciences, engineering and nanotechnology developed at Rice, combined with Rice's strong multidisciplinary science program, especially the [Institute for Biosciences and Bioengineering](#) (IBB) and collaborations with the Texas Medical Center institutes. Key areas of research are:

- [Biomaterials and Drug Delivery,](#)
- [Biomedical Imaging and Diagnostics,](#)
- [Cellular and Biomolecular Engineering,](#)

- [Computational and Theoretical Bioengineering.](#)
- [Systems and Synthetic Biology.](#)
- [Tissue Engineering and Biomechanics.](#)

### **Rice 360° for Global Health Technologies:**

Rice 360° brings together an international group of faculty, students, clinicians, and private and public sector partners to design innovative health technologies for poor settings, to develop and implement entrepreneurial approaches that increase access to these technologies around the world, and to prepare students to lead tomorrow's global health technology workforce. The program focuses on developing point-of-care diagnostics and point-of-use water treatment by leveraging Rice's expertise in bioengineering and nano-sensors, and its partnerships with the Texas Medical Center.

### **The University of Texas Medical Branch in Galveston (UTMB):**

Over the past two decades, UTMB has developed a strong program in infectious disease research. UTMB has an internationally recognized group of emerging infectious disease investigators at a time when this subject is of critical public health importance and interest.

### **The Galveston National Laboratory:**

As one of two National BSL-4 Bio-containment Laboratories constructed with \$174 million from grants awarded by the National Institute of Allergy and Infectious Diseases/National Institutes of Health (NIAID/NIH), philanthropic foundations and state funds. The Galveston National Laboratory (GNL) is a unique world-class facility that provides much needed research space to develop therapies, vaccines and diagnostic tests for Anthrax, avian influenza, bubonic plague, hemorrhagic fevers (such as Ebola), typhus, West Nile virus, influenza, drug-resistant tuberculosis and others. UTMB has the expertise in molecular and structural biology to develop vaccines and antiviral drugs beginning at the most basic level and, in addition, has great proficiency in animal models to evaluate the utility of the candidate products. In addition to the GNL, UTMB's [Sealy Center for Vaccine Development](#), has the capability to test human vaccines and to use human challenge models to evaluate vaccines and other antivirals. Thus, because of the profusion of bio-threat agents, there is an emphasis on broad generic solutions, which UTMB is uniquely poised to provide.

### **UT Southwestern Medical Center, Dallas:**

UT Southwestern Medical Center ranks among the top academic medical centers in the world and has had 5 Nobel Laureates since 1985. Areas of excellence include: cancer, neuroscience, heart disease and stroke, arthritis, diabetes. UT Southwestern was nationally ranked in two specialty-care areas: urology and neurology/neurosurgery and it also houses the [Harold C. Simmons Cancer Center](#) which has National Cancer Institute (NCI) designation, an elite distinction held by only the top-tier cancer centers nationwide. The School also includes a one of the 12 prestigious [Howard Hughes Medical Institute](#) in the US.

## **Annex B: Energy in Texas**

More than perhaps any other state, Texas is associated with energy production. From images of oil-soaked wildcatters watching gushers come in to sprawling fields of wind turbines, Texas has been a national leader in energy production and innovation.

From the oilfields of the 1901 Spindletop strike to today's growing wind farms of the west Texas plains, energy has played a key role in the development and prosperity of Texas and Texans alike.

Through incentive and innovation, Texas has successfully diversified its energy portfolio, exploring all energy options from solar and wind to natural gas, nuclear and clean coal. Led by the ingenuity, vision and boldness of Texas entrepreneurs and state support of promising technology

### **The Texas Economy is diversified but Energy is still King:**

For much of the 20th century, Texas' economic performance was driven largely by changes in oil prices. Since the mid-1980's, the state's economy has diversified considerably. However, energy is still very important. Texas remains the nation's largest producer and refiner of oil and gas [[cbpp.org](http://cbpp.org)] Higher oil prices and the rapid expansion of gas production from shale formations continue to boost the state's economic growth. What this means is that an increase in oil prices still makes a big difference in the Texas economy. A 2005 study by the Federal Reserve Board of Dallas found that "the Texas economy has become less sensitive to oil price fluctuations, but it still responds favorably to higher energy prices."

For much of the twentieth century, Texas' economy was driven by the oil and gas industry. At the height of the oil boom of the early 1980s, the industry accounted for more than a quarter of the gross state product and of state government revenues.

Though the state's economy has diversified over the last 25 years, and the share of its economy accounted for by oil and gas has declined, the industry has seen a recent resurgence due to rising oil and gas prices. It remains a major component of the Texas economy and a significant contributor to the state's fiscal coffers.

Texas has the largest share of the nation's fossil fuel reserves, with nearly a quarter of all U.S. oil reserves and nearly 30 percent of the country's natural gas. And the

state is the national leader in refining capacity, with 23 refineries capable of refining 4.7 million barrels of oil per day, more than a quarter of all U.S. refining capacity.

### **QUICK FACTS**

- Texas was the leading crude oil-producing State in the Nation in 2011 and also exceeded production levels from the Federal offshore areas.
  - In 2011, Texas's 26 petroleum refineries had a capacity of over 4.7 million barrels of crude oil per day and accounted for 27 percent of total U.S. refining capacity.
  - Texas accounted for 28 percent of U.S. marketed natural gas production in 2011, making it the leading natural gas producer among the States.
  - West Texas Intermediate (WTI), a grade of crude oil produced in Texas and southern Oklahoma and traded in the domestic spot market at Cushing, Oklahoma, serves as a "benchmark" for oil pricing.
- 

### **Texas Energy Production ranking in the US**

<b>Total Energy</b>	1
<b>Crude Oil</b>	1
<b>Natural Gas</b>	1
<b>Coal</b>	6
<b>Electricity</b>	1
<b>CO2 Emissions</b>	1

### **Renewable Energy and Transmission:**

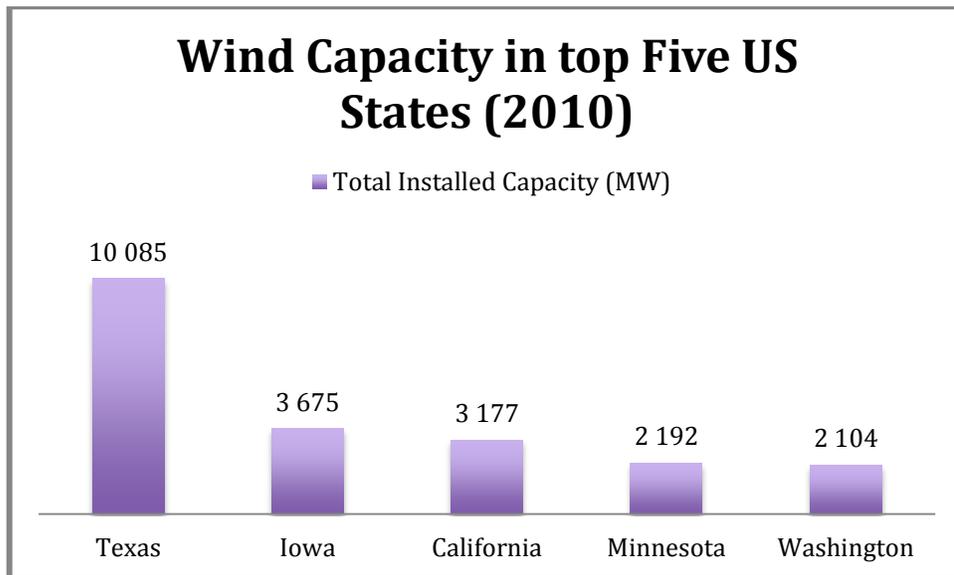
The state has also made a commitment to modernizing its transmission grid to enable the movement of more than 18,000 megawatts of wind power from West Texas to the major population centers in the eastern and central parts of the state. Texas has also invested more than \$1 billion from the Texas Enterprise Fund to support solar energy manufacturing and has invested more than \$4.5 billion from the Emerging Technology Fund to support the commercialization of the next generation of solar energy technologies. By 2014, Texas will have new transmission capacity to integrate over 18,500 megawatts of wind energy onto the state's grid.

## Wind Energy:

**Texas is a world leader in wind power, with more wind power installed than any other state and all but four other countries.**

**Texas is the national leader in overall wind installations** and is the first state to reach 10,000 MW of wind energy installations. **The Wind capacity in Texas is about 1/3 of the US total.** Texas is home to seven of the top ten largest wind farms, including four of the top five.

Texas wind resource is ranked first in the US. Texas's wind resources could provide 19 times the state's current electricity needs.



Source: [American Wind Energy Association](#)

Currently online: 10,929 Megawatts (MW)

Added in 2012 YTD: 535 MW

Added in 2011: 270 MW

Under construction: 1,291 MW

Wind projects in queue: 22,239 MW

The intermittent nature of wind energy, however, means that it cannot be relied upon as a primary source of electricity and must be supplemented by more reliable sources, such as coal, natural gas or nuclear power plants.

Texas also is the nation's largest producer of biodiesel transportation fuel, capable of making more than 100 million gallons of transportation fuel each year, with another 87 million gallons of capacity under construction. In 2007, Texas made about 73 million gallons of biodiesel.

### **Wind Manufacturing:**

Texas is a manufacturing leader for the wind energy industry. The state is home to numerous wind energy manufacturers, including wind turbine manufacturers DeWind and Alstom, five major tower manufacturers, blade manufacturer Molded Fiber Glass and many component suppliers. At least 37 Texas facilities currently manufacture components for the wind energy industry. In addition to the over one thousand manufacturing jobs already online in Texas, two more wind energy manufacturing facilities have been announced for the state.

### **Coal**

Texas produces about 4% of the national coal supply, almost all of which is low quality, lignite coal. All the coal produced in Texas is consumed by the state, however the majority of coal used in Texas is transported from Wyoming.<sup>2</sup> Over one third of Texas' electrical power is fired by coal. Coal plants have very high greenhouse gas emissions, incurring high costs to meet federal emission regulations.

### **Carbon Capture and Storage (CCS):**

CCS in Texas is seen as a viable energy source, and many commercial projects are starting to take shape. Texas has many depleted oil and gas reservoirs that can be used to sequester CO<sub>2</sub>, and Texas produces more CO<sub>2</sub> and other greenhouse gases than any other U.S. state. In addition, many of Texas' remaining petroleum resources must be extracted with the assistance of carbon dioxide (CO<sub>2</sub>) re-injection into oil and gas fields through enhanced oil recovery (EOR). In an effort to produce more oil along with cleaner energy, the Texas state government has taken many steps to encourage CCS projects, particularly in the most recent legislative session. Private industry is picking up where government incentives end, but the uncertainty about a price on carbon has slowed some projects. One project in particular has continued to thrive, [The Texas Clean Energy Project \(TCEP\)](#). Summit Power is behind this project, in Odessa, Texas. TCEP is currently in development; construction is scheduled to begin in the fourth quarter of 2011. An integrated gasification combined cycle (IGCC) 400MW power/polygen project, the TCEP will combine proven gasification and carbon dioxide (CO<sub>2</sub>) capture and storage (CCS) technologies to achieve a capture rate of 90%--about 3 million tons of CO<sub>2</sub> per year, which will be used for enhanced oil recovery (EOR) in the West Texas Permian

Basin. In December 2009, TCEP received a \$350 million award from the U.S. Department of Energy's Clean Coal Power Initiative (CCPI) - Round 3. Siemens is the primary equipment provider for TCEP's gasifiers, power island and controls. The project's front-end engineering design (FEED) study was launched in June 2010 by Fluor, Siemens and Selas Fluid Processing Corporation, a Linde Group subsidiary. The project is supported by H.B. 469, Texas legislation enacted in 2009 to promote carbon capture power projects with low emissions.

## **Bioenergy**

Texas currently has at least 21 biodiesel production plants producing 200.75 million gallons/year, and a further 242.6 million gallons/year is under construction. This diesel fuel can be used directly or mixed with conventional diesel for use in diesel engines. Major biodiesel resources come from agriculture, forests, and urban biomass. Biodiesel is also producing electric power to be sold to the electric grid. A biodiesel plant in the city of Oak Ridge North, operated by Biofuels Power Corp. is the first plant to run entirely off of biodiesel fuel producing 5 megawatts of electric power to the power grid.

The Texas A&M University System has many bioenergy projects being developed under the Bioenergy Alliance through the [Texas A&M AgriLife Research](#) and the Texas Engineering Experiment Station. Research projects in the Bioenergy Alliance include: bioenergy policy and economic analysis; manure management and use in coal fired power plants; development of distiller grains, an ethanol byproduct for cattle feed; the study of specialized algae as a feedstock for oil production; and the use of cellulosic ethanol sorghum and sugarcane as a biofuel. The university has agreements with both BP and Chevron on Biofuels research.

## Annex C: Information Technology in Texas

The IT Cluster is already a well-developed part of Texas' overall economy. Statewide, Texas has a strong heritage in various parts of the IT Cluster, with unique regional legacies that influence local economies and position Texas in the global marketplace. The Telecom Corridor® Genealogy Project tracks 5000 Texas companies who trace their roots back to Collins Radio and Texas Instruments, plus the presence (and often U.S. headquarter operations) of major global companies like Nortel, Alcatel, Ericsson, EDS and Cisco, as well as hundreds of other Texas entrepreneurial companies.

In the Metroplex, the legacy of reservation and travel systems began with Sabre and spawned Travelocity. The military presence in San Antonio and South Texas has helped those regions develop expertise and industry in Cybersecurity and related fields. SBC is now the 2nd largest service provider in North America and is busily upgrading its Texas and other states networks to broadband capability. Houston and the Gulf Coast's energy companies, Space Center, as well as world-renowned medical complex, depend upon IT technologies in a significant way. Austin's Dell Computer and Houston's Compaq (now HP) represent some of the world's major computer companies.

Technology is not just a passing fancy in Texas. Nanotechnology and semiconductors help form an innovative advanced manufacturing segment of the Texas economy with a distinguished track record to prove it. Texas has been a global leader in the semiconductor industry since the 1950s.

Texas is the birthplace of the integrated circuit and an entire industry that has grown up around the chip with the help of the state's world-renowned research institutions and universities, a highly skilled workforce and key investments by public and private partners. More than 26,000 high-tech companies, with more than 470,000 employees, make their home in Texas. Research and development expenditures for microelectronics and computer technology at Texas institutions of higher education top \$74 million annually

Nanotechnology is the understanding of very small materials at the atomic scale, but the size of the sector in Texas is huge. **Texas is a global leader in nanotechnology research and distribution, and is nationally ranked for its nanotech-related research, venture capital and commercialization efforts.**

One of the major reasons for the continuing vitality of the technology sector of the Texas economy is the number and quality of the public and private research institutions in the state. Additionally, there are other institutions that have organized around encouraging entrepreneurs to transition from early stage ventures into full-scale commercialization. One stellar example is the [Austin Technology Incubator](#), a nonprofit unit of The University of Texas in Austin.

### Texas Remains the US No.2 Cyberstate:

Texas remains the second-largest cyberstate in the nation ranked by tech employment, trailing California and ahead of New York. The largest tech employment gains in Texas took place in computer systems design and related services (+1,900 jobs), followed by engineering services (+300 jobs). A high-tech industry leader, Texas ranked among the top three Cyberstates in terms of employment in 9 of 15 high-tech sectors.

Texas has aggressively pursued cluster strategies for six technologies, one of which is information and communications. Other top High-tech states have had no strategy to maintain and grow its telecom cluster. As a result, Texas has continued to grow its telecom sector even in a period of industry downturn, while other states, like New Jersey's telecom sector continues to decline. Austin, Texas, is home to [a diverse group of high-tech companies and organizations](#), including its most well known anchor, Dell. As a result, the Austin area has become known as high tech's Silicon Hills, much as San Jose, California, is known as the industry's Silicon Valley. Most recently Samsung expanded its semiconductor works in Austin, creating an additional 500 jobs to produce advanced logic devices for its LS1 business. With the latest \$4.0 billion expansion, the largest single foreign investment ever made in the state of Texas, the Korean company will have invested more than \$9 billion in the Lone State. Austin also has regional divisions/headquarters of Apple, Google, Facebook, LegalZoom, 3M and many others

### **What does No.2 “Cyber” ranking mean for Texas:**

- 456,500 high-tech workers in 2010 (2<sup>nd</sup> ranked cyberstate)
- 11,800 jobs lost between 2009 and 2010
- High-tech firms employed 55 of every 1,000 private sector workers in 2010, ranked 16<sup>th</sup> nationwide
- High-tech workers earned an average wage of \$84,800 (13<sup>th</sup> ranked), or 84 percent more than Texas's average private sector wage
- A high-tech payroll of \$38.7 billion in 2010, ranked 2<sup>nd</sup> nationwide
- 27,900 high-tech establishments in 2010, ranked 2<sup>nd</sup> nationwide

## **Texas's National Industry IT Sector Rankings:**

- 2<sup>nd</sup> in internet and telecommunications services employment with 114,800 jobs
- 2<sup>nd</sup> in engineering services employment with 92,800 jobs
- 2<sup>nd</sup> in semiconductor manufacturing employment with 28,400 jobs

The shift in the U.S. economy away from manufacturing has created a need for highly trained and skilled professionals who can drive the service-based economy. Research and development (R&D), venture capital, and other seed investments are often a reflection of the industrial mix and the quality of technical skill in an area. While there is a “chicken or the egg” issue at hand, continued investment in an area can lead to the development of a high-tech “cluster”—a self-reinforcing combination of institutions, investment, and workforce skills—that can have a long-term positive effect on an area’s economic growth.

Nationally, areas of the East and West Coasts, in particular San Francisco and Boston, are most often recognized for the depth of their high-tech economies. In Texas, Austin has attained recognition as a technology center, and Dallas, because of the telecom industry, has joined Austin as one of the top US Cybercities. Dallas has a diversified high-tech base the Dallas metro area includes six of the nation’s 20 largest telecommunication services companies. GTE’s global headquarters is based in Dallas, while Nortel, Ericsson, Fujitsu, and Alcatel have U.S. headquarters there. Austin is thought by many to be the center of Texas’ electronic components industry, but Dallas produces over 20 percent more in terms of value of output and employs 4,200 more people.

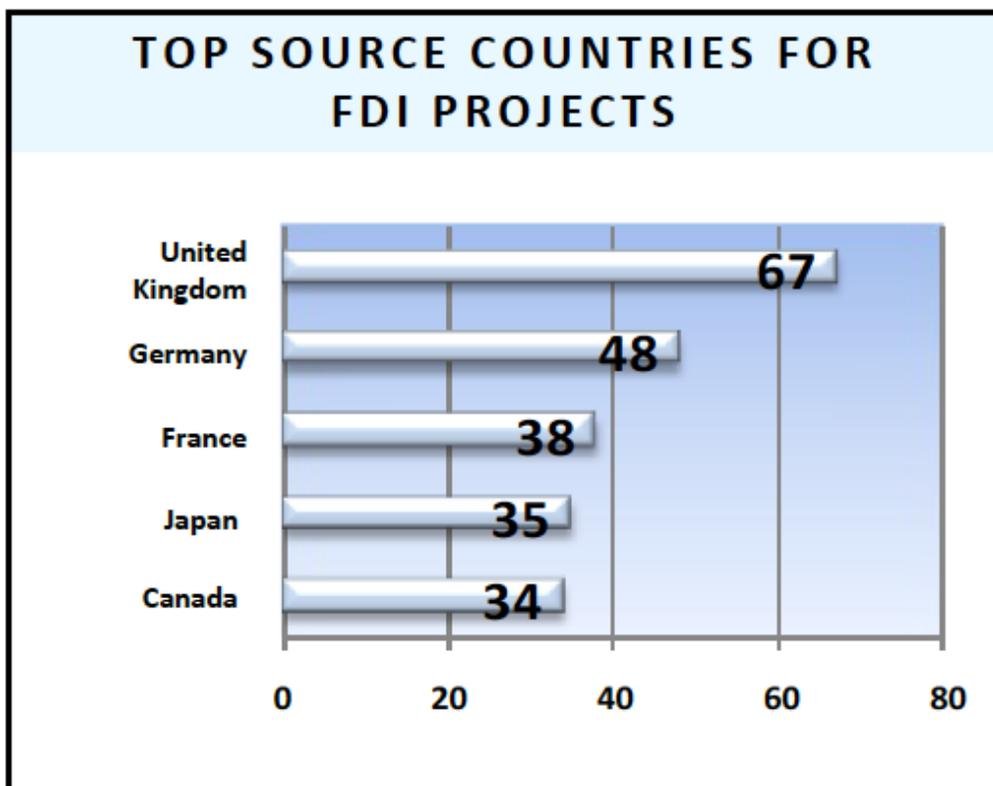
## Annex D: European FDI in Texas

### Summary:

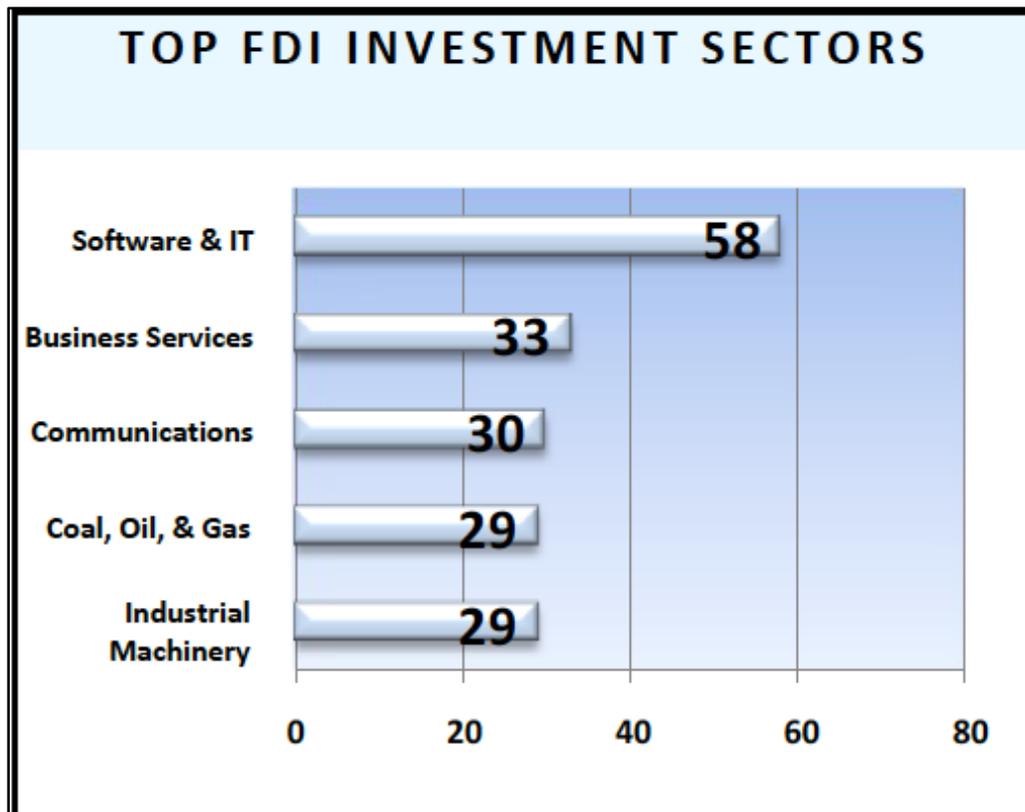
[Texas is a top-ranked global destination for foreign direct investment](#) (FDI). These FDI projects are mainly located in Houston, Dallas and Austin, which also rank in the top 10 cities in the US for FDI. The state's strong economy, competitive business climate, and central location within North America have attracted more than 2,000 foreign multinationals to establish locations here. European FDI represents 60% of all foreign investment in Texas, led by the UK, Germany and France.

### FDI Investments by European Country and Sector:

	UK	Germany	France	Netherlands	Sweden	Norway
<b>Coal/Oil/Gas</b>	2		4	5		
<b>Communication</b>	4		2			
<b>Business Services</b>	1	3				2
<b>IT</b>	1		3	4		
<b>Industrial/tools/machines</b>	1	2			4	



## FDI in Texas by Sector:



### **No. 1: Software and Information Technology is the No.1 FDI sector in Texas:**

Software & IT is Texas' top sector for attracting foreign investment projects. Between 2005-2010, 58 investments in this sector have been recorded representing 14% of the state's total FDI projects. This fact, surprising perhaps to those who are not as familiar with Texas as a 'high-tech' state, not only shows the diversification of the Texas Economy but also the modernisation of the Oil and Gas industry to a much more technology intensive sector.

**On a national level, Texas was the destination for 1 in every 21 foreign Software & IT projects locating in the U.S.**

One of the most significant has been the recent Samsung investment. [Samsung recently started up a \\$3.6 billion facility in Austin](#), Texas that supplies processors for Apple's iPhone and iPad<sup>3</sup>. Part of the reason for the expansion was proximity to the top-notch engineering program at the University of Texas.

The roaring success of both the iPad and iPhone has helped the city of Austin, where Freescale Semiconductor is based and other chip companies, like ARM, Intel and Advanced Micro Devices, also have operations. Semiconductor companies are attracted to Austin because of a steady supply of educated employees from the University of Texas' [engineering](#) school. Samsung's factory is the largest foreign investment in Texas with a total investment of about \$9 billion, according to Austin Chamber of Commerce. Austin is also home to an Apple customer call center that deals with customer complaints in North America, Apple's biggest market. The Cupertino company employs thousands in that facility, who deal with calls ranging from complaints to support.

## **No.2: Business Services are the 2<sup>nd</sup> FDI Sector in Texas**

Business Services is Texas' second largest sector for attracting foreign investment. Since 2005, 33 investments in this sector have been recorded representing 8% of the state's total FDI projects.

**Norway's investment in the business services sector represented half of its FDI projects in Texas, all of them in Houston. Norwegian investments in this sector were led by companies such as DNV, who invested about \$27MM in 2009 alone.**