

Regional Innovation Best Practices in Competitiveness Strategy

2014

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CHAIRMAN'S LETTER



On behalf of the board of directors and members of the Global Federation of Competitiveness Councils (GFCC), I am pleased to present the 2014 report, *Regional Innovation: Best Practices in Competitiveness Strategy.*

When the GFCC was formed more than four years ago, it was predicated on the belief that the sharing of best practices among national competitiveness organizations and among nations would provide benefit to all. With the release of this year's report, we have again put that belief into practice and created what we hope will be a useful tool for competitiveness organizations and initiatives around the world.

GFCC members understand more than anyone that the nexus between regional innovation, national competitiveness and economic prosperity can manifest into a higher standard of living for all. Regional innovation is increasingly the best way to address global economic, environmental and energy challenges; to invest in regional innovation is to invest in the future of global potential.

It is the mission of the GFCC to actively promote debate and dialogue, competition and collaboration, and innovation above all else. In this year's report we highlight outstanding examples of regional innovation from eight countries from all parts of the world-the United States, Canada, Mongolia, Korea, Brazil, the United Kingdom, the United Arab Emirates and Ireland.

Best Practices in Competitiveness Strategy is issued annually by the GFCC. I hope you enjoy the 2014 edition.

Sincerely,

Charles O. Holliday, Jr. Chairman Global Federation of Competitiveness Councils

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EXECUTIVE SUMMARY

Leveraging Competitive Assets and Improving the Capacity for Regional Competitiveness

Over the past two decades, regional competitiveness has gained increased attention from governments, the economic development community, academia, and competitiveness organizations around the world. This expanded focus on regional competitiveness is driven by a number of factors:

- Success of a number of regionally based industry clusters around the world, many built on a base of regional assets, and some supported by "grow your own" regional economic development strategies
- Economic regions, labor markets, and networks of talent that drive innovation typically transcend historically-drawn political boundaries
- Natural resource endowments and other competitive assets are often regionally based
- Many economic opportunities and competitiveness challenges are regional in nature, and require leadership across regions to address them
- Businesses consider regional conditions such as labor availability, infrastructure, cost of energy, base of suppliers and supporting industries, and access to education and training for employees—in making decisions about where they will invest and locate their business facilities

Regions around the world have diverse competitive assets and resources, they are in different stages of economic development, have different industrial bases, face different challenges, and see different opportunities for their future. No single policy or strategy will work for all regions, so a diversity of distinctive approaches to regional competitiveness is emerging and reflected in the 2014 GFCC Best Practices. Themes explored include: leadership for regional competitiveness; integrating national and regional industrial policies and competitiveness initiatives; validating and disseminating new regional models; strengthening small and medium size enterprises; metrics; and leveraging regional assets, with a special focus on renewable energy as an opportunity to attract investment and spur new business formation and regional economic growth.

Leadership for Regional Competitiveness

Across countries, a diversity of organizations– governments at different levels, non-profits, and other entities–lead efforts to strengthen regional competitiveness. Important roles for these leaders are coordinating with other organizations that provide key support for regional initiatives, and convening stakeholders to identify challenges and priorities, and plan for the future.

In Brazil, the regional development policy is implemented through an institutional structure, including the Superintendency for Regional Development of the Northeast (Sudene), Superintendency of Development for the Amazon (Sudam), Superintendency of Development for the Midwest (Sudeco), and the Ministry of National Integration, which leads the National Policy for Regional Development (PNDR). At the Federal government level, efforts to support the productive sector are mainly led by the Ministry of Development, Industry and Foreign Trade, with support from others such as the Ministry of Science, Technology and Innovation; Ministry of National Integration; Ministry of Finance; State-owned enterprises such as the Brazilian Development Bank and Funding Authority for Studies and Projects; and parastate entities such as Brazilian Agency for Industrial Development (ABDI), Brazilian Agency for Promotion of Exports and Investments, and the Brazilian Services for Supporting Micro and Small Enterprises. At the state level, efforts are led by mission oriented local government Secretariats (i.e., Economic Development Secretariat, Secretariat of Science and Technology, etc.), and the state Development Banks.

Brazil's RS Eolic program, focused on developing the country's wind energy sector, played the role of convener, engaging with companies, entrepreneurs, researchers, and government officials to discuss the main factors that could determine regional competitiveness, and the measures local government could take to improve it. For the first time, there was a clear policy that defined the state goals in this industry, and the measures that would support their achievement, designed with the academy and private sector.

In Ireland, in 2010, the Government launched the National Research Prioritisation Exercise (NRPE) to guide economically motivated research, development and innovation (RD&I) investment for the period 2013-2017. To lead the NRPE, the Government established a Steering Group comprised of senior representatives of key stakeholders including enterprise, academia and public policy. Thematic Working Groups provided a structure for more in-depth consideration, brought domainspecific expertise into the exercise, and convened workshops for stakeholder engagement. Fourteen priorities were identified and six platform technologies priorities. The government established a Research Prioritization Action Group (RPAG) to drive implementation of the priorities, for example, by developing an action plan to re-align public R&D funding. The RPAG is an all-of-Government forum, which brings together senior officials from ten State agencies and six Government departments with responsibility for funding research and innovation. It also includes the Department of the Taoiseach (Prime Minister), the Department of Public Expenditure and Reform, and the Department of Foreign Affairs and Trade. It is chaired by the Minister for Skills, Research and Innovation.

One of the most important impacts of the NRPE has been the enhanced coordination and cooperation it has engendered between the State agencies and Government departments funding research. The funding agencies and departments have a range of mandates, spanning enterprise development (indigenous industry, foreign direct investment), sectoral development (marine, agrofood, and energy), societal challenges (health, environment) and crosscutting (education). By convening senior officials and executives from the funders on a regular basis, the RPAG provides a forum that facilitates communication and coordination between these bodies. Action plans developed in the NRPE have driven practical cooperation at the operational level, as the majority of actions in the plans require several funders to cooperate in their implementation.

In Ireland and Northern Ireland, a different type of entity has taken the lead. Irish and Northern Irish system operators are leading a significant crossborder infrastructure project. In the North Atlantic Green Zone project, ESB Networks, Northern Ireland Electricity, EirGrid and System Operator of Northern Ireland are coming together to implement a major, technologically advanced interconnected network infrastructure project to deliver a Smart Grid.

In Korea, the regional government of Ulleung Island is leading an "Eco-friendly Energy Independence Project" that will turn Ulleung Island into a zero-carbon island by replacing its conventional electricity supply system with a highly technological system that uses new and renewable energy sources. To achieve this goal, a Special Purpose Company was formed with stakeholders ranging from the energy supplier (the Korea Electric Power Corporation) and battery producer (LG), to various government authorities, such as the Ministry of Trade, Industry and Energy, Gyeongsangbuk-do provincial government and the regional municipality of the Ulleung County.

In Mongolia, the national Government established the 2012-16 Action Plan of the Government of Mongolia, which plans for investing in new infrastructure, social policies that improve quality of life for regional communities, investment and regulatory conditions that foster new businesses, and creating regional "centers" of industries that promote cooperative development and the advancement of knowledge in specific sectors within Mongolia.

In the UAE, the Emirates Competitiveness Council is the entity in the country responsible for coordinating the efforts of individuals and groups (private and public, both domestic and international) working-either directly or indirectly-to achieve the nation's competitiveness goals. Sustainable development is a key focus for competitiveness in the UAE, and supported by a *Green Economy* Strategy launched in 2012 by the federal government. Masdar-a subsidiary of the Mubadala Development Company-is playing a leading role in developing UAE's green energy economy. Masdar includes an investment arm (Masdar Capital), a renewable energy power generation and operation unit (Masdar Clean Energy), and an independent research-driven graduate university (Masdar Institute). Masdar's infrastructure includes a cutting-edge urban complex (Masdar City), where innovative technologies can be tested and implemented.

In the United States, the Council on Competitiveness—a non-profit organization of corporate CEOs, university presidents, labor leaders, and national laboratory directors—has led a 15 year effort to take emerging successful regional competitiveness models to national scale. This pivotal leadership role has included developing a better understanding of regional competitiveness, partnering with the Federal government to demonstrate new regional competitiveness models, disseminating lessons learned, engaging state government leaders who can adopt these models in their regions, and encouraging the Federal government to incorporate regional competitiveness models in its programs and funding focused on economic development and manufacturing competitiveness.

The Council also sought to better understand what kind of leadership enables regions to harness their assets to accelerate economic growth and job creation. Drawing on the work of practitioners and academics, the Council combined new field research and case studies to examine why some regions are more successful than others, special attributes of effective regional leaders, and organizational forms of regional leadership. The Council's 2010 report, *Collaborate: Leading Regional Innovation Clusters* explores the key roles of leaders and key characteristics of effective regional leadership, such as being proactive, creating a vision, strategic planning, being inclusive, and establishing metrics.

Building the National-Regional Connection

National efforts to improve competitiveness, and stimulate industrialization, economic growth and development need strong connections to regions.

In Brazil, national development policies and regional development policies are closely linked. The federal Government's current industrial, technological and foreign trade policy includes special regional development actions that contribute to state agendas for productive development; for example, they focus on strengthening local and regional productive activity chains; on building productive activities on local bases; on leveraging the purchasing power of the State; and on the states' technological agendas. In the effort to regionalize industrial policy, the National Network of Industrial Policy (RENAPI) has gained importance. While following the guidelines of national policy, it seeks to promote the industrialization of regions by identifying and addressing the specific problems and potential of each region. Created in 2006 by the Brazilian Agency for Industrial Development (ABDI), the RENAPI incorporates

the principle that, to ensure national development, the actions of industrial policy need to be decentralized. Originally named the National Network of Agents of Industrial Policy, the project's initial objective was to disseminate the Brazilian industrial policy throughout the states through mobilization and awareness-raising events. In 2008, the project was restructured and renamed the RENAPI Nuclei, to support implementation. These nuclei have encouraged wider use of industrial policy instruments, and the formation of priority action agendas that, in many cases, evolve into state industrial policy. Since 2008, more than 20 Nuclei have been established in different Brazilian states.

In Mongolia, an important aspect of implementing the 2012-16 Action Plan of the Government of Mongolia is establishing relationships between regional communities and the government, providing a means through which the problems and opportunities of these communities can be conveyed to the Ulaanbaatar-based Government of Mongolia and result in meaningful policy outcomes. Mongolia's Economic Policy and Competitiveness Research Center is playing a leading role connecting these communities to the national government's efforts, for example, by organizing workshops with provincial representatives, providing them with an opportunity to discuss current regional-specific issues and providing policy proposals for addressing them. A 2014 workshop convened the Governors of the 21 provinces and representatives from each of the Citizens Representative Hurals (Community representatives). A component of the meeting was breakaway groups of representatives by geographical location, to provide an opportunity to highlight challenges and opportunities for different areas of Mongolia, making it easier for decision-makers to target regional policy changes.

In the United States, to engage leadership at the state level, and inform these leaders of models for greater regional competitiveness and growth, in 2006 the Council on Competitiveness partnered with the National Governors Association and co-published the Governors Guide to Cluster-Based Strategies for Growing State Economies. This guide summarizes the lessons learned from recent experience, and offers practical steps for cluster initiatives that governors can take to strengthen their states' economies. The Council has also engaged national government policy leaders, and advised on how regional models can be integrated into national government economic development funding. A partner with the Council in its Regional Innovation Initiative demonstration projects, the U.S. Economic Development Administration (EDA) has embraced regional competitiveness models in its economic development investments. For example, EDA Regional Innovation and i6 Grants support U.S. regions in developing innovation strategies and innovation clusters. Funding is available for: innovation capacity-building such as establishing new or scaling existing Proof of Concept centers and commercialization programs; feasibility studies and development of science and research parks; and support for seed capital funds for early-stage companies and clusters.

Validating and Disseminating New Models

Competitiveness and regional leadership entities can play a crucial role in demonstrating and validating new models, disseminating best practices, and encouraging adoption.

In Korea, the regional government of Ulleung Island's "Eco-friendly Energy Independence Project" will serve as a test bed for an environmentally friendly energy independent island model. If the project is successful, Korea plans to apply its microgrid model to other remote regions in Korea, such as military units and mountainous areas. Through the project, Korea will gain substantial knowledge and experience, and build a track record for this large-scale business model, which will open a new opportunity for domestic businesses in overseas microgrid markets. With the Ulleung energy independent model, Korea plans to develop similar projects for developing nations around the world.

In Ireland and Northern Ireland, the North Atlantic Green Zone (NAGZ) is a cross border project geographically located in the Northwest of Ireland. The competiveness of the region is hindered as its current electricity and communications infrastructure has the worst continuity and security of supply performance of all electricity systems on the island. The current challenges faced by the island of Ireland and particularly in the Northwest region, in both electricity distribution and transmission systems are challenges other European countries will face over the coming decade. The NAGZ project will tackle these challenges through implementation of Smart Grid technologies and solutions to manage the highest levels of variable renewable generation penetration in an integrated cross border market without a synchronous connection to a wider grid, the first implementation of a Smart Grid of scale within the EU. The project will serve as a template for future Smart Grid deployment in Ireland and across Europe.

In the United States, the Council on Competitiveness demonstrated and validated emerging models of regional competitiveness. To first build a base of knowledge, in 1999 the Council launched the *Clusters of Innovation Initiative*, which compared the development of clusters around the country and identified factors that contribute to strong regional clusters and regional competitiveness. The study built on the cluster work of Michael Porter of the Harvard Institute for Strategy and Competitiveness, and involved regional surveys and interviews in five U.S. regions: Atlanta, Pittsburgh, the North Carolina Research Triangle, San Diego, and Wichita. A case study on each of these regions

explored their clusters, key regional assets, business environment, and leadership and institutions that foster regional collaboration. To help mature regional competitiveness models, the Council served as a leading partner in the U.S. Department of Labor's \$300 million Workforce Innovation in Regional Economic Development (WIRED) initiative, focused on the role of talent development in regional competitiveness. WIRED was a living laboratory in which 39 regions of the country launched efforts to build innovationbased economic development strategies. Regional innovation clusters entered a new stage where demonstration projects and lessons they provided were a critical success factor in advancing them. Building on its past work, the Council launched the Regional Innovation Initiative (RII) in 2003. In RII's first major activity, the Council joined forces with the U.S. Department of Commerce's Economic Development Administration to implement regional initiatives with local partners in six areas: Central New Mexico, Northeast Ohio, Wilmington, Delaware, the Inland Northwest (Spokane-Coeur d'Alene area), West Michigan, and St. Louis. In each region, the Council worked with local partners to implement an innovation assessment that evaluated regional strengths and weaknesses, and opportunities to strengthen competitiveness. Also, the Council developed tools, techniques, and step-by-step instructions that states and regions could use to inventory, evaluate, and benchmark their competitive assets and innovation capacity. It published a report that described common regional challenges identified in the project regions and responses to those challenges. To achieve greater impact, the Council engaged national government policy leaders and advised on how regional models can be integrated into national government economic development funding and used to better leverage government investments in areas such as sustainable energy and advanced manufacturing.

Critical Role Small and Medium Sized Enterprises Play In Regional Competitiveness

Small and medium-sized enterprises (SMEs) play a critical role in regional economies. Efforts to stimulate economic development and regional competitiveness often focus on these enterprises. SMEs also play a key role in innovation and have many advantages as innovators, but many do not use their advantages for innovation, growth, and increased competitiveness. This barrier to innovation can be addressed through learning, strategic thinking, and planning.

In Brazil, through RENAPI, the Brazilian Agency for Industrial Development (ABDI) has focused attention on emerging companies. These midsize enterprises develop innovations and make investments using their own resources, without taking advantage of tax incentives and financial instruments of federal industrial policy. In partnership with the Brazilian Development Bank, Funding Authority for Studies and Projects, the National Research Council, the Superintendency for Development of the Amazon, and the Superintendency for the Development of the Northeast, ABDI has provided assistance to such companies in several states. ABDI's role involves informing these companies about the financial instruments they can access to promote innovation, as well as monitoring, evaluating, and coordinating with these emerging companies to support their growth and innovation efforts. ABDI created the Productive Development Support Tool Guide (http://guia.abdi.com.br/default.aspx) to inform companies of the financial instruments and other assistance they can access for business development and improved competitiveness. The Guide is a virtual platform that brings together more than 300 tools offered by federal, regional, state and municipal entities to support development of Brazilian production.

In Canada, SMEs account for 90 percent of all jobs and 99.8 percent of all businesses. However, between 2009 and 2011, only 37 percent of Alberta SMEs conducted at least one innovation project. GO Productivity sought to determine why 63 percent of these SMEs did not conduct innovation processes and found that three primary reasons were given: innovation is not part of our business plan, business does not need to innovate, and the market does not need new products or processes. GO Productivity's knowledge of SMEs across Alberta provided a unique opportunity to develop a program that provides the basic building blocks for a successful innovation program. While the program was developed with the needs of Alberta SMEs in mind, it was designed to apply to SMEs across Canada and as a model for SMEs regardless of region or country. The program consists of a workshop that uses applied learning and action planning to understand innovation and the basic components of an innovation program, and an innovation assessment tool that provides a picture of where an organization stands vis a vis innovation. For example, in the workshop, participants identify the kinds of innovations that would create opportunities for them in operations, new products, product improvements, and market opportunities; and their potential internal and external sources of new ideas. The key outcome for participants is to apply the concepts, techniques and learning to a 90-day action plan. GO Productivity follows

up with the participants 30, 60 and 90 days after the workshop to check on progress, and provide additional coaching and other assistance.

Metrics

Metrics play an important role in focusing attention on challenges, goals and priorities, in measuring how efforts to improve regional competitiveness progress, and in motivating stakeholders to take needed action.

In Ireland, as part of its Prioritization Exercise, which identified key strategic technologies for research, development, and innovation, the Research Prioritisation Action Group devised indicators to measure the impact of implementing Research Prioritisation in 14 Priority Areas and, more generally, the impact of public science, technology, and innovation investment. To this end, it developed a Framework of Metrics and Targets which was adopted by Government in July 2013.

In Mongolia, since 2010, the Economic Policy and Competitiveness Research Center (EPCRC) has produced the Mongolia in World Competitiveness Yearbook in coordination with the International Institute for Management Development (IMD). The Report looks at more than 300 competitiveness criteria in order to rank Mongolia against 14 comparable nations that are also captured in the IMD's World Competitiveness Yearbook. In 2012, the EPCRC began publishing a Mongolian version that compares and ranks the 21 provinces of the country against each other, published as the *Provincial Competitiveness Report.* This report covers 180 criteria in areas of economic efficiency, government efficiency, business efficiency, and infrastructure. The

individual criterion are standardized and displayed in the report as a ranking of the 21 provinces. A competitiveness index is then calculated for the four categories identified above and displayed on a diamond graph, relative to the averaged value of all other regions. A general competitiveness index is calculated to provide an *Overall Competitiveness Scoreboard* for each of the provinces in Mongolia. The ranking of the individual provinces of Mongolia helps highlight the most urgent public policy needs, and where new legislation and regulation, infrastructure and government spending could have the greatest impact on competitiveness and economic prosperity.

Leveraging Regional Competitive Assets

Regions have competitive assets—natural resource endowments, R&D, education and training institutions, talent bases, companies, etc.—that can be leveraged and integrated through networks and ecosystems to drive regional competitiveness. Many countries and regions have natural resource endowments that can serve as sources of clean energy, and many view renewable energy as an important opportunity to attract investment, and stimulate new business formation and economic growth.

Brazil has major efforts underway to leverage its natural resource endowments for developing renewable energy and associated industries. For example, in biofuels, the *National Program for Production and Use of Biodiesel*, started in 2003, encouraged the use of oilseeds to produce biodiesel. A law passed in 2005 required that diesel fuel sold in Brazil contain 2 percent biodiesel by 2008 and 5 percent by 2013. The program's goals have been accelerated. In Rio Grande do Sul, one of Brazil's major soybean producers, the program was an opportunity to develop the soybean chain beyond production of grain for exports. The state established tax incentives that benefited investments in biodiesel plants. Rio Grande do Sul has become the largest biodiesel producer in the country, accounting for 30.3 percent of Brazilian production in 2013.

Also in Brazil, in 2004, the federal government started the PROINFA, which allowed charging a higher price for energy if produced from wind, biomass, or small hydropower plants. At that time, there were few wind farms in Brazil, even though Brazil's wind energy potential is one of the world's largest. The *PROINFRA* policies resulted in Rio Grande do Sul establishing the first major wind farm in Brazil, with 75 towers capable of producing 150 MW of electricity. The state of Bahia has significant wind energy potential, estimated at 14.5 GW, representing 10 percent of the national potential and 19 percent of the potential in the Northeast region. The state's Government attracts and facilitates wind energy projects and, to date, wind power projects totaling more than 15,000 MW have been developed in the state. Latin America's largest wind farm complex is located between the municipalities of Igaporã, Caetité and Guanambi on the border of the state. Managed by Renova Energia, the Alto Sertão I complex consists of 14 wind farms and 184 wind turbines, totaling 293.6 MW of installed capacity. Its construction generated more than 1,300 direct jobs, paved 68 km of access roads, stimulated the economy of the involved regions, stimulated the housing market, and fostered local trade and

the creation of midsize enterprises. These wind projects are stimulating new economic activity such as new factories and production of aero generators, towers, and components for the wind power industry, as well as attracting investments from global companies.

The Minas Program of Renewable Energy-Energy of Minas is developing Minas Gerais, a state in Southeastern Brazil, into an important center of clean energy production. Launched in August 2013, the program is part of the Minas Government's strategy of creating incentives to attract investment that will stimulate new industrial ventures and increase the role of renewable energy in the energy matrix of Minas Gerais. Through the program, enterprises related to energy generated from solar, wind, biomass, biogas and hydro sources, as well as from Small Hydropower Plants and Hydroelectric Generating Plants can access incentives, ranging from differentiated tax treatment for Minas Gerais-based production of components and tools used in the generation of renewable energy to long-term financing offered by the Minas Gerais Development Bank (BDMG).

Considered a major resource for clean energy in Brazil, the sea is gaining the attention of experts, who are testing and deploying ocean energy technology, such as a wave power generation plant. It is estimated that enough wave power plants to generate 87 GW of power could be sited along the 8,000 kilometers-long coastline of Brazil. The state of Ceará, located in Northeastern Brazil, is a pioneer in wave energy. Ceará's wave power plant is the first in Latin America to generate electrical energy from waves. The wave power plant has can generate 100 kilowatts (KW) for the power supply of the main port of Ceará. In Ireland, energy is a crosscutting theme in the National Prioritisation Exercise. The focus of the *Marine Renewable Energy* priority area is positioning Ireland as a research, development and innovation hub to drive the deployment of marine renewable energy technologies and services. Ireland's ocean territory, at approximately ten times the size of its land area, is an excellent potential source of energy, and can potentially provide a vast amount of energy technologies.

In Korea, Ulleung Island "Eco-friendly Energy Independence Project" will turn Ulleung Island into a zero-carbon, energy independent island powered by new and renewable energy sources, such as solar power, wind, small hydropower, geothermal and fuel cells. Korea hopes that Ulleung Island's clean green image will boost the region's tourism industry. The project plans to use its eco-friendly features—new and renewable energy plants, smart-grid system and electric cars—to create a unique experience for visitors to the island, such as a geothermal energy powered holiday resort with hot springs.

Also in Korea, after unprecedented nationwide blackouts in 2011, with serious disruptive effects on businesses and factories, the government at various levels initiated energy conservation measures nationwide. Among regions, the city of Gwangju is committed to making itself a worldclass energy efficient city through systematic implementation of energy savings programs. The city targeted florescent lamps at underground parking lots of multi-dwelling units, such as apartment buildings. By replacing these lights with highly efficient LED lights, the city reduced

electricity costs and encouraged the use of LED lights. The city instituted a Carbon-bank system, in which cash value points are awarded to residents who reduce their consumption of energy, which are converted to cash-equivalent amounts deposited into personal banking accounts, which can then be cashed at Gwangju Bank or other participating financial institutions. Gwangju City has also carried out diverse energy conservation campaigns, targeted at raising energy consciousness in the daily activities of citizens such as a public awareness campaign on building the "civic power plant," which informs the public that the combined small amount of energy savings from each of the citizens is equivalent to the capacity of one power plant.

In Northern Ireland, to strengthen energy infrastructure as a competitive asset, the North Atlantic Green Zone is a cross border project located in the Northwest of Ireland. Irish and Northern Irish system operators are proposing a significant and technologically advanced infrastructure project, the first implementation of a Smart Grid of scale within the EU. The project will make the region more competitive and position Ireland as a leader in Smart Grids. Also, a high-speed communications network will be deployed. Increased broadband availability would increase regional gross value added (GVA) and employment for the Republic of Ireland portion of this region. More than 55 percent of households in this region have broadband connections, however the speeds are significantly below 10 Mbps. Infrastructure provided by this project would revolutionize the reach and robustness of optical fiber in the region, doubling the broadband speeds available. This would lead to a €7m p.a. increase in GVA for

this region. In addition, 10 percent of households in the region have Internet connections, which are not broadband speed. Should the increased availability of high speed broadband enable the use of web-based services, this 10 percent is likely to at least take up the broadband service now available. This would lead to a €40m p.a. increase in the regional GVA and an estimated 1,000 or more new jobs in a region with a population of 200,000.

In the UAE, government-led initiatives or government-supported entities are making inroads across all sectors of the green economy. Masdar-a subsidiary of the Mubadala Development Company-is playing a leadership role in developing the solar power industry in the UAE. Masdar PV is producing the next generation of PV films, and manufactures solar cells that are eight times larger and more powerful than the industry standards. It has achieved this industry leadership through a corporate strategy centered on R&D for product improvement and industry-academia collaborations. Masdar Clean Energy's utility-scale projects use PV solar energy, concentrated solar power (CSP), and wind energy. These include the 10 MW PV plant at Masdar City, which reduces carbon emissions by 25,000 tons annually, and meets the energy needs of the Masdar Institute, Masdar's site offices, and the on-going construction activities of Masdar City. It is developing one of the world's largest solar PV plants (Noor 1, a 100 MW plant in Abu Dhabi). Also, in a joint venture with Abengoa Solar and Total, Masdar Clean Energy is developing Shams 1, a 100 MW state-of-the-art parabolic trough CSP plant in the western region of Abu Dhabi, set to be the largest of its kind in the Middle East. Shams 1 will reduce

 $\rm CO_2$ emissions by 175,000 tons annually, equivalent to eliminating the use of 15,000 cars in a city like Abu Dhabi.

In the United States, the Council on Competitiveness served as a leading partner in the U.S. Department of Labor's Workforce Innovation in Regional Economic Development initiative, in which 39 U.S. regions launched efforts to build innovation-based economic development strategies. To support this national initiative, the Council developed *Asset Mapping Roadmap: A Guide to Assessing Regional Development Resources*, a tool to help the regions identify and evaluate their competitive assets—human capital, education and R&D institutions, financial capital, industrial base, connective organizations, legal and regulatory environment, and infrastructure—and how these assets are linked

BRAZIL

Regional Actions for Strengthening Productive Capacities: An Analysis of the Brazilian Case

1. The Regional Aspect in Brazil

With an extensive land area of 8.5 million square kilometers, Brazil is divided into five official macro-regions (Midwest, Northeast, Southeast, North and South) that are very culturally, socially, and economically diverse. These five regions are divided into 26 states and the Federal District, and are home to 5,570 municipalities.

Economically and socially, the Country is marked by great inequality, with stark differences in the industrial and spatial concentration of GDP and per capita income among regions. This heterogeneity stems from the beginning of the organization of the Brazilian nation, and the colonization process that occurred in very distinctive ways among its regions. To ensure the federal pact and its development, the Country faces the challenge of solving such inequalities.

For several decades, concern about Brazilian regional inequality has motivated discussions among policy makers and social scientists. This



Spatial organization of Brazil

Source: ABDI



Figure 1. Economic Data About Brazilian Macro-Regions (2011)

Source: ABDI using IBGE data (2011)

| Macro-region | Percent of Brazil's GDP | Income per capita | Percent of the country's companies |
|--------------|----------------------------|-------------------|------------------------------------|
| Midwest | 9.6 percent | R\$ 27,829.00 | 7.44 percent |
| Northeast | 13.4 percent | R\$ 10,379.00 | 15.7 percent |
| North | 5.4 percent | R\$ 13,888.00 | 3.58 percent |
| Southeast | 55.4 percent | R\$ 28,350.00 | 51.83 percent |
| South | 16.2 percent | R\$ 24,382.00 | 21.45 percent |

debate took on greater importance in the mid 1950s, a period of great disparity in economic growth among different Brazilian regions and adverse conditions in the Northeast, affected by two major droughts and low per capita income. During this period, the federal Government expanded the implementation of policies to reduce regional inequalities, based on specific strategies for overcoming underdevelopment, especially in the Northeast and North regions. These included the Superintendency for Regional Development of the Northeast (Sudene-Superintendência de Desenvolvimento Regional do Nordeste) and the Superintendency of Development for the Amazon (Sudam-Superintendência do Desenvolvimento da Amazônia).

While closely linked to national development policies, these regional policies weakened during the 1980s. During this period, the absence of an explicit policy for regional development, and elimination of its instruments and institutional framework could be blamed for the so-called "fiscal war." Without national coordination, states and municipalities engaged in a fiscal war, acting individually and independently to use their state revenues to offer incentives (i.e., tax exemptions, reductions, and deferrals) to attract business investment, creating competition between the territories and losses for the public budget.

As a result, in the beginning of the 21st century, two situations became even more pronounced: (1) the spatial pattern of socioeconomic inequalities in the Country; and (2) the high concentration of industrial activity in the South and Southeast regions, especially in the State of São Paulo, which had more technology-intensive activities, generated more quality jobs and higher incomes, in contrast to other regions that have had less significant economic growth.

These differences justified resuming the federal Government's regional development policies, mainly after 2003. Thus, the institutional structure of the regional development policy was gradually restored through reestablishment of the Sudam and Sudene, creation of the Superintendency of Development for the Midwest (SUDECO–Superintendência do Desenvolvimento do Centro-Oeste) and creation of the Ministry of National Integration, which leads the National Policy for Regional Development (PNDR–Política Nacional de Desenvolvimento Regional).

In addition to the PNDR, through various ministries, the federal Government heads other policies and institutional arrangements to stimulate regional development. Particularly notable are industrial policies and the creation of the Brazilian Agency for Industrial Development (ABDI–*Agência Brasileira de Desenvolvimento Industrial*), which has also contributed to the revival and strengthening of the strategy to overcome socioeconomic distortions within the national territory. Such initiatives are designed to promote local industrial activity, decentralize production and, consequently, raise income and generate jobs to improve the economic and social conditions in regions where development is lagging behind.

It is worth noting that the federal Government's current industrial, technological and foreign trade policy includes special regional development actions—aimed at contributing to state agendas for productive development—focused on strengthening local, regional and national productive activ-

The PNDR has the following goals:

(1) to provide the necessary conditions—infrastructure, credit, technology, etc.—for Brazilian regions to enhance economic opportunities for their development;

(2) to promote the social and productive integration of the population, the training of human resources and the improvement of life quality in all regions;

(3) to strengthen regional socio-productive organizations through the expansion of social participation and the formulation of development plans and programs by the regions and the states; and

(4) to stimulate the exploitation of sub-regional potential arising from the magnificent economic, environmental and cultural diversity of the Country.

ity chains; building productive activities on local bases; on leveraging the purchasing power of the State (government procurement); and on the states' technological agendas. In this effort to regionalize industrial policy, the *National Network of Industrial Policy* (RENAPI–*Rede Nacional de Política Industrial*) has gained importance. While following the guidelines of national policy, it seeks to promote the industrialization of regions by identifying and addressing the specific problems and potential of each region.

2. The role of the National Network of Industrial Policy (RENAPI)

Created in 2006 by ABDI, the RENAPI incorporates the principle that, to ensure national development, the actions of industrial policy need to be decentralized. To effectively support local economic growth within the framework of national development policy, it is crucial that states and municipalities use the tools provided by the federal Government to promote industrial development and innovation. Complementary federal and state actions generate synergy, creating favorable conditions for industrial expansion and the reduction of regional inequalities.

Originally named the National Network of Agents of Industrial Policy, the project's initial objective was to disseminate the Brazilian industrial policy throughout the states through mobilization and awareness-raising events. However, in 2008, the project was restructured and renamed the RENAPI Nuclei, to support the implementation of federal industrial policy. Created to strengthen interaction and ongoing dialogue with the states, these nuclei have disseminated information on and encouraged wider use of industrial policy instruments, as well as the formation of priority action agendas that, in many cases, evolve into state industrial policy. The nuclei are formalized through Technical Cooperation agreements between ABDI, the state Federations of Industries, and the State Secretariats for Economic Development, Industry and Trade. Since 2008, more than 20 Nuclei have been established in different Brazilian states.

Figure 2. RENAPI Nuclei Implanted in Brazilian States

Source: ABDI/RENAPI (2014)

| Ano (Year) | Instalados (Installed) | Total |
|---------------|---------------------------|-------|
| 2008 | 3 | 3 |
| 2009 | 10 | 13 |
| 2010 | 6 | 19 |
| 2012 | 2 | 21 |
| 2013 | 1 | 22 |



Throughout its years of operation, the RENAPI has been embraced by public and private entities, which have joined efforts to support the productive development of states and advance discussions on regional policy issues.

In addition to supporting and participating directly in the process of establishing state actions agendas and policies for industrial development, the ABDI has undertaken actions through RENAPI focused on so-called emerging companies. These midsize enterprises are often geared to the domestic market, and develop innovations and make investments using their own resources, without taking advantage of tax incentives and financial instruments of federal industrial policy. In partnership with Brazilian Development Bank (BNDES), Funding Authority for Studies and Projects (Finep-*Financiadora de Estudos e Projetos*), the National Research Council (CNPq-*Conselho Nacional de Pesquisa*), the Superintendency for Development of the Amazon (Sudam) and the Superintendency for the Development of the Northeast (Sudene), the ABDI has provided assistance to such companies in several states. ABDI's role involves informing these companies about the financial instruments they can access to promote innovation, as well as monitoring, evaluating, and coordinating with these emerging companies to support their growth and innovation efforts.

ABDI/RENAPI's initiatives have contributed to promoting regional development, critical for territorial cohesion and the consolidation of national In its work with RENAPI, ABDI created the Productive Development Support Tool Guide (*Guia de Apoio ao Desenvolvimento Produtivo*, available at http://guia.abdi.com. br/default.aspx) to inform companies of the financial instruments and other assistance they can access for business development and improved competitiveness. The Guide is a virtual platform that brings together more than 300 tools offered by federal, regional, state and municipal entities to support development of Brazilian production.

identity. Regional actions to strengthen production not only contribute to the generation of wealth, but also to broader social distribution of economic growth and opportunity.

3. The industrial development policies of the states, and their coordination and implementation organizations

Some states in Brazil have adopted industrial development policies in order to encourage the establishment, expansion, diversification, rehabilitation and modernization of local industries that are key to the state's growth.

In the past, state actions were more focused on industrial recruiting via tax incentives. Currently, in addition to traditional instruments of industrial policy (i.e., tax, fiscal, infrastructure and credit), with support from RENAPI, state industrial policies have sought to use the so-called "new generation" tools (i.e., science, technology and innovation), and focus on increasing competitiveness, developing skills, reducing environmental impacts, job creation and retention, and expanding export capacity. Such policies are an important tool in support of regional development, complementing federal Government efforts to improve income distribution and strengthen productive activity.

State productive development policies are linked to actions implemented at the national level, so a state's policy is complementary to the national strategy, which includes urban and regional development policies, industrial policy, and policies for science, technology and innovation. In this regard, one of the main roles of state policymakers is to disseminate information on these federal policies to local actors. As the actions of the federal Government are many, and implemented by different parts of Government, this role has the potential to reduce transaction costs for companies and local actors that seek to take advantage of national policy instruments. State policies of this type have already been deployed, for example, in the states of Bahia, Ceará, Maranhão, Minas Gerais, Paraná, Rio Grande do Sul, and Sergipe. The policies create synergy between public and private actors, and convergence of actions carried out at the federal and state levels.

Efforts to support the productive sector involve a number of different institutional bodies, roles, and forums for consultation. In summary, at the federal level, efforts are mainly led and coordinated by the Ministry of Development, Industry and Foreign Trade (MDIC- Ministério do Desenvolvimento, Indústria e Comércio Exterior), with support from and in cooperation with others such as the Ministry of Science, Technology and Innovation (MCTI-Ministério Ciência, Tecnologia e Inovação); Ministry of National Integration (MI-Ministério da Integração Nacional); Ministry of Finance (MF-Ministério da Fazenda); State-owned enterprises such as the BNDES and Finep; and parastate entities such as ABDI, Brazilian Agency for Promotion of Exports and Investments (Apex Brasil-Agência Brasileira de Promoção de Exportações e Investimentos) and the Brazilian Services for Supporting Micro and Small Enterprises (SEBRAE-Serviços Brasileiros de Apoio a Micro e Pequenas Empresas).

At the state level, efforts are led by mission oriented local government Secretariats (i.e., Economic Development Secretariat, Secretariat of Science and Technology, etc.), and the state Development Banks. At this level, it is important to highlight the role of local SEBRAE branches local Development Agencies, and entities that represent industries. Most of the private institutions linked to state industrial development policies are focused on sectorial performance. Those focused on industrial performance more broadly include the state Federations of Industries (FIEMG, FIEP, FIESC, etc.) that are linked at the federal level to guidelines of the National Industry Confederation (CNI-Confederação Nacional da Indústria).

Figure 3. Summary chart of the organization and implementation organizations Source: ABDI



The human, institutional and business resources of different levels of the Federation must be integrated to effectively promote regional development. The great challenge is ensuring that policies and actions among the organizations of the federal Government, state authorities, and other sub-national organizations are efficient and rational. Another major challenge is promoting better coordination between public and private entities.

4. Contributions of the state initiatives in the energy sector for regional development

State industrial development policies involve actions integrated with Local Productive Arrangements¹ (APL-*Arranjos Produtivos Locais*), as both seek to contribute to national integration, regional development, and rapid development of the endogenous efforts of regions and localities in search of better standards of living. Industrial development policies stimulate the structuring of APLs to deploy them in areas where inequality is concentrated and industrial dynamism is low.

Proposals for developing APLs for the energy sector are important because different energy resources are available in various Brazilian regions, and there is a need to strengthen Brazil's oil and gas, biofuels, wind energy, and other energy production chains. Energy production has special relevance for the country, because of its important contribution to regional integration, industrial development, and decentralization of economic activity. To improve its competitiveness, Brazil's energy sector must reduce production costs in certain localities and increase productivity. Generally, lower production costs and higher productivity will attract more private capital by increasing the returns on investment, stimulating employment and income growth, and contributing to improved well-being of the population.

4.1. Wind power: Bahia case study

Developing alternative sources of energy is a high priority across the contemporary world. The high cost of energy, the ever increasing demand for it, and the challenges of sustainable development have generated great interest in producing electricity with reduced use of fossil fuels. Energy obtained from wind has become one such alternative.

Brazil's wind energy potential is one of the world's largest. More than 71,000 km² of the country's territory have wind speeds greater than 7m/s, a wind power potential of 143,000 MW, 11 times greater than the installed capacity of Itaipu Power Plant (the largest electric power plant in the world, with 20 generator units and 14,000 MW of installed power). Most of Brazil's wind power potential is in the Northeast region.

The state of Bahia has significant wind energy potential, estimated at 14.5 GW to a height of 70 m- representing 10.1 percent of the national potential and 19.3 percent of the potential in the Northeast region. Unlike other states in the region, which have a higher incidence of winds on the coast, Bahia's wind potential is inland. Three important characteristics-high speed, low turbulence, and regularity-make Bahia's wind conditions very favorable for producing wind power. Currently, Bahia is the second largest state in subscribed demand in the wind energy auctions. The state's Government attracts and facilitates the implementation of wind energy projects because renewable energy generation is characterized as a means to bring development to this semi-arid region. To date, wind power projects totaling more than 15,000 MW have been developed in the state, according to its Secretariat of Industry, Commerce and Mining (SICM).

Latin America's largest wind farm complex is located between the municipalities of Igaporã, Caetité and Guanambi on the border of the state. Managed by *Renova Energia, the Alto Sertão I* complex consists of 14 wind farms and 184 wind turbines, totaling 293.6 MW of installed capacity.

¹ In this document, the concept of APL is used more freely and with less accuracy than customarily used by academics. APLs, here, are a significant number of enterprises and individuals who engage in a complex network of relationships and act around a predominant productive activity, in a limited geographical area, and that share forms of cooperation and some mechanism of governance, which are essential for providing innovative capabilities.

Taking 18 months and an investment of R\$1.2 billion to build, its construction generated more than 1,300 direct jobs, stimulated the economy of the involved regions, increased the population due to the pace of building, stimulated the housing market, and fostered local trade and the creation of midsize enterprises.

Generating clean energy in the state and market potential are stimulating new economic activity such as new factories and production of aero generators, towers and industrial components for the wind power industry, and the installation in Bahia of the first industrial units of wind turbines from global companies such as Alstom (France) and Gamesa (Spain). Also present in the region are Acciona Wind Power (Spain), which produces wind power hubs and nacelles, and General Electric Energy (United States), which has installed several wind turbines in Bahia.

It is expected that Bahia will expand its role in the wind market over the next few years, doubling its participation to about 40 percent of the market sold annually.

4.2. Wave Power: Ceará Case Study

Considered a major resource for clean energy generation in Brazil, the sea is gaining the attention of experts, who are already testing and deploying ocean energy technology, such as a wave-power generation plant. It is estimated that enough wave power plants to generate 87 GW of power could be sited along the 8,000 kilometerslong coastline of Brazil. Of this total, 20 percent would be converted into electrical energy, equivalent to approximately 17 percent of the total installed capacity in the country. The state of Ceará, located in Northeastern Brazil, is a pioneer in the production of wave energy. Located on the breakwater at the port of Pecém, 60 km from the state's capital (Fortaleza), Ceará's wave power plant is the first in Latin America to generate electrical energy from waves. This location was chosen because the sea on the coast of Ceará has constant waves of 1.20 m height during 11 months of the year. With 100 percent Brazilian technology, the wave power plant has low impact and can generate 100 kilowatts (KW) for the power supply of the main port of Ceará.

The project's technology was developed by Alberto Luiz Coimbra Institute for Post-Graduate Studies and Engineering Research (Coppe) at the Federal University of Rio de Janeiro (UFRJ), and patented in the United States. The new system has the support of the government of Ceará and was financed by *Tractebel Energia* through the Research and Development Program of the National Electric Energy Agency (Aneel–*Agência Nacional de Energia Elétrica*), at a cost of R\$18 million over four years.

Through the Secretariat of Infrastructure of Ceará (Seinfra), Ceará state government was responsible for preparing the 200-meter site for the pilot wave power plant. This plant is highly innovative compared to many other wave power plants around the world. It has two floats attached to mechanical arms, which are set in motion by waves. This motion operates a pump that pressurizes water stored in an accumulator connected to hyperbaric chamber, to create a jet of water that drives a turbine, which powers a generator that produces electricity. The water jet's power is equivalent to a 500-meter high waterfall similar to a large hydroelectric dam. There are plans to expand the number of mechanical arms with floats to capture more energy from sea waves and convert it into electricity.

4.3. Photovoltaic Energy: Minas Gerais Case Study

The Minas Program of Renewable Energy–Energy of Minas (*Programa Mineiro de Energia Renovável–Energias de Minas*) is turning Minas Gerais, a state in Southeastern Brazil, into an important center of clean energy production. Launched in August 2013, the program is part of the Minas Government's strategy of creating incentives to attract investment that will stimulate new industrial ventures and thereby increase the role of renewable energy in the energy matrix of Minas Gerais.

Through the program, enterprises using solar, wind, biomass, biogas and hydro sources, as well as from Small Hydropower Plants (PCHs-*Pequenas Centrais Hidrelétricas*) and Hydroelectric Generating Plants (CGHs-*Centrais Geradoras Hidrelétricas*) can access incentives, ranging from differentiated tax treatment for Minas Gerais-based production of components and tools used in the generation of renewable energy (solar panels, wind generators and wind turbines, inverters, etc.), to long-term financing offered by the Minas Gerais Development Bank (BDMG).

Solar power generation has acquired prominence in the state. The Experimental Solar Generating Photovoltaic Plant of Sete Lagoas is an important initiative of Minas Gerais Energy Company (Cemig-Companhia Energética de Minas Gerais), and reinforces the commitment of the state to develop clean energy technologies. The project was developed within the framework of the Aneel Program to Encourage Research, in partnership with the Spanish company Solaria, Federal University of Minas Gerais (UFMG) and the Foundation of Research Support in the State of Minas Gerais (Fapemig–*Fundação de Amparo à Pesquisa no Estado de Minas Gerais*). The plant is expected to be the largest of its kind in Latin America, occupying an area of 80,000 square meters provided by the city of Sete Lagoas, with 3 MW of photovoltaic panels, with a capacity of 4,200 MWh, enough to supply more than 3,000 homes. The project involves investments of approximately R\$40 million.

In addition to being close to the state capital and the Confins International Airport, the city has a satisfactory solar radiation index, and is a focus of the Cities of the Future Project, in which Cemig is evaluating distribution networks automation and modernization of the electric system, in the context of smart grid technology.

The solar panels and technologies used to capture solar energy in the project are still imported. However, Minas Gerais may be the first state in the country to have a factory capable of producing solar panels and photovoltaic cells. The state government has initiated several negotiations internationally, including with French companies, recognized for their knowledge in the area of renewable energy, microelectronics and nanotechnology, in order to give prominence to Minas Gerais.

Also of note is a public-private partnership project in Minas Gerais focused on organic and printed electronics that promises to put Brazil at the forefront of generating electricity by means of solar energy. A cooperative agreement was signed by CSEM Brazil Innovations Center, a private nonprofit institution, and the Minas Gerais state government. Organic photovoltaic (OPV) technology generates electricity using a thin and transparent plastic film that captures solar energy. The technology can be used in home windows, buildings coatings, automobiles, clothing, and cell phones.

5. Conclusion

In the past decade, socio-economic inequalities among Brazilian regions and the spatial concentration of production have motivated federal policies designed to boost less developed regions of the country and to improve distribution of productive activities throughout the territory.

Towards this end, both the National Policy for Regional Development (PNDR-*Política Nacional de Desenvolvimento Regional*) and industrial policy have offered a path for developing and implementing regional development projects. Such projects involve the federated entities (federal, state and municipal Governments), relevant social groups and the productive sectors, and they are guided by a common national benchmark to produce the desired effect in reducing regional inequalities. In this regard, ABDI's actions, through the RENAPI, are essential both for coordinating efforts between the actors involved in these projects, as well as for the design of state policies to strengthen productive activity. Regional development projects also seek to take advantage of each region's and each state's economic and competitive assets, leveraging them to create diverse economic and productive opportunities promising for development in the region. The projects in the energy sector are good examples, as they take advantage of natural resource endowments of the states and the Brazilian region's conditions (infrastructure, credit, technology, etc.) to help them grow.

KOREA

Regional Innovations for Energy Efficiency: The Korean Cases

1. Eco-friendly Energy Independence Project in Ulleung Island

Many isolated regions of Korea, such as islands, often rely on power plants that use high-cost fuels-such as heavy oil and diesel-to generate their supply of electricity. Recently, the regional government of Ulleung Island, located 120 km east of the Korean Peninsula, announced its plan to become the world's first large-scale energy independent island. This ambitious "Eco-friendly Energy Independence Project" will turn Ulleung Island into a zero-carbon island by replacing its electricity supply system, which currently uses conventional power plants, with a highly technological, ICT (Information and Communications Technology) converged system that utilizes new and renewable energy sources, such as solar power, wind, small hydropower, geothermal and fuel cells. To achieve this goal, a Special Purpose Company (SPC) was formed with stakeholders ranging from the energy



supplier (the Korea Electric Power Corporation) and battery producer (LG), to various levels of government authorities, such as the Ministry of Trade, Industry and Energy, Gyeongsangbuk-do provincial government and the regional municipality of the Ulleung County. The project plans to establish a new electrical grid with a built-in system that will store spare electricity, using the domestic Energy Storage System (ESS) and Energy Management System (EMS), which will employ the latest energy technologies. The project will be implemented in two stages, with the following schedules:

| Project name | Ulleung Island's Eco-friendly Energy Independence |
|--------------------------------------|--|
| Special purpose company (SPC) period | October 2014 to December 2014 (3 months) |
| First implementation stage | January 2015 to December 2017 (3 years) |
| Second implementation stage | January 2018 to December 2020 (3 years) |
| Project management period | January 2017 to December 2036 (20 years) |
| Key tasks | Management of ICT converged solar power, wind, small hydro, geothermal and fuel cell generation plants |

Table 1. Summary of Ulleung Island's Eco-friendly Energy Independence Project

1.1 Project purpose

1.1.1 Creation of a business model on energy independent island

The project targets isolated island regions that are powered by high cost fossil fuels that have a low cost recovery rate. Once preparations are complete, the project plans to build a decentralized, smart-grid power supply system, which will utilize new and renewable energy sources. Smart grid projects such as the Ulleung Island project are expected to create a new business model and a great opportunity for developing a new market. If the project is successfully implemented, Korea plans to apply the micro grid model to other remote regions in Korea, such as military units and mountainous areas.

1.1.2 Promotion of the Ulleung Island model to overseas markets

The project will be a test bed for an environmentally friendly energy independent island model. Participants in the project will be equipped with experience and knowledge, which will be helpful in securing competitive advantage over other competitors in global markets. Once the project is proven successful, it will open an opportunity for joint projects with international organizations, in which domestic firms can participate and gain great advantage for overseas market advancement.



Figure 1. Aerial View of Ulleung Island Energy Independence

1.1.3 Promotion of regional tourism and economic revitalization

Korea hopes that Ulleung Island's clean green image will boost the region's tourism industry.

The project plans to utilize its eco-friendly features—new and renewable energy plants, smartgrid system and electric cars—to create a unique experience for visitors to the island, such as a geothermal energy powered holiday resort with hot springs. The tourism industry will not only increase the profile of the Ulleung model, but also revitalize the island's economy.

1.2 Procedures

1.2.1 Establishing a special purpose company (SPC) and financing

Prior to official launch of the project, a smallscale SPC was formed, with the Korea Electric Power Corporation (KEPCO), Korean battery producer LG, the Ministry of Trade, Industry and Energy, Gyeongsangbuk-do provincial government and the Ulleung County as members. The SPC will carry out preliminary work, such as Met Mast installation and analysis, securing construction sites, licensing, and obtaining authorizing permits and approvals for the project by the end of December 2014. The estimated project expense is 330 billion KRW, and the cost will be shared by SPC investment funds and Project Financing (PF). To increase the participation of local residents and discuss their share of the cost burden, the SPC plans to devise a detailed regional participation plan.

Figure 2. Financing Strategy (Billion KRW)



1.2.2 Implementation plan

The first stage of the project has the goal of supplying 30 percent of the total electricity used on the island through new and renewable energy by 2017. During the first stage, ESS/EMS-equipped power generators using solar energy, wind, and small hydropower will be installed, which will reduce the island's dependency on diesel-powered electricity. Once the installation is completed, a load control test for the entire island will be carried out. In the second stage, which aims to turn the island into a diesel-zero island by 2020, geothermal and fuel cell power plants will provide base load power generation. Upon completion of the second stage, Ulleung Island will become the world's largest scale (more than 10,000 inhabitants) eco-friendly energy independent island with the latest ICT that combines ESS and EMS.

Table 2. Composition Plan for Capacity by Project Stage and Energy Source

| Current | (MW) | | | Capacity by stage and energy source (MW) | | | | | | | |
|---------------|-------|-------|------|--|--------|-------|------|----------------|-----------------|--------------|--------------|
| Diesel | Hydro | Total | | Stage | Diesel | Hydro | Wind | Solar power | Geo- thermal | Fuel cell | ESS (MWh) |
| 18.5 0.7 19.2 | 1st | 15.2 | 0.66 | 8.0 | 1.0 | | | 21 | | | |
| | | | | 2nd | 0 | 0.66 | 8.0 | 1.0 | 4 | 23 | 36.5 |

Figure 3. Timetable for introducing new and renewable energy sources



1.2.3. Regional specialization projects

In connection with the ongoing energy project, Ulleung Island plans to carry out two specialization projects for the islanders. With the estimated cost of 228 billion KRW, the "Green Island Project" aims to make Ulleung a zero-carbon island that features Green Roads, World Geologic Park, and Ulleungdo and Dokdo Ecology Research Centers, which may attract tourists from the mainland and overseas. With the estimated cost of 25 billion KRW, the "Eco-friendly Energy Specialization Project" is intended to provide financial support for subsequent programs/projects related to new and renewable energy convergence and for fostering regional specialization.

1.3 Expected Effects

The estimated economic effect of the Ecofriendly Energy Independence Project is expected to be about 3.1 trillion KRW. Once implemented, the project will enhance Korea's capability for blackout prevention, save costs on generating units, supply electricity in an economical way, and increase new and renewable energy use, all of which will bring a combined economic benefit equivalent of 1.7 trillion KRW. In addition, the economic effect of reduced energy consumption, production inducement effect, job creation and reduction in carbon dioxide emissions is expected to be about 1.4 trillion KRW. Once the project in Ulleung Island is successful, Korea will have the world's first proven track record of a large-scale business model that will open a new opportunity for domestic businesses to advance into overseas microgrid markets. The project will become a new growth engine in the energy sector for Korea.

Figure 4. Expected Effects of the Ulleung Project



1.3.1 Economic feasibility and impact

The total cost of the project is estimated to be 273.8 billion KRW (approximately 250 million USD), including first stage costs of 160.4 billion KRW and second stage costs of 113.4 billion KRW. Estimated savings from reduced fuel consumption are expected to be 320.7 billion KRW, making the level of benefit-cost ratio (BCR) 1.17 (320.7 billion KRW/273.8 billion KRW). In detail, during the first stage, Korea is expected to create 824 jobs and 74.3 billion KRW in value added, and reduce carbon dioxide by 4,771 (tCO₂), an economic impact of about 342.3 billion KRW in Korea.

1.3.2 Globalization of the energy-independent island model

With the Ulleung energy independent model, Korea plans to develop similar projects for developing nations around the world through cooperation between the Korea International Cooperation Agency (KOICA), a Korean ODA agency, and international multilateral development banks,

Table 3. Economic Impact(based on the first stage)

| Job creation | 824 jobs |
|---------------------------|------------------------|
| Value added cre- ation | 74.3 billion KRW |
| Production inducement | 268 billion KRW |
| CO ₂ reduction | 4,771 tCO ₂ |

such as the Inter-American Development Bank (IDB) and the Asian Development Bank (ADB). In particular, based on the Ulleung model, Korea plans to support master planning for energy-independent island regions of developing countries through KOICA's development funds. IDB is planning to carry out a feasibility study and verification test on energy efficiency and renewable energy in Central America and the Caribbean; Korea plans to discuss ways in which Korea and IDB can cooperate on the project, such as sending Korean experts and domestic energy firms to carry out the project.

In addition, Korea and ADB are jointly conducting a feasibility study on the development of decentralized power generation using new and renewable energy sources in island regions of the Philippines. A project agreement was signed between the Korea Energy Management Corporation (KEMC) and ADB in June 2014, with a goal to launch a feasibility study between July and December, 2014. The project will be financed by means of a matching fund of 430 million KRW, of which 300 million KRW will be financed from the Korean side.

Table 4. Inducement Coefficient by Energy Source (Job/1 billion won)

| | Hydropower | Wind | Solar energy | ESS |
|-----------------------------------|------------|-------|--------------|-------|
| Job creation coefficient | 7.931 | 7.654 | 15.633 | 4.4 |
| Value added coefficient | 0.636 | 0.641 | 0.540 | 0.543 |
| Production inducement coefficient | 2.247 | 2.294 | 1.963 | 1.986 |

2. The Gwangju-city case

On 15 September 2011, Korea experienced unprecedented and nationwide blackouts. The government attributed the blackouts to unseasonably high temperatures, which increased electricity demand for air conditioners. The Korea Power Exchange (KPX) estimated the daily peak-hour demand to be 64 million kWh that day, when the actual electricity demand was 67.26 million kWh, and the consumption level breached the 4 million kW reserve margin. When electricity consumption showed no signs of abating and reserves ran dangerously low, the KPX and KEPCO, the sole utility provider in Korea, implemented an emergency rolling blackout. This was Korea's first nationwide emergency rolling blackout, and the power outage was carried out immediately without prior notification. Hundreds of businesses and factories without backup power supply systems were hit by power failures and sustained damage. The rare blackout and possible recurrence threat prompted the government at various levels to pay serious attention to energy-saving efforts and to initiate energy conservation measures nationwide. Among regions, the metropolitan city of Gwangju has made notable progress in its innovative effort to conserve energy. The city of Gwangju is committed to making itself a world-class energy efficient city through systematic implementation of energy savings programs at a regional level. Gwangju's innovative, region-wide energy conservation efforts earned first place in the 2013 National Energy Savings Evaluation, and the Presidential Commendation in honor of energy conservation efforts. The following are some notable conservation policies the city of Gwangju has implemented successfully:

2.1 Scaling up energy efficiency through using LED lights

First, the city targeted florescent lamps at underground parking lots of multi-dwelling units, such as apartment buildings. By replacing these lights with highly efficient LED lights, the city reduced electricity costs and encouraged the usage of LED lights. The project aims to replace about 252,000 fluorescent light fixtures with LED lights by December 2015, at an estimated cost of 18.2 billion KRW. Private firms share the cost of 17 billion KRW, while the City of Gwangju bears 1.2 billion KRW. Incurred costs are expected to be recovered within 2 to 2.7 years by means of ESCO financing (ESCO: Energy Services Company), in which an energy services company finances or arranges financing for the energy-saving project and costs are repaid from the energy savings achieved. By the end of the project, the city expects to reduce power consumption by up to 75 percent, a decrease of about 60 million kWh, equivalent to cost savings of 10.8 billion KRW annually. Given the fact that participating LED lighting producers are small-scale local firms, the local government assists them in obtaining investment funds through a financing program called "factory financing" from local commercial banks, such as Gwangju Bank.

2.2. Carbon-bank system

Similar to many big cities around the world, Gwangju had a high proportion of electricity consumption from the household sector, which accounted for 59 percent of total electricity consumption in the city. Thus, reductions at the household level were urgently needed for energy conservation. For this reason, the city launched an innovative and household-centered carbon finance system to lead local residents to change their perception of climate change and become actively involved in energy conservation efforts.

In the carbon bank system, cash value points are rewarded to local residents who reduce their consumption of energy. Points are provided to each participating household every year, provided its electricity, water, and gas consumption has decreased compared to its average consumption over the last two years, calculated based on data from KEPCO, Gwangju Metropolitan Waterworks, and City Gas Corporation. Carbon points are converted to cash-equivalent amounts deposited into personal banking accounts, which can then be cashed at Gwangju Bank or other participating financial institutions. Through this system, the amount of greenhouse gas reduction is analyzed, which enables the system to be consistently improved through monitoring. As of 2012, the city was able to reduce electricity consumption by 44,245,538 kWh when compared to the base year, and some 300,000 of Gwangju city's total of 540,000 households are participating in the scheme, a participation rate of 56 percent.

In addition to energy conservation in the household sector, the government encouraged large commercial buildings to join a carbon-neutral program, in which an energy reduction goal is set and a partial amount of the reduction is recognized as carbon reductions, if the goal is met. Through this program, in 2012 alone, Gwangju City was able to further reduce electricity consumption by 232,973 kWh from 48 commercial buildings, including large department stores.

2.3 Energy conservation campaigning

Gwangju City has carried out diverse energy conservation campaigns, targeted at raising energy consciousness in the daily activities of its citizens. Together with 26 non-governmental organizations (NGOs), the city carried out a public awareness campaign many times throughout the city, focused on the importance of energy conservation. One notable example is the public campaign for building the so-called 'civic power plant'-which informs the public that the combined small amount of energy savings from each of the citizens is equivalent to the capacity of one power plant. Gwangju City formed a collaborative network with KEPCO, Korea Energy Management Corporation, and the city's boroughs, and reached out to the public by various means-TV commercials, radio, newspaper, bus advertising and electronic advertising boards-encouraging citizens to join the city's energy conservation efforts. To coordinate such efforts, Gwangju City formed an energy conservation headquarters, which became a control tower for campaigning in different districts of the city. Within the headquarters, a task force team was organized to effectively support the city's energy-saving efforts at a working level, and to communicate directly with the public to enhance the public awareness effect.

| | Household and commercial sector | | Transportation sector | | Industrial sector | | Public sector and others | | Total |
|-------------|---------------------------------|-------|--------------------------|-------|-------------------|-------|-----------------------------|-------|-------|
| | Usage | Share | Usage | Share | Usage | Share | Usage | Share | |
| Electricity | 396 | 59% | 5 | 1% | 231 | 34% | 44 | 7% | 676 |

Table 5. Final energy consumption by sector, 2012 (Unit: 1,000toe, percent)



Figure 5. Public Awareness Campaign

2.4 Dissemination of energy crisis and creation of emergency energy saving system

At the institutional level, Gwangju City established the so-called "Safety Management System" for multi-dwelling management office or industrial customers that have energy consumption levels above 3,000 kWh. When current energy consumption reaches a crisis level, a short-message service (SMS) sends emergency alerts in real time to participants' mobile devices, inducing them to conserve energy. This system is intended to encourage active and instant public participation to prevent energy blackouts or to get out of emergency situations quickly. The system is comprised of 1,963 participants, among which are 854 participants from the public sector, and 1,109 participants from the private sector.

UNITED ARAB EMIRATES

The UAE's Best Practices in Government-related Activities in the Green Economy

Abstract

The rising global challenge of energy supply and security, and climate impact has created a complex and uncertain energy environment. In this context, the United Arab Emirates (UAE) government has adopted a position as leader and pioneer in the new energy landscape, with significant projects and public policy focused on pursuing sustainable development. This can be seen in the country's Green Economy Strategy, launched in 2012 by the federal government. In addition, government-led initiatives (GLIs) or government-supported entities (GSEs) are making inroads across all sectors of the green economy, simultaneously improving the nation's competitiveness and reducing its ecological footprint.1 For example, Masdar City² is a multi-billion dollar, unique clean energy cluster that advances renewable energy and sustainable technologies through education, research and development (R&D), investment, commercialization, and adaptation. There are several other solar energy initiatives, with additional solar energy projects being used to desalinate seawater, as well as to bring fresh water to desert flora and fauna. Recognizing that the environment has no borders, the UAE's green ambitions also extend beyond its borders; for instance, Masdar is developing significant solar and wind energy projects internationally in conjunction with leaders in the clean energy field. These and





other initiatives are part of a sector-based approach and plan to make the UAE a leading green country of the 21st century.

Introduction

As a founding member nation of the Global Federation of Competitiveness Councils (GFCC), competitiveness is clearly an important topic for the UAE. The Emirates Competitiveness Council (ECC) is the entity in the country responsible for coordinating the efforts of the individuals and groups (private and public, both domestic and international) working-either directly or indirectly-to achieve the nation's competitiveness goals. From this vantage point, the ECC is well positioned to assess the actions, policies and initiatives in the UAE that work towards the nation's competitiveness strategy.

This paper outlines the UAE's strategic policies for sustainable development-the simultaneous achievement of economic, environmental and so-

¹ The ecological footprint is a measure of a human's impact on the Earth's ecosystem. It is calculated by Global Footprint Network. The most recent figures were released in 2014.

² Masdar, a.k.a. the "Abu Dhabi Future Energy Company", is a renewable energy company based in Abu Dhabi, UAE. Masdar City - part of Masdar - is designed to be an environmentally sustainable city powered completely by renewable energy.


<image><caption>

Driverless electrical pod shuttles people around Masdar Institute

Wind tower at Masdar Institute

What is competitiveness?

The challenge faced by all nations is how to ensure that they are able to provide the material and social goods and services that will improve the physical and mental wellbeing of their constituents. National competitiveness thus relates to how efficiently and sustainably countries are able to provide these to their people. The International Institute for Management Development (IMD), author of the World Competitiveness Yearbook (WCY) and a pioneer of the subject, defines competitiveness as the analysis of "how nations and enterprises manage the totality of their competencies to achieve prosperity or profit" (IMD, 2014). Likewise, the World Economic Forum (WEF), author of the Global Competitiveness

cial development—against the backdrop of global energy and environmental challenges. In particular, this piece examines how GLIs or GSEs are affecting or operating in the green economy space. It shows that the actions taken to capitalize on the green economy (and as a corollary reduce the UAE's ecological footprint) are not only socially responsible, but also improve the competitiveness of the country and have positive spillover both at home and abroad (Dechezlepretre et al., 2013; Scharwzer, 2013; UNEP, 2011). These efforts have set the stage for the UAE to lead in the clean energy sector as part of its goal to become a sustainable, diversified economy. Report (GCR), defines it as "the set of institutions, policies and factors that determine the level of productivity of a country" (WEF, 2014).

Nevertheless, competitiveness is not a static concept, and no entity has a monopoly on its definition. Indeed, academics and policymakers are increasingly becoming aware of the limitations of traditional measures of productivity and prosperity (e.g., GDP) as a means of measuring human development and the catch-all term "competitiveness." For this and other reasons, the notion of competitiveness has expanded from the more narrow view of economic productivity (aligned with GDP) to include more holistic factors such as happiness, sustainability, human capital, quality of life, etc. Indeed, the WEF also includes in its GCR a sustainability-adjusted ranking of competitiveness. At the same time, reports such as the World Happiness Report (WHR) and the Living Planet Report (LPR) have increasingly been attracting the attention of the public and decision makers. The United Nations (UN) has its own measure of human development (aptly named the Human Development Report) that looks at the totality of the human experience based on the dimensions of income (GNI per capita), education (mean years of schooling and expected years of schooling) and health (life expectancy at birth). More recently, the Organisation for Economic Cooperation and Development (OECD) has rolled out its Better Life Index trying to capture the totality of life satisfaction. The London-based Legatum Institute tries to balance both economic prosperity and social wellbeing in its Prosperity Index. All these measures of competitiveness convert a set of factors/indicators into a real-number output (or set of outputs), enabling cross-country comparisons on the effectiveness of nations in delivering the material and social goods that contribute to the welfare of their members. And, increasingly, these measures are incorporating more facets of sustainability.

Benchmarking is an essential tool in understanding one's relative strengths and weaknesses; however, competitiveness is not a zero-sum game with one country's strong performance diminishing another's less-strong standing. Indeed, national competitiveness has positive spillover effects insomuch that efficient technologies, processes and goods in one country are diffused to the world. And competitiveness also means different things to different nations (at different stages of development and with different endowments). A competitive economy is not necessarily one that excels in the production of every good or service. Rather, as economist David Ricardo captured in his seminal work on comparative advantage, individuals and countries benefit from specialization and trade. So countries can be simultaneously and complementary competitive. Case in point, the United States is a highly competitive economy with a focus on culture and media, while German competitiveness derives from manufacturing. Neither country's prosperity in their dominant sphere diminishes the other's wellbeing.

Energy and environmental challenges

Global climate change and the degradation of Earth's natural environment are a reality (e.g., UN, 2013). Scientists have already documented a dramatic increase in the level of greenhouse gas (GHG) in the past century leading to a rise in the global average temperature (average across all surface) by about 1 degree Celsius, and which is expected to continue climbing (UNEP, 2014). Climate change has already resulted in large economic losses as the result of greater incidence and stronger intensity of extreme climatic events (e.g., hurricanes, floods, etc.). Likewise, the technologies for extracting natural resources and converting them to goods have negatively impacted the natural environment causing the loss of natural habitats and reduced biodiversity (e.g., UN, 2013).

Calculations by the Global Footprint Network (GFN) show that the global ecological footprint exceeds the global bio-capacity (WWF, 2014). In other words, the amount of resources used to provide the goods and services used by the world exceeds the ability of the planet to replenish itself. This is not sustainable. Indeed, the planet has been running a deficit for many years, with rich nations consuming much more resources than their long-term carrying capacity (WWF, 2014). Indeed, the economic paradigm of development is surely doomed if there are no fundamental changes made to human behavior. If China and India—which account for more than one-third of the world's population—were to reach a level of prosperity in consonance with the "developed" world and consume resources and produce waste at similar levels, the planet will become environmentally bankrupt in a matter of decades.

The world must come up with a solution to the global environmental challenge. And herein lies the opportunity for those who are willing to be bold and take a leadership role in finding those sets of policies and actions that will ameliorate and repair the environmental damage that is currently underway because of our "development." And this is where the UAE has been astute in positioning itself within this niche as a leader (with the commensurate advantage of being a pioneer) in the green economy, with a particular focus on the renewable energies sector.

The UAE history as a hydrocarbon nation

The UAE was formed in 1971 as the union of seven emirates. Although the country is often referred to as an "oil-rich nation," the reality is that hydrocarbons have been only a recent discovery in the region and their presence is primarily limited to the emirate of Abu Dhabi. By most measures, the UAE is a diversified economy, with oil and gas accounting for less than a third of the UAE's GDP and less than half of its exports.³ Indeed, oil and gas account for only 2 percent of the gross product of Dubai and virtually zero in the remaining emirates.⁴

The UAE's Vision 2021

At the heart of the UAE's strategic plans is a diversification of the economy. Vision 2021–the county's national strategic development blue-print–calls for the nation to be among the best countries in the world by 2021 (the UAE's golden jubilee year). This vision is underpinned by 4 tenets: (1) responsibility, (2) destiny, (3) knowledge, and (4) prosperity.

Within the tenet of knowledge is a set of national goals, two of which are: (i) To transform the country into a "sustainable and diversified economy," and (ii) To become "a knowledge-based and highly productive economy. With regard to (i), Vision 2021 calls for "balanced growth [that will]... be fuelled by a sustainable range of energy sources...within which the UAE will ensure an important role for alternative and renewable [energies]." The aim is to create "lasting competitiveness" by looking "beyond traditional economic models and take a more flexible perspective [for development]...where growth is driven by knowledge and innovation." ⁵

The green economy

The green economy is defined by the United Nations Environmental Programme (UNEP) as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (i.e., it is low carbon, resource efficient and socially inclusive)" (UNEP, 2011). There are six components of the green economy:⁶

- 1. Renewable energies
- 2. Green building
- 3. Sustainable transport
- 4. Water management
- 5. Waste management
- 6. Land management

³ Sources: International Trade Competitiveness, National Bureau of Statistics, Observatory of Economic Complexity.

⁵ UAE Vision 2021: http://www.vision2021.ae/en

⁶ Another aspect of the green economy (but not included in UNEP definition) is biodiversity management; i.e. ensuring that the diversity of flora and fauna is maintained and not compromised by human activity.

The UAE, both directly in terms of GLIs and indirectly by the actions of its GSEs, is targeting all six of the green economy principles (as well as biodiversity management). For example, the UAE is home to the International Renewable Energy Agency (IRENA), an intergovernmental organization that supports countries in their transition to a sustainable energy future. More tangibly, Dubai Solar Park is expected to generate 1,000 MW of power by 2030. Most recently, the Dubai Government issued its Green Building Regulations & Specifications in September 2014, outlining the green specifications for all new buildings in that emirate. Dubai also created the Dubai Awards for Sustainable Transport (DART) several years back to encourage green solutions to its transportation system, which in recent years has rolled out two metro lines and a tram, alleviating some of the emirate's vehicular traffic (a big contributor of GHGs). The UAE is also home to the International Centre for Bio-saline Agriculture (ICBA), with its focus on water management. With regard to waste management, recycling programs are gaining traction with, for example, the launch in Dubai of My City My Environment in 2012. Finally, with respect to land management, much of the desert-a highly diverse and fragile landscapehas in recent times come under protection (e.g., Jebel Ali Sanctuary, Arabian Oryx Protected Area, Dubai Desert Conservation Reserve, etc.) as a result of growing awareness of the importance of land conservation.

The link between the green economy and competitiveness

Although there is a perception of an antagonism between the environment and the economy, nothing could be further from the truth. This distorted view derives from having an improper perspective on the economy/competitiveness. Competitiveness is not a one-off game; rather, it is an infinitely repeated set of interactions, where each period countries try to achieve the best for their constituents under the limitations of the economy and the planet. It is this long-term view that needs to be taken to see why the green economy and competitiveness are synonymous.

Green solutions help competitiveness when governments put the right framework in place for agents in the market to take more long-term and holistic views on their motivations. That is, policy makers should create an economic framework that makes firms include social and environmental goals in their objective function or, conversely, incorporate the environment into the constraint under which firms optimize. Strong environmental laws are not "anti-business"; rather they are "pro-market" and, in fact, spur innovation and help connect the current and future prosperity (e.g., CIEL, 2013).

The UAE's green economy initiative

In January 2012, Sheikh Mohammed bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, announced the launch of the nation's Green Economy Initiative under the slogan of "a green economy for sustainable development." The government has embraced the green economy not only as a means to ameliorate the country's environmental impact, but also to become a leader in the technologies that will underpin the green economy.⁷ There is much work that needs to be done in the UAE, where currently the region has one of the highest per capita ecological footprints. The country's extreme environs pose natural challenges (e.g., the weather necessitates air conditioning for much of the year). Likewise, the arid landscape makes desalination a necessity to produce fresh water. But GSEs in the UAE are turning these obstacles around and making them assets. For example, the abundance of desert sunshine has, in turn, spawned investments in solar technology. This includes using solar energy to desalinate seawater, as well as to draw brackish or brown water from the water table and purify them for

⁷ The Global Green Economy Index is one notable report that tries to quantify the effectiveness of countries in "creating strong economies that also reduce their degradation of the environment."

desert flora and fauna. ICBA is also working on R&D to develop plants more amenable to desert conditions and that can use brackish/saline water to reverse human-induced desertification. Likewise, Etihad Airways⁸ (in conjunction with Masdar) is working on developing algae that thrive in the desert conditions and saline water as biofuels for its planes.

The government's role in the green economy

The UAE government has taken a decisive role in spearheading the development of the green economy. This is not by some accident of chance or a strategy that only has merits in the UAE. Indeed, the environment knows no boundaries. Air pollution passes from one country to another unhindered by artificial political borders. Thus, while there remains wrangling on the international stage on getting countries to sign up to a green agenda, the UAE is unilaterally making strides in developing its green economy strategy.

The "green economy" and the "economy," often treated as two dichotomous subjects, are in reality highly interlinked and one and the same as all our activities in one way or another impact the environment—the goods and services we produce and consume are not done so in a vacuum in isolation of the planet. The ultimate goal is to ensure that the totality of our activities do not overburden the capacity of the environment to sustain us. It thus behooves governments to set up the correct framework to ensure that human actions are working within the boundaries of long-term prosperity.

Why government?

While some governments elsewhere are still debating the causes or the effects of climate change (or in some cases even its veracity), the UAE government has taken a forward-leaning approach. Under the current economic para-

digm-where goods and services do not reflect their total social costs and benefits-markets do not produce enough positive externality goods (e.g., clean air) and conversely too many negative externality goods (i.e., "bads," such as pollution). From basic economics we know that since we have poorly distributed/enforced property rights, especially with respect to common goods (e.g., the oceans), we as humanity suffer a "tragedy of the commons" (e.g., overfishing) on shared/ public resources. Simply put, neither purely selfinterested governments nor private entities will produce the optimal amount of green goods. This is a market failure that needs to be addressed by government. In the absence of a World government, global public goods-e.g., the global clean environment-will not be provided outside of unilateral (or altruistic) actions.

What can other countries learn?

It may be argued that UAE's example as a hydrocarbon-rich nation choosing to channel those funds into the green economy has inspired similar initiatives in the region. Hopefully, the country's bold vision and proactive government approach to the green economy will spur yet other countries to do likewise. Certainly, the UAE's actions through GLIs and GSEs are already helping the global green economy by funding and developing clean technologies that are otherwise underprovided by private markets.

The Stone Age came to an end not because humans exhausted the stock of stones. Just as much, the Fossil Fuel Age will end before fossil fuels are depleted from Earth. The UAE is not only planning for that transition, but also leading the way in spite of its comparative advantage as a resource-rich nation. There is no contradiction or inherent incongruousness in aiming to be a leading green economy while being rich in hydrocarbon resources. Indeed, steering funds derived from hydrocarbons and investing in renewable energies is a way of paying forward for our current dependence on fossil fuels.

⁸ Abu Dhabi's domestic airline.

Case study: Masdar

Established in 2006 as a subsidiary of the Mubadala Development Company,² Masdar ("source" in Arabic) is a highly innovative, multifaceted business model focused on the clean energy space. This case study explores a few of the projects that Masdar is undertaking in the renewable energies sector at home and abroad. In the process of investing in clean technology companies and developing large-scale renewable energy projects, Masdar is helping to contribute to the UAE's goals of economic diversification, its Green Economy Initiative, as well as Vision 2021 by building up the knowledge-based sectors of the economy that are a hallmark of green technologies.

Masdar is a major player in the global renewable energy market, which in 2013 saw \$214 billion in investments.³ Masdar is not only important for its business imperative, but also for providing a valuable platform for international policy makers to address global challenges in the energy sector. Additionally, by creating fertile soil and planting the seeds for a new generation of green energy experts, it is ensuring a bright future for the UAE where growth and prosperity are derived from knowledge and innovation.

Structured as integrated business units, Masdar includes an investment arm (Masdar Capital), a renewable energy power generation and operation unit (Masdar Clean Energy), and an indepen-



Student shaping frontiers of renewable energy, in a clean room at Masdar University's Institute of Science and Technology, UAE.

dent research-driven graduate university (Masdar Institute). Masdar's infrastructure also includes a cutting-edge urban complex (Masdar City), where innovative technologies can be tested and implemented in a real-life context of residences and workplaces. These integrated components allow Masdar to conduct a range of activities including innovation and R&D, investment, and utility-scale renewable energy projects. The coming together of different value chains including solar, wind and carbon capture, under a single umbrella creates a robust environment for knowledge sharing, collaboration, and commercialization to address today's energy challenges.

Masdar is making significant national and international contributions by competitively positioning the UAE in critical areas of the clean energy value chains. This includes manufacturing, energy generation and storage, power distribution, as well as the reduction of carbon output by means

Mohamed, Shaheena (2013). "Masdar: Powering UAE's competitiveness with clean energy." Policy In Action (Emirates Competitiveness Council) Issue 05 Jul-13.

² Mubadala is an investment vehicle of the Abu Dhabi government with a mandate to facilitate the diversification of the economy.

³ Source: Global Trends in Renewable Energy Investment 2014.

of efficiency and carbon capture and storage. Below are a few examples of key areas in which Masdar occupies a pivotal position in leadingedge technologies:

Manufacture of photovoltaic panels

Solar photovoltaics (PV) is a growing area of the solar energy market. PV is a technology that converts sunlight directly into electric current using semiconductor material such as silicon. Thin-film cells are manufactured by applying thin layers of semiconductor material to manufacture solar panels. Masdar PV GmBH (Masdar PV), a whollyowned subsidiary of Masdar, is producing the next generation of PV films, with new kinds of materials and innovative cell structures. It currently manufactures cells that are eight times larger and more powerful than the industry standards. For instance, it produces modules with up to 10 percent efficiency-an industry benchmark that implies a higher energy yield and profitability for the same surface area than competing products. It has been able to achieve this industry leadership through a corporate strategy centred on R&D for product improvement and on industry-academia collaborations.

In a separate initiative, to promote greater uptake of PV solar technology in the Middle East, Masdar Institute is collaborating with Siemens Energy to develop PV coatings that counteract the effects of dust accumulation (a problem in the desert) that hamper the effectiveness of solar panels.

Utility-scale power generation

Another key area in which Masdar is a strategic player is power generation using renewable sources of energy. Masdar Clean Energy invests in technologies for utility-scale renewable energy and is a developer of clean power generation projects. Its portfolio of utility-scale projects consists of direct investments in individual projects in all areas of renewable energy, with a focus on PV solar energy, concentrated solar power (CSP), and wind energy—areas which have relevance internationally and for the UAE. Some key projects include:

Photovoltaic solar energy

Masdar's earliest PV project in the UAE, the 10-megawatt (MW) PV plant at Masdar City, operational since 2009, reduces carbon emissions by 25,000 tonnes annually. The solar power plant meets the energy needs of the Masdar Institute, Masdar's site offices, and it powers the on-going construction activities of Masdar City. The PV plant, consisting of 87,777 panels (50 percent thin film and 50 percent crystalline silicon), is one of the most cost-efficient PV installations in the world.

Currently, Masdar Clean Energy is developing one of the world's largest solar PV plants (Noor 1, a 100 MW plant in Abu Dhabi).

Concentrated solar power

In a joint venture with Abengoa Solar and Total, Masdar Clean Energy is developing Shams 1, a 100 MW concentrated solar power (CSP) plant in the western region of Abu Dhabi, set to be the largest of its kind in the Middle East. At a cost of approximately \$600 million, Shams 1 will employ a state-of-the-art parabolic trough technology. It will reduce CO_2 emissions by 175,000 tonnes annually, equivalent to eliminating the use of



15,000 cars in a city like Abu Dhabi.⁴ Masdar Clean Energy also holds significant ownership stakes in Torresol, a joint venture with SENER Grupo de Ingeniería of Spain, to build and operate CSP plants. Masdar has invested in three projects in partnership with Torresol and SENER (Valle 1, Valle 2, and Gemasolar), all operational in the Andalucía region of southern Spain. Valle 1 and Valle 2, both parabolic trough plants with 7.5 hour of stored capacity, are in commercial operation with a total installed power of over 100 MW. Gemasolar, a CSP plant near Seville, provides electricity to more than 27,000 residents.

Wind technology

Often clustered in farms, wind turbines convert wind energy into electricity and are a growing source of energy globally. Large wind farms consist of hundreds of individual wind turbines connected to an electric power transmission network. Wind power is becoming a favoured source of renewable generation, with the global wind power market increasing 6 percent to 41 GW in 2011.⁵ Madar Clean Energy is building wind energy sources in the UAE and internationally. In the UAE, it is putting in place a wind farm on Sir Bani Yas Island, 250 km southwest of Abu Dhabi, with a targeted capacity of 28.8 MW for the first phase.

An iconic wind technology project of Masdar is the 1,000 MW London Array offshore wind farm in the Thames Estuary, a joint venture with DONG Energy and E.ON. Set to become the world's largest offshore wind farm, the project will consist of up to 278 wind turbines, producing enough energy to power 750,000 homes—displacing the emissions of 1.9 million tonnes of CO_2 per year as part of the UK government's goal of generating more than 15 percent of its electricity supply from renewable sources by 2015.

⁵ Bloomberg News, Wind Power Market Rose to 41 Gigawatts in 2011, Led by China, Alex Morales, 07 February 2012

⁴ Abengoa Solar website (accessed 12 December 2012).

A Race to the Top

By aggressively pursuing a green economy strategy, the UAE is helping to shine a spotlight on clean technologies. Governments can-and should-play an activist role in the green economy, especially as private markets acting alone are unable to achieve the socially optimal solution. This is because private markets do not price in externalities, leading to too many bads (e.g., pollution) and too few goods (e.g., clean air). As a corollary, public goods, such as the clean environment, are not best provided by free markets. Therein lies the impetus for strong policies by governments to ensure that environmental laws encourage longterm thinking of economic agents. Finding green solutions will help nations in transition avoid the path of pollution (i.e., a Kuznets curve between development and pollution) and leapfrog onto cleaner technologies.

When governments from around the world compete to deliver on good environmental outcomes, this will become a race to the top, with society and the planet benefiting. In short, what is good for the environment is good for competiveness.

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UNITED STATES

From Knowledge to Action: Taking a New Regional Competitiveness Model to National Scale

Regional Competitiveness: A New Model of Economic Development Emerges

Despite the rising competitive and economic challenges of the 1980s and 1990s, several regions of the United States were thriving by harnessing regional R&D, technology, investment, talent, and business resources to grow their economies and industry clusters, while other regions with similar competitive assets struggled. Examples include Silicon Valley and San Diego, California: the Boston. Massachusetts Route 128 corridor; and the Research Triangle in North Carolina. These regions were getting new business investment and new business formation, inflows of high-skill talent, and high wage job creation. Even Pittsburgh, Pennsylvania-a once thriving steel industry leader that had gone into industrial decline-was transforming its economy with advanced technology.

This "grow your own" economic development model was a significant departure from the industrial recruiting strategies that were predominant economic development tools of the time. These successes attracted growing attention from the economic development community across the United States, and many States and regions sought to replicate them.

The Council on Competitiveness sought to understand why some regions were more successful than others in harnessing their competitive assets to drive economic growth, believing there were important lessons to learn for the country and for policy makers at all levels of government who seek to implement policies, investments, and programs to stimulate the economy.



Developing the Knowledge Base

To first better understand factors that led to success in these regions, and build a solid base of knowledge, in 1999 the Council launched the *Clusters of Innovation Initiative*—one of the most ambitious projects in its history. It was designed to map and compare the development of clusters around the country, identify factors that contribute to strong regional clusters and overall regional competitiveness, and develop insights and recommendations for how regions can improve conditions that spur innovation and cluster development.

The project included a collaborative effort with Michael Porter of the Harvard Institute for Strategy and Competitiveness to examine the roots of regional economic performance. The study built on Porter's work on cluster-based economic development theory, and involved regional surveys and interviews focused in five U.S. regions: Atlanta, Pittsburgh, the North Carolina Research Triangle, San Diego, and Wichita. These regions were selected to provide diversity of size, geography, and economic maturity. They were similar enough to allow for important comparisons, yet

Overall Economy

Employment growth Rate of employment growth

Unemployment Percentage of persons unemployed

Average wages Payroll per person

Wage growth Growth rate for payroll per person

Cost of living Cost of living index

Exports

Value of manufactured and commodity exports per worker

diverse enough to encompass a wide variety of challenges and opportunities in regional economic development. A case study on each of these regions described their clusters, and identified key regional assets such as research institutes, talent, infrastructure, elements of a good business environment, and leadership and institutions that foster regional economic collaboration. The project looked at performance indicators such as job creation, wages, patent registrations, venture capital funding, new business formation, and fast growing firms.

In addition, the Council served as a leading partner in the U.S. Department of Labor's \$300 million Workforce Innovation in Regional Economic Development (WIRED) initiative, focused on the role of talent development in driving regional

Innovation Output

Patents Number of patents and patients per worker

Establishment formation Growth rate of number of establishments

Venture capital investments Value of venture capital invested per worker

Initial public offerings Number of initial public offerings per worker

Fast growth firms Number of firms on the Inc. 500 list vs. overall size of the regional economy

competitiveness, job growth, and worker opportunity. WIRED was a living laboratory in which 39 regions of the country brought together their universities, companies, government, workforce and economic development organizations, and launched efforts to build integrated, innovationbased economic development strategies.

The Council gave guidance and training to about 20 WIRED regions across the country, and gathered promising practices in these regions to create a quarterly newsletter called *The Learning Exchange*. To support this national initiative, the Council developed *Asset Mapping Roadmap: A Guide to Assessing Regional Development Resources*, a tool to help the regions identify and evaluate their competitive assets—human capital, education and R&D institutions, financial capital, industrial base, connective organizations, legal and regulatory environment, and infrastructure and how these assets are linked. The Council published a practitioner's guide highlighting the key role of higher education institutions in regional economic development, and steps to better connect the two.

To summarize and share what it had learned, and drawing heavily on analyses in the five region study with Michael Porter, the Council developed and published *Clusters of Innovation: Regional* *Foundations of U.S. Competitiveness*, which included a rich set of findings and implications, advice on creating and implementing a regional strategy, and steps government at all levels, universities, research institutes, firms, and others can take to improve their regional competitiveness and innovation capacity. Steps ranged from state support of R&D funding at universities, upgrading business infrastructure, and establishing research and industrial parks, to supporting technology transfer from universities, encouraging university

Council on Competitiveness Regional Initiatives



business spin-outs, and regional benchmarking initiatives. This body of groundbreaking work cluster theory as an organizing principle and innovation as an outcome—set off an explosion of activity both in theoretical and applied research, and in practical activity across the United States and throughout the world.

Applying and Maturing the New Model

Regional innovation clusters entered a new stage where demonstration projects and lessons they provided were a critical success factor in advancing them. Building on a growing base of knowledge, and to apply what it had learned, the Council launched the Regional Innovation Initiative (RII) in 2003. In RII's first major activity, the Council joined forces with the U.S. Department of Commerce's Economic Development Administration (the agency with the mission of stimulating economic development through investments at the state, regional, and local levels) to implement regional initiatives over a two-year period with local partners in six areas: Central New Mexico, Northeast Ohio, Wilmington, Delaware, the Inland Northwest (Spokane-Coeur d'Alene area), West Michigan, and St. Louis.

In each region, the Council worked with local partners to implement an innovation assessment that evaluated regional strengths and weaknesses, and opportunities to strengthen competitiveness. This included using a variety of analytical methods and a regional innovation survey. Across all six regions, more than 1,250 business leaders responded to the survey and more than 180 community leaders were interviewed. These local leaders joined Council representatives and national experts to share the findings of the regional assessments at a Regional Competitiveness Summit.

Taking a New Basic Model to National Scale

Based on its work in the RII, the Council developed tools, techniques, and step-by-step instructions that states and regions across the country could use to inventory, evaluate, and benchmark their competitive assets and innovation capacity. It also published a findings report that described common regional challenges identified in the project regions, and responses to those challenges.

To further highlight the economic opportunity presented by strengthening competitiveness at the regional level, and to disseminate its findings, lessons learned, and best practices to a broader audience, the Council hosted the National Summit on Regional Innovation in Washington, DC in April 2005. More than 100 economic development professionals shared insights and best practices, and learned first-hand from leaders in innovationbased economic development. At the Summit, participants focused on five keys to regional innovation: promoting regionalism, building and retaining talent, transitioning to advanced manufacturing, networking knowledge assets, and energizing the entrepreneurial economy. A major goal of the Summit was to link regional lessons to the broader national innovation agenda.

To engage the Nation's leadership at the state

level, and inform these leaders of models for greater regional competitiveness and growth, in 2006 the Council partnered with the National Governors Association and co-published *Governors Guide to Cluster-Based Strategies for Growing State Economies.* This guide examines the changing economic environment in which clusters function, summarizes the lessons learned from recent experience, and offers practical steps for cluster initiatives that governors can take to strengthen their states' economies.

To integrate its research and practical experience, with policy and action, the Council's 2010 report, Collaborate: Leading Regional Innovation Clusters, addressed the question of what kind of leadership enables regions to harness their assets to accelerate economic growth, job creation, and prosperity. While corporate, government, and NGO leadership has been the subject of a great deal of study, regional leadership has not. Schools of public policy have no offerings on regional leadership, nor are there any departments that specialize in it. There are few, if any, conferences and publications that explore the topic. Drawing on work of practitioners and academics, the Council combined new field research and case studies to examine: why some regions are more successful than others, new tasks of regional leadership in today's competitive environment, special attributes of effective regional leaders, and organizational forms of regional leadership. Collaborate explores the key roles of leaders, and seven key characteristics of effective regional leadership such as being proactive, creating a vision, gathering data for decision making, strategic planning, being inclusive, and establishing metrics.

To achieve even greater impact, the Council has engaged national government policy leaders, and advised on how regional models can be integrated into national government economic development funding, and used to better leveraging government investments in areas such as sustainable energy, advanced manufacturing, and high performance computing:

- Energy Security, Innovation, and Sustainability Initiative (ESIS):
 ESIS focused on the role of energy in competitiveness, energy efficiency as a productivity driver, and opportunities to develop new energy innovations, industries, and jobs. The Council recommended that the United States Congress establish 15 federally sponsored regional clean energy manufacturing centers.
- U.S. Manufacturing Competitiveness Initiative (USMCI): USMCI identified challenges facing American manufacturers in the new global economy, engaged in a dialogue with the manufacturing community across the country, and set an agenda to reinvigorate manufacturing excellence in the United States. The MAKE Call to Action recommended that Congress, the Administration, industry, academia, and labor create a national network of advanced manufacturing clusters. This includes crosssector research collaborations; public-private partnerships to develop and commercialize advanced manufacturing tools, processes, and

applications; incentives for shared advanced manufacturing facilities; and broad access to cost-effective prototyping, testing, and low volume manufacturing for small businesses and entrepreneurs. These clusters can spur the growth of manufacturing, serving as platforms for regional economic growth and development.

American Energy and Manufacturing Competitiveness Partnership (AEMC):

Throughout the Winter of 2012 and Spring 2013, and in partnership with the U.S. Department of Energy, the Council undertook a review and convened dialogues, in part, focused on models for public-private partnerships to foster competitive industries. It reviewed more than 30 public-private partnerships, selected 19 for in-depth analysis, and developed four as best models for energy manufacturing and innovation ecosystems. For example, development of the successful Toledo solar energy cluster involved industry leadership from an established manufacturing base, shared infrastructure, patient and consistent funding, complementary policy tools, in-kind equipment contributions, talent spillovers, and a focus on first-to-market technologies. The Council recommended establishing a Clean Energy Materials Accelerator, and Manufacturing and Energy Technology Accelerator, both designed to connect small and medium-sized enterprises, large companies, universities, and national

laboratories to transition cutting-edge clean energy technologies into products, processes, or services produced in the United States. These accelerators would play key roles in regional ecosystems for developing and manufacturing energy innovations.

Making Impact

The Council has catalyzed regional competitiveness models across the United States. For example:

 U.S. Economic Development Administration (EDA) Funding Models:

A partner with the Council in the RII demonstration projects, EDA has embraced regional competitiveness models in its economic development investments. For example, EDA Regional Innovation and i6 Grants support U.S. regions in developing innovation strategies and innovation clusters. Funding is available for: innovation capacitybuilding such as establishing new or scaling existing Proof of Concept centers, and commercialization centers and programs; feasibility studies and development of science and research parks; and support for seed capital funds for early-stage companies and clusters. These investments help build regional assets, and networks that use innovation to drive entrepreneurship for local and regional economic development. Also, regional competitiveness has become a key element in EDA's traditional Planning and Local Technical Assistance.

National Network for Manufacturing Innovation (NNMI), Institutes for Manufacturing Innovation: The NNMI is a major U.S. government initiative to build a national network of regional clusters of manufacturing innovation. An Institute for Manufacturing Innovation (IMI)-each with a technology focus that leverages the industrial, research, and institutional strengths of the region-anchors each hub, and serves to catalyze collaboration and maximize shared advanced manufacturing infrastructure. IMI hubs bring together manufacturers, engineering schools, community colleges, government agencies, non-profits, and regional and state organizations to integrate capabilities and expertise. IMI activities include applied manufacturing research and demonstration projects, education and training, and engagement with small and medium-sized manufacturers. An initial network of 15 institutes will be built out to 45 over ten years. To date, four IMIs have been established-additive manufacturing, next generation power electronics, digital manufacturing and design, and lightweight and modern metals manufacturing. For example, located in Youngstown, Ohio, in the American industrial heartland, the additive manufacturing institute involves a 94-member partnership of manufacturers, universities, community colleges, and non-profits. Twenty collaborative research projects are underway.

National Digital Engineering and Manufacturing Consortium (NDEMC) Midwest Pilot: The Council led the NDEMC, launched in March 2011 with an MOU signed at a White House ceremony. NDEMC's main purpose was to pilot programs that promote adoption of modeling, simulation, and high performance computing among small and medium-sized manufacturers in the United States. With funding from the U.S. Department of Commerce's Economic Development Administration, the project was initially focused in the Midwest region of the United States, where an extensive manufacturing base exists and a chance for major economic impact was identified. The Council and its partners are working to scale this project into a nationwide network.

In summary, through a decade and a half of work, the Council has illuminated how regional economies evolve, and how factors such as entrepreneurship, the presence of research and training institutions, the composition of regional industries, and public and private sector actions come together to drive regional competitiveness and growth. The Council developed and disseminated tools to help regions identify and assess their competitive assets, and demonstrated ways to knit these assets together and leverage them to capture economic opportunities. This model for regional competitiveness has been embedded in billions of dollars of national, state, and regional investment designed to stimulate economic development. By moving from knowledge to action to scale-up, the Council gave powerful momentum to regional models of competitiveness, and they have taken hold across the country.

Council on Competitiveness Publications on Regional Competitiveness

Collaborate: Leading Regional Innovation Clusters, June 2010. Explores characteristics of leadership that enables regions to harness their competitive assets to accelerate economic growth and job creation.

Regional Economic and Workforce Strategies: A Focus on the Mature Workforce, May 2010. Focused on strategies to engage mature workers in meeting regional skill needs.

Engage: A Practitioners Guide for Effective Engagement of Business Leaders in Regional

Development, October 2008. Offers recommendations to help regions recruit, develop, and sustain the involvement of business leaders in efforts to strengthen regional economic development.

Retooling for Growth, June 2008. Presents new frameworks and solutions for revitalizing older industrial areas, including a focus on labor-related challenges these areas face.

Cooperate. A Practitioner's Guide for Effective Alignment of Regional Development and Higher Education, March 2008. Discusses the connection

between regional development and higher education, and strategies for regions to capture fuller benefits from their higher education institutions.

Illuminate. Asset Mapping Roadmap: A Guide to Assessing Regional Development Resources, August 2007. Guidebook designed to inform regional leaders on the theory and practice of asset mapping, and provides a step-by-step guide for implementing a regional competitive asset mapping effort in any community.

Governor's Guide to Cluster-Based Strategies for Growing State Economies, March 2007. Offers practical steps for cluster initiatives that governors can take to strengthen their states' economies.

Measuring Regional Innovation: A Guidebook for Conducting Regional Innovation Assessments, October 2005. Outlines a process for collecting data on key measures of innovation. Guidebook metrics can be used to develop an evaluation tool for regions tracking their innovation economy. **Regional Innovation/National Prosperity**, May 2005. Summary of the six-region project with the U.S. Economic Development Administration, and proceedings of the National Summit on Regional Innovation held in April 2005. Report identifies five key issues faced by regions seeking to build innovation-based strategies and suggests potential responses to these challenges.

Fanning the Flames of Economic Progress: Igniting Greater Rochester's Entrepreneurial Economy, September 2004. Assessment of Rochester, New York's economic performance and innovation capacity.

Clusters of Innovation Initiative: Pittsburgh, April 2002. Examines the Pittsburgh, Pennsylvania regional economy and its industry clusters (biotechnology/pharmaceutical, information technology, and productivity technology).

Clusters of Innovation Initiative: Atlanta-Columbus, April 2002. Examines the Atlanta-Columbus, Georgia regional economy and its industry clusters (financial services, transportation and logistics, and information technology).

Clusters of Innovation: Regional Foundations of U.S. Competitiveness, October 2001. Drawing on five regional studies, examines the composition and performance of regional economies and their industry clusters, and how a region can establish a strategy and action program to drive its economy and clusters forward. The framework used and lessons learned apply to every region of the country.

Clusters of Innovation Initiative: Research Triangle, October 2001. Examines the Research Triangle, North Carolina regional economy and its industry clusters (pharmaceutical/biotechnology, communications equipment, and chemicals, textiles, and plastics).

Clusters of Innovation Initiative: Wichita, May 2001. Examines the Wichita, Kansas regional economy and its industry clusters (aerospace vehicles and defense, and plastics).

Clusters of Innovation Initiative: San Diego, May 2001. Examines the San Diego, California regional economy and its industry clusters (biotechnology/pharmaceutical, and communications).

CANADA

A Comprehensive Innovation Structure for Alberta SMEs

Small and medium-sized enterprises (SMEs) play a critical role in both economic development and as innovators, as they make up about 90 percent of all firms worldwide (OECD, 3). Perhaps most importantly, SMEs have some significant advantages over large firms due to their size.¹ They have strong relationships with both customers and suppliers that can enable them to act more quickly to changing business environments and market needs. They have shorter lines of internal communication, and many have a strong entrepreneurial management style. Studies have shown that technical capabilities of employees in SMEs are in many cases higher than those in large companies, allowing for faster and less expensive innovation. However there are studies that show that only a small number of SMEs use these size advantages for innovation, growth and increased competitiveness. There has been little attention placed in the recent past on how to manage and support the innovation process in SMEs; indeed, most case studies and articles focus on large successful innovators, e.g., Proctor and Gamble, 3M, Apple, etc. However, the dynamics, structures and resources in those types of companies do not match up well with the majority of SMEs (Scozzi, Garavelli and Crowston, 121,124-126).

In Canada (Industry Canada 1:8, 6), SMEs account for 90 percent of all jobs across the country and 92 percent in the province of Alberta. For Alberta, fully 99.8 percent of all businesses are SMEs, and in aggregate they contribute 27 percent of the total GDP of the province (Industry Canada 2:22). Adding to the importance of

PRODUCTIVITY Productivity



SMEs, they act as centers for innovation and social integration (OECD, 3), two areas of critical importance for Alberta.

Between 2009 and 2011, only 37 percent of Alberta SMEs conducted at least one innovation project (the Canadian average is 38 percent). Innovation projects included innovations in products/services, processes, organizational design and marketing innovations. These innovations resulted in increases in sales, reduction in costs, and increases in market share. Only 11 percent of the projects initiated showed no result (Industry Canada 1:14-17).

For the 63 percent that did not conduct an innovation project, three primary reasons were given: (1) innovation is not part of our business plan, (2) business (in general) does not need to innovate, and (3) the market does not need new products or processes. At the same time, reasons for external obstacles to growth included "unstable demand for products and services" and "increased competition." Internal obstacles included "insufficient knowledge of competitors or market trends" and "too much time spent on current operations"

Industry Canada classifies SMEs as: Small = 1 - 99 paid employees, and Medium = 100 - 499 paid employees.

(Industry Canada 1:13,18). These obstacles also stand directly in the way of decisions supporting innovation projects.

Given the importance of SMEs to Alberta's regional and global competitiveness and economic and social well-being, there is increasing concern over the question of: Why do so many SMEs in Alberta have trouble establishing and sustaining innovation programs?

While conducting surveys after client engagements and workshops throughout the province, GO Productivity² has heard over and over about problems facing SMEs and innovation, including:

- Our employees don't care/aren't engaged enough to give ideas
- As a management team, we don't have enough time to deal with all of the ideas coming to us
- Innovation is in the core values of our company, but we have not explained what innovation means to our employees, or how they influence innovation
- We gave time for people to innovate, they didn't use it-How do we get them to engage?
- We ask for ideas about anything and everything-we have no focus
- We tried to start an innovation program/ initiative, but we could not sustain it
- We had an innovation initiative, but it was not successful

Herman and Williams (4-5) identified five challenges for Canada's SME sector that directly undermine SMEs' abilities and desires to pursue growth, and hence innovation:

- 1. Lack of incentives to pursue growth and expansion beyond the province and internationally
- 2. Shortage of management skills required to achieve high growth
- 3. Under-investment in technology to enhance productivity and growth
- 4. A lack of investment in R&D to drive innovation
- 5. Insufficient access to capital to finance growth

The problems and challenges noted above that SMEs face in innovation are not specific to Canada or Alberta, and are common among SMEs worldwide.

Today's business environment is both complex and changing faster than ever before. Even industries such as mining and energy utilities, considered slow moving just a decade ago, now face new and unexpected challenges they are ill equipped to deal with. This is especially true for SMEs. Innovation, as a dynamic process for generating both new business models and new products and services, is even more essential in this new business world.

Establishing and sustaining innovation in the face of the challenges noted above, coupled with a complex and fast changing business environment, require basic building blocks in any innovation process (McGrath) that are not in place in most SMEs.

² GO Productivity began life as Productivity Alberta, before expanding its services countrywide. Founded in 2008 as a service of the Government of Alberta to help the province's construction and manufacturing sectors be more productive, more competitive and more profitable, Productivity Alberta transitioned into a private, not-for-profit corporation in October 2011 and, in November of 2014, grew into a nationwide company called GO Productivity. These changes have allowed the company to refocus its efforts and enhance its services.

For those SMEs that try to establish an innovation program without learning from other's mistakes and there is a wealth of knowledge to draw from many SMEs and large companies make the same mistakes when they try to jump start innovation (Patnaik):

- Over reliance on pilot initiatives-looking at a single near term opportunity
- Unhealthy fascination with charismatic examples—"Let's be more like (insert iconic person/company name here), they're really innovative!"
- Misapplication of other companies' approaches—innovation programs work because they are tailored to the conditions of each company
- Descent into a cycle of recrimination—"Our people just won't contribute new ideas."
- Resignation to simple ideas, "...just change the paint on the walls like Google."

McGrath identified six key warning signs that an innovation program is broken or in trouble:

- Innovation is episodic—it's on again/off again, more a matter of senior management whims than a part of the day-to-day business processes, resulting in dispirited and jaded employees
- The innovation program was created from scratch, without guidance from knowledgeable sources of best and proven practices, with poorly designed and/or missing pieces
- Existing products and services hold resource priority—both for people and funding
- No home or champion for ideas and innovation development-they "fall through the cracks"
- Using the same criteria to evaluate an innovation and investment in core products/ services, even though innovations are inherently new, uncertain and not predictable
- Insisting on sticking with the "plan"-rarely if ever do innovations turn out as originally planned

GO Productivity has heard and seen these mistakes and warning signs in discussions with SMEs across Alberta, and taken together they point to a general lack of understanding among SMEs (and even large companies) about what innovation is, why it is critical for growth and value creation, the key components of a successful innovation program, and how innovation is supported and sustained over time. The good news for SMEs is that establishing and sustaining an innovation program need not be a mystery, but it does take intentionality and commitment to do it.

GO Productivity's knowledge of SMEs across Alberta in a number of different industry sectors provided a unique opportunity to develop a program that provides the basic building blocks for a successful and sustainable innovation program for its clients. In addition, while the program was developed with the needs of Alberta SMEs in mind, the program was intentionally designed to apply to SMEs across Canada and act as a model for SMEs regardless of region or country.

Considering the issues and challenges discussed above, the program is based on an innovation program built around six basic building blocks: (1) Innovation focus, (2) Innovation strategy, (3) Idea generation and flow, (4) Innovation climate, (5) Management actions, and (6) Human resource and social practices. The components are supported with an understanding of a working definition of innovation and seven distinct types of innovation.

As currently instituted and in Beta testing, the program consists of a workshop that uses applied learning and action planning to understand innovation and the basic components of a successful innovation program, and an innovation assessment tool, developed from the program components listed above, that provides a clear picture of just where an organization stands vis a vis innovation, both at the organizational and individual levels. The assessment tool has the added benefit of allowing the workshop to be custom configured for a client or group of workshop attendees depending on assessment results. The program can be thought of as a "roadmap" for SMEs for establishing and sustaining an innovation program:

Considering the program within in the context of the workshop illustrates how the components build on each other into a well-designed SME innovation program model. The assessment tool will be discussed afterwards.

Defining Innovation

All too often innovation programs get stuck or never leave the starting blocks simply because there is no working definition of innovation in place that is understood and shared by both management and the workforce. GO Productivity found that such an innovation definition must include the concepts of commercial success, value creation and collaboration for it to act as a foundation of any innovation program:

Innovation is two or more people or organizations working towards a common goal of the commercially successful exploitation of new technologies, ideas, or methods through the introduction of new products or processes, or through the improvement of existing ones, adding new sources of growth.

Dialogue with participants during and after workshops has validated this definition as easily understood and yet comprehensive enough to guide an innovation program.

Figure 1. The Roadmap to Innovation: Three Parellel Tracks to Success



Seven Types of Innovation

Most SMEs, as well as most people, will use invention and innovation interchangeably, yet this is a very limiting way of thinking about innovation. We have seen that those Alberta SMEs that have conducted innovation projects know that innovation can be focused internally on new and improved business models, processes, etc., and externally by creating new or improved products and services. Innovation can be used to improve productivity, reduce costs, and expand or create new markets.

Considered by clients as one of the most compelling concepts in GO Productivity programs, GO Productivity suggests seven types of innovation that can be considered and acted on singularly or in any combination by SMEs:

• **Social Systems:** New ideas—products, services and models—that simultaneously meet internal and business environment social needs and create new social relationships or collaborations. They are innovations that are not only good for the organization, but also enhance the organization's capacity to act in the marketplace, with partners, etc.

- **Market Extension:** Meeting a need in the marketplace where no solutions exist or adapting a product for use in a new market
- **Business Models:** Reconfiguring the nature of the business to make it easier to do business, create more integrated products and services, devise better ways to be profitable, or use resources in a new way
- **Process Improvement:** Making processes simpler, faster, more accurate, more reliable, less expensive, or more integrated
- Systems Solutions: Rethinking and integrating existing systems or generating new systems to solve existing problems
- **Product Improvement/Integration:** Improving products in ways that allow companies to be more competitive, to create new value to the customer or to increase productivity
- **Technology Invention:** Product creation/ development with a new core technology or with breakthrough technology

The innovation types are best presented as an "innovation engine" or "innovation wheel."



Figure 2. The Seven Types of Innovation

In speaking to the concept of seven types of innovation, Management Actions and Processes are said to act as the "rim" that holds the innovation program together, with Social Systems acting as the "axle" or "hub" of the wheel.

Noting that 80 percent of innovation does not have to be or is not "technical," and that at least 99 percent of innovation is not invention drives home the point that anyone in the organization can be engaged in and contribute to the innovation effort.

Most successful SMEs actively engage in multiple types of innovation within their programs and initiatives.

Applied learning: In the workshop, participants are provided a designed worksheet and asked to check off those innovation type(s) which would address or create operations/productivity improvements, which type(s) might/would address/ create opportunities for new products/product improvements, which type(s) would create market opportunities in existing markets or customers and/or open new markets or customers, and which type(s) would create new joint opportunities, or would add value to existing opportunities with customers and/or suppliers and/or with competitors. We then ask them to circle those types checked they are not doing, and then note which type they should be doing. Note the participants are beginning to build up the foundation for their innovation program.

Innovation Focus

A company cannot be all things to all customers. Yet, as described above, Alberta SMEs receive ideas from the workforce "...about anything and everything." This happens all too frequently when SMEs attempt innovation projects and initiatives without thinking through just where and why they need innovation.

For a workforce to be actively and effectively engaged in an innovation program, it must know where the company needs to go, what is driving it from the business environment, what it will do and what it won't do, and what is desirable. This sets boundaries for thinking, creativity, and innovation, which are enhanced when working within boundaries; in effect, you bring outside the box thinking into the box. This allows ideas and therefore innovation to be focused and targeted—regardless of whether internally or market facing, core improvement or expansion beyond the core products/services, establishing new and/or expanded markets, improving productivity, etc.—within the creative boundaries.

Applied learning: Workshop participants are again asked to use a designed worksheet, in this exercise to describe what they WILL do, what they will NOT do, and what is desirable, e.g., improve operations, improve business processes, new and/or expanded products/services/markets/customers/alliance opportunities. They are asked to be very specific in describing each area. This exercise continues to build up the decisions that will drive the innovation program, and serves as a starting point for an innovation strategy.

Idea Generation and Flow

Now that an outline of the types of innovation the company needs to pursue and where innovation should be focused is in place, consideration turns to understanding and developing the source of innovation. Ideas are the top innovation tier, the primary source of innovation whether aimed at process improvements or the marketplace. Research tells us that "Eureka!" moments actually happen when a number of seemingly unrelated ideas, from many different sources, suddenly coalesce in a group or in an individual's mind (Johnson, 59-61, 87-91). Innovation does not come out of nowhere; it is the act of combining and recombining, compounding, transposing, augmenting and diminishing ideas into a concept that can be refined, adopted and used (Wired, 121-124).

The successful innovating SME will identify idea generation sources, and manage idea flows in the company through a designed development process. Sources of new ideas for an SME are either internal, through individuals and teams in the workforce, or external, through suppliers, customers, university or research institutions, "open" sources, government departments and agencies, and many others. The innovation focused SME will use all of the idea sources that match its innovation focus it can comfortably manage. For most SMEs, the company workforce should be its single best source of ideas, as employees know the company and its innovation focus, and have contact and knowledge connections outside the company (suppliers, customers, alliance partners, etc.). Also considered are different ways to engage external sources of information, e.g., through collaborative innovation/knowledge networks, partnerships and alliances.

Applied learning: Using designed worksheets with the innovation wheel as a central point, participants are asked to consider each innovation type, and then list innovation sources for each, first internal sources and then, on a second worksheet, external sources. At this point, as preparation for the next program component, participants are asked to consider and list the existing and potential barriers to innovation for their company.

Innovation Program Basics

The goal of a successful innovation program is to be embedded in the operations and processes of the company, as simply a part of the job, as "something we do here." However, there are a number of barriers to innovation that can easily block the creation of an innovation program, or cause an established program to fail. These barriers include management actions not aligned with expectations, too "loose" a definition of innovation, uncertainty of innovation focus, social systems not supportive of innovation, innovation ideas not willing to be heard, no real way to move ideas from concept to product/adoption, and trust missing in the organization. Since innovation is dependent on the people within the company, it should come as no surprise that most barriers to innovation are also barriers to a healthy organization, growth, employee retention/job satisfaction, hiring/training, and more.

An innovation program that is enabled by aligned management actions, and is centered on innovation supporting processes and systems can avoid these barriers. For the SME, an innovation program should be simple, using the four key components of innovation focus, idea generation and flow, management actions and human resources, and social practices.

Note that the concept of an "innovation culture" is not included in the innovation program basics, yet many SMEs and large companies think they must have a culture of innovation. And many companies go through long and arduous cultural transformation and change processes to try and have one. Transformation and change programs are hard to do, and studies continually show a very high failure rate (Hamel and Zanini, 1-2). For SMEs (and even for large companies), GO Productivity considers the concept of a climate of innovation as a better model, as the culture within an organization flows from and is sustained by aligned management actions and expectations, perspectives and strategy, processes, rewards systems and hiring practices-the climate of the organization. A strong case can be made then that culture is a lagging indicator of the climate of the organization, and establishing a climate is relatively easier, faster, and well within the management skills of SMEs. Simply put, establish a climate of innovation and a culture of innovation will follow.

The GO Productivity workshop focuses on five main actions critical to creating a climate of innovation: (1) define innovation focus and foster idea flows, (2) manage idea flows—set a simple and visible process to push them through generation, nurturing, development, testing, adopting or dropping, (3) add the support system(s) e.g., knowledge sharing intranet sites, wikis, networked file storage, library, paper files, meeting and thinking spaces, even idea management software, (4) establish a set of management and human resource practices that support innovation, and (5) reinforce trust within the organization.

Management actions and human resource practices are of particular importance, as they speak directly to the workforce of commitment and intent in establishing innovation within the company. The workshop suggests SMEs hire and train for creativity and innovation; include an innovation component in quarterly and yearly reviews; align reward systems to support innovation matched to innovation metrics; create and facilitate social opportunities for idea sharing and transfer, and focused idea generation; and perhaps most importantly, set and state clear expectations for good ideas and innovation.

Applied learning: Action Planning: At this point in the workshop, participants have a working definition of innovation, understand seven types of innovation and which ones are important to them and their customers and market place, know where they should focus innovation efforts, have mapped sources of ideas and structures for generating and developing idea flows, and know the basic components of an innovation program. However, the half-life of learning in workshops is very short once a participant returns to the workplace, and an additional step is added to the workshop to make the learning actionable.

The key outcome for workshop participants is to apply the concepts, techniques and learning to a 90-day action plan, using designed worksheets. First, they are asked to consider and answer: Where would you like to/must be in 90 days with respect to (1) Innovation focus, (2) Idea flow, (3) Management actions, and (4) Human resources/ social processes? And then, they are asked to note 3-5 actions for each area that could be taken to rejuvenate or establish a climate of innovation and kick start idea flows.

Second, participants are asked to write a statement for each area as a 90 day end point, and then describe by back casting: "What had to have happened in the 30 days prior, the 60 days prior and 90 days prior for each key area (1, 2, 3 and 4) for us to be here in the 90th day." Note for each item WHAT we will do, identify WHO will be responsible for it, and WHEN it will be completed.

Unlike other workshops, GO Productivity follows up with the participant groups 30, 60 and 90 days after the workshop to check on progress, and provide additional coaching and other assistance. Coupled with knowledge from the assessment tool survey (see below), which all participants take prior to the workshop, GO Productivity is uniquely placed to provide this assistance long term, further ensuring a successful and enduring innovation program for the SME.

Innovation Assessment Tool

GO Productivity's Innovation Assessment Tool is designed to do two basic things: (1) provide a valid assessment of an organization's Innovation Capacity and Vitality, and (2) provide a basis for specific recommendations for action to the organization for establishing or improving an innovation program.

The primary foundation of the tool is a 110 statement Assessment Questionnaire focused on five "Innovation Domains": (1) Innovation Focus, (2) Innovation Sources, (3) Innovation Climate, (4) Innovation Leadership, and (5) Individual Innovation Qualities. Each Domain has a number of subcategory areas of innovation understanding and processes that can be easily scored to provide an "Innovation Capacity Grade." The questionnaire is applied to a sample of personnel within an organization allowing for both breadth and depth of understanding and crosschecking.

While the Assessment Questionnaire can be used as a "self-assessment," it is only a preliminary evaluation tool, and is not used as the only evaluation of an organization's Innovation Capacity. In addition, and perhaps more importantly, the questionnaire includes suggested "open ended" follow-up interview questions based on the organization's overall Innovation Capacity Score. The questions can be used to elicit anecdotes, stories and/or examples from across a broad spectrum of the client's staff and workforce. This allows a more nuanced and deeper understanding of the organization's culture, climate and management actions vis a vis innovation. Therefore, a complete organization Innovation Assessment as conducted by GO Productivity for its clients—that both the client and GO Productivity can rely on for analysis and recommendations—would include both the Assessment Questionnaire and the Interviews, followed by an Innovation Assessment Report and a PowerPoint presentation based on the report.

As an added benefit, the results of the Assessment Questionnaire can be used to specifically configure the follow on workshop described above for individual GO Productivity clients' needs.

The last piece of the total program is an Innovation Assessment Guide that provides GO Productivity assessment staff and client managers background on the workshop and survey design, how they are used together, and how to interpret results of the client assessment; a report and presentation template; and guidance on how to craft conclusions and recommendations for further coaching, assistance and more in-depth engagements with the client.

This combination of unique approach, assessment tool, workshop components, delivery and continued engagement gives GO Productivity's clients their single best opportunity to establish and sustain an effective and dynamic innovation program.

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- Richard Marrs, President and Founder of Altamont Consulting Group LLC, works within organizations on creating and executing Collaborative Innovation, Strategy and Strategic Processes, Corporate Development, and Alliance and Strategic Relationships.
- 12. Lori Schmidt, CEO of GO Productivity, has combined her private and public expertise to support and facilitate creative approaches and alliance building in tackling regional and global competitiveness issues.
- 13. Rene Ziorio, Manager of Content Development and Delivery at GO Productivity, uses her project management expertise to ensure Canada's progressive mid-size companies get the latest in productivity best practices.

MONGOLIA

Competitiveness in Mongolia: Establishing a Platform for Change in Regional Communities

Introduction

For a country often dubbed 'Minegolia' in international circles, the importance of Mongolia's natural resources in securing its advancement into a prosperous and developed economy cannot be understated. In the last ten years alone, while mineral exports have grown at an annualized rate of close to 30 percent, economic growth has averaged more than 9 percent per annum, and GDP per capita has risen fourfold, from USD 798 to USD 4,056 (World Bank Data).

However, as with many developing nations bestowed with an abundant supply of natural resources and a rapidly expanding economy, much of the recent dialogue in the country has been about how to progress this from short-term advantage into long-term prosperity—how best to diversify the Mongolian economy into one that sustains new industries and insulates itself from the swings of international commodity prices and the eventual depletion of its natural assets.

A major consideration in facing this challenge is the high prevalence of the traditional nomadic lifestyle in the modern Mongolian population. It stands in stark contrast to the industrialization and commercialization that are also currently underway in the country. The most recent estimates from the World Bank suggest that up to 30 percent of the population retain some form of a nomadic lifestyle (World Bank News–Protecting Mongolian Herders). In addition, recent EPCRC research (Green Jobs Mapping in Mongolia pg. 4) found that close to 30 percent of the population's workforce remains in the traditional economic livelihood of animal husbandry.



Under ideal conditions, these two facets of a modern day Mongolia might successfully coexist. However, the country is also becoming increasingly burdened with issues such as climate change, extreme weather conditions and rapid urbanization that are creating significant economic and social complications for both the regional and urban populations of Mongolia.

Land degradation from the country's heavy take up of mining is altering what were previously large sections of traditional pastoral land, and draining the natural ground water aquifers that Mongolians have used for centuries to support their herds. Furthermore, freak weather patterns have exacerbated the troubles of this industry and way of life. The most recent, a harsh Mongolian winter referred to as a 'Dzud,' struck in 2009-10 and destroyed some 8.5 million livestock, about 20 percent of the country's total count (Lessons from the Dzud).

The overwhelming consequence has been increasing urbanization, as a large proportion of the population turns away from the traditional lifestyle and moves to live in the capital of Ulaanbaatar in search of work or a better way of life. In the last few decades alone, the transition has been stark, with the percentage of urban population rising from 57 percent in 1994 to more than 70 percent by 2013 (World Bank Data–Urban Population).

The issues this creates are two-fold. First, the mass shift in population creates extraordinary strain on the infrastructure and services of the capital Ulaanbaatar. Unprepared for the influx, that then leads to the occurrence of social issues like unemployment, poverty and homelessness. Second, regional areas are left devoid of the labor and resources necessary to grow and strengthen.

In addressing both of these issues, economic diversification and empowering regional communities is key. If Mongolia is to continue to reduce its dependence on its mining industries and exports, and guarantee long-term economic and social prosperity, then it must find a way to engage these communities, and give them their own voice in the national policy dialogue and their own means with which to thrive economically.

Diversifying Mongolia's economy and the role of the EPCRC

Fortunately, the Government of Mongolian has realized the importance of this period for pursuing such an agenda. The 2012-16 Action Plan of the Government of Mongolia ("A Secure Mongolian") includes an objective to turn provincial centers into cities. This includes investing in new infrastructure, social policies that improve quality of life for regional communities, investment and regulatory conditions that foster new businesses, and creating regional 'centers' of industries that promote cooperative development and the advancement of knowledge in specific sectors within Mongolia (Tsotgerel pg. 5).

An important aspect of successfully implementing this Action Plan is establishing an effective relationship between these communities and the government, providing a means through which the problems and opportunities of these communities can be accurately conveyed to the Ulaanbaatarbased Government of Mongolia and result in meaningful policy outcomes. It is here where the EPCRC has been active in supporting the activities of government and private industry.

This includes the introduction of reports (such as that discussed in-depth in the following section) that give a comprehensive and quantifiable measure of all components of competitiveness in different provinces of Mongolia. It also includes arranging for greater involvement of the regions through the organization of workshops with provincial representatives, providing them with an opportunity to discuss current regional-specific issues, as well as provide policy proposals for addressing them.

While it might seem a small role in the processcreating this dialogue between regional communities and decision-makers tasked with improving their conditions—it is a crucial responsibility if the long-term prosperity of regional areas is to be ensured. Communities need a strong sense of ownership of the policies that affect their economic livelihood, just as government and businesses need quantifiable measures of these outcomes to gauge their own activities.

Mongolia's Provincial Competitiveness Report

Since 2010, the EPCRC has produced the Mongolia in *World Competitiveness Yearbook* in coordination with the International Institute for Management Development (IMD). The Report looks at more than 300 competitiveness criteria in order to rank Mongolia against 14 comparable nations that are also captured in the IMD's World Competitiveness Yearbook publication.

Following the ongoing success of this publication, in 2012 the EPCRC began publishing a corresponding Mongolian version that compares and ranks the 21 provinces of the country against each other, published as the *Provincial Competitiveness Report*.

The Report largely follows the same methodology as the existing yearbook, with a total of 180 criteria in the following areas:

Economic Efficiency

- Economy
- Development of Economic Sectors
- · Standards of Living
- Employment

Government Efficiency

- Provincial Budget
- Institutional Framework
- Business Legislation
- Societal Framework



Business Efficiency

- Business Environment
- Labor Market
- Productivity
- Finance
- Management Practices

Infrastructure

- Basic Infrastructure
- Technological Infrastructure
- Science, Education and Culture
- Health and Environment

About two-thirds of the criteria are based on statistical data collected by the EPCRC, while the remaining one-third is composed of an Executive Opinion Survey distributed to more than 500 top and middle executives of regional businesses, equating to about 25 representatives for each province. The survey includes 64 closed questions and one open question.

The individual criterion are standardized and displayed in the report as a ranking of the 21 provinces. A competitiveness index is then calculated for the four categories identified above (economic efficiency, government efficiency, business efficiency and infrastructure) and displayed on a diamond graph, relative to the averaged value of all other regions. Finally, a general competitiveness index is calculated to provide an *Overall Competitiveness Scoreboard* for each of the provinces in Mongolia.

The ranking of the individual provinces of Mongolia goes a long way toward highlighting the most urgent public policy needs, and where new legislation and regulation, infrastructure and government spending could have the greatest impact on competitiveness and economic prosperity.

Importantly, the Report also offers an opportunity to draw out wider national trends. For example, in the 2012 edition, under the title of "Unlocking the Hidden Countryside," the Report recommended the following as the most important considerations for policy-makers moving forward:

- · Improving roads and countryside
- Supporting small and medium enterprises
- Fighting against corruption and bureaucracy
- Improving education and health sectors, and
- Efficient allocation of mining income

The impact of the Report has been felt immedi-

ately. Just one year after the initial 2012 edition, results of the 2013 Report indicated that the overall competitiveness of Mongolia had already significantly increased and major increases were felt by some of Mongolia's previously worst performing provinces. For example, the Dundgobi province placed in the bottom two in 2012, and was identified as desperately needing greater transportation linkage with Ulaanbaatar. By 2013, it had increased its overall competitiveness index from 28 to 43 following the construction of a paved road to the capital.

As already discussed, the Report has come at a time when the Mongolian Government is undertaking its 2012-16 Action Plan of the Government of Mongolia ("A Secure Mongolian"). As such, the report acts not only as a guide for policy-makers to identify necessary and urgent work, but also as a means with which to benchmark the impact of their measures into the future, ensuring a greater level of efficiency and culpability for the government.

2014 Regional Competitiveness Workshop

Following ongoing success of the *Provincial Competitiveness Report*, a Regional Competitiveness Workshop was held for the first time in October 2014.

This Workshop aimed at giving provincial representatives the opportunity to discuss the rankings of the report, identify the reasons for competitiveness issues that exist in their region and target opportunities for reform that can be undertaken by both government and private industry.



The structure of the meeting had the Governors of each of the 21 provinces, as well as representatives from each of the Citizens Representative Hurals (Community representatives).

Guest speakers from international organizations, such as German Federal Enterprise for International Cooperation (GIZ), provided case studies on previous international examples of regional diversification.

A core component of the meeting was the breakaway groups of representatives by geographical location, to provide an opportunity to highlight challenges and opportunities for different areas of Mongolia, making it easier for decision-makers to target regional policy changes. Interestingly, while many of the identified issues and recommendations did contain this regional element, there was also a high level of similarity in their responses that can be of greater use for the government in producing nationwide policies in the future.



Some of the common issues and constraints identified included:

- Significant environmental pollution and degradation—particularly influential for social and health issues, and for managing land available to animal husbandry, a major industry for employment in Mongolia
- Low human resources available—the brain drain effect toward Ulaanbaatar and internationally is reducing the opportunity to build an effective and knowledgeable workforce in many industries
- Low development of Small and Medium Enterprises—creating a lack of economic and industry diversity in regional areas
- Lack of economic autonomy of provincial areas
- Underdeveloped infrastructure in areas such as roads and energy provision



As a consequence, the following were identified as recommendations for government based on these constraints:

- Introducing the requirement for sequential mining patterns and restoration activities from the mining industry to reduce the impact to agriculture and animal husbandry in nearby areas
- Encouraging the expansion of 'value add,' natural resource-based exports such as in metallurgical and construction materials industries by reducing bureaucratic barriers to entry, offering tax incentives and improving the legislative and regulatory environment

3. Along the same lines, encouraging new industries such as meat and buckthorn production and wool and cashmere processing that utilize the natural commodities of Mongolia, utilizing the same sort of measures as those offered to existing 'value add' industries

Conclusion

For Mongolia, the last few years have seen increasing urbanization and centralization of economic activity in the capital, Ulaanbaatar. Large gains in wealth have been countered by urban infrastructure and services unable to keep pace with population growth, leading to a rise in socio-economic issues such as unemployment, lack of access to basic amenities and services, and poverty.

At the same time, regional areas have struggled to capitalize economically on the large mining projects that occupy their landscape. Different factors have led to an exodus of the population from the provinces to the capital, draining them of the human capital, innovation and industry necessary to sustain the communities.

The emphasis must now be on economic diversification into industries naturally suited to Mongolia and its natural and human capital endowments. The development of targeted industries such as wool and cashmere processing, tourism, agriculture and food production, and sustainable mining will all have a role to play in the economic future of Mongolia. A major component of this will be empowering regional communities, where much of this industry and social development will need to take place, thereby reducing Mongolia's overreliance on its capital city and diversifying industry away from its primary export of mining. The EPCRC, through its publication of the Provincial Competitiveness Report and ongoing work with regional communities, is providing policymakers with the platform necessary to make regional competitiveness a reality, helping to identify regional-specific issues and opportunities, and formulate effective regional policy measures as a consequence. It will also play an important future role, providing a robust and measurable review of these policy initiatives to future decisionmakers in Mongolia.

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IRELAND

Enhancing Ireland's Competitiveness through the National Research Prioritisation Exercise

Abstract

Research, development and innovation (RD&I) have a positive impact on productivity through a number of channels. For example, investment in RD&I can result in higher value outputs and reduced input costs. RD&I is, therefore, a key driver of national competitiveness.

Science and technology have progressed to a point where high levels of investment are required to sustain world-class RD&I in any given field. Consequently, choosing the optimal position on the research-possibilities frontier is a significant challenge in a small nation such as Ireland with limited resources available for investment.

To address this challenge, in 2012 Ireland adopted a new paradigm for public investment in research, known as *Research Prioritisation*. Treating Ireland as a *single* region, Research Prioritisation designates *Priority Areas* in which significant economic opportunities have been identified. Some Priority Areas are strongly aligned to enterprise sectors (e.g., Marine Renewable Energy, Smart Grids/Smart Cities), while others are crosscutting (e.g., Manufacturing Competitiveness, and Business Processes). Implementing *Research Prioritisation* has been the Government's top STI policy goal over past two years.

This paper will describe the process used to identify the Priority Areas, discuss the alignment of funding programs with these Priority Areas, and provide examples of the impact of prioritization.

National Competitiveness Council

Introduction

It is widely recognized that research, development and innovation (RD&I) are key drivers of longterm economic growth.² RD&I lead to technological progress and increases in human capital (i.e., skills). These two factors combine to improve productivity and competitiveness which, in turn, drive long-term economic growth. It is also generally accepted that the State has a role in funding RD&I to address market failures.

However, science and technology have progressed to a point where high levels of investment are required to sustain world-class RD&I in any given field. Expensive infrastructure ranging from sophisticated laboratory equipment to large-scale test-beds are prerequisites for leading-edge research. In addition, assembling large, multidisciplinary teams of scientists, engineers and technicians is an integral part of capacity building. Consequently, balancing critical mass against breath of capacity is a challenge, particularly for a small nation such as Ireland with limited public resources available for investment. Aiming for critical mass suggests concentrating investment

¹ The National Competitiveness Council was established by Government in 1997. It reports to the Taoiseach (Prime Minister) on key competitiveness issues facing the Irish economy and offers recommendations on policy actions required to enhance Ireland's competitive position. The Department of Jobs, Enterprise and Innovation (DJEI) provides the Council with research and secretariat support.

² Research and innovation as sources of renewed growth, *COM(2014) 339*, European Commission.

in a small number of fields. However, if taken to extreme, such a strategy runs the risk of being overly prescriptive (*picking winners*); it is important to maintain sufficient breath and diversity to be able to respond to emerging, unforeseen opportunities (*future-proofing*).

Public Investment in RD&I

Prior to the 1990s, public investment in RD&I in Ireland was low in comparison with international peers. Researchers in public institutions relied heavily on the European Commission's Framework programs for funding.

However, in the late 1990s, the Government embarked on a program of significantly expanded investment in RD&I. There were two strands to this program: first, an infrastructural strand operated by the funding agency for higher education, under the auspices of the Department of Education and Science; and, second, a people/ investigators strand under the auspices of the then Department of Enterprise and Employment. A new funding body, Science Foundation Ireland, was established in 2001 specifically to operate the latter strand. Its mandate was to support *oriented basic research*³ in two areas: Biotechnology and ICT.

Over the subsequent seven years, these complementary programs were responsible for sustained increases in public investment (see Figure 1) that grew at a rate well in excess of growth in the





^{3 &}quot;Oriented basic research is research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognised or expected current or future problems or possibilities", Frascati Manual, 5th edition, OECD, 1993.
economy (the growth of the economy was spectacular over this period; GDP increased by 61 percent in nominal terms between 2001 and 2007).

As a result of this sustained investment, Ireland developed world-class research capacity across a range of fields. Both the quantity and quality of scientific output have increased, as gauged by academic publications and citations. Ireland has attained world-leading ranking for citations per paper in several key fields:

- 1st in Immunology
- 1st in Animal and Dairy
- 3rd in Nanosciences
- 4th in Computer Science
- 6th in Materials Science

Ireland is ranked 20th overall for citations per paper across all fields.

In parallel with this growing domestic capability in RD&I, Ireland had great success in attracting FDI in high value-added industries aligned with the chosen fields of RD&I specialization (e.g., Medical Devices, Biopharma and ICT). Much of this investment was directly linked to public research facilities and capacity.

In 2010, in recognition of the vital role RD&I plays in a developed economy, the Government decided that it was time to reflect on the achievements over the preceding decade and to establish a new framework to guide future investment in RD&I. While the focus of the previous decade had been building capacity in the public research system, the Government was of the view that, for the next phase of development, the focus should be on accelerating the economic returns from further public investment. The down-turn in 2008 added additional impetus to this re-orientation.

To this end, the Government launched the National Research Prioritisation Exercise (NRPE) to establish a framework to guide economicallymotivated RD&I investment for the five-year period 2013-2017. The framework was intended to maximize public investment's impact on jobs and socio-economic progress.

National Research Prioritisation Exercise

As the first step, the Government established a Steering Group to lead the Prioritisation Exercise. The Group comprised senior representatives of key stakeholders including enterprise, academia and public policy. This inclusive approach was important not only for accessing the best available intelligence to guide the exercise (*wisdom of the crowd*), but also for securing buy-in from the stakeholders and, ultimately, expediting implementation.

The Government set the following terms of reference for the exercise:

- 1. Develop a consensus on a number of priority areas and/or approaches to tackling national challenges which need to be underpinned by future investment in publicly funded STI
- Identify a list of supporting fields of science and technology that will underpin the priority areas and/or approaches to national challenges in the medium term (5 years) and beyond
- 3. Identify actions required for each of the priority areas put forward including goals to be realized in the medium term (5 years) and beyond

The following additional guidance was provided:

- The Prioritisation Exercise should take account of fields of research activity where Ireland has built significant strength to date, and particularly areas that have the greatest potential to deliver sustainable economic return through enterprise development, employment growth, job retention and tangible improvements to quality of life.
- The exercise should also identify fields of science where new strengths could be developed in support of priority areas.
- The exercise should take account of complementary developments at the EU level (Framework programs, etc.) and other international initiatives.

• The selected areas will be reviewed on a regular basis to ensure their continued relevance and to ensure that new opportunities are identified. The major steps in the exercise and the overall timeline are illustrated in Figure 2.

Based on the Terms of Reference and early deliberations, the Steering Committee developed the formal selection criteria for the Priority Areas (PA) set out in Table 1.



Figure 2. Overview of the Prioritisation Process

An important intermediate step in the process was the establishment of the Thematic Working Groups (TWGs). These groups provided a structure for more in-depth consideration of the data and analysis generated in the earlier steps. Furthermore, as the membership of the TWGs was extended beyond that of the Steering Group, these groups provided a mechanism to bring additional, domain-specific expertise into the heart of the exercise. Four such groups were established:

- 1. Health, Well-being and Ageing
- 2. Natural Resources and Sustainable Environment
- 3. Technology, Social Media; Creative and Cultural Enterprise
- 4. Innovative Processes for Enterprise (Advanced Manufacturing and Business Services)

Table 1. Criteria used to select the PriorityAreas

- 1. The PA is associated with a large global market or markets in which Irish-based enterprises already compete or can realistically compete.
- Publicly performed R&D in Ireland is required to exploit the PA and will complement private sector research and innovation in Ireland.
- 3. Ireland has built or is building strengths in research disciplines relevant to the PA.
- The PA represents an appropriate approach to a recognized national challenge and/or a global challenge to which Ireland should respond.

Stakeholder engagement was an integral part of the overall process. To augment the inclusive composition of the Steering Group, workshops were convened under the auspices of each Working Group. A further round of consultations was undertaken as the Group's recommendations were being finalized.

Recommendations from the Prioritisation Exercise

Following a detailed investigation, informed by empirical data and extensive consultation, the Steering Group proposed 14 Priority Areas (PA) for future public investment in research. The 14 areas are listed in Table 2.

Table 2. Priority Areas

- A. Future Networks & Communications
- B. Data Analytics, Management, Security & Privacy
- C. Digital Platforms, Content & Applications
- D. Connected Health & Independent Living
- E. Medical Devices
- F. Diagnostics
- G. Therapeutics Synthesis, Formulation, Processing & Drug Delivery
- H. Food for Health
- I. Sustainable Food Production & Processing
- J. Marine Renewable Energy
- K. Smart Grids & Smart Cities
- L. Manufacturing Competitiveness
- M. Processing Technologies & Novel Materials
- N. Innovation in Services & Business Processes

In addition, the Group identified six Platform Science and Technologies necessary to underpin research in the Priority Areas (see Table 3).

Public investment which is competitively-awarded for economic objectives should be aligned with these Areas or platforms (approximately 50 percent of the total public investment in research⁴ falls outside the scope of Research Prioritisation).

The Group also put forward 13 systemic actions aimed at improving the efficiency and effectiveness of the public Science, Technology and Innovation (STI) system. These actions address the operation and evaluation of program by the responsible agencies, for example.

Finally, the Group acknowledges the requirement to complement the economically-motivated investment with support for:

- 1. Research for Policy to support public policy and service delivery
- 2. Research for Knowledge to support the training and development of young researchers

The Steering Group's report⁵ was adopted by Government in February 2012. The Government set the implementation of the report's recommendations as its main STI policy goal for the fiveyear period 2013-2017.

Energy

Ireland currently relies on imported fossil fuels (> 90 percent) for its primary energy sources (oil, gas, coal). However, it has considerable potential for developing renewable energy, primarily wind and marine. The former is well developed, with onshore wind providing 18 percent of electrical energy consumption in 2012. Ireland has an EU target of 40 percent for electrical energy consumption by 2020. Marine energy is in a nascent stage of development.

Table 3. Platform Science andTechnologies

- 1. Basic Biomedical Science
- 2. Nanotechnology
- 3. Advanced Material
- 4. Microelectronics
- 5. Photonics
- 6. Software Engineering

Therefore, it is appropriate that energy is a crosscutting theme in Prioritisation. It is the focus of two vertical areas: Marine Renewable Energy, and Smart Grids and Smart Cities. In addition, the three ICT areas (A, B & C) are strongly linked to energy research, as is Manufacturing Competitiveness.

The focus of the Marine Renewable Energy priority area is to promote the green economy by positioning Ireland as a research, development and innovation hub to drive the deployment of marine renewable energy technologies and services. Ireland's ocean territory, at approximately ten times the size of its land area, is an excellent potential source of energy. Ireland's marine environment can potentially provide a vast amount of energy through offshore wind, wave and tidal energy technologies. This priority area also supports the Government's ambitious target of 40 percent of electricity generated from renewables by 2020, which is on track to be met, and vital to ensure that Ireland meets its internationally binding renewable energy and greenhouse gas emissions targets.

⁴ Ireland's GBAORD for 2013 was €773m.

⁵ Report of the Research Prioritisation Steering Group, Forfás, 2012. www.forfas. ie/publications/2012/title,9545,en.php.

The Smart Grids and Smart Cities priority area involves the application of advanced technologies to more effectively and efficiently manage complex infrastructure systems by using embedded sensor technologies to harness and apply real time data. Ireland has distinct advantages as an agile test-bed for these technologies. In the area of Smart Grids, Irerland's island status means that the national electricity grid provides an ideal vehicle for research and deployment. Ireland also has a deep base of indigenous and foreign owned ICT firms. The Smart Cities priority area aims to deploy ICT technologies in a similar manner to better manage Ireland's water, waste and transport services-all of which are essential components of a holistic energy agenda.

Regional Considerations

Ireland is small relative to many of its peers in the EU, both in terms of its geographical extent and its economy. Therefore, it was appropriate that the country was treated as a single region for the Prioritisation Exercise.

However, the Prioritisation Exercise does recognize and build on a number of established regional clusters, spanning enterprise and higher education institutions (e.g., a pharmaceutical cluster in the South is reflected in the Therapeutics priority area and, similarly, the Medical Devices cluster in the West is acknowledged in the Medical Devices priority area).

Implementation

In March 2012, the Government established the Research Prioritisation Action Group (RPAG) to drive the implementation of Research Prioritisation. Specifically, it was tasked with developing an action plan to implement the recommendations and to re-align funding programs with the 14 priority areas and six Science and Technology Platforms.

The RPAG is an all-of-Government forum which brings together senior officials from ten State agencies and six Government departments with responsibility for funding research and innovation. It also includes the Department of the Taoiseach (Prime Minister), the Department of Public Expenditure and Reform, and the Department of Foreign Affairs and Trade. It is chaired by the Minister for Skills, Research and Innovation.

The first task for the RPAG was to oversee the development of an action plan for each of the 14 Priority Areas. The Government agreed to these action plans, which were published in July 2013.⁶ The plans set out in considerable detail the steps necessary for Ireland to realize the opportunity associated with the Priority Areas. For each action, the body with primary responsibility for its implementation is specified (typically a Government department or State agency) and also the timeline by which key milestones are to be achieved.

To add further impetus to implementation, a Champion from the RPAG was appointed for each Priority Area. In most instances, this person chaired the sub-group that developed the corresponding Action Plan. Therefore, each Champion has an in-depth understanding of the vision for the Area and the intention behind each of the actions. While the Champions do not have any executive responsibility for driving implementation outside of their own agency, they are well-placed to provide a high-level, holistic, cross-agency view of progress towards realization of the opportunity associated with the Area.

A second key task for the RPAG was to devise indicators to measure the impact of implementation of Research Prioritisation in the 14 Priority Areas and, more generally, the impact of public STI investment. To this end, it developed a Framework of Metrics and Targets which was also adopted by Government in July 2013.⁷

⁶ www.forfas.ie/publications/2013/Title,11020,en.php.

⁷ Research Prioritisation: Framework for Monitoring Public Investment in Science, Technology and Innovation and 14 Action Plans, Forfás, 2013. www.forfas.ie/ publications/2013/Title,11020,en,php.

Outcomes

Alignment of Funding

Although Research Prioritisation was adopted by the Government in March 2012, the implementation only began in earnest in 2013. Therefore, it is unrealistic to expect to find measurable economic impacts in terms of employment, exports, etc. at this juncture. However, a number of definite outcomes can be identified, primarily in terms of realignment of public investment in RD&I. Science Foundation Ireland (SFI), the largest public funder of economically-motivated research, reported that of the €297m awards made in 2013, €279m (94 percent) fell within either the 14 Priority Areas or the six underpinning Platform Science and Technologies.

In addition, over the past two years, SFI has established 12 new large-scale, national research centers representing a total investment of €545m (with enterprise contributing €190m of this total). As can be seen in Table 4, these centers are strongly aligned with Priority Areas and underpinning Platform Science and Technologies.

Table 4.

| | Large-scale National Research Centres | Priority Area / Platform S&T (PST) |
|----|--|---|
| 1 | Advanced Materials And Bio-Engineering Research – AMBER | Processing Technologies and Novel Materials |
| | | PST: Nanotechnology; Advanced Materials; Biomedical Research |
| 2 | Alimentary Pharmabiotic Centre-APC | Food for Health |
| | | PST: Biomedical Research |
| 3 | Big Data And Analytics Research Centre–INSIGHT | Data Analytics; Connected Health |
| 4 | Irish Photonic Integration Research Centre–I-PIC | Future Networks |
| | | PST: Photonics |
| 5 | Irish Centre For Fetal And Neonatal Translational Research—INFANT | Diagnostics |
| | | PST: Biomedical Research |
| 6 | Marine Renewable Energy Ireland-MAREI | Marine Renewable Energy; Data Analytics |
| 7 | Synthesis & Solid State Pharmaceutical Cluster-SSPC | Therapeutics |
| 8 | Centre of Excellence for Digital Content and Media Innovation—ADAPT | Digital Platforms, Content and Applications |
| 9 | Centre for Future Networks & Communications—CONNECT | Future Networks and Communications |
| 10 | Centre for Research in Medical Devices- CÚRAM | Medical Devices |
| 11 | Irish Centre for Research in Applied Geosciences—iCRAG | Energy; Research for Policy |
| 12 | Irish Software Engineering Research Centre-Lero | PST: Software Engineering |

Coherence of the Public STI System

One of the most important impacts of the Prioritisation Exercise has been the enhanced coordination and cooperation it has engendered between the State agencies and Government departments funding research.

The funding agencies and departments have a range of mandates, spanning enterprise development (indigenous industry, foreign direct investment), sectoral development (marine, agri-food, and energy), societal challenges (health, environment) and cross-cutting (education). By convening senior officials and executives from the funders on a regular basis, the RPAG provides a forum which facilitates communication and coordination between these bodies, while respecting the diversity of their mandates. Furthermore, the development and implementation of the Action Plans has driven practical cooperation at the operational level as the majority of the actions in the Plans require several funders to cooperate in their implementation.

A further impetus for cooperation has come from the cross-cutting Priority Areas, such as Manufacturing Competitiveness and Innovation in Services and Business Processes. As these areas span many sectors of the economy and hence fall within the remit of several agencies and departments, a unified, national approach is required to fully exploit the opportunities identified in these areas. Such an approach is now evident in these areas.

The visible manifestation of this enhanced coordination and cooperation has been the significant expansion in the number of joint programs operated by the funding agencies (see Box 1), including between agencies with an economic mandate and those with a societal mission.

Box 1. Case study to illustrate enhanced cooperation

In 2014, a collaboration agreement, "Future Agri-Food," was signed between Science Foundation Ireland and Teagasc (the agriculture and food development authority in Ireland). This agreement aims to strengthen and accelerate research and innovation in Ireland's agri-food sector. Agri-food is Ireland's largest indigenous industry, employing about 150,000 people and delivered a record € billion in exports in 2012. SFI and Teagasc now jointly fund research grants between scientists from the agriculture and food disciplines, and scientists from other scientific and engineering disciplines. The joint initiative aims to bring a broad range of disciplines and technologies to bear on strengthening innovation in the agri-food sector and to offer opportunities to scientists in a wide range of disciplines including genomics, robotics, material science, nanotechnology, immunology and ICT. The convergence of this broad range of disciplines will help underpin the competitiveness of the sector.

The cumulative effect of these developments has been to bring a greater coherence to the public research and innovation funding system. This should, in turn, lead to greater efficacy and efficiency in the science, technology and innovation system, which was one of the key challenges identified in the report of the Research Prioritisation Steering Group.

Conclusion

Public investment in RD&I has a key role to play in sustaining long-term competitiveness and growth. The challenge for a small nation such as Ireland with limited resources for investment is to balance depth against breath. Depth is required to achieve critical mass in an area, while breath is necessary to provide the flexibility to respond to new and emerging opportunities.

Ireland undertook the National Research Prioritisation Exercise as its approach to this conundrum. While it is too early to assess the full economic impact of the resulting framework, it has already delivered tangible benefits in terms of increased coherence and transparency of the national funding system. Results to date suggest that this is a process that could be successfully replicated in other countries.

Appendix 1: Research in Energy Supported By Department of Jobs, Enterprise and Innovation

MaREI: Marine Renewable Energy Ireland (SFI Research Centre)

The MaREI program is founded on well-established Marine Renewable Energy research entities distributed throughout Ireland. The centre brings together expert groups who have established themselves as international authorities in different aspects of Marine Renewable Energy.

Research Themes

- Marine renewable energy devices
- Novel materials for marine renewable energy systems
- Power take off and energy storage for marine renewable energy systems
- Marine renewable energy decision support and data management IERC: International Energy Research Centre (EI/IDA Technology Centre)

International Energy Research Centre (IERC)

The International Energy Research Centre (IERC) is an industry led, world-leading, collaborative program of research and innovation in integrated sustainable energy system technologies.

Research Themes

- Commercial building integration of energy systems
- Home area networks to drive energy reduction
- Smart energy networks in factories

ICMR: Irish Centre for Manufacturing Research (EI/IDA Technology Centre)

ICMR's focus includes research in areas of energy efficiency in industrial, manufacturing and commercial facilities. It includes areas of research in energy from low grade heat, appropriate working environments such as HVAC, energy management methods, compressed air and industrial smart grid.

Research Themes

- Chilled Water Systems
- CHP
- Compressed Air
- Energy
- Energy from Low Grade Heat
- Energy Metrics & Standards
- HVAC Tyndall National Institute

Tyndall National Institute

Tyndall National Institute is one of Europe's leading research centres in ICT research and development.

Research Themes

- Energy performance contracting
- · Residential sector third party services
- Human Machine Interfaces
- Smart inertial systems for wave energy monitoring
- Integrity monitoring of composite structures.
- Long-life, wireless sensor systems for energy demand side management
- Integrated circuits for next generation communications networks for smart cities/ grid.
- Power management of data-centers
- City and group energy networks (including heat)
- Energy storage (thermal and electrical)
- Embedded renewable energy system

SEES: Sustainable Electrical Energy Systems (SFI Strategic Research Cluster)

SEES brings together multi-disciplinary expertise in electrical, mechanical and electronic engineering, applied mathematics, economics and geology to tackle fundamental applied research and demonstration challenges.

Research Themes

- System analysis Markets and regulation
- Policy and social studies Flexibility in power systems
- Intelligent energy systems

SmartBay

Ireland supports the collection of marine data, the trial, demonstration and validation of novel marine sensors and equipment and the development of collaborative translation projects.

Research Themes

- Data fusion sensors
- Ocean energy test-bed
- Underwater acoustic monitoring
- Elastomeric mooring solution development
- Geospatial multimedia
- Satellite remote sensing

BRAZIL

Rio Grande do Sul Development Agency (AGDI)

Introduction

Historically, Rio Grande do Sul State has not been a major energy producer in Brazil, but rather mainly focused on building huge dams due to Brazil's great hydropower potential. With regard to fuel production, Rio Grande do Sul also was not a leading producer, since decisions on oil refining were made at the national level, and alternatives such as sugar cane ethanol were not based in the state.

However, that situation changed dramatically in the new millennium. A strong new focus on renewable energies in Brazil, combined with suitable local policies, made Rio Grande do Sul the biggest biodiesel producer in Brazil, and one of the leading states in wind power. In 2013, the state joined the Brazilian Platform for Aviation Biofuel, and has advanced talks to convert an oil refinery to a biorefinery, thus positioning the state on the cutting-edge of renewable energies innovation worldwide.

Context of Renewable Energies in Brazil

The main energy resource for electricity production in Brazil has historically been hydropower, which today accounts for 63 percent of the installed capacity, while fossil fuels, such as coal and natural gas, account for a small share. However, Rio Grande do Sul is not one of the states with larger hydropower potential and, thus, has historically been a net importer of electricity from other Brazilian states. Even having more than 90 percent of the coal reserves in Brazil, the high level of ashes and low calorific power do not allow



a great scale of thermal energy production. Alternatives such as coal gasification are under study, but have not yet been deemed viable.

Concerning fuels, Brazil's interest in renewable energies goes back to the 1970s, when the oil crisis forced countries to both reduce consumption and find alternatives. During that time, Brazil created a successful policy, called Pro-Álcool, which promoted the use of sugarcane ethanol as an alternative to gasoline, which had a major impact on reducing imports of oil. That program increased ethanol production from 600 million liters/year in 1975/76 to 12.3 billion liters/year in 1986/87. However, the Rio Grande do Sul soil is not suited for sugarcane crops; therefore, the state was mostly unaffected by this development.

In the following decades, the decline of oil prices and macroeconomic turmoil in Brazil shifted the government focus to containing inflation and, after the Plano Real succeeded in that task, to reforms that could put the economy back on the path of economic development. During that time, even the ethanol policies were reduced, with an ever-diminishing fleet of cars adapted for alternative fuels. However, by the beginning of the new millennium, inflation was under control, and fiscal responsibility and the positive effects of many economic reforms allowed Brazil to shift focus to economic growth, in which renewable energies gained a more important role than in previous "development eras." First, there were government incentives for the domestic manufacture of cars with flexible-fuel engines that could run on gasoline, ethanol, or any mix of them, which led to a huge boost for the ethanol industry.

The government also started a program on biodiesel, which required that diesel fuel sold in Brazil contain a percentage of biodiesel, beginning with 2 percent in 2008, with incentives to the manufacturers. To diversify the sources of electric energy in Brazil, in 2004 the federal government started the PROINFA, which benefited wind, biomass and small hydroelectric plants. While other sources of electricity, such as thermal, usually have their energy sold in highly competitive public auctions determined by the lesser price, in PROINFA higher prices were allowed in order to increase the diversity of energy generation sources in the country. The following will show how Rio Grande do Sul reacted to these policies and emerged as one of the leading states in renewable energies.

Biodiesel

The National Program for Production and Use of Biodiesel started in 2003, and focused on the utilization of oilseeds of any kind to produce biodiesel. A new law passed in 2005 required that diesel fuel sold in Brazil contain 2 percent biodiesel by 2008 and 5 percent by 2013. However, the program was supported enthusiastically, and the socalled B5 requirement was moved-up to 2010. In 2014, the percentage was increased to 6 percent in July and to 7 percent in November, increasing the demand for biodiesel in the country.

In Rio Grande do Sul, one of Brazil's major soybean producers, the program was viewed as an opportunity to develop the soybean chain, given that most of the state production was exported in grains, without further manufacturing. The state established tax incentives that benefited investments in biodiesel plants and, as the federal government guaranteed the demand, it was highly successful. Since the beginning of the program, Rio Grande do Sul has been the largest biodiesel producer in the country, accounting for 30.3 percent of Brazilian production in 2013, even though the state demand is only 6 percent of the country's total.

The program is particularly successful in the state because of its "Social Fuel Seal" given by the government to biodiesel producers who buy at least 30 percent of their raw material from family farms, benefiting Rio Grande do Sul, which has more family farms than other major state soybean producers do. This way, the program has a strong impact on family farms that otherwise would lose ground to large producers in other states of Brazil.

Wind Power

The Brazilian policies on wind power mostly began in the 2000s with the PROINFA program, which allowed charging a higher price for energy if produced from wind, biomass, or small hydropower plants. At that time, there were very few



wind farms in Brazil, only 22 MW of installed capacity, with a goal to increase it to 1.422 MW. In addition, with the aims of benefiting local industry, decreasing external dependence, and ensuring the long-term development of wind farms, the government set a 60 percent domestic industry content requirement for equipment.

In Rio Grande do Sul, the PROINFA was preceded by local policies to increase information about the state's wind energy potential. When President Dilma Rousseff was Rio Grande do Sul Energy Secretary, the state developed an atlas of wind power potential, with measurements on wind speed at 50m height. These policies were of great importance when the federal government launched PROINFRA and guaranteed to Rio Grande do Sul the first major wind farm in Brazil, with 75 towers capable of producing 150 MW of electricity. Its construction in Osorio started in 2005, and it was launched in 2006, then the biggest wind farm in Latin America. PROINFA encouraged development of other wind farms, increasing the installed capacity to 228 MW. The program enabled a great reduction in the price of wind power in Brazil, making it competitive with other electricity sources in the auctions held periodically. Thus, when the PRO-INFA was ended in 2008, there was no loss for Rio Grande do Sul's wind industry, with another 431.8 MW of installed capacity contracted from auctions in 2009 and 2010.

Nevertheless, it was only in 2011 when the state started a bold industrial policy, including 22 sectorial programs, a methodology published by the Global Federation of Competitiveness Councils (GFCC) in 2013 as a best practice. Among the selected sectors was wind energy in a program called RS Eolic. The program engaged with companies, entrepreneurs, researchers, and government officials to discuss the main factors that could determine regional competitiveness, and the measures the local government could take to improve it. The program is regarded as an institutional innovation; for the first time, there was a clear policy that defined the state goals in this industry, and the measures that would support their achievement, designed with the academy and private sector.

In the program, some priorities were established, such as a new wind atlas with updated information on wind speed at 100m height. To reduce the costs of developing the new atlas, companies that already had wind farms in Rio Grande do Sul cooperated and made their measures of wind available to the government. The updated atlas is scheduled to be launched in December 2014, and will be a vital tool in increasing the number of wind farms in the state. Another important role for the RS Eolic is addressing the need for more energy transmission infrastructure. As the regions in Rio Grande do Sul with better winds are located far from current transmission lines, a study is under development to estimate the actual need for infrastructure and project the need for years ahead. It aims to support the federal government with information and, thus, improve the chances of wind farms in the state to get a better chance in the auctions.

In Brazil, a crucial bottleneck in energy investments involves environmental licenses, due to the rich ecosystem present throughout the country. Even though wind energy is considered one of the least polluting ways to produce electricity, it does impact the environment and, in Rio Grande do Sul, some of the regions with the most wind power potential are also those with the most fragile ecosystem. The State Foundation for Environment Protection and the industry union are developing an Environment Zoning study that will analyze the environmental impact of wind farms throughout the state in order to reduce the uncertainties and make the analysis associated with environmental licenses faster. Meanwhile, the Development Secretary created a Work Group with the Foundation for Environment Protection, in order to prioritize the projects that will be in the next auctions.

This group is managed by the Room for Investors program, created in 2011 with the goal of making the steps for investing in Rio Grande do Sul easier and more transparent. In the program, there is currently a portfolio of US\$ 20 billion in national and foreign investments, a third in the wind industry. The program has reduced the necessary steps by creating a Project Manager, a person in the government who is responsible for contacting all institutions needed to achieve the investment. These institutions can be responsible for the funding of the project, environmental licenses, land acquisition, tax cuts, company registering, among others. Before the program, any investor would have to contact the institution responsible for each of these subjects individually, which could be time consuming and discouraging. Today, the program is widely regarded in the state as having bolstered the investment in Rio Grande do Sul.

Another current important task of the RS Eolic program is attracting suppliers to the wind farms, such as turbine, shovel and tower manufacturers, as well as service providers in fields such as engineering, logistics and maintenance. Already there are national and foreign companies in the state that manufacture towers, and some companies have declared plans to establish a turbine factory.

Because of these combined policies, Rio Grande do Sul has greatly increased its electricity generation capacity, with an ever-greater share of energy produced from winds. As seen in Graphs 1 and 2, wind energy is already responsible for 8 percent of the installed electricity generation in Rio Grande do Sul, and wind farms already contracted by the government will increase that percentage to 19 percent in 2018, to 2,000 MW. The total investments, including PROINFA and the auctions, reach more than US\$ 3 billion. As the wind potential in the state is more than 15,000 MW,



Source: National Agency of Electric Energy (ANEEL)



wind energy will continue to develop and, along with other power plants, make Rio Grande do Sul a net energy exporter in Brazil.

Aviation Biofuel

In response to the ever-growing concern about the world environment and dangers posed by carbon dioxide emissions, air carriers and aircraft manufacturers have been discussing alternatives to the jet fuel derived from oil that is used today. Although the aviation industry generates only 2 percent of global emissions,

that number is projected to grow, compromising the goals of achieving carbon neutral growth by 2020 and reducing carbon dioxide emissions by 50 percent (from 2005 levels) by 2050.

In 2012, Brazil launched the Brazilian Platform for Aviation Biofuel. Rio Grande do Sul joined this Platform at the end of 2013, and since then has engaged in talks within the private sector focused on the feasibility of aviation biofuel production.

The most promising situation in the state is the possibility of converting an oil refinery into a biorefinery, using soybean oil to produce aviation biofuel. Currently, talks are underway to identify the technologies that would enable this conversion, as well as possible certifiers to this process. Once that step is achieved, the state government will start a discussion about possible incentives that could be offered to make the aviation biofuel competitive with regular fuel. It is foreseen that the Rio Grande do Sul Platform for Aviation Biofuel will be launched in 2015 when the state will announce the program, and therefore will be able to engage in more extensive discussions with possible partners in this endeavor.

Conclusions

The advances we present here show that, since the previous decade, Rio Grande do Sul has started to overcome the chronic energy dependence it has had in the past. Initially, the state followed the lead of federal initiatives, such as the biodiesel and PROINFA programs, with actions that proved very successful in the short term, even if not part of a larger plan for state development.

Beginning in 2011, the state went one step further, with an industrial policy clearly defining sectors and goals to be pursued, and, through this, creating a better environment for both investors and local companies. Regarding energy, wind power has gained a completely new status, considered an axis of state development, and receiving an explicit priority that has helped the sector grow even further.

Finally, the priority placed on energy enabled the state to climb the technology ladder, starting with technologies already in widespread use world-wide, such as biodiesel production and wind energy, and now investing in aviation biofuel, which air carriers have not yet adopted in large scale.

This climbing was made possible only because the state, through institutional innovations such as a new industrial policy, has succeeded in creating a friendly environment for business, in which public and private sectors act together to pursue state development.

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UNITED KINGDOM

Best Practices in Competitiveness Policy–Regional Innovation: The North Atlantic Green Zone

Summary

The North Atlantic Green Zone is a cross border project geographically located in the North-West of Ireland. The competiveness of the region is hindered due to the state of its current electricity and communications infrastructure. It suffers from the worst continuity and security of supply performance of all electricity systems on the island. The Irish and Northern Irish system operators are proposing a significant and technologically advanced infrastructure project, which will see the first implementation of a Smart Grid of scale within the EU through addition of advanced communication and IT layers onto upgraded and more resilient electricity networks.

The estimated cost of the project is €107.2m, with more than €238.9m returned in benefits. The main societal benefits include electricity savings due to reduced outage times, reduced compensation costs for wind generation curtailment and savings through conservation voltage reduction. The project, which has obtained EU funding, will serve as the blueprint for future smart network deployment on the island of Ireland and across Europe. It will make the region more competitive by enabling increased penetration of renewable energy resources, reduced system losses and improved continuity, positioning Ireland as a leader in the area of Smart Grids.

Background

The current challenges faced by the island of Ireland and particularly in the North-West geographic region, on both electricity distribution and transmission systems, are challenges other European countries will experience over the coming



decade. The North Atlantic Green Zone (NAGZ) project will tackle these challenges through the implementation of Smart Grid technologies and solutions to manage the highest levels of variable renewable generation penetration in an integrated cross border market without a synchronous connection to a wider grid.

All System Operators on the island of Ireland– ESB Networks, Northern Ireland Electricity (NIE), EirGrid and System Operator of Northern Ireland (SONI)—are proposing a major interconnected network infrastructure project to deliver a Smart Grid. Intelligent distribution networks will be overlaid with high speed communications and technologically advanced IT systems and these, coupled with increased cross-border capability, will enable operational excellence and leverage the involvement of all users to ensure an economical, sustainable power system with low losses, high levels of efficiency, and improved security of supply and safety for all consumers within the zone.

The island of Ireland has two jurisdictions, Ireland and Northern Ireland (which is part of the UK), and two electricity systems that are combined into a single electricity market. NAGZ will leverage the potential of increased cross border

Figure 1. North Atlantic Green Zone and Project Partners



connection within a single electricity market and demonstrate the benefits of increased cooperation between EU Member States. NAGZ will overcome the difficulties and provide solutions to multiple challenges which will soon be faced by all European electricity systems and, in so doing, will be the recognized template for future Smart Grid deployment across Europe.

The island of Ireland is the ideal location to carry out this Smart Grid development as it is unique; Ireland/Northern Ireland's electricity systems, with an integrated market but no synchronous connection to a wider grid, have already reached record levels of instantaneous variable renewable generation penetrations. How the island of Ireland manages this challenge through Smart Grid deployment will provide Europe with a scalable blueprint for managing this future challenge on a pan-European scale.

Challenges and Objectives

The main challenges and objectives to be addressed by the NAGZ project are summarized in the five points below:

1. Mitigating the challenges presented by increasing penetrations of distribution connected renewables

Challenge: Both Ireland and Northern Ireland have the target of delivering 40 percent of electricity energy consumption from renewable sources by 2020, of which 37 percent will come from non-synchronous wind. This challenge is particularly critical for the Transmission System Operators (TSOs) as there is no synchronous interconnection to other electricity systems.

Objective: Several innovative implementations are proposed to mitigate the challenges associated with distributed renewables. These include advanced protection systems utilizing advanced communication networks, and reactive power and voltage control technologies to respond to the displacement of reactive capabilities by increased wind generation. These are all leading edge technologies which combined or individually can solve the challenges that will be and are currently being experienced across Europe in accommodating rapidly increasing levels of renewable energy sources connecting to distribution systems.

2. Improving continuity and security of supply

Challenge: The North Atlantic Green Zone project's region currently suffers from the worst continuity and security of supply performance of all electricity systems on the island. This is due primarily to environmental and economic factors. The average number and duration of outages within the NAGZ region is more than twice the national average.

Objective: The automation of monitoring and control equipment, combined with increased medium voltage interconnection between both countries will dramatically improve the quality of supply and encourage commercial and industrial growth in the area. Modernization of the networks is also crucial to harness the exceptional renewable generation resource and thus enable the island of Ireland to achieve its renewable targets.

3. Increasing variable access capacity on distribution networks and at system level

Challenge: Current generation access to the distribution network is dependent on fixed rating standards. In the absence of real time monitoring and high-speed, robust communications, this will continue to be necessary to maintain network security. Significant costs are incurred accommodating renewable generation connections, but these can be minimized and maximum asset utilization ensured through the implementation of variable access for renewable generation, dynamic line rating and advanced network monitoring.

Objective: Through the implementation of advanced network control and automation, it will be possible to achieve major benefits through the use of Variable Access. Combining dynamic

line rating, active network management, and generation Volt/VAr control will enable Distribution System Operators (DSOs) and TSOs to work together to ensure maximum asset utilization and will minimize the environmental impact and engineering costs associated with network construction normally required to accommodate similar levels of renewable generation connections.

4. Reducing losses and leveraging innovative operational methods to deliver energy efficiencies

Challenge: In setting a 20 percent energy efficiency target for 2020, the EU has called for all Member States to commit to delivering the required advancements to achieve this goal. Distribution system losses represent more than 7.5 percent of total energy distributed due to the island of Ireland's highly dispersed, largely rural population (the region has the highest level of overhead network per capita in the EU at four times the average). To achieve this energy efficiency target, the innovative technologies included in the project need to be implemented as a priority.

Objective: Specific energy efficiency objectives include:

- Doubling the nominal MV voltage on the ESB Networks' system to reduce losses and increase hosting capacity
- Reduction of system losses through dynamic network sectionalization
- Implementing Conservation Voltage Reduction to significantly reduce energy consumed by customers

5. Leveraging the benefits of increased crossborder cooperation and connectivity

Challenge: The NAGZ project covers an important part of the Single Electricity Market (SEM), which is the wholesale electricity market operating on the island of Ireland. As a gross mandatory pool physical market operating with dual currencies and in two jurisdictions with no synchronous connection to another system, the SEM represents the first market of its kind in the world. This project focuses on increasing the physical number of cross-border interconnections, increasing the potential usage of the existing 110kV connections and further improving collaboration between the System Operators for the benefit of all customers.

Objective: Increasing cooperation between DSOs and TSOs is one of the major challenges facing EU Member States going forward. This action will contribute to cross-border electricity markets by increasing interconnection capacities and alleviating loop-flows through load-flow control. The promoters are determined to leverage the full operational benefit of a common, harmonized electricity market. The mechanisms and learning gained from exploiting this process will be emulated across the EU with the aim of delivering the Common Electricity Market.

Actions

To achieve these objectives, the following activities will be undertaken:

Active System Management

Operational systems will be developed towards a fully integrated Distribution Management System (DMS). The new DMS will utilize a technologi-

cally advanced architecture of network sensors and devices superimposed over full schematic electrical models of the MV, 38kV and 110kV systems to enable increased control and monitoring of the network. Network automation and smart fault passage indicators on all MV networks within the zone will play a crucial role in realizing an active system. Medium voltage arc suppression and single phase reclosing will ensure improved network continuity performance.

High Speed Communications Infrastructure

A high-speed, low-latency and reliable communications network will be delivered. This will be comprised of an optical fiber network deployed on the 38kV and 33kV networks to communicate with all 38kV and 33kV substations. In addition, an advanced 4th Generation (4G) wireless mobile field area network or polled radio solution will be deployed to connect down-line remote sensors and devices.

Network Development and Cross Border Interconnection

The 11kV system in Northern Ireland will connect to the 20kV system in Ireland through the installation of new transformer, substation and network infrastructure. This will promote more dynamic use of the interconnection between systems. Network conversion from 10kV to 20kV in Ireland will increase network capacity, reduce losses and provide superior security of supplies.



Figure 2. A Smart Grid Combines Electricity, IT and Communication Infrastructure

Benefits

Improved availability of broadband

Increased broadband availability with the fiber extension of this project would increase regional gross value added (GVA) and employment for the Republic of Ireland portion of this region. Irish census figures show that more than 55 percent of households in this region have broadband connections, however the speeds available to them are significantly below 10 Mbps given this is an extremely peripheral region. This is typical of rural Irish regions, which are lagging behind the required EU targets of:

- Access to broadband with speeds of 30 Mbps or above available to all citizens by 2020, and
- 50 percent of European households subscribed to services of 100 Mbps or higher by 2020.

However, the infrastructure provided by this project would revolutionize the reach and robustness of optical fiber into the region. An extremely conservative estimate of the resulting service improvement and competition would be a doubling of the regional broadband speeds available. This in itself would lead to a \notin 7m p.a. increase in the GVA of this region, \notin 4.19bn at present and an increase of 0.3 percent GVA due to the doubled broadband speed.

In addition, 10 percent of households in this region have internet connections which are not broadband speed. Should the increased availability of high speed broadband enable the use of web based services, this 10 percent is likely to at least take up the broadband service now available. This would lead to a \notin 40m p.a. increase in the regional GVA and an estimated 1,000 or more new jobs in a region with a population of 200,000.

Safety

The new system of fault location is significantly safer than the current system where MV arc suppression and fault passage indicators are not in place. A key aspect is that full reclosing on a fault for the purpose of locating it is no longer required and, in cases where pulsing of current is applied, network technicians have a relatively accurate awareness of the fault location. Thus, the situation is significantly more controlled and there is a far lower risk to the public. In addition, without remotely controlled overhead network switches, each switching operation required in the existing process (at least 2-4) would have required a technician to climb a pole and manually operate a switch. This has inherent risks involved, but is not necessary if remotely operated. Finally, as all network faults introduce inherent public safety risks, ranging from there being a fault site to risks

incurred when homes lose their electricity supply (loss of light, and loss of other systems required by the elderly or physically impaired, alarm systems included), the significant reduction in the length of outages and the complete elimination of widespread outages for earth faults will improve safety for all customers.

While public safety cannot be accurately quantified, the scale of its improvement can at least be indicated. In the year 2011, there were 2,192 faults on the networks in question, resulting in 147,125 customer interruptions and 183,802 customer hours lost. The impact of the continuity measures described above will be a reduction of 66.67 percent in the frequency of faults in customer hours lost due to fault outages. This means a reduction of 66.67 percent in the number of occasions where operators are required to locate and repair faults. Taking just 30 percent of faults to be earth faults, 351 fewer occasions where operators are required to make at least 2-4 pole climbs will be required, due to new fault location practices not requiring multiple pole climbs. Finally, through remotely controlled switches, in all cases of planned or fault outages, numbering 3,327 on the networks in guestion in 2011, pole climbing for manual switching will be reduced by at least 50 percent.

Public acceptance and environmental impact

The project's inherent efficiency, leveraging of existing physical infrastructures, and reducing the overall quantity of overhead electricity networks required in the region will bring significiant societal and environmental benefits. This is achieved through:

- Smart operations and monitoring allowing more effective use of the full capacity of existing networks.
- Variable access for wind generation and dynamic line ratings reducing the new build of electricity networks required for wind to be connected in the region.

 Cross-border interconnections at distribution level being made available as an option for reinforcements required either side of the border. This means that, in the cases of the proposed interconnections and all future reinforcements required both in this region and all border regions between Ireland and Northern Ireland, shorter line routes will be offered as potential reinforcement options.

This is particularly pertinent given the nature of the border region between Ireland and Northern Ireland. It is largely a rural region of natural scenic beauty, thus there can be objections to the construction of networks which would have a visual impact on the environment. That being the case, where technically and economically acceptable, it is preferable to construct the shortest possible reinforcement of networks. In treating the two distribution systems as isolated systems, without considering their interconnection, the shortest routes are potentially precluded.

The precedents set in delivering the project's interconnections will deliver value which cannot be quantified in the options which will be available to network planners for all reinforcements in the border regions in the future.

Benefits to the transmission and distribution systems

Applied across transmission and distribution systems, the full benefits will include:

- Integration of unprecedented levels of renewable generation, while maintaining the stability of the electricity system
- Increased variable access capacity for RES connections
- Enhanced network efficiency and delivery of energy reductions for all users
- Reduced losses and higher capacity networks
- Improved security of supply to all customers and users

- Increased cross-border connectivity and operational flexibility
- Delivery of significant economic and environmental savings

Economic benefit of improved electricity infrastructure

As previously stated, the region in question is peripheral and faces significant challenges in economic growth. Having seen significant loss of industry over the past decade, this is an area which continues to be a target for strategic infrastructural planning. It is vital to the region that robust infrastructures can be delivered in order to attract investment. In 2011, the Irish Department of Foreign Affairs published a document stating that "Both sides of the border in the North West share common problems:

- Relative peripherality.
- A lack of joined up action.
- Failure to capture synergies.
- An infrastructure deficit.
- High levels of economic inactivity and unemployment (in some cases intergenerational).
- A relatively low level of educational attainment.
- The legacy of economic and social problems from the Troubles."

And

"There are potential cross border solutions to the deficit in energy infrastructure in parts of the region." The North Atlantic Green Zone project directly addresses both the issues of joined up action and infrastructure deficits, while playing a very active role in mitigating the challenges of peripherality and economic inactivity. Targeted actions to stimulate economic development in the region undertaken by both IDA Ireland and Invest Northern Ireland focus on seeking inward investment from top-tier corporations and companies in Life Sciences (Pharmaceuticals, Biotechnology, Medical Technology), Financial Services and Information Communications Technologies (ICT), Entrepreneurship and Innovation. These are business sectors which rely heavily on both exceptionally robust and stable electricity infrastructure, and high speed, high capacity telecommunications links. At present, these resources need to be developed. In delivering the North Atlantic Green Zone, the region will have these vital infrastructures and an opportunity to take the action which truly proves to potential investors that commitment to this region will be reciprocated.

The three largest economic benefits are:

Reduced compensation costs for wind generation curtailment

The Transmission System Operator has determined that the level of wind generation being installed on the Irish electricity system, and its impact on the stability of an island system with no synchronous interconnection, will necessitate 25 percent of it to be curtailed if mitigating measures are not taken. However, the delivery of solutions addressing the frequency and voltage stability of the system as impacted by high penetrations of wind generation would result in the level of curtailment being reduced to just 6 percent.

Reduced outage times-value of lost load saved through continuity improvement

The project includes a number of initiatives which will drive down the level of outages, which is more than 220 percent the national average. The value of lost load of €10,749.08/MWh was provided by the Single Electricity Market, the common market on the island of Ireland.

Electricity savings to customer through conservation voltage reduction

Conservation voltage reduction has the capability to reduce annual consumption in the region by 2.4 percent per annum. This saving will be seen through reduced distribution tariffs in customers' bills.

A significant portion of the project's benefits will go to society rather than the project promoters. The NAGZ project will enable sustainable resource utilization and, at the same time, provide cheaper, more reliable electricity to the region. This regional innovation project is crucial in securing national competitiveness in an uncertain economic environment. In addition, competitiveness will be increased by promoting further integration of the internal energy market and improving the interoperability of electricity networks. Implementation of the technologies outlined above will enable greater usage of renewable energy resources. The region has one of the greatest wind resources in Europe, so facilitating these projects will ensure that the region continues to see strong growth and development.

About the author

John Byrne is the head of Smart Networks at ESB Networks Ltd. Since joining ESB, he has held a number of senior positions across the business managing the full spectrum of DSO activities, including roles in network design and construction, and as Regulation Manager. It is his responsibility to identify, demonstrate, and implement new and innovative technologies and solutions to transform the existing distribution networks into a pro-active Smart system, capable of integrating large penetrations of renewable generation, delivering clean and secure energy, adding value to our existing asset base and involving the customer in the management of their energy supply.

A significant aspect of John's role is securing national and EU funding to finance these R&D programs. He oversees a large number of national and international collaborations with both industry and academia to identify and exploit new commercial opportunities and confirm ESB Networks' and Ireland's position as a global leader in this innovative area.

He is a Chartered Engineer, and holds a diploma in Engineering from Dublin Institute of Technology and a B.Sc. (Eng) degree from Trinity College Dublin.

GFCC

The Global Competitiveness Principles

The GFCC developed a set of foundational Global Competitiveness Principles, supported by its network of more than 30 national competitiveness organizations and deemed essential for every country. First released in 2010 and finalized in 2012, these principles offer an overarching framework for national policies and programs aimed at fostering innovation, competitiveness and prosperity in the 21st century global economy. They emphasize key drivers of competitiveness such as investment in research and development, education and training for all citizens, sustainable and responsible development of natural resources, strong intellectual property rights, open trade and a stable, transparent, efficient and fair environment for business investment, formation and growth.

Pioneered by the GFCC, the Global Competitiveness Principles represent ideals that can serve as a beacon for economic progress around the world. They have been recognized as a best practice by other nations and emulated, for example, in the 10 General Competitiveness Principles of the Americas adopted by the Inter-American Competitiveness Network comprised of public and private institutions that promote competitiveness from the 34 OAS member countries. The GFCC Principles have also been referenced by organizations such as the World Economic Forum.

To ensure they remain current and relevant to the ever-evolving global economy, each year the Principles have been refined to reflect the changing global competitive landscape and to highlight new critical priorities, while keeping their foundational roots.

The Foundational Global Competitiveness Principles

- Ensure Fiscally Responsible, Transparent and Ethical Governance. National fiscal stability, discipline and certainty foster private sector and foreign direct investment, economic expansion, new business formation and job creation. Transparent regulations and tax rules enable market efficiency and reduce the cost of doing business. Government corruption reduces the productivity and performance improvements that come from fair and open competition.
- Fulfill Human Potential. All nations should educate and train their citizens without regard for gender, race, religion, age, ethnicity or economic status. Worker safety and international labor standards also are important underpinnings for individual and national success.
- Invest in Research Technology and Innovation. As the driving force of innovation, nations should increase investment in research and development, coupled with the domestic deployment of new technologies, to stimulate increased productivity, standards of living and leadership in global markets.
- Ignite Entrepreneurship. Supporting entrepreneurs—who are the source of new ideas, new products and services, new companies and new industries—is essential to economic vitality and improving productivity, competitiveness and economic performance.

- Improve Infrastructure. Investment in a modern, well-maintained resilient infrastructure—transportation, energy, digital networks and telecommunications—is critical to encourage domestic and foreign investment, support modern commerce and grow an economy. Cybersecurity is essential to the performance and safety of all economic activity, consumer access to the marketplace and personal privacy protection.
- Establish Public-Private Partnerships. Collaboration between the public and private sectors is essential to drive innovation, economic growth and job creation. Private sector leadership is vital in developing national policy initiatives to address short- and long-term competitiveness challenges and opportunities.
- Foster Regional and Metropolitan Centers of Innovation. Regional clusters and metropolitan areas connect talent with science, technology, manufacturing and service resources, fostering the creativity, idea generation and innovation that drive competitiveness.
- Encourage Sustainable Growth. Sustainable growth and responsible development through increased natural resource productivity, energy efficiency, and access to or development of critical materials will foster innovation, increase standards of living, help ensure food security and access to clean water, improve health and enhance national security.

- **Protect Intellectual Property.** Strong intellectual property rights are a prerequisite to attract high-value investment and innovation in new technology, new product development and creative works such as software and entertainment.
- Expand Access to Global Market Opportunities. Open and transparent markets expand global trade and investment, and drive economic growth around the world. Protectionist policies hinder innovation, growth and business performance. Well-defined international standards are essential to facilitate global commerce.

Driving Regional Competitiveness to Bolster National Prosperity

Release of the Global Competitiveness Principles is a highlight of the Global Innovation Summit and Annual Meeting of the GFCC. This year, the theme of the Global Innovation Summit and GFCC Annual Meeting is Regional Competitiveness—how regions can strengthen and leverage their competitive assets to spur economic growth and development.

In recognition of the economic opportunities that can be brought about by thinking, planning and acting regionally, the GFCC is releasing a special edition Global Competitiveness Principles—Driving Regional Competitiveness to Bolster National Prosperity. This special edition focuses the foundational principles through the lens of regional competitiveness for example:

- Optimizing a region's education and training resources to increase its human capital and broaden access to learning;
- The importance of modern regional infrastructure for business productivity and attracting business investment;
- Connecting regional R&D assets to a region's entrepreneurs and businesses; and
- The role of regional leadership in strengthening and leveraging a region's competitive assets.

Strengthen Regional Competitive Assets.

Strengthening a region's human capital, research and development, financial capital, infrastructure, institutions, and intangibles creates more regional economic opportunity, and helps all businesses and workers in a region compete.

Enable Business Competition. Robust business competition is essential for innovation, market efficiency, and fueling the economic vitality and productivity that raise standards of living and enable business to give back to the communities in which they operate.

Leverage Regional Competitive Assets. Ecosystems and networks that knit a region's diverse competitive assets together to seize economic opportunities drive innovation, sustained economic development, and regional competitiveness. Regional leadership organizations can catalyze efforts to expand and strengthen a region's ecosystems and networks to better leverage its competitive assets. **Foster Regional Fiscal Responsibility.** Fiscal stability in a region encourages private sector investment, economic expansion, new business formation, job creation, and talent attraction and retention. Rational and transparent regulations and tax rules across a region enable market efficiency and reduce the cost of doing business. Excessive levels of government debt and deficit drag down a regional economy and crowd out economically stimulating investments.

Optimize a Region's Education and Training Resources. Develop human capital through education and training—regardless of citizens' gender, race, religion, age, ethnicity, or economic status. Optimizing a region's education and training assets helps achieve this goal by reducing barriers to education and skill attainment, broadening access to education and training resources, and increasing options for learners.

Stimulate Regional Research and Innovation. As the driving force of innovation, regions should nurture research and development, connect R&D to business opportunities, and encourage deployment of new technologies to stimulate productivity, foster regional prosperity, and improve regional competitiveness in global markets.

Nurture Entrepreneurship. Supporting a region's entrepreneurs—the source of new ideas, new products and services, new companies, and new industries—is essential to regional economic vitality, and for improving productivity, competitiveness, and economic performance.

Invest in Regional Infrastructure. Modern, well-maintained infrastructure supports economic growth, enhances a region's attractiveness for business investment and talent recruitment, makes regional commerce more efficient and businesses more productive, and raises the quality of work life.

Foster Sustainable Development. Sustainable regional economic development can be advanced through environmental and natural resource stewardship, energy efficiency, and adoption of cost-effective sustainable building, energy, infrastructure, and manufacturing innovations.

Establish a Stable Environment and Reduce Uncertainty. Political instability and regional unrest disrupt economic activity, deter economic development, and damage a region's competitiveness. Policy, legislative, regulatory, and financial uncertainty discourages investment, raises business risk, and dampens regional business formation and expansion needed to create jobs.

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The Global Federation of Competitiveness Councils (GFCC) is a network of leaders from competitiveness organizations around the world. The GFCC believes that acting globally is now a prerequisite to economic competitiveness nationally.

For more information, please visit www.thegfcc.org.

